S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing and Stormwater Management Report

769 - 783 BRANT STREET, 2023 - 2033 Ghent Avenue

(PHASE 2 OF 3)

PROPOSED MIX-USE BUILDING

CITY OF BURLINGTON

JUNE 2021

SLA File: 20062

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by Molinaro Group to provide consulting engineering services for the proposed development located at the NW, NE and SE corners of the intersection at Brant Street and Ghent Avenue in the City of Burlington. This report will outline the functional servicing strategy for Phase 1 of the proposed development (see Figure 1.0 for location plan).

The proposed Phase 1 development consists of constructing a mix use building including a 25-storey mix-use building, with a total of 328 residential units and 492m^2 of commercial area. The proposed site will also include 2 levels of underground parking, concrete curbing/sidewalk, asphalt drive aisle and landscaped areas.

This Functional Servicing Report will provide detailed information of the proposed servicing scheme for Phase 2 of this development. Please refer to the site engineering plans prepared by S. Llewellyn and Associates Limited and the site plan prepared by Graziani and Corazza Architects Inc. for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)

Ref. 2: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

Ref. 3: Low Impact Development Stormwater Management Planning and Design Guide (Toronto and Region Conservation Authority & Credit Valley Conservation, 2010)

Ref. 4: Water and Wastewater Linear Design Manual (Regional Municipality of Halton, October 2019)

Ref. 5: Hydrogeological Investigation (Landtek Limited, May 2020)

Ref.6: Stormwater Management Design Guidelines (City of Burlington, May 2021)



Figure 1.0 - Location Plan

2.0 HYDROGEOLOGICAL INVESTIGATION

A hydrogeological investigation was prepared by Landtek Limited dated May 25, 2021. Four (4) boreholes were drilled at the site between August 31 and September 2, 2020 to approximate depths ranging between 7.3 and 12.1m below grade. Asphalt and topsoil were encountered overlain fill ranging in thickness of 1.5 to 3.0m below grade. Native soils of clayey silt till were encountered within all boreholes ranging in thickness of 1.0 to 2.0m underlaying the fill soils. Shale bedrock was encountered in all four boreholes at depths ranging from 3.5 to 4.0m below grade.

Groundwater was encountered at depths between 1.63 and 2.34m below grade (elevations of 90.11 to 89.40m). Temporary construction dewatering will be required and the dewatering flow outside periods of active precipitation is approximately 153,054 l/day (1.8 l/s) (FS 1.3) which is less than the 5-year allowable discharge rate of 136 l/s to Ghent Avenue (see Table 3.2 of this report). A permit to take water (PTTW) is required for this volume of water taking, as the estimated discharge rate is more than 50,000 l/day. Long-term dewatering will not be required for the site, as the developer has proposed to waterproof the below grade structure to prevent inflow of groundwater into the subsurface parking structures and foundation.

The groundwater quality was analysed and found that the levels of total phosphorus, total suspended solids, total manganese and total zinc exceed the City of Burlington Municipal Storm Sewer Discharge Limits Guidelines. Based on these results, pre-treatment of the groundwater will be required prior to discharging to the storm sewer system during temporary dewatering at the construction stage.

Groundwater levels are continued to being monitored to determine the seasonal high groundwater level and the report will be updated upon completion of the groundwater monitoring program. For additional information, refer to the Hydrogeological Investigation in Appendix D.

3.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, through pre-consultation comments (dated June 17, 2020) from the City of Burlington, Halton Region and Conservation Halton staff:

Quantity Control

The post-development stormwater discharge rate shall be controlled to the 5-year pre-development discharge rate from site for all storm events (2 to 100-year and Regional storm events). The overland flow route is to flow to Brant Street.

Quality Control

The stormwater runoff from the proposed site must meet Level 1 (Enhanced) stormwater quality control (80% TSS removal, 90% average annual runoff treatment).

Water Balance

It is recommended to retain/infiltrate the first 5mm on site.

Erosion Control

Erosion and sediment control measures will be implemented in accordance with the standards of the City of Burlington.

3.1 EXISTING CONDITIONS

In the existing conditions, the approximate 0.53ha site consists of an asphalt parking lot and two commercial houses. The site is bound by Ghent Avenue to the southeast, Brant Street to the south west, existing residential lands to the northeast, and existing commercial lands to the northwest. There existing a 1500mmø storm sewer on Brant Street adjacent to the property, at 0.25% flowing southeast and a 525mmø storm sewer on Ghent Avenue adjacent to the property, at 0.35% flowing southwest.

The topography of the existing site generally slopes from northwest to southeast with the majority of the site being collected by on-site catchbasins which ultimately outlet to the storm sewer on Ghent Avenue. The remaining site area sheet drains to Brant Street where it is collected by existing catchbasins within the right-of-way.

Three (3) catchment areas, Catchment 101, 102 and 103, have been identified in the existing condition. See Table 3.1 and the Pre-Development Storm Drainage Area Plan in Appendix A for details.

Catchment 101 represents the existing conditions discharge from the subject site draining towards the existing 5250mmø storm sewer on Ghent Avenue.

Catchment 102 represents the existing conditions discharge from the subject site draining towards the existing 1500mmø storm sewer on Brant Street.

Catchment 103 represents the external drainage from the residential lands north of the site, which ultimately discharge to Ghent Avenue.

Table 3.1 – Existing Conditions Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Runoff Coefficient (C)
101	Drainage from subject lands to Ghent Avenue	0.61	70	0.71
102	Drainage from subject lands to Brant Street	0.06	64	0.67
103	External drainage from the north residential lands to Ghent Avenue	0.02	0	0.25
	Total	**0.69**	**67**	**0.69**

An analysis was performed on Catchments 101, 102 and 103 using the SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2 to 100-year City of Burlington 6-hour Chicago and Regional (Hurricane Hazel) Design Storms. A summary of the results can be found in Table 3.2 and the detailed SWMHYMO input/output information in Appendix A.

Table 3.2 – Allowable Discharge from Site

Storm Event	Discharge to Brant Street (m^3/s)	Discharge to Ghent Avenue (m^3/s)
2-year	0.009	0.100
5-year	**0.012**	**0.135**
10-year	0.015	0.160
25-year	0.018	0.191
50-year	0.020	0.214
100-year	0.022	0.237
Regional	0.009	0.091

[1] Discharge to Ghent Avenue = Discharge from Catchment 101 + Discharge from Catchment 103

3.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a 25-storey mix-use building containing a total of 328 residential units, 492m^2 of commercial area and 2 levels of underground parking. The proposed site will also include concrete curbing/sidewalk, asphalt parking lot and drive aisle, and landscaped areas. It is proposed to service the site with a private storm sewer system designed and constructed in accordance with the standards and specifications of the City of Burlington, directing all captured stormwater runoff to the 525mmø storm sewer located within Ghent Avenue. Allocating all stormwater runoff to this location will limit the number of quantity and quality control facilities to one location.

Four (4) catchment areas, Catchment 201, 202, 203 and 103, have been identified in the proposed condition. Refer to Table 3.3 below and the Proposed Condition Drainage Area Plan in Appendix A for details.

Catchment 201 represents the drainage area for the portion of the site which will be captured via on-site storm network and controlled by the proposed stormwater management tank which will ultimately discharge to the existing 525mmø storm sewer along Ghent Avenue.

Catchment 202 represents the drainage area for the portion of the site which will sheet drain uncontrolled to Ghent Avenue, ultimately discharging to the existing 525mmø storm sewer along Ghent Avenue.

Catchment 203 represents the drainage area for the portion of the site which will sheet drain uncontrolled to Brant Street, ultimately discharging to the existing 1500mmø storm sewer along Brant Street.

Catchment 103 represents the external drainage from the residential lands north of the site, which ultimately discharge to Ghent Avenue.

Table 3.3 – Proposed Condition Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Run-off Coefficient (C)
201	Controlled drainage to Ghent Avenue	0.60	97	0.88
202	Uncontrolled drainage to Ghent Avenue	0.05	80	0.77
203	Uncontrolled drainage to Brant Street	0.02	99	0.89
103	External drainage from the north residential lands to Ghent Avenue	0.02	0	0.25
	Total	**0.69**	**93**	**0.85**

Water Quantity Control

It is proposed to apply quantity control measures to the runoff from Catchment 201 by means of an 200mmø orifice pipe installed between the SWM tank and MH1, to restrict discharge from the site to the 5-year pre-development allowable discharge rate.

With the installation of on-site quantity control measures for Catchment 201, it will be required to provide stormwater storage during storm events up to and including the 100-year event. To provide the required storage, a cast-in-place storage vault within the underground parking structure with approximately 160m^3 of storage will be provided.

The proposed storage vault will be designed with an upper and lower section. The upper section of the vault will drain via gravity through the orifice pipe to MH1. Once the upper vault storage volume is full, stormwater will spill over the weir, filling up the lower section of the vault which will be equipped with a pump capable of pumping 55.7 l/s. Once the water level drops below the weir elevation, stormwater will be pumped from the lower level of the tank to the upper level, where it will drain via gravity through the orifice pipe to MH1, until the lower level is empty.

Preliminary details of the proposed stormwater management tanks can be found on the Preliminary Grading and Servicing Plans. The stage-storage-discharge characteristics can be seen in Table 3.4 and Appendix A for details.

Table 3.4 – Proposed Condition Stage-Storage-Discharge

Elevation (m)	Storage (m^3)	Discharge (m^3/s)	Comments
90.15	0.0	0.0000	Bottom of Upper Section and Invert of 200mmø Orifice Pipe
90.50	17.5	0.0557	Top of Weir
87.90	17.5	0.0557	Bottom of Lower Section
88.45	45.0	0.0557	0.55m ponding
89.00	72.5	0.0557	1.10m ponding
89.55	100.0	0.0557	1.65m ponding
90.15	130.0	0.0557	Top of Lower Section
90.50	130.0	0.0557	Top of Weir
91.10	160.0	0.1026	Top of Tank

The maximum discharge rate for Catchment 201, 202, 203 and 103 were calculated using SWMHYMO hydrologic modelling program developed by J.F. Sabourin & Associates for the 2-year to 100-year City of Burlington 6-hour Chicago and Regional (Hurricane Hazel) Design Storms based on the post-development condition runoff coefficients. The proposed discharge rates and storage volumes are summarized in Tables 3.5 and 3.6, with details provided in Appendix A.

Table 3.5 – Proposed Condition Stormwater Discharge and Storage Volumes to Ghent Avenue

Storm Event	201 & 103 (Controlled) (m^3/s)[1]	202 (Uncontrolled) (m^3/s)[1]	Total Discharge (m^3/s)[1]	Allowable Discharge (m^3/s)[2]	Required Storage (m^3)[1]	Storage Provided (m^3)[3]
2-Year	0.056	0.009	0.065	0.135	52.45	160
5-Year	0.056	0.012	0.068		77.75	
10-Year	0.056	0.014	0.070		98.45	
25-Year	0.056	0.017	0.072		126.1	
50-Year	0.072	0.019	0.078		140.4	
100-Year	0.086	0.021	0.093		149.4	
Regional	0.065	0.007	0.071		136.1	

[1] Based on SWMHYMO Output. Refer to Appendix A for details.
[2] Refer to Table 3.2.
[3] Refer to Table 3.4.

Table 3.6 – Proposed Condition Stormwater Discharge to Ghent Avenue

Storm Event	203 (Uncontrolled) (m^3/s)[1]	Allowable Discharge (m^3/s)[2]
2-Year	0.004	0.012
5-Year	0.006	
10-Year	0.006	
25-Year	0.007	
50-Year	0.008	
100-Year	0.009	
Regional	0.003	

[1] Based on SWMHYMO Output. Refer to Appendix A for details.
[2] Refer to Table 3.2.

This analysis determined the following:

- The proposed condition discharge rates will not exceed the allowable 5-year pre-development flow rates from the site.
- Catchment 201 will require 149.4m^3 of stormwater storage during the 100-year event, which can be accommodated within the proposed storage tank, having a volume of 160m^3.

Water Quality Control

The proposed development is required to achieve an "Enhanced" (80% TSS removal) level of water quality protection. To achieve this criterion, discharge from Catchment 202 will be subject to a treatment train that consists of ADS FlexStorm Pure permanent inlet filters and a Hydrostorm oil/grit separator (or approved equivalent) before ultimately discharging to the existing 525mmø storm sewer within Ghent Avenue.

The Hydroworks sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a Hydrostorm HS8 unit will provide 84% TSS removal and 96% average annual runoff treatment. See the Hydrostorm unit sizing procedures in Appendix B for details.

The Hydrostorm unit (HS8) has been certified under the NJDEP for a 50% removal credit. As such, the HS8 has been designed to achieve an 'Enhanced' (80% TSS removal) level of stormwater quality control, but only credited for 50% TSS removal within the treatment train.

Based on similar products, the ADS FlexStorm Pure permanent inlet filters have been assigned a conservative TSS removal efficiency of 35%.

The treatment train mechanisms have been summarized in Table 3.7. In order to calculate the TSS removal from the proposed development, a cumulative weighted average has been taken.

Table 3.7 – Proposed Conditions Stormwater Treatment Train

Surface Type	Area (ha)	Treatment Train Features (%TSS Removal Rate)		Total TSS Removal [4]
Roof / Grass	0.43	N/A [1] (80%)	HydroStorm HS10 (50%) [3]	90%
Asphalt / Concrete	0.17	ADS FlexStorm Pure (35%) [2]		67.5%
Total Area	**0.60**	**Total Weighted %TSS Removal**		**84%**

[1] Roof surfaces are considered clean runoff which do not require quality treatment and have been assigned a TSS removal of 80%.
[2] The ADS FlexStorm Pure permanent inlet filters have been assigned a conservative TSS removal of 35% based on similar products.
[3] The HydroStorm unit has been designed to achieve 80% TSS removal. As per the standards of the NJDEP, the HydroStorm unit is credited with only 50% TSS removal.
[4] Total TSS removal calculated using the following formula: R=A+B-[(AxB)/100] where R=total TSS removal rate, A=TSS removal rate for first mechanism, B=TSS removal rate for second mechanism

As such, the weighted TSS removal from the proposed development reveals that the treatment train approach will provide 84% TSS removal and meet the 'Enhanced' (80% TSS removal, 90% average annual runoff treatment) level of water quality protection.

Hydrostorm units and ADS FlexStorm Pure filters require regular inspection and maintenance as per the manufacturer's specifications to ensure the unit operates properly. See the Hydrostorm and ADS FlexStorm Pure Maintenance Manuals in Appendix B for details.

Water Balance

The proposed development is recommended to retain or infiltrate the first 5mm of every rainfall on site. Due to the nature of the development having an underground parking garage which spans the majority of the site, retaining and infiltrating any amount of water is not feasible. This has been discussed in preliminary conversations with City of Burlington staff and will be confirmed at the detailed design stage.

3.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;
- Install sediment control (silt sacks) in the proposed area drains as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system; and
- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, outlets, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or his contractor shall be responsible for any costs incurred during the remediation of problem areas.

For details on the proposed erosion and sediment control for the proposed site, see the Preliminary Grading & Erosion Control Plan included in the engineering drawings.

3.4 FLOOD SPILL CONTROL

The City of Burlington will be completing a Phase 2 study intended to confirm the extent of the flood hazard within the site area and further discuss policy and mitigation measures in this area. Once this study is complete, the site will be reviewed to ensure all requirements with respect to the spill hazards are met.

4.0 SANITARY SEWER SERVICING

4.1 EXSTING CONDITIONS

The site is located at 769-783 Brant Street and 2032-2033 Ghent Avenue with an existing 250mmø sanitary sewer on Ghent Avenue flowing southwest and existing 300mmø and 450mmø sanitary sewers located along Brant Street, flowing southeast.

4.2 SANITARY DEMAND

The proposed development consists of a 25-storey mix-use building containing a total of 328 residential units and 492m^2 of retail floor area. Wastewater generation for the site was calculated based on the Ontario Building Code (OBC) and Tables 3-1 Residential Dry Weather Flow and 3-2 Commercial, Industrial, and Community Dry Weather Flow of the 2019 Regional Municipality of Halton Water and Wastewater Linear Design Manual.

Table 4.1 summarizes population and Table 4.2 summarizes the sanitary sewer discharge rates from the proposed site.

Table 4.1 – Proposed Population

Occupancy Type	No. of Beds [A]	Gross Floor Area (m^2) [A]	Population Density [B]	Population
Residential	493	---	2 per/bed	986
Commercial	---	492	3.7m^2/per	133
			Total Population [C]:	**1,119**

[A] Information from site plan prepared by Graziana & Corazza Architects Inc., dated May 14, 2021.
[B] Residential population density per OBC 3.1.17.1.1(b); commercial population density as per OBC Table 3.1.13.1 (5).
[C] Total population = Residential Population + Commercial Population

Table 4.2 – Proposed Sanitary Sewer Discharge

Site Area (ha)	Population [A]	Avg. Demand [B] (l/s)	Peak Factor [C]	Infiltration [D] (l/s)	Peak Flow [E] (l/s)
0.66	1,119	3.56	3.77	0.19	**13.42**

[A] From Table 3.1.
[B] Based on a unit sewage flow of 0.275m^{3}pcd (as per Table 3-1 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
[C] Based on the modified Harmon Formula (as per section 3.2.3 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
Peak Factor, $M = 1 + [14 / (4+P^{0.5})]$, where P is in thousands
[D] Based on an infiltration rate of 0.286 l/ha/s (as per Section 3.2.4 of the Regional Municipality of Halton Water and Wastewater Linear Design Manual).
[E] Peak Flow = (Avg. Demand x Peak Factor) + Infiltration

Based on the above, the estimate of sanitary demand for the townhouse development is:

13.42 L/s

4.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed mix-use building will be serviced by a 200mmø sanitary sewer, designed and constructed in accordance with the City of Burlington standards. Drainage from this sewer will discharge to the existing 250mmø sanitary sewer along Ghent Avenue.

The minimum grade of the proposed 200mmø sanitary sewer will be 1.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.033 m^3/s (33 l/s). Therefore, the proposed 200mmø sanitary sewer at 1.0% grade is adequately sized to service the proposed development.

5.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

5.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 150mmø watermain located on Ghent Avenue and existing 200mmø and 400mmø watermains located on Brant Street. Existing fire hydrants are located in front of 786 Brant Street and in front of 2047 Ghent Avenue.

5.2 DOMESTIC WATER DEMAND

The following is an estimate of the water usage for the proposed building. Water usage for the site was calculated based on the "Fixture Unit Method" as per Table 7.6.3.2.A. forming part of sentences 7.6.3.1(1) to (3) and 7.6.3.4.(2), (3) and (5) of the 2012 Ontario Building Code. See Table 5.1 for fixture unit (FU) calculations.

Table 5.1 – Domestic Water Demand

Component	No. of Fixtures	FU/ Fixture	Total FU
Lavatory (8.3L/min or less per head) (Private)[1,3]	463	0.7	324.1
Shower Head (9.5L/min or less per head) (Private)[1]	462	1.4	646.8
Water Closet (6 LPF or less with flush tank) (Private)[1,3]	463	2.2	1,018.6
Sink (kitchen, domestic, 8.3 L/min or less) (public)[2,3]	329	4	1,316.0
Dishwasher (domestic)[2,3]	329	1.4	460.6
Clothes Washer (3.5 kg) (private)[2]	328	1.4	359.2
Mop Sink[4]	2	3	6
		Total FU:	**4,131.3**
		Water Usage (l/s):	**33.8**

[1] Each 1-bedroom unit was assumed to have one full bathroom and each 2 and 3-bedroom unit was assumed to have two full bathrooms
[2] Each unit was assumed to have one kitchen with dishwasher and one washing machine
[3] The building was assumed to have one common room that includes a kitchen with dishwasher and a half bathroom
[4] The building was assumed to have one mop sink per parking level

Total peak water usage for the site was derived below from the fixture unit count as per Table 7.4.10.5 of the Ontario Building Code.

Total Fixture Unit Count = 4,131.3 FU

Water Usage: 446.2 IGPM (33.8 l/s)

5.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), the Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA). Since FUS criteria provides adjustments for sprinklered buildings (OBC does not), the FUS method was used to determine the fire flow demand for the proposed development.

The proposed development consists of constructing a 25-storey mix-use building containing a total of 328 residential units, 435m^2 of commercial area and 2 levels of underground parking. Existing hydrants are located at 786 Brant Street and 2047 Ghent Avenue. Both hydrants are within the required 90m separation to the building face (as per Sentence 3.2.5.7 of the Ontario Building Code).

Proposed building is fire-resistive construction (C=0.6), with limited combustible occupancy (-15% correction) and a fully supervised sprinkler system (-50% correction). Exposure components are based on the following:

North Face: 30.1 to 40m (5% correction)
South Face: 30.1 to 40m (5% correction)
East Face: 20.1 to 30m (10% correction)
West Face: 10.1 to 20m (15% correction)

It is estimated that the required fire flow for the proposed development will be **167 l/s**. See the Fire Flow Demand Requirements in Appendix C for details.

Hydrant flow tests were performed by Jackson Waterworks on the two municipal hydrants closest to the site to determine the performance of the existing water distribution system. The following hydrant flow test data has been analyzed to determine if the municipal system adjacent to the site is adequate to provide the required fire flow, with a minimum pressure of 20 psi. Table 5.2 summarizes the hydrant flow data provided by Jackson Waterworks.

Table 5.2 – Hydrant Flow Test Data

Hydrant ID	H20737
Location	786 Brant Street
Static Pressure	62 psi
Residual Pressure During Test Flow	57 psi
Test Flow Rate	2,014 USGPM (127.1 l/s)
Theoretical Flow @ 20 psi	**7,355 USGPM (464 l/s)**
Hydrant ID	H9419
Location	2047 Ghent Avenue
Static Pressure	60 psi
Residual Pressure During Test Flow	55 psi
Test Flow Rate	1,776 USGPM (112.0 l/s)
Theoretical Flow @ 20 psi	**5,737 USGPM (362 l/s)**

Based on the above hydrant flow test data, the theoretical maximum available flow rate from the hydrant is **362 l/s**, while the maximum required fire flow for the proposed development is only **167**

l/s. Therefore, the water distribution system has adequate pressure and capacity to service the subject site.

5.4 PROPOSED WATER SERVICING AND ANALYSIS

Proposed water servicing for the site consists of connecting a 150mmø water service off of the existing 150mmø watermain adjacent to the site on Ghent Avenue. The proposed 150mmø water service will provide domestic and fire water service for the proposed. Water services for the site are to be designed and constructed in accordance with City of Burlington standards.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development at 741 & 746 Brant Street can be constructed to meet the requirements of the City of Burlington and Region of Halton. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading & Erosion Control Plan and the Preliminary Site Servicing Plan prepared by S. Llewellyn & Associates Limited;
- A 200mmø orifice pipe be installed as per the Preliminary Site Servicing Plan and this report to provide adequate quantity control;
- A two level underground storage vault, complete with pump system for lower level dewatering, be installed within the underground parking garage as per the Preliminary Site Servicing Plan and this report to provide effective stormwater storage during storm events;
- Erosion and sediment controls be installed as described in this report to meet City of Burlington requirements;
- HydroStorm HS8 oil/grit separator and ADS FlexStorm Pure permanent inlet filters be installed as per the Preliminary Site Servicing Plan and this report to provide efficient stormwater quality control;
- Short-term dewatering be addressed at a discharge rate of 1.8 l/s and be filtered prior to discharging to the existing storm sewer system as per this report; and
- The proposed sanitary and water servicing system be installed as per the Preliminary Site Servicing Plan and this report to adequately service the proposed development.

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

Prepared by:

S. LLEWELLYN & ASSOCIATES LIMITED

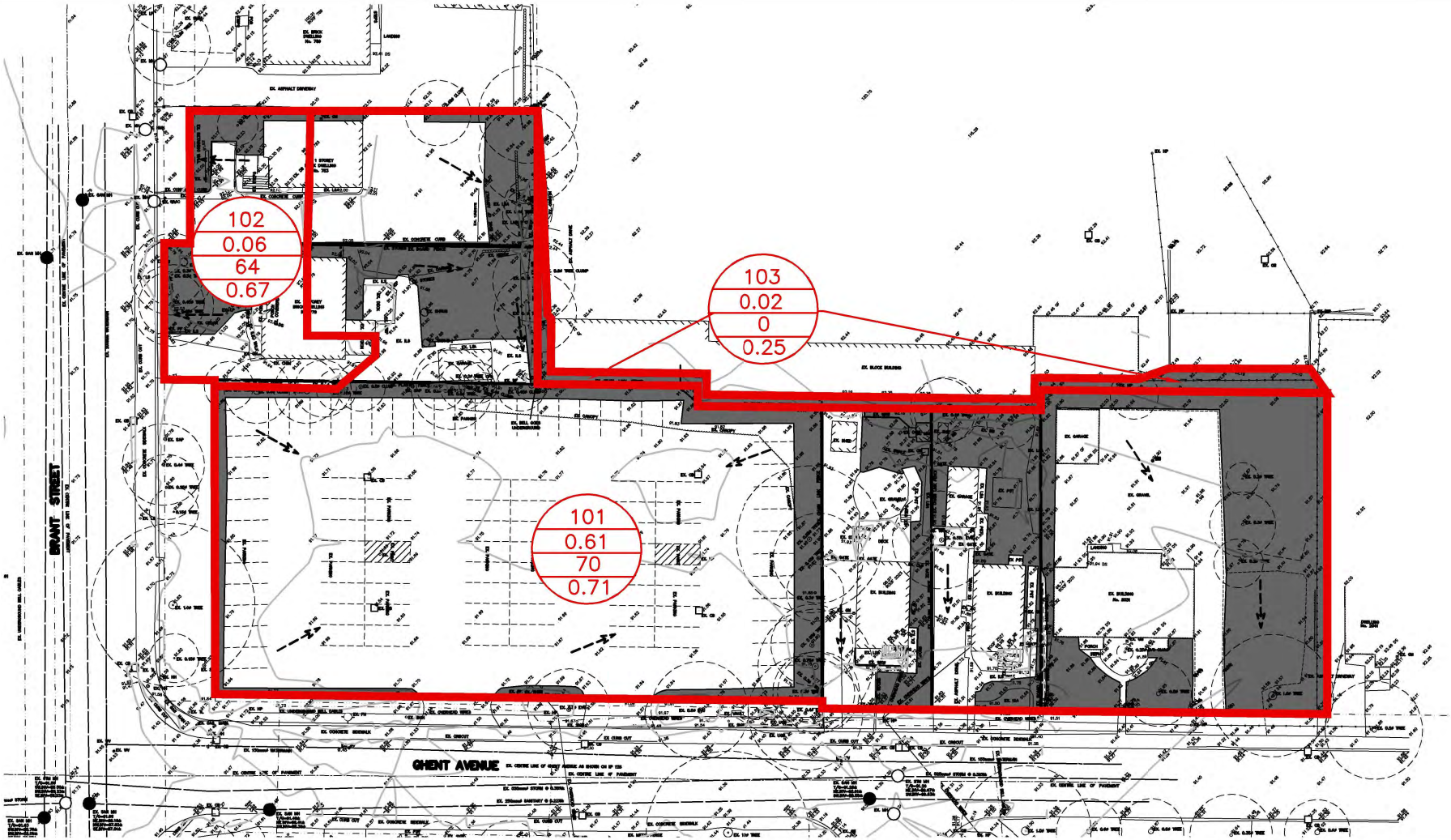


A. Porco, B.Eng.

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APPENDIX A

STORMWATER MANAGEMENT INFORMATION



LEGEND:

- CATCHMENT AREA BOUNDARY
- PERVIOUS AREA
- 101 / 0.018 / 100 / 0.90 — DRAINAGE AREA ID; DRAINAGE AREA (ha); PERCENT IMPERVIOUS; RUNOFF COEFFICIENT
- EXISTING DIRECTION OF DRAINAGE

FIGURE A1
PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:750

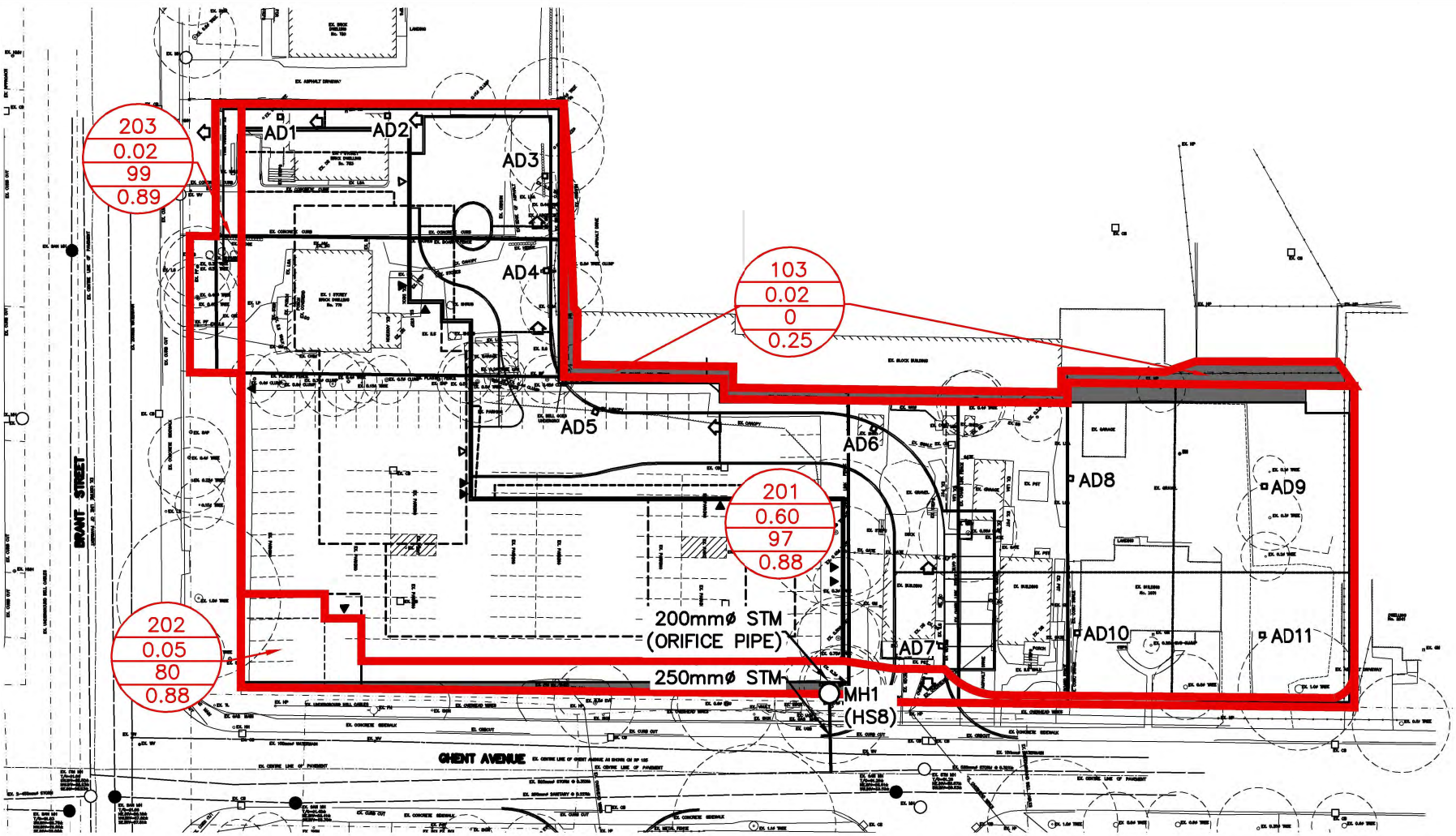
PROJECT: 769-783 BRANT STREET, 2023-2033 GHENT AVENUE BURLINGTON, ON
PROJECT No.: 20062

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Tel. (905) 631-6978
Website: www.sla.on.ca
email: info@sla.on.ca

3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

S:\20062\WORKING\CURRENT\20062 - DAPs.dwg
6/11/2021 4:03:00 PM - Alexandra Porco



LEGEND:

- CATCHMENT AREA BOUNDARY
- PERVIOUS AREA
- 101 / 0.04 / 25 / 0.41 — DRAINAGE AREA ID; DRAINAGE AREA (ha); PERCENT IMPERVIOUS; RUNOFF COEFFICIENT
- PROPOSED OVERLAND FLOW ROUTE

FIGURE A2
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:750

PROJECT: 769-783 BRANT STREET, 2023-2033 GHENT AVENUE BURLINGTON, ON
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3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

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6/11/2021 4:03:32 PM - Alexandra Porco

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

STAGE-STORAGE-DISCHARGE CALCULATIONS

Outlet Device No. 1 (Quantity)

Type:	Orifice Pipe
Diameter (mm)	**200**
Area (m^2)	0.03142
Invert Elev. (m)	90.15
C/L Elev. (m)	90.25
Disch. Coeff. (C_d)	0.8
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

