ALLIANCE
DEVELOPMENT VENTURES

"164 Thorold"

164 Thorold Road, Welland, Ontario L3C 3V6

Functional Servicing & Stormwater Management Report

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1.0 Introduction

Alliance Development Ventures has prepared a comprehensive Servicing and Stormwater Management Report in support of an Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) for the proposed development of a 0.29 ha through lot municipally known as 164 Thorold Road, located in Welland and serviced via Thorold Road.

The proposed development is an apartment building comprising 76 residential dwelling units, to be fully serviced by existing municipal water and sanitary sewer infrastructure, with primary vehicular access provided from Thorold Road.

The proposed stormwater management strategy has been developed in accordance with the 2025 Development Engineering Design Standards of the City of Welland, the Niagara Peninsula Conservation Authority (NPCA) Stormwater Management Guidelines, and applicable guidelines established by the Ontario Ministry of the Environment, Conservation and Parks (MECP). This report has been prepared to provide the necessary engineering analysis and technical justification in support of the OPA/ZBA applications.

2.0 Background

The proposed development site located at 164 Thorold Road in Welland comprises an approximately 0.29 ha parcel situated within the northern portion of the City of Welland in the Niagara Region. The surrounding area is characterized by a mix of low-density residential dwellings, institutional uses, commercial establishments, and mixed-use developments.

The subject property is currently occupied by an existing residential dwelling associated with low-density residential use. Under the designated “RH” zoning classification, the existing dwelling is proposed to be redeveloped into a 76-unit apartment building, consistent with the intensification objectives identified within Schedule “A” of the City of Welland Official Plan for the Thorold Road corridor.

The proposed development will be accessed from Thorold Road and will incorporate an internal one-way driveway system to accommodate site circulation, including ingress and egress movements. Municipal water supply and sanitary sewer servicing are proposed to connect to existing infrastructure within Thorold Road. Due to the absence of a municipal storm sewer system adjacent to the site, stormwater management will be accommodated through on-site stormwater management measures.

In accordance with the City of Welland pre-consultation requirements, a stormwater extension report is typically required where a development

cannot connect to an existing municipal stormwater sewer system. As the proposed development has no available municipal storm outlet along Thorold Road, a stormwater design needs to address this requirement within the development site.

This submission reflects the updated site plan for the proposed 76-unit apartment building development and outlines the proposed municipal servicing strategy, including the implementation of infiltration-based Low Impact Development (LID) stormwater management controls. The proposed stormwater management approach has been designed to provide the required quantity and quality controls in accordance with the 2025 Development Engineering Design Standards of the City of Welland and the Niagara Peninsula Conservation Authority (NPCA) Stormwater Management Technical Guide.

3.0 Existing Site Conditions

The 0.29 ha site at 164 Thorold, Welland, Ontario is located within an established low-density residential area in the City of Welland. The site currently occupied by a two-story single detached dwelling.

Based on the topographic survey, the site exhibits a generally flat topography with no swales, channels, or significant elevation changes. It should be noted that the city does not have a piped stormwater system near the site. Stormwater is assumed to infiltrate through existing pervious areas, such as lawn and landscaped spaces, while runoff from impervious surfaces likely flows towards those landscaped spaces.

Currently the site is serviced by the Municipal water supply and sanitary sewer system through Thorold Rd.

4.0 Geotechnical and Hydrogeological Information

The proposed development has been prepared with an Environmental Site Assessment (ESA). As per the ESA under Limitations of the Report, sampling and analysis of soil was not carried out as part of the scope of work. However, it was mentioned under Section 3.6 of the report that according to the review of the quaternary geology of the area, the site consists of predominantly silt and clay, minor sand, basin and quiet water deposits from the glaciolacustrine deposits. As per ESA, Local Groundwater flow direction has been inferred to be in an easterly direction towards the Welland Canal, located approximately 1.32 km east of the site.

A Geotechnical and Hydrogeological Report is pending for the OPA/ZBA application.

5.0 Stormwater Modelling of Existing Conditions

We have utilized the PCSWMM (Ver. 7.7) modelling software to conduct analysis of the existing site. Topographic survey of the site is used to determine the infiltration and runoff factors of the site.

We have modeled the site as one catchment, which will have ground permeation as well as a runoff that drains towards the existing road.

We have also utilized the Green Ampt Values as presented in Rawls et al. (1983) for soil infiltration for Silty Clay Loam.

Keff = 3.0 mm/hr **Suction Head** = 273 mm **Initial Deficit (fraction)** = 0.25

Input parameters are Manning Roughness Coefficient for grass = 0.25

The climate-change adjusted Intensity-Duration-Frequency (IDF) curves from the city standards were added to the PCSWMM IDF library to create design storms. Additionally, a 25mm Chicago storm was added for water balance check and LID performance.

6.0 Proposed Site Design

The proposed development is an apartment building development with 76 apartment units. The site will have an internal one-way driveway with a 6.0m wide entry and exit routes.

The project will include a total of 48 parking spaces where the driveway and outdoor parking will encompass the whole permeable paver LID control module.

The proposed permeable pavement system utilizes a cell grid system that has high load bearing capacity which replaces the traditional slab on grade parking and driveway structure. The pavement units are 50mm thick with a proposed storage layer with minimum depths of 300 mm using clean angular stone that will have an approximate storage capacity of 40% of the storage layer. This will also provide a degree of suspended solid removal and pollutants to ensure water quality.

