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FUNCTIONAL SERVICING REPORT

FOR THE

TAMARACK (RICHMOND EAST) CORPORATION LANDS

CITY OF OTTAWA

PROJECT NO.: 19-1042

NOVEMBER 12, 2020
1ST SUBMISSION

**FUNCTIONAL SERVICING REPORT
FOR THE**

**TAMARACK (RICHMOND EAST) CORPORATION LANDS
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1.0 INTRODUCTION

Tamarack (Richmond East) Corporation have retained David Schaeffer Engineering Ltd. (DSEL) to prepare a Functional Servicing Report (FSR) in support of their applications for Draft Plan of Subdivision and Zoning By-law Amendment for 6012 Ottawa Street, which is referred to as the Tamarack Richmond Lands in this report.

The Tamarack Richmond Lands are located south of Ottawa Street, Marlborough Creek (Richmond By-Pass Drain) and an existing high-speed railway corridor, between McBean Street and Eagleson Road, in the Village of Richmond as depicted on ***Figure 1F – Key Plan***. The subject site is approximately 67 hectares and is proposed to be comprised of Residential, Institutional (School), Parks, Open Space, a Stormwater Management (SWM) Pond and Commercial (Employment Land), as depicted on ***Figure 2F – Concept Plan.*** The internal road network will consist of a mix of proposed 16.5 m, 20 m and 24 m rights-of-way (ROW). A new east-west connection between McBean Street and Eagleson Road through the subject lands is introduced in the plan.

The subject site, formerly identified as the Southeast Development Lands, was previously zoned for industrial development; however, Official Plan Amendment (OPA) 150 amended the Village of Richmond Secondary Plan (in Volume 2C of the Official Plan) to re-designate a portion of the Tamarack Richmond Lands from ‘Industrial Area’ to ‘Residential Area – One and Two Unit’ and ‘Village Commercial’ as illustrated on ***Schedule A – Land Use*** from the Richmond Secondary Plan, enclosed in ***Appendix A***. The OPA requires that at least 18.5 net hectares of employment land (i.e. lands designated ‘Industrial 1’) be retained.

The current concept plan contemplates 18.69 hectares of ’Industrial 1’ (employment land), which exceeds the requirement stipulated in the OPA.

Refer to ***Table 1*** for the projected land uses and development statistics.

Table 1: Development Statistic Projections

Land Use	Total Area (ha)*	Projected Population **
Residential	21.99	3249
Industrial 1 (Employment Land)	18.69	
Parks	3.11	
School	2.90	
Open Space	0.16	
SWM Pond	3.82	
Marlborough Creek (Richmond By-Pass Drain) (+30m Setback)	4.51	
Roads (16.5m, 20m, 24m ROW)	11.80	
Total	**66.98**	**3249**

* Derived from preliminary draft plan of subdivision prepared by Annis, O'Sullivan, Vollebekk Ltd.
** Based on preliminary concept plans prepared by WND Associates, Planning and Urban Design.

This FSR is provided to describe serviceability with the design criteria of the City of Ottawa, background studies and general industry practice.

1.1 Existing Conditions / Constraints

The subject site is a Greenfield Site within the Village of Richmond, with existing grades varying between 93.0 m and 98.0 m. A preliminary geotechnical investigation was undertaken in December 2018 with supplemental investigations conducted in February 2019 with the results and recommendations documented in the ***Geotechnical Investigation*** (Paterson Group, April 4, 2019). Generally, the subsurface profile consists of a layer of topsoil followed by a layer of loose to dense brown silty sand and/or very stiff to firm silty clay to clayey silt deposit. Glacial till consisting of a silty sand with gravel, cobbles and boulders was encountered below the above noted layers. Overburden drift thickness over existing bedrock is expected to range from 1 to 10 m depth.

There is an existing tributary to Marlborough Creek (Richmond By-Pass Drain) which currently bisects the site and is referred to as Reach 4. It was identified in the ***Headwater Drainage Feature Assessment*** (Kilgour & Associates, August 8, 2019) that the tributary could be removed, but had to be replaced by a feature that replicated or augmented its functionality. The ***HDFA*** references several other minor drains throughout the site, but they are not considered significant and do not require compensation. Infilling of any of the existing drainage features is subject to approvals from the appropriate agencies

There are several adjacent parcels of land that currently drain through the subject site before ultimately discharging to Marlborough Creek (Richmond By-Pass Drain). Refer to ***Drawing 2D – Pre-Development Storm Drainage Plan*** for the external areas and existing drainage patterns.

Marlborough Creek (Richmond By-Pass Drain), which drains to the Jock River, traverses the northern boundary of the site, south of an existing high-speed railway corridor and existing properties fronting onto Ottawa Street, and there is associated flood plain with this feature.

The subject site is located within the Jock River Subwatershed (Reach 2), which is under the jurisdiction of the Rideau Valley Conservation Authority (RVCA).

1.2 Summary of Pre-Consultation

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

1.2.1 City of Ottawa

A pre-consultation meeting was held on July 24, 2018 with input provided by various stakeholders. The notes from the meeting are included in ***Appendix A***.

1.2.2 Ministry of the Environment, Conservation and Parks (MECP)

Environmental Compliance Approvals (ECA) will be required for storm and sanitary sewers and the proposed stormwater management pond and outlet to the existing Marlborough Creek (Richmond By-Pass Drain). The proposed works will be approved through the MECP Transfer of Review program with the City of Ottawa. Pre-consultation, if required, will be forthcoming.

MECP approval will also be required for any work pertaining to the existing King's Park Communal Well and Caivan Communal Well (Richmond West Pumping Station) as well as any expansion of the Richmond Pump Station (RPS). These approvals will require coordination with the City of Ottawa and other stakeholders.

1.2.3 Rideau Valley Conservation Authority (RVCA)

The RVCA was present at the pre-consultation meeting held on July 24, 2018 and their comments are documented in ***Appendix A***. Approval will be required from the RVCA for any works related to the regulatory flood plain and alterations to watercourses. RVCA approval will also be required for a new stormwater management outlet to the existing Marlborough Creek (Richmond By-Pass Drain).

1.2.4 Department of Fisheries and Oceans Canada (DFO)

As Marlborough Creek is the only fish bearing feature with the Tamarack Richmond Lands and it is not subject to any alterations or disturbance within 30 m of its riparian corridor, no permits or consultation with Fisheries and Oceans Canada (DFO) are required per the ***Environmental Impact Statement*** (Kilgour & Associates, January 14, 2020).

1.3 Required Permits / Approvals

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, including any required upgrades to existing sewers.	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, including any required upgrades to existing sewers.	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)	Environmental Compliance Approval for Stormwater Management Pond	Construction of stormwater management pond and outlet to the Marlborough Creek (Richmond By-Pass Drain)	The ECA application for the stormwater management pond will be processed by the City of Ottawa through the transfer of review program and sent to the MECP for final approval.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval for upgrades to the existing King's Park Communal Well and Caivan Communal Well (Richmond West Pumping Station)	System upgrades to provide reliability to service the proposed development	The ECA application for the communal well upgrades will be coordinated with the City of Ottawa and sent to the MECP for final approval.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval for upgrades to the existing Richmond Sanitary Pump Station	System upgrades to provide sanitary servicing for the proposed development	The ECA application for the pump station upgrades will be coordinated with the City of Ottawa and sent to the MECP for final approval.

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 new outlet to the Marlborough Creek (Richmond By-Pass Drain).	Construction of the stormwater management pond.	Authorization related to the construction of a new outlet to the Marlborough Creek (Richmond By-Pass Drain).
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 decommissioning of Reach 4.	Decommissioning of existing Reach 4.	Authorization related to the relocation and design of existing Reach 4 per the HDFA (must be replaced by feature that replicates or augments functionality) and the closure of the other existing tributaries. An application has been submitted to the RVCA.

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)
    - Technical Bulletin ISTB-2019-02
      City of Ottawa, July 8, 2019
      (ISTB-2019-02)
- 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)

➢ 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)

➢ Development Opportunity – Southeast Development Lands, Village of Richmond
Novatech Engineers, Planners & Landscape Architects
(Novatech Report)

➢ Geotechnical Investigation, Proposed Mixed-Used Development
Paterson Group Inc., April 4, 2019
(Geotechnical Investigation)

➢ Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing
Stantec, April 5, 2019
(Water Analysis)

➢ Headwater Drainage Feature Assessment
Kilgour & Associates, August 8, 2019
(HDFA)

➢ Environmental Impact Statement for the Proposed Development of 6012 Ottawa Street Area
Kilgour & Associates, January 14, 2020
(EIS)

3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

Existing developed areas in Richmond are serviced primarily by private individual wells, with the exception of King's Park, a small private system in the north and the Western Development Lands, located west of Fortune Street. Refer to ***Figure 4F – Watermain Servicing Plan*** for the location of the existing King's Park Communal Well and Caivan Communal Well (Richmond West Pumping Station), relative to the subject lands.

In 2011, Stantec completed a Water & Sanitary Master Servicing Study (***MSS***) for the Village of Richmond. The ***MSS*** provided recommendations for long-term servicing requirements for existing and future potential development within the Village. It was determined though the MSS process that the preferred alternative was a new public communal well system, where water would be pumped from a deep aquifer to provide servicing for potential growth areas in the western part of the Village (Western Development Lands), and through a phased approach and system expansions, supply all demand in the entire Village (existing and future) as the need arises in the future.

As noted above, since the 2011 MSS, the communal well has been commissioned within the Western Development Lands. Upgrades to the King's Park well's electrical and SCADA systems have been completed.

3.2 Proposed Water Supply

It is proposed that the site will be serviced through connections to existing communal wells. A preliminary analysis was undertaken for the subject site with respect to the water supply alternatives. The ***Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives***, prepared by Stantec on April 5, 2019 ***(Water Analysis)*** is enclosed in ***Appendix B*** of this report.

Per the ***Water Analysis***, the recommended alternative to service the subject site in the is to provide a single feed from the Caivan Communal Well (Richmond West Pumping Station) and to provide a connection to the King's Park Communal Well System. The proposed watermain connection to the King's Park Communal Well will cross the existing Marlborough Creek (Richmond By-Pass Drain), along Ottawa Street and connect to the existing 300 mm watermain on King Street. The proposed watermain connection to the Caivan Communal Well (Richmond West Pumping Station) will extend down McBean Street to Ottawa Street, crossing the existing Jock River to Fortune Street, Strachan Street and connecting to the existing building. Refer to ***Figure 1F – Watermain Servicing Plan*** for the detailed layout. A detailed hydraulic analysis will be prepared to support the recommended water servicing alternative.

The site will be serviced by an internal watermain distribution network, which will be looped to the extended trunks. The ***Water Supply Guidelines,*** which will be used to design the water distribution system, are summarized in ***Table 3***.

Table 3: Water Supply Design Criteria

Design Parameter	Value
Residential - Single Family	3.4 p/unit
Residential - Townhome	2.7 p/unit
Residential – Average Daily Demand	280 L/p/day
Residential - Maximum Daily Demand	2.5 x Average Daily Demand
Residential - Maximum Hourly Demand	2.2 x Maximum Daily Demand
Residential – Minimum Hourly Demand	0.5 x Average Daily Demand
Commercial / Institutional Average Daily Demand	28,000 L/gross ha/day
Park Average Daily Demand	9,300 L/ha/day
Commercial / Institutional / Park Maximum Daily Demand	1.5 x Average Daily Demand
Commercial / Institutional / Park Maximum Hour Demand	1.8 x Maximum Daily Demand
Commercial / Institutional / Park Minimum Hour Demand	0.5 x Average Daily Demand
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	275 kPa and 690 kPa
Fire flow operating pressure minimum	140 kPa
Extracted from Section 4: Ottawa Design Guidelines, Water Distribution (July 2010) and all relevant Technical Bulletins	

A complete hydraulic analysis will be prepared for the proposed water distribution network at the time of detailed design 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. The proposed water supply design will conform to all applicable guidelines and policies.

3.3 MSS Conformance

As noted in the ***MSS***, the subject lands are to be serviced by one of three methods, as follows:

- Private wells; or
- New communal wells; or
- Connect to expanded King's Park Communal Well system.

Refer to "Service Area 4" on ***Figure 7-1 Communal Water Supply Alternative Service Areas***, enclosed in ***Appendix B***.

The ***MSS*** provided recommendations for long-term servicing requirements for existing and future potential development within the Village of Richmond. Through the process, it was determined that the preferred alternative was a new public communal well system, where water would be pumped from a deep aquifer to provide servicing for potential growth areas in the western part of the Village (Western Development Lands), and through a phased approach and system expansions, supply all demand in the entire Village (existing and future) as the need arises in the future.

Proposing to service the site by connecting to the Caivan Communal Well (Richmond West Pumping Station) and the King's Park Communal Well System presents conformance to the ***MSS***.

3.4 Water Supply Conclusion

The conceptual watermain design includes single feed connections to the King's Park Communal Well and Caivan Communal Well (Richmond West Pumping Station) involving a number of off-site watermains and watercourse crossings. The site will be serviced by an internal watermain network which will be looped to the extended trunks and will be sized to meet all required pressure requirements under City of Ottawa guidelines.

A complete hydraulic analysis will be prepared for the proposed water distribution network at the time of detailed design 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.

The proposed water servicing design conforms to the MSS as the connection to the existing communal well system, where water is pumped from a deep aquifer, was recommended in the ***MSS***.

The detailed water supply design will conform to all relevant City guidelines and policies.

4.0 WASTEWATER SERVICING

4.1 Existing Wastewater Services

The sanitary outlet for the subject site is the Richmond Pump Station (RPS), located approximately 600 m north of the site, at the intersection of Cockburn Street and Royal York Street.

The RPS discharges to the City of Ottawa's central wastewater collection system in Kanata via a discharge forcemain as noted in the ***MSS***. The existing 250 mm and 300 mm diameter sanitary sewers on King Street and Royal York Street are identified in the ***MSS*** as the preferred route to provide servicing capacity for the subject site. Refer to the As-Built Drawing 1167-1 for the Richmond Sewage Pumping Station Site Plan by Kostuch Engineering Limited dated September 28, 1983, enclosed in ***Appendix C***, for the layout of the RPS.

The proposed connection point for the sanitary sewer network is at existing MH 6091A, located at the intersection of King Street and Ottawa Street.

Refer to ***Figure 5F – External Sanitary Servicing Plan*** and ***Drawing 1D – Sanitary Servicing Plan*** for the location of the existing RPS and sanitary sewers.

4.2 Wastewater Design

As noted in the ***MSS***, the following is required for sanitary servicing:

- The existing King Street and Royal York sewers are not large enough or deep enough to service the subject site; therefore, a new trunk sewer along this route will be required;
- Expansion of the existing Richmond Pump Station;
- Repairs to the existing 500 mm diameter forcemain; and
- New 600 mm diameter forcemain from Richmond and the City's central collection system for redundancy.

The proposed outlet for the subject site is via Ottawa Street, King Street and Royal York Street to the existing RPS, as shown on ***Figure 5F – External Sanitary Servicing Plan.*** As noted above, the existing King Street and Royal York sewers are not large enough or deep enough to service the subject site. The following describes the proposed external sanitary servicing:

- Proposed 450 mm diameter sanitary trunk from the site along Ottawa Street from MH 114A to existing MH 6091A (to be replaced) at the intersection of Ottawa Street and King Street;
- Proposed replacement of existing 250 mm and 300mm diameter sanitary sewers on King Street and Royal York Street with a lowered 525 mm diameter sanitary trunk sewer from existing MH 6091A to existing MH 43672A near the RPS; and

- Proposed connection to the RPS from MH 43672A to MH 1001A to the RPS, which is 600 mm in diameter.

In order to connect to existing sanitary sewers on King Street, a sanitary sewer crossing existing Marlborough Creek (Richmond By-Pass Drain) will be required. Refer to ***Drawings 5D, 6D and 7D – Profiles*** showing the existing Marlborough Creek (Richmond By-Pass Drain), culvert crossing Ottawa Street and proposed sanitary sewer network.

Refer to ***Drawing 1D – Sanitary Servicing Plan*** and ***Figure 5F – External Sanitary Servicing Plan*** for a depiction of the required wastewater servicing works. The drainage area plans which correspond to the sanitary design sheets are presented on these plans. The sanitary sewer design sheets are included in ***Appendix C*** for reference.

The ***Sewer Design Guidelines*** used in the preliminary design are summarized in ***Table 4***.

Table 4: Wastewater Design Criteria

Design Parameter	Value
Residential - Single Family	3.4 persons/unit
Residential – Semi-Detached Home / 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
Commercial / Institutional – Average Flow	28,000 L/ha/day
Commercial / 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
Service Lateral Size	135 mm diameter PVC SDR 28 with a minimum slope of 1.0%
Minimum Depth of Cover	2.5 m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6 m/s
Maximum Full Flowing Velocity	3.0 m/s
Additional Considerations	Sewers servicing less than 10 residential connections to have a minimum gradient of 0.65%
	Where expected depth of flow is less than 1/3 pipe diameter, calculate actual flowing velocity and increase slope as required to achieve 0.6 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 proposed sanitary sewer upgrades along King Street and Royal York Street are designed to service the Tamarack Richmond Lands, and existing external areas tributary to the sanitary sewer network. The existing external areas are depicted on ***Figure 5F – External Sanitary Servicing Plan*** and were established based on the ***MSS***. The total existing external areas and populations presented in the current design were based on the sums of existing and future residential presented in the MSS Design Sheets, contained in ***Appendix C*** for reference.

The projected peak flow from the Tamarack Richmond Lands based on the current City of Ottawa Standards referenced in ***Table 4*** is ***61.23 L/s*** at existing MH 6091A (to be replaced). The projected flow from the Tamarack Richmond Lands and all external areas to the RPS is ***341.03 L/s*** at existing MH 1001A.

As noted in the ***MSS,*** upgrades to the existing RPS and forcemains will be required to secure capacity for the Tamarack Richmond Lands. However, the expansion process is currently underway with the City of Ottawa and MECP and it is anticipated that there will be sufficient capacity for the proposed development at the time of construction.

4.3 MSS Conformance

The ***MSS*** identified the lowering and upgrading of the existing sanitary on King Street (from Ottawa Street to Royal York Street), Royal York Street (from King Street to Cockburn Street) and Coburn Street (from Royal York Street to the RPS) as the preferred route to provide servicing capacity for future potential development south of the Jock River, including the subject site. Refer to ***MSS Figure 5.4 – Connection Locations to the Central Collection System***, enclosed in ***Appendix C***.

The ***MSS*** contemplated upgrades to the existing RPS and existing sanitary sewers as depicted on ***Figure 8.7 – Functional Sanitary Sewer Design South of the Jock River***, contained in ***Appendix C***. A summary of the proposed upgrades is presented in ***Table 5***.

Table 5: Summary of MSS Proposed Upgrades, South of the Jock River

Street	From MH	To MH	Diameter (mm)	Length (m)	Slope (%)	U/S Invert (m)	D/S Invert (m)
King Street	6091 (Ottawa)	6094 (Chanonhouse South Leg)	300	244	0.20	89.36	88.87
King Street	6094 (Chanonhouse South Leg)	6095 (Royal York)	375	132[1]	0.15	88.79	88.60
Royal York	6095 (King)	6328 (Cockburn)	375	146	0.15	87.95	87.73
Cockburn	6328 (Cockburn)	6330 (RPS)	375	98	0.15/ 0.25	87.70	87.54
RPS	6330	6331	675	54	0.37	86.20	86.00

1. This distance is listed in the MSS but does not reflect the correct distance between Chanonhouse South and Royal York, which is measured at approximately 290 m

The proposed design for upgrades to the outlet deviates from the ***MSS***. A summary of the proposed design is presented in ***Table 6***.

Table 6: Summary of Proposed Upgrades, South of the Jock River

Street	From MH	To MH	Diameter (mm)	Length (m)	Slope (%)	U/S Invert (m)	D/S Invert (m)
King Street	6091 (Ottawa)	6094 (Chanonhouse South Leg)	525	237	0.10	87.55	87.27
King Street	6094 (Chanonhouse South Leg)	6095 (Royal York)	525	299	0.10	87.24	86.82
Royal York	6095 (King)	6328 (Cockburn)	525	142	0.10	86.76	86.59
Cockburn	6328 (Royal York)	43671	525	28	0.10	86.53	86.50
RPS	6330	6331	600	23	0.26	86.44	86.35

The ***MSS*** contemplated the size of upgraded sanitary sewer on King Street and Royal York Street to vary between 300 mm and 375 mm; however, many of the proposed sanitary sewers in the MSS are above 80% of their design capacity and the proposed sanitary sewer for the Tamarack Richmond Lands have been designed to be as flat as possible. The proposed 525 mm trunk sewer runs at a slope of 0.10%, which was required to provide clearance below the culvert crossing of Marlborough Creek on Ottawa Street. The proposed outlet is realigned at Cockburn Street for a shorter route to the RPS.

The ***MSS*** was completed at a time when the subject lands were zoned completely as industrial and uses outdated design guidelines.

Refer to the enclosed Sewer Design Sheet from the ***MSS***, which shows the anticipated flows from the subject lands when they were zoned industrial. Based on a total area of 67.26 ha and design parameters from previous City guidelines, the following flow was calculated:

- At MH 6091A, 67.26 ha of Industrial
  - Industrial demand: 5,000 L/s/ha
  - Peak factor: 1.5
  - Infiltration: 0.12 L/s/ha

- Total peak flow = ***13.91 L/s***

Based on the updated City guidelines (Technical Bulletin ISTB-2018-01, March 21, 2018) and current concept plan, the total flow from the Tamarack Richmond Lands is ***61.23 L/s*** at MH 6091A, which is more than originally contemplated in the ***MSS***.

The sanitary design sheets prepared, which accompany the current design, reflect the current demands based on existing and proposed land use as well as the latest City guidelines. The peak flow at the RPS in the ***MSS*** is 458 L/s and the peak flow at the RPS in the current design is 341 L/s. It is confirmed that there is capacity in the upgraded RPS for the flows from the subject lands.

4.4 Wastewater Servicing Conclusion

The proposed wastewater design follows all current City guidelines and policies including ISTB-2018-01 (March 21, 2018). The proposed wastewater design is based on existing and proposed land uses for all areas tributary to the RPS.

The subject site will be serviced by a network of internal and external sanitary sewers discharging to the existing Richmond Pump Station via Ottawa Street, King Street and Royal York Street, requiring existing sanitary sewers to be upgraded and a new crossing under existing Marlborough Creek (Richmond By-Pass Drain) at Ottawa Street. The existing sewers along King Street, Royal York and Cockburn Street were identified in the ***MSS*** to be upgraded and lowered. Although the size and elevation are updated per the current design, the servicing strategy is in general conformance with the ***MSS***. The peak flow at the RPS is lower than contemplated in the ***MSS***.

Upgrades to the existing RPS and forcemains will be required to secure capacity for the Tamarack Richmond Lands. However, the expansion process is currently underway with the City of Ottawa and MECP and it is confirmed that there will be sufficient capacity for the proposed development at the time of construction.

5.0 STORMWATER CONVEYANCE

The proposed stormwater servicing solution consists of a minor system, a major system, and homes with basement, which will be equipped with sump pumps to provide foundation drainage as is typical in the Village of Richmond.

5.1 Existing Conditions

The subject site is a Greenfield Site within the Village of Richmond, with existing grades varying between 93.0 m and 98.0 m as depicted on ***Drawing 5D – Grading Plan***. A preliminary geotechnical investigation was undertaken in December 2018 with supplemental investigations conducted in February 2019 with the results and recommendations documented in the ***Geotechnical Investigation***.

The subject site is situated within the Jock River Subwatershed (Reach 2) and is within the jurisdiction of the Rideau Valley Conservation Authority (RVCA). Marlborough Creek (Richmond By-Pass Drain) traverses the north end of the subject site and there is associated regulatory flood plain. Jock River Subwatershed (Reach 2) Flood Risk Maps prepared by the RVCA are included in ***Appendix D*** and identify cross-sections for stations 2150 to 3137 adjacent to the Tamarack Richmond Lands. A detailed HEC-RAS model of the Jock River Subwatershed (Reach 2) was created by JFSA and used to determine the existing flows and water elevations in the Marlborough Creek (Richmond By-Pass Drain), which is referred to as Tributary D – Reach 1 in the model.

The 2-year water elevation in the Marlborough Creek (Richmond By-Pass Drain) is 92.35 m and the 100-year elevation is 93.58 m. Refer to the highlighted tables for Tributary D – Reach 1 in ***Appendix D****.*

There is an existing tributary to Marlborough Creek (Richmond By-Pass Drain) which currently bisects the site (Reach 4 per the HDFA). It was identified in the ***HDFA*** that the tributary could be removed, but had to be replaced by a feature that replicated or augmented its functionality, subject to approvals from the appropriate agencies. The ***HDFA*** references several other minor drains throughout the site, but they are not considered significant and do not require compensation.

There are several adjacent parcels of land that currently drain through the subject site before ultimately discharging to Marlborough Creek (Richmond By-Pass Drain). Refer to ***Drawing 2D – Pre-Development Storm Drainage Plan*** for the external areas and existing drainage patterns.

5.2 Minor System

Minor system flows for the Tamarack Richmond Lands and adjacent parcels of land currently draining through the site will be captured and conveyed to a proposed SWM Pond and existing Marlborough Creek (Richmond By-Pass Drain) through 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).

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

The storm sewers will outlet to a proposed stormwater management pond via two (2) inlets (west inlet – 1800 mm diameter storm sewer to HW2 and east inlet – 1200 mm diameter storm sewer to HW1), where the flows will be treated for quality control and quantity control.

The proposed stormwater management pond will discharge to the existing Marlborough Creek (Richmond By-Pass Drain), which connects to the Jock River approximately 2 km downstream, east of Eagleson Road.

Drawing 3D – Storm Servicing Plan depicts the proposed minor storm sewer system. The relevant ***Sewer Design Guidelines*** to be used in the minor system design are summarized in ***Table 7***.

Table 7: 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) storm event 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 10-year storm event: A = 1174.184, B = 6.014, C = 0.816	$i = \frac{A}{(t_c + B)^C}$
Initial Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Runoff coefficient for paved and roof areas	0.9
Runoff coefficient for landscaped areas	0.2
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	250 mm diameter
Minimum Manning's 'n'	0.013
Service Lateral Size	100 mm dia PVC SDR 28 with a minimum slope of 1.0%
Minimum Depth of Cover	2.0 m from crown of sewer to grade (insulation when not possible)
Minimum Full Flowing Velocity	0.8 m/s
Maximum Full Flowing Velocity	3.0 m/s
Extracted from Sections 5 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012 and associated Technical Bulletins.	

The storm sewers will be sized using City of Ottawa IDF curves. Note that 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."*

A 100-year hydraulic grade line (HGL) analysis will be completed to confirm that the 100-year HGL is 35 cm (total static and dynamic depth) or less at the gutter and that the 100-year + 20% stress test HGL does not touch any building envelopes given that the development will be on sump pumps.

At the inlets to the proposed SWM Pond, the storm sewers are partially submerged, but the amount of standing water in the pipes is gradually reduced as the sewers progress upstream and the inverts rise above the permanent pool elevation. At the time of detailed design, the submergence will be modelled to consider the standard sedimentation requirement. The guidelines require that the modelling be completed to address the 10-year hydraulic grade line plus 25% sediment accumulation.

Based on calculations using the rational method, the stormwater flows from the Tamarack Richmond Lands and adjacent external development areas to the proposed SWM Pond are ***5344 L/s*** (west inlet) and ***1913 L/s*** (east inlet).

Refer to ***Drawings 5D, 6D and 7D – Profiles*** showing the proposed storm sewer network and storm sewer design sheets located in ***Appendix D***.

5.3 Major System

The major system flows will be conveyed through a proposed internal network, discharging to the proposed stormwater management pond, where they are treated for quality control and quantity control prior to release to the Marlborough Creek (Richmond By-Pass Drain) and the Jock River, 2 km downstream, east of Eagleson Road.

The major system is to be 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).

Refer to ***Drawing 4D – Grading Plan*** for the proposed major system (overland flow route).

5.4 Proposed Outlet – Stormwater Management (SWM) Pond

The proposed SWM Pond was identified to service the Tamarack Richmond Lands and the adjacent external lands, as depicted on ***Drawing 3D – Storm Drainage Plan.***

The proposed SWM Pond has been sized for a total drainage area of 152.46 ha which includes the Tamarack Richmond Lands and adjacent external lands that currently drain through the site. Based on a preliminary SWMHYMO model, the peak 100-year pre-development inflow to the pond are estimated to be 3.368 m^3/s, and a 100-year storage volume of 45,210 m^3 is required to control the flows from this post-development area. Refer to correspondence from JFSA included in ***Appendix D***.

The proposed SWM Pond will have a bottom elevation of 90.85 m, permanent pool elevation of 92.35 m, extended detention elevation of 92.65 m and maximum storage elevation of 94.30 m. The permanent pool elevation is based on the 2-year water level in the existing Marlborough Creek (Richmond By-Pass Drain) at cross-section 2070 based on HEC-RAS modelling by JFSA. Refer to tables for Tributary D – Reach 1 in ***Appendix D***.

Pond characteristics and volumes based on preliminary design are summarized in ***Table 8***:

Table 8: SWM Pond Volumes

Pond Characteristics				
	Lower Elevation (m)	**Upper Elevation (m)**	**Volume Required (m^3)**	**Volume Provided (m^3)**
Permanent Pool	90.85	92.35	15,246	27,899
Extended Detention	92.35	92.65	6,098	6,746
Max WL	92.35	94.30	45,210	48,308

The proposed SWM Pond and outlet channel to the existing Marlborough Creek (Richmond By-Pass Drain) are depicted on ***Figure 6F – SWM Pond***. Refer to detailed sizing calculations including in ***Appendix D.***

The proposed SWM Pond is located within the Jock River Subwatershed (Reach 2) and is subject to the following design criteria:

5.4.1 Water Quality Control

The minor and major system flows from the subject site are to be treated by the proposed stormwater management facility.

The recommended quality control objective is an Enhanced Level of Protection, which corresponds to an 80% total suspended solids (TSS) removal in accordance with the MECP Stormwater Management Planning and Design Manual (March, 2003). This was discussed in the City of Ottawa's pre-consultation notes included in ***Appendix A***.

5.4.2 Water Quantity Control

Although there are no quantity control requirements for the Jock River Subwatershed (Reach 2), the proposed outlet is the existing Marlborough Creek (Richmond By-Pass Drain). Specific criteria for Marlborough Creek (Richmond By-Pass Drain) was unavailable; however, as the stormwater management facility is discharging to this environmental feature, a typical 100-year post development flow control target to the 100-year pre-development flow is proposed.

The 100-year pre-development flow from the subject site and external areas is calculate to be 3.368 m^3/s per correspondence included in ***Appendix D.***

5.5 Stormwater Conclusions

The subject site will be serviced with sump pumps. Minor system flows for the Tamarack Richmond Lands and adjacent parcels of land currently draining through the site will be captured and conveyed to a proposed SWM Pond and existing Marlborough Creek (Richmond By-Pass Drain) through an internal storm sewer system.

The major system flows will be conveyed through a proposed internal network, discharging to the proposed SWM Pond.

A 100-year hydraulic grade line (HGL) analysis will be completed to confirm that the 100-year HGL is 35 cm (total static and dynamic depth) or less at the gutter and that the 100-year + 20% stress test HGL does not touch any building envelopes given that the development will be on sump pumps.

The proposed SWM Pond is located in the Jock River Subwatershed (Reach 2), will have two (2) storm sewer inlets from the proposed development and will discharge to the existing Marlborough Creek (Richmond By-Pass Drain). Enhanced Level of Protection (80% TSS Removal) will be provided and the 100-year post-development flow will be controlled to the 100-year pre-development flow.

At the inlets to the proposed SWM Pond, the storm sewers are partially submerged, but the amount of standing water in the pipes is gradually reduced as the sewers progress upstream and the inverts rise above the permanent pool elevation. At the time of detailed design, the submergence will be modelled to consider the standard sedimentation requirement.

The storm sewers are designed as per the City of Ottawa guidelines, including the amendment to the guidelines per Technical Bulletins PIEDTB-2016-01 (September 6, 2018), ISTB-2018-04 (June 27, 2018) and ISTB-2019-02 (July 8, 2019).

6.0 GRADING

6.1 Master Grading

Based on the proposed stormwater management facility, the proposed road grades are expected to in the 94.5 m to 96.0 m range and the proposed house grades are expected to be in the 95.0 m to 96.5 m range with sump pumps or for slab on grade units. Refer to ***Drawing 4D – Grading Plan*** for a depiction of preliminary grading.

The maximum allowable grade raise is 2 m for the majority of eastern portion of the site (east of existing Reach 4) and for a small semi-circular area to the southwest as depicted in ***Figure PG4216-3*** in the ***Geotechnical Investigation.***

Proposed grades for the site have been designed to be as low as possible based on grade raise restrictions, servicing constraints and existing surrounding properties.

Detailed grading plans will be forwarded to the geotechnical consultant for review and recommendations at the time of detailed design. Final signoff for detailed grading plans will be provided by the Geotechnical Engineer.

6.2 Grading Criteria

The following grading criteria and guidelines will be applied at the time of detailed design as per City of Ottawa Guidelines:

- Driveway slopes will have a maximum slope of 6%;
- Grading in grassed / landscaped areas to range from 2% to 3:1, with terracing required for flops larger than 7%;
- Swales are to be 0.15 m deep with 3:1 side slopes unless otherwise indicated on the drawings;
- Perforated pipe will be required for drainage swales if they are less than 1.5% in slope; and
- Swales are to be 0.15 m deep with 3:1 side slopes unless otherwise indicated on the drawings.

7.0 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.

A temporary drainage system design and erosion and sediment control plan were submitted to the RVCA to obtain permission to proceed with earthworks activities prior to development

The erosion and sediment control plan will allow for construction activities on-site, from preliminary earthworks movements to installation of sewers and pond structures, to occur while being able to treat and protect surface water prior to discharge to the Marlborough Creek (Richmond By-Pass Drain) and Jock River. The plan will be implemented during construction of the Tamarack Richmond Lands to ensure there are no negative impacts on the natural areas, particularly Marlborough Creek (Richmond By-Pass Drain) and the Jock River. Existing Reach 4 which currently bisects the site will be protected until such a time that all necessary approvals have been issued by the RVCA and it can be decommissioned.

Silt fence will be installed around the perimeter of the site and Reach 4 and will be cleaned and maintained throughout construction. (Reach 4 will be protected until approvals are in place to relocate it… or something like that 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 temporary sediment pond and outlet to the Marlborough Creek (Richmond By-Pass Drain) will be constructed with the implementation of a turbidity curtain in the pond and straw bales in the outlet.

Sediment traps are proposed at locations where existing drainage will not be directed towards the proposed temporary sediment pond and will provide treatment of runoff prior to discharging to the Marlborough Creek (Richmond By-Pass Drain).

A mud mat will be installed at the construction accesses 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 regularlycomplete 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.

Refer to ***Figure 3F – Erosion and Sediment Control Plan.***

8.0 CONCLUSION AND RECOMMENDATIONS

A summary of the servicing requirements for the Tamarack Richmond Lands is as follows:

- The subject lands were zoned as Industrial but are now comprised of Residential, Institutional and Village Commercial as per City of Ottawa Official Plan Amendment (OPA) 150.

- Approvals will be required from the City of Ottawa, MECP and RVCA. As Marlborough Creek is the only fish bearing feature with the Tamarack Richmond Lands and it is not subject to any alterations or disturbance within 30 m of its riparian corridor, no permits or consultation with DFO are required.

- The Marlborough Creek (Richmond By-Pass Drain) traverses the north end of the Tamarack Richmond Lands and there is associated flood plain.

- Internal and external watermains will be designed per City of Ottawa Standards. Water servicing will require connections to the King's Park Communal Well and Caivan Communal Well (Richmond West Pumping Station) as well as the crossing of several watercourses. A complete hydraulic analysis will be prepared for the proposed water distribution network at the time of detailed design 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.

- The proposed wastewater design follows all current City guidelines and policies including ISTB-2018-01 (March 21, 2018).

- The subject site will be serviced by a network of internal and external sanitary sewers discharging to the existing Richmond Pump Station via Ottawa Street, King Street and Royal York Street requiring existing sanitary sewers to be upgraded and a new crossing under existing Marlborough Creek (Richmond By-Pass Drain) at Ottawa Street.

- Upgrades to the existing RPS and forcemains will be required to secure capacity for the Tamarack Richmond Lands. However, the expansion process is currently underway with the City of Ottawa and MECP and it is confirmed that there will be sufficient capacity for the proposed development at the time of construction.

- Although the site was previously contemplated as an industrial development and has since been revised to include residential and institutional development and parkland, the proposed wastewater servicing is in general conformance with the ***MSS***.

- The subject site will be serviced with sump pumps. Minor system flows for the Tamarack Richmond Lands and adjacent parcels of land currently draining through the site will be captured and conveyed to a proposed SWM Pond and existing Marlborough Creek (Richmond By-Pass Drain) through an internal storm sewer system.

- The major system flows will be conveyed through a proposed internal network, discharging to the proposed SWM Pond.

- A 100-year hydraulic grade line (HGL) analysis will be completed to confirm that the 100-year HGL is 35 cm (total static and dynamic depth) or less at the gutter and that the 100-year + 20% stress test HGL does not touch any building envelopes given that the development will be on sump pumps.

- The proposed SWM Pond is located in the Jock River Subwatershed (Reach 2), will have two (2) storm sewer inlets from the proposed development and will discharge to the existing Marlborough Creek (Richmond By-Pass Drain). Enhanced Level of Protection (80% TSS Removal) will be provided and the 100-year post-development flow will be controlled to the 100-year pre-development flow.

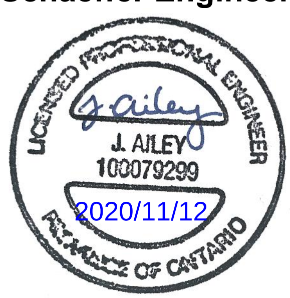
- At the inlets to the proposed SWM Pond, the storm sewers are partially submerged, but the amount of standing water in the pipes is gradually reduced as the sewers progress upstream and the inverts rise above the permanent pool elevation. At the time of detailed design, the submergence will be modelled to consider the standard sedimentation requirement.

- The storm sewers are designed as per the City of Ottawa guidelines, including the amendment to the guidelines per Technical Bulletins PIEDTB-2016-01 (September 6, 2018), ISTB-2018-04 (June 27, 2018) and ISTB-2019-02 (July 8, 2019).

Prepared by,
David Schaeffer Engineering Ltd.

Per: Anthony Temelini, P.Eng.

Prepared by,
David Schaeffer Engineering Ltd.



Per: Jennifer Ailey, P.Eng.

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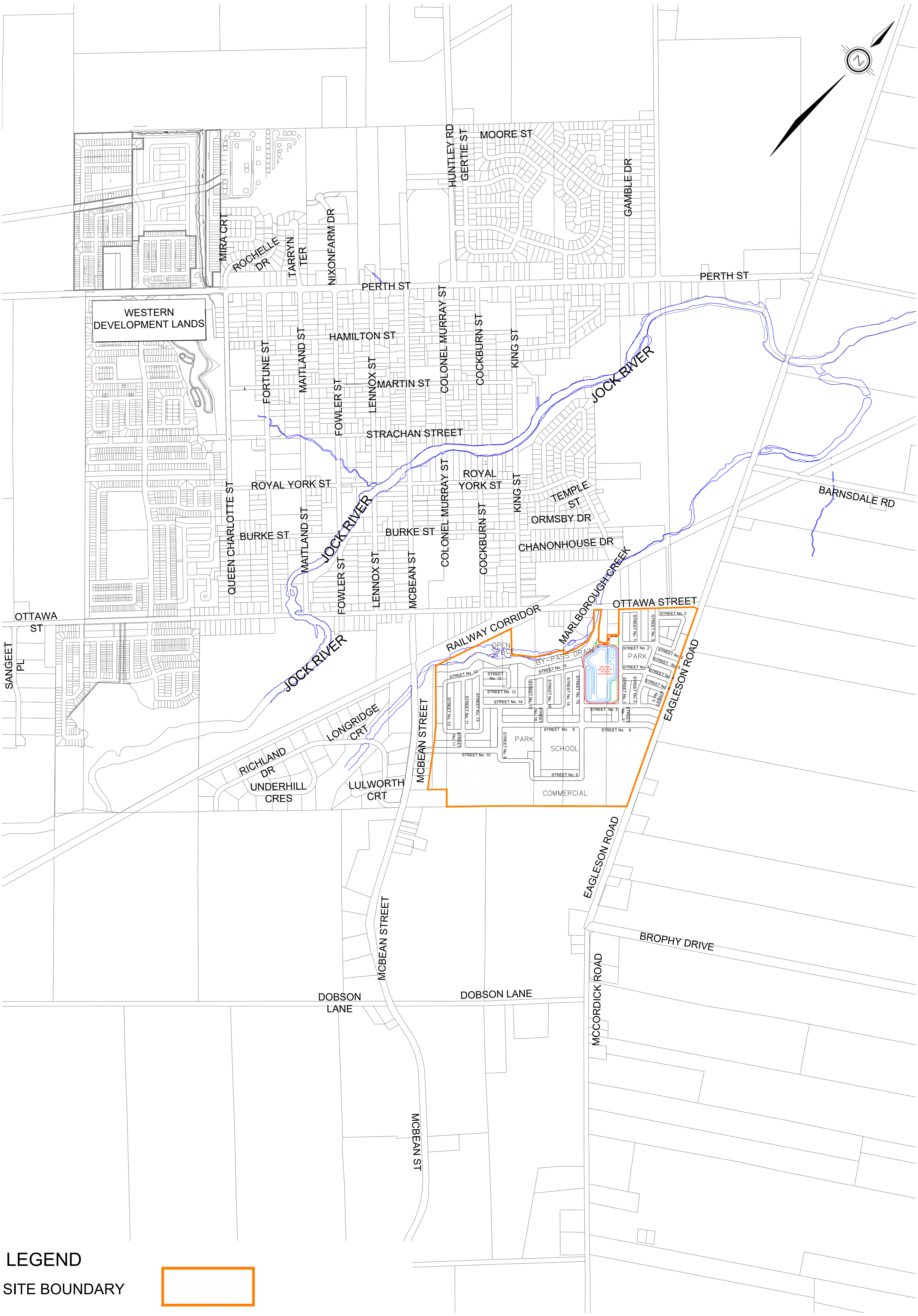
FIGURES & DRAWNGS



LEGEND

SITE BOUNDARY

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Tel. (613) 836-0856
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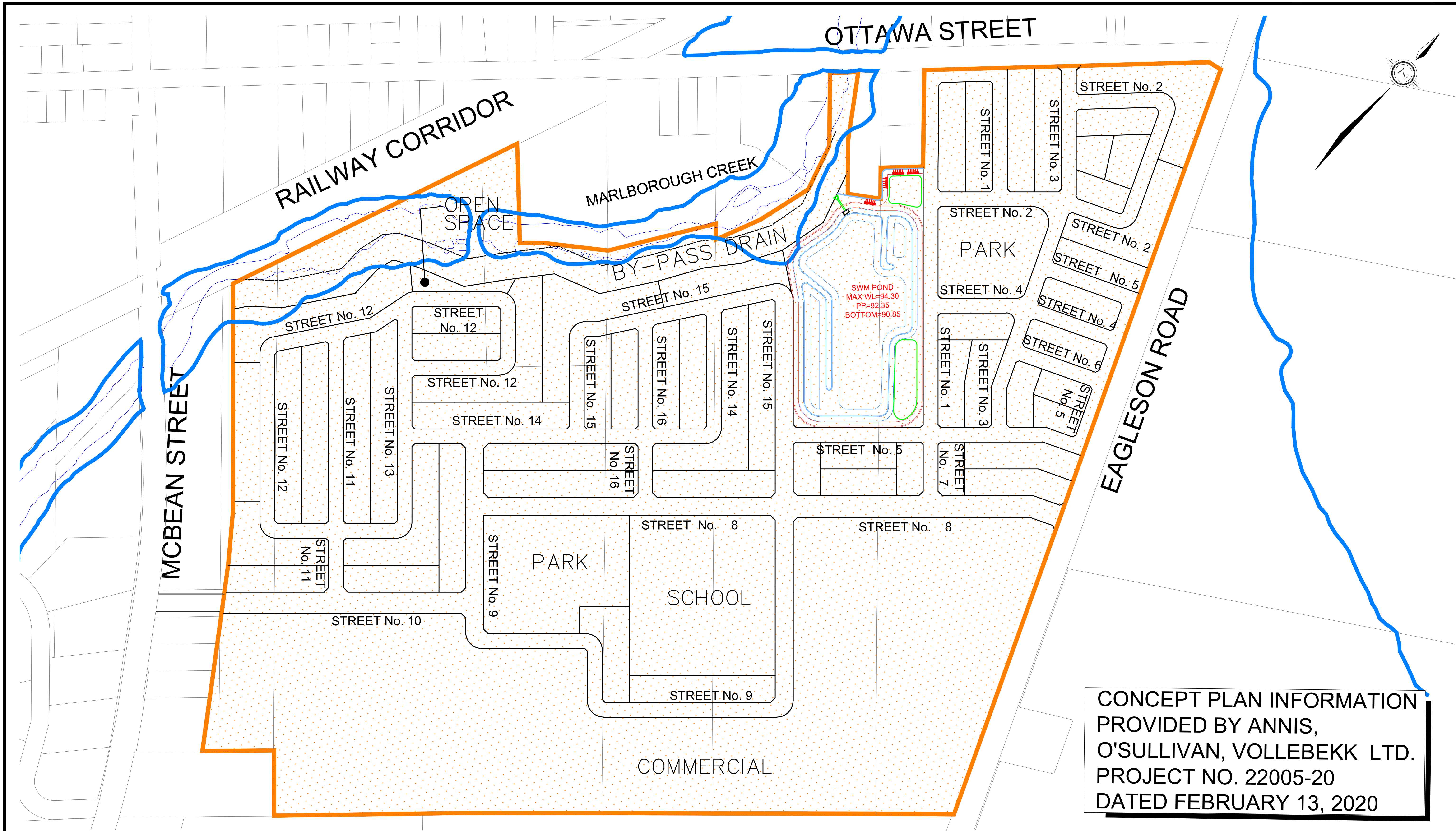
TAMARACK RICHMOND

CITY OF OTTAWA

KEY PLAN

SCALE:	1:15000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	01F



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LEGEND

SITE BOUNDARY

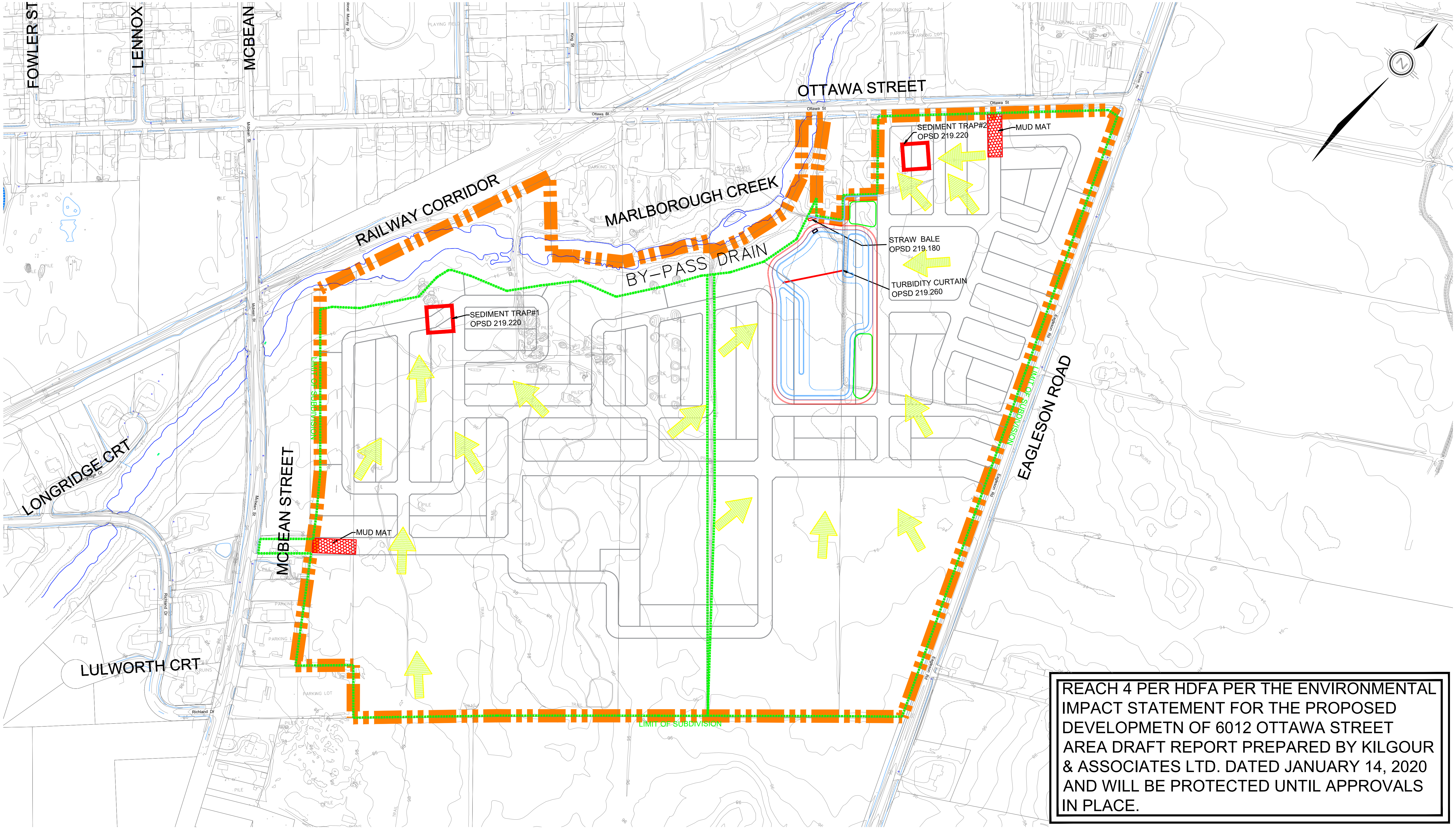
FLOODPLAIN

TAMARACK RICHMOND

CITY OF OTTAWA

CONCEPT PLAN

SCALE:	1:4000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	02F



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LEGEND

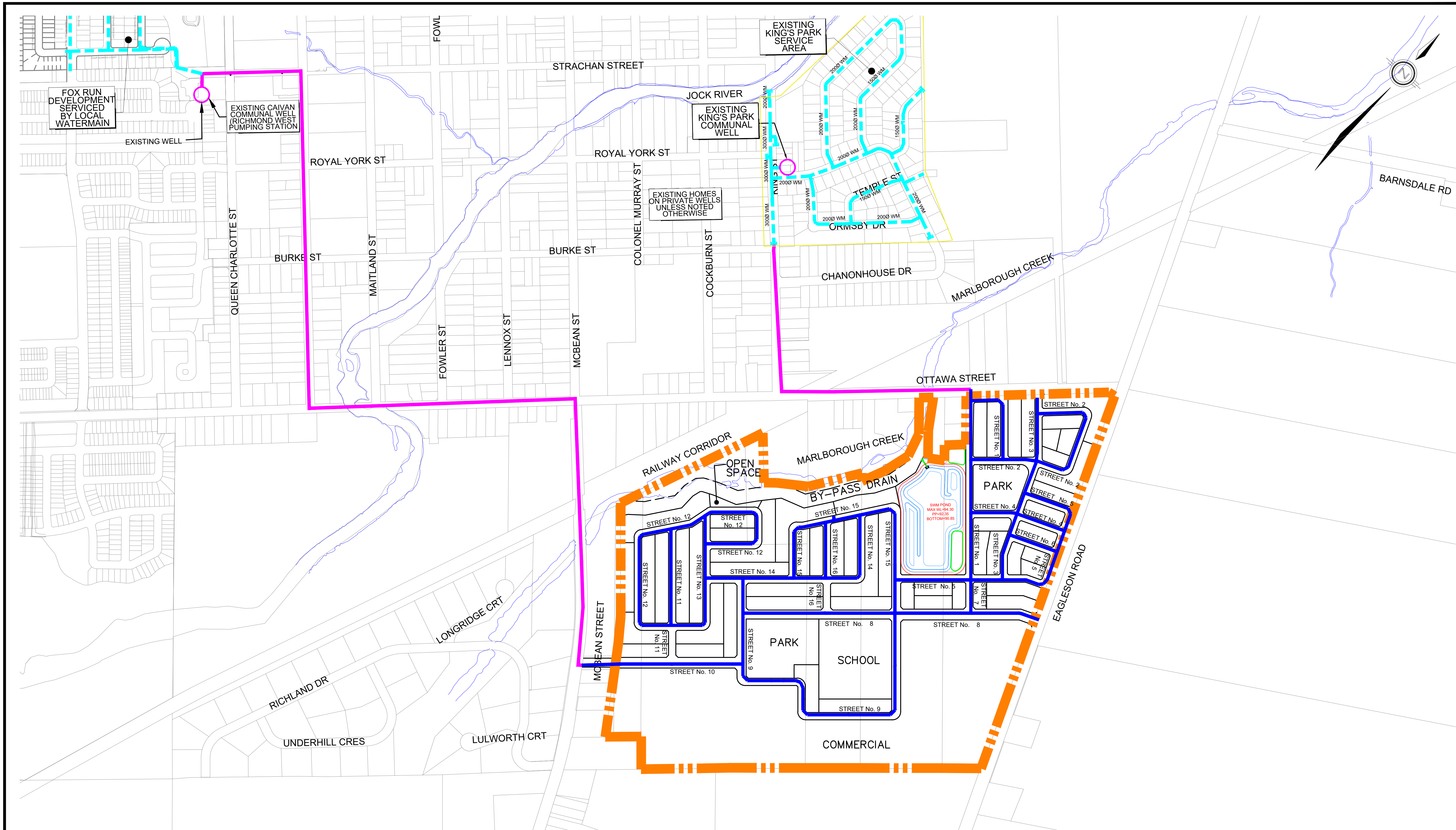
- SILT FENCE
- SUBJECT LANDS
- OVERLAND FLOW

TAMARACK RICHMOND

CITY OF OTTAWA

EROSION SEDIMENT CONTROL PLAN

SCALE:	1:5000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	03F



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LEGEND

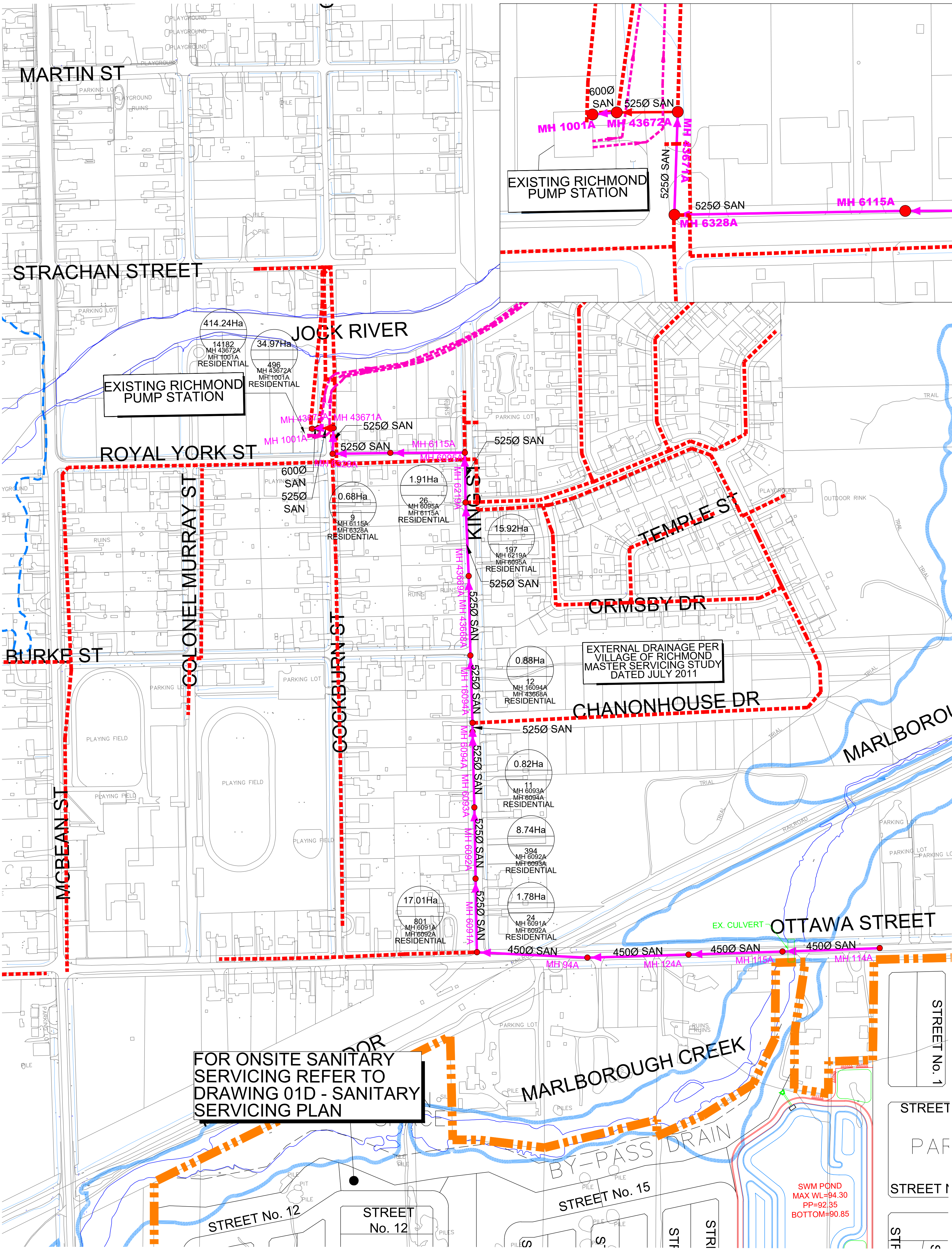
- SUBJECT LANDS
- PROPOSED LOCAL WATERMAIN
- EXISTING WATERMAIN
- PROPOSED EXTERNAL WATERMAIN

