FUNCTIONAL SERVICING REPORT
SOLMAR DEVELOPMENT CORP.
RESIDENTIAL SUBDIVISION
200 JOHN STREET EAST

Town of Niagara on the Lake
Project: 2018-4696 **July 2020**

SCHAEFFERS
CONSULTING ENGINEERS

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Concord, Ontario L4K 4R3

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1 INTRODUCTION

1.1 Study Objectives and Location

This report is provided in support of the proposed residential development, to be located at 200 John Street East and 588 Charlotte Street, to facilitate the design of appropriate storm water management facilities, and guide the design of municipal services. The proposed residential subdivision is part of a primarily residential block located within the Town of Niagara on the Lake, defined as Lots 145 and 156 of the Registrar's Compiled Plan 692, and Lot 14 Plan M-11. The subject development is accessible by Charlotte Street to the North West and John Street to the North East. The site is located south east of the intersection of Charlotte and John Street, south of the existing hotel and woodlot to the north, as well as Weatherstone Court to the west. Please refer to **Figure 1.1** for the location plan. **Figure 1.2** illustrates the site's development plan.

This report demonstrates that the proposed sanitary servicing, water supply and stormwater management strategy is designed in accordance with the Town of Niagara on the Lake, Niagara Region, Niagara Peninsula Conservation Authority and the Ministry of Environment stormwater management and municipal design guidelines. Low Impact Development mitigation measures (LID) are proposed through the site to satisfy surface base flow requirements, and water balance requirements.

1.2 Background

A series of background texts were referenced and reviewed in the design proposed within this report. Relevant excerpts from the reports referenced below are provided in the appendices to establish context and provide background.

Background texts are as follows:

- *"Municipal Engineering Standards"* dated January 2018, by the Town of Niagara-on-the-Lake;
- *"Water and Wastewater Master Servicing Plan Update*" dated 2016 by the Region of Niagara, revised June 2017*;*
- *"Stormwater Management Guidelines Report"* dated January 2010 by AECOM, and approved by the NPCA March 17, 2010;

- *"Low Impact Development Stormwater Management Planning and Design Guide"* dated 2017, by TRCA and CVC;
- *"Stormwater Management Planning and Design Manual",* dated March 2003, by MOECC;
- *"Servicing Brief – Two Sisters Resort/Randwood Estate Re-development, 144 & 176 John Street, Niagara-on-the-Lake, Ontario"*, dated June 2018, by Quartek Group Inc. Engineers, Architects & Planners.
- *"Hydrogeological Investigation, 200 John Street and 588 Charlotte Street, Niagara-on-the-Lake, Ontario" Project No. 2018-0419,* dated June 2020, by Cole Engineering Group Ltd.

1.3 Proposed Development

The proposed development consists of primarily semi-detached units, with a large quantity of detached homes located along the South East and Southern limits of the development. All houses are proposed to front on future private roads within the development. Additional land uses proposed within the subject site are listed below. A draft plan is attached in **Appendix A** to better grasp proposed land uses.

- A 3.59 greenbelt area within the south east portion of the site;
- A 0.84ha Park Block at the site's western entrance;
- Woodlot, Stream and buffer areas;
- Hotel entrance and walkways; and
- Private Laneway traversing northeast to John Street.

1.4 Population Estimate

The subject site's population has been estimated based on the proposed number of units. **Table 1-1** provides a summary of the population estimates to be used to design the site's servicing. A population density of 2.53people per unit has been used based on the unit density forecast for the Town of Niagara on the Lake obtained for the year 2018, as per the Regional Official Plan, **Table 4-1**. The use of this density has been checked and confirmed in correspondence with the Town of Niagara on the Lake, which is provided in **Appendix A**.

Table 1-1 Summary of Populations

Tenure Type	Number of Units	Pop. Density (persons/unit)	Populations
Single-Detached	125	2.53	316
Semi-Detached	66	2.53	167
Total	191	2.53	483

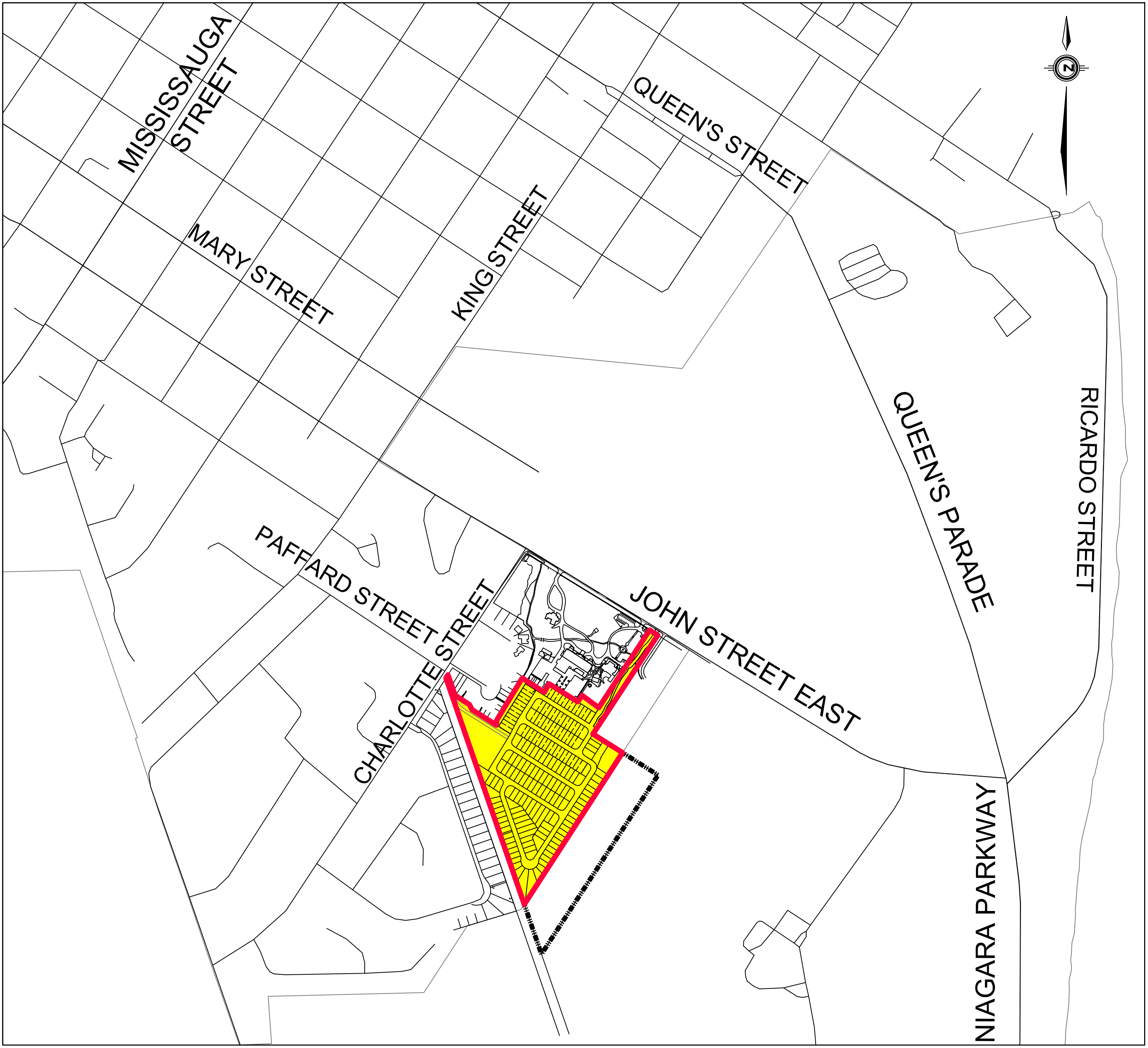

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FIGURE 1.1
LOCATION PLAN

2018-4696	JULY 2020	SCALE: N.T.S.

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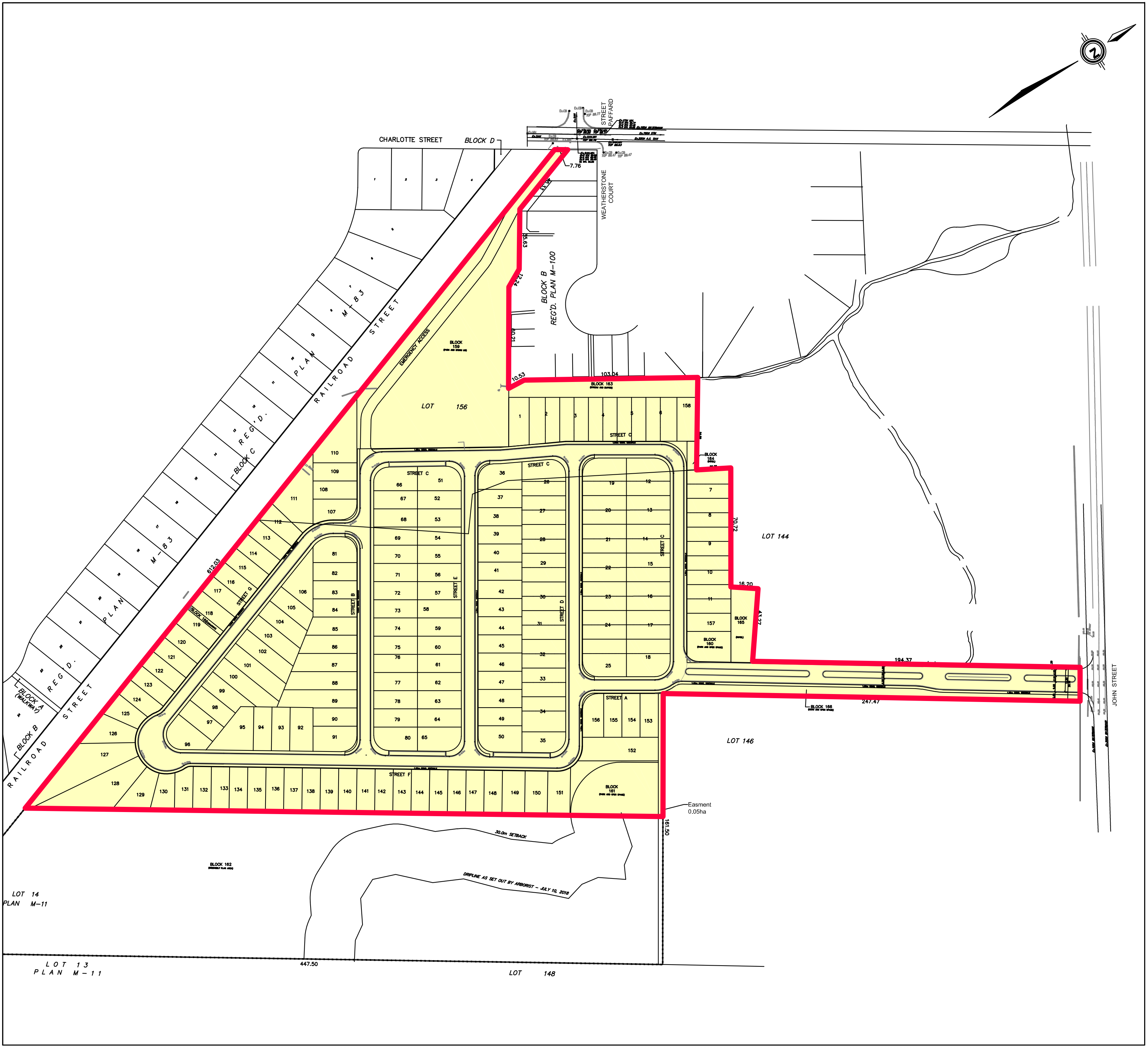

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FIGURE 1.2
SITE PLAN

2018-4696	JULY 2020	SCALE: N.T.S.

2 Sanitary Servicing

2.1 Existing Sanitary Infrastructure

In the existing condition the site is predominantly undeveloped with no major sanitary servicing connections located on site. The nearest existing sanitary sewers include a 50mmØ force main along John Street East, as well as a 200mmØ sanitary sewer running south west along Charlotte Street, to Pafford Street, via gravity drainage.

In addition, as part of the servicing for the proposed Two Sisters Resort/Randwood Estate Re-development (Hotel) to the north it had been proposed, as per Quartek's 2018 Servicing Brief, that a sanitary servicing connection to the proposed subdivision's gravity drainage system would be feasible. As such the sanitary demands for the subject site will incorporate considerations for such a connection. See **Appendix A** for relevant demand calculations from Quartek's servicing brief.

2.2 Sanitary Design Criteria

The following design criterion for the design of sanitary sewer has been derived for the site based on the 2018 Niagara-on-the-Lake Municipal Engineering Standards, as well as the Regional Municipality of Niagara Water-Wastewater Project Design Manual.

- Domestic sewage flow rate for residential and employment area is 275 L/cap/day;
- Infiltration rate of 0.286 L/ha/s as the wet weather level of service;
- Pipe size determined using Manning's Formula: $Q = (1/n)R^{2/3}S^{1/2}$
- Harmon Peaking Factor, K is $1 + 14/(4 + P^{0.5})$ with values between 2 and 4, and where P is population in thousands;
- Minimum sewer pipe size of 200mmØ at a minimum 0.60% grade (minimum of 1.0% for the first reach of permanent dead-end sewers);
- Minimum sanitary sewer velocity of 0.76m/sec, with a maximum of 3.0 m/s under theoretical flows;
- Roughness coefficient of n = 0.013 for all pipes;
- Population Density of 2.53 people per unit, as per the Regional Official Plan population forecasts;

2.3 Proposed Sanitary Servicing Strategy

It is proposed to service the proposed subdivision via a single connection to the existing 200mmØ gravity sewer along Charlotte Street. A summary of the expected sanitary flows from the development are provided in **Table 2-1**. Note that the estimated sanitary flows from the proposed hotel connection have been incorporated into the following demand calculations. Infiltration flows were taken based on 8.32ha of development area (i.e. 8.32 ha = 12.34ha – 3.59ha Greenbelt – 0.02ha of Easement along lot 146).

Table 2-1 Summary of Sanitary Flows

Subject Development Flows

Average Demand (L/s)	Total Population	M	Area (ha)	Infiltration (L/s)	Total Peak Flow (L/s)
1.54	483	3.98	8.32	2.38	8.50

Hotel Development Flows*

Average Demand (L/min)	M	Infiltration (L/s)	Total Peak Flow (L/s)
0.94	4.50	0.20	4.44

*Values from 2018 Quartek Servicing Brief

Total Development Flows

Average Demand (L/s)	Infiltration (L/s)	Total Peak Flow (L/s)
2.48	2.58	12.71

Based on available Town plan and profiles the Charlotte Street sewer has a gravity conveyance capacity of 18.74L/s at a diameter of 200mm and grade of 0.3%. With this estimate the proposed developments would take up 68% of the existing sanitary sewer's capacity. Correspondence currently is in the works to obtain the town sanitary sewer model and identify the extent of necessary sewer upgrades in order to support the proposed development.

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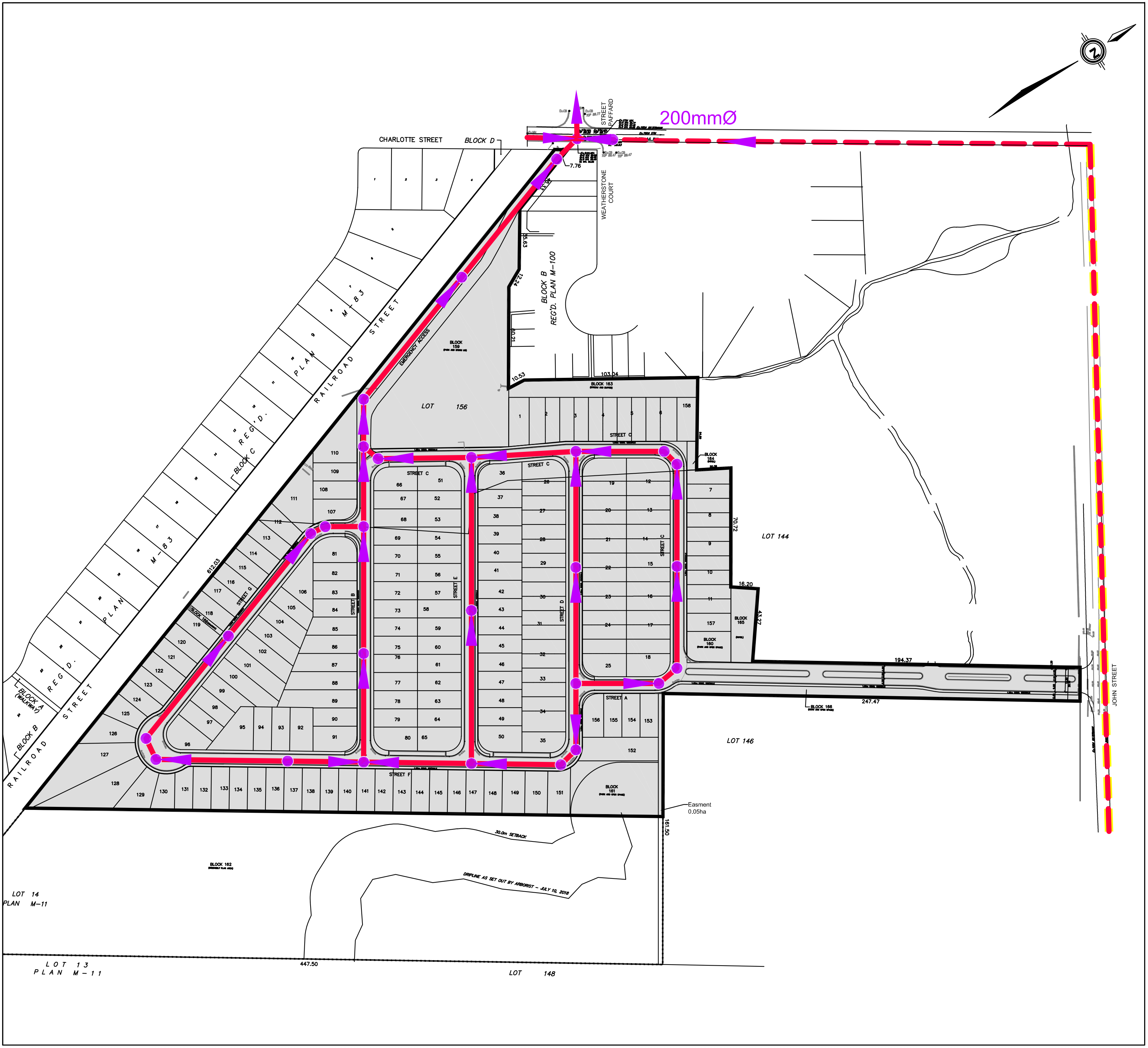

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PROPOSED SANITARY SEWER

EXISTING SANITARY SEWER

EXISTING SANITARY FORCEMAIN

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FIGURE 2.1
SANITARY SERVICING

2018-4696	JULY 2020	SCALE: N.T.S.

3 Water Supply Servicing

3.1 Existing Water Supply Infrastructure

As with the sanitary servicing, the available existing watermains are located along Charlotte Street to the west, and John Street East. The water main along Charlotte Street is currently a 150mmØ pipe, located within the eastern boulevard, while along John Street there is a 200mmØ water main within the northern boulevard. The subject site is located within the Old Town Pressure Zone as per the Niagara Region 2016 Master servicing plan.

3.2 Water Supply Design Criteria

The following design criterion for the design of the water supply system has been derived for the site based on the 2018 Niagara-on-the-Lake Municipal Engineering Standards, the Regional Municipality of Niagara Water-Wastewater Project Design Manual, as well as the MOE 2008 Design Guidelines for Drinking-Water Systems.

- Average Day Demand of 300 L/cap/day;
- Max Day Peaking Factor of 2.75 based on MOE 2008 Table 3-1;
- Max Hour Peaking Factor of 4.0 for residential lands;
- Max Hour Peaking Factor of 2.0 for employment lands;
- Minimum Hour Peaking Factor of 0.4 based on MOE 2008 Table 3-1;
- Minimum watermain size of 150mmØ;
- Fire Protection Demand of 7000L/min (117L/s);
- Watermain shall be provided with a minimum cover of 1.7m;
- Hydrants placed every 150 meters, or to provide a maximum 75m hose length;

In addition, the following design pressure conditions shall be met:

- Minimum pressure of 20psi (140kPa) under max day + fire flow conditions;
- Minimum pressure of 40psi (275kPa) under normal operating conditions;
- Maximum sustained operating pressure of 100psi (700kPa);

Friction Factors used to model the water distribution system were obtained from the City of Niagara Falls 2012 Engineering Design Guidelines and are as follows:

Pipe Diameter (mm)	C - Factor
50	120
100 to 150	100
200 to 250	110
300 to 600	120
Over 600	130

3.3 Water Supply Design

To service the proposed development and provide adequate fire flows it is proposed that the site make a connection to the existing 150mmØ watermain along Charlotte Street, as well as the 200mmØ watermain on John Street to provide a looped connection to existing infrastructure. In absence of a required fire flow demand from the Town criteria, a residential fire flow demand of 7000 L/min (117 L/s) was applied for the site based on the City of Vaughan Engineering Design criteria for Semi and Single detached residential land use. Based on the current draft plan of the development the following water demand scenarios shown in **Table 3-1** are expected.

Table 3-1 Summary of Estimated Site Water Supply Demands

Average Day Demand (L/s)	Max Hour Demand Peaking Factor	Max Hour Demand (L/s)	Max Day Peaking Factor	Max Day Demand (L/s)	Max Day Demand + Fire (L/s)
1.68	4.0	6.71	2.75	4.61	121.28

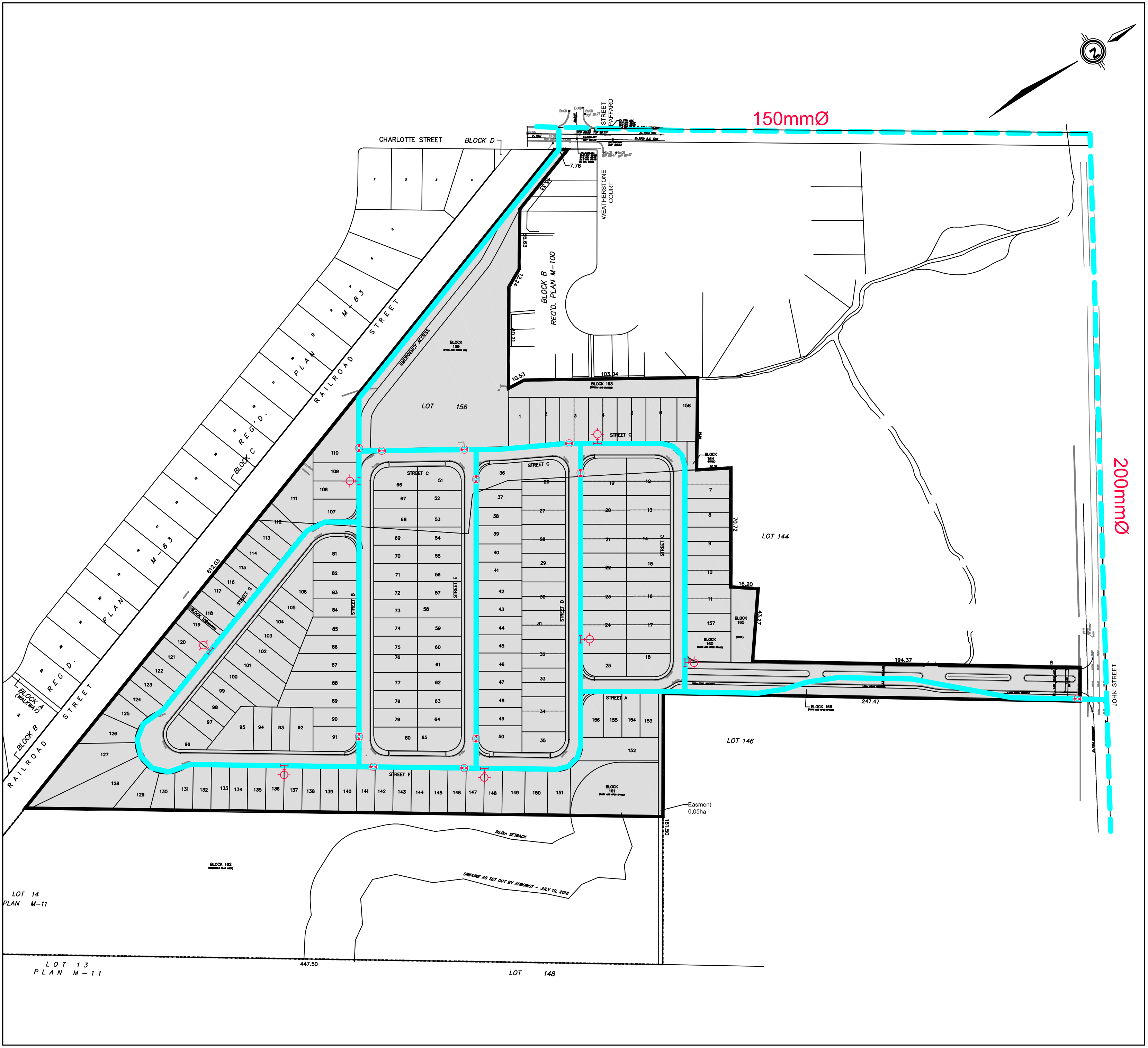
From this analysis the governing scenario of max day + fire flow demand is 121.28L/s to adequately service the site. A hydrant test along the nearby John Street Watermain was conducted on July 2nd of 2020, and was performed on the hydrants located across from 201 and 200 John Street East. Based on the results of this test a static pressure of 50psi (345 kPa) is expected, with an available flow of 3234 USGPM (204 L/s) available at a minimum operating pressure of 20 psi (140kPa). These results are consistent with Niagara Region's recent Water and Waste Water

Master Servicing Plan Update, Figure 3.C.7, where it is shown that there is 100 to 150 L/s of available fire flow in the area (relevant excerpts are provided in **Appendix C**).

Furthermore, an additional hydrant test was conducted along Charlotte Street Watermain was conducted on July 2nd of 2020, and was performed on the hydrants located across from 61 Pafford Street and 609 Charlotte Street. Based on the results of this test a static pressure of 50psi (359 kPa) is expected, with an available flow of 6991 USGPM (441 L/s) available at a minimum operating pressure of 20 psi (140kPa).

With the current test results, it appears the subject site is expected to have sufficient available pressures for the development. However, as was previously stated, it is known that available fire flows in the area can range from 100L/s and 150L/s. As the hydrant test result is only for a short period of time, it is proposed that a monitoring device is installed at the hydrant location to determine the available daily minimum and maximum servicing conditions which occur over a weeks' time to better understand the site's serviceability.

In addition, correspondence with the Town is currently in the works to obtain the Town's water supply model. This analysis will be used to identify any need for water supply servicing upgrades, and appropriate infrastructure improvements, if necessary, to provide adequate servicing to the site.



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▨ SUBJECT AREA

━ PROPOSED WATERMAIN

╍ EXISTING WATERMAIN

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FIGURE 3.1
WATER SUPPLY SERVICING

2018-4696	JULY 2020	SCALE: N.T.S.

4 STORMWATER MANAGEMENT

4.1 Existing Site Conditions

The subject site is presently primarily undeveloped with open grass land, with trees widely scattered across the property. The general drainage direction is northwards and is primarily defined by its even shallow grading. The site is tributary to the 1 Mile Creek which traverses and outlets northwards towards Lake Ontario. In existing conditions, the majority of the site is tributary to this watercourse, with a localized 0.03ha area draining to the Charlotte Street storm sewer. A series of existing ditches and swales within the site diverts flows from 11.91ha of land within the property limit, to the site's existing northern outlet. Of this 11.91ha, 3.61ha along the south side of the site is to remain as part of a greenbelt buffer zone, and therefore the effective pre-development area is 8.30ha used to analyse the site. An additional 0.40ha area in the north east portion of the site drains through a separate outlet to 1 Mile Creek. Pre-development drainage from this site is depicted in **Figure 4.1**.

An external drainage area is located to the southwest of the site. In the existing condition, flows originating from the external area passed along an existing ditch along the southwest property line, which then cuts through the site to the existing northern outlet. In the post development condition, it is proposed to maintain this ditch and allow the external flows to pass through the development and discharge to the northern outlet.

From available plan and profiles, it is understood that a storm sewer exists along Charlotte Street. The Charlotte Street storm sewer drains north east and is sized to 450mmØ, and increases to 750mmØ north of Pafford Street, where it eventually discharges to a roadside ditch along the south side of John Street East.

4.2 Design Criteria

SWM Facilities

The proposed SWM facilities are designed following the design criteria outlines in the MOE SWM manual, Town of Niagara on the Lake, and NPCA SWM Guidelines. A summary of the Stormwater management design criteria are as follows:

- The hydrologic modelling to size the required SWM volumes shall utilize the most critical storm which yields the lowest pre-development peak flow and highest post-development peak flow, checking the 3-hour Chicago, 12-hour AES and 24-hour SCS distributions at a minimum.

Major and Minor System Design:

- Storm drainage design is to comprise of both major and minor systems;
- The minor system shall be designed to convey runoff from the uncontrolled 5-year flow without surface ponding for storm sewer under public roadways;
- The major system shall be designed to safely convey the City of St. Catherine's 100-year design storm within the right of way leading to major outlets. Relief is to be provided in low points to avoid ponding exceeding 0.6m;

In addition to the above, the following criteria shall be used:

- Storm sewers shall be designed using the Rational Method Formula:

  $Q = 2.78\ AIR/1000$

  Q = flow rate in m^3/s;

  A = area in ha;

  I = rainfall intensity in mm/hr;

  R = runoff coefficient (dimensionless).

Storm sewer design shall be based on City of St. Catherine's Rainfall Intensity Curves with a Time of Concentration of 10 minutes. The formula is expressed as $I = A / (T + C)^B$, where R is rainfall intensity in mm/hr and T is time in hours. The parameters for the 2 to 100-year storm events are provided in **Table 4.1** below:

Table 4-1: City of St. Catherine's Rainfall Intensity Parameters

Coefficient	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
A	567	664	724	821	900	980
B	0.746	0.744	0.739	0.735	0.734	0.732
C	5.2	4.7	4.3	4.0	3.8	3.7

Water Balance:

- Best efforts shall be made to match the pre and post development infiltration volumes to maintain groundwater recharge, in accordance with the MOE 2003 criteria.

Water Quality:

- 1 Mile Creek, the receiving watercourse, has been identified as a Type '3' (Marginal) fish habitat. As such a minimum 'basic' level of protection (60% TSS removal) shall be achieved according to MOECC best stormwater management practices.

Erosion Control:

- Quantity controls put in place to detain and release the 25mm, 4-hour Chicago design storm within 24 hours to stable watercourses.

4.3 Proposed Stormwater Management Plan

The proposed SWM plan for the site will make use of an ADS storage structure in place of a traditional pond structure to service the proposed subdivision. The storage structure will be located below the 0.84ha proposed park block area located in the north east portion of the site, and will discharge to 1 Mile Creek through the existing site outlet along the northern site boundary.

Of the proposed developed site area, approximately 8.30 ha of land, originally drains through the existing northern site outlet to 1 Mile Creek. However, as a result of restrictions in the proposed site grading, a total of approximately 0.88 ha from this area will drain uncontrolled to 1 Mile Creek. The uncontrolled area consists of backyard areas, woodlots and pervious buffer areas. Note that roof drainage adjacent to these uncontrolled areas are proposed to be directed towards the site roadways, and will therefore remain part of the controlled site flows. This results in a tributary area of 7.42ha to the proposed tank structure.

External flows west of the property are also known to pass through an existing ditch along the western site boundary. These flows currently pass through the proposed park area. In order to maintain the existing ditch, the proposed underground storage structure will be divided into two sections, north and south of the ditch. The two tank sections will be connected via a series of pipes extended below the ditch bottom. The underground tank will then discharge to a proposed storm pipe, parallel to the existing ditch, and will then release flows to the existing outlet location. Note that a culvert is proposed to be installed along a portion of the ditch along western site boundary, to maintain the ditch's capacity.

Sizing of the underground storage structure is based on the criteria presented in **Section 4.2**, and is further discussed later in this section. Quality treatment for the 7.42ha of controlled residential site area is proposed through the use of isolation rows within the ADS chamber system to allow sediment to be detained. The isolation rows will be sized to achieve 60% TSS removal to achieve the 'basic' level of protection. A treatment train approach is proposed making use of additional treatment via catchbasin (CB) shields upstream from the storage structure. This result can also be obtained using an OGS unit to provide pre-treatment should CB shields be unfavourable. Furthermore, the erosion control target is proposed to be achieved based on the detention and release of a 25mm storm event over a 24hour period, and has been incorporated as part of the underground storage design.

As previously stated in **Section 4.1** the existing north outlet currently accepts flows from approximately 11.91ha of land within the property boundary. In the post-development condition, it is proposed that 3.59ha is left as part of green belt area. The northeast most portion of runoff from this greenbelt will be left to drain north to 1 Mile Creek. An existing swale is known to collect remaining flows through the greenbelt area and eventually discharge to the northern site outlet. It is proposed to divert the flows from the existing swale as it enters the site using a clean water collector. This pipe will by-pass the existing swale's flows through the site and to the existing ditch, along the western site boundary. These flows will then outlet to the northern site outlet, as is the case in existing conditions.

Other areas of note include approximately 0.03ha of paved access route (located within the park block) which will drain uncontrolled north to Charlotte Street in the post development condition. In addition, there is a 0.39 ha drainage area, labeled Condo Road and Open space. This area has an estimated runoff coefficient of 0.55 and consists of a paved access road and open green area. The paved portion includes a culvert to maintain 1 Mile Creek's flow path. Flows from this area are proposed to drain directly to 1 Mile Creek, as it currently does in the pre-development condition.

A dual-drainage scheme is proposed for the subject development. In this configuration minor and major system flows will be captured and conveyed via internal site storm sewers, equipped with strategic full capture locations, in order to divert minor system flows to the aforementioned underground Stormwater tanks located beneath the proposed park block. In doing this the minor system will be sized to convey storms up to and including the 100-year storm without surcharge. Overland flow routes will be provided for rainfall events exceeding the 100-year storm event by providing emergency overland flow routes towards 1 Mile Creek. **Figure 4.2** and **Figure 4.3** illustrate the proposed drainage system and storm servicing scheme.

Lastly the residential subdivision is proposed to contain various LID measures in the form of topsoil amendment, disconnected downspouts and sub-surface infiltration trenches to promote on-site infiltration to meet the pre to post development water balance. This is further discussed in **Section 6**.

4.4 Uncontrolled Drainage Areas

Prior to discussing the proposed storage structure, a comparison of flows was performed to determine the impact of post-development flows along Charlotte Street. As mentioned in the pre-development condition a 0.032ha drainage area exists to Charlotte Street consisting of gravel road and pervious area. A weighted runoff coefficient of 0.55 was estimated for this area. In the post-development condition, approximately 0.03ha of uncontrolled roadway (C = 0.9) will discharge to Charlotte Street. Based on these changes to drainage and runoff coefficients, it is estimated that the 100-year flows increase by 3.1L/s over the pre-development condition. The following **Table 4-2** compares the pre to post development flows for the 2 through 100 year storm event using the modified rational method and the City of St. Catherine’s IDF parameters. Supporting calculations are provided in **Appendix D**.

Table 4-2 Pre to Post development Flow Comparison to Charlotte Street

Design Storm Event	*Pre-development Peak Flow (L/s)*	*Post-development Peak Flow (L/s)*	*Increase in Flows (L/s)*
2 - Year	*3.8*	*5.4*	*1.6*
5 - Year	*4.6*	*6.5*	*1.9*
10 - Year	*5.1*	*7.3*	*2.2*
25 - Year	*6.0*	*8.5*	*2.5*
50 - Year	*6.6*	*9.5*	*2.8*
100 - Year	*7.3*	*10.4*	*3.1*

The above comparison illustrates that the proposed development will have a negligible impact on the existing flows along Charlotte Street. In addition, the downstream storm sewer, which is designed to convey the 5-year storm event, is sized to 750mmØ at 0.08% (approximate capacity of 352L/s) based on available plan and profiles. Based on the above comparison, the estimated increase in 5-year flows of 1.9L/s accounts for a 0.55% (i.e. (1.9L/s ÷ 352L/s) x 100% = 0.55%)

increase in the pipe's capacity. As such the impact of the development on the Charlotte Street storm sewer is expected to be negligible.

In addition, the modified rational method was used to estimate the flows from the approximately 0.88ha uncontrolled areas tributary to 1 Mile Creek, as shown in **Figure 4.2**. As this area consists of woodlot, buffer and grassed backyard areas, a runoff coefficient of 0.25 was utilized in this analysis. The following table summarizes the expected peak flows from the 2 through 100-year storm using the St. Catherine's IDF curves, with an appropriate time of concentration determined from the lower of the Airport and Upland's method for the area. The resulting flows were removed from the allowable release rate to determine the appropriate release rate from the proposed underground storage tanks, which is further discussed in **Section 5.4**.

Table 4-3 Uncontrolled Flows to 1 Mile Creek Outlet

Design Storm Event	***Tc (min)***	***Intensity (mm/hr)***	***Peak Flow (L/s)***
2 - Year	*41*	*32.5*	*19.8*
5 - Year	*41*	*38.7*	*23.5*
10 - Year	*41*	*43.2*	*26.3*
25 - Year	*41*	*50.0*	*30.4*
50 - Year	*41*	*55.2*	*33.6*
100 - Year	*41*	*60.7*	*36.9*

4.5 Floodplain Considerations

Due to the proximity of 1 Mile creek to the proposed development, the nearby floodplain has been checked to ensure that critical developments remain outside of the 100-year flood area. Based on information available regarding the watercourse the 100-year flood elevation lies at an elevation of approximately 88.0m, which is below the proposed site's outlet elevation of 88.13m. As an additional precaution the site has been graded such that lot elevations remain above the 100-year flood elevation, as is shown in the site grading plans, SG-1 through SG-3.

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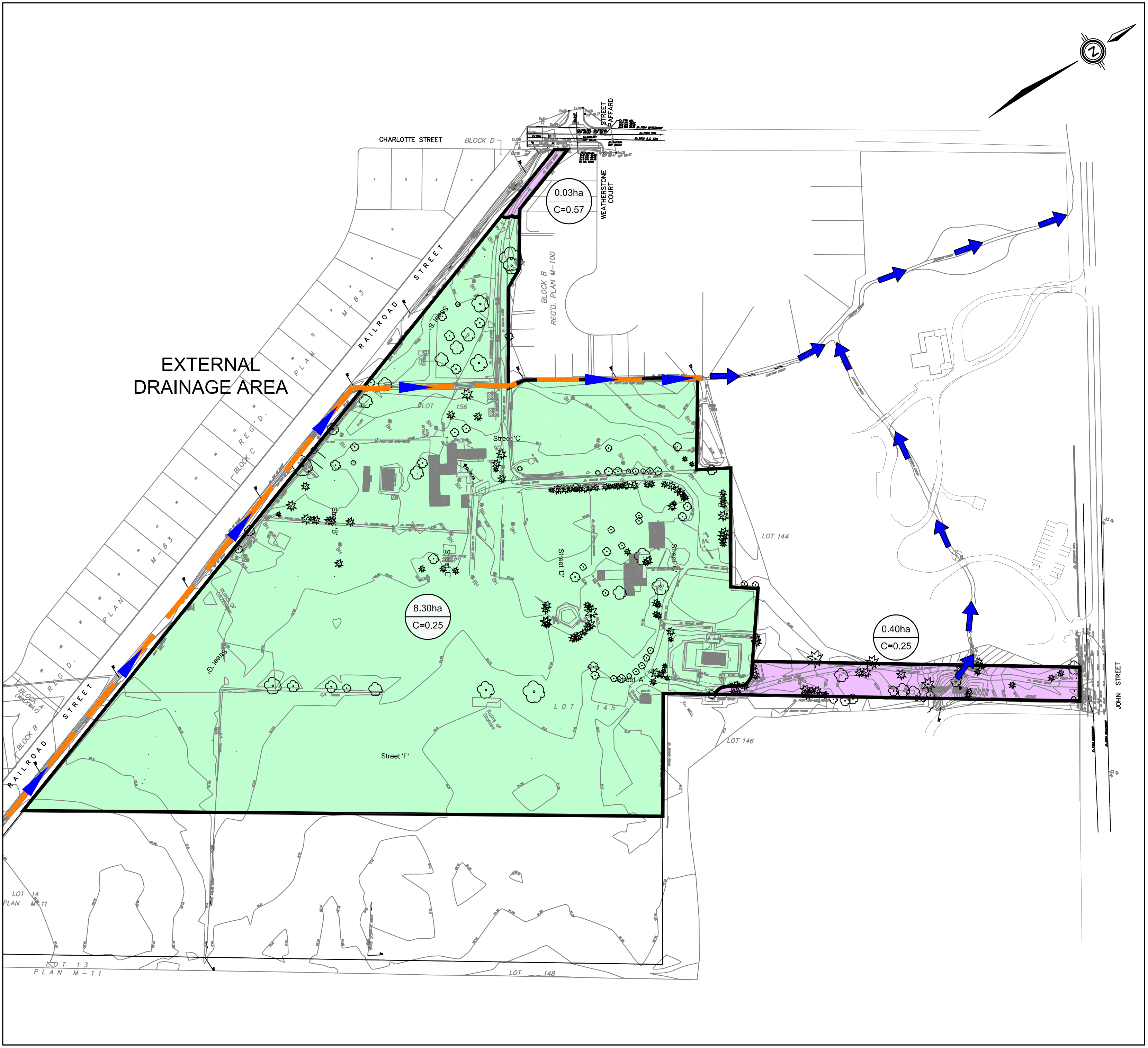

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▭ EXISTING DRAINAGE BOUNDARY

0.03ha / C=0.25 AREA IN HECTARES / RUNOFF COEFFCIENT

- - EXISTING CONVEYANCE DITCH TO BE MAINTAINED

← EXISTING CREEK DRAINAGE

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FIGURE 4.1
PRE-DEVELOPMENT DRAINAGE PLAN

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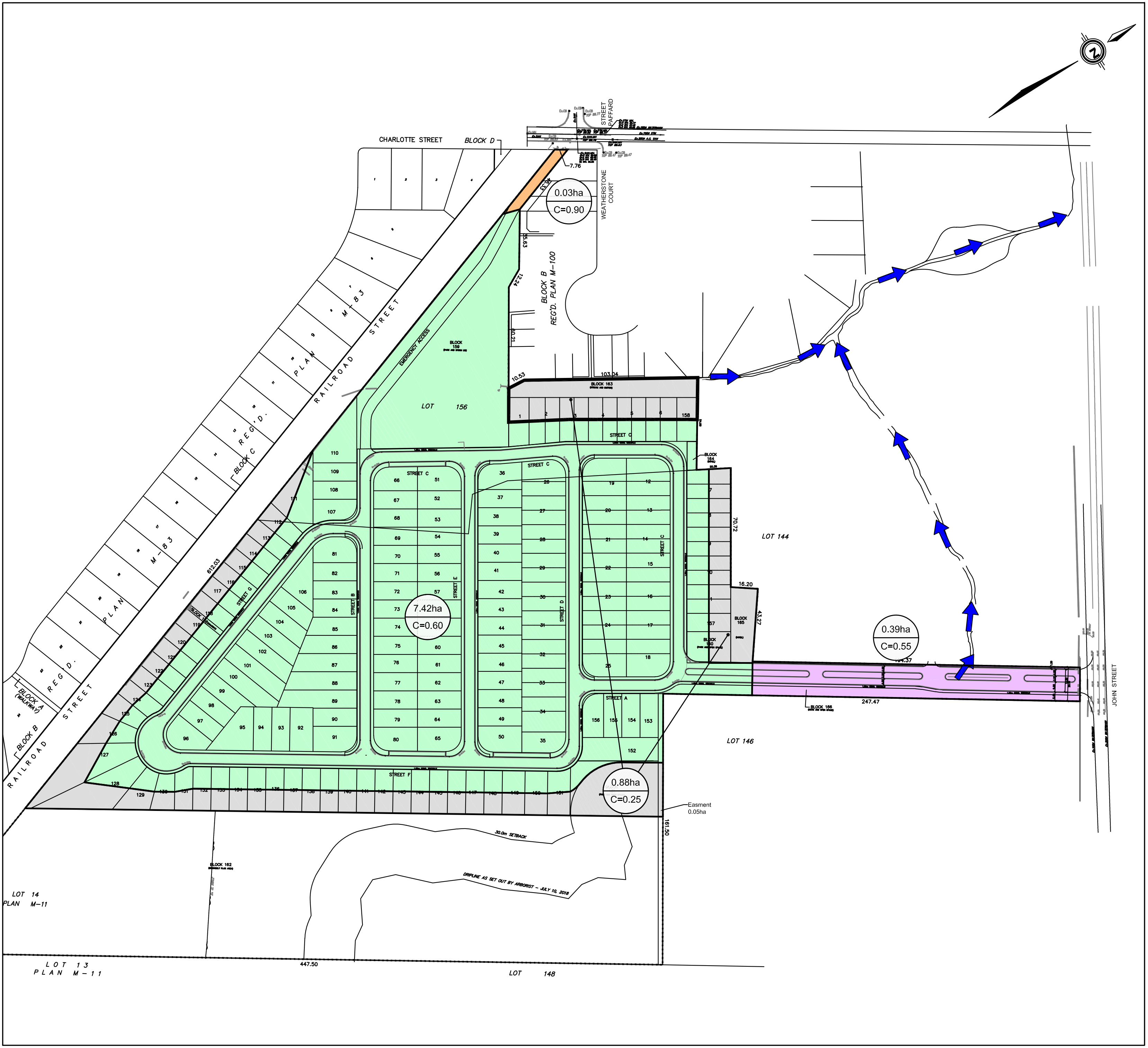

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- 🟩 CONTROLLED DRAINAGE AREA FROM SITE
- ⬜ UNCONTROLLED DRAINAGE AREA FROM SITE
- 🟪 UNCONTROLLED EAST DRAINAGE TO ONE MILE CREEK
- 🟧 UNCONTROLLED DRAINAGE AREA TO CHAROLETTE STREET
- 0.03ha / C=0.25 AREA IN HECTARES / RUNOFF COEFFCIENT
- ⬅ EXISTING CREEK DRAINAGE

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FIGURE 4.2
POST-DEVELOPMENT DRAINAGE PLAN

2018-4696	JULY 2020	SCALE: N.T.S.

