FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT BRIEF

IN SUPPORT OF AN APPLICATION TO AMEND

THE OFFICIAL PLAN AND ZONING BY-LAW

6546 Fallsview Blvd
Commercial Development

Niagara Falls, Ontario

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File Number: 22087

Prepared For:

Hennepin's View Inc.

2	Reissued for First Submission	2024-01-15
1	Issued for First Submission	2023-03-06
No.	**Revision**	**Date**

This Functional Servicing and Stormwater Management (SWM) Brief has been prepared on behalf of **Hennepin's View Inc.** in support of an application to amend the Official Plan and Zoning By-Law for the proposed hotel redevelopment at 6546 Fallsview Boulevard in the City of Niagara Falls, Ontario.

The purpose of this Functional Servicing and Stormwater Management (SWM) Brief is to demonstrate that adequate municipal servicing capacity exists and to outline the servicing and stormwater management strategy for the proposed hotel redevelopment. The servicing strategy for the proposed development is summarized as follows:

Water Servicing:

Per the record drawings provided by the City of Niagara Falls, there is an existing 450mm watermain on Fallsview Boulevard. The proposed development will be serviced through two new 200mm connections to the existing watermain, with one connection for each tower. The maximum day plus fire flow demand for the proposed development is **10,719 L/min**. Flow tests of nearby fire hydrants will need to be completed to confirm that residual system pressures are adequate at the governing flow rate.

Sanitary Servicing:

Sanitary flows for the proposed development will be directed to the existing 250mm sanitary sewer on Fallsview Boulevard. The peak sanitary flow generated by the proposed development is estimated to be **23.72 L/s**, which represents an increase of approximately 323 % in sanitary flows over the existing conditions. Given the subject site's location at the upstream end of the sanitary sewer shed, there are no capacity concerns for the sanitary sewer at the connection point. An analysis will be conducted at the detailed design stage to confirm the available capacity of the sanitary sewer further downstream**.**

Stormwater Servicing:

There is an existing 300mm storm sewer on Fallsview Boulevard that currently captures storm runoff from half of the existing site. The proposed development will be serviced through a new 300mm storm sewer connecting to the existing 300mm storm sewer on Fallsview Boulevard.

Site drainage will be captured by proposed area drains and directed to the proposed SWM tank that will be located underneath the ramp that is located immediately north of the proposed building. Roof drainage will be conveyed by the internal storm system and directed to the SWM tank.

The 100-year post-development flow rate for the entire site will be restricted to the 5-year pre-development release rate of **107 L/s**. Under post development conditions, the subject site will be comprised of 0.17 Ha. of uncontrolled area and 0.89 Ha. of controlled area. The uncontrolled area will drain onto Fallsview Boulevard and Portage Road while stormwater management will be applied to the controlled area. Runoff from the controlled area will be captured and directed to the SWM tank and pumped to a proposed 300mm storm sewer connection to the existing 300mm storm sewer on Fallsview Boulevard.

An 'Enhanced' level of quality control (80% TSS Removal) is required for the proposed development, which will be achieved through a treatment train approach. The treatment train will include the initial TSS removal credit from the landscape/roof areas and an Oil Grit Separator Unit (OGS) unit at the storm sewer outlet, resulting in an overall TSS removal rate of 91%.

The required water balance target of **53 m^3** will be achieved through onsite retention and reuse within the proposed building(s).

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1.0 INTRODUCTION

1.1 Background

Hennepin's View Inc. has retained Counterpoint Engineering Inc. to prepare this Functional Servicing and Stormwater Management Brief in support of an application to amend the Official Plan and Zoning By-Law for the proposed hotel redevelopment at 6546 Fallsview Boulevard (the "Subject Site"). This brief report was prepared to respond to submission requirements determined through the pre-consultation process. Section 14 of the City's Official Plan requires a pre-application consultation between an applicant and the City prior to submission of an application under the Planning Act to determine submission requirements for a complete application. The pre-consultation checklist issued following the submission of an updated conceptual design package in connection with a pre-consultation meeting held on Dec 15, 2022, included the following submission requirements for an application to amend the Official Plan and Zoning By-law:

(i) a Municipal Servicing Brief to review municipal services and demonstrate servicing capacity.

(ii) a Stormwater Management Plan addressing pre- and post-development flows for a 5-year peak flow rate.

This Functional Servicing and Stormwater Management Brief has been prepared to demonstrate that adequate municipal servicing capacity exists and to outline the servicing, stormwater management, and grading strategy for the proposed development.

The subject site is 1.06 Ha. in area and is situated within the City of Niagara Falls at the northeast quadrant of the intersection of Fallsview Boulevard and Portage Road. The Subject Site is bounded by Fallsview Boulevard to the west, Portage Road to the south, and existing commercial development (Fallsview Hotel and Casino) to the east and north. Currently, the Subject Site is occupied by the Oakes Hotel with a connected service commercial building, tenanted by an Applebee's restaurant, and with a surface parking lot along the Fallsview

Avenue frontage and decked parking on the eastern portion of the site. **Figure 1 – Site Location** illustrates the subject site within the context of its surroundings.

The Official Plan and Zoning By-law application contemplates the redevelopment of the property with a hotel complex comprised of two 58-storey hotel towers, a 7-storey podium and two underground levels (the "Proposed Hotel Redevelopment"). In terms of specific uses, the proposed redevelopment includes an accommodation component of approximately 1,140 hotel rooms and suites, 126 residential units, hotel-related food and beverage, a spa, ancillary retail and service uses, and the potential to accommodate a variety of entertainment uses. Refer to the proposed site plan concept included in **Appendix A**.

1.2 Study Parameters

The following were referenced in the preparation of this report:

- City of Niagara Falls Engineering Design Standards, 2016
- City of Niagara Falls Storm and Sanitary Sewer Design Criteria
- Regional Municipality of Niagara Model Urban Design Guidelines
- Design Guidelines for Drinking-Water Systems, MOE, 2008
- Water Supply for Public Fire Protection (Fire Underwriters Survey), 2020
- Stormwater Management Planning and Design Manual, MOE, 2003
- Topographic and legal survey completed by Richard Larocque Limited, dated December 20, 2016
- Architectural plans completed by Architects Alliance

2.0 WATER SUPPLY

2.1 Existing Water Supply

Per the record drawings provided by the City of Niagara Falls, there is an existing 450mm watermain on Fallsview Boulevard. Minimal information is available regarding the internal site servicing layout. However, it is assumed that the existing buildings are serviced via connection to the 450mm watermain on Fallsview Boulevard.

There is one abandoned water service connection and two existing water service connections that are to be abandoned, all connected to the existing 450mm watermain. Additionally, there

are two existing hydrants located on the east side of Fallsview Boulevard connected to the existing 450mm watermain. Refer to **Figure 2 – Water Servicing Plan** for the existing watermain network layout.

2.2 Proposed Water Supply

The proposed development will be serviced through two new 200mm connections to the existing 450mm watermain on Fallsview Boulevard. Each tower will be serviced by a 200mm connection, which will separate into a 200mm fire and 100mm domestic line. The two firelines will be looped internally as per the requirement of Ontario Building Code Section 3.2.9.7.

The City of Niagara Falls's engineering design manual states that demand flows shall be determined based on MOE's design guidelines for drinking water systems. Per MOE guidelines, governing flows shall be the greater of: a) maximum day demand plus fire flow, or b) maximum hour demand. The MOE guidelines recommend an average daily water use rate of 225 L/bed/day for hotels. Therefore, based on current site statistics and MOE guidelines, the average daily demand for the hotel was calculated to be 288 L/min. Peaking factors of 3.75 and 2.50 were used to determine the maximum hour and maximum day demand. The calculated daily demands for the proposed development are as follows:

- Average Day Demand = 288 L/min
- Maximum Hour Demand = 1,079 L/min
- Maximum Day Demand = 719 L/min

The City of Niagara Falls's engineering design manual states that the Fire Underwriter's Survey (FUS) guidelines shall be used to calculate the fire flow requirements of the proposed development. For a fire-resistant building with protected vertical openings, the FUS recommends that the total effective area consist of the single largest floor area plus 25% of each of the two immediately adjoining floors. The floor areas considered in the calculation include the lower ground floor, the ground floor, and the second level. Therefore, the resulting fire flow was 10,000 L/min and the resulting maximum day plus fire flow demand for the proposed development is 10,719 L/min.

Flow tests of nearby fire hydrants will need to be completed to confirm that residual system pressures are adequate at the governing flow rate. The City of Niagara Falls' design criteria dictate the following system pressure requirements:

- Maximum pressure during the minimum hourly demand = 700 kPa
- Minimum pressure during maximum hour demand = 275 kPa
- Minimum Fire Flow pressure during simultaneous maximum day demand plus fire flow = 149 kPa.

Refer to **Appendix B** for the supporting calculations of the proposed water supply system.

3.0 SANITARY SERVICING

3.1 Existing Sanitary Servicing

There is an existing 250mm sanitary sewer on Fallsview Boulevard directing flows northwards from Portage Road towards Dixon Street. There is an existing 250mm sanitary service connected to the Fallsview Boulevard sewer that terminates at a maintenance hole at the property line. Additionally, there is an existing 150mm sanitary service connected to the Fallsview Boulevard sewer that also terminates within the property.

Minimal information is available regarding the internal site servicing layout. However, it is assumed that the existing buildings are serviced via connection to the 250mm Fallsview Boulevard sewer.

Design criteria provided by the City of Niagara Falls dictates that sanitary design flows be estimated by applying population equivalent densities based on the respective land use. As the subject site is located within a tourist commercial land use area, the population equivalent density is 284.2 persons/ha. With an average daily flow of 380 L/person/day, an infiltration rate of 0.28 L/s/ha, and Harmon's peaking factor, it can be assumed that the existing development produces an estimated peak sanitary flow of **5.61 L/s**.

