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FUNCTIONAL SERVICING REPORT

FOR

VILLAGE OF RICHMOND

MATTAMY HOMES

CITY OF OTTAWA

PROJECT NO.: 17-977

FEBRUARY 1, 2019 – REV 6

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FUNCTIONAL SERVICING REPORT
FOR
MATTAMY HOMES OTTAWA
VILLAGE OF RICHMOND

FEBRUARY 1, 2019 – REV 6

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1.0 INTRODUCTION

Mattamy Homes Ottawa have retained David Schaeffer Engineering Ltd. (DSEL) to prepare a Functional Servicing Report (FSR) in support of their application for draft plan approval.

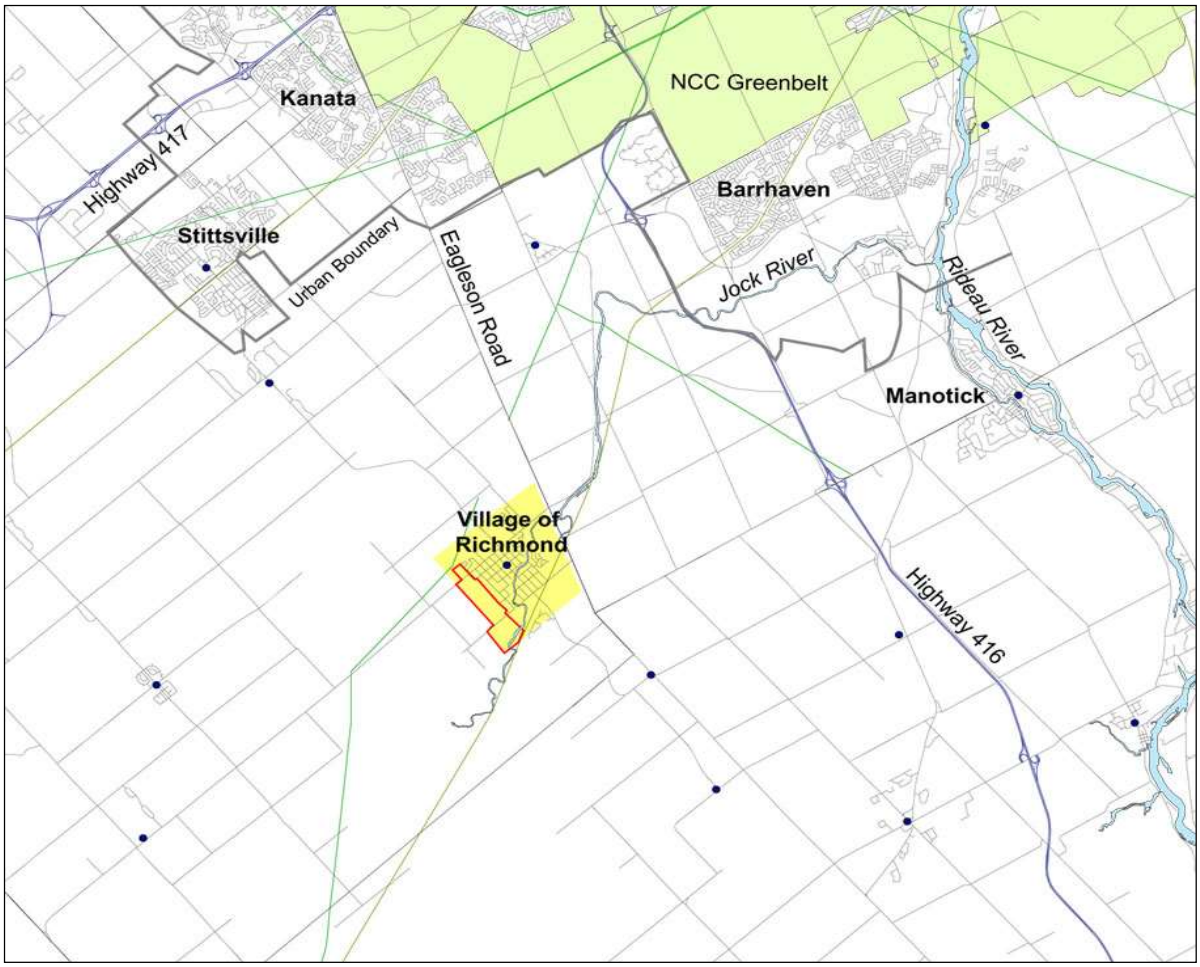

Figure 1: Location of the Village of Richmond

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Mattamy Homes Ottawa is proposing a residential development within the Village of Richmond Western Development Lands (WDL). The subject property measures approximately ***66 ha*** and is located west of the existing Village of Richmond, South of Perth Street and extends to the Jock River. ***Figure 1*** illustrates the subject lands in the context of the City of Ottawa urban boundary. ***Figure 2*** provides site context within the Village of Richmond.

The draft plan contemplates approximately ***1098 units*** comprised of single detached dwellings and attached dwellings (townhomes and back-to-back units). The proposed subdivision layout is depicted on ***Figure 4*** included in ***Figures*** appended to this report.

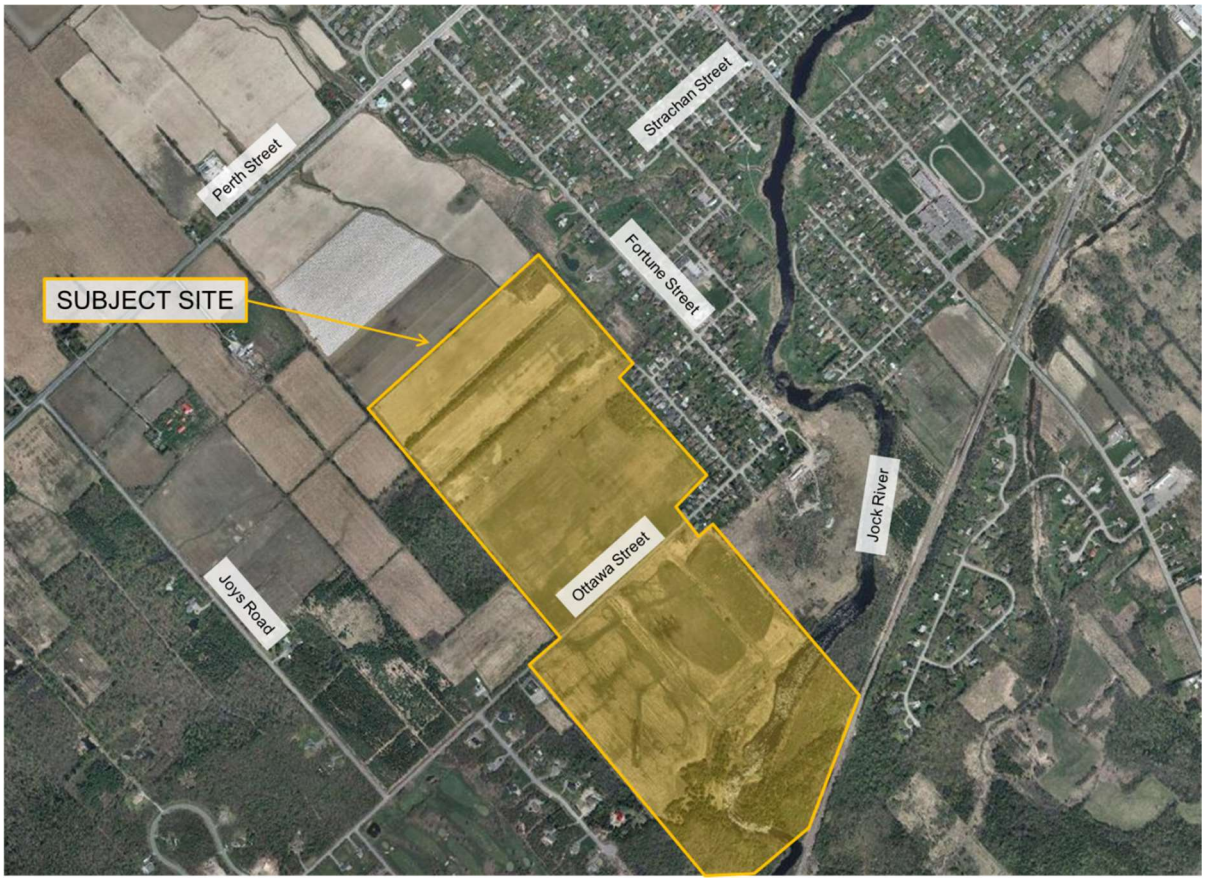

Figure 2: Site Context within Richmond

This FSR is provided to demonstrate conformance with the design criteria of the City of Ottawa, the Background Studies, and general industry practice.

The ***Master Drainage Plan Western Development Lands for Richmond Village (South) Limited*** prepared by David Schaeffer Engineering Ltd., dated November 2013 (***MDP***) proposed the site to be serviced by two stormwater management ponds (Pond 1 and Pond 2). However, due to updated storm guidelines as per Technical Bulletin PIEDTB-2016-01 (September 6, 2016), the storm design has been updated for the entire

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site to be serviced by SWM Pond 1 as shown on ***Drawing 2*** in the ***Drawings*** section and Pond 2 is eliminated from the design.

The Laffin Lands, located in the northeast corner of the site where the Pond 2 was originally proposed, are not part of this development, but they have been included as external development lands for design purposes. In the ***MDP***, the 7.08 ha Laffin Lands included the 2.75 ha Pond 2 block. As such, the population for the Laffin Lands was then 260 people, based on only 4.33 ha that could be developed and a 60 person/ha assumption. With the elimination of Pond 2, the entire Laffin Lands is developable with the drainage block being increased to 7.18 ha and the proposed design using an 80 person/ha assumption. The population for the proposed design for the Laffin Lands is 575 people.

1.1 Existing Conditions

The terrain is relatively flat and the majority has been cleared of trees, with the exception of a number of hedgerows around the periphery of the site. A forested area measuring approximately 1.0 ha exists north of Ottawa Street along the eastern property boundary.

The lands to the west are located outside of the Village boundary and are predominantly occupied by agricultural uses. An estate lot subdivision, Jock River Estates, is situated west of the subject lands, south of Ottawa Street. The lands to the east are predominantly built out at varying residential densities. The lands immediately to the north are owned by the Richmond Village Development Corporation (RVDC) and are draft plan approved with detailed design and construction underway.

The proposed development is located within the jurisdiction of the Rideau Valley Conservation Authority (RVCA). The Richmond development is located within the Jock River sub-watershed and is connected to the Jock River via the Arbuckle Drain. The area south of Ottawa Street naturally drains directly into the Jock River.

Existing ground elevations are between 94.00 m to 97.80 m. The site consists of agricultural lands and lands formerly used for agricultural purposes. As per the ***Geotechnical Investigation Report PG4683-1*** prepared by Paterson Group on December 18, 2018 ***(Geotechnical Investigation)***, the north portion of the site consists of a silty clay layer which is subject to a grade raise restriction of 2.0 m. The south and central portion consists of shallow bedrock and no grade raise restriction is required.

The RVCA completed floodplain mapping for the Jock River in November 2004.

Figure 3 was extracted from the Jock River Flood Risk Map and illustrates a significant portion of the subject lands south of Ottawa Street within the Regulatory Flood Limit.

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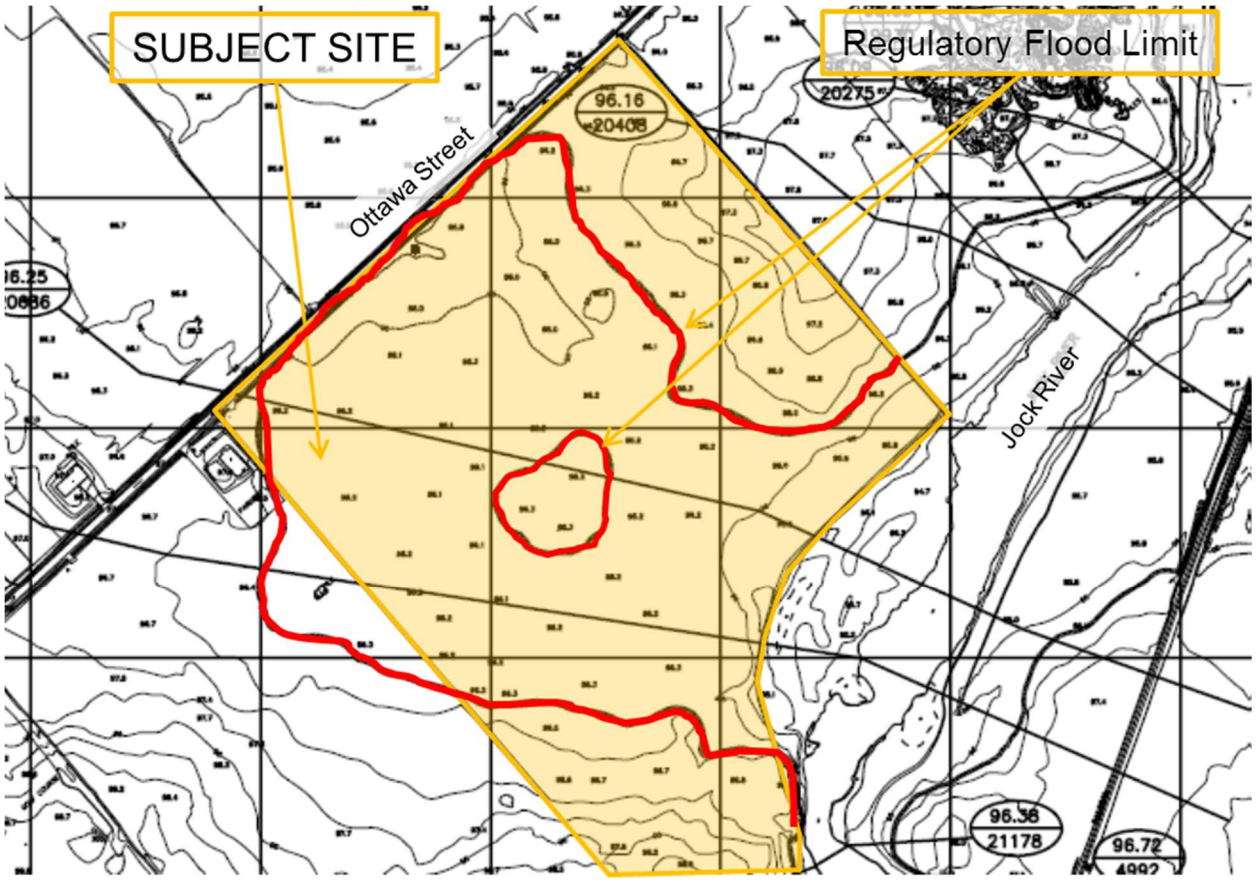

Figure 3: Regulatory Floodplain Mapping – Jock River

In December 2005, a letter of permission was issued by the RVCA to the original landowner for the construction of a berm to maintain flood risk mapping land levels as per (the 1980 Acres Floodplain) Mapping Study (96.0 m) south of Ottawa Street. On March 3, 2009, the RVCA issued a letter of permission, included in ***Appendix A***, authorizing works to be conducted based on past approvals granted on the property. The authorized works involved the removal of the existing berm and relocation to the approved 2005 location. The existing flap gate and culvert from the drainage easement are to be removed. The berm will also extend parallel along both sides of the drainage easement north up to Ottawa Street. The permission letter also includes the placement of fill between the new berm and Ottawa Street to a maximum level of 96.5 m.

It is acknowledged that the RVCA letter of permission, dated March 3, 2009, is almost 10 years old and as such, the letter is considered expired. Mattamy, DSEL and JFSA met with the RVCA on October 31, 2018 where the RVCA confirmed that the revised proposal can move forward with the same submission as what was proposed in the March 3, 2009 permission letter.

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DSEL will prepare and submit an updated proposal under Ontario Regulation 174/06 to move forward with the draft plan application and the amendment to the floodplain mapping.

1.2 Summary of Pre-consultation

The following provides a summary of pre-consultation to date.

1.2.1 City of Ottawa

The following is a list of the pre-consultation meetings with the City of Ottawa for the Richmond site:

- November 6, 2012 – a formal Pre-Application Consultation with Municipal Staff for the Village of Richmond Subdivision. The intent of the meeting was to discuss the proposed development, review technical considerations and identify/confirm studies required to accompany the submission of a Plan of Subdivision application and Zoning By-Law Amendment.

- October 26, 2017 – a meeting occurred with Mattamy Homes and City Staff to discuss reactivating the file.

- October 17, 2018 – a meeting occurred with Mattamy Homes, Fotenn and City Staff to discuss the comments provided on the latest draft plan submission.

Copies of all the above noted pre-consultation minutes are enclosed in ***Appendix A*** for reference.

1.2.2 Rideau Valley Conservation Authority (RVCA)

The subject site is within the jurisdiction of the Rideau Valley Conservation Authority (RVCA). Mattamy, DSEL and JFSA met with the RVCA on October 31, 2018 where they confirmed that the revised proposal can move forward with the same submission as what was proposed in the March 3, 2009 permission letter. The relocation of the Moore Drain was also discussed and deemed appropriate. The RVCA noted it should be a fairly straightforward ditch with features and improvements such as a low flow channel and plantings.

1.2.3 Ministry of Environment, Conservation and Parks (MECP)

MECP pre-consultation relating to the pond expansion will be forthcoming.

1.3 Existing Permits / Approvals

The existing approvals, related to the Mattamy Richmond development, are presented in ***Table 1*** and the approvals are enclosed in ***Appendix A***.

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Table 1: Existing Permits / Approvals

Agency	Approval Type	Approval Number	Remarks
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	1060-AY8JK4 (May 30, 2018)	Interim Stormwater Management Pond 1, which includes a portion of the Mattamy Richmond Lands. Relocation of Arbuckle Municipal Drain.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	5426-A5PMR (January 6, 2016)	Martin Street Sanitary Trunk Sewer for conveyance of sanitary flows from the WDL development area.
Rideau Valley Conservation Authority (RVCA)	Alteration of Waterways Permit under O.Reg. 174/06	RV5-22/16T (October 8, 2016)	Authorization related to the construction of the proposed Stormwater Management Pond 1, located partially within the Regulatory Floodplain of the Jock River and Arbuckle Municipal Drain.
Department of Fisheries and Oceans (DFO)			Self-assessment to confirm that work related to the development associated with the WDL in the vicinity of the Arbuckle Drain and Moore Branch

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1.4 Required Permits / Approvals

Mattamy Richmond is subject to the following permits and approvals, presented in ***Table 2***.

Table 2: Required Permits / Approvals

Agency	Approval Type	Trigger	Remarks
City of Ottawa	Commence Work Notification (CWN)	Construction of new sanitary and storm sewers throughout the subdivision.	The City of Ottawa will issue a commence work notification for construction of the sanitary and storm sewers once an ECA is issued by the MECP.
City of Ottawa	MECP Form 1 – Record of Watermains Authorized as a Future Alteration	Construction of watermains throughout the subdivision.	The City of Ottawa is expected to review the watermains on behalf of the MECP through the Form 1 – Record of Watermains Authorized as a Future Alteration.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval for sanitary and storm sewers	Construction of new sanitary and storm sewers throughout the subdivision.	The MECP will review the sanitary and storm sewer design through the City of Ottawa transfer of review process.
Ministry of the Environment, Conservation and Parks (MECP)	Amendment to Environmental Compliance Approval for the Interim Stormwater Management Pond 1	Construction of the interim stormwater management pond (Interim Pond 1).	The ECA application for the stormwater management pond has been processed by the City of Ottawa through the transfer of review program and is at the MECP for final approval.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval for the Ultimate Stormwater Management Pond 1	Construction of the ultimate stormwater management pond (Ultimate Pond 1).	The ECA application for the stormwater management pond will be processed by the City of Ottawa through the transfer of review program to the MECP for final approval.
Rideau Valley Conservation Authority (RVCA)	Permit under Ontario Regulation 174/06, RVCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. Required for new outlet to the Jock River.	Construction of the clean water pipe on Ottawa Street to the Jock River.	Authorization related to the construction of a new outlet to the Jock River.

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Agency	Approval Type	Trigger	Remarks
Rideau Valley Conservation Authority (RVCA)	Permit under Ontario Regulation 174/06, RVCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. Required for the realignment of the Moore Drain.	Construction of the realigned Moore Drain.	Authorization related to the relocation of the Moore Drain through the site.
Rideau Valley Conservation Authority (RVCA)	Permit under Ontario Regulation 174/06, RVCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. Required for amendment to the floodplain limit south of Ottawa Street.	Construction within the existing floodplain.	Permission required to construct within the flood plain. Once work is completed, updated survey will be coordinated with the RVCA to update the flood plain mapping.

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2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report.

- **Ottawa Sewer Design Guidelines,**
  City of Ottawa, October 2012.
  (Sewer Design Guidelines)
    - Technical Bulletin ISDTB-2014-01
      City of Ottawa, February 5, 2014
      (ITSB-2014-01)
    - Technical Bulletin PIEDTB-2016-01
      City of Ottawa, September 6, 2016
      (PIEDTB-2016-01)
    - Technical Bulletin ISTB-2018-01
      City of Ottawa, March 21, 2018
      (ISTB-2018-01)
    - Technical Bulletin ISTB-2018-04
      City of Ottawa, June 27, 2018
      (ISTB-2018-04)
- **Ottawa Design Guidelines – Water Distribution**
  City of Ottawa, July 2010
  (Water Supply Guidelines)
    - Technical Bulletin ISD-2010-2
      City of Ottawa, December 15, 2010.
      (ISD-2010-2)
    - Technical Bulletin ISDTB-2014-2
      City of Ottawa, May 27, 2014.
      (ISDTB-2014-2)
    - Technical Bulletin ISTB-2018-02
      City of Ottawa, March 21, 2018
      (ISTB-2018-02)
- **Stormwater Planning and Design Manual**
  Ministry of the Environment, March 2003.
  (SWMP Design Manual)
- **Erosion & Sediment Control Guidelines for Urban Construction**
  Greater Golden Horseshoe Area Conservation Authorities, December 2006
  (E&S Guidelines)

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- **Ontario Building Code Compendium**
  Ministry of Municipal Affairs and Housing Building Development Branch, January 1, 2010 Update
  (OBC)

- **Village of Richmond Water and Sanitary Master Servicing Study**
  Stantec Consulting Ltd., July 2011
  (MSS)

- **Village of Richmond Community Design Plan**
  City of Ottawa, July 2010
  (CDP)

- **Preliminary Geotechnical Investigation Report, Proposed Residential Subdivision Perth and Ottawa Streets Richmond Area, Ottawa, ON.**
  Jacques Whitford Consultants, June 2007
  (Preliminary Geotechnical Investigation)

- **Geotechnical Investigation, Proposed Residential Development – Richmond Subdivision**
  Paterson Group Inc., December 18, 2018
  (Geotechnical Investigation)

- **Master Drainage Plan Western Development Lands for Richmond Village (South) Limited**
  David Schaeffer Engineering Ltd., November 2013.
  (MDP)

- **Sanitary Design Brief (Off-Site Trunk Sewers) for Richmond Village (North & South) Ltd, Village of Richmond**
  David Schaeffer Engineering Ltd, October 26, 2015 (2nd Submission)
  (Off-Site Trunk Sewers)

- **Design Brief for Stormwater Management Pond 1, Western Development Lands, Richmond**
  JF Sabourin and Associates Inc. and David Schaeffer Engineering Limited, November 2015
  (Ultimate Pond 1 Design Brief)

- **Design Brief for Interim Stormwater Management Pond 1, Western Development Lands, Richmond**
  JF Sabourin and Associates Inc. and David Schaeffer Engineering Limited, March 2018
  (Pond 1 Design Brief)

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2.2 Design Guideline Deviations

Section 7.2.1.6.8 of the ***City of Ottawa Sewer Design Guidelines*** outlines the Emergency Provision for Flood Protection for Pump Station Design. Where it is indicated that:

In anticipation of a potential catastrophic failure of a wastewater pumping facility and above contingency provisions, the feasibility of providing gravity based emergency conduit is to be evaluated as a last line of protection against basement flooding. The elevation and hydraulic capacity of emergency conduit connections are to be optimized to minimize the risk of basement flooding due to sanitary system backup. The elevation of this conduit must be maintained at least 1.0 m below the elevation of the lowest basement elevation within the service area. This emergency connection should permit the excess flow to bypass the pumping station. If this is not possible, then a conduit from the pumping station wet well will be permitted.

The existing Village of Richmond Pumping Station does not provide this level of service to the existing residents of Richmond.

Section 6.1.11 – Depth of Cover, indicates that there shall be a minimum separation of 0.50 m from the storm sewer obvert to the top of building footing. Furthermore, the minimum cover from finished grade to top of sewer shall be 2.0 m. The proposed storm sewer servicing solution violates both conditions. In order to reduce the quantity of fill imported to the site, it is proposed to service the foundations with sump pumps. Furthermore, the storm sewer collection system was designed to ensure that the 100-year HGL does not surcharge to the surface.

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3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

The existing City of Ottawa water distribution network currently terminates in Kanata and Barrhaven, approximately 10 km from the subject site.

The majority of existing residences and businesses in the Village of Richmond are supplied with potable water by both shallow and deep private wells. Parts of the Village of Richmond are supplied with potable water by a public communal well system (King's Park Water Treatment Facility).

3.2 Water Supply Servicing Design

Water Supply servicing for the subject site is contemplated in the ***Village of Richmond Water and Sanitary Master Servicing Study*** prepared by Stantec Consulting Ltd., July 2011 (***MSS***). The preferred design concept indicated by the ***MSS***, for development of the WDL, consists of a new public communal well system connected to the deep aquifer. The communal well is located at the northeast corner of the development as depicted on ***Figure 5*** appended to this report in ***Figures***. Design of the communal well system was undertaken concurrently with the RVDC subdivision design, along with other supporting infrastructure (sanitary trunk and stormwater management pond) to service the WDL. The communal well is constructed and commissioning testing is set to begin the first week of February 2019.

The City of Ottawa requested that the location of a third well be confirmed as part of the development of the proposed lands. Stantec and Golder Associates were consulted to confirm the location of the third well to ensure that additional land must not be set aside. As per the ***Third Well Requirement – Western Development Lands Technical Memorandum*** prepared by Golder Associates, dated December 18, 2018 (***Third Well Memo***), the City requires that the maximum day demand for a development serviced by communal wells be provided with the best well out of service. With the best well out of service and updated water demands provided by Stantec, an additional 2.2 L/s would be required to service the proposed development. As part of hydrogeological investigations for this development conducted over the past ten years, an additional well was constructed to allow the two wells on site to operate as an alternative pair. This additional well has demonstrated that it can maintain a long-term pumping rate of at least 10 L/s, which is well above the required 2.2 L/s. Based on this, a new location for a third well is not required and there is no need to secure additional land. Refer to ***Appendix B*** for the ***Third Well Memo*** prepared by Golder.

Potable water will be supplied to the subject lands through pressurized watermains. The proposed development will be serviced internally by 152 mm, 203 mm and 305 mm diameter watermains designed in accordance with the ***Water Supply Guidelines*** or ***2013 Water Master Plan***, as summarized in ***Table 3***.

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Table 3: Water Supply Design Criteria

Design Parameter	Value
Residential – Detached Single	3.4 persons/unit
Residential - Townhome	2.7 persons/unit
Institutional	28,000 L/ha/day
(1) Residential – Basic Day Demand (BSDY)	180 L/cap/day (for Detached Single Homes)
(1) Residential – Basic Day Demand (BSDY)	198 L/cap/day (for Townhomes)
(1) Residential - Maximum Daily Demand (MXDY)	As per 2013 WMP
(1) Residential – Peak Hour Demand (PKHR)	As per 2013 WMP
Fire Flow	Calculated as per the Fire Underwriter's Survey 1999.
Minimum Watermain Size	150 mm diameter
Service Lateral Size	19 mm dia Soft Copper Type 'K' or approved equivalent
Minimum Depth of Cover	2.4 m from top of watermain to finished grade
Peak hourly demand operating pressure	275k Pa and 690 kPa
Fire flow operating pressure minimum	140k Pa
Extracted from Section 4: Ottawa Design Guidelines, Water Distribution (July 2010), ISDTB-2010-2 *(1) See Section 2.3 "Demand Projections" discussion in Stantec Water Analysis found in Appendix B.*	

The internal watermains will connect to a proposed 406 mm diameter watermain service which will extend from the Communal Well as designed by Stantec. The proposed watermains are depicted on ***Figure 5***, appended to this report in ***Figures***.

Through the detailed design of the RVDC lands, a complete hydraulic analysis was prepared for the water distribution network to confirm that water supply is available within the required pressure range under the anticipated demand during average day, peak hour and fire flow conditions. This analysis was completed for the RVDC Lands – Phase 1 as well as under ultimate conditions, which includes all of the Richmond WDL (Mattamy and Laffin Lands). Refer to the ***Richmond Western Development Lands, Caivan Communities - Phase 1, Water Distribution System Analysis*** prepared by Stantec Consulting Ltd. dated October 2017 ***(Stantec Water Analysis)***, enclosed in ***Appendix B***.

Please note that during detailed design, the ***Stantec Water Analysis*** will be updated for the current population counts for both Mattamy and the Laffin Lands.

3.3 Master Servicing Study

The proposed water design conforms to the ***MSS*** in that it proposes a communal well to service the site. This allows for expansion/integration to service all existing and future development areas within the Village of Richmond with the intent of ultimately creating a single communal well system.

3.4 Water Supply Conclusion

Potable water is delivered to the proposed development area via a communal well located at the northeast corner of the proposed development. The communal well consists of groundwater wells, an at-grade water storage tank, and a high lift pumping station with disinfection and treatment as required.

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Design of the communal well system was undertaken concurrently with the RVDC subdivision design along with other supporting infrastructure (sanitary trunk and stormwater management pond) to service the WDL. The communal well is constructed and will begin commission testing the first week of February 2019.

As per the ***Third Well Memo*** by Golder, a new location for a third well is not required as the existing wells on site can provide the required water demand as per calculations by Stantec and there is no need to secure additional land.

The development will be serviced by a watermain network, which will be sized to meet maximum hour and maximum day plus fire flow demands. A complete watermain analysis indicates that the 152 mm, 203 mm and 305 mm diameter watermains will satisfy the demands under all conditions.

The Laffin Lands to the north east of the site have been included as external area for the proposed water design but are not a part of development for this site.

The detailed water supply system will be designed to conform to all relevant City Standards and policies.

The proposed water design conforms to the ***MSS*** by proposing the site be serviced by a communal well.

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4.0 WASTEWATER SERVICING

4.1 Existing Wastewater Services

The existing Village of Richmond is serviced primarily by City of Ottawa sanitary sewers that convey wastewater to the Richmond Pumping Station located south of the Jock River, on the northwest corner of Cockburn and York Street. The Richmond Pump Station (RPS) discharges to the Glen Cairn Trunk Sewer just south of Hazeldean and Robertson Road in Kanata through a 13.85 km long, 500 mm diameter forcemain along Eagleson Road as depicted on Stantec's ***MSS Figure 5-2***, enclosed in ***Appendix C*** for reference.

The WDL (including the Mattamy Richmond Lands) will be serviced via a new sanitary trunk sewer that has been designed along Martin Street from Cockburn Street to the boundary of Phase 1 of the RVDC development. The Martin Street trunk sewer was recently constructed and commissioned. The ***Sanitary Drainage Plan*** (DSEL, Rev 4, 16-09-13) and ***Sanitary Design Sheets*** are enclosed in ***Appendix C*** for reference.

A sanitary capacity analysis is underway by the City of Ottawa to confirm capacity of the in the downstream sanitary infrastructure.

4.2 Off-site Wastewater Services Upgrades

Wastewater collection services for the subject site was contemplated in the ***Village of Richmond Water and Sanitary Master Servicing Study*** prepared by Stantec Consulting Ltd., July 2011 (***MSS***). The recommended solution is expanding the current wastewater collection system and to continue to pump wastewater to the City's central wastewater treatment facility. ***MSS Figure 9.1***, enclosed in ***Appendix C*** for reference.

The preferred design concept for the wastewater services includes:

- Upgrades to the existing gravity collection system (pipe size and length improvements for the gravity collection system along specific road segments) ***This is accomplished via the approved Martin Street trunk sewer upgrade.***
- Expansion of the existing Richmond Pump Station ***Analysis / design ongoing.***
- Repairs to the existing 500 mm diameter forcemain ***Process ongoing.***
- New 600 mm forcemain from Richmond to the City's central collection system.

A sanitary capacity analysis is underway by the City of Ottawa to confirm capacity of the in the downstream sanitary infrastructure.

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4.3 Wastewater Design

The Mattamy development will be serviced by a network of new gravity sewers designed in accordance with City of Ottawa criteria. ***Table 4*** summarizes the ***Sewer Design Guidelines*** employed in the design of the proposed wastewater sewer system. The subject lands are tributary to the recently constructed Martin Street sanitary sewer as contemplated in the ***MSS***. ***MSS Figure 8.6***, enclosed in ***Appendix C*** for reference illustrates the contemplated upgrades to the Martin Street sanitary sewer.

Table 4: Wastewater Design Criteria

Design Parameter	Value
Residential - Single Family	3.4 persons/unit
Residential - Townhome	2.7 persons/unit
Residential - Average Daily Demand	280 L/d/per
Residential - Peaking Factor	Harmon's Peaking Factor. Max 4.0, Min 2.0
Harmon - Correction Factor	0.80
Institutional – Average Flow	28,000 L/ha/day
Institutional – Peaking Factor	1.5 if ICI in contributing area is >20% 1.0 if ICI in contributing area is <20%
Infiltration and Inflow Allowance	0.33 L/s/ha
Park Flow	9,300 L/ha/day
Sanitary sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	200 mm diameter
Minimum Manning's 'n'	0.013
Minimum Depth of Cover	2.5m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6 m/s
Maximum Full Flowing Velocity	3.0 m/s
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012 and Technical Bulletin ISTB-2018-01.	

The Richmond Phase 1 sanitary system is designed to accept external flows from future Laffin Lands, located north east of the site. A summary of the Laffin external flows is as follows:

- Drainage Area = 7.18 ha
- Population = 575
- Total Peak Flow = 8.62 L/s

Refer to ***Drawing 3*** Sanitary Servicing Plan in the ***Drawings*** section and sanitary sewer design sheet in ***Appendix D*** for details.

The peak sanitary flow contributions from the proposed development were estimated to be ***57.05 L/s*** at the outlet to the Martin Street sanitary trunk. The supporting preliminary sanitary sewer calculation sheets are found in ***Appendix C*** and the sanitary drainage area plan is contained in the ***Drawings*** section. The preliminary sanitary and storm servicing profiles are also contained in the ***Drawings*** section.

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4.4 Low Lying Areas

In Section 8.3.2 of the ***MSS*** it was indicated that "*a more detailed servicing investigation of the low lying area west of Fortune and south of Ottawa, where the ground elevation is less than 96 m, is needed to confirm if gravity servicing is or is not feasible*" based on Stantec's high level review of servicing. Through the preparation of functional grading and sanitary profiles it has been determined that the extent of development proposed can be serviced via gravity.

4.5 Master Servicing Study

The proposed sanitary sewer design deviations from the ***MSS*** are as follows:

- The proposed design implements the amendment to the storm sewer elements of the Ottawa Design Guidelines – Sewer Technical Bulletin (ISTB-2018-01, March 21, 2018);

- With the implementation of Technical Bulletin (ISTB-2018-01, March 21, 2018), the proposed flows downstream of the WDL are lower than what the ***MSS*** calculated, even though the WDL population is higher than the projected population from the ***MSS***.

The ***MSS*** proposes sanitary design parameters for the construction of sanitary sewers in Richmond based on the design criteria from the City of Ottawa ***Sewer Design Guidelines*** (October 2012). Per Technical Bulletin ISTB-2018-01 (March 21, 2018), there have been updates to the wastewater design flow parameters for the design of sanitary sewers. The deviations between the design parameters of the ***MSS*** (from the ***Sewer Design Guidelines***) and ISTB-2018-01 (March 21, 2018) are summarized in ***Table 4.1***.

Table 4.1: Comparison of Sanitary Design Parameters

Parameter	MSS (Sewer Design Guidelines)	ISTB-2018-01 (Updated Guidelines)
Residential Flow Generation	350 L/p/day	280 L/p/day
Infiltration	0.28 L/s/ha	0.33 L/s/ha
ICI Peak Factor	1.5	1.5/1[a]
Harmon Correction Factor	1.0	0.8

[a] ICI Peak Factor = 1.5 if ICI in contributing area is >20%; ICI Peak Factor = 1.0 if ICI in contributing area <20%

The proposed design follows the changes per Technical Bulletin ISTB-2018-01 (March 21, 2018) for the updated sanitary design parameters. Design sheets are enclosed in ***Appendix C***.

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Since the ***MSS*** was finalized, preparation and coordination of the draft plan concepts and conditions has more clearly defined the future configuration of the WDL area. A more accurate evaluation of the sanitary network design, constraints and design requirements has been established and the populations have increased from what the ***MSS*** originally projected. To confirm capacity downstream for the WDL, ***Table 4.2*** compares the drainage area, population and flow to downstream MHSA06270 between the ***MSS*** and the proposed design.

Table 4.2: Comparison of Drainage Area, Population and Total Flow to Upstream MHSA06270 on Cockburn Street

Sanitary Design	Sanitary Guidelines Used	Total Drainage Area (ha)	Total Population	Total Flow (L/s)
MSS	Sewer Design Guidelines / Monitored Parameters	253.52	9,741	238.30
Proposed Design	Sewer Design Guidelines	246.68	11,034	258.36
Proposed Design	Updated Guidelines	246.68	11,034	229.61

As shown in ***Table 4.2***, the total flow to upstream MHSA06270 is less than what was originally proposed in the ***MSS*** when the updated guidelines as per Technical Bulletin ISTB-2018-01 (March 21, 2018) are implemented. Because the proposed design uses the updated guidelines this shows that there is sufficient capacity in the downstream sewers of the Martin Street Trunk for the proposed development, even with the increase in population. Refer to ***Appendix C*** for design sheets and calculations.

4.6 Wastewater Servicing Conclusions

The Laffin Lands to the north east of the site have been included as external area for the proposed wastewater design but are not a part of development for this site.

The proposed wastewater system will outlet to the Martin Street trunk sewer and will be supported by downstream sanitary infrastructure, requiring upgrades for full build-out of the ***WDL*** and development parcel within the Village of Richmond. The Martin Street trunk sewer is constructed and commissioned as well as modifications to the existing pump station and repairs of the existing 500 mm diameter forcemain.

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The City of Ottawa is completing a sanitary analysis to confirm capacity of the downstream sanitary infrastructure.

Overall, the proposed design generally conforms to the ***MSS***. In comparison to the ***MSS***, the proposed design implements the guidelines as per Technical Bulletin ISTB-2018-01 (March 21, 2018). With the updates as per Technical Bulletin ISTB-2018-01 (March 21, 2018), the proposed flows downstream of the WDL is lower than what the ***MSS*** calculated, even with the increase in population of the WDL from what the ***MSS*** originally projected.

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5.0 STORMWATER CONVEYANCE

Stormwater conveyance for the subject site was detailed in the ***Stormwater Management Report for Richmond Village (South) Limited*** prepared by David Schaeffer Engineering Ltd., November 2013 ***(MDP)***.

As presented in the ***MDP***, the recommended stormwater servicing solution consists of a major system, a minor system, and homes with basements that will be equipped with sump pumps to provide foundation drainage. The sump pump detail from Technical Bulletin ISTB-2018-04 (June 27, 2018) is presented on ***Figure 6*** appended to this report in ***Figures***.

The ***MDP*** conceptualized the stormwater management system based on the City of Ottawa standard criteria at the time (i.e. 5-year level of service for sewers and 30 cm of ponding etc). With the release of new standards in September 2016, the stormwater design has been updated to reflect the new standards. See ***Section 5.4*** for additional discussion.

The ***MDP*** stormwater management system included two stormwater management ponds for the overall development lands. Due to the update of City of Ottawa standards, noted above, the design has been updated and all of the development lands have been directed to Pond 1.

5.1 Grade Control Plan - Major System

The proposed master grading plan is depicted on ***Drawing 1***. ***Drawing 1*** illustrates centerline of road grades, which were established on three criteria:

- Minimum depth to pipe invert = 2.1 m
- Minimum depth to pipe obvert = 1.5 m
- Minimum slope of saw tooth road pattern = 0.15% from high point to high point.

Where major system flow is shown to cross Ottawa Street, the minor system was designed to convey flow under these streets. Additional information regarding conveyance through the minor system is contained in ***Section 5.2***.

5.2 Minor System

The Mattamy Richmond development will be serviced by a storm sewer system designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01, September 6, 2016).

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The minor storm sewer system will be sized as follows:

- 2-year event for local streets;
- 5-year event for collector streets; and
- 10-year events for arterial roads

Drawing 2 illustrates the proposed minor system. ***Table 5*** summarizes the minimum parameters utilized to size the stormwater conveyance system.

Table 5: Storm Sewer Design Criteria

Design Parameter	Value
Minor System Design Return Period	2-Year (Local Streets), 5-Year (Collector Streets), 10-Year (Arterial Streets) – PIEDTB-2016-01
Major System Design Return Period	100-Year
Intensity Duration Frequency Curve (IDF) 2-year storm event: A = 723.951, B = 6.199, C = 0.810 5-year storm event: A = 998.071, B = 6.053, C = 0.814	$i = \frac{A}{(t_c + B)^C}$
Minimum Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Runoff coefficient for paved and roof areas	0.90
Runoff coefficient for landscaped areas	0.20
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} AR^{2/3} S^{1/2}$
Minimum Sewer Size	250 mm diameter
Minimum Manning's 'n'	0.013
Service Lateral Size	100mm dia PVC SDR 28 with a minimum slope of 1.0%.
Minimum Depth of Cover	2.0m from crown of sewer to grade (insulation when not possible)
Minimum Full Flowing Velocity	0.8 m/s
Maximum Full Flowing Velocity	6.0 m/s
Extracted from Sections 5 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012 and PIEDTB-2016-01	

The proposed storm system is designed to accept external flows from future Laffin Lands, north east of the site. A summary of the Laffin external flows is as follows:

- Drainage Area: 7.33 ha
- Runoff Coefficient: 0.70
- Return Period: 2-Year
- Total Flow: 915.25 L/s

Refer to the ***Drawing 2*** Storm Servicing Plan in ***Drawings*** section and storm sewer design sheet in ***Appendix D*** for details.

The peak flow from the proposed development to Pond 1 based on the Rational Method is 5784 L/s. The supporting preliminary storm sewer calculation sheets are found in

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Appendix D and the storm drainage area plan is contained in the ***Drawings*** section. The preliminary sanitary and storm servicing profiles are also contained in the ***Drawings*** section.

The storm sewers will be sized using City of Ottawa IDF curves. Inlet control devices will be employed to ensure that storm flows entering the minor system are limited to the flows described above. A 100-year hydraulic grade line (HGL) analysis will be completed at the time of detailed design to confirm that the HGL will be maintained at least 0.20 m below the centerline of road elevation, given that the development will be on sump pumps. Note that recently issued City of Ottawa Technical Bulletin (ISTB-2018-04, June 27, 2018) specifies that "In new subdivisions designed with the use of sump pumps, the 100-year HGL can surcharge to the surface. ICDs will be required if the hydraulic modelling shows that the HGL is higher than the ground surface. If no ICDs are proposed, then the flow into the minor system is controlled by the type of inlet, its slope and its orientation."

The subject lands slope generally from west to east. There are significant areas west of the subject lands that drain through the development property. As illustrated on ***Drawing 2***, the external areas are summarized below:

- 94.2 ha approximately midpoint between Perth and Ottawa Streets (existing Moore Tributary) to existing Moore Ditch;
- 39.2 ha Ottawa Street road side ditch north to existing Moore Ditch;
- 16.3 ha Ottawa Street road side ditch south to storm sewer; and
- 16.3 ha Ottawa Street road side ditch south to clean water pipe.

The tributary flows from the 39.2 ha of external area will be directed to the Moore Tributary which matches existing drainage patterns based on topographic mapping. These flows are in addition to the tributary flows from the 94.2 ha of external area which are directed to the realigned Moore Tributary. The preliminary plan and profile of the Moore Tributary is presented on ***Figure 7***, appended to this report in ***Figures***.

It is anticipated that Ottawa Street will be urbanized. The tributary flows from 16.3 ha of external area will outlet to Storm Trunk 4 MH 120 and be collected in Storm Trunk 4 along Ottawa Street to the SWM Pond. The tributary flows from the other 16.3 ha of external area will be collected in proposed clean water pipe, south of Ottawa Street, through proposed development. The 16.3 ha flows matches existing drainage patterns and will be conveyed to the Jock River. The location of the drainage to MH 302 of the clean water pipe is based on an identified low point on topographic mapping. An oil and grit separator (OGS) has been introduced upstream of MH 302 to avoid a pipe conflict. Should this not be preferable, another option would be to raise the grades from the development south of the clean water pipe by approximately 1.0 m, so that it can connect to Storm Trunk 1 MH 70 and no OGS is required.

In addition, external drainage from the west will also be accommodated along the north and south sides of Perth Street via lands owned by Richmond Village (North & South)

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Ltd. These land areas are 63.1 ha and 34.4 ha, respectively, and are accounted for in the minor system in Perth Street where required. Flows are tributary to the proposed Pond 1 and are not part of this design.

5.3 Moore Ditch Realignment

Subject to review and approval by the RVCA, the proposed development includes the realignment of the existing Moore Ditch to align with the proposed Richmond development as shown on ***Drawing 2*** in the ***Drawings*** section.

Please note that as per the ***Village of Richmond Community Design Plan*** prepared by the City of Ottawa, July 2010 ***(CDP)***, there is a "No Touch/No Development" setback for the Moore Ditch which is 15 m from the watercourse. The minimum 15 m setback from top of bank for the Moore tributary is met for the proposed design and is shown on ***Figure 7***, appended to this report in ***Figures***.

The Realigned Moore Ditch conveys external flows through the subject site, collecting flows from the Ottawa Street road side ditch, which runs southwest along the subject property, to eventually outlet to the Jock River. Refer to ***Drawing 2*** in ***Drawings*** section for a depiction of the external drainage areas 133.40 ha (94.2 + 39.2 ha) draining to the Realigned Moore Ditch.

The corridor width of the Moore Ditch is 43.2 m has been sized to have 15.5 m setback from the top of bank, 3:1 slopes and a 6.5 m bottom width as per recommendation from Geo Morphix to enhance the Moore Ditch with features and improvements and a low flow channel. The channel has been sized to convey the 133.40 ha external drainage area for the 100-year 24-hr SCS design storm, which is 2.793 L/s as per calculations from JFSA enclosed in ***Appendix D***.

As per ***Figure 7***, the existing ditch along the southwest of the subject property, draining to the Moore Ditch, is approximately 0.75 m deep with a 3.0 m wide bottom and 3:1 slopes as per Channel Cross Section 1-1.

The Realigned Moore Ditch is approximately 0.95 m deep with a 6.5 m wide bottom and 3:1 slopes as per Channel Cross Section 2-2. The Realigned Moore Ditch consists of the following from southwest of the subject site to Queen Charlotte Street:

- 249.9 m Ditch length at a slope of 0.1%;
- Proposed 3300 x 900 mm diameter, 33.0 m long concrete box culvert at a slope of 0.35%;
- 255.5 m Ditch length at a slope of 0.13%;
- Proposed 3300 x 900 mm diameter, 27.5 m long concrete box culvert at a slope of 0.35%;
- 56.4 m Ditch length at a slope of 0.58%.

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Please refer to ***Figure 7*** for the Plan and Profile of the Realignment of the Moore Ditch.

The capacity of the Realigned Moore Ditch was calculated to be 3.387 m^3/s as per Moore Ditch Channel Conveyance Calculation Sheet enclosed in ***Appendix D***. This shows that the capacity of the Realigned Moore Ditch is sufficient to convey the 100-year flows of 2.793 m^3/s. To calculate the capacity of the Realigned Moore Ditch, the minimum slope of 0.1% was used as this is the flattest section of the Ditch and calculates the minimum capacity for the entire Ditch.

Both proposed culverts have a capacity of 3.304 m^3/s as shown on the Storm Sewer Calculation Sheet enclosed in ***Appendix D***, which can adequately convey the 2.793 m^3/s 100-year flow.

Erosion and sediment control measures will be implemented for the Realignment of the Moore Ditch as follows; silt fence, straw bales, rip rap stone, rock check dams and erosion control blankets and mats.

Prior to the approval being in place from the RVCA, the existing Moore Ditch will be protected until such a time that it can be diverted. Once approval is granted from the RVCA (Alteration of Waterways), the Realignment of the Moore Ditch will be constructed. The portion of the existing Moore Ditch that has been diverted will then be in-filled / decommissioned. After the completion of Realignment of the Moore Ditch, residential development will proceed.

5.4 Master Drainage Plan

The proposed storm design deviations from the MDP area as follows:

- The proposed design implements the amendment to the storm sewer elements of the Ottawa Design Guidelines – Sewer Technical Bulletin (PIEDTB-2016-01, September 6, 2016) with the change of design return periods;
- The proposed design services the entire site by SWM Pond 1, instead of by two SWM ponds;
- The proposed design redirects 39.2 ha external drainage area, originally proposed to drain to Ottawa Street then to SWM Pond 2, to now drain to the Realigned Moore Ditch and outlet to the Jock River via the Arbuckle Drain;
- The proposed design redirects 16.3 ha external drainage area, originally proposed to drain to Ottawa Street then to SWM Pond 2, to now outlet to Storm Trunk 4 MH 120 on Ottawa Street; and
- The proposed design redirects 16.3 ha external drainage area, originally proposed to drain to Ottawa Street then to SWM Pond 2, to now drain to a newly proposed

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clean water pipe south of Ottawa Street, through the proposed development, to the Jock River. Because Storm Trunk 1A, which services development south of the proposed clean water pipe, conflicts with the proposed clean water pipe, an OGS is proposed for Storm Trunk 1A before it outlets to the clean water pipe.

The ***MDP*** proposes storm design parameters for the construction of storm sewers and stormwater management methods in Richmond based on the design criteria from the City of Ottawa Sewer Design Guidelines (October 2012). Per Technical Bulletin PIEDTB-2016-01 (September 6, 2016), there have been updates to the storm sewer and stormwater management criteria for the ***Sewer Design Guidelines***. The deviations between the design return periods of the ***MDP*** (from the ***Sewer Design Guidelines***) and PIEDTB-2016-01 (September 6, 2016) are summarized in ***Table 5.1.***

Table 5.1: Comparison of Design Return Periods

MDP (Sewer Design Guidelines)	PIEDTB-2016-01 (Updated Guidelines)
5-Year: Local and Collector Roads 10-Year: Arterial Roads and Transitway	2-Year: Local Roads 5-Year: Collector Roads 10-Year: Arterial Roads and Transitway

The proposed design follows the changes as per Technical Bulletin (PIEDTB-2016-01, September 6, 2016) for the updated design return period. Design sheets are enclosed in ***Appendix D***.

Due to the updates as per Technical Bulletin (PIEDTB-2016-01, September 6, 2016), the design has been updated from the ***MDP*** with the elimination of SWM Pond 2 and the entire site to be serviced by SWM Pond 1. Please refer to memo ***Western Development Lands – Richmond / Expansion of Drainage Area to SWM Facility 1*** memo prepared by JFSA on May 23, 2018, enclosed in ***Appendix E,*** which confirms the drainage area of SWM Pond 1 can be expanded to include the entire Mattamy Richmond development.

Due to the elimination of SWM Pond 2, the external drainage areas of 39.2 ha and 32.6 ha that were previously directed to SWM Pond 2, have been redirected to match their existing drainage pattern. The 39.2 ha external area has been redirected to the road side ditch south west of the site to drain to the Realigned Moore Ditch and ultimately to the Jock River. 16.3 ha external area has been directed to Storm Trunk 4 MH 120 on Ottawa Street and ultimately to SWM Pond 1. The remaining 16.3 ha external area will be conveyed through a proposed clean water pipe to ultimately outlet to the Jock River which matches the existing drainage pattern. The Jock River does not require any quantity control measures.

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5.5 Proposed Outlet – Stormwater Management (SWM) Pond

The proposed storm outlet for both the minor system and the major system from the proposed development is Pond 1. Pond 1 is situated in the Jock River Subwatershed and is approved but must be amended for expanded drainage area. Pond 1 provides quality (80% TSS removal per MECP Enhanced Protection), erosion and quantity control and discharges to the Arbuckle Drain, and ultimately to the Jock River.

Further details of Pond 1, including the outlet, are included in the ***Pond 1 Design Brief*** prepared by J.F. Sabourin and Associates dated March 2018. The approved pond design includes a portion of the Mattamy Richmond development from the north boundary to the existing Moore Tributary. To confirm that the drainage area to Pond 1 could be expanded to include the remainder of the Mattamy Richmond development, an analysis was completed by J.F. Sabourin and Associates. Refer to the ***Western Development Lands – Richmond / Expansion of Drainage Area to SWM Facility 1*** memo prepared by JFSA on May 23, 2018, contained in ***Appendix E***.

5.6 Arbuckle Drain

Pond 1 will discharge to the Arbuckle Drain which will require quality, quantity and erosion control, and will then ultimately discharge to the Jock River. Quality control will be provided by 80% TSS removal as per MECP Enhanced Protection and quantity control by limiting the 2- and 100-year release rates to pre-development levels. Erosion control will be provided by controlling the 2-year release rate to 330 L/s or less and the velocity to 0.225 m/s or less to the Arbuckle Drain.

5.7 Stormwater Management Conclusions

Stormwater management for the subject lands are discussed in detail in the ***MDP***; however, there are a few updates due to the update of City of Ottawa design standards and the elimination of Pond 2. The drainage from the proposed development will be directed to Pond 1, which is currently in the final stages of approval. It has been confirmed that the pond has capacity for the proposed development, with some minor revisions.

The Laffin Lands to the north east of the site have been included as external area for the proposed storm design but are not a part of development for this site.

Pond 1 will discharge to the Arbuckle Drain, where it will require quality, quantity and erosion control and will ultimately outlet to the Jock River.

The associated storm sewer collection system, and stormwater management facility designs have been prepared in accordance with standard City of Ottawa modeling techniques.

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External flows, which currently drain through the site, have been considered in the storm design. The Moore Tributary flows will be maintained through the site. Originally discharging to SWM Pond 2 as per the ***MDP***, the ditch flows along Ottawa Street will be redirected to match their existing drainage patterns. 39.2 ha will drain to the Moore Tributary and ultimately outlet to the Jock River, 16.3 ha will drain to storm trunk along Ottawa Street and outlet to the proposed minor system and 16.3 ha will outlet to a clean water pipe south of Ottawa Street to the Jock River.

The location of the drainage to MH 302 of the clean water pipe is based on an identified low point on topographic mapping. An oil and grit separator (OGS) has been introduced upstream of MH 302 to avoid a pipe conflict. Should this not be preferable, another option would be to raise the grades from the development south of the clean water pipe by approximately 1.0 m, so that it can connect to Storm Trunk 1 MH 70 and no OGS is required.