This system is designed to meet applicable criteria for water quality, quantity control, and water balance.

6.1 Sanitary Servicing

The 76-Unit apartment building development at 164 Thorold, Welland, Ontario, Canada will be serviced with a 200mm diameter sanitary sewer line on a 0.8% Slope. A new sanitary manhole is proposed at property line with a 200mm sewer line servicing the building.

As per City of Welland municipal standards, Niagara Public Works Department's Guidelines for the Design and Construction of Sewer and Watermain Systems, and Ontario MECP guidelines, the following design flows were used for the calculation of the sanitary sewer capacity:

- Average Daily per Capita Flow: 350 L/cap/day
- Extraneous Flow Allowance: 0.28 L/sec/gross hectare
- Occupancy Rate: 2.6 persons per unit
- Peaking Factor: 4.0 Harmon method
- Peak Velocity: Min. 0.60 m/s, Max. 3.0 m/s
- Pipe Size and Slope: 200mm Dia., 0.80% Slope
- Mannings "n": 0.013

Using a Harmon peaking factor of 4.0, the calculated average residential sanitary flow was determined to be 0.80 L/s, resulting in a peak residential sanitary flow of 3.21 L/s. An additional infiltration/extraneous flow allowance of 0.08 L/s was incorporated based on an allocation rate of 0.28 L/s/ha, resulting in a total peak sanitary design flow of approximately 3.29 L/s.

The proposed sanitary sewer consists of a 200 mm diameter sewer installed at a minimum grade of 0.80%. Sanitary sewer calculation using Manning's Equation with a roughness coefficient of $n = 0.013$ indicates that the proposed sewer provides a full flow capacity of approximately 29.3 L/s with a full flow velocity of approximately 0.93 m/s and a peak flow velocity of approximately 0.62 m/s operating at approximately 23% full capacity.

Based on the completed sanitary sewer calculations, the proposed sanitary sewer design satisfies the municipal requirements.

6.2 Water Supply

A domestic water demand calculation was completed for the proposed 76-Unit Apartment Building development based on fixture unit count and peak demand factors. The development is proposed to be served with a 150mm diameter water supply line. The required capacity needs to be assessed using the Ontario Building Code to determine both domestic and fire supply flow rates for the building.

The proposed 76-Unit apartment building will have 42 one-bedroom, one-bathroom units; 7 one-bedroom with den units; and 27 two-bedroom, two-bathroom units.

Fixture units were calculated for one bedroom, one-bedroom with den, and two-bedroom two-bathroom units to include a kitchen sink, dishwasher, washing machine, and a three-piece bathroom as well as office space, and other amenity and utility spaces.

The total number of water-using fixture units in the building is therefore equal to:

- Water closet = 2.2 fixture units × 105 = 231.0 fixture units
- Lavatory = 0.7 fixture units × 106 = 74.2 fixture units
- Shower = 1.4 fixture units × 103 = 144.2 fixture units
- Kitchen sink = 1.4 fixture units × 76 = 106.4 fixture units
- Dishwasher = 1.4 fixture units × 76 = 106.4 fixture units
- Washing machine = 1.4 fixture units × 76 = 106.4 fixture units

Total number of fixture units is equal to 768.6.
In total, the peak domestic demand is 0.32 L/s. The peak fire supply flow rate is 9000 L/min (150 L/s), resulting in a combined domestic and fire supply flow rate of 150.32 L/s.

6.3 Stormwater Management

6.3.1 Approval Criteria

The site requires approval for stormwater management design. The following is a list of the criteria the site must meet:

- Provide quantity control to match or improve from predevelopment runoff for the 2 to 100 yr storm events
- Provide quality controls to an enhanced level of protection as defined by the MECP, specifically the removal of 80% Total Suspended Solids over a long-term annual basis
- Using Low Impact Development (LID) measures where possible
- Best efforts towards a site water balance

6.3.2 Proposed Stormwater Management Design

The native silty clay loam soil of the site is generally suitable for Low Impact Development (LID) practices for its measurable infiltration capacity. Its infiltration capacity is sufficient for reduced runoff volume

rate, promotes groundwater recharge, and satisfy water detention objectives.

All pervious areas on the site will be modelled in PCSWMM (Ver. 7.7) with parameters as urban lawn with a manning's n value of 0.15 and a depression storage of 5mm.

The areas that will have the permeable pavement LID is modelled in PCSWMM under the subcatchments parameters to be 100% impervious as the model parameters under the LID editor will be used to account for the permeable nature of the LID. The following permeable paver LID input parameters are used in the model:

- Berm Height: 100mm
- Surface Roughness: 0.013
- Average Surface Slope: 1%
- Paver Thickness: 50mm
- Impervious Surface Fraction: 0.00
- Pavement Layer Depth and Design: 50.8 mm (2-inch) thick pavement layer with a void ratio of 0.15
- Drainage Storage Layer Depth and Design: 300mm thick drainage layer comprised of clear stone with a void ratio of 0.40 and an infiltration rate of 23mm/hr (incorporating a safety factor of 2). The bottom elevation of this layer should not exceed a depth of 3.2 m below grade, to maintain a 1 m clearance from the measured groundwater depth.
- Storage layer seepage rate: approx. 3.0 mm/hr (hydraulic conductivity of Silty Clay Loam)

The proposed building design will have a roof deck that is modelled in PCSWMM to outfall towards the subcatchments permeable paver LID storage layer.