TAMARACK RICHMOND

CITY OF OTTAWA

WATERMAIN SERVICING PLAN

SCALE:	1:8000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	04F



LEGEND

- SUBJECT LANDS
- EXISTING SANITARY SEWER
- REMOVE AND REPLACE EXISTING SANITARY SEWER
- EXISTING SANITARY FORCEMAIN
- SANITARY MANHOLE

0.77	EXTERNAL DRAINAGE AREA IN HECTARES
63	POPULATION
MH 513A	UPSTREAM MANHOLE
MH 514A	DOWNSTREAM MANHOLE
RESIDENTIAL	TRIBUTARY TYPE

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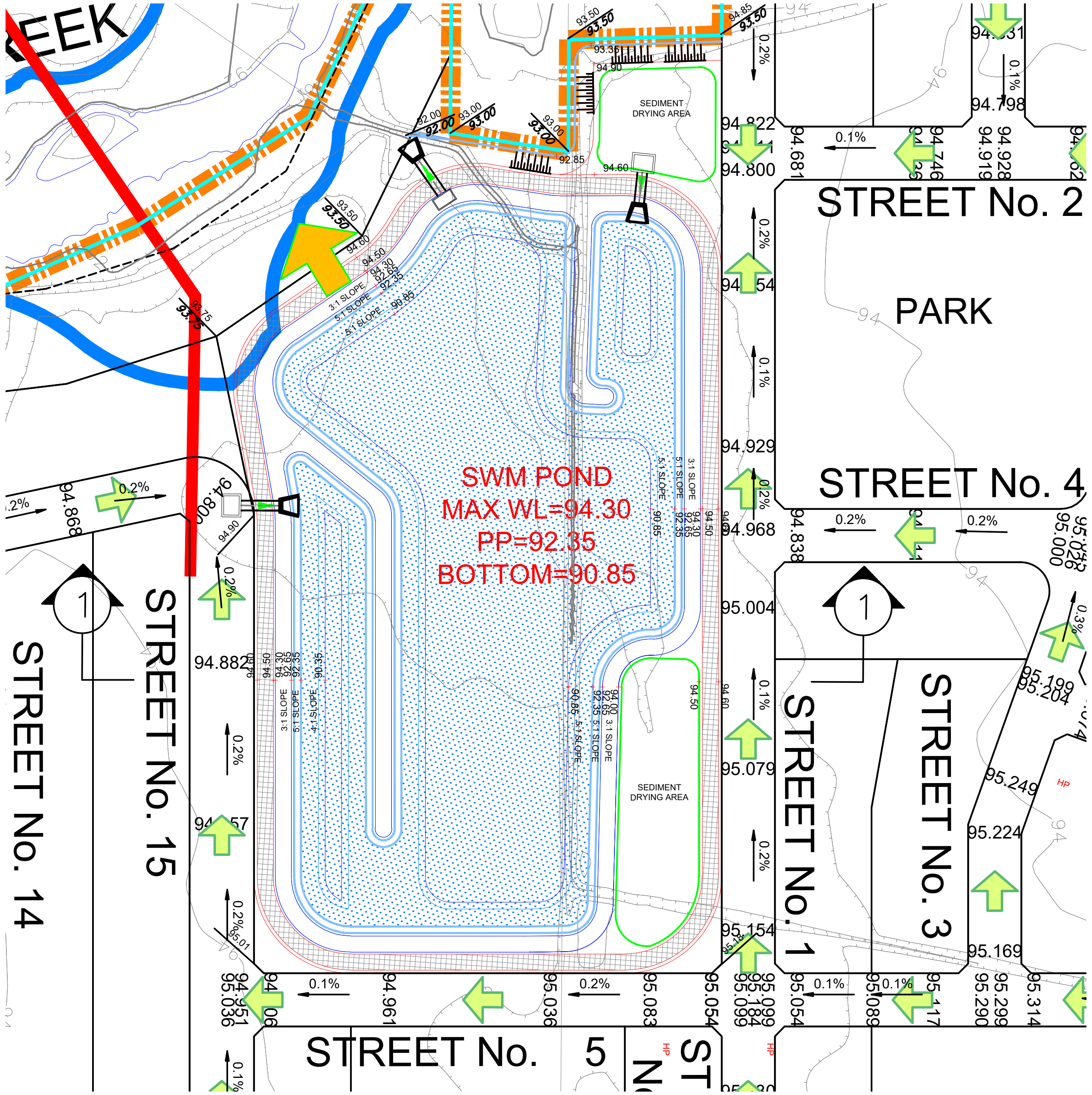
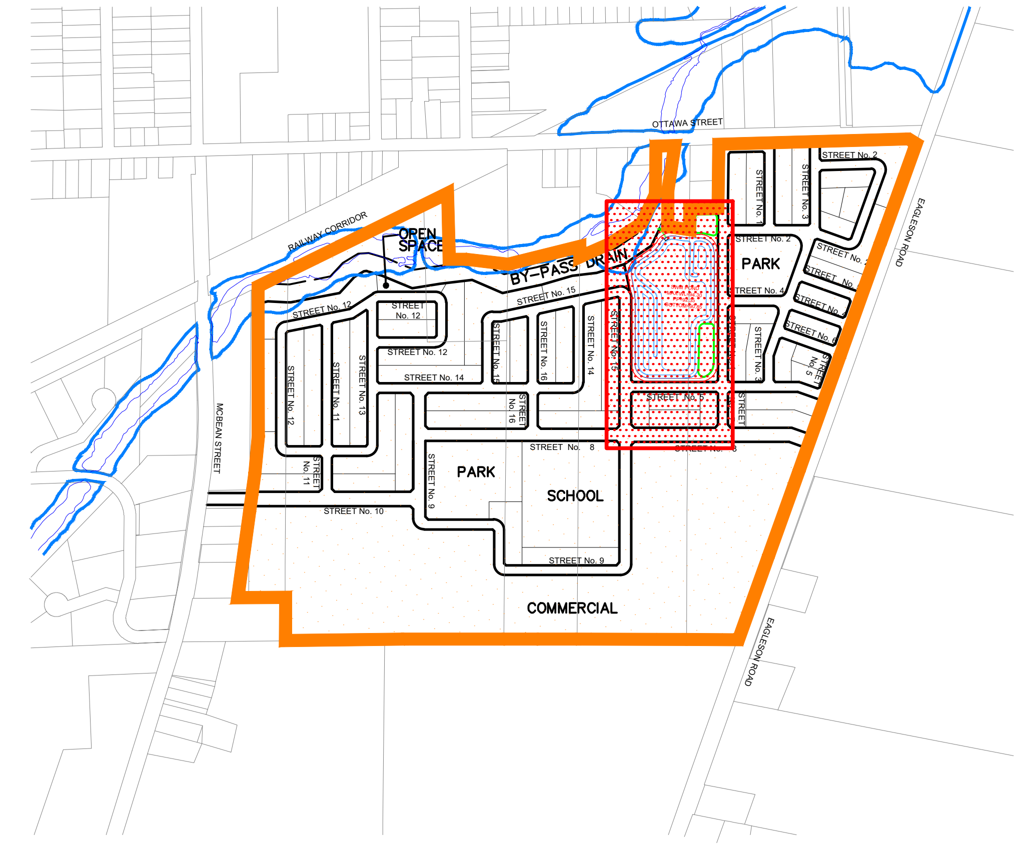
CITY OF OTTAWA

EXTERNAL SANITARY SERVICING PLAN

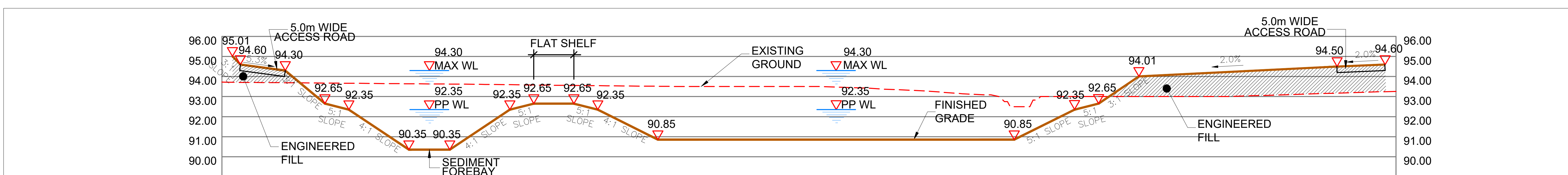
SCALE:	1:4000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	05F





POND CHARACTERISTICS

	LOWER ELEVATION (m)	UPPER ELEVATION (m)	VOLUME REQUIRED (m³)	VOLUME PROVIDED (m³)
PERMANENT POOL	90.85	92.35	15,246	27,899
EXTENDED DETENTION	92.35	92.65	6,098	6,746
MAX WL	92.35	94.30	45,210	48,308



POND SECTION 1–1
SCALE HOR. 1:500

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LEGEND

- SITE BOUNDARY
- PROPOSED CHANNEL
- ACCESS ROAD
- FLOODPLAIN
- EMERGENCY OVERFLOW DIRECTION
- 165.12 PROPOSED GRADE
- POND OUTLET
- PERMANENT POOL
- POND INLET
- OVERLAND FLOW DIRECTION

TAMARACK RICHMOND

CITY OF OTTAWA

SWM POND

SCALE:	1:2000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	FIGURE:	06F

LEGEND

- SUBJECT LANDS
- SANITARY SEWER
- EXISTING SANITARY SEWER
- REMOVE AND REPLACE EXISTING SANITARY SEWER
- SANITARY DRAINAGE AREA
- SANITARY MANHOLE

0.77	DRAINAGE AREA IN HECTARES
82.07	POPULATION PER HA
63	POPULATION
MH 513A	UPSTREAM MANHOLE
MH 514A	DOWNSTREAM MANHOLE
RESIDENTIAL	TRIBUTARY TYPE

3.4	POPULATION PER UNIT
0.30	EXTERNAL DRAINAGE AREA IN HECTARES
18	POPULATION
Residential	TRIBUTARY TYPE

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TAMARACK RICHMOND

CITY OF OTTAWA

SANITARY SERVICING PLAN

SCALE:	1:2000	PROJECT No.:	1042
DATE:	NOVEMBER 2020	DRAWING:	01D


STRACHAN STREET
JOCK RIVER
ROYAL YORK ST
ROYAL YORK ST
KING ST
TEMPLE ST
ORMSBY DR
CHANONHOUSE DR
BURKE ST
BURKE ST
QUEEN CHARLOTTE ST
MAITLAND ST
COLONEL MURRAY ST
COCKBURN ST
FOWLER ST
LENNOX ST
MCBEAN ST
MARLBOROUGH CREEK
BARNSDALE RD
OTTAWA STREET
RAILWAY CORRIDOR
MARLBOROUGH CREEK
AREA=2.74 HA
TC = 20 MIN
C= 0.20
100-YR
TO MARLBOROUGH CREEK DOWNSTREAM OF OTTAWA ST
AREA=0.67 HA
TC = 28 MIN
C= 0.40
100-YR
EXTERNAL DRAINAGE TO SUBJECT PROPERTY
EXISTING CULVERT
EAGLESON ROAD
LONGRIDGE CRT
MCBEAN STREET
AREA=59.80 HA
TC = 46 MIN
C= 0.20
100-YR
TO MARLBOROUGH CREEK UPSTREAM OF OTTAWA STREET
AREA=1.51 HA
TC = 23 MIN
C= 0.70
100-YR
EXTERNAL DRAINAGE TO SUBJECT SITE
RICHLAND DR
UNDERHILL CRES
LULWORTH CRT
AREA=19.92 HA
TC = 69 MIN
C= 0.20
100-YR
EXTERNAL DRAINAGE TO EAGLESON ROAD CULVERT TO REACH R1 AND R2 PER EIS
AREA=7.06 HA
TC = 46 MIN
C= 0.20
100-YR
EXTERNAL FLOW TO SUBJECT SITE
EAGLESON ROAD
AREA=60.72 HA
TC = 140 MIN
C= 0.20
100-YR
EXTERNAL FLOW TO SUBJECT SITE TO REACH R4 PER EIS
900mm DIA. EXISTING CULVERT
EXISTING CULVERT
BROPHY DRIVE
MCBEAN STREET
EXISTING CULVERT
900mm DIA. EXISTING CULVERT
DOBSON LANE
DOBSON LANE
LEGEND
SUBJECT LANDS
EXISTING STORM DRAINAGE AREA
100 YEAR FLOODPLAIN
OVERLAND FLOW DIRECTION
RIVER/CREEK FLOW DIRECTION
AREA=1.00 HA
TC = 10 MIN
C= 0.20
100-YR
EXTERNAL DRAINAGE AREA
TIME OF CONCENTRATION
RUNOFF COEFFICIENT
STORM FREQUENCY
DSEL
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TAMARACK RICHMOND
CITY OF OTTAWA
PRE-DEVELOPMENT STORM DRAINAGE PLAN
SCALE: 1:5000
PROJECT No.: 1042
DATE: NOVEMBER 2020
DRAWING: 02D

LEGEND

- SUBJECT LANDS
- STORM SEWER
- EXISTING STORM SEWER
- STORM SEWER BY OTHERS
- STORM DRAINAGE AREA
- EXISTING STORM DRAINAGE AREA
- STORM MANHOLE
- 100 YEAR FLOODPLAIN
- PROPOSED CUTOFF SWALE
- EXTERNAL DRAINAGE

RUNOFF COEFFICIENT: AREA=1.00 HA — EXTERNAL DRAINAGE AREA; TC = 10 MIN — TIME OF CONCENTRATION; C= 0.20, 100-YR — STORM FREQUENCY; 614 L/S — 100-YEAR FLOW RATE

0.45 — DRAINAGE AREA; 0.66 — IMPERVIOUSNESS; MH 41 MH 42 — UPSTREAM/DOWNSTREAM MANHOLE; 2-YEAR — STORM FREQUENCY

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TAMARACK RICHMOND	STORM SERVICING PLAN
CITY OF OTTAWA	SCALE: 1:2000 — PROJECT No.: 1042
	DATE: NOVEMBER 2020 — DRAWING: 03D

OTTAWA STREET
XS 2150 PER JOCK RIVER FLOOD RISK MAP JULY 21, 2005
XS 2170 PER HEC RAS RESULTS
MIN CHANNEL ELEV = 90.80
2-YR = 92.35
100-YR = 93.57
XS 2353 PER JOCK RIVER FLOOD RISK MAP JULY 21, 2005
MIN CHANNEL ELEV = 91.52
2-YR = 92.35
100-YR = 93.58
RAILWAY CORRIDOR
MARLBOROUGH CREEK
BY-PASS DRAIN
OPEN SPACE
SWM POND
MAX WL=94.30
PP=92.35
BOTTOM=90.85
STREET No. 1
STREET No. 2
STREET No. 3
STREET No. 4
STREET No. 5
STREET No. 6
STREET No. 7
STREET No. 8
STREET No. 9
STREET No. 10
STREET No. 11
STREET No. 12
STREET No. 13
STREET No. 14
STREET No. 15
STREET No. 16
PARK
SCHOOL
COMMERCIAL
MCBEAN STREET
EAGLESON ROAD
LULWORTH CRT
DGE CRT
LEGEND
SUBJECT LANDS
STORM OVERLAND FLOW ARROW
PROPOSED CENTERLINE ELEVATION
FUTURE GRADES (BY OTHERS)
100 YEAR FLOODPLAIN
PROPOSED ELEVATION
EXISTING ELEVATION
EXISTING CONTOUR ELEVATION
GRADE CHANGE
1.00m
CUT-FILL DEPTH TO EXISTING GROUND
CUT DEPTH (m)
0 - 1.0
1.0 - 2.0
2.0 - 3.0
>3.0
FILL DEPTH (m)
0 - 1.0
1.0 - 2.0
2.0 - 3.0
>3.0
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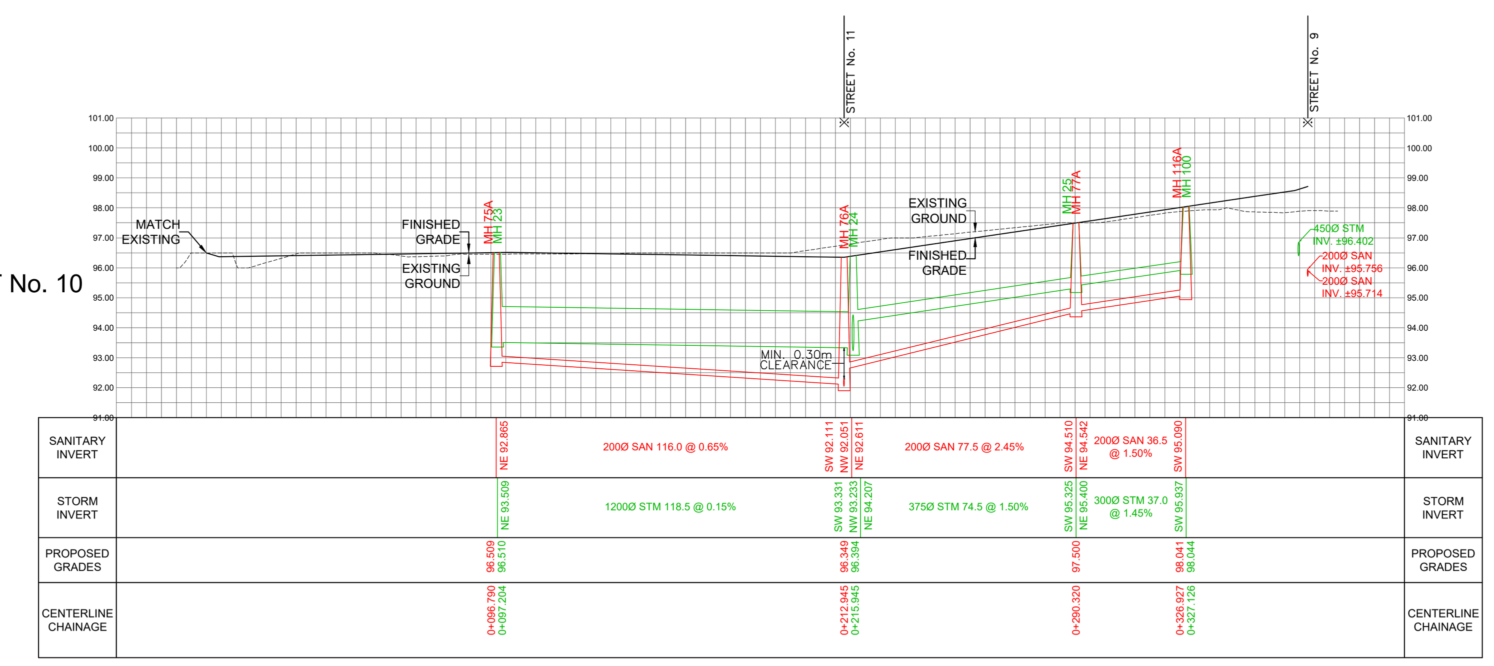
TAMARACK RICHMOND
CITY OF OTTAWA
GRADING PLAN
SCALE: 1:2000
PROJECT No.: 1042
DATE: NOVEMBER 2020
DRAWING: 04D

STREET No. 10



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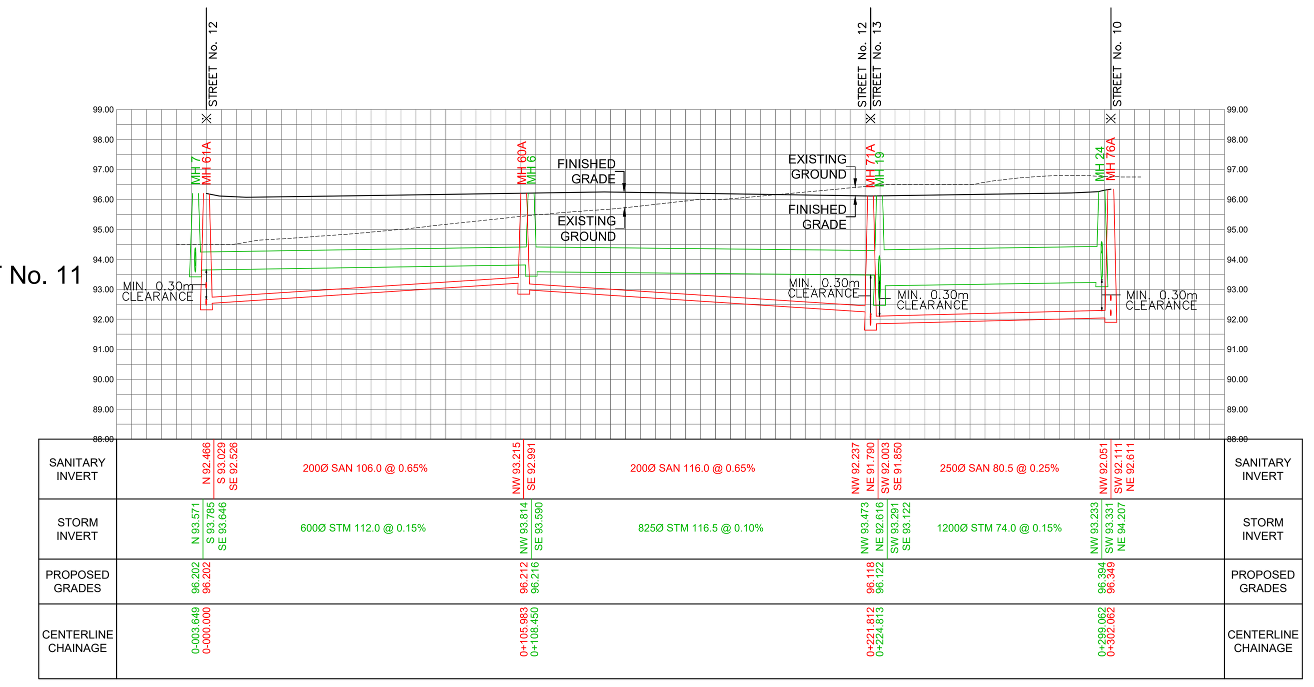

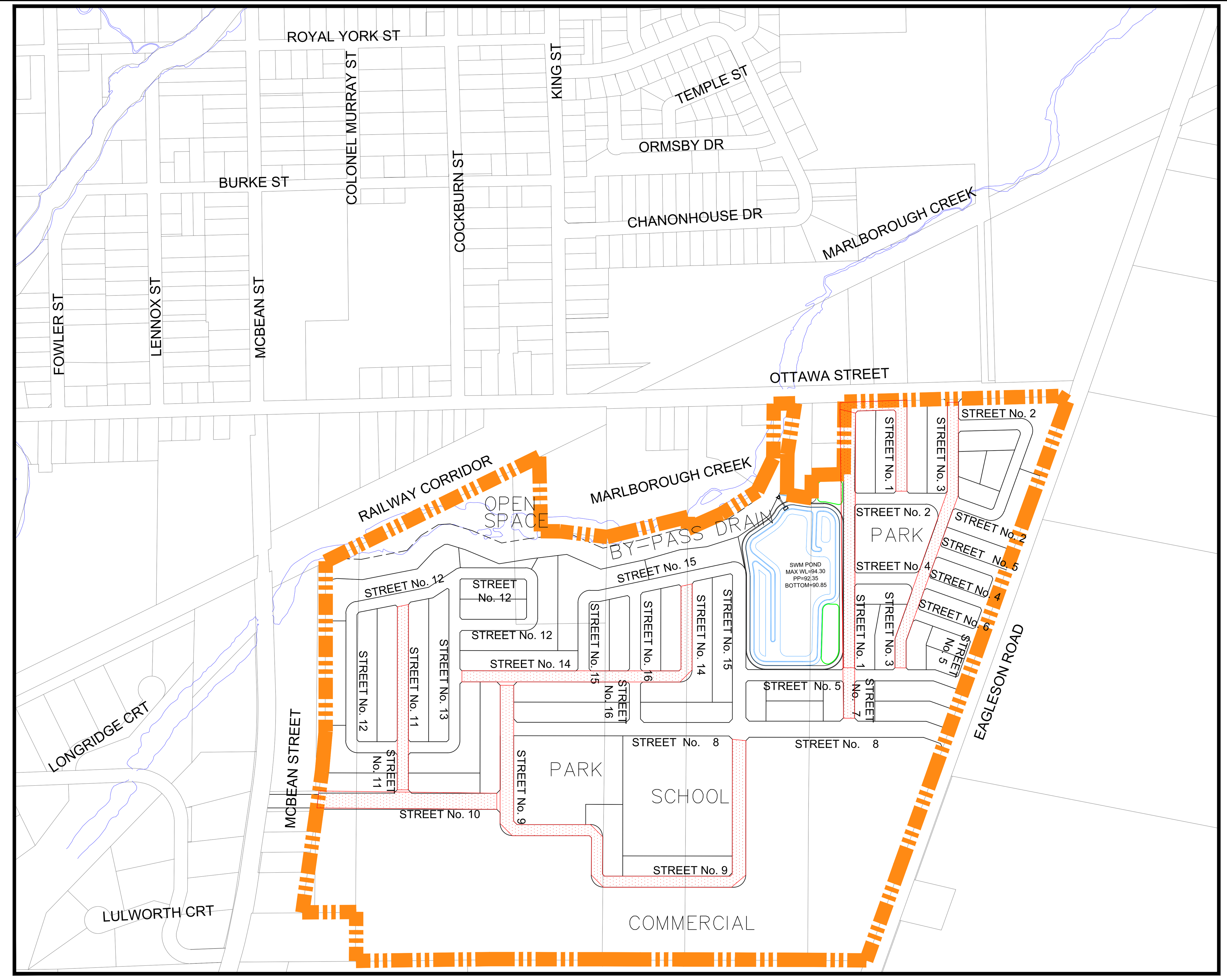

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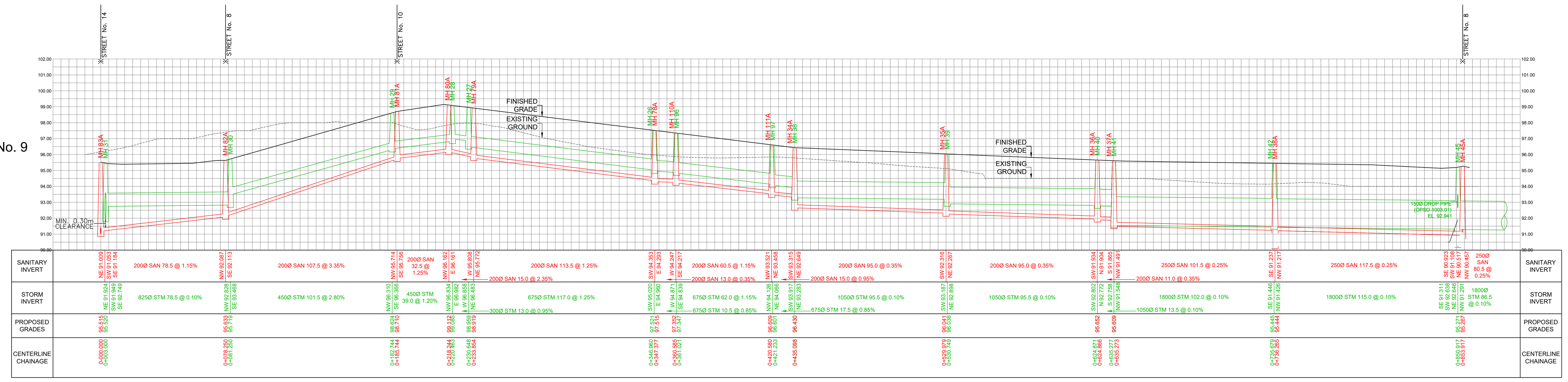

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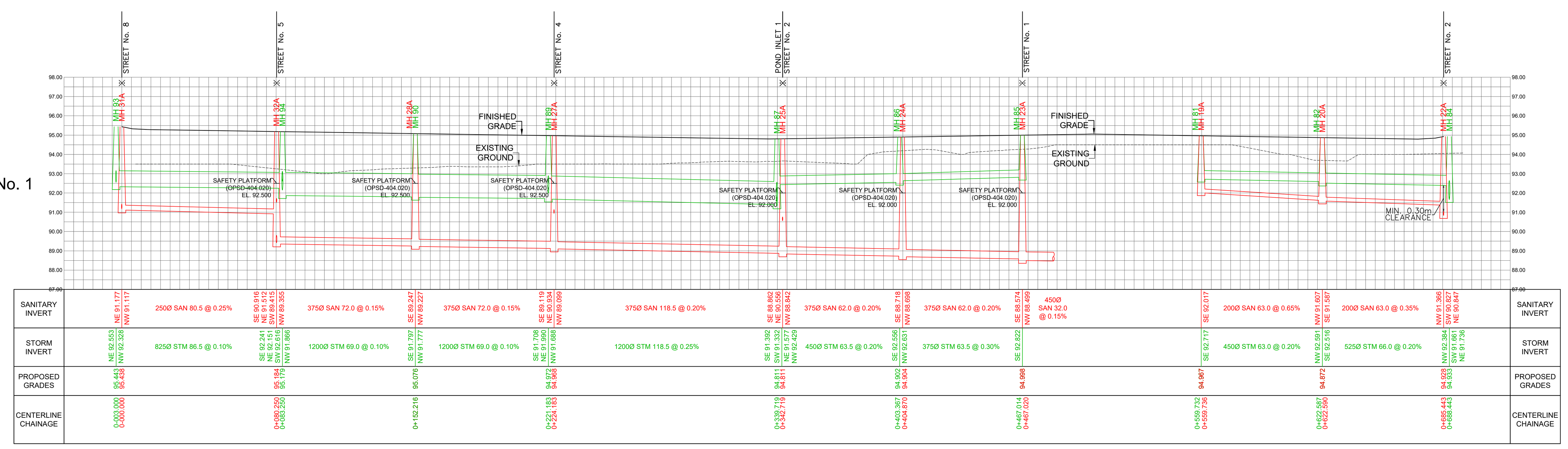

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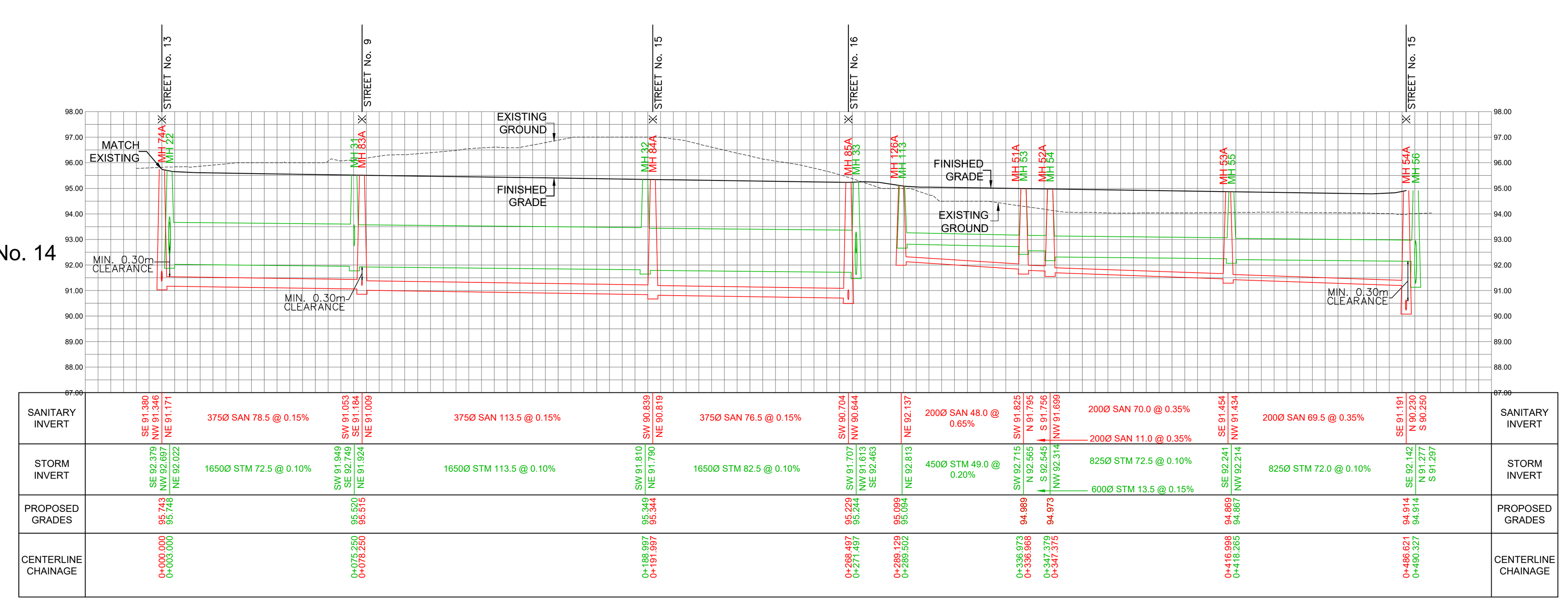

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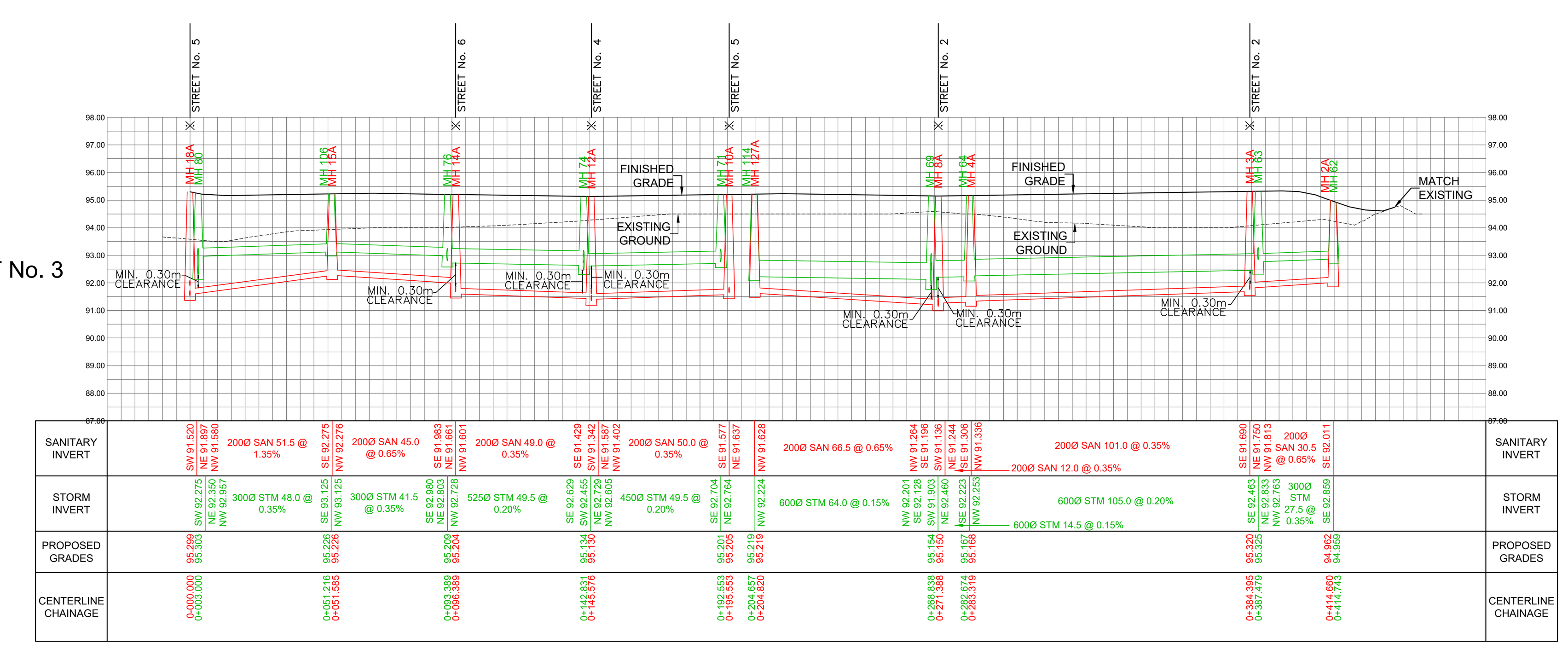

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TAMARACK RICHMOND

CITY OF OTTAWA

PROFILES

SCALE:	H 1:2000 V 1:200	PROJECT No.:	1042
DATE:	NOVEMBER 2020	DRAWING:	05D

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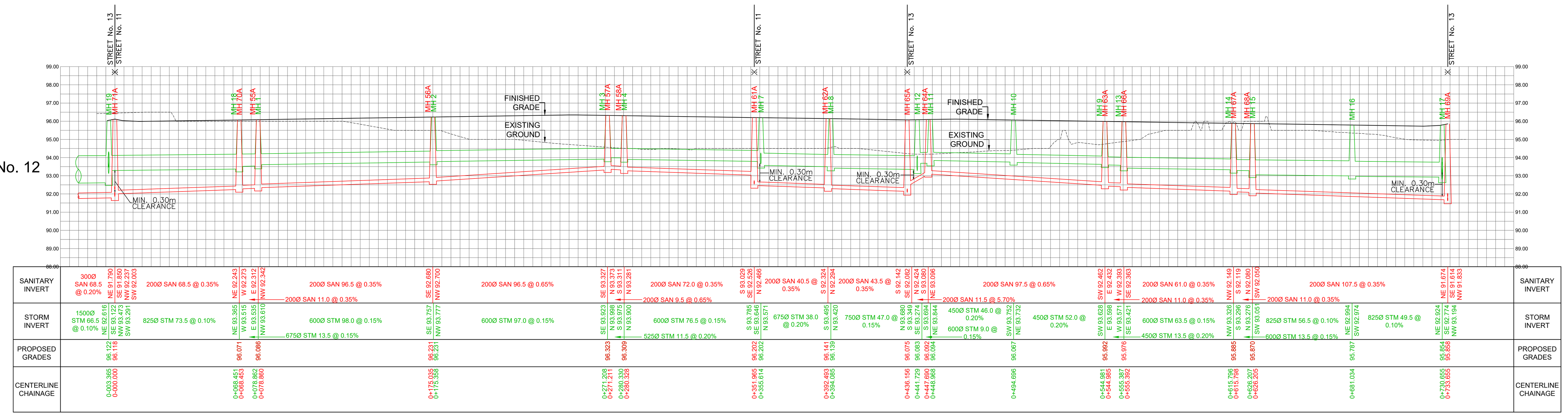

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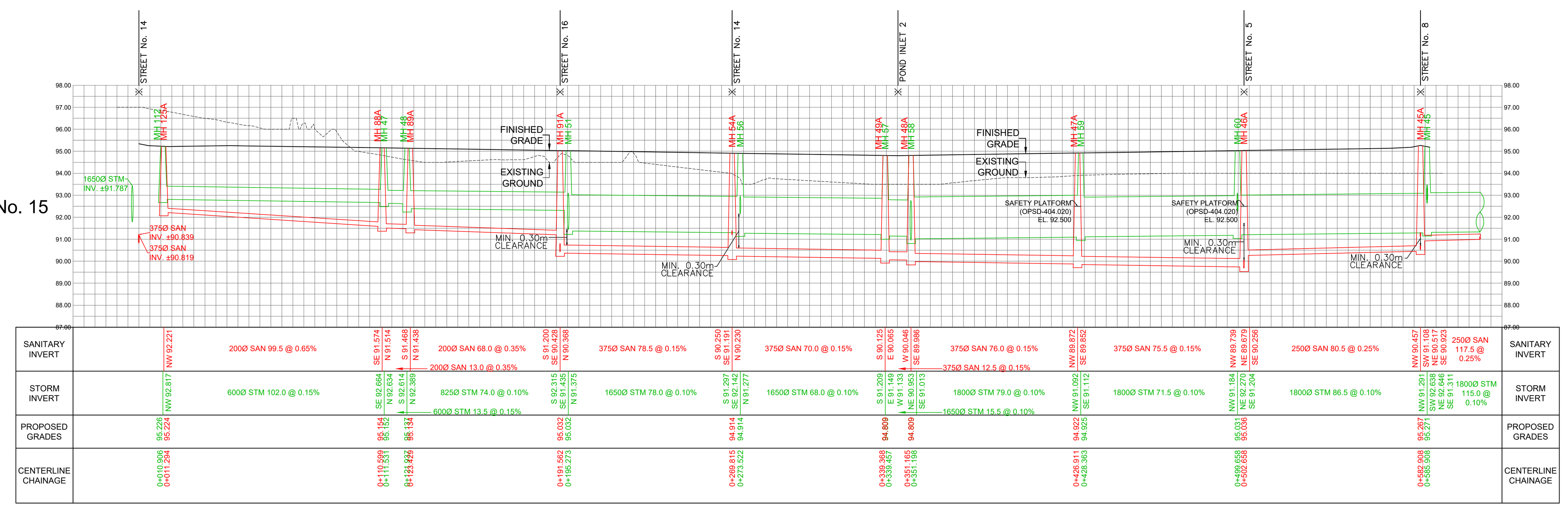

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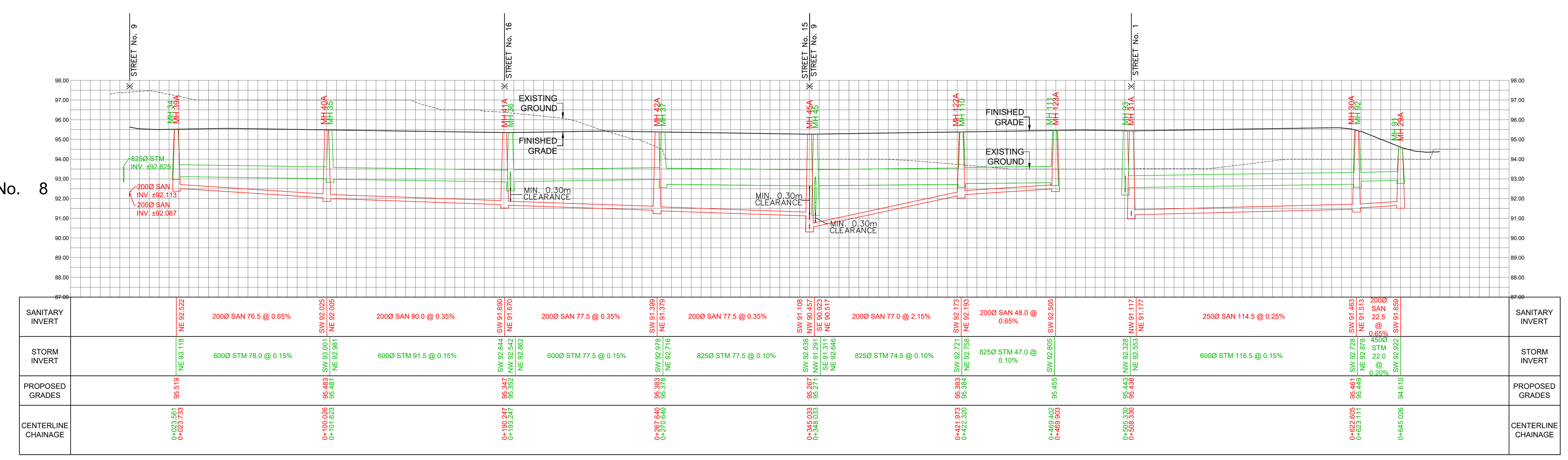

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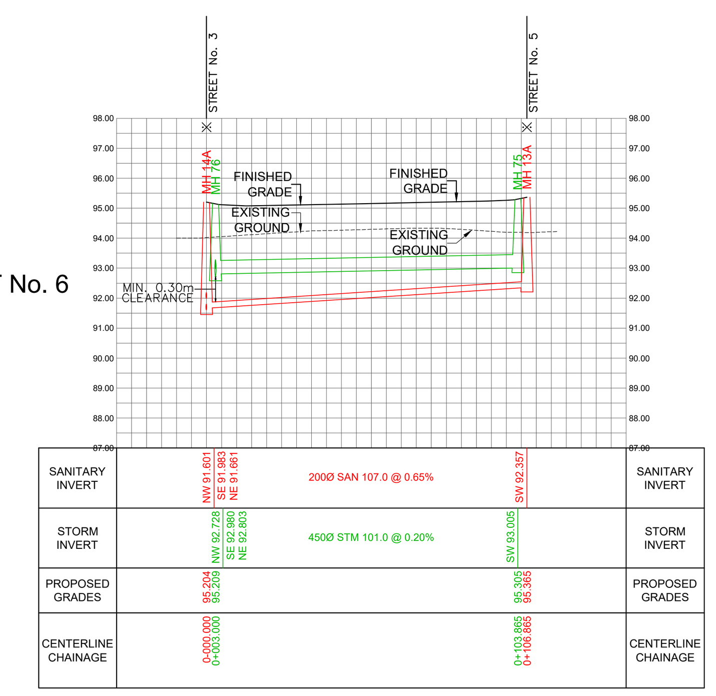

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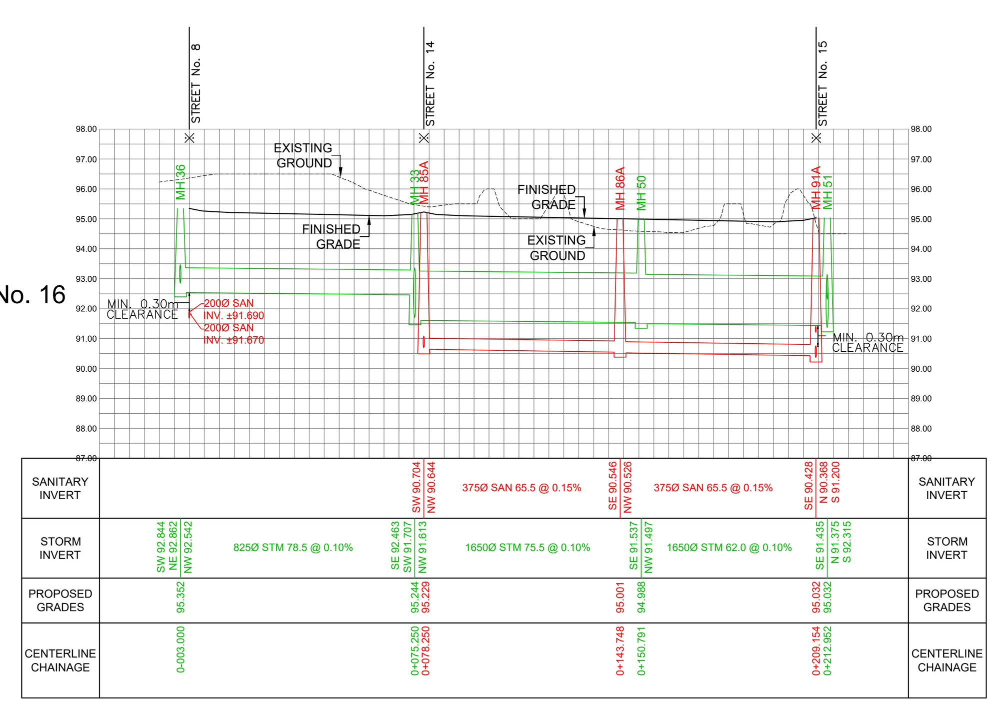

