August 27, 2020
WE: 20029

Mr. Paul Stewart
717906 Highway 6
Georgian Bluffs, Ontario
N4K 5N7

Dear Mr. Stewart:

RE: 717906 Highway 6
Hydraulic Analysis and Floodline Delineation

1. Introduction

We are pleased to provide you with the results of our hydraulic analysis for the above noted project. The intent of this memo is to provide the methodology and results of the hydraulic analysis and the resulting floodlines for the study area. The study area includes the 717906 Highway 6 property as well as the creek and floodplain adjacent to it extending to the west.

2. Background and Methodology

The hydraulic analysis was completed using HEC-RAS version 5.0.7. Existing hydraulic models were not available for the site. The Ontario Flow Assessment Tool (OFAT) was used to estimate return period flows. According to OFAT, the Springmount Drain at the subject property has a drainage area of 5.87 km^2. The contributing area is about 73% agriculture and undeveloped areas, 17% forests, and 10% community/infrastructure areas. There does not appear to be any flow regulation within the upstream watercourses.

The Springmount Drain, which flows adjacent to the subject property, is a straightened and channelized reach that was designed to convey the 25-year flow without spilling beyond the banks. This data point was used to validate the results from OFAT and ensure that the results were reasonable. The regulatory storm for the study area is the Timmins Storm. The peak flow for the Timmins Storm is not provided by OFAT, although for similar small watersheds it is generally about three times the 100-year peak flow, which is about 20 m^3/s in this case. The flow rates from OFAT using the primary multiple regression method are shown in **Table 1**.

Table 1: Flow Rates Used for Hydraulic Modelling

Storm	100y	50y	20y	10y	5y	2y
Flow (m^3/s)	6.62	5.55	4.21	3.34	2.52	1.49

The flow for the Timmins Storm was not provided by OFAT, so a basic hydrology model using MIDUSS was developed to ensure that the estimate of 20 m^3/s was reasonable. Since no calibration data was available, the precise peak flow rate for the Timmins Storm is still not known but applying multiple methods to determine the flow creates more confidence in the estimates. For the MIDUSS model, the subcatchment characteristics and land uses were obtained from OFAT. Most of the watershed is poorly drained and some portions were not defined, so it was assumed that the entire contributing area belongs to hydrologic soil group D. The agricultural areas were assumed to be in good condition and use row crops without additional best management practices. The forested areas were also assumed to be good quality. The residential areas were assumed to have an average lot size of one acre based on measurements from aerial imagery. Based on the residential classification, there will be 20% impervious area that is assumed to be directly connected. All curve numbers and impervious percentages were obtained from NRCS TR-55 method documentation (NRCS, 1986). The length of the main channel is 4.54 km and the longest flowpath is 8.49 km, with an average watershed slope of 2.08%. The model produced a Timmins Storm peak flow of 19.97 m^3/s, which corroborates the expected flow based off of the OFAT results. Water's Edge performed a topographic survey to define the floodplain topography in the study area. The survey data was used to produce a surface in AutoCAD Civil 3D that would be used as the terrain in the HEC-RAS model. Local benchmarks such as the inverts and obverts of the culvert and the centreline of road were shot to ensure that elevations could be adjusted if a different projection is needed. All survey data was surveyed using the CGVD:2013 datum and the CRCS UTM Zone 17N projection. No structures were present on the main channel in the study area or immediately upstream or downstream. Cross-sections were defined according to the HEC-RAS User's Manual and are sufficient for representing channel and overbank flowpaths. The channel roughness was based on standard parameters used by many conservation authorities in Ontario; the main channel Manning's n was 0.035, and the overbank Manning's n was 0.08. All cross-sections used contraction and expansion coefficients of 0.1 and 0.3, respectively since there was no major expansions or contractions within the study reach. The downstream boundary condition is based on the normal depth of flow with a friction slope of 0.002 m/m, based on the slope of the channel at the downstream boundary.

If the 20-year flow is contained within the channel, and there is reasonable agreement between the estimates of the peak flow of the Timmins Storm, then the OFAT flow rates and the Timmins Storm flows can be considered accurate. Given the lack of calibration data, the highest estimate of the Timmins Storm flow should be used to create conservative floodlines for the regional storm.