		SWM Tank Volumes				Outlet No. 1	
	Elevation m	Area m^2	Tank Incremental Volume	Cumulative Tank Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s
Bottom of Upper Section	90.15	50.0	0	0	0.0	0.000	0.0000
Top of Weir	90.50	50.0	17	17	17.5	0.250	0.0557
Bottom of Tank	87.90	50.0	0	17	17.5	0.000	0.0557
	88.45	50.0	27	45	45.0	0.000	0.0557
	89.00	50.0	27	72	72.5	0.000	0.0557
	89.55	50.0	27	100	100.0	0.000	0.0557
Top of Lower Section	90.15	50.0	30	130	130.0	0.000	0.0557
Top of Weir	90.50	50.0	0	130	130.0	0.250	0.0557
Top of Tank	91.10	50.0	30	160	160.0	0.850	0.1026

```
00001> 2     Metric units
00002> *#*************************************************************************|
00003> *#  Project Name: BRANT & GHENT (PHASE 2)
00004> *#               BURLINGTON, ONTARIO
00005> *#  JOB NUMBER  : 20062
00006> *#       Date   : JUNE 2021
00007> *#    Revised   :
00008> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00009> *#       File   : 20062B.DAT
00010> *#*************************************************************************|
00011> *
00012> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[002]
00013>                     BUR6_002.stm
00014> *
00015> READ STORM          STORM_FILENAME "STORM.001"
00016> *
00017> *#*************************************************************************|
00018> *#
00019> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00020> *#        ========================================================
00021> *#
00022> *#*************************************************************************|
00023> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
00024> *
00025> CALIB STANDHYD      ID=[1], NHYD=["101"], DT=[1](min), AREA=[0.61](ha),
00026>                     XIMP=[0.70], TIMP=[0.70], DWF=[0](cms), LOSS=[2],
00027>                     SCS curve number CN=[80],
00028>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
00029>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00030>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00031>                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
00032>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00033> *%-----------------|-------------------------------------------------------|
00034> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
00035> *
00036> CALIB STANDHYD      ID=[2], NHYD=["102"], DT=[1](min), AREA=[0.06](ha),
00037>                     XIMP=[0.64], TIMP=[0.64], DWF=[0](cms), LOSS=[2],
00038>                     SCS curve number CN=[80],
00039>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.5](%),
00040>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00041>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00042>                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
00043>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00044> *%-----------------|-------------------------------------------------------|
00045> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
00046> *
00047> CALIB NASHYD        ID=[3], NHYD=["103"], DT=[1]min, AREA=[0.02](ha),
00048>                     DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
00049>                     N=[3], TP=[0.04]hrs,
00050>                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
00051> *%-----------------|-------------------------------------------------------|
00052> *# ADD TOTAL EX. FLOWS TO GHENT
00053> ADD HYD             IDsum=[4], NHYD=["EX.GHENT"], IDs to add=[1,3]
00054> *%-----------------|-------------------------------------------------------|
00055> *# ADD TOTAL EX. FLOWS FROM STIE
00056> ADD HYD             IDsum=[10], NHYD=["EX.TOTAL"], IDs to add=[4,2]
00057> *%-----------------|-------------------------------------------------------|
00058> *#*************************************************************************|
00059> *#
00060> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00061> *#        ========================================================
00062> *#
00063> **#************************************************************************|
00064> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
00065> *
00066> CALIB STANDHYD      ID=[1], NHYD=["201"], DT=[1](min), AREA=[0.60](ha),
00067>                     XIMP=[0.97], TIMP=[0.97], DWF=[0](cms), LOSS=[2],
00068>                     SCS curve number CN=[80],
00069>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00070>                                          LGP=[10](m), MNP=[0.250], SCP=[0](min),
00071>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00072>                                          LGI=[20](m), MNI=[0.013], SCI=[0](min),
00073>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00074> *%-----------------|-------------------------------------------------------|
00075> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
00076> *
00077> CALIB NASHYD        ID=[2], NHYD=["103"], DT=[1]min, AREA=[0.02](ha),
00078>                     DWF=[0](cms),  CN/C=[80], IA=[6.35](mm),
00079>                     N=[3], TP=[0.04]hrs,
00080>                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
00081> *%-----------------|-------------------------------------------------------|
00082> *# ADD TOTAL FLOWS TO SWM TANK
00083> ADD HYD             IDsum=[3], NHYD=["PROP.GHENT"], IDs to add=[1,2]
00084> *%-----------------|-------------------------------------------------------|
00085> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
00086> *
00087> ROUTE RESERVOIR     IDout=[1],  NHYD=["201_CTL"],  IDin=[3],
00088>                     RDT=[1](min),
00089>                          TABLE of ( OUTFLOW-STORAGE ) values
00090>                                   (cms) - (ha-m)
00091>  0.0000     0.0000
00092>  0.0557     0.0018
00093>  0.0557     0.0018
00094>  0.0557     0.0045
00095>  0.0557     0.0073
00096>  0.0557     0.0100
00097>  0.0557     0.0130
00098>  0.0557     0.0130
00099>  0.1026     0.0160
00100>
00101>                                  -1  ,  -1    (max twenty pts)
00102>                     IDovf=[2], NHYDovf=["201_OVF"]
00103> *%-----------------|-------------------------------------------------------|
00104> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00105> *
00106> CALIB STANDHYD      ID=[3], NHYD=["202"], DT=[1](min), AREA=[0.05](ha),
00107>                     XIMP=[0.80], TIMP=[0.80], DWF=[0](cms), LOSS=[2],
00108>                     SCS curve number CN=[80],
00109>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00110>                                          LGP=[5](m), MNP=[0.250], SCP=[0](min),
00111>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[2.0](%),
00112>                                          LGI=[5](m), MNI=[0.013], SCI=[0](min),
00113>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00114> *%-----------------|-------------------------------------------------------|
00115> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
00116> *
00117> CALIB STANDHYD      ID=[4], NHYD=["203"], DT=[1](min), AREA=[0.02](ha),
00118>                     XIMP=[0.99], TIMP=[0.99], DWF=[0](cms), LOSS=[2],
00119>                     SCS curve number CN=[80],
00120>                     Pervious   surfaces: IAper=[6.35](mm), SLPP=[2.0](%),
00121>                                          LGP=[5](m), MNP=[0.250], SCP=[0](min),
00122>                     Impervious surfaces: IAimp=[1.0](mm), SLPI=[3.0](%),
00123>                                          LGI=[5](m), MNI=[0.013], SCI=[0](min),
00124>                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
00125> *%-----------------|-------------------------------------------------------|
00126> *# ADD TOTAL FLOWS TO GHENT
00127> ADD HYD             IDsum=[6], NHYD=["PROP.GHENT"], IDs to add=[1,2,3]
00128> *%-----------------|-------------------------------------------------------|
00129> *# ADD TOTAL FLOWS FROM SITE
00130> ADD HYD             IDsum=[7], NHYD=["SITE.P2"], IDs to add=[6,4]
00131> *%-----------------|-------------------------------------------------------|
00132> *# AREA CHECK
00133> ADD HYD             IDsum=[9], NHYD=["CHECK"], IDs to add=[10,7]
00134> *%-----------------|-------------------------------------------------------|
00135> **#************************************************************************|
00136> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00137> *
00138> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[005]
00139>                     BUR6_005.stm
00140> *
00141> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[010]
00142>                     BUR6_010.stm
00143> *
00144> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[025]
00145>                     BUR6_025.stm
00146> *
00147> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[050]
00148>                     BUR6_050.stm
00149> *
00150> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[100]
00151>                     BUR6_100.stm
00152> *
00153> START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[200]
00154>                     hazel.stm
00155> *
00156> *%-----------------|-------------------------------------------------------|
00157> FINISH
00158>
00159>
00160>
00161>
00162>
00163>
00164>
00165>
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00189>
```

```
00001> ================================================================================
00002>
00003>   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
00004>   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
00005>   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
00006>       S  W W  M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
00007>   SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9   =========
00008>                                                        9   9  9   9   # 3902680
00009>         StormWater Management HYdrologic Model          999    999    =========
00010>
00011>  ********************************************************************************
00012>  ************************** SWMHYMO Ver/4.05  ***************************
00013>  *********  A single event and continuous hydrologic simulation model  *********
00014>  *********     based on the principles of HYMO and its successors      *********
00015>  *********                  OTTHYMO-83 and OTTHYMO-89.                 *********
00016>  ********************************************************************************
00017>  ******** Distributed by:  J.F. Sabourin and Associates Inc.           *********
00018>  *********                  Ottawa,  Ontario: (613) 836-3884           *********
00019>  *********                  Gatineau, Quebec: (819) 243-6858           *********
00020>  *********                  E-Mail: swmhymo@jfsa.com                   *********
00021>  ********************************************************************************
00022>
00023>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00024>  +++++++++ Licensed user: S. Llewellyn & Associates Ltd                +++++++++
00025>  +++++++++                  Burlington          SERIAL#:3902680       +++++++++
00026>  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
00027>
00028>  ********************************************************************************
00029>  *********            ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *********
00030>  *********            Maximum value for ID numbers  :     10            *********
00031>  *********            Max. number of rainfall points: 105408            *********
00032>  *********            Max. number of flow points    : 105408            *********
00033>  ********************************************************************************
00034>
00035>
00036>  **********************   D E T A I L E D   O U T P U T   **********************
00037>  ********************************************************************************
00038>  *         DATE: 2021-06-03     TIME: 13:27:12     RUN COUNTER: 000103         *
00039>  ********************************************************************************
00040>  * Input   filename: T:\projects\20062\SWMHYMO\20062B.dat                       *
00041>  * Output  filename: T:\projects\20062\SWMHYMO\20062B.out                       *
00042>  * Summary filename: T:\projects\20062\SWMHYMO\20062B.sum                       *
00043>  * User comments:                                                              *
00044>  * 1:_____________________________________________________________________     *
00045>  * 2:_____________________________________________________________________     *
00046>  * 3:_____________________________________________________________________     *
00047>  ********************************************************************************
00048>
00049> --------------------------------------------------------------------------------
00050> 001:0001--------------------------------------------------------------------------
00051> *#*************************************************************************|
00052> *#  Project Name: BRANT & GHENT (PHASE 2)
00053> *#               BURLINGTON, ONTARIO
00054> *#  JOB NUMBER  : 20062
00055> *#       Date   : JUNE 2021
00056> *#    Revised   :
00057> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00058> *#       File   : 20062B.DAT
00059> *#*************************************************************************|
00060> *
00061>   ** END OF RUN :   1
00062>
00063> ********************************************************************************
00064>
00065>
00066>
00067>
00068>
00069> --------------------
00070> | START            |  Project  dir.: T:\projects\20062\SWMHYMO\
00071> --------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
00072>     TZERO =   .00 hrs on       0
00073>     METOUT=   2 (output = METRIC)
00074>     NRUN  = 002
00075>     NSTORM=   1
00076>           #  1=BUR6_002.stm
00077> --------------------------------------------------------------------------------
00078> 002:0002--------------------------------------------------------------------------
00079> *#*************************************************************************|
00080> *#  Project Name: BRANT & GHENT (PHASE 2)
00081> *#               BURLINGTON, ONTARIO
00082> *#  JOB NUMBER  : 20062
00083> *#       Date   : JUNE 2021
00084> *#    Revised   :
00085> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00086> *#       File   : 20062B.DAT
00087> *#*************************************************************************|
00088> *
00089> --------------------------------------------------------------------------------
00090> 002:0002--------------------------------------------------------------------------
00091> *
00092> --------------------
00093> | READ STORM       |    Filename: Burlington 2-yr 6hr CHICAGO  (A=681.52,
00094> | Ptotal=  40.93 mm|    Comments: Burlington 2-yr 6hr CHICAGO  (A=681.52,
00095> --------------------
00096>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00097>                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00098>                 .17   1.715 |   1.67   8.325 |   3.17   4.467 |   4.67   2.213
00099>                 .33   1.858 |   1.83  19.646 |   3.33   3.978 |   4.83   2.105
00100>                 .50   2.032 |   2.00  78.391 |   3.50   3.595 |   5.00   2.008
00101>                 .67   2.247 |   2.17  25.776 |   3.67   3.286 |   5.17   1.920
00102>                 .83   2.522 |   2.33  13.777 |   3.83   3.030 |   5.33   1.841
00103>                1.00   2.888 |   2.50   9.511 |   4.00   2.815 |   5.50   1.769
00104>                1.17   3.399 |   2.67   7.331 |   4.17   2.632 |   5.67   1.703
00105>                1.33   4.172 |   2.83   6.005 |   4.33   2.474 |   5.83   1.642
00106>                1.50   5.492 |   3.00   5.111 |   4.50   2.335 |   6.00   1.586
00107>
00108> --------------------------------------------------------------------------------
00109> 002:0003--------------------------------------------------------------------------
00110> *
00111> *#*************************************************************************|
00112> *#
00113> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00114> *#        ============================================================
00115> *#
00116> *#*************************************************************************|
00117> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
00118> *
00119> ----------------------
00120> | CALIB STANDHYD     |   Area    (ha)=     .61
00121> | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
00122> ----------------------
00123>                                IMPERVIOUS    PERVIOUS (i)
00124>      Surface Area     (ha)=        .43          .18
00125>      Dep. Storage     (mm)=       1.00         6.35
00126>      Average Slope     (%)=       2.00         2.50
00127>      Length            (m)=      20.00        10.00
00128>      Mannings n            =       .013         .250
00129>
00130>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00131>                 over (min)        1.00         6.00
00132>      Storage Coeff.  (min)=        .87 (ii)    6.08 (ii)
00133>      Unit Hyd. Tpeak (min)=       1.00         6.00
00134>      Unit Hyd. peak  (cms)=       1.16          .19
00135>                                                          *TOTALS*
00136>      PEAK FLOW       (cms)=        .09          .01          .099 (iii)
00137>      TIME TO PEAK    (hrs)=       2.00         2.07         2.000
00138>      RUNOFF VOLUME    (mm)=      39.93        12.19        31.611
00139>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00140>      RUNOFF COEFFICIENT   =        .98          .30          .772
00141>
00142>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00143>            CN* =  80.0    Ia = Dep. Storage  (Above)
00144>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00145>              THAN THE STORAGE COEFFICIENT.
00146>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00147>
00148> --------------------------------------------------------------------------------
00149> 002:0004--------------------------------------------------------------------------
00150> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
00151> *
00152> ----------------------
00153> | CALIB STANDHYD     |   Area    (ha)=     .06
00154> | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
00155> ----------------------
00156>                                IMPERVIOUS    PERVIOUS (i)
00157>      Surface Area     (ha)=        .04          .02
00158>      Dep. Storage     (mm)=       1.00         6.35
00159>      Average Slope     (%)=       2.00         2.50
00160>      Length            (m)=      20.00        10.00
00161>      Mannings n            =       .013         .250
00162>
00163>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00164>                 over (min)        1.00         6.00
00165>      Storage Coeff.  (min)=        .87 (ii)    6.08 (ii)
00166>      Unit Hyd. Tpeak (min)=       1.00         6.00
00167>      Unit Hyd. peak  (cms)=       1.16          .19
00168>                                                          *TOTALS*
00169>      PEAK FLOW       (cms)=        .01          .00          .009 (iii)
00170>      TIME TO PEAK    (hrs)=       2.00         2.07         2.000
00171>      RUNOFF VOLUME    (mm)=      39.93        12.19        29.946
00172>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00173>      RUNOFF COEFFICIENT   =        .98          .30          .732
00174>
00175>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00176>            CN* =  80.0    Ia = Dep. Storage  (Above)
00177>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00178>              THAN THE STORAGE COEFFICIENT.
00179>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00180>
00181> --------------------------------------------------------------------------------
00182> 002:0005--------------------------------------------------------------------------
00183> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
00184> *
00185> ----------------------
00186> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
00187> | 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00188> ----------------------   U.H. Tp(hrs)=    .040
00189>
00190>      Unit Hyd Qpeak  (cms)=     .019
00191>
00192>      PEAK FLOW       (cms)=     .001 (i)
00193>      TIME TO PEAK    (hrs)=    2.000
00194>      RUNOFF VOLUME    (mm)=   12.188
00195>      TOTAL RAINFALL   (mm)=   40.933
00196>      RUNOFF COEFFICIENT   =     .298
00197>
00198>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00199>
00200> --------------------------------------------------------------------------------
00201> 002:0006--------------------------------------------------------------------------
00202> *# ADD TOTAL EX. FLOWS TO GHENT
00203> ------------------------
00204> | ADD HYD (EX.GHENT  ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
00205> ------------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
00206>                        ID1 01:101          .61     .099    2.00  31.61    .000
00207>                       +ID2 03:103          .02     .001    2.00  12.19    .000
00208>                        ========================================================
00209>                        SUM 04:EX.GHENT      .63     .100    2.00  30.99    .000
00210>
00211>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00212>
00213> --------------------------------------------------------------------------------
00214> 002:0007--------------------------------------------------------------------------
00215> *# ADD TOTAL EX. FLOWS FROM STIE
00216> ------------------------
00217> | ADD HYD (EX.TOTAL  ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
00218> ------------------------                   (ha)     (cms)   (hrs)   (mm)    (cms)
00219>                        ID1 04:EX.GHENT      .63     .100    2.00  30.99    .000
00220>                       +ID2 02:102          .06     .009    2.00  29.95    .000
00221>                        ========================================================
00222>                        SUM 10:EX.TOTAL      .69     .109    2.00  30.90    .000
00223>
00224>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00225>
00226> --------------------------------------------------------------------------------
00227> 002:0008--------------------------------------------------------------------------
00228> *#*************************************************************************|
00229> *#
00230> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00231> *#        ========================================================
00232> *#
00233> **#*************************************************************************|
00234> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
00235> *
00236> ----------------------
00237> | CALIB STANDHYD     |   Area    (ha)=     .60
00238> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
00239> ----------------------
00240>                                IMPERVIOUS    PERVIOUS (i)
00241>      Surface Area     (ha)=        .58          .02
00242>      Dep. Storage     (mm)=       1.00         6.35
00243>      Average Slope     (%)=       2.00         2.00
00244>      Length            (m)=      20.00        10.00
00245>      Mannings n            =       .013         .250
00246>
00247>      Max.eff.Inten.(mm/hr)=      78.39        22.56
00248>                 over (min)        1.00         6.00
00249>      Storage Coeff.  (min)=        .87 (ii)    6.44 (ii)
00250>      Unit Hyd. Tpeak (min)=       1.00         6.00
00251>      Unit Hyd. peak  (cms)=       1.16          .18
00252>                                                          *TOTALS*
00253>      PEAK FLOW       (cms)=        .13          .00          .127 (iii)
00254>      TIME TO PEAK    (hrs)=       2.00         2.07         2.000
00255>      RUNOFF VOLUME    (mm)=      39.93        12.19        39.100
00256>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00257>      RUNOFF COEFFICIENT   =        .98          .30          .955
00258>
00259>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00260>            CN* =  80.0    Ia = Dep. Storage  (Above)
00261>         (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00262>              THAN THE STORAGE COEFFICIENT.
00263>        (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00264>
00265> --------------------------------------------------------------------------------
00266> 002:0009--------------------------------------------------------------------------
00267> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
00268> *
00269> ----------------------
00270> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
```

```
00271> | 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00272> ----------------------   U.H. Tp(hrs)=    .040
00273>
00274>      Unit Hyd Qpeak  (cms)=     .019
00275>
00276>      PEAK FLOW       (cms)=     .001 (i)
00277>      TIME TO PEAK    (hrs)=    2.000
00278>      RUNOFF VOLUME    (mm)=   12.188
00279>      TOTAL RAINFALL   (mm)=   40.933
00280>      RUNOFF COEFFICIENT   =     .298
00281>
00282>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00283>
00284> ---------------------------------------------------------------------------
00285> 002:0010-----------------------------------------------------------------
00286> *# ADD TOTAL FLOWS TO SWM TANK
00287> ------------------------
00288> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00289> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
00290>                      ID1 01:201            .60      .127    2.00  39.10    .000
00291>                     +ID2 02:103            .02      .001    2.00  12.19    .000
00292>                      ========================================================
00293>                      SUM 03:PROP.GHENT      .62      .129    2.00  38.23    .000
00294>
00295>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00296>
00297> ---------------------------------------------------------------------------
00298> 002:0011-----------------------------------------------------------------
00299> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
00300> *
00301> ----------------------
00302> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
00303> |  IN>03:(PROP.G)   |
00304> | OUT<01:(201_CT)   |    =========  OUTLFOW STORAGE TABLE  =========
00305> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
00306>                             (cms)    (ha.m.)   |    (cms)    (ha.m.)
00307>                              .000  .0000E+00    |     .056  .1000E-01
00308>                              .056  .1800E-02    |     .056  .1300E-01
00309>                              .056  .1800E-02    |     .056  .1300E-01
00310>                              .056  .4500E-02    |     .103  .1600E-01
00311>                              .056  .7300E-02    |     .000  .0000E+00
00312>
00313>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
00314>      ---------------------      (ha)     (cms)     (hrs)       (mm)
00315>      INFLOW >03: (PROP.G)        .62      .129     2.000     38.232
00316>      OUTFLOW<01: (201_CT)        .62      .056     1.883     38.232
00317>     OVERFLOW<02: (201_OV)        .00      .000      .000       .000
00318>
00319>                      TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
00320>                      CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
00321>                      PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
00322>
00323>
00324>                      PEAK   FLOW   REDUCTION [Qout/Qin](%)=   43.332
00325>                      TIME SHIFT OF PEAK FLOW         (min)=   -7.00
00326>                      MAXIMUM  STORAGE   USED       (ha.m.)=.5245E-02
00327>
00328> ---------------------------------------------------------------------------
00329> 002:0012-----------------------------------------------------------------
00330> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
00331> *
00332> ----------------------
00333> | CALIB STANDHYD     |   Area    (ha)=     .05
00334> | 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
00335> ----------------------
00336>                              IMPERVIOUS    PERVIOUS (i)
00337>      Surface Area     (ha)=        .04          .01
00338>      Dep. Storage     (mm)=       1.00         6.35
00339>      Average Slope     (%)=       2.00         2.00
00340>      Length            (m)=       5.00         5.00
00341>      Mannings n            =       .013         .250
00342>
00343>      Max.eff.Inten.(mm/hr)=     78.39        24.53
00344>                  over (min)        1.00         4.00
00345>      Storage Coeff.  (min)=        .38 (ii)    3.93 (ii)
00346>      Unit Hyd. Tpeak (min)=       1.00         4.00
00347>      Unit Hyd. peak  (cms)=       1.58          .29
00348>                                                          *TOTALS*
00349>      PEAK FLOW       (cms)=        .01          .00          .009 (iii)
00350>      TIME TO PEAK    (hrs)=       1.93         2.03         2.000
00351>      RUNOFF VOLUME    (mm)=      39.93        12.19        34.385
00352>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00353>      RUNOFF COEFFICIENT   =        .98          .30          .840
00354>
00355>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00356>            CN* =  80.0    Ia = Dep. Storage  (Above)
00357>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00358>            THAN THE STORAGE COEFFICIENT.
00359>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00360>
00361> ---------------------------------------------------------------------------
00362> 002:0013-----------------------------------------------------------------
00363> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
00364> *
00365> ----------------------
00366> | CALIB STANDHYD     |   Area    (ha)=     .02
00367> | 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
00368> ----------------------
00369>                              IMPERVIOUS    PERVIOUS (i)
00370>      Surface Area     (ha)=        .02          .00
00371>      Dep. Storage     (mm)=       1.00         6.35
00372>      Average Slope     (%)=       3.00         2.00
00373>      Length            (m)=       5.00         5.00
00374>      Mannings n            =       .013         .250
00375>
00376>      Max.eff.Inten.(mm/hr)=     78.39        24.53
00377>                  over (min)        1.00         4.00
00378>      Storage Coeff.  (min)=        .34 (ii)    3.89 (ii)
00379>      Unit Hyd. Tpeak (min)=       1.00         4.00
00380>      Unit Hyd. peak  (cms)=       1.61          .29
00381>                                                          *TOTALS*
00382>      PEAK FLOW       (cms)=        .00          .00          .004 (iii)
00383>      TIME TO PEAK    (hrs)=       1.92         2.03         2.000
00384>      RUNOFF VOLUME    (mm)=      39.93        12.19        39.655
00385>      TOTAL RAINFALL   (mm)=      40.93        40.93        40.933
00386>      RUNOFF COEFFICIENT   =        .98          .30          .969
00387>
00388>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00389>            CN* =  80.0    Ia = Dep. Storage  (Above)
00390>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00391>            THAN THE STORAGE COEFFICIENT.
00392>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00393>
00394> ---------------------------------------------------------------------------
00395> 002:0014-----------------------------------------------------------------
00396> *# ADD TOTAL FLOWS TO GHENT
00397> ------------------------
00398> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00399> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
00400>                      ID1 01:201_CTL         .62      .056    1.88  38.23    .000
00401>                     +ID2 02:201_OVF         .00      .000     .00    .00    .000
00402>                     +ID3 03:202             .05      .009    2.00  34.38    .000
00403>                      ========================================================
00404>                      SUM 06:PROP.GHENT      .67      .065    2.00  37.95    .000
00405>
00406>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00407>
00408> ---------------------------------------------------------------------------
00409> 002:0015-----------------------------------------------------------------
00410> *# ADD TOTAL FLOWS FROM SITE
00411> ------------------------
00412> | ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00413> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
00414>                      ID1 06:PROP.GHENT      .67      .065    2.00  37.95    .000
00415>                     +ID2 04:203             .02      .004    2.00  39.66    .000
00416>                      ========================================================
00417>                      SUM 07:SITE.P2         .69      .069    2.00  37.99    .000
00418>
00419>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00420>
00421> ---------------------------------------------------------------------------
00422> 002:0016-----------------------------------------------------------------
00423> *# AREA CHECK
00424> ------------------------
00425> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00426> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
00427>                      ID1 10:EX.TOTAL        .69      .109    2.00  30.90    .000
00428>                     +ID2 07:SITE.P2         .69      .069    2.00  37.99    .000
00429>                      ========================================================
00430>                      SUM 09:CHECK           1.38     .179    2.00  34.45    .000
00431>
00432>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00433>
00434> ---------------------------------------------------------------------------
00435> 002:0017-----------------------------------------------------------------
00436> **#*************************************************************************|
00437> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00438> *
00439>   ** END OF RUN :   4
00440>
00441> ***************************************************************************
00442>
00443>
00444>
00445>
00446>
00447> --------------------
00448> | START            |  Project  dir.: T:\projects\20062\SWMHYMO\
00449> --------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
00450>     TZERO =   .00 hrs on      0
00451>     METOUT=  2 (output = METRIC)
00452>     NRUN  = 005
00453>     NSTORM=  1
00454>              #  1=BUR6_005.stm
00455> ---------------------------------------------------------------------------
00456> 005:0002-----------------------------------------------------------------
00457> *#*************************************************************************|
00458> *#  Project Name: BRANT & GHENT (PHASE 2)
00459> *#               BURLINGTON, ONTARIO
00460> *#  JOB NUMBER  : 20062
00461> *#       Date   : JUNE 2021
00462> *#    Revised   :
00463> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00464> *#       File   : 20062B.DAT
00465> *#*************************************************************************|
00466> *
00467> ---------------------------------------------------------------------------
00468> 005:0002-----------------------------------------------------------------
00469> *
00470> --------------------
00471> | READ STORM       |    Filename: Burlington 5-yr 6hr CHICAGO    (A=802.04
00472> | Ptotal=  53.05 mm|    Comments: Burlington 5-yr 6hr CHICAGO    (A=802.04
00473> --------------------
00474>                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00475>                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
00476>                 .17   2.348 |   1.67  10.690 |   3.17   5.897 |   4.67   3.004
00477>                 .33   2.537 |   1.83  24.479 |   3.33   5.279 |   4.83   2.862
00478>                 .50   2.766 |   2.00 101.312 |   3.50   4.790 |   5.00   2.734
00479>                 .67   3.048 |   2.17  31.941 |   3.67   4.394 |   5.17   2.619
00480>                 .83   3.407 |   2.33  17.333 |   3.83   4.065 |   5.33   2.514
00481>                1.00   3.881 |   2.50  12.145 |   4.00   3.788 |   5.50   2.419
00482>                1.17   4.539 |   2.67   9.469 |   4.17   3.550 |   5.67   2.331
00483>                1.33   5.523 |   2.83   7.826 |   4.33   3.344 |   5.83   2.251
00484>                1.50   7.185 |   3.00   6.709 |   4.50   3.164 |   6.00   2.176
00485>
00486> ---------------------------------------------------------------------------
00487> 005:0003-----------------------------------------------------------------
00488> *
00489> *#*************************************************************************|
00490> *#
00491> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00492> *#        ======================================================
00493> *#
00494> *#*************************************************************************|
00495> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
00496> *
00497> ----------------------
00498> | CALIB STANDHYD     |   Area    (ha)=     .61
00499> | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
00500> ----------------------
00501>                              IMPERVIOUS    PERVIOUS (i)
00502>      Surface Area     (ha)=        .43          .18
00503>      Dep. Storage     (mm)=       1.00         6.35
00504>      Average Slope     (%)=       2.00         2.50
00505>      Length            (m)=      20.00        10.00
00506>      Mannings n            =       .013         .250
00507>
00508>      Max.eff.Inten.(mm/hr)=    101.31        39.72
00509>                  over (min)        1.00         5.00
00510>      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
00511>      Unit Hyd. Tpeak (min)=       1.00         5.00
00512>      Unit Hyd. peak  (cms)=       1.22          .23
00513>                                                          *TOTALS*
00514>      PEAK FLOW       (cms)=        .12          .01          .133 (iii)
00515>      TIME TO PEAK    (hrs)=       2.00         2.03         2.000
00516>      RUNOFF VOLUME    (mm)=      52.05        19.79        42.375
00517>      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
00518>      RUNOFF COEFFICIENT   =        .98          .37          .799
00519>
00520>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00521>            CN* =  80.0    Ia = Dep. Storage  (Above)
00522>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00523>            THAN THE STORAGE COEFFICIENT.
00524>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00525>
00526> ---------------------------------------------------------------------------
00527> 005:0004-----------------------------------------------------------------
00528> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
00529> *
00530> ----------------------
00531> | CALIB STANDHYD     |   Area    (ha)=     .06
00532> | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
00533> ----------------------
00534>                              IMPERVIOUS    PERVIOUS (i)
00535>      Surface Area     (ha)=        .04          .02
00536>      Dep. Storage     (mm)=       1.00         6.35
00537>      Average Slope     (%)=       2.00         2.50
00538>      Length            (m)=      20.00        10.00
00539>      Mannings n            =       .013         .250
00540>
```

```
      Max.eff.Inten.(mm/hr)=     101.31        39.72
                  over (min)        1.00         5.00
      Storage Coeff.  (min)=        .79 (ii)    4.94 (ii)
      Unit Hyd. Tpeak (min)=       1.00         5.00
      Unit Hyd. peak  (cms)=       1.22          .23
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .012 (iii)
      TIME TO PEAK    (hrs)=       1.98         2.03         2.000
      RUNOFF VOLUME    (mm)=      52.05        19.79        40.439
      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
      RUNOFF COEFFICIENT   =        .98          .37          .762

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

------------------------------------------------------------------------------
005:0005------------------------------------------------------------------------
*# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
| 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .040

      Unit Hyd Qpeak  (cms)=     .019

      PEAK FLOW       (cms)=     .002 (i)
      TIME TO PEAK    (hrs)=    2.000
      RUNOFF VOLUME    (mm)=   19.787
      TOTAL RAINFALL   (mm)=   53.053
      RUNOFF COEFFICIENT   =     .373

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

------------------------------------------------------------------------------
005:0006------------------------------------------------------------------------
*# ADD TOTAL EX. FLOWS TO GHENT
------------------------
| ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 01:101           .61     .133    2.00  42.37    .000
                     +ID2 03:103           .02     .002    2.00  19.79    .000
                      ========================================================
                      SUM 04:EX.GHENT       .63     .135    2.00  41.66    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
005:0007------------------------------------------------------------------------
*# ADD TOTAL EX. FLOWS FROM STIE
------------------------
| ADD HYD (EX.TOTAL  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 04:EX.GHENT       .63     .135    2.00  41.66    .000
                     +ID2 02:102            .06     .012    2.00  40.44    .000
                      ========================================================
                      SUM 10:EX.TOTAL       .69     .148    2.00  41.55    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
005:0008------------------------------------------------------------------------
*#*************************************************************************|
*#
*#       POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
*#       ========================================================
*#
**#************************************************************************|
*# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .60
| 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
----------------------

                           IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .58          .02
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       2.00         2.00
      Length            (m)=      20.00        10.00
      Mannings n           =       .013         .250

      Max.eff.Inten.(mm/hr)=     101.31        39.72
                  over (min)        1.00         5.00
      Storage Coeff.  (min)=        .79 (ii)    5.23 (ii)
      Unit Hyd. Tpeak (min)=       1.00         5.00
      Unit Hyd. peak  (cms)=       1.22          .22
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .16          .00          .165 (iii)
      TIME TO PEAK    (hrs)=       2.00         2.05         2.000
      RUNOFF VOLUME    (mm)=      52.05        19.79        51.085
      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
      RUNOFF COEFFICIENT   =        .98          .37          .963

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

------------------------------------------------------------------------------
005:0009------------------------------------------------------------------------
*# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
| 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .040

      Unit Hyd Qpeak  (cms)=     .019

      PEAK FLOW       (cms)=     .002 (i)
      TIME TO PEAK    (hrs)=    2.000
      RUNOFF VOLUME    (mm)=   19.787
      TOTAL RAINFALL   (mm)=   53.053
      RUNOFF COEFFICIENT   =     .373

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

------------------------------------------------------------------------------
005:0010------------------------------------------------------------------------
*# ADD TOTAL FLOWS TO SWM TANK
------------------------
| ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 01:201           .60     .165    2.00  51.09    .000
                     +ID2 02:103           .02     .002    2.00  19.79    .000
                      ========================================================
                      SUM 03:PROP.GHENT     .62     .167    2.00  50.08    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
005:0011------------------------------------------------------------------------
*# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
*
----------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>03:(PROP.G)    |
| OUT<01:(201_CT)    |    =========  OUTFLOW STORAGE TABLE  =========
----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)     (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00    |     .056  .1000E-01
                             .056  .1800E-02    |     .056  .1300E-01
                             .056  .1800E-02    |     .056  .1300E-01
                             .056  .4500E-02    |     .103  .1600E-01
                             .056  .7300E-02    |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------            (ha)     (cms)     (hrs)       (mm)
     INFLOW >03: (PROP.G)        .62      .167     2.000     50.076
     OUTFLOW<01: (201_CT)        .62      .056     1.867     50.076
    OVERFLOW<02: (201_OV)        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=   33.324
                  TIME SHIFT OF PEAK FLOW          (min)=    -8.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.7775E-02

------------------------------------------------------------------------------
005:0012------------------------------------------------------------------------
*# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .05
| 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------

                           IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .04          .01
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       2.00         2.00
      Length            (m)=       5.00         5.00
      Mannings n           =       .013         .250

      Max.eff.Inten.(mm/hr)=     101.31        42.29
                  over (min)        1.00         3.00
      Storage Coeff.  (min)=        .34 (ii)    3.20 (ii)
      Unit Hyd. Tpeak (min)=       1.00         3.00
      Unit Hyd. peak  (cms)=       1.61          .36
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .012 (iii)
      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
      RUNOFF VOLUME    (mm)=      52.05        19.79        45.601
      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
      RUNOFF COEFFICIENT   =        .98          .37          .860

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

------------------------------------------------------------------------------
005:0013------------------------------------------------------------------------
*# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------

                           IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .02          .00
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       3.00         2.00
      Length            (m)=       5.00         5.00
      Mannings n           =       .013         .250

      Max.eff.Inten.(mm/hr)=     101.31        42.29
                  over (min)        1.00         3.00
      Storage Coeff.  (min)=        .30 (ii)    3.16 (ii)
      Unit Hyd. Tpeak (min)=       1.00         3.00
      Unit Hyd. peak  (cms)=       1.64          .37
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .006 (iii)
      TIME TO PEAK    (hrs)=       1.90         2.02         2.000
      RUNOFF VOLUME    (mm)=      52.05        19.79        51.730
      TOTAL RAINFALL   (mm)=      53.05        53.05        53.053
      RUNOFF COEFFICIENT   =        .98          .37          .975

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

------------------------------------------------------------------------------
005:0014------------------------------------------------------------------------
*# ADD TOTAL FLOWS TO GHENT
------------------------
| ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 01:201_CTL        .62      .056    1.87  50.08    .000
                     +ID2 02:201_OVF        .00      .000     .00    .00    .000
                     +ID3 03:202            .05      .012    2.00  45.60    .000
                      ========================================================
                      SUM 06:PROP.GHENT     .67     .068    2.00  49.74    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
005:0015------------------------------------------------------------------------
*# ADD TOTAL FLOWS FROM SITE
------------------------
| ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 06:PROP.GHENT     .67     .068    2.00  49.74    .000
                     +ID2 04:203            .02     .006    2.00  51.73    .000
                      ========================================================
                      SUM 07:SITE.P2        .69     .073    2.00  49.80    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

------------------------------------------------------------------------------
005:0016------------------------------------------------------------------------
*# AREA CHECK
------------------------
| ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
                      ID1 10:EX.TOTAL       .69     .148    2.00  41.55    .000
                     +ID2 07:SITE.P2        .69     .073    2.00  49.80    .000
                      ========================================================
                      SUM 09:CHECK          1.38     .221    2.00  45.68    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
00811>
00812> ---------------------------------------------------------------------------
00813> 005:0017-----------------------------------------------------------------
00814> **#*************************************************************************|
00815> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
00816> *
00817> ---------------------------------------------------------------------------
00818> 005:0002-----------------------------------------------------------------
00819> *
00820>   ** END OF RUN :   9
00821>
00822> ***************************************************************************
00823>
00824>
00825>
00826>
00827>
00828> --------------------
00829> | START            |  Project  dir.: T:\projects\20062\SWMHYMO\
00830> --------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
00831>     TZERO =   .00 hrs on       0
00832>     METOUT=  2 (output = METRIC)
00833>     NRUN  = 010
00834>     NSTORM=   1
00835>                #  1=BUR6_010.stm
00836> ---------------------------------------------------------------------------
00837> 010:0002-----------------------------------------------------------------
00838> *#*************************************************************************|
00839> *#  Project Name: BRANT & GHENT (PHASE 2)
00840> *#               BURLINGTON, ONTARIO
00841> *#  JOB NUMBER  : 20062
00842> *#       Date   : JUNE 2021
00843> *#    Revised   :
00844> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
00845> *#       File   : 20062B.DAT
00846> *#*************************************************************************|
00847> *
00848> ---------------------------------------------------------------------------
00849> 010:0002-----------------------------------------------------------------
00850> *
00851> --------------------
00852> | READ STORM       |    Filename: Burlington 10-yr 6hr CHICAGO     (A=918.
00853> | Ptotal=  61.10 mm|    Comments: Burlington 10-yr 6hr CHICAGO     (A=918.
00854> --------------------
00855>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
00856>               hrs   mm/hr  |   hrs   mm/hr  |   hrs   mm/hr  |   hrs   mm/hr
00857>                .17   2.714 |   1.67  12.326 |   3.17   6.808 |   4.67   3.472
00858>                .33   2.933 |   1.83  28.176 |   3.33   6.095 |   4.83   3.308
00859>                .50   3.197 |   2.00 116.310 |   3.50   5.532 |   5.00   3.161
00860>                .67   3.523 |   2.17  36.748 |   3.67   5.075 |   5.17   3.027
00861>                .83   3.937 |   2.33  19.967 |   3.83   4.696 |   5.33   2.907
00862>               1.00   4.483 |   2.50  14.001 |   4.00   4.376 |   5.50   2.796
00863>               1.17   5.242 |   2.67  10.921 |   4.17   4.102 |   5.67   2.695
00864>               1.33   6.377 |   2.83   9.030 |   4.33   3.864 |   5.83   2.602
00865>               1.50   8.291 |   3.00   7.743 |   4.50   3.656 |   6.00   2.516
00866>
00867> ---------------------------------------------------------------------------
00868> 010:0003-----------------------------------------------------------------
00869> *
00870> *#*************************************************************************|
00871> *#
00872> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00873> *#        ======================================================
00874> *#
00875> *#*************************************************************************|
00876> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
00877> *
00878> ----------------------
00879> | CALIB STANDHYD     |   Area    (ha)=     .61
00880> | 01:101     DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
00881> ----------------------
00882>                              IMPERVIOUS    PERVIOUS (i)
00883>      Surface Area     (ha)=       .43          .18
00884>      Dep. Storage     (mm)=      1.00         6.35
00885>      Average Slope     (%)=      2.00         2.50
00886>      Length            (m)=     20.00        10.00
00887>      Mannings n            =      .013         .250
00888>
00889>      Max.eff.Inten.(mm/hr)=    116.31        53.05
00890>                    over (min)      1.00         4.00
00891>      Storage Coeff.  (min)=       .74 (ii)    4.45 (ii)
00892>      Unit Hyd. Tpeak (min)=      1.00         4.00
00893>      Unit Hyd. peak  (cms)=      1.26          .26
00894>                                                          *TOTALS*
00895>      PEAK FLOW       (cms)=       .14          .02          .157 (iii)
00896>      TIME TO PEAK    (hrs)=      2.00         2.03         2.000
00897>      RUNOFF VOLUME    (mm)=     60.10        25.35        49.676
00898>      TOTAL RAINFALL   (mm)=     61.10        61.10        61.101
00899>      RUNOFF COEFFICIENT   =       .98          .41          .813
00900>
00901>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00902>            CN* =  80.0    Ia = Dep. Storage  (Above)
00903>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00904>            THAN THE STORAGE COEFFICIENT.
00905>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00906>
00907> ---------------------------------------------------------------------------
00908> 010:0004-----------------------------------------------------------------
00909> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
00910> *
00911> ----------------------
00912> | CALIB STANDHYD     |   Area    (ha)=     .06
00913> | 02:102     DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
00914> ----------------------
00915>                              IMPERVIOUS    PERVIOUS (i)
00916>      Surface Area     (ha)=       .04          .02
00917>      Dep. Storage     (mm)=      1.00         6.35
00918>      Average Slope     (%)=      2.00         2.50
00919>      Length            (m)=     20.00        10.00
00920>      Mannings n            =      .013         .250
00921>
00922>      Max.eff.Inten.(mm/hr)=    116.31        53.05
00923>                    over (min)      1.00         4.00
00924>      Storage Coeff.  (min)=       .74 (ii)    4.45 (ii)
00925>      Unit Hyd. Tpeak (min)=      1.00         4.00
00926>      Unit Hyd. peak  (cms)=      1.26          .26
00927>                                                          *TOTALS*
00928>      PEAK FLOW       (cms)=       .01          .00          .015 (iii)
00929>      TIME TO PEAK    (hrs)=      1.98         2.03         2.000
00930>      RUNOFF VOLUME    (mm)=     60.10        25.35        47.591
00931>      TOTAL RAINFALL   (mm)=     61.10        61.10        61.101
00932>      RUNOFF COEFFICIENT   =       .98          .41          .779
00933>
00934>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
00935>            CN* =  80.0    Ia = Dep. Storage  (Above)
00936>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
00937>            THAN THE STORAGE COEFFICIENT.
00938>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00939>
00940> ---------------------------------------------------------------------------
00941> 010:0005-----------------------------------------------------------------
00942> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
00943> *
00944> ----------------------
00945> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
00946> | 03:103     DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
00947> ----------------------   U.H. Tp(hrs)=    .040
00948>
00949>      Unit Hyd Qpeak  (cms)=     .019
00950>
00951>      PEAK FLOW       (cms)=     .003 (i)
00952>      TIME TO PEAK    (hrs)=    2.000
00953>      RUNOFF VOLUME    (mm)=   25.344
00954>      TOTAL RAINFALL   (mm)=   61.101
00955>      RUNOFF COEFFICIENT   =     .415
00956>
00957>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
00958>
00959> ---------------------------------------------------------------------------
00960> 010:0006-----------------------------------------------------------------
00961> *# ADD TOTAL EX. FLOWS TO GHENT
00962> ------------------------
00963> | ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00964> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00965>                        ID1 01:101          .61     .157    2.00  49.68    .000
00966>                       +ID2 03:103          .02     .003    2.00  25.34    .000
00967>                        ==========================================================
00968>                        SUM 04:EX.GHENT      .63     .160    2.00  48.90    .000
00969>
00970>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00971>
00972> ---------------------------------------------------------------------------
00973> 010:0007-----------------------------------------------------------------
00974> *# ADD TOTAL EX. FLOWS FROM STIE
00975> ------------------------
00976> | ADD HYD (EX.TOTAL  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
00977> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
00978>                        ID1 04:EX.GHENT      .63     .160    2.00  48.90    .000
00979>                       +ID2 02:102          .06     .015    2.00  47.59    .000
00980>                        ==========================================================
00981>                        SUM 10:EX.TOTAL      .69     .175    2.00  48.79    .000
00982>
00983>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
00984>
00985> ---------------------------------------------------------------------------
00986> 010:0008-----------------------------------------------------------------
00987> *#*************************************************************************|
00988> *#
00989> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
00990> *#        ========================================================
00991> *#
00992> **#*************************************************************************|
00993> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
00994> *
00995> ----------------------
00996> | CALIB STANDHYD     |   Area    (ha)=     .60
00997> | 01:201     DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
00998> ----------------------
00999>                              IMPERVIOUS    PERVIOUS (i)
01000>      Surface Area     (ha)=       .58          .02
01001>      Dep. Storage     (mm)=      1.00         6.35
01002>      Average Slope     (%)=      2.00         2.00
01003>      Length            (m)=     20.00        10.00
01004>      Mannings n            =      .013         .250
01005>
01006>      Max.eff.Inten.(mm/hr)=    116.31        51.53
01007>                    over (min)      1.00         5.00
01008>      Storage Coeff.  (min)=       .74 (ii)    4.75 (ii)
01009>      Unit Hyd. Tpeak (min)=      1.00         5.00
01010>      Unit Hyd. peak  (cms)=      1.26          .23
01011>                                                          *TOTALS*
01012>      PEAK FLOW       (cms)=       .19          .00          .190 (iii)
01013>      TIME TO PEAK    (hrs)=      2.00         2.03         2.000
01014>      RUNOFF VOLUME    (mm)=     60.10        25.35        59.059
01015>      TOTAL RAINFALL   (mm)=     61.10        61.10        61.101
01016>      RUNOFF COEFFICIENT   =       .98          .41          .967
01017>
01018>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01019>            CN* =  80.0    Ia = Dep. Storage  (Above)
01020>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01021>            THAN THE STORAGE COEFFICIENT.
01022>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01023>
01024> ---------------------------------------------------------------------------
01025> 010:0009-----------------------------------------------------------------
01026> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
01027> *
01028> ----------------------
01029> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
01030> | 02:103     DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01031> ----------------------   U.H. Tp(hrs)=    .040
01032>
01033>      Unit Hyd Qpeak  (cms)=     .019
01034>
01035>      PEAK FLOW       (cms)=     .003 (i)
01036>      TIME TO PEAK    (hrs)=    2.000
01037>      RUNOFF VOLUME    (mm)=   25.344
01038>      TOTAL RAINFALL   (mm)=   61.101
01039>      RUNOFF COEFFICIENT   =     .415
01040>
01041>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01042>
01043> ---------------------------------------------------------------------------
01044> 010:0010-----------------------------------------------------------------
01045> *# ADD TOTAL FLOWS TO SWM TANK
01046> ------------------------
01047> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01048> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01049>                        ID1 01:201          .60     .190    2.00  59.06    .000
01050>                       +ID2 02:103          .02     .003    2.00  25.34    .000
01051>                        ==========================================================
01052>                        SUM 03:PROP.GHENT    .62     .193    2.00  57.97    .000
01053>
01054>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01055>
01056> ---------------------------------------------------------------------------
01057> 010:0011-----------------------------------------------------------------
01058> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
01059> *
01060> ----------------------
01061> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01062> |  IN>03:(PROP.G)    |
01063> | OUT<01:(201_CT)    |    =========  OUTFLOW STORAGE TABLE  =========
01064> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01065>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
01066>                              .000  .0000E+00    |     .056  .1000E-01
01067>                              .056  .1800E-02    |     .056  .1300E-01
01068>                              .056  .1800E-02    |     .056  .1300E-01
01069>                              .056  .4500E-02    |     .103  .1600E-01
01070>                              .056  .7300E-02    |     .000  .0000E+00
01071>
01072>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
01073>      ---------------            (ha)     (cms)     (hrs)       (mm)
01074>      INFLOW >03: (PROP.G)        .62      .193     2.000     57.971
01075>      OUTFLOW<01: (201_CT)        .62      .056     1.867     57.971
01076>     OVERFLOW<02: (201_OV)        .00      .000      .000       .000
01077>
01078>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
01079>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01080>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
```

```
                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   28.932
                    TIME SHIFT OF PEAK FLOW          (min)=    -8.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.9842E-02

 ------------------------------------------------------------------------------
 010:0012-------------------------------------------------------------------------
 *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
 *
 ----------------------
 | CALIB STANDHYD     |   Area    (ha)=     .05
 | 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .04          .01
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       2.00         2.00
      Length            (m)=       5.00         5.00
      Mannings n            =       .013         .250

      Max.eff.Inten.(mm/hr)=     116.31        54.51
                  over (min)        1.00         3.00
      Storage Coeff.  (min)=        .32 (ii)    2.91 (ii)
      Unit Hyd. Tpeak (min)=       1.00         3.00
      Unit Hyd. peak  (cms)=       1.62          .38
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .014 (iii)
      TIME TO PEAK    (hrs)=       1.92         2.02         2.000
      RUNOFF VOLUME    (mm)=      60.10        25.35        53.151
      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
      RUNOFF COEFFICIENT   =        .98          .41          .870

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

 ------------------------------------------------------------------------------
 010:0013-------------------------------------------------------------------------
 *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
 *
 ----------------------
 | CALIB STANDHYD     |   Area    (ha)=     .02
 | 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .02          .00
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       3.00         2.00
      Length            (m)=       5.00         5.00
      Mannings n            =       .013         .250

      Max.eff.Inten.(mm/hr)=     116.31        54.51
                  over (min)        1.00         3.00
      Storage Coeff.  (min)=        .29 (ii)    2.87 (ii)
      Unit Hyd. Tpeak (min)=       1.00         3.00
      Unit Hyd. peak  (cms)=       1.65          .39
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .006 (iii)
      TIME TO PEAK    (hrs)=       1.90         2.02         2.000
      RUNOFF VOLUME    (mm)=      60.10        25.35        59.754
      TOTAL RAINFALL   (mm)=      61.10        61.10        61.101
      RUNOFF COEFFICIENT   =        .98          .41          .978

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

 ------------------------------------------------------------------------------
 010:0014-------------------------------------------------------------------------
 *# ADD TOTAL FLOWS TO GHENT
 ------------------------
 | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
 ------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:201_CTL        .62      .056    1.87  57.97    .000
                      +ID2 02:201_OVF        .00      .000     .00    .00    .000
                      +ID3 03:202            .05      .014    2.00  53.15    .000
                       ==========================================================
                       SUM 06:PROP.GHENT      .67      .070    2.00  57.61    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ------------------------------------------------------------------------------
 010:0015-------------------------------------------------------------------------
 *# ADD TOTAL FLOWS FROM SITE
 ------------------------
 | ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
 ------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 06:PROP.GHENT      .67      .070    2.00  57.61    .000
                      +ID2 04:203            .02      .006    2.00  59.75    .000
                       ==========================================================
                       SUM 07:SITE.P2         .69      .076    2.00  57.67    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ------------------------------------------------------------------------------
 010:0016-------------------------------------------------------------------------
 *# AREA CHECK
 ------------------------
 | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
 ------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 10:EX.TOTAL        .69      .175    2.00  48.79    .000
                      +ID2 07:SITE.P2         .69      .076    2.00  57.67    .000
                       ==========================================================
                       SUM 09:CHECK          1.38      .251    2.00  53.23    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ------------------------------------------------------------------------------
 010:0017-------------------------------------------------------------------------
 **#*************************************************************************|
 * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
 *
 ------------------------------------------------------------------------------
 010:0002-------------------------------------------------------------------------
 *
 ------------------------------------------------------------------------------
 010:0002-------------------------------------------------------------------------
 *
   ** END OF RUN :  24

 ********************************************************************************




 ----------------------
 | START              |  Project  dir.: T:\projects\20062\SWMHYMO\
 ----------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
     TZERO =   .00 hrs on        0
     METOUT=   2 (output = METRIC)
     NRUN  = 025
     NSTORM=   1
              #  1=BUR6_025.stm
 ------------------------------------------------------------------------------
 025:0002-------------------------------------------------------------------------
 *#*************************************************************************|
 *#  Project Name: BRANT & GHENT (PHASE 2)
 *#               BURLINGTON, ONTARIO
 *#  JOB NUMBER  : 20062
 *#       Date   : JUNE 2021
 *#    Revised   :
 *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
 *#       File   : 20062B.DAT
 *#*************************************************************************|
 *
 ------------------------------------------------------------------------------
 025:0002-------------------------------------------------------------------------
 *
 --------------------
 | READ STORM       |    Filename: Burlington 25-yr 6hr CHICAGO      (A=106
 | Ptotal=  71.35 mm|    Comments: Burlington 25-yr 6hr CHICAGO      (A=106
 --------------------
                TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
                 hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
                 .17   3.182 |   1.67  14.410 |   3.17   7.968 |   4.67   4.068
                 .33   3.437 |   1.83  32.881 |   3.33   7.135 |   4.83   3.876
                 .50   3.746 |   2.00 135.380 |   3.50   6.477 |   5.00   3.704
                 .67   4.128 |   2.17  42.866 |   3.67   5.943 |   5.17   3.548
                 .83   4.612 |   2.33  23.321 |   3.83   5.499 |   5.33   3.407
                1.00   5.251 |   2.50  16.365 |   4.00   5.125 |   5.50   3.278
                1.17   6.138 |   2.67  12.771 |   4.17   4.805 |   5.67   3.160
                1.33   7.465 |   2.83  10.563 |   4.33   4.527 |   5.83   3.051
                1.50   9.700 |   3.00   9.061 |   4.50   4.284 |   6.00   2.950

 ------------------------------------------------------------------------------
 025:0003-------------------------------------------------------------------------
 *
 *#*************************************************************************|
 *#
 *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
 *#        ========================================================
 *#
 *#*************************************************************************|
 *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
 *
 ----------------------
 | CALIB STANDHYD     |   Area    (ha)=     .61
 | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .43          .18
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       2.00         2.50
      Length            (m)=      20.00        10.00
      Mannings n            =       .013         .250

      Max.eff.Inten.(mm/hr)=     135.38        69.33
                  over (min)        1.00         4.00
      Storage Coeff.  (min)=        .70 (ii)    4.03 (ii)
      Unit Hyd. Tpeak (min)=       1.00         4.00
      Unit Hyd. peak  (cms)=       1.29          .28
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .16          .03          .187 (iii)
      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
      RUNOFF VOLUME    (mm)=      70.35        32.88        59.106
      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
      RUNOFF COEFFICIENT   =        .99          .46          .828

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

 ------------------------------------------------------------------------------
 025:0004-------------------------------------------------------------------------
 *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
 *
 ----------------------
 | CALIB STANDHYD     |   Area    (ha)=     .06
 | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=        .04          .02
      Dep. Storage     (mm)=       1.00         6.35
      Average Slope     (%)=       2.00         2.50
      Length            (m)=      20.00        10.00
      Mannings n            =       .013         .250

      Max.eff.Inten.(mm/hr)=     135.38        69.33
                  over (min)        1.00         4.00
      Storage Coeff.  (min)=        .70 (ii)    4.03 (ii)
      Unit Hyd. Tpeak (min)=       1.00         4.00
      Unit Hyd. peak  (cms)=       1.29          .28
                                                        *TOTALS*
      PEAK FLOW       (cms)=        .01          .00          .018 (iii)
      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
      RUNOFF VOLUME    (mm)=      70.35        32.88        56.857
      TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
      RUNOFF COEFFICIENT   =        .99          .46          .797

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  80.0    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.

 ------------------------------------------------------------------------------
 025:0005-------------------------------------------------------------------------
 *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
 *
 ----------------------
 | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
 | 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
 ----------------------  U.H. Tp(hrs)=    .040

      Unit Hyd Qpeak  (cms)=     .019

      PEAK FLOW       (cms)=     .004 (i)
      TIME TO PEAK    (hrs)=    2.000
      RUNOFF VOLUME    (mm)=   32.873
      TOTAL RAINFALL   (mm)=   71.347
      RUNOFF COEFFICIENT   =     .461

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

 ------------------------------------------------------------------------------
 025:0006-------------------------------------------------------------------------
 *# ADD TOTAL EX. FLOWS TO GHENT
 ------------------------
 | ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