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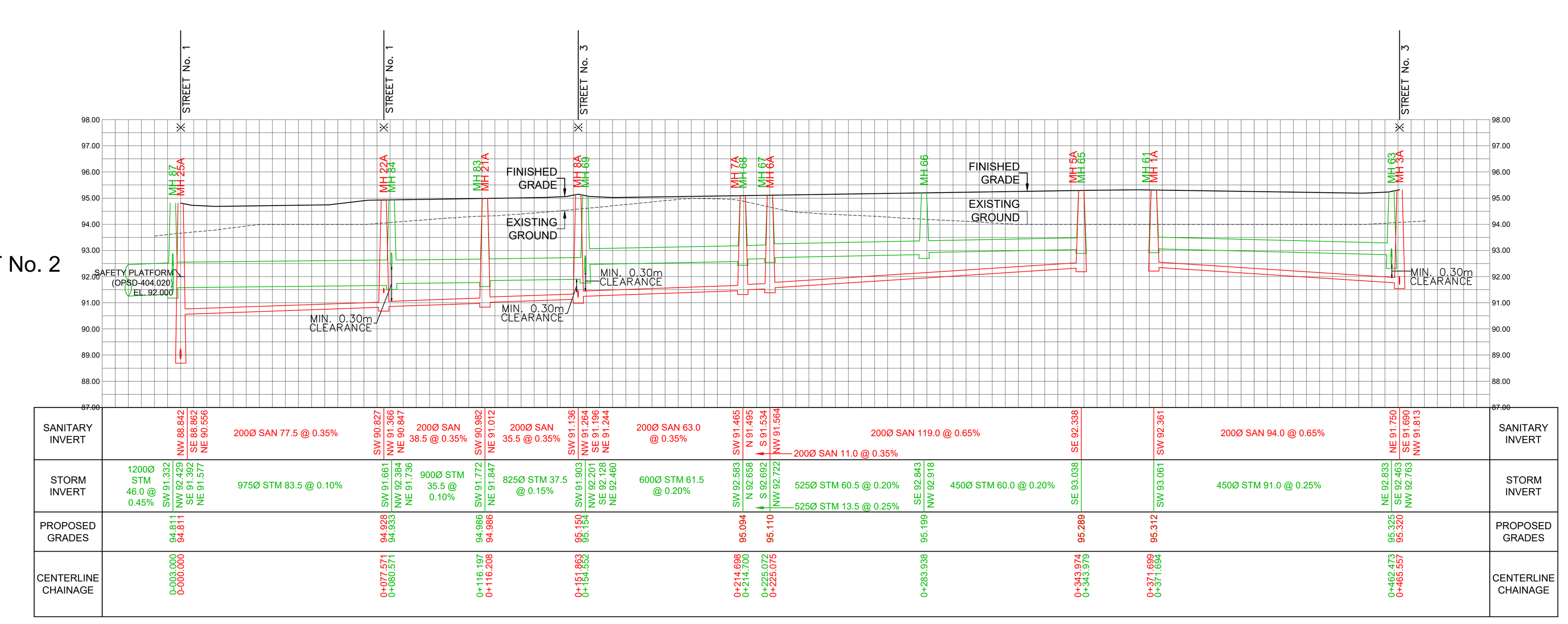

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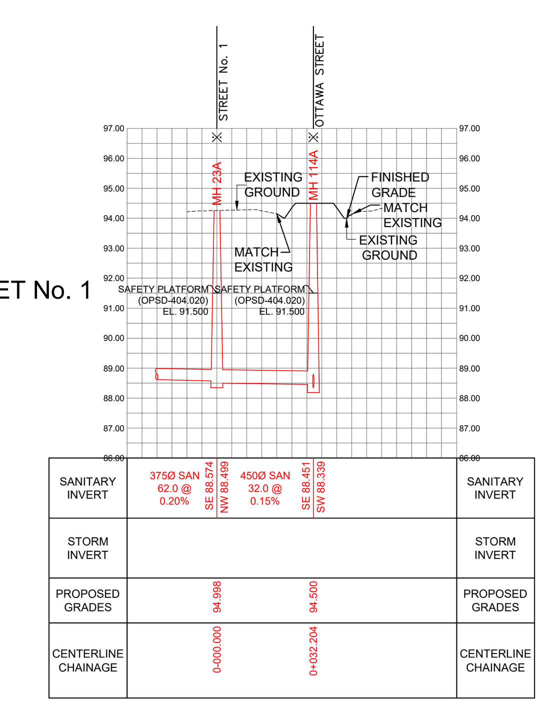

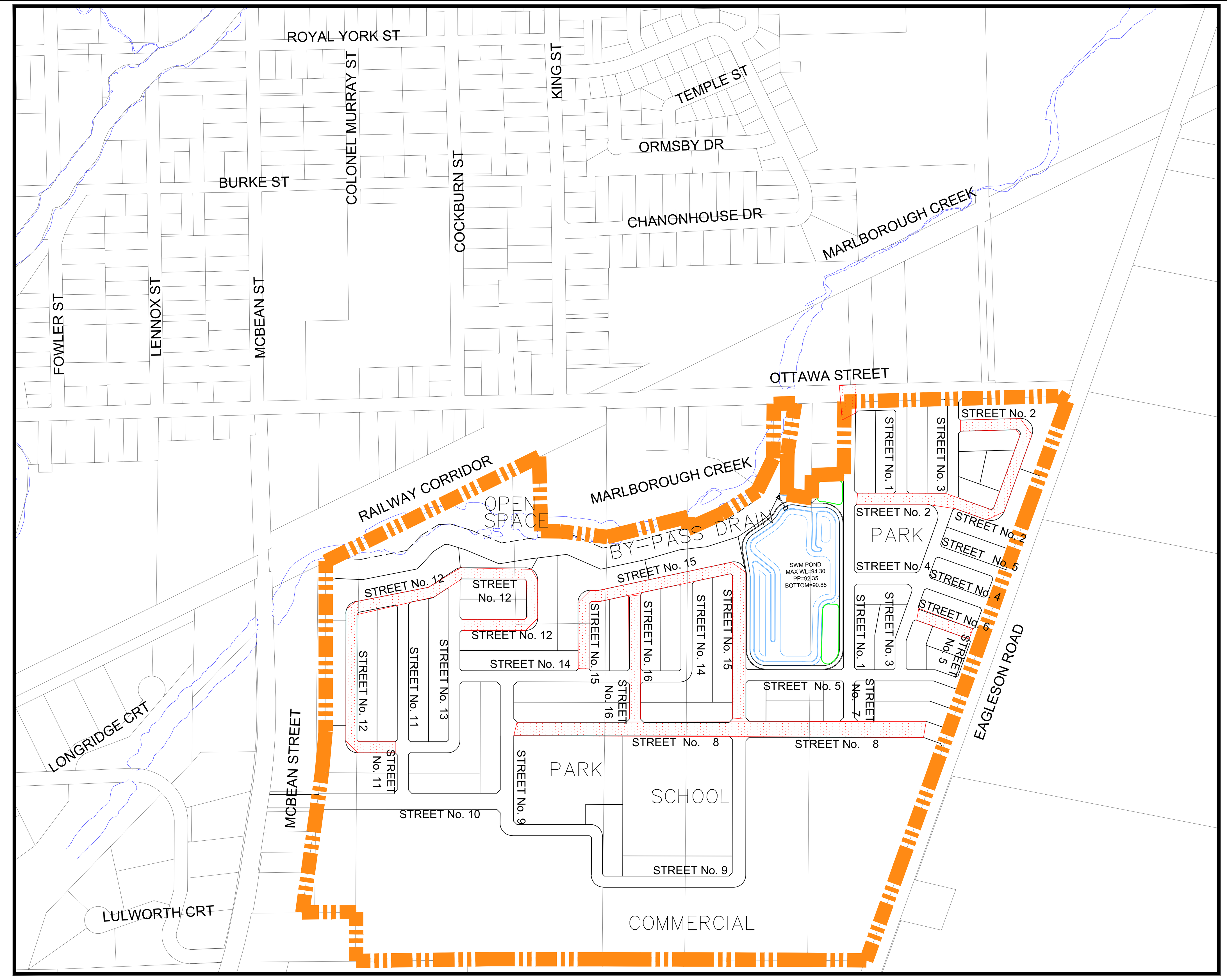

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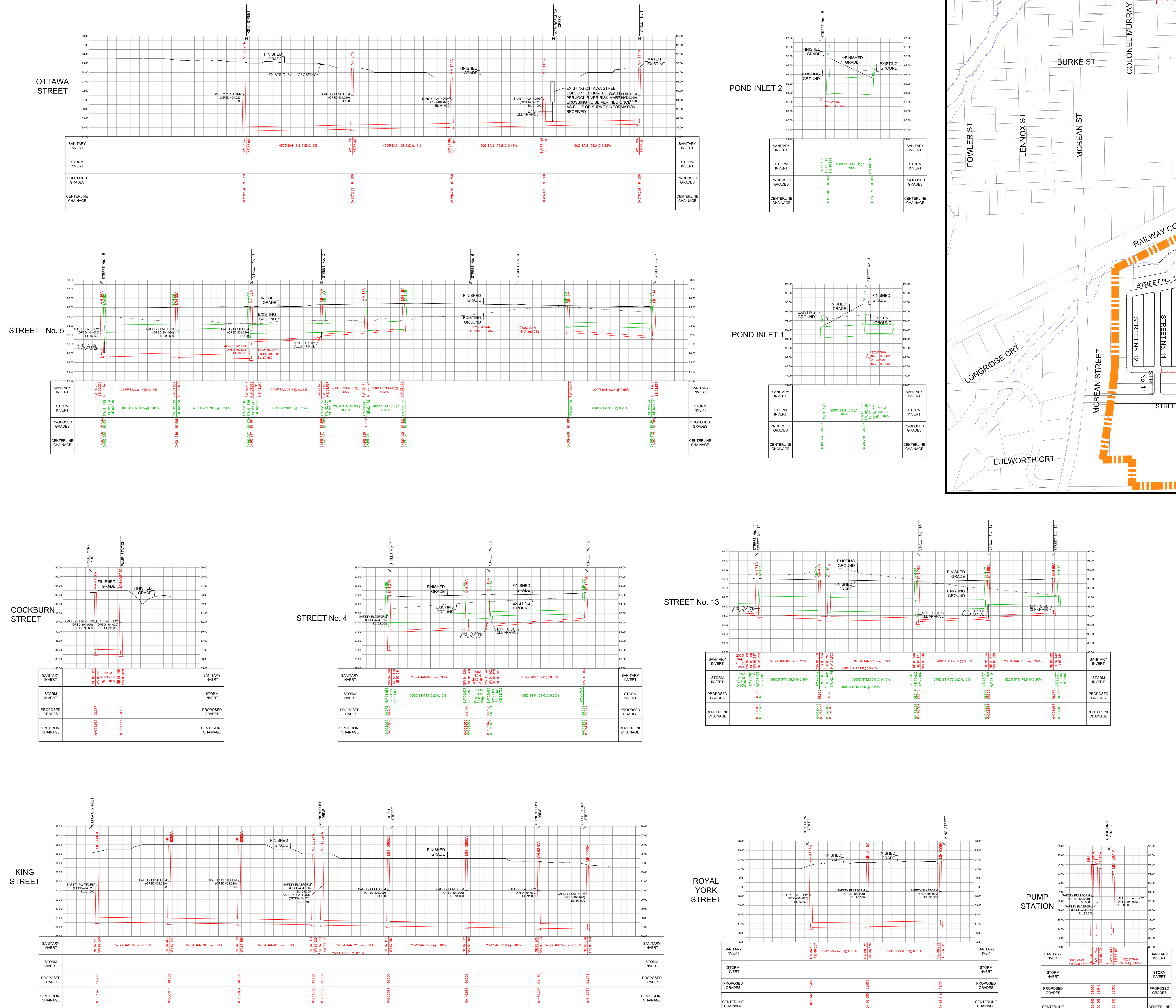
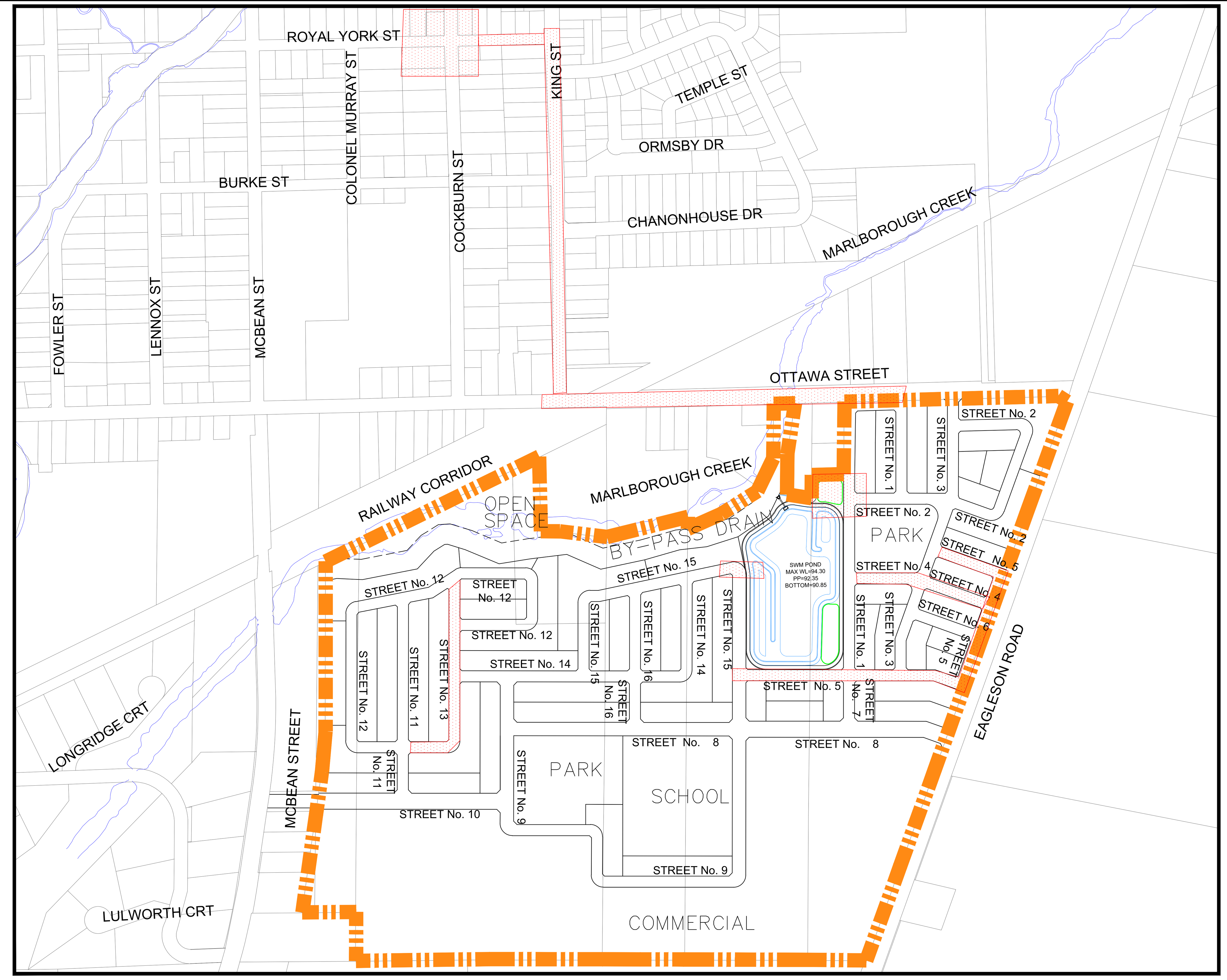
TAMARACK RICHMOND

CITY OF OTTAWA

PROFILES

SCALE:	H 1:2000 V 1:200
PROJECT No.:	1042
DATE:	NOVEMBER 2020
DRAWING:	06D





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TAMARACK RICHMOND	PROFILES		
CITY OF OTTAWA	SCALE: H 1:2000 V 1:200	PROJECT No.:	1042
	DATE: NOVEMBER 2020	DRAWING:	07D

APPENDIX A

Background / Pre-Consultation

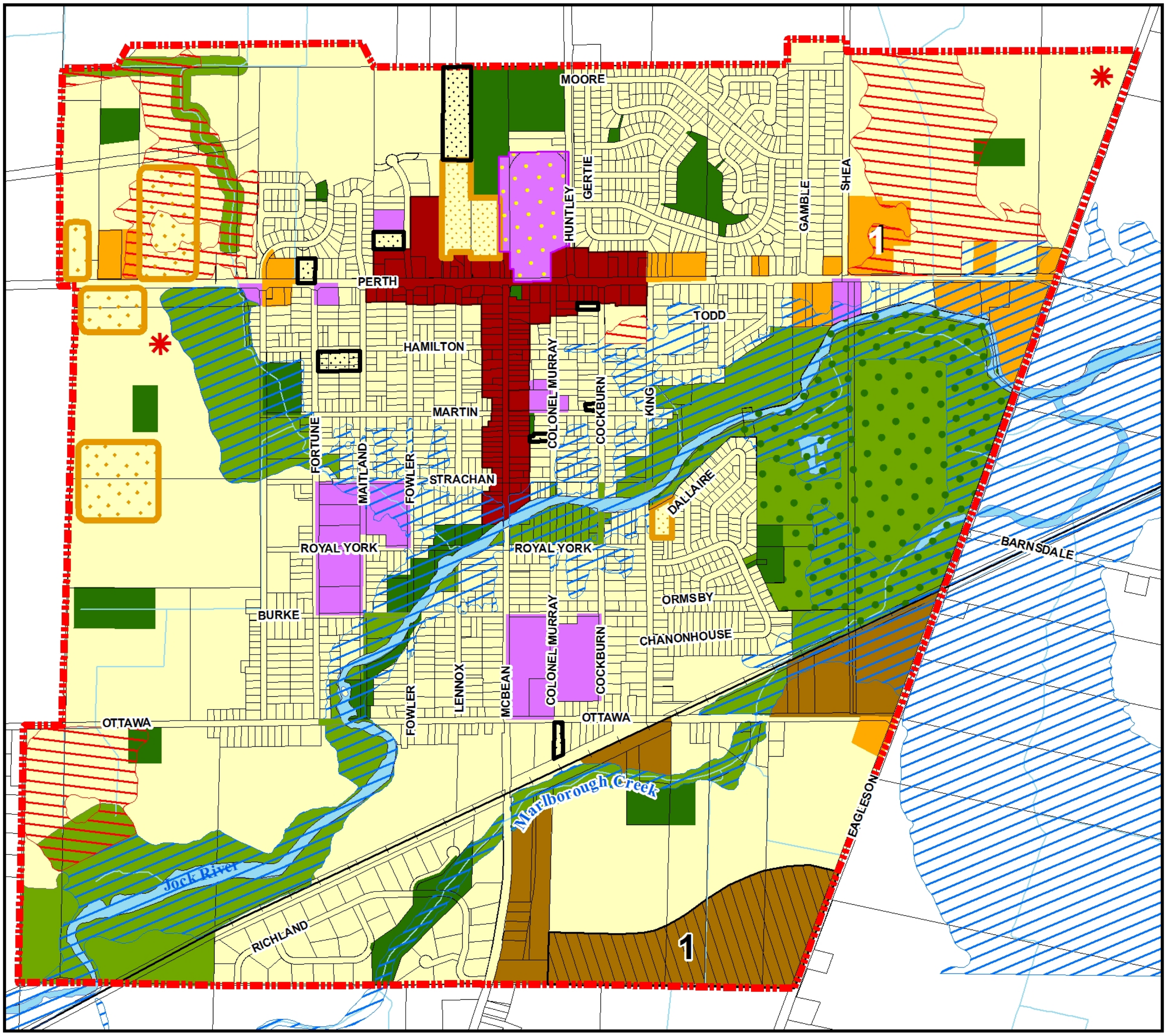
- Schedule A – Land Use, Richmond Secondary Plan
- Pre-Application Consultation Notes by the City of Ottawa dated July 24, 2018

SCHEDULE A - LAND USE

Richmond Secondary Plan

ANNEXE A - UTILISATION DU SOL

Richmond - Plan de conception communautaire



- * Potential Convenience Commercial Uses / Utilisations possibles de commerce de proximité
- Richmond Conservation Area / Zone de conservation de Richmond
- Fairgrounds / Parc d'expositions
- Open Space / Espace ouvert
- Parks / Parcs
- Industrial Area / Zonr industrielle
- 1 Industrial Area 1 / Zone 1 industrielle
- Village Commercial / Commerce de village
- 1 Village Commercial 1 / Commerce de village 1
- Institutional / Institutionnel
- Village Core / Centre du village
- Residential - One and Two Unit / Résidentiel – une et deux unités
- Residential - Ground Oriented Attached / Résidentiel – contiguës de plain-pied
- Residential Apartments / Résidentiel – Appartements
- Floodplain / Plaine inondable
- Floodplain - interim / Plaine inondable – provisoire
- Village Boundary / Limites du village
- Water / Eau
- Watercourses / Cours d'eau

Ottawa

0 250 500 750 1,000 Meters

Scale / Echelle 1 : 19,000 approx.

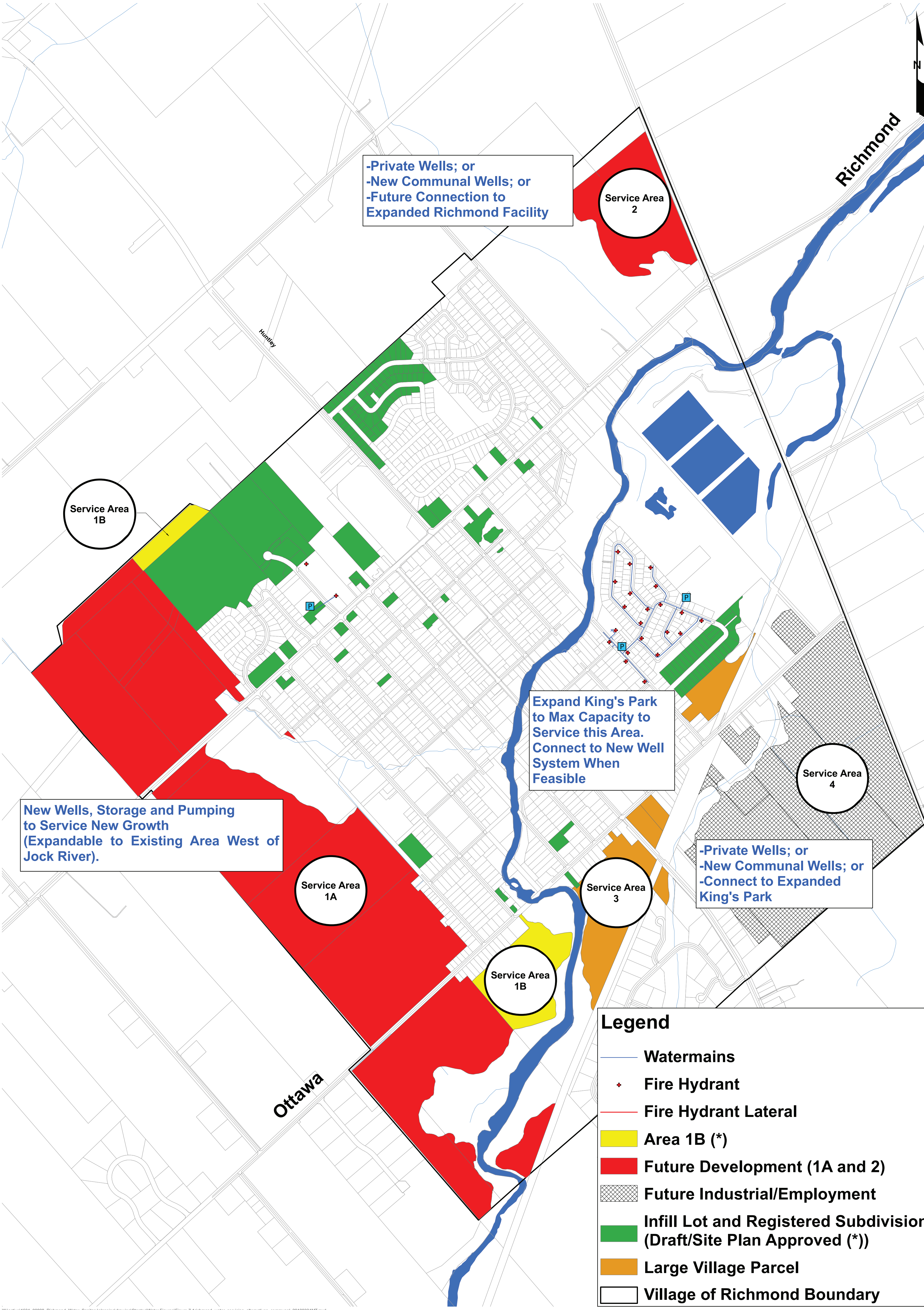
Produced by Infrastructure Services and Community Sustainability /Planning Department / Urban Services / Mapping and Graphics
Produit par Services d'infrastructure et Viabilité des collectivités/ Urbanisme et Gestion de la croissance / Cartographie et Graphiques.

Official Plan for the City of Ottawa Consolidation and Amendments

Plan officiel de la Ville d'Ottawa Amendement au plan directeur approuvé

 # 177 # 209

 # 150



* DENOTES FORMERLY LARGE PARCEL

Stantec

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

Figure No. 7-1

Title
COMMUNAL WATER SUPPLY
ALTERNATIVE SERVICE AREAS

March 2010
1634-00808

Stantec **Memo**

To:	Michelle Taggart c/o Kevin Murphy (DSEL)	From:	Jasmin Sidhu
	Tamarack Developments & Taggart Investments		Stantec Consulting Ltd.
File:	1634-01541	Date:	April 5, 2019

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

OBJECTIVE

Stantec Consulting Ltd. (Stantec) was retained by Tamarack Homes to undertake a hydraulic potable water study to assess, at a high level, various servicing alternatives for the proposed Tamarack Homes development in the Village of Richmond. The proposed development is to be located in the south-eastern part of the Village, bound by Eagleson Road to the northeast, Ottawa Street to the northwest, McBean Street to the southwest, and the intersection of McBean Street and Richland Drive to the south (see **Figure 1**).

This technical memo documents the identification and review of preliminary potable water servicing alternatives.

BACKGROUND

2011 MASTER SERVICING STUDY

Currently, the majority of residences and businesses within Richmond have private shallow or deep wells for their water supply. A small part of the Village is serviced by a City of Ottawa operated communal well system in King's Park. Hyde Park is serviced by a small private communal well system.

In 2011, Stantec completed a Water & Sanitary Master Servicing Study (MSS) for the Village. The MSS provided recommendations for long-term servicing requirements for existing and future potential development within the Village. With regards to water servicing for the entire Village, three (3) alternative solutions were considered, including private well services, communal well system (expansion of existing system and/or addition of new systems), and connection(s) to the City's central water supply system (in Kanata or Barrhaven), or combinations of these.

The preferred alternative was a new public communal well system, where water would be pumped from a deep aquifer to provide servicing for potential growth areas in the western part of the Village, and through a phased approach and system expansions, supply all demand in the entire Village (existing and future) as the need arises in the future.

RECENT WORK

Since completion of the 2011 MSS, development within the Village has progressed and a number of system upgrades have been made. These include the planning and/or construction of new Caivan and Mattamy developments in the Western Development Lands (located west of the Jock River); a proposed infill development (located at 11 King Street); upgrades to the King's Park wells' electrical and SCADA systems; and the construction and commissioning of a new communal well system (i.e. Richmond West Pump Station).

The Richmond West Pump Station, as currently constructed, includes deep wells, well pumps, inground storage, treatment, high lift pumping and fire pumps. This provides adequate potable water and fire flows to service up to the 10-year development level (as per the 2011 MSS), which corresponds to 1,000 single family units or a MXDY demand of 1,611 L/min. The station has been designed to allow for future expansion to accommodate MSS demands for the ultimate high growth scenario which corresponds to a total of 5,361 units (i.e. all existing development plus all future residential and industrial/commercial/institutional development) with a MXDY demand of 7,229 L/min.

TAMARACK DEVELOPMENT WATER DEMANDS

In the 2011 MSS, Parcel 4 (i.e. the Tamarack development area) was originally planned to contain industrial/employment lands and it was proposed to be serviced by either private wells, new communal wells, a connection to the existing King's Park Communal Well System or a connection to the new Richmond West PS (depending on timing and type of development). However, it is now understood that this area is anticipated to be primarily residential and is planned to be rezoned as such. Based on the draft preliminary concept plan (see **Draft Preliminary Concept Plan** attached), the total number of units is estimated to be 1,040 (660 single family and 380 townhouse units). The estimated residential population for the Tamarack development is determined based on projected household sizes as per the City of Ottawa's Water Design Guidelines and is estimated to be 3,270 persons (refer to **Table 1**).

The criteria outlined in the 2013 Water Master Plan (WMP) were followed to estimate water demands for the Tamarack development. Zone Level demands for populations greater than 3,000 persons were used to estimate basic day (BSDY) demands. The demand rates from the WMP were applied to the population projections based on land use and location with respect to the Greenbelt (i.e. outside, denoted as "outside Greenbelt" or OGB). Maximum day (MXDY) demands were determined by adding an outdoor water demand (OWD) of 1,049 L/SFH/d to all single-family house (SFH) units within the development. Peak hour (PKHR) demands were determined by applying a peaking factor of 2.2 to the MXDY demand.

A fire flow of 8,000 L/min was used for the Tamarack development. This flow corresponds to the fire flow used in recently completed water assessments for other residential developments in Richmond and was calculated using the Fire Underwriters Survey (FUS) method for typical connected townhouses (i.e. governing configuration).

Estimated demands are summarized in Table 1.

Table 1 – Conceptual Tamarack Development Water Demands

Unit Type	Unit Count	PPU	Population	2013 WMP Consumption Rates (L/d/cap)	BSDY (L/min)	MXDY (L/min)	PKHR (L/min)
Single-family	660	3.4	2,244	180	281	761	1,674
Townhouse	380	2.7	1,026	198	141	141	310
Total	***1,040***		***3,270***		***422***	***902***	***1,984***
Minimum Required Fire Flow					8,000 L/min for 2.0 hrs		

Reference: **Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives**

SERVICING IMPLICATIONS

The servicing recommendations made in the 2011 MSS were based on the assumption that the land use for this area was to be industrial/employment. The MSS estimated the BSDY, MXDY and PKHR demands for this area to be 0.13 ML/d (90 L/min), 0.20 ML/d (139 L/min), and 0.20 ML/d (139 L/min), respectively. These industrial/employment demand estimates are considerably less than the recalculated conceptual residential water demands presented in **Table 2**.

Table 2 – Recalculated Ultimate Water Demands

Development Level / Scenario	Total # Units	Demands			
		BSDY	MXDY	PKHR	
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	2,861	7,229	17,438	L/min
		4.1	10.4	25.1	ML/d
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	3,193	7,993	19,282	L/min
		4.6	11.5	27.8	ML/d
Difference	***1,040***	***332***	***764***	***1,844***	***L/min***
		0.5	***1.1***	***2.7***	***ML/d***

The recently commissioned Richmond West PS was designed to allow for future expansion to accommodate MSS demands for the ultimate high growth scenario. This scenario considers servicing for the entire Village, including all future development, infill, and existing properties and would provide an ultimate firm capacity of 7,229 L/min and an ultimate storage capacity of 4,455 m^3. However, these ultimate capacities were based on industrial/employment land use in the MSS Parcel 4, not on the proposed Tamarack residential development area.

To quantify the implications of the change in land use, the Village's ultimate development demands were recalculated accordingly. A breakdown and comparison of the MSS versus recalculated pumping rate and storage volume requirements are summarized in **Table 3** and **Table 4**.

Table 3 – Recalculated Ultimate Pumping Rate Requirements

Development Level / Scenario	Total # Units	PKHR Pumping (L/min)	MXDY+Fire Pumping (L/min)	MXDY Pumping (L/min)	BSDY Pumping (L/min)
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	17,438	15,229	7,229	2,861
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	19,282	15,993	7,993	3,193
Difference	***1,040***	***1,844***	***764***	***764***	***332***

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

Table 4 – Recalculated Ultimate Storage Volume Requirements

Development Level / Scenario	Total # Units	MXDY (L/min)	Fire Flow (L/min)	Required MECP Storage Volume (m^3) (1)
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	7,229	8,000 @ 2.0 hrs	4,455
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	7,993	8,000 @ 2.0 hrs	4,800
Difference	***1,040***	***764***		***345***

Notes:
(1) Volume rounded up to the nearest 5 m^3.

PRELIMINARY SERVICING ALTERNATIVES

Based on the understanding of the existing and planned development and servicing in Richmond, three (3) preliminary alternatives have been identified as feasible servicing solutions for the proposed Tamarack development. Each alternative was developed with the following key considerations:

(1) The proposed servicing provides fire flow that meets 8,000 L/min fire flow design criteria based on FUS calculations;

(2) The proposed servicing provides sufficient peak flows to meet City standards; and

(3) The proposed servicing provides system reliability.

The MSS considered the use of private wells to service this area, however that was based on the assumption that the land use would be industrial/employment with limited or no for protection. Private wells are not considered to be a feasible servicing solution for a new residential development of this size based on City of Ottawa and MECP design guidelines, therefore it was not considered as part of this assessment. The MSS also looked at connecting the Village to the City's central water supply system, however this alternative is not considered in this assessment as it clearly not economical for this size of development.

ALTERNATIVE 1: SINGLE FEED FROM RICHMOND WEST PS

1A: Single Feed from Richmond West PS + Connection to King's Park Communal Well System

Alternative 1A consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus approximately 0.4 km feedermain along King Street from the existing King's Park system to the north end of the Tamarack development (refer to **Figure 2**). Under this configuration, the Tamarack development would be serviced such that MXDY, PKHR and fire flow demands would be supplied by the Richmond West PS, while the King's Park system would supply flows during emergency conditions (i.e. break in the feedermain from the PS). A connection could be made to the King's Park system, but is not included in this assessment as it is not required to provide service to the Tamarack development.

The existing King's Park communal well system is owned and operated by the City of Ottawa and provides potable water to a subdivision in the east end of the Village. The system is fed by two groundwater wells. Each well is equipped with a submersible pump with a Ministry of Environment, Conservation and Parks (MECP) permitted throttle withdrawal rate of 912 L/min at a TDH of 48 m (1,824 L/min for the total well system). A 1991 Jacques Whitford Limited study suggested the existing wells could provide up to 1,920 L/min and 4,620 L/min each with a safe aquifer yield of 3,360 L/min (a revised MECP Certificate of Authorization would be required for this increase in pumping capacity). The system provides a limited fire flow capacity of 1,000 L/min for 2 hours which meets minimum allowable fire flow for accreditation but does not meet the 8,000 L/min fire flow criteria based on FUS calculations.

Currently there is insufficient capacity within the King's Park system to accommodate the proposed development. Therefore, King's Park cannot be used to provide the additional MXDY (764 L/min) and PKHR (1,844 L/min) demands, storage (345 m^3), nor the reliability needs required for the proposed revised Tamarack development.

The additional pumping and storage requirement capacity may be accommodated within the existing property limits of the new Richmond West PS, as shown in **Pump Floor Plan** attached. Extending the south wall of future cell 3 out by 2.5 m would provide additional storage capacity to accommodate the additional 345 m^3 required for the Tamarack development. Additional pumping capacity may be provided by converting the existing pumps to larger pumps in the future to accommodate the additional MXDY (764 L/min) and PKHR (1,844 L/min) demands.

The opinion of probable cost (OPC) for the design and construction of Alternative 1A is as follows:

2,400 m of 400 mm dia. feedermain	$2,040,000 (1)
Additional storage (345 m^3), well capacity (764 L/min), and high lift pumping (1,844 L/min) capacity at Richmond West PS	$2,588,000 (2)
1 new well	$350,000 (3)
Sub-Total	*$4,978,000*
Engineering Services (25%)	$1,244,500
Utilities Relocations (5%)	$248,900
City of Ottawa Internal Costs (10%)	$497,800
Miscellaneous Soft Costs (5%)	$248,900
Contingencies (50%)	$3,609,050
Estimated Project Capital Cost	***$10,828,000*** (4)

(1) Assumes a unit rate of $850/m (includes valve chambers).

(2) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).

(3) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.

(4) Rounded up to nearest $1,000.

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

For costing purposes, a feedermain diameter of 400 mm has been assumed, however this size will need to be confirmed through a hydraulic analysis to meet design criteria.

Benefits of Alternative 1A include added reliability and full fire flow to the King's Park system, and the opportunity to service future development parcels south of Ottawa Street (between the Western Development Lands and the Tamarack development area) and approximately 70 existing properties along the proposed feedermain alignment. Other considerations to assess when evaluating this solution include impacts associated with the installation of new feedermains along existing right-of-ways (ROWs), crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

This alternative cannot provide full fire flow to the Tamarack development under emergency conditions (i.e. break in feedermain for Richmond West PS). In the event of a break in the feedermain from the PS, only a limited fire flow of 1,000 L/min could be provided. Therefore, this scenario does not meet the City's current standards for reliability.

1B: Single Feed from Richmond West PS + Elevated Storage Tank

Similar to Alternative 1A, Alternative 1B consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus an additional feedermain from a new elevated storage tank to the Tamarack development (refer to **Figure 3**). For the purpose of this assessment, it is assumed that the elevated tank can be constructed immediately west of the Tamarack development area, therefore a feedermain length of approximately 50 m was used. Under this configuration, the Tamarack development would be serviced such that MXDY demands would be supplied by the Richmond West PS, while PKHR and fire flow demands would be supplied by the elevated storage tank.

For this alternative to be considered feasible, the Richmond West PS would need to be upgraded to provide additional well capacity (764 L/min). The high lift pumping increase would be limited to the MXDY increase, as the increased PKHR flow would be accommodated from the elevated tank. The elevated tank would need to be sized to provide (at minimum) sufficient storage for a fire flow volume of 960 m^3 (i.e. fire flow of 8,000 L/min for 2.0 hrs) plus a balancing and emergency volume of 640 m^3 (i.e. for a MXDY demand of 902 L/min for the Tamarack development) for a total minimum required storage volume of 1,600 m^3. In the event of a break in the feedermain from the Richmond West PS, the elevated tank would be capable of providing full fire flow to the Tamarack development.

Since the Richmond West PS would only be expected to provide MXDY demands (i.e. no PKHR or fire flow demands), a smaller feedermain size of 300 mm has been assumed between the PS and the development for costing purposes. However, this size will need to be confirmed through a hydraulic analysis to meet design criteria.

The OPC for the design and construction Alternative 1B is as follows:

2,000 m of 300 mm dia. feedermain	$1,300,000 (1)
50 m of 400 mm dia. feedermain	$43,000 (2)
Additional well capacity (764 L/min), and high lift pumping (764 L/min) capacity at Richmond West PS	$150,000 (3)
1 new well	$350,000 (4)

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

Elevated storage tank (1,600 m^3)	$3,600,000 (5)
Sub-Total	*$5,443,000*
Engineering Services (25%)	$1,360,750
Utilities Relocations (5%)	$272,150
City of Ottawa Internal Costs (10%)	$544,300
Miscellaneous Soft Costs (5%)	$272,150
Contingencies (50%)	$3,946,175
Estimated Project Capital Cost	***$11,839,000*** (6)

(1) Assumes a unit rate of $650/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(3) Assumes pump change out only.
(4) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(5) Based on recent construction costs for an elevated storage tank (50% of construction cost taken as fixed, remaining 50% taken as a function of storage volume). Expected to vary depending on volume and height.
(6) Rounded up to nearest $1,000.

Benefits of an elevated storage tank include having a constant, reliable water supply and pressure within the system, flow balancing (i.e. lower pumping costs), and potentially reduced feedermain size. Other considerations to assess when evaluating this solution include land acquisition costs for the elevated tank and connected feedermain, social impacts (e.g. compatibility with existing community character), impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

1C: Single Feed from Richmond West PS + At-Grade Storage Tank and High Lift Pumping Station

Similar to Alternatives 1A and 1B, Alternative 1C consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus an additional feedermain from a new at-grade storage tank to the Tamarack development (refer to **Figure 3**) with a high lift pumping station. For the purpose of this assessment, it is assumed that the at-grade storage tank can be constructed immediately west of the Tamarack development area (i.e. same location as elevated storage tank), therefore a feedermain length of approximately 50 m was used. Under this configuration, the Tamarack development would be serviced such that MXDY demands would be supplied by the Richmond West PS, while PKHR and fire flow demands would be supplied by the at-grade storage tank and high lift pumping station.

For this alternative to be considered feasible, the Richmond West PS would need to be upgraded to provide additional well capacity (764 L/min). The high lift pumping increase would be limited to the MXDY increase, as the increased PKHR flow would be accommodated from the at-grade tank. Similar to Alternative 1B, the at-grade tank shall be sized to provide a minimum required storage volume of 1,600 m^3, such that full fire flow protection is available to the Tamarack development under emergency conditions.

The OPC for the design and construction of Alternative 1C is as follows:

2,000 m of 300 mm dia. feedermain		$1,300,000 (1)
50 m of 400 mm dia. feedermain		$43,000 (2)
Additional well capacity (764 L/min), and high lift pumping (764 L/min) capacity at Richmond West PS		$150,000 (3)
1 new well		$350,000 (4)
At-grade storage tank (1,600 m^3) and high lift pumping		$10,400,000 (5)
	Sub-Total	*$12,243,000*
	Engineering Services (25%)	$3,060,750
	Utilities Relocations (5%)	$612,150
	City of Ottawa Internal Costs (10%)	$1,224,300
	Miscellaneous Soft Costs (5%)	$612,150
	Contingencies (50%)	$8,876,175
	Estimated Project Capital Cost	***$26,629,000*** (6)

(1) Assumes a unit rate of $650/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(3) Assumes pump change out only.
(4) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(5) Assumes a unit rate of $6,500/m^3 (based on recent construction costs for an at-grade facility).
(6) Rounded up to nearest $1,000.

Since the Richmond West PS would only be expected to provide MXDY demands (i.e. no PKHR or fire flow demands), a smaller feedermain size of 300 mm has been assumed between the PS and the development for costing purposes. However, this size will need to be confirmed through a hydraulic analysis to meet design criteria.

Other considerations to assess when evaluating this solution include land acquisition costs for the at-grade tank and connected feedermain, higher operational and maintenance costs (i.e. higher pumping costs, additional facility in Richmond for the City to maintain and operate) than an elevated tank, impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

ALTERNATIVE 2: DUAL FEED FROM RICHMOND WEST PS

Alternative 2 consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus approximately 2.1 km of feedermain along Royal York Street east to King Street and south to the Tamarack development (refer to **Figure 4**). Under this configuration, the Tamarack development would be fully serviced by the Richmond West PS (i.e. MXDY, PKHR, fire flow demands).

For this alternative to be considered feasible, the same capacity upgrades to the Richmond West PS as suggested for Alternative 1A would be required (i.e. expanding future cell 3 and increasing high lift pumping/well capacity).

The OPC for the design and construction of Alternative 2 is as follows:

4,100 m of 400 mm dia. feedermain	$3,485,000 (1)
Additional storage (345 m^3), well capacity (764 L/min), and high lift pumping (1,844 L/min) capacity at Richmond West PS	$2,588,000 (2)
1 new well	$350,000 (3)
Sub-Total	*$6,423,000*
Engineering Services (25%)	$1,605,750
Utilities Relocations (5%)	$321,150
City of Ottawa Internal Costs (10%)	$642,300
Miscellaneous Soft Costs (5%)	$321,150
Contingencies (50%)	$4,656,675
Estimated Project Capital Cost	***$13,971,000*** (4)

(1) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).
(3) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(4) Rounded up to nearest $1,000.

With a dual feed from the Richmond West PS, full fire flow would be available to the Tamarack development under emergency conditions of a major pipe break. Additional benefits of a dual feed from one facility include lower operational and maintenance costs (i.e. one facility versus multiple), and the opportunity to service future development, infill, and more than 70 existing properties along the proposed feedermain alignment (depending on the preferred alignment). Depending on the routing, the King's Park system could be decommissioned and the entire area serviced from the Richmond West PS, as recommended in the MSS.

Other considerations to assess when evaluating this solution include impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

ALTERNATIVE 3: NEW STANDALONE COMMUNAL WELL SYSTEM

Alternative 3 consists of a new communal well system within the Tamarack development (refer to **Figure 5**) which would fully service the area (i.e. MXDY, PKHR, fire flow demands). This system would be similar to the Richmond West PS system, consisting of new wells, storage reservoirs, building structure, piping, pumps, equipment, electrical, generator, SCADA, and treatment. The new system would be designed to sufficiently service domestic and fire flow demands for the Tamarack development. The new standalone system would be designed to provide a minimum required storage volume of 1,600 m^3, which would provide sufficient storage for a fire flow volume of 960 m^3 (i.e. fire flow of 8,000 L/min for 2.0 hrs) plus a balancing and emergency volume of 640 m^3 (i.e. for a MXDY demand of 902 L/min for the Tamarack development).

The OPC for the design and construction of Alternative 3 is as follows:

New pumping station & reservoirs		$12,000,000 (1)
2 new wells		$700,000 (2)
	Sub-Total	*$12,700,000*
	Engineering Services (25%)	$3,175,000
	Utilities Relocations (5%)	$635,000
	City of Ottawa Internal Costs (10%)	$1,270,000
	Miscellaneous Soft Costs (5%)	$635,000
	Contingencies (50%)	$9,207,500
	Estimated Project Capital Cost	***$27,623,000*** (3)

(1) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).
(2) Includes well drilling and preparation.
(3) Rounded up to nearest $1,000.

The benefit of a new communal well system is that it can be designed to have sufficient capacity (pumping and storage) to service domestic and full fire flow demands for the Tamarack development. It can also be designed with the consideration of future expansion to potentially service nearby future development areas and/or add reliability to the King's Park system. A portion of the development area would need to be allocated for the new pump station which reduces the total number of lots. Other considerations to assess when evaluating this solution include wastewater needs for treatment, additional operational and maintenance costs for the City to operate a third station in Richmond, and potential hydrogeological impacts.

ALTERNATIVE FEEDERMAIN ALIGNMENTS

Alternative feedermain alignments may be considered to optimize ultimate servicing conditions. These alternative alignments may include any combination of the following:

- One feed along the southern part of the Village. This feed would be approximately 2.6 km long and run from the PS, southeast through the Western Development Lands, then northeast through either future development lands or along Ottawa Street to the Tamarack development. With this alignment, feedermain costs may be shared with other developers to reduce total costs to Tamarack Homes. A hydraulic analysis would be required to appropriately size this feedermain to service any connected properties.

- One feed through the centre of the Village. This feed would be approximately 2.3 km long and run from the PS, northeast along Royal York Street (or an adjacent parallel ROW), then southeast along King Street to the Tamarack development. This alignment would provide an opportunity for a future connection between the King's Park system and the Richmond West PS, which would add reliability and additional flow capacity for firefighting to the King's Park system. There is also opportunity to service future development and infill near King's Park and to connect existing properties along the feedermain corridor.
- One feed along the northern part of the Village. This feed would be approximately 3.0 km long and run from the PS, northwest along Fortune Street, northeast along Perth Street, then southeast along King Street to the Tamarack development. This alignment would provide an opportunity to service future development and infill along Perth Street (including the future development area in the northern part of the Village at Eagleson Road and Perth Street), and to connect more existing properties along the feedermain corridor. Similar to the previous alignment, this feed would also provide an opportunity for a future connection between the King's Park system and the Richmond West PS.

For each of the different feedermain alignments there would likely be different cost sharing possibilities for existing and future developments. These may require considerable further discussion to select the optimum route for the feedermain(s).

Costs associated with water quality (i.e. re-disinfection for long pipe lengths), operation and maintenance have not been included in the OPCs presented above. Water quality may be considered through a water age analysis to establish treatment needs. Private wells or connection to the City's central water supply were not considered to be feasible servicing options.

SUMMARY

Three preliminary servicing alternatives were identified and established to service the proposed Tamarack development. Although Alternative 1A does not meet the full fire protection under a feedermain break scenario, and therefore does not meet the City's current standards for reliability, it has been included in this assessment for consideration as a potential short term alternative. The OPC for Alternative 1A is as follows:

Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System	$10,828,000

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

Alternatives 1B, 1C, 2 and 3 are considered to be technically feasible solutions. The OPC for each of these alternatives are as follows:

Alternative 1B: Single Feed from Richmond PS + Elevated Storage Tank	$11,839,000
Alternative 1C: Single Feed from Richmond PS + At-Grade Storage Tank and High Lift Pumping Station	$26,629,000
Alternative 2: Dual Feed from Richmond PS	$13,971,000
Alternative 3: New Standalone Communal Well System	$27,623,000

REFERENCES

Stantec Consulting Ltd. (2011). *Village of Richmond Water & Sanitary Master Servicing Study.* Ottawa.

Stantec Consulting Ltd. (2013). *City of Ottawa 2013 Water Master Plan.* Ottawa.

Stantec Consulting Ltd. (2015). *Village of Richmond Water Servicing - Staging/Phasing Functional Design.* Ottawa.

Stantec Consulting Ltd. (2017). *Richmond Pump Station - Design Brief.* Ottawa.

Stantec Consulting Ltd. (2017). *Richmond Western Development Lands Caivan Communities - Phase 1 Water Distribution System Analysis.* Ottawa.

Stantec Consulting Ltd. (2018). *Richmond Infill Development - Extension of King's Park Well System Potable Water Hydraulic Assessment.* Ottawa.

Stantec Consulting Ltd.

