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FUNCTIONAL SERVICING REPORT

FOR

RICHMOND NORTH WEST & EAST (WESTERN DEVELOPMENT LANDS)

CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

PROJECT NO.: 20-1183

AUGUST 2022
6TH SUBMISSION

FUNCTIONAL SERVICING REPORT
FOR THE
RICHMOND NORTH WEST /EAST
(WESTERN DEVELOPMENT LANDS)

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1.0 INTRODUCTION

This functional servicing report is submitted in support of a draft plan application for property parcels within the Western Development Lands (WDL) in the Village of Richmond on behalf of the Richmond Village Development Corporation (RVDC).

The following figure provides a site context for the WDL area in the within the Village.

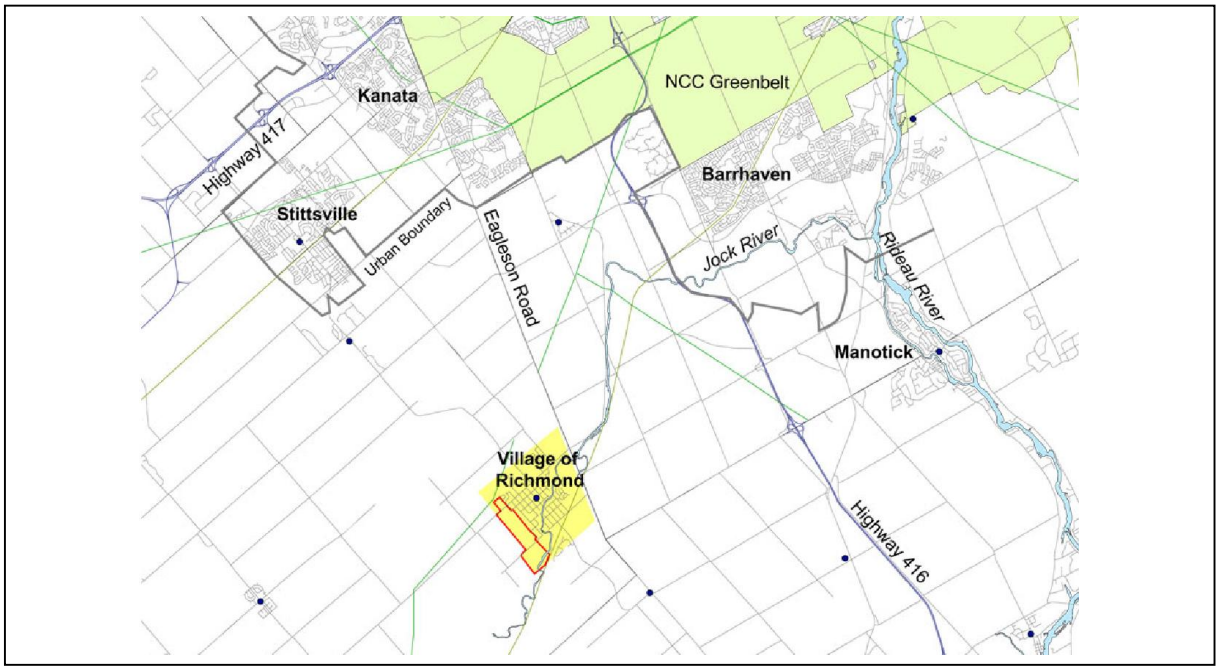

Figure A: Western Development Lands within Richmond

The ***Figure 1 Site Location*** plan in the ***Figures*** section at the back of this report illustrates the land parcels that are the subject of the current draft plan application and are identified as “Richmond North West” and “Richmond North East” (note that these areas were formerly referred to as Green West and Green East in background reports

referenced in this FSR). The draft plan for the areas is included for reference and identified as ***Figure 2***.

1.1 Richmond North West & East

Richmond North West is proposed to be comprised of 139 single family homes and 233 townhomes (total 372 units).

Richmond North East is proposed to be comprised of 30 single family homes.

Figure 1 also demonstrates the surrounding areas of development that have been (or are being) advanced within this area of the WDL to date:

1. The first phase of development within the WDL was Fox Run Phase 1 (located south of Perth Street) and consisted of 220 single family homes, an interim stormwater management (SWM) pond and a sanitary trunk sewer outlet upgrade for the WDL along Martin Street. Phase 1 has been constructed to base course asphalt and home construction activities are ongoing;

2. Subsequent to Phase 1, detailed design submissions were made for:

    a. Fox Run Phase 2 (North) (between Richmond North West and East) which has been approved and is currently undergoing homebuilding construction at the time of the writing of this FSR. This phase of development also included an expansion to the interim SWM Pond to its ultimate footprint which will also service the Richmond North West (see further discussion in Section 5 of this FSR). Phase 2 (North) consists of 31 single family homes and 163 townhomes;

    b. Phase 2 (South) design approval is anticipated in July 2020 with servicing construction to commence upon approval. Phase 2 (South) consists of 200 single family homes.

3. An updated application is also being advanced with respect to the Fox Run Phase 4 development area which is located between Richmond North West/East. This development area was previously draft approved but has been revised/recirculated in order to account for revisions to the road layout and incorporation of the former Hydro One lands and a Zoning By-law amendment. The site is proposed to have 162 single family homes and 82 townhomes.

This FSR is provided to demonstrate conformance with the design criteria of the City of Ottawa, background studies, including the Master Servicing Study, and general industry practice.

1.2 Existing Conditions

Richmond North West: The majority of this 13.86 ha site is currently undeveloped and is active farmland. The site area surrounds an existing BMR commercial property that fronts onto Perth Street. Immediately west of the BMR property is a residential property/structure at 6387 and 6409 Perth Street which will be removed as part of the site development. The general terrain is relatively flat and the majority has been previously cleared of trees, with the exception of some minor hedgerows along the some ditches, along the periphery of the site and in the vicinity of the existing residential buildings.

Existing ground elevations are on average between 96.10m to 94.40m (with some isolated higher elevations at the existing dwellings).

As identified in the ***Green Lands Geotechnical Report*** prepared by Golder Associates, the subsurface conditions within the development area are anticipated to consist of topsoil overlaying a silty clay over sandy silt and glacial till. For additional details please see the borehole logs and descriptions found in ***Appendix F***. The geotechnical investigation of the area indicates that the deposit of generally firm unweathered grey silty clay has a limited capacity to support additional stress and as such there are recommended grade raise restrictions of 1.3m to 1.5m at future home locations and approximately 2 meters at roadways.

Richmond North East: The majority of this 3.65 ha site is currently undeveloped and is active farmland. The general terrain is relatively flat and the majority has been previously cleared of trees, with the exception of a hedgerow along the frontage of Mira Court. The future alignment of the Van Gaal Drain borders the west side of the property and the east side fronts onto Mira Court (the proposed south units) or back onto the adjacent Richmond Oaks Subdivision (the proposed north units).

Existing ground elevations are on average between 95.35m to 94.40m (with some isolated higher elevations at the existing dwellings) with a gradient to the southeast.

As identified in the ***Green Lands Geotechnical Report*** prepared by Golder Associates, the subsurface conditions within the development area are anticipated to consist of topsoil overlaying a silty clay over sandy silt and glacial till. For additional details please see the borehole logs and descriptions found in ***Appendix F***. The geotechnical investigation of the area indicates that the deposit of generally firm unweathered grey silty clay has a limited capacity to support additional stress and as such there are recommended grade raise restrictions of 1.3 m to 1.5 m at future home locations and approximately 2 m at roadways.

The WDL development is located within the jurisdiction of the Rideau Valley Conservation Authority (RVCA).

1.3 Summary of Pre-Consultation

The following provides a summary of the pre-consultation:

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

Prior consultations associated with the Western Development Land area have previously been undertaken for the approval of the Martin Street Sanitary Trunk Sewer, the interim & Ultimate SWM 'Pond 1' that services the development areas, and the sanitary/storm sewers associated with the Phase 1 development area.

1.3.2 City of Ottawa

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

- March 13, 2020 – a formal pre-application Consultation with Municipal Staff for the Green Lands (now referred to as Richmond North West/East) was held. The intent of the meeting was to discuss the proposed development, review technical considerations and identify/confirm studies required to accompany the submission of a Plan of Subdivision application.

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

1.4 Existing Permits / Approvals

The existing approvals for surrounding infrastructure, related to the proposed development areas, are presented in the following table. Prior ECA approvals are provided in ***Appendix B*** for reference.

Table 1: Existing Permits / Approvals

Agency	Approval Type	Approval Number	Remarks
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	1608-BPHMBF (May 19, 2020)	Stormwater Management Pond 1 expansion which accounts for future drainage from the Richmond North West
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	5426-A5PMR (January 6, 2016)	Martin Street Sanitary Trunk Sewer for conveyance of sanitary flows from the WDL development area.

Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	1528-BLFNVH (February 24, 2020)	Caivan Communities – Richmond Phase 2 (North) for sanitary and storm sewers
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	9297-AV9KAL (January 25, 2018)	Caivan Communities – Richmond Phase 1 for sanitary and storm sewers
Rideau Valley Conservation Authority (RVCA)	Alteration of Waterways Permit under O.Reg. 174/06	RV5-4619 (October 1, 2019)	Authorization related to the construction of the Ultimate Stormwater Management Pond 1 located partially within the Regulatory Floodplain of the Jock River and Arbuckle Municipal Drain.
Rideau Valley Conservation Authority (RVCA)	Alteration of Waterways Permit under O.Reg. 174/06	RV5-2919 (January 23, 2020)	Authorization related to the realignment of the Van Gaal Municipal Drain to accommodate development in the WDL development area.

1.5 Required Permits / Approvals

The Richmond North West/East development areas are subject to the following 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.	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 will 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/storm sewers throughout the subdivision areas.	The MECP will issue an ECA for the sanitary/storm sewer design through the transfer of review process.

City of Ottawa	Permission for a storm outlet from the Richmond North East to the Van Gaal Municipal Drain.	Condition of subdivision approval.	The City of Ottawa will issue a permission letter for the connection via the development review process.
Rideau Valley Conservation Authority (RVCA)	RVCA Letter of Permission: Fill Permit	Removal of a minor area of floodplain located in the northwest corner of the Richmond North West area.	Authorization related to a balanced cut/fill placement in a regulated area.
Lands Owned by Others	Permission of installation of infrastructure where required	Construction of new sanitary/storm sewers or watermain.	Proof of authorization to be provided when required.

2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

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

- Ottawa Sewer Design Guidelines
  City of Ottawa, October 2012
  (Sewer Design Guidelines)
  - Technical Bulletin ISDTB-2014-01
    City of Ottawa, February 5, 2014
    (ITSB-2014-01)
  - Technical Bulletin PIEDTB-2016-01
    City of Ottawa, September 6, 2016
    (PIEDTB-2016-01)
  - Technical Bulletin ISTB-2018-01
    City of Ottawa, March 21, 2018
    (ISTB-2018-01)
  - Technical Bulletin ISTB-2018-04
    City of Ottawa, June 27, 2018
    (ISTB-2018-04)
- Ottawa Design Guidelines – Water Distribution
  City of Ottawa, July 2010
  (Water Supply Guidelines)

  - Technical Bulletin ISD-2010-2
    City of Ottawa, December 15, 2010.
    *(ISD-**2010-2**)*
  - Technical Bulletin ISDTB-2014-2
    City of Ottawa, May 27, 2014.
    ***(ISDTB-2014-2**)*
  - Technical Bulletin ISTB-2018-02
    City of Ottawa, March 21, 2018
    ***(ISTB-2018-02**)*

- City of Ottawa Official Plan,
  adopted by Council 2003.
  ***(Official Plan**)*
- 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**)*
- Master Drainage Plan Western Development Lands for Richmond Village (South) Limited
  David Schaeffer Engineering Ltd., November 2013 and March 2020 as amended
  ***(MDP and MDP 2020 Update respectively**)*
- Preliminary Geotechnical Investigation Report, Proposed Residential Subdivision Perth and Ottawa Streets Richmond Area, Ottawa, ON.
  Jacques Whitford Consultants, June 2007
  ***(Geotechnical Investigation**)*
- Preliminary Geotechnical Report, Green Lands West and Green Lands East
  Golder Associates, June 2020 (Project No. 20144864-3000-01)
  ***(Green Lands Geotechnical Report**)*
- Groundwater Impact Assessment, Proposed Residential Development, 6305 Ottawa Street West - Richmond

Paterson Group, June 2020 (Reference No. PH4034-LET.01)
(Paterson Groundwater Report)

- Design Brief for Ultimate Stormwater Management Pond 1, Western Development Lands, Richmond
  JF Sabourin & Associates and David Schaeffer Engineering Ltd, March 2020)
  (Ultimate Pond 1 Design Brief)
- Sanitary Design Brief (Off-Site Trunk Sewers) for Richmond Village (North & South) Ltd, Village of Richmond
  David Schaeffer Engineering Ltd., October 26, 2015 (2nd Submission)
  (Off-Site Trunk Sewers)
- Stormwater Management Report for Fox Run Subdivision – Phase 2 North
  JF Sabourin and Associates, March 2020
  (PH2 North SWM Report)
- Stormwater Management Report for Fox Run Subdivision – Phase 2 South
  JF Sabourin and Associates, May 2020
  (PH2 South SWM Report)
- Stormwater Management Report for Fox Run Subdivision – Phase 1
  JF Sabourin and Associates, October 2017
  (PH1 SWM Report)
- Design Brief for Caivan Communities Richmond Phase 1
  DSEL, November 2017
  (PH1 Design Brief)
- Technical Memorandum No. 1A – Richmond Population and Wastewater Flow Projections
  Parsons, March 2019
  (TM No.1A)
- Technical Memorandum No. 2 – Proposed Richmond Pumping Station Upgrade
  Parsons, May 2019
  (TM No.2)
- Village of Richmond Wastewater Collection System Upgrades Functional Design Study
  Parsons, September 2019
  (Wastewater Functional Design)

3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

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

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

In tandem with the construction of Phase 1 of the Fox Run development area, a new communal well system was constructed (referred to as the Richmond West Pumping Station), and is now commissioned, and will provide water supply service to the entire future *WDL* area. With the advancement of the Fox Run Phase 2 (North) and (South) development areas, the water supply network will be available to the boundaries of the Richmond North West development area at Perth Street at two locations as seen in ***Figure 3A*** in the ***Figures*** section.

3.2 Proposed Water Supply

3.2.1 Richmond North West Water Supply

Water servicing for the Richmond North West area was contemplated in the ***Village of Richmond Water and Sanitary Master Servicing Study*** prepared by Stantec Consulting Ltd., July 2011 (***MSS***). The preferred design concept indicated by the ***MSS***, for development of the WDL, consisted of a new public communal well system connected to the deep aquifer. The facility is now operational.

The Richmond North West area will be serviced internally by 150 mm, 200 mm and 300mm diameter watermains designed in accordance with the ***Water Supply Guidelines*** and ***2013 Water Master Plan***. Various design criteria are summarized in the following table.

Table 3: Water Supply Design Criteria

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

The internal watermains will connect to watermain stubs that were installed as part of the Phase 1 (a 300mm diameter stub to be extended from Equitation Circle across Perth Street) and Phase 2 (north) construction from Oldenburg Avenue (and from future watermain installations from extensions of Oldenburg Avenue). The proposed and existing watermains are depicted in ***Figure 3A***.

Stantec has completed a review of the Richmond North West area given that the prior projected number of units assessed for this land area, during evaluation of the Fox Run Phase 2 (North) development, is increased from 150 single family homes (SFH) with a population of 510 (based on 3.4 p/unit) to 139 SFH and 233 townhomes (~1,102 people). Refer to the technical memorandum ***Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis*** prepared by Stantec Consulting Ltd. dated February 2021 ***(Stantec Water Review)***, enclosed in ***Appendix C*** which indicates that the additional populations and unit counts can be accommodated. Note: The draft plan layout has been updated slightly from the February 2021 Stantec report. However, the overall unit count and population in the Richmond North West/East and Fox Run Phase 3 development areas is slightly reduced so the results and findings remain valid. In addition, recent reporting associated with the adjacent Fox Run Phase 4 development area (D07-16-21-0031) detailed design submission also accounts for the Richmond North West lands. Planned future expansion of the Communal Well storage will ultimately be dictated by the rate of progress of the WDL development area up until

demand approaches the current 28 L/s supply with the largest well (40 L/s) out of service.

3.2.2 Richmond North East Water Supply

Similar to the Richmond North West area, it is proposed that watermains will be extended to provide water service to the Richmond North East area. Two crossings of the Van Gaal Drain are proposed to provide sufficient system pressures for this water supply connection. The preliminary analysis completed by Stantec indicates that the required system pressures are satisfied with the proposed configuration shown in ***Figure 3A***.

3.2.3 Water Demand Calculations

A summary of water demands taken from the ***Stantec Water Review*** is presented in the following table. The Richmond North West/East areas are represented by the "Green Lands West/East" references. The total population of those areas is 1,219 (highlighted in the table below) while the proposed draft plan concept yields 1,102 (based on a total of 139 single family homes and 233 townhomes. 139x3.4 + 233x2.7).

Table 4 – Summary of Water Demands[(1)]

Development Area	Unit Type	Population	Area (ha)	Water Demands		
				BSDY (L/s)	OWD (L/s)	MXDY (L/s)
[(1)]RVDC Fox Run Ph1	SFH	748	-	1.56	2.67	4.23
RVDC Fox Run Ph2 (North)	SFH	105	-	0.22	0.38	0.60
	MLT	440	-	1.01	-	1.01
RVDC Fox Run Ph2 (South)	SFH	680		1.42	2.43	3.85
RVDC Fox Run Ph3	SFH	751	-	1.57	2.68	4.25
Mattamy Ph1	SFH	449	-	0.94	1.60	2.54
	MLT	127	-	0.29	-	0.29
Green Lands West (Caivan (Richmond North) Ltd)	SFH	391	-	0.81	1.40	2.21
	MLT	702	-	1.61	-	1.61
Green Lands East (Caivan (Richmond North) Ltd)	SFH	126	-	0.26	0.45	0.71
Laffin Lands (Caivan (Richmond South) Ltd)	SFH	367	-	0.76	1.31	2.08
	MLT	178	-	0.41	-	0.41
Interim Conditions (Sub-total)		***5,064***	***0***	***10.85***	***12.92***	***23.78***
Mattamy Buildout	SFH	2,176	-	4.53	7.77	12.30
	MLT	635	-	1.45	-	1.45

	INS	-	2.63	0.85	-	0.85
	MLT	146	-	0.33	-	0.33
Buildout Conditions (Total)		***7,875***	***2.63***	***17.69***	***20.69***	***38.39***

(1) Extracted from Table 3 of the "Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis" by Stantec Consulting Ltd. dated February 2021. See report in Appendix C for further population details and allocation for Phase 2 South and Phase 2 North.
(2) RVDC = Richmond Village Development Corporation
SFH (Single-Family Home); MLT (Multi / Townhouses); BSDY (Basic Day); OWD (Outdoor Water Demand of 1049 L/SFH/d)); MXDY (Maximum Day).

3.3 Water Supply Conclusion

The proposed development areas will be serviced by 150 mm, 200mm and 300 mm diameter watermains which will be connected to the existing water distribution network currently in place. Coordination with the advancement of any detailed design of adjacent properties will be undertaken at the time of the design advancement of the Richmond North West/East Lands properties.

The ***Stantec Water Review*** indicates that the proposed watermain layouts will satisfy the demands under all conditions and the proposed layout conforms to the water servicing plan as conceptualized in the Communal Well design.

4.0 WASTEWATER SERVICING

4.1 Existing/Approved Wastewater Services

The existing Village of Richmond is serviced primarily by City of Ottawa sanitary sewers that convey wastewater to the Richmond Pumping Station located south of the Jock River, on the northwest corner of Cockburn Street and York Street. The Richmond Pump Station (RPS) discharges to the Glen Cairn Trunk Sewer just south of Hazeldean and Robertson Road in Kanata.

The WDL is serviced via the new sanitary trunk sewer that has been recently constructed along Martin Street from Cockburn Street to the boundary of the Fox Run Phase 1 development area.

Wastewater collection services for the WDL was contemplated in the ***MSS*** and there are currently system capacity constraints requiring upgrades in order to facilitate servicing capacity for the balance of the WDL. The recommended solution is expanding the current wastewater collection system and to continue to pump wastewater to the City's central wastewater treatment facility.

The preferred design concepts for the improvements to the wastewater service includes:

- Upgrades to the existing gravity collection system (City program to remove extraneous flows and pipe size and length improvements for the gravity collection system along specific road segments). ***This was accomplished via the approved Martin Street trunk sewer upgrade.***
- Operation upgraded to facilitate emergency use of the Richmond Lagoon Cell C in extreme wet weather conditions. Twinning of 1200 m of existing forcemain with new 600 mm sewer and repairs to the existing 500mm diameter forcemain. ***Partially Completed*** *(twinning still ongoing at the time of this FSR preparation).*
- Extension of 5.9 km forcemain twinning from the current termination point with an additional 600 mm diameter forcemain along Eagleson Road. ***Design initiated.***
- Upgrades / expansion of the existing Richmond Pump Station. Analysis/design ongoing by Stantec with design expected to be completed in 2022/2023.
- New 600mm forcemain twinning from Richmond to the City's central collection system in Kanata. ***Future work.***

Ongoing coordination with the wastewater upgrades/analyses will determine how much flow from the advancing development of the WDL will be allowed. The City of Ottawa has previously retained Parsons to review wastewater within the Village of Richmond. They have prepared Technical Memorandums (***TM No.1 – Richmond Population and Wastewater Flow Projections (March 2019)*** and ***TM No.2 – Proposed Richmond***

Pumping Station Upgrade (May 2019)) to review the sanitary system in order to facilitate growth within the Village of Richmond. Follow up analyses and consultations are continuing and will ultimately determine system capacity allocations and timing. In addition, a sanitary monitoring program has been initiated/installed within the sanitary trunk downstream of the WDL development area. The monitoring will for the assessment as to whether flows from the new contributing network are in-line with expectations and will also serve to guide development buildout rates as downstream system improvements are implemented.

4.2 Wastewater Design

The Richmond North West/East development areas will be serviced by new gravity sewers designed in accordance with City of Ottawa design criteria which will connect to the existing sanitary sewer infrastructure constructed during the development of Fox Run Phase 1 and Phase 2 (North) areas. The proposed sanitary sewer layouts are depicted in ***Drawing 2A*** in the ***Drawings*** section at the back of this report. The following table summarizes the ***City Standards*** which are used in the design of the proposed wastewater sewer system.

Table 5: Wastewater Design Criteria

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

The *Fox Run Phase 1* sanitary design sheets are provided in ***Appendix D*** as a frame of reference for the previously anticipated sanitary flows from the future Richmond North properties. It is noted that the prior design for the ***WDL*** sewers was based on older City guidelines with an average daily demand of 350 L/d/person while the new guidelines

specify 280 L/d/person. The prior infiltration allowance of 0.28 L/s/ha was also used while the current guidelines specify 0.33 L/s/ha as per the table above.

The updated design parameters from the above table are used for the Richmond North areas.

4.2.1 Richmond North West

The draft plan demonstrates 139 single family homes and 233 townhomes (total 372 units) which results in an increased population that was projected from this external area in the *Fox Run Phase 2 (North)* sanitary design sheet (which was based on a per hectare population due to uncertainty about the future development unit mix) . As per the sanitary design sheet for the Richmond North Lands West area found in ***Appendix D***, the overall projected flows tributary to the connection point at the previously constructed trunk sewer (at existing sanitary manhole MH150A at the Perth Street and Meynell Road intersection) are lower than the flows assessed in the Fox Run Phase 1 design (i.e. *41.93 L/s* from the Fox Run Phase 1 design and **37.96 L/s** in this FSR design sheet). As such, the proposed unit mix and population results in design flows through the Fox Run Phase 1 development area that are lower than previously anticipated flows that were used for trunk sewer designs.

City Parks staff have asked for confirmation that the proposed watermain and sanitary servicing block that abuts the park area (provides services to the rear lane townhomes) does not encroach into the park. A servicing cross-section has been provided in ***Drawing 5A*** which demonstrates that there is no impact based on the servicing locations proposed.

4.2.2 Richmond North East

The draft plan demonstrates 30 single family homes for the Richmond North East development area. As per the sanitary design sheet in ***Appendix D*** this area generates flows of approximately **2.79 L/s** that will be connected to existing sanitary sewers located within the Richmond Oaks development to the east.

Within the ***MSS,*** various infill and future development scenarios were reviewed in order to assess system capacities. For the Richmond North East area the *MSS Figure 5.7* (provided in ***Appendix D***) demonstrates that there are no local system bottlenecks for capacity (other than the Martin Street sewer which has already been upgraded and future pump station and forcemain upgrades which are planned to be implemented). It is anticipated that this small increase in flows can be readily incorporated into the sewer networks and will ultimately be captured in the future sanitary system upgrades for the Village of Richmond.

4.3 Sanitary Hydraulic Grade Line – Richmond Pump Station Failure Scenario

Stantec Consulting has previously prepared a memo (see ***Appendix D***) that was circulated to City staff reviewing the level of service of the RPS (*Richmond Pump Station – Design Level of Service, Stantec, Oct 5/12, File No. 163401146*). In the event of a catastrophic failure of the RPS, the estimated HGL starting point at the RPS would be at approximately the 100-year water level at the overflow outlet point at the Jock River (~93.80m per page 4). Given this starting HGL, it will theoretically be above the underside of footings (USFs) of the proposed units (and most of the Village). City staff have commented that per guidelines, there is a requirement for the USFs to be established at an elevation above the 25-year water levels in the Jock River at the sanitary pumping station. The RVCA flood mapping in this area (Jock River Reach 3, cross-section 18224) indicates that this elevation would be ~93.44m. Based on the functional grading for the Richmond North properties the proposed USFs would be above this elevation. Notwithstanding, within a grade raise restricted development area, all units are established at as high an elevation as possible and will be protected by backwater valves in the sanitary sewer laterals to the dwellings as required per Section 4.4.5 of the Design Guidelines.

4.4 Wastewater Servicing Conclusion

The Richmond North West Lands will connect to existing downstream sewers previously constructed as part of the Fox Run Phase 1 development area. When comparing the projected flows from the areas, the downstream sewer systems were designed for flows that were greater than the projected flows therefore capacity exists in those sewers.

Richmond North East units will outlet to existing sewers in the adjacent Richmond Oaks development. A review of the MSS indicates that there are no downstream contstraints in the downstream sewers up to the sanitary pump station.

In a greater context, there are ongoing studies and agreements being formulated in order to increase the sanitary capacity for the Village of Richmond through downstream twinning of forcemains and planned expansion of the Richmond Sanitary Pump station.

The functional sanitary sewers have been designed adhering to all relevant *City Standards*.

5.0 STORMWATER CONVEYANCE

Stormwater conveyance for the Richmond North Lands West properties were contemplated in the ***Stormwater Management Report for Richmond Village (South) Limited*** (now known as RVDC) prepared by David Schaeffer Engineering Ltd., November 2013 ***(MDP)*** and the subsequent ***March 2020*** update (to be referred to as the ***MDP 2020 Update*** that was approved in April 2020). The Richmond North West area conforms to the ***MDP 2020 Update.***

The Richmond North East area was not previously contemplated within the ***MDP*** studies and the proposed solution is based on maintaining post-development flows to pre-development levels for quantity control and quality controls via an oil-grit separator (OGS) unit as noted in the pre-consultation minutes.

5.1 Master Drainage Plan Updates

The original 2013 ***MDP*** for the WDL conceptualized the stormwater management systems based on the City of Ottawa standard criteria at the time (i.e. 5-year level of service for sewers and 30cm of ponding etc). The ***MDP 2020 Update*** was prepared at the request of City of Ottawa staff to reflect a number of important updates to the ***Sewer Design Guidelines*** subsequent to the preparation of the 2013 ***MDP***. As presented in the ***MDP*** and ***MDP 2020 Update***, the recommended stormwater servicing solution consists of a major system, a minor system, and homes with basements equipped with sump pumps to provide foundation drainage.

The *Drawing 3* (*Storm Servicing Plan*) draft from the ***MDP 2020 Update*** can be found in ***Appendix E*** for reference.

The following were the most relevant aspects of the recent ***MDP 2020 Update*** for the WDL:

- Technical Bulletin ISTB-2019-02 dated July 8, 2019 regarding the use of sump pumps;
- Technical Bulletin PIEDTB-2016-01 dated September 6, 2016 regarding the updated sizing for the minor system (i.e. 2-year for local streets, 5-year for collector streets and 10-year for arterial roads);

5.2 Richmond North West

5.2.1 Minor System

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

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 are sized using City of Ottawa IDF curves. The proposed storm sewer layout for the development is depicted in the schematic ***Drawing 3A*** *Storm Servicing Plan* in ***Drawings***. The storm sewers for this development area will outlet to future sewers to be constructed along Oldenburg Avenue as approved in the Fox Run Phase 2 (North) development and to the future extension of Oldenburg Avenue and sewer network as development progresses. The downstream sewers in Phase 2 (North) were designed with the Richmond North West considered. As illustrated in the Richmond North West and Fox Run Phase 2 (North) design sheets in ***Appendix E,*** the projected storm flows of ***2,118 L/s*** are less than the 2,201 L/s within the previously designed Oldenburg Avenue sewer segment MH263 to MH264 with sufficient capacity within the previously designed sewers all the way to the SWM Pond 1 inlet.

The sewers ultimately outlet to SWM Pond 1 as per the approved design for the ultimate pond that was designed and approved as a component of the Fox Run Phase 2 (North) development (see further discussion in Section 5.2.3 of this FSR report).

The following table summarizes the relevant ***City Standards*** employed in the design of the proposed minor storm sewer system.

Table 6: 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) 5-year storm event. A = 998.071 B = 6.053	$i = \frac{A}{(t_c + B)^C}$

C = 0.814	
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	$Q = \frac{1}{n} AR^{2/3} S^{1/2}$
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 PIEDTB-2016-01	

The paved area and grassed area runoff coefficients of 0.9 and 0.2 were used to calculate average runoff coefficients that were applied across the site. The storm drainage areas are found in ***Drawings*** and the storm design sheets are enclosed in ***Appendix E*** for reference.

The storm sewers will be sized using City of Ottawa IDF curves. In keeping with the design for Fox Run Phase 2 (North) and (South), the system will not be designed with inlet control devices (ICDs) for catchbasins. The prior analyses for the adjacent phase of the development (which included the Richmond North West) have been modelled with no ICDs and modeled the catchbasins and surface storage dynamically as part of the XPSWMM storm sewer model. This was undertaken in order to confirm the performance of the system when high hydraulic gradeline elevations interact with catchbasin and surface storage. A 100-year hydraulic grade line (HGL) analysis will be completed at the time of detailed design (with detailed grading in place) to confirm that the HGL will be maintained below the gutter line elevation, given that the development will be on sump pumps.

5.2.2 Major System

The major system flows will be conveyed through the internal road network where the 100-year event will be captured by required 100-year inlets prior to discharge to the SWM Pond 1 where they are managed for quality/quantity control prior to release to the Arbuckle Drain. Major events in excess of the 100-year event will outlet to the Van Gaal Drain through the adjacent development to the east (i.e. Fox Run Phase 2 (North) and

subsequent phases) in accordance with the ***MDP 2020 Update*** (see MDP *Grading Plan Drawing 2* in ***Appendix E*** for details). The emergency overflow is via a 6m land block, proposed behind the existing residential property at 6305 Perth Street, as well as a curb cut along the south side of Perth Street. The JFSA stormwater modelling design for Phase 2 (North) provided "*Calculation Sheet 2E: Required Capacity of Phase 2B Overland Flow Route"* in its Appendix D and projected that minimal overland flow will occur due to 100-year surface storage within the development areas. The modelling conceptually considered future contributing areas (i.e. the Richmond North West lands) as well. The JFSA calculation sheet is provided in ***Appendix E*** of this report for reference.

The major system will 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).

5.2.3 Quality and Quantity Control

As per the ***MDP 2020 Update***, the storm outlet for both the minor/major systems (up to the 100-year event) from the Richmond North West land area will be to Ultimate SWM Pond 1. This wet pond facility provides the required erosion, quality, and quantity release components and outlets to the existing Arbuckle Drain. Water quality control is provided by the permanent pool sized for enhanced level of protection per MECP guidelines (80% TSS Removal). The SWM Pond 1 facility was designed and approved during the design of the Fox Run Phase 2 (North) subdivision lands to the east and accounted for the subject lands within in the design. Further details of the SWM Pond 1 modelling and sizing are included in the ***Design Brief for Stormwater Management Pond 1, Western Development Lands – Richmond*** (Project No. 15-764 dated March 2020) prepared by J.F. Sabourin and Associates provided under separate cover.

5.2.4 Floodplain

In association with the development of the Fox Run Phase 2 (North), and other RVDC lands to the northeast of Richmond North West, the Van Gaal Drain that previously bisected those properties has been realigned (based on prior approvals already received) to the perimeter of that development area. Construction is essentially complete (landscaping work remaining) with asbuilts submitted as of January 2021. There is currently ongoing coordination for the update of the floodline overlay with RVCA in order to officially remove the floodplain designation for those properties.

As seen in the FSR *Grading Plan* (***Drawing 1A***) and *Storm Servicing Plan* (***Drawing 3A***) there is a minor encroachment of the floodline into the proposed lot areas shown for Richmond North West property (northwest corner). The prior Van Gaal Drain realignment work downstream does not specifically remove the floodline from the Richmond North West property as it did for the other WDL lands. It is proposed that

similar to the adjacent development area to the northeast, the proposed Block 43 Open Space area (as shown in the ***Figure 2*** Draft Plan) will be used to provide channel and riparian improvements in order to contain the 100-year water levels within the corridor. It is noted that unlike the adjacent development, the Van Gaal Drain will be shifted and will not have to be significantly re-routed as its current alignment is at the periphery, and parallel, to the site boundary. Based on the minimal extent of floodline impacted, as shown in ***Drawings 1A/3A,*** it is anticipated that the same methodology and similar fluvial cross-section for the prior Van Gaal adjustments are feasible.

The attached analysis memorandum prepared by JFSA entitled "*Richmond Village Development / Proposed Realignment of the Van Gaal Drain Adjacent to the Green Lands*" (August 2020) evaluates the pre and post development conditions proposed and concludes that flows can be maintained within the proposed corridor and riparian storage volumes will be equal or greater than existing riparian storage. This Block 43 area of the draft plan is currently active farmland with no significant features or tree cover

5.3 Richmond North East

5.3.1 Minor System

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

With an individual local street being introduced for this infill development, the minor storm sewer system will be sized as follows:

- 2-year event for local streets;

The relevant ***City Standards*** summarized in Section 5.1.1 will be used for the design of the proposed minor storm sewer system.

The storm sewers will be sized using City of Ottawa IDF curves and are proposed to outlet to the adjacent Van Gaal Drain which is the natural receiver of stormwater runoff from these lands (similar to the nearby Mira Court sewers). Given that this is a Municipal Drain, the appropriate consultation with the City's Drainage Engineer and City staff will be undertaken.

A 100-year hydraulic grade line (HGL) analysis will be completed at the time of detailed design (with detailed grading in place) to confirm that the HGL will be maintained below the gutter line elevation, given that the development will be on sump pumps.

5.3.2 Major System

The major system flows will be conveyed through the internal road network where the 100-year event will be captured by required 100-year inlets prior to discharge to the Van Gaal Drain. Major events in excess of the 100-year event will outlet to the Van Gaal Drain as demonstrated in the conceptual *Grading Plan* ***Drawing 1A***, along with any required erosion control treatments.

5.3.3 Quantity and Quality Control

Unlike the Richmond North West area, ICDs will be employed to ensure that storm flows entering the minor system are limited to the pre-development limits. The evaluations related to ICDs for other WDL development areas was based on those areas being hydraulically connected to the SWM Pond 1 which is not the circumstance for the Richmond North East area.
Quality control will be facilitated by an appropriately sized OGS unit prior to discharge to the adjacent Van Gaal Drain. A preliminary conservative sizing for the unit (CDS Model 3020) can be found in ***Appendix E*** for reference and will be confirmed during future detailed design.

5.3.4 Floodplain

The newly realigned Van Gaal Drain (VGD) is parallel to the western boundary of the Richmond North East area. The VGD, in its former state, imposed a floodplain overlay over a portion of the property (see the *Storm Servicing Plan* (***Drawing 3A***) in ***Appendix E*** for reference). As noted in Section 5.2.4, through a separate process, design and construction has been completed for the realignment of the Van Gaal Drain. The design has been vetted/approved through consultation with the City's Drainage Engineer, Rideau Valley Conservation Authority and the Department of Fisheries and Oceans.

The revised alignment and configuration defines a revised floodline within the limits of the Drain and ultimately removes the floodplain designation from the Richmond North East development area once the realignment construction of the Drain is accepted. Full details can be found in the ***Richmond Village Development / Proposed Realignment of Van Gaal Drain*** analysis prepared by JFSA (April 20, 2017) and other supporting documentation under separate cover.

5.4 Sump Pumps

Similar to Fox Run Phase 1 and Phase 2 (North/South), the proximity of the development area to the stormwater receiver (Arbuckle Drain), high HGL, and grade raise restrictions, the proposed centerline of road grades do not allow for standard basements with a gravity connection to the storm sewer system. Therefore the Richmond North areas will also be serviced entirely by sump pumps due to the site constraints imposed. This is consistent with the original ***MDP*** and ***MDP 2020 Update***.

In 2018 and 2019, the City published Technical Bulletins ITSB-2018-04 (June 27, 2018) and ITSB-2019-02 (July 8, 2019), which outline the criteria for sump pumps, the requirements for hydrogeological assessments areas with sump pumps, and revised information on HGL for storm sewers with sump pumps. In detailed design, the proposed sump pump design will conform to Technical Bulletins ITSB-2018-04 (June 27, 2018) and ITSB-2019-02 (July 8, 2019). The sump pump detail can be found on ***Figure 4***, and the sump pump components and requirements are outlined in the following table.

Table 7: Sump Pump Design Criteria

Component	Requirements
Sump Pump (General)	Shall be: o In accordance with City of Ottawa Technical Bulletin ISTB-2018-04 (June 27, 2018); o A submersible pump; o Automatically controlled and set to maintain the water level at the same elevation as the foundation drain; capable of discharging a minimum flow of 0.9 L/s at 3.6 m head.
Sump Pump (Primary)	Shall be: o CSA Approved; o Connected to an electrical circuit that supplies no other outlets, switches or equipment; o Equipped with a self-resetting thermal overload protection switch; o Rated for continuous duty.
Sump Pump (Backup)	Shall be: o CSA Approved; o Connected to an electrical circuit that supplies no other outlets, switches or equipment except: A) Charging equipment for backup power and B) Alarm system for primary pump and power failure; o Equipped with a self-resetting thermal overload protection switch; o Rated for continuous duty; o Equipped with an audible failure alarm to notify homeowner that the primary pump has failed or the power supply has been interrupted; o Capable of discharging a minimum capacity of 0.90 L/s at 3.6 m head; o Powered by a deep-cycle lead-acid battery with a min. ampere-hour rating of 100 AH.
Sump Pit	Shall: o Have walls and bottoms constructed of concrete polyethylene, polypropylene, or fiberglass; o Be provided with a sealed cover; o Have a cover which must be secured in a manner acceptable to the authority having jurisdiction; o Be vented to the outdoors.
Discharge Pipe System from Sump Pump	Shall: o Be in accordance with *Appendix 9 – Standard Sump Pump Configuration in Greenfield Subdivisions with Clay Soils on Full Municipal Services*; o Consist of materials and be installed in conformance with the Ontario Building Code; o Have a minimum internal diameter of 38 mm (1-1/2") from the sump pump to the 100 mm (4") storm building drain; o Have a union, a check valve and a shut-off valve installed in that sequence in the direction of discharge outside of the sump pit; o Have a goose neck with a height of no more than 250 mm below the top of the foundation wall and discharge into the vertical leg of the storm building drain; o Have a minimum dimension of 600 mm from the vertical leg of the storm discharge pipe to the horizontal offset upstream of the backwater valve; o Include a CSA approved backwater valve for the stormwater discharge; o Include an emergency discharge pipe to the outside ground surface; o Be vented to the outdoors; o Be graded or otherwise protected to prevent the freezing of water in the system.
Connections	o Only the perimeter foundation drainage system will be connected to the sump pit. Eaves trough, surface exterior drainage, swimming pool backwash, floor drains and any other water sources shall not be connected to the sump pit;

	○ All new residences with installed sump pump systems must include: ○ Eaves troughs discharging to the surface with appropriate drainage away from the house at the time of the original sale; ○ Drainage layer as per the Ontario Building Code; ○ Clay backfill placed against the drainage layer with the clay extending a minimum 1.5 m out from the drainage layer for all sides of the foundation; ○ Impervious backfill capping at the ground surface surrounding the perimeter of the residence area and slope away from the building after settling of backfill; except in areas where window wells are required by Ontario Building Code; ○ The sump pump shall be directly connected to a storm building drain from the building to the property line.

5.5 Low Impact Development (LID)

The following Low Impact Development (LID) techniques may be incorporated as part of detailed design where feasible:

- Rear-yard swales have been designed with minimum grades where possible, to promote infiltration;
- Rear-yard catchbasin leads/subdrain will be perforated (except for the last segment connecting to the storm sewer within the right-of-way), to promote infiltration;
- Where eavestroughs are provided on residential units, they are to be directed to landscaped surfaces, to promote infiltration; and,

These LIDs are implemented as part of the general design requirements for the site.

5.6 Stormwater Management Conclusions

Stormwater management for the Richmond North West follows the previous rationale provided for in the ***MDP 2020 Update***. Stormwater flows will be directed to SWM Pond 1 and managed for quality and quantity control prior to discharge to the Arbuckle Drain.

The Richmond North East area was not considered in the original ***MDP***, and subsequent updates, and will provide quality and quantity control within that development area via ICDs and an OGS unit prior within the ROW prior to any discharge. The lots to be provided on a new street extension will be tributary to a new outlet to the Van Gaal Drain (with the approval with the City Drainage Engineer). Sump pumps for the new units fronting onto the west side of existing Mira Court will connect to a storm sewer extension that will be installed for those ‘clean water’ connections.

The associated storm sewer collection system, and stormwater management facility designs have been prepared in accordance with standard City of Ottawa modeling techniques. In circumstances where infrastructure may be required outside of an individual landowner’s development area (due to differences in development timing), there will need to be agreements in place facilitating cost sharing and access when necessary.

6.0 SITE GRADING

6.1 Grading Criteria

The following grading criteria and guidelines have been applied to the detailed design as per City of Ottawa Guidelines:

- Maximum slope in grassed areas between 2% and 5%;
- Grades in excess of 7% require terracing to a maximum of a 3:1 slope;
- Driveway grades between 2% and 6%;
- Drainage ditches and swales should have a minimum slope of 1.5%;
- Perforated pipe is required for swales less than 1.5% in slope;
- Swales are to be 0.15 m deep with 3:1 side slopes unless otherwise indicated on the drawings;

The ideal grading for the proposed 100-year ponding approach is summarized as follows:

- 0.5% longitudinal road slopes from high point to low point and from low point to high point within the ponding area;
- A 2.0% road cross-slope (although a 3.0% road cross-slope is also acceptable);
- As reasonable a freeboard as feasible between the maximum extent of surface storage on the road (i.e. the 100-year water level) and the lowest nearby building opening elevation, in order to ensure that the 100-year + 20% stress test water levels do not reach the building envelope; and
- Back-to-front drainage or well-spaced discharge points for excess rear yard flows draining to the street. Rear yard catchbasins are connected to street catchbasins, which in turn connects to the main storm sewer, allowing rear yard flows to back up into road ponding areas when the capacity of the catchbasin lead is exceeded.

6.2 Functional Grading Design

6.2.1 Richmond North West

The Richmond North West development is constrained by grade raise restrictions. The geotechnical investigation provided an assessment of permissible grade raises based on unit weights of fill of 18.0 kN/m^3 and 19.5 kN/m^3. The most restrictive grade raise is for the 19.5 kN/m^3 unit weight with restrictions of 2.0 m within the roadway and 1.3 m to 1.5 m at the house. See the ***Green Lands Geotechnical Report*** for full details. The servicing and grading have been designed as low as possible, to minimize the proposed

grade raise within the subdivision and adheres to this requirement. In future, the detailed grading plans will be forwarded to the geotechnical consultant for review and recommendations. Final signoff for the detailed grading plans will be provided by the Geotechnical Engineer.

6.2.2 Richmond North East

The results of the ***Green Lands Geotechnical Report*** as summarized above for the Richmond North West is the same for the East area. Grading is kept as low as possible and ties into the adjacent existing development grading.

7.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosions losses is exaggerated during construction where the vegetation has been removed and the top layer of soil is disturbed.

- 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.
- Installation of mud mats at construction accesses.

8.0 CONCLUSION AND RECOMMENDATIONS

Caivan (Richmond North) Ltd. is proposing residential development within the Village of Richmond Western Development Lands The subject properties are the Richmond North West (13.86 ha) and Richmond North East (3.65 ha) (formerly referred to as the Green Lands West/East). DSEL was retained to prepare a Functional Servicing Study in support of draft plan application.

- Approvals will be required from the City of Ottawa, the Ministry of the Environment, Conservation and Parks (MECP) and the RVCA as required;
- Water supply to the Richmond North West was previously contemplated in the ***MSS***. Water supply to the development areas will be via extension of watermains from the now functional Communal Well for the WDL. This water supply will also be extended to the Richmond North East development area given the minor increase in demand for those 30 units. The City is currently undertaking a review of the Communal Well to assess future upgrades for the WDL and external development areas;
- Wastewater services will be provided through a network of gravity sewers that are tributary to the recently constructed and commissioned Martin Street sanitary sewer and any ongoing and planned future upgrades to the existing Richmond Sanitary Pumping Station and downstream forcemains. The ongoing, and future, off-site upgrades required to support the development area were contemplated in the ***MSS***;
- With the implementation of the new sanitary design criteria as per Technical Bulletin ISTB-2018-01 (March 21, 2018), the proposed flows downstream of the WDL is lower than what the ***MSS*** calculated, even with the increase in population of the WDL from what the ***MSS*** originally projected;
- Foundation drainage for all units will be via sump pumps in the Richmond North West/East development areas;
- Richmond North West storm sewers are designed in accordance with the new City of Ottawa stormwater guidelines with new 100-year ponding design criteria with a minimum 2-year minor system capture on local roads and a minimum 5-year minor system capture on collector roads. The sewers will outlet to SWM Pond 1 via Fox Run Phase 2 sewers which have considered this drainage area previously;
- Richmond North East storm sewers are designed to the same standard noted for Richmond North West. The sewers will have a new outlet to the adjacent Van Gaal Drain (with the approval with the City Drainage Engineer and RVCA). Quality and quantity control within the development area will be via ICDs and an OGS unit prior to any discharge. Sump pumps for the new units fronting onto the

west side of existing Mira Court will connect to a storm sewer extension that will be installed for those 'clean water' connections;

- The proposed stormwater management Pond 1 has been designed to meet MECP Enhanced Level of suspended solid removal and will attenuate stormwater to limit impacts on water levels in the receiving Arbuckle Drain;
- The Richmond North West/East areas will be subject to grade raise restrictions ranging from 2.0 m in the roadways to 1.3 m to 1.5 m at the future residential units (depending on the fill used). Ultimately the grading plan will be reviewed and signed off by the geotechnical engineer or they will provide recommendations to suite;
- Erosion and sediment control measures will be implemented and maintained throughout construction.

Prepared by,
David Schaeffer Engineering Ltd.

Per: Kevin L. Murphy, P.Eng.

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APPENDIX A

PC2020-0062 – Perth and Ottawa Street Richmond: DRAFT

Friday March 13 2020

Attendance:

May Pham, Caivan

Matthew Hayley, Environmental Planner

Neeti Paudel, Transportation Engineer

Sarah McCormick, Planner

Damien Whittaker, Senior Engineer

Eric Lalande, RVCA

Reid Shepherd, Parks Planner

Cheryl McWilliams, Planner

Matthew Ippersiel, Urban Design (absent)

The proposal relates to residential subdivision development of lands known as the [redacted] and the Laffin lands would see an additional approximately 600 plus units. There a[redacted] of separate parcels at 6295, 6363, 6409 Perth Street and 6305 Ottawa Street.

General

Please note that this pre-consultation is only valid for one year. In addition, given t[redacted] sanitary servicing constraints in Richmond, capacity may not be available for the de[redacted] of these sites until the completion of the final stage of the upgrades, which is the fu[redacted] replacement of the pump station not yet scheduled, so possibly 20 years away.

Given the timing and preliminary nature we are available to speak further on these matters and any revised plans.

Planning

- The road widths and cross-section, block depths and proposed setbacks must be demonstrated as supporting trees (one on each lot not just on average) as part of draft approval
- 16.5 m row widths will not be accepted
- The depths of the blocks must be adequate along the west lot line (Village boundary) to preserve any hedge row.
- There are some older trees on the house lot that should be preserved.
- Demonstrate consistency with the CDP and secondary plan for connections. Look at the north side potential of a MUP connecting across the drains to the east side of the van Gaal Drain to connect eventually to Cedarstone. Alternatively consider the hydro corridor. Royal York is the vehicular connection Mattamy is proposing to the village on

the south side. Burke Street connection as shown is also an option, but we would also want to see pedestrian links through to Meynell.
- Demonstrate compliance with the unit counts and density mixes per the CDP and secondary plan
- The sidewalk will need to be extended along Perth Street to the window street west of the Home Hardware.
- Servicing will need to be confirmed as available prior to supporting any draft approval.
- Consider approaching Hydro again with respect to their lands.
- The current version of the draft update to the Master Drainage Plan for the Western Development lands shows a 3rd storm pond within the hydro corridor and seems to be an in-line pond of the van Gaal. This is not acceptable.
- That same MDP is also showing much of the Laffin lands as a storm pond, which is consistent with the current approved version of the MDP but not the concept plan provided.
- An Archaeological Assessment will be needed
- The LandOwners Agreement and trustee sign-off will be required, for any works to commence.
- There is some sensitivity of the residents in Cedarstone Subdivision (north of Perth) to increases in traffic.
- There is a triangle parcel that is not owned and would limit frontage of the southern most lots on Mira.
- There is a small watercourse abutting the Laffin lands that will require some setback

Engineering

This is a follow-up to the pre-application consultation held on Friday March 13, 2020, at City Hall for regarding a proposal PC2020-0062 for development of the balance of the Western development Lands; 6363, 6409 and 6296 Perth Street in the City of Ottawa district of Rideau-Goulbourn (Ward 21) covered by Councillor Scott Moffatt. The purpose of the meeting was to identify and conduct a general overview of the key issues regarding the proposed development to ensure the application, when submitted, will be as complete as possible prior to circulation of the application and review.

Please find below City of Ottawa engineering/infrastructure information regarding an engineering design submission relevant to the proposed development. The information provided will assist the applicant for their plan of subdivision application.

Guidelines;

Please note that as this application is quite premature, the guidelines to be reviewed against will need to be the (future) amended versions, and there may even be guidelines in place then, that are not currently contemplated.

Water/Sanitary/Storm Servicing:

Water pipes:

Municipal water pipes will need to be extended to service the proposed development. The Western Development Lands developments will need to expand the well supply when appropriate and need to collectively expand the water storage at 28 l/s demand.

Sanitary Sewers:

No capacity exists in the sanitary sewer system presently and the application will not be accepted for draft approval for, probably, ten years, or more. Design parameters shall be the higher of the rates in the Sewer Design Guidelines, as amended and monitored flows. The developer shall apply I/I reduction techniques beyond that provided for the Fox Run Phase II development, that presently consists of blueskin wrap to the existing groundwater level and the use of pressure-rated pipe.

Storm Sewers:

The developer will need to extend conveyance systems in the Village of Richmond to include the development and, entirely at their cost, provide such extension.

Storm Water Management:

The consultant should determine a stormwater management regime for the application and, generally, maintain post-development flows to pre-development levels by way of providing storage to offset increased impervious areas. The existing runoff coefficient shall be taken as that from approved development; non-approved development should be ignored by the consultant in the determination of existing runoff coefficient and will not be taken into consideration by City engineering review staff.

Any existing stormwater runoff from adjacent site(s) that crosses the property must be accommodated by the proposed stormwater management design.

Stormwater quality control is required for the site. The Rideau Valley Conservation Authority (RVCA) can be contacted to determine the level of stormwater quality control required for the site.

All stormwater management determinations shall have supporting rationale.

Stormwater management solutions should be in concurrence with the content of the Western Development Lands Master Drainage Plan (MDP) that shows stormwater management ponds on both areas of proposed development; it is not clear how some of the development will proceed as the MDP plan currently shows the Laffin Lands to be entirely a SWM pond and SWM pond 1 was not designed to take more flow nor is there space for it to be expanded.

Please note that the SWM pond and upstream pipe/s and connected manholes shall be held in securities until the pond unit accepts the pond (at a date anticipated to be later than the rest of the subdivision)

A hydrogeoloogical report will be required for each, and all, stormwater management ponds

Please note that LID will be required and that the forthcoming LID policy may impact the design.

Roads:

Please refer to the City of Ottawa Private Approach By-Law 2003-447 for the entrance design.

Please note that Council has adopted a safer roads initiative called the Road Safety Action Plan that requires local residential roads be both, signed and designed to a 30 km/h limit. This means that curvilinear design is required to deny vehicles from achieving speeds accessible on long straight roads.

Please note that 16.5 m ROW will not be permitted for the development.

Please note that 18 m ROW will not be permitted where either sensitive marine clay is found (whether named or not) or a sidewalk is proposed
Please note that a 25 m, or wider, ROW will be required for any road sections with two sidewalks.

Sensitive Marine Clay:

It is understood that sensitive marine clay (or by any other name) exists in the vicinity. Enhanced investigation will be required including, but not limited to: Atterberg limits testing, sensitivity analysis (if sensitivity analysis is not included an exhaustive discussion of why will be required), consolidation testing (cyclic and non-cyclic) and plasticity chart

Discussion of vibration induced loss of strength (by any name) is required

Discussion of retrogressive landslides is required.

Peer-reviewed and published papers may be necessary for the consultant's reviews; any papers/articles/journals/textbooks used shall be sufficiently provided to the City and the reference shall show unmistakable and undeniable concurrence with the consultant's usage.

Relatively impervious clay shall not be accepted as a reason for not applying LID.

High Performance design Standard:

In due time the City will have High Performance Design Standards in place that the proposal will need to adhere to that may include, but not be limited to; enhanced insulation, electrical generation, electrical grid security, reduced energy demand, reduced environmental "footprint".

Permits and Approvals:

Please note that approval through the Ministry of the Environment, Conservation and Parks (MECP), amongst other federal and provincial departments/agencies, including the Rideau Valley Conservation Authority (RVCA), will be 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 transfer-of-review type of Environmental Compliance

Approval (ECA) application with the MECP; please speak with your engineering consultant to understand the impact of time and cost this has on the application. An MECP ECA is not submitted until after planning approval. No construction shall commence until after a commence work notification is given from an engineering representative from Development Review.

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

Plan requirements;

Grading and Drainage Plans*

Erosion and Sediment Control Plan/s*

*All identified required plans are to be submitted on standard A1 size sheets as per City of Ottawa Servicing and Grading Plan Requirements and 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]:

-Site Servicing Report

A plan is required that clearly shows the proposed water service layout.

-Storm Water Management Report

-Erosion and Sediment Control Measures

-Geotechnical Investigation Study

Please note that the area may contain sensitive marine clays. Please note that Atterberg limits, consolidation testing, grade raise restriction, and chemical analysis and discussion will be required in the report if sensitive marine clay is found. 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.

-Slope Stability Study (if topography deems necessary)

-Phase 1 Environmental Site Assessment (ESA)

The Phase 1 Environmental Site Assessment (ESA) as per O.Reg. 153/04. Phase 1 ESA documents performed to CSA standards are not acceptable.

Please find relevant City of Ottawa Links to Preparing Studies and Plans below:

Guide to preparing drawings for City of Ottawa engineering submissions

https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#servicing-and-grading-plan-requirements

Guide to preparing City of Ottawa Studies and Plans:

http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans

Servicing Study Guidelines for Development Applications:

https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#servicing-and-grading-plan-requirements

To request City of Ottawa plan(s) or report information please contact the ISD Information Centre:

Information Centre

(613) 580-2424 ext. 44455

Please feel free to contact me if you have any questions.

Damien

Parks Planning

- Area Parks Plan (APP) is currently in place and was approved in 2019.
- The amenities and park sizes in the APP should be considered minimum requirements for any new proposals.
- If unit density is above that which is listed in the APP, park size requirements and/or Cash-in-Lieu will be larger than those required in the APP. These sizes would need to be determined once a more detailed proposal is put forward containing actual unit numbers.
- Parkland funding agreement required to be in place prior to registering any new phases of development in Western Lands.
- Parks recommends that the lotting pattern around the proposed northern parkette be adjusted to shift the park south so that it is adjacent to the hydro corridor that contains a proposed Multi-Use Pathway (MUP). The adjustment will improve connectivity from the MUP to the park, which was the intention behind the proposed location originally shown in the APP.

Reid Shepherd

Environmental Planning

- A Tree Conservation Report and an Environmental Impact Statement will be required
- A preliminary Integrated Environmental Impact Statement will be required at submission, and form part of the Planning Rationale.
- A 30 m setback is require for the watercourses to the north
- A minimum 6 m access will be needed to the watercourse buffer lands – likely best off the north end of the collector road.

Matthew Hayley

Transportation:

- Follow Traffic Impact Assessment Guidelines
    - Traffic Impact Assessment will be required. Proceed to scoping.
    - Start this process asap.
    - Applicant advised that their application will not be deemed complete until the submission of the draft step 1-4, including the functional draft RMA package (if applicable) and/or monitoring report (if applicable).
    - Request base mapping asap if RMA is required. Contact Engineering Services (https://ottawa.ca/en/city-hall/planning-and-development/engineering-services)
- ROW protection on Perth Street between Eagleson and Village Boundary is 30m even.
- Geometric Road Design (GRD) drawings will be required with the first submission of underground infrastructure and grading drawings. These drawings should include such items as, but is not limited to:
    - Road Signage and Pavement Marking for the subdivision;
    - Intersection control measure at new internal intersections; and
    - Location of depressed curbs and TWSIs;
    - More details can be provided upon request
- Include traffic calming measures on roads within the limits of their subdivision to limit vehicular speed and improve pedestrian safety. Traffic calming measures shall reference best management practices from the Canadian Guide to Neighbourhood Traffic Calming, published by the Transportation Association of Canada, and/or Ontario Traffic Manual, and/or the City of Ottawa's Draft Traffic Calming Design Guidelines. These measures may include either vertical or horizontal features (such measures shall not interfere with stormwater management and overland flow routing), including but not limited to:
    - intersection or mid block narrowings, chicanes, medians;
    - speed humps, speed tables, raised intersections, raised pedestrian crossings;
    - road surface alterations (for example, use of pavers or other alternate materials, provided these are consistent with the City's Official Plan polices related to Design Priority Areas);
    - pavement markings/signage; and
    - temporary/seasonal installations such as flexi posts or removable bollards.
- Corner triangles as per OP Annex 1 - Road Classification and Rights-of-Way at the following locations on the final plan will be required:
    - Local Road to Local Road: 3 metre x 3 metres
    - Local Road to Collector Road: 5 metre x 5 metres

    - Collector Road to Collector Road: 5 metre x 5 metres
    - Collector Road to Arterial Road: 5 metre x 5 metres
- Noise Impact Studies required (Road):
    - Feasibility before draft approval
    - Detailed before registration

-Residential streets (local and collector) are to be designed for 30 kph speed limits (posted). (Direction from Councillors and Director of Traffic Services).

Neeti Paudel, P.Eng.

Rideau Valley Conservation Authority

- Some flood plain showing on the lands. Confirm that the realignment of the Van Gaal Drain resolves that
- Looking for 80% TSS removal for water quality
- Require a 30 metre setbacks from the drain to the north side of the Green lands.

Eric Lalande

Green Lands Urban Design Comments

- Ensure lot sizes, ROWs, and setbacks are sufficiently sized to achieve the design guidelines found in Section 7.4 of the Village of Richmond CDP. Currently, there may be enough space to achieve such guidelines as having enough space to plant a tree in the front yard, having a varied building setbacks, or parking a vehicle without it overhanging onto the sidewalk or street.
- Explore opportunities to integrate large-lot, village-style detached dwellings into the development along targeted and highly visible streets. See section 7.4.8 of the Village of Richmond CDP for additional details.
- Include a greater mix of the proposed building typologies. It appears the highest densities units have been clustered south of the hydro corridor.
- Open a vehicular connection to Perth Road as a gateway into the community, as shown in the Richmond CDP Demonstration Plan.
- If a window street is created adjacent to Perth Road, re-orient as many of the properties towards Perth as possible.
- Create pedestrian pathway connections in the north-most block to break up the long block and provide a link to a potential future pedestrian pathway north of the site. The pathways should be aligned with proposed north-south streets to create view corridors.
- It would be preferable to have the park open to the public realm on at least three sides, surrounded by single-loaded streets. Configure surrounding roads to have the park terminate views and offset the street grid.

Laffin Lands Urban Design Comments

- Relocate the proposed park to a more central location in the development that is well connected.
- Include mid-block pedestrian pathways to align with adjacent proposed pathways.

Matt Ippersiel

APPENDIX B

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

ENVIRONMENTAL COMPLIANCE APPROVAL
NUMBER 1528-BLFNVH
Issue Date: February 24, 2020

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Fox Run Subdivision - Phase 2 (North)
6335 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

the establishment of wastewater infrastructure Works located in the City of Ottawa, consisting of the following:

- **storm sewers** on proposed Trammel Road (from Station 0-14.006 to Station 0-0.25, and from Station 0-0.25 to Station 0+187.215), proposed Postilion Street (from Station 0+160 to Station 0+149.62, and from Station 0+149.62 to 0-1.995), proposed Latigo Ridge (from Station 0+1.952 to Station 0+151.572), proposed Chasing Grove (from Station 0+2.05 to Station 0+151.67), proposed Brush Lane (from Station 0+85.71 to Station 0+151.63), proposed Bascule Place (from Station 0+135.562 to Station 0+197.009, from Station 0+135.562 to Station 0+71.69, from Station 0+71.69 to 0+34.591, and from Station 0+34.591 to 0+2.202), proposed Vaulting Crescent (from Station 0+7.492 to Station 0+53.326), proposed Oldenburg Avenue (from Station 0+238.745 to Station 0+223.481, and from Station 223.481 to Station 0+0.813), Perth Street (from adjacent Block 221 to Station 0+241.788, from Station 0+36.821 to 0+476.497, from Station 0+476.497 to Station 0+37.095, from southwest of Block 282 to 0+242.061, from Station 240.762 to Station 0+285.925, and from Station 285.925 to 0+335.294), proposed Griseo Way (from Station 0+36.761 to Station 0+2.021), and servicing Block 280, discharging to the existing stormwater management facility, located southeast of the intersection of Perth Street and Meynell Road; and

- **sanitary sewers** on proposed Trammel Road (from Station 0+72.432 to Station 0+133.61, from Station 0+180.711 to Station 0+133.61, from Station 0+72.432 to Station 0-0.25, and from Station -0+14.006 to Station 0+0.25), proposed Postilion Street (from Station 0+160.000 to Station 0+0.000), proposed Latigo Ridge (from Station 0+0.000 to Station 149.620), proposed Chasing Grove (from Station 0+0.000 to Station 0+149.620), proposed Bascule Place (from Station 0+194.808 to Station 0+72.432, and from Station 0+72.432 to 0-0.25), and proposed Oldenburg Avenue (from Station 0+238.745 to Station 0+75.807, and from Station 0+75.807 to Station 0-14.971), discharging to existing sanitary sewers, located

on Meynell Road (southeast of Perth Street);

including erosion/sedimentation control measures during construction and all other controls and appurtenances essential for the proper operation of the aforementioned Works;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this approval.

For the purpose of this environmental compliance approval, the following definitions apply:

DEFINITIONS

1. "Approval" means this entire document and any schedules attached to it, and the application;

2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;

4. "EPA" means the *Environmental Protection Act,* R.S.O. 1990, c.E.19, as amended;

5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

6. "Owner" means Richmond Village Development Corporation, and includes its successors and assignees;

7. "OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O.40, as amended;

8. "Works" means the sewage Works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

    a. change of Owner;

    b. change of address of the Owner;

    c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act,* R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

    d. change of name of the corporation where the Owner is or at any time becomes a

corporation, and a copy of the most current information filed under the Corporations Information Act, R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

Schedule "A"

1. Application for Environmental Compliance Approval, dated December 12, 2019, received on January 20, 2020, submitted by Richmond Village Development Corporation;

2. Transfer of Review Letter of Recommendation, dated January 14, 2020, revised on January 31, 2020, and signed by Damien Whittaker, P. Eng., Senior Engineer - Infrastructure Applications, Planning, Infrastructure and Economic Development Department, City of Ottawa;

    a. Final Plans and Specifications prepared by David Schaeffer Engineering Ltd.

    b. Pipe Data Form - Watermain, Storm Sewer, Sanitary Sewer, and Forcemain Design Supplement to Application for Approval for Water and Sewage Works.

    c. Hydraulic Design Sheets prepared by David Schaeffer Engineering Ltd.

3. Emails dated January 30, 2020, January 31, 2020, and February 7, 2020, from Damien Whittaker, P. Eng., City of Ottawa.

4. Emails dated February 3, 2020 and February 7, 2020, from Kevin Murphy, David Schaeffer Engineering Ltd.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to prevent the operation of stormwater pipes and other conveyance until such time that their required associated stormwater management Works are also constructed.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of
Part II.1 of the Environmental Protection Act
Ministry of the Environment,
Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 24th day of February, 2020

Aziz Ahmed, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

CA/

c: District Manager, MECP Ottawa
Clerk, City of Ottawa (File No. D07-16-19-0009)
Damien Whittaker, City of Ottawa
Kevin Murphy, David Schaeffer Engineering Ltd.

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

AMENDED ENVIRONMENTAL COMPLIANCE APPROVAL

NUMBER 1608-BPHMBF
Issue Date: May 19, 2020

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Fox Run Subdivision
6350 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

modifications to existing stormwater management Works to serve the Western Development Lands and related to the Fox Run subdivision Phase II (North), located in the City of Ottawa, for the collection, transmission, treatment and disposal of stormwater runoff from a total catchment area of 185.19 hectares, to provide Enhanced Level water quality protection and erosion control, baseflow augmentation, and to attenuate post-development peak flows to pre-development peak flows for all storm events up to and including the 100-year storm event, discharging to the Van Gaal/Arbuckle Drain, consisting of the following:

- **stormwater management facility (catchment area 185.19 hectares):** one (1) wet pond with two existing sediment forebays and the inclusion of an additional sediment forebay, located southeast of Perth Street, southwest of Queen Charlotte Street North and northeast of Meynell Road, having a permanent storage volume of 45,330 cubic metres, an extended detention volume of 43,875 cubic metres, and a total storage volume of 66,394 cubic metres including the permanent pool, at a total depth of 1.85 metres, and a new additional inlet structure consisting of a 2100 millimetre and a 975 millimetre diameter series of storm inlet pipes and a concrete headwall, an existing middle inlet of a 1200 millimetre diameter pipe and a concrete headwall, and 'south' inlet consisting of a 1350 millimetre and a 1650 millimetre diameter series of pipes; an outlet structure comprised of a 900 millimetre diameter storm outlet pipe equipped with a 300 millimetre diameter orifice, allowing a maximum extended detention discharge of 440 litres per second under the 100-year storm event to the Van Gaal/Arbuckle Drain, located to east of the pond, cool drain baseflow augmentation via a 100 millimetre diameter orifice and a 300 millimetre diameter pipe providing 28 litres per second and, for emergency events, a 45 metre wide spillway is also provided in

collaboration with an 88.5 metre long quantity control weir;

including erosion/sedimentation control measures during construction and all other controls and appurtenances essential for the proper operation of the aforementioned Works;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this Approval.

For the purpose of this environmental compliance approval, the following definitions apply:

1. "Approval" means this entire document and any schedules attached to it, and the application;

2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;

4. "EPA" means the *Environmental Protection Act,* R.S.O. 1990, c.E.19, as amended;

5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

6. "Owner" means Richmond Village Development Corporation, and includes its successors and assignees;

7. "OWRA" means the *Ontario Water Resources Act, R.S.O. 1990, c. O.40* , as amended;

8. "Works" means the sewage Works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the

application for approval of the Works.

3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

    a. change of Owner;

    b. change of address of the Owner;

    c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act,* R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

d. change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the *Corporations Information Act,* R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

2. The Owner shall make all necessary investigations, take all necessary steps and obtain all necessary approvals so as to ensure that the physical structure, siting and operations of the Works do not constitute a safety or health hazard to the general public.

3. The Owner shall inspect and ensure that the design minimum liquid retention volume is maintained in the Works at all times, except when maintenance is required.

4. The Owner shall undertake an inspection of the condition of the Works, at least once a year, and undertake any necessary cleaning and maintenance to ensure that sediment, debris and excessive decaying vegetation are removed from the Works to prevent the excessive build-up of sediment, oil/grit, debris and/or decaying vegetation, to avoid reduction of the capacity and/or permeability of the Works, as applicable. The Owner shall also regularly inspect and clean out the inlet to and outlet from the Works to ensure that these are not obstructed.

5. The Owner shall construct, operate and maintain the Works with the objective that the effluent from the Works is essentially free of floating and settleable solids and does not contain oil or any other substance in amounts sufficient to create a visible film, sheen, foam or discoloration on the receiving waters.

6. The Owner shall maintain a logbook to record the results of these inspections and any cleaning and maintenance operations undertaken, and shall keep the logbook at the Owner's administrative office for inspection by the Ministry. The logbook shall include the following:

   a. the name of the Works; and

b. the date and results of each inspection, maintenance and cleaning, including an estimate of the quantity of any materials removed and method of clean-out of the Works.

7. The Owner shall prepare an operations manual prior to the commencement of operation of the Works that includes, but is not necessarily limited to, the following information:

   a. operating and maintenance procedures for routine operation of the Works;

   b. inspection programs, including frequency of inspection, for the Works and the methods or tests employed to detect when maintenance is necessary;

   c. repair and maintenance programs, including the frequency of repair and maintenance for the Works;

   d. contingency plans and procedures for dealing with potential spills and any other abnormal situations and for notifying the District Manager; and

   e. procedures for receiving, responding and recording public complaints, including recording any follow-up actions taken.

8. The Owner shall maintain the operations manual current and retain a copy at the Owner's administrative office for the operational life of the Works. Upon request, the Owner shall make the manual available to Ministry staff.

5. TEMPORARY EROSION AND SEDIMENT CONTROL

1. The Owner shall install and maintain temporary sediment and erosion control measures during construction and conduct inspections once every two (2) weeks and after each significant storm event (a significant storm event is defined as a minimum of 25 mm of rain in any 24 hours period). The inspections and maintenance of the temporary sediment and erosion control measures shall continue until they are no longer required and at which time they shall be removed and all disturbed areas reinstated properly.

2. The Owner shall maintain records of inspections and maintenance which shall be made available for inspection by the Ministry, upon request. The record shall include the name of the inspector, date of inspection, and the remedial measures, if any, undertaken to maintain the temporary sediment and erosion control measures.

6. REPORTING

1. One (1) week prior to the start-up of the operation of the Works, the Owner shall notify the District Manager (in writing) of the pending start-up date.

2. The Owner shall, upon request, make all reports, manuals, plans, records, data, procedures and supporting documentation available to Ministry staff.

3. The Owner shall prepare a performance report within ninety (90) days following the end of the period being reported upon, and submit the report(s) to the District Manager when requested. The first such report shall cover the first annual period following the commencement of operation of the Works and subsequent reports shall be prepared to cover successive annual periods following thereafter. The reports shall contain, but shall not be limited to, the following information:

    a. a description of any operating problems encountered and corrective actions taken;

    b. a summary of all maintenance carried out on any major structure, equipment, apparatus, mechanism or thing forming part of the Works, including an estimate of the quantity of any materials removed from the Works;

    c. a summary of any complaints received during the reporting period and any steps taken to address the complaints;

    d. a summary of all spill or abnormal discharge events; and

    e. any other information the District Manager requires from time to time.

7. RECORD KEEPING

1. The Owner shall retain for a minimum of five (5) years from the date of their creation, all records and information related to or resulting from the operation, maintenance and monitoring activities required by this Approval.

Schedule "A"

1. Application for Environmental Compliance Approval, dated March 27, 2020, received on April 30, 2020, submitted by Richmond Village Development Corporation;

2. Transfer of Review Letter of Recommendation, dated April 30, 2020 and signed by Damien Whittaker, P.Eng., Infrastructure Applications, Development Review, City of Ottawa, including the following supporting documents:

   a. Final Plans and Specifications prepared by David Schaeffer Engineering Ltd.

   b. Stormwater Management Report prepared by David Schaeffer Engineering Ltd.

   c. Design Brief for Stormwater Management Pond 1, Western Development Lands - Richmond, Revised March 2020, prepared by J.F. Sabourin and Associates & David Schaeffer Engineering Ltd.

3. Emails received on May 7, 2020, May 8, 2020, May 12, 2020, and May 13, 2020 from Damien Whittaker, P. Eng., City of Ottawa.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included as regular inspection and necessary removal of sediment and excessive decaying vegetation from the Works are required to mitigate the impact of sediment, debris and/or decaying vegetation on the treatment capacity of the Works. The Condition also ensures that adequate storage is maintained in the Works at all times as required by the design. Furthermore, this Condition is included to ensure that the Works are operated and maintained to function as designed.

5. Condition 5 is included as installation, regular inspection and maintenance of the temporary sediment and erosion control measures is required to mitigate the impact on the downstream receiving watercourse during construction until they are no longer required.

6. Condition 6 is included to provide a performance record for future references, to ensure that the Ministry is made aware of problems as they arise, and to provide a compliance record for all the terms and conditions outlined in this Approval, so that the Ministry can work with the Owner in resolving any problems in a timely manner.

7. Condition 7 is included to require that all records are retained for a sufficient time period to adequately evaluate the long-term operation and maintenance of the Works.

Upon issuance of the environmental compliance approval, I hereby revoke Approval No(s). 1060-AY8JK4 issued on May 30, 2018.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

Pursuant to subsection 139(3) of the Environmental Protection Act, a hearing may not be required with respect to any terms and conditions in this environmental compliance approval, if the terms and conditions are substantially the same as those contained in an approval that is amended or revoked by this environmental compliance approval.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of Part II.1 of the Environmental Protection Act
Ministry of the Environment, Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 19th day of May, 2020

Aziz Ahmed, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

SW/

c: District Manager, MECP Ottawa District Office
City Clerk, City of Ottawa
Damien Whittaker, P. Eng., Senior Engineer, Infrastructure Applications, City of Ottawa
Kevin Murphy, David Schaeffer Engineering Ltd.

Ontario

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

ENVIRONMENTAL COMPLIANCE APPROVAL

NUMBER 9297-AV9KAL
Issue Date: January 25, 2018

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Caivan Communities - Richmond Phase 1
6350 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

sanitary and storm sewers to be constructed in the City of Ottawa, as follows:

- sanitary sewers on Meynell Road (from Station 0+671.0 to Station 1+225.3), Cantle Crescent (from Station 0+000.0 to Station 0+267.9), Pelham Crescent (from Station 0-013.0 to Station 0+377.6), Reynard Crescent (from Station 0+000.0 to Station 0+308.6), Noriker Court (from Station 0-014.0 to Station 0+228.3), Hackamore Crescent (from Station 0+000.0 to Station 0+084.3), Equitation Circle (from Station 0+000.0 to Station 0+503.4), and Pond Inlet 3 - Storm Trunk 2 (from Station 0+080.0 to Station 0+172.6), discharging to Richmond Stormwater Management Pond 1, located in the City of Ottawa; and

- storm sewers on Meynell Road (from Station 0+687.1 to Station 1+225.7), Cantle Crescent (from Station 0+002.5 to Station 0+267.9), Pelham Crescent (from Station 0-013.5 to Station 0+380.0), Reynard Crescent (from Station 0-002.0 to Station 0+310.6), Noriker Court (from Station 0-016.0 to Station 0+238.0), Hackamore Crescent (from Station 0-002.5 to Station 0+084.3), Equitation Circle (from Station 0+002.5 to Station 0+505.8), Block 235 (from Station 0+002.5 to Station 0+070.8), Pond Inlet 2 (from Station 0+006.9 to Station 0+076.8, Pond Inlet 3 - Storm Trunk 1 (from Station 0+003.9 to Station 0+162.3), and Pond Inlet 3 - Storm Trunk 2 (from Station 0+077.7 to Station 0+206.7), discharging to Richmond Stormwater Management Pond 1, located in the City of Ottawa;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this approval.

For the purpose of this environmental compliance approval, the following definitions apply:

1. "Approval" means this entire document and any schedules attached to it, and the application;

2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;

4. "EPA" means the Environmental Protection Act, R.S.O. 1990, c.E.19, as amended;

5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

6. "Owner" means Richmond Village Development Corporation, and includes their successors and assignees;

7. "OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O.40, as amended;

8. "Significant Threat Policy(ies)" has the same meaning as in the Clean Water Act, 2006;

9. "Source Protection Plan" means a drinking water source protection plan prepared under the Clean Water Act, 2006;

10. "Works" means the sewage works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Work which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

   a. change of Owner;

   b. change of address of the Owner;

   c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the Business Names Act, R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

   d. change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the Corporations Information Act, R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. Notwithstanding any other requirements in this Approval, upon transfer of the ownership or assumption of the Works to a municipality if applicable, any reference to the District Manager shall be replaced with the Water Supervisor.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

5. SOURCE WATER PROTECTION

1. The Owner shall ensure, if applicable, that the design, construction and operation of the Works conforms to any Significant Threat Policies in any Source Protection Plan that applies to the location of the Works.

SCHEDULE "A"

1. Application for Environmental Compliance Approval for Municipal and Private Sewage Works, dated December 19, 2017 and received on December 28, 2017, submitted by Richmond Village Development Corporation.