 ------------------------                   (ha)     (cms)   (hrs)   (mm)   (cms)
                       ID1 01:101             .61      .187    2.00  59.11    .000
                      +ID2 03:103             .02      .004    2.00  32.87    .000
```

```
                    ============================================================
                    SUM 04:EX.GHENT        .63     .191    2.00  58.27    .000
                    ============================================================

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0007----------------------------------------------------------------------
*# ADD TOTAL EX. FLOWS FROM STIE
------------------------
| ADD HYD (EX.TOTAL  ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
------------------------------------      (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 04:EX.GHENT        .63     .191    2.00  58.27    .000
                    +ID2 02:102             .06     .018    2.00  56.86    .000
                     ============================================================
                     SUM 10:EX.TOTAL        .69     .209    2.00  58.15    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0008----------------------------------------------------------------------
*#*************************************************************************|
*#
*#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
*#        ========================================================
*#
**#*************************************************************************|
*# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .60
| 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .58          .02
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=      20.00        10.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     135.38        69.33
                  over (min)        1.00         4.00
     Storage Coeff.  (min)=        .70 (ii)    4.26 (ii)
     Unit Hyd. Tpeak (min)=       1.00         4.00
     Unit Hyd. peak  (cms)=       1.29          .27
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .22          .00          .221 (iii)
     TIME TO PEAK    (hrs)=       2.00         2.02         2.000
     RUNOFF VOLUME    (mm)=      70.35        32.88        69.223
     TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
     RUNOFF COEFFICIENT   =        .99          .46          .970

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    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.

--------------------------------------------------------------------------------
025:0009----------------------------------------------------------------------
*# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
*
----------------------
| CALIB NASHYD       |   Area    (ha)=     .02   Curve Number    (CN)=80.00
| 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
----------------------   U.H. Tp(hrs)=    .040

     Unit Hyd Qpeak  (cms)=     .019

     PEAK FLOW       (cms)=     .004 (i)
     TIME TO PEAK    (hrs)=    2.000
     RUNOFF VOLUME    (mm)=   32.873
     TOTAL RAINFALL   (mm)=   71.347
     RUNOFF COEFFICIENT   =     .461

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

--------------------------------------------------------------------------------
025:0010----------------------------------------------------------------------
*# ADD TOTAL FLOWS TO SWM TANK
------------------------
| ADD HYD (PROP.GHENT) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
------------------------------------      (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:201             .60     .221    2.00  69.22    .000
                    +ID2 02:103             .02     .004    2.00  32.87    .000
                     ============================================================
                     SUM 03:PROP.GHENT      .62     .225    2.00  68.05    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0011----------------------------------------------------------------------
*# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
*
----------------------
| ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
|  IN>03:(PROP.G)    |
| OUT<01:(201_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
                             .000  .0000E+00   |     .056  .1000E-01
                             .056  .1800E-02   |     .056  .1300E-01
                             .056  .1800E-02   |     .056  .1300E-01
                             .056  .4500E-02   |     .103  .1600E-01
                             .056  .7300E-02   |     .000  .0000E+00

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     ---------------          (ha)     (cms)     (hrs)       (mm)
     INFLOW >03: (PROP.G)        .62      .225     2.000     68.050
     OUTFLOW<01: (201_CT)        .62      .056     1.850     68.050
    OVERFLOW<02: (201_OV)        .00      .000      .000       .000

                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   24.749
                    TIME SHIFT OF PEAK FLOW          (min)=    -9.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=.1261E-01

--------------------------------------------------------------------------------
025:0012----------------------------------------------------------------------
*# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .05
| 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .04          .01
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       2.00         2.00
     Length            (m)=       5.00         5.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     135.38        71.01
                  over (min)        1.00         3.00
     Storage Coeff.  (min)=        .30 (ii)    2.63 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.64          .41
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .02          .00          .017 (iii)
     TIME TO PEAK    (hrs)=       1.92         2.00         2.000
     RUNOFF VOLUME    (mm)=      70.35        32.88        62.853
     TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
     RUNOFF COEFFICIENT   =        .99          .46          .881

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    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.

--------------------------------------------------------------------------------
025:0013----------------------------------------------------------------------
*# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
*
----------------------
| CALIB STANDHYD     |   Area    (ha)=     .02
| 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .02          .00
     Dep. Storage     (mm)=       1.00         6.35
     Average Slope     (%)=       3.00         2.00
     Length            (m)=       5.00         5.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     135.38        71.01
                  over (min)        1.00         3.00
     Storage Coeff.  (min)=        .27 (ii)    2.59 (ii)
     Unit Hyd. Tpeak (min)=       1.00         3.00
     Unit Hyd. peak  (cms)=       1.66          .41
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .007 (iii)
     TIME TO PEAK    (hrs)=       1.90         2.00         2.000
     RUNOFF VOLUME    (mm)=      70.35        32.88        69.972
     TOTAL RAINFALL   (mm)=      71.35        71.35        71.347
     RUNOFF COEFFICIENT   =        .99          .46          .981

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  80.0    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.

--------------------------------------------------------------------------------
025:0014----------------------------------------------------------------------
*# ADD TOTAL FLOWS TO GHENT
------------------------
| ADD HYD (PROP.GHENT) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
------------------------------------      (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 01:201_CTL         .62     .056    1.85  68.05    .000
                    +ID2 02:201_OVF         .00     .000     .00    .00    .000
                    +ID3 03:202             .05     .017    2.00  62.85    .000
                     ============================================================
                     SUM 06:PROP.GHENT      .67     .072    2.00  67.66    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0015----------------------------------------------------------------------
*# ADD TOTAL FLOWS FROM SITE
------------------------
| ADD HYD (SITE.P2   ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
------------------------------------      (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 06:PROP.GHENT      .67     .072    2.00  67.66    .000
                    +ID2 04:203             .02     .007    2.00  69.97    .000
                     ============================================================
                     SUM 07:SITE.P2         .69     .080    2.00  67.73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0016----------------------------------------------------------------------
*# AREA CHECK
------------------------
| ADD HYD (CHECK     ) | ID: NHYD          AREA     QPEAK   TPEAK   R.V.    DWF
------------------------------------      (ha)     (cms)   (hrs)   (mm)   (cms)
                     ID1 10:EX.TOTAL        .69     .209    2.00  58.15    .000
                    +ID2 07:SITE.P2         .69     .080    2.00  67.73    .000
                     ============================================================
                     SUM 09:CHECK          1.38     .288    2.00  62.94    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
025:0017----------------------------------------------------------------------
**#*************************************************************************|
* RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
*
--------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
--------------------------------------------------------------------------------
025:0002----------------------------------------------------------------------
*
  ** END OF RUN :  49
**********************************************************************
-----------------------
| START               |  Project  dir.: T:\projects\20062\SWMHYMO\
-----------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
    TZERO =   .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 050
    NSTORM=   1
            #  1=BUR6_050.stm
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
*#*************************************************************************|
*#  Project Name: BRANT & GHENT (PHASE 2)
*#               BURLINGTON, ONTARIO
*#  JOB NUMBER  : 20062
*#       Date   : JUNE 2021
*#    Revised   :
*#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
*#       File   : 20062B.DAT
*#*************************************************************************|
*
--------------------------------------------------------------------------------
050:0002----------------------------------------------------------------------
```

```
01621> *
01622> --------------------
01623> | READ STORM       |    Filename: Burlington 50-yr 6hr CHICAGO     (A=1172
01624> | Ptotal=  78.93 mm|    Comments: Burlington 50-yr 6hr CHICAGO     (A=1172
01625> --------------------
01626>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
01627>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
01628>                .17   3.533 |   1.67  15.961 |   3.17   8.836 |   4.67   4.516
01629>                .33   3.817 |   1.83  36.356 |   3.33   7.913 |   4.83   4.304
01630>                .50   4.160 |   2.00 149.296 |   3.50   7.185 |   5.00   4.113
01631>                .67   4.582 |   2.17  47.374 |   3.67   6.593 |   5.17   3.940
01632>                .83   5.119 |   2.33  25.806 |   3.83   6.102 |   5.33   3.783
01633>               1.00   5.827 |   2.50  18.121 |   4.00   5.688 |   5.50   3.640
01634>               1.17   6.809 |   2.67  14.149 |   4.17   5.333 |   5.67   3.509
01635>               1.33   8.278 |   2.83  11.707 |   4.33   5.025 |   5.83   3.388
01636>               1.50  10.753 |   3.00  10.045 |   4.50   4.755 |   6.00   3.277
01637>
01638> -------------------------------------------------------------------------------
01639> 050:0003-------------------------------------------------------------------------
01640> *
01641> *#*************************************************************************|
01642> *#
01643> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
01644> *#        ========================================================
01645> *#
01646> *#*************************************************************************|
01647> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
01648> *
01649> ----------------------
01650> | CALIB STANDHYD     |   Area    (ha)=     .61
01651> | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
01652> ----------------------
01653>                              IMPERVIOUS    PERVIOUS (i)
01654>      Surface Area     (ha)=        .43          .18
01655>      Dep. Storage     (mm)=       1.00         6.35
01656>      Average Slope     (%)=       2.00         2.50
01657>      Length            (m)=      20.00        10.00
01658>      Mannings n             =      .013         .250
01659>
01660>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01661>                    over (min)        1.00         4.00
01662>      Storage Coeff.  (min)=        .67 (ii)    3.79 (ii)
01663>      Unit Hyd. Tpeak (min)=       1.00         4.00
01664>      Unit Hyd. peak  (cms)=       1.31          .29
01665>                                                        *TOTALS*
01666>      PEAK FLOW       (cms)=        .18          .03          .210 (iii)
01667>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
01668>      RUNOFF VOLUME    (mm)=      77.93        38.71        66.166
01669>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01670>      RUNOFF COEFFICIENT   =        .99          .49          .838
01671>
01672>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01673>            CN* =  80.0    Ia = Dep. Storage  (Above)
01674>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01675>            THAN THE STORAGE COEFFICIENT.
01676>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01677>
01678> -------------------------------------------------------------------------------
01679> 050:0004-------------------------------------------------------------------------
01680> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
01681> *
01682> ----------------------
01683> | CALIB STANDHYD     |   Area    (ha)=     .06
01684> | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
01685> ----------------------
01686>                              IMPERVIOUS    PERVIOUS (i)
01687>      Surface Area     (ha)=        .04          .02
01688>      Dep. Storage     (mm)=       1.00         6.35
01689>      Average Slope     (%)=       2.00         2.50
01690>      Length            (m)=      20.00        10.00
01691>      Mannings n             =      .013         .250
01692>
01693>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01694>                    over (min)        1.00         4.00
01695>      Storage Coeff.  (min)=        .67 (ii)    3.79 (ii)
01696>      Unit Hyd. Tpeak (min)=       1.00         4.00
01697>      Unit Hyd. peak  (cms)=       1.31          .29
01698>                                                        *TOTALS*
01699>      PEAK FLOW       (cms)=        .02          .00          .020 (iii)
01700>      TIME TO PEAK    (hrs)=       1.98         2.02         2.000
01701>      RUNOFF VOLUME    (mm)=      77.93        38.71        63.813
01702>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01703>      RUNOFF COEFFICIENT   =        .99          .49          .808
01704>
01705>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01706>            CN* =  80.0    Ia = Dep. Storage  (Above)
01707>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01708>            THAN THE STORAGE COEFFICIENT.
01709>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01710>
01711> -------------------------------------------------------------------------------
01712> 050:0005-------------------------------------------------------------------------
01713> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
01714> *
01715> ----------------------
01716> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
01717> | 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01718> ----------------------  U.H. Tp(hrs)=    .040
01719>
01720>      Unit Hyd Qpeak  (cms)=     .019
01721>
01722>      PEAK FLOW       (cms)=     .004 (i)
01723>      TIME TO PEAK    (hrs)=    2.000
01724>      RUNOFF VOLUME    (mm)=   38.709
01725>      TOTAL RAINFALL   (mm)=   78.932
01726>      RUNOFF COEFFICIENT   =     .490
01727>
01728>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01729>
01730> -------------------------------------------------------------------------------
01731> 050:0006-------------------------------------------------------------------------
01732> *# ADD TOTAL EX. FLOWS TO GHENT
01733> ------------------------
01734> | ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01735> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01736>                       ID1 01:101          .61      .210    2.00   66.17    .000
01737>                     +ID2 03:103           .02      .004    2.00   38.71    .000
01738>                       ========================================================
01739>                       SUM 04:EX.GHENT     .63      .214    2.00   65.29    .000
01740>
01741>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01742>
01743> -------------------------------------------------------------------------------
01744> 050:0007-------------------------------------------------------------------------
01745> *# ADD TOTAL EX. FLOWS FROM STIE
01746> ------------------------
01747> | ADD HYD (EX.TOTAL  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01748> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01749>                       ID1 04:EX.GHENT     .63      .214    2.00   65.29    .000
01750>                     +ID2 02:102           .06      .020    2.00   63.81    .000
01751>                       ========================================================
01752>                       SUM 10:EX.TOTAL     .69      .234    2.00   65.17    .000
01753>
01754>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01755>
01756> -------------------------------------------------------------------------------
01757> 050:0008-------------------------------------------------------------------------
01758> *#*************************************************************************|
01759> *#
01760> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
01761> *#        ========================================================
01762> *#
01763> **#************************************************************************|
01764> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
01765> *
01766> ----------------------
01767> | CALIB STANDHYD     |   Area    (ha)=     .60
01768> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
01769> ----------------------
01770>                              IMPERVIOUS    PERVIOUS (i)
01771>      Surface Area     (ha)=        .58          .02
01772>      Dep. Storage     (mm)=       1.00         6.35
01773>      Average Slope     (%)=       2.00         2.00
01774>      Length            (m)=      20.00        10.00
01775>      Mannings n             =      .013         .250
01776>
01777>      Max.eff.Inten.(mm/hr)=     149.30        81.82
01778>                    over (min)        1.00         4.00
01779>      Storage Coeff.  (min)=        .67 (ii)    4.00 (ii)
01780>      Unit Hyd. Tpeak (min)=       1.00         4.00
01781>      Unit Hyd. peak  (cms)=       1.31          .28
01782>                                                        *TOTALS*
01783>      PEAK FLOW       (cms)=        .24          .00          .245 (iii)
01784>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
01785>      RUNOFF VOLUME    (mm)=      77.93        38.71        76.755
01786>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01787>      RUNOFF COEFFICIENT   =        .99          .49          .972
01788>
01789>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01790>            CN* =  80.0    Ia = Dep. Storage  (Above)
01791>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01792>            THAN THE STORAGE COEFFICIENT.
01793>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01794>
01795> -------------------------------------------------------------------------------
01796> 050:0009-------------------------------------------------------------------------
01797> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
01798> *
01799> ----------------------
01800> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
01801> | 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
01802> ----------------------  U.H. Tp(hrs)=    .040
01803>
01804>      Unit Hyd Qpeak  (cms)=     .019
01805>
01806>      PEAK FLOW       (cms)=     .004 (i)
01807>      TIME TO PEAK    (hrs)=    2.000
01808>      RUNOFF VOLUME    (mm)=   38.709
01809>      TOTAL RAINFALL   (mm)=   78.932
01810>      RUNOFF COEFFICIENT   =     .490
01811>
01812>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01813>
01814> -------------------------------------------------------------------------------
01815> 050:0010-------------------------------------------------------------------------
01816> *# ADD TOTAL FLOWS TO SWM TANK
01817> ------------------------
01818> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01819> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01820>                       ID1 01:201          .60      .245    2.00   76.76    .000
01821>                     +ID2 02:103           .02      .004    2.00   38.71    .000
01822>                       ========================================================
01823>                       SUM 03:PROP.GHENT   .62      .249    2.00   75.53    .000
01824>
01825>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01826>
01827> -------------------------------------------------------------------------------
01828> 050:0011-------------------------------------------------------------------------
01829> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
01830> *
01831> ----------------------
01832> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
01833> |  IN>03:(PROP.G)    |
01834> | OUT<01:(201_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
01835> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
01836>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
01837>                              .000  .0000E+00    |     .056  .1000E-01
01838>                              .056  .1800E-02    |     .056  .1300E-01
01839>                              .056  .1800E-02    |     .056  .1300E-01
01840>                              .056  .4500E-02    |     .103  .1600E-01
01841>                              .056  .7300E-02    |     .000  .0000E+00
01842>
01843>      ROUTING RESULTS             AREA     QPEAK     TPEAK       R.V.
01844>      ---------------------       (ha)     (cms)     (hrs)       (mm)
01845>      INFLOW >03: (PROP.G)         .62      .249     2.000     75.528
01846>      OUTFLOW<01: (201_CT)         .62      .072     2.167     75.528
01847>     OVERFLOW<02: (201_OV)         .00      .000      .000       .000
01848>
01849>                    TOTAL NUMBER OF SIMULATED OVERFLOWS  =         0
01850>                    CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
01851>                    PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
01852>
01853>
01854>                    PEAK   FLOW   REDUCTION [Qout/Qin](%)=   28.779
01855>                    TIME SHIFT OF PEAK FLOW          (min)=    10.00
01856>                    MAXIMUM  STORAGE   USED       (ha.m.)=.1404E-01
01857>
01858> -------------------------------------------------------------------------------
01859> 050:0012-------------------------------------------------------------------------
01860> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
01861> *
01862> ----------------------
01863> | CALIB STANDHYD     |   Area    (ha)=     .05
01864> | 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
01865> ----------------------
01866>                              IMPERVIOUS    PERVIOUS (i)
01867>      Surface Area     (ha)=        .04          .01
01868>      Dep. Storage     (mm)=       1.00         6.35
01869>      Average Slope     (%)=       2.00         2.00
01870>      Length            (m)=       5.00         5.00
01871>      Mannings n             =      .013         .250
01872>
01873>      Max.eff.Inten.(mm/hr)=     149.30        85.37
01874>                    over (min)        1.00         2.00
01875>      Storage Coeff.  (min)=        .29 (ii)    2.45 (ii)
01876>      Unit Hyd. Tpeak (min)=       1.00         2.00
01877>      Unit Hyd. peak  (cms)=       1.64          .49
01878>                                                        *TOTALS*
01879>      PEAK FLOW       (cms)=        .02          .00          .019 (iii)
01880>      TIME TO PEAK    (hrs)=       1.92         2.00         2.000
01881>      RUNOFF VOLUME    (mm)=      77.93        38.71        70.088
01882>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01883>      RUNOFF COEFFICIENT   =        .99          .49          .888
01884>
01885>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01886>            CN* =  80.0    Ia = Dep. Storage  (Above)
01887>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01888>            THAN THE STORAGE COEFFICIENT.
01889>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01890>
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01891> ------------------------------------------------------------------------------
01892> 050:0013------------------------------------------------------------------------
01893> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
01894> *
01895> ----------------------
01896> | CALIB STANDHYD     |   Area    (ha)=     .02
01897> | 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
01898> ----------------------
01899>                              IMPERVIOUS    PERVIOUS (i)
01900>      Surface Area     (ha)=        .02          .00
01901>      Dep. Storage     (mm)=       1.00         6.35
01902>      Average Slope     (%)=       3.00         2.00
01903>      Length            (m)=       5.00         5.00
01904>      Mannings n            =       .013         .250
01905>
01906>      Max.eff.Inten.(mm/hr)=     149.30        85.37
01907>                    over (min)       1.00         2.00
01908>      Storage Coeff.  (min)=        .26 (ii)    2.42 (ii)
01909>      Unit Hyd. Tpeak (min)=       1.00         2.00
01910>      Unit Hyd. peak  (cms)=       1.66          .50
01911>                                                          *TOTALS*
01912>      PEAK FLOW       (cms)=        .01          .00          .008 (iii)
01913>      TIME TO PEAK    (hrs)=       1.90         2.00         2.000
01914>      RUNOFF VOLUME    (mm)=      77.93        38.71        77.540
01915>      TOTAL RAINFALL   (mm)=      78.93        78.93        78.932
01916>      RUNOFF COEFFICIENT   =        .99          .49          .982
01917>
01918>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
01919>            CN* =  80.0    Ia = Dep. Storage  (Above)
01920>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
01921>            THAN THE STORAGE COEFFICIENT.
01922>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
01923>
01924> ------------------------------------------------------------------------------
01925> 050:0014------------------------------------------------------------------------
01926> *# ADD TOTAL FLOWS TO GHENT
01927> ------------------------
01928> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01929> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01930>                       ID1 01:201_CTL        .62      .072    2.17  75.53    .000
01931>                      +ID2 02:201_OVF        .00      .000     .00    .00    .000
01932>                      +ID3 03:202            .05      .019    2.00  70.09    .000
01933>                       ========================================================
01934>                       SUM 06:PROP.GHENT      .67      .078    2.17  75.12    .000
01935>
01936>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01937>
01938> ------------------------------------------------------------------------------
01939> 050:0015------------------------------------------------------------------------
01940> *# ADD TOTAL FLOWS FROM SITE
01941> ------------------------
01942> | ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01943> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01944>                       ID1 06:PROP.GHENT      .67      .078    2.17  75.12    .000
01945>                      +ID2 04:203            .02      .008    2.00  77.54    .000
01946>                       ========================================================
01947>                       SUM 07:SITE.P2         .69      .083    2.00  75.19    .000
01948>
01949>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01950>
01951> ------------------------------------------------------------------------------
01952> 050:0016------------------------------------------------------------------------
01953> *# AREA CHECK
01954> ------------------------
01955> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
01956> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
01957>                       ID1 10:EX.TOTAL        .69      .234    2.00  65.17    .000
01958>                      +ID2 07:SITE.P2         .69      .083    2.00  75.19    .000
01959>                       ========================================================
01960>                       SUM 09:CHECK          1.38      .316    2.00  70.18    .000
01961>
01962>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
01963>
01964> ------------------------------------------------------------------------------
01965> 050:0017------------------------------------------------------------------------
01966> **#*************************************************************************|
01967> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
01968> *
01969> ------------------------------------------------------------------------------
01970> 050:0002------------------------------------------------------------------------
01971> *
01972> ------------------------------------------------------------------------------
01973> 050:0002------------------------------------------------------------------------
01974> *
01975> ------------------------------------------------------------------------------
01976> 050:0002------------------------------------------------------------------------
01977> *
01978> ------------------------------------------------------------------------------
01979> 050:0002------------------------------------------------------------------------
01980> *
01981>   ** END OF RUN :  99
01982>
01983> ******************************************************************************
01984>
01985>
01986>
01987>
01988>
01989> --------------------
01990> | START            |  Project  dir.: T:\projects\20062\SWMHYMO\
01991> --------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
01992>     TZERO =   .00 hrs on       0
01993>     METOUT=   2 (output = METRIC)
01994>     NRUN  = 100
01995>     NSTORM=   1
01996>               #  1=BUR6_100.stm
01997> ------------------------------------------------------------------------------
01998> 100:0002------------------------------------------------------------------------
01999> *#*************************************************************************|
02000> *#  Project Name: BRANT & GHENT (PHASE 2)
02001> *#               BURLINGTON, ONTARIO
02002> *#  JOB NUMBER  : 20062
02003> *#       Date   : JUNE 2021
02004> *#    Revised   :
02005> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
02006> *#       File   : 20062B.DAT
02007> *#*************************************************************************|
02008> *
02009> ------------------------------------------------------------------------------
02010> 100:0002------------------------------------------------------------------------
02011> *
02012> --------------------
02013> | READ STORM       |    Filename: Burlington 100-yr 6hr CHICAGO        (A=
02014> | Ptotal=  86.27 mm|    Comments: Burlington 100-yr 6hr CHICAGO        (A=
02015> --------------------
02016>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
02017>               hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
02018>               .17   3.862 |   1.67  17.445 |   3.17   9.657 |   4.67   4.936
02019>               .33   4.172 |   1.83  39.736 |   3.33   8.649 |   4.83   4.704
02020>               .50   4.546 |  2.00 163.177 |   3.50   7.853 |   5.00   4.495
02021>               .67   5.008 |   2.17  51.779 |   3.67   7.206 |   5.17   4.306
02022>               .83   5.595 |   2.33  28.205 |   3.83   6.670 |   5.33   4.135
02023>              1.00   6.369 |   2.50  19.806 |   4.00   6.217 |   5.50   3.979
02024>              1.17   7.443 |   2.67  15.465 |   4.17   5.829 |   5.67   3.835
02025>              1.33   9.048 |   2.83  12.795 |   4.33   5.492 |   5.83   3.703
02026>              1.50  11.752 |   3.00  10.979 |   4.50   5.197 |   6.00   3.581
02027>
02028> ------------------------------------------------------------------------------
02029> 100:0003------------------------------------------------------------------------
02030> *
02031> *#*************************************************************************|
02032> *#
02033> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
02034> *#        ============================================================
02035> *#
02036> *#*************************************************************************|
02037> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
02038> *
02039> ----------------------
02040> | CALIB STANDHYD     |   Area    (ha)=     .61
02041> | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
02042> ----------------------
02043>                              IMPERVIOUS    PERVIOUS (i)
02044>      Surface Area     (ha)=        .43          .18
02045>      Dep. Storage     (mm)=       1.00         6.35
02046>      Average Slope     (%)=       2.00         2.50
02047>      Length            (m)=      20.00        10.00
02048>      Mannings n            =       .013         .250
02049>
02050>      Max.eff.Inten.(mm/hr)=     163.18        94.55
02051>                    over (min)       1.00         4.00
02052>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
02053>      Unit Hyd. Tpeak (min)=       1.00         4.00
02054>      Unit Hyd. peak  (cms)=       1.33          .30
02055>                                                          *TOTALS*
02056>      PEAK FLOW       (cms)=        .19          .04          .232 (iii)
02057>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
02058>      RUNOFF VOLUME    (mm)=      85.27        44.54        73.050
02059>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
02060>      RUNOFF COEFFICIENT   =        .99          .52          .847
02061>
02062>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02063>            CN* =  80.0    Ia = Dep. Storage  (Above)
02064>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02065>            THAN THE STORAGE COEFFICIENT.
02066>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02067>
02068> ------------------------------------------------------------------------------
02069> 100:0004------------------------------------------------------------------------
02070> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
02071> *
02072> ----------------------
02073> | CALIB STANDHYD     |   Area    (ha)=     .06
02074> | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
02075> ----------------------
02076>                              IMPERVIOUS    PERVIOUS (i)
02077>      Surface Area     (ha)=        .04          .02
02078>      Dep. Storage     (mm)=       1.00         6.35
02079>      Average Slope     (%)=       2.00         2.50
02080>      Length            (m)=      20.00        10.00
02081>      Mannings n            =       .013         .250
02082>
02083>      Max.eff.Inten.(mm/hr)=     163.18        94.55
02084>                    over (min)       1.00         4.00
02085>      Storage Coeff.  (min)=        .65 (ii)    3.59 (ii)
02086>      Unit Hyd. Tpeak (min)=       1.00         4.00
02087>      Unit Hyd. peak  (cms)=       1.33          .30
02088>                                                          *TOTALS*
02089>      PEAK FLOW       (cms)=        .02          .00          .022 (iii)
02090>      TIME TO PEAK    (hrs)=       1.97         2.02         2.000
02091>      RUNOFF VOLUME    (mm)=      85.27        44.54        70.606
02092>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
02093>      RUNOFF COEFFICIENT   =        .99          .52          .818
02094>
02095>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02096>            CN* =  80.0    Ia = Dep. Storage  (Above)
02097>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02098>            THAN THE STORAGE COEFFICIENT.
02099>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02100>
02101> ------------------------------------------------------------------------------
02102> 100:0005------------------------------------------------------------------------
02103> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
02104> *
02105> ----------------------
02106> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
02107> | 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02108> ----------------------  U.H. Tp(hrs)=    .040
02109>
02110>      Unit Hyd Qpeak  (cms)=     .019
02111>
02112>      PEAK FLOW       (cms)=     .005 (i)
02113>      TIME TO PEAK    (hrs)=    2.000
02114>      RUNOFF VOLUME    (mm)=   44.531
02115>      TOTAL RAINFALL   (mm)=   86.271
02116>      RUNOFF COEFFICIENT   =     .516
02117>
02118>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02119>
02120> ------------------------------------------------------------------------------
02121> 100:0006------------------------------------------------------------------------
02122> *# ADD TOTAL EX. FLOWS TO GHENT
02123> ------------------------
02124> | ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02125> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02126>                       ID1 01:101             .61      .232    2.00  73.05    .000
02127>                      +ID2 03:103             .02      .005    2.00  44.53    .000
02128>                       ========================================================
02129>                       SUM 04:EX.GHENT        .63      .237    2.00  72.15    .000
02130>
02131>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02132>
02133> ------------------------------------------------------------------------------
02134> 100:0007------------------------------------------------------------------------
02135> *# ADD TOTAL EX. FLOWS FROM STIE
02136> ------------------------
02137> | ADD HYD (EX.TOTAL  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02138> ------------------------                  (ha)     (cms)   (hrs)   (mm)    (cms)
02139>                       ID1 04:EX.GHENT        .63      .237    2.00  72.15    .000
02140>                      +ID2 02:102             .06      .022    2.00  70.61    .000
02141>                       ========================================================
02142>                       SUM 10:EX.TOTAL        .69      .259    2.00  72.01    .000
02143>
02144>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02145>
02146> ------------------------------------------------------------------------------
02147> 100:0008------------------------------------------------------------------------
02148> *#*************************************************************************|
02149> *#
02150> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
02151> *#        =============================================================
02152> *#
02153> **#************************************************************************|
02154> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
02155> *
02156> ----------------------
02157> | CALIB STANDHYD     |   Area    (ha)=     .60
02158> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
02159> ----------------------
02160>                              IMPERVIOUS    PERVIOUS (i)
```

```
02161>      Surface Area     (ha)=        .58          .02
02162>      Dep. Storage     (mm)=       1.00         6.35
02163>      Average Slope     (%)=       2.00         2.00
02164>      Length            (m)=      20.00        10.00
02165>      Mannings n            =       .013         .250
02166>
02167>      Max.eff.Inten.(mm/hr)=     163.18        94.55
02168>                 over (min)        1.00         4.00
02169>      Storage Coeff.  (min)=         .65 (ii)    3.79 (ii)
02170>      Unit Hyd. Tpeak (min)=       1.00         4.00
02171>      Unit Hyd. peak  (cms)=       1.33          .29
02172>                                                          *TOTALS*
02173>      PEAK FLOW       (cms)=        .26          .00          .268 (iii)
02174>      TIME TO PEAK    (hrs)=       2.00         2.02         2.000
02175>      RUNOFF VOLUME    (mm)=      85.27        44.54        84.049
02176>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
02177>      RUNOFF COEFFICIENT   =        .99          .52          .974
02178>
02179>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02180>            CN* =  80.0    Ia = Dep. Storage  (Above)
02181>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02182>            THAN THE STORAGE COEFFICIENT.
02183>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02184>
02185> ------------------------------------------------------------------------------
02186> 100:0009------------------------------------------------------------------------
02187> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
02188> *
02189> ----------------------
02190> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number    (CN)=80.00
02191> | 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02192> ----------------------   U.H. Tp(hrs)=    .040
02193>
02194>      Unit Hyd Qpeak  (cms)=     .019
02195>
02196>      PEAK FLOW       (cms)=     .005 (i)
02197>      TIME TO PEAK    (hrs)=    2.000
02198>      RUNOFF VOLUME    (mm)=   44.531
02199>      TOTAL RAINFALL   (mm)=   86.271
02200>      RUNOFF COEFFICIENT   =     .516
02201>
02202>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02203>
02204> ------------------------------------------------------------------------------
02205> 100:0010------------------------------------------------------------------------
02206> *# ADD TOTAL FLOWS TO SWM TANK
02207> -------------------------
02208> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02209> -------------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
02210>                       ID1 01:201          .60     .268    2.00  84.05    .000
02211>                      +ID2 02:103          .02     .005    2.00  44.53    .000
02212>                       ========================================================
02213>                       SUM 03:PROP.GHENT    .62     .273    2.00  82.77    .000
02214>
02215>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02216>
02217> ------------------------------------------------------------------------------
02218> 100:0011------------------------------------------------------------------------
02219> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
02220> *
02221> ---------------------
02222> | ROUTE RESERVOIR   |    Requested routing time step =  1.0 min.
02223> |  IN>03:(PROP.G)   |
02224> | OUT<01:(201_CT)   |    =========  OUTLFOW STORAGE TABLE  =========
02225> ---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
02226>                            (cms)    (ha.m.)   |    (cms)    (ha.m.)
02227>                             .000  .0000E+00    |     .056  .1000E-01
02228>                             .056  .1800E-02    |     .056  .1300E-01
02229>                             .056  .1800E-02    |     .056  .1300E-01
02230>                             .056  .4500E-02    |     .103  .1600E-01
02231>                             .056  .7300E-02    |     .000  .0000E+00
02232>
02233>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
02234>      ---------------            (ha)     (cms)     (hrs)       (mm)
02235>      INFLOW >03: (PROP.G)        .62      .273     2.000     82.774
02236>      OUTFLOW<01: (201_CT)        .62      .086     2.167     82.774
02237>     OVERFLOW<02: (201_OV)        .00      .000      .000       .000
02238>
02239>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
02240>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
02241>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
02242>
02243>
02244>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   31.532
02245>                     TIME SHIFT OF PEAK FLOW         (min)=    10.00
02246>                     MAXIMUM  STORAGE   USED       (ha.m.)=.1494E-01
02247>
02248> ------------------------------------------------------------------------------
02249> 100:0012------------------------------------------------------------------------
02250> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
02251> *
02252> ----------------------
02253> | CALIB STANDHYD     |   Area    (ha)=     .05
02254> | 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
02255> ----------------------
02256>                              IMPERVIOUS    PERVIOUS (i)
02257>      Surface Area     (ha)=        .04          .01
02258>      Dep. Storage     (mm)=       1.00         6.35
02259>      Average Slope     (%)=       2.00         2.00
02260>      Length            (m)=       5.00         5.00
02261>      Mannings n            =       .013         .250
02262>
02263>      Max.eff.Inten.(mm/hr)=     163.18        98.36
02264>                 over (min)        1.00         2.00
02265>      Storage Coeff.  (min)=         .28 (ii)    2.32 (ii)
02266>      Unit Hyd. Tpeak (min)=       1.00         2.00
02267>      Unit Hyd. peak  (cms)=       1.65          .51
02268>                                                          *TOTALS*
02269>      PEAK FLOW       (cms)=        .02          .00          .021 (iii)
02270>      TIME TO PEAK    (hrs)=       1.92         2.00         2.000
02271>      RUNOFF VOLUME    (mm)=      85.27        44.54        77.124
02272>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
02273>      RUNOFF COEFFICIENT   =        .99          .52          .894
02274>
02275>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02276>            CN* =  80.0    Ia = Dep. Storage  (Above)
02277>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02278>            THAN THE STORAGE COEFFICIENT.
02279>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02280>
02281> ------------------------------------------------------------------------------
02282> 100:0013------------------------------------------------------------------------
02283> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
02284> *
02285> ----------------------
02286> | CALIB STANDHYD     |   Area    (ha)=     .02
02287> | 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
02288> ----------------------
02289>                              IMPERVIOUS    PERVIOUS (i)
02290>      Surface Area     (ha)=        .02          .00
02291>      Dep. Storage     (mm)=       1.00         6.35
02292>      Average Slope     (%)=       3.00         2.00
02293>      Length            (m)=       5.00         5.00
02294>      Mannings n            =       .013         .250
02295>
02296>      Max.eff.Inten.(mm/hr)=     163.18        98.36
02297>                 over (min)        1.00         2.00
02298>      Storage Coeff.  (min)=         .25 (ii)    2.29 (ii)
02299>      Unit Hyd. Tpeak (min)=       1.00         2.00
02300>      Unit Hyd. peak  (cms)=       1.67          .51
02301>                                                          *TOTALS*
02302>      PEAK FLOW       (cms)=        .01          .00          .009 (iii)
02303>      TIME TO PEAK    (hrs)=       1.90         2.00         2.000
02304>      RUNOFF VOLUME    (mm)=      85.27        44.54        84.864
02305>      TOTAL RAINFALL   (mm)=      86.27        86.27        86.271
02306>      RUNOFF COEFFICIENT   =        .99          .52          .984
02307>
02308>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02309>            CN* =  80.0    Ia = Dep. Storage  (Above)
02310>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02311>            THAN THE STORAGE COEFFICIENT.
02312>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02313>
02314> ------------------------------------------------------------------------------
02315> 100:0014------------------------------------------------------------------------
02316> *# ADD TOTAL FLOWS TO GHENT
02317> -------------------------
02318> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02319> -------------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
02320>                       ID1 01:201_CTL      .62     .086    2.17  82.77    .000
02321>                      +ID2 02:201_OVF      .00     .000     .00    .00    .000
02322>                      +ID3 03:202          .05     .021    2.00  77.12    .000
02323>                       ========================================================
02324>                       SUM 06:PROP.GHENT    .67     .093    2.17  82.35    .000
02325>
02326>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02327>
02328> ------------------------------------------------------------------------------
02329> 100:0015------------------------------------------------------------------------
02330> *# ADD TOTAL FLOWS FROM SITE
02331> -------------------------
02332> | ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02333> -------------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
02334>                       ID1 06:PROP.GHENT    .67     .093    2.17  82.35    .000
02335>                      +ID2 04:203          .02     .009    2.00  84.86    .000
02336>                       ========================================================
02337>                       SUM 07:SITE.P2       .69     .097    2.00  82.43    .000
02338>
02339>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02340>
02341> ------------------------------------------------------------------------------
02342> 100:0016------------------------------------------------------------------------
02343> *# AREA CHECK
02344> -------------------------
02345> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02346> -------------------------                (ha)     (cms)   (hrs)   (mm)   (cms)
02347>                       ID1 10:EX.TOTAL      .69     .259    2.00  72.01    .000
02348>                      +ID2 07:SITE.P2       .69     .097    2.00  82.43    .000
02349>                       ========================================================
02350>                       SUM 09:CHECK         1.38     .356    2.00  77.22    .000
02351>
02352>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02353>
02354> ------------------------------------------------------------------------------
02355> 100:0017------------------------------------------------------------------------
02356> **#*********************************************************************|
02357> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
02358> *
02359> ------------------------------------------------------------------------------
02360> 100:0002------------------------------------------------------------------------
02361> *
02362> ------------------------------------------------------------------------------
02363> 100:0002------------------------------------------------------------------------
02364> *
02365> ------------------------------------------------------------------------------
02366> 100:0002------------------------------------------------------------------------
02367> *
02368> ------------------------------------------------------------------------------
02369> 100:0002------------------------------------------------------------------------
02370> *
02371> ------------------------------------------------------------------------------
02372> 100:0002------------------------------------------------------------------------
02373> *
02374>   ** END OF RUN : 199
02375>
02376> ******************************************************************************
02377>
02378>
02379>
02380>
02381>
02382> ---------------------
02383> | START            |  Project  dir.: T:\projects\20062\SWMHYMO\
02384> ---------------------  Rainfall dir.: T:\projects\20062\SWMHYMO\
02385>     TZERO =   .00 hrs on        0
02386>     METOUT=   2 (output = METRIC)
02387>     NRUN  = 200
02388>     NSTORM=   1
02389>               #  1=hazel.stm
02390> ------------------------------------------------------------------------------
02391> 200:0002------------------------------------------------------------------------
02392> *#*********************************************************************|
02393> *#  Project Name: BRANT & GHENT (PHASE 2)
02394> *#               BURLINGTON, ONTARIO
02395> *#  JOB NUMBER  : 20062
02396> *#       Date   : JUNE 2021
02397> *#    Revised   :
02398> *#    Company   : S. LLEWELLYN AND ASSOCIATES LTD.
02399> *#       File   : 20062B.DAT
02400> *#*********************************************************************|
02401> *
02402> ------------------------------------------------------------------------------
02403> 200:0002------------------------------------------------------------------------
02404> *
02405> ---------------------
02406> | READ STORM       |    Filename: Regional - Hurricane Hazel
02407> | Ptotal= 284.97 mm|    Comments: Regional - Hurricane Hazel
02408> ---------------------
02409>               TIME    RAIN |   TIME    RAIN |   TIME    RAIN |   TIME    RAIN
02410>                hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr |    hrs   mm/hr
02411>               1.00   2.027 |  13.00   2.027 |  25.00   2.027 |  37.00   6.000
02412>               2.00   2.027 |  14.00   2.027 |  26.00   2.027 |  38.00   4.000
02413>               3.00   2.027 |  15.00   2.027 |  27.00   2.027 |  39.00   6.000
02414>               4.00   2.027 |  16.00   2.027 |  28.00   2.027 |  40.00  13.000
02415>               5.00   2.027 |  17.00   2.027 |  29.00   2.027 |  41.00  17.000
02416>               6.00   2.027 |  18.00   2.027 |  30.00   2.027 |  42.00  13.000
02417>               7.00   2.027 |  19.00   2.027 |  31.00   2.027 |  43.00  23.000
02418>               8.00   2.027 |  20.00   2.027 |  32.00   2.027 |  44.00  13.000
02419>               9.00   2.027 |  21.00   2.027 |  33.00   2.027 |  45.00  13.000
02420>              10.00   2.027 |  22.00   2.027 |  34.00   2.027 |  46.00  53.000
02421>              11.00   2.027 |  23.00   2.027 |  35.00   2.027 |  47.00  38.000
02422>              12.00   2.027 |  24.00   2.027 |  36.00   2.027 |  48.00  13.000
02423>
02424> ------------------------------------------------------------------------------
02425> 200:0003------------------------------------------------------------------------
02426> *
02427> *#*********************************************************************|
02428> *#
02429> *#        PRE-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
02430> *#        ============================================================
```

```
02431> *#
02432> *#*************************************************************************|
02433> *# CATCHMENT 101 -  EXISTING DRAINAGE TO GHENT AVENUE
02434> *
02435> ----------------------
02436> | CALIB STANDHYD     |   Area    (ha)=     .61
02437> | 01:101    DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
02438> ----------------------
02439>                              IMPERVIOUS    PERVIOUS (i)
02440>      Surface Area     (ha)=        .43          .18
02441>      Dep. Storage     (mm)=       1.00         6.35
02442>      Average Slope     (%)=       2.00         2.50
02443>      Length            (m)=      20.00        10.00
02444>      Mannings n            =       .013         .250
02445>
02446>      Max.eff.Inten.(mm/hr)=      53.00        50.44
02447>                    over (min)        1.00         5.00
02448>      Storage Coeff.  (min)=       1.02 (ii)    4.80 (ii)
02449>      Unit Hyd. Tpeak (min)=       1.00         5.00
02450>      Unit Hyd. peak  (cms)=       1.06          .23
02451>                                                          *TOTALS*
02452>      PEAK FLOW       (cms)=        .06          .03          .088 (iii)
02453>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02454>      RUNOFF VOLUME    (mm)=     283.97       226.90       266.854
02455>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02456>      RUNOFF COEFFICIENT   =       1.00          .80          .936
02457>
02458>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02459>            CN* =  80.0    Ia = Dep. Storage  (Above)
02460>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02461>            THAN THE STORAGE COEFFICIENT.
02462>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02463>
02464> -------------------------------------------------------------------------------
02465> 200:0004----------------------------------------------------------------------
02466> *# CATCHMENT 102 -  EXISTING DRAINAGE TO BRANT STREET
02467> *
02468> ----------------------
02469> | CALIB STANDHYD     |   Area    (ha)=     .06
02470> | 02:102    DT= 1.00 |   Total Imp(%)=   64.00   Dir. Conn.(%)=   64.00
02471> ----------------------
02472>                              IMPERVIOUS    PERVIOUS (i)
02473>      Surface Area     (ha)=        .04          .02
02474>      Dep. Storage     (mm)=       1.00         6.35
02475>      Average Slope     (%)=       2.00         2.50
02476>      Length            (m)=      20.00        10.00
02477>      Mannings n            =       .013         .250
02478>
02479>      Max.eff.Inten.(mm/hr)=      53.00        50.44
02480>                    over (min)        1.00         5.00
02481>      Storage Coeff.  (min)=       1.02 (ii)    4.80 (ii)
02482>      Unit Hyd. Tpeak (min)=       1.00         5.00
02483>      Unit Hyd. peak  (cms)=       1.06          .23
02484>                                                          *TOTALS*
02485>      PEAK FLOW       (cms)=        .01          .00          .009 (iii)
02486>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02487>      RUNOFF VOLUME    (mm)=     283.97       226.91       263.431
02488>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02489>      RUNOFF COEFFICIENT   =       1.00          .80          .924
02490>
02491>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02492>            CN* =  80.0    Ia = Dep. Storage  (Above)
02493>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02494>            THAN THE STORAGE COEFFICIENT.
02495>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02496>
02497> -------------------------------------------------------------------------------
02498> 200:0005----------------------------------------------------------------------
02499> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
02500> *
02501> ----------------------
02502> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
02503> | 03:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02504> ----------------------   U.H. Tp(hrs)=    .040
02505>
02506>      Unit Hyd Qpeak  (cms)=     .019
02507>
02508>      PEAK FLOW       (cms)=     .003 (i)
02509>      TIME TO PEAK    (hrs)=   46.000
02510>      RUNOFF VOLUME    (mm)=  226.906
02511>      TOTAL RAINFALL   (mm)=  284.973
02512>      RUNOFF COEFFICIENT   =     .796
02513>
02514>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02515>
02516> -------------------------------------------------------------------------------
02517> 200:0006----------------------------------------------------------------------
02518> *# ADD TOTAL EX. FLOWS TO GHENT
02519> ------------------------
02520> | ADD HYD (EX.GHENT  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02521> ------------------------ -----------------(ha)-----(cms)---(hrs)---(mm)---(cms)
02522>                       ID1 01:101           .61      .088   46.00 266.85    .000
02523>                      +ID2 03:103           .02      .003   46.00 226.91    .000
02524>                       ================================================================
02525>                       SUM 04:EX.GHENT       .63      .091   46.00 265.59    .000
02526>
02527>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02528>
02529> -------------------------------------------------------------------------------
02530> 200:0007----------------------------------------------------------------------
02531> *# ADD TOTAL EX. FLOWS FROM STIE
02532> ------------------------
02533> | ADD HYD (EX.TOTAL  ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02534> ------------------------ -----------------(ha)-----(cms)---(hrs)---(mm)---(cms)
02535>                       ID1 04:EX.GHENT       .63      .091   46.00 265.59    .000
02536>                      +ID2 02:102           .06      .009   46.00 263.43    .000
02537>                       ================================================================
02538>                       SUM 10:EX.TOTAL       .69      .100   46.00 265.40    .000
02539>
02540>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02541>
02542> -------------------------------------------------------------------------------
02543> 200:0008----------------------------------------------------------------------
02544> *#*************************************************************************|
02545> *#
02546> *#        POST-DEVELOPMENT CONDITIONS HYDROLOGIC MODELING (PHASE 2)
02547> *#        ================================================
02548> *#
02549> **#************************************************************************|
02550> *# CATCHMENT 201 - CONTROLLED DISCHARGE TO GHENT AVENUE
02551> *
02552> ----------------------
02553> | CALIB STANDHYD     |   Area    (ha)=     .60
02554> | 01:201    DT= 1.00 |   Total Imp(%)=   97.00   Dir. Conn.(%)=   97.00
02555> ----------------------
02556>                              IMPERVIOUS    PERVIOUS (i)
02557>      Surface Area     (ha)=        .58          .02
02558>      Dep. Storage     (mm)=       1.00         6.35
02559>      Average Slope     (%)=       2.00         2.00
02560>      Length            (m)=      20.00        10.00
02561>      Mannings n            =       .013         .250
02562>
02563>      Max.eff.Inten.(mm/hr)=      53.00        50.44
02564>                    over (min)        1.00         5.00
02565>      Storage Coeff.  (min)=       1.02 (ii)    5.06 (ii)
02566>      Unit Hyd. Tpeak (min)=       1.00         5.00
02567>      Unit Hyd. peak  (cms)=       1.06          .22
02568>                                                          *TOTALS*
02569>      PEAK FLOW       (cms)=        .09          .00          .088 (iii)
02570>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02571>      RUNOFF VOLUME    (mm)=     283.97       226.90       282.261
02572>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02573>      RUNOFF COEFFICIENT   =       1.00          .80          .990
02574>
02575>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02576>            CN* =  80.0    Ia = Dep. Storage  (Above)
02577>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02578>            THAN THE STORAGE COEFFICIENT.
02579>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02580>
02581> -------------------------------------------------------------------------------
02582> 200:0009----------------------------------------------------------------------
02583> *# CATCHMENT 103 -  EXTERNAL (NORTH) DRAINAGE THROUGH SITE TO GHENT AVENUE
02584> *
02585> ----------------------
02586> | CALIB NASHYD       |   Area    (ha)=     .02   Curve Number   (CN)=80.00
02587> | 02:103    DT= 1.00 |   Ia      (mm)=   6.350   # of Linear Res.(N)= 3.00
02588> ----------------------   U.H. Tp(hrs)=    .040
02589>
02590>      Unit Hyd Qpeak  (cms)=     .019
02591>
02592>      PEAK FLOW       (cms)=     .003 (i)
02593>      TIME TO PEAK    (hrs)=   46.000
02594>      RUNOFF VOLUME    (mm)=  226.906
02595>      TOTAL RAINFALL   (mm)=  284.973
02596>      RUNOFF COEFFICIENT   =     .796
02597>
02598>      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02599>
02600> -------------------------------------------------------------------------------
02601> 200:0010----------------------------------------------------------------------
02602> *# ADD TOTAL FLOWS TO SWM TANK
02603> ------------------------
02604> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02605> ------------------------ -----------------(ha)-----(cms)---(hrs)---(mm)---(cms)
02606>                       ID1 01:201            .60      .088   46.00 282.26    .000
02607>                      +ID2 02:103           .02      .003   46.00 226.91    .000
02608>                       ================================================================
02609>                       SUM 03:PROP.GHENT     .62      .091   46.00 280.48    .000
02610>
02611>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02612>
02613> -------------------------------------------------------------------------------
02614> 200:0011----------------------------------------------------------------------
02615> *# ROUTE CATCHMENT 201 THROUGH ORIFICE PIPE
02616> *
02617> ----------------------
02618> | ROUTE RESERVOIR    |    Requested routing time step =  1.0 min.
02619> |  IN>03:(PROP.G)    |
02620> | OUT<01:(201_CT)    |    =========  OUTLFOW STORAGE TABLE  =========
02621> ----------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
02622>                             (cms)     (ha.m.)   |    (cms)    (ha.m.)
02623>                              .000  .0000E+00    |     .056  .1000E-01
02624>                              .056  .1800E-02    |     .056  .1300E-01
02625>                              .056  .1800E-02    |     .056  .1300E-01
02626>                              .056  .4500E-02    |     .103  .1600E-01
02627>                              .056  .7300E-02    |     .000  .0000E+00
02628>
02629>      ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
02630>      ---------------------       (ha)     (cms)     (hrs)       (mm)
02631>      INFLOW >03: (PROP.G)         .62      .091    46.000    280.476
02632>      OUTFLOW<01: (201_CT)         .62      .065    47.000    280.476
02633>     OVERFLOW<02: (201_OV)         .00      .000      .000       .000
02634>
02635>                     TOTAL NUMBER OF SIMULATED OVERFLOWS  =         0
02636>                     CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
02637>                     PERCENTAGE OF TIME OVERFLOWING    (%)=      .00
02638>
02639>
02640>                     PEAK   FLOW   REDUCTION [Qout/Qin](%)=   71.742
02641>                     TIME SHIFT OF PEAK FLOW          (min)=    60.00
02642>                     MAXIMUM  STORAGE   USED       (ha.m.)=.1361E-01
02643>
02644> -------------------------------------------------------------------------------
02645> 200:0012----------------------------------------------------------------------
02646> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO GHENT AVENUE
02647> *
02648> ----------------------
02649> | CALIB STANDHYD     |   Area    (ha)=     .05
02650> | 03:202    DT= 1.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
02651> ----------------------
02652>                              IMPERVIOUS    PERVIOUS (i)
02653>      Surface Area     (ha)=        .04          .01
02654>      Dep. Storage     (mm)=       1.00         6.35
02655>      Average Slope     (%)=       2.00         2.00
02656>      Length            (m)=       5.00         5.00
02657>      Mannings n            =       .013         .250
02658>
02659>      Max.eff.Inten.(mm/hr)=      53.00        50.46
02660>                    over (min)        1.00         3.00
02661>      Storage Coeff.  (min)=        .44 (ii)    3.11 (ii)
02662>      Unit Hyd. Tpeak (min)=       1.00         3.00
02663>      Unit Hyd. peak  (cms)=       1.52          .37
02664>                                                          *TOTALS*
02665>      PEAK FLOW       (cms)=        .01          .00          .007 (iii)
02666>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02667>      RUNOFF VOLUME    (mm)=     283.97       226.91       272.559
02668>      TOTAL RAINFALL   (mm)=     284.97       284.97       284.973
02669>      RUNOFF COEFFICIENT   =       1.00          .80          .956
02670>
02671>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02672>            CN* =  80.0    Ia = Dep. Storage  (Above)
02673>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02674>            THAN THE STORAGE COEFFICIENT.
02675>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02676>
02677> -------------------------------------------------------------------------------
02678> 200:0013----------------------------------------------------------------------
02679> *# CATCHMENT 202 - UNCONTROLLED DISCHARGE TO BRANT STREET
02680> *
02681> ----------------------
02682> | CALIB STANDHYD     |   Area    (ha)=     .02
02683> | 04:203    DT= 1.00 |   Total Imp(%)=   99.00   Dir. Conn.(%)=   99.00
02684> ----------------------
02685>                              IMPERVIOUS    PERVIOUS (i)
02686>      Surface Area     (ha)=        .02          .00
02687>      Dep. Storage     (mm)=       1.00         6.35
02688>      Average Slope     (%)=       3.00         2.00
02689>      Length            (m)=       5.00         5.00
02690>      Mannings n            =       .013         .250
02691>
02692>      Max.eff.Inten.(mm/hr)=      53.00        50.46
02693>                    over (min)        1.00         3.00
02694>      Storage Coeff.  (min)=        .39 (ii)    3.06 (ii)
02695>      Unit Hyd. Tpeak (min)=       1.00         3.00
02696>      Unit Hyd. peak  (cms)=       1.57          .37
02697>                                                          *TOTALS*
02698>      PEAK FLOW       (cms)=        .00          .00          .003 (iii)
02699>      TIME TO PEAK    (hrs)=      45.45        46.00        46.000
02700>      RUNOFF VOLUME    (mm)=     283.98       226.91       283.403
```

```
02701>      TOTAL RAINFALL   (mm)=     284.97       284.97        284.973
02702>      RUNOFF COEFFICIENT   =       1.00          .80           .994
02703>
02704>        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
02705>            CN* =  80.0    Ia = Dep. Storage  (Above)
02706>       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
02707>            THAN THE STORAGE COEFFICIENT.
02708>      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
02709>
02710> ------------------------------------------------------------------------------
02711> 200:0014-----------------------------------------------------------------------
02712> *# ADD TOTAL FLOWS TO GHENT
02713> ------------------------
02714> | ADD HYD (PROP.GHENT) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02715> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02716>                       ID1 01:201_CTL        .62     .065   47.00 280.48    .000
02717>                      +ID2 02:201_OVF        .00     .000     .00    .00    .000
02718>                      +ID3 03:202            .05     .007   46.00 272.56    .000
02719>                       ============================================================
02720>                       SUM 06:PROP.GHENT      .67     .071   47.00 279.89    .000
02721>
02722>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02723>
02724> ------------------------------------------------------------------------------
02725> 200:0015-----------------------------------------------------------------------
02726> *# ADD TOTAL FLOWS FROM SITE
02727> ------------------------
02728> | ADD HYD (SITE.P2   ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02729> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02730>                       ID1 06:PROP.GHENT      .67     .071   47.00 279.89    .000
02731>                      +ID2 04:203             .02     .003   46.00 283.40    .000
02732>                       ============================================================
02733>                       SUM 07:SITE.P2         .69     .073   47.00 279.99    .000
02734>
02735>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02736>
02737> ------------------------------------------------------------------------------
02738> 200:0016-----------------------------------------------------------------------
02739> *# AREA CHECK
02740> ------------------------
02741> | ADD HYD (CHECK     ) | ID: NHYD         AREA     QPEAK   TPEAK   R.V.    DWF
02742> ------------------------                  (ha)     (cms)   (hrs)   (mm)   (cms)
02743>                       ID1 10:EX.TOTAL        .69     .100   46.00 265.40    .000
02744>                      +ID2 07:SITE.P2         .69     .073   47.00 279.99    .000
02745>                       ============================================================
02746>                       SUM 09:CHECK          1.38     .172   46.00 272.69    .000
02747>
02748>    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
02749>
02750> ------------------------------------------------------------------------------
02751> 200:0017-----------------------------------------------------------------------
02752> **#*************************************************************************|
02753> * RUN REMAINING DESIGN STORMS (CITY OF BURLINGTON 5 TO 100-YR)
02754> *
02755> ------------------------------------------------------------------------------
02756> 200:0002-----------------------------------------------------------------------
02757> *
02758> ------------------------------------------------------------------------------
02759> 200:0002-----------------------------------------------------------------------
02760> *
02761> ------------------------------------------------------------------------------
02762> 200:0002-----------------------------------------------------------------------
02763> *
02764> ------------------------------------------------------------------------------
02765> 200:0002-----------------------------------------------------------------------
02766> *
02767> ------------------------------------------------------------------------------
02768> 200:0002-----------------------------------------------------------------------
02769> *
02770> ------------------------------------------------------------------------------
02771> 200:0002-----------------------------------------------------------------------
02772> *
02773>       FINISH
02774> ------------------------------------------------------------------------------
02775> ******************************************************************************
02776>      WARNINGS / ERRORS / NOTES
02777>      -------------------------
02778>    Simulation ended on 2021-06-03     at 13:27:17
02779> ==============================================================================
02780>
```