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Senior Technical Reviewer
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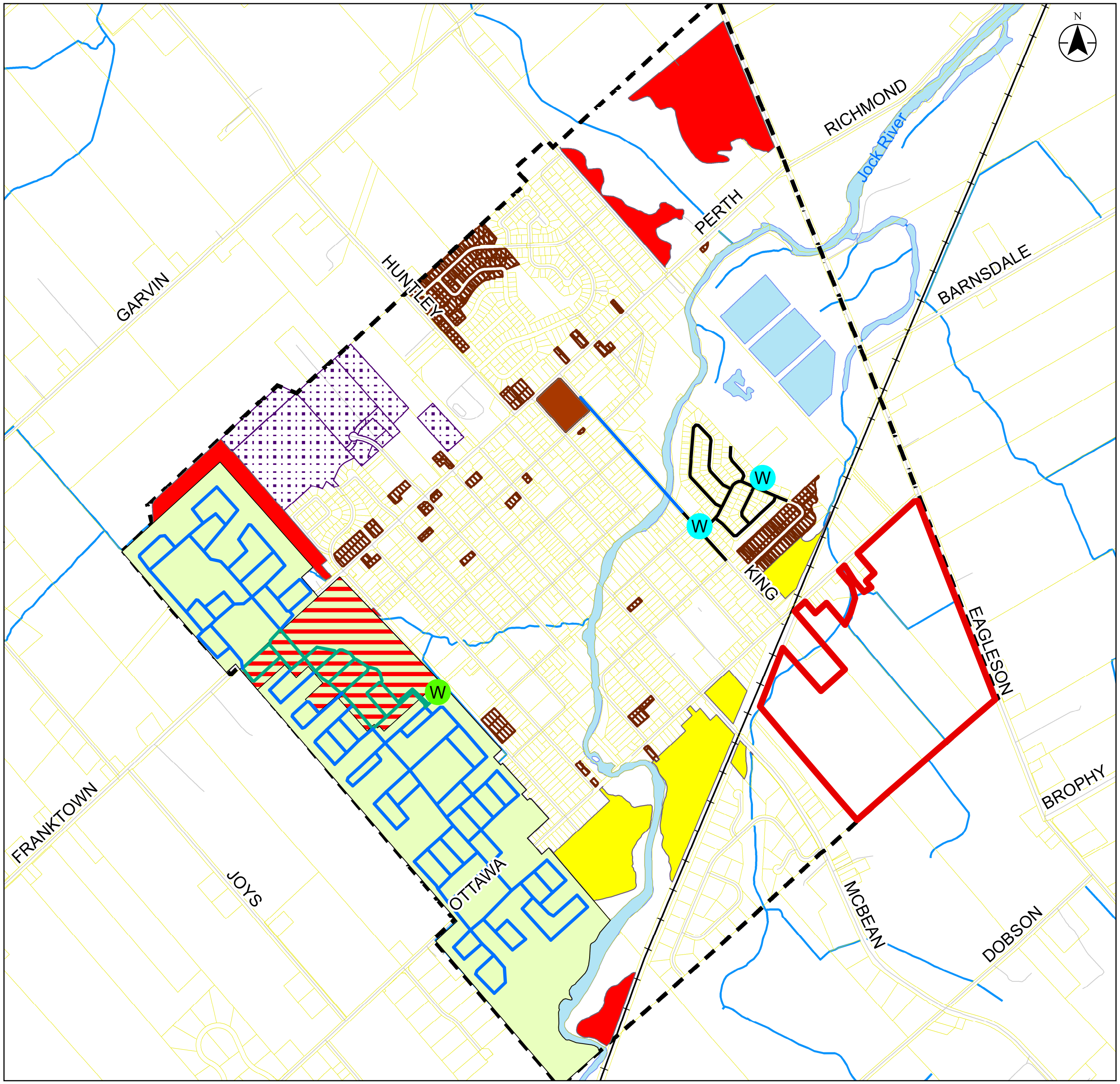
John.Krug@stantec.com

c. Kevin Alemany, Gregory Chochlinski

Attachment:
Figure 1 – Tamarack Development Area & Richmond's Water Servicing
Draft Preliminary Concept Plan
Figure 2 – Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System
Pump Floor Plan (Proposed Expansion of Richmond West PS)
Figure 3 – Alternative 1B/1C: Single Feed from Richmond PS + Elevated/At-Grade Storage Tank
Figure 4 – Alternative 2: Dual Feed from Richmond PS
Figure 5 – Alternative 3: New Standalone Communal Well System



Stantec

Legend

- Existing Watermain
- Proposed Watermain (Caivan Phase 1)
- Proposed Watermain (Other)
- W King's Park Communal Well
- W Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Caivan Phase 1
- Western Development Lands
- 11 King Street Infill Development
- Other Future Development
- Other Future Large Village Parcel
- Other Future Residential Development
- Other Future Infill Development
- Property Parcel
- Village of Richmond Boundary

0 500 1,000 metres

1:25,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
1

Title
Tamarack Development Area & Richmond's Water Servicing

DRAFT

PRELIMINARY LAND USE

LAND USE	BLOCK	AREA (ha)
Residential Area *30-33m Lot Depth*	-	36.4
Village Commercial	Block A	1.4
Woodlot	Block B	1.1
Richmond By-Pass Drain	Blocks C-E	2.8
Stormwater Management Facility	Block F	2.4
Other Lands	Blocks G-H	1.5
Park & Parkette	Block I-J	3.3
Roads	-	14.8

APPROXIMATE TOTAL AREA **63.7ha**
Residential area does not include the area required to provide road access to adjacent property

APPROXIMATE RESIDENTIAL FRONTAGE **10,655m**
Frontage does not account for exterior side yard setbacks

APPROXIMATE ROAD LENGTH **8,535m**
Includes 14.0m Window Streets; 16.5m Local Roads; 24.0m Collector Road

Note: Concept plan is preliminary and land use areas are approximately only; Not based on a survey

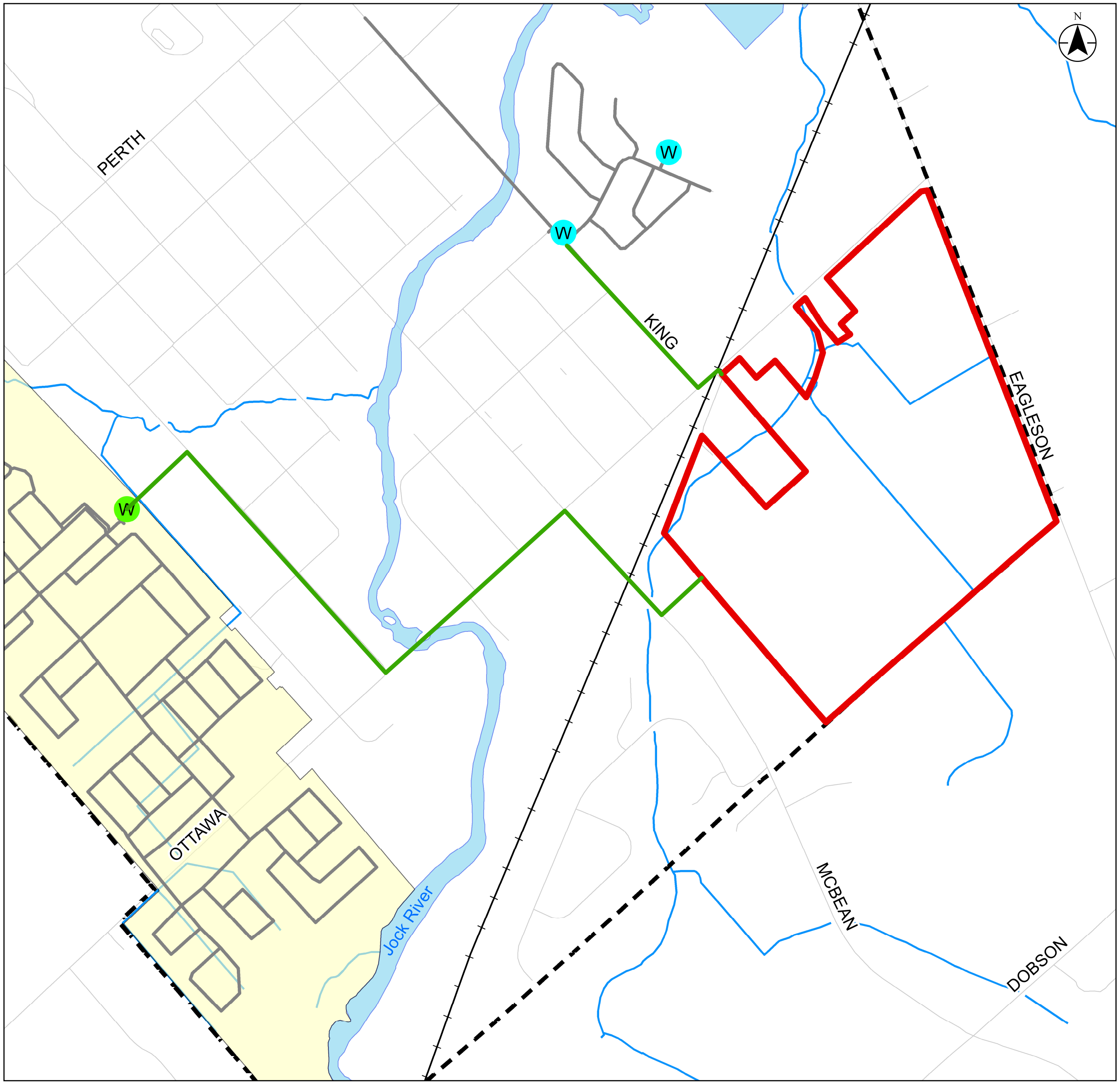
Not to Scale October 12, 2018 18.549

PRELIMINARY CONCEPT PLAN Option 1B *Residential*

Ottawa Street and Eagleson Road

City of Ottawa

WND associates
planning + urban design



Stantec

Legend

- Alternative 1A Feedermain
- Existing / Proposed (Other) Watermain
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

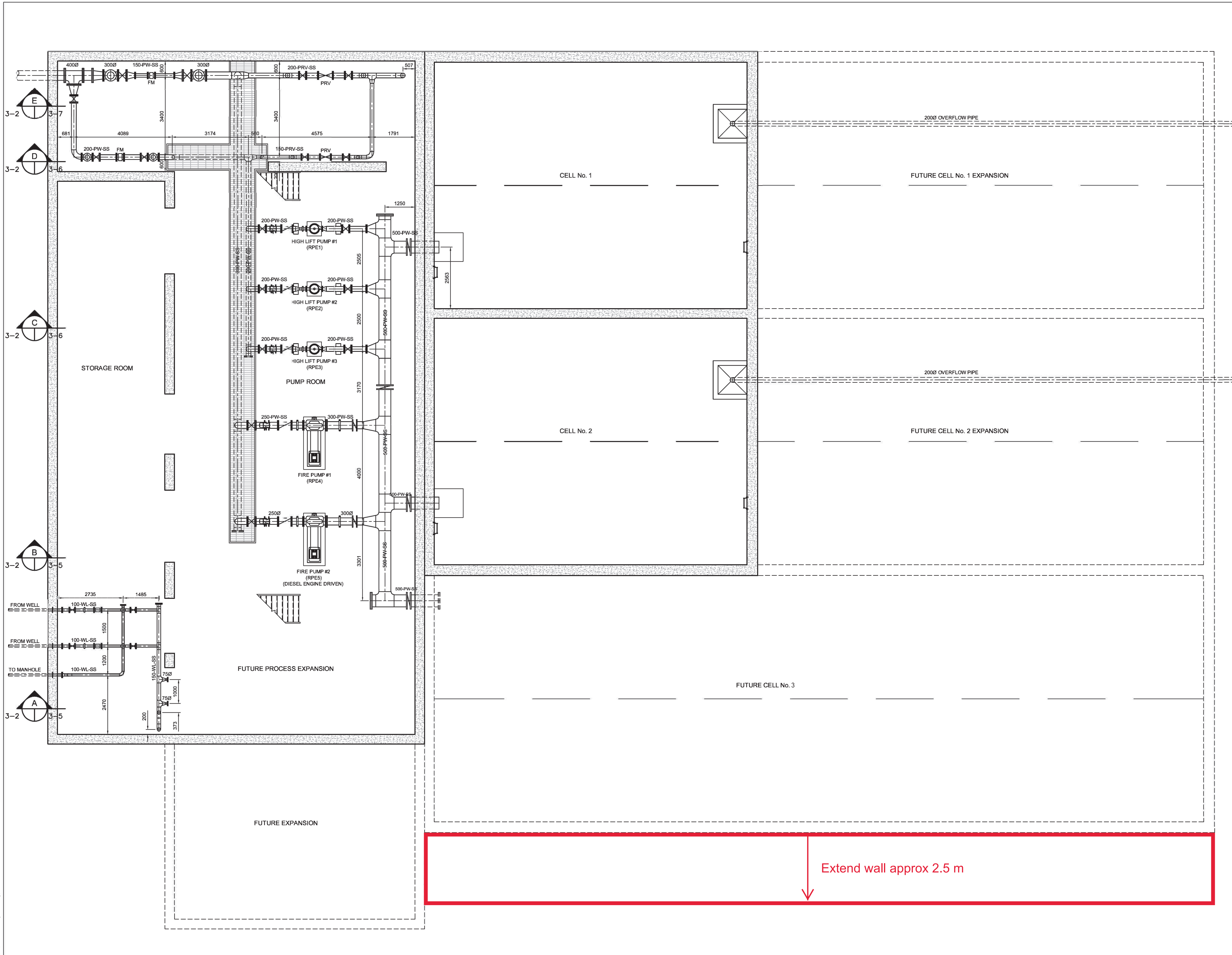
1:15,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
2

Title
Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System



Stantec

1331 Clyde Avenue
Ottawa, ON, K2C 3G4
Tel. 613-722-4420
www.stantec.com

Consultants

Legend

Notes

Revision | By | Appd. | YY.MM.DD

A ISSUED FOR FUNCTIONAL DESIGN	G.C.	J.K.	15.10.15

Issued | By | Appd. | YY.MM.DD

File Name: | Dwn. | Chkd. | Dsgn. | YY.MM.DD

Permit-Seal

Client/Project

VILLAGE OF RICHMOND
NEW RESERVOIR
Ottawa, ON.

Title

PUMP FLOOR PLAN
ELEV.95.000

Project No. 163401291

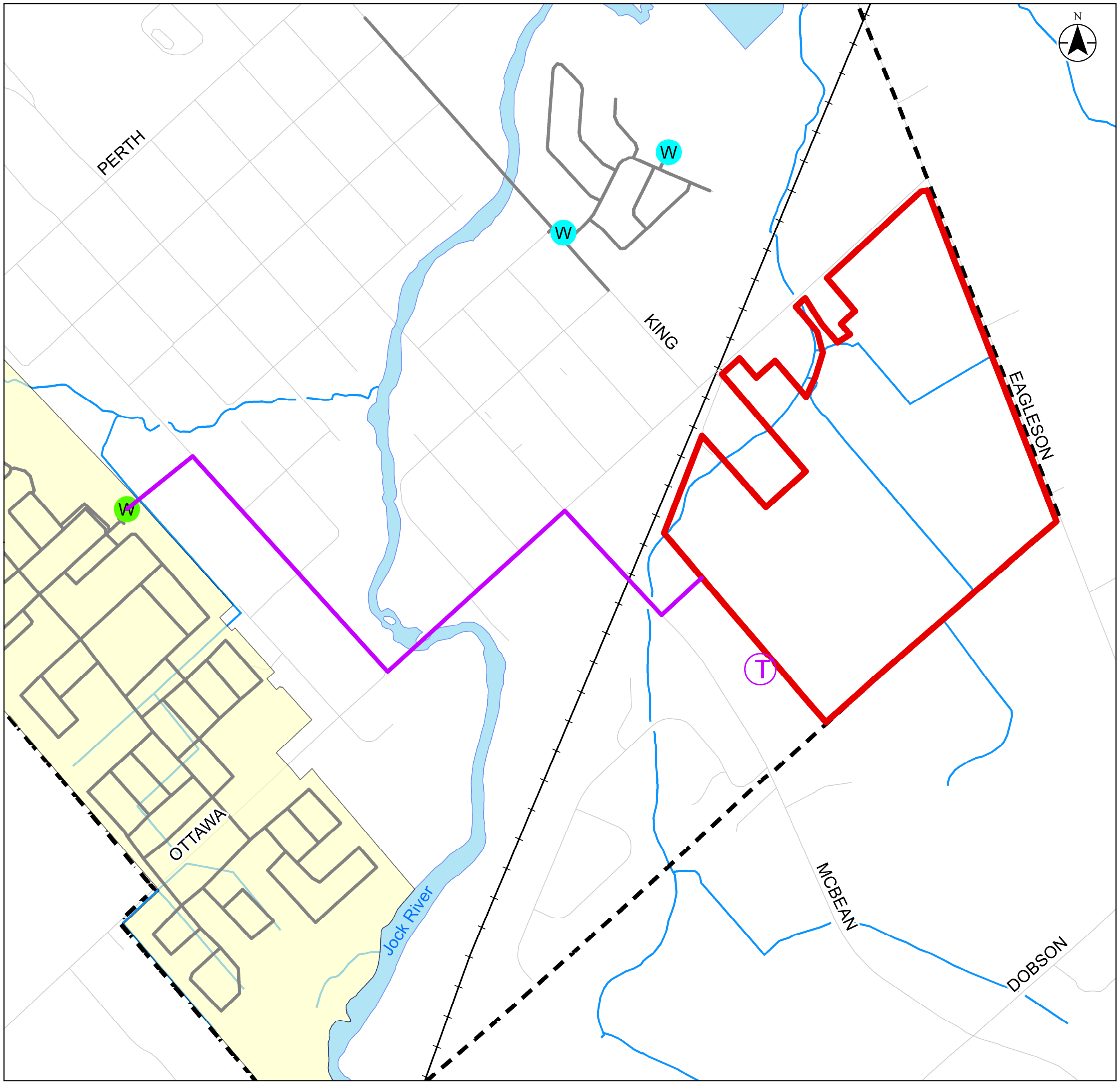
Scale 0 750 2250 3750mm

Figure No. 3-2

Sheet of

Revision

ORIGINAL SHEET - ANSI D



Stantec

Legend

- Alternative 1B/1C Elevated/At-Grade Storage Tank
- Alternative 1B/1C Feedermain
- Existing / Proposed (Other) Watermain
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

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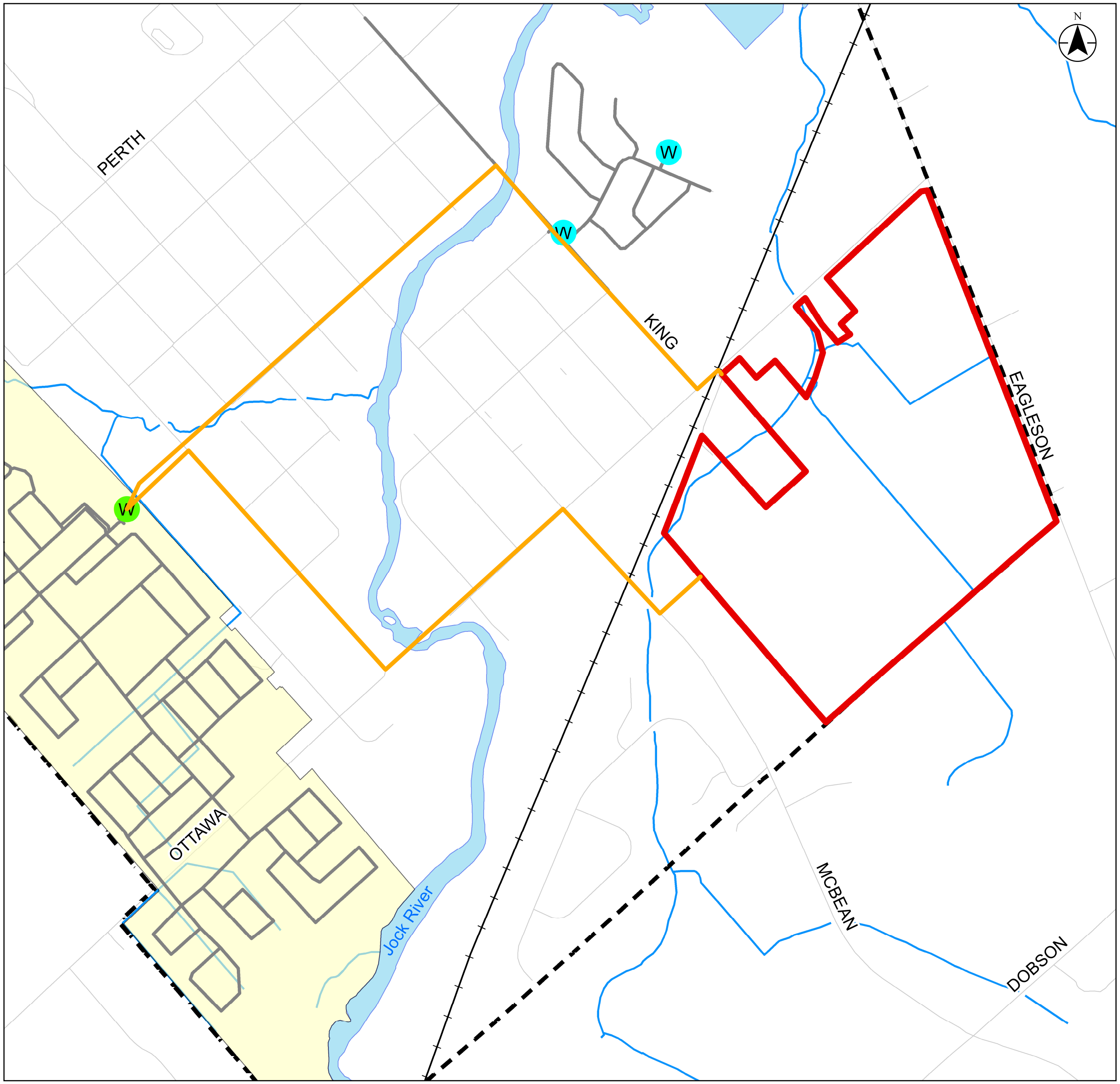
Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
3

Title
Alternative 1B/1C: Single Feed from Richmond PS + Elevated/At-Grade Storage Tank



Stantec

Legend

- Alternative 2 Feedermain
- Existing / Proposed (Other) Watermain
- W King's Park Communal Well
- W Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

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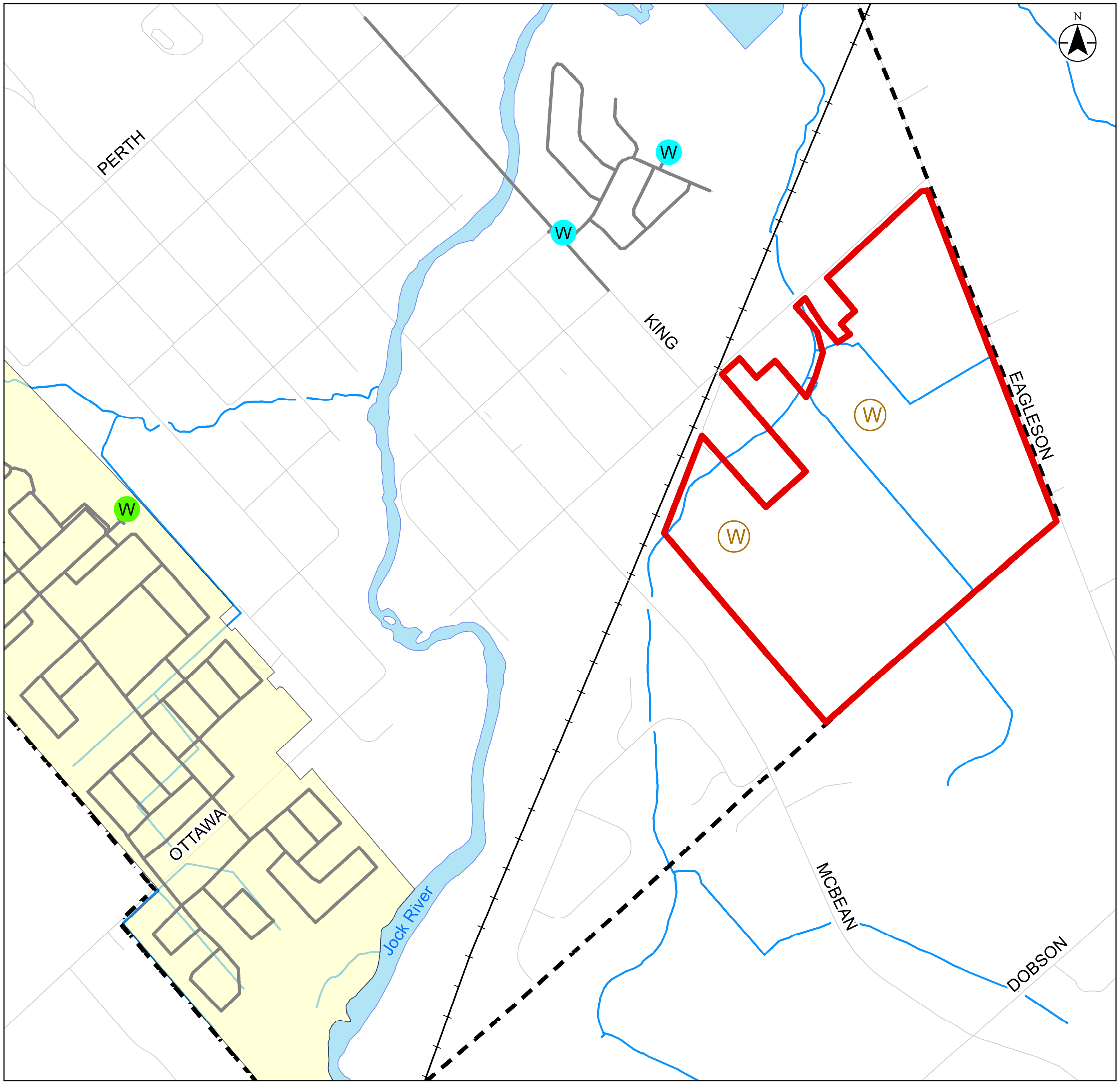
Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
4

Title
Alternative 2: Dual Feed from Richmond PS



Stantec

Legend

- W — Alternative 3 Communal Well
- Existing / Proposed (Other) Watermain
- W — King's Park Communal Well
- W — Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

1:15,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
5

Title
Alternative 3: New Standalone Communal Well System

Pre-Application Consultation Notes

Date:	July 24th, 2018
Subject Address:	Ottawa Street and Eagleson Road
City Staff Attendees:	Sarah McCormick, Planner II (File lead) Damien Whittaker, Senior Engineer Matthew Hayley, Planner II (Environmental) Joseph Zagorski, Senior Project Manager John Bougadis, Senior Project Manager Tessa Di Iorio, Risk Management Official Amira Shehata, Project Manager (Transportation) Bruce Finlay, Planner III (Policy) Mark Young, Planner II (Design) Eric Lalande, Planner - Rideau Valley Conservation Authority
Existing Use:	
Existing Policies:	
Zoning:	RG3[385r]-h
Official Plan:	Village
Secondary Plan:	Residential1/2 Unit, Industrial Area 1, Village Commercial, Parks
CDP:	Industrial Area, Parks, Residential, off road pathways
Proposed Use:	Residential subdivision (mix of singles, townhomes, and back-to-back towns) Modify location of Industrial Lands 1 to accommodate industrial subdivision.
Comments:	
Planning Sarah.McCormick@ottawa.ca **(613) 580-2424 Ext. 24487**	It is understood that the residential built form includes a mix of singles, semis, and townhouses. I would note that stacked townhouses, as defined by the zoning by-law, would require an Official Plan Amendment. The Secondary Plan does permit for limited multiple attached dwellings, therefore a planning rationale will need to demonstrate how the concept plan meets this policy as there is currently more land dedicated to townhouses then semis and singles. The city would also be looking for a greater mix of the various housing forms, not split by dwelling type. Staff are not opposed to the relocation of the Industrial lands along Eagleson Road, as long as the Secondary Plan policy regarding a minimum of 18.5 hectares of employment land are maintained within the subdivision. Please note that the application will need to demonstrate how the floodplain will affect the employment land. After considering land that will be removed as a result of the floodplain, the employment lands will need to retain 18.5 hectares of land. In addition, that the portion of the property designated Village Commercial (along Ottawa Street), are not considered within this 18.5 hectares.

Infrastructure Damien.Whittaker@ottawa.ca **(613)580-2424 ext. 16968**	Water pipes: No municipal water pipes are adjacent the proposed development. A hydrogeological and terrain analysis study is required, with GUDI analysis, to determine that a satisfactory quality of groundwater is available and at a flow that exceeds design requirements should the proponent wish to source groundwater for potable water. The parameters tested shall be the "subdivision suite" known to local well testing companies. Please note that a Drinking Water Works Permit (DWWP) and a Drinking Water License (DWL) will be required and a comprehensive threat assessment that updates the reports of the existing large supply wells in the area. The current timeframe for the Ministerial approval process is approximately three years. Fire protection will be required- please note that the Master Servicing Study (MSS) suggests an elevated tank. The City will need any new municipal well system to be connected to the King's Park well system. Sewers near the well system, and the connection to the King's Park well system, shall be designed, constructed, and tested to significantly higher than normal sewer pressures. A chlorine testing chamber, with full-weather, paved access will be required. Sanitary Sewers: No municipal sanitary pipes are adjacent the proposed development. There are no sanitary sewers near the proposal. The development should, in due course, connect to the existing Richmond Village sanitary pump station, though presently no capacity exists. Buoyancy calculations will be required and the previous sanitary rates with the new infiltration rates will be required. Flow rates shall be based on the higher, design rates (and not the recently revised rates), except infiltration that shall be the revised, higher rate. Storm Sewers: No municipal storm pipes are adjacent the proposed development. Should storm sewers be designed with standing water the full inclusion of appropriate requirements of the sewer design guidelines will need to be applied. Part of the conveyance flow of the storm sewers and, if proposed, SMW pond, will be subtracted for groundwater flow. Buoyancy calculations will be required. Groundwater: Groundwater is anticipated to be high and the level is to be derived from long-term analysis. With the high groundwater anticipated, the City advises against basements for the

	development. An (annual) groundwater elevation will be required- it is suggested that the current year will be artificially low, and also that certain times of the year will provide artificially low results. A hydrogeologist may be retained to provide support for the required analysis. Noise and vibration: A noise and vibration study is required for the train corridor in proximity to the proposal and a noise report for traffic. A significant safety barrier is anticipated to be required between the rail location and the development. Storm Water Management: Stormwater management quality criteria shall follow the RVCA's requirements of 80% TSS removal. The quantity criteria for the development is that 100-year post-development shall match 5-year pre-development. LID is required as per the memo from the former MOECC (now MOECP). The developer will need to show legal and sufficient outlet for stormwater flows. A water budget will need to be developed for the proposal. Any existing stormwater runoff from adjacent site(s) that crosses the property must be accommodated by the proposed stormwater management design. All stormwater management determinations shall have supporting rationale. Stormwater management solutions should be in concurrence with the content of the jock River reach 2 and mud Creek Subwatershed Study. Front-ending agreement Should the developer intend to pursue front-ending agreements for parts of the development a longer notice may assist a smoother process. Roads: Please refer to the City of Ottawa Private Approach By-Law 2003-447 for the entrance design. Fire Route: Fire Routes now require designation with By-law parallel to the planning application/s; please contact Jennifer Therkelsen at the City of Ottawa (Jennifer.Therkelsen@ottawa.ca). Snow Storage:

	Any portion of the subject property which is intended to be used of permanent or temporary snow storage shall be as shown on the approved site plan and grading plan. Snow storage shall not interfere with approved grading and drainage patterns or servicing. Snow storage areas shall be setback from the property lines, foundations, fencing or landscaping a minimum of 1.5m. Snow storage areas shall not occupy driveways, aisles, required parking spaces or any portion of a road allowance. Permits and Approvals: Please contact the Ministry of the Environment, Conservation and Parks (MECP), the Municipal Drain unit, and the Rideau Valley Conservation Authority (RVCA), amongst other federal and provincial departments/agencies, to identify all the necessary permits and approvals required to facilitate the development: responsibility rests with the developer and their consultant for determining which approvals are needed and for obtaining all external agency approvals. The address shall be in good standing with all approval agencies, for example the RVCA, prior to approval. Copies of confirmation of correspondence will be required by the City of Ottawa from all approval agencies that a form of assent is given. Please note that a stormwater program for multiple lots is understood to be the expanded type of Environmental Compliance Approval (ECA) application with the MECP; please speak with your engineering consultant to understand the impact this has on the application. An MECP ECA application is not submitted until after City of Ottawa engineering is satisfied that components directly or indirectly aligned with the ECA process concur with standards, directives and guidelines of the MECP. No construction shall commence until after a commence work notification is given by Development Review.

Ministry of the Environment, Conservation and Parks	Rideau Valley Conservation Authority
Contact Information: Christina Des Rochers Water Inspector 613-521-3450 ext. 231 Chstina.Desrochers@ontario.ca	Contact Information: Roxanne Coghlan roxanne.coghlan@rvca.ca

Plan Submission Requirements for engineering:

	Site Servicing Plan* Grading and Drainage Area Plan* Erosion and Sediment Control Plan* *All identified required plans are to be submitted on standard A1 size sheets as per City of Ottawa Servicing and Grading Plan Requirements and shall note the survey monument used to establish datum on the plans with sufficient information to enable a layperson to locate the monument. Report Submission Requirements[1]: - Hydrogeological and Terrain Analysis - Noise and Vibration Study - Site Servicing Report To be prepared as per requirements. -Storm Water Management Report -Erosion and Sediment Control Measures -Geotechnical Investigation Study Please note that Sensitive marine clays are anticipated in the area of the proposal and, if so, enhanced geotechnical investigation and analysis will be necessary. Investigation of clays should be undertaken with vane shear, Atterberg limits, shrinkage, size, grade raise restriction, consolidation, sensitivity, and liquefaction analysis- amongst others. Further, to maintain the desired result of the trees in clay soils policy all of the conditions of the policy need to be met and the 2.1 m of cover in the vicinity of the footings is sometimes a challenge as is the necessary comprehensive linkages between geotechnical, grading, parks, utilities, and trees. The geotechnical consultant will need to provide full copies of any published and peer reviewed papers relied on to determine results and conclusions Earthquake analysis is now required to be provided in the report. -Phase 1 Environmental Site Assessment (ESA) The Phase 1 Environmental Site Assessment (ESA) shall be as per O.Reg. 153/04. Phase 1 ESA documents performed to CSA standards are not acceptable. Guide to preparing City of Ottawa Studies and Plans: http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans To request City of Ottawa plan(s) or report information please contact the ISD Information Centre:

	Information Centre (613) 580-2424 ext. 44455
Environment **Matthew.Hayley@ottawa.ca** **(613)580-2424 ext. 23358**	The property is adjacent to Marlborough Creek which requires a set back There are two other watercourses which cross the property, these will require a setback or they will need RVCA approval of their removal An Environmental Impact Assessment is required to address: • potential for endangered and threatened species • woodlands using the NHRM method since this is a rural site • wildlife habitat, assess if there are any significant habitat present A Tree Conservation Report is required – along watercourses and if any of the numerous hedgerows can be retained in various areas
Joseph.Zagorski@ottawa.ca **(613)580-2424 ext. 22611**	Comments will follow under separate cover.

Risk Management
 	
Tessa.Dilorio@ottawa.ca
(613)580-2424 . 17658
	A Well Water Study will be required (to support water quantity and water quality), as well as an Impact Assessment and GUDI study (part of the requirements for the servicing)
	
	Source Protection Studies and Requirements:
	▪ A Groundwater Vulnerability Study and Threats Assessment will be required, as per the *Clean Water Act*
	▪ Prior to commencing these studies it is recommended to consult with the City's Risk Management Official and/or the Mississippi-Rideau Source Protection Region since the work must be consistent within the Source Protection Region and there are clear legislative requirements
	▪ Please note the following:
	  - External peer review will be required for the technical studies, as well as reviews by the City and the Source Protection Region
	  - It is anticipated that pumping at the new well system will affect the groundwater flow to the near-by existing well systems at Richmond West, Richmond King's Park and Munster. The vulnerability studies must assess and update ALL affected systems. A final vulnerability and threat report must be prepared which includes all four systems.
	  - New legislation under the Safe Drinking Water Act clarifies timing for source protection studies in relation to the

	Drinking Water Works Permit and Municipal Drinking Water License. Please note that the process to amend a Source Protection Plan is clearly identified in the Clean Water Act an includes the completion of technical studies; amending the Source Protection Assessment Report and Source Protection Plan; pre-consultation with implementing bodies; Council endorsement; public consultation; and approval by the MECP. Technical studies are completed by the proponent, while the amendments to the Source Protection Assessment Report and Source Protection Plan, and the consultation process (etc.) will be handled by the Source Protection Region and the City. Note that new legislation identifies that a new Municipal Drinking Water System will not be permitted to provide water to the public until the new system is included in the amended Source Protection Plan and approved by the MECP.
Transportation **Amira.Shehata@ottawa.ca** **(613)580-2424 ext. 27737**	Protected right-of-way widths are as follows: • Eagleson Road (existing arterial) – 34 metres • Ottawa Street (existing collector) – 26 metres • Collector through subdivision (collector) – 26 metres A Transportation Impact Study is required as part of the subdivision application. Additional comments will follow under separate cover.
Policy **Bruce.Finlay@ottawa.ca** **(613)580-2424 ext. 21850**	The Secondary Plan indicates the boundaries of the Industrial Area 1 designation are approximate. The minimum area is to be 18.5 hectares and the final delineation of the Industrial Area 1 will be determined at the time of the subdivision and development of the land. The shape and location of the land designated Industrial Area 1 on Schedule A of the Official Plan was intended to ensure that no one land owner would have an unequal share of Industrial Land. Since the land is now a single ownership, there is an opportunity to locate the employment area more efficiently. Policy 7 in Section 3.6 provides sufficient flexibility to relocate the Industrial Lands without an OPA.
Urban Design **Mark.Young@ottawa.ca** **(613)580-2424 ext. 41396**	Please see the following comments to consider during the design of the subdivision: • Consider approach to interface with Industrial land uses • Pedestrian/Cycling connection to Ottawa Street should be provided.

	• Follow direction in CDP for cycling and pedestrian connections. • Re-location of Commercial block to be more central to the new residential community (collector road frontage) • Park Location – TBD – Size and Number of parks based on change of land use. • Follow direction in CDP for Western Development Lands as it relates to built form, design, etc. • Consider alternative design standards for local streets (no curbs) to enforce village character. • Please ensure a mix of housing units/types to create a diverse streetscape. • Please consider rear-lane housing approach to east-west collector road – similar to Findlay Creek and Jackson Trails.
Parks Lise.Guevremont@ottawa.ca **(613)580-2424 ext. 27784**	1. Parkland Dedication: This subdivision development is proposed at a density of more than 18 units per net hectare; therefore, as per the City of Ottawa Parkland Dedication By-law No. 2009-95, the parkland requirement will be calculated as one hectare per 300 units on the site being developed. Please request the estimated number of units for this subdivision so that a parkland dedication requirement can be calculated (in hectares). The full amount of parkland dedication is owing as land and must be dedicated in this phase of development. The park would be an active recreation park and would need to be large enough to accommodate a variety of amenities. Woodlot and open space blocks are not accepted as parkland dedication. Please note: These areas should be considered as 'approximate' until the final version of the proposed 4M-plan for the subdivision is developed at time of registration, and block areas are confirmed to 3-decimal places. In the event that block sizes and/or proposed uses change, parkland dedication requirements will be re-calculated to reflect this change. 2. Proposed Park Block Location: Please refer to Figure 1 below. The proposed park block location is flanked on the West side by property that is not part of the development, on the East side by the water reservoir and pump station, and on the North side by a municipal drain. Please relocate the park so that it is provided in a more central location within the proposed development and closer to higher density, townhouses and semi detached homes. This location will create a focal

point, as well as be easier to meet the Official Plan target of residents being within 400m of a greenspace. The current location is closer to the employment lands than the centre of the community. It will also be nicely located along the collector road and a minimum of 50% continuous frontage on abutting streets with sidewalks is preferred. This park block, sized to parkland dedication requirements, will be able to accommodate increased programing for the area.

The proposed location is subject to a geotechnical investigation to ensure that it is suitable for parkland uses.

Figure 1: Proposed Park Block:

3. <u>Connections to pathways:</u>
   Connections between the proposed Park Block and pathways will be determined at a future date as the application progresses.

4. <u>Design of the Proposed Park Block:</u>

To be noted: A Park Facility Fit Plan will be required for the proposed park block before Registration of the Subdivision can proceed.

5. <u>Park Development Funding:</u>

   Park development funding will be based on the current Park Development Rate at time of Subdivision Registration

6. <u>Vegetation:</u>

The preservation of existing vegetation on the proposed Park Block, if

	any, will be determined at a later date. The tree canopy target is 30% within the park, please include existing vegetation as well as vegetation to be removed or newly planted on the facility fit plan. 7. <u>Encumbrances:</u> No encumbrances on the proposed Park Block will be allowed. 8. <u>Service Locations within the proposed Park Block:</u> Parks & Facilities Planning requires the following park services to the Park Block: *Please note: The exact location of the servicing will be determined as the Composite Utility Plan is being developed; this plan is to be submitted to Parks & Facilities Planning at draft stage for comment.* • A 300mm diameter storm sewer and CB/MH at 2m inside the park property line. • A 50mm diameter water line complete with standpost at 2m inside the park property line. A city standard park water vault chamber, standard detail W31.1 latest version, must also be installed as part of parks water works. The park water vault will be funded from the park budget. Co-ordination of all park water works including water vault and meter installation is an Owner responsibility. • 150mm diameter sanitary sewer and MH at 2m inside the park property line. • A 120/240 volt, 200 amperes single phase hydro service at 2m inside the park property line. The Owner is responsible for making all arrangements and coordinating the connection of the new hydro (electrical) service, including costs and inspections, with the respective hydro (electricity) agencies. The Owner is also responsible to ensure the park electricity service(s) is included on the approved CUP drawings. 9. <u>Fill and Grading of the Park Block:</u> I'd like to request that a preliminary grading plan for the subdivision, and the park block, be forwarded to me, for comment. Reviewing the subdivision grading will allow me to place the proposed service drops for the park (water, storm, electrical). Please note, that grading of the park block, to subdivision levels (ensuring positive drainage), is a requirement of the subdivision construction, and not of the park construction. Any desired grading above subdivision level (ex: berms, etc) will be funded from the park development budget (to within 10% of this budget). Backfill, if required, for the proposed park must be comprised of "earth

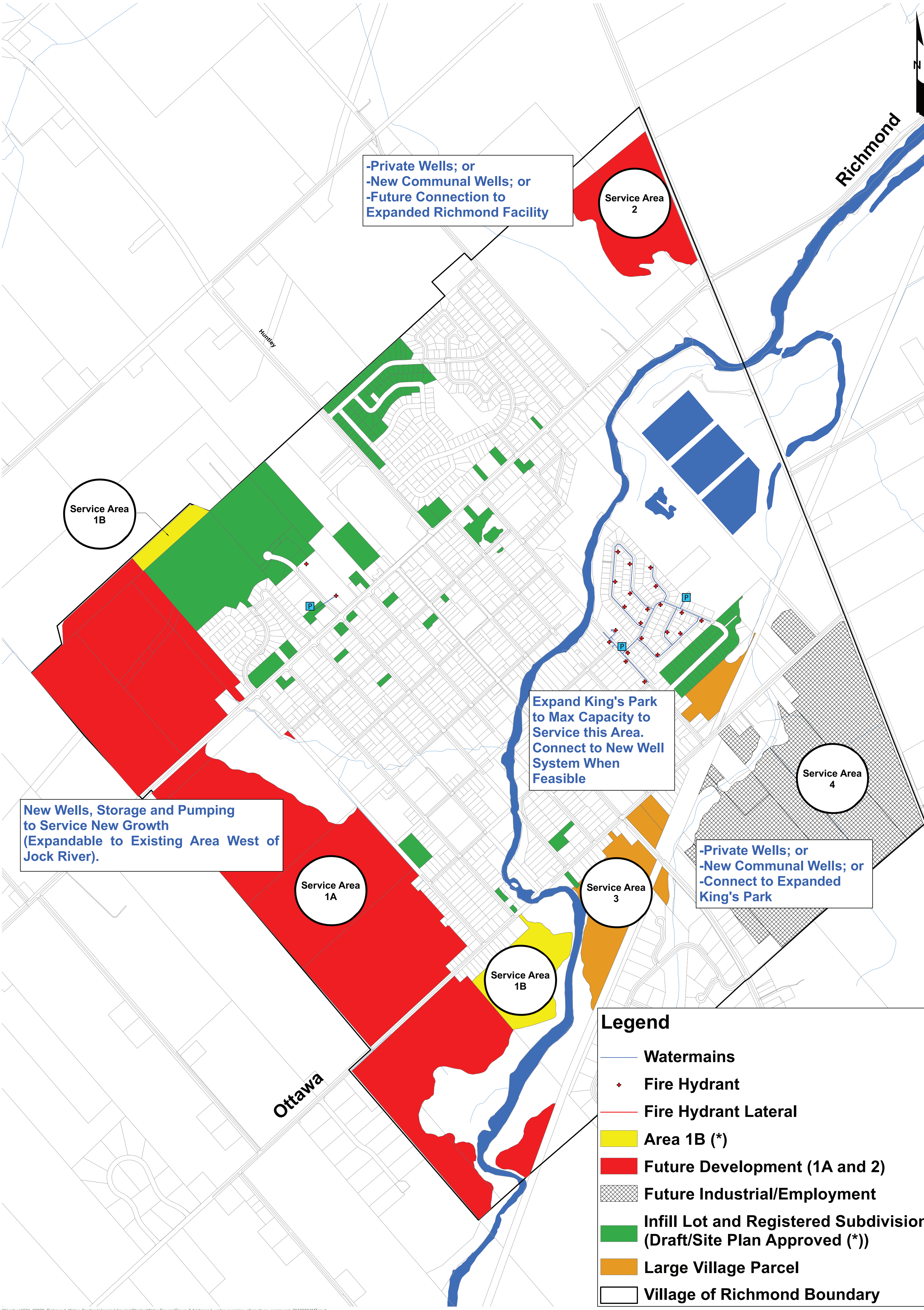
	borrow" (not granular material) and comply with the current (at time of Work) City of Ottawa standards and specifications for Parks, including, but not limited to: ▪ Section 31 22 13 – Rough Grading ▪ Section 31 23 33 01 – Excavating, Trenching and Backfilling 10. <u>Stormwater Management Pond</u> • Pathway all around the pond. • Bench every 50 m required to meet City accessibility standards. • No benches are permitted within the sediment area. • Pathway connection to the park is recommended.
Rideau Valley Conservation **Eric Lalande** **Eric.lalande@rvca.ca** **(613)692-3571 ext. 1137**	The subject lands are located in an area affected by the Floodplain. Development is limited to lands located outside of the floodplain. It should be noted that the proposed stormwater block is shown as being located within the floodplain, while it is discouraged from locating there. Any portion of the SWM facility with the floodplain is subject to an EA process. (similar to Richmond West Development lands). There are a number of watercourses identified on the subject lands, any impacts/alterations are subject to review and permits from the RVCA. A headwater drainage feature assessment is required prior to any proposed interference. The floodplain elevation is between 93.58 and 93.61 masl in this reach of Tributary D – Reach 1. There are a few unevaluated wetlands identified on the subject lands, while not currently regulated, the presence of wetlands, if any, may be subject to permits from the RVCA in the future.

APPENDIX B

Water Supply

- Village of Richmond Water and Wastewater Master Servicing Study Figure 7-1: Communal Water Supply Alternative Service Areas by Stantec

- Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives by Stantec dated April 5, 2019



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\Stantec\Water Figures\Figure 7-1richmond_water_servicing_alternatives_communal_20100324MT.mxd

* DENOTES FORMERLY LARGE PARCEL

Stantec

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

Figure No. 7-1

Title
COMMUNAL WATER SUPPLY
ALTERNATIVE SERVICE AREAS

March 2010
1634-00808

Stantec

Memo

To:	Michelle Taggart c/o Kevin Murphy (DSEL) Tamarack Developments & Taggart Investments	From:	Jasmin Sidhu Stantec Consulting Ltd.
File:	1634-01541	Date:	April 5, 2019

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

OBJECTIVE

Stantec Consulting Ltd. (Stantec) was retained by Tamarack Homes to undertake a hydraulic potable water study to assess, at a high level, various servicing alternatives for the proposed Tamarack Homes development in the Village of Richmond. The proposed development is to be located in the south-eastern part of the Village, bound by Eagleson Road to the northeast, Ottawa Street to the northwest, McBean Street to the southwest, and the intersection of McBean Street and Richland Drive to the south (see **Figure 1**).

This technical memo documents the identification and review of preliminary potable water servicing alternatives.

BACKGROUND

2011 MASTER SERVICING STUDY

Currently, the majority of residences and businesses within Richmond have private shallow or deep wells for their water supply. A small part of the Village is serviced by a City of Ottawa operated communal well system in King's Park. Hyde Park is serviced by a small private communal well system.

In 2011, Stantec completed a Water & Sanitary Master Servicing Study (MSS) for the Village. The MSS provided recommendations for long-term servicing requirements for existing and future potential development within the Village. With regards to water servicing for the entire Village, three (3) alternative solutions were considered, including private well services, communal well system (expansion of existing system and/or addition of new systems), and connection(s) to the City's central water supply system (in Kanata or Barrhaven), or combinations of these.

The preferred alternative was a new public communal well system, where water would be pumped from a deep aquifer to provide servicing for potential growth areas in the western part of the Village, and through a phased approach and system expansions, supply all demand in the entire Village (existing and future) as the need arises in the future.

RECENT WORK

Since completion of the 2011 MSS, development within the Village has progressed and a number of system upgrades have been made. These include the planning and/or construction of new Caivan and Mattamy developments in the Western Development Lands (located west of the Jock River); a proposed infill development (located at 11 King Street); upgrades to the King's Park wells' electrical and SCADA systems; and the construction and commissioning of a new communal well system (i.e. Richmond West Pump Station).

The Richmond West Pump Station, as currently constructed, includes deep wells, well pumps, inground storage, treatment, high lift pumping and fire pumps. This provides adequate potable water and fire flows to service up to the 10-year development level (as per the 2011 MSS), which corresponds to 1,000 single family units or a MXDY demand of 1,611 L/min. The station has been designed to allow for future expansion to accommodate MSS demands for the ultimate high growth scenario which corresponds to a total of 5,361 units (i.e. all existing development plus all future residential and industrial/commercial/institutional development) with a MXDY demand of 7,229 L/min.

TAMARACK DEVELOPMENT WATER DEMANDS

In the 2011 MSS, Parcel 4 (i.e. the Tamarack development area) was originally planned to contain industrial/employment lands and it was proposed to be serviced by either private wells, new communal wells, a connection to the existing King's Park Communal Well System or a connection to the new Richmond West PS (depending on timing and type of development). However, it is now understood that this area is anticipated to be primarily residential and is planned to be rezoned as such. Based on the draft preliminary concept plan (see **Draft Preliminary Concept Plan** attached), the total number of units is estimated to be 1,040 (660 single family and 380 townhouse units). The estimated residential population for the Tamarack development is determined based on projected household sizes as per the City of Ottawa's Water Design Guidelines and is estimated to be 3,270 persons (refer to **Table 1**).

The criteria outlined in the 2013 Water Master Plan (WMP) were followed to estimate water demands for the Tamarack development. Zone Level demands for populations greater than 3,000 persons were used to estimate basic day (BSDY) demands. The demand rates from the WMP were applied to the population projections based on land use and location with respect to the Greenbelt (i.e. outside, denoted as "outside Greenbelt" or OGB). Maximum day (MXDY) demands were determined by adding an outdoor water demand (OWD) of 1,049 L/SFH/d to all single-family house (SFH) units within the development. Peak hour (PKHR) demands were determined by applying a peaking factor of 2.2 to the MXDY demand.

A fire flow of 8,000 L/min was used for the Tamarack development. This flow corresponds to the fire flow used in recently completed water assessments for other residential developments in Richmond and was calculated using the Fire Underwriters Survey (FUS) method for typical connected townhouses (i.e. governing configuration).

Estimated demands are summarized in Table 1.

Table 1 – Conceptual Tamarack Development Water Demands

Unit Type	Unit Count	PPU	Population	2013 WMP Consumption Rates (L/d/cap)	BSDY (L/min)	MXDY (L/min)	PKHR (L/min)
Single-family	660	3.4	2,244	180	281	761	1,674
Townhouse	380	2.7	1,026	198	141	141	310
Total	***1,040***		***3,270***		***422***	***902***	***1,984***
Minimum Required Fire Flow					8,000 L/min for 2.0 hrs		

Reference: **Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives**

SERVICING IMPLICATIONS

The servicing recommendations made in the 2011 MSS were based on the assumption that the land use for this area was to be industrial/employment. The MSS estimated the BSDY, MXDY and PKHR demands for this area to be 0.13 ML/d (90 L/min), 0.20 ML/d (139 L/min), and 0.20 ML/d (139 L/min), respectively. These industrial/employment demand estimates are considerably less than the recalculated conceptual residential water demands presented in **Table 2**.

Table 2 – Recalculated Ultimate Water Demands

Development Level / Scenario	Total # Units	Demands			
		BSDY	MXDY	PKHR	
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	2,861	7,229	17,438	L/min
		4.1	10.4	25.1	ML/d
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	3,193	7,993	19,282	L/min
		4.6	11.5	27.8	ML/d
Difference	***1,040***	***332***	***764***	***1,844***	***L/min***
		0.5	***1.1***	***2.7***	***ML/d***

The recently commissioned Richmond West PS was designed to allow for future expansion to accommodate MSS demands for the ultimate high growth scenario. This scenario considers servicing for the entire Village, including all future development, infill, and existing properties and would provide an ultimate firm capacity of 7,229 L/min and an ultimate storage capacity of 4,455 m^3. However, these ultimate capacities were based on industrial/employment land use in the MSS Parcel 4, not on the proposed Tamarack residential development area.

To quantify the implications of the change in land use, the Village's ultimate development demands were recalculated accordingly. A breakdown and comparison of the MSS versus recalculated pumping rate and storage volume requirements are summarized in **Table 3** and **Table 4**.

