
**24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT
189-197 DUCKWORTH STREET
CITY OF BARRIE**



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1.0 INTRODUCTION

1.1 General

The proposed development site is located on lots 189-197 Duckworth Street, at the north-east corner of the Duckworth Street and Mountbatten Road intersection. The property is legally described as Lots 4, 5, and 6 and Part of Lot 7, Registered Plan 1104 in the City of Barrie, County of Simcoe.

The subject site is approximately 0.293 hectares in area and is currently occupied by four (4) single-family residential homes. Access to the site is provided directly from Duckworth Street by four (4) separate asphalt driveways. The site is bounded by existing residential development to the north and east, Mountbatten Road to the south, and Duckworth Street to the west. The location of the subject site is illustrated on Figure 1.

The developer is proposing construction of a 3-storey block of stacked townhouse units, totaling 24 residential units. Access to the development will be provided from Mountbatten Road and parking will be provided via surface parking facility. A reduced copy of the proposed site plan concept and parking lot layout plan prepared by CLA for the purposes of the rezoning application is included in Appendix A for additional information.

1.2 Purpose and Scope

Pinestone Engineering Ltd. (PEL) has been retained by the developer to provide professional engineering services related to the preparation of a Functional Servicing Report (FSR). This report has been prepared to support a Rezoning Application for the subject lands. The purpose of this report is to describe the existing servicing infrastructure in the vicinity of the site, and provide recommendations for the provision of sanitary drainage, water distribution, and storm water management in accordance with City of Barrie criteria.

2.0 EXISTING CONDITIONS

2.1 General

The subject site is approximately 0.293 hectares in area and is currently occupied by four (4) single-family residential homes. Access to the site is provided directly from Duckworth Street by four (4) separate asphalt driveways. The site is located within the City's urban servicing area and municipal services are readily available for connection. Existing vegetation on the site generally consists of maintained grass area throughout, with sporadic tree growth along the peripheral of the property.

2.2 Topography

Based on a review of the topographic survey provided by Joe TOPO Surveying, the property is relatively flat and generally slopes southwesterly towards the intersection of Duckworth Street and Mountbatten Road and the adjacent residential property at an average slope of

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1.0%. Elevations across the site range between 275.54m ASL at the northeast corner of the site to 273.30m ASL at the southwest corner.

2.3 Site Geology

A geotechnical investigation was completed by Cambium Inc. in October 2020. Field work for this investigation consisted of three boreholes advanced approximately 3.1 – 4.7m deep. Based on our review of their report, the borehole logs reveal topsoil was encountered over a deep layer of silty sand with traces of gravel and clay. Groundwater was not evident in the boreholes during the investigation and the monitoring wells were recorded as dry on October 15th, 2020. On October 19th, 2023, monitoring wells within BH101 and BH103 were recorded as dry while groundwater was recorded at 4.33m below the ground surface within BH102.

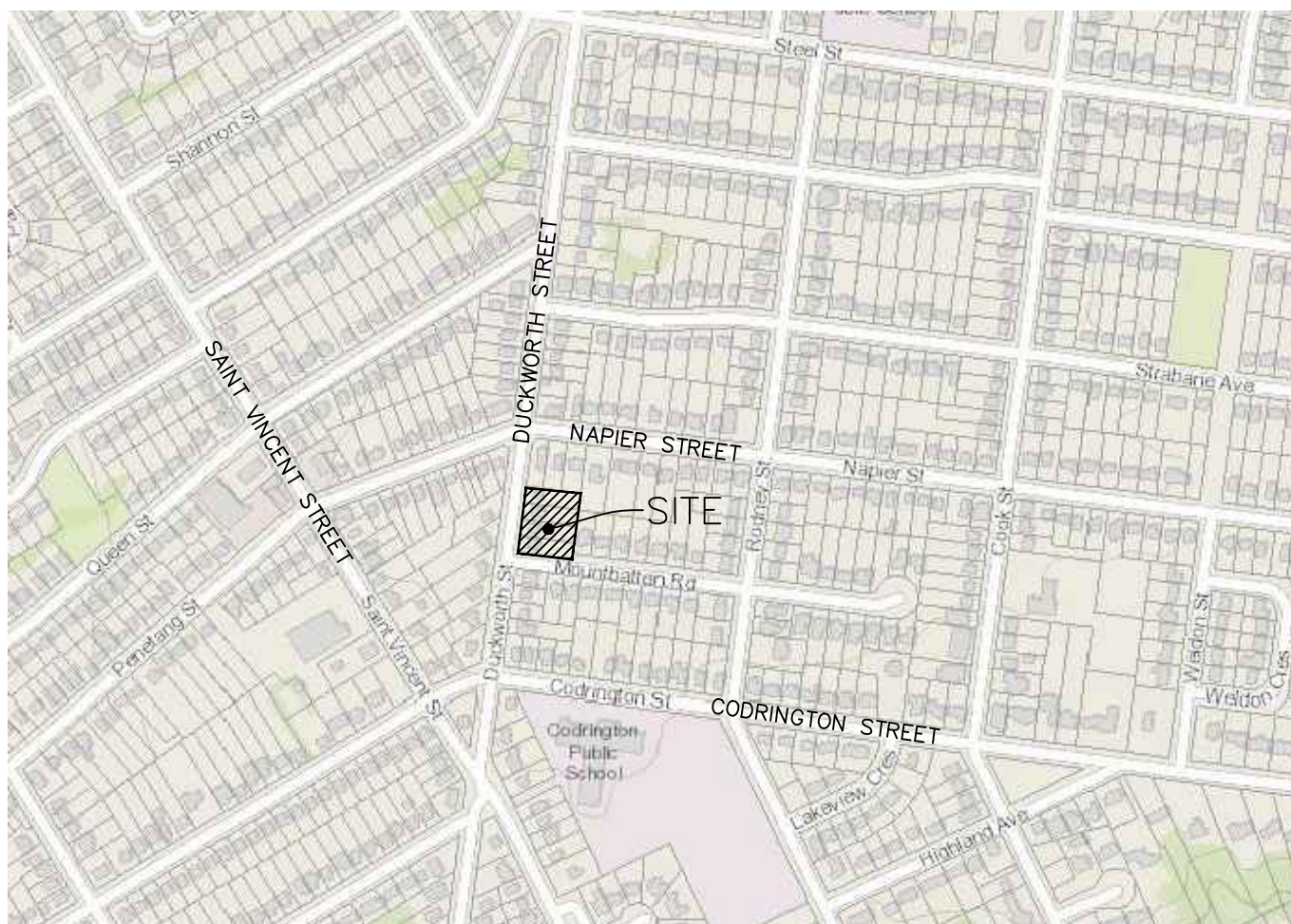
Based on our review of the soil descriptions outlined in the MTO Drainage Manual on Chart 1.08, we have classified the site material as a Type B under the Soil Conservation Service, hydrologic soil group.

Excerpts from the Geotechnical Investigation Report, prepared by Cambium Inc. dated October 31st, 2023, and Chart 1.08 of the MTO Drainage Manual is included in Appendix B.

2.4 Drainage Conditions

Drainage from the site is generally conveyed southwest in the form of overland sheet flow towards the existing 375mm dia. concrete storm sewer underneath Duckworth Street and Mountbatten Road. Flows are conveyed southeast and ultimately discharge to Kempenfelt Bay.

The site is not located within an LSRCA regulated area based on available mapping on their website, however, the site is considered a “major development” as defined in the Lake Simcoe Protection Plan, therefore stormwater phosphorus control measures are required in accordance with the LSRCA Phosphorus Offsetting Policy (2023), and a water balance analysis is required in accordance with the LSRCA Water Balance Recharge Offsetting Policy (2023).



**PROPOSED STACKED TOWNHOUSE DEVELOPMENT
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LOCATION PLAN

DATE: OCT. 2023	SCALE: N.T.S.	PROJECT No. 20-11545B	FIGURE No. FIGURE 1
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3.0 SANITARY SERVICING

3.1 Existing Sanitary Servicing

An existing 250mm diameter sanitary sewer exists along Duckworth Street and conveys sewage southerly to City Pumping Station 17 located on Kempenfelt Drive. A 250mm diameter sanitary sewer also exists underneath Mountbatten Road and conveys sewage easterly and ultimately discharges to City Pumping Station 17.

Based on our review of the existing wastewater collection performance assessments completed by Cole Engineering in the Wastewater Collection Master Plan, under 2019 wet weather flow conditions for the 25-year storm event, the downstream sewers maintain a peak conduit depth ratio of less than 0.5 and a freeboard of greater than 1.8m. Therefore, no surcharging of downstream sanitary sewers from the subject site were noted.

The development area is currently serviced with four (4) 100mm diameter sanitary laterals to each of the existing homes. As part of the development works, the existing sanitary laterals will be decommissioned per City of Barrie standards.

3.2 Proposed Sanitary Flows

Contributing sanitary flows from the proposed development were calculated using design criteria for medium density dwellings per the City of Barrie Sanitary Infrastructure Design Standard (2023), as follows:

- A residential average sewage flow of 225 litres/capita/day.
- A residential population density of 2.34 persons/unit.
- An extraneous flow rate of 0.1 litres/sec/ha.
- A peaking factor based on Harmon's equation.

With a total residential count of 24 townhouse units, the total population to be serviced is 56 persons based on the above distribution. Incorporating extraneous flows, the combined peak sewage flow generated by the proposed development is calculated to be approximately 0.66 L/sec. Detailed sanitary calculations are included in Appendix C.

A review of the existing capacity of the immediate downstream reach of 250mm sanitary sewer underneath Mountbatten Road was completed. The existing reach of sewer has a conveyance capacity of approximately 59 L/sec and the proposed peak sanitary flows from the development represents approximately 1.1% of the total pipe capacity.

Based on the total conveyance capacity of the immediate downstream reach of sewer, the existing infrastructure is expected to have the available capacity necessary to support the development without the need for external sanitary upgrades.

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3.3 Proposed Sanitary Servicing

The proposed development will be serviced by a new connection to existing sanitary manhole SAL08303. A new 200mm diameter service will extend to a new manhole at property line for inspection and maintenance purposes and up the proposed parking lot to service the townhouses. The stacked townhouses will be serviced by individual 125mm dia. laterals off the 200mm dia. sanitary sewer. Servicing details will conform to City of Barrie standards and the exact size and locations of the service laterals will be determined during detailed design to support the Site Plan Application.

A conceptual servicing layout is provided on the attached drawings included in Appendix E.

4.0 WATER SERVICING

4.1 Existing Water Servicing

A 300mm diameter watermain exists underneath the west side of Duckworth Street and reduces to a 150mm diameter watermain that runs underneath the north side of Mountbatten Road. The site is currently serviced by four (4) 25mm diameter water service connections to each of the residential homes. These services will require decommissioning by turning off the main stop and cutting the service at the main.

For the proposed zoning amendment, onsite pressures and flows have been confirmed to ensure there is sufficient capacity available for both domestic and firefighting conditions.

We have utilized information obtained from the municipal hydrants in the vicinity of the subject site connected to the existing 300mm diameter watermain from the intersection of Duckworth Street and Napier Street, to the intersection of Duckworth Street and Mountbatten Road. Table 1 illustrates the flow results of the testing conducted by Vipond on September 22nd, 2020.

Table 1
Results of Hydrant Flow Tests

Test #	Outlet Inside Dia. (in.)	Number of Outlets	Residual Reading (PSI)	Flow@ Residual (gal/min)
1	n/a	n/a	70 (static)	n/a
2	1.75	1	68	678
3	2.5	1	64	939
4	2.5	2	55	1582

Based on the above information, the estimated available flowrate from the municipal hydrants at a minimum operating pressure of 20psi is 190.6L/sec.

Refer to Appendix C for the flow testing information obtained from Vipond.

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4.2 Proposed Water Demands

The subject site is located within Water Pressure Zone 2N. As per the City of Barrie Water Supply Masterplan (WSP, July 2019) domestic water demand for the development is listed in Table 2 below. Domestic water demand calculation parameters are as follows:

- Max day factor of 1.8 per Table 3.5 of the Water Supply Masterplan, and peak hour factor of 2.62 based on Table 3-1 of the MECP Design Guidelines for Drinking Water Systems (2008).
- Medium Density Townhouse Dwellings – 2.34 persons per unit (City of Barrie Drinking Water Infrastructure Design Standard, 2023).
- Residential water demand of 162 L/cap/day per Table 3.5 of the Water Supply Masterplan.

**Table 2
Domestic Water Demand**

Population	Residential Consumption (L/sec)	Peaking Factors		Domestic Flows (L/sec)	
		Peak Hour	Maximum Day	Peak Hour	Maximum Day
56	0.105	2.62	1.8	0.28	0.19

Fire demands for the proposed development were calculated in accordance with the Fire Underwriters Survey (FUS) as follows:

$$RFF = 220C(A)^{0.5}$$

Where,

RFF = the required fire flow in litres per minute.

C = coefficient related to the type of construction.

A = total floor area of building (excluding basements)

**Table 3
Water Requirements for Fire Fighting**

Total Area (m ²)	Construction Coefficient "C"	Base Required Fire Flow (RFF) (L/min)	Occupancy and Contents Adjustment Factor	Automatic Sprinkler Protection Credit	Exposure Adjustment Charge	Design Required Fire Flow (RFF)
2,000	1.0	10,000	-15% (-1,500L/min)	---	+15% (+1,275L/min)	10,000L/min (167L/sec)

Based on the guidance provided in the FUS and applying the relevant reductions and charges in flow for construction type (Type III), occupancy (Group C), and exposure distances, the estimated required fire flowrate for the development is 10,000L/min (167L/sec). As the calculated FUS fire flowrate is larger than the minimum required fire

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flowrate of 155L/sec from section 4.3.1 of the Drinking Water Infrastructure Design Standard, the FUS fire flowrate will be used for this analysis. Detailed FUS calculations are provided in Appendix C.

4.3 Proposed Water Servicing

Domestic water servicing for the proposed development will be provided by a new service connection to the existing 300mm dia. PVC watermain beneath Duckworth Street. A new 50mm dia. HDPE Series 160 water service will extend off the existing watermain to the building's water meter room. A 50mm dia. curb stop valve and box will be installed at property line. Servicing details will conform to City of Barrie standards and the exact size and location of the water service will be determined during detailed design to support the Site Plan Application.

Existing hydrants (H3980 and H4093) in the vicinity of the site within the Mountbatten Road ROW and Duckworth Street ROW will provide water supply for firefighting. Based on the findings above, the minimum available flowrate of 190.6L/sec from the municipal hydrants is greater than the required FUS fire flowrate of 167L/sec for the site.

Based on the provided flow test results, it is concluded that the max day plus fire flow rate of 167.19L/sec can be delivered to the proposed building from the existing municipal hydrants with a residual pressure of 31.0psi. Fire flowrate calculations are included in Appendix C. A conceptual servicing layout is provided on the drawings included in Appendix E.

5.0 HYDROLOGY

5.1 Design Criteria

Based on a review of the City of Barrie's Stormwater Infrastructure Design Standard (June, 2023) and the LSRCA's Technical Guidelines for Stormwater Management Submissions (April, 2022), the following design criteria, in accordance with the current MECP SWM Planning and Design Manual (MECP, 2003) were established for the proposed development:

Quantity Control:

- Peak flow attenuation for the 2-year through 100-year storm events to allowable release rates using the City of Barrie's WPCC IDF parameters.
- Both the 4-hour Chicago and 24-hour SCS Type II storms must be modelled for the specified storm events.
- Safe conveyance of the regulatory flows through the site to a sufficient outlet is required. The regulatory storm for developments within the Barrie Creeks watershed is the Hurricane Hazel Flood Event Standard in accordance with Ontario Regulation 179/06.

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Quality Control:

- The City of Barrie and the LSRCA in accordance with Ontario Regulation 219/09 regarding water quality and phosphorus loading to Lake Simcoe, requires that all new storm water management facilities provide as a minimum the “enhanced” level of protection in accordance with the MECP Storm Water Management Planning and Design Manual (MECP, 2003).
- Preparation of phosphorus and water balance calculations to meet City of Barrie and LSRCA requirements and the Lake Simcoe Protection Plan.
- Preparation of detailed erosion, sediment control and construction mitigation plan to be implemented as part of the construction program.

5.2 Design Storms

We have selected the following design storms as part of our evaluation:

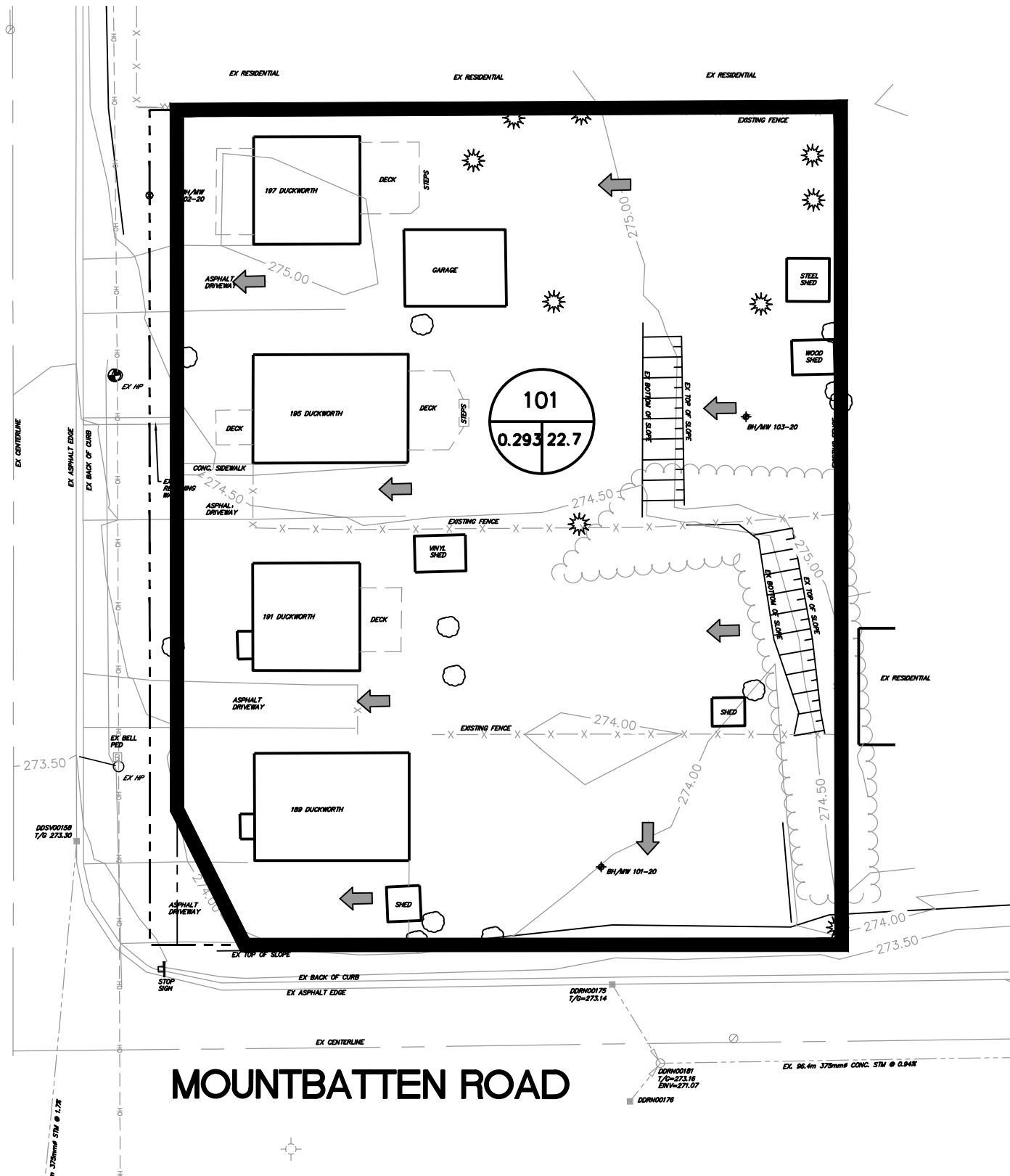
- 2-year design storm
- 5-year design storm
- 10-year design storm
- 25-year design storm
- 50-year design storm
- 100-year design storm
- Hurricane Hazel

The rainfall runoff event simulation model Visual OTTHYMO was used to simulate watershed response to design rainfall events. Derivation of the design storm hyetographs were based on the 24-hour SCS Type II storms, the 4-hr Chicago design storms, and the Hurricane Hazel storm event. STM files for the applicable design storms are provided from the City of Barrie website.

5.3 Drainage Catchments

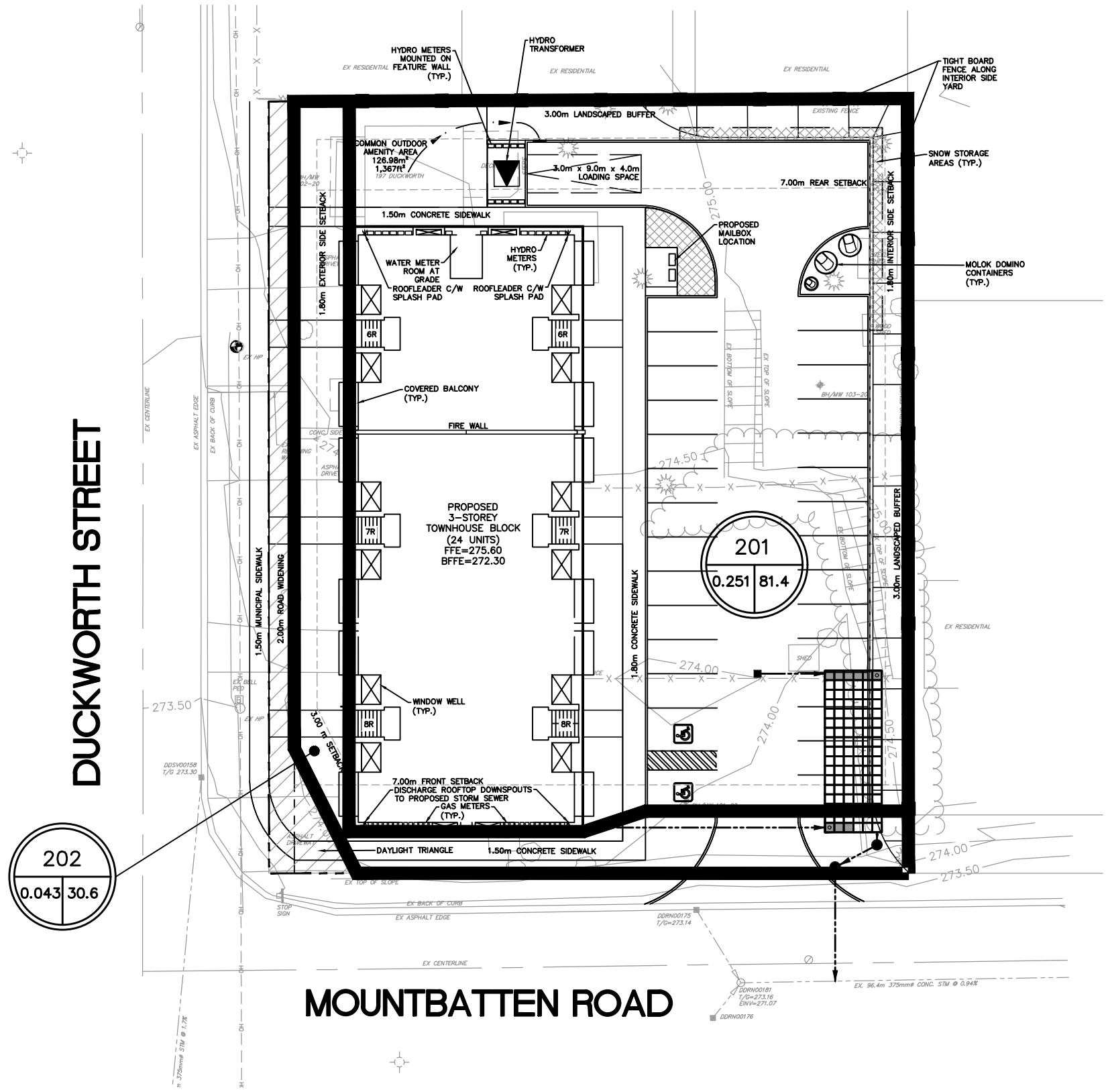
One (1) pre-development and two (2) post-development catchments have been delineated for the site in order to estimate the corresponding peak runoff rates for the site. The pre-development catchment area represents the existing condition of the proposed development area, which consists of single-family dwellings, paved driveways, and landscape area. The post-development catchments represent the proposed development consisting of a block of stacked townhouses, a paved parking lot, and landscape area. The pre-development and post-development catchment parameters are listed in Table 4. Pre-development and post-development catchment areas are illustrated on Figure 2 and Figure 3.

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LEGEND

- PRE-DEVELOPMENT RURAL/LANDSCAPE CATCHMENT NUMBER
- PRE-DEVELOPMENT URBAN CATCHMENT NUMBER
- PRE-DEVELOPMENT IMPERVIOUS AREA (%)
- PRE-DEVELOPMENT CATCHMENT AREA (ha.)
- DIRECTION OF OVERLAND FLOW
- PRE-DEVELOPMENT CATCHMENT BOUNDARY



LEGEND

- DIRECTION OF MAJOR OVERLAND FLOW
- POST-DEVELOPMENT CATCHMENT BOUNDARY
- POST-DEVELOPMENT RURAL/LANDSCAPE CATCHMENT NUMBER
- POST-DEVELOPMENT RUN-OFF COEFFICIENT
- POST-DEVELOPMENT CATCHMENT AREA (ha.)
- POST-DEVELOPMENT URBAN CATCHMENT NUMBER
- POST-DEVELOPMENT IMPERVIOUS AREA (%)
- POST-DEVELOPMENT CATCHMENT AREA (ha.)



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POST-DEVELOPMENT CATCHMENT PLAN

PROJECT NO. 20-11545B	
SCALE: 1:400	DATE: OCT. 2023
FIGURE 3	

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**Table 4
Catchment Parameters**

Catchments	Area (ha)	Total Impervious (%)	Directly Connected Imperviousness (%)	Weighted Pervious Initial Abstraction Storage (mm)	Weighted Pervious SCS Curve #
101	0.293	22.7	16.6	5.0	60
201	0.2505	81.4	81.4	5.0	60
202	0.0425	30.6	18.4	5.0	60

5.4 Model Results

The results of the hydrologic modelling are displayed in Tables 5 and 6 below for the Hurricane Hazel storm event, and the 2-year to 100-year return frequency storm events for the 4hr Chicago distribution, and the 24hr SCS Type II distribution. The model outputs for all events are included in Appendix D.

**Table 5
Model Results - 4hr Chicago Distributions**

	2Yr	5Yr	10Yr	25Yr	50Yr	100Yr
PRE-DEVELOPMENT (m³/sec)						
Catchment 101	0.015	0.021	0.024	0.029	0.033	0.039
Total Pre-Development Runoff Rate	0.015	0.021	0.024	0.029	0.033	0.039
POST-DEVELOPMENT (m³/sec)						
Catchment 201	0.066	0.087	0.101	0.119	0.132	0.146
Catchment 202	0.003	0.005	0.006	0.008	0.010	0.011
Total Post-Development Runoff Rate	0.069	0.092	0.108	0.128	0.142	0.157

**Table 6
Model Results - 24hr SCS Type II and Hurricane Hazel Regional Storm Distributions**

	2Yr	5Yr	10Yr	25Yr	50Yr	100Yr	Hazel
PRE-DEVELOPMENT (m³/sec)							
Catchment 101	0.011	0.020	0.030	0.039	0.047	0.055	0.039
Total Pre-Development Runoff Rate	0.011	0.020	0.030	0.039	0.047	0.055	0.039
POST-DEVELOPMENT (m³/sec)							
Catchment 201	0.041	0.059	0.070	0.085	0.097	0.107	0.036
Catchment 202	0.003	0.006	0.007	0.009	0.011	0.013	0.006
Total Post-Development Runoff Rate	0.044	0.064	0.078	0.094	0.108	0.120	0.042

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Based on the results of the hydrological modelling, without mitigation, an increase in stormwater runoff rates can be expected during all storm events. Visual OTTHYMO modelling files are included in Appendix D.

6.0 STORM WATER MANAGEMENT PLAN

6.1 Quantity Control

As noted in the comparison of the pre-development and post-development flows, an increase in runoff will occur due to the proposed construction of the building and paved surfaces. To satisfy the selected design criteria, peak flow attenuation of post-development flows to pre-development levels for all storm events up to and including the 100-year storm event will be provided by directing roof drainage and driveway runoff to a stormwater management facility consisting of parking lot surface ponding and subsurface infiltration tanks located beneath the parking level.

Drainage generated from catchment 201 (building, hard surfaces, and landscape) will be directed to a private onsite storm sewer system installed beneath the parking lot. Stormwater will be attenuated within a subsurface infiltration system (Geoplast Aquabox HP system or equivalent), with additional attenuation storage provided in a surface cell created within the asphalt parking lot. Peak flowrates will be controlled using an orifice plate/tube installed on the outlet pipe from STMMH#1. The maximum ponding elevation during the 100-year storm event will be limited to 0.3m above the parking lot surface. Attenuated flows will outlet through a hydrodynamic separator for treatment, prior to discharging offsite via a storm sewer connection to the existing 375mm dia. storm sewer beneath Mountbatten Road. Major overland flow from catchment 201 will surcharge the grate of CB#1 and overflow to the Mountbatten Road ROW once ponding levels exceed the driveway grade. The subsurface infiltration system will also be equipped with observation ports for inspection and maintenance.

According to the results of VO modelling of the property during the 100-year storm event, the development yields a total runoff volume of 215m³ (2930m² * 0.073m) and 337m³ (2930m² * 0.121m) in the pre-development and post-development condition, respectively. The resulting approximate storage volume required for attenuation is 122m³. Additional extended detention storage will be provided by a 34m³ surface storage cell in the asphalt parking lot and 88m³ of subsurface tank storage within a Geoplast Aquabox HP system. Thus, it is anticipated that there will be sufficient extended-detention storage available to attenuate post-development runoff flows to pre-development levels.

Drainage generated from catchment 202, which includes perimeter landscape area, sidewalk frontages onto Duckworth Street, and the driveway entrance, will continue to drain offsite uncontrolled like pre-development conditions.

Further hydrological modelling, and design sheets including the stage-storage-discharge relationship of the proposed stormwater management facility, and control sizing for the orifice will be provided at the detailed design to support the Site Plan Application. The

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location of the stormwater management facility and further design details are illustrated on the conceptual drawings included in Appendix E (envelope at the rear of this report).

6.2 Quality Control

The primary objective of the stormwater management plan for this development is to maintain acceptable water quality within the receiving storm sewer network and ultimate outfall, Kempenfelt Bay, by maintaining existing site drainage patterns and flowrates. In order to provide water quality enhancement to an “enhanced” level of protection (80% TSS removal) for this development, we have incorporated a “treatment train” approach consisting of the following elements:

- Provision of “soft” landscaping where feasible.
- Yard grading using minimal surface slopes where possible to promote infiltration.
- Construction of a subsurface infiltration system (Geoplast Aquabox HP or equivalent) to service catchment 201. Runoff detained in the system is filtered through the debris row and underlying stone reservoir prior to discharging through a hydrodynamic separator to the existing municipal storm sewer beneath Mountbatten Road. According to the LSRCA LID-TTT manual, infiltration chamber systems are credited with 75% TSS removal.
- Provision of a hydrodynamic separator (Hydroworks Hydrostorm or equivalent) for oil and sediment removal. The Hydrodynamic Separator Sizing Program, by Hydroworks, will be utilized to design the appropriate treatment unit to achieve 80% TSS removal for catchment 201. A design report utilizing the manufacturer’s software, and a copy of the operation and maintenance manual, will be included in the next submission for the Site Plan Application.
- Suitable construction mitigation measures to be utilized during the site development.

6.3 Water Budget

As per City policy 4.1.3 of the Stormwater Infrastructure Design Standards, sites less than 5 ha shall minimize any anticipated changes in the water balance between pre-development and post development conditions and shall provide a minimum infiltration equivalent to the first 5mm of rainfall. Based on a total development area of 2,930m², the first 5mm of rainfall to be retained on the site for infiltration equates to 14.7m³. Initial abstraction values provided in Table 7.5 of the City’s Stormwater Infrastructure Design Standards are as follows:

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**Table 7
Initial Abstraction Values**

Cover	Initial Abstraction / Depression Storage (mm)
Woods	10
Meadow	8
Cultivated	7
Lawns	5
Impervious Areas	2

Adapted from UNESCO, Manual on Drainage in Urbanized Areas, 1987

Using the values provided in Table 7 above, the subject property yields an overall initial abstraction value of 2.78mm, therefore, approximately 8.1m³ of rainfall will be retained on the site through initial abstraction in the post-development condition. A water balance deficit of 6.6m³ exists in the post-development condition.

Based on a review of the geotechnical report prepared for the site, and the infiltration techniques outlined in the MECP SWMPD Manual (2003) and the TRCA LID Stormwater Management Planning and Design Guide (2010), infiltration measures are suitable for the site given the soils condition and development-built form. The proposed subsurface infiltration system between CB#1 and STMMH#1 will provide the additional 6.6m³ of storage required to meet the water balance requirement of the City of Barrie. Detailed design calculations for the infiltration system will be provided at the detailed design stage to support the Site Plan Application.

A water balance analysis was conducted by Cambium Inc. in accordance with the LSRCA Technical Guidelines and the Water Balance Recharge Offsetting Policy. The analysis follows the Thornthwaite and Mather approach, where surplus is estimated based on precipitation minus evapotranspiration (Steenhuis and Van Der Molen, 1986). The precipitation, temperature, and evaporation data for the site were obtained from the Environment Canada 1981-2010 climate normal of the Barrie Water Pollution Control Centre (WPCC) station. In the pre-development and post-development conditions, the site was broken down into rooftop, pavement, and landscape land uses. A copy of the results of the annual pre-development and post-development water balance from the Cambium Hydrogeological Report is provided in Appendix B and summarized below.

**Table 8
Water Balance Summary**

Characteristic	Site	
	Pre-Development	Post-Development
Precipitation (m ³ /yr)	2,734	2,734
Evapotranspiration (m ³ /yr)	1,175	571
Infiltration (m ³ /yr)	538	178
Runoff (m ³ /yr)	1,021	1,984

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Based on the results of the water balance analysis, the site yields an infiltration rate of 538m³/year in the pre-development condition and 178m³/year in the post-development condition, resulting in a water balance deficit of 360m³/year.

To mitigate the water balance deficit, as a result of the proposed building and hard surfaces, rooftop runoff and pavement drainage will be conveyed to low-impact development measures including a subsurface infiltration system (Geoplast Aquabox HP or equivalent). These infiltration devices will be sized in accordance with design criteria stipulated in the TRCA LID Stormwater Management Planning and Design Guide and the MECP SWMPD Manual. Other design features will include maintaining minimum building setbacks, providing 1.0m of separation from the seasonally high groundwater table, and inclusion of a high-flow bypass during major storm events. LID sizing sheets and a detailed water balance assessment (with stormwater management measures implemented) will be provided at the detailed design stage for the site plan application.

6.4 Phosphorus Budget

According to the LSRCA Phosphorus Offsetting Policy, all new developments must control phosphorus loading in the post-development scenario to pre-development levels. In addition, any “major development” should strive to achieve an 80% removal of annual Total Phosphorus (TP) load in accordance with section 2.3.2 of the LSRCA Technical Guidelines.

To mitigate the increase in phosphorus loading in the post-development condition, the stormwater management strategy will include the integration of LID measures and a hydrodynamic separator.

Hydrodynamic separators have some total phosphorus removal benefit. Sediment particles in captured runoff containing concentrations of total phosphorus are screened and settled-out in the lower chambers of the separator. According to the LSRCA Technical Guidelines for Stormwater Management Submissions, OGS units that are ETV verified will now be credited with a 20% total phosphorus removal efficiency. Thus, the proposed Hydroworks Hydrostorm (or equivalent) will provide 20% TP removal from runoff generated in catchment 201.

Phosphorus removal will also be provided by conveying rooftop and pavement runoff to a subsurface infiltration system. According to Table 3 of the Phosphorus Budget Tool Version 2 Report, prepared by Hutchinson Environmental Sciences Ltd. (2012), soakaways/infiltration trenches are credited with a 60% TP removal efficiency.

A pre-development and post-development phosphorus loading assessment will be conducted at the detailed design stage for the site plan application.

7.0 SUMMARY AND CONCLUSIONS

The findings of this report are summarized as follows:

- The existing 250mm diameter gravity sewer beneath Mountbatten Road has the capacity to

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24-UNIT STACKED TOWNHOUSE DEVELOPMENT

FUNCTIONAL SERVICING REPORT

service the proposed development. The existing 100mm dia. sanitary service laterals will be decommissioned in accordance with City of Barrie standards.

- The max day plus fire flow rate of 167.19L/sec can be delivered to the proposed building from the existing watermain beneath Duckworth Street and Mountbatten Road with a residual pressure of 31.0psi. All existing 25mm dia. water services will be decommissioned in accordance with City of Barrie standards.
- This site is considered a “major development” as defined in the Lake Simcoe Protection Plan; therefore, stormwater phosphorus control measures are required in accordance with the LSRCA Phosphorus Offsetting Policy (2023), and a water balance analysis is required in accordance with the LSRCA Water Balance Recharge Offsetting Policy (2023).
- Attenuation of peak post-development flowrates to pre-development levels will be provided by utilizing parking lot surface ponding and low-impact development measures including a subsurface infiltration system.
- Quality control for the development will be provided by the installation of a hydrodynamic separator and infiltration-based, low-impact development measures to treat rooftop and pavement runoff.

It is therefore recommended that:

- 1) This report and drawings be submitted to the City of Barrie and LSRCA for review and approval.

We trust this is satisfactory and should you have any questions, please call.

All of which is respectfully submitted by,

PINESTONE ENGINEERING LTD.



Dwight Hordyk, P.Eng.
Project Engineer

**189-197 DUCKWORTH STREET – CITY OF BARRIE
24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT**

APPENDIX A

Proposed Site Plan Concept

**189-197 DUCKWORTH STREET – CITY OF BARRIE
24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT**

APPENDIX B

Cambium Report Excerpts

**GEOTECHNICAL
INVESTIGATION**
CYGNUS DEVELOPMENTS
189 - 197 Duckworth Street,
Barrie, Ontario

LEGEND

-  Monitoring Well
 Site (approximate)

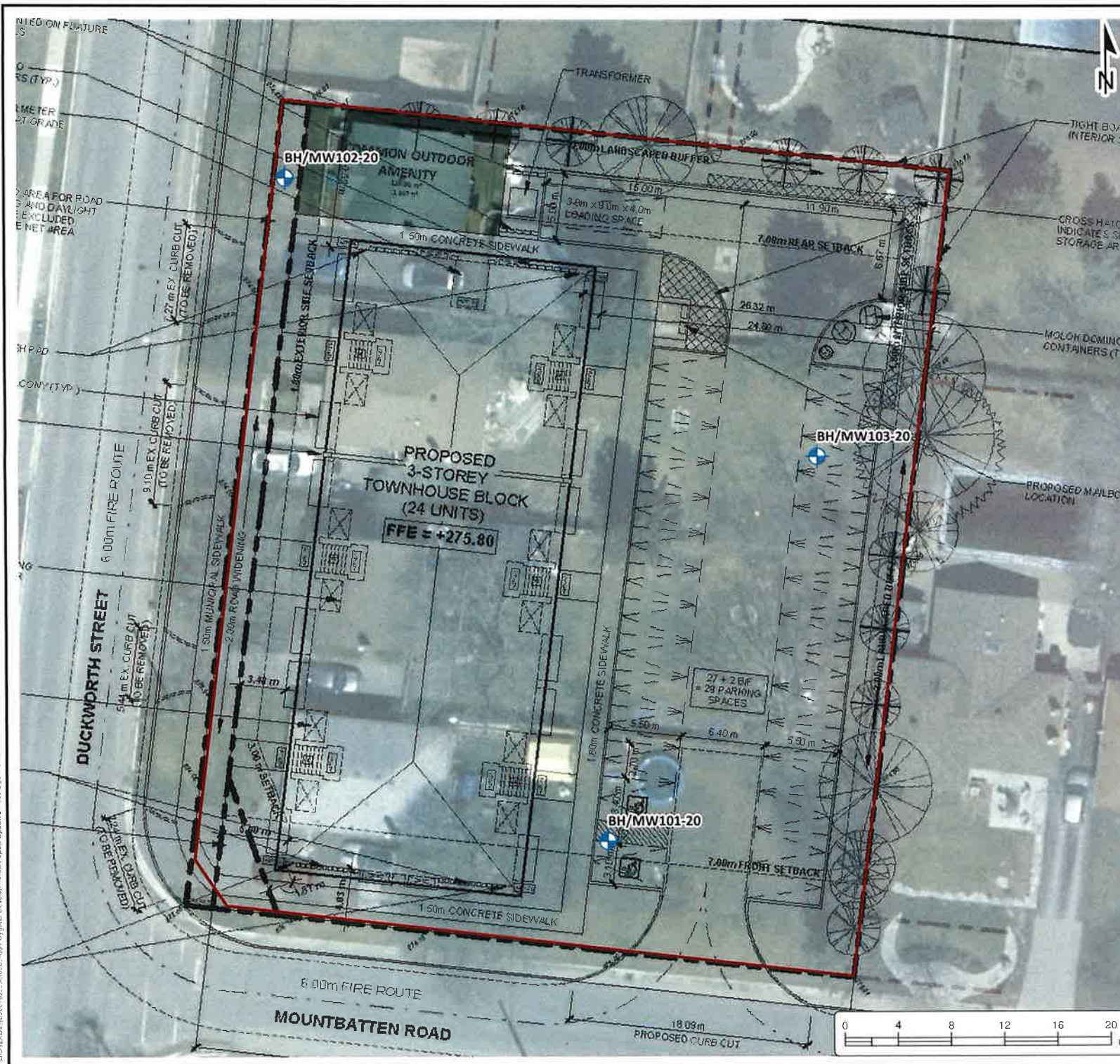
Notes:
- Overlay was created by Cambium Inc. Advertisers, Project no. 23010, during no. A 1 01, titled Site Plan (Road View), dated September 2023.
- Bathymetry features are © King's Printer of Ontario, 2023 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors, but cannot be held responsible for any damages due to errors or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference only.



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BOREHOLE LOCATION PLAN

Project No.: 18989-001	Date: November 2020 Rev.: October 2023
Scale: 1:400	Projection: NAD 1983 UTM Zone 17N
Created by: MAT	Checked by: CM Figure: 1





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Kingston
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Client: Cygnus Developments

Contractor: Walker Drilling Ltd.

Location: 189 Duckworth Street, Barrie

Project Name: Geotech Investigation - 189 to 197 Duckworth St.

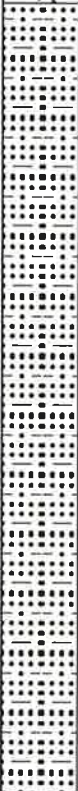
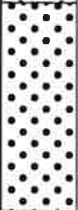
Method: Hollow Stem Augers

UTM: 17T, 605493 m E, 49176988 m N

Project No.: 10273-001

Date Completed: October 2, 2020

Elevation: 273.97 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)				Well Installation	Remarks
								25	50	75	10	20	30	40		
0	0		Topsoil: Black sandy topsoil, compact, moist	1	SS	40	12								Cap	Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
															Bentonite Plug	
				2A											PVC Standpipe	
-1	1		Sand and silt: Brown sand and silt, some clay, trace gravel, dense, moist	2B	SS	75	30									GSA SS3: 5% Gravel 43% Sand 41% Silt 11% Clay
			-very dense													
				3	SS	50	50/ 175 mm									
				4	SS	40	50/ 100 mm									
-2	2															Sand Pack
-3	3		Sand: Brown sand, some silt, trace gravel, very dense, dry	5	SS	25	50/ 125 mm								PVC Screen	

Logged By: JD

Input By: JD



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Client: Cygnus Developments

Contractor: Walker Drilling Ltd.

Location: 189 Duckworth Street, Barrie

Project Name: Geotech Investigation - 189 to 197 Duckworth St.

Method: Hollow Stem Augers

UTM: 17T, 605493 m E, 49176988 m N

Project No.: 10273-001

Date Completed: October 2, 2020

Elevation: 273.97 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)				Well Installation	Remarks
								25	50	75	10	20	30	40		
4	4		Silty Sand: Brown silty sand, some gravel, very dense, dry	6	SS	25	50/100 mm									
																Borehole terminated at 4.7 mbgs.



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Client: Cygnus Developments

Contractor: Walker Drilling Ltd.

Location: 197 Duckworth Street, Barrie

Project Name: Geotech Investigation - 189 to 197 Duckworth St.

Method: Hollow Stem Augers

UTM: 17T, 605469 m E, 4917043 m N

Project No.: 10273-001

Date Completed: October 2, 2020

Elevation: 274.96 mASL

SUBSURFACE PROFILE				SAMPLE													
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)				Well Installation	Remarks	
								25	50	75	10	20	30	40			
0	0		Topsoil: Black sandy topsoil, loose, moist	1	SS	10	5									Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.	
			Gravelly Sand: Brown gravelly sand, trace silt, trace clay, dense, moist	2	SS	50	50/225 mm										GSA SS2: 25% Gravel 65% Sand 8% Silt 2% Clay
-1	1																
			-less gravel	3	SS	70	50/250 mm										
-2	2																
			Sand and Silt: Brown sand and silt, some clay, trace gravel, dense, moist	4	SS	75	49									GSA SS5: 7% Gravel 44% Sand 36% Silt 13% Clay	
-3	3		-very dense	5	SS	75	50/280 mm										

Logged By: JD

Input By: JD



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Client: Cygnus Developments

Contractor: Walker Drilling Ltd.

Location: 197 Duckworth Street, Barrie

Project Name: Geotech Investigation - 189 to 197 Duckworth St.

Method: Hollow Stem Augers

UTM: 17T, 605469 m E, 4917043 m N

Project No.: 10273-001

Date Completed: October 2, 2020

Elevation: 274.96 mASL

SUBSURFACE PROFILE				SAMPLE												
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)				Well Installation	Remarks
								25	50	75	10	20	30	40		
4	4		-more clay Borehole terminated at 4.6 mbgs.	6	SS	13	50/ 75 mm								Sand Pack PVC Screen Cap	



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Client: Cygnus Developments

Contractor: Walker Drilling Ltd.

Location: 195 Duckworth Street, Barrie

Project Name: Geotech Investigation - 189 to 197 Duckworth St.

Method: Hollow Stem Augers

UTM: 17T, 605509 m E, 4917022 mN

Project No.: 10273-001

Date Completed: October 2, 2020

Elevation: 275.23 mASL

SUBSURFACE PROFILE				SAMPLE											
Elevation (m)	Depth	Lithology	Description	Number	Type	% Recovery	SPT (N)	% Moisture			SPT (N)	Well Installation	Remarks		
								25	50	75	10	20	30	40	
0	0		Topsoil: Black sandy topsoil, compact, moist	1	SS	25	12								Cap Bentonite Plug PVC Standpipe Sand Pack PVC Screen Cap Top of Standpipe (TOS) elevation: 274.94 mASL. Standpipe dry when measured on October 15, 2020.
			Silty Sand: Brown silty sand, trace clay, trace gravel, very dense, moist	2	SS	0	50/50 mm								
-1	1														
				3	SS	50	50/100 mm								
-2	2		Gravelly Sand: Grey gravelley sand, some silt, very dense, moist	4	SS	0	50/50 mm								
-3	3				GS										
			Borehole terminated at 3.1 mbgs upon auger refusal.												



Grain Size Distribution Chart

Project Number:

10273-001

Client:

Cygnus Developments

Project Name:

Geo. & HydroG - 189 Duckworth St., Barrie

Sample Date:

October 2, 2020

Sampled By:

Jon De Jong - Cambium Inc.

Location:

BH 102-20 SS 5

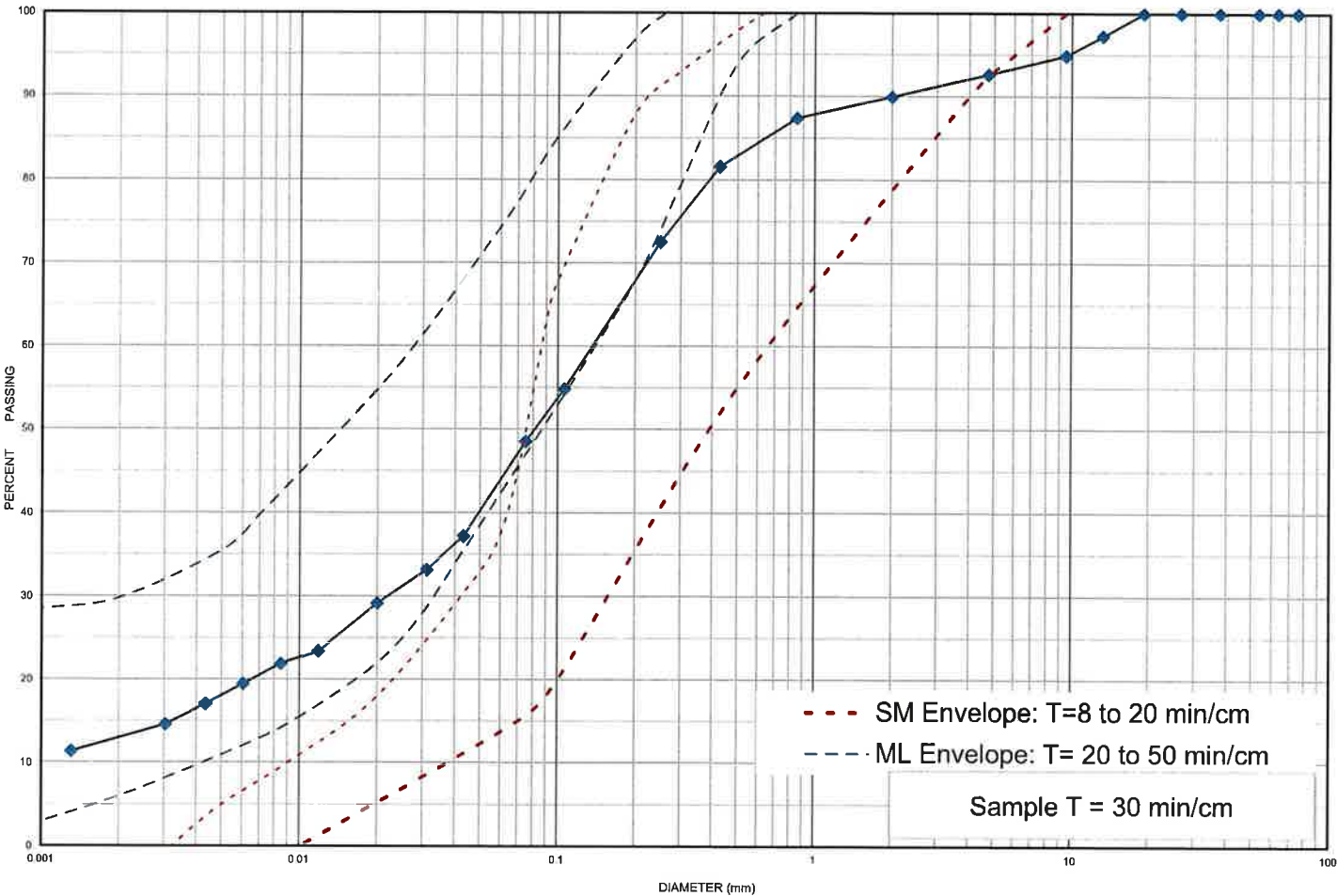
Depth:

3 m to 3.5 m

Lab Sample No:

S-20-0821

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-20	SS 5	3 m to 3.5 m	7	44	36	13	9.7
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand and Silt some Clay trace Gravel		SM	0.145	0.022	0.000	-	-

Additional information available upon request

Issued By:

Jon De Jong

(Senior Project Manager)

Date Issued:

November 24, 2020

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Form: L6V.2 - Grad.Hydo



Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sample Date: October 2, 2020

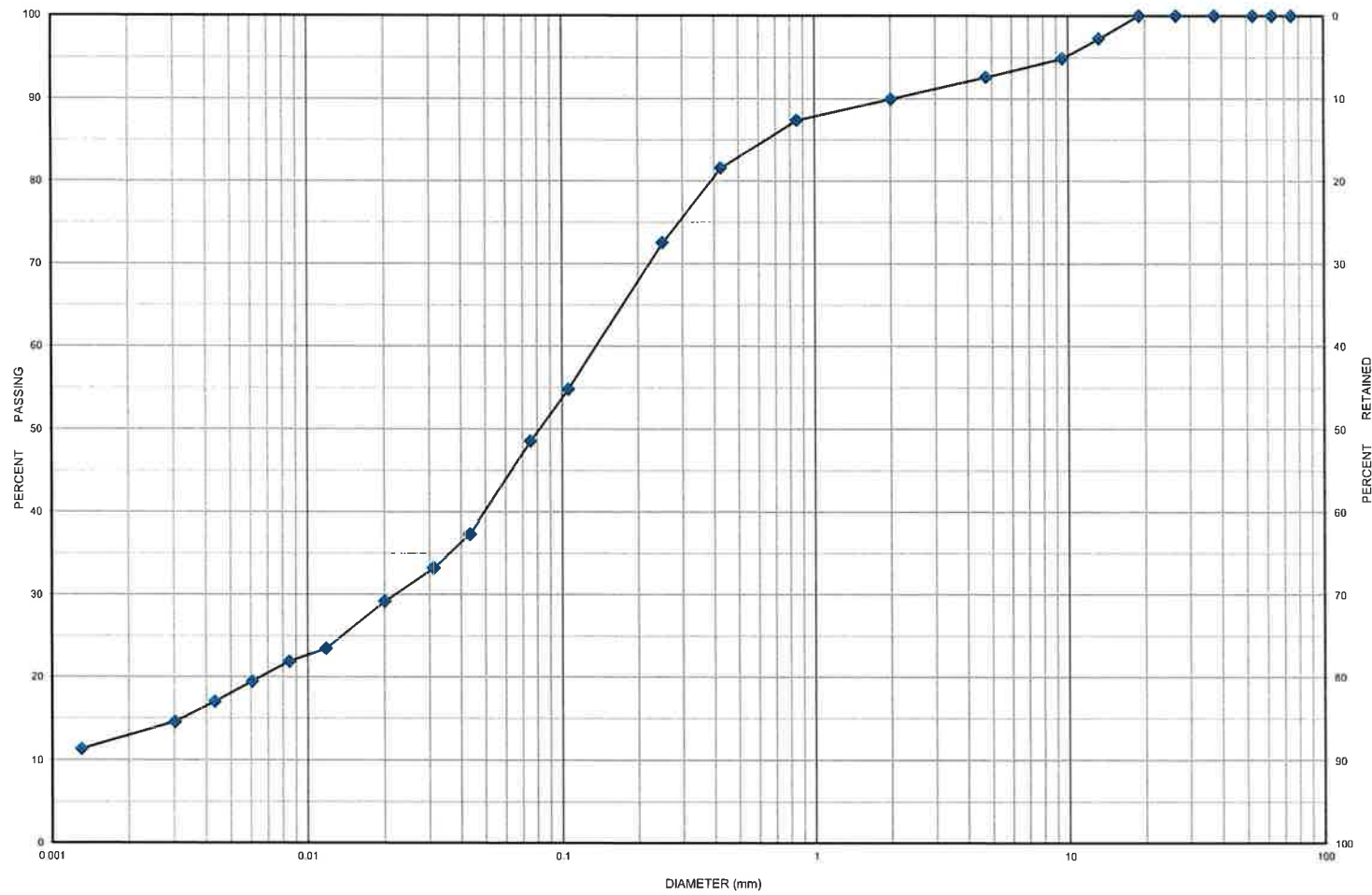
Sampled By: Jon De Jong - Cambium Inc.

Location: BH 102-20 SS 5

Depth: 3 m to 3.5 m

Lab Sample No: S-20-0821

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-20	SS 5	3 m to 3.5 m	7	44	36	13	9.7
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand and Silt some Clay trace Gravel		SM	0.145	0.022	0.000	-	-

Additional information available upon request

Issued By:

Date Issued: October 16, 2020

(Senior Project Manager)

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Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sampled By: Jon De Jong - Cambium Inc.