APPENDIX B

QUALITY CONTROL INFORMATION

Hydroworks Sizing Summary

20062 - 769-783 Brant Street, 2023&2027 Ghent Avenue Phase 2 of 3

06-03-2021

Recommended Size: HS 8

A HydroStorm HS 8 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.47 (ha) with an imperviousness of 77 % and Hamilton RBG, Ontario rainfall for the ETV Canada particle size distribution.

The recommended HydroStorm HS 8 treats 96 % of the annual runoff and provides 84 % annual TSS removal for the Hamilton RBG rainfall records and ETV Canada particle size distribution.

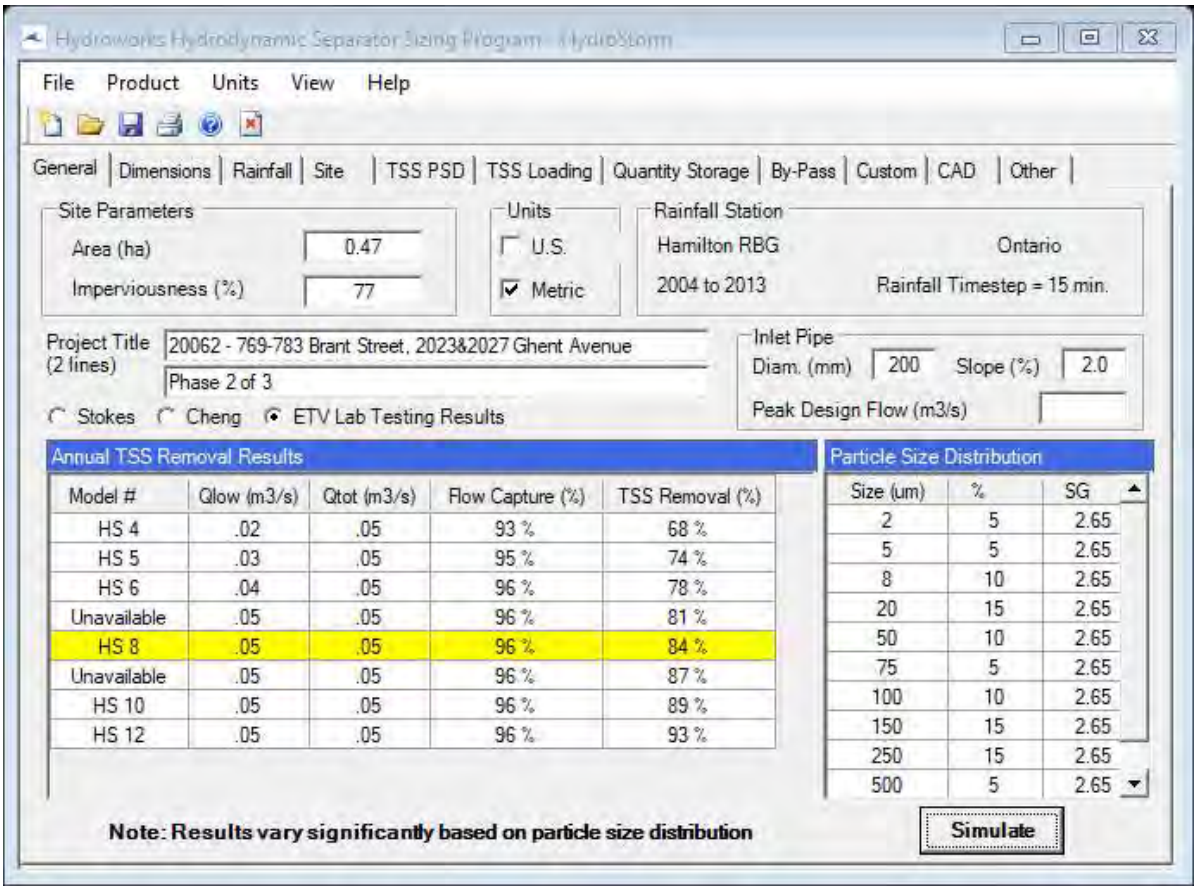
The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .05 (m3/s) for the given 200 (mm) pipe diameter at 2% slope. The headloss was calculated to be 116 (mm) based on a flow depth of 200 (mm) (full pipe flow).

This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

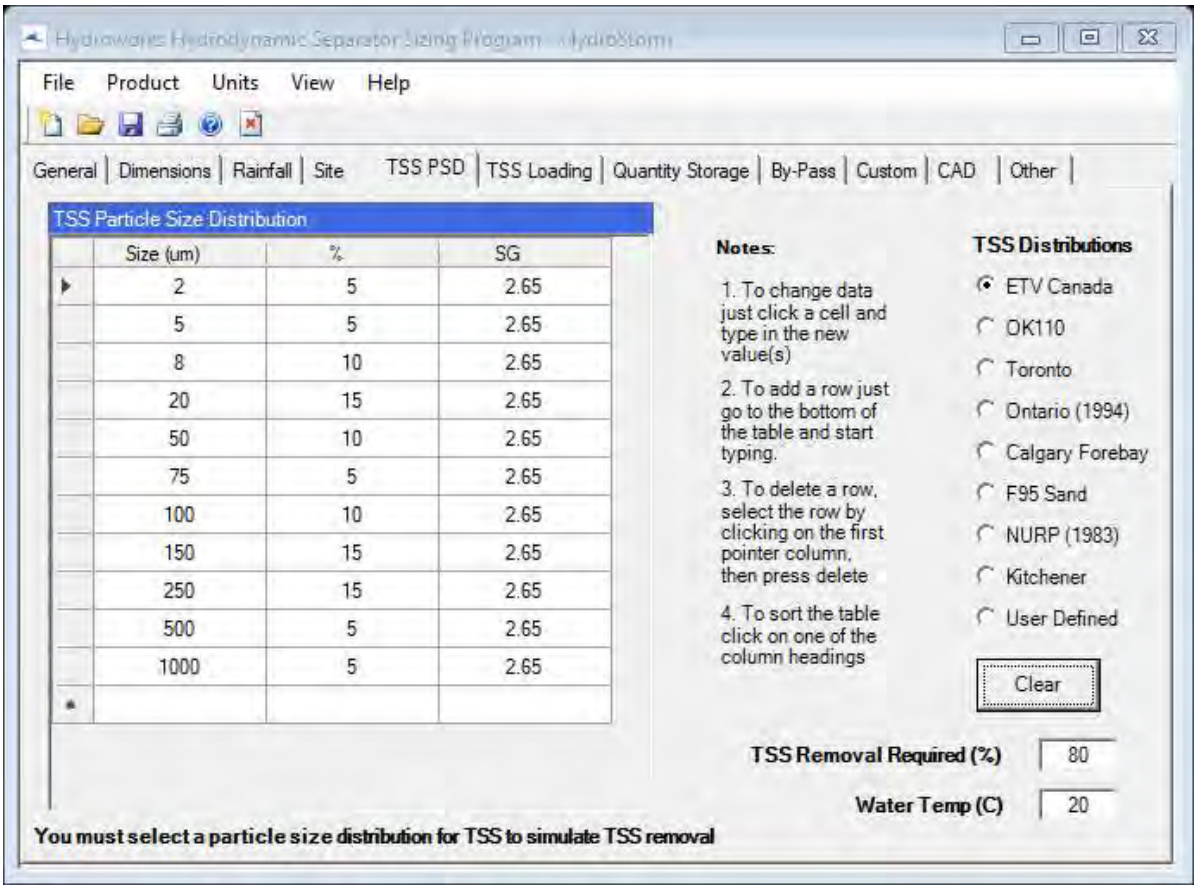
If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm . Design liability is only valid for lawsuits brought within the United States where Hydroworks has its corporate headquarters.

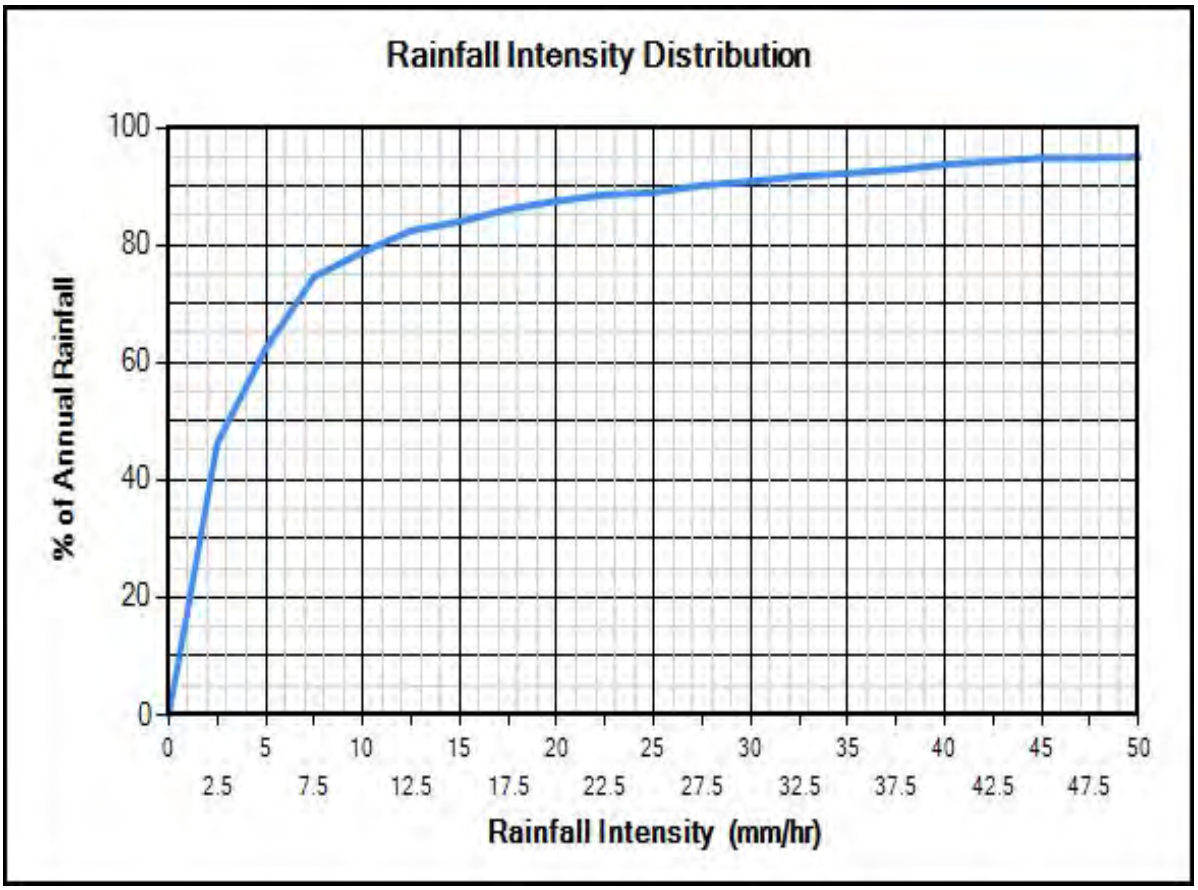
TSS Removal Sizing Summary



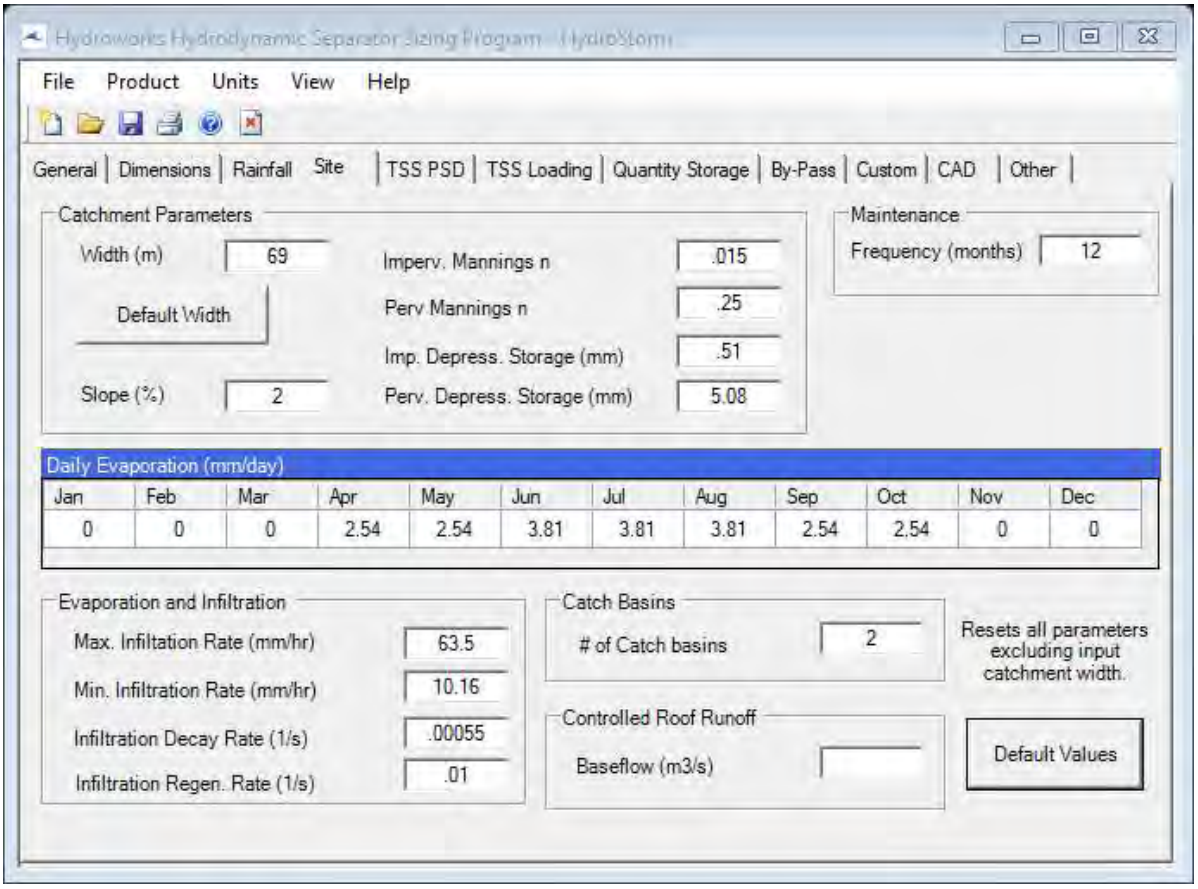
TSS Particle Size Distribution



Rainfall Station - Hamilton RBG, Ontario(2004 to 2013)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

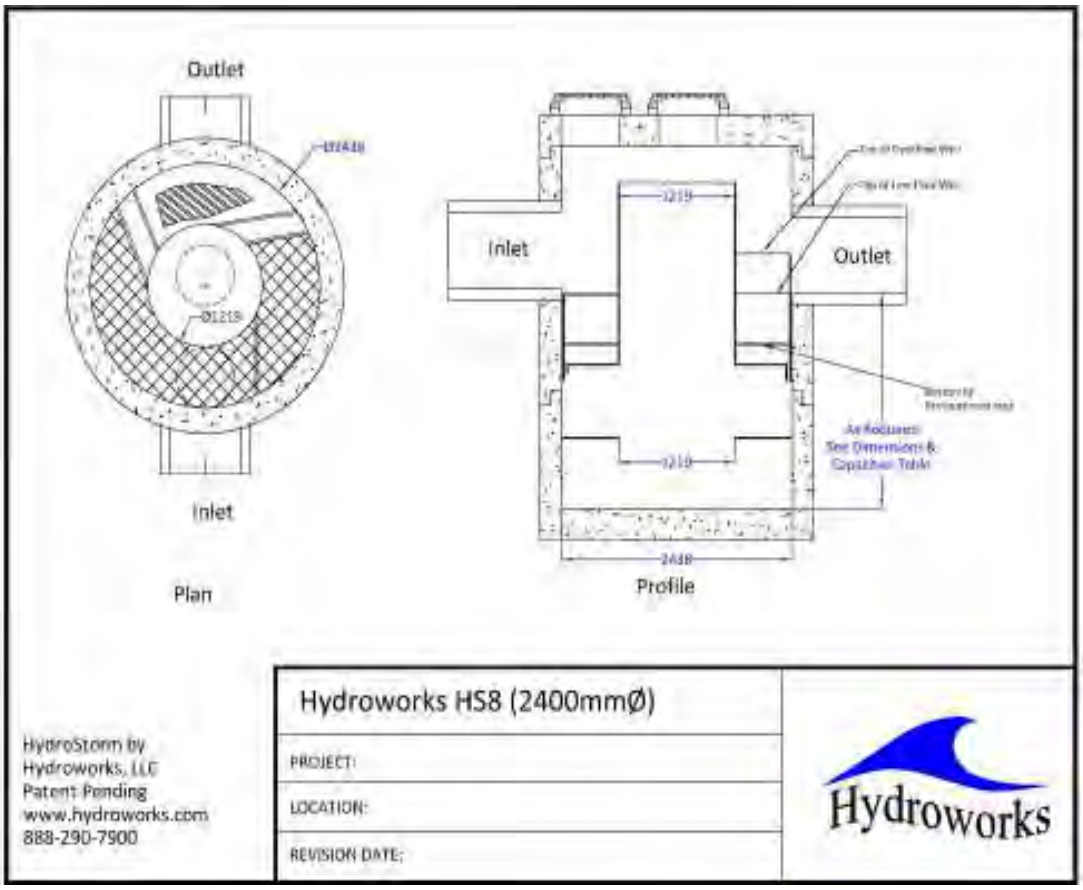
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

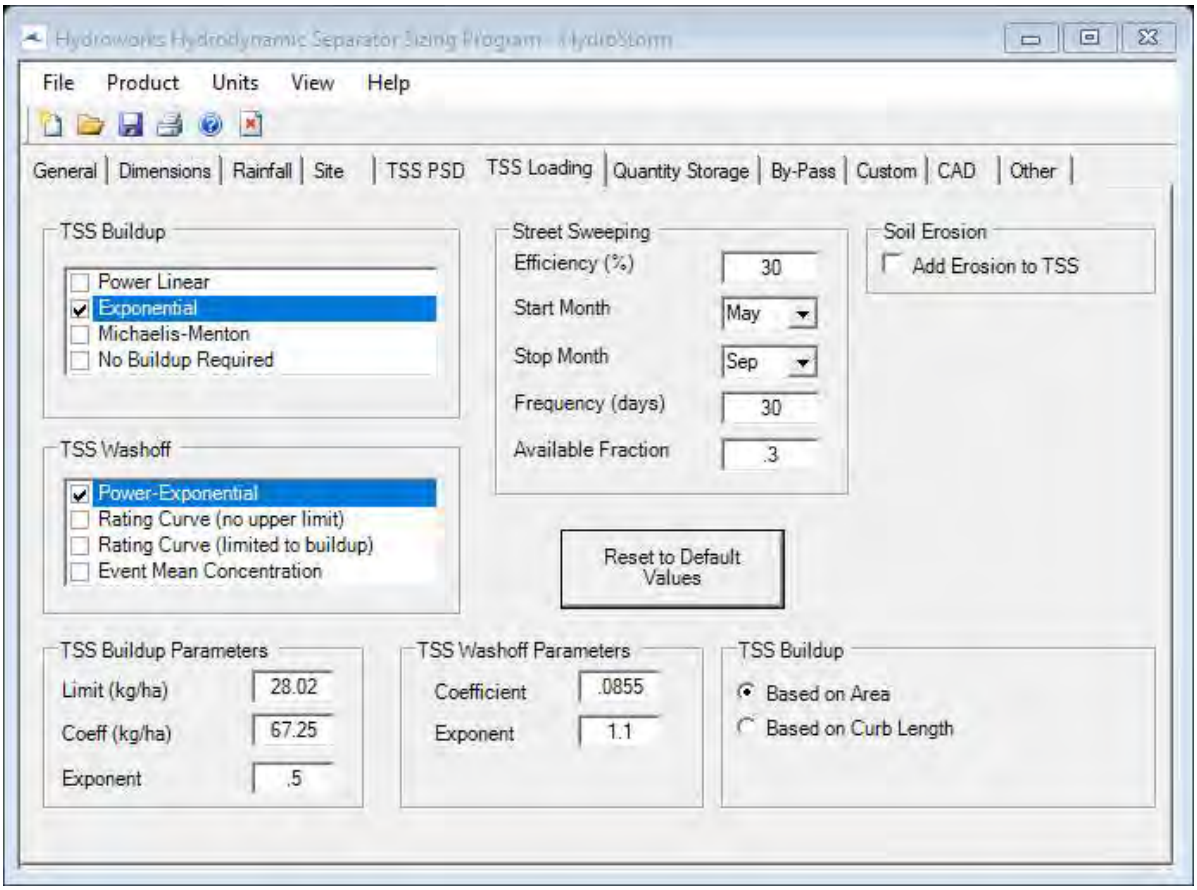
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 9	2.74	2.44	3242	9.3	14.4
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

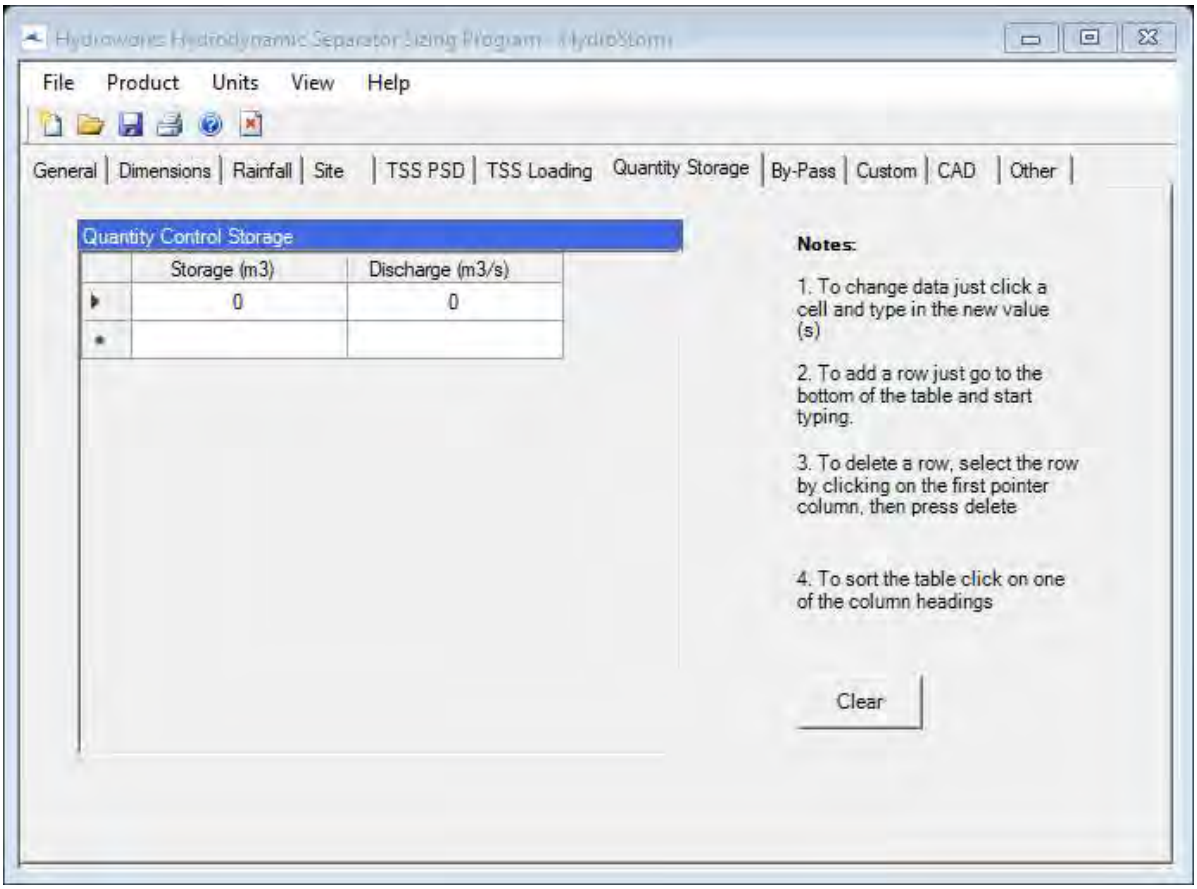
Generic HS 8 CAD Drawing



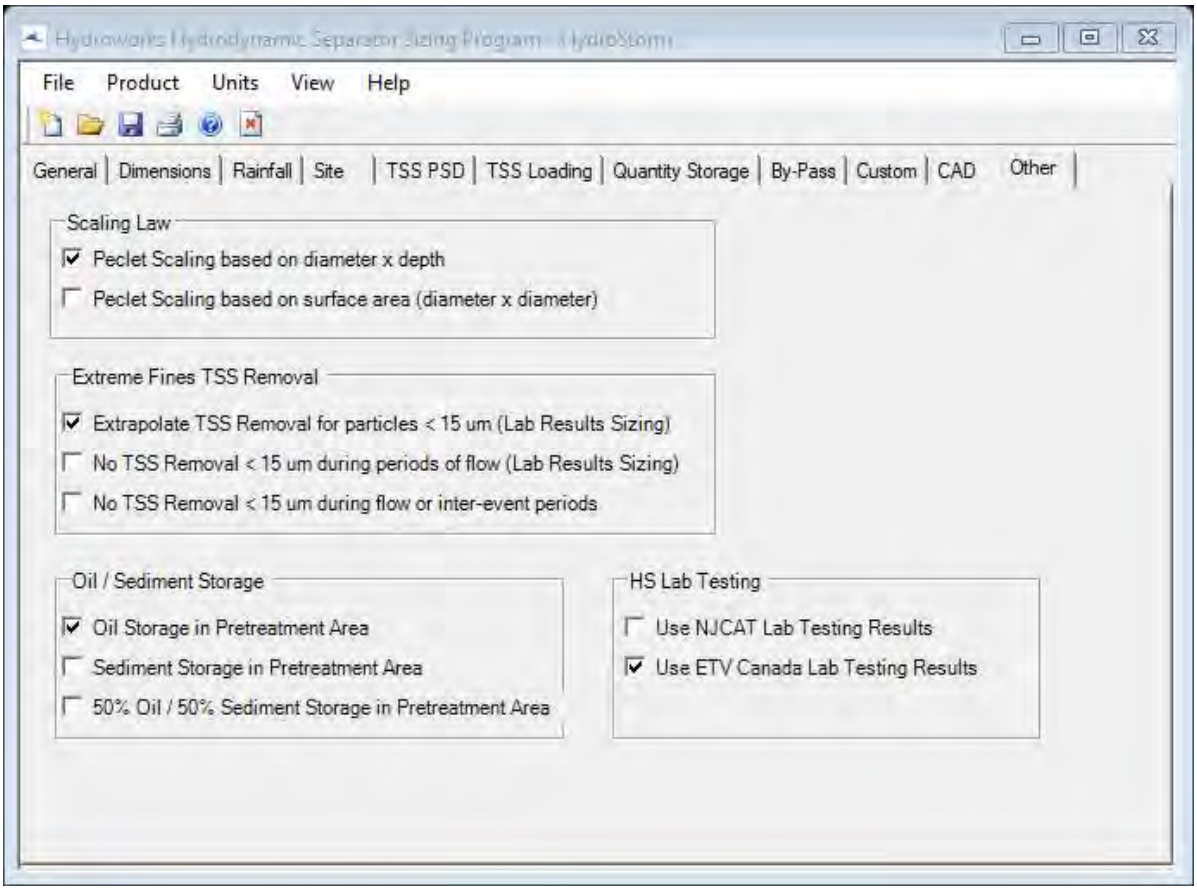
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 5.0
Copyright Hydroworks, LLC, 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.

