Trails Edge East

6615 & 6635 Renaud Road and 191 Rappel Circle

Servicing and Stormwater Management Report

February 21, 2025

Prepared for:

Richcraft Homes Ltd.

Prepared by:

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File Number: 160401250

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
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Limitations and Sign-off

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1 Introduction

Richcraft Homes Ltd. (Richcraft) has commissioned Stantec Consulting Ltd. (Stantec) to prepare the following Servicing and Stormwater Management Report in support of the Zoning By-Law Application for 6615 & 6635 Renaud Road and 191 Rappel Circle as part of the Trails Edge East subdivision. The subject site is within the City of Ottawa, bound by Rappel Circle to the north, Mer Bleue Road to the east, Renaud Road to the south and adjacent to the 239 Rappel Circle and 6611 Renaud Road properties to the west (refer to **Figure 1.1** below).

Figure 1.1 Key Map of Trails Edge Subdivision – 6615 & 6635 Renaud Road and 191 Rappel Circle

The 191 Rappel Circle and 6635 Renaud Road properties are currently zoned R1Z (Residential First Density) and the 6615 Renaud Road property is zoned DR (Development Reserve). The total site occupies approximately 0.65 ha of land. The 6615 Renaud site is currently occupied by a signle family dwelling along with accessory structures including an existing cell tower which will remain on-site. The proposed development consists of six (6) single family units and six (6) row townhome units as shown in the site plan under separate cover.

Servicing and stormwater management constraints for the site were identified as part of the previously approved *Trailsedge Est Phase 2-3 – Servicing and Stormwater Management Report* (Stantec Consuting Ltd., June 10, 2022). Findings from the above noted report are referenced throughout this report.

1.1 Objective

This site servicing and stormwater management (SWM) report has been prepared to present an internal servicing scheme that is free of conflicts, uses existing/approved infrastructure, and meets all design criteria as identified in background documents and City of Ottawa design guidelines.

2 Reference Documents

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

- City of Ottawa Sewer Design Guidelines, 2nd Edition, City of Ottawa, October 2012.
- City of Ottawa Design Guidelines – Water Distribution, 1st Edition, Infrastructure Services Department, City of Ottawa, July 2010.
- Technical Bulletin ISDTB-2014-02 Revision to Ottawa Design Guidelines – Water, City of Ottawa, May 2014.
- Technical Bulletin PIEDTB-2016-01 Revisions to Ottawa Design Guidelines – Sewer, City of Ottawa, September 2016.
- Technical Bulletin ISTB-2018-01 Revision to Ottawa Design Guidelines – Sewer, City of Ottawa, March 2018.
- Technical Bulletin ISTB-2018-02 Revision to Ottawa Design Guidelines – Water Distribution, City of Ottawa, March 2018.
- Trailsedge East Phase 2-3 – Servicing and Stormwater Management Report, Stantec Consulting Ltd., June 10, 2022.
- Geotechnical Investigation: Proposed Residential Development Trails Edge East -Renaud Road, Ottawa, Ontario, Paterson Group, August 12, 2024 .
- Pre-Consultation: Meeting Feedback Proposed Zoning By-Law Application – 6615 Renaud Road, 6635 Renaud Road, 191 Rappel Circle, City of Ottawa, August 9, 2024.

3 Potable Water Servicing

3.1 Background

The proposed development is located within Zone 2E of the City of Ottawa's water distribution system. The site will be fed by the existing 300mm diameter watermain on Renaud Road and the 200 mm diameter watermain on Rappel Circle. Reconfiguration of the proposed units was anticipated and coordinated with City of Ottawa during design and construction of Trails Edge East Phases 2 and 3. Service laterals to the proposed units were delivered from both Rappel Circle and Renaud Road to avoid excavation within the newly constructed road and to avoid impacts to public sewers / watermains. These laterals will be utilized for the 6 new townhouse units and 6 new single family units.

3.2 Domestic Water Demands

The proposed site contains a total of six (6) single family house units and six (6) row townhouse units, with an estimated total population of 37 persons.

Water demands for the development were estimated using the City of Ottawa's Water Distribution Design Guidelines. For residential developments, the average day (AVDY) per capita water demand is 280 L/cap/d. For maximum day (MXDY) demand, AVDY was multiplied by a factor of 2.5 and for peak hour (PKHR) demand, MXDY was multiplied by a factor of 2.2. The calculated residential water consumption is represented in **Table 3.1**.

Table 3.1 Residential Water Demands for 6615 & 6635 Renaud Road and 191 Rappel Circle

Unit Type	Units	Persons/Unit	Population	AVDY (L/s)	MXDY (L/s)	PKHR (L/s)
Townhouse Units	6	2.7	16	0.05	0.13	0.29
Single Family Units	6	3.4	21	0.07	0.17	0.36
Total	**12**		**37**	**0.12**	**0.30**	**0.65**

3.3 Level of Service

3.3.1 Allowable Pressures

The City of Ottawa Water Distribution Design Guidelines state that the desired range of system pressures under normal demand conditions (i.e., basic day, maximum day, and peak hour) should be in the range of 350 to 552 kPa (50 to 80 psi) and no less than 275 kPa (40 psi) at the ground elevation on the streets (i.e., at hydrant level). The maximum pressure at any point in the distribution system in occupied areas outside of the public right-of-way is 552 kPa (80 psi). As per the Ontario Building Code (OBC) & Guide for Plumbing, if pressures greater than 552 kPa (80 psi) are anticipated, pressure relief measures are required. The maximum pressure at any point in the distribution system in unoccupied areas shall not exceed 689 kPa (100 psi). Under emergency fire flow conditions, the minimum pressure objective in the distribution system is 138 kPa (20 psi).

3.3.2 Fire Flow Demands

A maximum fire flow of 9,000 L/min (150 L/s) was determined for the proposed development based on the Fire Underwriters Survey (FUS) requirements using a two-storey, three-unit row townhouse, and considering a minimum 3m offset from adjacent structures. Refer to **Appendix A** for detailed FUS calculations.

As per the City's technical bulletin ISDTB-2014-02 (City of Ottawa, 2014), fire flow shall be capped at 10,000 L/min for traditional side-by-side townhomes constructed in accordance with the OBC and with a minimum separation of 10 meters between the back of adjacent units.

3.4 Boundary Condition

The boundary conditions on Rappel Circle and for Renaud Road are based the previously approved hydraulic model for *Trailsedge East Phase 2-3 – Servicing and Stormwater Management Report* (Stantec, 2022). Excerpts from the previously approved report are included in **Appendix A**. Values for Rappel Circle were extracted for the adjacent model node (52) at elevation 88.83. The boundary condition for Renaud Road was conservatively set based on background data for the Renaud Road / Alpenstock intersection to the west, further from the supplying 400mm main within Mer Bleue Road. Additionally, boundary conditions for Phase 2-3 were previously provided at the 200L/s fire flow rate, whereas the site required fire flow of 150L/s is significantly lower.

Table 3.2 Boundary Condtions

Location	Max. HGL (AVDY), Head (m)	PKHR, Head (m)	MXDY+FF (200 L/s), Head (m)
Renaud Road	130.5	126.0	123.7
Rappel Circle	130.6	126.2	124.9

3.5 Results

A maximum pressure check can be conducted using the buildings' lowest finished floor elevation (~88.7 m) and the maximum boundary condition HGL of 130.5m. This results in a pressure of 407 kPa (59 psi). This value is below the limit of 80 psi for which pressure reducing valves would be required.

Boundary conditions confirm that a flow rate of 12,000 L/min (200 L/s) would have a residual pressure of 343 kPa (50 psi) on Renaud based on anticipated finished floor elevations. As such, the required fire flow rate of 9,000 L/min is achievable within the watermain while maintaining a residual pressure above the minimum allowable pressure of 138kPa (20 psi).

There are two hydrants along Rappel Circle in close proximity to the site, a further hydrant exists on the south side of Renaud Road to the immediate southwest, and a fourth exists on the east side of Mer Bleue Road southeast of the site, all of which are within 90m. As such, there are no concerns with provision of the site required fire flow based on existing hydrant spacing.

In conclusion, based on the boundary conditions available, the existing watermains on Renaud Road and Rappel Circle provide adequate fire flow capacity and water volumes to meet domestic demands for the proposed development.

4 Wastewater Servicing

4.1 Background

Reconfiguration of the proposed units was anticipated and coordinated with City of Ottawa during design and construction of Trails Edge East Phase 2 and 3. Service laterals to the future units were delivered from both Rappel Circle and Renaud Road to avoid excavation within the newly constructed road and to avoid impacts to the public sewers. These laterals will be utilized for the 6 new townhouse units and 6 new single family units. Downstream sanitary servicing is outlined in the *Trails Edge East Phase 2-3 – Servicing and Stormwater Management Report* (Stantec Consulting, 2022),

4.2 Design Criteria

As outlined in the City of Ottawa Sewer Design Guidelines, the following design parameters were used to calculate wastewater flow rates and to size on-site sanitary sewers:

- Minimum full flow velocity – 0.6 m/s
- Maximum full flow velocity – 3.0 m/s
- Manning's roughness coefficient for all smooth-walled pipes – 0.013
- Single family home persons per unit – 3.4
- Townhouse persons per unit – 2.7
- Extraneous flow allowance – 0.33 L/s/ha
- Residential average flows – 280 L/cap/day
- Commercial/mixed-use flows – 28,000 L/ha/day
- Maintenance hole spacing – 120 m for pipes under 450 mm diameter, 150 m for pipes 450 mm diameter and larger
- Minimum cover – 2.5 m
- Harmon correction factor – 0.8

In addition, a residential peak factor based on Harmon's Equation was used to determine the peak design flows, per the City of Ottawa Sewer Design Guidelines.

4.3 Sanitary Servicing Design

The six (6) proposed row townhouse units are proposed to be serviced via the 200mm diameter sanitary sewers within Rappel Circle and the six (6) proposed single family units are to be serviced by the 200 mm diameter sanitary sewer within Renaud Road. As per the *Trailsedge East Phase 2-3 – Servicing and Stormwater Management Report* (Stantec Consulting Ltd, 2022), sanitary flows on both Renaud Road and Rappel Circle are directed to the west to the 300mm diameter sanitary sewer on Crevasse Street within the Trails Edge East Subdivision Phase 1, and ultimately towards the Forest Valley Trunk Sewer. The previously approved sanitary sewer design sheet and drainage area plans for the Trails Edge East subdivision are included in **Appendix B**.

The previously approved Sanitary Drainage Plan for Trails Edge East Phase 2-3 identifies two townhome services tributary to the Rappel Circle sewer, with remaining site lands (two additional townhomes plus a population allotment for the remaining tributary area of approximately 12 persons) dedicated to the Renaud Road sewer. The current site plan would increase the population tributary to the Rappel Circle sewer by 11 persons, and to the Renaud Road sewer by 3 persons. The residual capacity noted in the servicing report for Trail Edge East Phase 2-3 demonstrates that the downstream sewer system maintains sufficient capacity to accept the relatively small increase in expected site sanitary peak discharge.

The proposed peak flows from the site are summarized in **Table 4.1** below.

Table 4.1 Site Sanitary Peak Discharge

Location	Total Area (ha)	Population	Peak Flow (L/s)
R355A	0.15	41	0.2
R246A, G246	0.31	20	0.3

5 Stormwater Management and Storm Servicing

The objective of this stormwater management plan is to determine the measures necessary to control the quantity/quality of stormwater released from the proposed development to criteria established by the previous approved *Trailsedge East Phase 2-3 Servicing and Stormwater Management Report* (Stantec, 2022) for the region as well as other applicable background documents, and to provide sufficient detail for approval and construction.

5.1 Background

The proposed development encompasses approximately 0.47 ha of land as part of the Trails Edge East Subdivision. The entire development is residential, containing single family and row townhouse units.

5.1.1 Design Criteria and Constraints

The design methodology for the SWM component of the development is as follows:

General

- Application of the IDF information derived from the Meteorological Services of Canada rainfall data, taken from the MacDonald Cartier Airport, collected 1966 to 1997, as described in Ottawa's Sewer Design Guidelines.
- Use of the dual drainage principle (City of Ottawa).
- Wherever feasible and practical, site-level measures should be used to reduce and control the volume and rate of runoff. (City of Ottawa).
- Assess impact of 100-year event and climate change event outlined in the City of Ottawa Sewer Design Guidelines on major & minor drainage system (City of Ottawa).

Storm Sewer & Inlet Controls

- Proposed site to discharge to the existing storm sewers at Rappel Circle and Renaud Road (Stantec).
- Minor system inflow to be restricted for all contributing areas to capture at minimum the 2-year event for local streets, or to the 5-year event along proposed collector roads (City of Ottawa).
- 100-year Storm HGL to be a minimum of 0.30 m below building foundation footing (City of Ottawa).
- Climate Change event HGL to be below building foundation footing (City of Ottawa)

Surface Storage & Overland Flow

- Building openings to be a minimum of 0.15 m above the 100-year water level within adjacent ROWs (City of Ottawa).

- Maximum depth of flow under either static or dynamic conditions shall be less than 0.35m for design storm events (i.e. up to 100-year storm) (City of Ottawa).
- Minimum clearance depth of 0.30m to be provided from rear yard spill elevation to the ground elevation at the adjacent building envelope (City of Ottawa).
- Water must not encroach upon proposed building envelopes and must remain below all proposed building openings during the climate change event (City of Ottawa).
- Provide adequate emergency overflow conveyance off-site (City of Ottawa).
- No rear-yard ponding volumes to be accounted for in SWM model preparation (City of Ottawa).
- Major and minor flow to be conveyed to SWM pond 1 for quality (70% TSS Removal) and quantity control (EUC MSS, Stantec).

As shown on **Drawing SD-1**, post-development minor system peak flows from the development will be discharged to the existing 375 mm diameter storm sewer on Rappel Circle and existing 1050 mm diameter storm sewer on Renaud Road. Emergency overland flows during storm events above that of the 100-year design storm event will be mostly directed to Renaud Road Right-of-Way and ultimately directed to the East Urban Community (EUC) Pond 1 located west of the site.

5.2 Stormwater Management Design

Modeling for the site was previously prepared for the Trails Edge East Subdivision per the previously approved *Trailsedge East Phase 2-3 Servicing and Stormwater Management Report* (Stantec, 2022). Modeling prepared using PCSWMM had identified four subcatchment areas (identified as L2067A, R2-DI7A, R2-DI7B, and R2-DCB2) enveloping the proposed site, with the majority being tributary to various uncontrolled ditch inlets discharging directly to the storm sewer within Renaud Road downstream of manhole 3007. A small portion of the site forming part of subcatchment L2067A and measuring approximately 290m2 was identified as being tributary to road catch basins on Rappel Circle. Model excerpts are included as part of **Appendix C**.

Areas tributary to Renaud Road were modeled considering an overall runoff coefficient of 0.70, whereas the area tributary to Rappel Circle was considered at a runoff coefficient of 0.77. Previously modeled A x C values for the proposed site are summarized in the Table below:

Table 5.1 Previously Approved Modeled A x C Values

Drainage Outlet	Area (ha)	Runoff C	A x C
Rappel Circle	0.029	0.77	0.022
Renaud Road	0.441	0.70	0.309
Total	**0.47**		**0.331**

The proposed site has similarly been divided into catchment areas tributary to surface inlets on Rappel Circle (subcatchment area EX-1) and Renaud Road (areas 3007A and EX-2), and assigned runoff coefficients based on surface coverage in consideration of buildout to maximum extents as permissible by zoning for developed lots. Overall A x C values for each drainage outlet are summarized below:

Table 5.2 Proposed Site A x C Values

Drainage Outlet	Area (ha)	Runoff C	A x C
Rappel Circle (EX-1)	0.05	0.65	0.033
Renaud Road (3007A, EX-2)	0.42	0.52	0.218
Total	**0.47**		**0.251**

As overall site A x C values have decreased from that initially assumed within modeling for the Trails Edge Phase 2-3 Subdivision, no additional peak runoff controls are required in order to meet stormwater management requirements for the site.

Nonetheless, an ICD has been proposed for the rear yard catchment 3007A to provide additional protection for the sewer on Renaud Road and to coincide with the 5-year level of service of the minor system within Renaud Road. Major overland flow routes from rear yards within the site are identified on **Drawing SSGP-1**. Sizing for the ICD was prepared using the rational method for an area of 0.30ha, runoff C of 0.43, time of concentration of 15 minutes for a rear yard area, the City of Ottawa IDF curve for the 5-year storm event, and in consideration of a circular orifice with discharge coefficient set to 0.572 to match manufacturer specified discharge curves for the selected ICD.

Table 5.3 Rational Method Runoff – Controlled Areas

Area ID	Area (ha)	Runoff C	T of C (min)	I (mm/hr)	Q (L/s)
3007A	0.30	0.43	0.033	83.6	30.0

Table 5.4 ICD Sizing

CB ID	Invert (m)	T/G Elev. (m)	ICD Type	5yr Head (m)	5yr Flow (L/s)
3007A-1	85.60	87.44	IPEX Tempest 108mm	1.84	31.5

5.3 Results and Discussion

The overall release rate from the proposed development is anticipated to be less than that previously anticipated within modeling for the Trails Edge Phases 2-3 subdivision based on an overall reduction in imperviousness. Building underside of footing elevations have been set based on 100yr HGLs observed within their respective receiving sewers. Major overland flow routes have been provided to the adjacent municipal right-of-way (Renaud Road) for events exceeding the 5-year capture rate of the proposed ICD for rear yard areas.

6 Geotechnical Considerations and Grading

6.1 Geotechnical Investigation

A geotechnical investigation report for Trail Edge East - Renaud Road Subdivision was completed by Paterson Group on July 29, 2021. Field testing consisting of data from a first round of investigation including a total of ten (10) test pits and ten (10) test boreholes with a maximum depth of 5.7m on October 14, 15, 16 and 24, 2008, followed by an additional round of investigation consist of nineteen (19) test pits completed on July 10, 2018 and eleven (11) boreholes with a maximum depth of 23.72m throughout the subject site completed on May 8, 9 and 10, 2017. All field investigations were carried out by Paterson, the geotechnical investigation report is included in **Appendix D**.

The site consists of the property of 6615 & 6635 Renaud Road and 191 Rappel Circle, which are most close to the boreholes 3A-17 and 3B-17 with surface grade of 87.59. From the borehole log data, the subsurface profile within the site consisted of a topsoil/organic layer underlain by a firm to stiff silty clay layer, followed by a grey silty clay over a dense glacial till layer.

Groundwater levels were taken at the nearest boreholes were assessed in 2017. The long-term groundwater table is anticipated to be at a 3 to 4 m depth, subject to seasonal fluctuations.

The site is considered suitable for the proposed development from a geotechnical perspective. Conventional shallow foundations placed on undisturbed stiff to firm silty clay, compacted silty sand to sandy silt, or engineered compacted fill, can be used for the proposed buildings.

6.2 Grading Plan

Proposed grading for the development within the property of 6615 & 6635 Renaud Road and 191 Rappel Circle is shown on **Drawing SSGP-1**. The proposed grading design for the site directs the majority of site runoff toward the existing Renaud Road ROW. A small northern portion of the site containing mostly landscaped and driveway areas drains uncontrolled towards existing Rappel Circle ROW.

The proposed grading has been developed to match the existing bottom of retaining wall elevation along Mer-Bleue Road to the East, and to existing road grades along Rappel Circle and Renaud Road to the north and south respectively. The site provides an access from the Renaud Road to the existing cell tower to remain with positive drainage from its foundation.

All grading, in-filling and backfilling works are to be completed as per the geotechnical recommendations made in Paterson's geotechnical investigation report (summarized above in Section 6.1).

7 Utilities

Utility infrastructure for Bell, Rogers, Hydro Ottawa, and Enbridge exists within underground plant servicing urbanized rights-of-way adjacent to the subject site. Coordination regarding the exact size, location, and routing of utilities will begin following design circulation.

8 Approvals

The City of Ottawa will review most development applications as they relate to the provision of water supply, wastewater collection and disposal, and stormwater conveyance and treatment for Site Plan Approval.

An Environmental Compliance Approval (ECA) is not expected to be required from the Ontario Ministry of the Environment, Conservation and Parks (MECP) for the proposed servicing works. The Rideau Valley Conservation Authority (RVCA) will be circulated on this submission.

An MECP Permit to Take Water (PTTW) or registration on the Environmental Activity and Sector Registry (EASR) is unlikely to be required for the site given previous service installations and the lack of proposed deep sewers or watermain. The geotechnical consultant shall confirm at the time of application whether a PTTW or EASR registration is required.

No other approval requirements from other regulatory agencies are anticipated.

9 Erosion Control

In order to protect downstream water quality and prevent sediment build up in catch basins and storm sewers, erosion and sediment control measures must be implemented during construction. The following recommendations will be included in the contract documents and communicated to the Contractor.

- Implement best management practices to provide appropriate protection of the existing and proposed drainage system and the receiving water course(s).
- Limit the extent of the exposed soils at any given time.
- Re-vegetate exposed areas as soon as possible.
- Minimize the area to be cleared and grubbed.
- Protect exposed slopes with geotextiles, geogrid, or synthetic mulches.
- Provide sediment traps and basins during dewatering works.
- Install sediment traps (such as SiltSack® by Terrafix) between catch basins and frames.
- Schedule the construction works at times which avoid flooding due to seasonal rains.

The Contractor will also be required to complete inspections and guarantee the proper performance of their erosion and sediment control measures at least after every rainfall. The inspections are to include:

- Verification that water is not flowing under silt barriers.
- Cleaning and changing the sediment traps placed on catch basins.

Refer to **Drawing EC-1** for the proposed location of silt fences, straw bales, and other erosion control measures.

10 Conclusions and Recommendations

10.1 Potable Water Servicing

The existing watermain in Renaud Road and Rappel Circle is capable of achieving the level of service required by the City of Ottawa based on the hydraulic analysis. The following conclusions were made:

- The water distribution network operates below the maximum pressure objective of 552 kPa (80 psi) in both the average day (AVDY) and peak hour (PKHR) conditions and no less than 275 kPa (40 psi) at the ground elevation.
- During maximum day domestic demands with a fire flow demand of 12,000 L/min (200 L/s), the proposed watermain network is capable of providing sufficient fire flow while maintaining a residual pressure of 138 kPa (20 psi) in all areas within the development.

10.2 Wastewater Servicing

Wastewater from the proposed development will be conveyed to the existing 200mm diameter sanitary sewers on Renaud Road and Rappel Circle constructed as part of Trails Edge East Subdivision Phase 2-3.

The capacity of the existing sanitary sewers on Renaud Road and Rappel Circle and further downstream was verified with the estimated peak wastewater flows from the site and their relative increase from the estimates made in the *Trailsedge East Phase 2-3 – Servicing and Stormwater Management Report* (Stantec Consulting Ltd, 2022). The analysis confirmed that there is sufficient capacity within the downstream sanitary sewer system to service the site.

10.3 Stormwater Management and Servicing

The proposed stormwater management plan is in compliance with the requirements outlined in the background documents, the City of Ottawa Sewer Design Guidelines and the Ontario Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual.

Site imperviousness has not increased beyond that anticipated within modeling for the *Trailsedge East Phase 2-3 – Servicing and Stormwater Management Report* (Stantec Consulting Ltd, 2022). Emergency major system flows from the site for storm events above that of the 100-year design storm will be directed to Renaud Road ROW and Rappel Circle ROW. Minor system peak flows will be directed to the existing 1050 mm diameter storm sewer on Renaud Road. Quantity and quality control (80% TSS removal) of stormwater runoff from the site has already been accounted for in the downstream EUC Pond 1.

10.4 Grading

Proposed grading for the site directs emergency major system flows from events above that of the 100-year design storm event to the surrounding ROWs. The proposed grading implements sags in the undeveloped area and rear yard swale based on standard City of Ottawa subdivision configurations.

All grading, in-filling and backfilling works are to be completed as per the geotechnical recommendations made in the background geotechnical investigation report (summarized above).

10.5 Approvals/Permits

An MECP Environmental Compliance Approval (ECA) is not anticipated to be required for the subject site. A Permit to Take Water or registration on the EASR is unlikely to be required for dewatering works during foundation excavation, pending confirmation by the geotechnical consultant. The Rideau Valley Conservation Authority (RVCA) will need to be consulted in order to obtain municipal approval for site development. No other approval requirements from other regulatory agencies are anticipated.

10.6 Utilities

Utility infrastructure for Bell, Rogers, Hydro Ottawa, and Enbridge exists within underground plant servicing urbanized rights-of-way adjacent to the subject site. Coordination regarding the exact size, location, and routing of utilities will begin following design circulation.

Appendices

Appendix A Potable Water Servicing

A.1 FUS Calculation Sheets

Stantec

FUS Fire Flow Calculation Sheet - 2020 FUS Guidelines

Stantec Project #: 160402058
Project Name: 6635 Renaud Road
Date Created: 9/27/2023
Fire Flow Calculation #: 1
Description: Row Townhouse

Created By: Z. Wang
Revision No.: 0
Revised By:
Revision Date:
Checked By: M. Wu

Notes: West 3-Unit Row Townhouse (Worst-case exposures)

Step	Task	Notes							Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Type V - Wood Frame / Type IV-D - Mass Timber Construction							1.5	-
2	Determine Effective Floor Area	Sum of All Floor Areas							-	-
		321	321						642	-
3	Determine Required Fire Flow	(F = 220 x C x A$^{1/2}$). Round to nearest 1000 L/min							-	8000
4	Determine Occupancy Charge	Limited Combustible							-15%	6800
5	Determine Sprinkler Reduction	None							0%	0
		Non-Standard Water Supply or N/A							0%	
		Not Fully Supervised or N/A							0%	
		% Coverage of Sprinkler System							0%	
6	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	Firewall / Sprinklered ?	-	-
		North	20.1 to 30	26	2	41-60	Type V	NO	4%	2312
		East	3.1 to 10	20	2	21-49	Type V	NO	16%	
		South	10.1 to 20	26	2	41-60	Type V	NO	12%	
		West	20.1 to 30	20	2	21-49	Type V	NO	2%	
7	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min								9000
		Total Required Fire Flow in L/s								150.0
		Required Duration of Fire Flow (hrs)								2.00
		Required Volume of Fire Flow (m^3)								1080

Stantec

FUS Fire Flow Calculation Sheet - 2020 FUS Guidelines

Stantec Project #: 160402058
Project Name: 6635 Renaud Road
Date Created: 9/27/2023
Fire Flow Calculation #: 2
Description: Single Family Units

Created By: Z. Wang
Revision No.: 0
Revised By:
Revision Date:
Checked By: M. Wu

Notes:

Step	Task	Notes										Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Type V - Wood Frame / Type IV-D - Mass Timber Construction										1.5	-
2	Determine Effective Floor Area	Sum of All Floor Areas										-	-
		155	155									310	-
3	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min										-	6000
4	Determine Occupancy Charge	Limited Combustible										-15%	5100
5	Determine Sprinkler Reduction	None										0%	0
		Non-Standard Water Supply or N/A										0%	
		Not Fully Supervised or N/A										0%	
		% Coverage of Sprinkler System										0%	
6	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall		Firewall / Sprinklered ?			-	-
		North	10.1 to 20	8	2	0-20	Type V		NO			10%	2652
		East	0 to 3	19	2	21-49	Type V		NO			21%	
		South	> 30	8	2	0-20	Type V		NO			0%	
		West	0 to 3	19	2	21-49	Type V		NO			21%	
7	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min											8000
		Total Required Fire Flow in L/s											133.3
		Required Duration of Fire Flow (hrs)											2.00
		Required Volume of Fire Flow (m^3)											960

A.2 Watermain Hydraulic Analysis Excerpts – Trails Edge East Phases 2-3

3.0 POTABLE WATER SERVICING

3.1 EXISTING CONDITIONS

The proposed development is located within Zone 2E of the City of Ottawa's water distribution system. This zone is fed by the Forest Ridge Pump Station, with the Innes Road elevated storage tank providing balancing storage for peak flows and demands. A 300mm diameter watermain exists along Renaud Road immediately south of the Trailsedge East development area, and a 400mm diameter main exists along Mer Bleue Road between Renaud Road and Brian Coburn Boulevard, and north of the Hydro One Corridor (HEPC). 400mm and 600mm watermains exist further north along Innes Road. A 600mm watermain exists north of the site along the HEPC.

3.2 PROPOSED WATERMAIN SIZING AND LAYOUT

The proposed watermain alignment and sizing for the development is demonstrated on **Drawings SSP-1-6**. Proposed watermain diameters of 200mm and 300mm (nominal) have been used for the development (refer to **Figure 2**). The East Uban Community Master Servicing Study (DSEL, 2020) was referenced to determine that 300mm diameter watermains were required on Copperhead Street and the northern section of Alpenstock Avenue. These watermain diameters are required to adequately service lands to the north which are slated for future development. The watermain network plan from this master servicing study is included in **Appendix A**.

A 200 mm diameter watermain connecting the mains on Ascender Avenue and Crux Road is proposed to achieve the required fire flows before the lands to the north of Phase 2-3 are developed (at which point the watermain network will be extended and additional looping will be implemented).

3.2.1 Connection to Existing Infrastructure

Water supply for Phase 2-3 of the Trailsedge East Subdivision is proposed to be connected to the existing mains located within the Ascender Avenue, Renaud Road, and Mer Bleue Road rights-of-way. **Figure 2** shows the location of the seven (7) connection points to the existing watermains.

Figure 2: Watermain Layout and Connections to Existing Infrastructure

3.2.2 Phasing

The Trailsedge East Subdivision is a three-phase development. Phase 1 included lands between Fern Casey Street and Ascender Avenue, whereas Phase 2 includes lands east of Ascender Street and south of proposed Copperhead Street (formerly Street 3), and Phase 3 includes lands east of Ascender Street and north of Copperhead Street. For the purpose of hydraulic analysis, Phase 2 and 3 have been considered as a single development phase.

The Phase 2-3 site herein represents an interim stage for the overall development of the area. The watermain stubs on the north end of Ascender Avenue, north end of Crux Road, and north end of Alpenstock Avenue are to be extended into the adjacent Trailsedge Phase 4 development site to the north, and are not intended to remain as dead ends in their ultimate configurations. Hydrants have been provided near these stub locations to permit installation in the interim.

3.2.3 Ground Elevations

The proposed ground elevations of the development range from approximately 87.8m and 89.5m. The elevations shown on **Figure 3** were interpolated from the proposed grading plan and assigned to the nodes in the hydraulic model.

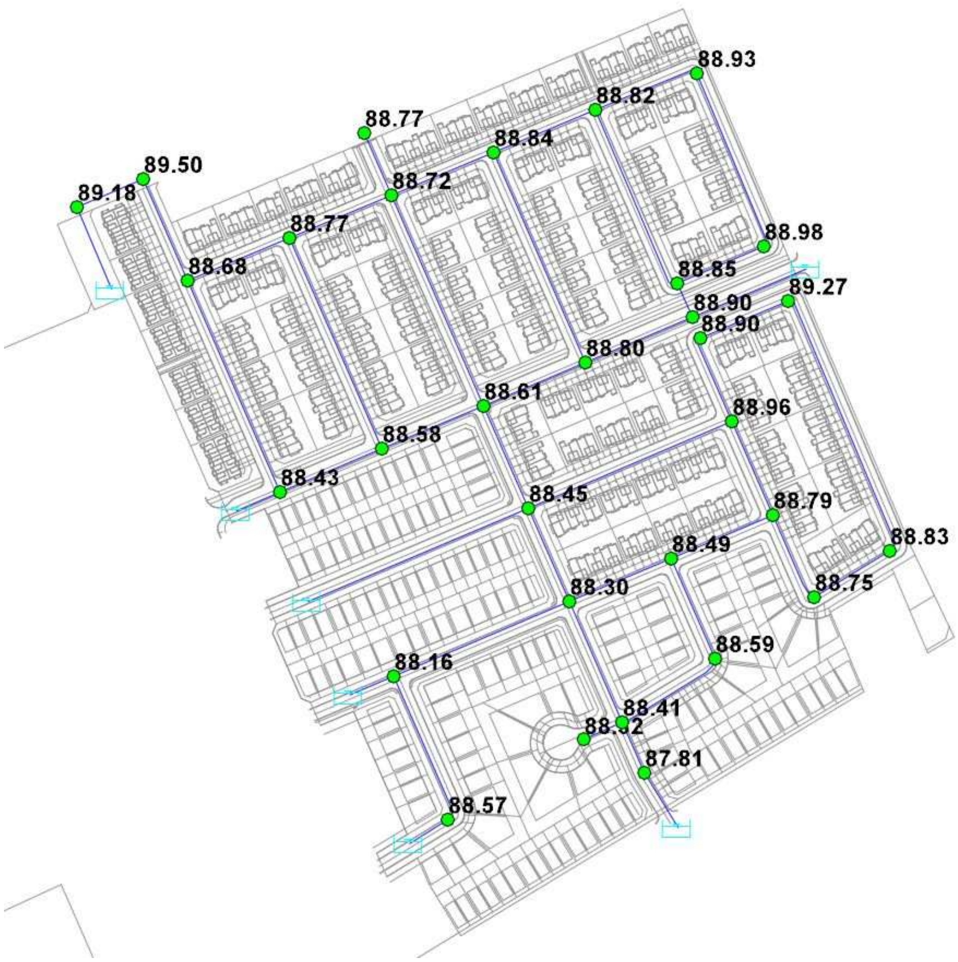


Figure 3: Proposed Ground Elevations at Nodes (m)

3.2.4 Water Demand

Phase 2-3 of the Trailsedge East Development contain a total of 162 single units, 438 townhouse units, and an estimated population of 1,733 persons.