The proposed development includes the realignment of the existing Moore Ditch to align with the proposed Richmond development which is subject to review and approval by the RVCA. The realignment of the Moore Ditch meets the minimum 15 m setback from top of bank as required by the ***CDP*** and provides improvements with a low flow channel and proposed plantings as required by the RVCA.

In circumstances where infrastructure may be required outside of an individual landowner's development area (due to differences in development timing), there will be agreements in place facilitating cost sharing and access when necessary.

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6.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosion losses is exaggerated during construction where vegetation has been removed and the top layer of soil is disturbed. Prior to topsoil stripping, earthworks or underground construction, erosion and sediment controls will be implemented and will be maintained throughout construction.

Silt fence will be installed around the perimeter of the site and will be cleaned and maintained throughout construction. Silt fence will remain in place until the working areas have been stabilized and re-vegetated. Catch basins will have filter fabric installed under the grate during construction to protect from silt entering the storm sewer system.

A mud mat will be installed at the construction access in order to prevent mud tracking onto adjacent roads.

Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents.

- Limit extent of 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 plastic or synthetic mulches.
- Install silt fence to prevent sediment from entering existing ditches.
- No refueling or cleaning of equipment near existing watercourses.
- Provide sediment traps and basins during dewatering.
- Install filter cloth between catch basins and frames.
- Plan construction at proper time to avoid flooding.
- Establish material stockpiles away from watercourses, so that barriers and filters may be installed.

The contractor will, at every rainfall, complete inspections and guarantee proper performance. The inspection is to include:

- Verification that water is not flowing under silt barriers.
- Clean and change filter cloth at catch basins.

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7.0 CONCLUSION AND RECOMMENDATIONS

Mattamy Homes Ottawa is proposing a residential development within the Village of Richmond WDL. The subject property measures approximately ***66 ha*** and is located west of the existing Village of Richmond, South of Perth Street and extends to the Jock River. DSEL was retained to prepare a Functional Servicing Study in support of their draft plan application.

- The RVCA will be required to review and approve the proposed filling of lands south of Ottawa Street under Ont. Reg 174/06 to allow for development of the lands.
- The Laffin Lands to the north east of the site have been included as external area for the proposed water, wastewater and storm design but are not a part of development for this site.
- Water supply to the subject lands was previously contemplated in the ***MSS***. Water supply to the subject property will be through a new communal well and associated watermain designed in accordance with City Guidelines.
- A new location for a third well is not required as the existing wells on site can provide the required water demand as per calculations and analysis by Golder and Stantec.
- Wastewater services will be provided through a network of gravity sewers that outlet to the recently constructed and commissioned Martin Street sanitary sewer and Richmond Pumping Station. The off-site upgrades required to support the development were contemplated in the ***MSS***.
- With the implementation of the new sanitary design criteria as per Technical Bulletin ISTB-2018-01 (March 21, 2018), the proposed flows downstream of the WDL is lower than what the ***MSS*** calculated, even with the increase in population of the WDL from what the ***MSS*** originally projected.
- The City of Ottawa is completing a sanitary analysis to confirm capacity of the downstream sanitary infrastructure.
- Stormwater services will be provided through gravity sewers that outlet to a new stormwater management facility, which is currently in the final stages of approval. The foundation drainage will be provided through the use of sump pumps.
- Due to updates to storm design criteria as per Technical Bulletin (PIEDTB-2016-01, September 6, 2016), the storm design has been updated from the MDP with the elimination of SWM Pond 2 and the entire site to be serviced by SWM Pond 1.
- The proposed stormwater management Pond 1 was designed to meet MECP Enhanced Level of suspended solid removal and will attenuate stormwater to limit impacts on water levels in the receiving Arbuckle Drain.

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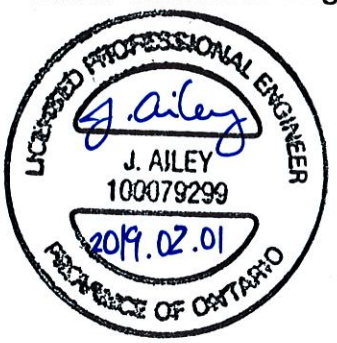
Prepared by,
David Schaeffer Engineering Ltd.



Per: Jennifer Ailey, P.Eng

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APPENDIX A

Pre-Consultation

Meeting Minutes
November 6, 2012
Project: Mattamy Homes - Richmond Village, Western Development Lands
Purpose of Meeting: Pre consultation Meeting Minutes

Meeting Attendees:
Cheryl McWilliams (CM), City of Ottawa
Michel Kearney (MK), City of Ottawa
Jeff McEwen (JM), City of Ottawa
Kevin Hall (KH), City of Ottawa
Amira Shihata (AS), City of Ottawa
Don Morse (DM), City of Ottawa
Amy MacPherson (AX) (on behalf of Matt Hayley), City of Ottawa
Jocelyn Chandler (JC), Rideau Valley Conservation Authority
Mike Green (MG), Mattamy Homes
Gordon Frenke (GF), Mattamy Homes
Anthony (Tony) Francis (TF), Kilgour and Associates
Adam Fobert (AF), DSEL
Robert Vastag (RV), Stantec Consulting
Chris Gordon (CG), Stantec Consulting
Stephen Wilson (SW), Golder Associates
Sarah Millar Martin (SMM), FOTENN Consultants Inc.

REF	CONTENT	ACTION
1.0	**Project Overview**	
1.1.	SMM provided project overview, highlighted features of the design. A clear outline of the submission requirements for subdivision and zoning was requested as an outcome of the meeting.	
1.2.	SMM requested comment from the RVCA on the interim floodplain south of Ottawa Street.	
1.3.	SMM requested an update on the status of: - The update to the terms of reference for the Source Water Protection Plan; - The Financial Implementation Plan.	
1.4.	Project Features: - approximately 1,000 lots; - Phased development in line with the CDP; - Areas of varying unit density with higher density lots targeted north of Ottawa Street and the N-S collector, but overall the plan will maintain consistency with the CDP and provide continuity of village character.	
2.0	**City Staff Comments**	
1.1.	DM requested the provision of a sidewalk connectivity	

	plan with the application in order to understand the linkages throughout the site and into the development to the north and existing village to the east. DM supplied MG with a concept connectivity plan from the City for consideration. **MG to review and provide to consultant team for application.**	
1.2.	DM commented that he would like to see a small number of Village-Style lots provided on the plan. **MG to review for application submission.**	
1.3.	LC enquired about the status of the woodlot that sits just north of Ottawa Street – as it is shown to be hatched on the plan with lotting underneath. MG confirmed that the woodlot sits outside of the Mattamy property boundary. The road pattern shown in the area was only to provide some context. LC and AX requested the Tree Conservation Report for the subdivision include the woodlot regardless, given the liklihood of the Mattamy application proceeding well in advance of the neighbouring lot. **MG agreed, TF to incorporate into study.**	**TF**
1.4.	LC requested confirmation of the parkland dedication on the plan. SMM confirmed that the Community Park was 3.25 Ha. in line with the CDP; and the Neighbourhood Park was 0.8 Ha in line with the CDP. LC commented that the green open space areas provided adjacent to the Jock River corridor would not be considered parkland for dedication purposes. LC also noted that if the woodlot were to be retained, it would not be considered parkland dedication. **MG acknowledged and concurred**.	
1.5.	AS confirmed that a Transportation Brief (TB) would be appropriate for submission with the Draft Plan of Subdivision application, but that a Transportation Impact Study (TIS) would be made a condition of draft approval	**CG/RV**

	for every phase registration. Brief to outline any required road modifications. AS needs to understand the timeframes if they differ from the CDP approved timeframes. **CG/RV to submit terms of reference to AS prior to completion of study for approval.**	
1.6.	CM confirmed that a Phase 1 Environmental Site Assessment would be required.	
1.7.	AX outlined that both a Tree Conservation Report (TCR) and an Environmental Impact Statement (EIS) would be required. AX outlined that the triggers for both studies were that the property sat within 120m of a significant woodlot (Marlborough Forest); and 120m of a rural natural feature. **TF to address species at risk in the EIS – including: Butternut trees; Eastern Meadowlark and the Bobolink.**	**TF**
1.8.	SMM requested confirmation from CM and AX that the application would still be Deemed Complete should the submission of the EIS occur prior to breeding season for the Bobolink and the Meadowlark. **CM to confirm**.	**CM**
1.9.	AX outlined that with each phase registration, the EIS would need to be reviewed to confirm if it required updating.	
1.10.	**CM to confirm that the woodlot adjacent to the Mattamy has no status with the City. i.e. not a Rural Natural Feature.**	**CM**
3.0	**Servicing, Stormwater and Drainage**	
1.1.	DC noted that the Master Drainage Plan update and approval had not been granted. DC understands that this is being led through the Caivan Application.	
1.2.	AF confirmed that the Stormwater Management and Drainage Report supports both the Caivan and the Mattamy applications.	
1.3.	DC requested that a meeting be arranged asap with City	**CM/SMM**

	staff (including DC; MK; CM) and DSEL prior to the resubmission of the Stormwater and Drainage Plan in order to run through the matters that need to be addressed in the final report. **CM to coordinate a time internally and request attendance of the project team through SMM.** **SMM to coordinate project team.**	
1.4.	DC noted that the City do not have a clear direction on the Environmental Assessment process being undertaken for storm water in the Western Development Lands. MG confirmed that the EA process for Water and Sanitary was completed as part of the overall Master Servicing Study for the western development lands as part of CDP. MG noted that a ministerial decision was still outstanding 11 months after submission. AF confirmed that as requested, Kelly Roberts was preparing a memo to outline the Environmental Assessment process being undertaken for Stormwater.	
4.0	**Servicing, Water**	
4.1.	CM outlined that the Terms of Reference to the Source Water Protection Plan were still outstanding. MK noted that Brian Stratton (Mississippi Rideau) is the co-chair of the source protection committee. CM outlined that the implementation of this update requires Council endorsement first and then Ministry approval.	
4.2.	CM outlined that the Financial Implementation Plan for the Village of Richmond was still outstanding. **CM to follow up internally to get update on status and determine who would push this forward.**	**CM**
4.3.	MK would like to address land set aside for the Communal Well on the draft plan. Is the Block shown the appropriate size? MK highlighted that the plan must follow the Drinking Water Services Standards and the Communal Municipal Well Standards.	**MK**

	MK to confirm to CM and Mattamy if additional modeling is needed to determine this.	
4.4.	MK would like to talk to Drinking Water Services about assessment of capture zone influences – particularly the Kings Park and Munster municipal wells**.** Ultimately who is responsible for this assessment? **MK to advise.**	**MK**
4.5.	MK confirmed receipt of Golder Wellhead Protection Study, and peer review by Dillon Consulting. SW noted no comments had been received to date. CM noted she was still waiting on comments from City Water services and Drinking Water.	**MK**
5.0	**RVCA Matters**	
5.1.	JC identified that the existing test well existed on the Mattamy land. SW confirmed that the Artisinal Well had been capped and the monitoring data for this well was included as part of the 72 hour pump test.	
5.2.	JC outlined that required setbacks to the Moore Drain as per the CDP: - 30.0m setback on drain Sections 3&4 Mattamy Land - North) - 15.0m setback on drain Sections 5-8 (Mattamy land - West)	
5.3.	JC highlighted existing watercourses on site (agricultural drains) will need permits from the RVCA to close. **MG noted. AF/SP to coordinate.**	**AF/SP**
5.4.	JC noted that there were other drains on the property south of Ottawa Street that have City easements that will need to be lifted. **Project Team noted.**	
5.5.	JC inquired about the outlet for the Stormwater pond under Ottawa Street. **DSEL to review the existing outfall off of Queen Charlotte in the servicing brief.**	**AF/SP**
5.6.	JC requested that contributing flows to the Moore Drain be nominated in the DSEL report.	**AF/SP**

	AF confirmed that all the Mattamy land south of Ottawa Street would be draining to Pond #2 North of Ottawa Street. **AF/SP to include analysis in application submission.**	
5.7.	JC raised the matter of the Berm Construction along the Jock River and permit issue. JC noted the existing permit had expired, and a new permit application would need to be submitted – along with the existing and proposed grades pre-and post berm. JC noted that it not her preference to have to issue conditions for draft plan approval prior to a permit for the berm being resolved. **AF/SP to coordinate with the RVCA on this matter.**	**AF/SP/JC**
5.8.	JC aware of interim floodplain over section of Mattamy Land. **JC to review and advise how best to resolve amendment to interim floodplain in line with applications from RVCA perspective.**	**JC**
6.0	**Zoning**	
6.1.	CM requested the following plans be included to support the Zoning Application: - Conceptual Streetscape plan which includes sidewalks; - Street Cross Section showing sidewalk and street tree layout; - Conceptual elevations (examples of product types). **MG/GF to review for application and coordinate with SMM.**	**MG/GF/SMM**
7.0	**Next Steps**	
7.1.	CM to provide list of required studies to SMM for application submission.	
7.2.	CM outlined that she would like to provide two separate lists: 1) Draft Plan of Subdivision; 2) Zoning Amendment; and also highlight those reports which sit at a Western Development Lands level rather than specific to the	**CM**

	Mattamy application. **CM to forward to SMM on completion**.	

Meeting concluded at 3:00 pm.

NOTE: Any omissions or errors in these minutes should be forwarded to the author immediately.

MEETING MINUTES
RICHMOND VILLAGE PLAN OF SUBDIVISION

Meeting/Project Name: Mattamy – Richmond Village Plan of Subdivision Redesign

Date of Meeting: October 26, 2017 **Time:** 2:30 pm

Location: City Hall

Meeting Objective
To discuss CDP progress and next steps.

Attendees

Name	Representing
Jason Rumer	Mattamy
Mina Rassa	Mattamy
Jaime Posen	Fotenn
Cheryl McWilliams	City of Ottawa

Red font = Action Items

Meeting Minutes

- JR explained the rationale for the main changes:
  - Denser uses moved further south to improve traffic circulation at north and provide proximity to collector roads and greenspaces
  - Co-location of community park and school
  - Laffin lands removed from plan

- CM provided overall comments:
  1. Servicing
     - P-loop road designs are effective dead-ends, and cannot be serviced with water
     - Through-road connections or pathway connections needed
     - Back-to-back units are located at the highest point, so there is a problem with fire flow servicing
     - Subdivision to be redesigned with consideration for topography and servicing
  2. Well block
     - Access to the well block has already been constructed at the southwest side
     - There is a need for a third production well, but it's not clear that there is room in the block as proposed (has not been studied yet)
     - The overland flow route crosses over this well block
     - DSEL to advise on and address these items
  3. Stream corridor
     - Re-channeling may be subject to Drainage Act process
     - JR: RVCA is open to re-channeling so fish habitat is improved through grading
     - Are there opportunities to preserve existing trees, for water quality and shading? Ideally, at least one side of the channel would be vegetated with existing trees.
     - MR: This might work on the north side.
     - JR: Could lot depths be reduced to save the trees?

- Mina to determine whether tree preservation is possible through strategic channel alignment and / or lot depths.

4. Parks (from Jennifer Hemmings)
    - Parks Department has committed to a splash pad, skateboard park, soccer field, basketball pad, and possibly a skating rink in the Community Park, so is concerned with the total park area.
    - School board may want a fence and a locked gate, which negates the benefits of the co-location.
    - JP: Could the fence be provided only along the common lot line, to allow park visitors to use parking?
    - Park wants in-park parking, plus the ability to take advantage of nearby street parking. There may be conflicts with the overflow parking of the back-to-back townhouses across the street.
    - Meynell Road (north-south collector) is part of the Transitway, and bike lanes and sidewalks will be provided on both sides, so space for street parking is limited.
    - More road frontage along the park could solve this problem.
    - Splitting of parkettes not desirable, as programming is limited (Parks Department prefers two play structures per parkette).
    - Are Laffin lands included in Parks Agreement? Mattamy should ensure that all details are coordinated, the City does not want to pay any money or accept cash in-lieu of parkland. The governing Trustee would provide proof to satisfy any draft condition of approval.
    - It would be preferable to relocate the northern parkette east of Meynell to improve accessibility.
    - Mina to revise plan to merge southern parkettes (co-location with stormwater management pond preferred) and re-locate northern parkette east of Meynell.
    - Mattamy / Fotenn to discuss fencing requirements with school board.
5. Village-style lots
    - Want transition along Ottawa Street and Meynell from the agricultural character to the west.
    - Townhouses are too dense, particularly west of Meynell; should be broken up, but still on collector.
    - Is there any way to break up the back-to-back blocks, to have a maximum of two adjacent blocks, rather than three? This may create parking issues.
    - Mina to explore alternative locations for townhouses and back-to-back blocks.
    - Mina to examine possibility of inserting Village lots along Ottawa Street, particularly west of Meynell.
6. Pedestrian pathways
    - For the pathway over the drainage channel, a bridge would be required.
    - This may be a moot point if the parkette is moved east.
7. Road connections
    - Create connections to Laffin land: east-west, as well as from the north.
    - An additional connection to be made south of the stormwater management pond to the lands to the east.
8. Floodplain
    - Avoid roads in floodplain, want to avoid retaining walls.
    - Mattamy to confirm design and requirements with DSEL.
9. Roundabout
    - Possible addition at Meynell and Ottawa Street
    - But this was not part of original comments, so City won't push the point.

- There will be a roundabout on Perth Street north of the subdivision.
- A roundabout at this location would provide traffic calming, and signal an entrance to the new Richmond Village neighbourhood.
- Mattamy to determine if roundabout is possible / desirable.

10. Environmental (from Matthew Haley)
    - Does the Conservation Authority need a Headwater Assessment in relation to the Municipal Drain?
    - Mattamy to confirm requirements for a Headwater Assessment.
11. Policies
    - Cheryl to consult with CDP team and determine if relief is required from policy framework.
12. Window Streets
    - Window street suggested at the southwest, to reduce overlook to the west.
    - Window street suggested along the floodplain, as in previous design.
    - Mina to incorporate window streets in revised design, where possible.

/ A recirculation application is required for consultation with City Staff, Conservation Authority, school boards, public, etc.
  - This would be a formal resubmission, with an application form and fee required.

/ Cheryl to provide list of submission requirements, which will likely include memos from subconsultants.
  - Likely to include Tree Conservation Report, Stormwater Management Report, Well / Servicing Memo, and possibly a revised Environmental Impact Statement.

/ The Councillor may want to host an information meeting.

MEETING MINUTES
MATTAMY - RICHMOND

Meeting/Project Name: Mattamy (Richmond Village)
Date of Meeting: October 24, 2018 **Time:** 1:00pm
Meeting Facilitator: **Location:** City Hall

Meeting Objective
To discuss technical circulation of Plan of Subdivision application.

Attendees

Name	Representing	Email
Mina Rassa	Mattamy	Mina.rassa@mattamycorp.com
Kevin Murphy	Mattamy	Kevin.murphy@mattamycorp.com
Jaime Posen	Fotenn	Posen@fotenn.com
Jennifer Ailey	DSEL	JAiley@dsel.ca
Lise Guevremont	City of Ottawa	Lise.guevremont@ottawa.ca
Cheryl McWilliams	City of Ottawa	Cheryl.mcwilliams@ottawa.ca
Damien Whittaker	City of Ottawa	Damien.whittaker@ottawa.ca
Mark Young	City of Ottawa	Mark.young@ottawa.ca
Eric Lalande	RVCA	Eric.lalande@rvca.ca

Meeting Minutes

- New floodplain mapping (2-3 years)
    - RFP out now
- Currently “interim” floodplain
- Berm no longer has status
- Conditions to be added: “no development in southern area until floodplain is determined.”
    - But Mattamy still wants draft approval on all lands
- Eric wants to resurrect the old permit for some comfort
- Watercourse setbacks
    - Eric asks for 30 metres, but should be 15 metres
    - Jen and Eric will work this out
- Overland flow
    - Note that RVCA and City have different measurements
- Parkette: Lise prefers more central location
- Area Parks Plan – will be reviewed with Caivan
- Laffin lands: could use 34 units per net hectare measurement
- Wells
    - 3rd well likely required
    - City water department is sensitive to drilling test wells in existing production facility
- Royal York extension
    - Confirmed: road connection
- Townhouses
    - Could new road to Ottawa Street be added to relieve traffic?
- Pedestrian crossing from east to park / school

- A 4-way stop may be safer
- Consider logical location…

/ 2nd window street at the northwest?
- Probably better than near townhouses for a future connection westward

/ Park vs. Open Space should be in separate colours
/ No path because hedgerow to be revegetated
/ Mattamy looking at options for larger lots
/ Coordinate grading and foundation considerations before planning for trees
/ Groundwater
- MSS through OMB settlement required coordination with Caivan development

/ Amendments to Source Protection Plan must be approved by Minister prior to occupancy
/ Arbuckle Drain
- Jen to look into quantity and rate
- Could be a problem, since it's a Municipal Drain

/ There is no capacity in Richmond Pump Station
- Comment was not specific about this
- Damien has some info about this

/ When plan updated, Cheryl would like PDF

RIDEAU VALLEY
CONSERVATION AUTHORITY

3889 Rideau Valley Drive, P.O. Box 599, Manotick, ON K4M 1A5
tel 613-692-3571 | 1-800-267-3504 | fax 613-692-0831 | www.rvca.ca

A member of Conservation Ontario

RVCA LETTER OF PERMISSION – ONT. REG. 174/06, S. 28 CONSERVATION AUTHORITIES ACT 1990, AS AMENDED.

Revised Date: March 3, 2009
Orig Date: February 17, 2009
File: RV5 0309

Mattamy Ltd. (Jock River)
123 Huntmar Drive
Ottawa, ON
K2S 1B9

Attention: Sean MacFarlane,

Subject: **Application for Development being the establishment of an earth berm on a property at part of Unit 19, Index Plan 4D-23 and part of Lot 2, Concession 2, former Township of Goulbourn, now in the City of Ottawa, bounded by Ottawa Street to the North and the Jock River to the south within the Village of Richmond.**

Dear Mr. MacFarlane,

The Rideau Valley Conservation Authority has reviewed the application submitted on behalf of Mattamy Ltd. and understands the proposal to be for:

1. The removal of fill associated with construction of a berm already on the property.
2. The establishment of a new berm closer to the municipal road and farther from the river.
3. The reinstatement of the land area at the existing/"*original*" berm site.
4. The placement of fill between the new berm and Ottawa Street to match existing surrounding grades.

This proposal was reviewed under Ontario Regulation 174/06, the "*Development, Interference with Wetlands, and Alteration to Watercourse and Shorelines*" regulation, which the Conservation Authority administers as well as the approved "Policies Regarding the Construction of Buildings and Structures, Placing of Fill and Alterations to Waterways" (Adopted by the Executive Committee, October 21, 1993 and last revised and approved by the Board of Directors, April 2006).

History

This proposal relates to two previous regulation application filings on the property, RV5-16/05 submitted and approved by the RVCA on December 9, 2005 under Ont. Regulation 166/90 and RV5-01/08 submitted by Mattamy relating to work undertaken in December 2007.

In 2005, a letter of permission was issued by the RVCA for the construction of a berm "to maintain flood risk mapping land levels as per (the 1980 Acres Floodplain) Mapping Study (96.0 metres)". The application indicated that the berm would be 15 cm to 30 cm in height and on site material would be used to construct the berm at a height of land determined in the field as the natural or high point of land, approximately the 96.0 metre contour. The berm as it exists today is 1-2 metres in height, 10-20 metres in width at the base, 2-100 metres from the Jock River and established more or less at the 95.5 metres contour.

On May 6, 2006, Ontario Regulation 166/90 (Fill, Construction and Alteration to Waterways Regulation) was rescinded and Ontario Regulation 174/06 was enacted. Both regulations were made pursuant to the provisions of Section 28 of the Conservation Authorities Act, and both gave responsibility for administration to the Rideau Valley Conservation Authority. The change in the regulatory legislation in May 2006 resulted in, amongst other things, incorporation of revised and extended hazard delineation along the Jock River (Jock River Floodplain Mapping Study completed in July 2005 by PSR). The new Mapping Study extended the hazard mapping upstream of the previous limit of study and provided for additional lands being subject to RVCA's regulatory jurisdiction; the 1:100 year flood level was considered to be 96.35 metres. A provincially mandated public process was followed in order for this new mapping to take effect.

The purpose of the 2005 application (previous property owner) was to establish a berm at the flood level, (96.0 metres – defined by the pre 2006 Flood Plain Mapping Study) thereby, preventing the remainder of the property from being subject to the floodplain regulations after incorporation of the New Mapping Study into the regulation in May 2006.

Project Scope

This application proposes removing the existing berm [established in Winter/Spring 2006, with further filling and reinforcement in December 2007] and locating it at the 2005 approved location. It is also proposed to remove the flapgate and culvert from the drainage easement until the issues relating to drainage for the property and greater surrounding area can be addressed. The berm will also be extended parallel along both sides of the drainage easement north up to Ottawa Street. The overall function of the drainage ditch/easement will be reviewed as part of a Storm Water Management and Drainage Plan to be completed by Mattamy respecting any future development applications.

The placing of fill for the berm and the associated filling behind the berm up to Ottawa Street is not expected to have a negative impact on the control of flooding. The filling operation and location of the "berm" should not impact the roadside conveyance of water and should not impact the conveyance of water through the Drainage Easement running through the centre of the subject property providing the work in undertaken as proposed.

This permission results in the re-location of the 2005 berm in the originally approved location. The filling between the relocated berm (maximum height 96.4 metres geodetic) and Ottawa Street will be to a maximum level of 96.5 and only to a level to taper to match existing grades.

Permission and Conditions

By this letter the Rideau Valley Conservation Authority hereby grants you permission to undertake the works on this property as outlined in the application, covering letter dated January 23, 2009 from David Schaeffer Engineering Ltd. and Drawings completed by same, Project 303, Figures 1-4, dated January 21, 2009 prepared for Mattamy Ltd. and all subject to the following conditions:

1. The existing berm will be removed from its current site. The material may be used for the construction of the new berm **if** deemed appropriate by a qualified Professional Engineer. Any excess material not required for the construction of the new berm may be used as fill in areas to the north of the relocated berm to a maximum elevation of 96.5 metres, noting the maximum berm height will be 96.4 metres. Any excess material will be disposed of in a suitable location outside all 1:100 year floodplains and regulated areas and not within a wetland.

2. The proposed berm shall be established as noted on the attached plan, (DSEL, Project 303, Figure 1-4 dated January 21, 2009) with the southern most boundary of the berm located no further south than the line denoted on the plan and established at an original grade no lower than 96. 1 metres

as depicted on the plan with the top of the berm at a maximum elevation of 96.4 metres or not greater than 0.3 metres in height. Grades along Ottawa Street will also be no higher than 96.4 metres.

3. The berm is to be located no closer than 3 metres to the drainage watercourse on both sides and/or **not** within the City of Ottawa's Drainage Easement, whichever is greater.

4. The culvert located in the drainage easement will be removed as the earthworks are completed and no fill or other obstruction will be placed in the drainage easement without approval from the City of Ottawa. The flap gate will be removed immediately from the culvert to ensure free flow of water.

5. The area of the original berm will be rehabilitated to original grade with plant material re-established as discussed in DSEL letter dated January 23, 2009.

6. A finished grading plan will be submitted as soon as the work is complete to confirm the height and location of the new berm and the grade height and location of the existing berm reinstated to original grade. A refundable deposit of $3000.00 is required to be submitted prior to commencement of the work.

7. No earthworks shall commence before May 1, 2009 and only if flows in the Jock River are considered at or lower than summer levels. Sediment control will be established as defined on Figure 3 prepared by David Schaeffer Engineering Ltd. (DSEL), dated January 21, 2009 and additional measures will be installed as deemed necessary.

8. Sediment and Erosion control Inspections will take place daily by DSEL or other appropriate and designated engineering staff while work is ongoing, and thereafter prior to and immediately following any forecasted rainfall event until such time as the site is revegetated, to ensure sediment control is operational and functional. This is ultimately the responsibility of the property owner and all persons associated with the construction/earthworks/grading on the property. Failure to comply may result in this permission being revoked and charges under other applicable law.

9. Any material excavated from the property and not required must be removed immediately and disposed of at a suitable disposal site outside the 100 year floodplain and regulated area.

10. The RVCA is to receive 48 hours notice of the proposed commencement of the proposed works to ensure compliance with all conditions.

11. There is to be **no** work at the bank or in the Jock River as part of this approval. The contractor will take all necessary measures to ensure no sediment migration into the river occurs and that no machinery, no grubbing and no further vegetation clearing takes place on the property as part of the proposed rehabilitation work. Failure to comply may result in this permission being revoked and charges under other applicable law.

12. It is acknowledged by all parties that the area of the fill operation between the new berm and Ottawa Street, when completed and confirmed, will be considered outside the 1:100 year flood plain of the Jock River. The Regulated Area of Ontario Regulation 174/06 nevertheless extends 15 metres from the 1:100 flood elevation which will be confirmed as the outer limit of the relocated berm. The portion of the property within the Regulated Area of Ontario Regulation 174/06 remains subject to the RVCA's regulatory jurisdiction regarding the *Development, Interference with Wetlands and Alteration to Watercourses"* regulation and associated implementation policies, as amended from time to time by the RVCA Board of Directors.

The regulatory mapping for Ontario Regulation 174/06 is reviewed once a year and amendments introduced as required. Once the works are completed, the Rideau Valley Conservation Authority agrees to pursue an amendment to the regulatory mapping to reflect the changes to the 1:100 floodplain contemplated in this approval.

Failure to comply with any or all conditions will result in the letter of permission being revoked with associated legal action to remedy the situation to the Conservation Authority's satisfaction.

By this letter, the Rideau Valley Conservation Authority assumes no responsibility or liability for any flood or erosion damage which may occur either to your property or the structures on it, or if any activity undertaken by you adversely affects the property or interests of adjacent landowners. This letter does not relieve you of the necessity or responsibility for obtaining any other federal or provincial permits including, but not limited to, approvals under the Public Lands Act, Ontario Water Resources Act, Building Code Act, Planning Act, Endangered Species Act etc.

Nothing in this letter of permission is intended to imply or confer any right of occupation or use of public land. This permission may not be transferred to any other party.

Should you have any questions, please contact Shelley Macpherson at our office.

Yours truly,

Donald A. Maciver, MCIP, RPP
Director of Planning

SM/DAM/sm

cc: Susan Murphy, Mattamy Ltd.
City of Ottawa, Guy Bourgon
City of Ottawa, Mike Wildman
City of Ottawa, Don Morse MCIP RPP
Helmut Brodmann LL.B. Bell, Baker
DSEL

NOTE: This letter of permission does not come into full force and effect until the attached copy of this letter is signed by the responsible corporate official, dated, and returned to the Authority offices in Manotick.

This letter's **return shall be taken as an acknowledgment and an acceptance of the conditions contained herein, as per the Authority's approval based on the application submitted.**

Pursuant to the provisions of S. 28 (12) of the Conservation Authorities Act (R.S.O. 1990, as amended) any or all of the conditions set out above may be appealed to the Executive Committee of the Conservation Authority in the event that they may be unsatisfactory or can not be met.

Name (printed) _____ **Date**: _____

Corporate position / title: _____

Signed: _____

APPENDIX B

Water Supply

TECHNICAL MEMORANDUM

DATE December 19, 2018 **Proposal No.** P18112472

TO Jennifer Ailey, P.Eng.
David Schaeffer Engineering Ltd.

FROM Stephen Wilson, P.Geo. **EMAIL** srwilson@golder.com

THIRD WELL REQUIREMENT – WESTERN DEVELOPMENT LANDS

Mattamy Homes have applied for draft plan approval for their portion of the Western Development Lands (WDL) in Richmond, Ontario. The development is to be serviced by the communal well system that has been established and licensed by the Richmond Village Development Corporation (RVDC) to support development within the WDL. It is our understanding that the City of Ottawa has requested that a location and requirements for a for a third well be determined.

City Comment A.4:

As previously discussed a third well will be required as part of the development of the proposed lands. The location needs to be identified and the requirements for same need to be discussed. We are looking for the well to be located within proximity of the existing wells and note that the Source Protection plan amendments will need to be approved prior to occupancy of any unit in the phase when that well needs to be in service.

The City of Ottawa requires that the maximum day demand for a development serviced by communal wells be provided with the best well out of service. Based on the Master Servicing Study (Stantec 2011), the maximum day rate at full buildout of the WDL (both Caivan/RVDC and Mattamy lands) was 2,450 L/min or 40.8 L/sec. The proven capacities of PW09-1 and PW08-1, the two existing licensed and permitted wells, are 40.2 L/sec and 28.0 L/sec, respectively. Therefore, based on the MSS, an additional 12.8 L/sec of capacity would be required at full buildout of both developments. Stantec recalculated the expected water demand (Stantec 2017) and determined that the predicted maximum day at full buildout would be 30.2 L/sec. Therefore, with the best well (PW09-1) out of service, an additional 2.2 L/sec would be required over that which can be provided by PW08-1.

As part of the hydrogeological investigations for these developments, that were conducted over the past ten years, an additional well (PW09-2) was constructed. This well is located within five metres of PW09-1 and was designed to enable PW09-1 and PW09-2 to operate as an alternate pair, with only one of the wells pumping at any given time. Due to the comparatively low yield of PW09-2 as compared to the other two wells, it was not considered cost effective to use the well and include it in the license and Permit To Take Water applications, as it was questionable that the well could supply the 12.8 L/sec required with PW09-1 out of service. However, the pumping and rehabilitation work conducted on PW09-2 has demonstrated that the well can maintain a long-term pumping rate of at least 10 L/sec, which is well in excess of the yield now required (2.2 L/sec). Based on this information, a new location for an additional well is not required as the existing PW09-2 is deemed to be sufficient.

Prior to bringing PW09-2 into service, which is not expected to be necessary for a number of years, a number of tasks will require completion. These tasks include:

- A pumping test to refine the actual long-term yield of the well. The constant rate test would be up to 72 hours in duration.
- Chemical and bacteriological assessment of the water. This is best undertaken during a pumping test.
- Incorporation of the additional well in the Drinking Water License and the Permit To Take Water.
- Inclusion of the well in the Source Protection Plan. The work needed is expected to be relatively minor, as the inclusion of the well will not change the predicted groundwater withdrawal rates. In addition, the location of PW09-2 (between the two licensed wells) would limit the new area that would be classified as WHPA-A (a radius of 100 metres from the well) to a few square metres. Assessment of potential significant threats within this area would be straightforward. There would be no change to the other mapped Wellhead Protection Areas (B, C and D) due to the scale of the model used to create them. It is anticipated that an addendum to the existing reports would be sufficient, but the City and/or the Source Protection Authority may require a more comprehensive report that would include the previous studies.

Please contract the undersigned if you have any questions.

Golder Associates Ltd.

Stephen Wilson, P.Geo
Senior Hydrogeologist

SRW/BTB/sg
https://golderassociates.sharepoint.com/sites/101895/proposal project management/p18112472-p-rev 0-mattamy western development third well_19dec2018.docx

References

Stantec Consulting Ltd. July 22, 2011. Village of Richmond Water and Sanitary Master Servicing Study.

Stantec Consulting Ltd., October 19, 2017. Richmond Western Development Lands Caivan Communities – Phase 1 Water Distribution System Analysis.

Richmond Western Development Lands
Caivan Communities – Phase 1
Water Distribution System Analysis

Final Report

Prepared for:
Richmond Village Development Corporation

Prepared by:
Stantec Consulting Ltd.

October 19, 2017

Sign-off Sheet

This document entitled **Richmond Western Development Lands Caivan Communities – Phase 1 Water Distribution System Analysis** was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Village of Richmond (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by _____
(signature)

Kevin Alemany, M.A.Sc., P.Eng.

Reviewed by _____
(signature)

John Krug, M.Eng., P.Eng.

Approved by _____
(signature)

John Krug, M.Eng., P.Eng.

Stantec

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Executive Summary

A hydraulic analysis for the water distribution system internal to the Western Development Lands (referred to in previous reports as Area 1A) in the Village of Richmond was undertaken by Stantec Consulting Ltd. to develop the recommended sizing of the piping system for Caivan Communities Phase 1 conditions and ultimate conditions. The total population of the Western Development Lands under full development is expected to be 6,075 persons with a combination of 1,900 single family houses and multi-unit townhomes. Although potable water servicing of other future development beyond this area, including the existing Village, would be provided from the new communal well, reservoir and pump station located within the Western Development Lands, the distribution piping servicing these other lands would be independent of the distribution network within the Western Development area. New piping from the pump station would be designed to service the other areas.

The pump curves used for the hydraulic modelling are considered preliminary. The actual pump selection will be done during the design stage and the curves may be similar but not necessarily match the ones shown in this report. However, the final pump selection should consider flow and pressure requirements included in this report. As the fire flow is much greater than the domestic flow, fire pumps operating separately during emergency fire flow conditions should be considered.

Ground elevations within the Western Development area vary from approximately 95-99m ASL, so the resulting hydraulic grade line (HGL) in the system must be maintained between approximately 134m and 151m to achieve pressures of 345-552kPa (50-80 psi) in the system. However, since the highest elevation in the Caivan Communities Phase 1 lands is approximately 95m, a minimum HGL of 130m can maintain pressures above 345kPa (50 psi) during Phase 1 peak demands.

The discharge HGL at the pump station should range from 130-145m for Caivan Communities Phase 1 and 135-145m for ultimate conditions during basic day and peak hour conditions and should be maintained at approximately 145m during fire-fighting events.

The proposed network is composed of a 305mm diameter spine and a combination of 203mm and 152mm diameter pipes. The proposed pipe layout and sizing is based on both Caivan Communities Phase 1 and subsequently build-out conditions. Additional looping in the system may be required depending on phasing plans. As per the City of Ottawa's standards, areas with 50 units or more require two feeds. This report discusses potential looping alternatives for interim conditions.

During basic day conditions and peak hour conditions, hydraulic modelling results showed that the proposed system was capable of operating within the target pressure ranges. Additionally, based on the fire flow analysis performed, the proposed system was capable of providing sufficient fire flow while maintaining a residual pressure of 138kPa (20 psi).

A reliability assessment was also carried out and included critical breaks at various locations on the proposed 305mm diameter watermain (representing the spine of the network) under build-out conditions. Results show that the proposed network was capable of providing basic day demand plus fire while maintaining a residual pressure of 138kPa (20 psi) at all various locations tested.

Looping should be considered depending on phasing of the development. As per recent plans of Caivan Communities Phase 1, it is recommended that a secondary feed from pump station be considered.

In regards to extending the proposed system to future or existing developments, contour maps show that the surrounding lands are relatively flat and similar to that of the Western Development Lands. As such, the proposed HGL will be sufficient in providing the appropriate pressures to other growth areas and the existing Village in the future if it becomes necessary to connect these areas to the new communal system.

1.0 INTRODUCTION

1.1 OVERVIEW

Stantec Consulting Ltd. (Stantec) was requested to develop the water distribution system layout and pipe sizing for the Western Development Lands in the Village of Richmond. Richmond is located in the southern region of Ottawa southwest of Barrhaven. The proposed Western Development Lands (Study Site) are located within the existing Village boundaries adjacent to the existing developed area as shown in **Figure 1-1**. The development area is predominantly flat, with ground elevations varying from 94.8 - 98.7m ASL.

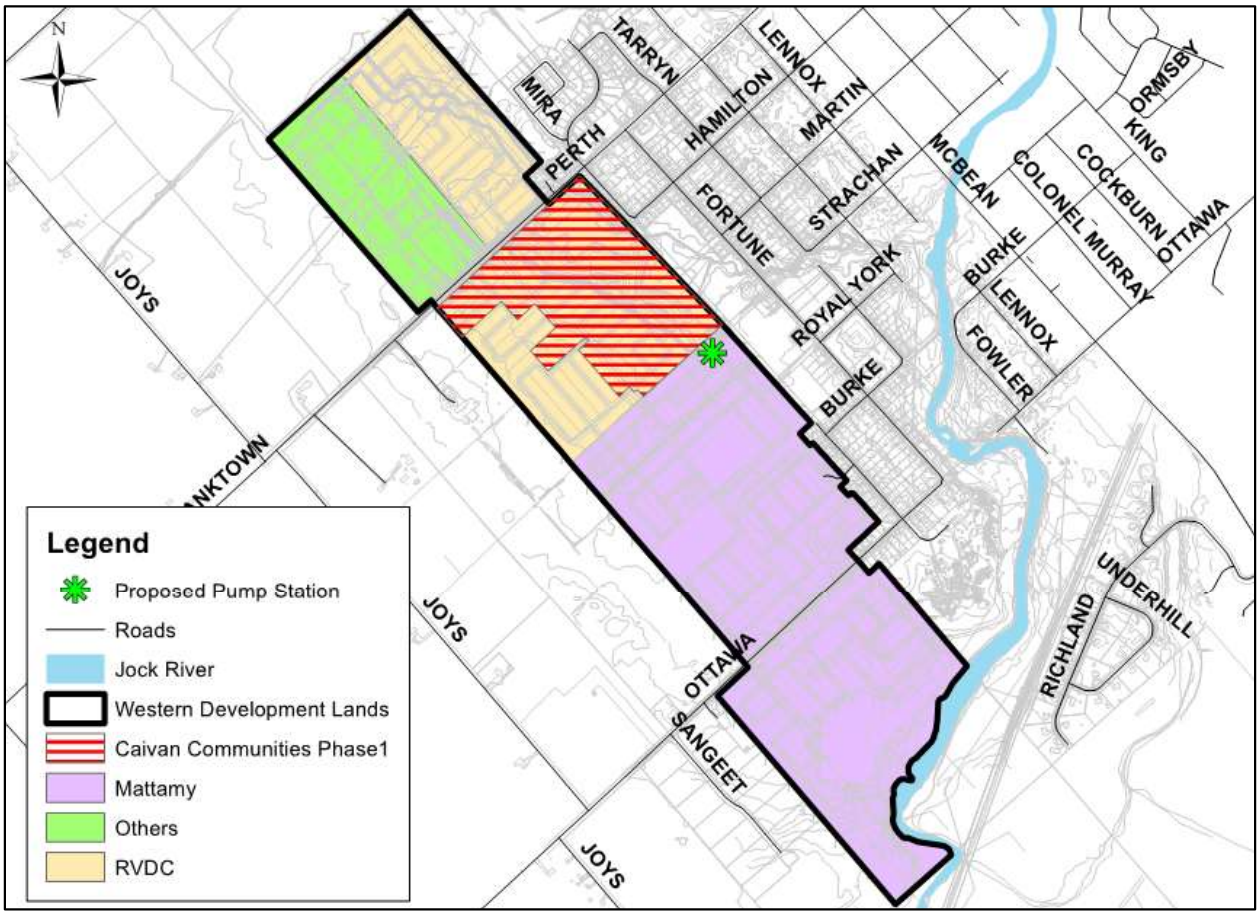


Figure 1-1: Location of the Western Development Lands

1.2 PHASING

The Village of Richmond Water Servicing - Staging/Phasing Functional Design Report (Stantec, 2015), which herein will be referred to as the FDR, describes a staging plan for the pumps at the proposed pump station as development proceeds. There will be five (5) pump bays where pumps will be replaced or upsized periodically to meet growing demands.

In summary, the proposed pump station and well facility will be phased to servicing the following areas:

- Caivan Communities Phase 1 of the Western Development Lands;
- Build-out of the Western Development Lands;
- Existing Village of Richmond and Infill.

Piping from the pump station is proposed to be routed through the Caivan Communities Phase 1 development to service Phase 1 and not through any future right of way areas to minimize "throwaway" pipe costs. In other words, constructing a watermain to service Caivan Communities Phase 1 within the right of way areas of future development in the Western Development where sanitary and stormwater pipes are to be installed for future servicing would be considered as a throwaway and therefore, not ideal.

This report confirms the proposed pipe sizing and layout of the Caivan Communities Phase 1 and subsequently the entire Western Development. Any temporary linkages or looping will be identified, if applicable.

2.0 HYDRAULIC ASSESSMENT

The City of Ottawa Water Design Guidelines and criteria outlined in the 2013 Water Master Plan were used to determine water demands, level of service and pressure objectives during normal and emergency conditions. Design fire flows were developed from the Fire Underwriters Survey (FUS) guidelines.

2.1 SERVICEABILITY

2.1.1 System Pressures

Based on the City of Ottawa Water Design Guidelines, the desired range of pressure under basic day, maximum day and peak hour demands is 345-552kPa (50 to 80 psi) and no less than 276kPa (40 psi) at ground elevation (i.e. at street level). Furthermore, the maximum pressure at any point in the water distribution should not exceed 552kPa (80 psi); pressure reducing measures are required to service areas where pressures greater than 552kPa (80 psi) are anticipated. Under emergency fire conditions, the system must be able to supply the appropriate fire flow while maintaining a residual pressure of 138kPa (20 psi).

2.1.2 Fire Flows

A fire flow of 8,000L/min is used for Caivan Communities Phase 1 of the Western Development Land in the Village of Richmond based on the FUS requirements. Refer to **Appendix A** for FUS fire flow calculations for typical connected townhouse requirements.

Caivan Communities Phase 1 is comprised of residential units with all of units being single detached family homes. No non-residential development will take place in the limits of Caivan Communities Phase 1.

Fire flow assessment based on the subdivision approval phase will be required in which local watermains are checked for their ability to provide the objective FUS fire flows.

2.2 GROWTH PROJECTIONS

The estimated residential population for Caivan Communities Phase1 is determined based on projected household sizes as per the City of Ottawa's Water Design Guidelines. **Table 2-1** shows the estimated number of units in Caivan Communities Phase 1 and the projected populations for the development based on the distribution of residential types. The total number of units is estimated to be 220 single family home units with a residential population of 748 persons.

Table 2-1: Estimated Number of Residential Units and Population for Caivan Communities Phase 1

Unit Type	Unit Mix	Units	PPU	Population
Singles	100%	220	3.4	748

Upon build-out of the Western Development, the majority of the land is proposed to be residential with approximately 2.60 ha proposed to be institutional (school in a future phase). **Table 2-2** shows the estimated units in the Mattamy lands, Richmond Village Development Corporation (RVDC) lands and a balance of the remaining lands for residential growth (assumed all single homes) for a total of 1,900 units. Additionally, the projected population for the development upon build-out is based on the distribution of residential types is projected to be 6,075 persons as shown in **Table 2-3.**

Table 2-2: Estimated Number of Residential Units upon Build-Out

	Unit Counts	Singles		Townhomes	
		Mix	Units	Mix	Units
Mattamy	1,000	75%	750	25%	250
RVDC	750	60%	450	40%	300
Balance	150	100%	150	0%	0
Total	***1,900***	**-**	***1,350***	**-**	***550***

Table 2-3: Estimated Residential Population based on Unit Types upon Build-Out

Unit Type	Unit Mix	Units	PPU	Population
Singles	71%	1,350	3.4	4,590
Townhomes	29%	550	2.7	1,485
Total	**-**	***1,900***	**-**	***6,075***

2.3 DEMAND PROJECTIONS

The criteria outlined in the 2013 Water Master Plan (WMP) were followed to determine water demands of the Western Development Lands. Zone Level demands for populations greater than 3,000 persons were used. The demand rates from the WMP were applied to the population projections based on land use and location with respect to the Greenbelt (outside denoted as "outside greenbelt" or OGB). It is noted that the Zone Level demands are generally used to assess larger service areas and are not generally used to size smaller internal piping. However, fire flows generally govern the minimum sizing for smaller internal watermain infrastructure and therefore using these Zone Level demands for this analysis is considered appropriate.

The projected BSDY and MXDY demands for the site were distributed to the nodes within the piping network for the corresponding scenarios (i.e. winter/BSDY and summer/MXDY). Demand patterns developed by the City were applied to the demands within the Village of Richmond.

For residential land-uses, single family and semi-detached homes were considered to have similar demands, with both types of residential home categorized under "single family home" or SFH. Similarly, all townhomes were categorized under "multi-level townhomes" or MLT. **Table 2-4** shows the consumption rate of each unit type along with estimated BSDY water demands.

Table 2-4: Residential Basic Day Demands

Unit Type	Consumption Rate (L/cap/d)	BSDY (L/s)	
		Caivan Communities Phase 1	Build-Out
SFH	180	1.56	9.56
MLT	198	-	3.40
	Total	1.56	12.97

A demand rate of 28,000 L/ha/d was used to determine the water demands of the school (institution) to be developed in this area. **Table 2-5** shows the estimated basic day demand of the school.

Table 2-5: Non Residential Water Demands

	Area (ha)	Consumption Rate (L/ha/d)	BSDY (L/s)
Institutional	2.60	28,000	0.84

To determine the maximum day demand of the development, the 2013 WMP allocates an outdoor water demand (OWD) of 1,049 L/SFH/d to all SFH units located within the development. This outdoor water demand is added to the basic day demand (BSDY) to obtain the maximum day demand (MXDY) for the development.

Peak hour (PKHR) demands were determined by applying diurnal patterns developed by the City of Ottawa to the maximum day demands. The diurnal patterns are different for each unit type and all vary with time of day. The overall maximum observed demand, when patterns are applied, is the PKHR demand. For example: single family homes will have peak demands during 7-8AM in the morning and 5-8PM in the evening whereas for a school, peak demands will occur during lunch hours but also during the evenings during custodial cleaning. **Table 2-6** shows the BSDY, MXDY and PKHR demands.

Table 2-6: Summary of Total Water Demands

	BSDY (L/s)	MXDY (L/s)	PKHR (L/s)
Caivan Communities Phase 1	1.56	4.23	8.30
Build-out	13.8	30.2	69.2

2.4 MODEL DEVELOPMENT

The computer modelling software package used to carry out the analysis was H2OMAP Water by Innovyze. Pipe layouts were based on the most recent road layouts and topography provided by DSEL.

New watermains 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 2-7**).

Table 2-7: Hazen Williams C Factors for Different Pipe Sizes

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

2.4.1 Proposed Piping

Figure 2-1 shows the preliminary alignments and sizing of the proposed watermains for Caivan Communities Phase 1 as well as the location of the proposed pump station and well facility.

Based on pre-design of the pump station and well facility currently underway, the discharge pipe from the pump station is anticipated to be 500mm in diameter and reduced to 400mm in diameter to the Western Development.

The network within the Caivan Communities Phase 1 and the entire development is proposed to be 305mm, 203mm and 152mm diameter watermains. Larger piping is recommended closer to the pumping station to ensure sufficient transmission into the network with minimal head losses. Additional looping in the system may be required depending on phasing of the development.

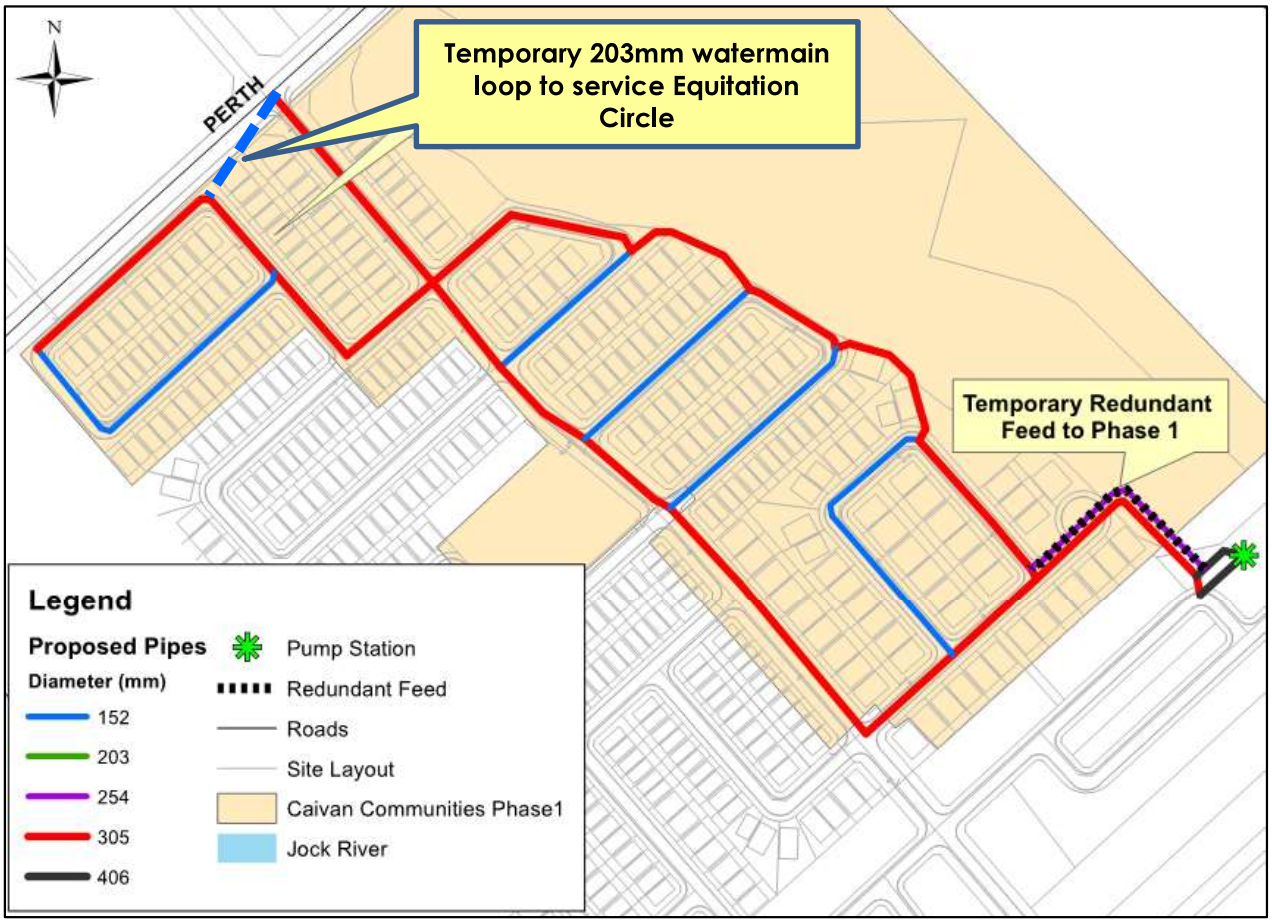


Figure 2-1: Proposed Pipe Layout and Diameters of Caivan Communities Phase 1

The City of Ottawa's standards require areas with basic day demands greater than 50 m^3/d or more to have at least two feeds. Therefore, it is proposed that a secondary feed be aligned as shown in **Figure 2-1**. It is understood that any temporary looping in the vicinity of future development (i.e. outside of Caivan Communities Phase 1 boundaries) should be planned such that throwaway costs are minimized. Modeling showed that a temporary 250mm diameter pipe size is sufficient for the redundant feed (see **Appendix B** for modeling results).

It should be noted that the eastern 305mm diameter watermain may cross property lots and as such, they should be aligned along the property lines to minimize easement requirements.

In regards to the northwest portion of Caivan Communities Phase 1, a basic day demand for these 59 units (proposed to be single family homes) was estimated to be approximately 49 m^3/d. This is estimated using a consumption rate of 835 L/unit/d for single family homes as per the 2011 Master Servicing Study (MSS). Therefore, a single feed to this portion of Caivan Communities Phase 1 is sufficient.