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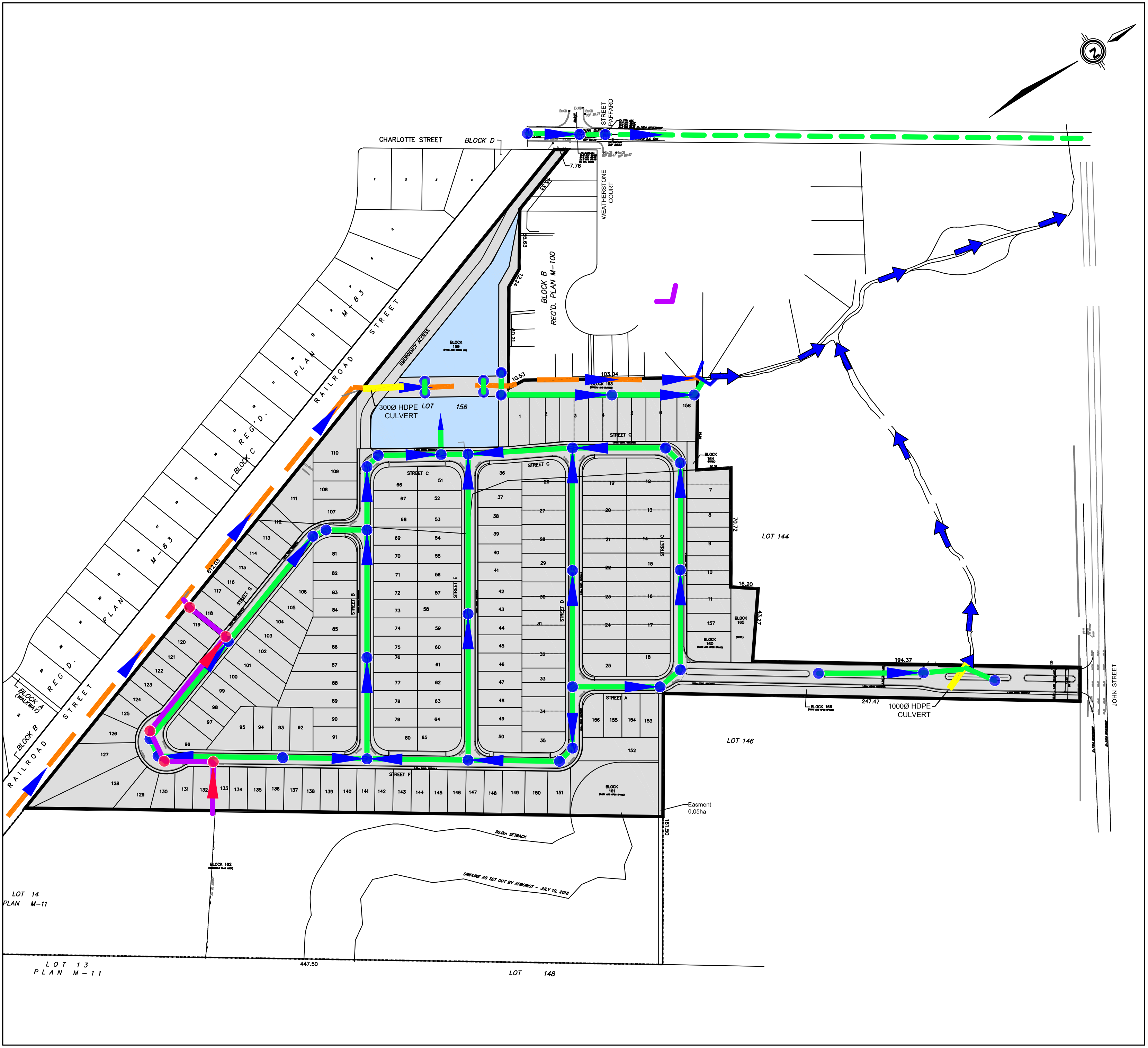

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LEGEND

- ▨ SUBJECT AREA
- 🟩 PROPOSED STORM SEWER
- 🟩 🟩 EXISTING STORM SEWER
- ━ PROPOSED CLEAN WATER COLLECTOR
- ▭ PROPOSED UNDERGROUND STORAGE CHAMBER
- ━ ━ EXISTING CONVEYANCE DITCH TO BE MAINTAINED
- ⊏ EXISTING OUTLET
- ← EXISTING CREEK DRAINAGE

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CONSULTING ENGINEERS
6 Ronrose Drive, Concord, Ontario L4K 4R3
Tel: (905) 738-6100 Email: general@schaeffers.com
www.schaeffers.com

FIGURE 4.3
STORM SERVICING

2018-4696	JULY 2020	SCALE: N.T.S.

5 Underground Storage Design

5.1 Contributing Drainage Area

The contributing drainage area to the proposed underground storage, in the post-development condition is illustrated in **Figure 4.2**. The approximate total drainage area to the underground storage tanks, and the northern site outlet is 7.42 ha with a total imperviousness of 58%, accounting for 0.53ha of uncontrolled backyard areas, and 0.35ha of uncontrolled buffer and woodlot, for a total uncontrolled area of 0.88ha. These lands currently drain to 1 Mile Creek through a ditch located along the northern site boundary. As previously noted, 3.59ha of drainage from the undeveloped southern greenbelt area, as well as 0.02ha of proposed easement neighbouring Lot 146, will be diverted away from the proposed development, and has therefore been excluded from this contributing area. **Table 5-1** summarizes the drainage area to the underground storage tank, with detailed calculations presented in **Appendix D**.

Table 5-1: Drainage Area to Underground Storage

LAND USE	Area (ha)	C	A*C	A*TIMP	TIMP	A*XIMP	XIMP
Residential Semi-Detached Homes	1.63	0.55	0.89	0.81	0.50	0.61	0.38
Residential Single Detached Homes	3.92	0.54	2.10	1.88	0.48	1.28	0.33
Park Storm LID	0.81	0.25	0.20	0.06	0.07	0.06	0.07
Landscape Buffer	0.02	0.25	0.00	0.00	0.07	0.00	0.07
Condo Road and Open Space	0.03	0.90	0.03	0.04	1.00	0.04	1.00
Walkway	0.01	0.90	0.01	0.01	1.00	0.01	1.00
Road Right of Way	1.53	0.90	1.37	1.52	1.00	1.52	1.00
TOTAL*	***7.95***	***0.58***	***4.61***	***4.31***	***0.54***	***3.51***	***0.44***

Does not include 0.35ha of uncontrolled buffer & woodlot.

Less Uncontrolled to Backyards	***0.53***	***0.25***	***0.13***

Net Controlled Area to Storage	***7.42***	***0.60***	***4.48***	***4.27***	***0.58***	***3.41***	***0.46***

Note that as a conservative measure, due to the measured values being lower than typical subdivisions, it is proposed that the design of the underground storage structure, including all related modeling, has been based on a bumped-up runoff coefficient of 0.62, TIMP of 0.60 and XIMP of 0.49.

5.2 Water Quality

In order to achieve the prescribed 'basic' level of quality protection for the site, it is proposed that the underground ADS storage chamber structure is equipped with an isolation row to provide TSS removal. These isolation row systems are typically credited as providing 60% TSS removal. As a supplementary measure it is proposed that catch basin shields across the site provide TSS removal for site areas captured via catchbasin, upstream from the proposed storage structure. As the catchbasin shield is typically credited with a TSS removal of 50%, an overall 80% TSS removal is achieved on site via this treatment train approach (i.e. 80% = (50% + (1-0.5) x 60%)). Likewise, should CB shields be unfavourable, the same result can be obtained using OGS units within the upstream pipe system to provide pre-treatment of 50% TSS removal.

5.3 Erosion Control

The required Erosion control release rate and detention volumes for the SWM facility were determined as per the MOE criteria's erosion control requirement. In this case site runoff from a 25mm 4 hour-Chicago storm event is to be detained over a 48-hour period. The table below summarizes design parameters and detention volumes for the underground SWM facility. Detailed calculations are provided within **Appendix D**.

Table 5-2: Erosion Control Requirement

Drainage Area	7.42 ha
Average Outflow	0.007 m^3/s
Required storage to attenuate a 25mm 4 hour-Chicago Event	1,238 m^3
Provided Erosion Control Storage	1,238 m^3
Peak Outflow	0.011m^3/s

5.4 Allowable Release Rate

Based on the NPCA SWM design criteria, the allowable release rate from a new development is to be based on the pre-development release for all storm events from the 2 through 100-year level. In doing this the release rate shall also be based on the most critical storm, which produces the lowest pre-development release, and the highest post-development runoff. The 3 storm distributions checked in this analysis were the 3-hour Chicago, 12-hour AES and 24-hour SCS storm distribution, as per the NPCA SWM design criteria.

In order to determine the critical storm event, the pre-development site condition was ran in Visual OTTHYMO (VO) for all 3 rainfall distributions for the 2 year through 100 year storm event, using the parameters described in **Section 5.1** (Modeled Area of 8.30ha = 7.42ha controlled + 0.88ha uncontrolled as shown in **Figure 4.2**). A CN number of 70.4 was selected for the site based on the site's existing soil type and the presence of small amounts of developments on-site consisting of primarily roofed area. A time of concentration of 73 minutes (1.22 hr) was selected based on the greater of the Airport and Upland's method's results. This equates to a time to peak (TP) of 0.81hr, which was used to carry out hydraulic modeling. Detailed calculations, as well as relevant VO output, are provided in **Appendix D**. The following table summarizes the pre-development release rates estimated using each storm distribution.

Table 5-3: Pre-development Peak Flow Calculation

Design Storm Event	***24 Hour SCS (L/s)***	***12 Hour AES (L/s)***	***3 Hour Chicago (L/s)***	***3 Hour Chicago less Uncontrolled (L/s)***
Erosion	*11*	*11*	*11*	*11*
2 - Year	*141*	*71*	*68*	*48*
5 - Year	*193*	*118*	*97*	*73*
10 - Year	*240*	*155*	*122*	*96*
25 - Year	*313*	*204*	*162*	*132*
50 - Year	*369*	*244*	*195*	*161*
100 - Year	*434*	*285*	*233*	*196*

Based on the results of **Table 5-3** the 3 hour Chicago storm distribution produces the lowest pre-development release rates, and will therefore be used as the allowable release rate for the site. However, as mentioned previously, the uncontrolled site flows (shown in Table 4-3) to 1 Mile Creek were then removed from this release rate. As such it is proposed that the area tributary to the northern site outlet is controlled to the pre-development rates determined using the 3-hour Chicago Storm less the uncontrolled flows, as is presented in the table above.

5.5 Stage-Storage Discharge Relationship

Making use of the pre-development release rates established in **Section 5.4**, the theoretical minimum required storages were computed by running a scenario for each of the three design storms. Post-development site parameters used match those described in **Section 5.1** (Area = 7.42, TIMP = 0.60, XIMP = 0.49). **Table 5-4** shows that a theoretical minimum 100-year storage required for the site is 4,590m^3 based on the 24-hour SCS storm distribution. Detailed calculations and VO output results are provided in **Appendix D**.

Table 5-4: Minimum Storage Requirements

Design Storm Event	*Maximum Release (L/s)*	*24 Hour SCS (m^3)*	*12 Hour AES (m^3)*	*3 Hour Chicago (m^3)*
Erosion	*11*	*1238*	*1238*	*1238*
2 - Year	*48*	*2370*	*1720*	*1600*
5 - Year	*73*	*2830*	*2220*	*1860*
10 - Year	*96*	*3210*	*2550*	*2050*
25 - Year	*132*	*3760*	*2950*	*2340*
50 - Year	*161*	*4150*	*3240*	*2560*
100 - Year	*196*	*4590*	*3510*	*2800*

The results provided in **Table 5-4** show that the stage storage discharge curve produced by the 24 hour SCS storm event represents the most desirable curve, which will be used during the detailed design stage. It should be further noted that the provided underground chambers will be divided into two sections in order to facilitate the continued passage of external flows through the existing drainage ditch. The two sections will be connected via a series of pipes which will cross below the existing ditch. Furthermore, the underground storage tanks will control discharge to the existing conveyance ditch at rates equal to or below the prescribed release rates. Controlled flows will then be conveyed offsite at the existing site outlet. This arrangement has been depicted in **Figure 4.3**.

5.6 Groundwater Considerations

As previously noted, a preliminary hydrological investigation was conducted by Cole Engineering Ltd., dated June, 2020. Groundwater across the site was considered in the selection of appropriate locations for infiltration-based LID's, and determining where infiltration would not be possible. Based on the findings of the investigation the native site soils present are of a predominantly low permeability, consisting of Silts, silty sands and silty clay. Hydraulic conductivities of the soils were estimated to be in the range of 10^{-4}cm/s to 10^{-6}cm/s, which equates to a percolation rate roughly between 45 mm/hr to 15mm/hr (as per TRCA Stormwater Management Criteria, Figure C 11), which would support infiltration. Borehole examinations of ground water found that water levels were mostly greater than 5m from surface. A major exception to this is below the proposed park block in the north east portion of the site, where groundwater was found around 2.0m from surface. Due to the high groundwater, no infiltration is possible below the tanks as there would be less than 1m from the tank bottom to groundwater. Therefore, the underground tanks are to be wrapped with an impermeable sheet to prevent groundwater from backing up into the storage system. Relevant excerpts are included in **Appendix A** for reference.

6 WATER BALANCE ANALYSIS

A water balance was prepared for the development area to determine the characteristics of water movement, including runoff and groundwater recharge under existing conditions. The subject development is not located within a Wellhead Protection Area (WHPA), or a significant groundwater recharge area (SGRA). However, the site is located within a highly vulnerable aquifer (HVA).

The objective of this water balance is to ensure the level of post-development infiltration within the subdivision meets the pre-development levels, as is required by the NPCA. The water balance analysis takes into account the site precipitation, evapotranspiration, infiltration, soil types, and land use. Through this analysis, we have demonstrated that the annual pre-development infiltration levels can be maintained during post-development conditions.

An annual precipitation of 880mm/year and evapotranspiration of 660mm/year were obtained for the site as per Cole Engineering Ltd.'s (Cole) Preliminary Hydrogeological Investigation Report (dated June, 2020) for the proposed development. The analysis made use of the Thornthwaite and Mather method was used alongside climate normals from the St. Catherine's/Niagara District Airport Station (ID# 6137287) to estimate monthly potential infiltration.

The pre-development water balance was divided into two distinct areas. The first includes woodlots where a pre-development infiltration rate of 144mm/year was estimated based on an infiltration factor of 0.6. The second area consists of open grass and shrubs, where a pre-development infiltration rate of 120mm/year was estimated based on an infiltration factor of 0.5. Furthermore, due to changes in the post-development condition an infiltration factor of 0.45 was applied for pervious areas, resulting in a post-development infiltration rate of 108mm/year. The selected infiltration factors for post and pre-development water budgets are based on MOE's Stormwater Management Planning and Design Manual (MOE, 2003). Furthermore, the infiltration factors used for the analysis are representative of the site topography, underlying soils and land use.

In order to meet pre-development infiltration targets, the following mitigation methods are proposed:

- Infiltration trenches along backyards;
- Additional topsoil for lawn areas such that it is 300 mm in total;
- Use of disconnected downspouts directed towards lawn areas.

The results of this analysis are summarized in Table 6-1. The analysis includes three specific scenarios, the pre-development level, post-development level without mitigation and the post-development level with mitigation measures to promote increased infiltration.

The pre-development scenario is calculated as follows:

P - ET - Surplus = Infiltration + Runoff (Where: Infiltration = Surplus x Infiltration Factor)

The post-development scenario is calculated as follows:

- 10% of precipitation evaporates from roof (or roof runoff = 90% P) – commonly documented in surface hydrology modeling.

Therefore, the post-development indirectly connected water balance is as follows:

- Roof runoff directed to pervious lawns is subject to a 25% runoff reduction (Table 4.3.2 LID Manual CVC and TRCA, 2010)
- Of the 25% runoff reduction, it is assumed that 18.4% infiltrates and 81.6% evaporates (same composition as pervious areas) based on the ratio of evapotranspiration to infiltration in pre-development conditions.
- Roof Runoff = Precipitation – Roof Evaporation
- Lawn Retention = 25% of Roof Runoff
- Lawn Infiltration (of Roof Runoff) = Lawn Retention x IF Factor
- Lawn Evapotranspiration (of Roof Runoff) = Lawn Retention – Lawn Infiltration

Our analysis reveals that the pre-development infiltration of 11,071 m^3/year can be met during post-development conditions. Based on our preliminary calculations, approximately 9,637 m^2 of roof area, and 7,269 m^2 of backyard area can be directed to these trenches. Please refer to the calculations attached in **Appendix D** as well as **Figure 6.1** for the location of the proposed trenches.

Table 6-1: Summary of Water Balance

Pre-Development (m^3/year)	Post-Development (m^3/year)	Annual Deficit (m^3/year)	Post-Development Infiltration with LID’s (m^3/year)
11,071	4,710	6,361	11,104

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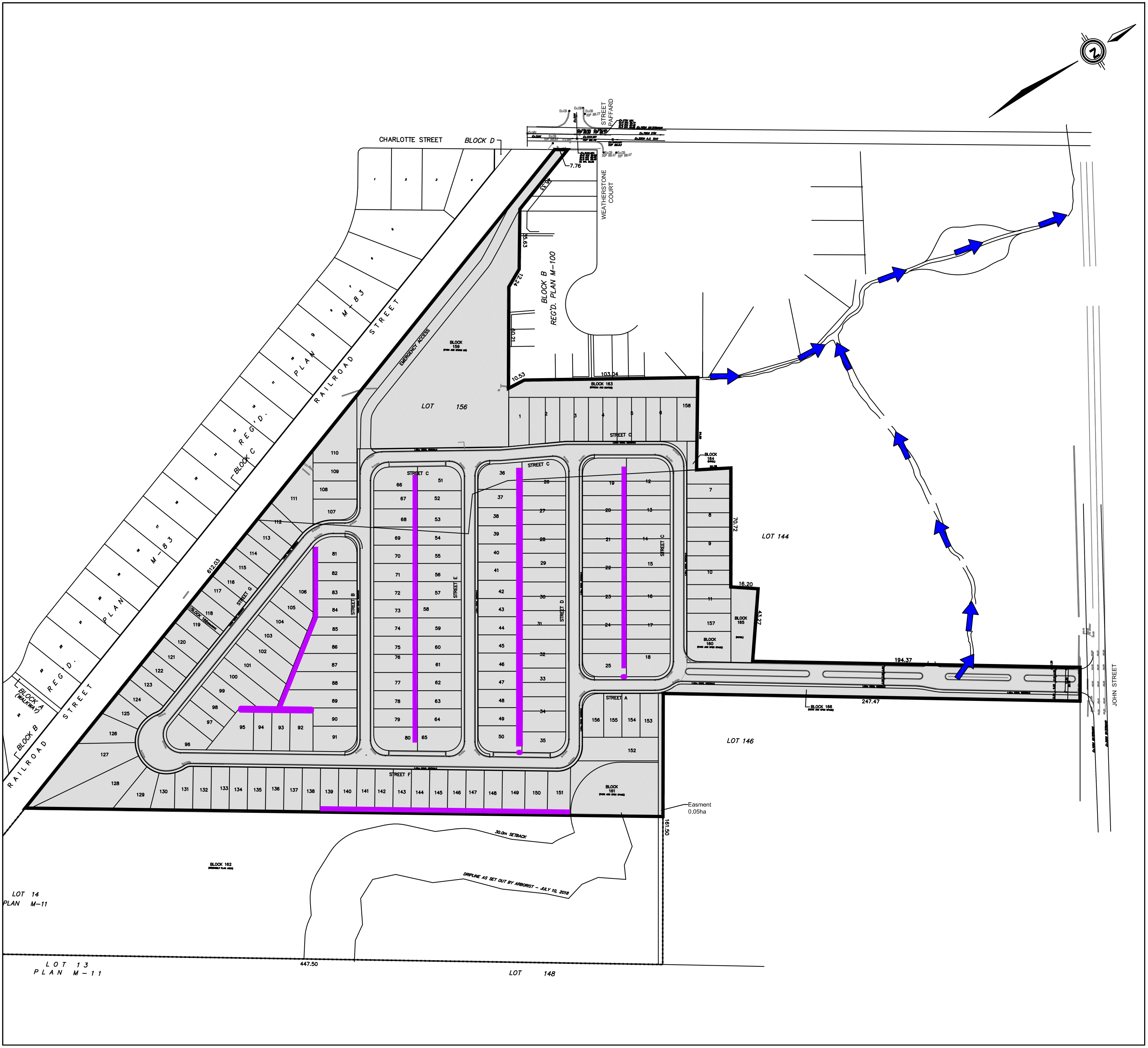
Phil Gotfried



200 JOHN STREET EAST
RESIDENTIAL SUBDIVISION
NIAGARA ON THE LAKE

LEGEND

▨ SUBJECT AREA

— INFILTRATION TRENCH

← EXISTING CREEK DRAINAGE

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FIGURE 6.1
PROPOSED LID PLAN

2018-4696	JULY 2020	SCALE: N.T.S.

7 SUMMARY AND CLOSING REMARKS

This report is provided in support of the proposed residential subdivision located at 200 John Street East and 588 Charlotte Street, in the Town of Niagara on the Lake. The report demonstrates that sufficient water quality and erosion control is provided by the proposed underground SWM facility to service the drainage area to the primary site outlet to 1 Mile Creek. Water quality will be provided by isolation rows within the ADS chamber system. An additional layer of quality treatment is proposed through catchbasin shields upstream from the storage chambers. Likewise, the site erosion requirements will be handled through quantity controls within the ADS Chambers.

Water balance for the subject site is provided by a series of LID measures. Provided LID's include amended topsoil, disconnected roof leaders, infiltration trenches. Furthermore, the water balance analysis carried out for this project reveals that annual pre-development infiltration volumes can be exceeded during post-development conditions.

Water supply servicing will be provided via the existing infrastructure along Charlotte Street. Preliminary analysis reveals that available servicing may be available. Correspondence with the Town is underway to provide detailed modeling to identify required system upgrades. An updated hydrant test will also be provided, weather permitting.

Sanitary servicing will be provided by the existing sanitary sewer along Charlotte Street. Preliminary analysis shows that the proposed subdivision will take up majority of the sewer's capacity. Correspondence with the town is underway to identify required infrastructure improvements by incorporating the development in the existing Town sanitary model.

We trust that you will find the contents of this report satisfactory. Please contact the undersigned if you have any questions or concerns.

Respectfully Submitted,

SCHAEFFER & ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
K. SHAHBIKIAN
100090411
July 21 2020
PROVINCE OF ONTARIO

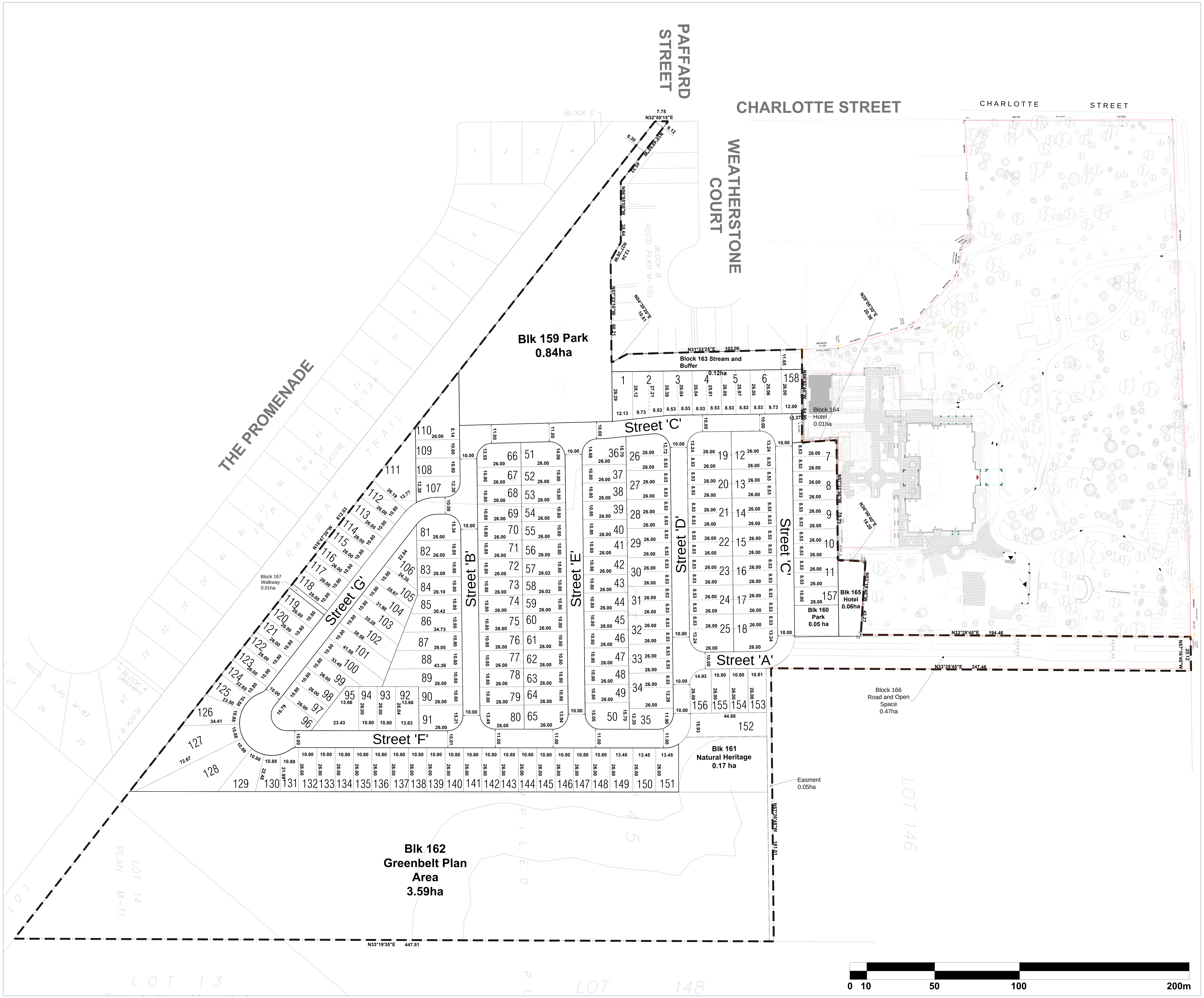
Giancarlo Volpe, M.Eng,
Water Resources Analyst

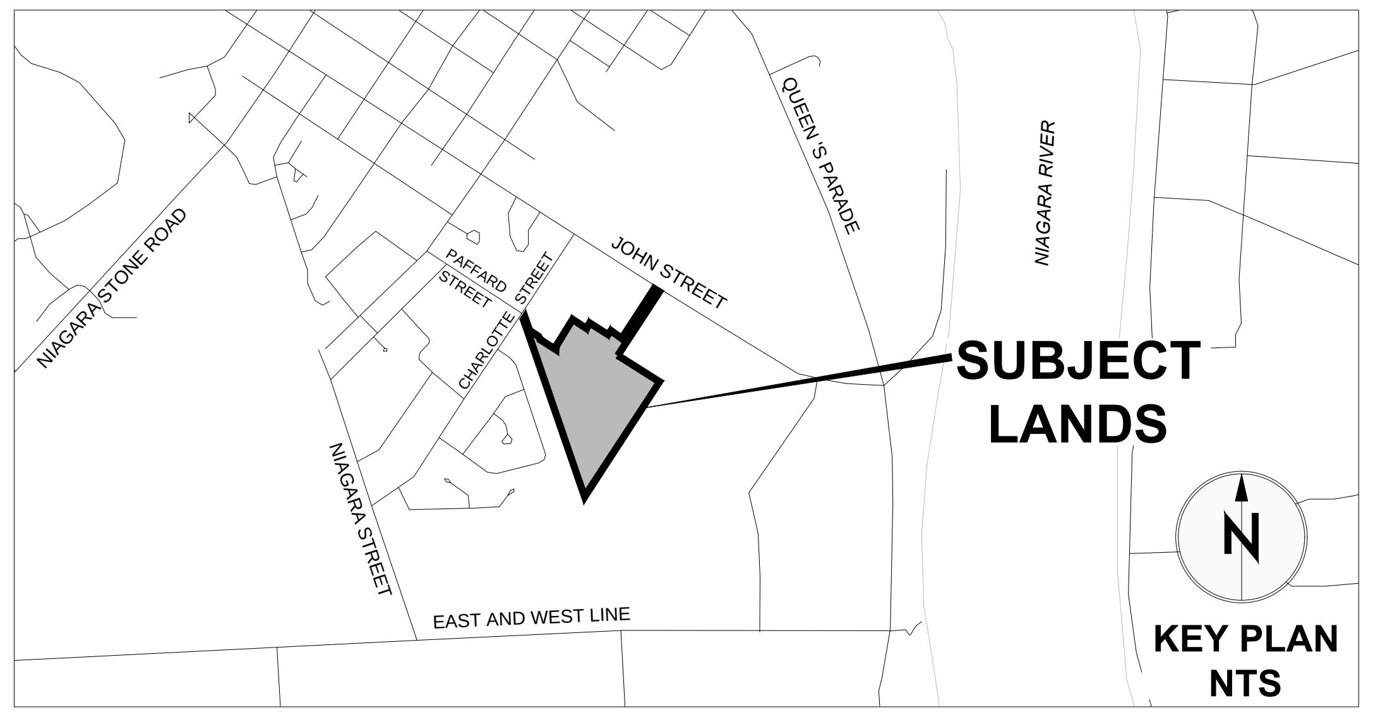
Koryun Shahbikian, P.Eng, M.Eng
Associate

APPENDIX A

Background

Z:\Projects\JS.NL Solmar John and Charlotte NOTL\Mapping\CAD\4 - DRAFT PLAN\June 29 2020\2020-06-29_Draft_Plan.dwg





SOLMAR® DEVELOPMENT CORP

DRAFT PLAN OF SUBDIVISION
SOLMAR
FILE #

LOTS 145 and 156
REGISTRAR'S COMPILED PLAN 692 and LOT 14
PLAN M-11
TOWN OF NIAGARA-ON-THE-LAKE
REGIONAL MUNICIPALITY OF NIAGARA

OWNERS CERTIFICATE

I HEREBY AUTHORIZE SGL PLANNING & DESIGN INC. TO SUBMIT THIS PLAN FOR APPROVAL.

SIGNED ____________________ DATE: ______________
Solmar (Niagara 2) Inc.

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE CORRECTLY AND ACCURATELY SHOWN.

SIGNED ____________________ DATE: ______________
SHAN GOONEWARDENA, O.L.S.
R-PE SURVEYING LTD.

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT) INFORMATION REQUIRED BY CLAUSES A,B,C,D,E,F,G,J & L ARE SHOWN ON THE DRAFT AND KEY PLANS.

H)MUNICIPAL AND PIPED WATER TO BE PROVIDED
I) SILTY CLAY, SILTY CLAY TILL, SANDY SILT, SANDY SILT TILL
K)SANITARY AND STORM SEWERS TO BE PROVIDED

LAND USE SCHEDULE

LAND USE	LOT / BLOCK #	AREA (ha)	AREA (ac)	UNITS
RESIDENTIAL SEMI DETACHED HOMES	2-34	1.54	3.81	66
RESIDENTIAL SINGLE DETACHED HOMES	1,35-158	4.03	9.96	125
PARK	159 - 160	0.89	2.20	
NATURAL HERITAGE	161	0.17	0.42	
GREENBELT PLAN AREA & EASEMENT	162	3.63	8.97	
STREAM & BUFFER	163	0.12	0.30	
HOTEL	164-165	0.07	0.17	
ROAD & OPEN SPACE	166	0.47	1.16	
WALKWAY	167	0.01	0.02	
ROAD R.O.W.		1.41	3.48	
TOTAL	**167**	**12.34**	**30.49**	**191**

SGL
Planning & Design Inc.
416-923-6630 sglplanning.ca

SCALE 1: 1,000
(24x36)
July 7, 2020

N

Town of Niagara-on-the-Lake Correspondence and Population Estimates

From: MKomljenovic@notl.org
Sent: Wednesday, October 31, 2018 11:07 AM
To: Dunsmore, Susan
Cc: Giancarlo Volpe
Subject: RE: Inquiry Regarding Population Densities for NOTL

Hi Susan/Giancarlo,

Population Estimates via our Planning Dept. -

Hi Mike:

Officially, we should still be using the estimates in the Regional Official Plan, which show 2.55 in 2016 ans 2.50 in 2021. Based on this the ppu for 2018 would be 2.53.

The table is here:

https://www.niagararegion.ca/living/icp/pdf/2015/Table-4-1.pdf

Five Year Rolling Average Peaking Factor Data - we don't have that information available.

Watermain Design and design flows shall conform to MOE "Guidelines for the Design of Water Storage Facilities... and the Regional Municipality of Niagara Public Works Department's "Guidelines for the Design and Construction of Sewer and Watermain systems"

Thanks

Mike Komljenovic
Engineering Supervisor
905-468-3061 ext. 240 Fax: 905-468-1722
1593 Four Mile Creek Road, PO Box 100, Virgil, ON L0S 1T0
Website:www.notl.org Facebook: @Town.of.NOTL
Twitter: @Town_of_NOTL& @NOTLfiredept

Niagara-on-the-Lake
EST.1781

From: "Dunsmore, Susan" <Susan.Dunsmore@niagararegion.ca>
To: "'Giancarlo Volpe'" <GVolpe@schaeffers.com>
Cc: "'MKomljenovic@notl.org'" <MKomljenovic@notl.org>
Date: 2018-10-31 07:50 AM
Subject: RE: Inquiry Regarding Population Densities for NOTL

Hello

I have attached our Design Guidelines that Regional Staff use for Regional projects. The Region owns and operates and designs for the transmission mains, plants and pumping stations. I have copied Mike so he can provide the design requirements for the Town because the Region does not normally provide population estimates or requirements for the local water systems.

If you have any further questions please contact me at your convenience.

Thanks

Susan M. Dunsmore, P. Eng.
Manager, Development Engineering
Planning and Development Services

Phone: (905) 980-6000 or 1-800-263-7215 ext 3661
Address: 1815 Sir Isaac Brock Way, Thorold ON, L2V4T7
Wesbite:www.niagararegion.ca

From: Giancarlo Volpe [mailto:GVolpe@schaeffers.com]
Sent: Tuesday, October 30, 2018 10:04 AM
To: Dunsmore, Susan
Cc: 'MKomljenovic@notl.org'
Subject: RE: Inquiry Regarding Population Densities for NOTL

Hello Ms. Dunsmore,

Thank you for the information regarding the Region's Water and Wastewater standards.

I have had some time to review the Region design criteria, and I have a few remaining questions, listed below:

- Both the Region and Town of NOTL 2018 guidelines do not specify any guidelines for estimating populations, which are required to determine sanitary and water demands. Are there any preferred approaches to population estimates which the Town/Region would find acceptable? My current approach is to use values from other municipalities, such as the City of Vaughan for example, which have detailed population densities of 4.0 persons/unit for single/semi-detached houses and 3.5 persons/unit for townhouses. Would this be acceptable?
- The NOTL 2018 guidelines specify Fire Flow pressure requirements (i.e. Max Day + Fire Flow pressure of 140kPa) however it does not address required fire flows for residential/employment. Does Niagara Region have recommended fire flows for different land uses, or would a similar approach of using a nearby municipality values be appropriate?
- Lastly with regards to determining the Max Day peaking factors for Water Supply design, does the Town of NOTL have data to obtain the 5 year rolling average to determine an appropriate peaking factor? (Perhaps Mr. Komljenovic can assist with this point.)

Thank you again for any clarification you can provide.

SCHAEFFERS
CONSULTING ENGINEERS
GIANCARLO VOLPE, M.Eng.
WATER RESOURCES ANALYST
6 Ronrose Drive, Concord, Ontario, L4K 4R3
tel. 905.738.6100 fax. 905.738.6875

From: Dunsmore, Susan [mailto:Susan.Dunsmore@niagararegion.ca]
Sent: Monday, October 29, 2018 2:54 PM

To: Giancarlo Volpe
Cc: 'MKomljenovic@notl.org'
Subject: FW: Inquiry Regarding Population Densities for NOTL

Hello Mr. Volpe,

In response to your inquiry to Mr. Miller, I have cut out the Region's current design information that is used to determine the flows during our Master Serivcing Studies for Regional Infrastructure. I have also copied Mike Komljenovic at the Town so he can provide you with the Town's standards for municipal infrastrucutre that you are designing.

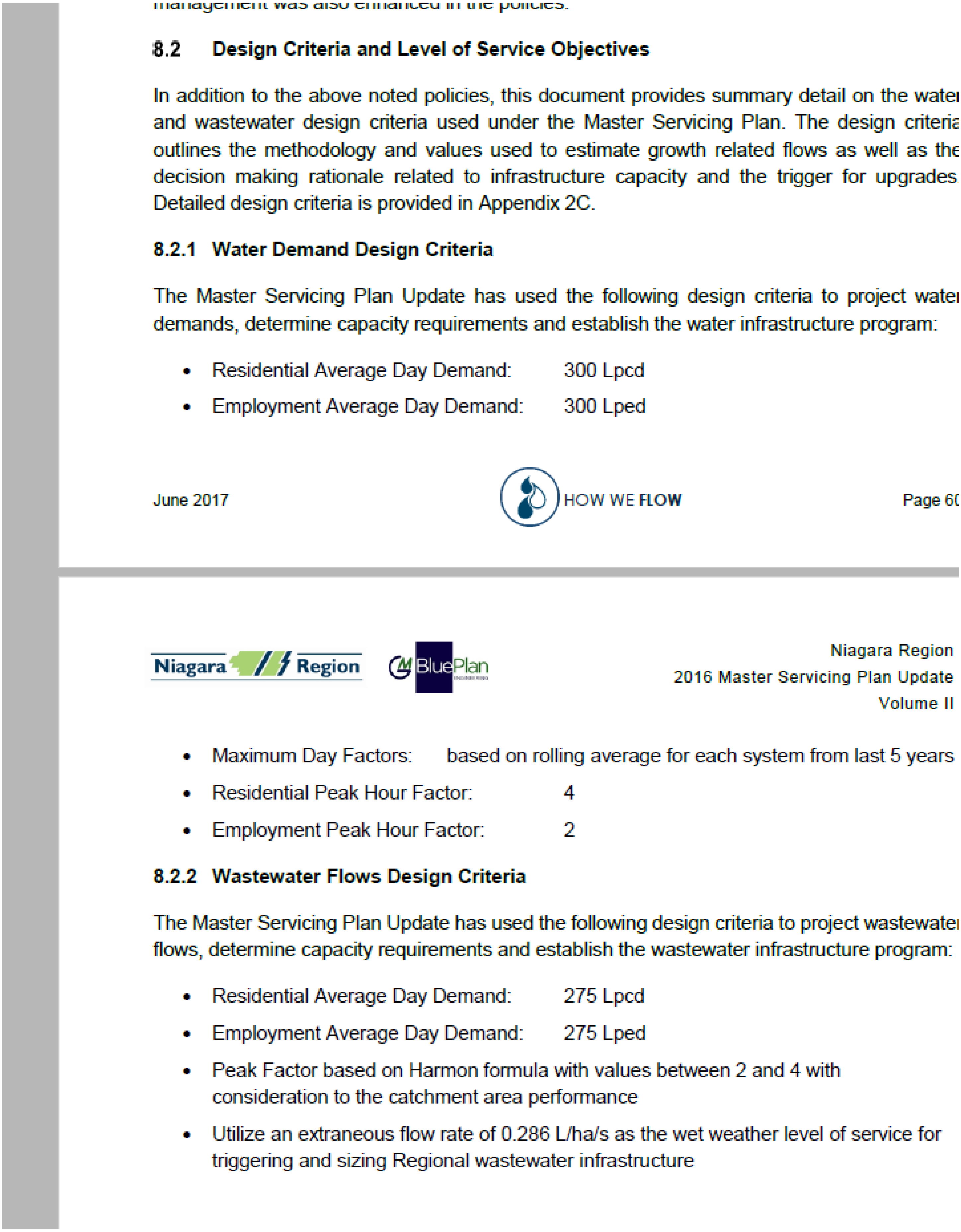
Our Master Plan is available on-line at the following link if you require anything furhter. If you have further questions please contact me at your conveninece.

https://www.niagararegion.ca/2041/master-servicing-plan/default.aspx

Thank you,

Susan M. Dunsmore, P. Eng.
Manager, Development Engineering
Planning and Development Services

Phone: (905) 980-6000 or 1-800-263-7215 ext 3661
Address: 1815 Sir Isaac Brock Way, Thorold ON, L2V4T7
Wesbite:www.niagararegion.ca
Niagara Region



management was also enhanced in the policies.

8.2 Design Criteria and Level of Service Objectives

In addition to the above noted policies, this document provides summary detail on the water and wastewater design criteria used under the Master Servicing Plan. The design criteria outlines the methodology and values used to estimate growth related flows as well as the decision making rationale related to infrastructure capacity and the trigger for upgrades. Detailed design criteria is provided in Appendix 2C.

8.2.1 Water Demand Design Criteria

The Master Servicing Plan Update has used the following design criteria to project water demands, determine capacity requirements and establish the water infrastructure program:

- Residential Average Day Demand: 300 Lpcd
- Employment Average Day Demand: 300 Lped

- Maximum Day Factors: based on rolling average for each system from last 5 years
- Residential Peak Hour Factor: 4
- Employment Peak Hour Factor: 2

8.2.2 Wastewater Flows Design Criteria

The Master Servicing Plan Update has used the following design criteria to project wastewater flows, determine capacity requirements and establish the wastewater infrastructure program:

- Residential Average Day Demand: 275 Lpcd
- Employment Average Day Demand: 275 Lped
- Peak Factor based on Harmon formula with values between 2 and 4 with consideration to the catchment area performance
- Utilize an extraneous flow rate of 0.286 L/ha/s as the wet weather level of service for triggering and sizing Regional wastewater infrastructure

From: Giancarlo Volpe [mailto:GVolpe@schaeffers.com]
Sent: Friday, October 26, 2018 3:15 PM
To: Miller, Steven <Steven.Miller@niagararegion.ca>
Subject: Inquiry Regarding Population Densities for NOTL

Hello Mr. Miller,

Thank you in the past for your help with obtaining floodplain models for the Niagara on the Lake (NOTL) area.

We are currently in the midst of designing for sanitary and water supply servicing for a site in NOTL, however the NOTL design criteria appears to be vague regarding the estimation of future populations in the area.

I have seen that in the past a general population density of 2.5 people/unit has been applied for other sites, however I am uncertain of where this value has been referenced.

In addition the MOE criteria suggests a minimum 25 people/ha, however the proposed development will likely be much more densely populated as it will be a subdivision.

The NOTL design guidelines also refer to the Niagara region criteria, however I have had no luck finding this information. Is there a particular document or population density I should be considering which is accepted by the Region?

Any clarification you can provide would be greatly appreciated.

Regards,

SCHAEFFERS
CONSULTING ENGINEERS
GIANCARLO VOLPE, M.Eng.
WATER RESOURCES ANALYST
6 Ronrose Drive, Concord, Ontario, L4K 4R3
tel. 905.738.6100 fax. 905.738.6875

From: Miller, Steven [mailto:Steven.Miller@niagararegion.ca]
Sent: Tuesday, September 18, 2018 9:59 AM
To: Giancarlo Volpe
Cc: Sarah Mastroianni
Subject: RE: Inquiry Regarding AES Storms and Floodplain Models

Hello Mr. Volpe;

Thank you for your enquiry. Things have recently changed here in Niagara with respect to stormwater management. I have attached the ‘Update on SWM Review’ letter to help clarify things.

With respect to design storms, the Region will defer to what is noted in the current 2018 NOTL Engineering Standards. I have attached a copy for your convenience.

I can confirm that the Niagara Peninsula Conservation Authority is still the agency responsible for floodplain mapping and floodplain information. I would recommend that you contact the NPCA and ask for the floodplain mapping report (and associated hydrologic and hydraulic computer models) that was generated for the 2008 ‘Niagara-on-the-Lake Watershed Study’ (by Aquafor Beech Limited).

Feel free to contact me should you have any further questions.

Kind regards;

Steve Miller, P.Eng.
Stormwater Management Engineer
Niagara Region Planning & Development Services
1815 Sir Issac Brock Way

Thorold, ON L2V 4T7
Tel: 905-980-6000 ext. 3177
steven.miller@niagararegion.ca

From: Giancarlo Volpe [mailto:GVolpe@schaeffers.com]
Sent: Tuesday, September 18, 2018 9:36 AM
To: Miller, Steven <Steven.Miller@niagararegion.ca>
Subject: Inquiry Regarding AES Storms and Floodplain Models

Hello Mr. Miller,

This is Giancarlo Volpe from Schaeffers Consulting Engineers. I am currently working on the design of a project within the Town of Niagara on the Lake, particularly with regards to Stormwater Management. I had contacted the NPCA and they recommended speaking to you about the following concerns.

1) I have a question regarding the design storms to be used. In the NPCA's current guidelines developed by AECOM, it recommends the use of the 12hour AES storm. I have generated a 1hour AES storm for the site given the ST. Catherine's IDF rainfall data. Would it be possible to use the 1hour AES storm to develop our pre-development peak flows? If not does the town have the rainfall data available for the 12hour AES storm?

2) In addition we would also like to carry out some studies regarding potential future impacts on the existing flood plain. Would it be possible for the region to provide the Hydrology and Hydraulic Models for the Niagara on the Lake area?

Any assistance or clarification you can provide would be appreciated.

Regards,

SCHAEFFERS
CONSULTING ENGINEERS

GIANCARLO VOLPE, M.Eng.
WATER RESOURCES ANALYST
6 Ronrose Drive, Concord, Ontario, L4K 4R3
tel. 905.738.6100 fax. 905.738.6875

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Table 4-1: Niagara Region, Population, Household and Employment Forecast by Local Municipality, 2006-2031

Development Location	Forecast Period	Total Households	Total Population	Total Population With Undercount[1]	Total Population in Households[1]	Persons Per Household (PPH)	Total Employment	Total Employment Including NFPOW[1]	Total Employment Activity Rate[1]
Fort Erie	2006	12,220	30,000	31,200	30,600	2.50	10,720	11,790	0.38
	2011	12,950	31,600	32,900	32,200	2.49	11,490	12,580	0.38
	2016	13,660	33,300	34,600	33,800	2.47	12,130	13,230	0.38
	2021	14,460	34,700	36,100	35,300	2.44	12,760	13,870	0.38
	2026	15,220	36,100	37,500	36,600	2.40	13,350	14,460	0.39
	2031	15,860	37,400	38,877	37,900	2.39	13,820	14,950	0.38
Grimsby	2006	8,745	23,900	24,900	24,500	2.80	7,380	8,120	0.33
	2011	9,560	25,900	26,900	26,400	2.76	7,880	8,630	0.32
	2016	10,090	27,100	28,200	27,600	2.74	8,060	8,820	0.31
	2021	10,540	27,900	29,000	28,400	2.69	8,120	8,890	0.31
	2026	10,950	28,400	29,500	28,900	2.64	8,310	9,080	0.31
	2031	11,400	29,400	30,582	29,900	2.62	8,550	9,340	0.31
Lincoln	2006	7,680	21,700	22,600	21,800	2.84	9,270	10,200	0.45
	2011	8,190	22,900	23,800	22,900	2.80	9,760	10,690	0.45
	2016	8,780	24,300	25,300	24,400	2.78	9,960	10,910	0.43
	2021	9,340	25,400	26,400	25,400	2.72	10,180	11,130	0.42
	2026	9,840	26,500	27,600	26,500	2.69	10,420	11,390	0.41
	2031	10,300	27,500	28,583	27,500	2.67	10,700	11,670	0.41

---

[1] Total population in households excluding institutional population.

Table 4-1: Niagara Region, Population, Household and Employment Forecast by Local Municipality, 2006-2031

Development Location	Forecast Period	Total Households	Total Population	Total Population With Undercount[1]	Total Population In Households[2]	Persons Per Household (PPH)	Total Employment	Total Employment Including NFPOW[1]	Total Employment Activity Rate[1]
Niagara Falls	2006	32,495	82,200	85,500	83,900	2.58	38,900	42,800	0.50
	2011	33,750	84,800	88,200	86,500	2.56	40,490	44,410	0.50
	2016	34,940	86,800	90,300	88,500	2.53	41,380	45,330	0.50
	2021	36,470	89,400	93,000	91,000	2.50	41,930	45,890	0.49
	2026	38,550	93,000	96,700	94,500	2.45	42,680	46,670	0.48
	2031	40,300	96,500	100,341	98,000	2.43	43,640	47,670	0.47
Niagara-on-the-Lake	2006	5,445	14,600	15,200	14,300	2.63	9,990	11,000	0.72
	2011	6,150	16,200	16,800	15,800	2.57	10,360	11,370	0.68
	2016	6,790	17,700	18,400	17,300	2.55	10,590	11,620	0.63
	2021	7,240	18,500	19,200	18,100	2.50	10,880	11,910	0.62
	2026	7,550	18,900	19,700	18,600	2.46	11,310	12,340	0.63
	2031	7,990	19,900	20,688	19,500	2.44	11,650	12,690	0.61
Pelham	2006	5,930	16,100	16,700	16,600	2.80	3,870	4,260	0.26
	2011	6,420	17,500	18,200	18,000	2.80	4,070	4,470	0.25
	2016	6,930	18,700	19,400	19,200	2.77	4,200	4,600	0.24
	2021	7,580	20,400	21,200	20,900	2.76	4,340	4,750	0.22
	2026	7,930	21,000	21,800	21,400	2.70	4,540	4,960	0.23
	2031	8,200	21,500	22,387	22,000	2.68	4,700	5,130	0.23

---

[2] Total population in households excluding institutional population.