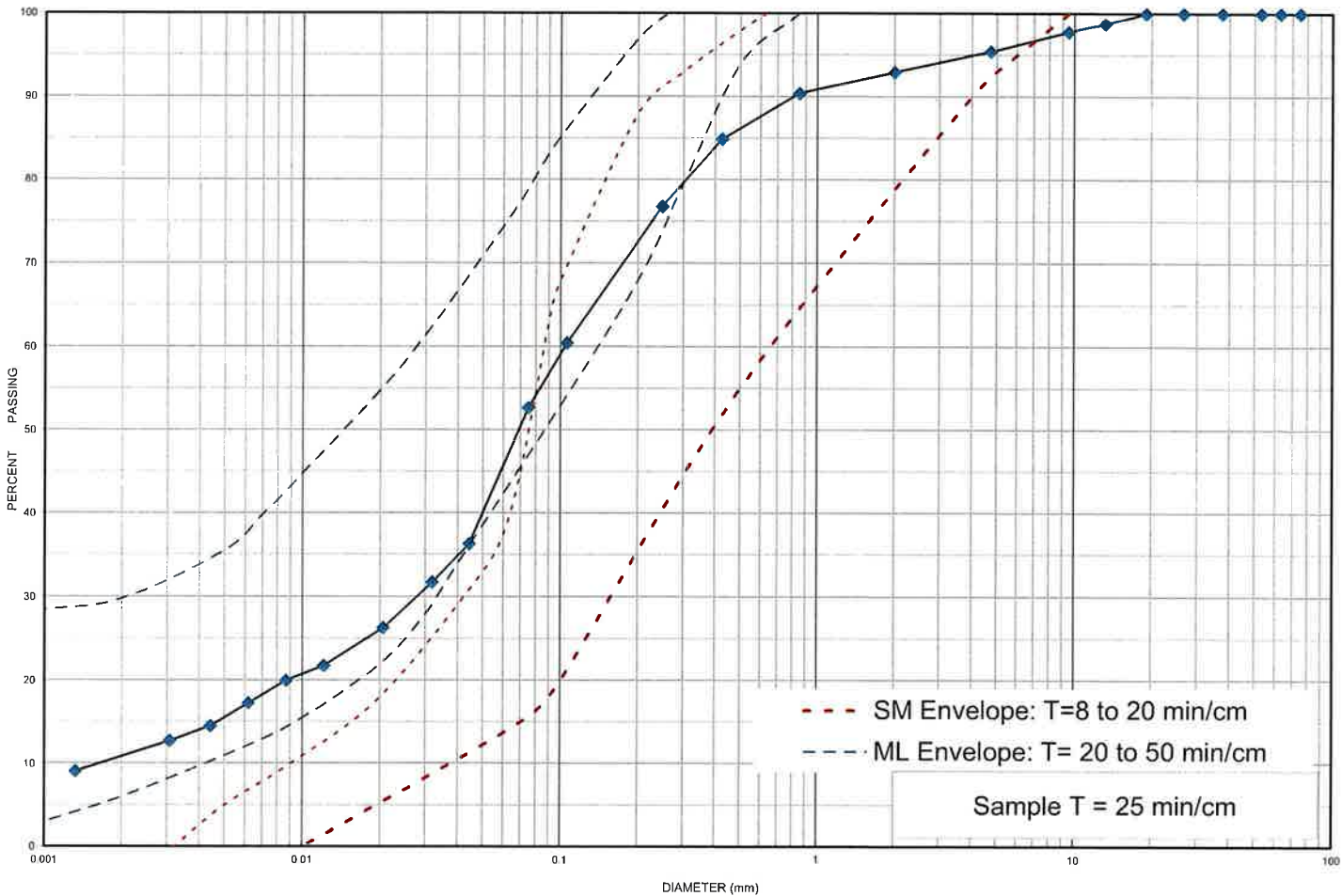
Sample Date: October 2, 2020

Depth: 1.5 m to 1.8 m

Lab Sample No: S-20-0822

Location: BH 101-20 SS 3

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-20	SS 3	1.5 m to 1.8 m	5	43	41	11	9.9
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand and Silt some Clay trace Gravel		ML	0.1100	0.0180	0.0016	68.75	1.84

Additional information availabe upon request

Issued By: 

Date Issued: November 24, 2020

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Form: L6V.2 - Grad.Hydo



Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sample Date: October 2, 2020

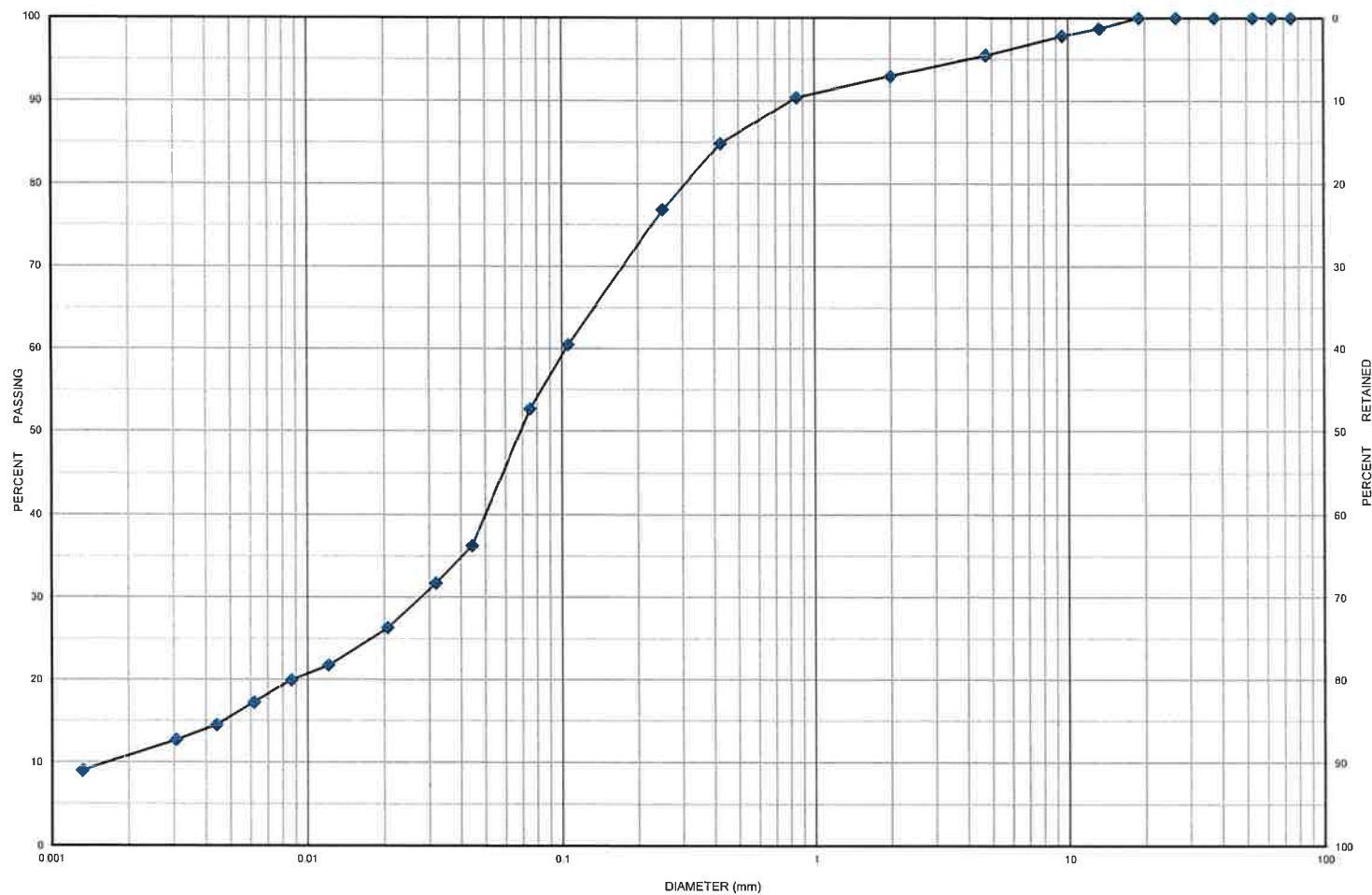
Sampled By: Jon De Jong - Cambium Inc.

Location: BH 101-20 SS 3

Depth: 1.5 m to 1.8 m

Lab Sample No: S-20-0822

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-20	SS 3	1.5 m to 1.8 m	5	43	41	11	9.9
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Sand and Silt some Clay trace Gravel		ML	0.1100	0.0180	0.0016	68.75	1.84

Additional information available upon request

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Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sampled By: Jon De Jong - Cambium Inc.

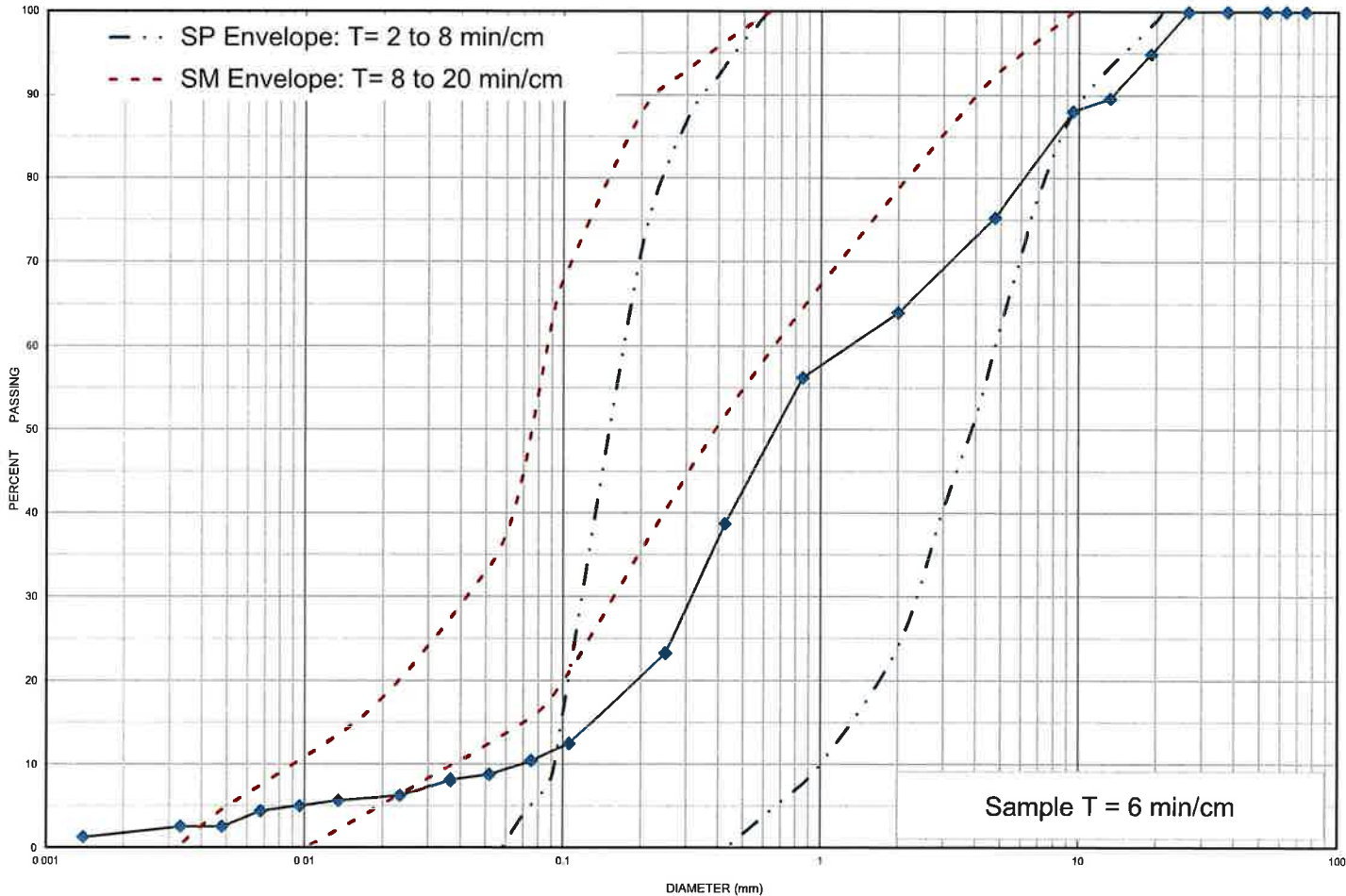
Sample Date: October 2, 2020

Depth: 0.8 m to 1.2 m

Lab Sample No: S-20-0880

Location: BH 102-20 SS 2

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-20	SS 2	0.8 m to 1.2 m	25	65	8	2	4.9
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Sand trace Silt trace Clay		SW	1.400	0.310	0.070	20.00	0.98

Additional information available upon request

Issued By:

Date Issued: November 24, 2020

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Form: L6V.2 - Grad.Hydo



Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sample Date: October 2, 2020

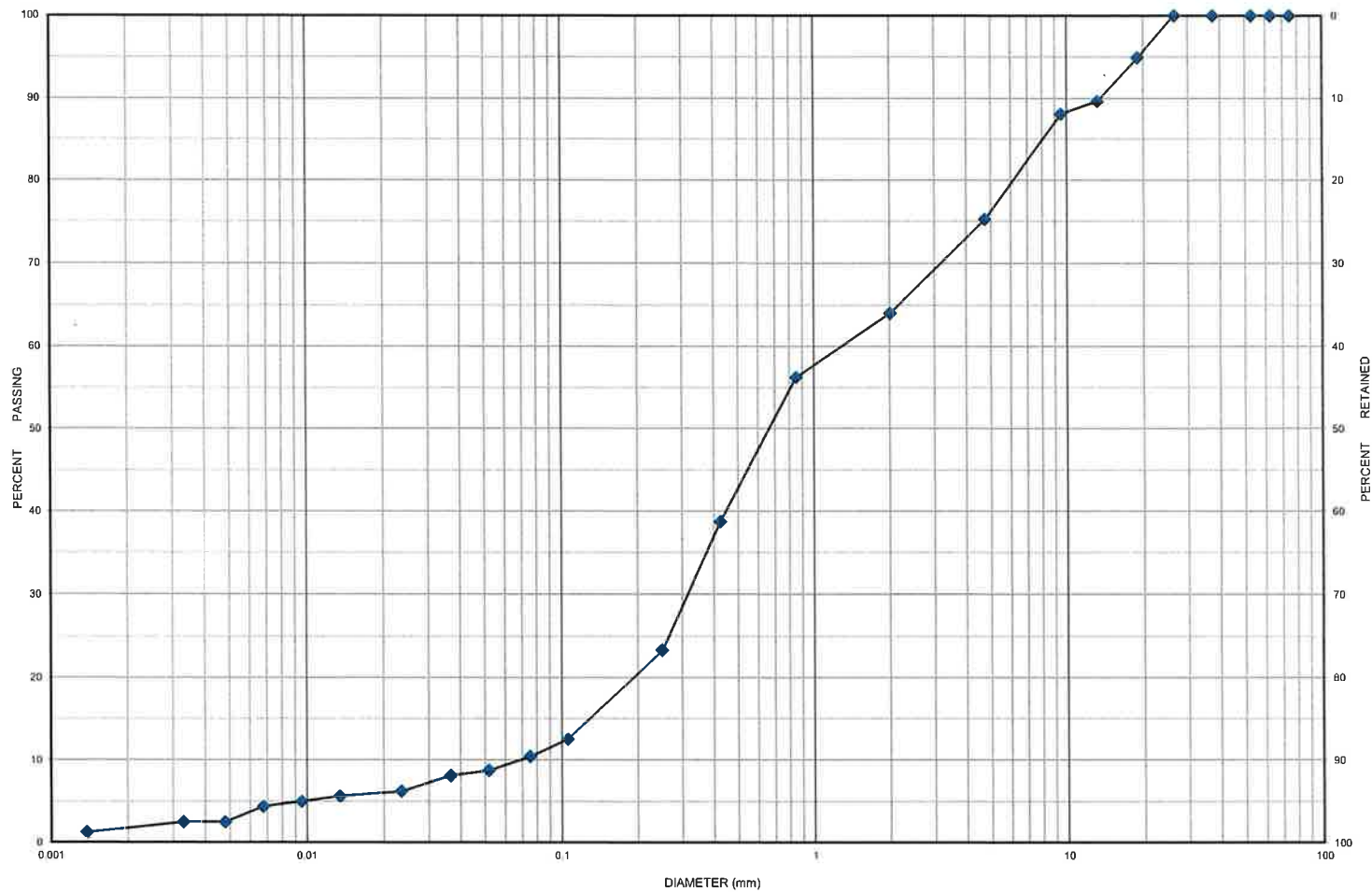
Sampled By: Jon De Jong - Cambium Inc.

Location: BH 102-20 SS 2

Depth: 0.8 m to 1.2 m

Lab Sample No: S-20-0880

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-20	SS 2	0.8 m to 1.2 m	25	65	8	2	4.9
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Gravelly Sand trace Silt trace Clay		SW	1.400	0.310	0.070	20.00	0.98

Additional information available upon request

Issued By: 

(Senior Project Manager)

Date Issued:

October 27, 2020

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Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sampled By: Jon De Jong - Cambium Inc.

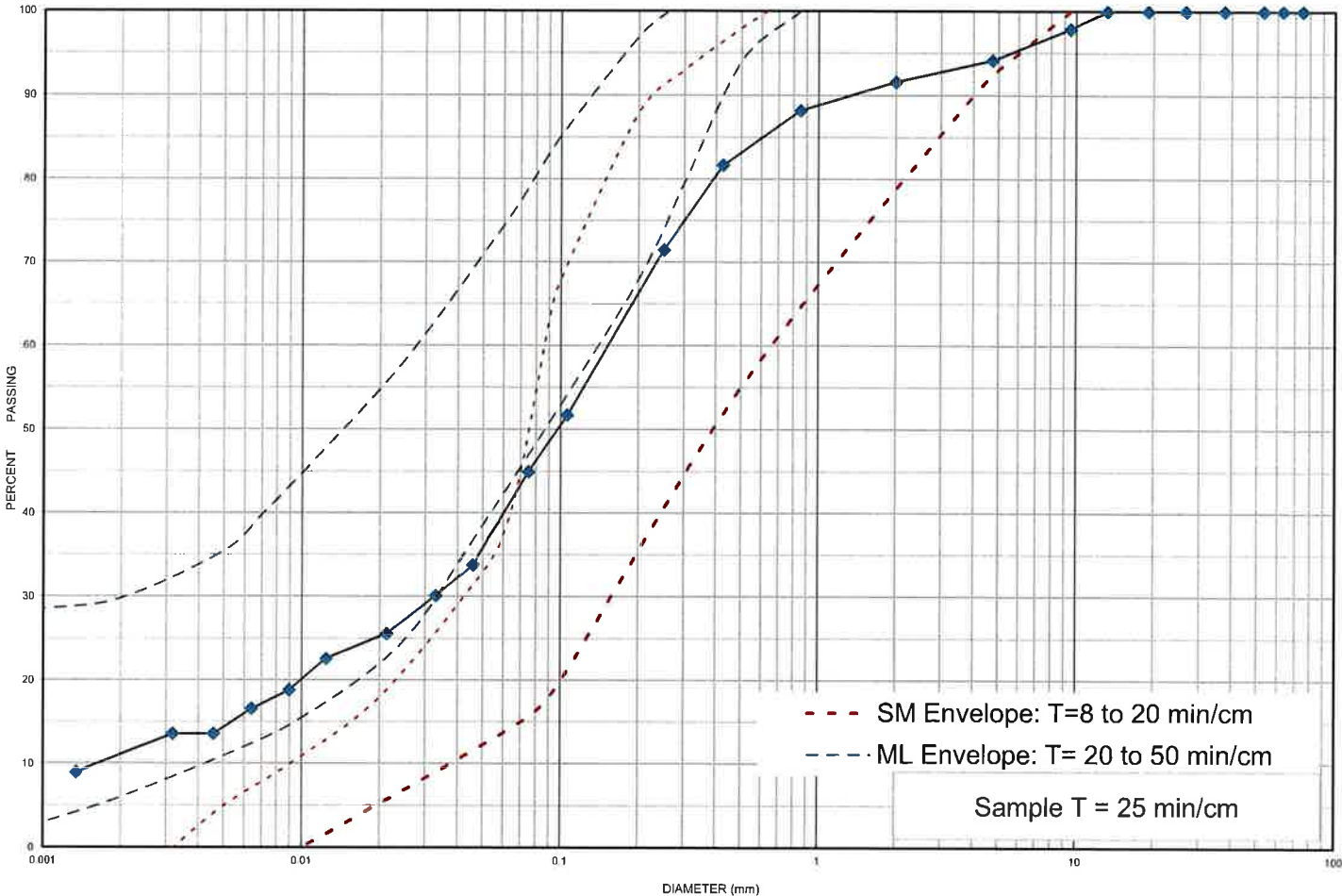
Sample Date: October 2, 2020

Location: BH 101-20 SS 2B

Depth: 0.9 m to 1.2 m

Lab Sample No: S-20-1094

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-20	SS 2B	0.9 m to 1.2 m	6	49	33	12	9.5
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand some Clay trace Gravel		SM	0.1550	0.0320	0.0016	96.88	4.13

Additional information available upon request

Issued By:

Date Issued: November 26, 2020

(Senior Project Manager)

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Grain Size Distribution Chart

Project Number: 10273-001

Client: Cygnus Developments

Project Name: Geo. & HydroG - 189 Duckworth St., Barrie

Sample Date: October 2, 2020

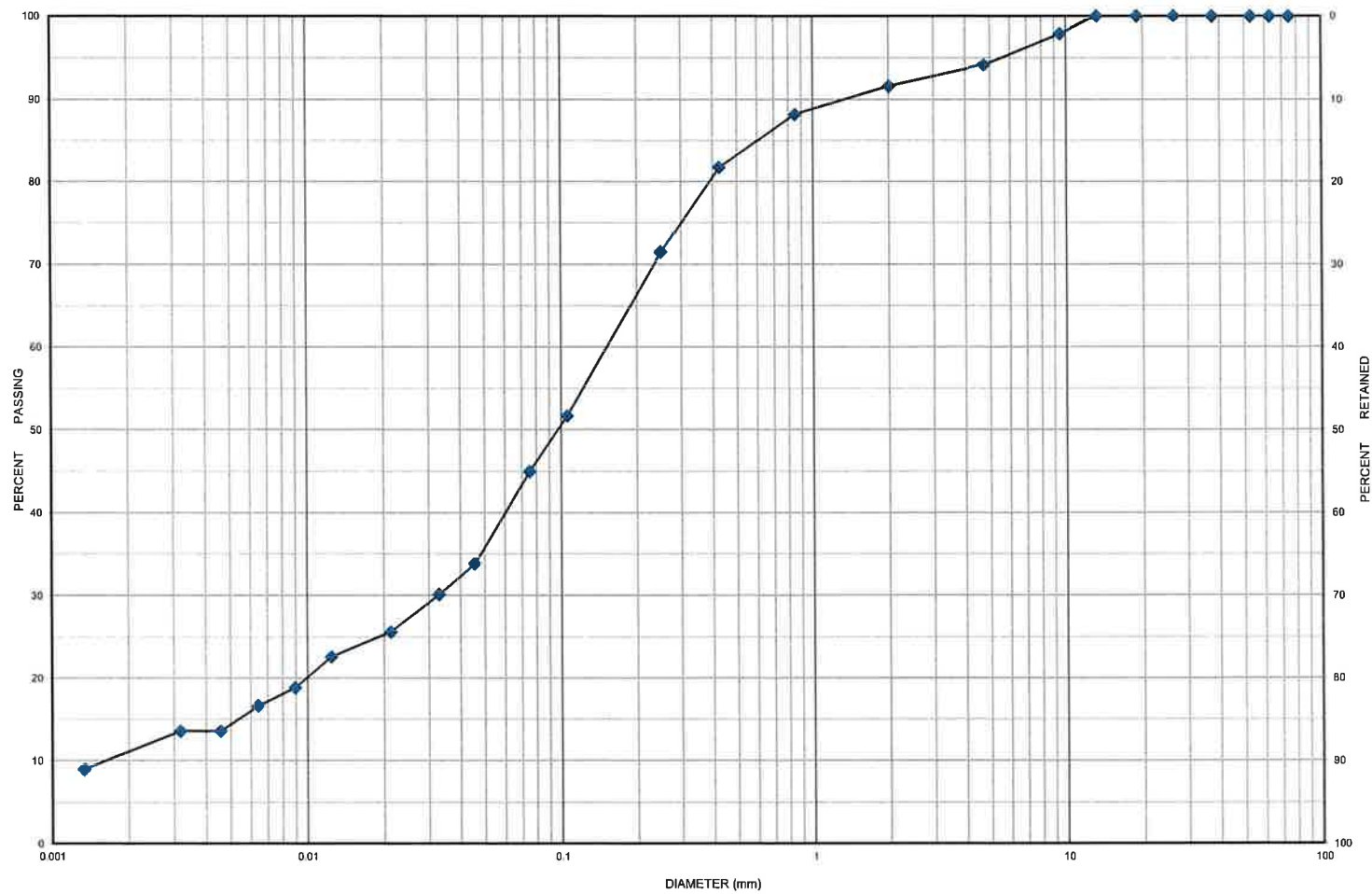
Sampled By: Jon De Jong - Cambium Inc.

Location: BH 101-20 SS 2B

Depth: 0.9 m to 1.2 m

Lab Sample No: S-20-1094

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-20	SS 2B	0.9 m to 1.2 m	6	49	33	12	9.5
Description		Classification	D ₆₀	D ₃₀	D ₁₀	C _u	C _c
Silty Sand some Clay trace Gravel		SM	0.1550	0.0320	0.0016	96.88	4.13

Additional information available upon request

Issued By: 

Date Issued: November 26, 2020

(Senior Project Manager)

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Form: L6V.2 - Grad.Hydo

5.0 Water Balance

Based on the Thornthwaite and Mather methodology (1957), the water balance is an accounting of water in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can run off towards lakes and streams (R), infiltrate to the groundwater table (I), or evaporate from ground or evapotranspiration by vegetation (ET). When long-term average values of P, R, I, and ET are used, there is minimal or no net change to groundwater storage (ΔS).

The annual water budget can be expressed as:

$$P = ET + R + I + \Delta S$$

Where:

P = Precipitation (mm/year)

ET = Evapotranspiration (mm/year)

R = Run-off (mm/year)

I = Infiltration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

It is noted that the water balance described herein does not account for catchment areas that extend off-site. The calculations compare the pre- and post-development water balance changes within the Site boundaries.

currently consists of four (4) developed residential properties with dwellings (serviced with municipal water and wastewater and natural gas), and associated landscaping (mature tree coverage and existing property line fencing). The proposed development consists of re-developing the residential properties to a townhouse development with one level of underground parking.

Based on the available design information, the development area at the Site can be generally categorized into three (3) types as paved area, roof area, and landscape areas. A summary of the surface areas of the development is listed in Table 2.

Table 2 Pre- and Post-Development Statistics

Type of Land Coverage	Pre-Developments Areas (m ²)	Post Development Areas (m ²)
Paved Area	223	1,457
Building Roof Area	648	792
Landscape Area	2,059	681
Total (m ²)	2,930	2,930

Supporting information referenced herein (including detailed water balance calculations) is attached in Appendix D.

5.1 Water Surplus

Water surplus is calculated by determining the difference between precipitation and evapotranspiration (changes in soil water storage was assumed to be negligible over the course of a year). The volume of water surplus is further sub-divided into portions that infiltrate the on-site soils and that are directed off-site as runoff.

The climatic data including monthly average temperature and precipitation were obtained from Environment Canada, for Barrie WPCP Weather Station (Climate ID: 6110557) located about 3 km distance from the Site. Accordingly, the average annual evapotranspiration was estimated to be about 531 mm/annum using the USGS Thornthwaite Monthly Water Balance methodology (Appendix D), and the average annual precipitation was recorded to be 933 mm/annum. The water surplus of the Site was calculated to be 402 mm/yr.

Evapotranspiration does not occur from structures, paved areas, or gravel surfaces. It was assumed that 10% of precipitation falling on these surfaces is lost directly to evaporation. The remaining depth (i.e., 90% of precipitation) was considered surplus and converted to infiltration and/or runoff.

5.2 Infiltration Factor

The volume of surplus water that infiltrates through pervious surfaces on-site was determined by applying an infiltration factor to the surplus depth. The surplus water that does not infiltrate into pervious surfaces will leave the Site as surface water runoff. The infiltration factor varies from 0 to 1 and is estimated based on topography, soils, and vegetation cover as per the *Stormwater Management Planning and Design Manual* (Ministry of the Environment, 2003).

The rate of infiltration at a site is expected to vary, based on a number of factors to be considered in any infiltration model. To partition the available water surpluses into infiltration and surface run-off, the Ministry of Environment, Conservation and Parks (MECP) infiltration factor was used. The MECP Storm Water Management Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used, and a corresponding run-off component was calculated for the soil moisture storage conditions.

Prior to development, the topography of the Site exhibits a minor slope southward and the landscaped areas are vegetated with grass. The soils were determined to be glacial till deposits predominantly sand with gravel to silty sand. The infiltration factor of the pre-development landscaped areas was assumed to be 0.65 of available surplus. The infiltration factor of all landscaped included in the proposed development was also assumed to be 0.65. An infiltration factor of 0.65 corresponds to an infiltration rate of 261 mm/yr and a runoff rate of 141 mm/yr.

5.3 Pre-Development Water Balance

The water balance for existing conditions at the Site is summarized in Table 3. The pre-development infiltration rate and runoff rate was calculated to be 538 m³/yr and 1,021 m³/yr, respectively. The calculations assume no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

Table 3 Pre-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	223	208	21	-	187
	Roof Area	648	605	60	-	544
Pervious Areas	Landscape Area	2,059	1,921	1,093	538	290
Total		2,930	2,734	1,175	538	1,021

5.4 Post Development Water Balance

The water balance for post-development conditions at the Site is summarized in Table 4. The pre-development infiltration rate and runoff rate was calculated to be 178 m³/yr and 1,994 m³/yr, respectively. The calculations assume no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

Table 4 Post-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	1,457	1,360	136	-	1,224
	Roof Area	792	739	74	-	665
Pervious Areas	Landscape Area	681	635	362	178	96
Total		2,930	2,734	571	178	1,984

5.5 Water Balance Comparison

The water balances of the pre-development and post-development scenarios are summarized below in Table 5.

Table 5 Water Balance Comparison

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Pre-Development	2,734	1,175	538	1,021
Post-Development	2,734	571	178	1,984
Change in Volume	0	-603	-360	963
Change in %	0	-51	-67	94

Based on the above, there is a net infiltration deficit of about 360 m³/year compared to the pre-development infiltration, while the runoff rate upon development of the Site will increase by 963 m³/year.

To compensate for the post-development infiltration deficit (and applicable WHPA Q2 policies), a portion of roof run-off water can be captured and directed towards infiltration. As the infiltration deficit volume is 360 m³/yr and the total roof run-off volume is projected to be 665 m³/yr, the percentage of roof run-off that is required to be redirected to maintain pre-development infiltration volumes is 54%. These details are summarized in Table 6.

Table 6 Requirement of Infiltration from Roof Runoff

Volume of Pre-Development Infiltration (m³/yr)	538
Volume of Post-Development Infiltration (m³/yr)	178
Deficit from Pre to Post Development Infiltration (m³/yr)	360
Percentage of Roof Runoff required to match the pre-development infiltration (%)	54

A qualified stormwater management engineer should be retained to design re-infiltration features. Groundwater infiltration features should target the native soils underlying the fill. Additional infiltration in-situ testing should be completed (as needed) to support the detailed design of groundwater infiltration features.



Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL

modified from Dingman 2015: Box 6-8 (pg 299) using ET model of Hamon (1963)

Input Data

Computed Values

Surplus 402 mm/yr

Weather Station Location: Barrie WPCP

Latitude: 44.4 degree

Solar Declination (degree)	-20.6	-12.6	-1.5	10.0	19.0	23.1	21.0	13.4	2.6	-9.0	-18.5	-23.0
DayLength (hr)*	9.1	10.3	11.8	13.3	14.6	15.3	14.9	13.8	12.3	10.8	9.5	8.7

Available Water Storage Capacity 0.18 m/m Root Depth 460 mm SOILmax 82.8 mm

MONTHLY WATER BALANCE DATA

Temperatures in C, water-balance terms in mm.

Month:	J	F	M	A	M	J	J	A	S	O	N	D	Year
TEMPERATURE (T)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	
PRECIPITATION (P)	82.5	61.8	58.1	62.2	82.4	84.8	77.2	89.9	94.0	77.5	88.9	73.6	933
RAIN	16.6	16.0	29.2	56.6	82.3	84.8	77.2	89.9	94.0	75.2	66.0	22.2	710
SNOW	66	46	29	6	0	0	0	0	0	2	23	51	223
MELT FACTOR (F)	0.00	0.00	0.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	0.45	0.00	
PACK	130	176	205	14	0	0	0	0	0	0	13	64	
MELT	0	0	0	196	14	0	0	0	0	2	10	0	223
INPUT (W)	17	16	29	253	96	85	77	90	94	78	76	22	933
POTENTIAL ET (PET)	0	0	0	39	68	97	116	100	67	40	23	0	548
NET INPUT (ΔW)	17	16	29	214	29	-12	-38	-10	27	38	54	22	
SOIL MOISTURE (SOIL)	83	83	83	83	83	72	45	40	67	83	83	83	
ΔSOIL	0	0	0	0	0	-11	-27	-5	27	16	0	0	0
ET	0	0	0	39	68	96	104	95	67	40	23	0	531
SURPLUS=W-ET-ΔSOIL	17	16	29	214	29	0	0	0	0	22	54	22	402

Notes:

Precipitation, Rain, Temperature, and Latitude are inputted parameters

SOILmax = available water storage capacity * root depth

m = month

D = Day length (hrs) = $2 * \cos^{-1} \{-\tan(\text{Latitude}) * \tan(\text{Declination})\} / 0.2618$ [calculation is in radians]

$SNOW_m = P_m - RAIN_m$

$F_m = 0$ if $T_m \leq 0^\circ\text{C}$; $F_m = 0.167 * T_m$ if $0^\circ\text{C} < T_m < 6^\circ\text{C}$; $F_m = 1$ if $T_m \geq 6^\circ\text{C}$

$PACK_m = (1 - F_m) * (SNOW_m + PACK_{m-1})$

$MELT = F_m * (SNOW_m + PACK_{m-1})$

$W_m = RAIN_m + MELT_m$

$PET = 0$ if $T_m < 0$; otherwise $PET = 2.98 * 0.611 * \exp(17.3 * T_m / (T_m + 237)) / (T_m + 237.2) * \text{Number of days in month}$ [Hamon ET model (1963)]

$\Delta W_m = W_m - PET_m$

$SOIL = \min\{\Delta W_m + SOIL_{m-1}, SOIL_{max}\}$, if $\Delta W_m > 0$; otherwise $SOIL = SOIL_{m-1} * \exp(\Delta W / SOIL_{max})$

$\Delta SOIL = SOIL_{m-1} - SOIL_m$

$ET = PET$ if $W_m > PET$; otherwise, $ET = W_m - \Delta SOIL$



Pre- and Post-Development Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

1 Climate Information

Precipitation	933 mm/yr
Actual Evapotranspiration	531 mm/yr
Water Surplus	402 mm/yr

2 Infiltration Rates

Table 2 Approach - Infiltration factors

Topography: Flat to Gently Sloping Land	0.25
Soil Type: medium combinations of clay and loam	0.2
Cover: Cultivated land	0.2
Total Infiltration Factor	0.65

Infiltration (Water Surplus * Infiltration Factor)	261 mm/yr
Run-off (Water Surplus - Infiltration)	141 mm/yr

Table 3 Approach - Typical Recharge Rates

Coarse Sand and Gravel	>250	mm/yr
Fine to medium sand	200-250	mm/yr
Silty sand to sandy silt	150-200	mm/yr
Silt	125-150	mm/yr
Clayey Silt	100- 125	mm/yr
Clay	<100	mm/yr

Site development area is underlain predominantly by sand and silty sand with gravel and trace clay.

Based on the above, the recharge rate is typically 200-250 mm/yr

3 Pre-Development Property Statistics

	ha	m ²
Total Paved Area	0.02	223
Total Roof Area	0.06	648
Total Landscape Area	0.21	2,059
Total	0.29	2,930

4 Post-Development Property Statistics

	ha	m ²
Total Paved Area	0.15	1,457
Total Roof Area	0.08	792
Total Landscape Area	0.07	681
Total	0.29	2,930



Pre- and Post-Development Water Balance Calculations

189-197 Duckworth Street, Barrie, ON

5 Pre-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	223	208	21	-	187
	Roof Area	648	605	60	-	544
Pervious Areas	Landscape Area	2,059	1,921	1,093	538	290
Totals		2,930	2,734	1,175	538	1,021

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

6 Post-Development Water Balance

Land Use		Area (m ²)	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Impervious Areas	Paved Area	1,457	1,360	136	-	1,224
	Roof Area	792	739	74	-	665
Pervious Areas	Landscape Area	681	635	362	178	96
Totals		2,930	2,734	571	178	1,984

Assuming no infiltration occurring in paved and roof areas, and 10% of precipitation to be evaporated from paved and roof areas.

7 Comparison of Pre- and Post -Development

	Precipitation (m ³)	Evapotranspiration (m ³)	Infiltration (m ³)	Run-off (m ³)
Pre-Development	2,734	1,175	538	1,021
Post-Development	2,734	571	178	1,984
Change in Volume	0	- 603	- 360	963
Change in %	0	- 51	- 67	94

8 Requirement for Infiltration of Roof Run-off

Volume of Pre-Development Infiltration (m ³ /yr)	538
Volume of Post-Development Infiltration (m ³ /yr)	178
Deficit from Pre to Post Development Infiltration (m ³ /yr)	360
Percentage of Roof Runoff required to match the pre-development infiltration (%)	54

Design Chart 1.08: Hydrologic Soil Groups (Continued)**- Based on Soil Texture**

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

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

**189-197 DUCKWORTH STREET – CITY OF BARRIE
24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT**

APPENDIX C

Water and Sanitary Servicing Calculations

3.2.4. Septic Systems

Development of private sewage treatment systems is not permitted. The review and approval of new private sewage treatment systems may be considered by the City only in cases where replacement or upgrading of existing systems is warranted.

3.2.5. Standard Drawings

In addition to these written guidelines, reference should also be made to the City of Barrie's Infrastructure Standard Drawings.

3.3. Design Flows

The careful determination of design flows is a crucial step in the design of an appropriate sanitary sewage collection system. The design flows for sanitary sewer design must account for flows from all sources: residential connections, commercial and institutional connections, industrial connections and extraneous flows from groundwater infiltration and surface water inflow.

In lieu of precise information on development on the whole or any part of the sanitary sewer drainage area, reference will be made to the latest zoning plan issued by the Planning Services Department.

3.3.1. Residential Flows

3.3.1.1. Design Population

Land Use or Zoning Designation Basis

When the most detailed knowledge of the ultimate land use for the tributary area consists simply of its overall proposed land use and/or zoning as determined from such sources as the governing Official Plan, Secondary Plans or Zoning By-Law, the design population can be estimated on an area basis using the following minimum design population values. When the exact land use/zoning is not confidently known, then an assessment shall be made and more restrictive values must be used. The City may alter the values associated with any particular development as determined appropriate.

Low Density	single detached, duplexes or semi-detached dwellings	25 units/hectare @ 3.13 ppu
-------------	--	-----------------------------

- Typical zoning designations for Low Density Development may include RH, R1, R2, R3, R4, RM1 and RM1-SS. It should be noted that zoning designations are subject to change, and it is the responsibility of the designer to ensure that the most current zoning by-laws and designations are being used.

Medium Density	triplexes and fourplexes	26 - 35 units/hectare @ 2.34 ppu
	cluster and/or block townhouses	40 units/hectare @ 2.34 ppu
	street townhouses	47 units/hectare @ 2.34 ppu
	'walk-up' apartments	26 - 53 units/hectare @ 2.34 ppu

- Typical zoning designations for Medium Density Development may include RM2 and RM2-TH. It should be noted that zoning designations are subject to change and it is the responsibility of the designer to ensure that the most current zoning by-laws and designations are being used.

High Density Apartment dwellings 54 - 300 units/hectare @ 1.67ppu

- Typical zoning designations for High Density Development may include RA1 and RA2. It should be noted that zoning designations are subject to change, and it is the responsibility of the designer to ensure that the most current zoning by-laws and designations are being used.

The method of determining design population for residential flows will depend upon the particular stage that is being considered and the appropriate detail required for the desired level of design accuracy. Reference shall be made to current zoning policies.

Development Details Basis

When the details regarding the proposed uses on individual lots are known, or can be assumed with reasonable certainty, a more detailed approach to design population and associated design flow estimation is required. This approach involves the determination of individual design flows for the various areas in the tributary area which will contribute to an individual sewer reach. The actual number of units shall be used and the design population estimated using the following people per unit (ppu) values.

Low Density	3.13 ppu
Medium Density	2.34 ppu
High Density	1.67 ppu

3.3.1.2. Average Daily Flow

Average daily domestic flow = 225 L/day/person (excluding extraneous flows)

3.3.1.3. Peak Flow

Peak domestic flow is to be calculated using the following formula:

$$Q_p = \frac{P \times q \times M}{86.4} + I \times A$$

Where Q_p = Peak residential sanitary sewage flow, including peak extraneous flows (L/s)

P = Design population in thousands (see Section 3.3.1.1)

q = Average daily domestic flow per capita (L/day/person) (see Section 3.3.1.2)

M = Peaking factor (see Section 3.3.1.3)

I = Peak extraneous flow (L/s/ha) (see Section 3.3.4)

A = Tributary area (ha) (see Section 3.2.2)

As per the MOECC Design Guidelines for Sewage Works, 2008 (MOE Guidelines), the peaking factor, M , can be calculated using the Harmon Formula or Babbitt Formula. The Babbitt Formula gives peaking factors that are more representative of instantaneous peaks, and the Harmon Formula gives peaking factors that are more representative of peak hour. The Babbitt Formula shall only be used to assess the upstream reaches of the sewer shed where depth of flow and minimum scour is a concern for partial flow conditions where depth of flow is less than 30% of the pipe diameter.

Harmon Formula

$$M = 1 + \frac{14}{4 + P^{0.5}}$$

Babbitt Formula

$$M = 5/P^{0.2}$$

Where P = Design population in thousands

The minimum permissible peaking factor M is 2.0 per the MOECC Guidelines.

3.3.2. Commercial and Institutional Flows**3.3.2.1. Average Daily Flow**

Due to the high variability of sanitary flows between various commercial and institutional establishments, design flows for specific commercial and institutional uses are to be based on actual flow records for similar uses whenever possible. In the absence of historical data for estimation, the designer may refer the common commercial sewage flow rates recommended in the most current Ministry of the Environment Guidelines. For more general applications, where the specific use is not known, a minimum average design flow rate of 28 m³/day/ha shall be used. This does not include an allowance for extraneous flows.

3.3.2.2. Peak Flow

Whenever possible, peaking factors should be based on an individual assessment of each type of use. Peak values and peak times vary greatly between various commercial and institutional establishments. so the designer must consider the intended use and design accordingly. Peak sewage flows will often correspond to water usage rates for most establishments. For more general applications, where specific information is not known, a factor of two (2) may be used.

3.3.3. Industrial Flows**3.3.3.1. Average Daily Flow**

Sanitary sewage flows from industrial areas are industry/process specific and can vary greatly. Where possible, design flows should be based on an individual assessment of expected flow rates or actual flow records for each individual industrial use. In the absence of such information, the following average day design flows shall be used for industrial development:

General Industrial	= 35 m ³ /day/ha
Heavy or Special Industrial Use	= 55 m ³ /day/ha
Unknown Mix of General & Heavy	= 50 m ³ /day/ha

These rates do not include extraneous flows.

3.3.3.2. Peak Flow

Peak sewage flow rates vary greatly depending on the type of industry, production schedules and processes used. As such, peak sewage flow rates shall be based on an individual assessment of expected peak flow rates or actual flow records whenever possible. In the absence of such information, a peaking factor between two (2) and four (4) may be used based on the designer's best judgement. Industrial uses, which have the potential to produce higher than average sewage flow rates, may be required to provide flow monitoring devices and/or flow equalization with off-peak discharge facilities as determined by the City.

3.3.4. Extraneous Flows

When designing a sanitary sewer system, an allowance should be made for the infiltration of groundwater into the sewers and sanitary service connections (infiltration) and for other extraneous water entering the sewers from sources such as maintenance hole covers (inflow).

The amount of groundwater leakage into the sewer system will vary with the quality of construction, type of joints, ground conditions, and level of groundwater in relation to pipe. Although such infiltration can be reduced by proper design, construction, and maintenance, it cannot be completely eliminated and an allowance should be made in the design sewage flows to incorporate this flow component.

An extraneous flow rate of 0.1 L/s/ha shall be used for sanitary sewer design.

The above rate assumes strict adherence to construction standards in the installation of sanitary sewers and building connections, and does not account for any other extraneous flows such as foundation drain connections, excessive flooding through maintenance hole covers, significant groundwater problems, etc.

Where collection system infrastructure is being designed to convey flows from existing developed areas, the extraneous flow allowance used may be increased based on flow monitoring data and/or system modelling, as directed by the City of Barrie.

Where a sewer is located within the floodplain of a watercourse, maintenance hole covers are to be raised above the maximum flood elevations, or watertight maintenance hole covers with associated air vents may be required as directed by the City.

3.4. Sanitary Sewer Design

3.4.1. Hydraulic Design Sheets

The design of sanitary sewers shall be completed using the City of Barrie's Sanitary Sewer Design Sheets as provided in Appendix C, or a similar format as deemed appropriate by the City.

3.4.2. Minimum Pipe Diameter

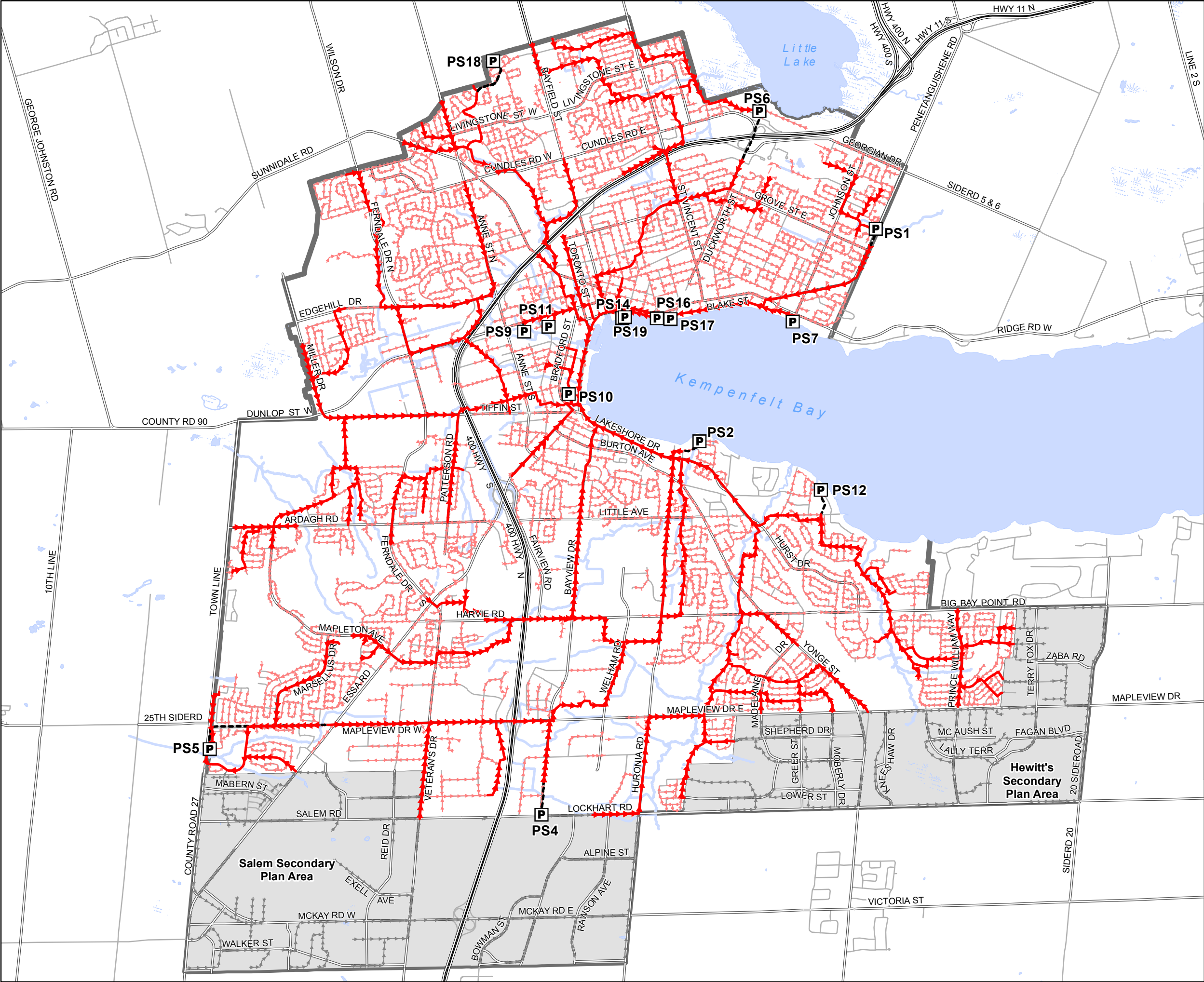
The minimum diameter for sanitary sewers conveying raw sewage from residential areas with no potential for future intensification or sanitary sewer shall be no less than 200mm in diameter (NPS-8). Sanitary sewers located in Industrial, Commercial, Institutional, and mixed land use areas shall be no less than 250 mm in diameter (NPS-10). The downstream sanitary sewer diameter shall be no less than the upstream sanitary sewer diameter.

3.4.3. Minimum and Maximum Velocities

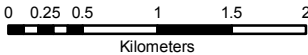
Sanitary sewers shall be designed such that a minimum sewage flow velocity of 0.60 m/s is achieved without including inflow and infiltration flows. The actual velocity at peak flow conditions should be calculated and slope increased to ensure adequate flushing velocities are maintained. A sample spreadsheet is available on City of Barrie website, and can be reviewed in Appendix C.

In order to reduce pipe scour, the maximum flow velocity shall be 3 m/s. Velocities in excess of 3 m/s may be permitted in special situations, provided that slope anchors are used to prevent pipe separation, and measures are taken to protect against scour. If velocities above 3 m/s are proposed, documentation must be submitted to the City for approval, indicating potential risks and mitigative measures required to ensure the long term integrity of the collection system. Minimum calculated velocities shall not exceed full flow velocities.

Figure ES-1
City of Barrie
Existing Wastewater
Collection System



- Pumping Stations
- Sanitary Trunk Sewer
- Forcemain
- Sanitary Sewer
- Future Annexed Lands Sewers
- Secondary Plan Boundaries
- City of Barrie Limits



8.2.2 Evaluation of Existing Pumping Stations

The capacity of existing pump stations to convey future flows was also evaluated for the various planning horizons. For this analysis, peak modelled flows corresponding to the 25-year design event were compared against the firm capacity of each station. **Table 8.3** presents the results. The station firm capacity represents the current available capacity at each station while the 2017 Existing, 2021, 2026, 2031, 2036 and 2041 values represent the required capacity in the time period. It is noted that the Huronia PS has already been decommissioned and the Lockhart PS is planned to be decommissioned. In addition, the Holly PS is currently being expanded and the station firm capacity is being increased. The values shown in **Table 8.3** correspond to the post-construction firm capacity.

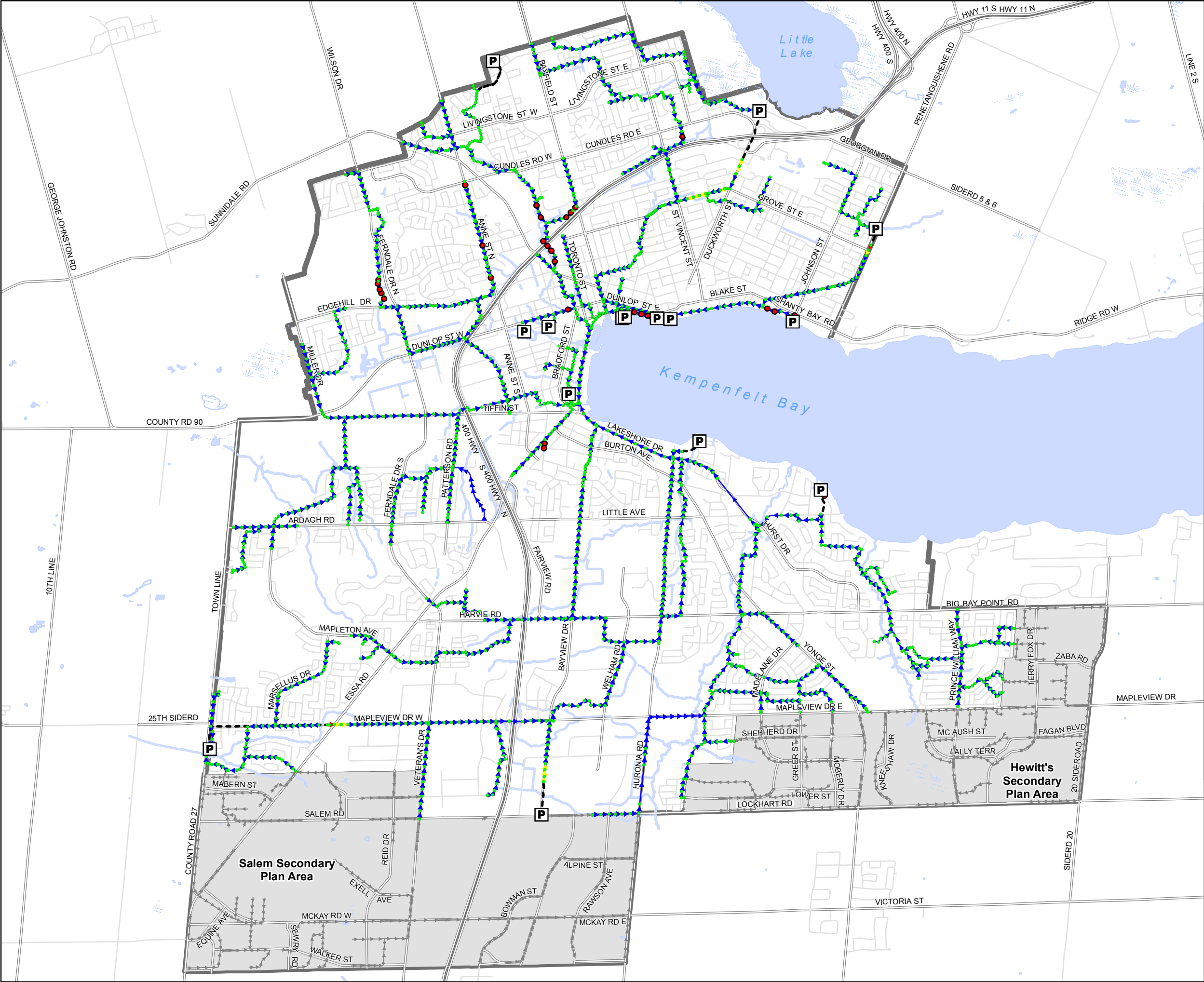
Table 8.3 Pumping Station Capacity Assessment (2017-2041)

Modelled Pumping Station	Station Firm Capacity (L/s)	2017 Existing Peak Flow Entering Station (L/s)	2021 Peak Flow Entering Station (L/s)	2026 Peak Flow Entering Station (L/s)	2031 Peak Flow Entering Station (L/s)	2036 Peak Flow Entering Station (L/s)	2041 Peak Flow Entering Station (L/s)
Barrie WwTF (PS10)	2,205	1,736	1,910	1,963	2,057	2,061	2,109
Grove Street (PS1)	158	53	52	54	54	57	63
Minets Point (PS2)	61.3	22.1	22.2	22.3	22.6	22.9	23.6
Huronia (PS3)	91	Decommissioned					
Lockhart (PS4)	51	5	Planned to Be Decommissioned				
Holly (PS5)	200.9	67	81	95	108	120	130
Little Lake (PS6)	110	37	37	40	40	41	42
Tynedale (PS12)	11	10	15	15	16	16	16
Mooregate (PS18)	21	8	8.5	8.5	8.7	8.9	9.1

It is noted that the influent flow to PS10 does not include any recycle streams. For PS10, the Wastewater Treatment Master Plan contains a detailed examination of future needs.

The results presented above indicated that all SPSs, with the exception of Tynedale SPS (PS12), have sufficient firm capacity to convey peak flows associated with the 25-year design event through to the year 2041. PS12 will require a pump capacity increase in the planning phase 2021.