6.3.3 Proposed Stormwater Management Model

In the post-development model, the site is designed as one catchment showing the pervious and impervious areas as well as the areas consisting of the LIDs.

- Impervious Surface – Building roof deck to outfall to permeable pavers
- Pervious Surface – Landscaping to have sub routing towards permeable pavers
- Permeable Pavers – The entirety of the driveway and outdoor parking

The pre- and post-development peak flow rates discharging off-site are summarized in **Table 1**. In the post-condition, all runoff is fully infiltrated on-site through the permeable pavers. This strategy is intended to alleviate potential flooding issues in the existing condition. The PCSWMM LID control results for the pavers are summarized in **Table 2**, indicating no surface flooding during major 100-year design storm events.

Additionally, as all post-development runoff is captured and infiltrated within site, the proposed stormwater management approach addresses the need for a Municipal stormwater extension along Thorold Road.

6.3.4 Stormwater Quality Control

To achieve the desired stormwater quality criteria, the site needs to achieve an "Enhanced" level of protection. An enhanced level of protection, as defined by the MECP, requires 80% long-term suspended solid removal.

The proposed stormwater quality controls are to provide minimum 80% removal of total suspended solids (TSS). Treatment is primarily provided through infiltration of water in the permeable pavers.

The permeable pavers will achieve full infiltration, and 100% TSS removal, for the area they cover as well as the runoff from the building and the pervious contributing areas. There is no runoff from the site in the 25 mm storm event and therefore the site achieves 100% TSS removal and exceeds the MECP Enhanced level criteria.

6.3.5 Water Balance

A Thornthwaite Water Balance was completed for the 76-Unit Apartment Building development. This analysis incorporates the proposed stormwater LID measures.

The assessment indicates that in pre-development conditions, the site will have clay and urban lawn based in Table 3.1, MOE SWMPDM, 2003. The site has a total area of 0.29 ha with approximately 30% of it as impervious surface, and 70% as pervious landscaped area. The site generates an estimated runoff volume of 441 m^3/yr and groundwater recharge of 717 m^3/year.

Under post-development conditions, the site will have about 29% of it as impervious surface, 57% as permeable paver area, and 14% as pervious landscaped area. The post-development assessment sees an estimated runoff volume of 212 m^3/yr, a 52% reduction from pre-

development conditions, and groundwater recharge of 824 m^3/yr, a 15% increase from pre-development conditions.

The stormwater management LID measures substantially improved the post-development hydrologic performance by improving infiltration and reduction in surface runoff. As a result, a full water balance is achieved. See **Table 2** for the inflow and infiltration performance of the permeable paver.

6.3.6 Erosion and Sediment Controls

The use of silt fence, as per the City of Welland Municipal Standards and Niagara Peninsula Conservation Authority, is recommended around the perimeter of the site. The silt fence shall be installed prior to, and remain for, the duration of construction. A mud mat shall be installed and maintained. There shall be no mud or debris transfer onto Thorold Rd for the duration of the construction. Special care shall be taken of the permeable pavers during construction to ensure proper function after construction is complete. The pavers once installed shall not be used for storage of materials, and effort shall be taken to keep the pavers clean and free of sediment during construction. We recommend sediment or silt booms be placed on the surface of the parking area around the perimeter of the permeable pavers during construction and/or the pavers be cleaned using a vacuum truck following construction. Additional recommendations, including maintenance measures for the site, are included in the site Operation and Maintenance Manual, which has been submitted under separate cover.

We recommend the site be constructed in stages to minimize the impact on the proposed permeable paver system. It is anticipated that the following sequence will be undertaken:

- Installation of a temporary entrance and mud mat from Thorold Rd
- Removal of the site vegetation as per the tree removal/preservation plan
- Installation of the perimeter erosion and sediment control fencing
- Installation of the site perimeter retaining walls and building foundation
- Backfill of the site with approved material to below the permeable paver stone storage level
- Installation of the Thorold Rd servicing
- Construction of the proposed 76-Unit Apartment Building
- Installation of the stone storage layer for the permeable paving system with removal of contaminated sand layer as required

under the supervision of a geotechnical engineer
- Installation of concrete barrier curb and walkways
- Installation of the permeable paving surface system

The stone storage layer and permeable pavers should not be used for storage of materials, and the contractor should limit access to finished permeable paver areas as much as possible with construction equipment. Sediment and erosion control details will be provided in a future submission, including site-specific plans to be developed in coordination with the City of Welland and Niagara Peninsula Conservation Authority.

7.0 Hydro-electric, Telephone, Cable & Natural Gas Utilities

It has been acknowledged that the following utility regulators have services in the immediate area:

- Hydro-Electric – Welland Hydro;
- Natural Gas - Enbridge Gas;
- Telephone – Bell Canada; and,
- Telecommunication – Rogers Communications

Each of these companies will be contacted in advance of final design to determine whether sufficient capacity exists within the current installations to support the proposed 76-Unit Apartment Building development.

8.0 Transportation

- The site is estimated to generate 31 new trips during the AM peak hour, 35 new trips during the PM peak hour, and 32 new trips during Saturday peak hour.

