Memo

To: Tara Buonpensiero, Town of Halton Hills
Steve Grace, Town of Halton Hills

From: Abhijeet Patel/Aaron Farrell/Ron Scheckenberger, Wood

Date: September 6, 2018

File: TPB188001

cc: Steve Burke, Town of Halton Hills
John Lindhart, Town of Halton Hills
Chris Mills, Town of Halton Hills

Re: **Supplemental Assessment of Stormwater Management Plan for Vision Georgetown Secondary Plan Area, Town of Halton Hills**

1. INTRODUCTION

Further to the Town's request (ref. e-mail correspondence Buonpensiero-Scheckenberger/Farrell, July 5, 2018), Wood has completed supplemental hydrologic analyses to optimize the unitary storage and discharge criteria for sizing the stormwater management facilities within the Vision Georgetown Secondary Plan Area. The hydrologic analysis conducted in previous assessment (ref. Farrell/Scheckenberger-Buonpensiero/Grace, May 4, 2018) assessed the performance of the stormwater management infrastructure in accordance with the targets and criteria established in the approved Subwatershed Study (ref. AECOM, May 2017). As noted in the May 4, 2018 memorandum, the results of the hydrologic analyses indicated that the stormwater management criteria advanced in the May 2017 Subwatershed Study would overcontrol post-development peak flows compared to pre-development levels at the drainage outlets, hence it was recommended that additional analyses be conducted to update the stormwater management sizing criteria advanced in the May 2017 Subwatershed Study, with the objective of reducing the extent of over-control resulting from the current criteria and methodology. This Technical Memorandum provides the results and recommendations of the additional analyses completed to optimize the stormwater management sizing criteria for the Vision Georgetown Secondary Plan Area.

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2. SUMMARY OF SUBWATERSHED STUDY CRITERIA AND PREVIOUS ANALYSES

2.1 Stormwater Management Sizing Criteria Per May 2017 Subwatershed Study

The hydrologic analyses completed by AECOM for the May 2017 Subwatershed Study applied the PCSWMM methodology. The stormwater management criteria for peak flow control, as advanced in the May 2017 Subwatershed Study, was established such that the post-development peak flow rates along the receiving watercourses would not exceed pre-development rates for the 2-year through Regional Storm design storm events. The hydrologic analyses to establish peak flow controls applied the 24 hour Chicago synthetic design storm distribution, and corresponding hyetographs were developed based on the Town of Halton Hills Intensity-Duration-Frequency (IDF) standards. In addition, the Regional Storm (Hurricane Hazel) event was simulated as a discrete storm event for evaluating the impacts of the future development and establishing stormwater management criteria accordingly. The unitary storage and discharge criteria for sizing stormwater management facilities, per the recommendations of the May 2017 Subwatershed Study, are summarized in Tables 1 and 2 respectively.

Table 1: Unitary Storage Volume (m^3/ha) (ref. AECOM, May 2017)							
Tributary/outlet	**2 yr**	**5 yr**	**10 yr**	**25 yr**	**50 yr**	**100 yr**	**Regional**
A	146	263	360	493	593	697	1693
B	159	238	318	427	514	600	1226
C	198	317	415	549	651	752	1676
D	373	538	665	836	956	1079	2507
E	360	525	652	820	946	1072	2498

Table 2: Unitary Flow targets($m^3/s/ha$) (ref. AECOM, May 2017)							
Tributary/outlet	**2 yr**	**5 yr**	**10 yr**	**25 yr**	**50 yr**	**100 yr**	**Regional**
A	0.0024	0.012	0.023	0.042	0.049	0.05	0.053
B	0.0016	0.0017	0.013	0.023	0.023	0.024	0.027
C	0.0017	0.004	0.013	0.03	0.036	0.037	0.041
D	0.0066	0.02	0.037	0.038	0.039	0.04	0.043
E	0.0035	0.009	0.009	0.01	0.01	0.01	0.011

2.2 Summary of Previous Hydrologic Verification (ref. May, 2018)

Hydrologic analyses have been previously completed by Wood to verify the performance of the stormwater management sizing criteria advanced in the Subwatershed Study for the functional stormwater management plan developed for the conceptual land use plan for the Vision Georgetown Area. The PCSWMM hydrologic model which was developed for the May 2017 Subwatershed Study was revised within the limits of the Vision Georgetown Area to represent the drainage area and impervious coverage for the land uses in each subcatchment per the conceptual land use plan. The soil parameterization has been retained from the parent subcatchments within the PCSWMM hydrologic model. In addition, the channel routing elements through the Vision Georgetown Area were updated to represent the recommended configuration of the watercourse corridors (ref. Farrell/Scheckenberger-Howatt/Mayes, April 19, 2018).