3.2 Proposed Sanitary Servicing

Sanitary servicing will be provided for the proposed development via a new 200mm connection to the existing maintenance hole located at the property line. Ultimately, the proposed development will direct sanitary flows to the existing Fallsview Boulevard sewer, which conveys flows northwards towards Dixon Street.

Refer to **Figure 3 – Sanitary Servicing Plan** for the existing and proposed sanitary sewer layout.

The proposed development will introduce additional population density that will be higher than a typical tourist commercial land use area. As such, it will be more appropriate to use the per capita wastewater flows for Niagara Falls Wastewater Treatment Plant (WWTP) Plant (Table 4.3 of the 2021 Water and Wastewater Master Servicing Plan Update (WWMPU)).

For the population density, the hotel occupancy was divided into four categories: Standard (1 bed), Executive (2 bed), Deluxe (3 bed), and Presidential (4 bed). With 1,140 hotel units, the hotel quest equivalent population was determined to be of 1,164. Similarly, the residential units were divided into three categories: 1 Bed, 2 Bed and 3 Bed. Based on the 126 residential units, the residential equivalent population was determined to be 210. The total equivalent population for the development including hotel and residential is 1,874. Hotel staff population is anticipated to be negligible and will be confirmed at the detail design stages.

With an infiltration rate of 0.286 L/s/ha (as specified by the WWMPU) and a peaking factor of 3.61 per the Harmon formula, the peak sanitary flow generated by the proposed development can be estimated to be **23.72 L/s**. This represents an increase of approximately 323% in sanitary flows over the existing conditions and given the subject site's location at the upstream end of the sanitary sewer shed (refer to the sanitary drainage area included in **Appendix C**), there are no capacity concerns for the sanitary sewer at the connection point. An analysis will be conducted at the detailed design stage to confirm the available capacity of the sanitary sewer further downstream.

Refer to **Appendix C** for supporting calculations.

4.0 STORMWATER SERVICING

4.1 Existing Stormwater Drainage

There is an existing 300mm storm sewer on Fallsview Boulevard that drains north into a 600mm storm sewer further down Fallsview Boulevard. There is also a 375mm storm sewer on Portage Road draining west to a 375mm storm sewer on Main Street. Approximately nine existing catchbasins are located on the parking lot east of the site. Refer to **Figure 4 – Existing Conditions Drainage Plan** for existing drainage patterns, areas, and runoff coefficients.

The existing site is comprised of 2 drainage areas that are summarized in **Table 1**. Based on the City of Niagara Falls's specified IDF curves, the pre-development 5-year peak runoff rates for the existing site are as follows:

Table 1– Pre-Development Drainage Areas

ID	Area	Runoff Coefficient	5-Yr Peak Flow (L/s)
101	0.52	0.88	107
102	0.54	0.77	97

Refer to **Appendix D** for predevelopment release rate calculations.

Per the storm drainage plans provided by the City of Niagara Falls (refer to **Figure ST-02** in **Appendix D**), it has been determined that runoff generated by Drainage Area 101 drains to the existing 300mm storm sewer on Fallsview Boulevard. Runoff from Area 102 drains eastwards onto the existing parking lot and is captured by the existing catchbasins. The provided storm drainage plans that flows from Drainage Area 102 are directed to the east towards Niagara River Parkway and ultimately, Niagara River.

4.2 Proposed Stormwater Management

The allowable stormwater release rate to the existing storm sewer on Fallsview Boulevard has been determined to be equivalent to the 5-year peak flow rate generated by Existing Conditions Area 101 (refer to **Figure 4 – Existing Conditions Drainage Plan**). This is to allow the capture

of all minor and major flows (for storm events up to and including the 1:100 year return period) generated from the subject and to ensure the proposed development's site drainage is self-contained and will outlet to one location (Fallsview Boulevard storm connection) in accordance with current City of Niagara Falls Engineering Design Guidelines. Currently, the minor and major flows from the eastern half of the subject site are directed to the adjacent property to the east. Major flows from storm events of a return period greater than 1:100 years will continue to be directed towards the adjacent property to the east.

The allowable stormwater release rate has been determined to be **107 L/s**.

Refer to **Figure 5 – Proposed Conditions Drainage Plan** for the proposed drainage patterns, areas, and runoff coefficients.

Table 2 provides a preliminary allocation of the allowable release rate and associated storage requirements for the proposed development.

Table 2 – Peak Flow and Storage Summary - 100-Year Storm Event

Area ID	Area (ha)	Runoff Coefficient	t_c (min)	Storage Available (m^3)	Storage Required (m^3)	Release Rate (L/s)	Description	Orifice Size (mm)
201	0.17	0.82	10	N/A	N/A	33	Uncontrolled	N/A
202	0.89	0.90	10	170	165	74	Controlled	Pump

The combined site release rate from the controlled and uncontrolled areas will be **107 L/s**, which is equal to the allowable release rate. A proposed SWM tank that will be located underneath the ramp that is immediately north of the proposed building will be utilized to provide the storage required to attenuate stormwater flows to the required rates. This tank has been oversized to **170m^3** to accommodate the required **165m^3** storage volume. Refer to **Appendix D** for storage volume calculations.

Area drains and catch basins are proposed to collect site drainage and direct it to the proposed SWM tank. Roof drainage will be conveyed by the internal storm drain system to the SWM tank. Control flow roof drains and rooftop detention are not required.

The bottom of the SWM tank (approx. invert at 179.05) will be below the existing storm sewer invert (180.95) and therefore controlled stormwater discharge will be through a pump. Refer to **Figure 6 – Storm Servicing Plan** for the existing and proposed stormwater sewer layout including the location of the SWM tank. Short-term and long-term groundwater discharge details will be determined at the detailed design stages.

The stormwater quality control target is 'Enhanced' (Level 1) treatment of stormwater runoff which corresponds to a total suspended solids (TSS) removal rate of at least 80%. Based on the site plan, the unmitigated TSS removal rate is only 55%. A treatment train approach consisting of a conventional roof area, landscape area, and a filter unit is proposed to achieve the quality control requirement. A Jellyfish® model JF4 has been preliminarily sized to treat this development. Refer to **Appendix D** for sizing and specifications.

The objective of the water balance criteria is to capture and manage annual rainfall on-site to preserve the pre-development hydrology. Water balance consists of runoff, infiltration, and evapotranspiration. The target set out by Niagara Peninsula Conservation Authority (NPCA) for infill developments is onsite retention of 5mm rainfall depth across the subject site.

Based on the area of the subject site (1.06 ha), 5mm rainfall depth equates to a retention volume of **53m^3**. The required retention volume will be achieved through an internal water reuse cistern located upstream of the proposed SWM tank. Rooftop drainage will be directed to the water re-use cistern which will overflow into the proposed SWM tank upon the capture of 55m^3 of storage. Refer to **Appendix D** for water balance calculations.

Given that the subject site fronts onto a regional road, Niagara Region SWM requirements will apply. The SWM measures outlined in this document will address Niagara Region's SWM requirements pertaining to quantity and quality control and water balance and therefore no additional SWM measures will be required.

5.0 CONCLUSIONS

Our conclusions as they relate to the proposed hotel redevelopment, and more specifically, the submission requirements required in connection with the application to amend the Official Plan and Zoning By-law, are as follows:

i. The proposed hotel redevelopment can be serviced with existing municipal servicing.
ii. The post development 5-year peak flows can be addressed through a proposed SWM storage tank while stormwater quality control targets can be achieved using a treatment train approach.

The preceding conclusions are based on the engineering criteria for the City of Niagara Falls, the Regional Municipality of Niagara, and the Niagara Peninsula Conservation Authority. We trust the information provided in the report meets your requirements. Should there be any questions or comments, please feel free to contact the undersigned.

Sincerely,

Counterpoint Engineering Inc.

