Appendix A

Excerpts from Cut/Fill Analysis

Draft Plan of Subdivision
(Prepared by AOV)

Excerpts from GEMTEC
Geotechnical Report

Conceptual Grading Plan
(DWG. 20002-GRD)

April 3rd, 2020

301 Moodie Dr., Suite 300
Ottawa, ON
K2H 9C4

Attention: **Mr. Chris Collins**
Senior Land Development Manager
10470426 Ontario Inc.
c/o Cardel Homes

Reference: **Creekside 2 Subdivision**
Richmond, ON
Cut/Fill Analysis Memorandum
Our Project No. 20002

Dear Mr. Collins:

This memorandum has been prepared to summarize the work completed by Robinson Land Development (RLD) in assisting J.F. Sabourin and Associates Inc. (JFSA) with the cut/fill analysis in support of the Creekside 2 Subdivision located in the Village of Richmond.

Attached to this memorandum are detailed section drawings, cut/fill volume tables (calculated from the sections), detailed grading plans, and an erosion and sediment control plan to support the required cut/fill permit. The methodology used in creating the attached documents has been detailed below:

An arbitrary baseline alignment was first created between the designated cut/fill area and the existing Flowing Creek Municipal Drain (located to the west of the proposed development area). The baseline alignment was then used to create sections at 25 metre intervals spanning the entire area proposed for the cut/fill analysis.

The created sections illustrate the existing topographic conditions of the subject area from City of Ottawa LIDAR data. The LIDAR data was verified with topographic survey information and deemed to be accurate for the purpose of this analysis. The existing 20 year and 100 year floodplains have also been shown based on floodplain limits provided by JFSA. The existing 100 year floodplain elevation ranges from 93.86 to 94.17 metres above sea level (Flowing Creek Study, 2017) in the subject area analyzed by JFSA. The proposed limit of development has been indicated based on a preliminary concept plan provided by the Developer. The proposed grading design to support the cut/fill analysis which also ties into the existing conditions of the subject site has also been provided.

From the created sections, cut/fill volumes were calculated using an average end area procedure. The cut/fill volumes were analyzed in 0.30 metre increments ranging from an elevation of 92.57 m to an elevation of 94.07 m. Cumulative cut/fill volumes have been provided for each 0.30 metre elevation range and summarized in table form. The cut volumes have been calculated with respect to the existing 100 year floodplain elevation (at each respective section), such that, only cut volumes below the existing 100 year floodplain elevation down to the proposed finished grade have been analyzed. The fill volumes have been calculated with respect to the existing 100 year floodplain limit and floodplain elevation (at each respective section), such that, only fill volumes within the existing 100 year floodplain limit, from original ground up to the 100 year floodplain elevation have been analyzed.

Robinson
Land Development

An erosion and sediment control plan has been prepared for the subject site in order to mitigate any potential impacts from the proposed cut/fill operations to the neighbouring Flowing Creek Municipal Drain. The erosion and sediment control measures detailed on the plan are to be installed prior to any on-site construction work and are to remain (and be maintained) until vegetation in the proposed cut areas has been reestablished.

Should you have any questions in regards to the above or if we can provide additional information, please feel free to contact the undersigned.

Yours truly,

ROBINSON LAND DEVELOPMENT

LICENSED PROFESSIONAL ENGINEER
Apr 3/20
A. H. JONKMAN
PROVINCE OF ONTARIO

Brandon MacKechnie, P.Eng.
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April 23, 2020 Project Number: 1355-19(03)

Cardel Homes
Suite 100, 301 Moodie Drive
Ottawa, ON
K2H 9C4

Attention: **Chris Collins**

Subject: **Cardel Creekside - Flowing Creek: Floodplain Cut Fill Analysis**

1 OVERVIEW

J.F Sabourin and Associates Inc (JFSA) were retained by Cardel Homes to investigate the potential impact of a balanced cut and fill proposal to support a future residential subdivision in the lower reaches of Flowing Creek in Richmond, Ontario. The proposed development is situated on the eastern banks of Flowing Creek near the intersection of Eagleson Road and Perth Street.

To make full use of potentially developable land the proposed placement of fill will slightly infringe on the existing 50-year and 100-year floodplain extents. This infringement will be offset with an equivalent cut adjacent and upstream of the site on the eastern banks of Flowing Creek on the same property. Figure 1 provides an overview of the approximate location of the proposed cut and fill, in conjunction with the existing 100-Year flood extents overlaid on City LiDAR.

2 BACKGROUND

In undertaking this work, the following documents and data were obtained and reviewed:

- Flowing Creek Flood Risk Mapping from Flewellyn Road to Jock River Report – Completed by RVCA in May 2017.
- HEC-RAS model of Flowing Creek – Completed by RVCA in May 2017.
- LiDAR data of the subject area – obtained from the City of Ottawa in December 2019, reflective of topographic conditions in 2015.
- Pre-development topographic survey of the subject site - completed by Robinson Consulting in January 2020.
- Proposed Cut/Fill grading plan - designed by Robinson Consulting in March 2020.

Figure 1: Cut/Fill Overview

3 LIDAR DATA VERIFICATION & MODIFICATION

The LiDAR data obtained from the City of Ottawa has been reviewed for accuracy by comparing it with spot elevations taken from Robinson Consulting's topographic survey of the pre-development subject area completed in January 2020. A total of 113 spot heights were recorded in the topographic survey and compared against the LiDAR data. From this analysis, it was found that; 43.4% of the LiDAR values were within ±5 cm, 72.6% within ±10 cm and 100% within ±25 cm. Given the potential for the topography to change over time since the LiDAR was flown (especially in the fields due to ploughing), JFSA has concluded that the accuracy of the LiDAR is appropriate for use in this hydraulic analysis. Note that the LiDAR data used in this analysis is the same LiDAR data that RVCA used in its hydraulic study of Flowing Creek in 2017. Refer to Attachment A for the full details of this analysis.

As LiDAR data is unable to return channel bathymetry, the low flow channel contained in the RVCA 2017 HEC-RAS model of Flowing Creek, which was originally taken from survey data, has been extracted from the model as a raster and overlaid on the City LiDAR to create a complete Digital Elevation Model (DEM). Also note that there is a residential development currently under construction on Kirkham Crescent, located on the western banks of Flowing Creek just off Shea Road. This development is not captured in the City of Ottawa's LiDAR, as modifications to these lands commenced after the LiDAR was obtained. An additional patch was applied to the DEM which approximated the extent and elevation of this development.

4 EXISTING CONDITIONS

All hydraulic analysis completed in this report builds on the Flowing Creek HEC-RAS model of record, developed by RVCA in May 2017. To ensure that the changes created by the proposed cut and fill will be accurately represented in the hydraulic model, the Flowing Creek model of record had to be updated as follows:

- 12 Additional cross-sections have been added to the existing conditions model. Figure B-1, in Attachment B, outlines the existing RVCA cross-sections and the additional cross-sections added to the model by JFSA as a part of this study. New cross-sections were added to the model using HEC-RAS's internal RAS Mapper tool, to easily add cross-sections using this tool, the original RVCA cross-sections had to be renamed to reflect their respective distance from the downstream extent, as these cross-sections were previously named based on the survey cross-section. Note that for traceability the original RVCA cross-section names have been moved to the comments section in each cross-section.
- 5 existing cross-sections have been extended to capture the full floodplain and proposed development changes, these were original RVCA cross-sections 1010,1015,1020,1025 &1030. Refer to Figure B-1, in Attachment B for full details of these extensions
- The existing conditions DEM was loaded into HEC-RAS's RAS Mapper and all cross-sections from Garvin Road to the confluence with the Jock River were updated, the remaining cross-sections in the model were not adjusted as a part of this study.
- For all updated cross sections manning's roughness values were set per the existing RVCA model.

- Peak Flows were not adjusted from the values determined in the 2017 study
- No structures were adjusted.

With these changes made to more accurately reflect existing conditions, it is expected that there will be slight differences in calculated water levels at the updated cross-sections. A full comparison of the latest model results against the RVCA model of record has been provided in Attachment B. From this analysis it was found that the above updates resulted in a maximum water level difference of +7.4 cm (XS 552, 10-Year Event) and -0.8 cm (XS 1311, 5-Year Event), and an average difference of +1.3 cm through Reach M1 for all key events (2-100 year).

5 PROPOSED CONDITIONS

A detailed cut/fill grading plan was developed by Robinson and provided to JFSA as a TIN surface, which was incorporated in the HEC-RAS model to assess the potential hydraulic impacts of the proposed changes. For full details on the proposed balanced cut/fill refer to Robinson March 2020 report titled “Creekside 2 Subdivision Richmond, ON Cut/Fill Analysis Memorandum”. From this analysis it was found that based on the 100-year water level on Flowing Creek the proposed development envelope would require 17,592 m³ of fill to be placed within the floodplain, which will be offset with a balancing cut of 17,865 m³, resulting in a net gain of floodplain storage of 273 m³.

Existing model cross-sections that intercepted the proposed cut/fill were updated in the proposed conditions model, and the model re-run. Figure C1 in Attachment C provides an overview of the proposed terrain and the respective model cross-sections. A full comparison of these results against the JFSA updated Existing Conditions Model has been provided in Attachment C. From this analysis it was found that the proposed cut/fill will result in a maximum water level increase of 7 mm (XS 277, 100-year event), a maximum water level decrease of 22 mm (XS 1187, 100-year event), and an average water level difference of –1 mm was found throughout reach M1 for all key events (2-100 year). The proposed cut/fill results in either no change or slight reductions in peak water levels for all events upstream of Garvin Road. Note that according to the HEC-RAS model the total floodplain storage volume at Garvin Road due to the cut/fill has increased by 5,360 m³ for the 50-year event and decreased by -3,540 m³ for the 100-year event. These storage volume differences equate to a 1.03% increase and a 0.47% decrease in the total storage volume throughout the full reach. Note that these values are calculated in the model by interpolating the volume contained from cross-section to cross-section and are not at the same level of detail as the comprehensive cut/fill grading completed by Robinson, please refer to the Robinson detailed plans and tables which provide the precise cut and fill volumes and confirmation that the proposed cut/fill is balanced.

6 FLOODPLAIN MAPPING

For visual comparison purposes, floodplain maps have been generated for the existing and proposed conditions based on the modelling work completed in this analysis. Note that these figures have been provided simply for visual comparison and should not be considered nor used in any way as official floodplain maps. Please see Attachment D for the existing and proposed floodplain maps for this area.

7 SUMMARY

JFSA, in conjunction with Robinson Consulting, has developed and assessed the hydraulic impacts of a proposed balanced cut/fill for the Cardel Homes property on the eastern banks of Flowing Creek in Richmond. The RVCA hydraulic model of record of Flowing Creek was updated to capture the proposed changes to the existing topography. From this analysis, it was found that the proposed cut/fill will result in a maximum water level increase of 7 mm (XS 277, 100-year event), a maximum water level decrease of 22 mm (XS 1187, 100-year event), and an average water level difference of 1 mm was found throughout reach M1 for all key events (2-100 year). The proposed cut/fill results in either no change or slight reductions in peak water levels for all events upstream of Garvin Road. According to the HEC-RAS model, the total floodplain storage volume at Garvin Road due to the cut/fill has increased by 5,360 m³ for the 50-year event and decreased by -3,540 m³ for the 100-year event. These storage volume differences equate to a 1.03% increase and a 0.47% decrease in the total storage volume throughout the full reach (M1). Note that these values are calculated in the model by interpolating the volume contained from cross-section to cross-section and are not at the same level of detail as the comprehensive cut/fill grading completed by Robinson, please refer to the Robinson detailed plans and tables which provide the precise cut and fill volumes and confirmation that the proposed cut/fill is balanced. Floodplain maps were generated under existing and proposed conditions for the 2-100 year events under both existing and proposed conditions to provide a visual comparison of the proposed changes to these lands and the existing floodplain.

Yours truly,
J.F Sabourin and Associates Inc.

LICENSED PROFESSIONAL ENGINEER
J. J. BURNETT
100227734
PROVINCE OF ONTARIO

Jonathon Burnett, B.Eng, P.Eng
Water Resources Engineer

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

Figures
Figure 1: Cut Fill Overview

Attachments
Attachment A: LiDAR Verification
Attachment B: HEC-RAS: Existing Conditions
Attachment C: HEC-RAS: Proposed Conditions
Attachment D: Floodplain Maps

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Attachment B

HEC-RAS Model: Existing Conditions

Legend

Cross-Sections (RVCA 2017)

Additional Cross Sections (JFSA 2020)

Creek Centreline

Cut

Fill

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CARDEL HOMES

SCALE : 1:5000

0 100 200 300 m

PROJECT :

Cardel Creekside - Flowing Creek: Floodplain Cut Fill Analysis

TITLE :

Figure B1: Existing Conditions Model Cross-Sections

PROJECT	1355-19(03)
DRAWN:	JB
DATE:	APRIL 2020

HEC-RAS Plan: PlanB River: Flowing Reach: M1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	1030 1030	50 yr	63.37	90.85	93.870	92.65	93.91	0.000524	1.08	128.59	174.94	0.23	258.42
M1	1030 1030	100 yr	74.46	90.85	94.125	92.78	94.17	0.000490	1.13	198.18	373.68	0.23	394.35
M1	1025 1025	2 yr	13.82	90.81	92.404		92.45	0.001006	0.94	14.63	13.06	0.28	24.10
M1	1025 1025	5 yr	27.31	90.81	92.830		92.90	0.001290	1.19	36.12	70.20	0.33	51.90
M1	1025 1025	10 yr	37.19	90.81	93.021		93.10	0.001334	1.33	50.53	81.31	0.35	73.71
M1	1025 1025	20 yr	48.54	90.81	93.248		93.33	0.001249	1.41	72.69	121.50	0.34	107.54
M1	1025 1025	50 yr	63.37	90.81	93.748		93.79	0.000531	1.09	194.33	337.97	0.23	219.53
M1	1025 1025	100 yr	74.46	90.81	94.052		94.07	0.000304	0.90	303.38	397.14	0.18	333.83
M1	1020 1020	2 yr	13.82	90.67	92.211		92.24	0.000572	0.75	27.10	61.23	0.22	18.31
M1	1020 1020	5 yr	27.31	90.67	92.592		92.63	0.000709	0.93	62.94	114.81	0.25	38.14
M1	1020 1020	10 yr	37.19	90.67	92.793		92.83	0.000680	0.99	86.30	119.06	0.25	54.70
M1	1020 1020	20 yr	48.54	90.67	93.056		93.09	0.000571	1.00	119.05	133.60	0.23	80.91
M1	1020 1020	50 yr	63.37	90.67	93.656		93.68	0.000279	0.84	237.09	262.08	0.17	159.60
M1	1020 1020	100 yr	74.46	90.67	93.986		94.00	0.000209	0.79	347.35	419.92	0.15	243.44
M1	1015 1015	2 yr	13.82	90.50	91.985		92.03	0.001411	0.97	18.79	39.39	0.33	12.78
M1	1015 1015	5 yr	27.31	90.50	92.300		92.37	0.001651	1.28	34.03	52.51	0.38	26.47
M1	1015 1015	10 yr	37.19	90.50	92.494		92.58	0.001670	1.43	44.47	55.25	0.39	38.96
M1	1015 1015	20 yr	48.54	90.50	92.811		92.89	0.001242	1.41	62.60	59.00	0.35	59.05
M1	1015 1015	50 yr	63.37	90.50	93.518		93.58	0.000613	1.25	147.09	287.65	0.26	113.37
M1	1015 1015	100 yr	74.46	90.50	93.905		93.94	0.000340	1.03	288.70	503.20	0.20	166.89
M1	1010 1010	2 yr	13.82	89.80	91.702	90.95	91.74	0.001090	0.94	30.93	120.00	0.28	7.14
M1	1010 1010	5 yr	27.31	89.80	92.057	91.36	92.09	0.000908	0.95	77.43	143.18	0.27	14.12
M1	1010 1010	10 yr	37.19	89.80	92.325	91.78	92.35	0.000601	0.88	116.07	144.69	0.23	21.29
M1	1010 1010	20 yr	48.54	89.80	92.728	91.87	92.74	0.000325	0.75	174.73	146.63	0.17	33.04
M1	1010 1010	50 yr	63.37	89.80	93.497	91.96	93.50	0.000136	0.61	291.09	169.00	0.12	66.01
M1	1010 1010	100 yr	74.46	89.80	93.875	92.02	93.88	0.000142	0.68	392.63	423.41	0.12	93.55
M1	1005 1005	2 yr	13.82	89.40	91.536	90.30	91.57	0.000848	0.87	19.35	56.44	0.25	2.74
M1	1005 1005	5 yr	27.31	89.40	91.844	90.83	91.90	0.001152	1.17	46.91	101.15	0.31	3.25
M1	1005 1005	10 yr	37.19	89.40	92.188	91.12	92.23	0.000721	1.06	82.35	104.82	0.25	3.94
M1	1005 1005	20 yr	48.54	89.40	92.649	91.63	92.68	0.000413	0.94	140.34	186.86	0.20	5.23
M1	1005 1005	50 yr	63.37	89.40	93.469	91.86	93.48	0.000145	0.68	265.72	410.69	0.12	8.72
M1	1005 1005	100 yr	74.46	89.40	93.851	91.94	93.86	0.000121	0.67	339.33	556.89	0.11	11.97
M1	1003		Culvert										
M1	1000 1000	2 yr	13.82	89.40	91.484		91.50	0.000369	0.63	22.31	28.79	0.17	2.19
M1	1000 1000	5 yr	27.31	89.40	91.583		91.65	0.001169	1.15	26.11	42.06	0.31	2.38
M1	1000 1000	10 yr	37.19	89.40	91.693		91.80	0.001646	1.44	31.97	68.33	0.37	2.67
M1	1000 1000	20 yr	48.54	89.40	91.856		91.98	0.001850	1.63	43.96	78.39	0.40	3.25
M1	1000 1000	50 yr	63.37	89.40	92.110	91.16	92.24	0.001701	1.71	65.64	92.09	0.39	4.31
M1	1000 1000	100 yr	74.46	89.40	92.322	91.37	92.44	0.001454	1.70	85.91	98.90	0.37	5.31
M1	10	2 yr	13.82	89.40	91.450	90.02	91.47	0.000339	0.62	22.50	19.13	0.17	
M1	10	5 yr	27.31	89.40	91.450	90.35	91.53	0.001326	1.22	22.50	19.13	0.33	
M1	10	10 yr	37.19	89.40	91.450	90.56	91.59	0.002459	1.66	22.50	19.13	0.44	
M1	10	20 yr	48.54	89.40	91.450	90.80	91.69	0.004187	2.16	22.50	19.13	0.58	
M1	10	50 yr	63.37	89.40	91.450	91.09	91.86	0.007138	2.83	22.50	19.13	0.76	
M1	10	100 yr	74.46	89.40	91.450	91.29	92.01	0.009854	3.32	22.50	19.13	0.89	

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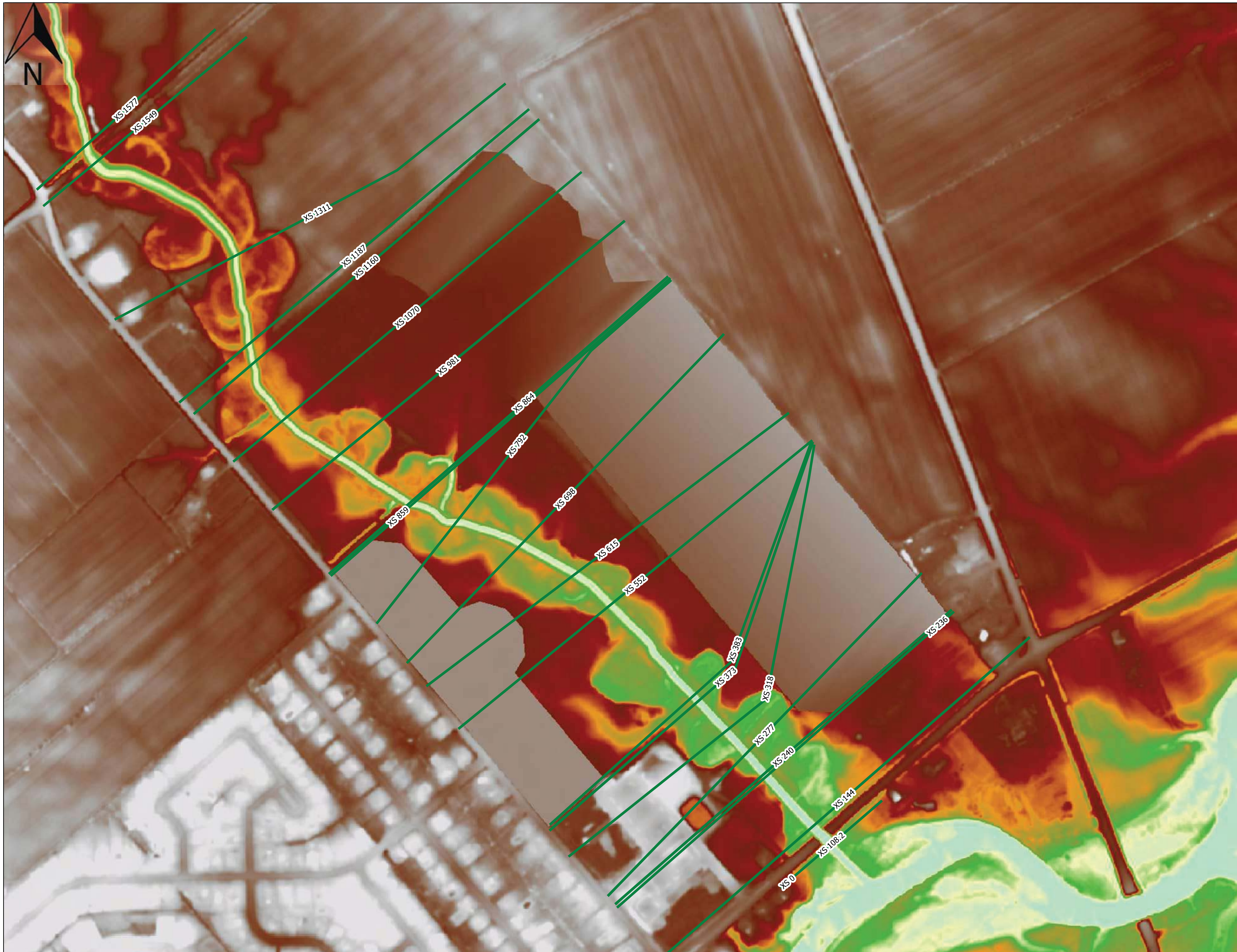
Attachment C

HEC-RAS Model: Proposed Conditions



Legend
Cross Sections (JFSA 2020)
Creek Centreline
Proposed Terrain (m)
90.5
91
91.5
92
92.5
93
93.5
94
94.5
95

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SCALE : 1:5000

0 100 200 300 m

PROJECT :

Cardel Creekside - Flowing Creek: Floodplain Cut Fill Analysis

TITLE :

Figure C1:
Model Cross-Sections & Proposed Terrain

PROJECT	1355-19(03)
DRAWN:	JB
DATE:	MARCH 2020

HEC-RAS Plan: Existing-JFSA River: Flowing Reach: M1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	3504	2 yr	12.62	92.94	94.915		94.97	0.001283	1.04	12.18	10.99	0.31	67.07
M1	3504	5 yr	26.53	92.94	95.607		95.68	0.001332	1.22	23.45	34.63	0.33	140.98
M1	3504	10 yr	37.19	92.94	95.964		96.04	0.001085	1.29	41.19	63.72	0.31	201.36
M1	3504	20 yr	48.54	92.94	96.219		96.31	0.001038	1.38	60.62	89.04	0.31	280.20
M1	3504	50 yr	63.37	92.94	96.551		96.64	0.000898	1.43	102.35	174.83	0.30	518.86
M1	3504	100 yr	74.46	92.94	96.716		96.81	0.000916	1.51	151.63	433.13	0.31	746.69
M1	3283	2 yr	12.62	92.77	94.563		94.63	0.001800	1.18	10.66	10.11	0.37	64.54
M1	3283	5 yr	26.53	92.77	95.229		95.34	0.001831	1.46	18.39	17.33	0.39	136.36
M1	3283	10 yr	37.19	92.77	95.645		95.75	0.001571	1.49	32.98	54.57	0.37	193.17
M1	3283	20 yr	48.54	92.77	95.927		96.04	0.001393	1.56	51.09	84.43	0.36	267.86
M1	3283	50 yr	63.37	92.77	96.330		96.43	0.001018	1.52	101.93	229.34	0.32	496.30
M1	3283	100 yr	74.46	92.77	96.532		96.61	0.000840	1.45	160.15	318.18	0.29	712.26
M1	3067	2 yr	12.62	92.30	94.140		94.22	0.002077	1.23	10.25	10.12	0.39	62.29
M1	3067	5 yr	26.53	92.30	94.831		94.94	0.001853	1.46	18.15	12.52	0.39	132.41
M1	3067	10 yr	37.19	92.30	95.262		95.38	0.001931	1.52	27.76	45.97	0.40	186.62
M1	3067	20 yr	48.54	92.30	95.632		95.74	0.001393	1.48	47.77	61.33	0.35	257.20
M1	3067	50 yr	63.37	92.30	96.170		96.23	0.000708	1.25	135.56	381.77	0.26	470.67
M1	3067	100 yr	74.46	92.30	96.424		96.46	0.000480	1.11	244.28	512.47	0.22	668.61
M1	2812	2 yr	12.62	91.75	93.594	92.89	93.67	0.002196	1.24	10.19	10.32	0.40	59.68
M1	2812	5 yr	26.53	91.75	94.428	93.45	94.52	0.001457	1.30	20.35	14.07	0.35	127.50
M1	2812	10 yr	37.19	91.75	94.887	93.72	94.98	0.001254	1.35	29.15	26.47	0.33	179.35
M1	2812	20 yr	48.54	91.75	95.343	93.95	95.43	0.001006	1.33	44.20	38.38	0.31	245.46
M1	2812	50 yr	63.37	91.75	96.018	94.21	96.08	0.000530	1.15	95.07	140.73	0.23	439.53
M1	2812	100 yr	74.46	91.75	96.288	94.40	96.34	0.000459	1.15	120.70	150.08	0.22	618.66
M1	2766		Culvert										
M1	2764	2 yr	12.62	91.63	93.546	92.19	93.56	0.000141	0.45	28.33	17.19	0.11	59.11
M1	2764	5 yr	26.53	91.63	94.220	92.45	94.24	0.000221	0.66	40.31	18.68	0.14	126.60
M1	2764	10 yr	37.19	91.63	94.515	92.63	94.55	0.000305	0.81	48.27	39.50	0.17	178.21
M1	2764	20 yr	48.54	91.63	94.762	92.79	94.81	0.000371	0.94	58.59	44.16	0.19	243.97
M1	2764	50 yr	63.37	91.63	95.022	92.98	95.08	0.000458	1.09	70.57	49.06	0.21	436.72
M1	2764	100 yr	74.46	91.63	95.182	93.12	95.25	0.000508	1.19	78.63	51.44	0.23	614.81
M1	2543	2 yr	13.82	91.51	93.452		93.49	0.000724	0.83	16.62	13.87	0.24	54.15
M1	2543	5 yr	27.31	91.51	94.094		94.15	0.000777	1.04	27.15	26.94	0.26	119.15
M1	2543	10 yr	37.19	91.51	94.359		94.43	0.000913	1.18	35.62	38.74	0.29	168.95
M1	2543	20 yr	48.54	91.51	94.576		94.67	0.001007	1.35	47.79	86.93	0.31	232.23
M1	2543	50 yr	63.37	91.51	94.819		94.92	0.001038	1.48	70.00	94.16	0.32	421.20
M1	2543	100 yr	74.46	91.51	94.976		95.08	0.001041	1.55	85.00	96.72	0.32	596.75
M1	2366	2 yr	13.82	91.44	93.353		93.38	0.000497	0.70	19.81	16.61	0.20	50.92
M1	2366	5 yr	27.31	91.44	93.996		94.03	0.000513	0.85	34.69	30.28	0.22	113.66
M1	2366	10 yr	37.19	91.44	94.247		94.29	0.000586	0.97	45.71	57.50	0.24	161.94
M1	2366	20 yr	48.54	91.44	94.456		94.52	0.000650	1.11	58.73	67.29	0.25	223.39
M1	2366	50 yr	63.37	91.44	94.690		94.76	0.000709	1.25	75.76	77.11	0.27	409.48
M1	2366	100 yr	74.46	91.44	94.842		94.92	0.000744	1.34	87.80	81.37	0.28	583.09
M1	2099	2 yr	13.82	91.44	93.147	92.38	93.19	0.001025	0.94	14.64	13.35	0.29	46.32
M1	2099	5 yr	27.31	91.44	93.774	92.74	93.84	0.001078	1.12	25.31	25.81	0.31	105.66
M1	2099	10 yr	37.19	91.44	93.983	92.95	94.07	0.001283	1.30	33.31	53.78	0.34	151.40
M1	2099	20 yr	48.54	91.44	94.153	93.15	94.26	0.001485	1.48	42.81	59.78	0.37	209.85
M1	2099	50 yr	63.37	91.44	94.359	93.40	94.49	0.001574	1.65	56.03	68.21	0.39	391.91
M1	2099	100 yr	74.46	91.44	94.492	93.59	94.64	0.001637	1.76	65.53	78.34	0.40	562.64
M1	1899	2 yr	13.82	91.23	92.999	92.09	93.03	0.000627	0.78	19.75	30.00	0.23	42.87
M1	1899	5 yr	27.31	91.23	93.669	92.44	93.70	0.000428	0.82	67.79	124.70	0.20	96.32
M1	1899	10 yr	37.19	91.23	93.879	92.65	93.91	0.000443	0.90	95.56	137.58	0.21	138.48
M1	1899	20 yr	48.54	91.23	94.041	92.86	94.08	0.000497	1.01	118.71	149.42	0.22	193.65
M1	1899	50 yr	63.37	91.23	94.246	93.12	94.29	0.000540	1.12	170.88	384.62	0.24	369.15
M1	1899	100 yr	74.46	91.23	94.405	93.34	94.44	0.000474	1.10	237.92	445.81	0.22	532.20
M1	1577	2 yr	13.82	90.74	92.902	91.39	92.92	0.000209	0.54	29.23	26.25	0.14	35.00
M1	1577	5 yr	27.31	90.74	93.578	91.74	93.60	0.000222	0.68	65.36	151.52	0.15	71.74
M1	1577	10 yr	37.19	90.74	93.767	91.95	93.80	0.000287	0.82	84.96	199.95	0.17	104.07
M1	1577	20 yr	48.54	90.74	93.900	92.16	93.94	0.000378	0.97	101.07	265.12	0.20	150.70
M1	1577	50 yr	63.37	90.74	94.071	92.40	94.12	0.000480	1.15	125.22	309.83	0.22	309.71
M1	1577	100 yr	74.46	90.74	94.232	92.63	94.29	0.000483	1.19	150.47	312.80	0.23	453.92
M1	1550		Culvert										
M1	1549	2 yr	13.82	90.87	92.748	91.48	92.76	0.000186	0.45	30.41	23.54	0.13	34.51
M1	1549	5 yr	27.31	90.87	93.204	91.80	93.22	0.000303	0.64	48.59	89.86	0.17	70.50
M1	1549	10 yr	37.19	90.87	93.426	91.95	93.45	0.000346	0.72	70.59	131.91	0.18	102.23
M1	1549	20 yr	48.54	90.87	93.650	92.12	93.68	0.000348	0.79	95.75	145.20	0.19	148.28
M1	1549	50 yr	63.37	90.87	94.006	92.30	94.03	0.000290	0.81	146.40	324.09	0.17	306.35
M1	1549	100 yr	74.46	90.87	94.241	92.43	94.27	0.000253	0.81	190.04	346.28	0.17	449.64
M1	1311	2 yr	13.82	90.91	92.657	91.77	92.68	0.000609	0.69	20.05	21.52	0.22	28.50
M1	1311	5 yr	27.31	90.91	93.071	92.11	93.11	0.000689	0.93	40.44	82.68	0.25	59.71