Figure 6-2
City of Barrie
Existing Wastewater
Collection System Performance
Peak Dry Weather Flow
Conditions



- P** Pumping Stations
- Secondary Plan Boundaries
- City of Barrie Limits
- Forcemain
- Future Annexed Lands Sewers
- Freeboard (m)**
 - ≤ 1.8m
 - > 1.8m
- Peak Conduit Depth Ratio (d/D)**
 - < 0.5
 - 0.5 - 0.7
 - > 0.7

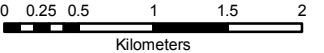
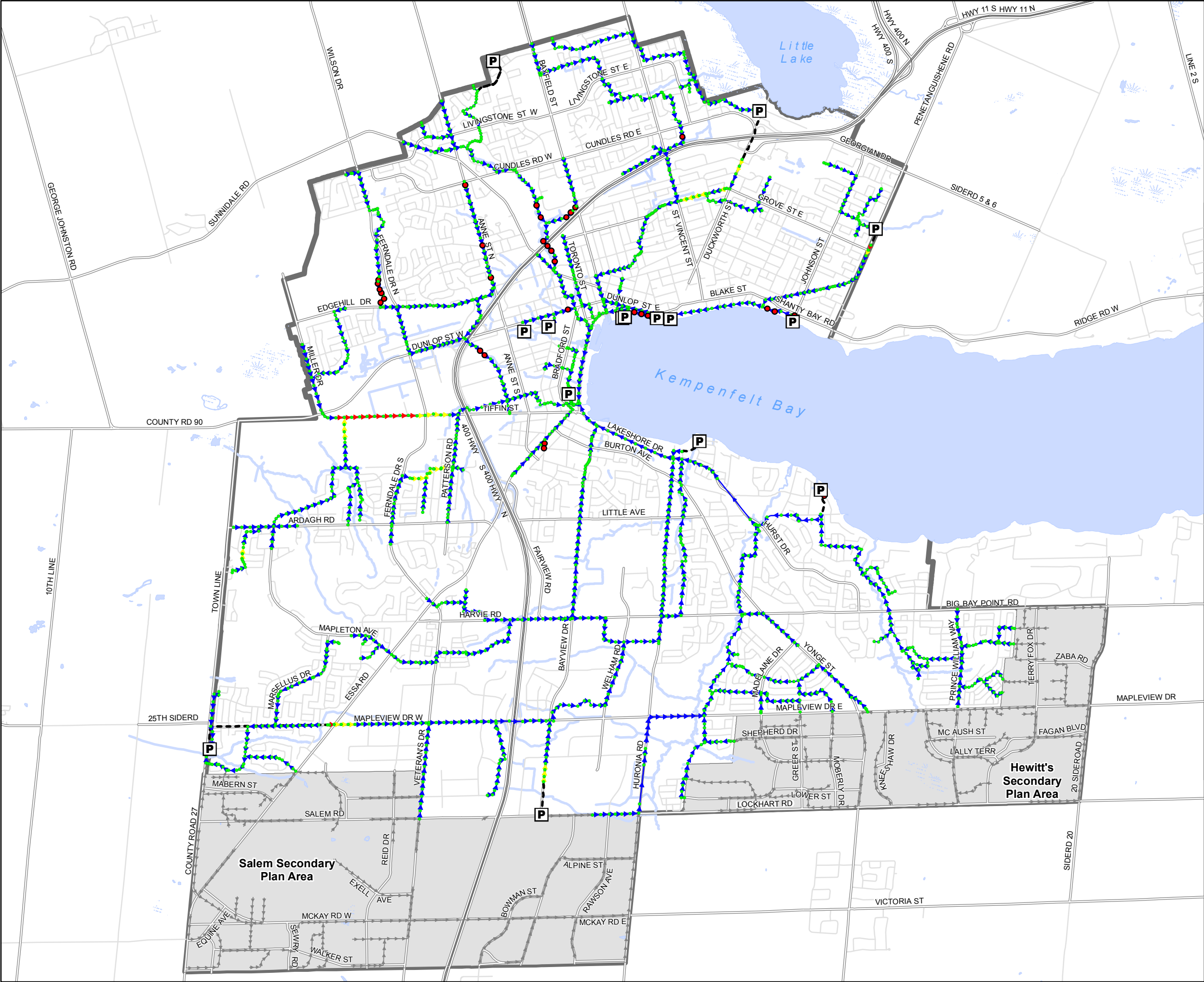


Figure 6-3
City of Barrie
Existing Wastewater
Collection System Performance
Wet Weather Flow Conditions
(2 Year Storm Event)



- P** Pumping Stations
- Secondary Plan Boundaries
- Forcemain
- Future Annexed Lands Sewers
- City of Barrie Limits
- Freeboard (m)**
- $\leq 1.8\text{m}$
 - $> 1.8\text{m}$
- Peak Conduit Depth Ratio (d/D)**
- < 0.5
 - $0.5 - 0.7$
 - > 0.7

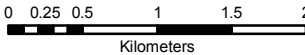
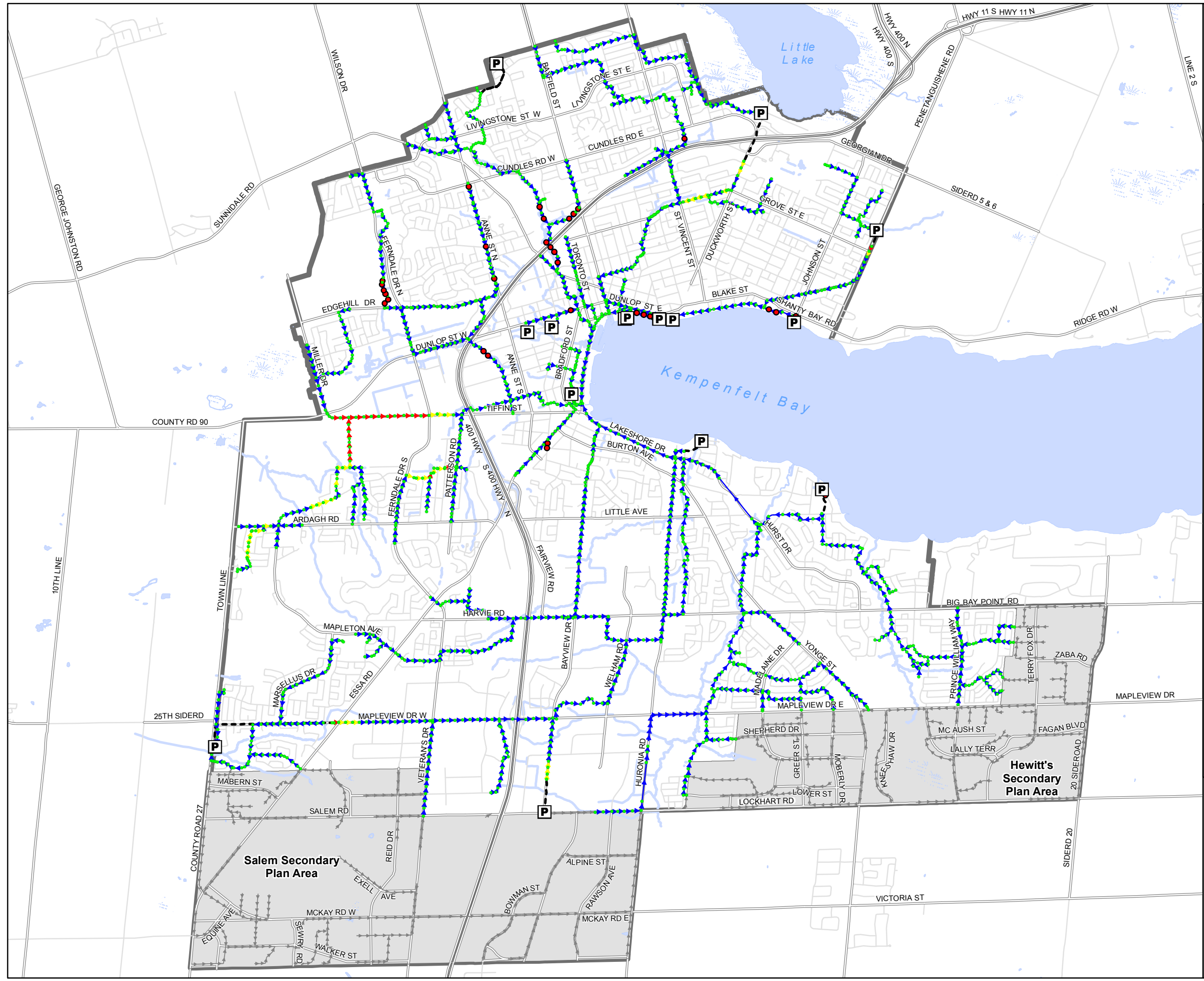


Figure 6-4
City of Barrie
Existing Wastewater
Collection System Performance
Wet Weather Flow Conditions
(5 Year Storm Event)



- P** Pumping Stations
- Secondary Plan Boundaries
- City of Barrie Limits
- Sanitary Collection System**
- Forcemain
- Future Annexed Lands Sewers
- Freeboard (m)**
- ≤ 1.8m
- > 1.8m
- Peak Conduit Depth Ratio (d/D)**
- < 0.5
- 0.5 - 0.7
- > 0.7



Figure 6-5
City of Barrie
Existing Wastewater
Collection System Performance
Wet Weather Flow Conditions
(10 Year Storm Event)

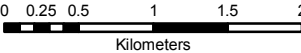
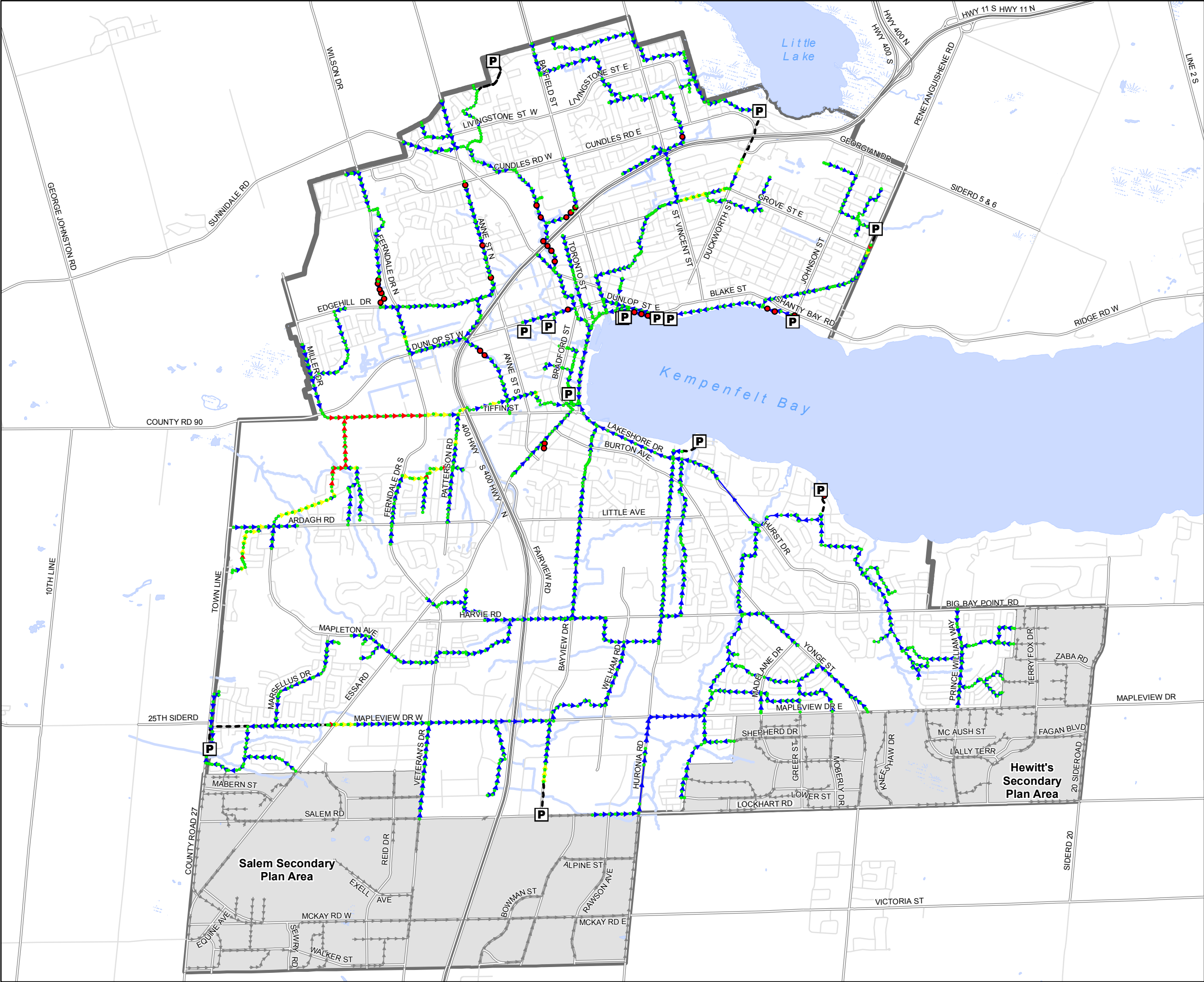
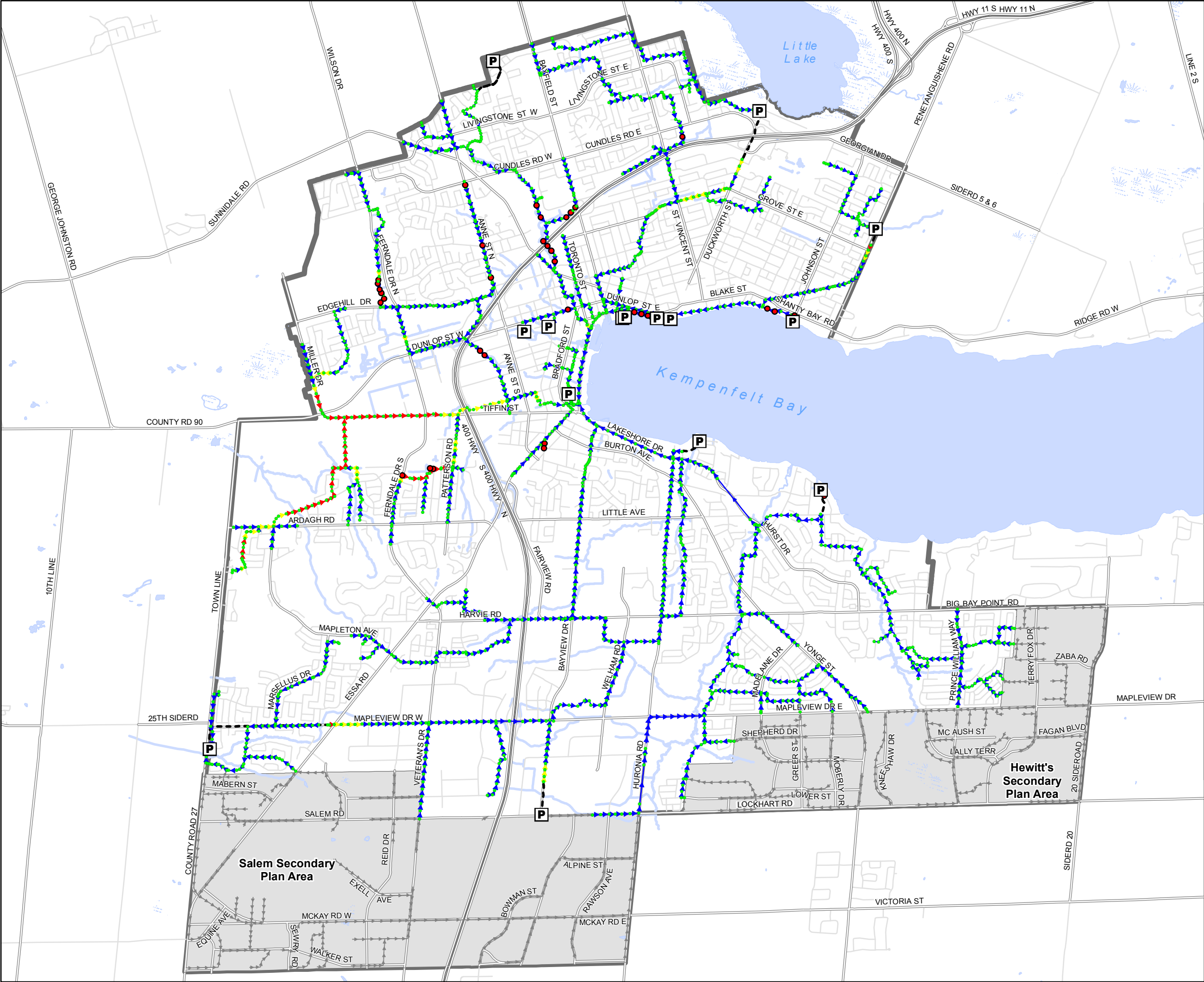
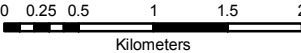


Figure 6-6
City of Barrie
Existing Wastewater
Collection System Performance
Wet Weather Flow Conditions
(25 Year Storm Event)



- P** Pumping Stations
- Forcemain
- Secondary Plan Boundaries
- City of Barrie Limits
- Future Annexed Lands Sewers
- NewFreebrd25yr**
 - $\leq 1.8\text{m}$
 - $> 1.8\text{m}$
- NewMaxFullDpth25yr**
 - < 0.5
 - $0.5 - 0.7$
 - > 0.7



189 - 197 DUCKWORTH STREET - PROPOSED TOWNHOUSE DEVELOPMENT														Design Parameters										 PEL PINESTONE ENGINEERING LTD.																																																																																																																																																																																																																																																																																																																																																																																			
City of Barrie				SANITARY SEWER DESIGN SHEET										Average Daily Flow					Mannings "n" 0.0130																																																																																																																																																																																																																																																																																																																																																																																								
Project Number: 20-11545B Date: October 2, 2023 Design By: DH Checked By: JHV File: Z:\Project Documents\11545B 191 Duckworth Street FSR\FSR\Sanitary Sewer Design Sheet.xls				ENGINEERING AND PUBLIC WORKS										Residential 0.0026 L/s/c					Min. Velocity 0.60 m/sec Max. Velocity 3.0 m/sec Residential Harmon Peaking Factor (F)																																																																																																																																																																																																																																																																																																																																																																																								
														Commercial 0.326 L/s/ha					Infiltration 0.10 L/s/ha																																																																																																																																																																																																																																																																																																																																																																																								
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LOCATION				RESIDENTIAL AREAS and POPULATION						SCHOOL, INSTITUTIONAL			COMMERCIAL			INDUSTRIAL				INFILTRATION			DESIGN																																																																																																																																																																																																																																																																																																																																																																																				
STREET	AREA NO.	MANHOLE LOCATION		AREA	UNITS	POPUL.	CUMUL POPUL.	PEAK FACTOR "F"	PEAK RES. FLOW	HECTARES AND FLOW OF EACH ZONING						TOTALS- C-I FLOW	AREA	CUMUL AREA	INFIL FLOW	TOTAL VOLUME FLOW	LENGTH	SLOPE	PIPE SIZE	CAPACITY	FULL FLOW VELOCITY	ACTUAL VELOCITY																																																																																																																																																																																																																																																																																																																																																																																	
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Proposed Development (24 Townhouse Units)		1A 2A	2A SAL08303	0.29	24.00	0.056	0.056	4.304239 0.056	4.304239 0.6295																																																																																																																																																																																																																																																																																																																																																																																																		

FLOW TEST RESULTS



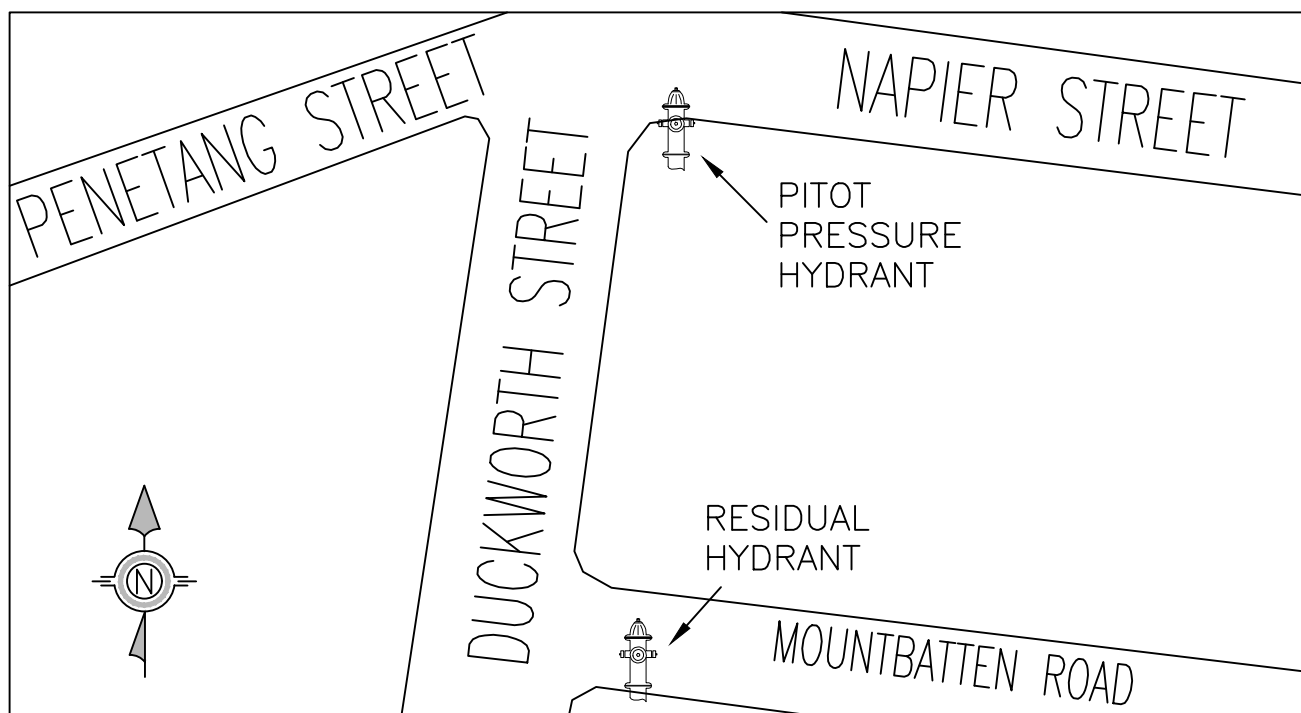
DATE : TUESDAY SEPTEMBER 22, 2020 TIME : 3:15 PM

LOCATION : DUCKWORTH STREET & MOUNTBATTEN ROAD

BARRIE

ONTARIO

TEST BY : VIPOND FIRE PROTECTION AND LOCAL PUC



STATIC PRESSURE : 70 PSI

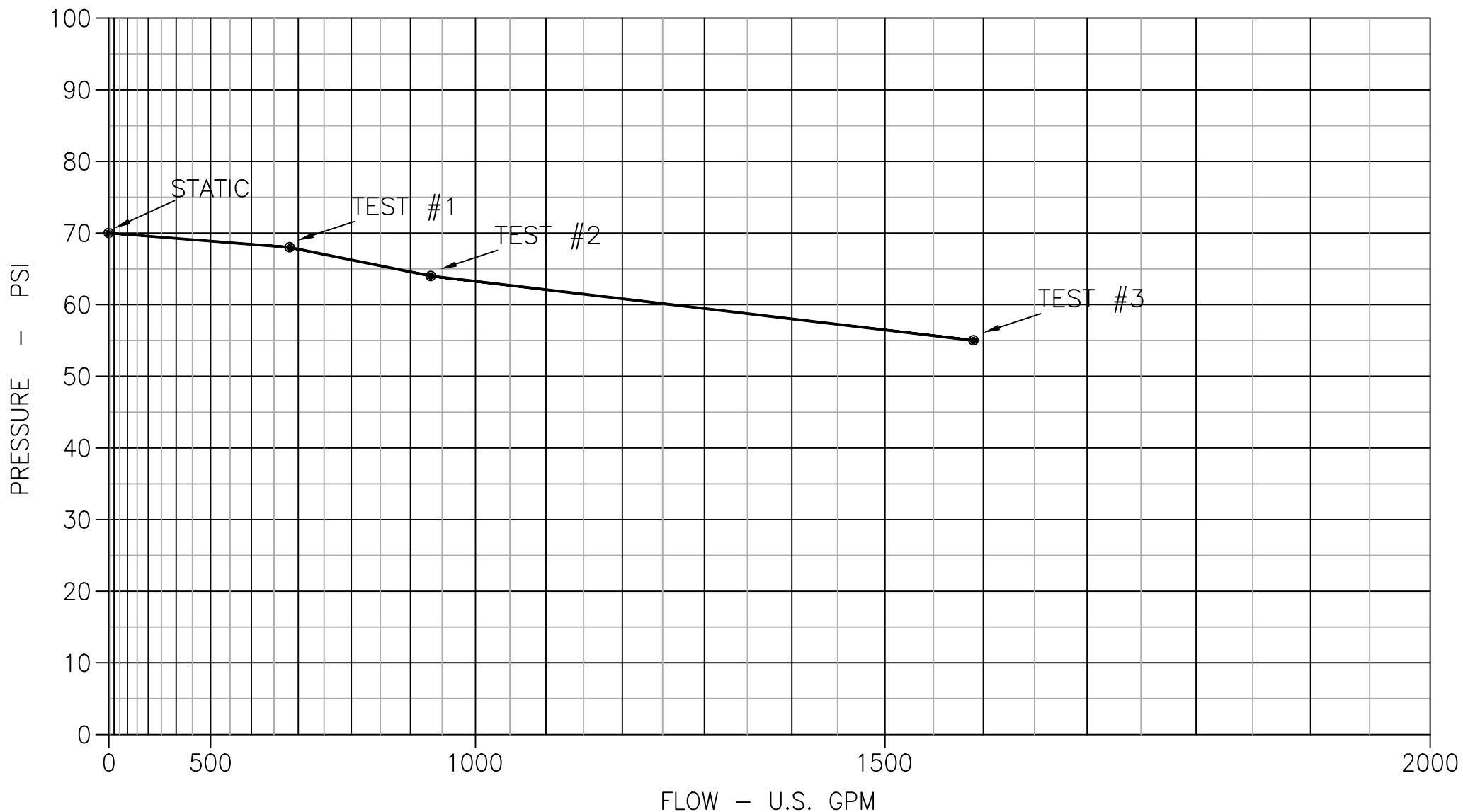
UNDERGROUND TYPE & SIZE: 12" PVC

TEST NO.	NO. OF NOZZLES	NOZZLE DIAMETER (INCHES)	DISCHARGE CO-EFFICIENT	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	DISCHARGE (U.S.GPM)
1	1	1-3/4	0.995	68	58	678
2	1	2-1/2	0.9	64	31	939
3	2	2-1/2	0.9	55	22	1582



DUCKWORTH STREET & MOUNTBATTEN ROAD	BY : GUS A.
BARRIE	OFFICE : BARRIE
ONTARIO	TEST BY : VIPOND & PUC
	DATE : SEPTEMBER 22, 2020

STATIC:	RESIDUAL:	FLOW:
<u>70</u> PSI	TEST#1 <u>68</u> PSI	@ <u>678</u> GPM
	TEST#2 <u>64</u> PSI	@ <u>939</u> GPM
	TEST#3 <u>55</u> PSI	@ <u>1582</u> GPM



physical disconnection from any piping or plumbing that is to be connected to the municipal water supply.

4.2.3. Infrastructure Standard Drawings

In addition to these written guidelines, reference should also be made to the City's Infrastructure Standard Drawings.

4.2.4. Approved Products for Drinking Water Systems

In addition to these written guidelines, reference should also be made to the approved products list for drinking water systems.

4.3. Watermain Design Criteria

4.3.1. Flow Calculations

The Developer/Owner and his Consultant shall propose the size of the watermain to accommodate the development.

The watermain shall be sized to meet the greater of either:

- Maximum day demand plus fire flow or
- Peak hour demand.

DENSITIES – the following densities shall be used for population:

Residential P.P.U.

Low Density (single detached, duplexes or semi-detached dwellings)	3.25 ppu
Medium Density (triplexes and fourplexes, cluster and/or block townhouses, street townhouses, walk-up apartments)	2.57 ppu
High Density (apartment dwellings)	1.67 ppu

Adopted from "Development Charges Background Study City of Barrie", Watson & Associates, April 2019

AVERAGE DAY DEMANDS – the following minimum average consumption rates shall be used in average demand calculation:

Average Water Consumption Rate

Residential	225 Litres/Capita/Day
Commercial/Institutional	28 m ³ /ha/Day
Industrial	35 m ³ /ha/Day

Note: Industrial consumption rate is for light industrial use. Heavy industrial use could have significantly higher water consumptions.

PEAKING FACTORS – peaking factors shall be based on MECP Design Guidelines for Drinking – Water Systems, 2008 (Table 3-1 and Table 3-3).

HAZEN-WILLIAMS "C" FACTORS – the following "C-Factors", as recommended by MECP, shall be used, based on inside diameter of the pipe/ regardless of material:

Watermain Pipe C-Factors

Pipe Diameter (mm)	"C" Factor
150	100
200-250	110
300-600	120
Over 600	130

According to MECP Design Guidelines for Drinking – Water Systems (2008), a minimum operations pressure of 275 kPa (40 psi) and a maximum operating pressure of 700 kPa (100 psi) shall be maintained through the system. Preferred operating pressure shall generally be in the range of 350 to 485 kPa (50 to 70 psi) under maximum daily flow. Pressures outside of this range can be accepted; however, where the maximum pressures exceed 550 kPa (80 psi), PRVs are required inside the building after the meter that is supplied and installed by the contractor/homeowner. Pressure during maximum day demand plus fire flow shall not fall below 140 kPa (20 psi).

The developer's consulting engineer shall contact the Corporate Asset Management Branch of the Infrastructure and Growth Management Division to determine if the development site is in an area experiencing problematic static and residual pressures along with any deficiencies in meeting fire flow requirements.

Fire flows shall meet the following criteria:

FIRE FLOW DEMAND – the following minimum fire flow demands shall be used in hydraulic network analysis unless FUS calculations require a higher fire flow:

Fire Flow Requirements

Description	Minimum Required Fire Flow (L/s) ¹
Large Residential Lots ²	70
Residential	100
Townhouse	155
Apartment	200
High Rise Residential / Downtown / Mixed Use	- ³
Institutional	200
Commercial	283
Industrial	333

Note 1: Subject to requirements of the Ontario Building Code

2: Refers to Buildings having a minimum of 3.0 meters of separation between buildings

3: Applicant will need to provide their own calculations

Specific fire flow demand shall be calculated according to the latest published requirements of the Water Supply for Public Fire Protection; Fire Underwriters Survey (as amended). Proposed Fire Flows less than minimums indicated would be subject to recommendation by a qualified Professional Engineer and approval by the City on a case by case basis.

Table 3-1: Peaking Factors

POPULATION	MINIMUM RATE FACTOR (MINIMUM HOUR)	MAXIMUM DAY FACTOR	PEAK RATE FACTOR (PEAK HOUR)
500 - 1 000	0.40	2.75	4.13
1 001 - 2 000	0.45	2.50	3.75
2 001 - 3 000	0.45	2.25	3.38
3 001 - 10 000	0.50	2.00	3.00
10 001 - 25 000	0.60	1.90	2.85
25 001 - 50 000	0.65	1.80	2.70
50 001 - 75 000	0.65	1.75	2.62
75 001 -150 000	0.70	1.65	2.48
greater than 150 000	0.80	1.50	2.25

3.4.3 Commercial and Institutional Water Demands

Institutional and commercial flows should be determined by using historical records, where available. Where no records are available, the values in Table 3.2 should be used. For other commercial and tourist-commercial areas, an allowance of 28 m³/(ha·d) [3000 USgal/(acre·d)] average flow should be used in the absence of reliable flow data.

When using the above unit demands, maximum day and peak rate factors should be developed. For establishments in operation for only a portion of the day such as schools and shopping plazas, the water usage should also be factored accordingly. For instance, with schools operating for 8 hours per day, the water use rate would be at an average rate of 70 L/(student·day) [19 USgal/(student·day)] x 24/8 or 210 L/student (55 USgal/student) over the 8-hour period of operation. The water use will drop to a residual amount during the remainder of the day. Schools generally do not exhibit large maximum day to average day ratios and a factor of 1.5 will generally cover this variation. For estimation of *peak demand* rates, an assessment of the water-using fixtures is generally necessary and a fixture-unit approach should be used.

Table 3-5 Maximum Day Factor and Average Daily Demand Per Capita Per Zone

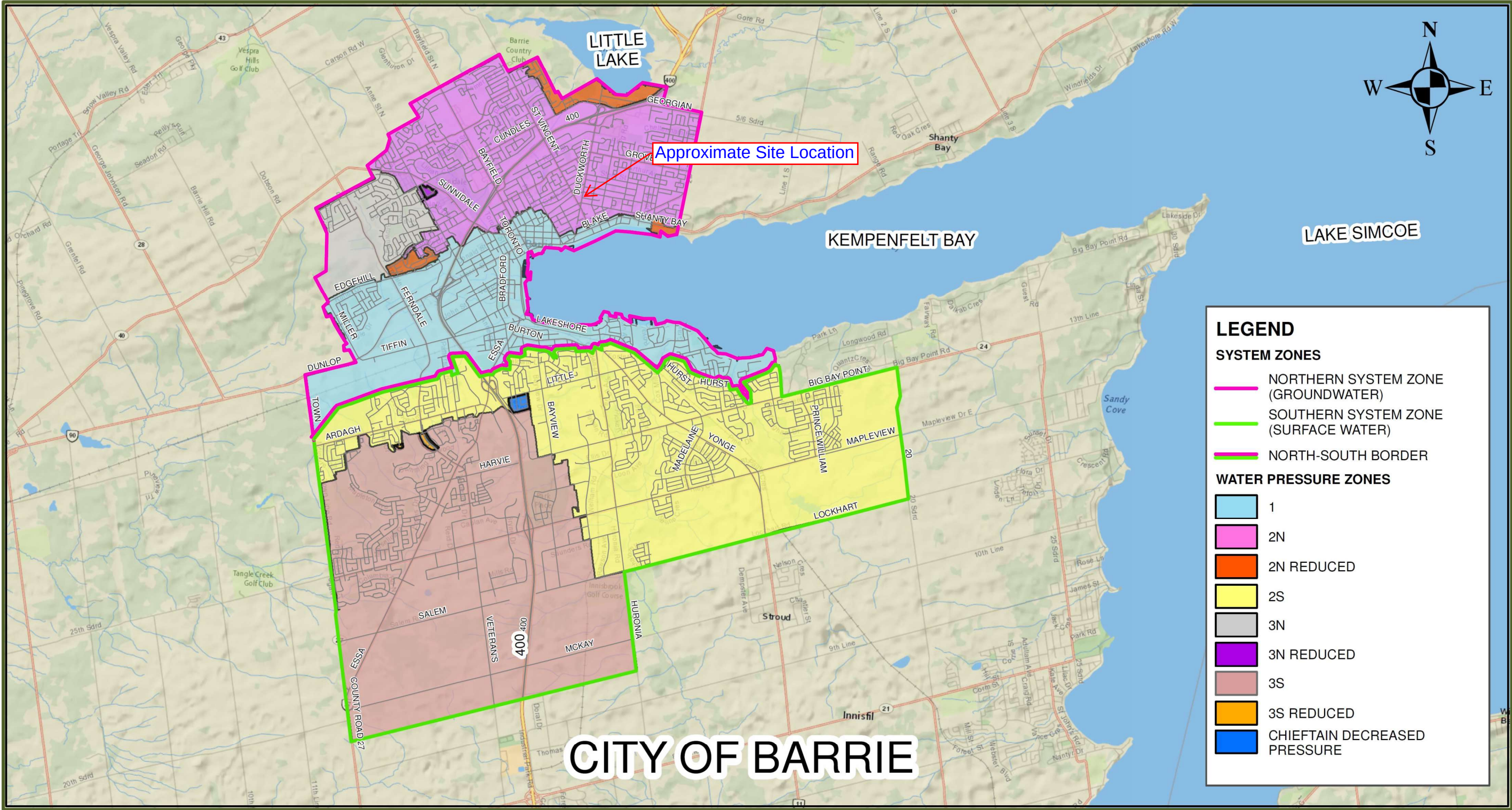
	ZONE 1	ZONE 2N	ZONE 3N	ZONE 2S	ZONE 3S
Maximum Day Factor from 2015 to 2017 ¹	2.30	1.66	2.41	2.32	1.63
Maximum Day Factor for Established Population	2.30	1.80	2.41	2.32	1.80
Maximum Day Factor for Future Population ²					
2021	1.90	1.80	2.00	1.75	1.80
2026	1.80	1.80	2.00	1.75	1.80
2031	1.80	1.75	2.00	1.75	1.80
2036	1.80	1.75	2.00	1.65	1.80
2041	1.80	1.75	2.00	1.65	1.80
2071	1.75	1.75	1.90	1.65	1.75
Average Daily Demand Per Capita (Lpcd) for Established and Future Population ³	174	162	210	129	224

¹ Based on the maximum day factor of each zone found in Table 3-2, Table 3-3 and Table 3-4.

² The maximum day factors for the future population were based on Table 3-1: Peaking factors of *Design Guidelines For-Drinking Water Systems, 2008* from MECP, according to the total equivalent population of each projected year.

³ The average daily demand each zone was calculated based on the average daily demand per capita found in Table 3-2, Table 3-3 and Table 3-4.

The combined population projections, average day demand and maximum day demand projections to ultimate buildout are summarized in Table 3-6. The demands associated with growth in the Salem and Hewitts Secondary Plan Areas have been included in Zones 2S and 3S.



Fire Flow Calculations – Fire Underwriters Survey 2020

189-197 Duckworth Street, City of Barrie

Fire demands for the proposed development were calculated in accordance with the Fire Underwriters Survey (FUS) as follows:

$$RFF = 220C(A)^{0.5}$$

Where, $F =$ the required fire flow in litres per minute.
 $C =$ coefficient related to the type of construction.
 $A =$ total floor area of building (excluding basements) calculated as per FUS

Construction Coefficient (C)

C = 1.0 for Type III Ordinary Construction

Total Effective Area (A):

Total Effective Area: 2000.61m² (Excludes Water Meter Room and Units 1,2,11, and 12)

Base Required Fire Flow (RFF)

$RFF = 220 * 1.0 * (2,000)^{0.5}$
 $RFF = 9,839\text{L/min} \sim 10,000\text{L/min}$

Occupancy and Contents Adjustment Factor

Residential Units (Group C): -15%
 $RFF \text{ Reduction} = 10,000\text{L/min} * 0.15 = 1,500\text{L/min}$
 $RFF = 10,000\text{L/min} - 1,500\text{L/min} = 8,500\text{L/min}$

Exposure Adjustment Charge

Exposure Charge for Proposed Building Fire Wall to the North (+10%)
Exposure Charge for Existing Building to the South (~18.5m): (+5%)
Exposure Charge for Existing Building to the East (~26.8m): (+0%)
Exposure Charge for Existing Building to the West (~32.5m): (+0%)
Total Building Exposure Charge: 15%
 $RFF \text{ Increase} = 8,500\text{L/min} * 0.15 = 1,275\text{L/min}$

DESIGN Required Fire Flow (RFF)

Design RFF (FUS 2020) = 8,500L/min + 1,275L/min
Design RFF (FUS 2020) = 9,775L/min = 10,000L/min = 167L/sec

189-197 DUCKWORTH STREET DEVELOPMENT
MINIMUM WATER SUPPLY FLOWRATE ANALYSIS
Barrie, Ontario



Project Number: 20-11545B
 Date: October 2, 2023
 Design By: DPH
 File: Z:\Project Documents\11545B 191 Duckworth Street FSR\FSR\Minimum Water Supply Flowrate Analysis.xls

CALCULATION OF RESIDUAL PRESSURE AT EXISTING WATERMAIN

1. Boundary Conditions (Based on Fire Flow Test Results):			
	Metric	Imperial	
P0 - Starting Pressure	49.23 <i>m</i>	70 <i>psi</i>	
P1 - Pressure at Q1	38.68 <i>m</i>	55 <i>psi</i>	
Q1 - From Fire Flow Test	5989 <i>L/min</i>	1582 <i>U.S. gal/min</i>	
Q2 - Required Flow	11435 <i>L/min</i>	3021 <i>U.S. gal/min</i>	From FUS
P-loss 1	10.55 <i>m</i>	15 <i>psi</i>	
P-loss 2	34.95 <i>m</i>	50 <i>psi</i>	
P2 - Residual Pressure	14.28 <i>m</i>	20.3 <i>psi</i>	Extrapolated from Fire Flow Test Results

ANALYSIS SUMMARY

Residual Pressure after Losses	14.28 <i>m</i>	20.3 <i>psi</i>	PASS
<i>Allowable Residual Pressure</i>	<i>140 kPa</i>	<i>20.3 <i>psi</i></i>	

189-197 DUCKWORTH STREET DEVELOPMENT
FIRE FLOW ANALYSIS
Barrie, Ontario



Project Number: 20-11545B
 Date: October 2, 2023
 Design By: DPH
 File: Z:\Project Documents\11545B 191 Duckworth Street FSR\FSR\Site Fire Flow Analysis.xls

CALCULATION OF RESIDUAL PRESSURE AT EXISTING WATERMAIN

1. Boundary Conditions (Based on Fire Flow Test Results):			
	Metric	Imperial	
P0 - Starting Pressure	49.23 <i>m</i>	70 <i>psi</i>	
P1 - Pressure at Q1	38.68 <i>m</i>	55 <i>psi</i>	
Q1 - From Fire Flow Test	5989 <i>L/min</i>	1582 <i>U.S. gal/min</i>	
Q2 - Required Flow	10031 <i>L/min</i>	2650 <i>U.S. gal/min</i>	From FUS
P-loss 1	10.55 <i>m</i>	15 <i>psi</i>	
P-loss 2	27.42 <i>m</i>	39 <i>psi</i>	
P2 - Residual Pressure	21.81 <i>m</i>	31.0 <i>psi</i>	Extrapolated from Fire Flow Test Results

ANALYSIS SUMMARY

Residual Pressure after Losses	21.81 <i>m</i> 214 <i>kPa</i>	31.0 <i>psi</i>	PASS
<i>Allowable Residual Pressure</i>	<i>140 <i>kPa</i></i>	<i>20.3 <i>psi</i></i>	

**189-197 DUCKWORTH STREET – CITY OF BARRIE
24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT**

APPENDIX D

SWM Design Calculations

where,

- Q = the design flow in (m³/s)
 C = the site specific runoff coefficient
 A = the drainage area (ha)
 i = rainfall intensity (mm/hr)

The rainfall intensity shall be calculated in accordance with the following table and equation:

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
A	675.586	843.019	976.898	1133.123	1251.473	1383.628
B	4.681	4.582	4.745	4.734	4.847	4.905
C	0.780	0.763	0.760	0.756	0.753	0.754

Rainfall Intensity, I (mm/hr) = A/(t+B)^C, where t is time duration in minutes

Parameters based on rain gauge data for the period 1979 – 2003 for the Barrie WPCC Station #6110557

Based on a review of the literature, the IDF intensity values for Barrie WPCC Station were increased by 15% before calculating a, b, c values to account for climate change.

$$i = \frac{A}{(t_d + B)^C}$$

where,

- i = the rainfall intensity (mm/hr)
 t_d = the storm duration (minutes)

A, B, C = a function of the local intensity-duration data.

The storm duration is set to the time of concentration (i.e. the sewer inlet time plus the time of travel in the pipe or channel) for the total cumulative drainage area to the node of interest. The maximum inlet time for the first pipe of a storm sewer system is 10 minutes.

The runoff coefficient shall be calculated in accordance with the following table:

Table 3.2: Runoff Coefficients (Rational C) (5-yr to 10-yr) Based on Hydrologic Soil Group

Land Use	Runoff Coefficient "C"		
	A-AB	B-BC	C-D
Cultivated Land, 0 - 5% grade	0.22	0.35	0.55
Cultivated Land, 5 - 10% grade	0.30	0.45	0.60
Cultivated Land, 10 - 30% grade	0.40	0.65	0.70
Pasture Land, 0 - 5% grade	0.10	0.28	0.40
Pasture Land, 5 - 10% grade	0.15	0.35	0.45
Pasture Land, 10 - 30% grade	0.22	0.40	0.55
Woodlot or Cutover, 0 - 5% grade	0.08	0.25	0.35
Woodlot or Cutover, 5 - 10% grade	0.12	0.30	0.42
Woodlot or Cutover, 10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands	0.05	0.05	0.05
Impervious Area (i.e., buildings, roads, parking lots, etc.)	0.95	0.95	0.95
Gravel (not to be used for proposed parking or storage areas)	0.40	0.50	0.60
Residential – Single Family	0.30	0.40	0.50
Residential – Multiple (i.e., semi, townhouse, apartment)	0.50	0.60	0.70
Industrial – light	0.55	0.65	0.75
Industrial – heavy	0.65	0.75	0.85
Commercial	0.60	0.70	0.80
Unimproved Areas	0.10	0.20	0.30
Lawn, < 2% grade	0.05	0.11	0.17
Lawn, 2 - 7% grade	0.10	0.16	0.22
Lawn, > 7% grade	0.15	0.25	0.35

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO. (1997)

An approximation of the runoff coefficient can be calculated based on the following relationship

$$\text{with: } c = (0.7)(TIMP) + 0.2$$

where,

c = the runoff coefficient

$TIMP$ = total impervious fraction (dimensionless)

The runoff coefficient shall be adjusted for return period events greater than the 10-yr storm per the following table:

Table 3.3: Runoff Coefficient Adjustment for 25-yr to 100-yr Storms

Return Period	Runoff Coefficient "C"
25 years	$C_{25} = 1.1 \cdot C_5$
50 years	$C_{50} = 1.2 \cdot C_5$
100 years	$C_{100} = 1.25 \cdot C_5$

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO. (1997).

7.2.5 Calculation of Model Parameters

Model parameters shall be site specific, area weighted if required, and provided with the design documents. Soils information shall be obtained from on-site soil testing (e.g. borehole data) or soil survey mapping (e.g. *Soil Survey of Simcoe County*).

Table 7.4: Curve Numbers for Selected Land Uses

Land Use Description	Hydrologic Soil Group (AMC II)						
	A	AB	B	BC	C	CD	D
Cultivated Land (Fallow)	77	82	86	89	91	93	94
²Cultivated Land (Row Crops)							
---- without agricultural BMPs	72	77	81	85	88	90	91
---- ³ with agricultural BMPs	62	67	71	75	78	80	81
⁴Cultivated Land (Small Grain)							
---- without agricultural BMPs	65	71	76	80	84	86	88
---- with agricultural BMPs	59	65	70	74	78	80	81
⁵Cultivated Land (Close-seeded Legumes or Rotation Meadow)							
---- without agricultural BMPs	66	72	77	81	85	87	89
---- with agricultural BMPs	51	59	67	72	76	78	80
Pasture or Range Land							
---- ⁶ poor condition	68	74	79	83	86	88	89
---- ⁷ good condition	39	50	61	68	74	77	80
Meadow							
---- good condition	30	44	58	65	71	75	78
Wooded or Forest Land							
---- ⁸ poor cover	45	56	66	72	77	80	83
---- ⁹ good cover	25	40	55	63	70	74	77
Open Spaces, Lawns, Parks, Golf Courses, Cemeteries							
---- good condition (≥75% grass coverage)	39	50	61	68	74	77	80

---- fair condition (50% - 75% grass coverage)	49	59	69	74	79	82	84
Commercial and Business Areas (~85% impervious)	89	91	92	93	94	95	95
Industrial Areas (~72% impervious)	81	85	88	90	91	92	93
¹⁰Residential Areas							
---- ≤ 1/8 acre lot size (~65% impervious)	77	81	85	88	90	91	92
---- 1/4 acre lot size (~38% impervious)	61	68	75	79	83	85	87
---- 1/3 acre lot size (~30% impervious)	57	65	72	77	81	84	86
---- ½ acre lot size (~25% impervious)	54	62	70	75	80	83	85
---- 1 acre lot size (~20% impervious)	51	60	68	74	79	82	84
Paved Parking Lots, Roofs, Driveways	98	98	98	98	98	98	98
Streets and Roads							
---- paved with curb and storm sewer connection	98	98	98	98	98	98	98
---- gravel	76	81	85	87	89	90	91
---- dirt	72	77	82	85	87	88	89
¹¹Open Water Bodies (Lakes, Wetlands, Ponds)	100	100	100	100	100	100	100

1 -- Adapted from U.S. Soil Conservation Service National Engineering Handbook (1972), MTC Drainage Manual Chapter B (1984),

MTO Drainage Management Manual (1997).

2 -- Includes row crops such as soybeans, corn, sorghum hay, peanut, potato, etc.

3 -- Includes agricultural best management practices (BMPs) such as contouring and terracing.

4 -- Includes small grain crops such as winter wheat, spring wheat, durham wheat, barley, oats, rye, etc.

5 -- Includes close-seeded legumes such as alfalfa, timothy grass, grass hay, etc.

6 -- Poor condition is defined as heavily grazed, no mulch, or has plant cover on less than 50% of the area.

7 -- Good condition is defined as lightly grazed, more than 75% of the area has plant cover.

8 -- Poor cover is defined as heavily grazed or regularly burned so that litter, small trees and brush are regularly destroyed.

9 -- Good cover is defined as protected from grazing so that litter and shrubs cover the soil.

10 -- Curve numbers are calculated assuming that roof leaders are connected to the driveway and/or road with a minimum of additional infiltration.

11 -- When a number of water bodies within a large multi-land use catchment is modeled, a CN value of 50 may be applied to the water bodies in calculating the area-weighted CN value. When isolating a water body and modeling as a separate catchment, then a CN value of 100 should be used and the catchment is typically routed through a reservoir.

189-197 DUCKWORTH STREET TOWNHOUSE DEVELOPMENT

PRE DEVELOPMENT SWM INPUT PARAMETERS

Barrie, Ontario

Project Number:20-11545B

Date:September 29, 2023

Design By:DH

File:Z:\Project Documents\11545B 191 Duckworth Street FSR\FSR\HYMO SWM Calculations - DH.xls



Runoff Coefficients	
Land Use	"C"
Lawn (<2%)	0.11
Lawn (2-7%)	0.16
Single Family Rooftop Area	0.95
Semi-detached Rooftop Area	0.95
Townhouse Rooftop Area	0.95
Medium/High Density Impervious Area	0.60
Industrial	0.65
Commercial	0.70
Paved areas	0.95

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

Pre Development Runoff Coefficients:

Catchment	Total Area (m ²)	Lawn (<2%) (m ²)	Lawn (2-7%) (m ²)	Single Family Rooftop Area (m ²)	Semi-detached Rooftop Area (m ²)	Townhouse Rooftop Area (m ²)	Medium/High Density Impervious Area (m ²)	Industrial Area (m ²)	Commercial Area (m ²)	Paved Area (m ²)	Weighted C
101	2,930	2,265		355						310	0.30

Time of Concentration Calculations:

Catchment Parameters			
Catchment ID	=	101	
Catchment Area	=	0.2930	ha
Pervious Flow Length	=	50	m
Pervious Slope	=	0.01	m/m
Impervious Slope	=	0.01	m/m
Weighted Runoff Coefficient	=	0.30	

Pre Development Curve Number (CN):

Catchment	Hydrologic Soil Group	Soil Texture	Total Area (m ²)	Lakes / Wetlands / SWMF's (m ²)	Forest / Woodlot Area (m ²)	Meadow / Field Area (m ²)	Lawn / Grass Area (m ²)	Crop Area (m ²)	Weighted CN
101	B	Silty Sand	2,265				2,265		61.0

Pre Development Initial Abstraction (IA):

Catchment	Total Area (m ²)	Lawn/Grass Area (m ²)	Forest/Woodlot Area (m ²)	Lakes / Wetlands SWMF (m ²)	Meadow/Field Area (m ²)	Pasture/Range Area (m ²)	Weighted IA
101	2,265	2,265					5.0

Pre-Development Modified Curve Number (CN*):

Catchment	Weighted CN (AMC II)	Total Precipitation (P), mm (100-Year SCS Type II Event)	Weighted CN (AMC III)	Soil Storage (S), mm (AMC III)	Initial Abstraction (IA), SCS Method (AMC III)	Runoff Volume (Q), mm (AMC III)	Soil Storage (S*), mm (AMC III)	Weighted CN* (AMC III)	Weighted CN* (AMC II)
101	61.0	137	78.2	70.6	7.1	84.2	75.0	77.2	60

* Process for calculating the Modified Curve Number (CN*) follows section 1.2 of the Visual Otthymo Reference Guide Version 5.1, prepared by Civica Infrastructure Inc. (2018)

For STANDHYD Command in Otthymo:

Pervious Area Calculations:	Catchment	Total Pervious Area (m2)				
	101	2,265				
Impervious Area Calulations:	Catchment	Total Directly Connected Area (m2)	Total Indirectly Connected Area (m2)	Total Impervious Area (m2)	% Ximp	% Timp
	101	488	178	665	16.6	22.7

SCS Curve Numbers							
Cover	Hydrologic Soil Group						
	A	AB	B	BC	C	CD	D
Wetlands / Lakes/ SWMF's	100	100	100	100	100	100	100
Forest/Woodlot	25	40	55	63	70	74	77
Meadow/Field	30	44	58	65	71	75	78
Lawn/Grass	39	50	61	68	74	77	80
Pasture/Range	39	50	61	68	74	77	80
Impervious Areas	98	98	98	98	98	98	98

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

Initial Abstraction / Depression Storage	
Cover	Depth (mm)
Wetlands / Lakes/ SWMF	0
Forest/Woodlot	10
Meadow/Field	8
Lawn/Grass	5
Pasture/Range	7
Impervious Areas	2

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

189-197 DUCKWORTH STREET TOWNHOUSE DEVELOPMENT
POST DEVELOPMENT SWM INPUT PARAMETERS
Barrie, Ontario

Project Number: 20-11545B
Date: September 29, 2023
Design By: DH
File: Z:\Project Documents\11545B 191 Duckworth Street FSR\FSR\HYMO SWM Calculations - DH.xls



Runoff Coefficients	
Land Use	"C"
Lawn (<2%)	0.11
Lawn (2-7%)	0.16
Single Family Rooftop Area	0.95
Semi-detached Rooftop Area	0.95
Townhouse Rooftop Area	0.95
Medium/High Density Impervious Area	0.60
Industrial	0.65
Commercial	0.70
Paved areas	0.95

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

Post Development Runoff Coefficients:

Catchment	Total Area (m ²)	Lawn (<2%) (m ²)	Lawn (2-7%) (m ²)	Single Family Rooftop Area (m ²)	Semi-detached Rooftop Area (m ²)	Townhouse Rooftop Area (m ²)	Medium/High Density Impervious Area (m ²)	Industrial Area (m ²)	Commercial Area (m ²)	Paved Area (m ²)	Weighted C
201	2,505		465			885				1,155	0.80
202	425		295							130	0.40

Time of Concentration Calculations:

Catchment Parameters			
Catchment ID	=	201	ha
Catchment Area	=	0.2505	
Pervious Flow Length	=	30	
Pervious Slope	=	0.05	m/m
Impervious Slope	=	0.03	
Weighted Runoff Coefficient	=	0.80	

Catchment Parameters			
Catchment ID	=	202	ha
Catchment Area	=	0.0425	
Pervious Flow Length	=	10	
Pervious Slope	=	0.05	m/m
Impervious Slope	=	0.02	
Weighted Runoff Coefficient	=	0.40	

Post Development Curve Number (CN):

Catchment	Hydrologic Soil Group	Soil Texture	Total Area (m ²)	Lakes / Wetlands / SWMF's (m ²)	Forest / Woodlot Area (m ²)	Meadow / Field Area (m ²)	Lawn / Grass Area (m ²)	Crop Area (m ²)	Weighted CN
201	B	Silty Sand	465				465		61.0
202	B	Silty Sand	295				295		61.0

Post Development Initial Abstraction (IA):

Catchment	Total Area (m ²)	Lawn/Grass Area (m ²)	Forest/Woodlot Area (m ²)	Lakes / Wetlands SWMF (m ²)	Meadow/Field Area (m ²)	Cultivated Area (m ²)	Weighted IA
201	465	465					5.0
202	295	295					5.0

Post-Development Modified Curve Number (CN*):

Catchment	Weighted CN (AMC II)	Total Precipitation (P), mm (100-Year SCS Type II Event)	Weighted CN (AMC III)	Soil Storage (S), mm (AMC III)	Initial Abstraction (IA), SCS Method (AMC III)	Runoff Volume (Q), mm (AMC III)	Soil Storage (S*), mm (AMC III)	Weighted CN* (AMC III)	Weighted CN* (AMC II)
101	61.0	137	78.2	70.6	7.1	84.2	75.0	77.2	60
102	61.0	137	78.2	70.6	7.1	84.2	75.0	77.2	60

* Process for calculating the Modified Curve Number (CN*) follows section 1.2 of the Visual Otthymo Reference Guide Version 5.1, prepared by Civica Infrastructure Inc. (2018)

For STANDHYD Command in Otthymo:

Pervious Area Calculations:	Catchment	Total Pervious Area (m2)				
	201	465				
Impervious Area Calulations:	Catchment	Total Directly Connected Area (m2)	Total Indirectly Connected Area (m2)	Total Impervious Area (m2)	% Ximp	% Timp
	201	2,040	0	2,040	81.4	81.4

Pervious Area Calculations:	Catchment	Total Pervious Area (m2)				
	202	295				
Impervious Area Calulations:	Catchment	Total Directly Connected Area (m2)	Total Indirectly Connected Area (m2)	Total Impervious Area (m2)	% Ximp	% Timp
	202	78	52	130	18.4	30.6

SCS Curve Numbers							
Cover	Hydrologic Soil Group						
	A	AB	B	BC	C	CD	D
Wetlands / Lakes/ SWMF's	100	100	100	100	100	100	100
Forest/Woodlot	25	40	55	63	70	74	77
Meadow/Field	30	44	58	65	71	75	78
Lawn/Grass	39	50	61	68	74	77	80
Pasture/Range	39	50	61	68	74	77	80
Impervious Areas	98	98	98	98	98	98	98

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

Initial Abstraction / Depression Storage	
Cover	Depth (mm)
Wetlands / Lakes/ SWMF	0
Forest/Woodlot	10
Meadow/Field	8
Lawn/Grass	5
Cultivated	7
Impervious Areas	2

* Values taken from the City of Barrie Stormwater Infrastructure Design Standard (2023)

PRE-DEVELOPMENT



101

**PRE-DEVELOPMENT
AREA [ha] - 0.293**

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V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
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***** D E T A I L E D O U T P U T *****

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DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS: _____

** SIMULATION : 100yr 24hr 5min SCS Type II **

| READ STORM | Filename: C:\Users\dhordyk\AppData\Local\Temp\
| |

3.75	1.79	9.83	4.95	15.92	4.13	22.00	1.65
3.83	1.79	9.92	4.95	16.00	4.13	22.08	1.65
3.92	1.79	10.00	4.95	16.08	2.48	22.17	1.65
4.00	1.79	10.08	6.33	16.17	2.48	22.25	1.65
4.08	2.20	10.17	6.33	16.25	2.48	22.33	1.65
4.17	2.20	10.25	6.33	16.33	2.48	22.42	1.65
4.25	2.20	10.33	6.33	16.42	2.48	22.50	1.65
4.33	2.20	10.42	6.33	16.50	2.48	22.58	1.65
4.42	2.20	10.50	6.33	16.58	2.48	22.67	1.65
4.50	2.20	10.58	8.53	16.67	2.48	22.75	1.65
4.58	2.20	10.67	8.53	16.75	2.48	22.83	1.65
4.67	2.20	10.75	8.53	16.83	2.48	22.92	1.65
4.75	2.20	10.83	8.53	16.92	2.48	23.00	1.65
4.83	2.20	10.92	8.53	17.00	2.48	23.08	1.65
4.92	2.20	11.00	8.53	17.08	2.48	23.17	1.65
5.00	2.20	11.08	13.21	17.17	2.48	23.25	1.65
5.08	2.20	11.17	13.21	17.25	2.48	23.33	1.65
5.17	2.20	11.25	13.21	17.33	2.48	23.42	1.65
5.25	2.20	11.33	13.21	17.42	2.48	23.50	1.65
5.33	2.20	11.42	13.21	17.50	2.48	23.58	1.65
5.42	2.20	11.50	13.21	17.58	2.48	23.67	1.65
5.50	2.20	11.58	40.74	17.67	2.48	23.75	1.65
5.58	2.20	11.67	40.74	17.75	2.48	23.83	1.65
5.67	2.20	11.75	40.74	17.83	2.48	23.92	1.65
5.75	2.20	11.83	168.46	17.92	2.48	24.00	1.65
5.83	2.20	11.92	168.46	18.00	2.48		
5.92	2.20	12.00	168.46	18.08	2.48		
6.00	2.20	12.08	19.82	18.17	2.48		

| CALIB |
| STANDHYD (0101) | Area (ha)= 0.29
| ID= 1 DT= 5.0 min | Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	168.46	90.51
over (min)	5.00	15.00
Storage Coeff. (min)=	1.27 (ii)	11.61 (ii)
Unit Hyd. Tpeak (min)=	5.00	15.00
Unit Hyd. peak (cms)=	0.33	0.09
		TOTALS
PEAK FLOW (cms)=	0.02	0.04 0.055 (iii)

| Ptotal=137.63 mm | 076b810b-fee7-4861-b4d4-af28d1f0031d\91b85d5e
| Comments: 100yr 24hr 5min SCS Type II