Water demands for the development were estimated using the City of Ottawa's Water Distribution Design Guidelines. For residential developments, the average day (AVDY) per capita water demand is 350 L/cap/d. For maximum day (MXDY) demand, AVDY was multiplied by a factor of 2.5 and for peak hour (PKHR) demand, MXDY was multiplied by a factor of 2.2. The calculated residential water consumption is represented in **Table 1** below:

Table 1: Residential Water Demands

Unit Type	Units	Person/Unit	Population	AVDY (L/s)	MXDY (L/s)	PKHR (L/s)
Singles	162	3.4	551	2.23	5.58	12.27
Townhomes	442	2.7	1193	4.83	12.09	26.59
		Total	1744	7.06	17.67	38.86

3.3 LEVEL OF SERVICE

3.3.1 Allowable Pressures

The City of Ottawa Water Distribution Design Guidelines state that the desired range of system pressures under normal demand conditions (i.e. basic day, maximum day and peak hour) should be in the range of 350 to 552 kPa (50 to 80 psi) and no less than 275 kPa (40 psi) at the ground elevation in the streets (i.e. at hydrant level). The maximum pressure at any point in the distribution system in occupied areas outside of the public right-of-way is 552 kPa (80 psi). As per the Ontario Building Code (OBC) & Guide for Plumbing, if pressures greater than 552 kPa (80 psi) are anticipated, pressure relief measures are required. The maximum pressure at any point in the distribution system in unoccupied areas shall not exceed 689 kPa (100 psi). Under emergency fire flow conditions, the minimum pressure objective in the distribution system is 138 kPa (20 psi).

3.3.2 Fire Flow

A maximum fire flow of 15,000 L/min (250 L/s) was determined for Phase 2-3 of the Trailsedge East Subdivision based on the Fire Underwriters Survey (FUS) requirements using 10-unit clusters of back-to-back townhomes without consideration of 2-hour fire separation between unit clusters, and considering a minimum 3m offset from adjacent structures. Refer to **Appendix A.3** for FUS fire flow calculations for typical connected back-to-back townhouse requirements.

As per the City's technical bulletin ISDTB-2014-02 (City of Ottawa, 2014), fire flow shall be capped at 10,000 L/min for traditional side-by-side townhomes constructed in accordance with the OBC and with a minimum separation of 10 meters between the back of adjacent units.

3.4 HYDRAULIC ANALYSIS

A hydraulic model was built by Stantec using the following boundary conditions:

1) Boundary conditions for the connections on Renaud Road and Mer Bleue Road provided by the City
2) Boundary conditions for the remaining five (5) connections to Trailsedge East Phase 1 were taken from the Phase 1 hydraulic model prepared by Stantec.

The anticipated pressures in this development were assessed to meet minimum servicing requirements (average day and peak hour demands). A fire flow analysis was also performed under maximum day conditions. This analysis herein only assesses conditions for Phase 2-3. Refer to the hydraulic model prepared for the EUC Master Servicing Update (July 2006) for additional details of the watermain network within the EUC area at large or to the hydraulic model prepared for Phase 1 of the Trailsedge East Subdivision (Stantec, 2019) for details of the watermain network within that phase.

3.4.1 Boundary Conditions

The boundary conditions provided by the City and taken from the Phase 1 hydraulic analysis were based on computer model simulations and are summarized in **Table 2**. Boundary conditions requests and correspondence with the City are included in **Appendix A.1**.

Fixed head reservoirs simulating these boundary conditions were placed at the connection locations as shown in **Figure 2** for the analysis of Phase 2-3.

Table 2: Boundary Conditions for Connection Points in Phase 2-3

Location	AVDY (m)	PKHR (m)	MXDY+FF-200L/s (m)	MXDY+FF-250L/s (m)
1 – Ascender/Verglas	130.69	126.58	125.33	124.48
2 – Ascender/Copperhead	130.69	126.58	125.29	124.46
3 – Ascender/Cornice	130.69	126.55	125.34	124.32
4 – Ascender/Crevasse	130.68	126.52	125.36	124.01
5 – Ascender/Piton	130.64	126.51	124.43	123.11
6 – Alpenstock/Renaud	130.50	126.00	123.70	123.00
7 – Copperhead/Mer Bleue	130.40	126.00*	126.10*	126.20*

*Note: A recent boundary condition request for a required FF of 250L/s has identified improved pressures at the Mer Bleue connection point than previously received boundary conditions for the 200L/s FF scenario. Previously received boundary conditions for the 200L/s FF scenario are considered conservative in this regard.

3.4.2 Model Development

New watermains were added to the hydraulic model to simulate the proposed distribution system. Hazen-Williams coefficients (“C-Factors”) were applied to the new watermain in accordance with the City of Ottawa’s Water Distribution Design Guidelines (**Table 3**).

Table 3: C-Factors Applied Based on Watermain Diameter

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

3.4.3 Hydraulic Modeling Results

H2OMAP Water by Innovyze was used to conduct the watermain hydraulic analysis. The model was tested for AVDY, PKHR and MXDY+FF demands under the boundary conditions provided by the City and taken from the Phase 1 hydraulic model.

3.4.3.1 Average Day & Peak Hour

The hydraulic model results show that the maximum pressures (AVDY condition) are anticipated to be approximately 405-419 kPa (58.7-60.7 psi) within Phase 2-3. These pressures lie below the maximum allowable pressure of 552 kPa (80 psi).

Minimum pressures during PKHR are anticipated to be approximately 362-375 kPa (52.5-54.4 psi) for Phase 2-3. These pressures are well above the minimum allowable pressure of 276 kPa (40 psi), and do not exceed the maximum objective pressure of 552 kPa (80 psi).

Figure 4 and **Figure 5** below identify the minimum and maximum pressure results for the simulation in psi.

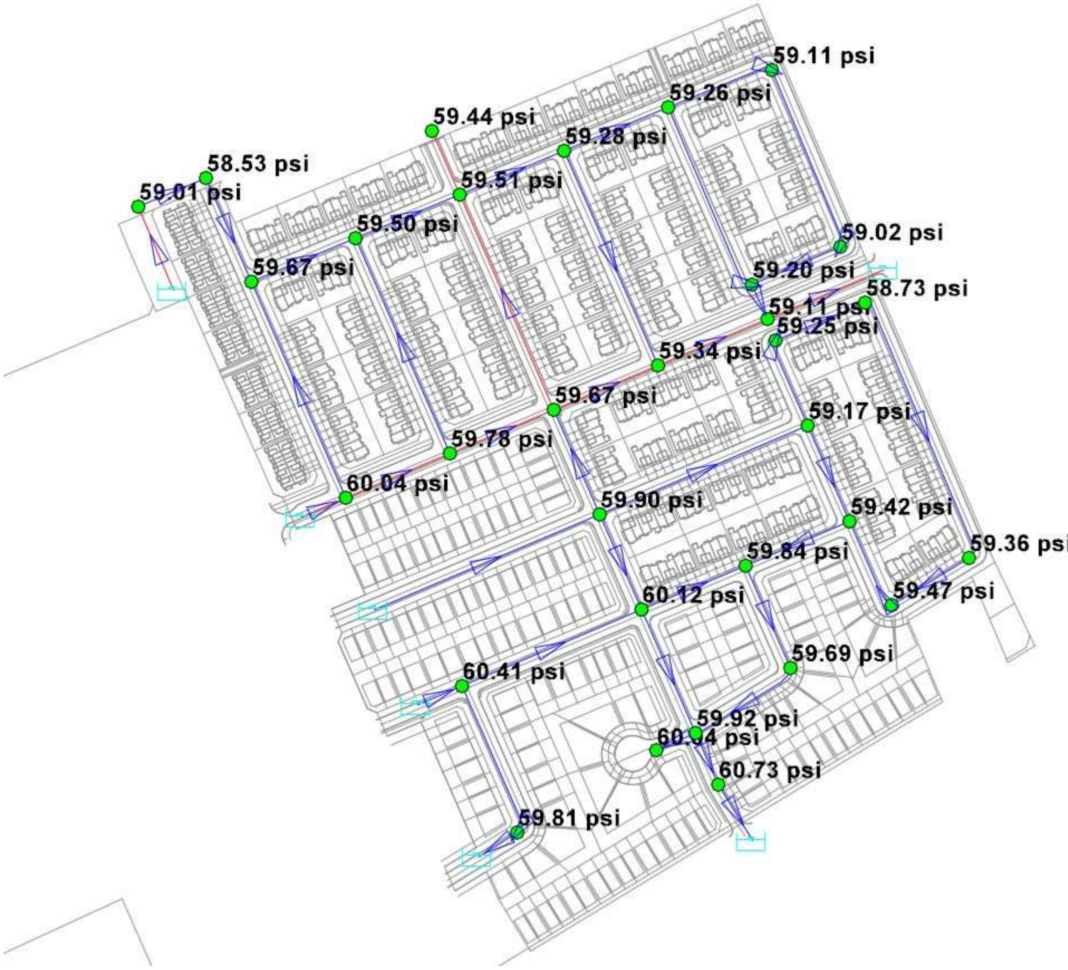


Figure 4: Maximum Pressures in Phase 2-3 During AVDY Conditions

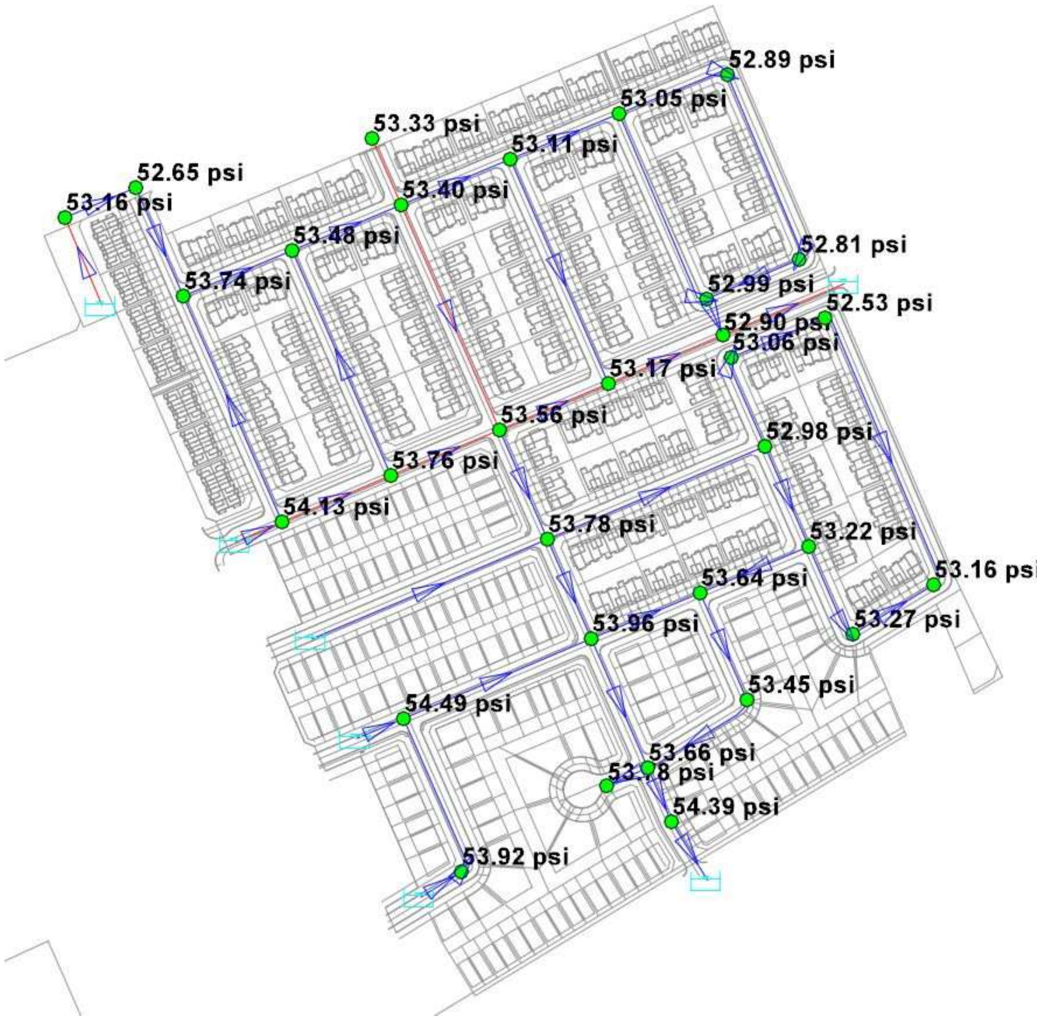


Figure 5: Minimum Pressures in Phase 2-3 During PKHR Conditions

3.4.3.2 Maximum Day Plus Fire Flow

An analysis was carried out using the hydraulic model to determine if the proposed development, under maximum day demands, can achieve a fire flow of 15,000 L/min (250 L/s) in proximity to proposed back-to-back townhomes and a fire flow of 12,000 L/min (200L/s) elsewhere while maintaining a residual pressure of 138 kPa (20 psi). This was accomplished using a steady-state maximum day demand scenario along with the automated fire flow simulation feature of the software. Fire flow analysis was only performed for Phase 2-3 and excludes future developments to the north.

Figure 6: Available Fire Flows During MXDY Conditions (250L/s and 200L/s)

Using the proposed pipe layout and sizing, a fire flow of 12,000 L/min (200 L/s) can be achieved at all locations, and a fire flow of 15,000 L/min (250 L/s) can be met in proximity to the back-to-back townhomes upon development of Phase 2-3.

Appendix B Wastewater Background Excerpts – Trails Edge Phases 2-3

4.0 WASTEWATER SERVICING

4.1 BACKGROUND

As indicated in the EUC Master Servicing Update, wastewater servicing for the Trailsedge Development is conveyed to the Forest Valley Trunk Sewer (FVT) via a free flow gravity trunk running along Renaud Road to the Forest Valley Pumping Station. The Master Servicing Study (MSS) also outlines the sanitary servicing requirements for the subject property, which identify an integrated network within Minto and further Richcraft lands to the west, eventually connecting to the newly constructed 600 mm trunk sewer extension along Renaud Road recommended by the MSS. The Trailsedge East Phase 1 – Servicing and Stormwater Management Report further detailed assumed contributing flows from Phases 2-3 through sewers on Ascender and Crevasse Street. The Sanitary Drainage Plan and sanitary sewer design sheet for the existing Trailsedge East Phase 1 development is included in **Appendix B.2**.

The Design Brief – Minto Trailsedge Phase II report (IBI Group, 2015) identifies an external contribution to their subdivision based on a future population of 4,212, which includes drainage from the entirety of the Trailsedge East development, as well as future lands forming a mixed-used community (MUC) identified within the EUC Master Servicing Update.

4.2 DESIGN CRITERIA

As outlined in the City's Sewer Design Guidelines, the following design parameters were used to calculate estimated wastewater flow rates and to preliminarily size on-site sanitary sewers:

- Minimum Full Flow Velocity – 0.6 m/s
- Maximum Full Flow Velocity – 3.0 m/s
- Manning's roughness coefficient for all smooth walled pipes – 0.013
- Single Family Persons per unit – 3.4
- Townhouse Persons per unit – 2.7
- Extraneous Flow Allowance – 0.33 L/s/ha
- Residential Average Flows – 280 L/cap/day
- Commercial/Mixed Use Flows – 28,000 L/ha/day
- Harmon Correction Factor – 0.8
- Maintenance hole Spacing – 120 m
- Minimum Cover – 2.5 m

In addition, a residential peak factor based on Harmon's Equation was used to determine the peak design flows. Institutional and commercial areas were assigned a peaking factor of 1.5 where commercial areas contribute greater than 20% of the total tributary area to each sanitary sewer per Ottawa's Sewer Design Guidelines.

4.3 PROPOSED SERVICING

Phase 1 of the Trailsedge East Subdivision is serviced by a network of gravity sewers which direct wastewater flows westerly to the trunk sewer within Fern Casey Street within the adjacent Minto development. Phases 2-3 of the Trailsedge East Subdivision flow westerly and connect to the sanitary sewer network established in Phase 1. Flows from external lands to the north and northeast will be conveyed through Phase 1 sewers without impact the Phase 2-3 network as identified in the background reports. The proposed sanitary sewer design sheet and associated Sanitary Drainage Area Plan can be found in **Appendix B** & **Appendix E**. The proposed sanitary sewer design indicates four (4) connection points to the recently constructed sanitary sewers within Phase 1. A single connection to an existing sanitary sewer stub on Renaud Road is also proposed for a total of five (5) sanitary sewer connections. This final connection is needed to extend the sanitary sewers to service the single-family homes proposed to front onto Renaud Road, and will form part of the Renaud Road urbanization project.

The connection points and associated flows are summarized in **Table 4** below. Previously allocated flows for the available connection points are noted in **Table 5**.

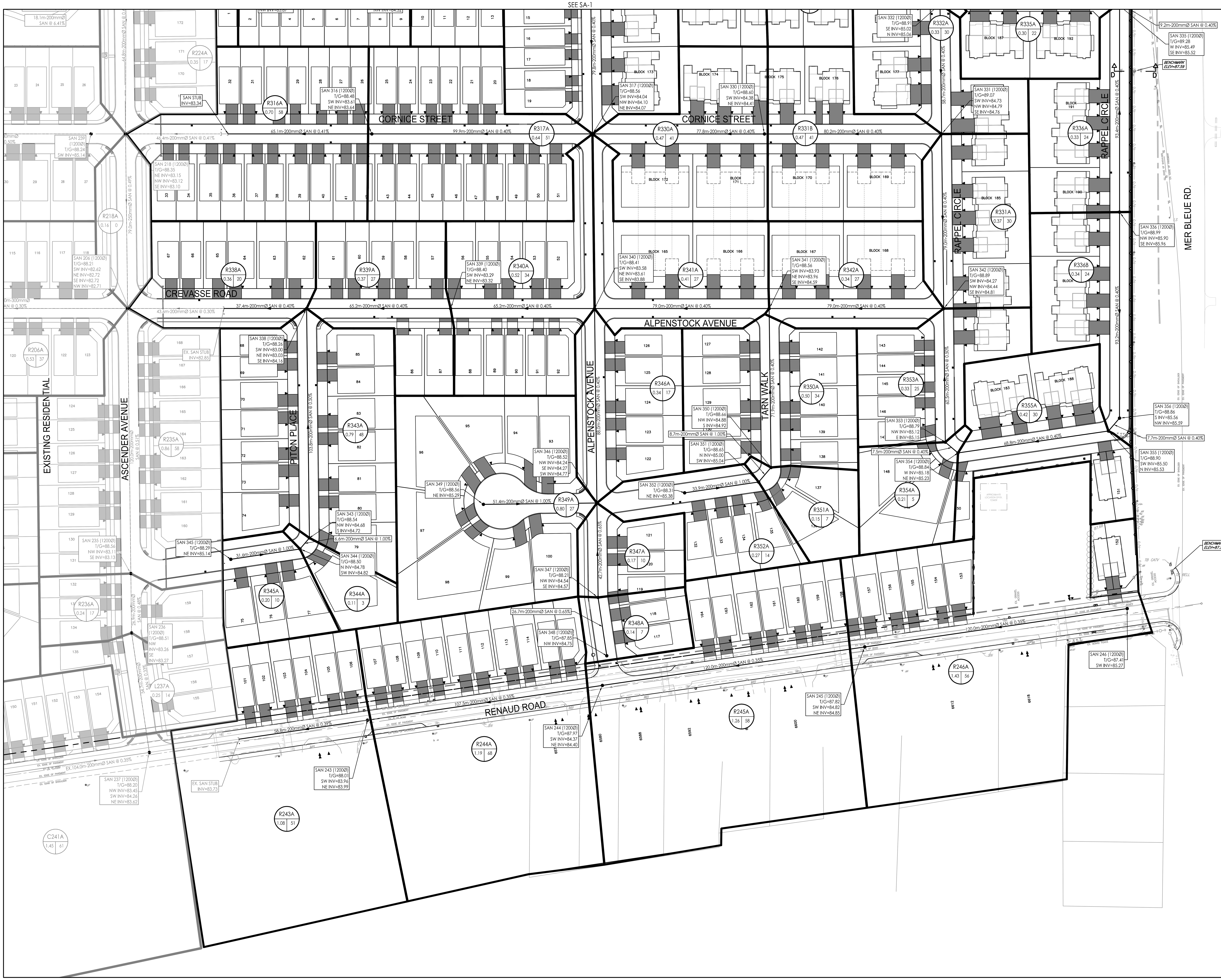
Table 4: Wastewater Connections to Existing Network

MH ID	Total Area (ha)	Residential Population	Total Flow (L/s)	Sewer Dia. (mm)
226 (Stub 359)	0.31	47	0.7	200
224 (Stub 300)	5.85	498	7.4	200
218 (Stub 315)	7.78	604	9.1	200
206 (Stub 337)	7.26	438	7.2	200
237 (Renaud)	4.96	233	4.3	200
Total	**26.15**	**1820**	**28.6**	

Table 5: Wastewater Connections per Trailsedge East Phase 1 Servicing Report

MH ID	Total Area (ha)	Residential Population	Total Flow (L/s)	Sewer Dia. (mm)
226 (Stub 359)	0.31	27	0.4	200
224 (Stub 300)	10.13	798	11.8	200
218 (Stub 315)	3.84	256	4.2	200
206 (Stub 337)	7.16	429	7.1	200
237 (Renaud)	4.94	231	4.3	200
Total	**26.38**	**1741**	**27.8**	

Based on sanitary sewer design sheets for downstream areas as provided in the Trailsedge East Phase 1 Servicing Report (Stantec, 2019), the minor increase in peak flows from the proposed development and upstream contributing areas can be accommodated within the downstream sewer network.



Stantec

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www.stantec.com

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Legend

PROPOSED SANITARY SEWER
R200A 0.38 14 — SANITARY DRAINAGE AREA ID#; POPULATION; SANITARY DRAINAGE AREA ha.
SANITARY DRAINAGE AREA ha.
TYPICAL SERVICE LATERAL LOCATION
TYPICAL SERVICE LATERAL LOCATION (EXISTING)
EXISTING SANITARY SEWER
R200A 0.38 14 — EXISTING SANITARY DRAINAGE AREA ID#; FUTURE/EXISTING POPULATION; EXISTING SANITARY DRAINAGE AREA ha.
EXISTING SANITARY DRAINAGE AREA ha.

Notes

		By	Appd.	YY.MM.DD
8	GRADING APPROVAL, CITY COMMENTS	JP	SG	22.06.06
7	HYDRANT RELOCATION : CRUX,CREVASSE,SWITCHBACK	JP	GR	22.02.15
6	ISSUED FOR CONSTRUCTION	JP	SG	22.01.17
5	ADDENDUM # 1	JP	GR	21.11.26
4	ISSUED FOR TENDER	JP	SG	21.11.22
3	ISSUED FOR CITY REVIEW	JP	DT	21.10.14
2	ISSUED FOR CITY REVIEW	JP	DT	21.08.31
1	ISSUED TO CITY FOR REVIEW	JP	DT	21.06.16
0	ISSUED TO CITY FOR REVIEW	MJS	DT	20.12.11

Revision

File Name	Dwn.	Chkd.	Dsgn.	YY.MM.DD
160401250 PH2-3-SA.dwg	JP	MJS	MJS	20.05.06

Permit-Seal

Client/Project
RICHCRAFT GROUP OF COMPANIES
2280 ST. LAURENT BLVD
OTTAWA, ON, K1G 4K1

TRAILSEDGE EAST SUBDIVISION PHASE 2 AND 3
OTTAWA, ON, CANADA

Title
SANITARY DRAINAGE PLAN

Project No. 160401250
Scale 1:750 (0 7.5 22.5 37.5m)
Drawing No. SA-2
Sheet 49 of 50
Revision 8
D07-16-16-0021
DWG# 17807

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2022/06/06 4:49 PM By: Pataragi, Jupiter

Appendix C Stormwater Management Model Excerpts – Trails Edge East Phases 2-3

5.0 STORMWATER MANAGEMENT

5.1 OBJECTIVES

The objective of this stormwater management plan is to determine the measures necessary to control the quantity/quality of stormwater released from the proposed development to criteria established by the *Trailsedge East Functional Servicing Report* (Stantec, August 2017) (FSR) for the region as well as other applicable background documents, and to provide sufficient detail for approval and construction.

5.2 SWM CRITERIA AND CONSTRAINTS

Criteria were established by combining current design practices outlined by the City of Ottawa Design Guidelines (2012), through the various background documents and through consultation with City of Ottawa staff. The following summarizes the criteria, with the source of each criterion indicated in brackets:

General

- Use of the dual drainage principle (City of Ottawa).
- Wherever feasible and practical, site-level measures should be used to reduce and control the volume and rate of runoff. (City of Ottawa).
- Assess impact of 100-year event and climate change event outlined in the City of Ottawa Sewer Design Guidelines on major & minor drainage system (City of Ottawa).

Storm Sewer & Inlet Controls

- Proposed site to discharge the existing storm sewer stubs at Ascender Avenue (Stantec).
- Minor system inflow to be restricted for all contributing areas to capture at minimum the 2-year event for local streets, or to the 5-year event along proposed collector roads (City of Ottawa).
- Boundary conditions for the site outlets per PCSWMM model prepared for Trailsedge East Phase 1 Subdivision (Stantec).
- 100-year Storm HGL to be a minimum of 0.30 m below building foundation footing (City of Ottawa).
- Climate Change event HGL to be below building foundation footing (City of Ottawa)

Surface Storage & Overland Flow

- Building openings to be a minimum of 0.15 m above the 100-year water level within adjacent ROWs (City of Ottawa).
- No overland flow was originally accounted for to Ascender Avenue from Phases 2-3 up to the 100-year event. Overland flow allowances made to Ascender Avenue for climate change (100yr+20%) event (Stantec).
- Subdivision to provide sufficient storage to contain at minimum 30 m3/ha (IBI/JFSA).
- No surface ponding is to be permitted on local roads during the 2-year storm event, and no surface ponding is to be permitted on collector roads during the 5-year storm event (City of Ottawa).
- Maximum depth of flow under either static or dynamic conditions shall be less than 0.35m for design storm events (i.e. up to 100-year storm) (City of Ottawa).
- Minimum clearance depth of 0.30m to be provided from rear yard spill elevation to the ground elevation at the adjacent building envelope (City of Ottawa).

- Minimum clearance depth of 0.15m to be provided from spill elevations within the proposed rights-of-way to building envelopes in proximity of overland flow routes or ponding areas.
- Water must not encroach upon proposed building envelopes and must remain below all proposed building openings during the climate change event (City of Ottawa).
- Provide adequate emergency overflow conveyance off-site (City of Ottawa).
- No rear-yard ponding volumes to be accounted for in SWM model preparation (City of Ottawa).
- The product of depth times velocity on streets not to be greater than 0.6 during the 100-year storm (City of Ottawa).
- Major and minor flow to be conveyed to SWM pond 1 for quality (70% TSS Removal) and quantity control (EUC MSS).

5.3 STORMWATER MANAGEMENT

5.3.1 Allowable Release Rate

Based on PCSWMM modeling files for the Trailsedge East Phase 1 Servicing and Stormwater Management Report (Stantec, 2019), the peak post-development discharge from the development to the minor system was estimated for four storm sewer connections along Ascender Avenue, as well as a storm sewer connection along Renaud Road to service proposed units fronting from the north. Peak release rates for the subdivision at these connection points are summarized in **Table 6** below:

Table 6: Minor System Release Rate Targets

Outlet Node	5yr Target Flow Rate (m^3/s)	100yr Target Flow Rate (m^3/s)	100yr + 20% Target Flow Rate (m^3/s)
2025	1.426	1.538	1.552
2022	0.484	0.550	0.521
2006	1.302	1.427	1.449
2037	0.019	0.034	0.037
Total (On-Site)	**3.231**	**3.549**	**3.559**
ST4 (Renaud)	0.608	0.660	0.676

Additionally, an allowance was provided for major system outflows at each of the above outlet locations to provide relief during events beyond the 100-year event. Peak release rates during the climate change event at these major system nodes are summarized in **Table 7**.

Table 7: Major System Release Rate Targets

Outlet Node	100yr + 20% Target Flow Rate (m^3/s)
L2025A-S1	1.552
L2022A-S1	0.521
L2006A-S1	1.449
MERBLEUE-MJ	0.386

5.3.2 Modeling Rationale

A comprehensive hydrologic modeling exercise was completed with PCSWMM, accounting for the estimated major and minor systems to evaluate the storm sewer infrastructure. The use of PCSWMM for modeling of the site hydrology and hydraulics allowed for an analysis of the systems response during various storm events. Surface storage estimates were based on the final grading plan design (see **Drawing GP-1 through GP-6**). The following assumptions were applied to the detailed model:

- Hydrologic parameters as per Ottawa Sewer Design Guidelines, including Manning's 'n', and depression storage values.
- Subcatchment infiltration parameters per Horton Infiltration method per Ottawa Sewer Design Guidelines.
- 3-hour Chicago Storm distribution for the 2, 5, and 100-year analysis, the 24 hour SCS Storm distribution for the 100-year event, and historical events July 1979, August 1988, and August 1996 with the downstream system modeled up to the outlet from Pond 1.
- To 'stress test' the system a 'climate change' scenario was created by adding 20% of the individual intensity values of the 100-year Chicago storm event at their specified time step.
- Percent imperviousness calculated based on actual soft and hard surfaces on each subcatchment, converted to equivalent Runoff Coefficient using the relationship C = (Imp. x 0.7) + 0.2
- Subcatchment areas are defined from high-point to high-point where sags occur. Subcatchment width determined by multiplying street segment length x 2 (length of overland flow path measured from high-point to high-point) for street (double-sided) catchments, multiplying by 1.5 for single-loaded roads, multiplying by 1.0 for single-sided catchments, or by multiplying the subcatchment area by 225m where a street segment flow path has not otherwise been defined.
- Number of catchbasins based on proposed servicing plans (**Drawings SSP-1-6**)
- Catchbasin inflow restricted with inlet-control devices (ICDs) as necessary to maintain inflow target rate, maximize use of surface storage, and minimize standing water during the 2-year event (5-year event level of service for collector roads). Copperhead and Renaud Road are defined as collector roadways within the current draft plan. Catchbasins are not to be interconnected.
- For storage on roads with defined cross-sections, active storage was modeled based on actual conduit flow using cross-sections as detailed on **Drawing DS-1**.
- Rear-yard swales modeled as triangular cross-sections at a continuous 1.5% grade for continuity purposes.
- Runoff from Renaud Road east of Fern Casey to Mer Bleue is captured at the 5-year rate with increases of 12.0% and 13.6% for storage depths of 0.20m (100-year event) and 0.40m (100-year+20% event) respectively.
- Renaud Road major system west of Ascender Street to be directed to Pond 1. Runoff for Renaud Road east of Ascender Avenue up to the 100-year event will be retained and captured to the minor system draining to Pond 1, with emergency overland outlet to Mer Bleue Road.

5.3.2.1 SWMM Dual Drainage Methodology

The proposed subdivision is modeled in one modeling program as a dual conduit system (see **Figure 7**), with: 1) circular conduits representing the sewers & junction nodes representing maintenance holes; 2) irregular conduits using street-shaped cross-sections to represent the sawtoothed overland road network from high-point to low-point and storage nodes representing catchbasins. The dual drainage systems are connected via orifice link objects (or outlets) from storage node (i.e. CB) to junction (i.e. MH), and represent inlet control devices (ICDs). Subcatchments are linked to the storage node on the surface so that generated hydrographs are directed there firstly.