Figure 2-2 and **Figure 2-3** show the proposed pipe layout of the Western Development upon build-out, where **Figure 2-3** shows the twin 406mm diameter discharge pipes from the pump station.

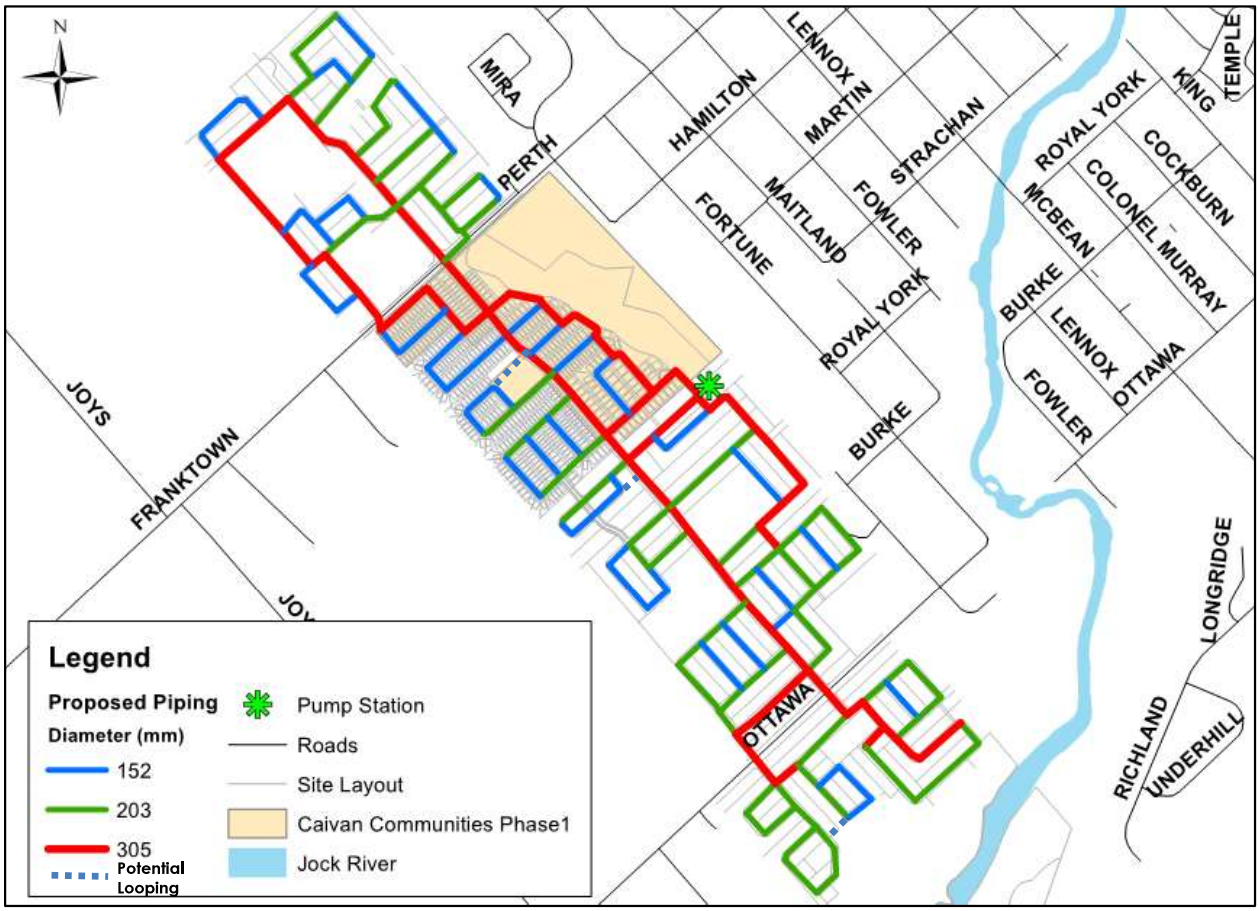


Figure 2-2: Proposed Pipe Layout and Diameters of Build-out Conditions

Figure 2-3: Proposed Piping Layout from the Pumping Station Discharge Pipe

2.4.2 Proposed Hydraulic Gradeline

Figure 2-4 shows the ground elevations of the development which range from 94.8m to 98.7m. Based on these elevations and the operating objective pressures, the hydraulic grade line (HGL) in the entire system should not drop below 134m to avoid pressures less than 345kPa (50 psi) and should not be above 151m to avoid pressures exceeding 552kPa (80 psi). The recommended operating HGL is between 134m-151m (**Table 2-8**). However, because the ground elevation within Caivan Communities Phase 1 slightly differs in range (94.8 - 95.2m), the recommended HGL for Phase 1 is 130 - 151m.

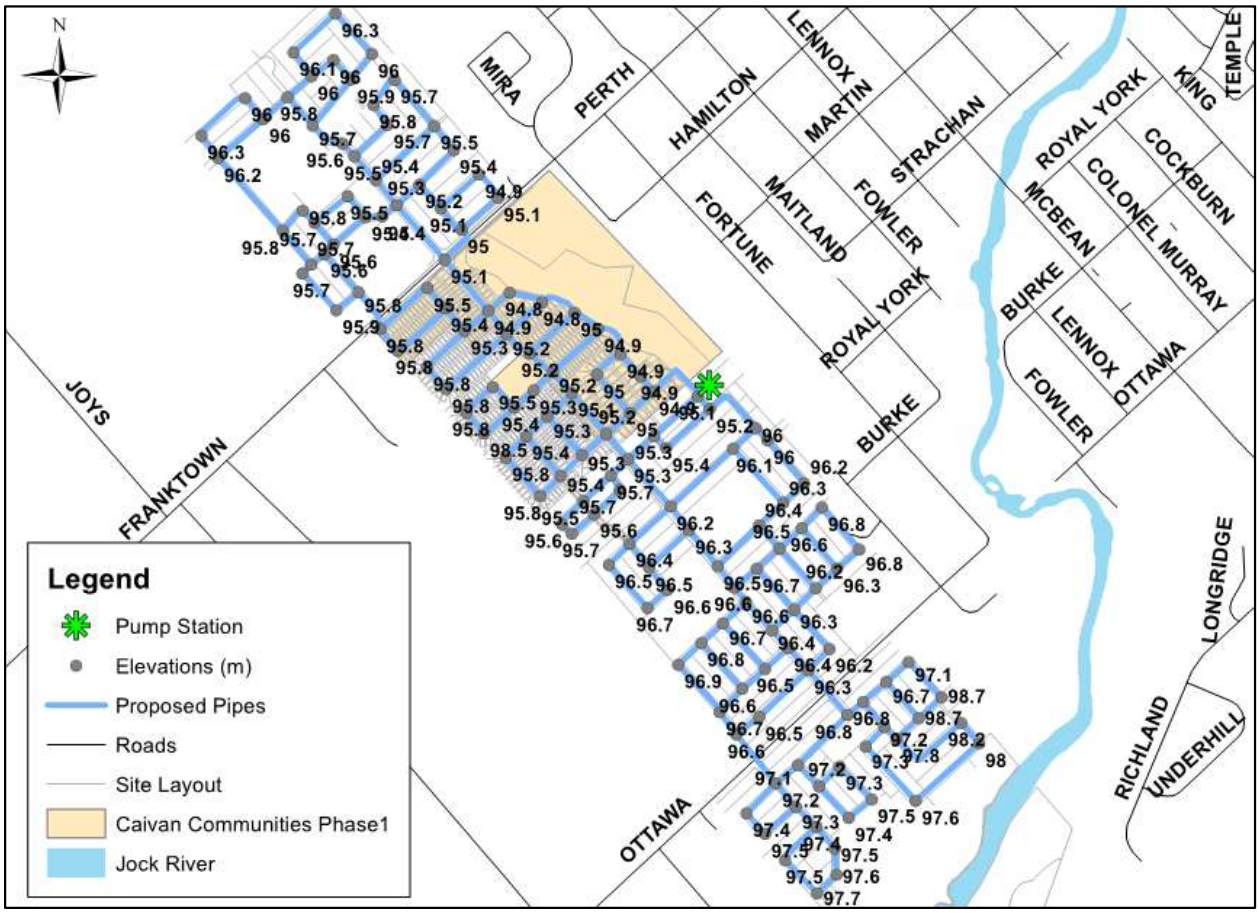


Figure 2-4: Ground Elevations

Table 2-8: Hydraulic Grade Line of the System

Pressure (psi)	Pressure (m)	Max Elevation (m)	HGL (m) = Pressure + Elev.	
			Min	Max
40	28.1	98.7	127	-
50	35.2	98.7	134	-
70	49.2	94.8	-	144
80	56.3	94.8	-	151

2.4.3 Proposed Pump Curves

The selection of suitable pump curves was established from demand projections and discharge head objectives. The pump curves herein are only associated with ***preliminary*** stages of the actual pump selection and are mainly for the purposes of hydraulic modelling. These pump curves were constructed to satisfy the demand and pressure objectives of the system in the model simulations. Actual pump curve selection will be done during the pump station design

phase and may be similar but not necessary match the pump curves shown. Variable speed drive pumps will likely be considered in the final design.

A fire flow of 8,000 L/min is used following the recommendations presented in the 2013 WMP for system level analysis in the core area (population greater than 3,000 persons). This results in a much higher flow as compared to the peak demands. To avoid over sizing the service pumps or having large pumps constantly pushing high head on their pump curves (inefficient), it is recommended to have a separate pump sized for fire flow conditions.

The pump curves show the typical operating range of the pump station during BSDY and PKHR. Design points were based on the maximum and minimum flows that the PS will need to supply and their corresponding head gain (difference discharge head between suction head). Since the pumps are capable of more flow as it rides lower on its curve (lower head, more flow), the pump curves were determined for:

- Maximum flow at minimum head gain;
- Minimum flow at maximum head gain.

The Village of Richmond Water Servicing - Staging/Phasing Functional Design Report (FDR) (Stantec, 2015) describes a staging plan for the proposed pumps as development proceeds. In short, there will be five (5) pump bays where pumps will be replaced or upsized periodically to meet growing development and demands.

The following sections will briefly describe the pump characteristics and pump curves for the required for Caivan Communities Phase 1 and subsequently build-out conditions

2.4.3.1 Caivan Communities Phase 1

Because the demands of Caivan Communities Phase 1 are quite small, the FDR (Stantec, 2015) indicated that a small duty pump will be dedicated to providing basic day demands. Peak flows will be supplemented by a larger pump and fire flow will be provided by dedicated fire pumps.

The following pump curves were established based on Caivan Communities Phase 1 demands and head objectives. They should be considered as preliminary and for hydraulic modelling purposes. Actual pump curves should be confirmed and verified upon detailed design.

Table 2-9 shows the design points of the pump curves assuming the elevation of the pump station is equal to the ground elevation. According to the topography provided by DSEL, the ground elevation at the proposed pump station location is approximately 95.2m. **Figure 2-5** shows the pump curves used for hydraulic modelling to satisfy minimum BSDY, maximum BSDY and PKHR demand during normal day conditions.

Table 2-9: Pump Curve Design Points for Caivan Communities Phase 1

	HGL (m)	Head Gain (m)	Flow (L/s)
PKHR	134	40	9.8
Max BSDY	134	40	3.0
Min BSDY	145	50	0.6
MXDY+FF	145	50	136

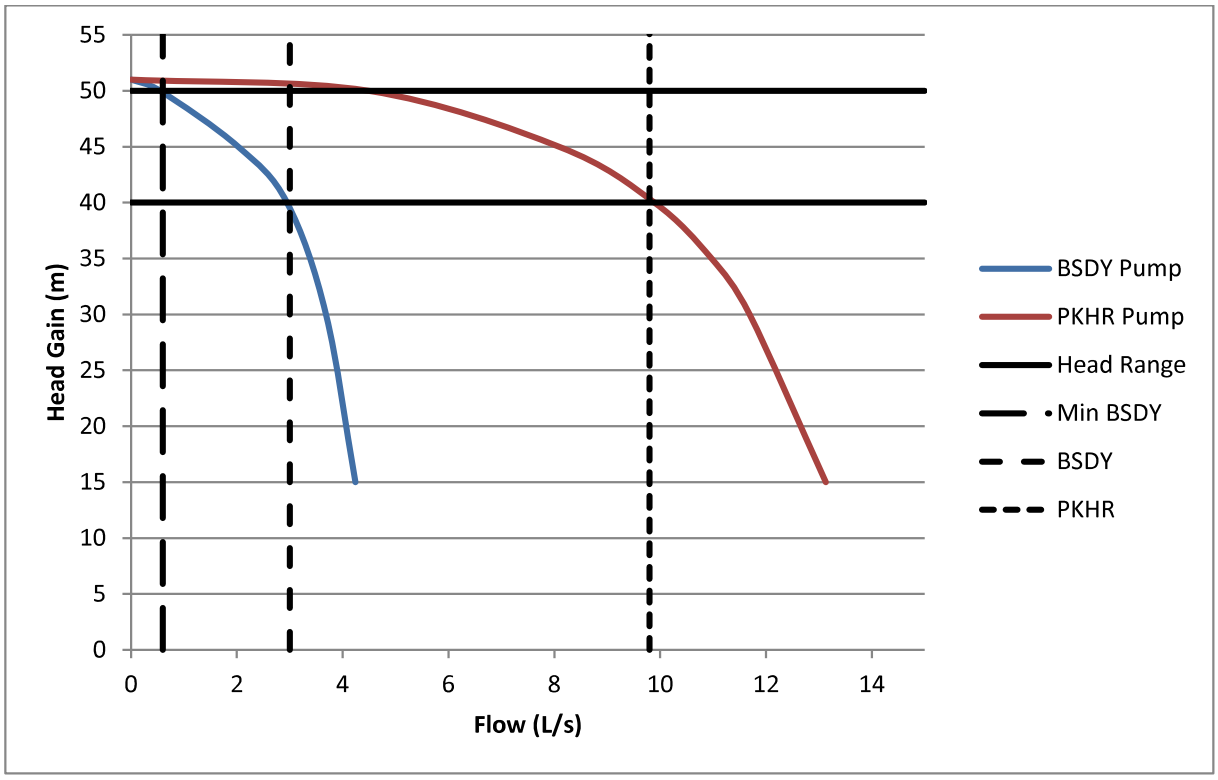


Figure 2-5: Preliminary Pump Curves of Servicing Pumps for Caivan Communities Phase 1

Figure 2-6 shows the pump curve of the fire pump that is to provide MXDY+FF. As determined, the MXDY demand of the development was approximately 3.00 L/s and the required fire flow was 133 L/s (8,000 L/min). This equates to a total of approximately 136 L/s for MXDY+FF conditions.

The fire pump would operate at an HGL of approximately 145m to provide 136 L/s (MXDY+FF) for Phase 1. This HGL was determined through hydraulic modelling by adjusting the HGL to maintain 20 psi in the system during MXDY+FF demands.

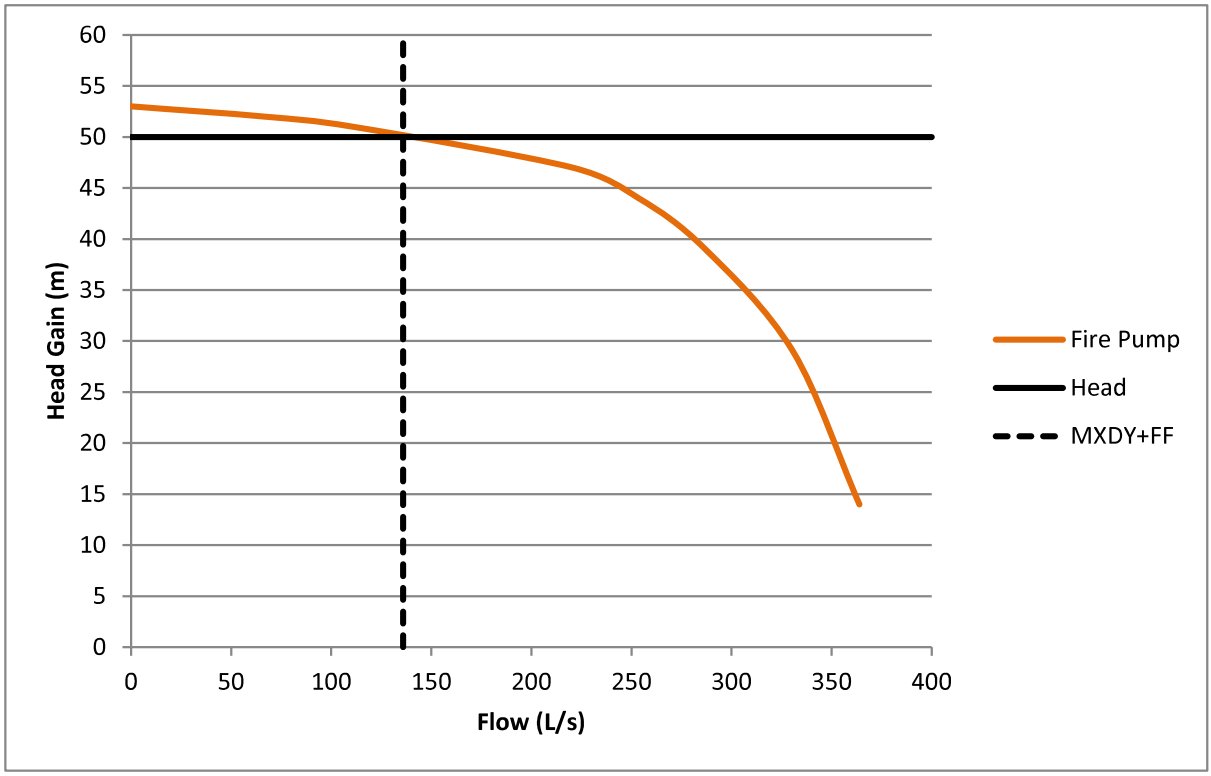


Figure 2-6: Preliminary Pump Curve for Fire Pump for Caivan Communities Phase 1

2.4.3.2 Build-Out

Table 2-10 shows the design points of the pump curves assuming the elevation of the pump station is equal to the ground elevation. Furthermore, **Figure 2-7** shows the pump curves of the two service pumps and the combination of both pumps operating. The small pump (*shown in red*) would be capable of providing minimum and maximum BSDY demands at an HGL between 135-145m. Both pumps would operate (*shown in green*) to provide demands greater than the maximum BSDY. PKHR demands would be provided at an HGL 135m. The *blue* pump curve in **Figure 2-7** represents the slightly larger pump that would operate with the small pump to supply demands greater than BSDY.

Table 2-10: Pump Curve Design Points for Build-Out

	HGL (m)	Head Gain (m)	Flow (L/s)
PKHR	135	40	69.7
Max BSDY	135	40	24.7
Min BSDY	145	50	5.1
MXDY+FF	145	50	163.2

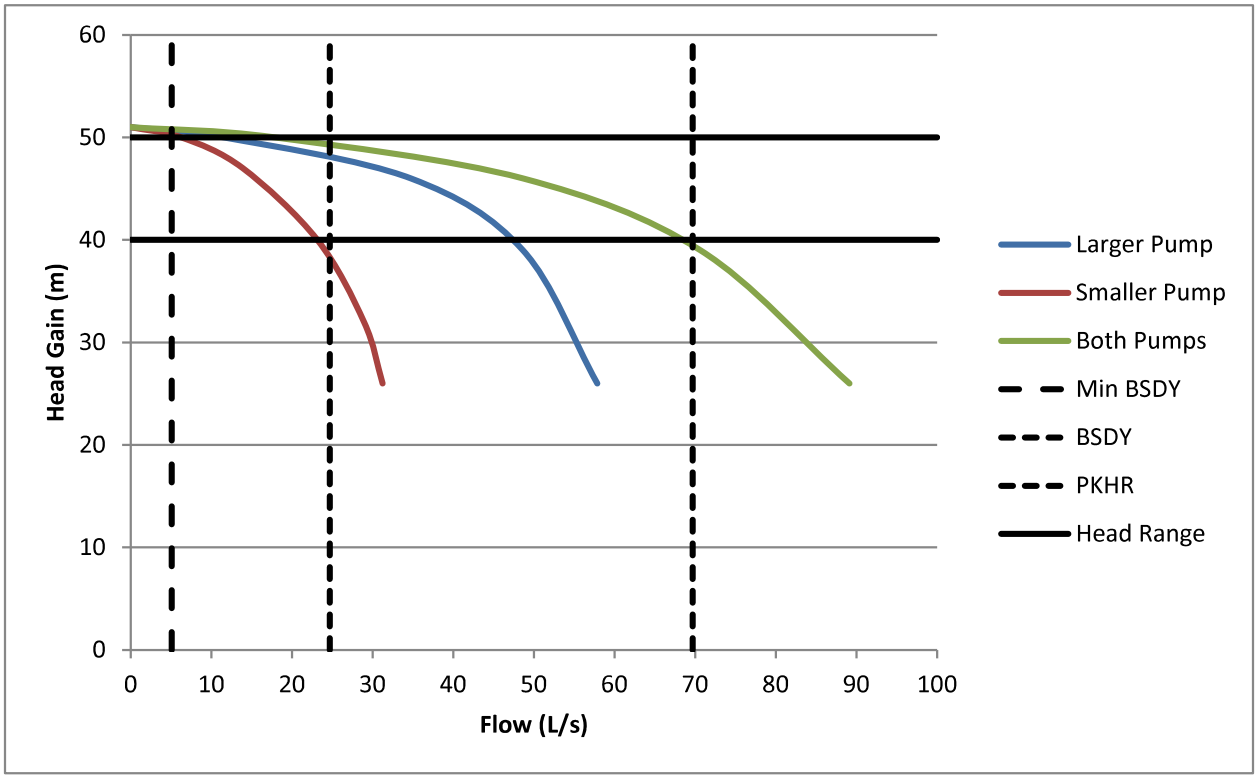


Figure 2-7: Preliminary Pump Curves of Servicing Pumps

Alternatively, a larger peak flow pump can be considered to operate independently during peak demands as oppose to having a small pump operate with a slightly larger pump. In other words, the small pump would supply BSDY demands and shut off when system demands are greater than BSDY. The large pump would then turn on and provide all demands greater than maximum BSDY along with PKHR demands. This pump would have a curve similar to the *green* curve in **Figure 2-7** to supply PKHR.

Figure 2-8 shows the pump curve of the fire pump that is to provide MXDY+FF for ultimate conditions. The fire pump would operate at an HGL of approximately 145m to provide 163 L/s. This HGL was determined through hydraulic modelling by adjusting the HGL to maintain 20 psi in the system during MXDY+FF demands.

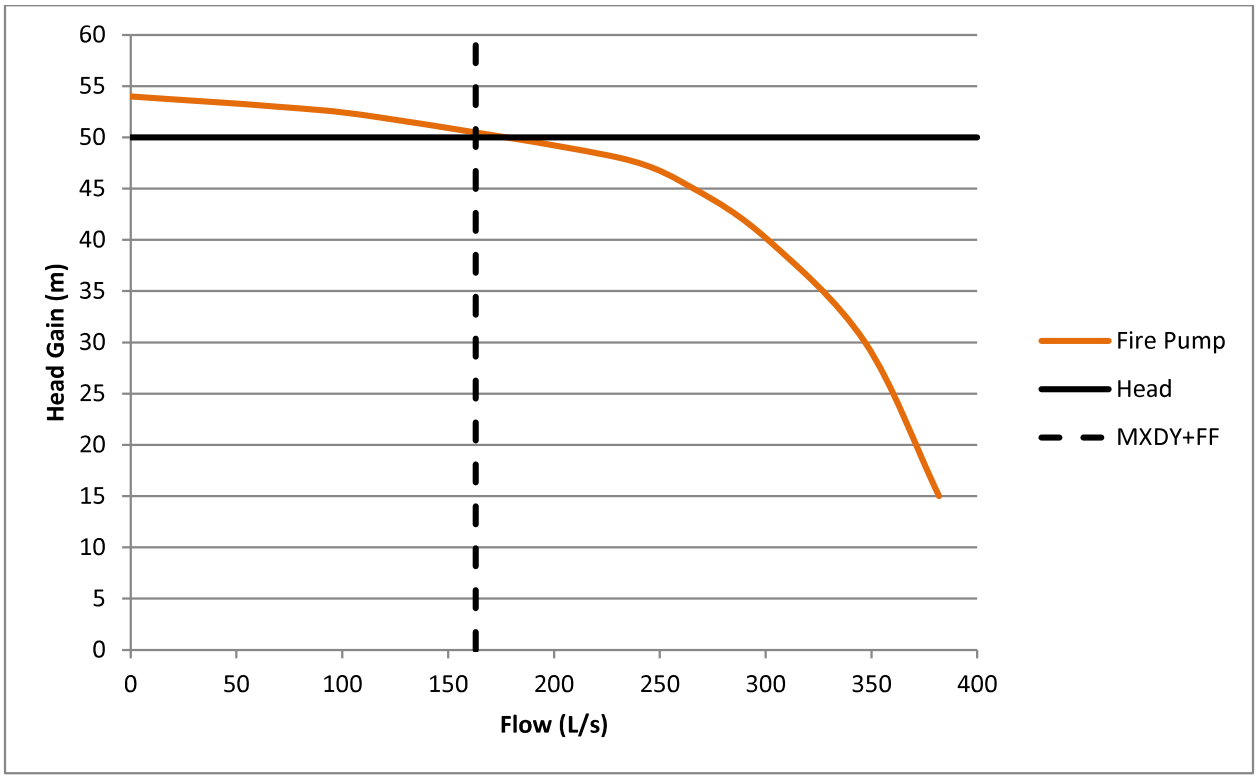


Figure 2-8: Preliminary Pump Curve of Fire Pump

3.0 HYDRAUALIC MODELLING RESULTS

Hydraulic modelling was performed under Caivan Communities Phase 1 conditions and ultimate conditions to verify how the proposed network would respond. The following sections present the hydraulic modelling results with under basic day (BSDY) demands, maximum day (MXDY) and peak hour (PKHR) demands, and under emergency fire flow (FF) conditions.

3.1 BASIC DAY & PEAK HOUR DEMANDS

During BSDY conditions, the maximum HGL in the system was 145m, which resulted in maximum pressures of 490kPa (71 psi) during Caivan Communities Phase 1 and ultimate conditions.

In regards to PKHR conditions, the minimum HGL in the system was 131m and 135m in Caivan Communities Phase 1 and in build-out conditions, which resulted in minimum pressures of 344kPa (50 psi) during Phase 1 and 357kPa (52 psi) during build-out conditions. Therefore, the anticipated minimum and maximum pressures are within City's objective of 345 - 552kPa (50 - 80 psi).

3.2 MAXIMUM DAY + FIRE FLOW

Maximum day demand fire flow analysis was carried out to determine the anticipated available flows at each node within the Western Development Lands. Fire flows greater than 8,000L/min with a residual pressure of 138kPa (20 psi) are anticipated at all locations with the proposed emergency pump in both Caivan Communities Phase 1 and ultimate conditions.

Smaller local internal watermains will have to be further assessed and verified as development planning proceeds to check their ability to provide the objective Fire Underwriter Survey (FUS) fire flows.

3.3 RELIABILITY

For populations greater than 10,000 persons, during one (1) major failure, the system must be able to provide basic day demands plus fire while maintaining a residual pressure of at least 138kPa (20 psi). Although the Western Development Lands are projected to have a population of 6,075, any future connections to the surrounding growth areas or the existing Village of Richmond will equate to a population over 10,000 persons.

A reliability analysis was performed under build-out conditions that consider an extended break of the 305mm diameter spine of the network at selected locations (**Figure 3-1**). These "breaks" were based on any location that had two feeds. As shown in **Figure 3-1**, the numbered locations shown in a *black box* are the "breaks" and the locations denoted with the letter "a"

shown in the *white box* are the secondary feeds. This analysis confirms whether the secondary feed can provide the level of service if the break occurred on the 305mm diameter spine.

According the hydraulic modelling results (**Table 3-1**), the proposed piping network can provide BSDY+FF while maintaining a pressure of 20 psi during a watermain break along the 305mm diameter spine.

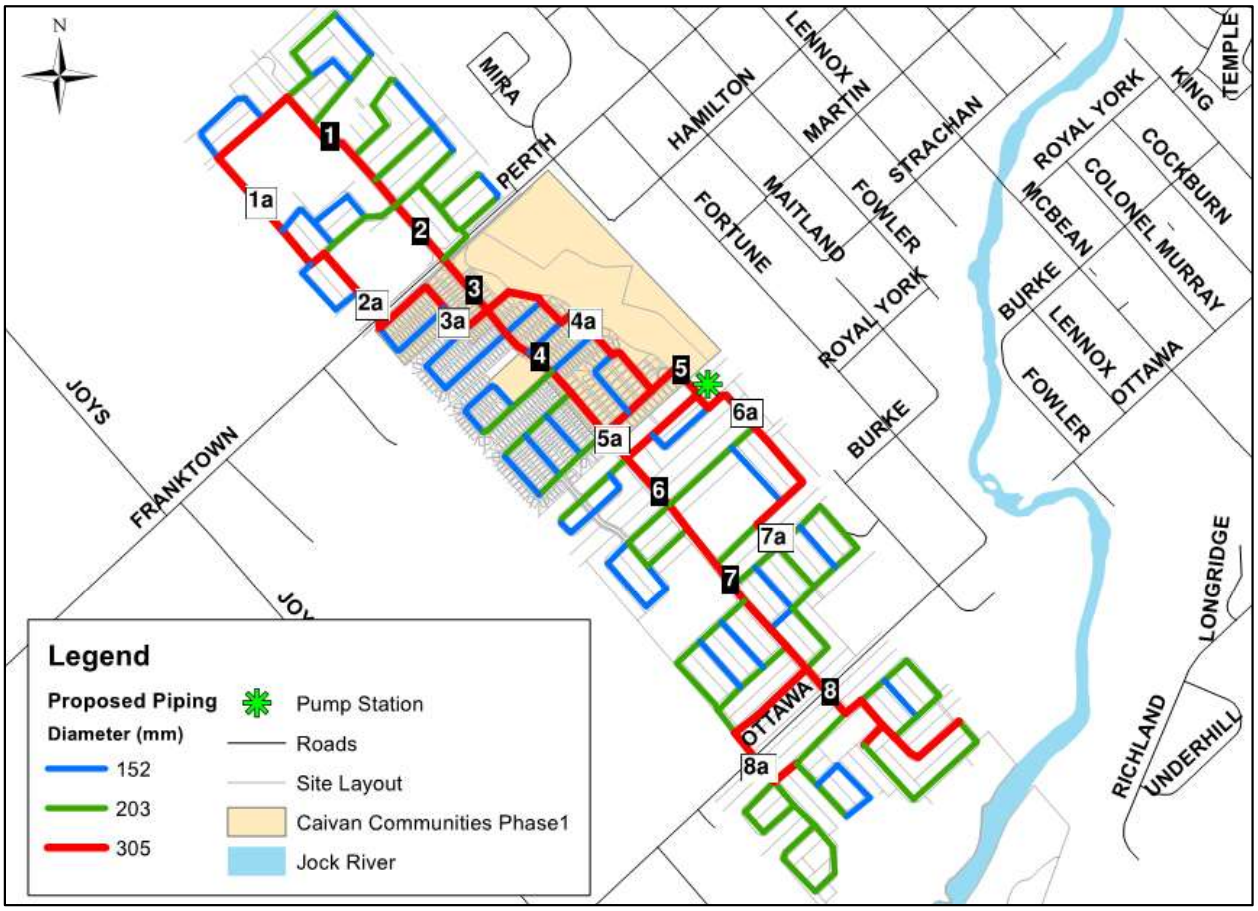


Figure 3-1: Reliability Analysis of Watermain Breaks

Table 3-1: Minimum Pressure during Watermain Break at Selected Locations

Break Location	Secondary Feed	Min. Pressure in System (kPa)	Min. Pressure in System (psi)
1	1a	187	27
2	2a	187	27
3	3a	187	27
4	4a	162	23
5	5a	173	25
6	6a	150	22
7	7a	144	21
8	8a	141	20

A reliability analysis was carried out for Phase 1. It was determined that an interim 200mm diameter watermain is required as a bypass along Perth Road to Equitation Circle to maintain minimum flows greater than 8000L/min during a break of any single watermain feeding that area. Fire flow results are shown in **Figure 3-2** for the worst case scenario modeled.

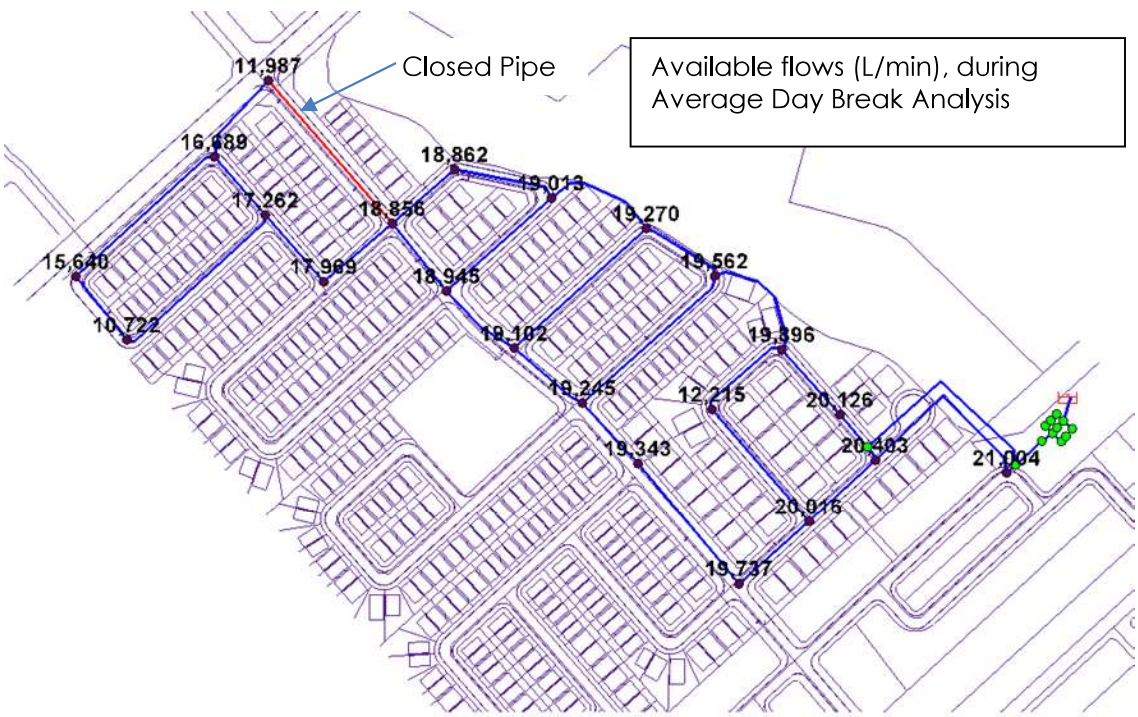


Figure 3-2: Phase 1 Reliability Analysis of Watermain Breaks

4.0 CONCLUSION

The proposed piping alignment and sizing along with the proposed HGL and pumping are capable of achieving the level of service in the Western Development Lands. Based on the hydraulic analysis, the following conclusions were made:

- The proposed water distribution system is recommended to include a 305mm diameter watermain as the spine of the network with a combination of 203mm and 152mm diameter pipes;
- Piping from the proposed pump station to service Caivan Communities Phase 1 is recommended to be routed through Phase 1 lands and not within the right of way of future development areas; this is to minimize throwaway pipe costs;
- Caivan Communities Phase 1 and future plans for phasing will need to consider the City of Ottawa's standard of having at least two feeds into an area that is estimated to have a basic day demand of 50m^3/d;
- The discharge HGL at the pump station should range from 135-145m in Caivan Communities Phase 1 and in ultimate conditions during basic day and peak hour conditions and should be maintained at approximately 145m during fire-fighting events.
- There will be considerable variability in the demands, especially during the early development years. Since the basic day demands (especially the minimum BSDY) are small and much less than the peak hour demands, a small pump may be considered to provide BSDY until the pressures in the system drop to approximately 345kPa (50 psi), in which case a larger pump would turn on and operate in conjunction with the smaller pump. Alternatively, a large pump can be considered to operate independently when demands are greater than maximum BSDY independently of the small BSDY pump;
- Since fire flow is much larger than the peak demands, it is recommended that a large fire pump be considered and operate independently during emergency fire flow conditions;
- During basic day conditions and peak hour conditions, the proposed system is capable of operating within the target pressure ranges during Caivan Communities Phase 1 and upon built-out;
- During fire conditions, the proposed system is capable of providing sufficient fire flow while maintaining a residual pressure of 138kPa (20 psi) during Caivan Communities Phase 1 and upon build-out conditions;

- During a critical watermain break (at various locations along the 305mm diameter spine through the network), the proposed system is capable of providing basic day plus fire flow while maintaining a residual pressure of 138kPa (20 psi) upon build-out conditions.

- A reliability analysis was carried out for Phase 1. It was determined that an interim 200mm diameter watermain is required as bypass along Perth Road to Equitation Circle to maintain minimum flows greater than 8000L/min during a break of any single watermain feeding that area.

A number of aspects that were mentioned briefly throughout this report should be considered as planning of the Western Development Lands continues:

- Additional looping in the system may be required depending on phasing of the area, potential looping considerations have been identified and are to be considered in future phases;

- The pump curves used for hydraulic modelling were based on water demands and the required HGL but are considered as preliminary - actual pump curve selection will be done during the pump station design phase and may be similar, but not necessary match the pump curves in this report;

- Pressure reducing measures such as PRVs at the pumping station should be considered to prevent high pressure during near zero demand periods (i.e. overnight);

- Fire flow assessment based on the subdivision approval phase will be required in which local watermains are checked for their ability to provide the objective Fire Underwriter Survey (FUS) fire flows;

- According to the contour maps provided for the existing Richmond area, it can be seen that the village is on relatively flat land and as such, the proposed HGL will be sufficient to provide the appropriate level of service to future connections in the area.

Appendix A FUS FIRE FLOW CALCULATIONS

FUS Fire Flow Calculation

Calculations based on: "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey, 1999

Stantec Project #: 163401290
Project Name: Richmond Western Development
Date: March 31, 2015
Data input by: Kevin Alemany

Fire Flow Calculation #: 1
Building Type/Description/Name: Residential

Notes:

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Townhouse - indicate # of units	5	Units	
			Townhouse - indicate # of units	5				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement):			2	2	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based total floor area of all floors (non-fire resistive construction):			900	836	Area in Square Meters (m^2)	
					Square Feet (ft2)			
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						6,000
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	4,500
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	0
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	0
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	0
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	3.1 to 10.0m	0.2	0.7	m	3,150
			East Side	10.1 to 20.0m	0.15			
			South Side	3.1 to 10.0m	0.2			
			West Side	10.1 to 20.0m	0.15			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:***						**8,000**
		Total Required Fire Flow (above) in L/s:						**133**
		Required Duration of Fire Flow (hrs)						**2.00**
		Required Volume of Fire Flow (m^3)						**960**

FUS Fire Flow Calculation

Calculations based on: "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey, 1999

Stantec Project #: 163401190
Project Name: Richmond Western Development
Date: March 31, 2015
Data input by: Valerie Hoang

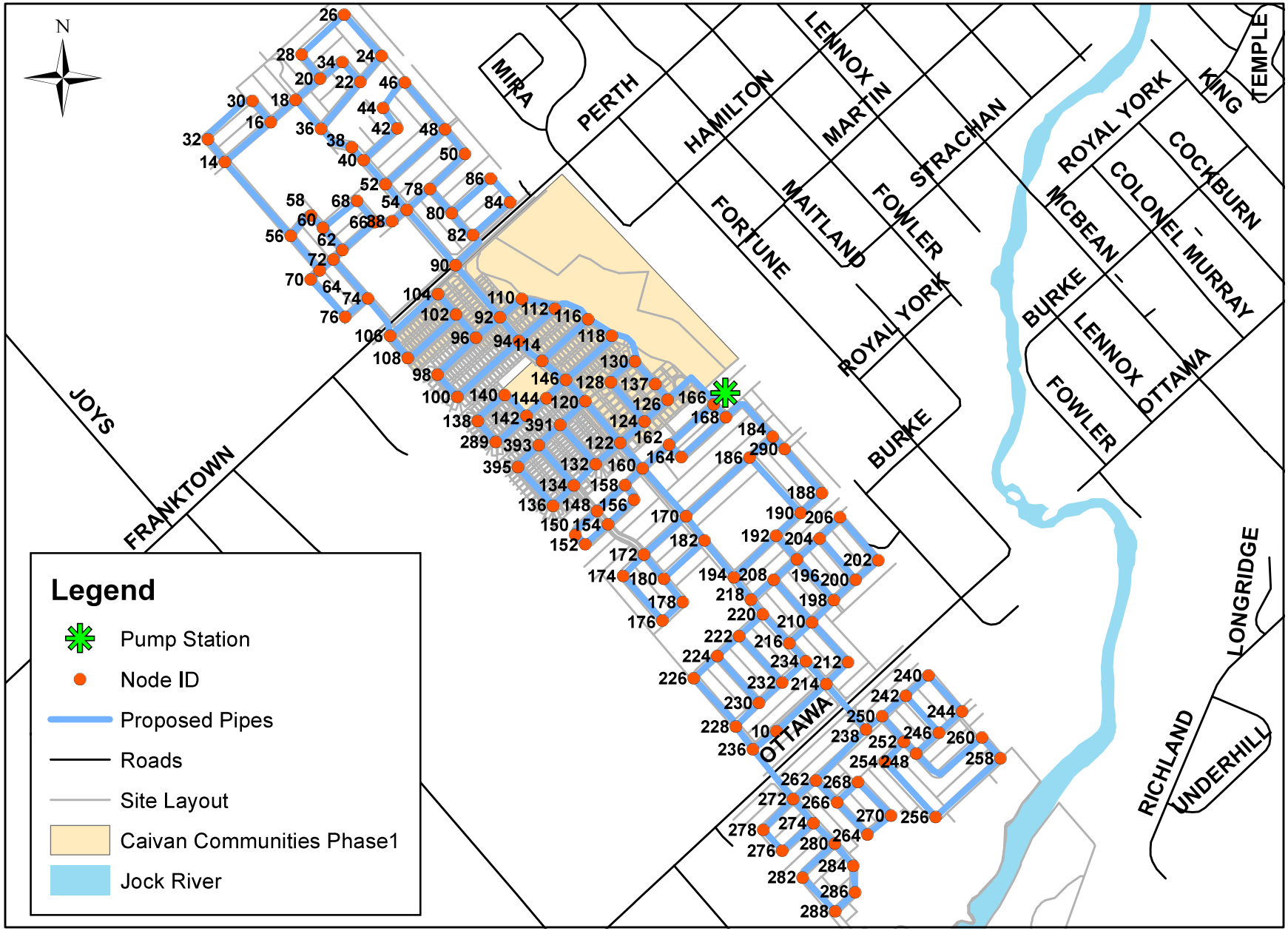
Fire Flow Calculation #: 1
Building Type/Description/Name: Institutional

Notes:

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (> 3 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Other (Comm, Ind, Apt etc.)	1	Units	
			Townhouse - indicate # of units	1				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement):			1	1	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based on design with one hour rating for vertical openings and exterior vertical communications:			4,000	4,000	Area in Square Meters (m^2)	
					Square Metres (m2)			
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						**14,000**
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	**10,500**
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	Adequate Sprinkler conforms to NFPA13	-0.3	N/A	**-3,150**
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is standard for sprinkler and fire dept. hose line	-0.1	N/A	**-1,050**
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler system is fully supervised	-0.1	N/A	**-1,050**
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	45.1m or greater	0	0.15	m	**1,575**
			East Side	45.1m or greater	0			
			South Side	30.1 to 45.0m	0.05			
			West Side	20.1 to 30.1m	0.1			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:***						**7,000**
		Total Required Fire Flow (above) in L/s:						**117**
		Required Duration of Fire Flow (hrs)						**2.25**
		Required Volume of Fire Flow (m^3)						**945**

Appendix B HYDRAULIC MODELLING RESULTS


N
Legend
Pump Station
Node ID
Proposed Pipes
Roads
Site Layout
Caivan Communities Phase1
Jock River
MIRA
PERTH
HAMILTON
LENNOX
MARTIN
STRACHAN
FORTUNE
MAITLAND
FOWLER
ROYAL YORK
BURKE
ROYAL YORK
KING
TEMPLE
COCKBURN
COLONEL MURRAY
MCBEAN
BURKE
LENNOX
FOWLER
OTTAWA
JOYS
FRANKTOWN
OTTAWA
LONGRIDGE
RICHLAND
UNDERHILL

Phase 1 - BSDY

MAX	**71**	**52**
MIN	**70**	**51**

ID	Max Pressure (psi)	Min Pressure (psi)
110	71	52
92	71	52
94	71	52
96	71	51
102	70	51
104	70	51
106	70	51
108	70	51
112	71	52
114	71	52
116	71	52
118	71	52
120	71	52
122	71	52
124	71	52
126	71	52
128	71	52
130	71	52
146	71	52
137	71	52

Phase 1 - PKHR

MAX	**73**	**52**
MIN	**71**	**50**

ID	Max Pressure (psi)	Min Pressure (psi)
110	73	52
92	73	51
94	72	51
96	72	51
102	72	51
104	72	51
106	71	50
108	71	50
112	73	52
114	72	51
116	72	51
118	72	51
120	72	51
122	72	51
124	72	51
126	72	51
128	72	51
130	72	51
146	72	51
137	72	51

Phase 1 - MXDY+FF

Min Pressure (psi) 44

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
102	0.213	76	149.1	7,980	64	17,889	20
104	0.213	76	149.1	7,980	63	17,249	20
106	0.213	76	149.1	7,980	61	16,119	20
108	0.213	76	149.1	7,980	44	10,925	20
110	0.213	77	149.1	7,980	68	19,658	20
112	0.213	77	149.1	7,980	68	19,847	20
114	0.213	77	149.1	7,980	68	19,941	20
116	0.213	77	149.1	7,980	68	20,034	20
118	0.213	77	149.1	7,980	69	20,554	20
120	0.213	77	149.1	7,980	68	20,202	20
122	0.213	77	149.1	7,980	69	20,592	20
124	0.213	77	149.1	7,980	70	20,836	20
126	0.213	77	149.1	7,980	71	21,172	20
128	0.213	77	149.1	7,980	54	13,210	20
130	0.213	77	149.1	7,980	70	20,717	20
137	0.213	77	149.1	7,980	70	20,982	20
146	0.213	77	149.1	7,980	68	20,103	20
92	0.213	77	149.1	7,980	68	19,648	20
94	0.213	77	149.1	7,980	68	19,754	20
96	0.213	77	149.1	7,980	66	18,667	20

Steady-State at 16:00

Phase 1 - BSDY+FF
250mm dia. Watermain as Redundant Feed from PS

Min Pressure (psi) 35

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
102	0.083	75	148.2	7,980	56	14,174	20
104	0.083	75	148.2	7,980	54	13,774	20
106	0.083	75	148.2	7,980	52	13,051	20
108	0.083	74	148.2	7,980	35	9,587	20
110	0.083	76	148.2	7,980	59	15,412	20
112	0.083	76	148.2	7,980	59	15,504	20
114	0.083	75	148.2	7,980	59	15,538	20
116	0.083	76	148.2	7,980	60	15,658	20
118	0.083	76	148.2	7,980	60	15,852	20
120	0.083	75	148.2	7,980	60	15,689	20
122	0.083	75	148.2	7,980	60	15,921	20
124	0.083	76	148.2	7,980	61	16,208	20
126	0.083	76	148.2	7,980	62	16,581	20
128	0.083	76	148.2	7,980	43	10,650	20
130	0.083	76	148.2	7,980	61	16,136	20
137	0.083	76	148.2	7,980	61	16,389	20
146	0.083	75	148.2	7,980	59	15,627	20
92	0.083	76	148.2	7,980	59	15,402	20
94	0.083	75	148.2	7,980	59	15,442	20
96	0.083	75	148.2	7,980	57	14,742	20

Steady-State at 16:00

Build-out - BSDY

MAX	**72**	**53**
MIN	**70**	**51**

ID	Max Pressure (psi)	Min Pressure (psi)	ID	Max Pressure (psi)	Min Pressure (psi)	ID	Max Pressure (psi)	Min Pressure (psi)
14	70	51	112	72	53	208	69	51
16	70	52	114	71	53	210	70	51
18	70	52	116	71	53	212	70	51
20	70	52	118	72	53	214	70	51
22	70	52	120	71	53	216	70	51
24	70	52	122	71	53	218	69	51
26	70	51	124	71	53	220	69	51
28	70	52	126	72	53	222	69	51
30	70	52	128	72	53	224	69	50
32	70	51	130	72	53	226	69	50
34	70	52	132	71	53	228	69	51
36	71	52	134	71	53	230	69	51
38	71	52	136	70	52	232	69	51
40	71	52	138	70	52	234	70	51
42	71	52	140	71	52	236	69	51
44	70	52	142	71	53	238	69	50
46	71	52	144	71	53	240	69	50
48	71	52	146	71	53	242	69	51
50	71	53	148	71	52	244	66	48
52	71	52	150	71	52	246	66	48
54	71	53	152	71	52	248	68	49
56	70	52	154	71	52	250	69	51
58	70	52	156	71	52	252	69	50
60	71	52	158	71	52	254	68	50
62	71	52	160	71	53	256	68	49
64	71	52	162	71	53	258	67	49
66	71	52	164	71	53	260	67	49
68	71	52	166	71	53	262	69	50
70	71	52	168	71	53	264	68	50
72	71	52	170	70	51	266	68	50
74	70	52	172	70	51	268	68	50
76	70	52	182	70	51	270	68	50
78	71	53	184	70	52	272	68	50
80	71	53	186	70	52	274	68	50
82	72	53	188	70	51	276	68	50
84	71	53	190	70	51	278	68	50
86	72	53	192	70	51	280	68	50
88	71	53	196	69	51	282	68	49
90	71	53	202	69	51	284	68	50
92	72	53	204	69	51	286	68	49
94	71	53	206	69	51	288	68	49
96	71	53	290	70	52	10	69	51
98	70	52	174	69	51	137	72	53
100	70	52	176	69	51	289	67	48
102	71	52	178	69	51	391	71	53
104	71	52	180	69	51	393	71	53
106	70	52	194	69	51	395	70	52
108	70	52	198	70	51			
110	72	53	200	70	51			

Build-out - PKHR

MAX	**72**	**57**
MIN	**70**	**55**

ID	Max Pressure (psi)	Min Pressure (psi)	ID	Max Pressure (psi)	Min Pressure (psi)	ID	Max Pressure (psi)	Min Pressure (psi)
14	70	55	112	72	57	208	70	55
16	71	56	114	72	57	210	70	55
18	71	56	116	72	57	212	70	55
20	71	56	118	72	57	214	70	55
22	71	56	120	72	57	216	70	55
24	71	56	122	72	57	218	70	55
26	70	55	124	72	57	220	70	55
28	71	55	126	72	57	222	70	55
30	71	56	128	72	57	224	69	54
32	70	55	130	72	57	226	69	54
34	71	56	132	72	57	228	70	55
36	71	56	134	71	57	230	70	55
38	71	56	136	71	56	232	70	55
40	71	56	138	71	56	234	70	55
42	71	56	140	71	56	236	70	55
44	71	56	142	71	57	238	69	54
46	71	56	144	72	57	240	69	54
48	71	56	146	72	57	242	70	55
50	71	56	148	71	56	244	67	52
52	71	56	150	71	56	246	67	52
54	72	57	152	71	56	248	68	53
56	71	56	154	71	56	250	70	55
58	71	56	156	71	56	252	69	54
60	71	56	158	71	56	254	69	54
62	71	56	160	72	57	256	68	53
64	71	56	162	72	57	258	68	53
66	71	56	164	71	57	260	68	53
68	71	56	166	72	57	262	69	54
70	71	56	168	72	57	264	69	54
72	71	56	170	70	56	266	69	54
74	71	56	172	70	55	268	69	54
76	71	56	182	70	55	270	69	54
78	72	57	184	71	56	272	69	54
80	72	57	186	71	56	274	69	54
82	72	57	188	70	56	276	69	54
84	72	57	190	70	55	278	69	54
86	72	57	192	70	55	280	69	54
88	71	56	196	70	55	282	68	53
90	72	57	202	69	55	284	69	54
92	72	57	204	70	55	286	68	53
94	72	57	206	70	55	288	68	53
96	72	57	290	71	56	10	70	55
98	71	56	174	70	55	137	72	57
100	71	56	176	70	55	289	67	52
102	71	56	178	70	55	391	72	57
104	71	56	180	70	55	393	71	57
106	71	56	194	70	55	395	71	56
108	71	56	198	70	56			
110	72	57	200	70	55			