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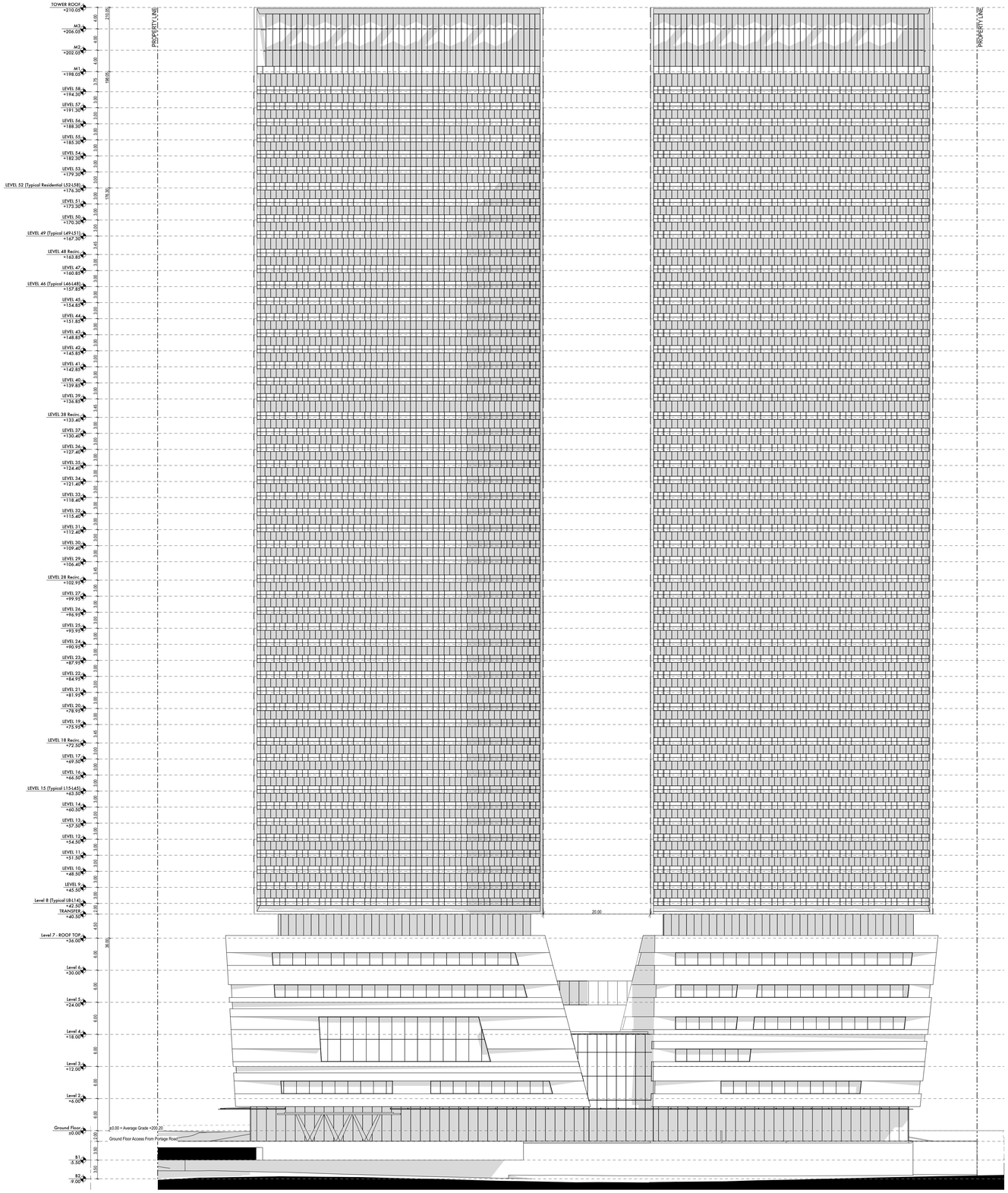
APPENDIX A

Figures & Site Plan

Project No.: 22087



1 A-2.1 EAST ELEVATION
SCALE: 1:400

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No	Issued For	Date
1.	DRAFT SET	2023 - 03 - 14
2.	ZONING BY-LAW AMENDMENT	2024 - 02 - 01

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Oakes Hotel Redevelopment
6546 Fallsview Blvd
6546 Fallsview Blvd, Niagara Falls, ON

Hennepin's View Inc.

EAST ELEVATION

Scale: 1:400

Project No: 22023-1

01 February 2024

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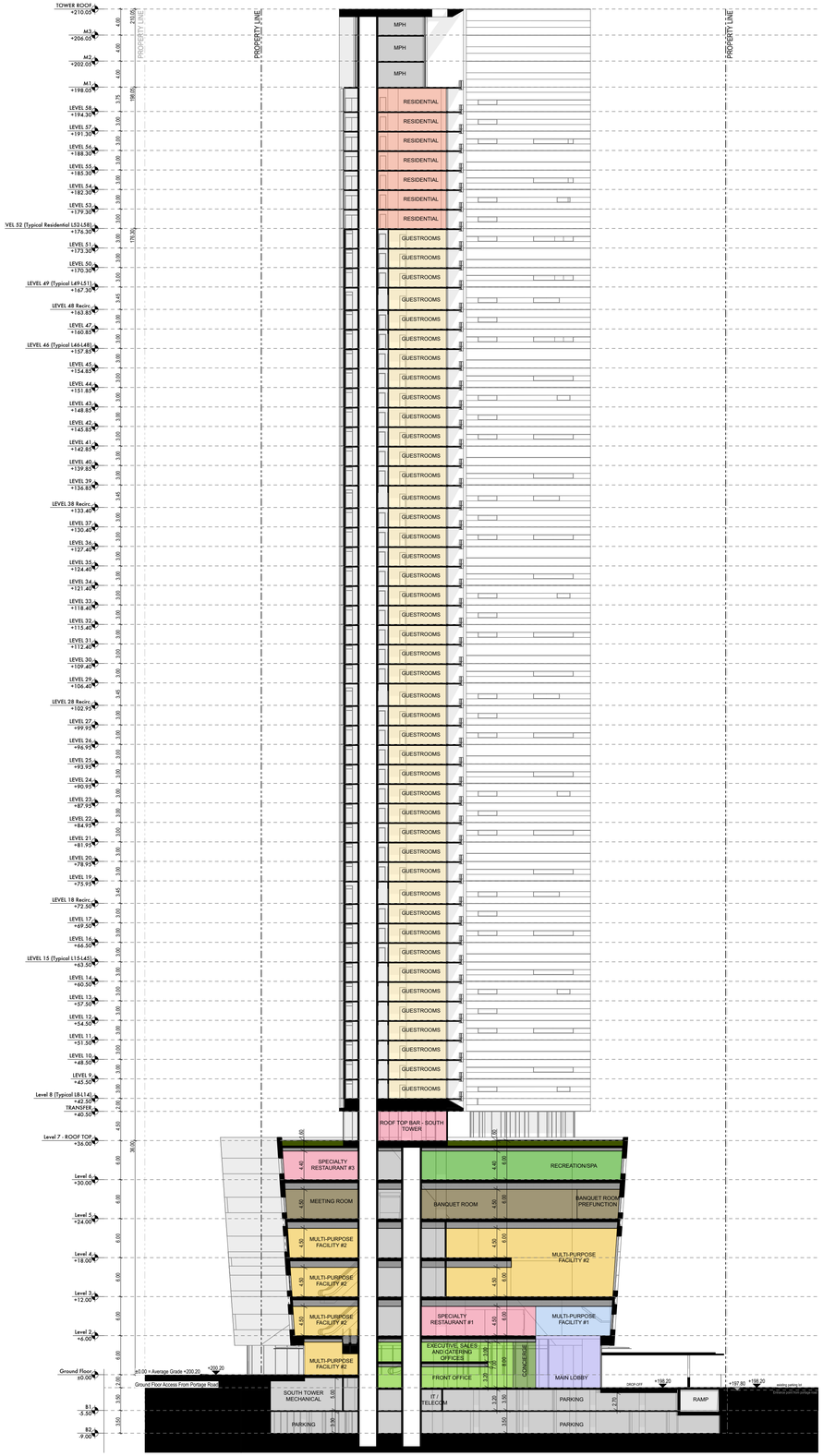

1 A-3.1 SOUTH PODIUM LOOKING NORTH
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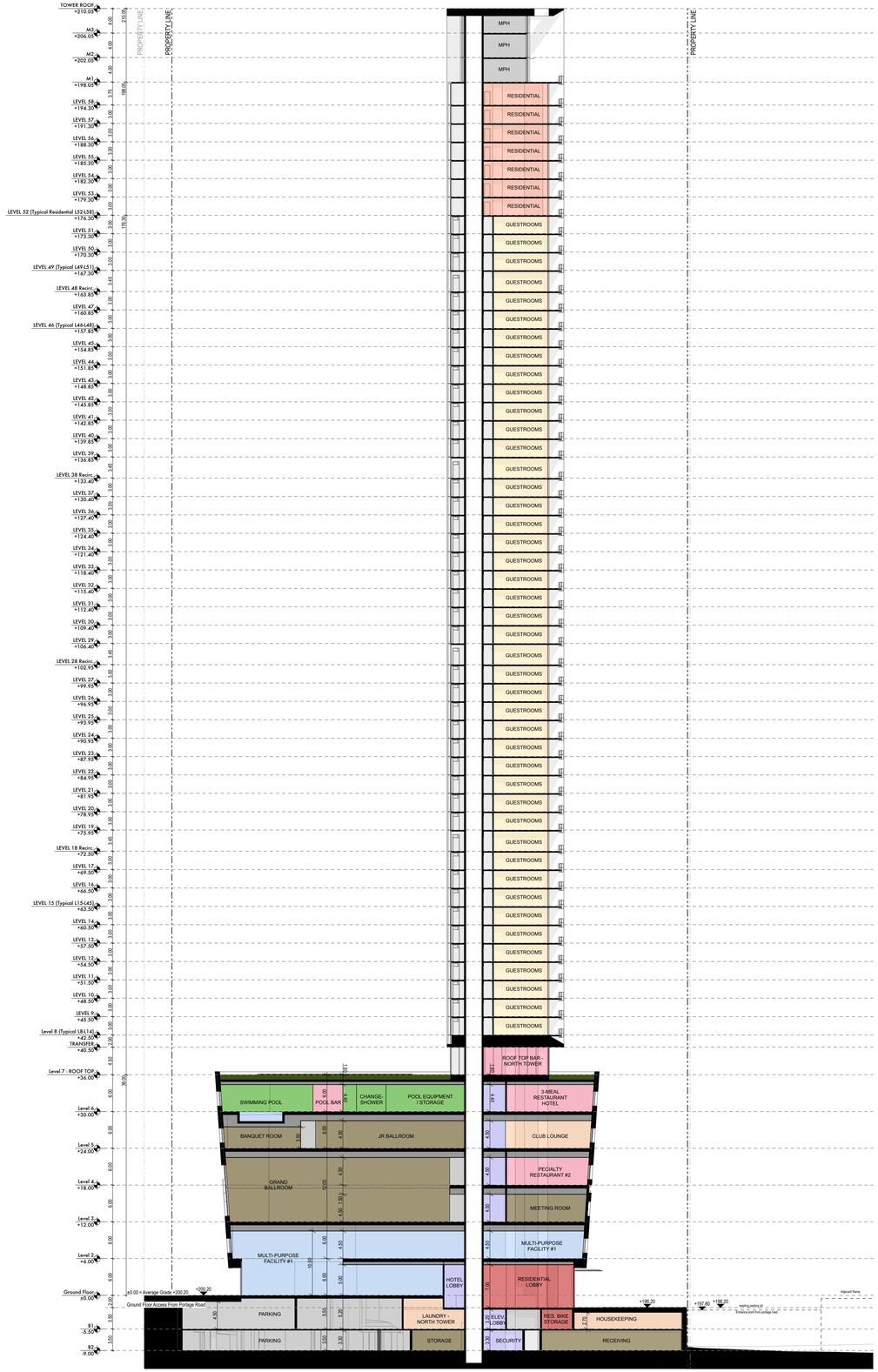

2 A-3.1 NORTH PODIUM LOOKING NORTH
SCALE: 1:400

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Oakes Hotel Redevelopment
6546 Fallsview Blvd,
6546 Fallsview Blvd, Niagara Falls, ON

Hennepin's View Inc.