2. Transfer of Review Letter of Recommendation, dated December 28, 2017 and signed by Damien Whittaker, Senior Engineer, City of Ottawa.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to prevent the operation of stormwater pipes and other conveyance until such time that their required associated stormwater management Works are also constructed.

5. Condition 5 is included to ensure that the Works conform to the policies of the local Source Water Protection Plan.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of
Part II.1 of the Environmental Protection Act
Ministry of the Environment and
Climate Change
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 25th day of January, 2018

C. Labarge

Christina Labarge, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

RS/

c: District Manager, MOECC Ottawa
City Clerk, City of Ottawa (File No. D07-16-11-0014)
Linda Carkner, Program Mananger, Right of Way Unit (MC 26-61)
Harry R. Alvey, P.E., P.Eng., Project Manager, Rural Branch
Kevin Murphy, David Schaeffer Engineering Ltd.

APPENDIX C

Stantec

Memo

To:	Kevin Murphy David Schaeffer Engineering Ltd.	From:	Jasmin Sidhu / Kevin Alemany Stantec Consulting Ltd.
File:	163401550	Date:	February 26, 2021

Reference: Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis

OVERVIEW

To support David Schaeffer Engineering Ltd. (DSEL) with their Functional Servicing Report, Stantec Consulting Ltd. (Stantec) was retained by Richmond Village Development Corporation (RVDC) to complete a potable water hydraulic analysis for Caivan's recently acquired properties within the Richmond Western Development Lands.

To date, Stantec has completed hydraulic analyses for the water distribution system internal to the Western Development Lands, including that within Caivan's Richmond Fox Run development lands (Phases 1 and 2) and under buildout conditions.

Caivan has recently acquired additional property in the Western Development Lands, including:

(1) The lands adjacent to their Fox Run Phase 2 subdivision lands on the north side of Perth Street, including Green Lands West and Fox Run Phase 3 (formerly identified as 'Other' as part of previous potable water analyses complete for the Western Development Lands), and Green Lands East (formerly not part of the Western Development Lands); and,

(2) The Laffin Lands which is within the land area owned by Mattamy.

This technical memorandum quantifies the updated unit density (and population) and documents the associated supply and distribution system capacity analyses to identify if the Green Lands West, Green Lands East and Laffin development lands can still be serviced by the communal well. This memo also identifies if the existing watermain distribution network is capable of servicing the areas in question and if required, what watermain upgrades might be required.

HYDRAULIC ASSESSMENT

PHASING

For the purpose this assessment, development within the Western Development Lands, as shown in **Figure 1**, was assumed to occur (or have occurred) in the following phasing order:

(1) Caivan Fox Run Phase 1 (servicing construction completed and home building/occupancies ongoing);

(2) Caivan Fox Run Phase 2 North and South (draft approved with Phase 2 North and South servicing construction ongoing);

(3) Caivan Fox Run Phase 3 (future; draft approved);

(4) Mattamy Phase 1 (future; not yet draft approved);

(5) Caivan Green Lands West, Green Lands East and Laffin Lands; and,

(6) Buildout of the remaining Western Development Lands, including other developments from Mattamy (draft approved landholdings with design pending).

Herein, “interim conditions” was considered to include constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands (i.e., development phases 1 to 5).

GROWTH & DEMAND PROJECTIONS

Growth Projections

The estimated residential population for the Green Lands West, Green Lands East and Laffin Lands is estimated based on projected household sizes as per the Ottawa Water Design Guidelines. **Table 1** attached shows the estimated number of units for these two development lands and their respective projected populations based on the distribution of residential unit types. In summary:

- Green Lands West is estimated to have a total of 375 residential units with a population of 1,093 persons;
- Green Lands East is estimated to have a total of 37 residential units with a population of 126 persons; and,
- Laffin Lands is estimated to have a total of 174 residential units with a population of 545 persons.

Upon buildout of the Western Development Lands, the majority of the land is proposed to be residential, with 2.63 ha proposed to be institutional (i.e., school) as a future phase of the Mattamy buildout development area. **Table 2** attached provides a breakdown of the estimated units and populations for each development phase/area within the Western Development Lands. The total number of units upon buildout is estimated to be 2,475, with a total projected population of 7,875 persons.

Demand Projections

The criteria outlined in the City of Ottawa 2013 Water Master Plan (WMP) were followed to establish water demands for the Green Lands West, Green Lands East and Laffin Lands, as well as the rest of the Western Development Lands. As per **Table 2** attached, the estimated buildout population for the Western Development Lands is 7,875 persons, therefore Zone Level demands for populations greater than 3,000 persons were used. The demand rates from the Table 3-1 of the 2013 WMP were applied to the population projections presented in **Table 2** attached based on land-use and location with respect to the Greenbelt (i.e., outside, denoted as “outside Greenbelt” or OGB). Zone level demands are generally used to assess larger service areas and are not generally used to size smaller internal watermains; however, fire flows generally govern the minimum sizing for smaller internal watermain infrastructure and therefore the use of Zone Level demands for this analysis was considered appropriate.

For residential land use, single-family and semi-detached homes were considered to have similar demands, therefore both housing types were classified as “single-family houses” (SFH) that have a unit consumption rate of 180 L/cap/d. All townhouses were classified as “multi-level townhouses” (MLT) with a unit consumption rate of 198 L/cap/d. For the institutional (INS) lands, a unit demand rate of 28,000 L/ha/d was applied to establish basic day (BSDY) demands. BSDY demands for the Green Lands West, Green Lands East and Laffin Lands and the rest of the Western Development Lands are summarized in **Table 3** attached.

Reference: **Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis**

To establish maximum day (MXDY) demands, an outdoor water demand (OWD) of 1,049 L/SFH/d was taken, as per the 2013 WMP, and allocated to all SFH units. This outdoor water demand was added to BSDY demands to obtain the MXDY demand (see **Table 3** attached).

Peak hour (PKHR) demands were established by applying diurnal patterns developed by the City of Ottawa to the maximum day demands. The diurnal patterns are different for each unit type and vary with time of day. The overall maximum observed demand, with patterns applied, is the PKHR demand. For example, single-family houses will typically have peak demands during 7 to 8 a.m. in the morning and 5 to 8 p.m. in the evening, whereas a school will typically experience peak demands during lunch hours and during the evenings for custodial cleaning.

DISTRIBUTION SYSTEM CAPACITY ANALYSIS

Serviceability

System Pressures

As per the Ottawa Water Design Guidelines, the desired range of pressure under BSDY, MXDY and PKHR demands is 345 to 552 kPa (50 to 80 psi) and no less than 276 kPa (40 psi) at ground elevation (i.e., at street level). The maximum pressure at any point in the water distribution system should not exceed 552 kPa (80 psi); pressure reducing measures are required to service areas where pressures greater than 552 kPa (80 psi) are anticipated.

Under emergency fire conditions, the system must be able to supply appropriate fire flow while maintaining a residual pressure of 138 kPa (20 psi).

Fire Flows

The City requires a fire flow assessment to be completed to demonstrate that local watermains can provide the objective fire flows. For this analysis, an available fire flow of 167 L/s (10,000 L/min), as previously established for the Western Development Lands (Stantec, 2020), was applied. This flow rate was calculated based on the detailed Fire Underwriters Survey (FUS) Guidelines (long method) and capped as per the City of Ottawa Technical Bulletin ISDTB-2014-02 since a minimum separation of 10 m between backs of adjacent units will be provided. The local watermains must therefore be able to provide a minimum fire flow of 167 L/s at a residual pressure of 20 psi.

Proposed Watermain Sizing & Layout

Watermain sizing and layout proposed as part of the Fox Run Phase 2 development and buildout conditions water distribution system analysis (Stantec, 2020) were used for this analysis and updated to reflect the currently proposed site plans for the Green Lands West, Green Lands East and Laffin Lands. The updated watermain sizing and layout for the Green and Laffin development areas are shown in **Figure 2** and **Figure 3**, respectively.

Within Green Lands West, the network is proposed to consist of 152 to 305 mm diameter watermains as shown in **Figure 2**. Based on the current proposed site plan and assumed phasing, the 375 proposed units would be serviced by five feeds. These include one feed across Perth St from Fox Run Phase 1, and four feeds from the

305 mm and 203 mm proposed watermains sized to accommodate buildout demand conditions to fully service both the adjacent Fox Run Phase 3 lands and Green Lands West.

Within Green Lands East, the network is proposed to consist of a looped 203 mm diameter watermain. As shown in **Figure 2**, this loop is proposed to cross the Van Gaal Drain in two locations, connecting to the Fox Run Phase 3 lands to the north and the Fox Run Phase 2 North lands to the south.

Within the Laffin Lands, the network is proposed to consist of 152 to 305 mm diameter watermains. As previously stated, it is assumed that development of the Mattamy Phase 1 lands, which are located north of the Laffin Lands, will start prior to development of the Laffin Lands. Based on the current proposed site plan, the Laffin Lands will consist of 174 residential units. As such, this development will need to be serviced by more than one feed. Therefore, it is proposed to service the Laffin Lands via two 305 mm diameter feeds through the Mattamy buildout development lands, as shown in **Figure 3** attached. The current site plan also shows 5 properties located along Ottawa Street. To service these properties, the looped 305 mm diameter feed would need to be extended south to Ottawa Street and connected to a proposed 254 mm diameter watermain along Ottawa Street, as shown in **Figure 3** attached. Alternatively, sale of these 5 lots may be frozen until development of the adjacent Mattamy lands. The proposed 305 mm diameter feeds and 254 mm watermain extension along Ottawa Street were previously identified as required upon buildout of the surrounding Mattamy lands. As such, these proposed watermains have been sized to accommodate current buildout demand projections.

Model Results

Basic Day & Peak Hour Demands

Under interim and buildout BSDY conditions, model results show that the maximum HGL in the system is 149 m and 148 m respectively, which correspond to maximum pressures of 531 kPa (77 psi) 524 kPa (76 psi). Under PKHR demands, model results show that the minimum HGL in the system is 144 m for interim conditions and 132 m for buildout conditions, which corresponds to minimum pressures of 455 kPa (66 psi) and 324 kPa (47 psi), respectively. Therefore, modelled minimum and maximum pressures are within the City's objective of 345 to 552 kPa (50 to 80 psi). Detailed modelling results are provided in the **Hydraulic Modelling Results** attachment.

Maximum Day + Fire Flow

Under both interim and buildout maximum day + fire flow (MXDY+FF) conditions, model results show that fire flows greater than 10,000 L/min with a residual pressure of 138 kPa (20 psi) are available throughout the distribution system. Detailed modelling results are provided in the **Hydraulic Modelling Results** attachment.

SUPPLY CAPACITY ANALYSIS

Maximum Day Supply

With respect to well supply capacity, the 2008 Ministry of Environment of Ontario Design Guidelines for Drinking-Water Systems require that the total developed groundwater source capacity shall equal or exceed the design maximum day demand with the largest producing well out of service (i.e., firm capacity). The two existing groundwater supply wells servicing the Richmond West Pumping Station provide 28 L/s and 40 L/s, respectively. With the largest well out of service, the available supply is **28 L/s**. The cumulative maximum day

demand for interim conditions (i.e., constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands) is **23.8 L/s** (refer to **Table 4** attached). Therefore, the existing firm capacity of the well supply exceeds the supply required to service these developments.

The projected buildout maximum day demand from other developments to be serviced by the Richmond West Pumping Station is currently estimated to exceed 28 L/s. As such, as the maximum day demand of the area to be serviced approaches the firm capacity of 28 L/s, additional well supply will be required. It is recommended that the well supply be expanded prior to the system demand reaching 90% of the firm capacity, or 25 L/s.

Fire Flow Storage & Supply

With respect to storage capacity, the Richmond West Pump Station has an existing reservoir storage volume of 1,175 m^3. The reservoir is comprised of two reservoirs each capable of operating independently with a volume of 588 m^3.

The current fire flow demand of 10,000 L/min was determined following the latest City of Ottawa Water Design Guidelines recommendations for interpretation of the Fire Underwriters Survey (FUS). From an operational perspective, an analysis was carried out to assess the pumping station's ability to provide the maximum day plus fire flow demand over a design period of 2 hours. **Table 5** attached demonstrates the existing facility's ability to provide a 10,000 L/min fire flow using excess well capacity and with various levels of storage water available, ranging from 70% to 90% full. Based on this sensitivity analysis, a fire flow of 10,000 L/min for a duration of 2 hours is available for all anticipated development phases (this assumes additional well capacity is added upon Mattamy Buildout to address maximum day well supply needs).

It is noted that the overall system storage requirements will be assessed as part of a new Village of Richmond functional design report (FDR). The new FDR will be assessing system storage requirements based on the current projection of number of units in Richmond, the Ministry of Environment of Ontario Design Guidelines for new or expanded storage facilities, and the revised fire flow design requirements. This separate study will ultimately identify triggers for both well and storage expansions.

Redundant Storage Requirement

Section 3.29 (Reliability & Redundancy) of the 2008 Ministry of Environment of Ontario Design Guidelines for Drinking-Water Systems states:

> "*The design of water treatment plants should be based on the premise that failure of any single component must not prevent the drinking-water system from satisfying all applicable regulatory requirements and other site specific treated water quality and quantity criteria, while operating at design flows.*"

As such, with respect to treated storage, the failure of a single cell in the dual cell reservoir is considered a failure for reliability purposes. Furthermore, to supplement the MOE design guidelines, the City of Ottawa 2013 Water Master Plan Level of Service guidelines stated that for populations less than 10,000 persons, the minimum demands to be met by major infrastructure at all times is Basic Day demand only.

The Richmond West Pumping Station has a reservoir that is split into two independent cells. The storage capacity of each cell is 588 m^3. For operation and reliability, each cell can operate independently when the other cell is taken out of service. The cumulative basic day demand for interim conditions is 10.85 L/s.

Therefore, the well supply and remaining storage capacity meet the basic day demand with one cell out of service (refer to **Table 6** attached).

As the current Western Development Lands service area is not currently projected to exceed 10,000 persons, the current redundant storage and well supply would be capable of meeting the buildout basic day demand of 17.69 L/s for all known developments.

CONCLUSION

Supply and distribution system capacity analyses were completed for the Green Lands West, Green Lands East and Laffin Lands within Richmond's Western Development Lands. The purpose of these analyses was to identify if the additional associated properties can still be serviced by the Communal Well and if the existing watermain distribution network is capable of servicing the areas in question and if required, what watermain upgrades might be required. Based on the results of the analyses, the following conclusions were made:

- Within Green Lands West, the network is proposed to consist of 152 to 305 mm diameter watermains. Based on the current proposed site plan and assumed phasing, the 375 proposed units would be serviced by five feeds from other adjacent development lands sized to accommodate buildout demand conditions to fully service both the adjacent Fox Run Phase 3 lands and Green Lands West.
- Within Green Lands East, the network is proposed to consist of a looped 203 mm diameter watermain. This loop is proposed to cross the Van Gaal Drain in two locations, connecting to the Fox Run Phase 3 lands to the north and the Fox Run Phase 2 North lands to the south.
- Similarly, the network within the Laffin Lands is proposed to consist of 152 to 305 mm diameter watermains and also requires more than one service feed to meet City of Ottawa standards. Therefore, it is proposed to service the Laffin Lands via two 305 mm diameter feeds through the Mattamy buildout development lands. The current site plan also shows 5 properties located along Ottawa Street. To service these properties, the looped 305 mm diameter feed would need to be extended south to Ottawa Street and connected to a proposed 254 mm diameter watermain along Ottawa Street. Alternatively, sale of these 5 lots may be frozen until development of the adjacent Mattamy lands. The proposed 305 mm diameter feeds and 254 mm watermain extension along Ottawa Street were previously identified as required upon buildout of the surrounding Mattamy lands. As such, these proposed watermains have been sized to accommodate buildout demand conditions.
- With the proposed watermain sizing/configuration, system pressures and fire flow serviceability requirements are met under interim and buildout conditions for BSDY, PKHR and MXDY+FF demands.
- The current well supply capacity of the Richmond West Pumping Station meets maximum day demands for constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands (i.e., interim conditions).
- The current Richmond West Pumping Station has a total storage capacity of 1,175 m^3. An operational assessment demonstrated that with a range of existing reservoir volume, plus excess well capacity, a fire flow of 10,000 L/min for a duration of 2 hours can be provided for all anticipated development phases (this assumes additional well capacity is added upon Mattamy Buildout to address maximum day well supply needs).
- The current Richmond West Pumping Station has a storage volume of approximately 590 m^3 when one cell is taken out of service. Under the reliability scenario of one cell out of service, the supply wells and remaining storage are capable of meeting the required basic day demand.

Reference: **Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis**

REFERENCES

City of Ottawa. (2010). *Ottawa Design Guidelines - Water Distribution.* Ottawa.
City of Ottawa. (2014). *Technical Bulletin ISDTB-2014-02: Revisions to Ottawa Design Guidelines - Water.* Ottawa.
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Stantec Consulting Ltd.

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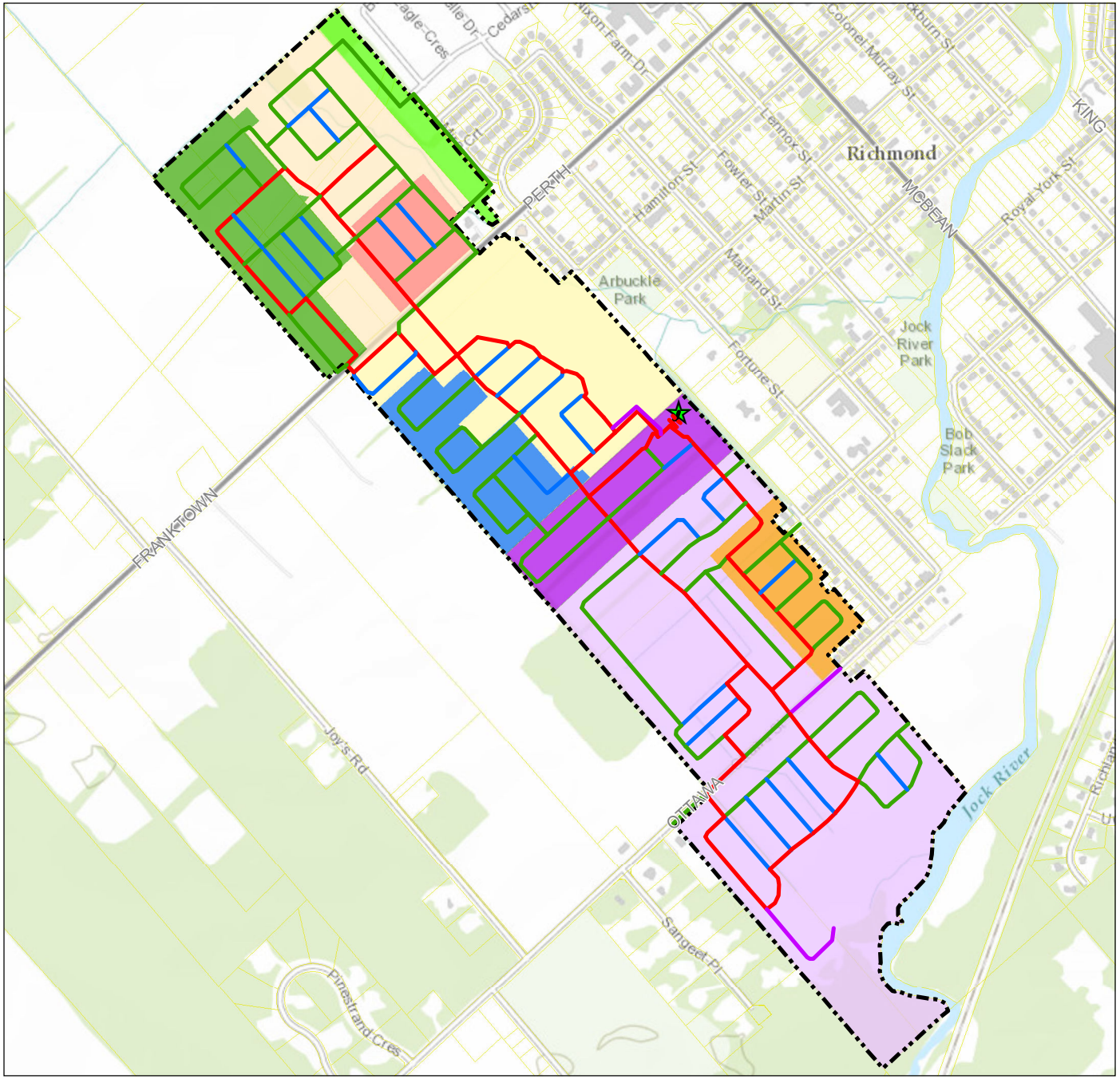
Attachments:

Figure 1: Western Development Lands
Figure 2: Proposed Watermain Sizing/Layout – Green Lands West & East
Figure 3: Proposed Watermain Sizing/Layout – Laffin Lands

Table 1: Estimated Unit Counts and Populations for Green & Laffin Lands
Table 2: Estimated Unit Counts and Populations for Buildout Conditions
Table 3: Estimated Water Demands
Table 4: Maximum Day Supply
Table 5: Sensitivity Analysis of Existing Available Storage
Table 6: Redundant Storage Requirement

Figure A1: Model System Map
Hydraulic Modelling Results



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Legend

- Caivan Fox Run Phase 1
- Caivan Fox Run Phase 2 North
- Caivan Fox Run Phase 2 South
- Caivan Fox Run Phase 3 (formerly RVDC)
- Caivan Green Lands West
- Caivan Green Lands East
- Caivan Laffin Lands
- Mattamy Phase 1
- Mattamy (Buildout)
- Western Development Lands
- Property Parcel
- Richmond West Pumping Station

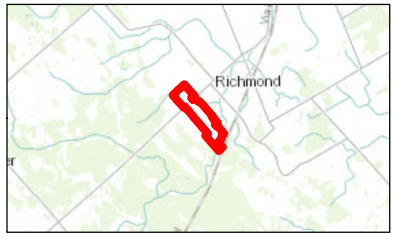
N

0 190 380 metres

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

Notes

1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
1

Title
Western Development Lands

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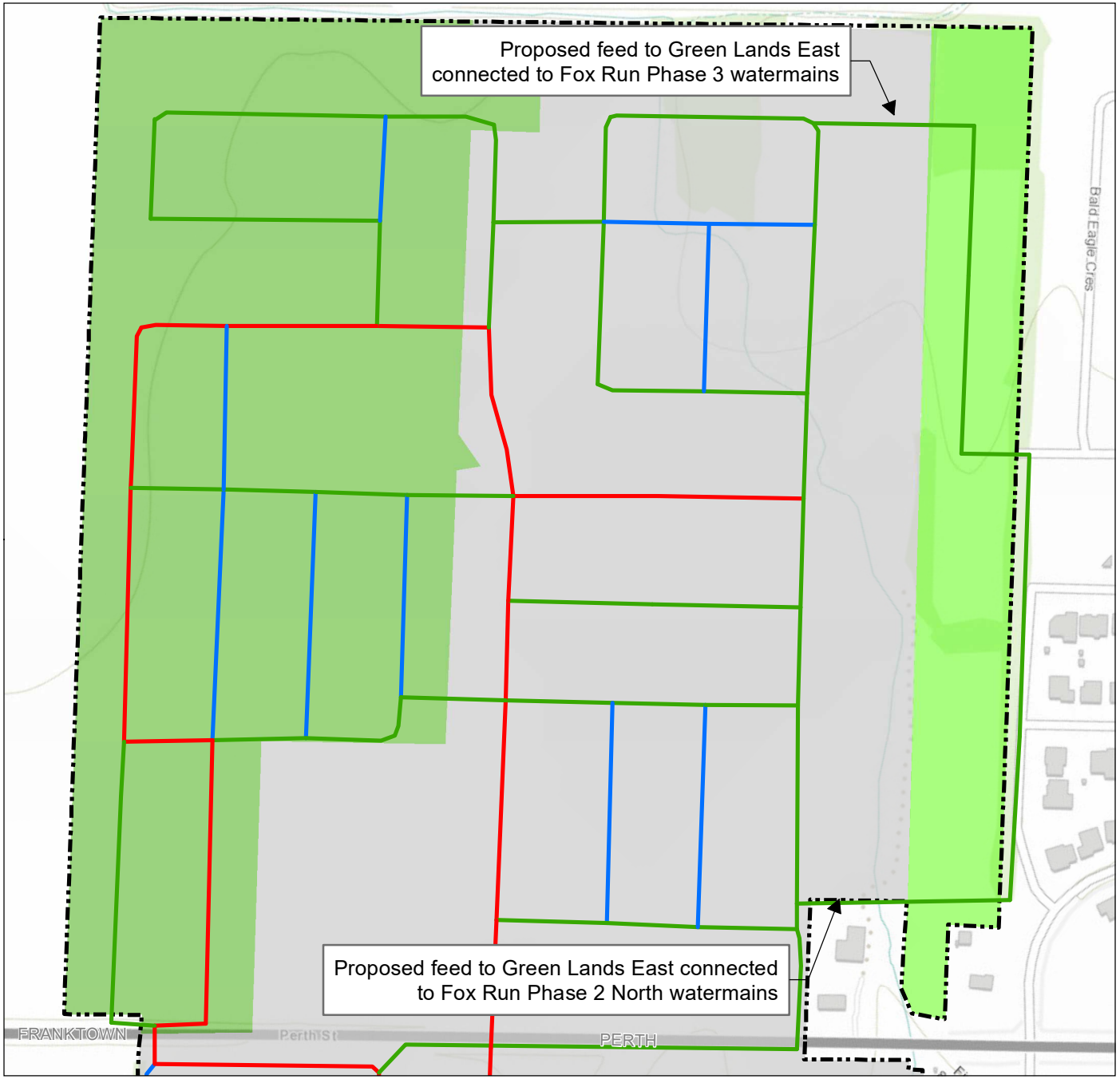


Stantec

Legend

- Caivan Green Lands West
- Caivan Green Lands East
- Other Development
- Western Development Lands

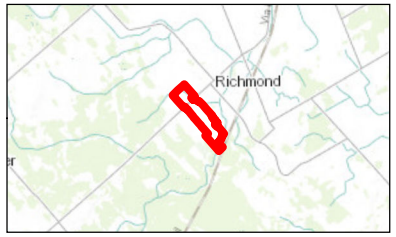
Watermain Diameter (mm)

- 305
- 203
- 152

0 50 100 metres
(At original document size of 8.5x11)
1:4,000

Notes

1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
2

Title
Proposed Watermain Sizing/Layout - Green Lands West & East

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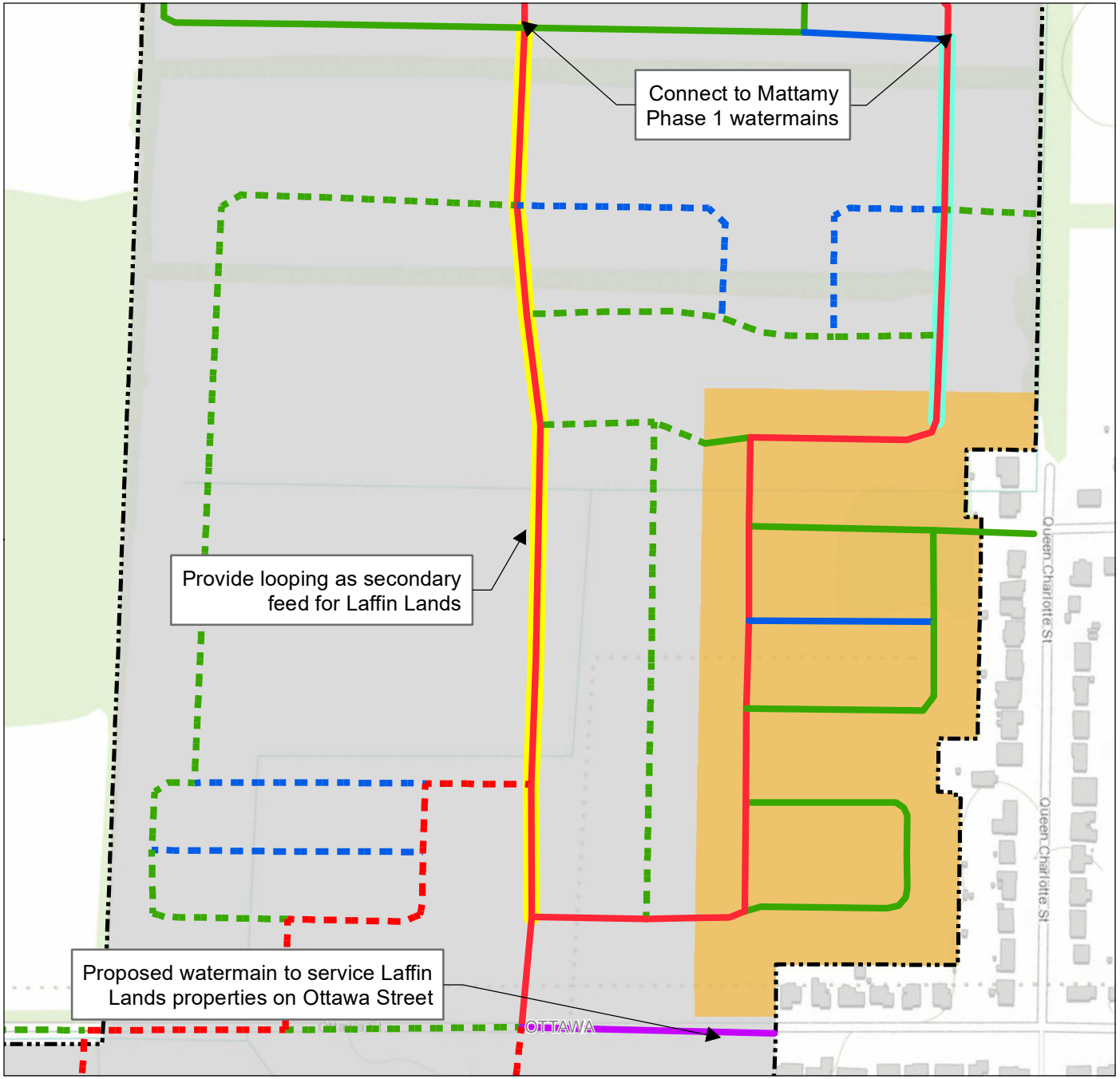


Stantec

Legend

Existing/Proposed (Interim) Watermain (mm)

- 305
- 254
- 203
- 152

Future (Buildout) Watermain (mm)

- 305
- 203
- 152

- Proposed Primary Feed
- Proposed Secondary Feed
- Caivan Laffin Lands
- Other Development
- Western Development Lands

N

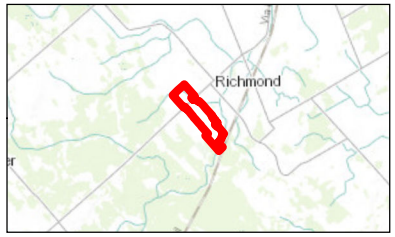
0 50 100 metres

(At original document size of 8.5x11)

1:4,000

Notes

1. Coordinate System: NAD 1983 MTM 9



Project Location

Richmond, ON

Client/Project

Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.

3

Title

Proposed Watermain Sizing/Layout - Laffin Lands

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Table 1: Estimated Unit Counts and Populations for Green & Laffin Lands

Development Area	Unit Type	Unit Count	PPU	Population
Caivan Green Lands West	SFH	115	3.4	391
	MLT	260	2.7	702
Caivan Green Lands East	SFH	37	3.4	126
Caivan Laffin Lands	SFH	108	3.4	367
	MLT	66	2.7	178
Total		***586***		***1,764***

Table 2: Estimated Unit Counts and Populations for Buildout Conditions

Development Area	Unit Type	Unit Count	Area (ha)	PPU	Population
Caivan Fox Run Phase 1	SFH	220	-	3.4	748
Caivan Fox Run Phase 2 North	SFH	31	-	3.4	105
	MLT	163	-	2.7	440
Caivan Fox Run Phase 2 South	SFH	200	-	3.4	680
Caivan Fox Run Phase 3	SFH	221	-	3.4	751
Mattamy Phase 1	SFH	132	-	3.4	449
	MLT	47	-	2.7	127
Caivan Green Lands West	SFH	115	-	3.4	391
	MLT	260	-	2.7	702
Caivan Green Lands East	SFH	37	-	3.4	126
Caivan Laffin Lands	SFH	108	-	3.4	367
	MLT	66	-	2.7	178
Interim Conditions (Sub-total)		***1,600***	***0***	***-***	***5,064***
Mattamy (Buildout)	SFH	640	-	3.4	2,176
	MLT	235	-	2.7	635
	INS	-	2.63	-	-
Buildout Conditions (Total)		***2,475***	***2.63***	***-***	***7,875***

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Table 3: Estimated Water Demands

Development Area	Unit Type	Population	Area (ha)	Water Demands		
				BSDY (L/s)	OWD (L/s)	MXDY (L/s)
Caivan Fox Run Phase 1	SFH	748	-	1.56	2.67	4.23
Caivan Fox Run Phase 2 North	SFH	105	-	0.22	0.38	0.60
	MLT	440	-	1.01	-	1.01
Caivan Fox Run Phase 2 South	SFH	680	-	1.42	2.43	3.85
Caivan Fox Run Phase 3	SFH	751	-	1.57	2.68	4.25
Mattamy Phase 1	SFH	449	-	0.94	1.60	2.54
	MLT	127	-	0.29	-	0.29
Caivan Green Lands West	SFH	391	-	0.81	1.40	2.21
	MLT	702	-	1.61	-	1.61
Caivan Green Lands East	SFH	126	-	0.26	0.45	0.71
Caivan Laffin Lands	SFH	367	-	0.76	1.31	2.08
	MLT	178	-	0.41	-	0.41
Interim Conditions (Sub-total)		***5,064***	***0***	***10.85***	***12.92***	***23.78***
Mattamy (Buildout)	SFH	2,176	-	4.53	7.77	12.30
	MLT	635	-	1.45	-	1.45
	INS	-	2.63	0.85	-	0.85
Buildout Conditions (Total)		***7,875***	***2.63***	***17.69***	***20.69***	***38.39***

Table 4: Maximum Day Well Supply

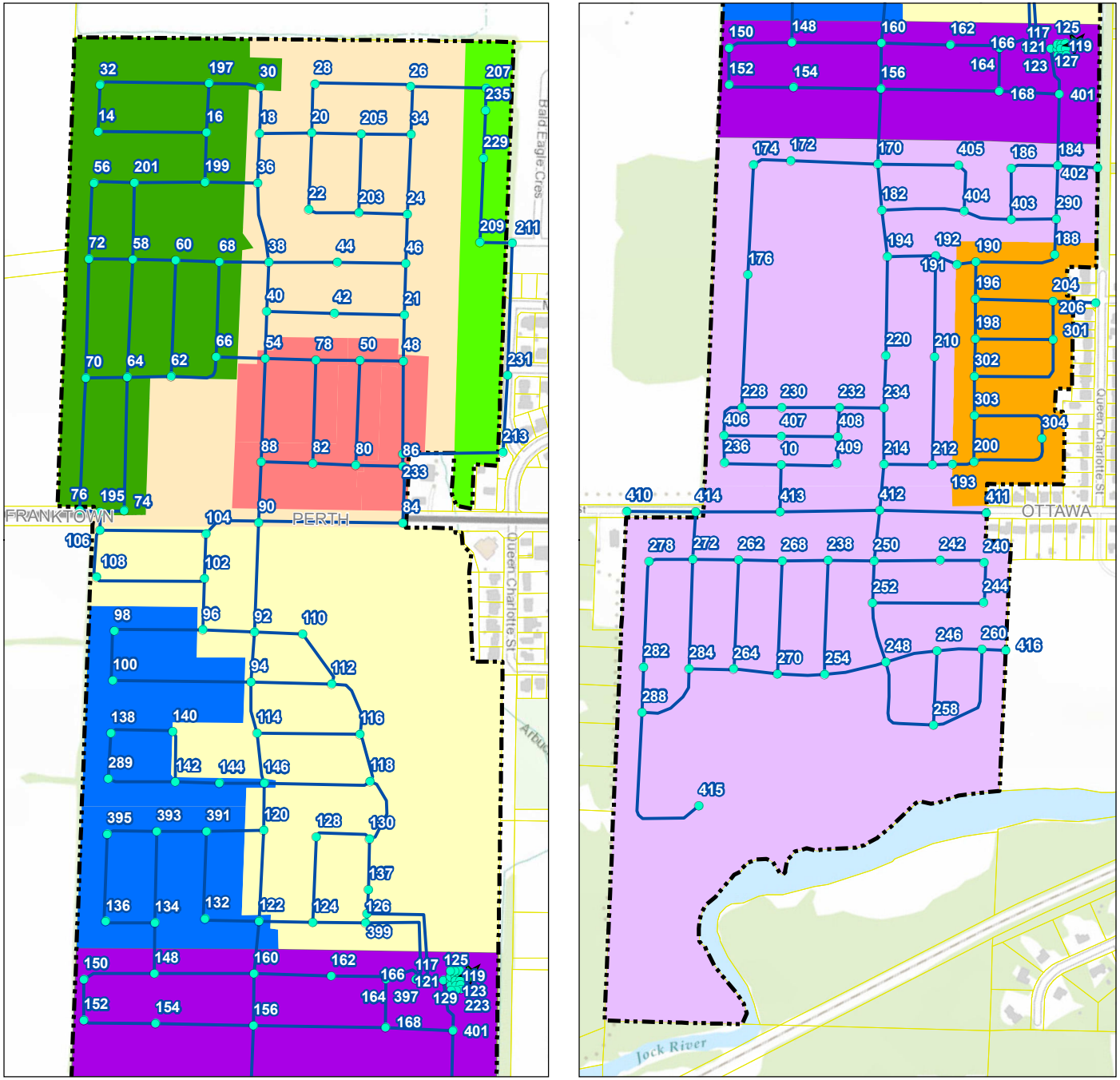
	(A)	(B)	(C)	(D)	(E)	(F) = *[Sum of (C) to (E)] - [Max of (C) to (E)]*	(G) = *(F) - (B)*
Development Area	MXDY	Cumulative MXDY	Well Capacity				Additional Firm Well Capacity Available for MXDY
			Well #1 (Existing)	Well #2 (Existing)	Well #3 (Future)	Firm Well Capacity (Largest Well Out of Service)	
	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)
Caivan Fox Run Phase 1	4.23	4.23	28.0	40.0		28.0	23.77
Caivan Fox Run Phase 2 (South)	3.85	8.08	28.0	40.0		28.0	19.92
Caivan Fox Run Phase 2 (North)	1.61	9.69	28.0	40.0		28.0	18.31
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	4.25	13.94	28.0	40.0		28.0	14.06
Mattamy Phase 1	2.83	16.77	28.0	40.0		28.0	11.23
Caivan Green Lands West (incl. Flowing Creek Farms)	3.82	20.59	28.0	40.0		28.0	7.41
Caivan Green Lands East	0.71	21.30	28.0	40.0		28.0	6.70
Caivan Laffin Lands	2.48	23.78	28.0	40.0		28.0	4.22
Mattamy (Buildout)	14.61	38.39	28.0	40.0	40.0	68.0	29.61
Tamarack[1]	21.42	59.81	28.0	40.0	40.0	68.0	8.19
Trigger (90% of Existing Firm Capacity)[2]	-	*25.20*	*28.0*	*40.0*		*28.0*	*2.80*
Trigger (Existing Firm Capacity)[2]	-	*28.00*	*28.0*	*40.0*		*28.0*	*0*

Table 5: Sensitivity Analysis of Existing Available Storage

	(A)	(B)	(C)	(D)	(E) = *(D)*0.9*1000/60/2.0*	(F) = *(E) + (C)*	(G) = *(F)*60 (rounded to nearest 1,000)*	(H) = **0.8*1000/60/60/2.0*	(I) = *(H) + (C)*	(J) = *(I)*60 (rounded to nearest 1,000)*	(K) = *(D)*0.7*1000/60/60/2.0*	(L) = *(K) + (C)*	(M) = *(L)*60 (rounded to nearest 1,000)*
Development Area	MXDY	Cumulative MXDY	Excess Total Well Capacity (Total Well Capacity - Cumulative MXDY)	Existing Storage Available	Sensitivity Analysis of Existing Available Storage								
					w/ 90% Existing Available Storage			w/ 80% Existing Available Storage			w/ 70% Existing Available Storage		
					Available FF Provided by 90% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity		Available FF Provided by 80% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity		Available FF Provided by 70% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity	
	(L/s)	(L/s)	(L/s)	(m^3)	(L/s)	(L/s)	(L/min)	(L/s)	(L/s)	(L/min)	(L/s)	(L/s)	(L/min)
Caivan Fox Run Phase 1	4.23	4.23	63.8	1,175	146.9	210.6	13,000	130.6	194.3	12,000	114.2	178.0	11,000
Caivan Fox Run Phase 2 (South)	3.85	8.08	59.9	1,175	146.9	206.8	12,000	130.6	190.5	11,000	114.2	174.2	10,000
Caivan Fox Run Phase 2 (North)	1.61	9.69	58.3	1,175	146.9	205.2	12,000	130.6	188.9	11,000	114.2	172.5	10,000
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	4.25	13.94	54.1	1,175	146.9	200.9	12,000	130.6	184.6	11,000	114.2	168.3	10,000
Mattamy Phase 1	2.83	16.77	51.2	1,175	146.9	198.1	12,000	130.6	181.8	11,000	114.2	165.5	10,000
Caivan Green Lands West (incl. Flowing Creek Farms)	3.82	20.59	47.4	1,175	146.9	194.3	12,000	130.6	178.0	11,000	114.2	161.7	10,000
Caivan Green Lands East	0.71	21.30	46.7	1,175	146.9	193.6	12,000	130.6	177.3	11,000	114.2	160.9	10,000
Caivan Laffin Lands	2.48	23.78	44.2	1,175	146.9	191.1	11,000	130.6	174.8	10,000	114.2	158.5	10,000
Mattamy (Buildout)	14.61	38.39	69.6	1,175	146.9	216.5	13,000	130.6	200.2	12,000	114.2	183.8	11,000
Tamarack	21.42	59.81	48.2	1,175	146.9	195.1	12,000	130.6	178.7	11,000	114.2	162.4	10,000

Table 6: Redundant Storage Requirement

	(A)	(B)	(C)	(D)	(E)	(F)	(G) = *(D) or [(D) + (E)]*	(H)	(I)	(J)	(K) = *Sum of (H) to (J)*	(L)	(M)	(N) = *(L)*	(O) = *(N)*1000/2/3600*	(P) = *(K) + (O)*	(Q) = *(P) - (G)*	(R) = *(L) + (M)*	(S) = *(R)*1000/2/3600*	(T) = *(K) + (S)*	(U) = *(T) - (G)*
Development Area	Population	Cumulative Population	BSDY	Cumulative BSDY	FUS FF		BSDY (<10,000 persons) or BSDY + Fire Flow (>10,000 persons)	Well Capacity				Existing Storage with One Cell Out of Service	Additional Storage to Be Provided	w/ Existing Available Storage				w/ Additional Storage			
								Well #1 (Existing)	Well #2 (Existing)	Well #3 (Future)	Total Well Capacity			Available Storage with One Cell Out of Service	Flow from Storage with One Cell Out of Service (over 2 hours)	Total Well & Storage Supply Available (over 2 hours)	Excess Well & Storage Supply Available (over 2 hours)	Available Storage with One Cell Out of Service	Flow from Storage with One Cell Out of Service (over 2 hours)	Firm Well & Storage Supply Available (over 2 hours)	Excess Well & Storage Supply Available (over 2 hours)
	(persons)	(persons)	(L/s)	(L/s)	(L/s)	(hrs)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(m^3)	(m^3)	(m^3)	(L/s)	(L/s)	(L/s)	(m^3)	(L/s)	(L/s)	(L/s)
Caivan Fox Run Phase 1	748	748	1.56	1.56	0	0	1.56	28.0	40.0		68.0	588	0	588	82	150	148.0	588	82	150	148.0
Caivan Fox Run Phase 2 (South)	680	1,428	1.42	2.98	0	0	2.98	28.0	40.0		68.0	588	1,300	588	82	150	146.6	1,888	262	330	327.2
Caivan Fox Run Phase 2 (North)	546	1,974	1.23	4.20	0	0	4.20	28.0	40.0		68.0	588	1,300	588	82	150	145.4	1,888	262	330	325.9
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	751	2,725	1.57	5.77	0	0	5.77	28.0	40.0		68.0	588	1,300	588	82	150	143.8	1,888	262	330	324.4
Mattamy Phase 1	576	3,301	1.23	6.99	0	0	6.99	28.0	40.0		68.0	588	1,300	588	82	150	142.6	1,888	262	330	323.2
Caivan Green Lands West (incl. Flowing Creek Farms)	1,093	4,394	2.42	9.42	0	0	9.42	28.0	40.0		68.0	588	1,300	588	82	150	140.2	1,888	262	330	320.7
Caivan Green Lands East	126	4,519	0.26	9.68	0	0	9.68	28.0	40.0		68.0	588	1,300	588	82	150	139.9	1,888	262	330	320.5
Caivan Laffin Lands	545	5,065	1.17	10.85	0	0	10.85	28.0	40.0		68.0	588	1,300	588	82	150	138.7	1,888	262	330	319.3
Mattamy (Buildout)	2,811	7,875	6.84	17.69	0	0	17.69	28.0	40.0	40.0	108.0	588	1,300	588	82	190	171.9	1,888	262	370	352.5
Tamarack[1]	3,249	11,124	15.62	33.31	166.7	2	200.01	28.0	40.0	40.0	108.0	588	2,750	588	82	190	-10.4	3,338	464	572	371.5
Trigger (Population/BSDY when Redundant Storage Req. Changes)	-	*10,000*	-	*22.59*	*166.7*	*2*	*189.29*	*28.0*	*40.0*	*40.0*	*108.0*	*588*	*1,300*	*588*	*82*	*190*	*0.4*	*1,888*	*262*	*370*	*180.9*



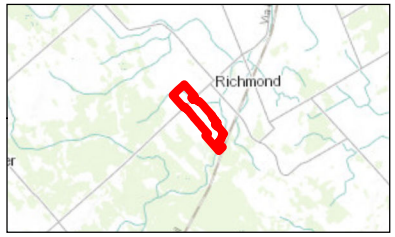
Stantec

Legend

- Model Node
- Model Pipe
- Caivan Fox Run Phase 1
- Caivan Fox Run Phase 2 North
- Caivan Fox Run Phase 2 South
- Caivan Fox Run Phase 3 (formerly RVDC)
- Caivan Green Lands West
- Caivan Green Lands East
- Caivan Laffin Lands
- Mattamy Phase 1
- Mattamy (Buildout)
- Western Development Lands
- Property Parcel
- Richmond West Pumping Station

0 100 200 metres
(At original document size of 8.5x11)
1:9,500

Notes
1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
A1

Title
Model System Map

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163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - BSDY (Interim Conditions)

Head

	Min		147.62			
	Max	148.59				
ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
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102	148.59	3:00	147.62	7:00	148.18	0.97
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106	148.59	3:00	147.62	7:00	148.18	0.97
108	148.59	3:00	147.62	7:00	148.18	0.97
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112	148.59	3:00	147.63	7:00	148.18	0.96
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194	148.59	3:00	147.65	7:00	148.19	0.95
195	148.59	3:00	147.62	7:00	148.18	0.97
196	148.59	3:00	147.65	7:00	148.19	0.94
197	148.59	3:00	147.62	7:00	148.18	0.98
198	148.59	3:00	147.65	7:00	148.19	0.94
199	148.59	3:00	147.62	7:00	148.18	0.98
20	148.59	3:00	147.62	7:00	148.18	0.98
200	148.59	3:00	147.65	7:00	148.19	0.94
201	148.59	3:00	147.62	7:00	148.18	0.98
203	148.59	3:00	147.62	7:00	148.18	0.98
204	148.59	3:00	147.65	7:00	148.19	0.94
205	148.59	3:00	147.62	7:00	148.18	0.98
206	148.59	3:00	147.65	7:00	148.19	0.94
207	148.59	3:00	147.62	7:00	148.18	0.98
209	148.59	3:00	147.62	7:00	148.18	0.98
21	148.59	3:00	147.62	7:00	148.18	0.97
211	148.59	3:00	147.62	7:00	148.18	0.98
212	148.59	3:00	147.65	7:00	148.19	0.94
213	148.59	3:00	147.62	7:00	148.18	0.97
214	148.59	3:00	147.65	7:00	148.19	0.94
217	97.80	3:00	97.80	7:00	97.80	0
219	148.59	3:00	147.67	7:00	148.20	0.93
22	148.59	3:00	147.62	7:00	148.18	0.98
220	148.59	3:00	147.65	7:00	148.19	0.94
221	148.59	3:00	147.67	7:00	148.20	0.93
223	97.80	3:00	97.80	7:00	97.80	0
225	148.59	3:00	147.67	7:00	148.20	0.93
227	148.59	3:00	147.67	7:00	148.20	0.93
229	148.59	3:00	147.62	7:00	148.18	0.98
231	148.59	3:00	147.62	7:00	148.18	0.98
233	148.59	3:00	147.62	7:00	148.18	0.97
234	148.59	3:00	147.65	7:00	148.19	0.94
235	148.59	3:00	147.62	7:00	148.18	0.98
24	148.59	3:00	147.62	7:00	148.18	0.98
26	148.59	3:00	147.62	7:00	148.18	0.98
28	148.59	3:00	147.62	7:00	148.18	0.98
289	148.59	3:00	147.64	7:00	148.19	0.96

Pressure

	Min		70.89			
	Max	76.54				
ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
100	75.83	3:00	74.46	7:00	75.25	1.37
102	75.60	3:00	74.23	7:00	75.02	1.38
104	75.43	3:00	74.05	7:00	74.85	1.38
106	75.12	3:00	73.74	7:00	74.53	1.38
108	75.01	3:00	73.63	7:00	74.42	1.38
110	76.54	3:00	75.17	7:00	75.96	1.37
112	76.40	3:00	75.03	7:00	75.82	1.37
114	76.06	3:00	74.70	7:00	75.48	1.36
116	76.12	3:00	74.75	7:00	75.54	1.36
117	72.21	3:00	70.89	7:00	71.64	1.32
118	76.32	3:00	74.96	7:00	75.74	1.36
119	72.21	3:00	70.89	7:00	71.65	1.32
120	75.61	3:00	74.25	7:00	75.03	1.36
121	72.21	3:00	70.89	7:00	71.65	1.32
122	75.72	3:00	74.37	7:00	75.15	1.35
123	72.21	3:00	70.89	7:00	71.65	1.32
124	76.12	3:00	74.77	7:00	75.54	1.35
125	72.21	3:00	70.89	7:00	71.65	1.32
126	76.27	3:00	74.93	7:00	75.70	1.35
127	0	3:00	0	7:00	0	0
128	76.20	3:00	74.85	7:00	75.63	1.35
129	72.21	3:00	70.89	7:00	71.65	1.32
130	76.32	3:00	74.96	7:00	75.74	1.35
131	0	3:00	0	7:00	0	0
132	75.48	3:00	74.13	7:00	74.90	1.35
133	72.21	3:00	70.89	7:00	71.65	1.32
134	74.94	3:00	73.59	7:00	74.36	1.35
135	0	3:00	0	7:00	0	0
136	74.79	3:00	73.44	7:00	74.22	1.35
137	76.30	3:00	74.95	7:00	75.73	1.35
138	75.48	3:00	74.11	7:00	74.90	1.36
14	73.84	3:00	72.45	7:00	73.25	1.39
140	75.31	3:00	73.94	7:00	74.73	1.36
142	75.19	3:00	73.83	7:00	74.61	1.36
144	75.06	3:00	73.70	7:00	74.49	1.36
146	75.41	3:00	74.05	7:00	74.83	1.36
148	75.45	3:00	74.10	7:00	74.87	1.35
150	75.31	3:00	73.96	7:00	74.73	1.35
152	75.18	3:00	73.83	7:00	74.60	1.35
154	75.35	3:00	74.00	7:00	74.78	1.35
156	75.18	3:00	73.83	7:00	74.61	1.34
16	74.58	3:00	73.19	7:00	73.99	1.39
160	75.79	3:00	74.44	7:00	75.22	1.35
162	75.73	3:00	74.39	7:00	75.16	1.34
164	75.63	3:00	74.30	7:00	75.06	1.34
166	76.02	3:00	74.68	7:00	75.45	1.33
168	75.93	3:00	74.59	7:00	75.36	1.34
170	74.50	3:00	73.15	7:00	73.92	1.34
18	74.58	3:00	73.19	7:00	73.99	1.39
182	74.35	3:00	73.01	7:00	73.78	1.34
184	74.84	3:00	73.51	7:00	74.27	1.33
188	74.75	3:00	73.42	7:00	74.18	1.33
190	74.50	3:00	73.16	7:00	73.93	1.34
191	74.41	3:00	73.08	7:00	73.84	1.34
193	73.77	3:00	72.43	7:00	73.20	1.34
194	74.10	3:00	72.76	7:00	73.53	1.34
195	74.20	3:00	72.81	7:00	73.61	1.38
196	74.37	3:00	73.03	7:00	73.80	1.34
197	74.01	3:00	72.62	7:00	73.42	1.39
198	74.24	3:00	72.90	7:00	73.67	1.34
199	74.69	3:00	73.31	7:00	74.11	1.39
20	74.51	3:00	73.12	7:00	73.92	1.39
200	73.81	3:00	72.47	7:00	73.24	1.34
201	74.55	3:00	73.17	7:00	73.96	1.39
203	74.62	3:00	73.24	7:00	74.03	1.39
204	74.44	3:00	73.10	7:00	73.87	1.34
205	74.42	3:00	73.04	7:00	73.84	1.39
206	74.35	3:00	73.02	7:00	73.78	1.34
207	74.57	3:00	73.18	7:00	73.98	1.39
209	75.11	3:00	73.72	7:00	74.52	1.39
21	75.48	3:00	74.09	7:00	74.89	1.39
211	74.44	3:00	73.05	7:00	73.85	1.39
212	74.55	3:00	73.21	7:00	73.98	1.34
213	74.05	3:00	72.67	7:00	73.47	1.39
214	74.38	3:00	73.04	7:00	73.81	1.34
217	0	3:00	0	7:00	0	0
219	72.21	3:00	70.89	7:00	71.65	1.32
22	74.69	3:00	73.31	7:00	74.11	1.39
220	73.89	3:00	72.54	7:00	73.31	1.34
221	72.21	3:00	70.89	7:00	71.65	1.32
223	0	3:00	0	7:00	0	0
225	72.21	3:00	70.89	7:00	71.65	1.32
227	72.21	3:00	70.89	7:00	71.65	1.32
229	74.76	3:00	73.38	7:00	74.18	1.39
231	74.20	3:00	72.81	7:00	73.61	1.39
233	76.33	3:00	74.94	7:00	75.74	1.39
234	74.23	3:00	72.88	7:00	73.66	1.34
235	74.67	3:00	73.28	7:00	74.08	1.39
24	74.84	3:00	73.45	7:00	74.25	1.39
26	74.40	3:00	73.01	7:00	73.81	1.39
28	74.35	3:00	72.97	7:00	73.76	1.39
289	74.87	3:00	73.50	7:00	74.29	1.36

290	148.59	3:00	147.66	7:00	148.19	0.94	290	74.75	3:00	73.42	7:00	74.19	1.33
30	148.59	3:00	147.62	7:00	148.18	0.98	30	74.49	3:00	73.11	7:00	73.91	1.39
301	148.59	3:00	147.65	7:00	148.19	0.94	301	74.31	3:00	72.97	7:00	73.74	1.34
302	148.59	3:00	147.65	7:00	148.19	0.94	302	74.10	3:00	72.76	7:00	73.53	1.34
303	148.59	3:00	147.65	7:00	148.19	0.94	303	73.96	3:00	72.62	7:00	73.39	1.34
304	148.59	3:00	147.65	7:00	148.19	0.94	304	73.66	3:00	72.32	7:00	73.09	1.34
32	148.59	3:00	147.62	7:00	148.18	0.98	32	73.50	3:00	72.11	7:00	72.91	1.39
34	148.59	3:00	147.62	7:00	148.18	0.98	34	74.55	3:00	73.16	7:00	73.96	1.39
36	148.59	3:00	147.62	7:00	148.18	0.98	36	74.81	3:00	73.42	7:00	74.22	1.39
38	148.59	3:00	147.62	7:00	148.18	0.97	38	75.39	3:00	74.00	7:00	74.80	1.39
391	148.59	3:00	147.64	7:00	148.19	0.95	391	75.78	3:00	74.42	7:00	75.20	1.35
393	148.59	3:00	147.64	7:00	148.19	0.95	393	75.14	3:00	73.78	7:00	74.56	1.35
395	148.59	3:00	147.64	7:00	148.19	0.95	395	75.18	3:00	73.83	7:00	74.60	1.35
397	148.59	3:00	147.66	7:00	148.19	0.94	397	76.02	3:00	74.69	7:00	75.45	1.33
399	148.59	3:00	147.64	7:00	148.19	0.95	399	76.27	3:00	74.92	7:00	75.70	1.35
40	148.59	3:00	147.62	7:00	148.18	0.97	40	75.45	3:00	74.06	7:00	74.86	1.39
401	148.59	3:00	147.66	7:00	148.20	0.93	401	75.90	3:00	74.58	7:00	75.34	1.33
411	148.59	3:00	147.65	7:00	148.19	0.94	411	73.35	3:00	72.00	7:00	72.77	1.34
412	148.59	3:00:00	147.65	7:00	148.19	0.94	412	73.63	3:00:00	72.29	7:00	73.06	1.34
42	148.59	3:00:00	147.62	7:00	148.18	0.97	42	75.21	3:00:00	73.82	7:00	74.62	1.39
44	148.59	3:00:00	147.62	7:00	148.18	0.98	44	75.05	3:00:00	73.66	7:00	74.46	1.39
46	148.59	3:00	147.62	7:00	148.18	0.98	46	75.05	3:00	73.66	7:00	74.46	1.39
48	148.59	3:00:00	147.62	7:00	148.18	0.97	48	75.52	3:00:00	74.13	7:00	74.93	1.39
50	148.59	3:00	147.62	7:00	148.18	0.97	50	75.66	3:00	74.28	7:00	75.07	1.39
54	148.59	3:00:00	147.62	7:00	148.18	0.97	54	75.76	3:00:00	74.38	7:00	75.17	1.38
56	148.59	3:00:00	147.62	7:00	148.18	0.98	56	74.35	3:00:00	72.97	7:00	73.76	1.39
58	148.59	3:00	147.62	7:00	148.18	0.97	58	74.65	3:00	73.27	7:00	74.06	1.39
60	148.59	3:00:00	147.62	7:00	148.18	0.97	60	74.76	3:00:00	73.38	7:00	74.18	1.39
62	148.59	3:00:00	147.62	7:00	148.18	0.97	62	75.38	3:00:00	73.99	7:00	74.79	1.39
64	148.59	3:00	147.62	7:00	148.18	0.97	64	74.62	3:00	73.24	7:00	74.04	1.38
66	148.59	3:00	147.62	7:00	148.18	0.97	66	75.59	3:00	74.20	7:00	75.00	1.39
68	148.59	3:00	147.62	7:00	148.18	0.97	68	74.88	3:00	73.49	7:00	74.29	1.39
70	148.59	3:00:00	147.62	7:00	148.18	0.97	70	74.62	3:00:00	73.24	7:00	74.04	1.38
72	148.59	3:00:00	147.62	7:00	148.18	0.97	72	74.24	3:00:00	72.85	7:00	73.65	1.39
74	148.59	3:00	147.62	7:00	148.18	0.97	74	74.27	3:00	72.88	7:00	73.68	1.38
76	148.59	3:00	147.62	7:00	148.18	0.97	76	74.20	3:00	72.81	7:00	73.61	1.38
78	148.59	3:00	147.62	7:00	148.18	0.97	78	75.93	3:00	74.55	7:00	75.34	1.39
80	148.59	3:00	147.62	7:00	148.18	0.97	80	76.09	3:00	74.70	7:00	75.50	1.38
82	148.59	3:00	147.62	7:00	148.18	0.97	82	76.24	3:00	74.86	7:00	75.66	1.38
84	148.59	3:00:00	147.62	7:00	148.18	0.97	84	76.06	3:00:00	74.67	7:00	75.47	1.38
86	148.59	3:00	147.62	7:00	148.18	0.97	86	76.33	3:00	74.94	7:00	75.74	1.38
88	148.59	3:00	147.62	7:00	148.18	0.97	88	75.66	3:00	74.28	7:00	75.07	1.38
90	148.59	3:00	147.62	7:00	148.18	0.97	90	76.03	3:00	74.65	7:00	75.45	1.38
92	148.59	3:00:00	147.63	7:00	148.18	0.97	92	76.39	3:00:00	75.01	7:00	75.80	1.37
94	148.59	3:00:00	147.63	7:00	148.18	0.96	94	75.83	3:00:00	74.46	7:00	75.25	1.37
96	148.59	3:00	147.63	7:00	148.18	0.97	96	76.13	3:00	74.76	7:00	75.55	1.37
98	148.59	3:00:00	147.63	7:00	148.18	0.97	98	75.63	3:00:00	74.26	7:00	75.05	1.37

Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - BSDY (Buildout Conditions)

Head

Min			***146.21***			
Max	***148.48***					
ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
10	148.48	3:00	146.23	7:00	147.64	2.25
100	148.48	3:00	146.22	7:00	147.64	2.26
102	148.48	3:00	146.22	7:00	147.64	2.26
104	148.48	3:00	146.21	7:00	147.64	2.26
106	148.48	3:00	146.21	7:00	147.64	2.27
108	148.48	3:00	146.21	7:00	147.64	2.26
110	148.48	3:00	146.22	7:00	147.64	2.26
112	148.48	3:00	146.22	7:00	147.64	2.25
114	148.48	3:00	146.23	7:00	147.64	2.25
116	148.48	3:00	146.23	7:00	147.64	2.25
117	148.48	3:00	146.27	7:00	147.66	2.21
118	148.48	3:00	146.23	7:00	147.64	2.25
119	148.48	3:00	146.28	7:00	147.66	2.20
120	148.48	3:00	146.23	7:00	147.64	2.25
121	148.48	3:00	146.28	7:00	147.66	2.20
122	148.48	3:00	146.24	7:00	147.65	2.24
123	148.48	3:00	146.28	7:00	147.66	2.20
124	148.48	3:00	146.24	7:00	147.65	2.24
125	148.48	3:00	146.28	7:00	147.66	2.20
126	148.48	3:00	146.24	7:00	147.65	2.24
127	97.80	3:00	97.80	7:00	97.80	0
128	148.48	3:00	146.23	7:00	147.65	2.24
129	148.48	3:00	146.28	7:00	147.66	2.20
130	148.48	3:00	146.23	7:00	147.64	2.24
131	97.80	3:00	97.80	7:00	97.80	0
132	148.48	3:00	146.23	7:00	147.64	2.24
133	148.48	3:00	146.28	7:00	147.66	2.20
134	148.48	3:00	146.23	7:00	147.64	2.25
135	97.80	3:00	97.80	7:00	97.80	0
136	148.48	3:00	146.23	7:00	147.64	2.25
137	148.48	3:00	146.24	7:00	147.65	2.24
138	148.48	3:00	146.23	7:00	147.64	2.25
14	148.48	3:00	146.21	7:00	147.63	2.27
140	148.48	3:00	146.23	7:00	147.64	2.25
142	148.48	3:00	146.23	7:00	147.64	2.25
144	148.48	3:00	146.23	7:00	147.64	2.25
146	148.48	3:00	146.23	7:00	147.64	2.25
148	148.48	3:00	146.23	7:00	147.64	2.24
150	148.48	3:00	146.23	7:00	147.64	2.24
152	148.48	3:00	146.23	7:00	147.64	2.24
154	148.48	3:00	146.24	7:00	147.65	2.24
156	148.48	3:00	146.24	7:00	147.65	2.24
16	148.48	3:00	146.21	7:00	147.63	2.27
160	148.48	3:00	146.24	7:00	147.65	2.24
162	148.48	3:00	146.24	7:00	147.65	2.23
164	148.48	3:00	146.25	7:00	147.65	2.23
166	148.48	3:00	146.26	7:00	147.65	2.22
168	148.48	3:00	146.25	7:00	147.65	2.23
170	148.48	3:00	146.23	7:00	147.64	2.24
172	148.48	3:00	146.23	7:00	147.64	2.25
174	148.48	3:00	146.23	7:00	147.64	2.25
176	148.48	3:00	146.23	7:00	147.64	2.25
18	148.48	3:00	146.21	7:00	147.63	2.27
182	148.48	3:00	146.23	7:00	147.64	2.25
184	148.48	3:00	146.25	7:00	147.65	2.23
186	148.48	3:00	146.24	7:00	147.65	2.24
188	148.48	3:00	146.24	7:00	147.65	2.24
190	148.48	3:00	146.23	7:00	147.64	2.25
191	148.48	3:00	146.23	7:00	147.64	2.25
192	148.48	3:00	146.23	7:00	147.64	2.25
193	148.48	3:00	146.23	7:00	147.64	2.25
194	148.48	3:00	146.23	7:00	147.64	2.25
195	148.48	3:00	146.21	7:00	147.64	2.27
196	148.48	3:00	146.23	7:00	147.64	2.25
197	148.48	3:00	146.21	7:00	147.63	2.27
198	148.48	3:00	146.23	7:00	147.64	2.25
199	148.48	3:00	146.21	7:00	147.63	2.27
20	148.48	3:00	146.21	7:00	147.63	2.27
200	148.48	3:00	146.23	7:00	147.64	2.25
201	148.48	3:00	146.21	7:00	147.64	2.27
203	148.48	3:00	146.21	7:00	147.63	2.27
204	148.48	3:00	146.23	7:00	147.64	2.25
205	148.48	3:00	146.21	7:00	147.63	2.27
206	148.48	3:00	146.23	7:00	147.64	2.25
207	148.48	3:00	146.21	7:00	147.63	2.27
209	148.48	3:00	146.21	7:00	147.63	2.27
21	148.48	3:00	146.21	7:00	147.64	2.27
210	148.48	3:00	146.23	7:00	147.64	2.25
211	148.48	3:00	146.21	7:00	147.63	2.27
212	148.48	3:00	146.23	7:00	147.64	2.25
213	148.48	3:00	146.21	7:00	147.64	2.27
214	148.48	3:00	146.23	7:00	147.64	2.25
217	97.80	3:00	97.80	7:00	97.80	0
219	148.48	3:00	146.28	7:00	147.66	2.20
22	148.48	3:00	146.21	7:00	147.63	2.27
220	148.48	3:00	146.23	7:00	147.64	2.25
221	148.48	3:00	146.28	7:00	147.66	2.20
223	97.80	3:00	97.80	7:00	97.80	0
225	148.48	3:00	146.28	7:00	147.66	2.20
227	148.48	3:00	146.28	7:00	147.66	2.20
228	148.48	3:00	146.23	7:00	147.64	2.25
229	148.48	3:00	146.21	7:00	147.63	2.27

Pressure

			67.56			
	76.38					
ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
10	73.88	3:00	70.68	7:00	72.69	3.20
100	75.67	3:00	72.46	7:00	74.48	3.21
102	75.44	3:00	72.23	7:00	74.25	3.22
104	75.27	3:00	72.05	7:00	74.07	3.22
106	74.96	3:00	71.74	7:00	73.76	3.22
108	74.84	3:00	71.62	7:00	73.65	3.22
110	76.38	3:00	73.17	7:00	75.19	3.21
112	76.24	3:00	73.03	7:00	75.05	3.20
114	75.90	3:00	72.69	7:00	74.71	3.20
116	75.95	3:00	72.75	7:00	74.76	3.20
117	72.05	3:00	68.91	7:00	70.88	3.14
118	76.15	3:00	72.96	7:00	74.96	3.20
119	72.05	3:00	68.92	7:00	70.88	3.13
120	75.44	3:00	72.25	7:00	74.25	3.19
121	72.05	3:00	68.92	7:00	70.89	3.13
122	75.56	3:00	72.37	7:00	74.37	3.19
123	72.05	3:00	68.92	7:00	70.88	3.13
124	75.95	3:00	72.77	7:00	74.77	3.19
125	72.05	3:00	68.92	7:00	70.89	3.13
126	76.11	3:00	72.93	7:00	74.93	3.18
127	0	3:00	-0.01	7:00	0	0.01
128	76.04	3:00	72.85	7:00	74.85	3.19
129	72.05	3:00	68.92	7:00	70.88	3.13
130	76.15	3:00	72.96	7:00	74.97	3.19
131	0	3:00	-0.01	7:00	0	0.01
132	75.31	3:00	72.12	7:00	74.13	3.19
133	72.05	3:00	68.92	7:00	70.88	3.13
134	74.77	3:00	71.58	7:00	73.59	3.19
135	0	3:00	-0.01	7:00	0	0.01
136	74.63	3:00	71.44	7:00	73.45	3.19
137	76.14	3:00	72.95	7:00	74.95	3.19
138	75.31	3:00	72.11	7:00	74.12	3.20
14	73.68	3:00	70.45	7:00	72.48	3.23
140	75.14	3:00	71.94	7:00	73.95	3.20
142	75.03	3:00	71.83	7:00	73.84	3.20
144	74.90	3:00	71.70	7:00	73.71	3.20
146	75.24	3:00	72.04	7:00	74.05	3.20
148	75.29	3:00	72.10	7:00	74.10	3.19
150	75.14	3:00	71.95	7:00	73.96	3.19
152	75.02	3:00	71.83	7:00	73.83	3.19
154	75.19	3:00	72.00	7:00	74.00	3.19
156	75.02	3:00	71.83	7:00	73.83	3.19
16	74.42	3:00	71.19	7:00	73.22	3.22
160	75.63	3:00	72.44	7:00	74.44	3.19
162	75.57	3:00	72.39	7:00	74.39	3.18
164	75.47	3:00	72.30	7:00	74.29	3.17
166	75.86	3:00	72.69	7:00	74.68	3.16
168	75.77	3:00	72.60	7:00	74.59	3.17
170	74.33	3:00	71.14	7:00	73.15	3.19
172	74.05	3:00	70.85	7:00	72.86	3.20
174	73.93	3:00	70.74	7:00	72.75	3.20
176	73.61	3:00	70.41	7:00	72.42	3.20
18	74.42	3:00	71.19	7:00	73.22	3.22
182	74.19	3:00	71.00	7:00	73.00	3.19
184	74.67	3:00	71.50	7:00	73.50	3.17
186	74.52	3:00	71.34	7:00	73.34	3.18
188	74.59	3:00	71.41	7:00	73.41	3.18
190	74.33	3:00	71.14	7:00	73.15	3.19
191	74.25	3:00	71.05	7:00	73.06	3.19
192	73.99	3:00	70.80	7:00	72.80	3.19
193	73.61	3:00	70.41	7:00	72.42	3.20
194	73.93	3:00	70.74	7:00	72.75	3.19
195	74.03	3:00	70.81	7:00	72.84	3.22
196	74.20	3:00	71.01	7:00	73.02	3.19
197	73.85	3:00	70.62	7:00	72.65	3.23
198	74.08	3:00	70.88	7:00	72.89	3.19
199	74.53	3:00	71.31	7:00	73.33	3.22
20	74.35	3:00	71.12	7:00	73.15	3.23
200	73.65	3:00	70.45	7:00	72.46	3.20
201	74.39	3:00	71.16	7:00	73.19	3.22
203	74.46	3:00	71.23	7:00	73.26	3.23
204	74.28	3:00	71.08	7:00	73.09	3.19
205	74.26	3:00	71.03	7:00	73.06	3.23
206	74.19	3:00	71.00	7:00	73.00	3.19
207	74.40	3:00	71.18	7:00	73.20	3.23
209	74.94	3:00	71.72	7:00	73.74	3.22
21	75.31	3:00	72.09	7:00	74.11	3.22
210	74.23	3:00	71.04	7:00	73.05	3.20
211	74.27	3:00	71.05	7:00	73.08	3.22
212	74.39	3:00	71.19	7:00	73.20	3.20
213	73.89	3:00	70.67	7:00	72.69	3.22
214	74.22	3:00	71.02	7:00	73.03	3.20
217	0	3:00	-0.01	7:00	0	0.01
219	72.05	3:00	68.92	7:00	70.89	3.13
22	74.53	3:00	71.30	7:00	73.33	3.23
220	73.72	3:00	70.52	7:00	72.53	3.20
221	72.05	3:00	68.92	7:00	70.89	3.13
223	0	3:00	-0.01	7:00	0	0.01
225	72.05	3:00	68.92	7:00	70.88	3.13
227	72.05	3:00	68.92	7:00	70.88	3.13
228	73.59	3:00	70.39	7:00	72.40	3.20
229	74.60	3:00	71.38	7:00	73.40	3.22

230	148.48	3:00	146.23	7:00	147.64	2.25
231	148.48	3:00	146.21	7:00	147.64	2.27
232	148.48	3:00	146.23	7:00	147.64	2.25
233	148.48	3:00	146.21	7:00	147.64	2.27
234	148.48	3:00	146.23	7:00	147.64	2.25
235	148.48	3:00	146.21	7:00	147.63	2.27
236	148.48	3:00	146.23	7:00	147.64	2.25
238	148.48	3:00	146.22	7:00	147.64	2.25
24	148.48	3:00	146.21	7:00	147.63	2.27
240	148.48	3:00	146.22	7:00	147.64	2.25
242	148.48	3:00	146.22	7:00	147.64	2.25
244	148.48	3:00	146.22	7:00	147.64	2.25
246	148.48	3:00	146.22	7:00	147.64	2.25
248	148.48	3:00	146.22	7:00	147.64	2.25
250	148.48	3:00	146.22	7:00	147.64	2.25
252	148.48	3:00	146.22	7:00	147.64	2.25
254	148.48	3:00	146.22	7:00	147.64	2.25
258	148.48	3:00	146.22	7:00	147.64	2.25
26	148.48	3:00	146.21	7:00	147.63	2.27
260	148.48	3:00	146.22	7:00	147.64	2.25
262	148.48	3:00	146.22	7:00	147.64	2.25
264	148.48	3:00	146.22	7:00	147.64	2.25
268	148.48	3:00	146.22	7:00	147.64	2.25
270	148.48	3:00	146.22	7:00	147.64	2.25
272	148.48	3:00	146.22	7:00	147.64	2.25
278	148.48	3:00	146.22	7:00	147.64	2.25
28	148.48	3:00	146.21	7:00	147.63	2.27
282	148.48	3:00	146.22	7:00	147.64	2.25
284	148.48	3:00	146.22	7:00	147.64	2.25
288	148.48	3:00	146.22	7:00	147.64	2.25
289	148.48	3:00	146.23	7:00	147.64	2.25
290	148.48	3:00	146.24	7:00	147.65	2.24
30	148.48	3:00	146.21	7:00	147.63	2.27
301	148.48	3:00	146.23	7:00	147.64	2.25
302	148.48	3:00	146.23	7:00	147.64	2.25
303	148.48	3:00	146.23	7:00	147.64	2.25
304	148.48	3:00	146.23	7:00	147.64	2.25
32	148.48	3:00	146.21	7:00	147.63	2.27
34	148.48	3:00	146.21	7:00	147.63	2.27
36	148.48	3:00	146.21	7:00	147.63	2.27
38	148.48	3:00	146.21	7:00	147.64	2.27
391	148.48	3:00	146.23	7:00	147.64	2.25
393	148.48	3:00	146.23	7:00	147.64	2.25
395	148.48	3:00	146.23	7:00	147.64	2.25
397	148.48	3:00	146.26	7:00	147.65	2.22
399	148.48	3:00	146.24	7:00	147.65	2.24
40	148.48	3:00	146.21	7:00	147.64	2.27
401	148.48	3:00	146.26	7:00	147.66	2.22
402	148.48	3:00	146.25	7:00	147.65	2.23
403	148.48	3:00	146.24	7:00	147.65	2.24
404	148.48	3:00	146.24	7:00	147.65	2.24
405	148.48	3:00	146.23	7:00	147.64	2.24
406	148.48	3:00	146.23	7:00	147.64	2.25
407	148.48	3:00	146.23	7:00	147.64	2.25
408	148.48	3:00	146.23	7:00	147.64	2.25
409	148.48	3:00	146.23	7:00	147.64	2.25
410	148.48	3:00	146.22	7:00	147.64	2.25
411	148.48	3:00	146.23	7:00	147.64	2.25
412	148.48	3:00	146.23	7:00	147.64	2.25
413	148.48	3:00	146.23	7:00	147.64	2.25
414	148.48	3:00	146.22	7:00	147.64	2.25
415	148.48	3:00	146.22	7:00	147.64	2.25
416	148.48	3:00	146.22	7:00	147.64	2.25
42	148.48	3:00	146.21	7:00	147.64	2.27
44	148.48	3:00	146.21	7:00	147.64	2.27
46	148.48	3:00	146.21	7:00	147.64	2.27
48	148.48	3:00	146.21	7:00	147.64	2.27
50	148.48	3:00	146.21	7:00	147.64	2.27
54	148.48	3:00	146.21	7:00	147.64	2.27
56	148.48	3:00	146.21	7:00	147.64	2.27
58	148.48	3:00	146.21	7:00	147.64	2.27
60	148.48	3:00	146.21	7:00	147.64	2.27
62	148.48	3:00	146.21	7:00	147.64	2.27
64	148.48	3:00	146.21	7:00	147.64	2.27
66	148.48	3:00	146.21	7:00	147.64	2.27
68	148.48	3:00	146.21	7:00	147.64	2.27
70	148.48	3:00	146.21	7:00	147.64	2.27
72	148.48	3:00	146.21	7:00	147.64	2.27
74	148.48	3:00	146.21	7:00	147.64	2.27
76	148.48	3:00	146.21	7:00	147.64	2.27
78	148.48	3:00	146.21	7:00	147.64	2.27
80	148.48	3:00	146.21	7:00	147.64	2.27
82	148.48	3:00	146.21	7:00	147.64	2.27
84	148.48	3:00	146.21	7:00	147.64	2.27
86	148.48	3:00	146.21	7:00	147.64	2.27
88	148.48	3:00	146.21	7:00	147.64	2.26
90	148.48	3:00	146.22	7:00	147.64	2.26
92	148.48	3:00	146.22	7:00	147.64	2.26
94	148.48	3:00	146.22	7:00	147.64	2.26
96	148.48	3:00	146.22	7:00	147.64	2.26
98	148.48	3:00	146.22	7:00	147.64	2.26