Table 4-1: Niagara Region, Population, Household and Employment Forecast by Local Municipality, 2006-2031

Development Location	Forecast Period	Total Households	Total Population	Total Population With Undercount[1]	Total Population in Households[3]	Persons Per Household (PPH)	Total Employment	Total Employment Including NFPOW[1]	Total Employment Activity Rate[1]
Port Colborne	2006	7,790	18,600	19,300	18,800	2.41	6,150	6,760	0.35
	2011	7,950	18,700	19,400	18,900	2.38	6,440	7,060	0.36
	2016	8,300	19,400	20,200	19,700	2.37	6,580	7,200	0.36
	2021	8,690	20,100	20,900	20,300	2.34	6,720	7,350	0.35
	2026	8,900	20,100	20,900	20,300	2.28	6,930	7,570	0.36
	2031	9,020	20,100	20,888	20,300	2.25	7,140	7,770	0.37
Welland	2006	20,715	50,300	52,300	51,800	2.50	18,550	20,410	0.39
	2011	21,320	51,100	53,100	52,600	2.47	19,300	21,170	0.40
	2016	22,070	52,300	54,400	53,800	2.44	19,770	21,660	0.40
	2021	23,120	54,100	56,300	55,600	2.40	20,320	22,220	0.39
	2026	24,210	55,900	58,100	57,300	2.37	21,110	23,020	0.40
	2031	25,670	59,100	61,464	60,500	2.36	21,710	23,650	0.38
West Lincoln	2006	4,295	13,200	13,700	13,600	3.17	3,490	3,840	0.28
	2011	4,750	14,500	15,100	14,900	3.14	3,780	4,130	0.27
	2016	5,100	15,400	16,000	15,800	3.10	3,990	4,350	0.27
	2021	5,370	16,000	16,600	16,400	3.05	4,410	4,780	0.29
	2026	5,510	16,200	16,800	16,500	2.99	4,710	5,080	0.30
	2031	5,610	16,300	16,990	16,700	2.98	4,930	5,300	0.31

---

[3] Total population in households excluding institutional population.

Table 4-1: Niagara Region, Population, Household and Employment Forecast by Local Municipality, 2006-2031

Development Location	Forecast Period	Total Households	Total Population	Total Population With Undercount[1]	Total Population in Households[4]	Persons Per Household (PPH)	Total Employment	Total Employment Including NFPOW[1]	Total Employment Activity Rate[1]
St. Catharines	2006	54,725	132,000	137,300	134,900	2.47	59,750	65,750	0.48
	2011	55,830	132,300	137,600	135,200	2.42	60,600	66,600	0.48
	2016	57,020	132,500	137,800	135,400	2.37	61,090	67,130	0.49
	2021	58,330	132,200	137,500	135,100	2.32	61,750	67,800	0.49
	2026	59,720	131,700	137,000	134,600	2.25	62,130	68,190	0.50
	2031	61,120	132,700	137,919	135,600	2.22	62,640	68,740	0.50
Wainfleet	2006	2,390	6,600	6,900	6,900	2.89	1,300	1,430	0.21
	2011	2,450	6,700	7,000	7,000	2.86	1,360	1,490	0.21
	2016	2,580	7,000	7,300	7,300	2.83	1,390	1,530	0.21
	2021	2,730	7,300	7,600	7,600	2.78	1,420	1,550	0.20
	2026	2,840	7,600	7,900	7,800	2.75	1,460	1,590	0.20
	2031	2,980	7,900	8,195	8,100	2.72	1,490	1,630	0.20
Thorold	2006	7,055	18,200	18,900	18,800	2.66	7,280	8,010	0.42
	2011	7,260	18,500	19,200	19,100	2.63	7,670	8,400	0.44
	2016	7,900	20,100	20,900	20,700	2.62	7,890	8,630	0.41
	2021	8,390	21,200	22,000	21,700	2.59	8,130	8,880	0.40
	2026	8,950	22,200	23,100	22,800	2.55	8,390	9,150	0.40
	2031	9,400	23,200	24,086	23,700	2.52	8,690	9,460	0.39
REGION OF NIAGARA	2031	207,850	491,500	511,000	499,700	N/A	199,660	218,000	N/A

---

[4] Total population in households excluding institutional population.

Cole Engineering Hydrogeological Investigation Excerpts

Solmar (Niagara 2) Inc.

HYDROGEOLOGICAL INVESTIGATION

200 John Street and 588 Charlotte Street, Niagara-on-the-Lake, Ontario

Project No. 2018-0419

COLE

COLE ENGINEERING GROUP LTD.

HEAD OFFICE
70 Valleywood Drive Markham, ON L3R 4T5
T. 905 940 6161 | 416 987 6161 F. 905 940 2064
www.coleengineering.ca

June 2020

June 30, 2020
Reference No. 2018-0419

Luis Correia
Solmar (Niagara 2) Inc.
122 Romina Drive
Concord, ON L4K 4Z7

Attention: Mr. Correia

Hydrogeological Investigation Report
Proposed Development at 200 John Street and 588 Charlott Street,
Niagara-on-the-Lake, ON

Cole Engineering Group Ltd. (COLE) is pleased to submit the enclosed hydrogeological investigation report for the site located at 200 John Street and 588 Charlotte Street, Niagara-on-the-Lake, ON. This investigation includes a review of the hydrogeological information collected from the site, characterization of the geological and hydrogeological setting, assessment of potential impacts due to the proposed development, and proposed mitigation measures.

Should you have any questions or comments, please do not hesitate to contact the undersigned.

Best Regards,
COLE ENGINEERING GROUP LTD.

Hejazi

Alireza Hejazi, Ph.D., P.Eng.
Project Manager and Hydrogeologist

Hejazi

For Steve Davies, M.Sc., P.Geo.
Senior Hydrogeologist

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CANADA AWARDS FOR EXCELLENCE
BRONZE RECIPIENT EXCELLENCE, INNOVATION & WELLNESS 2016

PREPARED BY:

COLE ENGINEERING GROUP LTD.

reza Hejazi

For James Magee, M.Sc.
Environmental Specialist

CHECKED BY:

COLE ENGINEERING GROUP LTD.

reza Hejazi

Alireza Hejazi, Ph.D., P.Eng.
Hydrogeologist and Environmental Engineer

AUTHORIZED FOR ISSUE BY:

COLE ENGINEERING GROUP LTD.

M. M Husain

Muin Husain, Ph.D., P.Geo.
Senior Hydrogeologist

Issues and Revisions Registry

Identification	Date	Description of issued and/or revision
Draft Report	27 November 2018	For internal review
Draft Report	30 November 2018	For client review
Final Report	4 October 2019	For client review
Final Report (minor site plan updates)	30 June 2020	For client review

Statement of Conditions

This Report has been prepared at the request of, and for the exclusive use of, Solmar (Niagara 2) Inc., and its affiliates (the “Intended User”). No one other than the Intended User has the right to use and rely on the Work without first obtaining the written authorization of Cole Engineering Group Ltd. and Solmar (Niagara 2) Inc. Cole Engineering Group Ltd. expressly excludes liability to any party except the Intended User for any use of, and/or reliance upon, the work.

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Executive Summary

Cole Engineering Group Ltd. (“COLE”) was retained by Solmar (Niagara 2) Inc. to undertake a hydrogeological investigation in support of the proposed residential development 220 John Street and 588 Charlotte Street, Niagara-on-the-Lake, ON (the “Site”).

The Site is situated in the Iroquois Plain physiographic region, and falls under the jurisdiction of the Niagara Peninsula Conservation Authority (“NPCA”). Regional mapping indicates that the Site is not located within Wellhead Protection Area (“WHPA”) or Significant Recharge Area (“SGRA”). However, the Site is located within a highly vulnerable aquifer (“HVA”).

At a regional scale, groundwater flows to the north towards Lake Ontario. Four (4) monitoring events were completed from September 27, 2018 to August 21, 2019 to assess groundwater levels at the Site. Groundwater elevations were generally higher in the southern portion of the Site and at a lower elevation in the northern portion of the Site. Shallow groundwater flow appears to augment the direction of regional groundwater flow and surface topography and flows in a northeasterly direction towards Lake Ontario.

Single-well hydraulic tests were conducted in three (3) on-site monitoring wells to determine the in-situ hydraulic conductivity (K) of the screened overburden materials. The in-situ K values were estimated to range from 1.1×10^{-6} m/s to 2.5×10^{-8} m/s.

Two (2) groundwater samples were collected from two (2) on-site monitoring wells. The results were compared against the Provincial Water Quality Objectives (“PWQO”). Based on the laboratory analysis, the results met the applicable criteria with the exception of minor exceedances of total cobalt and total uranium.

A small tributary has been mapped across the northern portion of the Site. No stream flow was observed at the monitoring station during the four (4) monitoring events. A mini-piezometer nest station was installed to assess potential interaction between the groundwater system and on-site watercourse. The downward vertical hydraulic gradient estimates obtained at mini-piezometer nest indicates that that the stream is not groundwater fed.

Potential impacts to the groundwater system associated with the proposed development include reduction in infiltration, lowering of the groundwater levels in the overburden, and the potential introduction of preferential pathways for contaminants. Based on the results of a preliminary water balance analysis for the Site, an infiltration reduction of 12,075 m^3/year is anticipated as a result of the proposed development without any mitigation.

Low Impact Development (“LID”) measures (e.g., underground infiltration trenches, grassed or dry swales, and green roofs) may be proposed and designed at the detailed design stage to address the infiltration deficit and match pre-development infiltration. The use of collars or other methods to restrict preferential movement of groundwater along the subsurface infrastructure corridors are recommended to preserve the existing groundwater flow regime. Furthermore, road salt application at the proposed development should be managed to minimize sodium and/or chloride loading to the shallow groundwater system.

4.2.1 Groundwater Levels

Each monitoring well was developed prior to measuring the water level by removing a minimum of three (3) well volumes of water to clear any silt or drilling debris from the sandpack and well casing. Four (4) monitoring events were conducted from September 27, 2018 to August 21, 2019 to assess groundwater levels at the Site. Monitoring data are presented in **Table 4.1**.

Table 4.1 Water Level Measurements

Well ID	Ground Elevation (masl)	Depth to bottom (mbgs)	27 Sep 18		16 Nov 18		29 March 19		21 Aug 19	
			mbgs	masl	mbgs	masl	mbgs	masl	mbgs	masl
MW1-S	91.50	6.2	2.14	89.36	1.78	89.72	1.27	**90.23**	1.40	90.10
MW1-D	91.50	9.3	2.24	89.26	1.86	89.64	1.33	90.17	1.45	90.05
MW2	91.10	6.3	4.12	**86.98**	3.76	87.34	2.46	88.64	3.06	88.04
MW7	90.50	6.6	2.57	87.93	2.55	87.95	1.81	88.69	2.03	88.47

Notes:

mbgs	meters below ground surface
masl	meters above sea level

A review of the groundwater level measurements indicates that the groundwater level ranges from 90.23 masl (1.27 mbgs) to 86.98 masl (4.12 mbgs). The highest observed groundwater level (90.23 masl) was measured at MW1-S on March 29, 2019 and the lowest observed water level (86.98 masl) was measured at MW2 on September 27, 2018.

Based on our conceptual understanding of the local hydrogeology, monitoring wells are considered to be screened within the unconfined overburden and the water levels recorded from the monitoring wells are interpreted to be representative of the shallow groundwater table.

4.2.2 Groundwater Flow

At a regional scale, groundwater is expected to flow north or northeast towards Lake Ontario and / or the Niagara River (Waterloo Hydrogeologic, 2005). Based on the groundwater levels collected during the four (4) monitoring events, shallow groundwater flows in a northeast direction and is consistent with the direction of the regional groundwater flow.

The vertical hydraulic gradient was also estimated at a monitoring well nest (MW1D/MW1S). **Table 4.2** below summarizes the calculated vertical hydraulic gradient at the well nest for the water level monitoring events conducted from September 27, 2018 to August 21, 2019.

Table 4.2 Estimated Vertical Hydraulic Gradient at onsite Monitoring Wells

Well Nest	Vertical Hydraulic Gradient (m/m)			
	27-Sep-18	16-Nov-18	29-March-19	21-Aug-19
MW1D/MW1S	0.04	0.03	0.02	0.02

Notes:

Well Nest	Vertical Hydraulic Gradient (m/m)			
	27-Sep-18	16-Nov-18	29-March-19	21-Aug-19

Negative values indicate an upward gradient; positive values indicate a downward gradient.

Based on the available water level measurement collected between September 27, 2018 and August 21, 2019, the vertical hydraulic gradient at the MW1D/MW1S well nest was determined to be neutral to downward.

4.2.3 Hydraulic Conductivity

Single-well hydraulic tests were conducted by COLE on September 27 and 28, 2018 in three (3) monitoring wells. These tests were carried out to estimate the in-situ hydraulic conductivity (K) of the screened overburden materials.

During each hydraulic test, a known volume of water was displaced from the well by either inserting a slug or removing water. The recovery was measured either manually or using a data logger until a minimum of 80% recovery was achieved. Hydraulic conductivity estimates were obtained using the Hvorslev method (1951). Estimated K values are presented in **Table 4.3**. Details of the Hvorslev method and a summary of Hvorslev calculations are presented in **Appendix C.**

Table 4.3 Estimated Hydraulic Conductivity

Well ID	Well Diameter (m)	Screen Length (m)	Screen Unit	K (m/s)
MW1-D	0.05	3	Sandy Silt Till/Shale	1.1×10^{-6}
MW2	0.05	3	Sandy Silt Till	2.5×10^{-8}
MW7	0.05	3	Sandy Silt Till	5.4×10^{-8}

The in-situ K values estimated using the Hvorslev method range from 1.1×10^{-6} m/s to 2.5×10^{-8} m/s. Overall, the estimated hydraulic conductivities are within the range for the types of materials (sandy silt till) in which the shallow monitoring wells were screened (Freeze and Cherry, 1979).

4.2.4 Groundwater Quality

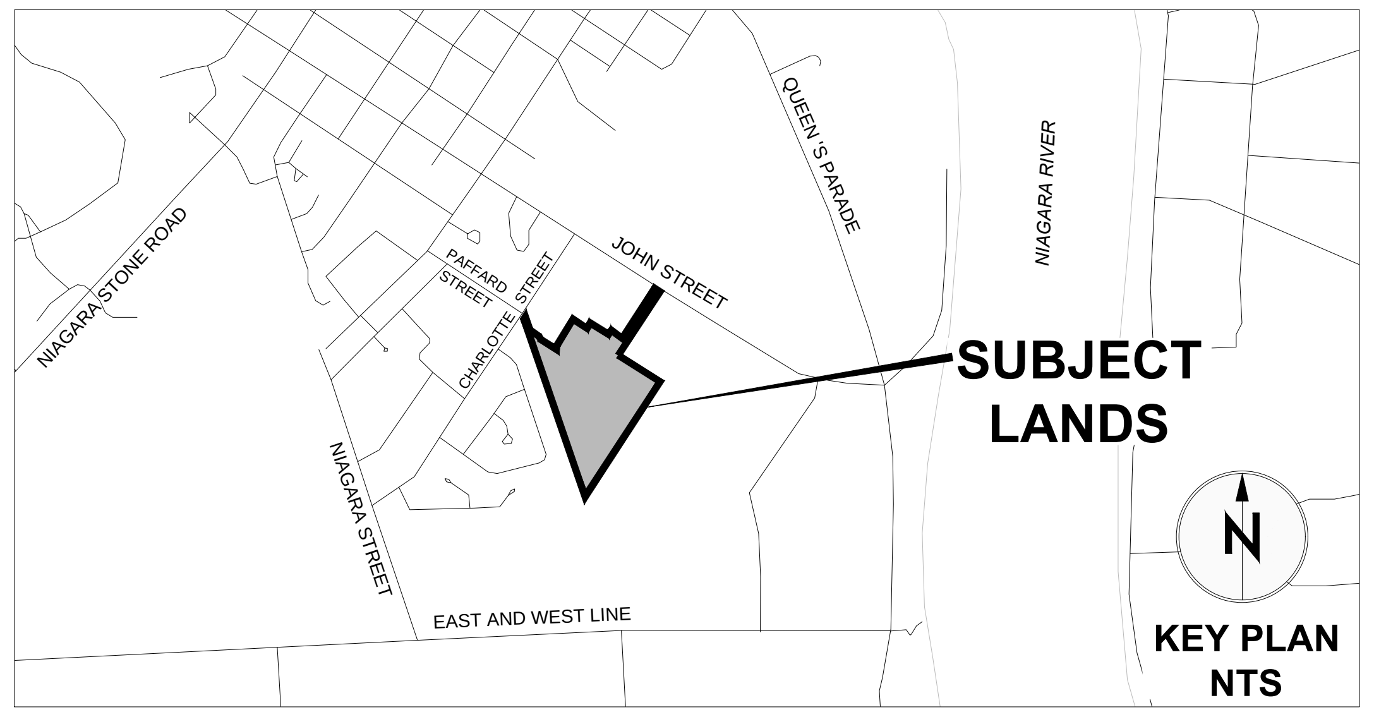
COLE collected two (2) groundwater samples on September 28, 2018 from two (2) on-site monitoring wells (MW1-D and MW2). The collected samples were sent to Maxxam Analytics for analyses of metal and inorganic criteria. Analytical results were compared to Provincial Water Quality Objectives ("PWQO"). Results are summarized in **Table 4.4** below. The laboratory analytical results and Certificate of Analysis are included in **Appendix D**.

Table 4.4 Groundwater Quality Results

Parameter	Units	PWQO Guidelines	MW1-D	MW2
Inorganics				
Total Ammonia	mg/L	20	0.051	0.25

Appendix A

Conceptual Site Plan



SOLMAR®
DEVELOPMENT CORP

DRAFT PLAN OF SUBDIVISION
SOLMAR
FILE #

LOTS 145 and 156
REGISTRAR'S COMPILED PLAN 692 and LOT 14
PLAN M-11
TOWN OF NIAGARA-ON-THE-LAKE
REGIONAL MUNICIPALITY OF NIAGARA

OWNERS CERTIFICATE

I HEREBY AUTHORIZE SGL PLANNING & DESIGN INC. TO SUBMIT THIS PLAN FOR APPROVAL.

SIGNED ______________________ DATE: ______________
Solmar (Niagara 2) Inc.

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE CORRECTLY AND ACCURATELY SHOWN.

SIGNED ______________________ DATE: ______________
SHAN GOONEWARDENA, O.L.S.
R-PE SURVEYING LTD

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT) INFORMATION REQUIRED BY CLAUSES A,B,C,D,E,F,G,J & L ARE SHOWN ON THE DRAFT AND KEY PLANS.

H) MUNICIPAL AND PIPED WATER TO BE PROVIDED
I) SILTY CLAY, SILTY CLAY TILL, SANDY SILT, SANDY SILT TILL
K) SANITARY AND STORM SEWERS TO BE PROVIDED

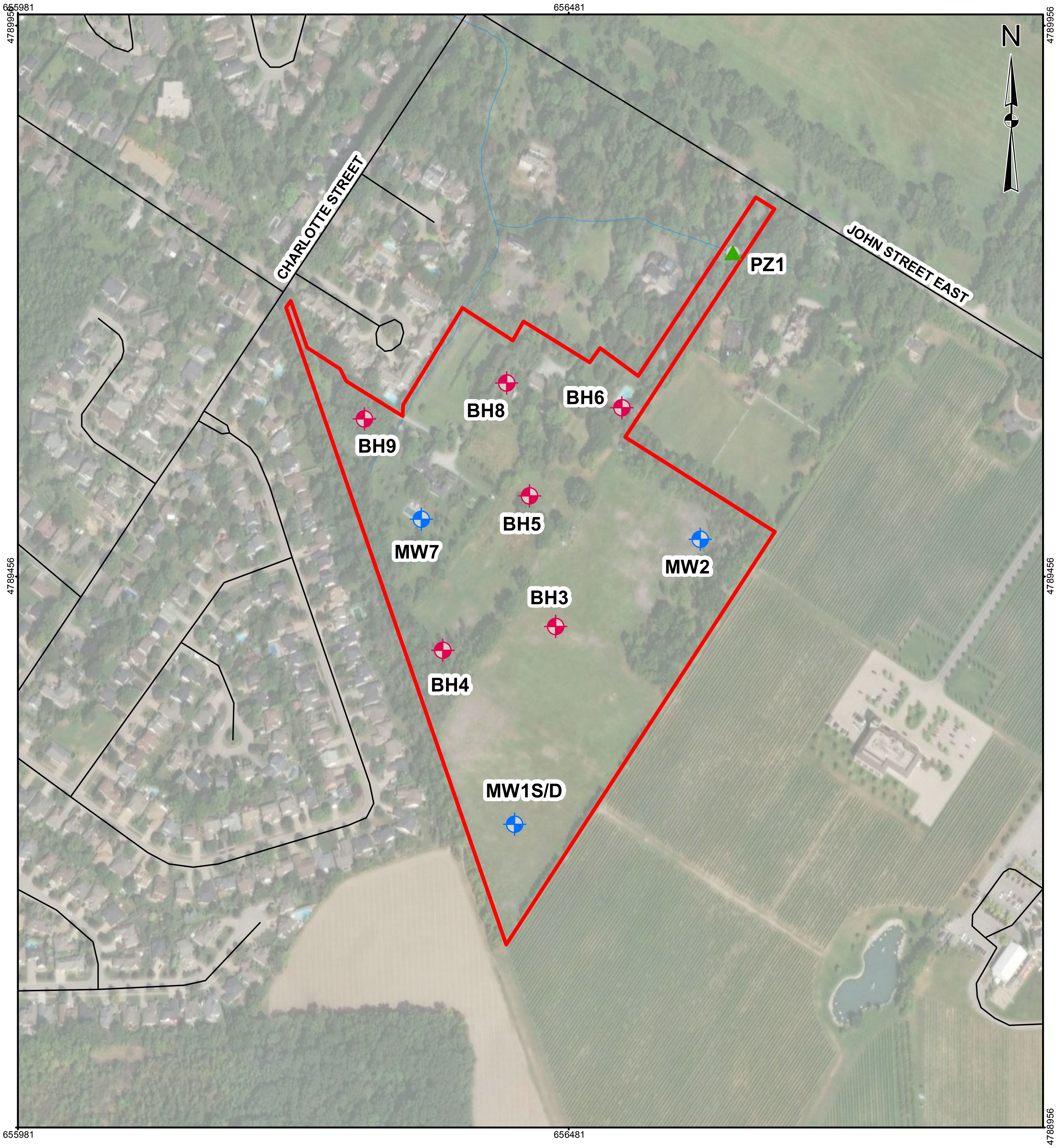
LAND USE SCHEDULE

LAND USE	LOT / BLOCK #	AREA (ha)	AREA (ac)	UNITS
RESIDENTIAL SEMI DETACHED HOMES	2-34	1.54	3.81	66
RESIDENTIAL SINGLE DETACHED HOMES	1,35-158	4.03	9.96	125
PARK	159 - 160	0.89	2.20	
NATURAL HERITAGE	161	0.17	0.42	
GREENBELT PLAN AREA & EASEMENT	162	3.63	8.97	
STREAM & BUFFER	163	0.12	0.30	
HOTEL	164-165	0.07	0.17	
ROAD & OPEN SPACE	166	0.47	1.16	
WALKWAY	167	0.01	0.02	
ROAD R.O.W.		1.41	3.48	
TOTAL	**167**	**12.34**	**30.49**	**191**

SGL
Planning & Design Inc.
416-923-6630 sglplanning.ca

SCALE 1: 1,000
(24x36)
July 7, 2020

N

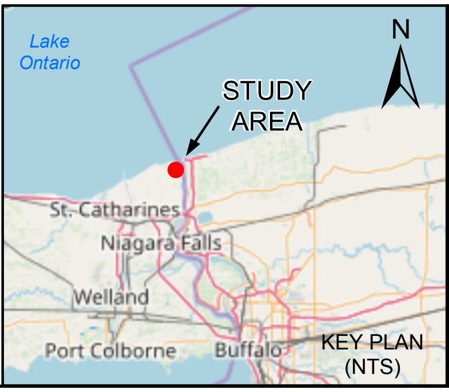


LEGEND

- 🟥 Site Boundary
- — Road
- ~ Watercourse
- ⊕ Monitoring Well
- ⊕ Borehole
- ▲ Piezometer Station

REFERENCE

Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Produced by Cole Engineering Group Ltd. under licence from the Ontario



SCALE 1:5,000

100 0 100 200 Meters

PROJECT
Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

TITLE

MONITORING WELL AND BOREHOLE LOCATION

COLE

DATE: 11/28/2018		
GIS	A.H.	06/25/2018
DESIGN		
CHECK	S.D.	06/25/2018

PROJECT: 2018-0419

REV. 0.0

FIGURE 6

Appendix B

Geotechnical Borehole Logs

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

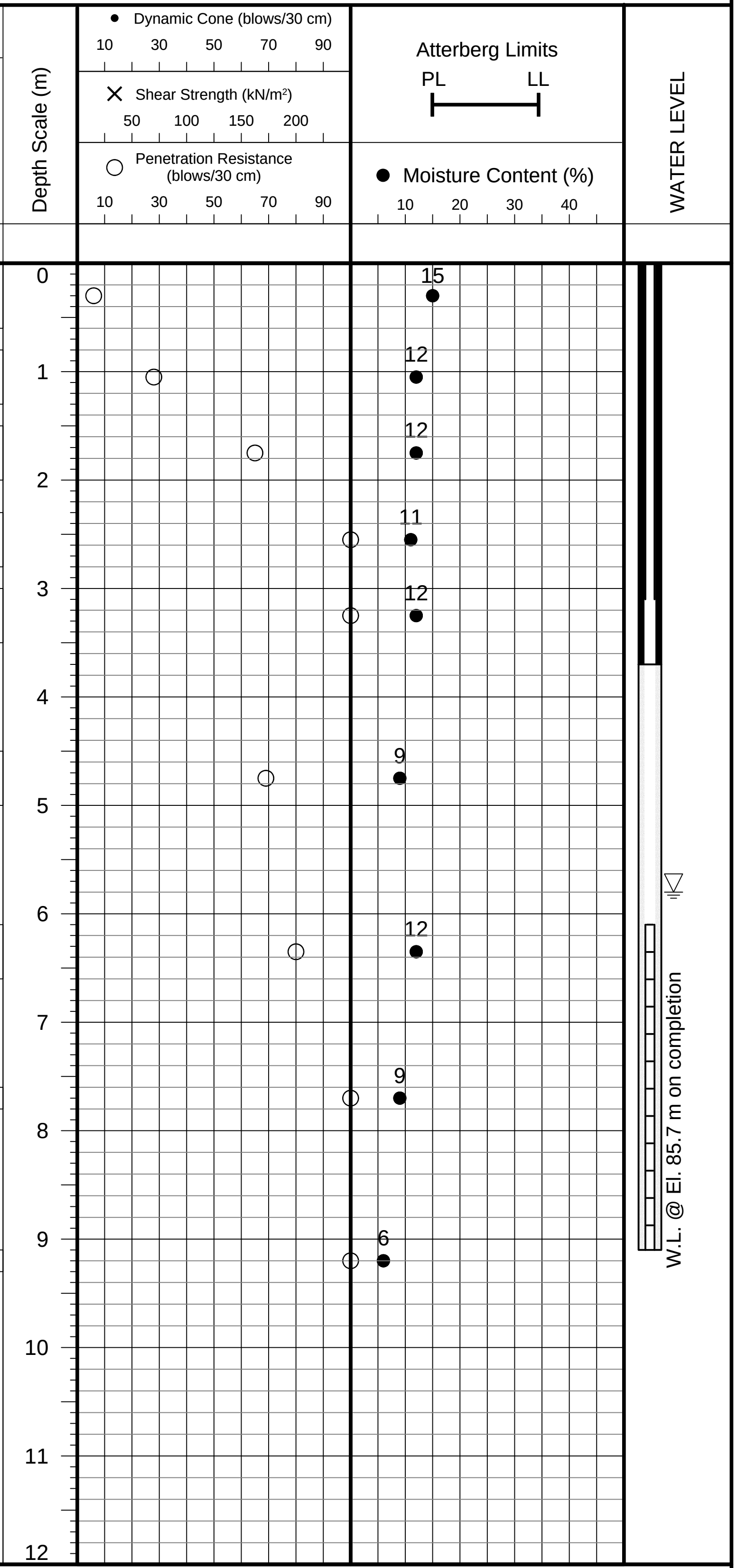
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
91.5	Ground Surface			
0.0	**18 cm TOPSOIL** Brown, firm, weathered **SILTY CLAY**	1	DO	6
90.8 0.7	Brown, compact to very dense **SANDY SILT**	2	DO	28
		3	DO	65
		4	DO	50/13
		5	DO	50/8
87.5 4.0	Brown to reddish-brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	69
		7	DO	80
		8	DO	50/10
83.7 7.8	Reddish-brown **SHALE BEDROCK** (weathered)	9	DO	50/8
82.2 9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring wells to 6.1 m and 9.1 m (nest wells) provided with a steel protective casing			



JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

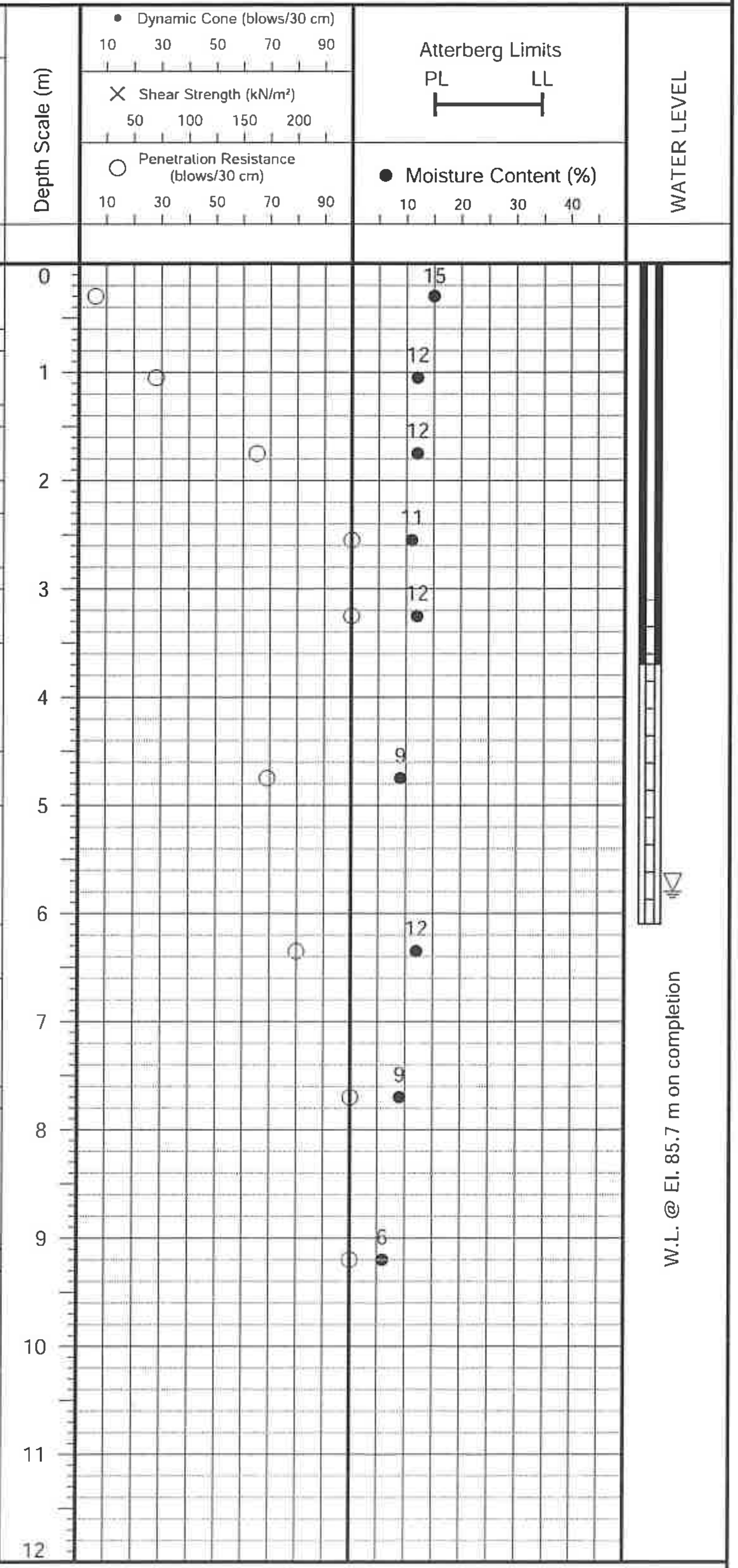
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
91.5	Ground Surface			
0.0	**18 cm TOPSOIL** Brown, firm, weathered **SILTY CLAY**	1	DO	6
90.8 0.7	Brown, compact to very dense **SANDY SILT**	2	DO	28
		3	DO	65
		4	DO	50/13
		5	DO	50/8
87.5 4.0	Brown to reddish-brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	69
		7	DO	80
83.7 7.8	Reddish-brown **SHALE BEDROCK** (weathered)	8	DO	50/10
82.2 9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring wells to 6.1 m and 9.1 m (nest wells) provided with a steel protective casing	9	DO	50/8



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JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

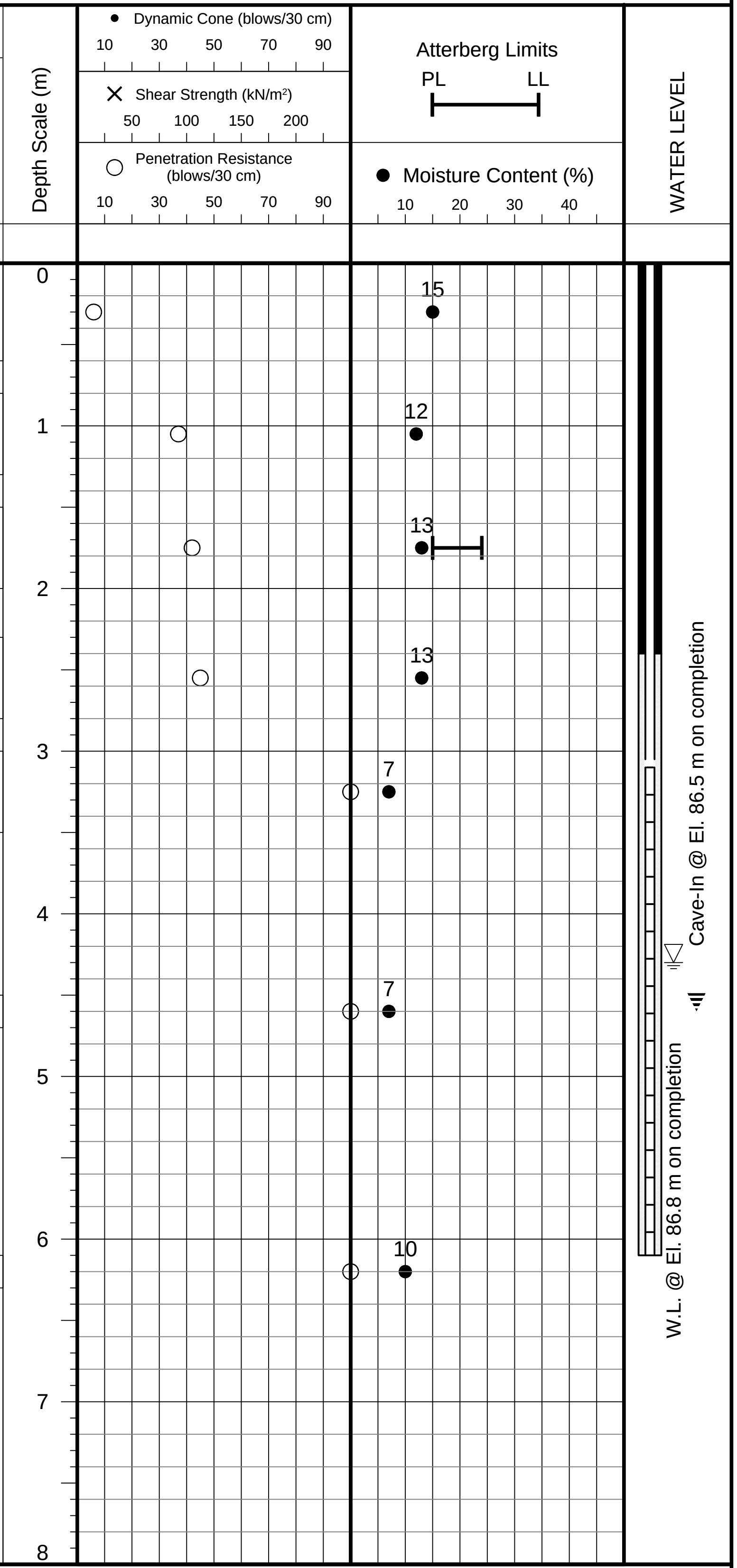
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
91.1	Ground Surface			
0.0	**20 cm TOPSOIL** Brown, firm, weathered **SILTY CLAY**	1	DO	6
90.4 0.7	Brown, hard **SILTY CLAY TILL** occ. wet sand and silt seams and layers, cobbles and boulders	2 3 4	DO DO DO	37 42 45
88.2 2.9	Reddish-brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	5 6	DO DO	50/13 50/15
85.3 5.8	Reddish-brown **SHALE BEDROCK** (weathered)	7	DO	50/8
84.8 6.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m provided with a steel protective casing			



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JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

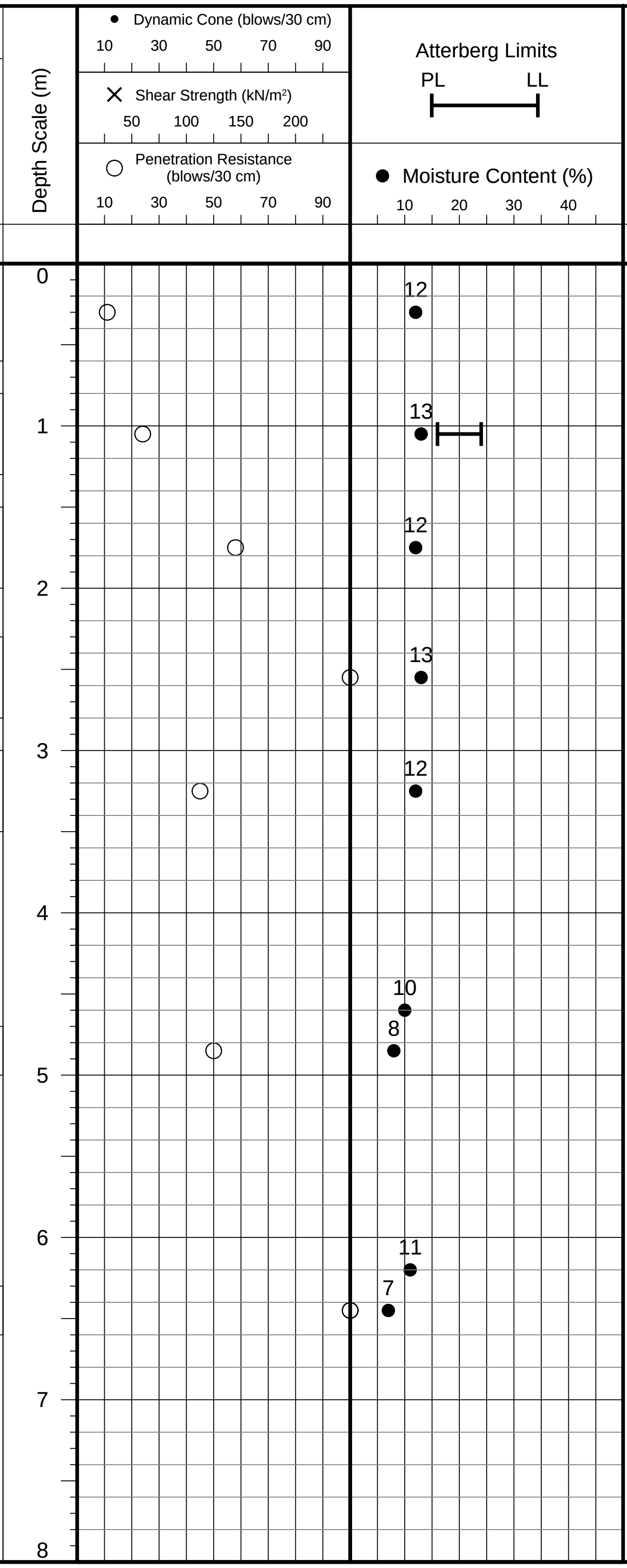
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
91.0	Ground Surface			
0.0	**23 cm TOPSOIL**			
	Brown, stiff, weathered **SILTY CLAY**	1	DO	11
90.3 0.7	Brown, very stiff **SILTY CLAY TILL**	2	DO	24
89.6 1.4	Brown to reddish-brown, dense to very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	58
		4	DO	50/13
		5	DO	45
		6A	DO	
		6B	DO	50
		7A	DO	
84.7 6.3	Reddish-brown **SHALE BEDROCK**	7B	DO	50/13
84.4 6.6	**END OF BOREHOLE**			



WATER LEVEL: Dry on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

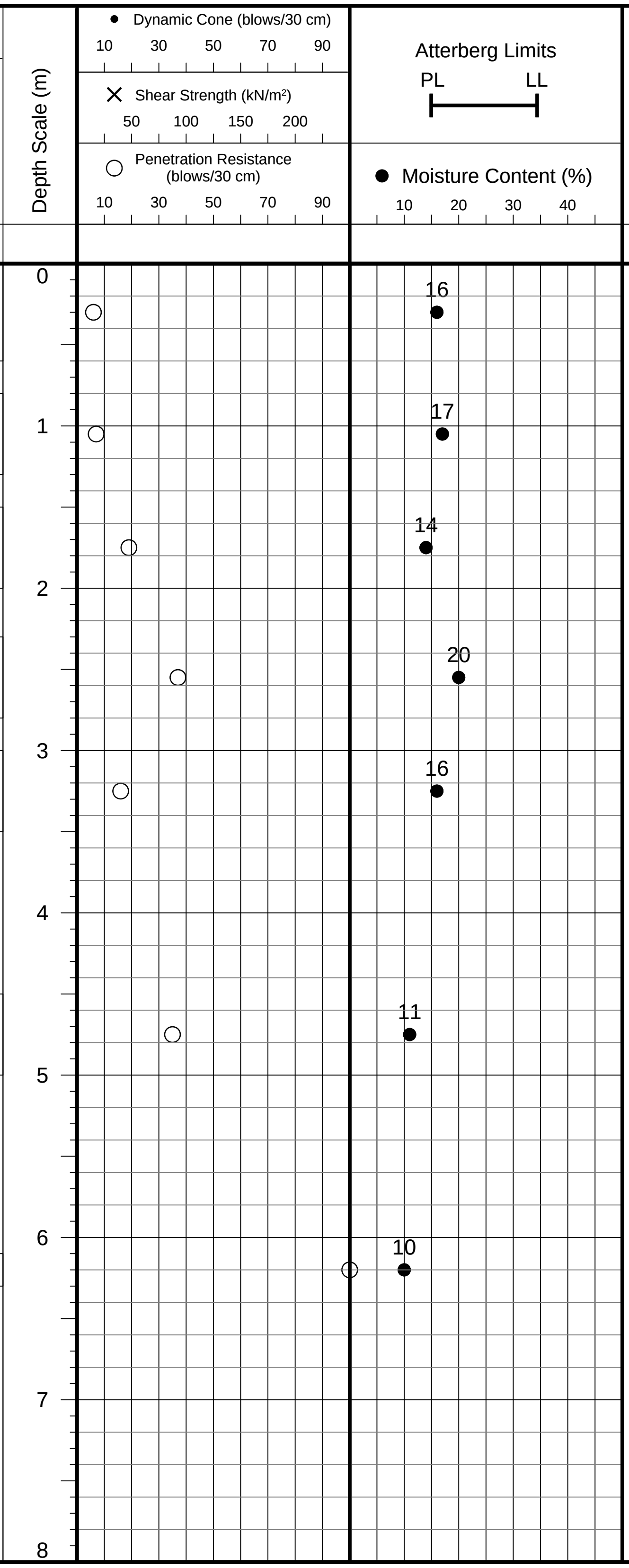
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
90.6	Ground Surface			
0.0	**15 cm TOPSOIL**			
	Brown, firm, weathered **SILTY CLAY**	1	DO	6
		2	DO	7
89.2 1.4	Brown, compact to dense **SANDY SILT**	3	DO	19
		4	DO	37
87.7 2.9	Grey, stiff **SILTY CLAY**	5	DO	16
86.6 4.0	Reddish-brown, dense to very dense **SANDY SILT TILL**	6	DO	35
		7	DO	50/10
84.3 6.3	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 87.6 m on completion

Cave-In @ El. 85.4 m on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

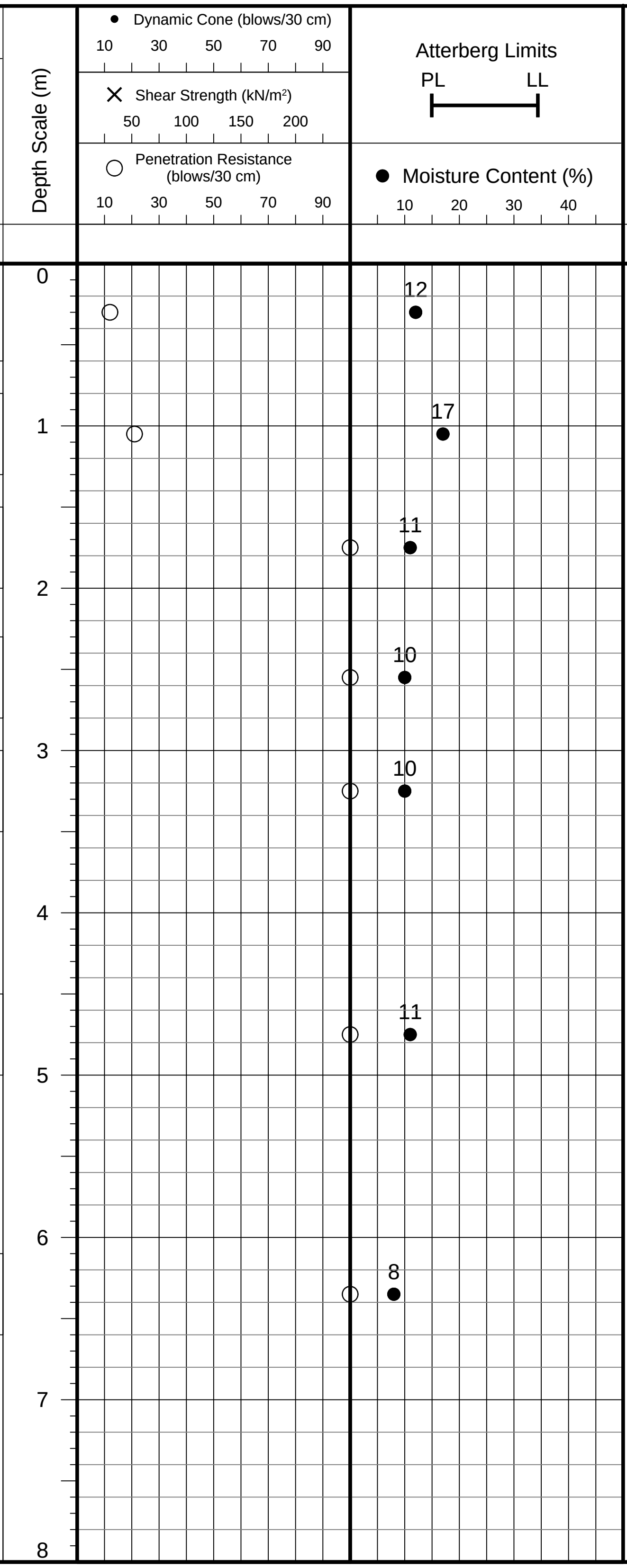
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
90.4	Ground Surface			
0.0	**10 cm TOPSOIL**			
	Brown, stiff to very stiff weathered **SILTY CLAY**	1	DO	12
		2	DO	21
89.0 1.4	Brown, very dense **SANDY SILT**	3	DO	50/13
88.3 2.1	Brown, hard **SILTY CLAY** brown grey occ. wet sand and silt seams and layers	4	DO	50/13
		5	DO	50/13
86.4 4.0	Reddish-brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	50/13
		7	DO	50/13
83.8 6.6	**END OF BOREHOLE**			