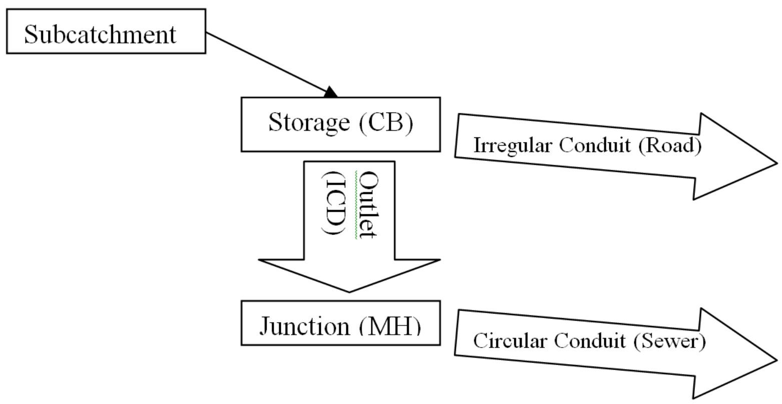


Figure 7: Schematic Representing Model Object Roles

Storage nodes are used in the model to represent catchbasins as well as major system junctions. For storage nodes representing catchbasins (CBs), the invert of the storage node represents the invert of the CB and the rim of the storage node is the top of the CB plus an additional constant depth of 0.35m-0.50m to represent depth of surface water over the storage node (to be limited to a maximum of 0.35m during the 100-year event). The additional depth has been added to rim elevations to allow routing from one surface storage to the next, and is unused where no spillage occurs between ponding areas. Storage nodes that represent catchbasins at sags, are surrounded by two or more transects that represent the road segments forming the sag. The storage value assigned to the storage node represents only the volume available within the structure. If the available storage volume in a storage node is exceeded, flows spill above the storage node and into the sag in the irregular conduits (representing roads). The volume stored within the road sags includes the total static volume and the ponded depth above the node representing the dynamic flow depth. Flow storage volumes exceeding the sag storage available in the transect (roadway) will spill at the downstream highpoint into the next sag and continue routing through the system until ultimately flows either re-enter the minor system or reach the outfall of the major system. Storage nodes representing high points are assigned an invert elevation equal to the transect invert (spill elevation at edge of pavement) and a rim elevation equal to the maximum allowable flow depth elevation above the storage node (equal to the spill elevation at edge of pavement plus an additional 0.50 m). A Storage value of 0 has been assigned to these nodes to disable linear volume calculations. No storage has been accounted for within storage nodes at high points. In this manner, storage will accumulate according to the actual ponding depths before spilling along the roadway conduit, and to the next downstream road conduit.

Inlet control devices, as represented by orifice/outlet links, use a user-specified diameter and discharge coefficient or functional head relationship taken from manufacturer's specifications for the chosen ICD model.

Subcatchment imperviousness was calculated via impervious area measured from **Drawings SSP-1-6**. It is of note that recent changes in interpretation of the City's Sewer Design Guidelines have introduced the requirement to determine the proposed subcatchment imperviousness based on maximum zoning constraints rather than those of the builder anticipated maximum building size or based on other prevailing criteria such as minimum tree setbacks. As sewer sizing and HGLs within the existing Phase 1 were based on assumed imperviousness within future phases at lesser values, the increase in runoff resultant from the newly interpreted runoff coefficients would result in deleterious surcharge of downstream sewers should full capture of the minor system event within Phases 2/3 occur. In order to ensure increases in anticipated imperviousness do not impact downstream users, City of Ottawa review staff have indicated that ICDs may be sized to allow ponding during the minor system design storm event, so long as such ponding is evenly distributed through the subdivision, dissipates immediately following the rainfall event, and is minimal in nature. Remaining components of the modeling rationale identified above continue to apply. No ponding is to be observed for Renaud Road or street segments within Phase 1 during the minor system design storm event, and no ponding is to be apparent at the end of the 2/5 year design storm events. It is understood that this allowance does not set precedent for future projects or phases.

5.3.2.2 Boundary Conditions

The detailed PCSWMM hydrology and the proposed storm sewers were used to assess the peak inflows and hydraulic grade line (HGL) for the site, as well as to assess downstream sewers to the existing SWM Pond 1. Downstream storm sewer details and inflow hydrographs were extracted from the approved XPSWMM model as prepared by JFSA and later modified by IBI for the *Minto Trailsedge Phase II Design Brief*, as well as during design of Phase 1 of the Trailsedge East subdivision. All storm events used to demonstrate outflow rates for the site are identical to that used under assessment of the downstream sewer system within the Trailsedge Phase II and Trailsedge East Phase 1 reports.

5.3.3 Input Parameters

Drawings SD-1 and 2 summarize the discretized subcatchments used in the analysis of the proposed site and outlines the major overland flow paths.

Appendix C2 summarizes the modeling input parameters and results for the subject area; a PCSWMM layout figure and an example input file is provided for the 100-year 3hr Chicago storm. For all other input files and results of storm scenarios, please examine the electronic model files located on the CD provided with this report. This analysis was performed using PCSWMM, which is a front-end GUI to the EPA-SWMM engine. Model files can be examined in any program which can read EPA-SWMM files version 5.1.014.

5.3.3.1 Hydrologic Parameters

Table 8 presents the general subcatchment parameters used for the model:

Table 8: General Subcatchment Parameters

Parameter	Value
Infiltration Method	Horton
Max. Infiltration Rate (mm/hr)	76.2
Min. Infiltration Rate (mm/hr)	13.2
Decay Constant (1/hr)	4.14
Drying Time (d)	7
N Impervious	0.013
N Pervious	0.25
Dstore Imperv. (mm)	1.57
Dstore Perv. (mm)	4.67
Zero Imperv. (%)	0

Table 9 presents the individual parameters that vary for each of the proposed subcatchments:

Table 9: Subcatchment Parameters

Name	Outlet	Area (ha)	Width (ha)	Slope (%)	Imperv. (%)
C1001A	C1001A-S	0.206	228.9	3.0	70.0
C1002A	C1002C-S	0.130	144.0	3.0	70.0
C1002AA	L1002A-S	0.068	35.8	3.0	70.0
C1002AB	L1003A-S	0.183	101.6	3.0	34.2
C1003A	C1003A-S	0.302	154.7	3.0	70.0
C1003B	C1002B-S	0.179	91.5	3.0	70.0
C1007A	C1007A-S	0.186	84.0	3.0	70.0
C1007B	C1007B-S	0.294	134.9	3.0	70.0
C1007W	C1007W-S	0.320	146.7	3.0	70.0
C2026A	C2026A-S	0.183	82.4	3.0	70.0
C2026B	C2026B-S	0.239	115.9	3.0	70.0
C2069A	C2069A-S	0.158	137.2	3.0	67.1
C2070A	C2070A-S	0.215	114.4	3.0	67.1
C2071A	C2071A-S	0.160	66.0	3.0	67.1
C2071B	C2071B-S	0.073	55.4	3.0	67.1
C2072A	C2072A-S	0.175	114.6	3.0	67.1
C2072B	C2072B-S	0.033	20.9	3.0	67.1

C2073A	C2073A-S	0.307	210.8	3.0	67.1
C2074A	C2074A-S	0.214	123.0	3.0	67.1
CB10A	CB10A-S	0.292	125.0	3.0	71.4
CB11A	CB11A-S	0.072	96.0	2.0	100.0
CB12A	CB12A-S	0.197	80.0	3.0	71.4
CB13A	CB13A-S	0.080	125.0	2.0	100.0
CB14A	CB14A-S	0.035	28.0	3.0	91.4
CB15A	CB15A-S	0.020	17.0	3.0	71.4
CB1A	CB1A-S	0.064	46.5	3.0	80.0
CB2A	CB2A-S	0.094	125.0	2.0	100.0
CB3A	CB3A-S	0.080	66.0	3.0	71.4
CB4A	CB4A-S	0.028	23.0	3.0	71.4
CB5A	CB5A-S	0.016	13.0	3.0	71.4
CB6A	CB6A-S	0.041	48.9	2.0	100.0
CB7A	CB7A-S	0.137	112.0	3.0	71.4
CB8A	CB8A-S	0.062	76.1	2.0	100.0
CB9A	CB9A-S	0.022	29.0	2.0	100.0
DI1A	N399	0.271	125.0	2.0	50.0
DI2A	ST1	0.074	48.9	2.0	50.0
DI4A	ST2	0.140	76.1	2.0	50.0
DI7A	ST2	0.139	80.0	2.0	50.0
DI8A	ST3	0.346	170.0	2.0	50.0
L1002A	L1002A2-S	3.195	719.6	1.0	85.7
L1006A	L1006A-S	0.158	60.0	3.0	70.0
L1006B	L1006B-S	0.357	302.0	3.0	70.0
L1006W	L1006W-S	0.282	118.1	3.0	70.0
L1008A	L1008A-S	27.890	6275.3	1.0	85.7
L2001A	L2001A-S	0.261	111.8	3.0	75.7
L2002A	L2002A-S	0.407	217.6	3.0	75.7
L2002B	L2002B-S	0.674	318.2	3.0	34.3
L2002C	L2002C-S	0.436	259.9	3.0	54.3
L2003A	L2003A-S	0.255	140.8	3.0	75.7
L2003B	L2003B-S	0.442	225.6	3.0	54.3
L2004A	L2004A-S	0.236	134.0	3.0	75.7
L2004B	L2004B-S	0.261	128.3	3.0	54.3
L2004C	L2004C-S	0.579	314.4	3.0	54.3
L2005A	L2005A-S	0.310	156.0	3.0	75.7
L2006A	L2006A-S	0.285	158.8	3.0	75.7

L2007A	L2007A-S	0.272	192.2	3.0	75.7
L2007B	L2007B-S	0.146	96.0	3.0	54.3
L2007C	L2007B-S	0.160	96.0	3.0	54.3
L2008A	L2008A-S	0.316	167.4	3.0	77.1
L2009A	L2009A-S	0.181	158.0	3.0	70.0
L2009B	L2009B-S	0.629	328.0	3.0	34.3
L2010A	L2010A-S	0.266	174.3	3.0	70.0
L2010B	L2010B-S	0.569	296.4	3.0	34.3
L2012A	L2012A-S	0.178	80.3	3.0	70.0
L2013A	L2013A-S	0.167	107.9	3.0	70.0
L2013B	L2013B-S	0.157	72.9	3.0	70.0
L2014A	L2014A-S	0.238	124.4	3.0	77.1
L2014B	L2014B-S	0.242	140.0	3.0	77.1
L2015A	L2015A-S	0.234	139.4	3.0	77.1
L2016A	L2016A-S	0.324	166.8	3.0	77.1
L2017A	L2017A-S	0.329	167.8	3.0	77.1
L2019A	L2019A-S	0.126	120.4	3.0	60.0
L2020A	L2020A-S	0.221	177.5	3.0	75.7
L2020B	L2020B-S	0.549	304.8	3.0	34.3
L2021A	L2021A-S	0.255	140.0	3.0	75.7
L2021B	L2021B-S	0.283	167.0	3.0	54.3
L2021C	L2021C-S	2.254	413.6	1.5	7.0
L2022A	L2022A-S	0.241	121.8	3.0	75.7
L2022B	L2022B-S	0.277	122.8	3.0	75.7
L2022S	L2022S-S	0.161	158.0	3.0	70.0
L2023A	L2023A-S	0.269	124.4	3.0	77.1
L2023B	L2023B-S	0.183	90.0	3.0	77.1
L2024A	L2024A-S	0.293	151.2	3.0	77.1
L2025A	L2025A-S	0.226	118.1	3.0	75.7
L2025B	L2025B-S	0.226	157.7	3.0	54.3
L2027A	L2027A-S	0.305	116.1	3.0	70.0
L2030A	L2030A-S	0.198	120.8	3.0	75.7
L2030B	L2030B-S	0.102	61.0	3.0	54.3
L2031A	L2031A-S	0.249	144.8	3.0	75.7
L2031B	L2031B-S	0.409	214.0	3.0	54.3
L2032A	L2032A-S	0.231	120.2	3.0	75.7
L2034A	L2034A-S	0.275	115.1	3.0	75.7
L2034B	L2034B-S	0.585	304.5	3.0	54.3

L2035A	L2035A-S	0.327	138.8	3.0	75.7
L2036A	L2036A-S	0.188	138.0	3.0	75.7
L2036B	L2036B-S	0.668	374.8	3.0	54.3
L2037A	L2037A-S	0.521	270.0	3.0	75.7
L2039A	L2039A-S	0.236	83.1	3.0	75.7
L2040A	L2040A-S	0.092	61.2	3.0	74.3
L2040B	L2040B-S	0.292	195.5	3.0	75.7
L2042A	L2042A-S	0.208	107.9	3.0	75.7
L2042B	L2042B-S	0.214	104.3	3.0	75.7
L2042C	L2042C-S	0.699	422.0	3.0	54.3
L2043A	L2043A-S	0.236	150.0	3.0	81.4
L2043B	L2043B-S	0.170	130.8	3.0	54.3
L2044A	L2044A-S	0.229	146.8	3.0	81.4
L2044B	L2044B-S	0.522	310.2	3.0	54.3
L2045A	L2045A-S	0.357	201.6	3.0	81.4
L2045B	L2045B-S	0.681	371.6	3.0	58.6
L2049A	L2049A-S	0.240	157.2	3.0	75.7
L2049B	L2049B-S	0.248	136.0	3.0	54.3
L2050A	L2050A-S	0.301	163.0	3.0	54.3
L2051A	L2051A-S	0.263	148.5	3.0	75.7
L2052A	L2052A-S	0.336	144.0	3.0	75.7
L2053A	L2053A-S	0.302	152.8	3.0	75.7
L2055A	L2055A-S	0.283	158.6	3.0	75.7
L2055B	L2055B-S	0.384	220.9	3.0	54.3
L2056A	L2056A-S	0.200	158.0	3.0	75.7
L2056B	L2056B-S	0.650	382.6	3.0	54.3
L2056C	L2056C-S	0.456	280.0	3.0	58.6
L2058A	L2058A-S	0.383	181.4	3.0	75.7
L2059A	L2059A-S	0.297	137.8	3.0	75.7
L2060A	L2060A-S	0.237	106.6	3.0	75.7
L2060B	L2060B-S	0.563	309.4	3.0	54.3
L2061A	L2061A-S	0.120	70.8	3.0	81.4
L2061B	L2061B-S	0.494	280.0	3.0	58.6
L2062A	L2062A-S	0.430	225.0	3.0	81.4
L2062B	L2062B-S	0.270	196.4	3.0	81.4
L2063A	L2063A-S	0.382	253.6	3.0	81.4
L2067A	L2067A-S	0.265	200.0	3.0	81.4
L2067B	L2067B-S	0.301	261.6	3.0	81.4

L2068A	L2068A-S	0.344	157.6	1.0	75.7
L2070A	L2070A-S	0.396	282.6	3.0	58.6
L2071A	L2071A-S	0.413	281.8	3.0	58.6
L2072A	L2072A-S	0.361	281.0	3.0	58.6
L2073A	L2073A-S	0.478	280.4	3.0	58.6
L2077A	L2077A-S	0.376	224.4	3.0	81.4
L2077B	L2077B-S	0.324	172.8	3.0	58.6
L2077C	L2077C-S	0.137	64.0	3.0	58.6
L2078A	L2078A-S	0.190	126.8	3.0	81.4
L2078B	L2078B-S	0.155	139.2	3.0	81.4
L2080A	L2080A-S	0.343	172.8	3.0	81.4
L2081A	L2081A-S	0.331	156.4	3.0	81.4
L2082A	L2082A-S	0.319	161.4	3.0	81.4
L2083A	L2083A-S	0.434	168.6	3.0	81.4
L2084A	L2084A-S	0.282	146.2	3.0	81.4
L2085A	L2085A-S	0.468	266.6	3.0	81.4
L2086A	L2086A-S	0.217	91.5	3.0	81.4
L2086B	L2086B-S	0.281	132.2	3.0	81.4
L2087A	L2087A-S	0.399	185.4	3.0	81.4
L2089A	L2089A-S	0.481	181.8	3.0	81.4
L2091A	L2091A-S	0.142	151.2	3.0	81.4
L2091B	L2091B-S	0.267	154.6	3.0	58.6
L2091C	L2091C-S	0.212	140.0	3.0	58.6
L2092A	L2092A-S	0.288	139.8	3.0	81.4
L2092B	L2092B-S	0.292	148.0	3.0	81.4
L2093A	L2093A-S	0.289	151.2	3.0	81.4
L2093B	L2093B-S	0.160	84.0	3.0	58.6
L2095A	L2095A-S	0.138	112.6	3.0	81.4
L2095B	L2095B-S	0.162	144.0	3.0	81.4
R2-CB1	R2-CB1-S	0.051	67.0	3.0	100.0
R2-CB10	R2-CB10-S	0.064	82.0	3.0	100.0
R2-CB11	R2-CB11-S	0.136	63.0	3.0	100.0
R2-CB12	R2-CB12-S	0.050	63.0	3.0	71.4
R2-CB2	R2-CB2-S	0.162	67.9	3.0	71.4
R2-CB3	R2-CB3-S	0.056	22.4	3.0	71.4
R2-CB4	R2-CB4-S	0.024	33.0	3.0	100.0
R2-CB5	R2-CB5-S	0.214	90.8	3.0	71.4
R2-CB6	R2-CB6-S	0.060	80.0	3.0	100.0

R2-CB7	R2-CB7-S	0.046	34.0	3.0	71.4
R2-CB8	R2-CB8-S	0.028	37.9	3.0	100.0
R2-CB9	R2-CB9-S	0.202	82.0	3.0	71.4
R2-DCB1	R2-DCB1-S	0.061	77.0	3.0	100.0
R2-DCB2	R2-DCB2-S	0.293	77.0	3.0	71.4
R2-DI1	3005	0.050	500.0	3.0	50.0
R2-DI2	3005	0.195	103.0	3.0	50.0
R2-DI3	3006	0.084	49.5	3.0	50.0
R2-DI4	3006	0.110	58.0	3.0	50.0
R2-DI5	3007	0.136	65.0	3.0	50.0
R2-DI6	3007	0.082	46.0	3.0	50.0
R2-DI7	3007	0.256	57.5	3.0	71.4
R2-DI7B-INT	3007	0.229	53.0	3.0	10.6
S3901	S3901-S	0.240	101.1	3.0	85.7
S54	S54-S	0.270	88.5	3.0	85.7
S55A	S55A-S	0.219	71.8	3.0	85.7
S55B	S55B-S	0.213	70.0	3.0	85.7
S55C	S55C-S	0.154	50.5	3.0	85.7
S56	S56-S	0.210	68.9	3.0	85.7

Table 10 summarizes the storage node parameters used in the model. Rim elevations for each node correspond to the rim elevation of the associated area's catchbasin plus maximum depth of storage plus an additional buffer depth to allow for demonstration of overland flow in the climate change event scenario. The buffer is unused during other modeled events. Storage curves noted as 'functional' are set not to provide any additional storage for the node, as storage will occur within the major system conduit (transect) connecting the storage nodes within the model. Storage curves for development blocks are based on attenuation of events between the 2 and 100-year design event on-site.

Table 10: Storage Node Parameters

Name	Invert	Rim	Depth	Storage Curve	Curve Name
C1001A-S	86.34	88.22	1.88	FUNCTIONAL	*
C1001A-S0	87.89	88.29	0.40	FUNCTIONAL	*
C1001A-S1	88.12	88.62	0.50	FUNCTIONAL	*
C1002B-S	86.64	88.52	1.88	FUNCTIONAL	*
C1002B-S1	88.24	88.74	0.50	FUNCTIONAL	*
C1002C-S	86.58	88.46	1.88	FUNCTIONAL	*
C1002C-S1	88.19	88.69	0.50	FUNCTIONAL	*
C1003A-S	86.68	88.56	1.88	FUNCTIONAL	*

C1007A-S	87.09	88.97	1.88	FUNCTIONAL	*
C1007B-S	86.78	88.66	1.88	FUNCTIONAL	*
C1007B-S1	88.64	89.14	0.50	FUNCTIONAL	*
C1007W-S	86.92	88.80	1.88	FUNCTIONAL	*
C1007W-S1	88.69	89.19	0.50	FUNCTIONAL	*
C1007W-S2	88.54	89.04	0.50	FUNCTIONAL	*
C2026A-S	86.95	88.83	1.88	FUNCTIONAL	*
C2026A-S1	88.46	88.96	0.50	FUNCTIONAL	*
C2026B-S	86.81	88.69	1.88	FUNCTIONAL	*
C2026B-S1	88.48	88.98	0.50	FUNCTIONAL	*
C2069A-S	86.74	88.52	1.78	FUNCTIONAL	*
C2069A-S1	88.30	88.70	0.40	FUNCTIONAL	*
C2069A-S2	88.45	88.85	0.40	FUNCTIONAL	*
C2070A-S	86.91	88.69	1.78	FUNCTIONAL	*
C2070A-S1	88.50	88.90	0.40	FUNCTIONAL	*
C2071A-S	87.01	88.79	1.78	FUNCTIONAL	*
C2071A-S1	88.58	88.98	0.40	FUNCTIONAL	*
C2071B-S	87.00	88.78	1.78	FUNCTIONAL	*
C2071B-S1	88.51	88.91	0.40	FUNCTIONAL	*
C2071B-S2	88.65	89.05	0.40	FUNCTIONAL	*
C2072A-S	87.16	88.94	1.78	FUNCTIONAL	*
C2072A-S1	88.63	89.03	0.40	FUNCTIONAL	*
C2072B-S	87.07	88.85	1.78	FUNCTIONAL	*
C2073A-S	87.14	88.92	1.78	FUNCTIONAL	*
C2073A-S1	88.84	89.24	0.40	FUNCTIONAL	*
C2074A-S	85.96	87.74	1.78	FUNCTIONAL	*
CB10A-S	86.36	88.09	1.73	FUNCTIONAL	*
CB10A-S1	88.10	88.45	0.35	FUNCTIONAL	*
CB11A-S	86.40	88.13	1.73	FUNCTIONAL	*
CB11A-S1	88.16	88.51	0.35	FUNCTIONAL	*
CB12A-S	86.47	88.20	1.73	FUNCTIONAL	*
CB13A-S	86.53	88.26	1.73	FUNCTIONAL	*
CB13A-S1	88.28	88.63	0.35	FUNCTIONAL	*
CB14A-S	86.62	88.35	1.73	FUNCTIONAL	*
CB15A-S	86.82	88.55	1.73	FUNCTIONAL	*
CB15A-S1	88.23	88.58	0.35	FUNCTIONAL	*
CB1A-S	86.22	87.95	1.73	FUNCTIONAL	*
CB1A-S0	87.80	88.15	0.35	FUNCTIONAL	*

CB2A-S	86.15	87.88	1.73	FUNCTIONAL	*
CB2A-S1	87.91	88.26	0.35	FUNCTIONAL	*
CB3A-S	86.12	87.85	1.73	FUNCTIONAL	*
CB4A-S	86.37	88.10	1.73	FUNCTIONAL	*
CB4A-S1	87.85	88.20	0.35	FUNCTIONAL	*
CB5A-S	86.41	88.14	1.73	FUNCTIONAL	*
CB6A-S	86.35	88.08	1.73	FUNCTIONAL	*
CB7A-S	86.22	87.95	1.73	FUNCTIONAL	*
CB7A-S1	87.98	88.33	0.35	FUNCTIONAL	*
CB8A-S	86.25	87.98	1.73	FUNCTIONAL	*
CB8A-S1	88.03	88.38	0.35	FUNCTIONAL	*
CB9A-S	86.53	88.26	1.73	FUNCTIONAL	*
ForeN	80.00	83.50	3.50	TABULAR	ForeN_Storage_Curve
ForeS	80.00	83.50	3.50	TABULAR	ForeS_Storage_Curve
L1002A2-S	87.16	89.04	1.88	TABULAR	L1002A2_V
L1002A-S	86.67	88.45	1.78	FUNCTIONAL	*
L1003A-S	86.14	88.58	2.44	FUNCTIONAL	*
L1006A-S	87.18	89.06	1.88	FUNCTIONAL	*
L1006B-S	86.85	88.73	1.88	FUNCTIONAL	*
L1006B-S1	88.72	89.22	0.50	FUNCTIONAL	*
L1006W-S	87.02	88.90	1.88	FUNCTIONAL	*
L1006W-S1	88.79	89.29	0.50	FUNCTIONAL	*
L1008A-S	87.16	89.04	1.88	TABULAR	L1008A-V
L2001A-S	85.87	87.75	1.88	FUNCTIONAL	*
L2001A-S1	87.52	88.02	0.50	FUNCTIONAL	*
L2002A-S	85.91	87.79	1.88	FUNCTIONAL	*
L2002A-S1	87.56	88.06	0.50	FUNCTIONAL	*
L2002B-S	85.43	87.78	2.35	FUNCTIONAL	*
L2002C-S	85.80	88.10	2.30	FUNCTIONAL	*
L2003A-S	86.09	87.97	1.88	FUNCTIONAL	*
L2003A-S1	87.78	88.28	0.50	FUNCTIONAL	*
L2003B-S	85.52	87.81	2.29	FUNCTIONAL	*
L2004A-S	86.16	88.04	1.88	FUNCTIONAL	*
L2004A-S1	87.80	88.30	0.50	FUNCTIONAL	*
L2004B-S	85.60	88.05	2.45	FUNCTIONAL	*
L2004C-S	85.72	88.05	2.33	FUNCTIONAL	*
L2005A-S	86.25	88.13	1.88	FUNCTIONAL	*
L2005A-S1	87.88	88.38	0.50	FUNCTIONAL	*

L2006A-S	86.33	88.21	1.88	FUNCTIONAL	*
L2006A-S1	87.96	88.46	0.50	FUNCTIONAL	*
L2007A-S	86.43	88.21	1.78	FUNCTIONAL	*
L2007A-S1	88.07	88.47	0.40	FUNCTIONAL	*
L2007A-S2	88.22	88.62	0.40	FUNCTIONAL	*
L2007B-S	86.03	88.49	2.46	FUNCTIONAL	*
L2008A-S	85.95	87.83	1.88	FUNCTIONAL	*
L2008A-S1	87.61	88.11	0.50	FUNCTIONAL	*
L2009A-S	86.11	87.99	1.88	FUNCTIONAL	*
L2009A-S1	87.71	88.21	0.50	FUNCTIONAL	*
L2009B-S	85.69	88.01	2.32	FUNCTIONAL	*
L2010A-S	86.21	88.09	1.88	FUNCTIONAL	*
L2010A-S1	87.87	88.37	0.50	FUNCTIONAL	*
L2010B-S	85.60	87.95	2.35	FUNCTIONAL	*
L2012A-S	86.33	88.21	1.88	FUNCTIONAL	*
L2012A-S1	87.94	88.44	0.50	FUNCTIONAL	*
L2013A-S	86.50	88.38	1.88	FUNCTIONAL	*
L2013B-S	86.42	88.30	1.88	FUNCTIONAL	*
L2013B-S1	87.99	88.49	0.50	FUNCTIONAL	*
L2014A-S	86.18	88.06	1.88	FUNCTIONAL	*
L2014A-S1	88.01	88.51	0.50	FUNCTIONAL	*
L2014B-S	86.51	88.39	1.88	FUNCTIONAL	*
L2014B-S1	88.23	88.73	0.50	FUNCTIONAL	*
L2015A-S	86.64	88.52	1.88	FUNCTIONAL	*
L2015A-S1	88.33	88.83	0.50	FUNCTIONAL	*
L2016A-S	86.09	87.97	1.88	FUNCTIONAL	*
L2016A-S1	88.04	88.54	0.50	FUNCTIONAL	*
L2017A-S	86.48	88.36	1.88	FUNCTIONAL	*
L2017A-S1	88.27	88.77	0.50	FUNCTIONAL	*
L2019A-S	86.68	88.56	1.88	FUNCTIONAL	*
L2020A-S	86.17	88.05	1.88	FUNCTIONAL	*
L2020A-S1	88.00	88.50	0.50	FUNCTIONAL	*
L2020A-S2	87.81	88.31	0.50	FUNCTIONAL	*
L2020B-S	85.61	87.97	2.36	FUNCTIONAL	*
L2021A-S	86.45	88.33	1.88	FUNCTIONAL	*
L2021A-S1	88.10	88.60	0.50	FUNCTIONAL	*
L2021B-S	85.88	88.27	2.39	FUNCTIONAL	*
L2021C-S	86.44	88.44	2.00	FUNCTIONAL	*

L2022A-S	86.60	88.48	1.88	FUNCTIONAL	*
L2022A-S1	88.25	88.75	0.50	FUNCTIONAL	*
L2022B-S	86.55	88.43	1.88	FUNCTIONAL	*
L2022B-S1	88.17	88.67	0.50	FUNCTIONAL	*
L2022S-S	86.42	88.30	1.88	FUNCTIONAL	*
L2023A-S	86.31	88.19	1.88	FUNCTIONAL	*
L2023A-S1	88.14	88.64	0.50	FUNCTIONAL	*
L2023B-S	86.39	88.27	1.88	FUNCTIONAL	*
L2023B-S1	87.92	88.42	0.50	FUNCTIONAL	*
L2024A-S	86.55	88.43	1.88	FUNCTIONAL	*
L2024A-S1	88.34	88.84	0.50	FUNCTIONAL	*
L2025A-S	86.74	88.62	1.88	FUNCTIONAL	*
L2025A-S1	88.35	88.85	0.50	FUNCTIONAL	*
L2025B-S	86.12	88.44	2.32	FUNCTIONAL	*
L2027A-S	86.96	88.84	1.88	FUNCTIONAL	*
L2027A-S1	88.50	89.00	0.50	FUNCTIONAL	*
L2030A-S	86.65	88.43	1.78	FUNCTIONAL	*
L2030A-S1	88.41	88.81	0.40	FUNCTIONAL	*
L2030B-S	86.27	88.84	2.57	FUNCTIONAL	*
L2031A-S	86.18	88.06	1.88	FUNCTIONAL	*
L2031A-S1	87.95	88.45	0.50	FUNCTIONAL	*
L2031B-S	85.60	88.05	2.45	FUNCTIONAL	*
L2032A-S	86.43	88.31	1.88	FUNCTIONAL	*
L2032A-S1	88.04	88.54	0.50	FUNCTIONAL	*
L2034A-S	86.43	88.31	1.88	FUNCTIONAL	*
L2034B-S	86.31	88.61	2.30	FUNCTIONAL	*
L2035A-S	86.38	88.26	1.88	FUNCTIONAL	*
L2035A-S1	88.12	88.62	0.50	FUNCTIONAL	*
L2036A-S	86.25	88.13	1.88	FUNCTIONAL	*
L2036A-S1	87.95	88.45	0.50	FUNCTIONAL	*
L2036B-S	85.72	88.16	2.44	FUNCTIONAL	*
L2037A-S	86.51	88.39	1.88	FUNCTIONAL	*
L2037A-S1	88.33	88.81	0.48	FUNCTIONAL	*
L2039A-S	86.57	88.41	1.84	FUNCTIONAL	*
L2040A-S	86.12	88.30	2.18	FUNCTIONAL	*
L2040B-S	86.70	88.48	1.78	FUNCTIONAL	*
L2042A-S	86.72	88.50	1.78	FUNCTIONAL	*
L2042A-S1	88.29	88.69	0.40	FUNCTIONAL	*

L2042B-S	86.75	88.53	1.78	FUNCTIONAL	*
L2042B-S1	88.34	88.74	0.40	FUNCTIONAL	*
L2042C-S	86.14	88.69	2.55	FUNCTIONAL	*
L2043A-S	86.77	88.55	1.78	FUNCTIONAL	*
L2043B-S	86.16	88.76	2.60	FUNCTIONAL	*
L2044A-S	86.98	88.76	1.78	FUNCTIONAL	*
L2044A-S1	88.72	89.12	0.40	FUNCTIONAL	*
L2044B-S	86.44	88.99	2.55	FUNCTIONAL	*
L2045A-S	87.23	89.01	1.78	FUNCTIONAL	*
L2045A-S1	88.91	89.31	0.40	FUNCTIONAL	*
L2045B-S	86.74	89.21	2.47	FUNCTIONAL	*
L2049A-S	86.64	88.47	1.83	FUNCTIONAL	*
L2049A-S1	88.33	88.73	0.40	FUNCTIONAL	*
L2049A-S2	88.48	88.88	0.40	FUNCTIONAL	*
L2049B-S	86.07	88.47	2.40	FUNCTIONAL	*
L2050A-S	86.12	88.64	2.52	FUNCTIONAL	*
L2051A-S	86.29	88.07	1.78	FUNCTIONAL	*
L2052A-S	86.83	88.61	1.78	FUNCTIONAL	*
L2052A-S1	88.58	88.98	0.40	FUNCTIONAL	*
L2053A-S	86.77	88.55	1.78	FUNCTIONAL	*
L2053A-S1	88.39	88.79	0.40	FUNCTIONAL	*
L2055A-S	86.74	88.52	1.78	FUNCTIONAL	*
L2055A-S1	88.57	88.97	0.40	FUNCTIONAL	*
L2055B-S	86.16	88.71	2.55	FUNCTIONAL	*
L2056A-S	86.67	88.50	1.83	FUNCTIONAL	*
L2056A-S1	88.39	88.79	0.40	FUNCTIONAL	*
L2056B-S	86.12	88.67	2.55	FUNCTIONAL	*
L2056C-S	86.12	88.60	2.48	FUNCTIONAL	*
L2058A-S	86.47	88.25	1.78	FUNCTIONAL	*
L2058A-S1	88.50	88.90	0.40	FUNCTIONAL	*
L2059A-S	86.84	88.62	1.78	FUNCTIONAL	*
L2059A-S1	88.49	88.89	0.40	FUNCTIONAL	*
L2060A-S	86.93	88.71	1.78	FUNCTIONAL	*
L2060A-S1	88.55	88.95	0.40	FUNCTIONAL	*
L2060B-S	86.45	88.98	2.53	FUNCTIONAL	*
L2061A-S	86.93	88.71	1.78	FUNCTIONAL	*
L2061A-S1	88.63	89.03	0.40	FUNCTIONAL	*
L2061B-S	86.52	89.01	2.49	FUNCTIONAL	*