230	73.75	3:00	70.55	7:00	72.56	3.20
231	74.03	3:00	70.81	7:00	72.84	3.22
232	73.91	3:00	70.70	7:00	72.72	3.20
233	76.16	3:00	72.94	7:00	74.97	3.22
234	74.06	3:00	70.86	7:00	72.87	3.20
235	74.50	3:00	71.28	7:00	73.30	3.22
236	73.78	3:00	70.58	7:00	72.59	3.20
238	73.42	3:00	70.22	7:00	72.23	3.20
24	74.67	3:00	71.45	7:00	73.47	3.22
240	73.04	3:00	69.83	7:00	71.85	3.20
242	73.68	3:00	70.47	7:00	72.49	3.20
244	70.76	3:00	67.56	7:00	69.57	3.20
246	70.76	3:00	67.56	7:00	69.57	3.20
248	72.04	3:00	68.84	7:00	70.85	3.20
250	73.52	3:00	70.32	7:00	72.33	3.20
252	72.97	3:00	69.76	7:00	71.78	3.20
254	72.71	3:00	69.51	7:00	71.52	3.20
258	71.70	3:00	68.50	7:00	70.51	3.20
26	74.23	3:00	71.01	7:00	73.03	3.23
260	71.50	3:00	68.30	7:00	70.31	3.20
262	73.07	3:00	69.86	7:00	71.88	3.20
264	72.65	3:00	69.45	7:00	71.46	3.20
268	72.75	3:00	69.55	7:00	71.56	3.20
270	72.54	3:00	69.34	7:00	71.35	3.20
272	72.91	3:00	69.71	7:00	71.72	3.20
278	72.65	3:00	69.45	7:00	71.46	3.20
28	74.19	3:00	70.96	7:00	72.99	3.23
282	72.40	3:00	69.19	7:00	71.21	3.20
284	72.51	3:00	69.31	7:00	71.32	3.20
288	72.14	3:00	68.94	7:00	70.95	3.20
289	74.70	3:00	71.50	7:00	73.51	3.20
290	74.59	3:00	71.41	7:00	73.41	3.18
30	74.33	3:00	71.11	7:00	73.13	3.23
301	74.15	3:00	70.95	7:00	72.96	3.19
302	73.93	3:00	70.74	7:00	72.75	3.20
303	73.79	3:00	70.60	7:00	72.60	3.20
304	73.49	3:00	70.30	7:00	72.31	3.20
32	73.34	3:00	70.11	7:00	72.14	3.23
34	74.39	3:00	71.16	7:00	73.19	3.23
36	74.64	3:00	71.42	7:00	73.45	3.22
38	75.23	3:00	72.00	7:00	74.03	3.22
391	75.61	3:00	72.42	7:00	74.43	3.19
393	74.97	3:00	71.78	7:00	73.79	3.19
395	75.01	3:00	71.82	7:00	73.83	3.19
397	75.86	3:00	72.70	7:00	74.68	3.16
399	76.11	3:00	72.92	7:00	74.93	3.19
40	75.28	3:00	72.06	7:00	74.09	3.22
401	75.74	3:00	72.59	7:00	74.57	3.16
402	74.60	3:00	71.43	7:00	73.43	3.17
403	74.46	3:00	71.28	7:00	73.28	3.18
404	75.46	3:00	72.27	7:00	74.27	3.19
405	75.60	3:00	72.41	7:00	74.41	3.19
406	73.61	3:00	70.41	7:00	72.42	3.20
407	73.75	3:00	70.55	7:00	72.56	3.20
408	74.03	3:00	70.83	7:00	72.84	3.20
409	74.18	3:00	70.97	7:00	72.99	3.20
410	73.18	3:00	69.98	7:00	71.99	3.20
411	73.18	3:00	69.98	7:00	71.99	3.20
412	73.47	3:00	70.26	7:00	72.28	3.20
413	73.04	3:00	69.84	7:00	71.85	3.20
414	72.90	3:00	69.69	7:00	71.71	3.20
415	72.19	3:00	68.98	7:00	71.00	3.20
416	71.47	3:00	68.27	7:00	70.28	3.20
42	75.04	3:00	71.82	7:00	73.84	3.22
44	74.89	3:00	71.66	7:00	73.69	3.22
46	74.89	3:00	71.66	7:00	73.69	3.22
48	75.35	3:00	72.13	7:00	74.16	3.22
50	75.50	3:00	72.27	7:00	74.30	3.22
54	75.60	3:00	72.37	7:00	74.40	3.22
56	74.19	3:00	70.96	7:00	72.99	3.22
58	74.49	3:00	71.26	7:00	73.29	3.22
60	74.60	3:00	71.38	7:00	73.4	3.22
62	75.21	3:00	71.99	7:00	74.02	3.22
64	74.46	3:00	71.24	7:00	73.26	3.22
66	75.43	3:00	72.20	7:00	74.23	3.22
68	74.71	3:00	71.49	7:00	73.52	3.22
70	74.46	3:00	71.24	7:00	73.26	3.22
72	74.08	3:00	70.85	7:00	72.88	3.22
74	74.10	3:00	70.88	7:00	72.91	3.22
76	74.03	3:00	70.81	7:00	72.84	3.22
78	75.77	3:00	72.54	7:00	74.57	3.22
80	75.92	3:00	72.70	7:00	74.73	3.22
82	76.08	3:00	72.86	7:00	74.88	3.22
84	75.89	3:00	72.67	7:00	74.7	3.22
86	76.16	3:00	72.94	7:00	74.97	3.22
88	75.50	3:00	72.28	7:00	74.3	3.22
90	75.87	3:00	72.65	7:00	74.67	3.22
92	76.22	3:00	73.01	7:00	75.03	3.21
94	75.67	3:00	72.46	7:00	74.48	3.21
96	75.97	3:00	72.75	7:00	74.77	3.21
98	75.47	3:00	72.26	7:00	74.28	3.21

Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - PKHR (Interim Conditions)

Head

Min			***143.93***			
Max	***148.77***					
ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
100	148.76	3:00	143.99	20:00	147.55	4.77
102	148.76	3:00	143.97	20:00	147.54	4.79
104	148.76	3:00	143.96	20:00	147.54	4.80
106	148.76	3:00	143.95	20:00	147.54	4.81
108	148.76	3:00	143.96	20:00	147.54	4.81
110	148.76	3:00	144.00	20:00	147.55	4.76
112	148.76	3:00	144.01	20:00	147.55	4.75
114	148.76	3:00	144.02	20:00	147.56	4.74
116	148.76	3:00	144.03	20:00	147.56	4.74
117	148.77	3:00	144.22	20:00	147.61	4.55
118	148.76	3:00	144.04	20:00	147.56	4.72
119	148.77	3:00	144.25	20:00	147.62	4.52
120	148.77	3:00	144.06	20:00	147.57	4.71
121	148.77	3:00	144.25	20:00	147.62	4.52
122	148.77	3:00	144.09	20:00	147.58	4.67
123	148.77	3:00	144.25	20:00	147.62	4.52
124	148.77	3:00	144.09	20:00	147.58	4.67
125	148.77	3:00	144.25	20:00	147.62	4.52
126	148.77	3:00	144.10	20:00	147.58	4.67
127	97.80	3:00	97.79	20:00	97.80	0.01
128	148.77	3:00	144.08	20:00	147.57	4.69
129	148.77	3:00	144.25	20:00	147.62	4.52
130	148.77	3:00	144.07	20:00	147.57	4.70
131	97.80	3:00	97.79	20:00	97.80	0.01
132	148.77	3:00	144.08	20:00	147.57	4.69
133	148.77	3:00	144.25	20:00	147.62	4.52
134	148.77	3:00	144.07	20:00	147.57	4.69
135	97.80	3:00	97.79	20:00	97.80	0.01
136	148.77	3:00	144.07	20:00	147.57	4.70
137	148.77	3:00	144.08	20:00	147.57	4.68
138	148.76	3:00	144.03	20:00	147.56	4.74
14	148.76	3:00	143.93	20:00	147.53	4.83
140	148.76	3:00	144.03	20:00	147.56	4.74
142	148.76	3:00	144.03	20:00	147.56	4.74
144	148.76	3:00	144.03	20:00	147.56	4.73
146	148.76	3:00	144.04	20:00	147.56	4.73
148	148.77	3:00	144.09	20:00	147.57	4.68
150	148.77	3:00	144.09	20:00	147.58	4.68
152	148.77	3:00	144.09	20:00	147.58	4.68
154	148.77	3:00	144.10	20:00	147.58	4.67
156	148.77	3:00	144.11	20:00	147.58	4.65
16	148.76	3:00	143.93	20:00	147.53	4.83
160	148.77	3:00	144.11	20:00	147.58	4.66
162	148.77	3:00	144.13	20:00	147.59	4.64
164	148.77	3:00	144.15	20:00	147.59	4.62
166	148.77	3:00	144.17	20:00	147.60	4.60
168	148.77	3:00	144.15	20:00	147.59	4.62
170	148.77	3:00	144.12	20:00	147.58	4.65
18	148.76	3:00	143.93	20:00	147.53	4.83
182	148.77	3:00	144.12	20:00	147.58	4.65
184	148.77	3:00	144.19	20:00	147.60	4.58
188	148.77	3:00	144.17	20:00	147.60	4.60
190	148.77	3:00	144.15	20:00	147.59	4.61
191	148.77	3:00	144.15	20:00	147.59	4.61
193	148.77	3:00	144.13	20:00	147.59	4.63
194	148.77	3:00	144.12	20:00	147.58	4.65
195	148.76	3:00	143.95	20:00	147.54	4.81
196	148.77	3:00	144.15	20:00	147.59	4.62
197	148.76	3:00	143.93	20:00	147.53	4.83
198	148.77	3:00	144.14	20:00	147.59	4.62
199	148.76	3:00	143.94	20:00	147.53	4.83
20	148.76	3:00	143.93	20:00	147.53	4.83
200	148.77	3:00	144.13	20:00	147.59	4.63
201	148.76	3:00	143.94	20:00	147.53	4.83
203	148.76	3:00	143.93	20:00	147.53	4.83
204	148.77	3:00	144.14	20:00	147.59	4.62
205	148.76	3:00	143.93	20:00	147.53	4.83
206	148.77	3:00	144.14	20:00	147.59	4.62
207	148.76	3:00	143.93	20:00	147.53	4.83
209	148.76	3:00	143.93	20:00	147.53	4.83
21	148.76	3:00	143.94	20:00	147.53	4.82
211	148.76	3:00	143.93	20:00	147.53	4.83
212	148.77	3:00	144.13	20:00	147.59	4.63
213	148.76	3:00	143.94	20:00	147.53	4.83
214	148.77	3:00	144.13	20:00	147.59	4.64
217	97.80	3:00	97.79	20:00	97.80	0.01
219	148.77	3:00	144.25	20:00	147.62	4.52
22	148.76	3:00	143.93	20:00	147.53	4.83
220	148.77	3:00	144.12	20:00	147.58	4.64
221	148.77	3:00	144.25	20:00	147.62	4.52
223	97.80	3:00	97.79	20:00	97.80	0.01
225	148.77	3:00	144.25	20:00	147.62	4.52
227	148.77	3:00	144.25	20:00	147.62	4.52
229	148.76	3:00	143.93	20:00	147.53	4.83
231	148.76	3:00	143.93	20:00	147.53	4.83
233	148.76	3:00	143.94	20:00	147.54	4.82
234	148.77	3:00	144.13	20:00	147.58	4.64
235	148.76	3:00	143.93	20:00	147.53	4.83
24	148.76	3:00	143.93	20:00	147.53	4.83
26	148.76	3:00	143.93	20:00	147.53	4.83
28	148.76	3:00	143.93	20:00	147.53	4.83
289	148.76	3:00	144.03	20:00	147.56	4.74

Pressure

			65.99			
	76.79					
ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
100	76.07	3:00	69.29	20:00	74.35	6.79
102	75.85	3:00	69.03	20:00	74.11	6.81
104	75.67	3:00	68.85	20:00	73.94	6.82
106	75.36	3:00	68.52	20:00	73.62	6.84
108	75.25	3:00	68.41	20:00	73.51	6.83
110	76.79	3:00	70.01	20:00	75.06	6.77
112	76.64	3:00	69.89	20:00	74.92	6.76
114	76.30	3:00	69.56	20:00	74.59	6.74
116	76.36	3:00	69.63	20:00	74.65	6.73
117	72.46	3:00	65.99	20:00	70.81	6.47
118	76.56	3:00	69.85	20:00	74.85	6.71
119	72.46	3:00	66.03	20:00	70.82	6.43
120	75.85	3:00	69.16	20:00	74.15	6.69
121	72.46	3:00	66.04	20:00	70.82	6.42
122	75.96	3:00	69.32	20:00	74.27	6.64
123	72.46	3:00	66.03	20:00	70.82	6.43
124	76.36	3:00	69.72	20:00	74.67	6.64
125	72.46	3:00	66.04	20:00	70.82	6.42
126	76.52	3:00	69.88	20:00	74.83	6.64
127	0	3:00	-0.02	20:00	-0.01	0.02
128	76.45	3:00	69.78	20:00	74.75	6.67
129	72.46	3:00	66.03	20:00	70.82	6.43
130	76.56	3:00	69.88	20:00	74.86	6.68
131	0	3:00	-0.02	20:00	0	0.02
132	75.72	3:00	69.06	20:00	74.03	6.67
133	72.46	3:00	66.03	20:00	70.82	6.43
134	75.18	3:00	68.51	20:00	73.48	6.67
135	0	3:00	-0.02	20:00	0	0.02
136	75.04	3:00	68.36	20:00	73.34	6.68
137	76.55	3:00	69.89	20:00	74.85	6.65
138	75.72	3:00	68.98	20:00	74.01	6.74
14	74.08	3:00	67.21	20:00	72.33	6.87
140	75.55	3:00	68.81	20:00	73.84	6.74
142	75.44	3:00	68.70	20:00	73.72	6.73
144	75.31	3:00	68.58	20:00	73.60	6.73
146	75.65	3:00	68.93	20:00	73.94	6.72
148	75.69	3:00	69.04	20:00	74.00	6.65
150	75.55	3:00	68.90	20:00	73.86	6.65
152	75.42	3:00	68.78	20:00	73.73	6.65
154	75.59	3:00	68.96	20:00	73.90	6.64
156	75.42	3:00	68.81	20:00	73.74	6.62
16	74.82	3:00	67.95	20:00	73.07	6.87
160	76.04	3:00	69.41	20:00	74.35	6.62
162	75.98	3:00	69.39	20:00	74.30	6.59
164	75.88	3:00	69.32	20:00	74.21	6.56
166	76.27	3:00	69.73	20:00	74.60	6.54
168	76.18	3:00	69.61	20:00	74.51	6.57
170	74.74	3:00	68.13	20:00	73.06	6.61
18	74.82	3:00	67.95	20:00	73.07	6.87
182	74.60	3:00	67.99	20:00	72.92	6.61
184	75.09	3:00	68.58	20:00	73.43	6.51
188	75.00	3:00	68.46	20:00	73.33	6.54
190	74.74	3:00	68.19	20:00	73.07	6.56
191	74.66	3:00	68.10	20:00	72.99	6.56
193	74.02	3:00	67.43	20:00	72.34	6.59
194	74.34	3:00	67.74	20:00	72.66	6.61
195	74.44	3:00	67.60	20:00	72.70	6.84
196	74.62	3:00	68.05	20:00	72.94	6.57
197	74.25	3:00	67.38	20:00	72.50	6.87
198	74.49	3:00	67.92	20:00	72.81	6.57
199	74.93	3:00	68.07	20:00	73.19	6.86
20	74.75	3:00	67.88	20:00	73.00	6.87
200	74.06	3:00	67.48	20:00	72.38	6.59
201	74.79	3:00	67.93	20:00	73.05	6.86
203	74.86	3:00	67.99	20:00	73.11	6.87
204	74.69	3:00	68.11	20:00	73.01	6.57
205	74.66	3:00	67.79	20:00	72.92	6.87
206	74.60	3:00	68.03	20:00	72.93	6.57
207	74.81	3:00	67.94	20:00	73.06	6.87
209	75.35	3:00	68.48	20:00	73.60	6.87
21	75.72	3:00	68.86	20:00	73.97	6.86
211	74.68	3:00	67.81	20:00	72.93	6.87
212	74.80	3:00	68.21	20:00	73.12	6.59
213	74.29	3:00	67.44	20:00	72.55	6.86
214	74.63	3:00	68.04	20:00	72.95	6.59
217	0	3:00	-0.02	20:00	-0.01	0.02
219	72.46	3:00	66.04	20:00	70.82	6.42
22	74.93	3:00	68.06	20:00	73.19	6.87
220	74.13	3:00	67.53	20:00	72.45	6.60
221	72.46	3:00	66.04	20:00	70.82	6.42
223	0	3:00	-0.02	20:00	0	0.02
225	72.46	3:00	66.03	20:00	70.82	6.43
227	72.46	3:00	66.03	20:00	70.82	6.43
229	75.01	3:00	68.14	20:00	73.26	6.87
231	74.44	3:00	67.57	20:00	72.69	6.86
233	76.57	3:00	69.72	20:00	74.83	6.85
234	74.47	3:00	67.88	20:00	72.79	6.60
235	74.91	3:00	68.03	20:00	73.16	6.87
24	75.08	3:00	68.21	20:00	73.33	6.87
26	74.64	3:00	67.76	20:00	72.89	6.87
28	74.59	3:00	67.72	20:00	72.84	6.87
289	75.11	3:00	68.37	20:00	73.39	6.74

290	148.77	3:00	144.18	20:00	147.60	4.59	290	75.00	3:00	68.47	20:00	73.34	6.53
30	148.76	3:00	143.93	20:00	147.53	4.83	30	74.74	3:00	67.87	20:00	72.99	6.87
301	148.77	3:00	144.14	20:00	147.59	4.62	301	74.56	3:00	67.98	20:00	72.88	6.57
302	148.77	3:00	144.14	20:00	147.59	4.63	302	74.35	3:00	67.77	20:00	72.67	6.58
303	148.77	3:00	144.14	20:00	147.59	4.63	303	74.20	3:00	67.62	20:00	72.53	6.58
304	148.77	3:00	144.14	20:00	147.59	4.63	304	73.90	3:00	67.32	20:00	72.23	6.58
32	148.76	3:00	143.93	20:00	147.53	4.83	32	73.74	3:00	66.87	20:00	71.99	6.87
34	148.76	3:00	143.93	20:00	147.53	4.83	34	74.79	3:00	67.92	20:00	73.04	6.87
36	148.76	3:00	143.94	20:00	147.53	4.83	36	75.05	3:00	68.19	20:00	73.30	6.86
38	148.76	3:00	143.94	20:00	147.53	4.83	38	75.63	3:00	68.77	20:00	73.89	6.86
391	148.77	3:00	144.07	20:00	147.57	4.70	391	76.02	3:00	69.34	20:00	74.32	6.68
393	148.77	3:00	144.07	20:00	147.57	4.70	393	75.38	3:00	68.70	20:00	73.68	6.68
395	148.77	3:00	144.07	20:00	147.57	4.70	395	75.42	3:00	68.75	20:00	73.72	6.68
397	148.77	3:00	144.18	20:00	147.60	4.59	397	76.27	3:00	69.74	20:00	74.60	6.52
399	148.77	3:00	144.09	20:00	147.58	4.67	399	76.52	3:00	69.88	20:00	74.83	6.64
40	148.76	3:00	143.94	20:00	147.53	4.82	40	75.69	3:00	68.83	20:00	73.94	6.86
401	148.77	3:00	144.20	20:00	147.60	4.57	401	76.15	3:00	69.66	20:00	74.50	6.49
411	148.77	3:00	144.13	20:00	147.59	4.64	411	73.59	3:00	67.00	20:00	71.91	6.59
412	148.77	3:00	144.13	20:00	147.59	4.64	412	73.88	3:00	67.28	20:00	72.2	6.59
42	148.76	3:00	143.94	20:00	147.53	4.82	42	75.45	3:00	68.59	20:00	73.7	6.86
44	148.76	3:00	143.94	20:00	147.53	4.83	44	75.29	3:00	68.43	20:00	73.54	6.86
46	148.76	3:00	143.94	20:00	147.53	4.83	46	75.29	3:00	68.43	20:00	73.54	6.86
48	148.76	3:00	143.94	20:00	147.53	4.82	48	75.76	3:00	68.90	20:00	74.01	6.85
50	148.76	3:00	143.94	20:00:00	147.53	4.82	50	75.90	3:00	69.05	20:00:00	74.16	6.85
54	148.76	3:00	143.94	20:00	147.54	4.82	54	76.00	3:00	69.15	20:00	74.26	6.85
56	148.76	3:00	143.94	20:00	147.53	4.83	56	74.59	3:00	67.73	20:00	72.85	6.86
58	148.76	3:00:00	143.94	20:00	147.53	4.82	58	74.89	3:00:00	68.03	20:00	73.15	6.86
60	148.76	3:00	143.94	20:00:00	147.53	4.82	60	75.01	3:00	68.15	20:00:00	73.26	6.86
62	148.76	3:00	143.94	20:00	147.53	4.82	62	75.62	3:00	68.76	20:00	73.87	6.85
64	148.76	3:00	143.94	20:00	147.54	4.82	64	74.86	3:00	68.01	20:00	73.12	6.85
66	148.76	3:00	143.94	20:00	147.53	4.82	66	75.83	3:00	68.98	20:00	74.09	6.85
68	148.76	3:00:00	143.94	20:00	147.53	4.82	68	75.12	3:00:00	68.26	20:00	73.37	6.86
70	148.76	3:00	143.94	20:00	147.54	4.82	70	74.86	3:00	68.01	20:00	73.12	6.85
72	148.76	3:00	143.94	20:00	147.53	4.82	72	74.48	3:00	67.62	20:00	72.73	6.86
74	148.76	3:00:00	143.95	20:00	147.54	4.81	74	74.51	3:00:00	67.67	20:00	72.77	6.84
76	148.76	3:00	143.95	20:00	147.54	4.81	76	74.44	3:00	67.59	20:00	72.70	6.84
78	148.76	3:00:00	143.94	20:00	147.54	4.82	78	76.17	3:00:00	69.32	20:00	74.43	6.85
80	148.76	3:00	143.94	20:00	147.54	4.82	80	76.33	3:00	69.48	20:00	74.58	6.85
82	148.76	3:00	143.95	20:00	147.54	4.82	82	76.48	3:00	69.64	20:00	74.74	6.85
84	148.76	3:00	143.95	20:00	147.54	4.82	84	76.30	3:00	69.45	20:00	74.56	6.85
86	148.76	3:00	143.94	20:00	147.54	4.82	86	76.57	3:00	69.72	20:00	74.83	6.85
88	148.76	3:00	143.95	20:00	147.54	4.81	88	75.90	3:00	69.07	20:00	74.16	6.84
90	148.76	3:00	143.97	20:00	147.54	4.8	90	76.27	3:00	69.45	20:00	74.54	6.82
92	148.76	3:00	143.99	20:00:00	147.55	4.77	92	76.63	3:00	69.85	20:00:00	74.90	6.78
94	148.76	3:00	144.00	20:00	147.55	4.76	94	76.07	3:00	69.31	20:00	74.35	6.77
96	148.76	3:00	143.98	20:00:00	147.55	4.78	96	76.37	3:00	69.58	20:00:00	74.64	6.8
98	148.76	3:00	143.98	20:00:00	147.55	4.78	98	75.87	3:00	69.08	20:00:00	74.15	6.79

Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - PKHR (Buildout Conditions)

Head

Min			***131.65***			
Max	***148.53***					
ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
10	148.52	3:00	131.74	20:00	145.32	16.78
100	148.51	3:00	131.71	20:00	145.31	16.80
102	148.51	3:00	131.69	20:00	145.31	16.82
104	148.51	3:00	131.69	20:00	145.30	16.83
106	148.51	3:00	131.68	20:00	145.30	16.84
108	148.51	3:00	131.68	20:00	145.30	16.84
110	148.51	3:00	131.73	20:00	145.31	16.79
112	148.52	3:00	131.74	20:00	145.32	16.78
114	148.52	3:00	131.75	20:00	145.32	16.77
116	148.52	3:00	131.76	20:00	145.32	16.76
117	148.52	3:00	132.05	20:00	145.40	16.47
118	148.52	3:00	131.77	20:00	145.33	16.74
119	148.53	3:00	132.12	20:00	145.42	16.40
120	148.52	3:00	131.78	20:00	145.33	16.73
121	148.53	3:00	132.13	20:00	145.42	16.40
122	148.52	3:00	131.81	20:00	145.34	16.70
123	148.53	3:00	132.12	20:00	145.42	16.40
124	148.52	3:00	131.82	20:00	145.34	16.70
125	148.53	3:00	132.13	20:00	145.42	16.40
126	148.52	3:00	131.83	20:00	145.34	16.69
127	97.80	3:00	97.77	20:00	97.79	0.03
128	148.52	3:00	131.81	20:00	145.34	16.71
129	148.53	3:00	132.12	20:00	145.42	16.40
130	148.52	3:00	131.80	20:00	145.33	16.72
131	97.80	3:00	97.77	20:00	97.79	0.03
132	148.52	3:00	131.80	20:00	145.33	16.72
133	148.53	3:00	132.12	20:00	145.42	16.40
134	148.52	3:00	131.79	20:00	145.33	16.73
135	97.80	3:00	97.77	20:00	97.79	0.03
136	148.52	3:00	131.79	20:00	145.33	16.73
137	148.52	3:00	131.82	20:00	145.34	16.70
138	148.52	3:00	131.75	20:00	145.32	16.77
14	148.51	3:00	131.65	20:00	145.29	16.86
140	148.52	3:00	131.75	20:00	145.32	16.77
142	148.52	3:00	131.75	20:00	145.32	16.77
144	148.52	3:00	131.75	20:00	145.32	16.76
146	148.52	3:00	131.76	20:00	145.32	16.75
148	148.52	3:00	131.80	20:00	145.33	16.72
150	148.52	3:00	131.80	20:00	145.33	16.72
152	148.52	3:00	131.80	20:00	145.33	16.72
154	148.52	3:00	131.81	20:00	145.34	16.71
156	148.52	3:00	131.82	20:00	145.34	16.70
16	148.51	3:00	131.65	20:00	145.29	16.86
160	148.52	3:00	131.82	20:00	145.34	16.70
162	148.52	3:00	131.87	20:00	145.35	16.65
164	148.52	3:00	131.91	20:00	145.36	16.61
166	148.52	3:00	131.95	20:00	145.37	16.57
168	148.52	3:00	131.90	20:00	145.36	16.62
170	148.52	3:00	131.80	20:00	145.33	16.72
172	148.52	3:00	131.78	20:00	145.33	16.74
174	148.52	3:00	131.77	20:00	145.33	16.75
176	148.52	3:00	131.75	20:00	145.32	16.76
18	148.51	3:00	131.65	20:00	145.29	16.86
182	148.52	3:00	131.79	20:00	145.33	16.72
184	148.52	3:00	131.90	20:00	145.36	16.62
186	148.52	3:00	131.87	20:00	145.35	16.65
188	148.52	3:00	131.84	20:00	145.34	16.68
190	148.52	3:00	131.79	20:00	145.33	16.72
191	148.52	3:00	131.79	20:00	145.33	16.73
192	148.52	3:00	131.78	20:00	145.33	16.73
193	148.52	3:00	131.76	20:00	145.32	16.76
194	148.52	3:00	131.78	20:00	145.33	16.74
195	148.51	3:00	131.67	20:00	145.30	16.84
196	148.52	3:00	131.79	20:00	145.33	16.73
197	148.51	3:00	131.65	20:00	145.29	16.86
198	148.52	3:00	131.78	20:00	145.33	16.74
199	148.51	3:00	131.66	20:00	145.30	16.86
20	148.51	3:00	131.65	20:00	145.29	16.86
200	148.52	3:00	131.76	20:00	145.32	16.75
201	148.51	3:00	131.66	20:00	145.30	16.85
203	148.51	3:00	131.65	20:00	145.29	16.86
204	148.52	3:00	131.78	20:00	145.33	16.74
205	148.51	3:00	131.65	20:00	145.29	16.86
206	148.52	3:00	131.78	20:00	145.33	16.74
207	148.51	3:00	131.65	20:00	145.29	16.86
209	148.51	3:00	131.65	20:00	145.29	16.86
21	148.51	3:00	131.66	20:00	145.30	16.85
210	148.52	3:00	131.77	20:00	145.33	16.75
211	148.51	3:00	131.65	20:00	145.29	16.86
212	148.52	3:00	131.76	20:00	145.32	16.76
213	148.51	3:00	131.66	20:00	145.30	16.85
214	148.52	3:00	131.75	20:00	145.32	16.77
217	97.80	3:00	97.77	20:00	97.79	0.03
219	148.53	3:00	132.13	20:00	145.42	16.40
22	148.51	3:00	131.65	20:00	145.29	16.86
220	148.52	3:00	131.76	20:00	145.32	16.76
221	148.53	3:00	132.13	20:00	145.42	16.40
223	97.80	3:00	97.77	20:00	97.79	0.03
225	148.53	3:00	132.12	20:00	145.42	16.40
227	148.53	3:00	132.12	20:00	145.42	16.40
228	148.52	3:00	131.74	20:00	145.32	16.77
229	148.51	3:00	131.65	20:00	145.29	16.86

Pressure

			46.95			
	76.43					
ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
10	73.93	3:00	50.08	20:00	69.38	23.85
100	75.72	3:00	51.83	20:00	71.17	23.89
102	75.49	3:00	51.58	20:00	70.93	23.91
104	75.32	3:00	51.40	20:00	70.76	23.92
106	75.01	3:00	51.07	20:00	70.44	23.94
108	74.89	3:00	50.96	20:00	70.33	23.93
110	76.43	3:00	52.56	20:00	71.88	23.87
112	76.29	3:00	52.44	20:00	71.74	23.85
114	75.95	3:00	52.11	20:00	71.41	23.84
116	76.01	3:00	52.18	20:00	71.47	23.83
117	72.11	3:00	48.70	20:00	67.67	23.41
118	76.21	3:00	52.40	20:00	71.67	23.80
119	72.11	3:00	48.79	20:00	67.69	23.32
120	75.50	3:00	51.71	20:00	70.96	23.79
121	72.11	3:00	48.80	20:00	67.70	23.31
122	75.61	3:00	51.87	20:00	71.09	23.74
123	72.11	3:00	48.79	20:00	67.69	23.32
124	76.01	3:00	52.27	20:00	71.49	23.74
125	72.11	3:00	48.80	20:00	67.70	23.31
126	76.17	3:00	52.44	20:00	71.65	23.72
127	0	3:00	-0.05	20:00	-0.01	0.05
128	76.09	3:00	52.34	20:00	71.57	23.76
129	72.11	3:00	48.79	20:00	67.69	23.32
130	76.21	3:00	52.44	20:00	71.68	23.76
131	0	3:00	-0.04	20:00	-0.01	0.04
132	75.37	3:00	51.60	20:00	70.84	23.77
133	72.11	3:00	48.79	20:00	67.69	23.32
134	74.83	3:00	51.05	20:00	70.30	23.78
135	0	3:00	-0.04	20:00	-0.01	0.04
136	74.69	3:00	50.90	20:00	70.16	23.78
137	76.19	3:00	52.45	20:00	71.67	23.74
138	75.37	3:00	51.53	20:00	70.83	23.83
14	73.73	3:00	49.76	20:00	69.15	23.97
140	75.20	3:00	51.36	20:00	70.65	23.83
142	75.08	3:00	51.25	20:00	70.54	23.83
144	74.95	3:00	51.13	20:00	70.41	23.83
146	75.30	3:00	51.48	20:00	70.76	23.82
148	75.34	3:00	51.57	20:00	70.82	23.77
150	75.20	3:00	51.43	20:00	70.67	23.76
152	75.07	3:00	51.31	20:00	70.55	23.76
154	75.24	3:00	51.48	20:00	70.72	23.76
156	75.07	3:00	51.33	20:00	70.55	23.74
16	74.47	3:00	50.50	20:00	69.89	23.97
160	75.68	3:00	51.95	20:00	71.16	23.74
162	75.63	3:00	51.96	20:00	71.13	23.66
164	75.53	3:00	51.92	20:00	71.04	23.61
166	75.91	3:00	52.36	20:00	71.44	23.56
168	75.83	3:00	52.20	20:00	71.34	23.62
170	74.39	3:00	50.62	20:00	69.86	23.77
172	74.10	3:00	50.30	20:00	69.57	23.80
174	73.99	3:00	50.18	20:00	69.45	23.81
176	73.66	3:00	49.83	20:00	69.12	23.83
18	74.47	3:00	50.50	20:00	69.89	23.97
182	74.25	3:00	50.47	20:00	69.72	23.78
184	74.73	3:00	51.10	20:00	70.24	23.63
186	74.57	3:00	50.90	20:00	70.07	23.67
188	74.64	3:00	50.93	20:00	70.13	23.72
190	74.39	3:00	50.62	20:00	69.86	23.77
191	74.30	3:00	50.52	20:00	69.77	23.78
192	74.05	3:00	50.26	20:00	69.51	23.79
193	73.66	3:00	49.84	20:00	69.12	23.82
194	73.99	3:00	50.20	20:00	69.46	23.79
195	74.08	3:00	50.14	20:00	69.51	23.94
196	74.26	3:00	50.47	20:00	69.73	23.79
197	73.90	3:00	49.93	20:00	69.32	23.97
198	74.13	3:00	50.34	20:00	69.60	23.79
199	74.58	3:00	50.62	20:00	70.01	23.96
20	74.40	3:00	50.42	20:00	69.82	23.97
200	73.70	3:00	49.89	20:00	69.17	23.82
201	74.44	3:00	50.48	20:00	69.86	23.96
203	74.51	3:00	50.54	20:00	69.93	23.97
204	74.33	3:00	50.54	20:00	69.80	23.79
205	74.31	3:00	50.34	20:00	69.73	23.97
206	74.24	3:00	50.45	20:00	69.71	23.79
207	74.45	3:00	50.48	20:00	69.88	23.97
209	74.99	3:00	51.02	20:00	70.42	23.97
21	75.36	3:00	51.40	20:00	70.79	23.96
210	74.29	3:00	50.48	20:00	69.75	23.81
211	74.32	3:00	50.36	20:00	69.75	23.97
212	74.44	3:00	50.62	20:00	69.90	23.82
213	73.94	3:00	49.98	20:00	69.37	23.96
214	74.27	3:00	50.44	20:00	69.73	23.84
217	0	3:00	-0.05	20:00	-0.01	0.05
219	72.11	3:00	48.80	20:00	67.70	23.31
22	74.58	3:00	50.61	20:00	70.00	23.97
220	73.77	3:00	49.95	20:00	69.24	23.82
221	72.11	3:00	48.80	20:00	67.70	23.31
223	0	3:00	-0.04	20:00	-0.01	0.04
225	72.11	3:00	48.79	20:00	67.69	23.32
227	72.11	3:00	48.79	20:00	67.69	23.32
228	73.65	3:00	49.80	20:00	69.10	23.85
229	74.65	3:00	50.68	20:00	70.08	23.97

230	148.52	3:00	131.74	20:00	145.32	16.77
231	148.51	3:00	131.66	20:00	145.30	16.86
232	148.52	3:00	131.74	20:00	145.32	16.77
233	148.51	3:00	131.66	20:00	145.30	16.85
234	148.52	3:00	131.75	20:00	145.32	16.77
235	148.51	3:00	131.65	20:00	145.29	16.86
236	148.52	3:00	131.74	20:00	145.32	16.78
238	148.52	3:00	131.73	20:00	145.32	16.79
24	148.51	3:00	131.65	20:00	145.29	16.86
240	148.52	3:00	131.73	20:00	145.32	16.79
242	148.52	3:00	131.73	20:00	145.32	16.79
244	148.52	3:00	131.73	20:00	145.32	16.79
246	148.52	3:00	131.73	20:00	145.31	16.79
248	148.52	3:00	131.73	20:00	145.32	16.79
250	148.52	3:00	131.73	20:00	145.32	16.78
252	148.52	3:00	131.73	20:00	145.32	16.79
254	148.52	3:00	131.73	20:00	145.32	16.79
258	148.52	3:00	131.73	20:00	145.31	16.79
26	148.51	3:00	131.65	20:00	145.29	16.86
260	148.52	3:00	131.73	20:00	145.31	16.79
262	148.52	3:00	131.73	20:00	145.32	16.79
264	148.52	3:00	131.73	20:00	145.32	16.79
268	148.52	3:00	131.73	20:00	145.32	16.79
270	148.52	3:00	131.73	20:00	145.32	16.79
272	148.52	3:00	131.73	20:00	145.32	16.79
278	148.52	3:00	131.73	20:00	145.32	16.79
28	148.51	3:00	131.65	20:00	145.29	16.86
282	148.52	3:00	131.73	20:00	145.32	16.79
284	148.52	3:00	131.73	20:00	145.32	16.79
288	148.52	3:00	131.73	20:00	145.32	16.79
289	148.52	3:00	131.75	20:00	145.32	16.77
290	148.52	3:00	131.85	20:00	145.35	16.66
30	148.51	3:00	131.65	20:00	145.29	16.86
301	148.52	3:00	131.78	20:00	145.33	16.74
302	148.52	3:00	131.77	20:00	145.33	16.74
303	148.52	3:00	131.77	20:00	145.33	16.75
304	148.52	3:00	131.76	20:00	145.32	16.75
32	148.51	3:00	131.65	20:00	145.29	16.86
34	148.51	3:00	131.65	20:00	145.29	16.86
36	148.51	3:00	131.66	20:00	145.30	16.86
38	148.51	3:00	131.66	20:00	145.30	16.85
391	148.52	3:00	131.78	20:00	145.33	16.73
393	148.52	3:00	131.79	20:00	145.33	16.73
395	148.52	3:00	131.79	20:00	145.33	16.73
397	148.52	3:00	131.98	20:00	145.38	16.54
399	148.52	3:00	131.83	20:00	145.34	16.69
40	148.51	3:00	131.66	20:00	145.30	16.85
401	148.52	3:00	131.98	20:00	145.38	16.54
402	148.52	3:00	131.90	20:00	145.36	16.62
403	148.52	3:00	131.84	20:00	145.34	16.68
404	148.52	3:00	131.81	20:00	145.34	16.70
405	148.52	3:00	131.80	20:00	145.33	16.71
406	148.52	3:00	131.74	20:00	145.32	16.78
407	148.52	3:00	131.74	20:00	145.32	16.78
408	148.52	3:00	131.74	20:00	145.32	16.77
409	148.52	3:00	131.74	20:00	145.32	16.78
410	148.52	3:00	131.73	20:00	145.32	16.79
411	148.52	3:00	131.74	20:00	145.32	16.78
412	148.52	3:00	131.74	20:00	145.32	16.78
413	148.52	3:00	131.74	20:00	145.32	16.78
414	148.52	3:00	131.73	20:00	145.32	16.78
415	148.52	3:00	131.73	20:00	145.32	16.79
416	148.52	3:00	131.73	20:00	145.31	16.79
42	148.51	3:00	131.66	20:00	145.30	16.85
44	148.51	3:00	131.66	20:00	145.30	16.85
46	148.51	3:00	131.66	20:00	145.30	16.86
48	148.51	3:00	131.66	20:00	145.30	16.85
50	148.51	3:00	131.66	20:00	145.30	16.85
54	148.51	3:00	131.66	20:00	145.30	16.85
56	148.51	3:00	131.66	20:00	145.30	16.85
58	148.51	3:00	131.66	20:00	145.30	16.85
60	148.51	3:00	131.66	20:00:00	145.3	16.85
62	148.51	3:00	131.66	20:00:00	145.3	16.85
64	148.51	3:00:00	131.67	20:00:00	145.3	16.85
66	148.51	3:00	131.66	20:00:00	145.3	16.85
68	148.51	3:00	131.66	20:00:00	145.3	16.85
70	148.51	3:00	131.66	20:00:00	145.3	16.85
72	148.51	3:00	131.66	20:00:00	145.3	16.85
74	148.51	3:00:00	131.67	20:00:00	145.3	16.84
76	148.51	3:00	131.67	20:00:00	145.3	16.84
78	148.51	3:00	131.66	20:00:00	145.3	16.85
80	148.51	3:00	131.67	20:00:00	145.3	16.85
82	148.51	3:00	131.67	20:00:00	145.3	16.84
84	148.51	3:00	131.67	20:00:00	145.3	16.84
86	148.51	3:00:00	131.67	20:00:00	145.3	16.85
88	148.51	3:00	131.68	20:00:00	145.3	16.84
90	148.51	3:00	131.69	20:00:00	145.3	16.82
92	148.51	3:00	131.72	20:00:00	145.31	16.8
94	148.51	3:00	131.73	20:00:00	145.31	16.79
96	148.51	3:00	131.71	20:00:00	145.31	16.81
98	148.51	3:00	131.71	20:00:00	145.31	16.81

230	73.80	3:00	49.96	20:00	69.26	23.85
231	74.08	3:00	50.12	20:00	69.51	23.96
232	73.96	3:00	50.12	20:00	69.42	23.84
233	76.22	3:00	52.26	20:00	71.64	23.95
234	74.12	3:00	50.28	20:00	69.57	23.84
235	74.55	3:00	50.58	20:00	69.98	23.97
236	73.83	3:00	49.98	20:00	69.29	23.85
238	73.48	3:00	49.61	20:00	68.93	23.86
24	74.72	3:00	50.75	20:00	70.15	23.97
240	73.09	3:00	49.23	20:00	68.54	23.86
242	73.73	3:00	49.87	20:00	69.18	23.86
244	70.82	3:00	46.95	20:00	66.27	23.86
246	70.82	3:00	46.95	20:00	66.27	23.87
248	72.10	3:00	48.23	20:00	67.55	23.87
250	73.57	3:00	49.72	20:00	69.03	23.86
252	73.02	3:00	49.16	20:00	68.47	23.86
254	72.76	3:00	48.90	20:00	68.22	23.87
258	71.75	3:00	47.89	20:00	67.21	23.87
26	74.28	3:00	50.31	20:00	69.71	23.97
260	71.56	3:00	47.69	20:00	67.01	23.87
262	73.12	3:00	49.26	20:00	68.57	23.86
264	72.71	3:00	48.84	20:00	68.16	23.87
268	72.81	3:00	48.94	20:00	68.26	23.86
270	72.59	3:00	48.73	20:00	68.04	23.87
272	72.96	3:00	49.10	20:00	68.41	23.86
278	72.71	3:00	48.84	20:00	68.16	23.86
28	74.24	3:00	50.27	20:00	69.66	23.97
282	72.45	3:00	48.59	20:00	67.90	23.87
284	72.57	3:00	48.70	20:00	68.02	23.87
288	72.20	3:00	48.33	20:00	67.65	23.87
289	74.76	3:00	50.92	20:00	70.21	23.83
290	74.65	3:00	50.96	20:00	70.14	23.69
30	74.38	3:00	50.41	20:00	69.81	23.97
301	74.20	3:00	50.41	20:00	69.67	23.80
302	73.99	3:00	50.19	20:00	69.45	23.80
303	73.85	3:00	50.04	20:00	69.31	23.81
304	73.55	3:00	49.73	20:00	69.01	23.81
32	73.39	3:00	49.42	20:00	68.81	23.97
34	74.44	3:00	50.47	20:00	69.86	23.97
36	74.69	3:00	50.73	20:00	70.12	23.96
38	75.28	3:00	51.32	20:00	70.70	23.96
391	75.67	3:00	51.88	20:00	71.14	23.79
393	75.03	3:00	51.24	20:00	70.50	23.78
395	75.07	3:00	51.29	20:00	70.54	23.78
397	75.91	3:00	52.40	20:00	71.45	23.52
399	76.17	3:00	52.44	20:00	71.65	23.73
40	75.33	3:00	51.38	20:00	70.76	23.96
401	75.80	3:00	52.29	20:00	71.34	23.52
402	74.66	3:00	51.03	20:00	70.17	23.63
403	74.52	3:00	50.81	20:00	70.01	23.71
404	75.51	3:00	51.77	20:00	70.99	23.75
405	75.65	3:00	51.89	20:00	71.13	23.76
406	73.66	3:00	49.81	20:00	69.12	23.85
407	73.80	3:00	49.95	20:00	69.26	23.85
408	74.09	3:00	50.24	20:00	69.54	23.85
409	74.23	3:00	50.38	20:00	69.68	23.85
410	73.23	3:00	49.37	20:00	68.69	23.86
411	73.23	3:00	49.38	20:00	68.69	23.85
412	73.52	3:00	49.67	20:00	68.97	23.85
413	73.09	3:00	49.24	20:00	68.55	23.85
414	72.95	3:00	49.09	20:00	68.40	23.86
415	72.24	3:00	48.37	20:00	67.69	23.87
416	71.53	3:00	47.66	20:00	66.98	23.87
42	75.09	3:00	51.14	20:00	70.52	23.96
44	74.94	3:00	50.98	20:00	70.36	23.96
46	74.94	3:00	50.98	20:00	70.36	23.96
48	75.41	3:00	51.45	20:00	70.83	23.95
50	75.55	3:00	51.60	20:00	70.98	23.95
54	75.65	3:00	51.70	20:00	71.08	23.95
56	74.24	3:00	50.28	20:00	69.67	23.96
58	74.54	3:00	50.58	20:00	69.96	23.96
60	74.65	3:00	50.69	20:00:00	70.08	23.96
62	75.26	3:00	51.31	20:00:00	70.69	23.95
64	74.51	3:00:00	50.56	20:00:00	69.94	23.95
66	75.48	3:00	51.52	20:00:00	70.9	23.95
68	74.77	3:00	50.81	20:00:00	70.19	23.96
70	74.51	3:00	50.56	20:00:00	69.94	23.95
72	74.13	3:00	50.17	20:00:00	69.55	23.96
74	74.15	3:00:00	50.21	20:00:00	69.59	23.94
76	74.08	3:00	50.14	20:00:00	69.51	23.94
78	75.82	3:00	51.87	20:00:00	71.25	23.95
80	75.97	3:00	52.03	20:00:00	71.4	23.95
82	76.13	3:00	52.19	20:00:00	71.56	23.94
84	75.95	3:00	52	20:00:00	71.38	23.94
86	76.22	3:00:00	52.27	20:00:00	71.64	23.95
88	75.55	3:00	51.61	20:00:00	70.98	23.93
90	75.92	3:00	52	20:00:00	71.36	23.92
92	76.27	3:00	52.39	20:00:00	71.72	23.88
94	75.72	3:00	51.86	20:00:00	71.17	23.86
96	76.02	3:00	52.12	20:00:00	71.46	23.89
98	75.52	3:00	51.63	20:00:00	70.97	23.89

Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1
Model Results - MXDY+FF (Interim Conditions)

					26.87	***175.93***	
					67.90	***244.92***	
ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
100	0.28	92.66	160.43	167.00	50.99	216.37	20.00
102	0.17	92.43	160.43	167.00	60.18	237.23	20.00
104	0.17	92.26	160.43	167.00	59.42	236.57	20.00
106	0.17	91.94	160.42	167.00	58.09	233.95	20.00
108	0.17	91.83	160.42	167.00	30.43	181.03	20.00
110	0.17	93.38	160.44	167.00	63.11	239.70	20.00
112	0.17	93.24	160.44	167.00	63.36	240.01	20.00
114	0.17	92.90	160.44	167.00	63.74	240.57	20.00
116	0.17	92.96	160.44	167.00	63.70	240.48	20.00
118	0.17	93.16	160.45	167.00	64.39	241.09	20.00
120	0.17	92.46	160.45	167.00	64.63	241.70	20.00
122	0.17	92.58	160.46	167.00	65.96	243.02	20.00
124	0.17	92.98	160.46	167.00	66.05	242.90	20.00
126	0.17	93.14	160.46	167.00	66.51	243.32	20.00
128	0.17	93.06	160.45	167.00	37.67	192.51	20.00
130	0.17	93.17	160.45	167.00	65.16	241.87	20.00
132	0.28	92.34	160.45	167.00	37.10	191.88	20.00
134	0.28	91.80	160.45	167.00	56.49	229.55	20.00
136	0.28	91.65	160.45	167.00	51.11	217.25	20.00
137	0.17	93.16	160.45	167.00	65.81	242.56	20.00
138	0.28	92.32	160.44	167.00	26.87	175.93	20.00
14	0.22	90.65	160.42	167.00	38.84	196.10	20.00
140	0.28	92.15	160.44	167.00	29.07	179.05	20.00
142	0.28	92.04	160.44	167.00	36.21	190.52	20.00
144	0.28	91.91	160.44	167.00	49.61	214.09	20.00
146	0.17	92.25	160.44	167.00	63.76	240.90	20.00
148	0.28	92.31	160.46	167.00	59.64	236.70	20.00
150	0.32	92.17	160.46	167.00	53.58	222.21	20.00
152	0.32	92.04	160.46	167.00	52.39	219.68	20.00
154	0.32	92.22	160.46	167.00	54.06	223.23	20.00
156	0.32	92.05	160.46	167.00	65.34	242.75	20.00
16	0.22	91.39	160.42	167.00	49.29	213.98	20.00
160	0.32	92.66	160.46	167.00	66.40	243.59	20.00
162	0.32	92.61	160.47	167.00	66.29	243.47	20.00
164	0.32	92.52	160.47	167.00	66.83	244.10	20.00
166	0.17	92.90	160.47	167.00	67.90	244.92	20.00
168	0.32	92.81	160.47	167.00	63.37	240.21	20.00
170	0	91.37	160.46	167.00	63.17	240.46	20.00
18	0.25	91.39	160.42	167.00	53.10	222.24	20.00
182	0	91.23	160.46	167.00	62.33	239.64	20.00
184	0	91.73	160.48	167.00	64.47	241.59	20.00
188	0.19	91.64	160.47	167.00	62.81	240.09	20.00
190	0.19	91.38	160.47	167.00	61.56	238.93	20.00
191	0.19	91.29	160.47	167.00	54.86	225.77	20.00
193	0.19	90.65	160.47	167.00	59.83	237.53	20.00
194	0	90.97	160.46	167.00	61.49	238.89	20.00
195	0.22	91.02	160.42	167.00	57.01	232.24	20.00
196	0.19	91.25	160.47	167.00	61.10	238.52	20.00
197	0.22	90.82	160.42	167.00	46.18	208.35	20.00
198	0.19	91.12	160.47	167.00	60.67	238.15	20.00
199	0.22	91.51	160.42	167.00	56.18	229.54	20.00
20	0.25	91.32	160.42	167.00	51.19	218.07	20.00
200	0.19	90.69	160.47	167.00	59.91	237.59	20.00
201	0.22	91.37	160.42	167.00	55.93	229.07	20.00
203	0.25	91.43	160.42	167.00	48.56	212.54	20.00
204	0.19	91.32	160.47	167.00	53.43	222.41	20.00
205	0.25	91.24	160.42	167.00	41.18	199.59	20.00
206	0.19	91.23	160.47	167.00	38.90	195.61	20.00
209	0.14	91.92	160.42	167.00	30.97	181.83	20.00
21	0.25	92.29	160.42	167.00	55.42	226.79	20.00
211	0.14	91.25	160.42	167.00	30.22	180.83	20.00
212	0	91.43	160.47	167.00	60.60	237.75	20.00
213	0.14	90.87	160.42	167.00	39.18	196.48	20.00
214	0	91.26	160.46	167.00	60.47	237.70	20.00
22	0.25	91.51	160.42	167.00	46.43	208.45	20.00
220	0	90.76	160.46	167.00	60.42	237.89	20.00
229	0	91.58	160.42	167.00	33.63	186.03	20.00
231	0	91.01	160.42	167.00	33.55	186.06	20.00
233	0	93.14	160.42	167.00	55.35	225.47	20.00
234	0	91.10	160.46	167.00	60.48	237.79	20.00
235	0	91.48	160.42	167.00	36.94	191.87	20.00
24	0.25	91.65	160.42	167.00	51.99	219.51	20.00
26	0.25	91.21	160.42	167.00	47.50	210.65	20.00
28	0.25	91.16	160.42	167.00	46.18	208.19	20.00
289	0.28	91.71	160.44	167.00	27.51	176.90	20.00
290	0	91.64	160.48	167.00	63.38	240.49	20.00
30	0.25	91.31	160.42	167.00	48.34	212.19	20.00
301	0.19	91.19	160.47	167.00	54.16	224.24	20.00
302	0.19	90.98	160.47	167.00	60.46	238.01	20.00
303	0.19	90.83	160.47	167.00	60.14	237.76	20.00
304	0.19	90.54	160.47	167.00	51.77	219.38	20.00
32	0.22	90.31	160.42	167.00	38.26	195.12	20.00
34	0.25	91.36	160.42	167.00	48.45	212.38	20.00
36	0.25	91.62	160.42	167.00	56.54	230.37	20.00
38	0.25	92.20	160.42	167.00	57.86	233.17	20.00
391	0.28	92.63	160.45	167.00	60.16	237.08	20.00
393	0.28	91.99	160.45	167.00	56.76	230.03	20.00
395	0.28	92.04	160.45	167.00	51.40	217.55	20.00
399	0.17	93.14	160.46	167.00	66.28	243.07	20.00
40	0.25	92.26	160.42	167.00	58.07	233.64	20.00
401	0.32	92.80	160.48	167.00	67.36	244.47	20.00
411	0.19	90.22	160.46	167.00	45.09	206.33	20.00
412	0	90.50	160.46	167.00	57.54	233.43	20.00
42	0.25	92.02	160.42	167.00	51.78	218.69	20.00
44	0.25	91.86	160.42	167.00	56.45	229.87	20.00
46	0.25	91.86	160.42	167.00	56.08	228.93	20.00
48	0.18	92.33	160.42	167.00	55.32	226.42	20.00
50	0.18	92.48	160.42	167.00	54.48	224.26	20.00
54	0.18	92.58	160.42	167.00	58.78	235.11	20.00
56	0.22	91.17	160.42	167.00	55.69	228.65	20.00
58	0.22	91.47	160.42	167.00	54.56	225.52	20.00
60	0.22	91.58	160.42	167.00	53.50	222.90	20.00
62	0.22	92.19	160.42	167.00	54.69	225.07	20.00
64	0.22	91.44	160.42	167.00	57.02	231.78	20.00
66	0.22	92.41	160.42	167.00	54.91	225.40	20.00
68	0.22	91.69	160.42	167.00	54.00	223.97	20.00
70	0.22	91.44	160.42	167.00	56.82	231.26	20.00
72	0.22	91.05	160.42	167.00	55.98	229.53	20.00
74	0.22	91.09	160.42	167.00	56.78	231.54	20.00
76	0.22	91.01	160.42	167.00	53.79	224.10	20.00
78	0.18	92.75	160.42	167.00	55.26	225.85	20.00
80	0.18	92.9	160.42	167.00	54.96	224.95	20.00
82	0.18	93.06	160.42	167.00	55.82	226.85	20.00
84	0.18	92.88	160.42	167.00	50.31	214.83	20.00
86	0.18	93.15	160.42	167.00	55.78	226.67	20.00
88	0.18	92.48	160.42	167.00	59.28	236.35	20.00
90	0.17	92.85	160.43	167.00	60.28	237.14	20.00
92	0.17	93.22	160.43	167.00	63.01	239.69	20.00
94	0.17	92.67	160.44	167.00	62.89	239.82	20.00
96	0.17	92.96	160.43	167.00	61.67	238.47	20.00
98	0.28	92.46	160.43	167.00	51.82	218.26	20.00

No units serviced in this area under interim conditions

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1
Model Results - MXDY+FF (Buildout Conditions)

Min					***21.95***	***169.76***	
Max					***62.92***	***229.96***	
ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
10	0.26	90.54	160.20	167.00	54.40	222.97	20.00
100	0.28	92.33	160.20	167.00	46.07	205.94	20.00
102	0.17	92.09	160.19	167.00	55.26	223.11	20.00
104	0.17	91.92	160.19	167.00	54.50	222.50	20.00
106	0.17	91.60	160.19	167.00	53.16	221.45	20.00
108	0.17	91.49	160.19	167.00	25.50	174.56	20.00
110	0.17	93.04	160.20	167.00	58.19	225.38	20.00
112	0.17	92.90	160.20	167.00	58.44	225.66	20.00
114	0.17	92.57	160.20	167.00	58.82	226.14	20.00
116	0.17	92.63	160.21	167.00	58.77	226.06	20.00
118	0.17	92.83	160.21	167.00	59.47	226.62	20.00
120	0.17	92.12	160.21	167.00	59.72	227.14	20.00
122	0.17	92.25	160.22	167.00	61.06	228.34	20.00
124	0.17	92.65	160.22	167.00	61.13	228.23	20.00
126	0.17	92.81	160.22	167.00	61.58	228.60	20.00
128	0.17	92.73	160.22	167.00	32.75	184.59	20.00
130	0.17	92.84	160.22	167.00	60.23	227.32	20.00
132	0.28	92.00	160.22	167.00	32.21	184.15	20.00
134	0.28	91.46	160.21	167.00	51.62	218.18	20.00
136	0.28	91.31	160.21	167.00	46.25	206.78	20.00
137	0.17	92.83	160.22	167.00	60.88	227.93	20.00
138	0.28	91.98	160.21	167.00	21.95	169.76	20.00
14	0.22	90.32	160.18	167.00	33.91	186.91	20.00
140	0.28	91.81	160.21	167.00	24.15	172.73	20.00
142	0.28	91.70	160.21	167.00	31.29	183.08	20.00
144	0.28	91.57	160.21	167.00	44.69	203.76	20.00
146	0.17	91.92	160.21	167.00	58.84	226.40	20.00
148	0.28	91.97	160.22	167.00	54.79	222.72	20.00
150	0.32	91.83	160.22	167.00	48.74	211.49	20.00
152	0.32	91.70	160.22	167.00	47.55	209.14	20.00
154	0.32	91.87	160.22	167.00	49.24	212.50	20.00
156	0.32	91.71	160.22	167.00	60.60	228.26	20.00
16	0.22	91.06	160.18	167.00	44.36	203.54	20.00
160	0.32	92.32	160.22	167.00	61.54	228.91	20.00
162	0.32	92.28	160.23	167.00	61.36	228.73	20.00
164	0.32	92.19	160.24	167.00	61.87	229.26	20.00
166	0.17	92.59	160.25	167.00	62.92	229.96	20.00
168	0.32	92.49	160.24	167.00	58.37	225.77	20.00
170	0.26	91.02	160.22	167.00	58.93	226.91	20.00
172	0.26	90.73	160.21	167.00	44.40	203.62	20.00
174	0.26	90.61	160.21	167.00	41.19	197.97	20.00
176	0.26	90.28	160.21	167.00	38.32	193.42	20.00
18	0.25	91.06	160.18	167.00	48.17	211.16	20.00
182	0.61	90.87	160.21	167.00	58.33	226.76	20.00
184	0.26	91.39	160.24	167.00	59.88	227.63	20.00
186	0.26	91.22	160.23	167.00	36.69	190.55	20.00
188	0.19	91.29	160.22	167.00	58.57	226.38	20.00
190	0.19	91.02	160.21	167.00	57.54	225.54	20.00
191	0.19	90.93	160.21	167.00	55.44	223.64	20.00
192	0.26	90.67	160.21	167.00	55.10	223.50	20.00
193	0.19	90.28	160.21	167.00	55.61	224.07	20.00
194	0.61	90.61	160.21	167.00	57.51	226.10	20.00
195	0.22	90.68	160.19	167.00	52.09	220.33	20.00
196	0.19	90.89	160.21	167.00	56.80	224.91	20.00
197	0.22	90.49	160.18	167.00	41.25	198.26	20.00
198	0.19	90.76	160.21	167.00	56.27	224.47	20.00
199	0.22	91.17	160.18	167.00	51.25	217.90	20.00
20	0.25	90.98	160.18	167.00	46.26	207.30	20.00
200	0.19	90.32	160.21	167.00	55.58	224.02	20.00
201	0.22	91.03	160.18	167.00	51.01	217.45	20.00
203	0.25	91.10	160.18	167.00	43.62	202.21	20.00
204	0.19	90.96	160.21	167.00	49.06	212.79	20.00
205	0.25	90.90	160.18	167.00	36.25	190.17	20.00
206	0.19	90.87	160.21	167.00	34.53	187.51	20.00
209	0.14	91.58	160.18	167.00	26.02	175.29	20.00
21	0.25	91.95	160.18	167.00	50.49	215.48	20.00
210	0.26	90.91	160.21	167.00	47.50	209.59	20.00
211	0.14	90.91	160.18	167.00	25.27	174.28	20.00
212	0.26	91.06	160.21	167.00	56.51	224.67	20.00
213	0.14	90.53	160.18	167.00	34.24	187.24	20.00
214	0.26	90.89	160.20	167.00	56.30	224.55	20.00
22	0.25	91.17	160.18	167.00	41.50	198.42	20.00
220	0.61	90.39	160.21	167.00	56.02	224.82	20.00
228	0.26	90.26	160.20	167.00	46.99	209.06	20.00
229	0	91.24	160.18	167.00	28.67	179.23	20.00
230	0.26	90.42	160.20	167.00	31.84	184.02	20.00
231	0	90.67	160.18	167.00	28.61	179.23	20.00
232	0.26	90.57	160.20	167.00	55.27	223.73	20.00
233	0	92.81	160.19	167.00	50.42	214.35	20.00
234	0.26	90.73	160.20	167.00	56.23	224.55	20.00
235	0.14	91.14	160.18	167.00	31.98	184.01	20.00
236	0.26	90.44	160.20	167.00	48.87	212.93	20.00
238	0.26	90.09	160.20	167.00	49.12	213.81	20.00
24	0.25	91.31	160.18	167.00	47.05	208.67	20.00
240	0.26	89.70	160.20	167.00	40.76	197.73	20.00
242	0.26	90.34	160.20	167.00	43.66	202.55	20.00
244	0.26	87.43	160.20	167.00	38.44	194.78	20.00
246	0.26	87.43	160.20	167.00	41.09	199.42	20.00
248	0.26	88.71	160.20	167.00	50.51	218.29	20.00
250	0.26	90.19	160.20	167.00	53.43	222.23	20.00
252	0.26	89.63	160.20	167.00	52.15	221.31	20.00
254	0.26	89.38	160.20	167.00	50.97	218.78	20.00
258	0.26	88.37	160.20	167.00	39.83	196.75	20.00
26	0.25	90.87	160.18	167.00	42.56	200.42	20.00
260	0.26	88.17	160.20	167.00	36.91	192.04	20.00
262	0.26	89.73	160.20	167.00	48.45	212.61	20.00
264	0.26	89.32	160.20	167.00	50.57	217.87	20.00

268	0.26	89.42	160.20	167.00	47.58	210.96	20.00
270	0.26	89.20	160.20	167.00	50.65	218.16	20.00
272	0.26	89.57	160.20	167.00	51.72	220.44	20.00
278	0.26	89.32	160.20	167.00	50.64	218.04	20.00
28	0.25	90.83	160.18	167.00	41.25	198.15	20.00
282	0.26	89.06	160.20	167.00	49.58	215.74	20.00
284	0.26	89.18	160.20	167.00	50.17	217.03	20.00
288	0.26	88.81	160.20	167.00	49.33	215.39	20.00
289	0.28	91.37	160.21	167.00	22.60	170.64	20.00
290	0.26	91.29	160.23	167.00	59.18	227.01	20.00
30	0.25	90.97	160.18	167.00	43.41	201.87	20.00
301	0.19	90.83	160.21	167.00	49.78	214.48	20.00
302	0.19	90.61	160.21	167.00	56.01	224.29	20.00
303	0.19	90.47	160.21	167.00	55.72	224.09	20.00
304	0.19	90.17	160.21	167.00	47.38	209.82	20.00
32	0.22	89.98	160.18	167.00	33.33	186.18	20.00
34	0.25	91.03	160.18	167.00	43.52	202.05	20.00
36	0.25	91.29	160.18	167.00	51.61	218.68	20.00
38	0.25	91.87	160.18	167.00	52.93	221.26	20.00
391	0.28	92.29	160.21	167.00	55.28	223.05	20.00
393	0.28	91.65	160.21	167.00	51.89	218.63	20.00
395	0.28	91.70	160.21	167.00	46.54	207.10	20.00
399	0.17	92.81	160.22	167.00	61.35	228.38	20.00
40	0.25	91.93	160.18	167.00	53.14	221.42	20.00
401	0.32	92.48	160.26	167.00	62.39	229.62	20.00
402	0.26	91.32	160.24	167.00	46.23	206.64	20.00
403	0.26	91.16	160.23	167.00	55.36	223.51	20.00
404	0.26	92.15	160.22	167.00	55.14	222.94	20.00
405	0.26	92.29	160.22	167.00	30.88	182.37	20.00
406	0.26	90.27	160.20	167.00	48.61	212.50	20.00
407	0.26	90.42	160.20	167.00	27.86	178.32	20.00
408	0.26	90.70	160.20	167.00	55.02	223.45	20.00
409	0.26	90.84	160.20	167.00	54.87	223.27	20.00
410	0.26	89.85	160.20	167.00	28.88	180.06	20.00
411	0.19	89.85	160.20	167.00	42.06	199.82	20.00
412	0.26	90.13	160.20	167.00	54.51	223.21	20.00
413	0.26	89.70	160.20	167.00	53.27	222.26	20.00
414	0.26	89.56	160.20	167.00	52.01	221.17	20.00
415	0.26	88.85	160.20	167.00	30.00	181.93	20.00
416	0.26	88.14	160.20	167.00	28.88	180.44	20.00
42	0.25	91.68	160.18	167.00	46.86	207.98	20.00
44	0.25	91.53	160.18	167.00	51.53	218.26	20.00
46	0.25	91.53	160.18	167.00	51.16	217.39	20.00
48	0.18	92.00	160.18	167.00	50.39	215.14	20.00
50	0.18	92.14	160.18	167.00	49.55	213.17	20.00
54	0.18	92.24	160.19	167.00	53.86	221.86	20.00
56	0.22	90.83	160.18	167.00	50.76	217.04	20.00
58	0.22	91.13	160.18	167.00	49.63	214.20	20.00
60	0.22	91.24	160.18	167.00	48.58	211.80	20.00
62	0.22	91.86	160.18	167.00	49.76	213.88	20.00
64	0.22	91.10	160.19	167.00	52.10	219.96	20.00
66	0.22	92.07	160.18	167.00	49.99	214.21	20.00
68	0.22	91.36	160.18	167.00	49.08	212.80	20.00
70	0.22	91.10	160.19	167.00	51.90	219.48	20.00
72	0.22	90.72	160.18	167.00	51.06	217.84	20.00
74	0.22	90.75	160.19	167.00	51.86	219.70	20.00
76	0.22	90.68	160.19	167.00	48.87	212.84	20.00
78	0.18	92.41	160.19	167.00	50.34	214.66	20.00
80	0.18	92.57	160.19	167.00	50.03	213.86	20.00
82	0.18	92.72	160.19	167.00	50.9	215.64	20.00
84	0.18	92.54	160.19	167.00	45.39	204.51	20.00
86	0.18	92.81	160.19	167.00	50.85	215.48	20.00
88	0.18	92.14	160.19	167.00	54.35	222.32	20.00
90	0.17	92.52	160.19	167.00	55.36	223.05	20.00
92	0.17	92.88	160.20	167.00	58.09	225.37	20.00
94	0.17	92.33	160.20	167.00	57.97	225.45	20.00
96	0.17	92.62	160.19	167.00	56.75	224.25	20.00
98	0.28	92.13	160.20	167.00	46.89	207.66	20.00

APPENDIX D

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 'D'																											
	418A	419A	0.21		28	0.21	28	3.7	0.33		0.00		0.00		0.00	0.00	0.21	0.21	0.07	0.40	47.0	200	0.65	26.44	0.02	0.84	0.30
	419A	420A	0.21		28	0.42	56	3.6	0.66		0.00		0.00		0.00	0.00	0.21	0.42	0.14	0.80	61.5	200	0.35	19.40	0.04	0.62	0.30
	420A	422A	0.22		30	0.64	86	3.6	1.01		0.00		0.00		0.00	0.00	0.22	0.64	0.21	1.22	61.5	200	0.35	19.40	0.06	0.62	0.34
To STREET 'B', Pipe 422A - 423A						0.64	86				0.00		0.00		0.00			0.64									
STREET 'E'																											
	414A	415A	0.56		76	0.56	76	3.6	0.89		0.00		0.00		0.00	0.00	0.56	0.56	0.18	1.08	85.5	200	0.65	26.44	0.04	0.84	0.41
To STREET 'B', Pipe 415A - 416A						0.56	76				0.00		0.00		0.00			0.56									
COMMERCIAL BLOCK																											
	4100A	410A				0.00					0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	25.5	200	0.65	26.44	0.00	0.84	0.05
To STREET 'C/F', Pipe 410A - 411A						0.00	0				0.00		0.00		0.00			0.00									
STREET 'C/F'																											
	412A	413A	0.51		69	0.51	69	3.6	0.81		0.00		0.00		0.00	0.00	0.51	0.51	0.17	0.98	82.0	200	0.65	26.44	0.04	0.84	0.40
To STREET 'B', Pipe 413A - 415A						0.51	69				0.00		0.00		0.00			0.51									
Contribution From COMMERCIAL BLOCK, Pipe 4100A - 410A						0.00	0				0.00		0.00		0.00		0.00	0.00									
	410A	411A	0.38		51	0.38	51	3.7	0.60		0.00		0.00		0.00	0.00	0.38	0.38	0.13	0.73	54.0	200	0.35	19.40	0.04	0.62	0.29
	411A	413A	0.69		93	1.07	144	3.6	1.66		0.00		0.00		0.00	0.00	0.69	1.07	0.35	2.01	120.0	200	0.35	19.40	0.10	0.62	0.40
To STREET 'B', Pipe 413A - 415A						1.07	144				0.00		0.00		0.00			1.07									
STREET 'B'																											
			0.03		4	0.03	4				0.00		0.00		0.00		0.03	0.03									
			0.04		5	0.07	9				0.00		0.00		0.00		0.04	0.07									
	421A	422A	0.15		20	0.22	29	3.7	0.35		0.00		0.00		0.00	0.00	0.15	0.22	0.07	0.42	21.0	200	0.65	26.44	0.02	0.84	0.30
Contribution From STREET 'D', Pipe 420A - 422A						0.64	86				0.00		0.00		0.00		0.64	0.86									
	422A	423A	0.30		41	1.16	156	3.5	1.79		0.00		0.00		0.00	0.00	0.30	1.16	0.38	2.18	85.5	200	0.35	19.40	0.11	0.62	0.41
To STREET 'J', Pipe 423A - 332A						1.16	156				0.00		0.00		0.00			1.16									
Contribution From STREET 'I', Pipe 406A - 409A						0.78	106				0.00		0.00		0.00		0.78	0.78									
Contribution From STREET 'I', Pipe 408A - 409A						1.08	146				0.00		0.00		0.00		1.08	1.86									
	409A	413A	0.09		12	1.95	264	3.5	2.98		0.00		0.00		0.00	0.00	0.09	1.95	0.64	3.62	61.0	200	0.35	19.40	0.19	0.62	0.47
Contribution From STREET 'C/F', Pipe 411A - 413A						1.07	144				0.00		0.00		0.00		1.07	3.02									
Contribution From STREET 'C/F', Pipe 412A - 413A						0.51	69				0.00		0.00		0.00		0.51	3.53									
	413A	415A	0.16		22	3.69	499	3.4	5.47		0.00		0.00		0.00	0.00	0.16	3.69	1.22	6.68	60.5	200	0.35	19.40	0.34	0.62	0.56
Contribution From STREET 'E', Pipe 414A - 415A						0.56	76				0.00		0.00		0.00		0.56	4.25									
	415A	416A	0.18		24	4.43	599	3.3	6.50		0.00		0.00		0.00	0.00	0.18	4.43	1.46	7.96	51.0	200	0.35	19.40	0.41	0.62	0.59
	416A	417A	0.18		24	4.61	623	3.3	6.74		0.00		0.00		0.00	0.00	0.18	4.61	1.52	8.26	13.5	200	0.35	19.40	0.43	0.62	0.59
	417A	423A	0.11		15	4.72	638	3.3	6.89		0.00		0.00		0.00	0.00	0.11	4.72	1.56	8.45	19.5	200	0.35	19.40	0.44	0.62	0.60
To STREET 'J', Pipe 423A - 332A						4.72	638				0.00		0.00		0.00			4.72									
STREET 'J'																											
Contribution From STREET 'B', Pipe 417A - 423A						4.72	638				0.00		0.00		0.00		4.72	4.72									
Contribution From STREET 'B', Pipe 422A - 423A						1.16	156				0.00		0.00		0.00		1.16	5.88									
	423A	332A	0.05		7	5.93	801	3.3	8.54		0.00		0.00		0.00	0.00	0.05	5.93	1.96	10.49	35.0	200	0.35	19.40	0.54	0.62	0.63
To FOX RUN PHASE 3, Pipe 332A - 315A						5.93	801				0.00		0.00		0.00			5.93									
STREET 'I'																											
	4060A	406A	0.25		34	0.25	34	3.7	0.41		0.00		0.00		0.00	0.00	0.25	0.25	0.08	0.49	50.5	200	0.65	26.44	0.02	0.84	0.32

DESIGN PARAMETERS

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

Designed:		PROJECT:	**Richmond North West and Richmond North East**
Checked:	C.M.K.	LOCATION:	**City of Ottawa**
Dwg. Reference:	Sanitary Drainage Plan, Dwgs. No.	File Ref:	Date: **Aug 2022**
			Sheet No. 1 of 3

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)
	406A	409A	0.53		72	0.78	106	3.6	1.23		0.00		0.00		0.00	0.00	0.53	0.78	0.26	1.49	91.5	200	0.35	19.40	0.08	0.62	0.36
To STREET 'B', Pipe 409A - 413A						0.78	106				0.00		0.00		0.00			0.78									
	407A	408A	0.37		50	0.37	50	3.7	0.59		0.00		0.00		0.00	0.00	0.37	0.37	0.12	0.71	48.0	200	0.65	26.44	0.03	0.84	0.36
	408A	409A	0.71		96	1.08	146	3.6	1.68		0.00		0.00		0.00	0.00	0.71	1.08	0.36	2.04	120.0	200	0.35	19.40	0.11	0.62	0.40
To STREET 'B', Pipe 409A - 413A						1.08	146				0.00		0.00		0.00			1.08									
			0.20		11	0.20	11				0.00		0.00		0.00		0.20	0.20									
	429A	430A	0.67		37	0.87	48	3.7	0.57		0.00		0.00		0.00	0.00	0.67	0.87	0.29	0.86	100.5	200	0.65	26.44	0.03	0.84	0.38
	430A	305A	0.78		43	1.65	91	3.6	1.06		0.00		0.00		0.00	0.00	0.78	1.65	0.54	1.61	120.0	200	0.35	19.40	0.08	0.62	0.37
To FOX RUN PHASE 3, Pipe 305A - 306A						1.65	91				0.00		0.00		0.00			1.65									
	400A	4010A	0.44		25	0.44	25	3.7	0.30		0.00		0.00		0.00	0.00	0.44	0.44	0.15	0.44	60.0	200	0.65	26.44	0.02	0.84	0.32
	4010A	401A	0.59		33	1.03	58	3.6	0.68		0.00		0.00		0.00	0.00	0.59	1.03	0.34	1.02	80.0	200	0.35	19.40	0.05	0.62	0.33
	401A	405A	0.57		32	1.60	90	3.6	1.05		0.00		0.00		0.00	0.00	0.57	1.60	0.53	1.58	88.5	200	0.35	19.40	0.08	0.62	0.37
Contribution From STREET 'G', Pipe 404A - 405A						0.11	7				0.00		0.00		0.00		0.11	1.71									
	405A	424A	0.11		7	1.82	104	3.6	1.21		0.00		0.00		0.00	0.00	0.11	1.82	0.60	1.81	18.0	200	0.35	19.40	0.09	0.62	0.39
To BLOCK 36, Pipe 424A - 425A						1.82	104				0.00		0.00		0.00			1.82									
BLOCK 36																											
Contribution From STREET 'I', Pipe 405A - 424A						1.82	104				0.00		0.00		0.00		1.82	1.82									
	424A	425A	0.32		43	2.14	147	3.6	1.69		0.00		0.00		0.00	0.00	0.32	2.14	0.71	2.40	111.5	200	0.35	19.40	0.12	0.62	0.42
	425A	426A	0.31		42	2.45	189	3.5	2.16		0.00		0.00		0.00	0.00	0.31	2.45	0.81	2.97	98.0	200	0.35	19.40	0.15	0.62	0.44
To FOX RUN PHASE 3, Pipe 426A - 310A						2.45	189				0.00		0.00		0.00			2.45									
STREET 'G'																											
	403A	434A	0.55		31	0.55	31	3.7	0.37		0.00		0.00		0.00	0.00	0.55	0.55	0.18	0.55	80.5	200	0.65	26.44	0.02	0.84	0.33
To STREET 'H', Pipe 434A - 435A						0.55	31				0.00		0.00		0.00			0.55									
	431A	434A	0.28		16	0.28	16	3.7	0.19		0.00		0.00		0.00	0.00	0.28	0.28	0.09	0.28	64.5	200	0.65	26.44	0.01	0.84	0.27
To STREET 'H', Pipe 434A - 435A						0.28	16				0.00		0.00		0.00			0.28									
	403A	404A				0.00					0.00		0.00		0.00	0.00	0.00	0.00	0.00	0.00	12.0	200	0.65	26.44	0.00	0.84	0.05
	404A	405A	0.11		7	0.11	7	3.7	0.08		0.00		0.00		0.00	0.00	0.11	0.11	0.04	0.12	66.0	200	0.65	26.44	0.00	0.84	0.20
To STREET 'I', Pipe 405A - 424A						0.11	7				0.00		0.00		0.00			0.11									
	431A	432A	0.20		11	0.20	11	3.7	0.13		0.00		0.00		0.00	0.00	0.20	0.20	0.07	0.20	10.5	200	0.65	26.44	0.01	0.84	0.24
	432A	433A	0.51		29	0.71	40	3.7	0.48		0.00		0.00		0.00	0.00	0.51	0.71	0.23	0.71	74.0	200	0.65	26.44	0.03	0.84	0.36
	433A	306A	0.46		26	1.17	66	3.6	0.78		0.00		0.00		0.00	0.00	0.46	1.17	0.39	1.16	75.5	200	0.35	19.40	0.06	0.62	0.34
To FOX RUN PHASE 3, Pipe 306A - 307A						1.17	66				0.00		0.00		0.00			1.17									
STREET 'H'																											
Contribution From STREET 'G', Pipe 403A - 434A						0.55	31				0.00		0.00		0.00		0.55	0.55									
Contribution From STREET 'G', Pipe 431A - 434A						0.28	16				0.00		0.00		0.00		0.28	0.83									
	434A	435A	0.32		18	1.15	65	3.6	0.77		0.00		0.00		0.00	0.00	0.32	1.15	0.38	1.14	80.0	200	0.35	19.40	0.06	0.62	0.33
	435A	308A	0.33		19	1.48	84	3.6	0.98		0.00		0.00		0.00	0.00	0.33	1.48	0.49	1.47	80.0	200	0.35	19.40	0.08	0.62	0.36
To FOX RUN PHASE 3, Pipe 308A - 309A						1.48	84				0.00		0.00		0.00			1.48									

DESIGN PARAMETERS

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

Designed:		PROJECT:	Richmond North West and Richmond North East
Checked:	C.M.K.	LOCATION:	City of Ottawa
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No.	File Ref:	Date: Aug 2022	Sheet No. 2 of 3

Lower flows (37.96 L/s) projected for the Richmond North West and other areas north of Perth Street than the flows that were previously summarized in the Fox Run Phase 1 design sheet (41.93 L/s). Therefore, no downstream impacts.