- Though not attributed to the proposed development, the results of the operational analysis indicate that most un-signaled intersections operate at Level of Service (LOS) 'A' indicating a free flow traffic, through 2031. But, by 2036-2041, they degrade to LOS 'B/C' indicating stable flow but slight delays in the PM peak hour by 2041.

- The proposed Entry and Exit of the proposed development maintain a LOS A/B throughout all future years.

- As such, no improvements to the road network are considered necessary to accommodate the future background or total volumes.

- For parking analysis, overall, the parking supply is appropriately calibrated to the project demand for a mid-rise development. It accommodates peak load without reaching critical saturation and supports long-duration parking behavior of residents.

- An auto turn analysis was also conducted using a comprehensive swept path using an auto turn software. The results confirm that with the internal driveway, all designated vehicle types can smoothly enter, circulate, and exit the proposed site in compliance with applicable engineering and safety standards.

- A Transportation Demand Management (TDM) is also a requirement for the development to encourage adoption of alternative modes of transportation. TDM measures include a safe bicycle parking and pedestrian connections to public roads with improvements such as speed table and pedestrian warning markings.

9.0 Conclusion

The Functional Servicing and Stormwater Management Report demonstrates that the proposed 76-Unit Apartment Building development at 164 Thorold, Welland, Ontario, meets the established criteria for general servicing and stormwater management, as outlined in the 2025 Development Engineering Design Standards of the City of Welland, the Niagara Peninsula Conservation Authority (NPCA) Stormwater Management Guidelines as well as the Ontario Ministry of the Environment, Conservation and Parks (MECP) Guidelines. The development can proceed without negatively impacting the existing municipal infrastructure, provided the following recommendations are implemented:

- **Sanitary Sewer Line**: A new manhole at property line with 200mm Dia. Sanitary sewer pipe at 0.80% grade to service the building

- **Water Servicing Line**: A 150mm dia. water supply line will be installed along Thorold Rd with peak domestic demand of 0.32 L/s and peak fire supply flow rate of 150 L/s

- **Stormwater Extension:** The need of a stormwater extension was brought up in the project pre-consultation report since the development cannot connect to an existing sewer system. This has been addressed through the proposed permeable paver LID system which removes off-site runoff up to the 100-yr design storm event.

- **Utilities Coordination**: Contact Bell Canada, Enbridge Gas, Rogers Cable and Welland Hydro in advance of final design to verify sufficient

capacity for the 76-Unit Apartment Building development and to establish new connections where required.

- **Traffic Impact Study**: The estimated 31 AM peak hour, 35 PM peak hour, and 32 Saturday peak hour trips, ensuring no road network improvements are needed.

- **Erosion and Sediment Controls**: Develop and submit site-specific erosion and sediment control plans in coordination with the City of Welland and Niagara Peninsula Conservation Authority, incorporating the staged construction sequence and permeable paver protection measures outlined in this report.

- **Future Development**: Revisit the assessment for any future phases or adjacent developments (e.g., undevelopable portions designated as green space) when they proceed through Site Plan control.

The proposed development will be serviced from Thorold Rd for water, sanitary sewer, and utilities, with existing services extended to the property line and new connections established as needed. Stormwater management is provided using permeable pavers, achieving quantity and quality control, and a full water balance.

This report is intended to provide engineering support for the Official Plan Amendment (OPA) and Zoning By-Law Amendment (ZBA) and demonstrates that the development is feasible from an engineering perspective. We believe that this report, supported by the appended analyses, confirms the site can be constructed to meet the 2025 Development Engineering Design Standards of the City of Welland, the Niagara Peninsula Conservation Authority (NPCA) Stormwater Management Guidelines as well as the Ontario Ministry of the Environment, Conservation and Parks (MECP) Guidelines.

All of which is respectfully submitted,



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Table 1. Pre- and Post-Development Peak Flows

Design Storm	Pre- (L/s)	Post- (L/s)
Local 2yr	15.8	No off-site discharge
Local 5yr	20.6	
Local 10yr	22.8	
Local 25yr	26.0	
Local 50yr	28.6	
Local 100yr	31.2	
Chicago 4-hr 25mm	7.0	