Build-out - MXDY+FF

Min Pressure (psi) 25

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	13.412	74	148.7	7,980	61	16,893	20
100	11.901	75	148.7	7,980	28	8,692	20
102	11.764	76	148.7	7,980	64	17,698	20
104	11.764	76	148.7	7,980	63	17,435	20
106	11.764	75	148.7	7,980	62	17,140	20
108	11.764	75	148.7	7,980	45	11,204	20
110	11.764	77	148.7	7,980	66	18,701	20
112	11.764	77	148.7	7,980	66	18,854	20
114	11.764	76	148.7	7,980	66	19,052	20
116	11.764	76	148.7	7,980	67	18,999	20
118	11.764	76	148.7	7,980	67	19,192	20
120	11.764	76	148.7	7,980	67	19,296	20
122	11.764	76	148.7	7,980	68	19,556	20
124	11.764	76	148.7	7,980	68	19,539	20
126	11.764	76	148.7	7,980	69	19,653	20
128	11.764	76	148.7	7,980	52	12,854	20
130	11.764	76	148.7	7,980	68	19,301	20
132	11.901	76	148.7	7,980	63	17,264	20
134	11.901	76	148.7	7,980	60	15,702	20
136	11.901	75	148.7	7,980	54	13,829	20
137	11.764	76	148.7	7,980	68	19,478	20
138	11.901	75	148.7	7,980	26	8,562	20
14	10.888	75	148.7	7,980	60	16,249	20
140	11.901	76	148.7	7,980	28	8,737	20
142	11.901	76	148.7	7,980	49	12,100	20
144	11.901	76	148.7	7,980	58	14,835	20
146	11.764	76	148.7	7,980	67	19,177	20
148	13.412	76	148.7	7,980	51	12,697	20
150	13.412	75	148.7	7,980	46	11,431	20
152	13.412	75	148.7	7,980	39	10,119	20
154	13.412	75	148.7	7,980	34	9,413	20
156	13.412	75	148.7	7,980	43	10,931	20
158	13.412	75	148.7	7,980	59	15,596	20
16	10.888	75	148.7	7,980	60	16,269	20
160	13.412	76	148.7	7,980	68	19,544	20
162	13.412	76	148.7	7,980	66	18,759	20
164	13.412	76	148.7	7,980	55	13,811	20
166	12.687	76	148.7	7,980	70	20,165	20
168	13.412	76	148.7	7,980	69	19,937	20
170	18.235	75	148.7	7,980	66	19,246	20
172	13.412	74	148.7	7,980	59	16,073	20
174	13.412	74	148.7	7,980	37	9,839	20
176	13.412	74	148.7	7,980	28	8,765	20
178	13.412	74	148.7	7,980	37	9,822	20
18	10.705	75	148.7	7,980	60	16,332	20
180	13.412	74	148.7	7,980	59	16,054	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	13.412	74	148.7	7,980	65	19,114	20
184	13.412	75	148.7	7,980	67	19,407	20
186	18.235	75	148.7	7,980	64	17,848	20
188	13.412	75	148.7	7,980	65	19,053	20
190	13.412	74	148.7	7,980	65	18,962	20
192	13.412	74	148.7	7,980	65	18,793	20
194	13.412	74	148.7	7,980	65	18,845	20
196	13.412	74	148.7	7,980	64	18,465	20
198	13.412	75	148.7	7,980	62	17,168	20
20	10.705	75	148.7	7,980	55	14,199	20
200	13.412	74	148.7	7,980	59	15,977	20
202	13.412	74	148.7	7,980	56	14,700	20
204	13.412	74	148.7	7,980	60	16,226	20
206	13.412	74	148.7	7,980	56	14,805	20
208	13.412	74	148.7	7,980	62	17,487	20
210	13.412	74	148.7	7,980	62	17,135	20
212	13.412	75	148.7	7,980	60	16,145	20
214	13.412	74	148.7	7,980	62	17,443	20
216	13.412	74	148.7	7,980	63	17,862	20
218	13.412	74	148.7	7,980	64	18,509	20
22	10.705	75	148.7	7,980	53	13,493	20
220	13.412	74	148.7	7,980	63	18,178	20
222	13.412	74	148.7	7,980	60	16,350	20
224	13.412	74	148.7	7,980	58	15,513	20
226	13.412	74	148.7	7,980	56	14,696	20
228	13.412	74	148.7	7,980	59	16,308	20
230	13.412	74	148.7	7,980	59	15,961	20
232	13.412	74	148.7	7,980	60	16,329	20
234	13.412	74	148.7	7,980	63	17,659	20
236	13.412	74	148.7	7,980	61	16,826	20
238	13.412	74	148.7	7,980	60	16,510	20
24	10.705	75	148.7	7,980	48	12,001	20
240	13.412	73	148.7	7,980	50	12,854	20
242	13.412	74	148.7	7,980	55	14,254	20
244	13.412	71	148.7	7,980	48	12,523	20
246	13.412	71	148.7	7,980	51	13,714	20
248	13.412	72	148.7	7,980	56	15,167	20
250	13.412	74	148.7	7,980	59	16,076	20
252	13.412	73	148.7	7,980	57	15,461	20
254	13.412	73	148.7	7,980	56	14,993	20
256	13.412	73	148.7	7,980	47	12,233	20
258	13.412	72	148.7	7,980	49	12,830	20
26	10.705	74	148.7	7,980	42	10,800	20
260	13.412	72	148.7	7,980	53	14,103	20
262	13.412	73	148.7	7,980	58	15,899	20
264	13.412	73	148.7	7,980	38	10,154	20
266	13.412	73	148.7	7,980	48	12,277	20
268	13.412	73	148.7	7,980	27	8,677	20
270	13.412	73	148.7	7,980	25	8,496	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
272	13.412	73	148.7	7,980	59	16,104	20
274	13.412	73	148.7	7,980	53	14,031	20
276	13.412	73	148.7	7,980	51	13,395	20
278	13.412	73	148.7	7,980	52	13,721	20
28	10.705	75	148.7	7,980	49	12,407	20
280	13.412	73	148.7	7,980	43	11,180	20
282	13.412	73	148.7	7,980	36	9,881	20
284	13.412	73	148.7	7,980	38	10,169	20
286	13.412	73	148.7	7,980	36	9,787	20
288	13.412	72	148.7	7,980	35	9,640	20
290	13.412	75	148.7	7,980	66	19,285	20
30	10.888	75	148.7	7,980	40	10,299	20
32	10.888	74	148.7	7,980	39	10,221	20
34	10.705	75	148.7	7,980	46	11,595	20
36	10.705	75	148.7	7,980	61	16,434	20
38	10.705	75	148.7	7,980	61	16,624	20
40	10.705	76	148.7	7,980	62	16,738	20
42	10.705	75	148.7	7,980	52	13,207	20
44	10.705	75	148.7	7,980	49	12,163	20
46	10.705	75	148.7	7,980	45	11,257	20
48	10.705	76	148.7	7,980	55	13,866	20
50	10.705	76	148.7	7,980	54	13,552	20
52	10.705	76	148.7	7,980	62	16,962	20
54	10.705	76	148.7	7,980	63	17,258	20
56	10.888	75	148.7	7,980	61	16,624	20
58	10.888	75	148.7	7,980	49	12,150	20
60	10.888	75	148.7	7,980	52	13,191	20
62	10.888	75	148.7	7,980	61	16,357	20
64	10.888	75	148.7	7,980	62	16,835	20
66	10.888	76	148.7	7,980	60	15,920	20
68	10.888	76	148.7	7,980	45	11,207	20
70	10.888	75	148.7	7,980	51	12,695	20
72	10.888	75	148.7	7,980	62	16,933	20
74	10.888	75	148.7	7,980	62	16,977	20
76	10.888	75	148.7	7,980	44	11,004	20
78	10.705	76	148.7	7,980	61	16,032	20
80	10.705	76	148.7	7,980	59	15,283	20
82	10.705	76	148.7	7,980	59	15,403	20
84	10.705	76	148.7	7,980	52	12,801	20
86	10.705	76	148.7	7,980	52	12,738	20
88	10.888	76	148.7	7,980	61	16,205	20
90	10.705	76	148.7	7,980	64	17,636	20
92	11.764	76	148.7	7,980	66	18,703	20
94	11.764	76	148.7	7,980	66	18,824	20
96	11.764	76	148.7	7,980	65	18,096	20
98	11.901	75	148.7	7,980	31	9,096	20

Steady-State at 16:00

Break Location 1

Min Pressure (psi) 27

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	62	17,558	20
100	2.117	76	148.9	7,980	29	8,803	20
102	5.873	76	148.9	7,980	65	18,198	20
104	5.873	76	148.9	7,980	64	17,861	20
106	5.873	76	148.9	7,980	63	17,388	20
108	5.873	75	148.9	7,980	45	11,263	20
110	5.873	77	148.9	7,980	68	19,402	20
112	5.873	77	148.9	7,980	68	19,563	20
114	5.873	76	148.9	7,980	68	19,802	20
116	5.873	77	148.9	7,980	68	19,717	20
118	5.873	77	148.9	7,980	68	19,978	20
120	5.873	77	148.9	7,980	69	20,092	20
122	5.873	76	148.9	7,980	69	20,368	20
124	5.873	77	148.9	7,980	69	20,345	20
126	5.873	77	148.9	7,980	70	20,465	20
128	5.873	77	148.9	7,980	53	13,120	20
130	5.873	77	148.9	7,980	69	20,092	20
132	2.117	76	148.9	7,980	65	17,872	20
134	2.117	76	148.9	7,980	61	16,167	20
136	2.117	76	148.9	7,980	56	14,144	20
137	0	77	148.9	7,980	69	20,274	20
138	2.117	76	148.9	7,980	28	8,682	20
14	10.888	75	148.9	7,980	54	13,916	20
140	2.117	76	148.9	7,980	30	8,858	20
142	2.117	76	148.9	7,980	50	12,298	20
144	2.117	76	148.9	7,980	59	15,274	20
146	5.873	76	148.9	7,980	68	19,966	20
148	6.052	76	148.9	7,980	52	12,983	20
150	6.052	76	148.9	7,980	47	11,601	20
152	6.052	76	148.9	7,980	40	10,263	20
154	6.052	76	148.9	7,980	35	9,541	20
156	6.052	76	148.9	7,980	45	11,088	20
158	6.052	76	148.9	7,980	60	16,065	20
16	10.888	75	148.9	7,980	52	13,188	20
160	6.052	76	148.9	7,980	69	20,355	20
162	6.052	76	148.9	7,980	67	19,420	20
164	6.052	76	148.9	7,980	56	14,085	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,754	20
170	10.874	75	148.9	7,980	67	20,049	20
172	6.052	75	148.9	7,980	61	16,580	20
174	6.052	75	148.9	7,980	38	9,979	20
176	6.052	74	148.9	7,980	30	8,886	20
178	6.052	74	148.9	7,980	38	9,964	20
18	8.429	75	148.9	7,980	51	12,746	20
180	6.052	75	148.9	7,980	61	16,561	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	67	19,911	20
184	6.052	75	148.9	7,980	68	20,208	20
186	10.874	75	148.9	7,980	65	18,491	20
188	6.052	75	148.9	7,980	67	19,813	20
190	6.052	75	148.9	7,980	66	19,702	20
192	6.052	75	148.9	7,980	66	19,532	20
194	6.052	75	148.9	7,980	66	19,600	20
196	6.052	74	148.9	7,980	65	19,190	20
198	6.052	75	148.9	7,980	63	17,812	20
20	8.429	75	148.9	7,980	45	11,293	20
200	6.052	75	148.9	7,980	61	16,494	20
202	6.052	74	148.9	7,980	57	15,156	20
204	6.052	74	148.9	7,980	61	16,756	20
206	6.052	74	148.9	7,980	57	15,266	20
208	6.052	74	148.9	7,980	63	18,153	20
210	6.052	75	148.9	7,980	63	17,785	20
212	6.052	75	148.9	7,980	61	16,690	20
214	6.052	75	148.9	7,980	64	18,137	20
216	6.052	75	148.9	7,980	64	18,574	20
218	6.052	74	148.9	7,980	65	19,252	20
22	8.429	75	148.9	7,980	43	10,815	20
220	6.052	74	148.9	7,980	65	18,908	20
222	6.052	74	148.9	7,980	61	16,931	20
224	6.052	74	148.9	7,980	59	16,034	20
226	6.052	74	148.9	7,980	57	15,176	20
228	6.052	74	148.9	7,980	61	16,888	20
230	6.052	74	148.9	7,980	60	16,507	20
232	6.052	75	148.9	7,980	61	16,907	20
234	6.052	75	148.9	7,980	64	18,364	20
236	6.052	74	148.9	7,980	62	17,488	20
238	6.052	74	148.9	7,980	61	17,157	20
24	8.429	75	148.9	7,980	38	9,914	20
240	6.052	74	148.9	7,980	52	13,204	20
242	6.052	74	148.9	7,980	56	14,676	20
244	6.052	71	148.9	7,980	49	12,870	20
246	6.052	71	148.9	7,980	53	14,119	20
248	6.052	73	148.9	7,980	57	15,704	20
250	6.052	74	148.9	7,980	60	16,650	20
252	6.052	74	148.9	7,980	59	16,007	20
254	6.052	73	148.9	7,980	57	15,514	20
256	6.052	73	148.9	7,980	49	12,507	20
258	6.052	72	148.9	7,980	51	13,188	20
26	8.429	75	148.9	7,980	32	9,223	20
260	6.052	72	148.9	7,980	54	14,521	20
262	6.052	74	148.9	7,980	60	16,469	20
264	6.052	73	148.9	7,980	40	10,344	20
266	6.052	74	148.9	7,980	49	12,564	20
268	6.052	73	148.9	7,980	29	8,825	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	27	8,640	20
272	6.052	74	148.9	7,980	60	16,688	20
274	6.052	73	148.9	7,980	55	14,444	20
276	6.052	73	148.9	7,980	53	13,777	20
278	6.052	73	148.9	7,980	54	14,114	20
28	8.429	75	148.9	7,980	39	10,201	20
280	6.052	73	148.9	7,980	45	11,410	20
282	6.052	73	148.9	7,980	38	10,072	20
284	6.052	73	148.9	7,980	40	10,369	20
286	6.052	73	148.9	7,980	37	9,976	20
288	6.052	73	148.9	7,980	36	9,825	20
290	6.052	75	148.9	7,980	68	20,080	20
30	10.888	75	148.9	7,980	33	9,298	20
32	10.888	75	148.9	7,980	33	9,320	20
34	8.429	75	148.9	7,980	36	9,702	20
36	8.429	76	148.9	7,980	50	12,365	20
38	8.429	76	148.9	7,980	60	15,918	20
40	8.429	76	148.9	7,980	61	16,300	20
42	8.429	76	148.9	7,980	52	13,005	20
44	8.429	76	148.9	7,980	48	11,937	20
46	8.429	76	148.9	7,980	45	11,107	20
48	8.429	76	148.9	7,980	55	13,850	20
50	8.429	76	148.9	7,980	54	13,661	20
52	8.429	76	148.9	7,980	62	16,962	20
54	8.429	76	148.9	7,980	64	17,579	20
56	10.888	75	148.9	7,980	59	15,814	20
58	10.888	76	148.9	7,980	48	11,973	20
60	10.888	76	148.9	7,980	53	13,199	20
62	10.888	76	148.9	7,980	61	16,405	20
64	10.888	76	148.9	7,980	61	16,528	20
66	10.888	76	148.9	7,980	61	16,365	20
68	10.888	76	148.9	7,980	45	11,253	20
70	10.888	76	148.9	7,980	50	12,523	20
72	10.888	76	148.9	7,980	62	16,808	20
74	10.888	76	148.9	7,980	62	17,060	20
76	10.888	75	148.9	7,980	44	10,902	20
78	8.429	76	148.9	7,980	61	16,277	20
80	8.429	77	148.9	7,980	60	15,567	20
82	8.429	77	148.9	7,980	60	15,701	20
84	8.429	77	148.9	7,980	52	12,978	20
86	8.429	77	148.9	7,980	52	12,911	20
88	10.888	76	148.9	7,980	62	16,701	20
90	8.429	77	148.9	7,980	65	18,112	20
92	5.873	77	148.9	7,980	67	19,407	20
94	5.873	76	148.9	7,980	67	19,538	20
96	5.873	76	148.9	7,980	66	18,707	20
98	2.117	76	148.9	7,980	33	9,214	20

Break Location 2

Min Pressure (psi) 27

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	62	17,558	20
100	2.117	76	148.9	7,980	29	8,802	20
102	5.873	76	148.9	7,980	65	18,115	20
104	5.873	76	148.9	7,980	64	17,747	20
106	5.873	76	148.9	7,980	62	17,193	20
108	5.873	75	148.9	7,980	45	11,206	20
110	5.873	77	148.9	7,980	68	19,402	20
112	5.873	77	148.9	7,980	68	19,563	20
114	5.873	76	148.9	7,980	68	19,802	20
116	5.873	77	148.9	7,980	68	19,717	20
118	5.873	77	148.9	7,980	68	19,978	20
120	5.873	77	148.9	7,980	69	20,092	20
122	5.873	76	148.9	7,980	69	20,368	20
124	5.873	77	148.9	7,980	69	20,345	20
126	5.873	77	148.9	7,980	70	20,465	20
128	5.873	77	148.9	7,980	53	13,120	20
130	5.873	77	148.9	7,980	69	20,092	20
132	2.117	76	148.9	7,980	65	17,872	20
134	2.117	76	148.9	7,980	61	16,167	20
136	2.117	76	148.9	7,980	56	14,144	20
137	0	77	148.9	7,980	69	20,274	20
138	2.117	76	148.9	7,980	28	8,682	20
14	10.888	75	148.9	7,980	58	15,359	20
140	2.117	76	148.9	7,980	30	8,858	20
142	2.117	76	148.9	7,980	50	12,298	20
144	2.117	76	148.9	7,980	59	15,274	20
146	5.873	76	148.9	7,980	68	19,966	20
148	6.052	76	148.9	7,980	52	12,983	20
150	6.052	76	148.9	7,980	47	11,601	20
152	6.052	76	148.9	7,980	40	10,263	20
154	6.052	76	148.9	7,980	35	9,541	20
156	6.052	76	148.9	7,980	45	11,088	20
158	6.052	76	148.9	7,980	60	16,065	20
16	10.888	75	148.9	7,980	58	15,317	20
160	6.052	76	148.9	7,980	69	20,355	20
162	6.052	76	148.9	7,980	67	19,420	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
164	6.052	76	148.9	7,980	56	14,085	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,754	20
170	10.874	75	148.9	7,980	67	20,049	20
172	6.052	75	148.9	7,980	61	16,580	20
174	6.052	75	148.9	7,980	38	9,979	20
176	6.052	74	148.9	7,980	30	8,886	20
178	6.052	74	148.9	7,980	38	9,964	20
18	8.429	75	148.9	7,980	58	15,329	20
180	6.052	75	148.9	7,980	61	16,561	20
182	6.052	75	148.9	7,980	67	19,911	20
184	6.052	75	148.9	7,980	68	20,208	20
186	10.874	75	148.9	7,980	65	18,491	20
188	6.052	75	148.9	7,980	67	19,813	20
190	6.052	75	148.9	7,980	66	19,702	20
192	6.052	75	148.9	7,980	66	19,532	20
194	6.052	75	148.9	7,980	66	19,600	20
196	6.052	74	148.9	7,980	65	19,190	20
198	6.052	75	148.9	7,980	63	17,812	20
20	8.429	75	148.9	7,980	53	13,355	20
200	6.052	75	148.9	7,980	61	16,494	20
202	6.052	74	148.9	7,980	57	15,156	20
204	6.052	74	148.9	7,980	61	16,756	20
206	6.052	74	148.9	7,980	57	15,266	20
208	6.052	74	148.9	7,980	63	18,153	20
210	6.052	75	148.9	7,980	63	17,785	20
212	6.052	75	148.9	7,980	61	16,690	20
214	6.052	75	148.9	7,980	64	18,137	20
216	6.052	75	148.9	7,980	64	18,574	20
218	6.052	74	148.9	7,980	65	19,252	20
22	8.429	75	148.9	7,980	51	12,753	20
220	6.052	74	148.9	7,980	65	18,908	20
222	6.052	74	148.9	7,980	61	16,931	20
224	6.052	74	148.9	7,980	59	16,034	20
226	6.052	74	148.9	7,980	57	15,176	20
228	6.052	74	148.9	7,980	61	16,888	20
230	6.052	74	148.9	7,980	60	16,507	20
232	6.052	75	148.9	7,980	61	16,907	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
234	6.052	75	148.9	7,980	64	18,364	20
236	6.052	74	148.9	7,980	62	17,488	20
238	6.052	74	148.9	7,980	61	17,157	20
24	8.429	75	148.9	7,980	45	11,341	20
240	6.052	74	148.9	7,980	52	13,204	20
242	6.052	74	148.9	7,980	56	14,676	20
244	6.052	71	148.9	7,980	49	12,870	20
246	6.052	71	148.9	7,980	53	14,119	20
248	6.052	73	148.9	7,980	57	15,704	20
250	6.052	74	148.9	7,980	60	16,650	20
252	6.052	74	148.9	7,980	59	16,007	20
254	6.052	73	148.9	7,980	57	15,514	20
256	6.052	73	148.9	7,980	49	12,507	20
258	6.052	72	148.9	7,980	51	13,188	20
26	8.429	75	148.9	7,980	40	10,324	20
260	6.052	72	148.9	7,980	54	14,521	20
262	6.052	74	148.9	7,980	60	16,469	20
264	6.052	73	148.9	7,980	40	10,344	20
266	6.052	74	148.9	7,980	49	12,564	20
268	6.052	73	148.9	7,980	29	8,825	20
270	6.052	73	148.9	7,980	27	8,640	20
272	6.052	74	148.9	7,980	60	16,688	20
274	6.052	73	148.9	7,980	55	14,444	20
276	6.052	73	148.9	7,980	53	13,777	20
278	6.052	73	148.9	7,980	54	14,114	20
28	8.429	75	148.9	7,980	47	11,723	20
280	6.052	73	148.9	7,980	45	11,410	20
282	6.052	73	148.9	7,980	38	10,072	20
284	6.052	73	148.9	7,980	40	10,369	20
286	6.052	73	148.9	7,980	37	9,976	20
288	6.052	73	148.9	7,980	36	9,825	20
290	6.052	75	148.9	7,980	68	20,080	20
30	10.888	75	148.9	7,980	38	9,931	20
32	10.888	75	148.9	7,980	37	9,864	20
34	8.429	75	148.9	7,980	44	11,003	20
36	8.429	76	148.9	7,980	59	15,376	20
38	8.429	76	148.9	7,980	59	15,472	20
40	8.429	76	148.9	7,980	59	15,529	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
42	8.429	76	148.9	7,980	50	12,367	20
44	8.429	76	148.9	7,980	46	11,396	20
46	8.429	76	148.9	7,980	42	10,645	20
48	8.429	76	148.9	7,980	52	12,981	20
50	8.429	76	148.9	7,980	52	12,917	20
52	8.429	76	148.9	7,980	59	15,630	20
54	8.429	76	148.9	7,980	60	15,713	20
56	10.888	75	148.9	7,980	60	15,890	20
58	10.888	76	148.9	7,980	47	11,636	20
60	10.888	76	148.9	7,980	51	12,654	20
62	10.888	76	148.9	7,980	59	15,605	20
64	10.888	76	148.9	7,980	61	16,237	20
66	10.888	76	148.9	7,980	58	15,053	20
68	10.888	76	148.9	7,980	43	10,759	20
70	10.888	76	148.9	7,980	50	12,346	20
72	10.888	76	148.9	7,980	61	16,394	20
74	10.888	76	148.9	7,980	61	16,732	20
76	10.888	75	148.9	7,980	43	10,778	20
78	8.429	76	148.9	7,980	59	15,423	20
80	8.429	77	148.9	7,980	59	15,394	20
82	8.429	77	148.9	7,980	60	15,732	20
84	8.429	77	148.9	7,980	52	12,957	20
86	8.429	77	148.9	7,980	52	12,848	20
88	10.888	76	148.9	7,980	58	15,140	20
90	8.429	77	148.9	7,980	65	18,033	20
92	5.873	77	148.9	7,980	67	19,407	20
94	5.873	76	148.9	7,980	67	19,538	20
96	5.873	76	148.9	7,980	66	18,673	20
98	2.117	76	148.9	7,980	33	9,211	20

Break Location 3

Min Pressure (psi) 27

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	62	17,558	20
100	2.117	76	148.9	7,980	29	8,796	20
102	5.873	76	148.9	7,980	64	17,687	20
104	5.873	76	148.9	7,980	62	17,125	20
106	5.873	76	148.9	7,980	60	15,936	20
108	5.873	75	148.9	7,980	43	10,884	20
110	5.873	77	148.9	7,980	68	19,402	20
112	5.873	77	148.9	7,980	68	19,563	20
114	5.873	76	148.9	7,980	68	19,802	20
116	5.873	77	148.9	7,980	68	19,717	20
118	5.873	77	148.9	7,980	68	19,978	20
120	5.873	77	148.9	7,980	69	20,092	20
122	5.873	76	148.9	7,980	69	20,368	20
124	5.873	77	148.9	7,980	69	20,345	20
126	5.873	77	148.9	7,980	70	20,465	20
128	5.873	77	148.9	7,980	53	13,120	20
130	5.873	77	148.9	7,980	69	20,092	20
132	2.117	76	148.9	7,980	65	17,872	20
134	2.117	76	148.9	7,980	61	16,167	20
136	2.117	76	148.9	7,980	56	14,144	20
137	0	77	148.9	7,980	69	20,274	20
138	2.117	76	148.9	7,980	28	8,682	20
14	10.888	75	148.9	7,980	51	12,904	20
140	2.117	76	148.9	7,980	30	8,858	20
142	2.117	76	148.9	7,980	50	12,298	20
144	2.117	76	148.9	7,980	59	15,274	20
146	5.873	76	148.9	7,980	68	19,966	20
148	6.052	76	148.9	7,980	52	12,983	20
150	6.052	76	148.9	7,980	47	11,601	20
152	6.052	76	148.9	7,980	40	10,263	20
154	6.052	76	148.9	7,980	35	9,541	20
156	6.052	76	148.9	7,980	45	11,088	20
158	6.052	76	148.9	7,980	60	16,065	20
16	10.888	75	148.9	7,980	50	12,702	20
160	6.052	76	148.9	7,980	69	20,355	20
162	6.052	76	148.9	7,980	67	19,420	20
164	6.052	76	148.9	7,980	56	14,085	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,754	20
170	10.874	75	148.9	7,980	67	20,049	20
172	6.052	75	148.9	7,980	61	16,580	20
174	6.052	75	148.9	7,980	38	9,979	20
176	6.052	74	148.9	7,980	30	8,886	20
178	6.052	74	148.9	7,980	38	9,964	20
18	8.429	75	148.9	7,980	50	12,600	20
180	6.052	75	148.9	7,980	61	16,561	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	67	19,911	20
184	6.052	75	148.9	7,980	68	20,208	20
186	10.874	75	148.9	7,980	65	18,491	20
188	6.052	75	148.9	7,980	67	19,813	20
190	6.052	75	148.9	7,980	66	19,702	20
192	6.052	75	148.9	7,980	66	19,532	20
194	6.052	75	148.9	7,980	66	19,600	20
196	6.052	74	148.9	7,980	65	19,190	20
198	6.052	75	148.9	7,980	63	17,812	20
20	8.429	75	148.9	7,980	45	11,208	20
200	6.052	75	148.9	7,980	61	16,494	20
202	6.052	74	148.9	7,980	57	15,156	20
204	6.052	74	148.9	7,980	61	16,756	20
206	6.052	74	148.9	7,980	57	15,266	20
208	6.052	74	148.9	7,980	63	18,153	20
210	6.052	75	148.9	7,980	63	17,785	20
212	6.052	75	148.9	7,980	61	16,690	20
214	6.052	75	148.9	7,980	64	18,137	20
216	6.052	75	148.9	7,980	64	18,574	20
218	6.052	74	148.9	7,980	65	19,252	20
22	8.429	75	148.9	7,980	43	10,791	20
220	6.052	74	148.9	7,980	65	18,908	20
222	6.052	74	148.9	7,980	61	16,931	20
224	6.052	74	148.9	7,980	59	16,034	20
226	6.052	74	148.9	7,980	57	15,176	20
228	6.052	74	148.9	7,980	61	16,888	20
230	6.052	74	148.9	7,980	60	16,507	20
232	6.052	75	148.9	7,980	61	16,907	20
234	6.052	75	148.9	7,980	64	18,364	20
236	6.052	74	148.9	7,980	62	17,488	20
238	6.052	74	148.9	7,980	61	17,157	20
24	8.429	75	148.9	7,980	37	9,879	20
240	6.052	74	148.9	7,980	52	13,204	20
242	6.052	74	148.9	7,980	56	14,676	20
244	6.052	71	148.9	7,980	49	12,870	20
246	6.052	71	148.9	7,980	53	14,119	20
248	6.052	73	148.9	7,980	57	15,704	20
250	6.052	74	148.9	7,980	60	16,650	20
252	6.052	74	148.9	7,980	59	16,007	20
254	6.052	73	148.9	7,980	57	15,514	20
256	6.052	73	148.9	7,980	49	12,507	20
258	6.052	72	148.9	7,980	51	13,188	20
26	8.429	75	148.9	7,980	32	9,171	20
260	6.052	72	148.9	7,980	54	14,521	20
262	6.052	74	148.9	7,980	60	16,469	20
264	6.052	73	148.9	7,980	40	10,344	20
266	6.052	74	148.9	7,980	49	12,564	20
268	6.052	73	148.9	7,980	29	8,825	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	27	8,640	20
272	6.052	74	148.9	7,980	60	16,688	20
274	6.052	73	148.9	7,980	55	14,444	20
276	6.052	73	148.9	7,980	53	13,777	20
278	6.052	73	148.9	7,980	54	14,114	20
28	8.429	75	148.9	7,980	39	10,135	20
280	6.052	73	148.9	7,980	45	11,410	20
282	6.052	73	148.9	7,980	38	10,072	20
284	6.052	73	148.9	7,980	40	10,369	20
286	6.052	73	148.9	7,980	37	9,976	20
288	6.052	73	148.9	7,980	36	9,825	20
290	6.052	75	148.9	7,980	68	20,080	20
30	10.888	75	148.9	7,980	30	8,986	20
32	10.888	75	148.9	7,980	30	8,944	20
34	8.429	75	148.9	7,980	36	9,651	20
36	8.429	76	148.9	7,980	50	12,537	20
38	8.429	76	148.9	7,980	50	12,477	20
40	8.429	76	148.9	7,980	50	12,451	20
42	8.429	76	148.9	7,980	40	10,359	20
44	8.429	75	148.9	7,980	36	9,742	20
46	8.429	76	148.9	7,980	33	9,246	20
48	8.429	76	148.9	7,980	42	10,613	20
50	8.429	76	148.9	7,980	41	10,362	20
52	8.429	76	148.9	7,980	50	12,425	20
54	8.429	76	148.9	7,980	50	12,422	20
56	10.888	75	148.9	7,980	54	13,623	20
58	10.888	76	148.9	7,980	41	10,427	20
60	10.888	76	148.9	7,980	45	11,161	20
62	10.888	76	148.9	7,980	53	13,459	20
64	10.888	76	148.9	7,980	55	14,054	20
66	10.888	76	148.9	7,980	51	12,644	20
68	10.888	76	148.9	7,980	37	9,729	20
70	10.888	76	148.9	7,980	45	11,177	20
72	10.888	76	148.9	7,980	56	14,237	20
74	10.888	76	148.9	7,980	57	15,046	20
76	10.888	75	148.9	7,980	39	10,064	20
78	8.429	76	148.9	7,980	47	11,615	20
80	8.429	77	148.9	7,980	45	11,136	20
82	8.429	77	148.9	7,980	45	11,141	20
84	8.429	76	148.9	7,980	37	9,838	20
86	8.429	77	148.9	7,980	37	9,826	20
88	10.888	76	148.9	7,980	50	12,423	20
90	8.429	76	148.9	7,980	48	11,879	20
92	5.873	77	148.9	7,980	67	19,407	20
94	5.873	76	148.9	7,980	67	19,538	20
96	5.873	76	148.9	7,980	65	18,507	20
98	2.117	76	148.9	7,980	33	9,200	20

Break Location 4

Min Pressure (psi) 23

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	62	17,551	20
100	2.117	76	148.9	7,980	23	8,274	20
102	5.873	76	148.9	7,980	60	15,846	20
104	5.873	76	148.9	7,980	59	15,627	20
106	5.873	76	148.9	7,980	58	15,377	20
108	5.873	75	148.9	7,980	41	10,376	20
110	5.873	77	148.9	7,980	63	17,195	20
112	5.873	77	148.9	7,980	65	17,865	20
114	5.873	76	148.9	7,980	67	19,035	20
116	5.873	77	148.9	7,980	66	18,617	20
118	5.873	77	148.9	7,980	68	19,594	20
120	5.873	77	148.9	7,980	68	19,974	20
122	5.873	76	148.9	7,980	69	20,347	20
124	5.873	77	148.9	7,980	69	20,345	20
126	5.873	77	148.9	7,980	70	20,455	20
128	5.873	77	148.9	7,980	53	13,085	20
130	5.873	77	148.9	7,980	68	19,951	20
132	2.117	76	148.9	7,980	64	17,826	20
134	2.117	76	148.9	7,980	61	16,119	20
136	2.117	76	148.9	7,980	56	14,104	20
137	0	77	148.9	7,980	69	20,227	20
138	2.117	76	148.9	7,980	27	8,626	20
14	10.888	75	148.9	7,980	56	14,562	20
140	2.117	76	148.9	7,980	29	8,799	20
142	2.117	76	148.9	7,980	49	12,140	20
144	2.117	76	148.9	7,980	58	15,049	20
146	5.873	76	148.9	7,980	68	19,641	20
148	6.052	76	148.9	7,980	52	12,974	20
150	6.052	76	148.9	7,980	47	11,593	20
152	6.052	76	148.9	7,980	40	10,258	20
154	6.052	76	148.9	7,980	35	9,537	20
156	6.052	76	148.9	7,980	45	11,082	20
158	6.052	76	148.9	7,980	60	16,049	20
16	10.888	75	148.9	7,980	56	14,587	20
160	6.052	76	148.9	7,980	69	20,342	20
162	6.052	76	148.9	7,980	67	19,415	20
164	6.052	76	148.9	7,980	56	14,084	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,754	20
170	10.874	75	148.9	7,980	67	20,041	20
172	6.052	75	148.9	7,980	61	16,570	20
174	6.052	75	148.9	7,980	38	9,977	20
176	6.052	74	148.9	7,980	30	8,884	20
178	6.052	74	148.9	7,980	38	9,961	20
18	8.429	75	148.9	7,980	57	14,651	20
180	6.052	75	148.9	7,980	61	16,551	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	67	19,905	20
184	6.052	75	148.9	7,980	68	20,206	20
186	10.874	75	148.9	7,980	65	18,486	20
188	6.052	75	148.9	7,980	67	19,806	20
190	6.052	75	148.9	7,980	66	19,695	20
192	6.052	75	148.9	7,980	66	19,524	20
194	6.052	75	148.9	7,980	66	19,590	20
196	6.052	74	148.9	7,980	65	19,183	20
198	6.052	75	148.9	7,980	63	17,806	20
20	8.429	75	148.9	7,980	51	12,872	20
200	6.052	75	148.9	7,980	61	16,488	20
202	6.052	74	148.9	7,980	57	15,152	20
204	6.052	74	148.9	7,980	61	16,750	20
206	6.052	74	148.9	7,980	57	15,261	20
208	6.052	74	148.9	7,980	63	18,147	20
210	6.052	75	148.9	7,980	63	17,779	20
212	6.052	75	148.9	7,980	61	16,684	20
214	6.052	75	148.9	7,980	64	18,130	20
216	6.052	75	148.9	7,980	64	18,567	20
218	6.052	74	148.9	7,980	65	19,243	20
22	8.429	75	148.9	7,980	49	12,276	20
220	6.052	74	148.9	7,980	65	18,899	20
222	6.052	74	148.9	7,980	61	16,924	20
224	6.052	74	148.9	7,980	59	16,029	20
226	6.052	74	148.9	7,980	57	15,171	20
228	6.052	74	148.9	7,980	61	16,882	20
230	6.052	74	148.9	7,980	60	16,501	20
232	6.052	75	148.9	7,980	61	16,901	20
234	6.052	75	148.9	7,980	64	18,357	20
236	6.052	74	148.9	7,980	62	17,482	20
238	6.052	74	148.9	7,980	61	17,151	20
24	8.429	75	148.9	7,980	44	10,995	20
240	6.052	74	148.9	7,980	52	13,201	20
242	6.052	74	148.9	7,980	56	14,672	20
244	6.052	71	148.9	7,980	49	12,866	20
246	6.052	71	148.9	7,980	53	14,115	20
248	6.052	73	148.9	7,980	57	15,698	20
250	6.052	74	148.9	7,980	60	16,643	20
252	6.052	74	148.9	7,980	59	16,001	20
254	6.052	73	148.9	7,980	57	15,509	20
256	6.052	73	148.9	7,980	49	12,504	20
258	6.052	72	148.9	7,980	51	13,185	20
26	8.429	75	148.9	7,980	38	10,054	20
260	6.052	72	148.9	7,980	54	14,516	20
262	6.052	74	148.9	7,980	60	16,462	20
264	6.052	73	148.9	7,980	40	10,342	20
266	6.052	74	148.9	7,980	49	12,560	20
268	6.052	73	148.9	7,980	29	8,824	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	27	8,639	20
272	6.052	74	148.9	7,980	60	16,681	20
274	6.052	73	148.9	7,980	55	14,440	20
276	6.052	73	148.9	7,980	53	13,773	20
278	6.052	73	148.9	7,980	54	14,110	20
28	8.429	75	148.9	7,980	45	11,340	20
280	6.052	73	148.9	7,980	45	11,407	20
282	6.052	73	148.9	7,980	38	10,070	20
284	6.052	73	148.9	7,980	40	10,367	20
286	6.052	73	148.9	7,980	37	9,974	20
288	6.052	73	148.9	7,980	36	9,824	20
290	6.052	75	148.9	7,980	68	20,077	20
30	10.888	75	148.9	7,980	36	9,653	20
32	10.888	75	148.9	7,980	35	9,586	20
34	8.429	75	148.9	7,980	42	10,683	20
36	8.429	76	148.9	7,980	57	14,757	20
38	8.429	76	148.9	7,980	57	14,952	20
40	8.429	76	148.9	7,980	58	15,057	20
42	8.429	76	148.9	7,980	49	12,040	20
44	8.429	76	148.9	7,980	45	11,134	20
46	8.429	76	148.9	7,980	41	10,427	20
48	8.429	76	148.9	7,980	51	12,604	20
50	8.429	76	148.9	7,980	50	12,341	20
52	8.429	76	148.9	7,980	58	15,249	20
54	8.429	76	148.9	7,980	59	15,499	20
56	10.888	75	148.9	7,980	57	14,941	20
58	10.888	76	148.9	7,980	45	11,122	20
60	10.888	76	148.9	7,980	48	12,024	20
62	10.888	76	148.9	7,980	57	14,684	20
64	10.888	76	148.9	7,980	58	15,132	20
66	10.888	76	148.9	7,980	56	14,321	20
68	10.888	76	148.9	7,980	41	10,389	20
70	10.888	76	148.9	7,980	47	11,596	20
72	10.888	76	148.9	7,980	58	15,216	20
74	10.888	76	148.9	7,980	58	15,246	20
76	10.888	75	148.9	7,980	40	10,221	20
78	8.429	76	148.9	7,980	57	14,421	20
80	8.429	77	148.9	7,980	55	13,811	20
82	8.429	77	148.9	7,980	55	13,914	20
84	8.429	77	148.9	7,980	48	11,707	20
86	8.429	77	148.9	7,980	48	11,657	20
88	10.888	76	148.9	7,980	57	14,554	20
90	8.429	76	148.9	7,980	60	15,819	20
92	5.873	77	148.9	7,980	62	16,693	20
94	5.873	76	148.9	7,980	61	16,263	20
96	5.873	76	148.9	7,980	61	16,171	20
98	2.117	76	148.9	7,980	27	8,623	20

Break Location 5

Min Pressure (psi) 25

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	61	16,810	20
100	2.117	76	148.9	7,980	26	8,546	20
102	5.873	76	148.9	7,980	63	17,097	20
104	5.873	76	148.9	7,980	62	16,821	20
106	5.873	76	148.9	7,980	61	16,512	20
108	5.873	75	148.9	7,980	43	10,843	20
110	5.873	77	148.9	7,980	65	17,941	20
112	5.873	77	148.9	7,980	65	18,080	20
114	5.873	76	148.9	7,980	65	18,170	20
116	5.873	77	148.9	7,980	65	18,216	20
118	5.873	77	148.9	7,980	66	18,600	20
120	5.873	77	148.9	7,980	66	18,430	20
122	5.873	76	148.9	7,980	66	18,679	20
124	5.873	77	148.9	7,980	67	19,087	20
126	5.873	77	148.9	7,980	68	19,685	20
128	5.873	77	148.9	7,980	51	12,444	20
130	5.873	77	148.9	7,980	67	18,854	20
132	2.117	76	148.9	7,980	61	16,316	20
134	2.117	76	148.9	7,980	58	14,883	20
136	2.117	76	148.9	7,980	52	13,131	20
137	0	77	148.9	7,980	67	19,261	20
138	2.117	76	148.9	7,980	25	8,414	20
14	10.888	75	148.9	7,980	59	15,593	20
140	2.117	76	148.9	7,980	27	8,578	20
142	2.117	76	148.9	7,980	47	11,607	20
144	2.117	76	148.9	7,980	56	14,211	20
146	5.873	76	148.9	7,980	65	18,320	20
148	6.052	76	148.9	7,980	49	12,039	20
150	6.052	76	148.9	7,980	44	10,897	20
152	6.052	76	148.9	7,980	37	9,760	20
154	6.052	76	148.9	7,980	32	9,132	20
156	6.052	76	148.9	7,980	41	10,466	20
158	6.052	76	148.9	7,980	57	14,701	20
16	10.888	75	148.9	7,980	59	15,613	20
160	6.052	76	148.9	7,980	66	18,587	20
162	6.052	76	148.9	7,980	66	18,759	20
164	6.052	76	148.9	7,980	55	13,889	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,707	20
170	10.874	75	148.9	7,980	65	18,724	20
172	6.052	75	148.9	7,980	59	15,587	20
174	6.052	75	148.9	7,980	36	9,665	20
176	6.052	74	148.9	7,980	27	8,658	20
178	6.052	74	148.9	7,980	36	9,650	20
18	8.429	75	148.9	7,980	59	15,677	20
180	6.052	75	148.9	7,980	58	15,576	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	65	18,621	20
184	6.052	75	148.9	7,980	67	19,960	20
186	10.874	75	148.9	7,980	64	17,927	20
188	6.052	75	148.9	7,980	66	19,115	20
190	6.052	75	148.9	7,980	65	18,953	20
192	6.052	75	148.9	7,980	65	18,721	20
194	6.052	75	148.9	7,980	64	18,523	20
196	6.052	74	148.9	7,980	64	18,375	20
198	6.052	75	148.9	7,980	62	17,140	20
20	8.429	75	148.9	7,980	54	13,643	20
200	6.052	75	148.9	7,980	59	15,849	20
202	6.052	74	148.9	7,980	56	14,594	20
204	6.052	74	148.9	7,980	59	16,088	20
206	6.052	74	148.9	7,980	56	14,715	20
208	6.052	74	148.9	7,980	62	17,421	20
210	6.052	75	148.9	7,980	62	17,101	20
212	6.052	75	148.9	7,980	60	15,983	20
214	6.052	75	148.9	7,980	62	17,376	20
216	6.052	75	148.9	7,980	63	17,745	20
218	6.052	74	148.9	7,980	64	18,290	20
22	8.429	75	148.9	7,980	52	13,031	20
220	6.052	74	148.9	7,980	63	18,013	20
222	6.052	74	148.9	7,980	59	16,157	20
224	6.052	74	148.9	7,980	58	15,380	20
226	6.052	74	148.9	7,980	56	14,553	20
228	6.052	74	148.9	7,980	59	16,128	20
230	6.052	74	148.9	7,980	59	15,799	20
232	6.052	75	148.9	7,980	60	16,147	20
234	6.052	75	148.9	7,980	63	17,567	20
236	6.052	74	148.9	7,980	61	16,733	20
238	6.052	74	148.9	7,980	60	16,374	20
24	8.429	75	148.9	7,980	46	11,552	20
240	6.052	74	148.9	7,980	50	12,752	20
242	6.052	74	148.9	7,980	55	14,095	20
244	6.052	71	148.9	7,980	48	12,385	20
246	6.052	71	148.9	7,980	51	13,574	20
248	6.052	73	148.9	7,980	56	15,085	20
250	6.052	74	148.9	7,980	59	15,926	20
252	6.052	74	148.9	7,980	57	15,360	20
254	6.052	73	148.9	7,980	56	14,909	20
256	6.052	73	148.9	7,980	47	12,073	20
258	6.052	72	148.9	7,980	49	12,724	20
26	8.429	75	148.9	7,980	41	10,483	20
260	6.052	72	148.9	7,980	53	13,936	20
262	6.052	74	148.9	7,980	58	15,763	20
264	6.052	73	148.9	7,980	38	10,092	20
266	6.052	74	148.9	7,980	48	12,129	20
268	6.052	73	148.9	7,980	27	8,664	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	26	8,488	20
272	6.052	74	148.9	7,980	59	15,951	20
274	6.052	73	148.9	7,980	53	13,880	20
276	6.052	73	148.9	7,980	51	13,284	20
278	6.052	73	148.9	7,980	52	13,586	20
28	8.429	75	148.9	7,980	48	11,952	20
280	6.052	73	148.9	7,980	43	11,076	20
282	6.052	73	148.9	7,980	37	9,837	20
284	6.052	73	148.9	7,980	38	10,114	20
286	6.052	73	148.9	7,980	36	9,746	20
288	6.052	73	148.9	7,980	35	9,605	20
290	6.052	75	148.9	7,980	67	19,737	20
30	10.888	75	148.9	7,980	38	10,031	20
32	10.888	75	148.9	7,980	38	9,958	20
34	8.429	75	148.9	7,980	45	11,194	20
36	8.429	76	148.9	7,980	59	15,784	20
38	8.429	76	148.9	7,980	60	15,983	20
40	8.429	76	148.9	7,980	60	16,102	20
42	8.429	76	148.9	7,980	51	12,765	20
44	8.429	76	148.9	7,980	47	11,708	20
46	8.429	76	148.9	7,980	44	10,897	20
48	8.429	76	148.9	7,980	53	13,357	20
50	8.429	76	148.9	7,980	53	13,086	20
52	8.429	76	148.9	7,980	61	16,336	20
54	8.429	76	148.9	7,980	62	16,645	20
56	10.888	75	148.9	7,980	60	15,981	20
58	10.888	76	148.9	7,980	47	11,694	20
60	10.888	76	148.9	7,980	51	12,747	20
62	10.888	76	148.9	7,980	59	15,706	20
64	10.888	76	148.9	7,980	60	16,201	20
66	10.888	76	148.9	7,980	59	15,325	20
68	10.888	76	148.9	7,980	43	10,852	20
70	10.888	76	148.9	7,980	49	12,245	20
72	10.888	76	148.9	7,980	61	16,304	20
74	10.888	76	148.9	7,980	61	16,347	20
76	10.888	75	148.9	7,980	42	10,667	20
78	8.429	76	148.9	7,980	59	15,421	20
80	8.429	77	148.9	7,980	58	14,746	20
82	8.429	77	148.9	7,980	58	14,868	20
84	8.429	77	148.9	7,980	50	12,360	20
86	8.429	77	148.9	7,980	50	12,298	20
88	10.888	76	148.9	7,980	59	15,565	20
90	8.429	77	148.9	7,980	63	17,041	20
92	5.873	77	148.9	7,980	65	17,935	20
94	5.873	76	148.9	7,980	65	18,010	20
96	5.873	76	148.9	7,980	63	17,430	20
98	2.117	76	148.9	7,980	30	8,924	20

Break Location 6

Min Pressure (psi) 22

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	57	15,831	20
100	2.117	76	148.9	7,980	29	8,772	20
102	5.873	76	148.9	7,980	65	20,229	20
104	5.873	76	148.9	7,980	64	19,773	20
106	5.873	76	148.9	7,980	63	19,280	20
108	5.873	75	148.9	7,980	45	11,348	20
110	5.873	77	148.9	7,980	67	21,885	20
112	5.873	77	148.9	7,980	67	22,117	20
114	5.873	76	148.9	7,980	67	22,427	20
116	5.873	77	148.9	7,980	67	22,352	20
118	5.873	77	148.9	7,980	68	22,935	20
120	5.873	77	148.9	7,980	68	23,120	20
122	5.873	76	148.9	7,980	68	23,879	20
124	5.873	77	148.9	7,980	69	24,077	20
126	5.873	77	148.9	7,980	69	24,659	20
128	5.873	77	148.9	7,980	53	13,147	20
130	5.873	77	148.9	7,980	68	23,316	20
132	2.117	76	148.9	7,980	64	19,260	20
134	2.117	76	148.9	7,980	60	16,832	20
136	2.117	76	148.9	7,980	55	14,260	20
137	0	77	148.9	7,980	69	23,966	20
138	2.117	76	148.9	7,980	27	8,641	20
14	10.888	75	148.9	7,980	61	17,781	20
140	2.117	76	148.9	7,980	29	8,820	20
142	2.117	76	148.9	7,980	49	12,264	20
144	2.117	76	148.9	7,980	58	15,705	20
146	5.873	76	148.9	7,980	67	22,791	20
148	6.052	76	148.9	7,980	51	12,756	20
150	6.052	76	148.9	7,980	46	11,425	20
152	6.052	76	148.9	7,980	39	10,135	20
154	6.052	76	148.9	7,980	34	9,427	20
156	6.052	76	148.9	7,980	43	10,932	20
158	6.052	76	148.9	7,980	59	16,387	20
16	10.888	75	148.9	7,980	61	17,803	20
160	6.052	76	148.9	7,980	68	23,269	20
162	6.052	76	148.9	7,980	67	22,288	20
164	6.052	76	148.9	7,980	56	14,547	20
166	12.687	77	149.0	7,980	71	26,388	20
168	6.052	76	148.9	7,980	70	25,735	20
170	10.874	75	148.9	7,980	60	17,033	20
172	6.052	75	148.9	7,980	53	13,931	20
174	6.052	75	148.9	7,980	31	9,046	20
176	6.052	74	148.9	7,980	22	8,178	20
178	6.052	74	148.9	7,980	31	9,031	20
18	8.429	75	148.9	7,980	61	17,907	20
180	6.052	75	148.9	7,980	53	13,924	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	60	17,187	20
184	6.052	75	148.9	7,980	66	22,175	20
186	10.874	75	148.9	7,980	62	18,409	20
188	6.052	75	148.9	7,980	63	19,976	20
190	6.052	75	148.9	7,980	63	19,441	20
192	6.052	75	148.9	7,980	62	18,746	20
194	6.052	75	148.9	7,980	60	17,594	20
196	6.052	74	148.9	7,980	61	18,147	20
198	6.052	75	148.9	7,980	59	16,442	20
20	8.429	75	148.9	7,980	56	14,834	20
200	6.052	75	148.9	7,980	56	15,061	20
202	6.052	74	148.9	7,980	52	13,698	20
204	6.052	74	148.9	7,980	56	15,353	20
206	6.052	74	148.9	7,980	53	13,822	20
208	6.052	74	148.9	7,980	59	16,719	20
210	6.052	75	148.9	7,980	58	16,297	20
212	6.052	75	148.9	7,980	56	15,028	20
214	6.052	75	148.9	7,980	59	16,483	20
216	6.052	75	148.9	7,980	59	16,921	20
218	6.052	74	148.9	7,980	60	17,483	20
22	8.429	75	148.9	7,980	54	13,950	20
220	6.052	74	148.9	7,980	59	17,196	20
222	6.052	74	148.9	7,980	56	15,107	20
224	6.052	74	148.9	7,980	54	14,263	20
226	6.052	74	148.9	7,980	52	13,447	20
228	6.052	74	148.9	7,980	56	15,099	20
230	6.052	74	148.9	7,980	55	14,737	20
232	6.052	75	148.9	7,980	56	15,125	20
234	6.052	75	148.9	7,980	59	16,710	20
236	6.052	74	148.9	7,980	57	15,750	20
238	6.052	74	148.9	7,980	56	15,382	20
24	8.429	75	148.9	7,980	48	12,170	20
240	6.052	74	148.9	7,980	46	11,815	20
242	6.052	74	148.9	7,980	51	13,053	20
244	6.052	71	148.9	7,980	44	11,482	20
246	6.052	71	148.9	7,980	47	12,518	20
248	6.052	73	148.9	7,980	52	13,943	20
250	6.052	74	148.9	7,980	55	14,894	20
252	6.052	74	148.9	7,980	53	14,262	20
254	6.052	73	148.9	7,980	52	13,781	20
256	6.052	73	148.9	7,980	44	11,253	20
258	6.052	72	148.9	7,980	45	11,770	20
26	8.429	75	148.9	7,980	43	10,944	20
260	6.052	72	148.9	7,980	49	12,866	20
262	6.052	74	148.9	7,980	54	14,702	20
264	6.052	73	148.9	7,980	34	9,578	20
266	6.052	74	148.9	7,980	44	11,305	20
268	6.052	73	148.9	7,980	24	8,302	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	22	8,141	20
272	6.052	74	148.9	7,980	55	14,906	20
274	6.052	73	148.9	7,980	50	12,834	20
276	6.052	73	148.9	7,980	48	12,279	20
278	6.052	73	148.9	7,980	49	12,561	20
28	8.429	75	148.9	7,980	50	12,639	20
280	6.052	73	148.9	7,980	40	10,426	20
282	6.052	73	148.9	7,980	33	9,350	20
284	6.052	73	148.9	7,980	35	9,596	20
286	6.052	73	148.9	7,980	32	9,270	20
288	6.052	73	148.9	7,980	31	9,143	20
290	6.052	75	148.9	7,980	65	21,552	20
30	10.888	75	148.9	7,980	40	10,430	20
32	10.888	75	148.9	7,980	40	10,351	20
34	8.429	75	148.9	7,980	47	11,755	20
36	8.429	76	148.9	7,980	62	18,083	20
38	8.429	76	148.9	7,980	62	18,417	20
40	8.429	76	148.9	7,980	62	18,603	20
42	8.429	76	148.9	7,980	53	13,597	20
44	8.429	76	148.9	7,980	49	12,347	20
46	8.429	76	148.9	7,980	46	11,407	20
48	8.429	76	148.9	7,980	55	14,400	20
50	8.429	76	148.9	7,980	55	14,011	20
52	8.429	76	148.9	7,980	63	18,970	20
54	8.429	76	148.9	7,980	64	19,465	20
56	10.888	75	148.9	7,980	62	18,429	20
58	10.888	76	148.9	7,980	49	12,330	20
60	10.888	76	148.9	7,980	53	13,574	20
62	10.888	76	148.9	7,980	62	17,936	20
64	10.888	76	148.9	7,980	62	18,769	20
66	10.888	76	148.9	7,980	61	17,281	20
68	10.888	76	148.9	7,980	46	11,353	20
70	10.888	76	148.9	7,980	51	12,977	20
72	10.888	76	148.9	7,980	63	18,930	20
74	10.888	76	148.9	7,980	63	19,012	20
76	10.888	75	148.9	7,980	44	11,147	20
78	8.429	76	148.9	7,980	61	17,429	20
80	8.429	77	148.9	7,980	60	16,367	20
82	8.429	77	148.9	7,980	60	16,535	20
84	8.429	77	148.9	7,980	52	13,099	20
86	8.429	77	148.9	7,980	52	13,022	20
88	10.888	76	148.9	7,980	61	17,681	20
90	8.429	77	148.9	7,980	65	20,107	20
92	5.873	77	148.9	7,980	67	21,895	20
94	5.873	76	148.9	7,980	67	22,082	20
96	5.873	76	148.9	7,980	65	20,938	20
98	2.117	76	148.9	7,980	32	9,190	20