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	6.08	2.48	12.17	19.82	18.25	2.48
0.08	1.51	6.17	2.48	12.25	19.82	18.33	2.48
0.17	1.51	6.25	2.48	12.33	19.82	18.42	2.48
0.25	1.51	6.33	2.48	12.42	19.82	18.50	2.48
0.33	1.51	6.42	2.48	12.50	19.82	18.58	2.48
0.42	1.51	6.50	2.48	12.58	10.18	18.67	2.48
0.50	1.51	6.58	2.48	12.67	10.18	18.75	2.48
0.58	1.51	6.67	2.48	12.75	10.18	18.83	2.48
0.67	1.51	6.75	2.48	12.83	10.18	18.92	2.48
0.75	1.51	6.83	2.48	12.92	10.18	19.00	2.48
0.83	1.51	6.92	2.48	13.00	10.18	19.08	2.48
0.92	1.51	7.00	2.48	13.08	7.43	19.17	2.48
1.00	1.51	7.08	3.03	13.17	7.43	19.25	2.48
1.08	1.51	7.17	3.03	13.25	7.43	19.33	2.48
1.17	1.51	7.25	3.03	13.33	7.43	19.42	2.48
1.25	1.51	7.33	3.03	13.42	7.43	19.50	2.48
1.33	1.51	7.42	3.03	13.50	7.43	19.58	2.48
1.42	1.51	7.50	3.03	13.58	5.78	19.67	2.48
1.50	1.51	7.58	3.03	13.67	5.78	19.75	2.48
1.58	1.51	7.67	3.03	13.75	5.78	19.83	2.48
1.67	1.51	7.75	3.03	13.83	5.78	19.92	2.48
1.75	1.51	7.83	3.03	13.92	5.78	20.00	2.48
1.83	1.51	7.92	3.03	14.00	5.78	20.08	1.65
1.92	1.51	8.00	3.03	14.08	4.13	20.17	1.65
2.00	1.51	8.08	3.58	14.17	4.13	20.25	1.65
2.08	1.79	8.17	3.58	14.25	4.13	20.33	1.65
2.17	1.79	8.25	3.58	14.33	4.13	20.42	1.65
2.25	1.79	8.33	3.58	14.42	4.13	20.50	1.65
2.33	1.79	8.42	3.58	14.50	4.13	20.58	1.65
2.42	1.79	8.50	3.58	14.58	4.13	20.67	1.65
2.50	1.79	8.58	3.85	14.67	4.13	20.75	1.65
2.58	1.79	8.67	3.85	14.75	4.13	20.83	1.65
2.67	1.79	8.75	3.85	14.83	4.13	20.92	1.65
2.75	1.79	8.83	3.85	14.92	4.13	21.00	1.65
2.83	1.79	8.92	3.85	15.00	4.13	21.08	1.65
2.92	1.79	9.00	3.85	15.08	4.13	21.17	1.65
3.00	1.79	9.08	4.40	15.17	4.13	21.25	1.65
3.08	1.79	9.17	4.40	15.25	4.13	21.33	1.65
3.17	1.79	9.25	4.40	15.33	4.13	21.42	1.65
3.25	1.79	9.33	4.40	15.42	4.13	21.50	1.65
3.33	1.79	9.42	4.40	15.50	4.13	21.58	1.65
3.42	1.79	9.50	4.40	15.58	4.13	21.67	1.65
3.50	1.79	9.58	4.95	15.67	4.13	21.75	1.65
3.58	1.79	9.67	4.95	15.75	4.13	21.83	1.65
3.67	1.79	9.75	4.95	15.83	4.13	21.92	1.65

TIME TO PEAK (hrs)=	12.08	12.17	12.08
RUNOFF VOLUME (mm)=	135.63	61.00	73.37
TOTAL RAINFALL (mm)=	137.63	137.63	137.63
RUNOFF COEFFICIENT =	0.99	0.44	0.53

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

=====

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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DATE: 10-12-2023 TIME: 03:44:42

USER:

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1.83	1.02	7.92	2.05	14.00	3.91	20.08	1.12
1.92	1.02	8.00	2.05	14.08	2.79	20.17	1.12
2.00	1.02	8.08	2.42	14.17	2.79	20.25	1.12
2.08	1.21	8.17	2.42	14.25	2.79	20.33	1.12
2.17	1.21	8.25	2.42	14.33	2.79	20.42	1.12
2.25	1.21	8.33	2.42	14.42	2.79	20.50	1.12
2.33	1.21	8.42	2.42	14.50	2.79	20.58	1.12
2.42	1.21	8.50	2.42	14.58	2.79	20.67	1.12
2.50	1.21	8.58	2.60	14.67	2.79	20.75	1.12
2.58	1.21	8.67	2.60	14.75	2.79	20.83	1.12
2.67	1.21	8.75	2.60	14.83	2.79	20.92	1.12
2.75	1.21	8.83	2.60	14.92	2.79	21.00	1.12
2.83	1.21	8.92	2.60	15.00	2.79	21.08	1.12
2.92	1.21	9.00	2.60	15.08	2.79	21.17	1.12
3.00	1.21	9.08	2.98	15.17	2.79	21.25	1.12
3.08	1.21	9.17	2.98	15.25	2.79	21.33	1.12
3.17	1.21	9.25	2.98	15.33	2.79	21.42	1.12
3.25	1.21	9.33	2.98	15.42	2.79	21.50	1.12
3.33	1.21	9.42	2.98	15.50	2.79	21.58	1.12
3.42	1.21	9.50	2.98	15.58	2.79	21.67	1.12
3.50	1.21	9.58	3.35	15.67	2.79	21.75	1.12
3.58	1.21	9.67	3.35	15.75	2.79	21.83	1.12
3.67	1.21	9.75	3.35	15.83	2.79	21.92	1.12
3.75	1.21	9.83	3.35	15.92	2.79	22.00	1.12
3.83	1.21	9.92	3.35	16.00	2.79	22.08	1.12
3.92	1.21	10.00	3.35	16.08	1.67	22.17	1.12
4.00	1.21	10.08	4.28	16.17	1.67	22.25	1.12
4.08	1.49	10.17	4.28	16.25	1.67	22.33	1.12
4.17	1.49	10.25	4.28	16.33	1.67	22.42	1.12
4.25	1.49	10.33	4.28	16.42	1.67	22.50	1.12
4.33	1.49	10.42	4.28	16.50	1.67	22.58	1.12
4.42	1.49	10.50	4.28	16.58	1.67	22.67	1.12
4.50	1.49	10.58	5.77	16.67	1.67	22.75	1.12
4.58	1.49	10.67	5.77	16.75	1.67	22.83	1.12
4.67	1.49	10.75	5.77	16.83	1.67	22.92	1.12
4.75	1.49	10.83	5.77	16.92	1.67	23.00	1.12
4.83	1.49	10.92	5.77	17.00	1.67	23.08	1.12
4.92	1.49	11.00	5.77	17.08	1.67	23.17	1.12
5.00	1.49	11.08	8.93	17.17	1.67	23.25	1.12
5.08	1.49	11.17	8.93	17.25	1.67	23.33	1.12
5.17	1.49	11.25	8.93	17.33	1.67	23.42	1.12
5.25	1.49	11.33	8.93	17.42	1.67	23.50	1.12
5.33	1.49	11.42	8.93	17.50	1.67	23.58	1.12
5.42	1.49	11.50	8.93	17.58	1.67	23.67	1.12
5.50	1.49	11.58	27.54	17.67	1.67	23.75	1.12
5.58	1.49	11.67	27.54	17.75	1.67	23.83	1.12
5.67	1.49	11.75	27.54	17.83	1.67	23.92	1.12
5.75	1.49	11.83	113.87	17.92	1.67	24.00	1.12
5.83	1.49	11.92	113.87	18.00	1.67		

5.92 1.49 | 12.00 113.87 | 18.08 1.67 |
6.00 1.49 | 12.08 13.40 | 18.17 1.67 |

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\9eec4b2d-2c39-4ecf-8958-5a3fed877047\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\9eec4b2d-2c39-4ecf-8958-5a3fed877047\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS: _____

** SIMULATION : 10yr 4hr 5min Chicago **

CHICAGO STORM IDF curve parameters: A= 976.898
Ptotal= 59.77 mm B= 4.745
C= 0.760
used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	4.04	1.00	16.64	2.00	10.79	3.00	5.32
0.08	4.28	1.08	25.08	2.08	9.86	3.08	5.13

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min
Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	113.87	46.63
over (min)	5.00	15.00
Storage Coeff. (min)=	1.49 (ii)	14.97 (ii)
Unit Hyd. Tpeak (min)=	5.00	15.00
Unit Hyd. peak (cms)=	0.33	0.08
PEAK FLOW (cms)=	0.02	0.02
TIME TO PEAK (hrs)=	12.08	12.17
RUNOFF VOLUME (mm)=	91.03	31.85
TOTAL RAINFALL (mm)=	93.03	93.03
RUNOFF COEFFICIENT =	0.98	0.34

TOTALS
0.030 (iii)

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
VV I SSSS UUUU A A LLLLL
000 TTTTT TTTTT H H Y Y M M 000 TM

0.17	4.55	1.17	55.96	2.17	9.10	3.17	4.94
0.25	4.86	1.25	173.13	2.25	8.45	3.25	4.78
0.33	5.22	1.33	71.59	2.33	7.91	3.33	4.62
0.42	5.65	1.42	40.40	2.42	7.43	3.42	4.48
0.50	6.18	1.50	28.30	2.50	7.02	3.50	4.34
0.58	6.83	1.58	21.92	2.58	6.65	3.58	4.22
0.67	7.66	1.67	17.99	2.67	6.33	3.67	4.10
0.75	8.77	1.75	15.33	2.75	6.04	3.75	3.99
0.83	10.31	1.83	13.40	2.83	5.78	3.83	3.89
0.92	12.65	1.92	11.94	2.92	5.54	3.92	3.79

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min
Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	173.13	20.12
over (min)	5.00	25.00
Storage Coeff. (min)=	1.26 (ii)	20.12 (ii)
Unit Hyd. Tpeak (min)=	5.00	25.00
Unit Hyd. peak (cms)=	0.33	0.05
PEAK FLOW (cms)=	0.02	0.01
TIME TO PEAK (hrs)=	1.33	1.75
RUNOFF VOLUME (mm)=	57.77	14.33
TOTAL RAINFALL (mm)=	59.77	59.77
RUNOFF COEFFICIENT =	0.97	0.24

TOTALS
0.024 (iii)

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
VV I SSSS UUUU A A LLLLL
000 TTTTT TTTTT H H Y Y M M 000 TM
O O T T T H H Y Y MM MM O O
O O T T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\fc85e7c5-efb1-41bf-b485-c52e38f5028e\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\fc85e7c5-efb1-41bf-b485-c52e38f5028e\scen

DATE: 10-12-2023 TIME: 03:44:43

USER:

COMMENTS: _____

** SIMULATION : 25yr 24hr 5min SCS Type II **

READ STORM Filename: C:\Users\dhordyk\AppData\Local\Temp\076b810b-fee7-4861-b4d4-af28d1f0031d\94266df7
Ptotal=111.09 mm Comments: 25yr 24hr 5min SCS Type II

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	6.08	2.00	12.17	16.00	18.25	2.00
0.08	1.22	6.17	2.00	12.25	16.00	18.33	2.00
0.17	1.22	6.25	2.00	12.33	16.00	18.42	2.00
0.25	1.22	6.33	2.00	12.42	16.00	18.50	2.00
0.33	1.22	6.42	2.00	12.50	16.00	18.58	2.00
0.42	1.22	6.50	2.00	12.58	8.22	18.67	2.00
0.50	1.22	6.58	2.00	12.67	8.22	18.75	2.00
0.58	1.22	6.67	2.00	12.75	8.22	18.83	2.00
0.67	1.22	6.75	2.00	12.83	8.22	18.92	2.00
0.75	1.22	6.83	2.00	12.92	8.22	19.00	2.00
0.83	1.22	6.92	2.00	13.00	8.22	19.08	2.00
0.92	1.22	7.00	2.00	13.08	6.00	19.17	2.00
1.00	1.22	7.08	2.44	13.17	6.00	19.25	2.00
1.08	1.22	7.17	2.44	13.25	6.00	19.33	2.00
1.17	1.22	7.25	2.44	13.33	6.00	19.42	2.00
1.25	1.22	7.33	2.44	13.42	6.00	19.50	2.00
1.33	1.22	7.42	2.44	13.50	6.00	19.58	2.00
1.42	1.22	7.50	2.44	13.58	4.67	19.67	2.00
1.50	1.22	7.58	2.44	13.67	4.67	19.75	2.00
1.58	1.22	7.67	2.44	13.75	4.67	19.83	2.00
1.67	1.22	7.75	2.44	13.83	4.67	19.92	2.00
1.75	1.22	7.83	2.44	13.92	4.67	20.00	2.00
1.83	1.22	7.92	2.44	14.00	4.67	20.08	1.33
1.92	1.22	8.00	2.44	14.08	3.33	20.17	1.33
2.00	1.22	8.08	2.89	14.17	3.33	20.25	1.33
2.08	1.44	8.17	2.89	14.25	3.33	20.33	1.33
2.17	1.44	8.25	2.89	14.33	3.33	20.42	1.33
2.25	1.44	8.33	2.89	14.42	3.33	20.50	1.33
2.33	1.44	8.42	2.89	14.50	3.33	20.58	1.33
2.42	1.44	8.50	2.89	14.58	3.33	20.67	1.33
2.50	1.44	8.58	3.11	14.67	3.33	20.75	1.33
2.58	1.44	8.67	3.11	14.75	3.33	20.83	1.33
2.67	1.44	8.75	3.11	14.83	3.33	20.92	1.33
2.75	1.44	8.83	3.11	14.92	3.33	21.00	1.33
2.83	1.44	8.92	3.11	15.00	3.33	21.08	1.33
2.92	1.44	9.00	3.11	15.08	3.33	21.17	1.33
3.00	1.44	9.08	3.55	15.17	3.33	21.25	1.33
3.08	1.44	9.17	3.55	15.25	3.33	21.33	1.33
3.17	1.44	9.25	3.55	15.33	3.33	21.42	1.33
3.25	1.44	9.33	3.55	15.42	3.33	21.50	1.33
3.33	1.44	9.42	3.55	15.50	3.33	21.58	1.33
3.42	1.44	9.50	3.55	15.58	3.33	21.67	1.33
3.50	1.44	9.58	4.00	15.67	3.33	21.75	1.33
3.58	1.44	9.67	4.00	15.75	3.33	21.83	1.33
3.67	1.44	9.75	4.00	15.83	3.33	21.92	1.33
3.75	1.44	9.83	4.00	15.92	3.33	22.00	1.33
3.83	1.44	9.92	4.00	16.00	3.33	22.08	1.33

3.92	1.44	10.00	4.00	16.08	2.00	22.17	1.33
4.00	1.44	10.08	5.11	16.17	2.00	22.25	1.33
4.08	1.78	10.17	5.11	16.25	2.00	22.33	1.33
4.17	1.78	10.25	5.11	16.33	2.00	22.42	1.33
4.25	1.78	10.33	5.11	16.42	2.00	22.50	1.33
4.33	1.78	10.42	5.11	16.50	2.00	22.58	1.33
4.42	1.78	10.50	5.11	16.58	2.00	22.67	1.33
4.50	1.78	10.58	6.89	16.67	2.00	22.75	1.33
4.58	1.78	10.67	6.89	16.75	2.00	22.83	1.33
4.67	1.78	10.75	6.89	16.83	2.00	22.92	1.33
4.75	1.78	10.83	6.89	16.92	2.00	23.00	1.33
4.83	1.78	10.92	6.89	17.00	2.00	23.08	1.33
4.92	1.78	11.00	6.89	17.08	2.00	23.17	1.33
5.00	1.78	11.08	10.66	17.17	2.00	23.25	1.33
5.08	1.78	11.17	10.66	17.25	2.00	23.33	1.33
5.17	1.78	11.25	10.66	17.33	2.00	23.42	1.33
5.25	1.78	11.33	10.66	17.42	2.00	23.50	1.33
5.33	1.78	11.42	10.66	17.50	2.00	23.58	1.33
5.42	1.78	11.50	10.66	17.58	2.00	23.67	1.33
5.50	1.78	11.58	32.88	17.67	2.00	23.75	1.33
5.58	1.78	11.67	32.88	17.75	2.00	23.83	1.33
5.67	1.78	11.75	32.88	17.83	2.00	23.92	1.33
5.75	1.78	11.83	135.97	17.92	2.00	24.00	1.33
5.83	1.78	11.92	135.97	18.00	2.00		
5.92	1.78	12.00	135.97	18.08	2.00		
6.00	1.78	12.08	16.00	18.17	2.00		

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min

Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n	0.013	0.250
Max.Eff.Inten.(mm/hr)=	135.97	63.40
over (min)	5.00	15.00
Storage Coeff. (min)=	1.38 (ii)	13.30 (ii)
Unit Hyd. Tpeak (min)=	5.00	15.00
Unit Hyd. peak (cms)=	0.33	0.08
PEAK FLOW (cms)=	0.02	0.02
TIME TO PEAK (hrs)=	12.08	12.07
RUNOFF VOLUME (mm)=	109.09	43.02
		53.96

TOTALS
(iii)

TOTAL RAINFALL (mm)= 111.09 111.09 111.09
RUNOFF COEFFICIENT = 0.98 0.39 0.49

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

FINISH

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y M M 0 O
O O T T H H Y Y M M 0 O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\c87f
34d4-55d0-4870-934d-caede8e0a532\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\c87f
34d4-55d0-4870-934d-caede8e0a532\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS:

** SIMULATION : 25yr 4hr 5min Chicago **

CHICAGO STORM IDF curve parameters: A=1133.123
Ptotal= 70.87 mm B= 4.734
C= 0.756
used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	4.87	1.00	19.82	2.00	12.89	3.00	6.39
0.08	5.15	1.08	29.77	2.08	11.79	3.08	6.16
0.17	5.47	1.17	65.99	2.17	10.89	3.17	5.94
0.25	5.84	1.25	202.83	2.25	10.12	3.25	5.74
0.33	6.27	1.33	84.29	2.33	9.47	3.33	5.56
0.42	6.79	1.42	47.77	2.42	8.91	3.42	5.39
0.50	7.41	1.50	33.55	2.50	8.41	3.50	5.23
0.58	8.19	1.58	26.05	2.58	7.98	3.58	5.08
0.67	9.18	1.67	21.41	2.67	7.59	3.67	4.94
0.75	10.49	1.75	18.27	2.75	7.25	3.75	4.81
0.83	12.33	1.83	15.99	2.83	6.93	3.83	4.68
0.92	15.10	1.92	14.26	2.92	6.65	3.92	4.57

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min

Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00

Average Slope (%)= 1.00 1.00
Length (m)= 44.20 50.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 202.83 27.66
over (min) 5.00 20.00
Storage Coeff. (min)= 1.18 (ii) 17.79 (ii)
Unit Hyd. Tpeak (min)= 5.00 20.00
Unit Hyd. peak (cms)= 0.33 0.06

PEAK FLOW (cms)= 0.03 0.01 *TOTALS*
TIME TO PEAK (hrs)= 1.33 1.67 0.029 (iii)
RUNOFF VOLUME (mm)= 68.87 19.66 27.78
TOTAL RAINFALL (mm)= 70.87 70.87 70.87
RUNOFF COEFFICIENT = 0.97 0.28 0.39

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
V V I SSSSS UUUUU A A LLLLL

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O O T T H H Y Y M M O O
O O T T H H Y Y M M O O

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\V02\voin.dat

Output filename:
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Summary filename:
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d981-0da2-4c83-b1f6-2a46f6ac9abc\scen

DATE: 10-12-2023 TIME: 03:44:43

USER:

COMMENTS: _____

** SIMULATION : 2yr 24hr 5min SCS Type II **

READ STORM
Ptotal= 55.62 mm
Filename: C:\Users\dhordyk\AppData\Local\Temp\076b810b-fee7-4861-b4d4-af28d1f0031d\eb159c29
Comments: 2yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	1.00	12.17	8.01	18.25	1.00
0.08	0.61	6.17	1.00	12.25	8.01	18.33	1.00
0.17	0.61	6.25	1.00	12.33	8.01	18.42	1.00
0.25	0.61	6.33	1.00	12.42	8.01	18.50	1.00
0.33	0.61	6.42	1.00	12.50	8.01	18.58	1.00
0.42	0.61	6.50	1.00	12.58	4.12	18.67	1.00
0.50	0.61	6.58	1.00	12.67	4.12	18.75	1.00
0.58	0.61	6.67	1.00	12.75	4.12	18.83	1.00
0.67	0.61	6.75	1.00	12.83	4.12	18.92	1.00
0.75	0.61	6.83	1.00	12.92	4.12	19.00	1.00
0.83	0.61	6.92	1.00	13.00	4.12	19.08	1.00
0.92	0.61	7.00	1.00	13.08	3.00	19.17	1.00
1.00	0.61	7.08	1.22	13.17	3.00	19.25	1.00
1.08	0.61	7.17	1.22	13.25	3.00	19.33	1.00
1.17	0.61	7.25	1.22	13.33	3.00	19.42	1.00
1.25	0.61	7.33	1.22	13.42	3.00	19.50	1.00
1.33	0.61	7.42	1.22	13.50	3.00	19.58	1.00
1.42	0.61	7.50	1.22	13.58	2.34	19.67	1.00

1.50	0.61	7.58	1.22	13.67	2.34	19.75	1.00
1.58	0.61	7.67	1.22	13.75	2.34	19.83	1.00
1.67	0.61	7.75	1.22	13.83	2.34	19.92	1.00
1.75	0.61	7.83	1.22	13.92	2.34	20.00	1.00
1.83	0.61	7.92	1.22	14.00	2.34	20.08	0.67
1.92	0.61	8.00	1.22	14.08	1.67	20.17	0.67
2.00	0.61	8.08	1.45	14.17	1.67	20.25	0.67
2.08	0.72	8.17	1.45	14.25	1.67	20.33	0.67
2.17	0.72	8.25	1.45	14.33	1.67	20.42	0.67
2.25	0.72	8.33	1.45	14.42	1.67	20.50	0.67
2.33	0.72	8.42	1.45	14.50	1.67	20.58	0.67
2.42	0.72	8.50	1.45	14.58	1.67	20.67	0.67
2.50	0.72	8.58	1.56	14.67	1.67	20.75	0.67
2.58	0.72	8.67	1.56	14.75	1.67	20.83	0.67
2.67	0.72	8.75	1.56	14.83	1.67	20.92	0.67
2.75	0.72	8.83	1.56	14.92	1.67	21.00	0.67
2.83	0.72	8.92	1.56	15.00	1.67	21.08	0.67
2.92	0.72	9.00	1.56	15.08	1.67	21.17	0.67
3.00	0.72	9.08	1.78	15.17	1.67	21.25	0.67
3.08	0.72	9.17	1.78	15.25	1.67	21.33	0.67
3.17	0.72	9.25	1.78	15.33	1.67	21.42	0.67
3.25	0.72	9.33	1.78	15.42	1.67	21.50	0.67
3.33	0.72	9.42	1.78	15.50	1.67	21.58	0.67
3.42	0.72	9.50	1.78	15.58	1.67	21.67	0.67
3.50	0.72	9.58	2.00	15.67	1.67	21.75	0.67
3.58	0.72	9.67	2.00	15.75	1.67	21.83	0.67
3.67	0.72	9.75	2.00	15.83	1.67	21.92	0.67
3.75	0.72	9.83	2.00	15.92	1.67	22.00	0.67
3.83	0.72	9.92	2.00	16.00	1.67	22.08	0.67
3.92	0.72	10.00	2.00	16.08	1.00	22.17	0.67
4.00	0.72	10.08	2.56	16.17	1.00	22.25	0.67
4.08	0.89	10.17	2.56	16.25	1.00	22.33	0.67
4.17	0.89	10.25	2.56	16.33	1.00	22.42	0.67
4.25	0.89	10.33	2.56	16.42	1.00	22.50	0.67
4.33	0.89	10.42	2.56	16.50	1.00	22.58	0.67
4.42	0.89	10.50	2.56	16.58	1.00	22.67	0.67
4.50	0.89	10.58	3.45	16.67	1.00	22.75	0.67
4.58	0.89	10.67	3.45	16.75	1.00	22.83	0.67
4.67	0.89	10.75	3.45	16.83	1.00	22.92	0.67
4.75	0.89	10.83	3.45	16.92	1.00	23.00	0.67
4.83	0.89	10.92	3.45	17.00	1.00	23.08	0.67
4.92	0.89	11.00	3.45	17.08	1.00	23.17	0.67
5.00	0.89	11.08	5.34	17.17	1.00	23.25	0.67
5.08	0.89	11.17	5.34	17.25	1.00	23.33	0.67
5.17	0.89	11.25	5.34	17.33	1.00	23.42	0.67
5.25	0.89	11.33	5.34	17.42	1.00	23.50	0.67
5.33	0.89	11.42	5.34	17.50	1.00	23.58	0.67
5.42	0.89	11.50	5.34	17.58	1.00	23.67	0.67
5.50	0.89	11.58	16.46	17.67	1.00	23.75	0.67
5.58	0.89	11.67	16.46	17.75	1.00	23.83	0.67

5.67	0.89	11.75	16.46	17.83	1.00	23.92	0.67
5.75	0.89	11.83	68.08	17.92	1.00	24.00	0.67
5.83	0.89	11.92	68.08	18.00	1.00		
5.92	0.89	12.00	68.08	18.08	1.00		
6.00	0.89	12.08	8.01	18.17	1.00		

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min
Area (ha)= 0.29
Total Imp(%)= 22.70
Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	68.08	11.86
over (min)	5.00	30.00
Storage Coeff. (min)=	1.83 (ii)	25.13 (ii)
Unit Hyd. Tpeak (min)=	5.00	30.00
Unit Hyd. peak (cms)=	0.32	0.04
PEAK FLOW (cms)=	0.01	0.00
TIME TO PEAK (hrs)=	12.08	12.42
RUNOFF VOLUME (mm)=	53.62	12.50
TOTAL RAINFALL (mm)=	55.62	55.62
RUNOFF COEFFICIENT =	0.96	0.22
		0.35

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L

WV I SSSS UUUU A A LLLL
000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
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a0d8-b437-41f9-b2dd-de7d7f5c165b\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\f73d
a0d8-b437-41f9-b2dd-de7d7f5c165b\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS: _____

** SIMULATION : 2yr 4hr 5min Chicago **

CHICAGO STORM IDF curve parameters: A= 675.586
Ptotal= 37.03 mm B= 4.681
C= 0.780
used in: INTENSITY = A / (t + B)^C
Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN

hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	2.31	1.00	10.03	2.00	6.39	3.00	3.08
0.08	2.45	1.08	15.38	2.08	5.82	3.08	2.96
0.17	2.61	1.17	35.54	2.17	5.36	3.17	2.85
0.25	2.80	1.25	114.99	2.25	4.96	3.25	2.75
0.33	3.01	1.33	45.86	2.33	4.63	3.33	2.66
0.42	3.27	1.42	25.27	2.42	4.34	3.42	2.57
0.50	3.59	1.50	17.44	2.50	4.09	3.50	2.49
0.58	3.98	1.58	13.36	2.58	3.87	3.58	2.42
0.67	4.48	1.67	10.88	2.67	3.68	3.67	2.35
0.75	5.15	1.75	9.21	2.75	3.50	3.75	2.29
0.83	6.10	1.83	8.01	2.83	3.35	3.83	2.22
0.92	7.55	1.92	7.10	2.92	3.20	3.92	2.17

CALIB	Area (ha)	Dir. Conn.(%)
STANDHYD (0101)	0.29	
ID= 1 DT= 5.0 min	Total Imp(%)= 22.70	16.60

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.07	0.23
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	1.00	1.00
Length (m)=	44.20	50.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	114.99	5.73
over (min)	5.00	35.00
Storage Coeff. (min)=	1.48 (ii)	32.66 (ii)
Unit Hyd. Tpeak (min)=	5.00	35.00
Unit Hyd. peak (cms)=	0.33	0.03
PEAK FLOW (cms)=	0.02	0.00
TIME TO PEAK (hrs)=	1.33	2.00
RUNOFF VOLUME (mm)=	35.03	5.54
TOTAL RAINFALL (mm)=	37.03	37.03
RUNOFF COEFFICIENT =	0.95	0.15
		TOTALS
		0.015 (iii)

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
WV I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
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7c31-6e18-4362-94e0-c5666b404e0f\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\45ef
7c31-6e18-4362-94e0-c5666b404e0f\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS: _____

** SIMULATION : 50yr 24hr 5min SCS Type II **

READ STORM Filename: C:\Users\dhordyk\AppData

	ata\Local\Temp\
Ptotal=125.40 mm	076b810b-fee7-4861-b4d4-af28d1f0031d\9edc2a83
	Comments: 50yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	2.26	12.17	18.06	18.25	2.26
0.08	1.38	6.17	2.26	12.25	18.06	18.33	2.26
0.17	1.38	6.25	2.26	12.33	18.06	18.42	2.26
0.25	1.38	6.33	2.26	12.42	18.06	18.50	2.26
0.33	1.38	6.42	2.26	12.50	18.06	18.58	2.26
0.42	1.38	6.50	2.26	12.58	9.28	18.67	2.26
0.50	1.38	6.58	2.26	12.67	9.28	18.75	2.26
0.58	1.38	6.67	2.26	12.75	9.28	18.83	2.26
0.67	1.38	6.75	2.26	12.83	9.28	18.92	2.26
0.75	1.38	6.83	2.26	12.92	9.28	19.00	2.26
0.83	1.38	6.92	2.26	13.00	9.28	19.08	2.26
0.92	1.38	7.00	2.26	13.08	6.77	19.17	2.26
1.00	1.38	7.08	2.76	13.17	6.77	19.25	2.26
1.08	1.38	7.17	2.76	13.25	6.77	19.33	2.26
1.17	1.38	7.25	2.76	13.33	6.77	19.42	2.26
1.25	1.38	7.33	2.76	13.42	6.77	19.50	2.26
1.33	1.38	7.42	2.76	13.50	6.77	19.58	2.26
1.42	1.38	7.50	2.76	13.58	5.27	19.67	2.26
1.50	1.38	7.58	2.76	13.67	5.27	19.75	2.26
1.58	1.38	7.67	2.76	13.75	5.27	19.83	2.26
1.67	1.38	7.75	2.76	13.83	5.27	19.92	2.26
1.75	1.38	7.83	2.76	13.92	5.27	20.00	2.26
1.83	1.38	7.92	2.76	14.00	5.27	20.08	1.50
1.92	1.38	8.00	2.76	14.08	3.76	20.17	1.50
2.00	1.38	8.08	3.26	14.17	3.76	20.25	1.50
2.08	1.63	8.17	3.26	14.25	3.76	20.33	1.50
2.17	1.63	8.25	3.26	14.33	3.76	20.42	1.50
2.25	1.63	8.33	3.26	14.42	3.76	20.50	1.50
2.33	1.63	8.42	3.26	14.50	3.76	20.58	1.50
2.42	1.63	8.50	3.26	14.58	3.76	20.67	1.50
2.50	1.63	8.58	3.51	14.67	3.76	20.75	1.50
2.58	1.63	8.67	3.51	14.75	3.76	20.83	1.50
2.67	1.63	8.75	3.51	14.83	3.76	20.92	1.50
2.75	1.63	8.83	3.51	14.92	3.76	21.00	1.50
2.83	1.63	8.92	3.51	15.00	3.76	21.08	1.50
2.92	1.63	9.00	3.51	15.08	3.76	21.17	1.50
3.00	1.63	9.08	4.01	15.17	3.76	21.25	1.50
3.08	1.63	9.17	4.01	15.25	3.76	21.33	1.50
3.17	1.63	9.25	4.01	15.33	3.76	21.42	1.50
3.25	1.63	9.33	4.01	15.42	3.76	21.50	1.50
3.33	1.63	9.42	4.01	15.50	3.76	21.58	1.50
3.42	1.63	9.50	4.01	15.58	3.76	21.67	1.50
3.50	1.63	9.58	4.51	15.67	3.76	21.75	1.50
3.58	1.63	9.67	4.51	15.75	3.76	21.83	1.50

3.67	1.63	9.75	4.51	15.83	3.76	21.92	1.50
3.75	1.63	9.83	4.51	15.92	3.76	22.00	1.50
3.83	1.63	9.92	4.51	16.00	3.76	22.08	1.50
3.92	1.63	10.00	4.51	16.08	2.26	22.17	1.50
4.00	1.63	10.08	5.77	16.17	2.26	22.25	1.50
4.08	2.01	10.17	5.77	16.25	2.26	22.33	1.50
4.17	2.01	10.25	5.77	16.33	2.26	22.42	1.50
4.25	2.01	10.33	5.77	16.42	2.26	22.50	1.50
4.33	2.01	10.42	5.77	16.50	2.26	22.58	1.50
4.42	2.01	10.50	5.77	16.58	2.26	22.67	1.50
4.50	2.01	10.58	7.77	16.67	2.26	22.75	1.50
4.58	2.01	10.67	7.77	16.75	2.26	22.83	1.50
4.67	2.01	10.75	7.77	16.83	2.26	22.92	1.50
4.75	2.01	10.83	7.77	16.92	2.26	23.00	1.50
4.83	2.01	10.92	7.77	17.00	2.26	23.08	1.50
4.92	2.01	11.00	7.77	17.08	2.26	23.17	1.50
5.00	2.01	11.08	12.04	17.17	2.26	23.25	1.50
5.08	2.01	11.17	12.04	17.25	2.26	23.33	1.50
5.17	2.01	11.25	12.04	17.33	2.26	23.42	1.50
5.25	2.01	11.33	12.04	17.42	2.26	23.50	1.50
5.33	2.01	11.42	12.04	17.50	2.26	23.58	1.50
5.42	2.01	11.50	12.04	17.58	2.26	23.67	1.50
5.50	2.01	11.58	37.12	17.67	2.26	23.75	1.50
5.58	2.01	11.67	37.12	17.75	2.26	23.83	1.50
5.67	2.01	11.75	37.12	17.83	2.26	23.92	1.50
5.75	2.01	11.83	153.49	17.92	2.26	24.00	1.50
5.83	2.01	11.92	153.49	18.00	2.26		
5.92	2.01	12.00	153.49	18.08	2.26		
6.00	2.01	12.08	18.06	18.17	2.26		

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min

Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

Surface Area	(ha)=	0.07	0.23
Dep. Storage	(mm)=	2.00	5.00
Average Slope	(%)=	1.00	1.00
Length	(m)=	44.20	50.00
Mannings n	=	0.013	0.250
Max.Eff.Inten.(mm/hr)=	153.49	77.69	
over (min)	5.00	15.00	
Storage Coeff. (min)=	1.32 (ii)	12.31 (ii)	
Unit Hyd. Tpeak (min)=	5.00	15.00	
Unit Hyd. peak (cms)=	0.33	0.09	

TOTALS

PEAK FLOW	(cms)=	0.02	0.03	0.047 (iii)
TIME TO PEAK	(hrs)=	12.08	12.17	12.08
RUNOFF VOLUME	(mm)=	123.40	52.52	64.26
TOTAL RAINFALL	(mm)=	125.40	125.40	125.40
RUNOFF COEFFICIENT	=	0.98	0.42	0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U AAAAA L
V V I SS U U A A L
VV I SSSSS UUUU A A LLLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\b292
8a00-d400-4866-8834-aa9a143b83d8\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\b292
8a00-d400-4866-8834-aa9a143b83d8\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS:

** SIMULATION : 50yr 4hr 5min Chicago **

CHICAGO STORM
Ptotal= 79.54 mm

IDF curve parameters: A=1251.473
B= 4.847
C= 0.753

used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	5.53	1.00	22.40	2.00	14.60	3.00	7.26
0.08	5.85	1.08	33.57	2.08	13.36	3.08	6.99
0.17	6.21	1.17	73.94	2.17	12.33	3.17	6.75
0.25	6.63	1.25	223.60	2.25	11.47	3.25	6.52
0.33	7.12	1.33	94.25	2.33	10.74	3.33	6.31
0.42	7.70	1.42	53.72	2.42	10.10	3.42	6.12
0.50	8.41	1.50	37.82	2.50	9.54	3.50	5.94
0.58	9.29	1.58	29.40	2.58	9.05	3.58	5.77
0.67	10.40	1.67	24.19	2.67	8.61	3.67	5.61
0.75	11.89	1.75	20.65	2.75	8.22	3.75	5.46
0.83	13.96	1.83	18.09	2.83	7.87	3.83	5.32
0.92	17.09	1.92	16.14	2.92	7.55	3.92	5.19

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min

Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

Surface Area	(ha)=	0.07	0.23
Dep. Storage	(mm)=	2.00	5.00
Average Slope	(%)=	1.00	1.00
Length	(m)=	44.20	50.00

Mannings n	=	0.013	0.250
Max.Eff.Inten.(mm/hr)=	223.60	39.65	
over (min)	5.00	20.00	
Storage Coeff. (min)=	1.13 (ii)	15.52 (ii)	
Unit Hyd. Tpeak (min)=	5.00	20.00	
Unit Hyd. peak (cms)=	0.34	0.07	

TOTALS
PEAK FLOW (cms)= 0.03 0.01 0.033 (iii)
TIME TO PEAK (hrs)= 1.33 1.67 1.33
RUNOFF VOLUME (mm)= 77.54 24.20 33.03
TOTAL RAINFALL (mm)= 79.54 79.54 79.54
RUNOFF COEFFICIENT = 0.97 0.30 0.42

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A A L
V V I SS U U AAAAA L
V V I SS U U A A L L
VV I SSSSS UUUU A A LLLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\95f0

728c-354b-49f0-ba2c-6a371d0f0b5a\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\95f0
728c-354b-49f0-ba2c-6a371d0f0b5a\scen

DATE: 10-12-2023 TIME: 03:44:43

USER:

COMMENTS: _____

** SIMULATION : 5yr 24hr 5min SCS Type II **

| READ STORM | Filename: C:\Users\dhordyk\AppData
| | ata\Local\Temp\
| | 076b810b-fee7-4861-b4d4-af28d1f0031d\7d04c0f7
| Ptotal= 78.55 mm | Comments: 5yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	1.41	12.17	11.31	18.25	1.41	
0.08	0.86	6.17	1.41	12.25	11.31	18.33	1.41	
0.17	0.86	6.25	1.41	12.33	11.31	18.42	1.41	
0.25	0.86	6.33	1.41	12.42	11.31	18.50	1.41	
0.33	0.86	6.42	1.41	12.50	11.31	18.58	1.41	
0.42	0.86	6.50	1.41	12.58	5.81	18.67	1.41	
0.50	0.86	6.58	1.41	12.67	5.81	18.75	1.41	
0.58	0.86	6.67	1.41	12.75	5.81	18.83	1.41	
0.67	0.86	6.75	1.41	12.83	5.81	18.92	1.41	
0.75	0.86	6.83	1.41	12.92	5.81	19.00	1.41	
0.83	0.86	6.92	1.41	13.00	5.81	19.08	1.41	
0.92	0.86	7.00	1.41	13.08	4.24	19.17	1.41	
1.00	0.86	7.08	1.73	13.17	4.24	19.25	1.41	
1.08	0.86	7.17	1.73	13.25	4.24	19.33	1.41	
1.17	0.86	7.25	1.73	13.33	4.24	19.42	1.41	
1.25	0.86	7.33	1.73	13.42	4.24	19.50	1.41	
1.33	0.86	7.42	1.73	13.50	4.24	19.58	1.41	
1.42	0.86	7.50	1.73	13.58	3.30	19.67	1.41	
1.50	0.86	7.58	1.73	13.67	3.30	19.75	1.41	
1.58	0.86	7.67	1.73	13.75	3.30	19.83	1.41	

1.67	0.86	7.75	1.73	13.83	3.30	19.92	1.41	
1.75	0.86	7.83	1.73	13.92	3.30	20.00	1.41	
1.83	0.86	7.92	1.73	14.00	3.30	20.08	0.94	
1.92	0.86	8.00	1.73	14.08	2.36	20.17	0.94	
2.00	0.86	8.08	2.04	14.17	2.36	20.25	0.94	
2.08	1.02	8.17	2.04	14.25	2.36	20.33	0.94	
2.17	1.02	8.25	2.04	14.33	2.36	20.42	0.94	
2.25	1.02	8.33	2.04	14.42	2.36	20.50	0.94	
2.33	1.02	8.42	2.04	14.50	2.36	20.58	0.94	
2.42	1.02	8.50	2.04	14.58	2.36	20.67	0.94	
2.50	1.02	8.58	2.20	14.67	2.36	20.75	0.94	
2.58	1.02	8.67	2.20	14.75	2.36	20.83	0.94	
2.67	1.02	8.75	2.20	14.83	2.36	20.92	0.94	
2.75	1.02	8.83	2.20	14.92	2.36	21.00	0.94	
2.83	1.02	8.92	2.20	15.00	2.36	21.08	0.94	
2.92	1.02	9.00	2.20	15.08	2.36	21.17	0.94	
3.00	1.02	9.08	2.51	15.17	2.36	21.25	0.94	
3.08	1.02	9.17	2.51	15.25	2.36	21.33	0.94	
3.17	1.02	9.25	2.51	15.33	2.36	21.42	0.94	
3.25	1.02	9.33	2.51	15.42	2.36	21.50	0.94	
3.33	1.02	9.42	2.51	15.50	2.36	21.58	0.94	
3.42	1.02	9.50	2.51	15.58	2.36	21.67	0.94	
3.50	1.02	9.58	2.83	15.67	2.36	21.75	0.94	
3.58	1.02	9.67	2.83	15.75	2.36	21.83	0.94	
3.67	1.02	9.75	2.83	15.83	2.36	21.92	0.94	
3.75	1.02	9.83	2.83	15.92	2.36	22.00	0.94	
3.83	1.02	9.92	2.83	16.00	2.36	22.08	0.94	
3.92	1.02	10.00	2.83	16.08	1.41	22.17	0.94	
4.00	1.02	10.08	3.61	16.17	1.41	22.25	0.94	
4.08	1.26	10.17	3.61	16.25	1.41	22.33	0.94	
4.17	1.26	10.25	3.61	16.33	1.41	22.42	0.94	
4.25	1.26	10.33	3.61	16.42	1.41	22.50	0.94	
4.33	1.26	10.42	3.61	16.50	1.41	22.58	0.94	
4.42	1.26	10.50	3.61	16.58	1.41	22.67	0.94	
4.50	1.26	10.58	4.87	16.67	1.41	22.75	0.94	
4.58	1.26	10.67	4.87	16.75	1.41	22.83	0.94	
4.67	1.26	10.75	4.87	16.83	1.41	22.92	0.94	
4.75	1.26	10.83	4.87	16.92	1.41	23.00	0.94	
4.83	1.26	10.92	4.87	17.00	1.41	23.08	0.94	
4.92	1.26	11.00	4.87	17.08	1.41	23.17	0.94	
5.00	1.26	11.08	7.54	17.17	1.41	23.25	0.94	
5.08	1.26	11.17	7.54	17.25	1.41	23.33	0.94	
5.17	1.26	11.25	7.54	17.33	1.41	23.42	0.94	
5.25	1.26	11.33	7.54	17.42	1.41	23.50	0.94	
5.33	1.26	11.42	7.54	17.50	1.41	23.58	0.94	
5.42	1.26	11.50	7.54	17.58	1.41	23.67	0.94	
5.50	1.26	11.58	23.25	17.67	1.41	23.75	0.94	
5.58	1.26	11.67	23.25	17.75	1.41	23.83	0.94	
5.67	1.26	11.75	23.25	17.83	1.41	23.92	0.94	
5.75	1.26	11.83	96.15	17.92	1.41	24.00	0.94	

5.83	1.26	11.92	96.15	18.00	1.41	
5.92	1.26	12.00	96.15	18.08	1.41	
6.00	1.26	12.08	11.31	18.17	1.41	

| CALIB |
| STANDHYD (0101) | Area (ha)= 0.29
| ID= 1 DT= 5.0 min | Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

IMPERVIOUS			PERVIOUS (i)		
Surface Area (ha)=	0.07	0.23			
Dep. Storage (mm)=	2.00	5.00			
Average Slope (%)=	1.00	1.00			
Length (m)=	44.20	50.00			
Mannings n =	0.013	0.250			
Max.Eff.Inten.(mm/hr)=	96.15	27.28			
over (min)	5.00	20.00			
Storage Coeff. (min)=	1.59 (ii)	18.29 (ii)			
Unit Hyd. Tpeak (min)=	5.00	20.00			
Unit Hyd. peak (cms)=	0.33	0.06			
			TOTALS		
PEAK FLOW (cms)=	0.01	0.01	0.020 (iii)		
TIME TO PEAK (hrs)=	12.08	12.25	12.08		
RUNOFF VOLUME (mm)=	76.55	23.67	32.41		
TOTAL RAINFALL (mm)=	78.55	78.55	78.55		
RUNOFF COEFFICIENT =	0.97	0.30	0.41		

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U AAAAA L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
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Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\b680
9d3a-fd83-4965-ba70-a07de6919b7a\scen

DATE: 10-12-2023 TIME: 03:44:42

USER:

COMMENTS: _____

** SIMULATION : 5yr 4hr 5min Chicago **

| CHICAGO STORM | IDF curve parameters: A= 843.019
| Ptotal= 50.76 mm | B= 4.582
| | C= 0.763

used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.00	3.39	1.00	14.01	2.00	9.07	3.00	4.46	

0.08	3.58	1.08	21.15	2.08	8.29	3.08	4.30
0.17	3.81	1.17	47.54	2.17	7.64	3.17	4.15
0.25	4.07	1.25	150.31	2.25	7.10	3.25	4.01
0.33	4.38	1.33	60.96	2.33	6.64	3.33	3.88
0.42	4.74	1.42	34.18	2.42	6.24	3.42	3.75
0.50	5.18	1.50	23.88	2.50	5.89	3.50	3.64
0.58	5.73	1.58	18.47	2.58	5.58	3.58	3.54
0.67	6.43	1.67	15.15	2.67	5.31	3.67	3.44
0.75	7.36	1.75	12.90	2.75	5.07	3.75	3.35
0.83	8.67	1.83	11.27	2.83	4.85	3.83	3.26
0.92	10.64	1.92	10.04	2.92	4.65	3.92	3.18

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min

Area (ha)= 0.29
Total Imp(%)= 22.70 Dir. Conn.(%)= 16.60

	IMPERVIOUS	PERVIOUS (i)	
Surface Area (ha)=	0.07	0.23	
Dep. Storage (mm)=	2.00	5.00	
Average Slope (%)=	1.00	1.00	
Length (m)=	44.20	50.00	
Mannings n =	0.013	0.250	
Max.Eff.Inten.(mm/hr)=	150.31	12.97	
over (min)	5.00	25.00	
Storage Coeff. (min)=	1.33 (ii)	23.82 (ii)	
Unit Hyd. Tpeak (min)=	5.00	25.00	
Unit Hyd. peak (cms)=	0.33	0.05	
			TOTALS
PEAK FLOW (cms)=	0.02	0.00	0.021 (iii)
TIME TO PEAK (hrs)=	1.33	1.75	1.33
RUNOFF VOLUME (mm)=	48.76	10.48	16.78
TOTAL RAINFALL (mm)=	50.76	50.76	50.76
RUNOFF COEFFICIENT =	0.96	0.21	0.33

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

=====

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\aff5
526a-f9a1-4d52-b0fa-04ff313bcbff\scen
Summary filename:
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526a-f9a1-4d52-b0fa-04ff313bcbff\scen

DATE: 10-10-2023

TIME: 04:22:12

USER:

COMMENTS: _____

** SIMULATION : HAZEL **

READ STORM | Filename: C:\Users\dhordyk\AppData\Local\Temp\

0.833	6.00	3.833	13.00	6.833	23.00	9.83	53.00
0.917	6.00	3.917	13.00	6.917	23.00	9.92	53.00
1.000	6.00	4.000	13.00	7.000	23.00	10.00	53.00
1.083	4.00	4.083	17.00	7.083	13.00	10.08	38.00
1.167	4.00	4.167	17.00	7.167	13.00	10.17	38.00
1.250	4.00	4.250	17.00	7.250	13.00	10.25	38.00
1.333	4.00	4.333	17.00	7.333	13.00	10.33	38.00
1.417	4.00	4.417	17.00	7.417	13.00	10.42	38.00
1.500	4.00	4.500	17.00	7.500	13.00	10.50	38.00
1.583	4.00	4.583	17.00	7.583	13.00	10.58	38.00
1.667	4.00	4.667	17.00	7.667	13.00	10.67	38.00
1.750	4.00	4.750	17.00	7.750	13.00	10.75	38.00
1.833	4.00	4.833	17.00	7.833	13.00	10.83	38.00
1.917	4.00	4.917	17.00	7.917	13.00	10.92	38.00
2.000	4.00	5.000	17.00	8.000	13.00	11.00	38.00
2.083	6.00	5.083	13.00	8.083	13.00	11.08	13.00
2.167	6.00	5.167	13.00	8.167	13.00	11.17	13.00
2.250	6.00	5.250	13.00	8.250	13.00	11.25	13.00
2.333	6.00	5.333	13.00	8.333	13.00	11.33	13.00
2.417	6.00	5.417	13.00	8.417	13.00	11.42	13.00
2.500	6.00	5.500	13.00	8.500	13.00	11.50	13.00
2.583	6.00	5.583	13.00	8.583	13.00	11.58	13.00
2.667	6.00	5.667	13.00	8.667	13.00	11.67	13.00
2.750	6.00	5.750	13.00	8.750	13.00	11.75	13.00
2.833	6.00	5.833	13.00	8.833	13.00	11.83	13.00
2.917	6.00	5.917	13.00	8.917	13.00	11.92	13.00
3.000	6.00	6.000	13.00	9.000	13.00	12.00	13.00

Max.Eff.Inten.(mm/hr)= 53.00 51.78
over (min) 5.00 15.00
Storage Coeff. (min)= 2.02 (ii) 14.94 (ii)
Unit Hyd. Tpeak (min)= 5.00 15.00
Unit Hyd. peak (cms)= 0.31 0.08

TOTALS
PEAK FLOW (cms)= 0.01 0.03 0.039 (iii)
TIME TO PEAK (hrs)= 9.58 10.00 10.00
RUNOFF VOLUME (mm)= 210.00 157.07 165.83
TOTAL RAINFALL (mm)= 212.00 212.00 212.00
RUNOFF COEFFICIENT = 0.99 0.74 0.78

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 78.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| Ptotal=212.00 mm | cc71a33f-d128-494b-bbda-1e1984ffa84c\8a90a4d8
Comments: HAZEL

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.00	6.00	3.00	13.00	6.00	23.00	9.00	53.00	
0.20	6.00	3.20	13.00	6.20	23.00	9.20	53.00	
0.40	6.00	3.40	13.00	6.40	23.00	9.40	53.00	
0.60	6.00	3.60	13.00	6.60	23.00	9.60	53.00	
0.80	6.00	3.80	13.00	6.80	23.00	9.80	53.00	
1.00	4.00	4.00	17.00	7.00	13.00	10.00	38.00	
1.20	4.00	4.20	17.00	7.20	13.00	10.20	38.00	
1.40	4.00	4.40	17.00	7.40	13.00	10.40	38.00	
1.60	4.00	4.60	17.00	7.60	13.00	10.60	38.00	
1.80	4.00	4.80	17.00	7.80	13.00	10.80	38.00	
2.00	6.00	5.00	13.00	8.00	13.00	11.00	13.00	
2.20	6.00	5.20	13.00	8.20	13.00	11.20	13.00	
2.40	6.00	5.40	13.00	8.40	13.00	11.40	13.00	
2.60	6.00	5.60	13.00	8.60	13.00	11.60	13.00	
2.80	6.00	5.80	13.00	8.80	13.00	11.80	13.00	

CALIB
STANDHYD (0101)
ID= 1 DT= 5.0 min
Area (ha)= 0.29
Total Imp(%)= 22.70
Dir. Conn.(%)= 16.60

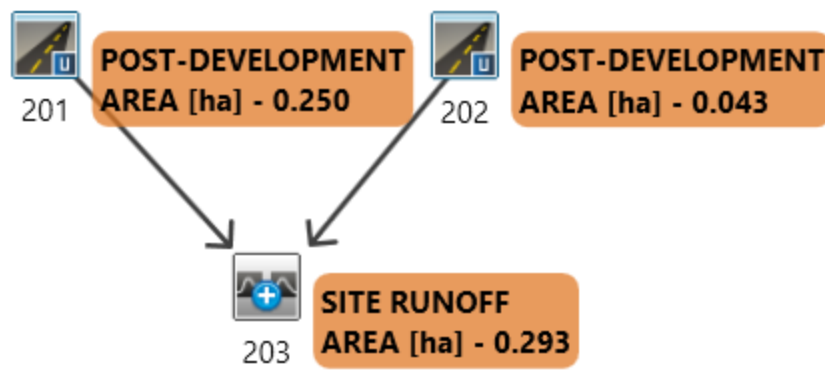
IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.07 0.23
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 1.00 1.00
Length (m)= 44.20 50.00
Mannth n = 0.013 0.250

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.083	6.00	3.083	13.00	6.083	23.00	9.08	53.00	
0.167	6.00	3.167	13.00	6.167	23.00	9.17	53.00	
0.250	6.00	3.250	13.00	6.250	23.00	9.25	53.00	
0.333	6.00	3.333	13.00	6.333	23.00	9.33	53.00	
0.417	6.00	3.417	13.00	6.417	23.00	9.42	53.00	
0.500	6.00	3.500	13.00	6.500	23.00	9.50	53.00	
0.583	6.00	3.583	13.00	6.583	23.00	9.58	53.00	
0.667	6.00	3.667	13.00	6.667	23.00	9.67	53.00	
0.750	6.00	3.750	13.00	6.750	23.00	9.75	53.00	

FINISH

POST-DEVELOPMENT



=====

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:

C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\ef3ed
3a94-94d6-41f9-af72-ba9ec17e45db\scen

Summary filename:

C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\ef3ed
3a94-94d6-41f9-af72-ba9ec17e45db\scen

DATE: 10-12-2023

TIME: 04:02:26

USER:

COMMENTS: _____

** SIMULATION : 100yr 24hr 5min SCS Type II **

| READ STORM | Filename: C:\Users\dhordyk\AppData\Local\Temp\

| Ptotal=137.63 mm | 26bfbc19-efc0-458c-9b8e-5c7e48c42e3e\91b85d5e
Comments: 100yr 24hr 5min SCS Type II

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	6.08	2.48	12.17	19.82	18.25	2.48
0.08	1.51	6.17	2.48	12.25	19.82	18.33	2.48
0.17	1.51	6.25	2.48	12.33	19.82	18.42	2.48
0.25	1.51	6.33	2.48	12.42	19.82	18.50	2.48
0.33	1.51	6.42	2.48	12.50	19.82	18.58	2.48
0.42	1.51	6.50	2.48	12.58	10.18	18.67	2.48
0.50	1.51	6.58	2.48	12.67	10.18	18.75	2.48
0.58	1.51	6.67	2.48	12.75	10.18	18.83	2.48
0.67	1.51	6.75	2.48	12.83	10.18	18.92	2.48
0.75	1.51	6.83	2.48	12.92	10.18	19.00	2.48
0.83	1.51	6.92	2.48	13.00	10.18	19.08	2.48
0.92	1.51	7.00	2.48	13.08	7.43	19.17	2.48
1.00	1.51	7.08	3.03	13.17	7.43	19.25	2.48
1.08	1.51	7.17	3.03	13.25	7.43	19.33	2.48
1.17	1.51	7.25	3.03	13.33	7.43	19.42	2.48
1.25	1.51	7.33	3.03	13.42	7.43	19.50	2.48
1.33	1.51	7.42	3.03	13.50	7.43	19.58	2.48
1.42	1.51	7.50	3.03	13.58	5.78	19.67	2.48
1.50	1.51	7.58	3.03	13.67	5.78	19.75	2.48
1.58	1.51	7.67	3.03	13.75	5.78	19.83	2.48
1.67	1.51	7.75	3.03	13.83	5.78	19.92	2.48
1.75	1.51	7.83	3.03	13.92	5.78	20.00	2.48
1.83	1.51	7.92	3.03	14.00	5.78	20.08	1.65
1.92	1.51	8.00	3.03	14.08	4.13	20.17	1.65
2.00	1.51	8.08	3.58	14.17	4.13	20.25	1.65
2.08	1.79	8.17	3.58	14.25	4.13	20.33	1.65
2.17	1.79	8.25	3.58	14.33	4.13	20.42	1.65
2.25	1.79	8.33	3.58	14.42	4.13	20.50	1.65
2.33	1.79	8.42	3.58	14.50	4.13	20.58	1.65
2.42	1.79	8.50	3.58	14.58	4.13	20.67	1.65
2.50	1.79	8.58	3.85	14.67	4.13	20.75	1.65
2.58	1.79	8.67	3.85	14.75	4.13	20.83	1.65
2.67	1.79	8.75	3.85	14.83	4.13	20.92	1.65
2.75	1.79	8.83	3.85	14.92	4.13	21.00	1.65
2.83	1.79	8.92	3.85	15.00	4.13	21.08	1.65
2.92	1.79	9.00	3.85	15.08	4.13	21.17	1.65
3.00	1.79	9.08	4.40	15.17	4.13	21.25	1.65
3.08	1.79	9.17	4.40	15.25	4.13	21.33	1.65
3.17	1.79	9.25	4.40	15.33	4.13	21.42	1.65
3.25	1.79	9.33	4.40	15.42	4.13	21.50	1.65
3.33	1.79	9.42	4.40	15.50	4.13	21.58	1.65
3.42	1.79	9.50	4.40	15.58	4.13	21.67	1.65
3.50	1.79	9.58	4.95	15.67	4.13	21.75	1.65
3.58	1.79	9.67	4.95	15.75	4.13	21.83	1.65
3.67	1.79	9.75	4.95	15.83	4.13	21.92	1.65

