



October 18, 2013

David Schaeffer Engineering Limited
120 Iber Road, Unit 203
Ottawa, Ontario K2S 1E9

Attention: Steve Pichette, P.Eng.

**Subject: Richmond Village (South) Limited Subdivision /
Continuous Erosion Analysis**

our file: 922-11

As requested by your office, we have performed, based on the available information described below, a continuous erosion analysis for Van Gaal Drain in the City of Ottawa under existing and proposed conditions.

As per the April 9, 2013 *Richmond Village (South) Limited Subdivision / Preliminary Stormwater Management Analysis*, the proposed Richmond Village (South) development consists of a 110.64 ha drainage area to be treated by two Stormwater Management (SWM) facilities; Pond 1 (66.71 ha at 49% imperviousness) discharging to Van Gaal Drain, and Pond 2 (43.93 ha at 49% imperviousness) discharging to the Ottawa River. Additionally, of the undeveloped lands south of the proposed subdivision, 114.0 ha (including 16.5 ha to be developed ultimately and controlled on-site) will drain through Pond 1, 71.8 ha will drain through Pond 2, and 94.2 ha will be conveyed through the subdivision by a tributary of the Moore Drain. Refer to the April 2013 *Preliminary SWM Analysis* memo for further details.

Continuous SWMHYMO models of the Van Gaal Drain under existing and proposed conditions were created for the purposes of this erosion analysis based on the single-event SWMHYMO models submitted with the April 2013 *Preliminary SWM Analysis* memo. Continuous modelling parameters were set as follows for both existing and proposed conditions:

A_{PII}=[50], A_{PIK}=[0.90]/day; used to compute the Antecedent Precipitation Index during the continuous simulation. Without model calibration these are the default values.

I_{aREC}=[6](hrs); the time that it takes for the Initial Abstraction over pervious areas to recover during a dry period in undeveloped areas.

S_{MIN}=[-1], S_{MAX}=[-1](mm); the negative values indicate that the storage volume in the SCS procedure will vary between the "S" determined for AMC I and AMC III conditions of the entered CN value in undeveloped areas.

S_K=[0.03]/(mm); a calibration coefficient that can typically vary from 0.01 to 0.3 for undeveloped areas. The higher the value, the more runoff generated. To set the baseline for existing conditions, we decided to take a value in the low range.

InitGWResVol=[100](mm), GWResK=[0.9](mm/day/mm), V_{hydCond}=[1](mm/hr); parameters that are used to simulate both the groundwater storage and discharge to surface watercourses from undeveloped areas. Without adequate field measurements, these parameters were selected based on

IaRECper=[3](hrs);	previous experience. the time that it takes for the Initial Abstraction over pervious areas to recover during a dry period in urban areas.
IaRECimp=[2](hrs);	the time that it takes for the Initial Abstraction over impervious areas to recover during a dry period in urban areas.
InterEventTime=[12](hrs);	the continuous dry time required to reset the parameters in the SCS procedure to their initial values.

Under existing and proposed conditions, by means of 36 years of continuous hydrologic simulations using hourly rainfall data from the Ottawa International Airport from 1967 to 2003 (excluding missing 2001 rainfall data), flows at the Fortune Street erosion site were computed and compared. It should be noted that restoration works are proposed for this critical erosion site and several other points along the Van Gaal Drain. The erosion thresholds at Fortune Street were set at 60 L/s, 151 L/s and 385 L/s, as provided by Coldwater Consulting Limited to correspond to their critical shear stress thresholds of 0.5 Pa, 1.0 Pa and 2.0 Pa.

Based on the 60 L/s erosion threshold, erosion occurs for 479.45 hours and 578.08 hours in an average year under existing and proposed conditions, respectively; that is, for 9.87% and 11.90% of the total simulation duration. This corresponds to a 20.6% increase in erosion under proposed conditions. Similarly, based on the 151 L/s erosion threshold, erosion occurs for 328.44 hours and 357.11 hours in an average year under existing and proposed conditions, respectively; that is, for 6.76% and 7.35% of the total simulation duration. This corresponds to an 8.7% increase in erosion under proposed conditions. Finally, based on the 385 L/s erosion threshold, erosion occurs for 203.81 hours and 200.53 hours in an average year under existing and proposed conditions, respectively; that is, for 4.20% and 4.13% of the total simulation duration. This corresponds to a 1.7% decrease in erosion under proposed conditions.

A summary of the erosion analysis results may be found in Attachment A. Digital SWMHYMO modelling input and output files are also attached.