Table 3 – Recalculated Ultimate Pumping Rate Requirements

Development Level / Scenario	Total # Units	PKHR Pumping (L/min)	MXDY+Fire Pumping (L/min)	MXDY Pumping (L/min)	BSDY Pumping (L/min)
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	17,438	15,229	7,229	2,861
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	19,282	15,993	7,993	3,193
Difference	***1,040***	***1,844***	***764***	***764***	***332***

Table 4 – Recalculated Ultimate Storage Volume Requirements

Development Level / Scenario	Total # Units	MXDY (L/min)	Fire Flow (L/min)	Required MECP Storage Volume (m^3) (1)
Ultimate – 2011 MSS (includes Parcel 4 as ICI)	5,361	7,229	8,000 @ 2.0 hrs	4,455
Ultimate – Updated for Tamarack Development (includes Parcel 4 as residential)	6,401	7,993	8,000 @ 2.0 hrs	4,800
Difference	***1,040***	***764***		***345***

Notes:

(1) Volume rounded up to the nearest 5 m^3.

PRELIMINARY SERVICING ALTERNATIVES

Based on the understanding of the existing and planned development and servicing in Richmond, three (3) preliminary alternatives have been identified as feasible servicing solutions for the proposed Tamarack development. Each alternative was developed with the following key considerations:

(1) The proposed servicing provides fire flow that meets 8,000 L/min fire flow design criteria based on FUS calculations;

(2) The proposed servicing provides sufficient peak flows to meet City standards; and

(3) The proposed servicing provides system reliability.

The MSS considered the use of private wells to service this area, however that was based on the assumption that the land use would be industrial/employment with limited or no for protection. Private wells are not considered to be a feasible servicing solution for a new residential development of this size based on City of Ottawa and MECP design guidelines, therefore it was not considered as part of this assessment. The MSS also looked at connecting the Village to the City's central water supply system, however this alternative is not considered in this assessment as it clearly not economical for this size of development.

ALTERNATIVE 1: SINGLE FEED FROM RICHMOND WEST PS

1A: Single Feed from Richmond West PS + Connection to King's Park Communal Well System

Alternative 1A consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus approximately 0.4 km feedermain along King Street from the existing King's Park system to the north end of the Tamarack development (refer to **Figure 2**). Under this configuration, the Tamarack development would be serviced such that MXDY, PKHR and fire flow demands would be supplied by the Richmond West PS, while the King's Park system would supply flows during emergency conditions (i.e. break in the feedermain from the PS). A connection could be made to the King's Park system, but is not included in this assessment as it is not required to provide service to the Tamarack development.

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

The existing King's Park communal well system is owned and operated by the City of Ottawa and provides potable water to a subdivision in the east end of the Village. The system is fed by two groundwater wells. Each well is equipped with a submersible pump with a Ministry of Environment, Conservation and Parks (MECP) permitted throttle withdrawal rate of 912 L/min at a TDH of 48 m (1,824 L/min for the total well system). A 1991 Jacques Whitford Limited study suggested the existing wells could provide up to 1,920 L/min and 4,620 L/min each with a safe aquifer yield of 3,360 L/min (a revised MECP Certificate of Authorization would be required for this increase in pumping capacity). The system provides a limited fire flow capacity of 1,000 L/min for 2 hours which meets minimum allowable fire flow for accreditation but does not meet the 8,000 L/min fire flow criteria based on FUS calculations.

Currently there is insufficient capacity within the King's Park system to accommodate the proposed development. Therefore, King's Park cannot be used to provide the additional MXDY (764 L/min) and PKHR (1,844 L/min) demands, storage (345 m^3), nor the reliability needs required for the proposed revised Tamarack development.

The additional pumping and storage requirement capacity may be accommodated within the existing property limits of the new Richmond West PS, as shown in **Pump Floor Plan** attached. Extending the south wall of future cell 3 out by 2.5 m would provide additional storage capacity to accommodate the additional 345 m^3 required for the Tamarack development. Additional pumping capacity may be provided by converting the existing pumps to larger pumps in the future to accommodate the additional MXDY (764 L/min) and PKHR (1,844 L/min) demands.

The opinion of probable cost (OPC) for the design and construction of Alternative 1A is as follows:

2,400 m of 400 mm dia. feedermain	$2,040,000 (1)
Additional storage (345 m^3), well capacity (764 L/min), and high lift pumping (1,844 L/min) capacity at Richmond West PS	$2,588,000 (2)
1 new well	$350,000 (3)
Sub-Total	*$4,978,000*
Engineering Services (25%)	$1,244,500
Utilities Relocations (5%)	$248,900
City of Ottawa Internal Costs (10%)	$497,800
Miscellaneous Soft Costs (5%)	$248,900
Contingencies (50%)	$3,609,050
Estimated Project Capital Cost	***$10,828,000*** (4)

(1) Assumes a unit rate of $850/m (includes valve chambers).

(2) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).

(3) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.

(4) Rounded up to nearest $1,000.

For costing purposes, a feedermain diameter of 400 mm has been assumed, however this size will need to be confirmed through a hydraulic analysis to meet design criteria.

Benefits of Alternative 1A include added reliability and full fire flow to the King's Park system, and the opportunity to service future development parcels south of Ottawa Street (between the Western Development Lands and the Tamarack development area) and approximately 70 existing properties along the proposed feedermain alignment. Other considerations to assess when evaluating this solution include impacts associated with the installation of new feedermains along existing right-of-ways (ROWs), crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

This alternative cannot provide full fire flow to the Tamarack development under emergency conditions (i.e. break in feedermain for Richmond West PS). In the event of a break in the feedermain from the PS, only a limited fire flow of 1,000 L/min could be provided. Therefore, this scenario does not meet the City's current standards for reliability.

1B: Single Feed from Richmond West PS + Elevated Storage Tank

Similar to Alternative 1A, Alternative 1B consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus an additional feedermain from a new elevated storage tank to the Tamarack development (refer to **Figure 3**). For the purpose of this assessment, it is assumed that the elevated tank can be constructed immediately west of the Tamarack development area, therefore a feedermain length of approximately 50 m was used. Under this configuration, the Tamarack development would be serviced such that MXDY demands would be supplied by the Richmond West PS, while PKHR and fire flow demands would be supplied by the elevated storage tank.

For this alternative to be considered feasible, the Richmond West PS would need to be upgraded to provide additional well capacity (764 L/min). The high lift pumping increase would be limited to the MXDY increase, as the increased PKHR flow would be accommodated from the elevated tank. The elevated tank would need to be sized to provide (at minimum) sufficient storage for a fire flow volume of 960 m^3 (i.e. fire flow of 8,000 L/min for 2.0 hrs) plus a balancing and emergency volume of 640 m^3 (i.e. for a MXDY demand of 902 L/min for the Tamarack development) for a total minimum required storage volume of 1,600 m^3. In the event of a break in the feedermain from the Richmond West PS, the elevated tank would be capable of providing full fire flow to the Tamarack development.

Since the Richmond West PS would only be expected to provide MXDY demands (i.e. no PKHR or fire flow demands), a smaller feedermain size of 300 mm has been assumed between the PS and the development for costing purposes. However, this size will need to be confirmed through a hydraulic analysis to meet design criteria.

The OPC for the design and construction Alternative 1B is as follows:

2,000 m of 300 mm dia. feedermain	\$1,300,000 (1)
50 m of 400 mm dia. feedermain	\$43,000 (2)
Additional well capacity (764 L/min), and high lift pumping (764 L/min) capacity at Richmond West PS	\$150,000 (3)
1 new well	\$350,000 (4)

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

Elevated storage tank (1,600 m^3)	$3,600,000 (5)
Sub-Total	*$5,443,000*
Engineering Services (25%)	$1,360,750
Utilities Relocations (5%)	$272,150
City of Ottawa Internal Costs (10%)	$544,300
Miscellaneous Soft Costs (5%)	$272,150
Contingencies (50%)	$3,946,175
Estimated Project Capital Cost	***$11,839,000*** (6)

(1) Assumes a unit rate of $650/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(3) Assumes pump change out only.
(4) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(5) Based on recent construction costs for an elevated storage tank (50% of construction cost taken as fixed, remaining 50% taken as a function of storage volume). Expected to vary depending on volume and height.
(6) Rounded up to nearest $1,000.

Benefits of an elevated storage tank include having a constant, reliable water supply and pressure within the system, flow balancing (i.e. lower pumping costs), and potentially reduced feedermain size. Other considerations to assess when evaluating this solution include land acquisition costs for the elevated tank and connected feedermain, social impacts (e.g. compatibility with existing community character), impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

1C: Single Feed from Richmond West PS + At-Grade Storage Tank and High Lift Pumping Station

Similar to Alternatives 1A and 1B, Alternative 1C consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus an additional feedermain from a new at-grade storage tank to the Tamarack development (refer to **Figure 3**) with a high lift pumping station. For the purpose of this assessment, it is assumed that the at-grade storage tank can be constructed immediately west of the Tamarack development area (i.e. same location as elevated storage tank), therefore a feedermain length of approximately 50 m was used. Under this configuration, the Tamarack development would be serviced such that MXDY demands would be supplied by the Richmond West PS, while PKHR and fire flow demands would be supplied by the at-grade storage tank and high lift pumping station.

For this alternative to be considered feasible, the Richmond West PS would need to be upgraded to provide additional well capacity (764 L/min). The high lift pumping increase would be limited to the MXDY increase, as the increased PKHR flow would be accommodated from the at-grade tank. Similar to Alternative 1B, the at-grade tank shall be sized to provide a minimum required storage volume of 1,600 m^3, such that full fire flow protection is available to the Tamarack development under emergency conditions.

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

The OPC for the design and construction of Alternative 1C is as follows:

2,000 m of 300 mm dia. feedermain	$1,300,000 (1)
50 m of 400 mm dia. feedermain	$43,000 (2)
Additional well capacity (764 L/min), and high lift pumping (764 L/min) capacity at Richmond West PS	$150,000 (3)
1 new well	$350,000 (4)
At-grade storage tank (1,600 m^3) and high lift pumping	$10,400,000 (5)
Sub-Total	*$12,243,000*
Engineering Services (25%)	$3,060,750
Utilities Relocations (5%)	$612,150
City of Ottawa Internal Costs (10%)	$1,224,300
Miscellaneous Soft Costs (5%)	$612,150
Contingencies (50%)	$8,876,175
Estimated Project Capital Cost	***$26,629,000*** (6)

(1) Assumes a unit rate of $650/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(3) Assumes pump change out only.
(4) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(5) Assumes a unit rate of $6,500/$m^3$ (based on recent construction costs for an at-grade facility).
(6) Rounded up to nearest $1,000.

Since the Richmond West PS would only be expected to provide MXDY demands (i.e. no PKHR or fire flow demands), a smaller feedermain size of 300 mm has been assumed between the PS and the development for costing purposes. However, this size will need to be confirmed through a hydraulic analysis to meet design criteria.

Other considerations to assess when evaluating this solution include land acquisition costs for the at-grade tank and connected feedermain, higher operational and maintenance costs (i.e. higher pumping costs, additional facility in Richmond for the City to maintain and operate) than an elevated tank, impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

ALTERNATIVE 2: DUAL FEED FROM RICHMOND WEST PS

Alternative 2 consists of approximately 2.0 km of feedermain from the Richmond West PS to Fortune Street, southeast to Ottawa Street, and northeast to the west end of the Tamarack development, plus approximately 2.1 km of feedermain along Royal York Street east to King Street and south to the Tamarack development (refer to **Figure 4**). Under this configuration, the Tamarack development would be fully serviced by the Richmond West PS (i.e. MXDY, PKHR, fire flow demands).

For this alternative to be considered feasible, the same capacity upgrades to the Richmond West PS as suggested for Alternative 1A would be required (i.e. expanding future cell 3 and increasing high lift pumping/well capacity).

The OPC for the design and construction of Alternative 2 is as follows:

4,100 m of 400 mm dia. feedermain	$3,485,000 (1)
Additional storage (345 m^3), well capacity (764 L/min), and high lift pumping (1,844 L/min) capacity at Richmond West PS	$2,588,000 (2)
1 new well	$350,000 (3)
Sub-Total	*$6,423,000*
Engineering Services (25%)	$1,605,750
Utilities Relocations (5%)	$321,150
City of Ottawa Internal Costs (10%)	$642,300
Miscellaneous Soft Costs (5%)	$321,150
Contingencies (50%)	$4,656,675
Estimated Project Capital Cost	***$13,971,000*** (4)

(1) Assumes a unit rate of $850/m (includes watermain and valve chambers).
(2) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).
(3) Includes well drilling and preparation. Additional well pumping capacity may potentially be accommodated by future proposed wells at the Richmond West PS, therefore a new well may not be necessary.
(4) Rounded up to nearest $1,000.

With a dual feed from the Richmond West PS, full fire flow would be available to the Tamarack development under emergency conditions of a major pipe break. Additional benefits of a dual feed from one facility include lower operational and maintenance costs (i.e. one facility versus multiple), and the opportunity to service future development, infill, and more than 70 existing properties along the proposed feedermain alignment (depending on the preferred alignment). Depending on the routing, the King's Park system could be decommissioned and the entire area serviced from the Richmond West PS, as recommended in the MSS.

Other considerations to assess when evaluating this solution include impacts associated with the installation of new feedermains along existing ROWs, crossings under the Jock River and an active rail corridor, and/or potential hydrogeological impacts.

Reference: Richmond Tamarack Hydraulic Potable Water Assessment – Preliminary Servicing Alternatives

ALTERNATIVE 3: NEW STANDALONE COMMUNAL WELL SYSTEM

Alternative 3 consists of a new communal well system within the Tamarack development (refer to **Figure 5**) which would fully service the area (i.e. MXDY, PKHR, fire flow demands). This system would be similar to the Richmond West PS system, consisting of new wells, storage reservoirs, building structure, piping, pumps, equipment, electrical, generator, SCADA, and treatment. The new system would be designed to sufficiently service domestic and fire flow demands for the Tamarack development. The new standalone system would be designed to provide a minimum required storage volume of 1,600 m^3, which would provide sufficient storage for a fire flow volume of 960 m^3 (i.e. fire flow of 8,000 L/min for 2.0 hrs) plus a balancing and emergency volume of 640 m^3 (i.e. for a MXDY demand of 902 L/min for the Tamarack development).

The OPC for the design and construction of Alternative 3 is as follows:

New pumping station & reservoirs	$12,000,000 (1)
2 new wells	$700,000 (2)
Sub-Total	*$12,700,000*
Engineering Services (25%)	$3,175,000
Utilities Relocations (5%)	$635,000
City of Ottawa Internal Costs (10%)	$1,270,000
Miscellaneous Soft Costs (5%)	$635,000
Contingencies (50%)	$9,207,500
Estimated Project Capital Cost	***$27,623,000*** (3)

(1) Assumes a unit rate of $7,500/$m^3$ (based on Richmond West PS construction costs).
(2) Includes well drilling and preparation.
(3) Rounded up to nearest $1,000.

The benefit of a new communal well system is that it can be designed to have sufficient capacity (pumping and storage) to service domestic and full fire flow demands for the Tamarack development. It can also be designed with the consideration of future expansion to potentially service nearby future development areas and/or add reliability to the King's Park system. A portion of the development area would need to be allocated for the new pump station which reduces the total number of lots. Other considerations to assess when evaluating this solution include wastewater needs for treatment, additional operational and maintenance costs for the City to operate a third station in Richmond, and potential hydrogeological impacts.

ALTERNATIVE FEEDERMAIN ALIGNMENTS

Alternative feedermain alignments may be considered to optimize ultimate servicing conditions. These alternative alignments may include any combination of the following:

- One feed along the southern part of the Village. This feed would be approximately 2.6 km long and run from the PS, southeast through the Western Development Lands, then northeast through either future development lands or along Ottawa Street to the Tamarack development. With this alignment, feedermain costs may be shared with other developers to reduce total costs to Tamarack Homes. A hydraulic analysis would be required to appropriately size this feedermain to service any connected properties.

- One feed through the centre of the Village. This feed would be approximately 2.3 km long and run from the PS, northeast along Royal York Street (or an adjacent parallel ROW), then southeast along King Street to the Tamarack development. This alignment would provide an opportunity for a future connection between the King's Park system and the Richmond West PS, which would add reliability and additional flow capacity for firefighting to the King's Park system. There is also opportunity to service future development and infill near King's Park and to connect existing properties along the feedermain corridor.
- One feed along the northern part of the Village. This feed would be approximately 3.0 km long and run from the PS, northwest along Fortune Street, northeast along Perth Street, then southeast along King Street to the Tamarack development. This alignment would provide an opportunity to service future development and infill along Perth Street (including the future development area in the northern part of the Village at Eagleson Road and Perth Street), and to connect more existing properties along the feedermain corridor. Similar to the previous alignment, this feed would also provide an opportunity for a future connection between the King's Park system and the Richmond West PS.

For each of the different feedermain alignments there would likely be different cost sharing possibilities for existing and future developments. These may require considerable further discussion to select the optimum route for the feedermain(s).

Costs associated with water quality (i.e. re-disinfection for long pipe lengths), operation and maintenance have not been included in the OPCs presented above. Water quality may be considered through a water age analysis to establish treatment needs. Private wells or connection to the City's central water supply were not considered to be feasible servicing options.

SUMMARY

Three preliminary servicing alternatives were identified and established to service the proposed Tamarack development. Although Alternative 1A does not meet the full fire protection under a feedermain break scenario, and therefore does not meet the City's current standards for reliability, it has been included in this assessment for consideration as a potential short term alternative. The OPC for Alternative 1A is as follows:

Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System	$10,828,000

Alternatives 1B, 1C, 2 and 3 are considered to be technically feasible solutions. The OPC for each of these alternatives are as follows:

Alternative 1B: Single Feed from Richmond PS + Elevated Storage Tank	$11,839,000
Alternative 1C: Single Feed from Richmond PS + At-Grade Storage Tank and High Lift Pumping Station	$26,629,000
Alternative 2: Dual Feed from Richmond PS	$13,971,000
Alternative 3: New Standalone Communal Well System	$27,623,000

REFERENCES

Stantec Consulting Ltd. (2011). *Village of Richmond Water & Sanitary Master Servicing Study.* Ottawa.

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Stantec Consulting Ltd. (2017). *Richmond Pump Station - Design Brief.* Ottawa.

Stantec Consulting Ltd. (2017). *Richmond Western Development Lands Caivan Communities - Phase 1 Water Distribution System Analysis.* Ottawa.

Stantec Consulting Ltd. (2018). *Richmond Infill Development - Extension of King's Park Well System Potable Water Hydraulic Assessment.* Ottawa.

Stantec Consulting Ltd.

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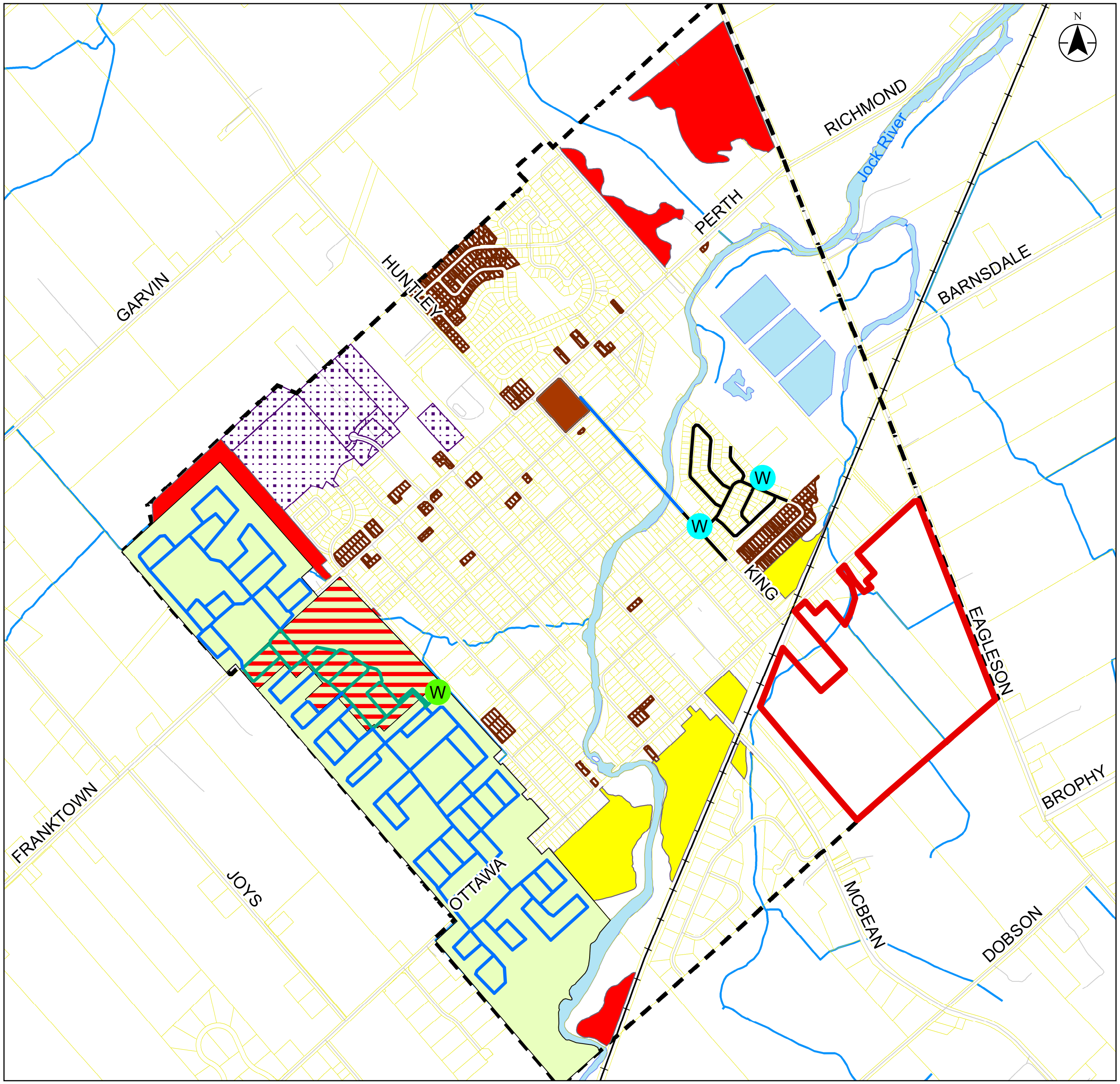
c. Kevin Alemany, Gregory Chochlinski

Attachment: Figure 1 – Tamarack Development Area & Richmond's Water Servicing
Draft Preliminary Concept Plan
Figure 2 – Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System
Pump Floor Plan (Proposed Expansion of Richmond West PS)
Figure 3 – Alternative 1B/1C: Single Feed from Richmond PS + Elevated/At-Grade Storage Tank
Figure 4 – Alternative 2: Dual Feed from Richmond PS
Figure 5 – Alternative 3: New Standalone Communal Well System



Stantec

Legend

- Existing Watermain
- Proposed Watermain (Caivan Phase 1)
- Proposed Watermain (Other)
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Caivan Phase 1
- Western Development Lands
- 11 King Street Infill Development
- Other Future Development
- Other Future Large Village Parcel
- Other Future Residential Development
- Other Future Infill Development
- Property Parcel
- Village of Richmond Boundary

0 500 1,000 metres

1:25,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
1

Title
Tamarack Development Area & Richmond's Water Servicing

DRAFT

PRELIMINARY LAND USE

LAND USE	BLOCK	AREA (ha)
Residential Area *30-33m Lot Depth*	-	36.4
Village Commercial	Block A	1.4
Woodlot	Block B	1.1
Richmond By-Pass Drain	Blocks C-E	2.8
Stormwater Management Facility	Block F	2.4
Other Lands	Blocks G-H	1.5
Park & Parkette	Block I-J	3.3
Roads	-	14.8

APPROXIMATE TOTAL AREA **63.7ha**
Residential area does not include the area required to provide road access to adjacent property

APPROXIMATE RESIDENTIAL FRONTAGE **10,655m**
Frontage does not account for exterior side yard setbacks

APPROXIMATE ROAD LENGTH **8,535m**
Includes 14.0m Window Streets; 16.5m Local Roads; 24.0m Collector Road

Note: Concept plan is preliminary and land use areas are approximately only; Not based on a survey

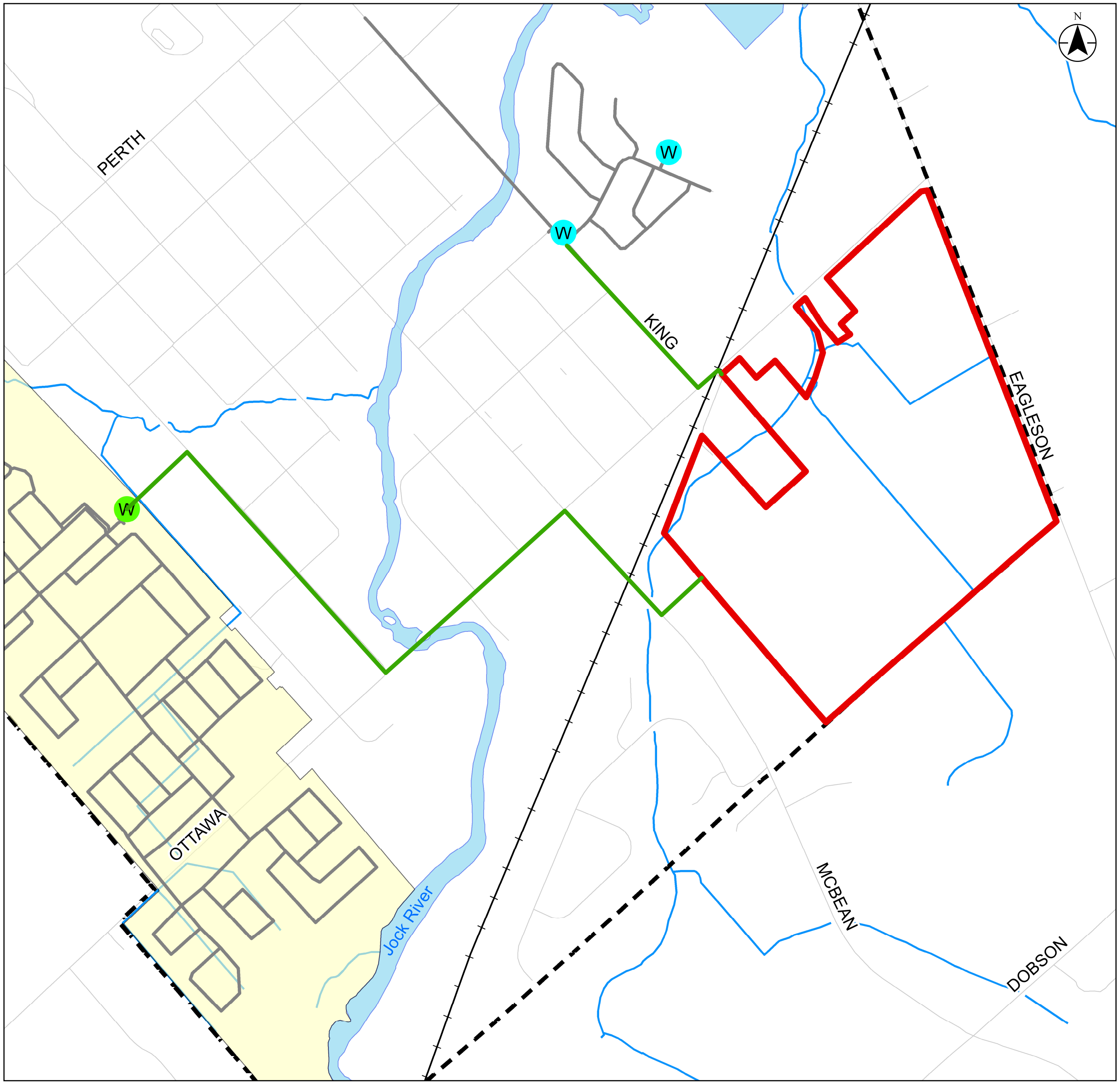
PRELIMINARY CONCEPT PLAN Option 1B *Residential*

Not to Scale October 12, 2018 18.549

Ottawa Street and Eagleson Road

City of Ottawa

WND associates
planning + urban design



Stantec

Legend

- Alternative 1A Feedermain
- Existing / Proposed (Other) Watermain
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

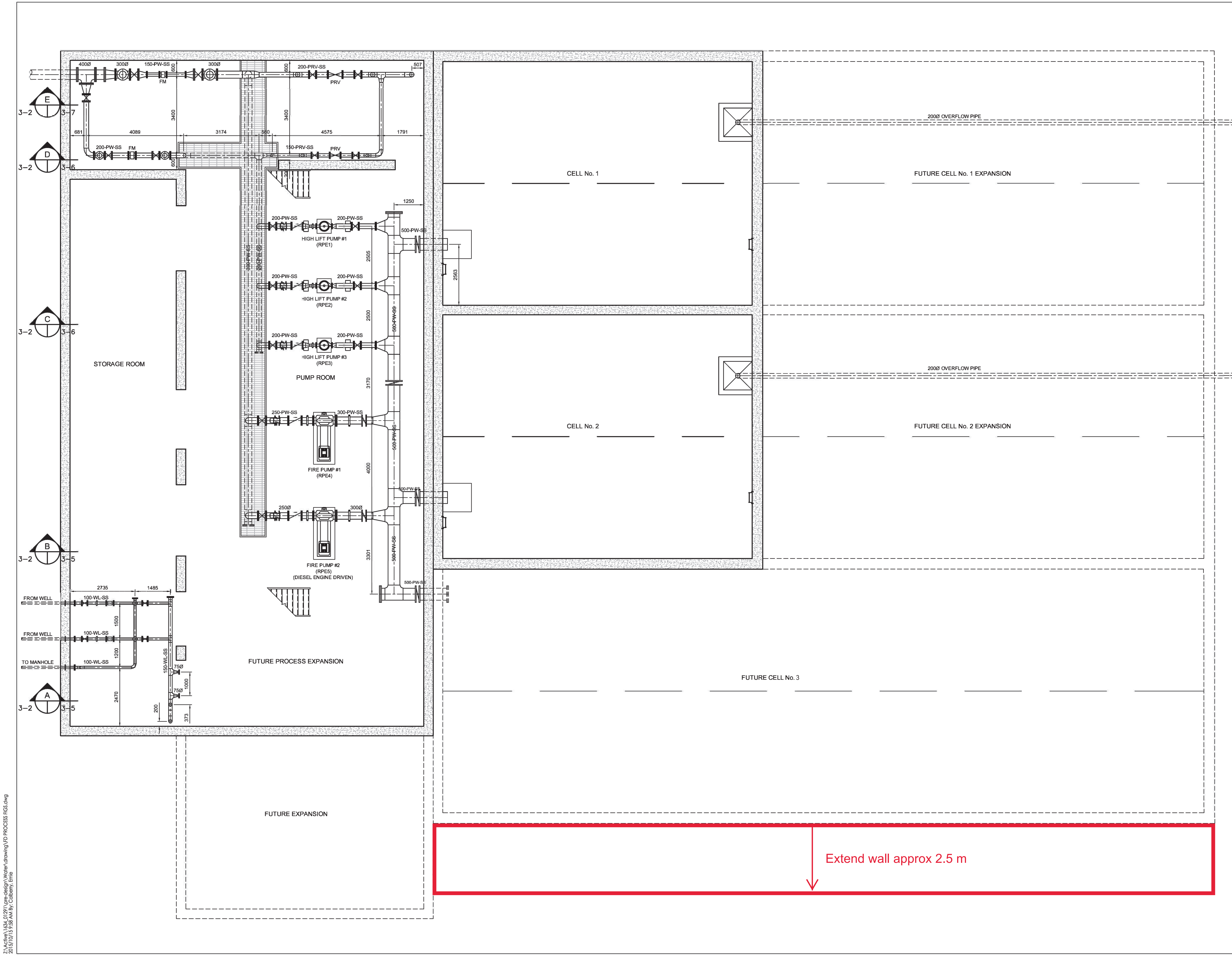
1:15,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
2

Title
Alternative 1A: Single Feed from Richmond PS + Connection to King's Park Communal Well System



Stantec

1331 Clyde Avenue
Ottawa, ON, K2C 3G4
Tel. 613-722-4420
www.stantec.com

Consultants

Legend

Notes

Revision | By | Appd. | YY.MM.DD

A ISSUED FOR FUNCTIONAL DESIGN | G.C. | J.K. | 15.10.15

Issued | By | Appd. | YY.MM.DD

File Name: | Dwn. | Chkd. | Dsgn. | YY.MM.DD

Permit-Seal

Client/Project

VILLAGE OF RICHMOND
NEW RESERVOIR
Ottawa, ON.

Title

PUMP FLOOR PLAN
ELEV.95.000

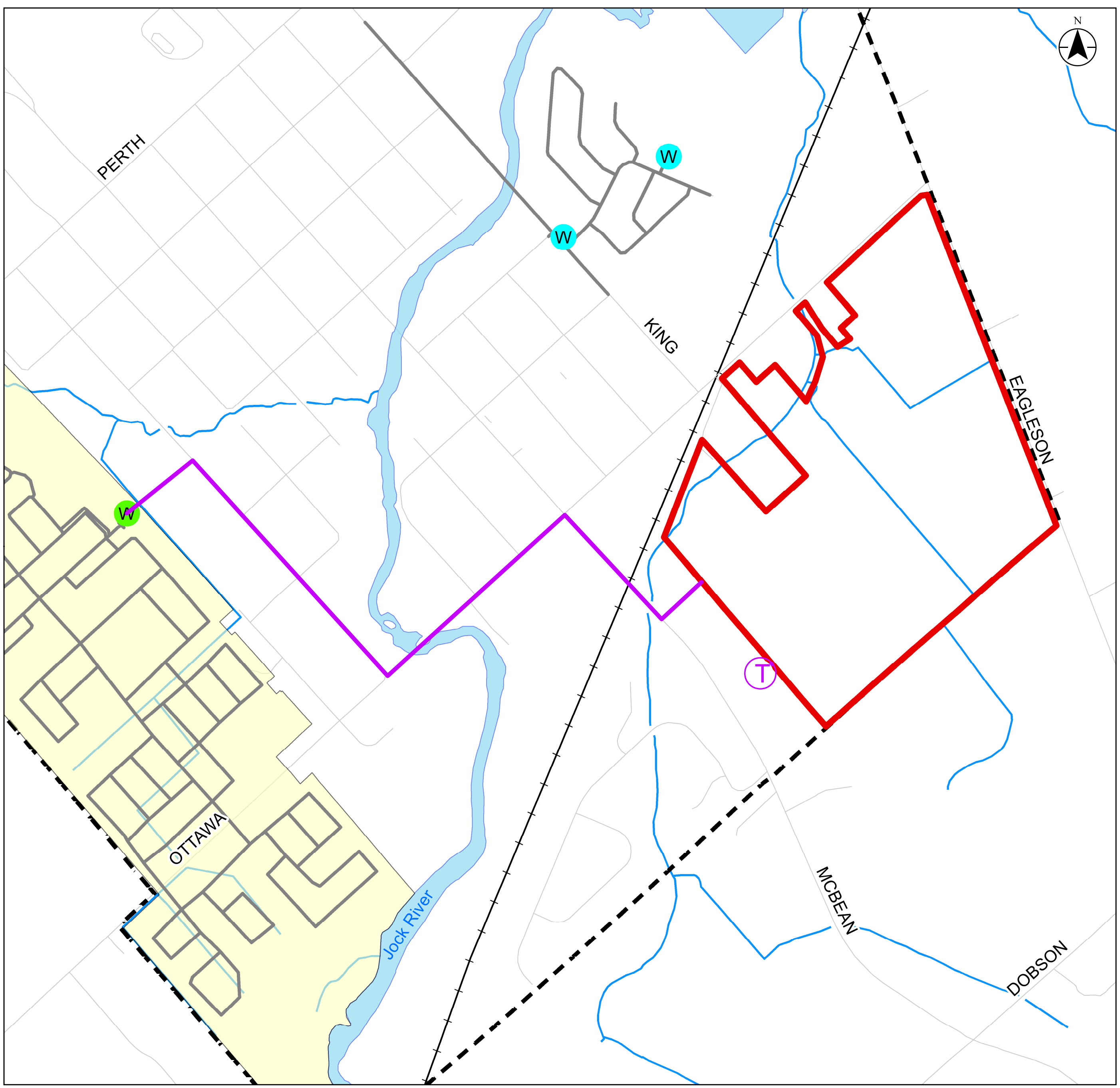
Project No. 163401291

Scale 0 750 2250 3750mm

Figure No. 3-2

Sheet of

Revision

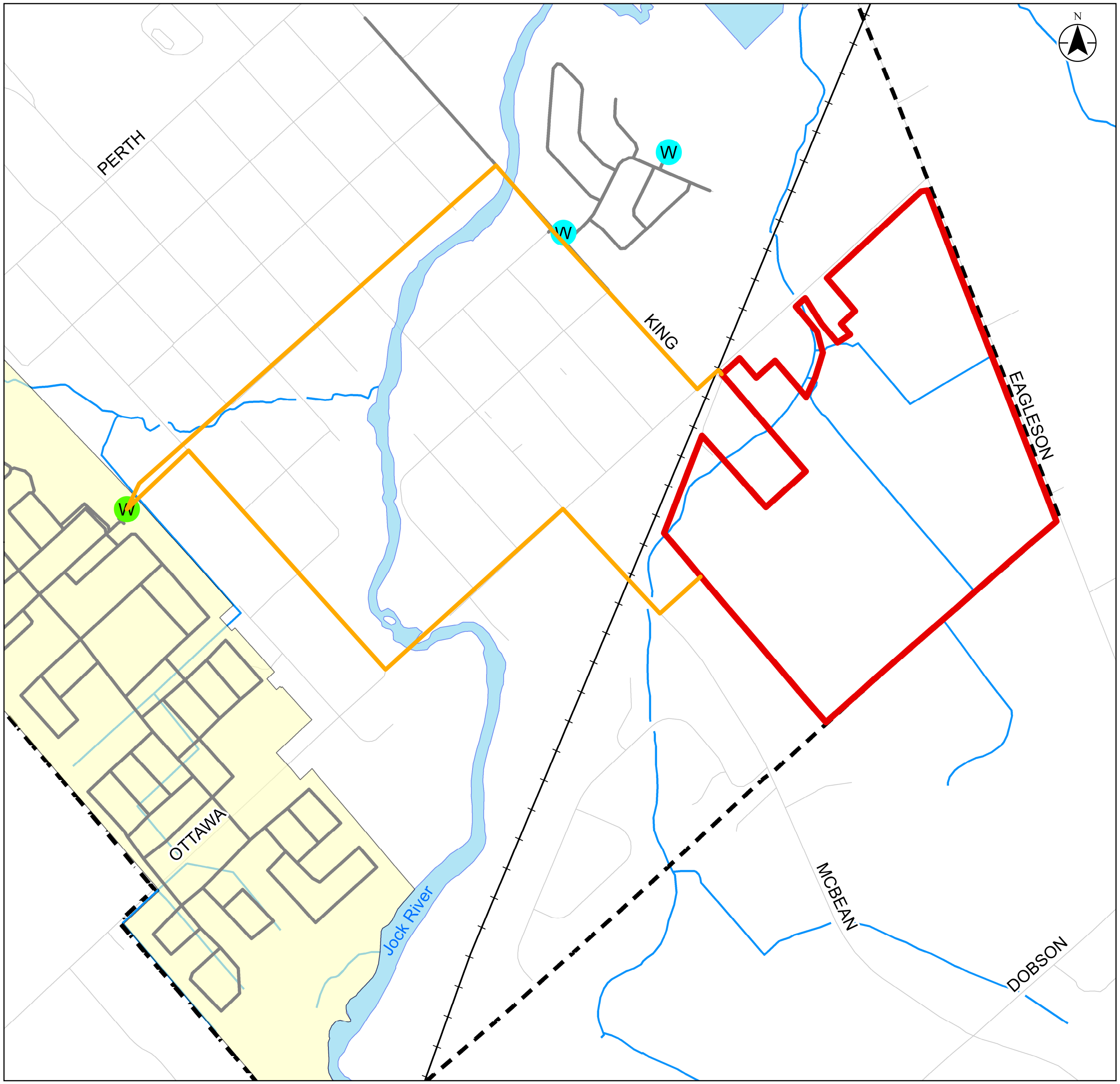


Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
3

Title
Alternative 1B/1C: Single Feed from Richmond PS + Elevated/At-Grade Storage Tank



Stantec

Legend

- Alternative 2 Feedermain
- Existing / Proposed (Other) Watermain
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

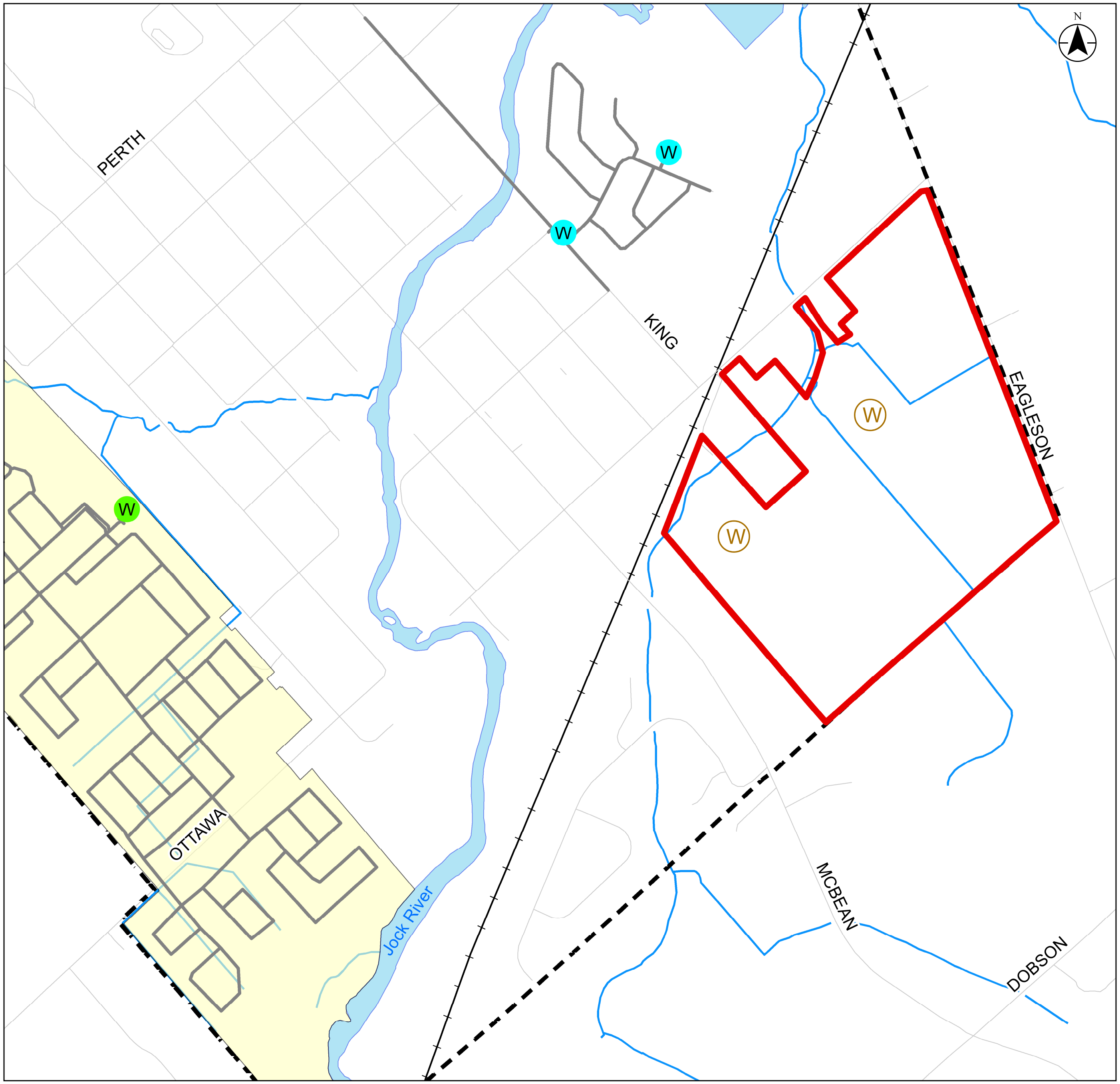
1:15,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
4

Title
Alternative 2: Dual Feed from Richmond PS



Stantec

Legend

- Alternative 3 Communal Well
- Existing / Proposed (Other) Watermain
- King's Park Communal Well
- Richmond West PS
- Tamarack Development (MSS Parcel 4)
- Western Development Lands
- Village of Richmond Boundary

0 300 600 metres

1:15,000 (At Original document size of 8.5x11)

Project Location
Village of Richmond, Ontario

Client/Project
Tamarack Homes
Richmond Tamarack Hydraulic Potable Water Assessment

Figure No.
5

Title
Alternative 3: New Standalone Communal Well System

APPENDIX C

Wastewater Collection

- Village of Richmond Sewage Pumping Station As-Built Drawing
- Sanitary Sewer Design Sheet for the Tamarack Richmond Lands by DSEL dated November 6, 2020
- Village of Richmond Master Servicing Study Sanitary Sewer Design Sheet by Stantec
- Village of Richmond Master Servicing Study Figure 5.4 Connection Locations to the Central Collection System
- Village of Richmond Master Servicing Study Figure 8.7: Functional Sanitary Sewer Design South of the Jock River by Stantec

No.	BY	DATE	REVISION
	DWL	83 09 28	200mmØ BY-PASS ADDED
3	EC	83 05 27	GENERAL REVISION

REGISTERED PROFESSIONAL ENGINEER — D. W. R. LISHMAN — PROVINCE OF ONTARIO

SCALE: 0 6 12 m HORIZONTAL; VERTICAL

DESIGN EC — CHECKED DL
DRAWN EC — CHECKED DL
APPROVED: D.W. Lishman
DATE: April 7 83

KOSTUCH ENGINEERING LIMITED
CONSULTING ENGINEERS
BROCKVILLE • OTTAWA • BELLEVILLE • CORNWALL

TOWNSHIP OF GOULBOURN
VILLAGE OF RICHMOND
SEWAGE PUMPING STATION

PUMPING STATION SITE PLAN

PROJECT No. 1167-2
CONTRACT No. 3
DRAWING No. 1167-1

12404

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET No. 2																											
	1A	3A	0.78		75	0.78	75	3.6	0.88		0.00		0.00		0.00	0.00	0.78	0.78	0.26	1.14	94.0	200	0.65	26.44	0.04	0.84	0.42
To STREET No. 3, Pipe 3A - 4A						0.78	75				0.00		0.00		0.00			0.78									
	5A	6A	1.12		107	1.12	107	3.6	1.24		0.00		0.00		0.00	0.00	1.12	1.12	0.37	1.61	119.0	200	0.65	26.44	0.06	0.84	0.46
	6A	7A	0.21		20	1.33	127	3.6	1.47		0.00		0.00		0.00	0.00	0.21	1.33	0.44	1.91	11.0	200	0.35	19.40	0.10	0.62	0.39
	7A	8A	0.45		43	1.78	170	3.5	1.95		0.00		0.00		0.00	0.00	0.45	1.78	0.59	2.54	63.0	200	0.35	19.40	0.13	0.62	0.42
Contribution From STREET No. 3, Pipe 127A - 8A						0.12	12				0.00		0.00		0.00		0.12	1.90									
Contribution From STREET No. 3, Pipe 4A - 8A						1.60	154				0.00		0.00		0.00		1.60	3.50									
	8A	21A	0.12		12	3.62	348	3.4	3.88		0.00		0.00		0.00	0.00	0.12	3.62	1.19	5.07	35.5	200	0.35	19.40	0.26	0.62	0.52
	21A	22A				3.62	348	3.4	3.88		0.00		0.00		0.00	0.00	0.00	3.62	1.19	5.07	38.5	200	0.35	19.40	0.26	0.62	0.52
Contribution From STREET No. 1, Pipe 20A - 22A						1.07	102				0.00		0.00		0.00		1.07	4.69									
	22A	25A	0.12		12	4.81	462	3.4	5.08		0.00		0.00		0.00	0.00	0.12	4.81	1.59	6.67	77.5	200	0.35	19.40	0.34	0.62	0.56
To STREET No. 1, Pipe 25A - 24A						4.81	462				0.00		0.00		0.00			4.81									
STREET No. 6																											
	13A	14A	0.57		55	0.57	55	3.6	0.65		0.00		0.00		0.00	0.00	0.57	0.57	0.19	0.84	107.0	200	0.65	26.44	0.03	0.84	0.38
To STREET No. 3, Pipe 14A - 12A						0.57	55				0.00		0.00		0.00			0.57									
STREET No. 4																											
	11A	12A	0.53		51	0.53	51	3.7	0.60		0.00		0.00		0.00	0.00	0.53	0.53	0.17	0.78	107.0	200	0.65	26.44	0.03	0.84	0.37
Contribution From STREET No. 3, Pipe 10A - 12A						0.74	71				0.00		0.00		0.00		0.74	1.27									
Contribution From STREET No. 3, Pipe 14A - 12A						0.99	96				0.00		0.00		0.00		0.99	2.26									
	12A	26A				2.26	218	3.5	2.48		0.00		0.00		0.00	0.00	0.00	2.26	0.75	3.22	23.5	200	0.35	19.40	0.17	0.62	0.46
	26A	27A	0.42		40	2.68	258	3.5	2.91		0.00		0.00		0.00	0.00	0.42	2.68	0.88	3.80	84.5	200	0.35	19.40	0.20	0.62	0.47
To STREET No. 1, Pipe 27A - 25A						2.68	258				0.00		0.00		0.00			2.68									
STREET No. 3																											
	127A	8A	0.12		12	0.12	12	3.7	0.14		0.00		0.00		0.00	0.00	0.12	0.12	0.04	0.18	66.5	200	0.65	26.44	0.01	0.84	0.23
To STREET No. 2, Pipe 8A - 21A						0.12	12				0.00		0.00		0.00			0.12									
	15A	18A	0.33		32	0.33	32	3.7	0.38		0.00		0.00		0.00	0.00	0.33	0.33	0.11	0.49	51.5	200	1.35	38.11	0.01	1.21	0.41
To STREET No. 5, Pipe 18A - 32A						0.33	32				0.00		0.00		0.00			0.33									
	15A	14A	0.35		34	0.35	34	3.7	0.41		0.00		0.00		0.00	0.00	0.35	0.35	0.12	0.52	45.0	200	0.65	26.44	0.02	0.84	0.33
Contribution From STREET No. 6, Pipe 13A - 14A						0.57	55				0.00		0.00		0.00		0.57	0.92									
	14A	12A	0.07		7	0.99	96	3.6	1.12		0.00		0.00		0.00	0.00	0.07	0.99	0.33	1.45	49.0	200	0.35	19.40	0.07	0.62	0.36
To STREET No. 4, Pipe 12A - 26A						0.99	96				0.00		0.00		0.00			0.99									
Contribution From STREET No. 5, Pipe 9A - 10A						0.66	63				0.00		0.00		0.00		0.66	0.66									
	10A	12A	0.08		8	0.74	71	3.6	0.83		0.00		0.00		0.00	0.00	0.08	0.74	0.24	1.08	50.0	200	0.35	19.40	0.06	0.62	0.33
To STREET No. 4, Pipe 12A - 26A						0.74	71				0.00		0.00		0.00			0.74									
	2A	3A	0.18		18	0.18	18	3.7	0.22		0.00		0.00		0.00	0.00	0.18	0.18	0.06	0.28	30.5	200	0.65	26.44	0.01	0.84	0.27
Contribution From STREET No. 2, Pipe 1A - 3A						0.78	75				0.00		0.00		0.00		0.78	0.96									
	3A	4A	0.64		61	1.60	154	3.5	1.77		0.00		0.00		0.00	0.00	0.64	1.60	0.53	2.30	101.0	200	0.35	19.40	0.12	0.62	0.41
	4A	8A				1.60	154	3.5	1.77		0.00		0.00		0.00	0.00	0.00	1.60	0.53	2.30	12.0	200	0.35	19.40	0.12	0.62	0.41
To STREET No. 2, Pipe 8A - 21A						1.60	154				0.00		0.00		0.00			1.60									

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 =	1.50				Townhouse coeff=		2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4	

Designed: SLM	PROJECT: TAMARACK RICHMOND		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: 01D	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. 1 of 6