3.75	1.79	9.83	4.95	15.92	4.13	22.00	1.65
3.83	1.79	9.92	4.95	16.00	4.13	22.08	1.65
3.92	1.79	10.00	4.95	16.08	2.48	22.17	1.65
4.00	1.79	10.08	6.33	16.17	2.48	22.25	1.65
4.08	2.20	10.17	6.33	16.25	2.48	22.33	1.65
4.17	2.20	10.25	6.33	16.33	2.48	22.42	1.65
4.25	2.20	10.33	6.33	16.42	2.48	22.50	1.65
4.33	2.20	10.42	6.33	16.50	2.48	22.58	1.65
4.42	2.20	10.50	6.33	16.58	2.48	22.67	1.65
4.50	2.20	10.58	8.53	16.67	2.48	22.75	1.65
4.58	2.20	10.67	8.53	16.75	2.48	22.83	1.65
4.67	2.20	10.75	8.53	16.83	2.48	22.92	1.65
4.75	2.20	10.83	8.53	16.92	2.48	23.00	1.65
4.83	2.20	10.92	8.53	17.00	2.48	23.08	1.65
4.92	2.20	11.00	8.53	17.08	2.48	23.17	1.65
5.00	2.20	11.08	13.21	17.17	2.48	23.25	1.65
5.08	2.20	11.17	13.21	17.25	2.48	23.33	1.65
5.17	2.20	11.25	13.21	17.33	2.48	23.42	1.65
5.25	2.20	11.33	13.21	17.42	2.48	23.50	1.65
5.33	2.20	11.42	13.21	17.50	2.48	23.58	1.65
5.42	2.20	11.50	13.21	17.58	2.48	23.67	1.65
5.50	2.20	11.58	40.74	17.67	2.48	23.75	1.65
5.58	2.20	11.67	40.74	17.75	2.48	23.83	1.65
5.67	2.20	11.75	40.74	17.83	2.48	23.92	1.65
5.75	2.20	11.83	168.46	17.92	2.48	24.00	1.65
5.83	2.20	11.92	168.46	18.00	2.48		
5.92	2.20	12.00	168.46	18.08	2.48		
6.00	2.20	12.08	19.82	18.17	2.48		

| CALIB |
| STANDHYD (0201) | Area (ha)= 0.25
| ID= 1 DT= 5.0 min | Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.20 0.05
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 3.00 5.00
Length (m)= 40.87 30.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 168.46 85.39
over (min) 5.00 5.00
Storage Coeff. (min)= 0.87 (ii) 2.90 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.28

TOTALS
PEAK FLOW (cms)= 0.10 0.01 0.107 (iii)

TIME TO PEAK (hrs)= 12.08 12.08 12.08
RUNOFF VOLUME (mm)= 135.63 58.25 121.23
TOTAL RAINFALL (mm)= 137.63 137.63 137.63
RUNOFF COEFFICIENT = 0.99 0.42 0.88

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| CALIB |
| STANDHYD (0202) | Area (ha)= 0.04
| ID= 1 DT= 5.0 min | Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.01 0.03
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 2.00 5.00
Length (m)= 16.83 10.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 168.46 110.44
over (min) 5.00 5.00
Storage Coeff. (min)= 0.58 (ii) 3.80 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.25

TOTALS
PEAK FLOW (cms)= 0.00 0.01 0.013 (iii)
TIME TO PEAK (hrs)= 12.00 12.08 12.08
RUNOFF VOLUME (mm)= 135.63 64.13 77.26
TOTAL RAINFALL (mm)= 137.63 137.63 137.63
RUNOFF COEFFICIENT = 0.99 0.47 0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

***** WARNING: FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V	V	I	SSSSS	U	U	A	L	(v 6.2.2015)
V	V	I	SS	U	U	A A	L	
V	V	I	SS	U	U	AAAAA	L	
V	V	I	SS	U	U	A A	L	
VV		I	SSSSS	UUUUU	A A	LLLLL		

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***** D E T A I L E D O U T P U T *****

C:\Users\dhordyk\AppData\Local\Civica\H5\c61c7218-2e29-428d-a513-ca86584781d5\5d2266d-14c5-4709-b58f-4ad4ca222855\scen

TIME: 04:02:26

COMMENTS: _____

```
Duration of storm = 4.00 hrs
Storm time step   = 5.00 min
Time to peak ratio = 0.33
```

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	6.06	1.00	24.64	2.00	16.94	3.00	7.96
0.08	6.41	1.08	36.97	2.08	14.68	3.08	7.67
0.17	6.81	1.17	81.48	2.17	13.55	3.17	7.40
0.25	7.27	1.25	245.55	2.25	12.60	3.25	7.15
0.33	7.81	1.33	103.86	2.33	11.79	3.33	6.92
0.42	8.45	1.42	59.20	2.42	11.08	3.42	6.71
0.50	9.23	1.50	41.66	2.50	10.47	3.50	6.51
0.58	10.19	1.58	32.37	2.58	9.93	3.58	6.32
0.67	11.42	1.67	26.62	2.67	9.45	3.67	6.15
0.75	13.06	1.75	22.72	2.75	9.02	3.75	5.99
0.83	15.34	1.83	19.89	2.83	8.63	3.83	5.83
0.92	18.79	1.92	17.73	2.92	8.28	3.92	5.69

Max. Eff. Inten. (mm/hr)=	245.55	49.91
over (min)	5.00	5.00
Storage Coeff. (min)=	0.75 (ii)	2.49 (ii)
Unit Hvd. Tpeak (min)=	5.00	5.00

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
- (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
- (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

UNIT	HYD. PEAK (cms)-	0.34	0.27	
PEAK FLOW (cms)=	0.01	0.01	0.01	(iii)
TIME TO PEAK (hrs)=	1.33	1.33	1.33	
RUNOFF VOLUME (mm)=	85.45	30.46	40.51	
TOTAL RAINFALL (mm)=	87.45	87.45	87.45	
RUNOFF COEFFICIENT =	0.98	0.35	0.46	

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
- (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
- (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V	V	I	SSSSS	U	U	A	L	(v 6.2.2015)
V	V	I	SS	U	U	A A	L	
V	V	I	SS	U	U	AAAAA	L	
V	V	I	SS	U	U	A A	L	
VV		I	SSSSS	UUUUU	A	A	LLLLL	

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***** D E T A I L E D O U T P U T *****

C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\ca46
9424-2879-4abb-8e71-0d926d358d70\scen

TIME: 04:02:26

USER:

COMMENTS: _____

** SIMULATION : 10yr 24hr 5min SCS Type II **

| READ STORM | File: C:\Users\dhordyk\AppData
| | ata\Local\Temp\
| Ptotal= 93.03 mm | 26fbfc19-efc0-458c-9b8e-5c7e48c42e3e\36007965
| | Comments: 10yr 24hr 5min SCS Type II
| |

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	1.67	12.17	13.40	18.25	1.67	
0.08	1.02	6.17	1.67	12.25	13.40	18.33	1.67	
0.17	1.02	6.25	1.67	12.33	13.40	18.42	1.67	
0.25	1.02	6.33	1.67	12.42	13.40	18.50	1.67	
0.33	1.02	6.42	1.67	12.50	13.40	18.58	1.67	
0.42	1.02	6.50	1.67	12.58	6.88	18.67	1.67	
0.50	1.02	6.58	1.67	12.67	6.88	18.75	1.67	
0.58	1.02	6.67	1.67	12.75	6.88	18.83	1.67	
0.67	1.02	6.75	1.67	12.83	6.88	18.92	1.67	
0.75	1.02	6.83	1.67	12.92	6.88	19.00	1.67	
0.83	1.02	6.92	1.67	13.00	6.88	19.08	1.67	
0.92	1.02	7.00	1.67	13.08	5.02	19.17	1.67	
1.00	1.02	7.08	2.05	13.17	5.02	19.25	1.67	
1.08	1.02	7.17	2.05	13.25	5.02	19.33	1.67	
1.17	1.02	7.25	2.05	13.33	5.02	19.42	1.67	
1.25	1.02	7.33	2.05	13.42	5.02	19.50	1.67	
1.33	1.02	7.42	2.05	13.50	5.02	19.58	1.67	
1.42	1.02	7.50	2.05	13.58	3.91	19.67	1.67	
1.50	1.02	7.58	2.05	13.67	3.91	19.75	1.67	
1.58	1.02	7.67	2.05	13.75	3.91	19.83	1.67	
1.67	1.02	7.75	2.05	13.83	3.91	19.92	1.67	
1.75	1.02	7.83	2.05	13.92	3.91	20.00	1.67	
1.83	1.02	7.92	2.05	14.00	3.91	20.08	1.12	
1.92	1.02	8.00	2.05	14.08	2.79	20.17	1.12	
2.00	1.02	8.08	2.42	14.17	2.79	20.25	1.12	
2.08	1.21	8.17	2.42	14.25	2.79	20.33	1.12	
2.17	1.21	8.25	2.42	14.33	2.79	20.42	1.12	
2.25	1.21	8.33	2.42	14.42	2.79	20.50	1.12	
2.33	1.21	8.42	2.42	14.50	2.79	20.58	1.12	
2.42	1.21	8.50	2.42	14.58	2.79	20.67	1.12	
2.50	1.21	8.58	2.60	14.67	2.79	20.75	1.12	

2.58	1.21	8.67	2.60	14.75	2.79	20.83	1.12	
2.67	1.21	8.75	2.60	14.83	2.79	20.92	1.12	
2.75	1.21	8.83	2.60	14.92	2.79	21.00	1.12	
2.83	1.21	8.92	2.60	15.00	2.79	21.08	1.12	
2.92	1.21	9.00	2.60	15.08	2.79	21.17	1.12	
3.00	1.21	9.08	2.98	15.17	2.79	21.25	1.12	
3.08	1.21	9.17	2.98	15.25	2.79	21.33	1.12	
3.17	1.21	9.25	2.98	15.33	2.79	21.42	1.12	
3.25	1.21	9.33	2.98	15.42	2.79	21.50	1.12	
3.33	1.21	9.42	2.98	15.50	2.79	21.58	1.12	
3.42	1.21	9.50	2.98	15.58	2.79	21.67	1.12	
3.50	1.21	9.58	3.35	15.67	2.79	21.75	1.12	
3.58	1.21	9.67	3.35	15.75	2.79	21.83	1.12	
3.67	1.21	9.75	3.35	15.83	2.79	21.92	1.12	
3.75	1.21	9.83	3.35	15.92	2.79	22.00	1.12	
3.83	1.21	9.92	3.35	16.00	2.79	22.08	1.12	
3.92	1.21	10.00	3.35	16.08	1.67	22.17	1.12	
4.00	1.21	10.08	4.28	16.17	1.67	22.25	1.12	
4.08	1.49	10.17	4.28	16.25	1.67	22.33	1.12	
4.17	1.49	10.25	4.28	16.33	1.67	22.42	1.12	
4.25	1.49	10.33	4.28	16.42	1.67	22.50	1.12	
4.33	1.49	10.42	4.28	16.50	1.67	22.58	1.12	
4.42	1.49	10.50	4.28	16.58	1.67	22.67	1.12	
4.50	1.49	10.58	5.77	16.67	1.67	22.75	1.12	
4.58	1.49	10.67	5.77	16.75	1.67	22.83	1.12	
4.67	1.49	10.75	5.77	16.83	1.67	22.92	1.12	
4.75	1.49	10.83	5.77	16.92	1.67	23.00	1.12	
4.83	1.49	10.92	5.77	17.00	1.67	23.08	1.12	
4.92	1.49	11.00	5.77	17.08	1.67	23.17	1.12	
5.00	1.49	11.08	8.93	17.17	1.67	23.25	1.12	
5.08	1.49	11.17	8.93	17.25	1.67	23.33	1.12	
5.17	1.49	11.25	8.93	17.33	1.67	23.42	1.12	
5.25	1.49	11.33	8.93	17.42	1.67	23.50	1.12	
5.33	1.49	11.42	8.93	17.50	1.67	23.58	1.12	
5.42	1.49	11.50	8.93	17.58	1.67	23.67	1.12	
5.50	1.49	11.58	27.54	17.67	1.67	23.75	1.12	
5.58	1.49	11.67	27.54	17.75	1.67	23.83	1.12	
5.67	1.49	11.75	27.54	17.83	1.67	23.92	1.12	
5.75	1.49	11.83	113.87	17.92	1.67	24.00	1.12	
5.83	1.49	11.92	113.87	18.00	1.67			
5.92	1.49	12.00	113.87	18.08	1.67			
6.00	1.49	12.08	13.40	18.17	1.67			

| CALIB |
| STANDHYD (0201) | Area (ha)= 0.25
| ID= 1 DT= 5.0 min | Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40
| ID= 1 DT= 5.0 min |

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.20	0.05
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	3.00	5.00
Length (m)=	40.87	30.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	113.87	44.09
over (min)=	5.00	5.00
Storage Coeff. (min)=	1.02 (ii)	3.39 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.26
PEAK FLOW (cms)=	0.06	0.01
TIME TO PEAK (hrs)=	12.08	12.08
RUNOFF VOLUME (mm)=	91.03	79.70
TOTAL RAINFALL (mm)=	93.03	93.03
RUNOFF COEFFICIENT =	0.98	0.86

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| CALIB |
| STANDHYD (0202) | Area (ha)= 0.04
| ID= 1 DT= 5.0 min | Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40
| ID= 1 DT= 5.0 min |

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.01	0.03
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	2.00	5.00
Length (m)=	16.83	10.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	113.87	58.34
over (min)=	5.00	5.00
Storage Coeff. (min)=	0.68 (ii)	4.44 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.23
PEAK FLOW (cms)=	0.00	0.00
TIME TO PEAK (hrs)=	12.08	12.08
RUNOFF VOLUME (mm)=	91.03	33.86
TOTAL RAINFALL (mm)=	93.03	93.03

RUNOFF COEFFICIENT = 0.98 0.36 0.44

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING: FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| ADD HYD (0203) |
| 1 + 2 = 3 | AREA QPEAK TPEAK R.V.
(ha) (cms) (hrs) (mm)
ID1= 1 (0201): 0.25 0.070 12.08 79.70
+ ID2= 2 (0202): 0.04 0.007 12.08 41.30
=====

ID = 3 (0203): 0.29 0.078 12.08 74.13

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
V V I SSSSS UUUU A A LLLLL
W I

000 TTTT TTTT H H Y Y M M TM
O O T T H H Y Y M M O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M O O

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat
Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\4300

3152-36ec-4f14-a73d-62b94135c64b\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\4300
3152-36ec-4f14-a73d-62b94135c64b\scen

DATE: 10-12-2023 TIME: 04:02:25

USER:

COMMENTS: _____

** SIMULATION : 10yr 4hr 5min Chicago **

CHICAGO STORM IDF curve parameters: A= 976.898
Ptotal= 59.77 mm B= 4.745
C= 0.760

used in: INTENSITY = $A / (t + B)^C$

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	4.04	1.00	16.64	2.00	10.79	3.00	5.32
0.08	4.28	1.08	25.08	2.08	9.86	3.08	5.13
0.17	4.55	1.17	55.96	2.17	9.10	3.17	4.94
0.25	4.86	1.25	173.13	2.25	8.45	3.25	4.78
0.33	5.22	1.33	71.59	2.33	7.91	3.33	4.62
0.42	5.65	1.42	40.40	2.42	7.43	3.42	4.48
0.50	6.18	1.50	28.30	2.50	7.02	3.50	4.34
0.58	6.83	1.58	21.92	2.58	6.65	3.58	4.22
0.67	7.66	1.67	17.99	2.67	6.33	3.67	4.10
0.75	8.77	1.75	15.33	2.75	6.04	3.75	3.99
0.83	10.31	1.83	13.40	2.83	5.78	3.83	3.89
0.92	12.65	1.92	11.94	2.92	5.54	3.92	3.79

CALIB

STANDHYD (0201) Area (ha)= 0.25
ID= 1 DT= 5.0 min Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.20	0.05
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	3.00	5.00
Length (m)=	40.87	30.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	173.13	24.29
over (min)=	5.00	5.00
Storage Coeff. (min)=	0.86 (ii)	2.87 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.28

		TOTALS
PEAK FLOW (cms)=	0.10	0.101 (iii)
TIME TO PEAK (hrs)=	1.33	1.33
RUNOFF VOLUME (mm)=	57.77	49.50
TOTAL RAINFALL (mm)=	59.77	59.77
RUNOFF COEFFICIENT =	0.97	0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0202) Area (ha)= 0.04
ID= 1 DT= 5.0 min Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.01	0.03
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	2.00	5.00
Length (m)=	16.83	10.00
Mannings n =	0.013	0.250
Max.Eff.Inten.(mm/hr)=	173.13	33.64
over (min)=	5.00	5.00
Storage Coeff. (min)=	0.57 (ii)	3.76 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.25

		TOTALS
PEAK FLOW (cms)=	0.00	0.006 (iii)

TIME TO PEAK (hrs)=	1.33	1.33	1.33
RUNOFF VOLUME (mm)=	57.77	15.44	23.19
TOTAL RAINFALL (mm)=	59.77	59.77	59.77
RUNOFF COEFFICIENT =	0.97	0.26	0.39

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)
1 + 2 = 3
ID1= 1 (0201): 0.25 0.101 1.33 49.50
+ ID2= 2 (0202): 0.04 0.006 1.33 23.19
ID = 3 (0203): 0.29 0.108 1.33 45.69

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U AAAAA L
V V I SS U U A A L
VV I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y Y M M O O
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\81c1
7d11-cae1-446e-a330-bf790525c301\scen

Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\81c1
7d11-cae1-446e-a330-bf790525c301\scen

DATE: 10-12-2023 TIME: 04:02:26

USER:

COMMENTS: _____

** SIMULATION : 25yr 24hr 5min SCS Type II **

READ STORM Filename: C:\Users\dhordyk\AppData
ata\Local\Temp\
26fbfc19-efc0-458c-9b8e-5c7e48c42e3e\94266df7
Ptotal=111.09 mm Comments: 25yr 24hr 5min SCS Type II

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	0.00	6.08	2.00	12.17	16.00	18.25	2.00
0.08	1.22	6.17	2.00	12.25	16.00	18.33	2.00
0.17	1.22	6.25	2.00	12.33	16.00	18.42	2.00
0.25	1.22	6.33	2.00	12.42	16.00	18.50	2.00
0.33	1.22	6.42	2.00	12.50	16.00	18.58	2.00
0.42	1.22	6.50	2.00	12.58	8.22	18.67	2.00
0.50	1.22	6.58	2.00	12.67	8.22	18.75	2.00
0.58	1.22	6.67	2.00	12.75	8.22	18.83	2.00
0.67	1.22	6.75	2.00	12.83	8.22	18.92	2.00
0.75	1.22	6.83	2.00	12.92	8.22	19.00	2.00
0.83	1.22	6.92	2.00	13.00	8.22	19.08	2.00
0.92	1.22	7.00	2.00	13.08	6.00	19.17	2.00
1.00	1.22	7.08	2.44	13.17	6.00	19.25	2.00
1.08	1.22	7.17	2.44	13.25	6.00	19.33	2.00
1.17	1.22	7.25	2.44	13.33	6.00	19.42	2.00
1.25	1.22	7.33	2.44	13.42	6.00	19.50	2.00
1.33	1.22	7.42	2.44	13.50	6.00	19.58	2.00

1.42	1.22	7.50	2.44	13.58	4.67	19.67	2.00
1.50	1.22	7.58	2.44	13.67	4.67	19.75	2.00
1.58	1.22	7.67	2.44	13.75	4.67	19.83	2.00
1.67	1.22	7.75	2.44	13.83	4.67	19.92	2.00
1.75	1.22	7.83	2.44	13.92	4.67	20.00	2.00
1.83	1.22	7.92	2.44	14.00	4.67	20.08	1.33
1.92	1.22	8.00	2.44	14.08	3.33	20.17	1.33
2.00	1.22	8.08	2.89	14.17	3.33	20.25	1.33
2.08	1.44	8.17	2.89	14.25	3.33	20.33	1.33
2.17	1.44	8.25	2.89	14.33	3.33	20.42	1.33
2.25	1.44	8.33	2.89	14.42	3.33	20.50	1.33
2.33	1.44	8.42	2.89	14.50	3.33	20.58	1.33
2.42	1.44	8.50	2.89	14.58	3.33	20.67	1.33
2.50	1.44	8.58	3.11	14.67	3.33	20.75	1.33
2.58	1.44	8.67	3.11	14.75	3.33	20.83	1.33
2.67	1.44	8.75	3.11	14.83	3.33	20.92	1.33
2.75	1.44	8.83	3.11	14.92	3.33	21.00	1.33
2.83	1.44	8.92	3.11	15.00	3.33	21.08	1.33
2.92	1.44	9.00	3.11	15.08	3.33	21.17	1.33
3.00	1.44	9.08	3.55	15.17	3.33	21.25	1.33
3.08	1.44	9.17	3.55	15.25	3.33	21.33	1.33
3.17	1.44	9.25	3.55	15.33	3.33	21.42	1.33
3.25	1.44	9.33	3.55	15.42	3.33	21.50	1.33
3.33	1.44	9.42	3.55	15.50	3.33	21.58	1.33
3.42	1.44	9.50	3.55	15.58	3.33	21.67	1.33
3.50	1.44	9.58	4.00	15.67	3.33	21.75	1.33
3.58	1.44	9.67	4.00	15.75	3.33	21.83	1.33
3.67	1.44	9.75	4.00	15.83	3.33	21.92	1.33
3.75	1.44	9.83	4.00	15.92	3.33	22.00	1.33
3.83	1.44	9.92	4.00	16.00	3.33	22.08	1.33
3.92	1.44	10.00	4.00	16.08	2.00	22.17	1.33
4.00	1.44	10.08	5.11	16.17	2.00	22.25	1.33
4.08	1.78	10.17	5.11	16.25	2.00	22.33	1.33
4.17	1.78	10.25	5.11	16.33	2.00	22.42	1.33
4.25	1.78	10.33	5.11	16.42	2.00	22.50	1.33
4.33	1.78	10.42	5.11	16.50	2.00	22.58	1.33
4.42	1.78	10.50	5.11	16.58	2.00	22.67	1.33
4.50	1.78	10.58	6.89	16.67	2.00	22.75	1.33
4.58	1.78	10.67	6.89	16.75	2.00	22.83	1.33
4.67	1.78	10.75	6.89	16.83	2.00	22.92	1.33
4.75	1.78	10.83	6.89	16.92	2.00	23.00	1.33
4.83	1.78	10.92	6.89	17.00	2.00	23.08	1.33
4.92	1.78	11.00	6.89	17.08	2.00	23.17	1.33
5.00	1.78	11.08	10.66	17.17	2.00	23.25	1.33
5.08	1.78	11.17	10.66	17.25	2.00	23.33	1.33
5.17	1.78	11.25	10.66	17.33	2.00	23.42	1.33
5.25	1.78	11.33	10.66	17.42	2.00	23.50	1.33
5.33	1.78	11.42	10.66	17.50	2.00	23.58	1.33
5.42	1.78	11.50	10.66	17.58	2.00	23.67	1.33
5.50	1.78	11.58	32.88	17.67	2.00	23.75	1.33

5.58	1.78	11.67	32.88	17.75	2.00	23.83	1.33
5.67	1.78	11.75	32.88	17.83	2.00	23.92	1.33
5.75	1.78	11.83	135.97	17.92	2.00	24.00	1.33
5.83	1.78	11.92	135.97	18.00	2.00		
5.92	1.78	12.00	135.97	18.08	2.00		
6.00	1.78	12.08	16.00	18.17	2.00		

CALIB							
STANDHYD (0201)	Area (ha)=	0.25					
ID= 1 DT= 5.0 min	Total Imp(%)=	81.40	Dir. Conn.(%)=	81.40			

		IMPERVIOUS	PERVIOUS (i)	
Surface Area (ha)=	0.20	0.05		
Dep. Storage (mm)=	2.00	5.00		
Average Slope (%)=	3.00	5.00		
Length (m)=	40.87	30.00		
Mannings n =	0.013	0.250		
Max.Eff.Inten.(mm/hr)=	135.97	59.89		
over (min)	5.00	5.00		
Storage Coeff. (min)=	0.95 (ii)	3.16 (ii)		
Unit Hyd. Tpeak (min)=	5.00	5.00		
Unit Hyd. peak (cms)=	0.34	0.27		
				TOTALS
PEAK FLOW (cms)=	0.08	0.01	0.085 (iii)	
TIME TO PEAK (hrs)=	12.08	12.08	12.08	
RUNOFF VOLUME (mm)=	109.09	40.86	96.40	
TOTAL RAINFALL (mm)=	111.09	111.09	111.09	
RUNOFF COEFFICIENT =	0.98	0.37	0.87	

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB							
STANDHYD (0202)	Area (ha)=	0.04					
ID= 1 DT= 5.0 min	Total Imp(%)=	30.60	Dir. Conn.(%)=	18.40			

		IMPERVIOUS	PERVIOUS (i)	
Surface Area (ha)=	0.01	0.03		
Dep. Storage (mm)=	2.00	5.00		

Average Slope (%)=	2.00	5.00		
Length (m)=	16.83	10.00		
Mannings n =	0.013	0.250		
Max.Eff.Inten.(mm/hr)=	135.97	78.42		
over (min)	5.00	5.00		
Storage Coeff. (min)=	0.63 (ii)	4.14 (ii)		
Unit Hyd. Tpeak (min)=	5.00	5.00		
Unit Hyd. peak (cms)=	0.34	0.24		
				TOTALS
PEAK FLOW (cms)=	0.00	0.01	0.009 (iii)	
TIME TO PEAK (hrs)=	12.08	12.08	12.08	
RUNOFF VOLUME (mm)=	109.09	45.50	57.18	
TOTAL RAINFALL (mm)=	111.09	111.09	111.09	
RUNOFF COEFFICIENT =	0.98	0.41	0.51	

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING: FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)							
1 + 2 = 3	AREA (ha)	QPEAK (cms)	TPEAK (hrs)	R.V. (mm)			
ID1= 1 (0201):	0.25	0.085	12.08	96.40			
+ ID2= 2 (0202):	0.04	0.009	12.08	57.18			
ID = 3 (0203):	0.29	0.094	12.08	90.71			

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V	V	I	SSSSS	U	U	A	L	(v 6.2.2015)
V	V	I	SS	U	U	A	A	L
V	V	I	SS	U	U	AAAAA	L	
V	V	I	SS	U	U	A	A	L
W	I	SSSSS	UUUUU	A	A	LLLLL		
OOO	TTTTT	TTTTT	H	H	Y	Y	M	MM
O	O	T	T	H	H	Y	Y	MM

O O T T H H Y M M O O
OOO T T H H Y M M OOO
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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voin.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\9e117ae-5287-4446-9676-1c40429257f9\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\9e117ae-5287-4446-9676-1c40429257f9\scen

DATE: 10-12-2023 TIME: 04:02:26

USER:

COMMENTS:

** SIMULATION : 25yr 4hr 5min Chicago

CHICAGO STORM	IDF curve parameters: A=1133.123
Ptotal= 70.87 mm	B= 4.734
	C= 0.756

used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	4.87	1.00	19.82	2.00	12.89	3.00	6.39
0.08	5.15	1.08	29.77	2.08	11.79	3.08	6.16
0.17	5.47	1.17	65.99	2.17	10.89	3.17	5.94

0.25	5.84	1.25	202.83	2.25	10.12	3.25	5.74
0.33	6.27	1.33	84.29	2.33	9.47	3.33	5.56
0.42	6.79	1.42	47.77	2.42	8.91	3.42	5.39
0.50	7.41	1.50	33.55	2.50	8.41	3.50	5.23
0.58	8.19	1.58	26.05	2.58	7.98	3.58	5.08
0.67	9.18	1.67	21.41	2.67	7.59	3.67	4.94
0.75	10.49	1.75	18.27	2.75	7.25	3.75	4.81
0.83	12.33	1.83	15.99	2.83	6.93	3.83	4.68
0.92	15.10	1.92	14.26	2.92	6.65	3.92	4.57

CALIB
STANDHYD (0201)
ID= 1 DT= 5.0 min

Area (ha)= 0.25
Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

Surface Area	(ha)=	0.20	0.05
Dep. Storage	(mm)=	2.00	5.00
Average Slope	(%)=	3.00	5.00
Length	(m)=	40.87	30.00
Mannings n	=	0.013	0.250

Max.Eff.Inten.(mm/hr)=	202.83	33.79
over (min)	5.00	5.00
Storage Coeff. (min)=	0.81 (ii)	2.69 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.29

PEAK FLOW	(cms)=	0.11	0.00	*TOTALS*
TIME TO PEAK	(hrs)=	1.33	1.33	0.119 (iii)
RUNOFF VOLUME	(mm)=	68.87	18.45	1.33
TOTAL RAINFALL	(mm)=	70.87	70.87	59.48
RUNOFF COEFFICIENT	=	0.97	0.26	0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0202)
ID= 1 DT= 5.0 min

Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

	IMPERVIOUS	PERVIOUS (i)	
Surface Area	(ha)= 0.01	0.03	
Dep. Storage	(mm)= 2.00	5.00	
Average Slope	(%)= 2.00	5.00	
Length	(m)= 16.83	10.00	
Mannings n	= 0.013	0.250	
Max.Eff.Inten.(mm/hr)=	202.83	46.25	
over (min)	5.00	5.00	
Storage Coeff. (min)=	0.54 (ii)	3.53 (ii)	
Unit Hyd. Tpeak (min)=	5.00	5.00	
Unit Hyd. peak (cms)=	0.34	0.26	
PEAK FLOW	(cms)= 0.00	0.00	*TOTALS*
TIME TO PEAK	(hrs)= 1.33	1.33	0.008 (iii)
RUNOFF VOLUME	(mm)= 68.87	21.07	1.33
TOTAL RAINFALL	(mm)= 70.87	70.87	29.81
RUNOFF COEFFICIENT	= 0.97	0.30	70.87

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING: FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)
1 + 2 = 3

	AREA	QPEAK	TPEAK	R.V.
	(ha)	(cms)	(hrs)	(mm)
ID1= 1 (0201):	0.25	0.119	1.33	59.48
+ ID2= 2 (0202):	0.04	0.008	1.33	29.81
ID = 3 (0203):	0.29	0.128	1.33	55.18

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

FINISH

=====

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
VV I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\b848
3fd1-5f66-48c0-8e3f-fad265d70868\scen

Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\b848
3fd1-5f66-48c0-8e3f-fad265d70868\scen

DATE: 10-12-2023 TIME: 04:02:26

USER:

COMMENTS:

** SIMULATION : 2yr 24hr 5min SCS Type II

READ STORM
Ptotal= 55.62 mm

Filename: C:\Users\dhordyk\AppData\Local\Temp\
26fbfc19-efc0-458c-9b8e-5c7e48c42e3e\eb159c29
Comments: 2yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	'	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	1.00	12.17	8.01	18.25	1.00	
0.08	0.61	6.17	1.00	12.25	8.01	18.33	1.00	
0.17	0.61	6.25	1.00	12.33	8.01	18.42	1.00	
0.25	0.61	6.33	1.00	12.42	8.01	18.50	1.00	
0.33	0.61	6.42	1.00	12.50	8.01	18.58	1.00	
0.42	0.61	6.50	1.00	12.58	4.12	18.67	1.00	
0.50	0.61	6.58	1.00	12.67	4.12	18.75	1.00	
0.58	0.61	6.67	1.00	12.75	4.12	18.83	1.00	
0.67	0.61	6.75	1.00	12.83	4.12	18.92	1.00	
0.75	0.61	6.83	1.00	12.92	4.12	19.00	1.00	
0.83	0.61	6.92	1.00	13.00	4.12	19.08	1.00	
0.92	0.61	7.00	1.00	13.08	3.00	19.17	1.00	
1.00	0.61	7.08	1.22	13.17	3.00	19.25	1.00	
1.08	0.61	7.17	1.22	13.25	3.00	19.33	1.00	
1.17	0.61	7.25	1.22	13.33	3.00	19.42	1.00	
1.25	0.61	7.33	1.22	13.42	3.00	19.50	1.00	
1.33	0.61	7.42	1.22	13.50	3.00	19.58	1.00	
1.42	0.61	7.50	1.22	13.58	2.34	19.67	1.00	
1.50	0.61	7.58	1.22	13.67	2.34	19.75	1.00	
1.58	0.61	7.67	1.22	13.75	2.34	19.83	1.00	
1.67	0.61	7.75	1.22	13.83	2.34	19.92	1.00	
1.75	0.61	7.83	1.22	13.92	2.34	20.00	1.00	
1.83	0.61	7.92	1.22	14.00	2.34	20.08	0.67	
1.92	0.61	8.00	1.22	14.08	1.67	20.17	0.67	
2.00	0.61	8.08	1.45	14.17	1.67	20.25	0.67	
2.08	0.72	8.17	1.45	14.25	1.67	20.33	0.67	
2.17	0.72	8.25	1.45	14.33	1.67	20.42	0.67	
2.25	0.72	8.33	1.45	14.42	1.67	20.50	0.67	
2.33	0.72	8.42	1.45	14.50	1.67	20.58	0.67	
2.42	0.72	8.50	1.45	14.58	1.67	20.67	0.67	
2.50	0.72	8.58	1.56	14.67	1.67	20.75	0.67	
2.58	0.72	8.67	1.56	14.75	1.67	20.83	0.67	
2.67	0.72	8.75	1.56	14.83	1.67	20.92	0.67	
2.75	0.72	8.83	1.56	14.92	1.67	21.00	0.67	
2.83	0.72	8.92	1.56	15.00	1.67	21.08	0.67	
2.92	0.72	9.00	1.56	15.08	1.67	21.17	0.67	
3.00	0.72	9.08	1.78	15.17	1.67	21.25	0.67	
3.08	0.72	9.17	1.78	15.25	1.67	21.33	0.67	
3.17	0.72	9.25	1.78	15.33	1.67	21.42	0.67	
3.25	0.72	9.33	1.78	15.42	1.67	21.50	0.67	
3.33	0.72	9.42	1.78	15.50	1.67	21.58	0.67	
3.42	0.72	9.50	1.78	15.58	1.67	21.67	0.67	
3.50	0.72	9.58	2.00	15.67	1.67	21.75	0.67	
3.58	0.72	9.67	2.00	15.75	1.67	21.83	0.67	
3.67	0.72	9.75	2.00	15.83	1.67	21.92	0.67	
3.75	0.72	9.83	2.00	15.92	1.67	22.00	0.67	
3.83	0.72	9.92	2.00	16.00	1.67	22.08	0.67	
3.92	0.72	10.00	2.00	16.08	1.00	22.17	0.67	

4.00	0.72	10.08	2.56	16.17	1.00	22.25	0.67
4.08	0.89	10.17	2.56	16.25	1.00	22.33	0.67
4.17	0.89	10.25	2.56	16.33	1.00	22.42	0.67
4.25	0.89	10.33	2.56	16.42	1.00	22.50	0.67
4.33	0.89	10.42	2.56	16.50	1.00	22.58	0.67
4.42	0.89	10.50	2.56	16.58	1.00	22.67	0.67
4.50	0.89	10.58	3.45	16.67	1.00	22.75	0.67
4.58	0.89	10.67	3.45	16.75	1.00	22.83	0.67
4.67	0.89	10.75	3.45	16.83	1.00	22.92	0.67
4.75	0.89	10.83	3.45	16.92	1.00	23.00	0.67
4.83	0.89	10.92	3.45	17.00	1.00	23.08	0.67
4.92	0.89	11.00	3.45	17.08	1.00	23.17	0.67
5.00	0.89	11.08	5.34	17.17	1.00	23.25	0.67
5.08	0.89	11.17	5.34	17.25	1.00	23.33	0.67
5.17	0.89	11.25	5.34	17.33	1.00	23.42	0.67
5.25	0.89	11.33	5.34	17.42	1.00	23.50	0.67
5.33	0.89	11.42	5.34	17.50	1.00	23.58	0.67
5.42	0.89	11.50	5.34	17.58	1.00	23.67	0.67
5.50	0.89	11.58	16.46	17.67	1.00	23.75	0.67
5.58	0.89	11.67	16.46	17.75	1.00	23.83	0.67
5.67	0.89	11.75	16.46	17.83	1.00	23.92	0.67
5.75	0.89	11.83	68.08	17.92	1.00	24.00	0.67
5.83	0.89	11.92	68.08	18.00	1.00		
5.92	0.89	12.00	68.08	18.08	1.00		
6.00	0.89	12.08	8.01	18.17	1.00		

CALIB							
STANDHYD (0201)	Area (ha)=	0.25					
ID= 1 DT= 5.0 min	Total Imp(%)=	81.40	Dir. Conn.(%)=	81.40			
	IMPERVIOUS		PERVIOUS (i)				
Surface Area (ha)=	0.20		0.05				
Dep. Storage (mm)=	2.00		5.00				
Average Slope (%)=	3.00		5.00				
Length (m)=	40.87		30.00				
Mannings n =	0.013		0.250				
Max.Eff.Inten.(mm/hr)=	68.08		16.98				
over (min)=	5.00		5.00				
Storage Coeff. (min)=	1.25 (ii)		4.17 (ii)				
Unit Hyd. Tpeak (min)=	5.00		5.00				
Unit Hyd. peak (cms)=	0.33		0.24				
				TOTALS			
PEAK FLOW (cms)=	0.04		0.00	0.041 (iii)			
TIME TO PEAK (hrs)=	12.08		12.08	12.08			
RUNOFF VOLUME (mm)=	53.62		11.65	45.81			
TOTAL RAINFALL (mm)=	55.62		55.62	55.62			

RUNOFF COEFFICIENT = 0.96 0.21 0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)

(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.

(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB							
STANDHYD (0202)	Area (ha)=	0.04					
ID= 1 DT= 5.0 min	Total Imp(%)=	30.60	Dir. Conn.(%)=	18.40			
	IMPERVIOUS		PERVIOUS (i)				
Surface Area (ha)=	0.01		0.03				
Dep. Storage (mm)=	2.00		5.00				
Average Slope (%)=	2.00		5.00				
Length (m)=	16.83		10.00				
Mannings n =	0.013		0.250				
Max.Eff.Inten.(mm/hr)=	68.08		23.18				
over (min)=	5.00		10.00				
Storage Coeff. (min)=	0.83 (ii)		5.46 (ii)				
Unit Hyd. Tpeak (min)=	5.00		10.00				
Unit Hyd. peak (cms)=	0.34		0.16				
				TOTALS			
PEAK FLOW (cms)=	0.00		0.00	0.003 (iii)			
TIME TO PEAK (hrs)=	12.08		12.08	12.08			
RUNOFF VOLUME (mm)=	53.62		13.50	17.21			
TOTAL RAINFALL (mm)=	55.62		55.62	55.62			
RUNOFF COEFFICIENT =	0.96		0.24	0.31			

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)

(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.

(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)							
1 + 2 = 3	AREA	QPEAK	TPEAK	R.V.			

	(ha)	(cms)	(hrs)	(mm)
ID1= 1 (0201):	0.25	0.041	12.08	45.81
+ ID2= 2 (0202):	0.04	0.003	12.08	17.21
ID = 3 (0203):	0.29	0.044	12.08	41.66

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V	V	I	SSSS	U	U	A	L	(v 6.2.2015)
V	V	I	SS	U	U	A	A	L
V	V	I	SS	U	U	A	A	A
V	V	I	SS	U	U	A	A	L
V	V	I	SSSS	UUUU	A	A	LLLL	

000	TTTT	TTTT	H	H	Y	Y	M	M	000	TM	
0	0	T	T	H	H	Y	Y	MM	MM	0	0
0	0	T	T	H	H	Y	Y	M	M	0	0
000	T	T	H	H	Y	Y	M	M	000		

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\4e21
efdc-0eb5-4e54-98ef-8c4cab577ca6\scen

Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\4e21
efdc-0eb5-4e54-98ef-8c4cab577ca6\scen

DATE: 10-12-2023

TIME: 04:02:25

USER:

COMMENTS: _____

** SIMULATION : 2yr 4hr 5min Chicago **

CHICAGO STORM	IDF curve parameters: A= 675.586
Ptotal= 37.03 mm	B= 4.681
	C= 0.780

used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	2.31	1.00	10.03	2.00	6.39	3.00	3.08
0.08	2.45	1.08	15.38	2.08	5.82	3.08	2.96
0.17	2.61	1.17	35.54	2.17	5.36	3.17	2.85
0.25	2.80	1.25	114.99	2.25	4.96	3.25	2.75
0.33	3.01	1.33	45.86	2.33	4.63	3.33	2.66
0.42	3.27	1.42	25.27	2.42	4.34	3.42	2.57
0.50	3.59	1.50	17.44	2.50	4.09	3.50	2.49
0.58	3.98	1.58	13.36	2.58	3.87	3.58	2.42
0.67	4.48	1.67	10.88	2.67	3.68	3.67	2.35
0.75	5.15	1.75	9.21	2.75	3.50	3.75	2.29
0.83	6.10	1.83	8.01	2.83	3.35	3.83	2.22
0.92	7.55	1.92	7.10	2.92	3.20	3.92	2.17

CALIB							
STANDHYD (0201)	Area (ha)=	0.25					
ID= 1 DT= 5.0 min	Total Imp(%)=	81.40	Dir. Conn.(%)=	81.40			
	IMPERVIOUS		PERVIOUS (i)				
Surface Area (ha)=	0.20		0.05				
Dep. Storage (mm)=	2.00		5.00				
Average Slope (%)=	3.00		5.00				
Length (m)=	40.87		30.00				
Mannings n =	0.013		0.250				
Max.Eff.Inten.(mm/hr)=	114.99		9.20				
over (min)=	5.00		5.00				
Storage Coeff. (min)=	1.02 (ii)		3.38 (ii)				
Unit Hyd. Tpeak (min)=	5.00		5.00				
Unit Hyd. peak (cms)=	0.34		0.26				
				TOTALS			
PEAK FLOW (cms)=	0.06		0.00	0.066 (iii)			

TIME TO PEAK (hrs)= 1.33 1.33 1.33
RUNOFF VOLUME (mm)= 35.03 5.10 29.46
TOTAL RAINFALL (mm)= 37.03 37.03 37.03
RUNOFF COEFFICIENT = 0.95 0.14 0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0202)
ID= 1 DT= 5.0 min

Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.01 0.03
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 2.00 5.00
Length (m)= 16.83 10.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 114.99 13.29
over (min) 5.00 5.00
Storage Coeff. (min)= 0.67 (ii) 4.43 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.23

PEAK FLOW (cms)= 0.00 0.00 *TOTALS*
TIME TO PEAK (hrs)= 1.33 1.33 0.003 (iii)
RUNOFF VOLUME (mm)= 35.03 6.08 11.38
TOTAL RAINFALL (mm)= 37.03 37.03 37.03
RUNOFF COEFFICIENT = 0.95 0.16 0.31

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)
1 + 2 = 3

AREA (ha) QPEAK (cms) TPEAK (hrs) R.V. (mm)
ID1= 1 (0201): 0.25 0.066 1.33 29.46
+ ID2= 2 (0202): 0.04 0.003 1.33 11.38
ID = 3 (0203): 0.29 0.069 1.33 26.84

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U AAAAA L
V V I SS U U A A L
VW I SSSS UUUU A A LLLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\V02\voin.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\aa0f
ae07-19cb-4dbf-afb3-fcc0bc50d9a8\scen

Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\aa0f
ae07-19cb-4dbf-afb3-fcc0bc50d9a8\scen

DATE: 10-12-2023

TIME: 04:02:26

USER:

COMMENTS:

** SIMULATION : 50yr 24hr 5min SCS Type II **

READ STORM
Filename: C:\Users\dhordyk\AppData\Local\Temp\26fbfc19-efc0-458c-9b8e-5c7e48c42e3e\9edc2a83
Ptotal=125.40 mm
Comments: 50yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	2.26	12.17	18.06	18.25	2.26
0.08	1.38	6.17	2.26	12.25	18.06	18.33	2.26
0.17	1.38	6.25	2.26	12.33	18.06	18.42	2.26
0.25	1.38	6.33	2.26	12.42	18.06	18.50	2.26
0.33	1.38	6.42	2.26	12.50	18.06	18.58	2.26
0.42	1.38	6.50	2.26	12.58	9.28	18.67	2.26
0.50	1.38	6.58	2.26	12.67	9.28	18.75	2.26
0.58	1.38	6.67	2.26	12.75	9.28	18.83	2.26
0.67	1.38	6.75	2.26	12.83	9.28	18.92	2.26
0.75	1.38	6.83	2.26	12.92	9.28	19.00	2.26
0.83	1.38	6.92	2.26	13.00	9.28	19.08	2.26
0.92	1.38	7.00	2.26	13.08	6.77	19.17	2.26
1.00	1.38	7.08	2.76	13.17	6.77	19.25	2.26
1.08	1.38	7.17	2.76	13.25	6.77	19.33	2.26
1.17	1.38	7.25	2.76	13.33	6.77	19.42	2.26
1.25	1.38	7.33	2.76	13.42	6.77	19.50	2.26
1.33	1.38	7.42	2.76	13.50	6.77	19.58	2.26
1.42	1.38	7.50	2.76	13.58	5.27	19.67	2.26
1.50	1.38	7.58	2.76	13.67	5.27	19.75	2.26
1.58	1.38	7.67	2.76	13.75	5.27	19.83	2.26
1.67	1.38	7.75	2.76	13.83	5.27	19.92	2.26
1.75	1.38	7.83	2.76	13.92	5.27	20.00	2.26
1.83	1.38	7.92	2.76	14.00	5.27	20.08	1.50
1.92	1.38	8.00	2.76	14.08	3.76	20.17	1.50
2.00	1.38	8.08	3.26	14.17	3.76	20.25	1.50
2.08	1.63	8.17	3.26	14.25	3.76	20.33	1.50
2.17	1.63	8.25	3.26	14.33	3.76	20.42	1.50
2.25	1.63	8.33	3.26	14.42	3.76	20.50	1.50
2.33	1.63	8.42	3.26	14.50	3.76	20.58	1.50
2.42	1.63	8.50	3.26	14.58	3.76	20.67	1.50
2.50	1.63	8.58	3.51	14.67	3.76	20.75	1.50
2.58	1.63	8.67	3.51	14.75	3.76	20.83	1.50
2.67	1.63	8.75	3.51	14.83	3.76	20.92	1.50
2.75	1.63	8.83	3.51	14.92	3.76	21.00	1.50

2.83	1.63	8.92	3.51	15.00	3.76	21.08	1.50
2.92	1.63	9.00	3.51	15.08	3.76	21.17	1.50
3.00	1.63	9.08	4.01	15.17	3.76	21.25	1.50
3.08	1.63	9.17	4.01	15.25	3.76	21.33	1.50
3.17	1.63	9.25	4.01	15.33	3.76	21.42	1.50
3.25	1.63	9.33	4.01	15.42	3.76	21.50	1.50
3.33	1.63	9.42	4.01	15.50	3.76	21.58	1.50
3.42	1.63	9.50	4.01	15.58	3.76	21.67	1.50
3.50	1.63	9.58	4.51	15.67	3.76	21.75	1.50
3.58	1.63	9.67	4.51	15.75	3.76	21.83	1.50
3.67	1.63	9.75	4.51	15.83	3.76	21.92	1.50
3.75	1.63	9.83	4.51	15.92	3.76	22.00	1.50
3.83	1.63	9.92	4.51	16.00	3.76	22.08	1.50
3.92	1.63	10.00	4.51	16.08	2.26	22.17	1.50
4.00	1.63	10.08	5.77	16.17	2.26	22.25	1.50
4.08	2.01	10.17	5.77	16.25	2.26	22.33	1.50
4.17	2.01	10.25	5.77	16.33	2.26	22.42	1.50
4.25	2.01	10.33	5.77	16.42	2.26	22.50	1.50
4.33	2.01	10.42	5.77	16.50	2.26	22.58	1.50
4.42	2.01	10.50	5.77	16.58	2.26	22.67	1.50
4.50	2.01	10.58	7.77	16.67	2.26	22.75	1.50
4.58	2.01	10.67	7.77	16.75	2.26	22.83	1.50
4.67	2.01	10.75	7.77	16.83	2.26	22.92	1.50
4.75	2.01	10.83	7.77	16.92	2.26	23.00	1.50
4.83	2.01	10.92	7.77	17.00	2.26	23.08	1.50
4.92	2.01	11.00	7.77	17.08	2.26	23.17	1.50
5.00	2.01	11.08	12.04	17.17	2.26	23.25	1.50
5.08	2.01	11.17	12.04	17.25	2.26	23.33	1.50
5.17	2.01	11.25	12.04	17.33	2.26	23.42	1.50
5.25	2.01	11.33	12.04	17.42	2.26	23.50	1.50
5.33	2.01	11.42	12.04	17.50	2.26	23.58	1.50
5.42	2.01	11.50	12.04	17.58	2.26	23.67	1.50
5.50	2.01	11.58	37.12	17.67	2.26	23.75	1.50
5.58	2.01	11.67	37.12	17.75	2.26	23.83	1.50
5.67	2.01	11.75	37.12	17.83	2.26	23.92	1.50
5.75	2.01	11.83	153.49	17.92	2.26	24.00	1.50
5.83	2.01	11.92	153.49	18.00	2.26		
5.92	2.01	12.00	153.49	18.08	2.26		
6.00	2.01	12.08	18.06	18.17	2.26		

CALIB
STANDHYD (0201)
ID= 1 DT= 5.0 min

Area (ha)= 0.25
Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.20 0.05
Dep. Storage (mm)= 2.00 5.00

Average Slope (%)= 3.00 5.00
Length (m)= 40.87 30.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 153.49 73.34
over (min) 5.00 5.00
Storage Coeff. (min)= 0.90 (ii) 3.01 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.28

PEAK FLOW (cms)= 0.09 0.01 *TOTALS*
TIME TO PEAK (hrs)= 12.08 12.08 0.097 (iii)
RUNOFF VOLUME (mm)= 123.40 50.03 109.75
TOTAL RAINFALL (mm)= 125.40 125.40 125.40
RUNOFF COEFFICIENT = 0.98 0.40 0.88

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0202)
ID= 1 DT= 5.0 min
Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.01 0.03
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 2.00 5.00
Length (m)= 16.83 10.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 153.49 95.37
over (min) 5.00 5.00
Storage Coeff. (min)= 0.60 (ii) 3.94 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.24

PEAK FLOW (cms)= 0.00 0.01 *TOTALS*
TIME TO PEAK (hrs)= 12.00 12.08 0.011 (iii)
RUNOFF VOLUME (mm)= 123.40 55.35 67.84
TOTAL RAINFALL (mm)= 125.40 125.40 125.40
RUNOFF COEFFICIENT = 0.98 0.44 0.54

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)
1 + 2 = 3
AREA QPEAK TPEAK R.V.
(ha) (cms) (hrs) (mm)
ID1= 1 (0201): 0.25 0.097 12.08 109.75
+ ID2= 2 (0202): 0.04 0.011 12.08 67.84
ID = 3 (0203): 0.29 0.108 12.08 103.67

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U AAAAA L
V V I SS U U A A L
VV I SSSS UUUU A A LLLLL

000 TTTT TTTT H H Y Y M M 000 TM
0 0 T T H H Y Y MM MM 0 0
0 0 T T H H Y Y M M 0 0
000 T T H H Y Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\cbfb
9b3e-f7c7-427d-94b3-16382e402847\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\cbfb

9b3e-f7c7-427d-94b3-16382e402847\scen

DATE: 10-12-2023 TIME: 04:02:26

USER:

COMMENTS:

** SIMULATION : 50yr 4hr 5min Chicago **

CHICAGO STORM
Ptotal= 79.54 mm
IDF curve parameters: A=1251.473
B= 4.847
C= 0.753
used in: INTENSITY = A / (t + B)^C
Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	5.53	1.00	22.40	2.00	14.60	3.00	7.26
0.08	5.85	1.08	33.57	2.08	13.36	3.08	6.99
0.17	6.21	1.17	73.94	2.17	12.33	3.17	6.75
0.25	6.63	1.25	223.60	2.25	11.47	3.25	6.52
0.33	7.12	1.33	94.25	2.33	10.74	3.33	6.31
0.42	7.70	1.42	53.72	2.42	10.10	3.42	6.12
0.50	8.41	1.50	37.82	2.50	9.54	3.50	5.94
0.58	9.29	1.58	29.40	2.58	9.05	3.58	5.77
0.67	10.40	1.67	24.19	2.67	8.61	3.67	5.61
0.75	11.89	1.75	20.65	2.75	8.22	3.75	5.46
0.83	13.96	1.83	18.09	2.83	7.87	3.83	5.32
0.92	17.09	1.92	16.14	2.92	7.55	3.92	5.19

CALIB
STANDHYD (0201)
ID= 1 DT= 5.0 min
Area (ha)= 0.25
Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.20 0.05
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 3.00 5.00
Length (m)= 40.87 30.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 223.60 41.66
over (min) 5.00 5.00
Storage Coeff. (min)= 0.78 (ii) 2.59 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.29

PEAK FLOW (cms)= 0.13 0.01 *TOTALS*
TIME TO PEAK (hrs)= 1.33 1.33 0.132 (iii)
RUNOFF VOLUME (mm)= 77.54 22.79 67.35
TOTAL RAINFALL (mm)= 79.54 79.54 79.54
RUNOFF COEFFICIENT = 0.97 0.29 0.85

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB
STANDHYD (0202)
ID= 1 DT= 5.0 min
Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.01 0.03
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 2.00 5.00
Length (m)= 16.83 10.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 223.60 56.61
over (min) 5.00 5.00
Storage Coeff. (min)= 0.52 (ii) 3.39 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.26

PEAK FLOW (cms)= 0.00 0.00 *TOTALS*
TIME TO PEAK (hrs)= 1.33 1.33 0.010 (iii)
RUNOFF VOLUME (mm)= 77.54 25.85 35.30
TOTAL RAINFALL (mm)= 79.54 79.54 79.54

RUNOFF COEFFICIENT = 0.97 0.32 0.44

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| ADD HYD (0203) |
1 + 2 = 3
ID1= 1 (0201): 0.25 0.132 1.33 67.35
+ ID2= 2 (0202): 0.04 0.010 1.33 35.30
=====

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

=====

V	V	I	SSSS	U	U	A	L		(v 6.2.2015)
V	V	I	SS	U	U	A	A	L	
V	V	I	SS	U	U	AAAA	L		
V	V	I	SS	U	U	A	A	L	
W	I	SSSS	UUUU	A	A	LLLL			

000	TTTT	TTTT	H	H	Y	Y	M	M	000	TM
0	0	T	T	H	H	Y	Y	MM	0	0
0	0	T	T	H	H	Y	Y	M	0	0
000	T	T	H	H	Y	Y	M	M	000	

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\V02\voin.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\5238

0f16-bf81-475b-8f8b-e7d199669ed1\scen

Summary filename:

C:\Users\dhordyk\AppData\Local\Civica\VHS\c61c7218-2e29-428d-a513-ca86584781d5\5238
0f16-bf81-475b-8f8b-e7d199669ed1\scen

DATE: 10-12-2023

TIME: 04:02:26

USER:

COMMENTS: -----

** SIMULATION : 5yr 24hr 5min SCS Type II **

| READ STORM |
| |
Ptotal= 78.55 mm

Filename: C:\Users\dhordyk\AppData\Local\Temp\26fbfc19-efc0-458c-9b8e-5c7e48c42e3e\7d04c0f7
Comments: 5yr 24hr 5min SCS Type II

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	hrs	mm/hr	hrs	mm/hr
0.00	0.00	6.08	1.41	12.17	11.31	18.25	1.41	
0.08	0.86	6.17	1.41	12.25	11.31	18.33	1.41	
0.17	0.86	6.25	1.41	12.33	11.31	18.42	1.41	
0.25	0.86	6.33	1.41	12.42	11.31	18.50	1.41	
0.33	0.86	6.42	1.41	12.50	11.31	18.58	1.41	
0.42	0.86	6.50	1.41	12.58	5.81	18.67	1.41	
0.50	0.86	6.58	1.41	12.67	5.81	18.75	1.41	
0.58	0.86	6.67	1.41	12.75	5.81	18.83	1.41	
0.67	0.86	6.75	1.41	12.83	5.81	18.92	1.41	
0.75	0.86	6.83	1.41	12.92	5.81	19.00	1.41	
0.83	0.86	6.92	1.41	13.00	5.81	19.08	1.41	
0.92	0.86	7.00	1.41	13.08	4.24	19.17	1.41	
1.00	0.86	7.08	1.73	13.17	4.24	19.25	1.41	
1.08	0.86	7.17	1.73	13.25	4.24	19.33	1.41	
1.17	0.86	7.25	1.73	13.33	4.24	19.42	1.41	
1.25	0.86	7.33	1.73	13.42	4.24	19.50	1.41	
1.33	0.86	7.42	1.73	13.50	4.24	19.58	1.41	
1.42	0.86	7.50	1.73	13.58	3.30	19.67	1.41	
1.50	0.86	7.58	1.73	13.67	3.30	19.75	1.41	
1.58	0.86	7.67	1.73	13.75	3.30	19.83	1.41	