L2062A-S	87.07	88.85	1.78	FUNCTIONAL	*
L2062B-S	87.28	89.06	1.78	FUNCTIONAL	*
L2062B-S1	88.90	89.30	0.40	FUNCTIONAL	*
L2063A-S	87.39	89.17	1.78	FUNCTIONAL	*
L2063A-S1	89.19	89.59	0.40	FUNCTIONAL	*
L2067A-S	87.33	89.11	1.78	FUNCTIONAL	*
L2067A-S1	89.01	89.41	0.40	FUNCTIONAL	*
L2067B-S	87.39	89.17	1.78	FUNCTIONAL	*
L2068A-S	86.81	88.59	1.78	FUNCTIONAL	*
L2070A-S	86.34	88.96	2.62	FUNCTIONAL	*
L2071A-S	86.54	89.17	2.63	FUNCTIONAL	*
L2072A-S	86.61	89.23	2.62	FUNCTIONAL	*
L2073A-S	86.57	89.18	2.61	FUNCTIONAL	*
L2077A-S	87.22	89.00	1.78	FUNCTIONAL	*
L2077A-S1	88.98	89.38	0.40	FUNCTIONAL	*
L2077B-S	86.60	89.09	2.49	FUNCTIONAL	*
L2077C-S	86.93	89.42	2.49	FUNCTIONAL	*
L2078A-S	87.41	89.19	1.78	FUNCTIONAL	*
L2078A-S1	89.09	89.49	0.40	FUNCTIONAL	*
L2078B-S	87.53	89.31	1.78	FUNCTIONAL	*
L2080A-S	87.05	88.83	1.78	FUNCTIONAL	*
L2080A-S1	88.90	89.30	0.40	FUNCTIONAL	*
L2081A-S	87.21	88.99	1.78	FUNCTIONAL	*
L2081A-S1	88.76	89.16	0.40	FUNCTIONAL	*
L2082A-S	86.85	88.63	1.78	FUNCTIONAL	*
L2082A-S1	88.62	89.02	0.40	FUNCTIONAL	*
L2083A-S	87.01	88.79	1.78	FUNCTIONAL	*
L2083A-S1	88.65	89.05	0.40	FUNCTIONAL	*
L2084A-S	86.86	88.64	1.78	FUNCTIONAL	*
L2084A-S1	88.61	89.01	0.40	FUNCTIONAL	*
L2085A-S	86.98	88.76	1.78	FUNCTIONAL	*
L2086A-S	87.01	88.79	1.78	FUNCTIONAL	*
L2086A-S1	88.62	89.02	0.40	FUNCTIONAL	*
L2086B-S	86.75	88.53	1.78	FUNCTIONAL	*
L2086B-S1	88.51	88.91	0.40	FUNCTIONAL	*
L2087A-S	87.05	88.83	1.78	FUNCTIONAL	*
L2087A-S1	88.58	88.98	0.40	FUNCTIONAL	*
L2089A-S	87.06	88.84	1.78	FUNCTIONAL	*

L2089A-S1	88.67	89.07	0.40	FUNCTIONAL	*
L2089A-S2	88.92	89.32	0.40	FUNCTIONAL	*
L2091A-S	87.13	88.91	1.78	FUNCTIONAL	*
L2091A-S1	88.64	89.04	0.40	FUNCTIONAL	*
L2091B-S	86.63	89.21	2.58	FUNCTIONAL	*
L2091C-S	86.63	89.21	2.58	FUNCTIONAL	*
L2092A-S	87.17	88.95	1.78	FUNCTIONAL	*
L2092B-S	87.27	89.05	1.78	FUNCTIONAL	*
L2092B-S1	88.82	89.22	0.40	FUNCTIONAL	*
L2093A-S	87.35	89.13	1.78	FUNCTIONAL	*
L2093A-S1	88.99	89.39	0.40	FUNCTIONAL	*
L2093B-S	87.68	89.42	1.74	FUNCTIONAL	*
L2095A-S	87.53	89.31	1.78	FUNCTIONAL	*
L2095A-S1	89.16	89.56	0.40	FUNCTIONAL	*
L2095B-S	87.43	89.21	1.78	FUNCTIONAL	*
L2095B-S1	89.06	89.46	0.40	FUNCTIONAL	*
MainN	79.00	83.50	4.50	TABULAR	MainN_Storage_Curve
MainS	79.10	83.50	4.40	TABULAR	MainS_Storage_Curve
N399	83.24	87.70	4.46	FUNCTIONAL	*
N400	83.12	87.80	4.68	FUNCTIONAL	*
N401	83.00	87.39	4.39	FUNCTIONAL	*
N402	82.84	87.26	4.42	FUNCTIONAL	*
R2-CB10-S	86.15	87.93	1.78	FUNCTIONAL	*
R2-CB10-S1	87.78	88.18	0.40	FUNCTIONAL	*
R2-CB11-S	86.03	87.81	1.78	FUNCTIONAL	*
R2-CB12-S	86.09	87.87	1.78	FUNCTIONAL	*
R2-CB1-S	86.57	88.35	1.78	FUNCTIONAL	*
R2-CB2-S	86.51	88.29	1.78	FUNCTIONAL	*
R2-CB3-S	86.40	88.18	1.78	FUNCTIONAL	*
R2-CB4-S	86.40	88.18	1.78	FUNCTIONAL	*
R2-CB5-S	86.20	87.98	1.78	FUNCTIONAL	*
R2-CB5-S1	87.98	88.38	0.40	FUNCTIONAL	*
R2-CB6-S	86.25	88.03	1.78	FUNCTIONAL	*
R2-CB6-S1	87.88	88.28	0.40	FUNCTIONAL	*
R2-CB7-S	86.26	88.04	1.78	FUNCTIONAL	*
R2-CB8-S	86.31	88.09	1.78	FUNCTIONAL	*
R2-CB9-S	86.13	87.91	1.78	FUNCTIONAL	*
R2-CB9-S1	87.73	88.13	0.40	FUNCTIONAL	*

R2-DCB1-S	85.97	87.75	1.78	FUNCTIONAL	*
R2-DCB1-S1	87.43	87.83	0.40	FUNCTIONAL	*
R2-DCB2-S	85.94	87.72	1.78	FUNCTIONAL	*
R2-DCB2-S1	87.50	87.90	0.40	FUNCTIONAL	*
R2-DI7B-S	86.16	87.41	1.25	TABULAR	R2-DI7B-V
S3901-S	86.53	88.31	1.78	FUNCTIONAL	*
S3901-S0	88.06	88.46	0.40	FUNCTIONAL	*
S3901-S1	88.26	88.66	0.40	FUNCTIONAL	*
S54-S	86.25	88.03	1.78	FUNCTIONAL	*
S55A-S	86.20	87.98	1.78	FUNCTIONAL	*
S55A-S1	87.78	88.18	0.40	FUNCTIONAL	*
S55B-S	86.15	87.93	1.78	FUNCTIONAL	*
S55B-S1	87.73	88.13	0.40	FUNCTIONAL	*
S55C-S	86.07	87.85	1.78	FUNCTIONAL	*
S55C-S1	87.68	88.08	0.40	FUNCTIONAL	*
S56-S	85.78	87.66	1.88	FUNCTIONAL	*
S56-S1	87.58	87.98	0.40	FUNCTIONAL	*
ST1	83.80	87.81	4.01	FUNCTIONAL	*
ST2	83.92	87.96	4.04	FUNCTIONAL	*
ST3	84.03	88.13	4.10	FUNCTIONAL	*
ST4	84.14	88.31	4.16	FUNCTIONAL	*
SU1	88.39	88.79	0.40	FUNCTIONAL	*

5.3.3.2 Hydraulic Parameters

As per the Ottawa Sewer Design Guidelines (OSDG), Manning's roughness values of 0.013 were used for sewer modeling and overland flow corridors representing roadways.

Storm sewers were modeled to confirm flow capacities and hydraulic grade lines (HGLs) in the ultimate condition with consideration of flow contributions from future areas. The detailed storm sewer design sheet is included in **Appendix C.1**.

Table 11 below presents the parameters for the outlet and orifice link objects in the model, which represent ICDs and existing flow-controlled areas based on SWM models as prepared by others, or future flow-controlled areas. All orifices were assigned a discharge coefficient of 0.572 to correspond to manufacturer supplied discharge curves for IPEX Tempest HF/MHF models. Should an approved equivalent model be required, the peak outlet rate of the selected model will be required to match that of the modeled ICD at the maximum head noted in the model results portion of this report.

Storage volumes for future development areas north of Phases 2-3 remain as indicated within the servicing report for Phase 1 of the Trailsedge East development. These future development areas include Phase 4 of the Trailsedge East Development, Blocks 193 and 194, as well as future EUC MUC development area as noted within the EUC Phase 3 CDP for the region. Areas noted are consistent with that assumed within the Phase 3 CDP, and are shown on **Figure SD-F** within **Appendix C.2**. Subcatchment widths were applied based on City guidelines for lumped catchment areas (width = 225*Area), and a conservative slope of 1% was applied (rough average of 0.5% road longitudinal slope and 1.5% rear yard swale longitudinal slopes). Runoff coefficients remain as per that assumed in the approved FSR, and are conservative in comparison to that of the CDP (0.80 vs. approximately 0.77 for lumped areas to the easterly future trunk connection location).

In addition to the above, subcatchment area R2-DI7B was considered to be captured via internal subdivision sewers in the interim until development of the holdout property adjacent to proposed Block 152 at Renaud Road permits an ultimate storm connection to the Renaud Road sewer. The area was assessed via rational method using City of Ottawa IDF curves for the 5-year design storm event to size an ICD for the proposed inlet L2047A. Based on a predevelopment runoff coefficient of 0.27 for the 0.23ha area, and using a time of concentration of 10 minutes, peak runoff from the subcatchment during the 5-year event was determined to be 18.0L/s. An ICD (IPEX Tempest 95mm) was selected to provide peak discharge of 18.1L/s at a head of 1m, corresponding to the proposed depth of catchbasin lead for the inlet. The interim subcatchment was applied for 100-year and 100-year + 20% event modeling to ensure appropriate freeboard is provided for proposed units in the interim condition (see sections below).

Maintenance hole loss coefficients have been applied as conduit exit losses with values assigned per Appendix 6-B of the City of Ottawa Sewer Design Guidelines 2014 assuming no flow deflector in the maintenance hole.

Table 11: Orifice Parameters

Name	Inlet	Outlet	Inlet Elev.	Type	Diameter
C1001A-O1	C1001A-S	1001	86.41	CIRCULAR	0.152
C1001A-O2	C1001A-S	1001	86.34	CIRCULAR	0.152
C1002B-O1	C1002B-S	1002B	86.64	CIRCULAR	0.127
C1002B-O2	C1002B-S	1002B	86.72	CIRCULAR	0.127
C1002C-O1	C1002C-S	1002B	86.58	CIRCULAR	0.095
C1002C-O2	C1002C-S	1002B	86.65	CIRCULAR	0.095
C1003A-O1	C1003A-S	1003	86.68	CIRCULAR	0.127
C1003A-O2	C1003A-S	1003	86.71	CIRCULAR	0.127
C1007A-O1	C1007A-S	1007	87.09	CIRCULAR	0.102
C1007A-O2	C1007A-S	1007	87.17	CIRCULAR	0.102
C1007B-O1	C1007B-S	1007	86.78	CIRCULAR	0.127
C1007B-O2	C1007B-S	1007	86.86	CIRCULAR	0.127
C1007W-O1	C1007W-S	1007	86.92	CIRCULAR	0.152
C1007W-O2	C1007W-S	1007	86.98	CIRCULAR	0.152

C2026A-O1	C2026A-S	2026	86.95	CIRCULAR	0.102
C2026A-O2	C2026A-S	2026	87.02	CIRCULAR	0.102
C2026B-O1	C2026B-S	2026	86.81	CIRCULAR	0.127
C2026B-O2	C2026B-S	2026	86.87	CIRCULAR	0.127
L1003A-O1	L1003A-S	1002A	86.14	CIRCULAR	0.127
L1006A-O1	L1006A-S	1006	87.18	CIRCULAR	0.083
L1006A-O2	L1006A-S	1006	87.18	CIRCULAR	0.083
L1006B-O1	L1006B-S	1006	86.85	CIRCULAR	0.108
L1006B-O2	L1006B-S	1006	86.85	CIRCULAR	0.108
L1006W-O1	L1006W-S	1006	87.02	CIRCULAR	0.102
L1006W-O2	L1006W-S	1006	87.02	CIRCULAR	0.102
L2001A-O1	L2001A-S	2001	85.87	CIRCULAR	0.152
L2001A-O2	L2001A-S	2001	85.87	CIRCULAR	0.152
L2002A-O1	L2002A-S	2002	85.91	CIRCULAR	0.152
L2002A-O2	L2002A-S	2002	85.91	CIRCULAR	0.152
L2002B-O1	L2002B-S	2002	85.43	CIRCULAR	0.152
L2002C-O1	L2002C-S	2002	85.80	CIRCULAR	0.152
L2003A-O1	L2003A-S	2003	86.09	CIRCULAR	0.152
L2003A-O2	L2003A-S	2003	86.09	CIRCULAR	0.152
L2003B-O1	L2003B-S	2003	85.52	CIRCULAR	0.250
L2004A-O1	L2004A-S	2004	86.16	CIRCULAR	0.102
L2004A-O2	L2004A-S	2004	86.16	CIRCULAR	0.102
L2004B-O1	L2004B-S	2004	85.60	CIRCULAR	0.200
L2004C-O1	L2004C-S	2004	85.72	CIRCULAR	0.200
L2005A-O1	L2005A-S	2005	86.25	CIRCULAR	0.108
L2005A-O2	L2005A-S	2005	86.25	CIRCULAR	0.108
L2006A-O1	L2006A-S	2006	86.33	CIRCULAR	0.108
L2006A-O2	L2006A-S	2006	86.33	CIRCULAR	0.108
L2008A-O1	L2008A-S	2008	85.95	CIRCULAR	0.152
L2008A-O2	L2008A-S	2008	85.95	CIRCULAR	0.152
L2009A-O1	L2009A-S	2009	86.11	CIRCULAR	0.102
L2009A-O2	L2009A-S	2009	86.11	CIRCULAR	0.102
L2009B-O1	L2009B-S	2009	85.69	CIRCULAR	0.152
L2010A-O1	L2010A-S	2010	86.21	CIRCULAR	0.127
L2010A-O2	L2010A-S	2010	86.21	CIRCULAR	0.127
L2010B-O1	L2010B-S	2010	85.60	CIRCULAR	0.127
L2012A-O1	L2012A-S	2012	86.33	CIRCULAR	0.083
L2012A-O2	L2012A-S	2012	86.33	CIRCULAR	0.083

L2013A-O1	L2013A-S	2013	86.50	CIRCULAR	0.083
L2013A-O2	L2013A-S	2013	86.50	CIRCULAR	0.083
L2013B-O1	L2013B-S	2013	86.42	CIRCULAR	0.083
L2013B-O2	L2013B-S	2013	86.42	CIRCULAR	0.083
L2014B-O1	L2014B-S	2014	86.51	CIRCULAR	0.102
L2014B-O2	L2014B-S	2014	86.51	CIRCULAR	0.102
L2015A-O1	L2015A-S	2015	86.64	CIRCULAR	0.095
L2015A-O2	L2015A-S	2015	86.64	CIRCULAR	0.095
L2016A-O1	L2016A-S	2016	86.09	CIRCULAR	0.108
L2016A-O2	L2016A-S	2016	86.09	CIRCULAR	0.108
L2017A-O1	L2017A-S	2017	86.48	CIRCULAR	0.127
L2017A-O2	L2017A-S	2017	86.48	CIRCULAR	0.127
L2019A-O1	L2019A-S	2019	86.68	CIRCULAR	0.083
L2019A-O2	L2019A-S	2019	86.68	CIRCULAR	0.083
L2020A-O1	L2020A-S	2020	86.17	CIRCULAR	0.108
L2020A-O2	L2020A-S	2020	86.17	CIRCULAR	0.108
L2020B-O1	L2020B-S	2020	85.61	CIRCULAR	0.127
L2021A-O1	L2021A-S	2021	86.45	CIRCULAR	0.108
L2021A-O2	L2021A-S	2021	86.45	CIRCULAR	0.108
L2021B-O1	L2021B-S	2021	85.88	CIRCULAR	0.127
L2022A-O1	L2022A-S	2022W	86.60	CIRCULAR	0.102
L2022A-O2	L2022A-S	2022W	86.60	CIRCULAR	0.102
L2022B-O1	L2022B-S	2022W	86.55	CIRCULAR	0.102
L2022B-O2	L2022B-S	2022W	86.55	CIRCULAR	0.102
L2022S-O1	L2022S-S	2022	86.42	CIRCULAR	0.083
L2022S-O2	L2022S-S	2022	86.42	CIRCULAR	0.083
L2023A-O1	L2023A-S	2023	86.31	CIRCULAR	0.127
L2023A-O2	L2023A-S	2023	86.31	CIRCULAR	0.127
L2023B-O1	L2023B-S	2023	86.39	CIRCULAR	0.095
L2023B-O2	L2023B-S	2023	86.39	CIRCULAR	0.095
L2024A-O1	L2024A-S	2024	86.55	CIRCULAR	0.102
L2024A-O2	L2024A-S	2024	86.55	CIRCULAR	0.102
L2025A-O1	L2025A-S	2025	86.74	CIRCULAR	0.102
L2025A-O2	L2025A-S	2025	86.74	CIRCULAR	0.102
L2025B-O1	L2025B-S	2025	86.12	CIRCULAR	0.102
L2027A-O1	L2027A-S	2027	86.96	CIRCULAR	0.095
L2027A-O2	L2027A-S	2027	87.04	CIRCULAR	0.152
L2031A-O1	L2031A-S	2031	86.18	CIRCULAR	0.127

L2031A-O2	L2031A-S	2031	86.18	CIRCULAR	0.127
L2031B-O1	L2031B-S	2031	85.60	CIRCULAR	0.152
L2032A-O1	L2032A-S	2032	86.43	CIRCULAR	0.127
L2032A-O2	L2032A-S	2032	86.43	CIRCULAR	0.127
L2034A-O1	L2034A-S	2034	86.43	CIRCULAR	0.127
L2034A-O2	L2034A-S	2034	86.43	CIRCULAR	0.127
L2034B-O1	L2034B-S	2034	86.31	CIRCULAR	0.152
L2035A-O1	L2035A-S	2035	86.38	CIRCULAR	0.127
L2035A-O2	L2035A-S	2035	86.38	CIRCULAR	0.127
L2036A-O1	L2036A-S	2036	86.25	CIRCULAR	0.095
L2036A-O2	L2036A-S	2036	86.25	CIRCULAR	0.095
L2036B-O1	L2036B-S	2036	85.72	CIRCULAR	0.200
L2037A-O1	L2037A-S	2037	86.51	CIRCULAR	0.152
L2037A-O2	L2037A-S	2037	86.51	CIRCULAR	0.152
L2039A-O1	L2039A-S	2039	86.57	CIRCULAR	0.152
L2039A-O2	L2039A-S	2039	86.57	CIRCULAR	0.152
S55C-O1	S55C-S	2000	86.07	CIRCULAR	0.152
L2014A-O1	L2014A-S	2014	86.18	CIRCULAR	0.102
L2014A-O2	L2014A-S	2014	86.18	CIRCULAR	0.102
L2007B-O1	L2007B-S	2007	86.03	CIRCULAR	0.152
L2040A-O1	L2040A-S	2040	86.12	CIRCULAR	0.095
L2030B-O1	L2030B-S	2030	86.27	CIRCULAR	0.095
L1002A-O1	L1002A-S	1002A	86.67	CIRCULAR	0.085
L1002A-O2	L1002A-S	1002A	86.67	CIRCULAR	0.085
O10A	CB10A-S	ST3	86.36	CIRCULAR	0.178
O12A	CB12A-S	ST4	86.47	CIRCULAR	0.152
O13A	CB13A-S	ST4	86.53	CIRCULAR	0.108
O14A	CB14A-S	ST4	86.62	CIRCULAR	0.083
O15A	CB15A-S	ST4	86.82	CIRCULAR	0.083
O1A	CB1A-S	N399	86.22	CIRCULAR	0.095
O2A	CB2A-S	N399	86.15	CIRCULAR	0.127
O3A	CB3A-S	N399	86.12	CIRCULAR	0.108
O4A	CB4A-S	ST1	86.37	CIRCULAR	0.083
O5A	CB5A-S	ST1	86.41	CIRCULAR	0.083
O6A	CB6A-S	ST1	86.35	CIRCULAR	0.083
O7A	CB7A-S	ST2	86.22	CIRCULAR	0.127
O8A	CB8A-S	ST2	86.25	CIRCULAR	0.095
O9A	CB9A-S	ST2	86.53	CIRCULAR	0.083

OF10	CB11A-S	ST3	86.40	CIRCULAR	0.108
C2069A-O1	C2069A-S	2069	86.74	CIRCULAR	0.102
C2069A-O2	C2069A-S	2069	86.74	CIRCULAR	0.083
C2070A-O1	C2070A-S	2070	86.91	CIRCULAR	0.152
C2070A-O2	C2070A-S	2070	86.99	CIRCULAR	0.102
C2071A-O1	C2071A-S	2071	87.01	CIRCULAR	0.127
C2071A-O2	C2071A-S	2071	87.08	CIRCULAR	0.127
C2071B-O1	C2071B-S	2071	87.00	CIRCULAR	0.083
C2071B-O2	C2071B-S	2071	87.07	CIRCULAR	0.083
C2072A-O1	C2072A-S	2072	87.16	CIRCULAR	0.127
C2072A-O2	C2072A-S	2072	87.24	CIRCULAR	0.127
C2073A-O1	C2073A-S	2073	87.14	CIRCULAR	0.152
C2073A-O2	C2073A-S	2073	87.21	CIRCULAR	0.152
C2074A-O1	C2074A-S	2074	85.96	CIRCULAR	0.102
C2074A-O2	C2074A-S	2074	86.03	CIRCULAR	0.102
L2007A-O1	L2007A-S	2007	86.43	CIRCULAR	0.102
L2007A-O2	L2007A-S	2007	86.43	CIRCULAR	0.102
L2030A-O1	L2030A-S	2030	86.65	CIRCULAR	0.095
L2030A-O2	L2030A-S	2030	86.65	CIRCULAR	0.095
L2040B-O1	L2040B-S	2040E	86.70	CIRCULAR	0.095
L2040B-O2	L2040B-S	2040E	86.70	CIRCULAR	0.095
L2042A-O1	L2042A-S	2042	86.72	CIRCULAR	0.095
L2042A-O2	L2042A-S	2042	86.72	CIRCULAR	0.095
L2042B-O1	L2042B-S	2042	86.75	CIRCULAR	0.095
L2042B-O2	L2042B-S	2042	86.75	CIRCULAR	0.095
L2042C-O1	L2042C-S	2042	86.14	CIRCULAR	0.178
L2043A-O1	L2043A-S	2043	86.77	CIRCULAR	0.095
L2043A-O2	L2043A-S	2043	86.77	CIRCULAR	0.095
L2043B-O1	L2043B-S	2043	86.22	CIRCULAR	0.102
L2044A-O1	L2044A-S	2044	86.98	CIRCULAR	0.095
L2044A-O2	L2044A-S	2044	86.98	CIRCULAR	0.095
L2044B-O1	L2044B-S	2044	86.44	CIRCULAR	0.152
L2045A-O1	L2045A-S	2045	87.23	CIRCULAR	0.127
L2045A-O2	L2045A-S	2045	87.23	CIRCULAR	0.127
L2045B-O1	L2045B-S	2045	86.74	CIRCULAR	0.152
L2049A-O1	L2049A-S	2049	86.64	CIRCULAR	0.127
L2049A-O2	L2049A-S	2049	86.64	CIRCULAR	0.127
L2050A-O1	L2050A-S	2050	86.12	CIRCULAR	0.152

L2051A-O1	L2051A-S	2051	86.29	CIRCULAR	0.127
L2051A-O2	L2051A-S	2051	86.29	CIRCULAR	0.127
L2052A-O1	L2052A-S	2052	86.83	CIRCULAR	0.127
L2052A-O2	L2052A-S	2052	86.83	CIRCULAR	0.127
L2053A-O1	L2053A-S	2053	86.77	CIRCULAR	0.108
L2053A-O2	L2053A-S	2053	86.77	CIRCULAR	0.108
L2055A-O1	L2055A-S	2055	86.74	CIRCULAR	0.095
L2055A-O2	L2055A-S	2055	86.74	CIRCULAR	0.095
L2055B-O1	L2055B-S	2055	86.16	CIRCULAR	0.127
L2056A-O1	L2056A-S	2056	86.67	CIRCULAR	0.083
L2056A-O2	L2056A-S	2056	86.67	CIRCULAR	0.083
L2056B-O1	L2056B-S	2056	86.12	CIRCULAR	0.250
L2056C-O1	L2056C-S	2056	86.12	CIRCULAR	0.200
L2058A-O1	L2058A-S	2058	86.47	CIRCULAR	0.127
L2058A-O2	L2058A-S	2058	86.47	CIRCULAR	0.127
L2059A-O1	L2059A-S	2059	86.84	CIRCULAR	0.102
L2059A-O2	L2059A-S	2059	86.84	CIRCULAR	0.102
L2060A-O1	L2060A-S	2060	86.93	CIRCULAR	0.095
L2060A-O2	L2060A-S	2060	86.93	CIRCULAR	0.095
L2060B-O1	L2060B-S	2060	86.45	CIRCULAR	0.178
L2061A-O1	L2061A-S	2061	86.93	CIRCULAR	0.083
L2061A-O2	L2061A-S	2061	86.93	CIRCULAR	0.083
L2061B-O1	L2061B-S	2061	86.52	CIRCULAR	0.127
L2062A-O1	L2062A-S	2062	87.07	CIRCULAR	0.152
L2062A-O2	L2062A-S	2062	87.07	CIRCULAR	0.127
L2062B-O1	L2062B-S	2062	87.28	CIRCULAR	0.102
L2062B-O2	L2062B-S	2062	87.28	CIRCULAR	0.102
L2063A-O1	L2063A-S	2063	87.39	CIRCULAR	0.127
L2063A-O2	L2063A-S	2063	87.39	CIRCULAR	0.127
L2067A-O1	L2067A-S	2067S	87.33	CIRCULAR	0.095
L2067A-O2	L2067A-S	2067S	87.33	CIRCULAR	0.095
L2067B-O1	L2067B-S	2067	87.39	CIRCULAR	0.102
L2067B-O2	L2067B-S	2067	87.39	CIRCULAR	0.102
L2068A-O1	L2068A-S	2068	86.81	CIRCULAR	0.127
L2068A-O2	L2068A-S	2068	86.81	CIRCULAR	0.127
L2070A-O1	L2070A-S	2070	86.34	CIRCULAR	0.127
L2071A-O1	L2071A-S	2071	86.54	CIRCULAR	0.127
L2072A-O1	L2072A-S	2072	86.61	CIRCULAR	0.127

L2073A-O1	L2073A-S	2073	86.57	CIRCULAR	0.127
L2077A-O1	L2077A-S	2077	87.22	CIRCULAR	0.127
L2077A-O2	L2077A-S	2077	87.22	CIRCULAR	0.127
L2077B-O1	L2077B-S	2077	86.60	CIRCULAR	0.108
L2078A-O1	L2078A-S	2078	87.41	CIRCULAR	0.083
L2078A-O2	L2078A-S	2078	87.41	CIRCULAR	0.083
L2078B-O1	L2078B-S	2078	87.53	CIRCULAR	0.083
L2078B-O2	L2078B-S	2078	87.53	CIRCULAR	0.083
L2080A-O1	L2080A-S	2080	87.05	CIRCULAR	0.127
L2080A-O2	L2080A-S	2080	87.05	CIRCULAR	0.127
L2081A-O1	L2081A-S	2081	87.21	CIRCULAR	0.127
L2081A-O2	L2081A-S	2081	87.21	CIRCULAR	0.127
L2082A-O1	L2082A-S	2082	86.85	CIRCULAR	0.127
L2082A-O2	L2082A-S	2082	86.85	CIRCULAR	0.127
L2083A-O1	L2083A-S	2083	87.01	CIRCULAR	0.127
L2083A-O2	L2083A-S	2083	87.01	CIRCULAR	0.152
L2084A-O1	L2084A-S	2084	86.86	CIRCULAR	0.102
L2084A-O2	L2084A-S	2084	86.86	CIRCULAR	0.102
L2085A-O1	L2085A-S	2085	86.98	CIRCULAR	0.127
L2085A-O2	L2085A-S	2085	86.98	CIRCULAR	0.127
L2086A-O1	L2086A-S	2086	87.01	CIRCULAR	0.095
L2086A-O2	L2086A-S	2086	87.01	CIRCULAR	0.095
L2086B-O1	L2086B-S	2086	86.75	CIRCULAR	0.102
L2086B-O2	L2086B-S	2086	86.75	CIRCULAR	0.102
L2087A-O1	L2087A-S	2087	87.05	CIRCULAR	0.152
L2087A-O2	L2087A-S	2087	87.05	CIRCULAR	0.095
L2088B-O1	L2091C-S	2091	86.63	CIRCULAR	0.095
L2089A-O1	L2089A-S	2089	87.06	CIRCULAR	0.152
L2089A-O2	L2089A-S	2089	87.06	CIRCULAR	0.152
L2091A-O1	L2091A-S	2091	87.13	CIRCULAR	0.083
L2091A-O2	L2091A-S	2091	87.13	CIRCULAR	0.083
L2091B-O1	L2091B-S	2091	86.63	CIRCULAR	0.102
L2092A-O1	L2092A-S	2092	87.17	CIRCULAR	0.102
L2092A-O2	L2092A-S	2092	87.17	CIRCULAR	0.102
L2092B-O1	L2092B-S	2092	87.27	CIRCULAR	0.108
L2092B-O2	L2092B-S	2092	87.27	CIRCULAR	0.108
L2093A-O1	L2093A-S	2093	87.35	CIRCULAR	0.108
L2093A-O2	L2093A-S	2093	87.35	CIRCULAR	0.108

L2093B-O1	L2093B-S	2093	87.68	CIRCULAR	0.083
L2095A-O1	L2095A-S	2095S	87.53	CIRCULAR	0.083
L2095A-O2	L2095A-S	2095S	87.53	CIRCULAR	0.083
L2095B-O1	L2095B-S	2095	87.43	CIRCULAR	0.083
L2095B-O2	L2095B-S	2095	87.43	CIRCULAR	0.083
C2072B-O1	C2072B-S	2072	87.07	CIRCULAR	0.083
L2077C-O1	L2077C-S	2077	86.93	CIRCULAR	0.083
L2049B-O1	L2049B-S	2049	86.07	CIRCULAR	0.127
R2-CB7-O	R2-CB7-S	3006	86.26	CIRCULAR	0.083
R2-CB2-O	R2-CB2-S	3005	86.51	CIRCULAR	0.152
R2-CB1-O	R2-CB1-S	3005	86.57	CIRCULAR	0.083
R2-CB5-O	R2-CB5-S	3005	86.20	CIRCULAR	0.152
R2-CB6-O	R2-CB6-S	3005	86.25	CIRCULAR	0.095
R2-CB8-O	R2-CB8-S	3006	86.31	CIRCULAR	0.083
R2-CB9-O	R2-CB9-S	3006	86.13	CIRCULAR	0.152
R2-CB10-O	R2-CB10-S	3006	86.15	CIRCULAR	0.095
R2-CB11-O	R2-CB11-S	3007	86.03	CIRCULAR	0.127
R2-CB12-O	R2-CB12-S	3007	86.09	CIRCULAR	0.083
R2-DCB2-O	R2-DCB2-S	3007	85.94	CIRCULAR	0.250
R2-DCB1-O	R2-DCB1-S	3007	85.97	CIRCULAR	0.095
R2-CB3-O	R2-CB3-S	3005	86.40	CIRCULAR	0.083
OR2	R2-CB4-S	3005	86.40	CIRCULAR	0.083
OL1	R2-DI7B-S	2047	86.16	CIRCULAR	0.095

5.3.4 Model Results

The following section summarizes the key hydrologic and hydraulic model results. For detailed model results or inputs please refer to the example input file in **Appendix C.2,** model output data in **Appendix C.3**, and the electronic model files on the enclosed disc.