Richmond North East sanitary flow total of 2.79 L/s projected to existing sewers.

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

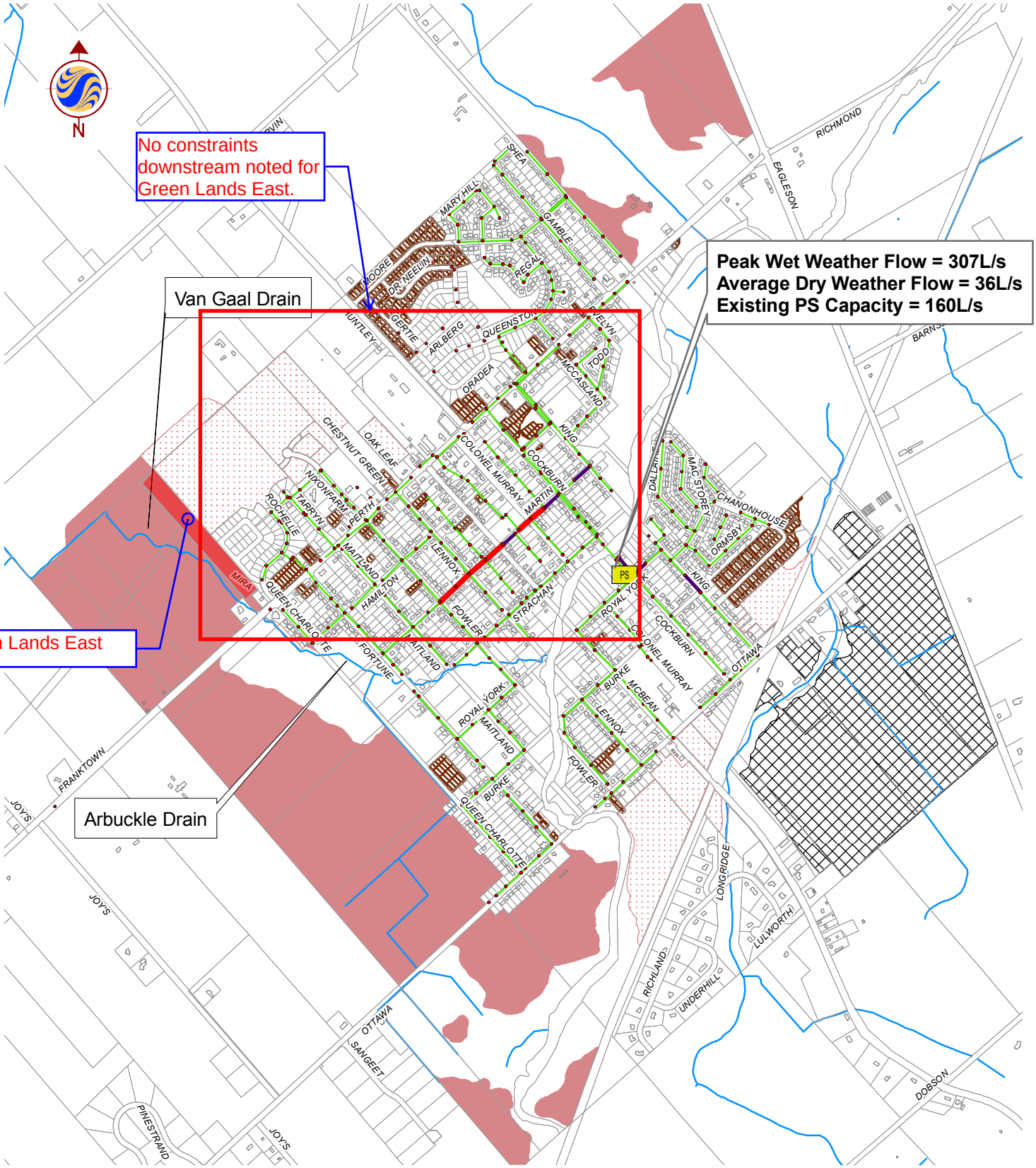
LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION					PIPE					
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	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)
MIRA COURT																											
	24	506A	0.48		16	0.48	16	3.7	0.19		0.00		0.00		0.00	0.00	0.48	0.48	0.16	0.35	101.5	200	0.65	26.44	0.01	0.84	0.29
To STREET 'G', Pipe 506A - 508A						0.48	16				0.00		0.00		0.00			0.48									
	24	23	0.47		16	0.47	16	3.7	0.19		0.00		0.00		0.00	0.00	0.47	0.47	0.16	0.35	69.0	300	0.70	80.91	0.00	1.14	0.27
	23	22	0.51		17	0.98	33	3.7	0.39		0.00		0.00		0.00	0.00	0.51	0.98	0.32	0.72	45.0	300	0.30	52.97	0.01	0.75	0.26
To ROCHELLE DRIVE, Pipe 22 - 21						0.98	33				0.00		0.00		0.00			0.98									
STREET 'A'																											
Contribution From MIRA COURT, Pipe 24 - 506A						0.48	16				0.00		0.00		0.00		0.48	0.48									
	506A	508A	0.00		0	0.48	16	3.7	0.19		0.00		0.00		0.00	0.00	0.00	0.48	0.16	0.35	30.0	200	1.55	40.83	0.01	1.30	0.40
To STREET 'A', Pipe 508A - 509A						0.48	16				0.00		0.00		0.00			0.48									
STREET 'A'																											
	502A	503A	0.71		24	0.71	24	3.7	0.29		0.00		0.00		0.00	0.00	0.71	0.71	0.23	0.52	86.5	200	0.65	26.44	0.02	0.84	0.33
	503A	504A	0.48		16	1.19	40	3.7	0.48		0.00		0.00		0.00	0.00	0.48	1.19	0.39	0.87	84.0	200	0.35	19.40	0.04	0.62	0.31
	504A	509A	0.53		17	1.72	57	3.6	0.67		0.00		0.00		0.00	0.00	0.53	1.72	0.57	1.24	83.5	200	0.35	19.40	0.06	0.62	0.34
To CEDARSTONE STREET, Pipe 509A - EX. MH						1.72	57				0.00		0.00		0.00			1.72									
Contribution From STREET 'A', Pipe 506A - 508A						0.48	16				0.00		0.00		0.00		0.48	0.48									
	508A	509A	0.69		23	1.17	39	3.7	0.46		0.00		0.00		0.00	0.00	0.69	1.17	0.39	0.85	23.0	200	1.45	39.49	0.02	1.26	0.50
To CEDARSTONE STREET, Pipe 509A - EX. MH						1.17	39				0.00		0.00		0.00			1.17									
CEDARSTONE STREET																											
Contribution From STREET 'G', Pipe 504A - 509A						1.72	57				0.00		0.00		0.00		1.72	1.72									
Contribution From STREET 'G', Pipe 508A - 509A						1.17	39				0.00		0.00		0.00		1.17	2.89									
	509A	EX. MH	0.00		0	2.89	96	3.6	1.12		0.00		0.00		0.00	0.00	0.00	2.89	0.95	2.07	9.0	200	0.35	19.40	0.11	0.62	0.40
OLDENBURG AVENUE																											
			2.87		176	2.87	176										2.87	2.87									
	304A	305A	0.18		10	3.05	186	3.5	2.13		0.00		0.00		0.00	0.00	0.18	3.05	1.01	3.13	28.0	200	0.65	26.44	0.12	0.84	0.56
Contribution From Richmond North West, Pipe 430A - 305A						1.65	91				0.00		0.00		0.00		1.65	4.70									
	305A	306A	0.32		18	3.37	295	3.5	3.31		0.00		0.00		0.00	0.00	0.32	5.02	1.66	4.97	72.0	200	0.35	19.40	0.26	0.62	0.52
Contribution From Richmond North West, Pipe 433A - 306A						1.17	66				0.00		0.00		0.00		1.17	6.19									
	306A	307A				3.37	361	3.4	4.02		0.00		0.00		0.00	0.00	0.00	6.19	2.04	6.06	54.5	200	0.35	19.40	0.31	0.62	0.54
	307A	308A	0.29		16	3.66	377	3.4	4.19		0.00		0.00		0.00	0.00	0.29	6.48	2.14	6.33	13.0	200	0.35	19.40	0.33	0.62	0.55
Contribution From ALIGNMENT 09, Pipe 303A - 308A						2.99	168				0.00		0.00		0.00		2.99	9.47									
Contribution From Richmond North West, Pipe 435A - 308A						1.48	84				0.00		0.00		0.00		1.48	10.95									
	308A	309A	0.15		9	6.80	638	3.3	6.89		0.00		0.00	1.07	1.07	0.00	1.22	12.17	4.02	10.91	77.5	250	0.25	29.73	0.37	0.61	0.56
Contribution From ALIGNMENT 05, Pipe 322A - 309A						0.68	38				0.00		0.00		0.00		0.68	12.85									
	309A	310A	0.14		19	7.62	695	3.3	7.47		0.00		0.00		1.07	0.00	0.14	12.99	4.29	11.76	11.0	250	0.25	29.73	0.40	0.61	0.57
Contribution From BLOCK 36, Pipe 426A - 310A						0.13	207				0.00		0.00		0.00		2.58	15.57									
	310A	311A				7.75	902	3.3	9.54		0.00		0.00		1.07	0.00	0.00	15.57	5.14	14.68	11.5	250	0.25	29.73	0.49	0.61	0.60
	311A	312A				7.75	902	3.3	9.54		0.00		0.00		1.07	0.00	0.00	15.57	5.14	14.68	18.0	250	0.25	29.73	0.49	0.61	0.60
	312A	314A	0.44		59	8.19	961	3.2	10.12		0.00		0.00		1.07	0.00	0.44	16.01	5.28	15.40	71.5	250	0.25	29.73	0.52	0.61	0.61
Contribution From ALIGNMENT 15, Pipe 326A - 314A						0.80	108				0.00		0.00		0.00		0.80	16.81									
	314A	315A	0.27		36	9.26	1105	3.2	11.52		0.00		0.00		1.07	0.00	0.27	17.08	5.64	17.16	60.5	300	0.20	43.25	0.40	0.61	0.57
Contribution From STREET 'J', Pipe 332A - 315A						6.27	847				0.00		0.00		0.00		6.27	23.35									
	315A	262A	0.50		44	9.76	1996	3.1	19.85		0.00		0.00		1.07	0.00	0.50	23.85	7.87	27.72	75.0	300	0.20	43.25	0.64	0.61	0.65
			0.26		25	10.02	2021				0.00		0.00		1.07		0.26	24.11									
	262A	263A	0.29		28	10.31	2049	3.1	20.33		0.00		0.00		1.07	0.00	0.29	24.40	8.05	28.39	75.0	300	0.20	43.25	0.66	0.61	0.65
Contribution From ALIGNMENT 10, Pipe 329A - 330A						4.04	319				0.00		0.00		0.00		4.04	28.44									
Contribution From BASCULE PLACE, Pipe 259A - 263A						3.86	345				0.00		0.00		0.00		1.48	29.92									
			0.18		11	8.08	2724				0.00		0.00		0.00		0.18	30.10									
	263A	267A	0.23		14	8.31	2738	3.0	26.45		0.00		0.00		0.00	0.00	0.23	30.33	10.01	36.46	69.0	375	0.15	67.91	0.54	0.61	0.62
Contribution From PERTH STREET, Pipe 256A - 267A						0.44	126				0.00		0.00		0.00		0.44	30.77									
	267A	150A	0.74		2	1.18	2866	3.0	27.56		0.00		0.00		0.00	0.00	0.74	31.51	10.40	37.96	22.0	375	0.15	67.91	0.56	0.61	0.63

DESIGN PARAMETERS

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

Designed:		PROJECT:	Richmond North West and Richmond North East
Checked:	C.M.K.	LOCATION:	City of Ottawa
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No.		File Ref:	Date: Aug 2022
			Sheet No. 3 of 3

1083_SAN.xlsx



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.7-richmond_wastewater_SS_Results_PS_ECapacity_portrait_mt20090130.mxd

Legend

Flow / Pipe Capacity

- 0.00-0.90
- 0.90-1.10
- +1.10

- Serviced Future Development
- Future Development
- Future Infill
- Future Industrial

Client/Project

CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.

5.7

Title

Existing, Infill & Limited Future Growth Area Gravity Collection System Bottlenecks

March 2009
1634-00808

Stantec

SANITARY SEWER CALCULATION SHEET

Ottawa

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 Nominal (mm)	DIA Actual (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)
cercle Equitation Circle																											
	5A	6A	0.38	9	30.6	0.38	30.6	4.00	0.50								0.38	0.38	0.106	0.61	50.0	200	200	0.90	31.12	0.02	0.99
	6A	7A	0.71	20	68.0	1.09	98.6	4.00	1.60								0.71	1.09	0.305	1.91	107.5	200	200	0.40	20.74	0.09	0.66
To cercle Equitation Circle , Pipe 7A - 8A						1.09	98.6																				
	1A	2A	0.24	4	13.6	0.24	13.6	4.00	0.22								0.24	0.24	0.067	0.29	40.0	200	200	0.65	26.44	0.01	0.84
	2A	3A	0.38	8	27.2	0.62	40.8	4.00	0.66								0.38	0.62	0.174	0.83	94.0	200	200	0.40	20.74	0.04	0.66
	3A	4A	0.06	1	3.4	0.68	44.2	4.00	0.72								0.06	0.68	0.190	0.91	11.0	200	200	0.40	20.74	0.04	0.66
	4A	7A	0.29	7	23.8	0.97	68.0	4.00	1.10								0.29	0.97	0.272	1.37	62.5	200	200	0.85	30.24	0.05	0.96
Contribution From cercle Equitation Circle, Pipe 6A - 7A						1.09	98.6										1.09	2.06									
	7A	8A	0.25	5	17.0	2.31	183.6	4.00	2.98								0.25	2.31	0.647	3.63	70.5	200	200	0.40	20.74	0.18	0.66
To croissant Hackamore Crescent , Pipe 8A - 152A						2.31	183.6																				
croissant Hackamore Crescent																											
Contribution From Future Phase						0.94	72.0										0.94	0.94									
	PLUG	8A	0.04	1	3.4	0.98	75.4	4.00	1.22								0.04	0.98	0.274	1.49	11.0	200	200	0.50	23.19	0.06	0.74
Contribution From cercle Equitation Circle, Pipe 7A - 8A						2.31	183.6										2.31	3.29									
	8A	152A	0.26	5	17.0	3.55	276.0	4.00	4.47								0.26	3.55	0.994	5.46	73.5	200	200	0.40	20.74	0.26	0.66
To chemin Meynell Road, Pipe 152A - 153A						3.55	276.0																				
croissant Cantle Crescent																											
Contribution From Flushing Device (1.50 L/s)																				1.50							
	9A	152A	0.34	4	13.6	0.34	13.6	4.00	0.22								0.34	0.34	0.095	1.82	59.0	200	200	0.65	26.44	0.07	0.84
To chemin Meynell Road, Pipe 152A - 153A						0.34	13.6																				
	10A	11A	0.22	3	10.2	0.22	10.2	4.00	0.17								0.22	0.22	0.062	0.23	16.5	200	200	0.65	26.44	0.01	0.84
	11A	153A	0.65	16	54.4	0.87	64.6	4.00	1.05								0.65	0.87	0.244	1.29	103.5	200	200	0.35	19.40	0.07	0.62
To chemin Meynell Road, Pipe 153A - 155A						0.87	64.6																				
Contribution From Future Phase						1.73	130.0										1.73	1.73									
	PLUG	153A	0.00	0	0.0	1.73	130.0	4.00	2.11								0.00	1.73	0.484	2.59	15.5	200	200	0.40	20.74	0.12	0.66
To chemin Meynell Road, Pipe 153A - 155A						1.73	130.0																				
croissant Pelham Crescent																											
	12A	13A	0.36	7	23.8	0.36	23.8	4.00	0.39								0.36	0.36	0.101	0.49	38.0	200	200	0.65	26.44	0.02	0.84
	13A	155A	0.65	16	54.4	1.01	78.2	4.00	1.27								0.65	1.01	0.283	1.55	105.0	200	200	0.40	20.74	0.07	0.66
To chemin Meynell Road, Pipe 155A - 156A						1.01	78.2																				
	1500A	15A	0.11	1	3.4	0.11	3.4	4.00	0.06								0.11	0.11	0.031	0.09	10.0	200	200	0.65	26.44	0.00	0.84
	15A	16A	0.27	6	20.4	0.38	23.8	4.00	0.39								0.27	0.38	0.106	0.50	37.0	200	200	0.65	26.44	0.02	0.84
	16A	156A	0.73	19	64.6	1.11	88.4	4.00	1.43								0.73	1.11	0.311	1.74	112.0	200	200	0.40	20.74	0.08	0.66
To chemin Meynell Road, Pipe 156A - 157A						1.11	88.4																				
Contribution From Future Phase						2.25	162.0										2.25	2.25									
	PLUG	156A	0.00	0	0.0	2.25	162.0	4.00	2.63								0.00	2.25	0.630	3.26	14.5	200	200	0.40	20.74	0.16	0.66
To chemin Meynell Road, Pipe 156A - 157A						2.25	162.0																				

DESIGN PARAMETERS

Average Daily Flow =	350	l/p/day	Industrial Peak Factor = as per MOE Graph	
Commercial/Institution Flow =	50000	L/ha/da	Extraneous Flow =	0.280 L/s/ha
Industrial Flow =	35000	L/ha/da	Minimum Velocity =	0.60 m/s
Max Res. Peak Factor =	4.00		Manning's n =	0.013
Commercial/Institution/Park Peak Factor =	1.50		Townhouse coeff=	2.7
Park Average Flow =	9300	L/ha/da	Single house coeff=	3.4

Designed: K.M.

Checked: W.L.

Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 39 - 40

PROJECT: **Caivan Coomunities - Richmond Phase 1**

LOCATION: **City of Ottawa**

File Ref: 15-783

Date: November, 2017

Sheet No. 1 of 2

SUMMATION OF PROJECTED POPULATIONS FROM THE DEVELOPMENT AREAS NORTH OF PERTH STREET CONSIDERED IN THE FOX RUN PHASE 1 DESIGN: TO MH150A

Projected Total flow of 41.93 L/s in the original Fox Run Phase 1 design sheet.

Projected Total flow from the Fox Run Phase 2 (North) and Richmond North West design sheet (including external areas) = 37.96/s < 41.93 L/s therefore OK for downstream capacities.

SANITARY SEWER CALCULATION SHEE

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 Nominal (mm)	DIA Actual (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)
croissant Reynard Crescent																											
	17A	18A	0.20	2	6.8	0.20	6.8	4.00	0.11								0.20	0.20	0.056	0.17	11.0	200	200	2.00	46.38	0.00	1.48
	18A	19A	0.28	4	13.6	0.48	20.4	4.00	0.33								0.28	0.48	0.134	0.46	61.0	200	200	0.50	23.19	0.02	0.74
	19A	20A	0.09	1	3.4	0.57	23.8	4.00	0.39								0.09	0.57	0.160	0.55	11.0	200	200	0.40	20.74	0.03	0.66
	20A	160A	0.77	9	30.6	1.34	54.4	4.00	0.88								0.77	1.34	0.375	1.26	114.0	200	200	0.40	20.74	0.06	0.66
To cour Noriker Court, Pipe 160A - 161A						1.34	54.4																				
	17A	159A	0.84	13	44.2	0.84	44.2	4.00	0.72								0.84	0.84	0.235	0.96	113.5	200	200	0.65	26.44	0.04	0.84
To cour Noriker Court, Pipe 159A - 160A						0.84	44.2																				
chemin Meynell Road																											
Contribution From External						31.61	1897.0			1.12		2.75		1.13			36.61	36.61									
	150A	151A	0.45	7	23.8	32.06	1920.8	3.60	28.01		1.12		2.75		1.13	3.54	0.45	37.06	10.377	41.93	73.5	450	450	0.13	102.80	0.41	0.65
	151A	152A	0.51	11	37.4	32.57	1958.2	3.59	28.48		1.12		2.75		1.13	3.54	0.51	37.57	10.520	42.54	73.5	450	450	0.13	102.80	0.41	0.65
Contribution From croissant Cantle Crescent, Pipe 9A - 152A						0.34	13.6										0.34	37.91									
Contribution From croissant Hackamore Crescent, Pipe 8A - 152A						3.55	276.0										3.55	41.46									
	152A	153A	0.13	0	0.0	36.59	2247.8	3.55	32.33		1.12		2.75		1.13	3.54	0.13	41.59	11.645	49.02	70.5	450	450	0.13	102.80	0.48	0.65
Contribution From Future Street, Pipe Plug - 153A						1.73	130.0										1.73	43.32									
Contribution From croissant Cantle Crescent, Pipe 11A - 153A						0.87	64.6										0.87	44.19									
	153A	155A	0.14	0	0.0	39.33	2442.4	3.52	34.83		1.12		2.75		1.13	3.54	0.14	44.33	12.412	52.28	70.5	450	450	0.13	102.80	0.51	0.65
Contribution From Block 236 (Park)														0.96	0.96	0.16	0.96	0.96	0.269	0.43	13.0	200	200	1.00	32.80	0.01	1.04
Contribution From croissant Pelham Crescent, Pipe 13A - 155A						1.01	78.2										1.01	46.30									
	155A	156A	0.14	0	0.0	40.48	2520.6	3.51	35.84		1.12		2.75		2.09	3.70	0.14	46.44	13.003	54.04	71.0	450	450	0.13	102.80	0.53	0.65
Contribution From Future Street, Pipe Plug - 156A						2.25	162.0										2.25	48.69									
Contribution From croissant Pelham Crescent, Pipe 16A - 156A						1.11	88.4										1.11	49.80									
	156A	157A	0.63	12	40.8	44.47	2811.8	3.47	39.52		1.12		2.75		2.09	3.70	0.63	50.43	14.120	58.84	102.5	450	450	0.13	102.80	0.57	0.65
	157A	158A	0.68	15	51.0	45.15	2862.8	3.46	40.13		1.12		2.75		2.09	3.70	0.68	51.11	14.311	59.64	92.5	450	450	0.13	102.80	0.58	0.65
To cour Noriker Court, Pipe 158A - 159A						45.15	2862.8				1.12		2.75		2.09												
cour Noriker Court																											
Contribution From Future Phase						4.42	330.0										4.42	4.42									
	PLUG	158A	0.00	0	0.0	4.42	330.0	4.00	5.35								0.00	4.42	1.238	6.59	14.0	200	200	0.35	19.40	0.34	0.62
Contribution From chemin Meynell Road, Pipe 157A - 158A						45.15	2862.8				1.12		2.75		2.09		51.11	55.53									
	158A	159A	0.34	4	13.6	49.91	3206.4	3.42	44.42		1.12		2.75		2.09	3.70	0.34	55.87	15.644	65.26	79.5	450	450	0.13	102.80	0.63	0.65
Contribution From croissant Reynard Crescent, Pipe 17A - 159A						0.84	44.2										0.84	56.71									
	159A	160A	0.37	5	17.0	51.12	3267.6	3.41	45.14		1.12		2.75		2.09	3.70	0.37	57.08	15.982	66.32	76.5	450	450	0.13	102.80	0.65	0.65
Contribution From croissant Reynard Crescent, Pipe 20A - 160A						1.34	54.4										1.34	58.42									
	160A	161A	0.36	4	13.6	52.82	3335.6	3.40	45.94		1.12		2.75		2.09	3.70	0.36	58.78	16.458	67.60	72.5	450	450	0.13	102.80	0.66	0.65
To Block 222 (SWM Pond), Pipe 161A - 121A						52.82	3335.6				1.12		2.75		2.09												
Block 222 (SWM Pond)																											
Contribution From External						51.61	3097.0					2.65		4.10			58.36	58.36									
	PLUG	161A	0.00	0	0.0	51.61	3097.0	3.43	43.03				2.65		4.10	2.96	0.00	58.36	16.341	62.33	48.5	450	450	0.13	102.80	0.61	0.65
Contribution From cour Noriker Court, Pipe 160A - 161A						52.82	3335.6				1.12		2.75		2.09		58.78	117.14									
	161A	121A	0.00	0	0.0	104.43	6432.6	3.14	81.82		1.12		5.40		6.19	6.66	0.00	117.14	32.799	122.78	42.0	600	600	0.12	212.70	0.58	0.75
To Sanitary Trunk, Pipe 121A - 123A						104.43	6432.6				1.12		5.40		6.19												

DESIGN PARAMETERS

Average Daily Flow =	350	l/p/day	Industrial Peak Factor = as per MOE Graph		
Commercial/Institution Flow =	50000	L/ha/da	Extraneous Flow =	0.280	L/s/ha
Industrial Flow =	35000	L/ha/da	Minimum Velocity =	0.60	m/s
Max Res. Peak Factor =	4.00		Manning's n =	0.013	
Commercial/Institution/Park Peak Factor =	1.50		Townhouse coeff=	2.7	
Park Average Flow =	9300	L/ha/da	Single house coeff=	3.4	

Designed: K.M.

Checked: W.L.

Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 39 - 40

PROJECT: **Caivan Coomunities - Richmond Phase 1**

LOCATION: **City of Ottawa**

File Ref: 15-783 | Date: November, 2017 | Sheet No. 2 of 2

Memo

Stantec

To:	Adam Fobert	From:	James Ricker / John Krug
	David Schaeffer Engineering Ltd. 120 Iber Road, Unit 203 Stittsville, ON		Stantec Consulting Ltd. 1505 Laperriere Ave. Ottawa, ON
File:	163401146	Date:	October 5, 2012

Reference: Richmond Pump Station – Design Level of Service

EXISTING CONDITIONS / BACKGROUND

The Richmond Pumping Station (RPS), located at 63 York Street consists of a dry well/wet well configuration equipped with emergency power, communication and control systems. The RPS moves wastewater collected from the villages of Richmond and Munster through a 13.85 km, 500 mm diameter forcemain to an outfall along the Glen Cairn trunk located on Eagleson Road across from the Hazeldean Mall. The RPS has an overflow to the Jock River and a bypass with two (2) portable connections to protect the station from flooding. Sewage can also be pumped to a lagoon cell C located off Eagleson Road during high flows or directly to the river in extreme measures. A biological odor control system is also installed in the wet well to remove hydrogen sulfide from the air.

The RPS has four (4) pumps utilizing a lead-lag configuration with a maximum firm capacity discharge flow of 160 L/s.

Typical water levels in the Jock River at the Station are 90.89m with a 100 year water level of 93.80m, which means the overflow is currently not effective to protect local residential basements should a catastrophic pump station failure occur during high water conditions.

TARGET LEVEL OF SERVICE

It is our understanding that City Staff have requested consideration for the following level of service with respect to sanitary servicing of the new development area:

- Provide a firm capacity of the station (i.e. largest pump out of service) with a 1:100 year peak flow to the station;
- Provide the ability to pump flow with primary power failure;
- Provide the ability to overflow should the secondary diesel generator backup power fail (i.e. catastrophic failure);

MINISTRY OF THE ENVIRONMENT (MOE) DESIGN GUIDELINES

The following excerpts from the 2008 MOE Design Guidelines for Sewage Works are generally considered as the minimum requirements for pump station design:

- 7.1.1 Station Capacity – "Sewage pump stations serving sanitary sewer systems should be able to pump the design peak instantaneous sewage flow."
    - *Comment: This condition is currently met and will be met with the proposed MSS upgrades.*
- 7.1.2 Flooding – "Sewage pumping stations structures and electrical and mechanical equipment should be protected from physical damage by the 100 year design event. Sewage pumping stations should remain fully operational and accessible during the 25-year flood event."
    - *Comment: This condition is currently met as floor elevation of pump station structure is at 94.0m, which is above the reported 1:100yr HWL of 93.80m thereby protecting electrical and mechanical equipment. The station is also fully operational in the 100 year event. The proposed upgrades at the station will not impact this condition.*
- 7.2.3 Pumps – "Multiple pumps should be provided. Where only two units are provided, they should be of the same size, to provide a firm capacity with one unit out-of service and at least capable of handling the 10-year design peak hourly flow."
    - *Comment: Condition currently met as there are four pumps (2 small and 2 large) to provide firm capacity. The MSS proposes to provide sufficient capacity to meet or exceed this condition.*
- 7.7 Standby Power and Emergency Operation – "Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability should be accomplished by provision of portable or in-place internal combustion engine equipment, which will generate electrical or mechanical energy, or by the provision of portable pumping equipment. For engine driven generating equipment, an automatic transfer switch should be provided to allow for bypass of unit for service. Such emergency standby systems should have sufficient capacity to start up and maintain the design capacity of the pumping station. Regardless of the type of emergency standby system provided, a portable pump connection to the forcemain with rapid connection capabilities and appropriate valving should be provided outside the dry well and wet well."
    - *Comment: This condition is currently met with a backup diesel generator and automatic transfer switch should primary power be unavailable. The system has sufficient capacity to provide the existing station with a firm capacity of 160L/s and is proposed to be upgraded with sufficient backup power to meet future firm capacity requirements. There is also provision at the station to connect portable pumps should they be required.*

- "Emergency High Level Overflows: A controlled, high-level wet well overflow to supplement alarm systems and emergency power generation should be provided for use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions. Where a high level overflow is utilized, consideration should also be given to the installation of storage/detention tanks, or basins, which should be made to drain to the pumping station wetwell. Where such overflows may affect public water supplies or other critical water uses, the ministry should be contacted for the necessary treatment or storage requirements and in the case of combined sewer overflow the application of the ministry Procedure F-5-5 to the site-specific conditions."
    - *Comment: The station has approval from the MOE to have an existing high level overflow to the Jock River should the station be overwhelmed to prevent basement flooding under normal water river levels.*

CITY OF OTTAWA SEWER DESIGN GUIDELINES

The City's November 2004 sewer design guidelines are consistent with the MOE's requirements as listed above. In addition, the City's guidelines for flood protection/overflow are more prescriptive giving specific design levels for the overflow elevation (i.e. 1m below basement elevation and the overflow ***should*** be above the 100 year elevation):

"7.2.1.6.8 Emergency Provision for Flood Protection

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

Provision for an emergency conduit connection to an adjacent or downstream sanitary sewer system is preferred; however, a connection of the conduit to a storm sewer system or watercourse is often the only feasible option. Emergency conduit connections to storm sewers with downstream stormwater treatment facilities are preferred over direct connections to watercourses. **Emergency conduit connections should be above the 100-year stormwater elevation.**

Emergency conduit connections to storm sewers, storage facilities, natural water courses, or surface outfall points will be subject to approval by the Ontario Ministry of the Environment. The emergency conduits should also be identified as part of the Municipal Class Environmental Assessment Process. Emergency conduit connections

see Section 4.1.1 of DSEL design brief for discussion

Reference: Richmond Pump Station – Design Level of Service

shall be provided with suitable protection to prevent backflow from the flow receptor into the pumping station. This may consist of backwater valves and/or shut off valving."

- *Comment: The existing overflow currently does not meet the City's guidelines of being above the 100 year stormwater elevation (i.e. 93.8m at this location), which states that this elevation "should" be met, but does not state that this condition "shall" be met. There are other pump stations in Ottawa that operate with similar high level overflows that are below the 100 year elevation (i.e. Signature Ridge PS).*

PROPOSED RPS UPGRADES

The proposed RPS upgrades within the MSS do not impact the current level of service at the station. The station currently meets, and the future upgrades will meet, the MOE and City's design guidelines. The only concern to be noted is that both the existing condition and proposed future upgrade will have an overflow elevation that is not consistent with the City's 2004 design guideline that the elevation "should" be above the 100 year stormwater elevation. Given the topography of the Richmond area this condition cannot be met.

In the event of catastrophic failure of the pump station, the City can bring additional measures to bear to prevent basement flooding and/or overflow including portable pumping or portable backup generator power. In the unlikely event of a catastrophic failure of the pump station during the 100 year storm event, the Western Development lands would likely not be affected immediately, as these lands lie a distance away from the pump station and the existing village lies between the pump station and the new development.

Given the remote possibility of each of these occurrences happening at the same time (i.e. 100yr event, primary power failure, backup generator failure) a probability cannot be accurately determined.

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APPENDIX E

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

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

	LOCATION		AREA (Ha)														FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			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 'D'																																
	421	422	0.21	0.80	0.47	0.47			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	36	300	300	PVC	0.35	48.5	57.2089	0.8093	0.9988	0.627
	422	423	0.23	0.80	0.51	0.98			0.00	0.00			0.00	0.00			0.00	0.00	11.00	73.17	99.20	116.26	169.92	72	375	375	PVC	0.30	61.5	96.0323	0.8695	1.1789	0.746
	423	425	0.20	0.80	0.44	1.42			0.00	0.00			0.00	0.00			0.00	0.00	12.18	69.35	93.94	110.07	160.83	99	450	450	CONC	0.20	61.5	127.5033	0.8017	1.2785	0.774
To STREET 'B', Pipe 425 - 426						1.42				0.00				0.00				0.00	13.46														
STREET 'E'																																
	417	418	0.57	0.70	1.11	1.11			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	85	450	450	CONC	0.20	87.5	127.5033	0.8017	1.8191	0.668
To STREET 'B', Pipe 418 - 419						1.11				0.00				0.00				0.00	11.82														
COMMERCIAL BLOCK																																
	DICB 1001	413			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	450	450	CONC	0.25	31.5	142.5531	0.8963	0.5857	0.000
To STREET 'C/F', Pipe 413 - 414						0.00				0.00				0.00				0.00	10.59														
STREET 'C/F'																																
	415	416	0.52	0.70	1.01	1.01			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	78	375	375	PVC	0.30	84.0	96.0323	0.8695	1.6101	0.809
To STREET 'B', Pipe 416 - 418						1.01				0.00				0.00				0.00	11.61														
Contribution From COMMERCIAL BLOCK, Pipe DICB 1001 - 41						0.00				0.00				0.00				0.00	10.59														
	413	414	0.38	0.70	0.74	0.74			0.00	0.00			0.00	0.00			0.00	0.00	10.59	74.63	101.20	118.61	173.38	55	525	525	CONC	0.20	54.0	192.3297	0.8885	1.0130	0.287
	414	416	0.68	0.70	1.32	2.06			0.00	0.00			0.00	0.00			0.00	0.00	11.60	71.17	96.44	113.02	165.16	147	525	525	CONC	0.20	116.5	192.3297	0.8885	2.1854	0.763
To STREET 'B', Pipe 416 - 418						2.06				0.00				0.00				0.00	13.78														
STREET 'I'																																
	410	411	0.38	0.70	0.74	0.74			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	57	375	375	PVC	0.30	50.5	96.0323	0.8695	0.9680	0.591
	411	412	0.70	0.70	1.36	2.10			0.00	0.00			0.00	0.00			0.00	0.00	10.97	73.28	99.34	116.43	170.17	154	525	525	CONC	0.20	116.0	192.3297	0.8885	2.1761	0.801
To STREET 'B', Pipe 412 - 416						2.10				0.00				0.00				0.00	13.14														
	432	433	0.81	0.65	1.46	1.46			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	112	450	450	CONC	0.25	104.5	142.5531	0.8963	1.9431	0.789
	433	305	0.78	0.65	1.41	2.87			0.00	0.00			0.00	0.00			0.00	0.00	11.94	70.07	94.94	111.24	162.55	201	600	600	CONC	0.20	119.0	274.5943	0.9712	2.0422	0.733
To OLDENBURG AVENUE, Pipe 332 - 314						2.87				0.00				0.00				0.00	13.99														
	401	402	0.96	0.65	1.73	1.73			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	133	525	525	CONC	0.20	123.0	192.3297	0.8885	2.3074	0.693
	402	406	0.70	0.65	1.26	3.00			0.00	0.00			0.00	0.00			0.00	0.00	12.31	68.95	93.40	109.44	159.90	207	675	675	CONC	0.15	108.0	325.5584	0.9098	1.9785	0.635
Contribution From STREET 'G', Pipe 405 - 406						0.22				0.00				0.00				0.00	11.77														
	406	408	0.21	0.65	0.38	3.60			0.00	0.00			0.00	0.00			0.00	0.00	14.29	63.51	85.94	100.65	147.00	228	675	675	CONC	0.15	47.5	325.5584	0.9098	0.8702	0.701
Contribution From STREET 'C/F', Pipe 407 - 408						0.40				0.00				0.00				0.00	11.15														
	408	409	0.13	0.70	0.25	4.25			0.00	0.00			0.00	0.00			0.00	0.00	15.16	61.40	83.06	97.26	142.03	261	675	675	CONC	0.20	33.0	375.9224	1.0505	0.5236	0.694
	409	412	0.53	0.70	1.03	5.28			0.00	0.00			0.00	0.00			0.00	0.00	15.68	60.21	81.42	95.34	139.21	318	750	750	CONC	0.15	95.0	431.1703	0.9760	1.6223	0.737
To STREET 'B', Pipe 412 - 416						5.28				0.00				0.00				0.00	17.30														
STREET 'B'																																
	424	425	0.04	0.80	0.09	0.09			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	7	300	300	PVC	0.35	20.0	57.2089	0.8093	0.4119	0.119
Contribution From STREET 'D', Pipe 423 - 425						1.42				0.00				0.00				0.00	13.46														
	425	426	0.30	0.70	0.58	2.10			0.00	0.00			0.00	0.00			0.00	0.00	13.46	65.67	88.90	104.14	152.12	138	525	525	CONC	0.20	90.0	192.3297	0.8885	1.6883	0.716
To STREET 'J', Pipe 426 - 332						2.10				0.00				0.00				0.00	15.14														
Contribution From STREET 'I', Pipe 409 - 412						5.28				0.00				0.00				0.00	17.30														
Contribution From STREET 'I', Pipe 411 - 412						2.10				0.00				0.00				0.00	13.14														
	412	416	0.09	0.70	0.18	7.56			0.00	0.00			0.00	0.00			0.00	0.00	17.30	56.82	76.79	89.89	131.22	429	825	825	CONC	0.15	65.0	555.9418	1.0400	1.0417	0.772
Contribution From STREET 'C/F', Pipe 414 - 416						2.06				0.00				0.00				0.00	13.78														
Contribution From STREET 'C/F', Pipe 415 - 416						1.01				0.00				0.00				0.00	11.61														
	416	418	0.16	0.70	0.31	10.94			0.00	0.00			0.00	0.00			0.00	0.00	18.34	54.86	74.11	86.74	126.60	600	900	900	CONC	0.20	60.5	809.5958	1.2726	0.7923	0.742
Contribution From STREET 'E', Pipe 417 - 418						1.11				0.00				0.00				0.00	11.82														
	418	419	0.19	0.70	0.37	12.42			0.00	0.00			0.00	0.00			0.00	0.00	19.14	53.46	72.21	84.51	123.32	664	900	900	CONC	0.25	50.0	905.1556	1.4228	0.5857	0.734
	419	420	0.16	0.70	0.31	12.73			0.00	0.00			0.00	0.00			0.00	0.00	19.72	52.48	70.87	82.94	121.01	668	900	900	CONC	0.25	15.0	905.1556	1.4228	0.1757	0.738
	420	426	0.10	0.70	0.19	12.93			0.00	0.00			0.00	0.00			0.00	0.00	19.90	52.20	70.48	82.48	120.34	675	900	900	CONC	0.25	18.5	905.1556	1.4228	0.2167	0.746
To STREET 'J', Pipe 426 - 332						12.93				0.00				0.00				0.00	20.11														

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:
Checked: C.M.K.
Dwg. Reference:

PROJECT: **Richmond North West and Richmond North East**
LOCATION: **City of Ottawa**
File Ref:
Date: Aug 2022
Sheet No. SHEET 1 OF 2

1083_STM.xlsx

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

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

	LOCATION		AREA (Ha)														FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			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 'J'																																
Contribution From STREET 'B', Pipe 420 - 426						12.93				0.00				0.00				0.00	20.11													
Contribution From STREET 'B', Pipe 425 - 426						2.10				0.00				0.00				0.00	15.14													
	426	332	0.05	0.70	0.10	15.12			0.00	0.00			0.00	0.00			0.00	0.00	20.11	51.85	70.00	81.92	119.52	784	975	975	CONC	0.20	35.0	1002.2295	1.3424	0.4346	0.782
To OLDENBURG AVENUE, Pipe 332 - 314						15.12				0.00				0.00				0.00	20.55													
STREET 'G'																																
	404	430	0.51	0.65	0.92	0.92			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	71	375	375	PVC	0.30	79.0	96.0323	0.8695	1.5143	0.737
To STREET 'H', Pipe 430 - 431						0.92				0.00				0.00				0.00	11.51													
	434	430	0.28	0.65	0.51	0.51			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	39	300	300	PVC	0.35	65.0	57.2089	0.8093	1.3385	0.679
To STREET 'H', Pipe 430 - 431						0.51				0.00				0.00				0.00	11.34													
	404	405			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	300	300	CONC	0.25	13.5	48.3504	0.6840	0.3289	0.000
	405	406	0.12	0.65	0.22	0.22			0.00	0.00			0.00	0.00			0.00	0.00	10.33	75.56	102.49	120.13	175.61	16	450	450	CONC	0.20	69.5	127.5033	0.8017	1.4449	0.129
To STREET 'I', Pipe 406 - 408						0.22				0.00				0.00				0.00	11.77													
	434	435	0.20	0.65	0.36	0.36			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	28	300	300	PVC	0.35	9.5	57.2089	0.8093	0.1956	0.485
	435	436	0.54	0.65	0.98	1.34			0.00	0.00			0.00	0.00			0.00	0.00	10.20	76.06	103.17	120.94	176.79	102	450	450	CONC	0.25	74.5	142.5531	0.8963	1.3853	0.713
	436	306	0.44	0.65	0.80	2.13			0.00	0.00			0.00	0.00			0.00	0.00	11.58	71.22	96.52	113.11	165.29	152	525	525	CONC	0.20	76.0	192.3297	0.8885	1.4257	0.790
To OLDENBURG AVENUE, Pipe 306 - 307						2.13				0.00				0.00				0.00	13.01													
STREET 'H'																																
Contribution From STREET 'G', Pipe 404 - 430						0.92				0.00				0.00				0.00	11.51													
Contribution From STREET 'G', Pipe 434 - 430						0.51				0.00				0.00				0.00	11.34													
	430	431	0.39	0.65	0.70	2.13			0.00	0.00			0.00	0.00			0.00	0.00	11.51	71.44	96.82	113.46	165.81	152	525	525	CONC	0.20	80.5	192.3297	0.8885	1.5101	0.792
	431	308	0.30	0.65	0.54	2.67			0.00	0.00			0.00	0.00			0.00	0.00	13.02	66.86	90.54	106.06	154.94	179	600	600	CONC	0.20	80.0	274.5943	0.9712	1.3729	0.651
To OLDENBURG AVENUE, Pipe 308 - 309						2.67				0.00				0.00				0.00	14.40													
LANE 'A'																																
	407	408	0.18	0.80	0.40	0.40			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	31	300	300	PVC	0.50	67.0	68.3778	0.9673	1.1544	0.450
To STREET 'I', Pipe 408 - 409						0.40				0.00				0.00				0.00	11.15													
	407	429	0.24	0.80	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	300	300	PVC	0.50	77.5	68.3778	0.9673	1.3353	0.600
	429	428	0.22	0.80	0.49	1.02			0.00	0.00			0.00	0.00			0.00	0.00	11.34	72.03	97.63	114.41	167.21	74	375	375	PVC	0.50	73.0	123.9771	1.1225	1.0839	0.594
To OLDENBURG AVENUE, Pipe 428 - 311						1.02				0.00				0.00				0.00	12.42													
STREET 'A'																																
	505	506 (OGS	0.13	0.65	0.23	0.23			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	18	300	300	PVC	0.35	16.0	57.21	0.81	0.33	0.32
To BLOCK 28, Pipe 506 (OGS) - 2804						0.23				0.00				0.00				0.00	10.33													
	501	502	0.15	0.65	0.27	0.27			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	21	300	300	PVC	0.35	18.0	57.21	0.81	0.37	0.36
	502	503	0.43	0.65	0.78	1.05			0.00	0.00			0.00	0.00			0.00	0.00	10.37	75.41	102.27	119.88	175.24	79	450	450	CONC	0.20	107.5	127.50	0.80	2.23	0.62
	503	504	0.46	0.65	0.83	1.88			0.00	0.00			0.00	0.00			0.00	0.00	12.61	68.06	92.19	108.00	157.80	128	525	525	CONC	0.20	106.5	192.33	0.89	2.00	0.67
	504	505	0.17	0.65	0.31	2.19			0.00	0.00			0.00	0.00			0.00	0.00	14.60	62.72	84.86	99.39	145.14	137	525	525	CONC	0.20	39.0	192.33	0.89	0.73	0.71
	505	506 (OGS	0.34	0.65	0.61	2.80			0.00	0.00			0.00	0.00			0.00	0.00	15.33	60.99	82.49	96.60	141.05	171	525	525	CONC	0.25	84.5	215.03	0.99	1.42	0.79
To BLOCK 28, Pipe 506 (OGS) - 2804						2.80				0.00				0.00				0.00	16.75													
BLOCK 28																																
Contribution From STREET 'G', Pipe 504 - 506 (OGS)						2.80				0.00				0.00				0.00	16.75													
Contribution From STREET 'G', Pipe 505 - 506 (OGS)						0.23				0.00				0.00				0.00	10.33													
	506 (OGS)	HW	0.09	0.65	0.16	3.20			0.00	0.00			0.00	0.00			0.00	0.00	16.75	57.92	78.29	91.66	133.81	185	525	525	CONC	0.80	71.0	384.66	1.78	0.67	0.48

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:
Checked: C.M.K.
Dwg. Reference:

PROJECT: **Richmond North West and Richmond North East**
LOCATION: **City of Ottawa**
File Ref:
Date: Aug 2022
Sheet No. SHEET 2 OF 2

1083_STM.xlsx

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) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA							
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	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	RATIO
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
OLDENBURG AVENUE																																
	304	305			0.00	0.00	0.18	0.65	0.33	0.33			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	34	300	300	PVC	0.35	24.5	57.2089	0.8093	0.5045	0.592
Contribution From Richmond North West, Pipe 433 - 305						2.87				0.00				0.00				0.00	13.99														
	305	306			0.00	2.87	0.35	0.65	0.63	0.96			0.00	0.00			0.00	0.00	13.99	64.27	86.99	101.88	148.81	268	675	675	CONC	0.20	76.0	375.9224	1.0505	1.2058	0.713
Contribution From Richmond North West, Pipe 436 - 306						2.13				0.00				0.00				0.00	13.01														
	306	307			0.00	5.01	0.26	0.65	0.47	1.43			0.00	0.00			0.00	0.00	15.19	61.32	82.94	97.13	141.84	425	750	750	CONC	0.25	52.0	556.6385	1.2600	0.6878	0.764
	307	308			0.00	5.01			0.00	1.43			0.00	0.00			0.00	0.00	15.88	59.77	80.82	94.63	138.17	415	750	750	CONC	0.25	15.0	556.6385	1.2600	0.1984	0.745
Contribution From ALIGNMENT 09, Pipe 303 - 308						5.42				0.00				0.00				0.00	16.36														
Contribution From Richmond North West, Pipe 431 - 308						2.67				0.00				0.00				0.00	14.40														
					0.00	13.10	0.15	0.65	0.27	1.70			0.00	0.00			0.00	0.00															
	308	309			0.00	13.10	1.28	0.40	1.42	3.12			0.00	0.00			0.00	0.00	16.36	58.73	79.40	92.96	135.72	1017	1050	1050	CONC	0.25	73.5	1365.3626	1.5768	0.7769	0.745
Contribution From ALIGNMENT 05, Pipe 321 - 309						1.25				0.00				0.00				0.00	12.59														
	309	310			0.00	14.35	0.15	0.70	0.29	3.41			0.00	0.00			0.00	0.00	17.14	57.14	77.23	90.41	131.97	1083	1050	1050	CONC	0.25	24.5	1365.3626	1.5768	0.2590	0.794
	310	311			0.00	14.35			0.00	3.41			0.00	0.00			0.00	0.00	17.40	56.63	76.53	89.59	130.77	1074	1200	1200	CONC	0.15	19.0	1509.9717	1.3351	0.2372	0.711
Contribution From LANE 'A', Pipe 428 - 311						1.24				0.00				0.00				0.00	13.32														
	311	313			0.00	15.59	0.43	0.80	0.96	4.37			0.00	0.00			0.00	0.00	17.64	56.17	75.91	88.86	129.70	1207	1350	1350	CONC	0.10	68.5	1687.8347	1.1792	0.9682	0.715
Contribution From ALIGNMENT 15, Pipe 326 - 313						1.58				0.00				0.00				0.00	12.94														
	313	314			0.00	17.17	0.23	0.80	0.51	4.88			0.00	0.00			0.00	0.00	18.60	54.39	73.47	85.99	125.50	1292	1350	1350	CONC	0.10	64.5	1687.8347	1.1792	0.9117	0.766
Contribution From ALIGNMENT 02, Pipe 332 - 314						15.99				0.00				0.00				0.00	20.94														
					0.00	33.15	0.15	0.65	0.27	5.15			0.00	0.00			0.00	0.00															
					0.00	33.15	0.15	0.65	0.27	5.42			0.00	0.00			0.00	0.00															
					0.00	33.15	0.12	0.75	0.25	5.67				0.00				0.00															
					0.00	33.15	0.12	0.71	0.24	5.91				0.00				0.00															
	314	264	0.40	0.67	0.75	33.90				5.91			0.00	0.00			0.00	0.00	20.94	50.57	68.26	79.87	116.52	2118	1500	1500	CONC	0.15	75.0	2737.7609	1.5493	0.8068	0.774
					0.00	33.90	0.19	0.75	0.40	6.31				0.00				0.00															
					0.00	33.90	0.25	0.71	0.49	6.80				0.00				0.00															
	264	265	0.22	0.54	0.33	34.23				6.80			0.00	0.00			0.00	0.00	20.94	50.57	68.26	79.87	116.52	2195	1500	1500	CONC	0.15	75.0	2737.7609	1.5493	0.8068	0.802
			2.93	0.69	5.62	39.85				6.80				0.00				0.00	16.70														
						39.85	0.11	0.75	0.23	7.03				0.00				0.00															
						39.85	0.12	0.71	0.24	7.27				0.00				0.00															
	265	266	0.07	0.54	0.11	39.96				7.27				0.00				0.00	21.74	49.39	66.64	77.97	113.74	2458	1500	1500	CONC	0.20	75.0	3161.2940	1.7889	0.6987	0.777
To PERTH STREET, Pipe 266 - 267						39.96				7.27				0.00				0.00	22.44														
PERTH STREET																																
Contribution From OLDENBURG AVENUE, Pipe 265 - 266						39.96				7.27				0.00				0.00	22.44														
							1.88	0.80	4.18	11.45			0.00	0.00			0.00	0.00															
									0.00	11.45	0.67	0.85	1.58	1.58			0.00	0.00															
									0.00	11.45	0.67	0.85	1.58	3.17			0.00	0.00															
									0.00	11.45	0.23	0.85	0.54	3.71	64.37	0.20	35.79	35.79															
	266	267 TEE			0.00	39.96			0.00	11.45	0.10	0.85	0.24	3.95	34.99	0.20	19.45	55.24	22.44	48.41	65.31	76.41	111.44	9140	2100	2100	CONC	0.15	70.5	6715.3752	1.9388	0.6060	1.361
	267 TEE	26701			0.00	39.96			0.00	11.45			0.00	3.95			0.00	55.24	23.05	47.59	64.20	75.11	109.53	8984	2100	2100	CONC	0.15	19.0	6715.3752	1.9388	0.1633	1.338
	26701	HW 1			0.00	39.96			0.00	11.45			0.00	3.95			0.00	55.24	23.21	47.38	63.91	74.76	109.03	8943	2100	2100	CONC	0.15	18.0	6715.3752	1.9388	0.1547	1.332

Projected storm flows as compared to the Fox Run Phase 2 (North) design sheet flow of 2,201 L/s at Oldenburg Avenue.

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:
Checked: C.M.K.
Dwg. Reference:

PROJECT: **Richmond North West and Richmond North East**
LOCATION: **City of Ottawa**
File Ref:
Date: Aug 2022
Sheet No. SHEET 2 OF 2

1083_STM.xlsx

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) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA							
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
Location	From Node	To Node	(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	Conc. (min)	2 Year (mm/h)	5 Year (mm/h)	10 Year (mm/h)	100 Year (mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
BRUSH LANE																																
	258	261	0.33	0.75	0.69	0.69			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.40	66.0	61	0.87	1.27	0.86
To BASCULE PLACE, Pipe 261 - 265						0.69				0.00				0.00				0.00	11.27													
CHASING GROVE																																
			0.03	0.75	0.06	0.06			0.00	0.00			0.00	0.00			0.00	0.00														
			0.25	0.72	0.50	0.56			0.00	0.00			0.00	0.00			0.00	0.00														
	251	256	0.27	0.75	0.56	1.13			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	86	457	450	CONC	0.20	149.5	133	0.81	3.08	0.65
To BASCULE PLACE, Pipe 256 - 261						1.13				0.00				0.00				0.00	13.08													
TRAMMEL ROAD																																
			0.12	0.54	0.18	0.18			0.00	0.00			0.00	0.00			0.00	0.00														
	250	252	0.13	0.72	0.26	0.44			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	34	300	300	PVC	0.35	51.5	57	0.81	1.06	0.59
To LATIGO RIDGE, Pipe 252 - 254						0.44				0.00				0.00				0.00	11.06													
			0.19	0.72	0.38	0.38			0.00	0.00			0.00	0.00			0.00	0.00														
	251	252	0.21	0.54	0.32	0.70			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.45	65.0	65	0.92	1.18	0.82
To LATIGO RIDGE, Pipe 252 - 254						0.70				0.00				0.00				0.00	11.18													
			0.03	0.75	0.06	0.06			0.00	0.00			0.00	0.00			0.00	0.00														
			0.13	0.54	0.20	0.26			0.00	0.00			0.00	0.00			0.00	0.00														
			0.07	0.75	0.15	0.40			0.00	0.00			0.00	0.00			0.00	0.00														
	251	263	0.14	0.72	0.28	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.40	68.0	61	0.87	1.31	0.86
To OLDENBURG AVENUE, Pipe 263 - 264						0.68				0.00				0.00				0.00	11.31													
LATIGO RIDGE																																
Contribution From TRAMMEL ROAD, Pipe 250 - 252						0.44				0.00				0.00				0.00	11.06													
Contribution From TRAMMEL ROAD, Pipe 251 - 252						0.70				0.00				0.00				0.00	11.18													
			0.14	0.54	0.21	1.35			0.00	0.00			0.00	0.00			0.00	0.00														
	252	254	0.51	0.72	1.02	2.37			0.00	0.00			0.00	0.00			0.00	0.00	11.18	72.55	98.35	115.26	168.44	172	610	600	CONC	0.15	149.5	249	0.85	2.93	0.69
To BASCULE PLACE, Pipe 254 - 256						2.37				0.00				0.00				0.00	14.11													
GRISEO WAY																																
			0.18	0.75	0.38	0.38			0.00	0.00			0.00	0.00			0.00	0.00														
	259	257	0.10	0.75	0.21	0.58			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	45	300	300	PVC	0.50	35.0	68	0.97	0.60	0.66
To BASCULE PLACE, Pipe 257 - 256						0.58				0.00				0.00				0.00	10.60													
BASCULE PLACE																																
			0.06	0.72	0.12	0.12			0.00	0.00			0.00	0.00			0.00	0.00														
			0.15	0.54	0.23	0.35			0.00	0.00			0.00	0.00			0.00	0.00														
	254	273	0.16	0.75	0.33	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	52	300	300	PVC	0.45	61.0	65	0.92	1.11	0.80
To VAULTING CRESCENT, Pipe 273 - 275						0.68				0.00				0.00				0.00	11.11													
Contribution From LATIGO RIDGE, Pipe 252 - 254						2.37				0.00				0.00				0.00	14.11													
			0.16	0.54	0.24	0.24			0.00	0.00			0.00	0.00			0.00	0.00														
	254	257	0.04	0.72	0.08	2.69			0.00	0.00			0.00	0.00			0.00	0.00	14.11	63.95	86.55	101.37	148.05	172	610	600	CONC	0.15	35.5	249	0.85	0.70	0.69
Contribution From GRISEO WAY, Pipe 259 - 257						0.58				0.00				0.00				0.00	10.60													
	257	256			0.00	3.27			0.00	0.00			0.00	0.00			0.00	0.00	14.81	62.23	84.19	98.59	143.98	204	610	600	CONC	0.15	30.0	249	0.85	0.59	0.82
Contribution From CHASING GROVE, Pipe 255 - 256						1.13				0.00				0.00				0.00	13.08													
	256	261	0.11	0.75	0.23	4.63			0.00	0.00			0.00	0.00			0.00	0.00	15.39	60.85	82.30	96.38	140.73	282	686	675	CONC	0.15	33.0	340	0.92	0.60	0.83
Contribution From BRUSH LANE, Pipe 258 - 261						0.69				0.00				0.00				0.00	11.27													
Contribution From VAULTING CRESCENT, Pipe 260 - 261						0.40				0.00				0.00				0.00	10.72													
	261	265			0.00	5.71			0.00	0.00			0.00	0.00			0.00	0.00	15.99	59.52	80.48	94.24	137.59	340	838	825	CONC	0.10	35.0	473	0.86	0.68	0.72
To OLDENBURG AVENUE, Pipe 265 - 266						5.71				0.00				0.00				0.00	16.67													

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: FOX RUN SUBDIVISION PHASE 2 NORTH	
Checked: ADF	LOCATION: City of Ottawa	
Dwg. Reference: Storm Drainage Plan Dwg. No. 30	File Ref: 19-1083	Date: 9-Mar-19 / Sheet No. SHEET 1 OF 3

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) 2 YEAR				AREA (Ha) 5 YEAR				AREA (Ha) 10 YEAR				AREA (Ha) 100 YEAR				FLOW						SEWER DATA							
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
Location	From Node	To Node	(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	Conc. (min)	2 Year (mm/h)	5 Year (mm/h)	10 Year (mm/h)	100 Year (mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
POSTILION STREET																																	
Contribution From Future Phase, Pipe 318 - 270						9.49				0.00				0.00				0.00	17.25														
			0.13	0.72	0.26	9.75			0.00	0.00			0.00	0.00			0.00	0.00															
			0.16	0.54	0.24	9.99			0.00	0.00			0.00	0.00			0.00	0.00															
	270	271	0.21	0.71	0.41	10.40			0.00	0.00			0.00	0.00			0.00	0.00	17.25	56.92	76.93	90.06	131.46	592	914	900	CONC	0.20	74.5	844	1.29	0.97	0.70
			0.11	0.72	0.22	10.62			0.00	0.00			0.00	0.00			0.00	0.00															
	271	273	0.14	0.71	0.28	10.90			0.00	0.00			0.00	0.00			0.00	0.00	18.22	55.09	74.43	87.12	127.15	600	914	900	CONC	0.30	75.5	1033	1.57	0.80	0.58
To VAULTING CRESCENT, Pipe 273 - 275						10.90				0.00				0.00				0.00	19.01														
VAULTING CRESCENT																																	
	260	261	0.19	0.75	0.40	0.40			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	0.30	32.5	53	0.75	0.72	0.57
To BASCULE PLACE, Pipe 261 - 265						0.40				0.00				0.00				0.00	10.72														
Contribution From BASCULE PLACE, Pipe 254 - 273						0.68				0.00				0.00				0.00	11.11														
Contribution From POSTILION STREET, Pipe 271 - 273						10.90				0.00				0.00				0.00	19.01														
	273	275	0.21	0.75	0.44	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.01	53.67	72.49	84.84	123.81	645	914	900	CONC	0.20	33.0	844	1.29	0.43	0.76
To Servicing & Walkway Block, Pipe 275 - 276						12.01				0.00				0.00				0.00	19.44														
Servicing & Walkway Block																																	
Contribution From VAULTING CRESCENT, Pipe 273 - 275						12.01				0.00				0.00				0.00	19.44														
	275	276			0.00	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.44	52.95	71.50	83.68	122.10	636	914	900	CONC	0.20	29.5	844	1.29	0.38	0.75
	276	277			0.00	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.82	52.32	70.64	82.67	120.62	629	914	900	CONC	0.20	17.0	844	1.29	0.22	0.75
To PERTH STREET, Pipe 277 - 278						12.01				0.00				0.00				0.00	20.04														
OLDENBURG AVENUE																																	
Contribution From TRAMMEL ROAD, Pipe 251 - 263						0.68				0.00				0.00				0.00	11.31														
Contribution From Future External, Pipe 329 - PLUG						15.44				0.00				0.00				0.00	13.39														
	PLUG	263	0.07	0.85	0.17	15.61			0.00	0.00			0.00	0.00			0.00	0.00	13.39	65.85	89.15	104.43	152.55	1028	1067	1050	CONC	0.25	13.0	1425	1.59	0.14	0.72
Contribution From Future External, Pipe 328 - PLUG						20.44				2.11				0.00				0.00	18.25														
	PLUG	263			0.00	20.44			0.00	2.11			0.00	0.00			0.00	0.00	18.25	55.03	74.34	87.02	127.00	1282	1372	1350	CONC	0.10	13.0	1762	1.19	0.18	0.73
					0.00	36.73	0.12	0.71	0.24	2.35			0.00	0.00			0.00	0.00															
	263	264			0.00	36.73	0.12	0.75	0.25	2.60			0.00	0.00			0.00	0.00	18.43	54.70	73.89	86.49	126.23	2201	1524	1500	CONC	0.15	75.0	2856	1.57	0.80	0.77
					0.00	36.73	0.19	0.75	0.40	3.00			0.00	0.00			0.00	0.00															
					0.00	36.73	0.25	0.71	0.49	3.49			0.00	0.00			0.00	0.00															
	264	265	0.43	0.54	0.65	37.37			0.00	3.49			0.00	0.00			0.00	0.00	19.23	53.30	71.99	84.25	122.95	2243	1524	1500	CONC	0.15	75.0	2856	1.57	0.80	0.79
Contribution From BASCULE PLACE, Pipe 261 - 265						5.71				0.00				0.00				0.00	16.67														
					0.00	43.08	0.11	0.75	0.23	3.72			0.00	0.00			0.00	0.00															
	265	266			0.00	43.08	0.12	0.71	0.24	3.96			0.00	0.00			0.00	0.00	20.03	51.99	70.19	82.14	119.85	2517	1524	1500	CONC	0.20	75.0	3298	1.81	0.69	0.76
To PERTH STREET, Pipe 266 - 267TEE						43.08				3.96				0.00				0.00	20.72														
PERTH STREET																																	
Contribution From Servicing & Walkway Block, Pipe 276 - 277						12.01				0.00				0.00				0.00	20.04														
					0.00	12.01			0.00	0.00	0.32	0.85	0.76	0.76			0.00	0.00															
	277	278			0.00	12.01			0.00	0.00	0.55	0.85	1.30	2.06			0.00	0.00	20.04	51.96	70.15	82.10	119.78	793	991	975	CONC	0.20	107.5	1047	1.36	1.32	0.76
	278	279			0.00	12.01			0.00	0.00			0.00	2.06			0.00	0.00	21.37	49.93	67.39	78.85	115.02	762	991	975	CONC	0.20	15.5	1047	1.36	0.19	0.73

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

Projected storm flows as compared to the Richmond North West design sheet flow of 2,118 L/s

Designed: SLM	PROJECT: FOX RUN SUBDIVISION PHASE 2 NORTH	
Checked: ADF	LOCATION: City of Ottawa	
Dwg. Reference: Storm Drainage Plan Dwg. No. 30	File Ref: 19-1083	Date: 9-Mar-19
		Sheet No. SHEET 2 OF 3

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) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
Location	From Node	To Node	(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	Conc. (min)	2 Year (mm/h)	5 Year (mm/h)	10 Year (mm/h)	100 Year (mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
To Pond Block, Pipe 279 - HW						12.01				0.00				2.06				0.00	21.56														
					0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00						3240	(DICB 100 Yr Intake)								
	280	266	0.13	0.54	0.20	0.20			0.00	0.00	0.80	0.85	1.89	1.89			0.00	0.00	10.00	76.81	104.19	122.14	178.56	3486	1676	1650	CONC	0.15	44.5	3680	1.67	0.44	0.95
Contribution From OLDENBURG AVENUE, Pipe 265 - 266						43.08				3.96				0.00				0.00	20.72														
					0.00	43.28					0.08	0.85	0.19	2.08			0.00	0.00															
	266	267TEE			0.00	43.28			0.00	3.96	0.14	0.85	0.33	2.41			0.00	0.00	20.72	50.90	68.71	80.40	117.30	5909	2134	2100	CONC	0.15	70.5	7009	1.96	0.60	0.84
	267TEE	26701			0.00	43.28			0.00	3.96			0.00	2.41			0.00	0.00	21.32	50.00	67.48	78.96	115.18	5861	2134	2100	CONC	0.15	19.0	7009	1.96	0.16	0.84
To Pond Block, Pipe 267TEE - HW						43.28				3.96				2.41				0.00	21.48														
Pond Block																																	
Contribution From PERTH STREET, Pipe 278 - 279						12.01				0.00				2.06				0.00	21.56														
	279	HW			0.00	12.01			0.00	0.00			0.00	2.06			0.00	0.00	21.56	49.66	67.01	78.41	114.37	758	991	975	CONC	0.20	16.5	1047	1.36	0.20	0.72
Contribution From PERTH STREET, Pipe 266 - 267TEE						43.28				3.96				2.41				0.00	21.48														
	26701	HW			0.00	43.28			0.00	3.96			0.00	2.41			0.00	0.00	21.48	49.77	67.16	78.58	114.63	5849	2134	2100	CONC	0.15	18.0	7009	1.96	0.15	0.83

Note:
Contributions to MH 280 per JFSA analysis Table C-1D
100-year 3-hour Chicago 2.60m3/s
100-year 24-Hour SCS Type II 3.24m3/s

LICENSED PROFESSIONAL ENGINEER
A.D. FOBERT
100145520
2020-03-09
PROVINCE OF ONTARIO
JOB# 19-1083

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: FOX RUN SUBDIVISION PHASE 2 NORTH	
Checked: ADF	LOCATION: City of Ottawa	
Dwg. Reference: Storm Drainage Plan Dwg. No. 30	File Ref: 19-1083	Date: 9-Mar-19 / Sheet No. SHEET 3 OF 3

1083_STM_v5.xlsx

Ottawa. ON
Paris. ON
Gatineau. QC
Montréal. QC
Québec. QC

August 12, 2020 Project Number: P922

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

Attention: **Mr. Adam Fobert, P.Eng.**

Subject: **Richmond Village Development / Proposed Realignment of the Van Gaal Drain Adjacent to the Green Lands**

As requested by your office, we have evaluated the channel dimensions required to contain the 100-year design water levels within the proposed realignment of the Van Gaal Drain adjacent to the Green Lands based on the information provided. This assessment builds on the *Richmond Village Development / Proposed Realignment of the Van Gaal Drain* by JFSA (April 20, 2017). The requested changes to the HEC-RAS models were to adjust cross sections 2478 – 2258 along the Van Gaal Drain Reach 2 as labelled in Figure 1. This section of the channel is immediately downstream of the realignment proposed in the April 2017 *Realignment* memo.

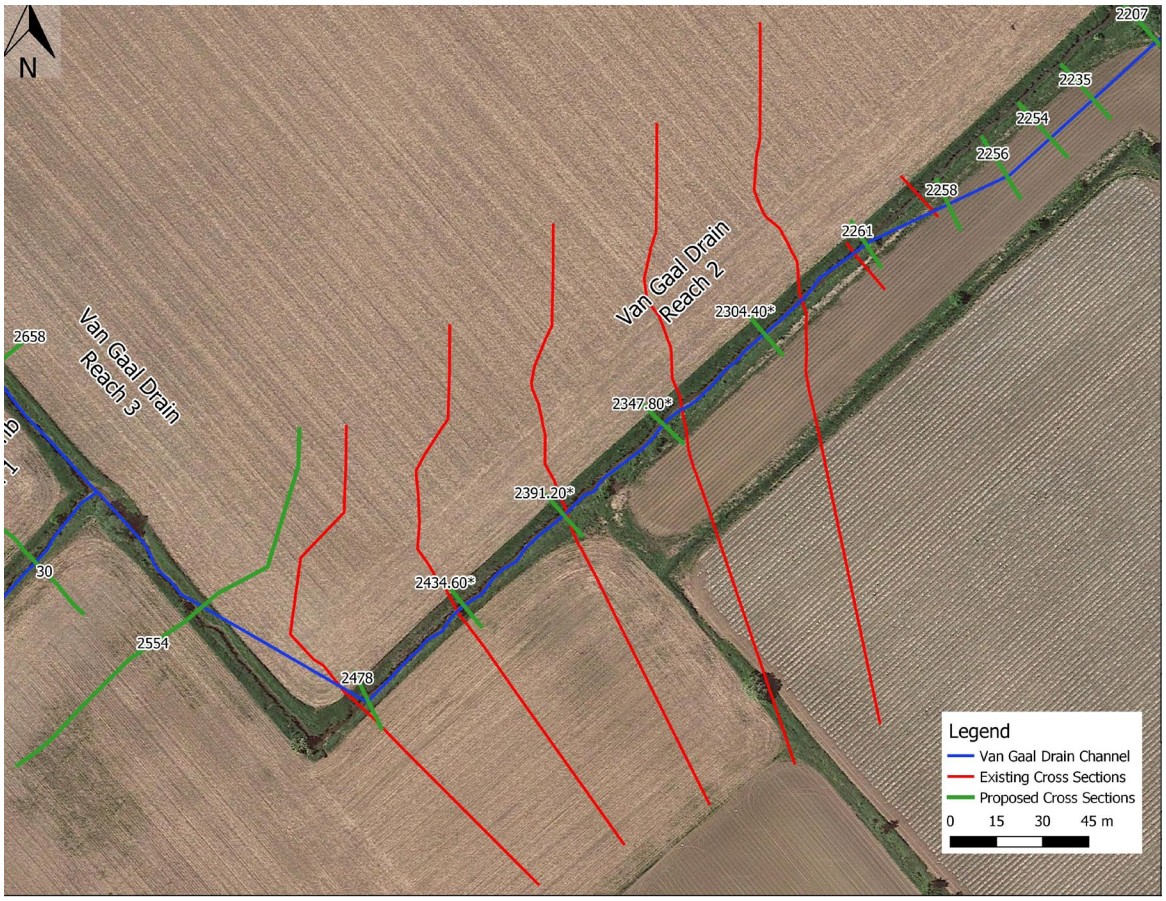

Figure 1: Van Gaal Drain Reach 2 Cross Section Labels

In undertaking this work, the following information was considered;

1) HEC-RAS models of Van Gaal Drain under existing conditions (spring and summer) were obtained from the *Floodplain Mapping Report for the Van Gaal Drain and Arbuckle Municipal Drains in the Village of Richmond* (JFSA, November 2009). The November 2009 report defined the maximum flood levels in the Van Gaal Drain based on three scenarios: (1) the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River; (2) The Van Gaal 100-year spring snowmelt plus rainfall peak flow reaches the Jock River; and (4) The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

2) The HEC-RAS models were modified as described in the April 2017 *Realignment* memo to evaluate the proposed realignment of approximately 900 m of the existing Van Gaal Drain to follow the boundary of the Richmond Village subdivision downstream of the Green Lands and upstream of Perth Street. Please refer to the April 2017 *Realignment* memo for further details of the existing (pre-realignment) and proposed (post-realignment) conditions modelling. Figure 1 of Attachment F in the current memo shows the proposed April 2017 channel realignment and cross-section extents.

3) The proposed conditions HEC-RAS models from the April 2017 *Realignment* memo were modified to reflect the current proposed channel realignment adjacent to the Green Lands based on information provided by DSEL. Going forward, this will be referred to as the proposed conditions model.

4) The typical proposed conditions channel dimension for updated cross-sections 2478 to 2258 include a 10 m wide floodplain with a cross-slope of 0.5%. The realigned channel is bounded by side slopes at 3H:1V and has a longitudinal slope of 0.4%. The low flow channel is 0.5 m deep with a bottom width of 1.0 m and a top width of 3.0 m. To match existing conditions, Manning's roughness coefficients for the proposed channel were set as 0.035 for the low flow channel, 0.05 for the banks under spring conditions and 0.08 for the banks under summer conditions. However, consistent with the April 2017 Realignment memo, we understand that trees and shrubs are to be planted on the banks about the 25 mm water level, and as such the Manning's roughness coefficients for this area of the proposed channel have been set to 0.08 under spring conditions and 0.10 under summer conditions.

5) Note that the proposed channel realignment will not significantly impact flows in the Van Gaal Drain. As such, existing conditions flows provided in the April 2017 *Realignment* memo models were also used to model proposed conditions. Consistent with the April 2017 *Realignment* memo, the 2-, 5-, 10-, 25- and 100-year return periods were assessed, as per the flows provided in the *March 26, 2010 P709(02) Richmond 2, 5, 10, 25 Year WSEL Results* email from JFSA to the City of Ottawa (forwarded to RVCA on March 30, 2012). The 25 mm 3-hour Chicago storm flows, as simulated using the March 26, 2010 SWMHYMO models, were also evaluated.

6) For the purpose of calculating floodplain elevations, all channel infrastructure was included in the existing and proposed conditions models. Conversely, for the purpose of calculating riparian storage volumes, all channel infrastructure was removed from the models. The existing flow profiles for the 25 mm and 2- to 100-year events were used to compare existing and proposed riparian storage volumes.

7) The proposed channel dimensions were set to contain the 100-year flood levels within the channel for all three spring and summer scenarios, and to set the 100-year proposed conditions water levels at comparable cross sections (for the Green lands realignment, cross-sections 2544 and 2478 in the Van Gaal Drain Reach 2) equal to or less than the maximum existing conditions flood levels defined in the November 2009 *Floodplain Mapping Report*. See Table 1 for details.

Based on the above information, 25 mm and 2- to 100-year design water levels and velocities were determined using HEC-RAS under the three spring and summer scenarios and are presented in Attachments A for existing conditions and Attachments C for proposed conditions. The 100-year design water levels for the proposed channel realignment of the Van Gaal Drain are presented in Table 1 and are contained within the proposed channel for all scenarios.

Table 1: Water Levels on Van Gaal Drain Reach 2 to Perth Street Under Proposed Conditions (1)

River Station	Scenario / Water Level (m)			
	1	*2*	*4*	*Max. Allowable* (2)
2554	95.90	95.89	95.54	96.28
2478	95.58	95.55	95.20	96.16
2434.60*	95.41	95.39	95.03	N/A
2391.20*	95.27	95.23	94.85	N/A
2347.80*	95.16	95.11	94.68	N/A
2304.40*	95.08	95.03	94.56	N/A
2261	95.03	94.98	94.50	N/A
2258	94.99	94.94	94.46	N/A
2256	94.98	94.92	94.44	N/A
2254	94.96	94.91	94.42	N/A
2235	94.95	94.89	94.40	N/A
2207	94.92	94.87	94.38	95.48
2188	94.88	94.83	94.36	N/A
2163	94.85	94.8	94.33	N/A
2141	94.82	94.77	94.31	N/A
2121	94.80	94.74	94.30	N/A
2101	94.77	94.72	94.28	N/A
2080	94.74	94.69	94.26	N/A
2059	94.71	94.66	94.25	N/A
2038	94.68	94.63	94.23	N/A
2017	94.67	94.62	94.23	N/A
2003	94.66	94.61	94.22	N/A
1982	94.63	94.58	94.21	N/A
1961	94.61	94.56	94.20	N/A
1940	94.58	94.54	94.19	N/A
1919	94.56	94.51	94.18	N/A
1898	94.54	94.49	94.18	N/A
1877	94.52	94.47	94.17	N/A
1857	94.50	94.45	94.17	N/A
1837	94.48	94.44	94.16	N/A
1817	94.46	94.42	94.16	N/A
1797	94.45	94.41	94.16	N/A
1777	94.43	94.39	94.15	N/A
1757	94.42	94.38	94.15	N/A
1736	94.40	94.37	94.15	N/A
1715	94.39	94.36	94.15	N/A
1694	94.38	94.35	94.15	N/A
1673	94.37	94.34	94.14	N/A
1653	94.36	94.33	94.14	N/A
1632	94.35	94.33	94.14	N/A
1615	94.35	94.32	94.14	94.61
1555	94.33	94.31	94.14	94.55
1488	94.31	94.29	94.14	94.45
1416	94.29	94.28	94.13	94.41
1400	94.28	94.27	94.13	94.36
1364	94.28	94.27	94.13	94.31
1340	94.24	94.22	94.13	94.21

(1) Scenario Descriptions:
1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

(2) Maximum water level at existing cross-sections as per "*Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond*" (JFSA, November 2009)

As seen in Table 1, the proposed conditions 100-year water levels at comparable cross sections 2554 and 2478 are equal to or less than the flood levels defined in *November 2009 Floodplain Mapping Report*.