HEC-RAS Plan: Existing-JFSA River: Flowing Reach: M1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	1311	10 yr	37.19	90.91	93.282	92.30	93.33	0.000703	1.03	59.59	95.27	0.26	86.08
M1	1311	20 yr	48.54	90.91	93.509	92.48	93.56	0.000669	1.10	82.42	107.45	0.26	125.74
M1	1311	50 yr	63.37	90.91	93.898	92.67	93.94	0.000488	1.06	133.27	180.52	0.23	267.90
M1	1311	100 yr	74.46	90.91	94.136	92.80	94.18	0.000464	1.11	205.92	404.67	0.23	393.03
M1	1187	2 yr	13.82	90.89	92.576		92.60	0.000656	0.72	19.19	20.73	0.23	26.07
M1	1187	5 yr	27.31	90.89	92.973		93.02	0.000793	0.99	36.46	73.49	0.27	54.96
M1	1187	10 yr	37.19	90.89	93.177		93.24	0.000838	1.12	52.10	80.27	0.28	79.18
M1	1187	20 yr	48.54	90.89	93.404		93.47	0.000817	1.20	72.38	97.15	0.28	116.16
M1	1187	50 yr	63.37	90.89	93.817		93.87	0.000599	1.18	123.86	173.91	0.25	252.00
M1	1187	100 yr	74.46	90.89	94.079		94.12	0.000465	1.12	187.09	349.05	0.23	368.72
M1	1160	2 yr	13.82	90.88	92.555		92.58	0.000740	0.76	20.58	46.45	0.24	25.54
M1	1160	5 yr	27.31	90.88	92.955		93.00	0.000768	0.98	46.90	86.02	0.26	53.84
M1	1160	10 yr	37.19	90.88	93.162		93.21	0.000774	1.07	65.84	96.73	0.27	77.60
M1	1160	20 yr	48.54	90.88	93.393		93.44	0.000716	1.13	89.45	111.16	0.27	113.99
M1	1160	50 yr	63.37	90.88	93.816		93.85	0.000465	1.05	176.38	312.97	0.22	247.97
M1	1160	100 yr	74.46	90.88	94.082		94.11	0.000331	0.95	281.99	437.17	0.19	362.43
M1	1070	2 yr	13.82	90.86	92.472		92.51	0.000924	0.86	16.29	26.51	0.27	23.88
M1	1070	5 yr	27.31	90.86	92.862		92.92	0.000999	1.11	39.74	71.53	0.30	49.94
M1	1070	10 yr	37.19	90.86	93.062		93.13	0.001044	1.24	55.38	84.56	0.31	72.13
M1	1070	20 yr	48.54	90.86	93.290		93.36	0.001028	1.34	79.68	134.43	0.32	106.38
M1	1070	50 yr	63.37	90.86	93.778		93.81	0.000452	1.04	205.92	340.46	0.22	230.75
M1	1070	100 yr	74.46	90.86	94.059		94.08	0.000283	0.89	307.46	400.74	0.18	335.88
M1	981	2 yr	13.82	90.81	92.380		92.42	0.001082	0.89	16.84	31.44	0.29	22.41
M1	981	5 yr	27.31	90.81	92.767		92.83	0.001103	1.13	41.87	90.22	0.31	46.30
M1	981	10 yr	37.19	90.81	92.974		93.03	0.001029	1.20	63.84	112.81	0.31	66.83
M1	981	20 yr	48.54	90.81	93.218		93.27	0.000876	1.23	93.70	137.35	0.29	98.66
M1	981	50 yr	63.37	90.81	93.749		93.77	0.000355	0.93	250.54	370.32	0.19	210.44
M1	981	100 yr	74.46	90.81	94.041		94.06	0.000215	0.78	365.42	433.69	0.15	305.93
M1	864	2 yr	13.82	90.75	92.295		92.32	0.000661	0.72	30.48	42.53	0.23	19.62
M1	864	5 yr	27.31	90.75	92.661		92.70	0.000894	1.04	50.62	82.29	0.28	40.87
M1	864	10 yr	37.19	90.75	92.868		92.92	0.000902	1.14	69.78	95.63	0.29	58.97
M1	864	20 yr	48.54	90.75	93.130		93.18	0.000746	1.15	95.42	100.25	0.27	87.54
M1	864	50 yr	63.37	90.75	93.699		93.73	0.000391	1.00	219.26	340.68	0.21	182.81
M1	864	100 yr	74.46	90.75	94.006		94.03	0.000263	0.89	333.73	436.60	0.17	264.82
M1	859	2 yr	13.82	90.74	92.294	91.47	92.31	0.000513	0.66	33.22	46.89	0.21	19.49
M1	859	5 yr	27.31	90.74	92.663	91.71	92.70	0.000689	0.94	55.87	92.30	0.25	40.64
M1	859	10 yr	37.19	90.74	92.871	91.86	92.91	0.000709	1.04	75.70	97.50	0.26	58.67
M1	859	20 yr	48.54	90.74	93.132	92.00	93.17	0.000607	1.06	101.61	100.90	0.25	87.13
M1	859	50 yr	63.37	90.74	93.698	92.14	93.73	0.000347	0.95	213.44	279.10	0.19	181.91
M1	859	100 yr	74.46	90.74	94.004	92.23	94.03	0.000253	0.88	311.38	379.27	0.17	263.47
M1	792	2 yr	13.82	90.70	92.252	91.43	92.28	0.000582	0.72	29.00	68.15	0.22	17.40
M1	792	5 yr	27.31	90.70	92.623	91.78	92.65	0.000609	0.89	66.44	115.13	0.24	36.54
M1	792	10 yr	37.19	90.70	92.834	91.98	92.87	0.000581	0.95	91.14	120.24	0.24	53.07
M1	792	20 yr	48.54	90.70	93.102	92.19	93.13	0.000495	0.97	125.41	138.98	0.22	79.51
M1	792	50 yr	63.37	90.70	93.686	92.37	93.70	0.000245	0.81	242.21	251.71	0.16	166.62
M1	792	100 yr	74.46	90.70	93.995	92.54	94.01	0.000182	0.76	325.15	326.40	0.14	242.11
M1	698	2 yr	13.82	90.68	92.170	91.47	92.21	0.000890	0.87	19.99	54.57	0.27	15.11
M1	698	5 yr	27.31	90.68	92.524	91.81	92.58	0.001009	1.13	45.86	85.33	0.30	31.28
M1	698	10 yr	37.19	90.68	92.735	91.99	92.79	0.000978	1.22	64.66	93.79	0.31	45.78
M1	698	20 yr	48.54	90.68	93.019	92.26	93.07	0.000792	1.22	94.34	126.89	0.28	69.22
M1	698	50 yr	63.37	90.68	93.651	92.46	93.68	0.000328	0.95	218.20	251.56	0.19	145.07
M1	698	100 yr	74.46	90.68	93.971	92.57	93.99	0.000228	0.86	308.97	332.83	0.16	212.44
M1	615	2 yr	13.82	90.66	92.093	91.50	92.13	0.000986	0.86	23.22	78.09	0.28	13.31
M1	615	5 yr	27.31	90.66	92.454	91.81	92.50	0.000898	1.02	54.52	91.34	0.28	27.09
M1	615	10 yr	37.19	90.66	92.671	92.02	92.71	0.000827	1.08	74.86	96.12	0.28	39.95
M1	615	20 yr	48.54	90.66	92.971	92.22	93.01	0.000628	1.06	104.43	100.74	0.25	60.93
M1	615	50 yr	63.37	90.66	93.626	92.35	93.65	0.000304	0.91	201.98	205.36	0.18	127.53
M1	615	100 yr	74.46	90.66	93.952	92.44	93.97	0.000221	0.84	296.29	359.57	0.16	187.17
M1	552	2 yr	13.82	90.64	92.018	91.49	92.06	0.001214	0.93	19.73	38.83	0.31	11.93
M1	552	5 yr	27.31	90.64	92.358	91.81	92.42	0.001376	1.22	36.01	52.15	0.35	24.20
M1	552	10 yr	37.19	90.64	92.568	91.98	92.64	0.001367	1.35	47.22	54.81	0.36	36.06
M1	552	20 yr	48.54	90.64	92.880	92.14	92.95	0.001081	1.36	65.10	60.00	0.33	55.52
M1	552	50 yr	63.37	90.64	93.571	92.31	93.62	0.000526	1.19	157.09	248.49	0.24	116.07
M1	552	100 yr	74.46	90.64	93.919	92.41	93.95	0.000339	1.04	262.76	427.71	0.20	169.33
M1	383	2 yr	13.82	90.28	91.806	91.23	91.85	0.001294	0.96	24.80	74.91	0.32	8.18
M1	383	5 yr	27.31	90.28	92.171	91.66	92.21	0.001061	1.09	60.68	121.50	0.31	16.05
M1	383	10 yr	37.19	90.28	92.427	91.85	92.46	0.000778	1.05	94.04	133.94	0.27	24.15
M1	383	20 yr	48.54	90.28	92.804	91.98	92.83	0.000447	0.92	152.19	165.38	0.21	37.20
M1	383	50 yr	63.37	90.28	93.554	92.11	93.56	0.000166	0.70	299.00	239.47	0.14	77.63
M1	383	100 yr	74.46	90.28	93.901	92.21	93.91	0.000137	0.69	429.88	489.46	0.13	110.94
M1	373	2 yr	13.82	90.20	91.790	91.16	91.84	0.001234	0.97	19.70	52.12	0.31	7.97

HEC-RAS Plan: Existing-JFSA River: Flowing Reach: M1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	373	5 yr	27.31	90.20	92.141	91.57	92.20	0.001260	1.20	46.69	92.22	0.33	15.54
M1	373	10 yr	37.19	90.20	92.400	91.79	92.45	0.000983	1.19	71.26	97.41	0.30	23.36
M1	373	20 yr	48.54	90.20	92.784	91.97	92.82	0.000597	1.08	109.81	103.06	0.24	35.94
M1	373	50 yr	63.37	90.20	93.538	92.15	93.56	0.000277	0.91	226.94	228.33	0.18	75.10
M1	373	100 yr	74.46	90.20	93.889	92.24	93.91	0.000208	0.86	348.54	476.37	0.16	107.21
M1	318	2 yr	13.82	90.01	91.737	91.07	91.77	0.001009	0.88	34.24	124.39	0.28	6.48
M1	318	5 yr	27.31	90.01	92.118	91.66	92.14	0.000655	0.88	85.99	143.41	0.24	11.87
M1	318	10 yr	37.19	90.01	92.387	91.78	92.41	0.000466	0.84	124.83	145.06	0.21	17.93
M1	318	20 yr	48.54	90.01	92.779	91.87	92.79	0.000276	0.74	182.18	147.39	0.17	27.87
M1	318	50 yr	63.37	90.01	93.539	91.96	93.55	0.000122	0.61	298.80	170.59	0.12	60.57
M1	318	100 yr	74.46	90.01	93.890	92.01	93.90	0.000099	0.60	360.08	416.99	0.11	86.52
M1	277	2 yr	13.82	90.00	91.669	90.98	91.72	0.001319	1.02	16.84	47.97	0.32	5.42
M1	277	5 yr	27.31	90.00	92.036	91.36	92.10	0.001295	1.23	46.64	100.52	0.34	9.12
M1	277	10 yr	37.19	90.00	92.328	91.70	92.38	0.000884	1.16	76.97	105.38	0.29	13.76
M1	277	20 yr	48.54	90.00	92.744	91.93	92.77	0.000497	1.01	121.68	109.77	0.22	21.58
M1	277	50 yr	63.37	90.00	93.520	92.07	93.54	0.000225	0.84	222.52	166.07	0.16	49.77
M1	277	100 yr	74.46	90.00	93.867	92.16	93.89	0.000222	0.90	319.58	379.92	0.16	71.63
M1	240	2 yr	13.82	89.94	91.618	90.98	91.67	0.001374	1.03	15.42	34.85	0.33	4.83
M1	240	5 yr	27.31	89.94	91.957	91.35	92.04	0.001668	1.38	33.69	69.88	0.38	7.66
M1	240	10 yr	37.19	89.94	92.266	91.60	92.34	0.001175	1.33	57.03	77.42	0.33	11.31
M1	240	20 yr	48.54	89.94	92.703	91.81	92.75	0.000672	1.18	92.67	102.54	0.26	17.63
M1	240	50 yr	63.37	89.94	93.506	92.06	93.53	0.000254	0.90	189.83	325.40	0.17	41.20
M1	240	100 yr	74.46	89.94	93.862	92.16	93.88	0.000192	0.85	248.42	408.92	0.15	58.84
M1	236	2 yr	13.82	89.93	91.618	90.86	91.66	0.001078	0.95	18.27	36.69	0.30	4.75
M1	236	5 yr	27.31	89.93	91.954	91.26	92.03	0.001445	1.32	34.99	69.37	0.36	7.50
M1	236	10 yr	37.19	89.93	92.262	91.54	92.33	0.001068	1.30	58.45	79.21	0.32	11.05
M1	236	20 yr	48.54	89.93	92.701	91.74	92.75	0.000631	1.16	96.91	115.46	0.25	17.19
M1	236	50 yr	63.37	89.93	93.509	91.87	93.53	0.000200	0.81	224.78	383.42	0.15	39.97
M1	236	100 yr	74.46	89.93	93.865	92.13	93.88	0.000152	0.76	286.30	411.91	0.13	56.97
M1	144	2 yr	13.82	89.50	91.546	90.56	91.58	0.000689	0.84	20.74	68.74	0.24	2.95
M1	144	5 yr	27.31	89.50	91.868	90.99	91.92	0.000906	1.13	50.38	100.34	0.29	3.56
M1	144	10 yr	37.19	89.50	92.210	91.25	92.25	0.000601	1.05	85.87	106.22	0.24	4.38
M1	144	20 yr	48.54	89.50	92.673	91.59	92.70	0.000353	0.93	145.26	190.28	0.19	5.79
M1	144	50 yr	63.37	89.50	93.499	91.83	93.51	0.000128	0.68	273.31	413.67	0.12	9.44
M1	144	100 yr	74.46	89.50	93.855	91.91	93.87	0.000112	0.68	343.07	470.00	0.12	12.56
M1	110		Culvert										
M1	108.2	2 yr	13.82	89.50	91.493		91.51	0.000360	0.63	22.65	33.93	0.18	2.39
M1	108.2	5 yr	27.31	89.50	91.609		91.67	0.001040	1.14	27.47	45.60	0.30	2.65
M1	108.2	10 yr	37.19	89.50	91.731		91.83	0.001413	1.40	35.10	71.05	0.36	3.06
M1	108.2	20 yr	48.54	89.50	91.896		92.02	0.001573	1.59	47.76	80.12	0.39	3.74
M1	108.2	50 yr	63.37	89.50	92.141	91.31	92.27	0.001488	1.68	69.15	94.18	0.38	4.90
M1	108.2	100 yr	74.46	89.50	92.333	91.48	92.45	0.001340	1.70	87.86	102.06	0.37	5.96
M1	0	2 yr	13.82	89.50	91.450	90.26	91.47	0.000403	0.66	21.45	23.79	0.19	
M1	0	5 yr	27.31	89.50	91.450	90.63	91.54	0.001574	1.30	21.45	23.79	0.37	
M1	0	10 yr	37.19	89.50	91.450	90.85	91.61	0.002918	1.77	21.45	23.79	0.50	
M1	0	20 yr	48.54	89.50	91.450	91.07	91.72	0.004970	2.31	21.45	23.79	0.65	
M1	0	50 yr	63.37	89.50	91.450	91.31	91.91	0.008472	3.01	21.45	23.79	0.85	
M1	0	100 yr	74.46	89.50	91.480	91.48	92.09	0.010803	3.45	22.25	29.69	0.97	

HEC-RAS Plan: Proposed_v03 River: Flowing Reach: M1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	3504	2 yr	12.62	92.94	94.915		94.97	0.001283	1.04	12.18	10.99	0.31	66.96
M1	3504	5 yr	26.53	92.94	95.607		95.68	0.001332	1.22	23.45	34.64	0.33	140.78
M1	3504	10 yr	37.19	92.94	95.964		96.04	0.001085	1.29	41.19	63.72	0.31	201.09
M1	3504	20 yr	48.54	92.94	96.219		96.31	0.001038	1.38	60.62	89.04	0.31	279.81
M1	3504	50 yr	63.37	92.94	96.551		96.64	0.000898	1.43	102.35	174.83	0.30	524.10
M1	3504	100 yr	74.46	92.94	96.716		96.81	0.000916	1.51	151.56	432.98	0.31	741.14
M1	3283	2 yr	12.62	92.77	94.563		94.63	0.001800	1.18	10.66	10.11	0.37	64.44
M1	3283	5 yr	26.53	92.77	95.229		95.34	0.001831	1.46	18.39	17.33	0.39	136.15
M1	3283	10 yr	37.19	92.77	95.645		95.75	0.001571	1.49	32.98	54.57	0.37	192.90
M1	3283	20 yr	48.54	92.77	95.927		96.04	0.001393	1.56	51.09	84.43	0.36	267.48
M1	3283	50 yr	63.37	92.77	96.330		96.43	0.001018	1.52	101.93	229.34	0.32	501.53
M1	3283	100 yr	74.46	92.77	96.532		96.61	0.000841	1.46	160.05	318.05	0.29	706.72
M1	3067	2 yr	12.62	92.30	94.140		94.22	0.002077	1.23	10.25	10.12	0.39	62.18
M1	3067	5 yr	26.53	92.30	94.831		94.94	0.001853	1.46	18.15	12.52	0.39	132.21
M1	3067	10 yr	37.19	92.30	95.262		95.38	0.001931	1.52	27.76	45.97	0.40	186.35
M1	3067	20 yr	48.54	92.30	95.632		95.74	0.001393	1.48	47.77	61.33	0.35	256.81
M1	3067	50 yr	63.37	92.30	96.170		96.23	0.000708	1.25	135.56	381.77	0.26	475.91
M1	3067	100 yr	74.46	92.30	96.423		96.46	0.000481	1.11	244.03	512.31	0.22	663.12
M1	2812	2 yr	12.62	91.75	93.594	92.89	93.67	0.002196	1.24	10.19	10.32	0.40	59.57
M1	2812	5 yr	26.53	91.75	94.428	93.45	94.52	0.001457	1.30	20.35	14.07	0.35	127.30
M1	2812	10 yr	37.19	91.75	94.887	93.72	94.98	0.001254	1.35	29.15	26.47	0.33	179.08
M1	2812	20 yr	48.54	91.75	95.343	93.95	95.43	0.001006	1.33	44.19	38.38	0.31	245.07
M1	2812	50 yr	63.37	91.75	96.018	94.21	96.08	0.000530	1.15	95.07	140.73	0.23	444.77
M1	2812	100 yr	74.46	91.75	96.288	94.40	96.34	0.000460	1.15	120.64	150.04	0.22	613.20
M1	2766		Culvert										
M1	2764	2 yr	12.62	91.63	93.546	92.19	93.56	0.000141	0.45	28.32	17.19	0.11	59.01
M1	2764	5 yr	26.53	91.63	94.220	92.45	94.24	0.000221	0.66	40.31	18.68	0.14	126.40
M1	2764	10 yr	37.19	91.63	94.515	92.63	94.55	0.000305	0.81	48.27	39.50	0.17	177.95
M1	2764	20 yr	48.54	91.63	94.762	92.79	94.81	0.000371	0.94	58.58	44.16	0.19	243.58
M1	2764	50 yr	63.37	91.63	95.021	92.98	95.08	0.000458	1.09	70.57	49.06	0.21	441.95
M1	2764	100 yr	74.46	91.63	95.180	93.12	95.25	0.000508	1.19	78.57	51.43	0.23	609.36
M1	2543	2 yr	13.82	91.51	93.452		93.49	0.000724	0.83	16.62	13.87	0.24	54.05
M1	2543	5 yr	27.31	91.51	94.094		94.15	0.000777	1.04	27.15	26.94	0.26	118.95
M1	2543	10 yr	37.19	91.51	94.359		94.43	0.000913	1.18	35.62	38.74	0.29	168.69
M1	2543	20 yr	48.54	91.51	94.576		94.67	0.001007	1.35	47.78	86.89	0.31	231.84
M1	2543	50 yr	63.37	91.51	94.818		94.92	0.001038	1.48	69.99	94.16	0.32	426.44
M1	2543	100 yr	74.46	91.51	94.974		95.08	0.001045	1.55	84.82	96.68	0.32	591.33
M1	2366	2 yr	13.82	91.44	93.353		93.38	0.000497	0.70	19.81	16.60	0.20	50.81
M1	2366	5 yr	27.31	91.44	93.996		94.03	0.000513	0.85	34.69	30.28	0.22	113.46
M1	2366	10 yr	37.19	91.44	94.247		94.29	0.000586	0.97	45.70	57.50	0.24	161.67
M1	2366	20 yr	48.54	91.44	94.456		94.52	0.000651	1.11	58.71	67.28	0.25	223.00
M1	2366	50 yr	63.37	91.44	94.690		94.76	0.000709	1.25	75.75	77.10	0.27	414.72
M1	2366	100 yr	74.46	91.44	94.840		94.92	0.000747	1.34	87.59	81.30	0.28	577.69
M1	2099	2 yr	13.82	91.44	93.146	92.38	93.19	0.001025	0.94	14.64	13.34	0.29	46.22
M1	2099	5 yr	27.31	91.44	93.774	92.74	93.84	0.001078	1.12	25.31	25.80	0.31	105.46
M1	2099	10 yr	37.19	91.44	93.983	92.95	94.07	0.001284	1.30	33.30	53.78	0.34	151.14
M1	2099	20 yr	48.54	91.44	94.152	93.15	94.26	0.001487	1.48	42.78	59.75	0.37	209.47
M1	2099	50 yr	63.37	91.44	94.359	93.40	94.49	0.001575	1.65	56.01	68.20	0.39	397.15
M1	2099	100 yr	74.46	91.44	94.486	93.59	94.63	0.001657	1.77	65.08	77.99	0.40	557.33
M1	1899	2 yr	13.82	91.23	92.998	92.09	93.03	0.000628	0.78	19.75	29.99	0.23	42.77
M1	1899	5 yr	27.31	91.23	93.669	92.44	93.70	0.000428	0.82	67.77	124.67	0.20	96.12
M1	1899	10 yr	37.19	91.23	93.879	92.65	93.91	0.000443	0.90	95.53	137.57	0.21	138.21
M1	1899	20 yr	48.54	91.23	94.041	92.86	94.08	0.000498	1.01	118.60	149.31	0.22	193.28
M1	1899	50 yr	63.37	91.23	94.246	93.12	94.29	0.000541	1.12	170.64	384.39	0.24	374.42
M1	1899	100 yr	74.46	91.23	94.396	93.34	94.43	0.000487	1.11	233.95	444.31	0.23	527.34
M1	1577	2 yr	13.82	90.74	92.901	91.39	92.92	0.000210	0.54	29.22	26.25	0.14	34.90
M1	1577	5 yr	27.31	90.74	93.578	91.74	93.60	0.000222	0.68	65.35	151.48	0.15	71.54
M1	1577	10 yr	37.19	90.74	93.767	91.95	93.80	0.000287	0.82	84.92	199.89	0.17	103.83
M1	1577	20 yr	48.54	90.74	93.899	92.16	93.94	0.000379	0.97	100.95	264.49	0.20	150.40
M1	1577	50 yr	63.37	90.74	94.070	92.40	94.12	0.000481	1.15	125.07	309.77	0.22	315.07
M1	1577	100 yr	74.46	90.74	94.218	92.63	94.27	0.000496	1.21	148.35	312.77	0.23	450.38
M1	1550		Culvert										
M1	1549	2 yr	13.82	90.87	92.748	91.48	92.76	0.000186	0.45	30.40	23.54	0.13	34.41
M1	1549	5 yr	27.31	90.87	93.203	91.80	93.22	0.000303	0.64	48.55	89.77	0.17	70.31
M1	1549	10 yr	37.19	90.87	93.426	91.95	93.45	0.000347	0.73	70.49	131.87	0.18	101.98
M1	1549	20 yr	48.54	90.87	93.649	92.12	93.68	0.000349	0.79	95.61	145.11	0.19	147.97
M1	1549	50 yr	63.37	90.87	94.006	92.30	94.03	0.000290	0.81	146.34	324.06	0.17	311.71
M1	1549	100 yr	74.46	90.87	94.227	92.43	94.25	0.000261	0.82	187.29	346.25	0.17	446.16
M1	1311	2 yr	13.82	90.91	92.657	91.77	92.68	0.000614	0.70	19.99	21.50	0.22	28.50
M1	1311	5 yr	27.31	90.91	93.071	92.11	93.11	0.000696	0.93	40.31	83.53	0.25	59.70

HEC-RAS Plan: Proposed_v03 River: Flowing Reach: M1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	1311	10 yr	37.19	90.91	93.283	92.30	93.33	0.000708	1.03	59.68	96.38	0.26	86.08
M1	1311	20 yr	48.54	90.91	93.509	92.48	93.56	0.000671	1.10	82.77	108.55	0.26	125.75
M1	1311	50 yr	63.37	90.91	93.900	92.68	93.94	0.000484	1.06	134.63	182.40	0.23	273.69
M1	1311	100 yr	74.46	90.91	94.118	92.81	94.17	0.000489	1.13	199.32	395.58	0.23	391.75
M1	1187	2 yr	13.82	90.89	92.576		92.60	0.000656	0.72	19.19	20.73	0.23	26.07
M1	1187	5 yr	27.31	90.89	92.973		93.02	0.000793	0.99	36.46	73.49	0.27	54.95
M1	1187	10 yr	37.19	90.89	93.177		93.24	0.000838	1.12	52.10	80.27	0.28	79.17
M1	1187	20 yr	48.54	90.89	93.404		93.47	0.000817	1.20	72.38	97.15	0.28	116.15
M1	1187	50 yr	63.37	90.89	93.819		93.88	0.000597	1.18	124.21	174.33	0.25	257.68
M1	1187	100 yr	74.46	90.89	94.057		94.11	0.000490	1.14	179.67	336.37	0.23	368.31
M1	1160	2 yr	13.82	90.88	92.555		92.58	0.000740	0.76	20.58	46.45	0.24	25.54
M1	1160	5 yr	27.31	90.88	92.955		93.00	0.000768	0.98	46.90	86.02	0.26	53.84
M1	1160	10 yr	37.19	90.88	93.162		93.21	0.000774	1.07	65.84	96.73	0.27	77.59
M1	1160	20 yr	48.54	90.88	93.393		93.44	0.000716	1.13	89.45	111.16	0.27	113.98
M1	1160	50 yr	63.37	90.88	93.819		93.86	0.000459	1.04	196.71	463.23	0.22	253.38
M1	1160	100 yr	74.46	90.88	94.065		94.09	0.000298	0.90	326.12	540.42	0.18	361.53
M1	1070	2 yr	13.82	90.86	92.472		92.51	0.000924	0.86	16.29	26.51	0.27	23.88
M1	1070	5 yr	27.31	90.86	92.862		92.92	0.000999	1.11	39.74	71.53	0.30	49.93
M1	1070	10 yr	37.19	90.86	93.062		93.13	0.001044	1.24	55.38	84.56	0.31	72.13
M1	1070	20 yr	48.54	90.86	93.290		93.36	0.001028	1.34	79.68	134.43	0.32	106.36
M1	1070	50 yr	63.37	90.86	93.777		93.81	0.000478	1.07	225.06	558.09	0.23	234.38
M1	1070	100 yr	74.46	90.86	94.045		94.06	0.000251	0.84	375.71	563.80	0.17	329.92
M1	981	2 yr	13.82	90.81	92.380		92.42	0.001082	0.89	16.84	31.44	0.29	22.41
M1	981	5 yr	27.31	90.81	92.767		92.83	0.001103	1.13	41.87	90.22	0.31	46.30
M1	981	10 yr	37.19	90.81	92.974		93.03	0.001029	1.20	63.84	112.81	0.31	66.82
M1	981	20 yr	48.54	90.81	93.218		93.27	0.000876	1.23	93.70	137.35	0.29	98.65
M1	981	50 yr	63.37	90.81	93.747		93.77	0.000374	0.95	271.28	512.36	0.20	212.29
M1	981	100 yr	74.46	90.81	94.028		94.04	0.000201	0.75	424.86	567.45	0.15	294.29
M1	864	2 yr	13.82	90.75	92.295		92.32	0.000662	0.72	30.48	42.53	0.23	19.62
M1	864	5 yr	27.31	90.75	92.661		92.70	0.000894	1.04	50.62	82.29	0.28	40.86
M1	864	10 yr	37.19	90.75	92.868		92.92	0.000902	1.14	69.78	95.63	0.29	58.97
M1	864	20 yr	48.54	90.75	93.130		93.18	0.000746	1.15	95.43	100.25	0.27	87.53
M1	864	50 yr	63.37	90.75	93.697		93.73	0.000391	1.00	218.61	338.74	0.21	183.48
M1	864	100 yr	74.46	90.75	93.991		94.01	0.000270	0.90	326.28	422.00	0.17	250.12
M1	860	2 yr	13.82	90.74	92.294	91.47	92.31	0.000513	0.66	33.22	46.89	0.21	19.49
M1	860	5 yr	27.31	90.74	92.663	91.71	92.70	0.000689	0.94	55.87	92.30	0.25	40.64
M1	860	10 yr	37.19	90.74	92.871	91.86	92.91	0.000709	1.04	75.70	97.50	0.26	58.66
M1	860	20 yr	48.54	90.74	93.132	92.00	93.17	0.000607	1.06	101.62	100.90	0.25	87.11
M1	860	50 yr	63.37	90.74	93.696	92.14	93.73	0.000356	0.97	213.50	290.31	0.20	182.58
M1	860	100 yr	74.46	90.74	93.990	92.23	94.01	0.000249	0.87	300.81	332.47	0.17	248.81
M1	793	2 yr	13.82	90.70	92.252	91.43	92.28	0.000582	0.72	29.00	68.15	0.22	17.40
M1	793	5 yr	27.31	90.70	92.623	91.78	92.65	0.000609	0.89	66.44	115.13	0.24	36.54
M1	793	10 yr	37.19	90.70	92.834	91.98	92.87	0.000581	0.95	91.14	120.24	0.24	53.06
M1	793	20 yr	48.54	90.70	93.102	92.19	93.13	0.000495	0.97	125.41	138.99	0.22	79.50
M1	793	50 yr	63.37	90.70	93.684	92.37	93.70	0.000251	0.82	243.55	267.89	0.17	167.24
M1	793	100 yr	74.46	90.70	93.982	92.54	94.00	0.000175	0.74	323.75	270.35	0.14	227.85
M1	699	2 yr	13.82	90.68	92.170		92.21	0.000890	0.87	19.99	54.57	0.27	15.11
M1	699	5 yr	27.31	90.68	92.524		92.58	0.001009	1.13	45.86	85.33	0.30	31.28
M1	699	10 yr	37.19	90.68	92.735		92.79	0.000978	1.22	64.66	93.79	0.31	45.77
M1	699	20 yr	48.54	90.68	93.019		93.07	0.000792	1.22	94.34	126.90	0.28	69.21
M1	699	50 yr	63.37	90.68	93.649		93.68	0.000330	0.95	217.66	251.48	0.19	145.66
M1	699	100 yr	74.46	90.68	93.959		93.98	0.000220	0.84	298.12	266.32	0.16	198.75
M1	616	2 yr	13.82	90.66	92.093	91.50	92.13	0.000986	0.86	23.22	78.09	0.28	13.31
M1	616	5 yr	27.31	90.66	92.454	91.81	92.50	0.000898	1.02	54.52	91.34	0.28	27.09
M1	616	10 yr	37.19	90.66	92.671	92.02	92.71	0.000827	1.08	74.86	96.11	0.28	39.95
M1	616	20 yr	48.54	90.66	92.971	92.22	93.01	0.000628	1.06	104.43	100.74	0.25	60.92
M1	616	50 yr	63.37	90.66	93.624	92.35	93.65	0.000306	0.91	201.52	205.09	0.18	128.16
M1	616	100 yr	74.46	90.66	93.940	92.44	93.96	0.000217	0.83	269.36	216.42	0.16	175.06
M1	552	2 yr	13.82	90.64	92.018	91.49	92.06	0.001214	0.93	19.73	38.83	0.31	11.94
M1	552	5 yr	27.31	90.64	92.358	91.81	92.42	0.001376	1.22	36.01	52.15	0.35	24.20
M1	552	10 yr	37.19	90.64	92.568	91.98	92.64	0.001367	1.35	47.22	54.81	0.36	36.05
M1	552	20 yr	48.54	90.64	92.880	92.14	92.95	0.001081	1.36	65.10	59.95	0.33	55.51
M1	552	50 yr	63.37	90.64	93.569	92.31	93.62	0.000529	1.19	156.92	255.59	0.24	116.72
M1	552	100 yr	74.46	90.64	93.911	92.41	93.94	0.000308	0.99	246.12	261.67	0.19	158.61
M1	383	2 yr	13.82	90.28	91.806	91.23	91.85	0.001294	0.96	24.79	74.86	0.32	8.18
M1	383	5 yr	27.31	90.28	92.171	91.66	92.21	0.001062	1.09	60.63	121.43	0.31	16.05
M1	383	10 yr	37.19	90.28	92.427	91.85	92.46	0.000778	1.05	93.99	133.86	0.27	24.15
M1	383	20 yr	48.54	90.28	92.804	91.98	92.83	0.000447	0.92	152.13	165.36	0.21	37.19
M1	383	50 yr	63.37	90.28	93.552	92.11	93.56	0.000163	0.69	311.81	260.32	0.14	77.21
M1	383	100 yr	74.46	90.28	93.897	92.21	93.90	0.000112	0.62	403.29	265.89	0.11	103.87
M1	374	2 yr	13.82	90.20	91.790	91.16	91.84	0.001232	0.97	19.74	52.12	0.31	7.97

HEC-RAS Plan: Proposed_v03 River: Flowing Reach: M1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
M1	374	5 yr	27.31	90.20	92.141	91.57	92.20	0.001259	1.20	46.73	92.22	0.33	15.54
M1	374	10 yr	37.19	90.20	92.400	91.78	92.45	0.000982	1.19	71.29	97.41	0.30	23.36
M1	374	20 yr	48.54	90.20	92.784	91.97	92.82	0.000597	1.08	109.85	103.06	0.24	35.94
M1	374	50 yr	63.37	90.20	93.538	92.15	93.56	0.000265	0.89	239.63	246.94	0.17	74.56
M1	374	100 yr	74.46	90.20	93.889	92.24	93.90	0.000170	0.77	327.15	253.42	0.14	100.36
M1	318	2 yr	13.82	90.01	91.737	91.07	91.77	0.001009	0.88	34.25	124.39	0.28	6.48
M1	318	5 yr	27.31	90.01	92.117	91.66	92.14	0.000655	0.88	85.99	143.28	0.24	11.87
M1	318	10 yr	37.19	90.01	92.387	91.78	92.41	0.000466	0.84	124.77	144.63	0.21	17.93
M1	318	20 yr	48.54	90.01	92.779	91.87	92.79	0.000276	0.74	181.84	146.44	0.17	27.87
M1	318	50 yr	63.37	90.01	93.539	91.96	93.55	0.000116	0.59	301.54	164.52	0.11	59.60
M1	318	100 yr	74.46	90.01	93.887	92.04	93.89	0.000095	0.58	359.39	167.95	0.11	81.38
M1	277	2 yr	13.82	90.00	91.669	90.98	91.72	0.001319	1.02	16.84	47.97	0.32	5.42
M1	277	5 yr	27.31	90.00	92.036	91.36	92.10	0.001295	1.23	46.63	100.52	0.34	9.12
M1	277	10 yr	37.19	90.00	92.328	91.70	92.38	0.000884	1.16	76.97	105.38	0.29	13.76
M1	277	20 yr	48.54	90.00	92.744	91.93	92.77	0.000497	1.01	121.89	112.92	0.22	21.58
M1	277	50 yr	63.37	90.00	93.523	92.07	93.54	0.000194	0.78	214.51	125.03	0.15	48.92
M1	277	100 yr	74.46	90.00	93.874	92.16	93.89	0.000160	0.77	260.13	140.32	0.14	68.56
M1	241	2 yr	13.82	89.94	91.618	90.98	91.67	0.001374	1.03	15.42	34.85	0.33	4.83
M1	241	5 yr	27.31	89.94	91.957	91.35	92.04	0.001668	1.38	33.69	69.88	0.38	7.66
M1	241	10 yr	37.19	89.94	92.266	91.60	92.34	0.001175	1.33	57.03	77.42	0.33	11.31
M1	241	20 yr	48.54	89.94	92.703	91.81	92.75	0.000672	1.18	92.67	102.55	0.26	17.63
M1	241	50 yr	63.37	89.94	93.506	92.06	93.53	0.000254	0.90	189.82	187.49	0.17	41.12
M1	241	100 yr	74.46	89.94	93.862	92.16	93.88	0.000192	0.85	248.42	219.67	0.15	58.62
M1	236	2 yr	13.82	89.93	91.618	90.86	91.66	0.001078	0.95	18.27	36.69	0.30	4.75
M1	236	5 yr	27.31	89.93	91.954	91.26	92.03	0.001445	1.32	34.99	69.37	0.36	7.50
M1	236	10 yr	37.19	89.93	92.262	91.54	92.33	0.001068	1.30	58.45	79.21	0.32	11.05
M1	236	20 yr	48.54	89.93	92.701	91.74	92.75	0.000631	1.16	96.91	115.47	0.25	17.19
M1	236	50 yr	63.37	89.93	93.509	91.87	93.53	0.000200	0.81	224.79	383.42	0.15	39.98
M1	236	100 yr	74.46	89.93	93.865	92.13	93.88	0.000152	0.76	286.30	411.91	0.13	56.98
M1	144	2 yr	13.82	89.50	91.546	90.56	91.58	0.000689	0.84	20.74	68.74	0.24	2.95
M1	144	5 yr	27.31	89.50	91.868	90.99	91.92	0.000905	1.13	50.41	100.35	0.29	3.56
M1	144	10 yr	37.19	89.50	92.210	91.25	92.25	0.000601	1.05	85.90	106.22	0.24	4.38
M1	144	20 yr	48.54	89.50	92.673	91.62	92.70	0.000353	0.93	145.29	190.28	0.19	5.79
M1	144	50 yr	63.37	89.50	93.499	91.83	93.51	0.000128	0.68	273.33	413.67	0.12	9.44
M1	144	100 yr	74.46	89.50	93.855	91.91	93.87	0.000112	0.68	343.09	470.00	0.12	12.56
M1	110		Culvert										
M1	108.2	2 yr	13.82	89.50	91.493		91.51	0.000360	0.63	22.65	33.93	0.18	2.39
M1	108.2	5 yr	27.31	89.50	91.609		91.67	0.001040	1.14	27.47	45.60	0.30	2.65
M1	108.2	10 yr	37.19	89.50	91.731		91.83	0.001413	1.40	35.10	71.05	0.36	3.06
M1	108.2	20 yr	48.54	89.50	91.896		92.02	0.001573	1.59	47.76	80.12	0.39	3.74
M1	108.2	50 yr	63.37	89.50	92.141	91.31	92.27	0.001488	1.68	69.15	94.18	0.38	4.90
M1	108.2	100 yr	74.46	89.50	92.333	91.48	92.45	0.001340	1.70	87.86	102.06	0.37	5.96
M1	0	2 yr	13.82	89.50	91.450	90.26	91.47	0.000403	0.66	21.45	23.79	0.19	
M1	0	5 yr	27.31	89.50	91.450	90.63	91.54	0.001574	1.30	21.45	23.79	0.37	
M1	0	10 yr	37.19	89.50	91.450	90.85	91.61	0.002918	1.77	21.45	23.79	0.50	
M1	0	20 yr	48.54	89.50	91.450	91.07	91.72	0.004970	2.31	21.45	23.79	0.65	
M1	0	50 yr	63.37	89.50	91.450	91.31	91.91	0.008472	3.01	21.45	23.79	0.85	
M1	0	100 yr	74.46	89.50	91.480	91.48	92.09	0.010803	3.45	22.25	29.69	0.97	

Ottawa. ON
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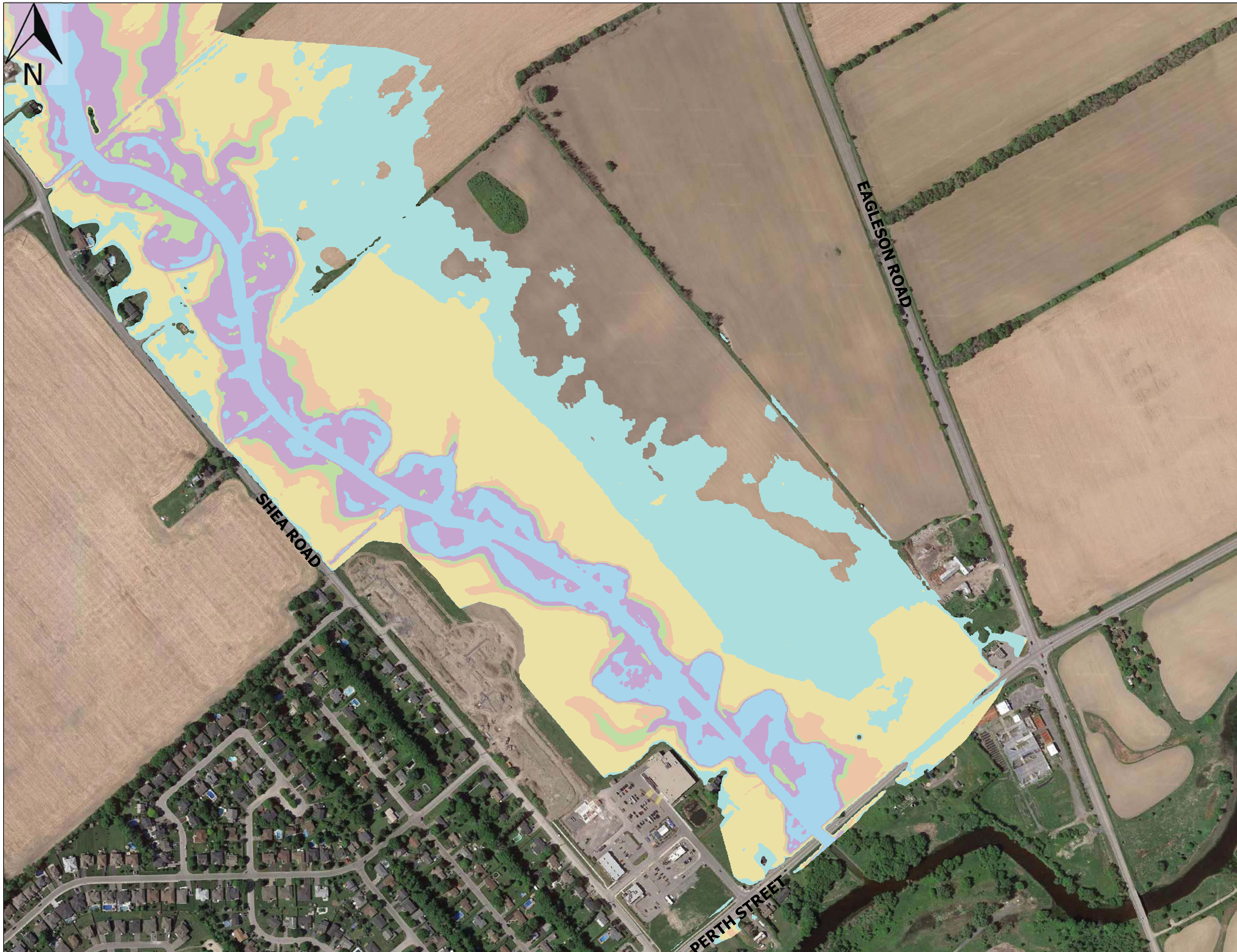
Montréal. QC
Québec. QC

Attachment D

Floodplain Maps: Existing and Proposed Conditions



Legend

- 2 Year Extent
- 5 Year Extent
- 10 Year Extent
- 20 Year Extent
- 50 Year Extent
- 100 Year Extent

NOTE: Floodplain maps have been provided for comparison purposes only and should not be used or considers in any way as official regulatory floodplain maps.