The floodlines were delineated based on the modelled HEC-RAS water surface elevations and the topographic surface that was created.

3. Results

The modelling results show that the 20-year storm will be contained within the main channel, as expected. The 100-year flow is contained within the channel in the downstream half of the site, but spills over both the right and left banks at the upstream end. The inundated areas for the 100-year flow are limited to the northwest corner of the site and do not impact any of the buildings or infrastructure. The inundation areas for the Timmins Storm cover a larger portion of the property, but does not impact the buildings or access to the property. The largest flow rate that would not inundate the existing footprint of the buildings was determined to be 41 m^3/s. Since the floor levels of both buildings are above grade, flows would need to be at least 65 m^3/s to reach the floor level of the house, and 91 m^3/s to reach the floor of the garage. Since the Timmins Storm peak flow is about 20 m^3/s, the buildings are not in the floodplain of the regulatory event, and have a large factor of safety.

The floodlines are included in the attached **Map 1**. The longitudinal profile through the site is shown in **Figure 1**. **Table 2** is attached and contains the HEC-RAS results summary table.

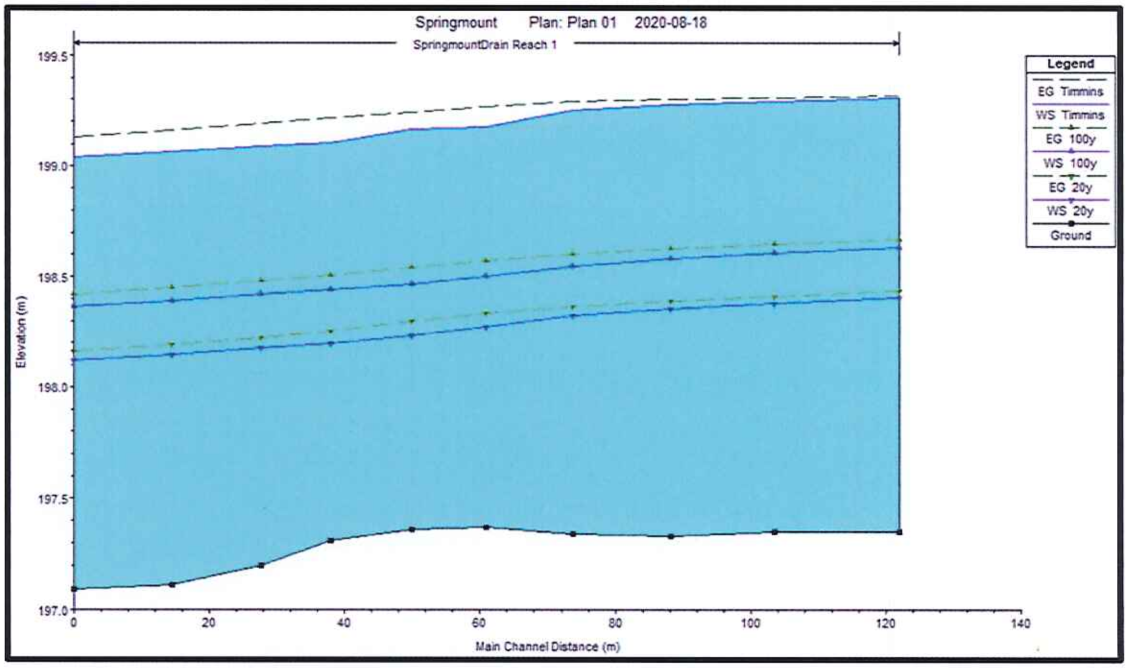

Figure 1: HEC-RAS profiles (W.S. = Water Surface, E.G. = Energy Grade)

The following results are noted:

1) The return period flow rates were obtained from OFAT;
2) The Timmins Storm peak flow was estimated to be 20 m^3/s, which was corroborated by the results of a MIDUSS model;
3) The only calibration data available was that the 25-year flow should be contained within the channel, which was confirmed;
4) Topographic data used in the hydraulic model was based on survey data collected by Water's Edge;
5) Standard modelling parameters were applied;
6) The 20-year flow is contained within the channel;
7) The Timmins Storm peak flow would not inundate the buildings;
8) A flow of 65 m^3/s is necessary to inundate the buildings to the surveyed floor levels, which is more than triple the Timmins peak flow and nearly ten times the 100-year flow.