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET No. 9																											
	80A	81A	0.06		6	0.06	6	3.7	0.07		0.00		0.00	1.97	1.97	0.32	2.03	2.03	0.67	1.06	32.5	200	1.25	36.67	0.03	1.17	0.51
	81A	82A	0.49		47	0.55	53	3.6	0.63		0.00		0.00		1.97	0.32	0.49	2.52	0.83	1.78	107.5	200	3.35	60.03	0.03	1.91	0.84
	82A	83A	0.35		34	0.90	87	3.6	1.02		0.00		0.00		1.97	0.32	0.35	2.87	0.95	2.28	78.5	200	1.15	35.17	0.06	1.12	0.62
To STREET No. 14, Pipe 83A - 84A						0.90	87				0.00		0.00		1.97			2.87									
	80A	79A				0.00					0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	15.0	200	2.35	50.28	0.00	1.60	0.09
	79A	78A	0.21		20	0.21	20	3.7	0.24	4.94	4.94		0.00		0.00	2.40	5.15	5.15	1.70	4.34	113.5	200	1.25	36.67	0.12	1.17	0.78
	78A	110A	0.26		25	0.47	45	3.7	0.53		4.94		0.00		0.00	2.40	0.26	5.41	1.79	4.72	13.0	200	0.35	19.40	0.24	0.62	0.51
	110A	111A	0.30		29	0.77	74	3.6	0.87		4.94		0.00		0.00	2.40	0.30	5.71	1.88	5.15	60.5	200	1.15	35.17	0.15	1.12	0.79
	111A	34A				0.77	74	3.6	0.87		4.94		0.00		0.00	2.40	0.00	5.71	1.88	5.15	15.0	200	0.95	31.97	0.16	1.02	0.74
	34A	35A	0.37		36	1.14	110	3.6	1.28		4.94		0.00		0.00	2.40	0.37	6.08	2.01	5.69	95.0	200	0.35	19.40	0.29	0.62	0.54
	35A	36A	0.46		44	1.60	154	3.5	1.77		4.94		0.00		0.00	2.40	0.46	6.54	2.16	6.33	95.0	200	0.35	19.40	0.33	0.62	0.55
	36A	37A				1.60	154	3.5	1.77		4.94		0.00		0.00	2.40	0.00	6.54	2.16	6.33	11.0	200	0.35	19.40	0.33	0.62	0.55
	37A	38A	0.43		41	2.03	195	3.5	2.23	7.88	12.82	2.90	2.90		0.00	7.64	11.21	17.75	5.86	15.72	101.5	250	0.25	29.73	0.53	0.61	0.61
	38A	45A				2.03	195	3.5	2.23		12.82		2.90		0.00	7.64	0.00	17.75	5.86	15.72	117.5	250	0.25	29.73	0.53	0.61	0.61
To STREET No. 15, Pipe 45A - 46A						2.03	195				12.82		2.90		0.00			17.75									
STREET No. 10																											
	75A	76A	0.67		64	0.67	64	3.6	0.75	5.87	5.87		0.00		0.00	2.85	6.54	6.54	2.16	5.77	116.0	200	0.65	26.44	0.22	0.84	0.67
To STREET No. 11, Pipe 76A - 71A						0.67	64				5.87		0.00		0.00			6.54									
	116A	77A	0.28		27	0.28	27	3.7	0.32		0.00		0.00		0.00	0.00	0.28	0.28	0.09	0.42	36.5	200	1.50	40.17	0.01	1.28	0.41
	77A	76A	0.42		40	0.70	67	3.6	0.79		0.00		0.00		0.00	0.00	0.42	0.70	0.23	1.02	77.5	200	2.45	51.34	0.02	1.63	0.63
To STREET No. 11, Pipe 76A - 71A						0.70	67				0.00		0.00		0.00			0.70									
STREET No. 11																											
	60A	61A	0.75		72	0.75	72	3.6	0.85		0.00		0.00		0.00	0.00	0.75	0.75	0.25	1.09	106.0	200	0.65	26.44	0.04	0.84	0.41
To STREET No. 12, Pipe 61A - 62A						0.75	72				0.00		0.00		0.00			0.75									
	60A	71A	0.83		79	0.83	79	3.6	0.93		0.00		0.00		0.00	0.00	0.83	0.83	0.27	1.20	116.0	200	0.65	26.44	0.05	0.84	0.43
To STREET No. 11, Pipe 71A - 72A						0.83	79				0.00		0.00		0.00			0.83									
Contribution From STREET No. 10, Pipe 75A - 76A						0.67	64				5.87		0.00		0.00		6.54	6.54									
Contribution From STREET No. 10, Pipe 77A - 76A						0.70	67				0.00		0.00		0.00		0.70	7.24									
	76A	71A				1.37	131	3.6	1.51		5.87		0.00		0.00	2.85	0.00	7.24	2.39	6.76	80.5	250	0.25	29.73	0.23	0.61	0.49
To STREET No. 11, Pipe 71A - 72A						1.37	131				5.87		0.00		0.00			7.24									
STREET No. 12																											
	64A	65A	0.10		10	0.10	10	3.7	0.12		0.00		0.00		0.00	0.00	0.10	0.10	0.03	0.15	11.5	200	5.70	78.31	0.00	2.49	0.46
To STREET No. 11, Pipe 65A - 69A						0.10	10				0.00		0.00		0.00			0.10									
	57A	56A	0.75		72	0.75	72	3.6	0.85		0.00		0.00		0.00	0.00	0.75	0.75	0.25	1.09	96.5	200	0.65	26.44	0.04	0.84	0.41
	56A	55A	0.72		69	1.47	141	3.6	1.63		0.00		0.00		0.00	0.00	0.72	1.47	0.49	2.11	96.5	200	0.35	19.40	0.11	0.62	0.40
	55A	70A				1.47	141	3.6	1.63		0.00		0.00		0.00	0.00	0.00	1.47	0.49	2.11	11.0	200	0.35	19.40	0.11	0.62	0.40
	70A	71A	0.56		54	2.03	195	3.5	2.23		0.00		0.00		0.00	0.00	0.56	2.03	0.67	2.90	68.5	200	0.35	19.40	0.15	0.62	0.44
To STREET No. 11, Pipe 71A - 72A						2.03	195				0.00		0.00		0.00			2.03									
	57A	58A	0.19		19	0.19	19	3.7	0.23		0.00		0.00		0.00	0.00	0.19	0.19	0.06	0.29	9.5	200	0.65	26.44	0.01	0.84	0.27

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 =	1.50				Townhouse coeff= 2.7
Institutional =	0.32	l/s/Ha			Single house coeff= 3.4

Designed:	SLM	PROJECT:	TAMARACK RICHMOND
Checked:	ADF	LOCATION:	City of Ottawa
Dwg. Reference:	01D	File Ref: 18-1042	Date: 06 Nov 2020

Sheet No. 2 of 6

1042_SAN.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
	58A	61A	0.34		33	0.53	52	3.6	0.61		0.00		0.00		0.00	0.00	0.34	0.53	0.17	0.79	72.0	200	0.35	19.40	0.04	0.62	0.30
Contribution From STREET No. 11, Pipe 60A - 61A						0.75	72				0.00		0.00		0.00		0.75	1.28									
	61A	62A	0.17		17	1.45	141	3.6	1.63		0.00		0.00		0.00	0.00	0.17	1.45	0.48	2.11	40.5	200	0.35	19.40	0.11	0.62	0.40
	62A	65A	0.22		21	1.67	162	3.5	1.86		0.00		0.00		0.00	0.00	0.22	1.67	0.55	2.41	43.5	200	0.35	19.40	0.12	0.62	0.42
To STREET No. 11, Pipe 65A - 69A						1.67	162				0.00		0.00		0.00			1.67									
	64A	63A	0.57		54	0.57	54	3.6	0.64		0.00		0.00	0.16	0.16	0.03	0.73	0.73	0.24	0.90	97.5	200	0.65	26.44	0.03	0.84	0.39
	63A	66A				0.57	54	3.6	0.64		0.00		0.00		0.16	0.03	0.00	0.73	0.24	0.90	11.0	200	0.35	19.40	0.05	0.62	0.31
	66A	67A	0.30		29	0.87	83	3.6	0.97		0.00		0.00		0.16	0.03	0.30	1.03	0.34	1.34	61.0	200	0.35	19.40	0.07	0.62	0.35
	67A	68A	0.20		19	1.07	102	3.6	1.19		0.00		0.00		0.16	0.03	0.20	1.23	0.41	1.62	11.0	200	0.35	19.40	0.08	0.62	0.37
	68A	69A	0.77		74	1.84	176	3.5	2.02		0.00		0.00		0.16	0.03	0.77	2.00	0.66	2.70	107.5	200	0.35	19.40	0.14	0.62	0.43
To STREET No. 11, Pipe 69A - 74A						1.84	176				0.00		0.00		0.16			2.00									
STREET No. 11																											
Contribution From STREET No. 12, Pipe 62A - 65A						1.67	162				0.00		0.00		0.00		1.67	1.67									
Contribution From STREET No. 12, Pipe 64A - 65A						0.10	10				0.00		0.00		0.00		0.10	1.77									
	65A	69A	0.24		23	2.01	195	3.5	2.23		0.00		0.00		0.00	0.00	0.24	2.01	0.66	2.89	71.0	200	0.35	19.40	0.15	0.62	0.44
Contribution From STREET No. 12, Pipe 68A - 69A						1.84	176				0.00		0.00		0.16		2.00	4.01									
	69A	74A	0.35		34	4.20	405	3.4	4.48		0.00		0.00		0.16	0.03	0.35	4.36	1.44	5.95	76.5	200	0.35	19.40	0.31	0.62	0.54
To STREET No. 14, Pipe 74A - 83A						4.20	405				0.00		0.00		0.16			4.36									
Contribution From STREET No. 11, Pipe 60A - 71A						0.83	79				0.00		0.00		0.00		0.83	0.83									
Contribution From STREET No. 12, Pipe 70A - 71A						2.03	195				0.00		0.00		0.00		2.03	2.86									
Contribution From STREET No. 11, Pipe 76A - 71A						1.37	131				5.87		0.00		0.00		7.24	10.10									
	71A	72A	0.32		31	4.55	436	3.4	4.81		5.87		0.00		0.00	2.85	0.32	10.42	3.44	11.10	68.5	300	0.20	43.25	0.26	0.61	0.51
	72A	73A	0.20		19	4.75	455	3.4	5.01		5.87		0.00		0.00	2.85	0.20	10.62	3.50	11.37	11.0	300	0.20	43.25	0.26	0.61	0.51
	73A	74A	0.72		69	5.47	524	3.4	5.72		5.87		0.00		0.00	2.85	0.72	11.34	3.74	12.32	97.5	375	0.15	67.91	0.18	0.61	0.46
To STREET No. 14, Pipe 74A - 83A						5.47	524				5.87		0.00		0.00			11.34									
STREET No. 14																											
	126A	51A	0.32		31	0.32	31	3.7	0.37		0.00		0.00		0.00	0.00	0.32	0.32	0.11	0.48	48.0	200	0.65	26.44	0.02	0.84	0.32
	51A	52A	0.20		19	0.52	50	3.7	0.59		0.00		0.00		0.00	0.00	0.20	0.52	0.17	0.76	11.0	200	0.35	19.40	0.04	0.62	0.30
	52A	53A	0.54		52	1.06	102	3.6	1.19		0.00		0.00		0.00	0.00	0.54	1.06	0.35	1.54	70.0	200	0.35	19.40	0.08	0.62	0.37
	53A	54A	0.47		45	1.53	147	3.6	1.69		0.00		0.00		0.00	0.00	0.47	1.53	0.50	2.20	69.5	200	0.35	19.40	0.11	0.62	0.41
To STREET No. 15, Pipe 54A - 49A						1.53	147				0.00		0.00		0.00			1.53									
Contribution From STREET No. 11, Pipe 69A - 74A						4.20	405				0.00		0.00		0.16		4.36	4.36									
Contribution From STREET No. 11, Pipe 73A - 74A						5.47	524				5.87		0.00		0.00		11.34	15.70									
	74A	83A	0.33		32	10.00	961	3.2	10.12		5.87		0.00		0.16	2.88	0.33	16.03	5.29	18.29	78.5	375	0.15	67.91	0.27	0.61	0.52
Contribution From STREET No. 9, Pipe 82A - 83A						0.90	87				0.00		0.00		1.97		2.87	18.90									
	83A	84A	0.81		77	11.71	1125	3.2	11.71		5.87		0.00		2.13	3.20	0.81	19.71	6.50	21.42	113.5	375	0.15	67.91	0.32	0.61	0.54
	84A	85A	0.35		34	12.06	1159	3.2	12.04		5.87		0.00		2.13	3.20	0.35	20.06	6.62	21.86	76.5	375	0.15	67.91	0.32	0.61	0.55
To STREET No. 16, Pipe 85A - 86A						12.06	1159				5.87		0.00		2.13			20.06									
STREET No. 16																											
Contribution From STREET No. 14, Pipe 84A - 85A						12.06	1159				5.87		0.00		2.13		20.06	20.06									
	85A	86A	0.44		42	12.50	1201	3.2	12.45		5.87		0.00		2.13	3.20	0.44	20.50	6.77	22.41	65.5	375	0.15	67.91	0.33	0.61	0.55
	86A	91A	0.44		42	12.94	1243	3.2	12.85		5.87		0.00		2.13	3.20	0.44	20.94	6.91	22.96	65.5	375	0.15	67.91	0.34	0.61	0.55
To STREET No. 15, Pipe 91A - 54A						12.94	1243				5.87		0.00		2.13			20.94									

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 =	1.50				Townhouse coeff= 2.7
Institutional =	0.32	l/s/Ha			Single house coeff= 3.4

Designed: SLM	PROJECT: TAMARACK RICHMOND		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: 01D	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. 3 of 6

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET No. 15																											
Contribution From STREET No. 8, Pipe 122A - 45A						0.62	60				0.00		0.00		0.00		0.62	0.62									
Contribution From STREET No. 9, Pipe 38A - 45A						2.03	195				12.82		2.90		0.00		17.75	18.37									
Contribution From STREET No. 8, Pipe 42A - 45A						1.65	159				0.00		0.00		0.00		1.65	20.02									
	45A	46A	0.45		43	4.75	457	3.4	5.03		12.82		2.90		0.00	7.64	0.45	20.47	6.76	19.43	80.5	250	0.25	29.73	0.65	0.61	0.64
To STREET No. 5, Pipe 46A - 33A						4.75	457				12.82		2.90		0.00			20.47									
	125A	88A	0.71		68	0.71	68	3.6	0.80		0.00		0.00		0.00	0.00	0.71	0.71	0.23	1.03	99.5	200	0.65	26.44	0.04	0.84	0.41
	88A	89A	0.29		28	1.00	96	3.6	1.12		0.00		0.00		0.00	0.00	0.29	1.00	0.33	1.45	13.0	200	0.35	19.40	0.07	0.62	0.36
	89A	91A	0.32		31	1.32	127	3.6	1.47		0.00		0.00		0.00	0.00	0.32	1.32	0.44	1.91	68.0	200	0.35	19.40	0.10	0.62	0.39
Contribution From STREET No. 16, Pipe 86A - 91A						12.94	1243				5.87		0.00		2.13		20.94	22.26									
	91A	54A	0.37		36	14.63	1406	3.2	14.40		5.87		0.00		2.13	3.20	0.37	22.63	7.47	25.06	78.5	375	0.15	67.91	0.37	0.61	0.57
Contribution From STREET No. 14, Pipe 53A - 54A						1.53	147				0.00		0.00		0.00		1.53	24.16									
	54A	49A	0.36		35	16.52	1588	3.1	16.10		5.87		0.00		2.13	3.20	0.36	24.52	8.09	27.39	70.0	375	0.15	67.91	0.40	0.61	0.58
	49A	48A				16.52	1588	3.1	16.10		5.87		0.00		2.13	3.20	0.00	24.52	8.09	27.39	12.5	375	0.15	67.91	0.40	0.61	0.58
	48A	47A	0.40		38	16.92	1626	3.1	16.46		5.87		0.00		2.13	3.20	0.40	24.92	8.22	27.88	76.0	375	0.15	67.91	0.41	0.61	0.58
	47A	46A	0.37		36	17.29	1662	3.1	16.79		5.87		0.00		2.13	3.20	0.37	25.29	8.35	28.33	75.5	375	0.15	67.91	0.42	0.61	0.59
To STREET No. 5, Pipe 46A - 33A						17.29	1662				5.87		0.00		2.13			25.29									
STREET No. 5																											
	9A	10A	0.66		63	0.66	63	3.6	0.74		0.00		0.00		0.00	0.00	0.66	0.66	0.22	0.96	93.5	200	0.65	26.44	0.04	0.84	0.40
To STREET No. 3, Pipe 10A - 12A						0.66	63				0.00		0.00		0.00			0.66									
	16A	17A	0.42		40	0.42	40	3.7	0.48		0.00		0.00		0.00	0.00	0.42	0.42	0.14	0.61	44.5	200	0.65	26.44	0.02	0.84	0.35
	17A	18A	0.21		20	0.63	60	3.6	0.71		0.00		0.00		0.00	0.00	0.21	0.63	0.21	0.92	48.5	200	0.55	24.32	0.04	0.77	0.37
Contribution From STREET No. 3, Pipe 15A - 18A						0.33	32				0.00		0.00		0.00		0.33	0.96									
	18A	32A	0.23		22	1.19	114	3.6	1.32		0.00		0.00		0.00	0.00	0.23	1.19	0.39	1.72	76.5	200	0.35	19.40	0.09	0.62	0.38
To STREET No. 1, Pipe 32A - 28A						1.19	114				0.00		0.00		0.00			1.19									
Contribution From STREET No. 15, Pipe 45A - 46A						4.75	457				12.82		2.90		0.00		20.47	20.47									
Contribution From STREET No. 15, Pipe 47A - 46A						17.29	1662				5.87		0.00		2.13		25.29	45.76									
	46A	33A	0.25		24	22.29	2143	3.0	21.18		18.69		2.90		2.13	10.84	0.25	46.01	15.18	47.20	81.5	375	0.15	67.91	0.70	0.61	0.66
	33A	32A	0.26		25	22.55	2168	3.0	21.41		18.69		2.90		2.13	10.84	0.26	46.27	15.27	47.51	81.5	375	0.15	67.91	0.70	0.61	0.66
To STREET No. 1, Pipe 32A - 28A						22.55	2168				18.69		2.90		2.13			46.27									
STREET No. 8																											
	123A	122A	0.34		33	0.34	33	3.7	0.39		0.00		0.00		0.00	0.00	0.34	0.34	0.11	0.51	48.0	200	0.65	26.44	0.02	0.84	0.33
	122A	45A	0.28		27	0.62	60	3.6	0.71		0.00		0.00		0.00	0.00	0.28	0.62	0.20	0.91	77.0	200	2.15	48.09	0.02	1.53	0.59
To STREET No. 15, Pipe 45A - 46A						0.62	60				0.00		0.00		0.00			0.62									
	29A	30A	0.18		18	0.18	18	3.7	0.22		0.00		0.00		0.00	0.00	0.18	0.18	0.06	0.28	22.5	200	0.65	26.44	0.01	0.84	0.27
	30A	31A	0.52		50	0.70	68	3.6	0.80		0.00		0.00		0.00	0.00	0.52	0.70	0.23	1.03	114.5	250	0.25	29.73	0.03	0.61	0.28
To STREET No. 1, Pipe 31A - 32A						0.70	68				0.00		0.00		0.00			0.70									
	39A	40A	0.46		44	0.46	44	3.7	0.52		0.00		0.00		0.00	0.00	0.46	0.46	0.15	0.67	76.5	200	0.65	26.44	0.03	0.84	0.35
	40A	41A	0.45		43	0.91	87	3.6	1.02		0.00		0.00		0.00	0.00	0.45	0.91	0.30	1.32	90.0	200	0.35	19.40	0.07	0.62	0.35
	41A	42A	0.39		38	1.30	125	3.6	1.45		0.00		0.00		0.00	0.00	0.39	1.30	0.43	1.88	77.5	200	0.35	19.40	0.10	0.62	0.39
	42A	45A	0.35		34	1.65	159	3.5	1.83		0.00		0.00		0.00	0.00	0.35	1.65	0.54	2.37	77.5	200	0.35	19.40	0.12	0.62	0.42
To STREET No. 15, Pipe 45A - 46A						1.65	159				0.00		0.00		0.00			1.65									

DESIGN PARAMETERS

Park Flow = 9300 L/ha/da 0.10764 l/s/Ha
Average Daily Flow = 280 l/p/day
Comm/Inst Flow = 28000 L/ha/da 0.3241 l/s/Ha
Industrial Flow = 35000 L/ha/da 0.40509 l/s/Ha
Max Res. Peak Factor = 4.00
Commercial/Inst./Park Peak Factor = 1.50
Institutional = 0.32 l/s/Ha

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: SLM
Checked: ADF
Dwg. Reference: 01D
Sanitary Drainage Plan, Dwgs. No.

PROJECT: **TAMARACK RICHMOND**
LOCATION: **City of Ottawa**
File Ref: 18-1042
Date: **06 Nov 2020**
Sheet No. 4 of 6

1042_SAN.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET No. 1																											
	19A	20A	0.64		61	0.64	61	3.6	0.72		0.00		0.00		0.00	0.00	0.64	0.64	0.21	0.93	63.0	200	0.65	26.44	0.04	0.84	0.39
	20A	22A	0.43		41	1.07	102	3.6	1.19		0.00		0.00		0.00	0.00	0.43	1.07	0.35	1.54	63.0	200	0.35	19.40	0.08	0.62	0.37
To STREET No. 2, Pipe 22A - 25A						1.07	102				0.00		0.00		0.00			1.07									
Contribution From STREET No. 8, Pipe 30A - 31A						0.70	68				0.00		0.00		0.00		0.70	0.70									
	31A	32A	0.48		46	1.18	114	3.6	1.32		0.00		0.00		0.00	0.00	0.48	1.18	0.39	1.71	80.5	250	0.25	29.73	0.06	0.61	0.33
Contribution From STREET No. 5, Pipe 18A - 32A						1.19	114				0.00		0.00		0.00		1.19	2.37									
Contribution From STREET No. 5, Pipe 33A - 32A						22.55	2168				18.69		2.90		2.13		46.27	48.64									
	32A	28A	0.30		29	25.22	2425	3.0	23.70		18.69		2.90		2.13	10.84	0.30	48.94	16.15	50.69	72.0	375	0.15	67.91	0.75	0.61	0.67
	28A	27A	0.24		23	25.46	2448	3.0	23.90		18.69		2.90		2.13	10.84	0.24	49.18	16.23	50.97	72.0	375	0.15	67.91	0.75	0.61	0.67
Contribution From STREET No. 4, Pipe 26A - 27A						2.68	258				0.00		0.00		0.00		2.68	51.86									
	27A	25A	0.19		19	28.33	2725	3.0	26.33		18.69		2.90	1.14	3.27	11.02	1.33	53.19	17.55	54.91	118.5	375	0.20	78.41	0.70	0.71	0.77
Contribution From STREET No. 2, Pipe 22A - 25A						4.81	462				0.00		0.00		0.00		4.81	58.00									
	25A	24A	0.26		25	33.40	3212	2.9	30.54		18.69		2.90		3.27	11.02	0.26	58.26	19.23	60.79	62.0	375	0.20	78.41	0.78	0.71	0.78
	24A	23A	0.38		37	33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.38	58.64	19.35	61.23	62.0	375	0.20	78.41	0.78	0.71	0.78
To STREET No. 1, Pipe 23A - 114A						33.78	3249				18.69		2.90		3.27			58.64									
STREET No. 1																											
Contribution From STREET No. 1, Pipe 24A - 23A						33.78	3249				18.69		2.90		3.27		58.64	58.64									
	23A	114A				33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.00	58.64	19.35	61.23	32.0	450	0.15	110.42	0.55	0.69	0.71
To OTTAWA STREET, Pipe 114A - 115A						33.78	3249				18.69		2.90		3.27			58.64									
OTTAWA STREET																											
Contribution From STREET No. 1, Pipe 23A - 114A						33.78	3249				18.69		2.90		3.27		58.64	58.64									
	114A	115A				33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.00	58.64	19.35	61.23	104.0	450	0.15	110.42	0.55	0.69	0.71
	115A	124A				33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.00	58.64	19.35	61.23	100.5	450	0.15	110.42	0.55	0.69	0.71
	124A	94A				33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.00	58.64	19.35	61.23	108.5	450	0.15	110.42	0.55	0.69	0.71
	94A	6091A				33.78	3249	2.9	30.85		18.69		2.90		3.27	11.02	0.00	58.64	19.35	61.23	118.5	450	0.15	110.42	0.55	0.69	0.71
To KING STREET, Pipe 6091A - 6092A						33.78	3249				18.69		2.90		3.27			58.64									
KING STREET																											
Contribution From OTTAWA STREET, Pipe 94A - 6091A						33.78	3249				18.69		2.90		3.27		58.64	58.64									
			1.78		24	35.56	3273				18.69		2.90		3.27		1.78	60.42									
	6091A	6092A	17.01		801	52.57	4074	2.9	37.77		18.69		2.90		3.27	11.02	17.01	77.43	25.55	74.35	79.0	525	0.10	136.00	0.55	0.63	0.64
	6092A	6093A	8.74		394	61.31	4468	2.8	41.01		18.69		2.90		3.27	11.02	8.74	86.17	28.44	80.46	76.5	525	0.10	136.00	0.59	0.63	0.65
	6093A	6094A	0.82		11	62.13	4479	2.8	41.09		18.69		2.90		3.27	11.02	0.82	86.99	28.71	80.82	81.0	525	0.10	136.00	0.59	0.63	0.66
	6094A	16094A				62.13	4479	2.8	41.09		18.69		2.90		3.27	11.02	0.00	86.99	28.71	80.82	9.5	525	0.10	136.00	0.59	0.63	0.66
	16094A	43668A	0.88		12	63.01	4491	2.8	41.19		18.69		2.90		3.27	11.02	0.88	87.87	29.00	81.21	72.0	525	0.10	136.00	0.60	0.63	0.66
	43668A	43669A				63.01	4491	2.8	41.19		18.69		2.90		3.27	11.02	0.00	87.87	29.00	81.21	85.0	525	0.10	136.00	0.60	0.63	0.66
	43669A	6219A				63.01	4491	2.8	41.19		18.69		2.90		3.27	11.02	0.00	87.87	29.00	81.21	79.0	525	0.10	136.00	0.60	0.63	0.66
	6219A	6095A	15.92		197	78.93	4688	2.8	42.79		18.69		2.90		3.27	11.02	15.92	103.79	34.25	88.07	53.5	525	0.10	136.00	0.65	0.63	0.67
To ROYAL YORK STREET, Pipe 6095A - 6115A						78.93	4688				18.69		2.90		3.27			103.79									
ROYAL YORK STREET																											
Contribution From KING STREET, Pipe 6219A - 6095A						78.93	4688				18.69		2.90		3.27		103.79	103.79									
	6095A	6115A	1.91		26	80.84	4714	2.8	43.00		18.69		2.90		3.27	11.02	1.91	105.70	34.88	88.91	80.0	525	0.10	136.00	0.65	0.63	0.67

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 =	1.50				Townhouse coeff=		2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4	

Designed: SLM	PROJECT: TAMARACK RICHMOND		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: 01D Sanitary Drainage Plan, Dwgs. No.	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. 5 of 6

1042_SAN.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	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	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
	6115A	6328A	0.68		9	81.52	4723	2.8	43.08		18.69		2.90		3.27	11.02	0.68	106.38	35.11	89.20	62.0	525	0.10	136.00	0.66	0.63	0.67
To COCKBURN STREET, Pipe 6328A - 43671A						81.52	4723				18.69		2.90		3.27			106.38									
COCKBURN STREET																											
Contribution From ROYAL YORK STREET, Pipe 6115A - 6328A						81.52	4723				18.69		2.90		3.27		106.38	106.38									
	6328A	43671A				81.52	4723	2.8	43.08		18.69		2.90		3.27	11.02	0.00	106.38	35.11	89.20	27.5	525	0.10	136.00	0.66	0.63	0.67
To PUMP STATION, Pipe 43671A - 43672A						81.52	4723				18.69		2.90		3.27			106.38									
PUMP STATION																											
Contribution From COCKBURN STREET, Pipe 6328A - 43671A						81.52	4723				18.69		2.90		3.27		106.38	106.38									
	43671A	43672A				81.52	4723	2.8	43.08		18.69		2.90		3.27	11.02	0.00	106.38	35.11	89.20	16.5	525	0.10	136.00	0.66	0.63	0.67
			34.97		496	116.49	5219				18.69		2.90		3.27		34.97	141.35									
	43672A	P.S.	414.24		14182	530.73	19401	2.3	146.66		18.69		2.90		3.27	11.02	414.24	555.59	183.34	341.03	6.5	600	0.26	313.09	1.09	1.11	1.11

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 =	1.50				Townhouse coeff=	2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=	3.4	

Designed:	SLM	PROJECT:	**TAMARACK RICHMOND**
Checked:	ADF	LOCATION:	**City of Ottawa**
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No.	01D	File Ref: 18-1042	Date: **06 Nov 2020** — Sheet No. 6 of 6

MONITORED PARAMETERS

LOCATION			EXISTING RESIDENTIAL				INFILL		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)
MARTIN ST.	MHSA06160	MHSA06287	320	320	24.87	24.87	53	53	373	3.00	3.99	0.37	17.16	17.53
MARTIN ST.	MHSA06287	MHSA06245	9	329	0.69	25.57	0	53	382	3.00	4.09	0.38	17.64	18.02
MARTIN ST.	MHSA06245	MHSA06288	104	433	7.84	33.41	6	59	492	2.97	5.20	0.50	23.05	23.55
MARTIN ST.	MHSA06288	MHSA06235	3	436	0.23	33.63	0	59	495	2.96	5.23	0.50	23.21	23.71
MARTIN ST.	MHSA06235	MHSA06289	729	1165	56.20	89.84	98	157	1322	2.79	13.17	1.35	61.99	63.34
MARTIN ST.	MHSA06289	MHSA06254	3	1168	0.25	90.08	0	157	1326	2.79	13.20	1.35	62.16	63.51
MARTIN ST.	MHSA06254	MHSA06291	134	1302	10.39	100.47	21	178	1480	2.77	14.62	1.51	69.33	70.83
MARTIN ST.	MHSA06291	MHSA06292	66	1368	5.06	105.53	8	186	1554	2.76	15.30	1.58	72.82	74.40
MARTIN ST.	MHSA06292	MHSA06293	2	1370	0.12	105.65	0	186	1556	2.76	15.31	1.58	72.90	74.48
MARTIN ST.	MHSA06293	MHSA06294	30	1400	2.25	107.90	0	186	1586	2.76	15.59	1.62	74.45	76.07
MARTIN ST.	MHSA06294	MHSA06262	89	1489	6.63	114.53	3	189	1678	2.74	16.42	1.72	79.03	80.74
MARTIN ST.	MHSA06262	MHSA06295	33	1522	2.43	116.97	0	189	1711	2.74	16.72	1.75	80.71	82.46
MARTIN ST.	MHSA06295	MHSA06270	58	1580	4.31	121.28	0	189	1769	2.73	17.24	1.82	83.68	85.50
COCKBURN ST.	MHSA06270	MHSA06267	1300	2880	106.17	227.44	440	629	3509	2.57	32.19	3.41	156.93	160.35
COCKBURN ST.	MHSA06267	MHSA06264	7	2887	0.52	227.96	0	629	3516	2.57	32.25	3.42	157.29	160.71
COCKBURN ST.	MHSA06264	MHSA06263	122	3009	9.02	236.98	0	629	3638	2.56	33.25	3.55	163.52	167.07
COCKBURN ST.	MHSA06263	MHSA06330	0	3009	0.00	236.98	0	629	3638	2.56	33.25	3.55	163.52	167.07
OTTAWA ST.	MHSA06372	MHSA06089	29	29	2.18	2.18	0	0	29	3.21	0.34	0.03	1.50	1.54
OTTAWA ST.	MHSA06089	MHSA06090	10	39	0.71	2.89	0	0	39	3.20	0.44	0.04	1.99	2.04
OTTAWA ST.	MHSA06090	MHSA06374	7	46	0.44	3.33	0	0	46	3.19	0.52	0.05	2.29	2.34
OTTAWA ST.	MHSA06374	MHSA06091	10	56	0.65	3.97	0	0	56	3.18	0.64	0.06	2.74	2.80
KING ST.	MHSA06091	MHSA06092	24	80	1.78	5.75	0	0	80	3.16	0.91	0.09	3.97	4.05
KING ST.	MHSA06092	MHSA06093	33	113	5.67	11.42	194	194	307	3.03	3.32	0.17	7.88	8.05
KING ST.	MHSA06093	MHSA06094	11	125	0.82	12.24	0	194	318	3.02	3.43	0.18	8.45	8.63
KING ST.	MHSA06094	MHSA06219	12	136	0.88	13.12	0	194	330	3.02	3.56	0.20	9.05	9.25
KING ST.	MHSA06219	MHSA06095	197	333	15.92	29.04	0	194	527	2.96	5.55	0.44	20.04	20.47
ROYAL YORK ST.	MHSA06095	MHSA06115	26	359	1.91	30.95	0	194	553	2.95	5.81	0.46	21.36	21.82
ROYAL YORK ST.	MHSA06115	MHSA06328	9	368	0.68	31.63	0	194	562	2.95	5.90	0.47	21.82	22.30
COCKBURN ST.	MHSA06328	MHSA39573	0	368	0.00	31.63	0	194	562	2.95	5.90	0.47	21.82	22.30
COCKBURN ST.	MHSA39573	MHSA06330	462	830	34.97	66.60	34	228	1058	2.84	10.70	1.00	45.96	46.95
RICHMOND PS	MHSA06330	MHSA06331	0	**3839**	0.00	**303.58**	0	**857**	4695	2.50	41.82	4.55	209.47	214.02

DESIGN PARAMETERS

LOCATION			INDUSTRIAL		MATTAMY HOMES				LARGE PARCELS				INDUSTRIAL CONTRIBUTIONS			RESIDENTIAL CONTRIBUTIONS			INFILTRATION CONTRIBUTIONS	
STREET	FROM MH	TO MH	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	0.00	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	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	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	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	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	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	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	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	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	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	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	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	0.00	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	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	0.00	**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
HARMON "K" 0.66
GWI **0.015 L/s/ha**
WWI **0.690 L/s/ha**

Manning's "n" 0.013

DESIGN PARAMETERS

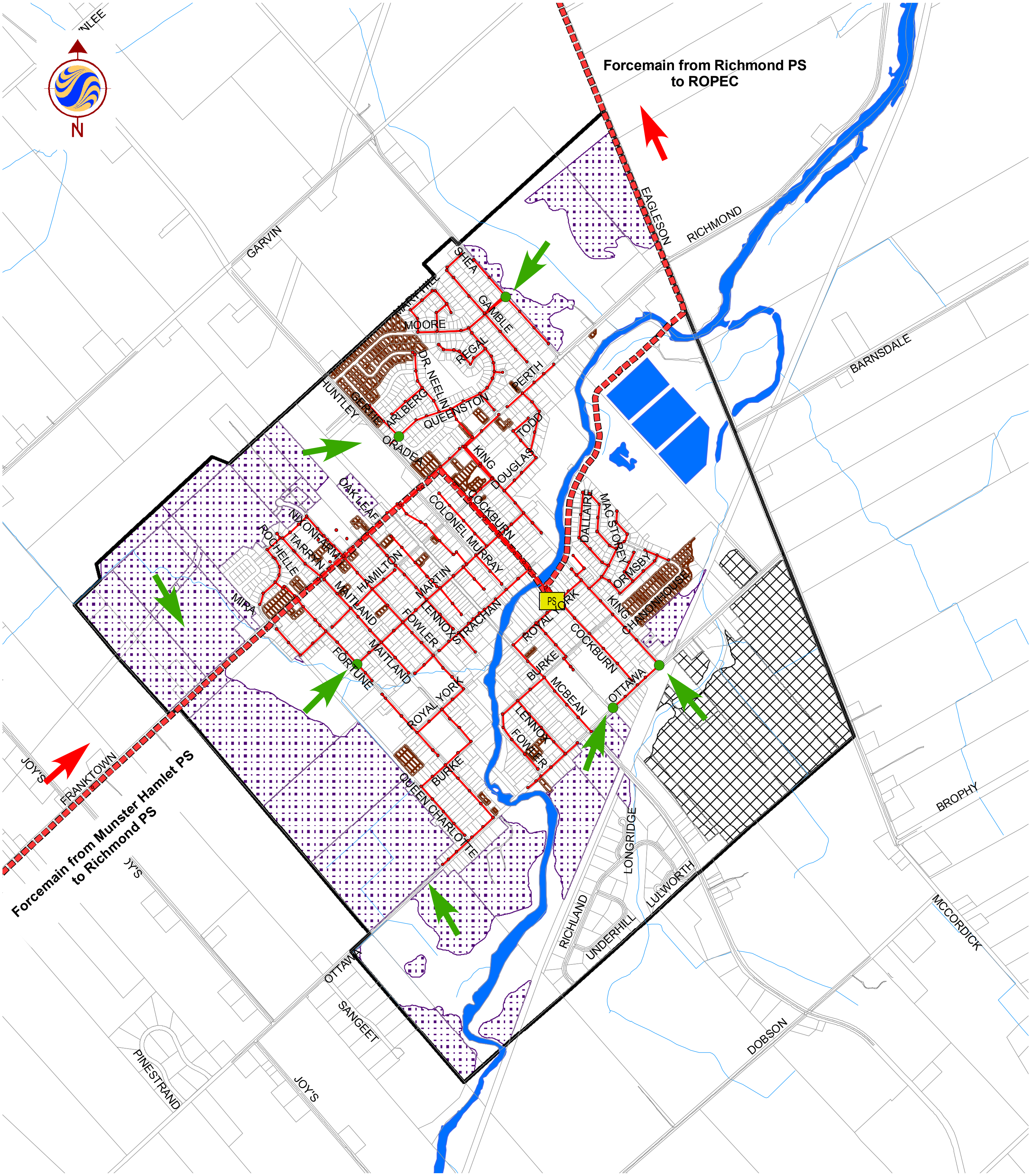
RESIDENTIAL **350 Lpcd**
HARMON "K" 1
RESIDENTIAL I/I **0.280 L/s/ha**
INDUSTRIAL **5000 L/ha/d**
INDUSTRIAL PF **1.5**
INDUSTRIAL I/I **0.120 L/s/ha**

Designed: MT
Checked: FW

PROJECT: Village of Richmond Sanitary Master Servicing Study
Existing, Infill and Future Growth (High Projection) - Options A, B and C

LOCATION: City of Ottawa

File Ref.: 163400808 Date: Mar-10 Sheet No. 1 of 1



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.4-richmond_wastewater_servicing_existing&alternatives_20090203.mxd

Legend

- PS — WWPS
- Future Dev. Loadings
- Sanitary MH
- Sanitary Collector
- Sanitary Forcemain
- Village of Richmond Boundary
- Future Residential Development
- Future Infill Development
- Future Industrial Development

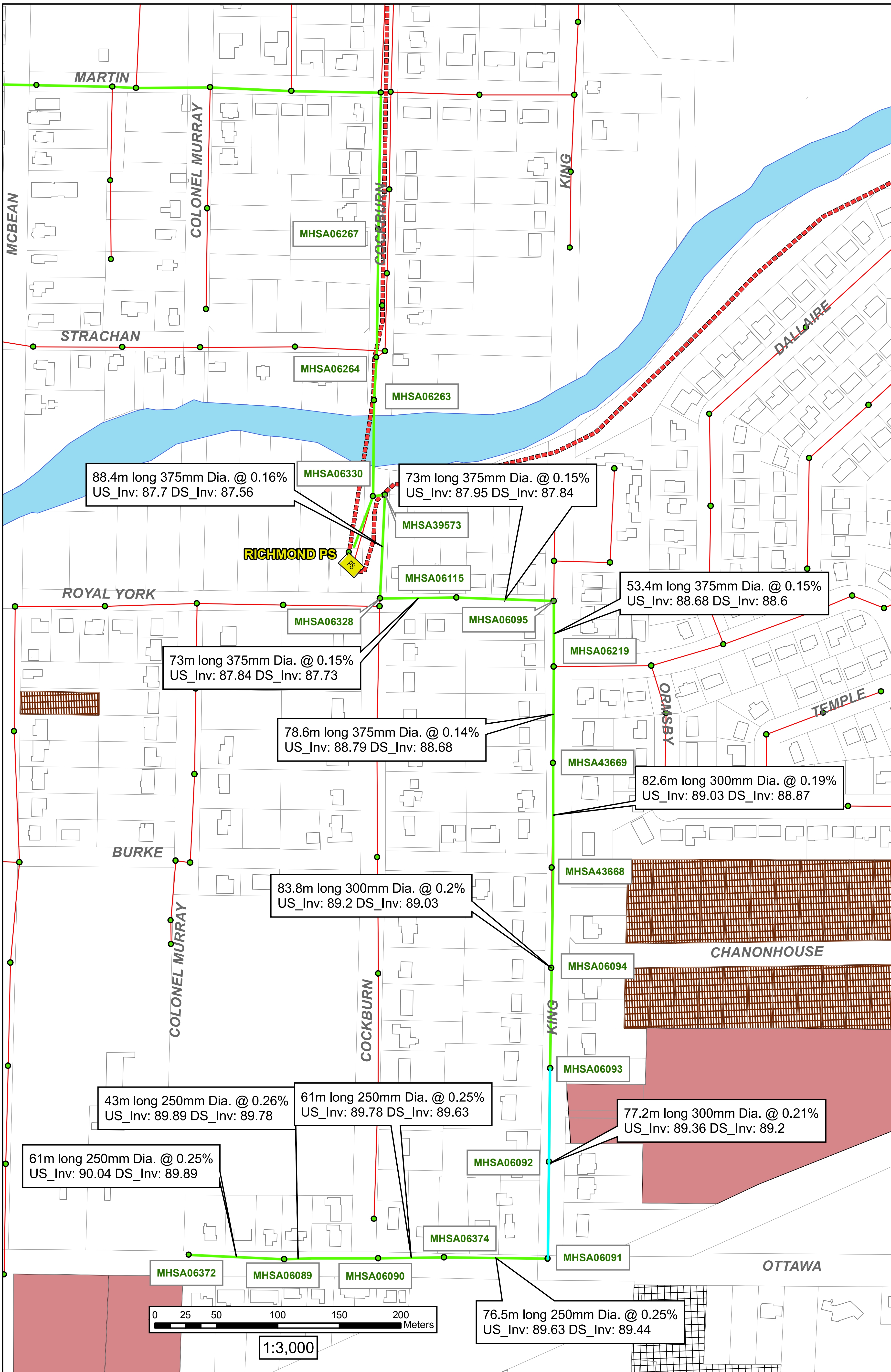
Stantec

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

Figure No.
5.4

Title **Connection Locations to the Central Collection System**

January 2009



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Open House April 8, 2010\Wastewater Options_A_B_C_mt20100503_#2.mxd

Legend

- Sanitary Manhole
- Existing Sanitary Sewer
- Existing Sanitary Forcemain
- Future Development
- Future Infill
- Future Industrial

Stantec

May 2010
1634-00808

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

Figure No.
8.7

Title
Functional Sanitary Sewer Design
South of the Jock River

APPENDIX D

Storm Collection

- HEC RAS Output for Tributaries to the Jock River Subwatershed (Reach 2) by JFSA
- Jock River Subwatershed (Reach 2) Flood Risk Maps by the Rideau Valley Conservation Authority
- Confirmation of Pre-Development Flows (e-mail) by JFSA dated September 11, 2020
- Storm Sewer Design Sheet for the Tamarack Richmond Lands by DSEL
- SWM Pond Sizing Calculations by DSEL

HEC-RAS Plan: Plan 01 (Continued)

River	Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Cum Ch Len	Volume	Top W Chnl
				(m3/s)	(m)	(m/s)	(m2)	(m)	(m)	(1000 m3)	(m)
Leamy Creek	Reach 1	4197	2 year	4.70	92.26	0.27	27.35	41.34	4197.00	274.48	6.56
Leamy Creek	Reach 1	4338	100 year	10.20	93.50	0.10	344.40	596.66	4338.00	1192.31	6.47
Leamy Creek	Reach 1	4338	50 year	9.40	93.34	0.13	255.01	554.23	4338.00	1000.44	6.47
Leamy Creek	Reach 1	4338	25 year	8.30	93.12	0.21	138.56	493.53	4338.00	766.12	6.47
Leamy Creek	Reach 1	4338	10 year	7.40	92.92	0.26	68.68	139.55	4338.00	593.41	6.47
Leamy Creek	Reach 1	4338	5 year	6.40	92.70	0.31	42.52	95.82	4338.00	460.22	6.47
Leamy Creek	Reach 1	4338	2 year	4.70	92.27	0.36	17.00	35.24	4338.00	277.97	6.47
Leamy Creek	Reach 1	4490	100 year	10.20	93.50	0.04	307.84	573.74	4490.00	1240.13	222.85
Leamy Creek	Reach 1	4490	50 year	9.40	93.34	0.06	222.93	524.27	4490.00	1035.49	173.38
Leamy Creek	Reach 1	4490	25 year	8.30	93.13	0.11	115.69	454.15	4490.00	784.80	103.26
Leamy Creek	Reach 1	4490	10 year	7.40	92.92	0.17	51.77	118.42	4490.00	602.31	58.19
Leamy Creek	Reach 1	4490	5 year	6.40	92.71	0.23	30.85	74.30	4490.00	465.68	43.86
Leamy Creek	Reach 1	4490	2 year	4.70	92.29	0.34	14.22	22.15	4490.00	280.32	20.79
Leamy Creek	Reach 1	4506	100 year	10.20	93.50	0.10	314.15	500.22	4506.00	1254.10	6.92
Leamy Creek	Reach 1	4506	50 year	9.40	93.34	0.13	238.51	478.42	4506.00	1045.86	6.92
Leamy Creek	Reach 1	4506	25 year	8.30	93.13	0.21	137.13	447.54	4506.00	790.40	6.92
Leamy Creek	Reach 1	4506	10 year	7.40	92.93	0.27	68.30	171.00	4506.00	604.79	6.92
Leamy Creek	Reach 1	4506	5 year	6.40	92.71	0.32	38.53	103.37	4506.00	466.92	6.92
Leamy Creek	Reach 1	4506	2 year	4.70	92.30	0.35	17.11	27.01	4506.00	280.70	6.92
Leamy Creek	Reach 1	4515	100 year	10.20	93.50	0.11	299.53	487.50	4515.00	1259.18	4.43
Leamy Creek	Reach 1	4515	50 year	9.40	93.34	0.14	225.75	467.34	4515.00	1049.65	4.43
Leamy Creek	Reach 1	4515	25 year	8.30	93.13	0.24	126.57	438.77	4515.00	792.43	4.43
Leamy Creek	Reach 1	4515	10 year	7.40	92.93	0.34	60.01	155.16	4515.00	605.63	4.43
Leamy Creek	Reach 1	4515	5 year	6.40	92.71	0.44	32.24	99.15	4515.00	467.34	4.43
Leamy Creek	Reach 1	4515	2 year	4.70	92.29	0.49	12.73	18.60	4515.00	280.85	4.43
Tributary D	Reach 1	0	100 year	4.24	93.56	0.01	533.34	329.54			76.44
Tributary D	Reach 1	0	50 year	3.96	93.42	0.01	485.29	326.05			76.44
Tributary D	Reach 1	0	25 year	3.52	93.21	0.01	418.81	317.39			76.44
Tributary D	Reach 1	0	10 year	3.10	93.00	0.01	352.41	307.97			76.44
Tributary D	Reach 1	0	5 year	2.67	92.55	0.01	244.83	175.65			76.44
Tributary D	Reach 1	0	2 year	1.88	92.33	0.01	209.60	145.16			76.44
Tributary D	Reach 1	232	100 year	4.24	93.56	0.01	822.20	486.46	231.50	163.98	114.30
Tributary D	Reach 1	232	50 year	3.96	93.42	0.01	751.06	486.15	231.50	150.19	114.30
Tributary D	Reach 1	232	25 year	3.52	93.21	0.01	650.66	485.71	231.50	130.87	114.30
Tributary D	Reach 1	232	10 year	3.10	93.00	0.01	547.65	484.73	231.50	111.26	114.30
Tributary D	Reach 1	232	5 year	2.67	92.55	0.01	356.73	373.52	231.50	76.71	114.30
Tributary D	Reach 1	232	2 year	1.88	92.33	0.01	277.05	337.38	231.50	63.41	114.30
Tributary D	Reach 1	255		Culvert							
Tributary D	Reach 1	261	100 year	4.24	93.56	0.01	815.44	486.62	260.66	178.26	108.28
Tributary D	Reach 1	261	50 year	3.96	93.42	0.01	744.36	485.21	260.66	163.55	108.28
Tributary D	Reach 1	261	25 year	3.52	93.21	0.01	644.31	483.11	260.66	142.94	108.28
Tributary D	Reach 1	261	10 year	3.10	93.00	0.01	542.02	480.47	260.66	122.01	108.28
Tributary D	Reach 1	261	5 year	2.67	92.55	0.01	353.99	364.84	260.66	84.86	108.28
Tributary D	Reach 1	261	2 year	1.88	92.33	0.01	276.11	330.98	260.66	70.36	108.28
Tributary D	Reach 1	277	100 year	4.24	93.56	0.01	677.79	379.65	277.06	213.43	118.24
Tributary D	Reach 1	277	50 year	3.96	93.42	0.01	622.42	375.83	277.06	195.83	118.24
Tributary D	Reach 1	277	25 year	3.52	93.21	0.01	545.73	366.36	277.06	171.17	118.24
Tributary D	Reach 1	277	10 year	3.10	93.00	0.01	469.02	356.25	277.06	146.14	118.24
Tributary D	Reach 1	277	5 year	2.67	92.55	0.01	334.40	248.91	277.06	101.01	118.24
Tributary D	Reach 1	277	2 year	1.88	92.33	0.01	282.25	218.93	277.06	82.84	118.24
Tributary D	Reach 1	524	100 year	4.24	93.56	0.01	915.14	508.56	523.80	379.13	42.40
Tributary D	Reach 1	524	50 year	3.96	93.42	0.01	840.96	503.58	523.80	347.73	42.40
Tributary D	Reach 1	524	25 year	3.52	93.21	0.01	738.17	491.21	523.80	304.06	42.40
Tributary D	Reach 1	524	10 year	3.10	93.00	0.01	635.28	478.45	523.80	260.13	42.40
Tributary D	Reach 1	524	5 year	2.67	92.55	0.01	431.26	438.74	523.80	180.38	42.40
Tributary D	Reach 1	524	2 year	1.88	92.33	0.01	333.65	428.41	523.80	147.56	42.40
Tributary D	Reach 1	684	100 year	4.24	93.56	0.01	534.68	236.83	684.32	503.98	40.58
Tributary D	Reach 1	684	50 year	3.96	93.42	0.01	500.05	236.43	684.32	463.02	40.58
Tributary D	Reach 1	684	25 year	3.52	93.21	0.01	451.30	235.42	684.32	406.07	40.58
Tributary D	Reach 1	684	10 year	3.10	93.00	0.01	401.45	234.40	684.32	348.78	40.58
Tributary D	Reach 1	684	5 year	2.67	92.55	0.01	297.43	233.25	684.32	242.26	40.58
Tributary D	Reach 1	684	2 year	1.88	92.33	0.01	245.89	220.52	684.32	196.58	40.58
Tributary D	Reach 1	930	100 year	4.24	93.56	0.01	641.06	287.20	930.11	589.36	48.70
Tributary D	Reach 1	930	50 year	3.96	93.42	0.01	599.05	287.20	930.11	542.89	48.70
Tributary D	Reach 1	930	25 year	3.52	93.21	0.01	539.70	287.20	930.11	478.17	48.70

HEC-RAS Plan: Plan 01 (Continued)