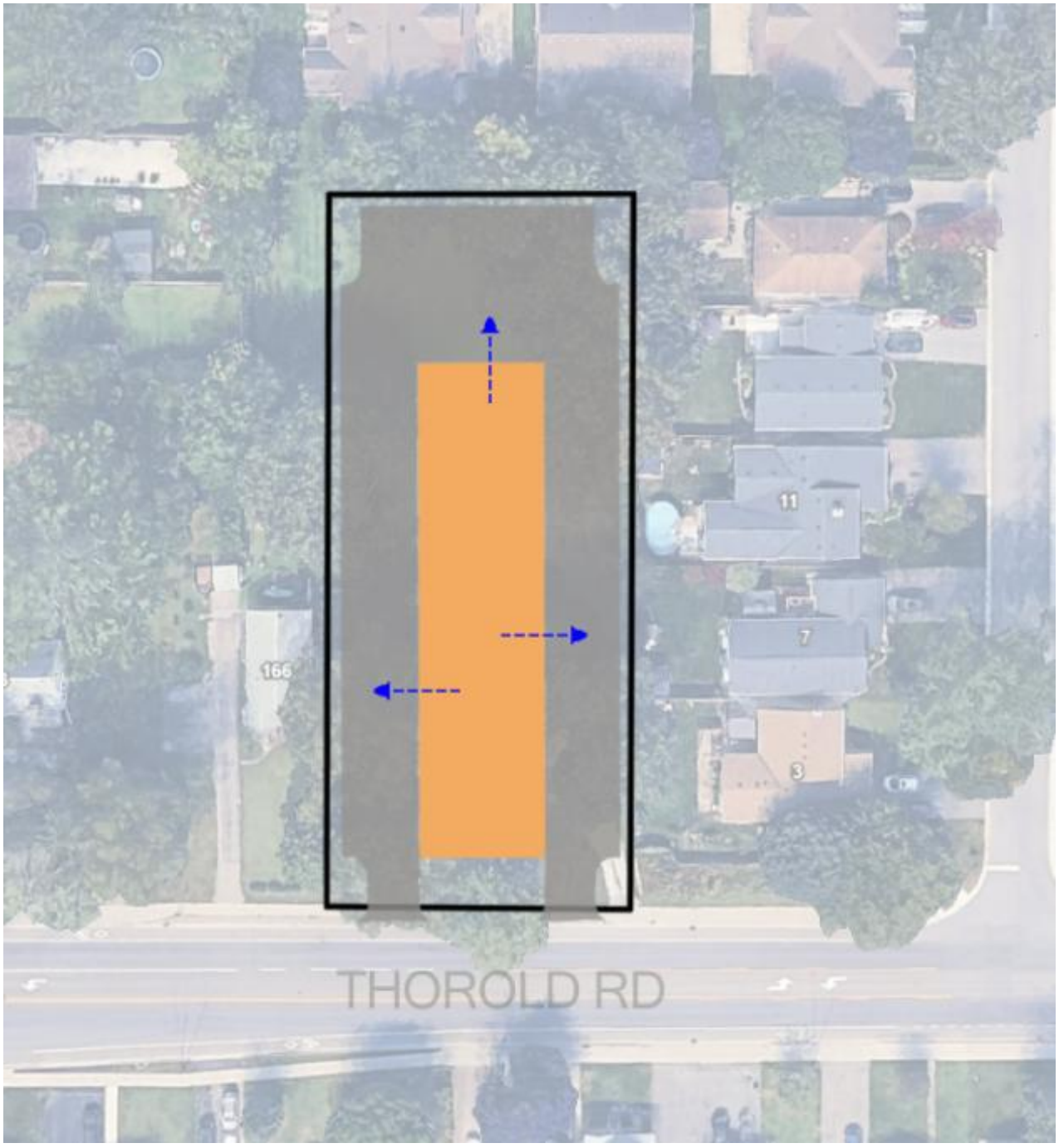
Note: *Local design storms are based on rainfall intensity IDF curve as indicated on* ***Section 7.2.4 Rainfall Intensity*** *on* ***Welland Municipal Standards***

Table 2. Permeable Paver Storage

Design Storm	Total Inflow into Pavers (m^3)	Effective Storage (m^3)	Soil Infiltration Capacity in 48-hr (m^3)	Remaining water after 48-hr (m^3)	Total drawdown time (hr)	Volume Runoff (m^3)	Status
Local 2yr	94.19	167.88	201.46	0	22.4	0	No Overflow
Local 5yr	113.95	167.88	201.46	0	27.1	0	No Overflow
Local 10yr	131.90	167.88	201.46	0	31.4	0	No Overflow
Local 25yr	158.82	167.88	201.46	0	37.8	0	No Overflow
Local 50yr	181.87	167.88	201.46	0	43.3	0	No Overflow
Local 100yr	201.45	167.88	201.46	0	48.0	0	No Overflow
Chicago 4-hr 25mm	62.80	167.88	201.46	0	15.0	0	No Overflow

APPENDIX A:
PCSWMM Post-Development Results

Figure 1: Proposed Condition



Post Development – 2-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.017        58.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.178
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.011        37.937
Continuity Error (%) .....        -0.027


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
-----------------------------------------------------------------------------------------------------------------------
1                        58.10       0.00       0.00      20.18      20.60       0.70      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	94.19	0.00	29.00	0.00	0.00	0.00	65.20	-0.02

Analysis begun on: Wed May 13 04:08:22 2026
Analysis ended on: Wed May 13 04:08:22 2026
Total elapsed time: < 1 sec

Post Development – 5-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.020        69.700
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.498
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.014        49.219
Continuity Error (%) .....        -0.024


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
-----------------------------------------------------------------------------------------------------------------------
1                        69.70       0.00       0.00      20.50      25.26       1.24      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	113.95	0.00	29.00	0.00	0.00	0.00	84.97	-0.01

Analysis begun on: Wed May 13 04:08:44 2026
Analysis ended on: Wed May 13 04:08:44 2026
Total elapsed time: < 1 sec

Post Development – 10-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


*************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
*************************     ---------       -------
Total Precipitation ......         0.023        80.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.651
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.017        59.467
Continuity Error (%) .....        -0.023


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
-----------------------------------------------------------------------------------------------------------------------
1                        80.10       0.00       0.00      20.65      29.57       1.87      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	131.90	0.00	29.00	0.00	0.00	0.00	102.92	-0.01

Analysis begun on: Wed May 13 04:09:00 2026
Analysis ended on: Wed May 13 04:09:00 2026
Total elapsed time: < 1 sec

Post Development – 25-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.028        95.600
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.787
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.022        74.834
Continuity Error (%) .....        -0.022