Should you have any comments or questions please do not hesitate to contact the undersigned.

Respectfully submitted,

Ed Gazendam, Ph.D., P. Eng.,
President, Sr. Geomorphologist
Water's Edge

Ryan Good, M.A.Sc., EIT
River Scientist

Att: **Map 1: Floodline Delineation**

Table 2: HEC-RAS Results Summary Table


XS 118
Reg. W.S. Elev.: 199.29m
XS 103
Reg. W.S. Elev.: 199.28m
XS 88
Reg. W.S. Elev.: 199.25m
XS 75
Reg. W.S. Elev.: 199.18m
XS 64
Reg. W.S. Elev.: 199.16m
XS 52
Reg. W.S. Elev.: 199.1m
XS 42
Reg. W.S. Elev.: 199.09m
XS 29
Reg. W.S. Elev.: 199.06m
XS 15
Reg. W.S. Elev.: 199.04m
Legend
Timmins Storm Inundation Boundary
100-year Inundation Boundary
20-year Inundation Boundary
Cross Sections
Watercourse
Scale
0 4 8 16 24 32 Meters
Projection: CRCS UTM Zone 17
North Arrow
N
Approved By
REVISIONS
NO. DESCRIPTION BY DATE
1 Original
Consultant
water's edge
ENVIRONMENTAL SOLUTIONS TEAM
717906 Highway 6
Floodplain Assessment
Date:
September 1, 2020
Drawn By:
RG
File No.:
WE20029
Map No.:
1

Table 2: HEC-RAS Results Summary Table

River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
136	Timmins	20	197.35	199.31		199.32	0.000265	0.62	106.68	199.08	0.16
136	100y	6.62	197.35	198.63		198.67	0.001118	0.88	11.4	40.93	0.29
136	20y	4.21	197.35	198.4		198.44	0.001388	0.81	5.76	15.2	0.31
136	41 cms	41	197.35	199.65		199.66	0.000288	0.74	175.11	201.97	0.17
136	65 cms	65	197.35	199.91		199.92	0.000336	0.86	226.87	203.3	0.19
136	91 cms	91	197.35	200.13		200.14	0.000382	0.98	272.26	206.07	0.2
118	Timmins	20	197.35	199.29		199.31	0.000463	0.82	78.84	181.63	0.21
118	100y	6.62	197.35	198.61		198.65	0.001126	0.88	9.37	23.41	0.29
118	20y	4.21	197.35	198.38		198.41	0.00129	0.78	5.54	10.68	0.3
118	41 cms	41	197.35	199.63		199.65	0.000459	0.93	143.04	192.89	0.21
118	65 cms	65	197.35	199.89		199.91	0.000498	1.05	192.41	194.44	0.23
118	91 cms	91	197.35	200.11		200.13	0.000542	1.17	235.75	197.6	0.24
103	Timmins	20	197.33	199.28		199.3	0.000615	0.91	69.18	181.66	0.24
103	100y	6.62	197.33	198.58		198.63	0.00144	0.94	8.66	16.47	0.33
103	20y	4.21	197.33	198.35		198.39	0.00153	0.85	5.52	11.38	0.33
103	41 cms	41	197.33	199.62		199.64	0.000547	0.98	133.77	189.76	0.23
103	65 cms	65	197.33	199.88		199.9	0.000578	1.1	182.47	191.88	0.24
103	91 cms	91	197.33	200.1		200.12	0.000619	1.22	225.08	195.2	0.25
88	Timmins	20	197.34	199.25		199.29	0.000872	1.06	57.03	179.41	0.28
88	100y	6.62	197.34	198.55		198.6	0.001747	1.04	6.92	12.86	0.36
88	20y	4.21	197.34	198.32		198.36	0.001807	0.9	4.71	7.44	0.35
88	41 cms	41	197.34	199.61		199.63	0.000678	1.08	122.69	187.75	0.25
88	65 cms	65	197.34	199.87		199.89	0.00069	1.19	171.24	191.01	0.26
88	91 cms	91	197.34	200.09		200.11	0.000722	1.3	213.76	195.2	0.27
75	Timmins	20	197.37	199.18		199.27	0.001993	1.49	30.33	113.76	0.41
75	100y	6.62	197.37	198.5		198.57	0.002639	1.19	5.74	10.12	0.43
75	20y	4.21	197.37	198.28		198.33	0.003018	1.06	3.96	6.85	0.44
75	41 cms	41	197.37	199.56		199.62	0.001381	1.47	83.1	149.67	0.36
75	65 cms	65	197.37	199.82		199.88	0.001332	1.59	126.62	179.21	0.36
75	91 cms	91	197.37	200.05		200.1	0.001254	1.66	167.76	184.6	0.36
64	Timmins	20	197.36	199.16		199.24	0.001826	1.41	32.77	113.66	0.39
64	100y	6.62	197.36	198.47		198.54	0.003053	1.22	5.43	7.93	0.46
64	20y	4.21	197.36	198.23		198.3	0.003674	1.14	3.71	6.7	0.49