River	Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Cum Ch Len	Volume	Top W Chnl
				(m3/s)	(m)	(m/s)	(m2)	(m)	(m)	(1000 m3)	(m)
Tributary D	Reach 1	930	10 year	3.10	93.00	0.01	478.76	287.20	930.11	412.94	48.70
Tributary D	Reach 1	930	5 year	2.67	92.55	0.01	351.23	286.13	930.11	289.86	48.70
Tributary D	Reach 1	930	2 year	1.88	92.33	0.01	286.70	285.58	930.11	235.98	48.70
Tributary D	Reach 1	981	100 year	4.24	93.56	0.01	510.39	255.16	980.65	636.91	34.94
Tributary D	Reach 1	981	50 year	3.96	93.42	0.01	473.06	255.16	980.65	587.11	34.94
Tributary D	Reach 1	981	25 year	3.52	93.21	0.01	420.33	255.16	980.65	517.70	34.94
Tributary D	Reach 1	981	10 year	3.10	93.00	0.01	366.19	255.16	980.65	447.65	34.94
Tributary D	Reach 1	981	5 year	2.67	92.55	0.02	252.68	255.16	980.65	314.47	34.94
Tributary D	Reach 1	981	2 year	1.88	92.33	0.02	196.51	238.53	980.65	255.51	34.94
Tributary D	Reach 1	1096	100 year	4.24	93.56	0.17	25.64	63.82	1095.96	682.94	32.00
Tributary D	Reach 1	1096	50 year	3.96	93.42	0.16	24.64	63.82	1095.96	629.99	32.00
Tributary D	Reach 1	1096	25 year	3.52	93.21	0.15	23.24	63.82	1095.96	556.12	32.00
Tributary D	Reach 1	1096	10 year	3.10	93.00	0.14	21.80	63.82	1095.96	481.50	32.00
Tributary D	Reach 1	1096	5 year	2.67	92.55	0.14	18.77	63.82	1095.96	338.74	32.00
Tributary D	Reach 1	1096	2 year	1.88	92.33	0.11	17.24	62.42	1095.96	275.01	32.00
Tributary D	Reach 1	1112		Culvert							
Tributary D	Reach 1	1128	100 year	4.24	93.56	0.16	26.28	94.19	1127.90	688.90	32.00
Tributary D	Reach 1	1128	50 year	3.96	93.42	0.16	25.29	93.40	1127.90	635.61	32.00
Tributary D	Reach 1	1128	25 year	3.52	93.21	0.15	23.88	91.40	1127.90	561.27	32.00
Tributary D	Reach 1	1128	10 year	3.10	93.00	0.14	22.46	89.40	1127.90	486.16	32.00
Tributary D	Reach 1	1128	5 year	2.67	92.55	0.14	19.41	82.85	1127.90	342.42	32.00
Tributary D	Reach 1	1128	2 year	1.88	92.33	0.11	17.87	80.07	1127.90	278.20	32.00
Tributary D	Reach 1	1132	100 year	4.24	93.57	0.04	163.92	80.45	1132.39	692.31	14.00
Tributary D	Reach 1	1132	50 year	3.96	93.42	0.04	152.14	79.95	1132.39	638.77	14.00
Tributary D	Reach 1	1132	25 year	3.52	93.21	0.04	135.70	78.67	1132.39	564.08	14.00
Tributary D	Reach 1	1132	10 year	3.10	93.00	0.04	119.44	77.37	1132.39	488.63	14.00
Tributary D	Reach 1	1132	5 year	2.67	92.55	0.05	88.26	61.36	1132.39	344.19	14.00
Tributary D	Reach 1	1132	2 year	1.88	92.33	0.04	74.95	57.11	1132.39	279.67	14.00
Tributary D	Reach 1	1305	100 year	4.24	93.57	0.04	182.72	155.02	1305.16	720.29	22.90
Tributary D	Reach 1	1305	50 year	3.96	93.42	0.04	160.10	153.39	1305.16	664.10	22.90
Tributary D	Reach 1	1305	25 year	3.52	93.21	0.05	128.52	151.31	1305.16	585.71	22.90
Tributary D	Reach 1	1305	10 year	3.10	93.00	0.05	97.21	149.22	1305.16	506.59	22.90
Tributary D	Reach 1	1305	5 year	2.67	92.56	0.06	58.49	57.50	1305.16	356.53	22.90
Tributary D	Reach 1	1305	2 year	1.88	92.33	0.05	47.07	47.96	1305.16	289.95	22.90
Tributary D	Reach 1	1453	100 year	4.24	93.57	0.04	195.63	231.55	1452.64	751.13	18.82
Tributary D	Reach 1	1453	50 year	3.96	93.42	0.05	162.38	214.09	1452.64	690.30	18.82
Tributary D	Reach 1	1453	25 year	3.52	93.21	0.05	122.61	169.72	1452.64	605.97	18.82
Tributary D	Reach 1	1453	10 year	3.10	93.00	0.06	91.90	125.11	1452.64	521.69	18.82
Tributary D	Reach 1	1453	5 year	2.67	92.56	0.06	59.96	59.78	1452.64	365.85	18.82
Tributary D	Reach 1	1453	2 year	1.88	92.33	0.05	47.84	50.89	1452.64	297.38	18.82
Tributary D	Reach 1	1644	100 year	4.24	93.57	0.03	235.17	281.23	1644.20	787.22	32.86
Tributary D	Reach 1	1644	50 year	3.96	93.42	0.04	195.16	255.70	1644.20	720.57	32.86
Tributary D	Reach 1	1644	25 year	3.52	93.21	0.04	148.24	197.18	1644.20	629.29	32.86
Tributary D	Reach 1	1644	10 year	3.10	93.00	0.04	113.30	138.36	1644.20	539.65	32.86
Tributary D	Reach 1	1644	5 year	2.67	92.56	0.05	65.31	76.24	1644.20	377.13	32.86
Tributary D	Reach 1	1644	2 year	1.88	92.33	0.04	53.04	47.40	1644.20	306.52	32.86
Tributary D	Reach 1	1862	100 year	4.24	93.57	0.11	76.94	78.96	1862.10	822.54	8.06
Tributary D	Reach 1	1862	50 year	3.96	93.42	0.11	66.77	65.30	1862.10	750.13	8.06
Tributary D	Reach 1	1862	25 year	3.52	93.21	0.12	53.76	60.29	1862.10	651.99	8.06
Tributary D	Reach 1	1862	10 year	3.10	93.00	0.13	41.73	55.24	1862.10	556.99	8.06
Tributary D	Reach 1	1862	5 year	2.67	92.56	0.24	18.47	48.35	1862.10	386.38	8.06
Tributary D	Reach 1	1862	2 year	1.88	92.33	0.24	10.80	25.62	1862.10	313.54	8.06
Tributary D	Reach 1	1943	100 year	4.24	93.57	0.19	42.95	48.32	1942.67	832.22	4.82
Tributary D	Reach 1	1943	50 year	3.96	93.42	0.20	36.62	40.73	1942.67	758.36	4.82
Tributary D	Reach 1	1943	25 year	3.52	93.21	0.22	28.56	37.22	1942.67	658.38	4.82
Tributary D	Reach 1	1943	10 year	3.10	93.01	0.25	21.19	33.68	1942.67	561.70	4.82
Tributary D	Reach 1	1943	5 year	2.67	92.56	0.37	10.19	15.80	1942.67	388.20	4.82
Tributary D	Reach 1	1943	2 year	1.88	92.34	0.34	7.25	11.84	1942.67	314.56	4.82
Tributary D	Reach 1	1957	100 year	4.24	93.57	0.24	20.63	11.10	1956.68	835.55	7.00
Tributary D	Reach 1	1957	50 year	3.96	93.42	0.24	19.10	11.01	1956.68	761.07	7.00
Tributary D	Reach 1	1957	25 year	3.52	93.21	0.24	16.93	10.84	1956.68	660.33	7.00
Tributary D	Reach 1	1957	10 year	3.10	93.01	0.24	14.75	10.67	1956.68	562.96	7.00
Tributary D	Reach 1	1957	5 year	2.67	92.57	0.29	10.22	9.78	1956.68	388.57	7.00
Tributary D	Reach 1	1957	2 year	1.88	92.34	0.25	8.10	9.15	1956.68	314.80	7.00
Tributary D	Reach 1	1959		Bridge							

HEC-RAS Plan: Plan 01 (Continued)

River	Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Cum Ch Len	Volume	Top W Chnl
				(m3/s)	(m)	(m/s)	(m2)	(m)	(m)	(1000 m3)	(m)
Tributary D	Reach 1	1964	100 year	4.24	93.57	0.25	19.81	12.06	1964.38	835.69	7.00
Tributary D	Reach 1	1964	50 year	3.96	93.42	0.25	18.20	11.35	1964.38	761.21	7.00
Tributary D	Reach 1	1964	25 year	3.52	93.21	0.25	15.96	10.56	1964.38	660.46	7.00
Tributary D	Reach 1	1964	10 year	3.10	93.01	0.25	13.85	9.77	1964.38	563.07	7.00
Tributary D	Reach 1	1964	5 year	2.67	92.57	0.29	9.75	8.90	1964.38	388.65	7.00
Tributary D	Reach 1	1964	2 year	1.88	92.34	0.25	7.81	8.44	1964.38	314.86	7.00
Tributary D	Reach 1	1971	100 year	4.24	93.57	0.13	51.93	54.80	1971.10	836.64	10.00
Tributary D	Reach 1	1971	50 year	3.96	93.42	0.14	44.25	49.36	1971.10	761.96	10.00
Tributary D	Reach 1	1971	25 year	3.52	93.22	0.14	34.97	40.29	1971.10	660.98	10.00
Tributary D	Reach 1	1971	10 year	3.10	93.01	0.15	27.55	31.20	1971.10	563.42	10.00
Tributary D	Reach 1	1971	5 year	2.67	92.57	0.17	17.03	16.86	1971.10	388.79	10.00
Tributary D	Reach 1	1971	2 year	1.88	92.35	0.15	13.75	13.68	1971.10	314.96	10.00
Tributary D	Reach 1	1985	100 year	4.24	93.57	0.01	868.82	486.33	1985.11	843.00	114.30
Tributary D	Reach 1	1985	50 year	3.96	93.43	0.01	797.55	486.17	1985.11	767.78	114.30
Tributary D	Reach 1	1985	25 year	3.52	93.22	0.01	697.00	485.73	1985.11	666.04	114.30
Tributary D	Reach 1	1985	10 year	3.10	93.01	0.01	596.26	485.28	1985.11	567.74	114.30
Tributary D	Reach 1	1985	5 year	2.67	92.57	0.01	406.42	378.49	1985.11	391.73	114.30
Tributary D	Reach 1	1985	2 year	1.88	92.35	0.01	326.23	340.11	1985.11	317.33	114.30
Tributary D	Reach 1	2087	100 year	4.24	93.57	0.06	102.74	122.14	2086.59	891.00	26.92
Tributary D	Reach 1	2087	50 year	3.96	93.43	0.06	87.73	83.61	2086.59	811.60	26.92
Tributary D	Reach 1	2087	25 year	3.52	93.22	0.06	71.38	74.42	2086.59	704.24	26.92
Tributary D	Reach 1	2087	10 year	3.10	93.01	0.06	56.90	65.20	2086.59	600.40	26.92
Tributary D	Reach 1	2087	5 year	2.67	92.57	0.08	36.62	39.20	2086.59	414.19	26.92
Tributary D	Reach 1	2087	2 year	1.88	92.35	0.07	28.46	33.90	2086.59	335.35	26.92
Tributary D	Reach 1	2128	100 year	4.24	93.57	0.17	33.72	25.03	2127.88	895.27	9.00
Tributary D	Reach 1	2128	50 year	3.96	93.42	0.17	30.08	24.14	2127.88	815.13	9.00
Tributary D	Reach 1	2128	25 year	3.52	93.22	0.17	25.34	21.69	2127.88	706.96	9.00
Tributary D	Reach 1	2128	10 year	3.10	93.01	0.18	21.09	19.23	2127.88	602.44	9.00
Tributary D	Reach 1	2128	5 year	2.67	92.57	0.21	13.90	13.58	2127.88	415.36	9.00
Tributary D	Reach 1	2128	2 year	1.88	92.35	0.18	11.08	11.91	2127.88	336.23	9.00
Tributary D	Reach 1	2150	100 year	4.24	93.57	0.28	15.01	48.92	2149.82	896.50	9.00
Tributary D	Reach 1	2150	50 year	3.96	93.42	0.28	14.18	47.81	2149.82	816.23	9.00
Tributary D	Reach 1	2150	25 year	3.52	93.22	0.27	13.00	44.81	2149.82	707.89	9.00
Tributary D	Reach 1	2150	10 year	3.10	93.01	0.26	11.82	41.80	2149.82	603.21	9.00
Tributary D	Reach 1	2150	5 year	2.67	92.57	0.29	9.32	39.28	2149.82	415.83	9.00
Tributary D	Reach 1	2150	2 year	1.88	92.35	0.23	8.04	32.03	2149.82	336.56	9.00
Tributary D	Reach 1	2159		Culvert							
Tributary D	Reach 1	2170	100 year	4.24	93.57	0.26	16.05	75.43	2170.82	901.00	22.86
Tributary D	Reach 1	2170	50 year	3.96	93.43	0.26	15.20	52.79	2170.82	820.12	22.86
Tributary D	Reach 1	2170	25 year	3.52	93.22	0.25	14.02	46.62	2170.82	711.05	22.86
Tributary D	Reach 1	2170	10 year	3.10	93.01	0.24	12.79	40.20	2170.82	605.73	22.86
Tributary D	Reach 1	2170	5 year	2.67	92.57	0.26	10.25	36.26	2170.82	417.18	22.86
Tributary D	Reach 1	2170	2 year	1.88	92.35	0.21	8.95	31.78	2170.82	337.40	22.86
Tributary D	Reach 1	2353	100 year	4.24	93.58	0.05	115.96	103.05	2354.43	920.16	35.68
Tributary D	Reach 1	2353	50 year	3.96	93.43	0.05	102.95	81.18	2354.43	836.59	35.68
Tributary D	Reach 1	2353	25 year	3.52	93.23	0.05	86.97	75.59	2354.43	724.67	35.68
Tributary D	Reach 1	2353	10 year	3.10	93.02	0.05	71.57	69.78	2354.43	616.86	35.68
Tributary D	Reach 1	2353	5 year	2.67	92.58	0.07	43.49	59.27	2354.43	424.21	35.68
Tributary D	Reach 1	2353	2 year	1.88	92.35	0.07	30.60	55.08	2354.43	342.66	35.68
Tributary D	Reach 1	2622	100 year	4.24	93.58	0.14	31.34	53.44	2623.48	940.13	48.88
Tributary D	Reach 1	2622	50 year	3.96	93.43	0.16	24.03	46.60	2623.48	853.73	46.60
Tributary D	Reach 1	2622	25 year	3.52	93.23	0.23	15.21	39.69	2623.48	738.40	39.69
Tributary D	Reach 1	2622	10 year	3.10	93.01	0.42	7.44	32.41	2623.48	627.44	32.41
Tributary D	Reach 1	2622	5 year	2.67	92.85	1.00	2.67	26.99	2623.48	430.37	26.99
Tributary D	Reach 1	2622	2 year	1.88	92.83	0.89	2.12	26.29	2623.48	347.02	26.29
Tributary D	Reach 1	2821	100 year	4.24	93.59	0.10	44.56	83.26	2822.19	947.66	69.88
Tributary D	Reach 1	2821	50 year	3.96	93.44	0.12	33.60	67.32	2822.19	859.45	67.32
Tributary D	Reach 1	2821	25 year	3.52	93.26	0.16	22.03	58.82	2822.19	742.10	58.82
Tributary D	Reach 1	2821	10 year	3.10	93.13	0.21	14.84	52.85	2822.19	629.66	52.85
Tributary D	Reach 1	2821	5 year	2.67	93.10	0.20	13.26	51.45	2822.19	431.95	51.45
Tributary D	Reach 1	2821	2 year	1.88	93.06	0.17	10.88	49.26	2822.19	348.31	49.26
Tributary D	Reach 1	3008	100 year	4.24	93.59	0.15	27.96	65.33	3008.66	954.33	56.32
Tributary D	Reach 1	3008	50 year	3.96	93.46	0.20	20.00	53.56	3008.66	864.45	53.56
Tributary D	Reach 1	3008	25 year	3.52	93.30	0.29	12.32	43.06	3008.66	745.30	43.06
Tributary D	Reach 1	3008	10 year	3.10	93.22	0.34	9.11	37.80	3008.66	631.89	37.80

HEC-RAS Plan: Plan 01 (Continued)

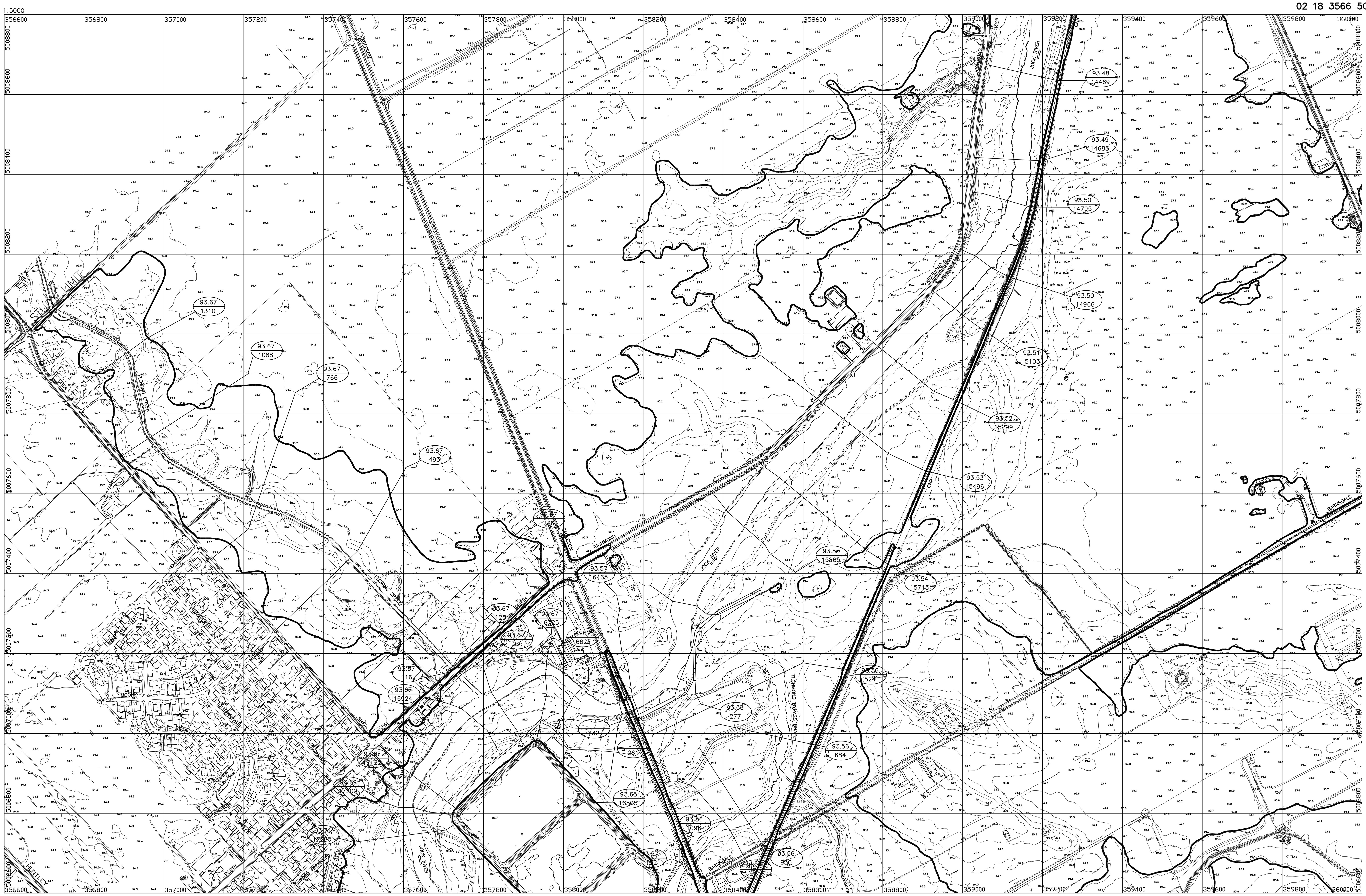
River	Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Cum Ch Len	Volume	Top W Chnl
				(m3/s)	(m)	(m/s)	(m2)	(m)	(m)	(1000 m3)	(m)
Tributary D	Reach 1	3008	5 year	2.67	93.19	0.33	8.12	36.03	3008.66	433.94	36.03
Tributary D	Reach 1	3008	2 year	1.88	93.14	0.30	6.30	32.52	3008.66	349.91	32.52
Tributary D	Reach 1	3075	100 year	4.24	93.59	0.38	11.03	35.51	3075.97	957.20	10.00
Tributary D	Reach 1	3075	50 year	3.96	93.46	0.38	10.37	31.99	3075.97	866.53	10.00
Tributary D	Reach 1	3075	25 year	3.52	93.31	0.37	9.60	26.05	3075.97	746.67	10.00
Tributary D	Reach 1	3075	10 year	3.10	93.23	0.34	9.21	23.08	3075.97	632.97	10.00
Tributary D	Reach 1	3075	5 year	2.67	93.20	0.29	9.07	22.02	3075.97	434.94	10.00
Tributary D	Reach 1	3075	2 year	1.88	93.15	0.21	8.80	19.90	3075.97	350.74	10.00
Tributary D	Reach 1	3090		Culvert							
Tributary D	Reach 1	3105	100 year	4.24	93.60	0.36	11.81	24.84	3105.68	959.12	10.00
Tributary D	Reach 1	3105	50 year	3.96	93.47	0.36	11.16	23.30	3105.68	867.96	10.00
Tributary D	Reach 1	3105	25 year	3.52	93.32	0.34	10.38	19.77	3105.68	747.63	10.00
Tributary D	Reach 1	3105	10 year	3.10	93.24	0.31	9.99	17.97	3105.68	633.74	10.00
Tributary D	Reach 1	3105	5 year	2.67	93.21	0.27	9.84	17.30	3105.68	435.65	10.00
Tributary D	Reach 1	3105	2 year	1.88	93.15	0.20	9.55	15.97	3105.68	351.35	10.00
Tributary D	Reach 1	3137	100 year	4.24	93.61	0.15	28.36	54.31	3137.79	960.21	48.92
Tributary D	Reach 1	3137	50 year	3.96	93.48	0.18	21.63	47.75	3137.79	868.81	47.75
Tributary D	Reach 1	3137	25 year	3.52	93.33	0.24	14.94	38.00	3137.79	748.25	38.00
Tributary D	Reach 1	3137	10 year	3.10	93.24	0.26	12.08	32.96	3137.79	634.27	32.96
Tributary D	Reach 1	3137	5 year	2.67	93.21	0.24	11.09	31.03	3137.79	436.14	31.03
Tributary D	Reach 1	3137	2 year	1.88	93.15	0.20	9.30	28.44	3137.79	351.78	28.44
Tributary D	Reach 1	3307	100 year	4.24	93.63	0.22	19.29	50.91	3308.14	964.24	43.98
Tributary D	Reach 1	3307	50 year	3.96	93.52	0.29	13.87	44.80	3308.14	871.83	43.98
Tributary D	Reach 1	3307	25 year	3.52	93.40	0.39	9.09	37.86	3308.14	750.29	37.86
Tributary D	Reach 1	3307	10 year	3.10	93.35	0.43	7.17	34.63	3308.14	635.91	34.63
Tributary D	Reach 1	3307	5 year	2.67	93.31	0.44	6.06	32.61	3308.14	437.60	32.61
Tributary D	Reach 1	3307	2 year	1.88	93.25	0.47	3.96	28.44	3308.14	352.91	28.44
Tributary D	Reach 1	3383	100 year	4.24	93.65	0.40	10.76	27.35	3384.08	965.40	25.68
Tributary D	Reach 1	3383	50 year	3.96	93.56	0.47	8.49	26.40	3384.08	872.68	25.68
Tributary D	Reach 1	3383	25 year	3.52	93.51	0.50	6.99	25.75	3384.08	750.90	25.68
Tributary D	Reach 1	3383	10 year	3.10	93.48	0.48	6.40	25.24	3384.08	636.42	25.24
Tributary D	Reach 1	3383	5 year	2.67	93.46	0.46	5.88	24.68	3384.08	438.05	24.68
Tributary D	Reach 1	3383	2 year	1.88	93.42	0.39	4.87	23.57	3384.08	353.25	23.57
Tributary D	Reach 1	3406	100 year	4.24	93.66	0.68	6.38	17.07	3407.43	965.60	14.38
Tributary D	Reach 1	3406	50 year	3.96	93.59	0.76	5.24	15.91	3407.43	872.84	14.38
Tributary D	Reach 1	3406	25 year	3.52	93.55	0.77	4.59	15.21	3407.43	751.04	14.38
Tributary D	Reach 1	3406	10 year	3.10	93.53	0.73	4.27	14.86	3407.43	636.55	14.38
Tributary D	Reach 1	3406	5 year	2.67	93.51	0.68	3.95	14.48	3407.43	438.17	14.38
Tributary D	Reach 1	3406	2 year	1.88	93.46	0.57	3.29	13.66	3407.43	353.34	13.66
Tributary D	Reach 1	3450	100 year	4.24	93.70	0.27	16.44	40.78	3450.95	966.10	31.90
Tributary D	Reach 1	3450	50 year	3.96	93.65	0.29	14.27	38.40	3450.95	873.27	31.90
Tributary D	Reach 1	3450	25 year	3.52	93.61	0.28	12.85	36.76	3450.95	751.42	31.90
Tributary D	Reach 1	3450	10 year	3.10	93.59	0.26	11.94	35.67	3450.95	636.90	31.90
Tributary D	Reach 1	3450	5 year	2.67	93.56	0.24	10.99	34.50	3450.95	438.49	31.90
Tributary D	Reach 1	3450	2 year	1.88	93.50	0.21	9.11	32.04	3450.95	353.61	31.90
Tributary D	Reach 1	3575	100 year	4.24	93.74	0.36	12.78	35.72	3576.39	967.96	25.24
Tributary D	Reach 1	3575	50 year	3.96	93.70	0.37	11.26	33.83	3576.39	874.89	25.24
Tributary D	Reach 1	3575	25 year	3.52	93.66	0.36	10.13	32.35	3576.39	752.87	25.24
Tributary D	Reach 1	3575	10 year	3.10	93.64	0.34	9.31	31.22	3576.39	638.24	25.24
Tributary D	Reach 1	3575	5 year	2.67	93.61	0.32	8.44	30.00	3576.39	439.72	25.24
Tributary D	Reach 1	3575	2 year	1.88	93.55	0.28	6.73	27.42	3576.39	354.61	25.24
Tributary D	Reach 1	3682	100 year	4.24	93.80	0.37	12.42	38.98	3683.48	969.31	27.32
Tributary D	Reach 1	3682	50 year	3.96	93.76	0.38	11.20	37.74	3683.48	876.08	27.32
Tributary D	Reach 1	3682	25 year	3.52	93.74	0.37	10.10	36.57	3683.48	753.95	27.32
Tributary D	Reach 1	3682	10 year	3.10	93.71	0.36	9.19	35.57	3683.48	639.23	27.32
Tributary D	Reach 1	3682	5 year	2.67	93.68	0.34	8.22	34.49	3683.48	440.61	27.32
Tributary D	Reach 1	3682	2 year	1.88	93.63	0.31	6.31	32.23	3683.48	355.30	27.32
Tributary D	Reach 1	3797	100 year	4.24	93.86	0.38	16.02	54.83	3798.19	970.81	15.68
Tributary D	Reach 1	3797	50 year	3.96	93.84	0.39	14.74	52.94	3798.19	877.46	15.68
Tributary D	Reach 1	3797	25 year	3.52	93.81	0.37	13.37	50.82	3798.19	755.20	15.68
Tributary D	Reach 1	3797	10 year	3.10	93.78	0.36	12.11	48.81	3798.19	640.36	15.68
Tributary D	Reach 1	3797	5 year	2.67	93.76	0.34	10.84	46.69	3798.19	441.63	15.68
Tributary D	Reach 1	3797	2 year	1.88	93.70	0.30	8.43	42.36	3798.19	356.10	15.68
Tributary D	Reach 1	3986	100 year	4.24	93.99	0.64	8.10	20.14	3987.45	973.06	10.26
Tributary D	Reach 1	3986	50 year	3.96	93.97	0.62	7.75	19.78	3987.45	879.56	10.26

HEC-RAS Plan: Plan 01 (Continued)

River	Reach	River Sta	Profile	Q Total	W.S. Elev	Vel Chnl	Flow Area	Top Width	Cum Ch Len	Volume	Top W Chnl
				(m3/s)	(m)	(m/s)	(m2)	(m)	(m)	(1000 m3)	(m)
Tributary D	Reach 1	3986	25 year	3.52	93.94	0.58	7.22	19.23	3987.45	757.12	10.26
Tributary D	Reach 1	3986	10 year	3.10	93.92	0.55	6.71	18.68	3987.45	642.11	10.26
Tributary D	Reach 1	3986	5 year	2.67	93.89	0.51	6.17	18.09	3987.45	443.20	10.26
Tributary D	Reach 1	3986	2 year	1.88	93.82	0.43	5.05	16.78	3987.45	357.34	10.26
Tributary D	Reach 1	4177	100 year	4.24	94.30	0.84	6.59	27.74	4178.49	974.37	11.20
Tributary D	Reach 1	4177	50 year	3.96	94.28	0.83	6.15	26.87	4178.49	880.80	11.20
Tributary D	Reach 1	4177	25 year	3.52	94.26	0.82	5.44	25.35	4178.49	758.25	11.20
Tributary D	Reach 1	4177	10 year	3.10	94.23	0.81	4.76	23.83	4178.49	643.14	11.20
Tributary D	Reach 1	4177	5 year	2.67	94.20	0.80	4.05	22.14	4178.49	444.13	11.20
Tributary D	Reach 1	4177	2 year	1.88	94.13	0.79	2.70	18.49	4178.49	358.05	11.20
Tributary D	Reach 1	4348	100 year	4.24	94.95	1.10	4.78	14.00	4349.06	975.47	6.70
Tributary D	Reach 1	4348	50 year	3.96	94.93	1.07	4.61	13.79	4349.06	881.83	6.70
Tributary D	Reach 1	4348	25 year	3.52	94.91	1.00	4.32	13.45	4349.06	759.18	6.70
Tributary D	Reach 1	4348	10 year	3.10	94.89	0.93	4.06	13.12	4349.06	643.98	6.70
Tributary D	Reach 1	4348	5 year	2.67	94.87	0.86	3.74	12.73	4349.06	444.86	6.70
Tributary D	Reach 1	4348	2 year	1.88	94.82	0.71	3.15	11.94	4349.06	358.59	6.70
Tributary D	Reach 1	4563	100 year	4.24	95.17	0.24	18.35	66.22	4564.27	977.97	51.78
Tributary D	Reach 1	4563	50 year	3.96	95.15	0.24	17.39	64.96	4564.27	884.22	51.78
Tributary D	Reach 1	4563	25 year	3.52	95.13	0.23	15.82	62.85	4564.27	761.37	51.78
Tributary D	Reach 1	4563	10 year	3.10	95.10	0.22	14.32	60.75	4564.27	645.97	51.78
Tributary D	Reach 1	4563	5 year	2.67	95.08	0.21	12.81	58.58	4564.27	446.66	51.78
Tributary D	Reach 1	4563	2 year	1.88	95.03	0.19	9.83	54.01	4564.27	360.00	51.78
Tributary D	Reach 1	4926	100 year	4.24	95.49	1.11	5.08	49.09	4926.65	982.12	17.10
Tributary D	Reach 1	4926	50 year	3.96	95.49	1.08	4.84	48.71	4926.65	888.16	17.10
Tributary D	Reach 1	4926	25 year	3.52	95.48	1.04	4.40	48.01	4926.65	764.97	17.10
Tributary D	Reach 1	4926	10 year	3.10	95.47	1.00	3.90	47.19	4926.65	649.23	17.10
Tributary D	Reach 1	4926	5 year	2.67	95.45	1.02	2.95	33.37	4926.65	449.49	17.10
Tributary D	Reach 1	4926	2 year	1.88	95.43	0.80	2.56	23.66	4926.65	362.23	17.10
Tributary D	Reach 1	4973	100 year	4.24	95.94	2.17	1.96	23.60	4973.59	982.56	23.60
Tributary D	Reach 1	4973	50 year	3.96	95.92	2.08	1.91	23.14	4973.59	888.58	23.14
Tributary D	Reach 1	4973	25 year	3.52	95.88	1.93	1.83	22.39	4973.59	765.35	22.39
Tributary D	Reach 1	4973	10 year	3.10	95.85	1.77	1.75	21.68	4973.59	649.57	21.68
Tributary D	Reach 1	4973	5 year	2.67	95.83	1.58	1.69	21.14	4973.59	449.78	21.14
Tributary D	Reach 1	4973	2 year	1.88	95.73	1.29	1.45	18.89	4973.59	362.47	18.89
Tributary D	Reach 1	4983		Culvert							
Tributary D	Reach 1	4992	100 year	4.24	96.67	1.16	3.66	142.55	4993.19	986.18	24.21
Tributary D	Reach 1	4992	50 year	3.96	96.60	1.13	3.49	141.92	4993.19	891.93	24.21
Tributary D	Reach 1	4992	25 year	3.52	96.49	1.09	3.23	140.76	4993.19	768.27	24.21
Tributary D	Reach 1	4992	10 year	3.10	96.40	1.04	2.99	137.65	4993.19	652.11	24.21
Tributary D	Reach 1	4992	5 year	2.67	96.30	0.97	2.74	134.42	4993.19	451.92	24.21
Tributary D	Reach 1	4992	2 year	1.88	96.11	0.83	2.27	128.24	4993.19	363.89	24.21
Tributary D	Reach 1	5175	100 year	4.24	96.76	0.07	83.53	102.64	5176.36	1005.78	29.58
Tributary D	Reach 1	5175	50 year	3.96	96.69	0.07	76.38	99.74	5176.36	909.99	29.58
Tributary D	Reach 1	5175	25 year	3.52	96.57	0.08	65.54	95.17	5176.36	783.98	29.58
Tributary D	Reach 1	5175	10 year	3.10	96.47	0.08	56.02	90.11	5176.36	665.73	29.58
Tributary D	Reach 1	5175	5 year	2.67	96.37	0.08	46.82	82.47	5176.36	463.47	29.58
Tributary D	Reach 1	5175	2 year	1.88	96.16	0.08	31.40	67.75	5176.36	371.74	29.58
Van Gaal Drain	Reach 1	0	100 year	12.00	94.09	0.03	654.06	265.66			32.73
Van Gaal Drain	Reach 1	0	50 year	12.00	93.93	0.03	611.37	264.70			32.73
Van Gaal Drain	Reach 1	0	25 year	10.00	93.71	0.03	552.95	263.94			32.73
Van Gaal Drain	Reach 1	0	10 year	9.00	93.50	0.03	498.41	263.23			32.73
Van Gaal Drain	Reach 1	0	5 year	8.00	93.16	0.03	409.50	256.36			32.73
Van Gaal Drain	Reach 1	0	2 year	6.00	92.82	0.03	325.69	235.08			32.73
Van Gaal Drain	Reach 1	226	100 year	12.00	94.09	0.29	80.39	57.60	225.61	82.85	4.00
Van Gaal Drain	Reach 1	226	50 year	12.00	93.93	0.33	71.11	57.11	225.61	76.99	4.00
Van Gaal Drain	Reach 1	226	25 year	10.00	93.71	0.34	58.64	55.58	225.61	68.99	4.00
Van Gaal Drain	Reach 1	226	10 year	9.00	93.50	0.38	47.25	54.14	225.61	61.55	4.00
Van Gaal Drain	Reach 1	226	5 year	8.00	93.16	0.48	31.30	38.56	225.61	49.73	4.00
Van Gaal Drain	Reach 1	226	2 year	6.00	92.82	0.51	20.36	28.84	225.61	39.04	4.00
Van Gaal Drain	Reach 1	263	100 year	12.00	94.08	0.87	15.92	13.10	262.84	85.09	6.34
Van Gaal Drain	Reach 1	263	50 year	12.00	93.91	0.97	13.76	13.10	262.84	78.98	6.34
Van Gaal Drain	Reach 1	263	25 year	10.00	93.69	0.94	10.88	13.10	262.84	70.65	6.34
Van Gaal Drain	Reach 1	263	10 year	9.00	93.48	0.93	9.68	12.97	262.84	62.91	6.34
Van Gaal Drain	Reach 1	263	5 year	8.00	93.14	0.96	8.31	9.97	262.84	50.65	6.34
Van Gaal Drain	Reach 1	263	2 year	6.00	92.81	0.86	6.99	7.09	262.84	39.66	6.34

1:5000

02 18 3566 50066



MAP No. 6
CARTE No.

RIDEAU VALLEY CONSERVATION AUTHORITY

OFFICE DE PROTECTION DE LA NATURE DE LA VALLEE RIDEAU

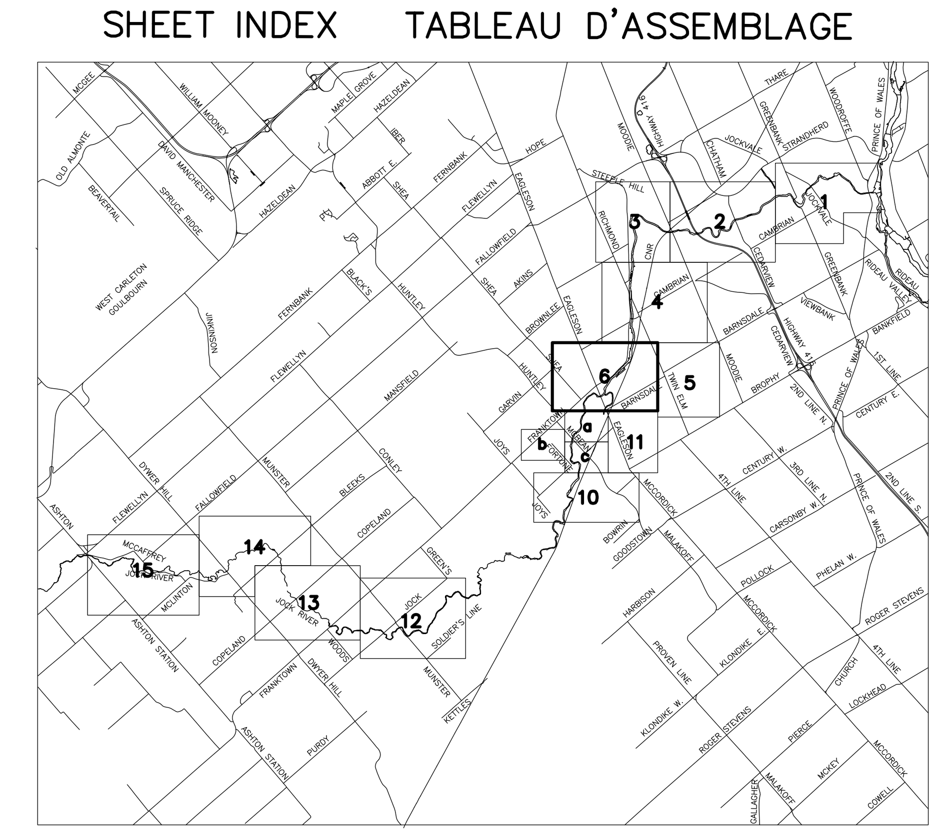
FLOOD RISK MAP
JOCK RIVER
CARTE DU RISQUE D'INONDATION

LÉGEND LEGENDE

Legend	Légende
Aerial Cableway	Telepherique
Boundary	**Frontiere**
International	Internationale
Interprovincial	de province
District Township Indian Reserve	Limite de district, de canton, de reserve indienne
Approximate	Approximatif
Lot, Concession	Lot, Concession
Approximate	Approximatif
Annotation LOT CON	Annotation
Park Boundary	Limite de parc
Bridge	**Pont**
Road, Railroad	de route, de chemin, de fer
Foot Bridge	Passerelle
Building	Batiment
Chimney	Cheminee
Cliff, Pit, Pile	Falaise, Graviere ou Sabliere, Pile
Contours	**Courbes de niveau**
Intermediate (69)	intermediaires
Index (70)	Maitresses
Auxiliary	Auxiliaires
Indefinite	Approximatives
Depression	Courbes de cuvettes
Control Points	**Points de controle**
Horizontal (010774051)	Horizontal
Vertical (100.02)	Vertical
Culvert	Ponceau
Dam	Barrage
Ditch (D)	Fosse
Dyke	Digue
Falls	Chutes
Double line river	Riviere a ligne double
Fence, Hedge, Wall (X, W)	Cloture , Haie, Mur
Feature Outline (construction features etc.)	Limites (en construction, etc.)
Flooded Land (Flooded)	Region Inondee
Lake, Pond	Lac, Bassin
Lock	Ecluses
Marsh or Swamp	Marais ou Marecage
Mast	Mat
Pipeline (above ground)	Pipe-Line (au dessus de la terre)
Railroad	**Chemin de fer**
Single Track	Voie Unique
Abandoned	Desaffecte
Turnable	Plaque Tournante
Rapids	**Rapides**
Double line river with multiple rapids (Rapids)	Riviere a ligne double avec plusieurs chutes
Double line river with multiple rapids	Riviere a ligne double avec plusieurs chutes
Reservoir	Reservoir
River, Stream, Canal	Fleuve, Riviere, Canal
Approximate Seasonal	Approximatif Saisonnier
Direction of Flow	Direction du courant
Road	**Route**
Hwy, County, Township	Chemin de Comte Canton
Access (road of doubtful maintenance or significant driveway)	Chemin d'acces (condition inconnue ou entree privee)
Trail, Bush , Road (portage, alley)	Sentier, Chemin de Bois (portage, ruelle)
Rock Significant	Roche Significatit
Shoal (SHOAL)	Banc
Spot Elevation (lake elevations) (104.7)	Point Cote (elevation du plan d'eau)
Tower	Tour
Transmission Line	Ligne de transport d'energie
Poles	Poteau
Pylon	Pylone
Tunnel	Tunnel
Utility Pole	Poteau
Wharf, Dock, Pier	Quai, Bassin, Jetee
Wooded Area	Region Boisee
Groyne	Epi
FLOOD PLAIN INFORMATION	**RENSEIGNEMENTS DES PLAINES INONDABLES**
Regulatory floodline	La crue regulatrice
Fill Line	Ligne de remblai

	87.65 / 1000	
Regulatory flood elevation	87.65	Niveau de la crue regulatrice
Cross section location		Emplacement de la coupe transversale
Cross section number	1000	Numero del la coupe transversale

SHEET INDEX TABLEAU D'ASSEMBLAGE



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Based on original mylar
dated May 31, 2005

15 1:5000 Map Sheet
e 1:2000 Map Sheet

CONTOUR INTERVAL 1.0 METRE
WITH 0.5 METRE AUXILLIARY CONTOUR
NORTH AMERICAN DATUM 1983

EQUIDISTANCE DES COURBES DE NIVEAU 1.0 METRE
AVEC COURBES DE NIVEAU AUXILIERE DE 0.5 METRE
SYSTEME DE REFERENCE GEODESIQUE NORD—AMERIQUE 1983

COMPILATION NOTE:
Production techniques used in the preparation of this map are designed for Class "A" standards.

PHOTOGRAMMETRIE:
Les normes de production de cette carte se conforment aux standards de premiere classe.

SCALE 1:5000 ECHELLE
METRES 50 0 100 200 300 400 500 METRES
FEET 200 0 200 400 600 800 1000 1200 1400 1600 1800 2000 FEET

GENERAL INFORMATION:

Vertical datum	Mean Sea Level
Horizontal datum	North American (1983)
Map Projection	3° Transverse Mercator
Central Meridian	75° 30m West
Grid Spacing	10 centimetres
Aerial Photography	September 2001 1:3600 scale

RESENSEIGNEMENTS GENEREAUX:

Niveau de reference	Niveau Moyen de la Mer
Systeme geodesique	Nord—Americain (1983)
Projection	3° Transverse de Mercator
Meridian central	75° 30m Ouest
Quadrillage de	10 centimetres
Photographies aeriennes	Septembre 2001 1:3600 Echelle

Ottawa

ASSOCIATION OF ONTARIO LAND SURVEYORS
S.M. PERKINS
CRII2
Responsible for provision of topographic mapping

PSR

REGISTERED PROFESSIONAL ENGINEER
P. FRIGON
PROVINCE OF ONTARIO
Responsible for flood plain delineation and hydrotechnical analysis

02 18 3566 50066

1:2000

02 18 3570 50056

MAP No. a
CARTE No.

RIDEAU VALLEY CONSERVATION AUTHORITY

OFFICE DE PROTECTION DE LA NATURE DE LA VALLÉE RIDEAU

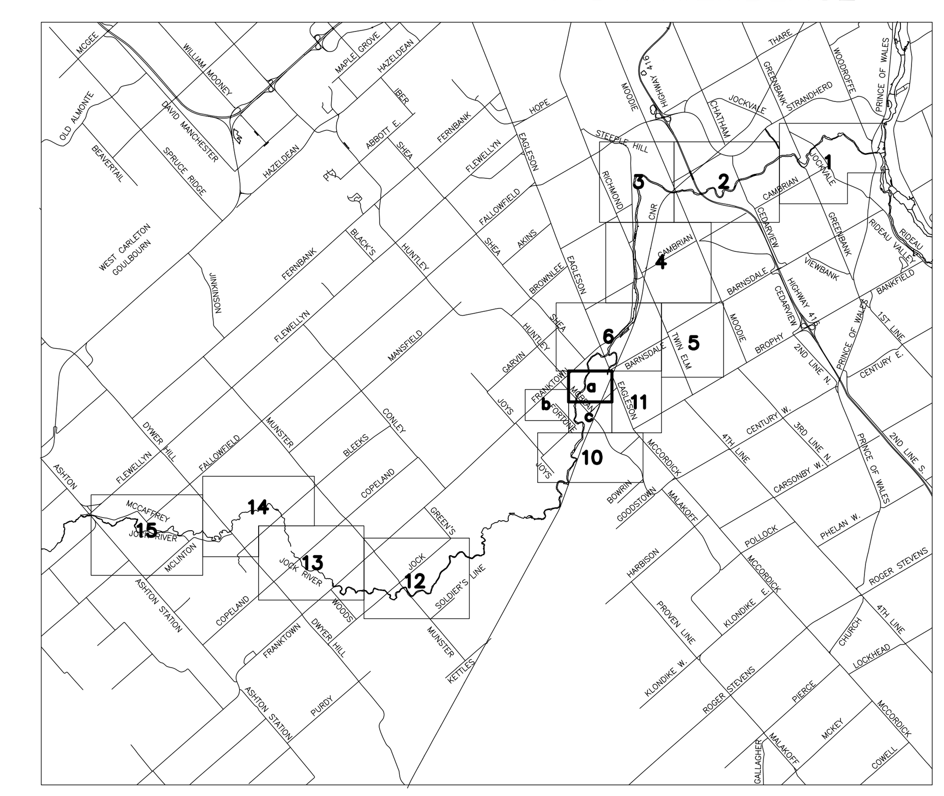
FLOOD RISK MAP
JOCK RIVER
CARTE DU RISQUE D'INONDATION

LÉGEND / LEGENDE

Legend	Légende
Aerial Cableway	Telepherique
Boundary	Frontiere
International	Internationale
Interprovincial	de province
District Township Indian Reserve	Limite de district, de canton, de reserve indienne
Approximate	Approximatif
Lot, Concession	Lot, Concession
Approximate	Approximatif
Annotation LOT CON	Annotation
Park Boundary	Limite de parc
Bridge	Pont
Road, Railroad	de route, de chemin, de fer
Foot Bridge	Passerelle
Building	Batiment
Chimney	Cheminee
Cliff, Pit, Pile	Falaise, Graviere ou Sabliere, Pile
Contours	Courbes de niveau
Intermediate 69	intermediaires
Index 70	Maitresses
Auxiliary	Auxiliaires
Indefinite	Approximatives
Depression	Courbes de cuvettes
Control Points	Points de controle
Horizontal 010774051	Horizontal
Vertical 100.02	Vertical
Culvert	Ponceau
Dam	Barrage
Ditch	Fosse
Dyke	Digue
Falls	Chutes
Double line river	Riviere a ligne double
Fence, Hedge, Wall	Cloture , Haie, Mur
Feature Outline (construction features etc.)	Limites (en construction, etc.)
Flooded Land	Region Inondee
Lake, Pond	Lac, Bassin
Lock	Ecluses
Marsh or Swamp	Marais ou Marecage
Mast	Mat
Pipeline (above ground)	Pipe-Line (au dessus de la terre)
Railroad	Chemin de fer
Single Track	Voie Unique
Abandoned	Desaffecte
Turnable	Plaque Tournante
Rapids	Rapides
Double line river with multiple rapids	Riviere a ligne double avec plusieurs chutes
Double line river with multiple rapids	Riviere a ligne double avec plusieurs chutes
Reservoir	Reservoir
River, Stream, Canal	Fleuve, Riviere, Canal
Approximate Seasonal	Approximatif Saisonnier
Direction of Flow	Direction du courant
Road	Route
Hwy, County, Township	Chemin de Comte Canton
Access (road of doubtful maintenance or significant driveway)	Chemin d'acces (condition inconnue ou entree privee)
Trail, Bush , Road (portage, alley)	Sentier, Chemin de Bois (portage, ruelle)
Rock Significant	Roche Significatit
Shoal	Banc
Spot Elevation (lake elevations) .104.7	Point Cote (elevation du plan d'eau)
Tower	Tour
Transmission Line	Ligne de transport d'energie
Poles	Poteau
Pylon	Pylone
Tunnel	Tunnel
Utility Pole	Poteau
Wharf, Dock, Pier	Quai, Bassin, Jetee
Wooded Area	Region Boisee
Groyne	Epi
FLOOD PLAIN INFORMATION	RENSEIGNEMENTS DES PLAINES INONDABLES
Regulatory floodline	La crue regulatrice
Fill Line	Ligne de remblai

	87.65 / 1000	
Regulatory flood elevation		Niveau de la crue regulatrice
Cross section location		Emplacement de la coupe transversale
Cross section number		Numero del la coupe transversale

SHEET INDEX TABLEAU D'ASSEMBLAGE



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Based on original mylar
dated May 31, 2005

15 1:5000 Map Sheet

e 1:2000 Map Sheet

CONTOUR INTERVAL 1.0 METRE
WITH 0.5 METRE AUXILLIARY CONTOUR
NORTH AMERICAN DATUM 1983

EQUIDISTANCE DES COURBES DE NIVEAU 1.0 METRE
AVEC COURBES DE NIVEAU AUXILIERE DE 0.5 METRE
SYSTEME DE REFERENCE GEODESIQUE NORD-AMERIQUE 1983

COMPILATION NOTE:
Production techniques used in the preparation of this map are designed for Class "A" standards.

PHOTOGRAMMETRIE:
Les normes de production de cette carte se conforment aux standards de premiere classe.