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
-----------------------------------------------------------------------------------------------------------------------
1                        95.60       0.00       0.00      20.79      36.09       2.88      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	158.82	0.00	29.00	0.00	0.00	0.00	129.83	-0.01

Analysis begun on: Wed May 13 04:09:13 2026
Analysis ended on: Wed May 13 04:09:13 2026
Total elapsed time: < 1 sec

Post Development – 50-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


*************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
*************************     ---------       -------
Total Precipitation ......         0.032       108.800
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.830
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.026        87.993
Continuity Error (%) .....        -0.021


**************************
Subcatchment Runoff Summary
**************************

---------------------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                 mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
---------------------------------------------------------------------------------------------------------------------
1                        108.80       0.00       0.00      20.83      41.71       3.82      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	181.87	0.00	29.00	0.00	0.00	0.00	152.88	-0.01

Analysis begun on: Wed May 13 04:09:27 2026
Analysis ended on: Wed May 13 04:09:27 2026
Total elapsed time: < 1 sec

Post Development – 100-Yr Storm Event

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.035       120.000
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        20.850
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.029        99.175
Continuity Error (%) .....        -0.021


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
-----------------------------------------------------------------------------------------------------------------------
1                       120.00       0.00       0.00      20.85      46.50       4.64      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	201.45	0.00	29.00	0.00	0.00	0.00	172.47	-0.01

Analysis begun on: Wed May 13 04:09:38 2026
Analysis ended on: Wed May 13 04:09:38 2026
Total elapsed time: < 1 sec

Post Development – 25mm Chicago

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
------------------------------------------------------------


***************
Analysis Options
***************
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Surcharge Method ..... EXTRAN
Starting Date ..... 05/12/2026 00:00:00
Ending Date ..... 05/13/2026 06:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ..... 00:01:00
Wet Time Step ..... 00:01:00
Dry Time Step ..... 00:01:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.007        25.000
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.005        18.404
Surface Runoff ...........        -0.000        -0.000
Final Storage ............         0.002         6.608
Continuity Error (%) .....        -0.046