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

CARDEL HOMES

SCALE : 1:5000

0 100 200 300 m

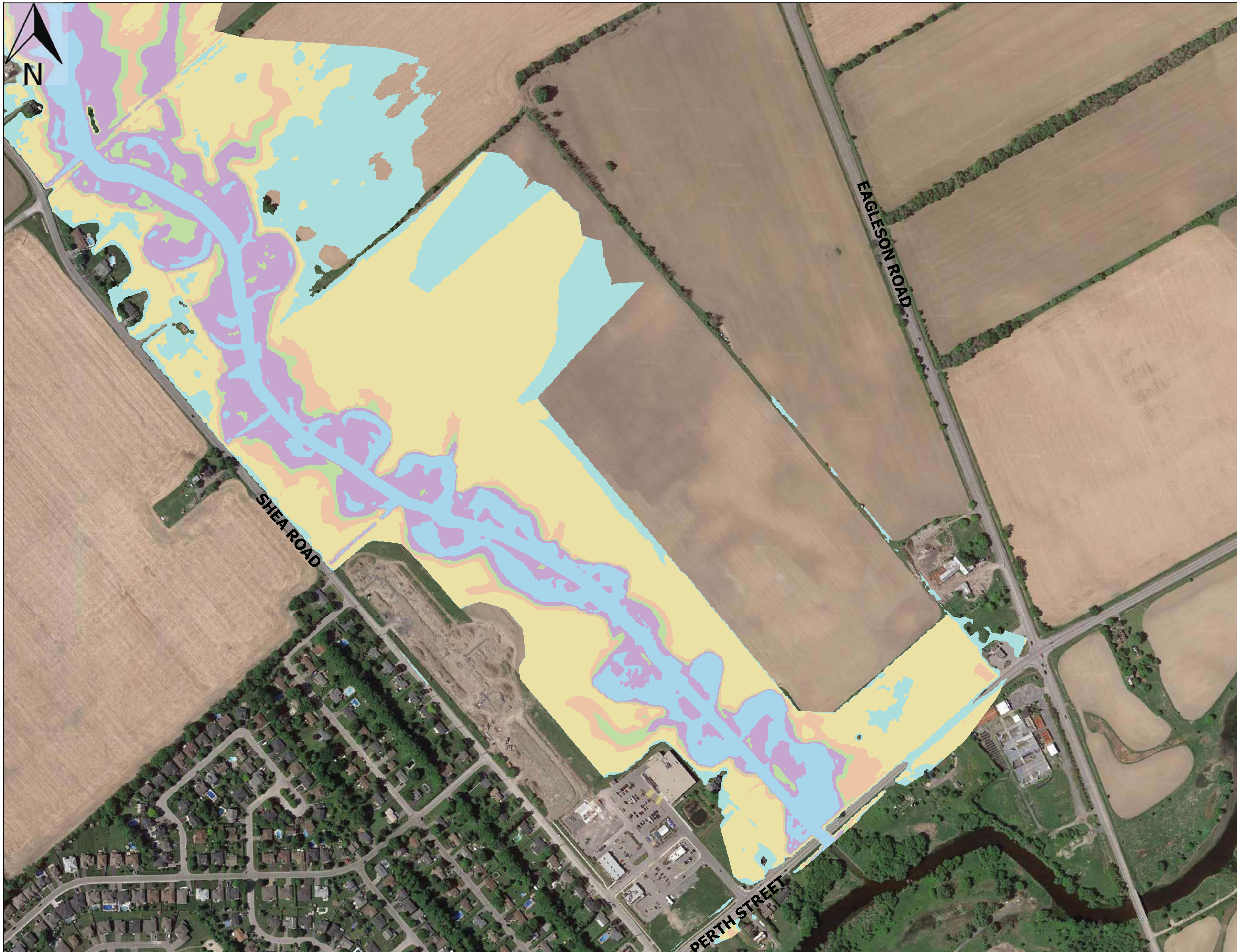
PROJECT :

Cardel Creekside - Flowing Creek: Floodplain Cut Fill Analysis

TITLE :

Figure D1: Existing Conditions Floodplain Extents

PROJECT	1355-19(03)
DRAWN:	JB
DATE:	MARCH 2020



Legend

- 2 Year Extent
- 5 Year Extent
- 10 Year Extent
- 20 Year Extent
- 50 Year Extent
- 100 Year Extent

NOTE: Floodplain maps have been provided for comparison purposes only and should not be used or considers in any way as official regulatory floodplain maps.

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www.jfsa.com

CARDEL HOMES

SCALE : 1:5000

0 100 200 300 m

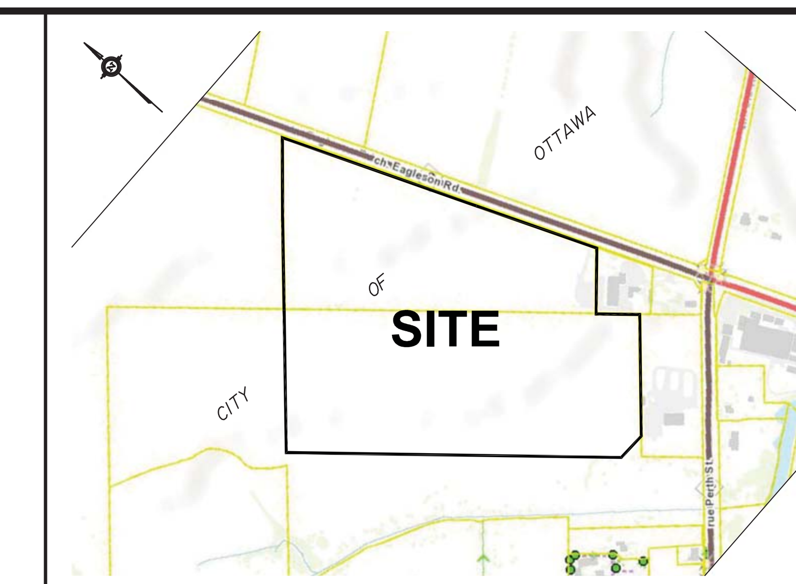
PROJECT :

Cardel Creekside - Flowing Creek: Floodplain Cut Fill Analysis

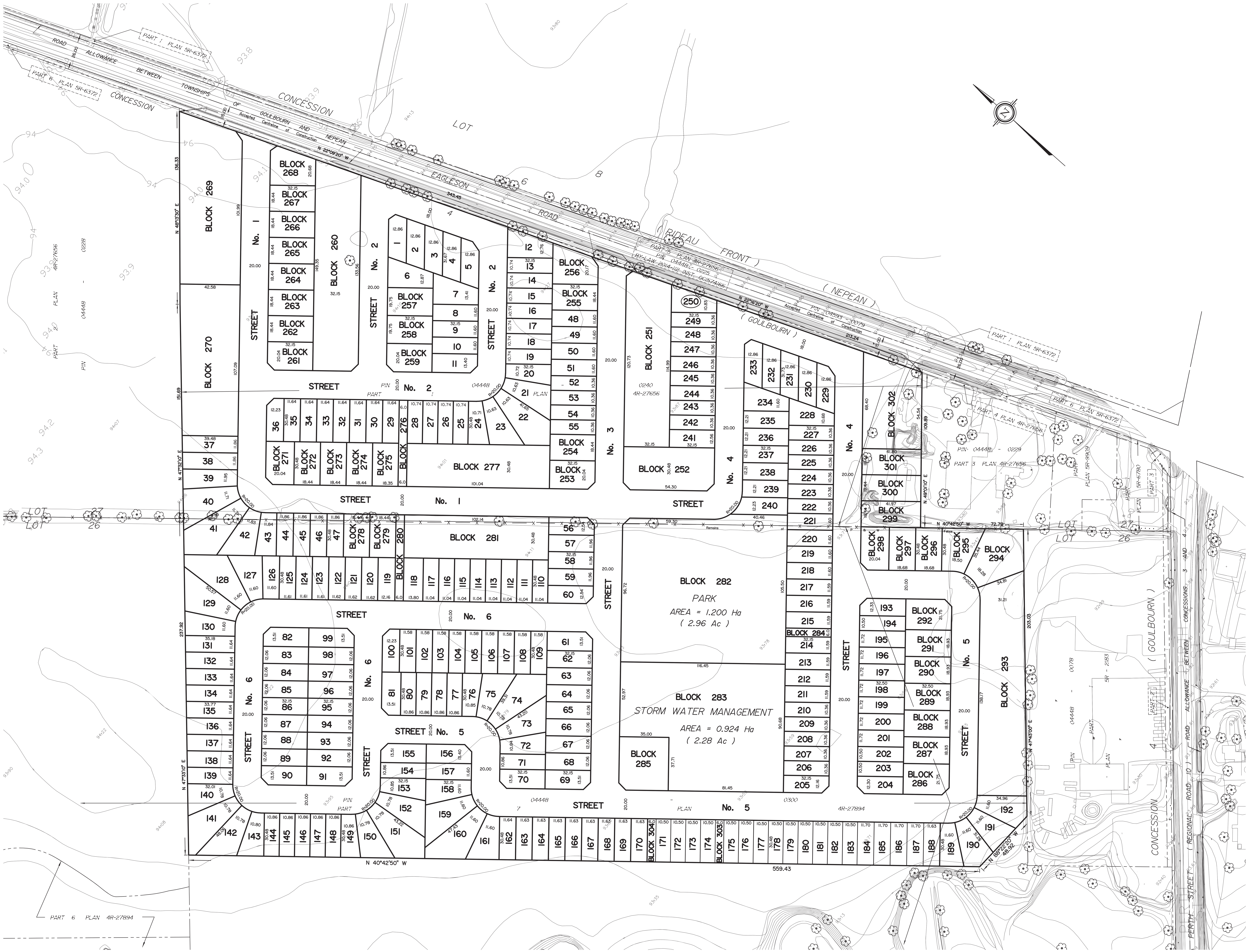
TITLE :

Figure D2: Proposed Conditions Floodplain Extents

PROJECT	1355-19(03)
DRAWN:	JB
DATE:	MARCH 2020



KEY MAP
NOT TO SCALE



DRAFT PLAN OF SUBDIVISION OF

PART OF LOTS 26 and 27 CONCESSION 4

Geographic Township of Goulbourn

CITY OF OTTAWA

Prepared by Annis , O'Sullivan , Vollebekk Ltd.

Scale 1 : 1250

50 37.5 25 12.5 0 25 50 Metres

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

SURVEYOR'S CERTIFICATE

I CERTIFY THAT :
The boundaries of the lands to be subdivided and their relationship to adjoining lands have been accurately and correctly shown.

_____________ Date

_____________ T. Hartwick
ONTARIO LAND SURVEYOR

OWNER'S CERTIFICATE

This is to certify that I am the owner / agent of the lands to be subdivided and that this plan was prepared in accordance with my instructions.

_____________ Date

_____________ Greg Graham
1470424 Ontario Inc.
Cardel Group of Companies
I have authority to bind the corporation

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51-17 OF THE PLANNING ACT

(a) see plan
(b) see plan
(c) see plan
(d) single and multi-family residential housing, park land, storm water management
(e) see plan
(f) see plan
(g) see plan
(h) City of Ottawa
(i) see soils report
(j) see plan
(k) sanitary, storm sewers, municipal water, bell, hydro, cable and gas to be available
(l) see plan

PROPOSED LAND USE TABLE

PROPOSED USE	LOTS / BLOCKS	NUMBER OF UNITS	AREA (sqm)
SINGLE DETACHED	1 - 250	250	99 986
TOWNHOMES	251, 252, 260, 269, 270, 277, 281, 293	130	31 043
SEMI DETACHED	253-259, 261-268, 271-275, 278, 279, 286-292, 294-301	74	23 887
STREETS	1 - 6		63 800
PARK LAND	282		12 000
WALKWAYS	276, 280, 284, 303, 304		1 229
STORM WATER LANDS	283		9 240
PUMPING STATION	285		1 307
OTHER	302		2 561
TOTAL		454	245 053

Ontario Land Surveyors
ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
14 Concourse Gate, Suite 500
Nepean, Ont. K2E 7S6
Phone: (613) 727-0850 / Fax: (613) 727-1079
Email: Nepean@aovltd.com

Job No. 22024-20 Cardel Pt Lt26 C4 GO DPS D2 | N

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DRAFT

Preliminary Geotechnical Investigation
Proposed Residential Development
Creekside Development - Village of Richmond
Shea Road at Perth Street

Ottawa, Ontario

experience • knowledge • integrity   expérience • connaissance • intégrité

The water content of one sample of the glacial till is about 10 percent.

4.5 Groundwater Levels

Well screens were installed in the overburden at all the borehole locations. The groundwater levels measured in the well screens on August 12 and 13, September 30, and November 9, 2020 and are summarized in Table 4.2.

Table 4.2 – Groundwater Depth and Elevation

Borehole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
20-22	1.64	91.55	August 12, 2020
	1.57	91.62	September 30, 2020
	0.98	92.21	November 9, 2020
20-23	1.59	91.45	August 12, 2020
	1.56	91.48	September 30, 2020
	1.23	91.81	Nov 9, 2020
20-24	1.62	92.50	August 13, 2020
	2.02	92.10	September 30, 2020
	1.37	92.75	Nov 9, 2020

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.6 Hydraulic Conductivity Estimates

Hydraulic conductivity estimates for the subject site are based on hydraulic conductivity testing completed for the Creekside 2 Development; refer to the GEMTEC report titled "Geotechnical and Hydrogeological Investigation, Proposed Residential Development, Creekside 2 – Village of Richmond, 2770 Eagleson Road, Ottawa, Ontario" dated December 11, 2020. The hydraulic conductivity estimates calculated for silty clay and glacial till range from 1 x 10^{-7} to 2 x 10^{-5} metres per second. The field measured hydraulic conductivity values were generally consistent with literature values for silty clay and glacial till, ranging from 1 x 10^{-12} to 1 x 10^{-6} metres per second. The slightly higher calculated hydraulic conductivity may be attributed to the variability of the fine-textured glaciomarine soils (e.g. glacial till) encountered on-site.

The subsurface geology of the boreholes advanced on the subject site (i.e. boreholes 20-22, 20-23 and 20-24) are consistent with those encountered in the Creekside 2 Development. The

Table 4.3 – Groundwater Depth and Elevation by Others

Borehole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
13-6	1.6	92.1	August 28, 2013
	1.1	92.6	January 17, 2014
	1.5	92.2	May 23, 2016
15-1	2.3	91.4	August 24, 2015
	1.9	91.8	May 23, 2016
15-2	1.8	91.7	August 24, 2015
	1.5	92.1	May 23, 2016

5.0 GEOTECHNICAL GUIDELINES

5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions. The implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from offsite sources are outside the terms of reference for this report and have not been addressed.

5.2 Site Grade Raise Restrictions

The development is underlain by deposits of sensitive silty clay, which has a limited capacity to support loads imposed by grade raise fill material, pavement structures and foundations for the houses. The placement of fill material on this site must therefore be carefully planned and controlled so that the stress imposed by the fill material does not result in excessive consolidation of the silty clay deposit. Concrete slabs, granular base materials, overall grade raise and pavement structures are considered grade raise filling. Groundwater lowering also results in a stress increase on the underlying sensitive silty clay deposit.

Based on the results of the subsurface investigation in conjunction with the oedometer consolidation test results carried out by others, and for preliminary planning purposes, the maximum thickness of any grade raise filling should be limited to the values for the borehole locations as provided in Table 5.1.

Table 5.1 – Maximum Permissible Grade Raise

Borehole Number	Maximum Grade Raise (metres)
20-22	1.0
20-23	1.9
20-24	3.0

The grade raise restriction at these locations has been calculated in order to limit the total settlement of the ground to about 25 millimetres in the long term. For design purposes, we have made the following assumptions:

- The groundwater lowering due to the development at this site will be at most 0.5 metres below the underside of footing elevation;
- The unit weight of the grade raise material used in the vicinity of the structures is not greater than 20 kilonewtons per cubic metre; and,
- The grade raise fill material used below the structures, where required, will be composed of compacted granular material having a unit weight of 22 kilonewtons per cubic metre.

If heavier grade raise fill material is used, the maximum grade raise will have to be reduced accordingly. Supplementary investigations should be carried out as the design progresses to delineate grade raise restriction zones.

5.3 Proposed Buildings

5.3.1 Excavation

The excavations for the foundations should be taken through topsoil to expose undisturbed native silty clay, and possibly into the glacial till. The sides of the excavations should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the shallow native overburden deposits can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical extending upwards from the base of the excavation.

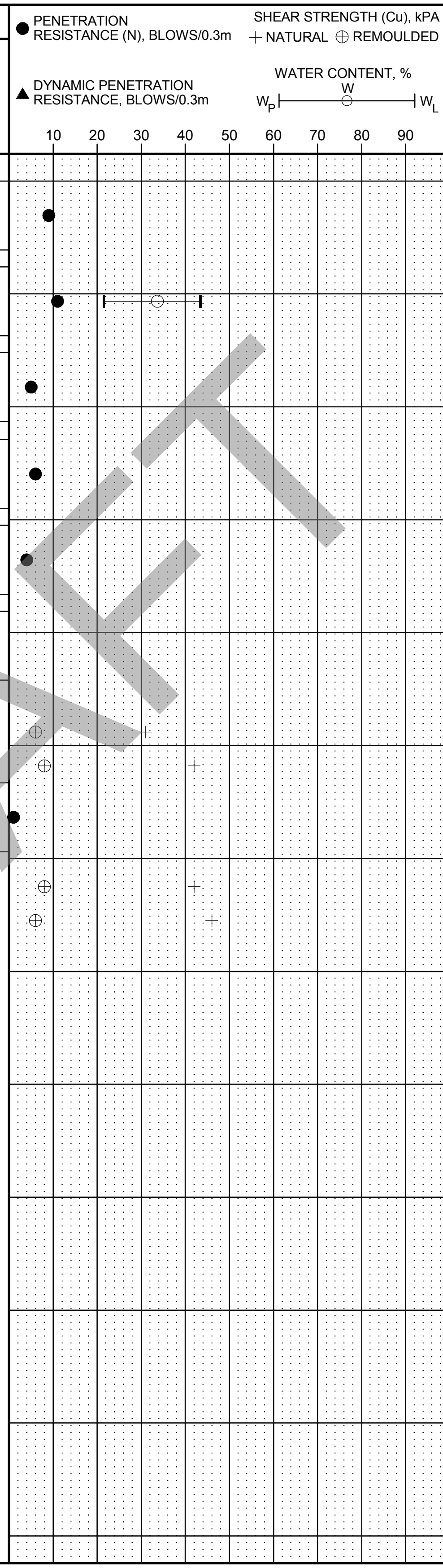
RECORD OF BOREHOLE 20-22

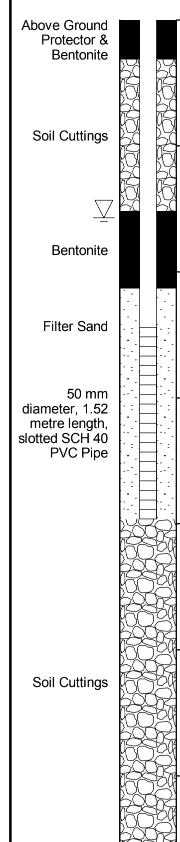
CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 20 2020

Boring method: Power Auger, Hollow Stem Auger (210mm OD)

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
Ground Surface	93.19				
TOPSOIL	93.04 / 0.15				
Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)		1	SS	205	9
		2	SS	310	11
		3	SS	510	5
		4	SS	610	6
		5	SS	610	4
FIrm, grey SILTY CLAY	89.53 / 3.66	6	SS	610	WH
		7	SS	610	1
End of borehole	86.64 / 6.55				





GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.6 ▽	91.6

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Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-23

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

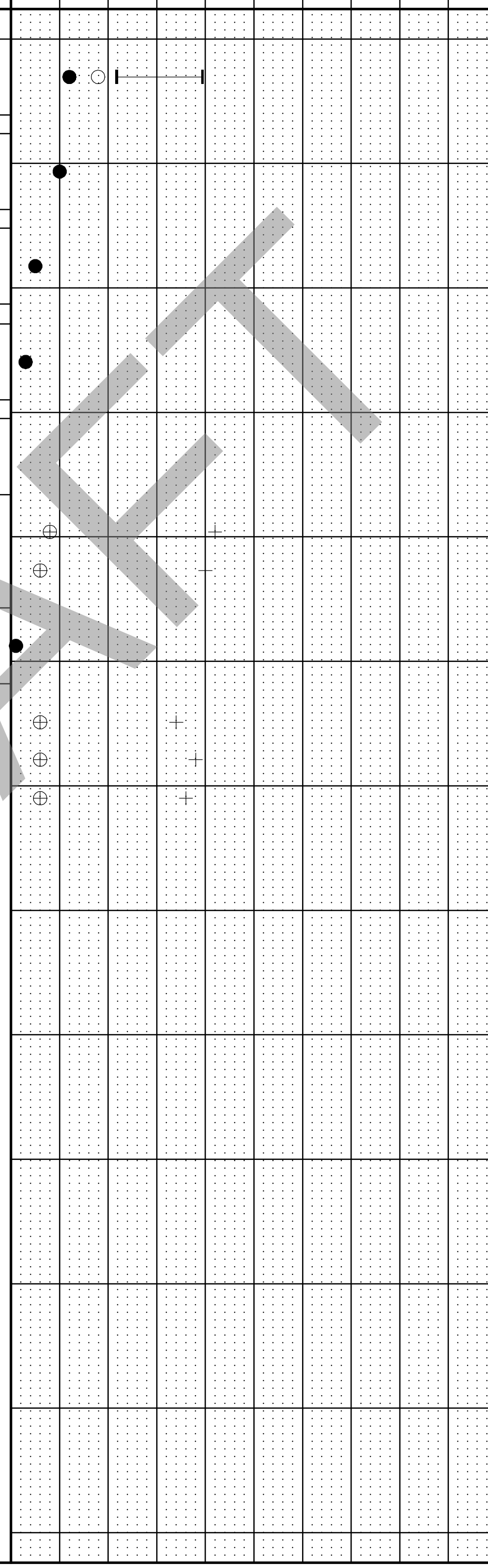
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 20 2020

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Ground Surface	93.04
	TOPSOIL	92.84 / 0.20
	Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)	
2.59	Firm, grey SILTY CLAY	90.45 / 2.59
6.10	End of borehole	86.94 / 6.10

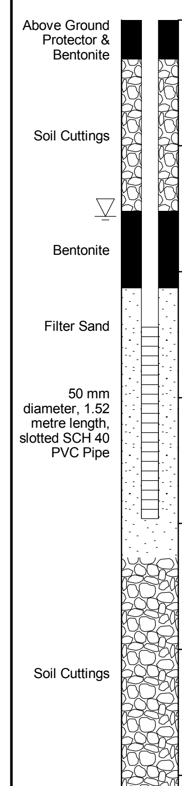
SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	SS	205	12
2	SS	100	10
3	SS	405	5
4	SS	610	3
5	SS	610	WH
6	SS	610	1

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.6 ▽	91.5

LOGGED: ML
CHECKED: WAM

GEMTEC Consulting Engineers and Scientists

RECORD OF BOREHOLE 20-24

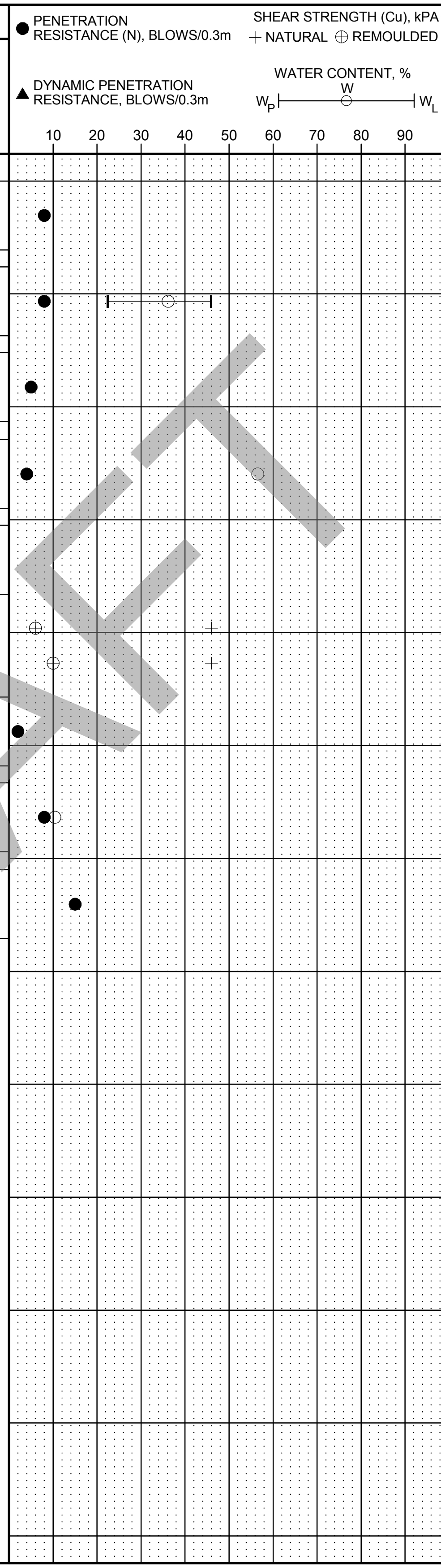
CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 8 2020

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)
Ground Surface	94.12
TOPSOIL	0.08
Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)	91.22 / 2.90
Firm, grey SILTY CLAY	89.14 / 4.98
Loose to compact, grey SILTY SAND, some gravel, with probable cobbles and boulders (GLACIAL TILL)	87.41 / 6.71
End of borehole	

SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	SS	75	8
2	SS	455	8
3	SS	610	5
4	SS	610	4
5	SS	610	WH
6	SS	610	2
7	SS	455	8
8	SS	455	15



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

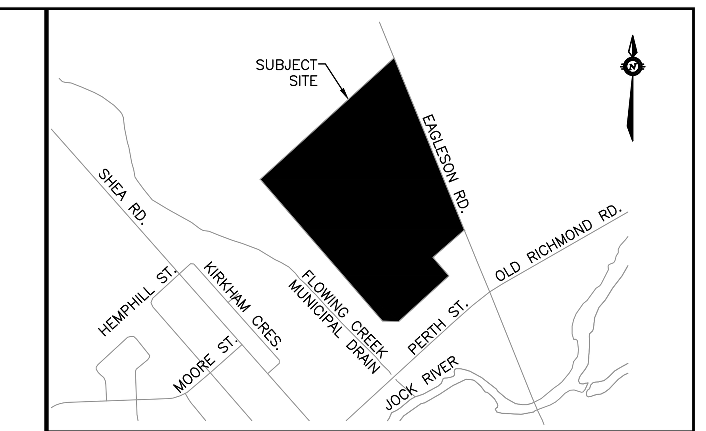
- Above Ground Protector & Bentonite
- Soil Cuttings
- Bentonite
- Filter Sand
- 50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
- Soil Cuttings

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.0 ▽	92.1

GEMTEC Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM



KEY PLAN

LEGEND

- SITE BOUNDARY
- 92.00 CENTRELINE OF ROAD GRADE
- 2.0 % ROAD SLOPE & DIRECTION
- MAJOR OVERLAND FLOW ROUTE

Elevations Table

Number	Depth of Fill (m)	Depth of Fill (m)	Color
1	0.0	0.5	
2	0.5	1.0	
3	1.0	1.5	
4	1.5	2.0	
5	2.0	2.5	
6	2.5	3.0	
7	3.0	3.5	
8	3.5	4.0	

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NO.	REVISION DESCRIPTION	DATE	BY
1	ISSUED FOR REVIEW	18/02/22	AHJ

SCALE
0 10m 20m 50m
HORIZONTAL 1:1250

LICENSED PROFESSIONAL ENGINEER
FEB. 18, 2022
A.H. JONKMAN
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Feb.18/22
B.L. MACKECHNIE
100199554
PROVINCE OF ONTARIO

Robinson Land Development
350 Palladium Drive
Ottawa, ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	JHB
CHECKED	BLM
DRAWN	JHB
CHECKED	AHJ
APPROVED	AHJ

1470424 ONTARIO INC.
301 MOODIE DRIVE, SUITE 100
OTTAWA, ON K2H 9C4

CREEKSIDE 2 SUBDIVISION
VILLAGE OF RICHMOND

CONCEPTUAL GRADING PLAN

PROJECT No.	20002
SURVEY	LIDAR
DATED	FEBRUARY 2022
DWG. No:	20002-GRD

Appendix B

Excerpts from GEMTEC Water Supply Assessment

Technical Memorandum (Prepared by JLR)

Communal Well Conceptual Site Plan (Prepared by JLR)

Conceptual Watermain Design (DWG. 20002-WM)

Watermain Design Sheet

Excerpts from Stantec Fire Flow Assessment

FUS Calculations

Fire Flow Correspondence with City

www.gemtec.ca

Submitted to:

Cardel Homes
301 Moodie Drive, Suite 100
Ottawa, Ontario
K2H 9C4

TW21-1C Water Supply Assessment Proposed Residential Development Creekside 2 - Village of Richmond 2770 Eagleson Road

Ottawa, Ontario

December 14, 2021
Project: 61899.03

experience • knowledge • integrity

However, the absence of drawdown in near surface wells installed in the clay deposits suggests that the aquifer system is still somewhat isolated from surface contamination.

Hydrogeological sensitive areas may exist where the clay is absent or it is removed from the surface by excavation. In general, the groundwater chemistry results, an absence of nitrate compounds and bacteriological parameters, also supports the water level data and suggest that the Site is not hydrogeological sensitive. However, consideration should be given to any excavations, such as storm water ponds, that could remove protective clays from the near surface at the Site. In these instances where excavations must be made, protective clay liners or geosynthetic liners should be considered.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the results of the hydrogeological investigation, the following conclusions and professional opinions are provided:

- The surficial geology across the Site generally consists of deposits of clay (with sand seams), till and lesser sands. The lowermost overburden sequence in the area is glacial till, overlain by glaciolacustrine silts and clays. Sand layers were also noted at two of 25 borehole locations. The Site overburden thickness ranges from approximately 6.5 to 13.6 metres, averaging 11 metres.
- The Site is not considered to be hydrogeologically sensitive based on the absence of thin soils, highly permeable soils or karst features.
- The water supply aquifers encountered at the Site includes limestone of the Oxford and March Formations (Beekmantown Group) underlain by sandstones of the Nepean Formation.
    - The Nepean sandstone lies approximately 67m bgs based on the on-site drilling results and is aquifer tested in this investigation.
    - Neighbouring water well users primarily rely on the Oxford and March Formation water supply aquifer.
    - Similar geological and hydrogeological conditions were found at both drilling and testing locations (e.g. TW21-1C; TW21-2C) located spatial 230 metres apart across the development site.
- Hydrogeological conceptual model (CSM)
    - The CSM was updated based on the on-site drilling results and hydraulic responses during the pump tests
    - The drawdown in the deep monitoring wells suggest that the groundwater in the overburden is connected to the bedrock aquifer system and that the overburden will respond to pumping stresses in the deep bedrock aquifers.

- Specifically, pumping in the Nepean Sandstone caused drawdown in the upper bedrock formations and in the overburden (deep) monitoring wells that were installed in both the till and clay (with sand seams).
  - It is likely that the sub-vertical fractures that cut across both the deep and shallow bedrock Formations can transmit groundwater to the deeper aquifer during pumping. The presence of a similarly orientated sub-vertical fracture set in both upper and lower bedrock formations may indicate a similar genesis.
  - Fracture aperatures / fracture zones in the Nepean Sandstone are typically wider than in the upper predominately limestone Formations which may explain why the sandstone has a much higher storage coefficient and transmissivity.
  - The measured water level drawdowns within the overburden unit during the pump tests, should be evaluated as part of the building geotechnical designs.
  - The aquifer may be more vulnerable to surficial contamination from reduced thickness of low permeability soils or higher permeable windows above the upper bedrock aquifer

- The water quality available from test well TW21-1C, completed in the Nepean sandstone aquifer is safe for consumption based on the absence of health-related exceedances; however, groundwater treatment for aesthetic parameters will be required.
  - Treatment for hardness, colour and iron may be desirable and can be treated using conventional water softeners and/or manganese greensand filters.
  - Sodium concentrations exceed the warning level for persons on sodium restricted diets of 20 mg/L and the Local Medical Officer of Health should be notified.
  - Total Dissolved Solids slightly exceeded the ODWQS aesthetic objective of 500 mg/L at 514 mg/L. LSI values indicate the water is considered scale forming, but non-corrosive; some encrustation can be expected.