SECTIONS

Scale: 1:400

Project No: 22023-1

01 February 2024

A-3.1

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Oakes Hotel Redevelopment
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6546 Fallsview Blvd, Niagara Falls, ON

Hennepin's View Inc.

GROUND FLOOR

Scale: 1:350

Project No: 22023-1

01 February 2024

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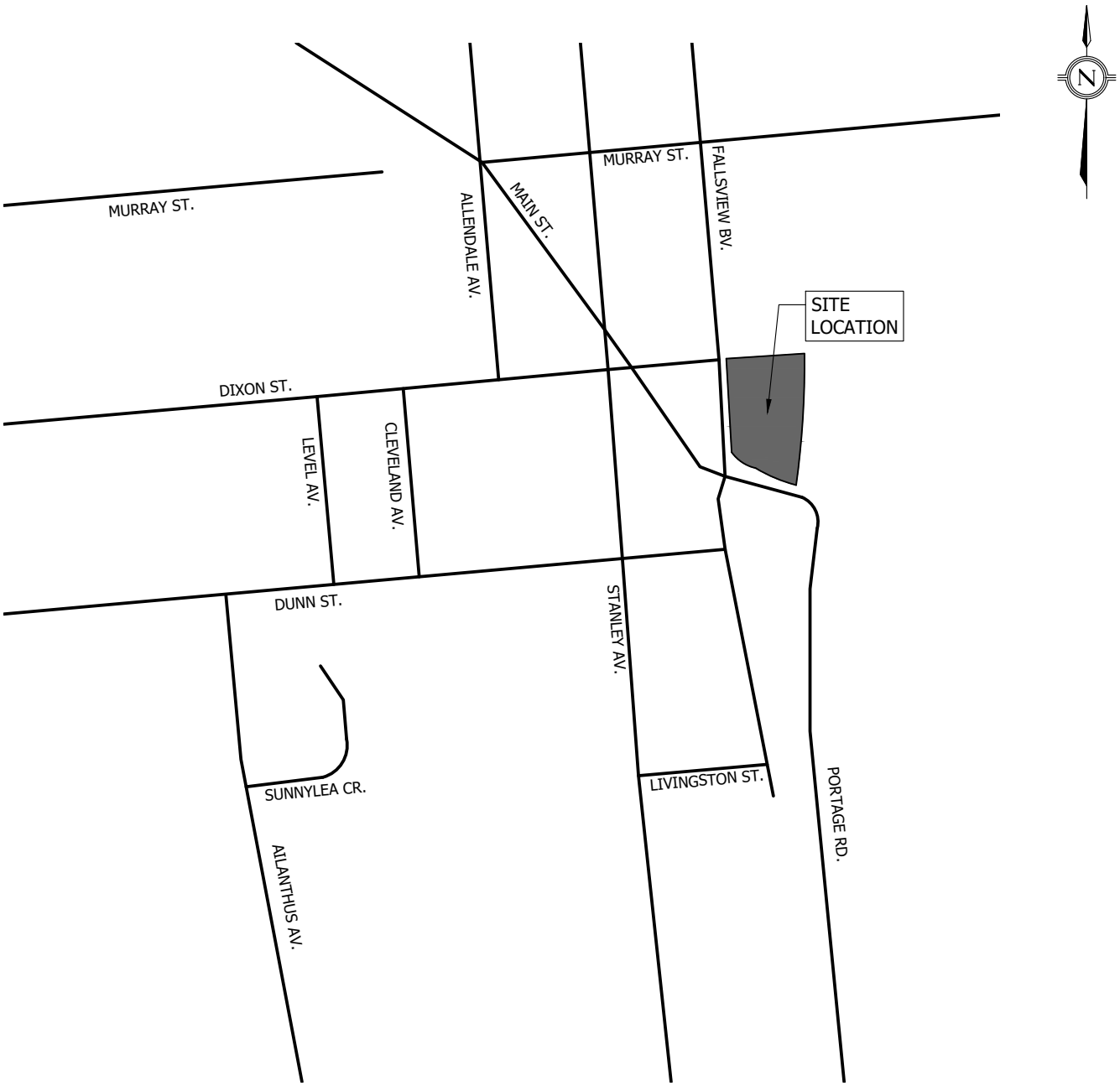

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6546 FALLSVIEW BOULEVARD

NIAGARA FALLS, ONTARIO

SITE LOCATION PLAN

DESIGNED BY: ET	DATE: FEB 08, 2023
CHECKED BY: PM	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 1
SCALE: NTS	

Z:\Shared\Projects\2022\22087_Hennepin Autograph Niagara Falls\Design\Drawings\Figures\22087 Figure 1 Site Location Plan.dwg

DIXON ROAD

EX. 200mmø WM

EX. WATER SERVICE TO BE ABANDONED

NEW 300mmø WM

EX. 450mmø WM

NEW 150mmø DOM.

FALLSVIEW BOULEVARD

NEW 300mmø FIRE

EX. WATER SERVICE AND CURB STOP TO BE ABANDONED

NEW 300mmø WM

NEW 300mmø FIRE

NEW 150mmø DOM.

EX. HYDRANT AND LEAD TO REMAIN

MAIN STREET

EX. 675mmø WM

EX. 200mmø WM

LINE OF BASEMENT WALL

LINE OF BUILDING AT GROUND LEVEL

LINE OF BUILDING ABOVE GROUND LEVEL

PROPOSED 58 STOREY TOWER

NORTH TOWER MECH. ROOM

SIAMESE CONNECTION

EX. HYDRANT AND LEAD TO REMAIN

PROPOSED 58 STOREY TOWER

SOUTH TOWER MECH. ROOM

LINE OF BUILDING AT GROUND LEVEL

CANOPY ABOVE

EXHAUST HATCH

EX. WATER SERVICE AND CURB STOP TO BE ABANDONED

LINE OF BASEMENT WALL

PORTAGE ROAD

PROPOSED ROAD WIDENING

N

LEGEND

- PROPERTY LINE
- LINE OF BASEMENT WALL
- EX. WATERMAIN
- PROP. WATERMAIN
- VALVE BOX
- (B) WATER METER LOCATION
- (M) BACKFLOW PREVENTOR
- HYDRANT

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6546 FALLSVIEW BOULEVARD

NIAGARA FALLS, ONTARIO

WATERMAIN SERVICING PLAN

DESIGNED BY: PM	DATE: FEB 08 2023
CHECKED BY: PW	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 2
SCALE: NTS	

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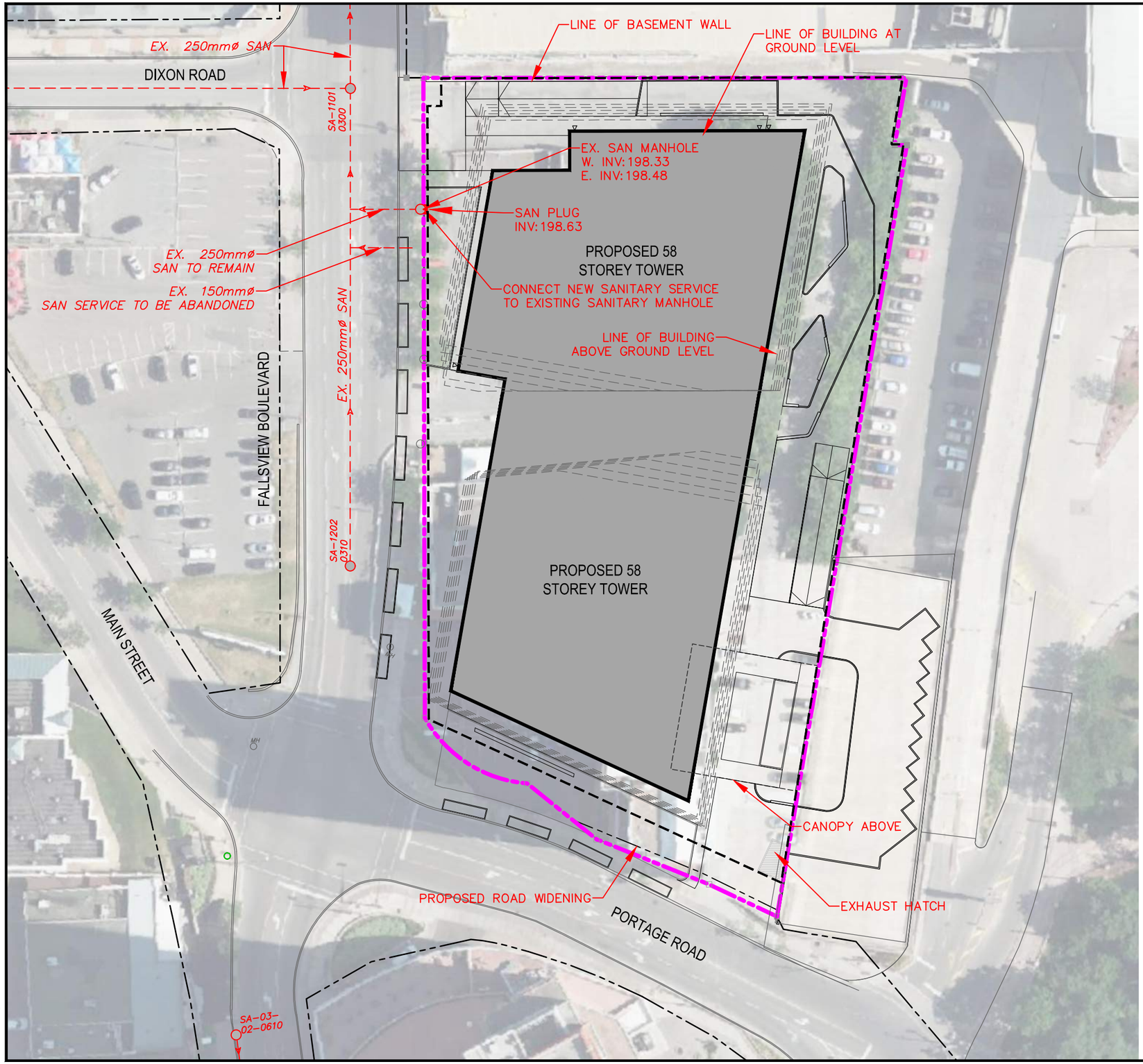