An analysis of riparian storage in the channel under existing and proposed conditions was performed using the 25 mm and 2-, 5-, 10-, 25-, and 100-year flows for the three scenarios. All drainage infrastructure was removed from the models for the purpose of this analysis. Refer to Attachments B and D for detailed results under existing and proposed conditions, respectively. Table 2 presents a summary of the riparian storage analysis results.

Table 2: Riparian Storage on Van Gaal Drain Reach 2 (1)

Event	Existing Volume (m^3)			Proposed Volume (m^3)		
	Scenario 1	Scenario 2	Scenario 4	Scenario 1	Scenario 2	Scenario 4
25 mm	3570	N/A	N/A	6800	N/A	N/A
2-Year	7640	12550	11550	14550	19630	18390
5-Year	11950	16610	5890	20230	23500	11060
10-Year	15650	20280	5250	24360	26120	9070
25-Year	22190	26230	9590	29890	30210	15300
100-Year	38090	39190	36830	40630	39360	44560

(1) No channel infrastructure included in Van Gaal Drain for riparian storage analysis.

Scenario Descriptions:

1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

As is seen in Table 2, riparian storage volumes under proposed conditions are equal to or greater than existing riparian storage volumes for all scenarios and return periods, and will not adversely impact downstream flooding.

Yours truly,
J.F Sabourin and Associates Inc.

DRAFT FOR REVIEW

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Figures

Tables

Attachments

JFSA
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

Project Ref #:P922
Client: David Schaeffer Engineering

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment A

HEC-RAS Results for Van Gaal Drain Reach 2

Existing Conditions (Floodplain Analysis)

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(1) 25 mm	0.72	94.75	95.41	0.41	0.85
2554	(1) 2-Year	1.95	94.75	95.72	0.56	0.70
2554	(1) 5-Year	3.20	94.75	95.93	0.65	0.61
2554	(1) 10-Year	4.11	94.75	96.04	0.71	0.57
2554	(1) 25-Year	5.28	94.75	96.14	0.78	0.55
2554	(1) 100-Year	7.27	94.75	96.26	0.84	0.58
2478	(1) 25 mm	0.72	94.75	95.35	0.42	0.80
2478	(1) 2-Year	1.95	94.75	95.65	0.59	0.66
2478	(1) 5-Year	3.20	94.75	95.85	0.72	0.58
2478	(1) 10-Year	4.11	94.75	95.94	0.82	0.54
2478	(1) 25-Year	5.28	94.75	96.03	0.93	0.53
2478	(1) 100-Year	7.27	94.75	96.12	1.10	0.56
2427.58*	(1) 25 mm	0.72	94.68	95.30	0.43	0.76
2427.58*	(1) 2-Year	1.95	94.68	95.60	0.61	0.64
2427.58*	(1) 5-Year	3.20	94.68	95.79	0.74	0.56
2427.58*	(1) 10-Year	4.11	94.68	95.87	0.84	0.53
2427.58*	(1) 25-Year	5.28	94.68	95.95	0.95	0.52
2427.58*	(1) 100-Year	7.27	94.68	96.04	1.11	0.54
2377.17*	(1) 25 mm	0.72	94.61	95.25	0.44	0.73
2377.17*	(1) 2-Year	1.95	94.61	95.54	0.62	0.61
2377.17*	(1) 5-Year	3.20	94.61	95.72	0.76	0.55
2377.17*	(1) 10-Year	4.11	94.61	95.80	0.86	0.51
2377.17*	(1) 25-Year	5.28	94.61	95.87	0.97	0.50
2377.17*	(1) 100-Year	7.27	94.61	95.95	1.09	0.53
2326.76*	(1) 25 mm	0.72	94.54	95.19	0.46	0.70
2326.76*	(1) 2-Year	1.95	94.54	95.48	0.64	0.59
2326.76*	(1) 5-Year	3.20	94.54	95.65	0.78	0.53
2326.76*	(1) 10-Year	4.11	94.54	95.72	0.88	0.50
2326.76*	(1) 25-Year	5.28	94.54	95.78	0.97	0.49
2326.76*	(1) 100-Year	7.27	94.54	95.85	1.07	0.52
2276.35*	(1) 25 mm	0.72	94.48	95.13	0.49	0.67
2276.35*	(1) 2-Year	1.95	94.48	95.41	0.68	0.57
2276.35*	(1) 5-Year	3.20	94.48	95.57	0.80	0.51
2276.35*	(1) 10-Year	4.11	94.48	95.63	0.89	0.48
2276.35*	(1) 25-Year	5.28	94.48	95.69	0.96	0.47
2276.35*	(1) 100-Year	7.27	94.48	95.77	0.98	0.50
2225.94*	(1) 25 mm	0.72	94.41	95.05	0.54	0.65
2225.94*	(1) 2-Year	1.95	94.41	95.33	0.74	0.55
2225.94*	(1) 5-Year	3.20	94.41	95.48	0.84	0.49
2225.94*	(1) 10-Year	4.11	94.41	95.54	0.88	0.46
2225.94*	(1) 25-Year	5.28	94.41	95.59	0.95	0.46
2225.94*	(1) 100-Year	7.27	94.41	95.66	1.05	0.49
2175.53*	(1) 25 mm	0.72	94.34	94.93	0.68	0.62
2175.53*	(1) 2-Year	1.95	94.34	95.18	0.92	0.53
2175.53*	(1) 5-Year	3.20	94.34	95.33	1.04	0.48

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2175.53*	(1) 10-Year	4.11	94.34	95.42	0.95	0.45
2175.53*	(1) 25-Year	5.28	94.34	95.47	1.01	0.44
2175.53*	(1) 100-Year	7.27	94.34	95.54	1.07	0.48
2157	(1) 25 mm	0.72	94.31	94.72	1.45	0.62
2157	(1) 2-Year	1.95	94.31	94.93	1.76	0.53
2157	(1) 5-Year	3.20	94.31	95.13	1.64	0.47
2157	(1) 10-Year	4.11	94.31	95.25	1.54	0.44
2157	(1) 25-Year	5.28	94.31	95.37	1.28	0.44
2157	(1) 100-Year	7.27	94.31	95.48	1.13	0.47
2076	(1) 25 mm	1.16	93.86	94.39	0.64	0.60
2076	(1) 2-Year	2.80	93.86	94.74	0.76	0.51
2076	(1) 5-Year	4.41	93.86	94.99	0.82	0.46
2076	(1) 10-Year	5.53	93.86	95.10	0.90	0.43
2076	(1) 25-Year	6.96	93.86	95.20	0.96	0.42
2076	(1) 100-Year	9.54	93.86	95.33	0.99	0.45
1974	(1) 25 mm	1.16	93.68	94.22	0.62	0.55
1974	(1) 2-Year	2.80	93.68	94.61	0.70	0.48
1974	(1) 5-Year	4.41	93.68	94.87	0.75	0.42
1974	(1) 10-Year	5.53	93.68	94.96	0.84	0.39
1974	(1) 25-Year	6.96	93.68	95.05	0.93	0.39
1974	(1) 100-Year	9.54	93.68	95.17	1.02	0.42
1922	(1) 25 mm	1.16	93.59	94.14	0.61	0.53
1922	(1) 2-Year	2.80	93.59	94.56	0.67	0.46
1922	(1) 5-Year	4.41	93.59	94.82	0.74	0.40
1922	(1) 10-Year	5.53	93.59	94.90	0.84	0.38
1922	(1) 25-Year	6.96	93.59	94.97	0.96	0.38
1922	(1) 100-Year	9.54	93.59	95.06	1.11	0.41
1833	(1) 25 mm	1.16	93.44	94.02	0.56	0.49
1833	(1) 2-Year	2.80	93.44	94.48	0.59	0.42
1833	(1) 5-Year	4.41	93.44	94.74	0.61	0.37
1833	(1) 10-Year	5.53	93.44	94.80	0.69	0.35
1833	(1) 25-Year	6.96	93.44	94.86	0.76	0.35
1833	(1) 100-Year	9.54	93.44	94.95	0.85	0.39
1796	(1) 25 mm	1.16	93.37	93.97	0.54	0.47
1796	(1) 2-Year	2.80	93.37	94.45	0.57	0.40
1796	(1) 5-Year	4.41	93.37	94.71	0.64	0.35
1796	(1) 10-Year	5.53	93.37	94.76	0.76	0.33
1796	(1) 25-Year	6.96	93.37	94.80	0.90	0.33
1796	(1) 100-Year	9.54	93.37	94.86	1.13	0.38
1735	(1) 25 mm	1.16	93.26	93.93	0.47	0.44
1735	(1) 2-Year	2.80	93.26	94.42	0.48	0.37
1735	(1) 5-Year	4.41	93.26	94.68	0.51	0.32
1735	(1) 10-Year	5.53	93.26	94.73	0.58	0.31
1735	(1) 25-Year	6.96	93.26	94.77	0.66	0.31
1735	(1) 100-Year	9.54	93.26	94.82	0.79	0.36

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1728	(1) 25 mm	1.16	93.25	93.91	0.56	0.44
1728	(1) 2-Year	2.80	93.25	94.41	0.60	0.37
1728	(1) 5-Year	4.41	93.25	94.67	0.68	0.32
1728	(1) 10-Year	5.53	93.25	94.71	0.80	0.31
1728	(1) 25-Year	6.96	93.25	94.73	0.96	0.31
1728	(1) 100-Year	9.54	93.25	94.75	1.25	0.36
1727		Culvert				
1717	(1) 25 mm	1.16	93.24	93.79	0.70	0.43
1717	(1) 2-Year	2.80	93.24	94.17	0.85	0.36
1717	(1) 5-Year	4.41	93.24	94.39	0.97	0.32
1717	(1) 10-Year	5.53	93.24	94.51	1.03	0.30
1717	(1) 25-Year	6.96	93.24	94.62	1.13	0.31
1717	(1) 100-Year	9.54	93.24	94.74	1.28	0.35
1615	(1) 25 mm	1.16	93.05	93.64	0.56	0.39
1615	(1) 2-Year	2.80	93.05	94.04	0.64	0.32
1615	(1) 5-Year	4.41	93.05	94.24	0.77	0.28
1615	(1) 10-Year	5.53	93.05	94.36	0.84	0.27
1615	(1) 25-Year	6.96	93.05	94.47	0.87	0.28
1615	(1) 100-Year	9.54	93.05	94.61	0.87	0.33
1555	(1) 25 mm	1.16	92.94	93.58	0.50	0.35
1555	(1) 2-Year	2.80	92.94	93.99	0.59	0.30
1555	(1) 5-Year	4.41	92.94	94.19	0.72	0.26
1555	(1) 10-Year	5.53	92.94	94.29	0.80	0.25
1555	(1) 25-Year	6.96	92.94	94.40	0.86	0.26
1555	(1) 100-Year	9.54	92.94	94.53	0.94	0.31
1488	(1) 25 mm	1.16	92.82	93.53	0.43	0.31
1488	(1) 2-Year	2.80	92.82	93.96	0.53	0.26
1488	(1) 5-Year	4.41	92.82	94.13	0.66	0.23
1488	(1) 10-Year	5.53	92.82	94.23	0.73	0.23
1488	(1) 25-Year	6.96	92.82	94.33	0.82	0.24
1488	(1) 100-Year	9.54	92.82	94.46	0.92	0.29
1416	(1) 25 mm	1.16	92.71	93.48	0.54	0.28
1416	(1) 2-Year	2.80	92.71	93.89	0.73	0.23
1416	(1) 5-Year	4.41	92.71	94.03	0.96	0.21
1416	(1) 10-Year	5.53	92.71	94.10	1.07	0.21
1416	(1) 25-Year	6.96	92.71	94.20	1.13	0.22
1416	(1) 100-Year	9.54	92.71	94.38	0.94	0.27
1400	(1) 25 mm	1.16	92.68	93.47	0.39	0.27
1400	(1) 2-Year	2.80	92.68	93.89	0.47	0.23
1400	(1) 5-Year	4.41	92.68	94.03	0.60	0.20
1400	(1) 10-Year	5.53	92.68	94.11	0.67	0.20
1400	(1) 25-Year	6.96	92.68	94.20	0.75	0.22
1400	(1) 100-Year	9.54	92.68	94.36	0.86	0.27

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1364	(1) 25 mm	1.16	92.62	93.46	0.34	0.24
1364	(1) 2-Year	2.80	92.62	93.87	0.46	0.20
1364	(1) 5-Year	4.41	92.62	94.00	0.61	0.19
1364	(1) 10-Year	5.53	92.62	94.07	0.71	0.19
1364	(1) 25-Year	6.96	92.62	94.16	0.81	0.20
1364	(1) 100-Year	9.54	92.62	94.31	0.92	0.25
1340	(1) 25 mm	1.53	92.61	93.45	0.37	0.22
1340	(1) 2-Year	3.64	92.61	93.85	0.60	0.19
1340	(1) 5-Year	5.57	92.61	93.97	0.84	0.18
1340	(1) 10-Year	6.92	92.61	94.03	1.00	0.18
1340	(1) 25-Year	8.58	92.61	94.09	1.18	0.20
1340	(1) 100-Year	11.43	92.61	94.21	1.46	0.25
1339		Culvert				
1312	(1) 25 mm	1.53	92.47	93.45	0.32	0.20
1312	(1) 2-Year	3.87	92.47	93.84	0.57	0.18
1312	(1) 5-Year	5.93	92.47	93.95	0.82	0.17
1312	(1) 10-Year	7.38	92.47	94.00	0.99	0.17
1312	(1) 25-Year	9.17	92.47	94.05	1.19	0.19
1312	(1) 100-Year	12.20	92.47	94.14	1.50	0.24
1302	(1) 25 mm	1.53	92.57	93.41	0.83	0.19
1302	(1) 2-Year	3.87	92.57	93.81	0.88	0.17
1302	(1) 5-Year	5.93	92.57	93.92	1.05	0.17
1302	(1) 10-Year	7.38	92.57	93.98	1.15	0.17
1302	(1) 25-Year	9.17	92.57	94.04	1.26	0.19
1302	(1) 100-Year	12.20	92.57	94.15	1.23	0.24
1268	(1) 25 mm	1.53	92.47	93.33	0.79	0.18
1268	(1) 2-Year	3.87	92.47	93.75	0.56	0.16
1268	(1) 5-Year	5.93	92.47	93.88	0.57	0.16
1268	(1) 10-Year	7.38	92.47	93.94	0.60	0.16
1268	(1) 25-Year	9.17	92.47	94.01	0.61	0.18
1268	(1) 100-Year	12.20	92.47	94.14	0.52	0.23
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.16
1212	(1) 2-Year	3.87	92.36	93.61	0.89	0.14
1212	(1) 5-Year	5.93	92.36	93.78	0.91	0.13
1212	(1) 10-Year	7.38	92.36	93.85	0.93	0.14
1212	(1) 25-Year	9.17	92.36	93.93	0.91	0.16
1212	(1) 100-Year	12.20	92.36	94.10	0.76	0.21
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.15
1169	(1) 2-Year	3.87	92.30	93.53	0.77	0.13
1169	(1) 5-Year	5.93	92.30	93.70	0.86	0.12
1169	(1) 10-Year	7.38	92.30	93.77	0.91	0.12
1169	(1) 25-Year	9.17	92.30	93.85	0.95	0.14
1169	(1) 100-Year	12.20	92.30	94.04	0.88	0.19
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.11

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1091	(1) 2-Year	3.87	92.15	93.40	0.75	0.10
1091	(1) 5-Year	5.93	92.15	93.57	0.82	0.09
1091	(1) 10-Year	7.38	92.15	93.65	0.85	0.10
1091	(1) 25-Year	9.17	92.15	93.75	0.85	0.12
1091	(1) 100-Year	12.20	92.15	93.97	0.83	0.17
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.08
1002	(1) 2-Year	3.87	92.06	93.21	0.90	0.07
1002	(1) 5-Year	5.93	92.06	93.39	0.98	0.07
1002	(1) 10-Year	7.38	92.06	93.50	0.93	0.07
1002	(1) 25-Year	9.17	92.06	93.65	0.83	0.09
1002	(1) 100-Year	12.20	92.06	93.93	0.65	0.13
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.06
961	(1) 2-Year	3.87	91.96	93.14	0.71	0.05
961	(1) 5-Year	5.93	91.96	93.31	0.76	0.05
961	(1) 10-Year	7.38	91.96	93.44	0.71	0.06
961	(1) 25-Year	9.17	91.96	93.61	0.52	0.07
961	(1) 100-Year	12.20	91.96	93.92	0.35	0.11
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.04
910	(1) 2-Year	3.87	91.93	93.07	0.72	0.03
910	(1) 5-Year	5.93	91.93	93.25	0.73	0.04
910	(1) 10-Year	7.38	91.93	93.40	0.69	0.04
910	(1) 25-Year	9.17	91.93	93.59	0.53	0.05
910	(1) 100-Year	12.20	91.93	93.91	0.33	0.07
840	(1) 25 mm	1.53	91.86	92.64	0.50	0.00
840	(1) 2-Year	3.87	91.86	93.00	0.44	0.00
840	(1) 5-Year	5.93	91.86	93.22	0.37	0.00
840	(1) 10-Year	7.38	91.86	93.38	0.33	0.00
840	(1) 25-Year	9.17	91.86	93.58	0.30	0.00
840	(1) 100-Year	12.20	91.86	93.91	0.25	0.00

[1] All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(2) 2-Year	4.13	94.75	96.03	0.71	0.58
2554	(2) 5-Year	5.24	94.75	96.13	0.78	0.55
2554	(2) 10-Year	6.01	94.75	96.18	0.81	0.54
2554	(2) 25-Year	6.94	94.75	96.23	0.83	0.57
2554	(2) 100-Year	8.32	94.75	96.28	0.82	0.68
2554	(4) 2-Year	3.97	94.75	96.02	0.70	0.58
2554	(4) 5-Year	2.02	94.75	95.74	0.56	0.71
2554	(4) 10-Year	1.57	94.75	95.64	0.52	0.82
2554	(4) 25-Year	2.25	94.75	95.78	0.58	0.93
2554	(4) 100-Year	2.86	94.75	95.88	0.63	2.01
2478	(2) 2-Year	4.13	94.75	95.93	0.83	0.55
2478	(2) 5-Year	5.24	94.75	96.02	0.93	0.52
2478	(2) 10-Year	6.01	94.75	96.06	1.00	0.52
2478	(2) 25-Year	6.94	94.75	96.10	1.09	0.55
2478	(2) 100-Year	8.32	94.75	96.14	1.17	0.66
2478	(4) 2-Year	3.97	94.75	95.92	0.81	0.56
2478	(4) 5-Year	2.02	94.75	95.67	0.60	0.67
2478	(4) 10-Year	1.57	94.75	95.57	0.55	0.78
2478	(4) 25-Year	2.25	94.75	95.71	0.63	0.89
2478	(4) 100-Year	2.86	94.75	95.80	0.69	1.98
2427.58*	(2) 2-Year	4.13	94.68	95.86	0.85	0.53
2427.58*	(2) 5-Year	5.24	94.68	95.94	0.95	0.51
2427.58*	(2) 10-Year	6.01	94.68	95.97	1.04	0.51
2427.58*	(2) 25-Year	6.94	94.68	96.01	1.09	0.53
2427.58*	(2) 100-Year	8.32	94.68	96.05	1.16	0.65
2427.58*	(4) 2-Year	3.97	94.68	95.85	0.83	0.54
2427.58*	(4) 5-Year	2.02	94.68	95.61	0.61	0.65
2427.58*	(4) 10-Year	1.57	94.68	95.52	0.56	0.75
2427.58*	(4) 25-Year	2.25	94.68	95.65	0.64	0.87
2427.58*	(4) 100-Year	2.86	94.68	95.74	0.70	1.96
2377.17*	(2) 2-Year	4.13	94.61	95.79	0.87	0.52
2377.17*	(2) 5-Year	5.24	94.61	95.85	0.97	0.49
2377.17*	(2) 10-Year	6.01	94.61	95.88	1.03	0.49
2377.17*	(2) 25-Year	6.94	94.61	95.91	1.08	0.52
2377.17*	(2) 100-Year	8.32	94.61	95.95	1.13	0.63
2377.17*	(4) 2-Year	3.97	94.61	95.78	0.85	0.52
2377.17*	(4) 5-Year	2.02	94.61	95.56	0.63	0.63
2377.17*	(4) 10-Year	1.57	94.61	95.47	0.58	0.73
2377.17*	(4) 25-Year	2.25	94.61	95.60	0.65	0.85
2377.17*	(4) 100-Year	2.86	94.61	95.68	0.72	1.94
2326.76*	(2) 2-Year	4.13	94.54	95.71	0.88	0.50
2326.76*	(2) 5-Year	5.24	94.54	95.76	0.98	0.48
2326.76*	(2) 10-Year	6.01	94.54	95.79	1.02	0.48
2326.76*	(2) 25-Year	6.94	94.54	95.82	1.06	0.51
2326.76*	(2) 100-Year	8.32	94.54	95.85	1.11	0.62
2326.76*	(4) 2-Year	3.97	94.54	95.70	0.87	0.51
2326.76*	(4) 5-Year	2.02	94.54	95.50	0.65	0.61
2326.76*	(4) 10-Year	1.57	94.54	95.41	0.60	0.70

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [(1)]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2326.76*	(4) 25-Year	2.25	94.54	95.54	0.68	0.83
2326.76*	(4) 100-Year	2.86	94.54	95.61	0.75	1.92
2276.35*	(2) 2-Year	4.13	94.48	95.62	0.90	0.49
2276.35*	(2) 5-Year	5.24	94.48	95.66	0.98	0.46
2276.35*	(2) 10-Year	6.01	94.48	95.69	1.00	0.47
2276.35*	(2) 25-Year	6.94	94.48	95.72	1.00	0.50
2276.35*	(2) 100-Year	8.32	94.48	95.76	0.99	0.61
2276.35*	(4) 2-Year	3.97	94.48	95.61	0.89	0.49
2276.35*	(4) 5-Year	2.02	94.48	95.43	0.69	0.58
2276.35*	(4) 10-Year	1.57	94.48	95.34	0.63	0.68
2276.35*	(4) 25-Year	2.25	94.48	95.46	0.71	0.81
2276.35*	(4) 100-Year	2.86	94.48	95.53	0.77	1.91
2225.94*	(2) 2-Year	4.13	94.41	95.52	0.87	0.47
2225.94*	(2) 5-Year	5.24	94.41	95.56	0.93	0.45
2225.94*	(2) 10-Year	6.01	94.41	95.59	0.97	0.45
2225.94*	(2) 25-Year	6.94	94.41	95.62	1.01	0.48
2225.94*	(2) 100-Year	8.32	94.41	95.65	1.06	0.59
2225.94*	(4) 2-Year	3.97	94.41	95.52	0.86	0.47
2225.94*	(4) 5-Year	2.02	94.41	95.34	0.75	0.57
2225.94*	(4) 10-Year	1.57	94.41	95.26	0.69	0.66
2225.94*	(4) 25-Year	2.25	94.41	95.37	0.77	0.79
2225.94*	(4) 100-Year	2.86	94.41	95.44	0.81	1.89
2175.53*	(2) 2-Year	4.13	94.34	95.43	0.83	0.45
2175.53*	(2) 5-Year	5.24	94.34	95.46	0.92	0.44
2175.53*	(2) 10-Year	6.01	94.34	95.47	0.99	0.44
2175.53*	(2) 25-Year	6.94	94.34	95.49	1.02	0.47
2175.53*	(2) 100-Year	8.32	94.34	95.54	1.02	0.58
2175.53*	(4) 2-Year	3.97	94.34	95.41	0.85	0.46
2175.53*	(4) 5-Year	2.02	94.34	95.19	0.93	0.55
2175.53*	(4) 10-Year	1.57	94.34	95.12	0.86	0.64
2175.53*	(4) 25-Year	2.25	94.34	95.23	0.96	0.77
2175.53*	(4) 100-Year	2.86	94.34	95.30	0.98	1.87
2157	(2) 2-Year	4.13	94.31	95.20	1.80	0.45
2157	(2) 5-Year	5.24	94.31	95.34	1.36	0.43
2157	(2) 10-Year	6.01	94.31	95.38	1.22	0.43
2157	(2) 25-Year	6.94	94.31	95.43	1.14	0.46
2157	(2) 100-Year	8.32	94.31	95.49	1.02	0.58
2157	(4) 2-Year	3.97	94.31	95.17	1.85	0.45
2157	(4) 5-Year	2.02	94.31	94.94	1.78	0.54
2157	(4) 10-Year	1.57	94.31	94.88	1.70	0.64
2157	(4) 25-Year	2.25	94.31	94.97	1.81	0.77
2157	(4) 100-Year	2.86	94.31	95.03	1.89	1.87
2076	(2) 2-Year	5.00	93.86	95.05	0.86	0.43
2076	(2) 5-Year	6.32	93.86	95.16	0.93	0.41
2076	(2) 10-Year	7.24	93.86	95.21	0.95	0.41
2076	(2) 25-Year	8.38	93.86	95.27	0.95	0.44
2076	(2) 100-Year	10.81	93.86	95.35	0.96	0.55

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2076	(4) 2-Year	4.78	93.86	95.03	0.85	0.44
2076	(4) 5-Year	2.34	93.86	94.65	0.75	0.53
2076	(4) 10-Year	1.78	93.86	94.53	0.71	0.62
2076	(4) 25-Year	2.60	93.86	94.70	0.76	0.75
2076	(4) 100-Year	3.29	93.86	94.85	0.76	1.85
1974	(2) 2-Year	5.00	93.68	94.92	0.80	0.40
1974	(2) 5-Year	6.32	93.68	95.01	0.90	0.38
1974	(2) 10-Year	7.24	93.68	95.06	0.94	0.38
1974	(2) 25-Year	8.38	93.68	95.11	0.98	0.41
1974	(2) 100-Year	10.81	93.68	95.20	1.01	0.53
1974	(4) 2-Year	4.78	93.68	94.90	0.78	0.40
1974	(4) 5-Year	2.34	93.68	94.51	0.70	0.49
1974	(4) 10-Year	1.78	93.68	94.37	0.67	0.58
1974	(4) 25-Year	2.60	93.68	94.57	0.70	0.71
1974	(4) 100-Year	3.29	93.68	94.74	0.68	1.81
1922	(2) 2-Year	5.00	93.59	94.86	0.79	0.38
1922	(2) 5-Year	6.32	93.59	94.93	0.91	0.37
1922	(2) 10-Year	7.24	93.59	94.97	0.99	0.37
1922	(2) 25-Year	8.38	93.59	95.01	1.07	0.40
1922	(2) 100-Year	10.81	93.59	95.08	1.18	0.51
1922	(4) 2-Year	4.78	93.59	94.84	0.77	0.39
1922	(4) 5-Year	2.34	93.59	94.44	0.67	0.47
1922	(4) 10-Year	1.78	93.59	94.30	0.66	0.56
1922	(4) 25-Year	2.60	93.59	94.51	0.67	0.69
1922	(4) 100-Year	3.29	93.59	94.69	0.65	1.79
1833	(2) 2-Year	5.00	93.44	94.78	0.65	0.35
1833	(2) 5-Year	6.32	93.44	94.84	0.71	0.34
1833	(2) 10-Year	7.24	93.44	94.87	0.75	0.34
1833	(2) 25-Year	8.38	93.44	94.90	0.78	0.37
1833	(2) 100-Year	10.81	93.44	94.97	0.82	0.49
1833	(4) 2-Year	4.78	93.44	94.76	0.64	0.35
1833	(4) 5-Year	2.34	93.44	94.35	0.60	0.43
1833	(4) 10-Year	1.78	93.44	94.20	0.59	0.52
1833	(4) 25-Year	2.60	93.44	94.42	0.60	0.65
1833	(4) 100-Year	3.29	93.44	94.63	0.55	1.75
1796	(2) 2-Year	5.00	93.37	94.74	0.70	0.33
1796	(2) 5-Year	6.32	93.37	94.79	0.83	0.32
1796	(2) 10-Year	7.24	93.37	94.80	0.93	0.33
1796	(2) 25-Year	8.38	93.37	94.83	1.04	0.36
1796	(2) 100-Year	10.81	93.37	94.87	1.23	0.48
1796	(4) 2-Year	4.78	93.37	94.73	0.68	0.34
1796	(4) 5-Year	2.34	93.37	94.33	0.57	0.41
1796	(4) 10-Year	1.78	93.37	94.17	0.56	0.50
1796	(4) 25-Year	2.60	93.37	94.40	0.57	0.64
1796	(4) 100-Year	3.29	93.37	94.60	0.55	1.73
1735	(2) 2-Year	5.00	93.26	94.71	0.53	0.31
1735	(2) 5-Year	6.32	93.26	94.76	0.57	0.30

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1735	(2) 10-Year	7.24	93.26	94.77	0.63	0.31
1735	(2) 25-Year	8.38	93.26	94.79	0.68	0.34
1735	(2) 100-Year	10.81	93.26	94.84	0.74	0.46
1735	(4) 2-Year	4.78	93.26	94.70	0.53	0.31
1735	(4) 5-Year	2.34	93.26	94.29	0.49	0.38
1735	(4) 10-Year	1.78	93.26	94.13	0.49	0.47
1735	(4) 25-Year	2.60	93.26	94.36	0.49	0.61
1735	(4) 100-Year	3.29	93.26	94.58	0.45	1.70
1728	(2) 2-Year	5.00	93.25	94.69	0.73	0.31
1728	(2) 5-Year	6.32	93.25	94.74	0.84	0.30
1728	(2) 10-Year	7.24	93.25	94.74	0.95	0.31
1728	(2) 25-Year	8.38	93.25	94.75	1.07	0.34
1728	(2) 100-Year	10.81	93.25	94.76	1.32	0.46
1728	(4) 2-Year	4.78	93.25	94.68	0.72	0.31
1728	(4) 5-Year	2.34	93.25	94.28	0.61	0.38
1728	(4) 10-Year	1.78	93.25	94.11	0.60	0.47
1728	(4) 25-Year	2.60	93.25	94.35	0.61	0.60
1728	(4) 100-Year	3.29	93.25	94.57	0.58	1.70
1727		Culvert				
1717	(2) 2-Year	5.00	93.24	94.45	1.02	0.30
1717	(2) 5-Year	6.32	93.24	94.57	1.10	0.29
1717	(2) 10-Year	7.24	93.24	94.62	1.17	0.30
1717	(2) 25-Year	8.38	93.24	94.67	1.26	0.34
1717	(2) 100-Year	10.81	93.24	94.74	1.39	0.46
1717	(4) 2-Year	4.78	93.24	94.42	1.01	0.30
1717	(4) 5-Year	2.34	93.24	94.06	0.84	0.37
1717	(4) 10-Year	1.78	93.24	93.94	0.80	0.46
1717	(4) 25-Year	2.60	93.24	94.12	0.86	0.60
1717	(4) 100-Year	3.29	93.24	94.32	0.79	1.69
1615	(2) 2-Year	5.00	93.05	94.29	0.83	0.27
1615	(2) 5-Year	6.32	93.05	94.40	0.88	0.26
1615	(2) 10-Year	7.24	93.05	94.47	0.87	0.28
1615	(2) 25-Year	8.38	93.05	94.53	0.87	0.31
1615	(2) 100-Year	10.81	93.05	94.62	0.82	0.43
1615	(4) 2-Year	4.78	93.05	94.26	0.82	0.27
1615	(4) 5-Year	2.34	93.05	93.92	0.65	0.34
1615	(4) 10-Year	1.78	93.05	93.78	0.63	0.42
1615	(4) 25-Year	2.60	93.05	93.98	0.66	0.56
1615	(4) 100-Year	3.29	93.05	94.24	0.58	1.65
1555	(2) 2-Year	5.00	92.94	94.22	0.79	0.25
1555	(2) 5-Year	6.32	92.94	94.33	0.85	0.25
1555	(2) 10-Year	7.24	92.94	94.39	0.88	0.26
1555	(2) 25-Year	8.38	92.94	94.45	0.91	0.29
1555	(2) 100-Year	10.81	92.94	94.55	0.96	0.41
1555	(4) 2-Year	4.78	92.94	94.19	0.78	0.25
1555	(4) 5-Year	2.34	92.94	93.87	0.59	0.31
1555	(4) 10-Year	1.78	92.94	93.72	0.58	0.40

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1555	(4) 25-Year	2.60	92.94	93.93	0.60	0.54
1555	(4) 100-Year	3.29	92.94	94.21	0.53	1.62
1488	(2) 2-Year	5.00	92.82	94.16	0.72	0.23
1488	(2) 5-Year	6.32	92.82	94.26	0.81	0.22
1488	(2) 10-Year	7.24	92.82	94.31	0.86	0.24
1488	(2) 25-Year	8.38	92.82	94.37	0.91	0.27
1488	(2) 100-Year	10.81	92.82	94.46	1.00	0.40
1488	(4) 2-Year	4.78	92.82	94.13	0.72	0.23
1488	(4) 5-Year	2.34	92.82	93.82	0.53	0.28
1488	(4) 10-Year	1.78	92.82	93.66	0.51	0.36
1488	(4) 25-Year	2.60	92.82	93.88	0.54	0.50
1488	(4) 100-Year	3.29	92.82	94.18	0.46	1.59
1416	(2) 2-Year	5.00	92.71	94.02	1.09	0.21
1416	(2) 5-Year	6.32	92.71	94.10	1.21	0.20
1416	(2) 10-Year	7.24	92.71	94.17	1.21	0.22
1416	(2) 25-Year	8.38	92.71	94.25	1.12	0.25
1416	(2) 100-Year	10.81	92.71	94.40	0.82	0.37
1416	(4) 2-Year	4.78	92.71	93.99	1.08	0.21
1416	(4) 5-Year	2.34	92.71	93.74	0.74	0.25
1416	(4) 10-Year	1.78	92.71	93.58	0.71	0.33
1416	(4) 25-Year	2.60	92.71	93.81	0.76	0.47
1416	(4) 100-Year	3.29	92.71	94.14	0.58	1.55
1400	(2) 2-Year	5.00	92.68	94.02	0.68	0.20
1400	(2) 5-Year	6.32	92.68	94.11	0.77	0.20
1400	(2) 10-Year	7.24	92.68	94.16	0.82	0.21
1400	(2) 25-Year	8.38	92.68	94.23	0.87	0.25
1400	(2) 100-Year	10.81	92.68	94.36	0.96	0.37
1400	(4) 2-Year	4.78	92.68	93.99	0.68	0.20
1400	(4) 5-Year	2.34	92.68	93.74	0.50	0.24
1400	(4) 10-Year	1.78	92.68	93.58	0.50	0.32
1400	(4) 25-Year	2.60	92.68	93.80	0.50	0.47
1400	(4) 100-Year	3.29	92.68	94.14	0.38	1.54
1364	(2) 2-Year	5.00	92.62	93.99	0.71	0.19
1364	(2) 5-Year	6.32	92.62	94.06	0.82	0.19
1364	(2) 10-Year	7.24	92.62	94.11	0.88	0.20
1364	(2) 25-Year	8.38	92.62	94.18	0.95	0.24
1364	(2) 100-Year	10.81	92.62	94.29	1.06	0.36
1364	(4) 2-Year	4.78	92.62	93.96	0.70	0.19
1364	(4) 5-Year	2.34	92.62	93.72	0.46	0.22
1364	(4) 10-Year	1.78	92.62	93.56	0.44	0.30
1364	(4) 25-Year	2.60	92.62	93.79	0.47	0.45
1364	(4) 100-Year	3.29	92.62	94.13	0.39	1.51
1340	(2) 2-Year	5.79	92.61	93.96	0.88	0.18
1340	(2) 5-Year	7.32	92.61	94.01	1.06	0.18
1340	(2) 10-Year	8.34	92.61	94.05	1.18	0.19
1340	(2) 25-Year	9.65	92.61	94.10	1.33	0.23
1340	(2) 100-Year	11.62	92.61	94.19	1.50	0.35

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1340	(4) 2-Year	5.26	92.61	93.93	0.81	0.18
1340	(4) 5-Year	2.44	92.61	93.71	0.45	0.21
1340	(4) 10-Year	1.86	92.61	93.55	0.40	0.29
1340	(4) 25-Year	2.71	92.61	93.78	0.47	0.43
1340	(4) 100-Year	3.43	92.61	94.13	0.46	1.50
1339		Culvert				
1312	(2) 2-Year	6.08	92.47	93.94	0.85	0.17
1312	(2) 5-Year	7.69	92.47	93.98	1.04	0.17
1312	(2) 10-Year	8.76	92.47	94.01	1.16	0.19
1312	(2) 25-Year	10.15	92.47	94.04	1.32	0.23
1312	(2) 100-Year	12.20	92.47	94.12	1.51	0.35
1312	(4) 2-Year	5.46	92.47	93.91	0.77	0.17
1312	(4) 5-Year	2.47	92.47	93.71	0.41	0.19
1312	(4) 10-Year	1.87	92.47	93.55	0.35	0.27
1312	(4) 25-Year	2.73	92.47	93.77	0.43	0.41
1312	(4) 100-Year	3.44	92.47	94.12	0.43	1.48
1302	(2) 2-Year	6.08	92.57	93.91	1.03	0.17
1302	(2) 5-Year	7.69	92.57	93.97	1.12	0.17
1302	(2) 10-Year	8.76	92.57	94.00	1.18	0.19
1302	(2) 25-Year	10.15	92.57	94.04	1.26	0.23
1302	(2) 100-Year	12.20	92.57	94.14	1.07	0.35
1302	(4) 2-Year	5.46	92.57	93.89	0.98	0.17
1302	(4) 5-Year	2.47	92.57	93.68	0.77	0.18
1302	(4) 10-Year	1.87	92.57	93.51	0.84	0.26
1302	(4) 25-Year	2.73	92.57	93.75	0.72	0.41
1302	(4) 100-Year	3.44	92.57	94.12	0.33	1.47
1268	(2) 2-Year	6.08	92.47	93.87	0.59	0.15
1268	(2) 5-Year	7.69	92.47	93.93	0.62	0.16
1268	(2) 10-Year	8.76	92.47	93.96	0.64	0.18
1268	(2) 25-Year	10.15	92.47	94.00	0.65	0.22
1268	(2) 100-Year	12.20	92.47	94.14	0.45	0.34
1268	(4) 2-Year	5.46	92.47	93.84	0.57	0.15
1268	(4) 5-Year	2.47	92.47	93.59	0.68	0.17
1268	(4) 10-Year	1.87	92.47	93.44	0.79	0.25
1268	(4) 25-Year	2.73	92.47	93.69	0.51	0.39
1268	(4) 100-Year	3.44	92.47	94.12	0.14	1.43
1212	(2) 2-Year	6.08	92.36	93.78	0.84	0.13
1212	(2) 5-Year	7.69	92.36	93.85	0.85	0.14
1212	(2) 10-Year	8.76	92.36	93.89	0.85	0.15
1212	(2) 25-Year	10.15	92.36	93.94	0.80	0.19
1212	(2) 100-Year	12.20	92.36	94.11	0.56	0.30
1212	(4) 2-Year	5.46	92.36	93.74	0.83	0.13
1212	(4) 5-Year	2.47	92.36	93.41	0.89	0.15
1212	(4) 10-Year	1.87	92.36	93.32	0.81	0.23
1212	(4) 25-Year	2.73	92.36	93.58	0.66	0.37
1212	(4) 100-Year	3.44	92.36	94.12	0.15	1.32

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(2) 2-Year	6.08	92.30	93.70	0.85	0.12
1169	(2) 5-Year	7.69	92.30	93.76	0.91	0.13
1169	(2) 10-Year	8.76	92.30	93.80	0.94	0.14
1169	(2) 25-Year	10.15	92.30	93.87	0.94	0.18
1169	(2) 100-Year	12.20	92.30	94.08	0.73	0.29
1169	(4) 2-Year	5.46	92.30	93.67	0.83	0.12
1169	(4) 5-Year	2.47	92.30	93.32	0.73	0.13
1169	(4) 10-Year	1.87	92.30	93.26	0.62	0.21
1169	(4) 25-Year	2.73	92.30	93.54	0.53	0.35
1169	(4) 100-Year	3.44	92.30	94.12	0.17	1.25
1091	(2) 2-Year	6.08	92.15	93.57	0.82	0.09
1091	(2) 5-Year	7.69	92.15	93.64	0.85	0.10
1091	(2) 10-Year	8.76	92.15	93.69	0.84	0.12
1091	(2) 25-Year	10.15	92.15	93.78	0.78	0.15
1091	(2) 100-Year	12.20	92.15	94.04	0.57	0.25
1091	(4) 2-Year	5.46	92.15	93.54	0.82	0.09
1091	(4) 5-Year	2.47	92.15	93.19	0.70	0.10
1091	(4) 10-Year	1.87	92.15	93.17	0.55	0.18
1091	(4) 25-Year	2.73	92.15	93.50	0.45	0.30
1091	(4) 100-Year	3.44	92.15	94.12	0.13	1.10
1002	(2) 2-Year	6.08	92.06	93.38	1.02	0.07
1002	(2) 5-Year	7.69	92.06	93.49	0.94	0.07
1002	(2) 10-Year	8.76	92.06	93.59	0.82	0.09
1002	(2) 25-Year	10.15	92.06	93.71	0.70	0.12
1002	(2) 100-Year	12.20	92.06	94.02	0.41	0.20
1002	(4) 2-Year	5.46	92.06	93.33	1.01	0.06
1002	(4) 5-Year	2.47	92.06	93.01	0.83	0.07
1002	(4) 10-Year	1.87	92.06	93.09	0.55	0.13
1002	(4) 25-Year	2.73	92.06	93.47	0.36	0.24
1002	(4) 100-Year	3.44	92.06	94.12	0.09	0.88
961	(2) 2-Year	6.08	91.96	93.28	0.83	0.05
961	(2) 5-Year	7.69	91.96	93.41	0.78	0.06
961	(2) 10-Year	8.76	91.96	93.52	0.65	0.07
961	(2) 25-Year	10.15	91.96	93.69	0.43	0.10
961	(2) 100-Year	12.20	91.96	94.02	0.24	0.17
961	(4) 2-Year	5.46	91.96	93.23	0.82	0.05
961	(4) 5-Year	2.47	91.96	92.97	0.62	0.06
961	(4) 10-Year	1.87	91.96	93.06	0.40	0.11
961	(4) 25-Year	2.73	91.96	93.46	0.25	0.21
961	(4) 100-Year	3.44	91.96	94.12	0.05	0.72
910	(2) 2-Year	6.08	91.93	93.22	0.70	0.03
910	(2) 5-Year	7.69	91.93	93.38	0.63	0.04
910	(2) 10-Year	8.76	91.93	93.49	0.52	0.05
910	(2) 25-Year	10.15	91.93	93.68	0.34	0.06
910	(2) 100-Year	12.20	91.93	94.02	0.20	0.10
910	(4) 2-Year	5.46	91.93	93.17	0.73	0.03
910	(4) 5-Year	2.47	91.93	92.91	0.64	0.03
910	(4) 10-Year	1.87	91.93	93.05	0.35	0.07

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
910	(4) 25-Year	2.73	91.93	93.46	0.18	0.14
910	(4) 100-Year	3.44	91.93	94.12	0.05	0.44
840	(2) 2-Year	6.08	91.86	93.18	0.41	0.00
840	(2) 5-Year	7.69	91.86	93.35	0.34	0.00
840	(2) 10-Year	8.76	91.86	93.48	0.30	0.00
840	(2) 25-Year	10.15	91.86	93.67	0.26	0.00
840	(2) 100-Year	12.20	91.86	94.02	0.18	0.00
840	(4) 2-Year	5.46	91.86	93.11	0.44	0.00
840	(4) 5-Year	2.47	91.86	92.83	0.47	0.00
840	(4) 10-Year	1.87	91.86	93.03	0.19	0.00
840	(4) 25-Year	2.73	91.86	93.45	0.10	0.00
840	(4) 100-Year	3.44	91.86	94.12	0.04	0.00

[1] All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

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WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

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Attachment B

HEC-RAS Results for Van Gaal Drain Reach 2

Existing Conditions (Riparian Storage Analysis)

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(1) 25 mm	0.72	94.75	95.41	0.41	3.57
2554	(1) 2-Year	1.95	94.75	95.72	0.56	7.64
2554	(1) 5-Year	3.20	94.75	95.93	0.65	11.95
2554	(1) 10-Year	4.11	94.75	96.04	0.71	15.65
2554	(1) 25-Year	5.28	94.75	96.14	0.78	22.19
2554	(1) 100-Year	7.27	94.75	96.26	0.84	38.09
2478	(1) 25 mm	0.72	94.75	95.35	0.42	3.44
2478	(1) 2-Year	1.95	94.75	95.65	0.59	7.39
2478	(1) 5-Year	3.20	94.75	95.85	0.72	11.60
2478	(1) 10-Year	4.11	94.75	95.94	0.82	15.23
2478	(1) 25-Year	5.28	94.75	96.03	0.93	21.64
2478	(1) 100-Year	7.27	94.75	96.12	1.10	37.03
2427.58*	(1) 25 mm	0.72	94.68	95.30	0.43	3.36
2427.58*	(1) 2-Year	1.95	94.68	95.60	0.61	7.23
2427.58*	(1) 5-Year	3.20	94.68	95.79	0.74	11.38
2427.58*	(1) 10-Year	4.11	94.68	95.87	0.84	14.96
2427.58*	(1) 25-Year	5.28	94.68	95.95	0.95	21.30
2427.58*	(1) 100-Year	7.27	94.68	96.04	1.11	36.45
2377.17*	(1) 25 mm	0.72	94.61	95.25	0.44	3.28
2377.17*	(1) 2-Year	1.95	94.61	95.54	0.62	7.07
2377.17*	(1) 5-Year	3.20	94.61	95.72	0.76	11.16
2377.17*	(1) 10-Year	4.11	94.61	95.80	0.86	14.68
2377.17*	(1) 25-Year	5.28	94.61	95.87	0.97	20.90
2377.17*	(1) 100-Year	7.27	94.61	95.95	1.09	35.75
2326.76*	(1) 25 mm	0.72	94.54	95.19	0.46	3.20
2326.76*	(1) 2-Year	1.95	94.54	95.48	0.64	6.91
2326.76*	(1) 5-Year	3.20	94.54	95.65	0.78	10.93
2326.76*	(1) 10-Year	4.11	94.54	95.72	0.88	14.37
2326.76*	(1) 25-Year	5.28	94.54	95.78	0.97	20.42
2326.76*	(1) 100-Year	7.27	94.54	95.85	1.07	34.92
2276.35*	(1) 25 mm	0.72	94.48	95.13	0.49	3.12
2276.35*	(1) 2-Year	1.95	94.48	95.41	0.68	6.77
2276.35*	(1) 5-Year	3.20	94.48	95.57	0.80	10.67
2276.35*	(1) 10-Year	4.11	94.48	95.63	0.89	14.00
2276.35*	(1) 25-Year	5.28	94.48	95.69	0.96	19.84
2276.35*	(1) 100-Year	7.27	94.48	95.77	0.98	33.90
2225.94*	(1) 25 mm	0.72	94.41	95.05	0.54	3.05
2225.94*	(1) 2-Year	1.95	94.41	95.33	0.74	6.63
2225.94*	(1) 5-Year	3.20	94.41	95.48	0.84	10.38
2225.94*	(1) 10-Year	4.11	94.41	95.54	0.88	13.58
2225.94*	(1) 25-Year	5.28	94.41	95.59	0.95	19.24
2225.94*	(1) 100-Year	7.27	94.41	95.66	1.05	32.94
2175.53*	(1) 25 mm	0.72	94.34	94.93	0.68	2.99
2175.53*	(1) 2-Year	1.95	94.34	95.18	0.92	6.51
2175.53*	(1) 5-Year	3.20	94.34	95.33	1.03	10.12

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2175.53*	(1) 10-Year	4.11	94.34	95.42	0.94	13.14
2175.53*	(1) 25-Year	5.28	94.34	95.47	1.01	18.68
2175.53*	(1) 100-Year	7.27	94.34	95.54	1.07	32.14
2157	(1) 25 mm	0.72	94.31	94.72	1.45	2.98
2157	(1) 2-Year	1.95	94.31	94.93	1.77	6.48
2157	(1) 5-Year	3.20	94.31	95.12	1.71	10.06
2157	(1) 10-Year	4.11	94.31	95.24	1.59	13.03
2157	(1) 25-Year	5.28	94.31	95.37	1.29	18.50
2157	(1) 100-Year	7.27	94.31	95.48	1.13	31.84
2076	(1) 25 mm	1.16	93.86	94.39	0.64	2.89
2076	(1) 2-Year	2.80	93.86	94.71	0.81	6.30
2076	(1) 5-Year	4.41	93.86	94.94	0.89	9.79
2076	(1) 10-Year	5.53	93.86	95.07	0.93	12.67
2076	(1) 25-Year	6.96	93.86	95.19	0.97	17.86
2076	(1) 100-Year	9.54	93.86	95.33	0.99	30.64
1974	(1) 25 mm	1.16	93.68	94.21	0.63	2.71
1974	(1) 2-Year	2.80	93.68	94.54	0.78	5.95
1974	(1) 5-Year	4.41	93.68	94.77	0.86	9.29
1974	(1) 10-Year	5.53	93.68	94.92	0.89	12.06
1974	(1) 25-Year	6.96	93.68	95.04	0.95	16.97
1974	(1) 100-Year	9.54	93.68	95.17	1.02	28.90
1922	(1) 25 mm	1.16	93.59	94.12	0.63	2.62
1922	(1) 2-Year	2.80	93.59	94.46	0.78	5.77
1922	(1) 5-Year	4.41	93.59	94.70	0.87	9.04
1922	(1) 10-Year	5.53	93.59	94.84	0.91	11.76
1922	(1) 25-Year	6.96	93.59	94.95	0.98	16.58
1922	(1) 100-Year	9.54	93.59	95.07	1.10	28.19
1833	(1) 25 mm	1.16	93.44	93.97	0.62	2.45
1833	(1) 2-Year	2.80	93.44	94.33	0.75	5.45
1833	(1) 5-Year	4.41	93.44	94.56	0.81	8.57
1833	(1) 10-Year	5.53	93.44	94.70	0.82	11.18
1833	(1) 25-Year	6.96	93.44	94.82	0.83	15.73
1833	(1) 100-Year	9.54	93.44	94.95	0.84	26.54
1796	(1) 25 mm	1.16	93.37	93.91	0.62	2.38
1796	(1) 2-Year	2.80	93.37	94.28	0.73	5.31
1796	(1) 5-Year	4.41	93.37	94.51	0.83	8.38
1796	(1) 10-Year	5.53	93.37	94.64	0.88	10.95
1796	(1) 25-Year	6.96	93.37	94.75	0.96	15.39
1796	(1) 100-Year	9.54	93.37	94.87	1.11	25.93
1735	(1) 25 mm	1.16	93.26	93.83	0.58	2.27
1735	(1) 2-Year	2.80	93.26	94.21	0.67	5.08
1735	(1) 5-Year	4.41	93.26	94.44	0.74	8.05
1735	(1) 10-Year	5.53	93.26	94.57	0.77	10.56
1735	(1) 25-Year	6.96	93.26	94.69	0.80	14.83
1735	(1) 100-Year	9.54	93.26	94.83	0.76	24.60

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1728	(1) 25 mm	1.16	93.25	93.81	0.68	2.26
1728	(1) 2-Year	2.80	93.25	94.19	0.84	5.05
1728	(1) 5-Year	4.41	93.25	94.41	0.95	8.01
1728	(1) 10-Year	5.53	93.25	94.53	1.01	10.51
1728	(1) 25-Year	6.96	93.25	94.64	1.11	14.76
1728	(1) 100-Year	9.54	93.25	94.78	1.17	24.43
1717	(1) 25 mm	1.16	93.24	93.79	0.71	2.24
1717	(1) 2-Year	2.80	93.24	94.16	0.86	5.01
1717	(1) 5-Year	4.41	93.24	94.38	0.98	7.96
1717	(1) 10-Year	5.53	93.24	94.50	1.04	10.45
1717	(1) 25-Year	6.96	93.24	94.61	1.14	14.69
1717	(1) 100-Year	9.54	93.24	94.73	1.32	24.28
1615	(1) 25 mm	1.16	93.05	93.63	0.56	2.05
1615	(1) 2-Year	2.80	93.05	94.03	0.65	4.63
1615	(1) 5-Year	4.41	93.05	94.24	0.78	7.45
1615	(1) 10-Year	5.53	93.05	94.35	0.85	9.83
1615	(1) 25-Year	6.96	93.05	94.46	0.89	13.75
1615	(1) 100-Year	9.54	93.05	94.59	0.90	22.47
1555	(1) 25 mm	1.16	92.94	93.57	0.50	1.92
1555	(1) 2-Year	2.80	92.94	93.99	0.60	4.36
1555	(1) 5-Year	4.41	92.94	94.18	0.73	7.10
1555	(1) 10-Year	5.53	92.94	94.28	0.81	9.41
1555	(1) 25-Year	6.96	92.94	94.39	0.88	13.09
1555	(1) 100-Year	9.54	92.94	94.51	0.97	21.28
1488	(1) 25 mm	1.16	92.82	93.53	0.43	1.76
1488	(1) 2-Year	2.80	92.82	93.95	0.53	4.04
1488	(1) 5-Year	4.41	92.82	94.12	0.67	6.69
1488	(1) 10-Year	5.53	92.82	94.22	0.75	8.93
1488	(1) 25-Year	6.96	92.82	94.31	0.83	12.45
1488	(1) 100-Year	9.54	92.82	94.43	0.97	20.32
1416	(1) 25 mm	1.16	92.71	93.47	0.55	1.59
1416	(1) 2-Year	2.80	92.71	93.88	0.74	3.73
1416	(1) 5-Year	4.41	92.71	94.01	0.98	6.31
1416	(1) 10-Year	5.53	92.71	94.08	1.11	8.48
1416	(1) 25-Year	6.96	92.71	94.16	1.22	11.83
1416	(1) 100-Year	9.54	92.71	94.28	1.29	19.29
1400	(1) 25 mm	1.16	92.68	93.46	0.39	1.55
1400	(1) 2-Year	2.80	92.68	93.87	0.48	3.65
1400	(1) 5-Year	4.41	92.68	94.01	0.61	6.21
1400	(1) 10-Year	5.53	92.68	94.08	0.69	8.37
1400	(1) 25-Year	6.96	92.68	94.16	0.79	11.69
1400	(1) 100-Year	9.54	92.68	94.27	0.95	19.07
1364	(1) 25 mm	1.16	92.62	93.45	0.35	1.44
1364	(1) 2-Year	2.80	92.62	93.86	0.46	3.44

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1364	(1) 5-Year	4.41	92.62	93.98	0.63	5.96
1364	(1) 10-Year	5.53	92.62	94.04	0.73	8.09
1364	(1) 25-Year	6.96	92.62	94.11	0.85	11.37
1364	(1) 100-Year	9.54	92.62	94.20	1.05	18.72
1340	(1) 25 mm	1.53	92.61	93.45	0.19	1.30
1340	(1) 2-Year	3.64	92.61	93.86	0.29	3.22
1340	(1) 5-Year	5.57	92.61	93.98	0.41	5.71
1340	(1) 10-Year	6.92	92.61	94.05	0.48	7.82
1340	(1) 25-Year	8.58	92.61	94.12	0.57	11.09
1340	(1) 100-Year	11.43	92.61	94.21	0.71	18.39
1312	(1) 25 mm	1.53	92.47	93.45	0.29	1.10
1312	(1) 2-Year	3.87	92.47	93.84	0.51	2.91
1312	(1) 5-Year	5.93	92.47	93.96	0.71	5.36
1312	(1) 10-Year	7.38	92.47	94.01	0.84	7.45
1312	(1) 25-Year	9.17	92.47	94.07	1.01	10.69
1312	(1) 100-Year	12.20	92.47	94.13	1.29	17.96
1302	(1) 25 mm	1.53	92.57	93.41	0.83	1.07
1302	(1) 2-Year	3.87	92.57	93.81	0.88	2.84
1302	(1) 5-Year	5.93	92.57	93.92	1.05	5.28
1302	(1) 10-Year	7.38	92.57	93.98	1.15	7.35
1302	(1) 25-Year	9.17	92.57	94.03	1.27	10.58
1302	(1) 100-Year	12.20	92.57	94.11	1.41	17.81
1268	(1) 25 mm	1.53	92.47	93.33	0.79	1.00
1268	(1) 2-Year	3.87	92.47	93.75	0.56	2.62
1268	(1) 5-Year	5.93	92.47	93.88	0.57	4.91
1268	(1) 10-Year	7.38	92.47	93.94	0.60	6.88
1268	(1) 25-Year	9.17	92.47	94.01	0.62	9.89
1268	(1) 100-Year	12.20	92.47	94.10	0.60	16.63
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.90
1212	(1) 2-Year	3.87	92.36	93.61	0.89	2.25
1212	(1) 5-Year	5.93	92.36	93.77	0.91	4.21
1212	(1) 10-Year	7.38	92.36	93.85	0.93	5.90
1212	(1) 25-Year	9.17	92.36	93.92	0.94	8.43
1212	(1) 100-Year	12.20	92.36	94.04	0.90	14.29
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.81
1169	(1) 2-Year	3.87	92.30	93.53	0.78	2.01
1169	(1) 5-Year	5.93	92.30	93.70	0.86	3.67
1169	(1) 10-Year	7.38	92.30	93.77	0.92	5.11
1169	(1) 25-Year	9.17	92.30	93.84	0.98	7.33
1169	(1) 100-Year	12.20	92.30	93.94	1.09	12.63
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.63
1091	(1) 2-Year	3.87	92.15	93.40	0.75	1.62
1091	(1) 5-Year	5.93	92.15	93.57	0.83	2.89
1091	(1) 10-Year	7.38	92.15	93.64	0.87	4.03
1091	(1) 25-Year	9.17	92.15	93.71	0.92	5.91

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(1) 100-Year	12.20	92.15	93.82	0.97	10.61
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.44
1002	(1) 2-Year	3.87	92.06	93.21	0.91	1.21
1002	(1) 5-Year	5.93	92.06	93.37	1.02	2.15
1002	(1) 10-Year	7.38	92.06	93.46	1.04	2.97
1002	(1) 25-Year	9.17	92.06	93.55	1.03	4.45
1002	(1) 100-Year	12.20	92.06	93.69	1.02	8.49
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.34
961	(1) 2-Year	3.87	91.96	93.13	0.72	1.01
961	(1) 5-Year	5.93	91.96	93.28	0.80	1.85
961	(1) 10-Year	7.38	91.96	93.37	0.83	2.56
961	(1) 25-Year	9.17	91.96	93.47	0.82	3.85
961	(1) 100-Year	12.20	91.96	93.64	0.64	7.42
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.20
910	(1) 2-Year	3.87	91.93	93.06	0.74	0.62
910	(1) 5-Year	5.93	91.93	93.20	0.81	1.16
910	(1) 10-Year	7.38	91.93	93.30	0.82	1.62
910	(1) 25-Year	9.17	91.93	93.41	0.83	2.38
910	(1) 100-Year	12.20	91.93	93.60	0.68	4.32
840	(1) 25 mm	1.53	91.86	92.65	0.50	0.00
840	(1) 2-Year	3.87	91.86	92.98	0.47	0.00
840	(1) 5-Year	5.93	91.86	93.16	0.43	0.00
840	(1) 10-Year	7.38	91.86	93.26	0.41	0.00
840	(1) 25-Year	9.17	91.86	93.38	0.41	0.00
840	(1) 100-Year	12.20	91.86	93.58	0.39	0.00

[1] All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(2) 2-Year	4.13	94.75	96.03	0.71	12.55
2554	(2) 5-Year	5.24	94.75	96.13	0.78	16.61
2554	(2) 10-Year	6.01	94.75	96.18	0.81	20.28
2554	(2) 25-Year	6.94	94.75	96.23	0.83	26.23
2554	(2) 100-Year	8.32	94.75	96.28	0.82	39.19
2554	(4) 2-Year	3.97	94.75	96.02	0.70	11.55
2554	(4) 5-Year	2.02	94.75	95.74	0.56	5.89
2554	(4) 10-Year	1.57	94.75	95.64	0.52	5.25
2554	(4) 25-Year	2.25	94.75	95.78	0.58	9.59
2554	(4) 100-Year	2.86	94.75	95.88	0.63	36.83
2478	(2) 2-Year	4.13	94.75	95.93	0.83	12.14
2478	(2) 5-Year	5.24	94.75	96.02	0.93	16.08
2478	(2) 10-Year	6.01	94.75	96.06	1.00	19.63
2478	(2) 25-Year	6.94	94.75	96.10	1.09	25.37
2478	(2) 100-Year	8.32	94.75	96.14	1.17	37.97
2478	(4) 2-Year	3.97	94.75	95.92	0.81	11.15
2478	(4) 5-Year	2.02	94.75	95.67	0.60	5.63
2478	(4) 10-Year	1.57	94.75	95.57	0.55	5.03
2478	(4) 25-Year	2.25	94.75	95.71	0.63	9.31
2478	(4) 100-Year	2.86	94.75	95.80	0.69	36.50
2427.58*	(2) 2-Year	4.13	94.68	95.86	0.85	11.88
2427.58*	(2) 5-Year	5.24	94.68	95.94	0.95	15.75
2427.58*	(2) 10-Year	6.01	94.68	95.97	1.04	19.25
2427.58*	(2) 25-Year	6.94	94.68	96.01	1.09	24.89
2427.58*	(2) 100-Year	8.32	94.68	96.05	1.16	37.34
2427.58*	(4) 2-Year	3.97	94.68	95.85	0.83	10.90
2427.58*	(4) 5-Year	2.02	94.68	95.61	0.61	5.47
2427.58*	(4) 10-Year	1.57	94.68	95.52	0.56	4.88
2427.58*	(4) 25-Year	2.25	94.68	95.65	0.64	9.13
2427.58*	(4) 100-Year	2.86	94.68	95.74	0.70	36.30
2377.17*	(2) 2-Year	4.13	94.61	95.79	0.87	11.60
2377.17*	(2) 5-Year	5.24	94.61	95.85	0.97	15.39
2377.17*	(2) 10-Year	6.01	94.61	95.88	1.03	18.81
2377.17*	(2) 25-Year	6.94	94.61	95.91	1.08	24.33
2377.17*	(2) 100-Year	8.32	94.61	95.95	1.13	36.61
2377.17*	(4) 2-Year	3.97	94.61	95.78	0.85	10.63
2377.17*	(4) 5-Year	2.02	94.61	95.56	0.63	5.30
2377.17*	(4) 10-Year	1.57	94.61	95.47	0.58	4.75
2377.17*	(4) 25-Year	2.25	94.61	95.60	0.65	8.96
2377.17*	(4) 100-Year	2.86	94.61	95.68	0.72	36.10
2326.76*	(2) 2-Year	4.13	94.54	95.71	0.88	11.31
2326.76*	(2) 5-Year	5.24	94.54	95.76	0.98	14.98
2326.76*	(2) 10-Year	6.01	94.54	95.79	1.02	18.30
2326.76*	(2) 25-Year	6.94	94.54	95.82	1.06	23.69
2326.76*	(2) 100-Year	8.32	94.54	95.85	1.11	35.80
2326.76*	(4) 2-Year	3.97	94.54	95.70	0.87	10.35
2326.76*	(4) 5-Year	2.02	94.54	95.50	0.65	5.14
2326.76*	(4) 10-Year	1.57	94.54	95.41	0.60	4.61

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2326.76*	(4) 25-Year	2.25	94.54	95.54	0.68	8.79
2326.76*	(4) 100-Year	2.86	94.54	95.61	0.75	35.90
2276.35*	(2) 2-Year	4.13	94.48	95.62	0.90	10.97
2276.35*	(2) 5-Year	5.24	94.48	95.66	0.98	14.50
2276.35*	(2) 10-Year	6.01	94.48	95.69	1.00	17.70
2276.35*	(2) 25-Year	6.94	94.48	95.72	1.00	22.95
2276.35*	(2) 100-Year	8.32	94.48	95.76	0.99	34.83
2276.35*	(4) 2-Year	3.97	94.48	95.61	0.89	10.03
2276.35*	(4) 5-Year	2.02	94.48	95.43	0.69	4.99
2276.35*	(4) 10-Year	1.57	94.48	95.34	0.63	4.48
2276.35*	(4) 25-Year	2.25	94.48	95.46	0.71	8.62
2276.35*	(4) 100-Year	2.86	94.48	95.53	0.77	35.68
2225.94*	(2) 2-Year	4.13	94.41	95.52	0.87	10.59
2225.94*	(2) 5-Year	5.24	94.41	95.56	0.93	14.00
2225.94*	(2) 10-Year	6.01	94.41	95.59	0.97	17.11
2225.94*	(2) 25-Year	6.94	94.41	95.62	1.01	22.24
2225.94*	(2) 100-Year	8.32	94.41	95.65	1.06	33.93
2225.94*	(4) 2-Year	3.97	94.41	95.52	0.86	9.67
2225.94*	(4) 5-Year	2.02	94.41	95.34	0.75	4.85
2225.94*	(4) 10-Year	1.57	94.41	95.26	0.69	4.36
2225.94*	(4) 25-Year	2.25	94.41	95.37	0.77	8.46
2225.94*	(4) 100-Year	2.86	94.41	95.44	0.81	35.46
2175.53*	(2) 2-Year	4.13	94.34	95.43	0.83	10.17
2175.53*	(2) 5-Year	5.24	94.34	95.46	0.92	13.49
2175.53*	(2) 10-Year	6.01	94.34	95.47	0.99	16.55
2175.53*	(2) 25-Year	6.94	94.34	95.49	1.02	21.61
2175.53*	(2) 100-Year	8.32	94.34	95.54	1.02	33.17
2175.53*	(4) 2-Year	3.97	94.34	95.42	0.85	9.27
2175.53*	(4) 5-Year	2.02	94.34	95.19	0.93	4.73
2175.53*	(4) 10-Year	1.57	94.34	95.12	0.86	4.26
2175.53*	(4) 25-Year	2.25	94.34	95.23	0.96	8.33
2175.53*	(4) 100-Year	2.86	94.34	95.30	0.98	35.25
2157	(2) 2-Year	4.13	94.31	95.18	1.86	10.06
2157	(2) 5-Year	5.24	94.31	95.34	1.37	13.33
2157	(2) 10-Year	6.01	94.31	95.38	1.22	16.37
2157	(2) 25-Year	6.94	94.31	95.43	1.14	21.39
2157	(2) 100-Year	8.32	94.31	95.49	1.02	32.87
2157	(4) 2-Year	3.97	94.31	95.16	1.91	9.17
2157	(4) 5-Year	2.02	94.31	94.94	1.78	4.70
2157	(4) 10-Year	1.57	94.31	94.88	1.70	4.24
2157	(4) 25-Year	2.25	94.31	94.97	1.81	8.29
2157	(4) 100-Year	2.86	94.31	95.03	1.90	35.20
2076	(2) 2-Year	5.00	93.86	95.01	0.91	9.75
2076	(2) 5-Year	6.32	93.86	95.14	0.95	12.81
2076	(2) 10-Year	7.24	93.86	95.21	0.96	15.68
2076	(2) 25-Year	8.38	93.86	95.27	0.95	20.49
2076	(2) 100-Year	10.81	93.86	95.35	0.96	31.59

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2076	(4) 2-Year	4.78	93.86	94.98	0.91	8.88
2076	(4) 5-Year	2.34	93.86	94.63	0.77	4.53
2076	(4) 10-Year	1.78	93.86	94.52	0.72	4.10
2076	(4) 25-Year	2.60	93.86	94.67	0.79	8.11
2076	(4) 100-Year	3.29	93.86	94.79	0.83	34.98
1974	(2) 2-Year	5.00	93.68	94.85	0.88	9.20
1974	(2) 5-Year	6.32	93.68	94.99	0.93	12.10
1974	(2) 10-Year	7.24	93.68	95.05	0.96	14.73
1974	(2) 25-Year	8.38	93.68	95.11	0.98	19.20
1974	(2) 100-Year	10.81	93.68	95.20	1.00	29.64
1974	(4) 2-Year	4.78	93.68	94.82	0.88	8.35
1974	(4) 5-Year	2.34	93.68	94.46	0.76	4.23
1974	(4) 10-Year	1.78	93.68	94.35	0.71	3.86
1974	(4) 25-Year	2.60	93.68	94.51	0.78	7.79
1974	(4) 100-Year	3.29	93.68	94.62	0.80	34.59
1922	(2) 2-Year	5.00	93.59	94.77	0.89	8.92
1922	(2) 5-Year	6.32	93.59	94.90	0.94	11.76
1922	(2) 10-Year	7.24	93.59	94.96	1.00	14.32
1922	(2) 25-Year	8.38	93.59	95.01	1.07	18.67
1922	(2) 100-Year	10.81	93.59	95.08	1.18	28.85
1922	(4) 2-Year	4.78	93.59	94.74	0.89	8.08
1922	(4) 5-Year	2.34	93.59	94.37	0.76	4.08
1922	(4) 10-Year	1.78	93.59	94.26	0.71	3.73
1922	(4) 25-Year	2.60	93.59	94.42	0.77	7.62
1922	(4) 100-Year	3.29	93.59	94.55	0.80	34.38
1833	(2) 2-Year	5.00	93.44	94.63	0.82	8.40
1833	(2) 5-Year	6.32	93.44	94.77	0.84	11.10
1833	(2) 10-Year	7.24	93.44	94.83	0.82	13.41
1833	(2) 25-Year	8.38	93.44	94.89	0.80	17.44
1833	(2) 100-Year	10.81	93.44	94.98	0.81	27.04
1833	(4) 2-Year	4.78	93.44	94.60	0.82	7.58
1833	(4) 5-Year	2.34	93.44	94.24	0.73	3.80
1833	(4) 10-Year	1.78	93.44	94.12	0.69	3.51
1833	(4) 25-Year	2.60	93.44	94.29	0.74	7.31
1833	(4) 100-Year	3.29	93.44	94.42	0.76	34.01
1796	(2) 2-Year	5.00	93.37	94.57	0.87	8.19
1796	(2) 5-Year	6.32	93.37	94.70	0.93	10.83
1796	(2) 10-Year	7.24	93.37	94.76	0.99	13.05
1796	(2) 25-Year	8.38	93.37	94.81	1.06	16.97
1796	(2) 100-Year	10.81	93.37	94.88	1.20	26.38
1796	(4) 2-Year	4.78	93.37	94.54	0.86	7.38
1796	(4) 5-Year	2.34	93.37	94.19	0.71	3.68
1796	(4) 10-Year	1.78	93.37	94.06	0.68	3.41
1796	(4) 25-Year	2.60	93.37	94.24	0.73	7.19
1796	(4) 100-Year	3.29	93.37	94.37	0.75	33.85
1735	(2) 2-Year	5.00	93.26	94.50	0.77	7.83
1735	(2) 5-Year	6.32	93.26	94.63	0.80	10.38

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1735	(2) 10-Year	7.24	93.26	94.70	0.80	12.45
1735	(2) 25-Year	8.38	93.26	94.77	0.74	16.06
1735	(2) 100-Year	10.81	93.26	94.85	0.69	24.90
1735	(4) 2-Year	4.78	93.26	94.47	0.76	7.04
1735	(4) 5-Year	2.34	93.26	94.11	0.66	3.49
1735	(4) 10-Year	1.78	93.26	93.98	0.64	3.26
1735	(4) 25-Year	2.60	93.26	94.17	0.67	6.97
1735	(4) 100-Year	3.29	93.26	94.31	0.67	33.58
1728	(2) 2-Year	5.00	93.25	94.47	1.00	7.79
1728	(2) 5-Year	6.32	93.25	94.59	1.07	10.33
1728	(2) 10-Year	7.24	93.25	94.65	1.14	12.38
1728	(2) 25-Year	8.38	93.25	94.71	1.19	15.95
1728	(2) 100-Year	10.81	93.25	94.81	1.12	24.69
1728	(4) 2-Year	4.78	93.25	94.44	0.99	7.00
1728	(4) 5-Year	2.34	93.25	94.09	0.82	3.46
1728	(4) 10-Year	1.78	93.25	93.96	0.78	3.24
1728	(4) 25-Year	2.60	93.25	94.14	0.84	6.94
1728	(4) 100-Year	3.29	93.25	94.29	0.85	33.55
1717	(2) 2-Year	5.00	93.24	94.44	1.03	7.74
1717	(2) 5-Year	6.32	93.24	94.56	1.11	10.26
1717	(2) 10-Year	7.24	93.24	94.61	1.18	12.30
1717	(2) 25-Year	8.38	93.24	94.66	1.28	15.86
1717	(2) 100-Year	10.81	93.24	94.73	1.45	24.52
1717	(4) 2-Year	4.78	93.24	94.41	1.02	6.94
1717	(4) 5-Year	2.34	93.24	94.06	0.85	3.43
1717	(4) 10-Year	1.78	93.24	93.93	0.81	3.21
1717	(4) 25-Year	2.60	93.24	94.11	0.87	6.91
1717	(4) 100-Year	3.29	93.24	94.26	0.87	33.51
1615	(2) 2-Year	5.00	93.05	94.28	0.84	7.18
1615	(2) 5-Year	6.32	93.05	94.40	0.89	9.52
1615	(2) 10-Year	7.24	93.05	94.46	0.88	11.35
1615	(2) 25-Year	8.38	93.05	94.52	0.88	14.62
1615	(2) 100-Year	10.81	93.05	94.62	0.84	22.57
1615	(4) 2-Year	4.78	93.05	94.25	0.83	6.41
1615	(4) 5-Year	2.34	93.05	93.92	0.65	3.11
1615	(4) 10-Year	1.78	93.05	93.77	0.64	2.96
1615	(4) 25-Year	2.60	93.05	93.97	0.66	6.56
1615	(4) 100-Year	3.29	93.05	94.15	0.65	33.06
1555	(2) 2-Year	5.00	92.94	94.21	0.79	6.82
1555	(2) 5-Year	6.32	92.94	94.33	0.86	9.01
1555	(2) 10-Year	7.24	92.94	94.39	0.89	10.68
1555	(2) 25-Year	8.38	92.94	94.45	0.92	13.73
1555	(2) 100-Year	10.81	92.94	94.54	0.98	21.28
1555	(4) 2-Year	4.78	92.94	94.19	0.79	6.06
1555	(4) 5-Year	2.34	92.94	93.86	0.60	2.89
1555	(4) 10-Year	1.78	92.94	93.71	0.59	2.79
1555	(4) 25-Year	2.60	92.94	93.92	0.61	6.32
1555	(4) 100-Year	3.29	92.94	94.11	0.59	32.74

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1488	(2) 2-Year	5.00	92.82	94.15	0.73	6.39
1488	(2) 5-Year	6.32	92.82	94.25	0.82	8.47
1488	(2) 10-Year	7.24	92.82	94.31	0.87	10.04
1488	(2) 25-Year	8.38	92.82	94.36	0.93	12.96
1488	(2) 100-Year	10.81	92.82	94.43	1.06	20.28
1488	(4) 2-Year	4.78	92.82	94.12	0.73	5.64
1488	(4) 5-Year	2.34	92.82	93.81	0.54	2.62
1488	(4) 10-Year	1.78	92.82	93.65	0.52	2.58
1488	(4) 25-Year	2.60	92.82	93.88	0.55	6.02
1488	(4) 100-Year	3.29	92.82	94.07	0.53	32.36
1416	(2) 2-Year	5.00	92.71	94.00	1.11	6.00
1416	(2) 5-Year	6.32	92.71	94.08	1.27	8.01
1416	(2) 10-Year	7.24	92.71	94.12	1.34	9.48
1416	(2) 25-Year	8.38	92.71	94.18	1.35	12.25
1416	(2) 100-Year	10.81	92.71	94.28	1.32	19.24
1416	(4) 2-Year	4.78	92.71	93.98	1.11	5.27
1416	(4) 5-Year	2.34	92.71	93.73	0.75	2.36
1416	(4) 10-Year	1.78	92.71	93.57	0.73	2.38
1416	(4) 25-Year	2.60	92.71	93.80	0.77	5.74
1416	(4) 100-Year	3.29	92.71	94.01	0.73	31.99
1400	(2) 2-Year	5.00	92.68	94.00	0.70	5.91
1400	(2) 5-Year	6.32	92.68	94.08	0.80	7.90
1400	(2) 10-Year	7.24	92.68	94.12	0.86	9.35
1400	(2) 25-Year	8.38	92.68	94.17	0.93	12.10
1400	(2) 100-Year	10.81	92.68	94.25	1.10	19.02
1400	(4) 2-Year	4.78	92.68	93.97	0.70	5.18
1400	(4) 5-Year	2.34	92.68	93.73	0.51	2.30
1400	(4) 10-Year	1.78	92.68	93.56	0.51	2.33
1400	(4) 25-Year	2.60	92.68	93.79	0.51	5.67
1400	(4) 100-Year	3.29	92.68	94.01	0.46	31.90
1364	(2) 2-Year	5.00	92.62	93.97	0.73	5.66
1364	(2) 5-Year	6.32	92.62	94.03	0.85	7.62
1364	(2) 10-Year	7.24	92.62	94.06	0.93	9.06
1364	(2) 25-Year	8.38	92.62	94.10	1.03	11.79
1364	(2) 100-Year	10.81	92.62	94.15	1.27	18.68
1364	(4) 2-Year	4.78	92.62	93.94	0.72	4.94
1364	(4) 5-Year	2.34	92.62	93.71	0.47	2.13
1364	(4) 10-Year	1.78	92.62	93.54	0.46	2.20
1364	(4) 25-Year	2.60	92.62	93.77	0.48	5.48
1364	(4) 100-Year	3.29	92.62	93.99	0.46	31.64
1340	(2) 2-Year	5.79	92.61	93.97	0.42	5.41
1340	(2) 5-Year	7.32	92.61	94.04	0.51	7.36
1340	(2) 10-Year	8.34	92.61	94.07	0.57	8.79
1340	(2) 25-Year	9.65	92.61	94.11	0.64	11.50
1340	(2) 100-Year	11.62	92.61	94.16	0.74	18.38
1340	(4) 2-Year	5.26	92.61	93.94	0.40	4.70
1340	(4) 5-Year	2.44	92.61	93.71	0.22	1.94