The updated PCSWMM hydrologic model was used to assess the performance of the stormwater management sizing criteria advanced in the May 2017 Subwatershed Study. Consistent with the methodology applied for the Subwatershed Study, the PCSWMM model was used to generate instantaneous 1.5 through 100 year return period peak flow rates based on 24 hour Chicago synthetic design storms, as well as generating instantaneous peak flows for the Regional storm (i.e. Hurricane Hazel) event. The results demonstrated significant reduction in the peak flows (i.e. over-control) at the outlets from the Vision Georgetown lands to external properties (i.e. between 0.5 % and 84 % reduction in 100 year event peak flow and between 16 % and 85 % reduction in Regional Storm event peak flow). This over-control was considered attributable, in part, to the methodology established in the Subwatershed Study, which applies the unitary storage criteria per hectare of development, as opposed to the more conventional approach of establishing and applying the unitary storage volume per impervious hectare.

3. SUPPLEMENTAL HYDROLOGIC ANALYSIS (OPTIMIZATION)

The supplemental hydrologic analyses to establish updated unitary storage and discharge criteria have applied the PCSWMM modelling from the previous hydrologic verification. Consistent with the previous methodology, the hydrologic analyses have applied the hyetographs for the 1.5 year through 100 year 24 hour Chicago design storms, as well as the Regional Storm (Hurricane Hazel) event. Further, minor modifications have been made to the PCSWMM models developed for the Subwatershed Study, to maintain consistency with current practices for hydrologic modelling; further details are provided below.

3.1 Updated Existing Conditions Flows

The PCSWMM hydrologic model for the existing conditions has been updated to remove the hydraulic structures (i.e. culverts) at roadway crossings, consistent with conventional practice. The updated existing conditions model has been used to generate peak flows at key locations within, and proximate to, the Vision Georgetown Secondary Plan Area (ref. Drawing 1). Consistent with the methodology applied for the May 2017 Subwatershed Study, the analyses have applied the 24-hour Chicago rainfall distribution, for the synthetic design storms, as well as the Regional (Hurricane Hazel) Storm event. The updated peak flows for existing land use conditions, at key locations, are presented in Table 3.

Town of Halton Hills
August 20, 2018

Table 3:	Simulated Peak Flows for updated Existing Controlled Land Use Conditions (m^3/s)								
Reference Node	Location	Return Period (Years)							Regional
		1.5	2	5	10	25	50	100	
Existing Land Use Conditions									
1		0.28	0.36	1.64	2.83	4.50	6.03	7.57	12.99
2		0.63	0.74	2.20	3.45	5.20	6.78	8.43	11.3
3		0.24	0.29	0.74	1.14	1.69	2.20	2.70	3.666
4		0.75	0.91	2.04	2.87	4.01	5.02	6.06	14.05
5		0.93	1.11	2.43	3.41	4.78	5.99	7.23	16.68
6		1.64	1.97	5.03	7.39	10.64	13.64	16.51	34.7
7		1.81	2.16	5.45	7.99	11.51	14.67	17.79	36.74
8	Tributary AM-4 and A4-1 Confluence	2.23	2.68	6.94	10.25	14.78	18.83	22.91	45.79
9	Tributary A Outlet	2.31	2.77	7.10	10.48	15.11	19.29	23.39	46.54
10	10 Side Road Outlet	0.13	0.15	0.38	0.57	0.84	1.08	1.33	1.513
11	Tributary A11-1 Outlet	0.31	0.37	0.92	1.39	2.05	2.64	3.23	3.427
12	Tributary C Outlet	0.11	0.13	0.81	1.52	2.50	3.44	4.38	6.586
13	Tributary B Outlet	0.08	0.09	0.61	1.44	2.66	3.83	4.96	5.897

Compared with the results presented in the May 2017 Subwatershed Study for existing conditions, the results in Table 3 indicate that the updated existing conditions model, with hydraulic structures removed, produces the most significant changes in peak flows at certain locations for events smaller than 2-year return period (+19.2% to -2.6%). For the events above 2-year, the changes in peak flows at key outlets are very minor (+1.4% to -0.3%) from those in the Subwatershed Study.