5.3.4.1 Hydrologic Results

The following tables demonstrate the peak outflow from each modeled connection point to downstream infrastructure during the design storm (3hr Chicago 2-100yr, historical storm) events. Drainage areas for Renaud Road east of Ascender Avenue are included in the PCSWMM model based on preliminary Renaud Road design. It is of note that the preliminary design for Renaud Road as prepared by JFSA included minor system drainage from Mer Bleue Road that has since been diverted through Avalon West to the Neighbourhood 5 SWM Facility.

Table 12: Storm Event Peak Discharge Rates (Minor System)

Outlet Node	2yr Peak Flow Rate (m^3/s)	5yr Peak Flow Rate (m^3/s)	100yr Peak Flow Rate (m^3/s)	100yr + 20% Peak Flow Rate (m^3/s)
2025	1.333	1.560	1.933	1.946
2022	0.458	0.527	0.577	0.564
2006	1.260	1.459	1.665	1.625
2037	0.014	0.022	0.030	0.029
Total (On-Site)	**3.065**	**3.568**	**4.205**	**4.190**
ST4 (Renaud)	0.311	0.441	0.728	0.768

Table 13: Storm Event Peak Discharge Rates (Major System)

Outlet Node	100yr Peak Flow Rate (m^3/s)	100yr + 20% Peak Flow Rate (m^3/s)
L2025A-S1	0.074	0.245
L2022A-S1	0.091	0.218
L2006A-S1	0.217	0.398
MERBLEUE-S, -N	0.000	0.000

5.3.4.2 Hydraulic Results

Table 14 summarizes the HGL results within the development and downstream storm sewer system for the 100 year, 3 hour Chicago storm event, the 100-year 24 hour SCS storm event and the ‘climate change’ scenario storm required by the City of Ottawa Sewer Design Guidelines (2012), where intensities are increased by 20%.

The City of Ottawa requires that during major storm events, the maximum hydraulic grade line be kept at least 0.30 m below the underside-of-footing (USF) of any adjacent units connected to the storm sewer during design storm events. HGLs during the climate change event are not to exceed adjacent USF elevations (Freeboard of 0.00m). Downstream nodes have been assessed within Trailsedge East Phase 1 to ensure shifts in peak runoff rates and times to peak will not produce deleterious impact on downstream infrastructure.

Table 14: Modeled Hydraulic Grade Line (HGL) Results

100yr 3hr Chicago					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
1	86.90	86.61	Copperhead	56.5	2029	30.8	86.28	2069	62.4	86.32	86.31	0.59
2	86.90	86.62	Copperhead	70.0	2069	62.4	86.32	2070	142.0	86.36	86.32	0.58
3	86.84	86.63	Copperhead	76.2	2069	62.4	86.32	2070	142.0	86.36	86.33	0.51
4	86.79	86.63	Copperhead	88.9	2069	62.4	86.32	2070	142.0	86.36	86.33	0.46
5	86.79	86.64	Copperhead	95.6	2069	62.4	86.32	2070	142.0	86.36	86.34	0.45
6	86.87	86.64	Copperhead	109.8	2069	62.4	86.32	2070	142.0	86.36	86.34	0.53
7	86.87	86.65	Copperhead	116.4	2069	62.4	86.32	2070	142.0	86.36	86.35	0.52
8	86.79	86.65	Copperhead	129.2	2069	62.4	86.32	2070	142.0	86.36	86.35	0.44
9	86.75	86.66	Copperhead	135.3	2069	62.4	86.32	2070	142.0	86.36	86.36	0.39
10	86.75	86.67	Copperhead	148.1	2070	142.0	86.36	2071	221.0	86.45	86.37	0.38
11	86.76	86.67	Copperhead	154.7	2070	142.0	86.36	2071	221.0	86.45	86.37	0.39
12	86.83	86.69	Copperhead	168.9	2070	142.0	86.36	2071	221.0	86.45	86.39	0.44
13	86.83	86.70	Copperhead	176.6	2070	142.0	86.36	2071	221.0	86.45	86.40	0.43
14	86.72	86.70	Alpenstock	238.4	2060	301.2	86.33	2068	236.3	86.40	86.40	0.32
15	86.69	86.68	Alpenstock	251.2	2060	301.2	86.33	2068	236.3	86.40	86.38	0.31
16	86.68	86.68	Alpenstock	257.3	2060	301.2	86.33	2068	236.3	86.40	86.38	0.30
17	86.68	86.66	Alpenstock	270.1	2060	301.2	86.33	2068	236.3	86.40	86.36	0.32
18	86.68	86.66	Alpenstock	276.2	2060	301.2	86.33	2068	236.3	86.40	86.36	0.32
19	86.68	86.64	Alpenstock	289.0	2060	301.2	86.33	2068	236.3	86.40	86.34	0.34
20	86.73	86.57	Cornice	179.0	2059	124.1	86.19	2060	220.3	86.33	86.27	0.46
21	86.73	86.55	Cornice	165.5	2059	124.1	86.19	2060	220.3	86.33	86.25	0.48
22	86.73	86.54	Cornice	159.2	2059	124.1	86.19	2060	220.3	86.33	86.24	0.49
23	86.73	86.52	Cornice	146.6	2059	124.1	86.19	2060	220.3	86.33	86.22	0.51
24	86.73	86.51	Cornice	140.5	2059	124.1	86.19	2060	220.3	86.33	86.21	0.52
25	86.73	86.49	Cornice	127.0	2059	124.1	86.19	2060	220.3	86.33	86.19	0.54
26	86.73	86.49	Cornice	119.8	2030	54.4	86.11	2059	124.1	86.19	86.19	0.54
27	86.79	86.47	Cornice	106.3	2030	54.4	86.11	2059	124.1	86.19	86.17	0.62
28	86.79	86.46	Cornice	96.8	2030	54.4	86.11	2059	124.1	86.19	86.16	0.63
29	86.79	86.46	Cornice	90.8	2030	54.4	86.11	2059	124.1	86.19	86.15	0.64
30	86.79	86.44	Cornice	77.3	2030	54.4	86.11	2059	124.1	86.19	86.14	0.65
31	86.79	86.44	Cornice	70.1	2030	54.4	86.11	2059	124.1	86.19	86.13	0.66
32	86.79	86.42	Cornice	55.9	2030	54.4	86.11	2059	124.1	86.19	86.11	0.68
33	86.52	86.37	Cornice	27.1	2022	9.0	86.03	2030	54.4	86.11	86.06	0.46
34	86.63	86.39	Cornice	39.6	2022	9.0	86.03	2030	54.4	86.11	86.08	0.55
35	86.63	86.41	Cornice	47.1	2022	9.0	86.03	2030	54.4	86.11	86.10	0.53
36	86.63	86.43	Cornice	61.1	2030	54.4	86.11	2059	124.1	86.19	86.12	0.51
37	86.55	86.43	Cornice	67.6	2030	54.4	86.11	2059	124.1	86.19	86.13	0.42
38	86.55	86.45	Cornice	80.5	2030	54.4	86.11	2059	124.1	86.19	86.14	0.41
39	86.52	86.45	Cornice	87.2	2030	54.4	86.11	2059	124.1	86.19	86.15	0.37
40	86.55	86.47	Cornice	101.4	2030	54.4	86.11	2059	124.1	86.19	86.16	0.39
41	86.58	86.47	Cornice	108.0	2030	54.4	86.11	2059	124.1	86.19	86.17	0.41
42	86.58	86.49	Cornice	120.8	2030	54.4	86.11	2059	124.1	86.19	86.19	0.39
43	86.54	86.49	Cornice	126.9	2059	124.1	86.19	2060	220.3	86.33	86.19	0.35
44	86.57	86.51	Cornice	140.4	2059	124.1	86.19	2060	220.3	86.33	86.21	0.36
45	86.57	86.52	Cornice	147.5	2059	124.1	86.19	2060	220.3	86.33	86.22	0.35
46	86.56	86.54	Cornice	161.0	2059	124.1	86.19	2060	220.3	86.33	86.24	0.32
47	86.57	86.55	Cornice	167.1	2059	124.1	86.19	2060	220.3	86.33	86.25	0.32
48	86.57	86.57	Cornice	179.9	2059	124.1	86.19	2060	220.3	86.33	86.27	0.30
49	86.61	86.58	Cornice	186.0	2059	124.1	86.19	2060	220.3	86.33	86.28	0.33
50	86.63	86.60	Cornice	198.8	2059	124.1	86.19	2060	220.3	86.33	86.30	0.33
51	86.63	86.61	Cornice	209.0	2059	124.1	86.19	2060	220.3	86.33	86.31	0.32
52	86.50	86.43	Crevasse	207.6	2041	94.0	85.99	2042	220.4	86.14	86.12	0.38
53	86.48	86.42	Crevasse	193.4	2041	94.0	85.99	2042	220.4	86.14	86.11	0.37
54	86.47	86.41	Crevasse	186.2	2041	94.0	85.99	2042	220.4	86.14	86.10	0.37
55	86.45	86.39	Crevasse	172.0	2041	94.0	85.99	2042	220.4	86.14	86.08	0.37
56	86.45	86.38	Crevasse	162.1	2041	94.0	85.99	2042	220.4	86.14	86.07	0.38
57	86.45	86.36	Crevasse	147.9	2041	94.0	85.99	2042	220.4	86.14	86.05	0.40
58	86.45	86.35	Crevasse	138.1	2041	94.0	85.99	2042	220.4	86.14	86.04	0.41
59	86.45	86.33	Crevasse	123.9	2041	94.0	85.99	2042	220.4	86.14	86.03	0.42
60	86.45	86.32	Crevasse	116.7	2041	94.0	85.99	2042	220.4	86.14	86.02	0.43
61	86.52	86.30	Crevasse	102.5	2041	94.0	85.99	2042	220.4	86.14	86.00	0.52
62	86.52	86.28	Crevasse	89.9	2007	54.6	85.93	2041	94.0	85.99	85.98	0.54
63	86.52	86.26	Crevasse	75.7	2007	54.6	85.93	2041	94.0	85.99	85.96	0.56

100yr 3hr Chicago					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
64	86.47	86.24	Crevasse	63.1	2007	54.6	85.93	2041	94.0	85.99	85.94	0.53
65	86.43	86.22	Crevasse	48.5	2006	9.1	85.85	2007	54.6	85.93	85.92	0.51
66	86.38	86.21	Crevasse	42.2	2006	9.1	85.85	2007	54.6	85.93	85.91	0.47
67	86.25	86.18	Crevasse	26.9	2006	9.1	85.85	2007	54.6	85.93	85.88	0.37
68	86.45	86.30	Piton	184.0	2041	197.0	85.99	2058	94.1	86.10	86.00	0.45
69	86.44	86.32	Piton	169.8	2041	197.0	85.99	2058	94.1	86.10	86.02	0.42
70	86.43	86.33	Piton	159.9	2041	197.0	85.99	2058	94.1	86.10	86.03	0.40
71	86.41	86.34	Piton	145.7	2041	197.0	85.99	2058	94.1	86.10	86.04	0.37
72	86.40	86.36	Piton	135.8	2041	197.0	85.99	2058	94.1	86.10	86.06	0.34
73	86.52	86.37	Piton	121.6	2041	197.0	85.99	2058	94.1	86.10	86.07	0.45
74	86.52	86.38	Piton	108.2	2041	197.0	85.99	2058	94.1	86.10	86.08	0.44
75	86.65	86.40	Piton	57.7	2057	90.0	86.12	2040	53.7	85.91	86.10	0.55
76	86.65	86.32	Piton	71.1	2057	90.0	86.12	2040	53.7	85.91	86.02	0.63
77	86.64	86.24	Piton	85.3	2057	90.0	86.12	2040	53.7	85.91	85.94	0.70
78	86.64	86.42	Piton	91.0	2058	94.1	86.10	2057	90.0	86.12	86.12	0.52
79	86.56	86.39	Piton	99.7	2041	197.0	85.99	2058	94.1	86.10	86.09	0.47
80	86.56	86.38	Piton	109.1	2041	197.0	85.99	2058	94.1	86.10	86.08	0.48
81	86.56	86.37	Piton	123.3	2041	197.0	85.99	2058	94.1	86.10	86.07	0.49
82	86.56	86.35	Piton	137.8	2041	197.0	85.99	2058	94.1	86.10	86.05	0.51
83	86.42	86.34	Piton	152.0	2041	197.0	85.99	2058	94.1	86.10	86.04	0.38
84	86.43	86.32	Piton	166.4	2041	197.0	85.99	2058	94.1	86.10	86.02	0.41
85	86.45	86.31	Piton	180.6	2041	197.0	85.99	2058	94.1	86.10	86.01	0.44
86	86.49	86.35	Crevasse	138.7	2041	94.0	85.99	2042	220.4	86.14	86.04	0.45
87	86.49	86.36	Crevasse	151.6	2041	94.0	85.99	2042	220.4	86.14	86.06	0.43
88	86.45	86.38	Crevasse	165.8	2041	94.0	85.99	2042	220.4	86.14	86.08	0.37
89	86.46	86.39	Crevasse	175.2	2041	94.0	85.99	2042	220.4	86.14	86.09	0.37
90	86.48	86.41	Crevasse	188.0	2041	94.0	85.99	2042	220.4	86.14	86.10	0.38
91	86.48	86.42	Crevasse	194.1	2041	94.0	85.99	2042	220.4	86.14	86.11	0.37
92	86.50	86.43	Crevasse	206.9	2041	94.0	85.99	2042	220.4	86.14	86.12	0.38
93	86.59	86.56	Wolf_Moon	41.2	2049	58.7	86.24	2052	10.3	86.29	86.26	0.33
94	86.59	86.58	Wolf_Moon	27.0	2049	58.7	86.24	2052	10.3	86.29	86.27	0.32
95	86.76	86.60	Wolf_Moon	12.7	2049	58.7	86.24	2052	10.3	86.29	86.29	0.47
96	86.76	86.60	Wolf_Moon	10.3	2049	58.7	86.24	2052	10.3	86.29	86.29	0.47
97	86.77	86.60	Wolf_Moon	10.3	2049	58.7	86.24	2052	10.3	86.29	86.29	0.48
98	86.77	86.60	Wolf_Moon	10.3	2049	58.7	86.24	2052	10.3	86.29	86.29	0.48
99	86.59	86.59	Wolf_Moon	21.8	2049	58.7	86.24	2052	10.3	86.29	86.28	0.31
100	86.59	86.57	Wolf_Moon	35.6	2049	58.7	86.24	2052	10.3	86.29	86.26	0.33
101	86.66	85.46	Renaud	1553.6	3004	1550.0	85.07	3005	1696.2	85.16	85.07	1.59
102	86.66	85.46	Renaud	1566.4	3004	1550.0	85.07	3005	1696.2	85.16	85.08	1.58
103	86.64	85.47	Renaud	1572.5	3004	1550.0	85.07	3005	1696.2	85.16	85.08	1.56
104	86.64	85.47	Renaud	1585.3	3004	1550.0	85.07	3005	1696.2	85.16	85.09	1.55
105	86.64	85.47	Renaud	1591.9	3004	1550.0	85.07	3005	1696.2	85.16	85.10	1.54
106	86.64	85.48	Renaud	1606.1	3004	1550.0	85.07	3005	1696.2	85.16	85.10	1.54
107	86.64	85.48	Renaud	1613.3	3004	1550.0	85.07	3005	1696.2	85.16	85.11	1.53
108	86.73	85.48	Renaud	1626.8	3004	1550.0	85.07	3005	1696.2	85.16	85.12	1.61
109	86.69	85.48	Renaud	1632.8	3004	1550.0	85.07	3005	1696.2	85.16	85.12	1.57
110	86.62	85.49	Renaud	1645.7	3004	1550.0	85.07	3005	1696.2	85.16	85.13	1.49
111	86.52	85.49	Renaud	1652.3	3004	1550.0	85.07	3005	1696.2	85.16	85.13	1.39
112	86.40	85.49	Renaud	1666.5	3004	1550.0	85.07	3005	1696.2	85.16	85.14	1.26
113	86.32	85.49	Renaud	1673.6	3004	1550.0	85.07	3005	1696.2	85.16	85.15	1.17
114	86.37	85.50	Renaud	1687.1	3004	1550.0	85.07	3005	1696.2	85.16	85.15	1.22
115	86.37	85.50	Renaud	1693.2	3004	1550.0	85.07	3005	1696.2	85.16	85.16	1.21
116	86.34	85.50	Renaud	1706.0	3005	1696.2	85.16	3006	1816.1	85.20	85.16	1.18
117	86.62	86.62	Alpenstock	535.6	2050	514.4	86.31	2051	545.1	86.33	86.32	0.30
118	86.62	86.61	Alpenstock	525.1	2050	514.4	86.31	2051	545.1	86.33	86.32	0.30
119	86.60	86.60	Alpenstock	509.7	2049	468.7	86.24	2050	514.4	86.31	86.30	0.30
120	86.60	86.59	Alpenstock	499.2	2049	468.7	86.24	2050	514.4	86.31	86.29	0.31
121	86.59	86.56	Alpenstock	485.0	2049	468.7	86.24	2050	514.4	86.31	86.26	0.33
122	86.57	86.52	Alpenstock	451.3	2042	384.7	86.14	2049	468.7	86.24	86.22	0.35
123	86.56	86.51	Alpenstock	437.9	2042	384.7	86.14	2049	468.7	86.24	86.20	0.36
124	86.55	86.49	Alpenstock	423.7	2042	384.7	86.14	2049	468.7	86.24	86.19	0.36
125	86.52	86.48	Alpenstock	410.9	2042	384.7	86.14	2049	468.7	86.24	86.17	0.35
126	86.53	86.46	Alpenstock	396.8	2042	384.7	86.14	2049	468.7	86.24	86.15	0.38

100yr 3hr Chicago					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
127	86.63	86.57	Tarn_Walk	150.7	2043	162.4	86.24	2053	95.1	86.35	86.26	0.37
128	86.61	86.59	Tarn_Walk	136.5	2043	162.4	86.24	2053	95.1	86.35	86.28	0.33
129	86.66	86.61	Tarn_Walk	123.9	2043	162.4	86.24	2053	95.1	86.35	86.30	0.36
130	86.76	86.64	Tarn_Walk	109.7	2043	162.4	86.24	2053	95.1	86.35	86.33	0.43
131	86.76	86.65	Tarn_Walk	99.1	2043	162.4	86.24	2053	95.1	86.35	86.34	0.42
132	86.71	86.71	Tarn_Walk	51.2	2054	80.9	86.37	2055	41.8	86.42	86.41	0.30
133	86.69	86.69	Tarn_Walk	61.7	2054	80.9	86.37	2055	41.8	86.42	86.39	0.30
134	86.71	86.68	Tarn_Walk	75.2	2054	80.9	86.37	2055	41.8	86.42	86.38	0.33
135	86.72	86.67	Tarn_Walk	80.7	2054	80.9	86.37	2055	41.8	86.42	86.37	0.35
136	86.73	86.66	Tarn_Walk	88.5	2053	95.1	86.35	2054	80.9	86.37	86.36	0.37
137	86.73	86.66	Tarn_Walk	89.7	2053	95.1	86.35	2054	80.9	86.37	86.36	0.37
138	86.72	86.65	Tarn_Walk	100.8	2043	162.4	86.24	2053	95.1	86.35	86.34	0.38
139	86.72	86.64	Tarn_Walk	107.8	2043	162.4	86.24	2053	95.1	86.35	86.33	0.39
140	86.72	86.62	Tarn_Walk	122.0	2043	162.4	86.24	2053	95.1	86.35	86.31	0.41
141	86.69	86.59	Tarn_Walk	135.3	2043	162.4	86.24	2053	95.1	86.35	86.28	0.41
142	86.69	86.57	Tarn_Walk	149.5	2043	162.4	86.24	2053	95.1	86.35	86.26	0.43
143	86.85	86.68	Rappel	92.0	2044	81.5	86.36	2045	141.0	86.45	86.38	0.47
144	86.85	86.70	Rappel	106.2	2044	81.5	86.36	2045	141.0	86.45	86.40	0.45
145	86.82	86.71	Rappel	112.1	2044	81.5	86.36	2045	141.0	86.45	86.41	0.41
146	86.82	86.74	Rappel	126.3	2044	81.5	86.36	2045	141.0	86.45	86.43	0.39
147	86.74	86.74	Rappel	131.5	2044	81.5	86.36	2045	141.0	86.45	86.44	0.30
148	86.99	86.76	Rappel	142.0	2045	141.0	86.45	2046	146.5	86.46	86.45	0.54
149	86.99	86.76	Rappel	143.6	2045	141.0	86.45	2046	146.5	86.46	86.45	0.54
150	86.83	86.78	Rappel	151.5	2046	146.5	86.46	2047	218.4	86.55	86.47	0.36
151	86.90	86.85	Rappel	217.7	2046	146.5	86.46	2047	218.4	86.55	86.55	0.35
152	85.97	85.64	Renaud	1955.1	3006	1816.1	85.20	3007	1957.7	85.23	85.23	0.74
153	86.61	85.58	Renaud	1883.8	3006	1816.1	85.20	3007	1957.7	85.23	85.21	1.40
154	86.56	85.57	Renaud	1870.4	3006	1816.1	85.20	3007	1957.7	85.23	85.21	1.35
155	86.56	85.57	Renaud	1863.2	3006	1816.1	85.20	3007	1957.7	85.23	85.21	1.35
156	86.56	85.56	Renaud	1849.7	3006	1816.1	85.20	3007	1957.7	85.23	85.21	1.35
157	86.56	85.55	Renaud	1841.5	3006	1816.1	85.20	3007	1957.7	85.23	85.21	1.35
158	86.55	85.54	Renaud	1827.3	3006	1816.1	85.20	3007	1957.7	85.23	85.20	1.35
159	86.48	85.53	Renaud	1819.6	3006	1816.1	85.20	3007	1957.7	85.23	85.20	1.28
160	86.48	85.53	Renaud	1806.8	3005	1696.2	85.16	3006	1816.1	85.20	85.20	1.28
161	86.54	85.53	Renaud	1799.7	3005	1696.2	85.16	3006	1816.1	85.20	85.19	1.35
162	86.54	85.52	Renaud	1786.2	3005	1696.2	85.16	3006	1816.1	85.20	85.19	1.35
163	86.46	85.52	Renaud	1778.0	3005	1696.2	85.16	3006	1816.1	85.20	85.19	1.27
164	86.41	85.52	Renaud	1763.8	3005	1696.2	85.16	3006	1816.1	85.20	85.18	1.23
165	86.55	86.51	Crevasse	270.4	2042	220.4	86.14	2043	299.5	86.24	86.20	0.35
166	86.57	86.55	Crevasse	297.9	2042	220.4	86.14	2043	299.5	86.24	86.24	0.33
167	86.61	86.59	Crevasse	325.4	2043	299.5	86.24	2044	378.4	86.36	86.28	0.33
168	86.72	86.64	Crevasse	366.6	2043	299.5	86.24	2044	378.4	86.36	86.34	0.38
169	86.99	86.82	Cornice	366.4	2061	298.7	86.43	2062	379.0	86.53	86.51	0.48
170	86.84	86.77	Cornice	325.1	2061	298.7	86.43	2062	379.0	86.53	86.46	0.38
171	86.74	86.74	Cornice	297.5	2060	220.3	86.33	2061	298.7	86.43	86.43	0.31
172	86.74	86.70	Cornice	270.1	2060	220.3	86.33	2061	298.7	86.43	86.39	0.35
173	86.73	86.66	Alpenstock	268.7	2068	236.3	86.40	2060	301.2	86.33	86.36	0.37
174	86.83	86.72	Cornice	285.5	2060	220.3	86.33	2061	298.7	86.43	86.41	0.42
175	86.83	86.76	Cornice	313.9	2061	298.7	86.43	2062	379.0	86.53	86.45	0.38
176	86.96	86.78	Cornice	336.1	2061	298.7	86.43	2062	379.0	86.53	86.48	0.48
177	87.08	86.92	Rappel	522.0	2062	555.6	86.53	2063	496.9	86.68	86.62	0.46
178	87.03	86.98	Rappel	496.0	2063	496.9	86.68	2064	492.0	86.69	86.68	0.35
179	86.95	86.91	Copperhead	337.2	2072	300.3	86.55	2073	384.4	86.67	86.60	0.35
180	86.96	86.87	Copperhead	314.9	2072	300.3	86.55	2073	384.4	86.67	86.57	0.39
181	86.96	86.83	Copperhead	286.5	2071	221.0	86.45	2072	300.3	86.55	86.53	0.43
182	86.96	86.63	Alpenstock	238.4	2068	236.3	86.40	2060	301.2	86.33	86.33	0.63
183	87.01	86.81	Rappel	181.8	2046	146.5	86.46	2047	218.4	86.55	86.50	0.51
184	86.94	86.70	Rappel	64.2	2044	81.5	86.36	2062	-1.5	86.53	86.40	0.54
185	86.94	86.78	Rappel	22.2	2044	81.5	86.36	2062	-1.5	86.53	86.48	0.46
186	87.11	86.93	Rappel	537.7	2063	496.9	86.68	2062	555.6	86.53	86.63	0.48
187	87.08	87.02	Rappel	460.4	2065	418.5	86.75	2064	492.0	86.69	86.72	0.36
188	87.04	86.84	Rappel	211.0	2046	146.5	86.46	2047	218.4	86.55	86.54	0.50
189	87.22	87.07	Rappel	293.7	2048	222.4	86.55	2067	319.5	86.85	86.77	0.45

100yr 3hr Chicago					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
190	87.35	87.15	Rappel	321.6	2066	413.7	86.76	2067	319.5	86.85	86.85	0.50
191	87.30	87.13	Rappel	342.6	2066	413.7	86.76	2067	319.5	86.85	86.83	0.47
192	87.23	87.04	Rappel	428.2	2064	492.0	86.69	2065	418.5	86.75	86.74	0.49
193	87.29	87.10	Switchback	559.5	2075	623.0	86.70	2078	549.9	86.81	86.80	0.49
194	87.36	87.13	Switchback	485.1	2079	544.0	86.82	2095	446.5	86.82	86.82	0.54
195	87.29	87.13	Switchback	450.0	2079	544.0	86.82	2095	446.5	86.82	86.82	0.47
196	87.15	87.10	Switchback	393.4	2092	281.8	86.73	2093	403.8	86.80	86.79	0.36
197	87.18	87.09	Switchback	361.3	2092	281.8	86.73	2093	403.8	86.80	86.78	0.40
198	87.12	87.12	Switchback	722.7	2076	628.8	86.71	2077	734.8	86.82	86.81	0.31
199	87.31	87.08	Switchback	687.5	2076	628.8	86.71	2077	734.8	86.82	86.77	0.54
200	87.19	87.05	Switchback	591.7	2075	623.0	86.70	2078	549.9	86.81	86.75	0.44
201	87.07	87.04	Switchback	644.8	2076	628.8	86.71	2077	734.8	86.82	86.73	0.34
202	87.14	87.06	Switchback	667.0	2076	628.8	86.71	2077	734.8	86.82	86.75	0.39
203	87.09	87.09	Switchback	695.2	2076	628.8	86.71	2077	734.8	86.82	86.78	0.31
204	87.12	87.12	Switchback	723.6	2076	628.8	86.71	2077	734.8	86.82	86.81	0.31
205	87.06	87.06	Switchback	312.4	2092	281.8	86.73	2093	403.8	86.80	86.75	0.31
206	87.05	87.04	Switchback	282.1	2092	281.8	86.73	2093	403.8	86.80	86.73	0.32
207	86.99	86.96	Tricam	53.3	2080	106.7	86.62	2081	28.0	86.68	86.66	0.33
208	87.05	86.94	Tricam	81.8	2080	106.7	86.62	2081	28.0	86.68	86.64	0.41
209	86.92	86.92	Tricam	110.2	2072	170.0	86.55	2080	106.7	86.62	86.62	0.30
210	86.89	86.89	Tricam	132.6	2072	170.0	86.55	2080	106.7	86.62	86.59	0.30
211	86.92	86.89	Tricam	132.0	2072	170.0	86.55	2080	106.7	86.62	86.59	0.33
212	87.00	86.92	Tricam	109.7	2072	170.0	86.55	2080	106.7	86.62	86.62	0.38
213	87.02	86.94	Tricam	81.3	2080	106.7	86.62	2081	28.0	86.68	86.64	0.38
214	86.98	86.96	Tricam	52.9	2080	106.7	86.62	2081	28.0	86.68	86.66	0.32
215	87.02	86.98	Switchback	233.4	2090	162.8	86.59	2092	281.8	86.73	86.67	0.35
216	86.95	86.95	Switchback	203.1	2090	162.8	86.59	2092	281.8	86.73	86.64	0.31
217	86.98	86.89	Alpenstock	104.3	2082	158.7	86.53	2083	95.7	86.60	86.59	0.39
218	86.98	86.86	Alpenstock	132.7	2082	158.7	86.53	2083	95.7	86.60	86.56	0.42
219	86.92	86.83	Alpenstock	161.2	2071	220.9	86.45	2082	158.7	86.53	86.53	0.39
220	86.87	86.80	Alpenstock	183.5	2071	220.9	86.45	2082	158.7	86.53	86.50	0.37
221	86.86	86.82	Alpenstock	170.3	2071	220.9	86.45	2082	158.7	86.53	86.52	0.34
222	86.89	86.85	Alpenstock	136.6	2082	158.7	86.53	2083	95.7	86.60	86.55	0.34
223	86.89	86.89	Alpenstock	102.9	2082	158.7	86.53	2083	95.7	86.60	86.59	0.30
224	87.04	86.89	Switchback	154.6	2089	86.4	86.54	2090	162.8	86.59	86.58	0.46
225	87.03	86.87	Switchback	124.1	2089	86.4	86.54	2090	162.8	86.59	86.56	0.47
226	86.96	86.96	Bivouac	53.3	2084	113.4	86.53	2085	42.0	86.68	86.66	0.30
227	86.93	86.89	Bivouac	87.0	2084	113.4	86.53	2085	42.0	86.68	86.59	0.34
228	86.86	86.81	Bivouac	120.6	2070	170.8	86.36	2084	113.4	86.53	86.51	0.35
229	86.81	86.81	Bivouac	120.3	2070	170.8	86.36	2084	113.4	86.53	86.51	0.30
230	86.92	86.89	Bivouac	86.6	2084	113.4	86.53	2085	42.0	86.68	86.59	0.33
231	86.96	86.96	Bivouac	52.9	2084	113.4	86.53	2085	42.0	86.68	86.66	0.30
232	86.93	86.83	Switchback	75.4	2087	6.5	86.44	2089	86.4	86.54	86.53	0.40
233	86.93	86.79	Switchback	45.0	2087	6.5	86.44	2089	86.4	86.54	86.49	0.44
234	86.89	86.71	Crux	134.7	2086	168.5	86.38	2087	88.5	86.44	86.41	0.48
235	86.82	86.69	Crux	168.4	2086	168.5	86.38	2087	88.5	86.44	86.38	0.44
236	86.73	86.66	Crux	202.0	2069	252.3	86.32	2086	168.5	86.38	86.36	0.37
237	86.74	86.66	Crux	206.3	2069	252.3	86.32	2086	168.5	86.38	86.35	0.39
238	86.71	86.68	Crux	178.6	2069	252.3	86.32	2086	168.5	86.38	86.37	0.34
239	86.81	86.70	Crux	150.9	2086	168.5	86.38	2087	88.5	86.44	86.39	0.42
240	86.79	86.72	Crux	117.3	2086	168.5	86.38	2087	88.5	86.44	86.42	0.37
241	86.86	86.74	Crux	89.6	2086	168.5	86.38	2087	88.5	86.44	86.44	0.42
242	87.14	86.74	Crux	61.9	2087	88.5	86.44	2088	26.5	86.44	86.44	0.70
243	87.27	86.74	Crux	28.0	2087	88.5	86.44	2088	26.5	86.44	86.44	0.83
244	86.95	86.79	Switchback	44.6	2087	6.5	86.44	2089	86.4	86.54	86.49	0.46
245	86.95	86.82	Switchback	72.7	2087	6.5	86.44	2089	86.4	86.54	86.52	0.43
246	86.95	86.85	Switchback	94.4	2089	86.4	86.54	2090	162.8	86.59	86.55	0.40
247	87.05	86.87	Switchback	122.5	2089	86.4	86.54	2090	162.8	86.59	86.56	0.49
248	87.08	86.89	Switchback	153.0	2089	86.4	86.54	2090	162.8	86.59	86.58	0.50
249	86.96	86.96	Switchback	213.3	2090	162.8	86.59	2092	281.8	86.73	86.65	0.31
250	86.99	86.99	Switchback	241.5	2090	162.8	86.59	2092	281.8	86.73	86.68	0.31
251	87.03	87.03	Switchback	269.5	2090	162.8	86.59	2092	281.8	86.73	86.72	0.31
252	87.12	87.05	Switchback	297.5	2092	281.8	86.73	2093	403.8	86.80	86.74	0.38