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



Laura Pipkins, P.Eng.

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

Attachment A: Simulated Annual Erosion Hours in the Van Gaal Drain at Fortune Street

ATTACHMENT

A

Simulated Annual Erosion Hours
In the Van Gaal Drain at Fortune Street

JFSA

Water Resources and
Environmental Consultants



**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 1A: Existing Conditions (60 L/s Erosion Threshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	6.576	0.129	373.00	14.66
1968	5160	5.096	0.068	488.80	9.47
1969	5160	5.825	0.049	382.50	7.41
1970	5160	6.150	0.058	452.30	8.77
1971	5160	5.267	0.051	419.80	8.14
1972	5160	10.071	0.111	668.30	12.95
1973	5160	7.253	0.088	585.50	11.35
1974	4392	3.542	0.038	324.00	7.38
1975	3696	5.493	0.080	444.50	12.03
1976	5160	3.728	0.045	421.80	8.17
1977	5160	5.297	0.062	512.00	9.92
1978	5160	5.782	0.050	486.00	9.42
1979	5160	8.422	0.107	608.80	11.80
1980	5160	3.583	0.054	544.80	10.56
1981	5160	21.687	0.142	701.80	13.60
1982	5160	5.226	0.043	442.30	8.57
1983	5160	6.867	0.054	465.50	9.02
1984	3696	4.399	0.069	394.00	10.66
1985	5160	3.375	0.045	446.80	8.66
1986	5160	9.724	0.120	731.00	14.17
1987	5160	6.648	0.068	494.80	9.59
1988	5160	7.423	0.066	462.00	8.95
1989	5160	4.226	0.045	413.80	8.02
1990	5160	7.061	0.079	542.80	10.52
1991	5160	4.841	0.051	442.30	8.57
1992	5160	9.789	0.072	490.50	9.51
1993	5160	1.914	0.048	532.50	10.32
1994	4416	4.772	0.077	471.80	10.68
1995	2952	12.479	0.098	248.30	8.41
1996	5136	4.963	0.052	427.50	8.32
1997	5160	1.542	0.029	396.50	7.68
1998	5088	2.992	0.044	428.00	8.41
1999	4440	4.772	0.052	450.50	10.15
2000	5160	7.496	0.064	502.30	9.73
2002	5088	12.146	0.095	535.80	10.53
2003	4440	5.617	0.09	527.30	11.88
Average	4858	6.446	0.069	479.45	9.87

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 1B: Proposed Conditions (60 L/s Erosion Theshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	4.518	0.108	449.50	17.67
1968	5160	3.511	0.062	602.80	11.68
1969	5160	4.123	0.045	451.50	8.75
1970	5160	4.066	0.053	551.00	10.68
1971	5160	3.455	0.047	512.00	9.92
1972	5160	7.313	0.100	842.30	16.32
1973	5160	4.825	0.079	725.00	14.05
1974	4392	2.260	0.036	371.80	8.47
1975	3696	3.610	0.072	555.80	15.04
1976	5160	2.663	0.042	490.00	9.50
1977	5160	3.496	0.057	606.80	11.76
1978	5160	3.783	0.046	565.50	10.96
1979	5160	6.595	0.097	787.50	15.26
1980	5160	2.654	0.050	620.80	12.03
1981	5160	17.414	0.126	868.00	16.82
1982	5160	3.654	0.041	513.80	9.96
1983	5160	5.037	0.049	553.30	10.72
1984	3696	3.199	0.062	463.00	12.53
1985	5160	2.323	0.042	533.50	10.34
1986	5160	7.909	0.108	912.80	17.69
1987	5160	4.835	0.063	601.50	11.66
1988	5160	4.965	0.060	561.30	10.88
1989	5160	2.770	0.042	495.80	9.61
1990	5160	5.049	0.072	665.80	12.90
1991	5160	3.380	0.047	490.50	9.51
1992	5160	6.753	0.066	597.50	11.58
1993	5160	1.326	0.046	612.00	11.86
1994	4416	3.242	0.069	585.30	13.25
1995	2952	10.286	0.084	305.00	10.33
1996	5136	3.425	0.048	515.00	10.03
1997	5160	1.018	0.027	454.00	8.80
1998	5088	1.971	0.041	499.00	9.81
1999	4440	3.227	0.049	525.50	11.84
2000	5160	5.221	0.059	602.50	11.68
2002	5088	9.185	0.089	678.00	13.33
2003	4440	4.022	0.08	645.50	14.54
Average	4858	4.641	0.063	578.08	11.90