3.2 Updated Future Conditions Modelling

The PCSWMM hydrologic model representing future land use conditions within the Vision Georgetown Area has been generated from the updated existing conditions model. The revisions noted in the May 4, 2018 correspondence (i.e. subcatchment discretization and parameterization, channel routing elements), have been incorporated into the hydrologic model. In addition, storage elements representing the stormwater management facilities within the Vision Georgetown Area (ref. Drawing 1) have been incorporated into the PCSWMM hydrologic model for future land use conditions.

3.3 Updated Stormwater Management Criteria

The updated future conditions model has been used to establish unitary storage and discharge criteria for sizing the stormwater management facilities within the Vision Georgetown Area. The unitary target flows have been established based on the results of updated existing conditions PCSWMM hydrologic model, and the proposed size of contributing drainage area to each outlet from the study area. The unitary storage criteria has been established by iteratively adjusting the sizing criteria in increments of 25 m^3/impervious ha until post-to-pre control has been achieved at the key outlets from the Vision Georgetown Area. (i.e. outlets for Tributary A,B,C and SWM D,E). It should be noted that the updated unitary storage criteria under this assessment have been calculated based upon the more conventional approach of providing a specified volume per impervious hectare (versus the sizing criteria of volume per development hectare as provided in the May 2017 Subwatershed Study). The updated unitary storage and discharge criteria are summarized in Tables 4 and 5, and the resulting storage-discharge relationships for the stormwater management facilities are provided in Appendix A.

Table 4: Updated Unitary Storage Criteria for Vision Georgetown Area Stormwater Management Facilities (m^3/Impervious ha)[1.]

Receiving Tributary	Facility Operating Level/Condition						
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	Regional
A	275	325	400	575	700	925	1300
B	300	400	475	575	650	675	1100
C	325	425	475	600	675	800	1200
D	250	325	375	425	475	500	550
E	350	475	550	675	750	800	1400

NOTE: [1.] Values represent cumulative storage volumes for flood control, exclusive of extended detention storage for erosion and/or stormwater quality control.

Table 5: Updated Unitary Discharge Criteria for Vision Georgetown Area Stormwater Management Facilities (m^3/s/ha)

Receiving Tributary	Facility Operating Level/Condition						
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	Regional
A	0.0053	0.014	0.020	0.029	0.037	0.045	0.089
B	0.0011	0.007	0.016	0.035	0.050	0.056	0.067
C	0.0016	0.010	0.019	0.031	0.042	0.053	0.080
D	0.0201	0.050	0.076	0.112	0.144	0.177	Uncontrolled
E	0.0073	0.018	0.027	0.040	0.051	0.063	0.071

The information in Tables 4 and 5 indicate that the stormwater management facility at Outlet D would require a significantly lower unitary storage volume compared to the balance of the stormwater management facilities within the Vision Georgetown Area. This is considered attributable to the proposed reduction in drainage area to Outlet D under the storm servicing concept evaluated (i.e. 29.55 ha existing versus 18.27 ha future).

The PCSWMM hydrologic model representing future land use conditions has been updated to incorporate storage-discharge relationships for the stormwater management facilities based upon the unitary storage and discharge criteria presented in Tables 4 and 5. Consistent with the methodology applied for the Subwatershed Study, the PCSWMM model has been used to generate instantaneous 1.5 through 100 year return period peak flow rates based on the 24 hour Chicago storm distribution, , as well as for the Regional Storm (Hurricane Hazel) event. The simulated peak flows for the future controlled land use conditions with the recommended revised sizing criteria are summarized in Table 6, and the percent change from existing conditions are summarized in Table 7.

Table 6: Simulated Peak Flows for Future Land Use Conditions with Recommended Revised Stormwater Management Sizing Criteria (m^3/s)