- The water quality of the upper bedrock water supply aquifer (Oxford/March Formations), with the exception of the localized wells in the southern portion of the Creekside 1 development, meets the ODWQS maximum acceptable concentrations and treatability limits, with aesthetic objective and operational guideline exceedances of colour, total dissolved solids, hardness and the sodium warning level.
  - Private well owners interviewed in Creekside 1 – Phase 1 noted multiple groundwater quality issues, namely 'sulfur' odours, iron staining, high hardness and total dissolved solids. The groundwater quality issues are consistent with the aesthetic objective and operational guideline exceedances stated in the hydrogeological investigation (Golder, 2017). Although the sampling did not identify ODWQS for hydrogen sulphide, 'sulphur' odours were noted by 10 homeowners.
  - Multiple wells in the southern portion of the Creekside 1 development have reported intermittent elevated chlorides, total dissolved solids, sodium, hardness

and turbidity. An offsite impact is suspected as the source of the contamination. This potential source is currently being investigated.

  - Impacted wells are localized to the southern portion of Phase 1 of the Creekside 1 development.
  - Follow-up sampling in July 2021 found decreasing chloride concentrations in all affected wells which are within the ODWQS aesthetic objective, suggesting that the source is seasonally active and the inputs are rapidly flushed through the aquifer system.
  - The investigation is currently ongoing and under review by the MECP. Follow-up water quality sampling has been completed at numerous times since May, 2021 and reported under separate cover.

- The water quality determined in the course of this investigation is representative of long-term water quality and is consistent with water quality investigations of the Nepean Aquifer in the Ottawa area (Golder, 2011; Geofirma, 2021; City of Ottawa 2018; City of Ottawa, 2020).

- The quantity of groundwater available from the proposed water supply aquifer is sufficient for the proposed development and will sustain repeated pumping at the test rate and duration at 24-hour intervals over the long term.
  - TW21-1C was pumped at a constant rate of approximately 910 litres per minute for 72 hours. The maximum drawdown observed at the end of pumping was 44.07 metres and following cessation of pumping, the water level recovered 95% within 2 hours.
  - The large drawdown observed in TW21-1C and relatively low transmissivity of the pumping well can be attributed to well inefficiencies (i.e. well losses, pump configuration, pump depth, etc.). Larger diameter production wells will reduce well inefficiencies and associated water level drawdown.

- Interference between neighbouring private drinking water wells is expected to be minimal.
  - Drawdown at neighbouring residential wells in the Creekside 1 development (Oxford/March Formations) and Colonnade commercial development (Oxford/ March/ Nepean Formation) during the pumping test was less than 0.5 metres.

6.2 Recommendations

The following provides recommendations regarding well construction specifications and water quality:

6.2.1 Well Construction Recommendations

- Future production wells should be constructed in accordance with the City of Ottawa's Drinking Water Facility Design Guidelines and MECP regulations, including, but not limited to, Ontario Reg. 903. The well bore opening should be a minimum of 0.254 metres (10 inches) to reduce well inefficiencies.

- Well casings should be extended at least 57.3 metres (188 feet) below ground surface. The entire annular space between the steel casing and the overburden/ bedrock should be filled with a suitable cement or bentonite grout;

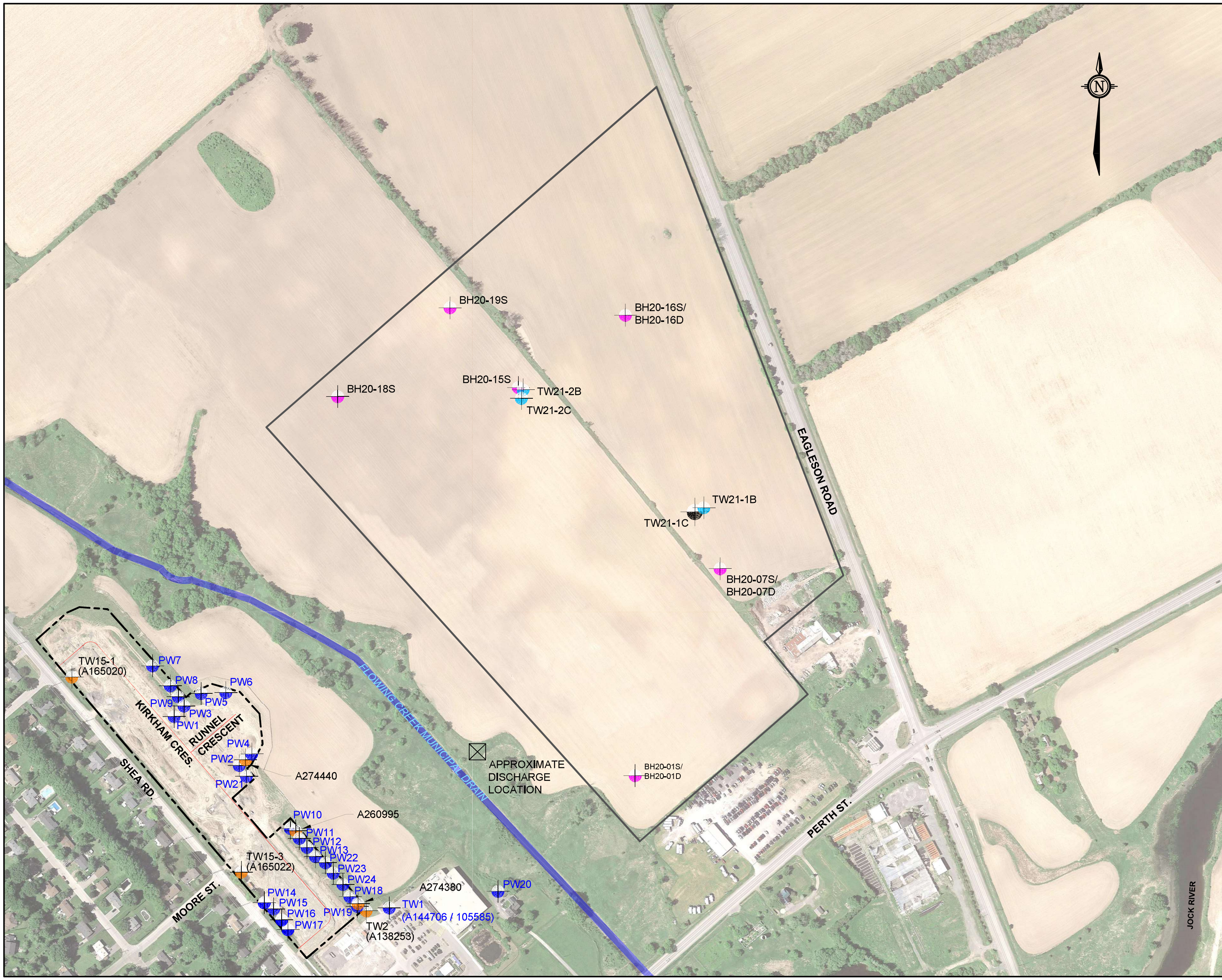
- A well grouting certification inspection should be conducted during the installation and grouting of the well casing for all future wells installed on the Site. The well grouting certification inspection should be conducted under the supervision of a professional engineer or professional geoscientist.

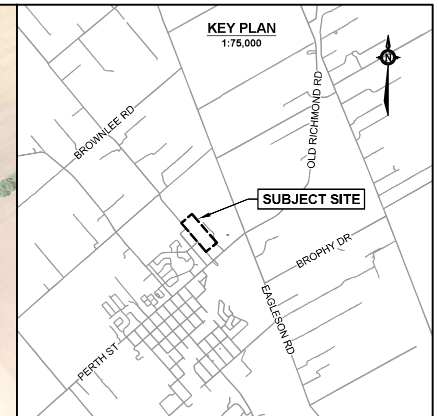
- The future production wells should be located proximal to TW21-1C within the proposed Communal Well location in accordance with any specific wellhead protection requirements. As the Nepean Aquifer is regionally extensive with similar hydrogeological properties, it is expected that comparable results in terms of groundwater quantity and quality will be obtained during communal well drilling at the proposed preferred location within the development area.

6.2.2 Water Quality Recommendations

- It is recommended that a water quality treatment specialist appropriately configure and size the treatment systems.

- It is recommended that homeowners and the Local Medical Officer of Health be informed that sodium concentrations exceed 20 mg/L and exceed the warning level for persons on sodium restricted diets.





LEGEND

- PUMPING WELL
- ON-SITE BEDROCK OBSERVATION WELL
- ON-SITE OVERBURDEN OBSERVATION WELL
- OFF-SITE OBSERVATION WELL
- PRIVATE WELL
- APPROXIMATE DISCHARGE LOCATION
- APPROXIMATE BOUNDARY OF CREEKSIDE 2 RESIDENTIAL DEVELOPMENT
- APPROXIMATE BOUNDARY OF CREEKSIDE 1 RESIDENTIAL DEVELOPMENT
- WATER COURSES
- EXISTING ROAD

Scale 1:4000

0 80 160 240m

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
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ottawa@gemtec.ca

Client	CARDEL HOMES
Project	61999.03
Location	CREEKSIDE DEVELOPMENT - PHASE 1 EAGLESON ROAD, OTTAWA, ONTARIO
Drwn by	S.L.
Chkd by	A.P.
Title	DETAILED SITE PLAN
Date	JULY, 2021
Rev.	0
	FIGURE 1

MEMORANDUM

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

J.L. Richards
& Associates Limited
700 - 1565 Carling Avenue
Ottawa, ON Canada
K1Z 8R1
Tel: 613 728 3571
Fax: 613 728 6012

To: Tyler Ferguson
Land Manager
1470424 Ontario Inc.

Date: January 28, 2022

JLR No.: 29540-000.1

CC: Matthew Marcuccio, P.Eng.

From: Ryan Ashford, P.Eng.

Re: **Creekside 2 Lands Communal Well Infrastructure Conceptual Design**

The purpose of this Technical Memorandum is to provide a conceptual design for proposed communal well infrastructure to service the Creekside 2 development in the Village of Richmond.

Background

The Village of Richmond (the Village) is located in the southwestern end of rural Ottawa, south of Kanata in Rideau-Goulbourn Ward. Richmond is the second largest village in the City of Ottawa and has significant projected development growth in the future. The majority of the Village is currently serviced by privately owned groundwater wells. A small portion of the southwestern part of the Village is serviced by two (2) communal groundwater wells, Kings Park Well No. 1 and No. 2. Each well has its own submersible pumping and treatment system (sodium hypochlorite injection), each feeding the distribution system directly. The source water quality has historically been clear of bacteria and chemical contaminants but has high hardness and detectable naturally occurring iron and hydrogen sulphide.

1470424 Ontario Inc. (Cardel) is currently proceeding with a Draft Plan Application for a new subdivision referred to as Creekside 2 lands, located in the northeast quadrant of the Village. The subject lands are bounded by Eagleson Road to the east, Perth Street to the south and Shea Road to the west. The Creekside 2 lands are also bounded by the Flowing Creek Municipal Drain on its southwest property limit. In order to facilitate development within the Creekside 2 lands, a new potable water supply is required to accommodate projected water demands. The proposed Communal Well site is located on the southeastern limit of the Creekside 2 lands adjacent to Eagleson Road.

Cardel retained Robinson Consultants Inc. (RCI) to prepare a serviceability study, lot grading design / layout and utilities design for the Creekside 2 development. Cardel also retained GEMTEC to provide geotechnical and hydrogeological investigation services for the Creekside 2 lands, including the planned future well site. J.L. Richards & Associates Limited was retained by Cardel to provide design, tendering and contract administration services in support of the construction of communal well infrastructure to service the Creekside 2 development.

Cardel is conducting ongoing consultations with the City of Ottawa (the City) on communal well infrastructure requirements to service the Creekside 2 lands. Cardel subsequently requested JLR to develop a conceptual design of the proposed new communal well, which is to be submitted to the City for review and approval.

Guidelines, Studies and Reports

The conceptual design of communal well infrastructure has been prepared in accordance with the following documents:

- City of Ottawa Drinking Water Facility Design Guidelines, Fourth Edition, July 2018
- Preliminary Geotechnical Investigation, GEMTEC Consulting Engineers and Scientists, February 2021
- TW21-1C Water Supply Assessment, GEMTEC Consulting Engineers and Scientists Limited, December 14, 2021
- Creekside 2 Subdivision Richmond, ON Serviceability Report (Draft), Robinson Land Development, January 2022

Groundwater Supply and Treatment

The Creekside 2 lands is to be serviced by communal well infrastructure located in Block 302 of the Draft Plan of Subdivision (refer to Appendix A of the Creekside 2 Subdivision Richmond, ON Serviceability Report (Draft), Robinson Land Development, January 2022).

The Preliminary Geotechnical Investigation, GEMTEC Consulting Engineers and Scientists, February 2021 confirmed that the quantity of groundwater available from the proposed water supply aquifer will sustain repeated, long term pumping at the maximum day design flow rate noted herein. In addition, the Creekside 2 water supply meets the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentrations and treatability limits, with aesthetic objective and operational guideline exceedances for colour, TDS, hardness, and the sodium warning level.

Therefore, the anticipated scope of required treatment will be limited to sodium hypochlorite injection to provide a chlorine disinfectant residual within the Creekside 2 water distribution system. Water softening systems are recommended to be installed by homeowners to address potential elevated hardness and TDS in the treated groundwater. It is also recommended that homeowners and the Local Medical Officer of Health be informed that sodium concentrations exceed 20 mg/L and exceed the warning level for persons on sodium restricted diets.

Design Basis

Water Demands

The Creekside 2 Subdivision Richmond, ON Serviceability Report (Draft), Robinson Land Development, January 2022 established the following build-out water demands for the Creekside 2 development:

Table 1: Creekside 2 Development Design Flows

Average Day Demand	Maximum Day Demand	Peak Hour Demand	Fire Flow Demand
4.54 L/s	11.35 L/s	24.97 L/s	13,000 L/min (217 L/s)

Water Storage Requirements

Per Section 13.0 of the City of Ottawa Drinking Water Facility Design Guidelines, Fourth Edition, July 2018, all water storage facilities shall have sufficient capacity to accommodate fire protection, balancing and emergency flow demands. The required storage volume when the water supply has a capacity equal to the maximum day demand is based on the following equation:

Total Treated Water Storage Required = A + B + C

Where: A = Fire Storage (Fire flow demand for a 2 hour duration);
B = Equalization Storage (25% of maximum day demand); and
C = Emergency Storage (25% of A + B).

The following table summarizes the required water storage volumes corresponding to the above-noted design flows:

Table 2: Required Water Storage Volumes

Water Storage Component	Volume
Fire Storage (A)	1,560 m^3
Equalization Storage (B)	245 m^3
Emergency Storage (C)	450 m3
Total Treated Water Storage Required	**2,255 m^3**

Proposed Site Layout

The proposed Creekside 2 Communal Well Conceptual Site Plan is shown in Figure SK7. The proposed site location is in the southeast quadrant of the development, adjacent to Street 'D' of the internal road network, but with vehicular access to the site to be provided by Eagleson Road.

All site services and utilities (except Ottawa Hydro) including watermain, storm sewer, sanitary sewer and natural gas are to connect to services within the Street 'D' Right-of-Way (ROW). The Hydro Ottawa electrical service entrance is to connect to the existing circuit(s) on Eagleson Road. The proposed communal well block provides adequate space for two (2) reservoirs, a pumping station, two (2) groundwater wells, a Diesel Generator Sets Enclosure, an access road and three (3) parking stalls. The site would be fully enclosed with chain link fencing and a swing type vehicle access gate for security purposes.

The access road entrance from Eagleson Road may slope upwards, depending on the overall grading plan for the Creekside 2 development. Retaining wall(s) may be required adjacent to Eagleson road to maximize usage of available space within the communal well block.

Groundwater Wells and Well Pumps

Two (2) 250 mm diameter groundwater wells are to be constructed in accordance with the City of Ottawa Drinking Water Facility Design Guidelines and O. Reg. 903. Each well is to be equipped with well casings and grout sealing extending at least 57.3 m below existing grade, per the TW21-1C Water Supply Assessment.

Each well is to also be equipped with a submersible pump with a rated capacity of 11.35 L/s, to provide a redundant water supply for accommodating the maximum day demand, should one well be taken out of service. Submersible pump discharge piping from each well shall be configured to discharge to either of the two (2) water storage reservoirs.

Water Storage Reservoirs

Two (2) at-grade water storage reservoirs are proposed to provide sufficient storage capacity for balancing and emergency flow demands. The proposed reservoir construction consists of a domed, glass-fused-to-steel cylindrical structure over a cast-in-place concrete base. The proposed reservoir design parameters are as follows:

Table 3: Reservoir Design Parameters

Water Storage Reservoir	Design Parameters
Number of Reservoirs	2
Available Storage Per Reservoir	1,130 m^3
Reservoir Diameter	18.0 m
Tank Sidewall Height (Incl. 1.0 m Freeboard)	5.5 m

Communal Well Building

A building enclosure is proposed to house the high lift pumping and sodium hypochlorite feed systems. Separate rooms are to be provided for the Pump Room, Electrical Room, Sodium Hypochlorite Room and a washroom.

High Lift and Fire Flow Pumping Systems

Two (2) pumps equipped with variable frequency drives are proposed to accommodate average day to peak hour flow demands (4.54 L/s to 24.97 L/s) from the Creekside 2 development, operating in a duty/standby arrangement. Pump speed is to modulate in order maintain a consistent distribution system pressure over the aforementioned flow range.

The fire flow pumping system is to be designed as a separate system. Fire flow pump system design, controls and flow monitoring shall be in accordance with NFPA 20-10. Two (2) split-case type pumps equipped with constant speed drives are proposed to deliver the design fire flow of 217 L/s, operating in a duty/standby arrangement.

The suction piping configuration would allow for isolation of either reservoir, without impacting high lift pumping system operations. The high lift and fire flow pumps discharge piping are to connect to separate headers equipped with flow metering and pressure monitoring instrumentation. Both discharge headers would then converge and connect to the water distribution system via a discharge watermain.

Sodium Hypochlorite Feed System

A sodium hypochlorite feed system is proposed to for secondary disinfection purposes in the Creekside 2 water distribution system. The feed system capacity is be based on the maintaining a minimum of 2.0 mg/L free chlorine residual following an effective contact time of 30 minutes, under maximum day flow and chlorine demand conditions.

The sodium hypochlorite feed system shall consist of two (2) positive displacement type feed pumps operating in a duty/standby arrangement, drawing from a single chemical storage day tank. Space is to be provided for long term storage of sodium hypochlorite shipping containers.

The primary dosing location would be into the well pump discharge header upstream of the water storage reservoirs. A secondary dosing location is to be provided on the high lift pumping system discharge header, to provide additional operational flexibility in maintaining consistent free chlorine residuals in the water distribution system.

Heating, Ventilation and Plumbing

Building heating systems for both the Communal Well Building and the Diesel Generator Sets Enclosure are to consist of gas-fired unit heaters supported by auxiliary electric heaters, in the event of interruption of the natural gas supply.

The Pump Room and Electrical Room is to be ventilated using an exhaust fan, with air being drawn into the space through a louvre and cold air trap. A dehumidifier is to be provided in the Pump Room to limit condensation on the pipes. The Sodium Hypochlorite Room is to be ventilated at all times to mitigate potential build-up of chlorine off-gassing. The

Electrical Room is to be provided with a dedicated AC unit in the space, which would turn on and off as required to offset the heat rejected by the electrical equipment.

The Communal Well Building plumbing system shall consist of a water heater and municipal hot and cold water piping to the washroom and the combination safety eyewash/shower in the Sodium Hypochlorite Room. Sanitary drainage piping is to be connected to the washroom fixtures and all floor drains, discharging to the sanitary sewer located in the Street 'D' ROW. No plumbing or sanitary drainage system is proposed for the Diesel Generator Sets Enclosure.

Electrical and Standby Power Systems

Service Distribution

Power distribution inside the Communal Well Building is to be provided via a new service entrance MCC (Motor Control Centre). The MCC is to house the service disconnect, the utility power meter, pump VFDs, and fire flow pump soft starters, two automatic transfer switches (ATSs), and a surge protective device. A 600V panelboard fed from the MCC is to distribute power to the other 600V loads and a 120V/ 208V transformer. 120V/ 208V power is to be distributed via a 120V/208V panelboard.

Standby Power

The proposed standby power system consists of two (2) diesel engine driven emergency generators connected to two (2) independent ATSs. Generator and ATS capacity are to be based on the combined loads of one (1) well pump, one (1) fire flow pump, one (1) chemical feed pump and all lighting, heating and ventilation equipment in operation.

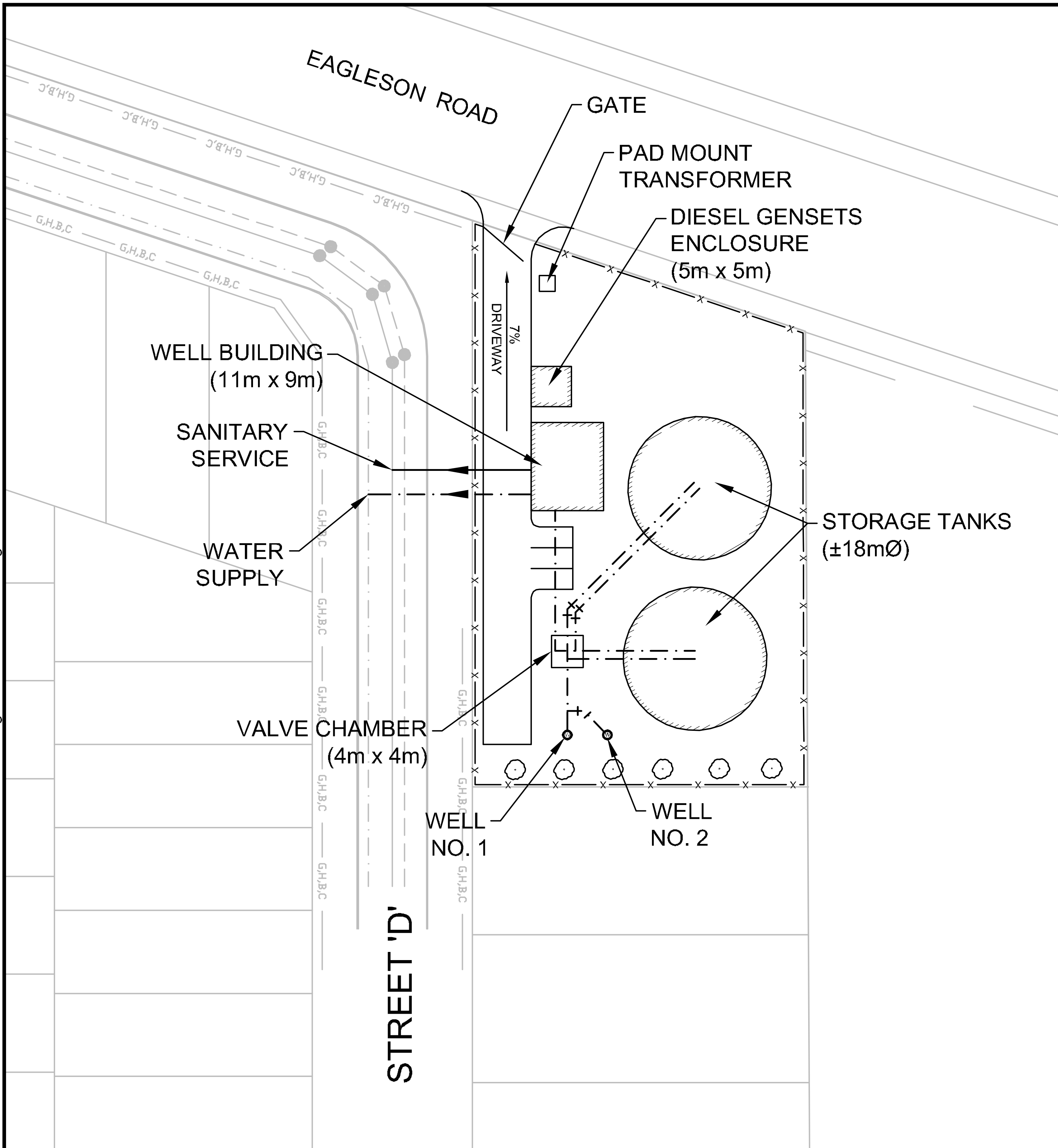
Both Generator sets are to be located within a prefabricated sound attenuation enclosure located adjacent to the eastern elevation of the Communal Well Building. Generator Sets are to include integral double-wall containment diesel fuel storage tanks. The enclosure base is to be recessed to provide 150% fuel storage tank volume spill containment.

J.L. RICHARDS & ASSOCIATES LIMITED

Prepared by:

Ryan Ashford, P.Eng.
Senior Environmental Engineer

RCA:ra



PROJECT:

CARDEL HOMES - CREEKSIDE 2

VILLAGE OF RICHMOND

DRAWING:

COMMUNAL WELL CONCEPTUAL SITE PLAN

www.jlrichards.ca

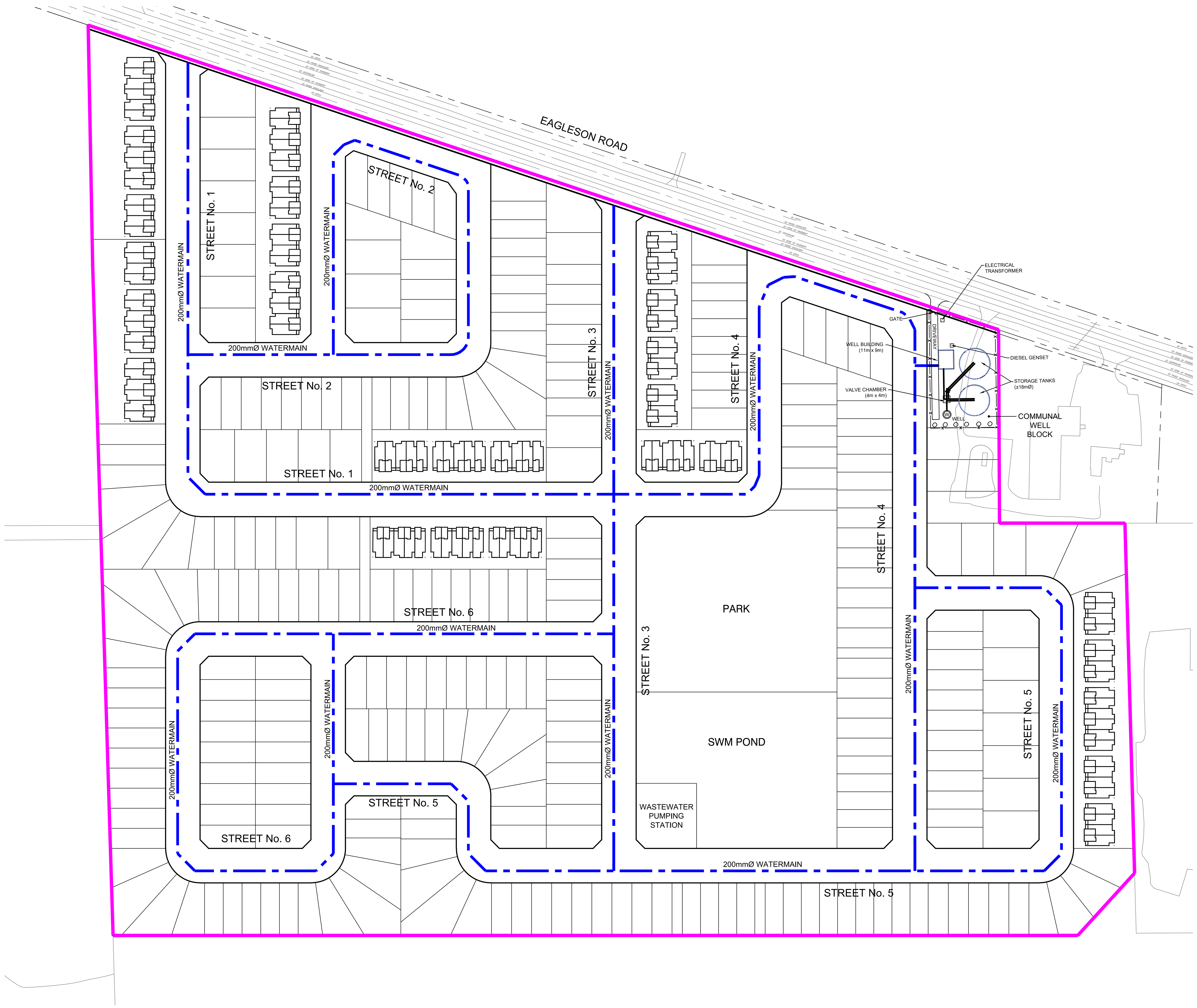
J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

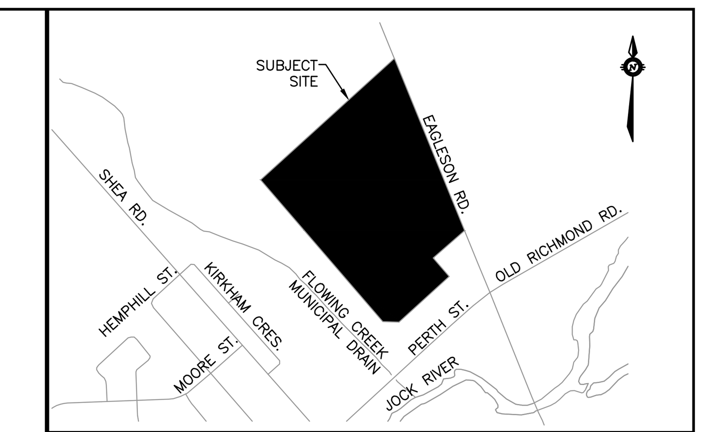
DESIGN:	MM
DRAWN:	TB
CHECKED:	RA
JLR #:	29540

DRAWING #: SK7

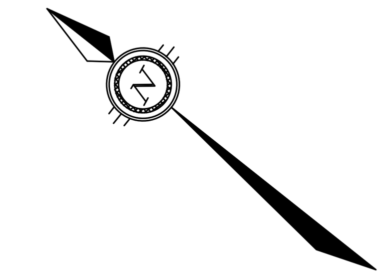
File Location: P:\29000\29540-000 - Cardel Creekside 2 in Richmond\5-Production\1-Civil\Figures\29540 C SK7.dwg

PLOT DATE: Friday, January 28, 2022 9:53:07 AM





KEY PLAN



LEGEND

- SITE BOUNDARY
- PROPOSED WATERMAIN

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NO.	REVISION DESCRIPTION	DATE	BY
1	ISSUED FOR REVIEW	18/02/22	AHJ

SCALE

0 10m 20m 50m
HORIZONTAL 1:1250

LICENSED PROFESSIONAL ENGINEER
FEB. 18, 2022
A.H. JONKMAN
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Feb. 18/22
B.L. MACKECHNIE
100199554
PROVINCE OF ONTARIO

Robinson
Land Development

350 Palladium Drive
Ottawa, ON K2V 1A8
(613) 592-6060 rcii.com

DESIGN	JHB
CHECKED	BLM
DRAWN	JHB
CHECKED	AHJ
APPROVED	AHJ

1470424 ONTARIO INC.
301 MOODIE DRIVE, SUITE 100
OTTAWA, ON K2H 9C4

CREEKSIDE 2 SUBDIVISION
VILLAGE OF RICHMOND

CONCEPTUAL WATERMAIN DESIGN

PROJECT No.	20002
SURVEY	LIDAR
DATED	FEBRUARY 2022
DWG. No:	20002-WM

WATERMAIN DESIGN SHEET

Creekside 2 Subdivision - 454 Units

Project No. 20002

TABLE

Junction Node Number	RESIDENTIAL POPULATION				NON-RES		AVG. DAILY				MAX. DAILY				MAX. HOURLY			
	ACTUAL COUNT				COMM. (HA)	INST. (HA)	DEMAND (L/s)				DEMAND (L/s)				DEMAND (L/s)			
	Low Density	Medium Density	High Density	Total Population			RES.	COMM.	INST.	TOTAL	RES.	COMM.	INST.	TOTAL	RES.	COMM.	INST.	TOTAL
J1	250	204		1400.8			4.54			4.54	11.35			11.35	24.97			24.97
Total	250	204		1400.8			4.54			4.54	11.35			11.35	24.97			24.97

<u>Residential Densities</u>

Low Density (SFH's) =	3.4	cap/unit
Medium Density (Townhouses, Semis) =	2.7	cap/unit
High Density (Apartments) =	1.8	cap/unit

<u>Avg. Daily Demand:</u>
Residential = 280 L/cap/day

<u>Max. Daily Demand:</u>
2.5 x Avg. Day

<u>Max. Hourly Demand:</u>
2.2 x Max. Day

Stantec

Memo

To:	M. Joseph Zagorski, P.Eng.	From:	Christène Razafimaharo/Kevin Alemany
	City of Ottawa		Stantec Consulting Ltd.
File:	163401668	Date:	September 9, 2021

Reference: Village of Richmond Water Supply – Functional Design Study – Fire Flow Requirements - DRAFT

OVERVIEW

The City of Ottawa retained Stantec to prepare the Village of Richmond Water Supply - Functional Design Study. As part of this Study, the City of Ottawa has requested that the current fire flow limitations in the Village of Richmond be presented and design criteria proposed for future fire flow requirements.

The objectives of this memo are:

- To review fire flow requirements as described in applicable guidelines;
- To present current fire flow limitations in the Village of Richmond;
- To establish the fire flow that will be used to size the infrastructure needs for the Village of Richmond's water supply.

The fire flow calculation method discussed and used in this memo is outlined in the Fire Underwriters Survey (FUS)'s *Water Supply for Public Fire Protection* (1999). It is a method commonly used in Canada to calculate fire flows for watermain sizing.

REVIEW OF FIRE FLOW REQUIREMENTS IN APPLICABLE GUIDELINES

MECP GUIDELINES

The Ministry of the Environment, Conservation and Parks (MECP) Design Guidelines for Drinking-Water Systems (2019) provides fire flow requirements for sizing water storage; however, they also refer communities to the FUS for fire flow calculations for fire protection requirements.

The MECP provides a table (Table 8-1 of the guidelines), which outlines required fire flow and duration, based on equivalent populations. The MECP guidelines indicate that the rates presented in its Table 8-1 are typically used by small municipalities in Ontario, and also state that:

"Fire protection is a municipal responsibility and the municipality may elect to provide for higher fire flow requirements or entirely forgo fire protection by way of the drinking-water distribution system."

Additionally, the MECP guidelines mention that:

"The above equation is for the calculation of the storage needs for a system where the water supply system is capable of satisfying only the maximum day demand. For situations where the water supply system can supply more, the storage requirements can be reduced accordingly."

Based on these statements, it can be interpreted that the water supply system's additional capacity, in excess of maximum day demand, could be used to supply fire flows, and hence reduce storage requirements. However, for future planning purposes, similar to the original Village of Richmond Servicing Study, it is recommended that excess well supply not be used to offset the storage requirement at the planning and design stages as this allows for system operational flexibility.

CITY OF OTTAWA GUIDELINES & TECHNICAL BULLETINS

The City of Ottawa Water Design Guidelines state the use of the FUS method is required to calculate fire flow requirements affecting pipe sizing. Historically, certain building design scenarios resulted in differing interpretations of how to apply the FUS guidelines. To improve the application of the FUS guideline, the City of Ottawa contracted the National Research Council Canada (NRC) to review current practices in calculating fire flow requirements (Roy-Poirier et al., 2016), and to develop a detailed protocol to clarify the application of the FUS method (published in the City's Technical Bulletin ISTB-2018-02). The Technical Bulletin ISTB-2018-02 also maintains the fire flow requirement cap of 10,000 L/min established in the previous Technical Bulletin ISDTB-2014-02 for single family houses with a minimum spatial separation of 10 m between the backs of adjacent units, and town and row houses (with specific requirements for firewalls).

CITY OF OTTAWA WATER MASTER PLAN

For system-level planning, the City of Ottawa 2013 Water Master Plan (WMP) level of service design criteria identifies target fire flows for the planning and design of pumping stations, storage facilities and transmission mains. The system planning fire flow values are based on typical FUS values, and while they consider building types in the pressure zones, it remains the responsibility of the building owners and building designers to ensure that the available fire flow in the distribution network is sufficient for their specific building's needs. Core areas (inside the Greenbelt) have a system level fire flow objective of 13,000 L/min, whereas non-core areas (outside the Greenbelt) have a system level fire flow objective of 10,000 L/min. A system level fire flow objective is one in which the major infrastructure such as pumping stations, storage facilities and large diameter transmission lines are design to convey these fire flows.