100yr 3hr Chicago					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
253	87.10	87.07	Switchback	325.6	2092	281.8	86.73	2093	403.8	86.80	86.76	0.34
254	87.15	87.08	Switchback	359.6	2092	281.8	86.73	2093	403.8	86.80	86.77	0.38
255	87.19	87.10	Switchback	381.5	2092	281.8	86.73	2093	403.8	86.80	86.79	0.40
256	87.22	87.11	Switchback	405.1	2093	403.8	86.80	2094	409.7	86.80	86.80	0.42

100yr 3hr Chicago +20%					DSMH			USMH			Interpolated	
Unit #	**USF**	**MUSF**	**Street**	**Station**	**MH ID**	**Station**	**HGL**	**MH ID**	**Station**	**HGL**	**HGL**	**Freeboard**
1	86.90	86.61	Copperhead	56.5	2029	30.8	86.54	2069	62.4	86.58	86.57	0.33
2	86.90	86.62	Copperhead	70.0	2069	62.4	86.58	2070	142.0	86.63	86.58	0.32
3	86.84	86.63	Copperhead	76.2	2069	62.4	86.58	2070	142.0	86.63	86.59	0.25
4	86.79	86.63	Copperhead	88.9	2069	62.4	86.58	2070	142.0	86.63	86.60	0.19
5	86.79	86.64	Copperhead	95.6	2069	62.4	86.58	2070	142.0	86.63	86.60	0.19
6	86.87	86.64	Copperhead	109.8	2069	62.4	86.58	2070	142.0	86.63	86.61	0.26
7	86.87	86.65	Copperhead	116.4	2069	62.4	86.58	2070	142.0	86.63	86.61	0.26
8	86.79	86.65	Copperhead	129.2	2069	62.4	86.58	2070	142.0	86.63	86.62	0.17
9	86.75	86.66	Copperhead	135.3	2069	62.4	86.58	2070	142.0	86.63	86.63	0.12
10	86.75	86.67	Copperhead	148.1	2070	142.0	86.63	2071	221.0	86.73	86.64	0.11
11	86.76	86.67	Copperhead	154.7	2070	142.0	86.63	2071	221.0	86.73	86.65	0.11
12	86.83	86.69	Copperhead	168.9	2070	142.0	86.63	2071	221.0	86.73	86.66	0.17
13	86.83	86.70	Copperhead	176.6	2070	142.0	86.63	2071	221.0	86.73	86.67	0.16
14	86.72	86.70	Alpenstock	238.4	2060	301.2	86.54	2068	236.3	86.61	86.61	0.11
15	86.69	86.68	Alpenstock	251.2	2060	301.2	86.54	2068	236.3	86.61	86.59	0.10
16	86.68	86.68	Alpenstock	257.3	2060	301.2	86.54	2068	236.3	86.61	86.59	0.09
17	86.68	86.66	Alpenstock	270.1	2060	301.2	86.54	2068	236.3	86.61	86.57	0.11
18	86.68	86.66	Alpenstock	276.2	2060	301.2	86.54	2068	236.3	86.61	86.57	0.11
19	86.68	86.64	Alpenstock	289.0	2060	301.2	86.54	2068	236.3	86.61	86.55	0.13
20	86.73	86.57	Cornice	179.0	2059	124.1	86.41	2060	220.3	86.54	86.48	0.25
21	86.73	86.55	Cornice	165.5	2059	124.1	86.41	2060	220.3	86.54	86.47	0.26
22	86.73	86.54	Cornice	159.2	2059	124.1	86.41	2060	220.3	86.54	86.46	0.27
23	86.73	86.52	Cornice	146.6	2059	124.1	86.41	2060	220.3	86.54	86.44	0.29
24	86.73	86.51	Cornice	140.5	2059	124.1	86.41	2060	220.3	86.54	86.43	0.30
25	86.73	86.49	Cornice	127.0	2059	124.1	86.41	2060	220.3	86.54	86.41	0.32
26	86.73	86.49	Cornice	119.8	2030	54.4	86.34	2059	124.1	86.41	86.41	0.32
27	86.79	86.47	Cornice	106.3	2030	54.4	86.34	2059	124.1	86.41	86.39	0.40
28	86.79	86.46	Cornice	96.8	2030	54.4	86.34	2059	124.1	86.41	86.38	0.41
29	86.79	86.46	Cornice	90.8	2030	54.4	86.34	2059	124.1	86.41	86.38	0.41
30	86.79	86.44	Cornice	77.3	2030	54.4	86.34	2059	124.1	86.41	86.36	0.43
31	86.79	86.44	Cornice	70.1	2030	54.4	86.34	2059	124.1	86.41	86.36	0.43
32	86.79	86.42	Cornice	55.9	2030	54.4	86.34	2059	124.1	86.41	86.34	0.45
33	86.52	86.37	Cornice	27.1	2022	9.0	86.26	2030	54.4	86.34	86.29	0.23
34	86.63	86.39	Cornice	39.6	2022	9.0	86.26	2030	54.4	86.34	86.31	0.32
35	86.63	86.41	Cornice	47.1	2022	9.0	86.26	2030	54.4	86.34	86.33	0.30
36	86.63	86.43	Cornice	61.1	2030	54.4	86.34	2059	124.1	86.41	86.35	0.28
37	86.55	86.43	Cornice	67.6	2030	54.4	86.34	2059	124.1	86.41	86.35	0.20
38	86.55	86.45	Cornice	80.5	2030	54.4	86.34	2059	124.1	86.41	86.37	0.18
39	86.52	86.45	Cornice	87.2	2030	54.4	86.34	2059	124.1	86.41	86.37	0.15
40	86.55	86.47	Cornice	101.4	2030	54.4	86.34	2059	124.1	86.41	86.39	0.16
41	86.58	86.47	Cornice	108.0	2030	54.4	86.34	2059	124.1	86.41	86.39	0.19
42	86.58	86.49	Cornice	120.8	2030	54.4	86.34	2059	124.1	86.41	86.41	0.17
43	86.54	86.49	Cornice	126.9	2059	124.1	86.41	2060	220.3	86.54	86.41	0.13
44	86.57	86.51	Cornice	140.4	2059	124.1	86.41	2060	220.3	86.54	86.43	0.14
45	86.57	86.52	Cornice	147.5	2059	124.1	86.41	2060	220.3	86.54	86.44	0.13
46	86.56	86.54	Cornice	161.0	2059	124.1	86.41	2060	220.3	86.54	86.46	0.10
47	86.57	86.55	Cornice	167.1	2059	124.1	86.41	2060	220.3	86.54	86.47	0.10
48	86.57	86.57	Cornice	179.9	2059	124.1	86.41	2060	220.3	86.54	86.49	0.08
49	86.61	86.58	Cornice	186.0	2059	124.1	86.41	2060	220.3	86.54	86.49	0.12
50	86.63	86.60	Cornice	198.8	2059	124.1	86.41	2060	220.3	86.54	86.51	0.12
51	86.63	86.61	Cornice	209.0	2059	124.1	86.41	2060	220.3	86.54	86.52	0.11
52	86.50	86.43	Crevasse	207.6	2041	94.0	86.21	2042	220.4	86.38	86.36	0.14
53	86.48	86.42	Crevasse	193.4	2041	94.0	86.21	2042	220.4	86.38	86.34	0.14
54	86.47	86.41	Crevasse	186.2	2041	94.0	86.21	2042	220.4	86.38	86.33	0.14
55	86.45	86.39	Crevasse	172.0	2041	94.0	86.21	2042	220.4	86.38	86.31	0.14
56	86.45	86.38	Crevasse	162.1	2041	94.0	86.21	2042	220.4	86.38	86.30	0.15
57	86.45	86.36	Crevasse	147.9	2041	94.0	86.21	2042	220.4	86.38	86.28	0.17
58	86.45	86.35	Crevasse	138.1	2041	94.0	86.21	2042	220.4	86.38	86.27	0.18
59	86.45	86.33	Crevasse	123.9	2041	94.0	86.21	2042	220.4	86.38	86.25	0.20
60	86.45	86.32	Crevasse	116.7	2041	94.0	86.21	2042	220.4	86.38	86.24	0.21
61	86.52	86.30	Crevasse	102.5	2041	94.0	86.21	2042	220.4	86.38	86.22	0.30
62	86.52	86.28	Crevasse	89.9	2007	54.6	86.15	2041	94.0	86.21	86.20	0.32
63	86.52	86.26	Crevasse	75.7	2007	54.6	86.15	2041	94.0	86.21	86.18	0.34

100yr 3hr Chicago +20%					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
64	86.47	86.24	Crevasse	63.1	2007	54.6	86.15	2041	94.0	86.21	86.16	0.31
65	86.43	86.22	Crevasse	48.5	2006	9.1	86.07	2007	54.6	86.15	86.14	0.29
66	86.38	86.21	Crevasse	42.2	2006	9.1	86.07	2007	54.6	86.15	86.13	0.25
67	86.25	86.18	Crevasse	26.9	2006	9.1	86.07	2007	54.6	86.15	86.10	0.15
68	86.45	86.30	Piton	184.0	2041	197.0	86.21	2058	94.1	86.33	86.23	0.22
69	86.44	86.32	Piton	169.8	2041	197.0	86.21	2058	94.1	86.33	86.24	0.20
70	86.43	86.33	Piton	159.9	2041	197.0	86.21	2058	94.1	86.33	86.25	0.18
71	86.41	86.34	Piton	145.7	2041	197.0	86.21	2058	94.1	86.33	86.27	0.14
72	86.40	86.36	Piton	135.8	2041	197.0	86.21	2058	94.1	86.33	86.28	0.12
73	86.52	86.37	Piton	121.6	2041	197.0	86.21	2058	94.1	86.33	86.30	0.22
74	86.52	86.38	Piton	108.2	2041	197.0	86.21	2058	94.1	86.33	86.31	0.21
75	86.65	86.40	Piton	57.7	2057	90.0	86.35	2040	53.7	86.12	86.32	0.33
76	86.65	86.32	Piton	71.1	2057	90.0	86.35	2040	53.7	86.12	86.24	0.41
77	86.64	86.24	Piton	85.3	2057	90.0	86.35	2040	53.7	86.12	86.15	0.49
78	86.64	86.42	Piton	91.0	2058	94.1	86.33	2057	90.0	86.35	86.35	0.29
79	86.56	86.39	Piton	99.7	2041	197.0	86.21	2058	94.1	86.33	86.32	0.24
80	86.56	86.38	Piton	109.1	2041	197.0	86.21	2058	94.1	86.33	86.31	0.25
81	86.56	86.37	Piton	123.3	2041	197.0	86.21	2058	94.1	86.33	86.30	0.26
82	86.56	86.35	Piton	137.8	2041	197.0	86.21	2058	94.1	86.33	86.28	0.28
83	86.42	86.34	Piton	152.0	2041	197.0	86.21	2058	94.1	86.33	86.26	0.16
84	86.43	86.32	Piton	166.4	2041	197.0	86.21	2058	94.1	86.33	86.25	0.18
85	86.45	86.31	Piton	180.6	2041	197.0	86.21	2058	94.1	86.33	86.23	0.22
86	86.49	86.35	Crevasse	138.7	2041	94.0	86.21	2042	220.4	86.38	86.27	0.22
87	86.49	86.36	Crevasse	151.6	2041	94.0	86.21	2042	220.4	86.38	86.29	0.20
88	86.45	86.38	Crevasse	165.8	2041	94.0	86.21	2042	220.4	86.38	86.31	0.14
89	86.46	86.39	Crevasse	175.2	2041	94.0	86.21	2042	220.4	86.38	86.32	0.14
90	86.48	86.41	Crevasse	188.0	2041	94.0	86.21	2042	220.4	86.38	86.34	0.14
91	86.48	86.42	Crevasse	194.1	2041	94.0	86.21	2042	220.4	86.38	86.34	0.14
92	86.50	86.43	Crevasse	206.9	2041	94.0	86.21	2042	220.4	86.38	86.36	0.14
93	86.59	86.56	Wolf_Moon	41.2	2049	58.7	86.48	2052	10.3	86.53	86.50	0.09
94	86.59	86.58	Wolf_Moon	27.0	2049	58.7	86.48	2052	10.3	86.53	86.51	0.08
95	86.76	86.60	Wolf_Moon	12.7	2049	58.7	86.48	2052	10.3	86.53	86.53	0.23
96	86.76	86.60	Wolf_Moon	10.3	2049	58.7	86.48	2052	10.3	86.53	86.53	0.23
97	86.77	86.60	Wolf_Moon	10.3	2049	58.7	86.48	2052	10.3	86.53	86.53	0.24
98	86.77	86.60	Wolf_Moon	10.3	2049	58.7	86.48	2052	10.3	86.53	86.53	0.24
99	86.59	86.59	Wolf_Moon	21.8	2049	58.7	86.48	2052	10.3	86.53	86.52	0.07
100	86.59	86.57	Wolf_Moon	35.6	2049	58.7	86.48	2052	10.3	86.53	86.50	0.09
101	86.66	85.46	Renaud	1553.6	3004	1550.0	85.19	3005	1696.2	85.30	85.19	1.47
102	86.66	85.46	Renaud	1566.4	3004	1550.0	85.19	3005	1696.2	85.30	85.20	1.46
103	86.64	85.47	Renaud	1572.5	3004	1550.0	85.19	3005	1696.2	85.30	85.21	1.43
104	86.64	85.47	Renaud	1585.3	3004	1550.0	85.19	3005	1696.2	85.30	85.22	1.42
105	86.64	85.47	Renaud	1591.9	3004	1550.0	85.19	3005	1696.2	85.30	85.22	1.42
106	86.64	85.48	Renaud	1606.1	3004	1550.0	85.19	3005	1696.2	85.30	85.23	1.41
107	86.64	85.48	Renaud	1613.3	3004	1550.0	85.19	3005	1696.2	85.30	85.24	1.40
108	86.73	85.48	Renaud	1626.8	3004	1550.0	85.19	3005	1696.2	85.30	85.25	1.48
109	86.69	85.48	Renaud	1632.8	3004	1550.0	85.19	3005	1696.2	85.30	85.25	1.44
110	86.62	85.49	Renaud	1645.7	3004	1550.0	85.19	3005	1696.2	85.30	85.26	1.36
111	86.52	85.49	Renaud	1652.3	3004	1550.0	85.19	3005	1696.2	85.30	85.27	1.25
112	86.40	85.49	Renaud	1666.5	3004	1550.0	85.19	3005	1696.2	85.30	85.28	1.12
113	86.32	85.49	Renaud	1673.6	3004	1550.0	85.19	3005	1696.2	85.30	85.28	1.04
114	86.37	85.50	Renaud	1687.1	3004	1550.0	85.19	3005	1696.2	85.30	85.29	1.08
115	86.37	85.50	Renaud	1693.2	3004	1550.0	85.19	3005	1696.2	85.30	85.30	1.07
116	86.34	85.50	Renaud	1706.0	3005	1696.2	85.30	3006	1816.1	85.32	85.30	1.04
117	86.62	86.62	Alpenstock	535.6	2050	514.4	86.54	2051	545.1	86.56	86.55	0.07
118	86.62	86.61	Alpenstock	525.1	2050	514.4	86.54	2051	545.1	86.56	86.55	0.07
119	86.60	86.60	Alpenstock	509.7	2049	468.7	86.48	2050	514.4	86.54	86.53	0.07
120	86.60	86.59	Alpenstock	499.2	2049	468.7	86.48	2050	514.4	86.54	86.52	0.08
121	86.59	86.56	Alpenstock	485.0	2049	468.7	86.48	2050	514.4	86.54	86.50	0.09
122	86.57	86.52	Alpenstock	451.3	2042	384.7	86.38	2049	468.7	86.48	86.46	0.11
123	86.56	86.51	Alpenstock	437.9	2042	384.7	86.38	2049	468.7	86.48	86.44	0.12
124	86.55	86.49	Alpenstock	423.7	2042	384.7	86.38	2049	468.7	86.48	86.43	0.12
125	86.52	86.48	Alpenstock	410.9	2042	384.7	86.38	2049	468.7	86.48	86.41	0.11
126	86.53	86.46	Alpenstock	396.8	2042	384.7	86.38	2049	468.7	86.48	86.39	0.14

100yr 3hr Chicago +20%					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
127	86.63	86.57	Tarn_Walk	150.7	2043	162.4	86.47	2053	95.1	86.58	86.49	0.14
128	86.61	86.59	Tarn_Walk	136.5	2043	162.4	86.47	2053	95.1	86.58	86.51	0.10
129	86.66	86.61	Tarn_Walk	123.9	2043	162.4	86.47	2053	95.1	86.58	86.53	0.13
130	86.76	86.64	Tarn_Walk	109.7	2043	162.4	86.47	2053	95.1	86.58	86.56	0.20
131	86.76	86.65	Tarn_Walk	99.1	2043	162.4	86.47	2053	95.1	86.58	86.57	0.19
132	86.71	86.71	Tarn_Walk	51.2	2054	80.9	86.59	2055	41.8	86.64	86.63	0.08
133	86.69	86.69	Tarn_Walk	61.7	2054	80.9	86.59	2055	41.8	86.64	86.61	0.08
134	86.71	86.68	Tarn_Walk	75.2	2054	80.9	86.59	2055	41.8	86.64	86.60	0.11
135	86.72	86.67	Tarn_Walk	80.7	2054	80.9	86.59	2055	41.8	86.64	86.59	0.13
136	86.73	86.66	Tarn_Walk	88.5	2053	95.1	86.58	2054	80.9	86.59	86.58	0.15
137	86.73	86.66	Tarn_Walk	89.7	2053	95.1	86.58	2054	80.9	86.59	86.58	0.15
138	86.72	86.65	Tarn_Walk	100.8	2043	162.4	86.47	2053	95.1	86.58	86.57	0.15
139	86.72	86.64	Tarn_Walk	107.8	2043	162.4	86.47	2053	95.1	86.58	86.56	0.16
140	86.72	86.62	Tarn_Walk	122.0	2043	162.4	86.47	2053	95.1	86.58	86.54	0.18
141	86.69	86.59	Tarn_Walk	135.3	2043	162.4	86.47	2053	95.1	86.58	86.51	0.18
142	86.69	86.57	Tarn_Walk	149.5	2043	162.4	86.47	2053	95.1	86.58	86.49	0.20
143	86.85	86.68	Rappel	92.0	2044	81.5	86.57	2045	141.0	86.65	86.58	0.27
144	86.85	86.70	Rappel	106.2	2044	81.5	86.57	2045	141.0	86.65	86.60	0.25
145	86.82	86.71	Rappel	112.1	2044	81.5	86.57	2045	141.0	86.65	86.61	0.21
146	86.82	86.74	Rappel	126.3	2044	81.5	86.57	2045	141.0	86.65	86.63	0.19
147	86.74	86.74	Rappel	131.5	2044	81.5	86.57	2045	141.0	86.65	86.64	0.10
148	86.99	86.76	Rappel	142.0	2045	141.0	86.65	2046	146.5	86.66	86.65	0.34
149	86.99	86.76	Rappel	143.6	2045	141.0	86.65	2046	146.5	86.66	86.65	0.34
150	86.83	86.78	Rappel	151.5	2046	146.5	86.66	2047	218.4	86.71	86.66	0.17
151	86.90	86.85	Rappel	217.7	2046	146.5	86.66	2047	218.4	86.71	86.71	0.19
152	85.97	85.64	Renaud	1955.1	3006	1816.1	85.32	3007	1957.7	85.34	85.34	0.63
153	86.61	85.58	Renaud	1883.8	3006	1816.1	85.32	3007	1957.7	85.34	85.33	1.28
154	86.56	85.57	Renaud	1870.4	3006	1816.1	85.32	3007	1957.7	85.34	85.33	1.23
155	86.56	85.57	Renaud	1863.2	3006	1816.1	85.32	3007	1957.7	85.34	85.33	1.23
156	86.56	85.56	Renaud	1849.7	3006	1816.1	85.32	3007	1957.7	85.34	85.32	1.24
157	86.56	85.55	Renaud	1841.5	3006	1816.1	85.32	3007	1957.7	85.34	85.32	1.24
158	86.55	85.54	Renaud	1827.3	3006	1816.1	85.32	3007	1957.7	85.34	85.32	1.23
159	86.48	85.53	Renaud	1819.6	3006	1816.1	85.32	3007	1957.7	85.34	85.32	1.16
160	86.48	85.53	Renaud	1806.8	3005	1696.2	85.30	3006	1816.1	85.32	85.32	1.16
161	86.54	85.53	Renaud	1799.7	3005	1696.2	85.30	3006	1816.1	85.32	85.32	1.22
162	86.54	85.52	Renaud	1786.2	3005	1696.2	85.30	3006	1816.1	85.32	85.32	1.22
163	86.46	85.52	Renaud	1778.0	3005	1696.2	85.30	3006	1816.1	85.32	85.31	1.15
164	86.41	85.52	Renaud	1763.8	3005	1696.2	85.30	3006	1816.1	85.32	85.31	1.10
165	86.55	86.51	Crevasse	270.4	2042	220.4	86.38	2043	299.5	86.47	86.44	0.11
166	86.57	86.55	Crevasse	297.9	2042	220.4	86.38	2043	299.5	86.47	86.47	0.10
167	86.61	86.59	Crevasse	325.4	2043	299.5	86.47	2044	378.4	86.57	86.50	0.11
168	86.72	86.64	Crevasse	366.6	2043	299.5	86.47	2044	378.4	86.57	86.56	0.16
169	86.99	86.82	Cornice	366.4	2061	298.7	86.64	2062	379.0	86.74	86.72	0.27
170	86.84	86.77	Cornice	325.1	2061	298.7	86.64	2062	379.0	86.74	86.67	0.17
171	86.74	86.74	Cornice	297.5	2060	220.3	86.54	2061	298.7	86.64	86.64	0.10
172	86.74	86.70	Cornice	270.1	2060	220.3	86.54	2061	298.7	86.64	86.60	0.14
173	86.73	86.66	Alpenstock	268.7	2068	236.3	86.61	2060	301.2	86.54	86.57	0.16
174	86.83	86.72	Cornice	285.5	2060	220.3	86.54	2061	298.7	86.64	86.62	0.21
175	86.83	86.76	Cornice	313.9	2061	298.7	86.64	2062	379.0	86.74	86.66	0.17
176	86.96	86.78	Cornice	336.1	2061	298.7	86.64	2062	379.0	86.74	86.69	0.27
177	87.08	86.92	Rappel	522.0	2062	555.6	86.74	2063	496.9	86.90	86.83	0.25
178	87.03	86.98	Rappel	496.0	2063	496.9	86.90	2064	492.0	86.91	86.90	0.13
179	86.95	86.91	Copperhead	337.2	2072	300.3	86.85	2073	384.4	86.96	86.90	0.05
180	86.96	86.87	Copperhead	314.9	2072	300.3	86.85	2073	384.4	86.96	86.87	0.09
181	86.96	86.83	Copperhead	286.5	2071	221.0	86.73	2072	300.3	86.85	86.83	0.13
182	86.96	86.63	Alpenstock	238.4	2068	236.3	86.61	2060	301.2	86.54	86.54	0.42
183	87.01	86.81	Rappel	181.8	2046	146.5	86.66	2047	218.4	86.71	86.68	0.33
184	86.94	86.70	Rappel	64.2	2044	81.5	86.57	2062	-1.5	86.74	86.61	0.33
185	86.94	86.78	Rappel	22.2	2044	81.5	86.57	2062	-1.5	86.74	86.69	0.25
186	87.11	86.93	Rappel	537.7	2063	496.9	86.90	2062	555.6	86.74	86.85	0.26
187	87.08	87.02	Rappel	460.4	2065	418.5	86.97	2064	492.0	86.91	86.94	0.14
188	87.04	86.84	Rappel	211.0	2046	146.5	86.66	2047	218.4	86.71	86.70	0.34
189	87.22	87.07	Rappel	293.7	2048	222.4	86.71	2067	319.5	87.07	86.97	0.25

100yr 3hr Chicago +20%					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
190	87.35	87.15	Rappel	321.6	2066	413.7	86.98	2067	319.5	87.07	87.07	0.28
191	87.30	87.13	Rappel	342.6	2066	413.7	86.98	2067	319.5	87.07	87.05	0.25
192	87.23	87.04	Rappel	428.2	2064	492.0	86.91	2065	418.5	86.97	86.96	0.27
193	87.29	87.10	Switchback	559.5	2075	623.0	86.98	2078	549.9	87.10	87.08	0.21
194	87.36	87.13	Switchback	485.1	2079	544.0	87.11	2095	446.5	87.08	87.10	0.26
195	87.29	87.13	Switchback	450.0	2079	544.0	87.11	2095	446.5	87.08	87.11	0.18
196	87.15	87.10	Switchback	393.4	2092	281.8	86.99	2093	403.8	87.06	87.05	0.10
197	87.18	87.09	Switchback	361.3	2092	281.8	86.99	2093	403.8	87.06	87.04	0.14
198	87.12	87.12	Switchback	722.7	2076	628.8	87.00	2077	734.8	87.09	87.08	0.04
199	87.31	87.08	Switchback	687.5	2076	628.8	87.00	2077	734.8	87.09	87.05	0.26
200	87.19	87.05	Switchback	591.7	2075	623.0	86.98	2078	549.9	87.10	87.03	0.16
201	87.07	87.04	Switchback	644.8	2076	628.8	87.00	2077	734.8	87.09	87.01	0.06
202	87.14	87.06	Switchback	667.0	2076	628.8	87.00	2077	734.8	87.09	87.03	0.11
203	87.09	87.09	Switchback	695.2	2076	628.8	87.00	2077	734.8	87.09	87.06	0.03
204	87.12	87.12	Switchback	723.6	2076	628.8	87.00	2077	734.8	87.09	87.08	0.04
205	87.06	87.06	Switchback	312.4	2092	281.8	86.99	2093	403.8	87.06	87.01	0.05
206	87.05	87.04	Switchback	282.1	2092	281.8	86.99	2093	403.8	87.06	86.99	0.06
207	86.99	86.96	Tricam	53.3	2080	106.7	86.91	2081	28.0	86.98	86.96	0.03
208	87.05	86.94	Tricam	81.8	2080	106.7	86.91	2081	28.0	86.98	86.93	0.12
209	86.92	86.92	Tricam	110.2	2072	170.0	86.85	2080	106.7	86.91	86.91	0.01
210	86.89	86.89	Tricam	132.6	2072	170.0	86.85	2080	106.7	86.91	86.89	0.00
211	86.92	86.89	Tricam	132.0	2072	170.0	86.85	2080	106.7	86.91	86.89	0.03
212	87.00	86.92	Tricam	109.7	2072	170.0	86.85	2080	106.7	86.91	86.91	0.09
213	87.02	86.94	Tricam	81.3	2080	106.7	86.91	2081	28.0	86.98	86.93	0.09
214	86.98	86.96	Tricam	52.9	2080	106.7	86.91	2081	28.0	86.98	86.96	0.02
215	87.02	86.98	Switchback	233.4	2090	162.8	86.85	2092	281.8	86.99	86.93	0.09
216	86.95	86.95	Switchback	203.1	2090	162.8	86.85	2092	281.8	86.99	86.90	0.05
217	86.98	86.89	Alpenstock	104.3	2082	158.7	86.82	2083	95.7	86.89	86.88	0.10
218	86.98	86.86	Alpenstock	132.7	2082	158.7	86.82	2083	95.7	86.89	86.85	0.13
219	86.92	86.83	Alpenstock	161.2	2071	220.9	86.73	2082	158.7	86.82	86.82	0.10
220	86.87	86.80	Alpenstock	183.5	2071	220.9	86.73	2082	158.7	86.82	86.78	0.09
221	86.86	86.82	Alpenstock	170.3	2071	220.9	86.73	2082	158.7	86.82	86.80	0.06
222	86.89	86.85	Alpenstock	136.6	2082	158.7	86.82	2083	95.7	86.89	86.84	0.05
223	86.89	86.89	Alpenstock	102.9	2082	158.7	86.82	2083	95.7	86.89	86.88	0.01
224	87.04	86.89	Switchback	154.6	2089	86.4	86.80	2090	162.8	86.85	86.84	0.20
225	87.03	86.87	Switchback	124.1	2089	86.4	86.80	2090	162.8	86.85	86.82	0.21
226	86.96	86.96	Bivouac	53.3	2084	113.4	86.80	2085	42.0	86.95	86.93	0.03
227	86.93	86.89	Bivouac	87.0	2084	113.4	86.80	2085	42.0	86.95	86.86	0.07
228	86.86	86.81	Bivouac	120.6	2070	170.8	86.63	2084	113.4	86.80	86.78	0.08
229	86.81	86.81	Bivouac	120.3	2070	170.8	86.63	2084	113.4	86.80	86.78	0.03
230	86.92	86.89	Bivouac	86.6	2084	113.4	86.80	2085	42.0	86.95	86.86	0.06
231	86.96	86.96	Bivouac	52.9	2084	113.4	86.80	2085	42.0	86.95	86.93	0.03
232	86.93	86.83	Switchback	75.4	2087	6.5	86.70	2089	86.4	86.80	86.79	0.14
233	86.93	86.79	Switchback	45.0	2087	6.5	86.70	2089	86.4	86.80	86.75	0.18
234	86.89	86.71	Crux	134.7	2086	168.5	86.65	2087	88.5	86.70	86.67	0.22
235	86.82	86.69	Crux	168.4	2086	168.5	86.65	2087	88.5	86.70	86.65	0.17
236	86.73	86.66	Crux	202.0	2069	252.3	86.58	2086	168.5	86.65	86.62	0.11
237	86.74	86.66	Crux	206.3	2069	252.3	86.58	2086	168.5	86.65	86.62	0.12
238	86.71	86.68	Crux	178.6	2069	252.3	86.58	2086	168.5	86.65	86.64	0.07
239	86.81	86.70	Crux	150.9	2086	168.5	86.65	2087	88.5	86.70	86.66	0.15
240	86.79	86.72	Crux	117.3	2086	168.5	86.65	2087	88.5	86.70	86.68	0.11
241	86.86	86.74	Crux	89.6	2086	168.5	86.65	2087	88.5	86.70	86.70	0.16
242	87.14	86.74	Crux	61.9	2087	88.5	86.70	2088	26.5	86.70	86.70	0.44
243	87.27	86.74	Crux	28.0	2087	88.5	86.70	2088	26.5	86.70	86.70	0.57
244	86.95	86.79	Switchback	44.6	2087	6.5	86.70	2089	86.4	86.80	86.75	0.20
245	86.95	86.82	Switchback	72.7	2087	6.5	86.70	2089	86.4	86.80	86.78	0.17
246	86.95	86.85	Switchback	94.4	2089	86.4	86.80	2090	162.8	86.85	86.81	0.14
247	87.05	86.87	Switchback	122.5	2089	86.4	86.80	2090	162.8	86.85	86.82	0.23
248	87.08	86.89	Switchback	153.0	2089	86.4	86.80	2090	162.8	86.85	86.84	0.24
249	86.96	86.96	Switchback	213.3	2090	162.8	86.85	2092	281.8	86.99	86.91	0.05
250	86.99	86.99	Switchback	241.5	2090	162.8	86.85	2092	281.8	86.99	86.94	0.05
251	87.03	87.03	Switchback	269.5	2090	162.8	86.85	2092	281.8	86.99	86.98	0.05
252	87.12	87.05	Switchback	297.5	2092	281.8	86.99	2093	403.8	87.06	87.00	0.12

100yr 3hr Chicago +20%					DSMH			USMH			Interpolated	
Unit #	USF	MUSF	Street	Station	MH ID	Station	HGL	MH ID	Station	HGL	HGL	Freeboard
253	87.10	87.07	Switchback	325.6	2092	281.8	86.99	2093	403.8	87.06	87.02	0.08
254	87.15	87.08	Switchback	359.6	2092	281.8	86.99	2093	403.8	87.06	87.03	0.12
255	87.19	87.10	Switchback	381.5	2092	281.8	86.99	2093	403.8	87.06	87.05	0.14
256	87.22	87.11	Switchback	405.1	2093	403.8	87.06	2094	409.7	87.06	87.06	0.16

As is demonstrated in the table above, the worst-case scenario results in HGL elevations that remain at least 0.30 m below the proposed and existing underside of footings, and HGL elevations remain below the proposed underside of footing elevations during the 20% increased intensity ‘climate change’ scenario. In addition, peak outflows at the system outlet to Mud Creek downstream of Phase 1 are reduced from that identified in the Phase 1 model due to additional routing time within the proposed Phase 2-3 sewers. As such, increases in peak outflow beyond that originally attributed in the Phase 1 PCSWMM model during the 100 year storm event will not have negative impact on downstream footing elevations.