**************************
Subcatchment Runoff Summary
**************************

---------------------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
Subcatchment                mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
---------------------------------------------------------------------------------------------------------------------
1                        25.00       0.00       0.00      18.40       8.46       0.30      -0.00       -0.00     0.00  -0.000
```

****
LID Performance Summary
****

Subcatchment	LID Control	Total Inflow mm	Evap Loss mm	Infil Loss mm	Surface Outflow mm	Drain Outflow mm	Initial Storage mm	Final Storage mm	Continuity Error %
1	PP	39.81	0.00	29.50	0.00	0.00	0.00	10.33	-0.04

Analysis begun on: Wed May 13 04:49:40 2026
Analysis ended on: Wed May 13 04:49:40 2026
Total elapsed time: < 1 sec

APPENDIX B - Thornthwaite Water Balance

Thornthwaite Water Balance Calculations
Project: 164 Thorold
City of Welland, Ontario

Pre- and Post-Development Monthly Water Balance Components

Potential Evapotranspiration Calculation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average Temperature (Degree C)[1]	-4.5	-4.0	0.5	7.5	14.0	19.0	22.0	21.0	17.0	10.0	4.0	-1.5	8.8
Heat Index = I = (t/5)$^{1.514}$	0.00	0.00	0.02	1.55	4.68	7.62	9.52	8.88	6.96	3.18	0.83	0.00	43.24
Unadjusted Daily Potential Evapotranspiration U (mm)	0.0	0.0	1.2	33.1	65.7	93.5	114.2	105.7	80.4	42.0	13.7	0.0	549.5
Adjusting Factor for U (Latitude 44° 52' N)[2]	0.84	0.88	1.03	1.12	1.24	1.29	1.31	1.21	1.03	0.93	0.80	0.78	—
Adjusted Potential Evapotranspiration PET (mm)	0	0	1	37	81	121	150	128	83	39	11	0	651

PRE-DEVELOPMENT WATER BALANCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation (P)	82	65	72	78	88	92	85	82	95	91	89	84	1003
PE - Potential Evapotranspiration (PET)	0	0	1	37	81	121	150	128	83	39	11	0	651
P - PE (Soil Moisture Storage Change)	82	65	71	41	7	-29	-65	-46	12	52	78	84	352
Soil Moisture Storage max AET (75mm – Fine Sandy Loam, Urban Lawn)	75	75	75	75	75	46	0	0	12	64	75	75	—
Actual Evapotranspiration (AET)	0	0	1	37	81	121	111	82	83	39	11	0	566
Surplus (Surplus = P - AET)	82	65	71	41	7	0	0	0	0	13	78	84	441
Potential Infiltration (assumed 70% of site available as pervious)	57	46	50	29	5	0	0	0	0	9	55	59	310
Potential Direct Surface Water Runoff (independent of temperature)	36	29	31	18	3	0	0	0	0	6	34	37	194

POST-DEVELOPMENT WATER BALANCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation (P)	82	65	72	78	88	92	85	82	95	91	89	84	1003
PE - Potential Evapotranspiration (PE) from impervious areas (assume 40%)	0	0	1	37	81	121	150	128	83	39	11	0	651
P - PE (surplus available for runoff from impervious areas)	82	65	71	41	7	-29	-65	-46	12	52	78	84	352
Water surplus change compared to pre-condition (for areas that change from vegetated open areas to impervious areas)	82	65	71	41	7	0	0	0	12	52	78	84	492
Potential Infiltration to Native Soil (mm)	11	9	10	6	1	0	0	0	2	7	11	12	69
Underdrain Controlled Discharge (mm)	47	37	40	23	4	0	0	0	7	30	44	48	280
Direct Surface Runoff (mm)	24	19	21	12	2	0	0	0	3	15	23	24	143

Thornthwaite Water Balance

Land Use Description	Approx. Land Area (m^2)	Estimated Impervious Fraction Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area (m^3/yr)	Estimated pervious Area (m^2)	Runoff from Pervious Area (m^3/yr)	Estimated Recharge from Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) (m^3/yr)	Total Recharge Volume (m^3/yr)
Pre Development Site	2,903.60	0.30	871.08	131	2,032.52	198	717	441	717
TOTAL PRE-DEVELOPMENT	2,903.60	0.30	871.08	131	2,032.52	198	717	441	717
Post Development Site	2,903.60	0.29	842.04	143	2,061.56	69	824	212	824
TOTAL POST-DEVELOPMENT	2,903.60	0.29	842.04	143	2,061.56	69	824	212	824
							% Change from Pre to Post	-52%	+15%
							Effect of Development (with no mitigation)	0.48 times decrease in runoff	1.15 times increase in recharge

To balance pre- to post-, the recharge target (m^3/a) = 0 (Post-Development recharge exceeds Pre-Development target by 107 m^3/a)

Notes:

- Climate data is based on European Centre for Medium-Range Weather Forecast (ECMWF) showing averages collected between 1991 - 2021
- Potential Infiltration (based on MOE methodology) is independent of temperature.

APPENDIX C - Sanitary Sewer Design Sheet

Project: 164 Thorold
Municipality: City of Welland
Manning n Value: 0.013

DESIGN SEWAGE FLOWS							SANITARY SEWER CAPACITY									
Location of Section	**Cumulative Sanitary Catchment Area (ha)**	**From Upstream**	**To Downstream**	**Cumulative Served Population**	**Peaking Factor**	**Average Flow Residential (L/s)**	**Peak Flow Residential (L/s)**	**Peak Flow Infiltration (L/s)**	**Total Peak Flow (L/s)**	**Pipe Length (m)**	**Pipe Diameter (mm)**	**Pipe Grade (%)**	**Full Flow Capacity (L/s)**	**Full Flow Velocity (m/s)**	**Peak Flow Velocity (m/s)**	**Relative Flow Depth (%)**
Thorold Rd	0.29	Building	PMH 2	198	4.0	0.80	3.21	0.08	3.29	7.79	200	0.8	29.3	0.93	0.62	23
		PMH 2	PMH 1							10.11	200	0.8	29.3	0.93	0.62	23

Notes:

- Based on 2.6 persons per unit × 76 units = 198 persons.
- Average daily flow per capita = 350 L/cap/day.