1.67	0.86	7.75	1.73	13.83	3.30	19.92	1.41	
1.75	0.86	7.83	1.73	13.92	3.30	20.00	1.41	
1.83	0.86	7.92	1.73	14.00	3.30	20.08	0.94	
1.92	0.86	8.00	1.73	14.08	2.36	20.17	0.94	
2.00	0.86	8.08	2.04	14.17	2.36	20.25	0.94	
2.08	1.02	8.17	2.04	14.25	2.36	20.33	0.94	
2.17	1.02	8.25	2.04	14.33	2.36	20.42	0.94	
2.25	1.02	8.33	2.04	14.42	2.36	20.50	0.94	
2.33	1.02	8.42	2.04	14.50	2.36	20.58	0.94	
2.42	1.02	8.50	2.04	14.58	2.36	20.67	0.94	
2.50	1.02	8.58	2.20	14.67	2.36	20.75	0.94	
2.58	1.02	8.67	2.20	14.75	2.36	20.83	0.94	
2.67	1.02	8.75	2.20	14.83	2.36	20.92	0.94	
2.75	1.02	8.83	2.20	14.92	2.36	21.00	0.94	
2.83	1.02	8.92	2.20	15.00	2.36	21.08	0.94	
2.92	1.02	9.00	2.20	15.08	2.36	21.17	0.94	
3.00	1.02	9.08	2.51	15.17	2.36	21.25	0.94	
3.08	1.02	9.17	2.51	15.25	2.36	21.33	0.94	
3.17	1.02	9.25	2.51	15.33	2.36	21.42	0.94	
3.25	1.02	9.33	2.51	15.42	2.36	21.50	0.94	
3.33	1.02	9.42	2.51	15.50	2.36	21.58	0.94	
3.42	1.02	9.50	2.51	15.58	2.36	21.67	0.94	
3.50	1.02	9.58	2.83	15.67	2.36	21.75	0.94	
3.58	1.02	9.67	2.83	15.75	2.36	21.83	0.94	
3.67	1.02	9.75	2.83	15.83	2.36	21.92	0.94	
3.75	1.02	9.83	2.83	15.92	2.36	22.00	0.94	
3.83	1.02	9.92	2.83	16.00	2.36	22.08	0.94	
3.92	1.02	10.00	2.83	16.08	1.41	22.17	0.94	
4.00	1.02	10.08	3.61	16.17	1.41	22.25	0.94	
4.08	1.26	10.17	3.61	16.25	1.41	22.33	0.94	
4.17	1.26	10.25	3.61	16.33	1.41	22.42	0.94	
4.25	1.26	10.33	3.61	16.42	1.41	22.50	0.94	
4.33	1.26	10.42	3.61	16.50	1.41	22.58	0.94	
4.42	1.26	10.50	3.61	16.58	1.41	22.67	0.94	
4.50	1.26	10.58	4.87	16.67	1.41	22.75	0.94	
4.58	1.26	10.67	4.87	16.75	1.41	22.83	0.94	
4.67	1.26	10.75	4.87	16.83	1.41	22.92	0.94	
4.75	1.26	10.83	4.87	16.92	1.41	23.00	0.94	
4.83	1.26	10.92	4.87	17.00	1.41	23.08	0.94	
4.92	1.26	11.00	4.87	17.08	1.41	23.17	0.94	
5.00	1.26	11.08	7.54	17.17	1.41	23.25	0.94	
5.08	1.26	11.17	7.54	17.25	1.41	23.33	0.94	
5.17	1.26	11.25	7.54	17.33	1.41	23.42	0.94	
5.25	1.26	11.33	7.54	17.42	1.41	23.50	0.94	
5.33	1.26	11.42	7.54	17.50	1.41	23.58	0.94	
5.42	1.26	11.50	7.54	17.58	1.41	23.67	0.94	
5.50	1.26	11.58	23.25	17.67	1.41	23.75	0.94	
5.58	1.26	11.67	23.25	17.75	1.41	23.83	0.94	
5.67	1.26	11.75	23.25	17.83	1.41	23.92	0.94	
5.75	1.26	11.83	96.15	17.92	1.41	24.00	0.94	

5.83	1.26	11.92	96.15	18.00	1.41	
5.92	1.26	12.00	96.15	18.08	1.41	
6.00	1.26	12.08	11.31	18.17	1.41	

| CALIB |
| STANDHYD (0201) |
ID= 1 DT= 5.0 min

Area (ha)= 0.25
Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.20	0.05
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	3.00	5.00
Length (m)=	40.87	30.00
Mannings n =	0.013	0.250

Max.Eff.Inten.(mm/hr)=	96.15	32.57
over (min)	5.00	5.00
Storage Coeff. (min)=	1.09 (ii)	3.63 (ii)
Unit Hyd. Tpeak (min)=	5.00	5.00
Unit Hyd. peak (cms)=	0.34	0.25

PEAK FLOW (cms)=	0.05	0.00
TIME TO PEAK (hrs)=	12.08	12.08
RUNOFF VOLUME (mm)=	76.55	22.27
TOTAL RAINFALL (mm)=	78.55	78.55
RUNOFF COEFFICIENT =	0.97	0.28
		0.85

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| CALIB |
| STANDHYD (0202) |
ID= 1 DT= 5.0 min

Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.01	0.03
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	2.00	5.00
Length (m)=	16.83	10.00
Mannings n =	0.013	0.250

Max.Eff.Inten.(mm/hr)= 96.15 43.53
over (min) 5.00 5.00
Storage Coeff. (min)= 0.72 (ii) 4.76 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.22

TOTALS
PEAK FLOW (cms)= 0.00 0.00 0.006 (iii)
TIME TO PEAK (hrs)= 12.08 12.08 12.08
RUNOFF VOLUME (mm)= 76.55 25.29 32.28
TOTAL RAINFALL (mm)= 78.55 78.55 78.55
RUNOFF COEFFICIENT = 0.97 0.32 0.41

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| ADD HYD (0203)|
1 + 2 = 3
ID1= 1 (0201): 0.25 0.059 12.08 66.45
+ ID2= 2 (0202): 0.04 0.006 12.08 32.28
=====

ID = 3 (0203): 0.29 0.064 12.08 61.49
NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

V V I SSSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
VV I SSSSS UUUU A A LLLLL

000 TTTT TTTT H H Y Y M M 000 TM
0 0 T T H H Y Y MM MM 0 0
0 0 T T H H Y M M 0 0
000 T T H H Y M M 000
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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\b584
9f82-26a3-45c7-938b-e916a4688e38\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\VH5\c61c7218-2e29-428d-a513-ca86584781d5\b584
9f82-26a3-45c7-938b-e916a4688e38\scen

DATE: 10-12-2023 TIME: 04:02:26

USER:

COMMENTS: _____

** SIMULATION : 5yr 4hr 5min Chicago **

CHICAGO STORM IDF curve parameters: A= 843.019
Ptotal= 50.76 mm B= 4.582
C= 0.763
used in: INTENSITY = A / (t + B)^C

Duration of storm = 4.00 hrs
Storm time step = 5.00 min
Time to peak ratio = 0.33

TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr
0.00	3.39	1.00	14.01	2.00	9.07	3.00	4.46
0.08	3.58	1.08	21.15	2.08	8.29	3.08	4.30
0.17	3.81	1.17	47.54	2.17	7.64	3.17	4.15
0.25	4.07	1.25	150.31	2.25	7.10	3.25	4.01
0.33	4.38	1.33	60.96	2.33	6.64	3.33	3.88
0.42	4.74	1.42	34.18	2.42	6.24	3.42	3.75

0.50	5.18	1.50	23.88	2.50	5.89	3.50	3.64
0.58	5.73	1.58	18.47	2.58	5.58	3.58	3.54
0.67	6.43	1.67	15.15	2.67	5.31	3.67	3.44
0.75	7.36	1.75	12.90	2.75	5.07	3.75	3.35
0.83	8.67	1.83	11.27	2.83	4.85	3.83	3.26
0.92	10.64	1.92	10.04	2.92	4.65	3.92	3.18

| CALIB
| STANDHYD (0201)| Area (ha)= 0.25
|ID= 1 DT= 5.0 min | Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.20 0.05
Dep. Storage (mm)= 2.00 5.00
Average Slope (%)= 3.00 5.00
Length (m)= 40.87 30.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 150.31 17.60
over (min) 5.00 5.00
Storage Coeff. (min)= 0.91 (ii) 3.04 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.27

TOTALS
PEAK FLOW (cms)= 0.08 0.00 0.087 (iii)
TIME TO PEAK (hrs)= 1.33 1.33 1.33
RUNOFF VOLUME (mm)= 48.76 9.73 41.49
TOTAL RAINFALL (mm)= 50.76 50.76 50.76
RUNOFF COEFFICIENT = 0.96 0.19 0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| CALIB
| STANDHYD (0202)| Area (ha)= 0.04
|ID= 1 DT= 5.0 min | Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

IMPERVIOUS PERVIOUS (i)
Surface Area (ha)= 0.01 0.03
Dep. Storage (mm)= 2.00 5.00

Average Slope (%)= 2.00 5.00
Length (m)= 16.83 10.00
Mannings n = 0.013 0.250

Max.Eff.Inten.(mm/hr)= 150.31 24.68
over (min) 5.00 5.00
Storage Coeff. (min)= 0.61 (ii) 3.98 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.24

TOTALS
PEAK FLOW (cms)= 0.00 0.00 0.005 (iii)
TIME TO PEAK (hrs)= 1.33 1.33 1.33
RUNOFF VOLUME (mm)= 48.76 11.35 18.20
TOTAL RAINFALL (mm)= 50.76 50.76 50.76
RUNOFF COEFFICIENT = 0.96 0.22 0.36

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 60.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

| ADD HYD (0203)|
1 + 2 = 3
ID1= 1 (0201): 0.25 0.087 1.33 41.49
+ ID2= 2 (0202): 0.04 0.005 1.33 18.20
=====

ID = 3 (0203): 0.29 0.092 1.33 38.11

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

=====

V V I SSSS U U A L (v 6.2.2015)
V V I SS U U A A L
V V I SS U U A A A A L
V V I SS U U A A L
W I SSSS UUUU A A LLLL

000 TTTT TTTT H H Y Y M M 000 TM
O O T T H H Y Y MM MM O O
O O T T H H Y M M O O
000 T T H H Y M M 000

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***** D E T A I L E D O U T P U T *****

Input filename: C:\Program Files (x86)\Visual OTTHYMO 6.2\VO2\voain.dat

Output filename:
C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\5bde
70e4-ad08-493e-b099-14f1c76cae3e\scen
Summary filename:
C:\Users\dhordyk\AppData\Local\Civica\XH5\c61c7218-2e29-428d-a513-ca86584781d5\5bde
70e4-ad08-493e-b099-14f1c76cae3e\scen

DATE: 10-13-2023 TIME: 04:38:25

USER:

COMMENTS: _____

** SIMULATION : HAZEL

READ STORM | Filename: C:\Users\dhordyk\AppData\Local\Temp\

0.833	6.00	3.833	13.00	6.833	23.00	9.83	53.00
0.917	6.00	3.917	13.00	6.917	23.00	9.92	53.00
1.000	6.00	4.000	13.00	7.000	23.00	10.00	53.00
1.083	4.00	4.083	17.00	7.083	13.00	10.08	38.00
1.167	4.00	4.167	17.00	7.167	13.00	10.17	38.00
1.250	4.00	4.250	17.00	7.250	13.00	10.25	38.00
1.333	4.00	4.333	17.00	7.333	13.00	10.33	38.00
1.417	4.00	4.417	17.00	7.417	13.00	10.42	38.00
1.500	4.00	4.500	17.00	7.500	13.00	10.50	38.00
1.583	4.00	4.583	17.00	7.583	13.00	10.58	38.00
1.667	4.00	4.667	17.00	7.667	13.00	10.67	38.00
1.750	4.00	4.750	17.00	7.750	13.00	10.75	38.00
1.833	4.00	4.833	17.00	7.833	13.00	10.83	38.00
1.917	4.00	4.917	17.00	7.917	13.00	10.92	38.00
2.000	4.00	5.000	17.00	8.000	13.00	11.00	38.00
2.083	6.00	5.083	13.00	8.083	13.00	11.08	13.00
2.167	6.00	5.167	13.00	8.167	13.00	11.17	13.00
2.250	6.00	5.250	13.00	8.250	13.00	11.25	13.00
2.333	6.00	5.333	13.00	8.333	13.00	11.33	13.00
2.417	6.00	5.417	13.00	8.417	13.00	11.42	13.00
2.500	6.00	5.500	13.00	8.500	13.00	11.50	13.00
2.583	6.00	5.583	13.00	8.583	13.00	11.58	13.00
2.667	6.00	5.667	13.00	8.667	13.00	11.67	13.00
2.750	6.00	5.750	13.00	8.750	13.00	11.75	13.00
2.833	6.00	5.833	13.00	8.833	13.00	11.83	13.00
2.917	6.00	5.917	13.00	8.917	13.00	11.92	13.00
3.000	6.00	6.000	13.00	9.000	13.00	12.00	13.00

Max.Eff.Inten.(mm/hr)= 53.00 47.54
over (min) 5.00 5.00
Storage Coeff. (min)= 1.38 (ii) 4.61 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.33 0.23

TOTALS
PEAK FLOW (cms)= 0.03 0.01 0.036 (iii)
TIME TO PEAK (hrs)= 9.50 10.00 10.00
RUNOFF VOLUME (mm)= 210.00 153.78 199.53
TOTAL RAINFALL (mm)= 212.00 212.00 212.00
RUNOFF COEFFICIENT = 0.99 0.73 0.94

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 78.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

f5f0146e-3c58-44ad-a41b-976597eb65f4\8a90a4d8
| Ptotal=212.00 mm | Comments: HAZEL

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	
0.00	6.00	3.00	13.00	6.00	23.00	9.00	53.00	
0.20	6.00	3.20	13.00	6.20	23.00	9.20	53.00	
0.40	6.00	3.40	13.00	6.40	23.00	9.40	53.00	
0.60	6.00	3.60	13.00	6.60	23.00	9.60	53.00	
0.80	6.00	3.80	13.00	6.80	23.00	9.80	53.00	
1.00	4.00	4.00	17.00	7.00	13.00	10.00	38.00	
1.20	4.00	4.20	17.00	7.20	13.00	10.20	38.00	
1.40	4.00	4.40	17.00	7.40	13.00	10.40	38.00	
1.60	4.00	4.60	17.00	7.60	13.00	10.60	38.00	
1.80	4.00	4.80	17.00	7.80	13.00	10.80	38.00	
2.00	6.00	5.00	13.00	8.00	13.00	11.00	13.00	
2.20	6.00	5.20	13.00	8.20	13.00	11.20	13.00	
2.40	6.00	5.40	13.00	8.40	13.00	11.40	13.00	
2.60	6.00	5.60	13.00	8.60	13.00	11.60	13.00	
2.80	6.00	5.80	13.00	8.80	13.00	11.80	13.00	

CALIB
STANDHYD (0201)
ID= 1 DT= 5.0 min | Area (ha)= 0.25
Total Imp(%)= 81.40 Dir. Conn.(%)= 81.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.20	0.05
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	3.00	5.00
Length (m)=	40.87	30.00
Mannings n =	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	
0.083	6.00	3.083	13.00	6.083	23.00	9.08	53.00	
0.167	6.00	3.167	13.00	6.167	23.00	9.17	53.00	
0.250	6.00	3.250	13.00	6.250	23.00	9.25	53.00	
0.333	6.00	3.333	13.00	6.333	23.00	9.33	53.00	
0.417	6.00	3.417	13.00	6.417	23.00	9.42	53.00	
0.500	6.00	3.500	13.00	6.500	23.00	9.50	53.00	
0.583	6.00	3.583	13.00	6.583	23.00	9.58	53.00	
0.667	6.00	3.667	13.00	6.667	23.00	9.67	53.00	
0.750	6.00	3.750	13.00	6.750	23.00	9.75	53.00	

CALIB
STANDHYD (0202)
ID= 1 DT= 5.0 min | Area (ha)= 0.04
Total Imp(%)= 30.60 Dir. Conn.(%)= 18.40

	IMPERVIOUS	PERVIOUS (i)
Surface Area (ha)=	0.01	0.03
Dep. Storage (mm)=	2.00	5.00
Average Slope (%)=	2.00	5.00
Length (m)=	16.83	10.00
Mannings n =	0.013	0.250

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

TIME	RAIN	TIME	RAIN	'	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	hrs	mm/hr	
0.083	6.00	3.083	13.00	6.083	23.00	9.08	53.00	
0.167	6.00	3.167	13.00	6.167	23.00	9.17	53.00	
0.250	6.00	3.250	13.00	6.250	23.00	9.25	53.00	
0.333	6.00	3.333	13.00	6.333	23.00	9.33	53.00	
0.417	6.00	3.417	13.00	6.417	23.00	9.42	53.00	
0.500	6.00	3.500	13.00	6.500	23.00	9.50	53.00	
0.583	6.00	3.583	13.00	6.583	23.00	9.58	53.00	
0.667	6.00	3.667	13.00	6.667	23.00	9.67	53.00	
0.750	6.00	3.750	13.00	6.750	23.00	9.75	53.00	
0.833	6.00	3.833	13.00	6.833	23.00	9.83	53.00	
0.917	6.00	3.917	13.00	6.917	23.00	9.92	53.00	
1.000	6.00	4.000	13.00	7.000	23.00	10.00	53.00	
1.083	4.00	4.083	17.00	7.083	13.00	10.08	38.00	
1.167	4.00	4.167	17.00	7.167	13.00	10.17	38.00	
1.250	4.00	4.250	17.00	7.250	13.00	10.25	38.00	
1.333	4.00	4.333	17.00	7.333	13.00	10.33	38.00	
1.417	4.00	4.417	17.00	7.417	13.00	10.42	38.00	
1.500	4.00	4.500	17.00	7.500	13.00	10.50	38.00	
1.583	4.00	4.583	17.00	7.583	13.00	10.58	38.00	
1.667	4.00	4.667	17.00	7.667	13.00	10.67	38.00	
1.750	4.00	4.750	17.00	7.750	13.00	10.75	38.00	
1.833	4.00	4.833	17.00	7.833	13.00	10.83	38.00	
1.917	4.00	4.917	17.00	7.917	13.00	10.92	38.00	
2.000	4.00	5.000	17.00	8.000	13.00	11.00	38.00	
2.083	6.00	5.083	13.00	8.083	13.00	11.08	13.00	
2.167	6.00	5.167	13.00	8.167	13.00	11.17	13.00	
2.250	6.00	5.250	13.00	8.250	13.00	11.25	13.00	
2.333	6.00	5.333	13.00	8.333	13.00	11.33	13.00	
2.417	6.00	5.417	13.00	8.417	13.00	11.42	13.00	
2.500	6.00	5.500	13.00	8.500	13.00	11.50	13.00	
2.583	6.00	5.583	13.00	8.583	13.00	11.58	13.00	
2.667	6.00	5.667	13.00	8.667	13.00	11.67	13.00	
2.750	6.00	5.750	13.00	8.750	13.00	11.75	13.00	

2.833	6.00	5.833	13.00	8.833	13.00	11.83	13.00
2.917	6.00	5.917	13.00	8.917	13.00	11.92	13.00
3.000	6.00	6.000	13.00	9.000	13.00	12.00	13.00

Max.Eff.Inten.(mm/hr)= 53.00 57.23
over (min) 5.00 5.00
Storage Coeff. (min)= 0.92 (ii) 3.84 (ii)
Unit Hyd. Tpeak (min)= 5.00 5.00
Unit Hyd. peak (cms)= 0.34 0.25

PEAK FLOW (cms)= 0.00 0.00 *TOTALS*
TIME TO PEAK (hrs)= 9.33 10.00 0.006 (iii)
RUNOFF VOLUME (mm)= 210.00 160.63 169.63
TOTAL RAINFALL (mm)= 212.00 212.00 212.00
RUNOFF COEFFICIENT = 0.99 0.76 0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
YOU SHOULD CONSIDER SPLITTING THE AREA.

- (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
CN* = 78.0 Ia = Dep. Storage (Above)
(ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
THAN THE STORAGE COEFFICIENT.
(iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

ADD HYD (0203)				
1 + 2 = 3				
	AREA	QPEAK	TPEAK	R.V.
	(ha)	(cms)	(hrs)	(mm)
ID1= 1 (0201):	0.25	0.036	10.00	199.53
+ ID2= 2 (0202):	0.04	0.006	10.00	169.63
=====				
ID = 3 (0203):	0.29	0.042	10.00	195.19

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

FINISH
=====

Soakaways, Infiltration Trenches & Chambers



DESIGN

GEOMETRY AND SITE LAYOUT

Infiltration chambers and soakaways can be designed in various shapes, while infiltration trenches are typically rectangular or trapezoidal, with a bottom generally between 0.6 and 2.4 m wide. Linear trench geometries will drain faster than round or square shapes due to larger perimeters. Facilities should have nearly level bottoms to spread flow evenly. They are typically designed with an impervious drainage area to pervious facility footprint ratio (I:P ratio) between 5:1 on low permeability soils, like hydrologic soil groups (HSG) C and D, and 20:1 on high permeability soils (HSG A & B) and not usually > 4 m deep. Refer to local criteria for required drainage time.

INLETS

Recommended to distribute inflow between multiple inlets to reduce risk of failure. May include delivery of runoff to the facility as concentrated overland or concentrated underground (i.e. pipe) flow.

PRE-TREATMENT

It is important to prevent sediment, trash and debris from entering infiltration facilities because they could contribute to clogging and failure of the system. Infiltration practices may be used to treat runoff from roofs and pavements with sedimentation or filtration pre-treatment. See 'General Specifications' section for pre-treatment options that facilitate maintenance and confine sediment and debris to an accessible area so that the risk of system clogging is reduced.

STORAGE RESERVOIR

Depth must meet both runoff storage and structural support requirements. See STEP LID Planning and Design Guide wiki page, 'Infiltration: Sizing and modelling', for guidance and tool for determining the reservoir depth and area required to store the design storm runoff volume. See 'General Specifications' for further details.

GEOTEXTILE

Storage reservoirs should be lined on the sides and top with geotextile filter fabric to maintain separation from the native soil. Geotextile on the base is optional but may be prone to blinding and eventual clogging.

PERFORATED PIPE

Continuously perforated, smooth interior HDPE or PVC drainage pipe, ≥200 mm interior diameter where possible to reduce risk of freezing and facilitate push camera inspection and cleaning with jet nozzle equipment. Including geotextile socks around perforated pipes is optional. May include an orifice plate or valve flow restrictor to provide erosion control and optimize infiltration.

CONVEYANCE AND OVERFLOW

Typically designed to be offline where a flow control structure or inlet allows only the design storm runoff volume to enter the facility. Excess flows are conveyed to a downstream storm sewer or other best management practice (BMP) by a flow-splitting manhole (i.e. flow through riser) containing a weir and overflow outlet pipe, or by by-passing the curb opening and flowing into a down-gradient catch basin.

MONITORING WELLS

Recommended for monitoring drainage time between storms. Monitoring well should be a vertical standpipe consisting of an anchored 100 to 150 mm diameter pipe with perforations along the length within the reservoir, installed to the bottom of the facility, with a lockable cap. Flow-splitting manholes may also be used for drainage time monitoring.

ACCESS STRUCTURES

Manholes or maintenance hatches connected to infiltration chambers, or standpipe inspection ports connected to infiltration trench or soakaway perforated pipe that provide access for inspection and maintenance. Should be installed at inlets and outlets at a minimum. Couplings used for standpipe connections should be 45° to facilitate pipe access by push camera and jet nozzle cleaning equipment.



BMP	Ability to meet stormwater criteria		
	Water balance	Water quality	Stream erosion control
Infiltration Trenches, Chambers and Soakaways	Yes	Yes	Yes

Soakaways, infiltration trenches and infiltration chambers are similar in that they consist of sub-surface reservoirs that store and infiltrate stormwater runoff from roofs, walkways, parking lots, and low to medium traffic roads without consuming a large amount of land.

Soakaways typically consist of rectangular or trapezoidal geotextile-lined excavations, filled with stone or other void-forming structures, that receive runoff from a perforated pipe inlet and infiltrate it into the native soil. They typically service individual lots and receive roof and walkway runoff, but can also receive overflows from stormwater practices.

Infiltration Trenches (also referred to as 'infiltration galleries') are design variations that consist of linear, rectangular or trapezoidal, geotextile-lined excavations with a level or gently sloping bottom grade. Like soakaways, they are also filled with stone or other void-forming structures. They are well suited to sites where available space for infiltration is limited to strips of land between buildings or properties, or along road rights-of-way. See 'Exfiltration Trench Systems' fact sheet for guidance on infiltration trench systems integrated with conventional storm sewers to also provide conveyance functions.

Infiltration chambers include a range of proprietary manufactured, modular structures installed underground (embedded in clean, crushed angular stone) to create large void spaces that temporarily store and infiltrate runoff into the underlying native soil. Typically installed under parking or landscaped areas, they can be used in various configurations. They are well suited to sites where available land area is limited, or where it is desirable for the facility to have a minimal surface footprint. They can be designed with enough load bearing capacity to support the weight of structures above them.



Infiltration Chamber System Under Parking Lot

PLANNING CONSIDERATIONS

Native Soil | Infiltration trenches, chambers and soakaways can be constructed over any soil type, but HSG A or B soils are best for achieving water balance and erosion control objectives. Facilities should be located on portions of the site with the highest infiltration rates. Native soil infiltration rate at the proposed location and depth should be confirmed through in-situ hydraulic conductivity measurements under field saturated conditions. Do not install in swelling clays or contaminated soils.

Wellhead Protection | Facilities receiving road or parking lot runoff should not be located within two (2) year time-of-travel wellhead protection areas (see Drinking Water Source Protection Plan).

Available Space | Recommended under parking, walkway or landscape areas and require little surface space. Need to plan carefully for location of inlets, outlets and access structures.

Site Topography | Facilities cannot be located on natural slopes greater than 15%.

Water Table | Maintaining a separation of one (1) metre between the elevations of the base of the practice and the seasonally high-water table, or top of bedrock is recommended. Lesser or greater values may be considered based on groundwater mounding analysis. See STEP LID Planning and Design Guide wiki page, ‘Groundwater’ for further guidance and spreadsheet tool.

Pollution Hot Spot Runoff | To mitigate groundwater contamination, runoff from hot spots should not be treated by infiltration trenches, chambers or soakaways.

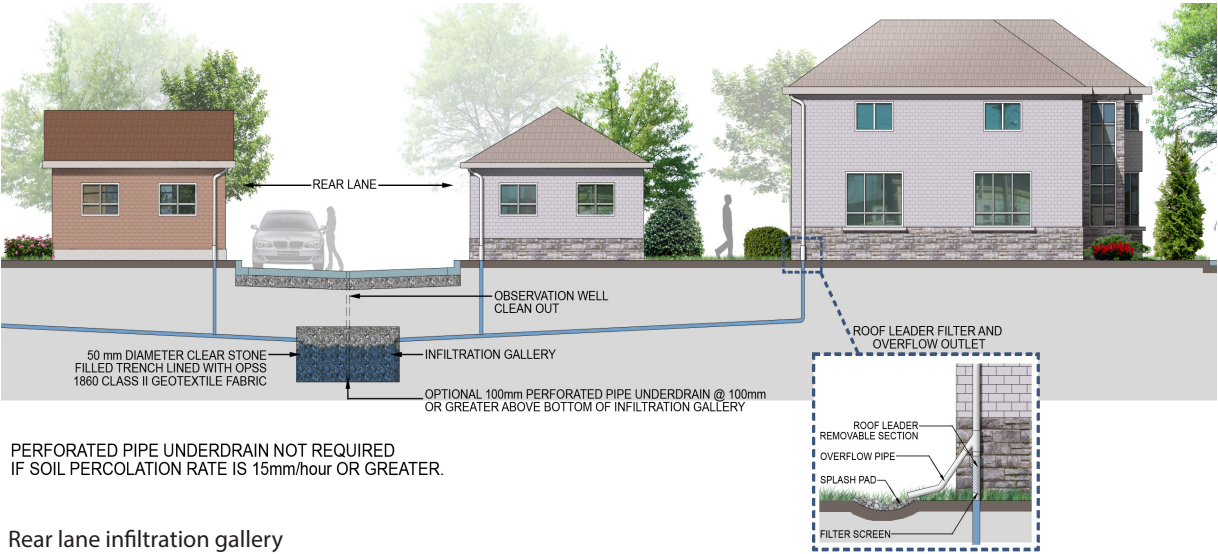
Proximity to Underground Utilities | Designers should consult local utility design guidance for horizontal and vertical clearances required between storm drains.

Karst | Infiltration trenches, chambers and soakaways are not suitable in areas of known or implied karst topography.

Setback from Buildings | Facilities should be at least 4 m from building foundations.

GENERAL SPECIFICATIONS

Material	Specification
Inlets	- For concentrated overland flow: (i) Catch basins or other inlet structures should be located at all sag points in the gutter grade and immediately upgrade of median breaks, crosswalks and street intersections, (ii) inlet types include curb openings, side inlet catch basins, trench drains and other pre-fabricated inlet structures, (iii) spillways aid in turning flow 30, 45 or 90 degrees into the practice, (iv) if the inlet structure itself does not provide sedimentation or filtration pre-treatment, incorporate a geotextile and stone filter inlet at curb opening or spillway locations to isolate sediment, trash and debris for ease of removal, and (v) provide a 50 to 100 mm drop in elevation between inlet invert and top elevation of the stone cover. - For concentrated underground flow, inlets may include plastic or concrete pipes from roof drains or catch basins, storm sewers, oil and grit separators (OGS) or outlet leader from an upstream BMP. Solid pipe transitions to perforated pipe within the storage reservoir 0.3 m from the sides. Trench plugs should be installed around solid pipes where they enter and exit the storage reservoir.
Pre-Treatment	- Leaf screens are mesh screens installed either on the building eavestroughs or roof downspouts and are used to remove leaves and other large debris from roof runoff. - Catch basin, manhole or other inlet structure sumps in combination with a shield, baffle, trap, or filter insert device, or goss trap, are used to pre-treat concentrated overland flow. They can be designed to retain both coarse and fine particulate sediments in the sump, and floatables (i.e. hydrocarbons, trash and debris). A variety of proprietary pre-treatment devices are available. - OGSs are used for concentrated underground flow. - Infiltration chambers are designed with an isolated filter row at inlets, not connected by pipes to the other chambers, that isolates the bulk of sediment and associated pollutants and is designed for ease of access by jet flushing cleaning equipment. - Grass swales can be used to pre-treat road and parking lot runoff. Provide a 75 to 150 mm elevation drop between the inlet invert and swale surface. - Geotextile and stone filter inlets are square or rectangular curb openings located directly over the practice, filled with clean aggregate, covered with a layer of geotextile filter fabric and stone, graded level and installed at concentrated overland flow inlets. Elevation change of 75 to 100 mm from pavement to top of the stone cover. Stone cover may be 50 to 150 mm diameter crushed angular stone, river rock/beach stone or rip rap.
Storage Reservoir	- Should be filled with uniformly graded, washed 25 or 50 mm diameter crushed angular stone (max. wash loss of 0.5%) with a porosity of 0.4. - For facilities located under load-bearing structures like pavements, aggregate should have a minimum durability index of 35 and a maximum abrasion of 10% for 100 revolutions and 50% for 500 revolutions. - Include organic material derived from untreated wood (e.g. chips, mulch or shavings) to enhance nitrogen removal. - Void-forming structures: Includes chambers, vaults, crates or perforated pipes that provide large water storage volume per unit area, reduce required facility footprint area and conserve aggregate. Plastic chamber systems should be compliant with CSA B184 SERIES 11 (R2015) or ASTM F2418-16A. Maximum allowable load for plastic chambers must be determined in accordance with ASTM F2787-13. - Concrete vault systems should be compliant with CSA A23.3-14 and CSA A23.1-09/A23.2-09 (R2014) or ASTM C858-10e1. See manufacturer for product specific specifications regarding maximum load, minimum cover depth and porosity or water storage per unit area.
Geotextile	- Material specifications should conform to Ontario Provincial Standard Specification (OPSS) 1860 for Class II geotextile fabrics. - Material should be woven monofilament or non-woven needle punched, or woven monofilament with a minimum overlap of 300 mm. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Specification of geotextile fabrics should consider the apparent opening size (AOS) for non-woven fabrics, or percent open area (POA) for woven fabrics, to maintain water flow even with sediment and microbial film build-up. Other factors that need consideration include maximum forces to be exerted on the fabric, and the load bearing ratio, texture (i.e., grain size distribution) and permeability of the native soil in which they will be installed. Geotextile socks around perforated pipes should conform to ASTM D6707 with minimum water flow rate conforming to ASTM D4491 (12,263 L/min/m² at 5 cm head).
Perforated Pipes	- Continuously perforated, smooth interior HDPE or PVC drainage pipe, ≥200 mm interior diameter where possible to reduce risk of freezing and facilitate push camera inspection and cleaning with jet nozzle equipment. Including geotextile socks around perforated pipes is optional. - May include an orifice plate or valve flow restrictor to provide erosion control and optimize infiltration.



Rear lane infiltration gallery

For more information:

Visit the online Low Impact Development Stormwater Management Planning and Design Guide for more information including links to all sources cited: wiki.sustainabletechnologies.ca.

LID Stormwater Inspection and Maintenance Guide (TRCA, 2016): sustainabletechnologies.ca.

LID Construction Guide (CVC, 2012): sustainabletechnologies.ca.

The water component of the Sustainable Technologies Evaluation Program is a collaboration of:

Toronto and Region Conservation Authority,
Credit Valley Conservation, and
Lake Simcoe Region Conservation Authority

CONSTRUCTION

Soil Disturbance and Compaction | Before site work begins, locations of facilities should be clearly marked. Ideally, infiltration practice locations should remain outside the limit of disturbance until construction of the facility begins to prevent soil compaction by heavy equipment.

Excavation | If >2 m in depth, trench shorings will be required to support the sidewalls. Use a toothed bucket to excavate and roughen the excavation bottom and sides prior to backfilling.

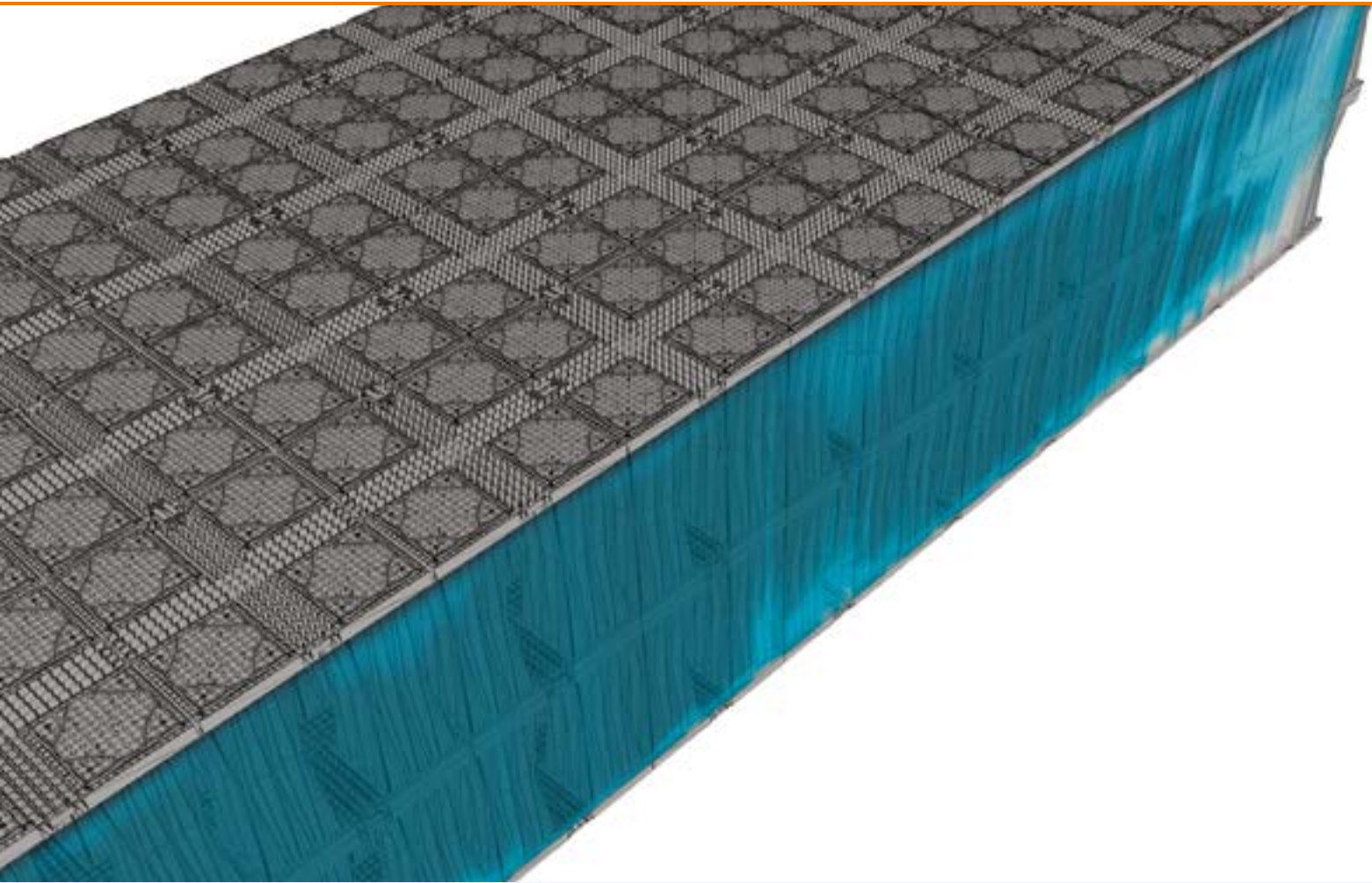
Erosion and Sediment Control (ESC) | Infiltration practice locations should not be used as sediment basins during construction. To prevent clogging, ESC measures should remain in place and runoff should be diverted from the facility until the contributing drainage area is fully stabilized and sediment has been removed from catch basins, pre-treatment devices and maintenance hole sumps.

OPERATION AND MAINTENANCE

Infiltration trenches, chambers and soakaways will continue to function during winter months if the overflow outlet is located below the local frost line.

Routine inspection and maintenance consists of checking and cleaning trash, debris and sediment from pre-treatment devices, inlets and outlets twice a year in the spring and/or late fall, or when pre-treatment device sump is half full. Use a hydro-vac truck to remove sediment from catch basin sumps, OGS and isolated chamber row filter pre-treatment devices. For isolated chamber row filters use a vacuum truck with rear-facing jet nozzle to clean large diameter pipes / culverts.

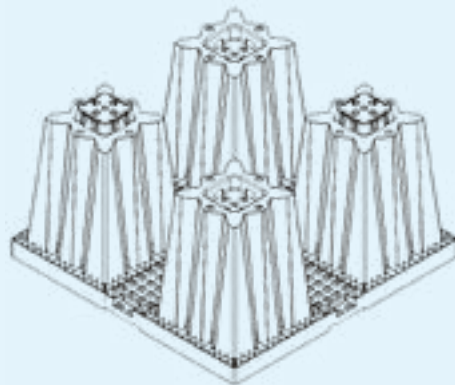
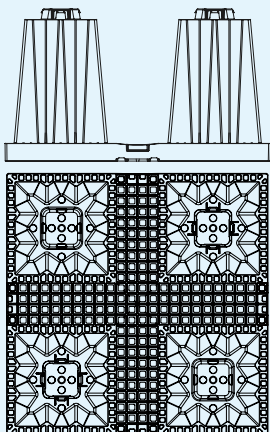
Periodic monitoring of storage reservoir water level during and after natural or simulated storm events using the monitoring well should be performed to verify facility drainage time (typically 72 hours). This should occur as part of inspections following construction or major rehabilitation prior to assumption, and at least every 15 years to track drainage performance over time.



TECHNICAL MANUAL

AQUABOX

MODULAR SYSTEM FOR STORMWATER MANAGEMENT



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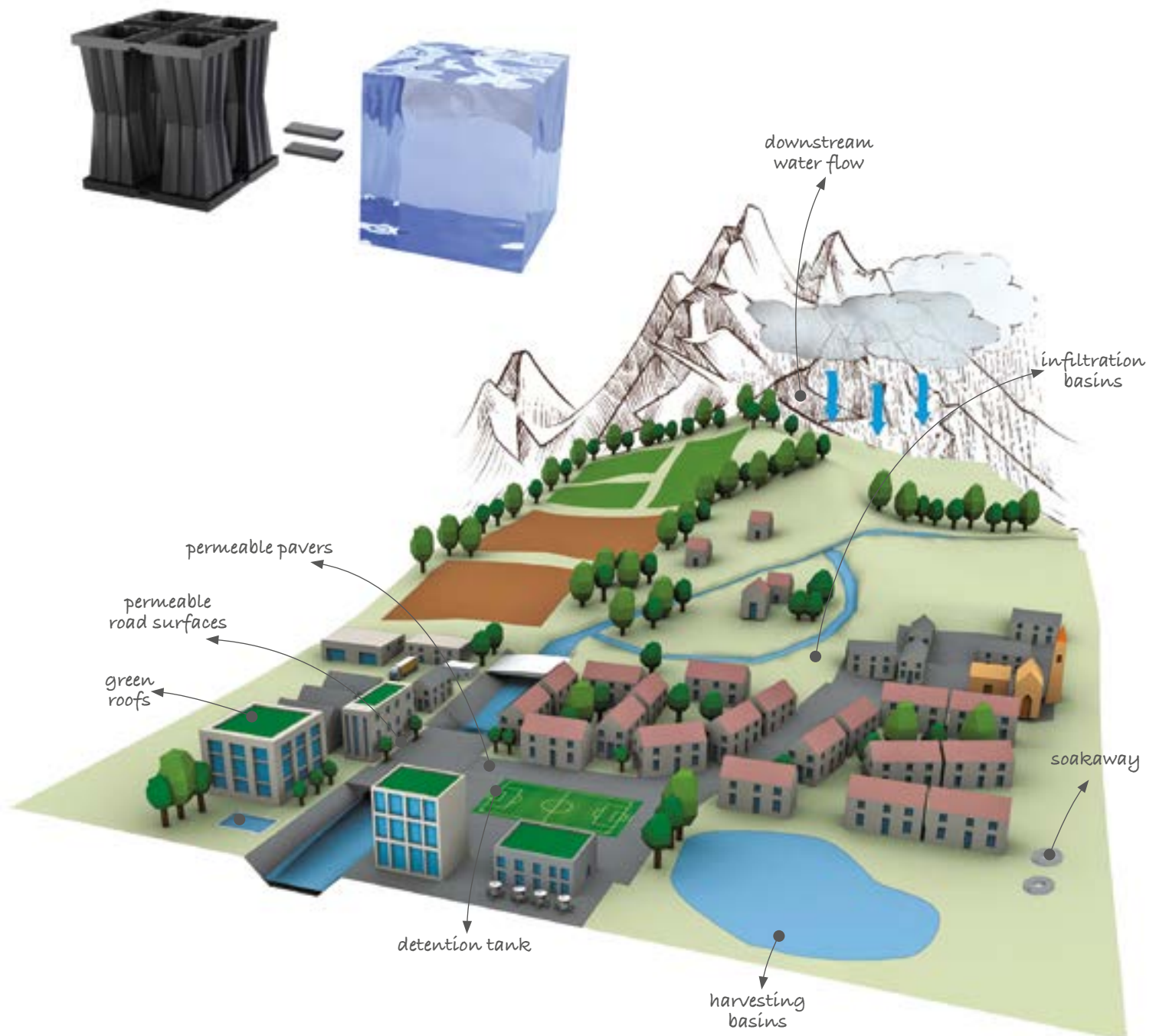
1. AQUABOX SYSTEM

1.1 PURPOSES AND FUNCTIONS

The heavy rainfalls combined with the growth of urban impervious surfaces are showing the need for efficient and sustainable stormwater management solutions. Geoplast offers several such solutions, suitable for different specific requirements. In situ stormwater detention and its controlled release into the drainage or

sewage system helps to mitigate the potential damage inflicted to local territory and urban areas during heavy rainfall events.

Geoplast has developed a wide range of solutions capable of responding to specific needs, based on project requirements.



1.2 BRIEF DESCRIPTION

AQUABOX is a modular element with a hollow truncated pyramid structure made of virgin or regenerated polypropylene available in four different compounds. It is designed to create underground basins for stormwater management.

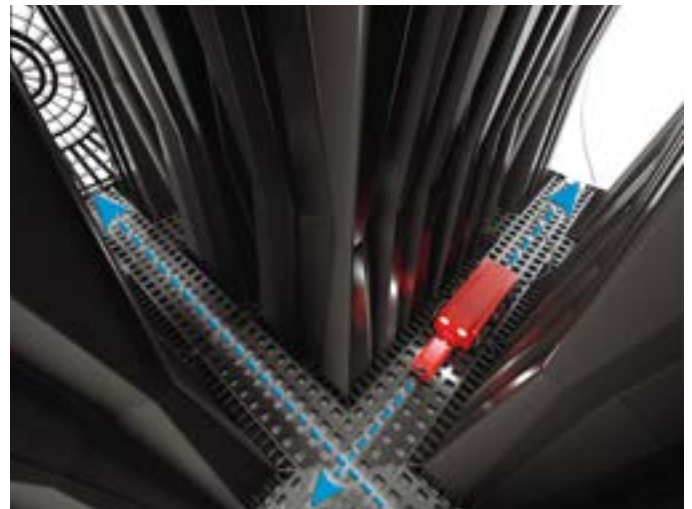
In order to reduce possible flooding phenomena resulting from the increase in urbanized areas, AQUABOX is used for the control and disposal of rainwater by creating infiltration, detention or harvesting tanks in order to enhance the water by reusing it.

The elements are assembled on site and laid. The modules are hooked together by means of special connectors that guarantee the stability of the basin. Thanks to its high mechanical resistance, AQUABOX can be installed both in urban areas and in industrial / commercial areas where there is an intense transit of heavy vehicles.

Below are the technical data relating to the single piece (1 AQUABOX = 2 pieces).

Thanks to its very high storage percentage of 96%, it allows you to accumulate up to 432 liters of rain water per module. The system can also be inspected through the AQUABOX CUBE accessory and components that will be illustrated in §1.4.

Inspection can be carried out through robots while cleaning and maintenance through a high pressure mechanical hose.



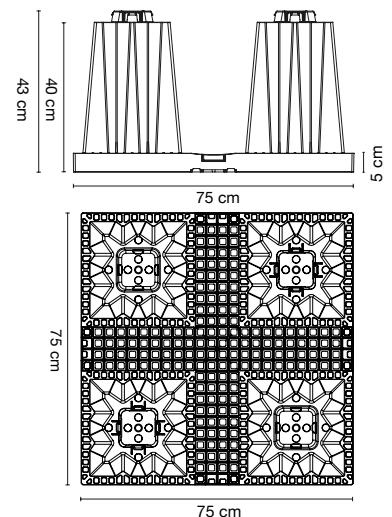
**AQUABOX
HPR**

**AQUABOX
HP**

**AQUABOX
STR**

**AQUABOX
ST**

Dimensions (cm)	75 x 75 x H43			
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene
Net storage volume (l/pcs)	216			
Void ratio	96%			
Package size (cm)	80 x 152 x H258			
No. pieces	80			
Product code	EDAQUVE1540	EDAQUFV1540	EDAQUFV0540	EDAQUAB0400



1.3 OVERVIEW

LID

LID SEAL RING

CORRUGATED TUBE

SEAL RING

D4 CONNECTOR

AQUABOX CUBE

CUBE
SIDEWALL
GRIDS

SINGLE JOINT

TOP CAP CUBE

TOP CUP

WATERPROOFING MEMBRANE

GEOTEXTILE

INLET PIPE

SIDEWALL GRID

DOUBLE JOINT

AQUABOX

INSPECTION ROBOT

CAP D4

160 cm

375 cm

150 cm

Images for illustrative purposes only.
Products may be subject to change.

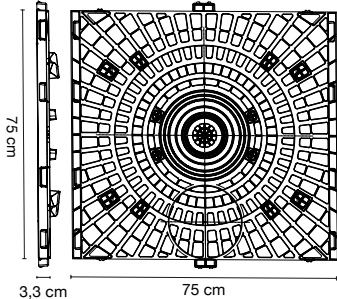


1.4 ACESSORIES LIST AND TECHINCAL DATA

Below the list of AQUABOX accessories and related technical data:

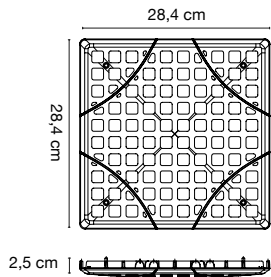
1.4.1 SIDEWALL GRID

The Aquabox sidewall grid is used to close the lateral surface of the basin and is fixed to Aquabox with a simple integrated clip.

	SIDEWALL GRID HPR	SIDEWALL GRID HP	SIDEWALL GRID STR	SIDEWALL GRID ST	
Dimensions (cm)	75 x 75 x H3,3				
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene	
Connection (DN/OD)	100, 110, 125, 160, 200, 225, 250, 315, 400, 500				
Package size (cm)	80 x 152 x H255				
No. pieces	140				
Product code	EDAQSWVE033	EDAQSWG033	EDAQSWFV033	EDAQSWG0033	

1.4.2 TOP CAP

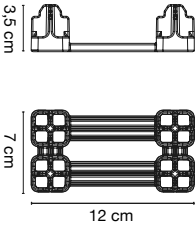
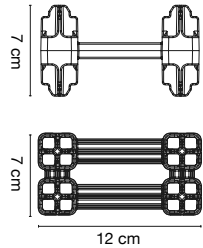
The upper surface of each element is equipped with four perforated closing covers that allow the passage of water. At the same time, these closures create a homogeneous walkable surface which is useful both during the installation phase and for the distribution of the loads acting on the system.

	HPR TOP CAP	HP TOP CAP	STR TOP CAP	ST TOP CAP	
Dimensions (cm)	28,4 x 28,4 x H2,5				
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene	
Package size (cm)	90 x 120 x H255				
No. pieces	1200				
Product code	EDAQTFV1524	EDAQTOCV024	EDAQTFV0524	EDAQTOC0024	

Universal components for AQUABOX and AQUABOX Cube

1.4.3 SINGLE-DOUBLE JOINTS

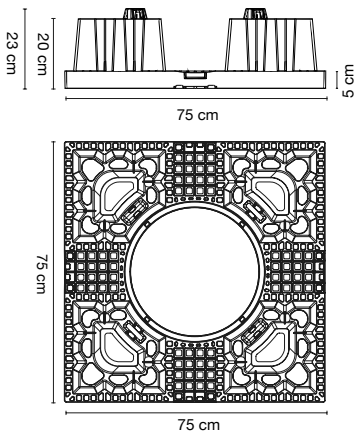
Single: allows the simple and quick horizontal connection (of the AQUABOX CUBE modules with the AQUABOX modules) located in the last level of the basin. Double: allows the simple and quick horizontal connection (of the AQUABOX CUBE modules with the AQUABOX modules) located in the intermediate levels.

	SINGLE JOINT			DOUBLE JOINT	
Dimensions (cm)	12 x 7 x H3,5		Dimensions (cm)	12 x 7 x H7	
Material	Graplene VN		Material	Graplene VN	
Colour	Red		Colour	Red	
No. pieces per bag	400		No. pieces per bag	300	
Product code	EDAQJOI0035		Product code	EDAQDOJ0070	

Universal components for AQUABOX and AQUABOX Cube

1.4.4 AQUABOX CUBE

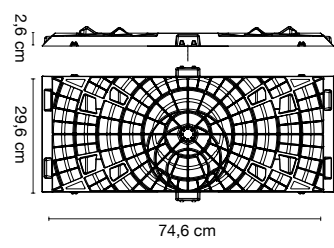
Aquabox Cube is a modular hollow element in virgin or recycled polypropylene, designed to make inspection shafts for the inspection and management of Aquabox underground tanks.

						
	AQUABOX CUBE HPR	AQUABOX CUBE HP	AQUABOX CUBE STR	AQUABOX CUBE ST		
Dimensions (cm)	75 x 75 x H23					
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene		
Net storage volume (l/pcs)	106					
Void ratio	94%					
Package size (cm)	80 x 152 x H250					
No. pieces	88					
Product code	EDAQUVE0200	EDAQUBCV200	EDAQUFV0200	EDAQUBC0200		

1.4.5 SIDEWALL GRID CUBE

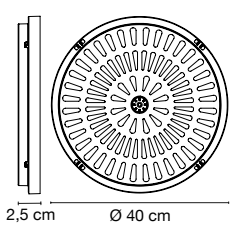
The AQUABOX CUBE side grid allows the lateral closure of each single module if the wells are installed along the perimeter part and / or in the vertex of the basin.

If the AQUABOX CUBE is located inside the basin, it does not need any side grid.

						
	SIDEWALL GRID CUBE HPR	SIDEWALL GRID CUBE HP	SIDEWALL GRID CUBE STR	SIDEWALL GRID CUBE ST		
Dimensions (cm)	74,6 x 29,6 x H2,6					
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene		
Connection (DN/OD)	100, 160, 200					
Package size (cm)	85 x 120 x H260					
No. pieces	280					
Product code	EDAQUVE0026	EDAQSWG0026	EDAQUFV0026	EDAQSWG0026		

1.4.6 D4 CAP

The CAP D4 is used to close the AQUABOX CUBE at the bottom of the tank and, if necessary, to close also the upper side if AQUABOX CUBE is not used as access to the tank itself.

						
	D4 HPR CAP	D4 HP CAP	D4 STR CAP	D4 ST CAP		
Dimensions (cm)	Ø40					
Material	Graplene VNFV 15	Graplene FV15	Graplene FV5	Graplene		
Package size (cm)	82 x 122 x H258					
No. pieces	312					
Product code	EDAQCVE0400	EDAQCCDV400	EDAQUFV0400	EDAQCCD0400		

2. HYDRAULIC DIMENSIONING

2.1 CALCULATION OF REQUIRED VOLUME

The calculation of the required volume of water to be stored in the reservoir or lamination or drainage basin is carried out by determining the drainage surface, i.e. the covered area from which the water is to be channelled and discharged into the AQUABOX tank. The drainage surface to consider can be a roof, a warehouse yard, a parking or a green area.

For the calculation of the flow rate in the drainage system, it is assumed that the maximum flow rate occurs at the beginning of the meteorological event.

This simplistic assumption implies that the flow rates entering the reservoir system are overestimated, as are the drainage volumes.

It is therefore necessary to assess the design rainfall, meaning the maximum rainfall event that the system must support, corresponding to the heaviest excess of water that the system must control. In synthetic terms:

$$Volume_{inlet} = f(h(t), u, S, Q_{out})$$

The “rainfall method” is used for this purpose.

The following is then used to calculate the value of the volume of water entering the basin:

$$V_{in} = \varphi \cdot h(t) \cdot S$$

Where:

$$V_{in} = \text{Inlet volume}$$

$$\varphi = \text{runoff coefficient}$$

$$S = \text{surface}$$

$$h(t) = a \cdot t^n = \text{rainfall potential curve}$$

h represents the rainfall height (in mm)

corresponding to an event of duration t

The output volume value is then calculated:

$$V_{out} = Q_{out} \cdot t$$

Where:

$$V_{out} = \text{Out volume}$$

$$t = \text{time in h}$$

In the case of a reservoir, the flow rate imposed on the discharge is discharge is:

$$Q_{out} = u_{out} \cdot S$$

u_{out} = the udometric coefficient that depends on the size and characteristics of the surfaces

$$S = \text{tank surface}$$

In the case of a drainage basin, the flow rate imposed on the discharge is:

$$Q_{out} = k \cdot S$$

$$k = \text{soil permeability}$$

$$S = S_b + \frac{1}{3} \cdot h_b \cdot p$$

where S_b is the surface of the tank's base

h_b net tank height

p tank's perimeter

The volume potted at time t will then be given by the difference of the volumes entering and leaving the system.

$$V_{bacinio} = V_{in} - V_{out} = \varphi \cdot a \cdot t^n \cdot S - Q_{out} \cdot t$$

It is therefore a question of finding the duration of the rain

$$t_{cr} = \text{duration}$$

for which the invaded volume is maximised by deriving the formula for t from the previous expression.

The maximum condition is expressed as follows:

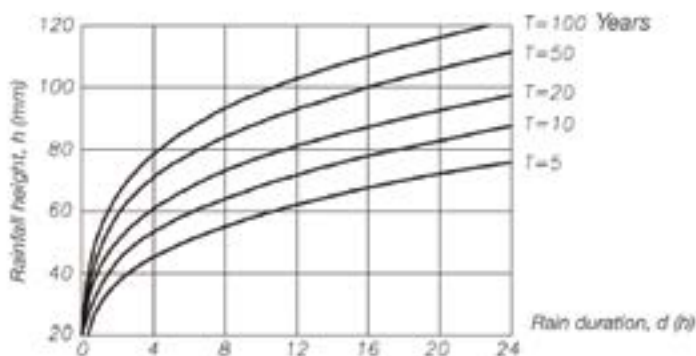
$$t_{cr} = \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}}$$

And substituting it into the previous equation maximises the storage volume

$$V_{max} = S \cdot \varphi \cdot a \cdot \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}} - Q_{out} \cdot \left(\frac{Q_{out}}{S \cdot \varphi \cdot a \cdot n} \right)^{\frac{1}{n-1}}$$

The application of the method using the rainfall possibility curves must be repeated because, having fixed the characteristics of the basin and other imposed conditions, for each of the six intervals of durations (pairs of parameters a and n), in fact since the critical time is not known it is not possible to identify the curve that best interprets the phenomenon.

Di seguito un esempio di curve di possibilità pluviometrica.



2.2 TANK SIZE

The resulting tank dimensions depend on the calculated maximum inlet volume.

For this calculation we recommend the use of the software AQUABOX calculator:



<https://www.geoplastglobal.com/it/prodotti/acqua/AQUABOX/calcolatore/>

which, once filled in, shows on the right-hand side the material list for creating the AQUABOX tank, given two possible types of input:

- INPUT 1)
 - Volume of water to be stored
 - Width of basin
 - Basin height
 - Loading data
 - Inspection position
- INPUT 2)
 - Tank length
 - Basin width
 - Basin height
 - Loading data
 - Inspection position

For ad hoc dimensioning please contact the Technical Office Geoplast Spa.