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1340	(4) 10-Year	1.86	92.61	93.54	0.20	2.05
1340	(4) 25-Year	2.71	92.61	93.78	0.23	5.28
1340	(4) 100-Year	3.43	92.61	93.99	0.25	31.39
1312	(2) 2-Year	6.08	92.47	93.95	0.71	5.07
1312	(2) 5-Year	7.69	92.47	94.00	0.85	7.00
1312	(2) 10-Year	8.76	92.47	94.03	0.95	8.41
1312	(2) 25-Year	10.15	92.47	94.06	1.08	11.11
1312	(2) 100-Year	12.20	92.47	94.09	1.27	17.96
1312	(4) 2-Year	5.46	92.47	93.92	0.65	4.37
1312	(4) 5-Year	2.47	92.47	93.71	0.36	1.67
1312	(4) 10-Year	1.87	92.47	93.54	0.32	1.82
1312	(4) 25-Year	2.73	92.47	93.77	0.37	4.99
1312	(4) 100-Year	3.44	92.47	93.99	0.39	31.03
1302	(2) 2-Year	6.08	92.57	93.91	1.03	4.98
1302	(2) 5-Year	7.69	92.57	93.97	1.13	6.90
1302	(2) 10-Year	8.76	92.57	94.00	1.18	8.31
1302	(2) 25-Year	10.15	92.57	94.04	1.26	11.00
1302	(2) 100-Year	12.20	92.57	94.07	1.39	17.84
1302	(4) 2-Year	5.46	92.57	93.89	0.98	4.28
1302	(4) 5-Year	2.47	92.57	93.68	0.77	1.62
1302	(4) 10-Year	1.87	92.57	93.50	0.85	1.79
1302	(4) 25-Year	2.73	92.57	93.74	0.73	4.94
1302	(4) 100-Year	3.44	92.57	93.98	0.49	30.93
1268	(2) 2-Year	6.08	92.47	93.87	0.59	4.63
1268	(2) 5-Year	7.69	92.47	93.93	0.62	6.46
1268	(2) 10-Year	8.76	92.47	93.96	0.64	7.77
1268	(2) 25-Year	10.15	92.47	94.00	0.67	10.34
1268	(2) 100-Year	12.20	92.47	94.05	0.64	16.97
1268	(4) 2-Year	5.46	92.47	93.84	0.57	3.96
1268	(4) 5-Year	2.47	92.47	93.59	0.68	1.50
1268	(4) 10-Year	1.87	92.47	93.43	0.81	1.71
1268	(4) 25-Year	2.73	92.47	93.67	0.53	4.78
1268	(4) 100-Year	3.44	92.47	93.98	0.24	30.37
1212	(2) 2-Year	6.08	92.36	93.78	0.84	3.93
1212	(2) 5-Year	7.69	92.36	93.85	0.85	5.52
1212	(2) 10-Year	8.76	92.36	93.88	0.86	6.62
1212	(2) 25-Year	10.15	92.36	93.93	0.84	8.90
1212	(2) 100-Year	12.20	92.36	94.00	0.80	15.05
1212	(4) 2-Year	5.46	92.36	93.74	0.83	3.36
1212	(4) 5-Year	2.47	92.36	93.41	0.89	1.32
1212	(4) 10-Year	1.87	92.36	93.30	0.83	1.58
1212	(4) 25-Year	2.73	92.36	93.54	0.74	4.52
1212	(4) 100-Year	3.44	92.36	93.97	0.24	28.89
1169	(2) 2-Year	6.08	92.30	93.70	0.86	3.39
1169	(2) 5-Year	7.69	92.30	93.76	0.91	4.74
1169	(2) 10-Year	8.76	92.30	93.80	0.95	5.69
1169	(2) 25-Year	10.15	92.30	93.84	0.99	7.77

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1169	(2) 100-Year	12.20	92.30	93.91	1.04	13.62
1169	(4) 2-Year	5.46	92.30	93.67	0.83	2.90
1169	(4) 5-Year	2.47	92.30	93.32	0.73	1.19
1169	(4) 10-Year	1.87	92.30	93.24	0.65	1.47
1169	(4) 25-Year	2.73	92.30	93.49	0.59	4.33
1169	(4) 100-Year	3.44	92.30	93.97	0.28	27.39
1091	(2) 2-Year	6.08	92.15	93.57	0.83	2.61
1091	(2) 5-Year	7.69	92.15	93.64	0.85	3.66
1091	(2) 10-Year	8.76	92.15	93.68	0.88	4.46
1091	(2) 25-Year	10.15	92.15	93.72	0.91	6.34
1091	(2) 100-Year	12.20	92.15	93.80	0.88	11.79
1091	(4) 2-Year	5.46	92.15	93.53	0.82	2.26
1091	(4) 5-Year	2.47	92.15	93.18	0.71	0.93
1091	(4) 10-Year	1.87	92.15	93.14	0.58	1.23
1091	(4) 25-Year	2.73	92.15	93.42	0.51	3.94
1091	(4) 100-Year	3.44	92.15	93.96	0.19	24.73
1002	(2) 2-Year	6.08	92.06	93.36	1.05	1.89
1002	(2) 5-Year	7.69	92.06	93.45	1.07	2.63
1002	(2) 10-Year	8.76	92.06	93.50	1.06	3.23
1002	(2) 25-Year	10.15	92.06	93.57	0.99	4.82
1002	(2) 100-Year	12.20	92.06	93.70	0.86	9.70
1002	(4) 2-Year	5.46	92.06	93.32	1.03	1.66
1002	(4) 5-Year	2.47	92.06	93.00	0.85	0.65
1002	(4) 10-Year	1.87	92.06	93.04	0.60	0.95
1002	(4) 25-Year	2.73	92.06	93.37	0.47	3.41
1002	(4) 100-Year	3.44	92.06	93.96	0.14	20.76
961	(2) 2-Year	6.08	91.96	93.25	0.88	1.61
961	(2) 5-Year	7.69	91.96	93.33	0.93	2.25
961	(2) 10-Year	8.76	91.96	93.39	0.95	2.77
961	(2) 25-Year	10.15	91.96	93.48	0.88	4.19
961	(2) 100-Year	12.20	91.96	93.67	0.55	8.56
961	(4) 2-Year	5.46	91.96	93.22	0.85	1.41
961	(4) 5-Year	2.47	91.96	92.95	0.64	0.51
961	(4) 10-Year	1.87	91.96	93.02	0.43	0.80
961	(4) 25-Year	2.73	91.96	93.35	0.32	3.09
961	(4) 100-Year	3.44	91.96	93.96	0.08	18.01
910	(2) 2-Year	6.08	91.93	93.17	0.79	0.99
910	(2) 5-Year	7.69	91.93	93.26	0.80	1.41
910	(2) 10-Year	8.76	91.93	93.32	0.77	1.75
910	(2) 25-Year	10.15	91.93	93.43	0.70	2.59
910	(2) 100-Year	12.20	91.93	93.65	0.44	4.99
910	(4) 2-Year	5.46	91.93	93.14	0.78	0.86
910	(4) 5-Year	2.47	91.93	92.89	0.67	0.31
910	(4) 10-Year	1.87	91.93	93.00	0.40	0.51
910	(4) 25-Year	2.73	91.93	93.35	0.24	2.01
910	(4) 100-Year	3.44	91.93	93.96	0.06	10.36
840	(2) 2-Year	6.08	91.86	93.10	0.50	0.00

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
840	(2) 5-Year	7.69	91.86	93.21	0.48	0.00
840	(2) 10-Year	8.76	91.86	93.28	0.46	0.00
840	(2) 25-Year	10.15	91.86	93.41	0.41	0.00
840	(2) 100-Year	12.20	91.86	93.64	0.34	0.00
840	(4) 2-Year	5.46	91.86	93.06	0.51	0.00
840	(4) 5-Year	2.47	91.86	92.80	0.52	0.00
840	(4) 10-Year	1.87	91.86	92.97	0.23	0.00
840	(4) 25-Year	2.73	91.86	93.34	0.12	0.00
840	(4) 100-Year	3.44	91.86	93.96	0.05	0.00

[1] All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

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WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

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Attachment C

HEC-RAS Results for Van Gaal Drain Reach 2

Proposed Conditions (Floodplain Analysis)

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(1) 25 mm	0.72	94.75	95.24	0.73	1.06
2554	(1) 2-Year	1.95	94.75	95.45	0.99	0.82
2554	(1) 5-Year	3.20	94.75	95.59	1.18	0.68
2554	(1) 10-Year	4.11	94.75	95.67	1.29	0.62
2554	(1) 25-Year	5.28	94.75	95.76	1.40	0.59
2554	(1) 100-Year	7.27	94.75	95.90	1.55	0.59
2478	(1) 25 mm	0.72	94.46	94.93	0.79	1.03
2478	(1) 2-Year	1.95	94.46	95.14	1.09	0.80
2478	(1) 5-Year	3.20	94.46	95.26	1.27	0.66
2478	(1) 10-Year	4.11	94.46	95.34	1.37	0.61
2478	(1) 25-Year	5.28	94.46	95.44	1.48	0.58
2478	(1) 100-Year	7.27	94.46	95.58	1.63	0.58
2434.60*	(1) 25 mm	0.72	94.28	94.75	0.80	1.01
2434.60*	(1) 2-Year	1.95	94.28	94.96	1.09	0.79
2434.60*	(1) 5-Year	3.20	94.28	95.09	1.27	0.65
2434.60*	(1) 10-Year	4.11	94.28	95.17	1.36	0.60
2434.60*	(1) 25-Year	5.28	94.28	95.26	1.46	0.57
2434.60*	(1) 100-Year	7.27	94.28	95.41	1.59	0.57
2434.60*						
2434.60*	(1) 25 mm	0.72	94.10	94.57	0.79	1.00
2434.60*	(1) 2-Year	1.95	94.10	94.78	1.09	0.78
2434.60*	(1) 5-Year	3.20	94.10	94.92	1.25	0.64
	(1) 10-Year	4.11	94.10	95.00	1.33	0.59
2391.20*	(1) 25-Year	5.28	94.10	95.11	1.41	0.56
2391.20*	(1) 100-Year	7.27	94.10	95.27	1.52	0.56
2391.20*						
2391.20*	(1) 25 mm	0.72	93.93	94.40	0.79	0.98
2391.20*	(1) 2-Year	1.95	93.93	94.61	1.06	0.77
2391.20*	(1) 5-Year	3.20	93.93	94.77	1.16	0.63
2391.20*	(1) 10-Year	4.11	93.93	94.87	1.22	0.58
2391.20*	(1) 25-Year	5.28	93.93	94.98	1.29	0.55
2391.20*	(1) 100-Year	7.27	93.93	95.16	1.39	0.56
2391.20*						
	(1) 25 mm	0.72	93.75	94.24	0.73	0.97
2347.80*	(1) 2-Year	1.95	93.75	94.49	0.89	0.76
2347.80*	(1) 5-Year	3.20	93.75	94.68	0.97	0.62
2347.80*	(1) 10-Year	4.11	93.75	94.78	1.04	0.57
2347.80*	(1) 25-Year	5.28	93.75	94.90	1.12	0.54
2347.80*	(1) 100-Year	7.27	93.75	95.08	1.23	0.55
2347.80*						
2347.80*	(1) 25 mm	0.72	93.57	94.18	0.49	0.95
2347.80*	(1) 2-Year	1.95	93.57	94.44	0.66	0.74
2347.80*	(1) 5-Year	3.20	93.57	94.63	0.78	0.60
2347.80*	(1) 10-Year	4.11	93.57	94.73	0.86	0.55
	(1) 25-Year	5.28	93.57	94.85	0.95	0.53
2304.40*	(1) 100-Year	7.27	93.57	95.03	1.07	0.54
2304.40*						
2304.40*	(1) 25 mm	0.72	93.57	94.14	0.56	0.93
2304.40*	(1) 2-Year	1.95	93.57	94.41	0.72	0.73
2304.40*	(1) 5-Year	3.20	93.57	94.60	0.82	0.59

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2304.40*	(1) 10-Year	4.11	93.57	94.70	0.90	0.55
2304.40*	(1) 25-Year	5.28	93.57	94.81	0.99	0.52
2304.40*	(1) 100-Year	7.27	93.57	94.99	1.11	0.53
2304.40*						
2304.40*	(1) 25 mm	0.72	93.49	94.12	0.46	0.92
2256	(1) 2-Year	1.95	93.49	94.39	0.63	0.72
2256	(1) 5-Year	3.20	93.49	94.58	0.75	0.59
2256	(1) 10-Year	4.11	93.49	94.68	0.81	0.54
2256	(1) 25-Year	5.28	93.49	94.80	0.88	0.51
2256	(1) 100-Year	7.27	93.49	94.98	0.96	0.52
2254	(1) 25 mm	0.72	93.46	94.11	0.44	0.91
2254	(1) 2-Year	1.95	93.46	94.38	0.62	0.71
2254	(1) 5-Year	3.20	93.46	94.56	0.73	0.58
2254	(1) 10-Year	4.11	93.46	94.67	0.80	0.53
2254	(1) 25-Year	5.28	93.46	94.78	0.87	0.51
2254	(1) 100-Year	7.27	93.46	94.96	0.95	0.52
2235	(1) 25 mm	0.72	93.44	94.10	0.43	0.90
2235	(1) 2-Year	1.95	93.44	94.36	0.60	0.70
2235	(1) 5-Year	3.20	93.44	94.55	0.72	0.57
2235	(1) 10-Year	4.11	93.44	94.65	0.78	0.53
2235	(1) 25-Year	5.28	93.44	94.77	0.85	0.50
2235	(1) 100-Year	7.27	93.44	94.95	0.94	0.51
2207	(1) 25 mm	0.72	93.40	94.08	0.40	0.88
2207	(1) 2-Year	1.95	93.40	94.35	0.59	0.69
2207	(1) 5-Year	3.20	93.40	94.53	0.71	0.56
2207	(1) 10-Year	4.11	93.40	94.63	0.78	0.52
2207	(1) 25-Year	5.28	93.40	94.74	0.85	0.49
2207	(1) 100-Year	7.27	93.40	94.92	0.94	0.50
2188	(1) 25 mm	1.16	93.37	94.05	0.65	0.87
2188	(1) 2-Year	2.80	93.37	94.31	0.84	0.68
2188	(1) 5-Year	4.41	93.37	94.49	0.98	0.56
2188	(1) 10-Year	5.53	93.37	94.59	1.05	0.51
2188	(1) 25-Year	6.96	93.37	94.71	1.12	0.49
2188	(1) 100-Year	9.54	93.37	94.88	1.23	0.50
2163	(1) 25 mm	1.16	93.34	94.02	0.65	0.86
2163	(1) 2-Year	2.80	93.34	94.28	0.84	0.67
2163	(1) 5-Year	4.41	93.34	94.46	0.97	0.55
2163	(1) 10-Year	5.53	93.34	94.56	1.04	0.50
2163	(1) 25-Year	6.96	93.34	94.67	1.11	0.48
2163	(1) 100-Year	9.54	93.34	94.85	1.22	0.49
2141	(1) 25 mm	1.16	93.31	93.99	0.65	0.85
2141	(1) 2-Year	2.80	93.31	94.25	0.83	0.67
2141	(1) 5-Year	4.41	93.31	94.43	0.97	0.54
2141	(1) 10-Year	5.53	93.31	94.53	1.04	0.50
2141	(1) 25-Year	6.96	93.31	94.65	1.11	0.48
2141	(1) 100-Year	9.54	93.31	94.82	1.22	0.49

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2121	(1) 25 mm	1.16	93.28	93.96	0.64	0.84
2121	(1) 2-Year	2.80	93.28	94.23	0.83	0.66
2121	(1) 5-Year	4.41	93.28	94.41	0.96	0.54
2121	(1) 10-Year	5.53	93.28	94.51	1.03	0.49
2121	(1) 25-Year	6.96	93.28	94.62	1.11	0.47
2121	(1) 100-Year	9.54	93.28	94.80	1.22	0.48
2101	(1) 25 mm	1.16	93.26	93.94	0.66	0.83
2101	(1) 2-Year	2.80	93.26	94.20	0.84	0.65
2101	(1) 5-Year	4.41	93.26	94.38	0.97	0.53
2101	(1) 10-Year	5.53	93.26	94.48	1.04	0.49
2101	(1) 25-Year	6.96	93.26	94.59	1.12	0.47
2101	(1) 100-Year	9.54	93.26	94.77	1.23	0.48
2080	(1) 25 mm	1.16	93.24	93.90	0.68	0.82
2080	(1) 2-Year	2.80	93.24	94.17	0.85	0.65
2080	(1) 5-Year	4.41	93.24	94.35	0.99	0.52
2080	(1) 10-Year	5.53	93.24	94.45	1.06	0.48
2080	(1) 25-Year	6.96	93.24	94.56	1.14	0.46
2080	(1) 100-Year	9.54	93.24	94.74	1.24	0.47
2059	(1) 25 mm	1.16	93.21	93.87	0.69	0.81
2059	(1) 2-Year	2.80	93.21	94.14	0.85	0.64
2059	(1) 5-Year	4.41	93.21	94.32	0.99	0.52
2059	(1) 10-Year	5.53	93.21	94.42	1.06	0.48
2059	(1) 25-Year	6.96	93.21	94.53	1.14	0.46
2059	(1) 100-Year	9.54	93.21	94.71	1.24	0.47
2038	(1) 25 mm	1.16	93.18	93.84	0.70	0.81
2038	(1) 2-Year	2.80	93.18	94.12	0.84	0.63
2038	(1) 5-Year	4.41	93.18	94.30	0.98	0.51
2038	(1) 10-Year	5.53	93.18	94.40	1.05	0.47
2038	(1) 25-Year	6.96	93.18	94.51	1.12	0.45
2038	(1) 100-Year	9.54	93.18	94.68	1.23	0.46
2017	(1) 25 mm	1.16	93.17	93.82	0.71	0.80
2017	(1) 2-Year	2.80	93.17	94.11	0.85	0.63
2017	(1) 5-Year	4.41	93.17	94.28	1.00	0.51
2017	(1) 10-Year	5.53	93.17	94.38	1.07	0.47
2017	(1) 25-Year	6.96	93.17	94.49	1.14	0.45
2017	(1) 100-Year	9.54	93.17	94.67	1.25	0.46
2003	(1) 25 mm	1.16	93.16	93.81	0.73	0.80
2003	(1) 2-Year	2.80	93.16	94.10	0.86	0.63
2003	(1) 5-Year	4.41	93.16	94.27	1.00	0.51
2003	(1) 10-Year	5.53	93.16	94.37	1.07	0.47
2003	(1) 25-Year	6.96	93.16	94.48	1.15	0.45
2003	(1) 100-Year	9.54	93.16	94.66	1.26	0.46
1982	(1) 25 mm	1.16	93.12	93.77	0.71	0.79
1982	(1) 2-Year	2.80	93.12	94.07	0.82	0.62

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1982	(1) 5-Year	4.41	93.12	94.25	0.97	0.50
1982	(1) 10-Year	5.53	93.12	94.34	1.04	0.46
1982	(1) 25-Year	6.96	93.12	94.46	1.11	0.44
1982	(1) 100-Year	9.54	93.12	94.63	1.22	0.46
1961	(1) 25 mm	1.16	93.08	93.74	0.70	0.78
1961	(1) 2-Year	2.80	93.08	94.05	0.80	0.62
1961	(1) 5-Year	4.41	93.08	94.22	0.94	0.50
1961	(1) 10-Year	5.53	93.08	94.32	1.01	0.46
1961	(1) 25-Year	6.96	93.08	94.43	1.09	0.44
1961	(1) 100-Year	9.54	93.08	94.61	1.20	0.45
1940	(1) 25 mm	1.16	93.04	93.70	0.68	0.78
1940	(1) 2-Year	2.80	93.04	94.03	0.77	0.61
1940	(1) 5-Year	4.41	93.04	94.20	0.92	0.49
1940	(1) 10-Year	5.53	93.04	94.30	0.99	0.45
1940	(1) 25-Year	6.96	93.04	94.41	1.07	0.43
1940	(1) 100-Year	9.54	93.04	94.58	1.18	0.45
1919	(1) 25 mm	1.16	93.01	93.67	0.68	0.77
1919	(1) 2-Year	2.80	93.01	94.01	0.75	0.60
1919	(1) 5-Year	4.41	93.01	94.18	0.90	0.49
1919	(1) 10-Year	5.53	93.01	94.27	0.97	0.45
1919	(1) 25-Year	6.96	93.01	94.38	1.05	0.43
1919	(1) 100-Year	9.54	93.01	94.56	1.16	0.44
1898	(1) 25 mm	1.16	92.97	93.64	0.66	0.76
1898	(1) 2-Year	2.80	92.97	93.99	0.72	0.59
1898	(1) 5-Year	4.41	92.97	94.16	0.87	0.48
1898	(1) 10-Year	5.53	92.97	94.25	0.94	0.44
1898	(1) 25-Year	6.96	92.97	94.36	1.03	0.42
1898	(1) 100-Year	9.54	92.97	94.54	1.14	0.44
1877	(1) 25 mm	1.16	92.93	93.61	0.64	0.75
1877	(1) 2-Year	2.80	92.93	93.97	0.70	0.59
1877	(1) 5-Year	4.41	92.93	94.14	0.84	0.47
1877	(1) 10-Year	5.53	92.93	94.24	0.91	0.43
1877	(1) 25-Year	6.96	92.93	94.34	1.00	0.42
1877	(1) 100-Year	9.54	92.93	94.52	1.12	0.43
1857	(1) 25 mm	1.16	92.89	93.59	0.62	0.74
1857	(1) 2-Year	2.80	92.89	93.96	0.67	0.58
1857	(1) 5-Year	4.41	92.89	94.12	0.81	0.47
1857	(1) 10-Year	5.53	92.89	94.22	0.89	0.43
1857	(1) 25-Year	6.96	92.89	94.32	0.98	0.41
1857	(1) 100-Year	9.54	92.89	94.50	1.10	0.43
1837	(1) 25 mm	1.16	92.86	93.57	0.60	0.73
1837	(1) 2-Year	2.80	92.86	93.95	0.65	0.57
1837	(1) 5-Year	4.41	92.86	94.11	0.79	0.46
1837	(1) 10-Year	5.53	92.86	94.20	0.87	0.42
1837	(1) 25-Year	6.96	92.86	94.31	0.96	0.40

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1837	(1) 100-Year	9.54	92.86	94.48	1.08	0.42
1817	(1) 25 mm	1.16	92.81	93.55	0.56	0.72
1817	(1) 2-Year	2.80	92.81	93.94	0.62	0.56
1817	(1) 5-Year	4.41	92.81	94.10	0.76	0.45
1817	(1) 10-Year	5.53	92.81	94.19	0.84	0.41
1817	(1) 25-Year	6.96	92.81	94.29	0.93	0.40
1817	(1) 100-Year	9.54	92.81	94.46	1.05	0.42
1797	(1) 25 mm	1.16	92.77	93.53	0.52	0.71
1797	(1) 2-Year	2.80	92.77	93.93	0.58	0.55
1797	(1) 5-Year	4.41	92.77	94.08	0.73	0.44
1797	(1) 10-Year	5.53	92.77	94.17	0.81	0.41
1797	(1) 25-Year	6.96	92.77	94.27	0.90	0.39
1797	(1) 100-Year	9.54	92.77	94.45	1.03	0.41
1777	(1) 25 mm	1.16	92.73	93.52	0.48	0.70
1777	(1) 2-Year	2.80	92.73	93.92	0.55	0.54
1777	(1) 5-Year	4.41	92.73	94.07	0.69	0.44
1777	(1) 10-Year	5.53	92.73	94.16	0.78	0.40
1777	(1) 25-Year	6.96	92.73	94.26	0.87	0.39
1777	(1) 100-Year	9.54	92.73	94.43	0.99	0.41
1757	(1) 25 mm	1.16	92.69	93.51	0.46	0.69
1757	(1) 2-Year	2.80	92.69	93.91	0.53	0.53
1757	(1) 5-Year	4.41	92.69	94.06	0.67	0.43
1757	(1) 10-Year	5.53	92.69	94.15	0.75	0.39
1757	(1) 25-Year	6.96	92.69	94.25	0.85	0.38
1757	(1) 100-Year	9.54	92.69	94.42	0.98	0.40
1736	(1) 25 mm	1.16	92.66	93.50	0.43	0.68
1736	(1) 2-Year	2.80	92.66	93.91	0.50	0.52
1736	(1) 5-Year	4.41	92.66	94.06	0.65	0.42
1736	(1) 10-Year	5.53	92.66	94.14	0.73	0.39
1736	(1) 25-Year	6.96	92.66	94.24	0.82	0.37
1736	(1) 100-Year	9.54	92.66	94.40	0.95	0.40
1715	(1) 25 mm	1.16	92.62	93.50	0.40	0.66
1715	(1) 2-Year	2.80	92.62	93.90	0.48	0.51
1715	(1) 5-Year	4.41	92.62	94.05	0.61	0.41
1715	(1) 10-Year	5.53	92.62	94.13	0.70	0.38
1715	(1) 25-Year	6.96	92.62	94.23	0.79	0.37
1715	(1) 100-Year	9.54	92.62	94.39	0.92	0.39
1694	(1) 25 mm	1.16	92.58	93.49	0.38	0.65
1694	(1) 2-Year	2.80	92.58	93.90	0.46	0.50
1694	(1) 5-Year	4.41	92.58	94.04	0.59	0.40
1694	(1) 10-Year	5.53	92.58	94.13	0.68	0.37
1694	(1) 25-Year	6.96	92.58	94.22	0.77	0.36
1694	(1) 100-Year	9.54	92.58	94.38	0.90	0.38
1673	(1) 25 mm	1.16	92.53	93.49	0.35	0.63

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1673	(1) 2-Year	2.80	92.53	93.89	0.43	0.48
1673	(1) 5-Year	4.41	92.53	94.04	0.57	0.39
1673	(1) 10-Year	5.53	92.53	94.12	0.65	0.36
1673	(1) 25-Year	6.96	92.53	94.21	0.74	0.35
1673	(1) 100-Year	9.54	92.53	94.37	0.87	0.38
1653	(1) 25 mm	1.16	92.50	93.48	0.33	0.62
1653	(1) 2-Year	2.80	92.50	93.89	0.41	0.47
1653	(1) 5-Year	4.41	92.50	94.03	0.55	0.38
1653	(1) 10-Year	5.53	92.50	94.11	0.63	0.35
1653	(1) 25-Year	6.96	92.50	94.20	0.72	0.34
1653	(1) 100-Year	9.54	92.50	94.36	0.85	0.37
1632	(1) 25 mm	1.16	92.46	93.48	0.31	0.60
1632	(1) 2-Year	2.80	92.46	93.89	0.40	0.46
1632	(1) 5-Year	4.41	92.46	94.03	0.53	0.37
1632	(1) 10-Year	5.53	92.46	94.11	0.61	0.34
1632	(1) 25-Year	6.96	92.46	94.20	0.71	0.34
1632	(1) 100-Year	9.54	92.46	94.35	0.84	0.36
1615	(1) 25 mm	1.16	92.43	93.48	0.31	0.58
1615	(1) 2-Year	2.80	92.43	93.88	0.38	0.45
1615	(1) 5-Year	4.41	92.43	94.02	0.51	0.36
1615	(1) 10-Year	5.53	92.43	94.10	0.59	0.34
1615	(1) 25-Year	6.96	92.43	94.19	0.68	0.33
1615	(1) 100-Year	9.54	92.43	94.35	0.81	0.36
1555	(1) 25 mm	1.16	92.35	93.47	0.28	0.53
1555	(1) 2-Year	2.80	92.35	93.88	0.35	0.40
1555	(1) 5-Year	4.41	92.35	94.01	0.47	0.33
1555	(1) 10-Year	5.53	92.35	94.09	0.55	0.31
1555	(1) 25-Year	6.96	92.35	94.17	0.64	0.30
1555	(1) 100-Year	9.54	92.35	94.33	0.76	0.34
1488	(1) 25 mm	1.16	92.28	93.46	0.24	0.46
1488	(1) 2-Year	2.80	92.28	93.87	0.32	0.35
1488	(1) 5-Year	4.41	92.28	94.00	0.44	0.29
1488	(1) 10-Year	5.53	92.28	94.08	0.51	0.27
1488	(1) 25-Year	6.96	92.28	94.16	0.60	0.27
1488	(1) 100-Year	9.54	92.28	94.31	0.72	0.31
1416	(1) 25 mm	1.16	92.20	93.46	0.21	0.38
1416	(1) 2-Year	2.80	92.20	93.87	0.30	0.29
1416	(1) 5-Year	4.41	92.20	94.00	0.41	0.25
1416	(1) 10-Year	5.53	92.20	94.07	0.48	0.24
1416	(1) 25-Year	6.96	92.20	94.15	0.57	0.25
1416	(1) 100-Year	9.54	92.20	94.29	0.70	0.29
1400	(1) 25 mm	1.16	92.17	93.46	0.20	0.35
1400	(1) 2-Year	2.80	92.17	93.87	0.29	0.27
1400	(1) 5-Year	4.41	92.17	93.99	0.40	0.23
1400	(1) 10-Year	5.53	92.17	94.06	0.47	0.22

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1400	(1) 25-Year	6.96	92.17	94.14	0.55	0.23
1400	(1) 100-Year	9.54	92.17	94.28	0.68	0.28
1364	(1) 25 mm	1.16	91.63	93.46	0.08	0.28
1364	(1) 2-Year	2.80	91.63	93.87	0.15	0.22
1364	(1) 5-Year	4.41	91.63	93.99	0.22	0.20
1364	(1) 10-Year	5.53	91.63	94.06	0.26	0.20
1364	(1) 25-Year	6.96	91.63	94.14	0.31	0.21
1364	(1) 100-Year	9.54	91.63	94.28	0.39	0.26
1340	(1) 25 mm	1.53	91.60	93.46	0.18	0.23
1340	(1) 2-Year	3.64	91.60	93.86	0.35	0.20
1340	(1) 5-Year	5.57	91.60	93.98	0.50	0.18
1340	(1) 10-Year	6.92	91.60	94.04	0.61	0.18
1340	(1) 25-Year	8.58	91.60	94.11	0.73	0.20
1340	(1) 100-Year	11.43	91.60	94.24	0.93	0.25
1339		Culvert				
1312	(1) 25 mm	1.53	92.47	93.45	0.32	0.20
1312	(1) 2-Year	3.87	92.47	93.84	0.57	0.18
1312	(1) 5-Year	5.93	92.47	93.95	0.82	0.17
1312	(1) 10-Year	7.38	92.47	94.00	0.99	0.17
1312	(1) 25-Year	9.17	92.47	94.05	1.19	0.19
1312	(1) 100-Year	12.20	92.47	94.13	1.50	0.24
1302	(1) 25 mm	1.53	92.57	93.41	0.83	0.19
1302	(1) 2-Year	3.87	92.57	93.81	0.88	0.17
1302	(1) 5-Year	5.93	92.57	93.92	1.05	0.17
1302	(1) 10-Year	7.38	92.57	93.98	1.15	0.17
1302	(1) 25-Year	9.17	92.57	94.03	1.26	0.19
1302	(1) 100-Year	12.20	92.57	94.15	1.23	0.24
1268	(1) 25 mm	1.53	92.47	93.33	0.79	0.18
1268	(1) 2-Year	3.87	92.47	93.75	0.56	0.16
1268	(1) 5-Year	5.93	92.47	93.88	0.57	0.16
1268	(1) 10-Year	7.38	92.47	93.94	0.60	0.16
1268	(1) 25-Year	9.17	92.47	94.01	0.61	0.18
1268	(1) 100-Year	12.20	92.47	94.14	0.52	0.23
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.16
1212	(1) 2-Year	3.87	92.36	93.61	0.89	0.14
1212	(1) 5-Year	5.93	92.36	93.77	0.91	0.13
1212	(1) 10-Year	7.38	92.36	93.85	0.93	0.14
1212	(1) 25-Year	9.17	92.36	93.93	0.91	0.16
1212	(1) 100-Year	12.20	92.36	94.10	0.76	0.21
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.15
1169	(1) 2-Year	3.87	92.30	93.53	0.77	0.13
1169	(1) 5-Year	5.93	92.30	93.70	0.86	0.12
1169	(1) 10-Year	7.38	92.30	93.77	0.91	0.12
1169	(1) 25-Year	9.17	92.30	93.85	0.95	0.14

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(1) 100-Year	12.20	92.30	94.04	0.88	0.19
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.11
1091	(1) 2-Year	3.87	92.15	93.40	0.75	0.10
1091	(1) 5-Year	5.93	92.15	93.57	0.82	0.09
1091	(1) 10-Year	7.38	92.15	93.65	0.85	0.10
1091	(1) 25-Year	9.17	92.15	93.75	0.85	0.12
1091	(1) 100-Year	12.20	92.15	93.97	0.82	0.17
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.08
1002	(1) 2-Year	3.87	92.06	93.21	0.90	0.07
1002	(1) 5-Year	5.93	92.06	93.39	0.98	0.07
1002	(1) 10-Year	7.38	92.06	93.50	0.93	0.07
1002	(1) 25-Year	9.17	92.06	93.65	0.83	0.09
1002	(1) 100-Year	12.20	92.06	93.93	0.64	0.13
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.06
961	(1) 2-Year	3.87	91.96	93.14	0.71	0.05
961	(1) 5-Year	5.93	91.96	93.31	0.76	0.05
961	(1) 10-Year	7.38	91.96	93.44	0.71	0.06
961	(1) 25-Year	9.17	91.96	93.61	0.52	0.07
961	(1) 100-Year	12.20	91.96	93.92	0.35	0.11
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.04
910	(1) 2-Year	3.87	91.93	93.07	0.72	0.03
910	(1) 5-Year	5.93	91.93	93.25	0.73	0.04
910	(1) 10-Year	7.38	91.93	93.40	0.69	0.04
910	(1) 25-Year	9.17	91.93	93.59	0.53	0.05
910	(1) 100-Year	12.20	91.93	93.91	0.33	0.07
840	(1) 25 mm	1.53	91.86	92.64	0.50	0.00
840	(1) 2-Year	3.87	91.86	93.00	0.44	0.00
840	(1) 5-Year	5.93	91.86	93.22	0.36	0.00
840	(1) 10-Year	7.38	91.86	93.38	0.33	0.00
840	(1) 25-Year	9.17	91.86	93.58	0.30	0.00
840	(1) 100-Year	12.20	91.86	93.91	0.25	0.00

[1] All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(2) 2-Year	4.13	94.75	95.68	1.28	0.69
2554	(2) 5-Year	5.24	94.75	95.77	1.38	0.64
2554	(2) 10-Year	6.00	94.75	95.82	1.44	0.62
2554	(2) 25-Year	6.94	94.75	95.89	1.51	0.63
2554	(2) 100-Year	8.32	94.75	95.98	1.56	0.72
2554	(4) 2-Year	3.97	94.75	95.67	1.26	0.70
2554	(4) 5-Year	2.02	94.75	95.47	1.00	0.92
2554	(4) 10-Year	1.57	94.75	95.40	0.91	1.03
2554	(4) 25-Year	2.25	94.75	95.49	1.04	1.14
2554	(4) 100-Year	2.86	94.75	95.56	1.13	2.31
2478	(2) 2-Year	4.13	94.46	95.34	1.42	0.67
2478	(2) 5-Year	5.24	94.46	95.42	1.54	0.62
2478	(2) 10-Year	6.00	94.46	95.47	1.61	0.61
2478	(2) 25-Year	6.94	94.46	95.53	1.69	0.62
2478	(2) 100-Year	8.32	94.46	95.62	1.79	0.70
2478	(4) 2-Year	3.97	94.46	95.32	1.40	0.68
2478	(4) 5-Year	2.02	94.46	95.14	1.12	0.90
2478	(4) 10-Year	1.57	94.46	95.09	1.03	1.01
2478	(4) 25-Year	2.25	94.46	95.17	1.16	1.12
2478	(4) 100-Year	2.86	94.46	95.23	1.26	2.29
2434.60*	(2) 2-Year	4.13	94.28	95.16	1.35	0.67
2434.60*	(2) 5-Year	5.24	94.28	95.24	1.44	0.61
2434.60*	(2) 10-Year	6.00	94.28	95.30	1.50	0.60
2434.60*	(2) 25-Year	6.94	94.28	95.36	1.56	0.61
2434.60*	(2) 100-Year	8.32	94.28	95.45	1.63	0.70
2434.60*	(4) 2-Year	3.97	94.28	95.15	1.33	0.67
2434.60*	(4) 5-Year	2.02	94.28	94.96	1.10	0.89
2434.60*	(4) 10-Year	1.57	94.28	94.91	1.02	1.00
2434.60*	(4) 25-Year	2.25	94.28	94.99	1.13	1.11
2434.60*	(4) 100-Year	2.86	94.28	95.05	1.21	2.28
2391.20*	(2) 2-Year	4.13	94.10	94.99	1.34	0.66
2391.20*	(2) 5-Year	5.24	94.10	95.08	1.43	0.60
2391.20*	(2) 10-Year	6.00	94.10	95.14	1.48	0.59
2391.20*	(2) 25-Year	6.94	94.10	95.20	1.54	0.60
2391.20*	(2) 100-Year	8.32	94.10	95.30	1.60	0.69
2391.20*	(4) 2-Year	3.97	94.10	94.98	1.32	0.66
2391.20*	(4) 5-Year	2.02	94.10	94.79	1.10	0.88
2391.20*	(4) 10-Year	1.57	94.10	94.73	1.02	0.98
2391.20*	(4) 25-Year	2.25	94.10	94.81	1.13	1.10
2391.20*	(4) 100-Year	2.86	94.10	94.87	1.21	2.27
2347.80*	(2) 2-Year	4.13	93.93	94.84	1.29	0.65
2347.80*	(2) 5-Year	5.24	93.93	94.93	1.37	0.60
2347.80*	(2) 10-Year	6.00	93.93	94.99	1.42	0.58
2347.80*	(2) 25-Year	6.94	93.93	95.06	1.47	0.60
2347.80*	(2) 100-Year	8.32	93.93	95.17	1.52	0.68
2347.80*	(4) 2-Year	3.97	93.93	94.82	1.28	0.65
2347.80*	(4) 5-Year	2.02	93.93	94.61	1.09	0.87
2347.80*	(4) 10-Year	1.57	93.93	94.55	1.02	0.97

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2347.80*	(4) 25-Year	2.25	93.93	94.64	1.12	1.09
2347.80*	(4) 100-Year	2.86	93.93	94.71	1.18	2.26
2304.40*	(2) 2-Year	4.13	93.75	94.72	1.17	0.64
2304.40*	(2) 5-Year	5.24	93.75	94.82	1.25	0.59
2304.40*	(2) 10-Year	6.00	93.75	94.88	1.30	0.57
2304.40*	(2) 25-Year	6.94	93.75	94.95	1.36	0.59
2304.40*	(2) 100-Year	8.32	93.75	95.06	1.41	0.67
2304.40*	(4) 2-Year	3.97	93.75	94.70	1.16	0.64
2304.40*	(4) 5-Year	2.02	93.75	94.47	1.00	0.86
2304.40*	(4) 10-Year	1.57	93.75	94.40	0.95	0.96
2304.40*	(4) 25-Year	2.25	93.75	94.50	1.02	1.07
2304.40*	(4) 100-Year	2.86	93.75	94.58	1.05	2.25
2261	(2) 2-Year	4.13	93.57	94.64	0.99	0.63
2261	(2) 5-Year	5.24	93.57	94.74	1.09	0.58
2261	(2) 10-Year	6.00	93.57	94.80	1.15	0.56
2261	(2) 25-Year	6.94	93.57	94.87	1.22	0.58
2261	(2) 100-Year	8.32	93.57	94.99	1.27	0.66
2261	(4) 2-Year	3.97	93.57	94.62	0.98	0.63
2261	(4) 5-Year	2.02	93.57	94.39	0.78	0.84
2261	(4) 10-Year	1.57	93.57	94.32	0.71	0.94
2261	(4) 25-Year	2.25	93.57	94.42	0.81	1.06
2261	(4) 100-Year	2.86	93.57	94.51	0.85	2.24
2258	(2) 2-Year	4.13	93.57	94.58	1.09	0.62
2258	(2) 5-Year	5.24	93.57	94.67	1.19	0.57
2258	(2) 10-Year	6.00	93.57	94.73	1.26	0.56
2258	(2) 25-Year	6.94	93.57	94.80	1.33	0.57
2258	(2) 100-Year	8.32	93.57	94.92	1.36	0.66
2258	(4) 2-Year	3.97	93.57	94.56	1.08	0.62
2258	(4) 5-Year	2.02	93.57	94.33	0.91	0.83
2258	(4) 10-Year	1.57	93.57	94.26	0.85	0.93
2258	(4) 25-Year	2.25	93.57	94.36	0.93	1.05
2258	(4) 100-Year	2.86	93.57	94.45	0.96	2.23
2256	(2) 2-Year	4.13	93.49	94.56	0.83	0.61
2256	(2) 5-Year	5.24	93.49	94.66	0.88	0.56
2256	(2) 10-Year	6.00	93.49	94.72	0.91	0.55
2256	(2) 25-Year	6.94	93.49	94.79	0.95	0.57
2256	(2) 100-Year	8.32	93.49	94.92	0.95	0.65
2256	(4) 2-Year	3.97	93.49	94.54	0.82	0.62
2256	(4) 5-Year	2.02	93.49	94.30	0.69	0.83
2256	(4) 10-Year	1.57	93.49	94.23	0.66	0.93
2256	(4) 25-Year	2.25	93.49	94.34	0.71	1.04
2256	(4) 100-Year	2.86	93.49	94.44	0.72	2.22
2254	(2) 2-Year	4.13	93.46	94.54	0.81	0.60
2254	(2) 5-Year	5.24	93.46	94.64	0.87	0.56
2254	(2) 10-Year	6.00	93.46	94.70	0.90	0.55
2254	(2) 25-Year	6.94	93.46	94.77	0.94	0.56
2254	(2) 100-Year	8.32	93.46	94.91	0.94	0.65

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2254	(4) 2-Year	3.97	93.46	94.53	0.81	0.61
2254	(4) 5-Year	2.02	93.46	94.28	0.68	0.82
2254	(4) 10-Year	1.57	93.46	94.21	0.65	0.92
2254	(4) 25-Year	2.25	93.46	94.31	0.70	1.04
2254	(4) 100-Year	2.86	93.46	94.42	0.71	2.22
2235	(2) 2-Year	4.13	93.44	94.53	0.80	0.60
2235	(2) 5-Year	5.24	93.44	94.62	0.86	0.55
2235	(2) 10-Year	6.00	93.44	94.68	0.89	0.54
2235	(2) 25-Year	6.94	93.44	94.76	0.92	0.55
2235	(2) 100-Year	8.32	93.44	94.89	0.92	0.64
2235	(4) 2-Year	3.97	93.44	94.51	0.80	0.60
2235	(4) 5-Year	2.02	93.44	94.26	0.68	0.81
2235	(4) 10-Year	1.57	93.44	94.19	0.64	0.91
2235	(4) 25-Year	2.25	93.44	94.29	0.70	1.03
2235	(4) 100-Year	2.86	93.44	94.40	0.69	2.21
2207	(2) 2-Year	4.13	93.40	94.50	0.80	0.59
2207	(2) 5-Year	5.24	93.40	94.60	0.86	0.54
2207	(2) 10-Year	6.00	93.40	94.66	0.89	0.53
2207	(2) 25-Year	6.94	93.40	94.73	0.93	0.55
2207	(2) 100-Year	8.32	93.40	94.87	0.92	0.63
2207	(4) 2-Year	3.97	93.40	94.48	0.80	0.59
2207	(4) 5-Year	2.02	93.40	94.23	0.68	0.80
2207	(4) 10-Year	1.57	93.40	94.16	0.65	0.90
2207	(4) 25-Year	2.25	93.40	94.26	0.70	1.02
2207	(4) 100-Year	2.86	93.40	94.38	0.69	2.20
2188	(2) 2-Year	5.00	93.37	94.47	0.96	0.58
2188	(2) 5-Year	6.32	93.37	94.56	1.03	0.54
2188	(2) 10-Year	7.24	93.37	94.62	1.07	0.53
2188	(2) 25-Year	8.38	93.37	94.69	1.11	0.54
2188	(2) 100-Year	10.81	93.37	94.83	1.20	0.63
2188	(4) 2-Year	4.78	93.37	94.45	0.95	0.59
2188	(4) 5-Year	2.33	93.37	94.20	0.77	0.79
2188	(4) 10-Year	1.78	93.37	94.13	0.71	0.89
2188	(4) 25-Year	2.60	93.37	94.24	0.79	1.01
2188	(4) 100-Year	3.29	93.37	94.36	0.77	2.19
2163	(2) 2-Year	5.00	93.34	94.44	0.95	0.58
2163	(2) 5-Year	6.32	93.34	94.53	1.02	0.53
2163	(2) 10-Year	7.24	93.34	94.59	1.06	0.52
2163	(2) 25-Year	8.38	93.34	94.66	1.10	0.53
2163	(2) 100-Year	10.81	93.34	94.80	1.18	0.62
2163	(4) 2-Year	4.78	93.34	94.42	0.94	0.58
2163	(4) 5-Year	2.33	93.34	94.17	0.77	0.78
2163	(4) 10-Year	1.78	93.34	94.10	0.71	0.88
2163	(4) 25-Year	2.60	93.34	94.20	0.79	1.00
2163	(4) 100-Year	3.29	93.34	94.33	0.75	2.18
2141	(2) 2-Year	5.00	93.31	94.41	0.95	0.57
2141	(2) 5-Year	6.32	93.31	94.50	1.01	0.52

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2141	(2) 10-Year	7.24	93.31	94.56	1.05	0.51
2141	(2) 25-Year	8.38	93.31	94.63	1.10	0.53
2141	(2) 100-Year	10.81	93.31	94.77	1.18	0.62
2141	(4) 2-Year	4.78	93.31	94.39	0.94	0.57
2141	(4) 5-Year	2.33	93.31	94.14	0.76	0.78
2141	(4) 10-Year	1.78	93.31	94.07	0.71	0.87
2141	(4) 25-Year	2.60	93.31	94.17	0.78	0.99
2141	(4) 100-Year	3.29	93.31	94.31	0.74	2.17
2121	(2) 2-Year	5.00	93.28	94.38	0.94	0.56
2121	(2) 5-Year	6.32	93.28	94.48	1.01	0.52
2121	(2) 10-Year	7.24	93.28	94.54	1.05	0.51
2121	(2) 25-Year	8.38	93.28	94.61	1.09	0.52
2121	(2) 100-Year	10.81	93.28	94.74	1.18	0.61
2121	(4) 2-Year	4.78	93.28	94.36	0.93	0.57
2121	(4) 5-Year	2.33	93.28	94.11	0.76	0.77
2121	(4) 10-Year	1.78	93.28	94.04	0.70	0.86
2121	(4) 25-Year	2.60	93.28	94.15	0.78	0.99
2121	(4) 100-Year	3.29	93.28	94.30	0.72	2.17
2101	(2) 2-Year	5.00	93.26	94.35	0.95	0.56
2101	(2) 5-Year	6.32	93.26	94.45	1.02	0.51
2101	(2) 10-Year	7.24	93.26	94.51	1.06	0.50
2101	(2) 25-Year	8.38	93.26	94.58	1.10	0.52
2101	(2) 100-Year	10.81	93.26	94.72	1.19	0.61
2101	(4) 2-Year	4.78	93.26	94.33	0.95	0.56
2101	(4) 5-Year	2.33	93.26	94.09	0.77	0.76
2101	(4) 10-Year	1.78	93.26	94.01	0.72	0.86
2101	(4) 25-Year	2.60	93.26	94.12	0.79	0.98
2101	(4) 100-Year	3.29	93.26	94.28	0.71	2.16
2080	(2) 2-Year	5.00	93.24	94.32	0.97	0.55
2080	(2) 5-Year	6.32	93.24	94.42	1.04	0.51
2080	(2) 10-Year	7.24	93.24	94.48	1.08	0.50
2080	(2) 25-Year	8.38	93.24	94.55	1.12	0.51
2080	(2) 100-Year	10.81	93.24	94.69	1.20	0.60
2080	(4) 2-Year	4.78	93.24	94.30	0.97	0.56
2080	(4) 5-Year	2.33	93.24	94.05	0.80	0.75
2080	(4) 10-Year	1.78	93.24	93.98	0.75	0.85
2080	(4) 25-Year	2.60	93.24	94.09	0.81	0.97
2080	(4) 100-Year	3.29	93.24	94.26	0.71	2.15
2059	(2) 2-Year	5.00	93.21	94.29	0.98	0.55
2059	(2) 5-Year	6.32	93.21	94.39	1.04	0.50
2059	(2) 10-Year	7.24	93.21	94.45	1.08	0.49
2059	(2) 25-Year	8.38	93.21	94.52	1.12	0.51
2059	(2) 100-Year	10.81	93.21	94.66	1.20	0.60
2059	(4) 2-Year	4.78	93.21	94.27	0.97	0.55
2059	(4) 5-Year	2.33	93.21	94.02	0.80	0.75
2059	(4) 10-Year	1.78	93.21	93.94	0.76	0.84
2059	(4) 25-Year	2.60	93.21	94.06	0.81	0.97
2059	(4) 100-Year	3.29	93.21	94.25	0.70	2.14

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2038	(2) 2-Year	5.00	93.18	94.27	0.96	0.54
2038	(2) 5-Year	6.32	93.18	94.36	1.03	0.50
2038	(2) 10-Year	7.24	93.18	94.43	1.07	0.49
2038	(2) 25-Year	8.38	93.18	94.50	1.11	0.50
2038	(2) 100-Year	10.81	93.18	94.63	1.19	0.59
2038	(4) 2-Year	4.78	93.18	94.25	0.96	0.55
2038	(4) 5-Year	2.33	93.18	93.99	0.80	0.74
2038	(4) 10-Year	1.78	93.18	93.91	0.76	0.83
2038	(4) 25-Year	2.60	93.18	94.03	0.80	0.96
2038	(4) 100-Year	3.29	93.18	94.23	0.67	2.13
2017	(2) 2-Year	5.00	93.17	94.26	0.98	0.54
2017	(2) 5-Year	6.32	93.17	94.35	1.05	0.49
2017	(2) 10-Year	7.24	93.17	94.41	1.09	0.49
2017	(2) 25-Year	8.38	93.17	94.48	1.13	0.50
2017	(2) 100-Year	10.81	93.17	94.62	1.21	0.59
2017	(4) 2-Year	4.78	93.17	94.23	0.98	0.54
2017	(4) 5-Year	2.33	93.17	93.98	0.81	0.74
2017	(4) 10-Year	1.78	93.17	93.90	0.78	0.83
2017	(4) 25-Year	2.60	93.17	94.02	0.82	0.96
2017	(4) 100-Year	3.29	93.17	94.23	0.68	2.13
2003	(2) 2-Year	5.00	93.16	94.24	0.99	0.54
2003	(2) 5-Year	6.32	93.16	94.34	1.06	0.49
2003	(2) 10-Year	7.24	93.16	94.40	1.10	0.48
2003	(2) 25-Year	8.38	93.16	94.47	1.14	0.50
2003	(2) 100-Year	10.81	93.16	94.61	1.22	0.59
2003	(4) 2-Year	4.78	93.16	94.22	0.98	0.54
2003	(4) 5-Year	2.33	93.16	93.97	0.83	0.74
2003	(4) 10-Year	1.78	93.16	93.88	0.81	0.83
2003	(4) 25-Year	2.60	93.16	94.01	0.83	0.95
2003	(4) 100-Year	3.29	93.16	94.22	0.68	2.13
1982	(2) 2-Year	5.00	93.12	94.22	0.95	0.53
1982	(2) 5-Year	6.32	93.12	94.31	1.02	0.49
1982	(2) 10-Year	7.24	93.12	94.38	1.06	0.48
1982	(2) 25-Year	8.38	93.12	94.45	1.10	0.50
1982	(2) 100-Year	10.81	93.12	94.58	1.18	0.59
1982	(4) 2-Year	4.78	93.12	94.20	0.95	0.54
1982	(4) 5-Year	2.33	93.12	93.94	0.79	0.73
1982	(4) 10-Year	1.78	93.12	93.85	0.78	0.82
1982	(4) 25-Year	2.60	93.12	93.98	0.79	0.95
1982	(4) 100-Year	3.29	93.12	94.21	0.63	2.12
1961	(2) 2-Year	5.00	93.08	94.19	0.92	0.52
1961	(2) 5-Year	6.32	93.08	94.29	0.99	0.48
1961	(2) 10-Year	7.24	93.08	94.35	1.03	0.47
1961	(2) 25-Year	8.38	93.08	94.42	1.08	0.49
1961	(2) 100-Year	10.81	93.08	94.56	1.16	0.58
1961	(4) 2-Year	4.78	93.08	94.17	0.92	0.53
1961	(4) 5-Year	2.33	93.08	93.91	0.77	0.72

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1961	(4) 10-Year	1.78	93.08	93.82	0.76	0.81
1961	(4) 25-Year	2.60	93.08	93.96	0.76	0.94
1961	(4) 100-Year	3.29	93.08	94.20	0.60	2.11
1940	(2) 2-Year	5.00	93.04	94.17	0.90	0.52
1940	(2) 5-Year	6.32	93.04	94.27	0.97	0.48
1940	(2) 10-Year	7.24	93.04	94.33	1.01	0.47
1940	(2) 25-Year	8.38	93.04	94.40	1.05	0.48
1940	(2) 100-Year	10.81	93.04	94.54	1.13	0.58
1940	(4) 2-Year	4.78	93.04	94.15	0.89	0.52
1940	(4) 5-Year	2.33	93.04	93.89	0.74	0.71
1940	(4) 10-Year	1.78	93.04	93.78	0.74	0.81
1940	(4) 25-Year	2.60	93.04	93.93	0.73	0.93
1940	(4) 100-Year	3.29	93.04	94.19	0.57	2.10
1919	(2) 2-Year	5.00	93.01	94.15	0.87	0.51
1919	(2) 5-Year	6.32	93.01	94.24	0.94	0.47
1919	(2) 10-Year	7.24	93.01	94.30	0.98	0.46
1919	(2) 25-Year	8.38	93.01	94.38	1.03	0.48
1919	(2) 100-Year	10.81	93.01	94.51	1.11	0.57
1919	(4) 2-Year	4.78	93.01	94.12	0.87	0.52
1919	(4) 5-Year	2.33	93.01	93.86	0.72	0.71
1919	(4) 10-Year	1.78	93.01	93.75	0.73	0.80
1919	(4) 25-Year	2.60	93.01	93.91	0.71	0.93
1919	(4) 100-Year	3.29	93.01	94.18	0.54	2.09
1898	(2) 2-Year	5.00	92.97	94.13	0.84	0.51
1898	(2) 5-Year	6.32	92.97	94.22	0.91	0.46
1898	(2) 10-Year	7.24	92.97	94.28	0.95	0.46
1898	(2) 25-Year	8.38	92.97	94.36	1.00	0.47
1898	(2) 100-Year	10.81	92.97	94.49	1.09	0.57
1898	(4) 2-Year	4.78	92.97	94.11	0.84	0.51
1898	(4) 5-Year	2.33	92.97	93.84	0.69	0.70
1898	(4) 10-Year	1.78	92.97	93.73	0.71	0.79
1898	(4) 25-Year	2.60	92.97	93.90	0.68	0.92
1898	(4) 100-Year	3.29	92.97	94.18	0.51	2.08
1877	(2) 2-Year	5.00	92.93	94.11	0.81	0.50
1877	(2) 5-Year	6.32	92.93	94.21	0.88	0.46
1877	(2) 10-Year	7.24	92.93	94.27	0.92	0.45
1877	(2) 25-Year	8.38	92.93	94.34	0.97	0.47
1877	(2) 100-Year	10.81	92.93	94.47	1.06	0.56
1877	(4) 2-Year	4.78	92.93	94.09	0.81	0.50
1877	(4) 5-Year	2.33	92.93	93.82	0.65	0.69
1877	(4) 10-Year	1.78	92.93	93.70	0.68	0.78
1877	(4) 25-Year	2.60	92.93	93.88	0.64	0.91
1877	(4) 100-Year	3.29	92.93	94.17	0.48	2.07
1857	(2) 2-Year	5.00	92.89	94.10	0.78	0.49
1857	(2) 5-Year	6.32	92.89	94.19	0.86	0.45
1857	(2) 10-Year	7.24	92.89	94.25	0.90	0.44
1857	(2) 25-Year	8.38	92.89	94.32	0.95	0.46

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1857	(2) 100-Year	10.81	92.89	94.45	1.04	0.55
1857	(4) 2-Year	4.78	92.89	94.07	0.78	0.50
1857	(4) 5-Year	2.33	92.89	93.81	0.62	0.68
1857	(4) 10-Year	1.78	92.89	93.68	0.65	0.78
1857	(4) 25-Year	2.60	92.89	93.87	0.62	0.90
1857	(4) 100-Year	3.29	92.89	94.17	0.46	2.06
1837	(2) 2-Year	5.00	92.86	94.08	0.75	0.48
1837	(2) 5-Year	6.32	92.86	94.17	0.83	0.44
1837	(2) 10-Year	7.24	92.86	94.23	0.87	0.44
1837	(2) 25-Year	8.38	92.86	94.30	0.92	0.46
1837	(2) 100-Year	10.81	92.86	94.44	1.01	0.55
1837	(4) 2-Year	4.78	92.86	94.06	0.75	0.49
1837	(4) 5-Year	2.33	92.86	93.79	0.59	0.67
1837	(4) 10-Year	1.78	92.86	93.66	0.63	0.77
1837	(4) 25-Year	2.60	92.86	93.85	0.59	0.89
1837	(4) 100-Year	3.29	92.86	94.16	0.44	2.04
1817	(2) 2-Year	5.00	92.81	94.07	0.72	0.48
1817	(2) 5-Year	6.32	92.81	94.16	0.80	0.44
1817	(2) 10-Year	7.24	92.81	94.22	0.85	0.43
1817	(2) 25-Year	8.38	92.81	94.29	0.90	0.45
1817	(2) 100-Year	10.81	92.81	94.42	0.99	0.54
1817	(4) 2-Year	4.78	92.81	94.04	0.72	0.48
1817	(4) 5-Year	2.33	92.81	93.78	0.56	0.66
1817	(4) 10-Year	1.78	92.81	93.64	0.59	0.76
1817	(4) 25-Year	2.60	92.81	93.84	0.56	0.88
1817	(4) 100-Year	3.29	92.81	94.16	0.42	2.03
1797	(2) 2-Year	5.00	92.77	94.06	0.69	0.47
1797	(2) 5-Year	6.32	92.77	94.15	0.77	0.43
1797	(2) 10-Year	7.24	92.77	94.21	0.82	0.42
1797	(2) 25-Year	8.38	92.77	94.27	0.87	0.44
1797	(2) 100-Year	10.81	92.77	94.41	0.96	0.54
1797	(4) 2-Year	4.78	92.77	94.03	0.69	0.47
1797	(4) 5-Year	2.33	92.77	93.77	0.53	0.65
1797	(4) 10-Year	1.78	92.77	93.63	0.55	0.75
1797	(4) 25-Year	2.60	92.77	93.84	0.53	0.87
1797	(4) 100-Year	3.29	92.77	94.16	0.40	2.02
1777	(2) 2-Year	5.00	92.73	94.05	0.65	0.46
1777	(2) 5-Year	6.32	92.73	94.14	0.73	0.42
1777	(2) 10-Year	7.24	92.73	94.19	0.78	0.42
1777	(2) 25-Year	8.38	92.73	94.26	0.83	0.44
1777	(2) 100-Year	10.81	92.73	94.39	0.93	0.53
1777	(4) 2-Year	4.78	92.73	94.02	0.65	0.47
1777	(4) 5-Year	2.33	92.73	93.77	0.49	0.64
1777	(4) 10-Year	1.78	92.73	93.62	0.51	0.74
1777	(4) 25-Year	2.60	92.73	93.83	0.49	0.86
1777	(4) 100-Year	3.29	92.73	94.15	0.37	2.00
1757	(2) 2-Year	5.00	92.69	94.04	0.63	0.45

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1757	(2) 5-Year	6.32	92.69	94.13	0.71	0.42
1757	(2) 10-Year	7.24	92.69	94.18	0.76	0.41
1757	(2) 25-Year	8.38	92.69	94.25	0.81	0.43
1757	(2) 100-Year	10.81	92.69	94.38	0.90	0.53
1757	(4) 2-Year	4.78	92.69	94.01	0.63	0.46
1757	(4) 5-Year	2.33	92.69	93.76	0.47	0.63
1757	(4) 10-Year	1.78	92.69	93.61	0.48	0.73
1757	(4) 25-Year	2.60	92.69	93.82	0.47	0.85
1757	(4) 100-Year	3.29	92.69	94.15	0.36	1.99
1736	(2) 2-Year	5.00	92.66	94.04	0.60	0.44
1736	(2) 5-Year	6.32	92.66	94.12	0.68	0.41
1736	(2) 10-Year	7.24	92.66	94.18	0.73	0.40
1736	(2) 25-Year	8.38	92.66	94.24	0.78	0.42
1736	(2) 100-Year	10.81	92.66	94.37	0.88	0.52
1736	(4) 2-Year	4.78	92.66	94.01	0.60	0.45
1736	(4) 5-Year	2.33	92.66	93.75	0.44	0.62
1736	(4) 10-Year	1.78	92.66	93.60	0.45	0.71
1736	(4) 25-Year	2.60	92.66	93.82	0.44	0.84
1736	(4) 100-Year	3.29	92.66	94.15	0.34	1.97
1715	(2) 2-Year	5.00	92.62	94.03	0.57	0.43
1715	(2) 5-Year	6.32	92.62	94.11	0.65	0.40
1715	(2) 10-Year	7.24	92.62	94.17	0.69	0.39
1715	(2) 25-Year	8.38	92.62	94.23	0.75	0.42
1715	(2) 100-Year	10.81	92.62	94.36	0.84	0.51
1715	(4) 2-Year	4.78	92.62	94.00	0.57	0.44
1715	(4) 5-Year	2.33	92.62	93.75	0.41	0.60
1715	(4) 10-Year	1.78	92.62	93.59	0.42	0.70
1715	(4) 25-Year	2.60	92.62	93.81	0.41	0.82
1715	(4) 100-Year	3.29	92.62	94.15	0.32	1.95
1694	(2) 2-Year	5.00	92.58	94.02	0.55	0.42
1694	(2) 5-Year	6.32	92.58	94.11	0.63	0.39
1694	(2) 10-Year	7.24	92.58	94.16	0.67	0.39
1694	(2) 25-Year	8.38	92.58	94.22	0.73	0.41
1694	(2) 100-Year	10.81	92.58	94.35	0.82	0.51
1694	(4) 2-Year	4.78	92.58	94.00	0.55	0.43
1694	(4) 5-Year	2.33	92.58	93.74	0.39	0.59
1694	(4) 10-Year	1.78	92.58	93.59	0.40	0.69
1694	(4) 25-Year	2.60	92.58	93.81	0.39	0.81
1694	(4) 100-Year	3.29	92.58	94.15	0.31	1.94
1673	(2) 2-Year	5.00	92.53	94.02	0.52	0.41
1673	(2) 5-Year	6.32	92.53	94.10	0.60	0.38
1673	(2) 10-Year	7.24	92.53	94.15	0.65	0.38
1673	(2) 25-Year	8.38	92.53	94.22	0.70	0.40
1673	(2) 100-Year	10.81	92.53	94.34	0.80	0.50
1673	(4) 2-Year	4.78	92.53	93.99	0.52	0.42
1673	(4) 5-Year	2.33	92.53	93.74	0.37	0.57
1673	(4) 10-Year	1.78	92.53	93.58	0.37	0.67
1673	(4) 25-Year	2.60	92.53	93.81	0.37	0.79

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1673	(4) 100-Year	3.29	92.53	94.14	0.30	1.92
1653	(2) 2-Year	5.00	92.50	94.02	0.50	0.40
1653	(2) 5-Year	6.32	92.50	94.09	0.58	0.37
1653	(2) 10-Year	7.24	92.50	94.15	0.62	0.37
1653	(2) 25-Year	8.38	92.50	94.21	0.68	0.39
1653	(2) 100-Year	10.81	92.50	94.33	0.77	0.49
1653	(4) 2-Year	4.78	92.50	93.99	0.50	0.41
1653	(4) 5-Year	2.33	92.50	93.74	0.35	0.56
1653	(4) 10-Year	1.78	92.50	93.58	0.35	0.66
1653	(4) 25-Year	2.60	92.50	93.80	0.35	0.78
1653	(4) 100-Year	3.29	92.50	94.14	0.28	1.90
1632	(2) 2-Year	5.00	92.46	94.01	0.49	0.39
1632	(2) 5-Year	6.32	92.46	94.09	0.56	0.36
1632	(2) 10-Year	7.24	92.46	94.14	0.61	0.36
1632	(2) 25-Year	8.38	92.46	94.20	0.66	0.38
1632	(2) 100-Year	10.81	92.46	94.33	0.76	0.49
1632	(4) 2-Year	4.78	92.46	93.98	0.48	0.39
1632	(4) 5-Year	2.33	92.46	93.74	0.33	0.54
1632	(4) 10-Year	1.78	92.46	93.58	0.33	0.64
1632	(4) 25-Year	2.60	92.46	93.80	0.33	0.76
1632	(4) 100-Year	3.29	92.46	94.14	0.28	1.88
1615	(2) 2-Year	5.00	92.43	94.01	0.46	0.38
1615	(2) 5-Year	6.32	92.43	94.09	0.53	0.35
1615	(2) 10-Year	7.24	92.43	94.14	0.57	0.35
1615	(2) 25-Year	8.38	92.43	94.20	0.62	0.38
1615	(2) 100-Year	10.81	92.43	94.32	0.71	0.48
1615	(4) 2-Year	4.78	92.43	93.98	0.46	0.38
1615	(4) 5-Year	2.33	92.43	93.73	0.32	0.53
1615	(4) 10-Year	1.78	92.43	93.57	0.32	0.63
1615	(4) 25-Year	2.60	92.43	93.80	0.32	0.75
1615	(4) 100-Year	3.29	92.43	94.14	0.26	1.86
1555	(2) 2-Year	5.00	92.35	94.00	0.42	0.34
1555	(2) 5-Year	6.32	92.35	94.07	0.48	0.32
1555	(2) 10-Year	7.24	92.35	94.13	0.53	0.32
1555	(2) 25-Year	8.38	92.35	94.19	0.57	0.35
1555	(2) 100-Year	10.81	92.35	94.31	0.66	0.45
1555	(4) 2-Year	4.78	92.35	93.97	0.41	0.35
1555	(4) 5-Year	2.33	92.35	93.73	0.28	0.47
1555	(4) 10-Year	1.78	92.35	93.57	0.29	0.57
1555	(4) 25-Year	2.60	92.35	93.79	0.29	0.69
1555	(4) 100-Year	3.29	92.35	94.14	0.24	1.80
1488	(2) 2-Year	5.00	92.28	93.99	0.38	0.30
1488	(2) 5-Year	6.32	92.28	94.07	0.45	0.28
1488	(2) 10-Year	7.24	92.28	94.11	0.49	0.29
1488	(2) 25-Year	8.38	92.28	94.17	0.53	0.32
1488	(2) 100-Year	10.81	92.28	94.29	0.62	0.43
1488	(4) 2-Year	4.78	92.28	93.96	0.38	0.30

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1488	(4) 5-Year	2.33	92.28	93.72	0.25	0.41
1488	(4) 10-Year	1.78	92.28	93.56	0.25	0.50
1488	(4) 25-Year	2.60	92.28	93.79	0.26	0.63
1488	(4) 100-Year	3.29	92.28	94.14	0.22	1.71
1416	(2) 2-Year	5.00	92.20	93.99	0.36	0.25
1416	(2) 5-Year	6.32	92.20	94.06	0.42	0.24
1416	(2) 10-Year	7.24	92.20	94.11	0.46	0.25
1416	(2) 25-Year	8.38	92.20	94.16	0.51	0.28
1416	(2) 100-Year	10.81	92.20	94.28	0.59	0.40
1416	(4) 2-Year	4.78	92.20	93.96	0.35	0.25
1416	(4) 5-Year	2.33	92.20	93.72	0.22	0.33
1416	(4) 10-Year	1.78	92.20	93.56	0.22	0.43
1416	(4) 25-Year	2.60	92.20	93.79	0.23	0.55
1416	(4) 100-Year	3.29	92.20	94.13	0.20	1.63
1400	(2) 2-Year	5.00	92.17	93.98	0.34	0.23
1400	(2) 5-Year	6.32	92.17	94.05	0.41	0.23
1400	(2) 10-Year	7.24	92.17	94.10	0.45	0.23
1400	(2) 25-Year	8.38	92.17	94.16	0.49	0.27
1400	(2) 100-Year	10.81	92.17	94.27	0.58	0.39
1400	(4) 2-Year	4.78	92.17	93.95	0.34	0.23
1400	(4) 5-Year	2.33	92.17	93.72	0.21	0.30
1400	(4) 10-Year	1.78	92.17	93.56	0.20	0.40
1400	(4) 25-Year	2.60	92.17	93.79	0.22	0.52
1400	(4) 100-Year	3.29	92.17	94.13	0.20	1.60
1364	(2) 2-Year	5.00	91.63	93.98	0.23	0.20
1364	(2) 5-Year	6.32	91.63	94.05	0.28	0.20
1364	(2) 10-Year	7.24	91.63	94.10	0.31	0.21
1364	(2) 25-Year	8.38	91.63	94.16	0.35	0.25
1364	(2) 100-Year	10.81	91.63	94.27	0.42	0.37
1364	(4) 2-Year	4.78	91.63	93.95	0.23	0.20
1364	(4) 5-Year	2.33	91.63	93.72	0.13	0.25
1364	(4) 10-Year	1.78	91.63	93.56	0.12	0.34
1364	(4) 25-Year	2.60	91.63	93.79	0.14	0.47
1364	(4) 100-Year	3.29	91.63	94.13	0.14	1.54
1340	(2) 2-Year	5.79	91.60	93.97	0.53	0.18
1340	(2) 5-Year	7.32	91.60	94.03	0.65	0.18
1340	(2) 10-Year	8.33	91.60	94.07	0.72	0.20
1340	(2) 25-Year	9.65	91.60	94.12	0.82	0.23
1340	(2) 100-Year	11.62	91.60	94.22	0.95	0.36
1340	(4) 2-Year	5.26	91.60	93.94	0.48	0.18
1340	(4) 5-Year	2.44	91.60	93.72	0.25	0.21
1340	(4) 10-Year	1.86	91.60	93.56	0.21	0.30
1340	(4) 25-Year	2.71	91.60	93.78	0.27	0.44
1340	(4) 100-Year	3.43	91.60	94.13	0.29	1.51
1339		Culvert				
1312	(2) 2-Year	6.08	92.47	93.94	0.85	0.17

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1312	(2) 5-Year	7.69	92.47	93.98	1.04	0.17
1312	(2) 10-Year	8.76	92.47	94.01	1.16	0.19
1312	(2) 25-Year	10.15	92.47	94.04	1.32	0.23
1312	(2) 100-Year	12.20	92.47	94.12	1.51	0.35
1312	(4) 2-Year	5.46	92.47	93.91	0.77	0.17
1312	(4) 5-Year	2.47	92.47	93.71	0.41	0.19
1312	(4) 10-Year	1.87	92.47	93.55	0.35	0.27
1312	(4) 25-Year	2.73	92.47	93.77	0.43	0.42
1312	(4) 100-Year	3.44	92.47	94.12	0.42	1.49
1302	(2) 2-Year	6.08	92.57	93.91	1.03	0.17
1302	(2) 5-Year	7.69	92.57	93.97	1.12	0.17
1302	(2) 10-Year	8.76	92.57	94.00	1.18	0.19
1302	(2) 25-Year	10.15	92.57	94.04	1.26	0.23
1302	(2) 100-Year	12.20	92.57	94.14	1.07	0.35
1302	(4) 2-Year	5.46	92.57	93.89	0.98	0.17
1302	(4) 5-Year	2.47	92.57	93.68	0.77	0.18
1302	(4) 10-Year	1.87	92.57	93.51	0.84	0.26
1302	(4) 25-Year	2.73	92.57	93.75	0.72	0.41
1302	(4) 100-Year	3.44	92.57	94.12	0.33	1.48
1268	(2) 2-Year	6.08	92.47	93.87	0.59	0.15
1268	(2) 5-Year	7.69	92.47	93.93	0.62	0.16
1268	(2) 10-Year	8.76	92.47	93.96	0.64	0.18
1268	(2) 25-Year	10.15	92.47	94.00	0.65	0.22
1268	(2) 100-Year	12.20	92.47	94.14	0.45	0.34
1268	(4) 2-Year	5.46	92.47	93.84	0.57	0.15
1268	(4) 5-Year	2.47	92.47	93.59	0.68	0.17
1268	(4) 10-Year	1.87	92.47	93.44	0.79	0.25
1268	(4) 25-Year	2.73	92.47	93.69	0.51	0.40
1268	(4) 100-Year	3.44	92.47	94.12	0.13	1.44
1212	(2) 2-Year	6.08	92.36	93.78	0.84	0.13
1212	(2) 5-Year	7.69	92.36	93.85	0.85	0.14
1212	(2) 10-Year	8.76	92.36	93.89	0.85	0.15
1212	(2) 25-Year	10.15	92.36	93.94	0.80	0.19
1212	(2) 100-Year	12.20	92.36	94.11	0.56	0.30
1212	(4) 2-Year	5.46	92.36	93.74	0.83	0.13
1212	(4) 5-Year	2.47	92.36	93.41	0.89	0.15
1212	(4) 10-Year	1.87	92.36	93.32	0.81	0.23
1212	(4) 25-Year	2.73	92.36	93.58	0.66	0.37
1212	(4) 100-Year	3.44	92.36	94.12	0.15	1.33
1169	(2) 2-Year	6.08	92.30	93.70	0.85	0.12
1169	(2) 5-Year	7.69	92.30	93.76	0.91	0.13
1169	(2) 10-Year	8.76	92.30	93.80	0.94	0.14
1169	(2) 25-Year	10.15	92.30	93.87	0.94	0.18
1169	(2) 100-Year	12.20	92.30	94.08	0.72	0.29
1169	(4) 2-Year	5.46	92.30	93.67	0.83	0.12
1169	(4) 5-Year	2.47	92.30	93.32	0.73	0.13
1169	(4) 10-Year	1.87	92.30	93.26	0.62	0.22
1169	(4) 25-Year	2.73	92.30	93.54	0.53	0.35

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(4) 100-Year	3.44	92.30	94.12	0.17	1.26
1091	(2) 2-Year	6.08	92.15	93.57	0.82	0.09
1091	(2) 5-Year	7.69	92.15	93.64	0.85	0.10
1091	(2) 10-Year	8.76	92.15	93.69	0.84	0.12
1091	(2) 25-Year	10.15	92.15	93.78	0.78	0.15
1091	(2) 100-Year	12.20	92.15	94.04	0.57	0.25
1091	(4) 2-Year	5.46	92.15	93.54	0.82	0.09
1091	(4) 5-Year	2.47	92.15	93.19	0.70	0.10
1091	(4) 10-Year	1.87	92.15	93.17	0.55	0.18
1091	(4) 25-Year	2.73	92.15	93.50	0.45	0.30
1091	(4) 100-Year	3.44	92.15	94.12	0.13	1.11
1002	(2) 2-Year	6.08	92.06	93.38	1.02	0.07
1002	(2) 5-Year	7.69	92.06	93.49	0.94	0.07
1002	(2) 10-Year	8.76	92.06	93.58	0.82	0.09
1002	(2) 25-Year	10.15	92.06	93.71	0.70	0.12
1002	(2) 100-Year	12.20	92.06	94.02	0.41	0.20
1002	(4) 2-Year	5.46	92.06	93.33	1.01	0.06
1002	(4) 5-Year	2.47	92.06	93.01	0.83	0.07
1002	(4) 10-Year	1.87	92.06	93.09	0.55	0.13
1002	(4) 25-Year	2.73	92.06	93.47	0.36	0.24
1002	(4) 100-Year	3.44	92.06	94.12	0.09	0.88
961	(2) 2-Year	6.08	91.96	93.28	0.83	0.05
961	(2) 5-Year	7.69	91.96	93.41	0.78	0.06
961	(2) 10-Year	8.76	91.96	93.52	0.65	0.07
961	(2) 25-Year	10.15	91.96	93.69	0.43	0.10
961	(2) 100-Year	12.20	91.96	94.02	0.24	0.17
961	(4) 2-Year	5.46	91.96	93.23	0.82	0.05
961	(4) 5-Year	2.47	91.96	92.96	0.62	0.06
961	(4) 10-Year	1.87	91.96	93.06	0.40	0.11
961	(4) 25-Year	2.73	91.96	93.46	0.25	0.21
961	(4) 100-Year	3.44	91.96	94.12	0.05	0.72
910	(2) 2-Year	6.08	91.93	93.22	0.70	0.04
910	(2) 5-Year	7.69	91.93	93.38	0.63	0.04
910	(2) 10-Year	8.76	91.93	93.49	0.52	0.05
910	(2) 25-Year	10.15	91.93	93.68	0.34	0.06
910	(2) 100-Year	12.20	91.93	94.02	0.20	0.10
910	(4) 2-Year	5.46	91.93	93.16	0.73	0.03
910	(4) 5-Year	2.47	91.93	92.91	0.64	0.03
910	(4) 10-Year	1.87	91.93	93.05	0.35	0.07
910	(4) 25-Year	2.73	91.93	93.46	0.18	0.14
910	(4) 100-Year	3.44	91.93	94.12	0.05	0.44
840	(2) 2-Year	6.08	91.86	93.18	0.41	0.00
840	(2) 5-Year	7.69	91.86	93.35	0.34	0.00
840	(2) 10-Year	8.76	91.86	93.48	0.30	0.00
840	(2) 25-Year	10.15	91.86	93.67	0.26	0.00
840	(2) 100-Year	12.20	91.86	94.02	0.18	0.00
840	(4) 2-Year	5.46	91.86	93.11	0.44	0.00