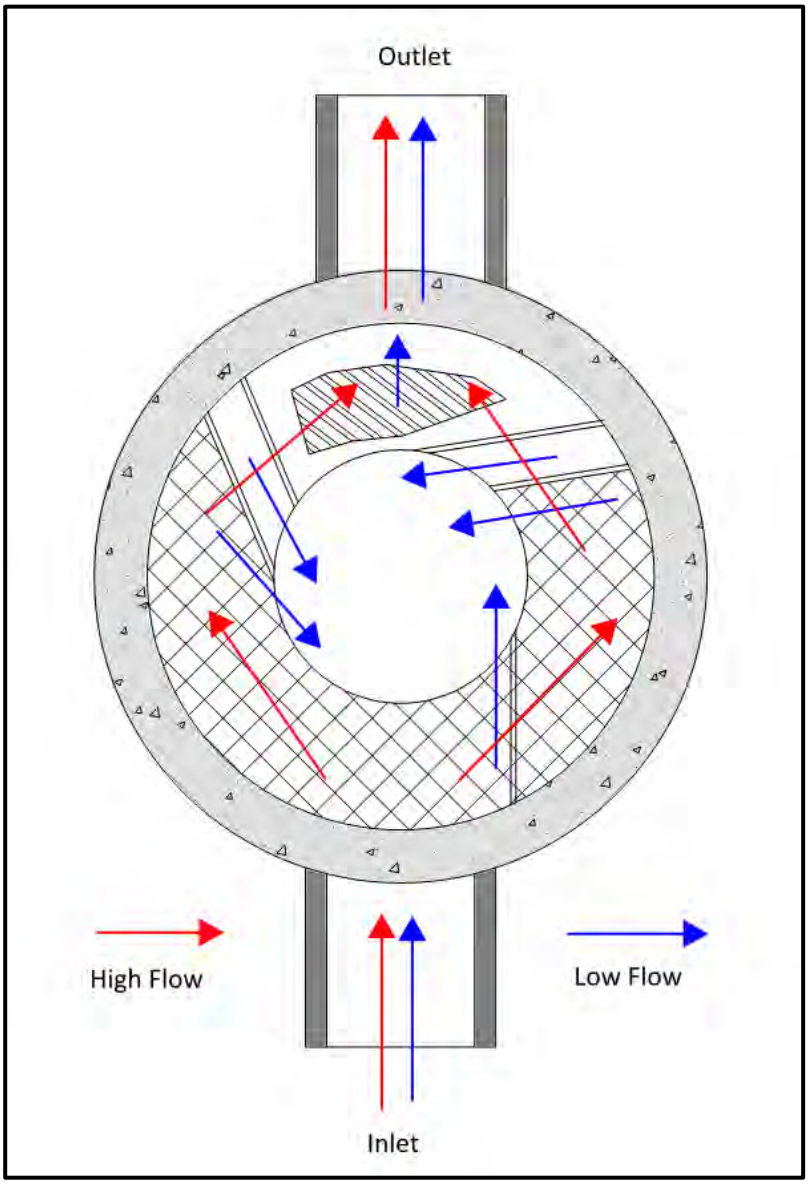


Figure 1. Hydroworks HydroStorm Operation – Plan View

Figure 2 is a profile view of the HydroStorm separator showing the flow patterns for low and high flows.

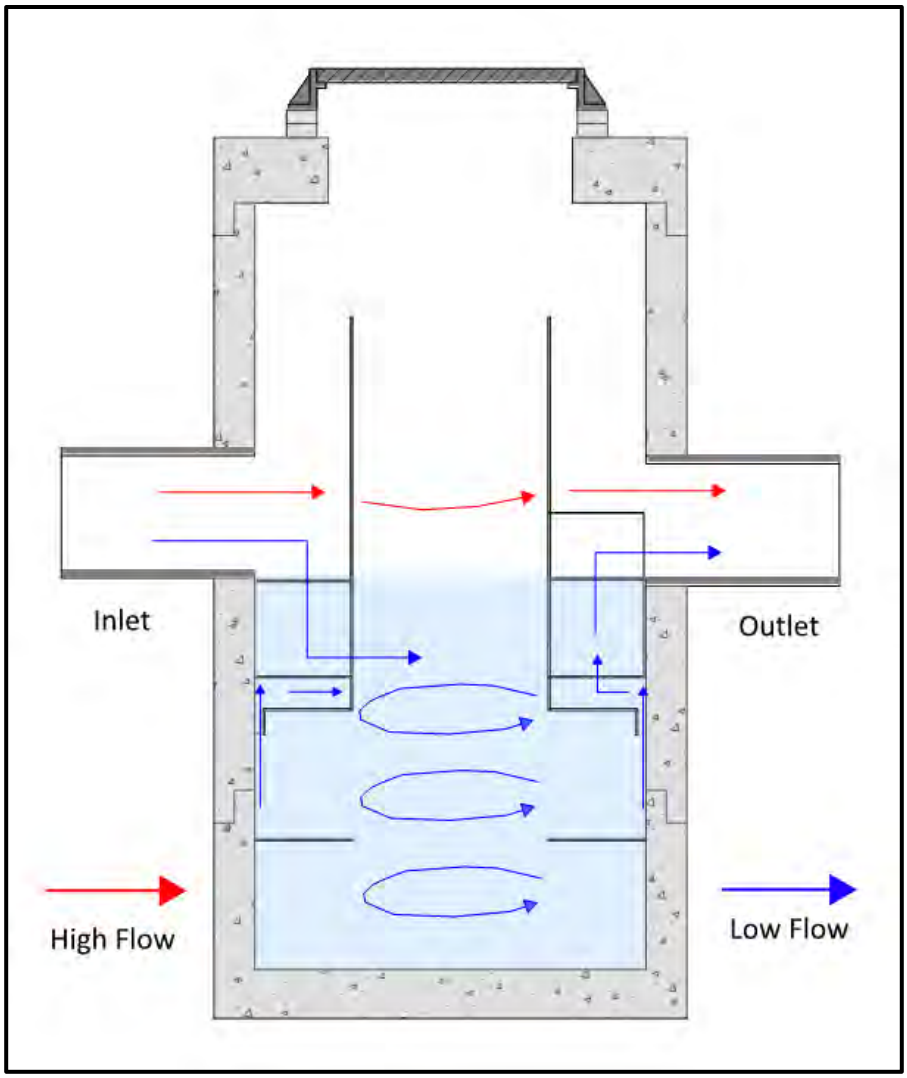


Figure 2. Hydroworks HydroStorm Operation – Profile View

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 sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all lows flows are properly treated. The whole funnel is removed for inspection and cleaning.

Hydroworks

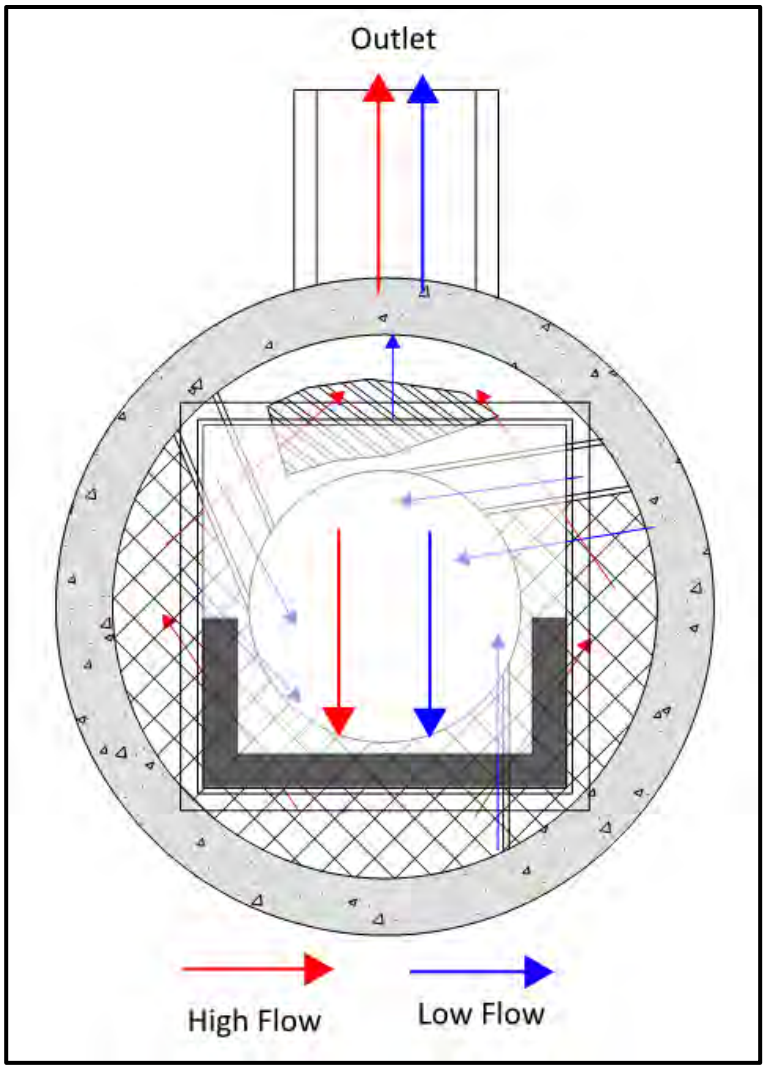


Figure 3. Hydroworks HS 4i Funnel

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.

Hydroworks

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).

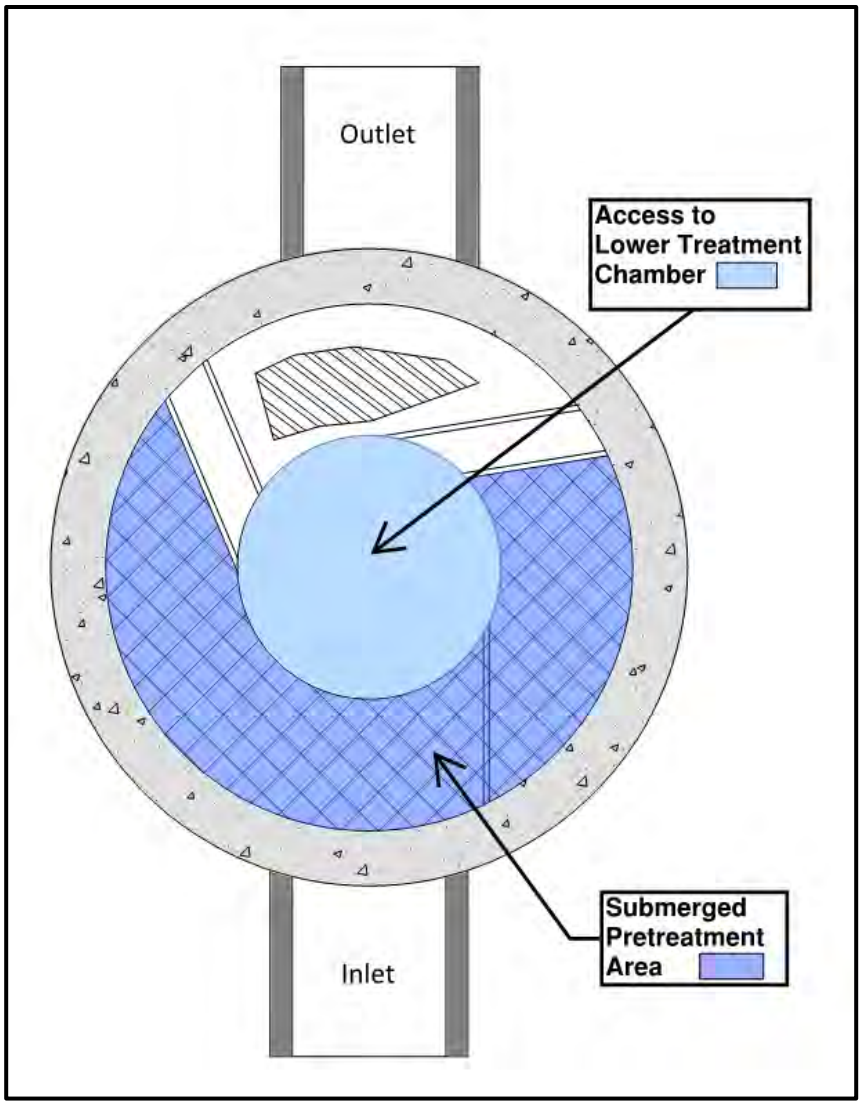


Figure 3. Maintenance Access

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

Other Comments:

Hydroworks

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.

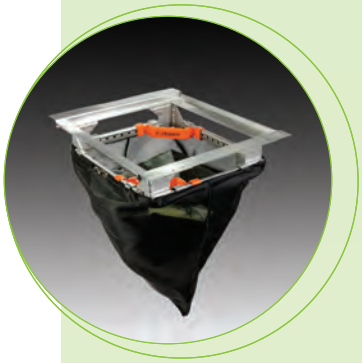
The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by 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.

FLEXSTORM® PURE PERMANENT INLET PROTECTION



SPECIFY WITH CONFIDENCE

State DOTs and municipalities across the country now have a universal structural BMP to address the issue of storm sewer inlet protection: FLEXSTORM PURE Inlet Filters.

The FLEXSTORM PURE system is the preferred choice for permanent inlet protection and storm water runoff control. Constructed of versatile stainless steel, FLEXSTORM PURE Inlet Filters will fit any drainage structure and are available with site-specific filter bags providing various levels of filtration. Whether you're the specifier or the user, it's clear to see how FLEXSTORM PURE Inlet Filters outperform the competition.

APPLICATIONS:

Car Washes	Gas Stations
Commercial	Parking Lots
Loading Ramps	Dock Drains
Industrial	Maintenance

FEATURES:

- Stainless Steel filter framing is custom configured to fit perfectly into any drainage structure, whether a standard design or obstructed inlet opening
- Filtered Flow Rates and Ultimate Bypass Rates are designed to meet your specific inlet requirements
- Multiple Filter Bags are available targeting site specific removal of trash, litter, leaves, or small particles, oil and grease
- Filters work below grade with an ultimate bypass allowing inlet area to drain with a full bag
- Units install in seconds and are easily maintained with the FLEXSTORM Universal Removal Tool (no heavy machinery required)

FEATURES:

- Receive payback on your investment: durable stainless steel framing provides extended service life while replaceable filter bags handle loads with a safety factor of 5
- Meets stringent removal requirements:
  - FX filter bags are rated for >80% removal efficiency of street sweep-size particles
  - PC/PC+ filter bags have been tested to 99% TSS removal of OK-110 US Silica Sand and 97% TPH (total petroleum hydrocarbon) removal
- Help prevent fines: FLEXSTORM Inlet Filters comply with EPA NPDES initiatives as a temporary or permanent BMP
- If not in stock, orders up to 100 pieces can ship within 48 hours



ADS Service: ADS representatives are committed to providing you with the answers to all your questions, including selecting the proper filter, specifications, installation and more. Also try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com

FLEXSTORM PURE INLET FILTERS SPECIFICATION

IDENTIFICATION

The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size, or other information will be necessary to finalize the FLEXSTORM part number and dimensions. The units are shipped to the field configured precisely to fit the identified drainage structure.

MATERIAL AND PERFORMANCE

The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment. The standard Woven Polypropylene FX filter bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The Post Construction PC filter bags are rated for 137 gpm/sqft and have been 3rd party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

INSTALLATION

Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drainage structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

INSPECTION FREQUENCY

Construction site inspection should occur following each ½" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with mild year round rainfall and four times per year (every three months Feb–Nov) in areas with summer rains and before and after the winter snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

MAINTENANCE GUIDELINES

Empty the filter bag if more than half filled with sediment and debris, or as directed by the engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift from the drainage structure. Dispose of the sediment or debris as directed by the engineer or maintenance contract in accordance with EPA guidelines.

As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked-on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to ½" diameter or greater on the lower half of the bag. Post Construction PC/PC+ Bags should be maintained prior to 50% oil saturation. The average 2' x 2' PC filter bag will retain approx. 96 oz (5.4 lbs) of oil at which time it should be serviced or replaced. It can be centrifuged or passed through a wringer to recover the oils, and the fabric reused with 85% to 90% efficacy. It may also be recycled for its fuel value through waste to energy incineration. When utilizing the Cleartec Rubberizer Pouches in the + bags, note that these oil skimmers will gradually turn brown and solidify as they become saturated, indicating time for replacement. Each pouch will absorb approximately 62 oz (4 lbs) of oil before requiring replacement. The spent media may also be recycled for its fuel value through waste to energy incineration. Dispose of all oil contaminated products in accordance with EPA guidelines.

FILTER BAG REPLACEMENT

Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band, and use a screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band.

Lift Handles ease installation and maintenance



Replaceable Sediment Bag

1/8" thick steel hangers & channels; precision stampings **configured to fit each individual casting**



CAD drawings, work instructions and test reports on website: ***www.inletfilters.com***



For more information on FLEXSTORM Inlet Filters and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710
Try the ADS FLEXSTORM Online Product Configurator at www.inletfilters.com.

ADS "Terms and Conditions of Sale" are available on the ADS website, www.ads-pipe.com
The ADS logo and the Green Stripe are registered trademarks of Advanced Drainage Systems, Inc. FLEXSTORM is a registered trademark of Inlet & Pipe Protection, Inc.
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APPENDIX C

WATER ANALYSIS INFORMATION

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Project Number: **20062**
Project Name: **769-783 Brant Street & 2023-2033 Ghent Avenue**
Date: **07-May-21**

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 1999).

An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\sqrt{A} \qquad \textbf{(1)}$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible).
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

	Building Area				(1)		(2)			(3)		(4)		Final Adjusted Fire Flow	
Building / Location	Footprint Area (m^2)	# of Storeys	**Total GFA (m^2)**	Type of Construction	***Fire Flow "F"*** (l/min)	(l/s)	***Occupancy*** %	Adjustment (l/min)	**Adjusted Fire Flow (l/min)**	***Sprinkler*** %	Adjustment (l/min)	***Exposure*** %	Adjustment (l/min)	**(l/min)**	**(l/s)**
Mix-use Building	10933	1	**10932.5**	0.6	14000	233.3	**-15**	-2100.0	**11900.0**	**-50**	-5950.0	**35**	4165.0	**10000**	**167**

Total Area Calculation:

Floor	Area	Tot. Area	Cumm. Area
1	2330	2330	2330
2	2180	2180	4510
3	2181	1091	5601
4	1551	776	6376
5	1358	679	7055
6	1551	776	7831
7	1551	776	8606
8	1551	776	9382
9	1551	776	10157
10	1551	776	**10933**

Two largest ajoining floors plus 50% of any floors immediately above them up to eight floors

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

(3) Sprinkler

Minimum credit for systems designed to NFPA 13 is 30%.

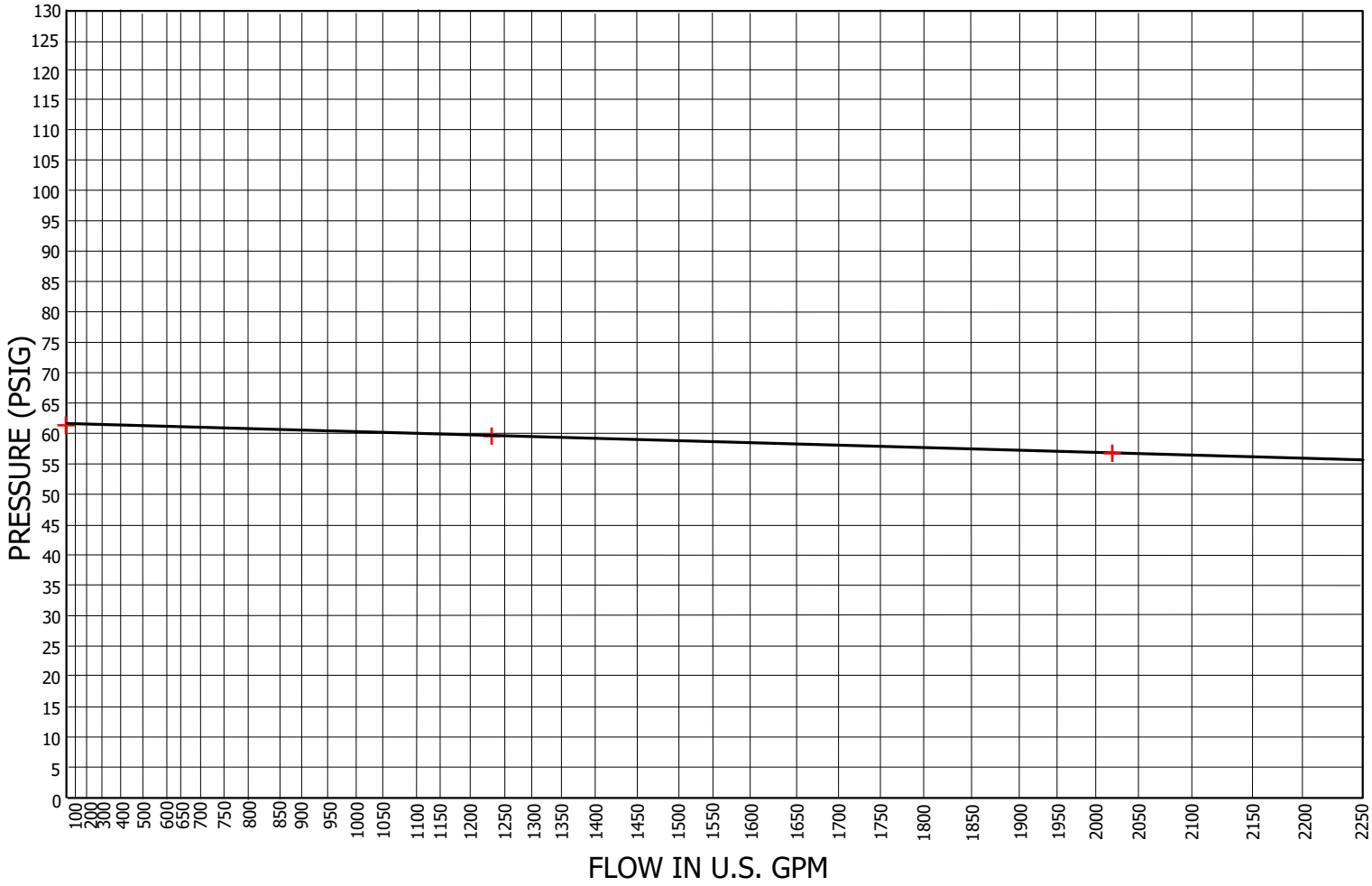
If the domestic and fire services are supplied by the same municipal water system, then take an additional 10%.

If the sprinkler system is fully supervised (ie. annunciator panel that alerts the Fire Dept., such as a school), then an additional 10% can be taken. Maximum credit = 50%.

(4) Exposure

0 to 3m	25%	
3.1 to 10m	20%	Calculate for all
10.1 to 20m	15%	sides. Maximum
20.1 to 30m	10%	charge shall not
30.1 to 45m	5%	exceed 75%

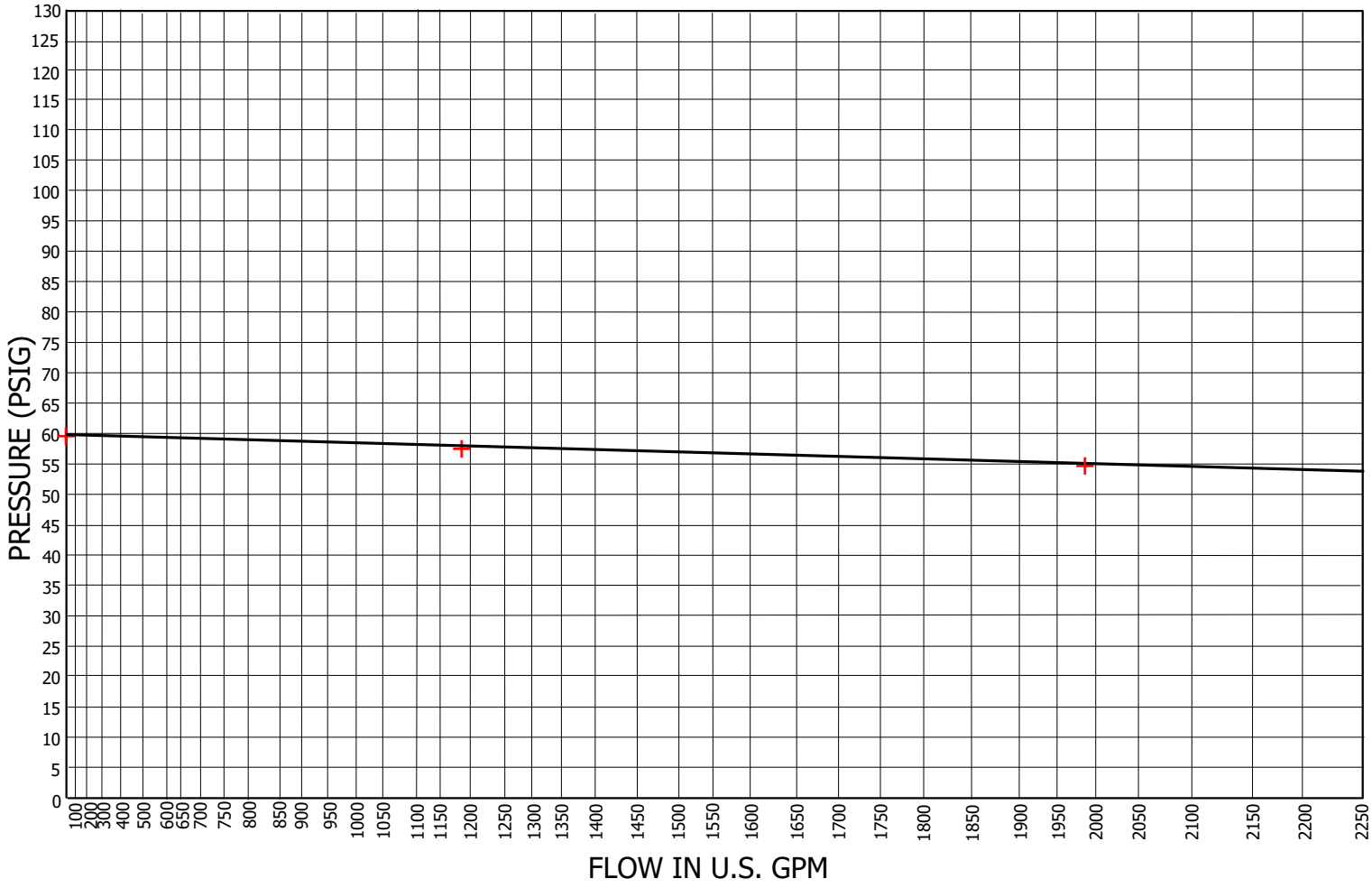
Side	Exposure	Charge (%)
North =	30.1 to 40m	5
South =	30.1 to 40m	5
East =	20.1 to 30m	10
West =	10.1 to 20m	15
Total Expoure =		***35***



# of Ports	PORT DIA. (in/mm)	PITOT (psig)	FLOW (usgpm)	RESIDUAL (psig)
1	2.50/63	54	1233	60
2	2.50/63	36/36	2014	57
THEORETICAL FLOW @ 20psi			7355	

General Data	
Test Date	23 October 2020
Test Time	08:30am
Pipe Dia.	16"
Static	62

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Front of 786 Brant Street
Location of Base Hydrant	Front of 760 Brant Street
Technician's Comments	No conversion factor used for flow calculation based on round and flush internal nozzle
	configuration. Flow testing has been conducted in accrodance with NFPA 291 guidelines
	wherever possible. Refer to attached report for further information.
	Verified By: Mark Schmidt



# of Ports	PORT DIA. (in/mm)	PITOT (psig)	FLOW (usgpm)	RESIDUAL (psig)
1	2.50/63	46	1138	58
2	2.50/63	28/28	1776	55
THEORETICAL FLOW @ 20psi			5737	

General Data	
Test Date	23 October 2020
Test Time	09:30am
Pipe Dia.	10"
Static	60

Site Information	
Site or Developer Name	S. Llewellyn & Associates
Site Address/Municipality	Brant Street, Burlington
Location of Test Hydrant	Near 2047 Ghent Avenue
Location of Base Hydrant	Ghent Avenue, 1st East of Brant Street
Technician's Comments	No conversion factor used for flow calculation based on round and flush internal nozzle
	configuration. Flow testing has been conducted in accrodance with NFPA 291 guidelines
	wherever possible. Refer to attached report for further information.
	Verified By: Mark Schmidt

APPENDIX D

HYDROGEOLOGICAL INVESTIGATION

LANDTEK LIMITED
Consulting Engineers
205 Nebo Road, Unit 3
Hamilton, Ontario
Canada
L8W 2E1
Phone: 905-383-3733
Fax: 905-383-8433
engineering@landteklimited.com
www.landteklimited.com

Hydrogeological Investigation
Proposed Development
Phase 2 – Lot B
769-789 Brant Street & 2023-2031 Ghent Avenue
Burlington, Ontario

Prepared for:
Brant Street Joint Venture
c/o Molinaro Group
472 Brock Avenue, Unit 103
Burlington, Ontario
L7S 1N1

Landtek File: 20255-B
May 25, 2021

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Proposed Development	Brant Street Joint Venture is intending to develop the site identified as civic addresses 769, 779, 783, & 782 Brant Street and 2023, 2027, & 2031 Ghent Avenue in Burlington, Ontario. It is understood that the proposed development is to consist of one 25-storey tower with a surrounding one-, two-, three-, seven-, eight- and ten-storey podiums; with two levels of basement parking across the full Site.
Report Deliverables	The Hydrogeological Investigation is required to assess the current site groundwater conditions, determine potential development/post development effects of the proposed development; and provide monitoring and mitigation plans for the development.

SITE DETAILS AND SETTING

Coordinates	596574, 4798566	**Site Area (approx.)**	6,598 m^2 (1.66 acres)
Site Description	The site is situated in a developed predominantly mixed commercial and residential area and is bounded by Brant Street to the southwest and Ghent Avenue to the northeast. Residential premises bound the site to the north and east. The site is currently the location of three 1- to 2-storey commercial buildings and three residential buildings with associated garages and sheds situated along Brant Street and Ghent Avenue respectively. The remainder of the site comprises a commercial parking lot. It is understood that the existing buildings are to be demolished.		
Geology	Asphalt was encountered at the ground surface. Underlying the pavement structure is fill comprising primarily of sand, silt, and clay. The fill extends to depths of between 1.5 m and 3.0 m. Underlying the fill is clayey silt till. The till extends to depths of between 3.5 m and 4.0 m below existing pavement surface. Red shale bedrock was encountered underlying the till.		
Groundwater	Depths to groundwater in monitoring wells installed at the Site were obtained manually on September 21 and 24, 2020, January 14, February 23, March 17, April 12, April 22, and May10, 2021. It was determined that depth to groundwater ranged from 1.63 to 2.34 metres below ground surface.		

DEWATERING CONSIDERATIONS

Short Term	Dewatering rate outside periods of active precipitation was estimated to be approximately 153,054 L/day (~153 m3/day); while Dewatering during Spring/active precipitation period: is estimated to be approximately 153,054 L/day (radial flow into excavation) + 660,000 L/day (direct precipitation) = 813,054 L/day or ~813 m^3/day. Normal condition is considered to be weather conditions that should be expected during the operation of the construction dewatering but excludes extreme weather events.
Long Term	It is proposed that the basement parking be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. As a result, long term dewatering will not be required at the Site.
Monitoring and Mitigation Plans	Monitoring and mitigation plans are provided. These include dewatering abstraction and settlement monitoring and responses; and limiting adverse dewatering related settlement and adverse effects on surface water bodies.

PERMIT CONSIDERATIONS

PTTW	Construction dewatering will be required only during the construction phase of the project, as it is proposed that the underground parking be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. This consideration is based on a 100 year-storm event for the City of Burlington. As a result, the maximum dewatering rate of groundwater for the proposed excavation is estimated to be approximately 813,054 L/day or ~813 m^3/day (radial inflow and direct precipitation). A permit to take water (PTTW) is required for this volume of water taking, as the estimated water taking is more than 400,000 L/day.

WATER BALANCE

Maintenance of Groundwater Recharge	The site is considered to have enhanced groundwater recharge due to additional landscape development at the site. Infiltration value is expected to increase from 208 to 219 m^3/year based on the water balance calculations. This increase in infiltration indicates that approximately 10% water surplus at the site. As a result, percentage of water collected from roof area required to match pre-development infiltration= 0%.

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1.0 INTRODUCTION

1.1 Background

Landtek Limited (Landtek) was retained by Molinaro Group to complete a Hydrogeological Investigation for the proposed development at Brant Street and Ghent Avenue (Phase 2) in Burlington, Ontario (the 'site' or 'development property').

The Site is irregular in shape and comprises an area of approximately 6,598 m^2 (1.63 acres) of developed land located to the west corner area of the intersection of the Brant Street and Ghent Avenue in Burlington, north of Brant Street. The Site is bound by Brant Street to the south, Ghent Avenue to the East, and developed properties to the West and North.

It is understood that the proposed development is to consist of one 25-storey tower with a surrounding one-, two-, three-, seven-, eight- and ten-storey podiums; with two levels of basement parking across the full Site.

A site location plan showing the Study Area for this investigation is presented on Figure 1 in Appendix A. The proposed development Site plan, and Dewatering assessment plan are shown on Figures 2 and 3, respectively in Appendix A.

The purpose of the Hydrogeological Investigation is to evaluate the current conditions of the Site, delineate possible development/post-development effects, and suggest mitigation measures to minimize the effects to the shallow groundwater system post-development. Specifically, the report provides the following:

- A description of the hydrogeologic setting of the property and a summary of the existing soil and groundwater conditions at the Site.
- Identification of hydrogeologic features such as zones of significant groundwater recharge and discharge.
- Assessment of the requirement for groundwater control during construction, if any.
- A detailed water budget for the Site based on the current and proposed Site development plans and recommendations for mitigation measures in order to maintain groundwater infiltration and aquifer recharge in the area.

1.2 Work Scope and Report Organization

The scope of work for this investigation includes the following:

- *Review of available background information.* A review of published works was done of available geologic and hydrogeologic information for the site including topographic and geologic maps. Meteorological data was reviewed to assess the local climate and to use the information for water balance calculations.
- *Site Assessment.* A detailed visual inspection of the site and surrounding area was completed to identify and document local topography, surface water drainage features, and the potential presence of significant hydrogeologic features such as closed.

depressions (areas of ground water recharge), seeps, springs, or the presence of phreatophytic vegetation.

- *A subsurface investigation.* Boreholes were drilled at the site and completed as monitoring wells. The subsurface investigation of the property was done to characterize the overburden and/or bedrock beneath the site as well as assess the site-specific groundwater conditions.

- *Water Balance.* A water balance of pre- and post-development scenarios for the site was completed, including suggestions for mitigation measures that could be implemented in order to maintain shallow groundwater recharge conditions.

- *Hydraulic Conductivity Tests.* In-situ rising head tests were completed in all monitoring wells to assess overburden permeability.

- *Groundwater Monitoring.* Groundwater level monitoring was conducted in all four monitoring wells in order to assess the depth in groundwater levels across the site.

The report is organized as follows:

Section 1 contains a brief introduction to the project and the scope of work undertaken by Landtek.

Section 2 outlines the methodologies followed during completion of the desktop study and the field investigation.

Section 3 summarizes the findings of the investigation. It includes:
- a description of the physical setting
- the results of the field investigation

Section 4 provides Water Taking Evaluation and Impact Assessment

Section 5 provides Monitoring Plan.

Section 6 provides Mitigation Plan.

Section 7 provides Site Development, Hydrogeology and Water Balance.

Section 8 provides Summary and Conclusions.

Section 9 provides Recommendations.

Section 10 provides Closure.

Section 11 provides References.

Section 12 provides Limitations.

2.0 METHODOLOGY

2.1 Desktop Study

A review of published works, existing site reports and available geologic and hydrogeological information for the site including topographic and geologic maps was completed.

Climate data for the period of 1981 to 2010 was obtained from Environment Canada publications and from the Hamilton A station (Hamilton Airport) to assess the local climate and to use the information for water balance calculations.

The MOE water well database for the local area was also accessed and the individual well records were obtained for wells that are located in the Study Area. The Study Area is defined, as an area extending 500 m outward from the edge of the excavation for the proposed basement parking levels.

2.2 Site Inspection to Assess Hydrogeologic Features

A detailed site inspection was conducted on August 24, 2020 to assess the presence of features which may be of Hydrogeologic significance. In particular, the site was inspected to assess the following:

- The presence of closed drainage features, depressions, or sandy areas which may allow for ponding and significant or enhanced infiltration of water.
- Assessment of the presence of phreatophytic vegetation which may indicate seasonally high groundwater levels and/or groundwater discharge and seepage.
- Identification of any zones of visible seepage or groundwater discharge.

2.3 Field Investigation

2.3.1 Drilling and Well Installation

Drilling: Landtek's investigation involved the advancement of eleven (11) boreholes, on August 31 to September 2, 2020, at the project area (four at the Site, four at the south adjacent property across Brant Street (774, 778, 780, and 782 Brant Street); and three at the east adjacent property, Ghent Avenue (747 and 761 Brant Street). All three properties are concomitantly connected hydrogeologically. The boreholes were drilled to log the stratigraphy and collect samples for laboratory testing. Six (6) of the eleven boreholes were completed as monitoring wells MW1, MW4, MW5, MW8, MW9, and MW11 to depths ranging from 9.1 m to 18.4 meter below ground surface (mbgs). The boreholes were advanced by Determination Pontil Drilling and were drilled using a CME 75 track-mounted drill rig, with hollow stem augers [150 mm outer diameter (OD) and 100 mm inner diameter (ID)]. Representative soil samples were retained for logging purposes and for subsequent grain-size composition analysis.

The drilling was supervised by an experienced Landtek soil technician, who also prepared borehole logs. The borehole logs are included in Appendix B of this report.

The monitoring wells MW1, MW4, MW5, MW8, MW9, and MW11 were constructed with 50 mm inner diameter, Schedule 40 machine slotted PVC screens equipped with a bottom cap,

and machine threaded riser pipe. The screen length and slot size are 3.0 m, and 0.10-inch, respectively.

The annular space between the PVC riser pipes and each borehole wall was backfilled to at least 0.3 m above the top of the screen with silica sand (No. 2). A bentonite seal was placed immediately above the sand pack to a height just below grade. Each monitoring well was finished with a protective steel casing, which was cemented in-place.

The boreholes and monitoring well locations are shown on Figure 4 in Appendix A, and well construction details are provided below in Table 1.

Table 1. Well Construction Details

Well ID	Ground Surface Elevation [masl*]	Well Diameter [mm]	Well Depth [mbgs]	Well UTMs**		Bentonite Seal Depth [masl]		Well Screen Depth [masl]	
				Easting	Northing	Top	Bottom	Top	Bottom
BH/MW1	92.80	50	18.4	596475.6	4798472.4	92.25	77.70	77.40	74.40
BH/MW4	91.53	50	18.4	596530.5	4798499.0	91.23	76.43	76.13	73.13
BH/MW5	91.77	50	12.1	596534.0	4798599.9	91.47	82.97	82.67	79.67
BH/MW8	91.74	50	12.1	596692.2	4798628.5	91.44	82.94	82.64	79.64
BH/MW9	91.44	50	9.1	596633.3	4798530.9	91.14	85.64	85.34	82.34
BH/MW11	91.13	50	9.3	596662.9	4798494.0	90.83	85.13	84.83	81.83

masl* = meters above sea level based on Topographical Survey completed by A.T. McLaren Limited for the site.
mm = millimetre
mbgs = metre below ground surface
UTMs**: +/- 4.0 m Error.

Well Development: Each of the installed four monitoring wells (MW1, MW4, MW5, MW8, MW9 and MW11) was developed to remove any sediment that may have been introduced during drilling/installation and to improve the hydraulic properties of the formation against which the wells were screened. This work was completed by Landtek staff on September 17, 2020. Development employed an electric well pump and/or Waterra Tubing with Foot Valve. Each well was pumped until a visible decrease in turbidity was observed.

Groundwater Sampling: On September 21, 2020, ground water samples were collected from monitoring wells MW5 and MW8 and submitted to ALS laboratories in Mississauga, Ontario for the City of Burlington Storm Water Discharge Parameters Limits analysis and e-coli.

2.3.2 Hydraulic Conductivity Tests

Hydraulic Conductivity Testing: Five (5) of the monitoring wells (MW1, MW4, MW5, MW8, and MW11) at the Site and adjacent area were tested to provide estimates of the hydraulic conductivity for the zones against which the screens for the wells were set. Rising head tests were conducted by Landtek on September 24, 2020. The tests involved the extraction of a known volume to displace the water level. A datalogger programed at 2 seconds intervals was used to record the water level response during the tests.

Data Analysis: The rising head test data were analyzed using AqteSolve Professional Version 4.5 software package developed by Glenn M. Duffield of HydroSOLVE Inc. applying the Hvorslev analysis solutions, depending on hydrogeology.

3.0 FINDINGS

3.1 Site Topography, Drainage and Hydrology

The Site is developed and flat lying at approximately 92 masl. Rambo Creek is located approximately 150 m southeast of the Site while Lake Ontario is located approximately 1.5 km southeast of the site. It is expected that the direction of groundwater flow at the site is southeast towards Lake Ontario.

3.2 Physiography

The Site is located in the Iroquois Plains physiographic region, as defined by Chapman and Putnam (1984). The Iroquois Plains extends 305 km along the western part of Lake Ontario, with varying conditions from the Niagara River to the Trent River. In more detail, Chapman and Putnam (1984) subdivided the Iroquois Plains into smaller areas to account for the varying conditions along this region. The Site and its surrounding area are described as being situated in a former gravel bar (extending between Hamilton and Toronto), with the nearby shoreline consisting of distinct bluff cuts into the red shale of the Queenston Formation.

3.3 Climate

The climate in the study area is largely influenced by Lake Ontario. The general climate data presented below in Table 2 was obtained from Environment Canada publications and from the Environment Canada online database. Average climate data was taken from Hamilton A station Airport (Hamilton Airport) for the period of 1981 to 2010.

Table 2. 1981 to 2010 Climate Normals for Hamilton A Station (as averages)

	Daily Average Temperature (°C)	Average Rainfall (mm)	Average Snowfall (cm)	Average Precipitation (mm)
January	-5.5	29.7	40.8	64.0
February	-4.6	28.2	35.1	57.8
March	-0.1	42.6	26.5	68.4
April	6.7	71.3	8.4	79.1
May	12.8	78.7	0.5	79.4
June	18.3	84.9	0.0	84.9
July	20.9	100.7	0.0	100.7
August	20.0	79.2	0.0	79.2
September	15.8	81.9	0.0	81.9
October	9.3	76.5	0.7	77.4
November	3.7	74.4	11.0	84.3
December	-2.3	43.8	33.5	73.0
Year	7.9	791.7	156.5	929.8

3.4 Regional Geology

The surficial geology of the Site and the surrounding area is mapped as sand and is shown on Figure 2. Ministry of Natural Resources mapping (accessed via Ontario Geological Survey (OGS) OGS Earth published by the Ontario Ministry of Natural Development, Mines and Forestry), indicates the regional surficial geology on the Site is comprised of coarse-textured glacio-lacustrine deposits of sand, gravel, minor silt and clay.

According to bedrock mapping provided by the OGS Earth website, bedrock in the area of the Site and the Study Area is identified as the Queenston Formation consisting of shale, limestone, dolostone, and siltstone.

The Site is generally flat with a slight slope from the northwest to southeast. Based on groundwater levels measured at the Site, the inferred shallow groundwater flow direction is southeasterly.