Reference Node	Location	Return Period (Years)							Regional
		1.5	2	5	10	25	50	100	
1		0.70	0.94	3.42	5.56	8.50	11.19	13.82	15.96
2		1.13	1.33	3.50	5.78	9.04	12.02	14.99	25.02
3		0.28	0.33	0.79	1.18	1.73	2.20	2.68	3.15
4		1.39	1.66	4.16	6.71	10.31	13.57	16.81	29.09
5		1.24	1.74	4.14	6.68	10.26	13.50	16.72	29.13
6		1.60	2.11	5.12	7.83	11.86	15.37	18.77	33.67
7		1.90	2.36	5.79	8.79	12.99	16.70	20.26	36.83
8	Tributary AM-4 and A4-1 Confluence	2.12	2.60	6.45	9.55	13.96	17.81	21.43	42.20
9	Tributary A Outlet	2.29	2.78	6.94	10.23	14.86	18.91	22.68	44.24
10	10 Side Road Outlet	0.14	0.15	0.35	0.56	0.78	1.01	1.31	1.46
11	Tributary A11-1 Outlet	0.32	0.34	0.87	1.32	1.99	2.47	3.12	2.46
12	Tributary C Outlet	0.09	0.10	0.79	1.51	2.41	3.29	3.93	5.95
13	Tributary B Outlet	0.06	0.09	0.56	1.32	2.62	3.76	4.74	5.62

Table 7: Percent Change in Simulated Peak Flows for Future Controlled Land Use Conditions Compared to Existing Land Use Conditions (%)									
Reference Node	Location	Return Period (Years)							Regional
		1.5	2	5	10	25	50	100	
1		153.5	162.6	109.0	96.6	89.0	85.5	82.7	22.9
2		79.9	80.0	59.1	67.7	73.8	77.3	77.9	121.4
3		18.2	15.4	6.6	3.6	2.1	0.3	-0.9	-14.2
4		85.8	83.0	103.8	133.5	157.2	170.2	177.5	107.0
5		33.4	57.5	70.4	95.9	114.7	125.3	131.3	74.6
6		-2.7	7.2	1.8	6.0	11.5	12.7	13.7	-3.0
7		5.1	9.5	6.2	10.0	12.9	13.8	13.9	0.2
8	Tributary AM-4 and A4-1 Confluence	-5.0	-2.9	-7.0	-6.9	-5.5	-5.4	-6.5	-7.8
9	Tributary A Outlet	-1.0	0.6	-2.2	-2.4	-1.7	-2.0	-3.0	-4.9
10	10 Side Road Outlet	5.9	-4.2	-6.2	-1.8	-6.6	-6.5	-1.4	-3.4
11	Tributary A11-1 Outlet	2.5	-6.7	-5.5	-4.9	-3.3	-6.4	-3.4	-28.3
12	Tributary C Outlet	-16.5	-24.7	-3.3	-0.3	-3.5	-4.5	-10.3	-9.6
13	Tributary B Outlet	-23.9	-8.8	-8.0	-7.9	-1.6	-1.8	-4.5	-4.7

The results in Tables 6 and 7 indicate that the peak flows at the outlets from the Vision Georgetown lands to external properties (ref. Nodes 9, 10, 11, 12, and 13) (ref. Drawing 1) would be reduced to at, or below, pre-development levels under proposed land use conditions with stormwater management facilities sized per the revised criteria. As such, the revised stormwater management sizing criteria would maintain post-development peak flows to pre-development levels, per the requirements of the May 2017 Subwatershed Study.

The results in Tables 6 and 7 also indicate that increased peak flows would be anticipated at various locations <u>within</u> the Vision Georgetown area (ref. Nodes, 1, 2, 3, 4, 5, 6 and 7) (ref. Drawing 1) under proposed controlled land use conditions with the stormwater management facilities sized per the revised criteria. The increases are noted to all lie along the reconstructed Tributary A, and are considered attributable to the changes in hydrology due to the relocation of Watercourse A2-1 and A2-2 along Trafalgar Road, as well as the location of stormwater management outfalls and proposed modifications to drainage boundaries. Nevertheless, given that these increases would be entirely within the Vision Georgetown lands, it is anticipated that the final grading adjacent to the reconstructed Tributary could be established so as to fully mitigate any potential flood risk to the future development associated with any increased water surface elevations resulting from these higher flows.

3.4 Stormwater Management Facility Sizes

The revised unitary storage criteria and the respective drainage area and imperviousness for each stormwater management facility has been used to estimate the facility footprints. For these calculations, a maximum 2.5 m depth has been assumed for the facility to provide flood control storage for 100-year storm event, and a maximum 3.5 m depth has been assumed for the facility to provide flood control storage for the Regional Storm event. The resulting facility volumes and footprints are presented in Appendix B. The results indicate that the facility footprints range from 0.39 ha to 2.46 ha for 100-year storm event and 0.47 ha to 2.49 ha for the Regional Storm event. The results also indicate that the estimated facility footprints represent between 3.6% to 10.1% of the drainage area for 100-year storm event and 3.6% to 10.8% of the drainage area for the Regional Storm event.