LEGEND

- PROPERTY LINE
- LINE OF BASEMENT WALL
- EX. SANITARY SEWER & FLOW DIRECTION
- PROP. SANITARY SEWER & FLOW DIRECTION
- EX/PROP SANITARY MANHOLE

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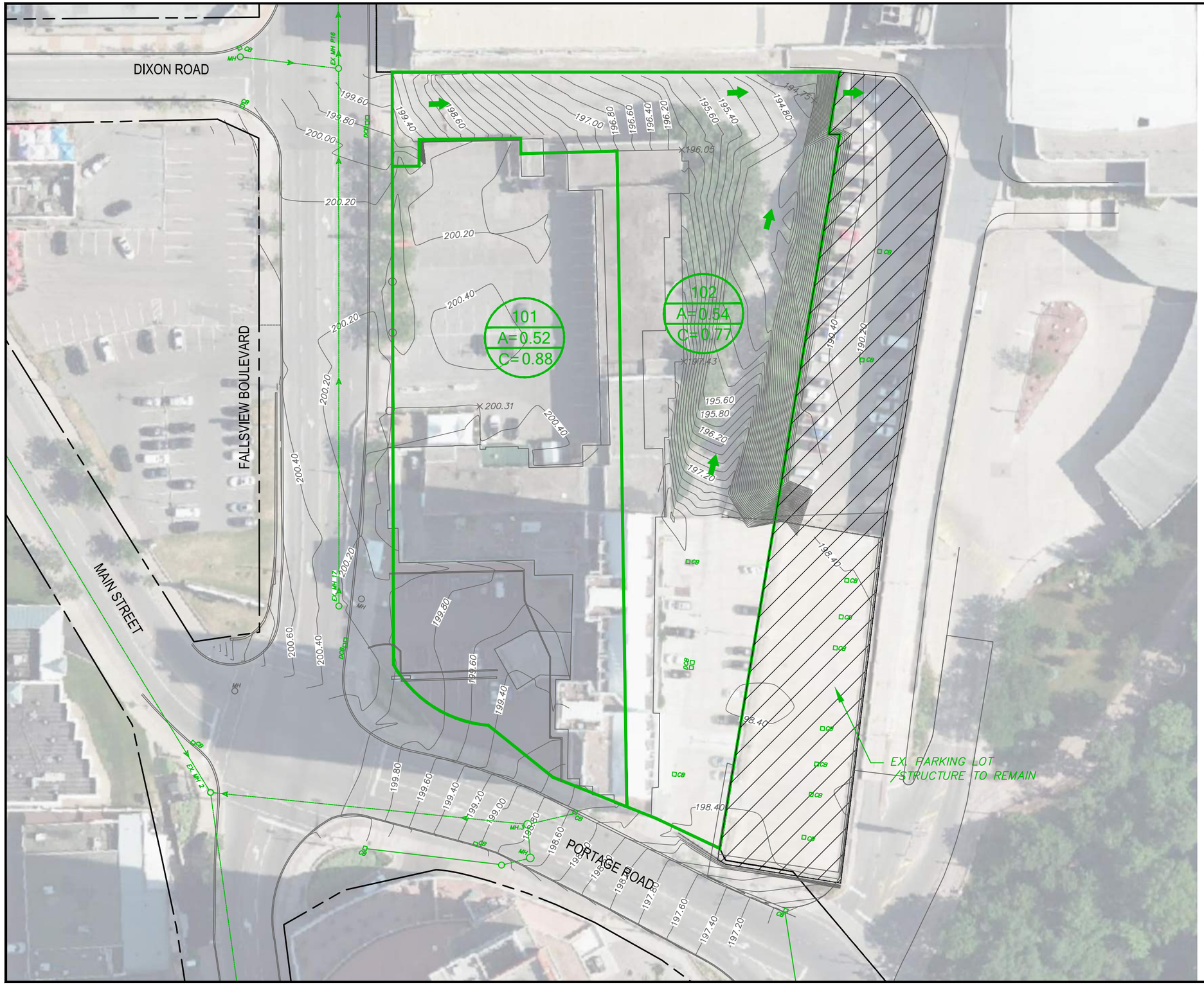
6546 FALLSVIEW BOULEVARD

NIAGARA FALLS, ONTARIO

SANITARY SERVICING PLAN

DESIGNED BY: PM	DATE: FEB 08 2023
CHECKED BY: PW	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 3
SCALE: NTS	

Z:\Shared\Projects\2022\22087_Hennepin Autograph Niagara Falls\Design\Drawings\Figures\22087 Figure 3 Sanitary Servicing Plan.dwg



LEGEND

- PROPERTY LINE
- EX. STORM SEWER & FLOW DIRECTION
- EX STORM MANHOLE
- CATCH BASIN
- DRAINAGE BOUNDARY
- AREA I.D
- AREA (Ha.)
- RUNOFF COEFFICIENT
- OVERLAND FLOW DIRECTION
- 183.25 EXISTING CONTOUR/ELEV.

(101 / A=0.90 / C=0.25)

SWM AREA 101 SUMMARY

SURFACE	AREA (m^2)	RC	AREA*RC
IMPERVIOUS	5,080	0.90	4,572
PERVIOUS	146	0.25	37
TOTAL	5,226		4,609
WEIGHTED RC	0.88		

SWM AREA 102 SUMMARY

SURFACE	AREA (m^2)	RC	AREA*RC
IMPERVIOUS	4,358	0.90	3,922
PERVIOUS	1,041	0.25	260
TOTAL	5,399		4,182
WEIGHTED RC	0.77		

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6546 FALLSVIEW BOULEVARD

FALLSVIEW, ONTARIO

EXISTING CONDITIONS STORM DRAINAGE PLAN

DESIGNED BY: PM	DATE: FEB 08 2023
CHECKED BY: PW	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 4
SCALE: NTS	

Z:\Shared\Projects\2022\22087_Hennepin Autograph Niagara Falls\Design\Drawings\Figures\22087 Figure 4 Existing Conditions Drainage Plan.dwg

OVERLAND FLOWS IN EXCESS OF THE 1:100 YEAR STORM WILL BE DIRECTED TOWARDS ADJACENT PROPERTY. MINOR SYSTEM FLOWS WILL BE CAPTURED AND CONVEYED TO THE SWM TANK AND DISCHARGED INTO THE FALLSVIEW BOULEVARD STORM SEWER

DIXON ROAD

FALLSVIEW BOULEVARD

MAIN STREET

PORTAGE ROAD

PROPOSED 58 STOREY TOWER

PROPOSED 58 STOREY TOWER

201
A=0.17
C=0.82

202
A=0.89
C=0.90

EX. PARKING LOT TO REMAIN

PROP. ROAD WIDENING

EX. MH P16

EX. MH 17

EX. MH 2

MH

MH.3

CB

DCB

200.00
199.80
199.60
199.40
199.20
199.00
198.80
198.60
198.40
198.20
198.00
197.80
197.60
197.40
197.20

LEGEND

- PROPERTY LINE
- EX. STORM SEWER & FLOW DIRECTION
- EX STORM MANHOLE
- CATCH BASIN
- DRAINAGE BOUNDARY
- 101 / A=0.90 / C=0.25 — AREA I.D; AREA (Ha.); RUNOFF COEFFICIENT
- OVERLAND FLOW DIRECTION
- 183.25 — EXISTING CONTOUR/ELEV.
- PAVED AREA
- LANDSCAPED AREA
- ROOF AREA
- UNCONTROLLED FLOW DIRECTION

SWM AREA 201 SUMMARY

SURFACE	AREA (m^2)	RC	AREA*RC
IMPERVIOUS	1,512	0.90	1,361
PERVIOUS	224	0.25	56
TOTAL	1,736		1,417
WEIGHTED RC	0.82		

SWM AREA 202 SUMMARY

SURFACE	AREA (m^2)	RC	AREA*RC
IMPERVIOUS	3,202	0.90	2,882
ROOF	5,687	0.90	5,118
PERVIOUS	0	0.25	0
TOTAL	8,889		8,000
WEIGHTED RC	0.90		

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8395 Jane St., Suite 100, Vaughan, ON L4K 5Y2 Phone 905.326.1404 Fax 905.326.1405