WATER LEVEL: Dry on completion



JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

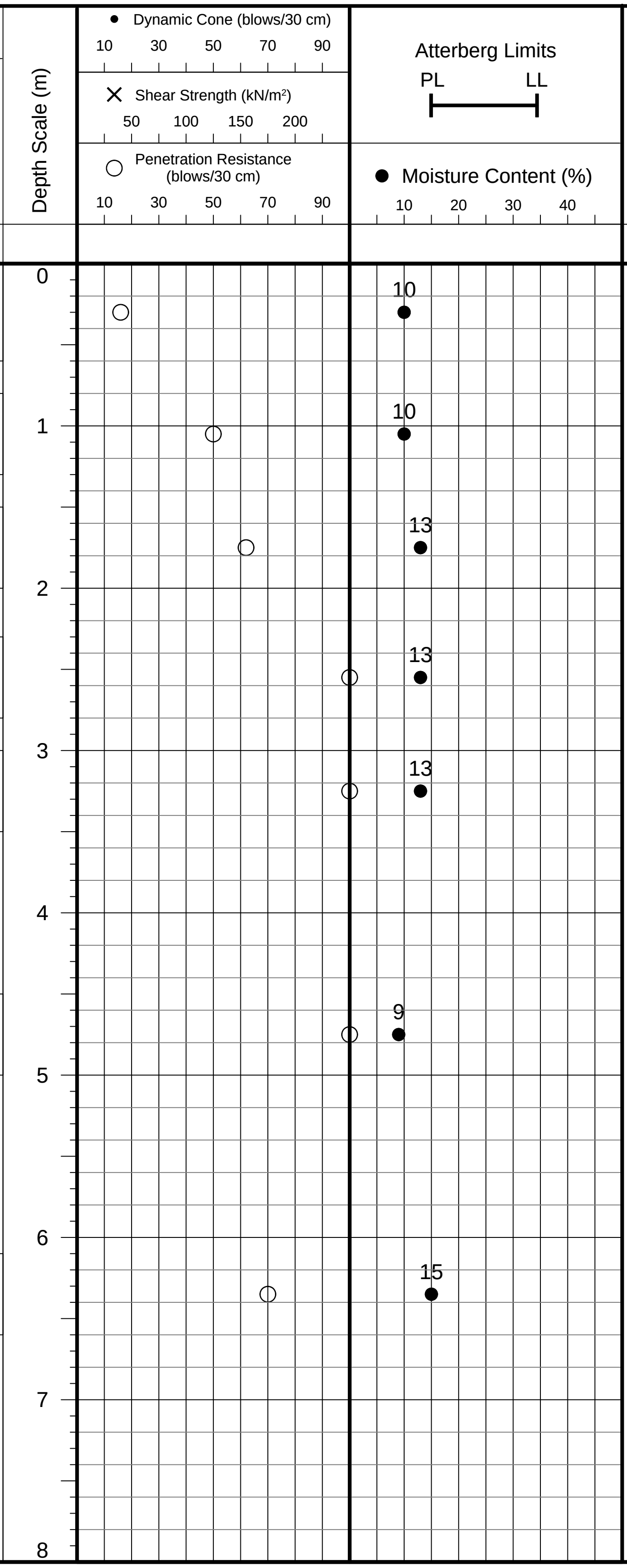
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 15. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
90.4	Ground Surface				
0.0	**8 cm TOPSOIL**				Dry on completion
	Brown, compact to dense **SANDY SILT**	1	DO	16	
		2	DO	50	
89.0 1.4	Brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	62	
		4	DO	50/10	
		5	DO	50/13	
		6	DO	50/10	
		7	DO	70	
83.8 6.6	**END OF BOREHOLE**				



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JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

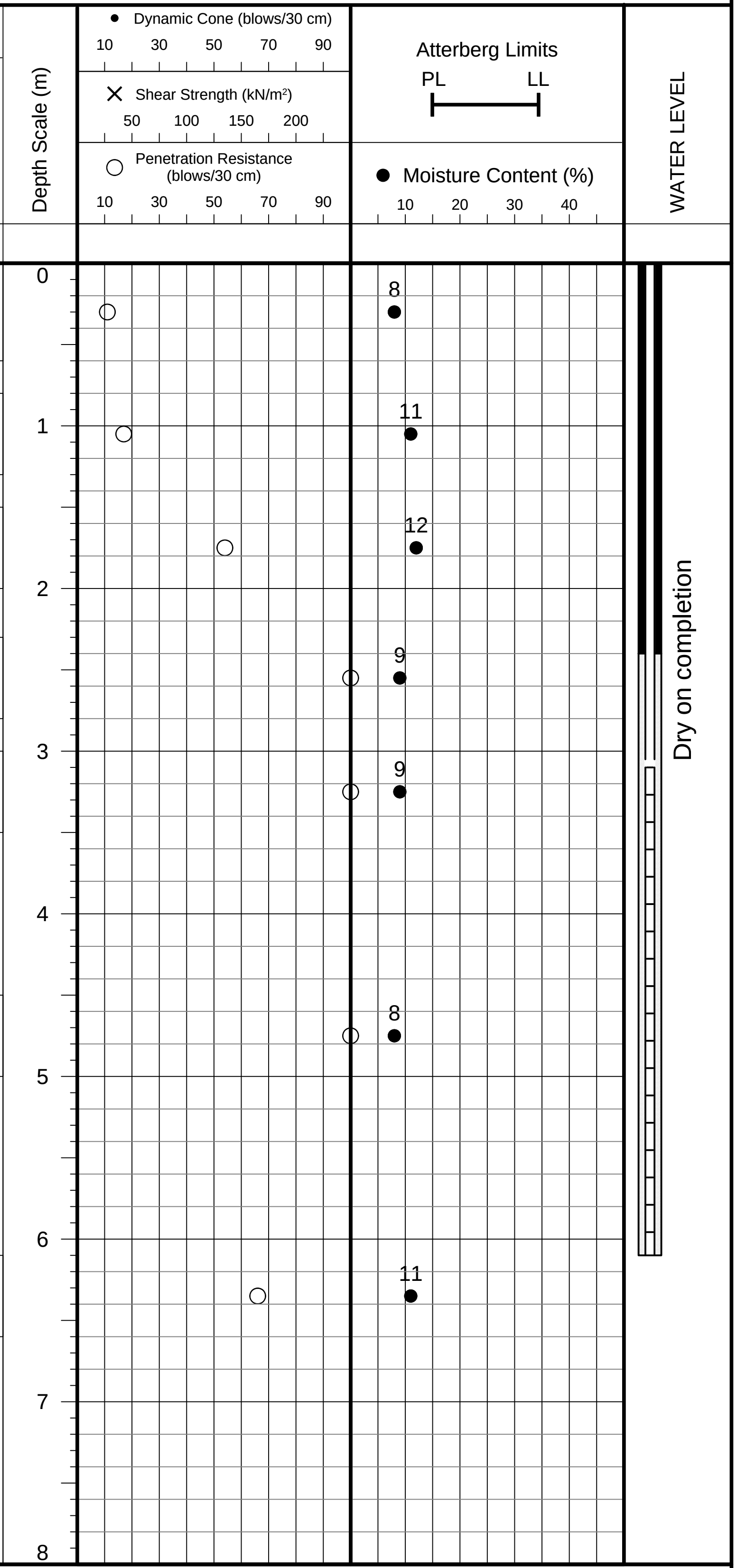
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
90.5	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Brown, compact, weathered **SANDY SILT**	1	DO	11
89.8 0.7	Compact to very dense	2	DO	17
		3	DO	54
		4	DO	50/15
	SANDY SILT TILL occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	50/13
		6	DO	50/13
	brown grey			
		7	DO	66
83.9 6.6	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m provided with a steel protective casing			



JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

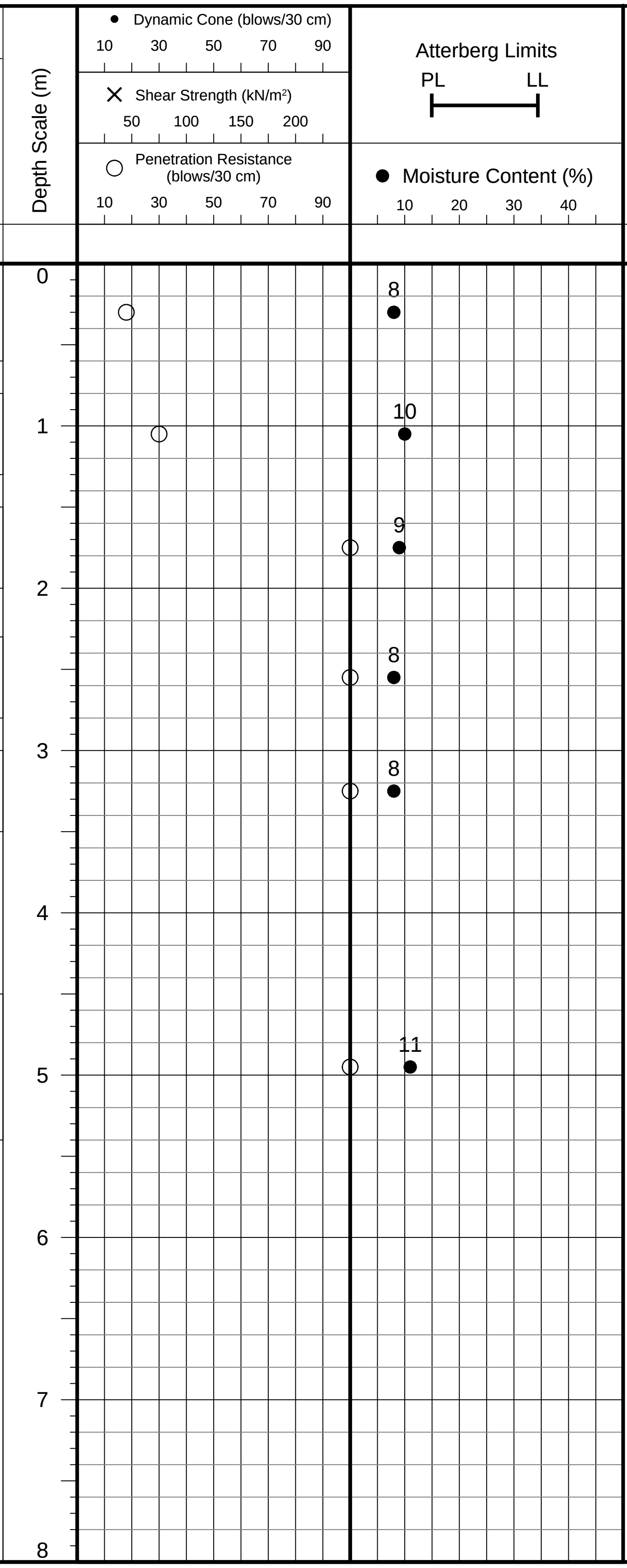
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 15. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
90.3	Ground Surface				
0.0	**15 cm TOPSOIL**				Dry on completion
	Brown **EARTH FILL** sandy silt with rock fragments and brick debris	1	DO	18	
		2	DO	30	
88.9 1.4	Brown to reddish-brown, very dense **SANDY SILT TILL** occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	50/15	
		4	DO	50/13	
		5	DO	50/15	
		6	AS	50/15	
84.9 5.4	**END OF BOREHOLE** **Refusal to augering** **Inferred bedrock or boulders**				



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JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

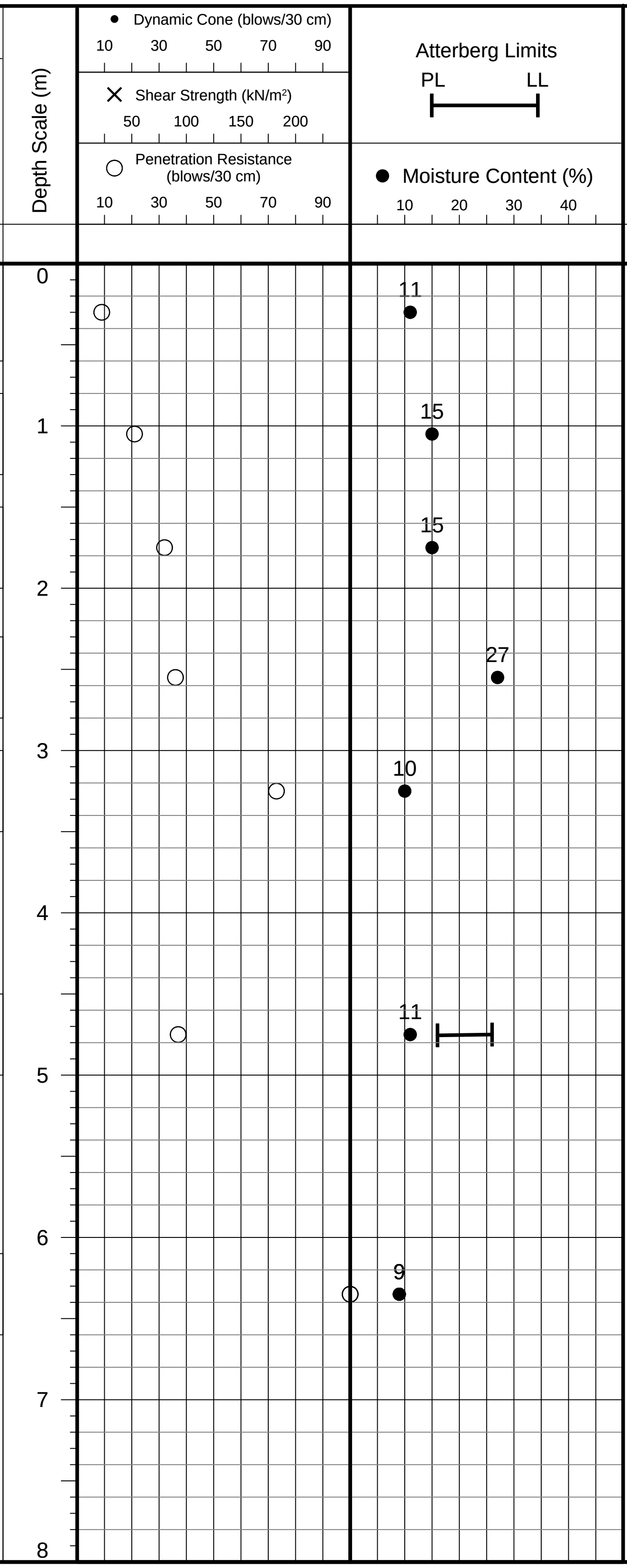
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
90.1	Ground Surface			
0.0	**18 cm TOPSOIL** Brown, loose to dense weathered **SANDY SILT**	1	DO	9
		2	DO	21
		3	DO	32
88.0 2.1	Brown, dense **SANDY SILT TILL**	4	DO	36
87.2 2.9	Grey, hard **SILTY CLAY TILL** occ. wet sand and silt seams and layer, cobbles and boulders	5	DO	73
		6	DO	37
84.3 5.8	Reddish-brown, very dense **SANDY SILT TILL**	7	DO	50/13
83.5 6.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 88.0 m on completion

Soil Engineers Ltd.

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Hotel Block Servicing Brief

SERVICING BRIEF

Two Sisters Resort / Randwood Estate Re-development

144 & 176 John Street
Niagara-on the-Lake, Ontario

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Quartek
Architects • Engineers • Planners • Project Managers

Revd. June 2018

Two Sisters Resort / Randwood Estate Re-development
144 & 176 John Street, Niagara-on the-Lake

Servicing Brief

Contents

Appendices

1. Introduction

This servicing brief serves to demonstrate how servicing of the subject development is intended to be achieved, and addresses the following key aspects of municipal servicing design:

- Water Supply and Distribution
- Sanitary Sewerage
- Drainage and Stormwater Management
- Roadways
- Utility Servicing

This brief should be read in conjunction with the separate stormwater management (SWM) report and Drawings 16332-SSG and 16332-D.

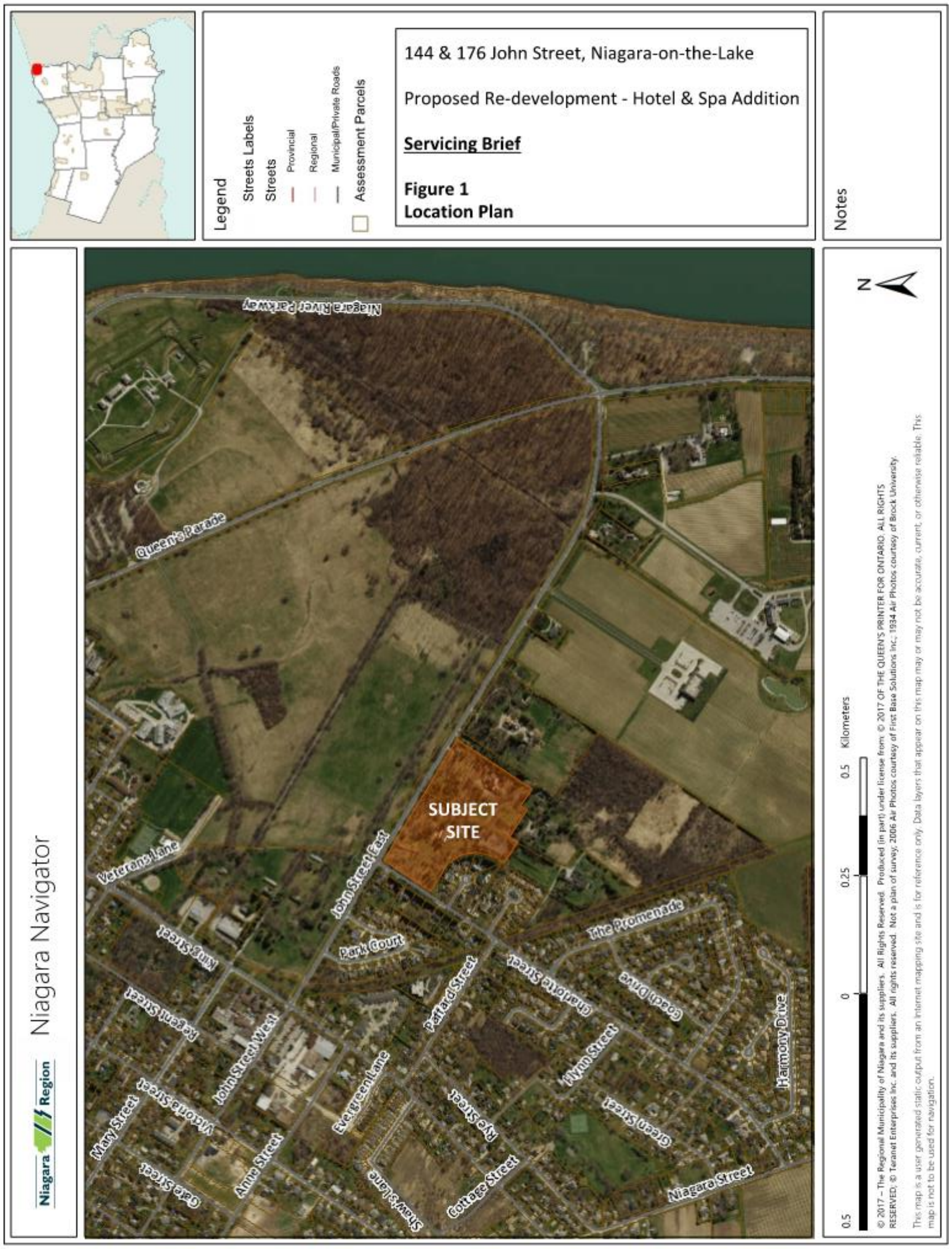
2. Background

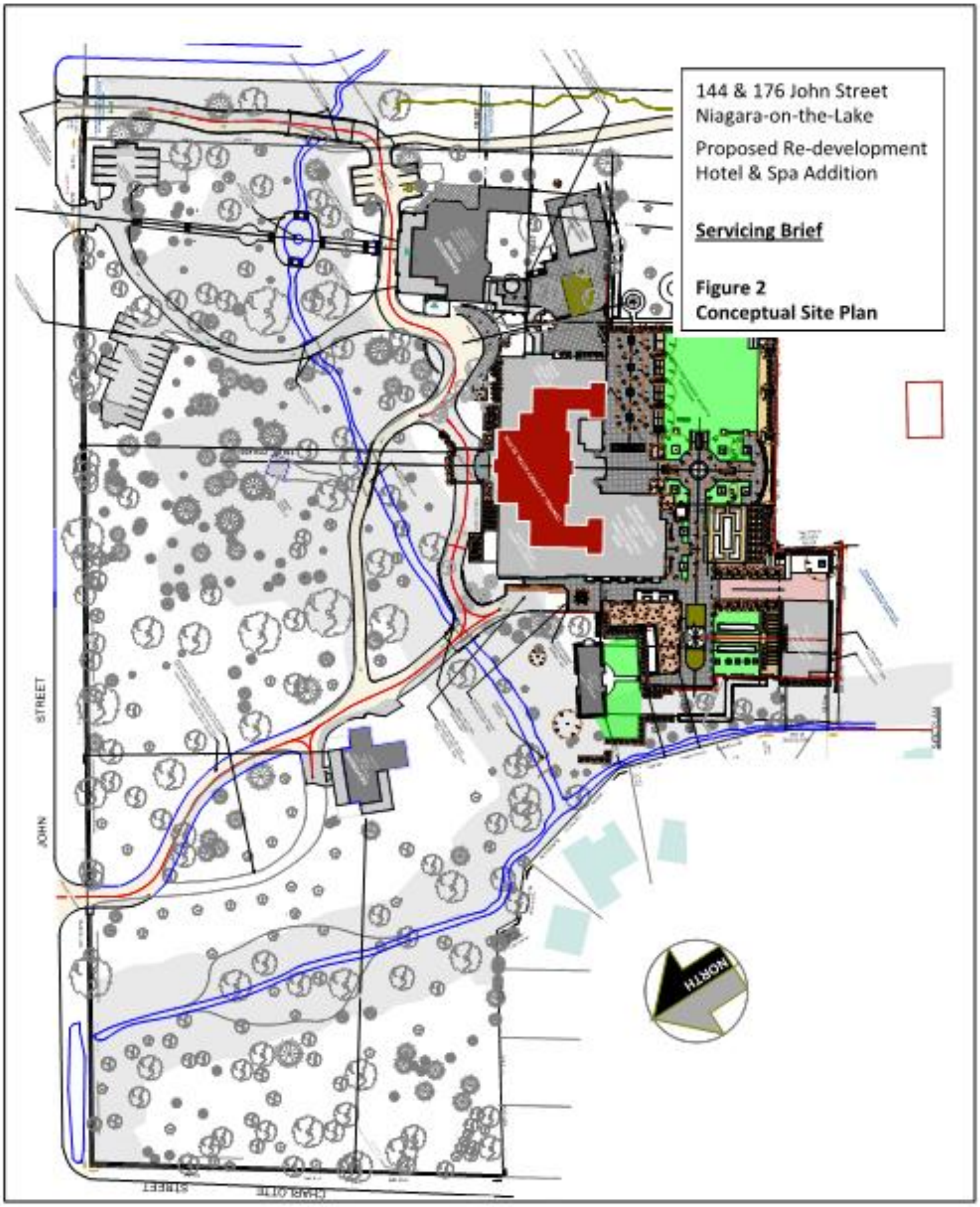
The 5.4 ha (13.3 acre) site, fronting on John Street in Niagara-on-the-Lake, has historically been occupied with a significant estate house. In recent decades this 'house' has had institutional uses such as a school of philosophy. In addition to the original estate house, there is now a smaller guest house known as the 'Devonian' and a coach house which more recently has housed a laundry facility, Servicing for these on-site facilities has evolved over the years and now includes municipal water supply for fire fighting and domestic usage, disposal of sanitary sewage by a system of holding tanks, balancing tanks and pumps, and drainage into on-site watercourses. There is a network of existing paved driveways on site and several small vehicle parking areas.

The development proposal contemplates the addition of a multi-storey hotel building with conference centre and spa facilities. New facilities are to include 145 hotel rooms, conference centre area, day spa and swimming pool. Vehicle parking will be largely underground located on 2-1/2 floors behind (south of) the hotel building. The area to be developed is currently occupied with a vehicle parking lot, a tennis court and grassed area.

It is relevant to an investigation of servicing for this proposed development to note that lands located immediately adjacent to the south, and once forming part of the Rand Estate, are currently designated as 'Residential Built Up Area' within the Town's Official Plan and therefore are contemplated for residential intensification uses. Both the subject lands and the lands adjacent are under the Ownership of the Applicant including a narrow strip of land parallel and adjacent to the multi-use recreational trail which runs NNW-SSE along the former railway. This strip is approximately 6.5 metres (22 feet) wide and has frontage on the east side of Charlotte Street, opposite Paffard Street. Accordingly, various servicing options have been investigated and the recommended serviceability of the site is based on existing services, which in future, can be alleviated through potential, future development immediately adjacent to the Subject Lands.

The site servicing plan, 16332-SSG, and accompanying drawing 16332-D, showing details for the SWM facility and servicing notes, are included in *Appendix A*, at reduced size for convenience and are enclosed in 24x36 format as well. An aerial image, derived from Niagara Navigator® and highlighting the subject property location, is shown as Figure 1 below and the conceptual site plan for the proposed condominium building is shown in Figure 2. Figure 3 presents conceptual elevation views of the proposed building for reference.



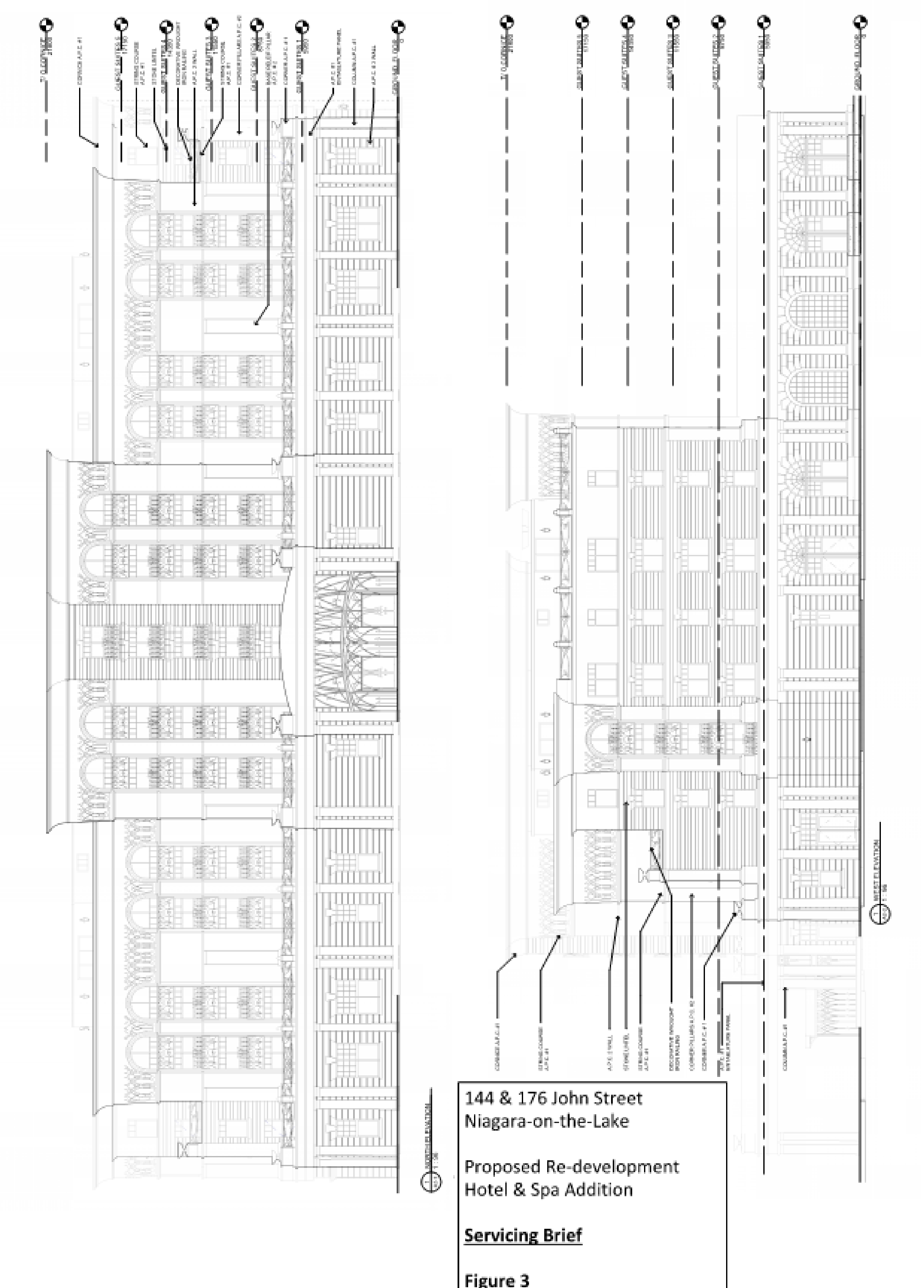


144 & 176 John Street
Niagara-on-the-Lake

Proposed Re-development
Hotel & Spa Addition

Servicing Brief

Figure 2
Conceptual Site Plan



144 & 176 John Street
Niagara-on-the-Lake

Proposed Re-development
Hotel & Spa Addition

Servicing Brief

Figure 3
Conceptual Building Elevations

3. Water Supply and Distribution

There is currently a 150 mm Ø watermain on John Street fronting the property. A 150 mm Ø private watermain on the site connects to the municipal watermain on John Street at 2 locations, creating a looped feed for two (2) existing fire hydrants on the site. Flow tests at hydrants in front of the site indicated a static base pressure of 58 psi. Although this may be adequate for domestic water supply, it is likely that booster pumping will be required to ensure adequate pressure at the upper floors of the proposed hotel building. This will be verified through the detailed building design process.

The flow tests at hydrants in front of 144 John Street and 176 John Street indicated predicted available flow of 2073 USGPM and 2049 USGPM respectively at 20 psi residual pressure. The flow test results are included in Appendix B. As demonstrated in Appendix B, predicted required fire flow for the proposed hotel development is 3.35 L/s. Accordingly, it is expected that municipal water supply on John Street will be adequate for fire fighting. We understand that the new hotel building will be sprinklered. Assuming booster pumping will be required, as indicated above, the booster pumping system must have full redundancy and backup power for fire protection sprinkler operation.

Water supply piping for the new hotel building will be extended from the existing 150 mm Ø private watermain on site, with appropriate isolation and check valves, and metering on the new domestic waterline. Proposed pipe sizes are 150 mm Ø for fire protection into the building to supply the sprinkler system and a 100 mm Ø branch for domestic/potable uses.

Design parameters for water supply and distribution are outlined in Appendix B.

Subject to further review and comment by the Town we expect that there will be no impediments to domestic and fire fighting water supply for the development using currently existing municipal waterworks.

4. Sanitary Sewerage

The existing estate home on the site, having served a number of other uses in the recent past, is serviced by a sewage system that includes a septic tank from which sewage is pumped to a balancing tank at the north-east corner of the property. From there, sewage is pumped through a 50 mm Ø forcemain along John Street to a maintenance hole just east of King Street.

The existing ‘Devonian’ house near the westerly limit of the property has a separate septic tank and pumping chamber located just to the west. It is believed that this building and the prior coach house building, which more recently has housed a laundry facility, are serviced by this septic tank and pumping facility and that the combined sewage is pumped through a 75 mm Ø forcemain to a sanitary sewage maintenance hole on Charlotte Street. However, this has not been confirmed as of the publishing of this report. It is noted that the Charlotte Street sewer flows southerly to Paffard Street and westerly from there.

Calculations of proposed sewage flows included in Appendix C suggest average daily flow for the hotel facility of approximately 60,000 L and a peak design flow 3.52 L/s Having investigated several alternatives for sanitary sewage servicing, including pumping and gravity pipe options, it is proposed to service the subject development using the existing 50 mm (2") Ø forcemain along John Street. The 450 metre length of forcemain results in head losses suggesting the strategic use of a balancing/holding tank to limit the peak pump discharge. The existing holding tank and pump chamber located just west of the existing estate house will require to be abandoned regardless due to their location within the proposed hotel building footprint. It is expected that a new holding tank with a capacity between 5,000 and 10,000 L and a pump chamber with duplex 10-12 hp pumps will be adequate to handle flows from the existing estate house, coach house and new hotel facility using the existing 50 mm (2") Ø forcemain. This tank and pumping facility is to be located within the new hotel building and will be designed and approved as part of the building permit application. It is proposed that the existing 'Devonian' house continue to discharge directly to the Charlotte Street sanitary sewer as it is expected to be onerous to implement gravity sewer to a new holding tank and pump facility at the new hotel building.

We understand from the *Town of Niagara-on-the-Lake King/Charlotte Area Sanitary Sewer Study* (Denco Engineering Ltd., February 1995) that downstream sewers have capacity for a full build-out allocation of 149,500 L/day (domestic sewage plus infiltration allowance) for the subject property. The predicted average daily sewage production is 60,900 L/day and infiltration is expected to be almost non-existent, given that gravity piping will be new, tight, PVC piping, and the rest of the piping is small diameter plastic forcemain. Accordingly, the anticipated average daily flow from the site is only approximately 40% of the sewage allocation for the fully developed property.

As noted in Section 2.0 Background, a residential subdivision is contemplated for the property abutting the subject site to the south. It is anticipated that the gravity sanitary sewer system for this subdivision will outlet to the existing municipal sewer at Charlotte and Paffard Streets. Given the long-term advantages of gravity sewer over pumping solutions related to operational costs, energy usage/costs, failure risks, etc., consideration should be given to an ultimate plan for sanitary sewage servicing for the subject property that consists of gravity sewer connecting to the subdivision sewer system. As the proposed residential development property is also owned by the owner of this subject property, it is considered that servicing of the 2 properties can be coordinated. A check of the sewer invert elevation at the existing receiving maintenance hole indicates that adequate grade exists to facilitate this approach. Thus, it is recommended that this approach be pursued at such time as the residential development is approved and servicing construction scheduled. We note that it may be necessary to continue to pump wastewater from one or more of the *existing facilities* even if a future gravity sewer outletting from the site becomes available.

Subject to further review and comment by the City, we expect that there will be no impediments to sanitary sewer servicing for the development using currently existing municipal sewage works.

5. Drainage and Stormwater Management

Storm drainage and stormwater management are addressed in a separate, accompanying 'Stormwater Management Report', updated June 2018. Observations and findings included in that report are summarized below, along with an overview description of proposed facilities. However, for detailed analysis, reference should be made to that report.

Surface runoff from the subject site currently drains to two (2) branches of One Mile Creek which traverse the site and convey drainage from approximately 55 hectares of upstream lands. One Mile Creek is regulated by the Niagara Peninsula Conservation Authority (NPCA) and regulated flood plain elevations vary from 88.57 metres at the east limit of the site to 86.86 metres where it leaves the site at its north-west corner to run westerly along the south side of John Street.

Rainfall over the parking garage will be collected using a network of landscape catchbasins and perforated tile drains and directed through the underground garage roof deck to the proposed SWM facilities. In addition, roof drainage will be piped to the storage facility after being managed using restricting roof drains.

Flows from storms up to the 100-year return period for the bulk of the site improvement area will be captured before they leave the site. We understand that it will be required to limit peak post-development flows to peak pre-development flow for storms up to the 100-year return period. Storm runoff storage requirements have been calculated based on a 3-hour, 100-year return period design storm.

Stormwater modeling indicate that, in addition to roof storage achieved through the use of flow-restricting roof drains, the proposed increase in impervious coverage will result in a requirement for storage in the range of 228 c.m. This is to be accounted for in a dedicated storage facility prior to outletting to an oil/grit separator and ultimately to the existing creek on site. A below-grade, cast-in-place concrete tank structure is proposed to abut the north-west corner of the proposed underground parking facility. A concrete structure will provide more storage per unit of surface area than a proprietary buried plastic chamber system (eg. Cultec), which will be important given the limited space available in the area of re-development for the hotel and parking garage. A tank with dimensions of 20m x 7m x 1.83m deep is proposed. Detailed structural design and construction will be coordinated with the proposed underground parking facility.

The receiving watercourse (One Mile Creek) is considered by the NPCA to be a Type '3' (Marginal) fish habitat. Accordingly, it is intended to provide water quality treatment consistent with 'Basic' level of protection in accordance with MOECC best stormwater management practices. This will require 60% total suspended solids (TSS) removal on an annual basis and associated total phosphorous and nitrogen removal. Given the limited site area available at grades above the regulated flood plain, it is recommended that water quality treatment be provided through the use of an oil/grit separator device HydroGuard® (Hydroworks) or Stormceptor® (Imbrium Systems). Based on the overall catchment area and proposed impervious area, a, HydroGuard HG5 or equivalent unit is proposed.

Major system design will ensure that all opportunities for directing surface flows to on-site facilities without impacting adjacent private properties are employed. This will include good grading practice, use of curbs, etc. However, it is noted that the intent is to capture runoff from the 100-year return period storm.

Subject to further review and comment by the Town and/or NPCA, and subject to detailed design once the site plan is finalized for site plan application purposes, we expect that there will be no impediments to storm drainage servicing for the development.

6. Site Grading

Site grading will generally be carried out to Town of Niagara-on-the-Lake standards. It is anticipated that the proposed hotel building will respect the existing ground grade as it is intended to utilize existing driveways and provide pedestrian linkage with the existing estate house. The underground parking garage will be accessed by vehicles to the west of the hotel building and the surface grades above will be generally slightly below the grade at the hotel. There may be some opportunities for grade modifications at the south limit of the subject property facilitating future access from the proposed subdivision. However, this is not necessarily required and will occur subject to the timing of approvals, design and construction of that subdivision.

It is noted that most of the area over the underground parking facility is proposed to be essentially level, with roof drains built into the drainage membrance associated with the roof of the parking garage structure. These drains will be piped inside the parking garage to the stormwater management detention tank. Accordingly, no fixed grading is indicated on the proposed site servicing and grading plan.

7. Road Access, Parking and Driveway

Vehicular access/egress, other transportation issues and the potential for external improvement requirements are dealt with in a Traffic Impact Study prepared by others and submitted under separate cover. Drawing 16332-CSS shows a network of existing and proposed on-site driveways providing access to building entrances, delivery doors, garbage facilities and the proposed underground parking garage. Apart from some accessible, registration and valet parking spots above grade, vehicle parking will be provided at below-grade level the proposed underground parking garage located to the south of the hotel building.

Prepared by:

Doug Peters, P. Eng.
President

REGISTERED PROFESSIONAL ENGINEER
D. K. PETERS
12 Jun 2018
PROVINCE OF ONTARIO

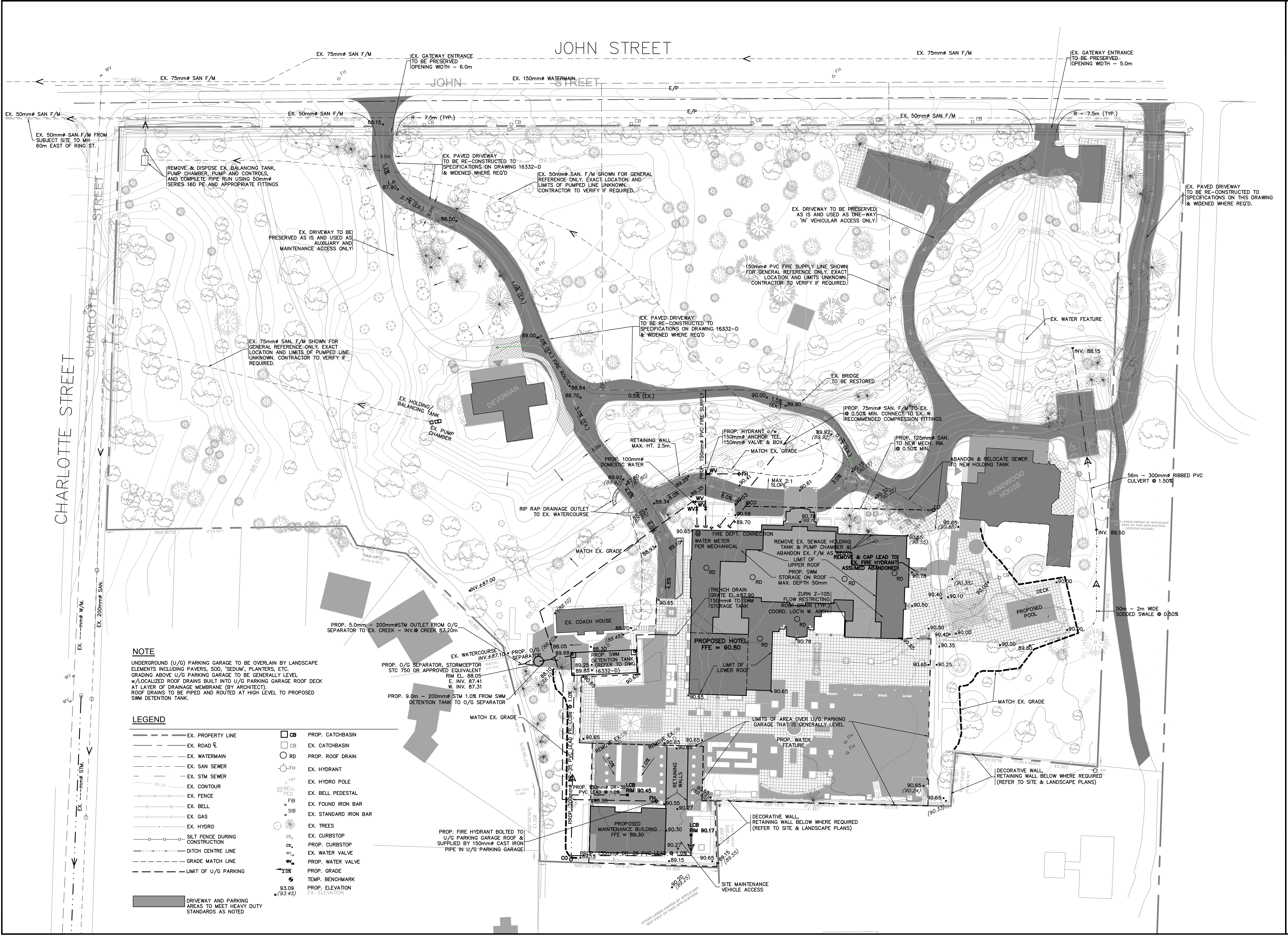
Functional Servicing Report

Two Sisters Resort /
Randwood Estate Re-development

144 & 176 John Street
Niagara-on the-Lake, Ontario

APPENDIX A

Site Servicing Drawings



NOTE

UNDERGROUND (U/G) PARKING GARAGE TO BE OVERLAIN BY LANDSCAPE ELEMENTS INCLUDING PAVERS, SOD, 'SEDUM', PLANTERS, ETC.
GRADING ABOVE U/G PARKING GARAGE TO BE GENERALLY LEVEL w/LOCALIZED ROOF DRAINS BUILT INTO U/G PARKING GARAGE ROOF DECK AT LAYER OF DRAINAGE MEMBRANE (BY ARCHITECT).
ROOF DRAINS TO BE PIPED AND ROUTED AT HIGH LEVEL TO PROPOSED SWM DETENTION TANK.