- Extraordinary flow allocation = 0.28 L/s/gross ha.
- Peaking factor = Harmon method, adjusted for population.
- Peak Velocity = Min. 0.60 m/s, Max. 3.0 m/s (City of Welland Municipality Standard Section 9.4.4)
- Pipe Size and Slope: Min. 200mm dia., 0.80% slope
- Full Flow Capacity, Full Flow Velocity, and Peak Flow Velocity as per Manning Equation
- Manning "n" = 0.013.

APPENDIX D - Water Demand Calculation

Project: 164 Thorold
Municipality: City of Welland

Domestic Flow Calculation

Fixture Count per Unit Type						
Fixtures	**Water Closet**	**Lavatory**	**Shower**	**Kitchen Sink**	**Dishwasher**	**Washing Machine**
Manager's Office	1	1				
Janitorial Room		1				
Co-Working Space	1	1				
Restaurant / Lobby						
1 Bedroom	42	42	42	42	42	42
1 Bedroom + 1 Den	7	7	7	7	7	7
2 Bedroom + 2 Bath	54	54	54	27	27	27
	105	**106**	**103**	**76**	**76**	**76**

Fixture Unit Calculation				
Fixtures	**WSFU**	**DFU**	**Total WSFU**	**Total DFU**
Water Closet	2.2	4	231	420
Lavatory	0.7	1	74.2	106
Shower	1.4	2	144.2	206
Kitchen Sink	1.4	2	106.4	152
Dishwasher	1.4	1	106.4	76
Washing Machine	1.4	2	106.4	152
			768.6	**1112**

Number of Water Fixture Units	768.6	
Water Demand	6994.26	L
Operating Hours	24 Hrs	
Average Day Demand	6994.26	L/day
	4.857	L/min
	0.081	L/s
Peak Factor	4	
Peak Demand	0.32	L/s
Total Domestic Peak Demand	0.32	L/s

OBC Table 7.6.3.2 Hydraulic Load

OBC Table 7.4.10.5 Conversion of WFSU to L/min (9.1L per fixture unit)

Fire Flow Calculation

Office of the Fire Marshal, OFM guideline, Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code (Oct 1999)

Q = KVSTotal

where:

Q = Minimum Supply of Water in Litres (L)

K = Water Supply Coefficient from Table 1

V = Total Building Volume in Cubic Meters

Stot = Total of the spacial coefficient values from the property line exposures on all sides as obtained from the formula

Stot = 1 + [Ss1 + Ss2 + Ss3... + etc]

where:

Sside = values are obtained from Figure 1, as modified by Sections 6.39(e) and 6.3(f) of the OBC Guideline

Stot = need not exceed 2.0

1. Building Classification

Building	Table 3.1.2.1 Classification	Type of Construction	Water Supply coefficient
164 Thorold	C	Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches. Non-combustible construction may be used in lieu of fire-resistance rating where permitted in subsection 3.2.2 of the OBC	18

TABLE 1
WATER SUPPLY COEFFICIENT -- K

TYPE OF CONSTRUCTION	Classification by Group or Division in Accordance with Table 3.1.2.1 of the Ontario Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2. of the OBC, including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. of the OBC. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2. of the OBC, including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2. of the OBC.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

OBC A-3.2.5.7 Water Supply Coefficient

Table 3.1.2.1.
Major Occupancy Classification
Forming Part of Sentences 3.1.2.1.(1), 3.1.2.2.(1) and 3.11.2.1.(3)

Group	Division	Description of *Major Occupancies*
A	1	*Assembly occupancies* intended for the production and viewing of the performing arts
A	2	*Assembly occupancies* not elsewhere classified in Group A
A	3	*Assembly occupancies* of the arena type
A	4	*Assembly occupancies* in which occupants are gathered in the open air
B	1	*Detention occupancies*
B	2	*Care and treatment occupancies*
B	3	*Care occupancies*
C	--	*Residential occupancies*
D	--	*Business and personal services occupancies*
E	--	*Mercantile occupancies*
F	1	*High-hazard industrial occupancies*
F	2	*Medium-hazard industrial occupancies*
F	3	*Low-hazard industrial occupancies*

OBC Table 3.1.2.1 – Major Occupancy Classicfication

2. Building Volume

BLDG	AREA (sq.m)	HEIGHT (m)	VOLUME (in cu.m)
164 Thorold	852.31	24	**20455.44**

3. Exposure Distances

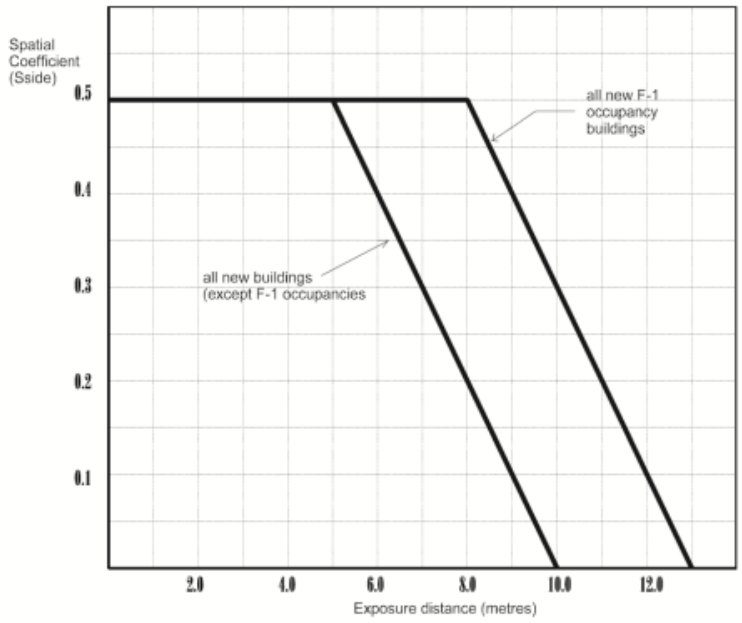


Figure 1
Spatial Coefficient vs Exposure Distance

Figure 1: Spatial Coefficient vs Exposure Distance

Bldg.	North	Ss (North)	East	Ss (East)	South	Sside (South)	West	Sside(W)	Stot
164 Thorold	>3m	0.5	8.85m	0.12	>10m	0	8.85m	0.12	1.74
Stotal	1								

4. Minimum Fire Water Supply

V	20455.44
K	18
Stotal	1.74

Q = KVStotal		
Q	**640664.38**	**liters**

5. Fire Water Supply Flow Rate

TABLE 2
MINIMUM WATER SUPPLY FLOW RATES

Building Code, Part 3 Buildings	Required Minimum Water Supply Flow Rate (L/min.)
One-storey building with building area not exceeding $600m^2$ (excluding F-1 occupancies)	1800
All other buildings	2700 (If **Q** ≤ 108,000L)[1] 3600 (If **Q** > 108,000L **and** ≤ 135,000L)[1] 4500 (If **Q** > 135,000L **and** ≤ 162,000L)[1] 5400 (If **Q** > 162,000L **and** ≤ 190,000L)[1] 6300 (If **Q** > 190,000L **and** ≤ 270,000L)[1] 9000 (If **Q** > 270,000L)[1]

Note: [1] $\mathbf{Q=KVS_{Tot}}$ as referenced in Section 3 (a)

OBC Table 2 Minimum Water Supply Flow Rate

6. Fire Water Supply

Fire Water Supply Flow Rate		
Q	640664.38	L
	9000 (If **Q** > 270,000L)	L/min
	150	**L/s**
Overall Flow Rate	**= Domestic + Fire Flow Rate**	
Domestic Peak Demand	0.32	L/s
Fire Flow Rate	150	L/s
Overall	**150.32**	**L/s**