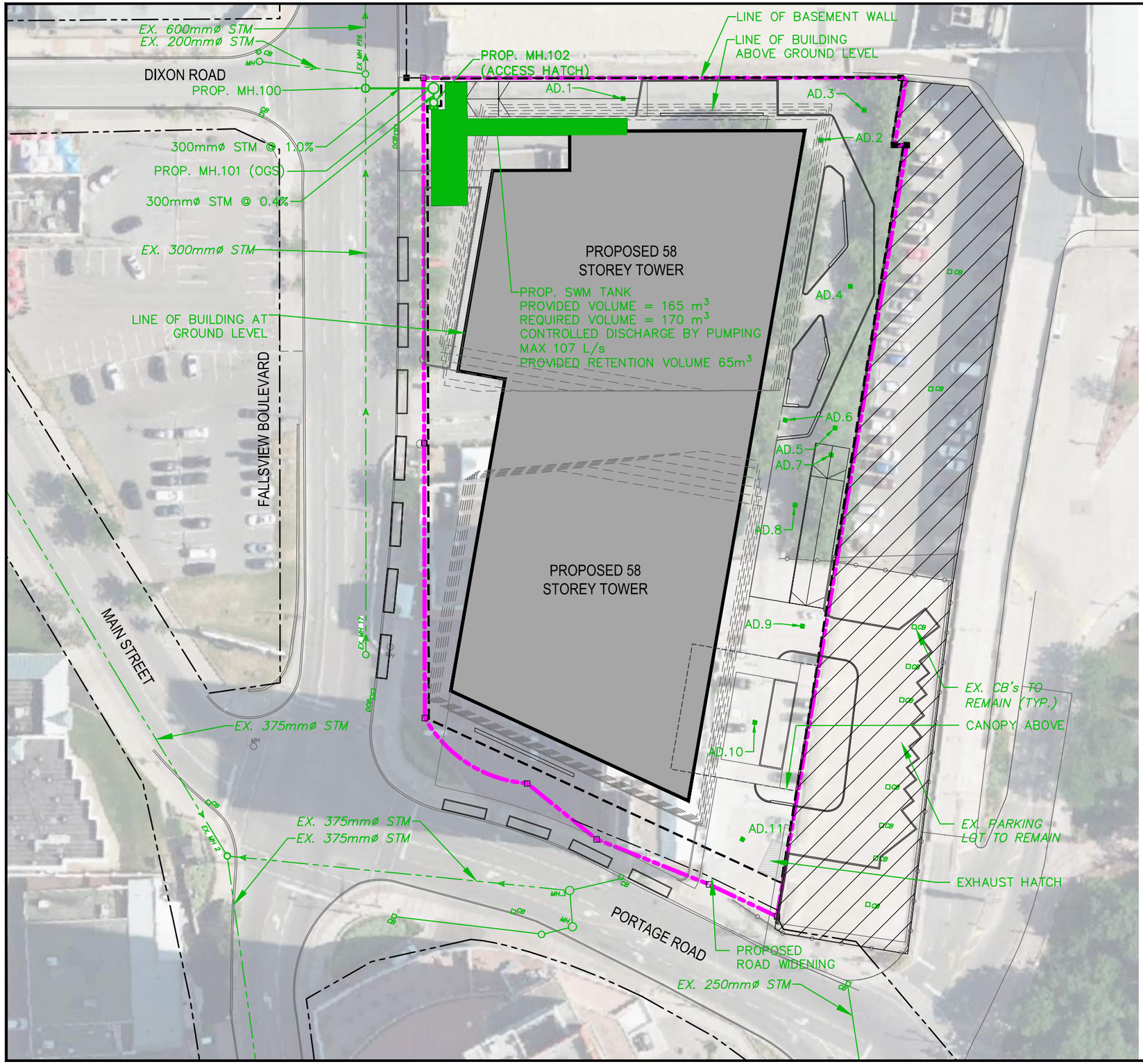
6546 FALLSVIEW BOULEVARD

NIAGARA FALLS, ONTARIO

PROPOSED CONDITIONS
STORM DRAINAGE PLAN

DESIGNED BY: PM	DATE: FEB 08 2023
CHECKED BY: PW	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 5
SCALE: NTS	

Z:\Shared\Projects\2022\22087_Hennepin Autograph Niagara Falls\Design\Drawings\Figures\22087 Figure 5 Proposed Conditions Drainage Plan.dwg



LEGEND

- PROPERTY LINE
- LINE OF BASEMENT WALL
- EX.STORM SEWER & FLOW DIRECTION
- PROP. STORM SEWER & FLOW DIRECTION
- EX/PROP SANITARY MANHOLE
- CATCH BASIN
- AREA DRAIN
- SWM TANK FOOTPRINT

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6546 FALLSVIEW BOULEVARD

NIAGARA FALLS, ONTARIO

STORM SERVICING PLAN

DESIGNED BY: PM	DATE: FEB 08 2023
CHECKED BY: PW	PROJECT No. 22087
DRAWING BY: ET	
CHECKED BY: PM	FIGURE No. 6
SCALE: NTS	

Z:\Shared\Projects\2022\22087_Hennepin Autograph Niagara Falls\Design\Drawings\Figures\22087 Figure 6 Storm Servicing Plan.dwg

APPENDIX B

Water Demand Calculations

Project No.: 22087

Table 3-1: Peaking Factors

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

3.4.3 Commercial and Institutional Water Demands

Institutional and commercial flows should be determined by using historical records, where available. Where no records are available, the values in Table 3.2 should be used. For other commercial and tourist-commercial areas, an allowance of 28 m^3/(ha·d) [3000 USgal/(acre·d)] average flow should be used in the absence of reliable flow data.

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

Counterpoint Engineering Inc.

Water Demand Design Calculations

Project: Hennepin Autograph
Project No: 22087
Location: 6546 Fallsview Boulevard
Site Area: 1.06 ha

Average Daily Consumption

Residential use	Water Use	Unit
Hotels	225	L/bed-space/day
Residential Units	190	L/capita/day

Per City of Toronto Design Criteria for Sewers and Watermains

Population Densities*

Apartment (1 bed)	1.4	ppu
Apartment (2 bed)	2.1	ppu
Apartment (3 bed)	3.1	ppu
Apartment (4 bed)	3.7	ppu

*City of Toronto Design Criteria for Sewers and Watermains - Chapter 2 (2nd Edition, January 2021)

Site Statistics (Circulated Nov 17, 2023)

	Standard*	Executive**	Deluxe***	Presidential****	TOTAL POPULATION
Hotel	1066	62	6	6	1140
Total Units					**1140**

*Standard hotel room contains 1 bay/bed
**Executive hotel room contains 2 bay/bed
***Deluxe hotel room contains 3 bay/bed
****Presidential hotel room contains 4 bay/bed

Site Statistics (Circulated Nov 17, 2023)

	1 Bed	2 Bed	3 Bed	4 Bed	TOTAL POPULATION
Residential units	98	14	14	0	126
Total Units					**126**

Equivalent Population

	Standard*	Executive**	Deluxe***	Presidential****	TOTAL EQUIVALENT POPULATION
Hotel	1492	130	19	22	1664
Total Equivalent Population					**1664**

*Standard hotel room contains 1 bay/bed
**Executive hotel room contains 2 bays/beds
***Deluxe hotel room contains 3 bays/beds
****Presidential hotel room contains 4 bays/beds

Equivalent Population

	1 Bed	2 Bed	3 Bed	4 Bed	TOTAL EQUIVALENT POPULATION
Residential units	137	29	43	0	210
Total Equivalent Population					**210**

Counterpoint Engineering Inc.

Water Demand Design Calculations

Project: Hennepin Autograph
Project No: 22087
Location: 6546 Fallsview Boulevard
Site Area: 1.06 ha

Peaking Factors

Population	Minimum Hour	Maximum Hour	Maximum Day
1874	0.45	3.75	2.50

*** Table 3-1 of the MECP Design Guidelines for Drinking-Water Systems, 2008

Water Demand based on Equivalent Population

Land Use	Total Units	Average Daily Demand (L/min)	Maximum Hour (L/min)	Maximum Day (L/min)	Fire Flow Required (L/min)	Max Day + Fire Flow (L/min)
Hotel	**1664**	**260.0**	**975.0**	**650.0**		
Residential Units	**210**	**27.7**	**103.9**	**69.3**		
Total	**1874**	**288**	**1079**	**719**	**10,000**	**10,719**

* See attached table in Appendix B for Fire Flow Duration

Counterpoint Engineering Inc.