Break Location 7

Min Pressure (psi) 21

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	63	17,604	20
100	2.117	76	148.9	7,980	67	19,495	20
102	5.873	76	148.9	7,980	66	18,727	20
104	5.873	76	148.9	7,980	65	18,392	20
106	5.873	76	148.9	7,980	64	18,000	20
108	5.873	75	148.9	7,980	46	11,488	20
110	5.873	77	148.9	7,980	48	11,572	20
112	5.873	77	148.9	7,980	43	10,676	20
114	5.873	76	148.9	7,980	68	19,841	20
116	5.873	77	148.9	7,980	35	9,454	20
118	5.873	77	148.9	7,980	35	9,406	20
120	5.873	77	148.9	7,980	69	20,256	20
122	5.873	76	148.9	7,980	70	20,559	20
124	5.873	77	148.9	7,980	70	20,517	20
126	5.873	77	148.9	7,980	70	20,553	20
128	5.873	77	148.9	7,980	44	10,873	20
130	5.873	77	148.9	7,980	48	11,773	20
132	2.117	76	148.9	7,980	63	17,217	20
134	2.117	76	148.9	7,980	68	20,178	20
136	2.117	76	148.9	7,980	68	20,056	20
137	0	77	148.9	7,980	69	20,243	20
138	2.117	76	148.9	7,980	67	19,775	20
14	10.888	75	148.9	7,980	61	16,905	20
140	2.117	76	148.9	7,980	64	17,837	20
142	2.117	76	148.9	7,980	66	18,759	20
144	2.117	76	148.9	7,980	65	18,373	20
146	5.873	76	148.9	7,980	68	20,037	20
148	6.052	76	148.9	7,980	69	20,302	20
150	6.052	76	148.9	7,980	62	17,002	20
152	6.052	76	148.9	7,980	57	14,783	20
154	6.052	76	148.9	7,980	67	19,866	20
156	6.052	76	148.9	7,980	58	14,842	20
158	6.052	76	148.9	7,980	69	20,395	20
16	10.888	75	148.9	7,980	62	16,919	20
160	6.052	76	148.9	7,980	70	20,627	20
162	6.052	76	148.9	7,980	70	20,668	20
164	6.052	76	148.9	7,980	67	19,727	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,786	20
170	10.874	75	148.9	7,980	68	20,296	20
172	6.052	75	148.9	7,980	65	19,058	20
174	6.052	75	148.9	7,980	42	10,647	20
176	6.052	74	148.9	7,980	33	9,331	20
178	6.052	74	148.9	7,980	41	10,556	20
18	8.429	75	148.9	7,980	62	16,997	20
180	6.052	75	148.9	7,980	64	18,069	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	67	20,150	20
184	6.052	75	148.9	7,980	68	20,283	20
186	10.874	75	148.9	7,980	65	18,685	20
188	6.052	75	148.9	7,980	67	19,948	20
190	6.052	75	148.9	7,980	67	19,909	20
192	6.052	75	148.9	7,980	66	19,825	20
194	6.052	75	148.9	7,980	66	19,922	20
196	6.052	74	148.9	7,980	66	19,482	20
198	6.052	75	148.9	7,980	64	18,050	20
20	8.429	75	148.9	7,980	57	14,646	20
200	6.052	75	148.9	7,980	61	16,721	20
202	6.052	74	148.9	7,980	58	15,331	20
204	6.052	74	148.9	7,980	61	16,992	20
206	6.052	74	148.9	7,980	58	15,442	20
208	6.052	74	148.9	7,980	64	18,416	20
210	6.052	75	148.9	7,980	64	18,029	20
212	6.052	75	148.9	7,980	62	16,939	20
214	6.052	75	148.9	7,980	64	18,401	20
216	6.052	75	148.9	7,980	65	18,870	20
218	6.052	74	148.9	7,980	66	19,598	20
22	8.429	75	148.9	7,980	55	13,894	20
220	6.052	74	148.9	7,980	65	19,228	20
222	6.052	74	148.9	7,980	61	17,172	20
224	6.052	74	148.9	7,980	60	16,235	20
226	6.052	74	148.9	7,980	57	15,329	20
228	6.052	74	148.9	7,980	61	17,035	20
230	6.052	74	148.9	7,980	61	16,713	20
232	6.052	75	148.9	7,980	62	17,152	20
234	6.052	75	148.9	7,980	65	18,647	20
236	6.052	74	148.9	7,980	62	17,396	20
238	6.052	74	148.9	7,980	33	9,343	20
24	8.429	75	148.9	7,980	49	12,252	20
240	6.052	74	148.9	7,980	24	8,297	20
242	6.052	74	148.9	7,980	28	8,733	20
244	6.052	71	148.9	7,980	21	8,085	20
246	6.052	71	148.9	7,980	25	8,430	20
248	6.052	73	148.9	7,980	29	8,907	20
250	6.052	74	148.9	7,980	32	9,231	20
252	6.052	74	148.9	7,980	31	9,041	20
254	6.052	73	148.9	7,980	29	8,898	20
256	6.052	73	148.9	7,980	21	8,061	20
258	6.052	72	148.9	7,980	23	8,226	20
26	8.429	75	148.9	7,980	44	11,008	20
260	6.052	72	148.9	7,980	26	8,573	20
262	6.052	74	148.9	7,980	57	15,224	20
264	6.052	73	148.9	7,980	37	9,890	20
266	6.052	74	148.9	7,980	47	11,788	20
268	6.052	73	148.9	7,980	26	8,534	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	24	8,365	20
272	6.052	74	148.9	7,980	58	15,784	20
274	6.052	73	148.9	7,980	53	13,751	20
276	6.052	73	148.9	7,980	51	13,171	20
278	6.052	73	148.9	7,980	52	13,465	20
28	8.429	75	148.9	7,980	51	12,731	20
280	6.052	73	148.9	7,980	43	11,000	20
282	6.052	73	148.9	7,980	36	9,783	20
284	6.052	73	148.9	7,980	38	10,055	20
286	6.052	73	148.9	7,980	36	9,694	20
288	6.052	73	148.9	7,980	35	9,554	20
290	6.052	75	148.9	7,980	68	20,164	20
30	10.888	75	148.9	7,980	41	10,489	20
32	10.888	75	148.9	7,980	41	10,410	20
34	8.429	75	148.9	7,980	48	11,830	20
36	8.429	76	148.9	7,980	62	17,124	20
38	8.429	76	148.9	7,980	63	17,323	20
40	8.429	76	148.9	7,980	63	17,444	20
42	8.429	76	148.9	7,980	54	13,584	20
44	8.429	76	148.9	7,980	50	12,426	20
46	8.429	76	148.9	7,980	46	11,472	20
48	8.429	76	148.9	7,980	56	14,269	20
50	8.429	76	148.9	7,980	55	13,932	20
52	8.429	76	148.9	7,980	64	17,680	20
54	8.429	76	148.9	7,980	65	17,991	20
56	10.888	75	148.9	7,980	63	17,358	20
58	10.888	76	148.9	7,980	50	12,429	20
60	10.888	76	148.9	7,980	54	13,586	20
62	10.888	76	148.9	7,980	62	17,052	20
64	10.888	76	148.9	7,980	63	17,596	20
66	10.888	76	148.9	7,980	62	16,533	20
68	10.888	76	148.9	7,980	46	11,428	20
70	10.888	76	148.9	7,980	52	13,080	20
72	10.888	76	148.9	7,980	64	17,708	20
74	10.888	76	148.9	7,980	64	17,787	20
76	10.888	75	148.9	7,980	45	11,239	20
78	8.429	76	148.9	7,980	62	16,621	20
80	8.429	77	148.9	7,980	60	15,816	20
82	8.429	77	148.9	7,980	61	15,941	20
84	8.429	77	148.9	7,980	53	13,138	20
86	8.429	77	148.9	7,980	53	13,071	20
88	10.888	76	148.9	7,980	62	16,834	20
90	8.429	77	148.9	7,980	65	18,375	20
92	5.873	77	148.9	7,980	67	19,445	20
94	5.873	76	148.9	7,980	67	19,579	20
96	5.873	76	148.9	7,980	67	19,289	20
98	2.117	76	148.9	7,980	66	19,277	20

Break Location 8

Min Pressure (psi) 20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
10	6.052	75	148.9	7,980	62	17,369	20
100	2.117	76	148.9	7,980	29	8,805	20
102	5.873	76	148.9	7,980	65	18,349	20
104	5.873	76	148.9	7,980	64	18,071	20
106	5.873	76	148.9	7,980	64	17,762	20
108	5.873	75	148.9	7,980	46	11,363	20
110	5.873	77	148.9	7,980	68	19,402	20
112	5.873	77	148.9	7,980	68	19,563	20
114	5.873	76	148.9	7,980	68	19,802	20
116	5.873	77	148.9	7,980	68	19,717	20
118	5.873	77	148.9	7,980	68	19,978	20
120	5.873	77	148.9	7,980	69	20,092	20
122	5.873	76	148.9	7,980	69	20,368	20
124	5.873	77	148.9	7,980	69	20,345	20
126	5.873	77	148.9	7,980	70	20,465	20
128	5.873	77	148.9	7,980	53	13,120	20
130	5.873	77	148.9	7,980	69	20,092	20
132	2.117	76	148.9	7,980	65	17,872	20
134	2.117	76	148.9	7,980	61	16,167	20
136	2.117	76	148.9	7,980	56	14,144	20
137	0	77	148.9	7,980	69	20,274	20
138	2.117	76	148.9	7,980	28	8,682	20
14	10.888	75	148.9	7,980	61	16,770	20
140	2.117	76	148.9	7,980	30	8,858	20
142	2.117	76	148.9	7,980	50	12,298	20
144	2.117	76	148.9	7,980	59	15,274	20
146	5.873	76	148.9	7,980	68	19,966	20
148	6.052	76	148.9	7,980	52	12,983	20
150	6.052	76	148.9	7,980	47	11,601	20
152	6.052	76	148.9	7,980	40	10,263	20
154	6.052	76	148.9	7,980	35	9,541	20
156	6.052	76	148.9	7,980	45	11,088	20
158	6.052	76	148.9	7,980	60	16,065	20
16	10.888	75	148.9	7,980	61	16,790	20
160	6.052	76	148.9	7,980	69	20,355	20
162	6.052	76	148.9	7,980	67	19,420	20
164	6.052	76	148.9	7,980	56	14,085	20
166	12.687	77	149.0	7,980	71	20,998	20
168	6.052	76	148.9	7,980	70	20,754	20
170	10.874	75	148.9	7,980	67	20,049	20
172	6.052	75	148.9	7,980	61	16,580	20
174	6.052	75	148.9	7,980	38	9,979	20
176	6.052	74	148.9	7,980	30	8,886	20
178	6.052	74	148.9	7,980	38	9,964	20
18	8.429	75	148.9	7,980	62	16,868	20
180	6.052	75	148.9	7,980	61	16,561	20

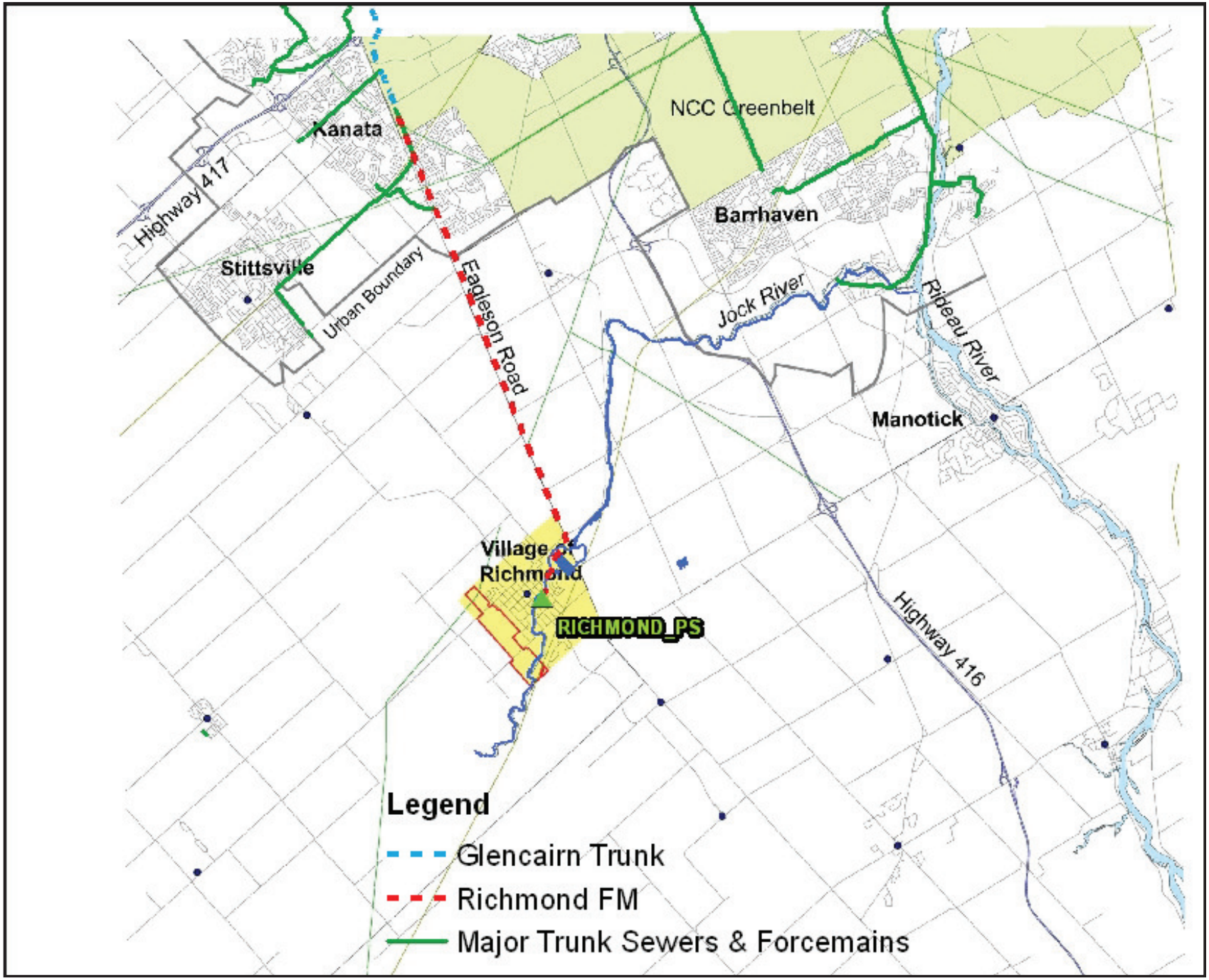
ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
182	6.052	75	148.9	7,980	67	19,911	20
184	6.052	75	148.9	7,980	68	20,208	20
186	10.874	75	148.9	7,980	65	18,491	20
188	6.052	75	148.9	7,980	67	19,813	20
190	6.052	75	148.9	7,980	66	19,702	20
192	6.052	75	148.9	7,980	66	19,532	20
194	6.052	75	148.9	7,980	66	19,600	20
196	6.052	74	148.9	7,980	65	19,190	20
198	6.052	75	148.9	7,980	63	17,812	20
20	8.429	75	148.9	7,980	56	14,550	20
200	6.052	75	148.9	7,980	61	16,494	20
202	6.052	74	148.9	7,980	57	15,156	20
204	6.052	74	148.9	7,980	61	16,756	20
206	6.052	74	148.9	7,980	57	15,266	20
208	6.052	74	148.9	7,980	63	18,153	20
210	6.052	75	148.9	7,980	63	17,785	20
212	6.052	75	148.9	7,980	61	16,688	20
214	6.052	75	148.9	7,980	64	18,132	20
216	6.052	75	148.9	7,980	64	18,574	20
218	6.052	74	148.9	7,980	65	19,252	20
22	8.429	75	148.9	7,980	54	13,813	20
220	6.052	74	148.9	7,980	65	18,908	20
222	6.052	74	148.9	7,980	61	16,916	20
224	6.052	74	148.9	7,980	59	16,005	20
226	6.052	74	148.9	7,980	57	15,138	20
228	6.052	74	148.9	7,980	61	16,771	20
230	6.052	74	148.9	7,980	60	16,464	20
232	6.052	75	148.9	7,980	61	16,895	20
234	6.052	75	148.9	7,980	64	18,364	20
236	6.052	74	148.9	7,980	62	17,169	20
238	6.052	74	148.9	7,980	33	9,280	20
24	8.429	75	148.9	7,980	49	12,187	20
240	6.052	74	148.9	7,980	23	8,251	20
242	6.052	74	148.9	7,980	28	8,681	20
244	6.052	71	148.9	7,980	21	8,040	20
246	6.052	71	148.9	7,980	24	8,380	20
248	6.052	73	148.9	7,980	29	8,850	20
250	6.052	74	148.9	7,980	32	9,170	20
252	6.052	74	148.9	7,980	30	8,982	20
254	6.052	73	148.9	7,980	29	8,842	20
256	6.052	73	148.9	7,980	20	8,019	20
258	6.052	72	148.9	7,980	22	8,180	20
26	8.429	75	148.9	7,980	44	10,959	20
260	6.052	72	148.9	7,980	26	8,521	20
262	6.052	74	148.9	7,980	56	15,037	20
264	6.052	73	148.9	7,980	36	9,815	20
266	6.052	74	148.9	7,980	46	11,666	20
268	6.052	73	148.9	7,980	26	8,485	20

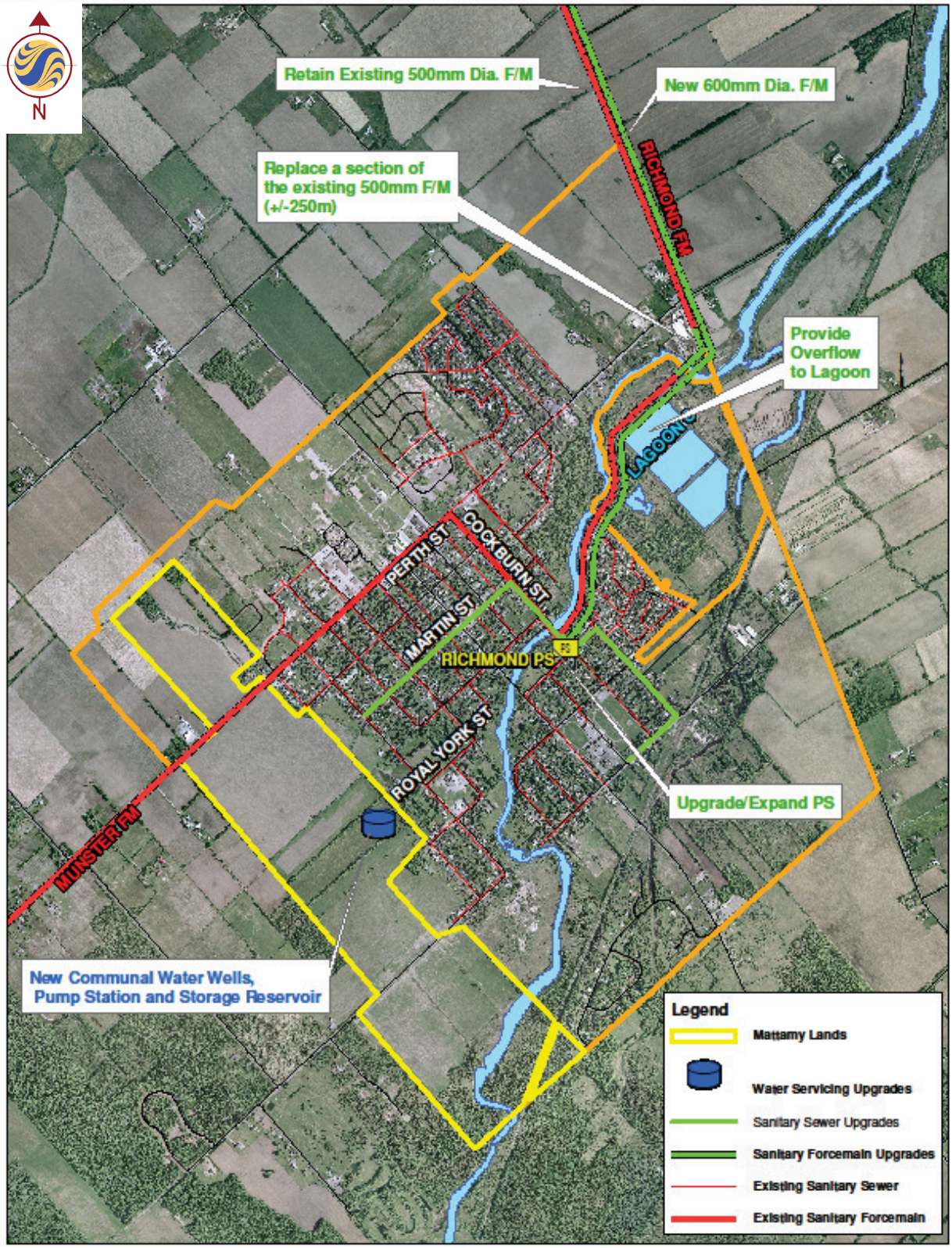
ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
270	6.052	73	148.9	7,980	24	8,318	20
272	6.052	74	148.9	7,980	58	15,574	20
274	6.052	73	148.9	7,980	53	13,586	20
276	6.052	73	148.9	7,980	51	13,025	20
278	6.052	73	148.9	7,980	52	13,310	20
28	8.429	75	148.9	7,980	51	12,657	20
280	6.052	73	148.9	7,980	43	10,898	20
282	6.052	73	148.9	7,980	36	9,709	20
284	6.052	73	148.9	7,980	37	9,976	20
286	6.052	73	148.9	7,980	35	9,622	20
288	6.052	73	148.9	7,980	34	9,485	20
290	6.052	75	148.9	7,980	68	20,080	20
30	10.888	75	148.9	7,980	41	10,445	20
32	10.888	75	148.9	7,980	40	10,367	20
34	8.429	75	148.9	7,980	47	11,771	20
36	8.429	76	148.9	7,980	62	16,999	20
38	8.429	76	148.9	7,980	63	17,219	20
40	8.429	76	148.9	7,980	63	17,340	20
42	8.429	76	148.9	7,980	54	13,515	20
44	8.429	76	148.9	7,980	50	12,364	20
46	8.429	76	148.9	7,980	46	11,423	20
48	8.429	76	148.9	7,980	56	14,193	20
50	8.429	76	148.9	7,980	55	13,866	20
52	8.429	76	148.9	7,980	64	17,576	20
54	8.429	76	148.9	7,980	64	17,888	20
56	10.888	75	148.9	7,980	62	17,223	20
58	10.888	76	148.9	7,980	50	12,347	20
60	10.888	76	148.9	7,980	54	13,496	20
62	10.888	76	148.9	7,980	62	16,896	20
64	10.888	76	148.9	7,980	63	17,444	20
66	10.888	76	148.9	7,980	61	16,414	20
68	10.888	76	148.9	7,980	46	11,369	20
70	10.888	76	148.9	7,980	52	12,983	20
72	10.888	76	148.9	7,980	63	17,547	20
74	10.888	76	148.9	7,980	63	17,595	20
76	10.888	75	148.9	7,980	45	11,163	20
78	8.429	76	148.9	7,980	62	16,528	20
80	8.429	77	148.9	7,980	60	15,742	20
82	8.429	77	148.9	7,980	61	15,866	20
84	8.429	77	148.9	7,980	53	13,088	20
86	8.429	77	148.9	7,980	53	13,022	20
88	10.888	76	148.9	7,980	62	16,712	20
90	8.429	77	148.9	7,980	65	18,284	20
92	5.873	77	148.9	7,980	67	19,407	20
94	5.873	76	148.9	7,980	67	19,538	20
96	5.873	76	148.9	7,980	66	18,769	20
98	2.117	76	148.9	7,980	33	9,217	20

APPENDIX C

Wastewater Collection

Figure 5-2: Richmond Connection to Central Wastewater Collection System





W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\New Figure 9.1_110606.mxd

Client/Project

CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.

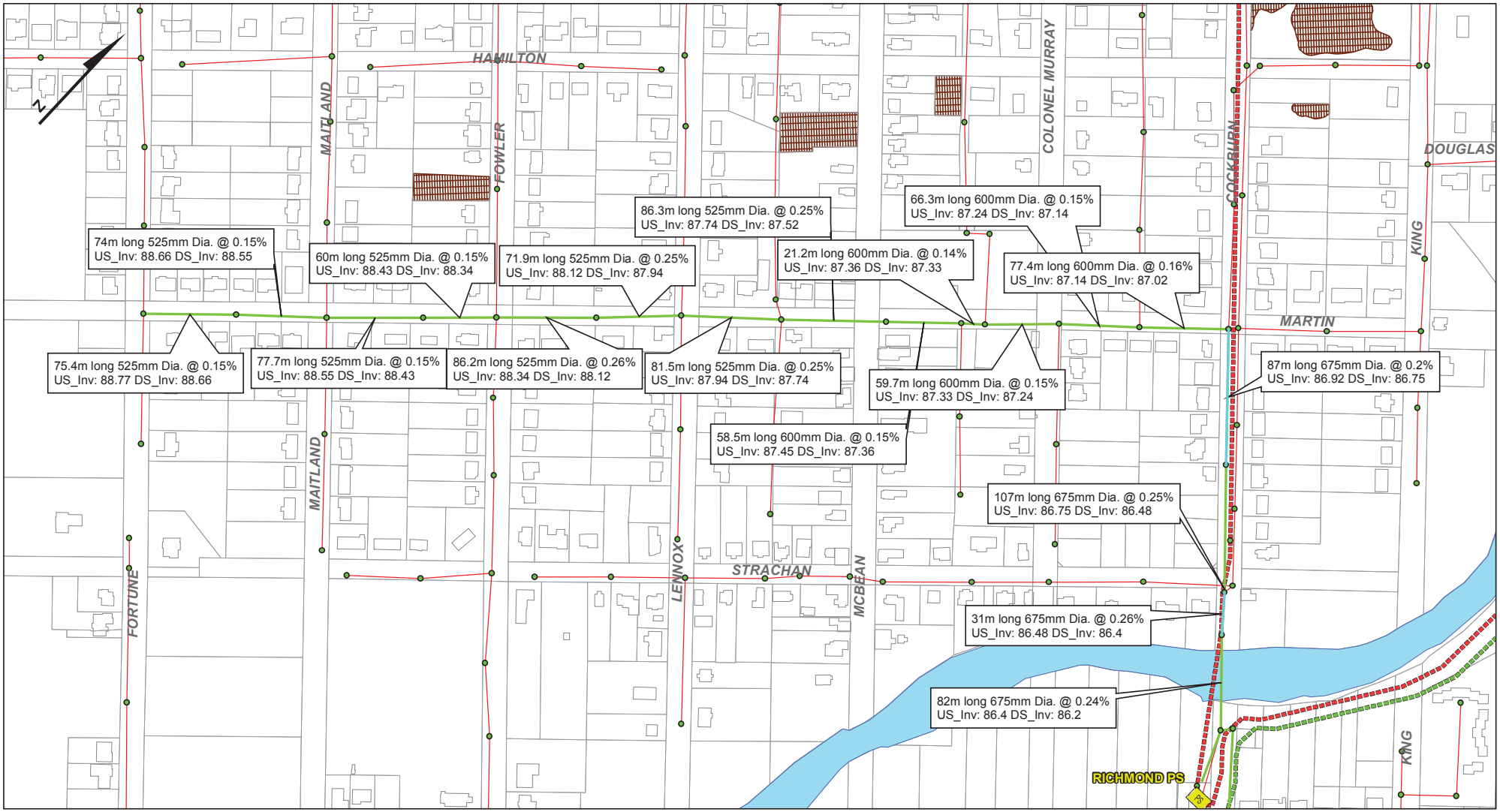
9.1

Title

Prefered Water and Wastewater Servicing Solutions

June 2011

Stantec



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Open House April 8, 2010\Wastewater Options_A_B_C_mt20100503.mxd

May 2010
1634-00808

Stantec

Legend

- Sanitary Sewer Options A, B, C
- Sanitary Forcemain Upgrades
- Existing Sanitary Sewer
- Existing Sanitary Forcemain
- Future Infill
- Future Development
- Sanitary Manhole

0 25 50 100 150 200 Meters

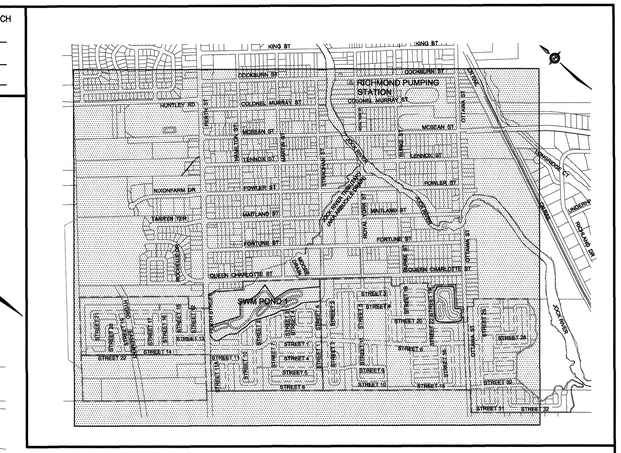
1:3,000

Client/Project
CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.
8.6

Title
Functional Sanitary Sewer Design
North of the Jock River

REVIEWED BY DEVELOPMENT REVIEW BRANCH
SIGNED Olga, MMA
DATE Sept 19 , 2016
PLAN NUMBER 17249
for Harry Alves



LEGEND

SANITARY DRAINAGE BOUNDARY
SUB-SANITARY SEWER TRIBUTARY BOUNDARY
MAINTENANCE HOLE — 200mmø SAN — MH136A
CAP
UPSTREAM MH TO DOWNSTREAM MH — 136A-137A
AREA IN HECTARES — 2.43
POPULATION — 45
UPSTREAM MH TO DOWNSTREAM MH — 135A-136A
AREA IN HECTARES — 0.83
AVERAGE FLOW — 50,000 L/Ha/d Institutional

TOPOGRAPHIC INFORMATION

TOPOGRAPHIC INFORMATION PROVIDED BY J.D. BARNES LIMITED,
PROJECT No. 10-10-314-00. DRAWING DATED SEPTEMBER 26, 2012.
PROJECT No. 13-10-606-02. DRAWING DATED JUNE 8, 2015.
CITY OF OTTAWA 1K MAPPING RECEIVED ON MARCH 27, 2013.

LEGAL INFORMATION

CALCULATED DRAFT PLAN PROVIDED BY J.D. BARNES LIMITED, PROJECT No. PROJECT No. 10-10-314-00-DRAFT, SURVEY DATED DECEMBER 7, 2012.
PROJECT No. PROJECT No. 10-10-314-00 (PHASE1-GROUND), SURVEY DATED APRIL 30, 2015
PROJECT No. 13-10-606-0010-OVERALL, SURVEY DATED SEPTEMBER 24, 2014
CITY OF OTTAWA 1K MAPPING, RECEIVED ON MARCH 27, 2013.

BENCH MARK No. 0011968U124 ELEVATION = 95.186 m
ELEVATIONS SHOWN ARE GEODETIC AND ARE REFERENCED TO BENCHMARK No. 0011968U124 HAVING A PUBLISHED ELEVATION OF 95.186m. LOCATION: BRIDGE OVER JOCK RIVER IN RICHMOND, 0.8 KM SOUTH OF RICHMOND ROAD, BRASS CAP IN TOP OF EAST WALL, 2.7M FROM NORTH END.

No.	DATE	BY	DESCRIPTION	BY
4.	16-09-13	Z.L.	ISSUED FOR CONSTRUCTION	
3.	15-10-20	Z.L.	MOE SUBMISSION	
2.	15-06-24	Z.L.	2nd SUBMISSION	
1.	15-02-09	Z.L.	1st SUBMISSION	

Ottawa CITY OF OTTAWA

PROJECT No. 15-764BA

LICENSED PROFESSIONAL ENGINEER Z. LI 16-09-15 PROVINCE OF ONTARIO

SANITARY DRAINAGE PLAN

© DSEL

RICHMOND VILLAGE NORTH / SOUTH LTD.

VILLAGE OF RICHMOND SANITARY TRUNK

DSEL david schaeffer engineering ltd
120 Iber Road, Unit 103
Stittsville, ON K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

DRAWN BY: W.L./C.M.	CHECKED BY: K.M.	DRAWING NO.	SHEET NO.
DESIGNED BY: K.M.	CHECKED BY: Z.L.		12
SCALE: 1:5000	DATE: FEBRUARY 2015		

CITY PLAN No. 17249
CITY FILE No. D07-16-11-0014

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION: STREET	FROM M.H.	TO M.H.	EXISITING AND INFILL AREA: RESIDENTIAL AREA AND POPULATION: AREA (ha)	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	COMM AREA (ha)	COMM ACCU. AREA (ha)	INSTIT AREA (ha)	INSTIT ACCU. AREA (ha)	PARK AREA (ha)	PARK ACCU. AREA (ha)	C+I+I PEAK FLOW (l/s)	INFILTRATION: TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	VILLAGE OF RICHMOND: RESIDENTIAL AREA AND POPULATION: AREA (ha)	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	COMM AREA (ha)	COMM ACCU. AREA (ha)	INSTIT AREA (ha)	INSTIT ACCU. AREA (ha)	PARK AREA (ha)	PARK ACCU. AREA (ha)	C+I+I PEAK FLOW (l/s)	INFILTRATION: TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	PIPE: TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STRACHAN STREET																																									
			0.10	4												0.10	0.10	0.071																							
	302A	303A	0.59	4	0.69	8	3.26	0.09								0.59	0.69	0.486																			0.58	76.0	250	1.00	59.47	1.21	0.37
	303A	304A			0.69	8	3.26	0.09								0.00	0.69	0.486																			0.58	99.5	250	0.50	42.05	0.86	0.30
To QUEEN CHARLOTTE STREET , Pipe 304A - 123A					0.69	8																																			
POND BLOCK																																									
Contribution From Future Richmond Village, Pipe Fut. MH - 121A																			103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	121A	123A																			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	122.71	108.0	600	0.12	212.70	0.75	0.77
To QUEEN CHARLOTTE STREET , Pipe 123A - 124A																					103.25	6195				1.12		5.32		6.19	10.96										
QUEEN CHARLOTTE STREET																																									
Contribution From STRACHAN STREET, 303A - 304A			0.69	8	0.69	8										0.69	0.69																								
	304A	123A			0.69	8	3.26	0.09								0.00	0.69	0.486														0.00	0.00	0.00	0.000	0.58	94.5	300	0.90	91.74	1.30	0.36
Contribution From POND BLOCK, 121A - 123A					0.69	8											0.69		103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	123A	124A			0.69	8	3.26	0.09								0.00	0.69	0.486			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.28	112.5	600	0.12	212.70	0.75	0.78
To MARTIN STREET , Pipe 124A - 125A					0.69	8															103.25	6195				1.12		5.32		6.19	10.96										
MARTIN STREET																																									
Contribution From QUEEN CHARLOTTE STREET , Pipe 123A - 124A			0.69	8	0.69	8										0.69	0.69		103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	124A	125A	0.00	0	0.69	8	3.26	0.09								0.00	0.69	0.486			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.28	111.0	600	0.12	212.70	0.75	0.78
	125A	126A	0.14	0	0.83	8	3.26	0.09								0.14	0.83	0.585			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.38	76.5	600	0.12	212.70	0.75	0.78
			0.36	44	0.36	44										0.36	0.36																								
			16.02	362	16.38	426										16.02	16.38																								
Contribution from Ex. San Pipe	Ex. SA16060	126A	1.37	20	17.75	446	2.98	4.74	0.26	0.26					0.05	1.63	18.01	12.697																			17.49	5.5	300	2.00	136.76	1.93	1.32
	126A	127A	0.66	17	19.24	471	2.97	4.99		0.26					0.05	0.66	19.50	13.748			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	141.49	74.5	600	0.12	212.70	0.75	0.80
	127A	128A	0.68	21	19.92	492	2.97	5.21		0.26					0.05	0.68	20.18	14.227			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	142.19	73.0	600	0.12	212.70	0.75	0.80
			0.27	49	0.27	49										0.27	0.27																								
			4.81	102	5.08	151										4.81	5.08																								
Contribution from Ex. San Pipe	Ex. SA16050	128A	2.12	41	7.20	192	3.08	2.11								2.12	7.20	5.075																			7.19	3.0	300	2.00	136.76	1.93	1.02
	128A	129A	0.65	17	27.77	701	2.91	7.27		0.26					0.05	0.65	28.03	19.761			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	149.79	80.0	600	0.12	212.70	0.75	0.81
	129A	130A	0.23	7	28.00	708	2.91	7.34		0.26					0.05	0.23	28.26	19.923			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	150.02	60.5	600	0.12	212.70	0.75	0.81
			10.23	614	10.23	614			2.48	2.48						12.71	12.71																								
			0.67	44	10.90	658			0.52	3.00						1.19	13.90																								
Contribution from Ex. San Pipe	Ex. SA06235	130A	51.61	785	62.51	1443	2.78	14.30	0.39	3.39					0.67	52.00	65.90	46.460																			61.43	5.5	300	2.00	136.76	1.93	1.87
	130A	131A	0.55	14	91.06	2165	2.69	20.76		3.65					0.72	0.55	94.71	66.771			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	210.98	61.0	675	0.12	291.19	0.81	0.88
	131A	132A	0.25	4	91.31	2169	2.69	20.80		3.65					0.72	0.25	94.96	66.947			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	211.17	71.0	675	0.12	291.19	0.81	0.88
									0.42	0.42						0.42	0.42																								
Contribution from Ex. San Pipe	Ex. SA06254	132A	10.31	214	10.31	214	3.07	2.34	0.35	0.77					0.15	10.66	11.08	7.811																			10.30	6.5	300	2.00	136.76	1.93	1.13
	132A	133A	0.61	14	102.23	2397	2.67	22.81		4.42					0.87	0.61	106.65	75.188			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	221.57	79.0	675	0.12	291.19	0.81	0.89
			2.42	41	2.42	41										2.42	2.42																								
Contribution from Ex. San Pipe	Ex. SA06291	133A	2.03	54	4.45	95	3.15	1.07								2.03	4.45	3.137																			4.21	4.5	300	2.00	136.76	1.93	0.87
	133A	134A	0.61	24	107.29	2516	2.65	23.77		4.42					0.87	0.61	111.71	78.756			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	226.10	86.5	675	0.12	291.19	0.81	0.89
	134A	1340A			107.29	2516	2.65	23.77		4.42					0.87	0.00	111.71	78.756			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	226.10	58.5	675	0.12	291.19	0.81	0.89
Contribution from Ex. San Pipe	Ex. SA06293	1340A	1.86	41	1.86	41	3.20	0.47	0.42	0.42			0.09	0.09		2.37	2.37	1.671																			2.14	4.0	300	2.00	136.76	1.93	0.70
	1340A	135A			109.15	2557	2.65	24.16		4.84			0.09	1.00		0.00	114.08	80.426			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	228.29	22.0	675	0.12	291.19	0.81	0.90
									0.20	0.20						0.20	0.20																								
Contribution from Ex. San Pipe	Ex. SA06294	135A	5.02	95	5.02	95	3.15	1.07	0.58	0.78	0.83	0.83			0.25	6.43	6.63	4.674																			5.99	5.0	300	2.00	136.76	1.93	0.96
	135A	136A			114.17	2652	2.64	24.96		5.62		0.83		0.09	1.25	0.00	120.71	85.101			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	234.02	59.5	675	0.12	291.19	0.81	0.90
	136A	137A			114.17	2652	2.64	24.96		5.62		0.83		0.09	1.25	0.00	120.71	85.101			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	234.02	66.5	675	0.12	291.19	0.81	0.90
Contribution from Ex. San Pipe	Ex. SA06295	137A	2.43	45	2.43	45	3.19	0.51								2.43	2.43	1.713																			2.22	4.5	300	2.00	136.76	1.93	0.70
	137A	138A	4.31	92	120.91	2789	2.63	26.15		5.62		0.83		0.09	1.25	4.31	127.45	89.852			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	239.96	65.0	675	0.12	291.19	0.81	0.90
	138A	Ex. MH SA06270			120.91	2789	2.63	26.15		5.62		0.83		0.09	1.25	0.00	127.45	89.852			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	239.96	6.5	675	0.12	291.19	0.81	0.90
To COCKBURN STREET , Pipe Ex. MH SA06270 - Ex. MH SA06267					120.91	2789				5.62		0.83		0.09			127.45				103.25	6195				1.12		5.32		6.19			115.88									

MONITORED PARAMETERS FOR EXISTING AND INFILL AREA

Harmon "K"=	0.66	
Average Daily Flow =	308	l/p/day
Commercial Flow =	17000	L/ha/da
Institutional Flow =	10000	L/ha/da
Max Res. Peak Factor =	4.00	
Commercial/Inst/Park peak Factor =	1.00	
Park Average Flow =	50000	L/ha/da

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.705 L/a/ha
Minimum Velocity = 0.60 m/s
Manning's n = 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

DESIGN PARAMETERS FOR NEW SUBDIVISION

Harmon "K"=	1	
Average Daily Flow =	350	l/p/day
Commlnst Flow =	50000	L/ha/da
Industrial Flow =	35000	L/ha/da
Max Res. Peak Factor =	4.00	
Commercial/Inst/Park peak Factor =	1.50	
Park Average Flow =	50000	L/ha/da

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.280 L/a/ha
Minimum Velocity = 0.60 m/s
Manning's n = 0.013
Population = 60 P/Ha for residential

LICENSED PROFESSIONAL ENGINEER
V. LIU
100167932
PROVINCE OF ONTARIO

Designed: K.M.	PROJECT: VILLAGE OF RICHMOND SANITARY TRUNK
Checked: Z.L.	LOCATION: City of Ottawa
Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 12	File Ref: 15-784BA; Date: October, 2015; Sheet No. 1 of 1

784_San.xls

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION: STREET	FROM M.H.	TO M.H.	RESIDENTIAL AREA AND POPULATION: AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	COMM AREA (ha)	COMM ACCU. AREA (ha)	INSTIT AREA (ha)	INSTIT ACCU. AREA (ha)	PARK AREA (ha)	PARK ACCU. AREA (ha)	C+I+I PEAK FLOW (l/s)	INFILTRATION: TOTAL AREA (ha)	INFILTRATION: ACCU. AREA (ha)	INFILTRATION: INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	PIPE: DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
SAN TRUNK 2			3.08				247	3.08	247				0.00		0.00		0.00		3.08	3.08									
			0.38	9	9		31	3.46	278				0.00		0.00		0.00		0.38	3.46									
	32A	33A	0.77	26		26	71	4.23	349	3.44	3.89		0.00		0.00		0.00	0.00	0.77	4.23	1.40	5.29	101.5	200	0.65	26.44	0.20	0.84	0.65
			0.39	15		15	41	4.62	390				0.00		0.00		0.00		0.39	4.62									
	33A	34A	0.40	8	8		28	5.02	418	3.41	4.62		0.00		0.00		0.00	0.00	0.40	5.02	1.66	6.28	110.5	300	0.20	43.25	0.15	0.61	0.43
			0.35	13		13	36	5.37	454				0.00		0.00		0.00		0.35	5.37									
	34A	35A	0.35	9	9		31	5.72	485	3.38	5.32		0.00		0.00		0.00	0.00	0.35	5.72	1.89	7.21	110.5	300	0.20	43.25	0.17	0.61	0.45
	35A	36A	0.39	6	6		21	6.11	506	3.38	5.54		0.00		0.00		0.00	0.00	0.39	6.11	2.02	7.55	72.0	300	0.20	43.25	0.17	0.61	0.46
			0.18	2	2		7	6.29	513				0.00		0.00		0.00		0.18	6.29									
	36A	37A	0.36	8	8		28	6.65	541	3.37	5.90		0.00		0.00		0.00	0.00	0.36	6.65	2.19	8.09	25.5	300	0.20	43.25	0.19	0.61	0.47
	37A	38A	0.10	2	2		7	6.75	548	3.36	5.97		0.00		0.00		0.00	0.00	0.10	6.75	2.23	8.20	28.5	300	0.20	43.25	0.19	0.61	0.47
	38A	39A	1.53	29	29		99	8.28	647	3.33	6.98		0.00		0.00		0.00	0.00	1.53	8.28	2.73	9.72	34.5	300	0.20	43.25	0.22	0.61	0.49
	39A	40A	0.19	4	4		14	8.47	661	3.33	7.13		0.00		0.00		0.00	0.00	0.19	8.47	2.80	9.92	38.5	300	0.20	43.25	0.23	0.61	0.50
	40A	41A	0.49	14	14		48	8.96	709	3.31	7.61		0.00		0.00		0.00	0.00	0.49	8.96	2.96	10.57	75.5	300	0.20	43.25	0.24	0.61	0.50
	41A	42A						8.96	709	3.31	7.61		0.00		0.00		0.00	0.00	0.00	8.96	2.96	10.57	11.0	300	0.20	43.25	0.24	0.61	0.50
	42A	43A	0.42	7	7		24	9.38	733	3.31	7.85		0.00		0.00		0.00	0.00	0.42	9.38	3.10	10.95	60.5	300	0.20	43.25	0.25	0.61	0.51
			4.10				328	13.48	1061				0.00		0.00		0.00		4.10	13.48									
			0.48	6	6		21	13.96	1082				0.00		0.00		0.00		0.48	13.96									
	43A	44A	1.23	25	25		85	15.19	1167	3.20	12.12		0.00		0.00		0.00	0.00	1.23	15.19	5.01	17.13	115.0	300	0.20	43.25	0.40	0.61	0.57
	44A	45A	0.73	15	15		51	15.92	1218	3.19	12.61		0.00		0.00		0.00	0.00	0.73	15.92	5.25	17.86	93.0	300	0.20	43.25	0.41	0.61	0.58
To SAN TRUNK 1, Pipe 45A - 46A								15.92	1218				0.00		0.00		0.00			15.92									
SAN TRUNK 4																													
	122A	123A	0.50	8	8		28	0.50	28	3.69	0.33		0.00		0.00		0.00	0.00	0.50	0.50	0.17	0.50	82.5	200	0.65	26.44	0.02	0.84	0.33
	123A	127A	0.64	13	13		45	1.14	73	3.62	0.86		0.00		0.00		0.00	0.00	0.64	1.14	0.38	1.23	87.5	300	0.20	43.25	0.03	0.61	0.27
To SAN TRUNK 1, Pipe 127A - 23A								1.14	73				0.00		0.00		0.00			1.14									
	118A	119A	0.55	8	8		28	0.55	28	3.69	0.33		0.00		0.00		0.00	0.00	0.55	0.55	0.18	0.52	110.5	200	0.65	26.44	0.02	0.84	0.33
	119A	120A	0.65	14	14		48	1.20	76	3.62	0.89		0.00		0.00		0.00	0.00	0.65	1.20	0.40	1.29	94.0	300	0.20	43.25	0.03	0.61	0.27
	120A	121A	0.75	12	12		41	1.95	117	3.58	1.36		0.00		0.00		0.00	0.00	0.75	1.95	0.64	2.00	94.0	300	0.20	43.25	0.05	0.61	0.31
	121A	127A	0.76	16	16		55	2.71	172	3.54	1.97		0.00		0.00		0.00	0.00	0.76	2.71	0.89	2.87	101.5	300	0.20	43.25	0.07	0.61	0.34
To SAN TRUNK 1, Pipe 127A - 23A								2.71	172				0.00		0.00		0.00			2.71									
SAN TRUNK 3																													
	14A	15A	0.71	17	17		58	0.71	58	3.64	0.68		0.00		0.00		0.00	0.00	0.71	0.71	0.23	0.92	86.5	300	0.65	77.96	0.01	1.10	0.37
	15A	16A	0.48	10	10		34	1.19	92	3.60	1.07		0.00		0.00		0.00	0.00	0.48	1.19	0.39	1.47	72.0	300	0.20	43.25	0.03	0.61	0.28
	16A	17A	0.95	21	21		72	2.14	164	3.54	1.88		0.00		0.00		0.00	0.00	0.95	2.14	0.71	2.59	42.0	300	0.20	43.25	0.06	0.61	0.34
	17A	18A	0.23	3	3		11	2.37	175	3.53	2.00		0.00		0.00		0.00	0.00	0.23	2.37	0.78	2.79	40.0	300	0.20	43.25	0.06	0.61	0.34
			1.18	19	19		65	3.55	240				0.00		0.00	0.24	0.24		1.42	3.79									
	18A	19A	1.18	19	19		65	4.73	305	3.46	3.42		0.00		0.00		0.24	0.03	1.18	4.97	1.64	5.09	48.5	300	0.20	43.25	0.12	0.61	0.41
	19A	20A	0.38	9	9		31	5.11	336	3.45	3.75		0.00		0.00		0.24	0.03	0.38	5.35	1.77	5.54	46.0	300	0.20	43.25	0.13	0.61	0.42
			0.27	6	6		21	5.38	357				0.00		0.00		0.24		0.27	5.62									
			0.52	14	14		48	5.90	405				0.00		0.00		0.24		0.52	6.14									
	20A	21A	0.55	21		21	57	6.45	462	3.39	5.08		0.00		0.00		0.24	0.03	0.55	6.69	2.21	7.31	68.0	300	0.20	43.25	0.17	0.61	0.45
To SAN TRUNK 1, Pipe 21A - 127A								6.45	462				0.00		0.00		0.24			6.69									
SAN TRUNK 1																													
	1A	2A	0.19	1	1		4	0.19	4	3.76	0.05		0.00		0.00		0.00	0.00	0.19	0.19	0.06	0.11	32.5	250	0.65	47.94	0.00	0.98	0.20

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha			
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =	0.330	L/s/ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =	0.600	m/s
Max Res. Peak Factor =	4.00				Manning's n = (Conc)	0.013	(Pvc) 0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=	2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=	3.4	

Designed: A.K.

Checked: W.L.

Dwg. Reference: Sanitary Drainage Plan, Dwgs. No.