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
840	(4) 5-Year	2.47	91.86	92.83	0.47	0.00
840	(4) 10-Year	1.87	91.86	93.03	0.19	0.00
840	(4) 25-Year	2.73	91.86	93.45	0.10	0.00
840	(4) 100-Year	3.44	91.86	94.12	0.04	0.00

[1] All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

JFSA
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

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Attachment D

HEC-RAS Results for Van Gaal Drain Reach 2

Proposed Conditions (Riparian Storage Analysis)

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(1) 25 mm	0.72	94.75	95.24	0.73	6.80
2554	(1) 2-Year	1.95	94.75	95.45	0.99	14.55
2554	(1) 5-Year	3.20	94.75	95.59	1.18	20.23
2554	(1) 10-Year	4.11	94.75	95.67	1.29	24.36
2554	(1) 25-Year	5.28	94.75	95.76	1.40	29.89
2554	(1) 100-Year	7.27	94.75	95.90	1.55	40.63
2478	(1) 25 mm	0.72	94.46	94.93	0.79	6.72
2478	(1) 2-Year	1.95	94.46	95.14	1.09	14.37
2478	(1) 5-Year	3.20	94.46	95.26	1.27	19.97
2478	(1) 10-Year	4.11	94.46	95.34	1.37	24.04
2478	(1) 25-Year	5.28	94.46	95.44	1.48	29.52
2478	(1) 100-Year	7.27	94.46	95.58	1.63	40.15
2434.60*	(1) 25 mm	0.72	94.28	94.75	0.80	6.68
2434.60*	(1) 2-Year	1.95	94.28	94.96	1.09	14.25
2434.60*	(1) 5-Year	3.20	94.28	95.09	1.27	19.78
2434.60*	(1) 10-Year	4.11	94.28	95.17	1.36	23.81
2434.60*	(1) 25-Year	5.28	94.28	95.26	1.46	29.23
2434.60*	(1) 100-Year	7.27	94.28	95.41	1.59	39.79
2391.20*	(1) 25 mm	0.72	94.10	94.57	0.79	6.64
2391.20*	(1) 2-Year	1.95	94.10	94.78	1.09	14.13
2391.20*	(1) 5-Year	3.20	94.10	94.92	1.25	19.59
2391.20*	(1) 10-Year	4.11	94.10	95.00	1.33	23.58
2391.20*	(1) 25-Year	5.28	94.10	95.11	1.41	28.95
2391.20*	(1) 100-Year	7.27	94.10	95.27	1.52	39.42
2347.80*	(1) 25 mm	0.72	93.93	94.40	0.79	6.60
2347.80*	(1) 2-Year	1.95	93.93	94.61	1.06	14.00
2347.80*	(1) 5-Year	3.20	93.93	94.77	1.16	19.39
2347.80*	(1) 10-Year	4.11	93.93	94.87	1.22	23.33
2347.80*	(1) 25-Year	5.28	93.93	94.98	1.29	28.64
2347.80*	(1) 100-Year	7.27	93.93	95.15	1.39	39.01
2304.40*	(1) 25 mm	0.72	93.75	94.24	0.73	6.56
2304.40*	(1) 2-Year	1.95	93.75	94.49	0.89	13.86
2304.40*	(1) 5-Year	3.20	93.75	94.68	0.98	19.16
2304.40*	(1) 10-Year	4.11	93.75	94.78	1.04	23.05
2304.40*	(1) 25-Year	5.28	93.75	94.90	1.12	28.29
2304.40*	(1) 100-Year	7.27	93.75	95.08	1.23	38.55
2261	(1) 25 mm	0.72	93.57	94.18	0.49	6.49
2261	(1) 2-Year	1.95	93.57	94.44	0.66	13.67
2261	(1) 5-Year	3.20	93.57	94.63	0.78	18.87
2261	(1) 10-Year	4.11	93.57	94.73	0.86	22.70
2261	(1) 25-Year	5.28	93.57	94.85	0.95	27.87
2261	(1) 100-Year	7.27	93.57	95.02	1.07	38.03
2258	(1) 25 mm	0.72	93.57	94.14	0.56	6.44
2258	(1) 2-Year	1.95	93.57	94.41	0.72	13.53
2258	(1) 5-Year	3.20	93.57	94.60	0.82	18.66

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [(1)]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2258	(1) 10-Year	4.11	93.57	94.70	0.90	22.45
2258	(1) 25-Year	5.28	93.57	94.81	0.99	27.57
2258	(1) 100-Year	7.27	93.57	94.98	1.12	37.66
2256	(1) 25 mm	0.72	93.49	94.12	0.46	6.40
2256	(1) 2-Year	1.95	93.49	94.39	0.63	13.42
2256	(1) 5-Year	3.20	93.49	94.58	0.75	18.50
2256	(1) 10-Year	4.11	93.49	94.68	0.81	22.25
2256	(1) 25-Year	5.28	93.49	94.80	0.88	27.34
2256	(1) 100-Year	7.27	93.49	94.97	0.97	37.35
2254	(1) 25 mm	0.72	93.46	94.11	0.44	6.35
2254	(1) 2-Year	1.95	93.46	94.38	0.62	13.32
2254	(1) 5-Year	3.20	93.46	94.56	0.73	18.35
2254	(1) 10-Year	4.11	93.46	94.67	0.80	22.06
2254	(1) 25-Year	5.28	93.46	94.78	0.87	27.10
2254	(1) 100-Year	7.27	93.46	94.95	0.96	37.05
2235	(1) 25 mm	0.72	93.44	94.10	0.43	6.30
2235	(1) 2-Year	1.95	93.44	94.36	0.60	13.21
2235	(1) 5-Year	3.20	93.44	94.55	0.72	18.20
2235	(1) 10-Year	4.11	93.44	94.65	0.79	21.87
2235	(1) 25-Year	5.28	93.44	94.76	0.86	26.87
2235	(1) 100-Year	7.27	93.44	94.94	0.95	36.74
2207	(1) 25 mm	0.72	93.40	94.08	0.40	6.23
2207	(1) 2-Year	1.95	93.40	94.35	0.59	13.06
2207	(1) 5-Year	3.20	93.40	94.53	0.71	17.96
2207	(1) 10-Year	4.11	93.40	94.63	0.78	21.58
2207	(1) 25-Year	5.28	93.40	94.74	0.85	26.51
2207	(1) 100-Year	7.27	93.40	94.92	0.94	36.28
2188	(1) 25 mm	1.16	93.37	94.05	0.65	6.18
2188	(1) 2-Year	2.80	93.37	94.31	0.84	12.95
2188	(1) 5-Year	4.41	93.37	94.49	0.98	17.80
2188	(1) 10-Year	5.53	93.37	94.59	1.05	21.38
2188	(1) 25-Year	6.96	93.37	94.70	1.13	26.27
2188	(1) 100-Year	9.54	93.37	94.88	1.25	35.98
2163	(1) 25 mm	1.16	93.34	94.02	0.65	6.12
2163	(1) 2-Year	2.80	93.34	94.28	0.84	12.81
2163	(1) 5-Year	4.41	93.34	94.46	0.97	17.60
2163	(1) 10-Year	5.53	93.34	94.56	1.04	21.13
2163	(1) 25-Year	6.96	93.34	94.67	1.12	25.97
2163	(1) 100-Year	9.54	93.34	94.84	1.23	35.59
2141	(1) 25 mm	1.16	93.31	93.99	0.65	6.06
2141	(1) 2-Year	2.80	93.31	94.25	0.84	12.69
2141	(1) 5-Year	4.41	93.31	94.43	0.97	17.42
2141	(1) 10-Year	5.53	93.31	94.53	1.04	20.91
2141	(1) 25-Year	6.96	93.31	94.64	1.11	25.69
2141	(1) 100-Year	9.54	93.31	94.81	1.23	35.23

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2121	(1) 25 mm	1.16	93.28	93.96	0.64	6.00
2121	(1) 2-Year	2.80	93.28	94.23	0.83	12.58
2121	(1) 5-Year	4.41	93.28	94.41	0.96	17.25
2121	(1) 10-Year	5.53	93.28	94.51	1.03	20.70
2121	(1) 25-Year	6.96	93.28	94.62	1.11	25.44
2121	(1) 100-Year	9.54	93.28	94.79	1.23	34.91
2101	(1) 25 mm	1.16	93.26	93.94	0.66	5.95
2101	(1) 2-Year	2.80	93.26	94.20	0.84	12.46
2101	(1) 5-Year	4.41	93.26	94.38	0.98	17.08
2101	(1) 10-Year	5.53	93.26	94.48	1.05	20.49
2101	(1) 25-Year	6.96	93.26	94.59	1.12	25.18
2101	(1) 100-Year	9.54	93.26	94.76	1.24	34.58
2080	(1) 25 mm	1.16	93.24	93.90	0.68	5.89
2080	(1) 2-Year	2.80	93.24	94.17	0.86	12.34
2080	(1) 5-Year	4.41	93.24	94.35	0.99	16.91
2080	(1) 10-Year	5.53	93.24	94.45	1.06	20.28
2080	(1) 25-Year	6.96	93.24	94.56	1.14	24.93
2080	(1) 100-Year	9.54	93.24	94.72	1.26	34.25
2059	(1) 25 mm	1.16	93.21	93.87	0.70	5.84
2059	(1) 2-Year	2.80	93.21	94.14	0.86	12.23
2059	(1) 5-Year	4.41	93.21	94.32	0.99	16.73
2059	(1) 10-Year	5.53	93.21	94.42	1.06	20.06
2059	(1) 25-Year	6.96	93.21	94.53	1.14	24.66
2059	(1) 100-Year	9.54	93.21	94.69	1.27	33.91
2038	(1) 25 mm	1.16	93.18	93.84	0.70	5.80
2038	(1) 2-Year	2.80	93.18	94.12	0.84	12.12
2038	(1) 5-Year	4.41	93.18	94.29	0.98	16.58
2038	(1) 10-Year	5.53	93.18	94.39	1.05	19.87
2038	(1) 25-Year	6.96	93.18	94.50	1.13	24.44
2038	(1) 100-Year	9.54	93.18	94.67	1.25	33.62
2017	(1) 25 mm	1.16	93.17	93.82	0.71	5.78
2017	(1) 2-Year	2.80	93.17	94.10	0.86	12.08
2017	(1) 5-Year	4.41	93.17	94.28	1.00	16.52
2017	(1) 10-Year	5.53	93.17	94.38	1.07	19.79
2017	(1) 25-Year	6.96	93.17	94.49	1.15	24.33
2017	(1) 100-Year	9.54	93.17	94.65	1.28	33.49
2003	(1) 25 mm	1.16	93.16	93.81	0.73	5.76
2003	(1) 2-Year	2.80	93.16	94.09	0.86	12.04
2003	(1) 5-Year	4.41	93.16	94.27	1.01	16.46
2003	(1) 10-Year	5.53	93.16	94.37	1.08	19.72
2003	(1) 25-Year	6.96	93.16	94.48	1.16	24.24
2003	(1) 100-Year	9.54	93.16	94.64	1.28	33.37
1982	(1) 25 mm	1.16	93.12	93.77	0.71	5.71
1982	(1) 2-Year	2.80	93.12	94.07	0.83	11.93

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1982	(1) 5-Year	4.41	93.12	94.24	0.97	16.29
1982	(1) 10-Year	5.53	93.12	94.34	1.04	19.51
1982	(1) 25-Year	6.96	93.12	94.45	1.12	23.99
1982	(1) 100-Year	9.54	93.12	94.61	1.25	33.04
1961	(1) 25 mm	1.16	93.08	93.73	0.70	5.66
1961	(1) 2-Year	2.80	93.08	94.04	0.80	11.81
1961	(1) 5-Year	4.41	93.08	94.22	0.95	16.11
1961	(1) 10-Year	5.53	93.08	94.32	1.02	19.29
1961	(1) 25-Year	6.96	93.08	94.42	1.10	23.73
1961	(1) 100-Year	9.54	93.08	94.59	1.24	32.71
1940	(1) 25 mm	1.16	93.04	93.70	0.68	5.61
1940	(1) 2-Year	2.80	93.04	94.02	0.78	11.68
1940	(1) 5-Year	4.41	93.04	94.19	0.92	15.93
1940	(1) 10-Year	5.53	93.04	94.29	1.00	19.07
1940	(1) 25-Year	6.96	93.04	94.40	1.08	23.46
1940	(1) 100-Year	9.54	93.04	94.56	1.22	32.38
1919	(1) 25 mm	1.16	93.01	93.67	0.69	5.56
1919	(1) 2-Year	2.80	93.01	94.00	0.76	11.55
1919	(1) 5-Year	4.41	93.01	94.17	0.90	15.74
1919	(1) 10-Year	5.53	93.01	94.27	0.98	18.84
1919	(1) 25-Year	6.96	93.01	94.37	1.06	23.19
1919	(1) 100-Year	9.54	93.01	94.53	1.20	32.04
1898	(1) 25 mm	1.16	92.97	93.64	0.67	5.51
1898	(1) 2-Year	2.80	92.97	93.98	0.73	11.42
1898	(1) 5-Year	4.41	92.97	94.15	0.87	15.55
1898	(1) 10-Year	5.53	92.97	94.25	0.95	18.61
1898	(1) 25-Year	6.96	92.97	94.35	1.04	22.91
1898	(1) 100-Year	9.54	92.97	94.51	1.18	31.69
1877	(1) 25 mm	1.16	92.93	93.61	0.64	5.45
1877	(1) 2-Year	2.80	92.93	93.97	0.70	11.28
1877	(1) 5-Year	4.41	92.93	94.13	0.84	15.34
1877	(1) 10-Year	5.53	92.93	94.23	0.92	18.36
1877	(1) 25-Year	6.96	92.93	94.33	1.01	22.62
1877	(1) 100-Year	9.54	92.93	94.49	1.16	31.33
1857	(1) 25 mm	1.16	92.89	93.59	0.62	5.39
1857	(1) 2-Year	2.80	92.89	93.95	0.68	11.13
1857	(1) 5-Year	4.41	92.89	94.12	0.82	15.13
1857	(1) 10-Year	5.53	92.89	94.21	0.90	18.11
1857	(1) 25-Year	6.96	92.89	94.31	0.99	22.33
1857	(1) 100-Year	9.54	92.89	94.46	1.14	30.97
1837	(1) 25 mm	1.16	92.86	93.56	0.60	5.33
1837	(1) 2-Year	2.80	92.86	93.94	0.65	10.98
1837	(1) 5-Year	4.41	92.86	94.10	0.80	14.91
1837	(1) 10-Year	5.53	92.86	94.19	0.88	17.86
1837	(1) 25-Year	6.96	92.86	94.29	0.97	22.02

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1837	(1) 100-Year	9.54	92.86	94.44	1.12	30.60
1817	(1) 25 mm	1.16	92.81	93.54	0.56	5.27
1817	(1) 2-Year	2.80	92.81	93.93	0.62	10.81
1817	(1) 5-Year	4.41	92.81	94.09	0.77	14.68
1817	(1) 10-Year	5.53	92.81	94.18	0.85	17.59
1817	(1) 25-Year	6.96	92.81	94.28	0.94	21.71
1817	(1) 100-Year	9.54	92.81	94.42	1.10	30.23
1797	(1) 25 mm	1.16	92.77	93.53	0.53	5.20
1797	(1) 2-Year	2.80	92.77	93.92	0.59	10.64
1797	(1) 5-Year	4.41	92.77	94.08	0.74	14.44
1797	(1) 10-Year	5.53	92.77	94.17	0.82	17.31
1797	(1) 25-Year	6.96	92.77	94.26	0.92	21.39
1797	(1) 100-Year	9.54	92.77	94.40	1.07	29.85
1777	(1) 25 mm	1.16	92.73	93.52	0.49	5.13
1777	(1) 2-Year	2.80	92.73	93.91	0.56	10.45
1777	(1) 5-Year	4.41	92.73	94.07	0.70	14.19
1777	(1) 10-Year	5.53	92.73	94.15	0.78	17.02
1777	(1) 25-Year	6.96	92.73	94.25	0.88	21.06
1777	(1) 100-Year	9.54	92.73	94.39	1.04	29.45
1757	(1) 25 mm	1.16	92.69	93.51	0.46	5.04
1757	(1) 2-Year	2.80	92.69	93.91	0.53	10.24
1757	(1) 5-Year	4.41	92.69	94.06	0.68	13.92
1757	(1) 10-Year	5.53	92.69	94.14	0.76	16.72
1757	(1) 25-Year	6.96	92.69	94.24	0.86	20.72
1757	(1) 100-Year	9.54	92.69	94.37	1.02	29.05
1736	(1) 25 mm	1.16	92.66	93.50	0.44	4.96
1736	(1) 2-Year	2.80	92.66	93.90	0.51	10.03
1736	(1) 5-Year	4.41	92.66	94.05	0.65	13.65
1736	(1) 10-Year	5.53	92.66	94.13	0.74	16.40
1736	(1) 25-Year	6.96	92.66	94.23	0.83	20.36
1736	(1) 100-Year	9.54	92.66	94.36	1.00	28.63
1715	(1) 25 mm	1.16	92.62	93.49	0.40	4.86
1715	(1) 2-Year	2.80	92.62	93.90	0.48	9.80
1715	(1) 5-Year	4.41	92.62	94.04	0.62	13.35
1715	(1) 10-Year	5.53	92.62	94.12	0.70	16.07
1715	(1) 25-Year	6.96	92.62	94.21	0.80	20.00
1715	(1) 100-Year	9.54	92.62	94.34	0.96	28.20
1694	(1) 25 mm	1.16	92.58	93.48	0.38	4.76
1694	(1) 2-Year	2.80	92.58	93.89	0.46	9.56
1694	(1) 5-Year	4.41	92.58	94.03	0.60	13.05
1694	(1) 10-Year	5.53	92.58	94.12	0.68	15.73
1694	(1) 25-Year	6.96	92.58	94.21	0.78	19.61
1694	(1) 100-Year	9.54	92.58	94.33	0.94	27.76
1673	(1) 25 mm	1.16	92.53	93.48	0.35	4.64

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1673	(1) 2-Year	2.80	92.53	93.89	0.44	9.30
1673	(1) 5-Year	4.41	92.53	94.03	0.57	12.73
1673	(1) 10-Year	5.53	92.53	94.11	0.66	15.38
1673	(1) 25-Year	6.96	92.53	94.20	0.75	19.22
1673	(1) 100-Year	9.54	92.53	94.32	0.92	27.31
1653	(1) 25 mm	1.16	92.50	93.47	0.33	4.52
1653	(1) 2-Year	2.80	92.50	93.88	0.42	9.02
1653	(1) 5-Year	4.41	92.50	94.02	0.55	12.39
1653	(1) 10-Year	5.53	92.50	94.10	0.64	15.01
1653	(1) 25-Year	6.96	92.50	94.19	0.73	18.81
1653	(1) 100-Year	9.54	92.50	94.31	0.89	26.85
1632	(1) 25 mm	1.16	92.46	93.47	0.31	4.39
1632	(1) 2-Year	2.80	92.46	93.88	0.40	8.74
1632	(1) 5-Year	4.41	92.46	94.02	0.54	12.05
1632	(1) 10-Year	5.53	92.46	94.10	0.62	14.63
1632	(1) 25-Year	6.96	92.46	94.18	0.72	18.39
1632	(1) 100-Year	9.54	92.46	94.30	0.88	26.37
1615	(1) 25 mm	1.16	92.43	93.47	0.31	4.28
1615	(1) 2-Year	2.80	92.43	93.88	0.39	8.49
1615	(1) 5-Year	4.41	92.43	94.01	0.52	11.75
1615	(1) 10-Year	5.53	92.43	94.09	0.60	14.30
1615	(1) 25-Year	6.96	92.43	94.18	0.69	18.04
1615	(1) 100-Year	9.54	92.43	94.29	0.85	25.97
1555	(1) 25 mm	1.16	92.35	93.46	0.28	3.83
1555	(1) 2-Year	2.80	92.35	93.87	0.36	7.55
1555	(1) 5-Year	4.41	92.35	94.00	0.48	10.64
1555	(1) 10-Year	5.53	92.35	94.08	0.56	13.09
1555	(1) 25-Year	6.96	92.35	94.16	0.64	16.71
1555	(1) 100-Year	9.54	92.35	94.27	0.80	24.49
1488	(1) 25 mm	1.16	92.28	93.46	0.25	3.24
1488	(1) 2-Year	2.80	92.28	93.86	0.33	6.40
1488	(1) 5-Year	4.41	92.28	93.99	0.44	9.30
1488	(1) 10-Year	5.53	92.28	94.07	0.52	11.64
1488	(1) 25-Year	6.96	92.28	94.14	0.61	15.14
1488	(1) 100-Year	9.54	92.28	94.24	0.76	22.76
1416	(1) 25 mm	1.16	92.20	93.45	0.21	2.59
1416	(1) 2-Year	2.80	92.20	93.86	0.30	5.23
1416	(1) 5-Year	4.41	92.20	93.99	0.42	7.96
1416	(1) 10-Year	5.53	92.20	94.06	0.49	10.20
1416	(1) 25-Year	6.96	92.20	94.13	0.58	13.61
1416	(1) 100-Year	9.54	92.20	94.22	0.73	21.09
1400	(1) 25 mm	1.16	92.17	93.45	0.20	2.31
1400	(1) 2-Year	2.80	92.17	93.86	0.29	4.76
1400	(1) 5-Year	4.41	92.17	93.98	0.40	7.42
1400	(1) 10-Year	5.53	92.17	94.05	0.48	9.63

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [(1)]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1400	(1) 25-Year	6.96	92.17	94.12	0.56	12.99
1400	(1) 100-Year	9.54	92.17	94.22	0.72	20.42
1364	(1) 25 mm	1.16	91.63	93.45	0.09	1.80
1364	(1) 2-Year	2.80	91.63	93.86	0.15	3.97
1364	(1) 5-Year	4.41	91.63	93.98	0.22	6.53
1364	(1) 10-Year	5.53	91.63	94.05	0.27	8.69
1364	(1) 25-Year	6.96	91.63	94.12	0.32	12.00
1364	(1) 100-Year	9.54	91.63	94.22	0.41	19.35
1340	(1) 25 mm	1.53	91.60	93.45	0.11	1.42
1340	(1) 2-Year	3.64	91.60	93.86	0.20	3.39
1340	(1) 5-Year	5.57	91.60	93.98	0.28	5.90
1340	(1) 10-Year	6.92	91.60	94.05	0.33	8.02
1340	(1) 25-Year	8.58	91.60	94.12	0.39	11.29
1340	(1) 100-Year	11.43	91.60	94.21	0.50	18.60
1312	(1) 25 mm	1.53	92.47	93.45	0.29	1.10
1312	(1) 2-Year	3.87	92.47	93.84	0.51	2.91
1312	(1) 5-Year	5.93	92.47	93.96	0.71	5.36
1312	(1) 10-Year	7.38	92.47	94.01	0.84	7.45
1312	(1) 25-Year	9.17	92.47	94.07	1.01	10.69
1312	(1) 100-Year	12.20	92.47	94.13	1.29	17.96
1302	(1) 25 mm	1.53	92.57	93.41	0.83	1.07
1302	(1) 2-Year	3.87	92.57	93.81	0.88	2.84
1302	(1) 5-Year	5.93	92.57	93.92	1.05	5.28
1302	(1) 10-Year	7.38	92.57	93.98	1.15	7.35
1302	(1) 25-Year	9.17	92.57	94.03	1.27	10.58
1302	(1) 100-Year	12.20	92.57	94.11	1.41	17.81
1268	(1) 25 mm	1.53	92.47	93.33	0.79	1.00
1268	(1) 2-Year	3.87	92.47	93.75	0.56	2.62
1268	(1) 5-Year	5.93	92.47	93.88	0.57	4.91
1268	(1) 10-Year	7.38	92.47	93.94	0.60	6.88
1268	(1) 25-Year	9.17	92.47	94.01	0.62	9.89
1268	(1) 100-Year	12.20	92.47	94.10	0.60	16.64
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.90
1212	(1) 2-Year	3.87	92.36	93.61	0.89	2.25
1212	(1) 5-Year	5.93	92.36	93.77	0.91	4.21
1212	(1) 10-Year	7.38	92.36	93.85	0.93	5.90
1212	(1) 25-Year	9.17	92.36	93.92	0.94	8.43
1212	(1) 100-Year	12.20	92.36	94.04	0.90	14.29
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.81
1169	(1) 2-Year	3.87	92.30	93.53	0.78	2.02
1169	(1) 5-Year	5.93	92.30	93.70	0.86	3.67
1169	(1) 10-Year	7.38	92.30	93.77	0.92	5.11
1169	(1) 25-Year	9.17	92.30	93.84	0.98	7.33
1169	(1) 100-Year	12.20	92.30	93.94	1.09	12.64

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.63
1091	(1) 2-Year	3.87	92.15	93.40	0.75	1.62
1091	(1) 5-Year	5.93	92.15	93.57	0.83	2.89
1091	(1) 10-Year	7.38	92.15	93.64	0.87	4.03
1091	(1) 25-Year	9.17	92.15	93.71	0.92	5.91
1091	(1) 100-Year	12.20	92.15	93.82	0.97	10.62
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.44
1002	(1) 2-Year	3.87	92.06	93.21	0.91	1.21
1002	(1) 5-Year	5.93	92.06	93.37	1.02	2.15
1002	(1) 10-Year	7.38	92.06	93.46	1.04	2.97
1002	(1) 25-Year	9.17	92.06	93.55	1.03	4.45
1002	(1) 100-Year	12.20	92.06	93.69	1.02	8.49
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.34
961	(1) 2-Year	3.87	91.96	93.13	0.72	1.01
961	(1) 5-Year	5.93	91.96	93.28	0.80	1.86
961	(1) 10-Year	7.38	91.96	93.37	0.83	2.56
961	(1) 25-Year	9.17	91.96	93.47	0.82	3.85
961	(1) 100-Year	12.20	91.96	93.64	0.64	7.42
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.20
910	(1) 2-Year	3.87	91.93	93.06	0.74	0.62
910	(1) 5-Year	5.93	91.93	93.20	0.81	1.16
910	(1) 10-Year	7.38	91.93	93.30	0.82	1.62
910	(1) 25-Year	9.17	91.93	93.41	0.83	2.38
910	(1) 100-Year	12.20	91.93	93.60	0.68	4.32
840	(1) 25 mm	1.53	91.86	92.65	0.50	0.00
840	(1) 2-Year	3.87	91.86	92.98	0.47	0.00
840	(1) 5-Year	5.93	91.86	93.16	0.42	0.00
840	(1) 10-Year	7.38	91.86	93.26	0.41	0.00
840	(1) 25-Year	9.17	91.86	93.38	0.41	0.00
840	(1) 100-Year	12.20	91.86	93.58	0.39	0.00

[1] All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(2) 2-Year	4.13	94.75	95.64	1.37	19.63
2554	(2) 5-Year	5.24	94.75	95.72	1.50	23.50
2554	(2) 10-Year	6.00	94.75	95.77	1.58	26.12
2554	(2) 25-Year	6.94	94.75	95.82	1.67	30.21
2554	(2) 100-Year	8.32	94.75	95.89	1.79	39.36
2554	(4) 2-Year	3.97	94.75	95.63	1.35	18.39
2554	(4) 5-Year	2.02	94.75	95.45	1.03	11.06
2554	(4) 10-Year	1.57	94.75	95.40	0.94	9.07
2554	(4) 25-Year	2.25	94.75	95.48	1.08	15.30
2554	(4) 100-Year	2.86	94.75	95.54	1.18	44.56
2478	(2) 2-Year	4.13	94.46	95.30	1.32	19.34
2478	(2) 5-Year	5.24	94.46	95.38	1.41	23.16
2478	(2) 10-Year	6.00	94.46	95.42	1.47	25.75
2478	(2) 25-Year	6.94	94.46	95.48	1.53	29.80
2478	(2) 100-Year	8.32	94.46	95.55	1.61	38.89
2478	(4) 2-Year	3.97	94.46	95.29	1.30	18.11
2478	(4) 5-Year	2.02	94.46	95.13	1.08	10.89
2478	(4) 10-Year	1.57	94.46	95.08	1.00	8.93
2478	(4) 25-Year	2.25	94.46	95.15	1.11	15.11
2478	(4) 100-Year	2.86	94.46	95.20	1.19	44.34
2434.60*	(2) 2-Year	4.13	94.28	95.12	1.32	19.14
2434.60*	(2) 5-Year	5.24	94.28	95.20	1.41	22.92
2434.60*	(2) 10-Year	6.00	94.28	95.25	1.46	25.48
2434.60*	(2) 25-Year	6.94	94.28	95.30	1.52	29.50
2434.60*	(2) 100-Year	8.32	94.28	95.38	1.59	38.54
2434.60*	(4) 2-Year	3.97	94.28	95.11	1.30	17.91
2434.60*	(4) 5-Year	2.02	94.28	94.95	1.08	10.77
2434.60*	(4) 10-Year	1.57	94.28	94.90	1.01	8.83
2434.60*	(4) 25-Year	2.25	94.28	94.97	1.11	14.98
2434.60*	(4) 100-Year	2.86	94.28	95.03	1.19	44.18
2391.20*	(2) 2-Year	4.13	94.10	94.95	1.31	18.93
2391.20*	(2) 5-Year	5.24	94.10	95.03	1.38	22.67
2391.20*	(2) 10-Year	6.00	94.10	95.08	1.43	25.20
2391.20*	(2) 25-Year	6.94	94.10	95.14	1.48	29.19
2391.20*	(2) 100-Year	8.32	94.10	95.23	1.53	38.18
2391.20*	(4) 2-Year	3.97	94.10	94.94	1.30	17.70
2391.20*	(4) 5-Year	2.02	94.10	94.77	1.08	10.65
2391.20*	(4) 10-Year	1.57	94.10	94.72	1.00	8.74
2391.20*	(4) 25-Year	2.25	94.10	94.79	1.11	14.85
2391.20*	(4) 100-Year	2.86	94.10	94.85	1.19	44.02
2347.80*	(2) 2-Year	4.13	93.93	94.79	1.24	18.72
2347.80*	(2) 5-Year	5.24	93.93	94.88	1.30	22.41
2347.80*	(2) 10-Year	6.00	93.93	94.94	1.33	24.91
2347.80*	(2) 25-Year	6.94	93.93	95.01	1.37	28.87
2347.80*	(2) 100-Year	8.32	93.93	95.11	1.40	37.80
2347.80*	(4) 2-Year	3.97	93.93	94.78	1.23	17.50
2347.80*	(4) 5-Year	2.02	93.93	94.59	1.08	10.53
2347.80*	(4) 10-Year	1.57	93.93	94.54	1.01	8.64

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2347.80*	(4) 25-Year	2.25	93.93	94.61	1.11	14.72
2347.80*	(4) 100-Year	2.86	93.93	94.68	1.16	43.87
2304.40*	(2) 2-Year	4.13	93.75	94.69	1.06	18.48
2304.40*	(2) 5-Year	5.24	93.75	94.78	1.12	22.12
2304.40*	(2) 10-Year	6.00	93.75	94.84	1.16	24.59
2304.40*	(2) 25-Year	6.94	93.75	94.91	1.21	28.50
2304.40*	(2) 100-Year	8.32	93.75	95.02	1.24	37.38
2304.40*	(4) 2-Year	3.97	93.75	94.67	1.06	17.27
2304.40*	(4) 5-Year	2.02	93.75	94.44	0.97	10.41
2304.40*	(4) 10-Year	1.57	93.75	94.38	0.94	8.55
2304.40*	(4) 25-Year	2.25	93.75	94.47	0.98	14.58
2304.40*	(4) 100-Year	2.86	93.75	94.55	1.01	43.69
2261	(2) 2-Year	4.13	93.57	94.63	0.85	18.19
2261	(2) 5-Year	5.24	93.57	94.72	0.93	21.77
2261	(2) 10-Year	6.00	93.57	94.78	0.97	24.21
2261	(2) 25-Year	6.94	93.57	94.85	1.02	28.08
2261	(2) 100-Year	8.32	93.57	94.97	1.06	36.88
2261	(4) 2-Year	3.97	93.57	94.61	0.84	16.99
2261	(4) 5-Year	2.02	93.57	94.38	0.70	10.25
2261	(4) 10-Year	1.57	93.57	94.31	0.65	8.42
2261	(4) 25-Year	2.25	93.57	94.41	0.72	14.41
2261	(4) 100-Year	2.86	93.57	94.49	0.77	43.48
2258	(2) 2-Year	4.13	93.57	94.58	0.92	17.98
2258	(2) 5-Year	5.24	93.57	94.68	0.99	21.53
2258	(2) 10-Year	6.00	93.57	94.74	1.03	23.94
2258	(2) 25-Year	6.94	93.57	94.81	1.09	27.79
2258	(2) 100-Year	8.32	93.57	94.93	1.12	36.54
2258	(4) 2-Year	3.97	93.57	94.57	0.91	16.79
2258	(4) 5-Year	2.02	93.57	94.33	0.80	10.13
2258	(4) 10-Year	1.57	93.57	94.26	0.77	8.32
2258	(4) 25-Year	2.25	93.57	94.36	0.82	14.28
2258	(4) 100-Year	2.86	93.57	94.44	0.85	43.32
2256	(2) 2-Year	4.13	93.49	94.56	0.83	17.83
2256	(2) 5-Year	5.24	93.49	94.66	0.88	21.34
2256	(2) 10-Year	6.00	93.49	94.72	0.92	23.73
2256	(2) 25-Year	6.94	93.49	94.79	0.95	27.55
2256	(2) 100-Year	8.32	93.49	94.91	0.96	36.26
2256	(4) 2-Year	3.97	93.49	94.54	0.82	16.64
2256	(4) 5-Year	2.02	93.49	94.30	0.69	10.04
2256	(4) 10-Year	1.57	93.49	94.23	0.66	8.25
2256	(4) 25-Year	2.25	93.49	94.33	0.71	14.19
2256	(4) 100-Year	2.86	93.49	94.42	0.75	43.21
2254	(2) 2-Year	4.13	93.46	94.54	0.82	17.68
2254	(2) 5-Year	5.24	93.46	94.64	0.87	21.16
2254	(2) 10-Year	6.00	93.46	94.70	0.91	23.53
2254	(2) 25-Year	6.94	93.46	94.77	0.94	27.32
2254	(2) 100-Year	8.32	93.46	94.90	0.95	35.98

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2254	(4) 2-Year	3.97	93.46	94.53	0.81	16.50
2254	(4) 5-Year	2.02	93.46	94.28	0.69	9.96
2254	(4) 10-Year	1.57	93.46	94.21	0.65	8.19
2254	(4) 25-Year	2.25	93.46	94.31	0.70	14.10
2254	(4) 100-Year	2.86	93.46	94.40	0.74	43.10
2235	(2) 2-Year	4.13	93.44	94.53	0.80	17.54
2235	(2) 5-Year	5.24	93.44	94.62	0.86	20.98
2235	(2) 10-Year	6.00	93.44	94.68	0.89	23.32
2235	(2) 25-Year	6.94	93.44	94.75	0.93	27.09
2235	(2) 100-Year	8.32	93.44	94.88	0.93	35.69
2235	(4) 2-Year	3.97	93.44	94.51	0.80	16.36
2235	(4) 5-Year	2.02	93.44	94.26	0.68	9.88
2235	(4) 10-Year	1.57	93.44	94.19	0.64	8.12
2235	(4) 25-Year	2.25	93.44	94.29	0.70	14.01
2235	(4) 100-Year	2.86	93.44	94.38	0.73	42.99
2207	(2) 2-Year	4.13	93.40	94.50	0.80	17.32
2207	(2) 5-Year	5.24	93.40	94.59	0.86	20.70
2207	(2) 10-Year	6.00	93.40	94.66	0.89	23.01
2207	(2) 25-Year	6.94	93.40	94.72	0.93	26.74
2207	(2) 100-Year	8.32	93.40	94.86	0.93	35.27
2207	(4) 2-Year	3.97	93.40	94.48	0.80	16.15
2207	(4) 5-Year	2.02	93.40	94.23	0.68	9.76
2207	(4) 10-Year	1.57	93.40	94.16	0.65	8.02
2207	(4) 25-Year	2.25	93.40	94.26	0.70	13.88
2207	(4) 100-Year	2.86	93.40	94.35	0.73	42.83
2188	(2) 2-Year	5.00	93.37	94.47	0.96	17.17
2188	(2) 5-Year	6.32	93.37	94.56	1.03	20.52
2188	(2) 10-Year	7.24	93.37	94.62	1.07	22.81
2188	(2) 25-Year	8.38	93.37	94.69	1.12	26.51
2188	(2) 100-Year	10.81	93.37	94.82	1.21	34.99
2188	(4) 2-Year	4.78	93.37	94.45	0.95	16.01
2188	(4) 5-Year	2.33	93.37	94.20	0.77	9.68
2188	(4) 10-Year	1.78	93.37	94.13	0.71	7.96
2188	(4) 25-Year	2.60	93.37	94.23	0.79	13.79
2188	(4) 100-Year	3.29	93.37	94.32	0.82	42.72
2163	(2) 2-Year	5.00	93.34	94.43	0.95	16.98
2163	(2) 5-Year	6.32	93.34	94.53	1.02	20.29
2163	(2) 10-Year	7.24	93.34	94.59	1.06	22.54
2163	(2) 25-Year	8.38	93.34	94.66	1.11	26.21
2163	(2) 100-Year	10.81	93.34	94.79	1.20	34.62
2163	(4) 2-Year	4.78	93.34	94.42	0.94	15.83
2163	(4) 5-Year	2.33	93.34	94.17	0.77	9.57
2163	(4) 10-Year	1.78	93.34	94.10	0.71	7.87
2163	(4) 25-Year	2.60	93.34	94.20	0.79	13.67
2163	(4) 100-Year	3.29	93.34	94.30	0.81	42.58
2141	(2) 2-Year	5.00	93.31	94.41	0.95	16.81
2141	(2) 5-Year	6.32	93.31	94.50	1.02	20.07

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2141	(2) 10-Year	7.24	93.31	94.56	1.06	22.30
2141	(2) 25-Year	8.38	93.31	94.63	1.11	25.94
2141	(2) 100-Year	10.81	93.31	94.76	1.20	34.30
2141	(4) 2-Year	4.78	93.31	94.39	0.94	15.66
2141	(4) 5-Year	2.33	93.31	94.14	0.77	9.48
2141	(4) 10-Year	1.78	93.31	94.07	0.71	7.79
2141	(4) 25-Year	2.60	93.31	94.17	0.79	13.57
2141	(4) 100-Year	3.29	93.31	94.27	0.80	42.45
2121	(2) 2-Year	5.00	93.28	94.38	0.94	16.65
2121	(2) 5-Year	6.32	93.28	94.48	1.01	19.88
2121	(2) 10-Year	7.24	93.28	94.53	1.05	22.08
2121	(2) 25-Year	8.38	93.28	94.60	1.10	25.70
2121	(2) 100-Year	10.81	93.28	94.73	1.20	34.00
2121	(4) 2-Year	4.78	93.28	94.36	0.94	15.51
2121	(4) 5-Year	2.33	93.28	94.11	0.76	9.39
2121	(4) 10-Year	1.78	93.28	94.04	0.70	7.72
2121	(4) 25-Year	2.60	93.28	94.15	0.78	13.48
2121	(4) 100-Year	3.29	93.28	94.25	0.79	42.34
2101	(2) 2-Year	5.00	93.26	94.35	0.96	16.49
2101	(2) 5-Year	6.32	93.26	94.45	1.03	19.68
2101	(2) 10-Year	7.24	93.26	94.51	1.07	21.86
2101	(2) 25-Year	8.38	93.26	94.57	1.12	25.45
2101	(2) 100-Year	10.81	93.26	94.70	1.21	33.69
2101	(4) 2-Year	4.78	93.26	94.33	0.95	15.36
2101	(4) 5-Year	2.33	93.26	94.09	0.77	9.30
2101	(4) 10-Year	1.78	93.26	94.01	0.72	7.65
2101	(4) 25-Year	2.60	93.26	94.12	0.79	13.38
2101	(4) 100-Year	3.29	93.26	94.23	0.79	42.22
2080	(2) 2-Year	5.00	93.24	94.32	0.98	16.33
2080	(2) 5-Year	6.32	93.24	94.42	1.05	19.48
2080	(2) 10-Year	7.24	93.24	94.48	1.09	21.64
2080	(2) 25-Year	8.38	93.24	94.54	1.14	25.20
2080	(2) 100-Year	10.81	93.24	94.67	1.23	33.39
2080	(4) 2-Year	4.78	93.24	94.30	0.97	15.21
2080	(4) 5-Year	2.33	93.24	94.05	0.80	9.21
2080	(4) 10-Year	1.78	93.24	93.98	0.75	7.58
2080	(4) 25-Year	2.60	93.24	94.09	0.81	13.28
2080	(4) 100-Year	3.29	93.24	94.20	0.80	42.09
2059	(2) 2-Year	5.00	93.21	94.29	0.98	16.17
2059	(2) 5-Year	6.32	93.21	94.39	1.05	19.28
2059	(2) 10-Year	7.24	93.21	94.45	1.09	21.41
2059	(2) 25-Year	8.38	93.21	94.51	1.14	24.94
2059	(2) 100-Year	10.81	93.21	94.63	1.24	33.08
2059	(4) 2-Year	4.78	93.21	94.27	0.97	15.05
2059	(4) 5-Year	2.33	93.21	94.02	0.81	9.13
2059	(4) 10-Year	1.78	93.21	93.94	0.76	7.51
2059	(4) 25-Year	2.60	93.21	94.06	0.82	13.19
2059	(4) 100-Year	3.29	93.21	94.18	0.79	41.96

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2038	(2) 2-Year	5.00	93.18	94.27	0.97	16.03
2038	(2) 5-Year	6.32	93.18	94.36	1.03	19.10
2038	(2) 10-Year	7.24	93.18	94.42	1.08	21.22
2038	(2) 25-Year	8.38	93.18	94.49	1.13	24.72
2038	(2) 100-Year	10.81	93.18	94.61	1.23	32.81
2038	(4) 2-Year	4.78	93.18	94.24	0.96	14.92
2038	(4) 5-Year	2.33	93.18	93.99	0.80	9.05
2038	(4) 10-Year	1.78	93.18	93.91	0.76	7.45
2038	(4) 25-Year	2.60	93.18	94.03	0.81	13.10
2038	(4) 100-Year	3.29	93.18	94.16	0.77	41.85
2017	(2) 2-Year	5.00	93.17	94.25	0.99	15.96
2017	(2) 5-Year	6.32	93.17	94.35	1.06	19.03
2017	(2) 10-Year	7.24	93.17	94.41	1.10	21.13
2017	(2) 25-Year	8.38	93.17	94.47	1.15	24.62
2017	(2) 100-Year	10.81	93.17	94.59	1.25	32.69
2017	(4) 2-Year	4.78	93.17	94.23	0.98	14.87
2017	(4) 5-Year	2.33	93.17	93.98	0.82	9.02
2017	(4) 10-Year	1.78	93.17	93.90	0.79	7.42
2017	(4) 25-Year	2.60	93.17	94.02	0.82	13.07
2017	(4) 100-Year	3.29	93.17	94.15	0.78	41.81
2003	(2) 2-Year	5.00	93.16	94.24	1.00	15.91
2003	(2) 5-Year	6.32	93.16	94.34	1.07	18.96
2003	(2) 10-Year	7.24	93.16	94.39	1.11	21.05
2003	(2) 25-Year	8.38	93.16	94.46	1.16	24.53
2003	(2) 100-Year	10.81	93.16	94.58	1.26	32.58
2003	(4) 2-Year	4.78	93.16	94.22	0.99	14.81
2003	(4) 5-Year	2.33	93.16	93.97	0.83	8.99
2003	(4) 10-Year	1.78	93.16	93.88	0.81	7.40
2003	(4) 25-Year	2.60	93.16	94.01	0.84	13.03
2003	(4) 100-Year	3.29	93.16	94.14	0.78	41.76
1982	(2) 2-Year	5.00	93.12	94.22	0.96	15.75
1982	(2) 5-Year	6.32	93.12	94.31	1.03	18.76
1982	(2) 10-Year	7.24	93.12	94.37	1.07	20.83
1982	(2) 25-Year	8.38	93.12	94.43	1.12	24.28
1982	(2) 100-Year	10.81	93.12	94.55	1.23	32.28
1982	(4) 2-Year	4.78	93.12	94.19	0.95	14.67
1982	(4) 5-Year	2.33	93.12	93.94	0.79	8.90
1982	(4) 10-Year	1.78	93.12	93.85	0.78	7.34
1982	(4) 25-Year	2.60	93.12	93.98	0.80	12.94
1982	(4) 100-Year	3.29	93.12	94.12	0.74	41.63
1961	(2) 2-Year	5.00	93.08	94.19	0.93	15.59
1961	(2) 5-Year	6.32	93.08	94.28	1.00	18.56
1961	(2) 10-Year	7.24	93.08	94.34	1.05	20.60
1961	(2) 25-Year	8.38	93.08	94.41	1.10	24.03
1961	(2) 100-Year	10.81	93.08	94.52	1.21	31.98
1961	(4) 2-Year	4.78	93.08	94.17	0.93	14.51
1961	(4) 5-Year	2.33	93.08	93.91	0.77	8.82

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1961	(4) 10-Year	1.78	93.08	93.81	0.77	7.27
1961	(4) 25-Year	2.60	93.08	93.95	0.77	12.84
1961	(4) 100-Year	3.29	93.08	94.11	0.71	41.50
1940	(2) 2-Year	5.00	93.04	94.17	0.90	15.42
1940	(2) 5-Year	6.32	93.04	94.26	0.97	18.35
1940	(2) 10-Year	7.24	93.04	94.32	1.02	20.37
1940	(2) 25-Year	8.38	93.04	94.38	1.07	23.77
1940	(2) 100-Year	10.81	93.04	94.50	1.19	31.67
1940	(4) 2-Year	4.78	93.04	94.14	0.90	14.35
1940	(4) 5-Year	2.33	93.04	93.88	0.74	8.72
1940	(4) 10-Year	1.78	93.04	93.78	0.75	7.20
1940	(4) 25-Year	2.60	93.04	93.93	0.74	12.74
1940	(4) 100-Year	3.29	93.04	94.09	0.68	41.36
1919	(2) 2-Year	5.00	93.01	94.15	0.88	15.24
1919	(2) 5-Year	6.32	93.01	94.24	0.95	18.14
1919	(2) 10-Year	7.24	93.01	94.29	1.00	20.13
1919	(2) 25-Year	8.38	93.01	94.36	1.05	23.50
1919	(2) 100-Year	10.81	93.01	94.47	1.17	31.35
1919	(4) 2-Year	4.78	93.01	94.12	0.88	14.18
1919	(4) 5-Year	2.33	93.01	93.86	0.72	8.63
1919	(4) 10-Year	1.78	93.01	93.75	0.74	7.13
1919	(4) 25-Year	2.60	93.01	93.91	0.72	12.63
1919	(4) 100-Year	3.29	93.01	94.08	0.65	41.21
1898	(2) 2-Year	5.00	92.97	94.13	0.85	15.06
1898	(2) 5-Year	6.32	92.97	94.22	0.92	17.91
1898	(2) 10-Year	7.24	92.97	94.27	0.97	19.89
1898	(2) 25-Year	8.38	92.97	94.34	1.03	23.23
1898	(2) 100-Year	10.81	92.97	94.45	1.15	31.03
1898	(4) 2-Year	4.78	92.97	94.10	0.85	14.01
1898	(4) 5-Year	2.33	92.97	93.84	0.69	8.53
1898	(4) 10-Year	1.78	92.97	93.72	0.72	7.06
1898	(4) 25-Year	2.60	92.97	93.89	0.68	12.52
1898	(4) 100-Year	3.29	92.97	94.07	0.62	41.05
1877	(2) 2-Year	5.00	92.93	94.11	0.82	14.86
1877	(2) 5-Year	6.32	92.93	94.20	0.89	17.68
1877	(2) 10-Year	7.24	92.93	94.25	0.94	19.63
1877	(2) 25-Year	8.38	92.93	94.32	1.00	22.95
1877	(2) 100-Year	10.81	92.93	94.42	1.12	30.70
1877	(4) 2-Year	4.78	92.93	94.08	0.81	13.82
1877	(4) 5-Year	2.33	92.93	93.82	0.66	8.43
1877	(4) 10-Year	1.78	92.93	93.69	0.69	6.99
1877	(4) 25-Year	2.60	92.93	93.87	0.65	12.41
1877	(4) 100-Year	3.29	92.93	94.06	0.58	40.88
1857	(2) 2-Year	5.00	92.89	94.09	0.79	14.66
1857	(2) 5-Year	6.32	92.89	94.18	0.87	17.44
1857	(2) 10-Year	7.24	92.89	94.24	0.92	19.37
1857	(2) 25-Year	8.38	92.89	94.30	0.98	22.66

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1857	(2) 100-Year	10.81	92.89	94.40	1.10	30.37
1857	(4) 2-Year	4.78	92.89	94.07	0.79	13.63
1857	(4) 5-Year	2.33	92.89	93.80	0.63	8.32
1857	(4) 10-Year	1.78	92.89	93.67	0.67	6.91
1857	(4) 25-Year	2.60	92.89	93.86	0.62	12.29
1857	(4) 100-Year	3.29	92.89	94.05	0.56	40.69
1837	(2) 2-Year	5.00	92.86	94.08	0.76	14.45
1837	(2) 5-Year	6.32	92.86	94.17	0.84	17.20
1837	(2) 10-Year	7.24	92.86	94.22	0.89	19.10
1837	(2) 25-Year	8.38	92.86	94.28	0.95	22.36
1837	(2) 100-Year	10.81	92.86	94.38	1.08	30.03
1837	(4) 2-Year	4.78	92.86	94.05	0.76	13.43
1837	(4) 5-Year	2.33	92.86	93.79	0.60	8.21
1837	(4) 10-Year	1.78	92.86	93.65	0.64	6.83
1837	(4) 25-Year	2.60	92.86	93.85	0.60	12.16
1837	(4) 100-Year	3.29	92.86	94.04	0.53	40.50
1817	(2) 2-Year	5.00	92.81	94.06	0.73	14.23
1817	(2) 5-Year	6.32	92.81	94.15	0.81	16.94
1817	(2) 10-Year	7.24	92.81	94.20	0.87	18.82
1817	(2) 25-Year	8.38	92.81	94.26	0.93	22.06
1817	(2) 100-Year	10.81	92.81	94.36	1.06	29.68
1817	(4) 2-Year	4.78	92.81	94.04	0.73	13.23
1817	(4) 5-Year	2.33	92.81	93.78	0.57	8.09
1817	(4) 10-Year	1.78	92.81	93.63	0.60	6.75
1817	(4) 25-Year	2.60	92.81	93.84	0.56	12.03
1817	(4) 100-Year	3.29	92.81	94.04	0.50	40.30
1797	(2) 2-Year	5.00	92.77	94.05	0.70	14.00
1797	(2) 5-Year	6.32	92.77	94.14	0.78	16.68
1797	(2) 10-Year	7.24	92.77	94.19	0.83	18.54
1797	(2) 25-Year	8.38	92.77	94.25	0.90	21.74
1797	(2) 100-Year	10.81	92.77	94.34	1.03	29.32
1797	(4) 2-Year	4.78	92.77	94.03	0.70	13.01
1797	(4) 5-Year	2.33	92.77	93.77	0.53	7.97
1797	(4) 10-Year	1.78	92.77	93.62	0.56	6.66
1797	(4) 25-Year	2.60	92.77	93.83	0.53	11.89
1797	(4) 100-Year	3.29	92.77	94.03	0.48	40.08
1777	(2) 2-Year	5.00	92.73	94.04	0.66	13.76
1777	(2) 5-Year	6.32	92.73	94.13	0.74	16.40
1777	(2) 10-Year	7.24	92.73	94.18	0.79	18.23
1777	(2) 25-Year	8.38	92.73	94.24	0.86	21.42
1777	(2) 100-Year	10.81	92.73	94.33	0.99	28.96
1777	(4) 2-Year	4.78	92.73	94.02	0.66	12.77
1777	(4) 5-Year	2.33	92.73	93.76	0.50	7.83
1777	(4) 10-Year	1.78	92.73	93.61	0.52	6.56
1777	(4) 25-Year	2.60	92.73	93.82	0.50	11.73
1777	(4) 100-Year	3.29	92.73	94.03	0.45	39.84
1757	(2) 2-Year	5.00	92.69	94.04	0.64	13.50

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1757	(2) 5-Year	6.32	92.69	94.12	0.72	16.10
1757	(2) 10-Year	7.24	92.69	94.17	0.77	17.92
1757	(2) 25-Year	8.38	92.69	94.22	0.83	21.08
1757	(2) 100-Year	10.81	92.69	94.31	0.97	28.58
1757	(4) 2-Year	4.78	92.69	94.01	0.63	12.53
1757	(4) 5-Year	2.33	92.69	93.75	0.47	7.69
1757	(4) 10-Year	1.78	92.69	93.60	0.49	6.46
1757	(4) 25-Year	2.60	92.69	93.81	0.47	11.57
1757	(4) 100-Year	3.29	92.69	94.02	0.43	39.59
1736	(2) 2-Year	5.00	92.66	94.03	0.61	13.23
1736	(2) 5-Year	6.32	92.66	94.11	0.69	15.80
1736	(2) 10-Year	7.24	92.66	94.16	0.74	17.60
1736	(2) 25-Year	8.38	92.66	94.21	0.81	20.73
1736	(2) 100-Year	10.81	92.66	94.30	0.94	28.19
1736	(4) 2-Year	4.78	92.66	94.00	0.61	12.27
1736	(4) 5-Year	2.33	92.66	93.75	0.45	7.54
1736	(4) 10-Year	1.78	92.66	93.59	0.47	6.35
1736	(4) 25-Year	2.60	92.66	93.81	0.45	11.39
1736	(4) 100-Year	3.29	92.66	94.02	0.41	39.33
1715	(2) 2-Year	5.00	92.62	94.02	0.58	12.95
1715	(2) 5-Year	6.32	92.62	94.10	0.66	15.48
1715	(2) 10-Year	7.24	92.62	94.15	0.71	17.26
1715	(2) 25-Year	8.38	92.62	94.20	0.77	20.37
1715	(2) 100-Year	10.81	92.62	94.29	0.91	27.79
1715	(4) 2-Year	4.78	92.62	93.99	0.57	12.00
1715	(4) 5-Year	2.33	92.62	93.74	0.42	7.37
1715	(4) 10-Year	1.78	92.62	93.58	0.43	6.23
1715	(4) 25-Year	2.60	92.62	93.80	0.42	11.20
1715	(4) 100-Year	3.29	92.62	94.02	0.38	39.05
1694	(2) 2-Year	5.00	92.58	94.02	0.56	12.65
1694	(2) 5-Year	6.32	92.58	94.09	0.64	15.15
1694	(2) 10-Year	7.24	92.58	94.14	0.69	16.91
1694	(2) 25-Year	8.38	92.58	94.19	0.75	19.99
1694	(2) 100-Year	10.81	92.58	94.28	0.89	27.37
1694	(4) 2-Year	4.78	92.58	93.99	0.55	11.72
1694	(4) 5-Year	2.33	92.58	93.74	0.39	7.19
1694	(4) 10-Year	1.78	92.58	93.58	0.41	6.10
1694	(4) 25-Year	2.60	92.58	93.80	0.40	10.99
1694	(4) 100-Year	3.29	92.58	94.01	0.37	38.75
1673	(2) 2-Year	5.00	92.53	94.01	0.53	12.34
1673	(2) 5-Year	6.32	92.53	94.09	0.61	14.81
1673	(2) 10-Year	7.24	92.53	94.13	0.66	16.54
1673	(2) 25-Year	8.38	92.53	94.19	0.72	19.60
1673	(2) 100-Year	10.81	92.53	94.26	0.86	26.95
1673	(4) 2-Year	4.78	92.53	93.98	0.52	11.42
1673	(4) 5-Year	2.33	92.53	93.74	0.37	6.99
1673	(4) 10-Year	1.78	92.53	93.57	0.38	5.97
1673	(4) 25-Year	2.60	92.53	93.80	0.37	10.77

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1673	(4) 100-Year	3.29	92.53	94.01	0.35	38.44
1653	(2) 2-Year	5.00	92.50	94.01	0.51	12.01
1653	(2) 5-Year	6.32	92.50	94.08	0.59	14.45
1653	(2) 10-Year	7.24	92.50	94.13	0.64	16.16
1653	(2) 25-Year	8.38	92.50	94.18	0.70	19.20
1653	(2) 100-Year	10.81	92.50	94.26	0.83	26.51
1653	(4) 2-Year	4.78	92.50	93.98	0.50	11.10
1653	(4) 5-Year	2.33	92.50	93.73	0.35	6.78
1653	(4) 10-Year	1.78	92.50	93.57	0.36	5.82
1653	(4) 25-Year	2.60	92.50	93.79	0.35	10.53
1653	(4) 100-Year	3.29	92.50	94.01	0.33	38.11
1632	(2) 2-Year	5.00	92.46	94.00	0.49	11.68
1632	(2) 5-Year	6.32	92.46	94.08	0.57	14.08
1632	(2) 10-Year	7.24	92.46	94.12	0.62	15.77
1632	(2) 25-Year	8.38	92.46	94.17	0.68	18.78
1632	(2) 100-Year	10.81	92.46	94.25	0.82	26.06
1632	(4) 2-Year	4.78	92.46	93.97	0.49	10.78
1632	(4) 5-Year	2.33	92.46	93.73	0.33	6.56
1632	(4) 10-Year	1.78	92.46	93.56	0.34	5.66
1632	(4) 25-Year	2.60	92.46	93.79	0.34	10.29
1632	(4) 100-Year	3.29	92.46	94.01	0.32	37.77
1615	(2) 2-Year	5.00	92.43	94.00	0.47	11.39
1615	(2) 5-Year	6.32	92.43	94.07	0.55	13.76
1615	(2) 10-Year	7.24	92.43	94.12	0.60	15.44
1615	(2) 25-Year	8.38	92.43	94.17	0.66	18.43
1615	(2) 100-Year	10.81	92.43	94.24	0.79	25.68
1615	(4) 2-Year	4.78	92.43	93.97	0.47	10.50
1615	(4) 5-Year	2.33	92.43	93.73	0.32	6.36
1615	(4) 10-Year	1.78	92.43	93.56	0.32	5.52
1615	(4) 25-Year	2.60	92.43	93.79	0.32	10.07
1615	(4) 100-Year	3.29	92.43	94.01	0.31	37.48
1555	(2) 2-Year	5.00	92.35	93.99	0.42	10.29
1555	(2) 5-Year	6.32	92.35	94.06	0.49	12.57
1555	(2) 10-Year	7.24	92.35	94.10	0.54	14.19
1555	(2) 25-Year	8.38	92.35	94.15	0.59	17.12
1555	(2) 100-Year	10.81	92.35	94.22	0.71	24.27
1555	(4) 2-Year	4.78	92.35	93.96	0.42	9.44
1555	(4) 5-Year	2.33	92.35	93.72	0.29	5.61
1555	(4) 10-Year	1.78	92.35	93.55	0.30	4.97
1555	(4) 25-Year	2.60	92.35	93.79	0.29	9.24
1555	(4) 100-Year	3.29	92.35	94.00	0.27	36.37
1488	(2) 2-Year	5.00	92.28	93.98	0.39	8.97
1488	(2) 5-Year	6.32	92.28	94.05	0.45	11.14
1488	(2) 10-Year	7.24	92.28	94.09	0.50	12.70
1488	(2) 25-Year	8.38	92.28	94.14	0.55	15.56
1488	(2) 100-Year	10.81	92.28	94.20	0.67	22.62
1488	(4) 2-Year	4.78	92.28	93.95	0.38	8.16

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1488	(4) 5-Year	2.33	92.28	93.72	0.26	4.66
1488	(4) 10-Year	1.78	92.28	93.55	0.26	4.26
1488	(4) 25-Year	2.60	92.28	93.78	0.26	8.20
1488	(4) 100-Year	3.29	92.28	94.00	0.25	35.03
1416	(2) 2-Year	5.00	92.20	93.98	0.36	7.64
1416	(2) 5-Year	6.32	92.20	94.04	0.43	9.72
1416	(2) 10-Year	7.24	92.20	94.08	0.47	11.22
1416	(2) 25-Year	8.38	92.20	94.13	0.52	14.02
1416	(2) 100-Year	10.81	92.20	94.18	0.64	21.00
1416	(4) 2-Year	4.78	92.20	93.95	0.35	6.88
1416	(4) 5-Year	2.33	92.20	93.71	0.23	3.69
1416	(4) 10-Year	1.78	92.20	93.54	0.22	3.49
1416	(4) 25-Year	2.60	92.20	93.78	0.23	7.15
1416	(4) 100-Year	3.29	92.20	94.00	0.23	33.68
1400	(2) 2-Year	5.00	92.17	93.97	0.35	7.11
1400	(2) 5-Year	6.32	92.17	94.04	0.41	9.15
1400	(2) 10-Year	7.24	92.17	94.08	0.46	10.63
1400	(2) 25-Year	8.38	92.17	94.12	0.51	13.41
1400	(2) 100-Year	10.81	92.17	94.18	0.62	20.36
1400	(4) 2-Year	4.78	92.17	93.95	0.34	6.36
1400	(4) 5-Year	2.33	92.17	93.71	0.22	3.28
1400	(4) 10-Year	1.78	92.17	93.54	0.21	3.17
1400	(4) 25-Year	2.60	92.17	93.78	0.22	6.71
1400	(4) 100-Year	3.29	92.17	94.00	0.22	33.13
1364	(2) 2-Year	5.00	91.63	93.97	0.24	6.23
1364	(2) 5-Year	6.32	91.63	94.04	0.28	8.22
1364	(2) 10-Year	7.24	91.63	94.08	0.32	9.67
1364	(2) 25-Year	8.38	91.63	94.12	0.36	12.41
1364	(2) 100-Year	10.81	91.63	94.17	0.45	19.32
1364	(4) 2-Year	4.78	91.63	93.94	0.23	5.50
1364	(4) 5-Year	2.33	91.63	93.71	0.13	2.60
1364	(4) 10-Year	1.78	91.63	93.54	0.12	2.60
1364	(4) 25-Year	2.60	91.63	93.78	0.14	5.98
1364	(4) 100-Year	3.29	91.63	94.00	0.15	32.24
1340	(2) 2-Year	5.79	91.60	93.97	0.27	5.60
1340	(2) 5-Year	7.32	91.60	94.04	0.33	7.56
1340	(2) 10-Year	8.33	91.60	94.08	0.37	8.99
1340	(2) 25-Year	9.65	91.60	94.12	0.41	11.71
1340	(2) 100-Year	11.62	91.60	94.17	0.48	18.58
1340	(4) 2-Year	5.26	91.60	93.94	0.25	4.88
1340	(4) 5-Year	2.44	91.60	93.71	0.14	2.09
1340	(4) 10-Year	1.86	91.60	93.54	0.12	2.18
1340	(4) 25-Year	2.71	91.60	93.78	0.15	5.44
1340	(4) 100-Year	3.43	91.60	94.00	0.16	31.59
1312	(2) 2-Year	6.08	92.47	93.95	0.71	5.07
1312	(2) 5-Year	7.69	92.47	94.00	0.85	7.00
1312	(2) 10-Year	8.76	92.47	94.03	0.95	8.41

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1312	(2) 25-Year	10.15	92.47	94.06	1.08	11.11
1312	(2) 100-Year	12.20	92.47	94.09	1.27	17.97
1312	(4) 2-Year	5.46	92.47	93.92	0.65	4.37
1312	(4) 5-Year	2.47	92.47	93.71	0.36	1.67
1312	(4) 10-Year	1.87	92.47	93.54	0.32	1.82
1312	(4) 25-Year	2.73	92.47	93.77	0.37	5.00
1312	(4) 100-Year	3.44	92.47	93.99	0.39	31.05
1302	(2) 2-Year	6.08	92.57	93.91	1.03	4.98
1302	(2) 5-Year	7.69	92.57	93.97	1.13	6.90
1302	(2) 10-Year	8.76	92.57	94.00	1.18	8.31
1302	(2) 25-Year	10.15	92.57	94.04	1.26	11.00
1302	(2) 100-Year	12.20	92.57	94.07	1.39	17.85
1302	(4) 2-Year	5.46	92.57	93.89	0.98	4.29
1302	(4) 5-Year	2.47	92.57	93.68	0.77	1.62
1302	(4) 10-Year	1.87	92.57	93.50	0.85	1.79
1302	(4) 25-Year	2.73	92.57	93.74	0.73	4.94
1302	(4) 100-Year	3.44	92.57	93.98	0.49	30.95
1268	(2) 2-Year	6.08	92.47	93.87	0.59	4.63
1268	(2) 5-Year	7.69	92.47	93.93	0.62	6.46
1268	(2) 10-Year	8.76	92.47	93.96	0.64	7.77
1268	(2) 25-Year	10.15	92.47	94.00	0.67	10.34
1268	(2) 100-Year	12.20	92.47	94.05	0.64	16.97
1268	(4) 2-Year	5.46	92.47	93.84	0.57	3.96
1268	(4) 5-Year	2.47	92.47	93.59	0.68	1.50
1268	(4) 10-Year	1.87	92.47	93.42	0.81	1.71
1268	(4) 25-Year	2.73	92.47	93.67	0.53	4.78
1268	(4) 100-Year	3.44	92.47	93.98	0.24	30.39
1212	(2) 2-Year	6.08	92.36	93.78	0.84	3.93
1212	(2) 5-Year	7.69	92.36	93.85	0.85	5.52
1212	(2) 10-Year	8.76	92.36	93.88	0.86	6.62
1212	(2) 25-Year	10.15	92.36	93.93	0.84	8.90
1212	(2) 100-Year	12.20	92.36	94.00	0.80	15.06
1212	(4) 2-Year	5.46	92.36	93.74	0.83	3.36
1212	(4) 5-Year	2.47	92.36	93.40	0.89	1.32
1212	(4) 10-Year	1.87	92.36	93.30	0.83	1.58
1212	(4) 25-Year	2.73	92.36	93.54	0.74	4.52
1212	(4) 100-Year	3.44	92.36	93.97	0.24	28.91
1169	(2) 2-Year	6.08	92.30	93.70	0.86	3.39
1169	(2) 5-Year	7.69	92.30	93.76	0.91	4.74
1169	(2) 10-Year	8.76	92.30	93.80	0.95	5.69
1169	(2) 25-Year	10.15	92.30	93.84	0.99	7.78
1169	(2) 100-Year	12.20	92.30	93.91	1.04	13.62
1169	(4) 2-Year	5.46	92.30	93.67	0.83	2.90
1169	(4) 5-Year	2.47	92.30	93.32	0.73	1.19
1169	(4) 10-Year	1.87	92.30	93.24	0.65	1.47
1169	(4) 25-Year	2.73	92.30	93.49	0.59	4.34
1169	(4) 100-Year	3.44	92.30	93.97	0.28	27.40

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(2) 2-Year	6.08	92.15	93.57	0.83	2.61
1091	(2) 5-Year	7.69	92.15	93.64	0.85	3.66
1091	(2) 10-Year	8.76	92.15	93.68	0.88	4.46
1091	(2) 25-Year	10.15	92.15	93.72	0.91	6.34
1091	(2) 100-Year	12.20	92.15	93.80	0.88	11.79
1091	(4) 2-Year	5.46	92.15	93.53	0.82	2.26
1091	(4) 5-Year	2.47	92.15	93.18	0.71	0.93
1091	(4) 10-Year	1.87	92.15	93.14	0.58	1.23
1091	(4) 25-Year	2.73	92.15	93.42	0.51	3.95
1091	(4) 100-Year	3.44	92.15	93.96	0.19	24.74
1002	(2) 2-Year	6.08	92.06	93.36	1.06	1.89
1002	(2) 5-Year	7.69	92.06	93.45	1.07	2.63
1002	(2) 10-Year	8.76	92.06	93.50	1.06	3.23
1002	(2) 25-Year	10.15	92.06	93.57	0.99	4.83
1002	(2) 100-Year	12.20	92.06	93.70	0.86	9.70
1002	(4) 2-Year	5.46	92.06	93.32	1.03	1.66
1002	(4) 5-Year	2.47	92.06	93.00	0.85	0.65
1002	(4) 10-Year	1.87	92.06	93.04	0.60	0.95
1002	(4) 25-Year	2.73	92.06	93.37	0.47	3.42
1002	(4) 100-Year	3.44	92.06	93.96	0.14	20.77
961	(2) 2-Year	6.08	91.96	93.25	0.88	1.61
961	(2) 5-Year	7.69	91.96	93.33	0.93	2.25
961	(2) 10-Year	8.76	91.96	93.38	0.95	2.77
961	(2) 25-Year	10.15	91.96	93.48	0.88	4.20
961	(2) 100-Year	12.20	91.96	93.67	0.55	8.56
961	(4) 2-Year	5.46	91.96	93.22	0.85	1.41
961	(4) 5-Year	2.47	91.96	92.95	0.64	0.51
961	(4) 10-Year	1.87	91.96	93.02	0.43	0.80
961	(4) 25-Year	2.73	91.96	93.35	0.32	3.09
961	(4) 100-Year	3.44	91.96	93.96	0.08	18.02
910	(2) 2-Year	6.08	91.93	93.17	0.79	0.99
910	(2) 5-Year	7.69	91.93	93.26	0.80	1.41
910	(2) 10-Year	8.76	91.93	93.32	0.77	1.75
910	(2) 25-Year	10.15	91.93	93.43	0.70	2.59
910	(2) 100-Year	12.20	91.93	93.65	0.44	5.00
910	(4) 2-Year	5.46	91.93	93.14	0.78	0.86
910	(4) 5-Year	2.47	91.93	92.89	0.67	0.31
910	(4) 10-Year	1.87	91.93	93.00	0.40	0.51
910	(4) 25-Year	2.73	91.93	93.35	0.24	2.01
910	(4) 100-Year	3.44	91.93	93.96	0.06	10.36
840	(2) 2-Year	6.08	91.86	93.10	0.50	
840	(2) 5-Year	7.69	91.86	93.21	0.48	
840	(2) 10-Year	8.76	91.86	93.28	0.46	
840	(2) 25-Year	10.15	91.86	93.41	0.41	
840	(2) 100-Year	12.20	91.86	93.64	0.34	
840	(4) 2-Year	5.46	91.86	93.06	0.51	
840	(4) 5-Year	2.47	91.86	92.80	0.52	
840	(4) 10-Year	1.87	91.86	92.97	0.23	

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
840	(4) 25-Year	2.73	91.86	93.34	0.12	
840	(4) 100-Year	3.44	91.86	93.96	0.05	

[1] All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

JFSA
WATER RESOURCES AND
ENVIRONMENTAL CONSULTANTS

Project Ref #:P922
Client: David Schaeffer Engineering

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment E

Figure 1

Richmond Village Development / Proposed Realignment of the Van Gaal Drain by JFSA (April 20, 2017).