REQUIRED FIRE FLOW WORKSHEET - PROPOSED DEVELOPMENT
Fire Underwriters Survey

Project : **Hennepin Autograph**
Project No: **22087**
Location: **6546 Fallsview Boulevard**

Guide for Determination of Required Fire Flow Copyright I.S.O

$$RFF = 220C\sqrt{A}$$

Where:

RFF = the Required Fire Flow in litres per minutes (LPM)
C = the Construction Coefficient is related to the type of construction of the building
A = the Total Effective Floor Area (effective building area) in square metres of the building

Type of Construction		Coefficient
Type V	Wood Frame	1.5
Type IV-A	Encapsulated Mass Timber	0.8
Type IV-B	Rated Mass Timber	0.9
Type IV-C	Ordinary Mass Timber	1.0
Type IV-D	Un-Rated Mass Timber	1.5
Type III	Ordinary	1.0
Type II	Noncombustible	0.8
Type I	Fire Resistive	0.6

Contents		Factor
NC	Non-Combustible	-25%
LC	Limited Combustible	-15%
C	Combustible	0%
FB	Free Burning	15%
RB	Rapid Burning	25%

1) Required Fire Flow

Type of Construction:	Type I
C=	0.6
A*=	12,799 m^2
F=	**14,934 L/min**

2) Occupancy and Contents Adjustment Factor

Type of Occupancy		C			
Contents Adjustment Factor		0%	=	0	L/min
F=	**14934L/min +**	**0**	**L/min =**	**14,934**	**L/min**

3) System Type Reduction

NFPA 13 Sprinkler:		YES	30%		
Standard Water Supply:		YES	10%		
Fully Supervised:		YES	10%		
Total Credit			50%		
Reduction of:		50%	L/min =	7,467	L/min
F=	**14934L/min -**	**7,467**	**L/min =**	**7,467**	**L/min**

4) Exposure Adjustment Charge

Building Face	Dist(m)	Charge
North	5	20%
East	30+	0%
South	30+	0%
West	30+	0%
Total		20% **of** 14934 **L/min =** 2,987 **L/min**

(max exposure charge can be 75%)

Separation Distance	Maximum Exposure Adjustment Charge
0 m to 3 m	25%
3.1 m to 10 m	20%
10.1 m to 20 m	15%
20.1 m to 30 m	10%
Greater than 30	0%

F= **7467L/min +** **2987L/min** **=** **10,453 L/min**

F=	**10,000**	**L/min**	(round to the nearest 1,000L/min)
F=	**167**	**L/s**	
F=	**2,642**	**gpm**	

APPENDIX C

Sanitary Design Flow Calculations

Project No.: 22087

2.4 Design Criteria

The 2021 MSPU has used the following design criteria to project wastewater flows, determine capacity requirements and establish the wastewater infrastructure program:

- Residential Flow Generation: 255 Lpcd
- Employment Flow Generation: 310 Lped
- Peaking Factor based on Harmon formula with values between 2 and 4.
- Extraneous Flow Design Allowance:
  - 0.4 L/s/ha for existing areas[1]
  - 0.286 L/s/ha for new developments

2.4.1 Updated Per Capita Flow Criteria

The Region's 2016 Master Servicing Plan Update utilized 275 Lpcd for both residential and employment land uses to project growth average wastewater generation rate. More granular data was analysed through this MSPU to reassess the per capita demand criteria as it is important to maintain a reasonable factor of safety within the consumption criteria while avoiding over-conservatism which ultimately impacts the capital projects that are triggered and when they are triggered.

Through this MSPU, ten years of daily flow data was provided for each WWTP. For the purposes of evaluating the wastewater flow criteria an in-depth review of a three-year period of records (2018-2020) was completed for each wastewater treatment plant. **Table 4.3** presents the average per capita rate (combined population and employment) that was calculated for each wastewater treatment plant. To account for the influence of wet weather flows on the daily wastewater treatment plant flows, two additional average daily flows criteria were used:

- Dry average daily flows, which excluded days with greater than 5 mm of precipitation and preceding day
- Summer dry average daily flows: same as dry average daily flows but only accounted for flows within the month of June through to September.

The identification of appropriate wastewater per capita growth criteria was complicated due to:

- The observed inflow and infiltration which included:
  - Substantial local and seasonal variability in daily flows
  - Observed flows to the wastewater treatment plants exceeding the water generated from the water treatment plants
- Limited ability to completed detailed employment vs. residential-based analysis
- Distribution of total equivalent population by treatment plant and ratio of residential and employment within each treatment plant catchment

[1] Refer to Section 2.4.2 for additional details

Through the review several potential per capita growth rates scenarios were considered including:

- Increasing to match the average daily flows
- Aligning to match the water daily demands
- Maintain the existing criteria
- Align with the observed dry average daily flows.

In consultation with the Region, it was decided that the per capital flow criteria would be adjusted to match the median average dry weather flow and while also applying the same ratio for residential and employment from the observed (local meter billing) water per capita rates. It should be noted that the use of the median flows was based on the Niagara Falls WWTP and not the Stevensville Douglastown Lagoons due to the majority of the WWTP with flow rates higher than the median represented smaller services areas including less than 50% of service population. Under this approach:

- The residential per capita rate was decreased to 255 Lpcd
- The employment per capita rate was increase to 310 Lpcd

The recommended residential and employment per capita rates represent a 7% reduction for the residential rate and a 12% increase for the employment rate compared to the Region's previous rate of 275 Lpcd for both residential and employment land uses.

Table 4.3 Per Capita Wastewater Flows by WWTP

WWTP	Per Capita Criteria (L/cap/d)		
	Average Flow	Average Dry Weather Flow (DWF)	Summer Average DWF – June to September Only
Baker Road WWTP	254	229	178
Port Dalhousie WWTP	286	260	210
Port Weller WWTP	312	291	215
NOTL Lagoon/WWTP	347	344	303
Queenston WWTP	142	114	132
Niagara Falls WWTP	299	262	219
SD Lagoon	323	297	257
Anger Ave WWTP	588	503	359
Crystal Beach WWTP	548	497	410
Seaway WWTP	581	568	511
Welland WWTP	374	337	261
Average	**369**	**336**	**278**
Median	**323**	**262-297**	**219-257**

CB- 1

NO.	REVISION	DATE	INIT.
3	ADDED PROP. SAN. SEW. ON MURRAY ST.	98/09/13	B.E.S.
2	ADDED DETAILS TO BUCHANAN AVE.	85-02-18	G.D.
1	ADDED BUCHANAN AVE., REVISED MAIN ST.	84-03-07	GDB

LEGEND

UNDERGROUND UTILITIES

DRAFTING G.D. B.D.
DESIGN B.D.
CHECKED BY
PROJ. SUPVR

D. K. TYAGI
DESIGN & CONST. ENG.

The City of Niagara Falls

BENCH MARK DATUM

MAIN STREET

SANITARY DRAINAGE AREA

FIELD NOTES
DATE
SCALE 1" = 200'
DWG. No.
MUN. REF. No. 81 - CB - 1
REF. 3

Counterpoint Engineering Inc.

Project: Hennepin Autograph
Project No: 22087
Location: Niagara Falls
Site Area: 1.06 ha

Existing Equivalent Population Calculations

As per Engineering Design Guidelines, City of Niagara Falls

Design flow = (Population in Thousands x Average Daily Flow x Peaking Factor)/86.4 + (Infiltration Rate x Area)

Persons Per Land Use

R1-R1	45.5	Persons/Ha
R3-R4	96.4	Persons/Ha
R5A-R5B	163.1	Persons/Ha
General Industrial	153.2	Persons/Ha
General Commercial	180.4	Persons/Ha
Tourist Commercial	284.2	Persons/Ha

* Site is currently zoned as TC (Tourist commercial zone)

***Per Niagara Falls sewer design criteria**

	TOTAL POPULATION
Residential	0
Commercial	302
Industrial	0
Total Equivalent Population	**302**

Peak flow Design Parameters

Average flow	380	litres/person/day
Infiltration	0.28	litres/second/ha

Harmon Peaking Factor

PF = 1 + (14/(4+(P/1000)$^{1/2}$))

Total Population	Harmon Peak Factor
302	**4.00**

Average Dry Weather Flow	1.33	**l/s**
Total Peak Wastewater Flow	5.31	**l/s**
Infiltration	0.30	**l/s**
Flow	**5.61**	**l/s**

Counterpoint Engineering Inc.

Project: Hennepin Autograph
Project No: 22087
Location: Niagara Falls
Site Area: 1.06 ha

Proposed Sanitary Flow Calculations

As per Engineering Design Guidelines, City of Niagara Falls 2016

Design flow = (Population in Thousands x Average Daily Flow x Peaking Factor)/86.4 + (Infiltration Rate x Area)

Population Densities*

Apartment (1 bed)	1.4	ppu
Apartment (2 bed)	2.1	ppu
Apartment (3 bed)	3.1	ppu
Apartment (4 bed)	3.7	ppu

*City of Toronto Design Criteria for Sewers and Watermains - Chapter 2 (2nd Edition, January 2021)

Site Statistics (Circulated Nov 17, 2023)

	Standard*	Executive**	Deluxe***	Presidential****	TOTAL POPULATION
Hotel	1066	62	6	6	1140
Total Units					**1140**

*Standard hotel room contains 1 bay/bed
**Executive hotel room contains 2 bay/bed
***Deluxe hotel room contains 3 bay/bed
****Presidential hotel room contains 4 bay/bed

Site Statistics (Circulated Nov 17, 2023)

	1 Bed	2 Bed	3 Bed	4 Bed	TOTAL POPULATION
Residential units	98	14	14	0	126
Total Units					**126**

Equivalent Population

	Standard*	Executive**	Deluxe***	Presidential****	TOTAL EQUIVALENT POPULATION
Hotel	1492	130	19	22	1664
Total Equivalent Population					**1664**

*Standard hotel room contains 1 bay/bed
**Executive hotel room contains 2 bays/beds
***Deluxe hotel room contains 3 bays/beds
****Presidential hotel room contains 4 bays/beds

Equivalent Population

	1 Bed	2 Bed	3 Bed	4 Bed	TOTAL EQUIVALENT POPULATION
Residential units	137	29	43	0	210
Total Equivalent Population					**210**

Peak flow Design Parameters (per Niagara Region 2021 Water and Wastewater Master Servicing Plan Update - Niagara Falls WWTP)

Average flow	299	litres/capita/day
Infiltration	0.286	litres/second/ha

Harmon Peaking Factor (per MOE sewer desin guidelines)