PROJECT: **Mattamy - Village of Richmond Western Development Lands**

LOCATION: **City of Ottawa**

File Ref:

Date: Jan 2019

Sheet No. 1 of 2

LICENSED PROFESSIONAL ENGINEER W. LIU 100170932 Jan 3, 2019 PROVINCE OF ONTARIO

977_SAN3.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE					VEL	
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	(FULL) (m/s)	(ACT.) (m/s)
	2A	3A	0.65	12	12		41	0.84	45	3.66	0.53		0.00		0.00		0.00	0.00	0.65	0.84	0.28	0.81	64.0	250	0.30	32.57	0.02	0.66	0.27
	3A	4A						0.84	45	3.66	0.53		0.00		0.00		0.00	0.00	0.00	0.84	0.28	0.81	11.0	300	0.20	43.25	0.02	0.61	0.24
	4A	5A	0.49	9	9		31	1.33	76	3.62	0.89		0.00		0.00		0.00	0.00	0.49	1.33	0.44	1.33	79.5	300	0.39	60.39	0.02	0.85	0.34
	5A	6A	0.60	10	10		34	1.93	110	3.59	1.28		0.00		0.00		0.00	0.00	0.60	1.93	0.64	1.92	79.5	300	0.23	46.38	0.04	0.66	0.32
	6A	7A	0.82	19	19		65	2.75	175	3.53	2.00		0.00		0.00		0.00	0.00	0.82	2.75	0.91	2.91	116.5	300	0.92	92.75	0.03	1.31	0.59
	7A	8A						2.75	175	3.53	2.00		0.00		0.00		0.00	0.00	0.00	2.75	0.91	2.91	116.5	300	0.20	43.25	0.07	0.61	0.35
	8A	9A	1.00	24	24		82	3.75	257	3.49	2.90		0.00		0.00		0.00	0.00	1.00	3.75	1.24	4.14	10.5	300	0.20	43.25	0.10	0.61	0.38
	9A	10A	0.28	6	6		21	4.03	278	3.47	3.13		0.00		0.00		0.00	0.00	0.28	4.03	1.33	4.46	64.5	300	0.20	43.25	0.10	0.61	0.39
	10A	11A	2.13	42	42		143	6.16	421	3.41	4.65		0.00		0.00		0.00	0.00	2.13	6.16	2.03	6.68	72.0	300	0.20	43.25	0.15	0.61	0.44
			0.31	7	7		24	6.47	445				0.00		0.00		0.00		0.31	6.47									
			0.47	17		17	46	6.94	491				0.00		0.00		0.00		0.47	6.94									
	11A	12A	0.48	13	13		45	7.42	536	3.37	5.85		0.00		0.00		0.00	0.00	0.48	7.42	2.45	8.30	68.0	300	0.20	43.25	0.19	0.61	0.47
			0.47	17		17	46	7.89	582				0.00		0.00		0.00		0.47	7.89									
	12A	13A	0.82	20	20		68	8.71	650	3.33	7.02		0.00		0.00		0.00	0.00	0.82	8.71	2.87	9.89	72.0	300	0.20	43.25	0.23	0.61	0.50
	13A	21A	1.33	33	33		113	10.04	763	3.30	8.16		0.00		0.00		0.00	0.00	1.33	10.04	3.31	11.47	72.5	300	0.20	43.25	0.27	0.61	0.52
Contribution From SAN TRUNK 3, Pipe 20A - 21A								6.45	462				0.00		0.00		0.24		6.69	16.73									
			0.11				0	16.60	1225				0.00		0.00		0.24		0.11	16.84									
			0.60	21		21	57	17.20	1282				0.00		0.00		0.24		0.60	17.44									
	21A	127A	1.11	24	24		82	18.31	1364	3.17	14.00		0.00		0.00		0.24	0.03	1.11	18.55	6.12	20.15	76.5	300	0.54	71.06	0.28	1.01	0.86
Contribution From SAN TRUNK 4, Pipe 121A - 127A								2.71	172				0.00		0.00		0.00		2.71	21.26									
Contribution From SAN TRUNK 4, Pipe 123A - 127A								1.14	73				0.00		0.00		0.00		1.14	22.40									
	127A	23A	0.22	3	3		11	22.38	1620	3.12	16.40		0.00		0.00		0.24	0.03	0.22	22.62	7.46	23.89	73.5	300	0.20	43.25	0.55	0.61	0.63
	23A	24A	0.63	14	14		48	23.01	1668	3.12	16.85		0.00		0.00		0.24	0.03	0.63	23.25	7.67	24.55	90.0	375	0.20	78.41	0.31	0.71	0.62
			0.59	9	9		31	23.60	1699				0.00		0.00		0.24		0.59	23.84									
	24A	25A	3.01	122		122	330	26.61	2029	3.06	20.15		0.00		0.00		0.24	0.03	3.01	26.85	8.86	29.04	121.0	450	0.15	110.42	0.26	0.69	0.59
	25A	26A	0.56	10	10		34	27.17	2063	3.06	20.46		0.00		0.00	3.60	3.84	0.41	4.16	31.01	10.23	31.11	121.0	450	0.15	110.42	0.28	0.69	0.59
	26A	27A	0.30	4	4		14	27.47	2077	3.06	20.59		0.00		0.00		3.84	0.41	0.30	31.31	10.33	31.33	72.5	450	0.15	110.42	0.28	0.69	0.59
	27A	28A	0.29	4	4		14	27.76	2091	3.06	20.71		0.00	2.63	2.63		3.84	1.27	2.92	34.23	11.30	33.27	73.0	450	0.15	110.42	0.30	0.69	0.61
	28A	29A	3.88	85	85		289	31.64	2380	3.02	23.30		0.00		2.63		3.84	1.27	3.88	38.11	12.58	37.14	115.0	450	0.15	110.42	0.34	0.69	0.62
			0.64	22		22	60	32.28	2440				0.00		2.63		3.84		0.64	38.75									
			0.66	16	16		55	32.94	2495				0.00		2.63		3.84		0.66	39.41									
			0.87	20	20		68	33.81	2563				0.00		2.63		3.84		0.87	40.28									
	29A	31A	3.53	81	81		276	37.34	2839	2.97	27.33		0.00		2.63		3.84	1.27	3.53	43.81	14.46	43.05	101.5	450	0.15	110.42	0.39	0.69	0.65
	31A	45A	0.61	15	15		51	37.95	2890	2.96	27.77		0.00		2.63		3.84	1.27	0.61	44.42	14.66	43.69	88.0	450	0.15	110.42	0.40	0.69	0.65
Contribution From SAN TRUNK 2, Pipe 44A - 45A								15.92	1218				0.00		0.00		0.00		15.92	60.34									
	45A	46A	0.31	3	3		11	54.18	4119	2.86	38.14		0.00		2.63		3.84	1.27	0.31	60.65	20.01	59.42	67.5	450	0.15	110.42	0.54	0.69	0.71
	46A	47A						54.18	4119	2.86	38.14		0.00		2.63		3.84	1.27	0.00	60.65	20.01	59.42	46.0	450	0.15	110.42	0.54	0.69	0.71
	47A	PLUG (B.O.)						54.18	4119	2.86	38.14		0.00		2.63		3.84	1.27	0.00	60.65	20.01	59.42	13.5	450	0.15	110.42	0.54	0.69	0.71

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Jan 31, 2019
PROVINCE OF ONTARIO

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha			
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =	0.330	L/s/ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =	0.600	m/s
Max Res. Peak Factor =	4.00				Manning's n = (Conc)	0.013	(Pvc) 0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=	2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=	3.4	

Designed: A.K.	PROJECT: Mattamy - Village of Richmond Western Development Lands		
Checked: W.L.	LOCATION: City of Ottawa		
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No.	File Ref:	Date: Jan 2019	Sheet No. 2 of 2

977_SAN3.xlsx

SANITARY SEWER CALCULATION SHEET

CLIENT: **Mattamy Homes**
LOCATION: **Richmond Phase 1**
FILE REF: **17-977**
DATE: **22-Jan-19**

DESIGN PARAMETERS - SEWER DESIGN GUIDELINES (OCTOBER 2012)

Avg. Daily Flow Res.	350	L/p/d	Peak Fact Res. Per Harmons: Min = 2.0, Max =4.0			Infiltration / Inflow	0.28	L/s/ha
Avg. Daily Flow Comn	50,000	L/ha/d	Peak Fact. Comm. / Instit.	1.5		Min. Pipe Velocity	0.60	m/s full flowing
Avg. Daily Flow Instit.	50,000	L/ha/d	Peak Fact. Indust.	1.5		Max. Pipe Velocity	3.00	m/s full flowing
Avg. Daily Flow Indust	35,000	L/ha/d	Peak Fact. Indust. per MOE graph			Mannings N	0.013	
Park Flow	9300	L/ha/d						

Location			Residential Area and Population									Commercial		Institutional		Industrial		Park			Infiltration				Pipe Data							
Area ID	Up	Down	Area	Number of Units by type				Pop.	Cumulative Area	Cumulative Pop.	Peak. Fact.	Q_{res}	Area	Accu. Area	Area	Accu. Area	Area	Accu. Area	Area	Accu. Area	Q_{C+I+I}	Total Area	Accu. Area	Infiltration Flow	Total Flow	DIA	Slope	Length	$A_{hydraulic}$	R	Velocity	Q_{cap}	Q / Q full
			(ha)	Singles	Semi's	Town's	Apt's		(ha)		(-)	(L/s)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(L/s)	(ha)	(ha)	(L/s)	(L/s)	(mm)	(%)	(m)	(m^2)	(m)	(m/s)	(L/s)	(-)
External (Lands Owned By Others)			31.610					2687.0	31.61	2687.0	3.48	37.91	1.12	1.12	2.75	2.75		0.00	1.13	1.13	3.5	36.610	36.610	10.251	51.64								
External (Future Phase)			9.340					694.0	9.34	694.0	3.90	10.95		0.00		0.00		0.00		0.00	0.0	9.340	9.340	2.615	13.57								
Richmond (977)			54.180					4119.0	54.18	4119.0	3.32	55.43		0.00	2.63	2.63		0.00	3.84	3.84	2.7	60.650	60.650	16.982	75.11								
Richmond Phase 1 (783)			11.670					744.6	11.67	744.6	3.88	11.70		0.00		0.00		0.00	0.96	0.96	0.1	12.630	12.630	3.536	15.34								
Total To SAN MH 121A			0.000					0.0	106.80	8244.6	3.04	101.45		1.12		5.38		0.00		5.93	6.3	0.000	119.230	33.384	141.11								

Notes:
External Lands Owned By Others, Future Phase and Richmond (783) areas and populations taken from 783 latest design: Z:\Projects\15-783_Richmond_Subdivision_Phase1\B_Design\B2_Drawings\B2-2_Main (DSEL)\2018-08-17_FULL COMPILED DRAWING SET - CITY SIGNED
Increase External (Caivan Lands) from 60 pop/ha to 85 pop/ha as per email dated January 22, 2019: Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-2_Sanitary\2019-01-18_MSS_CURRENT_comparison
Richmond (977) areas and populations taken from May 2018 Sanitary Design Sheets from FSR Rev 5 (correction to residential area from 42.28ha to 54.05ha): Z:\Projects\17-977_Mattamy_Richmond\B_Design\B3_Reports\B3-2_Servicing (DSEL)\2018-05-04_FSR_Rev5\Appendix_C

SANITARY SEWER CALCULATION SHEET

CLIENT: **Mattamy Homes**
LOCATION: **Richmond - Phase 1**
FILE REF: **17-977**
DATE: **22-Jan-19**

DESIGN PARAMETERS - TECHNICAL BULLETIN ISTB-2018-01 (MARCH 21, 2018)

Avg. Daily Flow Res.	280	L/p/d	Peak Fact Res. Per Harmons: Min = 2.0, Max =4.0		Infiltration / Inflow	0.33	L/s/ha
Avg. Daily Flow Comr	28,000	L/ha/d	Peak Fact. Comm. / Instit.	1	Min. Pipe Velocity	0.60	m/s full flowing
Avg. Daily Flow Instit.	28,000	L/ha/d	Peak Fact. Indust.	1.5	Max. Pipe Velocity	3.00	m/s full flowing
Avg. Daily Flow Indus	35,000	L/ha/d	Peak Fact. Indust. per MOE graph		Mannings N	0.013	
Park Flow	9300	L/ha/d			Correction Factor (K)	0.8	

Location			Residential Area and Population									Commercial		Institutional		Industrial		Park			Infiltration				Pipe Data							
Area ID	Up	Down	Area	Number of Units by type				Pop.	Cumulative Area	Cumulative Pop.	Peak. Fact.	Q_{res}	Area	Accu. Area	Area	Accu. Area	Area	Accu. Area	Area	Accu. Area	Q_{C+I+I}	Total Area	Accu. Area	Infiltration Flow	Total Flow	DIA	Slope	Length	$A_{hydraulic}$	R	Velocity	Q_{cap}	Q / Q full
			(ha)	Singles	Semi's	Town's	Apt's		(ha)		(-)	(L/s)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(L/s)	(ha)	(ha)	(L/s)	(L/s)	(mm)	(%)	(m)	(m^2)	(m)	(m/s)	(L/s)	(-)
External (Lands Owned By Others)			31.610					2687.0	31.61	2687.0	2.99	26.00	1.12	1.12	2.75	2.75		0.00	1.13	1.13	1.4	36.610	36.610	12.081	39.46								
External (Future Phase)			9.340					694.0	9.34	694.0	3.32	7.46		0.00		0.00		0.00		0.00	0.0	9.340	9.340	3.082	10.54								
Richmond (977)			54.180					4119.0	54.18	4119.0	2.86	38.14		0.00	2.63	2.63		0.00	3.84	3.84	1.3	60.650	60.650	20.015	59.42								
Richmond Phase 1 (783)			11.670					744.6	11.67	744.6	3.30	7.97		0.00		0.00		0.00	0.96	0.96	0.1	12.630	12.630	4.168	12.24								
Total To SAN MH 121A			0.000					0.0	106.80	8244.6	2.63	70.27		1.12		5.38		0.00		5.93	2.7	0.000	119.230	39.346	112.36								

Notes:
External Lands Owned By Others, Future Phase and Richmond (783) areas and populations taken from 783 latest design: Z:\Projects\15-783_Richmond_Subdivision_Phase1\B_Design\B2_Drawings\B2-2_Main (DSEL)\2018-08-17_FULL COMPILED DRAWING SET - CITY SIGNED
Increase External (Caivan Lands) from 60 pop/ha to 85 pop/ha as per email dated January 22, 2019: Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-2_Sanitary\2019-01-18_MSS_CURRENT_comparison
Richmond (977) areas and populations taken from May 2018 Sanitary Design Sheets from FSR Rev 5 (correction to residential area from 42.28ha to 54.05ha): Z:\Projects\17-977_Mattamy_Richmond\B_Design\B3_Reports\B3-2_Servicing (DSEL)\2018-05-04_FSR_Rev5\Appendix_C

LOCATION			MONITORED PARAMETERS												DESIGN PARAMETERS																	
			EXISTING RESIDENTIAL				INFILL		RESIDENTIAL CONTRIBUTIONS			INFILTRATION CONTRIBUTIONS			INDUSTRIAL		MATTAMY HOMES				LARGE PARCELS				INDUSTRIAL CONTRIBUTIONS			RESIDENTIAL CONTRIBUTIONS			INFILTRATION CONTRIBUTIONS	
STREET	FROM MH	TO MH	POPULATION	POPULATION (CUMULATIVE)	AREA (ha)	AREA (ha) (CUMULATIVE)	POPULATION	POPULATION (CUMULATIVE)	TOTAL POPULATION (CUMULATIVE)	PEAK FACTOR	FLOW (L/S)	GWI (L/S)	WWI (L/S)	FLOW (L/S)	AREA (ha)	AREA (ha) (CUMULATIVE)	POPULATION	POPULATION (CUMULATIVE)	AREA (ha)	NET AREA (ha) (CUMULATIVE)	POPULATION	POPULATION (CUMULATIVE)	AREA (ha)	NET AREA (ha) (CUMULATIVE)	ICI FLOW (L/S)	INFILTRATION (L/S)	FLOW (L/S)	TOTAL POPULATION (CUMULATIVE)	PEAK FACTOR	FLOW (L/S)	TOTAL RESIDENTIAL AREA (ha) (CUMULATIVE)	FLOW (L/S)
MARTIN ST.	MHSA06160	MHSA06287	320	320	24.87	24.87	53	53	373	3.00	3.99	0.37	17.16	17.53	0.00	0.00	5625	5625	95.96	91.16	2256	2256	41.57	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06287	MHSA06245	9	329	0.69	25.57	0	53	382	3.00	4.09	0.38	17.64	18.02	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06245	MHSA06288	104	433	7.84	33.41	6	59	492	2.97	5.20	0.50	23.05	23.55	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06288	MHSA06235	3	436	0.23	33.63	0	59	495	2.96	5.23	0.50	23.21	23.71	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06235	MHSA06289	729	1165	56.20	89.84	98	157	1322	2.79	13.17	1.35	61.99	63.34	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06289	MHSA06254	3	1168	0.25	90.08	0	157	1326	2.79	13.20	1.35	62.16	63.51	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06254	MHSA06291	134	1302	10.39	100.47	21	178	1480	2.77	14.62	1.51	69.33	70.83	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06291	MHSA06292	66	1368	5.06	105.53	8	186	1554	2.76	15.30	1.58	72.82	74.40	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06292	MHSA06293	2	1370	0.12	105.65	0	186	1556	2.76	15.31	1.58	72.90	74.48	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06293	MHSA06294	30	1400	2.25	107.90	0	186	1586	2.76	15.59	1.62	74.45	76.07	0.00	0.00	0	5625	0.00	91.16	0	2256	0.00	39.49	0.00	0.00	0.00	7881	3.06	97.58	130.65	36.58
MARTIN ST.	MHSA06294	MHSA06262	89	1489	6.63	114.53	3	189	1678	2.74	16.42	1.72	79.03	80.74	0.00	0.00	0	5625	0.00	91.16	91	2347	1.68	41.08	0.00	0.00	0.00	7972	3.05	98.56	132.24	37.03
MARTIN ST.	MHSA06262	MHSA06295	33	1522	2.43	116.97	0	189	1711	2.74	16.72	1.75	80.71	82.46	0.00	0.00	0	5625	0.00	91.16	0	2347	0.00	41.08	0.00	0.00	0.00	7972	3.05	98.56	132.24	37.03
MARTIN ST.	MHSA06295	MHSA06270	58	1580	4.31	121.28	0	189	1769	2.73	17.24	1.82	83.68	85.50	0.00	0.00	0	5625	0.00	91.16	0	2347	0.00	41.08	0.00	0.00	0.00	7972	3.05	98.56	132.24	37.03
COCKBURN ST.	MHSA06270	MHSA06267	1300	2880	106.17	227.44	440	629	3509	2.57	32.19	3.41	156.93	160.35	0.00	0.00	0	5625	0.00	91.16	2572	4919	47.39	86.10	0.00	0.00	0.00	10544	2.93	125.23	177.26	49.63
COCKBURN ST.	MHSA06267	MHSA06264	7	2887	0.52	227.96	0	629	3516	2.57	32.25	3.42	157.29	160.71	0.00	0.00	0	5625	0.00	91.16	0	4919	0.00	86.10	0.00	0.00	0.00	10544	2.93	125.23	177.26	49.63
COCKBURN ST.	MHSA06264	MHSA06263	122	3009	9.02	236.98	0	629	3638	2.56	33.25	3.55	163.52	167.07	0.00	0.00	0	5625	0.00	91.16	0	4919	0.00	86.10	0.00	0.00	0.00	10544	2.93	125.23	177.26	49.63
COCKBURN ST.	MHSA06263	MHSA06330	0	3009	0.00	236.98	0	629	3638	2.56	33.25	3.55	163.52	167.07	0.00	0.00	0	5625	0.00	91.16	0	4919	0.00	86.10	0.00	0.00	0.00	10544	2.93	125.23	177.26	49.63
OTTAWA ST.	MHSA06372	MHSA06089	29	29	2.18	2.18	0	0	29	3.21	0.34	0.03	1.50	1.54	0.00	0.00	0	0	0.00	0.00	745	745	13.73	13.04	0.00	0.00	0.00	745	3.88	11.71	13.04	3.65
OTTAWA ST.	MHSA06089	MHSA06090	10	39	0.71	2.89	0	0	39	3.20	0.44	0.04	1.99	2.04	0.00	0.00	0	0	0.00	0.00	0	745	0.00	13.04	0.00	0.00	0.00	745	3.88	11.71	13.04	3.65
OTTAWA ST.	MHSA06090	MHSA06374	7	46	0.44	3.33	0	0	46	3.19	0.52	0.05	2.29	2.34	0.00	0.00	0	0	0.00	0.00	0	745	0.00	13.04	0.00	0.00	0.00	745	3.88	11.71	13.04	3.65
OTTAWA ST.	MHSA06374	MHSA06091	10	56	0.65	3.97	0	0	56	3.18	0.64	0.06	2.74	2.80	0.00	0.00	0	0	0.00	0.00	0	745	0.00	13.04	0.00	0.00	0.00	745	3.88	11.71	13.04	3.65
KING ST.	MHSA06091	MHSA06092	24	80	1.78	5.75	0	0	80	3.16	0.91	0.09	3.97	4.05	67.26	67.26	0	0	0.00	0.00	0	745	0.00	13.04	5.84	8.07	13.91	745	3.88	11.71	13.04	3.65
KING ST.	MHSA06092	MHSA06093	33	113	5.67	11.42	194	194	307	3.03	3.32	0.17	7.88	8.05	0.00	67.26	0	0	0.00	0.00	167	912	3.07	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
KING ST.	MHSA06093	MHSA06094	11	125	0.82	12.24	0	194	318	3.02	3.43	0.18	8.45	8.63	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
KING ST.	MHSA06094	MHSA06219	12	136	0.88	13.12	0	194	330	3.02	3.56	0.20	9.05	9.25	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
KING ST.	MHSA06219	MHSA06095	197	333	15.92	29.04	0	194	527	2.96	5.55	0.44	20.04	20.47	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
ROYAL YORK ST.	MHSA06095	MHSA06115	26	359	1.91	30.95	0	194	553	2.95	5.81	0.46	21.36	21.82	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
ROYAL YORK ST.	MHSA06115	MHSA06328	9	368	0.68	31.63	0	194	562	2.95	5.90	0.47	21.82	22.30	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
COCKBURN ST.	MHSA06328	MHSA39573	0	368	0.00	31.63	0	194	562	2.95	5.90	0.47	21.82	22.30	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
COCKBURN ST.	MHSA39573	MHSA06330	462	830	34.97	66.60	34	228	1058	2.84	10.70	1.00	45.96	46.95	0.00	67.26	0	0	0.00	0.00	0	912	0.00	15.96	5.84	8.07	13.91	912	3.83	14.13	15.96	4.47
RICHMOND PS	MHSA06330	MHSA06331	0	**3839**	0.00	**303.58**	0	**857**	4695	2.50	41.82	4.55	209.47	214.02	0.00	**67.26**	0	**5625**	0.00	91.16	0	**5831**	0.00	102.06	5.84	8.07	13.91	11456	2.90	134.39	193.22	54.10

LOCATION			TOTAL FLOW (L/S)	SEWER DETAILS																
STREET	FROM MH	TO MH		Q/Qcap (%)	CAPACITY (L/s)	VELOCITY (m/s)	FLOW TIME (min)	Tributary Connection (Invert/Obvert)	OBV U/S MH (m)	INV U/S MH (m)	OBV D/S MH (m)	INV D/S MH (m)	DROP (m)	US T/G (m)	US COVER (m)	DS T/G (m)	DS COVER (m)	SIZE	LENGTH	SLOPE
MARTIN ST.	MHSA06160	MHSA06287	**155.7**	89.6%	173.8	0.78	1.62	90.89 Inv. / 91.4 Obv.	89.30	**88.77**	89.18	88.66	0.00	94.86	5.56	94.69	5.50	**525**	**75.4**	**0.15%**
MARTIN ST.	MHSA06287	MHSA06245	**156.3**	89.9%	173.8	0.78	1.59		89.18	88.66	89.07	88.55	0.00	94.69	5.50	94.39	5.32	**525**	**74.0**	**0.15%**
MARTIN ST.	MHSA06245	MHSA06288	**162.9**	93.8%	173.8	0.78	1.67	90.4 Inv. / 90.65 Obv.	89.07	88.55	88.96	88.43	0.00	94.39	5.32	94.52	5.57	**525**	**77.7**	**0.15%**
MARTIN ST.	MHSA06288	MHSA06235	**163.1**	93.9%	173.8	0.78	1.29		88.96	88.43	88.87	88.34	0.00	94.52	5.57	94.61	5.74	**525**	**60.0**	**0.15%**
MARTIN ST.	MHSA06235	MHSA06289	**210.7**	93.9%	224.3	1.00	1.43	89.94 Inv. / 90.24 Obv.	88.87	88.34	88.65	88.12	0.00	94.61	5.74	94.57	5.92	525	86.2	0.25%
MARTIN ST.	MHSA06289	MHSA06254	**210.9**	94.0%	224.3	1.00	1.19		88.65	88.12	88.47	87.94	0.00	94.57	5.92	94.90	6.43	525	71.9	0.25%
MARTIN ST.	MHSA06254	MHSA06291	**219.6**	97.9%	224.3	1.00	1.35	89.6 Inv. / 89.85 Obv.	88.47	87.94	88.27	87.74	0.00	94.90	6.43	95.54	7.27	525	81.5	0.25%
MARTIN ST.	MHSA06291	MHSA06292	**223.9**	99.8%	224.3	1.00	1.44	91.04 Inv. / 91.29 Obv.	88.27	87.74	88.05	87.52	0.00	95.54	7.27	94.55	6.50	525	86.5	0.25%
MARTIN ST.	MHSA06292	MHSA06293	**224.0**	90.3%	248.1	0.85	1.15		88.05	87.45	87.96	87.36	0.00	94.55	6.50	93.51	5.55	**600**	**58.5**	**0.15%**
MARTIN ST.	MHSA06293	MHSA06294	**225.8**	91.0%	248.1	0.85	0.41	91.25 Inv. / 91.5 Obv.	87.96	87.36	87.93	87.33	0.00	93.51	5.55	93.50	5.57	**600**	**21.0**	**0.15%**
MARTIN ST.	MHSA06294	MHSA06262	**232.7**	93.8%	248.1	0.85	1.18	89.59 Inv. / 89.84 Obv.	87.93	87.33	87.84	87.24	0.00	93.50	5.57	93.88	6.04	**600**	**60.0**	**0.15%**
MARTIN ST.	MHSA06262	MHSA06295	**234.8**	94.6%	248.1	0.85	1.30	90.17 Inv. / 90.42 Obv.	87.84	87.24	87.74	87.14	0.00	93.88	6.04	94.36	6.62	**600**	**66.5**	**0.15%**
MARTIN ST.	MHSA06295	MHSA06270	**238.3**	96.1%	248.1	0.85	1.52	90.13 Inv. / 90.38 Obv.	87.74	87.14	87.62	87.02	0.03	94.36	6.62	93.86	6.24	**600**	**77.4**	**0.15%**
COCKBURN ST.	MHSA06270	MHSA06267	**367.4**	94.8%	387.6	1.05	1.38	87.2 Inv. / 87.80 Obv.	87.59	86.92	87.42	86.75	0.00	93.86	6.27	93.54	6.12	675	87.0	0.20%
COCKBURN ST.	MHSA06267	MHSA06264	**367.8**	83.9%	438.4	1.19	1.50		87.42	86.75	87.16	86.48	0.00	93.54	6.12	92.86	5.70	675	107.0	0.25%
COCKBURN ST.	MHSA06264	MHSA06263	**375.2**	85.6%	438.4	1.19	0.44	87.4 Inv. / 87.65 Obv.	87.16	86.48	87.08	86.40	0.00	92.86	5.70	92.00	4.92	675	31.0	0.25%
COCKBURN ST.	MHSA06263	MHSA06330	**375.2**	85.6%	438.4	1.19	1.15		87.08	86.40	86.87	86.20	0.00	92.00	4.92	91.65	4.77	675	82.0	0.25%
OTTAWA ST.	MHSA06372	MHSA06089	**17.2**	55.6%	31.0	0.61	1.66		90.29	90.04	90.14	89.89	0.00	95.58	5.29	95.61	5.48	**250**	**61.0**	**0.25%**
OTTAWA ST.	MHSA06089	MHSA06090	**17.8**	57.5%	31.0	0.61	1.17		90.14	89.89	90.03	89.78	0.00	95.61	5.47	95.22	5.19	**250**	**43.0**	**0.25%**
OTTAWA ST.	MHSA06090	MHSA06374	**18.2**	58.8%	31.0	0.61	1.66		90.03	89.78	89.88	89.63	0.00	95.22	5.19	95.09	5.21	**250**	**61.0**	**0.25%**
OTTAWA ST.	MHSA06374	MHSA06091	**18.8**	60.6%	31.0	0.61	2.08		89.88	89.63	89.69	89.44	0.03	95.09	5.21	94.97	5.28	**250**	**76.5**	**0.25%**
KING ST.	MHSA06091	MHSA06092	**34.2**	75.9%	45.1	0.62	2.08	91.94 Inv. / 92.19 Obv.	89.66	89.36	89.50	89.20	0.00	94.97	5.31	96.50	7.00	300	77.2	0.20%
KING ST.	MHSA06092	MHSA06093	**43.9**	97.3%	45.1	0.62	2.26		89.50	89.20	89.33	89.03	0.00	96.50	7.00	94.15	4.82	300	83.8	0.20%
KING ST.	MHSA06093	MHSA06094	**44.6**	98.8%	45.1	0.62	2.23		89.33	89.03	89.17	88.87	0.00	94.15	4.82	94.15	4.98	300	82.6	0.20%
KING ST.	MHSA06094	MHSA06219	**45.3**	64.0%	70.8	0.62	2.11		89.17	88.79	89.05	88.68	0.00	94.15	4.98	93.72	4.67	**375**	**78.6**	**0.15%**
KING ST.	MHSA06219	MHSA06095	**58.5**	82.6%	70.8	0.62	1.43	90.36 Inv. / 90.61 Obv.	89.05	88.68	88.97	88.60	0.65	93.72	4.67	94.32	5.35	**375**	**53.4**	**0.15%**
ROYAL YORK ST.	MHSA06095	MHSA06115	**60.1**	84.9%	70.8	0.62	1.96	88.8 Inv. / 89.05 Obv.	88.32	87.95	88.21	87.84	0.00	94.32	6.00	93.58	5.37	**375**	**73.0**	**0.15%**
ROYAL YORK ST.	MHSA06115	MHSA06328	**60.7**	85.7%	70.8	0.62	1.96		88.21	87.84	88.10	87.73	0.03	93.58	5.37	94.49	6.39	**375**	**73.0**	**0.15%**
COCKBURN ST.	MHSA06328	MHSA39573	60.7	85.7%	70.8	0.62	2.37	88.37 Inv. / 88.62 Obv.	88.07	87.70	87.94	87.56	0.00	94.49	6.42	91.79	3.85	375	88.4	0.15%
COCKBURN ST.	MHSA39573	MHSA06330	90.2	98.6%	91.4	0.80	0.21		87.94	87.56	87.91	87.54	1.04	91.79	3.85	91.65	3.73	375	10.0	0.25%
RICHMOND PS	MHSA06330	MHSA06331	458.2	85.9%	533.4	1.44	0.62		86.87	86.20	86.68	86.00		91.65	4.77	91.72	5.04	**675**	54.0	0.37%

MONITORED PARAMETERS

RESIDENTIAL	308 Lpcd	Manning's "n"	0.013
HARMON "K"	0.66		
GWI	**0.015 L/s/ha**		
WWI	**0.690 L/s/ha**		

DESIGN PARAMETERS

RESIDENTIAL	**350 Lpcd**
HARMON "K"	1
RESIDENTIAL I/I	**0.280 L/s/ha**
INDUSTRIAL	**5000 L/ha/d**
INDUSTRIAL PF	**1.5**
INDUSTRIAL I/I	**0.120 L/s/ha**

Designed:	MT	PROJECT:	Village of Richmond Sanitary Master Servicing Study Existing, Infill and Future Growth (High Projection) - Options A, B and C
Checked:	FW	LOCATION:	City of Ottawa
		File Ref.: 163400808	Date: Mar-10 Sheet No. 1 of 1

To MHSA06270
POP = 1769 + 7972 = 9741
Area = 121.28 + 132.24 = 253.52 ha
Flow = 238.3 L/s

excerpt from Stantec's: "Village of Richmond Water and Sanitary Master Servicing Study", July 2011.

Appendix J

Replace with updated design sheet calculations for WDL

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION: STREET	FROM M.H.	TO M.H.	EXISITING AND INFILL AREA: RESIDENTIAL AREA AND POPULATION: AREA (ha)	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	COMM: AREA (ha)	ACCU. AREA (ha)	INSTIT: AREA (ha)	ACCU. AREA (ha)	PARK: AREA (ha)	ACCU. AREA (ha)	C+I+I: PEAK FLOW (l/s)	INFILTRATION: TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	VILLAGE OF RICHMOND: RESIDENTIAL AREA AND POPULATION: AREA (ha)	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	COMM: AREA (ha)	ACCU. AREA (ha)	INSTIT: AREA (ha)	ACCU. AREA (ha)	PARK: AREA (ha)	ACCU. AREA (ha)	C+I+I: PEAK FLOW (l/s)	INFILTRATION: TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	PIPE: TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STRACHAN STREET																																									
			0.10	4												0.10	0.10	0.071																							
	302A	303A	0.59	4	0.69	8	3.26	0.09								0.59	0.69	0.486																			0.58	76.0	250	1.00	59.47	1.21	0.37
	303A	304A			0.69	8	3.26	0.09								0.00	0.69	0.486																			0.58	99.5	250	0.50	42.05	0.86	0.30
To QUEEN CHARLOTTE STREET , Pipe 304A - 123A					0.69	8																																			
POND BLOCK																																									
Contribution From Future Richmond Village, Pipe Fut. MH - 121A																			103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	121A	123A																			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	122.71	108.0	600	0.12	212.70	0.75	0.77
To QUEEN CHARLOTTE STREET , Pipe 123A - 124A																					103.25	6195				1.12		5.32		6.19	10.96											
QUEEN CHARLOTTE STREET																																									
Contribution From STRACHAN STREET, 303A - 304A			0.69	8	0.69	8										0.69	0.69																								
	304A	123A			0.69	8	3.26	0.09								0.00	0.69	0.486														0.00	0.00	0.00	0.000	0.58	94.5	300	0.90	91.74	1.30	0.36
Contribution From POND BLOCK, 121A - 123A					0.69	8											0.69		103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	123A	124A			0.69	8	3.26	0.09								0.00	0.69	0.486			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.28	112.5	600	0.12	212.70	0.75	0.78
To MARTIN STREET , Pipe 124A - 125A					0.69	8															103.25	6195				1.12		5.32		6.19	10.96											
MARTIN STREET																																									
Contribution From QUEEN CHARLOTTE STREET , Pipe 123A - 124A			0.69	8	0.69	8										0.69	0.69		103.25	6195	103.25	6195			1.12	1.12	5.32	5.32	6.19	6.19		115.88									
	124A	125A	0.00	0	0.69	8	3.26	0.09								0.00	0.69	0.486			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.28	111.0	600	0.12	212.70	0.75	0.78
	125A	126A	0.14	0	0.83	8	3.26	0.09								0.14	0.83	0.585			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	123.38	76.5	600	0.12	212.70	0.75	0.78
			0.36	44	0.36	44										0.36	0.36																								
			16.02	362	16.38	426										16.02	16.38																								
Contribution from Ex. San Pipe	Ex. SA16060	126A	1.37	20	17.75	446	2.98	4.74	0.26	0.26					0.05	1.63	18.01	12.697																			17.49	5.5	300	2.00	136.76	1.93	1.32
	126A	127A	0.66	17	19.24	471	2.97	4.99		0.26					0.05	0.66	18.50	13.748			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	141.49	74.5	600	0.12	212.70	0.75	0.80
	127A	128A	0.68	21	19.92	492	2.97	5.21		0.26					0.05	0.68	20.18	14.227			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	142.19	73.0	600	0.12	212.70	0.75	0.80
			0.27	49	0.27	49										0.27	0.27																								
			4.81	102	5.08	151										4.81	5.08																								
Contribution from Ex. San Pipe	Ex. SA16050	128A	2.12	41	7.20	192	3.08	2.11								2.12	7.20	5.075																			7.19	3.0	300	2.00	136.76	1.93	1.02
	128A	129A	0.65	17	27.77	701	2.91	7.27		0.26					0.05	0.65	28.03	19.761			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	149.79	80.0	600	0.12	212.70	0.75	0.81
	129A	130A	0.23	7	28.00	708	2.91	7.34		0.26					0.05	0.23	28.26	19.923			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	150.02	60.5	600	0.12	212.70	0.75	0.81
			10.23	614	10.23	614			2.48	2.48						12.71	12.71																								
			0.67	44	10.90	658			0.52	3.00						1.19	13.90																								
Contribution from Ex. San Pipe	Ex. SA06235	130A	51.61	785	52.51	1443	2.78	14.30	0.39	3.39					0.67	52.00	65.90	46.460																			61.43	5.5	300	2.00	136.76	1.93	1.87
	130A	131A	0.55	14	91.06	2165	2.69	20.76		3.65					0.72	0.55	94.71	66.771			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	210.98	61.0	675	0.12	291.19	0.81	0.88
	131A	132A	0.25	4	91.31	2169	2.69	20.80		3.65					0.72	0.25	94.96	66.947			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	211.17	71.0	675	0.12	291.19	0.81	0.88
									0.42	0.42						0.42	0.42																								
Contribution from Ex. San Pipe	Ex. SA06254	132A	10.31	214	10.31	214	3.07	2.34	0.35	0.77					0.15	10.66	11.08	7.811																			10.30	6.5	300	2.00	136.76	1.93	1.13
	132A	133A	0.61	14	102.23	2397	2.67	22.81		4.42					0.87	0.61	106.65	75.188			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	221.57	79.0	675	0.12	291.19	0.81	0.89
			2.42	41	2.42	41										2.42	2.42																								
Contribution from Ex. San Pipe	Ex. SA06291	133A	2.03	54	4.45	95	3.15	1.07								2.03	4.45	3.137																			4.21	4.5	300	2.00	136.76	1.93	0.87
	133A	134A	0.61	24	107.29	2516	2.65	23.77		4.42					0.87	0.61	111.71	78.756			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	226.10	86.5	675	0.12	291.19	0.81	0.89
	134A	1340A			107.29	2516	2.65	23.77		4.42					0.87	0.00	111.71	78.756			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	226.10	58.5	675	0.12	291.19	0.81	0.89
Contribution from Ex. San Pipe	Ex. SA06293	1340A	1.86	41	1.86	41	3.20	0.47	0.42	0.42			0.09	0.09		2.37	2.37	1.671																			2.14	4.0	300	2.00	136.76	1.93	0.70
	1340A	135A			109.15	2557	2.65	24.16		4.84			0.09	1.00		0.00	114.08	80.426			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	228.29	22.0	675	0.12	291.19	0.81	0.90
									0.20	0.20						0.20	0.20																								
Contribution from Ex. San Pipe	Ex. SA06294	135A	5.02	95	5.02	95	3.15	1.07	0.58	0.78	0.83	0.83			0.25	6.43	6.63	4.674																			5.99	5.0	300	2.00	136.76	1.93	0.96
	135A	136A			114.17	2652	2.64	24.96		5.62		0.83		0.09	1.25	0.00	120.71	85.101			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	234.02	59.5	675	0.12	291.19	0.81	0.90
	136A	137A			114.17	2652	2.64	24.96		5.62		0.83		0.09	1.25	0.00	120.71	85.101			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	234.02	66.5	675	0.12	291.19	0.81	0.90
Contribution from Ex. San Pipe	Ex. SA06295	137A	2.43	45	2.43	45	3.19	0.51								2.43	2.43	1.713																			2.22	4.5	300	2.00	136.76	1.93	0.70
	137A	138A	4.31	92	120.91	2789	2.63	26.15		5.62		0.83		0.09	1.25	4.31	127.45	89.852			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	239.96	65.0	675	0.12	291.19	0.81	0.90
	138A	*Ex. MH SA06270*			120.91	2789	2.63	26.15		5.62		0.83		0.09	1.25	0.00	127.45	89.852			103.25	6195	3.16	79.30		1.12		5.32		6.19	10.96	0.00	115.88	32.446	239.96	6.5	675	0.12	291.19	0.81	0.90
To COCKBURN STREET , Pipe Ex. MH SA06270 - Ex. MH SA06267					120.91	2789				5.62		0.83		0.09			127.45				103.25	6195				1.12		5.32		6.19			115.88									

MONITORED PARAMETERS FOR EXISTING AND INFILL AREA

Harmon "K"=	0.66		Industrial Peak Factor = as per MOE Graph	
Average Daily Flow =	308	l/p/day	Extraneous Flow =	0.705 L/a/ha
Commercial Flow =	17000	L/ha/da	Minimum Velocity =	0.60 m/s
Institutional Flow =	10000	L/ha/da	Manning's n =	0.013
Max Res. Peak Factor =	4.00		Townhouse coeff=	2.7
Commercial/Inst/Park peak Factor =	1.00		Single house coeff=	3.4
Park Average Flow =	50000	L/ha/da		

DESIGN PARAMETERS FOR NEW SUBDIVISION

Harmon "K"=	1		Industrial Peak Factor = as per MOE Graph	
Average Daily Flow =	350	l/p/day	Extraneous Flow =	0.280 L/a/ha
Commi/Inst Flow =	50000	L/ha/da	Minimum Velocity =	0.60 m/s
Industrial Flow =	35000	L/ha/da	Manning's n =	0.013
Max Res. Peak Factor =	4.00		Population =	60 P/Ha for residential
Commercial/Inst/Park peak Factor =	1.50			
Park Average Flow =	50000	L/ha/da		

Designed: K.M.	PROJECT: VILLAGE OF RICHMOND SANITARY TRUNK		
Checked: Z.L.	LOCATION: City of Ottawa		
Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 12	File Ref: 15-784BA	Date: October, 2015	Sheet No. 1 of 1

Drainage Area: 127.45 + 119.23 = **246.68 ha**
Population: 2789 + 8245 = **11,034**
Total Flow (Sewer Design Guidelines, October 2012): 26.15 + 1.25 + 89.852 + 141.11 = **258.36 L/s**
Total Flow (ISTB-2018-01, March 21, 2018): 26.15 + 1.25 + 89.852 + 112.36 = **229.61 L/s**

784_Sen.xls

APPENDIX D

Storm Collection

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
STM TRUNK 2																																	
			1.21	0.70	2.35	2.35			0.00	0.00			0.00	0.00			0.00	0.00															
	32	33	3.23	0.70	6.29	8.64			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	664	975	975	CONC	0.16	95.0	896.4213	1.2006	1.3187	0.740
	33	34	0.77	0.70	1.50	10.14			0.00	0.00			0.00	0.00			0.00	0.00	11.32	72.09	97.71	0.00	167.34	731	975	975	CONC	0.19	110.5	976.8525	1.3084	1.4076	0.748
	34	35	0.72	0.70	1.40	11.54			0.00	0.00			0.00	0.00			0.00	0.00	12.73	67.71	91.70	0.00	156.96	781	1050	1050	CONC	0.15	110.5	1057.6053	1.2214	1.5078	0.739
	35	36	0.10	0.70	0.19	11.73			0.00	0.00			0.00	0.00			0.00	0.00	14.23	63.64	86.12	0.00	147.31	747	1050	1050	CONC	0.14	72.0	1021.7438	1.1800	1.0170	0.731
	36	37	0.69	0.70	1.34	13.08			0.00	0.00			0.00	0.00			0.00	0.00	15.25	61.18	82.75	0.00	141.51	800	1050	1050	CONC	0.16	22.0	1092.2901	1.2614	0.2907	0.732
	37	38	0.09	0.70	0.18	13.25			0.00	0.00			0.00	0.00			0.00	0.00	15.54	60.52	81.85	0.00	139.94	802	1050	1050	CONC	0.16	25.5	1092.2901	1.2614	0.3369	0.734
	38	39	1.60	0.70	3.11	16.37			0.00	0.00			0.00	0.00			0.00	0.00	15.88	59.77	80.82	0.00	138.17	978	1050	1050	CONC	0.23	37.5	1309.6098	1.5124	0.4132	0.747
	39	40	0.18	0.70	0.35	16.72			0.00	0.00			0.00	0.00			0.00	0.00	16.29	58.88	79.60	0.00	136.07	984	1050	1050	CONC	0.24	41.5	1337.7767	1.5450	0.4477	0.736
	40	41	0.61	0.70	1.19	17.90			0.00	0.00			0.00	0.00			0.00	0.00	16.74	57.94	78.33	0.00	133.87	1037	1200	1200	CONC	0.13	77.0	1405.7072	1.2429	1.0325	0.736
	41	42	0.19	0.70	0.37	18.27			0.00	0.00			0.00	0.00			0.00	0.00	17.77	55.91	75.55	0.00	129.09	1022	1200	1200	CONC	0.13	10.5	1405.7072	1.2429	0.1408	0.727
	42	43			0.00	18.27			0.00	0.00			0.00	0.00			0.00	0.00	17.91	55.65	75.19	0.00	128.46	1017	1200	1200	CONC	0.13	61.5	1405.7072	1.2429	0.8247	0.723
			0.73	0.70	1.42	19.69			0.00	0.00			0.00	0.00			0.00	0.00															
			0.78	0.70	1.52	21.21			0.00	0.00			0.00	0.00			0.00	0.00															
	43	44	4.10	0.70	7.98	29.19			0.00	0.00			0.00	0.00			0.00	0.00	18.74	54.15	73.15	0.00	124.94	1581	1350	1350	CONC	0.15	121.0	2067.1669	1.4442	1.3964	0.765
	44	45	0.74	0.70	1.44	30.63			0.00	0.00			0.00	0.00			0.00	0.00	20.13	51.82	69.96	0.00	119.45	1587	1500	1500	CONC	0.10	99.0	2235.3724	1.2650	1.3044	0.710
To STM TRUNK 1, Pipe 45 - 46						30.63				0.00				0.00				0.00	21.44														
STM TRUNK 4																																	
					0.00	0.00	0.23	0.70	0.45	0.45			0.00	0.00			0.00	0.00															
					0.00	0.00	0.30	0.00	0.00	0.45			0.00	0.00			0.00	0.00						40									
	124	125			0.00	0.00			0.00	0.45			0.00	0.00	0.96	0.70	1.87	1.87	10.00	76.81	104.19	0.00	178.56	420	825	825	CONC	0.16	83.5	574.1743	1.0741	1.2957	0.732
	125	76			0.00	0.00	0.56	0.70	1.09	1.54			0.00	0.00			0.00	1.87	11.30	72.16	97.81	0.00	167.52	503	900	900	CONC	0.14	84.0	677.3564	1.0847	1.3149	0.743
To STM TRUNK 1, Pipe 76 - 23						0.00				1.54				0.00				1.87	12.61					40									
					0.00	0.00			0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00						800									
	120	121			0.00	0.00	0.45	0.70	0.88	0.88			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	891	1050	1050	CONC	0.19	113.0	1190.2955	1.3746	1.3701	0.749
	121	122			0.00	0.00	0.41	0.70	0.80	1.67			0.00	0.00			0.00	0.00	11.37	71.92	97.47	0.00	166.94	963	1050	1050	CONC	0.23	85.0	1309.6098	1.5124	0.9367	0.735
	122	123			0.00	0.00	0.51	0.70	0.99	2.67			0.00	0.00			0.00	0.00	12.31	68.95	93.41	0.00	159.90	1049	1200	1200	CONC	0.13	97.5	1405.7072	1.2429	1.3074	0.746
	123	76			0.00	0.00	0.48	0.70	0.93	3.60			0.00	0.00			0.00	0.00	13.61	65.24	88.32	0.00	151.12	1118	1200	1200	CONC	0.15	105.5	1509.9717	1.3351	1.3170	0.740
To STM TRUNK 1, Pipe 76 - 23						0.00				3.60				0.00				0.00	14.93					800									
STM TRUNK 3																																	
	14	15	0.65	0.70	1.26	1.26			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	97	450	450	PVC	0.21	81.5	130.6520	0.8215	1.6535	0.744
	15	16	0.47	0.70	0.91	2.18			0.00	0.00			0.00	0.00			0.00	0.00	11.65	70.99	96.20	0.00	164.74	155	600	600	PVC	0.14	66.0	229.7421	0.8125	1.3538	0.673
	16	17	0.94	0.70	1.83	4.01			0.00	0.00			0.00	0.00			0.00	0.00	13.01	66.91	90.60	0.00	155.06	268	675	675	CONC	0.19	44.5	366.4039	1.0239	0.7243	0.732
	17	18	0.06	0.70	0.12	4.13			0.00	0.00			0.00	0.00			0.00	0.00	13.73	64.93	87.89	0.00	150.38	268	675	675	CONC	0.19	37.0	366.4039	1.0239	0.6023	0.731
			0.25	0.40	0.28	4.40			0.00	0.00			0.00	0.00			0.00	0.00															
	18	19	2.81	0.70	5.47	9.87			0.00	0.00			0.00	0.00			0.00	0.00	14.33	63.39	85.77	0.00	146.72	626	825	825	CONC	0.34	54.0	836.9956	1.5658	0.5748	0.748
	19	20	1.45	0.70	2.82	12.69			0.00	0.00			0.00	0.00			0.00	0.00	14.91	61.98	83.85	0.00	143.41	787	975	975	CONC	0.22	45.5	1051.1471	1.4079	0.5386	0.749
	20	21	2.09	0.70	4.07	16.76			0.00	0.00			0.00	0.00			0.00	0.00	15.45	60.73	82.14	0.00	140.45	1018	1050	1050	CONC	0.25	62.0	1365.3626	1.5768	0.6553	0.746
To STM TRUNK 1, Pipe 21 - 76						16.76				0.00				0.00				0.00	16.10														
STM TRUNK 1A																																	
	1	2	0.22	0.70	0.43	0.43			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	33	300	300	PVC	0.35	31.0	57.2089	0.8093	0.6384	0.575
	2	3	0.46	0.70	0.90	1.32			0.00	0.00			0.00	0.00			0.00	0.00	10.64	74.44	100.94	0.00	172.93	99	450	450	PVC	0.22	61.0	133.7266	0.8408	1.2091	0.737
	3	4	0.22	0.70	0.43	1.75			0.00	0.00			0.00	0.00			0.00	0.00	11.85	70.37	95.35	0.00	163.27	123	525	525	PVC	0.17	10.5	177.3192	0.8191	0.2136	0.695
	4	5	0.51	0.70	0.99	2.74			0.00	0.00			0.00	0.00			0.00	0.00	12.06	69.70	94.44	0.00	161.68	191	600	600	PVC	0.18	77.0	260.5030	0.9213	1.3929	0.734
	5	6	0.56	0.70	1.09	3.83			0.00	0.00			0.00	0.00			0.00	0.00	13.45	65.67	88.91	0.00	152.13	252	675	675	CONC	0.16	77.0	336.2353	0.9396	1.3658	0.749
			0.55	0.70	1.07	4.90			0.00	0.00			0.00	0.00			0.00	0.00															
	6	OGS	0.63	0.70	1.23	6.13			0.00	0.00			0.00	0.00			0.00	0.00	14.82	62.20	84.14	0.00	143.91	381	750	750	CONC	0.21	67.0	510.1676	1.1548	0.9670	0.747
	OGS	302			0.00	6.13			0.00	0.00			0.00	0.00			0.00	0.00	15.79	59.97	81.10	0.00	138.65	368	825	825	CONC	0.18	5.0	609.0038	1.1393	0.0731	0.604
To STM TRUNK 5, Pipe 302 - 303						6.13				0.00				0.00				0.00	15.86														
STM TRUNK 1																																	
	70	7	0.31	0.70	0.60	0.60			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	46	300	300	PVC	0.41	41.5	61.9187	0.8760	0.7896	0.748
	7	8	0.85	0.70	1.65	2.26			0.00	0.00			0.00	0.00			0.00	0.00	10.79	73.90	100.20	0.00	171.65	167	600	600	PVC	0.15	117.0	237.8056	0.8411	2.3185	0.701

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Jan 31, 2019
PROVINCE OF ONTARIO

Designed: A.K.	PROJECT:	Mattamy - Village of Richmond Western Development Lands	
Checked: W.L.	LOCATION:	City of Ottawa	
Dwg. Reference:	File Ref:	Date: Jan 2019	Sheet No. SHEET 1 OF 2

977_STM3.xlsx

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

Ottawa

LOCATION			AREA (Ha)															FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR																	
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
	8	9	0.26	0.70	0.51	2.76			0.00	0.00			0.00	0.00			0.00	0.00	13.11	66.63	90.21	0.00	154.39	184	600	600	PVC	0.16	10.5	245.6046	0.8686	0.2015	0.750
	9	10	0.38	0.70	0.74	3.50			0.00	0.00			0.00	0.00			0.00	0.00	13.31	66.07	89.45	0.00	153.07	231	675	675	CONC	0.14	65.5	314.5193	0.8789	1.2421	0.736
	10	11	1.87	0.70	3.64	7.14			0.00	0.00			0.00	0.00			0.00	0.00	14.55	62.85	85.03	0.00	145.44	449	825	825	CONC	0.18	72.0	609.0038	1.1393	1.0533	0.737
	11	12	1.27	0.70	2.47	9.61			0.00	0.00			0.00	0.00			0.00	0.00	15.60	60.38	81.65	0.00	139.61	580	900	900	CONC	0.19	68.0	789.0963	1.2404	0.9137	0.736
	12	13	1.39	0.70	2.70	12.32			0.00	0.00			0.00	0.00			0.00	0.00	16.52	58.40	78.95	0.00	134.95	719	975	975	CONC	0.19	72.0	976.8525	1.3084	0.9172	0.736
	13	21	0.99	0.70	1.93	14.24			0.00	0.00			0.00	0.00			0.00	0.00	17.44	56.56	76.43	0.00	130.60	806	1050	1050	CONC	0.16	72.5	1092.2901	1.2614	0.9579	0.738
Contribution From STM TRUNK 3, Pipe 20 - 21						16.76				0.00				0.00				0.00	16.10														
	21	76			0.00	31.01	0.15	0.70	0.29	0.29			0.00	0.00			0.00	0.00	18.39	54.77	73.99	0.00	126.39	1720	1200	1200	CONC	0.35	76.5	2306.5199	2.0394	0.6252	0.746
Contribution From STM TRUNK 4, Pipe 123 - 76						0.00				3.60				0.00				0.00	14.93					800									
Contribution From STM TRUNK 4, Pipe 125 - 76						0.00				1.54				0.00				1.87	12.61					40									
			0.09	0.70	0.18	31.18			0.00	5.43			0.00	0.00			0.00	1.87															
	76	23			0.00	31.18	0.13	0.70	0.25	5.68			0.00	0.00			0.00	1.87	19.02	53.67	72.48	0.00	123.79	3156	1800	1800	CONC	0.14	74.0	4300.9451	1.6902	0.7297	0.734
					0.00	31.18	0.22	0.70	0.43	6.11			0.00	0.00			0.00	1.87															
			0.22	0.70	0.43	31.61			0.00	6.11			0.00	0.00			0.00	1.87															
	23	24	0.22	0.70	0.43	32.04			0.00	6.11			0.00	0.00			0.00	1.87	19.75	52.44	70.81	0.00	120.91	3179	1800	1800	CONC	0.14	90.0	4300.9451	1.6902	0.8875	0.739
					0.00	32.04	0.19	0.70	0.37	6.48			0.00	0.00			0.00	1.87															
			0.21	0.70	0.41	32.45			0.00	6.48			0.00	0.00			0.00	1.87															
	24	25	3.33	0.70	6.48	38.93			0.00	6.48			0.00	0.00			0.00	1.87	20.64	51.03	68.89	0.00	117.60	3492	1800	1800	CONC	0.17	80.5	4739.4107	1.8625	0.7204	0.737
					0.00	38.93	0.18	0.70	0.35	6.83			0.00	0.00			0.00	1.87															
	25	26	0.22	0.70	0.43	39.35			0.00	6.83			0.00	0.00			0.00	1.87	21.36	49.95	67.41	0.00	115.05	3481	1800	1800	CONC	0.17	80.5	4739.4107	1.8625	0.7204	0.734
					0.00	39.35	0.17	0.70	0.33	7.16			0.00	0.00			0.00	1.87															
			0.20	0.70	0.39	39.74			0.00	7.16			0.00	0.00			0.00	1.87															
	26	27	3.60	0.40	4.00	43.75			0.00	7.16			0.00	0.00			0.00	1.87	22.08	48.91	66.00	0.00	112.63	3663	1800	1800	CONC	0.19	80.5	5010.4494	1.9690	0.6814	0.731
					0.00	43.75	0.16	0.70	0.31	7.47			0.00	0.00			0.00	1.87															
			0.25	0.70	0.49	44.23			0.00	7.47			0.00	0.00			0.00	1.87															
	27	28	2.63	0.75	5.48	49.72			0.00	7.47			0.00	0.00			0.00	1.87	22.76	47.98	64.73	0.00	110.44	3915	1800	1800	CONC	0.21	72.5	5267.5605	2.0700	0.5837	0.743
			0.15	0.70	0.29	50.01			0.00	7.47			0.00	0.00			0.00	1.87															
	28	29			0.00	50.01	0.16	0.70	0.31	7.78			0.00	0.00			0.00	1.87	23.34	47.21	63.68	0.00	108.63	3899	1800	1800	CONC	0.21	72.5	5267.5605	2.0700	0.5837	0.740
					0.00	50.01	0.25	0.70	0.49	8.27			0.00	0.00			0.00	1.87															
	29	30	3.66	0.70	7.12	57.13			0.00	8.27			0.00	0.00			0.00	1.87	23.93	46.47	62.67	0.00	106.89	4213	1950	1950	CONC	0.14	121.0	5324.3041	1.7828	1.1312	0.791
			0.55	0.70	1.07	58.20			0.00	8.27			0.00	0.00			0.00	1.87															
	30	31	1.57	0.70	3.06	61.26			0.00	8.27			0.00	0.00			0.00	1.87	25.06	45.10	60.81	0.00	103.69	4299	1950	1950	CONC	0.14	93.5	5324.3041	1.7828	0.8741	0.807
	31	45	0.64	0.70	1.25	62.50			0.00	8.27			0.00	0.00			0.00	1.87	25.93	44.10	59.45	0.00	101.36	4278	2100	2100	CONC	0.10	89.5	5483.0809	1.5831	0.9423	0.780
Contribution From STM TRUNK 2, Pipe 44 - 45						30.63				0.00				0.00				0.00	21.44														
	45	46	0.26	0.70	0.51	93.64			0.00	8.27			0.00	0.00			0.00	1.87	26.87	43.08	58.06	0.00	98.97	5539	2250	2250	CONC	0.12	65.5	7219.6677	1.8158	0.6012	0.767
					0.00	93.64	0.22	0.70	0.43	8.70			0.00	0.00			0.00	1.87															
			1.45	0.70	2.82	96.46			0.00	8.70			0.00	0.00			0.00	1.87															
	46	47	1.83	0.70	3.56	100.02			0.00	8.70			0.00	0.00			0.00	1.87	27.47	42.46	57.21	0.00	97.51	5767	2250	2250	CONC	0.12	48.0	7219.6677	1.8158	0.4406	0.799
	47	PLUG (B.O.)	0.84	0.70	1.63	101.65			0.00	8.70			0.00	0.00			0.00	1.87	27.91	42.01	56.61	0.00	96.47	5784	2250	2250	CONC	0.13	14.0	7514.4683	1.8899	0.1235	0.770
STM TRUNK 5																																	
																								800									
	300	302			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	800	975	975	CONC	0.16	43.0	896.4213	1.2006	0.5969	0.892
Contribution From STM TRUNK 1, Pipe 60 - 302						6.13				0.00				0.00				0.00	15.86														
	302	303			0.00	6.13			0.00	0.00			0.00	0.00			0.00	0.00	15.86	59.81	80.88	0.00	138.27	1167	1200	1200	CONC	0.11	91.0	1293.0625	1.1433	1.3265	0.902
	303	304			0.00	6.13			0.00	0.00			0.00	0.00			0.00	0.00	17.19	57.05	77.10	0.00	131.75	1150	1200	1200	CONC	0.10	54.0	1232.8868	1.0901	0.8256	0.933
	304	305			0.00	6.13			0.00	0.00			0.00	0.00			0.00	0.00	18.01	55.47	74.94	0.00	128.03	1140	1200	1200	CONC	0.10	86.5	1232.8868	1.0901	1.3225	0.925
	305	306			0.00	6.13			0.00	0.00			0.00	0.00			0.00	0.00	19.33	53.13	71.75	0.00	122.53	1126	1200	1200	CONC	0.10	16.5	1232.8868	1.0901	0.2523	0.913

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Jan 31, 2019
PROVINCE OF ONTARIO

Designed: A.K.	PROJECT:	Mattamy - Village of Richmond Western Development Lands	
Checked: W.L.	LOCATION:	City of Ottawa	
Dwg. Reference:	File Ref:	Date: Jan 2019	Sheet No. SHEET 2 OF 2

977_STM3.xlsx

Kate Anderson

From: Laura Pipkins <lpipkins@jfsa.com>
Sent: November 18, 2016 9:32 AM
To: Will Liu
Cc: jfsabourin@jfsa.com
Subject: RE: P922: Richmond Phase 1 - Stormwater management and new guidelines

These two flows (1.885 + 0.908 = 2.793) are being redirected to the Moore Ditch as per updated storm design with the elimination of Pond 2

Hi Will,

The 5- and 100-year flows are as follows:

Moore Ditch

Area ID	Drains To	Area (ha)	Flow (m^3/s)			
			5-Yr 3-Hr Chicago	100-Year 3-Hr Chicago	5-Year 24-Hr SCS	100-Year 24-Hr SCS
VG-2	Pond 1	63.1	0.826	1.936	1.11	2.392
VG-5	Pond 1	34.4	0.276	0.673	0.385	0.867
VG-6	~~Moore Trib~~	94.2	0.588	1.418	0.845	1.885
VG-7	~~Pond 2~~	39.2	0.293	0.697	0.414	0.908
JR-1	Pond 2	32.6	0.432	1.016	0.585	1.259

Thank you,
Laura

Laura Pipkins, P.Eng., LEED Green Associate
Project Engineer in Water Resources

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
52 Springbrook Drive, Ottawa, ON K2S 1B9
tel.: 613.836.3884 ext. 225, fax: 613.836.0332, www.jfsa.com

From: Will Liu [mailto:WLiu@dsel.ca]
Sent: November-17-16 7:30 PM
To: 'lpipkins@jfsa.com' <lpipkins@jfsa.com>
Subject: RE: P922: Richmond Phase 1 - Stormwater management and new guidelines

Hi Laura,

Can you sent us the external 5-yr to 100-yr flows from each external drainage area if possible? Please see attached sketch for the locations.