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
		(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
64	41 cms	41	197.36	199.55		199.6	0.001338	1.43	80.4	132.14	0.35
64	65 cms	65	197.36	199.8		199.86	0.001374	1.6	119.2	168.93	0.37
64	91 cms	91	197.36	200.03		200.09	0.001339	1.69	157.74	173.6	0.37
52	Timmins	20	197.31	199.1	198.59	199.22	0.002352	1.55	21.76	79.66	0.44
52	100y	6.62	197.31	198.44		198.51	0.002646	1.15	5.78	7.99	0.43
52	20y	4.21	197.31	198.2		198.25	0.00301	1.06	3.98	6.87	0.44
52	41 cms	41	197.31	199.49		199.58	0.001967	1.69	60.93	113.71	0.42
52	65 cms	65	197.31	199.74		199.84	0.002	1.88	94.5	156.62	0.44
52	91 cms	91	197.31	199.97		200.06	0.001833	1.95	131.82	162.3	0.43
42	Timmins	20	197.2	199.09		199.19	0.002103	1.48	22.26	75.81	0.42
42	100y	6.62	197.2	198.42		198.48	0.002208	1.08	6.2	9.52	0.39
42	20y	4.21	197.2	198.17		198.22	0.00234	0.98	4.3	6.83	0.39
42	41 cms	41	197.2	199.46		199.56	0.00205	1.73	60.52	121.68	0.43
42	65 cms	65	197.2	199.72		199.82	0.001978	1.87	97.52	150.17	0.43
42	91 cms	91	197.2	199.96		200.04	0.001785	1.93	133.56	152.8	0.42
29	Timmins	20	197.11	199.06		199.16	0.00219	1.46	22.58	76.38	0.42
29	100y	6.62	197.11	198.39		198.45	0.00212	1.08	6.19	9.01	0.39
29	20y	4.21	197.11	198.15		198.19	0.002108	0.96	4.39	6.61	0.38
29	41 cms	41	197.11	199.43		199.53	0.002029	1.68	59.88	116.55	0.43
29	65 cms	65	197.11	199.69		199.79	0.002008	1.85	94.44	141.06	0.43
29	91 cms	91	197.11	199.93		200.02	0.001839	1.92	128.04	141.7	0.42
15	Timmins	20	197.09	199.04	198.45	199.13	0.002	1.41	24.38	68.61	0.41
15	100y	6.62	197.09	198.36	197.86	198.42	0.002001	1.05	6.3	7.95	0.38
15	20y	4.21	197.09	198.12	197.7	198.16	0.002002	0.94	4.5	6.78	0.37
15	41 cms	41	197.09	199.4	199.14	199.5	0.002002	1.68	58.3	115.94	0.42
15	65 cms	65	197.09	199.66	199.39	199.76	0.002	1.86	88.5	117	0.43
15	91 cms	91	197.09	199.89	199.54	199.99	0.002001	2.01	115.08	117	0.44