3. STRUCTURAL DIMENSIONING

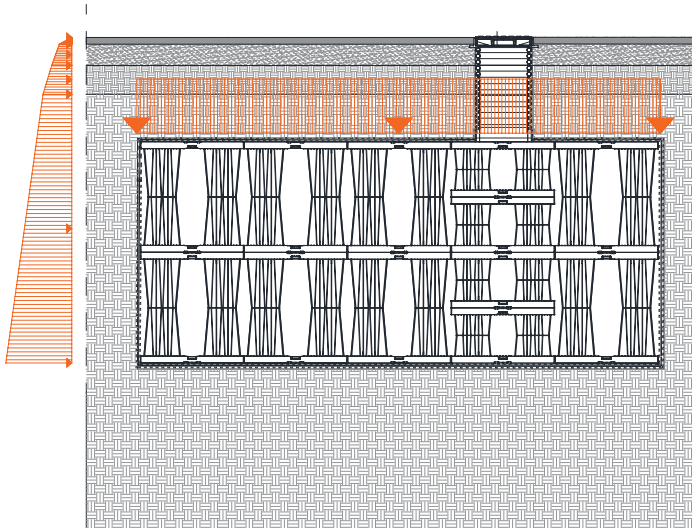
The calculation of the AQUABOX accumulation, dispersion or retention basin is carried out by checking the individual element installed under vertical and lateral load.

3.1 VERIFICATION UNDER VERTICAL LOAD

The verification of the AQUABOX element under vertical load is carried out according to this calculation scheme.

3.1.1 LOAD DUE TO SOIL WEIGHT

For soil loading:



Vertical pressure [kN/m^2]

$$P_v = \sum_{i=1}^n \gamma_i \cdot h_i$$

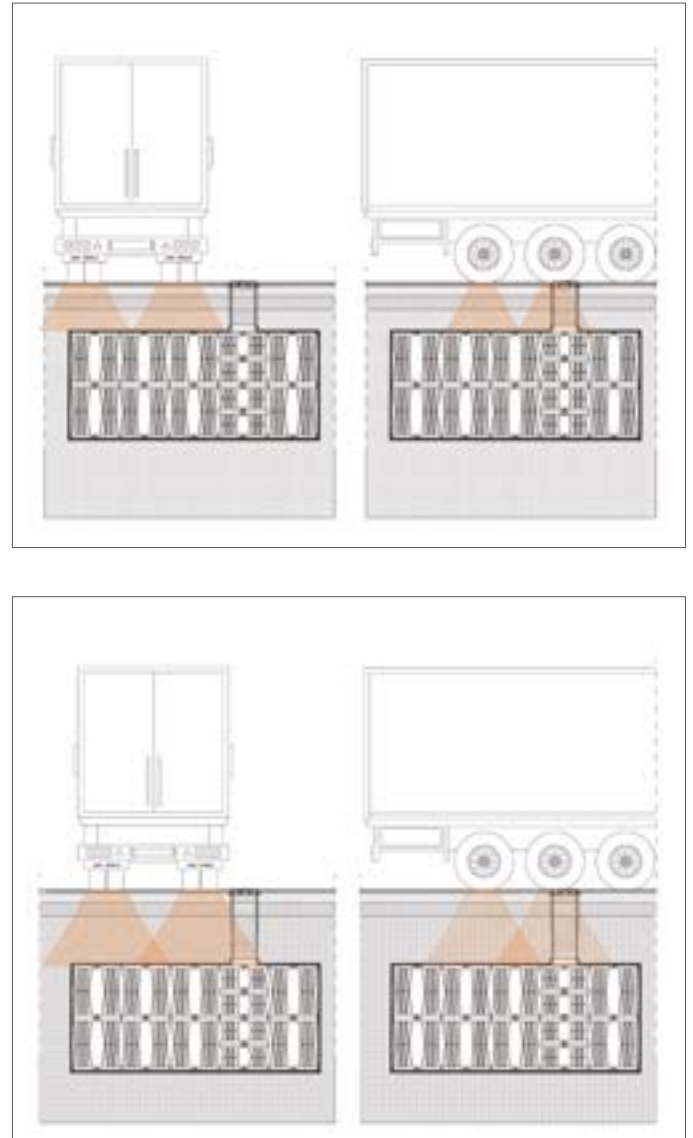
Legenda:

γ_i : density of the i-th layer [kN/m^3]

h_i : height of the i-th layerl [m]

3.1.2 CONCENTRATED AND DISTRIBUTED VERTICAL LOADS DUE TO PERMANENT AND ACCIDENTAL LOADS

For vehicle loading (concentrated) or other concentrated permanent loads:



Depending on the load imprint, this must be diffused through the stratigraphy considered.

Given the load impressions:

$A = \text{plate side in mm}$

in the direction of travel

$B = \text{plate side in mm}$

in the direction of the wheel width

And given the distances between the wheels:

$\text{axle } A = \text{Interasse ruote}$

$\text{axle } B = \text{distance between wheels along the axis}$

Calculate the diffuse footprints on the first support plane of AQUABOX:

$$Aq = A + \sum_i^n h_i \cdot tg(\theta_i)$$

$$Bq = A + \sum_i^n h_i \cdot tg(\theta_i)$$

$h_i = \text{height of the layer}$

$\theta = \text{layer diffusion angle}$

The load to be considered varies according to the value obtained from Aq and Bq , if:

- 1) $Aq < \text{axle } A$ and $Bq < \text{axle } B$
Consider the load of a wheel on the footprint $Aq \times Bq$;
- 2) $Aq < \text{axle } A$ or $Bq < \text{axle } B$
Then we consider the load of two wheels on the footprint $Aq \times Bq$;
- 3) $Aq < \text{axle } A$ and $Bq < \text{axle } B$
Then consider the four-wheel load on the footprint $Aq \times Bq$.

Given the above cases, the equivalent distributed load q_k is then calculated [kN/m^2]:

$$q_k = \frac{Q_k}{Aq \cdot Bq}$$

The same can be done for a permanent load G_{2k} .

3.1.3 LOADS AND SAFETY COEFFICIENTS FROM NTC2018

The loads are divided as follows and then multiplied by the corresponding safety coefficients:

$g_{1k} = \text{element own weight per } m^2$

$g_{2k} = \text{distributed non structural dead load per } m^2$

$G_{2k} = \text{concentrated non structural}$

$q_k = \text{distributed live load per } m^2$

$Q_k = \text{concentrated live load}$

According to the standard these are combined in the respective combinations SLE, SLU and verification during construction.

NTC 2018 (nome tecnico delle costruzioni 2018)

$\gamma_{g1} = 1,3$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5$

UNI EN 1990:2006

$\gamma_{g1} = 1,35$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5$

AASHTO

$\gamma_{g1} = 1,25$

$\gamma_{g2, G2} = 1,5$

$\gamma_{q, Q} = 1,5 ; 1,75$

Coefficients during construction UNI EN 1990:2006

$\gamma_{g1} = 1,05$

$\gamma_{g2, G2} = 1,35$

$\gamma_{q, Q} = 1,5$

Using the NTC2018, the STR (SLU) combination to be used is approach 2 (A1+M1+R3), in which the geotechnical soil parameters are considered with coefficients of = 1.00 and the coefficients for the loads are as above. Approach 2 is the most unfavourable in the present verification.

3.1.4 EXAMPLE

Here is an example of calculation, taking into consideration AQUABOX HP (Weight 10,23 kg/ pc), remembering that 1 module of AQUABOX is made of 2 pieces,

$$g1k = 10,23 \cdot \frac{2}{0,75 \cdot 0,75} \cdot \frac{10}{1000} = 0,36 kN/m^2$$

Assuming to have the following stratigraphy:

- Cobble stone

$$\gamma_1 = 15 [kN/m^2]$$

$$h_i = 0,08 m$$

$$\theta = 35^\circ$$

- Gravel

$$\gamma_1 = 18 [kN/m^2]$$

$$h_i = 0,22 m$$

$$\theta = 30^\circ$$

- Soil

$$\gamma_1 = 20 [kN/m^2]$$

$$h_i = 0,22 m$$

$$\theta = 30^\circ$$

$$g2k = 15 \cdot 0,08 + 18 \cdot 0,22 + 20 \cdot 0,50 = 15,16 kN/m^2$$

A concentrated non-structural permanent load, for example a concrete block 1m x 1m x h 0.20m.

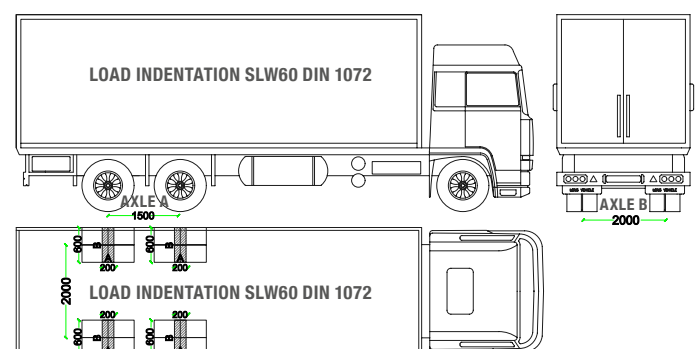
The diffuse footprint becomes:

$$A = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

$$B = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,471 m$$

$$G2k = \frac{5}{(1,471 \cdot 1,471)} = 2,31 kN/m^2$$

Considering the DIN1072 standard with which it is possible to categorize heavy vehicles, the highest load class is chosen, i.e. SLW60, corresponding to a vehicle of 60 tons and a wheel load of 10 tons distributed over a 600 x 200 mm footprint.



Considering the above stratigraphy, an equivalent footprint is obtained equal to:

Given then the following footprints and distances between the wheels.

$$A = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,143 m$$

$$B = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,543 m$$

$$A = 200 mm$$

$$B = 600 mm$$

$$axle A = 2000 mm$$

$$axle B = 1500 mm$$

A< A-axis and B> B-axis then double the load is considered.

So:

$$Q_{2k} = \frac{100 \cdot 2}{(1,143 \cdot 1,543)} = 113,33 \text{ kN/m}^2$$

Considering a load $q_{2k} = 5 \text{ kN/m}^2$ as a live distributed load, the above loads are combined together according to the SLU combination ref. NTC2018.

SLU load=

$$\begin{aligned} & \gamma_{g1} \cdot g_{1k} + \gamma_{g2} \cdot g_{2k} + \gamma_{G2} \cdot G_{2k} + \gamma_{q,Q} \cdot q_{2k} + \gamma_{q,Q} \cdot Q_{2k} = \\ & = 1,3 \cdot 0,36 + 1,5 \cdot 15,16 + 1,5 \cdot 2,31 + 1,5 \cdot 5 + 1,5 \cdot 113,33 = \\ & \quad 204,20 \text{ kN/m}^2 \end{aligned}$$

While the limit load of AQUABOX HP at breakage is to be considered equal to $R_k = 457 \text{ kN/m}^2$ to be reduced with a test and material coefficient of $\gamma_{test} = 2,00$ so:

$$R_d = 228,5 \text{ kN/m}^2$$

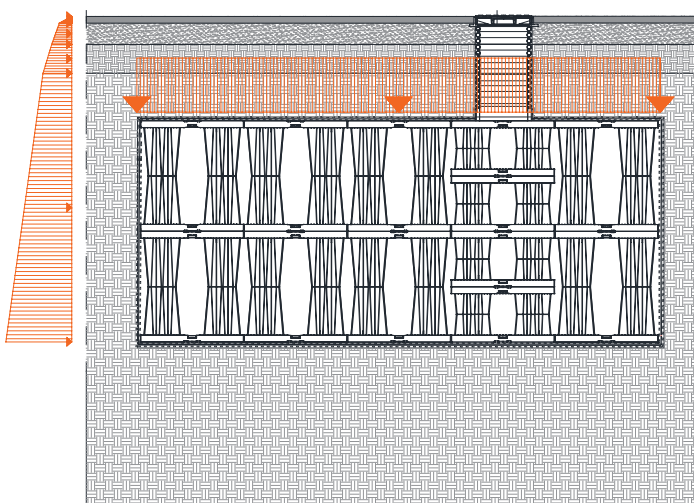
The utilization index is therefore equal to

$$S_d/R_d = 204,20/228,5 = 0,89 < 1,00, \text{ check satisfied.}$$

3.2 LATERAL LOAD CHECK

The verification of the AQUABOX element under lateral load is done according to this calculation scheme.

For the load due to the soil:



3.2.1 3.2.1 LATERAL LOAD DUE TO SOIL WEIGHT

Horizontal pressure $[kN/m^2]$

$$P_v = \sum_1^n \gamma_i \cdot h_i \cdot K_{Ai}$$

Where:

γ_i = Density of *ith* layer

h_i = Height of *ith* layer

k_i = Active pressure coefficient
of the *ith* layer

$$= tg^2 \left(\frac{\pi}{4} + \frac{\phi'}{2} \right)$$

3.2.2 LATERAL LOAD DUE TO DISTRIBUTED VERTICAL LOADS

Permanent distributed load (concrete pour or self-locking screed or other pavement type) and live distributed load (e.g., crowd load) are considered as follows:

$$P_v = q \cdot K_{An}$$

Dove:

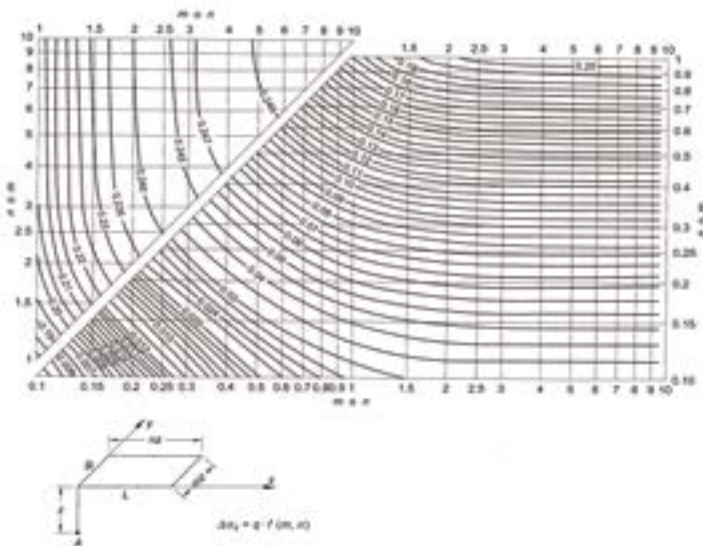
q = Distributed dead or live load

K_{An} = Active pressure coefficient
of the *n-th* layer on Aquabox

3.2.2 LATERAL LOADS DUE TO CONCENTRATED VERTICAL LOADS

The load distribution with increasing depth is provided by the analytical solution in terms of induced stresses and strains given by Boussinesq (1885).

The solution derived from Boussinesq's elastic problem for uniform pressure on a rectangular surface (permanent load G2k on footprint AxB or accidental load Qk on footprint AxB) is the solution of Newmark (1942).



The general formula results in the different stress components in the different directions, the stresses in x and y are as follows:

$L = A =$ Width of the load footprint spread across the stratigraphy

$B =$ Length of the load footprint spread through the stratigraphy

$z =$ Depth of diffuse load impression through the stratigraphy

$$\sigma_x = \frac{q}{2\pi} \left[\arctan\left(\frac{L \cdot B}{z \cdot R_3}\right) - \frac{LBz}{R_1^2 \cdot R_3} \right]$$

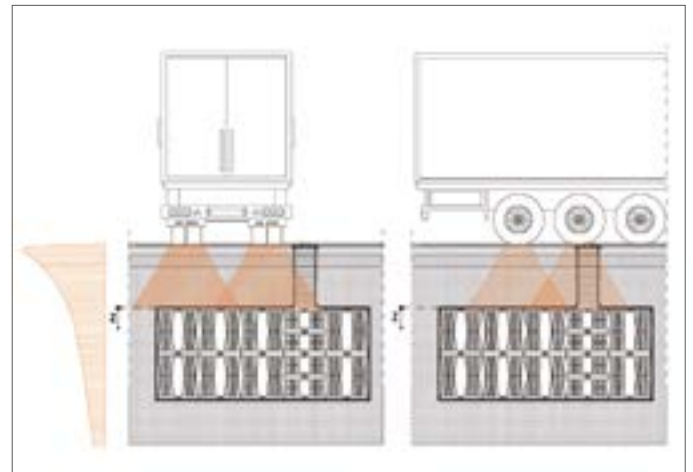
$$\sigma_y = \frac{q}{2\pi} \left[\arctan\left(\frac{L \cdot B}{z \cdot R_3}\right) - \frac{LBz}{R_2^2 \cdot R_3} \right]$$

The two components result in a load in kN/ m2. By multiplying this load by the lateral dimensions of the AQUA-BOX element, the resulting force at a given depth is obtained.

Depending on the direction, the component resulting in the highest load is always considered.

The above formulation is applied for both concentrated permanent loads and accidental loads, such as those of vehicle wheels.

Depending on the number of levels and the depth of installation, the most stressed* element of AQUABOX is evaluated and the lateral load verification is carried out as follows.



*This is because the horizontal soil load is linearly increasing with depth while the load due to concentrated permanent or live loads is decreasing with depth. For some AQUABOX overlay-layer combinations, the highest load is to be evaluated at all available depths.

3.2.4 LOADS AND SAFETY FACTORS

The loads are then multiplied by the relative partial safety coefficients and the heaviest load combination is identified, which in this case follows approach 2 (A1+M1+R3), in which the geotechnical parameters of the soil are considered with coefficients equal to = 1.00 and the coefficients for the loads are those set out in § 3.1.

3.2.5 EXAMPLE

Below is an example of a calculation of the above, taking into consideration AQUABOX HP. Assuming a stratigraphy made of:

- Cobble stone

$$\gamma_1 = 15 [kN/m^2]$$

$$h_i = 0,08 \text{ m}$$

$$K_A = 0$$

$$\theta = 35^\circ$$

- Gravel

$$\gamma_1 = 18 [kN/m^2]$$

$$h_i = 0,22 \text{ m}$$

$$K_A = 0,22$$

$$\theta = 30^\circ$$

- Natural soil

$$\gamma_1 = 20 [kN/m^2]$$

$$h_i = 0,5 \text{ m}$$

$$K_A = 0,36$$

$$\theta = 28^\circ$$

$$g2k = (15 \cdot 0,08 + 18 \cdot 0,22) \cdot 0,22 + 20 \cdot 0,5 \cdot 0,36 =$$

$$4,74 kN/m^2$$

A concentrated non-structural permanent load of, for example, a cast concrete block of 20cm height and 1m x 1m plan.

The footprint become:

$$A = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,471 \text{ m}$$

$$B = 1 + \sum_i^n h_i \cdot tg(\theta_i) = 1,471 \text{ m}$$

$$G2k = \frac{5}{(1,471 \cdot 1,471)} = 2,31 kN/m^2$$

It is applied therefore the formulation of Boussinesq obtaining:

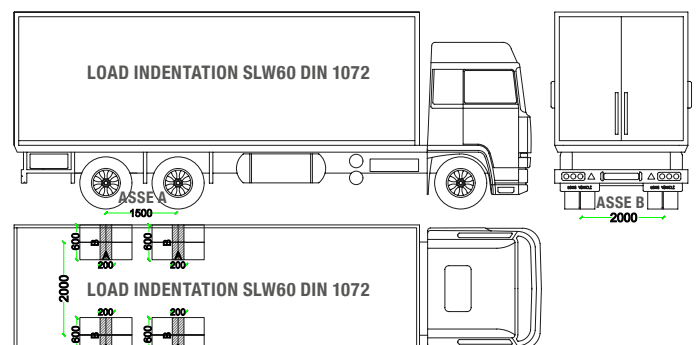
$$\sigma_x = 0,38 kN/m^2$$

$$\sigma_y = 0,38 kN/m^2$$

The tension between the two highest is multiplied by the lateral surface of an AQUABOX 0.8 x 0.75 obtaining:

$$G2k = 0,38 \cdot 0,75 \cdot 0,8 = 0,228 kN$$

Considering the DIN1072 regulation with which it is possible to categorize heavy vehicles, the highest load class is chosen, that is SLW60, corresponding to a vehicle of 60 tons and a wheel load of 10 tons distributed on a 600 x 200 mm footprint.



Considering the above stratigraphy, an equivalent footprint is obtained equal to:

Given then the following footprints and distances between the wheels.

$$A = 1 + \sum_{i=1}^n h_i \cdot \tan(\theta_i) = 1,143 \text{ m}$$

$$B = 1 + \sum_{i=1}^n h_i \cdot \tan(\theta_i) = 1,543 \text{ m}$$

$$A = 200 \text{ mm}$$

$$B = 600 \text{ mm}$$

$$\text{asse } A = 2000 \text{ mm}$$

$$\text{asse } B = 1500 \text{ mm}$$

A< axes A and B> axes B then double the load is considered.

So:

$$Q2k = \frac{100 \cdot 2}{(1,143 \cdot 1,543)} = 113,33 \text{ kN/m}^2$$

It is applied therefore the formulation of Boussinesq obtaining:

$$\sigma_x = 18,23 \text{ kN/m}^2$$

$$\sigma_y = 16,36 \text{ kN/m}^2$$

The tension between the two highest is multiplied by the lateral surface of an AQUABOX 0.8 x 0.75 obtaining:

$$G2k = 18,23 \cdot 0,75 \cdot 0,8 = 10,94 \text{ kN}$$

Considering a load of $q2k = 5 \text{ kN/m}^2$ a live distributed load, the above loads are combined together according to the SLU combination ref. NTC2018.

$$q2K = 5,00 \cdot 0,8 \cdot 0,36 \cdot 0,75 = 1,08 \text{ kN}$$

SLU load=

$$\gamma_{g1} \cdot g1k + \gamma_{g2} \cdot g2k + \gamma_{G2} \cdot G2k + \gamma_{q,Q} \cdot q2k + \gamma_{q,Q} \cdot Q2k = \\ = 1,5 \cdot 4,74 + 1,5 \cdot 0,228 + 1,5 \cdot 1,08 + 1,5 \cdot 10,94 = 25,3 \text{ kN/m}^2$$

While the limit load of AQUABOX HP lateral to breakage is to be considered $Rk = 51 \text{ kN/m}^2$ to be reduced with a test and material coefficient of $a = \gamma_{test} = 2,00$ so:

$$Rd = 25,50 \text{ kN/m}^2$$

The utilization index is therefore equal to

$$Sd/Rd = 25,3/25,50 = 0,99 < 1,00, \\ \text{check satisfied.}$$

3.3 UPLIFT CHECK

For the uplift test, check the maximum piezometric level with a 50-year return period.

The product must always be installed above the maximum piezometric level of the water table detected. For further information, please contact Geoplast Spa Technical Office.

3.4 PHYSICAL-MECHANICAL TESTS ON PRODUCT

The product has been tested according to the standards:

UNI EN 17150:2019

UNI EN 17151:2019

UNI EN17152:2019

CIRIA 737D

Load tests have been carried out by an accredited third party on the complete element and accessories such as AQUA BOX CUBE. Load certificates are available to the customer upon request.

3.5 GEOPLAST CALCULATION REPORT

Upon request, the calculation report for the static and/or hydraulic verification of the storage basin or infiltration with AQUABOX elements is provided.

To request pre-dimensioning or calculation reports, please contact the Technical Office of Geoplast Spa.



5. VERIFICHE 5.1. VERIFICA STATICA I carichi consentiti permanentemente strutturali e accidentali vengono diffusi dall'impronta di carico attraverso la stratigrafia considerata. Il carico consentito accidentale sommato con la ruota di un veicolo a mezzo pesante ed a seconda della sua diffusione attraverso il terreno e la stratigrafia considerata, possono considerarsi a fini delle verifiche 1, 2 e 4 luglio.		
Distanza tra le ruote S	80 [mm]	9800.00
Distanza tra due assi A	48 [mm]	8000.00
Impronta di carico diffusa per carichi accidentali S	8 [mm]	10413.40
Impronta di carico diffusa per carichi accidentali A	4 [mm]	1143.42
Carico equivalente distribuito da carico accidentale concentrato	Q _{acc} [kN/m ²]	143.38
Impronta di carico diffusa per carichi permanenti non strutturali S	8 [mm]	1474.71
Impronta di carico diffusa per carichi permanenti non strutturali A	4 [mm]	1679.70
Carico equivalente distribuito dal carico perm. non strutt. concentrato	q _{acc} [kN/m ²]	3.81
Tab. 10 - Carico distribuito equivalente per carichi consentiti permanenti e permanenti non strutturali		
Carico da ruota SUI dato equivalente	Q _{ru} [kN]	113.38 [kN/m ²]
Carico totale SUI dato equivalente	Q _{te} [kN]	184.17 [kN/m ²]
Carico distribuito limite verticale	Q _{lim}	100.70 [kN/m ²]
Coefficiente di sicurezza	γ _R	2.00
Verifica	R	0.88 +1.00
Tab. 11 - Verifica per carichi consentiti		
Carico accidentale nel terreno SUI	Q _{acc}	4.81 [kN]
Carico totale SUI terreno (permanentemente accidentale)	Q _{te} [kN]	18.29 [kN]
Carico distribuito limite accidentale	Q _{lim}	90.81 [kN]
Coefficiente di sicurezza	γ _R	2.00
Verifica	R	1.00 +1.00
Tab. 12 - Verifica dei carichi accidentali		
Geoplast Spa Via Merloni 1000, 38100 38100 (TRENTO) (TN) Italy GeoplastGlobal.com info@GeoplastGlobal.com Tel. +39 0461 543210 Fax. +39 0461 543211 Capitale Sociale € 3.000.000.000 i.v. Cod. Fisc. - Part. IVA e Reg. Imp. 02280710284 R.L.A. n. 30996/17		

4. 4. AQUABOX INFILTRATION SYSTEM INSTALLATION

As indicated by the rules on Hydraulic Invariance, in new urbanized areas it is necessary to provide a proper planning of the maximum flows discharged into the receiving water systems compared to those existing before urbanization. It is therefore of significant importance the evacuation of rainwater for their sustainable management over time. As a general rule, the verification of hydraulic invariance requires that the new flow generated by the urban modification is less than or equal to the pre-existing one or less than the maximum values allowed by the regulation or accepted by the managing body of the receiving water body.

In order to maintain invariance, the possible interventions, which can also be combined, are the following:

- infiltration;
- detention

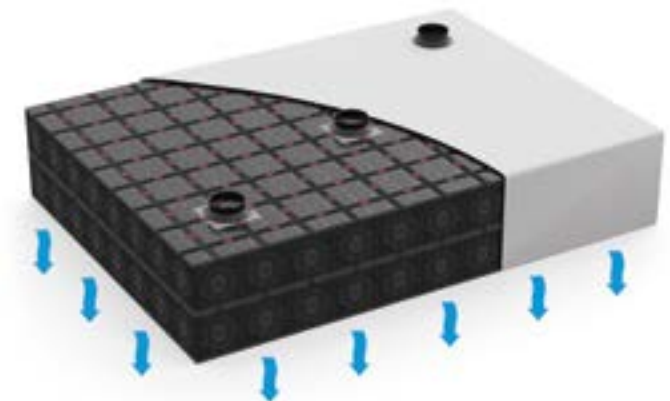
The AQUABOX module is a modular element made of plastic that allows to:

- infiltrate all rainwater into the ground creating an infiltration basin;
- infiltrate part of the rainwater into the ground while the remaining part will be channelled towards a network or a watercourse, creating a retention basin;
- retain stormwater in order to regulate runoff into the clearwater network or waterways, creating a storage basin.

4.1 INFILTRATION TANK

The AQUABOX system allows the creation of rainwater dispersion basins.

The speed of dispersion and emptying of the basin will depend on the characteristics of the ground. The following are the installation phases for creating a dispersion trench with AQUABOX.



4.2 PRELIMINARY CHECKS

Beforehand, it is advisable to carry out geotechnical and geological investigations on the site where the basin will be built in order to verify its suitability.

In particular, the following must be assessed:

- check minimum distances from existing buildings and constructions;
- soil permeability;
- soil load capacity;
- maximum water table level.

4.3 EXCAVATION AND BEDDING LAYER

The excavation should be made according to design specifications. During the work, the walls of the excavation should be sloped or made in such a way that they do not present a hazard to workers due to possible falling rocks. As a guideline, a perimeter clearance of at least 50 cm can be provided between the plastic structure and the excavation wall.

In addition, national regulations must be observed and all verification measures taken to ensure that the excavation is free of water during the entire installation phase.

For proper installation of the AQUABOX and AQUABOX CUBE modules, it is essential to create a flat and stable laying bed. To this end, it is advisable to create a leveling layer of at least 10 cm above the bottom of the excavation, preferably with crushed stone or fine gravel.

The layer must be carefully compacted and leveled to obtain a flat laying surface.

The layer must be carefully compacted and leveled to obtain a flat laying surface.

For particularly soft ground (shear strength <40 kPa or CBR<3, according to CIRIA report 737) a thorough evaluation is necessary to adopt the optimal technical solution.

It is generally recommended:

- creation of a gravel/sand bedding layer;
- installation of geotextile on the bedding layer;
- backfill compaction, every 0.6 m.

The quality of the bedding layer is critical for the installation of the modules and strongly influences both the load-bearing properties and the laying properties of the infiltration modules, especially in the case of multilayer basins and high loads (soil and vehicular traffic loads).



4.4 GEOTEXTILE INSTALLATION

The entire basin has to be wrapped with geotextile in order to provide mechanical protection and intrusion of backfill soil into the basin.

The geotextile has to be placed on the bedding layer before starting the installation of the modules.



The geotextile must have sufficient lateral length to envelop the entire system and must overlap at least 30 cm on all edges.

The geotextile must meet these minimum standards:

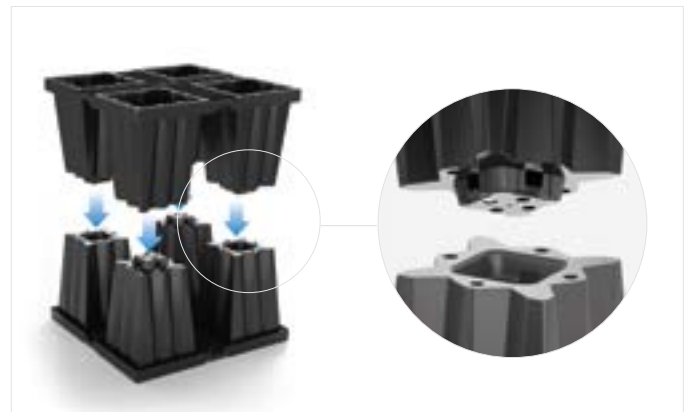
CHARACTERISTIC	REGULATION	VALUE
Thickness (mm)	EN ISO 9863-1	0,75
Weight (g/m ²)	EN ISO 9864	190
Punching resistance CBR (kN)	EN ISO 12236	4
Tensile strength (kN/m)	EN ISO 10319	40
Hole opening (µm)	EN ISO 12956	200
Normal plane permeability	EN ISO 11058	29
Material	-	PP

4.5 AQUABOX INSTALLATION

Once the geotextile has been laid at the bottom of the tank, the AQUABOX modules can be installed.

Each AQUABOX module consists of two half elements, each 43 cm high. Grazie al sistema di sovrapposizione facilitato Aqualock, ogni modulo può essere premontato senza l'ausilio di gru o mezzi meccanici. Infatti è sufficiente una leggera pressione per creare una connessione ad elevata resistenza.

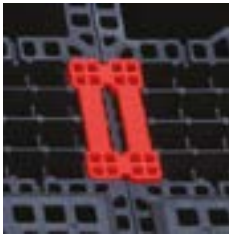
The pre-assembled modules must then be positioned according to the design specifications.



During laying, it is possible to walk on top of the elements. It is forbidden for operating machines, even small ones, to pass over the structure without adequate covering.

Each AQUABOX module is connected to the other by means of special connectors:

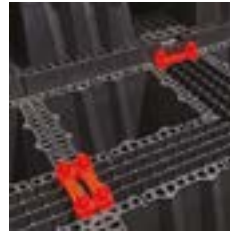
SINGLE JOINTS:



Allows modules of the first and last level to be joined (see photo).



DOUBLE JOINTS:



Allows modules of intermediate levels to be joined (see photo).



JOINT	APPLICATION	SPECIFICAT IONS	
Single	For 1 level basins	For 1 level instalaltion	2 pcs per module
		For multi storey installation	1 pc per module
Double	For multi storey basins	For 2 levels installation	1 pc per module
		For 3 levels installation	1.3 pc per module

4.6 AQUABOX-CUBE INSTALLATION

AQUABOX CUBE manholes can be positioned within the AQUABOX dispersion basin to ensure proper inspection and maintenance of the system.

These manholes can be placed in any position in the system depending on the trench geometry and design requirements.

The positioning of the manholes should be in accordance with the rules of good practice, i.e. 1 manhole every 10 m or 1 manhole every 100 m³.

The manhole shall be installed in the layout position as provided for in the project.

CUBE POSITIONING

The AQUABOX CUBE shaft can be placed in any point of the tank.

AQUABOX CUBE elements have a central hole with a diameter of DN 400mm which enables the connection of a corrugated pipe or PVC pipe to reach the top and on which a manhole cover will be laid, suitably sized according to the loads foreseen in the project.



- ① AQUABOX CUBE installation
- ② Joints installation
- ③ Final result



The AQUABOX CUBE elements have a central hole with a diameter of DN 400mm which enables the connection of a corrugated pipe or PVC pipe to reach the top and on which a manhole cover will be laid, suitably sized according to

the loads foreseen in the project.

The D4 cover is required for closing the base layer (on the level in contact with the ground).



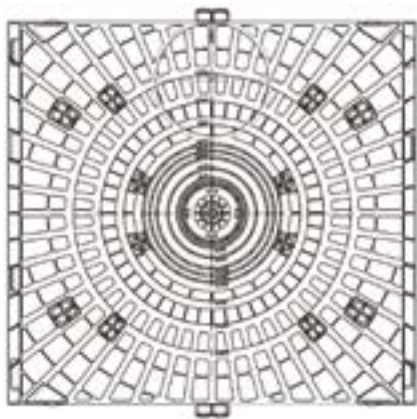
4.7 INSTALLATION OF SIDE GRIDS AND TOP CAPS

Sidewall grids and top caps are used to close the AQUA-BOX basin. This allows the distribution of the lateral loads and the simple laying of geotextiles or waterproofing membranes.

In addition, the grids are designed to allow the connection of pipes of different diameters for the management of incoming and outgoing flows.

The indications are the same for the AQUABOX CUBE side grid, which allows the side closure of each individual module if the sump is installed along the perimeter and/or at the top of the basin.

The top closing grates of the AQUABOX CUBE are instead the same as those of the AQUABOX, only that they must first be shaped before installation (see figure below).



The top caps allow each individual module on the top level of the entire basin to be closed. The installation is done with a simple clip fastening for both closures as shown in the pictures.

If there are problems with the attachment of the side grilles, it is advisable to use a rubber hammer to force the grilles into place. Do not use an iron hammer.



4.8 COVERING WITH GEOTEXTILE

AQUABOX systems must be completely wrapped in the geotextile that was previously laid on underneath.

At the edges, it is important to ensure enough overlap of the geotextile (at least 30 cm) to prevent the intrusion of the backfill material into the system.

Make a cross-shaped cut in the geotextile at inlet/outlet points.

Ensure before backfilling that the surface of the geotextile is completely closed and without any openings.



4.9 LATERAL BACKFILLING

For lateral backfill, it is recommended to use a non-cohesive, unfrozen material with a maximum grain size of 32 mm.

The space to the side of the infiltration or retention basin should be filled with fill material, free of stones. The backfill material shall be evenly distributed and compacted in layers of max. 30 cm using a compaction method that always spreads the layers evenly over the entire basin and compacts them with a hand-held vehicle or a light to medium-heavy vibrating machine with a maximum compaction force of 3 tons.

The margin between the structure and the edge of the excavation should be filled initially, rising in a uniform manner. Only one side should not be filled at a time, leaving the others empty. In doing so, a Dpr $\geq$ 97% must be achieved as a level of compaction.

Forms must NOT be damaged.

National soil handling guidelines must be followed.

Care must always be taken to ensure that the geotextile is properly overlaid and not damaged during backfilling and compaction.

Remarks for lateral filling:

- Do not use coarse/crushed fill materials > 30 mm and do not use clay materials;
- Do not damage the geotextile and/or geomembrane.



4.10 TOP BACKFILLING

A non-cohesive, unfrozen material with a maximum size of 32 mm is recommended for sidewall backfill. The space to the side of basin should be filled with backfill materials, free of stones. The backfill material shall be evenly distributed and compacted in layers of up to 30 cm. Only one side should not be filled at a time, leaving the others empty. In doing so, a $D_{pr} \geq 97\%$ must be achieved as a level of compaction.

It must always be ensured that the geotextile is well overlaid and not damaged during backfilling and compaction.



4.11 EQUIPMENT ALLOWED DURING THE INSTALLATION

The first layer of cover (of the minimum thickness indicated in the previous paragraph) can be laid using vehicles such as wheel loaders or small mobile excavators.

For the passage of a wheel loader or mobile excavator with a maximum total weight of 15 tons, a suitably compacted covering of at least 30 cm must be created over the AQUA-BOX system. Abrupt manoeuvres such as steering should be avoided at this stage.



The passage of heavy goods vehicles with a wheel load of more than 50 kN (e.g. HGV 30) over the basin is possible if the thickness of the covering is adequately compacted and not less than 60 cm.

When dumping the backfill material, the load per wheel shall not exceed 50 kN.

4.12 PLUMBING CONNECTIONS

Water entering the basin should be as clean as possible to avoid clogging the system and contaminating the final receptor.

The degree of purification to be achieved depends on:

- Inlet water quality.
- Current regulatory requirements.
- The final receptor.

In the absence of regulatory requirements we recommend:

- Provide systems to remove coarse solids (sediment traps). An increase in the depth of inlet wells can be provided to encourage sediment settling.
- Install an oil separator if the system disposes of runoff from a parking lot and the final discharge is the soil.

The sizing of the collectors is the responsibility of the designer of the project.

The maximum pipe diameter that can be inserted into the structure is Ø 500 mm.

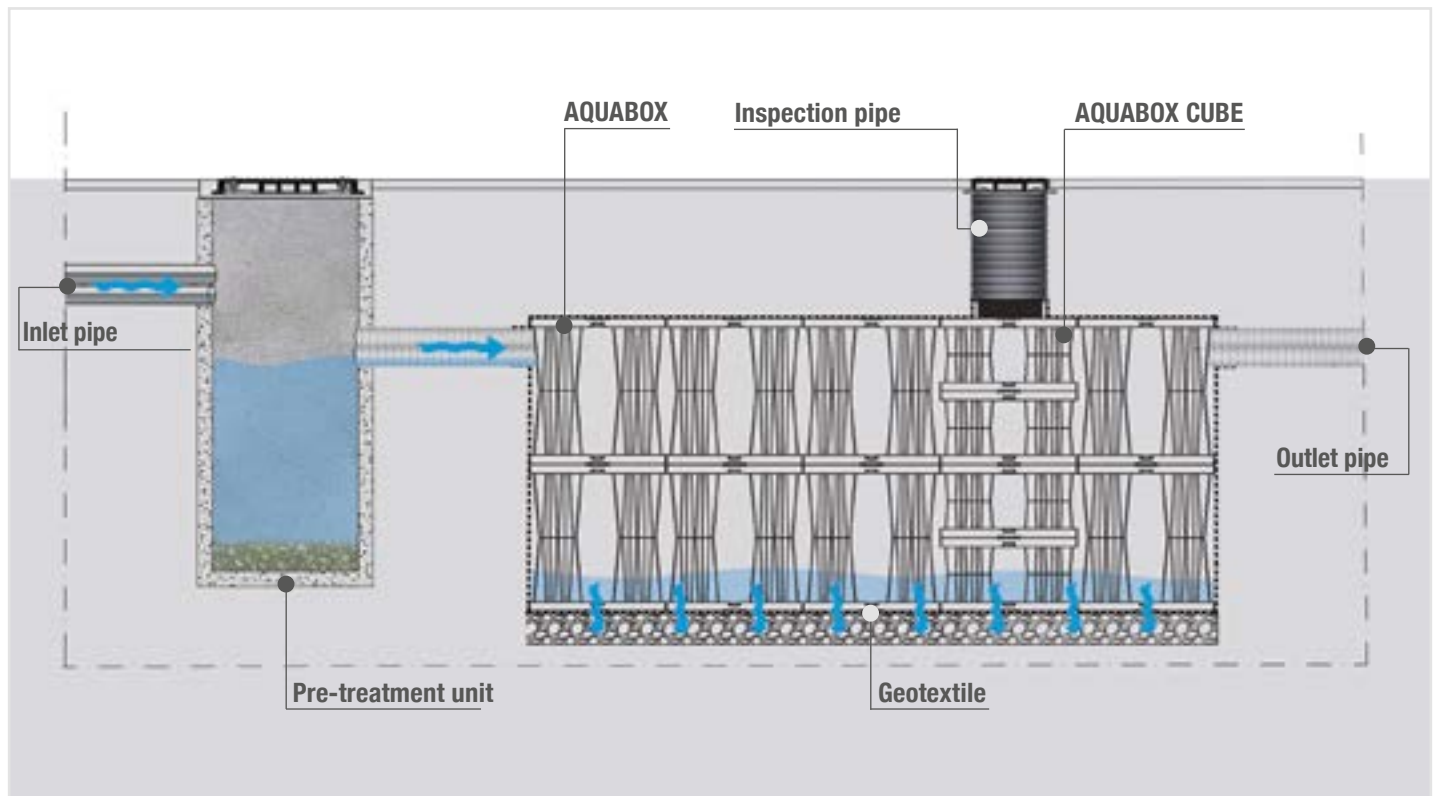
The adoption of a line to discharge the system must be evaluated in the design phase. Normally, it is the practice to provide a regulated flow discharge in cases where:

- The soil is weakly draining and should be allowed to drain in a reasonable time.
- The basin must work for pure lamination of flows.
- You want to ensure maximum hydraulic safety during exceptional events.

An emergency by-pass can also be provided, should a drainage system crisis occur.

4.13 INFILTRATION BASIN DIAGRAM

Below a technical diagram for the infiltration basin with AQUABOX:



5. AQUABOX-DETENTION AND SOTRAGE SYSTEM INSTALLATION

AQUABOX can be used to make rainwater storage and reuse basins.

AQUABOX can therefore be used to detain rainwater in order to regulate runoff into the sewage system.



5.1 PRELIMINARY CHECKS

It is advisable to carry out geotechnical and geological investigations on the site where the basin will be realized in order to verify its suitability. In particular, the following must be assessed:

- Soil bearing capacity.
- Water table max level.

To discharge excess flow rates into a basin it is necessary to know:

- Average level and maximum dischargeable flow (according to the prescriptions).
- Soil permeability in the case of a subsurface discharge.

With regard to the quality of the disposed water, reference should be made to the local regulations for discharge into the subsoil, in order to provide proper treatment plants upstream of the dispersing system.

5.2 EXCAVATION AND BEDDING LAYER

Ref. To paragraph 4.3 -

5.3 GEOTEXTILE INSTALLATION

Ref. To paragraph 4.4 -

5.4 AQUABOX INSTALLATION

Ref. To paragraph 4.5 -

5.5 AQUABOX-CUBE INSTALLATION

Ref. To paragraph 4.6 -

5.6 INSTALLATION OF THE SIDE GRIDS AND TOP CAPS

Ref. To paragraph 4.7 -

5.7 INSTALLATION OF GEOMEMBRANE AND COVERING WITH GEOTEXTILE

To make the basin waterproof, in order to ensure the accumulation of rainwater, a geomembrane is laid to wrap around the entire tank.

The sheath should be welded in place and around the inlet, outlet and AQUABOX CUBE pipes so as to make the basin watertight.

Both sides of the conduit should be protected with a woven fabric. The specifications for the liner (per CIRIA Report 737) and the geotextile are shown in the following tables:

GEOTEXTILE

FEATURE	REGULATION	VALUE
Thickness (mm)	EN ISO 9863-1	0,75
Weight (g/m ²)	EN ISO 9864	190
Static puncture resistance (kN)	EN ISO 12236	4
Tensile strength (kN/m)	EN ISO 10319	40
Opening holes (µm)	EN ISO 12956	200
Normal floor permeability	EN ISO 11058	29
Material	-	PP

GEOMEMBRANE

FEATURE	REGULATION	VALUE
Thickness (mm)	EN ISO 1849-2	1
Weight (g/m ²)	EN ISO 1849-2	900
Puncture resistance (N)	FTMS 101C	>150
Tensile strength (kN/m)	ASTM D4885	>1600
Shear strength (N/mm ²)	DIN 53155	>45
Thermal expansion (%)	DIN 53377	±3
Permeability (m/s)	ASTM D	>2x10 ⁻¹²

5.8 LATERAL BACKFILLING

Ref. To paragraph 4.9 -

5.9 RICOPRIMENTO DEL SISTEMA

Ref. To paragraph 4.10 -

5.10 EQUIPMENT ALLOWED DURING THE INSTALLATION

Ref. To paragraph 4.11 -

5.11 PLUMBING CONNECTIONS

Water entering the basin should be as clean as possible to avoid clogging the system and potential contamination from reuse of the collected water. It is recommended to:

- Provide systems to remove coarse solids (filters or sediment traps).
- Increase the depth of inlet wells to allow for sediment settling;
- Install an oil separator if the system collects runoff from road surfaces.

The sizing of the collectors is the responsibility of the designer.

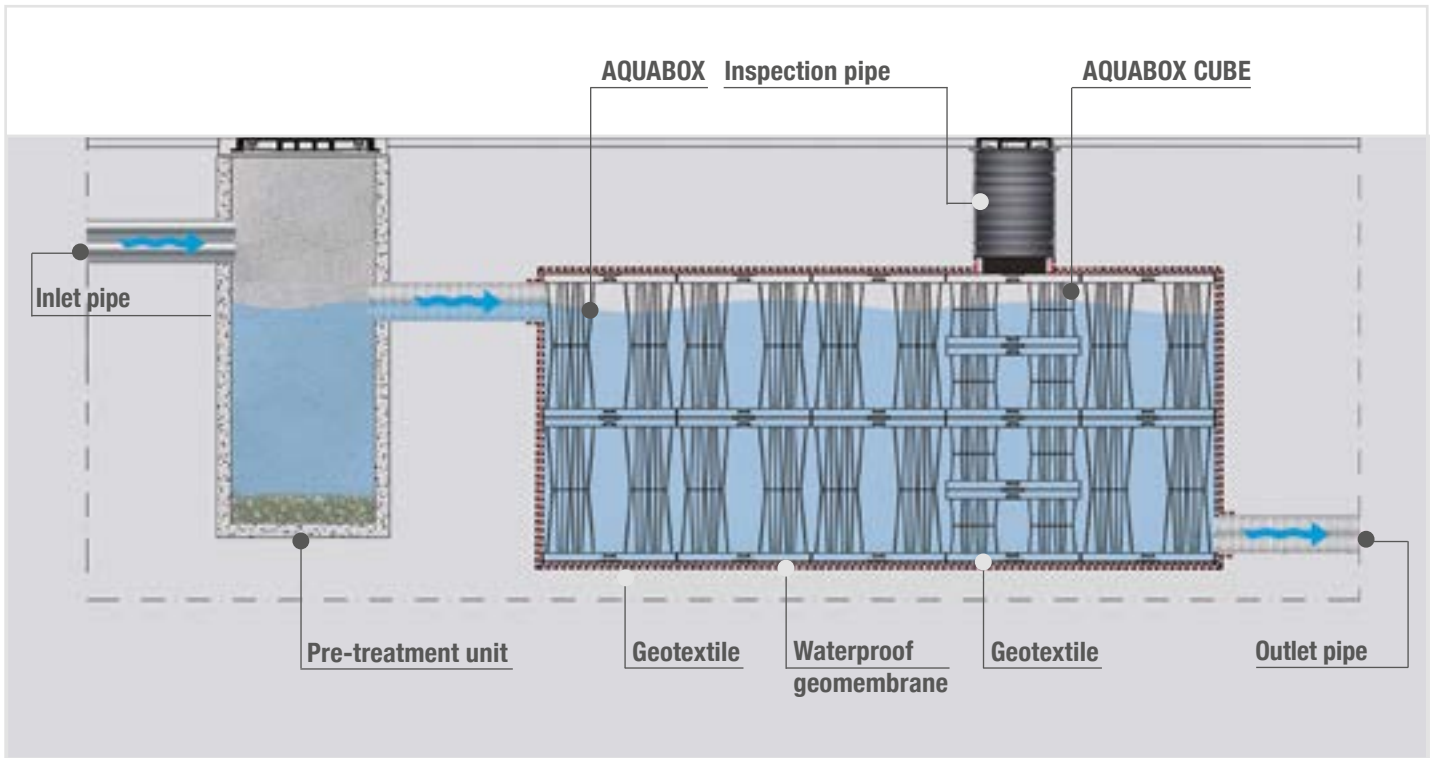
The maximum diameter of the pipe that can be placed in the structure is Ø 500 mm.

If the collector has a larger diameter, branches must be provided for connection to the system by means of diameter reductions.

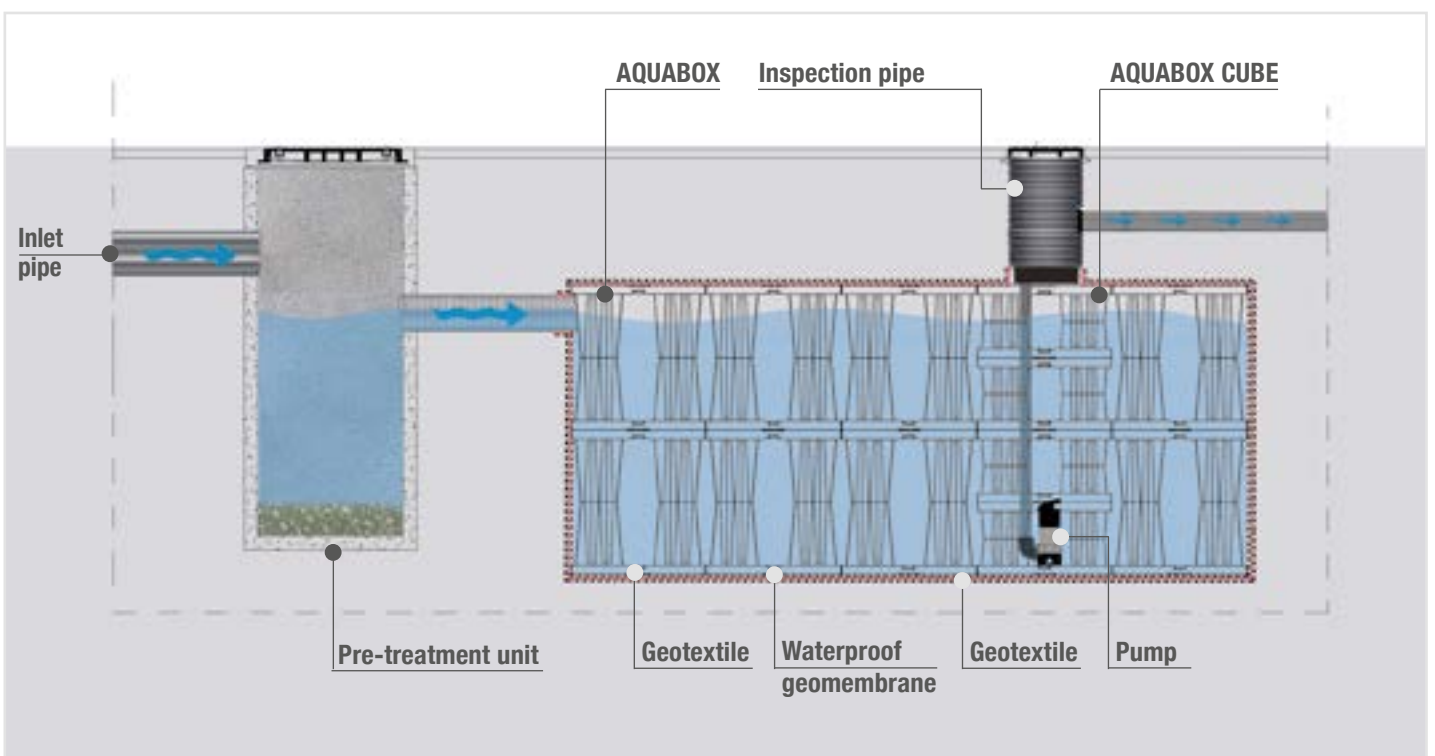
The number of branches will depend on the expected inlet flow rate;

The adoption of a discharge line is necessary for the disposal of incoming flow rates in excess of the expected storage volume.

5.12 DETENTION AND STORAGE BASIN DIAGRAM



Below is the technical diagram for a stormwater reuse basin made with AQUABOX:



6. INSTRUCTIONS

Here are some useful guidelines for choosing the right product depending on the expected load.

6.1 PEDESTRIAN LOADS

For pedestrian surfaces with occasional access of emergency vehicles such as ambulances, the product to be used is AQUABOX ST.

On-demand element verification is conducted using the crowd loads provided for pedestrian areas:

$$g1k = \text{Weight of the element } kN/m^2$$

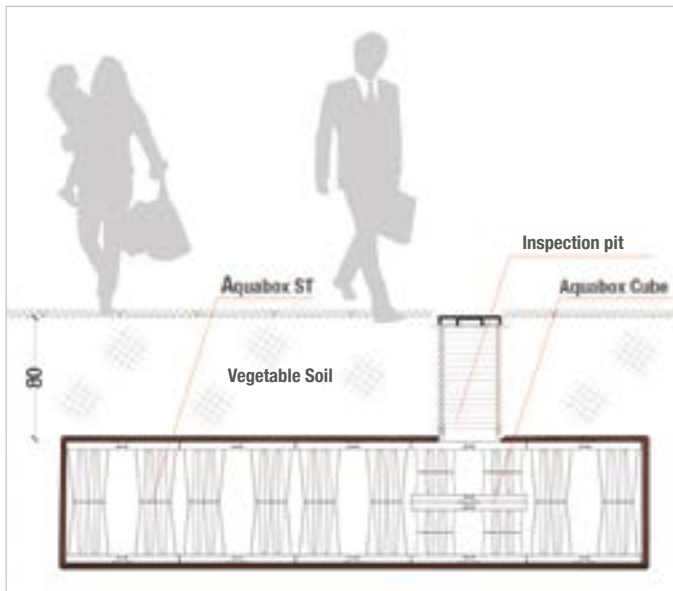
$$g2k = \text{Weight of the stratigraphy } kN/m^2$$

$$q2k = 5,00 \text{ } kN/m^2$$

$$Q2k = 10 \text{ } kN \text{ on an area } 200 \times 200 \text{ } mm^2$$

The following images show typical stratigraphies for the application of AQUABOX ST on pedestrian surfaces (sizes in cm):

FOLKS LOADS



6.2 LOAD CLASS HGV30

For driveway surfaces with light vehicles or light trucks, the product to be used is AQUABOX STR.

The verification of the element on request is conducted using the loads from DIN1072 with the traffic load equivalent to SLW30:

$$g1k = \text{Weight of the element } kN/m^2$$

$$q2k = 2,50 \text{ } kN/m^2$$

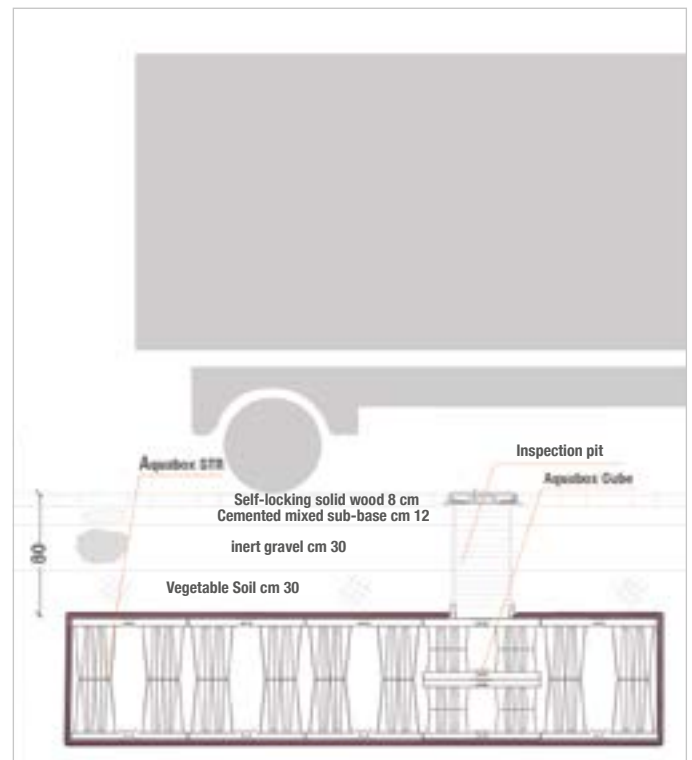
$$Q2k = 50 \text{ } kN \text{ on an area}$$

$$A = 400 \text{ } mm \text{ } B = 200 \text{ } mm \text{ ed}$$

$$\text{and axle spacing } axle \text{ } A = 2000 \text{ } mm \text{ } axle \text{ } B = 1500 \text{ } mm$$

The following images show typical stratigraphies for the application of AQUABOX STR on driveway surfaces (sizes in cm):

HGV30 (30 TONS TRUCK 10 TONS EACH AXES)



6.3 LOAD CLASS HGV60

For driveway surfaces with light vehicles or light trucks, the product to be used is AQUABOX STR.