FUS RESULTS FROM LOCAL CASE STUDIES

The fire flow requirements of recent studies in the City of Ottawa and in the Village of Richmond were reviewed as part of this assignment. The fire flows were calculated using the FUS approach, and encompass different housing and construction types, areas and exposure distances. The different examples shown are not equipped with sprinklers. The detailed calculations are provided in **Attachment 1**, and are summarized in **Table 1**.

The fire flows obtained range from 8,000 L/min for 2.00 hours to 13,000 L/min for 2.75 hours. The 10,000 L/min cap as per the City of Ottawa's Technical Bulletins is applicable provided that fire areas are limited to no more than the lesser of 7 dwellings or 600 m^2 in building footprint, and that there is a minimum separation of 10 m between the backs of adjacent units (e.g. calculation #3). The cap is not applicable to back-to-back townhouses, as illustrated by calculation #4.

Reference: **Village of Richmond Water Supply – Functional Design Study – Fire Flow Requirements - DRAFT**

Table 1: Overview of FUS Fire Flow Requirements for Various Cases

#	Housing Type	Construction Type	Number of Floors	Building Footprint	Exposure Coefficient	Firewall ?	FUS Fire Flow	Cap Applicable ?	FUS Fire Flow - Capped	Duration
[-]	[-]	[-]	[m^2]	[m^2]	[-]	[Y/N]	[L/min]	[Y/N/NA]	[L/min]	[hours]
1	MLT	Wood Frame	3	220	0.50	Y	10,000	NA	10,000	2.00
2	SFH	Wood Frame	2	186	0.65	N	8,000	NA	8,000	2.00
3	MLT	Wood Frame	2	318	0.65	N	11,000	Y	10,000	2.00
4	MLT	Wood Frame	3	330	0.55	Y	13,000	N	NA	2.75

FIRE FLOW REQUIREMENTS FOR THE VILLAGE OF RICHMOND

GENERAL CONSIDERATIONS

Given that the expected buildout population in the Village of Richmond is approximately 19,000 people (Technical Memorandum #1), the suggested MECP fire flow would be around 264 L/s (16,000 L/min) for a duration of 4.20 hours, based on Table 8-1 of the MECP guidelines (and interpolating between the table's values).

As the MECP allows for municipal requirements to supersede its guidelines, the City of Ottawa requirements should also be considered in establishing an applicable fire flow for the Village of Richmond. Indeed, as the Village of Richmond is a non-core area, a fire flow of 10,000 L/min would be applicable, as per the 2013 WMP. Existing developments in the Village of Richmond are deemed to meet the separation requirements described in the Technical Bulletins (or should be required to do so), thus a fire flow cap of 10,000 L/min may be applied. Future developments, however, tend to not meet the requirements for the 10,000 L/min fire flow; in this case, a higher fire flow may be warranted.

Furthermore, for fire flows of 10,000 L/min (167 L/s) and 13,000 L/min (217 L/s), the corresponding duration in MECP Table 8-1 of the guidelines is 3.00 hours, however the FUS' corresponding durations are 2.00 hours and 2.75 hours, respectively. As both the MECP and the City's design guidelines refer to the FUS, a duration of 2.00 hours is considered a reasonable design value.

WESTERN DEVELOPMENT LANDS

For new developments in the Village of Richmond (notably in the Western Development Lands, WDL), the 2015 Village of Richmond Water Servicing Functional Design Report (FDR) established fire flow requirements of 4,000 L/min for 1.50 hours for single family homes (SFH), and of 8,000 L/min for 2.00 hours for multi-level town homes (MLT). These fire flows were based on the FUS long method.

The initial storage sizing at the Richmond West Pumping Station (PS) to service the WDL was based on the requirements for single-family units expected to be developed within the first 10 years (i.e., 4,000 L/min for 1.50 hours), with staged expansions for future developments and increased fire flows. A resulting storage volume of 1,175 m^3 was therefore adopted.

For wood frame construction, and maintaining the same gross floor area and exposures, the required fire flow for SFH is 7,000 L/min for 2.25 hours, and for MLT it is 10,000 L/min for 2.00 hours with a firewall (which would limit the number of units to 3 units, and the building footprint to 250 m^2).

Reference: Village of Richmond Water Supply – Functional Design Study – Fire Flow Requirements - DRAFT

RECOMMENDED DESIGN CRITERIA AND SUPPLY

As per the 2015 FDR's original intent, fire flow is to be supplied solely from the reservoir storage and from high-lift pumps (HLPs). No storage requirement reduction using the groundwater wells' excess capacity (i.e., offsetting) is to be applied.

Based on the review presented in this memo and input from the City of Ottawa, it is recommended that the following fire flows be used:

- For new developments, a fire flow of 13,000 L/min for 2.00 hours; developers would ensure that new unit designs meet the requirements for this fire flow, as per the FUS;
- For existing developments' future requirements, a fire flow of 10,000 L/min for 2.00 hours, as per the FUS and as per current development designs (mostly SFH on large lots).

A fire flow of 13,000 L/min for a duration of 2.00 hours should be used to size storage in the Village of Richmond, with provision to expand to 3.00 hours.

Stantec Consulting Ltd.

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Attachments: 1. FUS Fire Flow Calculations

REFERENCES

City of Ottawa (2010). Ottawa Design Guidelines – Water Distribution. First Edition, July 2010.

City of Ottawa (2014). Technical Bulletin ISDTB-2014-02. Revisions to Ottawa Design Guidelines – Water.

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ATTACHMENT 1: FUS FIRE FLOW CALCULATIONS

FUS Fire Flow Calculation

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

Stantec Project #: 163401668
Project Name: Village of Richmond Water Supply
Date: August 6, 2021
Data inputted by: Christène Razafimaharo, M.Sc., EIT
Data reviewed by: Kevin Alemany, M.A.Sc., P.Eng

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

Notes:
Basements less than 50% above grade, i.e. more than 50% below grade.
Back-to-back townhomes.
*Analysis for a group of 4 back-to-back townhomes (combined floor space = 4 * 55 m^2), when 10 (or 12)-unit blocks are equipped with firewalls.*

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Townhouse - indicate # of units	4	Units	
			Townhouse - indicate # of units	4				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement if 50% below grade):			3	3	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based total floor area of all floors (non-fire resistive construction):			220 Square Metres (m2)	660	Area in Square Meters (m^2)	
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1,000 L/min						**8,000**
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited combustible	-0.15	N/A	**6,800**
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	**0**
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	**0**
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	**0**
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	20.1 to 30.1m	0.1	0.5	m	**3,400**
			East Side	Fire Wall	0.1			
			South Side	20.1 to 30.1m	0.1			
			West Side	3.1 to 10.0m	0.2			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1,000 L/min, with max/min limits applied:***						**10,000**
		Total Required Fire Flow (above) in L/s:						**167**
		Required Duration of Fire Flow (hrs)						**2.00**
		Required Volume of Fire Flow (m^3)						**1,200**

FUS Fire Flow Calculation

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

Stantec Project #: 163401668
Project Name: Village of Richmond Water Supply
Date: August 6, 2021
Data inputted by: Christène Razafimaharo, M.Sc., EIT
Data reviewed by: Kevin Alemany, M.A.Sc., P.Eng

Fire Flow Calculation #: 2
Building Type/Description/Name: Residential

Notes: -

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Single Family	1	Units	
			Townhouse - indicate # of units	5				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement if 50% below grade):			2	2	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based total floor area of all floors (non-fire resistive construction):			2,000 Square Feet (ft2)	372	Area in Square Meters (m^2)	
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1,000 L/min						**6,000**
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited combustible	-0.15	N/A	**5,100**
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	**0**
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	**0**
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	**0**
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	20.1 to 30.1m	0.1	0.65	m	**3,315**
			East Side	10.1 to 20.0m	0.15			
			South Side	3.1 to 10.0m	0.2			
			West Side	3.1 to 10.0m	0.2			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1,000 L/min, with max/min limits applied:***						**8,000**
		Total Required Fire Flow (above) in L/s:						**133**
		Required Duration of Fire Flow (hrs)						**2.00**
		Required Volume of Fire Flow (m^3)						**960**

FUS Fire Flow Calculation

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

Stantec Project #: 163401668
Project Name: Village of Richmond Water Supply
Date: August 6, 2021
Data inputted by: Christène Razafimaharo, M.Sc., EIT
Data reviewed by: Kevin Alemany, M.A.Sc., P.Eng

Fire Flow Calculation #: 3
Building Type/Description/Name: Residential

Notes: -

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Townhouse - indicate # of units	3	Units	
			Townhouse - indicate # of units	3				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement if 50% below grade):			2	2	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based total floor area of all floors (non-fire resistive construction):			3,426 Square Feet (ft2)	637	Area in Square Meters (m^2)	
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1,000 L/min						8,000
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited combustible	-0.15	N/A	6,800
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	0
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	0
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	0
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	20.1 to 30.1m	0.1	0.65	m	4,420
			East Side	3.1 to 10.0m	0.2			
			South Side	10.1 to 20.0m	0.15			
			West Side	3.1 to 10.0m	0.2			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1,000 L/min, with max/min limits applied:***						**11,000**
		Total Required Fire Flow (above) in L/s:						**183**
		Required Duration of Fire Flow (hrs)						**2.25**
		Required Volume of Fire Flow (m^3)						**1,485**

FUS Fire Flow Calculation

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

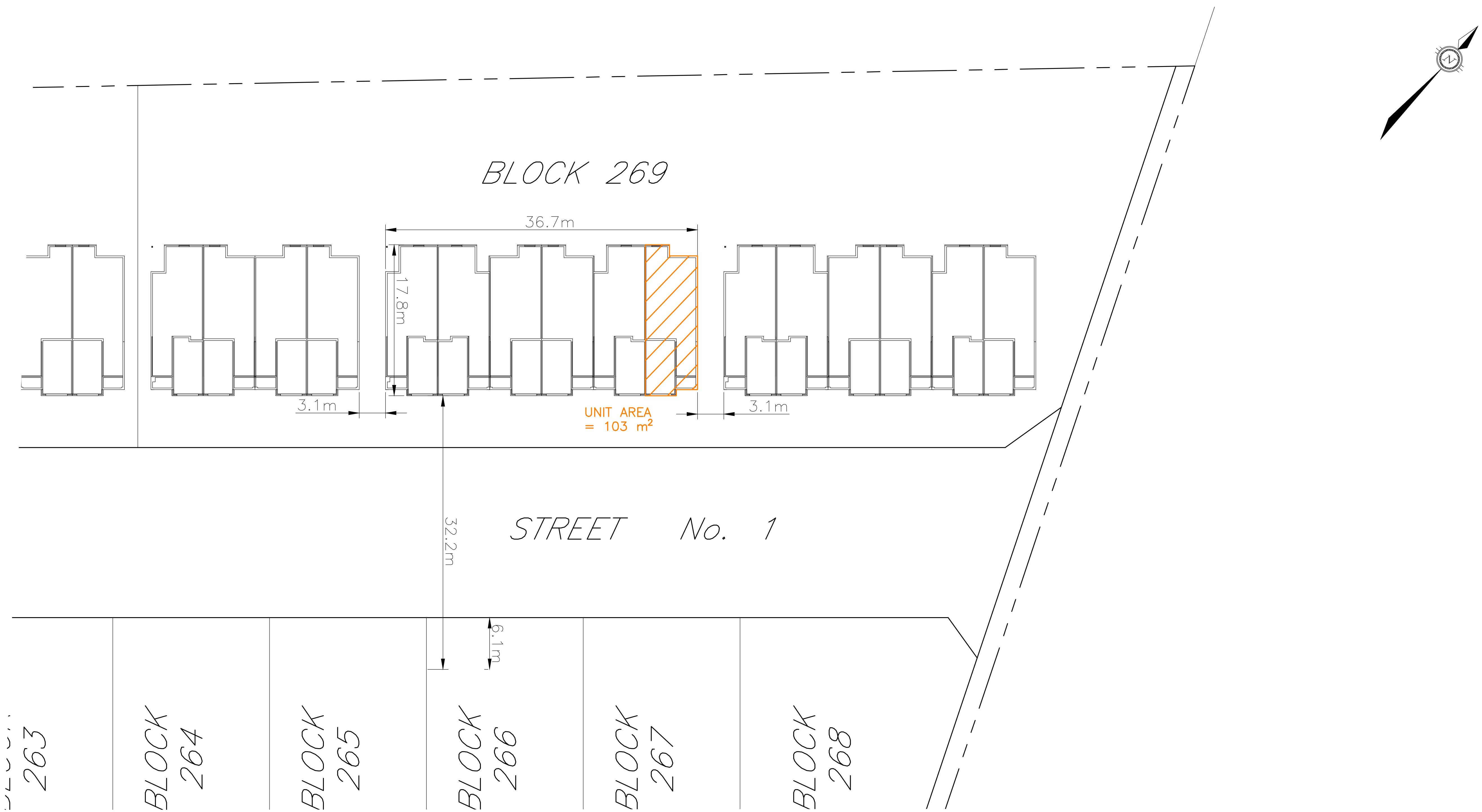
Stantec Project #: 163401668
Project Name: Village of Richmond Water Supply
Date: August 6, 2021
Data inputted by: Christène Razafimaharo, M.Sc., EIT
Data reviewed by: Kevin Alemany, M.A.Sc., P.Eng

Fire Flow Calculation #: 4
Building Type/Description/Name: Residential

Notes:
Basements less than 50% above grade, i.e. more than 50% below grade.
Back-to-back townhomes.
*Analysis for a group of 6 back-to-back townhomes (combined floor space = 6 * 55 m^2), when 12-unit blocks are equipped with firewalls.*

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
1	Choose Frame Used for Construction of Unit	**Framing Material**						
		Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	**Floor Space Area**						
		Type of Housing	Single Family	1	Townhouse - indicate # of units	6	Units	
			Townhouse - indicate # of units	6				
			Other (Comm, Ind, Apt etc.)	1				
2.2	# of Storeys	Number of Floors/Storeys in the Unit (do not include basement if 50% below grade):			3	3	Storeys	
3	Enter Ground Floor Area of One Unit	Average Floor Area (A) based total floor area of all floors (non-fire resistive construction):			330 Square Metres (m2)	990	Area in Square Meters (m^2)	
4	Obtain Required Fire Flow without Reductions	Required Fire Flow (without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1,000 L/min						**10,000**
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited combustible	-0.15	N/A	**8,500**
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	**0**
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	**0**
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	**0**
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	20.1 to 30.1m	0.1	0.55	m	**4,675**
			East Side	Fire Wall	0.1			
			South Side	10.1 to 20.0m	0.15			
			West Side	3.1 to 10.0m	0.2			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1,000 L/min, with max/min limits applied:***						**13,000**
		Total Required Fire Flow (above) in L/s:						**217**
		Required Duration of Fire Flow (hrs)						**2.75**
		Required Volume of Fire Flow (m^3)						**2,145**



Robinson Land Development

scale 1:500	CREEKSIDE 2 SUBDIVISION		project no. 20002
date 01/01/22	TITLE: TOWNHOUSE – 6 UNIT – BLK 269		TH–6
drawn by BLM			

Robinson Consultants

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "Water Supply for Public Fire Protection" by Fire Underwriters' Survey (FUS)

Project No.: 20002
Project Name: Creekside 2 Subdivision
Date: February 2022

Building Type/Description/Name: Townhouse w/ Firewall
6 Units (50% Reduction)
Block 269

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	**Choose Frame Used for Construction of Unit**	Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary Construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	**Choose Type of Housing (if TH, Enter Number of Units per TH Block)**	Type of Housing	Single Family	1	Townhouse - indicate # of units	3	Units	
			Townhouse - indicate # of units	6				
			Other (comm, ind, etc.)	1				
2.2	**# of Storeys**	Number of Floors/Storeys in the Unit (do not include basement):			2	2	Storeys	
2.3	**Length-height factor**	Length	North Side	36.7	Length-Height factor	73.4	m.Storeys	
			East Side	17.8	Length-Height factor	35.6	m.Storeys	
			South Side	36.7	Length-Height factor	73.4	m.Storeys	
			West Side	17.8	Length-Height factor	35.6	m.Storeys	
3	**Enter Ground Floor Area of One Unit**	Enter Ground Floor Area (A) of One Unit Only:			103	618	Area in Square Metres (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10,000				
4	**Obtain Required Fire Flow Without Reductions**	Required Fire Flow (without reductions or increases per FUS) (F=220*C*√A), round to nearest 1000 L/min						**8000**
5	**Apply Factors Affecting Burning**	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	**Choose Combustibility of Building Contents**	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited Combustible	-0.15	N/A	**6800**
			Limited Combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid Burning	0.25				
5.2	**Choose Reduction Due to Presence of Sprinklers**	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	None	0	N/A	**0**
			None	0				
5.3	**Choose Separation Distance Between Units**	Exposure Distance Between Units	North Side	100.0	5%	0.46	N/A	**3128**
			East Side	3.1	18%			
			South Side	30.1	5%			
			West Side	3.1	18%			
6	**Obtain Required Fire Flow, Duration & Volume**	***Total Required Fire Flow, rounded to nearest 1000 L/min:***						**10000**
		Total Required Fire Flow (above) in L/s:						**166.667**
		Required Duration of Fire Flow (hrs):						**2**
		Required Volume of Fire Flow (m^3):						**1200**

Note: The most current FUS document should be referenced before design to ensure that the above figures are consistent with the intent of the Guidelines

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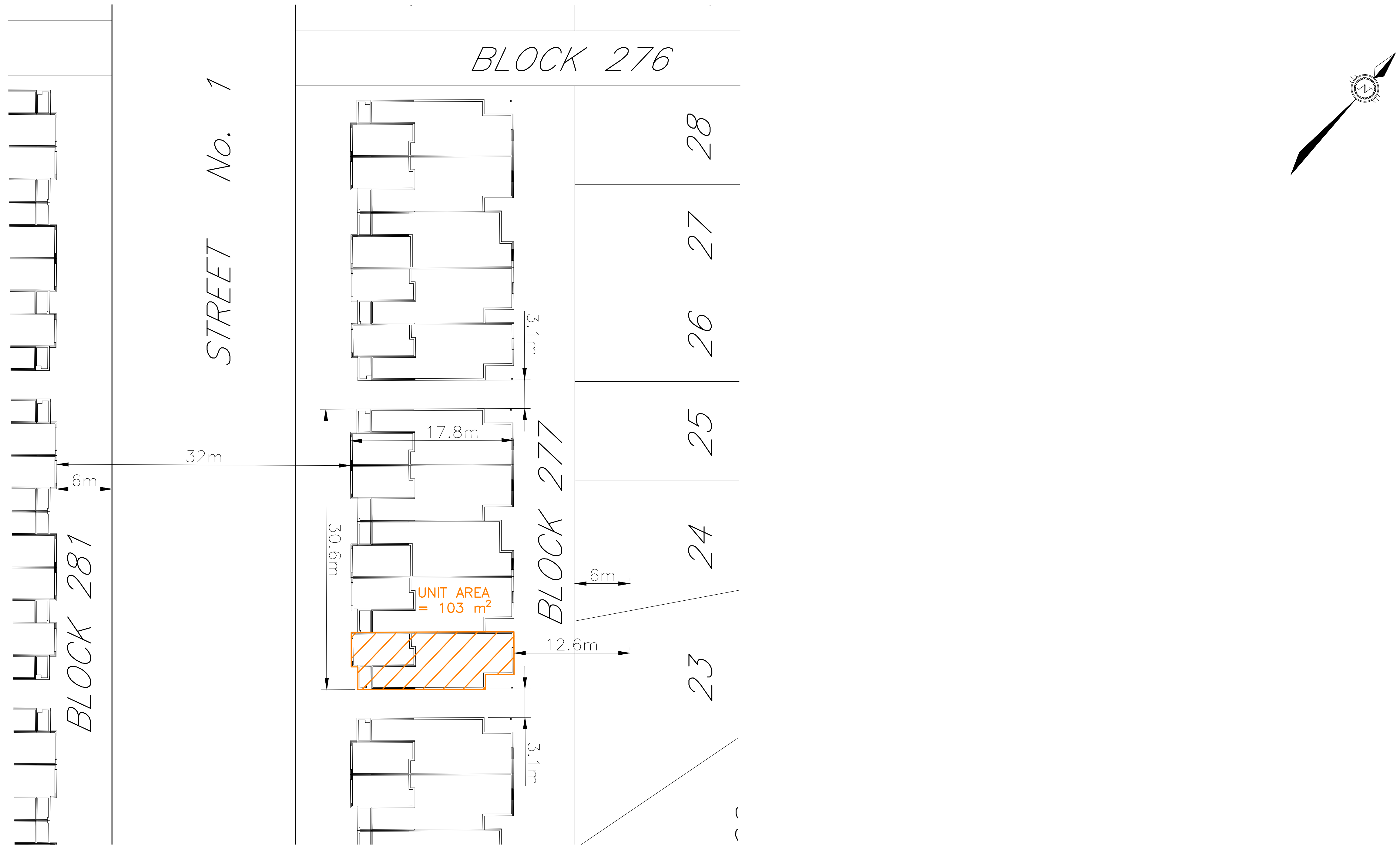
(grey)	No information, No input required



Robinson Land Development

scale	1:500	CREEKSIDE 2 SUBDIVISION	project no. 20002
date	01/01/22		
drawn by	BLM	TITLE: TOWNHOUSE – 5 UNIT – BLK 277	TH–5

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "Water Supply for Public Fire Protection" by Fire Underwriters' Survey (FUS)

Robinson Consultants

Project No.: 20002
Project Name: Creekside 2 Subdivision
Date: February 2022

Building Type/Description/Name: Townhouse w/ Firewall
5 Units (40% Reduction)
Block 277

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

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	**Choose Frame Used for Construction of Unit**	Coefficient related to type of construction (C)	Wood Frame	1.5	Wood Frame	1.5	m	
			Ordinary Construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	**Choose Type of Housing (if TH, Enter Number of Units per TH Block)**	Type of Housing	Single Family	1	Townhouse - indicate # of units	3	Units	
			Townhouse - indicate # of units	5				
			Other (comm, ind, etc.)	1				
2.2	**# of Storeys**	Number of Floors/Storeys in the Unit (do not include basement):			2	2	Storeys	
2.3	**Length-height factor**	Length	North Side	17.8	Length-Height factor	35.6	m.Storeys	
			East Side	30.6	Length-Height factor	61.2	m.Storeys	
			South Side	17.8	Length-Height factor	35.6	m.Storeys	
			West Side	30.6	Length-Height factor	61.2	m.Storeys	
3	**Enter Ground Floor Area of One Unit**	Enter Ground Floor Area (A) of One Unit Only:			103	618	Area in Square Metres (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10,000				
4	**Obtain Required Fire Flow Without Reductions**	Required Fire Flow (without reductions or increases per FUS) (F=220*C*√A), round to nearest 1000 L/min						**8000**
5	**Apply Factors Affecting Burning**	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	**Choose Combustibility of Building Contents**	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Limited Combustible	-0.15	N/A	**6800**
			Limited Combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid Burning	0.25				
5.2	**Choose Reduction Due to Presence of Sprinklers**	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	None	0	N/A	**0**
			None	0				
5.3	**Choose Separation Distance Between Units**	Exposure Distance Between Units	North Side	3.1	18%	0.55	N/A	**3740**
			East Side	12.6	14%			
			South Side	3.1	18%			
			West Side	32.0	5%			
6	**Obtain Required Fire Flow, Duration & Volume**	***Total Required Fire Flow, rounded to nearest 1000 L/min:***						**11000**
		Total Required Fire Flow (above) in L/s:						**183.333**
		Required Duration of Fire Flow (hrs):						**2**
		Required Volume of Fire Flow (m^3):						**1320**

Note: The most current FUS document should be referenced before design to ensure that the above figures are consistent with the intent of the Guidelines

Legend	
(green)	Drop down menu - choose option, or enter value
(grey)	No information, No input required

Subject: Richmond Water Supply Functional Design Study - TAC # 2 Minutes

From: Zagorski, Joseph <Joseph.Zagorski@ottawa.ca>
Sent: January 4, 2022 4:00 PM
To: Tyler Ferguson <Tyler.Ferguson@cardelhomes.com>
Cc: Angela Jonkman <ajonkman@rcii.com>; Chochlinski, Gregory <gregory.chochlinski@stantec.com>; Alemany, Kevin <kevin.alemany@stantec.com>; Zheng, Chuyi <Chuyi.Zheng@stantec.com>; Hebert, Jean <jean.hebert@stantec.com>; Razafimaharo, Christene <Christene.Razafimaharo@stantec.com>; Brown, Adam <Adam.Brown@ottawa.ca>; Hall, Kevin <Kevin.Hall@ottawa.ca>; McWilliams, Cheryl <Cheryl.McWilliams@ottawa.ca>; Whittaker, Damien <Damien.Whittaker@ottawa.ca>; Gray, Scott <scott.gray@ottawa.ca>; Lafrance, Maxime <Maxime.Lafrance@ottawa.ca>; Ahmad, Shohan <Shohan.Ahmad@ottawa.ca>; Bougadis, John <John.Bougadis@ottawa.ca>
Subject: RE: Richmond Water Supply Functional Design Study - TAC # 2 Minutes

"CAUTION: External Sender"
Hi Tyler,

Happy New Year to you too. Thank you for providing requested information. Stantec will proceed with finalizing Richmond water supply functional design study based on the 10,000 L/min fire flow requirement for your subdivision with the ability/space to expand (by the City) proposed water plant to provide 13,000 L/min in the future once needed.

MJZ

From: Tyler Ferguson <Tyler.Ferguson@cardelhomes.com>
Sent: January 04, 2022 3:25 PM
To: Zagorski, Joseph <Joseph.Zagorski@ottawa.ca>
Cc: Angela Jonkman <ajonkman@rcii.com>
Subject: RE: Richmond Water Supply Functional Design Study - TAC # 2 Minutes

Hi Joseph,

Happy new year. Apologies for my delayed reply I never responded to the below prior to the break.

Based on Robinson's calculations for the water demands and FUS for our current Creekside II draft plan, a fire flow of 10,000 L/min would generally suffice (with firewalls potentially necessary in a few locations) for our purposes. Our request is that we move forward with the 10,000 L/min requirement based on the density we are currently targeting.

In addition, the following is a bullet point summary provided by Robinson from your conversation with them. Can you confirm what else you need from us at this time? We will be submitting our draft plan application later this month and will proceed on the assumption we will be required to provide a 10,000 L/min fire flow. Thanks.

- *Required fireflow will be based on the type of development being proposed*

- *City could be satisfied with Cardel requesting a minimum 10,000 l/min fireflow (with FUS supporting calculations and firewalls if necessary along with the ability to expand/upgrade the water system to allow for 13,000 l/min in the future) but that 13,000 L/min gives greater flexibility for denser developments (Cardel currently does not appear to not be proposing the denser development that would require 13,000 L/min.)*
- *The City's long term objective is to have a centralized system but this may not occur if the public is not willing to bear the cost (i.e. existing homes historically have not wanted to pay to connect).*
- *City plans to eventually comply with the MECP guidelines (13,000 l/min. with a 3-hour duration) in the future (distant future was my understanding). Current standards require fireflow for a 2-hour duration.*

Tyler Ferguson
Land Manager

Cardel Group of Companies
301 Moodie Drive Suite 100
Ottawa ON K2H 9C4

Direct: 613.519.9075
Cell: 613.298.2921

ALBERTA • ONTARIO • COLORADO • FLORIDA

Appendix C

Excerpts from Stantec MSS

Excerpts from Parsons Memo No. 5

Excerpts from DSEL Report

Plan and Profile of Sanitary Easement (Prepared by DSEL)

Sanitary Sewer Design Sheet

Conceptual Sanitary Design (DWG. 20002-SAN)

Sanitary Pumping Station Conceptual Site Plan (prepared by JLR)

VILLAGE OF RICHMOND WATER & SANITARY MASTER SERVICING STUDY

Prepared for:

Mattamy Homes Limited
Ottawa Division
123 Huntmar Drive
Ottawa, ON K2S 1B9

Prepared by:

Stantec Consulting Ltd.
1505 Laperriere Avenue
Ottawa, ON K1Z 7T1

July 22, 2011

combination of the two contributions is still below the pumping capacity (80 L/s) of the 75 hp pumps in the Richmond PS.

5.3.1.2 Existing Wet Weather Flow Conditions

During typical rainfall events under existing conditions, inflows to the Richmond Pumping Station are, for the most part, less than 80 L/s (i.e. only requires the operation of the 75 hp pumps). During the spring snowmelt period or for large volume rainfall events, typically once or twice per year, inflows in the range of 100 to 140 L/s are observed. Once every 2 years, on average during large wet weather flow events (snowmelt and/or rainfall), the inflow to the Richmond Pumping Station exceeds its discharge capacity of 160 L/s. During these periods, discharges from the Munster PS are discontinued and the inflows from the Village of Richmond are pumped to and temporarily detained in Lagoon Cell C.

5.3.2 Future Flow Conditions

5.3.2.1 Unit Flows

An important consideration in the determination of wastewater capacity requirements for the Village of Richmond is the recognition that extraneous flow contributions within the Village's service area have been historically high. As such, our analysis provides perspective on the range of extraneous flow contributions that could potentially be expected on the basis of traditional design allowances (0.28 L/s/ha) as well as monitored results at the Richmond Pumping Station.

The wastewater contributions for residential and industrial areas as outlined in the City of Ottawa Design Guidelines are:

Future Area: Design Parameter Values (per City Guidelines):

- Average Wastewater Flows:
  - Residential = 350 Lpcd
  - Commercial = 50,000L/ha/d
  - Institutional = 50,000L/ha/d
  - Light Industrial = 35,000L/ha/d

- Peaking Factors
  - Residential = $1+\left[\dfrac{14}{4+\left(\dfrac{P}{1000}\right)^{\frac{1}{2}}}\right]\times K$

    where: P = Population
    K = Correction Factor (1)
  - Commercial = 1.5
  - Institutional = 1.5
  - Industrial = Per MOE Guidelines

- Peak Extraneous Flows:
  - Infiltration Allowance = 0.28 L/s/effective gross ha

Using monitored results at the Richmond Pumping Station, the wastewater contributions for the residential and ICI areas are:

Existing Area: Monitored (Operational) Parameters (per approach in City Guidelines):

- Average Wastewater Flows:
  - Residential = 308 Lpcd
  - Commercial = 17,000L/ha/d
  - Institutional = 10,000L/ha/d
  - Light Industrial = 10,000L/ha/d

- Peaking Factors
  - Residential = $1+\left[\dfrac{14}{4+\left(\dfrac{P}{1000}\right)^{\frac{1}{2}}}\right]\times K$

    where: P = Population
    K = Correction Factor (0.66)

  - Commercial = 1.0 (non-coincident peak)
  - Institutional = 1.0 (non-coincident peak)
  - Industrial = 1.0 (non-coincident peak)

- Peak Extraneous Flows:
  - Infiltration and Inflow Allowance = 0.705 L/s/effective net ha (based on September 9, 2004 event and assuming a net effective area 303ha).

5.3.2.2 Future Projected Wastewater Flows

For the low and high growth potential scenarios provided in **Table 3-1** and the unit demand rates presented in **Section 5.3.2.1**, wastewater flows were calculated for Richmond Village assuming the application of theoretical design flows only (**Table 5-1**) and both operational and theoretical design flows (**Table 5-2**).

Table 5-1: Wastewater Flows L/s - Design Parameters

	Low Growth Scenario			High Growth Scenario		
	Average DWF	Infiltration/ Inflow	Peak Flow	Average DWF	Infiltration/ Inflow	Peak Flow
Existing Village	15.6	81.3	133.4	15.6	81.3	133.4
Infill Village	2.5	5.4	15.2	2.8	5.4	16.2
Future Development (1)	31.8	54.1	160.2	57.9	54.1	233.3
Industrial Parcels	27.2	18.8	93.8	27.2	18.8	93.8
TOTAL			390.5			455.1

(1) Addition of the peaked large parcel and Mattamy development area flows.

Table 5-2: Wastewater Flows L/s – Operational and Design Parameters

	Low Growth Scenario			High Growth Scenario		
	Average DWF	Infiltration/ Inflow	Peak Flow	Average DWF	Infiltration/ Inflow	Peak Flow
Existing Village	13.7	204.7	239.6	13.7	204.7	239.6
Infill Village	2.2	13.5	20.0	2.4	13.5	20.6
Future Development (1)	31.8	54.1	160.2	57.9	54.1	233.3
Industrial Parcels	27.2	18.8	93.8	27.2	18.8	93.8
TOTAL			**496.7**			**561.3**

(1) Addition of the peaked large parcel and Mattamy development area flows.

The peak flow contribution is estimated to range between 391L/s and 562L/s, depending on the effectiveness of future extraneous flow removal efforts and development.

5.4 ALTERNATIVE WASTEWATER COLLECTION/TREATMENT SOLUTIONS

The City of Ottawa Official Plan (2003) denotes the Village of Richmond as a Public Service Area (PSA). For these areas, it is policy that development be on the basis of public services, however, the City is not obligated to service connections to every property in the PSA, and it is possible for private services to be considered within a PSA. With the exception of a few properties south of the CN Railway corridor, the majority of existing development in the village is serviced by a central collection system and therefore, these practices could be continued for new developments.

The City has indicated that, from a policy perspective, different combinations of sanitary services will be permitted within the Village of Richmond with appropriate consideration to the ultimate long term public health needs of the residences of the village.

Thus, for the purposes of this Master Servicing Study, the long term needs of the entire village area must first be identified. Following this, a staging or phasing strategy will be developed which identifies the optimal approach to achieving the ultimate servicing goal. Given this, wastewater solutions will be assessed for the following conditions:

trunk sewer. The upgrades to the Martin Street sewer recommended in the study have not yet been implemented.

The feasibility of the servicing recommendations made in the previous studies for the future development areas north of Perth, west of Fowler and south of the Jock River were reviewed as part of this MSS. The servicing recommendations for these lands are still considered suitable and therefore were carried forward in the assessment of the wastewater servicing strategy to 'connect to the existing collection system'. The servicing recommendations carried forward include:

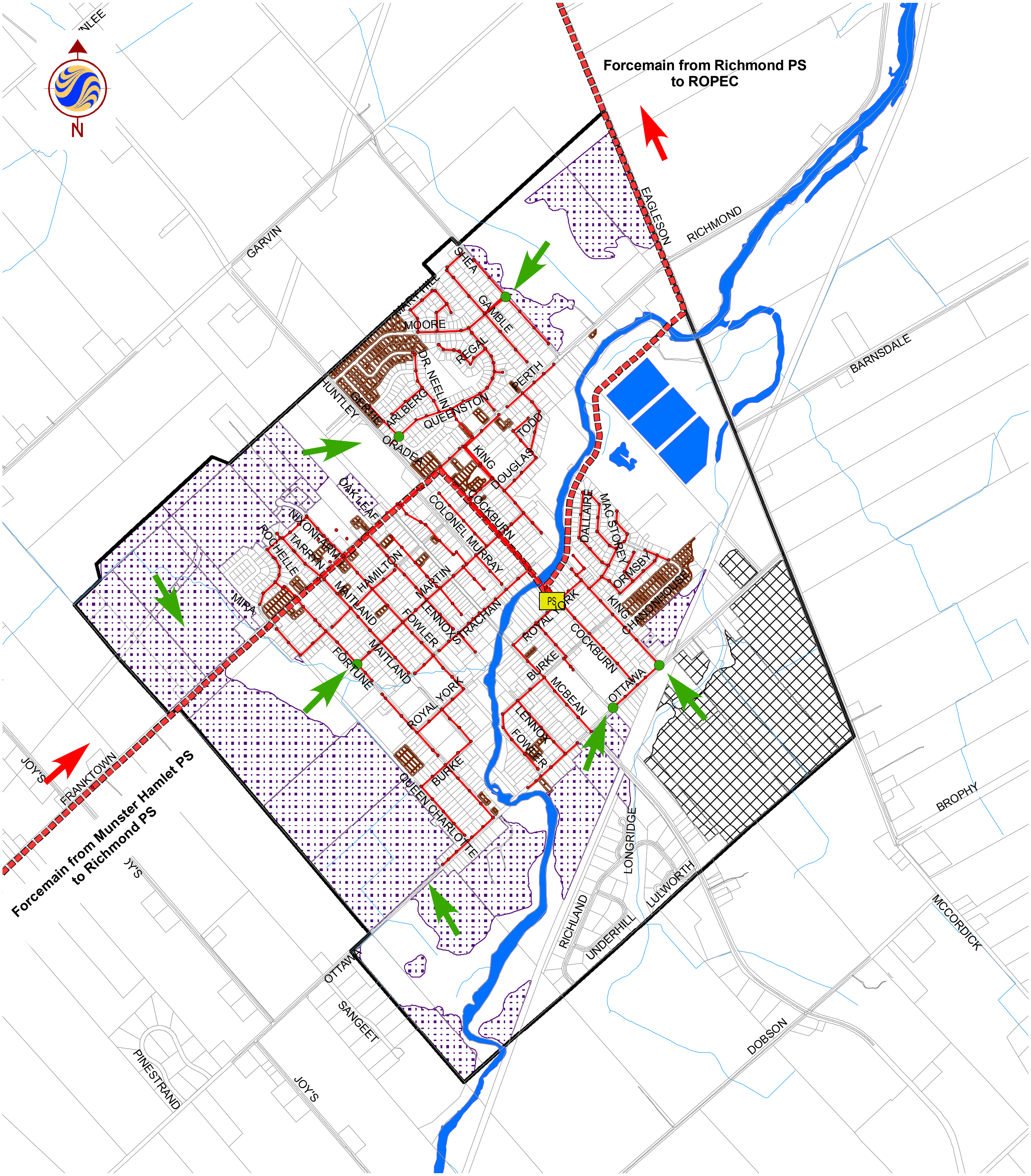
- Potential development area north of the Perth (situated between the VanGaal Drain and Flowing Creek) – Connect to the existing 600-750mm dia. trunk sewer that runs along King, Hamilton and Cockburn and discharges into the Richmond Pumping Station.