$PF = 1 + (14/(4+(P/1000)^{1/2}))$

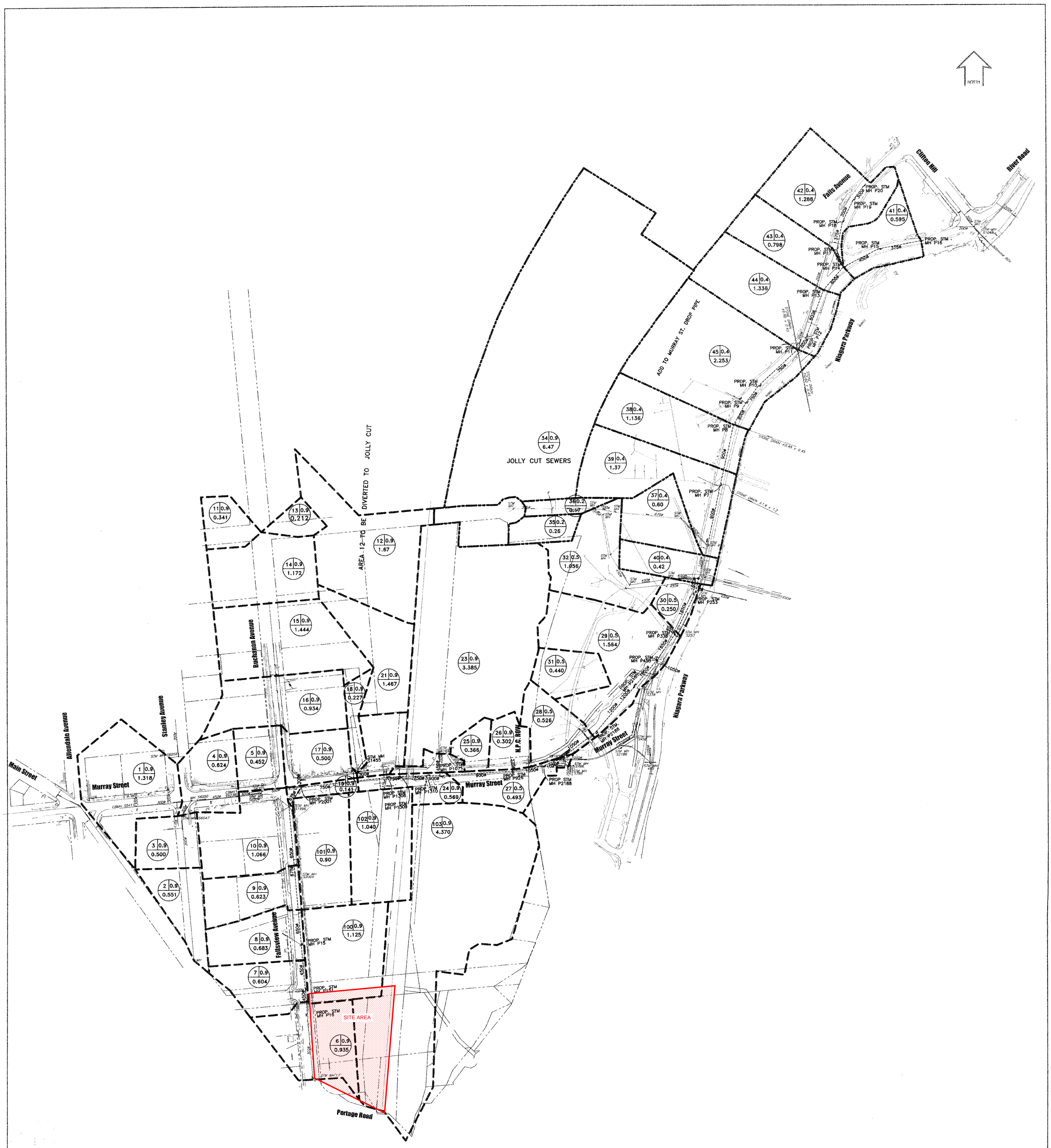
Residential Population	Peak Factor
1874	**3.61**

Residential Flow	23.41	**l/s**
Infiltration	0.30	**l/s**
Total Peak Flow	**23.72**	**l/s**

APPENDIX D

Stormwater Drainage and Stormwater Management Design Calculations

Project No.: 22087



NO.	REVISION	DATE	INIT.

NOTES

LEGEND

DRAFTING J.P./J.H.
DESIGN D.Ingram P.Eng.
CHECKED BY
PROJ. SUPVR. W.A.G.Mackay P.Eng.

KERRY T. HOWE ENGINEERING LTD.

KERRY T. HOWE ENGINEERING LTD.
CONSULTING ENGINEERS
98 Church Street
St. Catharines ,Ontario
(905) 688-6550

BENCH MARK DATUM

CITY OF NIAGARA FALLS
FALLSVIEW TOURIST CORE AREA
TRUNK SEWER – PHASES 2 & 3
ULTIMATE STORM DRAINAGE AREAS

FIGURE ST-02

FIELD NOTES
PLOT DATE OCTOBER 15, 2001
SCALE 1:1500
DWG. No. FIGURE ST02 REV.
CAD FILE: 006ST02.dwg

03-CA-166

SWM DESIGN CALCULATIONS
Pre-Development Release Rate (Area 101)

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 3-Feb-23

Prepared by: L.C.
Checked by:
Last Revised: 3-Feb-23

Rainfall Data

Location:	Niagara Falls, Ontario	a	719.50
Event	5-year	b	6.34
		c	0.769

Site Data

Area (ha)	0.52
Runoff Coefficient	0.88
AC	0.46
Tc (min)	10
Rainfall Intensity (mm/hr)	84
Rational Flow Rate (l/s)	107

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

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TEL: (905) 326-1404 FAX: (905) 326-1405
www.counterpointeng.com

SWM DESIGN CALCULATIONS
Pre-Development Release Rate (Area 102)

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 3-Feb-23

Prepared by: L.C.
Checked by:
Last Revised: 3-Feb-23

Rainfall Data

Location:	**Niagara Falls, Ontario**	a	**719.50**
Event	**5-year**	b	**6.34**
		c	**0.769**

Site Data

Area (ha)	**0.54**
Runoff Coefficient	**0.77**
AC	0.42
Tc (min)	**10**
Rainfall Intensity (mm/hr)	**84**
Rational Flow Rate (l/s)	**97**

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

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TEL: (905) 326-1404 FAX: (905) 326-1405
www.counterpointeng.com

SWM DESIGN CALCULATIONS
100-Year Flow Rate Calculations (Uncontrolled 201)

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 3-Feb-23

Prepared by: L.C.
Checked by:
Last Revised: 3-Feb-23

Rainfall Data

Location:	**Niagara Falls, Ontario**	a	**719.50**
Event	**5-year**	b	**6.34**
		c	**0.769**

Site Data

Area (ha)	**0.17**
Runoff Coefficient	**0.82**
AC	0.14
Tc (min)	**10**
Rainfall Intensity (mm/hr)	**84**
Rational Flow Rate (l/s)	**33**

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

Counterpoint Engineering Inc.
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TEL: (905) 326-1404 FAX: (905) 326-1405
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SWM DESIGN CALCULATIONS
Required Storage Calculations (Area 202)

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 21-Feb-23

Prepared by: L.C.
Checked by:
Last Revised: 21-Feb-23

Rainfall Data

Location:	Niagara Falls, Ontario	a	1264.57
Event	100-year	b	7.72
		c	0.7814

Site Data

Area (ha)	0.89
Runoff Coefficient	0.90
AC	0.80
Tc (min)	10
Time Increment (min)	5
Release Rate (l/s)	74
Storage Required (m^3)	**165**

The Rational Equation:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

Time	Rainfall Intensity	Storm Runoff	Runoff Volume	Released Volume	Storage Volume	
(min)	(mm/hr)	(m^3/s)	(m^3)	(m^3)	(m^3)	
10	134	0.30	179	45	134	
15	110	0.25	221	67	154	
20	94	0.21	252	89	163	
25	83	0.18	277	111	165	********
30	74	0.17	297	134	164	
35	67	0.15	315	156	159	
40	62	0.14	330	178	152	
45	57	0.13	343	200	143	
50	53	0.12	355	223	132	
55	50	0.11	366	245	121	
60	47	0.10	376	267	109	
65	44	0.10	385	290	96	
70	42	0.09	394	312	82	
75	40	0.09	402	334	68	

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SWM DESIGN CALCULATIONS
Water Balance Calculation

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 20-Jan-23

Prepared by: L.C.
Checked by:
Last Revised: 3-Feb-23

1. VOLUME TO BE RETAINED

Total Area of Site (A) =	10,600 sq.m.
Target Retention Depth (D) =	0.005 (m)

Storage Volume Required = V = A x D = **53.0** (cu.m.)

2. STORAGE VOLUME PROVIDED

Landscape Areas

Area (A) =	0.02 sq.m.
Initial Abstraction =	0.005 (m)

Storage Volume Provided = V = A x ν x d = **0.0** (cu.m.)

Water Re-use Cistern

Storage Volume Required = **53.0** (cu.m.)

Storage Volume Provided = **55.0** (cu.m.)

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SWM DESIGN CALCULATIONS
Post-development TSS Removal Calculation

Project Name: Oakes Hotel Redevelopment
Municipality: City of Niagara Falls
Project No.: 22087
Date: 20-Jan-23

Prepared by: L.C.
Checked by:
Last Revised: 3-Feb-23

Mitigated TSS Removal Rates with Landscape Areas, Roof and OGS Unit Treatment Train

Mitigated	Area (Ha)	TSS Removal Credit	% Area of Site	Overall TSS Removal
Conventinal Roof Area	**0.57**	100.0%	53.5%	53.5%
Conventional Pavement Area	**0.47**	0.0%	44.4%	0.0%
Landscaped Area	**0.02**	80.0%	2.1%	1.7%
Sub-Total Onsite TSS removal before OGS	**1.06**		100.0%	**55.2%**
Untreated TSS remaining %				44.8%
80% TSS Removal Credit for Remaining Untreated TSS for Filter Unit				35.8%
Total TSS removal				**91.0%**

Reference: New Jersey Stormwater Best Management Practices Manual
Chapter 4 - TSS Removal Rates for BMP's in Series

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