The foregoing results have been compared with the footprints estimated for the facilities sized in accordance with the May 2017 Subwatershed Study criteria. The results of this assessment indicate that the optimized sizing criteria presented above would reduce the facility footprints by between 2.2% – and 58.8% for the 100-year storm event and would reduce the footprints by between 28.5% – and 75.2% for the Regional Storm event. Consequently, the revised unitary storage and discharge criteria presented above would reduce the overall land requirements for stormwater management facilities to provide peak flow control, compared to facilities sized in accordance with the criteria advanced in the May 2017 Subwatershed Study.

4. CONCLUSIONS AND RECOMMENDATIONS

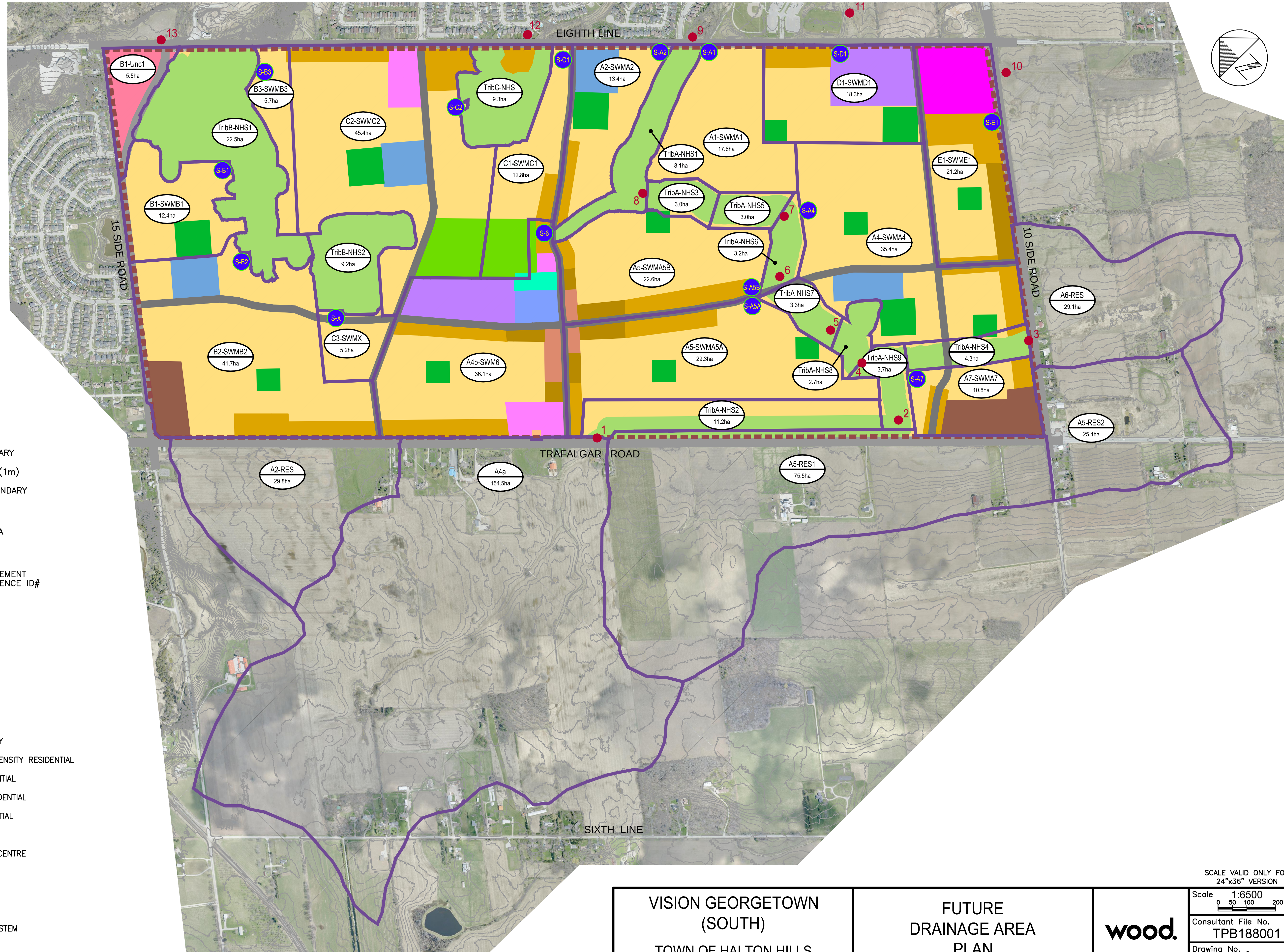
Based upon the foregoing, it is concluded that the revised stormwater management criteria applied to the conceptual development and stormwater management plan for the area, would provide sufficient peak flow control, as the post-development peak flows would be less than pre-development peak flows at the outlets of the Vision Georgetown area for all the events up to, and including, the Regional Storm event. The revised sizing criteria would reduce the footprints of the stormwater management facilities, compared to those required based upon the sizing criteria advanced in the May 2017 Subwatershed Study be up to 58.8 % for the 100 year event and 75.2 % for the Regional Storm event.