CEDARSTONE SUBDIVISION

VAN GAAL DRAIN

VAN GAAL DRAIN

PERTH ST

PERTH STREET

PERTH STREET

STREET 21

STREET 22

STREET 20

STREET 19

STREET 17

STREET 16

STREET 15

STREET 14

STREET 13

STREET 12

STREET 11

STREET 11A

STREET 10

2017 2003 1982 1961 1940 1919 1898 1877 1857 1837 1817 1797 1777 1757 1736 1715 1694 1673 1653 1632 1615 1555 1488 1416 1400 1364 1340 1312 1302 1268 1212 1169

2038 2059 2080 2101 2121 2141 2163 2188 2207 2235 2254 2256 2258 2261

2276.35*

2326.76*

2377.17*

2427.58*

2478

2554

LEGEND :

- LIMITS OF SUBDIVISION
- PROPOSED CROSS-SECTION
- EXISTING CROSS-SECTION
- EXISTING (INTERPOLATED) CROSS-SECTION
- EXISTING CHANNEL ALIGNMENT

SCALE :

0 25 50 75 100 125 150m

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836-3884
GATINEAU (819) 243-6858

CLIENT :

DSEL
david schaeffer engineering ltd
120 IBER ROAD, UNIT 203
OTTAWA, ONTARIO, K2S 1E9
(613) 836-0856

PROJECT :

PROPOSED REALIGNMENT OF
VAN GAAL DRAIN

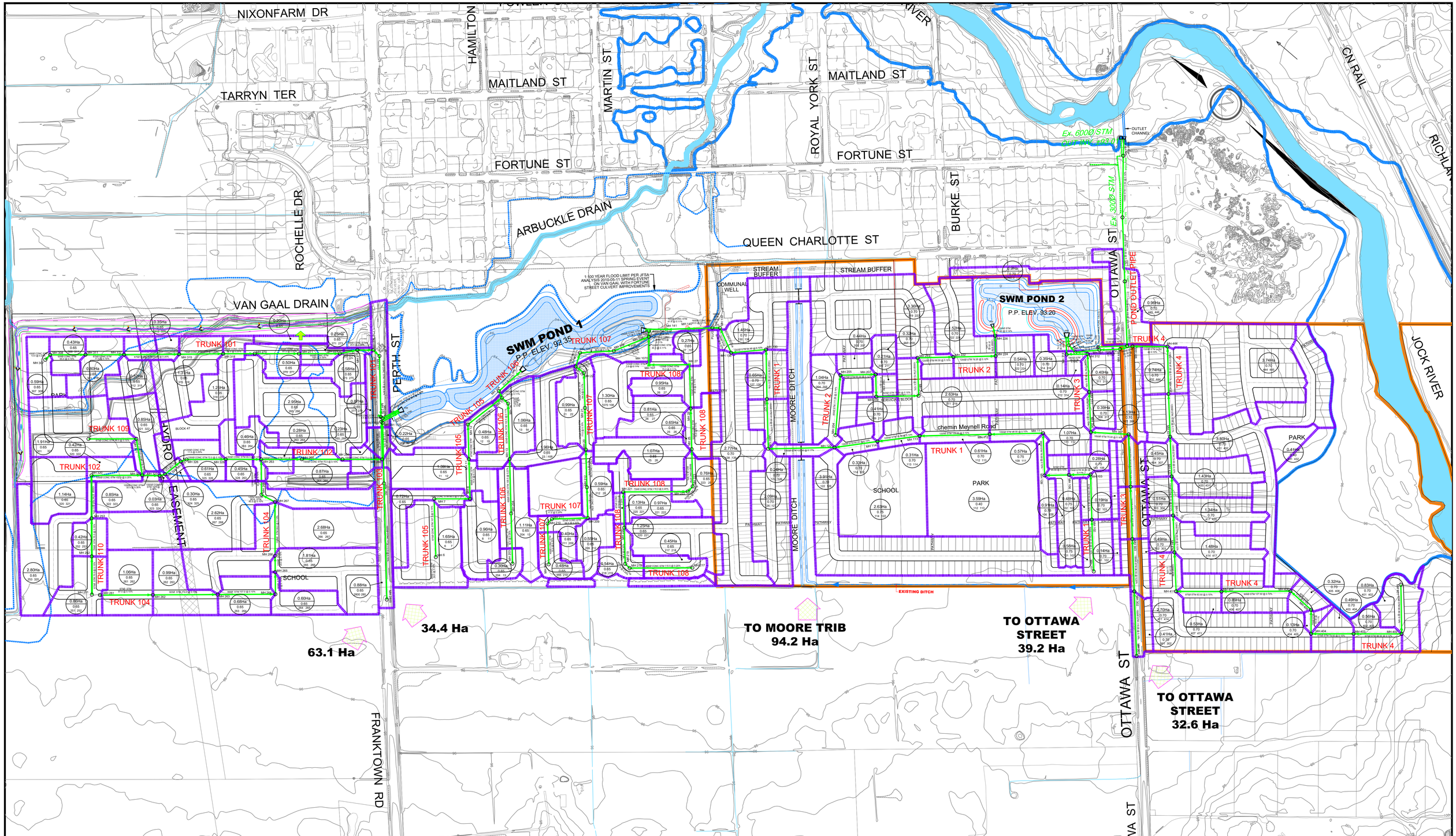
	BY	DATE	DESCRIPTION	BY

LOCATION OF PROPOSED
CROSS-SECTIONS

FIGURE 1

DESIGNED:	
DRAWN:	LP
VERIFIED:	JFS
APPROVED:	JFS

DRAWING REF.	DATE	PROJECT No.
922-11\201701 Channel\Design\CAD\ JFSA Figures.dwg	Apr/17	922-11



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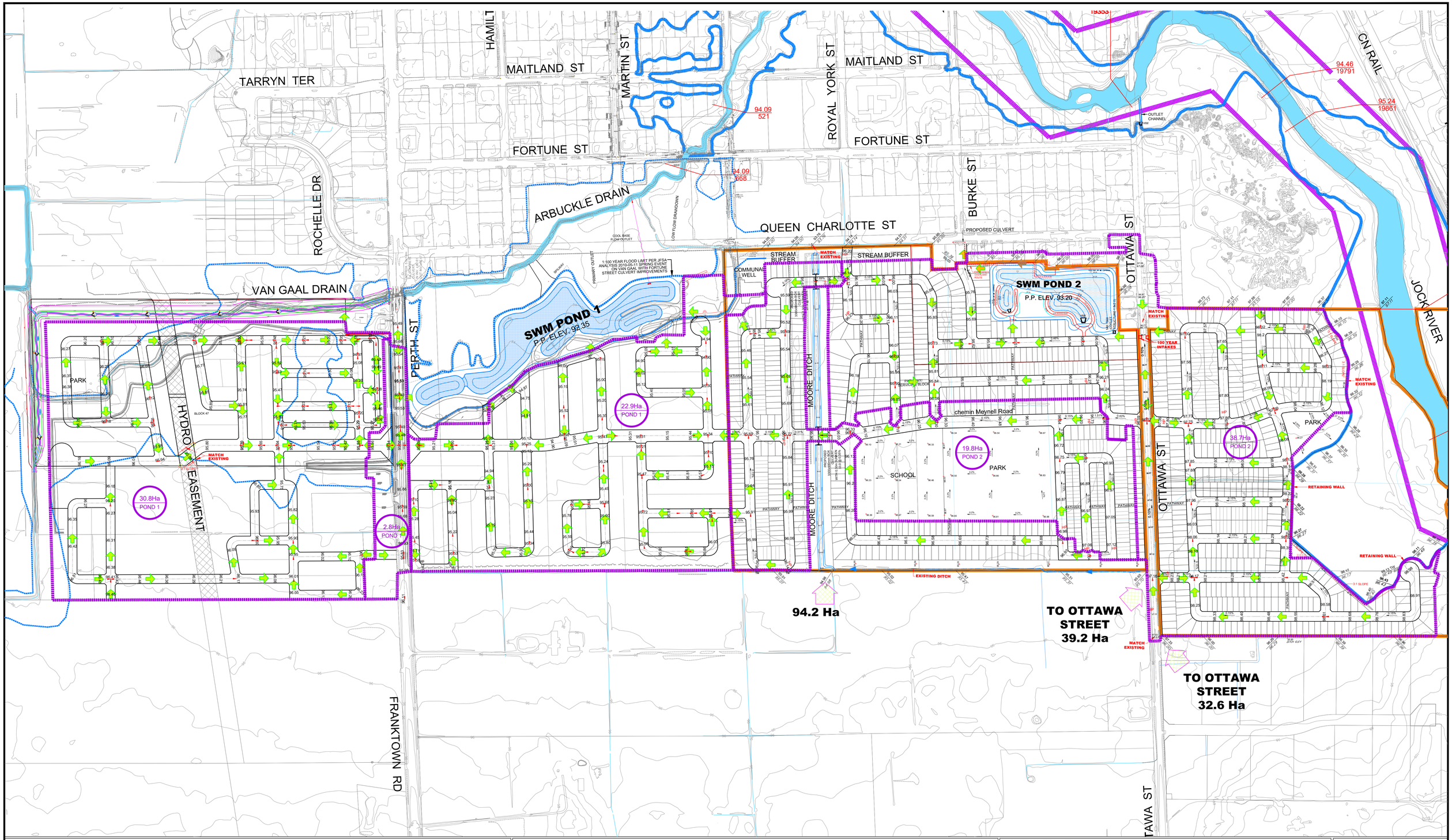
Fax. (613) 836-7183
www.DSEL.ca

WESTERN DEVELOPMENT LANDS
STORM SERVICING PLAN
CITY OF OTTAWA

LEGEND

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

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



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Fax. (613) 836-7183
www.DSEL.ca

WESTERN DEVELOPMENT LANDS

GRADING PLAN

CITY OF OTTAWA

LEGEND

- STUDY LIMIT
- EXISTING DITCH
- EXISTING ELEVATION CONTOUR
- MAJOR OVERLAND FLOW
- EXTERNAL DRAINAGE
- 1:100 YEAR REGULATORY FLOOD LINE PER JFSA NOVEMBER 2009 (BACKWATER FROM JOCK RIVER)
- EMERGENCY OVERLAND FLOW
- STORM MAJOR TRIBUTARY AREA
- 30.8Ha POND 1 — DRAINAGE AREA

CUT-FILL DEPTH ALONG CENTER LINE:

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

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

Excerpt from JF Sabourin & Associates'
"Stormwater Management Report for Fox Run Subdivision, Phase 2B"
Appendix D
JFSA Reference No. 922-11 (February 2020)

CALCULATION SHEET 2E: REQUIRED CAPACITY OF PHASE 2B OVERLAND FLOW ROUTE

OVERLAND FLOW ROUTE FROM POSTILION STREET TO THE VAN GAAL DRAIN - CURB CUT WEIR

Approaching flow =	0.064	m^3/s	for 100-yr storm (with 100% blockage of grates)
	0.186	*m^3/s*	*for 100-yr + 20% stress test (with 100% blockage of grates)*
Curb cut width =	3	m	as per DSEL grading plan
Spill height =	0.110	m	as per DSEL
Maximum flow depth at gutter =	0.350	m	
Average head of water over spill point =	0.240	m	
Curb cut weir coefficient =	1.84		
Maximum flow through cub cut =	0.649	m^3/s	for 100-yr event

Therefore the capacity of the curb cut (0.649 m^3/s) is higher than the computed overland flow (0.064 m^3/s)

OVERLAND FLOW ROUTE DOWNSTREAM OF CURB CUT (ASSUMED SLOPES)

$Q = 1/n \times AR^{2/3}S^{1/2}$

100-Year Storm	**Max Slope**		**Min Slope**
normal depth =	**0.017**	m	**0.060**
n =	0.03		0.03
Channel width =	3	m	3
A (area of flow) =	0.051	m^2	0.181
wetted perimeter =	3.034	m	3.121
R (hydraulic radius) =	0.017	m	0.058
S (slope) =	0.333	m/m	0.005
Q (flow) =	0.064	m^3/s	0.064
velocity =	1.26	m/s	0.35

100-Year + 20% Stress Test	**Max Slope**		**Min Slope**
normal depth =	***0.032***	*m*	***0.116***
n =	*0.03*		*0.03*
Channel width =	*3*	*m*	*3*
A (area of flow) =	*0.097*	*m^2*	*0.348*
wetted perimeter =	*3.064*	*m*	*3.232*
R (hydraulic radius) =	*0.032*	*m*	*0.108*
S (slope) =	*0.333*	*m/m*	*0.005*
Q (flow) =	*0.186*	*m^3/s*	*0.186*
velocity =	*1.92*	*m/s*	*0.53*

Now referred to as the "Richmond North East" area

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD BASED ON A FINE PARTICLE SIZE DISTRIBUTION

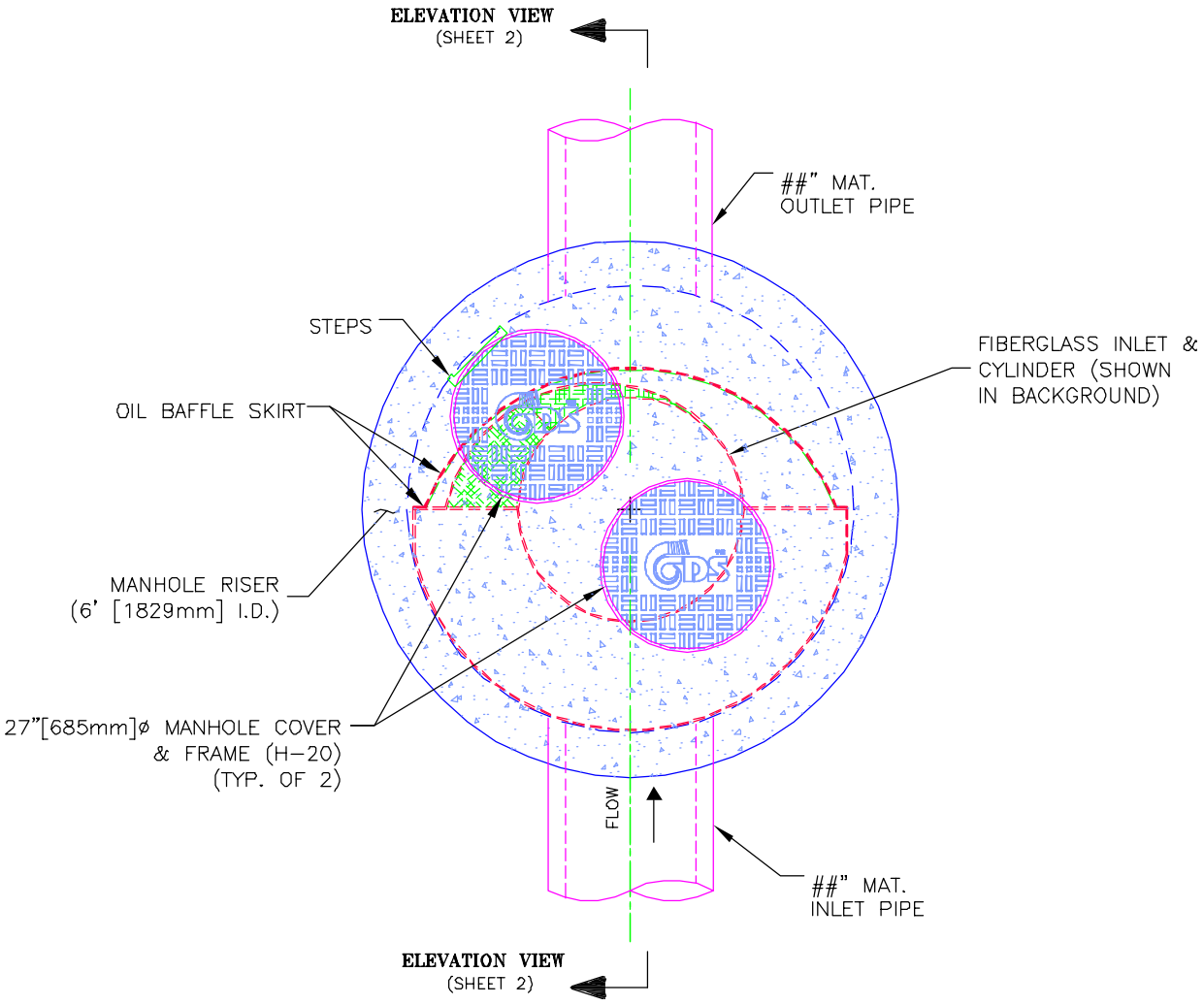
Project Name:	Green Property - Richmond	**Engineer:**	**DSEL**
Location:	Richmond, ON	**Contact:**	S. Merrick, P.Eng
OGS #:	OGS	**Report Date:**	8-Jul-20

Area	2.16	ha	**Rainfall Station #**	215	
Weighted C	0.66		**Particle Size Distribution**	FINE	
CDS Model	3020		**CDS Treatment Capacity**	57	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	2.0	2.0	3.5	97.9	9.0
1.0	10.6%	19.8%	4.0	4.0	7.0	96.9	10.3
1.5	9.9%	29.7%	5.9	5.9	10.5	95.8	9.5
2.0	8.4%	38.1%	7.9	7.9	14.0	94.8	7.9
2.5	7.7%	45.8%	9.9	9.9	17.5	93.8	7.2
3.0	5.9%	51.7%	11.9	11.9	21.0	92.8	5.5
3.5	4.4%	56.1%	13.9	13.9	24.5	91.8	4.0
4.0	4.7%	60.7%	15.9	15.9	28.0	90.8	4.2
4.5	3.3%	64.0%	17.8	17.8	31.5	89.8	3.0
5.0	3.0%	67.1%	19.8	19.8	35.0	88.8	2.7
6.0	5.4%	72.4%	23.8	23.8	42.0	86.8	4.7
7.0	4.4%	76.8%	27.7	27.7	49.0	84.8	3.7
8.0	3.5%	80.3%	31.7	31.7	56.0	82.8	2.9
9.0	2.8%	83.2%	35.7	35.7	63.0	80.8	2.3
10.0	2.2%	85.3%	39.6	39.6	70.0	78.8	1.7
15.0	7.0%	92.3%	59.4	56.6	100.0	66.9	4.7
20.0	4.5%	96.9%	79.3	56.6	100.0	50.2	2.3
25.0	1.4%	98.3%	99.1	56.6	100.0	40.1	0.6
30.0	0.7%	99.0%	118.9	56.6	100.0	33.4	0.2
35.0	0.5%	99.5%	138.7	56.6	100.0	28.7	0.1
40.0	0.5%	100.0%	158.5	56.6	100.0	25.1	0.1
							86.7
						Removal Efficiency Adjustment[2] =	6.5%
						Predicted Net Annual Load Removal Efficiency =	**80.2%**
						Predicted % Annual Rainfall Treated =	**96.8%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

PLAN VIEW

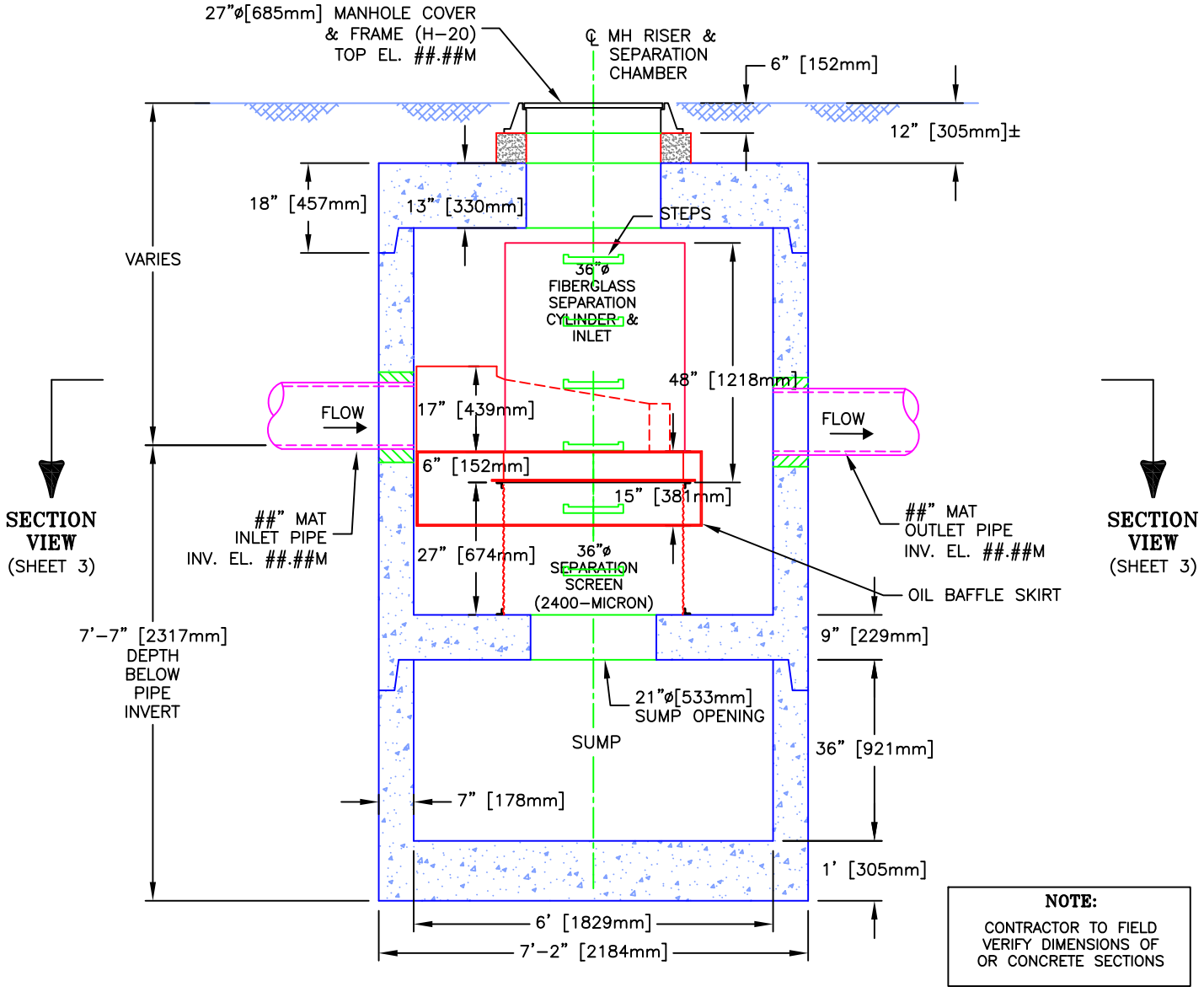


CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 2.5'
		DATE ##/##/##	SHEET 1
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



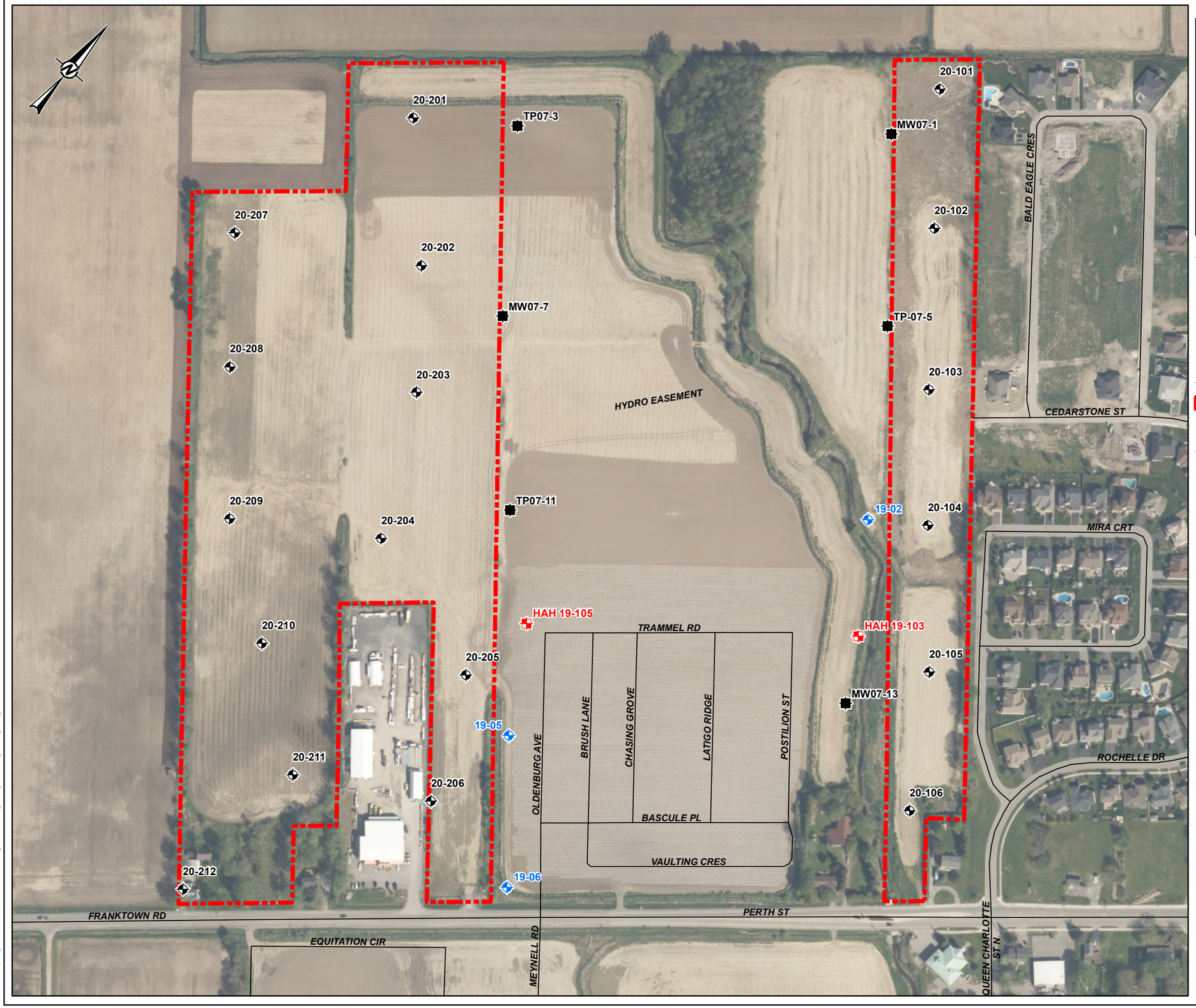
NOTE:
CONTRACTOR TO FIELD VERIFY DIMENSIONS OF OR CONCRETE SECTIONS

CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

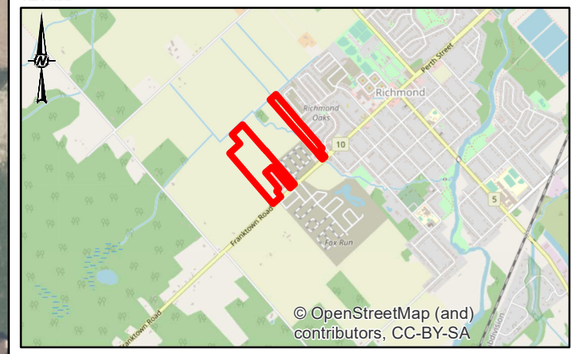
CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET 2
		DRAWN INITIALS	
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

APPENDIX F



KEY MAP



SCALE 1:50,000

LEGEND

- PROPOSED BOREHOLE LOCATION
- APPROXIMATE HAND AUGERHOLE LOCATION, PREVIOUS INVESTIGATION
- APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION
- APPROXIMATE TESTHOLE LOCATION, PREVIOUS INVESTIGATION BY JACQUES WHITFORD, JUNE 2007
- ROADWAY
- APPROXIMATE SITE BOUNDARY

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 30 60 120

1:3,000 METRES

CLIENT

CAIVAN (RICHMOND NORTH) LIMITED

PROJECT

PRELIMINARY GEOTECHNICAL REPORT
GREEN LANDS EAST AND GREEN LANDS WEST

TITLE

SITE PLAN

CONSULTANT

GOLDER

YYYY-MM-DD	2020-06-29
DESIGNED	----
PREPARED	JEM
REVIEWED	KCP
APPROVED	WC

PROJECT NO.	CONTROL	REV.	FIGURE
20144864	0005	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

Path: N:\Active\Spatial_IM\Caivan\Richmond\Proposed\SWMP\99_PRO\20144864_Caivan_Enviro\0005_Geotech_Memo_Green\EW\20144864-0005-BG-0001.mxd

APPENDIX A

Record of Previous Investigations

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index
A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

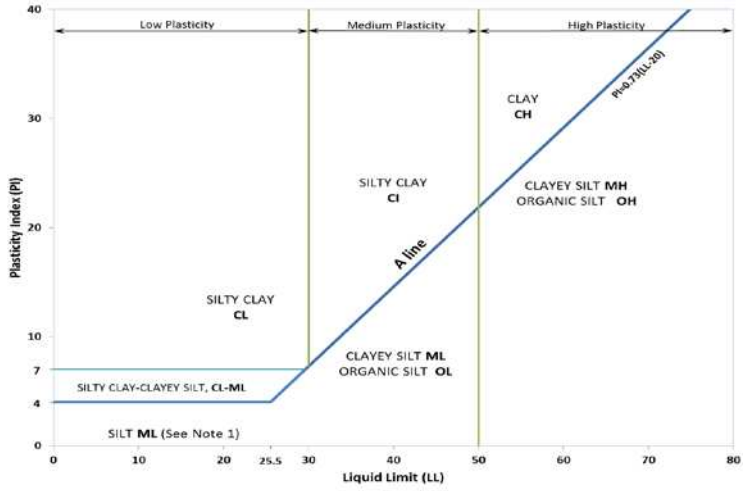
JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation
w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1522173

RECORD OF BOREHOLE: 19-02

SHEET 1 OF 1

LOCATION: N 5005908.9 ;E 355900.6

BORING DATE: April 23, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V. + Q - ● rem V. ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.75							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL- (ML) sandy SILT; dark brown		0.00 94.50	1	GRAB	-				
		(CL-ML) CLAYEY SILT to SILTY CLAY; grey brown, fissured, contains silty sand seams (WEATHERED CRUST); cohesive, w<PL, very stiff		0.25							Bentonite Seal
1					2	SS	6				
				93.38							Silica Sand
		(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, stiff		1.37							
2					3	SS	2				32 mm Diam. PVC #10 Slot Screen 'B'
3				91.70							
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm		3.05	4	TP	PH				
4											Native Backfill
					5	SS	WH				
5											Bentonite Seal
6				88.65							Silica Sand
		(CI/CH-ML) SILTY CLAY to CLAYEY SILT; grey; cohesive, w>PL		6.10 88.35	6	SS	4				
		(ML) sandy SILT; grey; non-cohesive, wet, loose to very loose		6.40							32 mm Diam. PVC #10 Slot Screen 'A'
7					7	SS	7				
8				86.52	8	SS	2				Silica Sand
		End of Borehole		8.23							WL in screen 'A' at Elev. 94.31 m on May 6, 2019 WL in screen 'B' at Elev. 93.64 m on May 6, 2019
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: WAM

MIS-BHS 001 1522173.GPJ GAL-MIS.GDT 19-6-12 SGL/JM

PROJECT: 1522173

RECORD OF BOREHOLE: 19-06

SHEET 1 OF 1

LOCATION: N 5005503.4 ;E 355883.6

BORING DATE: April 25, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		94.25							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown		0.00 94.03	1	AS	-				Bentonite Seal
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL very stiff to stiff		0.22							
1					2	SS	7				
											Silica Sand
2					3	SS	5				
											32 mm Diam. PVC #10 Slot Screen
3				91.20							
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm		3.05	4	SS	1				
4											
				89.68							Native Backfill
		(CI/CH-ML) SILTY CLAY, CLAYEY SILT and sandy SILT; grey, laminated; cohesive, w>PL, firm		4.57	5	TP	PH				
5											
				88.31							
6		End of Borehole Auger Refusal		5.94							WL in screen at Elev. 93.50 m on May 6, 2019
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: WAM

MIS-BHS 001 1522173.GPJ GAL-MIS.GDT 19-6-12 SGL/JM

TABLE 1

RECORD OF HAND AUGERHOLES

Hand Augerhole Number	Depth (metres)	Description
19-103	0.0 – 0.3	TOPSOIL – (ML) CLAYEY SILT some sand; brown; non-cohesive, moist
	0.3 – 0.5	(ML) CLAYEY SILT, some sand; brown (WEATHERED CRUST); cohesive, w>PL
	0.5 – 1.9	(ML-CI/CH) CLAYEY SILT to SILTY CLAY, trace to some sand; grey brown (WEATHERED CRUST); cohesive, w>PL
	1.9 – 2.5	(CI/CH) SILTY CLAY to CLAY trace sand; grey; cohesive, w>PL
	2.50	END OF AUGERHOLE
		Note: water seepage at 1.1 m depth upon completion

Sample	Depth (m)	Lab Testing
1	1.1 – 1.5	w_n = 51%, PI=35%, LL=56%
2	1.5 – 1.9	
3	1.9 – 2.3	
4	2.3 – 2.5	

19-105	0.00 – 0.20	TOPSOIL – (ML) CLAYEY SILT some sand; brown; non-cohesive, moist
	0.20 – 1.60	(CI/CH-ML) SILTY CLAY to CLAYEY SILT, some sand; grey brown (WEATHERED CRUST); cohesive, w>PL
	1.60 – 2.00	(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL
	2.00 – 2.50	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL
	2.50	END OF AUGERHOLE
		Note: water seepage at 1.1 m depth upon completion

Sample	Depth (m)	Lab Testing
1	0.7 – 1.1	w_n = 43%, PI=27%, LL=52%
2	1.1 – 1.6	
3	1.6 – 2.0	
4	2.0 – 2.5	

Jacques Whitford

MONITORING WELL RECORD

MW07-1

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-1

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.32							
	100.2	150 mm TOPSOIL			SS	1	300	4
		Firm to stiff, greyish brown lean CLAY (CL)						
1				▼	SS	2	610	5
2				▽	SS	3	610	6
3	97.3							
		Firm to stiff, grey lean CLAY			SS	4	610	3
4								
5					ST	5	610	
6								
	93.8				SS	6	610	2
7	93.6	Very loose, grey SANDY SILT (ML)						
		End of Borehole						
		Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

JWL-OLD 1026929.GPJ SMART.GDT 07/06/22

Jacques Whitford

MONITORING WELL RECORD

MW07-7

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-7

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.21							
		Firm to stiff, greyish brown lean CLAY (CL)						
1					SS	1	610	4
					SS	2	610	4
2								
3	97.2							
		Firm to stiff, grey lean CLAY			SS	3	610	3
4								
5					SS	4	610	2
6								
	93.8				SS	5	150	6
	93.5	Loose, grey SANDY SILT (ML)						
7		End of Borehole						
		Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1026929.GPJ SMART.GDT 07/08/22

Jacques Whitford

MONITORING WELL RECORD

MW07-13

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-13

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.30							
		Stiff, greyish brown lean CLAY (CL)			SS	1	120	8
1				▼	SS	2	75	7
2					SS	3	610	6
3	96.3			▽				
		Firm to stiff, grey lean CLAY			SS	4	40	4
4								
5					ST	5	610	
6	93.2							
		Very loose, grey SANDY SILT (ML)			SS	6	300	1
	92.6							
7		End of Borehole						
		Monitoring Well Installed						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

JWL-OLD 1026929.GPJ SMART.GDT 07/06/22

Jacques Whitford

TEST PIT RECORD

TP07-3

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-3

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.27							
	100.0	230 mm TOPSOIL						
		Stiff, greyish brown lean CLAY (CL)		▽				
1					BS	1		
2					BS	2		
	97.7							
		Firm, grey lean CLAY (CL)						
3					BS	3		
4					BS	4		
	96.1	End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

JWL-OLD 1026929.GPJ SMART.GDT 07/06/21

Jacques Whitford

TEST PIT RECORD

TP07-5

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-5

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.11							
	99.9	250 mm TOPSOIL			BS	1		
		Stiff, greyish brown lean CLAY (CL)		▽				
1					BS	2		
	98.1				BS	3		
2		Firm, grey lean CLAY (CL)						
					BS	4		
3								
					BS	5		
4	95.9				BS	6		
		End of Borehole						
5								
6								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1026929.GPJ SMART.GDT 07/06/21

Jacques Whitford

TEST PIT RECORD

TP07-11

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-11

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.89							
	99.6	250 mm TOPSOIL						
		Stiff, brown and grey lean CLAY (CL)		▽	BS	1		
1					BS	2		
2					BS	3		
	96.9				BS	4		
3		Firm, grey lean CLAY (CL)						
	96.2				BS	5		
		End of Borehole						
4								
5								
6								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

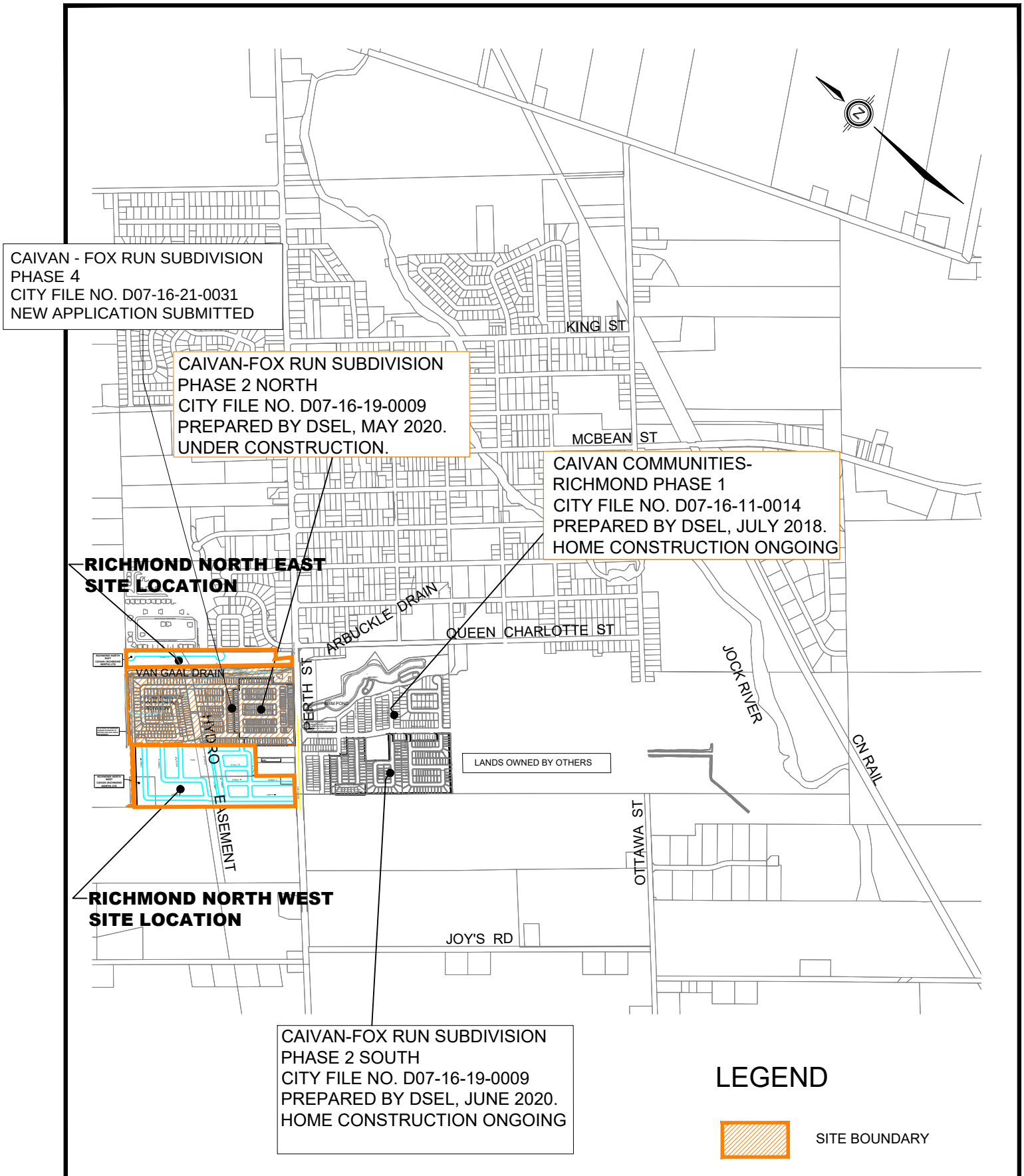
△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1026929.GPJ SMART.GDT 07/08/21

FIGURES



CAIVAN (RICHMOND NORTH) LTD RICHMOND NORTH WEST & RICHMOND NORTH EAST	SITE LOCATION	SCALE: 1:20
david schaeffer engineering ltd	120 Iber Road, Unit 103 Stittsville, ON K2S 1E9 Tel. (613) 836-0856 Fax. (613) 836-7183 www.DSEL.ca	DATE: APRIL 2022 PROJECT No.: 20-1183 FIGURE: 1

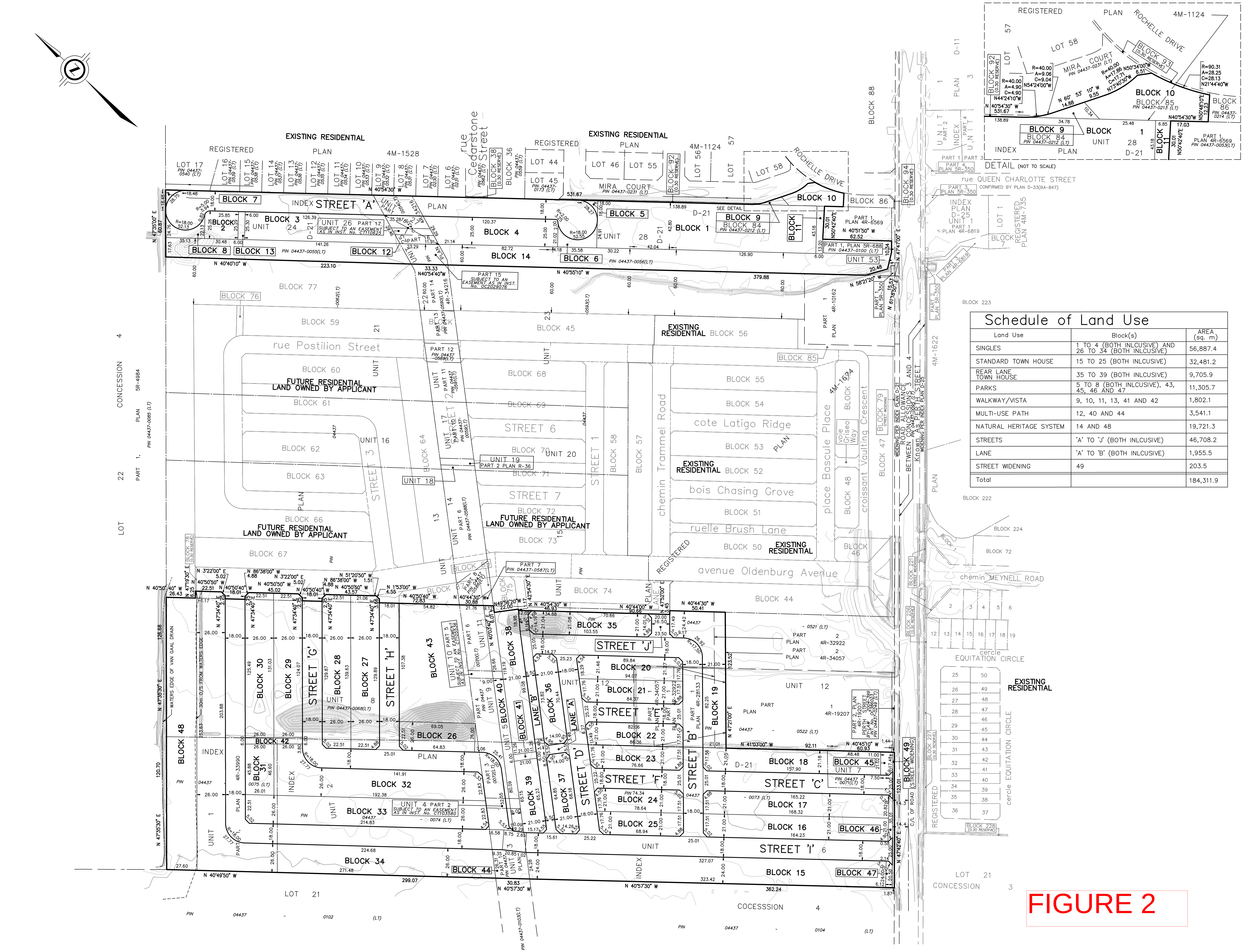
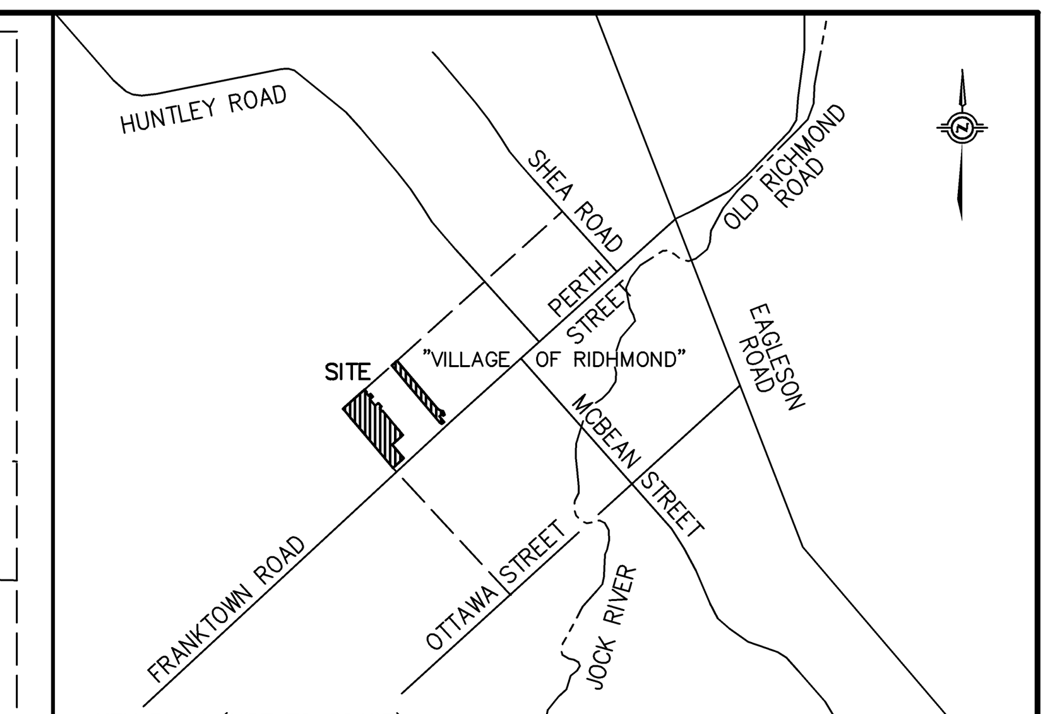


FIGURE 2

Schedule of Land Use

Land Use	Block(s)	AREA (sq. m)
SINGLES	1 TO 4 (BOTH INLCUSIVE) AND 26 TO 34 (BOTH INLCUSIVE)	56,887.4
STANDARD TOWN HOUSE	15 TO 25 (BOTH INLCUSIVE)	32,481.2
REAR LANE TOWN HOUSE	35 TO 39 (BOTH INLCUSIVE)	9,705.9
PARKS	5 TO 8 (BOTH INLCUSIVE), 43, 45, 46 AND 47	11,305.7
WALKWAY/VISTA	9, 10, 11, 13, 41 AND 42	1,802.1
MULTI-USE PATH	12, 40 AND 44	3,541.1
NATURAL HERITAGE SYSTEM	14 AND 48	19,721.3
STREETS	'A' TO 'J' (BOTH INLCUSIVE)	46,708.2
LANE	'A' TO 'B' (BOTH INLCUSIVE)	1,955.5
STREET WIDENING	49	203.5
Total		184,311.9



KEY PLAN (NOT TO SCALE)

DRAFT PLAN OF SUBDIVISION OF

UNITS 1, 2, 3, 4, 5, 6, 9, 10, 11, 24, 25, 26, 27 AND 28 INDEX PLAN D-21

AND

PART OF UNITS 8, 12 AND 13 INDEX PLAN D-21

AND

BLOCKS 84 AND 85 REGISTERED PLAN 4M-1124

(GEOGRAPHIC TOWNSHIP OF GOULBOURN)

NOW IN THE

CITY OF OTTAWA

J. D. BARNES LIMITED

METRIC DISTANCES AND/OR COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

SCALE 1 : 1500

30 0 30 60 90 metres

ELEVATION NOTE

1. ELEVATIONS SHOWN ON THIS PLAN ARE RELATED TO GEODETIC DATUM AND ARE DERIVED FROM THE MUNICIPALITY BENCHMARK No. 0011968U124 HAVING A PUBLISHED ELEVATION OF 95.185 METERS.
2. IT IS THE RESPONSIBILITY OF THE USER OF THIS INFORMATION TO VERIFY THAT THE SITE BENCHMARK HAS NOT BEEN ALTERED OR DISTRUBED AND THAT ITS' RELATIVE ELEVATION AND DESCRIPTION AGREES WITH THE INFORMATION SHOWN ON THIS DRAWING.

NOTES

DISTANCES ARE GROUND.

ALL DISTANCES ON CURVES ARE ARC DISTANCES UNLESS OTHERWISE SPECIFIED

LEGEND

CONTOUR INTERVALS ARE SHOWN AS 1.00m FOR MAJOR AND 0.25m FOR MINOR

DENOTES MAJOR CONTOUR

DENOTES MINOR CONTOUR

DENOTES SPOT ELEVATION

ADDITIONAL INFORMATION
As required under section 51(17) of the Planning Act R.S.O. 2001

(a)(b)(e)(f)(g)(j) and (l) - As shown on this Plan.

(c) - As shown on this Draft and Key Plan

(d) - Land to be used in accordance with the Schedule of Land Use.

(h)(k) - Full Municipal Services

(i) - Offshore Marine Deposits of clay, silty clay and silt, Bedrock

Ottawa Formation, limestone

SUBJECT TO THE CONDITIONS, IF ANY, SET FORTH IN OUR LETTER DATED......................,THIS DRAFT PLAN IS APPROVED BY THE CITY OF OTTAWA UNDER SECTION 51 OF THE PLANNING ACT THIS .... DAY OF ...., 2022.

ADAM BROWN, MANAGER
DEVELOPMENT REVIEW-RURAL
PLANNING, REAL ESTATE AND ECONOMIC DEVELOPMENT
DEPARTMENT, CITY OF OTTAWA

OWNER'S CERTIFICATE

RICHMOND VILLAGE DEVELOPMENT CORPORATION, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS HEREBY AUTHORIZES J. D. BARNES LIMITED TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

DATE

FOR REVIEW
FRANK CAIRO
PRESIDENT
(I HAVE THE AUTHORITY TO BIND THE CORPORATION)

RICHMOND VILLAGE DEVELOPMENT CORPORATION

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED ARE CORRECTLY SHOWN.

DATE

DRAFT
C.M. FOX
ONTARIO LAND SURVEYOR

J.D.BARNES LIMITED
SURVEYING MAPPING GIS
LAND INFORMATION SPECIALISTS
62 STEACIE DRIVE, SUITE 103, KANATA, ON K2K 2A9
T: (613) 731-7244 F: (613) 254-8659 www.jdbarnes.com

DRAWN BY:	CHECKED BY:	REFERENCE NO.: 19-10-122-00 DRAFT
NS	CF	GREEN V4.0
PLOTTED: 8/12/2022		DATED: 12/22/21

FILE: G:\19-10-122\00\Drawing\Draft Plan 2020\Green\19-10-122-00_DraftPlan(Grid).dgn


RICHMOND NORTH EAST
CAIVAN (RICHMOND NORTH) LTD
RICHMOND NORTH WEST
CAIVAN (RICHMOND NORTH) LTD
BALD EAGLE CRESCENT
CEDARSTONE STREE
MIRA COURT
MIRA COURT
ROCHELLE DRIVE
PERTH STREET
STREET 'A'
BLOCK 6
#6305 PERTH STREET
POSTILION STREET
CONNECT TO EX. WATERMAIN
LATIGO RIDGE
BASCULE PLACE
TRAMMEL ROAD
CAIVAN-FOX RUN SUBDIVISION
PHASE 2 NORTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, MAY 2020.
UNDER CONSTRUCTION.
GRISEO WAY
VAULTING CRESCENT
CHASING GROVE
BRUSH LANE
TIE IN POINT OF PROPOSED CHANNEL EXTENSION TO EXISTING VAN GAAL DRAIN REALIGNMENT
SWM POND 1
PP 92.35
CAIVAN COMMUNITIES-
RICHMOND PHASE 1
CITY FILE NO. D07-16-11-0014
PREPARED BY DSEL, JULY 2018.
CONSTRUCTION COMPLETED.
CANTLE CRESCENT
PELHAM CRESCENT
MEYNELL ROAD
EQUITATON CIRCLE
HACKAMORE CRESCENT
TERRIER CIRCLE
PURSUIT TERRACE
EQUITATION CIRCLE
STREET 'J'
PARK
BLOCK 30
STREET 'I'
STREET 'G'
STREET 'H'
STREET 'E'
STREET 'F'
STREET 'C'
STREET 'B'
STREET 'D'
LANE 'A'
EXISTING COMMERCIAL (BMR)
PROPOSED CHANNEL EXTENSION
CONNECT TO EX. WATERMAIN
CAIVAN-FOX RUN SUBDIVISION
PHASE 2 SOUTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, JUNE 2020.
UNDER CONSTRUCTION.
LEGEND
SUBJECT LANDS
PROPOSED LOCAL WATERMAIN
EXISTING WATERMAIN
PROPOSED 300Ø WATERMAIN
PLUG
FUTURE 300Ø WATERMAIN
FUTURE LOCAL WATERMAIN
DSEL
david schaeffer engineering ltd
120 Iber Road, Unit 103
Stittsville, Ontario, K2S 1E9
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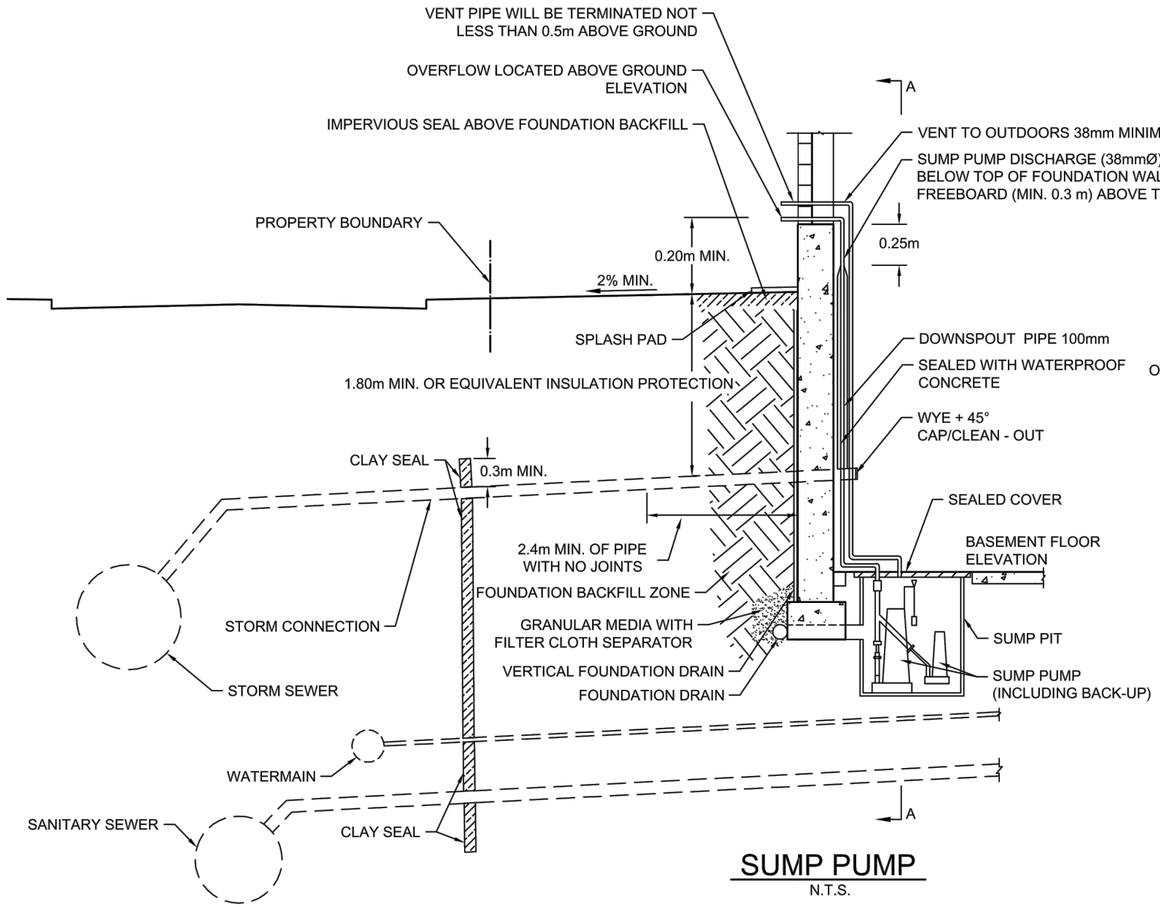
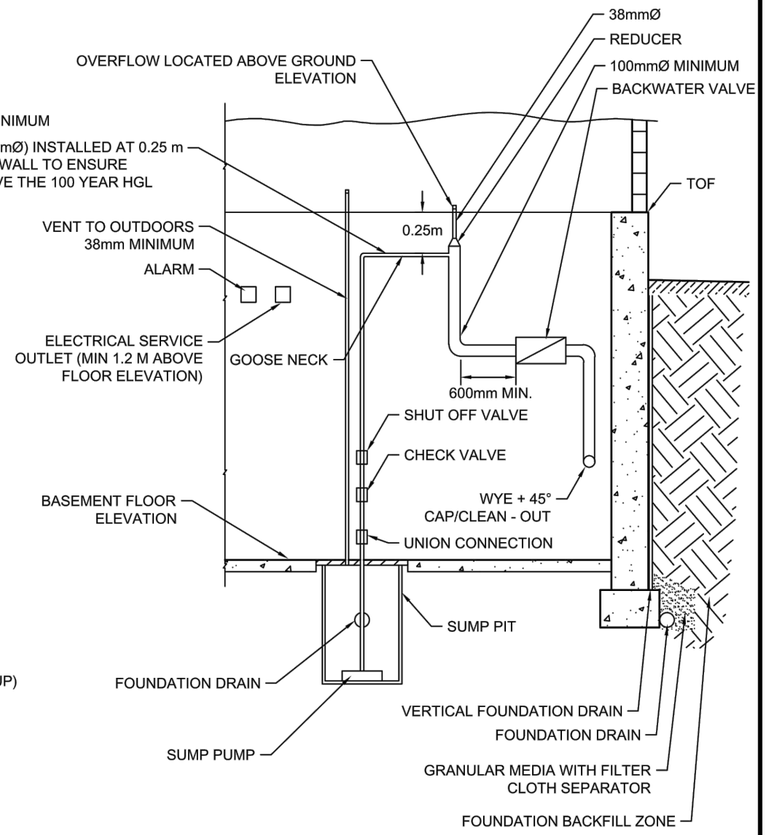
Fax. (613) 836-7183
www.DSEL.ca
CAIVAN (RICHMOND NORTH) LTD
CITY OF OTTAWA
WATERMAIN SERVICING PLAN
RICHMOND NORTH WEST &
RICHMOND NORTH EAST
SCALE: 1:1500_XREF
PROJECT No.: 1183
DATE: AUGUST 2022
FIGURE: 3A



SUMP PUMP
N.T.S.



SECTION A-A
N.T.S.

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

Ottawa

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

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

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CAIVAN (RICHMOND NORTH) LTD.

SUMP PUMP DETAIL
CITY OF OTTAWA

RICHMOND NORTH WEST
& RICHMOND NORTH EAST

PROJECT No.:	20-1184
DATE:	AUGUST 2021
SCALE:	N.T.S.
FIGURE:	4

DRAWINGS

RICHMOND NORTH EAST CAIVAN (RICHMOND NORTH) LTD

RICHMOND NORTH WEST CAIVAN (RICHMOND NORTH) LTD

BALD EAGLE CRESCENT

CEDARSTONE STREET

MIRA COURT

ROCHELLE DRIVE

PERTH STREET

Queen Charlotte St

PROP RETAINING WALL

STREET 'G'

MATCH EXISTING VAN GAAL DRAIN TOB

EX. BOX CULVERT

#6305 PERTH STREET

SWM POND 1
PP 92.35

POSTILION STREET

LATIGO RIDGE

BASCULE PLACE

FLAMMEL ROAD

GRISEO WAY

VAULTING CRESCENT

CHASING GROVE

BRUSH LANE

CAIVAN-FOX RUN SUBDIVISION
PHASE 2 NORTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, MAY 2020.
UNDER CONSTRUCTION.

CAIVAN COMMUNITIES-
RICHMOND PHASE 1
CITY FILE NO. D07-16-11-0014
PREPARED BY DSEL, JULY 2018.
CONSTRUCTION COMPLETED.

CANTLE CRESCENT

PELHAM CRESCENT

MEYNELL ROAD

HACKAMORE CRESCENT

TERRIER CIRCLE

EQUITATON CIRCLE

OLDENBURG AVENUE

EX. DITCH

EX. DICB
T/G=93.81

EX. 900mm CULVERT
TO BE ABANDONED

EX. DICB
T/G=93.88

EXISTING COMMERCIAL
(BMR)

PROP DICB
T/G=93.98
100-YEAR INTAKE

PROP RETAINING WALL

STREET 'A'

STREET 'B'

STREET 'C'

STREET 'D'

STREET 'E'

STREET 'F'

STREET 'H'

STREET 'I'

STREET 'J'

BLOCK 36

PARK

PROP ROADSIDE DITCH
1.0m DEEP
0.3m WIDE BOTTOM
3:1 SIDE SLOPES

1200mm CULVERT
INV IN = 94.58
INV OUT = 94.50

CAIVAN-FOX RUN SUBDIVISION
PHASE 2 SOUTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, JUNE 2020.
UNDER CONSTRUCTION.

JFSA CROSS SECTION 2207
100-YR = 94.92

TIE IN POINT OF PROPOSED CHANNEL EXTENSION TO EXISTING VAN GAAL DRAIN REALIGNMENT

JFSA CROSS SECTION 2258
100-YR = 94.99+/-

VAN GAAL DRAIN TO BE RECONSTRUCTED ± 280m

JFSA CROSS SECTION 2347.80
100-YR = 95.16+/-

JFSA CROSS SECTION 2478
100-YR = 95.58+/-

MATCH EXISTING VAN GAAL DRAIN

PROP CUTOFF DITCH
TO REDIRECT EXTERNAL FLOW
CONSTRUCTED ON NEIGHBORING
PROPERTY

LEGEND

- SUBJECT LANDS
- STORM OVERLAND FLOW ARROW
- 192.851 PROPOSED CENTERLINE ELEVATION
- [192.85] FUTURE GRADES (BY OTHERS)
- 100 YEAR FLOODPLAIN
- [192.85] EX. GRADES
- 193.50 / 193.50 PROPOSED ELEVATION / EXISTING ELEVATION
- 96 EXISTING CONTOUR ELEVATION
- ←1.00m— GRADE CHANGE

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)		FILL DEPTH (m)	
0 - 0.5	> 2.5	0 - 0.5	> 2.5
0.5 - 1.0		0.5 - 1.0	
1.0 - 1.5		1.0 - 1.5	
1.5 - 2.0		1.5 - 2.0	
2.0- 2.5		2.0- 2.5	

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CAIVAN (RICHMOND NORTH) LTD

CITY OF OTTAWA

GRADING PLAN
RICHMOND NORTH WEST & RICHMOND NORTH EAST

SCALE:	1:1500	PROJECT No.:	1183
DATE:	AUGUST 2022	DRAWING:	1A

RICHMOND NORTH EAST
CAIVAN (RICHMOND NORTH) LTD

RICHMOND NORTH WEST
CAIVAN (RICHMOND NORTH) LTD

TIE IN POINT OF PROPOSED CHANNEL EXTENSION TO EXISTING VAN GAAL DRAIN REALIGNMENT

SAN OBV =93.25
CHANNEL INV=93.52
2.87Ha
61.3 / Ha
AREA PER RICHMOND PHASE 1 EXTERNAL DRAINAGE PLAN

SANITARY FLOW FROM UNITS FRONTING MIRA COURT DIRECTED TO PROPOSED AND EXISTING SANITARY SEWERS IN MIRA COURT.

CAIVAN-FOX RUN SUBDIVISION PHASE 2 NORTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, MAY 2020.
UNDER CONSTRUCTION.

CAIVAN COMMUNITIES-RICHMOND PHASE 1
CITY FILE NO. D07-16-11-0014
PREPARED BY DSEL, JULY 2018.
CONSTRUCTION COMPLETED.

CAIVAN-FOX RUN SUBDIVISION PHASE 2 SOUTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, JUNE 2020.
UNDER CONSTRUCTION.

SWM POND 1
PP 92.35

#6305 PERTH STREET

EXISTING COMMERCIAL (BMR)

BALD EAGLE CRESCENT
CEDARSTONE STREET
MIRA COURT
ROCHELLE DRIVE
PERTH STREET
STREET 'A'
BLOCK 6
POSTILION STREET
LATIGO RIDGE
CHASING GROVE
BRUSH LANE
GRISEO WAY
TRAMMEL ROAD
BASCULE PLACE
VAULTING CRESCENT
STREET 'B'
STREET 'C'
STREET 'D'
STREET 'E'
STREET 'F'
STREET 'G'
STREET 'H'
STREET 'I'
STREET 'J'
LANE 'A'
BLOCK 5
PARK
PROPOSED CHANNEL EXTENSION
GANTLE CRESCENT
PELHAM CRESCENT
MEYNELL ROAD
REYNAR
MEYNELL
EQUITATON CIRCLE
EQUITATION CIRCLE
HACKAMORE CRESCENT
TERRIER CIRCLE
PURSUIT TERRACE

LEGEND

- SUBJECT LANDS
- PROPOSED SANITARY SEWER
- EXISTING SANITARY SEWER
- SANITARY SEWER BY OTHERS
- SANITARY DRAINAGE BOUNDARY
- EXTERNAL SANITARY DRAINAGE BOUNDARY
- 0.77 / 55 / MH 315A / MH 314A — SANITARY DRAINAGE AREA, POPULATION PER HA, TOTAL POPULATION, UPSTREAM/DOWNSTREAM MANHOLE
- SANITARY MANHOLE
- 0.30 / 135 / 18 — EXTERNAL DRAINAGE AREA IN HECTARES, EXTERNAL POPULATION PER HA, TOTAL EXTERNAL POPULATION

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CAIVAN (RICHMOND NORTH) LTD

CITY OF OTTAWA

SANITARY SERVICING PLAN
RICHMOND NORTH WEST & RICHMOND NORTH EAST

SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2022	DRAWING:	2A

RICHMOND NORTH EAST
CAIVAN (RICHMOND NORTH) LTD

RICHMOND NORTH WEST
CAIVAN (RICHMOND NORTH) LTD

100-YEAR FLOODLINE CURRENTLY BEING RELOCATED/UPDATED AS PART OF SCOPE OF VAN GAAL DRAIN REALIGNMENT

TIE IN POINT OF PROPOSED CHANNEL EXTENSION TO EXISTING VAN GAAL DRAIN REALIGNMENT

JFSA CROSS SECTION 2207
100-YR = 94.92

JFSA CROSS SECTION 2258
100-YR = 94.99+/-

VAN GAAL DRAIN TO BE RECONSTRUCTED ± 280m

JFSA CROSS SECTION 2347.80
100-YR = 95.16+/-

JFSA CROSS SECTION 2478
100-YR = 95.58+/-

PROPOSED CHANNEL EXTENSION

MATCH EXISTING VAN GAAL DRAIN

PROP CUTOFF DITCH TO REDIRECT EXTERNAL FLOW CONSTRUCTED ON NEIGHBORING PROPERTY
0.3m TO 0.5m DEEP
1.0m WIDE BOTTOM

BALD EAGLE CRESCENT
CEDARSTONE STREET
MIRA COURT
ROCHELLE DRIVE
PERTH STREET
#6305 PERTH STREET
PROPOSED OGS
STREET 'A'
BLOCK 6
POSTILION STREET
LATIGO RIDGE
BASCULE PLACE
TRAMMEL ROAD
GRISEO WAY
VAULTING CRESCENT
CHASING GROVE
BRUSH LANE
CAIVAN-FOX RUN SUBDIVISION PHASE 2 NORTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, MAY 2020.
UNDER CONSTRUCTION.
PARK
STREET 'B'
STREET 'C'
STREET 'D'
STREET 'E'
STREET 'F'
STREET 'G'
STREET 'H'
STREET 'I'
BLOCK 23
BLOCK 24
EXISTING COMMERCIAL (BMR)
PROP DICB
100-YEAR INTAKE
DICB 1001
1200mm CULVERT
SWM POND 1
PP 92.35
CAIVAN COMMUNITIES-
RICHMOND PHASE 1
CITY FILE NO. D07-16-11-0014
PREPARED BY DSEL, JULY 2018.
CONSTRUCTION COMPLETED.
MEYNELL ROAD
CANTLE CRESCENT
PELHAM CRESCENT
REYNARD
EQUITATON CIRCLE
EQUITATION CIRCLE
HACKAMORE CRESCENT
TERRIER CIRCLE
PURSUIT TERRACE
CAIVAN-FOX RUN SUBDIVISION PHASE 2 SOUTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL, JUNE 2020.
UNDER CONSTRUCTION.
AREA=64.37 HA
C= 0.20 | 100-YR
2430 L/S
AREA=34.99 HA
C= 0.20 | 100-YR
875 L/S

LEGEND
- SUBJECT LANDS
- STORM TRUNK
- LOCAL STORM SEWER
- EXISTING/BY OTHERS STORM SEWER
- STORM DRAINAGE AREA
- FUTURE STORM DRAINAGE AREA
- DRAINAGE AREA IMPERVIOUSNESS UPSTREAM/DOWNSTREAM MANHOLE
- EXTERNAL DRAINAGE
- 100 YEAR FLOODPLAIN
- PROPOSED CUTOFF SWALE
- STORM MANHOLE
- EXTERNAL DRAINAGE AREA IMPERVIOUSNESS UPSTREAM/DOWNSTREAM MANHOLE STORM FREQUENCY

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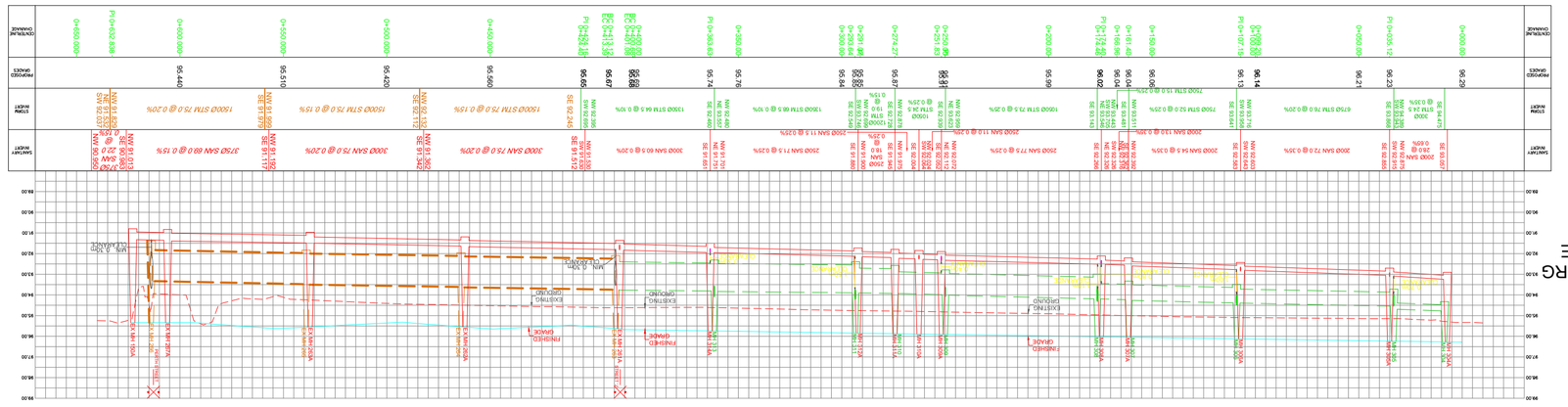
CAIVAN (RICHMOND NORTH) LTD

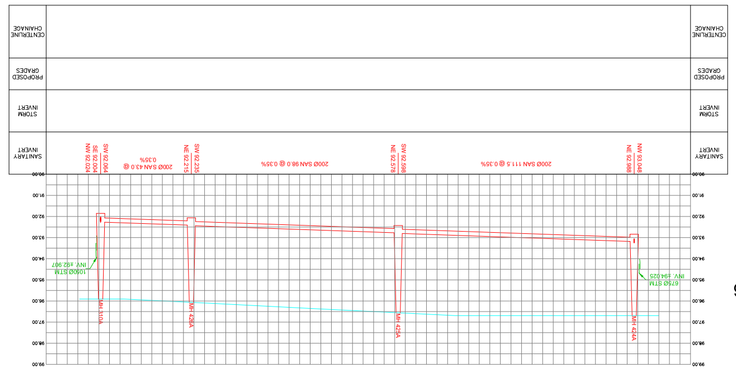
CITY OF OTTAWA

STORM SERVICING PLAN
RICHMOND NORTH WEST & RICHMOND NORTH EAST

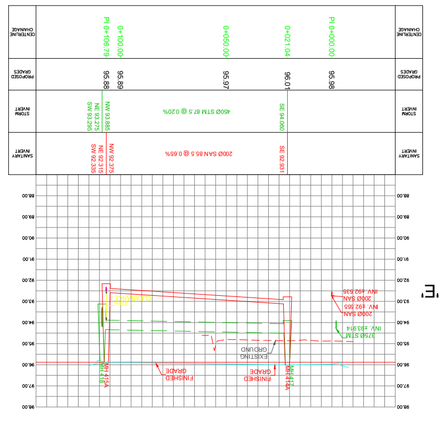
SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2022	DRAWING:	3A



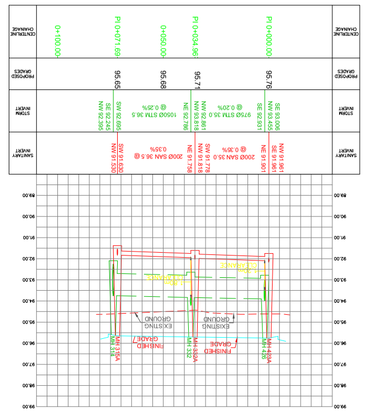
OLDENBURG AVENUE



BLOCK 36



STREET 'E'



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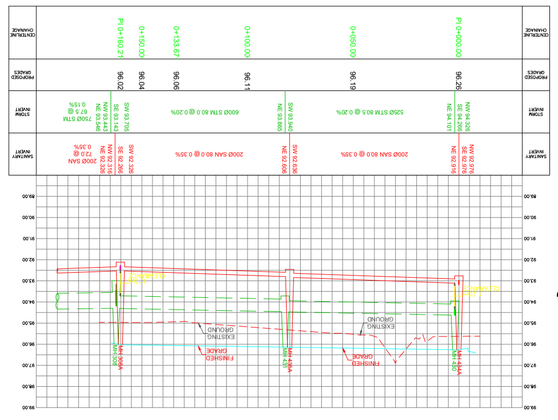

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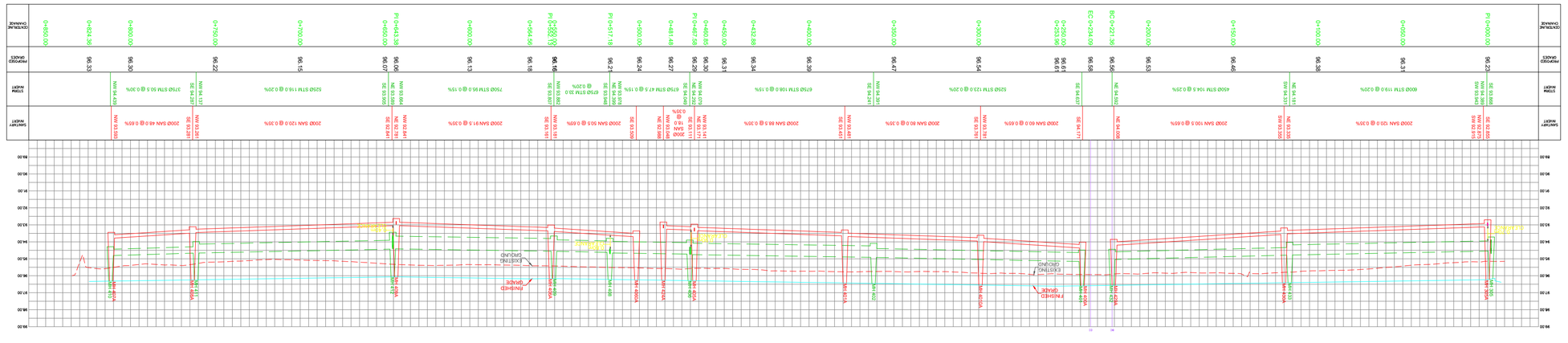
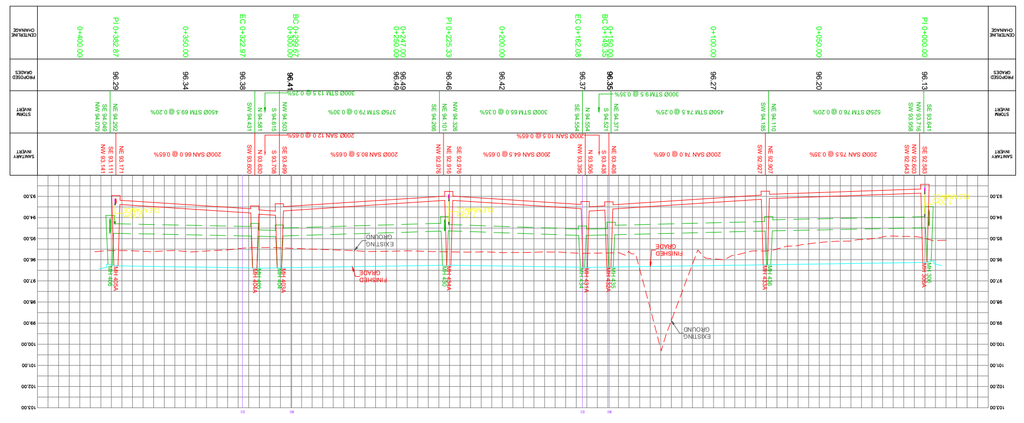


STREET 'I'



STREET 'G'

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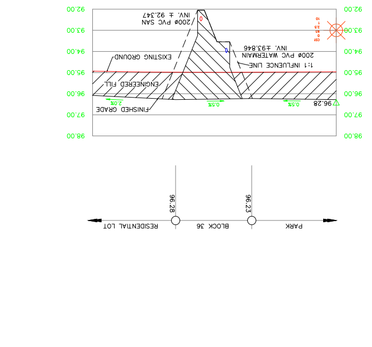
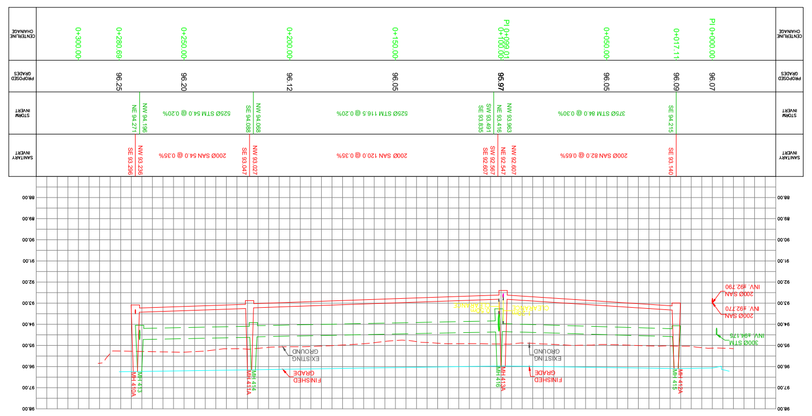
CAIVAN (RICHMOND NORTH) LTD

CITY OF OTTAWA

PROFILES
RICHMOND NORTH WEST &
RICHMOND NORTH EAST

SCALE:	1:2000	PROJECT No.:	1183
DATE:	AUGUST 2022	DRAWING:	4A





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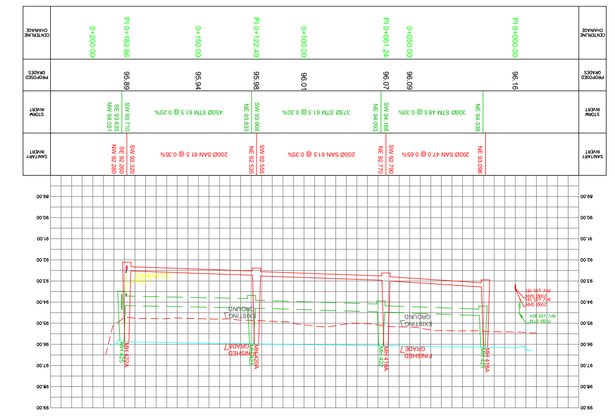

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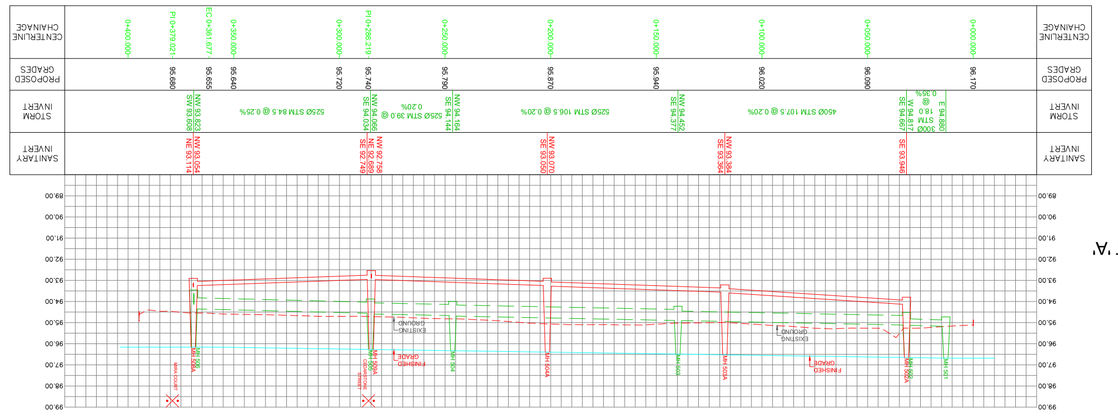

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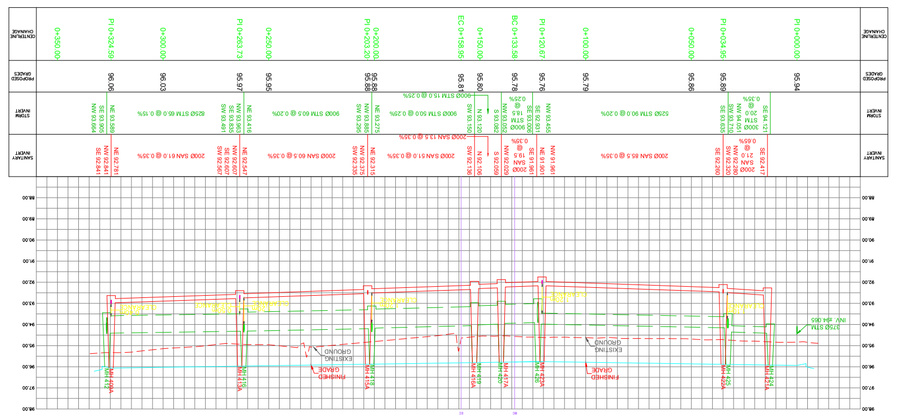

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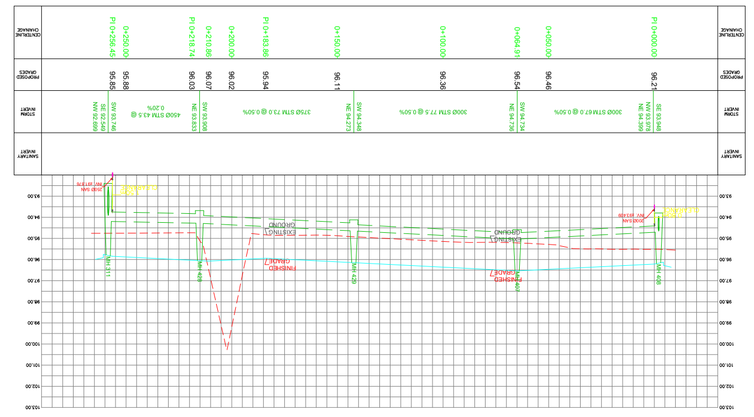

LANE 'A'

CAIVAN (RICHMOND NORTH) LTD

CITY OF OTTAWA

PROFILES
RICHMOND NORTH WEST &
RICHMOND NORTH EAST

SCALE: 1:2000	PROJECT No.: 1183
DATE: AUGUST 2022	DRAWING: 5A

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