3.5 Regional Hydrogeology

The Halton Till unit, underlying the Site and its vicinity, is generally regarded as an aquitard. The range of indicated hydraulic conductivity values for the Halton Till is from 7 x 10-10 m/s (Gartner Lee, 1983) to 4.8 x 10-5 m/s (Ostry, 1979). Ostry (1979) also calculated hydraulic conductivities for Peel Plain sediments as ranging from 4.0 x 10-5 m/s to 5.0 x 10-6 m/s in east and middle areas of the Town of Oakville. As such, the shallow overburden materials (Halton Till and Peel Plain sediments) are considered aquitards.

The underlying Queenston Formation shale bedrock, particularly the upper, weathered portion, is regarded as a poor aquifer, however the upper 3 to 6 m of weathered bedrock typically provides sufficient water supplies to meet domestic requirements (Ostry, 1979). The bedrock porosity is low as a result of the compaction and consolidation of these fine-grained rocks since their deposition. Groundwater does, however, flow within joints, fractures, cleavage planes and faults within the shale bedrock (which generally become tighter and fewer with increasing depth). Well yields from the Queenston Formation shale bedrock in Halton Region are generally low. Very few wells yield 276,480 L/day (3.2 L/s) or more, and a yield of approximately 13,824 L/day (0.16 L/s) is generally expected (Gore & Storrie et al., 1995).

A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 are presented. The indicated hydraulic conductivity values for the Halton Till range from 7 x 10-10 (Gartner Lee, 1983) to 4.8 x 10-5 m/s (Ostry, 1979). The range of indicated values for the Queenston Formation is from 1 x 10-8 m/s (Gartner Lee, 1983) to 3.2 x 10-5 m/s (Ostry, 1979).

3.6 Groundwater Resources/Well Survey

The site is located in the Halton Region Source Protection Area and is classified as a Highly Vulnerable Aquifer area with score of 6 and an Intake Protection Zone 2 with a score of 5.6. The source water protection details for the site were referenced from the Ministry of the Environment, Conservation and Park (MECP) website on Source Water Protection for the Province of Ontario (MECP, 2020). Observed evidence of karstification was not observed due to the character of bedrock, lack of outcrop and/or relative thickness of overburden.

Well records were downloaded from the MECP water well database for a radius of approximately 500 m from the proposed development. A total of 56 well records were identified within the search radius.

The well records were reviewed to assess the general nature and use of the groundwater resource in the area and to characterize local hydrogeologic conditions; and determine the type of well. A summary of the data obtained from this review is presented below.

Well Construction

- Wells terminated in bedrock 12
- Wells terminated in overburden 36
- Unknown 8
- **Total.....56**

Well Uses

- Domestic 0
- Observation Wells 26
- Test Holes/Monitoring Wells 21
- Abandoned.....4
- Unknown 5
- **Total.....56**

Well Depth

- Less than 15 m 46
- 15 to 30 m 3
- Greater than 30 m 0
- No Data 7
- **Total.....56**

The locations of all the MECP wells are plotted on Figure 5 in Appendix A, and the Well Records are included in Appendix C.

Based on the well records, it was determined that there are no water wells within 500 m of the site.

3.7 Local Geology and Hydrogeology

Based on the results of the Hydrogeological Investigations carried out at the Site, a brief description of the general surficial geology of the Site, in order of depth is summarized in the following sections. Boreholes BH5, BH6, BH7 and BH8 were sampled as part of the investigation on the Site and completed at depths ranging from 7.3 to 12.1 mbgs (Appendix B).

The borehole information is generally consistent with the geological data. The lithologies encountered by the boreholes are discussed further in the following sections.

Fill

A layer of fill ranging from 1.5 to 3.0 m in thickness was encountered in all the boreholes at the ground surface overlying clayey silt.

Clayey Silt

A layer of clayey silt ranging from 1.0 to 2. m in thickness was encountered in all the boreholes below the fill, overlying shale bedrock.

Bedrock

Shale bedrock was encountered below the clayey silt in all boreholes at depths ranging from 3.5 to 4.0 mbgs. The boreholes were terminated in bedrock at the maximum depth of approximately 12.1 mbgs.

3.8 Groundwater Monitoring

Depths to groundwater in all monitoring wells were obtained manually by Landtek staff on September 21 and 24, 2020, January 14, February 23, March 17, April 12, and April 22, 2021. Monitoring is ongoing to determine the seasonal high groundwater level. The readings are presented below in Table 3.

Table 3. Monitoring Well Details

Monitoring Well ID	Ground Surface Elevation (masl)*	Date	Stick-up	Water Strike Depth (mbgs)	Water Level (mbgs)	Water Level Elevation (masl)	Screened Material
MW1	92.80	21-Sep-20	0.85	1.50	3.02	89.78	Bedrock
		24-Sep-20			2.99	89.81	
		14-Jan-21			2.78	90.02	
		23-Feb-21			2.85	89.95	
		17-Mar-21			2.81	89.99	
		12-Apr-21			2.76	90.04	
		10-May-21			2.77	90.03	
MW4	91.53	21-Sep-20	0.91	3.50	2.61	88.92	Bedrock
		24-Sep-20			2.57	88.96	
		14-Jan-21			2.43	89.10	
		23-Feb-21			2.56	88.97	
		17-Mar-21			2.49	89.04	
		12-Apr-21			2.50	89.03	
		10-May-21			2.54	88.99	
MW5	91.77	21-Sep-20	Flush mount	7.60	2.33	89.44	Bedrock
		24-Sep-20			2.20	89.57	
		14-Jan-21			2.11	89.66	
		23-Feb-21			2.20	89.57	
		17-Mar-21			2.13	89.64	
		12-Apr-21			2.07	89.70	
		22-Apr-21			2.09	89.68	
		10-May-21			2.06	89.71	
MW8	91.74	21-Sep-20	Flush mount	1.5	2.34	89.40	Bedrock
		24-Sep-20			1.85	89.89	
		14-Jan-21			1.72	90.02	
		23-Feb-21			1.82	89.92	
		17-Mar-21			1.68	90.06	
		12-Apr-21			UW**	NA**	
		22-Apr-21			1.63	90.11	
		10-May-21			1.65	90.09	
MW9	91.30	21-Sep-20	Flush mount	None	3.13	88.17	Bedrock
		24-Sep-20			3.15	88.15	
		14-Jan-21			2.83	88.47	
		23-Feb-21			2.92	88.38	
		17-Mar-21			2.54	88.76	
		12-Apr-21			2.56	88.74	
		10-May-21			2.53	88.77	
MW11	91.13	21-Sep-20	Flush mount	None	2.00	89.13	Bedrock
		24-Sep-20			1.95	89.18	
		14-Jan-21			1.29	89.84	

		23-Feb-21			1.35	89.78	
		17-Mar-21			1.19	89.94	
		12-Apr-21			1.00	90.13	
		10-May-21			1.36	89.77	

Notes:
masl* = meters above sea level based on Topographical Survey completed by A.T. McLaren Limited for the site.
mbgs = meters below ground surface
mbtoc = meters below top of casing
[**] = under water/flooded

3.9 Hydraulic Gradients and Flow

Groundwater typically follows the general path of the surface water courses and flows to low lying and major surface water features from areas of higher gradients to areas of relative lower gradients.

The groundwater flow regime for the Site was determined by using the groundwater elevations recorded in monitoring wells MW4, MW5, and MW8. The water table contours lines were completed by using triangulation with linear interpolation. The arrow, perpendicular to the

contours, indicates the direction of groundwater flow was south-southwest on September 24, 2020 as shown on Figure 6 in Appendix A. The horizontal hydraulic gradient across the Site was approximately 0.007 m/m southwest toward Lake Ontario.

3.10 Estimated Hydraulic Conductivity

3.10.1 Hydraulic Conductivity Tests

The estimated hydraulic conductivity values are provided below in Table 4, and normalized head vs. time curves for each hydraulic conductivity test is provided in Appendix D.

Table 4. Estimated Hydraulic Conductivity

Monitoring Well	Hydraulic Conductivity (m/s)	Well Screened Material
MW1	1.847×10^{-5}	Bedrock
MW4	8.12×10^{-8}	Bedrock
MW5	1.871×10^{-5}	Bedrock
MW8	8.538×10^{-8}	Bedrock
MW11	1.597×10^{-7}	Bedrock

Note:
[1] A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 is presented in Appendix E. The indicated hydraulic conductivity values for the Queenston Formation range from 1×10^{-8} m/s (Gartner Lee, 1983) to $3.2\ 10^{-5}$ m/s (Ostry, 1979).

[2] Based on the hydraulic conductivity values in Table 4 above, the geometric mean of the hydraulic conductivity values was determined to be 8.252×10^{-7} m/s. As a result, the value of 8.252×10^{-7} m/s was adopted in estimating the potential dewatering requirement at the Site.

3.11 Groundwater Quality

Copies of the laboratory Certificates of Analysis are provided in Appendix F.

Sewer Discharge Analysis

The laboratory results for the analyzed groundwater samples collected from monitoring wells MW5 and MW8 were compared to the City of Burlington Municipal Storm Sewer Discharge Limits Guidelines. The parameters that exceeded the Limits Guidelines are highlighted on the table presented below.

Sample Date: October 21, 2020

Parameter	G/S (mg/L)	MW5	MW8
		Lab Result (mg/L)	Lab Result (mg/L)
pH	6.5-8.5*	7.58	7.04
BOD	15	<2	3
Total Cyanide	0.02	<0.002	<0.002
Phenols	0.008	<0.002	<0.002
Total Phosphorus	0.4	**0.56**	0.04
Total Suspended Solids	15	**54**	**21**
Total Arsenic	0.02	<0.030	<0.015
Total Cadmium	0.008	<0.010	<0.005
Total Chromium	0.08	<0.040	<0.020
Chromium VI	0.04	<0.005	<0.005
Total Copper	0.04	<0.040	<0.020
Total Lead	0.12	<0.040	<0.020
Total Manganese	0.05	**0.513**	**0.231**
Total Mercury	0.0004	<0.0002	<0.0002
Total Nickel	0.08	<0.030	<0.030
Total Selenium	0.02	<0.040	<0.020
Total Silver	0.12	<0.040	<0.020
Total Zinc	0.04	**0.042**	<0.020
E. Coli	200**	ND	6
Methylene Chloride	0.0052	<0.0003	<0.0003
trans-1,3-Dichloropropylene	0.0056	<0.0003	<0.0003
cis-1,2-Dichloroetylene	0.0056	<0.0002	<0.0002
Chloroform	0.002	<0.0002	<0.0002
Benzene	0.002	<0.0002	<0.0002
Trichloroethylene	0.0076	<0.0002	<0.0002
Toluene	0.002	<0.0002	<0.0002
Tetrachloroethylene	0.0044	<0.0001	<0.0001
Ethylbenzene	0.002	<0.0002	<0.0002

1,1,2,2-Tetrachloroethane	0.017	<0.0002	<0.0002
1,2-Dichlorobenzene	0.0056	<0.0002	<0.0002
1,4-Dichlorobenzene	0.0068	<0.0002	<0.0002
Total Xylenes	0.0044	<0.0002	<0.0002
PCBs	0.0004	<0.0002	<0.0002
Pentachlorophenol	0.002	<0.0005	<0.0005
Di-n-butyl phthalate	0.015	<0.0005	<0.0005
3,3'-dichlorobenzidine	0.0008	<0.0001	<0.0001
Bis(2-Ethylhexyl)phthalate	0.0088	<0.0005	<0.0005
Total PAHs	0.002	<0.0003	<0.0003
Total Nonylphenol	0.001	<0.001	<0.001
NP1E0	None	<0.001	<0.001
NP2E0	None	<0.0003	<0.0003
Total Nonylphenol Ethoxylates	0.01	<0.001	<0.001

[*] pH Units
[**] CFU/100ml
[*] Exceedance
[ND] – Not Detected

3.12 Site Inspection to Assess Hydrogeologic Features

Significant hydrogeologic features were not identified at the site during the inspection.

4.0 WATER TAKING EVALUATION & IMPACT ASSESSMENT

The Molinaro Group proposes to develop the property to consist of one 25-storey tower with a surrounding one-, three-, and six-storey podium in the west of the site, with three levels of basement parking across the full site. A three-storey townhouse block comprising of seven units is also proposed in the east of the Site.

4.1 Estimating Construction Dewatering Rate

It is assumed that the underground levels will be installed in a supported open excavation. The excavation area estimated from the Site Plan provided by Graziani + Corazza Architects Inc. consists of two sections (see Figure 3 in Appendix A) as follows:

1. Section A: approximately 70.3 m x 38.0 m = 2,671.4 m2
2. Section B: approximately 112.0 m x 35.0 m = 3,920.0 m2

Total Area: ~ 6598 m.

There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (9.1 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.

Basement Excavation

The potential groundwater flow rate to the underground parking excavation was estimated using the dewatering equation for a fully penetrated well of confined aquifer fed by circular source:

$$Q = 2\pi kD\,(H-h_w)/(\ln R_o/r_e)$$

Where: Q = pumping rate [m^3/s]
k = hydraulic conductivity [m/s]
D = aquifer thickness [m]
H = height of piezometer level above base of aquifer before dewatering [m]
h_w = height of water after dewatering [m]
R_o. = radius of influence [m]
r_e = equivalent radius [m]

The radius of cone of depression R can be estimated using:

$$R = Ch*Sqrt(K)$$

Where: C = is a factor equal to 3000 for radial flow to a pumping well

h = H- h_w = required drawdown [m]
K = hydraulic conductivity [m/s]

Dewatering of a rectangular area can be accomplished by using an equivalent radius (r_e) to assess drawdown where r_e is given by the following equation:

r_e = Sqrt (length*width/π) (applies when a/b>1.5 and $R_o << r_e$)

r_e = (length + width)/π (applies when a/b<1.5 and $R_o >> r_e$)

Static Water Levels

Depths to groundwater in all monitoring wells were obtained manually by Landtek staff on September 21 and 24, 2020, January 14, February 23, March 17, April 12, April 22, and May 10, 2021. The readings are presented in Table 3.

Based on the groundwater levels recorded in monitoring wells MW5 and MW8 located at the Site, it was determined that depth to groundwater ranged from 1.63 mbgs to 2.34 mbgs. The highest ground water level was determined to be 1.63 mbgs. Depth groundwater varies seasonally, and the water table is typically elevated during spring and periods of active precipitation. As a result, groundwater monitoring is ongoing and high groundwater level will be updated once the seasonal groundwater monitoring is completed at the Site, if required.

Radial Flow into Excavation

The total amount of groundwater required to be pumped for dewatering the excavation associated with the underground level construction assuming there is no rainfall and applying a factor of safety of 1.3 will be ~70,554 L/day and 82,000 L/day for Sections A and B, respectively. These calculations and associated assumptions are provided in Tables 1 and 3 Attachment G.

The total flow = 70,554 L/day + 82,500 L/day = 153,054 L/day.

The above estimate will be updated once the seasonal high groundwater level is determined as the groundwater monitoring at the Site is ongoing, if required.

4.2 Dewatering Considerations

4.2.1 Estimating Dewatering Volume

The dewatering rate for the proposed excavation must also consider management of direct precipitation input. As a result, dewatering volume is estimated from the following two contributions:

- Radial flow into an excavation under a water table condition (Section 4.1).
- Direct precipitation

Direct Precipitation

Note: Radial flow into an excavation under a water table condition estimate does not take into account storm water management from rainfall events. Additional volume generated from a 100 year-storm event for the City of Burlington of 100 mm (from Extreme Rainfall Intensity-Duration-Frequency [IDF] Curve for the City of Burlington) rainfall event is estimated as follows:

Direct Precipitation into the proposed excavation = A (m^2) *rainfall (m) = (6598)*0.100 m = ~660 m^3/day = 660,000 L/day

It is advised that dewatering should not be completed during period of active precipitation.

4.2.2 Short Term Dewatering Volume

- Dewatering rate outside periods of active precipitation: ~ 153,054 L/day (~153 m3/day)
- Dewatering during Spring/active precipitation period: ~153,054 L/day (radial flow into excavation) + 660,000 L/day (direct precipitation) = 813,054 L/day or ~813 m^3/day.

Normal condition is considered to be weather conditions that should be expected during the operation of the construction dewatering. Normal operation does not include extreme weather events. Dewatering requirements less precipitation is estimated to be approximately 153,054 L/day = ~153 m^3/day.

4.2.3 Long Term Groundwater Control (Post Construction)

The developer proposes that the proposed below ground structure be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. As a result, long term dewatering will not be required at the Site.

4.2.4 Permit to Take Water

The maximum dewatering rate of groundwater for the proposed excavation is estimated to be approximately 813,054 L/day or ~813 m^3/day (radial inflow and direct precipitation). A permit to take water (PTTW) is required for this volume of water taking, as the estimated water taking is more than 400,000 L/day.

4.2.5 Dewatering Volume Plan for Construction

A regional summary of hydraulic conductivity values derived from consulting work conducted throughout Halton Region, by Holysh, April 1997 is presented in Appendix E. The indicated hydraulic conductivity values for the Queenston Formation range from 1 x 10^{-8} m/s to 1 x 10^{-6} m/s (Gartner Lee, 1983).

The excavation dewatering volume was estimated based on the low-end value of hydraulic conductivity for the Burlington Shale of 1 x 10^{-8} m/s above; and was determined to be approximately 13,703 L/day after a factor of safety of 1.3. These calculations and associated assumptions are provided in Tables 3 and 4 as Appendix G.

Based on the above, it is recommended that the Dewatering Volume Plan should provide for dewatering volumes ranging from 13,703 L/day (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 813,054 L/day or ~813 m^3/day (radial inflow

[determined with the geometric mean of the field determined hydraulic conductivity values] + direct precipitation).

4.2.6 Dewatering Procedure

Based on the results of the hydraulic conductivity tests, seepage through the overburden/bedrock beneath the Site should be feasible to be handled by a sump and/or well point dewatering system. The type of dewatering system to be used should be discussed with a dewatering contractor and be evaluated based on anticipated low and high volumes estimates.

The following general construction practices can be implemented to minimize the volume of water to be extracted:

- Schedule construction outside the spring period when the water table is typically elevated and avoid constructing during period of active precipitation.

- It is recommended that any excavations should be staged or constructed in such a manner to be able to manage dewatering volume conveniently.
- Reduce the length of time during which the open cut remains open.

4.2.7 Water Management and Discharge Plan

Water extracted during construction dewatering is required to be discharged into an approved location which could be storm, sanitary or combined sewers or surface water body near the Site.

As per the Sewers ByLaw, in order to issue a discharge approval, information relating to the quality and quantity of the discharge must be provided to City of Burlington. It is strongly recommended that the applicant provide this information eight to twelve weeks prior to the proposed start of discharge.

It is expected that the rate and total volume of the discharge during dewatering be recorded. This would require that the discharge line be equipped with a flow meter capable of monitoring the discharge rate and a volume totalizer to record the total volume of water discharge. The discharge rate and total daily flow will need to be recorded with the records maintained on site. This can be accommodated by installing a flow meter on the discharge line.

If needed, a weir tank and filter bag can be utilized during dewatering to reduce total suspended solids (TSS) and turbidity prior to discharging of the water into a sewer system.

A T-Coupling and valves should be installed downstream of the flow meter, if necessary, can be operated to divert flow for mitigation purposes.

4.3 Assessment of Potential Impacts and Water Management

4.3.1 Impact to Existing Groundwater Users

A search of the Ontario Ministry of the Environment Water Well Records for an area extending about 500 m outward from the edge of the excavation was completed, identifying no Water wells.

in the database. As a result, it is not anticipated that there will be any impact to the existing water wells.

4.3.2 Impact to Surface Water and Natural Functions of the Ecosystem

Rambo Creek is located approximately 150 m southeast of the Site, Lake Ontario is located approximately 1.5 km southeast of the site. The groundwater dewatering activities will result in localized depression of the groundwater table, and it is anticipated that there will be impact within the maximum radius of influence of approximately 22 m calculated in Tables 1 and 3, Appendix G.

4.3.3 Contaminants Impacts

This occurs when pre-existing ground or groundwater contamination is mobilised and transported where transmission pathways are created.

Based on the environmental site assessments completed at the at the Site by Landtek, there are no known sources of contamination in groundwater at the site. As a result, there is no potential for mobilization of contaminants or creation of transmission pathways during the planned groundwater dewatering.

4.3.4 Geotechnical Impacts

Geotechnical impacts occur where the geotechnical properties or state of the ground are changed by groundwater control activities. The most common type of impact in this category is ground settlement, with the corresponding risk of distortion and damage to structures, services, and other sensitive infrastructure.

Ground settlement can be caused by two principal mechanisms:

- Increases in effective stress as a result of lowering of groundwater levels, resulting in compression and consolidation of the ground. Such settlements are an unavoidable consequence of lowering of groundwater levels.
- Removal of fine particles from the ground (loss of fines) which can occur when poorly controlled sump pumping draws out soil particles with the pumped water. With good design and implementation, loss of fines (and the associated settlement risk) can be avoided.

The Site is located to the north corner area of the intersection of the Brant Street and Ghent Avenue in Burlington, north of Brant Street. The Site is bound by Brant Street to the south, Ghent Avenue to the East, and developed properties to the West and North. It is anticipated that there will be impact within the maximum radius of influence of approximately 22 m calculated in in Tables 1 and 3 of Appendix G.

Dewatering could be handled by pumping from a sump/well point dewatering system. The well sump/point system used for lowering the water table within the excavation must be properly screened and installed to ensure that pumping will not remove sediment from the low permeability overburden aquifer. Removal of significant fines may result in the formation of voids and the loss of ground.

Based on the above, potential geotechnical impacts are anticipated during dewatering at the Site. Surrounding buildings and roads should be monitored by geotechnical instrumentation to determine impact, if any.

The proposed monitoring and mitigation plans are presented in Sections 5 and 6, respectively.

5.0 PROPOSED MONITORING PLAN

5.1 Construction Monitoring

Once construction dewatering is initiated it will be difficult to stop pumping or significantly reduce the rate of pumping without disrupting construction activities. It will however be possible to monitor the drawdown response at the construction site and to adjust the pumping rate to optimize drawdown and the associated pumping rate.

5.2 Management of Dewatering Abstraction

5.2.1 Monitoring, Trigger Levels and Management Responses

Abstraction management is critical to ensure target water levels within the construction zone are met, but that over-pumping does not occur.

Target groundwater levels in- and outside excavations will be set individually for each dewatering monitoring well based on location, aquifer and construction requirements, in-line with stated dewatering aims above.

Trigger levels for wells will typically be set 0.5 m above the dewatering target and 1.0 m below the dewatering target to give a 1.5 m target operational zone. These targets may be reviewed and adjusted to decrease size of the operational target zone and increase the factor of safety.

If monitoring indicates that dewatering zone groundwater levels exceed the upper trigger levels (i.e. required drawdown is not being achieved or maintained) management actions are available (in order of preference):

- Adjust automatic pump start and stop water levels.
- Increase pumping rates within the constraints of the system; and/or
- Install additional abstraction capacity (well points, spears or sump pumps).

If monitoring indicates that excavation zone groundwater levels are below the lower trigger levels (i.e. excessive drawdown) management actions available are (in order of preference):

- Adjust automatic pump start and stop water levels; and/or
- Decrease pumping rates; and/or
- Reduce the number of pumps operating.

5.2.2 Contingency Responses

If management responses prove to be insufficient to achieve and maintain the target levels, excavations may be slowed or suspended to enable contingencies to be implemented. Available contingency measures that will be assessed include (in order of preference):

- Construction of additional dewatering wells, spears or sumps.
- Construction of additional drains or groundwater control structures.

Excavation would resume when the required drawdown is able to be reliably obtained.

5.2.3 Settlement Monitoring

Implementation of a settlement monitoring plan is recommended to be completed within an approximate radius of 22 m of the Site. Prior to commencing dewatering condition surveys of adjacent properties that could potentially be affected by dewatering, considering anticipated effects and specific dewatering design should be completed.

A typical settlement monitoring system would comprise a series settlement marker sited at various distances beyond and at the site, within the zone of influence of groundwater drawdown. Monitoring points should be surveyed to an accuracy of +/-2 mm. Note that the reference benchmark must be located beyond the extent of the anticipated influence of groundwater drawdown. For very high-risk projects, incorporation of piezometer standpipes will allow confirmation of the field groundwater drawdown and will enable calibration of field settlement observation with theoretical assessments.

Alert and Action settlement thresholds should be set, selected though theoretical assessment of anticipated settlements and review of sensitivity of adjacent structures and infrastructure. It is prudent to implement staged groundwater drawdown, providing hold points to allow adequate time to enable observation of the delayed settlement response of the ground.

6.0 PROPOSED MITIGATION PLAN

The groundwater dewatering activities will result in localized depression of the groundwater table, and it is anticipated that there will be no impact beyond the radius of influence of 22 m.

Mitigation would involve the reduction or elimination of the impacts induced by construction dewatering. As noted above, the potential exists for dewatering to cause ground settlement, with the corresponding risk of distortion and damage to structures, services and other sensitive infrastructure.

Methods to limit adverse dewatering settlement are:

- Settlement associated with loss of fines can be mitigated through appropriate design of the dewatering system to control flow velocity and provide screens and/or filters matched to the grading of the in-situ soils. Entrainment of fines must be monitored during construction; actions could include analysis of TSS in discharge water and/or monitoring of accumulation of sediment in sedimentation tanks.
- Drawdown-induced ground settlement is mitigated though pre-construction estimation of groundwater drawdown and settlement coefficients to identify risk prior to drawing the groundwater down, and water level monitoring in monitoring boreholes to check that larger drawdowns than anticipated at distance from the excavation are not occurring.
- Differential settlement is most problematic; this can be reduced by managing the rate of drawdown and understanding where clear changes in soil type occur. Should potentially damaging settlement be indicated, these can be mitigated by installing groundwater cut-offs to stem or restrict groundwater flow and limit drawdown beyond the site.
- Provide sufficient temporary support to excavations to maintain stability, where seeps might otherwise induce progressive collapse of the sides of the excavation.
- During dewatering implement staged drawdowns (where appropriate), and monitor field settlement and water level changes beyond the immediate site, comparing against theoretical settlements and water levels to allow warning of potential dewatering settlement issues.

7.0 SITE DEVELOPMENT, HYDROGEOLOGY and WATER BALANCE

The following discussion and recommendations are based on the data gathered for the study and are presented for site planning purposes.

7.1 Site Development Concept

It is understood that the proposed development is to consist of a 25-storey tower with a surrounding one-, three-, and six-storey podium in the west of the site, with three levels of basement parking across the full-site area. A three-story townhouse block comprising of seven units is also proposed in the eat of the site.

The following summarizes the proposed approximate land coverage areas for the development:

- Building roof area ..... 0.248 ha
- Parking Areas, Roadways, and other impervious Areas..... 0.193 ha
- Green space, SWMP, natural areas..... 0.219 ha
- **Total Area ..... 0.660 ha**

7.2 Principal Hydrogeologic Features and Functions

The results of the study indicate that the site hydrogeologic characteristics can be summarized as follows:

- Generally, the site stratigraphy consists of clayey silt fills to depths varying from 3.5 -4.0 mbgs, overlying bedrock. Drilling was terminated at a maximum depth of approximately depth of 12.1 mbgs in bedrock.
- The water table recorded in September within the shale bedrock at the site ranges from 1.63 mbgs to 2.34 mbgs.
- There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, Level 2 = 3.0 m). An elevator shaft extension is assumed to be 1.5 m. Therefore, a total excavation depth of mbgs is required for the construction. A dewatering depth of approximately 0.5 m below the excavation bottom (9.1 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.
- The site is generally flat with a slight slope from the northeast to the southwest. Based on the groundwater levels measured at the Site, the inferred shallow groundwater flow at the site is southwesterly.

The above noted hydrogeological characteristics should be considered in conjunction with the requirement for site development plans and in particular storm water management practices at the site. Further information regarding water balance at the site is presented in the following section.

Based on the above information, the following considerations should be made with respect to maintenance of hydrogeologic functions and hydrogeologic conditions at the site:

- The site consists of fill/clayey silt overlying shale bedrock and would not be well suited to groundwater recharge due to the relatively high hydraulic conductivity of the subsurface

strata. Engineered infiltration methods, other Best Management Practices and low impact development methods should be implemented accordingly.

7.3 Water Balance

The proposed site development plan will result in the construction of buildings, parking areas, and roadways. Without mitigation, this will lead to a decrease in infiltration and groundwater recharge.

The surface soils at the site will provide relatively high-water recharge into the shallow groundwater system. This is a result of the relatively high permeable silty sand/sandy silt soil encountered below ground surface across the site. Based on the subsurface investigation completed for the site, no enhanced zones of groundwater flow or transmission were identified across the site.

Notwithstanding the above, one of the objectives during development should be to ensure that the overall volume of groundwater recharge is not significantly impacted. A water balance for the site was prepared to assess the distribution of precipitation, evapotranspiration, infiltration and runoff for existing (pre-development) conditions as well as post-development conditions. The water balance calculations are detailed in Appendix H.

Evapotranspiration represents the transport of water from the earth back to the atmosphere and is an important component to a water balance calculation. The Thornthwaite method was used to calculate potential evapotranspiration typical for the region. By using equations 8, 9, and 10 in Thornthwaite (1948), the potential evapotranspiration for the region was found to be 609 mm/year. The calculation is included in Appendix H.

As was presented in Table 2, the annual total precipitation was taken from the Hamilton Airport climate station for the period of 1981 to 2010. Total annual precipitation for the area is 930 mm/year and mean daily temperature is 7.9 °C.

In summary, the total shallow groundwater recharge rate for the site is estimated to be 175 mm/year. This recharge was referenced from the MOE Table 2 and Table 3 approach in the Technical Information Requirements for Land Development Applications (MOE, 1995). The post-development water budget was calculated and is presented in Appendix H. A recharge rate of 100 mm/year was assumed for clayey silt beneath the site.

The water balance (pre- and post-development) is summarized in Table 5 below from Appendix H.

Table 5. Comparison of Pre- and Post-Development Water Balance

Development	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	6,136	1,269	208	4,658
Post-Development	6,136	1,333	219	4,585

The decrease in run-off from 4,658 m^3 to 4,585 m^3 is the result of developing permeable areas at the site. The post-development result in the increase of evapotranspiration and infiltration across the site.

The above-noted values and associated calculations found in Appendix H are considered to be conservative and are based on the following assumptions:

- No infiltration will occur beneath the internal roads, walkways, buildings or driveways.
- No evapotranspiration will occur from the internal roads, walkways, buildings or parking areas.
- Infiltration will occur in landscape areas.

7.4 Mitigating Measures to Maintain Hydrogeological Functions

7.4.1 Maintenance of Groundwater Recharge

The site is considered to have enhanced of groundwater recharge due to additional landscape development at the site. Infiltration value is expected to increase from 208 to 219 m^3/year based on the water balance calculations outlined in Appendix H. This increase in infiltration indicates that approximately 10% water surplus at the site. As a result, percentage of water collected from roof area required to match pre-development infiltration= 0%.

It is recommended that development planners collaborate with storm water specialists or engineers to be able to maintain pre-development water balance and recharge at the site through storm water management design techniques. Perhaps Low Impact Development techniques would be applicable for this site.

7.4.2 Maintenance of Groundwater Transmission Pathways

As referenced from the Graziani & Corazza Architects Inc. drawings provided by Molinaro Group, it is understood that the earthworks and servicing will be completed within the clayey silt and bedrock beneath the Site. The overall continuity of the groundwater flow at the site should be maintained, where practical. Generally, any groundwater transmission pathways encountered can be maintained through the following means:

- The excavation of any underground services or utilities across more permeable layers may interrupt the groundwater flow. As good practice, it is recommended that trench backfilling operations be carried out with materials that are similar to the materials that have been excavated. In particular, if any mIore permeable sand zones are encountered, they must not be truncated by backfilling of the excavation or trench using lower permeability materials (such as the silty sand/sandy silt identified at the subject site).

8.0 SUMMARY AND CONCLUSIONS

The following summarizes the results of the investigation:

- Generally, the site stratigraphy consists of clayey silt fills to depths varying from 3.5 -4.0 mbgs, overlying bedrock. Drilling was terminated at a maximum depth of approximately depth of 12.1 mbgs in bedrock.
- Lake Ontario is located approximately 1.5 km southeast of the site. The direction of groundwater flow at the site is south-southwst towards Lake Ontario.
- Groundwater contour plot from groundwater monitoring levels recorded on September 24, 2020 indicates the direction of groundwater flow was south-southwest. The horizontal hydraulic gradient across the Site, was approximately 0.007 m/m south-southwest.
- The water table present within the shale bedrock at the site ranges from 1.63 meters mbgs to 2.34 mbgs.
- There will be two levels of underground parking. As a result, the maximum depth of the underground parking is estimated to be 7.1 mbgs (Level 1 = 4.1 m, and Level 2 = 3.0 m). A dewatering depth of approximately 0.5 m below the excavation bottom (7.6 mbgs) is assumed in order to keep the bottom of the excavation dry during construction.
- The maximum dewatering rate of groundwater for the proposed excavation under normal operation which does not include extreme weather events is estimated to be approximately 153,054 L/day = ~153 m3/day. Normal condition is considered to be weather conditions that should be expected during the operation of the construction dewatering. Normal operation does not include extreme weather events.
- The maximum short term dewatering rate of groundwater for the proposed excavation, with 100-Year Storm rainfall is estimated to be approximately 813,054 L/day or ~813 m^3/day (radial inflow and direct precipitation).
- The developer proposes that the proposed below ground structure be waterproofed to prevent inflow of groundwater into the subsurface parking structures and foundation, post construction. As a result, long term dewatering will not be required at the Site.
- A permit to take water (PTTW) is required for this volume of water taking, as the estimated water taking is more than 400,000 L/day.
- A Dewatering Volume Plan for construction should provide for dewatering volumes ranging from 13,703 L/day (determined using the low-end value of hydraulic conductivity value for Burlington shale) to 813,054 L/day or ~813 m^3/day (radial inflow [determined with the geometric mean of the field determined hydraulic conductivity values] + direct precipitation).
- Water extracted during construction dewatering is required to be discharged into an approved combined storm sewer near the Site.
- As per the Sewers ByLaw, in order to issue a discharge approval, information relating to the quality and quantity of the discharge must be provided to City of Burlington. It is strongly recommended that the applicant provide this information eight to twelve weeks prior to the proposed start of discharge.
- Geotechnical and surface water impacts are anticipated during groundwater dewatering within a radius of approximately 22 m outside the Site boundaries.

9.0 RECOMMENDATIONS

The following general construction practices are recommended to minimize the volume of water to be extracted:

- Schedule construction outside the spring period when the water table is typically elevated and avoid constructing during period of active precipitation.
- Reduce the length of time during which the open cut remains open.
- Install valves on the individual well point to allow for the flow adjustment.

As per the Sewers ByLaw, in order to issue a discharge approval, information relating to the quality and quantity of the discharge must be provided to City of Burlington. It is strongly recommended that the applicant provide this information eight to twelve weeks prior to the proposed start of discharge.

An application for a Permit to Take Water (PTTW) should be completed for the potential groundwater dewatering requirement at the Site.

10.0 CLOSURE

We trust this report is satisfactory for you purposes. If you have any questions regarding our submission, please do not hesitate to contact this office.

Yours truly,

Landtek Limited



Henry Erebor, M.Sc., P.Geo.,

11.0 REFERENCES

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Ontario Geological Survey, OGS Earth. Quaternary Geology of Ontario

Ontario Geological Survey, OGS Earth. Bedrock Geology of Ontario.

12.0 LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

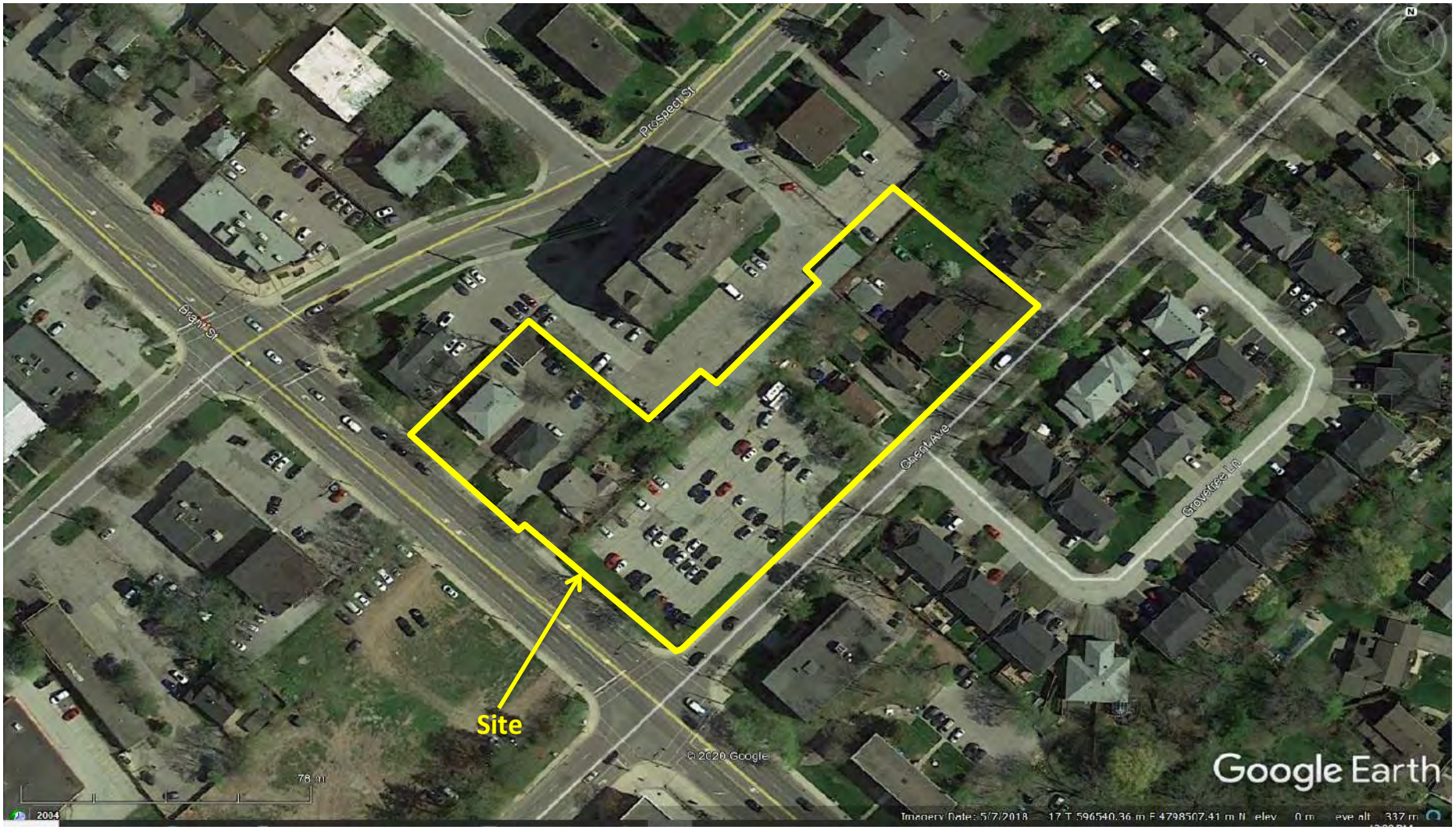
The survey elevations in the report were obtained by Landtek or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

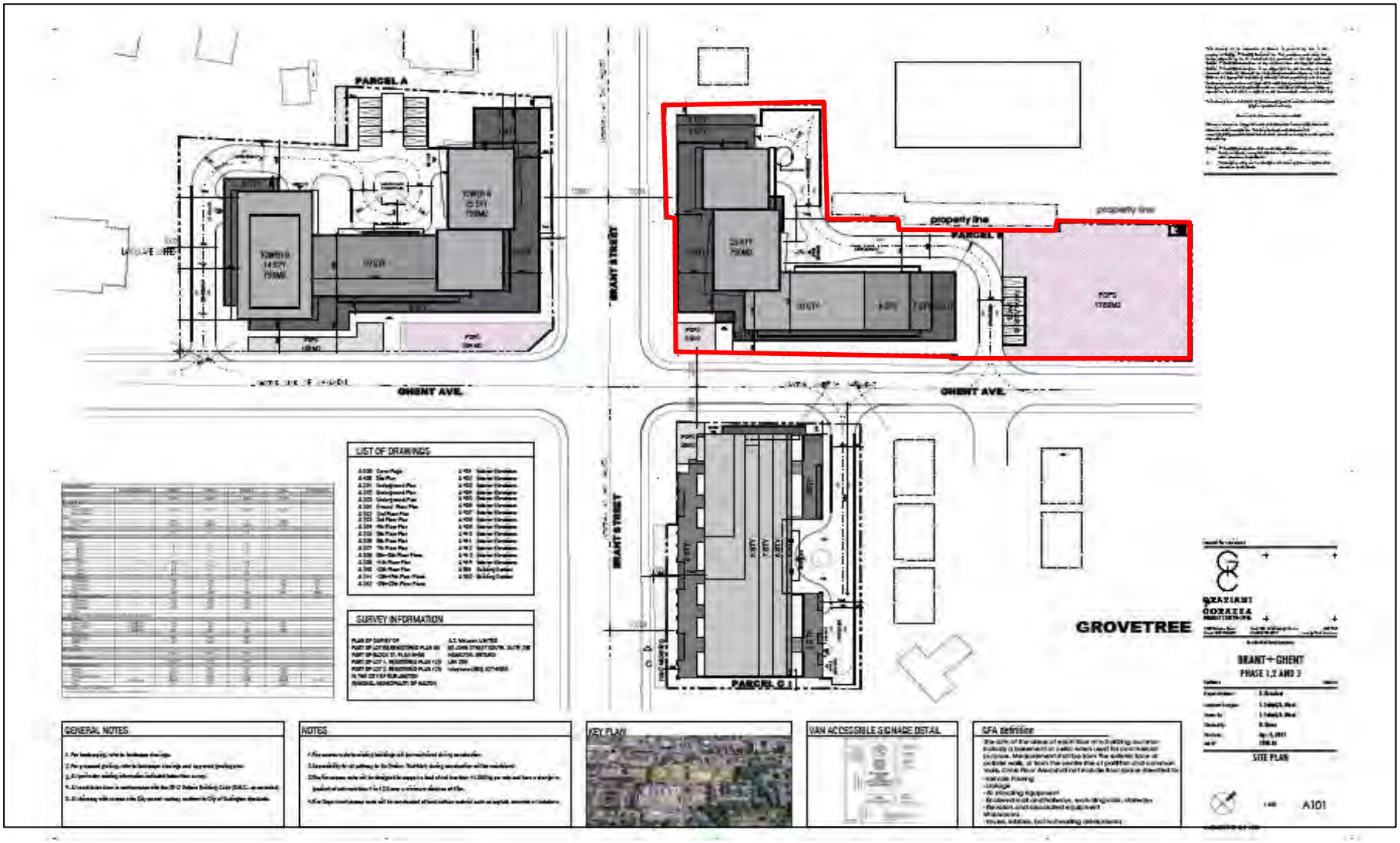
This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX A