Thanks.

Yours truly,

Will Liu, M.Sc., P.Eng.

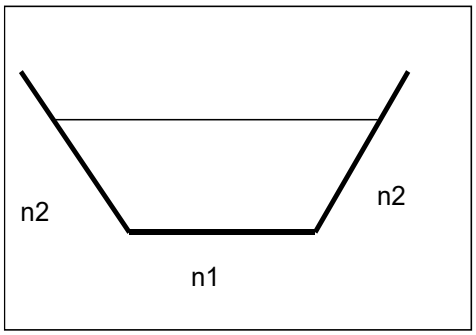
Date: January, 2019
DSEL File: 17-977

Moore Ditch

Channel Conveyance Calculations

Input:

Bottom Width	6.500	m	
Bottom "n1"	0.035		grass
Side Slope	3	:1	
Side "n2"	0.035		grass
Depth	0.650	m	
Freeboard	0.300	m	
Slope	0.10%		



Output:

Flow		**3.387**	**m^3/s**
	>	**2.793**	**m^3/s**
		OK	
Velocity		**0.62**	**m/s**
Total Width		**12.2**	**m**

Outflow per JFSA: VG-6 and VG7 - 100 yr 24Hr SCS design flow. Nov 18, 2016
\\dse-fsm1.dse.ads\design$\Design\11468\Others\JF\54_Nov1816_External_Predeve

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Conc. (min)	2 Year (mm/h)	5 Year (mm/h)	10 Year (mm/h)	100 Year (mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
External VG-6 to Moore Trib															94.20									1885									
External VG-7 to Pond 2															39.20									908									
Total Flow															133.40									2793	1800		CONC	0.16		4598	1.81	0.00	0.61
																								2793	2400x1200		CONC	0.16		4811	1.67	0.00	0.58
Note: Please see link below for flowrate information (100-yr 24hr SCS for area VG-6 and VG-7)																																	
Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-3_Storm\2018-11-28_markham_moore_calcs																																	
																								2793	1800x900		CONC	0.35		3304	2.04	0.00	0.85
Ottawa St. Ditch 100 YR							0.00								32.60									1154	1050		CONC	0.18		1159	1.34	0.00	1.00
Ottawa St. Ditch 5 YR							32.60																	681	900		CONC	0.18		768	1.21	0.00	0.89
Note: flows calculated from Upland Method																																	
Ottawa St. Ditch 100 YR							0.00								32.60									1259	1050		CONC	0.18		1159	1.34	0.00	1.09
Ottawa St. Ditch 5 YR							32.60																	585	900		CONC	0.18		768	1.21	0.00	0.76
Note: flows per JFSA email, Nov 18, 2016																																	
Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-3_Storm\2018-11-28_markham_moore_calcs																																	

to Moore Ditch

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: A.S.	PROJECT:		
Checked: V.C.	LOCATION: City of Ottawa		
Dwg. Reference:	File Ref: 14-733	Date: May, 2018	Sheet No. 1

APPENDIX E

Stormwater Management Outlet

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

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May 23, 2018

David Schaeffer Engineering Limited
120 Iber Road, Unit 103
Ottawa, Ontario K2S 1E9

Attention: **Ms. Jennifer Ailey, P.Eng.**

Subject: **Western Development Lands - Richmond / Expansion of Drainage Area to SWM Facility 1** *our file: 922-11*

As requested by your office and based on the available information as described below, we have evaluated the impact of increasing the ultimate conditions drainage area to Stormwater Management (SWM) Facility 1.

SWM Facility 1 is located within the Richmond Village development, within the City of Ottawa, and was designed to service a drainage area of 189.32 ha under ultimate conditions (including 97.50 ha external pre-development area) and 33.11 ha under interim conditions, as per the November 2015 *Design Brief for Stormwater Management Pond 1 Western Development Lands - Richmond* and the March 2018 *Design Brief for Interim Stormwater Management Pond 1 Western Development Lands - Richmond*, respectively. SWM Facility 1 provides quality, erosion and quantity control and discharges to the Van Gaal / Arbuckle Drain, and ultimately to the Jock River. The remainder of the proposed development (to the southeast) was designed to be serviced by SWM Facility 2, which discharges to the Jock River.

We understand from your office that you wish to consider a scenario wherein SWM Facility 2 is eliminated from the design, and the full development lands are serviced by SWM Facility 1, which would have an expanded drainage area of 221.176 ha at 34% imperviousness (including 97.50 ha external pre-development) under ultimate conditions. Refer to Figure 1 for the proposed expanded drainage area. Note that no changes are proposed to the interim pond drainage area or design.

The ultimate conditions development and ultimate Pond 1 were last modelled in DDSWMM / SWMHYMO / XPSWMM the November 2017 *Stormwater Management Report for Caivan Communities - Richmond Phase 1*. The models were updated to reflect the information presented in Figure 1 as provided by DSEL. Note that, as the DDSWMM program is most appropriate for use in modelling small urban drainage areas, the larger undetailed drainage areas in the expanded portion of the drainage area to Pond 1 were instead modelled using SWMYHMO, and the generated minor system hydrographs then input to XPSWMM. This is also true of other large undetailed drainage areas to Pond 1, including future development to the east of Phase 1 and natural drainage areas to the south of the subject site.

For modelling purposes, minor system capture rates on undetailed future development areas were limited to 114% of the 2-year post-development flows (5-year on collector roads; 100-year on arterial roads to be conservative), as simulated using SWMHYMO, in order to account for additional flows captured by standard inlet control devices and catchbasins during the 100-year storm. The external areas were assumed to be designed according to the new approach detailed in the September 2016 *City of Ottawa Technical Bulletin PIEDTB-2016-01*, with local road surface storage of excess 100-year flows. Flows in excess of the 100-year level spilling out of the road storage areas were modelled as captured to the minor system to be conservative.

A summary of drainage areas to Pond 1 is presented in Attachment A, along with target 2- to 100-year release rates for the pond. Note that the erosion and quantity control target release rates for Pond 1 are based on pre-development

drainage to the Van Gaal / Arkbuckle Drain from the subject site, and are unchanged by the proposed increase in post-development drainage area to Pond 1. The outlet controls for the pond were modified to meet the target release rates for an expanded drainage area with the same pond stage-storage-area relationship. Refer to Calculation Sheet B-1 of Attachment B for the proposed pond outlet controls.

The operation of the SWM facility was analysed using the updated DDSWMM / SWMHYMO / XPSWMM models for the 2- to 100-year 24-hour SCS Type II design storm and the 1979, 1988 and 1996 historical events, in accordance with the November 2015 *Design Brief*. The operating characteristics of the SWM facility are summarized below in Table 1A for free outfall conditions, and Table 1B for restrictive downstream conditions.

Table 1A: Summary of SWM Pond 1 Operating Characteristics (Free Outfall Conditions)

Pond Component	Lower Elevation (m)	Upper Elevation (m)	Allowable Release Rate [1] (m^3/s)	Pond Release Rate (m^3/s)	Volume Used [2] (m^3)
Permanent Pool	90.350	92.350	N/A	N/A	45330
Quality Control	92.350	92.647	N/A	0.090	8847
Extended Detention	92.647	93.680	N/A	0.415	43971
2yr/24hr SCS	92.350	93.179	0.330	0.294	26005
5yr/24hr SCS	93.179	93.564	4.290	0.390	39544
10yr/24hr SCS	93.564	93.787	5.348	1.999	48278
25yr/24hr SCS	93.787	93.827	6.694	2.968	49968
50yr/24hr SCS	93.827	93.909	7.749	5.294	53422
100yr/24hr SCS	93.909	93.990	8.894	8.102	57247
July 1st, 1979	93.990	94.044	N/A	9.127	59470
August 4th, 1988	93.990	93.936	N/A	6.197	54617
August 8th, 1996	93.990	93.836	N/A	2.899	50337

[1] 2-year erosion control release rate of 330 L/s, and 5- to 100-year pre-development flows (refer to Table A-3 of Appendix A).
[2] Volumes are active storage only for all pond components except the permanent pool.

Table 1B: Summary of SWM Pond 1 Operating Characteristics (Restrictive Downstream Conditions)

Pond Component	Lower Elevation (m)	Upper Elevation (m)	Allowable Release Rate [2] (m^3/s)	Pond Release Rate (m^3/s)	Volume Used [4] (m^3)
Permanent Pool	90.350	92.350	N/A	N/A	45330
Quality Control	92.350	92.647	N/A	0.090	8847
Extended Detention	92.647	93.680	N/A	0.415	43971
2yr/24hr SCS	92.350	93.553	0.330	0.000	39113
5yr/24hr SCS	93.553	93.723	4.290	0.493	45667
10yr/24hr SCS	93.723	93.808	5.348	2.139	49163
25yr/24hr SCS	93.808	93.844	6.694	3.073	50669
50yr/24hr SCS	93.844	93.939	7.749	5.996	54739
100yr/24hr SCS	93.939	94.011	8.894	8.629	58196
July 1st, 1979	94.011	94.036	N/A	9.588	59156
August 4th, 1988	94.011	93.951	N/A	6.411	55288
August 8th, 1996	94.011	93.852	N/A	3.272	50982

[1] 2-year erosion control release rate of 330 L/s, and 5- to 100-year pre-development flows (refer to Table A-3 of Appendix A).
[2] Volumes are active storage only for all pond components except the permanent pool.

The above results show that the actual provided release rates do not exceed the allowable release rates for SWM Pond 1. Note that the maximum 100-year pond level is 94.011 m; above the maximum 100-year water level of 93.785 m from the November 2015 *Design Brief.*

Pond 1 has been equipped with three sediment forebays. Calculations for the minimum dispersion length, settling length and the average velocity in the forebays under these expanded conditions are presented in Calculation Sheets B-2, B-3 and B-4 of Attachment B. The forebay lengths and widths are adequate to satisfy these MOE standards under expanded drainage area conditions.

SWM Pond 1 has a permanent pool volume of 45,330 m^3, which is more than the minimum permanent pool volume the *SWMP Design Manual* requires for enhanced protection for a wet pond for the 221.176 ha drainage area at 34% imperviousness, as calculated below.

$$(140.00 - 40)\ m^3/ha \times 221.176\ ha = 22{,}118\ m^3$$

The required quality control volume of 8,847 m^3 (40 m^3/ha) for the 221.176 ha drainage area is contained within the extended detention volume at an elevation of 92.647 m.

Under 100% blockage of the outlet control structure, the 100-year pond level will be 94.015 m based on the updated modelling. The 28 m long broad-crested quantity control weir will function as an emergency spillway under these conditions, and will convey the 100-year outflow of 8.557 m^3/s at a velocity of 0.86 m/s and a flow depth of 22.2 cm at a slope of 0.5%, or a velocity of 3.03 m/s and a flow depth of 6.3 cm at a slope of 33.3%.

It may therefore be concluded that the operation of SWM Pond 1, with the expanded drainage area to the southeast, is in conformance with the requirements presented in the November 2015 *Design Brief for Stormwater Management Pond 1 Western Development Lands - Richmond*, with the exception of the 100-year pond level, which exceeds the November 2015 elevation by 23 cm. I understand from DSEL that this higher 100-year pond level is acceptable, provided the berm between the pond and the Van Gaal / Arbuckle Drain can be raised to provide a 0.3 m freeboard around the pond without negatively impacting the performance of the pond or water levels on the drain.

The impact of the proposed drainage area expansion on the 100-year hydraulic gradeline elevations within the development was also evaluated using updated DDSWMM / SWMHYMO / XPSWMM models for the 100-year 3-hour Chicago storm and the 100-year 24-hour SCS Type II storm. Table 2 presents the composite hydraulic gradeline results for the 100-year 3-hour Chicago and 100-year 24-hour SCS Type II design storms. In accordance with the requirements presented in the November 2017 *Stormwater Management Report*, a freeboard of 0.2 m between the hydraulic grade line and the top of road has been provided throughout the proposed development, with the exception of MH 108. MH 108 has a freeboard of 0.199 m and is located within the pond block, and is therefore not a concern.

Due to modelling program (DDSWMM) limitations relating to the duration of the simulation, the 10-day rainfall + snowmelt event cannot be simulated using the detailed design model. Artificial ways to overcome these limitations were considered, as flawed but feasible approaches; however, previous reports have already demonstrated that the 100-year snowmelt event hydraulic gradeline is effectively a flat backwater from the Van Gaal / Arbuckle Drain floodplain, between elevations of 94.20 m and 94.21 m. Refer to the November 2015 *Design Brief* for further details. This approach is considered less flawed than the artificial alternatives, and the conclusions of the previous simulations would not be affected by the updated detailed design modelling, as the peak flows generated on-site are quite small for the 10-day rainfall + snowmelt event, and the hydraulic gradeline results are primarily driven by backwater from the watercourse and are relatively insensitive to the small inflows from the subdivision. The centreline of road elevations within the subdivision are to be at least 0.2 m above the maximum 100-year rainfall + snowmelt event hydraulic gradeline elevation of approximately 94.21 m, or the 100-year summer design storm (Chicago / SCS) hydraulic gradeline elevations, whichever is higher..

Table 2: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Interim / Ultimate)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
1	2	94.537	94.537	95.566	95.449	1.029
2	3	94.537	94.284	95.449	95.220	0.912
3	4	94.284	94.236	95.220	95.300	0.936
4	7	94.236	94.065	95.300	95.174	1.064
5	6	94.426	94.227	95.298	95.378	0.872
6	7	94.227	94.065	95.378	95.174	1.151
7	8	94.065	94.027	95.174	94.989	1.109
8	11	94.027	94.023	94.989	95.199	0.962
9	10	94.082	94.034	95.652	94.963	1.570
10	11	94.034	94.023	94.963	95.199	0.929
11	12	94.023	94.018	95.199	94.782	1.176
12	15	94.018	94.013	94.782	94.964	0.764
13	14	94.021	94.013	95.201	94.902	1.180
14	15	94.013	94.013	94.902	94.964	0.889
15	104	94.013	94.012	94.964	94.500	0.951
16	17	94.282	94.222	94.979	95.298	0.697
17	18	94.222	94.145	95.298	95.030	1.076
18	19	94.145	94.129	95.030	95.094	0.885
19	23	94.129	94.059	95.094	95.383	0.965
20	21	94.433	94.257	95.562	95.128	1.129
20	24	94.433	94.343	95.562	95.243	1.129
21	22	94.257	94.134	95.128	95.198	0.871
22	23	94.134	94.059	95.198	95.383	1.064
23	105	94.059	94.033	95.383	94.500	1.324
24	25	94.343	94.205	95.243	95.320	0.900
25	26	94.205	94.098	95.320	95.212	1.115
26	27	94.098	94.033	95.212	95.352	1.114
27	107	94.033	94.024	95.352	95.232	1.319
27	s110	94.033	94.230	95.352	95.120	1.319
30	26	94.206	94.098	95.372	95.212	1.166
30	31	94.206	94.146	95.372	95.212	1.166
31	32	94.146	94.031	95.212	94.974	1.066
32	33	94.031	94.029	94.974	95.049	0.943
33	330	94.029	94.025	95.049	95.230	1.020
104	Pond1	94.012	94.011	94.500	94.500	0.488
105	106	94.033	94.027	94.500	94.500	0.467
106	108	94.027	94.019	94.500	94.218	0.473
107	1070	94.024	94.023	95.232	95.055	1.208
108	109	94.019	94.011	94.218	94.500	0.199
109	Pond1	94.011	94.011	94.500	94.500	0.489
200	201	94.134	94.149	95.502	95.418	1.368
200	202	94.134	94.084	95.502	95.123	1.368
201	8	94.149	94.027	95.418	94.989	1.269
202	203	94.084	94.059	95.123	95.052	1.039
203	204	94.059	94.031	95.052	95.143	0.993
204	13	94.031	94.021	95.143	95.201	1.112
205	206	94.976	94.978	95.738	95.666	0.762
205	210	94.976	94.966	95.738	95.350	0.762
206	207	94.978	94.943	95.666	95.764	0.688
207	208	94.943	94.934	95.764	95.672	0.821
208	209	94.934	94.699	95.672	95.440	0.738
209	212	94.699	94.609	95.440	95.204	0.741
210	211	94.966	94.964	95.350	95.269	0.384

Table 2: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Interim / Ultimate)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
211	209	94.964	94.699	95.269	95.440	0.305
212	20	94.609	94.433	95.204	95.562	0.595
213	214	95.009	94.981	95.911	95.830	0.902
214	215	94.981	94.817	95.830	95.528	0.849
215	220	94.817	94.658	95.528	95.663	0.711
216	214	95.108	94.981	95.814	95.830	0.706
217	216	95.108	95.108	95.951	95.814	0.843
217	218	95.108	94.845	95.951	95.556	0.843
218	219	94.845	94.808	95.556	95.484	0.711
219	220	94.808	94.658	95.484	95.663	0.676
220	221	94.658	94.539	95.663	95.346	1.005
221	222	94.539	94.380	95.346	95.268	0.807
222	223	94.379	94.346	95.268	95.190	0.889
223	25	94.346	94.205	95.190	95.320	0.844
224	221	94.737	94.539	95.153	95.346	0.416
1600	16	94.295	94.282	95.090	94.979	0.795
Pond1	Out1	94.011	93.876	94.500	94.500	0.489
f101	f102	94.212	94.214	95.598	95.587	1.386
f102	f103	94.214	94.203	95.587	95.470	1.373
f103	f104	94.202	94.188	95.470	95.373	1.268
f104	f105	94.188	94.179	95.373	95.331	1.185
f105	f106	94.179	94.134	95.331	95.180	1.152
f106	f107	94.134	94.089	95.180	95.070	1.046
f107	f108	94.089	94.045	95.070	95.057	0.981
f108	f109	94.045	94.029	95.057	95.487	1.012
f109	Pond1	94.029	94.011	95.487	94.500	1.458
f202	f203	94.273	94.244	96.212	96.030	1.939
f203	f204	94.244	94.231	96.030	95.920	1.786
f204	f205	94.231	94.219	95.920	95.812	1.689
f205	f206	94.219	94.199	95.812	95.700	1.593
f206	f207	94.199	94.193	95.700	95.898	1.501
f207	f208	94.193	94.185	95.898	95.684	1.705
f208	f209	94.185	94.180	95.684	95.520	1.499
f209	f210	94.180	94.169	95.520	95.410	1.340
f210	f211	94.169	94.156	95.410	95.290	1.241
f211	f212	94.156	94.128	95.290	95.165	1.134
f212	f213	94.128	94.089	95.165	95.108	1.037
f213	f214	94.089	94.067	95.108	95.454	1.019
f214	f215	94.067	94.019	95.454	95.479	1.387
f215	Pond1	94.019	94.011	95.479	94.500	1.460
f251	f252	94.248	94.238	96.160	96.054	1.912
f252	f253	94.238	94.230	96.054	95.949	1.816
f253	f254	94.230	94.205	95.949	95.834	1.719
f254	f206	94.205	94.199	95.834	95.700	1.629
f261	f262	94.291	94.271	96.161	96.015	1.870
f262	f263	94.271	94.252	96.015	95.837	1.744
f263	f264	94.252	94.223	95.837	95.676	1.585
f264	f265	94.223	94.215	95.676	95.616	1.453
f265	f266	94.215	94.209	95.616	95.571	1.401
f266	f267	94.209	94.178	95.571	95.421	1.362
f267	f268	94.178	94.172	95.421	95.342	1.243
f268	f211	94.172	94.156	95.342	95.290	1.170
f1500	f1501	94.832	94.522	95.914	95.720	1.082

Table 2: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Interim / Ultimate)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard [1] (m)
f1501	f21400	94.522	94.265	95.720	95.562	1.198
f21400	Pond1	94.265	94.011	95.562	94.500	1.297
1070	108	94.023	94.019	95.055	94.218	1.032
330	1070	94.025	94.023	95.230	95.055	1.205
s101	s102	95.837	95.474	97.750	97.370	1.913
s102	s103	95.474	94.915	97.370	96.830	1.896
s103	s104	94.915	94.841	96.830	96.610	1.915
s104	s105	94.841	94.768	96.610	96.250	1.769
s105	s106	94.768	94.599	96.250	95.670	1.482
s106	s107	94.599	94.528	95.670	95.500	1.071
s107	s108	94.528	94.443	95.500	95.450	0.972
s108	s109	94.443	94.395	95.450	95.440	1.007
s109	s110	94.395	94.230	95.440	95.120	1.045
s110	Pond1	94.230	94.011	95.120	94.500	0.890
s201	s103	95.157	94.915	97.080	96.830	1.923
s301	s302	94.351	94.198	95.540	95.260	1.189
s302	s303	94.198	94.183	95.260	95.190	1.062
s303	s110	94.183	94.230	95.190	95.120	1.007

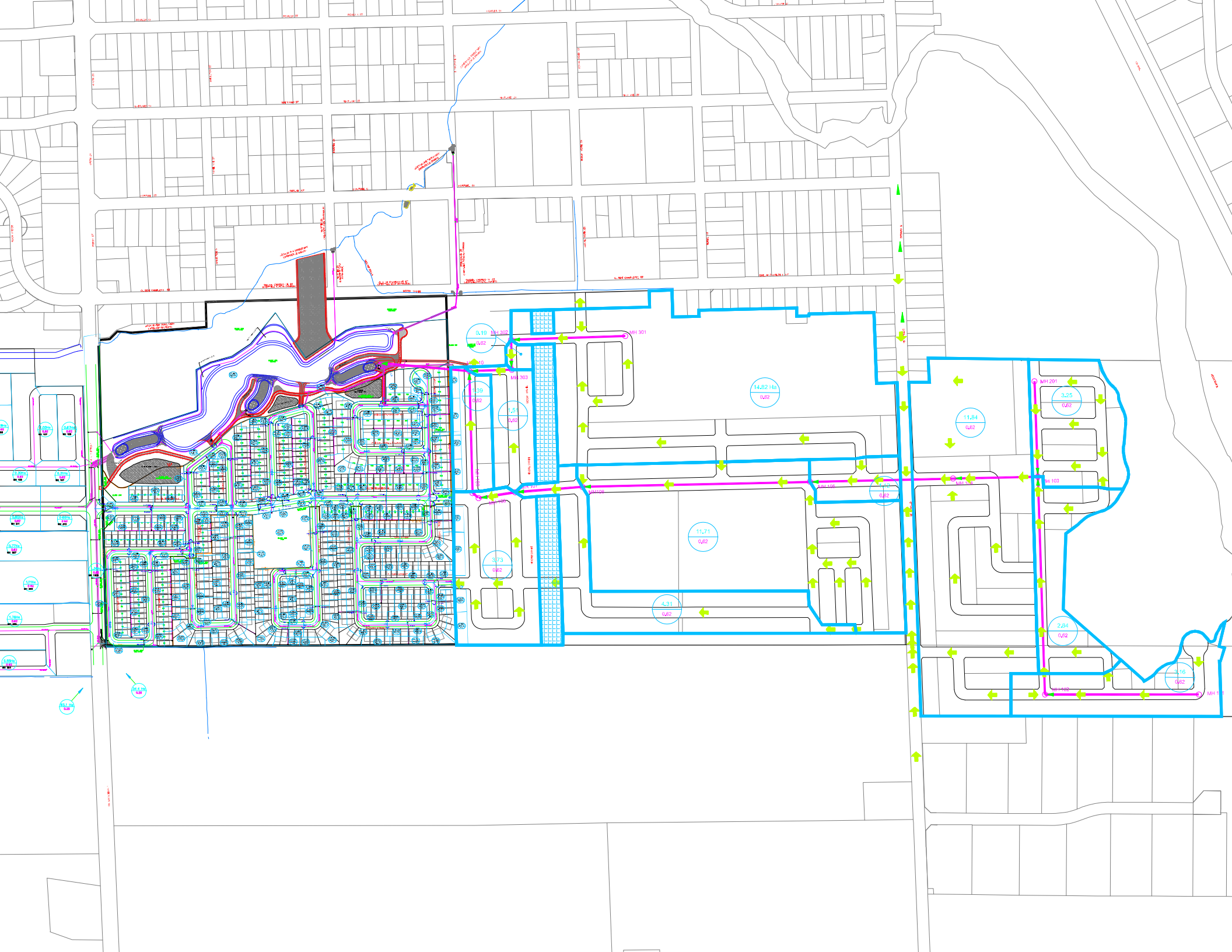
Note: [1] Freeboard between upstream hydraulic gradeline elevation and upstream manhole cover elevation.

Yours truly,
J.F. Sabourin and Associates Inc.

Laura Pipkins, P.Eng.

cc: J.F. Sabourin, M.Eng, P.Eng.
Director of Water Resources Projects

Attachment A: Drainage Areas and Target Release Rates
Attachment B: Pond Controls - Quality, Extended Detention and Quantity


MH 301
MH 302
MH 303
MH 201
MH 103
14,82 Ha
0,62
11,84
3,25
11,71
4,31
2,84
3,16
3,73
1,5
0,19

ATTACHMENT

A

Drainage Areas and Target Release Rates

JFSA Water Resources and Environmental Consultants

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
VG-2 [2]	63.100	7	441.700
VG-5 [2]	34.400	7	240.800
A002NE	0.072	61	4.392
A002NW	0.113	69	7.797
A002SE	0.198	72	14.256
A002SW	0.069	59	4.071
A005NE	0.050	74	3.700
A005NW	0.105	54	5.670
A005SE	0.090	69	6.210
A005SW	0.065	62	4.030
A006N1	0.035	43	1.505
A006NE	0.044	77	3.388
A006NW	0.046	76	3.496
A006R1	0.121	24	2.904
A006R2	0.113	25	2.825
A006R3	0.112	21	2.352
A006R4	0.107	17	1.819
A006R5	0.118	25	2.950
A006R6	0.106	24	2.544
A006R7	0.114	25	2.850
A006R8	0.042	25	1.050
A006SE	0.192	71	13.632
A006SW	0.192	69	13.248
A007NW	0.199	73	14.527
A007SW	0.074	43	3.182
A008NE	0.103	74	7.622
A008NW	0.058	41	2.378
A008R1	0.124	25	3.100
A008R2	0.064	23	1.472
A008SE	0.048	67	3.216
A008SW	0.013	54	0.702
A009NW	0.045	44	1.980
A009SW	0.091	27	2.457
A010NE	0.125	74	9.250
A010NW	0.123	72	8.856
A010R1	0.135	24	3.240
A010R2	0.083	25	2.075
A010R3	0.149	22	3.278
A010SE	0.132	77	10.164
A010SW	0.147	71	10.437
A011NE	0.053	30	1.590
A011NW	0.053	53	2.809
A011SE	0.116	76	8.816
A011SW	0.053	53	2.809
A012NE	0.028	36	1.008
A012R1	0.040	19	0.760
A012R2	0.138	26	3.588
A013N1	0.154	76	11.704
A013N2	0.045	38	1.710
A013NE	0.027	52	1.404
A013NW	0.052	40	2.080
A013R1	0.106	25	2.650
A013R2	0.128	24	3.072

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
A013R3	0.116	24	2.784
A013S1	0.155	78	12.090
A013S2	0.153	75	11.475
A013SE	0.028	48	1.344
A013SW	0.051	41	2.091
A016NE	0.087	76	6.612
A016NW	0.096	76	7.296
A017NE	0.073	36	2.628
A017NW	0.060	72	4.320
A017SE	0.172	73	12.556
A017SW	0.171	73	12.483
A020N1	0.039	72	2.808
A020N2	0.025	76	1.900
A020NE	0.049	78	3.822
A020NW	0.083	65	5.395
A020SE	0.013	69	0.897
A020SW	0.096	79	7.584
A021NE	0.151	76	11.476
A021NW	0.087	70	6.090
A021R1	0.087	25	2.175
A021R2	0.147	24	3.528
A021R3	0.070	24	1.680
A021R4	0.052	24	1.248
A021SE	0.166	77	12.782
A021SW	0.168	71	11.928
A024NE	0.135	77	10.395
A024NW	0.122	74	9.028
A024R1	0.109	24	2.616
A024R2	0.114	26	2.964
A024R3	0.067	23	1.541
A024SE	0.127	75	9.525
A024SW	0.102	74	7.548
A025NE	0.078	71	5.538
A025NW	0.035	43	1.505
A025R1	0.175	28	4.900
A025R2	0.142	28	3.976
A025S1	0.049	45	2.205
A025SE	0.075	75	5.625
A025SW	0.066	50	3.300
A026NE	0.031	74	2.294
A026R1	0.194	28	5.432
A026R2	0.187	28	5.236
A026R3	0.069	28	1.932
A026R4	0.123	28	3.444
A026R5	0.120	27	3.240
A026S1	0.041	41	1.681
A026SE	0.130	75	9.750
A026SW	0.036	42	1.512
A026WK1	0.029	59	1.711
A027N1	0.081	49	3.969
A027N2	0.140	74	10.360
A027NE	0.015	47	0.705
A027NW	0.122	64	7.808

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
A027S1	0.015	53	0.795
A027S2	0.042	69	2.898
A027SE	0.017	65	1.105
A027SW	0.133	74	9.842
A030NE	0.067	78	5.226
A030NW	0.142	76	10.792
A030R1	0.049	27	1.323
A030R2	0.124	27	3.348
A030R3	0.135	25	3.375
A030R4	0.087	27	2.349
A030SE	0.069	77	5.313
A030SW	0.144	70	10.080
A031NE	0.093	74	6.882
A031NW	0.105	64	6.720
A031R1	0.157	22	3.454
A031R2	0.146	26	3.796
A031R3	0.197	15	2.955
A031SE	0.082	35	2.870
A031SW	0.213	67	14.271
A1600N1	0.015	60	0.900
A1600N2	0.076	43	3.268
A1600NE	0.033	45	1.485
A1600NW	0.058	45	2.610
A1600PK1	0.963	29	27.927
A1600R1	0.026	25	0.650
A1600S1	0.018	56	1.008
A1600S2	0.054	59	3.186
A1600SE	0.028	54	1.512
A1600SW	0.053	49	2.597
A201NE	0.045	73	3.285
A201NW	0.038	74	2.812
A201R1	0.108	24	2.592
A201R2	0.099	24	2.376
A201R3	0.106	24	2.544
A201S1	0.049	67	3.283
A201S2	0.124	71	8.804
A201SE	0.142	74	10.508
A201SW	0.142	71	10.082
A202NE	0.104	76	7.904
A202NW	0.090	77	6.930
A202R1	0.162	7	1.134
A202R2	0.110	25	2.750
A202R3	0.059	18	1.062
A202R4	0.045	22	0.990
A202R5	0.062	17	1.054
A202SE	0.164	67	10.988
A202SW	0.062	39	2.418
A204NE	0.075	76	5.700
A204NW	0.079	77	6.083
A204R1	0.053	24	1.272
A204R2	0.073	24	1.752
A204R3	0.109	24	2.616
A204SE	0.192	73	14.016

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
A204SW	0.197	72	14.184
A204WK1	0.016	73	1.168
A206NE	0.028	36	1.008
A206NW	0.057	65	3.705
A206R1	0.063	23	1.449
A206R2	0.061	16	0.976
A206SE	0.052	73	3.796
A206SW	0.134	72	9.648
A208NE	0.124	77	9.548
A208NW	0.103	74	7.622
A208SE	0.152	72	10.944
A208SW	0.066	67	4.422
A211N1	0.037	43	1.591
A211NE	0.027	78	2.106
A211NW	0.155	72	11.160
A211R1	0.054	25	1.350
A211R2	0.100	24	2.400
A211R3	0.044	25	1.100
A211SE	0.018	39	0.702
A211SW	0.123	68	8.364
A212N1	0.017	65	1.105
A212NE	0.074	58	4.292
A212NW	0.044	57	2.508
A212R1	0.072	24	1.728
A212R2	0.075	23	1.725
A212R3	0.094	24	2.256
A212R4	0.122	25	3.050
A212R5	0.050	24	1.200
A212R6	0.021	24	0.504
A212SE	0.139	71	9.869
A212SW	0.052	56	2.912
A213NE	0.061	72	4.392
A213NW	0.041	68	2.788
A213SE	0.036	44	1.584
A215NE	0.159	74	11.766
A215NW	0.077	68	5.236
A215R1	0.140	25	3.500
A215R2	0.085	25	2.125
A215R3	0.076	24	1.824
A215SE	0.158	74	11.692
A215SW	0.058	74	4.292
A216NE	0.045	80	3.600
A216NW	0.040	50	2.000
A216R1	0.136	28	3.808
A216R2	0.184	22	4.048
A216SE	0.144	72	10.368
A216SW	0.046	41	1.886
A217NE	0.069	75	5.175
A217NW	0.069	72	4.968
A217R1	0.082	25	2.050
A217R2	0.072	24	1.728
A217R3	0.079	14	1.106
A217SE	0.068	66	4.488

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
A217SW	0.072	72	5.184
A219NE	0.053	40	2.120
A219NW	0.141	74	10.434
A219R1	0.137	20	2.740
A219R2	0.168	11	1.848
A219SE	0.097	68	6.596
A219SW	0.178	72	12.816
A221NE	0.101	68	6.868
A221NW	0.034	79	2.686
A221R1	0.089	24	2.136
A221R2	0.079	23	1.817
A221R3	0.097	26	2.522
A221S1	0.052	42	2.184
A221SE	0.093	68	6.324
A221SW	0.041	76	3.116
A223N1	0.023	65	1.495
A223N2	0.049	47	2.303
A223NE	0.058	79	4.582
A223NW	0.039	41	1.599
A223R1	0.153	29	4.437
A223R2	0.234	24	5.616
A223R3	0.159	19	3.021
A223SE	0.222	72	15.984
A223SW	0.121	64	7.744
A224NE	0.034	44	1.496
A224NW	0.033	42	1.386
A224R1	0.024	25	0.600
A224SE	0.038	45	1.710
A224SW	0.180	71	12.780
APOND1	6.509	56	364.504
APONDR1	0.138	24	3.312
APONDR2	0.043	19	0.817
APONDR3	0.167	23	3.841
APONDR4	0.022	7	0.154
101as	0.890	60	53.400
103as	0.460	60	27.600
103bs	0.610	60	36.600
105as	0.490	60	29.400
106as	0.180	60	10.800
106bs	0.240	60	14.400
107as	0.250	60	15.000
107bs	0.640	60	38.400
108as	0.540	60	32.400
202as	0.660	60	39.600
203as	0.690	60	41.400
204as	0.340	60	20.400
205as	0.320	60	19.200
206a	0.070	60	4.200
206bs	0.470	60	28.200
207as	0.300	60	18.000
209as	0.310	60	18.600
209bs	0.720	60	43.200
210as	0.300	60	18.000

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
210bs	0.460	60	27.600
211as	0.380	60	22.800
212as	0.380	60	22.800
251as	0.540	60	32.400
252as	0.260	60	15.600
253as	0.090	60	5.400
253bs	0.590	60	35.400
253cs	1.090	60	65.400
254as	0.400	60	24.000
254bs	1.980	60	118.800
261as	0.660	60	39.600
262as	0.620	60	37.200
263as	0.420	60	25.200
264a	0.050	60	3.000
264bs	0.450	60	27.000
265a	0.050	60	3.000
265bs	1.100	60	66.000
266as	0.360	60	21.600
266bs	0.620	60	37.200
266cs	0.690	60	41.400
267a	0.120	60	7.200
267bs	0.480	60	28.800
267cs	1.230	60	73.800
1500a	1.360	60	81.600
s101a	3.160	60	189.600
s102a	2.640	60	158.400
s103a	11.840	60	710.400
s104a	1.120	60	67.200
s105a	8.860	60	531.600
s105b	2.850	60	171.000
s106a	3.960	60	237.600
s106b	0.350	60	21.000
s107a	3.440	60	206.400
s107b	0.290	60	17.400
s109a	1.390	60	83.400
s201a	3.250	60	195.000
s301a	14.820	60	889.200
s302a	0.190	60	11.400
s303a	1.510	60	90.600
101ar	0.540	30	16.200
103ar	0.100	30	3.000
103br	0.360	30	10.800
105ar	0.290	30	8.700
106ar	0.110	30	3.300
106br	0.060	30	1.800
107ar	0.060	30	1.800
107br	0.380	30	11.400
108ar	0.130	30	3.900
202ar	0.400	30	12.000
203ar	0.410	30	12.300
204ar	0.200	30	6.000
205ar	0.190	30	5.700
206br	0.280	30	8.400

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
207ar	0.070	30	2.100
209ar	0.070	30	2.100
209br	0.430	30	12.900
210ar	0.070	30	2.100
210br	0.280	30	8.400
211ar	0.220	30	6.600
212ar	0.220	30	6.600
251ar	0.320	30	9.600
252ar	0.160	30	4.800
253ar	0.020	30	0.600
253br	0.360	30	10.800
253cr	0.650	30	19.500
254ar	0.240	30	7.200
254br	1.190	30	35.700
261ar	0.400	30	12.000
262ar	0.370	30	11.100
263ar	0.250	30	7.500
264br	0.100	30	3.000
265br	0.660	30	19.800
266ar	0.210	30	6.300
266br	0.370	30	11.100
266cr	0.420	30	12.600
267br	0.290	30	8.700
267cr	0.740	30	22.200
Total	**221.176**	**34**	**7483.337**

[1] Refer to Figure 2

[2] External pre-development areas.

Weighted Average Imperviousness = S(Area x Imp) / Total Area = 7483.337 / 221.176 = 34 %

Table A-2 : Summary of Total Drainage Area

Land Use [1]	Area (ha)	Imperviousness (%)	Area x Imp.
External Pre-Development	97.500	7	682.5
Proposed Development	123.676	55	6800.837
Total	221.176	34	7483.337

[1] Refer to Figure 2.

Weighted Average Imperviousness = S(Area x Imp) / Total Area = 7483.337 / 221.176 = 34 %

Table A-3: Target Release Rates for SWM Facility

Event	Pre-Development Release Rate [1] ($m^3/s/ha$)	Target Release Rate (m^3/s)
2-Year, 24-Hour SCS [2]	2.767	0.330
5-Year, 24-Hour SCS	4.290	4.290
10-Year, 24-Hour SCS	5.348	5.348
25-Year, 24-Hour SCS	6.694	6.694
50-Year, 24-Hour SCS	7.749	7.749
100-Year, 24-Hour SCS	8.894	8.894

[1] As per pre-development flows modelled in the January 2014 "*Richmond Village (South) Limited Subdivision / Preliminary Stormwater Management Plan*" memo.

[2] Target release rate based on erosion control of 2-year release rate to 330 L/s (per Parish Geomorphic erosion threshold; refer to January 2014 memo).

ATTACHMENT

B

Pond Controls – Quality, Extended Detention and Quantity

JFSA Water Resources and Environmental Consultants

Table B-1: Criteria for Required Storage Volumes

Pond	Area [1] (ha)	Imperviousness (%)	Storage Volume for Impervious Level [2] (m^3/ha)
N/A	N/A	35	140
Pond 1	221.176	34	140.00
N/A	N/A	55	190

[1] Refer to Appendix C for drainage areas to SWM Facility.

[2] Protection Level for Wet Pond: Enhanced 80% long-term S.S. removal. SWM Planning & Design Manual, Table 3.2, p.3-10 (March 2003). Pond 1 set to storage volume for 35% imperviousness, rather than extrapolating to 28% imperviousness.

Table B-2: Required Storage Volumes for SWM Facility

Pond Component	Required Volume (m^3)	Provided Volume [4] (m^3)	Volume Ratio	Provided Area [5] (m^2)	Provided Elevation (m)
Permanent Pool (PP) [1]	22118	45330	2.05	28938	92.350
Quality Control [2]	8847	8847	1.00	N/A	92.647
Extended Detention [3]	N/A	43971	N/A	N/A	93.680
Forebay (20% PP)	4424	N/A	N/A	6199	92.350
PP - Forebay	17694	N/A	N/A	22739	92.350
			Area Ratio (%) [6] =	21	

[1] Required PP volume based on Table B-1 (140.00 - 40 = 100.00 m^3/ha).

[2] Required quality control volume based on 40 m^3/ha.

[3] Extended detention based on 100-year summer flood level at the pond outfall.

[4] Provided volume based on stage-storage curve and extended detention (refer to Tables B-8 and B-9 of Appendix B).

[5] Based on grading plan provided by DSEL (refer to Figure 2).

[6] As per MOE, Maximum Forebay Area: 33% of Total Permanent Pool.

Table B-3: Extended Detention Parameters for SWM Facility

Permanent Pool Parameters			Baseflow Orifice Parameters			Quality Orifice Parameters		
Area (C3)	28938.05	m^2	Diameter	0.100	m	Diameter	0.300	m
Volume	45330.01	m^3						
PP Elev	92.350	m	Area	0.008	m^2	Area	0.071	m^2
QC Elev	92.647	m	Invert	92.100	m	Invert	92.350	m
h (m)	0.297	m	C_o	0.62		C_o	0.62	

Notes:
- C3 is the intercept from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- h is the maximum water elevation above the orifice (m).

Table B-4: Extended Detention Drawdown Time for SWM Facility

Elev.	Active Storage			C2	Drawdown Time	Drawdown Time	Flow	Demarkation
(m)	V (m^3)	A (m^2)	depth (m)	(m^2/m)	(h)	(days)	(m^3/s)	Point
92.35	**0.00**	**28938.05**	**0.00**				**0.011**	**PP Elev**
92.40	1447.42	28966.93	0.05	578	16.65	0.69	0.024	
92.45	2921.35	29497.69	0.10	5596	23.69	0.99	0.038	
92.50	4404.39	29790.67	0.15	5684	29.11	1.21	0.051	
92.55	5905.87	30117.00	0.20	5895	33.74	1.41	0.065	
92.60	7419.40	30403.23	0.25	5861	37.84	1.58	0.078	
92.647	**8847.00**	**30674.43**	**0.30**	**5852**	**41.35**	**1.72**	**0.090**	**QC Elev**
92.65	8946.63	30693.36	0.30	5851	41.59	1.73	0.091	
92.70	**10489.71**	**30979.41**	**0.35**	**5832**	**45.06**	**1.88**	**0.104**	
92.75	12047.14	31272.39	0.40	5836	48.33	2.01	0.127	
92.80	13618.54	31567.55	0.45	5843	51.43	2.14	0.149	
92.85	15204.56	31862.53	0.50	5849	54.39	2.27	0.171	
92.90	16806.83	32161.21	0.55	5860	57.23	2.38	0.192	
92.95	18424.87	32459.98	0.60	5870	59.97	2.50	0.213	
93.00	20054.22	32758.57	0.65	5878	62.63	2.61	0.233	
93.05	21698.57	33052.02	0.70	5877	65.20	2.72	0.252	
93.10	23361.36	33349.09	0.75	5881	67.70	2.82	0.269	
93.15	25037.25	33654.51	0.80	5896	70.16	2.92	0.285	
93.20	26728.92	33957.94	0.85	5906	72.55	3.02	0.300	
93.25	28425.62	34260.52	0.90	5914	74.90	3.12	0.314	
93.30	30162.12	34566.80	0.95	5925	77.21	3.22	0.327	
93.35	31900.53	34869.18	1.00	5931	79.47	3.31	0.340	
93.40	33804.14	35199.40	1.05	5963	81.72	3.40	0.353	
93.45	35591.37	35493.24	1.10	5959	83.90	3.50	0.365	
93.50	37203.33	35906.87	1.15	6060	86.17	3.59	0.376	
93.55	39003.77	36110.83	1.20	5977	88.21	3.68	0.387	
93.60	40880.31	38015.11	1.25	7262	91.83	3.83	0.398	
93.65	42783.82	38919.70	1.30	7678	94.53	3.94	0.409	
93.68	**43971.02**	**39350.27**	**1.33**	**7829**	**96.03**	**4.00**	**0.415**	**Ext. Det.**
93.70	44762.48	39637.33	1.35	7925	97.04	4.04	0.544	

Notes:
- C2 is the slope coefficient from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control, with a 24 to 48 hour drawdown time.
- Ext. Det. indicates the elevation of extended detention provided based on the 100-year summer flood level at the pond outfall.

Table B-5: Stage-Storage-Outflow Curve for Ultimate SWM Facility (Free Outfall Conditions)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.300	L (m)	28.000		
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.071	C_w	1.58		
			Invert (m)	92.10	Invert (m)	92.35	Invert (m)	92.70	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.075				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.250**	**0.011**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.011**	**0.000**
92.40	1447		0.300	0.012	0.050	0.013	0.000	0.000	0.000	0.000	0.024	0.145
92.45	2921		0.350	0.013	0.100	0.025	0.000	0.000	0.000	0.000	0.038	0.292
92.50	4404		0.400	0.014	0.150	0.038	0.000	0.000	0.000	0.000	0.051	0.440
92.55	5906		0.450	0.014	0.200	0.050	0.000	0.000	0.000	0.000	0.065	0.591
92.60	7419		0.500	0.015	0.250	0.063	0.000	0.000	0.000	0.000	0.078	0.742
92.647	**8847**	**QC Elev**	**0.547**	**0.016**	**0.297**	**0.074**	**0.000**	**0.000**	**0.000**	**0.000**	**0.090**	**0.885**
92.65	8947		0.550	0.016	0.300	0.075	0.000	0.000	0.000	0.000	0.091	0.895
92.70	**10490**		**0.600**	**0.017**	**0.350**	**0.087**	**0.000**	**0.000**	**0.000**	**0.000**	**0.104**	**1.049**
92.75	12047		0.650	0.017	0.400	0.097	0.050	0.013	0.000	0.000	0.127	1.205
92.80	13619		0.700	0.018	0.450	0.106	0.100	0.025	0.000	0.000	0.149	1.362
92.85	15205		0.750	0.019	0.500	0.115	0.150	0.038	0.000	0.000	0.171	1.520
92.90	16807		0.800	0.019	0.550	0.123	0.200	0.050	0.000	0.000	0.192	1.681
92.95	18425		0.850	0.020	0.600	0.130	0.250	0.063	0.000	0.000	0.213	1.842
93.00	20054		0.900	0.020	0.650	0.137	0.300	0.075	0.000	0.000	0.233	2.005
93.05	21699		0.950	0.021	0.700	0.144	0.350	0.087	0.000	0.000	0.252	2.170
93.10	23361		1.000	0.022	0.750	0.150	0.400	0.097	0.000	0.000	0.269	2.336
93.15	25037		1.050	0.022	0.800	0.157	0.450	0.106	0.000	0.000	0.285	2.504
93.20	26729		1.100	0.023	0.850	0.162	0.500	0.115	0.000	0.000	0.300	2.673
93.25	28426		1.150	0.023	0.900	0.168	0.550	0.123	0.000	0.000	0.314	2.843
93.30	30162		1.200	0.024	0.950	0.174	0.600	0.130	0.000	0.000	0.327	3.016
93.35	31901		1.250	0.024	1.000	0.179	0.650	0.137	0.000	0.000	0.340	3.190
93.40	33804		1.300	0.025	1.050	0.184	0.700	0.144	0.000	0.000	0.353	3.380
93.45	35591		1.350	0.025	1.100	0.189	0.750	0.150	0.000	0.000	0.365	3.559
93.50	37203		1.400	0.026	1.150	0.194	0.800	0.157	0.000	0.000	0.376	3.720
93.55	39004		1.450	0.026	1.200	0.199	0.850	0.162	0.000	0.000	0.387	3.900
93.60	40880		1.500	0.026	1.250	0.204	0.900	0.168	0.000	0.000	0.398	4.088
93.65	42784		1.550	0.027	1.300	0.208	0.950	0.174	0.000	0.000	0.409	4.278
93.68	**43971**	**Ext. Det.**	**1.580**	**0.027**	**1.330**	**0.211**	**0.980**	**0.177**	**0.000**	**0.000**	**0.415**	**4.397**
93.70	44762		1.600	0.027	1.350	0.213	1.000	0.179	0.020	0.125	0.544	4.476
93.75	46774		1.650	0.028	1.400	0.217	1.050	0.184	0.070	0.819	1.248	4.677
93.80	48835		1.700	0.028	1.450	0.221	1.100	0.189	0.120	1.837	2.276	4.883
93.85	50910		1.750	0.029	1.500	0.226	1.150	0.194	0.170	3.097	3.545	5.091
93.90	53051		1.800	0.029	1.550	0.230	1.200	0.199	0.220	4.558	5.015	5.305
93.95	55233		1.850	0.029	1.600	0.234	1.250	0.204	0.270	6.195	6.661	5.523
94.00	57758		1.900	0.030	1.650	0.238	1.300	0.208	0.320	7.990	8.466	5.776
94.05	59717		1.950	0.030	1.700	0.242	1.350	0.213	0.370	9.930	10.415	5.972
94.10	62027		2.000	0.031	1.750	0.246	1.400	0.217	0.420	12.006	12.499	6.203
94.11	**62503**	**Spring FL**	**2.010**	**0.031**	**1.760**	**0.246**	**1.410**	**0.218**	**0.430**	**12.436**	**12.931**	**6.250**
94.15	64409		2.050	0.031	1.800	0.249	1.450	0.221	0.470	14.207	14.709	6.441
94.20	66847		2.100	0.031	1.850	0.253	1.500	0.226	0.520	16.527	17.037	6.685
94.25	69257		2.150	0.032	1.900	0.257	1.550	0.230	0.570	18.961	19.479	6.926
94.30	71731		2.200	0.032	1.950	0.260	1.600	0.234	0.620	21.502	22.028	7.173
94.35	74339		2.250	0.032	2.000	0.264	1.650	0.238	0.670	24.146	24.680	7.434
94.40	77064		2.300	0.033	2.050	0.268	1.700	0.242	0.720	26.889	27.431	7.706
94.45	79331		2.350	0.033	2.100	0.271	1.750	0.246	0.770	29.727	30.277	7.933
94.50	81913		2.400	0.033	2.150	0.275	1.800	0.249	0.820	32.658	33.215	8.191

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided based on the 100-year summer flood level at the pond outfall.
- Spring FL indicates the elevation of the 100-year spring flood level at the pond outfall.

Table B-6: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Summer Flood Level = 93.62 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.300	L (m)	28.000		
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.071	C_w	1.58		
			Invert (m)	93.62	Invert (m)	93.62	Invert (m)	93.62	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.075				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.40	1447		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145
92.45	2921		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292
92.50	4404		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.440
92.55	5906		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.591
92.60	7419		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.742
92.647	**8847**	**QC Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.885**
92.65	8947		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.895
92.70	**10490**		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**1.049**
92.75	12047		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.205
92.80	13619		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.362
92.85	15205		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.520
92.90	16807		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.681
92.95	18425		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.842
93.00	20054		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.005
93.05	21699		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.170
93.10	23361		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.336
93.15	25037		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.504
93.20	26729		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.673
93.25	28426		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.843
93.30	30162		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.016
93.35	31901		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.190
93.40	33804		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.380
93.45	35591		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.559
93.50	37203		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.720
93.55	39004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.900
93.60	40880		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.088
93.65	42784		0.030	0.001	0.030	0.008	0.030	0.008	0.000	0.000	0.016	4.278
93.68	**43971**	**Ext. Det.**	**0.060**	**0.003**	**0.060**	**0.015**	**0.060**	**0.015**	**0.000**	**0.000**	**0.033**	**4.397**
93.70	44762		0.080	0.004	0.080	0.020	0.080	0.020	0.020	0.125	0.169	4.476
93.75	46774		0.130	0.006	0.130	0.033	0.130	0.033	0.070	0.819	0.890	4.677
93.80	48835		0.180	0.008	0.180	0.045	0.180	0.045	0.120	1.837	1.935	4.883
93.85	50910		0.230	0.009	0.230	0.058	0.230	0.058	0.170	3.097	3.222	5.091
93.90	53051		0.280	0.010	0.280	0.070	0.280	0.070	0.220	4.558	4.709	5.305
93.95	55233		0.330	0.011	0.330	0.082	0.330	0.082	0.270	6.195	6.371	5.523
94.00	57758		0.380	0.012	0.380	0.093	0.380	0.093	0.320	7.990	8.189	5.776
94.05	59717		0.430	0.013	0.430	0.103	0.430	0.103	0.370	9.930	10.149	5.972
94.10	62027		0.480	0.014	0.480	0.112	0.480	0.112	0.420	12.006	12.243	6.203
94.11	**62503**	**Spring FL**	**0.490**	**0.014**	**0.490**	**0.113**	**0.490**	**0.113**	**0.430**	**12.436**	**12.677**	**6.250**
94.15	64409		0.530	0.015	0.530	0.120	0.530	0.120	0.470	14.207	14.461	6.441
94.20	66847		0.580	0.016	0.580	0.127	0.580	0.127	0.520	16.527	16.798	6.685
94.25	69257		0.630	0.016	0.630	0.134	0.630	0.134	0.570	18.961	19.246	6.926
94.30	71731		0.680	0.017	0.680	0.141	0.680	0.141	0.620	21.502	21.802	7.173
94.35	74339		0.730	0.018	0.730	0.148	0.730	0.148	0.670	24.146	24.459	7.434
94.40	77064		0.780	0.018	0.780	0.154	0.780	0.154	0.720	26.889	27.216	7.706
94.45	79331		0.830	0.019	0.830	0.160	0.830	0.160	0.770	29.727	30.067	7.933
94.50	81913		0.880	0.020	0.880	0.166	0.880	0.166	0.820	32.658	33.009	8.191

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided based on the 100-year summer flood level at the pond outfall.
- Spring FL indicates the elevation of the 100-year spring flood level at the pond outfall.