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

Avg. Change in Erosion Threshold Exceedance: 20.6%

**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 2A: Existing Conditions (151 L/s Erosion Threshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	6.576	0.129	288.00	11.32
1968	5160	5.096	0.068	349.30	6.77
1969	5160	5.825	0.049	266.30	5.16
1970	5160	6.150	0.058	295.80	5.73
1971	5160	5.267	0.051	292.80	5.67
1972	5160	10.071	0.111	468.00	9.07
1973	5160	7.253	0.088	402.30	7.80
1974	4392	3.542	0.038	206.30	4.70
1975	3696	5.493	0.080	307.80	8.33
1976	5160	3.728	0.045	284.00	5.50
1977	5160	5.297	0.062	361.00	7.00
1978	5160	5.782	0.050	323.00	6.26
1979	5160	8.422	0.107	446.30	8.65
1980	5160	3.583	0.054	369.00	7.15
1981	5160	21.687	0.142	464.50	9.00
1982	5160	5.226	0.043	281.00	5.45
1983	5160	6.867	0.054	295.80	5.73
1984	3696	4.399	0.069	297.30	8.04
1985	5160	3.375	0.045	322.50	6.25
1986	5160	9.724	0.120	502.50	9.74
1987	5160	6.648	0.068	313.30	6.07
1988	5160	7.423	0.066	327.00	6.34
1989	5160	4.226	0.045	272.00	5.27
1990	5160	7.061	0.079	374.00	7.25
1991	5160	4.841	0.051	273.50	5.30
1992	5160	9.789	0.072	338.30	6.56
1993	5160	1.914	0.048	348.30	6.75
1994	4416	4.772	0.077	328.80	7.45
1995	2952	12.479	0.098	185.50	6.28
1996	5136	4.963	0.052	278.00	5.41
1997	5160	1.542	0.029	256.50	4.97
1998	5088	2.992	0.044	295.30	5.80
1999	4440	4.772	0.052	306.80	6.91
2000	5160	7.496	0.064	343.80	6.66
2002	5088	12.146	0.095	393.80	7.74
2003	4440	5.617	0.09	365.30	8.23
Average	4858	6.446	0.069	328.44	6.76

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 2B: Proposed Conditions (151 L/s Erosion Theshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	4.518	0.108	314.30	12.35
1968	5160	3.511	0.062	383.30	7.43
1969	5160	4.123	0.045	278.50	5.40
1970	5160	4.066	0.053	324.30	6.28
1971	5160	3.455	0.047	300.30	5.82
1972	5160	7.313	0.100	547.30	10.61
1973	5160	4.825	0.079	462.80	8.97
1974	4392	2.260	0.036	193.50	4.41
1975	3696	3.610	0.072	337.50	9.13
1976	5160	2.663	0.042	287.50	5.57
1977	5160	3.496	0.057	386.00	7.48
1978	5160	3.783	0.046	345.00	6.69
1979	5160	6.595	0.097	519.00	10.06
1980	5160	2.654	0.050	399.80	7.75
1981	5160	17.414	0.126	538.30	10.43
1982	5160	3.654	0.041	289.30	5.61
1983	5160	5.037	0.049	319.80	6.20
1984	3696	3.199	0.062	321.00	8.69
1985	5160	2.323	0.042	351.00	6.80
1986	5160	7.909	0.108	560.00	10.85
1987	5160	4.835	0.063	342.00	6.63
1988	5160	4.965	0.060	360.30	6.98
1989	5160	2.770	0.042	287.30	5.57
1990	5160	5.049	0.072	413.80	8.02
1991	5160	3.380	0.047	296.00	5.74
1992	5160	6.753	0.066	370.00	7.17
1993	5160	1.326	0.046	364.00	7.05
1994	4416	3.242	0.069	360.00	8.15
1995	2952	10.286	0.084	201.50	6.83
1996	5136	3.425	0.048	290.00	5.65
1997	5160	1.018	0.027	249.80	4.84
1998	5088	1.971	0.041	314.80	6.19
1999	4440	3.227	0.049	334.50	7.53
2000	5160	5.221	0.059	369.80	7.17
2002	5088	9.185	0.089	444.80	8.74
2003	4440	4.022	0.08	399.00	8.99
Average	4858	4.641	0.063	357.11	7.35

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

Avg. Change in Erosion Threshold Exceedance:

8.7%

**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 3A: Existing Conditions (385 L/s Erosion Threshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	6.576	0.129	205.80	8.09
1968	5160	5.096	0.068	231.30	4.48
1969	5160	5.825	0.049	171.80	3.33
1970	5160	6.150	0.058	188.30	3.65
1971	5160	5.267	0.051	171.50	3.32
1972	5160	10.071	0.111	276.00	5.35
1973	5160	7.253	0.088	273.80	5.31
1974	4392	3.542	0.038	109.00	2.48
1975	3696	5.493	0.080	176.80	4.78
1976	5160	3.728	0.045	161.30	3.13
1977	5160	5.297	0.062	225.30	4.37
1978	5160	5.782	0.050	194.80	3.78
1979	5160	8.422	0.107	283.30	5.49
1980	5160	3.583	0.054	203.30	3.94
1981	5160	21.687	0.142	306.00	5.93
1982	5160	5.226	0.043	170.00	3.29
1983	5160	6.867	0.054	177.00	3.43
1984	3696	4.399	0.069	191.80	5.19
1985	5160	3.375	0.045	193.50	3.75
1986	5160	9.724	0.120	302.50	5.86
1987	5160	6.648	0.068	182.50	3.54
1988	5160	7.423	0.066	220.00	4.26
1989	5160	4.226	0.045	155.50	3.01
1990	5160	7.061	0.079	268.00	5.19
1991	5160	4.841	0.051	177.30	3.44
1992	5160	9.789	0.072	205.80	3.99
1993	5160	1.914	0.048	212.50	4.12
1994	4416	4.772	0.077	227.00	5.14
1995	2952	12.479	0.098	104.00	3.52
1996	5136	4.963	0.052	161.30	3.14
1997	5160	1.542	0.029	131.00	2.54
1998	5088	2.992	0.044	184.00	3.62
1999	4440	4.772	0.052	183.00	4.12
2000	5160	7.496	0.064	207.30	4.02
2002	5088	12.146	0.095	262.00	5.15
2003	4440	5.617	0.09	243.00	5.47
Average	4858	6.446	0.069	203.81	4.20

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

**SIMULATED ANNUAL EROSION HOURS IN THE
VAN GAAL DRAIN AT FORTUNE STREET**

Table 3B: Proposed Conditions (385 L/s Erosion Theshold)

Year ⁽¹⁾	Duration (h)	Peak Flow (m ³ /s)	Average Flow (m ³ /s)	Erosion Hours (h)	Total Exceedance (%)
1967	2544	4.518	0.108	210.50	8.27
1968	5160	3.511	0.062	225.80	4.38
1969	5160	4.123	0.045	169.50	3.28
1970	5160	4.066	0.053	173.80	3.37
1971	5160	3.455	0.047	168.80	3.27
1972	5160	7.313	0.100	294.30	5.70
1973	5160	4.825	0.079	277.30	5.37
1974	4392	2.260	0.036	104.80	2.39
1975	3696	3.610	0.072	173.30	4.69
1976	5160	2.663	0.042	152.50	2.96
1977	5160	3.496	0.057	220.80	4.28
1978	5160	3.783	0.046	181.00	3.51
1979	5160	6.595	0.097	282.80	5.48
1980	5160	2.654	0.050	182.50	3.54
1981	5160	17.414	0.126	319.30	6.19
1982	5160	3.654	0.041	155.30	3.01
1983	5160	5.037	0.049	168.00	3.26
1984	3696	3.199	0.062	190.50	5.15
1985	5160	2.323	0.042	184.80	3.58
1986	5160	7.909	0.108	314.30	6.09
1987	5160	4.835	0.063	182.00	3.53
1988	5160	4.965	0.060	222.00	4.30
1989	5160	2.770	0.042	152.00	2.95
1990	5160	5.049	0.072	274.80	5.33
1991	5160	3.380	0.047	171.30	3.32
1992	5160	6.753	0.066	206.50	4.00
1993	5160	1.326	0.046	194.30	3.77
1994	4416	3.242	0.069	233.30	5.28
1995	2952	10.286	0.084	95.80	3.25
1996	5136	3.425	0.048	153.30	2.98
1997	5160	1.018	0.027	110.50	2.14
1998	5088	1.971	0.041	178.30	3.50
1999	4440	3.227	0.049	180.80	4.07
2000	5160	5.221	0.059	209.00	4.05
2002	5088	9.185	0.089	273.80	5.38
2003	4440	4.022	0.08	231.50	5.21
Average	4858	4.641	0.063	200.53	4.13

⁽¹⁾ Based on a simulation period from April 1st to October 31st.

Avg. Change in Erosion Threshold Exceedance: -1.7%