LEGEND

- EX. PROPERTY LINE
- EX. ROAD ℄
- EX. WATERMAIN
- EX. SAN SEWER
- EX. STM SEWER
- 80.50 EX. CONTOUR
- EX. FENCE
- EX. BELL
- EX. GAS
- EX. HYDRO
- SILT FENCE DURING CONSTRUCTION
- DITCH CENTRE LINE
- GRADE MATCH LINE
- LIMIT OF U/G PARKING
- ▨ DRIVEWAY AND PARKING AREAS TO MEET HEAVY DUTY STANDARDS AS NOTED

CB	PROP. CATCHBASIN
CB	EX. CATCHBASIN
RD	PROP. ROOF DRAIN
FH	EX. HYDRANT
HP	EX. HYDRO POLE
BELL PED	EX. BELL PEDESTAL
FIB	EX. FOUND IRON BAR
SIB	EX. STANDARD IRON BAR
	EX. TREES
CS	EX. CURBSTOP
CS	PROP. CURBSTOP
WV	EX. WATER VALVE
WV	PROP. WATER VALVE
2.0%	PROP. GRADE
	TEMP. BENCHMARK
93.09	PROP. ELEVATION
(93.45)	EX. ELEVATION

FOR SERVICING & GRADING NOTES
REFER TO DWG. 16332-D

issue	issued for	date	init.
C	SITE PLAN AGREEMENT	12 JUN 2018	BRHJ
B	SITE PLAN AGREEMENT	31 OCT 2017	JL
A	CLIENT REVIEW	30 OCT 2017	JL

seal

D. K. PETERS
12 Jun 2018

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◆ Engineers ◆ Project Managers
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TWO SISTERS
Resorts

project title

RANDWOOD HOTEL
RESORT

JOHN STREET, NIAGARA-ON-THE-LAKE

drawing title

SITE SERVICES AND
GRADING PLAN

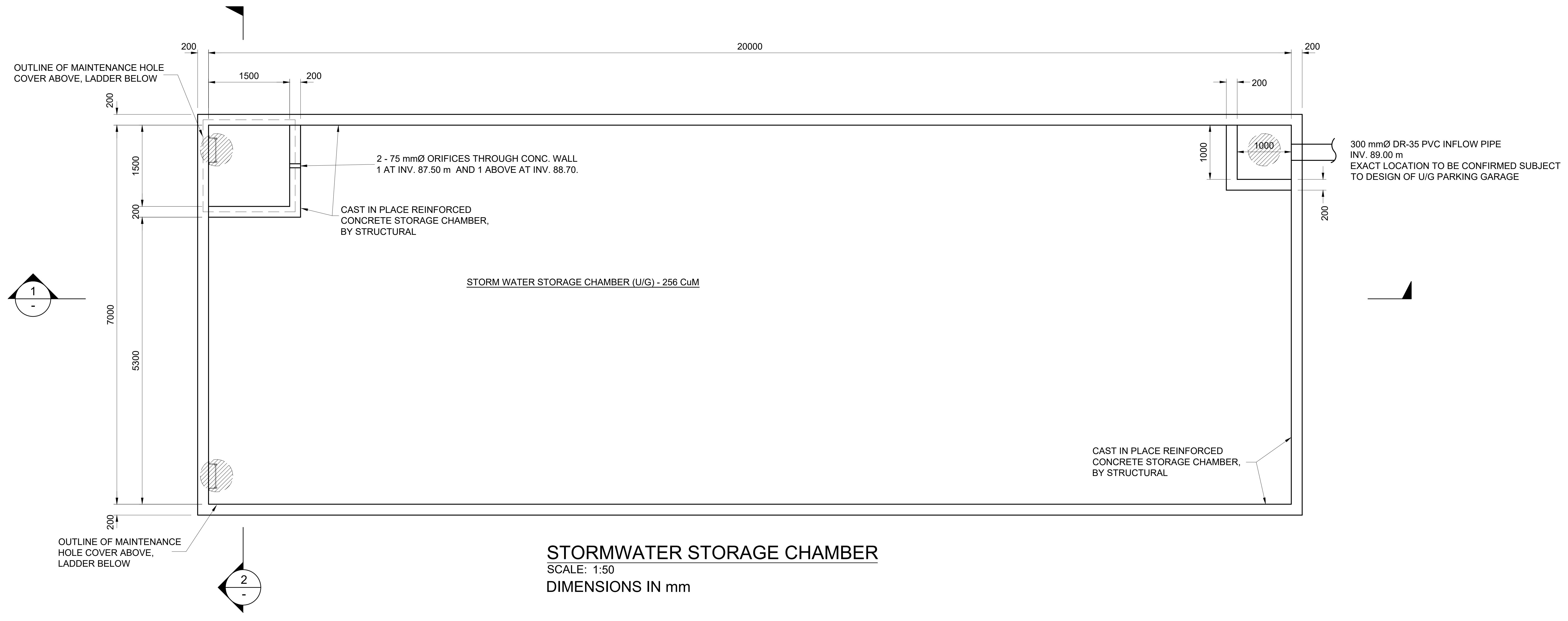
drawn by	designed by
JTB	HEK
scale	date
1:300	14 Jun 2018
job number	issue
16332	C

drawing number
16332-SSG

P:\2016 Projects\16332 Randwood Hotel Resort - Solmar\Drawings\Civil\16332-BP2.dwg drawing tab: 16332 SSG

plotted by: bjackson on Jun 14, 2018 - 3:37pm

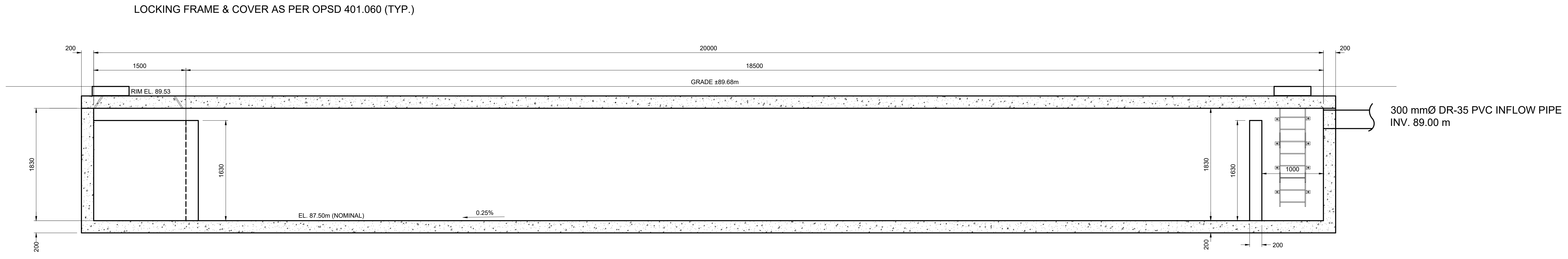
24"x36" Metric



STORMWATER STORAGE CHAMBER

SCALE: 1:50

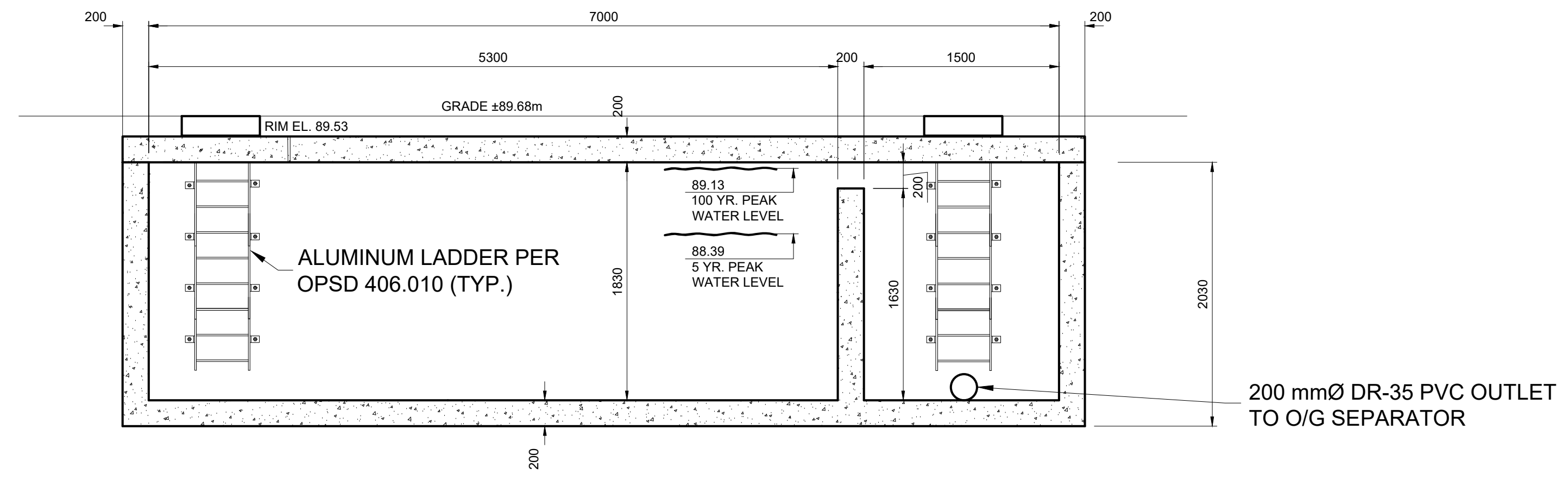
DIMENSIONS IN mm



SECTION 1

SCALE: 1:50

DIMENSIONS IN mm



SECTION 2

SCALE: 1:50

DIMENSIONS IN mm

GENERAL

1. LOCATION AND SIZE OF EXISTING UTILITIES WAS DERIVED FROM QUARTEK TOPOGRAPHIC SURVEY VARIOUS DRAWINGS FROM OTHERS. THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES ARE NOT NECESSARILY SHOWN AND, WHERE SHOWN, THE ACCURACY OF THE LOCATION SHOWN OF SUCH UTILITIES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL CONTACT ALL SUCH UTILITIES INVOLVED AND INFORM HIMSELF AS TO THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME LIABILITY FOR DAMAGE TO THEM. CONTRACTOR TO REPORT ANY CONFLICTS OR DISCREPANCIES WITH THIS DRAWING TO THE ENGINEER IMMEDIATELY.
2. ALL MEASUREMENTS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL WORK SHALL BE IN ACCORDANCE WITH THE RELEVANT SECTIONS OF THE TOWN MUNICIPAL ENGINEERING STANDARDS, THE ONTARIO PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS, AND THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT (NPSCD) UNLESS OTHERWISE NOTED ON THE DRAWINGS OR IN THE SPECIFICATIONS.
4. COMPUTER DRAWING FILE CO-ORDINATES FOR THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION LAYOUT UNLESS SPECIFICALLY DIRECTED BY THE ENGINEER.
5. ALL GRANULAR MATERIAL SHALL BE COMPACTED TO 100% STANDARD PROCTOR DENSITY AND ALL NATIVE BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR DENSITY UNLESS OTHERWISE NOTED.
6. ALL CONSTRUCTION SHALL BE CARRIED OUT IN SUCH A WAY THAT SILTATION OR OTHER DAMAGE TO WATER COURSES DOES NOT OCCUR. THE REQUIREMENTS OF THE MINISTRY OF NATURAL RESOURCES ARE TO BE ADHERED TO IN THIS RESPECT. AT A MINIMUM, PROVIDE SILT FENCE AND STABILIZED CONSTRUCTION ACCESS AND MAINTAIN SAME FOR DURATION OF CONSTRUCTION.
7. ALL EXCAVATION IN EXISTING ROADWAYS OR OTHER PAVED SURFACES SHALL BE BACKFILLED WITH GRANULAR 'A' COMPACTED TO 100% SPD. MINIMUM
8. PROPOSED GRADES SHALL NOT ADVERSELY AFFECT ADJACENT PROPERTIES.
9. REFER TO SITE PLAN FOR SITE DIMENSIONS.
10. ALL AREA OF DISTURBED SOIL SHALL BE STABILIZED AND RE-VEGETATED WITH A NATIVE SEED MIX IMMEDIATELY UPON COMPLETION OF WORK AND RESTORED TO A PRE-DISTURBED STATE OR BETTER.

WATER SUPPLY

11. CONTRACTOR SHALL OBTAIN EXPLICIT APPROVAL FROM TOWNSHIP OF NIAGARA ON THE LAKE WATER DEPARTMENT PRIOR TO MAKING A CONNECTION TO THE EXISTING WATERMAIN. TOWN STAFF TO OPERATE ALL EXISTING MUNICIPAL WATER VALVES.
12. A MINIMUM CLEAR HORIZONTAL SEPARATION OF 2.5m SHALL BE MAINTAINED BETWEEN ANY SEWER & ANY PARALLEL WATERMAIN. A MINIMUM CLEAR VERTICAL SEPARATION OF 0.15m IF W/M CROSSING OVER SAN. A MINIMUM OF 500mm VERTICAL CLERANCE SHALL BE PROVIDED BETWEEN WATERMAIN AND SANITARY SEWER PIPES. MINIMUM DEPTH OF COVER OVER WATERMAINS TO BE 1.7m, EXCEPT AS REQUIRED TO CONNECT TO EXISTING WATERMAIN.
13. WATERMAINS & SERVICES SMALLER THAN 150mmø SHALL BE TYPE 'K' SOFT COPPER OR MUNICIPEX OR APPROVED EQUIVALENT. MINIMUM FINISHED COVER OVER WATERMAINS & SERVICES SHALL BE 1.7m UNLESS OTHERWISE INDICATED.
14. ALL WATER SUPPLY AND DISTRIBUTION PIPING SHALL BE FLUSHED, PRESSURE TESTED & DISINFECTED IN ACCORDANCE WITH OPSS 441 & NPSCD SPC-D13 UNDER THE DIRECTION OF THE TOWN'S ENGINEERING PERSONNEL & TO THE SATISFACTION OF THE TOWN DIRECTOR OF PUBLIC WORKS.
15. FOR ALL NON-METALLIC WATERMAINS AND SERVICES, 8-GAUGE COPPER TRACING WIRE SHALL BE INSTALLED ALONG THE CROWN AT 3mm INTERVALS ALONG ITS ENTIRE LENGTH, ALONG HYDRANT LEAD AND EXTENDED ABOVE EXPOSED FLANGE AT HYDRANT.
16. ALL EXISTING HYDRANTS ON SITE TO BE INSPECTED BY QUALIFIED PERSONNEL AND REPLACED IF NOT COMPLIANT WITH CURRENT MUNICIPAL AND C.S.A. STANDARDS, AND OPSS 1105.010

ROADS AND EARTHWORKS

17. FILL FOR ROADWAY AND PARKING AREAS TO BE CONSTRUCTED IN ACCORDANCE WITH OPSS 201 IN 200mm THICK LIFTS, USING SUITABLE NATIVE EXCAVATED OR IMPORTED MATERIAL APPROVED BY CONTRACT ADMINISTRATOR AND GEOTECHNICAL ENGINEER. THE SUBSOIL BELOW ANY ROADWAY OR PARKING AREA SHALL BE COMPACTED, PROOF ROLLED AND INSPECTED BY THE GEOTECHNICAL ENGINEER OR HIS DESIGNATE PRIOR TO THE PLACEMENT OF ANY GRANULAR MATERIAL.THE UPPER 1.0m BELOW ANY RIGID OR PAVED SURFACE SHALL BE COMPACTED TO 100% SPD MIN.
18. WHERE DISTURBED OR DAMAGED, REINSTATEMENT OF EXISTING ROADS SHALL COMPLY WITH THE REQUIREMENT OF THE ROAD AUTHORITY. PAVEMENT REINSTATEMENT SHALL COMPLY WITH OPSD 509.010 AND OPSS 310.
19. CONCRETE CURBS WHERE SPECIFIED, TO COMPLY WITH OPSD 600.110 AND OPSS.MUNI 353.
20. SUBDRAIN TO BE 100mmø HDPE PERFORATED FILTER-WRAPPED TILE, PER OPSD 216.021, DISCHARGING TO AN EXISTING DITCH OR OTHER DRAINAGE OUTLET.
21. MINIMUM ASPHALT AND GRANULAR THICKNESS FOR NEW AND WIDENED DRIVEWAYS AND PARKING AREAS PER OPSS 310 & 314 AS FOLLOWS:

	HEAVY DUTY	LIGHT DUTY
SURFACE COURSE	40mm HL3	40mm HL3
BINDER COURSE	65mm HL8	50mm HL8
GRANULAR BASE	150mm GRAN. 'A'	150mm GRAN. 'A'
GRANULAR SUBBASE	350mm GRAN. 'B'	200mm GRAN. 'B'
TOTAL THICKNESS	605mm	440mm

22. AREAS TO BE SODDED SHALL INCLUDE MINIMUM 75mm TOPSOIL PER OPSS 802 AND NPSCD SPC-B21. SOD TO BE IN ACCORDANCE WITH OPSS 803 AND NPSCD SPC-B21. NATIVE BACKFILLED AREAS TO BE SODDED SHALL BE FREE OF GRANULAR PARTICLES OR OTHER MATERIALS DELETERIOUS TO PLANT GROWTH.

SEWERS

23. ALL SEWERS, LEADS AND LATERALS SHALL HAVE CLASS 'B' BEDDING PER OPSD 802.010, GRANULAR 'A' COVER MATERIAL AND SELECT NATIVE BACKFILL UNLESS OTHERWISE NOTED.
24. ALL STORM SEWERS AND CATCHBASIN LEADS TO BE CONCRETE, CLASS III PER CSA A257.2 WITH CLASS "B" BEDDING TO OPSD 802.030 OR PVC DR-35 PER CSA 182.1 WITH GRANULAR 'A' BEDDING TO OPSD 802.010 UNLESS OTHERWISE NOTED.
25. SEWER MAINTENANCE HOLES SHALL BE PRECAST CONCRETE PER OPSD 701.010 WITH FRAME & COVER PER OPSD 401.010 TYPE 'A', AND SHALL COMPLY WITH TOWNSHIP MUNICIPAL ENGINEERING STANDARDS, INCLUDING WATERPROOFING AND INSTALLATION OF A RAIN DISH.
26. OIL GRIT SEPARATOR TO BE STORMCEPTOR® STC750 OR APPROVED EQUIVALENT, CAPABLE OF ACHIEVING 70% tss REMOVAL FOR TOTAL CATCHMENT AREA OF 1.16ha AND 82% IMPERVIOUS AREA, AND A BY-PASS FLOW FOR 100-YR RETURN PERIOD STORM OF 0.018cms.
27. LANDSCAPE CATCHBASINS TO BE NDS MODEL NDS900, 9" (225mm) SQUARE, OR APPROVED EQUIVALENT, WITH MODEL 990 GRATES IN NON-VEHICULAR AREAS AND MODEL 1210 GRATES IN VEHICULAR TRAFFIC AREAS. OUTLETS TO BE 3" (75mm) WITH 90° BEND DOWN THROUGH U/G PARKING GARAGE CONCRETE ROOF DECK.
28. FLOW RESTRICTING ROOF DRAINS TO BE ZURN Z105 N-1 (1-NOTCH), OR APPROVED EQUIVALENT.
29. OIL/GRIT SEPARATOR TO BE HYDROWORKS HG-5 OR APPROVED EQUIVALENT.

issue	issued for	date	init.
C	SITE PLAN APPROVAL	12 JUN 2018	WE
B	SITE PLAN APPROVAL	31 OCT 2017	WE
A	REVIEW	30 OCT 2017	WE

seal

D. K. PETERS
12 Jun 2018

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www.quartekgroup.com

TWO SISTERS
Resorts

project title

RANDWOOD HOTEL RESORT

JOHN STREET, Niagara-on-the-Lake

drawing title

SITE SERVICES AND GRADING DETAILS

drawn by
WE

designed by
DP

scale
AS NOTED

date
2017-11-03

job number
16322

issue
C

drawing number
16332-D

P:\2016 Projects\16332 Randwood Hotel Resort - Solmar\Drawings\Civil\16332 Stormwater Storage Chamber.dwg drawing tab: 16332-D

plotted by: bjackson on Jun 14, 2018 - 3:38pm

Functional Servicing Report

Two Sisters Resort / Randwood Estate Re-development

144 & 176 John Street
Niagara-on the-Lake, Ontario

APPENDIX B

Domestic Water Supply and Fire Flow Calculations

Servicing Brief

APPENDIX B – Domestic Water Supply Calculations

Design Parameters for Water Supply and Distribution

No. of Hotel/Residential Units	145 equivalent rooms
Design Flow per Room	300 L/day
Conference Centre Occupancy	515
Design Flow per Seat	30 L/day
Restaurant Occupancy	60 seats
Design Flow per Restaurant Seat	300 L/day
Estimated Day Spa Demand	4,500 L/day
Average Domestic Water Demand	**81,450 L/day**
Maximum Day Peaking Factor	4
Maximum Day Flow	**3.77 L/s**
Peak Design Flow Peaking Factor	5
Peak Flow	**4.71 L/s**
Fire Flow Min. Residual Pressure	20 psi (14.1 m head)
Max-Day Minimum Residual Pressure	40 psi (28.2 m head)
Hazen-Williams ‘C’	120
Design Pipe Specification	PVC, CIOD, DR-18, CL235

Pressure Drop for Peak Domestic Water Flows

Minimal elevation head from the municipal main to buildings on site is assumed. Elevation head loss to 6th floor of hotel building = 175 kPa (25.5 psi)

Using Hazen-Williams, friction (velocity) head losses are as follows:

- through existing 150 mm Ø ‘fire’ main: ½ design flow, or 1.72 L/s through each of 2 legs of 91m length; resulting head loss = 0.1 kPa (0.02 psi)
- through proposed 150 mm Ø ‘fire’ main: design flow of 4.71 L/s over 37m length; resulting head loss = 0.3 kPa (0.04 psi)
- through proposed 100 mm Ø ‘domestic’ service: design flow of 4.71 L/s over 55m length; resulting head loss = 3.1 kPa (0.43 psi)

Total friction head loss at peak design flow = 3.5 kPa (0.49 psi)

Thus, total anticipated pressure drop at peak design flow to 6th floor = 179 kPa (26 psi)

Static pressures at hydrants on John Street opposite the site are understood to be 58-59 psi. Applying the total pressure drop above results in residuals of 32 psi.

Fire Flows

New hotel building to be sprinklered, with appropriate design at time of building permit application.

Functional Servicing Report

Two Sisters Resort /
Randwood Estate Re-development

144 & 176 John Street
Niagara-on the-Lake, Ontario

APPENDIX C

Sanitary Sewage Calculations

Two Sisters Resort / Randwood Estate Redevelopment
144 & 176 John Street, Niagara-on the-Lake

Servicing Brief

Appendix C - Sanitary Sewer Design Calculations

Design Parameters for Sanitary Sewer Servicing

No. of Hotel/Residential Units	145
Design Flow per Room	300 L/day
Conference Centre Occupancy	515
Design Flow per Conference Attendee	30 L/day
Restaurant Occupancy	60 seats
Design Flow per Restaurant Seat	300 L/day
Estimated Day Spa Demand	4,500 L/day
Average Domestic Sewage Flow	**81,450 L/day**
Peaking Factor	4.5
Peak Domestic Sewage Flow	**4.24 L/s**
Infiltration allowance (2 ha @ 0.10 L/s/ha)	**0.20 L/s**
TOTAL PEAK DESIGN FLOW	**4.44 L/s**

Available Grade Confirmation for Contemplated Future Gravity Sewer

Proposed hotel first floor elevation – 90.80 m

Proposed gravity sewer elevation at proposed hotel building – 89.25 m

Length of gravity sewer through proposed residential subdivision and corridor along recreational trail – 575 m

Minimum grade for proposed 200 mm Ø gravity sanitary sewer – 0.35%

Estimated # of maintenance holes – 9, with 0.03 m drop at each MH

Elevation drop through gravity sewer from proposed hotel building to outlet on Charlotte Street at Paffard Street – 2.57 m

Proposed Easterly Sewer Invert Charlotte at Paffard – 86.97 m

Existing West Invert Sanitary Sewer at Paffard – 86.22 m

Thus, there is adequate grade for gravity sewer to service first floor and above of the proposed multi-storey hotel building.

APPENDIX B

Sanitary Servicing Calculations

SANITARY DEMAND CALCULATIONS - 200 John Street East
Town of Niagara-on-the-Lake

Average Demand Calculation

Tenure Type	Area (m^2)	Units	Unit Density (ppu)	Population	Sanitary Demand (L/cap/d)	Average Demand (L/s)
Retail/commercial	0	n/a	n/a	0	275	0.000
Single-Detached	n/a	125.0	2.53	316	275	1.007
Semi-Detached	n/a	66.0	2.53	167	275	0.531
Townhomes	n/a	0.0	2.53	0	275	0.000
Total		191		**483**		**1.538**

Design Flow Calculation
Entire Site

Average Demand (L/s)	Total Population	M	Area (ha)	Infiltration* (L/s)	Total Peak Flow (L/s)
1.538	483	3.98	8.32	2.380	**8.50**

Two Sisters Resort (Hotel)**

Average Demand (L/day)	M	Area (ha)	Infiltration (L/s)	Total Peak Flow (L/s)
81450	4.50	2.00	0.200	**4.44**

Total Site Demand

Average Demand (L/s)	M	Area (ha)	Infiltration (L/s)	Total Peak Flow (L/s)
2.481	4.08	10.32	2.580	**12.71**

* Based on 0.286 L/s/ha of gross area
** Based on estimates from Two Sisters Resort FS Report, dated June 2018.

M = 1 + 14/(4 + (P/1000)0.5)

APPENDIX C

Water Supply Servicing Calculations

Water Supply Calculation (Based on MOE 2008 Design Guidelines for Drinking Water Systems)
Town of Niagara-on-the-Lake

Project No. 4696

Residential Development, City of Vaughan

Fire Flow:	25,000	L/Minutes
Fire Flow:	7,000	L/Minutes
Generation Rate:	300	L/Day per person

Residential Demands

Description	No. of Units	Population/Unit	Population	**Average Day Demand (L/s)**
Demand (Semi & Single-Detached)	191	2.53	483	**1.678**
				1.68

Total Site Demand

	Average Day Demand (L/s)	Max. Hour Demand Peaking Factor	**Max Hour Demand (L/s)**	Max Day Demand Peaking Factor †	**Max Day Demand (L/s)**	**Peak day demand + fire flow (L/s)**
TOTAL	**1.68**	4.00	**6.71**	2.75	**4.61**	**121.28**

*-Fire Flows Based on FUS

†Based on MOE 2008 Design Guidelines for Drinking Water Systems (Table 3.1)

200 John Street East - City of Niagara on the Lake

Project No. 2018-4696

Flow Test Results of 2nd July 2020

Location:	Residual:	201 John Street
	Flow:	200 John Street

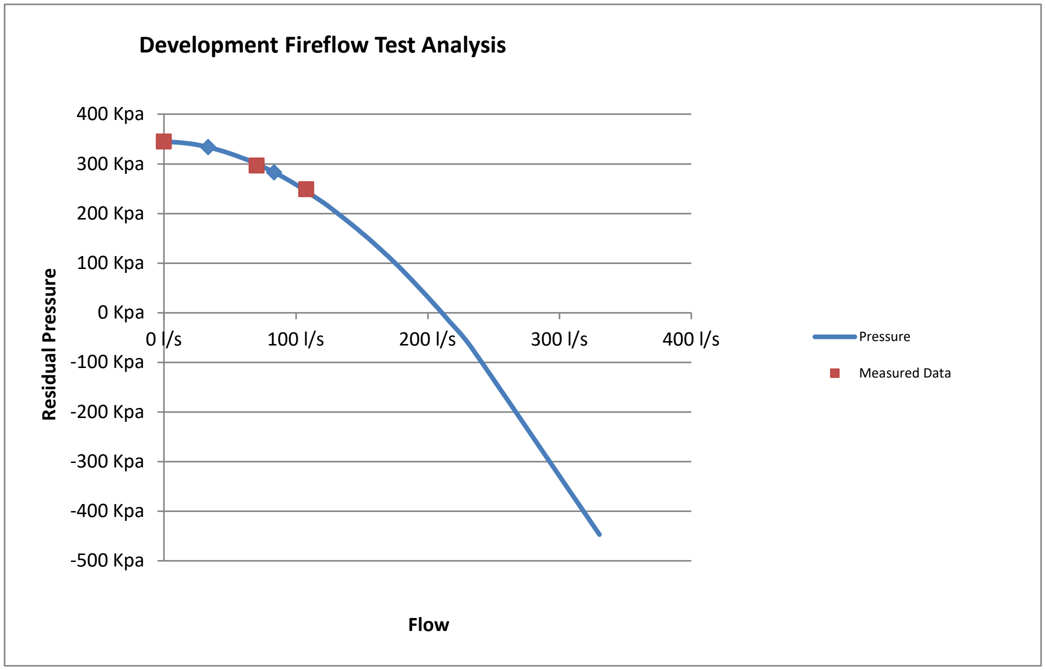
Test Results Flow US. GPM	Residual Pressure psi	Flow L/s	Residual Presure kPa
0	50	0	345
1113	43	70	297
1712	36	108	248

For a total required flow demand of **121.28 L/s** the equivalent residual pressure is

224	**kPa**
32	**psi**

For a residual pressure of **20 psi** or **140 kPa** the equivalent flow is

204	**L/s**
3234	**USGPM**
2692	**IGPM**



1 USG = 3.785 litres
1 IG = 4.546 litres
1 psi = 6.9 kpa

200 John Street East - City of Niagara on the Lake

Project No. 2018-4696

Flow Test Results of 2nd July 2020

Location: Residual: 61 Pafford Street
Flow: 609 Charlotte Street

Test Results			
Flow US. GPM	Residual Pressure psi	Flow L/s	Residual Presure kPa
0	52	0	359
1113	50	70	345
1712	49	108	338

For a total required flow demand of **121.28 L/s**
the equivalent residual pressure is

328 **kPa**

48 **psi**

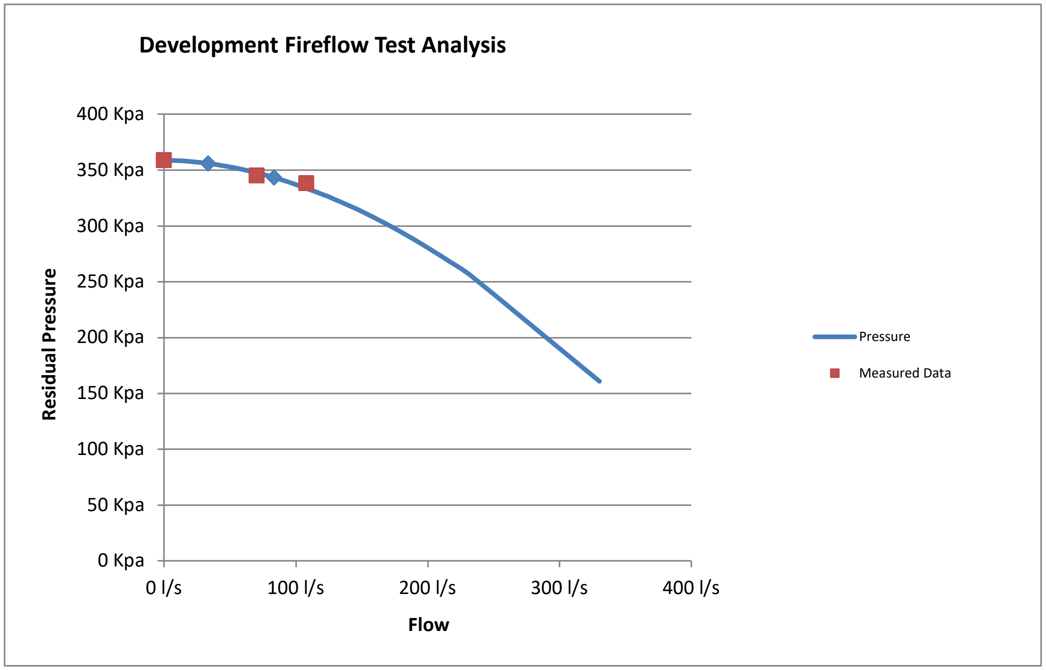
For a residual pressure of **20 psi**
or **140 kPa** the equivalent flow is

441 **L/s**

6991 **USGPM**

5821 **IGPM**

1 USG = 3.785 litres
1 IG = 4.546 litres
1 psi = 6.9 kpa



AQUACOM
CONTRACTING

81 Todd Road Suite 202 Georgetown Ont. L7G 4R8
(o) 905-467-5853 (c) 905-971-9956 (e) mark@aquacom.ca

July 5, 2020

Luis Correia
SOLMAR Development Corp
122 Romina Drive
Concord, Ontario
L4K 4Z7

Reference: **200 John Street Development**
Town of Niagara on The Lake
Hydrant Flow Testing

The flow testing was completed on Thursday July 2nd, 2020 as scheduled.

We advised the Town of Niagara on the Lake water operations staff of this schedule and they provided an operator to assist with the operation of the municipal hydrants and to assist with the test.

Please find the attached summary of test results. For your information;

the hydrant was flowed from one than two nozzles, using flow diffusers

residual pressures were recorded from a second fire hydrant

theoretical flows were produced from the attached chart, using a .90 nozzle coefficient

all discharge water was dechlorinated as per Ministry requirements

the hydrants were not colour coded at the time of the test

If you should require any further information please do not hesitate to contact the undersigned.

Sincerely yours,

Aquacom Contracting
Mark Kilbourne

AQUACOM
CONTRACTING
81 Todd Road Suite 202 Georgetown Ont. L7G 4R8
(o) 905-467-5853 (C) 905-971-9956 (e) mark@aquacom.ca

SITE NAME 200 JOHN STREET DEVELOPMENT

TEST DATE TIME THURSDAY JULY 2ND, 2020 @ 1345

SITE ADDRESS TOWN OF NIAGARA ON THE LAKE

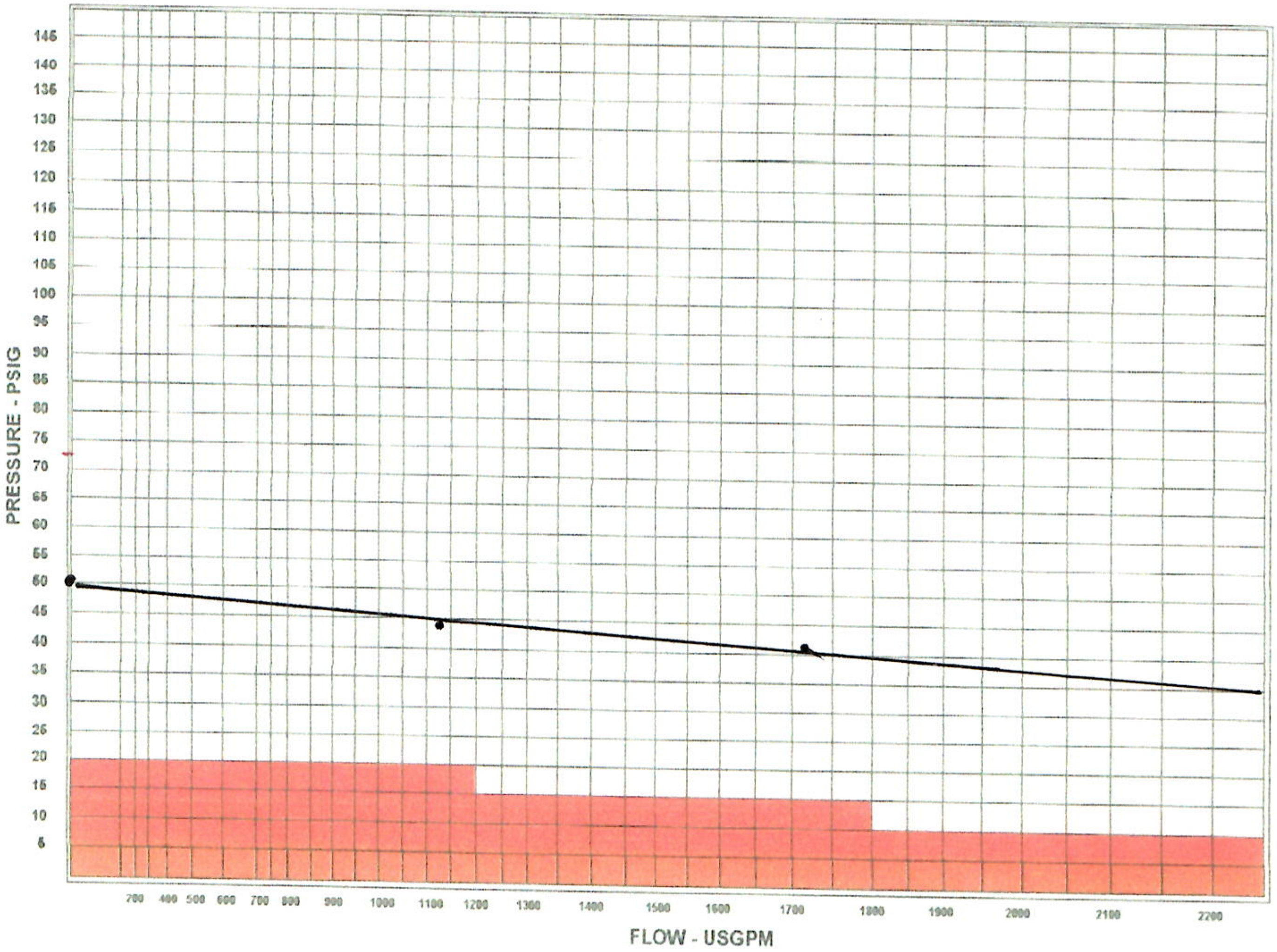
TECHNICIANS MARC COULTER & JEFF DAM

COMMENTS MUNICIPAL HYDRANTS

LOCATION OF FLOW HYDRANT 200 JOHN STREET

LOCATION OF RESIDUAL HYDRANT 201 JOHN STREET

# OUTLETS	SIZE INCHES	PITO PSI	FLOW USGPM	RESIDUAL PSI	STATIC PSI	PIPE DIA. MM
ONE	2.50	44	1113	43	50	
TWO	2.50	26	1712	36		200MM
		THEORETICAL	2584	20	TEST #	ONE
NOZZLE COEFF.		.90				



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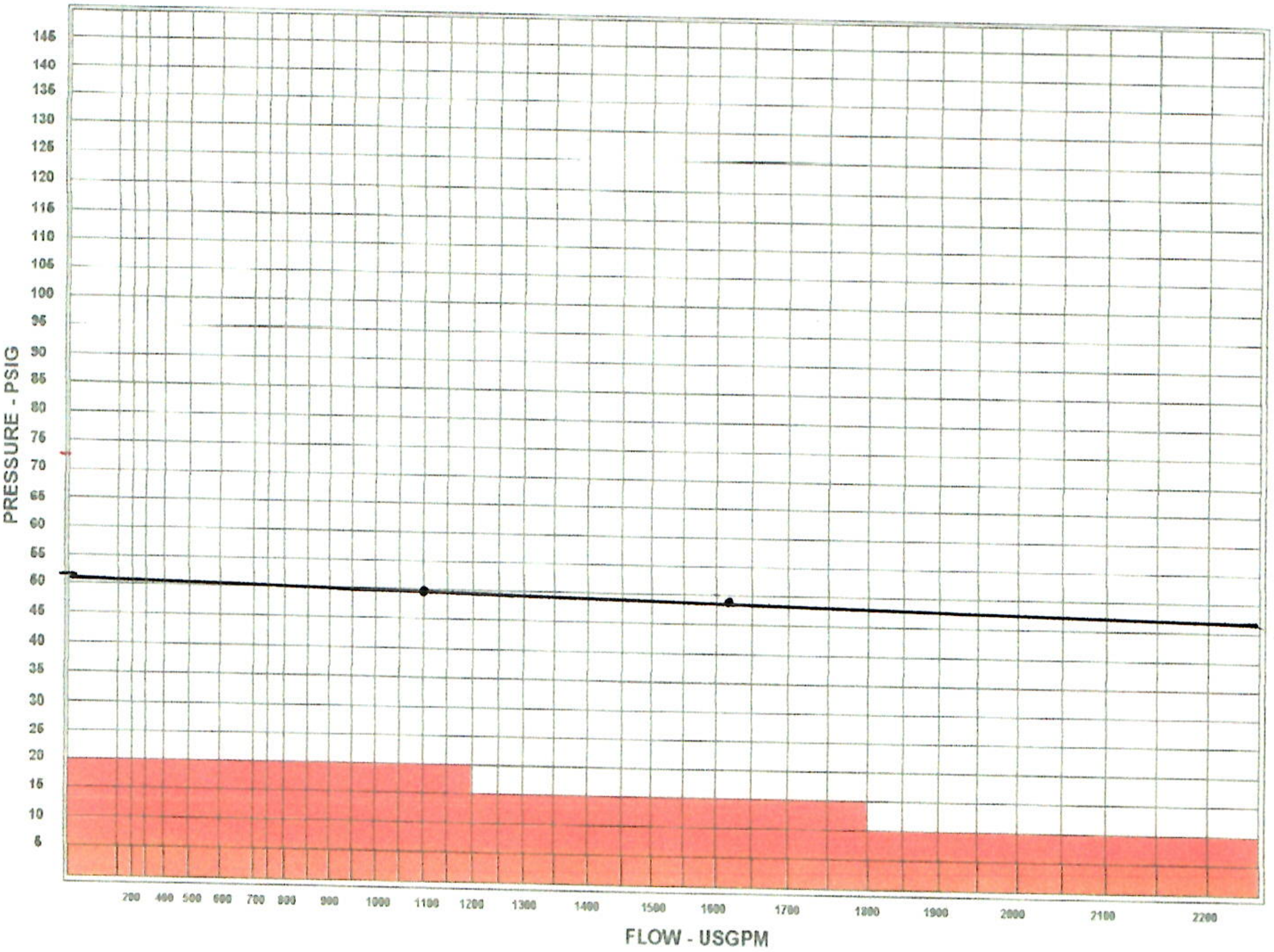
81 Todd Road Suite 202 Georgetown Ont. L7G 4R8
(o) 905-467-5853 (C) 905-971-9956 (e) mark@aquacom.ca

SITE NAME	200 JOHN STREET DEVELOPMENT
TEST DATE TIME	THURSDAY JULY 2ND, 2020 @ 1405
SITE ADDRESS	TOWN OF NIAGARA ON THE LAKE
TECHNICIANS	MARC COULTER & JEFF DAM
COMMENTS	MUNICIPAL HYDRANTS

LOCATION OF FLOW HYDRANT	**LOCATION OF RESIDUAL HYDRANT**
609 CHARLOTTE ST	61 PAFFORD ST

# OUTLETS	SIZE INCHES	PITO PSI	FLOW USGPM	RESIDUAL PSI	STATIC PSI	PIPE DIA. MM
ONE	2.50	43	1100	50	52	
TWO	2.50	23	1612	49		150MM
		THEORETICAL	5788	20	TEST #	TWO
NOZZLE COEFF.		.90				



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CONTRACTING

81 Todd Road Suite 202 Georgetown Ont. L7G 4R8
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HYDRANT FLOW TEST REPORT

		HYDRANT MAKE	SEC. VALVE CONDITION	TECH.	TIME	STATIC PSI	PITO 1-2.50" PSI	FLOW 1-2.50" US GPM	RESIDUAL 1-2.50" PSI	PITO 2-2.50" PSI	FLOW 2-2.50" US GPM	RESIDUAL 2-2.50" PSI	COLOUR CODE
F1	200 JOHN ST	McAVITY	OPEN/OK	JD	1345		44	1113		26	1712		
R1	210 JOHN ST	McAVITY	OPEN/OK	MC		50			44			36	
F2	609 CHARLOTTE ST	McAVITY	OPEN/OK	JD	1405		43	1100		23	1612		
R2	61 PAFFORD ST	CV DARLING	OPEN/OK	MC		52			50			49	
F3													
R3													
F4													
R4													
F5													
R5													

CUSTOMER
SOLMAR DEVELOPMENT CORP

LOCATION
JOHN ST/CHARLOTTE ST
TOWN OF NIAGARA ON THE LAKE

CONTACTS ON SITE
T OF NOTL STAFF

2.50" hydrant nozzle

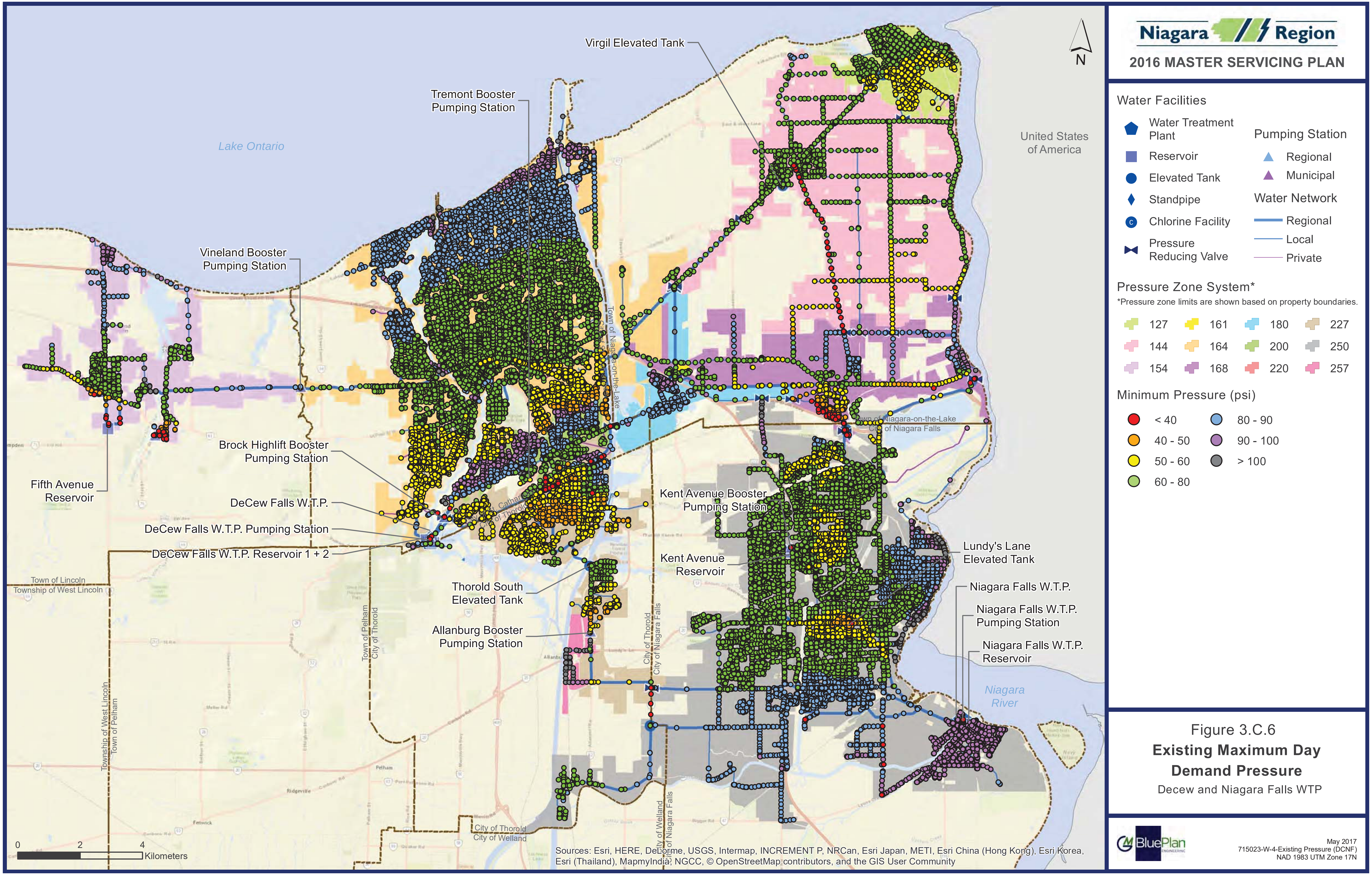
PITO READING PSI	ROUND ENTRANCE COEFF. 90	TWO NOZZLE
1	168	336
2	238	476
3	291	582
4	336	672
5	375	750
6	411	822
7	445	890
8	475	950
9	504	1008
10	531	1062
11	549	1098
12	581	1162
13	606	1212
14	628	1256
15	650	1300
16	671	1342
17	692	1384
18	172	344
19	732	1464
20	751	1502
22	789	1578
24	823	1646
26	856	1712
28	878	1756
30	920	1840
32	950	1900
34	979	1958
36	1007	2014
38	1035	2070
40	1062	2124
42	1088	2176
44	1113	2226
46	1164	2328
48	1164	2328
50	1187	2374
52	1211	2422
54	1234	2468
56	1256	2512
58	1279	2558
60	1301	2602
62	1323	2646
64	1344	2688
66	1364	2728
68	1385	2770
70	1405	2810
72	1425	2850
74	1445	2890
76	1464	2928
78	1483	2966
80	1502	3004

PITO READING PSI	SQUARE ENTRANCE COEFF. 80	TWO NOZZLE
1	150	300
2	211	422
3	258	516
4	298	596
5	334	668
6	366	732
7	395	790
8	422	844
9	448	896
10	472	944
11	483	966
12	517	1034
13	538	1076
14	558	1116
15	578	1156
16	597	1194
17	615	1230
18	633	1266
19	650	1300
20	667	1334
22	700	1400
24	731	1462
26	761	1522
28	790	1580
30	818	1636
32	844	1688
34	870	1740
36	895	1790
38	920	1840
40	944	1888
42	967	1934
44	990	1980
46	1012	2024
48	1034	2068
50	1055	2110
52	1076	2152
54	1097	2194
56	1117	2234
58	1137	2274
60	1156	2312
62	1176	2352
64	1194	2388
66	1213	2426
68	1231	2462
70	1249	2498
72	1266	2532
74	1284	2568
76	1302	2604
78	1318	2636
80	1335	2670

THE FLOWS SHOWN ARE IN US GPM
COEFFICIENT FOR EACH NOZZLE HAS BEEN APPLIED TO CALCULATE THEORETICAL FLOW

Niagara Region

2016 MASTER SERVICING PLAN



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

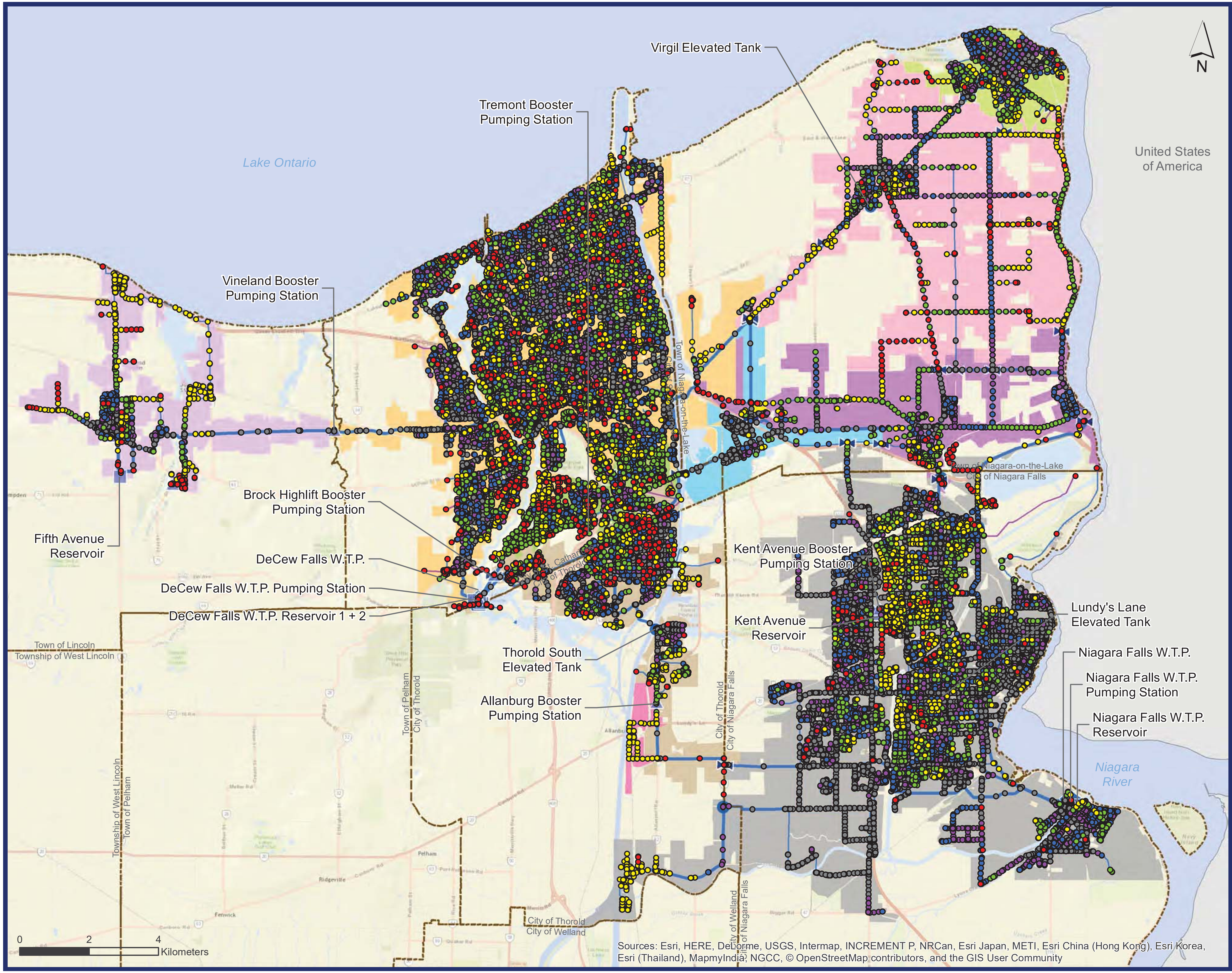
Figure 3.C.6

Existing Maximum Day Demand Pressure

Decew and Niagara Falls WTP

BluePlan ENGINEERING

May 2017
715023-W-4-Existing Pressure (DCNF)
NAD 1983 UTM Zone 17N



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Niagara Region
2016 MASTER SERVICING PLAN

Water Facilities

- Water Treatment Plant
- Reservoir
- Elevated Tank
- Standpipe
- Chlorine Facility
- Pressure Reducing Valve

Pumping Station

- Regional
- Municipal

Water Network

- Regional
- Local
- Private

Pressure Zone System*

*Pressure zone limits are shown based on property boundaries.