Table 15 presents the maximum total surface water depths (static ponding depth + dynamic flow) above the top-of-grate of catchbasins for the 100-year design storm and climate change storm. Based on the model results, the total ponding depth (static + dynamic) does not exceed the required 0.35m maximum during the 100-year event. Total ponding depths during the climate change scenario are below adjacent building openings and are not expected to impact proposed buildings within the development.

Table 15: Maximum Surface Water Depths

Storage Node ID	Node Type	Rim Elevation (m)	100yr 3hr Chicago		100yr +20% 3hr Chicago		Adjacent Building Opening Elevation
			Max. Surface HGL (m)	Total Surface Water Depth (m)	Max. Surface HGL (m)	Total Surface Water Depth (m)	
CB10A-S	RENAUD	87.74	87.92	0.18	87.97	0.23	88.23
CB11A-S	RENAUD	87.78	87.85	0.07	87.88	0.10	-
CB12A-S	RENAUD	87.85	88.02	0.17	88.07	0.22	88.39
CB13A-S	RENAUD	87.91	87.98	0.07	88.00	0.09	-
CB14A-S	RENAUD	88.00	88.03	0.03	88.07	0.07	88.45
CB15A-S	RENAUD	88.20	88.23	0.03	88.23	0.03	88.45
CB1A-S	RENAUD	87.60	87.63	0.03	87.68	0.08	-
CB2A-S	RENAUD	87.53	87.60	0.07	87.62	0.09	-
CB3A-S	RENAUD	87.50	87.63	0.13	87.67	0.17	-
CB4A-S	RENAUD	87.75	87.26	0.00	87.65	0.00	-
CB5A-S	RENAUD	87.79	86.74	0.00	86.88	0.00	-
CB6A-S	RENAUD	87.73	87.76	0.03	87.77	0.04	-
CB7A-S	RENAUD	87.60	87.73	0.13	87.77	0.17	-
CB8A-S	RENAUD	87.63	87.71	0.08	87.74	0.11	-
CB9A-S	RENAUD	87.91	87.19	0.00	87.45	0.00	-
C2069A-S	ROAD	88.12	88.40	0.28	88.45	0.33	88.90
C2070A-S	ROAD	88.29	88.55	0.26	88.58	0.29	88.94
C2071A-S	ROAD	88.39	88.59	0.20	88.62	0.23	88.98
C2071B-S	ROAD	88.38	88.44	0.06	88.61	0.23	88.98
C2072A-S	ROAD	88.54	88.72	0.18	88.76	0.22	89.07
C2072B-S	ROAD	88.45	88.54	0.09	88.61	0.16	89.07

C2073A-S	ROAD	88.52	88.79	0.27	88.82	0.30	89.06
C2074A-S	ROAD	87.34	87.62	0.28	87.68	0.24	-
L1002A-S	ROAD	88.05	88.11	0.06	88.38	0.33	-
L2007A-S	ROAD	87.81	88.05	0.24	88.10	0.29	88.38
L2030A-S	ROAD	88.03	88.30	0.27	88.34	0.31	88.63
L2040B-S	ROAD	88.08	88.29	0.21	88.33	0.25	88.70
L2042A-S	ROAD	88.10	88.33	0.23	88.38	0.28	88.60
L2042B-S	ROAD	88.13	88.36	0.23	88.44	0.31	88.49
L2043A-S	ROAD	88.15	88.43	0.28	88.48	0.33	88.57
L2044A-S	ROAD	88.36	88.58	0.22	88.64	0.28	88.72
L2045A-S	ROAD	88.61	88.90	0.29	88.93	0.32	89.03
L2051A-S	ROAD	87.87	87.82	0.00	87.94	0.07	88.23
L2052A-S	ROAD	88.21	88.41	0.20	88.48	0.27	88.67
L2053A-S	ROAD	88.15	88.48	0.33	88.52	0.37	88.62
L2055A-S	ROAD	88.12	88.41	0.29	88.48	0.36	88.77
L2058A-S	ROAD	87.85	88.14	0.29	88.19	0.34	88.31
L2059A-S	ROAD	88.22	88.48	0.26	88.52	0.30	88.73
L2060A-S	ROAD	88.31	88.58	0.27	88.60	0.29	88.85
L2061A-S	ROAD	88.31	88.49	0.18	88.52	0.21	88.85
L2062A-S	ROAD	88.45	88.65	0.20	88.68	0.23	88.80
L2062B-S	ROAD	88.66	88.80	0.14	88.83	0.17	89.05
L2063A-S	ROAD	88.77	88.95	0.18	88.99	0.22	89.14
L2067A-S	ROAD	88.71	88.89	0.18	88.93	0.22	89.15
L2067B-S	ROAD	88.77	88.95	0.18	88.99	0.22	89.26
L2068A-S	ROAD	88.19	88.47	0.28	88.51	0.32	88.68
L2077A-S	ROAD	88.60	88.90	0.30	88.92	0.32	89.13
L2078A-S	ROAD	88.79	89.01	0.22	89.04	0.25	89.18
L2078B-S	ROAD	88.91	89.07	0.16	89.10	0.19	89.40
L2080A-S	ROAD	88.43	88.69	0.26	88.76	0.33	88.98
L2081A-S	ROAD	88.59	88.83	0.24	88.86	0.27	89.09
L2082A-S	ROAD	88.23	88.51	0.28	88.62	0.39	88.75
L2083A-S	ROAD	88.39	88.69	0.30	88.75	0.36	88.96
L2084A-S	ROAD	88.24	88.53	0.29	88.60	0.36	88.75
L2085A-S	ROAD	88.36	88.62	0.26	88.66	0.30	88.96
L2086A-S	ROAD	88.39	88.57	0.18	88.60	0.21	88.81
L2086B-S	ROAD	88.13	88.36	0.23	88.43	0.30	88.76
L2087A-S	ROAD	88.43	88.67	0.24	88.70	0.27	89.00
L2089A-S	ROAD	88.44	88.67	0.23	88.70	0.26	89.04
L2091A-S	ROAD	88.51	88.74	0.23	88.78	0.27	89.19
L2092A-S	ROAD	88.55	88.74	0.19	88.77	0.22	89.05
L2092B-S	ROAD	88.65	88.83	0.18	88.87	0.22	89.11

L2093A-S	ROAD	88.73	88.90	0.17	88.91	0.18	89.21
L2095A-S	ROAD	88.91	89.07	0.16	89.09	0.18	89.40
L2095B-S	ROAD	88.81	88.97	0.16	89.01	0.20	89.33
L2049A-S	ROAD	88.02	88.37	0.35	88.48	0.46	88.53
L2056A-S	ROAD	88.05	88.40	0.35	88.49	0.44	88.98
L2039A-S	ROAD	87.95	87.96	0.01	88.04	0.09	88.45
C1001A-S	ROAD	87.72	87.58	0.00	88.08	0.36	88.27
C1002B-S	ROAD	88.02	88.10	0.08	88.42	0.40	88.52
C1002C-S	ROAD	87.96	88.10	0.14	88.33	0.37	88.46
C1003A-S	ROAD	88.06	88.25	0.19	88.46	0.40	88.56
C1007A-S	ROAD	88.47	88.66	0.19	88.69	0.22	88.97
C1007B-S	ROAD	88.16	88.36	0.20	88.44	0.28	88.66
C1007W-S	ROAD	88.30	88.36	0.06	88.51	0.21	88.80
C2026A-S	ROAD	88.33	88.50	0.17	88.53	0.20	88.83
C2026B-S	ROAD	88.19	88.35	0.16	88.42	0.23	88.69
L1006A-S	ROAD	88.56	88.73	0.17	88.75	0.19	89.06
L1006B-S	ROAD	88.23	88.47	0.24	88.53	0.30	88.73
L1006W-S	ROAD	88.40	88.58	0.18	88.71	0.31	88.90
L2001A-S	ROAD	87.25	87.47	0.22	87.62	0.37	87.75
L2002A-S	ROAD	87.29	87.59	0.30	87.72	0.43	87.79
L2003A-S	ROAD	87.47	87.66	0.19	87.72	0.25	87.97
L2004A-S	ROAD	87.54	87.79	0.25	87.87	0.33	88.04
L2005A-S	ROAD	87.63	87.90	0.27	87.99	0.36	88.13
L2006A-S	ROAD	87.71	87.96	0.25	88.05	0.34	88.21
L2008A-S	ROAD	87.33	87.65	0.32	87.76	0.43	87.83
L2009A-S	ROAD	87.49	87.72	0.23	87.78	0.29	87.99
L2010A-S	ROAD	87.59	87.81	0.22	87.84	0.25	88.09
L2012A-S	ROAD	87.71	87.88	0.17	87.91	0.20	88.21
L2013A-S	ROAD	87.88	88.01	0.13	88.03	0.15	88.38
L2013B-S	ROAD	87.80	87.95	0.15	87.98	0.18	88.30
L2014A-S	ROAD	87.56	87.79	0.23	87.82	0.26	-
L2014B-S	ROAD	87.89	88.06	0.17	88.08	0.19	88.39
L2015A-S	ROAD	88.02	88.22	0.20	88.25	0.23	88.52
L2016A-S	ROAD	87.47	87.73	0.26	87.76	0.29	87.97
L2017A-S	ROAD	87.86	88.05	0.19	88.08	0.22	88.36
L2019A-S	ROAD	88.06	88.17	0.11	88.21	0.15	88.56
L2020A-S	ROAD	87.55	87.75	0.20	87.80	0.25	88.05
L2021A-S	ROAD	87.83	88.06	0.23	88.13	0.30	88.33
L2022A-S	ROAD	87.98	88.18	0.20	88.24	0.26	88.48
L2022B-S	ROAD	87.93	88.14	0.21	88.17	0.24	88.43
L2022S-S	ROAD	87.80	88.04	0.24	88.08	0.28	88.30

L2023A-S	ROAD	87.69	87.85	0.16	87.92	0.23	88.19
L2023B-S	ROAD	87.77	87.87	0.10	87.92	0.15	88.27
L2024A-S	ROAD	87.93	88.17	0.24	88.19	0.26	88.43
L2025A-S	ROAD	88.12	88.28	0.16	88.34	0.22	88.62
L2027A-S	ROAD	88.34	88.53	0.19	88.55	0.21	88.84
L2031A-S	ROAD	87.56	87.82	0.26	87.89	0.33	88.06
L2032A-S	ROAD	87.81	87.94	0.13	87.98	0.17	88.31
L2034A-S	ROAD	87.81	87.97	0.16	88.02	0.21	88.31
L2035A-S	ROAD	87.76	87.96	0.20	87.99	0.23	88.26
L2036A-S	ROAD	87.63	87.93	0.30	87.99	0.36	88.13
L2037A-S	ROAD	87.89	88.05	0.16	88.08	0.19	88.39
R2-CB1-S	ROAD	87.95	87.98	0.03	87.99	0.04	88.44
R2-CB2-S	ROAD	87.89	87.94	0.05	87.95	0.06	88.44
R2-CB3-S	ROAD	87.78	87.84	0.06	87.85	0.07	88.40
R2-CB4-S	ROAD	87.78	87.81	0.03	87.82	0.04	88.40
R2-CB5-S	ROAD	87.58	87.78	0.20	87.85	0.27	88.17
R2-CB6-S	ROAD	87.63	87.71	0.08	87.75	0.12	88.17
R2-CB7-S	ROAD	87.64	87.75	0.11	87.81	0.17	88.09
R2-CB8-S	ROAD	87.69	87.38	0.00	87.70	0.01	88.09
R2-CB9-S	ROAD	87.51	87.75	0.24	87.81	0.30	88.03
R2-CB10-S	ROAD	87.53	87.62	0.09	87.64	0.11	88.03
R2-CB11-S	ROAD	87.41	87.48	0.07	87.49	0.01	88.03
R2-CB12-S	ROAD	87.47	87.50	0.03	87.51	0.04	88.03
R2-DCB1-S	ROAD	87.35	87.44	0.09	87.48	0.13	88.03
R2-DCB2-S	ROAD	87.32	87.36	0.04	87.43	0.11	88.03

Table 18 demonstrates anticipated ponding depths during the minor system design storm event (2-year storm for local streets, 5-year for collectors). As stated in sections above, City of Ottawa review staff have indicated that ponding during such events will be allowed given the increase in assumed site imperviousness per strict application of the Sewer Design Guidelines, and in order to prevent impact to downstream users. Due to limitations in City accepted ICD sizing and given that much of the increase in assumed impervious area originates within rear yard subcatchments, there is only limited ability to distribute ponding within roadways where such catchments discharge overland into the adjacent roadways. Ponding depths have been distributed as best as possible to achieve the design goals stated.

No ponding is observed for Renaud Road or street segments within Phase 1 during the minor system design storm event, and no ponding is apparent at the end of the 2/5 year design storm events. It is understood that this allowance does not set precedent for future projects or phases.

Table 16: Summary of Minor System Design Storm Ponding Depths

Storage Node ID	Design Storm	Rim Elevation (m)	3hr Chicago Storm Event	
			Max. HGL (m)	Total Surface Water Depth (m)
C2069A-S	5-Year	88.12	87.96	0.00
C2070A-S	5-Year	88.29	88.34	0.05
C2071A-S	5-Year	88.39	88.41	0.02
C2071B-S	5-Year	88.38	87.47	0.00
C2072A-S	5-Year	88.54	88.50	0.00
C2072B-S	5-Year	88.45	87.41	0.00
C2073A-S	5-Year	88.52	88.58	0.06
C2074A-S	5-Year	87.41	87.44	0.03
L2007A-S	2-Year	87.81	87.62	0.00
L2030A-S	2-Year	88.03	87.50	0.00
L2040B-S	2-Year	88.08	88.12	0.04
L2042A-S	2-Year	88.10	87.65	0.00
L2042B-S	2-Year	88.13	87.73	0.00
L2043A-S	2-Year	88.15	88.14	0.00
L2044A-S	2-Year	88.36	88.26	0.00
L2045A-S	2-Year	88.61	88.65	0.04
L2051A-S	2-Year	87.87	87.00	0.00
L2052A-S	2-Year	88.21	87.62	0.00
L2053A-S	2-Year	88.15	87.94	0.00
L2055A-S	2-Year	88.12	88.16	0.04
L2058A-S	2-Year	87.85	87.48	0.00
L2059A-S	2-Year	88.22	88.22	0.00
L2060A-S	2-Year	88.31	88.12	0.00
L2061A-S	2-Year	88.31	88.35	0.04
L2062A-S	2-Year	88.45	88.07	0.00
L2062B-S	2-Year	88.66	88.63	0.00
L2063A-S	2-Year	88.77	88.54	0.00
L2067A-S	2-Year	88.71	88.71	0.00
L2067B-S	2-Year	88.77	88.80	0.03
L2068A-S	2-Year	88.19	87.63	0.00
L2077A-S	2-Year	88.60	88.53	0.00
L2078A-S	2-Year	88.79	88.81	0.02
L2078B-S	2-Year	88.91	88.54	0.00
L2080A-S	2-Year	88.43	87.99	0.00

L2081A-S	2-Year	88.59	88.09	0.00
L2082A-S	2-Year	88.23	87.67	0.00
L2083A-S	2-Year	88.39	88.02	0.00
L2084A-S	2-Year	88.24	88.26	0.02
L2085A-S	2-Year	88.36	88.41	0.05
L2086A-S	2-Year	88.39	88.17	0.00
L2086B-S	2-Year	88.13	88.15	0.02
L2087A-S	2-Year	88.43	88.31	0.00
L2089A-S	2-Year	88.44	87.97	0.00
L2091A-S	2-Year	88.51	88.15	0.00
L2092A-S	2-Year	88.55	88.58	0.03
L2092B-S	2-Year	88.65	88.53	0.00
L2093A-S	2-Year	88.73	88.59	0.00
L2095A-S	2-Year	88.91	88.35	0.00
L2095B-S	2-Year	88.81	88.54	0.00
L2049A-S	2-Year	88.02	87.08	0.00
L2056A-S	2-Year	88.05	88.11	0.06

Table 18 demonstrates observed HGL elevations within the minor system of the previously constructed Phase 1 of the Trails Edge East development, and relates modeled HGL to that originally determined based on the Trails Edge East Phase 1 – Servicing and Stormwater Management Report.

Table 17: Modeled Hydraulic Grade Line (HGL) Results – Phase 1

STM MH	Adjacent USF (m)	100yr 3hr Chicago HGL			100yr 3hr Chicago + 20% HGL		
		Approved	Proposed	USF-HGL Clearance (m)	Approved	Proposed	USF-HGL Clearance (m)
1000	85.94	85.21	85.21	0.73	85.37	85.37	0.57
1001	86.31	85.31	85.31	1.00	85.49	85.49	0.82
1002A	-	85.84	85.84	-	86.01	86.01	-
1002B	-	85.50	85.50	-	85.70	85.70	-
1003	86.55	85.77	85.76	0.78	86.01	86.01	0.54
1004	86.96	86.24	86.24	0.72	86.50	86.49	0.46
1005	86.95	86.25	86.24	0.70	86.52	86.51	0.43
1006	86.94	86.44	86.46	0.48	86.64	86.69	0.29
1007	86.87	86.24	86.23	0.63	86.39	86.48	0.47
1008	87.03	86.29	86.29	0.74	86.55	86.54	0.48
2000	85.70	85.19	85.20	0.50	85.38	85.39	0.32
2001	85.65	85.25	85.27	0.38	85.45	85.47	0.18

2002	85.87	85.46	85.48	0.39	85.66	85.69	0.18
2003	85.98	85.55	85.58	0.40	85.75	85.80	0.18
2004	86.07	85.64	85.68	0.39	85.85	85.90	0.17
2005	86.20	85.72	85.77	0.43	85.93	86.00	0.20
2006	86.33	85.79	85.85	0.48	86.00	86.08	0.33
2007	86.29	85.85	85.93	0.36	86.06	86.16	0.13
2008	85.98	85.60	85.62	0.36	85.82	85.84	0.14
2009	86.06	85.69	85.71	0.35	85.91	85.93	0.13
2010	86.09	85.79	85.80	0.29	86.00	86.03	0.06
2011	86.16	85.80	85.81	0.35	86.01	86.04	0.12
2012	86.14	85.82	85.84	0.30	86.04	86.06	0.08
2013	86.28	85.98	85.98	0.30	86.20	86.23	0.05
2014	86.22	85.82	85.83	0.39	86.03	86.06	0.16
2015	86.52	85.87	85.89	0.63	86.09	86.12	0.40
2016	86.25	85.74	85.75	0.50	85.96	85.98	0.27
2017	86.53	85.85	85.86	0.67	86.07	86.09	0.44
2018	86.48	85.86	85.88	0.60	86.08	86.11	0.37
2019	86.45	85.89	85.90	0.55	86.11	86.14	0.34
2020	86.14	85.76	85.76	0.38	86.01	86.02	0.13
2021	86.17	85.87	85.86	0.30	86.16	86.16	0.01
2022	86.51	85.95	86.03	0.48	86.16	86.26	0.25
2022W	86.51	86.01	86.00	0.50	86.30	86.31	0.20
2023	86.24	85.94	85.94	0.30	86.20	86.21	0.03
2024	86.53	86.18	86.18	0.35	86.44	86.45	0.08
2025	86.68	86.06	86.16	0.52	86.28	86.41	0.27
2026	86.79	86.13	86.21	0.58	86.34	86.46	0.33
2027	86.89	86.23	86.29	0.60	86.44	86.54	0.35
2028	87.19	86.24	86.29	0.90	86.45	86.54	0.65
2029	86.63	86.16	86.28	0.35	86.37	86.54	0.09
2030	86.55	86.03	86.11	0.44	86.24	86.34	0.21
2031	86.20	85.75	85.77	0.43	85.98	86.02	0.18
2032	86.27	85.85	85.86	0.41	86.07	86.11	0.16
2033	86.19	85.87	85.88	0.31	86.10	86.14	0.05
2034	86.35	85.97	85.98	0.37	86.21	86.25	0.10
2035	86.29	85.97	85.98	0.31	86.21	86.25	0.04
2036	86.25	85.94	85.95	0.30	86.18	86.23	0.02
2037	86.70	85.85	85.91	0.79	86.10	86.12	0.58
2038	86.66	85.85	85.91	0.75	86.11	86.12	0.44

2039	86.41	85.97	85.92	0.44	86.26	86.20	0.21
2040	-	85.86	85.91	-	86.11	86.12	-

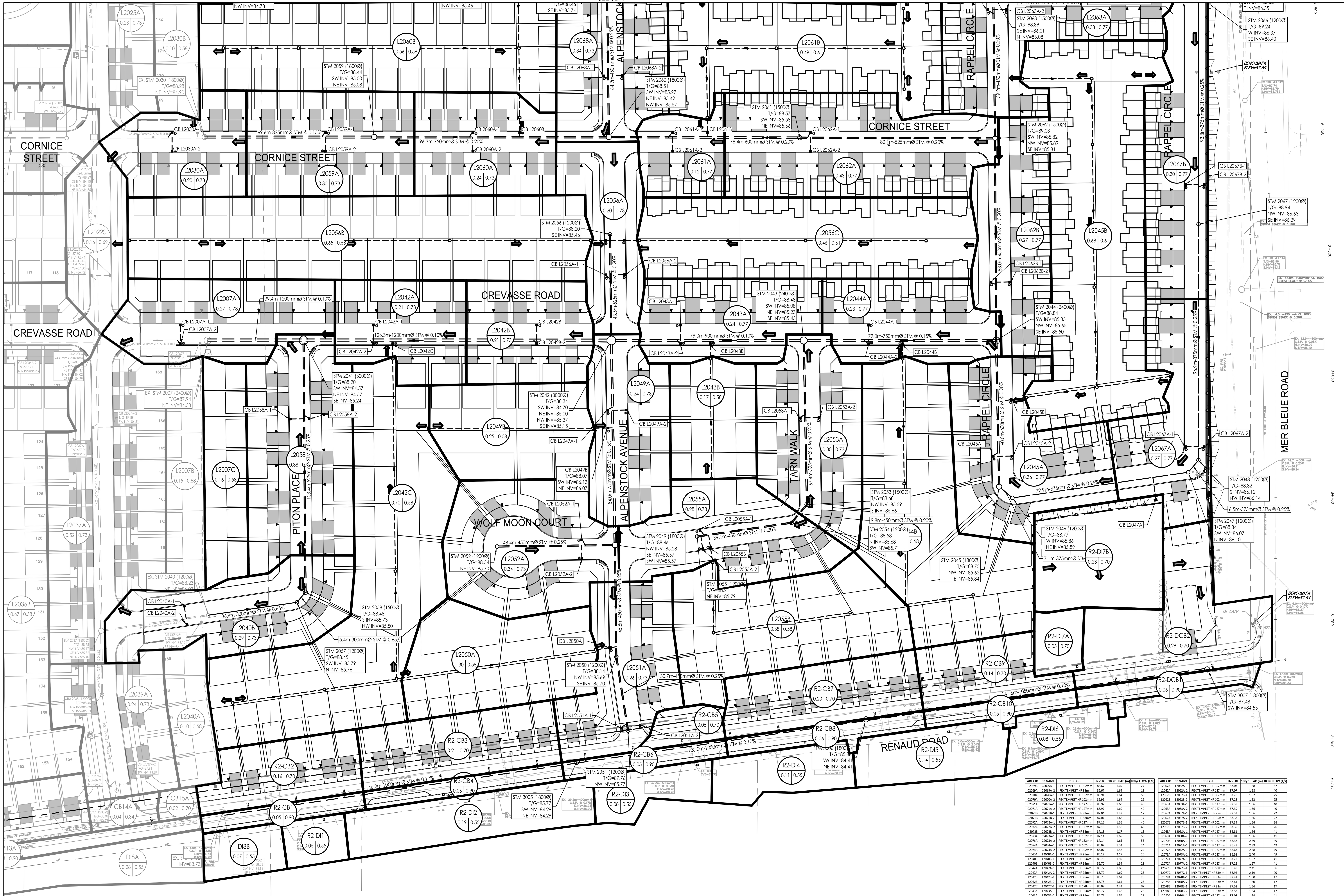
5.3.5 Results

As identified earlier in section 5.3.4, the proposed Phase 2-3 development peak minor system and major system outflows exceed that originally anticipated during development of Phase 1. As such, downstream minor system HGLs were assessed to ensure no deleterious impacts to existing unit footings within Phase 1, and major system surface water depths were assessed for the downstream phase to ensure surface water depths do not exceed 0.35m per City of Ottawa standards. Peak outflows from Phase 1 were then assessed to ensure increase in peak flow rates do not cause hydraulic impacts further downstream.

Table 18 demonstrates anticipated outflows from the proposed development storm sewers, along with those taken from the existing model for the downstream system to Mud Creek as prepared by Stantec for Phase 1 of Trailsedge East (outflow from model node N57). The table demonstrates that the proposed stormwater management plan provides adequate attenuation storage to meet the target peak outflow rates for the combined Phases 1-3 of the development during the 100yr event, and without negative impact on operation of the SWM facility.

Table 18: Summary of 100-Year and Climate Change Event Release Rates (Downstream Phase 1)

Storm Event & System	Modeled Peak Outflow (m^3/s)	Peak Outflow (m^3/s) per Phase 1 Model
3 Hour Chicago 100-Year (Minor System)	16.57	16.80
3 Hour Chicago 100-Year (Major System)	0.00	0.00
Total	**16.57**	**16.80**
3 Hour Chicago 100-Year + 20% (Minor System)	**17.26**	17.15
3 Hour Chicago 100-Year + 20% (Major System)	0.53	0.58
Total	**17.79**	**17.73**



AREA ID	CB NAME	ICD TYPE	INVERT	100yr HEAD (m)	100yr FLOW (L/s)
[illegible]	[illegible]	[illegible]	[illegible]	1.69	27
[illegible]	[illegible]	[illegible]	[illegible]	1.69	18
[illegible]	[illegible]	[illegible]	[illegible]	1.64	58
[illegible]	[illegible]	[illegible]	[illegible]	1.64	26
[illegible]	[illegible]	[illegible]	[illegible]	1.60	40
[illegible]	[illegible]	[illegible]	[illegible]	1.60	40
[illegible]	[illegible]	[illegible]	[illegible]	1.48	17
[illegible]	[illegible]	[illegible]	[illegible]	1.48	17
[illegible]	[illegible]	[illegible]	[illegible]	1.56	40
[illegible]	[illegible]	[illegible]	[illegible]	1.56	40
[illegible]	[illegible]	[illegible]	[illegible]	1.17	15
[illegible]	[illegible]	[illegible]	[illegible]	1.65	58
[illegible]	[illegible]	[illegible]	[illegible]	1.65	58
[illegible]	[illegible]	[illegible]	[illegible]	1.52	24
[illegible]	[illegible]	[illegible]	[illegible]	1.52	24
[illegible]	[illegible]	[illegible]	[illegible]	2.17	26
[illegible]	[illegible]	[illegible]	[illegible]	1.59	23
[illegible]	[illegible]	[illegible]	[illegible]	1.59	23
[illegible]	[illegible]	[illegible]	[illegible]	1.60	23
[illegible]	[illegible]	[illegible]	[illegible]	1.60	23
[illegible]	[illegible]	[illegible]	[illegible]	1.61	23
[illegible]	[illegible]	[illegible]	[illegible]	1.61	23
[illegible]	[illegible]	[illegible]	[illegible]	2.42	97
[illegible]	[illegible]	[illegible]	[illegible]	1.66	23
[illegible]	[illegible]	[illegible]	[illegible]	1.66	23
[illegible]	[illegible]	[illegible]	[illegible]	2.34	31
L2044A	L2044A-1	IPEX TEMPEST HF 95mm	86.98	1.61	23
L2044A	L2044A-2	IPEX TEMPEST HF 95mm	86.98	1.61	23
L2044B	L2044B-1	IPEX TEMPEST HF 152mm	86.39	2.40	70
L2045A	L2045A-1	IPEX TEMPEST HF 127mm	87.23	1.67	41
L2045A	L2045A-2	IPEX TEMPEST HF 127mm	87.23	1.67	41
L2045B	L2045B-1	IPEX TEMPEST HF 152mm	86.61	2.43	71
R2-DI17B	L2047A	IPEX TEMPEST HF 95mm	86.16	1.08	18
L2049A	L2049A-1	IPEX TEMPEST HF 127mm	86.64	1.73	43
L2049A	L2049A-2	IPEX TEMPEST HF 127mm	86.64	1.73	43
L2049B	L2049B-1	IPEX TEMPEST HF 127mm	86.07	2.30	48
L2050A	L2050A-1	IPEX TEMPEST HF 152mm	85.73	2.36	67
L2051A	L2051A-1	IPEX TEMPEST HF 127mm	86.49	1.39	38
L2051A	L2051A-2	IPEX TEMPEST HF 127mm	86.49	1.39	38
L2052A	L2052A-1	IPEX TEMPEST HF 127mm	86.83	1.58	40
L2052A	L2052A-2	IPEX TEMPEST HF 127mm	86.83	1.58	40
L2053A	L2053A-1	IPEX TEMPEST HF 108mm	86.77	1.70	30
L2053A	L2053A-2	IPEX TEMPEST HF 108mm	86.77	1.70	30
L2055A	L2055A-1	IPEX TEMPEST HF 95mm	86.74	1.67	23
L2055A	L2055A-2	IPEX TEMPEST HF 95mm	86.74	1.67	23
L2055B	L2055B-1	IPEX TEMPEST HF 127mm	86.41	2.09	46
L2056A	L2056A-1	IPEX TEMPEST HF 83mm	86.67	1.76	18
L2056A	L2056A-2	IPEX TEMPEST HF 83mm	86.67	1.76	18
L2056B	L2056B-1	250mm CIRCULAR ORIFICE	86.09	2.37	196
L2056C	L2056C-1	200mm CIRCULAR ORIFICE	86.00	2.44	126
L2058A	L2058A-1	IPEX TEMPEST HF 127mm	86.47	1.67	41
L2058A	L2058A-2	IPEX TEMPEST HF 127mm	86.47	1.67	41
L2059A	L2059A-1	IPEX TEMPEST HF 102mm	86.84	1.64	26
L2059A	L2059A-2	IPEX TEMPEST HF 102mm	86.84	1.64	26
L2060A	L2060A-1	IPEX TEMPEST HF 95mm	86.93	1.65	23
L2060A	L2060A-2	IPEX TEMPEST HF 95mm	86.93	1.65	23
L2060B	L2060B-1	IPEX TEMPEST HF 178mm	86.50	2.28	94
L2061A	L2061A-1	IPEX TEMPEST HF 83mm	86.93	1.56	17
L2061A	L2061A-2	IPEX TEMPEST HF 83mm	86.93	1.56	17
L2061B	L2061B-1	IPEX TEMPEST HF 127mm	86.41	2.41	49