SCALE 1:2000 ECHELLE

GENERAL INFORMATION:

Vertical datum	Mean Sea Level
Horizontal datum	North American (1983)
Map Projection	3° Transverse Mercator
Central Meridian	75° 30m West
Grid Spacing	10 centimetres
Aerial Photography	September 2001 1:3600 scale

RESENSEIGNEMENTS GENEREAUX:

Niveau de reference	Niveau Moyen de la Mer
Systeme geodesique	Nord-Americain (1983)
Projection	3° Transverse de Mercator
Meridian central	75° 30m Ouest
Quadrillage de	10 centimetres
Photographies aeriennes	Septembre 2001 1:3600 Échelle

Ottawa

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CRII2
Responsible for provision of topographic mapping

PSR

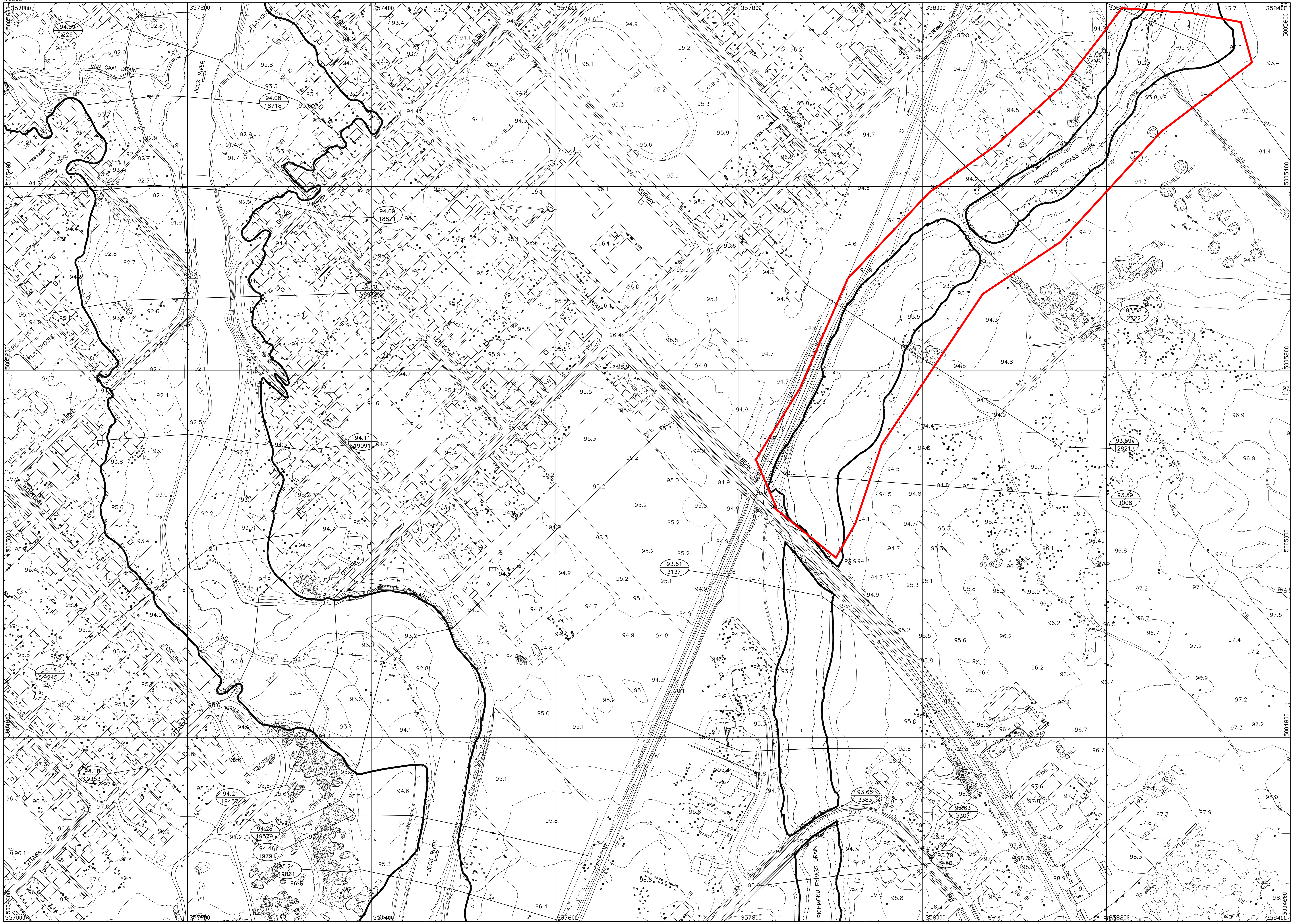
REGISTERED PROFESSIONAL ENGINEER
P. FRIGON
PROVINCE OF ONTARIO
Responsible for flood plain delineation and hydrotechnical analysis

02 18 3570 50056

1:2000

02 18 3570 50046

MAP No. c
CARTE No.



RIDEAU VALLEY CONSERVATION AUTHORITY

OFFICE DE PROTECTION DE LA NATURE DE LA VALLEE RIDEAU

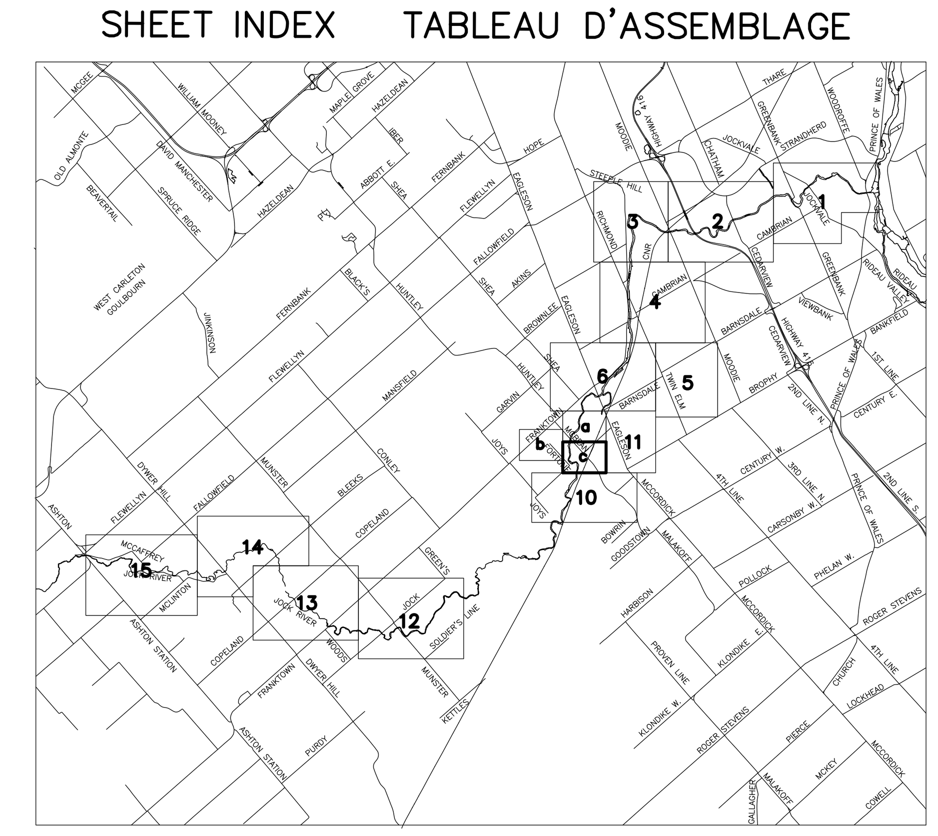
FLOOD RISK MAP
JOCK RIVER
CARTE DU RISQUE D'INONDATION

LÉGEND LEGENDE

Aerial Cableway	Telepherique
Boundary	Frontiere
International	Internationale
Interprovincial	de province
District Township Indian Reserve	Limite de district, de canton, de reserve indienne
Approximate	Approximatif
Lot, Concession	Lot, Concession
Approximate	Approximatif
Annotation LOT CON	Annotation
Park Boundary	Limite de parc
Bridge	Pont
Road, Railroad	de route, de chemin, de fer
Foot Bridge	Passerelle
Building	Batiment
Chimney	Cheminee
Cliff, Pit, Pile	Falaise, Graviere ou Sabliere, Pile
Contours	Courbes de niveau
Intermediate	intermediaires
Index	Maitresses
Auxiliary	Auxiliaires
Indefinite	Approximatives
Depression	Courbes de cuvettes
Control Points	Points de controle
Horizontal (010774051)	Horizontal
Vertical (100.02)	Vertical
Culvert	Ponceau
Dam	Barrage
Ditch	Fosse
Dyke	Digue
Falls	Chutes
Double line river	Riviere a ligne double
Fence, Hedge, Wall	Cloture , Haie, Mur
Feature Outline (construction features etc.)	Limites (en construction, etc.)
Flooded Land	Region Inondee
Lake, Pond	Lac, Bassin
Lock	Ecluses
Marsh or Swamp	Marais ou Marecage
Mast	Mat
Pipeline (above ground)	Pipe-Line (au dessus de la terre)
Railroad	Chemin de fer
Single Track	Voie Unique
Abandoned	Desaffecte
Turnable	Plaque Tournante
Rapids	Rapides
Double line river with multiple rapids	Riviere a ligne double avec plusieurs chutes
Double line river with multiple rapids	Riviere a ligne double avec plusieurs chutes
Reservoir	Reservoir
River, Stream, Canal	Fleuve, Riviere, Canal
Approximate Seasonal	Approximatif Saisonnier
Direction of Flow	Direction du courant
Road	Route
Hwy, County, Township	Chemin de Comte Canton
Access (road of doubtful maintenance or significant driveway)	Chemin d'acces (condition inconnue ou entree privee)
Trail, Bush , Road (portage, alley)	Sentier, Chemin de Bois (portage, ruelle)
Rock Significant	Roche Significatit
Shoal	Banc
Spot Elevation (lake elevations) (104.7)	Point Cote (elevation du plan d'eau)
Tower	Tour
Transmission Line	Ligne de transport d'energie
Poles	Poteau
Pylon	Pylone
Tunnel	Tunnel
Utility Pole	Poteau
Wharf, Dock, Pier	Quai, Bassin, Jetee
Wooded Area	Region Boisee
Groyne	Epi
FLOOD PLAIN INFORMATION	RENSEIGNEMENTS DES PLAINES INONDABLES
Regulatory floodline	La crue regulatrice
Fill Line	Ligne de remblai

Regulatory flood elevation	87.65	Niveau de la crue regulatrice
Cross section location		Emplacement de la coupe transversale
Cross section number	1000	Numero del la coupe transversale

SHEET INDEX TABLEAU D'ASSEMBLAGE



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15 1:5000 Map Sheet

e 1:2000 Map Sheet

CONTOUR INTERVAL 1.0 METRE
WITH 0.5 METRE AUXILLIARY CONTOUR
NORTH AMERICAN DATUM 1983

EQUIDISTANCE DES COURBES DE NIVEAU 1.0 METRE
AVEC COURBES DE NIVEAU AUXILIERE DE 0.5 METRE
SYSTEME DE REFERENCE GEODESIQUE NORD-AMERIQUE 1983

COMPILATION NOTE:
Production techniques used in the preparation of this map are designed for Class "A" standards.

PHOTOGRAMMETRIE:
Les normes de production de cette carte se conforment aux standards de premiere classe.

SCALE 1:2000 ECHELLE
METRES 40 0 100 200 METRES
FEET 100 0 100 200 300 400 500 600 700 800 FEET

GENERAL INFORMATION:

Vertical datum	Mean Sea Level
Horizontal datum	North American (1983)
Map Projection	3° Transverse Mercator
Central Meridian	75° 30m West
Grid Spacing	10 centimetres
Aerial Photography	September 2001 1:3600 scale

RESENSEIGNEMENTS GENEREAUX:

Niveau de reference	Niveau Moyen de la Mer
Systeme geodesique	Nord-Americain (1983)
Projection	3° Transverse de Mercator
Meridian central	75° 30m Ouest
Quadrillage de	10 centimetres
Photographies aeriennes	Septembre 2001 1:3600 Echelle

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Responsible for provision of topographic mapping

PSR

REGISTERED PROFESSIONAL ENGINEER P. FRIGON PROVINCE OF ONTARIO
Responsible for flood plain delineation and hydrotechnical analysis

02 18 3570 50046

Anthony Temelini

From: Laura Pipkins <lpipkins@jfsa.com>
Sent: September 11, 2020 2:51 PM
To: Adam Fobert
Cc: Anthony Temelini; Ciaran McKee; Matt Wingate; Steve Merrick; JF Sabourin; Jennifer Ailey; Steve Pichette
Subject: RE: P2001: DSEL #1042 - List of Drawings

Hi Adam,

As per your email below, I understand that the drainage area has been reduced from 157.2 ha to 149.72 ha. Based on this revised drainage area, the 2- to 100-year pre-development outflows from the site are simulated as follows in SWMHYMO, based on the 24-hour SCS Type II design storm:

2-year: 0.817 m3/s
5-year: 1.391 m3/s
10-year: 1.818 m3/s
25-year: 2.387 m3/s
50-year: 2.850 m3/s
100-year: 3.368 m3/s

Also as discussed, I understand that the post-development drainage area will have an average runoff coefficient of 0.40 (29% imperviousness). I assume that the post-development area does include the 2.74 ha area brought up below, for a total area of 152.46 ha. To control this post-development area to the targets above, with no reduction factor, a 100-year volume of 45,210 cu.m. is required based on SWMHYMO modelling. Note that I've assumed 40 m3/ha of active storage for quality control, but no additional erosion control requirements.

Please feel free to contact me with any comments or questions.

Thank you,
Laura

Laura Pipkins, P.Eng.
Project Engineer in Water Resources

JFSA

201-31 Mechanic Street, Paris ON, N3L 1K1
Tel.: 613-315-7517 | Email: lpipkins@jfsa.com | Website: www.jfsa.com
Ottawa-Paris(ON)-Gatineau-Montréal-Québec

From: Adam Fobert <AFobert@dsel.ca>
Sent: September 11, 2020 2:31 PM
To: Laura Pipkins <lpipkins@jfsa.com>
Cc: Anthony Temelini <ATemelini@dsel.ca>; Ciaran McKee <CMcKee@dsel.ca>; Matt Wingate <MWingate@dsel.ca>; Steve Merrick <SMerrick@dsel.ca>; JF Sabourin <jfsabourin@jfsa.com>; Jennifer Ailey <JAiley@dsel.ca>; Steve Pichette <SPichette@dsel.ca>
Subject: RE: P2001: DSEL #1042 - List of Drawings

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				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
STREET No. 9																																	
					0.00	0.00	1.97	0.40	2.19	2.19			0.00	0.00			0.00	0.00	15.00														
	28	29	0.09	0.66	0.17	0.17			0.00	2.19			0.00	0.00			0.00	0.00	15.00	61.77	83.56	97.85	142.89	193	450	450	CONC	1.20	39.0	312.3181	1.9637	0.3310	0.619
	29	30	0.48	0.66	0.88	1.05			0.00	2.19			0.00	0.00			0.00	0.00	15.33	61.00	82.50	96.61	141.07	245	450	450	CONC	2.80	101.5	477.0738	2.9997	0.5640	0.513
	30	31	0.36	0.66	0.66	1.71			0.00	2.19			0.00	0.00			0.00	0.00	15.89	59.73	80.77	94.58	138.09	279	825	825	CONC	0.10	78.5	453.9246	0.8492	1.5408	0.614
To STREET No. 14, Pipe 31 - 32						1.71				2.19				0.00				0.00	17.44														
	28	27	0.21	0.66	0.39	0.39			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30	300	300	PVC	0.95	13.0	94.2522	1.3334	0.1625	0.314
			4.97	0.70	9.67	10.06			0.00	0.00			0.00	0.00			0.00	0.00	15.00														
	27	26			0.00	10.06			0.00	0.00			0.00	0.00			0.00	0.00	15.00	61.77	83.56	97.85	142.89	621	675	675	CONC	1.25	117.0	939.8061	2.6263	0.7425	0.661
	26	96	0.47	0.66	0.86	10.92			0.00	0.00			0.00	0.00			0.00	0.00	15.74	60.07	81.23	95.12	138.88	656	675	675	CONC	0.85	10.5	774.9840	2.1657	0.0808	0.846
	96	97			0.00	10.92			0.00	0.00			0.00	0.00			0.00	0.00	15.82	59.89	80.99	94.83	138.46	654	675	675	CONC	1.15	62.0	901.4304	2.5190	0.4102	0.725
	97	38			0.00	10.92			0.00	0.00			0.00	0.00			0.00	0.00	16.23	59.00	79.77	93.40	136.36	644	675	675	CONC	0.85	17.5	774.9840	2.1657	0.1347	0.831
	38	39	0.46	0.66	0.84	11.76			0.00	0.00			0.00	0.00			0.00	0.00	16.37	58.72	79.38	92.94	135.69	691	1050	1050	CONC	0.10	95.5	863.5311	0.9973	1.5960	0.800
	39	40	0.43	0.66	0.79	12.55			0.00	0.00			0.00	0.00			0.00	0.00	17.96	55.55	75.06	87.86	128.24	697	1050	1050	CONC	0.10	95.5	863.5311	0.9973	1.5960	0.808
	40	41	0.23	0.66	0.42	12.97			0.00	0.00			0.00	0.00			0.00	0.00	19.56	52.75	71.23	83.36	121.64	684	1050	1050	CONC	0.10	13.5	863.5311	0.9973	0.2256	0.793
			7.88	0.70	15.33	28.31			0.00	0.00			0.00	0.00			0.00	0.00	15.00														
EXTERNAL AREA															7.06	0.20								1013									
EXTERNAL AREA															60.72	0.20								267									
					0.00	28.31	2.90	0.80	6.45	6.45			0.00	0.00			0.00	0.00	10.00														
	41	42			0.00	28.31			0.00	6.45			0.00	0.00			0.00	0.00	19.79	52.38	70.72	82.77	120.77	3219	1800	1800	CONC	0.10	102.0	3634.9621	1.4284	1.1901	0.886
	42	45	0.22	0.66	0.40	28.71			0.00	6.45			0.00	0.00			0.00	0.00	20.98	50.51	68.18	79.78	116.38	3170	1800	1800	CONC	0.10	115.0	3634.9621	1.4284	1.3418	0.872
To STREET No. 15, Pipe 45 - 60						28.71				6.45				0.00				0.00	22.32					1280									
STREET No. 10																																	
					0.00	0.00			0.00	0.00			0.00	0.00	1.51	0.70								151									
			5.84	0.70	11.36	11.36			0.00	0.00			0.00	0.00			0.00	0.00	15.00														
	23	24			0.00	11.36	0.65	0.66	1.19	1.19			0.00	0.00			0.00	0.00	15.00	61.77	83.56	97.85	142.89	953	1200	1200	CONC	0.15	118.5	1509.9717	1.3351	1.4793	0.631
To STREET No. 11, Pipe 24 - 19						11.36				1.19				0.00				0.00	16.48					151									
	100	25			0.00	0.00	0.26	0.66	0.48	0.48			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	50	300	300	PVC	1.45	37.0	116.4431	1.6473	0.3743	0.427
	25	24			0.00	0.00	0.38	0.66	0.70	1.17			0.00	0.00			0.00	0.00	10.37	75.40	102.26	119.86	175.21	120	375	375	PVC	1.50	74.5	214.7347	1.9442	0.6386	0.559
To STREET No. 11, Pipe 24 - 19						0.00				1.17				0.00				0.00	11.01														
STREET No. 11																																	
	6	19	0.81	0.66	1.49	1.49			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	114	825	825	CONC	0.10	116.5	453.9246	0.8492	2.2866	0.251
To STREET No. 11, Pipe 19 - 20						1.49				0.00				0.00				0.00	12.29														
	6	7	0.78	0.66	1.43	1.43			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	110	600	600	CONC	0.15	112.0	237.8056	0.8411	2.2194	0.462
To STREET No. 12, Pipe 7 - 8						1.43				0.00				0.00				0.00	12.22														
Contribution From STREET No. 10, Pipe 23 - 24						11.36				1.19				0.00				0.00	16.48					151									
Contribution From STREET No. 10, Pipe 25 - 24						0.00				1.17				0.00				0.00	11.01														
	24	19	0.11	0.66	0.20	11.57			0.00	2.37			0.00	0.00			0.00	0.00	16.48	58.48	79.06	92.57	135.14	1015	1200	1200	CONC	0.15	74.0	1509.9717	1.3351	0.9238	0.672
To STREET No. 11, Pipe 19 - 20						11.57				2.37				0.00				0.00	17.40					151									
STREET No. 12																																	
	11	12			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	600	600	CONC	0.15	9.0	237.8056	0.8411	0.1783	0.000
To STREET No. 11, Pipe 12 - 17						0.00				0.00				0.00				0.00	10.18														
	3	4	0.95	0.66	1.74	1.74			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	134	525	525	CONC	0.20	11.5	192.3297	0.8885	0.2157	0.696
	4	7	0.34	0.66	0.62	2.37			0.00	0.00			0.00	0.00			0.00	0.00	10.22	75.99	103.07	120.82	176.61	180	600	600	CONC	0.15	76.5	237.8056	0.8411	1.5159	0.756
Contribution From STREET No. 11, Pipe 6 - 7						1.43				0.00				0.00				0.00	12.22														
	7	8	0.16	0.66	0.29	4.09			0.00	0.00			0.00	0.00			0.00	0.00	12.22	69.22	93.77	109.87	160.53	283	675	675	CONC	0.20	38.0	375.9224	1.0505	0.6029	0.753
	8	12	0.30	0.66	0.55	4.64			0.00	0.00			0.00	0.00			0.00	0.00	12.82	67.44	91.32	106.99	156.31	313	750	750	CONC	0.15	47.0	431.1703	0.9760	0.8026	0.726
To STREET No. 11, Pipe 12 - 17						4.64				0.00				0.00				0.00	13.62														
	3	2			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	600	600	CONC	0.15	97.0	237.8056	0.8411	1.9222	0.000
	2	1	0.72	0.66	1.32	1.32			0.00	0.00			0.00	0.00			0.00	0.00	11.92	70.14	95.03	111.35	162.71	93	600	600	CONC	0.15	98.0	237.8056	0.8411	1.9420	0.390
	1	18	0.54	0.66	0.99	2.31			0.00	0.00			0.00	0.00			0.00	0.00	13.86	64.59	87.42	102.39	149.56	149	675	675	CONC	0.15	13.5	325.5584	0.9098	0.2473	0.459

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: SLM	PROJECT:	Tamarack Richmond	
Checked: ADF	LOCATION:	City of Ottawa	
Dwg. Reference: 03D	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. SHEET 1 OF 5

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
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
	18	19			0.00	2.31			0.00	0.00			0.00	0.00			0.00	0.00	14.11	63.95	86.54	101.36	148.05	148	825	825	CONC	0.10	73.5	453.9246	0.8492	1.4426	0.326
To STREET No. 11, Pipe 19 - 20						2.31				0.00				0.00				0.00	15.55														
			0.16	0.66	0.29	0.29			0.00	0.00			0.00	0.00			0.00	0.00	5.00														
	11	10	0.23	0.66	0.42	0.72			0.00	0.00			0.00	0.00			0.00	0.00	5.00	103.57	141.18	165.77	242.70	74	450	450	CONC	0.20	46.0	127.5033	0.8017	0.9563	0.581
	10	9	0.23	0.66	0.42	1.14			0.00	0.00			0.00	0.00			0.00	0.00	5.96	96.92	131.96	154.88	226.69	110	450	450	CONC	0.20	52.0	127.5033	0.8017	1.0810	0.865
	9	13	0.12	0.66	0.22	1.36			0.00	0.00			0.00	0.00			0.00	0.00	7.04	90.46	123.02	144.33	211.17	123	450	450	CONC	0.20	13.5	127.5033	0.8017	0.2807	0.963
	13	14	0.30	0.66	0.55	1.91			0.00	0.00			0.00	0.00			0.00	0.00	7.32	88.93	120.91	141.85	207.52	170	600	600	CONC	0.15	63.5	237.8056	0.8411	1.2583	0.714
	14	15	0.20	0.66	0.37	2.28			0.00	0.00			0.00	0.00			0.00	0.00	8.58	82.75	112.37	131.78	192.72	188	600	600	CONC	0.15	13.5	237.8056	0.8411	0.2675	0.792
	15	16	0.43	0.66	0.79	3.06			0.00	0.00			0.00	0.00			0.00	0.00	8.84	81.55	110.73	129.84	189.87	250	825	825	CONC	0.10	56.5	453.9246	0.8492	1.1089	0.551
	16	17	0.34	0.66	0.62	3.69			0.00	0.00			0.00	0.00			0.00	0.00	9.95	76.99	104.44	122.44	178.99	284	825	825	CONC	0.10	49.5	453.9246	0.8492	0.9716	0.625
To STREET No. 11, Pipe 17 - 22						3.69				0.00				0.00				0.00	10.92														
STREET No. 11																																	
Contribution From STREET No. 12, Pipe 18 - 19						2.31				0.00				0.00				0.00	15.55														
Contribution From STREET No. 11, Pipe 24 - 19						11.57				2.37				0.00				0.00	17.40					151									
Contribution From STREET No. 11, Pipe 6 - 19						1.49				0.00				0.00				0.00	12.29														
	19	20	0.29	0.66	0.53	15.90			0.00	2.37			0.00	0.00			0.00	0.00	17.40	56.62	76.52	89.58	130.75	1232	1500	1500	CONC	0.10	66.5	2235.3724	1.2650	0.8762	0.551
	20	21	0.20	0.66	0.37	16.26			0.00	2.37			0.00	0.00			0.00	0.00	18.28	54.97	74.27	86.93	126.87	1221	1500	1500	CONC	0.10	13.5	2235.3724	1.2650	0.1779	0.546
	21	22	0.71	0.66	1.30	17.57			0.00	2.37			0.00	0.00			0.00	0.00	18.46	54.65	73.83	86.42	126.12	1286	1500	1500	CONC	0.10	96.0	2235.3724	1.2650	1.2649	0.575
To STREET No. 14, Pipe 22 - 31						17.57				2.37				0.00				0.00	19.72					151									
Contribution From STREET No. 12, Pipe 11 - 12						0.00				0.00				0.00				0.00	10.18														
Contribution From STREET No. 12, Pipe 8 - 12						4.64				0.00				0.00				0.00	13.62														
	12	17	0.26	0.66	0.48	5.12			0.00	0.00			0.00	0.00			0.00	0.00	13.62	65.22	88.28	103.41	151.05	334	825	825	CONC	0.10	79.5	453.9246	0.8492	1.5604	0.735
Contribution From STREET No. 12, Pipe 16 - 17						3.69				0.00				0.00				0.00	10.92														
	17	22	0.35	0.66	0.64	9.45			0.00	0.00			0.00	0.00			0.00	0.00	15.19	61.33	82.96	97.15	141.87	580	975	975	CONC	0.10	76.5	708.6833	0.9492	1.3433	0.818
To STREET No. 14, Pipe 22 - 31						9.45				0.00				0.00				0.00	16.53														
STREET No. 14																																	
	113	53	0.29	0.66	0.53	0.53			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	41	450	450	CONC	0.20	49.0	127.5033	0.8017	1.0187	0.321
	53	54	0.20	0.66	0.37	0.90			0.00	0.00			0.00	0.00			0.00	0.00	11.02	73.10	99.10	116.15	169.75	66	600	600	CONC	0.15	13.5	237.8056	0.8411	0.2675	0.276
	54	55	0.55	0.66	1.01	1.91			0.00	0.00			0.00	0.00			0.00	0.00	11.29	72.20	97.86	114.68	167.60	138	825	825	CONC	0.10	72.5	453.9246	0.8492	1.4230	0.303
	55	56	0.47	0.66	0.86	2.77			0.00	0.00			0.00	0.00			0.00	0.00	12.71	67.76	91.77	107.52	157.08	188	825	825	CONC	0.10	72.0	453.9246	0.8492	1.4132	0.414
To STREET No. 15, Pipe 56 - 57						2.77				0.00				0.00				0.00	14.12														
Contribution From STREET No. 11, Pipe 17 - 22						9.45				0.00				0.00				0.00	16.53														
Contribution From STREET No. 11, Pipe 21 - 22						17.57				2.37				0.00				0.00	19.72					151									
	22	31	0.31	0.66	0.57	27.58			0.00	2.37			0.00	0.00			0.00	0.00	19.72	52.48	70.87	82.93	121.01	1766	1650	1650	CONC	0.10	72.5	2882.2416	1.3479	0.8964	0.613
Contribution From STREET No. 9, Pipe 30 - 31						1.71				2.19				0.00				0.00	17.44														
	31	32	0.74	0.66	1.36	30.65			0.00	4.56			0.00	0.00			0.00	0.00	20.62	51.06	68.92	80.65	117.66	2030	1650	1650	CONC	0.10	113.5	2882.2416	1.3479	1.4034	0.704
	32	33	0.42	0.66	0.77	31.42			0.00	4.56			0.00	0.00			0.00	0.00	22.02	48.99	66.10	77.34	112.81	1992	1650	1650	CONC	0.10	82.5	2882.2416	1.3479	1.0201	0.691
To STREET No. 16, Pipe 33 - 50						31.42				4.56				0.00				0.00	23.04					151									
STREET No. 16																																	
Contribution From STREET No. 8, Pipe 35 - 36						1.61				0.00				0.00				0.00	13.36														
Contribution From STREET No. 8, Pipe 37 - 36						0.66				0.00				0.00				0.00	11.54														
	36	33	0.12	0.66	0.22	2.50			0.00	0.00			0.00	0.00			0.00	0.00	13.36	65.93	89.26	104.57	152.75	165	825	825	CONC	0.10	78.5	453.9246	0.8492	1.5408	0.362
Contribution From STREET No. 14, Pipe 32 - 33						31.42				4.56				0.00				0.00	23.04					151									
	33	50	0.50	0.66	0.92	34.83			0.00	4.56			0.00	0.00			0.00	0.00	23.04	47.60	64.21	75.12	109.55	2102	1650	1650	CONC	0.10	75.5	2882.2416	1.3479	0.9335	0.729
	50	51	0.39	0.66	0.72	35.55			0.00	4.56			0.00	0.00			0.00	0.00	23.98	46.41	62.58	73.20	106.75	2086	1650	1650	CONC	0.10	62.0	2882.2416	1.3479	0.7666	0.724
To STREET No. 15, Pipe 51 - 56						35.55				4.56				0.00				0.00	24.74														
STREET No. 15																																	
Contribution From STREET No. 8, Pipe 110 - 45						0.00				1.12				0.00				0.00	12.38														
Contribution From STREET No. 8, Pipe 37 - 45						0.62				0.00				0.00				0.00	11.52														
Contribution From STREET No. 9, Pipe 42 - 45						28.71				6.45				0.00				0.00	22.32					1280									
	45	60	0.47	0.66	0.86	30.20			0.00	7.57			0.00	0.00			0.00	0.00	22.32	48.58	65.54	76.68	111.84	3243	1800	1800	CONC	0.10	86.5	3634.9621	1.4284	1.0093	0.892

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:	SLM	PROJECT:			
Checked:	ADF	LOCATION:		City of Ottawa	
Dwg. Reference:	03D	File Ref:	18-1042	Date: 06 Nov 2020	Sheet No. SHEET 2 OF 5

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
Contribution From STREET No. 5, Pipe 95 - 60						0.46				0.00				0.00				0.00	11.54														
	60	59	0.35	0.66	0.64	31.30			0.00	7.57			0.00	0.00			0.00	0.00	23.33	47.23	63.70	74.52	108.68	3240	1800	1800	CONC	0.10	71.5	3634.9621	1.4284	0.8342	0.891
	59	58	0.38	0.66	0.70	32.00			0.00	7.57			0.00	0.00			0.00	0.00	24.16	46.18	62.27	72.84	106.21	3229	1800	1800	CONC	0.10	79.0	3634.9621	1.4284	0.9217	0.888
To POND INLET 2, Pipe 58 - 103						32.00				7.57				0.00				0.00	25.08					1280									
	112	47	0.71	0.66	1.30	1.30			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	100	600	600	CONC	0.15	102.0	237.8056	0.8411	2.0212	0.421
	47	48	0.31	0.66	0.57	1.87			0.00	0.00			0.00	0.00			0.00	0.00	12.02	69.83	94.61	110.85	161.98	131	600	600	CONC	0.15	13.5	237.8056	0.8411	0.2675	0.550
	48	51	0.31	0.66	0.57	2.44			0.00	0.00			0.00	0.00			0.00	0.00	12.29	69.01	93.48	109.53	160.03	168	825	825	CONC	0.10	74.0	453.9246	0.8492	1.4524	0.371
Contribution From STREET No. 16, Pipe 50 - 51						35.55				4.56				0.00				0.00	24.74					151									
	51	56	0.36	0.66	0.66	38.65			0.00	4.56			0.00	0.00			0.00	0.00	24.74	45.47	61.31	71.71	104.56	2188	1650	1650	CONC	0.10	78.0	2882.2416	1.3479	0.9644	0.759
Contribution From STREET No. 14, Pipe 55 - 56						2.77				0.00				0.00				0.00	14.12														
	56	57	0.42	0.66	0.77	42.19			0.00	4.56			0.00	0.00			0.00	0.00	25.71	44.36	59.79	69.93	101.95	2295	1650	1650	CONC	0.10	68.0	2882.2416	1.3479	0.8408	0.796
	57	58			0.00	42.19			0.00	4.56			0.00	0.00			0.00	0.00	26.55	43.43	58.53	68.45	99.78	2250	1650	1650	CONC	0.10	15.5	2882.2416	1.3479	0.1916	0.781
To POND INLET 2, Pipe 58 - 103						42.19				4.56				0.00				0.00	26.74					151									
POND INLET 2																																	
Contribution From STREET No. 15, Pipe 57 - 58						42.19				4.56				0.00				0.00	26.74					151									
Contribution From STREET No. 15, Pipe 59 - 58						32.00				7.57				0.00				0.00	25.08					1280									
	58	103			0.00	74.19			0.00	12.13			0.00	0.00			0.00	0.00	26.74	43.23	58.25	68.12	99.30	5344	1800	1800	CONC	0.30	48.0	6295.9390	2.4741	0.3233	0.849
STREET No. 2																																	
	61	63	0.78	0.66	1.43	1.43			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	110	450	450	CONC	0.25	91.0	142.5531	0.8963	1.6921	0.771
To STREET No. 3, Pipe 63 - 64						1.43				0.00				0.00				0.00	11.69														
	65	66	0.74	0.66	1.36	1.36			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	104	450	450	CONC	0.20	60.0	127.5033	0.8017	1.2474	0.818
	66	67	0.38	0.66	0.70	2.05			0.00	0.00			0.00	0.00			0.00	0.00	11.25	72.33	98.04	114.89	167.91	149	525	525	CONC	0.20	60.5	192.3297	0.8885	1.1349	0.773
	67	68	0.20	0.66	0.37	2.42			0.00	0.00			0.00	0.00			0.00	0.00	12.38	68.73	93.09	109.07	159.36	166	525	525	CONC	0.25	13.5	215.0311	0.9933	0.2265	0.774
	68	69	0.45	0.66	0.83	3.25			0.00	0.00			0.00	0.00			0.00	0.00	12.61	68.06	92.17	107.99	157.77	221	600	600	CONC	0.20	61.5	274.5943	0.9712	1.0554	0.805
Contribution From STREET No. 3, Pipe 114 - 69						0.22				0.00				0.00				0.00	11.27														
Contribution From STREET No. 3, Pipe 64 - 69						2.95				0.00				0.00				0.00	13.78														
	69	83			0.00	6.42			0.00	0.00			0.00	0.00			0.00	0.00	13.78	64.80	87.71	102.74	150.07	416	825	825	CONC	0.15	37.5	555.9418	1.0400	0.6010	0.749
	83	84	0.12	0.66	0.22	6.64			0.00	0.00			0.00	0.00			0.00	0.00	14.38	63.26	85.61	100.26	146.43	420	900	900	CONC	0.10	35.5	572.4707	0.8999	0.6575	0.734
Contribution From STREET No. 1, Pipe 82 - 84						1.96				0.00				0.00				0.00	12.55														
	84	87	0.12	0.66	0.22	8.83			0.00	0.00			0.00	0.00			0.00	0.00	15.04	61.67	83.43	97.70	142.67	544	975	975	CONC	0.10	83.5	708.6833	0.9492	1.4662	0.768
To POND INLET 1, Pipe 87 - 104						8.83				0.00				0.00				0.00	16.51														
STREET No. 6																																	
	75	76	0.57	0.66	1.05	1.05			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	80	450	450	CONC	0.20	101.0	127.5033	0.8017	2.0997	0.630
To STREET No. 3, Pipe 76 - 74						1.05				0.00				0.00				0.00	12.10														
STREET No. 4																																	
	72	74	0.52	0.66	0.95	0.95			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	73	450	450	CONC	0.20	101.0	127.5033	0.8017	2.0997	0.575
Contribution From STREET No. 3, Pipe 71 - 74						1.34				0.00				0.00				0.00	12.91														
Contribution From STREET No. 3, Pipe 76 - 74						1.78				0.00				0.00				0.00	13.03														
	74	88			0.00	4.07			0.00	0.00			0.00	0.00			0.00	0.00	13.03	66.85	90.52	106.04	154.92	272	600	600	CONC	0.30	25.5	336.3080	1.1894	0.3573	0.810
			0.42	0.66	0.77	4.84			0.00	0.00			0.00	0.00			0.00	0.00															
	88	89			0.00	4.84	1.14	0.40	1.27	1.27			0.00	0.00			0.00	0.00	13.39	65.86	89.16	104.45	152.57	432	900	900	CONC	0.10	87.5	572.4707	0.8999	1.6206	0.755
To STREET No. 1, Pipe 89 - 87						4.84				1.27				0.00				0.00	15.01														
STREET No. 3																																	
	106	80	0.34	0.66	0.62	0.62			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	48	300	300	PVC	0.35	48.0	57.2089	0.8093	0.9885	0.838
To STREET No. 5, Pipe 80 - 94						0.62				0.00				0.00				0.00	10.99														
	114	69	0.12	0.66	0.22	0.22			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	17	600	600	CONC	0.15	64.0	237.8056	0.8411	1.2682	0.071
To STREET No. 2, Pipe 69 - 83						0.22				0.00				0.00				0.00	11.27														
	106	76	0.33	0.66	0.61	0.61			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	47	300	300	PVC	0.35	41.5	57.2089	0.8093	0.8546	0.813

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:	SLM	PROJECT:		Tamarack Richmond	
Checked:	ADF	LOCATION:		City of Ottawa	
Dwg. Reference:	03D	File Ref:	18-1042	Date: 06 Nov 2020	Sheet No. SHEET 3 OF 5

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 Conc.	Intensity 2 Year	Intensity 5 Year	Intensity 10 Year	Intensity 100 Year	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF FLOW	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	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	(min)	Q/Q full
Contribution From STREET No. 6, Pipe 75 - 76						1.05				0.00				0.00				0.00	12.10														
	76	74	0.07	0.66	0.13	1.78			0.00	0.00			0.00	0.00			0.00	0.00	12.10	69.58	94.27	110.46	161.40	124	525	525	CONC	0.20	49.5	192.3297	0.8885	0.9286	0.644
To STREET No. 4, Pipe 74 - 88						1.78				0.00				0.00				0.00	13.03														
Contribution From STREET No. 5, Pipe 70 - 71						1.21				0.00				0.00				0.00	11.88														
	71	74	0.07	0.66	0.13	1.34			0.00	0.00			0.00	0.00			0.00	0.00	11.88	70.26	95.20	111.56	163.01	94	450	450	CONC	0.20	49.5	127.5033	0.8017	1.0291	0.738
To STREET No. 4, Pipe 74 - 88						1.34				0.00				0.00				0.00	12.91														
	62	63	0.17	0.66	0.31	0.31			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24	300	300	PVC	0.35	27.5	57.2089	0.8093	0.5663	0.419
Contribution From STREET No. 2, Pipe 61 - 63						1.43				0.00				0.00				0.00	11.69														
	63	64	0.66	0.66	1.21	2.95			0.00	0.00			0.00	0.00			0.00	0.00	11.69	70.87	96.03	112.53	164.44	209	600	600	CONC	0.20	105.0	274.5943	0.9712	1.8019	0.762
	64	69			0.00	2.95			0.00	0.00			0.00	0.00			0.00	0.00	13.49	65.57	88.76	103.97	151.88	194	600	600	CONC	0.15	14.5	237.8056	0.8411	0.2873	0.814
To STREET No. 2, Pipe 69 - 83						2.95				0.00				0.00				0.00	13.78														
STREET No. 5																																	
	70	71	0.66	0.66	1.21	1.21			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	93	450	450	CONC	0.20	90.5	127.5033	0.8017	1.8814	0.729
To STREET No. 3, Pipe 71 - 74						1.21				0.00				0.00				0.00	11.88														
	95	60	0.25	0.66	0.46	0.46			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	35	825	825	CONC	0.10	78.5	453.9246	0.8492	1.5408	0.078
To STREET No. 15, Pipe 60 - 59						0.46				0.00				0.00				0.00	11.54														
	95	94	0.25	0.66	0.46	0.46			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	35	450	450	CONC	0.20	78.5	127.5033	0.8017	1.6320	0.276
To STREET No. 1, Pipe 94 - 90						0.46				0.00				0.00				0.00	11.63														
EXTERNAL AREA									0.00	0.00			0.00	0.00	19.92	0.20								614									
	78	79	0.42	0.66	0.77	0.77			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	673	900	900	CONC	0.30	45.5	991.5483	1.5586	0.4865	0.679
	79	80	0.20	0.66	0.37	1.14			0.00	0.00			0.00	0.00			0.00	0.00	10.49	74.99	101.69	119.19	174.23	699	900	900	CONC	0.20	46.0	809.5958	1.2726	0.6024	0.864
Contribution From STREET No. 3, Pipe 106 - 80						0.62				0.00				0.00				0.00	10.99														
	80	94	0.25	0.66	0.46	2.22			0.00	0.00			0.00	0.00			0.00	0.00	11.09	72.86	98.77	115.76	169.18	776	975	975	CONC	0.15	82.5	867.9562	1.1625	1.1828	0.894
To STREET No. 1, Pipe 94 - 90						2.22				0.00				0.00				0.00	12.27					614									
STREET No. 8																																	
	37	36	0.36	0.66	0.66	0.66			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	51	600	600	CONC	0.15	77.5	237.8056	0.8411	1.5358	0.213
To STREET No. 16, Pipe 36 - 33						0.66				0.00				0.00				0.00	11.54														
	37	45	0.34	0.66	0.62	0.62			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	48	825	825	CONC	0.10	77.5	453.9246	0.8492	1.5211	0.106
To STREET No. 15, Pipe 45 - 60						0.62				0.00				0.00				0.00	11.52														
	111	110			0.00	0.00	0.34	0.66	0.62	0.62			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	65	825	825	CONC	0.10	47.0	453.9246	0.8492	0.9225	0.143
	110	45			0.00	0.00	0.27	0.66	0.50	1.12			0.00	0.00			0.00	0.00	10.92	73.44	99.56	116.69	170.54	111	825	825	CONC	0.10	74.5	453.9246	0.8492	1.4622	0.245
To STREET No. 15, Pipe 45 - 60						0.00				1.12				0.00				0.00	12.38														
	34	35	0.47	0.66	0.86	0.86			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	66	600	600	CONC	0.15	78.0	237.8056	0.8411	1.5457	0.279
	35	36	0.41	0.66	0.75	1.61			0.00	0.00			0.00	0.00			0.00	0.00	11.55	71.34	96.68	113.30	165.56	115	600	600	CONC	0.15	91.5	237.8056	0.8411	1.8132	0.484
To STREET No. 16, Pipe 36 - 33						1.61				0.00				0.00				0.00	13.36														
	91	92			0.00	0.00	0.17	0.66	0.31	0.31			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	32	450	450	CONC	0.20	22.0	127.5033	0.8017	0.4574	0.255
	92	93			0.00	0.00	0.53	0.66	0.97	1.28			0.00	0.00			0.00	0.00	10.46	75.09	101.84	119.37	174.48	131	600	600	CONC	0.15	116.5	237.8056	0.8411	2.3086	0.550
To STREET No. 1, Pipe 93 - 94						0.00				1.28				0.00				0.00	12.77														
STREET No. 1																																	
	81	82	0.64	0.66	1.17	1.17			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	90	450	450	CONC	0.20	63.0	127.5033	0.8017	1.3097	0.707
	82	84	0.43	0.66	0.79	1.96			0.00	0.00			0.00	0.00			0.00	0.00	11.31	72.12	97.75	114.55	167.41	142	525	525	CONC	0.20	66.0	192.3297	0.8885	1.2381	0.736
To STREET No. 2, Pipe 84 - 87						1.96				0.00				0.00				0.00	12.55														
	85	86	0.39	0.66	0.72	0.72			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	55	375	375	PVC	0.30	63.5	96.0323	0.8695	1.2172	0.572
	86	87	0.26	0.66	0.48	1.19			0.00	0.00			0.00	0.00			0.00	0.00	11.22	72.43	98.18	115.05	168.15	86	450	450	CONC	0.20	63.5	127.5033	0.8017	1.3201	0.677
To POND INLET 1, Pipe 87 - 104						1.19				0.00				0.00				0.00	12.54														

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: SLM	PROJECT: Tamarack Richmond		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: 03D	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. SHEET 4 OF 5

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
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
			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
Contribution From STREET No. 8, Pipe 92 - 93						0.00				1.28				0.00				0.00	12.77														
	93	94	0.49	0.66	0.90	0.90			0.00	1.28			0.00	0.00			0.00	0.00	12.77	67.60	91.55	107.25	156.69	178	825	825	CONC	0.10	86.5	453.9246	0.8492	1.6978	0.393
Contribution From STREET No. 5, Pipe 80 - 94						2.22				0.00				0.00				0.00	12.27					614									
Contribution From STREET No. 5, Pipe 95 - 94						0.46				0.00				0.00				0.00	11.63														
	94	90	0.29	0.66	0.53	4.11			0.00	1.28			0.00	0.00			0.00	0.00	14.46	63.06	85.33	99.94	145.96	983	1200	1200	CONC	0.10	69.0	1232.8868	1.0901	1.0549	0.797
	90	89	0.24	0.66	0.44	4.55			0.00	1.28			0.00	0.00			0.00	0.00	15.52	60.57	81.92	95.92	140.07	995	1200	1200	CONC	0.10	69.0	1232.8868	1.0901	1.0549	0.807
Contribution From STREET No. 4, Pipe 88 - 89						4.84				1.27				0.00				0.00	15.01														
	89	87	0.18	0.66	0.33	9.72			0.00	2.55			0.00	0.00			0.00	0.00	16.57	58.29	78.80	92.25	134.68	1382	1200	1200	CONC	0.25	118.5	1949.3651	1.7236	1.1458	0.709
To POND INLET 1, Pipe 87 - 104						9.72				2.55				0.00				0.00	17.72					614									
POND INLET 1																																	
Contribution From STREET No. 2, Pipe 84 - 87						8.83				0.00				0.00				0.00	16.51														
Contribution From STREET No. 1, Pipe 86 - 87						1.19				0.00				0.00				0.00	12.54														
Contribution From STREET No. 1, Pipe 89 - 87						9.72				2.55				0.00				0.00	17.72					614									
	87	104			0.00	19.74			0.00	2.55			0.00	0.00			0.00	0.00	17.72	56.01	75.69	88.60	129.32	1913	1200	1200	CONC	0.45	46.0	2615.3478	2.3125	0.3315	0.731

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: SLM	PROJECT:	**Tamarack Richmond**	
Checked: ADF	LOCATION:	**City of Ottawa**	
Dwg. Reference: 03D	File Ref: 18-1042	Date: 06 Nov 2020	Sheet No. SHEET 5 OF 5

Preliminary Wet Pond Sizing Per MOE

Tributary Area	ha	152.46	
Estimated Imperviousness	(%)	29	
Volume Requirements	m^3/ha	100	<-- 40 m3/ha accounted for in ext. detention
Vol Req	m^3	15246	

Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level 35%	55%	70%	85%
Enhanced 80% long-term S.S. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250
Normal 70% long-term S.S. removal	Infiltration	20	20	25	30
	Wetlands	60	70	80	90
	Hybrid Wet Pond/Wetland	75	90	105	120
	Wet Pond	90	110	130	150
Basic 60% long-term S.S. removal	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

Source: Stormwater Management Planning and Design Manual prepared by the MOE, 2003

Increment	0.05
Pond Bottom	90.8
Perm. Pool	92.35

Elevation (m)	Δ Elev (sq.m)	Area (sq.m)	Δ Area (sq.m)
90.85	0	13800	1241
92.35	1.5	21933	5422.0
94.3	3.45	27340	2772.8

Elevation (m)	Depth (m)	Inc. Area (sq.m)	Cuml. Area (sq.m)	Inc. Volume (cu.m)	Cuml. Volume (cu.m)	Active Volume (cu.m)
90.8	0	13800.0	13800.0	0.0	0.0	
90.85	0.05	271.1	14071.1	696.8	696.8	
90.9	0.1	271.1	14342.2	710.3	1407.1	
90.95	0.15	271.1	14613.3	723.9	2131.0	
91	0.2	271.1	14884.4	737.4	2868.4	
91.05	0.25	271.1	15155.5	751.0	3619.4	
91.1	0.3	271.1	15426.6	764.6	4384.0	
91.15	0.35	271.1	15697.7	778.1	5162.1	
91.2	0.4	271.1	15968.8	791.7	5953.8	
91.25	0.45	271.1	16239.9	805.2	6759.0	
91.3	0.5	271.1	16511.0	818.8	7577.8	
91.35	0.55	271.1	16782.1	832.3	8410.1	
91.4	0.6	271.1	17053.2	845.9	9256.0	
91.45	0.65	271.1	17324.3	859.4	10115.4	
91.5	0.7	271.1	17595.4	873.0	10988.4	
91.55	0.75	271.1	17866.5	886.5	11874.9	
91.6	0.8	271.1	18137.6	900.1	12775.0	
91.65	0.85	271.1	18408.7	913.7	13688.7	
91.7	0.9	271.1	18679.8	927.2	14615.9	
91.75	0.95	271.1	18950.9	940.8	15556.7	
91.8	1	271.1	19222.0	954.3	16511.0	
91.85	1.05	271.1	19493.1	967.9	17478.9	
91.9	1.1	271.1	19764.2	981.4	18460.3	
91.95	1.15	271.1	20035.3	995.0	19455.3	
92	1.2	271.1	20306.4	1008.5	20463.8	
92.05	1.25	271.1	20577.5	1022.1	21485.9	
92.1	1.3	271.1	20848.6	1035.7	22521.6	
92.15	1.35	271.1	21119.7	1049.2	23570.8	
92.2	1.4	271.1	21390.8	1062.8	24633.6	
92.25	1.45	271.1	21661.9	1076.3	25709.9	

92.3	1.5	271.1	21933.0	1089.9	26799.8	0.0
92.35	1.55	138.6	22071.6	1100.1	27899.9	0.0
92.4	1.6	138.6	22210.3	1107.0	29006.9	1107.0
92.45	1.65	138.6	22348.9	1114.0	30120.9	2221.0
92.5	1.7	138.6	22487.6	1120.9	31241.8	3341.9
92.55	1.75	138.6	22626.2	1127.8	32369.7	4469.8
92.6	1.8	138.6	22764.8	1134.8	33504.4	5604.6
92.65	1.85	138.6	22903.5	1141.7	34646.1	6746.3
92.7	1.9	138.6	23042.1	1148.6	35794.8	7894.9
92.75	1.95	138.6	23180.8	1155.6	36950.3	9050.5
92.8	2	138.6	23319.4	1162.5	38112.9	10213.0
92.85	2.05	138.6	23458.1	1169.4	39282.3	11382.4
92.9	2.1	138.6	23596.7	1176.4	40458.7	12558.8
92.95	2.15	138.6	23735.3	1183.3	41642.0	13742.1
93	2.2	138.6	23874.0	1190.2	42832.2	14932.3
93.05	2.25	138.6	24012.6	1197.2	44029.4	16129.5
93.1	2.3	138.6	24151.3	1204.1	45233.5	17333.6
93.15	2.35	138.6	24289.9	1211.0	46444.5	18544.6
93.2	2.4	138.6	24428.5	1218.0	47662.4	19762.6
93.25	2.45	138.6	24567.2	1224.9	48887.3	20987.5
93.3	2.5	138.6	24705.8	1231.8	50119.2	22219.3
93.35	2.55	138.6	24844.5	1238.8	51357.9	23458.1
93.4	2.6	138.6	24983.1	1245.7	52603.6	24703.7
93.45	2.65	138.6	25121.7	1252.6	53856.2	25956.4
93.5	2.7	138.6	25260.4	1259.6	55115.8	27215.9
93.55	2.75	138.6	25399.0	1266.5	56382.3	28482.4
93.6	2.8	138.6	25537.7	1273.4	57655.7	29755.8
93.65	2.85	138.6	25676.3	1280.3	58936.0	31036.2
93.7	2.9	138.6	25814.9	1287.3	60223.3	32323.4
93.75	2.95	138.6	25953.6	1294.2	61517.5	33617.7
93.8	3	138.6	26092.2	1301.1	62818.7	34918.8
93.85	3.05	138.6	26230.9	1308.1	64126.8	36226.9
93.9	3.1	138.6	26369.5	1315.0	65441.8	37541.9
93.95	3.15	138.6	26508.2	1321.9	66763.7	38863.8
94	3.2	138.6	26646.8	1328.9	68092.6	40192.7
94.05	3.25	138.6	26785.4	1335.8	69428.4	41528.5
94.1	3.3	138.6	26924.1	1342.7	70771.1	42871.3
94.15	3.35	138.6	27062.7	1349.7	72120.8	44220.9
94.2	3.4	138.6	27201.4	1356.6	73477.4	45577.5
94.25	3.45	138.6	27340.0	1363.5	74840.9	46941.1
94.3	3.5	0.0	27340.0	1367.0	76207.9	48308.1