- Potential development area west of Fortune and north of the Jock River – Connect to the sanitary sewer on Martin Street. Upgrade and lower the sanitary sewer on Martin Street from Fowler to Cockburn. Upgrade the sanitary sewer on Cockburn between Martin and the Richmond Pumping Station.

- Potential development Area South of the Jock River – Upgrade and lower the sewer along King (Ottawa to Royal York), Royal York (King to Cockburn) and Cockburn (Royal York to Pumping Station)

Wastewater servicing for the potential development area situated north of Perth, between Flowing Creek and Eagleson Road, was not considered in the previous servicing studies. Servicing of this development area assuming connections to either the existing 250mm sanitary sewer on Moore or the 250mm sanitary sewer on Perth were investigated. Assuming a maximum grade raise of 1m across the site, the existing sanitary sewer elevations along Moore and Perth are too high to permit the development to outlet by gravity and therefore a local pumping station would be required. A more detailed servicing investigation of this area would need to be undertaken to confirm if gravity servicing is or is not feasible. Of the two outlets considered, the outlet on Moore was preferred due to the residual capacity available in the 600-750mm dia. trunk sewer.

The connection point to the existing wastewater collection system from each the future potential development areas are shown in **Figure 5-4**.



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

Legend

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

Stantec

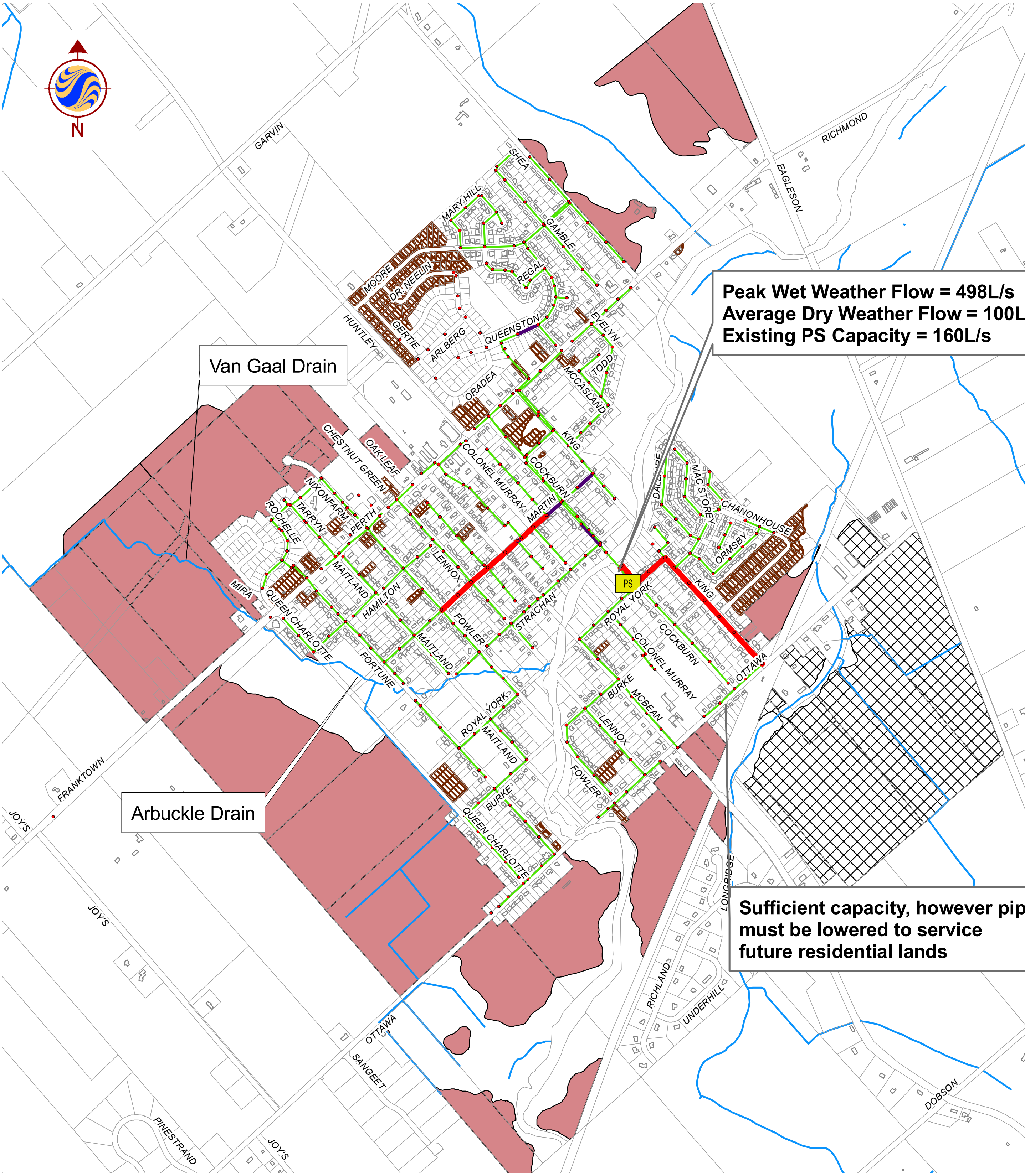
Client/Project

CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.
5.4

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

January 2009



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.8-richmond_wastewater_SS_Results_LOW GROWTH2_ALT1_portrait_mt20090203.mxd

Legend

Flow / Capacity

- 0.00-0.90
- 0.90-1.10
- +1.10

- Future Development
- Infill Development
- Industrial Development

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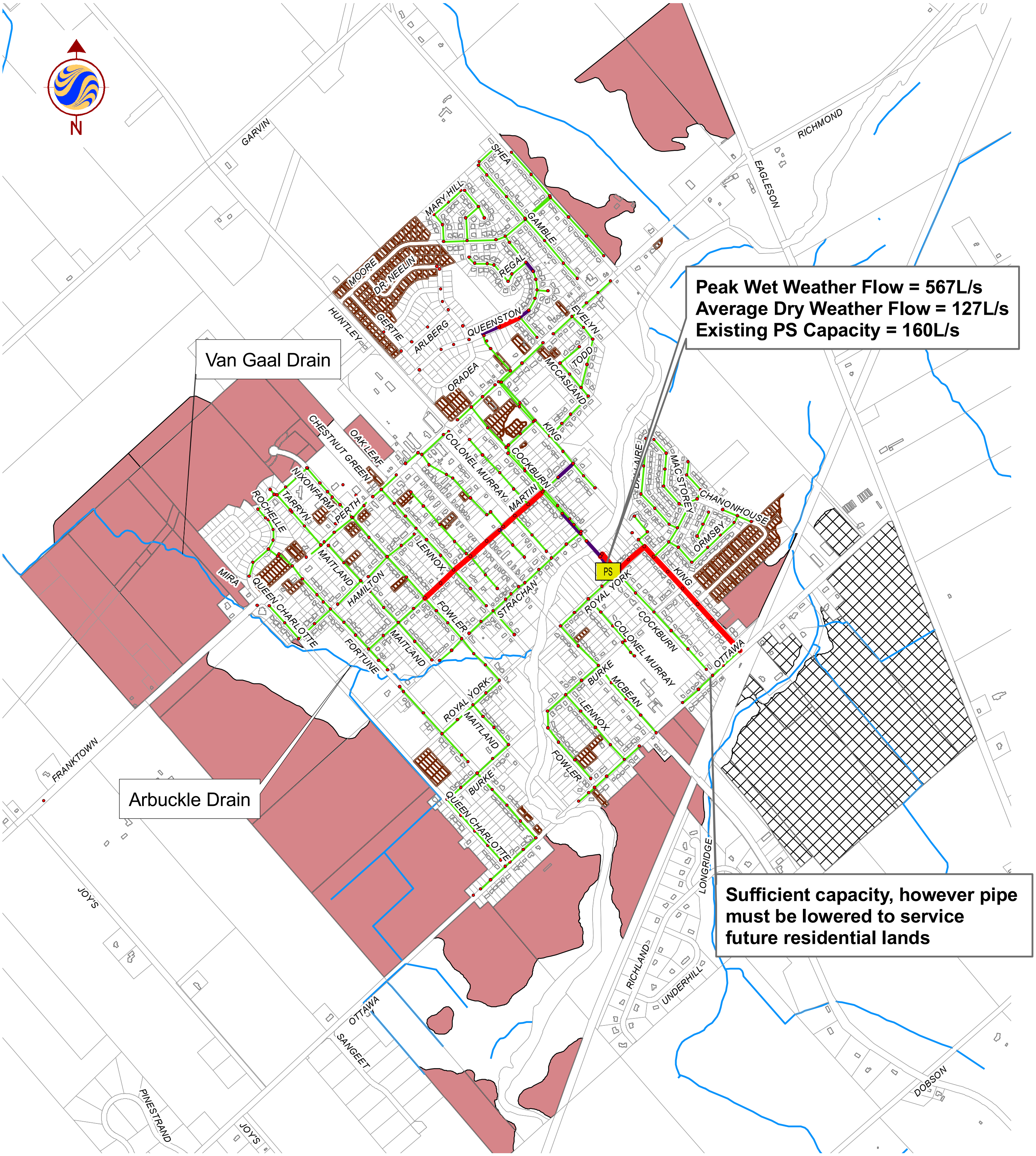
CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.
5.8

Title **Existing, Infill & Future Growth Areas (Low Potential) Gravity Collection System Bottlenecks**

March 2009
1634-00808



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.9-richmond_wastewater_SS_Results_HIGH GROWTH2_ALT1_portrait_mt2009203.mxd

Legend

Flow / Pipe Capacity

- 0.00-0.90
- 0.90-1.10
- +1.10

- Future Development
- Infill Development
- Industrial Development

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Client/Project

CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.

5.9

Title **Existing, Infill & Future Growth Areas (High Potential) Gravity Collection System Bottlenecks**

March 2009
1634-00808

The Richmond flows ultimately make their way into the Acres Road Pumping Station via the Glen Cairn Trunk and Tri-Township Collector. The capacity of a portion of the Tri-Township Collector (+/-2.1km) is exceeded, as is the capacity of the Acres Road Pumping Station, under projected build-out conditions for the entire western service area. As, the Tri-Township Collector and Acres Road Pumping Station convey flows from all of the western service area, the costs of any required upgrades should be apportioned accordingly.

Gravity Collection System Outlet to the Relocated Richmond Pumping Station

The peak WWF in the collection system at the pumping station assuming conveyance of flows from existing, infill and future growth areas ranges from 500L/s (under the low growth potential scenario) to 566L/s (under the high growth potential scenario). Overall the collection system has sufficient capacity to accommodate existing, infill and the future growth potential areas, with the exception of:

- Martin Street (Fortune to King)
- Cockburn (South of Martin to the Royal York)
- Royal York (Cockburn to King)
- King (Royal York to Ottawa)

The upgrades required along these sections, under low and high growth potential projections, are the same as those identified on **Figures 5-6** and **5-7** and include:

Martin Street

- Martin (Fortune to Maitland) – 150m – 450mm dia @ 0.40%
- Martin (Maitland to Fowler) – 138m – 525mm dia @ 0.20%
- Martin (Fowler to Colonel Murray) – 385m – 525mm dia @ 0.40%
- Martin (Colonel Murray to Cockburn) – 225m – 525mm dia @ 0.45%

Cockburn Street

- Cockburn (Martin to Stratchan) – 107m – 750mm dia @ 0.20%
- Cockburn (Stratchan to Royal York) – 180m – 825mm dia @ 0.10%

Royal York Street

- Royal York (Cockburn to King) – 146m – 825mm dia @ 0.10%

King Street

- King (Royal York to Ottawa) – 375m – 825mm dia @ 0.10%

Ottawa Street (New Sewer)

- Ottawa (King to Relocated Richmond Pumping Station) – 660m – 900mm dia @ 0.10%

PARSONS

Technical Memorandum No. 5
New Gravity Trunk Sewers and Local Pumping Station

Date: August 30, 2019

To: M. Joseph Zagorski, P.Eng.
City of Ottawa – Planning Infrastructure and Economic Development
110 Laurier Avenue West, 3rd Floor
Ottawa, ON K1P 1J1

From: Richard Telmosse, MBA, P.Eng., ing., LEED AP BD+C
Parsons Inc.
1223 Michael Street North, Suite 100
Ottawa, ON K1J 7T2

RE: **City of Ottawa – Village of Richmond Wastewater Collection System Upgrades Functional Design Study**

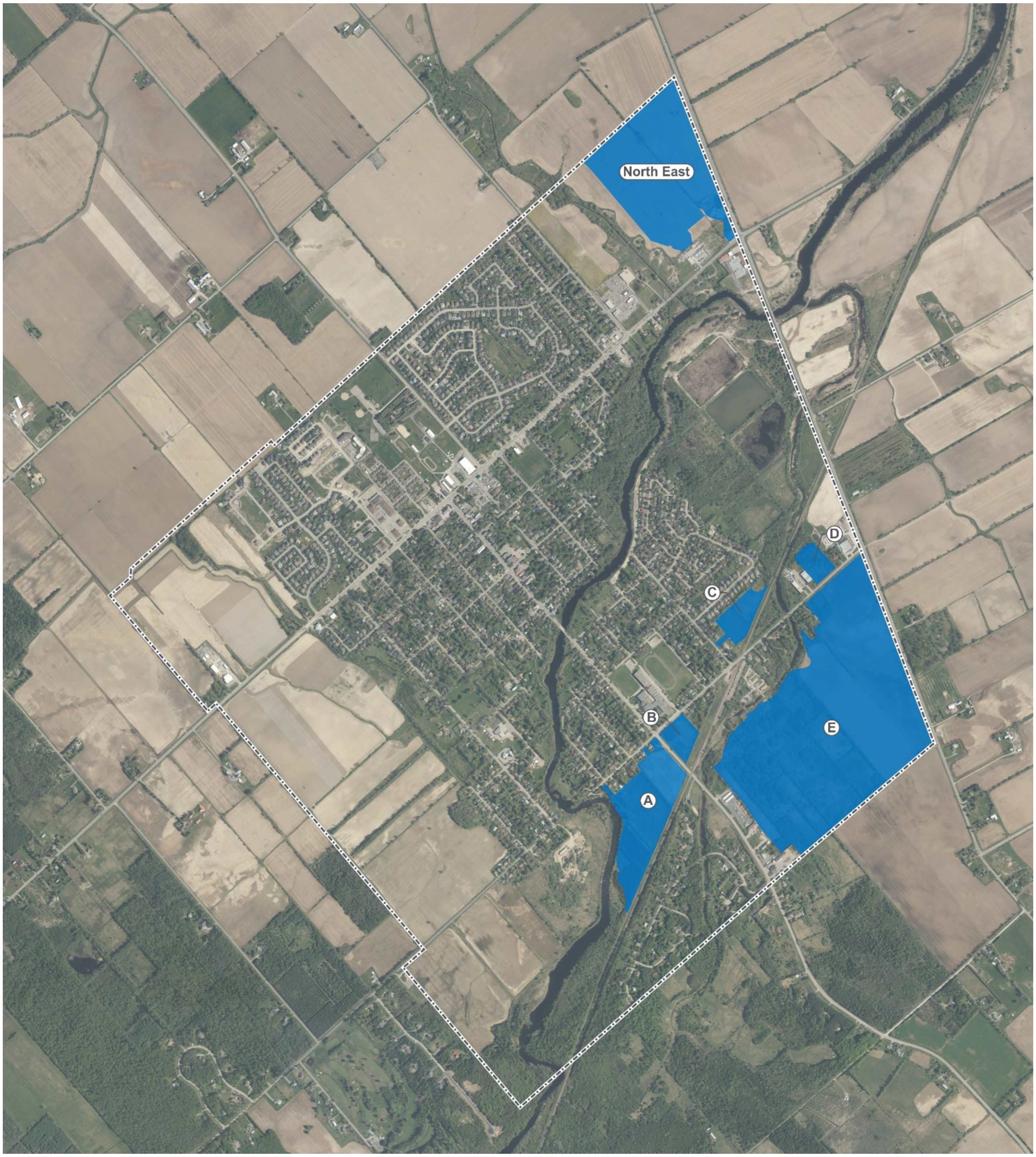
Introduction

In December 2017, Parsons was retained by the City of Ottawa (the City) to complete a Functional Design Study for wastewater collection system upgrades identified in the 2011 Master Servicing Study (MSS) for the Village of Richmond (the Village). A series of technical memorandums were to be produced as part of this study. Presently, five technical memorandums have been completed which are as follows:

- Technical Memorandum 1A (Revised March 2019): Richmond Population and Wastewater Flow Projections;
- Technical Memorandum 1B (October 2018): Conditions Assessment;
- Technical Memorandum 2 (May 2019): Proposed Richmond Pumping Station Upgrade; and
- Technical Memorandum 3 (June 2019): Proposed Richmond Forcemain System.
- Technical Memorandum 4 (June 2019): Richmond Emergency Storage Lagoon (Cell C).

The results of these previous studies help to inform Technical Memorandum No. 5, which describes the proposed gravity trunk sewers for undeveloped parcels south of the Jock River and a local pumping station for a parcel in the northeast quadrant of the village (refer to **Figure 1**). The plan and profile drawings (attached to this memorandum) should be referred to for further information.

Figure 1: Village of Richmond with parcels of interest for Technical Memo No. 5



Design Parameters

The design flow parameters applied to growth areas are shown in **Table 1.**

Table 1: Wastewater Design Parameters

Parameter	Value	Units
Residential Allowance	280	L/cap/day
Institutional Allowance	28,000	L/ha/day
Commercial Allowance	28,000	L/ha/day
Industrial Allowance	35,000	L/ha/day
I&I – dry weather flows	0.05	L/s/ha
I&I additional – wet weather event	0.28	L/s/ha
I&I total – wet weather event	0.33	L/s/ha
Harmon Correction Factor	0.8	
ICI Peak Factor – area >20%	1.5	
ICI Peak Factor – area <20%	1.0	

A population density of 63 p/ha has been applied for residential use, which generally correlates to the 'high' growth scenario presented in the MSS.

Gravity Trunk Sewers – North of Jock River

For areas north of the Jock River, the MSS had recommended gravity trunk sewers on Martin Street and Cockburn Street. These recommendations were advanced to detailed design and construction of the trunk sewer on Martin Street was completed in 2019. The area north of the Jock River does not form part of the current functional design study with respect to gravity trunk sewers.

Gravity Trunk Sewers – South of Jock River

Upon review of the latest existing and proposed land-use it was determined that the significant parcels of undeveloped land south of the Jock River include;

A. Two contiguous properties, west of McBean Street and south of Ottawa Street (6180 Ottawa Street, 3706 McBean Street), with an approximate development area of 11.5 ha.

B. Two contiguous properties immediately east of McBean Street, south of Ottawa Street, north of the railway tracks with an approximate development area of 1.9 ha.

C. A parcel east of King Street and immediately north of the railway tracks with an approximate development area of 2.8 ha.

D. A parcel on the north side of Ottawa Street, immediately east of 5935 Ottawa Street with an approximate development area of 1.7 ha.

E. The area formerly known as 'Industrial Lands', east of McBean Street and south of the railway tracks with an approximate development area of 63.7 ha. This is comprised of approximately 18.5 ha. of Industrial Area 1, 2.5 ha of Industrial Area, 41.7 ha of residential and 1.0 ha. of Village Commercial.

The secondary plan for the Village was recently amended (Amendment # 150, December 17, 2017) and the area formerly called 'Industrial Lands' has been redefined. Most of the portion south of Ottawa Street is now referred to as the Southeast Development Lands. The policy for the area has been changed to allow 'One and Two Unit – Large Lot Residential' and an Industrial Area 1 designation has been applied to ensure a minimum net area of 18.5 ha. of employment is provided.

For areas south of the Jock River, the MSS had recommended gravity trunk sewers on Ottawa Street, King Street, Royal York Street, and Cockburn Street. King Street provided the north/south trunk route. For the Functional Design this route has been advanced and identified as 'King Route'. An alternate route following Cockburn Street, instead of King Street, is identified as 'Cockburn Route'. The Cockburn Route may be beneficial as it follows a less congested right of way with fewer dwellings fronting onto the street. The total peak sanitary design flow for these parcels is estimated to be 72.5 L/s and can be accommodated with a 375mm sanitary sewer at 0.2% which has a capacity of 78.4 L/s.

The functional design has depicted the trunk sewers generally at the greatest depth feasible while maintaining the existing sewer entering the RSPS. These sewer profiles are intended to demonstrate a 'functional' and feasible design. Caution should be exercised when using these drawings to not over-rely on the depth nor alignment/corridor depicted for sewers. As the preliminary and detailed design is undertaken it will be necessary to refine the design accordingly. For instance, without the benefit of subdivision design plans, particularly for parcels A and E, it is difficult to optimize the depth of these sewers. Also, the location of the sewer within the right of way will need to be analysed further.

The depth of the proposed trunk sewers is significant and per 4.4.4.13 of the City of Ottawa Sewer Design Guidelines 2012 the use of High-Level Sewers should be considered. The existing local sanitary sewer could provide the 'High Level Sewer' if it were to remain in place and a deep trunk sewer installed parallel to it.

A Functional Level Estimate (Class C) has been prepared for both route options. The King Route has a construction cost estimate of $2.42M and an overall project cost of $4.08M. The Cockburn Route has a construction cost estimate of $2.07M and an overall project cost of $3.48M. Please refer to Appendix A for details.

North East Development Land

For the development land in the North East quadrant of the Village, Figure 8.8 in the MSS had indicated that a local pump station would be required. As part of the Functional Design, the need for a local pumping station has been confirmed.

The ultimate arrangement of streets will influence the location of the local sanitary pumping station, forcemain and gravity sewers. Furthermore, the final grading of the parcel will be greatly influenced by storm sewer servicing constraints, which are beyond the scope of this wastewater functional design study. Without the benefit of such design plans for this parcel, it is only possible to demonstrate a 'functional' and feasible servicing concept. As such, a conceptual location for the pump station has been selected east of Flowing Creek Drain, outside of the regulatory flood limit. A dual forcemain, per 7.2.1.6.7 of the City of Ottawa Sewer Design Guidelines 2012 and a short segment of sanitary sewer has been indicated discharging to an existing sanitary sewer on Moore Street at the intersection of Shea Road.

For functional design purposes, a three-meter diameter wet-well with duplex submersible pumps (one duty pump, one standby pump) is assumed.

The approximate development area includes 24.4 ha. of residential use and 1.1 ha. of commercial use. The total peak sanitary design flow is estimated to be 24.6 L/s. At a nominal flowrate of 25 L/s, a single 150mm diameter forcemain would have a velocity of 1.3 m/s which is within the desired velocity range for forcemains. The nominal characteristics of each pump is estimated to be 25L/s at 10m Total Dynamic Head.

The land is only marginally higher than the regulatory flood level of Flowing Creek Drain. As such, the provision of an emergency gravity overflow, in accordance with Technical Bulletin ISTB–2018-01, does not appear to be feasible if dwellings with traditional basements are desired. This issue will need to be analysed further as development plans for the parcel are initiated.

The Flowing Creek Drain crossing presents a notable forcemain design issue. A bathymetric survey of the Drain will be required during preliminary design to determine elevations and features. Trenchless techniques should be considered for this crossing.

A Functional Level Estimate (Class C) has been prepared for the North East Development Lands. The pump station and forcemain has a construction cost estimate of $1.35M and an overall project cost of $2.28M. Please refer to **Appendix A** for details.

Geotechnical and Hydrogeological Considerations

Gemtec has performed a desktop review of available information in order to provide preliminary geotechnical considerations (attached as **Appendix B**).

A review of the surficial geology maps was completed, and the anticipated subsurface conditions is summarized as offshore marine sediments (silt, clay) over Dolostone of the Oxford formation.

A review of previous boreholes advanced in the vicinity was completed and the anticipated subsurface condition, beginning at the surface, is summarized as fill material, silty clay, sandy silt/silt, glacial till, overlying bedrock. Gravel and Sand deposits are also expected at localized areas within the study area.

The groundwater is generally found within 1 to 3 m below existing ground surface. It is anticipated that groundwater inflow into excavations, within the silty deposits, should generally be handled by pumping from within braced steel trench boxes. In contrast, substantial groundwater pumping may be required in advance of construction in order to lower the groundwater levels within the sands and gravels, and possibly bedrock (e.g. using a well-point dewatering system installed in overburden or deep wells installed in bedrock).

As this investigation was based solely on available subsurface information, it is recommended that supplemental investigation be carried out during the preliminary design stage.

Conclusion

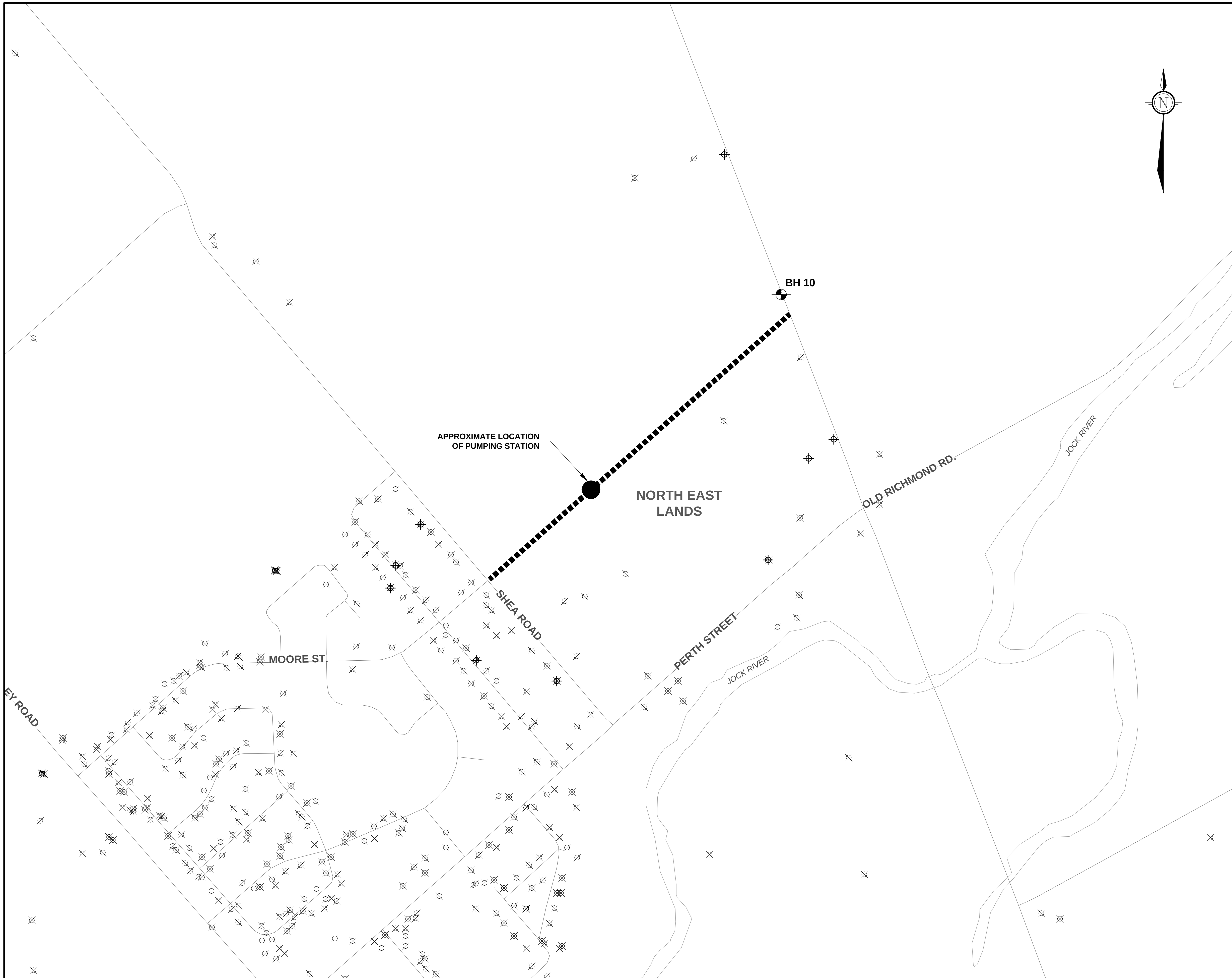
Functional design plan and profile drawings have been prepared for the proposed trunk sewers south of the Jock River previously identified in the MSS. The trunks are generally shown at the greatest depth feasible while maintaining the existing sewer entering the RSPS. These sewer profiles are intended to demonstrate a ‘functional’ and feasible design. Caution should be exercised when using these drawings to not over-rely on the depth nor alignment/corridor depicted for sewers. As the preliminary and detailed design is undertaken it will be necessary to refine the design to optimize depth and the location of the sewer within the right of way.

King Street was the north/south route identified for the trunk sewer in the MSS. Drawings for the King Street route, as well as an alternate route on Cockburn Street have been provided. A Functional Level Estimate (Class C) has been prepared for both route options. The King Route has a construction cost estimate of $2.42M and an overall project cost of $4.08M. The Cockburn Route has a construction cost estimate of $2.07M and an overall project cost of $3.48M. The trunk sewers project appears to be included in the background study for Development Charges By-Law 2019-156 (DC bylaw) and thus eligible for funding under the Area Specific Development Charge identified as Richmond Sanitary Sewer Service Area. Construction of the project might include the use of a front-ending agreement, similar to the process followed for the construction of the trunk sewers north of the Jock River (i.e. Martin Street).

For the development land in the North East quadrant of the Village the need for a local pump station, as identified in the MSS, has been confirmed. A conceptual location for the pump station has been selected east of Flowing Creek Drain, outside of the regulatory flood limit. A dual forcemain and short segment of sanitary sewer has been indicated discharging to an existing sanitary sewer on Moore Street at the intersection of Shea Road. The land is only marginally higher than the regulatory flood level. Therefore, provision of an emergency gravity overflow does not appear to be feasible if dwellings with traditional basements are desired. This issue will need to be analysed further as development plans for the parcel are initiated. A Functional Level Estimate (Class C) has been prepared. The pump station and forcemain has a construction cost estimate of $1.35M and an overall project cost of $2.28M. The local pump station does not appear to have been included in the background study for the DC bylaw and thus not eligible for funding through Area Specific Development Charges.

LICENSED PROFESSIONAL ENGINEER
K. P. McCAMBLEY
Sept 3, 2019
PROVINCE OF ONTARIO

Kevin McCambley, P.Eng.
Senior Municipal Engineer



LEGEND

- PROJECT LIMITS
- BOREHOLE LOCATION IN PLAN (previous investigation by Golder Associates Ltd., January 1981)
- XXX — BOREHOLE/MONITORING WELL ID
- ONTARIO GEOLOGICAL SURVEY BOREHOLES
- MECP WATER WELL RECORDS

Scale 1:7500

0 150 300 450m

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
www.gemtec.ca
ottawa@gemtec.ca

Client	Project
PARSONS	63333.33

Location: RICHMOND GRAVITY SEWER OTTAWA, ON

Drwn by	Chkd by	
P.C.	L.A.	SITE PLAN

Date	Rev.	
JULY 2019	1	FIGURE 1B

DSEL
david schaeffer engineering ltd
SMART SUBDIVISIONS™

120 Iber Road, Suite 103
Stiittsville, Ontario, K2S 1E9
Tel. (613) 836-0856
Fax (613) 836-7183
www.DSEL.ca

DESIGN BRIEF

FOR THE

CREEKSIDE SUBDIVISION VILLAGE OF RICHMOND

1470424 ONTARIO INC.

CITY OF OTTAWA

PROJECT NO.: 14-718

DECEMBER, 2017
3RD SUBMISSION

4.0 WASTEWATER SERVICING

4.1 Existing Wastewater Services

The sanitary outlet for the Creekside Subdivision will be to the existing 250mm diameter sanitary sewers located in Shea Road. New sanitary sewers will be constructed within the development right-of-ways and will connect to the existing sanitary sewer at the Moore Street intersection as well as 115m south of the Moore Street and Shea Road intersection. The existing and proposed sewers in relation to the site can be seen in the General Plan of Services ***Drawing 6*** at the back of this report.

4.2 Wastewater Design

The Creekside Subdivision will be serviced by new gravity sewers designed in accordance with City of Ottawa design criteria.

Table 4.1 summarizes the ***City Standards*** which will be employed in the design of the proposed wastewater sewer system for new areas contributing flows.

Table 4.1: Wastewater Design Criteria

Design Parameter	Value
Low Density Residential	3.4 p/unit
Medium Density Residential	2.7 p/unit
Residential Average Flow	350 L/p/day
Peaking Factor Applied	Harmon's Equation
Institutional Flows	50,000 L/ha/day
Institutional Peaking Factor	1.5
Infiltration and Inflow Allowance	0.28 L/s/ha
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	200mm diameter
Minimum Manning's 'n'	0.013
Service Lateral Size	135mm dia. PVC SDR 28 with a minimum slope of 1.0%
Minimum Depth of Cover	2.5m from crown of sewer to finished grade
Minimum Full Flowing Velocity	0.6m/s
Maximum Full Flowing Velocity	3.0m/s
Additional Considerations	Sewers servicing less than 10 residential connections to have a minimum gradient of 0.65%

Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012.

The sanitary design sheet, proposed sewer layout and drainage areas can be found in ***Appendix C***.

Flows will be conveyed via the existing Shea Road and Moore Street sanitary sewers and ultimately to the Cockburn Street trunk sewer and the Richmond Sanitary Pump Station. **Figure 5.5** from the "Village of Richmond Water & Sanitary Master Servicing Study" (Stantec, July 22, 2011) demonstrates Stantec's analysis of the existing sanitary sewer system and indicates that there are no capacity issues between the development area and the pump station (see excerpt in ***Appendix C***).

4.3 Richmond Sanitary Pump Station - Capacity

The existing Richmond Sanitary Pump Station (RSPS) has a rated firm capacity of 160 L/s. The ***Stantec MSS*** for the Village has identified that the station requires improvements to better manage the wet weather flow demands of the system as well as accommodate future flows generated from existing and future development within the Village.

In coordination with the advancement of the "Western Development Lands", located within the southwest edge of the Village of Richmond, several initiatives are underway in order to assess the existing pump station's current performance and potential for improvements to meet the station's rated capacity of 160 L/s. In addition, design work is underway for future forcemain improvements and ultimately there will be future pump station upgrades to increase capacity.

Depending on the timeframes associated with the above noted assessments and improvements, there may be an opportunity for the Creekside development to benefit from the findings/results. However, if the timelines do not coincide, and capacity is not available, an alternate approach to be undertaken would be in accordance with the methodology employed for the adjacent recent commercial development at 5873 Perth Street. In that circumstance the proponent undertook a process whereby capacity was "created" through the removal of equivalent extraneous flows. This would be accomplished by the identification and removal of unwanted sump pump connections to the sanitary sewer network at the proponent's cost.