127	161	180	227
144	164	200	250
154	168	220	257

Available Fire Flow (L/s)

● < 50	● 150 - 200
● 50 - 100	● 200 - 250
● 100 - 150	● > 250

Figure 3.C.7
Existing System Fire Flow
Decew and Niagara Falls WTP

May 2017
715023-W-6-Existing Fire Flow (DCNF)
NAD 1983 UTM Zone 17N

APPENDIX D

Stormwater Management Calculations

Niagara on the Lake - Design Criteria
Site Pre-Development Runoff Coefficient

Project: 2018-4696
200 John Street East

Criteria:

The Runoff Coefficients were taken from Town's Design Criteria.

Summary of North Drainage Area to existing 1 Mile Creek Outlet

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Grassland and Woodot	83043	0.25	20760.8
Sub Total	**83043**		**20760.8**
Weighted Coefficient - Controlled			**0.25**

**Note Area of stairwells and air vent was not considered as 100% of water fallen onto these areas will fall into parking structure.*

Summary of North East Drainage Area to 1 Mile Creek

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Pervious Landscape	4000	0.25	1000.0
Sub Total	**4000**		**1000.0**
Weighted Coefficient - Controlled			**0.25**

**Note Area of stairwells and air vent was not considered as 100% of water fallen onto these areas will fall into parking structure.*

Summary of North West Drainage to Charlotte Street

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Gravel Driveway	159	0.9	143.1
Grassed Area	161	0.25	40.3
Sub Total	**320**		**183.4**
Weighted Coefficient - Uncontrolled			**0.57**

Total Site	**87363**	**C =**	**0.25**

Schaeffers Consulting Engineers

Niagara on the Lake - Design Criteria
Uncontrolled Site Post-Development Runoff Coefficient

Project: 2018-4696
200 John Street East

Criteria:

The Runoff Coefficients were taken from Town's Design Criteria.

Summary of North East Drainage Area to 1 Mile Creek

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Road	1808	0.90	1627.2
Pervious Landscape	2100	0.25	525.0
Sub Total	**3908**		**2152.2**
Weighted Coefficient - Controlled			**0.55**

**Note Area of stairwells and air vent was not considered as 100% of water fallen onto these areas will fall into parking structure.*

Summary of North West Drainage to Charlotte Street

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Road	289	0.90	260.1
Sub Total	**289**		**260.1**
Weighted Coefficient - Uncontrolled			**0.90**

Summary of Uncontrolled Drainage to 1 Mile Creek

Area Designation	Area [m^2]	Runoff Coeff.	A x C
Backyards	5252	0.25	1313.0
Woodlot & Buffer	1700	0.25	425.0
Pervious Hotel Area	700	0.25	175.0
Stream & Buffer	1200	0.25	300.0
Sub Total	**8852**		**2213.0**
Weighted Coefficient - Uncontrolled			**0.25**

Schaeffers Consulting Engineers

Town of Niagara on the Lake Design Criteria

Release Rate Comparison Pre to Post - Drainage to Charlotte Street

Project: 2018-4585

Criteria:

The Runoff Coefficients are calculated in the attached worksheets, with guidelines from the Town of Niagara on the Lake Design Criteria.

Summary of Rainfall Intensity by the Town of Niagara on the Lake

Design Storm Event	A	B	C	I (mm/hr)
2-Year	567	5.2	-0.746	74.5
5-Year	664	4.7	-0.744	89.9
10-Year	724	4.3	-0.739	101.4
25-Year	821	4.0	-0.735	118.0
50-Year	900	3.8	-0.734	131.1
100-Year	980	3.7	-0.732	144.3

Note:

T = 10 min *10.0* *min*

I = A x T^C

Summary of Peak Discharge Rate to Charlotte Street Storm Sewer (Existing Condition)

Storm Event	Peak Flow	
2-Year Peak Flow, Q_2	3.8	L/s
5-Year Peak Flow, Q_5	4.6	L/s
10-Year Peak Flow, Q_{10}	5.1	L/s
25-Year Peak Flow, Q_{25}	6.0	L/s
50-Year Peak Flow, Q_{50}	6.6	L/s
100-Year Peak Flow, Q_{100}	7.3	L/s

Note:

Q = 2.78 x C x I x A *Runoff Coefficient, C* *0.57*

Pre-development Drainage Area, ha *0.032*

Summary of Peak Discharge Rate to Charlotte Street Storm Sewer (Proposed Condition)

Storm Event	Peak Flow		Change	
2-Year Peak Flow, Q_2	5.4	L/s	1.6	L/s
5-Year Peak Flow, Q_5	6.5	L/s	1.9	L/s
10-Year Peak Flow, Q_{10}	7.3	L/s	2.2	L/s
25-Year Peak Flow, Q_{25}	8.5	L/s	2.5	L/s
50-Year Peak Flow, Q_{50}	9.5	L/s	2.8	L/s
100-Year Peak Flow, Q_{100}	10.4	L/s	3.1	L/s

Note:

Q = 2.78 x C x I x A *Runoff Coefficient, C* *0.90*

Pre-development Drainage Area, ha *0.029*

Schaeffers Consulting Engineers

Town of Niagara on the Lake Design Criteria
Post - Uncontrolled to Creek from Backyards, Woodlot and Buffers

Project: 2018-4585

Criteria:

The Runoff Coefficients are calculated in the attached worksheets, with guidelines from the Town of Niagara on the Lake Design Criteria.

Summary of Rainfall Intensity by the Town of Niagara on the Lake

Design Storm Event	A	B	C	I (mm/hr)
2-Year	567	5.2	-0.746	32.5
5-Year	664	4.7	-0.744	38.7
10-Year	724	4.3	-0.739	43.2
25-Year	821	4.0	-0.735	50.0
50-Year	900	3.8	-0.734	55.2
100-Year	980	3.7	-0.732	60.7

Note:

T = 10 min *41.0* *min*

I = A x T^C

Summary of Peak Uncontrolled Flows from Backyards

Storm Event	Peak Flow	
2-Year Peak Flow, Q_2	19.8	L/s
5-Year Peak Flow, Q_5	23.5	L/s
10-Year Peak Flow, Q_{10}	26.3	L/s
25-Year Peak Flow, Q_{25}	30.4	L/s
50-Year Peak Flow, Q_{50}	33.6	L/s
100-Year Peak Flow, Q_{100}	36.9	L/s

Note:

Q = 2.78 x C x I x A

Runoff Coefficient, C *0.25*

Drainage Area, ha *0.875*

Schaeffers Consulting Engineers

200 John Street East- Town of Niagara on the Lake

PROJECT NO. 2018-4696
DATE: September 2018

Post-Development Area

LAND USE	Area	C	A*C	A*TIMP	TIMP	A*XIMP	XIMP
Residential Semi Detached Homes	1.63	0.55	0.89	0.81	0.50	0.61	0.38
Residential Single Detached Homes	3.92	0.54	2.10	1.88	0.48	1.28	0.33
Park Storm LID	0.81	0.25	0.20	0.06	0.07	0.06	0.07
Landscape Buffer	0.02	0.25	0.00	0.00	0.07	0.00	0.07
Condo Road and Open Space	0.03	0.90	0.03	0.03	1.00	0.03	1.00
Walkway	0.01	0.90	0.01	0.01	1.00	0.01	1.00
Road Right of Way	1.53	0.90	1.37	1.53	1.00	1.53	1.00
TOTAL	***7.95***	***0.58***	***4.61***	***4.31***	***0.54***	***3.51***	***0.44***

Less Uncontrolled Backyard Area	***0.53***	***0.25***	***0.13***

Total Controlled Area	***7.42***	***0.60***	***4.48***	4.27	0.58	3.41	0.46

Estimating Sheet - TIMP/XIMP for Typical 35ft Detached LOTs

W= Lot Width	35	ft.	→	10.8	m
D= Lot Depth	26	m			
bs= minimum Back yard set back	7.5	m			
fs= minimum Front set back	7.5	m			
ss= Minimum side set back	1.5	m			
dw = driveway Width	6	m			
Porch area=	4	sqm	(min. set back for Porch is4m)		

11.6

Calculation based on lot Fabric

Total Lot Area	280.80	sqm
Roof Area	85.80	sqm
Porch	4.00	sqm
Drive way	45.00	sqm
Grass Area	146.00	sqm

Total impervious Areas	134.80	sqm
Direct Impervious areas	91.90	sqm

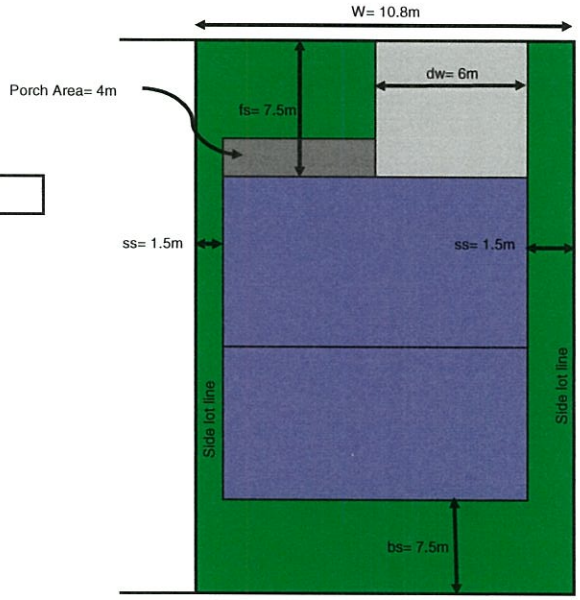
T IMP	48%
XIMP	33%

Minimum TIMP based on Town's Criteria

C	0.50	(Low Density Residential)
TIMP	43%	
XIMP	29%	

Minimum TIMP/XIMP used in the model

C	0.54
TIMP	48%
XIMP	33%



Estimating Sheet - TIMP/XIMP for Typical 28ft Semi-Detached LOTs

W= Lot Width	28	ft.	➡	8.53	m
D= Lot Depth	26	m			
bs= minimum Back yard set back	7.5	m			
fs= minimum Front set back	7.5	m			
ss= Minimum side set back	1.5	m			
dw = driveway Width	6	m			
Porch area=	4	sqm	(min. set back for Porch is4m)		

11.6

Calculation based on lot Fabric

Total Lot Area	221.78	sqm
Roof Area	60.83	sqm
Porch	4.00	sqm
Drive way	45.00	sqm
Grass Area	111.95	sqm

0.274

Total impervious Areas	109.83	sqm
Direct Impervious areas	79.42	sqm

T IMP	50%
XIMP	36%

Minimum TIMP based on Town's Criteria

C	0.50	(Low Density Residential)
TIMP	43%	
XIMP	31%	

Minimum TIMP/XIMP used in the model

C	0.55
TIMP	50%
XIMP	36%

Time of Concentration Calculations - Airport Method

NshHyde 1 pervious flow - Predevelopment

Enter the Length (L)	High Point	91.37
Enter the Average Slope (Sw)	Low Point	88.4
Enter the Runoff Coefficient (C)		

$Tc = (3.26\ (1.1 - C)\ L^{0.5})/Sw^{0.33}$

Area ID	Area Description	Length (m)	Average Slope	Runoff Coefficient	Tc (min)
1	Pre-dev Outlet	515.2	0.63	0.25	73

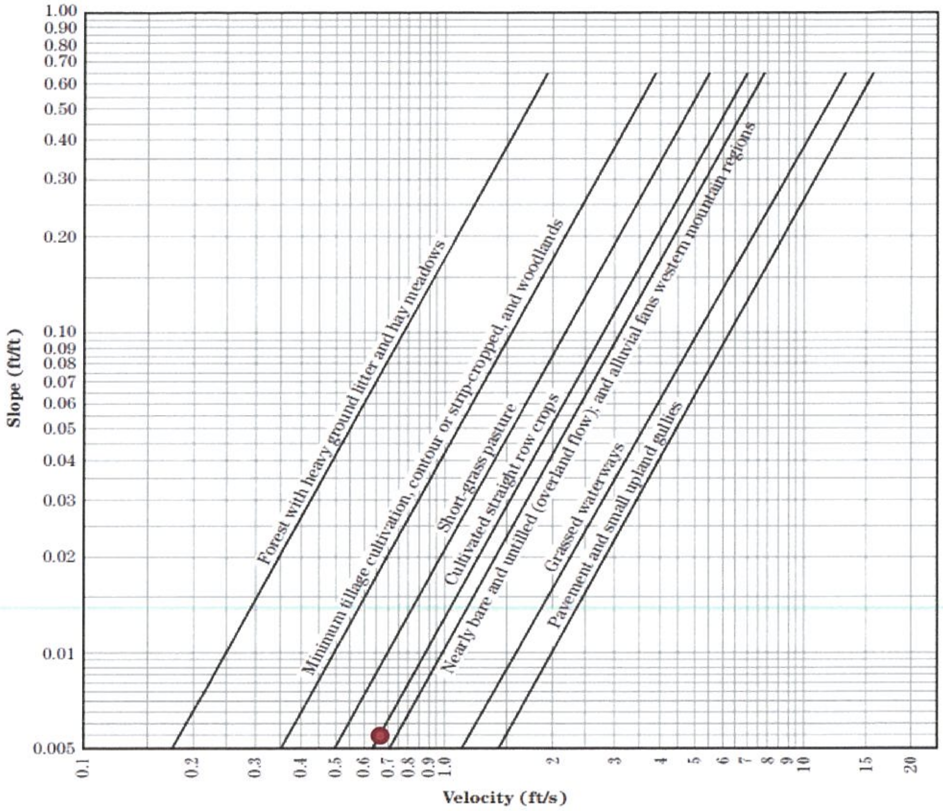
Pre-Development Time of Concentration Calculation
To 1 Mile Creek

Job: **2018-4696**
Date September 2018

Upland's Method			**Velocity Factor**		
Flow Length	**515.2**	m	ft/ft:	0.006	
High Point	91.37	m	Land Use:		
Outlet	88.4	m	Cultivated Straight row Crop		
Slope	0.63	%	Velocity	0.675	ft/s
Existing Landuse CN =	70.4			**0.21**	m/s

Tc	0.696	hr
	41.7	min

Both Tc's are above the Town minimum (10 min); therefore use Tc = 0.696hr.



Reference: "*Part 630 Hydrology, National Engineering Handbook, Chapter 15: Time of Concentration* ", United States Department of Agriculture. (2010)

Site Curve Number Determination

Project #: **4696** **Date:** **12/17/18**

Hydraulic Soil Group: AB (Table 2.5 - MTC Hydrology Section Rev. 13.5.75)
Soil: 40 - 100cm Sandy or Loamy Sediments over lacustrine clays/loams
Source: *Generalized Soil Map of Niagara, Soil Survey Report No. 60 of the Ontario Institute of Pedology.*
(Field Mapping 1981-1985)

Land Use: Crop and Other Improved Lands. Pre-development lands appear as mix of rural development and woodlot area.

Table 4 - Soil/Land Use Curve Numbers

Land Use	**Hydraulic Soil Group**						
	A	**AB**	**B**	**BC**	**C**	**CD**	**D**
Fallow (in special cases only)	77	82	86	89	91	93	94
Crop and other improved land	66*	70	74	78	82	84	86
Pasture & other unimproved land	58*	62*	66	71	76	79	81
Woodlots and forest	50*	54*	58	65	71	74	77
Impervious areas (paved)	98						
Water surfaces	100 (use in special cases only)						

Notes:
1. *Figures are based on average antecedant moisture condition (AMC II) except those marked *, which are initially wet (AMC III) or partly wet. For relationship of AMC and rainfall see Fig. 2. To convert CN's from one AMC to another see Fig. 3.*
2. *Table is not applicable to frozen soils or to periods in which snow melt contributes to runoff.*
3. *Source: SCS Handbook Chapter 9 (1), with modifications.*

-Table adapted from M.T.C Hydrology Section Rev. 25 June 1976.

Weighted Calculation based on Impervious Areas

Pre-development Area	8.19 ha	CN =	70
Pre-dev. Impervious Area	0.11 ha	CN =	98
		Weighted Site CN =	70.4

250 John Street East
Underground Storage
PRE-DEVELOPMENT RELEASE COMPARISON

Pre-development Drainage Area = 8.30 ha TP = 0.81 hr

CN = 70.4

	Post to Pre-development Allowable Release rates			
Design Storm Event	***24 Hr SCS (L/s)***	***12 Hr AES (L/s)***	***3 Hr Chicago* (L/s)***	**3hr Chicago Release less Uncontrolled (L/s)**
Erosion	*11*	*11*	*11*	11
2 - Year	*141*	*71*	*68*	48
5 - Year	*193*	*118*	*97*	73
10 - Year	*240*	*155*	*122*	96
25 - Year	*313*	*204*	*162*	132
50 - Year	*369*	*244*	*195*	161
100 - Year	*434*	*285*	*233*	196

**Lowest represents the target pre-development release rate*

250 John Street East
Underground Storage

Required Storage Volume Comparison

Post-development Drainage Area = 7.42 ha

Design Storm Event	***3hr Chicago Pre-dev Peak Flow (L/s)***	***Required StorageVO Results* (24 hr SCS)***
Erosion	*11*	*1,238*
2 - Year	*48*	*2,370*
5 - Year	*73*	*2,830*
10 - Year	*96*	*3,210*
25 - Year	*132*	*3,760*
50 - Year	*161*	*4,150*
100 - Year	*196*	*4,590*

Design Storm Event	***3hr Chicago Pre-dev Peak Flow (L/s)***	***Required StorageVO Results (12hr AES)***
Erosion	*11*	*1,238*
2 - Year	*48*	*1,720*
5 - Year	*73*	*2,220*
10 - Year	*96*	*2,550*
25 - Year	*132*	*2,950*
50 - Year	*161*	*3,240*
100 - Year	*196*	*3,510*

Design Storm Event	***3hr Chicago Pre-dev Peak Flow (L/s)***	***Required StorageVO Results (3hr Chicago)***
Erosion	*11*	*1,238*
2 - Year	*48*	*1,600*
5 - Year	*73*	*1,860*
10 - Year	*96*	*2,050*
25 - Year	*132*	*2,340*
50 - Year	*161*	*2,560*
100 - Year	*196*	*2,800*

**Highest Volume represents the required pond volume (active storage).*

250 John Street East
WATER QUALITY REQUIREMENT CALCULATIONS
Underground Storage

Table: Water Quality Storage Requirements Based on Receiving Waters

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level					
		0%	35%	55%	70%	85%	100%
Level 1	Infiltration	20	25	30	35	40	45

- From MOE 2003, Table 3.2

* For wet ponds, all of the storage, except for 40 m^3/ha represents the permanent pool volume.
The 40 m^3/ha represents extended detention storage.

Input:

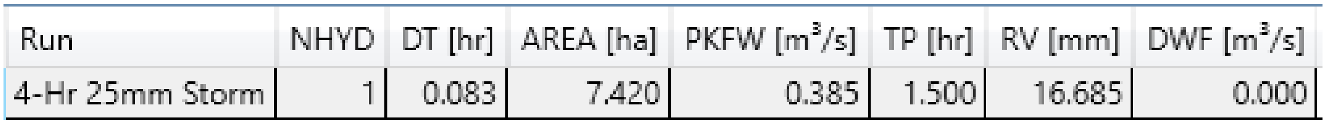
Estimated Imperviousness = 60%
Area = 7.42 ha
Level of Protection : 1
SWMP Type : Infiltration

Calculation:

Total Storage Volume Required = 32 m^3/ha → 235 m^3

Niagara on the Lake 200 John Street East
EROSION CONTROL CALCULATIONS
Underground Storage

Based on 25mm Storm Event Releasing over 48-Hour Period



Run	NHYD	DT [hr]	AREA [ha]	PKFW [m³/s]	TP [hr]	RV [mm]	DWF [m³/s]
4-Hr 25mm Storm	1	0.083	7.420	0.385	1.500	16.685	0.000

Input:

Area =	7.42	ha
R.V =	16.69	mm
Draw Down Time =	48	hrs

Calculations:

Required Storage =	1,238	m^3
Average Outflow =	0.007	m^3/s
Peak Outflow =	0.011	m^3/s (Estimated at 1.5 times Average Outflow)

Water Balance Calculations

TABLE 1: WATER BUDGET - PRE DEVELOPMENT
WATER BALANCE/WATER BUDGET ASSESSMENT

	Site		
Catchment Designation	Open Grass and Shrubs	Woodlot	Total
Area (m^2)	62884	24479	87363
Pervious Area (m^2)	62884	24479	87363
Impervious Area (m^2)	0	0	0
Infiltration Factors			
Topography Infiltration Factor-Rolling Land[1]	0.2	0.2	
Soil Infiltration Factor- Medium combinations of clay and loam[1]	0.2	0.2	
Land Cover Infiltration Factor- Cultivated[1]	0.1	0.2	
MOE Infiltration Factor[1]	0.5	0.6	
Inputs (per unit area)			
Precipitation (mm/year)[2]	880	880	880
Run-On (mm/year)			
Other Inputs (mm/year)			
Total Inputs (mm/year)	880	880	880
Outputs (per unit area)			
Precipitation Surplus (mm/year)	240	240	240
Net Surplus (mm/year)	240	240	240
Downspout Disconnection Retention	0	0	0
Evapotranspiration (mm/year)[2]	640	640	640
Roof Evapotranspiration (mm/year)	0	0	0
Rooftop Runoff Lawn Evaporation (mm/year)	0	0	0
Total Evapotranspiration (mm/yr)	**640**	**640**	**640**
Infiltration (mm/year)	120	144	120
Rooftop Infiltration (mm/year)	0	0	0
Total Infiltration (mm/year)	**120**	**144**	**120**
Runoff Pervious Area (mm/year)	120	96	120
Runoff Impervious Area (mm/year)	0	0	0
Total Runoff (mm/year)	**120**	**96**	**120**
Total Outputs (mm/year)	**880**	**880**	**880**
Difference (Inputs - Outputs)	0	0	0
Input Volumes			
Precipitation (m^3/year)	55338	21541	55338
Run On (m^3/year)	0	0	0
Other Inputs (m^3/year)	0	0	0
Total Inputs (m^3/year)	**55338**	**21541**	**55338**
Outputs (Volumes)			
Precipitation Surplus (m^3/year)	15092	5875	20967
Net Surplus (m^3/year)	15092	5875	20967
Downspout Disconnection Retention (m^3/year)	0	0	0
Evapotranpiration (m^3/year)	40246	15667	55912
Roof Evapotranspiration (m^3/year)	0	0	0
Rooftop Runoff Lawn Evaporation (m^3/year)	0	0	0
Total Evapotranspiration (m^3/year)	**40246**	**15667**	**55912**
Infiltration (m^3/year)	7546	3525	11071
Rooftop Infiltration (m^3/year)	0	0	0
Total Infiltration (m^3/year)	**7546**	**3525**	**11071**
Runoff Pervious Area (m^3/year)	7546	2350	9896
Runoff Impervious Area (m^3/year)	0	0	0
Total Runoff (m^3/year)	**7546**	**2350**	**9896**
Total Outputs (m^3/year)	**55338**	**21541**	**76879**
Difference (Inputs - Outputs)	0	0	0

1 - Infiltration factors based on MOE 2003 Guidelines

2 - Precipitation and evapotranspiration based on Preliminary Hydrogeological Investigation Report, Proposed Development at 200 John Street and 588 Charlott Street (2018) Cole Engineering Group Ltd.

TABLE 2: WATER BUDGET - POST-DEVELOPMENT WITHOUT MITIGATION
WATER BALANCE/WATER BUDGET ASSESSMENT

	Site										
Catchment Designation	Front Lawn	Backyard	Stream and Landscape Buffer & Open Space along Condo Road	Woodlot	Roofs	Front Porch Area	Park Storm	Pervious Areas as part of Future Hotel Development	Roadways & Private Lane	Driveways	Total
Area (m^2)	6299	22332	3799	1748	16461	853	8113	740	17344	9674	87363
Pervious Area (m^2)	6299	22332	3799	1748	0	0	8113	740	0	0	43031
Impervious Area (m^2)	0	0	0		16461	853	0	0	17344	9674	44332
Infiltration Factors											
Topography Infiltration Factor-Rolling Land[1]	0.15	0.15	0.15	0.2	N/A	N/A	0.15	0.15	N/A	N/A	
Soil Infiltration Factor- Medium combinations of clay and loa	0.2	0.2	0.2	0.2	N/A	N/A	0.2	0.2	N/A	N/A	
Land Cover Infiltration Factor- Cultivated[1]	0.1	0.1	0.1	0.2	N/A	N/A	0.1	0.1	N/A	N/A	
MOE Infiltration Factor[1]	0.45	0.45	0.45	0.6	N/A	N/A	0.45	0.45	N/A	N/A	
Inputs (per unit area)											
Precipitation (mm/year)[2]	880	880	880	880	880	880	880	880	880	880	880
Total Inputs (m^3/year)	880	880	880	880	880	880	880	880	880	880	880
Outputs (per unit area)											
Precipitation Surplus (mm/year)	240	240	240	240	792	792	240	240	792	792	461
Net Surplus (mm/year)	240	240	240	240	792	792	240	240	792	792	461
Downspout Disconnection Retention	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration (mm/year)[2,3]	640	640	640	640	0	88	640	640	88	88	410
Roof Evapotranspiration (mm/year)[2,3]	0	0	0	0	88	0	0	0	0	0	9
Rooftop Runoff Lawn Evaporation (mm/year)	0	0	0	0	0	0	0	0	0	0	0
Total Evapotranspiration (mm/yr)	**640**	**640**	**640**	**640**	**88**	**88**	**640**	**640**	**88**	**88**	419
Infiltration (mm/year)	108	108	108	144	0	0	108	108	0	0	68
Rooftop Infiltration (mm/year)	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (mm/year)	**108**	**108**	**108**	**144**	**0**	**0**	**108**	**108**	**0**	**0**	68
Runoff Pervious Area (mm/year)	132	132	132	96	0	0	132	132	0	0	76
Runoff Impervious Area (mm/year)	0	0	0	0	792	792	0	0	792	792	317
Total Runoff (mm/year)	**132**	**132**	**132**	**96**	**792**	**792**	**132**	**132**	**792**	**792**	392
Total Outputs (mm/year)	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	880
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0
Input Volumes											
Precipitation (m^3/year)	5543	19652	3343	1538	14485	751	7140	651	15263	8513	**76879**
Total Inputs (m^3/year)	**5543**	**19652**	**3343**	**1538**	**14485**	**751**	**7140**	**651**	**15263**	**8513**	**76879**
Outputs (Volumes)											
Precipitation Surplus (m^3/year)	1512	5360	912	420	13037	676	1947	178	13736	7662	45438
Net Surplus (m^3/year)	1512	5360	912	420	13037	676	1947	178	13736	7662	45438
Downspout Disconnection Retention (m^3/year)	0	0	0	0	0	0	0	0	0	0	0
Evapotranspiration (m^3/year)	4031	14293	2431	1119	0	75	5193	474	1526	851	29993
Roof Evapotranspiration (m^3/year)	0	0	0	0	1449	0	0	0	0	0	1449
Rooftop Runoff Lawn Evaporation (m^3/year)	0	0	0	0	0	0	0	0	0	0	0
Total Evapotranspiration (m^3/year)	**4031**	**14293**	**2431**	**1119**	**1449**	**75**	**5193**	**474**	**1526**	**851**	**31441**
Infiltration (m^3/year)	680	2412	410	252	0	0	876	80	0	0	4710
Rooftop Infiltration (m^3/year)	0	0	0	0	0	0	0	0	0	0	0
Total Infiltration (m^3/year)	**680**	**2412**	**410**	**252**	**0**	**0**	**876**	**80**	**0**	**0**	**4710**
Runoff Pervious Area (m^3/year)	831	2948	501	168	0	0	1071	98	0	0	5617
Runoff Impervious Area (m^3/year)	0	0	0	0	13037	676	0	0	13736	7662	35111
Total Runoff (m^3/year)	**831**	**2948**	**501**	**168**	**13037**	**676**	**1071**	**98**	**13736**	**7662**	**40728**
Total Outputs (m^3/year)	**5543**	**19652**	**3343**	**1538**	**14485**	**751**	**7140**	**651**	**15263**	**8513**	**76879**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	**0**

1 - Infiltration factors based on MOE 2003 Guidelines

2 - Precipitation and evapotranspiration based on Preliminary Hydrogeological Investigation Report, Proposed Development at 200 John Street and 588 Charlott Street (2018) Cole Engineering Group Ltd.

3- Assumes 10% Evaporation from Impervious Surfaces

TABLE 3: WATER BUDGET - POST-DEVELOPMENT WITH MITIGATION
WATER BALANCE/WATER BUDGET ASSESSMENT

	Site												
Catchment Designation	Front Lawn Area with Extra Topsoil	Backyard (Townhouses - Not going to Trenches)	Backyard to Trenches	Stream and Landscape Buffer & Open Space along Condo Road	Woodlot	Roofs to Trenches with Downspouts Disconnection	Roofs with Downspout Disconnection	Front Porch Area	Park Storm	Pervious Areas as part of Future Hotel Development	Roadways & Private Lane	Driveways	Total
Area (m^2)	6299	15063	7269	3799	1748	9637	6824	853	8113	740	17344	9674	87363
Pervious Area (m^2)	6299	15063	7269	3799	1748	0	0	0	8113	740	0	0	43031
Impervious Area (m^2)	0	0	0	0	0	9637	6824	853	0	0	17344	9674	44332
Infiltration Factors													
Topography Infiltration Factor-Rolling Land[1]	0.15	0.15	0.15	0.15	0.2	N/A	N/A	N/A	0.15	0.15	N/A	N/A	
Soil Infiltration Factor- Medium combinations of clay and loam[1]	0.2	0.2	0.2	0.2	0.2	N/A	N/A	N/A	0.2	0.2	N/A	N/A	
Land Cover Infiltration Factor- Cultivated[1]	0.1	0.1	0.1	0.1	0.2	N/A	N/A	N/A	0.1	0.1	N/A	N/A	
MOE Infiltration Factor[1]	0.45	0.45	0.45	0.45	0.6	N/A	N/A	N/A	0.45	0.45	N/A	N/A	
Inputs (per unit area)													
Precipitation (mm/year)[2]	880	880	880	880	880	880	880	880	880	880	880	880	880
Total Inputs (m^3/year)	880	880	880	880	880	880	880	880	880	880	880	880	880
Outputs (per unit area)													
Precipitation Surplus (mm/year)	240	240	240	240	240	792	792	792	240	240	792	792	470
Net Surplus (mm/year)	240	240	240	240	240	792	792	792	240	240	792	792	470
Downspout Disconnection Retention[5]	0	0	0	0	0	198	198	198	0	0	0	0	50
Evapotranspiration (mm/year)[2,3]	640	640	640	640	640	88	88	88	640	640	88	88	410
Roof Evapotranspiration (mm/year)[2,3]	0	0	0	0	0	0	0	0	0	0	0	0	0
Rooftop Runoff Lawn Evaporation (mm/year)	0	0	0	0	0	154	154	154	0	0	0	0	39
Total Evapotranspiration (mm/yr)	**640**	**640**	**640**	**640**	**640**	**242**	**242**	**242**	**640**	**640**	**88**	**88**	449
Infiltration (mm/year)	108	108	108	108	144	0	0	0	108	108	0	0	66
Rooftop Infiltration (mm/year)	0	0	0	0	0	44	44	44	0	0	0	0	11
Topsoil Amendment Mitigation Infiltratior	73	73	73	0	0	0	0	0	0	0	0	0	18
Infiltration through trenches	0	0	59	0	0	325	0	0	0	0	0	0	32
Total Infiltration (mm/year)	**181**	**181**	**240**	**108**	**144**	**369**	**44**	**44**	**108**	**108**	**0**	**0**	127
Runoff Pervious Area (mm/year)	59	59	0	132	96	0	0	0	132	132	0	0	51
Runoff Impervious Area (mm/year)	0	0	0	0	0	269	594	594	0	0	792	792	253
Total Runoff (mm/year)	**59**	**59**	**0**	**132**	**96**	**269**	**594**	**594**	**132**	**132**	**792**	**792**	304
Total Outputs (mm/year)	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	**880**	880
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	0
Input Volumes													
Precipitation (m^3/year)	5543	13255	6397	3343	1538	8481	6005	751	7140	651	15263	8513	**76879**
Total Inputs (m^3/year)	**5543**	**13255**	**6397**	**3343**	**1538**	**8481**	**6005**	**751**	**7140**	**651**	**15263**	**8513**	**76879**
Outputs (Volumes)													
Precipitation Surplus (m^3/year)	1512	3615	1745	912	420	7633	5404	676	1947	178	13736	7662	45438
Net Surplus (m^3/year)	1512	3615	1745	912	420	7633	5404	676	1947	178	13736	7662	45438
Downspout Disconnection Retention[2] (m^3/year)	0	0	0	0	0	1908	1351	169	0	0	0	0	3428
Evapotranspiration (m^3/year)	4031	9640	4652	2431	1119	848	600	75	5193	474	1526	851	31441
Roof Evapotranspiration (m^3/year)	0	0	0	0	0	0	0	0	0	0	0	0	0
Rooftop Runoff Lawn Evaporation (m^3/year)	0	0	0	0	0	1488	1054	132	0	0	0	0	2674
Total Evapotranspiration (m^3/year)	**4031**	**9640**	**4652**	**2431**	**1119**	**2336**	**1654**	**207**	**5193**	474	**1526**	**851**	**34115**
Infiltration (m^3/year)	680	1627	785	410	252	0	0	0	876	80	0	0	4710
Rooftop Infiltration (m^3/year)	0	0	0	0	0	420	297	37	0	0	0	0	754
Topsoil Amendment Mitigation Infiltration (m^3/year	457	1094	528	0	0	0	0	0	0	0	0	0	2079
Infiltration through trenches	0	0	429	0	0	3132	0	0	0	0	0	0	3561
Total Infiltration (m^3/year)	**1138**	**2720**	**1742**	**410**	**252**	**3552**	**297**	**37**	**876**	80	**0**	**0**	**11104**
Runoff Pervious Area (m^3/year)	374	895	3	501	168	0	0	0	1071	98	0	0	3110
Runoff Impervious Area (m^3/year)	0	0	0	0	0	2592	4053	507	0	0	13736	7662	28551
Total Runoff (m^3/year)	**374**	**895**	**3**	**501**	**168**	**2592**	**4053**	**507**	**1071**	98	**13736**	**7662**	**31660**
Total Outputs (m^3/year)	**5543**	**13255**	**6397**	**3343**	**1538**	**8481**	**6005**	**751**	**7140**	**651**	**15263**	**8513**	**76879**
Difference (Inputs - Outputs)	0	0	0	0	0	0	0	0	0	0	0	0	**0**

1 - Infiltration factors based on MOE 2003 Guidelines

2 - Precipitation and evapotranspiration based on Preliminary Hydrogeological Investigation Report, Proposed Development at 200 John Street and 588 Charlott Street (2018) Cole Engineering Group Ltd.

3- Assumes 10% Evaporation from Impervious Surfaces

4- 55% Runoff Reduction by Soil Amendment

5- 25% Runoff retention by downspout disconnection

Water Balance Mitigation Calculations

Pre Development Infiltration =	**11,071**	**m^3/y**
Post Development Infiltration =	**4,710**	**m^3/y**
Post to Pre Deficit =	**6,361**	**m^3/y**

Annual Mitigation Volumes			
Topsoil Amendment Infiltration =	**2,079**	**m^3/y**	
Downspout Disconnection =	**754**	**m^3/y**	
Infiltration Trenches =	**3,561**	**m^3/y**	
Post to Pre Deficit =	**-33**	**m^3/y**	(or 33m^3/y surplus)

Infiltration Trenches in Rearyards Mitigation Measures

1.69 ha x Annual Precipitation Depth =	3,561	m^3/year	
Required Annual Precpitation Depth to meet deficit =		211	mm/yr
Based on this analysis, it is concluded that precipitation events of depth less than or equal to			*5.64 mm*
will produce an annual amount of precipitation equal to		211	mm/yr

A precipitation analysis (rainfall & snowfall) was conducted to estimate an event with sufficient precipitation that produces an annual runoff volume of 3561 m^3/year (or a total depth of annual rainfall equal to 5.64 mm)

The analysis was performed on daily precipitation data collected from St. Catharines from 1978 to 2000 by Environment Canada. The data was then arranged into four categories for each year: Total Annual Depth of Precipitation from events less than or equal to 5mm, 10mm, 15mm and 20mm. This yearly data was then used to determine an average annual precipitation depth.

Job: 4696
January 2019

Infiltration Sizing Calculations for Infiltration Trenches

Rear Lot Trenches Required

Infiltration System Footprint Area

Infiltration Volume	95.35	m^3	(5.64mm x Roof and Backyard Area to Trenches)
Total Number of Lots with Trench	62		
Inillftration Volume Per Unit	1.54	m^3/unit	
Maximum Drawdown Time	48	hours	
Infiltration Rate*	18	mm/h	
Infiltration Rate Safety Factor	2.5		
Design Infiltration Rate	7.20	mm/h	(Infiltration Rate / Safety Factor)
Required Footprint Area	690	m^2	

Rear Lot Trenches on Detached Lots (10.80m)

Proposed Infiltration Details - Trenches

Length = 9.8 m
Width = 1.2 m
Number of Detached Lots with Trench = 50
Total Trench Volume Provided per unit = 1.626 m^3/unit
Maximum Storage Depth = 0.35 m
Drawdown time = 48.00 hours
Total Volume retained = 81 m^3

(9.8m x 1.2m x 0.35 m)

Rear Lot Trenches on Semi-detached Lots (8.53m)

Proposed Infiltration Details - Trenches

Length = 7.5 m
Width = 1.2 m
Number of Semi-detached Lots with Trench = 12
Total Trench Volume Provided per unit = 1.244 m^3/unit
Maximum Storage Depth = 0.35 m
Drawdown time = 48.00 hours
Total Volume retained = 15 m^3

(7.5m x 1.2m x 0.35 m)

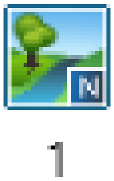
Total Volume retained = 96 m^3 > 95.35cu.m. required volume.

Therefore the proposed system has the required footprint area to drain within 48 hours and will provide a retention volume that exceeds the required volume for mitigation.

---

* Soils with Satutrated Hydraulic Conductivity = 2.5(10^{-6}) cm/s correlates to an infiltration rate of approximately 18mm/h as per Stormwater Management Criteria (TRCA, 2012) Appendix C-15.

Visual OTTHYMO^{TM} Model Results



SCHAEFFERS
CONSULTING ENGINEERS

Pre-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(3 hour Chicago Storm)

Job #: 2018-4696	**Date: January 2019**

```
****************************************
** SIMULATION:100yr 3hr 10min Chicago **
****************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 980.000
| Ptotal= 64.70 mm |                          B=   3.700
--------------------                          C=   0.732
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    6.80 |  1.00   35.84 |  1.83   13.51 |  2.67    7.17
                 0.33    7.87 |  1.17  144.26 |  2.00   11.32 |  2.83    6.62
                 0.50    9.43 |  1.33   42.89 |  2.17    9.81 |  3.00    6.15
                 0.67   12.01 |  1.50   23.73 |  2.33    8.71 |
                 0.83   17.23 |  1.67   17.02 |  2.50    7.85 |


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.80 | 0.833   17.23 | 1.583   17.02 |  2.33    8.71
                0.167    6.80 | 0.917   35.84 | 1.667   17.02 |  2.42    7.85
                0.250    7.87 | 1.000   35.84 | 1.750   13.51 |  2.50    7.85
                0.333    7.87 | 1.083  144.26 | 1.833   13.51 |  2.58    7.17
                0.417    9.43 | 1.167  144.26 | 1.917   11.32 |  2.67    7.17
                0.500    9.43 | 1.250   42.89 | 2.000   11.32 |  2.75    6.62
                0.583   12.01 | 1.333   42.89 | 2.083    9.81 |  2.83    6.62
                0.667   12.01 | 1.417   23.73 | 2.167    9.81 |  2.92    6.15
                0.750   17.23 | 1.500   23.73 | 2.250    8.71 |  3.00    6.15

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.233 (i)
     TIME TO PEAK    (hrs)=   2.167
     RUNOFF VOLUME    (mm)=  21.408
     TOTAL RAINFALL   (mm)=  64.704
     RUNOFF COEFFICIENT   =   0.331

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

-------------------------------------------------------------------------------
***************************************
** SIMULATION:10yr 3hr 10min Chicago **
***************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 724.000
| Ptotal= 45.98 mm |                          B=   4.300
--------------------                          C=   0.739
                        used in:   INTENSITY =  A / (t + B)^C
```

```
                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    4.76 |  1.00   26.02 |  1.83    9.61 |  2.67    5.03
                 0.33    5.53 |  1.17  101.38 |  2.00    8.02 |  2.83    4.64
                 0.50    6.65 |  1.33   31.22 |  2.17    6.93 |  3.00    4.30
                 0.67    8.52 |  1.50   17.11 |  2.33    6.13 |
                 0.83   12.33 |  1.67   12.17 |  2.50    5.52 |


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    4.76 | 0.833   12.33 | 1.583   12.17 |  2.33    6.13
                0.167    4.76 | 0.917   26.02 | 1.667   12.17 |  2.42    5.52
                0.250    5.53 | 1.000   26.02 | 1.750    9.61 |  2.50    5.52
                0.333    5.53 | 1.083  101.38 | 1.833    9.61 |  2.58    5.03
                0.417    6.65 | 1.167  101.38 | 1.917    8.02 |  2.67    5.03
                0.500    6.65 | 1.250   31.22 | 2.000    8.02 |  2.75    4.64
                0.583    8.52 | 1.333   31.22 | 2.083    6.93 |  2.83    4.64
                0.667    8.52 | 1.417   17.11 | 2.167    6.93 |  2.92    4.30
                0.750   12.33 | 1.500   17.11 | 2.250    6.13 |  3.00    4.30

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.122 (i)
     TIME TO PEAK    (hrs)=   2.250
     RUNOFF VOLUME    (mm)=  11.363
     TOTAL RAINFALL   (mm)=  45.978
     RUNOFF COEFFICIENT   =   0.247

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

-------------------------------------------------------------------------------
***************************************
** SIMULATION:25yr 3hr 10min Chicago **
***************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 821.000
| Ptotal= 53.30 mm |                          B=   4.000
--------------------                          C=   0.735
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    5.57 |  1.00   29.85 |  1.83   11.14 |  2.67    5.88
```

```
                 0.33    6.45 |  1.17  118.02 |  2.00    9.32 |  2.83    5.42
                 0.50    7.75 |  1.33   35.77 |  2.17    8.07 |  3.00    5.04
                 0.67    9.90 |  1.50   19.70 |  2.33    7.15 |
                 0.83   14.25 |  1.67   14.07 |  2.50    6.44 |


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    5.57 | 0.833   14.25 | 1.583   14.07 |  2.33    7.15
                0.167    5.57 | 0.917   29.85 | 1.667   14.07 |  2.42    6.44
                0.250    6.45 | 1.000   29.85 | 1.750   11.14 |  2.50    6.44
                0.333    6.45 | 1.083  118.02 | 1.833   11.14 |  2.58    5.88
                0.417    7.75 | 1.167  118.02 | 1.917    9.32 |  2.67    5.88
                0.500    7.75 | 1.250   35.77 | 2.000    9.32 |  2.75    5.42
                0.583    9.90 | 1.333   35.77 | 2.083    8.07 |  2.83    5.42
                0.667    9.90 | 1.417   19.70 | 2.167    8.07 |  2.92    5.04
                0.750   14.25 | 1.500   19.70 | 2.250    7.15 |  3.00    5.04

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.162 (i)
     TIME TO PEAK    (hrs)=   2.167
     RUNOFF VOLUME    (mm)=  15.042
     TOTAL RAINFALL   (mm)=  53.301
     RUNOFF COEFFICIENT   =   0.282

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

-------------------------------------------------------------------------------
**************************************
** SIMULATION:2yr 3hr 10min Chicago **
**************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 567.000
| Ptotal= 34.59 mm |                          B=   5.200
--------------------                          C=   0.746
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    3.55 |  1.00   20.16 |  1.83    7.29 |  2.67    3.75
                 0.33    4.13 |  1.17   74.46 |  2.00    6.05 |  2.83    3.45
                 0.50    5.00 |  1.33   24.22 |  2.17    5.21 |  3.00    3.20
                 0.67    6.44 |  1.50   13.18 |  2.33    4.60 |
                 0.83    9.42 |  1.67    9.29 |  2.50    4.13 |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```
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    3.55 | 0.833    9.42 | 1.583    9.29 |  2.33    4.60
                0.167    3.55 | 0.917   20.16 | 1.667    9.29 |  2.42    4.13
                0.250    4.13 | 1.000   20.16 | 1.750    7.29 |  2.50    4.13
                0.333    4.13 | 1.083   74.46 | 1.833    7.29 |  2.58    3.75
                0.417    5.00 | 1.167   74.46 | 1.917    6.05 |  2.67    3.75
                0.500    5.00 | 1.250   24.22 | 2.000    6.05 |  2.75    3.45
                0.583    6.44 | 1.333   24.22 | 2.083    5.21 |  2.83    3.45
                0.667    6.44 | 1.417   13.18 | 2.167    5.21 |  2.92    3.20
                0.750    9.42 | 1.500   13.18 | 2.250    4.60 |  3.00    3.20

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.068 (i)
     TIME TO PEAK    (hrs)=   2.250
     RUNOFF VOLUME    (mm)=   6.420
     TOTAL RAINFALL   (mm)=  34.590
     RUNOFF COEFFICIENT   =   0.186

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

-------------------------------------------------------------------------------
***************************************
** SIMULATION:50yr 3hr 10min Chicago **
***************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 900.000
| Ptotal= 58.78 mm |                          B=   3.800
--------------------                          C=   0.734
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    6.15 |  1.00   32.68 |  1.83   12.25 |  2.67    6.49
                 0.33    7.11 |  1.17  131.09 |  2.00   10.26 |  2.83    5.98
                 0.50    8.54 |  1.33   39.13 |  2.17    8.89 |  3.00    5.56
                 0.67   10.89 |  1.50   21.59 |  2.33    7.88 |
                 0.83   15.65 |  1.67   15.45 |  2.50    7.10 |


-------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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