The verification of the element on request is conducted using the loads from DIN1072 with the traffic load equivalent to SLW60:

$$g1k = \text{Weight of the element } kN/m^2$$

$$q2k = 2,50 \text{ } kN/m^2$$

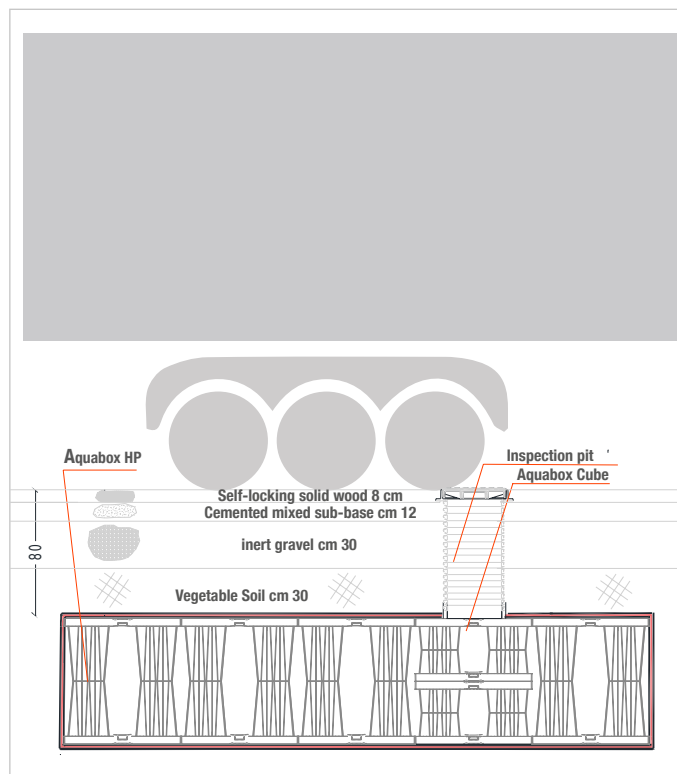
$$q2k = 4,00 \text{ } kN/m^2$$

$$Q2k = 100 \text{ } kN \text{ on an area}$$

$A = 600 \text{ mm}$ $B = 200 \text{ mm}$ ed
and axle spacing $axle A = 2000 \text{ mm}$ $axle B = 1500 \text{ mm}$

The following images show typical stratigraphy for the application of AQUABOX HP on driveway surfaces (sizes in cm):

SLW60 (60 TONS TRUCK 20 TONS EACH AXES)



6.4 OTHER REQUIREMENTS

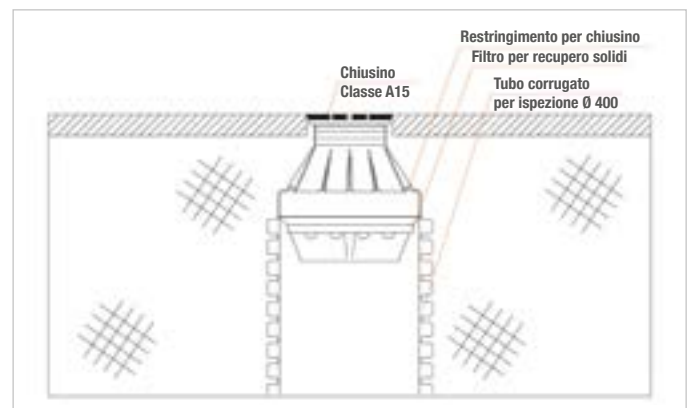
Regarding the use of AQUABOX to increase the drainage of some surfaces not contemplated in the usual use for dispersion, lamination and retention basins, it is advisable to contact the Geoplast Technical Department, which will be at your disposal for ad-hoc sizing.

If the product is used for a lamination basin, i.e. a watertight system wrapped by a geomembrane, it is recommended to keep the system above the maximum piezometric level of the water table.

Depending on the design load, the pipe and manhole should be installed as described in the following pictures.

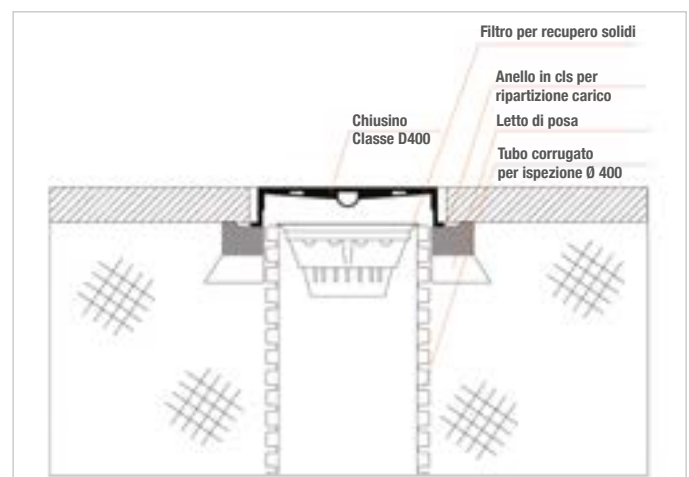
In case of purely pedestrian load then the manhole cover can be connected directly to the Ø 400 mm pipe.

DETAILS OF AQUABOX CUBE MANHOLE FOR PEDESTRIAN AREAS



In the case of driveways, the manhole cover is placed on the reinforced concrete ring specially sized to distribute the load on the ground.

DETAILS OF AQUABOX CUBE MANHOLE FOR DRIVEWAY AREAS



7. 7 MAINTENANCE AND CLEANING

During the construction phase it must always be ensured that no foreign objects enter the pipes or modules. Special care is required if, immediately after the construction phase, a high pollutant volume is expected from the connected areas.

Initial inspections (and eventual cleaning) should take place before delivery of the material and immediately after completion of the installation. A visual inspection of the plant and inlet manholes, as well as a camera inspection, are recommended. These inspections should then be recorded in a maintenance book. Additional inspections, if necessary, should take place every six months for the first year of use. These will provide useful information for future cleaning and inspection work.

For this, cleaning should begin with flushing of the supply pipes and upstream tanks, especially if they also act as sediment traps. It is advisable to inspect and clean the tank at least twice a year, preferably in the spring and fall.

Of course, in the event of extreme weather events, trench inspection/cleaning is always recommended.

Inspection of the system is therefore critical during the following periods:

- Termination of site operations;
- After particularly intense weather events;
- In correspondence of failure or malfunction of possible pre-treatment units if provided;
- At least once per year.

7.1 CLEANING OF AQUABOX MODULES

Cleaning of the drainage system can usually be accomplished by flushing and vacuuming dirt from the manhole.

The cleaning operations must start from the washing of the inlet pipes and the manholes located upstream, especially if they also act as sediment traps.

In fact, in case of heavy pollution (high amount of sediment) of the area under investigation, a trench cleaning with high-pressure washing of the channels around the trench must be foreseen.

For spray probe cleaning, the use of a 90° rotating nozzle with a 45° water jet is recommended.

The nozzles used should have a pressure of 80 to 120 bar; higher pressures may damage the geotextile.





8. CERTIFICATIONS AND TESTS

For certificates and load tests, please contact the Geoplast Technical Office.

9. TRANSPORT AND LOGISTICS

AQUABOX modules are delivered stacked on pallets measuring 80 x 152 x H258 cm.

A pallet contains 80 half AQUABOX elements for a total of 40 modules. Thanks to the geometry of the product and the possibility of stacking the same, the total volume transported by a normal truck is equivalent to 460 m³.

The side and top closing grids are packed on separate pallets.

The AQUABOX CUBE inspection components also arrive on separate pallets measuring 75 x 150 x H250 cm. These pallets are marked accordingly to distinguish them from other pallets.

Forklifts or cranes equipped with lifting straps can be used for unloading and handling pallets.

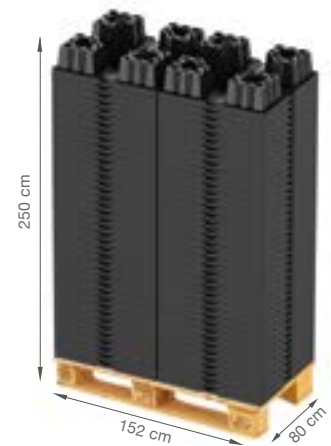
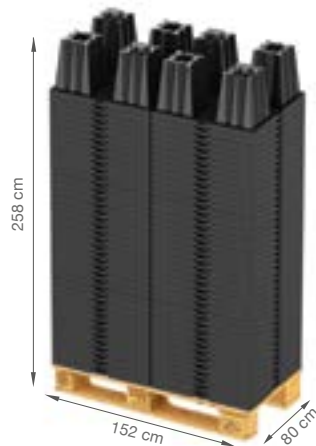
For proper storage, it is advisable to choose a stable surface that is as regular as possible. The product should be kept away from contact with fuels, lubricants, chemical agents or acids. UV exposure should be limited as much as possible. Once the elements have been removed from the pallet, the following should be avoided

- Improper storage (overlapping pallets, bulk stacking of elements,);
- Improper handling (throwing the elements, dragging,...);
- Contact or impact with blunt or sharp objects.

Stackable

The modules are stackable and are delivered on pallets of 80 pieces that are equivalent to 18 m³ each.

The size of the packaging is: 80 x 152 x H258 cm.



Easy installation

With the "Aqualock" overlapping system, two semi-modules are assembled together creating a cubic element ready to be placed in the excavation to form the drainage basin.



Ready to use

The modules once assembled are ready to be laid in the excavation for the creation of the basin. The side walls serve as fittings for the stormwater inlet/outlet pipes.





IMPORTANT: Before installation, check that the elements are not damaged or defective (they must comply with the characteristics described in paragraph 2). Avoid installation if there is any damage or defect in either the panels or the grids. Damaged modules must NOT be installed!



Geoplast S.p.A.

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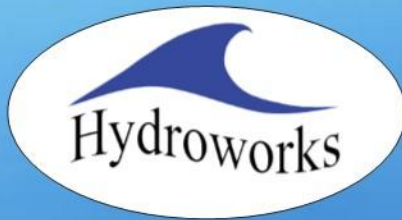
Geoplast@Geoplastglobal.com

GeoplastGlobal.com



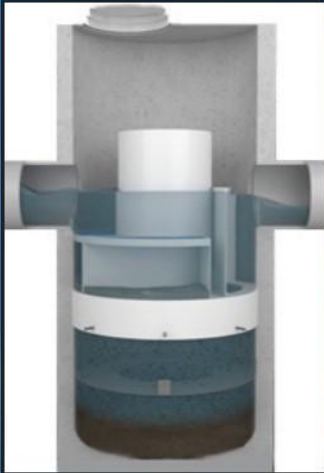
REV. 000 02/2022





HydroStorm

Hydrodynamic Separator



Product Info

HydroStorm efficiently removes oil, trash, and TSS (suspended solids and their associated metals, nutrients, bacteria), from stormwater runoff which is required in NDPES permits and the Clean Water Act.

Applications

HydroStorm is used as a standalone treatment solution for urban retrofit and redevelopment applications; as part of a treatment train for new developments; and as a pretreatment device for infiltration, underground storage, and bio-retention.



Features

- Internal high flow bypass prevents scour at high flows
- Designed to accommodate multiple inlet pipes
- Captures oil spills, TSS and trash
- Lower cost compared to other competitors
- Reduced sump depths to minimize excavation
- Small footprint to avoid conflicts with other services
- Engineered for traffic loading
- Can be used as a inlet, bend, or junction structure
- Sized based on independent TSS removal results
- Low Headloss ($K=1.04$) to minimize impact to drainage system
- Minimum elevation drop from inlet to outlet

Hydroworks LLC
888-290-7900
www.hydroworks.com
info@hydroworks.com

Sizing & Design

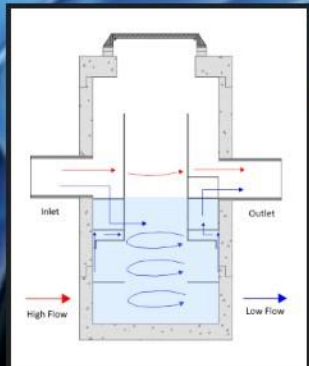
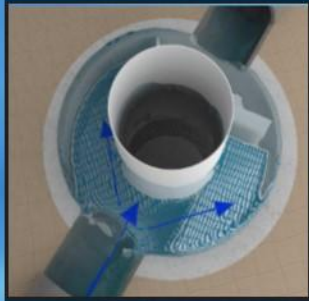
Sized based on independent laboratory testing results. Approved and/or certified by numerous agencies (NJDEP, 2018; NJCAT, 2018; ETV Canada, 2018)





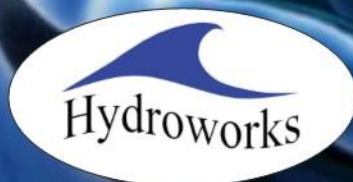
HydroStorm

Hydrodynamic Separator



Hydroworks will design a unit for you or you can download our free design software at www.hydroworks.com

Hydroworks LLC
888-290-7900
www.hydroworks.com
info@hydroworks.com



HYDROSTORM WATER QUALITY FLOW RATES (cfs)

Model	NJDEP* (67 um)	ConnDOT** (100 um)	NH*** (OK110)	150 um***	200 um***
HS 4/HS 4i	0.9	1.1	0.9	1.6	2.0
HS 5	1.4	2.0	1.5	2.5	3.2
HS 6	2.0	3.1	2.1	3.6	4.5
HS 7	2.7	4.5	2.9	4.9	6.2
HS 8	3.5	6.1	3.8	6.3	8.1
HS 10	5.5	11.3	5.9	9.9	12.6
HS 12	7.9	18.9	8.5	14.3	18.2

*50% Annual TSS Removal

**60% Annual TSS Removal

***80% TSS Removal at WQF

For more information, call your local Hydroworks representative:

Specifications

1. Must be independently tested to the 2013 NJDEP Laboratory Protocol and 2013 ETV Canada protocol (ISO 14024:2016). Separator must be sized based on this data.

2. Any testing performed by the manufacturer is unacceptable to demonstrate an alternate equal.

3. Field Testing is unreliable, site and storm specific, and subject to compounding equipment and analytical errors and therefore is unacceptable as verification of an alternate equal. TARP verification as per NJDEP is testing consistent with the 2013 NJDEP laboratory protocol.

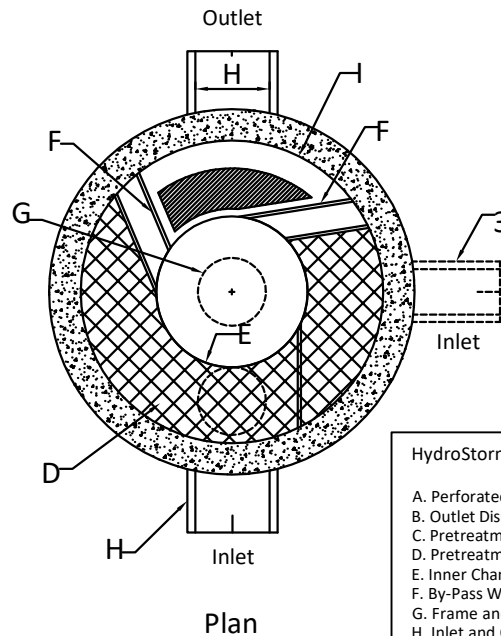
4. The separator must be designed based on the following criteria:

Flow Criteria	
Water Quality Flow Rate cfs (L/s)	
Peak Design Flow Rate cfs (L/s)	

TSS Removal Criteria	
Annual TSS Removal (%)	
NJDEP/ETV Canada TSS	
OK110 Sand	
City of Toronto	
Other	

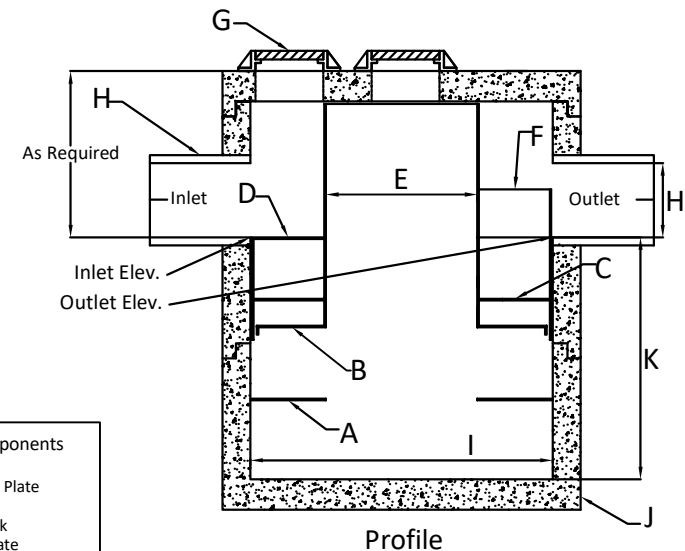
Notes:

- Headloss K factor of 1.04 for hydraulic gradeline calculations
- Sump depths shown are typical. Additional depth can be added as required
- Multiple inlet pipes allowed
- Drops allowed
- Inlet invert elevations should be the same or higher than the outlet invert elevation. Inlet can be up to 12" (300 mm) lower than outlet if pretreatment area is omitted but 12" (300 mm) must be added to sump depth to maintain overall treatment volume.
- Solid Cover shown. HydroStorm can be designed with an inlet grate if required.
- Oil capacities given are spill capacities.
- Sediment depths are maximum holding capacities and not recommended capacities for regular maintenance.
- Capacities are rounded down to nearest 5 gal or ft3 (1L or 0.1 m3 for metric units)
- Base Extensions not provided on standard units larger than the HS 6. Extensions can be provided if required due to groundwater/buoyancy concerns at the request of the engineer of record.
- HS4 to HS6 models require one frame and cover. HS7 to HS12 models require two covers



HydroStorm Components

- A. Perforated Scour Plate
- B. Outlet Disk
- C. Pretreatment Disk
- D. Pretreatment Grate
- E. Inner Chamber
- F. By-Pass Weirs
- G. Frame and Cover (1-2)
- H. Inlet and Outlet Pipes
- I. Structure Diameter
- J. Base Extension (HS4 - HS6)
- K. Sump Depth



HydroStorm by Hydroworks, LLC
US Patent No. 10,710,907
www.hydroworks.com
888-290-7900

HydroStorm Dimensions / Capacities

Model	Diameter ft (m) (9)	Sump Depth ft (m) (11)	Inner Chamber Diam. ft (m) (5)	Max. Pipe in (mm) (8)	Oil Spill Volume gal (L)	Sediment Volume ft3 (m3)	Total Volume gal (L)
HS 3	3 (0.9)	3 (0.9)	1.5 (0.45)	18 (450)	40 (155)	10 (0.35)	155 (600)
HS 4	4 (1.2)	4 (1.2)	2 (0.6)	24 (600)	95 (375)	30 (0.85)	375 (1420)
HS 5	5 (1.5)	5 (1.5)	2.5 (0.8)	30 (750)	165 (635)	60 (1.8)	730 (2780)
HS 6	6 (1.8)	6 (1.8)	3 (0.9)	36 (900)	270 (1030)	110 (3.2)	1265 (4800)
HS 7	7 (2.1)	6.5 (2.0)	3.5 (1.0)	42 (1050)	410 (1560)	160 (4.6)	1870 (7080)
HS 8	8 (2.4)	7 (2.1)	4 (1.2)	48 (1200)	615 (2330)	220 (6.2)	2630 (9960)
HS 10	10 (3.0)	9 (2.7)	5 (1.5)	60 (1500)	1130 (4285)	465 (13.1)	5285 (20015)
HS 12	12 (3.6)	11 (3.3)	6 (1.8)	72 (1800)	1875 (7100)	835 (23.7)	9305 (35225)

Hydroworks HydroStorm

PROJECT:

LOCATION:

REVISION DATE: 08/07/2020





Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.0

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

Introduction

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

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

Hydroworks® HydroStorm Operation

The Hydroworks HydroStorm (HS) separator is a unique hydrodynamic by-pass separator. It incorporates a protected submerged pretreatment zone to collect larger solids, a treatment tank to remove finer solids, and a dual set of weirs to create a high flow bypass. High flows are conveyed directly to the outlet and do not enter the treatment area, however, the submerged pretreatment area still allows removal of coarse solids during high flows.

Under normal or low flows, water enters an inlet area with a horizontal grate. The area underneath the grate is submerged with openings to the main treatment area of the separator. Coarse solids fall through the grate and are either trapped in the pretreatment area or conveyed into the main treatment area depending on the flow rate. Fines are transported into the main treatment area. Openings and weirs in the pretreatment area allow entry of water and solids into the main treatment area and cause water to rotate in the main treatment area creating a vortex motion. Water in the main treatment area is forced to rise along the walls of the separator to discharge from the treatment area to the downstream pipe.

The vortex motion forces solids and floatables to the middle of the inner chamber. Floatables are trapped since the inlet to the treatment area is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while water must flow up the walls of the separator to discharge into the downstream pipe.

A set of high flow weirs near the outlet pipe create a high flow bypass over both the pretreatment area and main treatment chamber. The rate of flow into the treatment area is regulated by the number and size of openings into the treatment chamber and the height of by-pass weirs. High flows flow over the weirs directly to the outlet pipe preventing the scour and resuspension of any fines collected in the treatment chamber.



A central access tube is located in the structure to provide access for cleaning. The arrangement of the inlet area and bypass weirs near the outlet pipe facilitate the use of multiple inlet pipes.

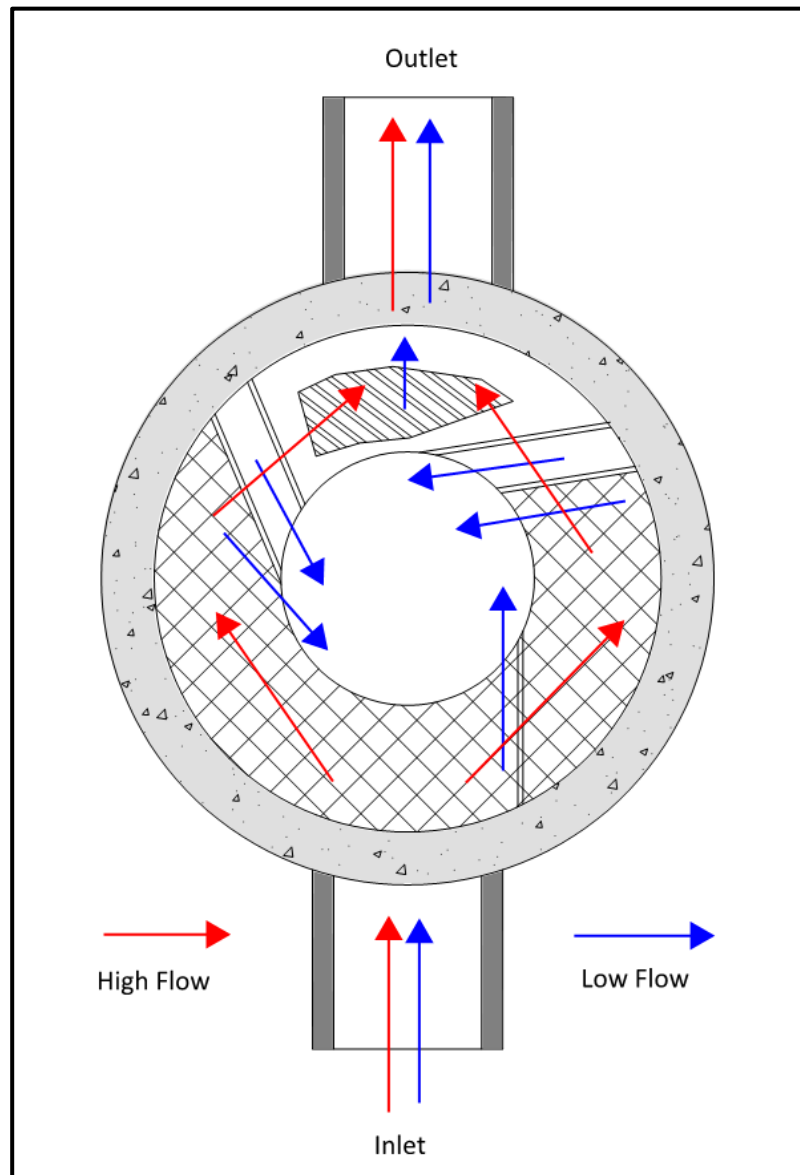


Figure 1. Hydroworks HydroStorm Operation – Plan View

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

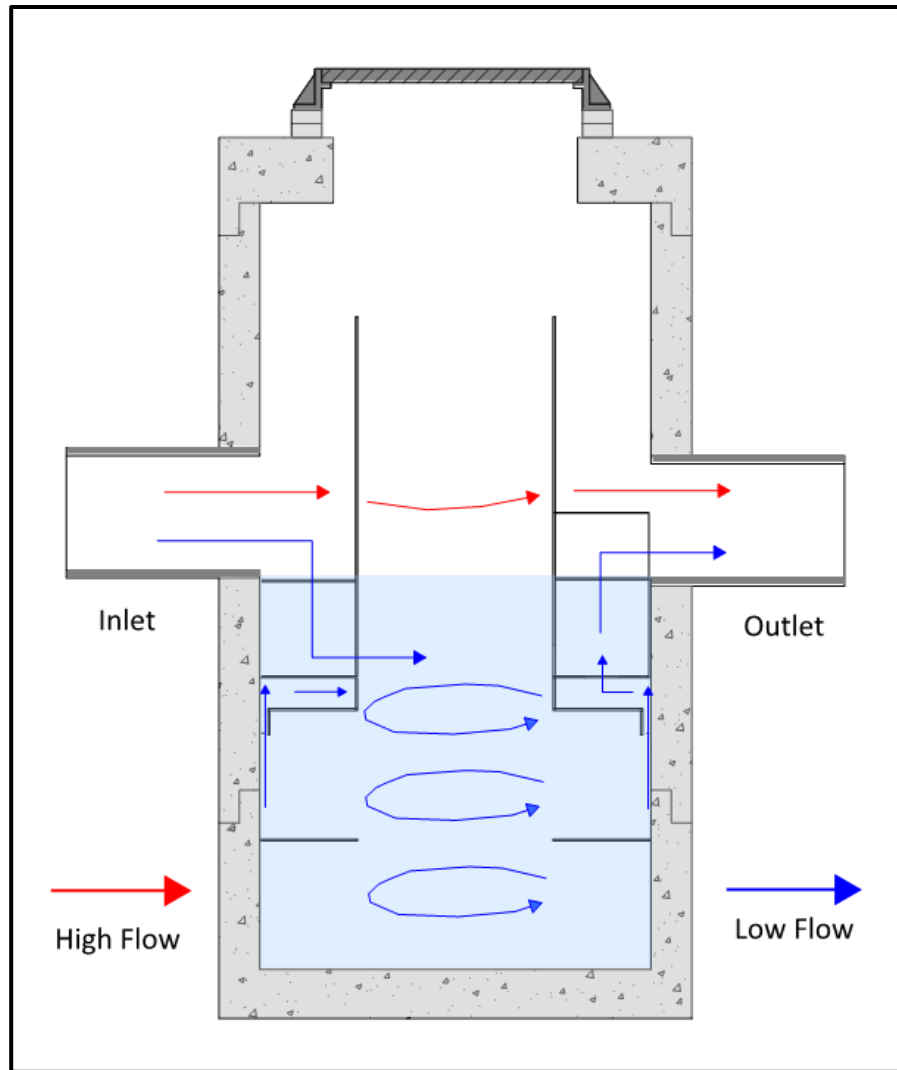


Figure 2. Hydroworks HydroStorm Operation – Profile View

The HS 4i is an inlet version of the HS 4 separator. There is a catch-basin grate on top of the HS 4i. A funnel sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all low flows are properly treated. The whole funnel is removed for inspection and cleaning.

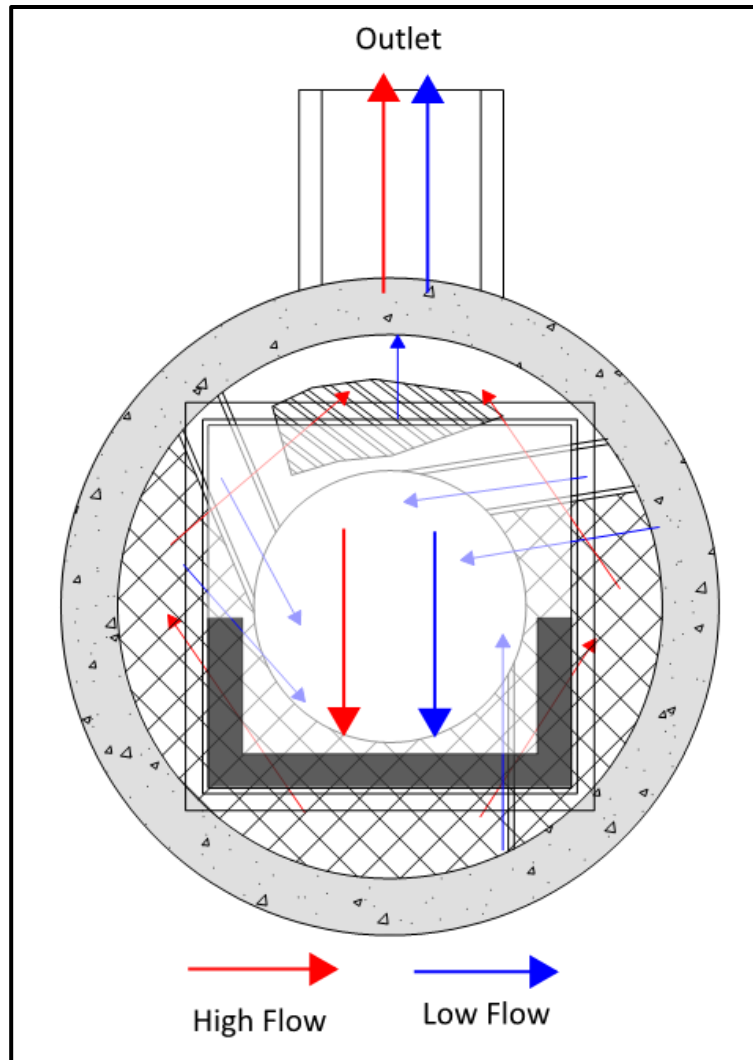


Figure 3. Hydroworks HS 4i Funnel

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the center access tube of the separator. Separators with an inlet grate (HS 4i or custom separator) will have a plastic funnel located under the grate that must be removed from the frame prior to inspection or maintenance. If you are missing a funnel please contact Hydroworks at the numbers provided at the end of this document.

TSS/Sediment

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

Frequency

Construction Period

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

Post-Construction Period

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

Reporting

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

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



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

Maintenance

Procedure

The Hydroworks HydroStorm unit is typically maintained using a vacuum truck. There are numerous companies that can maintain the HydroStorm separator. Maintenance with a vacuum truck involves removing all of the water and sediment together. The water is then separated from the sediment on the truck or at the disposal facility.

A central access opening (24" or greater) is provided to the gain access to the lower treatment tank of the unit. This is the primary location to maintain by vacuum truck. The pretreatment area can also be vacuumed and/or flushed into the lower treatment tank of the separator for cleaning via the central access once the water level is lowered below the pretreatment floor.

In instances where a vacuum truck is not available other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used the water must be decanted prior to cleaning since the sediment is under water and typically fine in nature. Disposal of the water will depend on local requirements. Disposal options for the decanted water may include:

1. Discharge into a nearby sanitary sewer manhole
2. Discharge into a nearby LID practice (grassed swale, bioretention)
3. Discharge through a filter bag into a downstream storm drain connection

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. Once the water is decanted the sediment can be removed with the clamshell bucket.

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HydroStorm unit will typically take 1 to 2 hours based on a vacuum truck and longer for other cleaning methods (i.e. clamshell bucket).



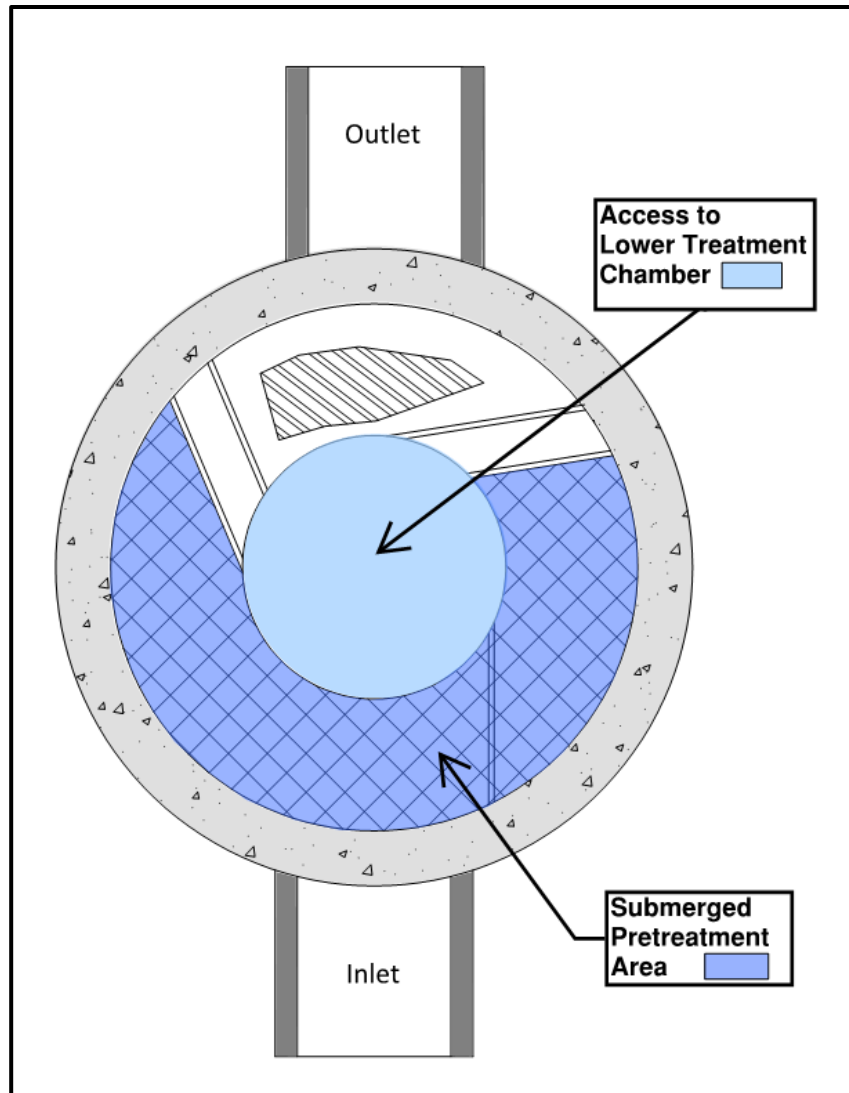


Figure 3. Maintenance Access

Frequency

Construction Period

A HydroStorm separator can fill with construction sediment quickly during the construction period. The HydroStorm must be maintained during the construction period when the depth of TSS/sediment reaches 24" (600 mm). It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the area of the separator

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

Post-Construction Period

The HydroStorm was independently tested by Alden Research Laboratory in 2017. A HydroStorm HS 4 was tested for scour with a 50% sediment depth of 0.5 ft. Therefore, maintenance for sediment accumulation is required if the depth of sediment is 1 ft or greater in separators with standard water (sump) depths (Table 1).

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total water depth in the separator through the central access tube should be taken and compared to water depth given in Table 1. The standard water depth from Table 1 should be subtracted from the measured water depth and the resulting extra depth should be added to the 1 ft to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured water depth in the HS-7 is 7 feet, then the sediment maintenance depth for that HS-7 is 2 ft ($= 1 + 7 - 6$) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2 ft.

The HydroStorm separator must also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the water surface of the separator.

Table 1 Standard Dimensions for Hydroworks HydroStorm Models

Model	Diameter (ft)	Total Water Depth (ft)	Sediment Maintenance Depth for Table 1 Total Water Depth(ft)
HS-3	3	3	1
HS-4	4	4	1
HS-5	5	4	1
HS-6	6	4	1
HS-7	7	6	1
HS-8	8	7	1
HS-9	9	7.5	1
HS-10	10	8	1
HS-11	11	9	1
HS-12	12	9.5	1



HYDROSTORM INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics

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

HydroStorm

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

Routine Measurements

Floating debris depth	< 0.5" (13mm)	☐	>0.5" 13mm)	☐ *
Floating debris coverage	< 50% of surface area	☐	> 50% surface area	☐ *
Sludge depth	< 12" (300mm)	☐	> 12" (300mm)	☐ *

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





Hydroworks® HydroStorm

One Year Limited Warranty

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

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

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

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

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

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

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

that class of BMP. In two cases, (sorbative media interceptors and soakways/infiltration trenches), although there are no Ontario phosphorus removal efficiencies reported in the review materials, the techniques are not limited by geography. The reported ranges in efficiency for these BMP classes are narrow so the median efficiency is chosen as a representative phosphorus removal efficiency. In all other cases, there are unacceptable regional differences and wide ranges in efficiencies that would not support the derivation of single representative phosphorus removal efficiencies. In the case of dry swales, the non-Ontario removal efficiencies may be usable, but the range of reported values is large such that it will be necessary to identify design criteria that will limit the range in efficiencies for this class of BMPs before a value can be chosen.

Table 3. Phosphorus Removal Efficiencies for Major Classes of BMPs Using the Decision Tree (Figure 5)

BMP Class	Reference IDs ¹	Reported Phosphorus Removal Efficiency (%)		Relevant to Ontario?	Range <40%?	Are Non-Ontario values acceptable?	Possible design criteria?	Median % Removal Efficiency
		Min	Max					
Post-development BMPs								
Bioretention Systems	8-10, 12, 13, 34-38, 40	-1552	80	no	no	no	No	none
Constructed Wetlands	104, 106, 109	72	87	yes	yes			77
Dry Detention Ponds	104, 109	0	20	no	yes	yes		10
Dry Swales	24, 26-32	-216	94	no	no	no	possible	none
Enhanced Grass/Water Quality Swales	21, 104	34	55	no	yes	no	No	none
Flow Balancing Systems	106	77		no	?	yes	Min data	77
Green Roofs	2	-248		no	no	no	No	none
Hydrodynamic Devices	109	-8		no	?	yes		none
Perforated Pipe Infiltration/Exfiltration Systems	7, 4	81	93	yes	yes			87
Sand or Media Filters	104, 109	30	59	no	yes	yes		45
Soakaways - Infiltration Trenches	6, 104	50	70	no	yes	yes		60
Sorbitive Media Interceptors	111	78	80	no	yes	yes		79
Underground Storage	106	25		no	?	yes	Min data	25
Vegetated Filter Strips/Stream Buffers	6, 42, 104	60	70	no	yes	yes	Yes	65
Wet Detention Ponds	104-106, 109	42	85	yes	yes			63

Notes: ¹References associated with IDs are provided in Appendix 7.

**189-197 DUCKWORTH STREET – CITY OF BARRIE
24-UNIT STACKED TOWNHOUSE DEVELOPMENT
FUNCTIONAL SERVICING REPORT**

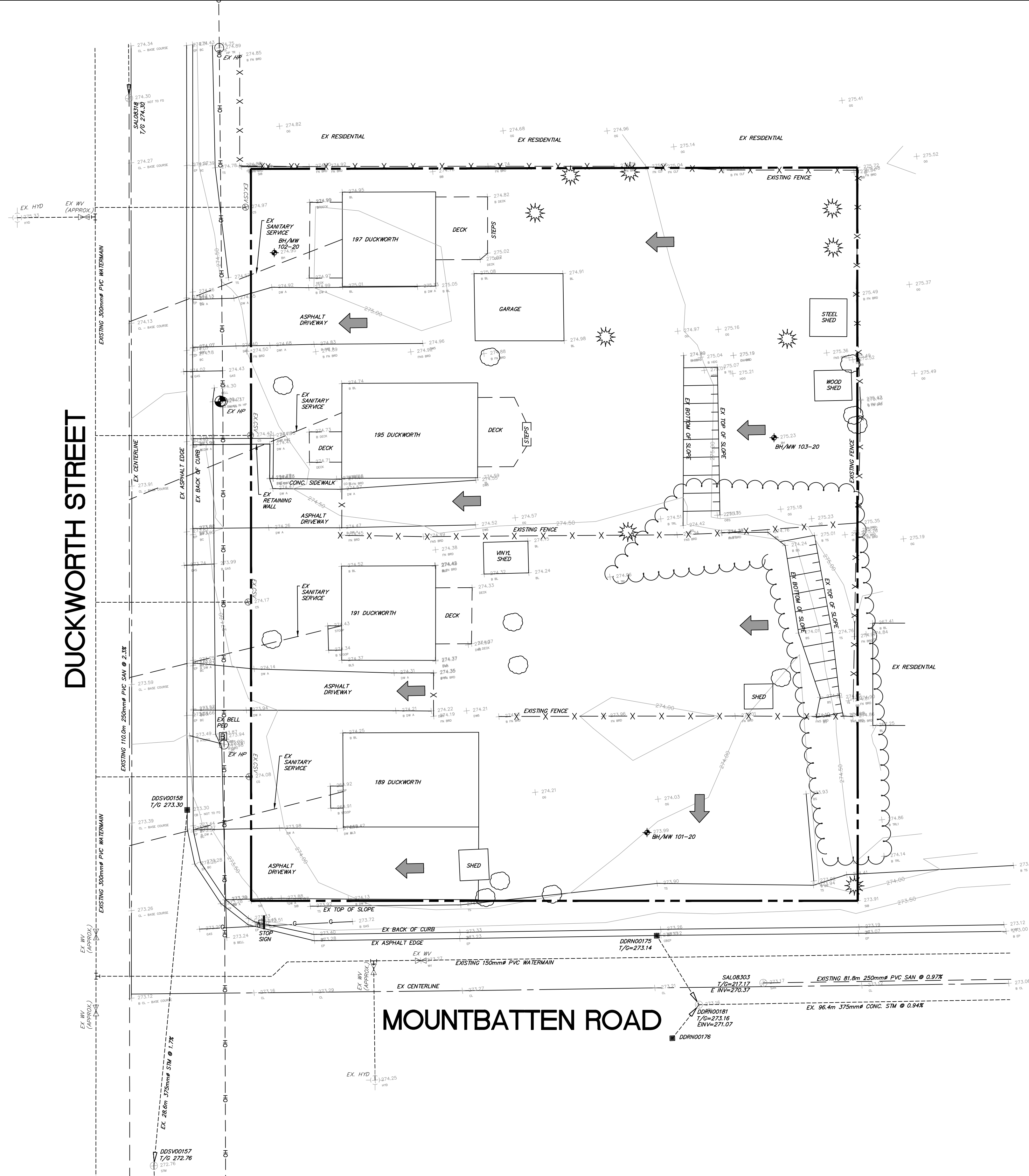
APPENDIX E

Preliminary Engineering Drawings





KEY MAP



NOTES

1. TOPOGRAPHIC SURVEY COMPLETED BY JOETPO, OCTOBER 2020. ELEVATIONS ARE GEODETIC IN NAD 83 CSRS DATUM
2. SITE PLAN PROVIDED BY CARICARI LEE ARCHITECTS.
3. LEGAL INFORMATION PROVIDED BY KRCMAR SURVEYORS LTD.

LEGEND

- SITE BOUNDARY
- - - LEGAL BOUNDARY
- IRON BAR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING DITCH
- EXISTING TREELINE
- EXISTING TREES: CONIFEROUS, DECIDUOUS
- EXISTING EDGE OF ASPHALT
- EXISTING GRAVEL SURFACE
- EXISTING FENCE
- EXISTING OVERHEAD WIRES
- BOREHOLE/MONITORING WELL LOCATION. SEE GEOTECH REPORT PREPARED BY CAMBIUM INC.
- OVERLAND FLOW ARROW

The position of existing above ground and underground utilities and facilities are not necessarily shown on the drawings, and where shown, the accuracy of the position of such utilities and facilities is not guaranteed. Before starting work, the contractor shall confirm the exact location of all existing utilities and facilities, and shall assume all liability for damage to them.

Drawings shall not be used for construction unless sealed and signed. All work to be performed in accordance with the Occupational Health & Safety Act 1990.

Any errors and/or omissions shall be reported to Pinestone Engineering Ltd. without delay.



BENCHMARK

- BENCHMARK NAIL IN HYDRO POLE ON EAST SIDE OF DUCKWORTH STREET IN FRONT OF HOUSE #189 ELEVATION 274.71

SEAL

DRAWN BY:

CHECKED BY:

DESIGNED BY:

J.V.

SCALE:

DATE:

NO. YY.MM.DD

REVISION

BY

NORTH ARROW



PROJECT:

PROPOSED STACKED TOWNHOUSE DEVELOPMENT
189-197 DUCKWORTH STREET
CITY OF BARRIE

DRAWING:

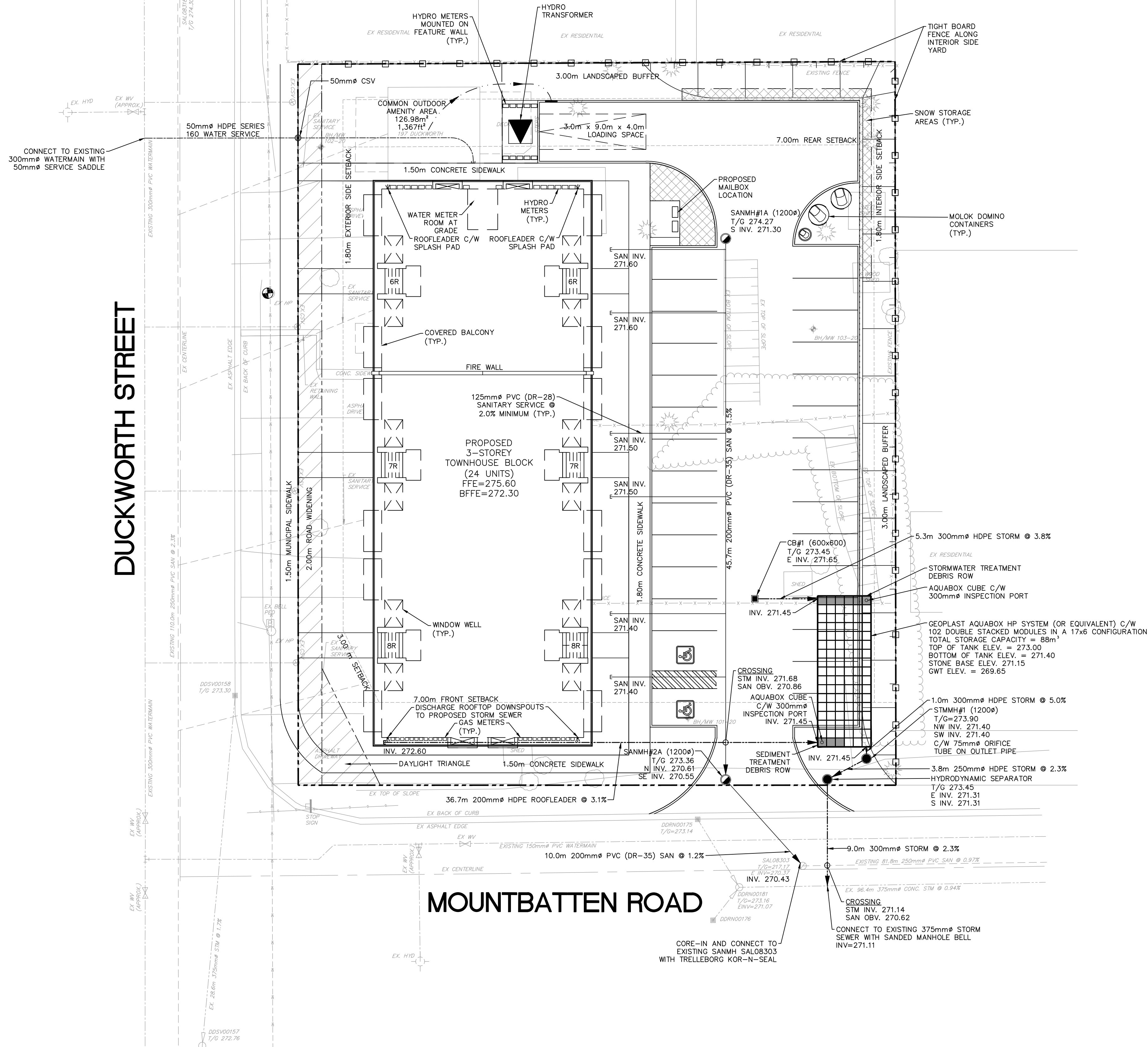
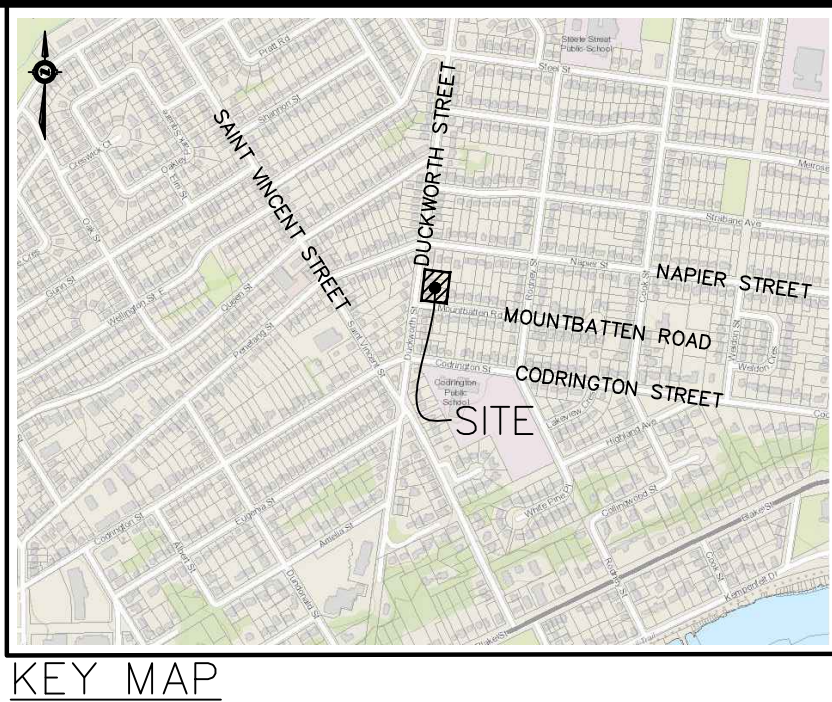
EXISTING CONDITIONS PLAN

PROJECT No. :

20-11545B

DRAWING No.

EX-1



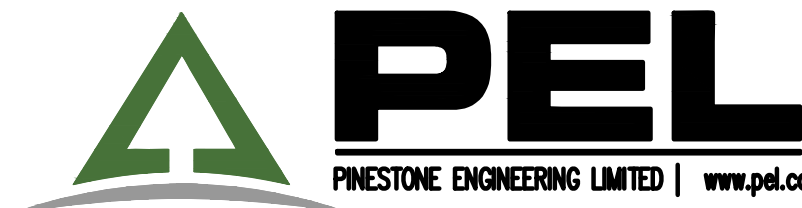
- NOTES**
1. TOPOGRAPHIC SURVEY COMPLETED BY JOETOPO, OCTOBER 2020. ELEVATIONS ARE GEODETIC IN NAD 83 CSRS DATUM
 2. SITE PLAN PROVIDED BY CARICARI LEE ARCHITECTS.
 3. LEGAL INFORMATION PROVIDED BY KRCMAR SURVEYORS LTD.

- LEGEND**
- SITE BOUNDARY
 - LEGAL BOUNDARY
 - IRON BAR
 - EX. STORM MH
 - EX. STORM CB/DCB
 - EX. SANITARY MH
 - ⊕ EX. FIRE HYDRANT
 - ⊕ EX. WATER VALVE
 - EX. WATERMAIN
 - EX. STORM SEWER
 - EX. SANITARY SEWER
 - ⊕ PROP. VALVE AND BOX
 - ⊕ PROP. CURB STOP VALVE
 - PROP. WATERMAIN
 - PROP. STORM SEWER
 - PROP. STMH
 - PROP. CBMH
 - PROP. CATCHBASIN
 - PROP. SANITARY SEWER
 - PROP. SANITARY MANHOLE
 - EXISTING TREE LINE
 - ⊕ EX. HYDRO POLE
 - ⊕ B.H.#1 BOREHOLE/MONITORING WELL LOCATION

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BENCHMARK

● TBM#1 NAIL IN HYDRO POLE ON EAST SIDE OF DUCKWORTH STREET IN FRONT OF HOUSE #195
ELEVATION 274.71

SEAL

DRAWN BY:
C.A.

DESIGNED BY:
D.H.

SCALE:
1:200

CHECKED BY:
J.V.

DATE:
OCT. 2023

NO.	YY.MM.DD	REVISION	BY

NORTH ARROW



PROJECT: **PROPOSED STACKED TOWNHOUSE DEVELOPMENT**
189-197 DUCKWORTH STREET
CITY OF BARRIE

DRAWING: **CONCEPTUAL SERVICING PLAN**

PROJECT No. :
20-11545B

DRAWING No.

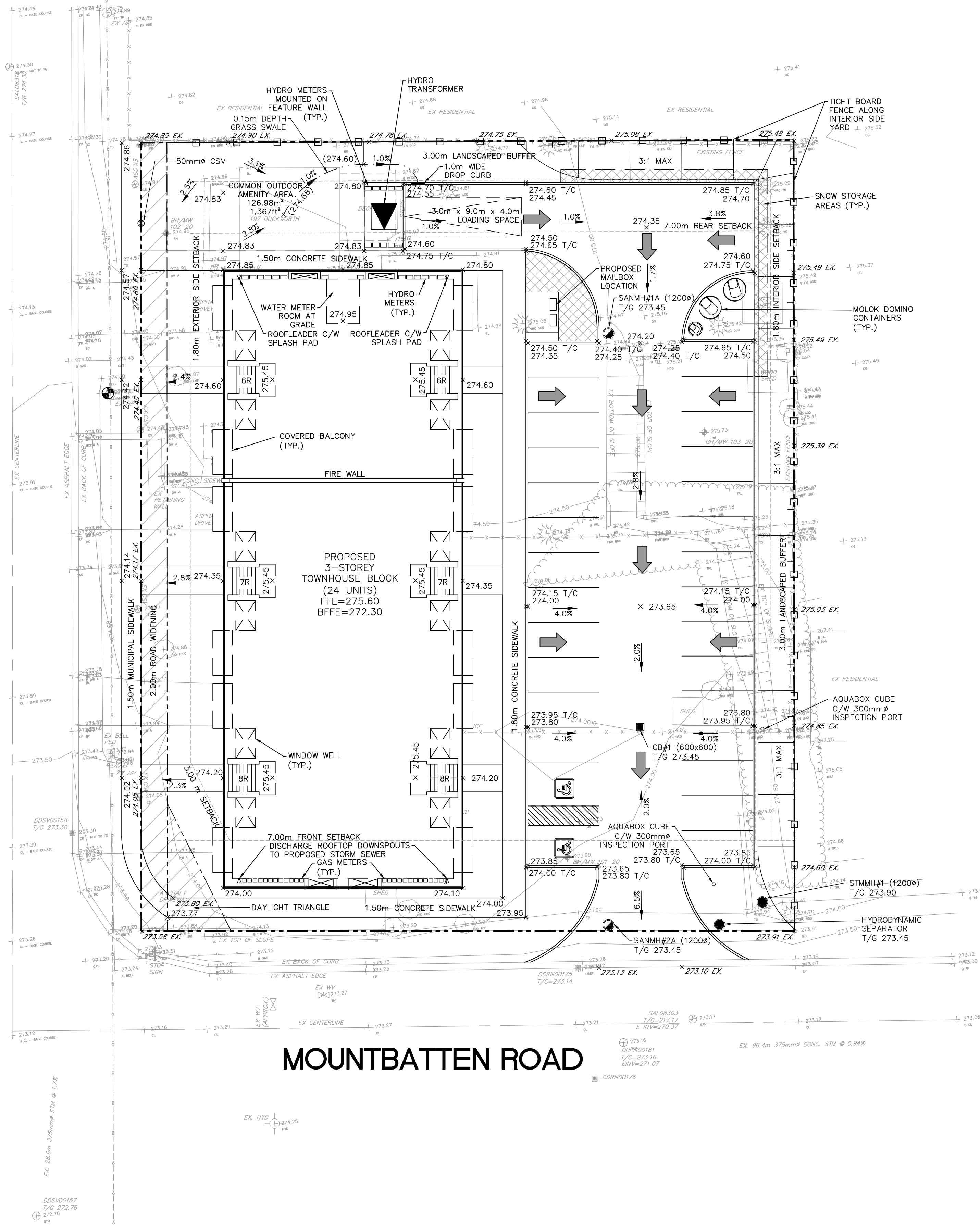
SERV-1

DUCKWORTH STREET

MOUNTBATTEN ROAD



KEY MAP



NOTES

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3. LEGAL INFORMATION PROVIDED BY KRCMAR SURVEYORS LTD.

LEGEND

- SITE BOUNDARY
- LEGAL BOUNDARY
- IRON BAR
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING TREELINE
- EXISTING TREES: CONIFEROUS, DECIDUOUS
- EX. HYDRO POLE
- EX. STORM MH
- EX. STORM CB/DCB
- EX. SANITARY MH
- EX. FIRE HYDRANT
- EX. WATER VALVE
- PROP. VALVE AND BOX
- PROP. CURB STOP VALVE
- PROP. STMMH
- PROP. CBMH
- PROP. SANITARY MANHOLE
- OVERLAND FLOW ARROW
- PROPOSED ASPHALT DRIVEWAY
- PROPOSED PERMEABLE PAVEMENT AREA
- × 273.05 EX EXISTING GRADE
- × 273.50 PROPOSED GRADE
- × T/C 274.80 PROPOSED TOP OF CURB GRADE
- × (273.85) PROPOSED SWALE GRADE
- PROPOSED FENCE
- BOREHOLE/MONITORING WELL LOCATION

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SEAL

DRAWN BY:

C.A.

DESIGNED BY:

D.H.

SCALE:

1: 200

CHECKED BY:

J.V.

DATE:

OCT. 2023

NO.

YY.MM.DD

REVISION

BY

NORTH ARROW



PROJECT:

PROPOSED STACKED TOWNHOUSE DEVELOPMENT
189-197 DUCKWORTH STREET
CITY OF BARRIE

DRAWING:

CONCEPTUAL GRADING PLAN

PROJECT No. :

20-11545B

DRAWING No.

GP-1