FIGURES

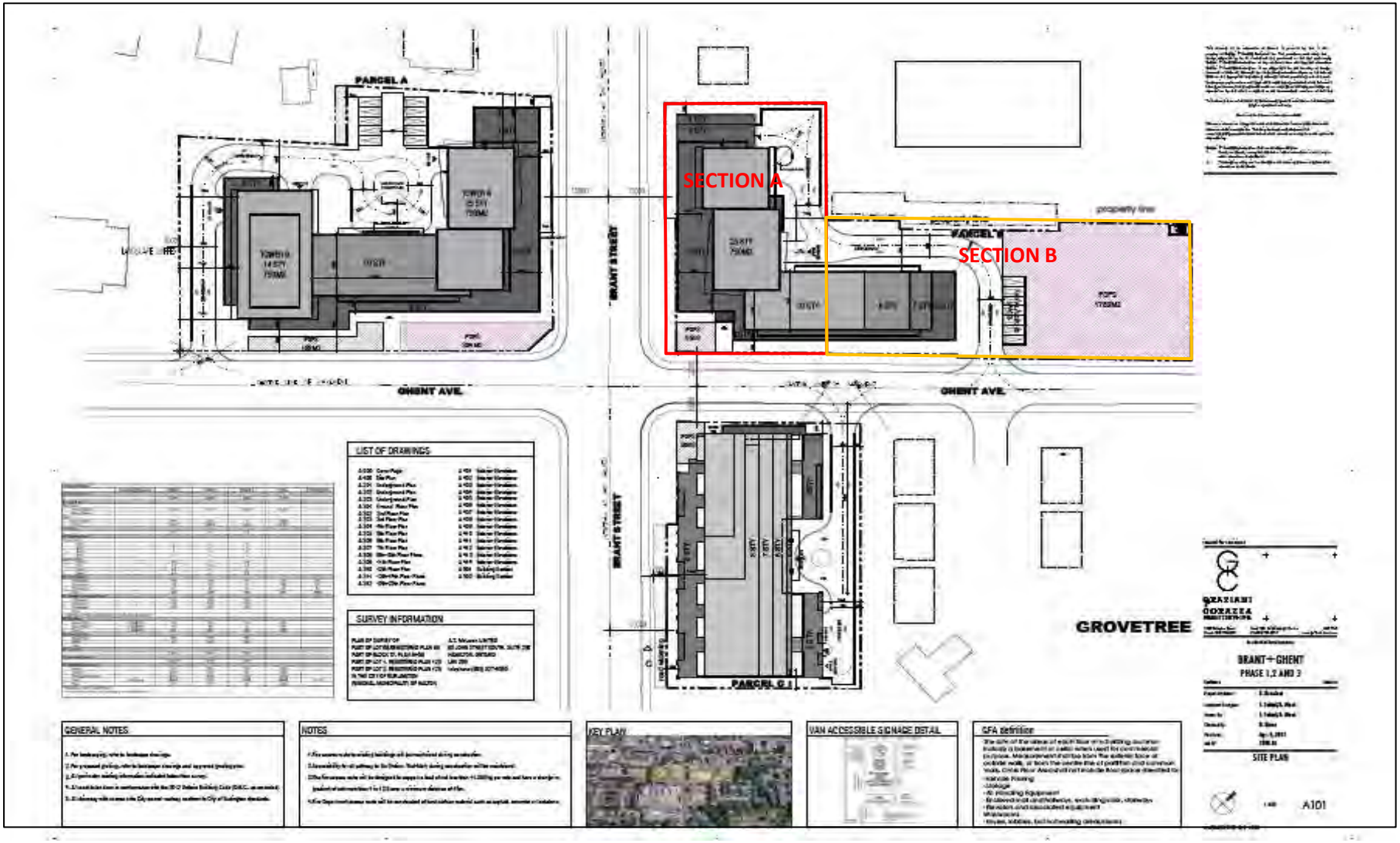


LANDTEK LIMITED ***CONSULTING ENGINEERS*** **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**	
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 769 to 789 Brant St. & 2023 to 2033 Ghent Ave. Burlington, Ontario
Title:	Figure 1: Site Location
Project No.	20255B



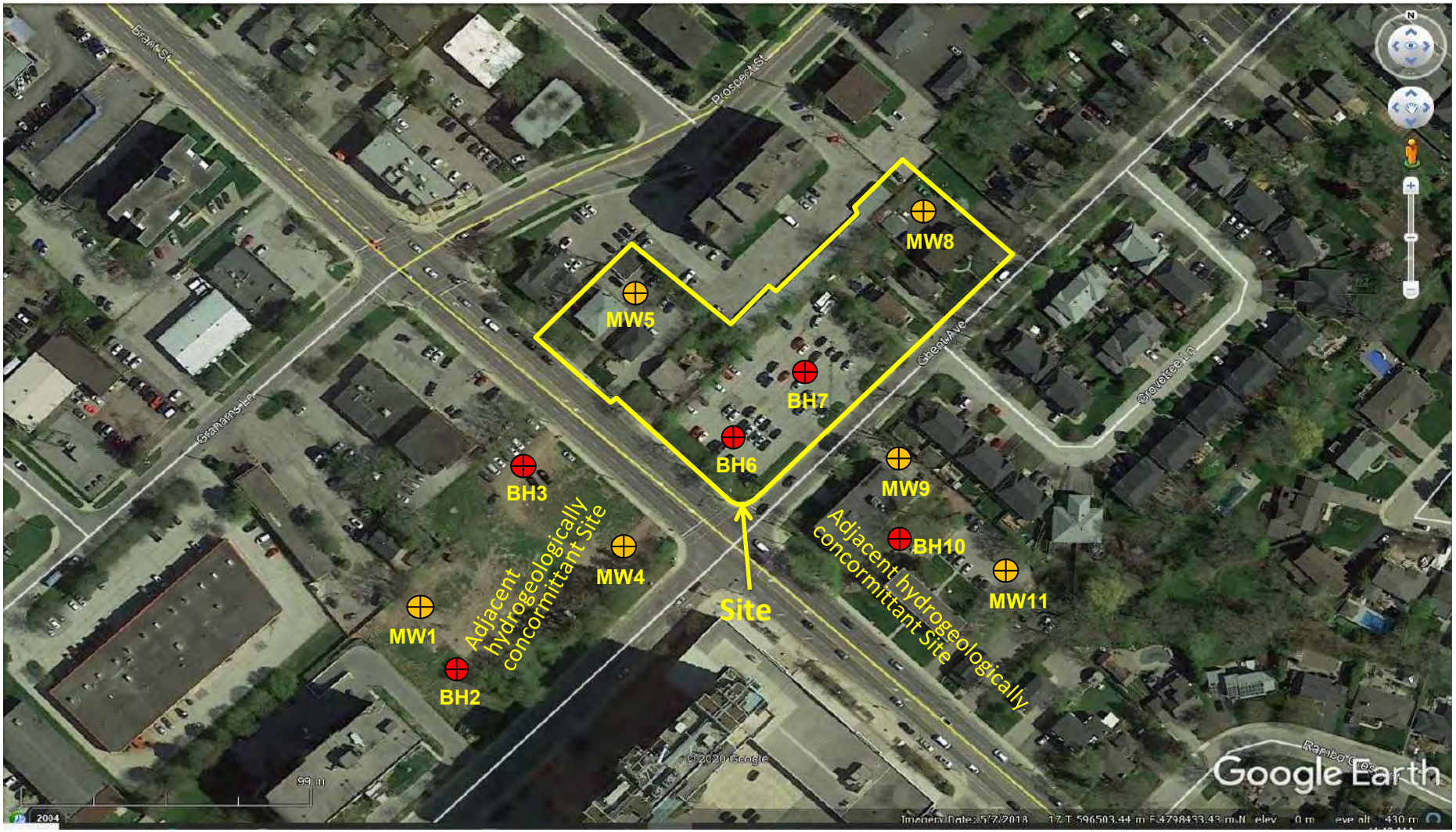
Site

LANDTEK LIMITED	
CONSULTING ENGINEERS	
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1	
Scale: On Plan	Date: May 2021
Project:	Hydrogeological Investigation
	774-782 Brant Street
	Burlington, Ontario
Title:	Figure 2: Site Plan
Project No.	20255B



Site

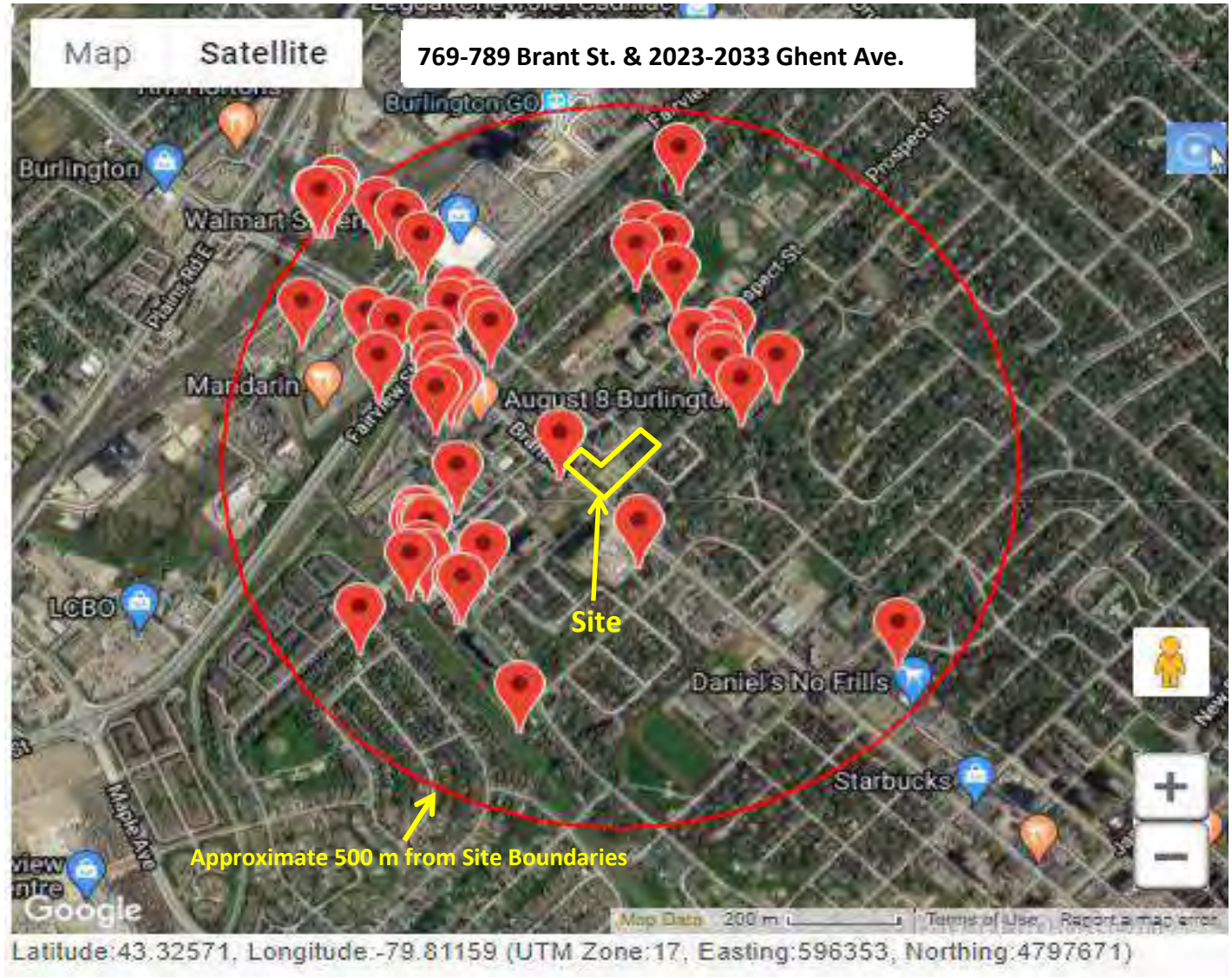
	LANDTEK LIMITED *CONSULTING ENGINEERS* **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**
	Scale: On Plan — Date: May 2021
Project:	Hydrogeological Investigation 774-782 Brant Street Burlington, Ontario
Title:	Figure 3: Dewatering Estimate Plan
Project No.	20255B



Monitoring Well Location

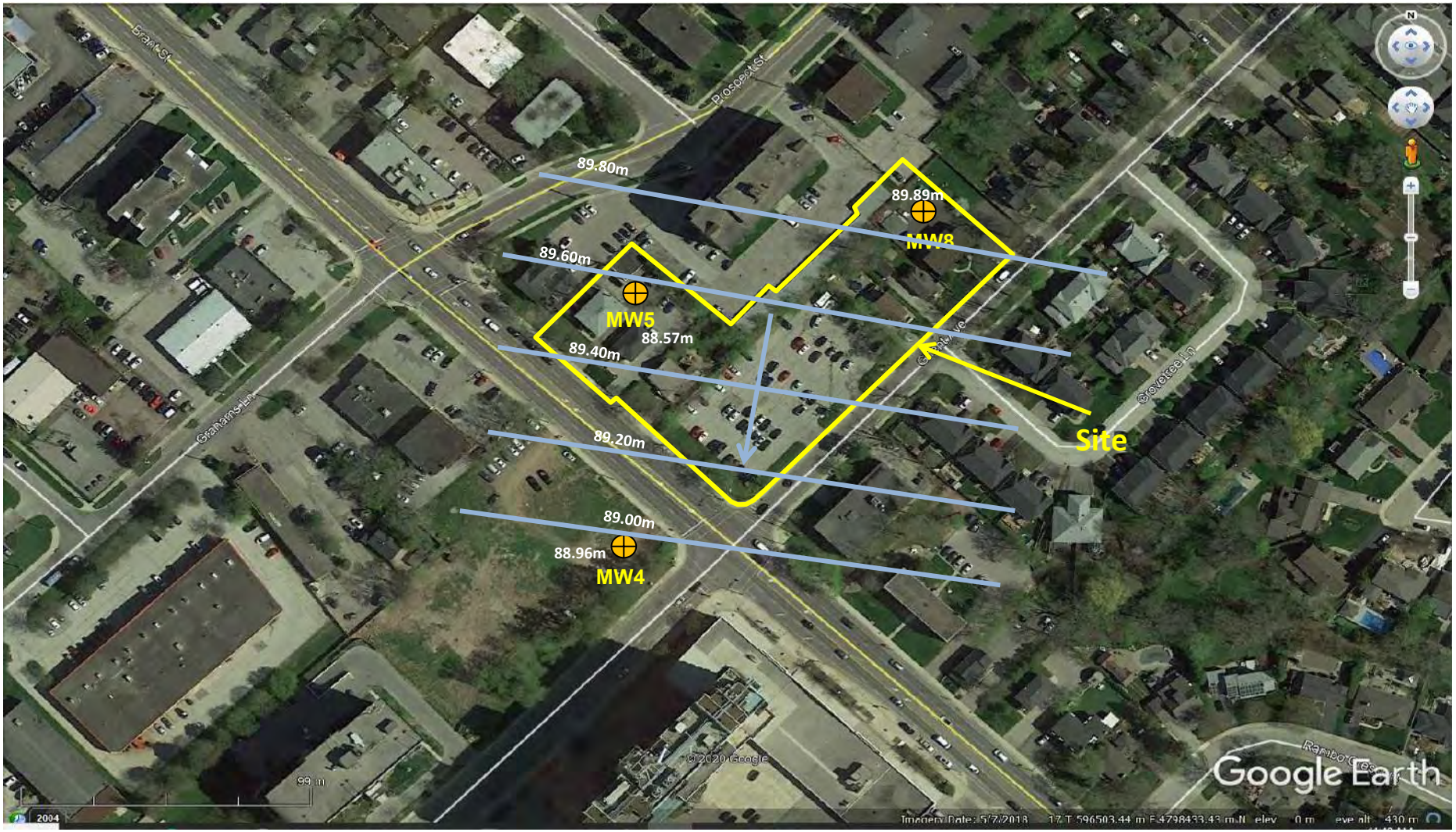
Borehole Location

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Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 769 to 789 Brant St. & 2023 to 2033 Ghent Ave. Burlington, Ontario
Title:	Figure 4: Boreholes and Monitoring Wells Locations
Project No.	20255-B



MOE Wells Locations

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Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 769 to 789 Brant St. & 2023 to 2033 Ghent Ave. Burlington, Ontario
Title:	Figure 5: MOE Wells Locations
Project No.	20255-B



LEGEND

- Borehole/Monitoring Well
- Groundwater Flow Direction
- 90.00 m — Groundwater Level Contour

	LANDTEK LIMITED *CONSULTING ENGINEERS* **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**
Scale: See Map	Date: September 2020
Project:	Hydrogeological Investigation 769-789 Brant St. & 2023-2033 Ghent Ave. Burlington, Ontario
Title:	Figure 6: Groundwater Contour Diagram
Project No.	20255-B

APPENDIX B

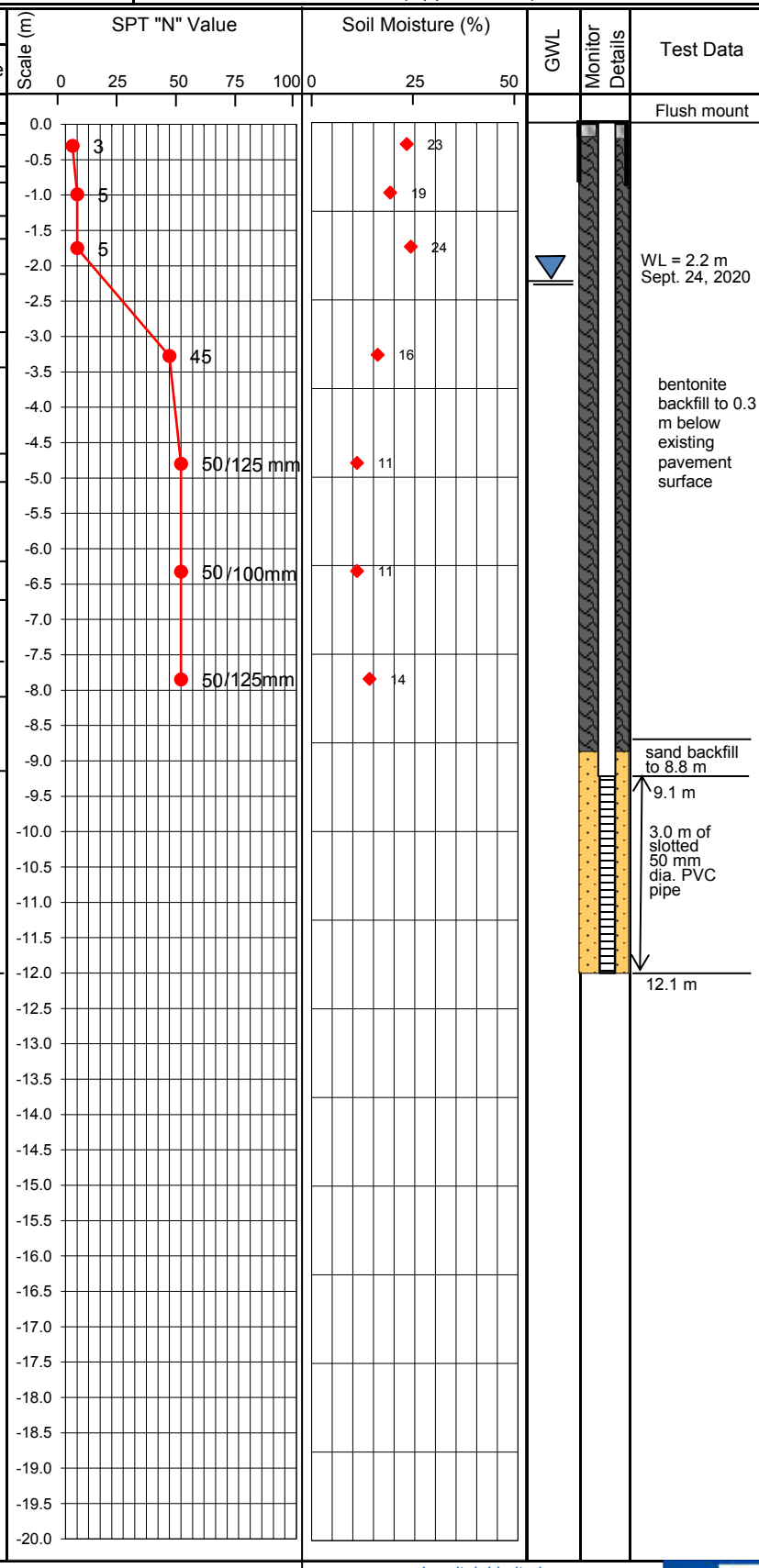
BOREHOLES & MONITORING WELLS LOGS

Landtek Limited

BH/MW 5

Project No.:	20255B	Drill Date:	September 2, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [x] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. / Depth	Samples No.	Samples Type
Ground Surface		91.8		
±50 mm of asphalt ± 200 mm of crushed limestone **FILL:** silty clay, some gravel, brown, firm, very moist, trace black mottling		0.0	1 2 3	SS SS SS
		88.8		
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		3.0 87.8	4	SS
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist 7.6 m to 9.3 m: wet		4.0	5 9 10	SS SS SS
		82.5		
highly weathered to fresh, red, strong Recovery = 100 %; RQD = 60 % ∂ = 25.5 kN/m³; UCS strength = 61.9 MPa		9.3 81.1	CORE RUN #1	63 mm Dia. Core
fresh, red and grey, medium strong Recovery = 100 %; RQD = 80 % ∂ = 25.5 kN/m³; UCS strength = 47.8 MPa		10.7 79.7	CORE RUN #2	63 mm Dia. Core
BOREHOLE TERMINATED		12.1		



GWL

Monitor Details

Test Data

Flush mount

WL = 2.2 m
Sept. 24, 2020

bentonite backfill to 0.3 m below existing pavement surface

sand backfill to 8.8 m

9.1 m

3.0 m of slotted 50 mm dia. PVC pipe

12.1 m

Notes:
1. Groundwater encountered at 7.6 m during drilling
2. Water level reading: 2.20 m on September 24, 2020

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

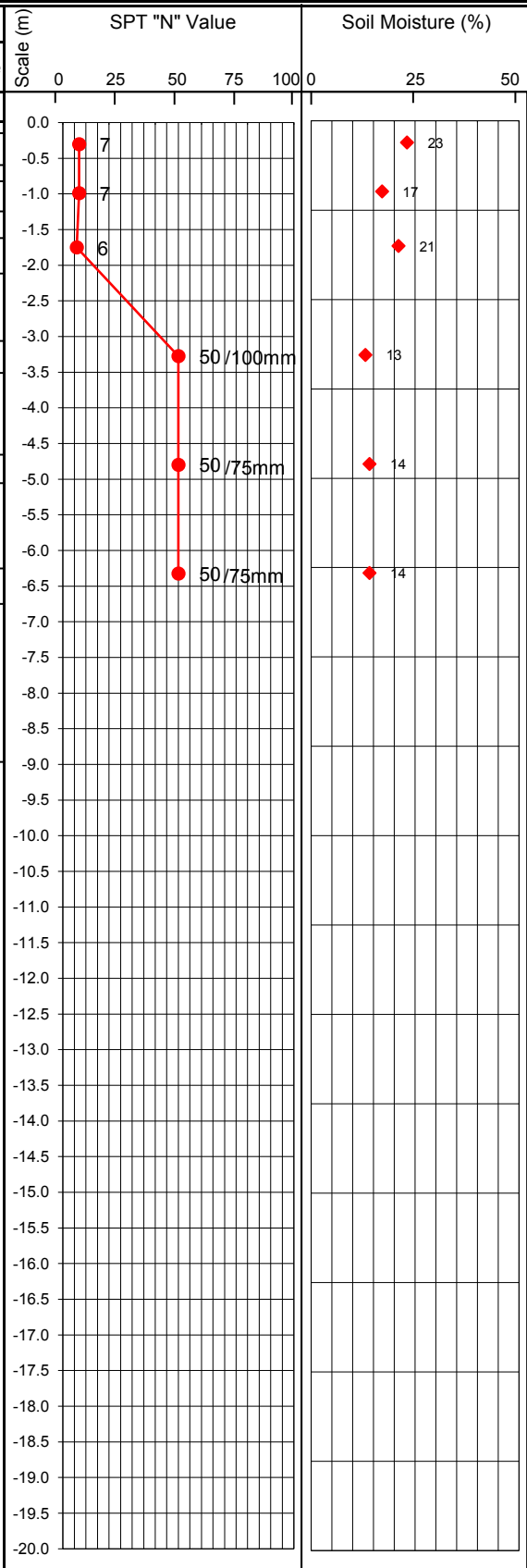
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www.landteklimited.com

Landtek Limited

BH 6

Project No.:	20255B	Drill Date:	September 2, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. / Depth	Sample No.	Sample Type	Scale (m)
Ground Surface		91.7			
±50 mm of asphalt		0.0	1	SS	0.0
± 200 mm of crushed limestone					-0.5
FILL: sand, brown, loose, moist		90.5	2	SS	-1.0
FILL: silt, dark brown, loose, moist, trace iron staining		1.2	3	SS	-1.5
		89.2			-2.0
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		2.5	4	SS	-2.5
		88.2			-3.0
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist		3.5	5	SS	-3.5
4.5 m to 8.0 m: wet					-4.0
					-4.5
					-5.0
					-5.5
					-6.0
			6	SS	-6.5
					-7.0
					-7.5
					-8.0
8.0 m to 9.1 m: slightly weathered to fresh					-8.5
		82.6			-9.0
AUGER REFUSAL		9.1			-9.5
BOREHOLE TERMINATED					-10.0
					-10.5
					-11.0
					-11.5
					-12.0
					-12.5
					-13.0
					-13.5
					-14.0
					-14.5
					-15.0
					-15.5
					-16.0
					-16.5
					-17.0
					-17.5
					-18.0
					-18.5
					-19.0
					-19.5
					-20.0



GWL | Monitor Details | Test Data

Notes: 1. Groundwater encountered at 4.5 m depth during drilling

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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Landtek Limited

BH 7

Project No.:	20255B	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. / Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface		91.7								
±50 mm of asphalt ± 200 mm of crushed limestone **FILL:** clayey silt, black, firm to stiff, moist		0.0 90.2	1 2	SS SS		4, 13	32, 17			
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, moist		1.5 88.2	3 4	SS SS		19, 50/75mm	19, 14			
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist 7.0 m to 7.3 m: wet		3.5 84.4	5	SS		50/75mm	5			
AUGER REFUSAL **BOREHOLE TERMINATED**		7.3								

Notes: 1. Groundwater encountred at 7.0 m depth during drilling

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

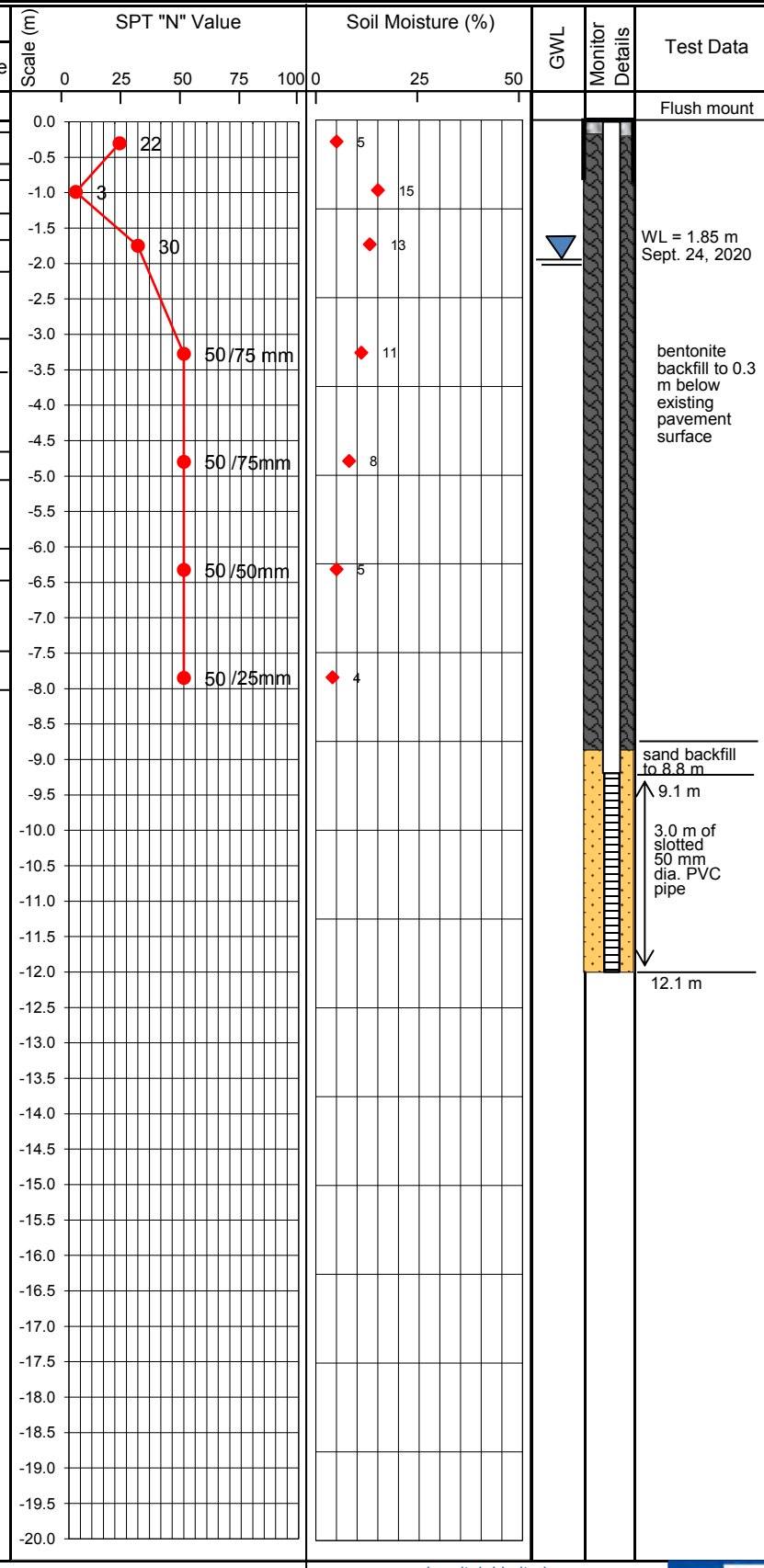
Landtek Limited
205 Nebo Road, Unit 3
Hamilton, Ontario, Canada, L8W 2E1
Ph: (905) 383-3733 Fax: (905) 383-8433
www.landteklimited.com

Landtek Limited

BH/MW 8

Project No.:	20255B	Drill Date:	August 31, 2020
Project:	Hydrogeological Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] Coring
Location:	Brant Street and Ghent Avenue, Burlington, Ontario	Datum:	Geodetic (Approximate)

Material Description	Elev. Depth	Sample No.	Sample Type	Test Data
Ground Surface	91.7			Flush mount
±50 mm of asphalt ± 200 mm of crushed limestone	0.0	1	SS	
FILL: clayey silt and silt, dark brown, loose to compact, moist	90.2	2	SS	
CLAYEY SILT TILL: trace gravel, trace shale, brownish grey, very stiff, wet	1.5	3	SS	
	88.2	4	SS	
SHALE BEDROCK (Queenston Formation) very weak to weak, highly weathered, red, moist	3.5	5	SS	
		6	SS	
	83.7	7	SS	
slightly weathered to fresh, red and grey, medium strong	8.0			
	79.6			
BOREHOLE TERMINATED	12.1			



Notes:
1. Wet soils encountred at 1.5 m depth during drilling
2. Water level reading: 1.85 m on September 24, 2020

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

Landtek Limited
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APPENDIX C

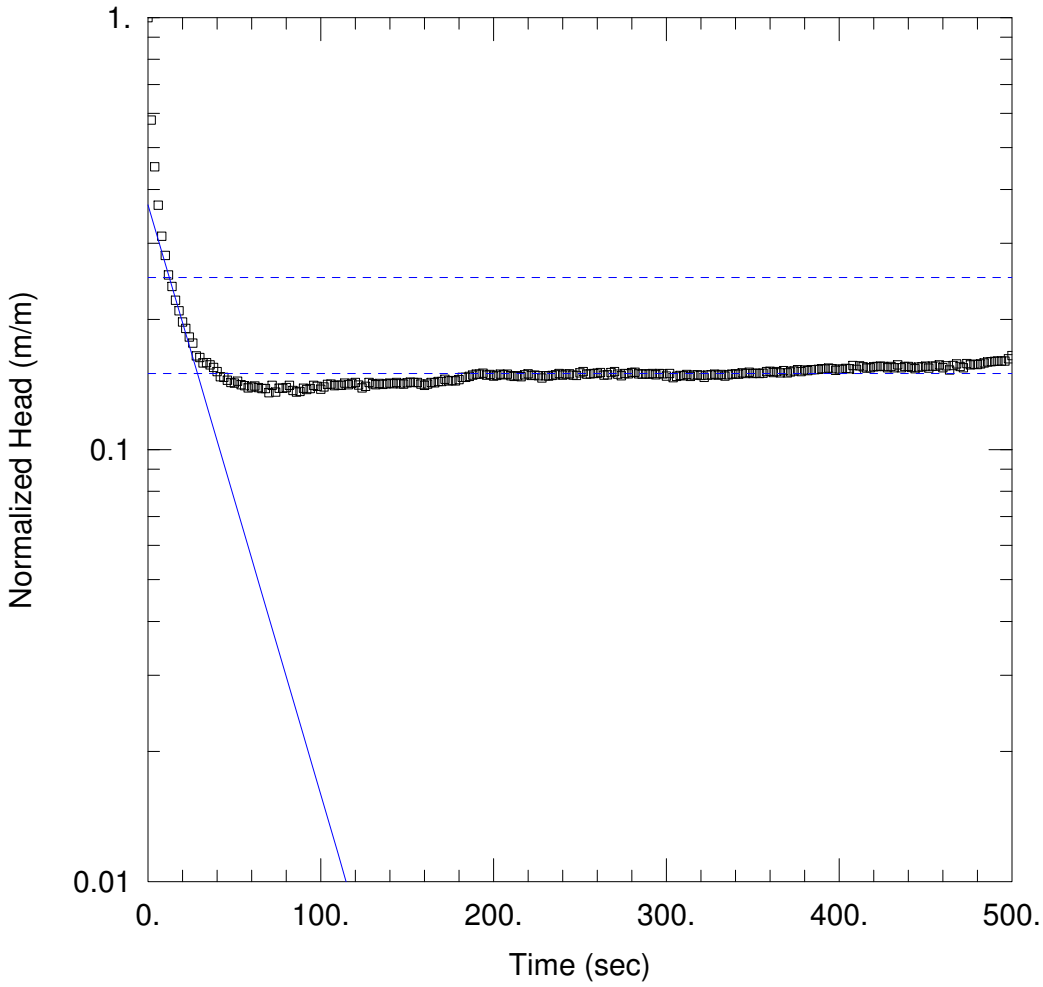
SUMMARY OF MOE WELL RECORDS

769-789 Brant Street 2023-2033 Ghent Avenue, Burlington

Well #	WELL_ID	DATE_COMPLETED	DATE_RECEIVED	EAST83	NORTH83	WATER_FOUND_DEPTH (FT)	Static Water Level (ft)	KIND	FINAL_STATUS	USE_1ST	DEPTH_TO (ft)	DEPTH_TO (m)	Well Construction	STREET	CITY
1	2800010	05-Jul-04	23-Sep-04	596231	4798928	NA	NA	NA	Observation Well	Observation Well	24.93	7.60	Bedrock	903 Brant Street	BURLINGTON
2	2810058	05-Jul-04	23-Sep-04	596231	4798928	NA	NA	NA	Observation Well	Observation Well	24.93	7.60	Bedrock	903 Brant Street	BURLINGTON
3	2810171	09-Feb-05	10-Mar-05	596252	4798292	11.5	NA	Fresh	Observation Well	Observation Well	14.8	4.51	Overburden	1380 Grahams Lane	BURLINGTON
4	2810214	21-Mar-05	26-Apr-05	596212	4798276	6.6	NA	NA	Observation Well	NA	14.8	4.51	Overburden	NA	BURLINGTON
5	2810308	16-May-05	03-Aug-05	596240	4798302	8.2	NA	Fresh	Observation Well	Observation Well	15.1	4.60	Overburden	1380 Grahams Lane	BURLINGTON
6	6715010	06-Jul-04	31-Aug-04	596235	4798927	10.5	NA	Fresh	Observation Well	Monitoring Well	14.8	4.51	Overburden	131 Ontario Street	BURLINGTON
7	7042731	03-Apr-07	17-Apr-07	596361	4798305	NA	NA	NA	Observation Well	Monitoring Well	13.1	3.99	Overburden	802 Hager Avenue	BURLINGTON
8	7047125	04-Jun-07	26-Jul-07	596126	4798177	9.8	NA	NA	Observation Well	Observation Well	11.8	3.60	Overburden	1380 Grahams Lane	BURLINGTON
9	7114804	27-Oct-08	12-Nov-08	596070	4799042	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	14	4.27	Overburden	2070 Queensway Blvd.	BURLINGTON
10	7114805	27-Oct-08	12-Nov-08	596052	4799019	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	14	4.27	Overburden	2070 Queensway Blvd.	BURLINGTON
11	7114806	27-Oct-08	12-Nov-08	596040	4799016	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	13.1	3.99	Overburden	2070 Queensway Blvd.	BURLINGTON
12	7128794	09-Jan-08	01-Sep-09	596186	4798748	NA	NA	NA	Abandoned	Monitoring Well	22.3	6.80	Overburden	2075 Fairview Street	BURLINGTON
13	7161863	10-Mar-11	14-Apr-11	596153	4798995	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
14	7179514	09-Jan-12	17-Apr-12	596238	4798370	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
15	7179515	19-Jan-12	17-Apr-12	596232	4798362	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
16	7179516	19-Jan-12	17-Apr-12	596245	4798354	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	16.73	5.10	Overburden	1380 Grahams Lane	BURLINGTON
17	7179605	19-Jan-12	17-Apr-12	596248	4798355	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	18	5.49	Overburden	1380 Grahams Lane	BURLINGTON
18	7181756	14-May-12	29-May-12	596046	4799010	NA	NA	NA	Observation Well	Monitoring Well	9.84	3.00	Overburden	2070 Queensway Blvd.	BURLINGTON
19	7181757	14-May-12	29-May-12	596051	4799006	NA	NA	NA	Monitoring Well	Monitoring Well	9.84	3.00	Overburden	2070 Queensway Blvd.	BURLINGTON
20	7181758	14-May-12	29-May-12	596063	4799013	NA	NA	NA	Observation Well	Monitoring Well	9.84	3.00	Overburden	2070 Queensway Blvd.	BURLINGTON
21	7187211	NA	17-Sep-12	596799	4798762	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2096 Hent Avenue	BURLINGTON
22	7187212	NA	17-Sep-12	596775	4798734	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2084 Ghgnt Avenue	BURLINGTON
23	7219025	26-Mar-14	07-Apr-14	597115	4798155	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
24	7220604	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Monitoring Well	Monitoring Well	17	5.18	Bedrock	2702 Ghent Avenue	BURLINGTON
25	7220605	21-Apr-14	20-May-14	596782	4798703	NA	NA	NA	Abandoned	NA	20	6.10	NA	2702 Ghent Avenue	BURLINGTON
26	7243101	29-Apr-15	16-Jun-15	596193	4798975	NA	NA	NA	Monitoring Well	Monitoring Well	25	7.62	Bedrock	923 Brant Street	BURLINGTON
27	7244979	03-Jun-15	21-Jul-15	596883	4798686	7	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
28	7244980	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	Monitoring Well	18	5.5	Bedrock	2086 Grant Avenue	BURLINGTON
29	7244981	03-Jun-15	21-Jul-15	596883	4798686	NA	NA	NA	Observation Well	NA	18	5.49	Bedrock	2086 Grant Avenue	BURLINGTON
30	7244982	03-Jun-15	21-Jul-15	596825	4798636	NA	NA	NA	Abandoned	NA	NA	NA	NA	2086 Grant Avenue	BURLINGTON
31	7251865	11-Sep-15	10-Nov-15	596782	4798684	NA	NA	NA	Monitoring Well	Monitoring Well	20	6.10	Bedrock	2068 Ghent Avenue	BURLINGTON
32	7252011	04-Sep-15	10-Nov-15	596736	4798745	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Bedrock	2071 Ghent Avenue	BURLINGTON
33	7265586	10-Mar-16	24-Jun-16	596019	4798801	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
34	7283351	04-Nov-16	17-Mar-17	596640	4798358	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	20	6.10	Overburden	730 Brant Street	BURLINGTON
35	7284939	07-Mar-17	10-Apr-17	596319	4798254	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	15	4.57	Bedrock	770 Haggar Avenue East	BURLINGTON
36	7284940	07-Mar-17	10-Apr-17	596309	4798244	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	15	4.57	Bedrock	770 Haggar Avenue East	BURLINGTON
37	7290057	26-May-17	07-Jul-17	596301	4798815	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	833 Brant Street	BURLINGTON
38	7290058	26-May-17	07-Jul-17	596289	4798790	NA	NA	NA	Observation Well	Test Hole	20	6.10	Overburden	855 Brant Street	BURLINGTON
39	7291911	12-Jun-17	02-Aug-17	596224	4798347	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON
40	7292314	21-Jun-17	11-Aug-17	596336	4798785	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	849 Brant Street	BURLINGTON
41	7292315	21-Jun-17	11-Aug-17	596336	4798786	NA	NA	NA	Observation Well	Monitoring Well	30	9.15	Overburden	849 Brant Street	BURLINGTON
42	7292316	21-Jun-17	11-Aug-17	596361	4798743	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
43	7292317	21-Jun-17	11-Aug-17	596352	4798776	NA	NA	NA	Observation Well	Monitoring Well	18	5.49	Overburden	849 Brant Street	BURLINGTON
44	7314898	04-Jul-18	19-Jul-18	596295	4798451	NA	NA	NA	Observation Well	Monitoring Well	15	4.57	Overburden	1416 Graham Lane	BURLINGTON
45	7320914	22-Aug-18	18-Oct-18	596673	4798937	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
46	7320915	22-Aug-18	18-Oct-18	596624	4798918	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
47	7320916	22-Aug-18	18-Oct-18	596697	4798876	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	65.6	20.00	Overburden	2087 Prospect Street	BURLINGTON
48	7323581	05-Oct-18	06-Dec-18	596643	4798961	NA	NA	NA	Monitoring and Test hole	Monitoring and Test hole	20	6.10	Overburden	2103 Prospect Street	BURLINGTON
49	7330854	14-Feb-19	01-Apr-19	596270	4798655	NA	NA	NA	Observation Well	Monitoring Well	13	3.96	Overburden	850 Brant Street	BURLINGTON
50	7330855	14-Feb-19	01-Apr-19	596305	4798644	NA	NA	NA	Observation Well	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
51	7330856	15-Feb-19	01-Apr-19	596261	4798608	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
52	7330857	15-Feb-19	01-Apr-19	596254	4798731	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
53	7330858	15-Feb-19	01-Apr-19	596259	4798693	NA	NA	NA	Monitoring and Test hole	Monitoring Well	15.6	4.76	Overburden	850 Brant Street	BURLINGTON
54	7330859	14-Feb-19	01-Apr-19	596288	4798651	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	850 Brant Street	BURLINGTON
55	7331850	23-Aug-18	23-Apr-19	596494	4798533	NA	NA	NA	Observation Well	Monitoring Well	20	6.10	Overburden	280 Brant Street	BURLINGTON
56	7332300	NA	08-May-19	596425	4798027	NA	NA	NA	NA	NA	NA	NA	NA	NA	BURLINGTON

APPENDIX D

HYDRAULIC CONDUCTIVITY TESTING ANALYSIS RESULTS



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW1-update.aqt
Date: 10/07/20 Time: 09:51:07

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-A
Location: 774-780 Brant Street E.
Test Well: MW1
Test Date: September 24, 2020

AQUIFER DATA

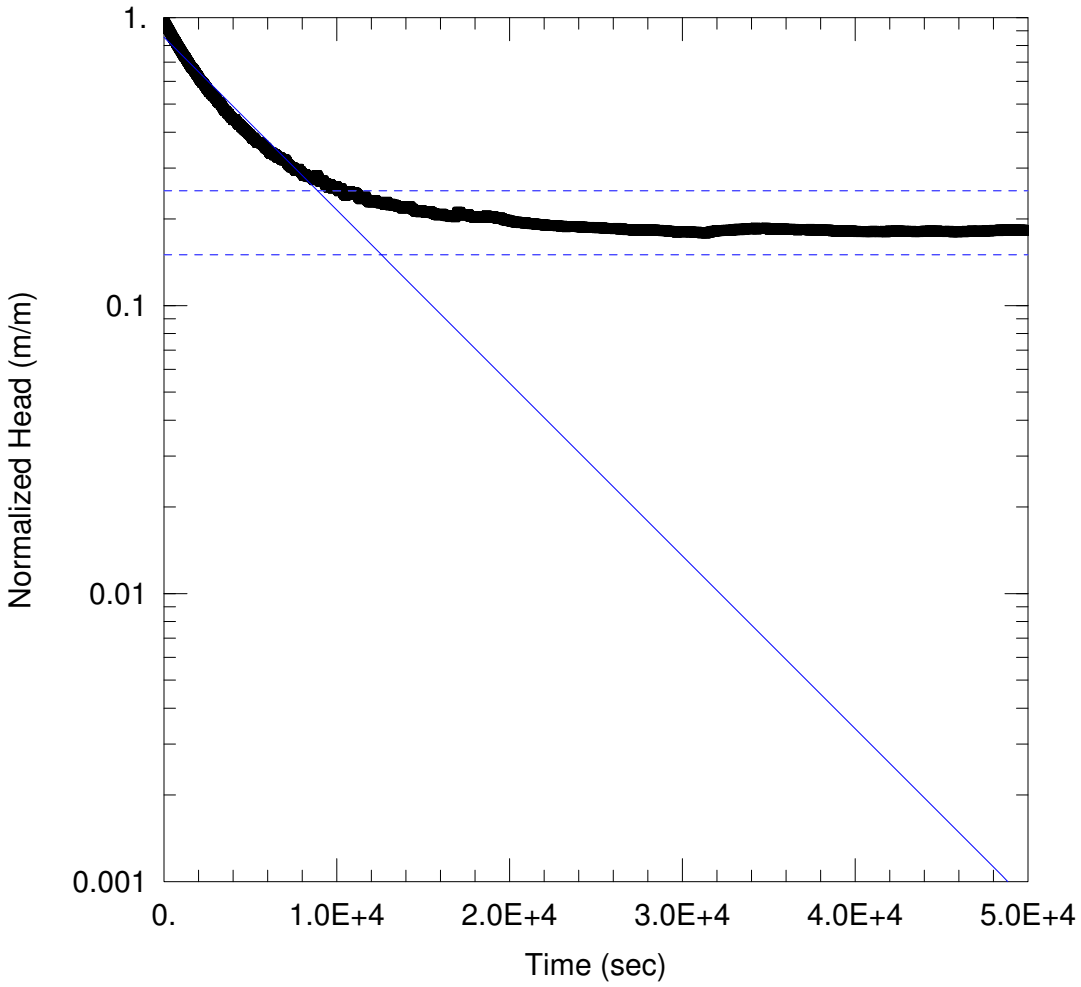
Saturated Thickness: 15.4 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW1)

Initial Displacement: 0.311 m
Total Well Penetration Depth: 18.4 m
Casing Radius: 0.0254 m
Static Water Column Height: 15.4 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.847E-5 m/sec
y0 = 0.1147 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW4.aqt
Date: 10/07/20 Time: 09:04:22

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-A
Location: 774-780 Brant Street E.
Test Well: MW4
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 14.4 m Anisotropy Ratio (Kz/Kr): 1.