4.4 Sanitary Capacity Improvements - Sump Pump Disconnections

As per the sanitary design sheet for the development (See ***Appendix C***), the peak design flow is determined to be approximately **3.83 L/s**. Through coordination with City staff, the requirement to 'create' sanitary capacity is via the removal of extraneous flows from the sanitary network (i.e. unwanted existing sump pump connections) at a rate of two times the projected flows. As such, the flow removal required would be in the order of 3.83 L/s x 2 = **7.66 L/s**.

Based on previous analyses for prior new developments within Richmond (i.e. such as those that were conducted in relation to the approval of the adjacent commercial development at 5873 Perth Street) the anticipated number of disconnections required would be approximately 7 or 8. It is also proposed that the same protocol and procedures that were required for the adjacent development will be followed. This would entail the identification of civic addresses for sump pump disconnections and an assessment of the flows that will be removed at each location.

The developer is responsible for coordination with the homeowners and for the associated costs for the disconnections. This program is currently underway and is being coordinated with the Richmond Village Association (RVA) who is proactively assisting the developer with identifying candidates for sump pump disconnections via social media feeds and the RVA website. In addition, an agreement with the property owner will be executed identifying the conditions for the disconnection and a specific condition that reconnection to the sanitary sewer network is not permitted. The form of the agreement would be to the satisfaction of City staff and the current format is provided in ***Appendix C*** for reference.

4.5 Wastewater Servicing Conclusion

The Creekside Subdivision will outlet to the existing sewer in Shea Road and ultimately to the RSPS. The sanitary sewers within the development will be 200mm in diameter and designed in accordance with City standards. As per the ***Stantec MSS***, there are no capacity issues in the existing gravity sewer network between the site and the pump station. Capacity in the RSPS will be ‘created’ via the identification and removal of unwanted sump pump connections to the sanitary network through coordination with participating residents that will be identified by the Developer.

5.0 STORMWATER CONVEYANCE

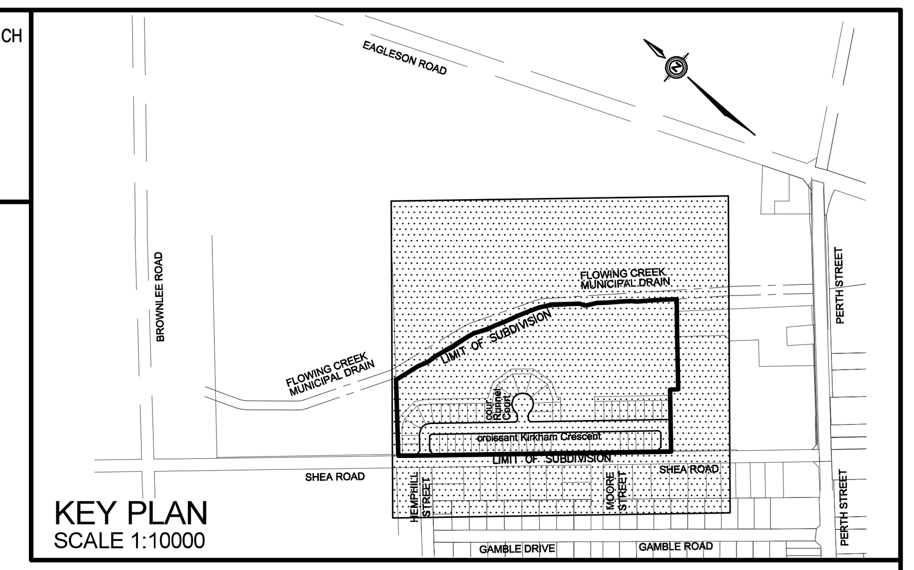
5.1 Existing Conditions

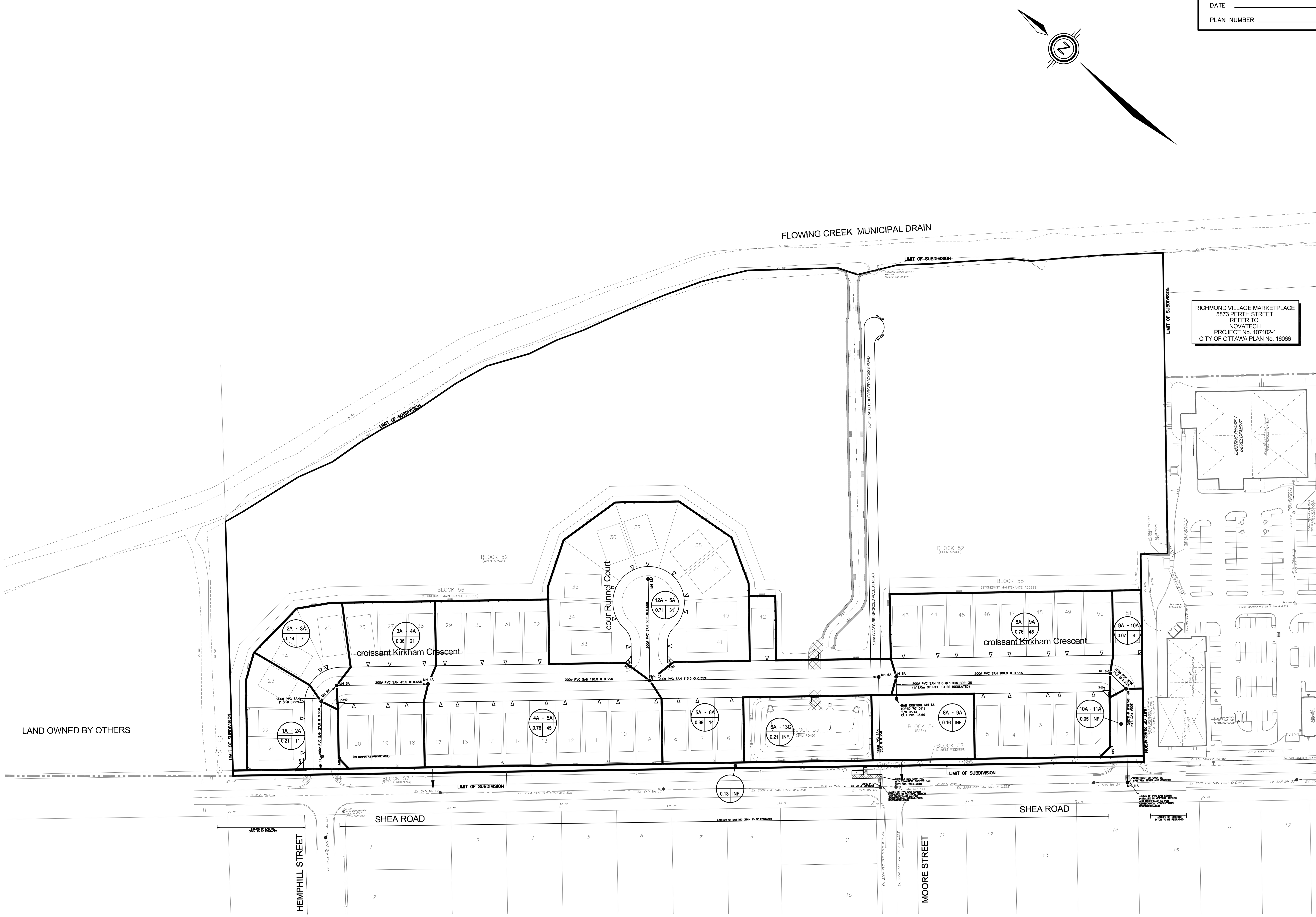
The development area is currently open agricultural field with a gentle northeasterly gradient to the Flowing Creek Municipal Drain (FCMD). The RVCA is currently going through the process to update the 100-year flood plain mapping for the FCMD and preliminary data received from RVCA has been used for the purposes of the site design. The draft updated model, analysis and mapping are currently being peer reviewed prior to being approved by the RVCA Board of Directors. The flood plain elevation used is in the order of 93.94m at the relevant RVCA cross-section along the site boundary adjacent to the FCMD. Correspondence from the RVCA can be found in ***Appendix A***).

APPENDIX C

- Sanitary Drainage Plan
- Sanitary Design Sheet
- Excerpt from Stantec MSS – Figure 5.5
- Example – 'Sump Pump Disconnection Agreement'

REVIEWED BY DEVELOPMENT REVIEW SERVICES BRANCH
SIGNED ________________
DATE ________________ 2017
PLAN NUMBER ________________





LEGEND

SANITARY DRAINAGE BOUNDARY

UPSTREAM MH TO DOWNSTREAM MH — 43A - 44A
AREA IN HECTARES — 0.78
POPULATION — 61

UPSTREAM MH TO DOWNSTREAM MH — 43A-44A
AREA IN OTHER PHASES IN HECTARES — 0.78
POPULATION — 61

MAINTENANCE HOLE — MH202A

CAP

TOPOGRAPHIC INFORMATION

TOPOGRAPHIC INFORMATION PROVIDED BY ANNIS O'SULLIVAN AND VOLLEBEKK LIMITED, PROJECT No. 15768–15. DRAWING DATED APRIL 15, 2015 AND SEPTEMBER 27, 2017. CITY OF OTTAWA 2K MAPPING, RECEIVED ON APRIL 6, 2015.

LEGAL INFORMATION

M–PLAN PROVIDED BY ANNIS O'SULLIVAN AND VOLLEBEKK LIMITED, PROJECT No. 19423–17, DRAFT M–PLAN RECEIVED ON JUNE 29, 2017

3rd SUBMISSION 17–12–11

NOT FOR CONSTRUCTION

BENCH MARK No. 001968U123 ELEVATION = 94.433 m

ELEVATIONS SHOWN ARE GEODETIC AND ARE REFERRED TO BENCHMARK 001968U123 HAVING A PUBLISHED ELEVATION OF 94.433m. LOCATION: RICHMOND BRIDGE OVER JOCK RIVER, 1.6KM NORTHEAST OF MAIN ROAD INTERSECTION IN RICHMOND. TABLET IN TOP OF EAST SIDEWALK, 61cm FROM SOUTH END AND APPROXIMATELY 0.3KM SOUTH OF RICHMOND ROAD. FOR LOCAL TEMPORARY BENCHMARK LOCATIONS REFER TO DRAWING 1 FOR DETAIL.

No.	DATE	BY	DESCRIPTION
3.	17-12-11	W.L.	3rd SUBMISSION
2.	17-10-20	W.L.	2nd SUBMISSION
1.	17-07-07	W.L.	1st SUBMISSION

Ottawa CITY OF OTTAWA

PROJECT No. 14–718

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
17-12-11
PROVINCE OF ONTARIO

SANITARY DRAINAGE PLAN

© DSEL

1470424 ONTARIO INC.

CREEKSIDE SUBDIVISION

DSEL
david schaeffer engineering ltd

120 Iber Road, Unit 203
Stittsville, ON K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

DRAWN BY:	P.P/A.B	CHECKED BY:	W.L/C.M	DRAWING NO.	SHEET NO.
DESIGNED BY:	W.L/C.M	CHECKED BY:	K.M		19
SCALE:	1:1000	DATE:	JULY 2017		

CITY PLAN No. ____

D07-16-16-0003

CITY FILE No. ____

SANITARY SEWER CALCULATION SHEET

Ottawa

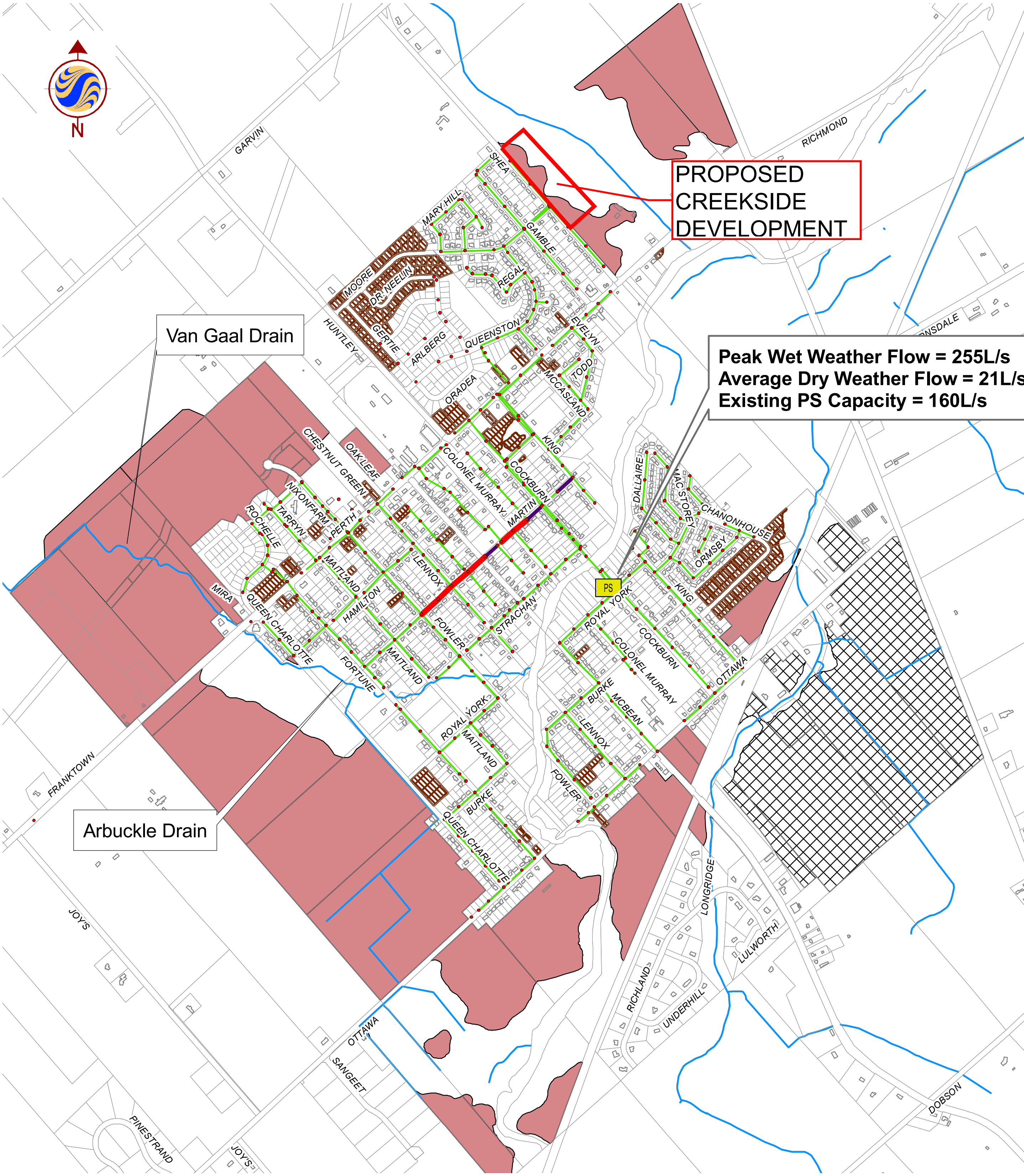
Manning's n=0.013

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)
Street 2																											
	12A	5A	0.71	9	31	0.71	31	4.00	0.50								0.71	0.71	0.199	0.70	50.5	200	200	0.65	26.44	0.03	0.84
To croissant Kirkham Crescent , Pipe 5A - 6A						0.71	31																				
croissant Kirkham Crescent																											
	1A	2A	0.21	3	11	0.21	11	4.00	0.18								0.21	0.21	0.059	0.24	27.0	200	200	0.65	26.44	0.01	0.84
	2A	3A	0.14	2	7	0.35	18	4.00	0.29								0.14	0.35	0.098	0.39	11.0	200	200	0.65	26.44	0.01	0.84
	3A	4A	0.36	6	21	0.71	39	4.00	0.63								0.36	0.71	0.199	0.83	45.5	200	200	0.65	26.44	0.03	0.84
	4A	5A	0.76	13	45	1.47	84	4.00	1.36								0.76	1.47	0.412	1.77	110.0	200	200	0.35	19.40	0.09	0.62
Contribution From Street 2, Pipe 12A - 5A						0.71	31										0.71	2.18									
	5A	6A	0.38	4	14	2.56	129	4.00	2.09								0.38	2.56	0.717	2.81	113.5	200	200	0.35	19.40	0.14	0.62
To SANITARY EASEMENT , Pipe 6A - *Ex. SAN MH 13C*						2.56	129																				
Contribution From Block 54 (Park)														0.16	0.16	0.03	0.16	0.16	0.045	0.08	11.0	200	200	1.00	32.80	0.00	1.04
	8A	9A	0.20	13	45	0.20	45	4.00	0.73								0.20	0.36	0.101	0.83	106.0	200	200	0.65	26.44	0.03	0.84
	9A	10A	0.07	1	4	0.27	49	4.00	0.79								0.07	0.43	0.120	0.91	11.0	200	200	0.35	19.40	0.05	0.62
	10A	11A	0.05	0	0	0.32	49	4.00	0.79								0.05	0.48	0.134	0.92	46.5	200	200	0.35	19.40	0.05	0.62
To SHEA ROAD, Pipe *Ex. 33 - Ex. 34*						0.32	49																				
SANITARY EASEMENT																											
Contribution From croissant Kirkham Crescent, Pipe 5A - 6A						2.56	129										2.56	2.56									
	6A	*Ex. SAN MH 13C*	0.37	0	0	2.93	129	4.00	2.09								0.37	2.93	0.820	2.91	55.0	200	200	0.35	19.40	0.15	0.62
To Moore Street, Pipe *Ex. 13C - Ex. 13B*						2.93	129																				

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Dec 11, 2017
PROVINCE OF ONTARIO

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: W.L.	PROJECT: **Creekside Subdivision**		
Checked: K.M.	LOCATION: **City of Ottawa**		
Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 20	File Ref: 14-718	Date: December, 2017	Sheet No. 1 of 1



W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.5-richmond_wastewater_SS_Results_Infil_Only_portrait_mt20090130.mxd

Legend

Flow / Pipe Capacity

- 0.00-0.90
- 0.90-1.10
- +1.10

- Future Development
- Future Infill
- Future Industrial

Stantec

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

Figure No.
5.5

Title
Existing and Infill Area Gravity Collection System Bottlenecks

March 2009
1634-00808

PAVEMENT DESIGN

40mm SUPERPAVE 12.5 ASPHALTIC CONCRETE
50mm SUPERPAVE 19.0 ASPHALTIC CONCRETE
150mm GRANULAR "A"
400mm GRANULAR "B" TYPE II

CONTRACTOR TO VERIFY THE PRECISE LOCATIONS AND INVERT ELEVATIONS OF Ex. UNDERGROUND SERVICES AND Ex. UTILITIES PRIOR TO STARTING CONSTRUCTION

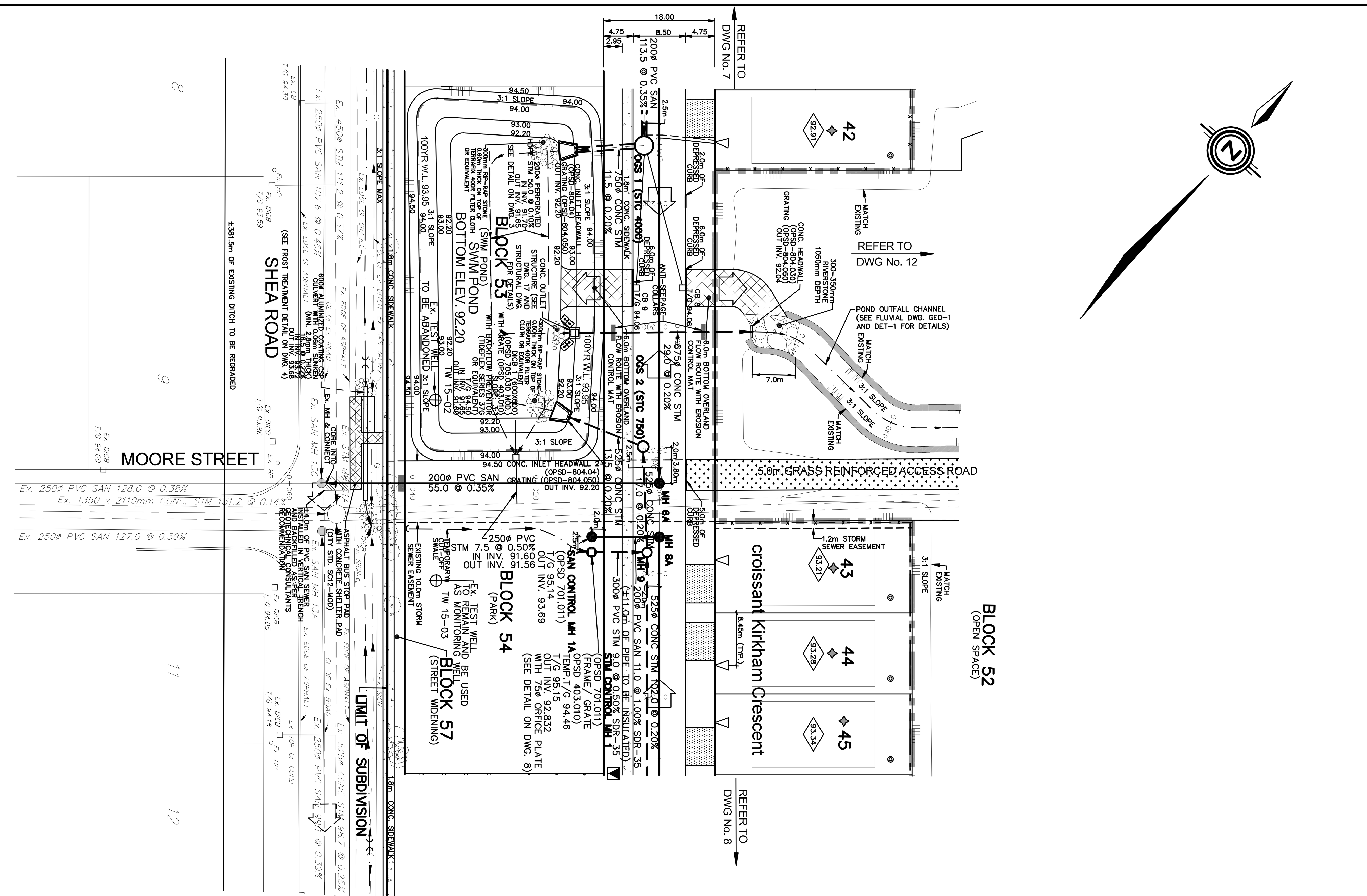
ANY DISTURBED AREA DURING CONSTRUCTION TO BE RESTORED TO THE ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF THE AUTHORITIES HAVING JURISDICTION

PERMISSION REQUIRED FOR WORK ON ADJACENT LANDS

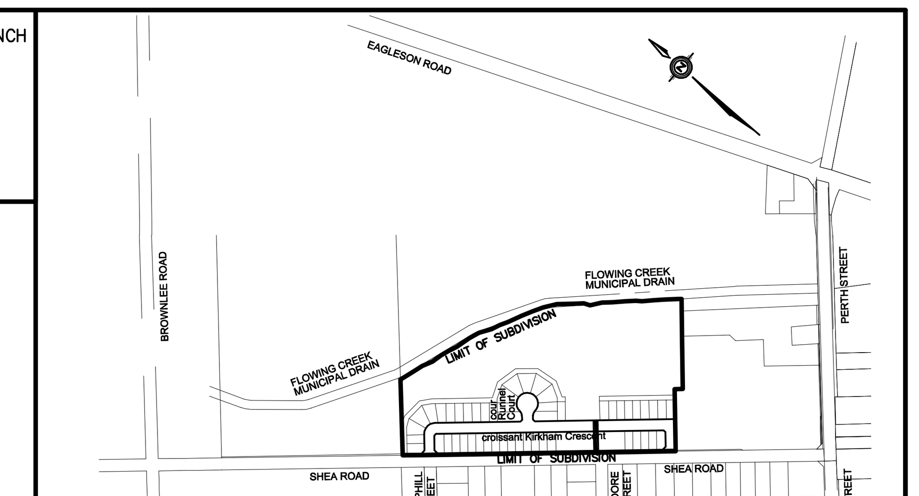
NOTE RE: TEST PIT/BOREHOLE EXCAVATIONS
ANY DISTURBED MATERIAL ENCOUNTERED BELOW THE SUBGRADE LEVEL WITHIN A BUILDING FOOTPRINT TO BE SUB-EXCAVATED AND BACKFILLED WITH COMPACTED ENGINEERED FILL AS PER GEOTECHNICAL ENGINEERS RECOMMENDATION.

NOTE:
ALL EXISTING POST & WIRE FENCE, TREES, ETC. WITHIN LOTS AND BLOCKS TO BE REMOVED, WHERE APPLICABLE

NOTE: ICD
FOR ICD APPLICATION, REFER TO DRAWINGS No. 6 & 21 FOR DETAIL.



REVIEWED BY DEVELOPMENT REVIEW SERVICES BRANCH
SIGNED
DATE 2017
PLAN NUMBER



KEY PLAN
SCALE 1:10000

ALL DWELLINGS ARE TO BE PROVIDED WITH SUMP PUMPS UNLESS OTHERWISE NOTED. SEE DETAIL ON DWG. 3.

LEGEND

SANITARY MAINTENANCE HOLE — 200mmø SAN — MH202A
CAP
STREET CATCHBASIN & LEAD — 375mmø ST
STORM MAINTENANCE HOLE — MH202
CURB INLET CATCHBASIN & LEAD
CATCHBASIN/ MAINTENANCE HOLE — CBMH201
INTERCONNECTED CATCH BASIN & LEADS
CAP
SINGLE SERVICE LOCATION (ST, SAN)
EXISTING SINGLE SERVICE LOCATION (ST, SAN)
SINGLE SERVICE LOCATION (ST, SAN)
TEE CATCHBASIN
PERFORATED PIPE
ELBOW CATCHBASIN
PRIVATE WELL
CURB & DEPRESSED CURB — DC — BARRIER — MOUNTABLE
ASPHALT SIDEWALK — 1.8m ASPH. SIDEWALK
1.8m HIGH CHAINLINK FENCE (UNLESS OTHERWISE NOTED)
1.8m HIGH NOISE BARRIER — 86.98TF — 85.18BF
1.8m BOARD-ON-BOARD FENCE
POST AND RAIL FENCE
PROPERTY BOUNDARY

BOREHOLE (BH)
TEST PIT (TP)
AUGER HOLE (AH)
MONITORING WELL LOCATION
CONCEPTUAL WELL LOCATION
— AS PER GEOTECHNICAL REPORT

UNITS REQUIRING PRESSURE REDUCING VALVES — PRV
WALKOUT UNITS — W.O.
SLAB ON GRADE — SOG
LOTS EQUIPPED WITH SUMP PUMP
UNDERSIDE OF FOOTING ELEVATION (USF) — 92.00
OVERLAND FLOW DIRECTION
EXTERNAL OVERLAND FLOW DIRECTION
TACTILE WALKING SURFACE INDICATOR (AS PER CITY OF OTTAWA STD. SC6, SC7, SC7.1, SC7.2, SC7.3)
CLAY SEAL (REFER TO GENERAL NOTES. No.18. ON DWG. No. 1, AND GEOTECHNICAL CONSULTANT'S SPECIFICATIONS)
DITCH AND CULVERT — 600ø CSP
CONCRETE SIDEWALK — 1.8m CONC. SIDEWALK
100 YR FLOODLINE
BOREHOLE LOCATION — BH 15-1
NATURAL GAS LINE — G
HYDRO TRANSFORMER

TOPOGRAPHIC INFORMATION

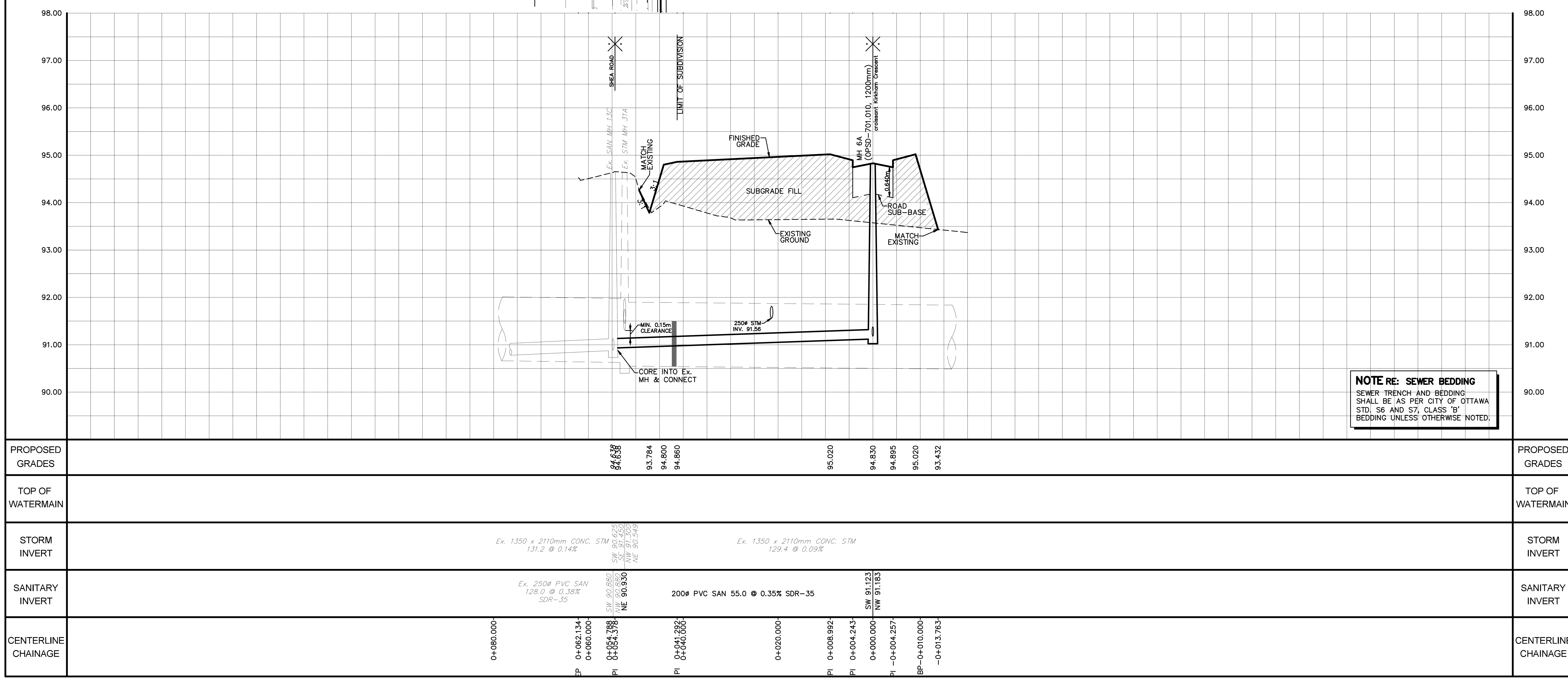
TOPOGRAPHIC INFORMATION PROVIDED BY ANNIS O'SULLIVAN AND VOLLEBEKK LIMITED, PROJECT No. 15768-15. DRAWING DATED APRIL 15, 2015 AND SEPTEMBER 27, 2017. CITY OF OTTAWA 2K MAPPING, RECEIVED ON APRIL 6, 2015.

LEGAL INFORMATION

M-PLAN PROVIDED BY ANNIS O'SULLIVAN AND VOLLEBEKK LIMITED, PROJECT No. 19423-17, DRAFT M-PLAN RECEIVED ON JUNE 29, 2017

3rd SUBMISSION 17-12-11

NOT FOR CONSTRUCTION



NOTE RE: SEWER BEDDING
SEWER TRENCH AND BEDDING SHALL BE AS PER CITY OF OTTAWA STD. S6 AND S7, CLASS 'B' BEDDING UNLESS OTHERWISE NOTED.

BENCH MARK No. 001968U123 ELEVATION = 94.433 m
ELEVATIONS SHOWN ARE GEODETIC AND ARE REFERRED TO BENCHMARK 001968U123 HAVING A PUBLISHED ELEVATION OF 94.433m. LOCATION: RICHMOND BRIDGE OVER JOCK RIVER, 1.6KM NORTHEAST OF MAIN ROAD INTERSECTION IN RICHMOND. TABLET IN TOP OF EAST SIDEWALK, 61cm FROM SOUTH END AND APPROXIMATELY 0.3KM SOUTH OF RICHMOND ROAD. FOR LOCAL TEMPORARY BENCHMARK LOCATIONS REFER TO DRAWING 1 FOR DETAIL.

No.	DATE	BY	DESCRIPTION
3.	17-12-11	W.L.	3rd SUBMISSION
2.	17-10-20	W.L.	2nd SUBMISSION
1.	17-07-07	W.L.	1st SUBMISSION

Ottawa CITY OF OTTAWA

PROJECT No. 14-718

LICENSED PROFESSIONAL ENGINEER W. LIU 100167932 17-12-11 PROVINCE OF ONTARIO

PLAN AND PROFILE OF
SANITARY EASEMENT
(STA. 0+000.000 TO 0+054.788)
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1470424 ONTARIO INC.

CREEKSIDE SUBDIVISION

DSEL david schaeffer engineering ltd
120 Iber Road, Unit 203
Stittsville, ON K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

DRAWN BY: P.P./A.B	CHECKED BY: W.L./C.M	DRAWING NO.	SHEET NO.
DESIGNED BY: W.L./C.M	CHECKED BY: K.M		10
SCALE: H=1:500/V=1:50	DATE: JULY 2017		

CITY PLAN No.
D07-16-16-0003
CITY FILE No.