```
                          ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.15 | 0.833   15.65 | 1.583   15.45 |  2.33    7.88
                0.167    6.15 | 0.917   32.68 | 1.667   15.45 |  2.42    7.10
                0.250    7.11 | 1.000   32.68 | 1.750   12.25 |  2.50    7.10
                0.333    7.11 | 1.083  131.09 | 1.833   12.25 |  2.58    6.49
                0.417    8.54 | 1.167  131.09 | 1.917   10.26 |  2.67    6.49
                0.500    8.54 | 1.250   39.13 | 2.000   10.26 |  2.75    5.98
                0.583   10.89 | 1.333   39.13 | 2.083    8.89 |  2.83    5.98
                0.667   10.89 | 1.417   21.59 | 2.167    8.89 |  2.92    5.56
                0.750   15.65 | 1.500   21.59 | 2.250    7.88 |  3.00    5.56

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.195 (i)
     TIME TO PEAK    (hrs)=   2.167
     RUNOFF VOLUME    (mm)=  18.013
     TOTAL RAINFALL   (mm)=  58.782
     RUNOFF COEFFICIENT   =   0.306

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

-------------------------------------------------------------------------------
**************************************
** SIMULATION:5yr 3hr 10min Chicago **
**************************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 664.000
| Ptotal= 41.02 mm |                          B=   4.700
--------------------                          C=   0.744
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  3.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.38

                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    4.21 |  1.00   23.53 |  1.83    8.57 |  2.67    4.45
                 0.33    4.89 |  1.17   89.88 |  2.00    7.13 |  2.83    4.09
                 0.50    5.90 |  1.33   28.27 |  2.17    6.15 |  3.00    3.79
                 0.67    7.59 |  1.50   15.40 |  2.33    5.43 |
                 0.83   11.04 |  1.67   10.90 |  2.50    4.88 |


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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                          ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    4.21 | 0.833   11.04 | 1.583   10.90 |  2.33    5.43
                0.167    4.21 | 0.917   23.53 | 1.667   10.90 |  2.42    4.88
                0.250    4.89 | 1.000   23.53 | 1.750    8.57 |  2.50    4.88
                0.333    4.89 | 1.083   89.88 | 1.833    8.57 |  2.58    4.45
                0.417    5.90 | 1.167   89.88 | 1.917    7.13 |  2.67    4.45
                0.500    5.90 | 1.250   28.27 | 2.000    7.13 |  2.75    4.09
                0.583    7.59 | 1.333   28.27 | 2.083    6.15 |  2.83    4.09
                0.667    7.59 | 1.417   15.40 | 2.167    6.15 |  2.92    3.79
                0.750   11.04 | 1.500   15.40 | 2.250    5.43 |  3.00    3.79

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.097 (i)
     TIME TO PEAK    (hrs)=   2.250
     RUNOFF VOLUME    (mm)=   9.083
     TOTAL RAINFALL   (mm)=  41.016
     RUNOFF COEFFICIENT   =   0.221

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

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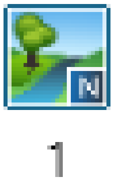

SCHAEFFERS
CONSULTING ENGINEERS

Pre-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(12 hour AES Storm)

Job #: 2018-4696 **Date: January 2019**

```
**************************************************
** SIMULATION:10 Year 12 Hour AES (Bloor, TRCA) **
**************************************************

--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\31f17d4f
| Ptotal= 62.71 mm |    Comments: 10 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50   10.66 |  6.75    4.39 | 10.00    0.63
                 0.50    0.63 |  3.75   10.66 |  7.00    4.39 | 10.25    0.63
                 0.75    0.63 |  4.00   10.66 |  7.25    4.39 | 10.50    0.63
                 1.00    0.63 |  4.25   10.66 |  7.50    2.51 | 10.75    0.63
                 1.25    0.63 |  4.50   28.84 |  7.75    2.51 | 11.00    0.63
                 1.50    0.63 |  4.75   28.84 |  8.00    2.51 | 11.25    0.63
                 1.75    0.63 |  5.00   28.84 |  8.25    2.51 | 11.50    0.63
                 2.00    0.63 |  5.25   28.84 |  8.50    1.25 | 11.75    0.63
                 2.25    0.63 |  5.50    8.15 |  8.75    1.25 | 12.00    0.63
                 2.50    3.76 |  5.75    8.15 |  9.00    1.25 | 12.25    0.63
                 2.75    3.76 |  6.00    8.15 |  9.25    1.25 |
                 3.00    3.76 |  6.25    8.15 |  9.50    0.63 |
                 3.25    3.76 |  6.50    4.39 |  9.75    0.63 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                            ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    3.76 | 6.250    8.15 |  9.33    0.63
                0.167    0.00 | 3.250    3.76 | 6.333    4.39 |  9.42    0.63
                0.250    0.00 | 3.333   10.66 | 6.417    4.39 |  9.50    0.63
                0.333    0.63 | 3.417   10.66 | 6.500    4.39 |  9.58    0.63
                0.417    0.63 | 3.500   10.66 | 6.583    4.39 |  9.67    0.63
                0.500    0.63 | 3.583   10.66 | 6.667    4.39 |  9.75    0.63
                0.583    0.63 | 3.667   10.66 | 6.750    4.39 |  9.83    0.63
                0.667    0.63 | 3.750   10.66 | 6.833    4.39 |  9.92    0.63
                0.750    0.63 | 3.833   10.66 | 6.917    4.39 | 10.00    0.63
                0.833    0.63 | 3.917   10.66 | 7.000    4.39 | 10.08    0.63
                0.917    0.63 | 4.000   10.66 | 7.083    4.39 | 10.17    0.63
                1.000    0.63 | 4.083   10.66 | 7.167    4.39 | 10.25    0.63
                1.083    0.63 | 4.167   10.66 | 7.250    4.39 | 10.33    0.63
                1.167    0.63 | 4.250   10.66 | 7.333    2.51 | 10.42    0.63
                1.250    0.63 | 4.333   28.84 | 7.417    2.51 | 10.50    0.63
                1.333    0.63 | 4.417   28.84 | 7.500    2.51 | 10.58    0.63
                1.417    0.63 | 4.500   28.84 | 7.583    2.51 | 10.67    0.63
                1.500    0.63 | 4.583   28.84 | 7.667    2.51 | 10.75    0.63
                1.583    0.63 | 4.667   28.84 | 7.750    2.51 | 10.83    0.63
                1.667    0.63 | 4.750   28.84 | 7.833    2.51 | 10.92    0.63
                1.750    0.63 | 4.833   28.84 | 7.917    2.51 | 11.00    0.63
                1.833    0.63 | 4.917   28.84 | 8.000    2.51 | 11.08    0.63
                1.917    0.63 | 5.000   28.84 | 8.083    2.51 | 11.17    0.63
                2.000    0.63 | 5.083   28.84 | 8.167    2.51 | 11.25    0.63
                2.083    0.63 | 5.167   28.84 | 8.250    2.51 | 11.33    0.63
                2.167    0.63 | 5.250   28.84 | 8.333    1.25 | 11.42    0.63
                2.250    0.63 | 5.333    8.15 | 8.417    1.25 | 11.50    0.63
                2.333    3.76 | 5.417    8.15 | 8.500    1.25 | 11.58    0.63
                2.417    3.76 | 5.500    8.15 | 8.583    1.25 | 11.67    0.63
                2.500    3.76 | 5.583    8.15 | 8.667    1.25 | 11.75    0.63
                2.583    3.76 | 5.667    8.15 | 8.750    1.25 | 11.83    0.63
                2.667    3.76 | 5.750    8.15 | 8.833    1.25 | 11.92    0.63
                2.750    3.76 | 5.833    8.15 | 8.917    1.25 | 12.00    0.63
                2.833    3.76 | 5.917    8.15 | 9.000    1.25 | 12.08    0.63
                2.917    3.76 | 6.000    8.15 | 9.083    1.25 | 12.17    0.63
                3.000    3.76 | 6.083    8.15 | 9.167    1.25 | 12.25    0.63
                3.083    3.76 | 6.167    8.15 | 9.250    1.25 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.155 (i)
     TIME TO PEAK    (hrs)=   5.833
     RUNOFF VOLUME    (mm)=  20.245
     TOTAL RAINFALL   (mm)=  62.710
     RUNOFF COEFFICIENT   =   0.323

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

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***************************************************
** SIMULATION:100 Year 12 Hour AES (Bloor, TRCA) **
***************************************************

--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\700cccb9
| Ptotal= 88.54 mm |    Comments: 100 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50   15.05 |  6.75    6.20 | 10.00    0.89
                 0.50    0.89 |  3.75   15.05 |  7.00    6.20 | 10.25    0.89
                 0.75    0.89 |  4.00   15.05 |  7.25    6.20 | 10.50    0.89
                 1.00    0.89 |  4.25   15.05 |  7.50    3.54 | 10.75    0.89
                 1.25    0.89 |  4.50   40.71 |  7.75    3.54 | 11.00    0.89
                 1.50    0.89 |  4.75   40.71 |  8.00    3.54 | 11.25    0.89
                 1.75    0.89 |  5.00   40.71 |  8.25    3.54 | 11.50    0.89
                 2.00    0.89 |  5.25   40.71 |  8.50    1.77 | 11.75    0.89
                 2.25    0.89 |  5.50   11.51 |  8.75    1.77 | 12.00    0.89
                 2.50    5.31 |  5.75   11.51 |  9.00    1.77 | 12.25    0.89
                 2.75    5.31 |  6.00   11.51 |  9.25    1.77 |
                 3.00    5.31 |  6.25   11.51 |  9.50    0.89 |
                 3.25    5.31 |  6.50    6.20 |  9.75    0.89 |

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                            ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
```

```
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs    mm/hr
               0.083    0.00 | 3.167    5.31 | 6.250   11.51 |  9.33    0.89
               0.167    0.00 | 3.250    5.31 | 6.333    6.20 |  9.42    0.89
               0.250    0.00 | 3.333   15.05 | 6.417    6.20 |  9.50    0.89
               0.333    0.89 | 3.417   15.05 | 6.500    6.20 |  9.58    0.89
               0.417    0.89 | 3.500   15.05 | 6.583    6.20 |  9.67    0.89
               0.500    0.89 | 3.583   15.05 | 6.667    6.20 |  9.75    0.89
               0.583    0.89 | 3.667   15.05 | 6.750    6.20 |  9.83    0.89
               0.667    0.89 | 3.750   15.05 | 6.833    6.20 |  9.92    0.89
               0.750    0.89 | 3.833   15.05 | 6.917    6.20 | 10.00    0.89
               0.833    0.89 | 3.917   15.05 | 7.000    6.20 | 10.08    0.89
               0.917    0.89 | 4.000   15.05 | 7.083    6.20 | 10.17    0.89
               1.000    0.89 | 4.083   15.05 | 7.167    6.20 | 10.25    0.89
               1.083    0.89 | 4.167   15.05 | 7.250    6.20 | 10.33    0.89
               1.167    0.89 | 4.250   15.05 | 7.333    3.54 | 10.42    0.89
               1.250    0.89 | 4.333   40.71 | 7.417    3.54 | 10.50    0.89
               1.333    0.89 | 4.417   40.71 | 7.500    3.54 | 10.58    0.89
               1.417    0.89 | 4.500   40.71 | 7.583    3.54 | 10.67    0.89
               1.500    0.89 | 4.583   40.71 | 7.667    3.54 | 10.75    0.89
               1.583    0.89 | 4.667   40.71 | 7.750    3.54 | 10.83    0.89
               1.667    0.89 | 4.750   40.71 | 7.833    3.54 | 10.92    0.89
               1.750    0.89 | 4.833   40.71 | 7.917    3.54 | 11.00    0.89
               1.833    0.89 | 4.917   40.71 | 8.000    3.54 | 11.08    0.89
               1.917    0.89 | 5.000   40.71 | 8.083    3.54 | 11.17    0.89
               2.000    0.89 | 5.083   40.71 | 8.167    3.54 | 11.25    0.89
               2.083    0.89 | 5.167   40.71 | 8.250    3.54 | 11.33    0.89
               2.167    0.89 | 5.250   40.71 | 8.333    1.77 | 11.42    0.89
               2.250    0.89 | 5.333   11.51 | 8.417    1.77 | 11.50    0.89
               2.333    5.31 | 5.417   11.51 | 8.500    1.77 | 11.58    0.89
               2.417    5.31 | 5.500   11.51 | 8.583    1.77 | 11.67    0.89
               2.500    5.31 | 5.583   11.51 | 8.667    1.77 | 11.75    0.89
               2.583    5.31 | 5.667   11.51 | 8.750    1.77 | 11.83    0.89
               2.667    5.31 | 5.750   11.51 | 8.833    1.77 | 11.92    0.89
               2.750    5.31 | 5.833   11.51 | 8.917    1.77 | 12.00    0.89
               2.833    5.31 | 5.917   11.51 | 9.000    1.77 | 12.08    0.89
               2.917    5.31 | 6.000   11.51 | 9.083    1.77 | 12.17    0.89
               3.000    5.31 | 6.083   11.51 | 9.167    1.77 | 12.25    0.89
               3.083    5.31 | 6.167   11.51 | 9.250    1.77 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.285 (i)
     TIME TO PEAK    (hrs)=   5.833
     RUNOFF VOLUME    (mm)=  36.666
     TOTAL RAINFALL   (mm)=  88.540
     RUNOFF COEFFICIENT   =   0.414

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

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*************************************************
** SIMULATION:2 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\a07a0687
| Ptotal= 42.00 mm |    Comments: 2 Year 12 Hour AES (Bloor, TRCA)
--------------------
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.25    0.00 |  3.50    7.14 |  6.75    2.94 | 10.00    0.42
                0.50    0.42 |  3.75    7.14 |  7.00    2.94 | 10.25    0.42
                0.75    0.42 |  4.00    7.14 |  7.25    2.94 | 10.50    0.42
                1.00    0.42 |  4.25    7.14 |  7.50    1.68 | 10.75    0.42
                1.25    0.42 |  4.50   19.32 |  7.75    1.68 | 11.00    0.42
                1.50    0.42 |  4.75   19.32 |  8.00    1.68 | 11.25    0.42
                1.75    0.42 |  5.00   19.32 |  8.25    1.68 | 11.50    0.42
                2.00    0.42 |  5.25   19.32 |  8.50    0.84 | 11.75    0.42
                2.25    0.42 |  5.50    5.46 |  8.75    0.84 | 12.00    0.42
                2.50    2.52 |  5.75    5.46 |  9.00    0.84 | 12.25    0.42
                2.75    2.52 |  6.00    5.46 |  9.25    0.84 |
                3.00    2.52 |  6.25    5.46 |  9.50    0.42 |
                3.25    2.52 |  6.50    2.94 |  9.75    0.42 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                            ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    2.52 | 6.250    5.46 |  9.33    0.42
                0.167    0.00 | 3.250    2.52 | 6.333    2.94 |  9.42    0.42
                0.250    0.00 | 3.333    7.14 | 6.417    2.94 |  9.50    0.42
                0.333    0.42 | 3.417    7.14 | 6.500    2.94 |  9.58    0.42
                0.417    0.42 | 3.500    7.14 | 6.583    2.94 |  9.67    0.42
                0.500    0.42 | 3.583    7.14 | 6.667    2.94 |  9.75    0.42
                0.583    0.42 | 3.667    7.14 | 6.750    2.94 |  9.83    0.42
                0.667    0.42 | 3.750    7.14 | 6.833    2.94 |  9.92    0.42
                0.750    0.42 | 3.833    7.14 | 6.917    2.94 | 10.00    0.42
                0.833    0.42 | 3.917    7.14 | 7.000    2.94 | 10.08    0.42
                0.917    0.42 | 4.000    7.14 | 7.083    2.94 | 10.17    0.42
                1.000    0.42 | 4.083    7.14 | 7.167    2.94 | 10.25    0.42
                1.083    0.42 | 4.167    7.14 | 7.250    2.94 | 10.33    0.42
                1.167    0.42 | 4.250    7.14 | 7.333    1.68 | 10.42    0.42
                1.250    0.42 | 4.333   19.32 | 7.417    1.68 | 10.50    0.42
                1.333    0.42 | 4.417   19.32 | 7.500    1.68 | 10.58    0.42
                1.417    0.42 | 4.500   19.32 | 7.583    1.68 | 10.67    0.42
                1.500    0.42 | 4.583   19.32 | 7.667    1.68 | 10.75    0.42
                1.583    0.42 | 4.667   19.32 | 7.750    1.68 | 10.83    0.42
                1.667    0.42 | 4.750   19.32 | 7.833    1.68 | 10.92    0.42
                1.750    0.42 | 4.833   19.32 | 7.917    1.68 | 11.00    0.42
                1.833    0.42 | 4.917   19.32 | 8.000    1.68 | 11.08    0.42
                1.917    0.42 | 5.000   19.32 | 8.083    1.68 | 11.17    0.42
                2.000    0.42 | 5.083   19.32 | 8.167    1.68 | 11.25    0.42
                2.083    0.42 | 5.167   19.32 | 8.250    1.68 | 11.33    0.42
                2.167    0.42 | 5.250   19.32 | 8.333    0.84 | 11.42    0.42
                2.250    0.42 | 5.333    5.46 | 8.417    0.84 | 11.50    0.42
                2.333    2.52 | 5.417    5.46 | 8.500    0.84 | 11.58    0.42
                2.417    2.52 | 5.500    5.46 | 8.583    0.84 | 11.67    0.42
                2.500    2.52 | 5.583    5.46 | 8.667    0.84 | 11.75    0.42
                2.583    2.52 | 5.667    5.46 | 8.750    0.84 | 11.83    0.42
                2.667    2.52 | 5.750    5.46 | 8.833    0.84 | 11.92    0.42
                2.750    2.52 | 5.833    5.46 | 8.917    0.84 | 12.00    0.42
                2.833    2.52 | 5.917    5.46 | 9.000    0.84 | 12.08    0.42
                2.917    2.52 | 6.000    5.46 | 9.083    0.84 | 12.17    0.42
                3.000    2.52 | 6.083    5.46 | 9.167    0.84 | 12.25    0.42
                3.083    2.52 | 6.167    5.46 | 9.250    0.84 |
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     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.071 (i)
     TIME TO PEAK    (hrs)=   5.917
     RUNOFF VOLUME    (mm)=   9.520
     TOTAL RAINFALL   (mm)=  42.000
     RUNOFF COEFFICIENT   =   0.227

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

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**************************************************
** SIMULATION:25 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\558d0d24
| Ptotal= 73.10 mm |    Comments: 25 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50   12.43 |  6.75    5.12 | 10.00    0.73
                 0.50    0.73 |  3.75   12.43 |  7.00    5.12 | 10.25    0.73
                 0.75    0.73 |  4.00   12.43 |  7.25    5.12 | 10.50    0.73
                 1.00    0.73 |  4.25   12.43 |  7.50    2.92 | 10.75    0.73
                 1.25    0.73 |  4.50   33.63 |  7.75    2.92 | 11.00    0.73
                 1.50    0.73 |  4.75   33.63 |  8.00    2.92 | 11.25    0.73
                 1.75    0.73 |  5.00   33.63 |  8.25    2.92 | 11.50    0.73
                 2.00    0.73 |  5.25   33.63 |  8.50    1.46 | 11.75    0.73
                 2.25    0.73 |  5.50    9.50 |  8.75    1.46 | 12.00    0.73
                 2.50    4.39 |  5.75    9.50 |  9.00    1.46 | 12.25    0.73
                 2.75    4.39 |  6.00    9.50 |  9.25    1.46 |
                 3.00    4.39 |  6.25    9.50 |  9.50    0.73 |
                 3.25    4.39 |  6.50    5.12 |  9.75    0.73 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    4.39 | 6.250    9.50 |  9.33    0.73
                0.167    0.00 | 3.250    4.39 | 6.333    5.12 |  9.42    0.73
                0.250    0.00 | 3.333   12.43 | 6.417    5.12 |  9.50    0.73
                0.333    0.73 | 3.417   12.43 | 6.500    5.12 |  9.58    0.73
                0.417    0.73 | 3.500   12.43 | 6.583    5.12 |  9.67    0.73
                0.500    0.73 | 3.583   12.43 | 6.667    5.12 |  9.75    0.73
                0.583    0.73 | 3.667   12.43 | 6.750    5.12 |  9.83    0.73
                0.667    0.73 | 3.750   12.43 | 6.833    5.12 |  9.92    0.73
                0.750    0.73 | 3.833   12.43 | 6.917    5.12 | 10.00    0.73
                0.833    0.73 | 3.917   12.43 | 7.000    5.12 | 10.08    0.73
                0.917    0.73 | 4.000   12.43 | 7.083    5.12 | 10.17    0.73
                1.000    0.73 | 4.083   12.43 | 7.167    5.12 | 10.25    0.73
                1.083    0.73 | 4.167   12.43 | 7.250    5.12 | 10.33    0.73
                1.167    0.73 | 4.250   12.43 | 7.333    2.92 | 10.42    0.73
                1.250    0.73 | 4.333   33.63 | 7.417    2.92 | 10.50    0.73
                1.333    0.73 | 4.417   33.63 | 7.500    2.92 | 10.58    0.73
                1.417    0.73 | 4.500   33.63 | 7.583    2.92 | 10.67    0.73
                1.500    0.73 | 4.583   33.63 | 7.667    2.92 | 10.75    0.73
                1.583    0.73 | 4.667   33.63 | 7.750    2.92 | 10.83    0.73
                1.667    0.73 | 4.750   33.63 | 7.833    2.92 | 10.92    0.73
                1.750    0.73 | 4.833   33.63 | 7.917    2.92 | 11.00    0.73
                1.833    0.73 | 4.917   33.63 | 8.000    2.92 | 11.08    0.73
                1.917    0.73 | 5.000   33.63 | 8.083    2.92 | 11.17    0.73
                2.000    0.73 | 5.083   33.63 | 8.167    2.92 | 11.25    0.73
                2.083    0.73 | 5.167   33.63 | 8.250    2.92 | 11.33    0.73
                2.167    0.73 | 5.250   33.63 | 8.333    1.46 | 11.42    0.73
                2.250    0.73 | 5.333    9.50 | 8.417    1.46 | 11.50    0.73
                2.333    4.39 | 5.417    9.50 | 8.500    1.46 | 11.58    0.73
                2.417    4.39 | 5.500    9.50 | 8.583    1.46 | 11.67    0.73
                2.500    4.39 | 5.583    9.50 | 8.667    1.46 | 11.75    0.73
                2.583    4.39 | 5.667    9.50 | 8.750    1.46 | 11.83    0.73
                2.667    4.39 | 5.750    9.50 | 8.833    1.46 | 11.92    0.73
                2.750    4.39 | 5.833    9.50 | 8.917    1.46 | 12.00    0.73
                2.833    4.39 | 5.917    9.50 | 9.000    1.46 | 12.08    0.73
                2.917    4.39 | 6.000    9.50 | 9.083    1.46 | 12.17    0.73
                3.000    4.39 | 6.083    9.50 | 9.167    1.46 | 12.25    0.73
                3.083    4.39 | 6.167    9.50 | 9.250    1.46 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.204 (i)
     TIME TO PEAK    (hrs)=   5.833
     RUNOFF VOLUME    (mm)=  26.516
     TOTAL RAINFALL   (mm)=  73.100
     RUNOFF COEFFICIENT   =   0.363

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

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*************************************************
** SIMULATION:5 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\54c54b2c
| Ptotal= 54.38 mm |    Comments: 5 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50    9.25 |  6.75    3.81 | 10.00    0.54
                 0.50    0.54 |  3.75    9.25 |  7.00    3.81 | 10.25    0.54
                 0.75    0.54 |  4.00    9.25 |  7.25    3.81 | 10.50    0.54
                 1.00    0.54 |  4.25    9.25 |  7.50    2.18 | 10.75    0.54
                 1.25    0.54 |  4.50   25.02 |  7.75    2.18 | 11.00    0.54
                 1.50    0.54 |  4.75   25.02 |  8.00    2.18 | 11.25    0.54
                 1.75    0.54 |  5.00   25.02 |  8.25    2.18 | 11.50    0.54
                 2.00    0.54 |  5.25   25.02 |  8.50    1.09 | 11.75    0.54
                 2.25    0.54 |  5.50    7.07 |  8.75    1.09 | 12.00    0.54
                 2.50    3.26 |  5.75    7.07 |  9.00    1.09 | 12.25    0.54
                 2.75    3.26 |  6.00    7.07 |  9.25    1.09 |
                 3.00    3.26 |  6.25    7.07 |  9.50    0.54 |
                 3.25    3.26 |  6.50    3.81 |  9.75    0.54 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    3.26 | 6.250    7.07 |  9.33    0.54
                0.167    0.00 | 3.250    3.26 | 6.333    3.81 |  9.42    0.54
                0.250    0.00 | 3.333    9.25 | 6.417    3.81 |  9.50    0.54
                0.333    0.54 | 3.417    9.25 | 6.500    3.81 |  9.58    0.54
                0.417    0.54 | 3.500    9.25 | 6.583    3.81 |  9.67    0.54
                0.500    0.54 | 3.583    9.25 | 6.667    3.81 |  9.75    0.54
                0.583    0.54 | 3.667    9.25 | 6.750    3.81 |  9.83    0.54
                0.667    0.54 | 3.750    9.25 | 6.833    3.81 |  9.92    0.54
                0.750    0.54 | 3.833    9.25 | 6.917    3.81 | 10.00    0.54
                0.833    0.54 | 3.917    9.25 | 7.000    3.81 | 10.08    0.54
                0.917    0.54 | 4.000    9.25 | 7.083    3.81 | 10.17    0.54
                1.000    0.54 | 4.083    9.25 | 7.167    3.81 | 10.25    0.54
                1.083    0.54 | 4.167    9.25 | 7.250    3.81 | 10.33    0.54
                1.167    0.54 | 4.250    9.25 | 7.333    2.18 | 10.42    0.54
                1.250    0.54 | 4.333   25.02 | 7.417    2.18 | 10.50    0.54
                1.333    0.54 | 4.417   25.02 | 7.500    2.18 | 10.58    0.54
                1.417    0.54 | 4.500   25.02 | 7.583    2.18 | 10.67    0.54
                1.500    0.54 | 4.583   25.02 | 7.667    2.18 | 10.75    0.54
                1.583    0.54 | 4.667   25.02 | 7.750    2.18 | 10.83    0.54
                1.667    0.54 | 4.750   25.02 | 7.833    2.18 | 10.92    0.54
                1.750    0.54 | 4.833   25.02 | 7.917    2.18 | 11.00    0.54
                1.833    0.54 | 4.917   25.02 | 8.000    2.18 | 11.08    0.54
                1.917    0.54 | 5.000   25.02 | 8.083    2.18 | 11.17    0.54
                2.000    0.54 | 5.083   25.02 | 8.167    2.18 | 11.25    0.54
                2.083    0.54 | 5.167   25.02 | 8.250    2.18 | 11.33    0.54
                2.167    0.54 | 5.250   25.02 | 8.333    1.09 | 11.42    0.54
                2.250    0.54 | 5.333    7.07 | 8.417    1.09 | 11.50    0.54
                2.333    3.26 | 5.417    7.07 | 8.500    1.09 | 11.58    0.54
                2.417    3.26 | 5.500    7.07 | 8.583    1.09 | 11.67    0.54
                2.500    3.26 | 5.583    7.07 | 8.667    1.09 | 11.75    0.54
                2.583    3.26 | 5.667    7.07 | 8.750    1.09 | 11.83    0.54
                2.667    3.26 | 5.750    7.07 | 8.833    1.09 | 11.92    0.54
                2.750    3.26 | 5.833    7.07 | 8.917    1.09 | 12.00    0.54
                2.833    3.26 | 5.917    7.07 | 9.000    1.09 | 12.08    0.54
                2.917    3.26 | 6.000    7.07 | 9.083    1.09 | 12.17    0.54
                3.000    3.26 | 6.083    7.07 | 9.167    1.09 | 12.25    0.54
                3.083    3.26 | 6.167    7.07 | 9.250    1.09 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.118 (i)
     TIME TO PEAK    (hrs)=   5.833
     RUNOFF VOLUME    (mm)=  15.613
     TOTAL RAINFALL   (mm)=  54.380
     RUNOFF COEFFICIENT   =   0.287

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

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**************************************************
** SIMULATION:50 Year 12 Hour AES (Bloor, TRCA) **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              01c79e78-7323-4480-8339-7cbfc77a4de5\a59d6e30
| Ptotal= 80.82 mm |    Comments: 50 Year 12 Hour AES (Bloor, TRCA)
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  3.50   13.74 |  6.75    5.66 | 10.00    0.81
                 0.50    0.81 |  3.75   13.74 |  7.00    5.66 | 10.25    0.81
                 0.75    0.81 |  4.00   13.74 |  7.25    5.66 | 10.50    0.81
                 1.00    0.81 |  4.25   13.74 |  7.50    3.23 | 10.75    0.81
                 1.25    0.81 |  4.50   37.17 |  7.75    3.23 | 11.00    0.81
                 1.50    0.81 |  4.75   37.17 |  8.00    3.23 | 11.25    0.81
                 1.75    0.81 |  5.00   37.17 |  8.25    3.23 | 11.50    0.81
                 2.00    0.81 |  5.25   37.17 |  8.50    1.62 | 11.75    0.81
                 2.25    0.81 |  5.50   10.50 |  8.75    1.62 | 12.00    0.81
                 2.50    4.85 |  5.75   10.50 |  9.00    1.62 | 12.25    0.81
                 2.75    4.85 |  6.00   10.50 |  9.25    1.62 |
                 3.00    4.85 |  6.25   10.50 |  9.50    0.81 |
                 3.25    4.85 |  6.50    5.66 |  9.75    0.81 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 3.167    4.85 | 6.250   10.50 |  9.33    0.81
                0.167    0.00 | 3.250    4.85 | 6.333    5.66 |  9.42    0.81
                0.250    0.00 | 3.333   13.74 | 6.417    5.66 |  9.50    0.81
                0.333    0.81 | 3.417   13.74 | 6.500    5.66 |  9.58    0.81
                0.417    0.81 | 3.500   13.74 | 6.583    5.66 |  9.67    0.81
                0.500    0.81 | 3.583   13.74 | 6.667    5.66 |  9.75    0.81
                0.583    0.81 | 3.667   13.74 | 6.750    5.66 |  9.83    0.81
                0.667    0.81 | 3.750   13.74 | 6.833    5.66 |  9.92    0.81
                0.750    0.81 | 3.833   13.74 | 6.917    5.66 | 10.00    0.81
                0.833    0.81 | 3.917   13.74 | 7.000    5.66 | 10.08    0.81
                0.917    0.81 | 4.000   13.74 | 7.083    5.66 | 10.17    0.81
                1.000    0.81 | 4.083   13.74 | 7.167    5.66 | 10.25    0.81
                1.083    0.81 | 4.167   13.74 | 7.250    5.66 | 10.33    0.81
                1.167    0.81 | 4.250   13.74 | 7.333    3.23 | 10.42    0.81
                1.250    0.81 | 4.333   37.17 | 7.417    3.23 | 10.50    0.81
                1.333    0.81 | 4.417   37.17 | 7.500    3.23 | 10.58    0.81
                1.417    0.81 | 4.500   37.17 | 7.583    3.23 | 10.67    0.81
                1.500    0.81 | 4.583   37.17 | 7.667    3.23 | 10.75    0.81
                1.583    0.81 | 4.667   37.17 | 7.750    3.23 | 10.83    0.81
                1.667    0.81 | 4.750   37.17 | 7.833    3.23 | 10.92    0.81
                1.750    0.81 | 4.833   37.17 | 7.917    3.23 | 11.00    0.81
                1.833    0.81 | 4.917   37.17 | 8.000    3.23 | 11.08    0.81
                1.917    0.81 | 5.000   37.17 | 8.083    3.23 | 11.17    0.81
                2.000    0.81 | 5.083   37.17 | 8.167    3.23 | 11.25    0.81
                2.083    0.81 | 5.167   37.17 | 8.250    3.23 | 11.33    0.81
                2.167    0.81 | 5.250   37.17 | 8.333    1.62 | 11.42    0.81
                2.250    0.81 | 5.333   10.50 | 8.417    1.62 | 11.50    0.81
```

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                2.333    4.85 | 5.417   10.50 | 8.500    1.62 | 11.58    0.81
                2.417    4.85 | 5.500   10.50 | 8.583    1.62 | 11.67    0.81
                2.500    4.85 | 5.583   10.50 | 8.667    1.62 | 11.75    0.81
                2.583    4.85 | 5.667   10.50 | 8.750    1.62 | 11.83    0.81
                2.667    4.85 | 5.750   10.50 | 8.833    1.62 | 11.92    0.81
                2.750    4.85 | 5.833   10.50 | 8.917    1.62 | 12.00    0.81
                2.833    4.85 | 5.917   10.50 | 9.000    1.62 | 12.08    0.81
                2.917    4.85 | 6.000   10.50 | 9.083    1.62 | 12.17    0.81
                3.000    4.85 | 6.083   10.50 | 9.167    1.62 | 12.25    0.81
                3.083    4.85 | 6.167   10.50 | 9.250    1.62 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.244 (i)
     TIME TO PEAK    (hrs)=   5.833
     RUNOFF VOLUME    (mm)=  31.479
     TOTAL RAINFALL   (mm)=  80.820
     RUNOFF COEFFICIENT   =   0.389

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

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SCHAEFFERS
CONSULTING ENGINEERS

Pre-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(24 hour SCS Storm)

Job #: 2018-4696	**Date: January 2019**

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*************************************
** SIMULATION:100yr 24hr 15min SCS **
*************************************

--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\43f15dc8
| Ptotal=114.47 mm |    Comments: 100yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    2.06 | 12.75   16.48 | 19.00    2.06
                 0.50    1.26 |  6.75    2.06 | 13.00    8.47 | 19.25    2.06
                 0.75    1.26 |  7.00    2.06 | 13.25    8.47 | 19.50    2.06
                 1.00    1.26 |  7.25    2.06 | 13.50    6.18 | 19.75    2.06
                 1.25    1.26 |  7.50    2.52 | 13.75    6.18 | 20.00    2.06
                 1.50    1.26 |  7.75    2.52 | 14.00    4.81 | 20.25    2.06
                 1.75    1.26 |  8.00    2.52 | 14.25    4.81 | 20.50    1.37
                 2.00    1.26 |  8.25    2.52 | 14.50    3.43 | 20.75    1.37
                 2.25    1.26 |  8.50    2.98 | 14.75    3.43 | 21.00    1.37
                 2.50    1.49 |  8.75    2.98 | 15.00    3.43 | 21.25    1.37
                 2.75    1.49 |  9.00    3.21 | 15.25    3.43 | 21.50    1.37
                 3.00    1.49 |  9.25    3.21 | 15.50    3.43 | 21.75    1.37
                 3.25    1.49 |  9.50    3.66 | 15.75    3.43 | 22.00    1.37
                 3.50    1.49 |  9.75    3.66 | 16.00    3.43 | 22.25    1.37
                 3.75    1.49 | 10.00    4.12 | 16.25    3.43 | 22.50    1.37
                 4.00    1.49 | 10.25    4.12 | 16.50    2.06 | 22.75    1.37
                 4.25    1.49 | 10.50    5.27 | 16.75    2.06 | 23.00    1.37
                 4.50    1.83 | 10.75    5.27 | 17.00    2.06 | 23.25    1.37
                 4.75    1.83 | 11.00    7.10 | 17.25    2.06 | 23.50    1.37
                 5.00    1.83 | 11.25    7.10 | 17.50    2.06 | 23.75    1.37
                 5.25    1.83 | 11.50   10.99 | 17.75    2.06 | 24.00    1.37
                 5.50    1.83 | 11.75   10.99 | 18.00    2.06 | 24.25    1.37
                 5.75    1.83 | 12.00   33.88 | 18.25    2.06 |
                 6.00    1.83 | 12.25  140.11 | 18.50    2.06 |
                 6.25    1.83 | 12.50   16.48 | 18.75    2.06 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    1.83 |12.250  140.11 | 18.33    2.06
                0.167    0.00 | 6.250    1.83 |12.333   16.50 | 18.42    2.06
                0.250    0.00 | 6.333    2.06 |12.417   16.48 | 18.50    2.06
                0.333    1.26 | 6.417    2.06 |12.500   16.48 | 18.58    2.06
                0.417    1.26 | 6.500    2.06 |12.583   16.48 | 18.67    2.06
                0.500    1.26 | 6.583    2.06 |12.667   16.48 | 18.75    2.06
                0.583    1.26 | 6.667    2.06 |12.750   16.48 | 18.83    2.06
                0.667    1.26 | 6.750    2.06 |12.833    8.47 | 18.92    2.06
                0.750    1.26 | 6.833    2.06 |12.917    8.47 | 19.00    2.06
                0.833    1.26 | 6.917    2.06 |13.000    8.47 | 19.08    2.06
                0.917    1.26 | 7.000    2.06 |13.083    8.47 | 19.17    2.06
                1.000    1.26 | 7.083    2.06 |13.167    8.47 | 19.25    2.06
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                1.083    1.26 | 7.167    2.06 |13.250    8.47 | 19.33    2.06
                1.167    1.26 | 7.250    2.06 |13.333    6.18 | 19.42    2.06
                1.250    1.26 | 7.333    2.52 |13.417    6.18 | 19.50    2.06
                1.333    1.26 | 7.417    2.52 |13.500    6.18 | 19.58    2.06
                1.417    1.26 | 7.500    2.52 |13.583    6.18 | 19.67    2.06
                1.500    1.26 | 7.583    2.52 |13.667    6.18 | 19.75    2.06
                1.583    1.26 | 7.667    2.52 |13.750    6.18 | 19.83    2.06
                1.667    1.26 | 7.750    2.52 |13.833    4.81 | 19.92    2.06
                1.750    1.26 | 7.833    2.52 |13.917    4.81 | 20.00    2.06
                1.833    1.26 | 7.917    2.52 |14.000    4.81 | 20.08    2.06
                1.917    1.26 | 8.000    2.52 |14.083    4.81 | 20.17    2.06
                2.000    1.26 | 8.083    2.52 |14.167    4.81 | 20.25    2.06
                2.083    1.26 | 8.167    2.52 |14.250    4.81 | 20.33    1.37
                2.167    1.26 | 8.250    2.52 |14.333    3.43 | 20.42    1.37
                2.250    1.26 | 8.333    2.98 |14.417    3.43 | 20.50    1.37
                2.333    1.49 | 8.417    2.98 |14.500    3.43 | 20.58    1.37
                2.417    1.49 | 8.500    2.98 |14.583    3.43 | 20.67    1.37
                2.500    1.49 | 8.583    2.98 |14.667    3.43 | 20.75    1.37
                2.583    1.49 | 8.667    2.98 |14.750    3.43 | 20.83    1.37
                2.667    1.49 | 8.750    2.98 |14.833    3.43 | 20.92    1.37
                2.750    1.49 | 8.833    3.21 |14.917    3.43 | 21.00    1.37
                2.833    1.49 | 8.917    3.21 |15.000    3.43 | 21.08    1.37
                2.917    1.49 | 9.000    3.21 |15.083    3.43 | 21.17    1.37
                3.000    1.49 | 9.083    3.21 |15.167    3.43 | 21.25    1.37
                3.083    1.49 | 9.167    3.21 |15.250    3.43 | 21.33    1.37
                3.167    1.49 | 9.250    3.21 |15.333    3.43 | 21.42    1.37
                3.250    1.49 | 9.333    3.66 |15.417    3.43 | 21.50    1.37
                3.333    1.49 | 9.417    3.66 |15.500    3.43 | 21.58    1.37
                3.417    1.49 | 9.500    3.66 |15.583    3.43 | 21.67    1.37
                3.500    1.49 | 9.583    3.66 |15.667    3.43 | 21.75    1.37
                3.583    1.49 | 9.667    3.66 |15.750    3.43 | 21.83    1.37
                3.667    1.49 | 9.750    3.66 |15.833    3.43 | 21.92    1.37
                3.750    1.49 | 9.833    4.12 |15.917    3.43 | 22.00    1.37
                3.833    1.49 | 9.917    4.12 |16.000    3.43 | 22.08    1.37
                3.917    1.49 |10.000    4.12 |16.083    3.43 | 22.17    1.37
                4.000    1.49 |10.083    4.12 |16.167    3.43 | 22.25    1.37
                4.083    1.49 |10.167    4.12 |16.250    3.43 | 22.33    1.37
                4.167    1.49 |10.250    4.12 |16.333    2.06 | 22.42    1.37
                4.250    1.49 |10.333    5.27 |16.417    2.06 | 22.50    1.37
                4.333    1.83 |10.417    5.27 |16.500    2.06 | 22.58    1.37
                4.417    1.83 |10.500    5.27 |16.583    2.06 | 22.67    1.37
                4.500    1.83 |10.583    5.27 |16.667    2.06 | 22.75    1.37
                4.583    1.83 |10.667    5.27 |16.750    2.06 | 22.83    1.37
                4.667    1.83 |10.750    5.27 |16.833    2.06 | 22.92    1.37
                4.750    1.83 |10.833    7.10 |16.917    2.06 | 23.00    1.37
                4.833    1.83 |10.917    7.10 |17.000    2.06 | 23.08    1.37
                4.917    1.83 |11.000    7.10 |17.083    2.06 | 23.17    1.37
                5.000    1.83 |11.083    7.10 |17.167    2.06 | 23.25    1.37
                5.083    1.83 |11.167    7.10 |17.250    2.06 | 23.33    1.37
                5.167    1.83 |11.250    7.10 |17.333    2.06 | 23.42    1.37
                5.250    1.83 |11.333   10.99 |17.417    2.06 | 23.50    1.37
                5.333    1.83 |11.417   10.99 |17.500    2.06 | 23.58    1.37
                5.417    1.83 |11.500   10.99 |17.583    2.06 | 23.67    1.37
                5.500    1.83 |11.583   10.99 |17.667    2.06 | 23.75    1.37
                5.583    1.83 |11.667   10.99 |17.750    2.06 | 23.83    1.37
                5.667    1.83 |11.750   10.99 |17.833    2.06 | 23.92    1.37
                5.750    1.83 |11.833   33.88 |17.917    2.06 | 24.00    1.37
                5.833    1.83 |11.917   33.88 |18.000    2.06 | 24.08    1.37
                5.917    1.83 |12.000   33.88 |18.083    2.06 | 24.17    1.37
                6.000    1.83 |12.083  140.10 |18.167    2.06 | 24.25    1.37
                6.083    1.83 |12.167  140.11 |18.250    2.06 |

     Unit Hyd Qpeak  (cms)=   0.392
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```
     PEAK FLOW       (cms)=   0.434 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  55.411
     TOTAL RAINFALL   (mm)= 114.470
     RUNOFF COEFFICIENT   =   0.484

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

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************************************
** SIMULATION:10yr 24hr 15min SCS **
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--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\49c56945
| Ptotal= 80.35 mm |    Comments: 10yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    1.45 | 12.75   11.57 | 19.00    1.45
                 0.50    0.88 |  6.75    1.45 | 13.00    5.95 | 19.25    1.45
                 0.75    0.88 |  7.00    1.45 | 13.25    5.95 | 19.50    1.45
                 1.00    0.88 |  7.25    1.45 | 13.50    4.34 | 19.75    1.45
                 1.25    0.88 |  7.50    1.77 | 13.75    4.34 | 20.00    1.45
                 1.50    0.88 |  7.75    1.77 | 14.00    3.37 | 20.25    1.45
                 1.75    0.88 |  8.00    1.77 | 14.25    3.37 | 20.50    0.96
                 2.00    0.88 |  8.25    1.77 | 14.50    2.41 | 20.75    0.96
                 2.25    0.88 |  8.50    2.09 | 14.75    2.41 | 21.00    0.96
                 2.50    1.04 |  8.75    2.09 | 15.00    2.41 | 21.25    0.96
                 2.75    1.04 |  9.00    2.25 | 15.25    2.41 | 21.50    0.96
                 3.00    1.04 |  9.25    2.25 | 15.50    2.41 | 21.75    0.96
                 3.25    1.04 |  9.50    2.57 | 15.75    2.41 | 22.00    0.96
                 3.50    1.04 |  9.75    2.57 | 16.00    2.41 | 22.25    0.96
                 3.75    1.04 | 10.00    2.89 | 16.25    2.41 | 22.50    0.96
                 4.00    1.04 | 10.25    2.89 | 16.50    1.45 | 22.75    0.96
                 4.25    1.04 | 10.50    3.70 | 16.75    1.45 | 23.00    0.96
                 4.50    1.29 | 10.75    3.70 | 17.00    1.45 | 23.25    0.96
                 4.75    1.29 | 11.00    4.98 | 17.25    1.45 | 23.50    0.96
                 5.00    1.29 | 11.25    4.98 | 17.50    1.45 | 23.75    0.96
                 5.25    1.29 | 11.50    7.71 | 17.75    1.45 | 24.00    0.96
                 5.50    1.29 | 11.75    7.71 | 18.00    1.45 | 24.25    0.96
                 5.75    1.29 | 12.00   23.78 | 18.25    1.45 |
                 6.00    1.29 | 12.25   98.35 | 18.50    1.45 |
                 6.25    1.29 | 12.50   11.57 | 18.75    1.45 |

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--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    1.29 |12.250   98.35 | 18.33    1.45
                0.167    0.00 | 6.250    1.29 |12.333   11.58 | 18.42    1.45
                0.250    0.00 | 6.333    1.45 |12.417   11.57 | 18.50    1.45
```