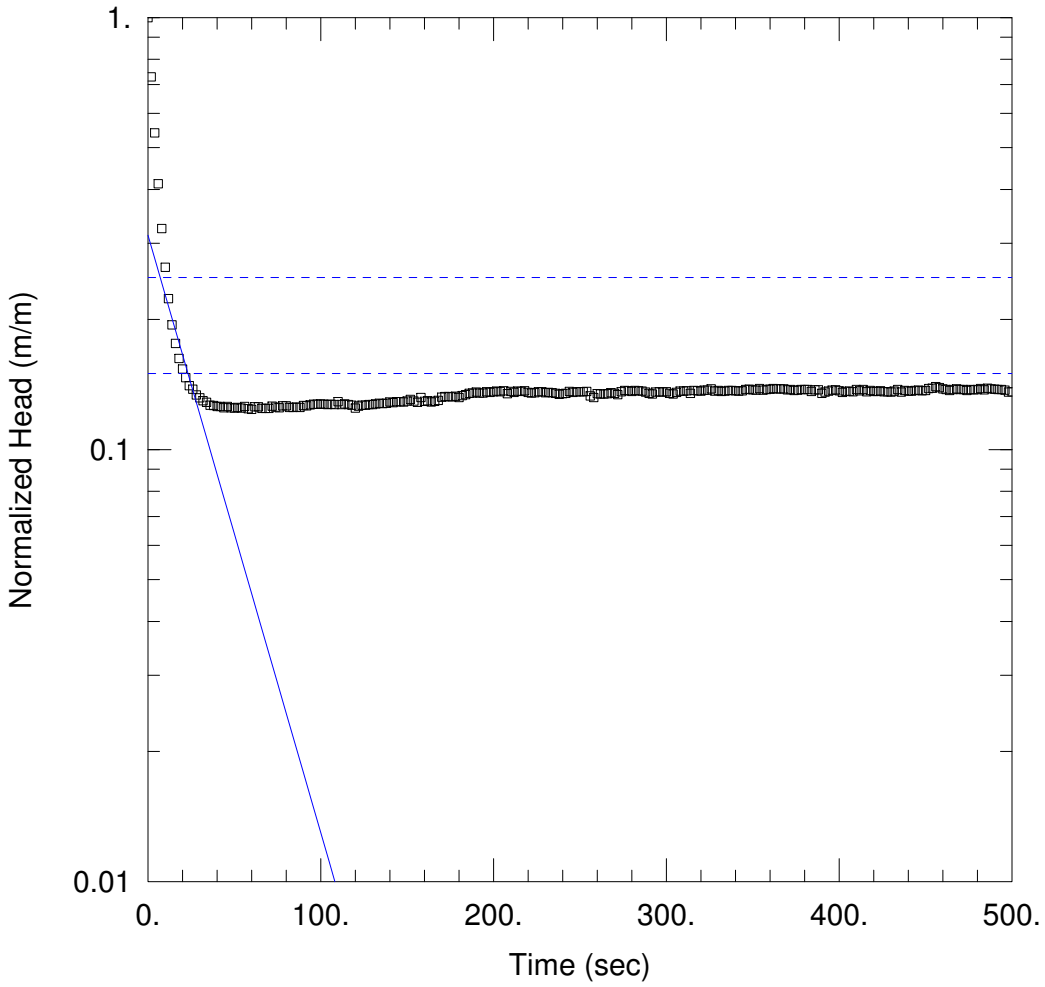
WELL DATA (MW4)

Initial Displacement: 0.5121 m
Total Well Penetration Depth: 18.4 m
Casing Radius: 0.0254 m
Static Water Column Height: 14.92 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 8.12E-8 m/sec y0 = 0.4371 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW5.aqt
Date: 10/07/20 Time: 09:07:35

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-B
Location: 769-789 Brant St.
Test Well: MW5
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 6.5 m Anisotropy Ratio (Kz/Kr): 1.

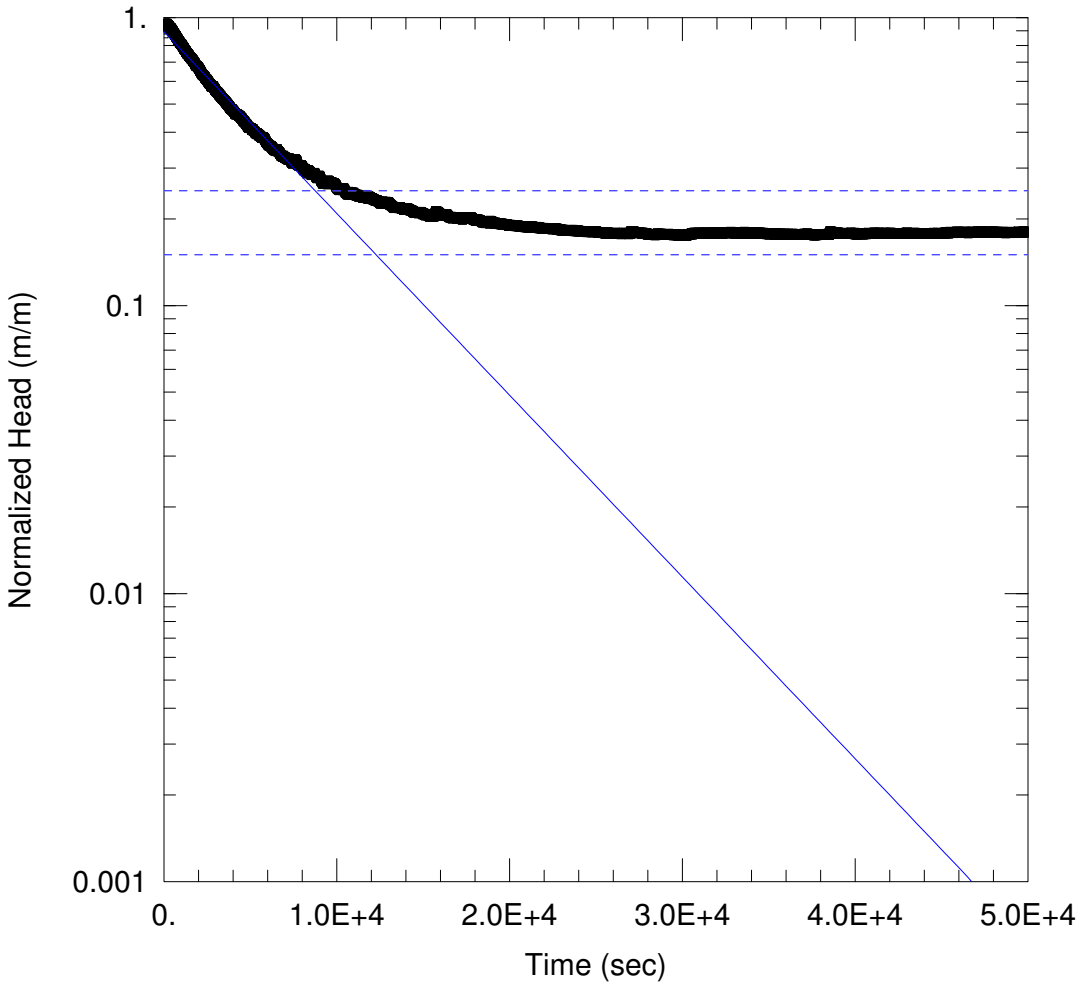
WELL DATA (MW5)

Initial Displacement: 0.4104 m
Total Well Penetration Depth: 9.9 m
Casing Radius: 0.0254 m
Static Water Column Height: 9.9 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.871E-5 m/sec y0 = 0.1285 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW8.aqt
Date: 10/07/20 Time: 09:09:17

PROJECT INFORMATION

Company: Landtek Limited
Client: Milinaro Group
Project: 20255-B
Location: 769-789 Brant Street
Test Well: MW8
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 9.6 m Anisotropy Ratio (Kz/Kr): 1.

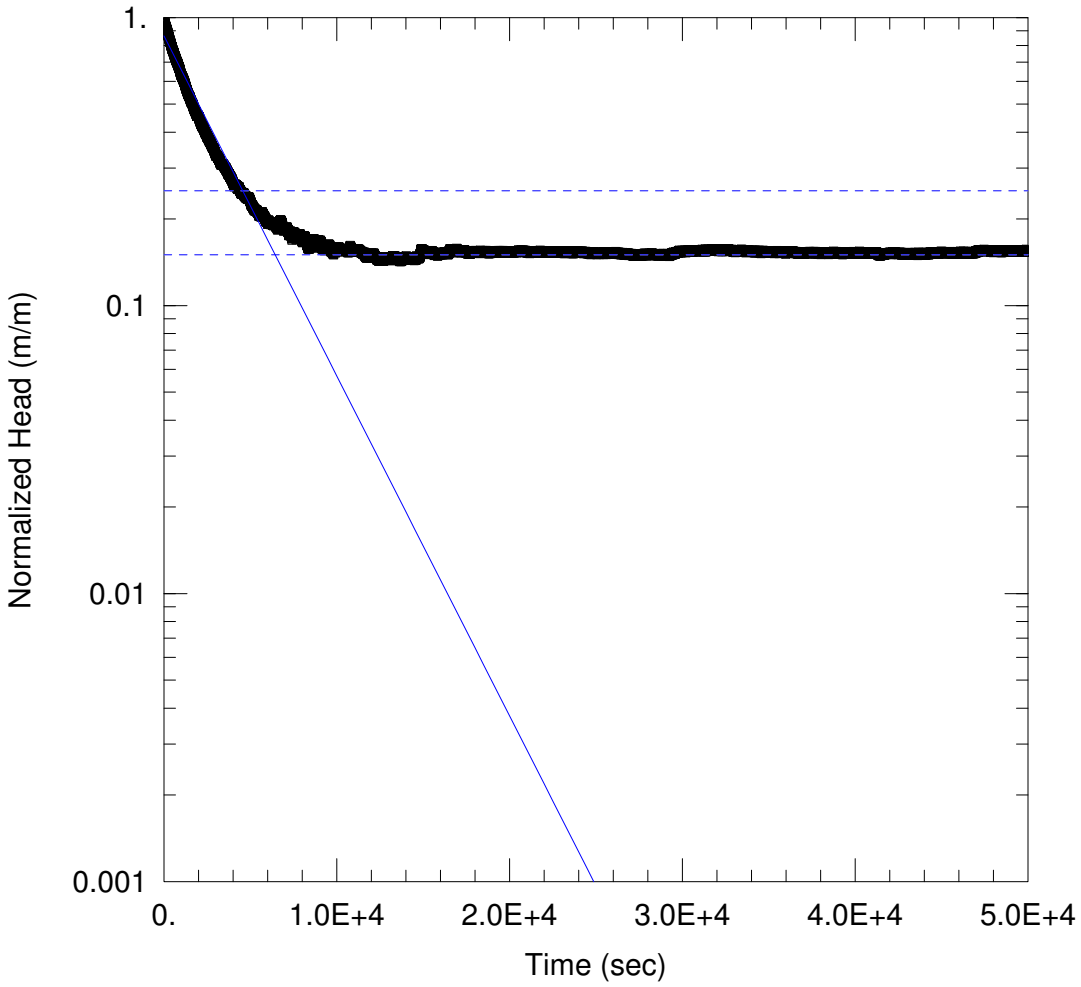
WELL DATA (MW8)

Initial Displacement: 0.4756 m
Total Well Penetration Depth: 10.25 m
Casing Radius: 0.0254 m
Static Water Column Height: 10.25 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 8.538E-8 m/sec y0 = 0.4245 m



HYDRGEOLOGICAL INVESTIGATION

Data Set: F:\...\MW11.aqt
Date: 10/07/20 Time: 09:10:53

PROJECT INFORMATION

Company: ppppppp
Client: Milinaro Group
Project: 20255-C
Location: 747 & 761 Brant Street
Test Well: MW11
Test Date: September 24, 2020

AQUIFER DATA

Saturated Thickness: 6.8 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW11)

Initial Displacement: 0.4362 m
Total Well Penetration Depth: 7.35 m
Casing Radius: 0.0254 m
Static Water Column Height: 7.35 m
Screen Length: 3. m
Well Radius: 0.0254 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.597E-7 m/sec y0 = 0.3765 m

APPENDIX E

SUMMARY OF HYDRAULIC CONDUCTIVITY RESULTS FROM PREVIOUS INVESTIGATIONS

Appendix G
Summary of Hydraulic Conductivity Results from Previous Investigations

Location	Author	Unit	K - Hydraulic Conductivity (m/sec)	
			Low	High
Various	Gartner Lee Ltd (1978)	Halton Till	1×10^{-9}	
Various	Gartner Lee Ltd (1978)	Queenston Shale	8.10×10^{-7}	
Various	Gartner Lee Ltd (1978)	Lacustrine Clay Silt (Peel Plain)	1×10^{-8}	
Georgetown	Gartner Lee Ltd. (1993)	Queenston Shale	1×10^{-6}	
Burlington	Gartner Lee Ltd. (1983)	Shale	1×10^{-8}	1×10^{-6}
Oakville (East)	MOE (1979)	Peel Plain	5×10^{-6}	4×10^{-5}
Oakville (East)	MOE (1979)	Queenston Shale	3.2×10^{-5}	2.3×10^{-6}
Oakville (East)	MOE (1979)	Georgian Bay Shale	5.1×10^{-6}	
Milton	International Water Consultants (1977)	Upper Sand and Gravel	2.83×10^{-3}	
Mississauga	Conestoga Rovers and Associates (2013)	Shale	2.4×10^{-5}	

Geometric Mean	K (m/sec)
Halton Till	1×10^{-9}
Peel Plain	2.5×10^{-6}
Sand/Gravel	2.83×10^{-3}
Queenston Shale	1.1×10^{-5}
Georgian Bay Shale	5.1×10^{-6}

Source: Holysh (1997)

APPENDIX F

LABORATORY CERTIFICATE OF ANALYSIS

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: LANDTEK LTD.
205 NEBO ROAD, UNIT 3
HAMILTON, ON L8W2E1
(905) 383-3733
ATTENTION TO: Henry Erebor
PROJECT: 20255B
AGAT WORK ORDER: 20T653945
MICROBIOLOGY ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer
TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist
ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste
WATER ANALYSIS REVIEWED BY: Yris Verastegui, Report Reviewer
DATE REPORTED: Oct 02, 2020
PAGES (INCLUDING COVER): 16
VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

VERSION 2:Version 2 supersedes work order 20T653945, Version 1, issued October 1, 2020. Complete.

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

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Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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AGAT Laboratories

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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

E. Coli (Using MI Agar)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

			SAMPLE DESCRIPTION:	**MW5**	**MW8**
			SAMPLE TYPE:	**Water**	**Water**
			DATE SAMPLED:	**2020-09-21 14:30**	**2020-09-21 14:30**
Parameter	**Unit**	**G / S**	**RDL**	**1468778**	**1468783**
Escherichia coli	CFU/100mL	200	1	ND	6

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

1468778 ND - Not Detected.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer - Organics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		MW5	MW8
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-09-21 14:30	2020-09-21 14:30
Parameter	Unit	G / S	RDL	1468778	1468783
Methylene Chloride	mg/L	0.0052	0.0003	<0.0003	<0.0003
trans-1,3-Dichloropropylene	mg/L	0.0056	0.0003	<0.0003	<0.0003
cis- 1,2-Dichloroethylene	mg/L	0.0056	0.0002	<0.0002	<0.0002
Chloroform	mg/L	0.002	0.0002	<0.0002	<0.0002
Benzene	mg/L	0.002	0.0002	<0.0002	<0.0002
Trichloroethylene	mg/L	0.0076	0.0002	0.0004	<0.0002
Toluene	mg/L	0.002	0.0002	<0.0002	<0.0002
Tetrachloroethylene	mg/L	0.0044	0.0001	<0.0001	<0.0001
Ethylbenzene	mg/L	0.002	0.0002	<0.0002	<0.0002
1,1,2,2-Tetrachloroethane	mg/L	0.017	0.0002	<0.0002	<0.0002
1,2-Dichlorobenzene	mg/L	0.0056	0.0002	<0.0002	<0.0002
1,4-Dichlorobenzene	mg/L	0.0068	0.0002	<0.0002	<0.0002
Xylenes (Total)	mg/L	0.0044	0.0002	<0.0002	<0.0002
PCBs	mg/L	0.0004	0.0002	<0.0002	<0.0002
Pentachlorophenol	mg/L	0.002	0.0005	<0.0005	<0.0005
Di-n-butyl phthalate	mg/L	0.015	0.0005	<0.0005	<0.0005
3,3'-Dichlorobenzidine	mg/L	0.0008	0.0001	<0.0001	<0.0001
Bis(2-Ethylhexyl)phthalate	mg/L	0.0088	0.0005	<0.0005	0.0005
Total PAHs	mg/L	0.002	0.0003	<0.0003	<0.0003

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: N Popnikolof

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AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW5	MW8
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-21 14:30	2020-09-21 14:30
Parameter	**Unit**	**G / S**	**RDL**		**1468778**	**1468783**
Total Nonylphenol	mg/L	0.001	0.001		<0.001	<0.001
NP1EO	mg/L		0.001		<0.001	<0.001
NP2EO	mg/L		0.0003		<0.0003	<0.0003
Total Nonylphenol Ethoxylates	mg/L	0.01	0.001		<0.001	<0.001

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Montreal (unless marked by *)

Certified By:



Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

BOD-Toronto

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

				SAMPLE DESCRIPTION:	MW5	MW8
				SAMPLE TYPE:	Water	Water
				DATE SAMPLED:	2020-09-21 14:30	2020-09-21 14:30
Parameter	**Unit**	**G / S**	**RDL**		**1468778**	**1468783**
Biochemical Oxygen Demand, Total	mg/L	15	2		<2	3

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By: Iris Verástegui

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Burlington Storm Sewer Use By-law - Inorganics

DATE RECEIVED: 2020-09-22

DATE REPORTED: 2020-10-02

		SAMPLE DESCRIPTION:		MW5		MW8
		SAMPLE TYPE:		Water		Water
		DATE SAMPLED:		2020-09-21 14:30		2020-09-21 14:30
Parameter	Unit	G / S	RDL	1468778	RDL	1468783
pH	pH Units	6.5 - 8.5	NA	7.58	NA	7.04
Total Suspended Solids	mg/L	15	10	**54**	10	**21**
Total Cyanide	mg/L	0.02	0.002	<0.002	0.002	<0.002
Phenols	mg/L	0.008	0.002	<0.002	0.002	<0.002
Total Phosphorus	mg/L	0.4	0.04	**0.56**	0.02	0.04
Total Arsenic	mg/L	0.02	**0.030**	<0.030	0.015	<0.015
Total Cadmium	mg/L	0.008	**0.010**	<0.010	0.005	<0.005
Total Chromium	mg/L	0.08	0.040	<0.040	0.020	<0.020
Chromium VI	mg/L	0.04	0.005	<0.005	0.005	<0.005
Total Copper	mg/L	0.04	0.040	<0.040	0.020	<0.020
Total Lead	mg/L	0.12	0.040	<0.040	0.020	<0.020
Total Manganese	mg/L	0.05	0.040	**0.513**	0.020	**0.231**
Total Mercury	mg/L	0.0004	0.0002	<0.0002	0.0002	<0.0002
Total Nickel	mg/L	0.08	0.060	<0.060	0.030	<0.030
Total Selenium	mg/L	0.02	**0.040**	<0.040	0.020	<0.020
Total Silver	mg/L	0.12	0.040	<0.040	0.020	<0.020
Total Zinc	mg/L	0.04	0.040	**0.042**	0.020	<0.020

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to ON Burlington Storm 086-2002
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

1468778 Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Iris Verástegui

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Exceedance Summary

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Henry Erebor

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
1468778	MW5	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	0.513
1468778	MW5	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Phosphorus	mg/L	0.4	0.56
1468778	MW5	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	54
1468778	MW5	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Zinc	mg/L	0.04	0.042
1468783	MW8	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Manganese	mg/L	0.05	0.231
1468783	MW8	ON Burlington SM	Burlington Storm Sewer Use By-law - Inorganics	Total Suspended Solids	mg/L	15	21

Results relate only to the items tested. Results apply to samples as received.

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Microbiology Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
E. Coli (Using MI Agar)															
Escherichia coli	1468036		ND	ND	NA	< 1									

Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By:



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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Burlington Storm Sewer - Organics															
Methylene Chloride	1467084		< 0.0003	< 0.0003	NA	< 0.0003	85%	60%	130%	103%	60%	130%	97%	60%	130%
trans-1,3-Dichloropropylene	1467084		< 0.0003	< 0.0003	NA	< 0.0003	83%	50%	140%	81%	60%	130%	77%	50%	140%
cis- 1,2-Dichloroethylene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	99%	60%	130%	106%	60%	130%	114%	60%	130%
Chloroform	1467084		< 0.0002	< 0.0002	NA	< 0.0002	96%	50%	140%	105%	60%	130%	112%	50%	140%
Benzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	88%	50%	140%	110%	60%	130%	115%	50%	140%
Trichloroethylene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	99%	50%	140%	114%	60%	130%	117%	50%	140%
Toluene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	102%	50%	140%	102%	60%	130%	92%	50%	140%
Tetrachloroethylene	1467084		< 0.0001	< 0.0001	NA	< 0.0001	103%	50%	140%	98%	60%	130%	102%	50%	140%
Ethylbenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	107%	50%	140%	105%	60%	130%	113%	50%	140%
1,1,2,2-Tetrachloroethane	1467084		< 0.0002	< 0.0002	NA	< 0.0002	114%	50%	140%	102%	60%	130%	96%	50%	140%
1,2-Dichlorobenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	96%	50%	140%	89%	60%	130%	105%	50%	140%
1,4-Dichlorobenzene	1467084		< 0.0002	< 0.0002	NA	< 0.0002	103%	50%	140%	98%	60%	130%	102%	50%	140%
PCBs	1470537		< 0.0002	< 0.0002	NA	< 0.0002	107%	60%	130%	87%	60%	130%	87%	60%	130%
Pentachlorophenol	1466584		< 0.0001	< 0.0001	NA	< 0.0005	85%	50%	140%	80%	50%	140%	85%	50%	140%
Di-n-butyl phthalate	1466584		< 0.0005	< 0.0005	NA	< 0.0005	88%	50%	140%	99%	50%	140%	89%	50%	140%
3,3'-Dichlorobenzidine	1466584		< 0.0005	< 0.0005	NA	< 0.0001	84%	30%	130%	95%	30%	130%	96%	30%	130%
Bis(2-Ethylhexyl)phthalate	1466584		< 0.0005	< 0.0005	NA	< 0.0005	71%	50%	140%	102%	50%	140%	99%	50%	140%
Total PAHs	1466584		< 0.0003	< 0.0003	NA	< 0.0003	70%	60%	130%	100%	60%	130%	80%	60%	130%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By: N Popowkolof

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AGAT Laboratories

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Ultra Trace Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)															
Total Nonylphenol	1	1468783	< 0.001	< 0.001	0.0%	< 0.001	90%	60%	140%	NA	60%	140%	NA	60%	140%
NP1EO	1	1468783	< 0.001	< 0.001	0.0%	< 0.001	49%	60%	140%	NA	60%	140%	NA	60%	140%
NP2EO	1	1468783	< 0.0003	< 0.0003	0.0%	< 0.0003	88%	60%	140%	NA	60%	140%	NA	60%	140%

Certified By:

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Quality Assurance

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Oct 02, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Burlington Storm Sewer Use By-law - Inorganics															
pH	1472945		7.07	7.00	1.0%	NA	100%	90%	110%						
Total Suspended Solids	1468130		<10	<10	NA	< 10	104%	80%	120%						
Total Cyanide	1438860		<0.002	<0.002	NA	< 0.002	90%	70%	130%	101%	80%	120%	103%	70%	130%
Phenols	1462918		<0.002	<0.002	NA	< 0.002	100%	90%	110%	96%	90%	110%	90%	80%	120%
Total Phosphorus	1466850		0.02	0.03	NA	< 0.02	100%	70%	130%	102%	80%	120%	97%	70%	130%
Total Arsenic	1453842		<0.015	<0.015	NA	< 0.015	99%	70%	130%	103%	80%	120%	102%	70%	130%
Total Cadmium	1453842		<0.005	<0.005	NA	< 0.005	100%	70%	130%	106%	80%	120%	102%	70%	130%
Total Chromium	1453842		<0.020	<0.020	NA	< 0.020	98%	70%	130%	104%	80%	120%	106%	70%	130%
Chromium VI	1468718		<0.005	<0.005	NA	< 0.005	100%	70%	130%	100%	80%	120%	97%	70%	130%
Total Copper	1453842		<0.020	<0.020	NA	< 0.020	100%	70%	130%	102%	80%	120%	102%	70%	130%
Total Lead	1453842		<0.020	<0.020	NA	< 0.020	94%	70%	130%	88%	80%	120%	88%	70%	130%
Total Manganese	1453842		<0.020	<0.020	NA	< 0.020	96%	70%	130%	102%	80%	120%	104%	70%	130%
Total Mercury	1472485		<0.0002	<0.0002	NA	< 0.0002	103%	70%	130%	96%	80%	120%	97%	70%	130%
Total Nickel	1453842		<0.030	<0.030	NA	< 0.030	99%	70%	130%	102%	80%	120%	102%	70%	130%
Total Selenium	1453842		<0.020	<0.020	NA	< 0.020	96%	70%	130%	99%	80%	120%	98%	70%	130%
Total Silver	1453842		<0.020	<0.020	NA	< 0.020	95%	70%	130%	100%	80%	120%	95%	70%	130%
Total Zinc	1453842		<0.020	<0.020	NA	< 0.020	101%	70%	130%	115%	80%	120%	117%	70%	130%

Comments: NA signifies Not Applicable.
If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.

BOD-Toronto

Biochemical Oxygen Demand, Total	1470130		76	73	4.0%	< 2	91%	70%	130%						

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Iris Verástegui

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Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

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QA Violation

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

RPT Date: Oct 02, 2020			REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Sample Description	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
				Lower	Upper		Lower	Upper		Lower	Upper
Nonylphenol and Nonylphenol Ethoxylates (Ontario, mg/L)											
NP1EO	1468783	MW5	49%	60%	140%	NA	60%	140%	NA	60%	140%

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Results relate only to the items tested. Results apply to samples as received.

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Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Trace Organics Analysis			
Methylene Chloride	VOL-91-5001	EPA SW-846 5030B & 8260B	(P&T)GC/MS
trans-1,3-Dichloropropylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
cis- 1,2-Dichloroethylene	VOL-91-5001	EPA SW-846 5030B & 8260B	(P&T)GC/MS
Chloroform	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Benzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Trichloroethylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Toluene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Tetrachloroethylene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Ethylbenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,1,2,2-Tetrachloroethane	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
Xylenes (Total)	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
PCBs	ORG-91-5112	EPA SW-846 3510C & 8082A	GC/ECD
Pentachlorophenol	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Di-n-butyl phthalate	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
3,3'-Dichlorobenzidine	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Bis(2-Ethylhexyl)phthalate	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Total PAHs	ORG-91-5114	EPA SW-846 3510C & 8270E	GC/MS
Ultra Trace Analysis			
Total Nonylphenol	NA	ASTM D7065-6	LC/MS/MS
NP1EO	NA	ASTM D7065-6	LC/MS/MS
NP2EO	NA	ASTM D7065-6	LC/MS/MS
Total Nonylphenol Ethoxylates	NA	ASTM D7065-6	LC/MS/MS

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: LANDTEK LTD.

AGAT WORK ORDER: 20T653945

PROJECT: 20255B

ATTENTION TO: Henry Erebor

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Biochemical Oxygen Demand, Total	INOR-121-6023	SM 5210 B	INCUBATOR
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	modified from EPA 1684,ON MOECC E3139,SM 2540C,D	BALANCE
Total Cyanide	INOR-93-6051	modified from MOECC E3015; SM 4500-CN- A, B, & C	TECHNICON AUTO ANALYZER
Phenols	INOR-93-6050	MOE ROPHEN-E3179 & SM 5530 D	TECHNICON AUTO ANALYZER
Total Phosphorus	INOR-93-6022	modified from SM 4500-P B and SM 4500-P E	SPECTROPHOTOMETER
Total Arsenic	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Cadmium	MET -93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Chromium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Chromium VI	INOR-93-6034	modified from SM 3500-CR B	SPECTROPHOTOMETER
Total Copper	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Lead	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Manganese	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Mercury	MET-93-6100	modified from EPA 245.2 and SM 3112 B	CVAAS
Total Nickel	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Selenium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Silver	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zinc	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS

Results relate only to the items tested. Results apply to samples as received.

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Landtek Limited
Contact: Henry Ereba
Address: 205 Nebo Rd., Hamilton, ON L8W 2E1
Phone: 289-550-3992 Fax:
Reports to be sent to:
1. Email: henry@landtek.ca
2. Email:

Project Information:

Project: 20255B
Site Location: 769-783 Brant St & 2023-2033 Ghent Ave
Sampled By: LB and HE
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☐ Fine

☐ Excess Soils R406
Table (Indicate One)
☐ Regulation 558
☐ CCME

☐ Sewer Use ☐ Sanitary ☑ Storm
(Region)
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
(Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Laboratory Use Only

Work Order #: 20T653945
Cooler Quantity:
Arrival Temperatures: 6.2 | 6 | 6.7 | 6 | 6 | 6.4
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: Ice

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	Metals - CrVI, Hg, HWSB	BTEX, F1-F4 PHCs, Analyze F4G if required Yes No	PAHs	PCBs	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: TCLP: M&I VOCs ABNs B(a)P PCBs	Excess Soils SPLP Rainwater Leach SPLP: Metals VOCs SVOCs	Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	O. Reg 406				Potentially Hazardous or High Concentration (Y/N)
MW5	21-Sep-20	2:30 AM/PM		GW		Y											Sewer Use	✓	✓	✓	
MW8	"	"		✓		N											City of Burlington	✓	✓	✓	
																	Storm Sewer Discharge				
																	& E. Coli				

Samples Relinquished By (Print Name and Sign): K. Ereba — Date: Sept. 22/20 — Time: 2:00pm
Samples Received By (Print Name and Sign): John Chyopyka — Date: Sept 22 — Time: 1:45
Samples Relinquished By (Print Name and Sign): — Date: — Time:
Samples Received By (Print Name and Sign): John Chyopyka — Date: Sept 22 — Time: 4:20
Samples Relinquished By (Print Name and Sign): — Date: — Time:

Page ____ of ____
N°: 109223

Document ID: DIV-78-1511.01S

AGAT Laboratories

Sample Temperature Log

Client: Landtek

# of Coolers: 8

COC# or Work Order #: 20T653945

# of Submissions:

Arrival Temperatures - Branch/Driver

Cooler #1:	6.2	6	6.2
Cooler #2:	6.6	6.6	6.8
Cooler #3:	6	6.2	6
Cooler #4:	6.4	6	6.4
Cooler #5:	6.4	6.4	6.4
Cooler #6:	6.2	6.2	6.2
Cooler #7:	7.2	7	7.2
Cooler #8	7.1	7.4	7.5
Cooler #9:			
Cooler #10:			

IR Gun ID:

Taken By: John Chypyha

Date (yyyy/mm/dd): Sept 22 Time: 1:45 AM / PM

Arrival Temperatures - Laboratory

Cooler #1:	6	6	6.4
Cooler #2:	6.8	6.6	7
Cooler #3:	6.6	6.6	6.8
Cooler #4:	6.6	6.8	6.8
Cooler #5:	7	6.8	7
Cooler #6:	6.4	6.6	6.6
Cooler #7:	7.4	7.6	7.8
Cooler #8	7.8	7.6	7.6
Cooler #9:			
Cooler #10:			

IR Gun ID:

Taken By: John Chypyha

Date (yyyy/mm/dd): Sept 22 Time: 11:30 AM / ~~PM~~

Instructions for use of this form: 1) complete all fields of info including total # of coolers and # of submissions rec'd, 2) photocopy and place in each submission prior to giving a WO#, 3) Proceed as normal, write the WO# and scan (please make sure to scan along with the COC)

Document ID: SR-78-9511.003
Date Issued: 2017-2-23

Page:____ of ____

APPENDIX G

DEWATERING ASSUMPTIONS & CALCULATIONS -BASEMENT PARKING LEVELS

Table 1 – Basement Excavation Dewatering Calculations-Scenario Based on Field Hydraulic Conductivity Tests – Section A

$$Q = 2\pi kD\,(H - h_w)/\ln\,(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 8.6 m

$R = C*(H - h)*\sqrt{(K)}$ Radius of Influence - Sichardt's equation

$r_e = \sqrt{(L * B)}/\pi$ (applies when a/b>1.5 and R0 << rs)

$r_e = (L + B)/\pi$ (applies when a/b<1.5 and R0 >> rs)

Basement	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (with 1.3 Factor of Safety
	10.47	3.0	~20.4	~29.2	~54,272 (6.28 x 10-4 m3/s)	~ 70,554

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.63 mbgs at MW8 on April 22, 2021 and extending to an estimated depth of approximately 12.1 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 9.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 8.252×10^{-7} m/s

Table 2 – Basement Excavation Dewatering Calculations-Scenario Based on Low Hydraulic Conductivity Values from Previous Investigations in Burlington Shale (Holysh, 1997) – Section A

$$Q = 2\pi kD\,(H - h_w)/\ln\,(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 8.6 m

R = C*(H – h)*√(K) Radius of Influence - Sichardt's equation

r_e = √(L * B)/π (applies when a/b>1.5 and R0 << rs)

r_e = (L + B)/π (applies when a/b<1.5 and R0 >> rs)

Basement	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (with 1.3 Factor of Safety
	10.47	3.0	~2.2	~29.2	~4,775 (7.53 x 10-5 m3/s)	~ 6,208

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.63 mbgs at MW11 on April 22, 2021 and extending to an estimated depth of approximately 12.1 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 9.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 1.0×10^{-8} m/s

Table 3– Basement Excavation Dewatering Calculations-Scenario Based on Field Hydraulic Conductivity Tests - Section B

$$Q = 2\pi kD\,(H - h_w)/\ln(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 8.6 m

R = C*(H – h)*√(K) Radius of Influence - Sichardt's equation

r_e = √(L * B)/π (applies when a/b>1.5 and R0 << rs)

r_e = (L + B)/π (applies when a/b<1.5 and R0 >> rs)

Basement	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (with 1.3 Factor of Safety
	10.47	3.0	~20.4	~35.3	~63,079 (7.3 x 10-4 m3/s)	~ 82,000

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.63 mbgs at MW8 on April 22, 2021 and extending to an estimated depth of approximately 12.1 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 9.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 8.252 x 10^{-7} m/s

Table 4 – Basement Excavation Dewatering Calculations-Scenario Based on Low Hydraulic Conductivity Values from Previous Investigations in Burlington Shale (Holysh, 1997) – Section B

$$Q = 2\pi kD\,(H - h_w)/\ln(R_o/r_e)$$

Equation 1: The potential groundwater flow rate to the excavation was estimated using equation for full penetration by single well of confined aquifer (artesian conditions) fed by a circular source.

Where: Q = discharge rate (m^3/s)
K = hydraulic conductivity (m/s)
D = Aquifer thickness (m)
H = height of piezometer level above based of aquifer (m)
h_w = height of water at outside edge of pumping wells after drawdown (m)
R = radius of influence (m)
r_e = equivalent radius (m)
C = 3000
D = 8.6 m

$$R = C*(H-h)*\sqrt{(K)}$$ Radius of Influence - Sichardt's equation

$$r_e = \sqrt{(L * B)}/\pi$$ (applies when a/b>1.5 and R0 << rs)

$$r_e = (L + B)/\pi$$ (applies when a/b<1.5 and R0 >> rs)

Basement	H (m)	h_w (m)	R (m)	r_e (m)	Q L/day	Q L/day (with 1.3 Factor of Safety
	10.47	3.0	~2.2	~35.3	~5,765 (6.67 x 10-5 m3/s)	~7,495

Assumptions for hydrogeological setting:

1. A confined aquifer is presumed to exist locally with a water table determined to be 1.63 mbgs at MW11 on April 22, 2021 and extending to an estimated depth of approximately 12.1 mbgl.
2. The maximum dewatering depth of construction activities is assumed to be 91.1 mbgl (0.5 m below Excavation).
3. It is assumed that as a requirement of the proposed construction activities the excavation will be pumped dry.
4. The hydraulic conductivity values for the bedrock beneath the site was determined to be 1.0×10^{-8} m/s

APPENDIX H

WATER BALANCE

APPENDIX H: D ETAILED WATER BALANCE - 769-789 Brant St. 2023-2033 Ghent Ave. (Phase 2), Burlington, ON.

1. Climate Information

Precipitation (collected from Env. Canada data)	930	mm/a
Evapotranspiration (calculated by Thornthwaite method	609	mm/a
Water Surplus	321	mm/a

2. Infiltration Rates

Infiltration Factors (Table 2)

Flat Land (average slope not exceeding 0.6 m per km)	0.3
Medium combinations of clay and loam	0.2
Cultivated Lands	0.1
TOTAL	0.6

Infiltration	193	mm/a
Run-off	128	mm/a

Typical Recharge Rates (Table 3)

Clayey Silt/Clayey Silt	100	mm/a
Silt	125-150	mm/a
silty sand to sandy silt	150-200	mm/a

Site development area is underlain by silty sand to sandy silt.

Based on the above, the recharge rate is approximately	100	mm/a
with runoff of	221	mm/a

3. Site Statistics

Pre-Development:

Building roofs	0.091	ha	913 m^2
Parking Areas, Roadways, Other impervious Areas	0.360	ha	3,601 m^2
Green space, open space, natural areas	0.208	ha	2,084 m^2
TOTAL	0.660	ha	6,598 m^2

Post-Development:

Building Roof	0.248	ha	2,477 m^2
Parking Areas, Roadways, Other impervious Areas	0.193	ha	1,933 m^2
Green space, SWMP, natural areas	0.219	ha	2,188 m^2
TOTAL	0.660	ha	6,598 m^2

Industrial Buildings

Landscape coverage (33.2%)	0.219	ha	2,188 m^2
Parking/Roadway coverage (29.3%)	0.193	ha	1,933 m^2
Building Roof (37.5%)	0.248	ha	2,477 m^2

4. Annual Pre-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building Roofs	913	849	-	-	849
Green Space	2,084	1,938	1,269	208	461
Roads, Other impervious	3,601	3,349	-	-	3,349
TOTAL	6,598	6,136	1,269	208	4,658

5. Annual Post-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Building Roofs	2,477	2,304	-	-	2,304
Roads, Other impervious	1,933	1,798	-	-	1,798
Green space, open space, natural areas	2,188	2,035	1,333	219	484
TOTAL	6,598	6,136	1,333	219	4,585

6. Comparison of Pre-Development and Post-Development

		Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development		6,136	1,269	208	4,658
Post-Development		6,136	1,333	219	4,585

7. Post development infiltration measures

Post-development infiltration volume	219	m^3
Pre-development infiltration volume	208	m^3
Deficit from pre to post-development infiltration	-10	m^3
Percentage of water collected from roof area required to match pre-development infiltration	0	%

Thornthwaite method for determining potential evapotranspiration

A monthly index is obtained from the equation:

$i = (t/5)^{1.514}$

Summation of the 12 monthly values gives an appropriate heat index, I.

To calculate a, the expression is:

$a = 0.000000675I^3 - 0.0000771I^2 + 0.01792I + 0.49239$

From these relations, a general equation for potential evapotranspiration is obtained. It is:

$$e = 1.6\left(\frac{10t}{I}\right)^a$$

in which a has the value given in the equation above.

APPENDIX H: Thornthwaite Method For Calculating Evapotranspiration

Hamilton Airport Climate Data

	Daily Average Temp (C^o)	Monthly index (i)	Potential Evapotranspiration (cm)	Adjusted Potential Evaportranspiration (cm)
Jan	-5.5			0
Feb	-4.6			0
Mar	-0.1			0
April	6.7	1.557530876	2.946791827	3.300406846
May	12.8	4.150260027	6.038429267	7.608420877
June	18.3	7.13034204	8.973741023	11.48638851
July	20.9	8.718883818	10.39718	13.4123622
August	20	8.156781464	9.902149829	11.88257979
September	15.8	5.708555702	7.625570812	7.930593644
October	9.3	2.558836857	4.238152363	4.026244745
November	3.7	0.633894267	1.526004012	1.236063249
Dec	-2.3			0
	HEAT INDEX (I) =	38.61508505		**60.88 cm/year**
				608.83 mm/year
	a =	1.108273042		