It is recommended that the foregoing be reviewed with Conservation Halton, to confirm the Authority's concurrence with the revised sizing criteria. Subject to receipt of approval from Conservation Halton, it is recommended that the foregoing be issued as an amendment to the

May 2017 Subwatershed Study, for land budget calculations and for sizing of stormwater management facilities as part of subsequent studies.

We trust that the foregoing and attached satisfies your current requirements. Feel free to contact our office should you have any questions or wish to discuss.

AP/AF/RBS/ap/af



LEGEND

	STUDY AREA BOUNDARY
	EXISTING CONTOUR (1m)
	SUBCATCHMENT BOUNDARY
A2-RES 29.8ha	SUBCATCHMENT ID#
	SUBCATCHMENT AREA
8	FLOW NODE AND REFERENCE ID#
S-X	STORMWATER MANAGEMENT FACILITY AND REFERENCE ID#

FUTURE LAND USE

	EXISTING ROADWAY
	FUTURE ROADWAY
	SPECIAL STUDY AREA
	MAJOR INSTITUTIONAL
	MAJOR COMMERCIAL
	COMMERCIAL
	MIXED USE – GATEWAY
	MIXED USE – HIGH DENSITY RESIDENTIAL
	HIGH DENSITY RESIDENTIAL
	MEDIUM DENSITY RESIDENTIAL
	LOW DENSITY RESIDENTIAL
	SCHOOL
	LIBRARY, COMMUNITY CENTRE
	TOWN SQUARE PARK
	COMMUNITY PARK
	PARKLAND
	NATURAL HERITAGE SYSTEM
	CEMETARY

SCALE VALID ONLY FOR 24"x36" VERSION

VISION GEORGETOWN (SOUTH) TOWN OF HALTON HILLS	FUTURE DRAINAGE AREA PLAN	wood.	Scale 1:6500 (0 50 100 200) Consultant File No. TPB188001 Drawing No. 1

Path: P:\2018\Projects\TPB188001 – Vision Georgetown (South) Area Svc\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJ\2018-05\Dwg1-2 FutConditions.dwg

Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2018-05-04
Last Saved: 2018-05-03

APPENDIX A

Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A1	17.57	60.51%	10.63	0.000	0
					0.093	2923
					0.239	3455
					0.353	4252
					0.508	6113
					0.649	7442
					0.787	9834
					1.566	13820
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A2	13.39	60.08%	8.04	0.000	0
					0.071	2212
					0.182	2614
					0.269	3217
					0.387	4625
					0.495	5630
					0.600	7440
					1.193	10456
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A4	35.35	58.39%	20.64	0.000	0
					0.187	5677
					0.481	6709
					0.709	8258
					1.023	11870
					1.306	14451
					1.583	19096
					3.151	26838
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	6	36.15	66.85%	24.17	0.000	0
					0.191	6645
					0.491	7854
					0.725	9666
					1.046	13895
					1.335	16916
					1.619	22353
					3.222	31415

Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A5A	29.31	61.08%	17.90	0.000	0
					0.155	4923
					0.398	5818
					0.588	7161
					0.848	10294
					1.083	12531
					1.313	16559
					2.612	23272
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A5B	22.61	62.99%	14.24	0.000	0
					0.120	3917
					0.307	4629
					0.454	5697
					0.654	8190
					0.835	9971
					1.013	13175
					2.015	18517
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
A	A7	10.79	71.77%	7.74	0.000	0
					0.057	2129
					0.147	2516
					0.216	3097
					0.312	4452
					0.398	5419
					0.483	7161
					0.961	10065
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
B	B1	12.43	55.71%	6.92	0.000	0
					0.013	2077
					0.086	2770
					0.203	3289
					0.435	3981
					0.621	4501
					0.701	4674
					0.834	7617

Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
B	B2	41.71	63.44%	26.46	0.000	0
					0.044	7939
					0.289	10585
					0.681	12569
					1.460	15216
					2.086	17200
					2.354	17862
					2.800	29108
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
B	B3	5.65	60.84%	3.44	0.000	0
					0.006	1031
					0.039	1375
					0.092	1633
					0.198	1976
					0.282	2234
					0.319	2320
					0.379	3781
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
C	C1	12.77	50.03%	6.39	0.000	0
					0.020	2076
					0.127	2714
					0.236	3034
					0.390	3832
					0.536	4311
					0.683	5110
					1.026	7664
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
C	C2	45.44	58.18%	26.44	0.000	0
					0.071	8592
					0.452	11236
					0.842	12557
					1.387	15862
					1.908	17845
					2.431	21149
					3.652	31724

Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
C	X	5.24	60.00%	3.14	0.000	0
					0.008	1022
					0.052	1336
					0.097	1493
					0.160	1886
					0.220	2122
					0.280	2515
					0.421	3772
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
D	D1	18.27	61.63%	11.26	0.000	0
					0.368	2815
					0.919	3660
					1.389	4223
					2.054	4786
					2.639	5349
					3.227	5630
					9.994	6194
Trib	SWM Facility	Drainage Area(ha)	Imp. (%)	Imp. Area (ha)	Flow (m3/s)	Volume(m3)
E	E1	21.18	73.49%	15.56	0.000	0
					0.154	5447
					0.378	7392
					0.574	8559
					0.839	10504
					1.081	11671
					1.326	12449
					1.513	21787

APPENDIX B

Facility	100 Year	Area (ha)	impervious - ness (%)	Impervious Area (ha)	Total DS	Facility Area (ha)	Percent of Total Area
	Depth				m^3		
A1	2.5	17.57	60.51%	10.63	15105	1.29	7.4
A2	2.5	13.39	60.08%	8.04	11458	1.06	7.9
6	2.5	36.15	66.85%	24.17	33198	2.38	6.6
A4	2.5	35.35	58.39%	20.64	29699	2.18	6.2
A5A	2.5	29.31	61.08%	17.90	25353	1.92	6.6
A5B	2.5	22.61	62.99%	14.24	19957	1.59	7.0
A7	2.5	10.79	71.77%	7.74	10400	0.99	9.2
B1	2.5	12.43	55.71%	6.93	5172	0.61	4.9
B2	2.5	41.71	63.44%	26.46	19529	1.57	3.8
B3	2.5	5.65	60.84%	3.44	2546	0.39	7.0
C1	2.5	12.77	50.03%	6.39	8942	0.88	6.9
C2	2.5	45.44	58.18%	26.44	34782	2.46	5.4
X	2.5	5.24	60.00%	3.14	4087	0.53	10.1
D1	2.5	18.27	61.63%	11.26	5630	0.65	3.6
E1	2.5	21.18	73.49%	15.56	12452	1.13	5.3

Tributary	ED (m3/ha)	100 Yr unit (m3/imp. Ha)
A	300	925
B	40	675
C	300	800
D	0	500
E	0	800

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Facility	Regional Depth	Area (ha)	impervious - ness (%)	Impervious Area (ha)	Total DS m^3	Facility Area (ha)	Percent of Total Area
A1	3.5	17.57	60.51%	10.63	19091	1.30	7.4
A2	3.5	13.39	60.08%	8.04	14474	1.07	8.0
6	3.5	36.15	66.85%	24.17	42260	2.35	6.5
A4	3.5	35.35	58.39%	20.64	37440	2.14	6.1
A5A	3.5	29.31	61.08%	17.90	32067	1.91	6.5
A5B	3.5	22.61	62.99%	14.24	25298	1.61	7.1
A7	3.5	10.79	71.77%	7.74	13305	1.01	9.4
B1	3.5	12.43	55.71%	6.93	8115	0.73	5.8
B2	3.5	41.71	63.44%	26.46	30775	1.85	4.4
B3	3.5	5.65	60.84%	3.44	4007	0.47	8.4
C1	3.5	12.77	50.03%	6.39	11498	0.92	7.2
C2	3.5	45.44	58.18%	26.44	45357	2.49	5.5
X	3.5	5.24	60.00%	3.14	5345	0.57	10.8
D1	3.5	18.27	61.63%	11.26	6193	0.62	3.4
E1	3.5	21.18	73.49%	15.56	21791	1.43	6.7