SANITARY SEWER DESIGN SHEET
for
CREEKSIDE 2 SUBDIVISION, VILLAGE OF RICHMOND

Robinson Land Development

LOCATION			RESIDENTIAL AREA AND POPULATION				RESIDENTIAL FLOW			PEAK DESIGN FLOW (L/s)	PIPE						
			INDIVIDUAL		CUMULATIVE												
STREET	FROM MH	TO MH	POP.	AREA (ha)	POP.	AREA (ha)	PEAK FACTOR	PEAK POP. FLOW (L/s)	EXTRAN. FLOW (L/s)		LENGTH (m)	DIAMETER (mm)	SLOPE (%)	CAPACITY (L/s)	FULL FLOW VELOCITY (m/s)	EXCESS CAPACITY (L/s)	PERCENT FULL
TO WASTEWATER PUMPING STATION BLK 285																	
STREET 1	112	113	56.7	0.85	56.7	0.85	3.64	0.67	0.28	0.95	87.0	201.16	0.32	18.95	0.60	18.00	5.01
STREET 1	113	111	56.7	0.79	113.4	1.64	3.58	1.32	0.54	1.86	87.0	201.16	0.32	18.95	0.60	17.09	9.80
STREET 2	101	102	10.8	0.16	10.8	0.16	3.73	0.13	0.05	0.18	15.0	201.16	0.65	26.88	0.85	26.70	0.68
STREET 2	102	103	62.8	0.84	73.6	1.00	3.62	0.86	0.33	1.19	122.0	201.16	0.97	32.84	1.03	31.64	3.64
STREET 2	101	100	17.0	0.32	17.0	0.32	3.71	0.20	0.11	0.31	67.0	201.16	0.66	27.09	0.85	26.78	1.14
STREET 2	100	105	3.4	0.09	20.4	0.41	3.70	0.24	0.14	0.38	15.0	201.16	0.65	26.88	0.85	26.50	1.41
STREET 2	105	106	44.2	0.66	64.6	1.07	3.63	0.76	0.35	1.11	85.0	201.16	0.33	19.15	0.60	18.04	5.81
STREET 2	106	107	10.2	0.23	74.8	1.30	3.62	0.88	0.43	1.31	19.0	201.16	0.32	18.95	0.60	17.64	6.90
STREET 2	107	103	20.4	0.36	95.2	1.66	3.60	1.11	0.55	1.66	71.0	201.16	0.32	18.95	0.60	17.29	8.75
STREET 2	103	111	23.8	0.41	192.6	3.07	3.52	2.20	1.01	3.21	84.0	201.16	0.50	23.58	0.74	20.36	13.62
STREET 1	111	114	26.4	0.42	332.4	5.13	3.45	3.71	1.69	5.41	68.0	201.16	0.32	18.95	0.60	13.54	28.53
STREET 1	114	115	10.2	0.28	342.6	5.41	3.44	3.82	1.79	5.61	19.0	201.16	0.32	18.95	0.60	13.34	29.59
STREET 1	115	116	76.4	1.02	419.0	6.43	3.41	4.63	2.12	6.75	120.0	201.16	0.32	18.95	0.60	12.20	35.63
STREET 1	116	117	59.4	0.69	478.4	7.12	3.39	5.25	2.35	7.60	120.0	201.16	0.33	19.15	0.60	11.55	39.69
STREET 3	118	119	54.8	0.72	54.8	0.72	3.65	0.65	0.24	0.88	82.0	201.16	0.32	18.95	0.60	18.06	4.67
STREET 3	119	117	39.9	0.53	94.7	1.25	3.60	1.10	0.41	1.52	82.0	201.16	0.32	18.95	0.60	17.43	8.01
STREET 4	121	122	6.8	0.13	6.8	0.13	3.74	0.08	0.04	0.13	15.0	201.16	0.83	30.38	0.96	30.25	0.41
STREET 4	122	123	44.2	0.69	51.0	0.82	3.65	0.60	0.27	0.87	106.0	201.16	0.83	30.38	0.96	29.50	2.88
STREET 4	123	124	6.8	0.13	57.8	0.95	3.64	0.68	0.31	1.00	19.0	201.16	0.70	27.90	0.88	26.90	3.57
STREET 4	124	117	24.3	0.33	82.1	1.28	3.61	0.96	0.42	1.38	71.0	201.16	0.82	30.19	0.95	28.81	4.58
STREET 3	117	142	17.0	1.55	672.2	11.20	3.32	7.24	3.70	10.94	81.0	201.16	0.57	25.17	0.79	14.24	43.45
STREET 6	143	138	64.6	0.98	64.6	0.98	3.63	0.76	0.32	1.08	105.0	201.16	0.65	26.88	0.85	25.80	4.03
STREET 6	138	139	10.2	0.26	74.8	1.24	3.62	0.88	0.41	1.29	19.0	201.16	0.70	27.90	0.88	26.61	4.61
STREET 6	139	140	23.8	0.39	98.6	1.63	3.60	1.15	0.54	1.69	71.0	201.16	0.34	19.44	0.61	17.75	8.68
STREET 6	143	144	10.2	0.23	10.2	0.23	3.73	0.12	0.08	0.20	19.0	201.16	0.70	27.90	0.88	27.70	0.71
STREET 6	144	145	23.8	0.37	34.0	0.60	3.68	0.41	0.20	0.60	58.0	201.16	0.66	27.09	0.85	26.48	2.23
STREET 6	145	146	10.2	0.24	44.2	0.84	3.66	0.52	0.28	0.80	19.0	201.16	0.70	27.90	0.88	27.09	2.87
STREET 6	146	147	20.4	0.31	64.6	1.15	3.63	0.76	0.38	1.14	37.0	201.16	0.35	19.73	0.62	18.59	5.78
STREET 6	147	140	20.4	0.38	85.0	1.53	3.61	0.99	0.50	1.50	81.0	201.16	0.86	30.92	0.97	29.42	4.85
STREET 6	140	141	40.8	0.61	224.4	3.77	3.50	2.55	1.24	3.79	84.0	201.16	0.32	18.95	0.60	15.16	20.01
STREET 6	141	142	27.2	0.43	251.6	4.20	3.49	2.84	1.39	4.23	84.0	201.16	0.32	18.95	0.60	14.72	22.32
STREET 3	142	133	23.8	0.47	947.6	15.87	3.25	9.99	5.24	15.22	96.0	201.16	0.33	19.15	0.60	3.93	79.48
STREET 5	147	148	20.4	0.34	20.4	0.34	3.70	0.24	0.11	0.36	71.0	201.16	0.65	26.88	0.85	26.52	1.33
STREET 5	148	149	10.2	0.24	30.6	0.58	3.68	0.37	0.19	0.56	19.0	201.16	0.70	27.90	0.88	27.34	2.00
STREET 5	149	150	20.4	0.30	51.0	0.88	3.65	0.60	0.29	0.89	24.0	201.16	0.33	19.15	0.60	18.26	4.67
STREET 5	150	151	10.2	0.25	61.2	1.13	3.64	0.72	0.37	1.09	19.0	201.16	0.32	18.95	0.60	17.85	5.77
STREET 5	151	132	20.4	0.35	81.6	1.48	3.61	0.96	0.49	1.44	71.0	201.16	0.32	18.95	0.60	17.51	7.62
STREET 4	121	120	17.0	0.32	17.0	0.32	3.71	0.20	0.11	0.31	67.0	201.16	0.66	27.09	0.85	26.78	1.14

SANITARY SEWER DESIGN SHEET
for
CREEKSIDE 2 SUBDIVISION, VILLAGE OF RICHMOND

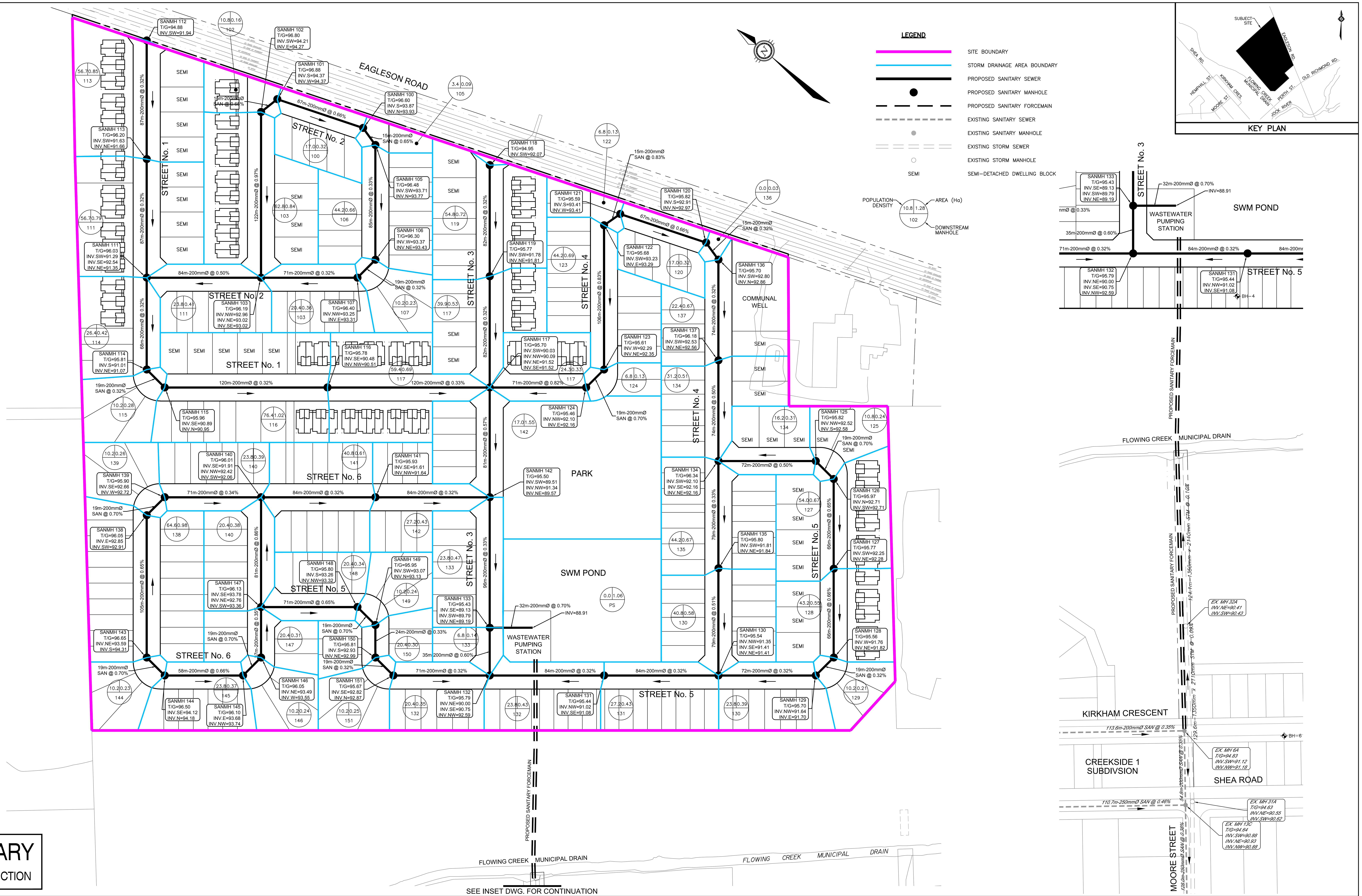
Robinson
Land Development

LOCATION			RESIDENTIAL AREA AND POPULATION				RESIDENTIAL FLOW			PEAK DESIGN FLOW (L/s)	PIPE						
			INDIVIDUAL		CUMULATIVE												
STREET	FROM MH	TO MH	POP.	AREA (ha)	POP.	AREA (ha)	PEAK FACTOR	PEAK POP. FLOW (L/s)	EXTRAN. FLOW (L/s)		LENGTH (m)	DIAMETER (mm)	SLOPE (%)	CAPACITY (L/s)	FULL FLOW VELOCITY (m/s)	EXCESS CAPACITY (L/s)	PERCENT FULL
STREET 4	120	136	0.0	0.03	17.0	0.35	3.71	0.20	0.12	0.32	15.0	201.16	0.32	18.95	0.60	18.63	1.69
STREET 4	136	137	22.4	0.67	39.4	1.02	3.67	0.47	0.34	0.80	74.0	201.16	0.32	18.95	0.60	18.14	4.25
STREET 4	137	134	31.2	0.51	70.6	1.53	3.63	0.83	0.50	1.33	74.0	201.16	0.50	23.58	0.74	22.24	5.66
STREET 5	126	125	10.8	0.24	10.8	0.24	3.73	0.13	0.08	0.21	19.0	201.16	0.70	27.90	0.88	27.69	0.75
STREET 5	125	134	16.2	0.31	27.0	0.55	3.69	0.32	0.18	0.50	72.0	201.16	0.50	23.58	0.74	23.07	2.14
STREET 4	134	135	44.2	0.67	141.8	2.75	3.56	1.64	0.91	2.54	79.0	201.16	0.33	19.15	0.60	16.61	13.28
STREET 4	135	130	40.8	0.58	182.6	3.33	3.53	2.09	1.10	3.19	79.0	201.16	0.51	23.81	0.75	20.62	13.39
STREET 5	126	127	54.0	0.67	54.0	0.67	3.65	0.64	0.22	0.86	66.0	201.16	0.65	26.88	0.85	26.02	3.20
STREET 5	127	128	43.2	0.55	97.2	1.22	3.60	1.13	0.40	1.54	66.0	201.16	0.66	27.09	0.85	25.55	5.67
STREET 5	128	129	10.2	0.21	107.4	1.43	3.59	1.25	0.47	1.72	19.0	201.16	0.32	18.95	0.60	17.23	9.08
STREET 5	129	130	23.8	0.39	131.2	1.82	3.57	1.52	0.60	2.12	72.0	201.16	0.32	18.95	0.60	16.83	11.17
STREET 5	130	131	27.2	0.43	341.0	5.58	3.44	3.81	1.84	5.65	84.0	201.16	0.32	18.95	0.60	13.30	29.80
STREET 5	131	132	23.8	0.43	364.8	6.01	3.43	4.06	1.98	6.04	84.0	201.16	0.32	18.95	0.60	12.91	31.88
STREET 3	132	133	6.8	0.14	453.2	7.63	3.40	4.99	2.52	7.51	35.0	201.16	0.60	25.83	0.81	18.32	29.07
STREET 3	133	PS	0.0	1.06	1400.8	24.56	3.16	14.35	8.10	22.45	32.0	201.16	0.70	27.90	0.88	5.44	80.49
TO MOORE STREET SEWER																	
CREEKSIDE 1		*EX 6A*	*125.8*	*2.56*	*125.8*	*2.56*	*3.57*	*1.46*	*0.84*	*2.30*							
KIRKHAM	*EX 6A*	*EX 13C*	*0.0*	*0.37*	*1526.6*	*27.49*	*3.14*	*15.53*	*9.07*	*24.60*	*55.0*	*201.16*	*0.35*	*19.73*	*0.62*	*-4.88*	*124.73*
(Upgraded existing 200mm to 250mm)																	
KIRKHAM	EX 6A	EX 13C	0.0	0.37	1526.6	27.49	3.14	15.53	9.07	24.60	55.0	251.46	0.35	35.77	0.72	11.17	68.78

DESIGN PARAMETERS

			Per Unit Populations:		
Average Daily Flow =	280	L/person/day	Single Family	3.4	persons/unit
Comm./Inst. Flow =	28000	L//ha/day	Semi-detached	2.7	persons/unit
Industrial Flow =			Duplex	2.3	persons/unit
Maximum Residential Peak Factor =	4.0		Townhouse	2.7	persons/unit
Harmon - Correction Factor (K) =	0.8		Apartments:		
Comm./Inst. Peak Factor =	1.5		Bachelor	1.4	persons/unit
Extraneous Flow =	0.33	L/s/ha	1 Bedroom	1.4	persons/unit
Minimum Full Flow Velocity =	0.60	m/s	2 Bedroom	2.1	persons/unit
Maximum Full Flow Velocity =	3.0	m/s	3 Bedroom	3.1	persons/unit
			Average Apt.	1.8	persons/unit

$$P.F. = 1 + \left(\frac{14}{4 + \left(\frac{P}{1000} \right)^{\frac{1}{2}}} \right) * K$$



PRELIMINARY

NOT FOR CONSTRUCTION

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NO.	REVISION DESCRIPTION	DATE	BY
1	ISSUED FOR REVIEW	18/02/22	AHJ

SCALE

0 10m 20m 50m

HORIZONTAL 1:1250

LICENSED PROFESSIONAL ENGINEER
FEB. 18, 2022
A.H. JONKMAN
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Feb.18/22
B.L MACKECHNIE
100199554
PROVINCE OF ONTARIO

Robinson Land Development

350 Palladium Drive
Ottawa, ON K2V 1A8
(613) 592-6060 rcii.com

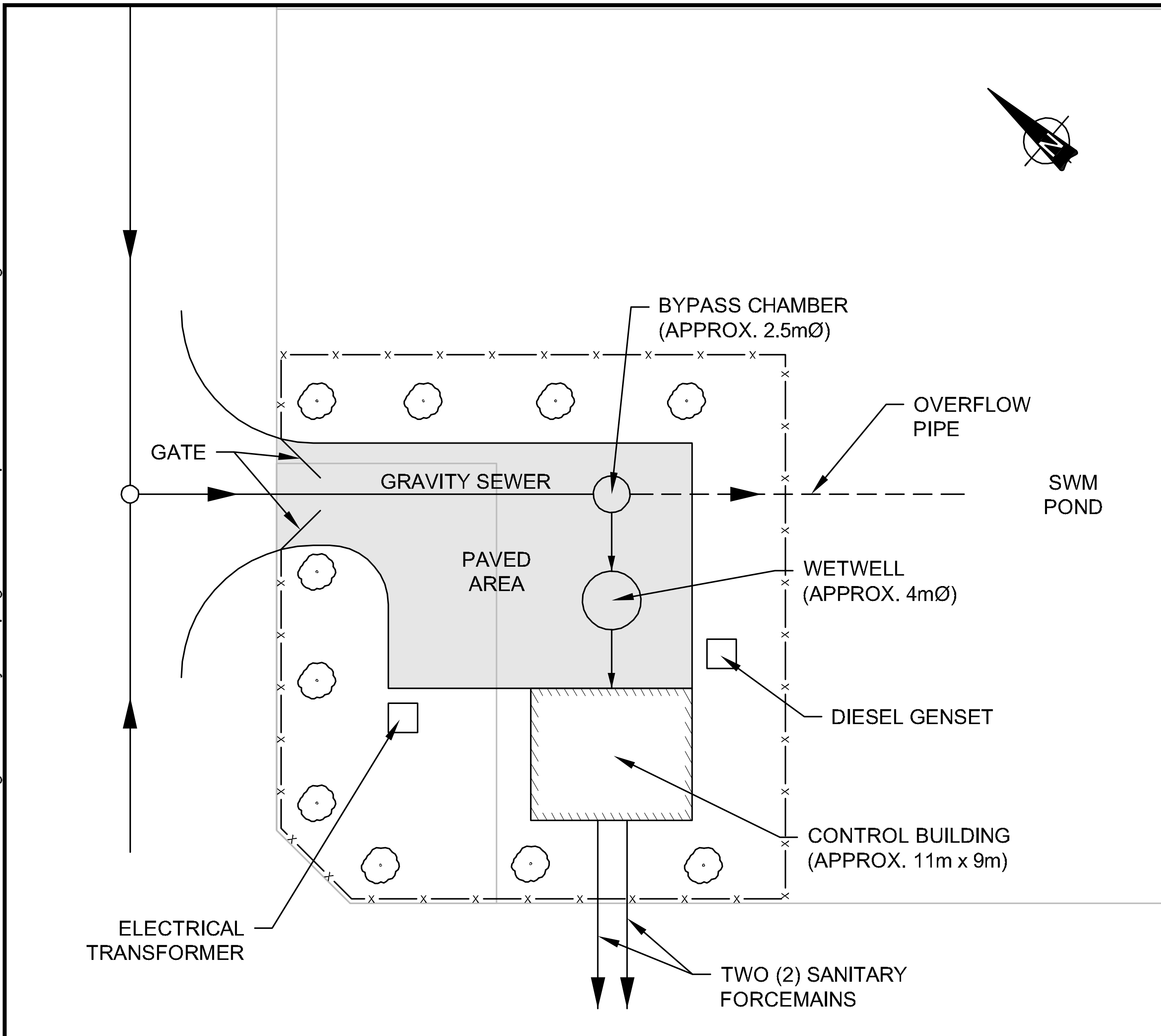
DESIGN	JHB
CHECKED	BLM
DRAWN	JHB
CHECKED	AHJ
APPROVED	AHJ

1470424 ONTARIO INC.
301 MOODIE DRIVE, SUITE 100
OTTAWA, ON K2H 9C4

CREEKSIDE 2 SUBDIVISION
VILLAGE OF RICHMOND

CONCEPTUAL SANITARY DESIGN

PROJECT No.	20002
SURVEY	LIDAR
DATED	FEBRUARY 2022
DWG. No:	20002-SAN



File Location: P:\29000\29540-000 - Cardel Creekside 2 in Richmond\5-Production\1-Civil\Figures\Sanitary Pumping Station Concept\29540 C SPS SK1.dwg

PROJECT:

CARDEL HOMES - CREEKSIDE 2

VILLAGE OF RICHMOND

DRAWING:

SANITARY PUMPING STATION CONCEPTUAL SITE PLAN

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J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

DESIGN:	MM
DRAWN:	TB
CHECKED:	RA
JLR #:	29540

DRAWING #: FIGURE1

PLOT DATE: Thursday, January 13, 2022 9:38:30 AM

Appendix D

Storm Sewer Design Sheet

Conceptual Storm Design
(DWG. 20002-STM)

Preliminary Flow and Storage Calculations

STORM SEWER DESIGN SHEET
for
CREEKSIDE 2 SUBDIVISION, VILLAGE OF RICHMOND

Robinson
Land Development

LOCATION				2 YEAR				FLOW				PROPOSED SEWER						
DRAINAGE AREA	STREET	FROM MH	TO MH	AREA (ha)	C	INDIV. 2.78AC	ACCUM. 2.78AC	TIME OF CONC. (min)	2 YEAR RAINFALL INTENSITY (mm/hr)	2 YEAR PEAK FLOW (L/s)	DESIGN PEAK FLOW (L/s)	PIPE DIA. (mm)	GRADE (%)	LENGTH (m)	CAPACITY (L/s)	FULL FLOW VELOCITY (m/s)	TIME OF FLOW (min)	PERCENT FULL
TO SWM BLK 283																		
	Street No. 1	209	210	0.75	0.65	1.36	1.36	10.00	76.81	104.09	104.09	762.0	0.10	87.0	367.64	0.81	1.80	28%
	Street No. 1	210	211	0.65	0.65	1.17	2.53	11.80	70.53	178.42	178.42	762.0	0.10	87.0	367.64	0.81	1.80	49%
	Street No. 2	201	202	0.12	0.65	0.22	0.22	10.00	76.81	16.65	16.65	251.5	0.91	20.0	57.67	1.16	0.29	29%
	Street No. 2	202	203	0.60	0.65	1.08	1.30	10.29	75.72	98.51	98.51	366.4	0.50	120.0	116.67	1.11	1.81	84%
	Street No. 2	201	204	0.19	0.65	0.34	0.34	10.00	76.81	26.37	26.37	366.4	0.30	66.0	90.38	0.86	1.28	29%
	Street No. 2	204	205	0.06	0.65	0.11	0.45	11.28	72.20	32.62	32.62	366.4	0.34	18.0	96.21	0.91	0.33	34%
	Street No. 2	205	206	0.44	0.65	0.80	1.25	11.61	71.12	88.68	88.68	457.0	0.20	85.0	133.00	0.81	1.75	67%
	Street No. 2	206	207	0.13	0.65	0.23	1.48	13.36	65.93	97.69	97.69	457.0	0.23	22.0	142.62	0.87	0.42	68%
	Street No. 2	207	203	0.49	0.65	0.89	2.37	13.78	64.80	153.40	153.40	533.0	0.18	73.0	190.16	0.85	1.43	81%
	Street No. 2	203	211	0.71	0.65	1.28	4.95	15.21	61.28	303.40	303.40	675.0	0.23	84.0	403.54	1.13	1.24	75%
	Street No. 1	211	212	0.69	0.65	1.25	8.73	16.45	58.54	510.96	510.96	1067.0	0.11	66.0	946.26	1.06	1.04	54%
	Street No. 1	212	213	0.28	0.65	0.51	9.23	17.49	56.45	521.28	521.28	1067.0	0.13	23.0	1028.70	1.15	0.33	51%
	Street No. 1	213	214	0.84	0.65	1.52	10.75	17.82	55.82	600.15	600.15	1067.0	0.10	120.0	902.23	1.01	1.98	67%
	Street No. 1	214	215	1.07	0.65	1.93	12.69	19.81	52.35	664.03	664.03	1067.0	0.10	120.0	902.23	1.01	1.98	74%
	Street No. 3	216	217	0.80	0.65	1.45	1.45	10.00	76.81	111.03	111.03	457.0	0.21	82.0	136.28	0.83	1.64	81%
	Street No. 3	217	215	0.78	0.65	1.41	2.86	11.64	71.02	202.76	202.76	762.0	0.10	82.0	367.64	0.81	1.70	55%
	Street No. 4	248	249	0.50	0.65	0.90	0.90	10.00	76.81	69.39	69.39	457.0	0.20	101.0	133.00	0.81	2.08	52%
	Street No. 4	249	250	0.09	0.65	0.16	1.07	12.08	69.66	74.26	74.26	457.0	0.23	22.0	142.62	0.87	0.42	52%
	Street No. 4	250	215	0.22	0.65	0.40	1.46	12.50	68.38	100.09	100.09	762.0	0.10	69.0	367.64	0.81	1.43	27%
	Street No. 3	215	224	0.30	0.65	0.54	17.55	21.79	49.32	865.42	865.42	1220.0	0.10	81.0	1289.75	1.10	1.22	67%
	Street No. 6	218	219	0.17	0.65	0.31	0.31	10.00	76.81	23.59	23.59	251.5	0.50	16.0	42.75	0.86	0.31	55%
	Street No. 6	219	220	0.78	0.65	1.41	1.72	10.31	75.64	129.84	129.84	457.0	0.25	105.0	148.69	0.91	1.93	87%
	Street No. 6	220	221	0.27	0.65	0.49	2.20	12.24	69.15	152.45	152.45	457.0	0.38	16.0	183.32	1.12	0.24	83%
	Street No. 6	221	222	0.70	0.65	1.26	3.47	12.48	68.44	237.44	237.44	533.0	0.35	69.0	265.17	1.19	0.97	90%
	Street No. 6	218	225	0.25	0.65	0.45	0.45	10.00	76.81	34.70	34.70	251.5	0.50	58.0	42.75	0.86	1.12	81%
	Street No. 6	225	226	0.12	0.65	0.22	0.67	11.12	72.75	48.64	48.64	299.4	0.38	16.0	59.33	0.84	0.32	82%
	Street No. 6	226	227	0.20	0.65	0.36	1.03	11.44	71.69	73.84	73.84	366.4	0.26	39.0	84.13	0.80	0.81	88%
	Street No. 6	227	222	0.46	0.65	0.83	1.86	12.25	69.11	128.63	128.63	457.0	0.31	77.0	165.58	1.01	1.27	78%
	Street No. 6	222	223	0.53	0.65	0.96	6.29	13.53	65.48	411.78	411.78	838.0	0.10	86.0	473.73	0.86	1.67	87%
	Street No. 6	223	224	0.45	0.65	0.81	7.10	15.19	61.31	435.42	435.42	838.0	0.10	86.0	473.73	0.86	1.67	92%
	Street No. 3	224	OSG 1	0.17	0.65	0.31	24.95	23.01	47.64	1188.91	1188.91	1220.0	0.25	55.0	2039.27	1.74	0.53	58%
	Street No. 5	227	228	0.35	0.65	0.63	0.63	10.00	76.81	48.58	48.58	299.4	0.49	73.0	67.37	0.96	1.27	72%
	Street No. 5	228	229	0.13	0.65	0.23	0.87	11.27	72.25	62.66	62.66	457.0	0.23	22.0	142.62	0.87	0.42	44%
	Street No. 5	229	230	0.17	0.65	0.31	1.17	11.69	70.86	83.23	83.23	533.0	0.17	24.0	184.80	0.83	0.48	45%
	Street No. 5	230	231	0.12	0.65	0.22	1.39	12.18	69.35	96.50	96.50	533.0	0.19	16.0	195.37	0.88	0.30	49%
	Street No. 5	231	232	0.66	0.65	1.19	2.58	12.48	68.43	176.84	176.84	686.0	0.19	73.0	382.93	1.04	1.17	46%

Robinson
Land Development

STORM SEWER DESIGN SHEET
for
CREEKSIDE 2 SUBDIVISION, VILLAGE OF RICHMOND

LOCATION				2 YEAR				FLOW				PROPOSED SEWER						
DRAINAGE AREA	STREET	FROM MH	TO MH	AREA (ha)	C	INDIV. 2.78AC	ACCUM. 2.78AC	TIME OF CONC. (min)	2 YEAR RAINFALL INTENSITY (mm/hr)	2 YEAR PEAK FLOW (L/s)	DESIGN PEAK FLOW (L/s)	PIPE DIA. (mm)	GRADE (%)	LENGTH (m)	CAPACITY (L/s)	FULL FLOW VELOCITY (m/s)	TIME OF FLOW (min)	PERCENT FULL
	Street No. 5	233	232	0.29	0.65	0.52	0.52	10.00	76.81	40.25	40.25	457.0	0.50	74.0	210.28	1.28	0.96	19%
	Street No. 3	232	OSG 1	0.24	0.65	0.43	3.54	13.65	65.14	230.70	230.70	762.0	0.10	72.0	367.64	0.81	1.49	63%
	Street No. 3	OSG 1	POND	0.00	0.00	0.00	28.50	23.54	46.96	1338.18	1338.18	1220.0	0.13	23.0	1470.54	1.26	0.30	91%
TO SWM BLK 283																		
	Street No. 4	248	247	0.12	0.65	0.22	0.22	10.00	76.81	16.65	16.65	299.4	0.35	17.0	56.94	0.81	0.35	29%
	Street No. 4	247	246	0.17	0.65	0.31	0.52	10.35	75.49	39.56	39.56	366.4	0.30	59.0	90.38	0.86	1.15	44%
	Street No. 4	246	245	0.11	0.65	0.20	0.72	11.50	71.50	51.68	51.68	366.4	0.31	16.0	91.87	0.87	0.31	56%
	Street No. 4	245	244	0.78	0.65	1.41	2.13	11.80	70.51	150.35	150.35	533.0	0.19	75.0	195.37	0.88	1.43	77%
	Street No. 4	244	242	0.73	0.65	1.32	3.45	13.23	66.28	228.77	228.77	610.0	0.16	75.0	256.93	0.88	1.42	89%
	Street No. 5	239	240	0.35	0.65	0.63	0.63	10.00	76.81	48.58	48.58	299.4	0.41	66.0	61.63	0.88	1.26	79%
	Street No. 5	240	241	0.16	0.65	0.29	0.92	11.26	72.30	66.63	66.63	366.4	0.31	16.0	91.87	0.87	0.31	73%
	Street No. 5	241	242	0.22	0.65	0.40	1.32	11.56	71.29	94.03	94.03	457.0	0.20	74.0	133.00	0.81	1.52	71%
	Street No. 4	242	243	0.75	0.65	1.36	6.13	14.65	62.60	383.46	383.46	762.0	0.13	77.0	419.18	0.92	1.40	91%
	Street No. 4	243	236	0.56	0.65	1.01	7.14	16.05	59.40	423.96	423.96	838.0	0.10	77.0	473.73	0.86	1.49	89%
	Street No. 5	239	238	0.36	0.65	0.65	0.65	10.00	76.81	49.96	49.96	299.4	0.35	66.0	56.94	0.81	1.36	88%
	Street No. 5	238	237	0.10	0.65	0.18	0.83	11.36	71.95	59.81	59.81	366.4	0.31	16.0	91.87	0.87	0.31	65%
	Street No. 5	237	236	0.42	0.65	0.76	1.59	11.67	70.95	112.82	112.82	457.0	0.20	74.0	133.00	0.81	1.52	85%
	Street No. 5	236	OSG 2	0.21	0.65	0.38	9.11	17.54	56.35	513.20	513.20	838.0	0.13	61.0	540.13	0.98	1.04	95%
	Street No. 5	235	OSG 2	0.07	0.65	0.44	0.44	10.00	76.81	33.79	33.79	457.0	0.51	18.0	212.38	1.29	0.23	16%
	Street No. 5	OSG 2	POND	0.00	0.00	0.00	9.55	18.58	54.43	519.67	519.67	838.0	0.13	23.0	540.13	0.98	0.39	96%
TO FLOWING CREEK MUNICIPAL DRAIN																		
	Easement	POND	251	2.25	0.65	4.07	42.11	23.84	46.57	1961.18	1961.18	1524.0	0.13	15.0	2661.60	1.46	0.17	74%
	Easement	251	OUTLET	0.00	0.00	0.00	42.11	24.01	46.36	1952.17	1952.17	1524.0	0.12	64.0	2557.18	1.40	0.76	76%
				23.13														

Design Parameters

Notes:
1. Rainfall intensity calculated using City of Ottawa IDF curve equations.
2. Peak flows calculated using the Rational Method.
   Q = 2.78CIA, where:
   Q = Peak Flow (L/s)
   A = Drainage Area (ha)
   I = Rainfall Intensity (mm/hr)
   C = Runoff Coefficient
3. Manning's roughness coefficient = 0.013
4. Full flow velocity: MIN 0.8 m/s; MAX 3.0 m/s (City of Ottawa Sewer Design Guidelines, v.2012)
5. Local roads return frequency = 2 Yr; Collector roads return frequency = 5 Yr (City of Ottawa Technical Bulletin PIEDTB-2016-01)

IDF curve equations (Intensity in mm/hr)

100 year Intensity $= 1735.688 / (\text{Time in min} + 6.014)^{0.820}$
50 year Intensity $= 1569.580 / (\text{Time in min} + 6.014)^{0.820}$
25 year Intensity $= 1402.884 / (\text{Time in min} + 6.018)^{0.819}$
10 year Intensity $= 1174.184 / (\text{Time in min} + 6.014)^{0.816}$
5 year Intensity $= 998.071 / (\text{Time in min} + 6.053)^{0.814}$
2 year Intensity $= 732.951 / (\text{Time in min} + 6.199)^{0.810}$

PRELIMINARY

NOT FOR CONSTRUCTION

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NO.	REVISION DESCRIPTION	DATE	BY
1	ISSUED FOR REVIEW	18/02/22	AHJ

SCALE

0 10m 20m 50m

HORIZONTAL 1:1250

LICENSED PROFESSIONAL ENGINEER FEB. 18, 2022 A.H. JONKMAN PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Feb.18/22 B.L. MACKECHNIE 100199554 PROVINCE OF ONTARIO

Robinson Land Development
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DESIGN	JHB
CHECKED	BLM
DRAWN	JHB
CHECKED	AHJ
APPROVED	AHJ

1470424 ONTARIO INC.
301 MOODIE DRIVE, SUITE 100
OTTAWA, ON K2H 9C4

CREEKSIDE 2 SUBDIVISION
VILLAGE OF RICHMOND

CONCEPTUAL STORM DESIGN

PROJECT No.	20002
SURVEY	LIDAR
DATED	FEBRUARY 2022
DWG. No:	20002-STM

Pre-Development Flow Calculations

Given:

Area (ha) = 24.5

C = 0.50

C (100 YR) = 0.63

Return Period	Time of Concentration (min)	Rainfall Intensity, i (mm/hr)	Flow, Q (L/s)
2 Year	60	24.6	836.3
5 Year	60	32.9	1121.9
100 Year	60	55.9	2379.4

Notes:

1. Rainfall intensity calculated using City of Ottawa IDF curve equations.
2. Flow calculated using the Rational Method (Q = 2.78CiA).
3. C (100 YR) = C + 25% (to a mximum of 1.0)
4. Runoff Coefficient estimated using Table 5.7 (Clay and silt loam; cultivated; flat slope)
5. Time of concentration estimated using the Uplands Method.

Table 5.7 Runoff Coefficients for Various Soil Conditions

Topography and Vegetation	Soil Texture		
	Open Sandy Loam	Clay and Silt Loam	Tight Clay
Woodland			
Flat 0-5 % Slope	0.10	0.30	0.40
Rolling 5-10 % Slope	0.25	0.35	0.50
Hilly 10-30 % Slope	0.30	0.50	0.60
Pasture			
Flat 0-5 % Slope	0.10	0.30	0.40
Rolling 5-10 % Slope	0.16	0.36	0.55
Hilly 10-30 % Slope	0.22	0.42	0.60
Cultivated			
Flat 0-5 % Slope	0.30	0.50	0.60
Rolling 5-10 % Slope	0.40	0.60	0.70
Hilly 10-30 % Slope	0.53	0.72	0.82

Reference: City of Ottawa Sewer Design Guidelines (2012)

Preliminary Flow and Storage Volume Calculations

Given:

Area (ha) = 24.5

C = 0.65

C (100 YR)[*3] = 0.81

Return Period	Time of Concentration (min)	Intensity[*1], i (mm/hr)	Flow[*2], Q (L/s)	Allowable Release Rate[*4] (L/s)	Net Runoff to be Stored (L/s)	Storage Required (m^3)
2 Year	10	76.8	3400.3	836.3	2564.0	1538.4
	15	61.8	2734.5	836.3	1898.2	1708.4
	20	**52.0**	**2303.5**	**836.3**	**1467.2**	**1760.6**
	25	45.2	1999.6	836.3	1163.3	1745.0
	30	40.0	1772.8	836.3	936.5	1685.7
	35	36.1	1596.4	836.3	760.1	1596.2
5 Year	10	104.2	4612.8	1121.9	3490.9	2094.5
	15	83.6	3699.2	1121.9	2577.3	2319.6
	20	**70.3**	**3110.1**	**1121.9**	**1988.2**	**2385.9**
	25	60.9	2696.0	1121.9	1574.1	2361.1
	30	53.9	2387.5	1121.9	1265.6	2278.0
	35	48.5	2147.9	1121.9	1026.1	2154.7
100 Year	10	178.6	9881.3	2379.4	7502.0	4501.2
	15	142.9	7907.7	2379.4	5528.3	4975.5
	20	**120.0**	**6638.0**	**2379.4**	**4258.6**	**5110.3**
	25	103.8	5746.8	2379.4	3367.5	5051.2
	30	91.9	5083.9	2379.4	2704.6	4868.2
	35	82.6	4569.8	2379.4	2190.5	4600.0

Notes:

1. Rainfall intensity calculated using City of Ottawa IDF curve equations.

2. Flow calculated using the Rational Method (Q = 2.78CiA).

3. C (100 YR) = C + 25% (Max. 1.0)

4. Allowable Release Rate = Pre-Development Flow