```
                0.333    0.88 | 6.417    1.45 |12.500   11.57 | 18.58    1.45
                0.417    0.88 | 6.500    1.45 |12.583   11.57 | 18.67    1.45
                0.500    0.88 | 6.583    1.45 |12.667   11.57 | 18.75    1.45
                0.583    0.88 | 6.667    1.45 |12.750   11.57 | 18.83    1.45
                0.667    0.88 | 6.750    1.45 |12.833    5.95 | 18.92    1.45
                0.750    0.88 | 6.833    1.45 |12.917    5.95 | 19.00    1.45
                0.833    0.88 | 6.917    1.45 |13.000    5.95 | 19.08    1.45
                0.917    0.88 | 7.000    1.45 |13.083    5.95 | 19.17    1.45
                1.000    0.88 | 7.083    1.45 |13.167    5.95 | 19.25    1.45
                1.083    0.88 | 7.167    1.45 |13.250    5.95 | 19.33    1.45
                1.167    0.88 | 7.250    1.45 |13.333    4.34 | 19.42    1.45
                1.250    0.88 | 7.333    1.77 |13.417    4.34 | 19.50    1.45
                1.333    0.88 | 7.417    1.77 |13.500    4.34 | 19.58    1.45
                1.417    0.88 | 7.500    1.77 |13.583    4.34 | 19.67    1.45
                1.500    0.88 | 7.583    1.77 |13.667    4.34 | 19.75    1.45
                1.583    0.88 | 7.667    1.77 |13.750    4.34 | 19.83    1.45
                1.667    0.88 | 7.750    1.77 |13.833    3.37 | 19.92    1.45
                1.750    0.88 | 7.833    1.77 |13.917    3.37 | 20.00    1.45
                1.833    0.88 | 7.917    1.77 |14.000    3.37 | 20.08    1.45
                1.917    0.88 | 8.000    1.77 |14.083    3.37 | 20.17    1.45
                2.000    0.88 | 8.083    1.77 |14.167    3.37 | 20.25    1.45
                2.083    0.88 | 8.167    1.77 |14.250    3.37 | 20.33    0.96
                2.167    0.88 | 8.250    1.77 |14.333    2.41 | 20.42    0.96
                2.250    0.88 | 8.333    2.09 |14.417    2.41 | 20.50    0.96
                2.333    1.04 | 8.417    2.09 |14.500    2.41 | 20.58    0.96
                2.417    1.04 | 8.500    2.09 |14.583    2.41 | 20.67    0.96
                2.500    1.04 | 8.583    2.09 |14.667    2.41 | 20.75    0.96
                2.583    1.04 | 8.667    2.09 |14.750    2.41 | 20.83    0.96
                2.667    1.04 | 8.750    2.09 |14.833    2.41 | 20.92    0.96
                2.750    1.04 | 8.833    2.25 |14.917    2.41 | 21.00    0.96
                2.833    1.04 | 8.917    2.25 |15.000    2.41 | 21.08    0.96
                2.917    1.04 | 9.000    2.25 |15.083    2.41 | 21.17    0.96
                3.000    1.04 | 9.083    2.25 |15.167    2.41 | 21.25    0.96
                3.083    1.04 | 9.167    2.25 |15.250    2.41 | 21.33    0.96
                3.167    1.04 | 9.250    2.25 |15.333    2.41 | 21.42    0.96
                3.250    1.04 | 9.333    2.57 |15.417    2.41 | 21.50    0.96
                3.333    1.04 | 9.417    2.57 |15.500    2.41 | 21.58    0.96
                3.417    1.04 | 9.500    2.57 |15.583    2.41 | 21.67    0.96
                3.500    1.04 | 9.583    2.57 |15.667    2.41 | 21.75    0.96
                3.583    1.04 | 9.667    2.57 |15.750    2.41 | 21.83    0.96
                3.667    1.04 | 9.750    2.57 |15.833    2.41 | 21.92    0.96
                3.750    1.04 | 9.833    2.89 |15.917    2.41 | 22.00    0.96
                3.833    1.04 | 9.917    2.89 |16.000    2.41 | 22.08    0.96
                3.917    1.04 |10.000    2.89 |16.083    2.41 | 22.17    0.96
                4.000    1.04 |10.083    2.89 |16.167    2.41 | 22.25    0.96
                4.083    1.04 |10.167    2.89 |16.250    2.41 | 22.33    0.96
                4.167    1.04 |10.250    2.89 |16.333    1.45 | 22.42    0.96
                4.250    1.04 |10.333    3.70 |16.417    1.45 | 22.50    0.96
                4.333    1.29 |10.417    3.70 |16.500    1.45 | 22.58    0.96
                4.417    1.29 |10.500    3.70 |16.583    1.45 | 22.67    0.96
                4.500    1.29 |10.583    3.70 |16.667    1.45 | 22.75    0.96
                4.583    1.29 |10.667    3.70 |16.750    1.45 | 22.83    0.96
                4.667    1.29 |10.750    3.70 |16.833    1.45 | 22.92    0.96
                4.750    1.29 |10.833    4.98 |16.917    1.45 | 23.00    0.96
                4.833    1.29 |10.917    4.98 |17.000    1.45 | 23.08    0.96
                4.917    1.29 |11.000    4.98 |17.083    1.45 | 23.17    0.96
                5.000    1.29 |11.083    4.98 |17.167    1.45 | 23.25    0.96
                5.083    1.29 |11.167    4.98 |17.250    1.45 | 23.33    0.96
                5.167    1.29 |11.250    4.98 |17.333    1.45 | 23.42    0.96
                5.250    1.29 |11.333    7.71 |17.417    1.45 | 23.50    0.96
                5.333    1.29 |11.417    7.71 |17.500    1.45 | 23.58    0.96
                5.417    1.29 |11.500    7.71 |17.583    1.45 | 23.67    0.96
                5.500    1.29 |11.583    7.71 |17.667    1.45 | 23.75    0.96
                5.583    1.29 |11.667    7.71 |17.750    1.45 | 23.83    0.96
```

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                5.667    1.29 |11.750    7.71 |17.833    1.45 | 23.92    0.96
                5.750    1.29 |11.833   23.78 |17.917    1.45 | 24.00    0.96
                5.833    1.29 |11.917   23.78 |18.000    1.45 | 24.08    0.96
                5.917    1.29 |12.000   23.78 |18.083    1.45 | 24.17    0.96
                6.000    1.29 |12.083   98.34 |18.167    1.45 | 24.25    0.96
                6.083    1.29 |12.167   98.35 |18.250    1.45 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.240 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  31.170
     TOTAL RAINFALL   (mm)=  80.350
     RUNOFF COEFFICIENT   =   0.388

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

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************************************
** SIMULATION:25yr 24hr 15min SCS **
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--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\1567aed1
| Ptotal= 93.82 mm |    Comments: 25yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    1.69 | 12.75   13.51 | 19.00    1.69
                 0.50    1.03 |  6.75    1.69 | 13.00    6.94 | 19.25    1.69
                 0.75    1.03 |  7.00    1.69 | 13.25    6.94 | 19.50    1.69
                 1.00    1.03 |  7.25    1.69 | 13.50    5.07 | 19.75    1.69
                 1.25    1.03 |  7.50    2.06 | 13.75    5.07 | 20.00    1.69
                 1.50    1.03 |  7.75    2.06 | 14.00    3.94 | 20.25    1.69
                 1.75    1.03 |  8.00    2.06 | 14.25    3.94 | 20.50    1.13
                 2.00    1.03 |  8.25    2.06 | 14.50    2.81 | 20.75    1.13
                 2.25    1.03 |  8.50    2.44 | 14.75    2.81 | 21.00    1.13
                 2.50    1.22 |  8.75    2.44 | 15.00    2.81 | 21.25    1.13
                 2.75    1.22 |  9.00    2.63 | 15.25    2.81 | 21.50    1.13
                 3.00    1.22 |  9.25    2.63 | 15.50    2.81 | 21.75    1.13
                 3.25    1.22 |  9.50    3.00 | 15.75    2.81 | 22.00    1.13
                 3.50    1.22 |  9.75    3.00 | 16.00    2.81 | 22.25    1.13
                 3.75    1.22 | 10.00    3.38 | 16.25    2.81 | 22.50    1.13
                 4.00    1.22 | 10.25    3.38 | 16.50    1.69 | 22.75    1.13
                 4.25    1.22 | 10.50    4.32 | 16.75    1.69 | 23.00    1.13
                 4.50    1.50 | 10.75    4.32 | 17.00    1.69 | 23.25    1.13
                 4.75    1.50 | 11.00    5.82 | 17.25    1.69 | 23.50    1.13
                 5.00    1.50 | 11.25    5.82 | 17.50    1.69 | 23.75    1.13
                 5.25    1.50 | 11.50    9.01 | 17.75    1.69 | 24.00    1.13
                 5.50    1.50 | 11.75    9.01 | 18.00    1.69 | 24.25    1.13
                 5.75    1.50 | 12.00   27.77 | 18.25    1.69 |
                 6.00    1.50 | 12.25  114.84 | 18.50    1.69 |
                 6.25    1.50 | 12.50   13.51 | 18.75    1.69 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81
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NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                    ---- TRANSFORMED HYETOGRAPH ----
      TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
       hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
     0.083    0.00 | 6.167    1.50 |12.250  114.84 | 18.33    1.69
     0.167    0.00 | 6.250    1.50 |12.333   13.52 | 18.42    1.69
     0.250    0.00 | 6.333    1.69 |12.417   13.51 | 18.50    1.69
     0.333    1.03 | 6.417    1.69 |12.500   13.51 | 18.58    1.69
     0.417    1.03 | 6.500    1.69 |12.583   13.51 | 18.67    1.69
     0.500    1.03 | 6.583    1.69 |12.667   13.51 | 18.75    1.69
     0.583    1.03 | 6.667    1.69 |12.750   13.51 | 18.83    1.69
     0.667    1.03 | 6.750    1.69 |12.833    6.94 | 18.92    1.69
     0.750    1.03 | 6.833    1.69 |12.917    6.94 | 19.00    1.69
     0.833    1.03 | 6.917    1.69 |13.000    6.94 | 19.08    1.69
     0.917    1.03 | 7.000    1.69 |13.083    6.94 | 19.17    1.69
     1.000    1.03 | 7.083    1.69 |13.167    6.94 | 19.25    1.69
     1.083    1.03 | 7.167    1.69 |13.250    6.94 | 19.33    1.69
     1.167    1.03 | 7.250    1.69 |13.333    5.07 | 19.42    1.69
     1.250    1.03 | 7.333    2.06 |13.417    5.07 | 19.50    1.69
     1.333    1.03 | 7.417    2.06 |13.500    5.07 | 19.58    1.69
     1.417    1.03 | 7.500    2.06 |13.583    5.07 | 19.67    1.69
     1.500    1.03 | 7.583    2.06 |13.667    5.07 | 19.75    1.69
     1.583    1.03 | 7.667    2.06 |13.750    5.07 | 19.83    1.69
     1.667    1.03 | 7.750    2.06 |13.833    3.94 | 19.92    1.69
     1.750    1.03 | 7.833    2.06 |13.917    3.94 | 20.00    1.69
     1.833    1.03 | 7.917    2.06 |14.000    3.94 | 20.08    1.69
     1.917    1.03 | 8.000    2.06 |14.083    3.94 | 20.17    1.69
     2.000    1.03 | 8.083    2.06 |14.167    3.94 | 20.25    1.69
     2.083    1.03 | 8.167    2.06 |14.250    3.94 | 20.33    1.13
     2.167    1.03 | 8.250    2.06 |14.333    2.81 | 20.42    1.13
     2.250    1.03 | 8.333    2.44 |14.417    2.81 | 20.50    1.13
     2.333    1.22 | 8.417    2.44 |14.500    2.81 | 20.58    1.13
     2.417    1.22 | 8.500    2.44 |14.583    2.81 | 20.67    1.13
     2.500    1.22 | 8.583    2.44 |14.667    2.81 | 20.75    1.13
     2.583    1.22 | 8.667    2.44 |14.750    2.81 | 20.83    1.13
     2.667    1.22 | 8.750    2.44 |14.833    2.81 | 20.92    1.13
     2.750    1.22 | 8.833    2.63 |14.917    2.81 | 21.00    1.13
     2.833    1.22 | 8.917    2.63 |15.000    2.81 | 21.08    1.13
     2.917    1.22 | 9.000    2.63 |15.083    2.81 | 21.17    1.13
     3.000    1.22 | 9.083    2.63 |15.167    2.81 | 21.25    1.13
     3.083    1.22 | 9.167    2.63 |15.250    2.81 | 21.33    1.13
     3.167    1.22 | 9.250    2.63 |15.333    2.81 | 21.42    1.13
     3.250    1.22 | 9.333    3.00 |15.417    2.81 | 21.50    1.13
     3.333    1.22 | 9.417    3.00 |15.500    2.81 | 21.58    1.13
     3.417    1.22 | 9.500    3.00 |15.583    2.81 | 21.67    1.13
     3.500    1.22 | 9.583    3.00 |15.667    2.81 | 21.75    1.13
     3.583    1.22 | 9.667    3.00 |15.750    2.81 | 21.83    1.13
     3.667    1.22 | 9.750    3.00 |15.833    2.81 | 21.92    1.13
     3.750    1.22 | 9.833    3.38 |15.917    2.81 | 22.00    1.13
     3.833    1.22 | 9.917    3.38 |16.000    2.81 | 22.08    1.13
     3.917    1.22 |10.000    3.38 |16.083    2.81 | 22.17    1.13
     4.000    1.22 |10.083    3.38 |16.167    2.81 | 22.25    1.13
     4.083    1.22 |10.167    3.38 |16.250    2.81 | 22.33    1.13
     4.167    1.22 |10.250    3.38 |16.333    1.69 | 22.42    1.13
     4.250    1.22 |10.333    4.32 |16.417    1.69 | 22.50    1.13
     4.333    1.50 |10.417    4.32 |16.500    1.69 | 22.58    1.13
     4.417    1.50 |10.500    4.32 |16.583    1.69 | 22.67    1.13
     4.500    1.50 |10.583    4.32 |16.667    1.69 | 22.75    1.13
     4.583    1.50 |10.667    4.32 |16.750    1.69 | 22.83    1.13
     4.667    1.50 |10.750    4.32 |16.833    1.69 | 22.92    1.13
     4.750    1.50 |10.833    5.82 |16.917    1.69 | 23.00    1.13
     4.833    1.50 |10.917    5.82 |17.000    1.69 | 23.08    1.13
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                4.917    1.50 |11.000    5.82 |17.083    1.69 | 23.17    1.13
                5.000    1.50 |11.083    5.82 |17.167    1.69 | 23.25    1.13
                5.083    1.50 |11.167    5.82 |17.250    1.69 | 23.33    1.13
                5.167    1.50 |11.250    5.82 |17.333    1.69 | 23.42    1.13
                5.250    1.50 |11.333    9.01 |17.417    1.69 | 23.50    1.13
                5.333    1.50 |11.417    9.01 |17.500    1.69 | 23.58    1.13
                5.417    1.50 |11.500    9.01 |17.583    1.69 | 23.67    1.13
                5.500    1.50 |11.583    9.01 |17.667    1.69 | 23.75    1.13
                5.583    1.50 |11.667    9.01 |17.750    1.69 | 23.83    1.13
                5.667    1.50 |11.750    9.01 |17.833    1.69 | 23.92    1.13
                5.750    1.50 |11.833   27.77 |17.917    1.69 | 24.00    1.13
                5.833    1.50 |11.917   27.77 |18.000    1.69 | 24.08    1.13
                5.917    1.50 |12.000   27.77 |18.083    1.69 | 24.17    1.13
                6.000    1.50 |12.083  114.83 |18.167    1.69 | 24.25    1.13
                6.083    1.50 |12.167  114.84 |18.250    1.69 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.313 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  40.329
     TOTAL RAINFALL   (mm)=  93.820
     RUNOFF COEFFICIENT   =   0.430

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

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***********************************
** SIMULATION:2yr 24hr 15min SCS **
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--------------------
|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\8304bae4
| Ptotal= 59.77 mm |    Comments: 2yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    1.08 | 12.75    8.61 | 19.00    1.08
                 0.50    0.66 |  6.75    1.08 | 13.00    4.42 | 19.25    1.08
                 0.75    0.66 |  7.00    1.08 | 13.25    4.42 | 19.50    1.08
                 1.00    0.66 |  7.25    1.08 | 13.50    3.23 | 19.75    1.08
                 1.25    0.66 |  7.50    1.31 | 13.75    3.23 | 20.00    1.08
                 1.50    0.66 |  7.75    1.31 | 14.00    2.51 | 20.25    1.08
                 1.75    0.66 |  8.00    1.31 | 14.25    2.51 | 20.50    0.72
                 2.00    0.66 |  8.25    1.31 | 14.50    1.79 | 20.75    0.72
                 2.25    0.66 |  8.50    1.55 | 14.75    1.79 | 21.00    0.72
                 2.50    0.78 |  8.75    1.55 | 15.00    1.79 | 21.25    0.72
                 2.75    0.78 |  9.00    1.67 | 15.25    1.79 | 21.50    0.72
                 3.00    0.78 |  9.25    1.67 | 15.50    1.79 | 21.75    0.72
                 3.25    0.78 |  9.50    1.91 | 15.75    1.79 | 22.00    0.72
                 3.50    0.78 |  9.75    1.91 | 16.00    1.79 | 22.25    0.72
                 3.75    0.78 | 10.00    2.15 | 16.25    1.79 | 22.50    0.72
                 4.00    0.78 | 10.25    2.15 | 16.50    1.08 | 22.75    0.72
                 4.25    0.78 | 10.50    2.75 | 16.75    1.08 | 23.00    0.72
                 4.50    0.96 | 10.75    2.75 | 17.00    1.08 | 23.25    0.72
                 4.75    0.96 | 11.00    3.71 | 17.25    1.08 | 23.50    0.72
                 5.00    0.96 | 11.25    3.71 | 17.50    1.08 | 23.75    0.72
                 5.25    0.96 | 11.50    5.74 | 17.75    1.08 | 24.00    0.72
                 5.50    0.96 | 11.75    5.74 | 18.00    1.08 | 24.25    0.72
                 5.75    0.96 | 12.00   17.69 | 18.25    1.08 |
                 6.00    0.96 | 12.25   73.16 | 18.50    1.08 |
                 6.25    0.96 | 12.50    8.61 | 18.75    1.08 |
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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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

                                ---- TRANSFORMED HYETOGRAPH ----
                   TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                    hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.083    0.00 | 6.167    0.96 |12.250   73.16 | 18.33    1.08
                  0.167    0.00 | 6.250    0.96 |12.333    8.61 | 18.42    1.08
                  0.250    0.00 | 6.333    1.08 |12.417    8.61 | 18.50    1.08
                  0.333    0.66 | 6.417    1.08 |12.500    8.61 | 18.58    1.08
                  0.417    0.66 | 6.500    1.08 |12.583    8.61 | 18.67    1.08
                  0.500    0.66 | 6.583    1.08 |12.667    8.61 | 18.75    1.08
                  0.583    0.66 | 6.667    1.08 |12.750    8.61 | 18.83    1.08
                  0.667    0.66 | 6.750    1.08 |12.833    4.42 | 18.92    1.08
                  0.750    0.66 | 6.833    1.08 |12.917    4.42 | 19.00    1.08
                  0.833    0.66 | 6.917    1.08 |13.000    4.42 | 19.08    1.08
                  0.917    0.66 | 7.000    1.08 |13.083    4.42 | 19.17    1.08
                  1.000    0.66 | 7.083    1.08 |13.167    4.42 | 19.25    1.08
                  1.083    0.66 | 7.167    1.08 |13.250    4.42 | 19.33    1.08
                  1.167    0.66 | 7.250    1.08 |13.333    3.23 | 19.42    1.08
                  1.250    0.66 | 7.333    1.31 |13.417    3.23 | 19.50    1.08
                  1.333    0.66 | 7.417    1.31 |13.500    3.23 | 19.58    1.08
                  1.417    0.66 | 7.500    1.31 |13.583    3.23 | 19.67    1.08
                  1.500    0.66 | 7.583    1.31 |13.667    3.23 | 19.75    1.08
                  1.583    0.66 | 7.667    1.31 |13.750    3.23 | 19.83    1.08
                  1.667    0.66 | 7.750    1.31 |13.833    2.51 | 19.92    1.08
                  1.750    0.66 | 7.833    1.31 |13.917    2.51 | 20.00    1.08
                  1.833    0.66 | 7.917    1.31 |14.000    2.51 | 20.08    1.08
                  1.917    0.66 | 8.000    1.31 |14.083    2.51 | 20.17    1.08
                  2.000    0.66 | 8.083    1.31 |14.167    2.51 | 20.25    1.08
                  2.083    0.66 | 8.167    1.31 |14.250    2.51 | 20.33    0.72
                  2.167    0.66 | 8.250    1.31 |14.333    1.79 | 20.42    0.72
                  2.250    0.66 | 8.333    1.55 |14.417    1.79 | 20.50    0.72
                  2.333    0.78 | 8.417    1.55 |14.500    1.79 | 20.58    0.72
                  2.417    0.78 | 8.500    1.55 |14.583    1.79 | 20.67    0.72
                  2.500    0.78 | 8.583    1.55 |14.667    1.79 | 20.75    0.72
                  2.583    0.78 | 8.667    1.55 |14.750    1.79 | 20.83    0.72
                  2.667    0.78 | 8.750    1.55 |14.833    1.79 | 20.92    0.72
                  2.750    0.78 | 8.833    1.67 |14.917    1.79 | 21.00    0.72
                  2.833    0.78 | 8.917    1.67 |15.000    1.79 | 21.08    0.72
                  2.917    0.78 | 9.000    1.67 |15.083    1.79 | 21.17    0.72
                  3.000    0.78 | 9.083    1.67 |15.167    1.79 | 21.25    0.72
                  3.083    0.78 | 9.167    1.67 |15.250    1.79 | 21.33    0.72
                  3.167    0.78 | 9.250    1.67 |15.333    1.79 | 21.42    0.72
                  3.250    0.78 | 9.333    1.91 |15.417    1.79 | 21.50    0.72
                  3.333    0.78 | 9.417    1.91 |15.500    1.79 | 21.58    0.72
                  3.417    0.78 | 9.500    1.91 |15.583    1.79 | 21.67    0.72
                  3.500    0.78 | 9.583    1.91 |15.667    1.79 | 21.75    0.72
                  3.583    0.78 | 9.667    1.91 |15.750    1.79 | 21.83    0.72
                  3.667    0.78 | 9.750    1.91 |15.833    1.79 | 21.92    0.72
                  3.750    0.78 | 9.833    2.15 |15.917    1.79 | 22.00    0.72
                  3.833    0.78 | 9.917    2.15 |16.000    1.79 | 22.08    0.72
                  3.917    0.78 |10.000    2.15 |16.083    1.79 | 22.17    0.72
                  4.000    0.78 |10.083    2.15 |16.167    1.79 | 22.25    0.72
                  4.083    0.78 |10.167    2.15 |16.250    1.79 | 22.33    0.72
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                4.167    0.78 |10.250    2.15 |16.333    1.08 | 22.42    0.72
                4.250    0.78 |10.333    2.75 |16.417    1.08 | 22.50    0.72
                4.333    0.96 |10.417    2.75 |16.500    1.08 | 22.58    0.72
                4.417    0.96 |10.500    2.75 |16.583    1.08 | 22.67    0.72
                4.500    0.96 |10.583    2.75 |16.667    1.08 | 22.75    0.72
                4.583    0.96 |10.667    2.75 |16.750    1.08 | 22.83    0.72
                4.667    0.96 |10.750    2.75 |16.833    1.08 | 22.92    0.72
                4.750    0.96 |10.833    3.71 |16.917    1.08 | 23.00    0.72
                4.833    0.96 |10.917    3.71 |17.000    1.08 | 23.08    0.72
                4.917    0.96 |11.000    3.71 |17.083    1.08 | 23.17    0.72
                5.000    0.96 |11.083    3.71 |17.167    1.08 | 23.25    0.72
                5.083    0.96 |11.167    3.71 |17.250    1.08 | 23.33    0.72
                5.167    0.96 |11.250    3.71 |17.333    1.08 | 23.42    0.72
                5.250    0.96 |11.333    5.74 |17.417    1.08 | 23.50    0.72
                5.333    0.96 |11.417    5.74 |17.500    1.08 | 23.58    0.72
                5.417    0.96 |11.500    5.74 |17.583    1.08 | 23.67    0.72
                5.500    0.96 |11.583    5.74 |17.667    1.08 | 23.75    0.72
                5.583    0.96 |11.667    5.74 |17.750    1.08 | 23.83    0.72
                5.667    0.96 |11.750    5.74 |17.833    1.08 | 23.92    0.72
                5.750    0.96 |11.833   17.69 |17.917    1.08 | 24.00    0.72
                5.833    0.96 |11.917   17.69 |18.000    1.08 | 24.08    0.72
                5.917    0.96 |12.000   17.69 |18.083    1.08 | 24.17    0.72
                6.000    0.96 |12.083   73.15 |18.167    1.08 | 24.25    0.72
                6.083    0.96 |12.167   73.16 |18.250    1.08 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.141 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  18.567
     TOTAL RAINFALL   (mm)=  59.770
     RUNOFF COEFFICIENT   =   0.311

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

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************************************
** SIMULATION:50yr 24hr 15min SCS **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\6cb0a606
| Ptotal=103.60 mm |    Comments: 50yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    1.86 | 12.75   14.92 | 19.00    1.86
                 0.50    1.14 |  6.75    1.86 | 13.00    7.67 | 19.25    1.86
                 0.75    1.14 |  7.00    1.86 | 13.25    7.67 | 19.50    1.86
                 1.00    1.14 |  7.25    1.86 | 13.50    5.59 | 19.75    1.86
                 1.25    1.14 |  7.50    2.28 | 13.75    5.59 | 20.00    1.86
                 1.50    1.14 |  7.75    2.28 | 14.00    4.35 | 20.25    1.86
                 1.75    1.14 |  8.00    2.28 | 14.25    4.35 | 20.50    1.24
                 2.00    1.14 |  8.25    2.28 | 14.50    3.11 | 20.75    1.24
                 2.25    1.14 |  8.50    2.69 | 14.75    3.11 | 21.00    1.24
                 2.50    1.35 |  8.75    2.69 | 15.00    3.11 | 21.25    1.24
                 2.75    1.35 |  9.00    2.90 | 15.25    3.11 | 21.50    1.24
                 3.00    1.35 |  9.25    2.90 | 15.50    3.11 | 21.75    1.24
                 3.25    1.35 |  9.50    3.32 | 15.75    3.11 | 22.00    1.24
                 3.50    1.35 |  9.75    3.32 | 16.00    3.11 | 22.25    1.24
                 3.75    1.35 | 10.00    3.73 | 16.25    3.11 | 22.50    1.24
                 4.00    1.35 | 10.25    3.73 | 16.50    1.86 | 22.75    1.24
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                 4.25    1.35 | 10.50    4.77 | 16.75    1.86 | 23.00    1.24
                 4.50    1.66 | 10.75    4.77 | 17.00    1.86 | 23.25    1.24
                 4.75    1.66 | 11.00    6.42 | 17.25    1.86 | 23.50    1.24
                 5.00    1.66 | 11.25    6.42 | 17.50    1.86 | 23.75    1.24
                 5.25    1.66 | 11.50    9.95 | 17.75    1.86 | 24.00    1.24
                 5.50    1.66 | 11.75    9.95 | 18.00    1.86 | 24.25    1.24
                 5.75    1.66 | 12.00   30.67 | 18.25    1.86 |
                 6.00    1.66 | 12.25  126.81 | 18.50    1.86 |
                 6.25    1.66 | 12.50   14.92 | 18.75    1.86 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    1.66 |12.250  126.81 | 18.33    1.86
                0.167    0.00 | 6.250    1.66 |12.333   14.93 | 18.42    1.86
                0.250    0.00 | 6.333    1.86 |12.417   14.92 | 18.50    1.86
                0.333    1.14 | 6.417    1.86 |12.500   14.92 | 18.58    1.86
                0.417    1.14 | 6.500    1.86 |12.583   14.92 | 18.67    1.86
                0.500    1.14 | 6.583    1.86 |12.667   14.92 | 18.75    1.86
                0.583    1.14 | 6.667    1.86 |12.750   14.92 | 18.83    1.86
                0.667    1.14 | 6.750    1.86 |12.833    7.67 | 18.92    1.86
                0.750    1.14 | 6.833    1.86 |12.917    7.67 | 19.00    1.86
                0.833    1.14 | 6.917    1.86 |13.000    7.67 | 19.08    1.86
                0.917    1.14 | 7.000    1.86 |13.083    7.67 | 19.17    1.86
                1.000    1.14 | 7.083    1.86 |13.167    7.67 | 19.25    1.86
                1.083    1.14 | 7.167    1.86 |13.250    7.67 | 19.33    1.86
                1.167    1.14 | 7.250    1.86 |13.333    5.59 | 19.42    1.86
                1.250    1.14 | 7.333    2.28 |13.417    5.59 | 19.50    1.86
                1.333    1.14 | 7.417    2.28 |13.500    5.59 | 19.58    1.86
                1.417    1.14 | 7.500    2.28 |13.583    5.59 | 19.67    1.86
                1.500    1.14 | 7.583    2.28 |13.667    5.59 | 19.75    1.86
                1.583    1.14 | 7.667    2.28 |13.750    5.59 | 19.83    1.86
                1.667    1.14 | 7.750    2.28 |13.833    4.35 | 19.92    1.86
                1.750    1.14 | 7.833    2.28 |13.917    4.35 | 20.00    1.86
                1.833    1.14 | 7.917    2.28 |14.000    4.35 | 20.08    1.86
                1.917    1.14 | 8.000    2.28 |14.083    4.35 | 20.17    1.86
                2.000    1.14 | 8.083    2.28 |14.167    4.35 | 20.25    1.86
                2.083    1.14 | 8.167    2.28 |14.250    4.35 | 20.33    1.24
                2.167    1.14 | 8.250    2.28 |14.333    3.11 | 20.42    1.24
                2.250    1.14 | 8.333    2.69 |14.417    3.11 | 20.50    1.24
                2.333    1.35 | 8.417    2.69 |14.500    3.11 | 20.58    1.24
                2.417    1.35 | 8.500    2.69 |14.583    3.11 | 20.67    1.24
                2.500    1.35 | 8.583    2.69 |14.667    3.11 | 20.75    1.24
                2.583    1.35 | 8.667    2.69 |14.750    3.11 | 20.83    1.24
                2.667    1.35 | 8.750    2.69 |14.833    3.11 | 20.92    1.24
                2.750    1.35 | 8.833    2.90 |14.917    3.11 | 21.00    1.24
                2.833    1.35 | 8.917    2.90 |15.000    3.11 | 21.08    1.24
                2.917    1.35 | 9.000    2.90 |15.083    3.11 | 21.17    1.24
                3.000    1.35 | 9.083    2.90 |15.167    3.11 | 21.25    1.24
                3.083    1.35 | 9.167    2.90 |15.250    3.11 | 21.33    1.24
                3.167    1.35 | 9.250    2.90 |15.333    3.11 | 21.42    1.24
                3.250    1.35 | 9.333    3.32 |15.417    3.11 | 21.50    1.24
                3.333    1.35 | 9.417    3.32 |15.500    3.11 | 21.58    1.24
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                3.417    1.35 | 9.500    3.32 |15.583    3.11 | 21.67    1.24
                3.500    1.35 | 9.583    3.32 |15.667    3.11 | 21.75    1.24
                3.583    1.35 | 9.667    3.32 |15.750    3.11 | 21.83    1.24
                3.667    1.35 | 9.750    3.32 |15.833    3.11 | 21.92    1.24
                3.750    1.35 | 9.833    3.73 |15.917    3.11 | 22.00    1.24
                3.833    1.35 | 9.917    3.73 |16.000    3.11 | 22.08    1.24
                3.917    1.35 |10.000    3.73 |16.083    3.11 | 22.17    1.24
                4.000    1.35 |10.083    3.73 |16.167    3.11 | 22.25    1.24
                4.083    1.35 |10.167    3.73 |16.250    3.11 | 22.33    1.24
                4.167    1.35 |10.250    3.73 |16.333    1.87 | 22.42    1.24
                4.250    1.35 |10.333    4.77 |16.417    1.86 | 22.50    1.24
                4.333    1.66 |10.417    4.77 |16.500    1.86 | 22.58    1.24
                4.417    1.66 |10.500    4.77 |16.583    1.86 | 22.67    1.24
                4.500    1.66 |10.583    4.77 |16.667    1.86 | 22.75    1.24
                4.583    1.66 |10.667    4.77 |16.750    1.86 | 22.83    1.24
                4.667    1.66 |10.750    4.77 |16.833    1.86 | 22.92    1.24
                4.750    1.66 |10.833    6.42 |16.917    1.86 | 23.00    1.24
                4.833    1.66 |10.917    6.42 |17.000    1.86 | 23.08    1.24
                4.917    1.66 |11.000    6.42 |17.083    1.86 | 23.17    1.24
                5.000    1.66 |11.083    6.42 |17.167    1.86 | 23.25    1.24
                5.083    1.66 |11.167    6.42 |17.250    1.86 | 23.33    1.24
                5.167    1.66 |11.250    6.42 |17.333    1.86 | 23.42    1.24
                5.250    1.66 |11.333    9.95 |17.417    1.86 | 23.50    1.24
                5.333    1.66 |11.417    9.95 |17.500    1.86 | 23.58    1.24
                5.417    1.66 |11.500    9.95 |17.583    1.86 | 23.67    1.24
                5.500    1.66 |11.583    9.95 |17.667    1.86 | 23.75    1.24
                5.583    1.66 |11.667    9.95 |17.750    1.86 | 23.83    1.24
                5.667    1.66 |11.750    9.95 |17.833    1.86 | 23.92    1.24
                5.750    1.66 |11.833   30.66 |17.917    1.86 | 24.00    1.24
                5.833    1.66 |11.917   30.67 |18.000    1.86 | 24.08    1.24
                5.917    1.66 |12.000   30.67 |18.083    1.86 | 24.17    1.24
                6.000    1.66 |12.083  126.79 |18.167    1.86 | 24.25    1.24
                6.083    1.66 |12.167  126.81 |18.250    1.86 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.369 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  47.332
     TOTAL RAINFALL   (mm)= 103.600
     RUNOFF COEFFICIENT   =   0.457

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

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***********************************
** SIMULATION:5yr 24hr 15min SCS **
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|    READ STORM    |    Filename: C:\Users\gvolpe\AppD
|                  |              ata\Local\Temp\
|                  |              ce3e8e08-26f8-47e0-9019-0d60b9a7093c\00f83cf9
| Ptotal= 71.04 mm |    Comments: 5yr 24hr 15min SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.25    0.00 |  6.50    1.28 | 12.75   10.23 | 19.00    1.28
                 0.50    0.78 |  6.75    1.28 | 13.00    5.26 | 19.25    1.28
                 0.75    0.78 |  7.00    1.28 | 13.25    5.26 | 19.50    1.28
                 1.00    0.78 |  7.25    1.28 | 13.50    3.84 | 19.75    1.28
                 1.25    0.78 |  7.50    1.56 | 13.75    3.84 | 20.00    1.28
                 1.50    0.78 |  7.75    1.56 | 14.00    2.98 | 20.25    1.28
                 1.75    0.78 |  8.00    1.56 | 14.25    2.98 | 20.50    0.85
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                 2.00    0.78 |  8.25    1.56 | 14.50    2.13 | 20.75    0.85
                 2.25    0.78 |  8.50    1.85 | 14.75    2.13 | 21.00    0.85
                 2.50    0.92 |  8.75    1.85 | 15.00    2.13 | 21.25    0.85
                 2.75    0.92 |  9.00    1.99 | 15.25    2.13 | 21.50    0.85
                 3.00    0.92 |  9.25    1.99 | 15.50    2.13 | 21.75    0.85
                 3.25    0.92 |  9.50    2.27 | 15.75    2.13 | 22.00    0.85
                 3.50    0.92 |  9.75    2.27 | 16.00    2.13 | 22.25    0.85
                 3.75    0.92 | 10.00    2.56 | 16.25    2.13 | 22.50    0.85
                 4.00    0.92 | 10.25    2.56 | 16.50    1.28 | 22.75    0.85
                 4.25    0.92 | 10.50    3.27 | 16.75    1.28 | 23.00    0.85
                 4.50    1.14 | 10.75    3.27 | 17.00    1.28 | 23.25    0.85
                 4.75    1.14 | 11.00    4.40 | 17.25    1.28 | 23.50    0.85
                 5.00    1.14 | 11.25    4.40 | 17.50    1.28 | 23.75    0.85
                 5.25    1.14 | 11.50    6.82 | 17.75    1.28 | 24.00    0.85
                 5.50    1.14 | 11.75    6.82 | 18.00    1.28 | 24.25    0.85
                 5.75    1.14 | 12.00   21.03 | 18.25    1.28 |
                 6.00    1.14 | 12.25   86.95 | 18.50    1.28 |
                 6.25    1.14 | 12.50   10.23 | 18.75    1.28 |

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| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   8.30   Curve Number   (CN)= 70.4
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.81

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


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    1.14 |12.250   86.95 | 18.33    1.28
                0.167    0.00 | 6.250    1.14 |12.333   10.24 | 18.42    1.28
                0.250    0.00 | 6.333    1.28 |12.417   10.23 | 18.50    1.28
                0.333    0.78 | 6.417    1.28 |12.500   10.23 | 18.58    1.28
                0.417    0.78 | 6.500    1.28 |12.583   10.23 | 18.67    1.28
                0.500    0.78 | 6.583    1.28 |12.667   10.23 | 18.75    1.28
                0.583    0.78 | 6.667    1.28 |12.750   10.23 | 18.83    1.28
                0.667    0.78 | 6.750    1.28 |12.833    5.26 | 18.92    1.28
                0.750    0.78 | 6.833    1.28 |12.917    5.26 | 19.00    1.28
                0.833    0.78 | 6.917    1.28 |13.000    5.26 | 19.08    1.28
                0.917    0.78 | 7.000    1.28 |13.083    5.26 | 19.17    1.28
                1.000    0.78 | 7.083    1.28 |13.167    5.26 | 19.25    1.28
                1.083    0.78 | 7.167    1.28 |13.250    5.26 | 19.33    1.28
                1.167    0.78 | 7.250    1.28 |13.333    3.84 | 19.42    1.28
                1.250    0.78 | 7.333    1.56 |13.417    3.84 | 19.50    1.28
                1.333    0.78 | 7.417    1.56 |13.500    3.84 | 19.58    1.28
                1.417    0.78 | 7.500    1.56 |13.583    3.84 | 19.67    1.28
                1.500    0.78 | 7.583    1.56 |13.667    3.84 | 19.75    1.28
                1.583    0.78 | 7.667    1.56 |13.750    3.84 | 19.83    1.28
                1.667    0.78 | 7.750    1.56 |13.833    2.98 | 19.92    1.28
                1.750    0.78 | 7.833    1.56 |13.917    2.98 | 20.00    1.28
                1.833    0.78 | 7.917    1.56 |14.000    2.98 | 20.08    1.28
                1.917    0.78 | 8.000    1.56 |14.083    2.98 | 20.17    1.28
                2.000    0.78 | 8.083    1.56 |14.167    2.98 | 20.25    1.28
                2.083    0.78 | 8.167    1.56 |14.250    2.98 | 20.33    0.85
                2.167    0.78 | 8.250    1.56 |14.333    2.13 | 20.42    0.85
                2.250    0.78 | 8.333    1.85 |14.417    2.13 | 20.50    0.85
                2.333    0.92 | 8.417    1.85 |14.500    2.13 | 20.58    0.85
                2.417    0.92 | 8.500    1.85 |14.583    2.13 | 20.67    0.85
                2.500    0.92 | 8.583    1.85 |14.667    2.13 | 20.75    0.85
                2.583    0.92 | 8.667    1.85 |14.750    2.13 | 20.83    0.85
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                2.667    0.92 | 8.750    1.85 |14.833    2.13 | 20.92    0.85
                2.750    0.92 | 8.833    1.99 |14.917    2.13 | 21.00    0.85
                2.833    0.92 | 8.917    1.99 |15.000    2.13 | 21.08    0.85
                2.917    0.92 | 9.000    1.99 |15.083    2.13 | 21.17    0.85
                3.000    0.92 | 9.083    1.99 |15.167    2.13 | 21.25    0.85
                3.083    0.92 | 9.167    1.99 |15.250    2.13 | 21.33    0.85
                3.167    0.92 | 9.250    1.99 |15.333    2.13 | 21.42    0.85
                3.250    0.92 | 9.333    2.27 |15.417    2.13 | 21.50    0.85
                3.333    0.92 | 9.417    2.27 |15.500    2.13 | 21.58    0.85
                3.417    0.92 | 9.500    2.27 |15.583    2.13 | 21.67    0.85
                3.500    0.92 | 9.583    2.27 |15.667    2.13 | 21.75    0.85
                3.583    0.92 | 9.667    2.27 |15.750    2.13 | 21.83    0.85
                3.667    0.92 | 9.750    2.27 |15.833    2.13 | 21.92    0.85
                3.750    0.92 | 9.833    2.56 |15.917    2.13 | 22.00    0.85
                3.833    0.92 | 9.917    2.56 |16.000    2.13 | 22.08    0.85
                3.917    0.92 |10.000    2.56 |16.083    2.13 | 22.17    0.85
                4.000    0.92 |10.083    2.56 |16.167    2.13 | 22.25    0.85
                4.083    0.92 |10.167    2.56 |16.250    2.13 | 22.33    0.85
                4.167    0.92 |10.250    2.56 |16.333    1.28 | 22.42    0.85
                4.250    0.92 |10.333    3.27 |16.417    1.28 | 22.50    0.85
                4.333    1.14 |10.417    3.27 |16.500    1.28 | 22.58    0.85
                4.417    1.14 |10.500    3.27 |16.583    1.28 | 22.67    0.85
                4.500    1.14 |10.583    3.27 |16.667    1.28 | 22.75    0.85
                4.583    1.14 |10.667    3.27 |16.750    1.28 | 22.83    0.85
                4.667    1.14 |10.750    3.27 |16.833    1.28 | 22.92    0.85
                4.750    1.14 |10.833    4.40 |16.917    1.28 | 23.00    0.85
                4.833    1.14 |10.917    4.40 |17.000    1.28 | 23.08    0.85
                4.917    1.14 |11.000    4.40 |17.083    1.28 | 23.17    0.85
                5.000    1.14 |11.083    4.40 |17.167    1.28 | 23.25    0.85
                5.083    1.14 |11.167    4.40 |17.250    1.28 | 23.33    0.85
                5.167    1.14 |11.250    4.40 |17.333    1.28 | 23.42    0.85
                5.250    1.14 |11.333    6.82 |17.417    1.28 | 23.50    0.85
                5.333    1.14 |11.417    6.82 |17.500    1.28 | 23.58    0.85
                5.417    1.14 |11.500    6.82 |17.583    1.28 | 23.67    0.85
                5.500    1.14 |11.583    6.82 |17.667    1.28 | 23.75    0.85
                5.583    1.14 |11.667    6.82 |17.750    1.28 | 23.83    0.85
                5.667    1.14 |11.750    6.82 |17.833    1.28 | 23.92    0.85
                5.750    1.14 |11.833   21.03 |17.917    1.28 | 24.00    0.85
                5.833    1.14 |11.917   21.03 |18.000    1.28 | 24.08    0.85
                5.917    1.14 |12.000   21.03 |18.083    1.28 | 24.17    0.85
                6.000    1.14 |12.083   86.95 |18.167    1.28 | 24.25    0.85
                6.083    1.14 |12.167   86.95 |18.250    1.28 |

     Unit Hyd Qpeak  (cms)=   0.392

     PEAK FLOW       (cms)=   0.193 (i)
     TIME TO PEAK    (hrs)=  13.000
     RUNOFF VOLUME    (mm)=  25.233
     TOTAL RAINFALL   (mm)=  71.040
     RUNOFF COEFFICIENT   =   0.355

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

-------------------------------------------------------------------------------
```

SCHAEFFERS
CONSULTING ENGINEERS

Post-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(3 hour Chicago Storm controlled to Allowable Release)

Job #: 2018-4696	**Date: January 2019**

```
****************************************
** SIMULATION:100yr 3hr 10min Chicago **
****************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.740      1.17      52.07
   OUTFLOW: ID= 1 (  0002)      7.420      0.195      2.25      51.69

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 11.23
                   TIME SHIFT OF PEAK FLOW        (min)= 65.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2791

--------------------------------------------------------------------------------
***************************************
** SIMULATION:10yr 3hr 10min Chicago **
***************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.140      1.17      34.84
   OUTFLOW: ID= 1 (  0002)      7.420      0.095      2.75      34.45

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  8.37
                   TIME SHIFT OF PEAK FLOW        (min)= 95.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2045

--------------------------------------------------------------------------------
***************************************
** SIMULATION:25yr 3hr 10min Chicago **
***************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.368      1.17      41.50
   OUTFLOW: ID= 1 (  0002)      7.420      0.131      2.50      41.12

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  9.60
                   TIME SHIFT OF PEAK FLOW        (min)= 80.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2334

--------------------------------------------------------------------------------
**************************************
** SIMULATION:2yr 3hr 10min Chicago **
**************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.788      1.17      24.76
   OUTFLOW: ID= 1 (  0002)      7.420      0.048      3.08      24.38

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  6.04
                   TIME SHIFT OF PEAK FLOW        (min)=115.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1598

--------------------------------------------------------------------------------
***************************************
** SIMULATION:50yr 3hr 10min Chicago **
***************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.551      1.17      46.56
   OUTFLOW: ID= 1 (  0002)      7.420      0.160      2.33      46.17

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 10.33
                   TIME SHIFT OF PEAK FLOW        (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2555

--------------------------------------------------------------------------------
**************************************
** SIMULATION:5yr 3hr 10min Chicago **
**************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2050
                          0.0110     0.1240   |   0.1320      0.2340
                          0.0480     0.1600   |   0.1610      0.2560
                          0.0730     0.1855   |   0.1960      0.2795
```

```
                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.987      1.17      30.40
   OUTFLOW: ID= 1 (  0002)      7.420      0.073      3.00      30.01

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  7.38
                   TIME SHIFT OF PEAK FLOW         (min)=110.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1853

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SCHAEFFERS
CONSULTING ENGINEERS

Post-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(24 hour SCS Storm controlled to Allowable Release)

Job #: 2018-4696	**Date: January 2019**

```
**************************************************
** SIMULATION:10 Year 12 Hour AES (Bloor, TRCA) **
**************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.498      5.25      50.21
   OUTFLOW: ID= 1 (  0002)      7.420      0.096      6.75      49.82

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 19.25
                   TIME SHIFT OF PEAK FLOW         (min)= 90.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2547

-------------------------------------------------------------------------------
***************************************************
** SIMULATION:100 Year 12 Hour AES (Bloor, TRCA) **
***************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.746      5.25      74.66
   OUTFLOW: ID= 1 (  0002)      7.420      0.196      6.33      74.28

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 26.22
                   TIME SHIFT OF PEAK FLOW         (min)= 65.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3507

-------------------------------------------------------------------------------
*************************************************
** SIMULATION:2 Year 12 Hour AES (Bloor, TRCA) **
*************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.302      5.25      31.27
   OUTFLOW: ID= 1 (  0002)      7.420      0.048      7.42      30.89

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 15.79
                   TIME SHIFT OF PEAK FLOW         (min)=130.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1716

-------------------------------------------------------------------------------
**************************************************
** SIMULATION:25 Year 12 Hour AES (Bloor, TRCA) **
**************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.597      5.25      59.97
   OUTFLOW: ID= 1 (  0002)      7.420      0.132      6.50      59.58

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 22.06
                   TIME SHIFT OF PEAK FLOW         (min)= 75.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2948

-------------------------------------------------------------------------------
*************************************************
** SIMULATION:5 Year 12 Hour AES (Bloor, TRCA) **
*************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.419      5.25      42.49
   OUTFLOW: ID= 1 (  0002)      7.420      0.073      7.25      42.11

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 17.34
                   TIME SHIFT OF PEAK FLOW         (min)=120.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2215

-------------------------------------------------------------------------------
**************************************************
** SIMULATION:50 Year 12 Hour AES (Bloor, TRCA) **
**************************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.2550
                          0.0110     0.1240   |   0.1320      0.2950
                          0.0480     0.1720   |   0.1610      0.3240
                          0.0730     0.2220   |   0.1960      0.3510
```

```
                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      0.672      5.25      67.29
   OUTFLOW: ID= 1 (  0002)      7.420      0.161      6.42      66.90

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 23.91
                   TIME SHIFT OF PEAK FLOW         (min)= 70.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3236

-------------------------------------------------------------------------------
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SCHAEFFERS
CONSULTING ENGINEERS

Post-development Visual OTTHYMO^{TM} Schematic
200 John Street East & 588 Charlotte Street
(24 hour SCS Storm controlled to Allowable Release)

Job #: 2018-4696	**Date: January 2019**

```
************************************
** SIMULATION:100yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      2.352     12.25      99.70
   OUTFLOW: ID= 1 (  0002)      7.420      0.196     13.00      99.31

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  8.32
                   TIME SHIFT OF PEAK FLOW        (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.4587

-------------------------------------------------------------------------------
************************************
** SIMULATION:10yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.450     12.25      66.84
   OUTFLOW: ID= 1 (  0002)      7.420      0.095     13.50      66.46

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  6.58
                   TIME SHIFT OF PEAK FLOW        (min)= 75.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3202

-------------------------------------------------------------------------------
************************************
** SIMULATION:25yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.747     12.25      79.73
   OUTFLOW: ID= 1 (  0002)      7.420      0.132     13.33      79.35

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  7.54
                   TIME SHIFT OF PEAK FLOW        (min)= 65.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3751

-------------------------------------------------------------------------------
************************************
** SIMULATION:2yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.011     12.25      47.47
   OUTFLOW: ID= 1 (  0002)      7.420      0.048     14.25      47.09

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  4.74
                   TIME SHIFT OF PEAK FLOW        (min)=120.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2368

-------------------------------------------------------------------------------
************************************
** SIMULATION:50yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      2.091     12.25      89.16
   OUTFLOW: ID= 1 (  0002)      7.420      0.161     13.17      88.78

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  7.69
                   TIME SHIFT OF PEAK FLOW        (min)= 55.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.4147

-------------------------------------------------------------------------------
************************************
** SIMULATION:5yr 24hr 15min SCS **
************************************
--------------------
| RESERVOIR(  0002)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0960      0.3210
                          0.0110     0.1238   |   0.1320      0.3755
                          0.0480     0.2370   |   0.1610      0.4150
                          0.0730     0.2830   |   0.1960      0.4590
```

```
                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0001)      7.420      1.249     12.25      58.02
   OUTFLOW: ID= 1 (  0002)      7.420      0.073     13.75      57.64

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  5.82
                   TIME SHIFT OF PEAK FLOW         (min)= 90.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2825

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```

APPENDIX E

Engineering Drawings

(Please refer to Submission Set)