Tributary	ED (m3/ha)	Reg unit (m3/imp. Ha)
A	300	1300
B	40	1100
C	300	1200
D	0	550
E	0	1400

Facility	Area (ha)	impervious - ness (%)	Impervious Area (ha)	AECOM		WOOD		Difference (%)	
				100 Yr Total DS	Facility Area (ha)	100 Yr Total DS	Facility Area (ha)	100 Yr Total DS	Facility Area (ha)
				m^3		m^3		m^3	
A1	17.57	60.51%	10.63	17258	1.43	15105	1.29	-12.48%	-9.73%
A2	13.39	60.08%	8.04	13350	1.18	11458	1.06	-14.17%	-10.76%
6	36.15	66.85%	24.17	36042	2.54	33198	2.38	-7.89%	-6.59%
A4	35.35	58.39%	20.64	35244	2.49	29699	2.18	-15.73%	-12.47%
A5A	29.31	61.08%	17.90	29222	2.15	25353	1.92	-13.24%	-10.68%
A5B	22.61	62.99%	14.24	22542	1.76	19957	1.59	-11.47%	-9.53%
A7	10.79	71.77%	7.74	10758	1.01	10400	0.99	-3.32%	-2.17%
B1	12.43	55.71%	6.93	7955	0.82	5172	0.61	-34.99%	-25.32%
B2	41.71	63.44%	26.46	26694	2.00	19529	1.57	-26.84%	-21.58%
B3	5.65	60.84%	3.44	3616	0.49	2546	0.39	-29.58%	-18.97%
C1	12.77	50.03%	6.39	13434	1.18	8942	0.88	-33.43%	-25.40%
C2	45.44	58.18%	26.44	47803	3.19	34782	2.46	-27.24%	-22.99%
X	5.24	60.00%	3.14	5512	0.64	4087	0.53	-25.86%	-17.58%
D1	18.27	61.63%	11.26	19713	1.58	5630	0.65	-71.44%	-58.85%
E1	21.18	73.49%	15.56	22705	1.76	12452	1.13	-45.16%	-36.06%

Facility	Area (ha)	impervious - ness (%)	Impervious Area (ha)	AECOM		WOOD		Difference (%)	
				Reg Total DS m^3	Facility Area (ha)	Reg Total DS m^3	Facility Area (ha)	Reg Total DS m^3	Facility Area (ha)
A1	17.57	60.51%	10.63	34499	2.02	19091	1.30	-44.66%	-35.54%
A2	13.39	60.08%	8.04	26686	1.66	14474	1.07	-45.76%	-35.63%
6	36.15	66.85%	24.17	72047	3.59	42260	2.35	-41.34%	-34.44%
A4	35.35	58.39%	20.64	70453	3.53	37440	2.14	-46.86%	-39.30%
A5A	29.31	61.08%	17.90	58415	3.04	32067	1.91	-45.10%	-37.24%
A5B	22.61	62.99%	14.24	45062	2.47	25298	1.61	-43.86%	-35.02%
A7	10.79	71.77%	7.74	21504	1.42	13305	1.01	-38.13%	-28.52%
B1	12.43	55.71%	6.93	15736	1.14	8115	0.73	-48.43%	-36.29%
B2	41.71	63.44%	26.46	52805	2.80	30775	1.85	-41.72%	-34.02%
B3	5.65	60.84%	3.44	7153	0.68	4007	0.47	-43.98%	-30.32%
C1	12.77	50.03%	6.39	25234	1.59	11498	0.92	-54.43%	-41.98%
C2	45.44	58.18%	26.44	89789	4.31	45357	2.49	-49.49%	-42.29%
X	5.24	60.00%	3.14	10354	0.86	5345	0.57	-48.38%	-34.00%
D1	18.27	61.63%	11.26	45803	2.51	6193	0.62	-86.48%	-75.19%
E1	21.18	73.49%	15.56	52908	2.80	21791	1.43	-58.81%	-49.02%