Table B-7: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Spring Flood Level = 94.11 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.250	L (m)	28.000		
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.049	C_w	1.58		
			Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.048				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.40	1447		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145
92.45	2921		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292
92.50	4404		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.440
92.55	5906		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.591
92.60	7419		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.742
92.647	**8847**	**QC Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.885**
92.65	8947		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.895
92.70	**10490**		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**1.049**
92.75	12047		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.205
92.80	13619		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.362
92.85	15205		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.520
92.90	16807		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.681
92.95	18425		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.842
93.00	20054		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.005
93.05	21699		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.170
93.10	23361		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.336
93.15	25037		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.504
93.20	26729		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.673
93.25	28426		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.843
93.30	30162		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.016
93.35	31901		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.190
93.40	33804		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.380
93.45	35591		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.559
93.50	37203		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.720
93.55	39004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.900
93.60	40880		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.088
93.65	42784		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.278
93.68	**43971**	**Ext. Det.**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**4.397**
93.70	44762		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.476
93.75	46774		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.677
93.80	48835		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.883
93.85	50910		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.091
93.90	53051		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.305
93.95	55233		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.523
94.00	57758		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.776
94.05	59717		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.972
94.10	62027		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.203
94.11	**62503**	**Spring FL**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**6.250**
94.15	64409		0.040	0.002	0.040	0.010	0.040	0.008	0.040	0.354	0.373	6.441
94.20	66847		0.090	0.004	0.090	0.023	0.090	0.017	0.090	1.194	1.238	6.685
94.25	69257		0.140	0.006	0.140	0.035	0.140	0.027	0.140	2.315	2.383	6.926
94.30	71731		0.190	0.008	0.190	0.048	0.190	0.036	0.190	3.659	3.751	7.173
94.35	74339		0.240	0.009	0.240	0.060	0.240	0.046	0.240	5.193	5.308	7.434
94.40	77064		0.290	0.011	0.290	0.073	0.290	0.055	0.290	6.895	7.033	7.706
94.45	79331		0.340	0.012	0.340	0.085	0.340	0.063	0.340	8.749	8.908	7.933
94.50	81913		0.390	0.013	0.390	0.095	0.390	0.069	0.390	10.745	10.922	8.191

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided based on the 100-year summer flood level at the pond outfall.
- Spring FL indicates the elevation of the 100-year spring flood level at the pond outfall.

CALCULATION SHEET B-1: CONTROLS

Baseflow Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.100
A_o	(m^2)	0.008
invert	(m)	92.10
C_o		0.62
100yr Water Level	(m)	94.011
Head of Water	(m)	1.911
Q_0	(m^3/s)	0.029

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Not including reverse pipe losses

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Quality Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.300
A_o	(m^2)	0.071
invert	(m)	92.35
C_o		0.62
100yr Water Level	(m)	94.011
Head of Water	(m)	1.661
Q_0	(m^3/s)	0.239

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Not including reverse pipe losses

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Erosion Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.300
A_o	(m^2)	0.071
Invert	(m)	92.70
C_o		0.62
100yr Water Level	(m)	94.011
Head of Water	(m)	1.311
Q_0	(m^3/s)	0.209

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Quantity Control 1		
Rectangular Weir		
L	(m)	28.000
C_w		1.58
Invert	(m)	93.680
n		2
Max Water Level	(m)	94.015
Head of Water	(m)	0.335
$Q_{w\ (100\%\ Blockage)}$	(m^3/s)	8.557

Note: Sloping Sides of weir are not considered in weir capacity (underestimated capacity)

Weir Equation:

$Qw = C_w (L-0.1nh)h^{1.5}$

Qw is the weir flow

Cw is the weir coefficient

L is the weir length

h is the weir height

n is the # of side contractions

Spillway Velocity - Minimum Slope		
Restangular Channel Equation: $Q = 1/n \times AR^{2/3}S^{1/2}$		
normal depth	(m)	0.222
n (roughness coef.)		0.03
W (width)	(m)	45.000
A (area of flow)	(m^2)	9.976
p (wetted perimeter)	(m)	45.443
R (hydraulic radius)	(m)	0.220
S (assumed slope)	(m/m)	0.005
Q (flow)	(m^3/s)	8.557
v (velocity)	(m/s)	0.86

Spillway Velocity - Maximum Slope		
Restangular Channel Equation: $Q = 1/n \times AR^{2/3}S^{1/2}$		
normal depth	(m)	0.063
n (roughness coef.)		0.03
W (width)	(m)	45.000
A (area of flow)	(m^2)	2.822
p (wetted perimeter)	(m)	45.125
R (hydraulic radius)	(m)	0.063
S (assumed slope)	(m/m)	0.333
Q (flow)	(m^3/s)	8.557
v (velocity)	(m/s)	3.03

CALCULATION SHEET B-2: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEV. LANDS - RICHMOND VILLAGE (SOUTH) LIMITED
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
South Forebay

© DSEL

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
- r = length to width ratio, at the invert of the inlet pipe.
- Q_p = peak outflow during design quality storm
- V_s = settling velocity

Input:

r =	3.07		(83 m / 27 m)
Q_p =	0.415	m^3/s	(at elevation 93.68 m)
V_s =	0.0003	m/s	

L_{min} = 65.20 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of permanent pool (forebay)
- V_f = desired final velocity

Input:

Q =	2.605	m^3/s
d =	2.0	m
Vf =	0.5	m/s

L_{min} = 20.84 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required	65.20 m	
Length of Forebay Provided	**83.00 m**	(at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of pond during peak 10-year inflow (12h:00min)
- W_{avg} = average width of forebay

Input:

Q =	2.605	m^3/s	
d =	2.64	m	
W_{avg} =	21	m	(15 m bottom, 27 m permanent pool)

V = 0.05 m/s < 0.15 m/s

CALCULATION SHEET B-3: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEV. LANDS - RICHMOND VILLAGE (SOUTH) LIMITED
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
West Forebay

© DSEL

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
- r = length to width ratio, at the invert of the inlet pipe.
- Q_p = peak outflow during design quality storm
- V_s = settling velocity

Input:

r =	2.39		(67 m / 28 m)
Q_p =	0.415	m^3/s	(at elevation 93.68 m)
V_s =	0.0003	m/s	

L_{min} = 57.52 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of permanent pool (forebay)
- V_f = desired final velocity

Input:

Q =	1.217	m^3/s
d =	2.0	m
Vf =	0.5	m/s

L_{min} = 9.74 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required	57.52 m	
Length of Forebay Provided	**67.00 m**	(at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of pond during peak 10-year inflow (12h:00min)
- W_{avg} = average width of forebay

Input:

Q =	1.217	m^3/s	
d =	2.64	m	
W_{avg} =	22	m	(16 m bottom, 28 m permanent pool)

V = 0.02 m/s < 0.15 m/s

CALCULATION SHEET B-4: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEV. LANDS - RICHMOND VILLAGE (SOUTH) LIMITED
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
North Forebay

© DSEL

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
- r = length to width ratio, at the invert of the inlet pipe.
- Q_p = peak outflow during design quality storm
- V_s = settling velocity

Input:

r =	3.04		(85 m / 28 m)
Q_p =	0.415	m^3/s	(at elevation 93.68 m)
V_s =	0.0003	m/s	

L_{min} = 64.79 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of permanent pool (forebay)
- V_f = desired final velocity

Input:

Q =	4.718	m^3/s
d =	2.0	m
Vf =	0.5	m/s

L_{min} = 37.74 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required	64.79 m	
Length of Forebay Provided	**85.00 m**	(at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

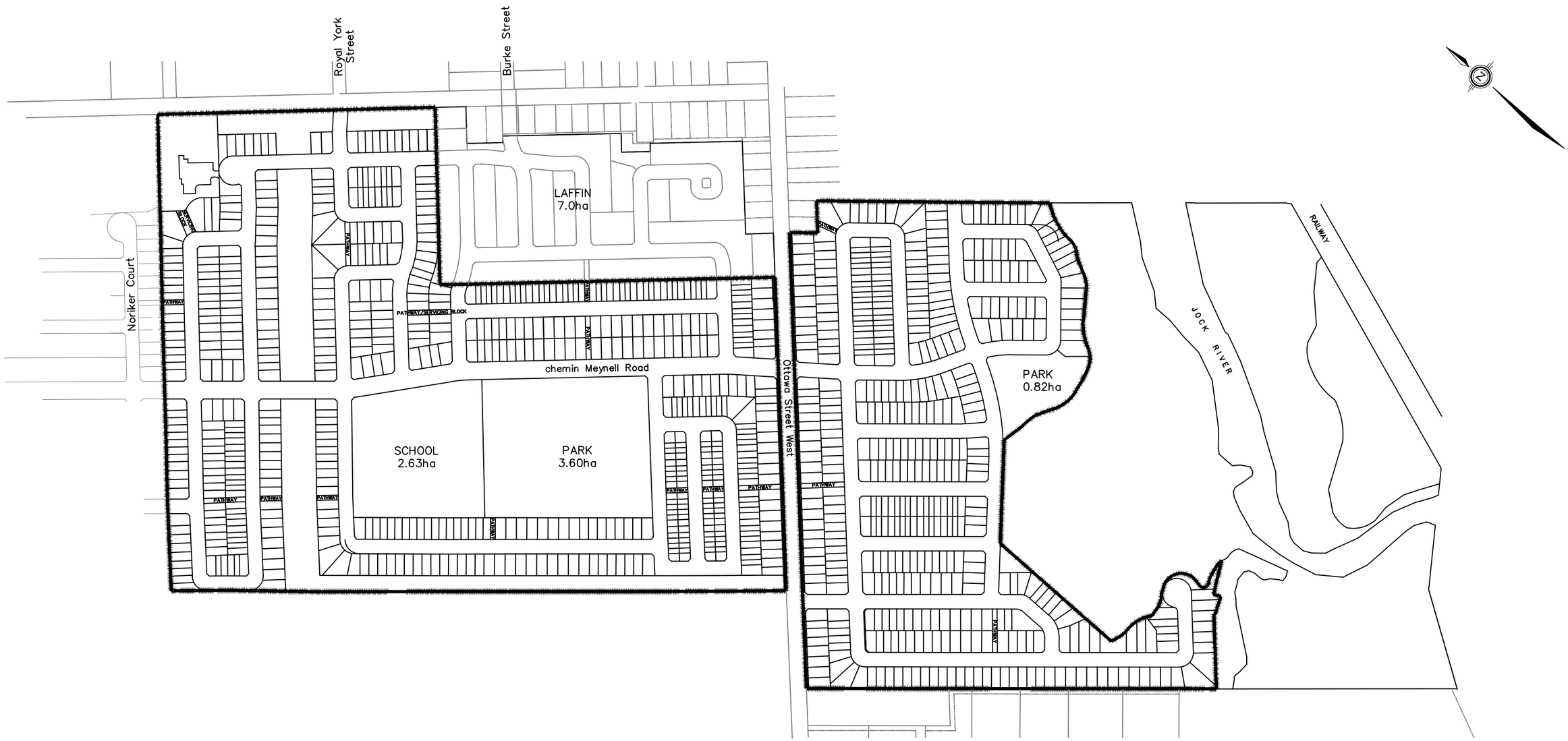
where:
- Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
- d = depth of pond during peak 10-year inflow (12h:00min)
- W_{avg} = average width of forebay

Input:

Q =	4.718	m^3/s	
d =	2.64	m	
W_{avg} =	22	m	(16 m bottom, 28 m permanent pool)

V = 0.08 m/s < 0.15 m/s

Figures



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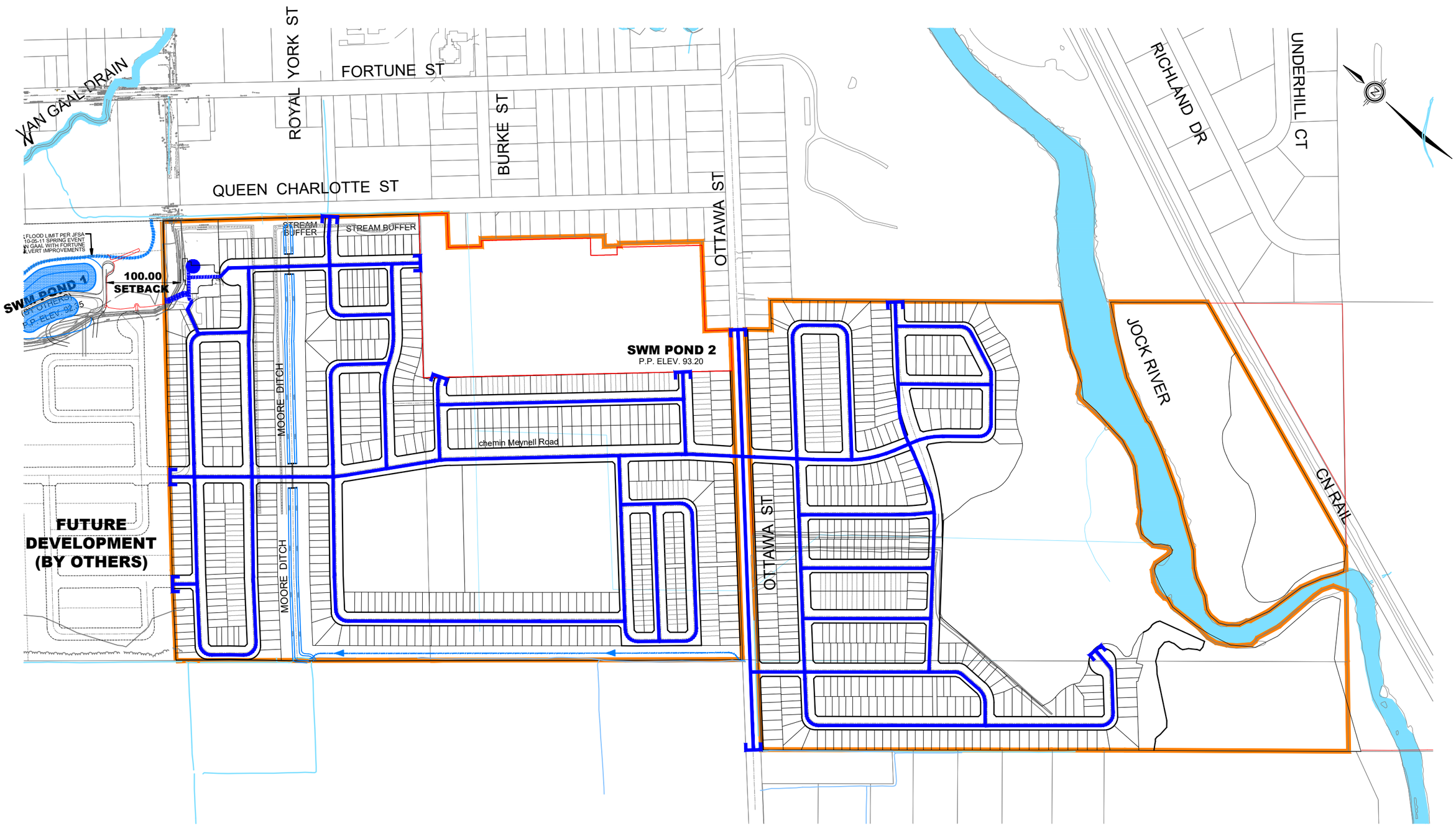
MATTAMY - VILLAGE OF RICHMOND
WESTERN DEVELOPMENT LANDS

DRAFT PLAN

CITY OF OTTAWA

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:5000
FIGURE:	4



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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

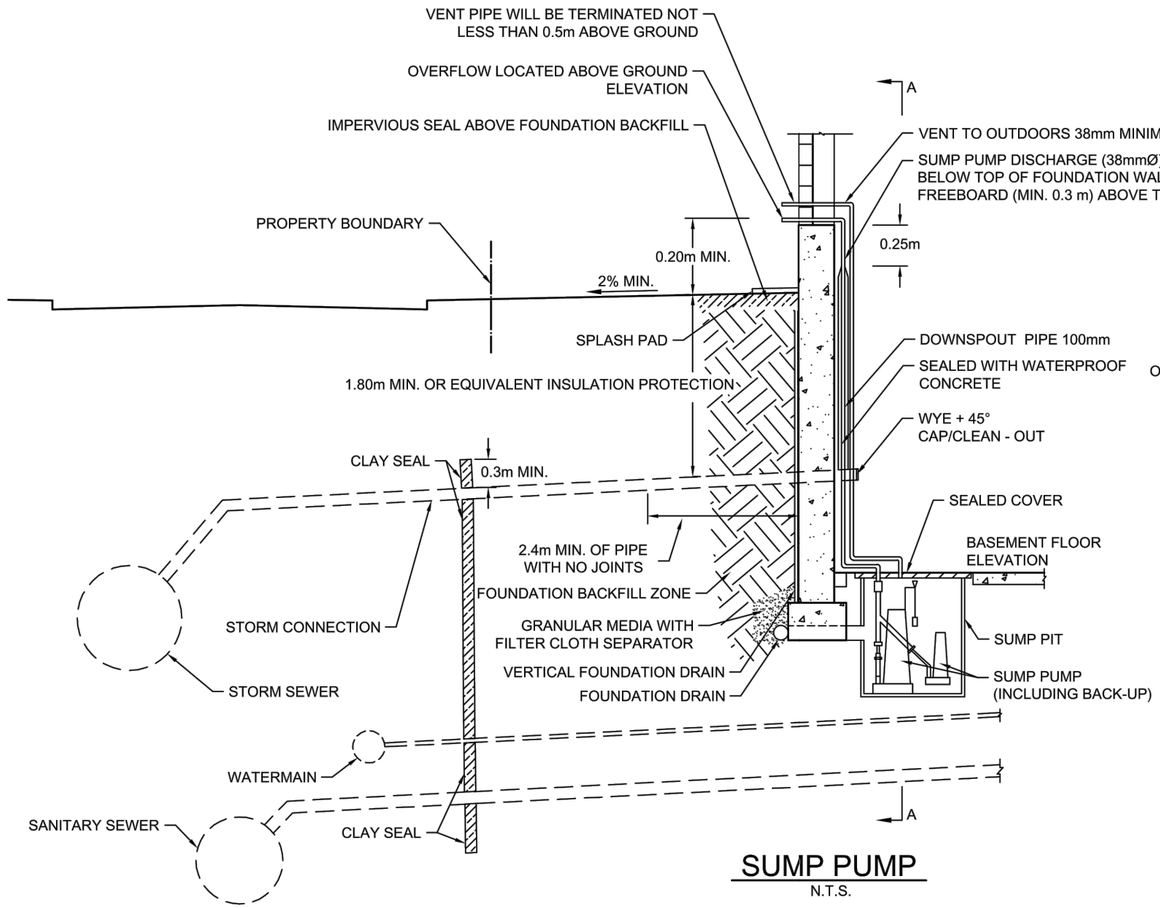
CONCEPTUAL WATERMAIN

CITY OF OTTAWA

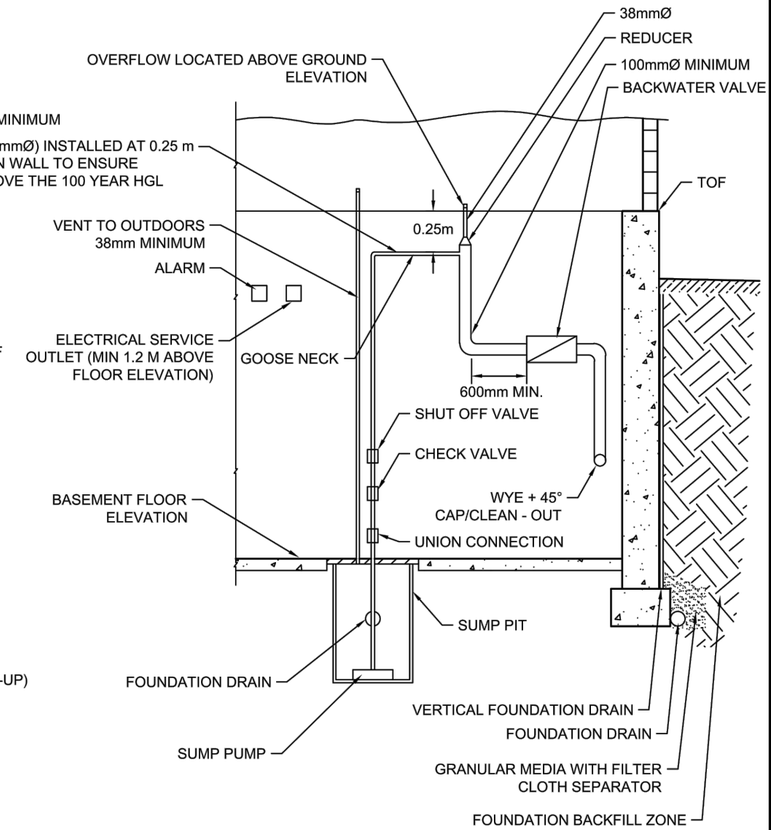
LEGEND

- SITE BOUNDARY
- LOCAL WATERMAIN
- EXISTING WATERMAIN
- COMMUNAL WELL
- PLUG

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:5000
FIGURE:	5



SUMP PUMP
N.T.S.



SECTION A-A
N.T.S.

NOTES:
1. WORKS TO BE COMPLETED IN ACCORDANCE WITH CITY OF OTTAWA STANDARDS, POLICIES AND GUIDELINES.
2. PRIMARY DISCHARGE TO STORM SEWER WITH OVERFLOW TO GRADE, AS INDICATED.
3. SERVICE TRENCH WILL HAVE CLAY SEAL TO PREVENT GROUNDWATER FLOW THROUGH SERVICE TRENCH TO FOUNDATION.
4. INSULATION DETAIL MUST BE PROVIDED BY PROFESSIONAL ENGINEER.
5. BACKWATER VALVE TO BE CSA APPROVED COMPLETE WITH ADEQUATE SUPPORT FOR PIPING.
6. REFER TO GUIDELINES FOR SUMP PIT LOCATION.
7. IMPERVIOUS SEAL TO EXTEND BEYOND THE LINE OF EXCAVATION, SLOPED AWAY FROM BUILDING A MINIMUM OF 2% AFTER SETTLING OF BACKFILL. SEAL CAN BE CLAY, OR A MEMBRANE OR LOW-PERMEABILITY INSULATION BOARD PLACED JUST BELOW GROUND.
8. FILL PLACED IN SERVICE TRENCH MUST BE COMPACTED TO AT LEAST 98% OF ITS STANDARD PROCTOR MAXIMUM DRY DENSITY.
9. FOUNDATION BACKFILL ZONE WILL CONSIST OF CLAY WITH A MINIMUM HORIZONTAL WIDTH OF 1.5m.
10. VERTICAL FOUNDATION DRAINS ARE REQUIRED ON THE PERIMETER OF THE FOUNDATION.
11. EVERY SERVICE TRENCH REQUIRES CLAY SEAL AS PER CITY STANDARD S8. CLAY SEAL TO EXTEND A MINIMUM 0.3m ABOVE THE OBVERT OF THE STORM SERVICE PIPE.

Ottawa

STANDARD SUMP PUMP CONFIGURATION
GREENFIELD SUBDIVISIONS WITH CLAY SOILS
AND FULL MUNICIPAL SERVICES

DATE:	JUNE 2018
REV. DATE:	JUNE 2018
DWG. No.:	P 01

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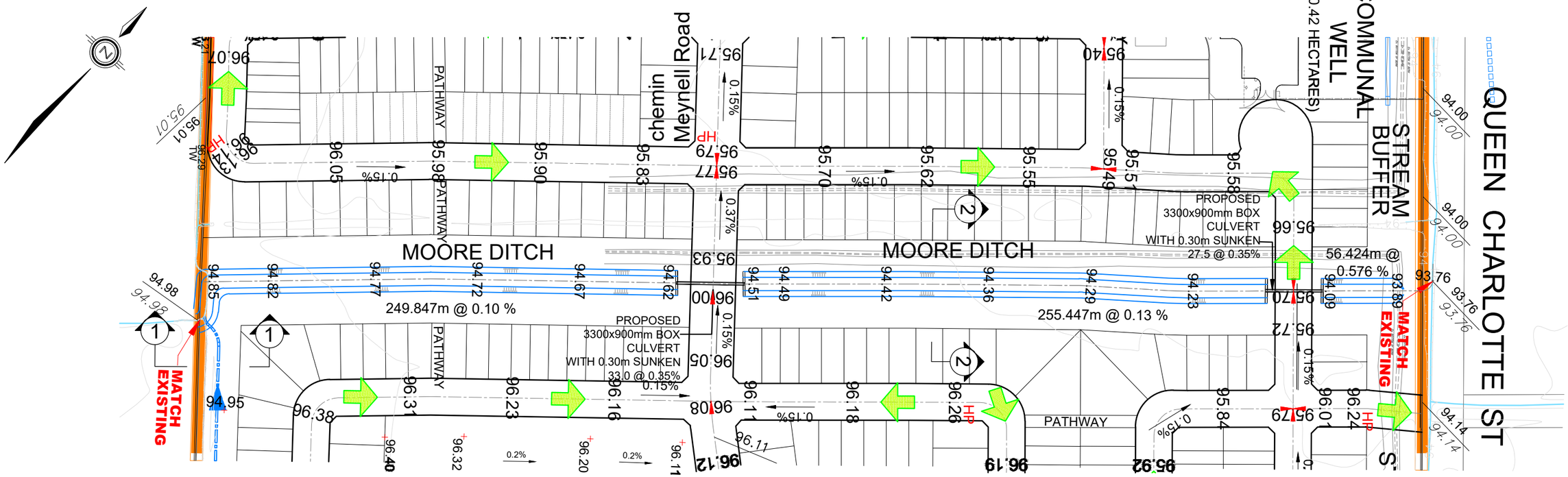
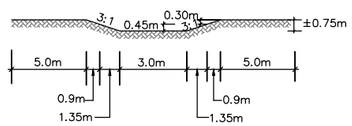
WESTERN DEVELOPMENT LANDS

SUMP PUMP DETAIL

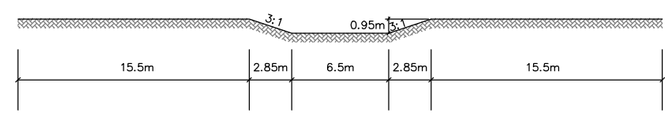
CITY OF OTTAWA

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	N.T.S.
FIGURE:	6

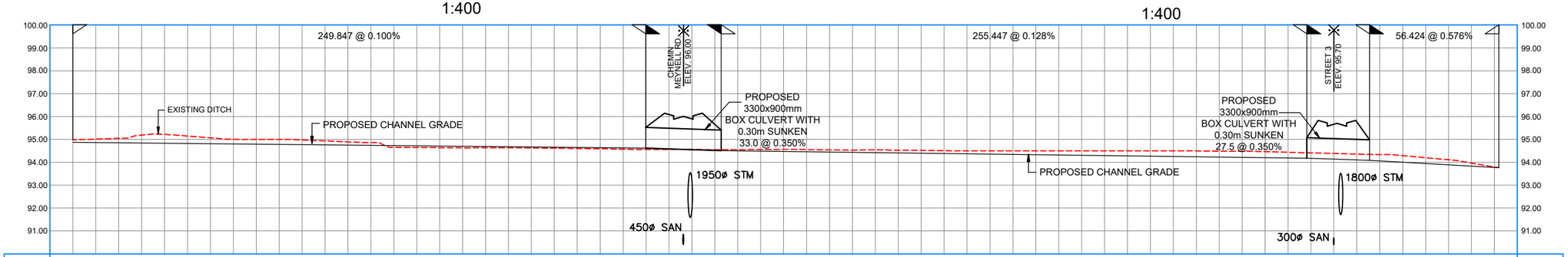




TYPICAL CHANNEL CROSS SECTION 1-1
1:400



TYPICAL CHANNEL CROSS SECTION 2-2
1:400



CENTERLINE CHAINAGE	PROPOSED DITCH ELEVATION
0+000.000	94.873
0+020.000	94.853
0+040.000	94.833
0+060.000	94.813
0+080.000	94.793
0+100.000	94.773
0+120.000	94.753
0+140.000	94.733
0+160.000	94.713
0+180.000	94.693
0+200.000	94.673
0+220.000	94.653
0+240.000	94.633
0+249.847	94.623
0+260.000	94.588
0+280.000	94.518
0+282.780	94.508
0+300.000	94.486
0+320.000	94.460
0+340.000	94.435
0+360.000	94.409
0+380.000	94.383
0+400.000	94.357
0+420.000	94.332
0+440.000	94.306
0+460.000	94.280
0+480.000	94.255
0+500.000	94.229
0+520.000	94.203
0+538.227	94.180
0+540.000	94.174
0+560.000	94.104
0+565.552	94.085
0+580.000	94.022
0+600.000	93.887
0+620.000	93.771
0+621.976	93.760

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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

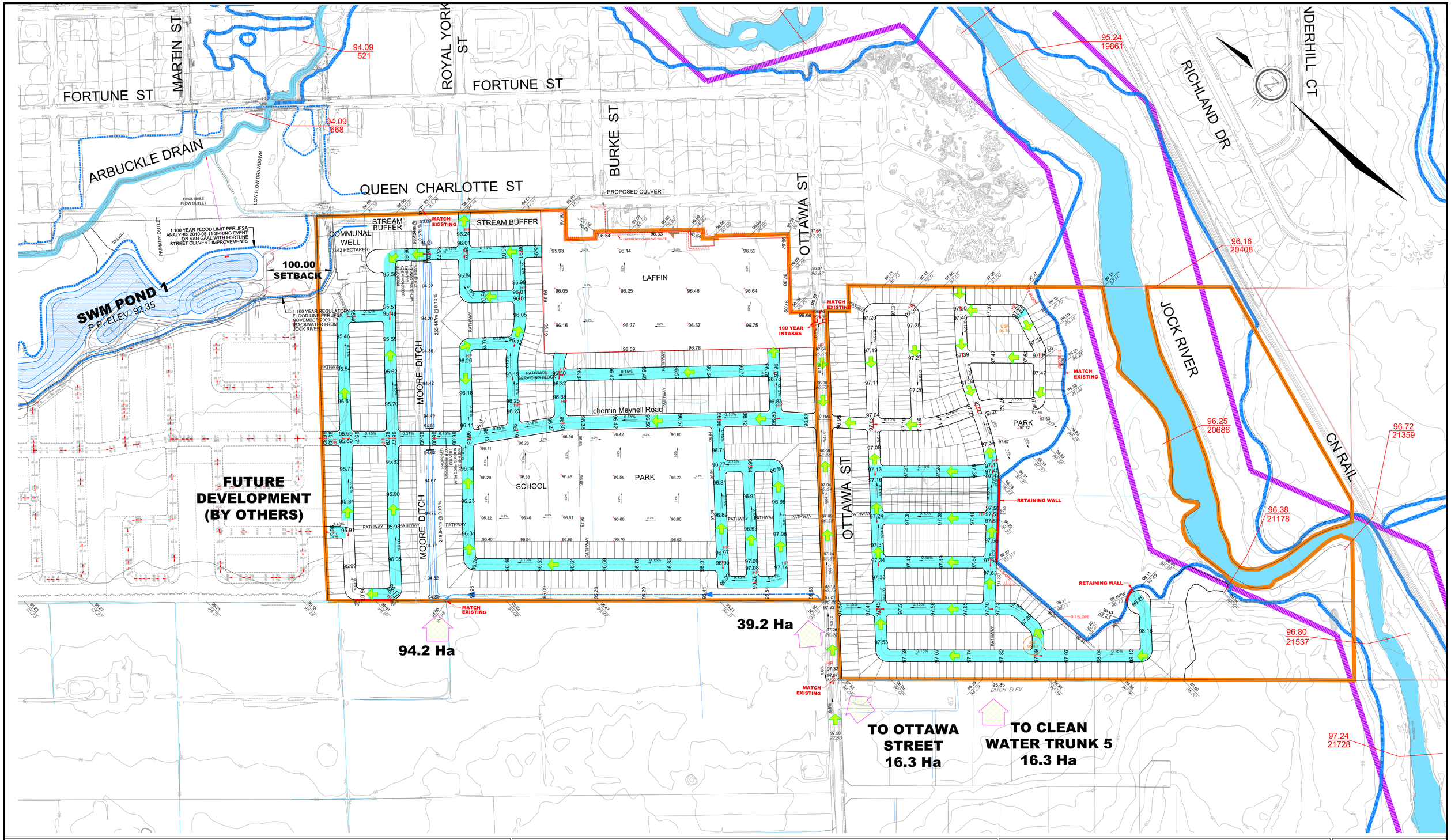
MOORE TRIBUTARY - PLAN PROFILE

CITY OF OTTAWA

LEGEND
- STUDY LIMIT
- REGULATORY FLOOD LINE
- OVERLAND FLOW DIRECTION
- EXISTING DITCH
- 95.00 EXISTING ELEVATION CONTOUR

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:2000
FIGURE:	7

Drawings



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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

GRADING PLAN

CITY OF OTTAWA

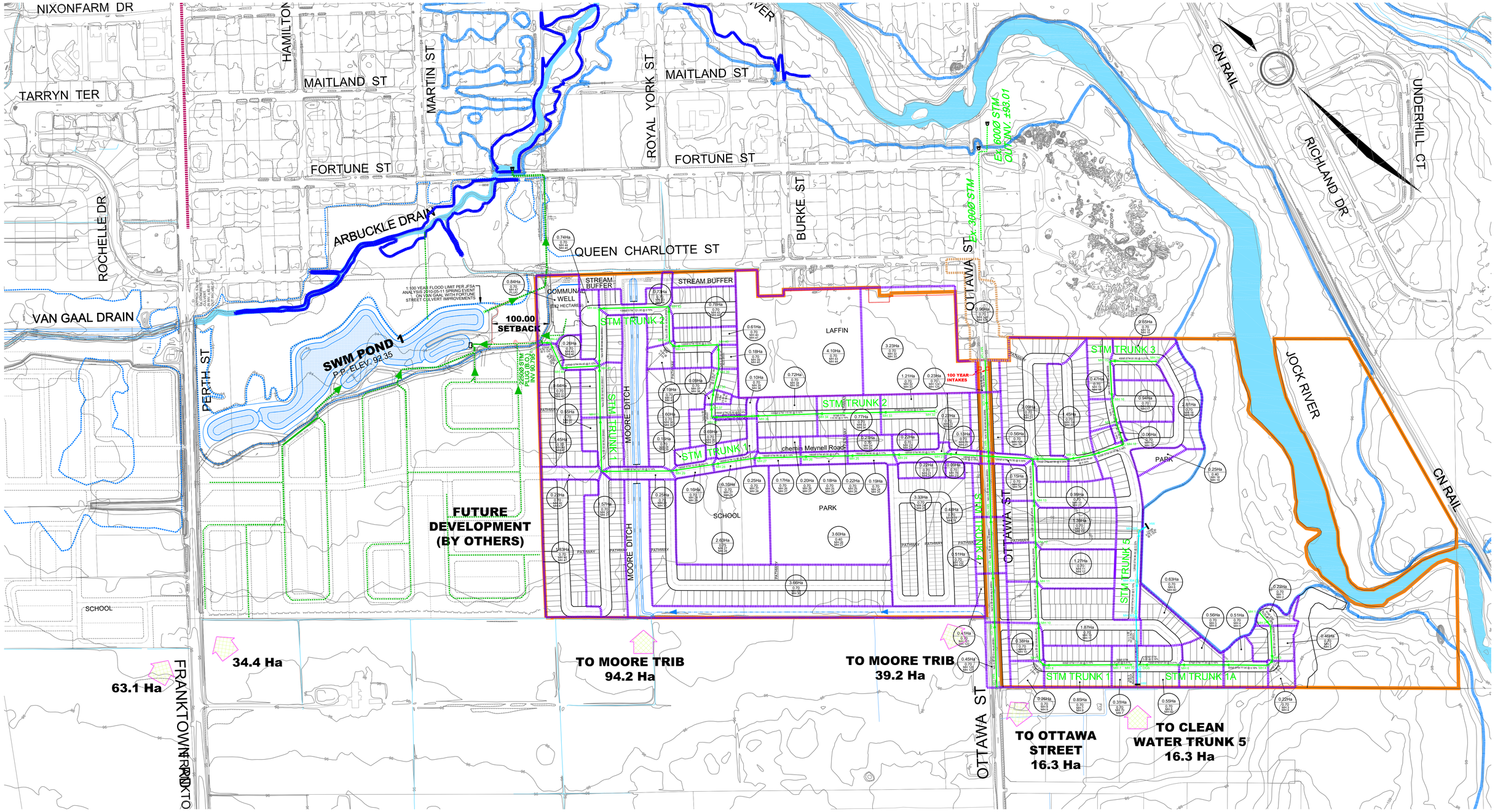
LEGEND

- STUDY LIMIT
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR
- MAJOR OVERLAND FLOW
- EXTERNAL DRAINAGE
- 1:100 YEAR REGULATORY FLOOD LINE PER JFSA NOVEMBER 2009 (BACKWATER FROM JOCK RIVER)

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)	FILL DEPTH (m)
0 - 1	0 - 1
1 - 2	1 - 2
2 - 3	2 - 3

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:2500
DRAWING:	1



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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

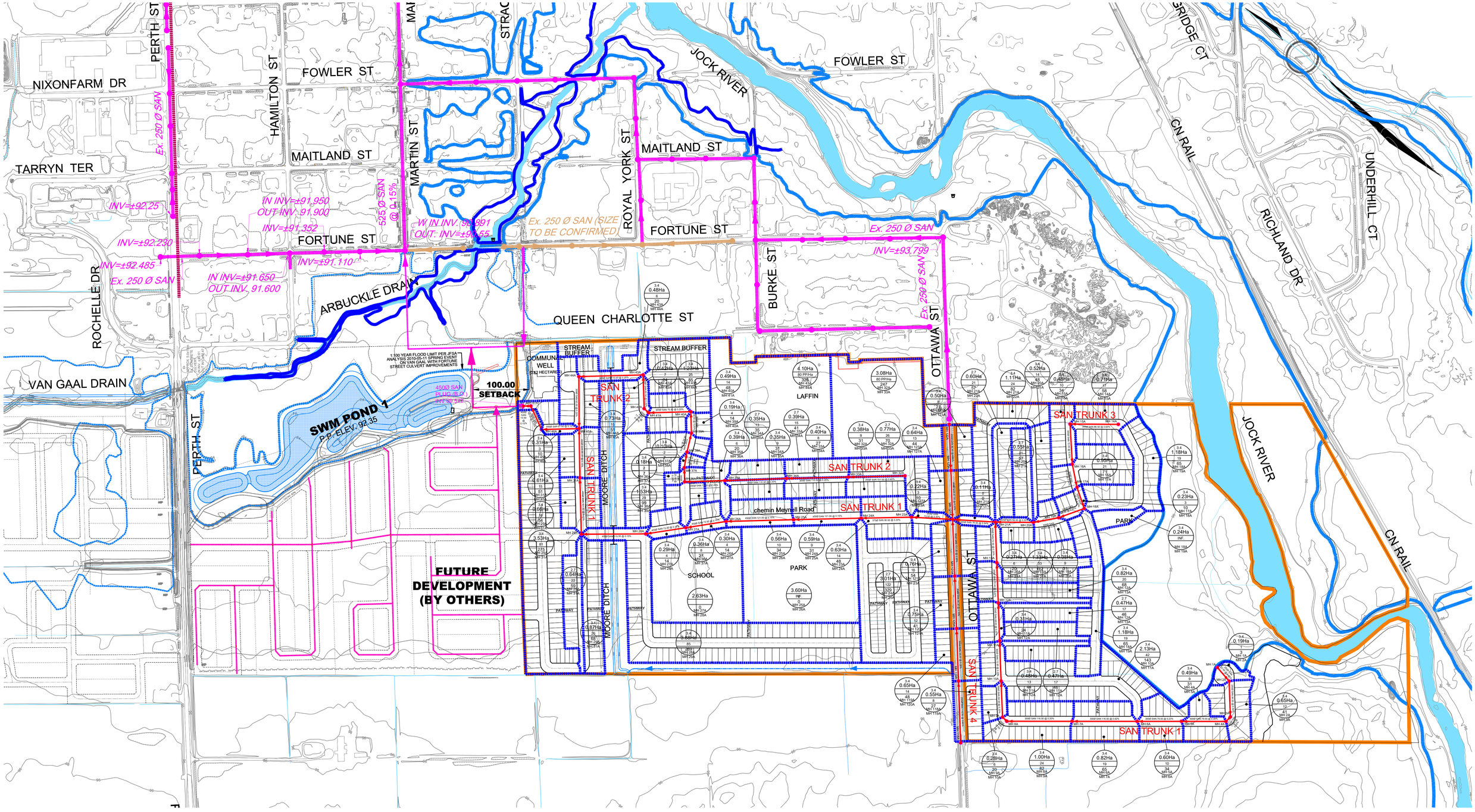
STORM SERVICING PLAN

CITY OF OTTAWA

LEGEND

- STUDY LIMIT
- EXISTING DITCH
- STORM TRIBUTARY AREA
- STORM TRUNK
- LOCAL STORM SEWER
- EXISTING STORM TRUNK
- STORM TRUNK BY OTHERS
- 1:100 YEAR REGULATORY FLOOD LINE PER JFSA NOVEMBER 2009 (BACKWATER FROM JOCK RIVER)
- 8.26Ha / 0.62 — DRAINAGE AREA / IMPERVIOUSNESS
- OVERLAND FLOW ROUTE
- EXTERNAL DRAINAGE
- CLEAN WATER PIPE
- 100 YEAR INTAKE AREA

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:3000
DRAWING:	2



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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

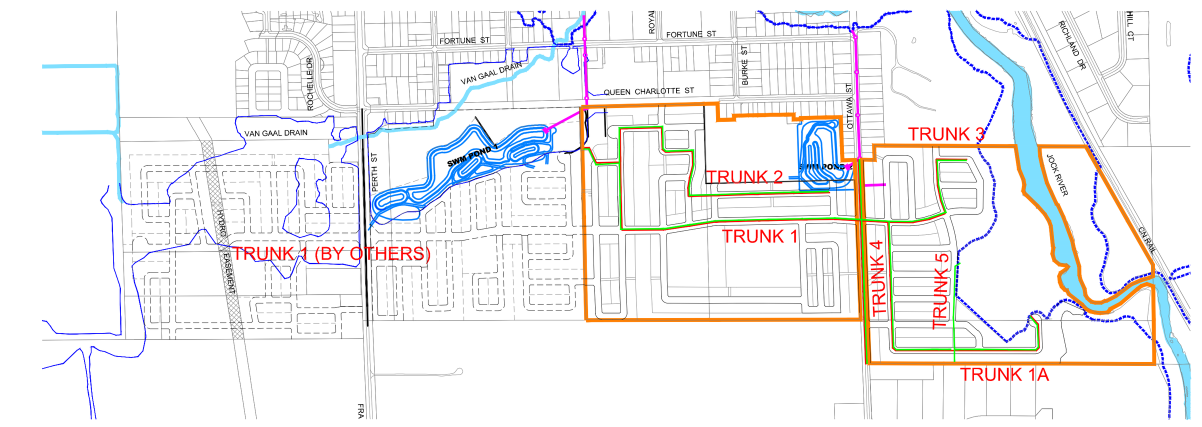
SANITARY SERVICING PLAN

CITY OF OTTAWA

LEGEND

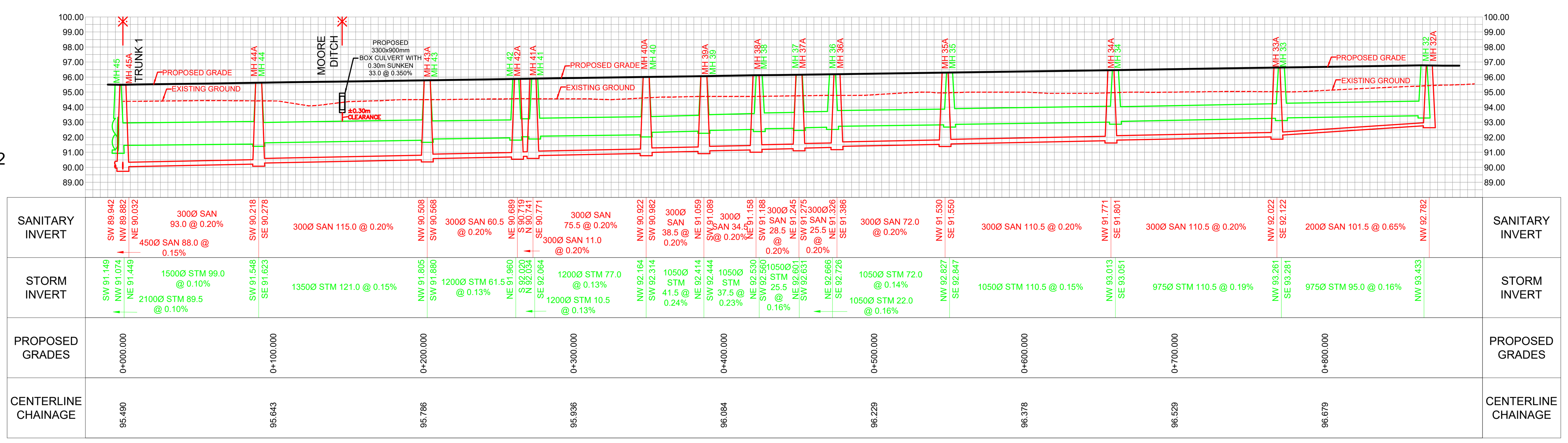
- STUDY LIMIT
- POPULATION PER UNIT / SANITARY DRAINAGE AREA / NUMBER OF UNITS / TOTAL POPULATION / UPSTREAM/DOWNSTREAM MANHOLE (e.g. 1.63Ha, 60, 98)
- EXISTING SANITARY SEWER
- SANITARY SEWER BY OTHERS
- SANITARY DRAINAGE BOUNDARY
- PROPOSED SANITARY TRUNK
- PROPOSED SANITARY SEWER

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:3000
DRAWING:	3

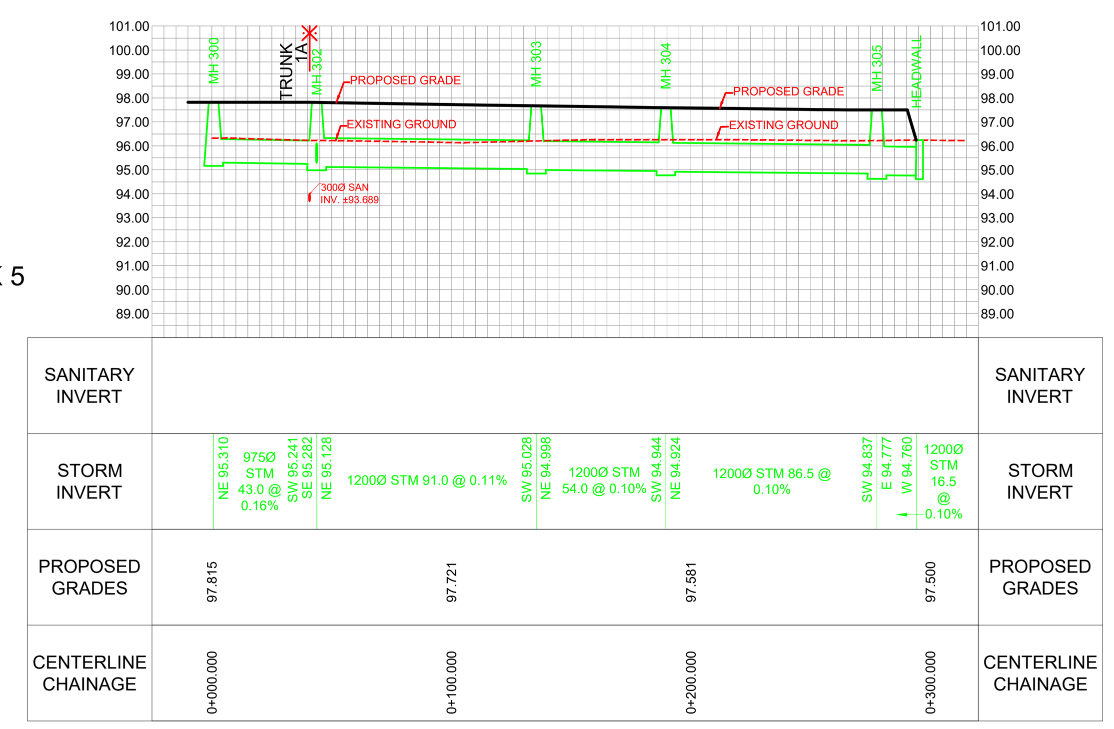


PROFILES KEYPLAN SCALE: 1:8000

TRUNK 2

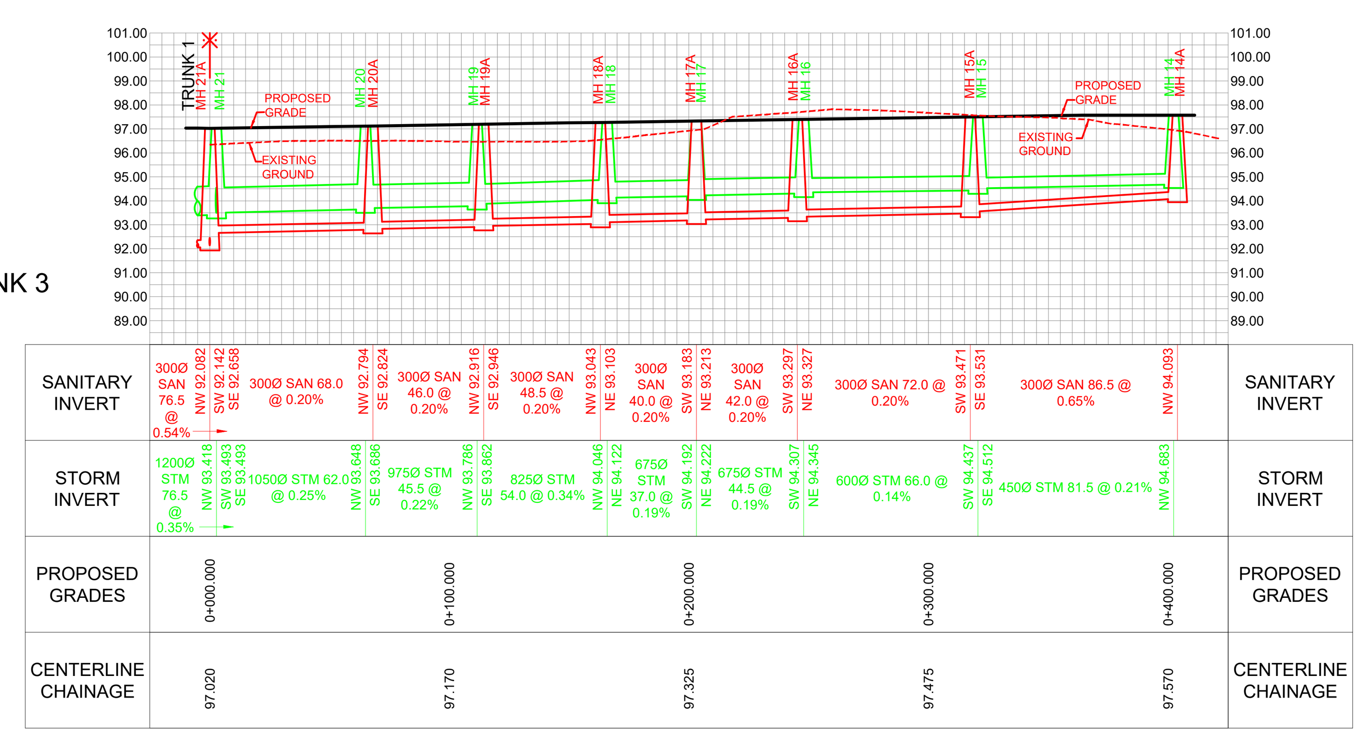


TRUNK 5

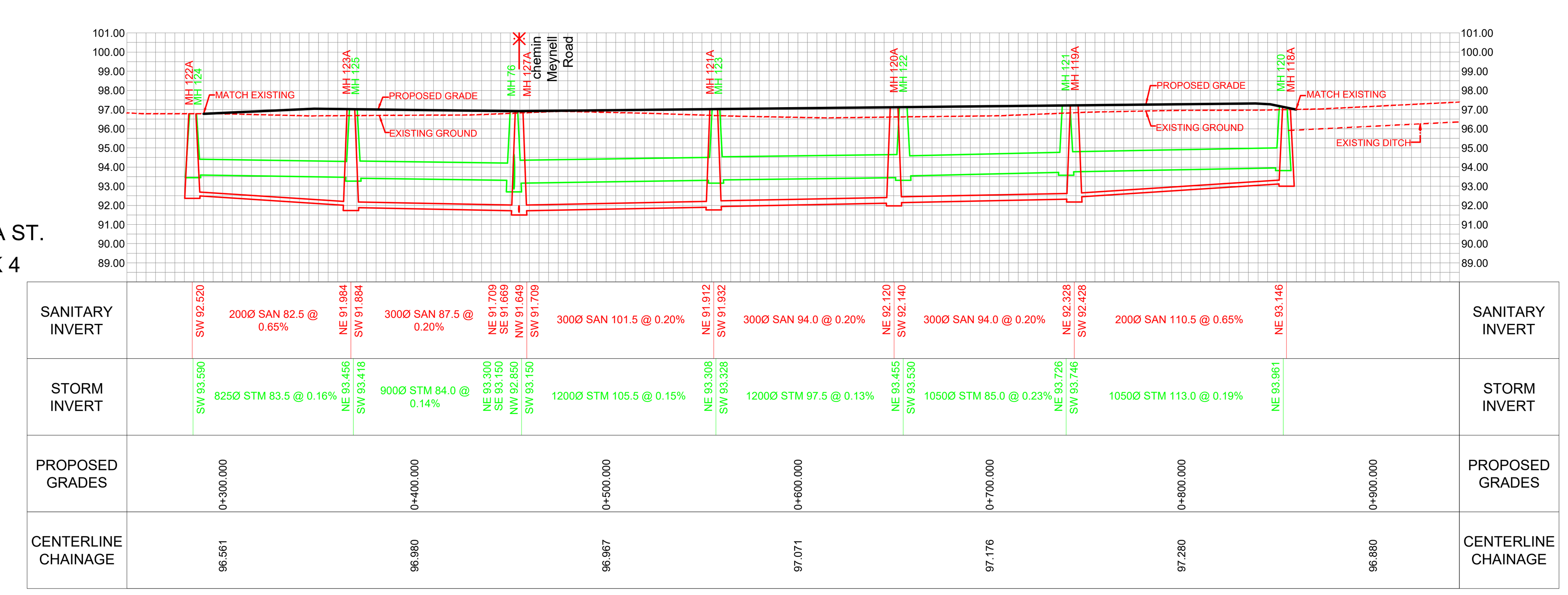


TRUNK 1/1A

TRUNK 3



OTTAWA ST.
TRUNK 4



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MATTAMY - VILLAGE OF RICHMOND WESTERN DEVELOPMENT LANDS

STORM AND SANITARY SERVICING PROFILES

CITY OF OTTAWA

PROJECT No.:	17-977
DATE:	January 2019
SCALE:	1:2500
DRAWING:	4