AREA ID	CB NAME	ICD TYPE	INVERT	100yr HEAD (m)	100yr FLOW (L/s)
L2062A	L2062A-1	IPEX TEMPEST HF 152mm	87.07	1.58	57
L2062A	L2062A-2	IPEX TEMPEST HF 127mm	87.07	1.58	40
L2062B	L2062B-1	IPEX TEMPEST HF 102mm	87.28	1.52	25
L2062B	L2062B-2	IPEX TEMPEST HF 102mm	87.28	1.52	25
L2063A	L2063A-1	IPEX TEMPEST HF 127mm	87.39	1.56	40
L2063A	L2063A-2	IPEX TEMPEST HF 127mm	87.39	1.56	40
L2067A	L2067A-1	IPEX TEMPEST HF 95mm	87.33	1.56	22
L2067A	L2067A-2	IPEX TEMPEST HF 95mm	87.33	1.56	22
L2067B	L2067B-1	IPEX TEMPEST HF 102mm	87.39	1.56	26
L2067B	L2067B-2	IPEX TEMPEST HF 102mm	87.39	1.56	26
L2068A	L2068A-1	IPEX TEMPEST HF 127mm	86.81	1.66	41
L2068A	L2068A-2	IPEX TEMPEST HF 127mm	86.81	1.66	41
L2070A	L2070A-1	IPEX TEMPEST HF 127mm	86.36	2.39	49
L2071A	L2071A-1	IPEX TEMPEST HF 127mm	86.49	2.39	49
L2072A	L2072A-1	IPEX TEMPEST HF 127mm	86.63	2.38	49
L2073A	L2073A-1	IPEX TEMPEST HF 127mm	86.58	2.40	49
L2077A	L2077A-1	IPEX TEMPEST HF 127mm	87.22	1.67	41
L2077A	L2077A-2	IPEX TEMPEST HF 127mm	87.22	1.67	41
L2077B	L2077B-1	IPEX TEMPEST HF 108mm	86.49	2.41	36
L2077C	L2077C-1	IPEX TEMPEST HF 83mm	86.95	2.19	20
L2078A	L2078A-1	IPEX TEMPEST HF 83mm	87.41	1.60	17
L2078A	L2078A-2	IPEX TEMPEST HF 83mm	87.41	1.60	17
L2078B	L2078B-1	IPEX TEMPEST HF 83mm	87.53	1.54	17
L2078B	L2078B-2	IPEX TEMPEST HF 83mm	87.53	1.54	17
L2080A	L2080A-1	IPEX TEMPEST HF 127mm	87.05	1.64	41
L2080A	L2080A-2	IPEX TEMPEST HF 127mm	87.05	1.64	41
L2081A	L2081A-1	IPEX TEMPEST HF 127mm	87.21	1.61	40
L2081A	L2081A-2	IPEX TEMPEST HF 127mm	87.21	1.61	40
L2082A	L2082A-1	IPEX TEMPEST HF 127mm	86.85	1.69	42
L2082A	L2082A-2	IPEX TEMPEST HF 127mm	86.85	1.69	42
L2083A	L2083A-1	IPEX TEMPEST HF 127mm	87.01	1.69	42
L2083A	L2083A-2	IPEX TEMPEST HF 152mm	87.01	1.69	59
L2084A	L2084A-1	IPEX TEMPEST HF 102mm	86.86	1.67	27
L2084A	L2084A-2	IPEX TEMPEST HF 102mm	86.86	1.67	27
L2085A	L2085A-1	IPEX TEMPEST HF 127mm	86.98	1.64	41
L2085A	L2085A-2	IPEX TEMPEST HF 127mm	86.98	1.64	41
L2086A	L2086A-1	IPEX TEMPEST HF 95mm	87.01	1.56	22
L2086A	L2086A-2	IPEX TEMPEST HF 95mm	87.01	1.56	22
L2086B	L2086B-1	IPEX TEMPEST HF 102mm	86.75	1.61	26
L2086B	L2086B-2	IPEX TEMPEST HF 102mm	86.75	1.61	26
L2087A	L2087A-1	IPEX TEMPEST HF 152mm	87.05	1.62	58
L2087A	L2087A-2	IPEX TEMPEST HF 95mm	87.05	1.62	23
L2088B	L2088B-1	IPEX TEMPEST HF 95mm	86.63	2.34	27
L2089A	L2089A-1	IPEX TEMPEST HF 152mm	87.06	1.61	58
L2089A	L2089A-2	IPEX TEMPEST HF 152mm	87.06	1.61	58
L2091A	L2091A-1	IPEX TEMPEST HF 83mm	87.13	1.62	17
L2091A	L2091A-2	IPEX TEMPEST HF 83mm	87.13	1.62	17
L2091B	L2091B-1	IPEX TEMPEST HF 102mm	86.51	2.39	32
L2092A	L2092A-1	IPEX TEMPEST HF 102mm	87.17	1.58	26
L2092A	L2092A-2	IPEX TEMPEST HF 102mm	87.17	1.58	26
L2092B	L2092B-1	IPEX TEMPEST HF 108mm	87.27	1.55	29
L2092B	L2092B-2	IPEX TEMPEST HF 108mm	87.27	1.55	29
L2093A	L2093A-1	IPEX TEMPEST HF 108mm	87.35	1.53	29
L2093A	L2093A-2	IPEX TEMPEST HF 108mm	87.35	1.53	29
L2093B	L2093B-1	IPEX TEMPEST HF 83mm	86.86	2.45	21
L2095A	L2095A-1	IPEX TEMPEST HF 83mm	87.53	1.54	17
L2095A	L2095A-2	IPEX TEMPEST HF 83mm	87.53	1.54	17
L2095B	L2095B-1	IPEX TEMPEST HF 83mm	87.43	1.54	17
L2095B	L2095B-2	IPEX TEMPEST HF 83mm	87.43	1.54	17

Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Legend

- L202A / 1.13 / 0.60 — AREA ID; RUNOFF COEFFICIENT; STORM DRAINAGE AREA ha.
- STORM DRAINAGE BOUNDARY
- EXISTING/FUTURE STORM DRAINAGE BOUNDARY
- S3901 — EXISTING/FUTURE DRAINAGE AREA
- TYPICAL SERVICE LATERAL LOCATION
- TYPICAL SERVICE LATERAL LOCATION(EXISTING)
- DIRECTION OF OVERLAND FLOW
- DIRECTION OF OVERLAND FLOW (EXISTING)
- PROPOSED STORM SEWER
- PROPOSED CATCHBASIN MANHOLE
- PROPOSED CATCHBASIN
- PROPOSED DOUBLE CATCH BASIN
- PROPOSED SUB DRAIN CATCH BASIN AS PER CITY OF OTTAWA STANDARD DETAIL DRAWINGS L10 AND L11.
- PROPOSED PERFORATED SUBDRAIN
- EXISTING STORM SEWER
- EXISTING CATCHBASIN MANHOLE
- EXISTING CATCHBASIN
- EXISTING SUBDRAIN CATCHBASIN
- FUTURE STORM SEWER
- FUTURE CATCHBASIN MANHOLE
- FUTURE CATCHBASIN
- FUTURE SUBDRAIN CATCHBASIN
- CIRCULAR ORIFICE (SEE SEE ICD TABLE)

Notes

3	ISSUED FOR CITY REVIEW	JP	DT	21.10.14
2	ISSUED FOR CITY REVIEW	JP	DT	21.08.31
1	ISSUED TO CITY FOR REVIEW	JP	DT	21.06.16
0	ISSUED TO CITY FOR REVIEW	MJS	DT	20.12.11
Revision		By	Appd.	YY.MM.DD

File Name: 160401250 PH2-3-SD.dwg	JP	MJS	MJS	20.05.06
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

RICHCRAFT GROUP OF COMPANIES
2280 ST. LAURENT BLVD
OTTAWA, ON, K1G 4K1

TRAILSEDGE EAST SUBDIVISION PHASE 2 AND 3
OTTAWA, ON, CANADA

Title

STORM DRAINAGE PLAN

Project No. 160401250

Scale 1:750 — 0, 7.5, 22.5, 37.5m

Drawing No. SD-2

Sheet 47 of 50

Revision 3

D07-16-16-0021

DWG# 17807

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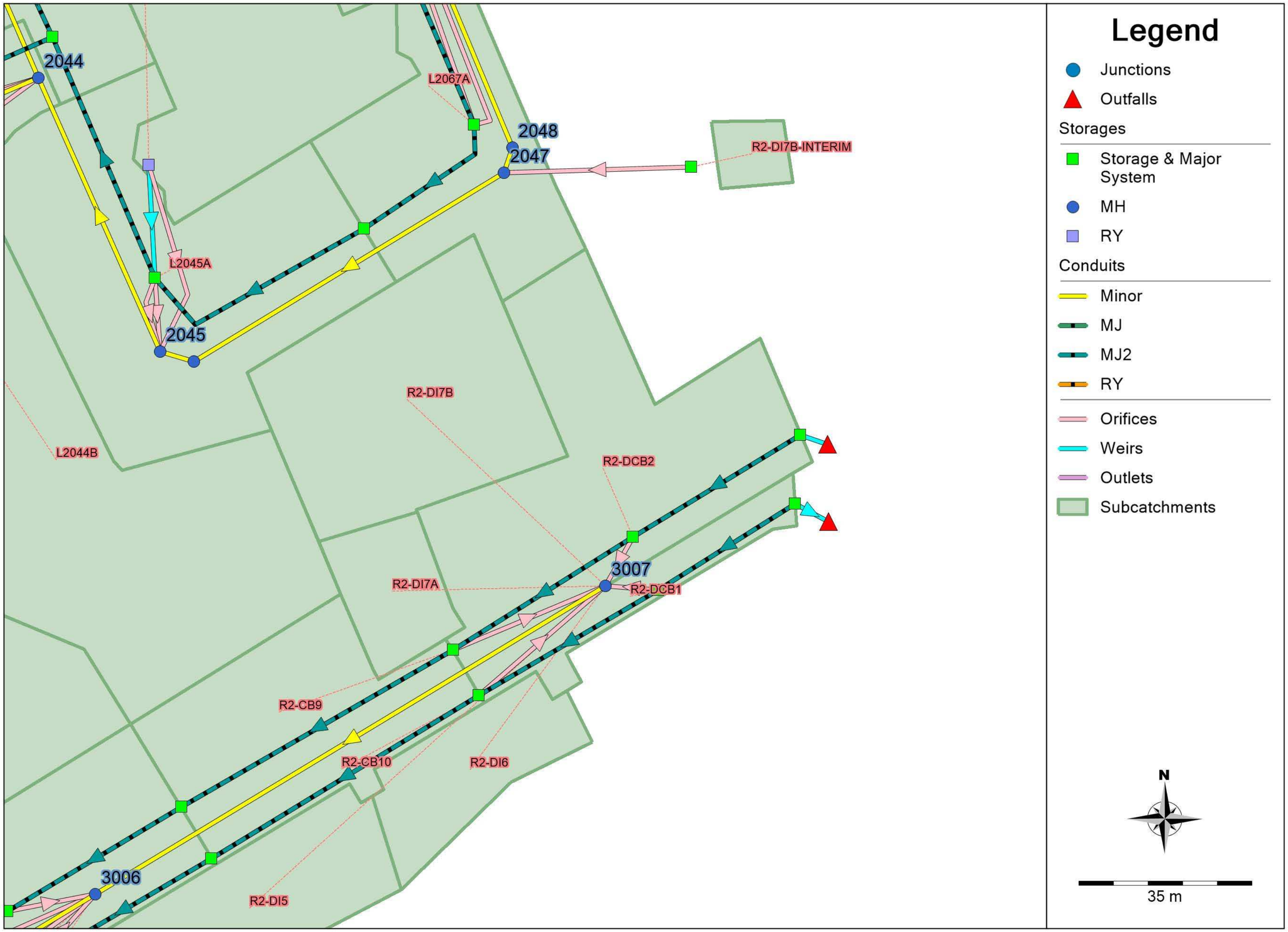

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Legend
Junctions
Outfalls
Storages
Storage & Major System
MH
RY
Conduits
Minor
MJ
MJ2
RY
Orifices
Weirs
Outlets
Subcatchments
N
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Appendix D Geotechnical Report Excerpts

patersongroup

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Noise & Vibration Studies

Geotechnical Investigation

Proposed Residential Development
Trails Edge East - Renaud Road
Ottawa, Ontario

Prepared For

Richcraft Homes

July 29, 2021

Report: PG0861-3
Revision 4

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Atterberg Limits Results
Grain Size Distribution Sheets
Analytical Test Results

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Figure 3 - Surcharge Monitoring Program - Phase 2
Figure 4 - Surcharge Monitoring Program - Phases 2 and 3
Figure 5 - Surcharge Monitoring Program - Phase 3
Drawing PG0861-6 - Test Hole Location Plan
Drawing PG0861-7 - Tree Planting Setback Recommendations

1.0 Introduction

Paterson Group (Paterson) was commissioned by Richcraft Homes (Richcraft) to conduct a geotechnical investigation for the proposed Trails Edge East residential development, to be located along Renaud Road in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

- ❑ determine the subsoil and groundwater conditions at this site by means of test holes.

- ❑ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

It is understood that the proposed development will consist of residential dwellings, parking areas, local roadways and parkland areas. It is further understood that the development will be fully municipally serviced once completed.

The subject site is located at the northwest corner of Renaud Road and Mer Bleue Road.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the investigation was carried out on October 14, 15, 16 and 24, 2008. At that time, ten (10) boreholes and ten (10) test pits were completed across the subject site. The test hole locations were distributed across the site in a manner to provide general coverage of the subject site. The locations of the test holes are shown on Drawing PG0861-6 - Test Hole Location Plan included in Appendix 2.

Eleven (11) additional boreholes were drilled on May 8, 9 and 10, 2017 within the east portion of the site. A supplementary soils review was also carried out on July 10, 2018 which included nineteen (19) additional test pits across the subject site.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew. The test pits were excavated using a rubber tired backhoe. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer. The testing procedure consisted of either augering or excavating to the required depths and at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler, using 73 mm diameter thin walled (TW) Shelby tubes in conjunction with a piston sampler, or the auger flights and as grab samples from the sidewalls of the test pits. All soil samples were visually inspected and initially classified on site. The split-spoon samples were placed in sealed plastic bags and the Shelby tubes were sealed at both ends on site. All samples were transported to our laboratory for further examination and classification. The depths at which the split-spoon, Shelby tube, auger and grab samples were recovered from the test holes are shown as SS, TW, AU and G, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The thickness of the silty clay layer was evaluated during the course of the investigation by a dynamic cone penetration test (DCPT) at BH 12-08 and BH 17-08. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Undrained shear strength testing was carried out in cohesive soils using a field vane apparatus.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Flexible standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Groundwater infiltration levels were noted at the time of excavation at the test pit locations.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The test hole locations were selected by Paterson personnel to provide general coverage of the site. The boreholes were located in the field by Stantec Geomatics (Stantec) and the test pits were located in the field by Paterson personnel. The ground surface elevations at the test hole locations were determined by Stantec. It is understood that the elevations are referenced to a geodetic datum.

The test hole locations and the ground surface elevation at each test hole location are presented on Drawing PG0861-6 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging.

A total of seven (7) Shelby tube samples were submitted for unidimensional consolidation and Atterberg limits testing.

The results of the consolidation and Atterberg limits testing are presented on the Consolidation Test and Atterberg Limits' Results sheets, respectively, presented in Appendix 1 and are further discussed in Sections 4 and 5.

Additional soil review was carried out in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) and included additional laboratory testing, including nineteen (19) Atterberg limits tests, six (6) grain size distribution (sieve and hydrometer analysis) and one (1) shrinkage limit test. The results are summarized in Section 4 and are further discussed in Subsection 6.8.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentrations of sulphate and chloride, the resistivity and the pH of the soil. The results are shown in Appendix 1 and are further discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently undeveloped and the original ground surface is relatively flat. However, currently the majority of the original ground surface is covered with several fill piles as part of an on-going settlement surcharge program. The majority of the fill material for the surcharge program was placed in 2015 to early 2016. However, a topsoil fill pile was originally placed in May 2011 (SP 1 to SP 9) within the south portion of the site. Additional fill material was placed over the existing topsoil pile as part of the current surcharge program in May 2015. Also, additional fill is still required for the area adjacent to several of the settlement plate locations (SP 25 to SP 28). The approximate outline of the existing surcharge fill piles are presented in Drawing PG0861-6 - Test Hole Location Plan in Appendix 2.

4.2 Subsurface Profile

Generally, the soil conditions encountered at the test hole locations consist of topsoil and/or a thin silty sand layer overlying a deep silty clay deposit. Practical refusal to DCPT was observed at depths of 18.9 and 23.7 m at BH 12-08 and BH 17-08, respectively. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Based on available geological mapping, the bedrock in this area mostly consists of interbedded limestone and shale of the Lindsay formation with an overburden drift thickness of 25 to 50 m depth.

Silty Clay

The upper portion of the silty clay has been weathered to a brown crust at all test hole locations. Grey silty clay was encountered below the brown silty clay crust at all test hole locations. In situ shear vane field testing conducted within the grey silty clay layer yielded undrained shear strength values ranging from 15 to 55 kPa. These values are indicative of a very soft to stiff consistency.

Six (6) silty clay samples collected at this site were subjected to unidimensional consolidation testing. The results are presented in Appendix 1, and summarized in Table 5 in Subsection 5.3. The results indicate that the silty clay is overconsolidated with overconsolidation ratios varying between 1.6 and 3.3. The natural water content of grey silty clay ranged from 72 to 96%.

Atterberg limits testing was completed on the recovered silty clay samples at selected locations throughout the subject site and associated moisture contents on the submitted soil samples. The results of Atterberg Limits tests conducted on samples of silty clay are presented in Table 1 and on the Atterberg Limits Results sheets in Appendix 1. The tested silty clay samples classify as inorganic clays of low plasticity (CL) and high plasticity (CH) in accordance with the Unified Soil Classification System.

Table 1
Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
BH 15-08 TW 2	4.91	66	28	38	84	CH
BH 17-08 TW 3	4.11	77	29	48	96	CH
TP1-18	0.48	72	18	54	34	CH
TP2-18	0.59	62	24	38	38	CH
TP3-18	0.76	63	22	41	44	CH
TP4-18	1.14	66	21	44	38	CH
TP5-18	4.19	72	20	52	39	CH
TP6-18	3.68	66	20	46	37	CH
TP7-18	0.49	65	23	42	46	CH
TP8-18	3.55	62	19	43	34	CH
TP9-18	1.25	68	22	46	44	CH
TP10-18	0.72	76	20	55	44	CH
TP11-18	0.73	68	19	49	40	CH
TP12-18	1.52	66	21	45	38	CH
TP13-18	2.7	48	16	32	29	CL
TP14-18	1.35	66	22	43	41	CH
TP15-18	3.72	70	21	48	32	CH
TP16-18	4.18	52	19	33	44	CH
TP17-18	1.3	77	20	57	34	CH
TP18-18	0.5	64	23	41	48	CH
TP19-18	0.52	62	22	40	46	CH

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content;
CL: Clay of Low Plasticity; CH: Clay of High Plasticity

The results of the shrinkage limit test indicate a shrinkage limit of 20% and a shrinkage ratio of 1.76.

Grain size distribution (sieve and hydrometer analysis) was also completed on six (6) selected samples. The results of the grain size analysis are presented in Table 2 below and on the Grain Size Distribution Results sheets in Appendix

Table 2 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP2-18	G1	0	1.4	29.1	69.5
TP7-18	G1	0	0.7	24.8	74.5
TP10-18	G1	0	0.2	21.3	78.5
TP12-18	G1	0	1.1	23.9	75
TP17-18	G1	0	1.5	29	69.5
TP19-18	G1	0	0.3	22.2	77.5

4.3 Groundwater

The measured groundwater levels in the boreholes and the open hole groundwater levels observed in the test pits are presented in Table 2. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

Table 3
Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 12-08	87.62	5.60	82.02	October 23, 2008
BH 13-08	87.38	6.30	81.08	October 23, 2008
BH 14-08	87.03	1.45	85.58	October 23, 2008
BH 15-08	87.24	6.10	81.14	October 23, 2008
BH 16-08	86.88	3.20	83.68	October 23, 2008
BH 17-08	87.41	0.45	86.96	October 23, 2008
BH 18-08	87.29	0.75	86.54	October 23, 2008
BH 19-08	86.80	0.80	86.00	October 23, 2008
BH 20-08	87.11	0.84	86.27	October 23, 2008

Table 3 (Continued)
Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 21-08	87.02	5.50	81.52	October 23, 2008
TP 17-08	87.62	Dry	-	October 24, 2008
TP 18-08	87.38	1.50	85.88	October 24, 2008
TP 19-08	87.03	1.60	85.43	October 24, 2008
TP 20-08	87.24	3.00	84.24	October 24, 2008
TP 21-08	86.88	2.30	84.58	October 24, 2008
TP 22-08	87.41	1.20	86.21	October 24, 2008
TP 23-08	87.29	1.50	85.79	October 24, 2008
TP 24-08	86.80	1.30	85.50	October 24, 2008
TP 25-08	87.11	1.00	86.11	October 24, 2008
TP 26-08	87.02	2.90	84.12	October 24, 2008

5.0 Discussion

5.1 Geotechnical Assessment

Generally, the subject site is acceptable from geotechnical perspective for the proposed residential development. Due to the presence of the sensitive silty clay layer, the subject site will be subjected to grade raise restrictions. Based on the finished grading currently proposed for the subject site, a settlement surcharge monitoring program has been designed for the subject phases. The settlement surcharge program was designed to eliminate the excessive settlement anticipated due to the proposed grading and the underlying silty clay deposit.

A settlement surcharge program has been completed for Phase 1 and the majority of Phases 2 and 3, and these areas are outlined on Drawing PG0861-6 - Test Hole Location Plan in Appendix 2. A detailed grading summary (Paterson Group Memo PG0861-MEMO.43 dated July 29, 2021) has been provided on a lot by lot basis. Any lots/blocks requiring lightweight fill due to grading exceedances are detailed in the summary table, which has been issued as part of the Sensitive Soil Protocol required by the City of Ottawa Building Permit department.

Several lots/blocks within the central portion of Phase 2, for which a surcharge settlement program has been completed, will require lightweight fill due to the minimal surcharge heights observed within areas of this overall surcharge pile. The specific details for the lightweight fill for these areas are outlined in our detailed grading summary table, as previously noted.

The periodic monitoring results from our settlement monitoring program to date are presented in Figures 2 through 5 - Settlement Surcharge Monitoring Program in Appendix 2.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

5.3 Foundation Design

Based on the results of the geotechnical investigation, lightly loaded structures, such as the residential buildings anticipated, could be founded on shallow footings bearing on stiff brown silty clay crust.

Bearing Resistance Values

Based on the subsurface profile encountered, it is expected that stiff silty clay will be encountered at the founding levels of the proposed structures.

Using continuously applied loads, strip footings, up to 2 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **100 kPa** and a factored bearing resistance values at ultimate limit states (ULS) of **200 kPa**.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Bearing resistance values for footing designs should be determined on a lot per lot basis at the time of construction.

Settlement/Grade Raise

Consideration must also be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied. For dwellings, a minimum value of 50% of the live load is often recommended by Paterson.

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. Seven (7) site specific consolidation tests were carried out for this project. The results of the consolidation tests are presented in Table 4 and in Appendix 1.

Value p'_c is the preconsolidation pressure of the sample and p'_o is the effective overburden pressure. The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater should not exceed the available preconsolidation if unacceptable settlements are to be avoided.

The values C_{cr} and C_c are the recompression and compression indices, respectively, and are a measure of the compressibility of the soil due to stress increases below and above the preconsolidation pressures. The higher values for the C_c, as compared to the C_{cr}, illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

Table 4
Summary of Consolidation Test Results

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 3	TW 3	3.48	145	47	0.048	2.478	A
BH 3	TW 5	6.53	103	64	0.043	2.967	A
BH 3	TW 7	9.6	175	82	0.028	3.046	A
BH 12-08	TW 4	9.4	109	68	0.031	3.080	A
BH 13-08	TW 2	3.42	142	43	0.025	1.334	A
BH 15-08	TW 2	4.91	87	50	0.028	1.890	A
BH 17-08	TW 3	4.11	100	42	0.034	3.750	A
BH 19-08	TW 3	4.9	99	43	0.026	3.100	A
BH 21-08	TW 4	4.19	89	50	0.041	3.172	A

* - Q - Quality assessment of sample - G: Good A: Acceptable P: Likely disturbed

It should be noted that the values of p'_c, p'_o, C_{cr} and C_c are determined using standard engineering practices and are estimates only. In addition, natural variations within the soil deposit would also affect the results. Furthermore, the p'_o parameter is directly influenced by the groundwater level. While the groundwater levels were measured at the time of the fieldwork, the levels vary with time and this has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The long-term groundwater table was used to determine the p'_o parameter, which was determined at each borehole location based on the colouring and moisture levels of the recovered soil samples and undrained shear strength profile of the silty clay.

To reduce potential long term liabilities, it is recommended to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, etc). It should be noted that building on silty clay deposits increases the likelihood of building movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking as compared to unreinforced foundations.

For building design purposes, the total and differential settlements are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed for our permissible grade raise calculations.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a stiff to firm silty clay above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

5.4 Settlement Surcharge Monitoring Program

Based on our current settlement survey information and existing soils information, a permissible grade raise restriction of **1.4 m** is recommended for housing and a permissible grade raise of **1.7 m** is recommended for roadways, where a settlement surcharge program is not planned, completed or currently underway. It is expected that any roadways in exceedance of our permissible grade raise recommendations will be surcharged. However, lightweight fill can be used for the buildings for raising the grade without adding a significant load to the underlying soils.

A settlement surcharge monitoring program was completed for Phase 1 and portions of Phases 2 and 3. The lightweight fill recommendations for Phases 2 and 3 have been updated based on the results of the settlement surcharge monitoring programs.

Settlement monitoring data showing cumulative settlement over the course of the surcharge program for Phases 1, 2 and 3 is presented in Figure 2 to Figure 5 in Appendix 2. The surcharge pile locations are shown on Drawing PG0861-6 - Test Hole Location Plan in Appendix 2.

5.5 Design for Earthquakes

The proposed site can be taken as seismic site response **Class E** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A) for shallow foundations considered at this site. The soils underlying the site are not susceptible to liquefaction.

5.6 Basement Floor Slab

With the removal of all topsoil and fill containing organic matter within the footprints of the proposed buildings, the undisturbed native soil surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type I or II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone.

5.7 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of driveways and local residential streets. It should be noted that for residential driveways and car only parking areas, an Ontario Traffic Category A is applicable. For local roadways, an Ontario Traffic Category B should be used for design purposes.

Table 5 - Recommended Pavement Structure - Driveways

Thickness (mm)	Material Description
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 6 - Recommended Pavement Structure - Local Residential Roadways

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 7 - Recommended Pavement Structure - Roadways with Bus Traffic	
Thickness (mm)	**Material Description**
40	**Wear Course** - Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course** - Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
600	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment. It is recommended that a compaction level between 91% and 96.5% be provided for Superpave 19.0. A compaction level between 92% to 97.5% be provided for Superpave 12.5.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction. These drains should be installed at each catch basin, be at least 3 m long and should extend in four orthogonal directions or longitudinally when placed along a curb. Along local streets, the drains should be placed along the edges of the pavement. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for proposed structures. The system should consist of a 100 to 150 mm diameter, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The site materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Platon or Miradrain G100N) connected to a drainage system is provided.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover (or equivalent) should be provided in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

The excavation for the proposed development will be mostly through silty clay. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. The lowermost 1.2 m can be vertical provided the material consists of stiff in situ silty clay. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by "cut and cover" methods and excavations will not be left open for extended periods of time.

It is expected that deep service trenches in excess of 3 m will be completed using a temporary shoring system designed by a structural engineer, such as stacked trench boxes in conjunction with steel plates. The trench boxes should be installed to ensure that the excavation sidewalls are tight to the outside of the trench boxes and that the steel plates are extended below the base of the excavation to prevent basal heave (if required).

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

Excavation Base Stability

The base of supported excavations can fail by three (3) general modes:

❑ Shear failure within the ground caused by inadequate resistance to loads imposed by grade difference inside and outside of the excavation,
❑ Piping from water seepage through granular soils, and
❑ Heave of layered soils due to water pressures confined by intervening low permeability soils.

Shear failure of excavation bases is typically rare in granular soils if adequate lateral support is provided. Inadequate dewatering can cause instability in excavations made through granular or layered soils. The potential for base heave in cohesive soils should be determined for stability of flexible retaining systems.

The factor of safety with respect to base heave, FS_b, is:

$$FS_b = N_b s_u / \sigma_z$$

where:

N_b - stability factor dependent upon the geometry of the excavation and given in Figure 1 on the following page.
s_u - undrained shear strength of the soil below the base level
σ_z - total overburden and surcharge pressures at the bottom of the excavation

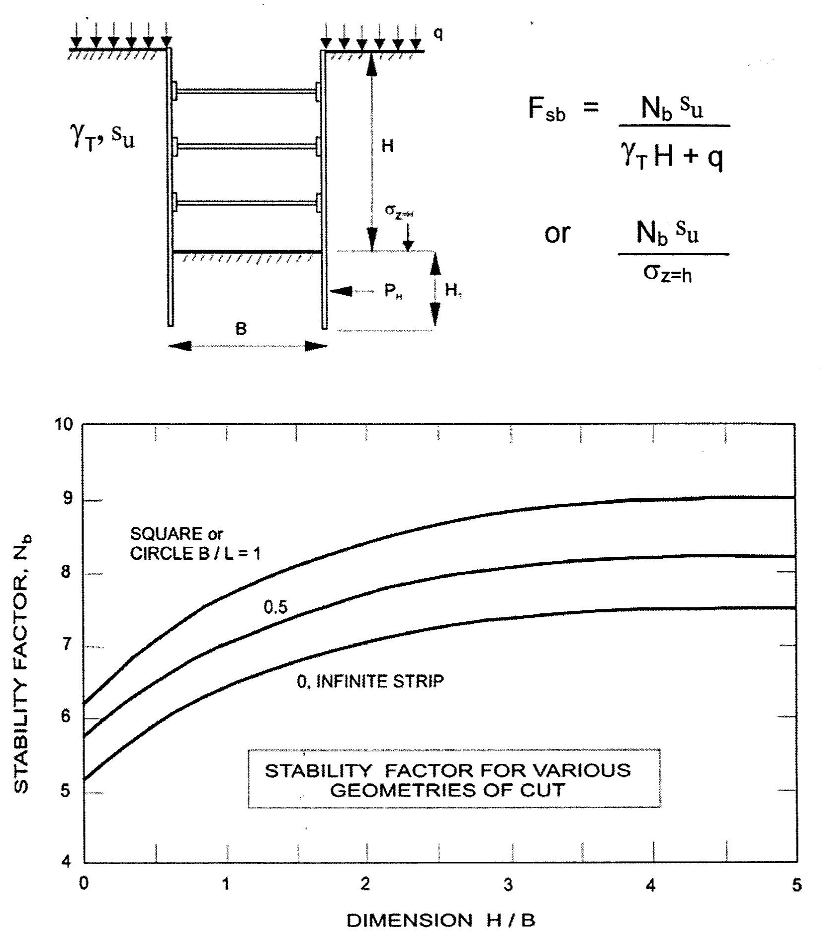

Figure 1 - Stability Factor for Various Geometries of Cut

In the case of soft to firm clays, a factor of safety of 2 is recommended for base stability.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within the soft to firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extent at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The clay seals should be as per Standard Drawing No. S8 of the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa. The seals should be at least 1.5 m long (in the trench direction), as compared to the 1 m minimum in the detail, and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment and Climate Change (MOECC) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MOECC.

For typical ground or surface water volumes, being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MOECC review of the PTTW application.

6.6 Winter Construction

The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be carried out in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing indicate that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of an aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Restrictions

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Sieve analysis testing was also completed on selected soil samples. The abovenoted test results were completed between design underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Table 1 in Subsection 4.1 and in Appendix 1.

Based on the results of our review, the two tree planting setback areas are present within the proposed development. The two areas are detailed below and have been outlined in Drawing PG0861-7 - Tree Planting Setback Recommendations presented in Appendix 2.

Area 1 - Low to Medium Sensitivity Area

A low to medium sensitivity clay soil was encountered between design underside of footing elevations and 3.5 m below finished grade as per City Guidelines at the areas outlined in Drawing PG0861-7 - Tree Planting Setback Recommendations in Appendix 2. Based on our Atterberg Limits test results, the modified plasticity limit does not exceed 40% in these areas.

The following tree planting setbacks are therefore recommended for the low to medium sensitivity area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the conditions noted below are met.

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan.

- ❑ A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- ❑ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- ❑ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- ❑ Grading surround the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Area 2 - High Sensitivity Area

A high sensitivity clay soil was encountered between design underside of footing elevations and 3.5 m below finished grade as per City Guidelines at the areas outlined in Drawing PG0861-7 - Tree Planting Setback Recommendations in Appendix 2. Based on our Atterberg Limits test results, the modified plasticity limit generally exceeds 40%. The following tree planting setbacks are recommended for these high sensitivity areas. Large trees (mature height over 14 m) can be planted within these provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits is 7.5 m for small (mature tree height up to 7.5m) provided that the following conditions are met:

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan.

- ❑ A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- ❑ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- ❑ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- ❑ Grading surround the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Aboveground Swimming Pools, Hot Tubs, Decks and Additions

The in-situ soils are considered to be acceptable for in-ground swimming pools. Above ground swimming pools must be placed at least 5 m away from the residence foundation and neighbouring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Additional grading around the hot tub should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

7.0 Recommendations

It is recommended that the following be carried out once the master plan and site development are determined:

- ❏ Review master grading plan from a geotechnical perspective, once available.
- ❏ Review detailed grading plan(s) from a geotechnical perspective.
- ❏ Observation of all bearing surfaces prior to the placement of concrete.
- ❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❏ Observation of all subgrades prior to backfilling.
- ❏ Field density tests to ensure that the specified level of compaction has been achieved.
- ❏ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request permission to review the grading plan once available. Also, our recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Richcraft Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
July 29-2021
D. J. GILBERT
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PROVINCE OF ONTARIO

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