2 | SANITARY SEWER SYSTEM IMPACT ANALYSIS

memorandum

SASAKI

date	February 15, 2013
to	Town of Wellesley Planning Board
from	Sasaki Associates
project name	Babson College - First Year Residence Hall
project #	26208.00
subject	Sewer System Impact Analysis

This memorandum summarizes the analysis of project-generated impacts on the municipal sewer system.

EXISTING SYSTEM DESCRIPTION

The Town of Wellesley has two systems to which the proposed building could discharge the new sanitary sewer flows. The eastern system, known as the Brookside Trunk, flows from Town manhole #830 at the intersection of Forest Street and Wellesley Avenue (SMH-130 in C4-1-Utility Plan) along Academy Brook through the golf course property to manhole #841 in Inverness Road. The system is then routed through manhole # 728 in Inverness Road to an intercepting sewer parallel to Academy Brook that eventually leads to the Boulevard Round Pumping Station and the MWRA sewer system. Per conversations with the Town, manhole #728 was selected as the point of analysis for this system. All lines leading to this point of analysis are 8" diameter (varying materials).

The second system to which the proposed building could discharge is known as the Fuller Brook Trunk. The point of connection for this system would be Town manhole #403 in Wellesley Avenue just west of the Forest Street intersection. This system is routed to the northwest along Forest Street to Berkshire Road and eventually Arlington Road. The point of analysis for this system is Town manhole #102 at the intersection of Arlington Road and Franklin Road. This system eventually leads to the Framingham Trunk interceptor and the MWRA sewer system. All segments upstream of this point of analysis are 8" diameter except the last two segments in Arlington Street which are 12" diameter.

A map of the existing sanitary sewer network can be found in Figure 1 – Town of Wellesley Sanitary Sewer System.

The two existing systems through this part of the Babson College campus are 8" systems known as the Canfield Lateral and the Forest Street Lateral. These systems were modeled as part of the Utilities Master Plan completed by ENSR Corporation (now AECOM) in October 2001. This plan can be found in Appendix A of this document.

SANITARY SEWER GENERATION

Generation rates for the study systems were determined by field-monitoring the flow rates of two Town manholes. For the Fuller Brook Trunk system, Town manhole #398 at the intersection of

Sawyer Park Road and Forest Street was used. For the Brookside Trunk system, Town manhole #849 at the intersection of Wellesley Street and Forest Street was used. Field monitoring was performed by Flow Assessment Services between the dates of 1/10/2013 and 1/28/2013 and the results are provided in Appendix B of this document.

The measured flow rates were compared to those projected in the Utilities Master Plan referenced above. The average flow rates described in the 2001 master plan are consistently higher than those measured in the field, which is the result of a number of water conservation initiatives undertaken at the College including the installation of low flow shower heads, toilets and urinals.

Flows generated by the existing homes downstream of the study points were calculated using Massachusetts Department of Environmental Protection (Mass DEP) Sewer System Extension and Connection Permit Program regulations 314 CMR 7.15: Calculation of Flows. In review of the Town of Wellesley Assessing Department online data, the average number of bedrooms per house in this neighborhood is five. Flows associated with the homes can be found in Figure 2 – Existing Flow Generation.

Flows generated by the Wellesley Country Club were estimated based on recent PSI submissions for the Paddle Facility and Pool Renovation projects dated October 29, 2012 and December 4, 2012, respectively. In addition, dining room and bar rates are estimated based on the total number of seats and Mass DEP Sewer System Extension and Connection Permit Program regulations 314 CMR 7.15: Calculation of Flows. It was conservatively assumed at all seats are filled for the purposes of this calculation.

Table 1: Proposed Country Club Sanitary Sewer Generation Rates

Type of Use/Generation	# of People	Flow Generation Rate (GPD/Person)	Total Daily Flow (GPD)
Ballroom	200	10	2,000
Restaurants/Dining	228	10	2,280
Bar Space	76	10	2,190
Paddle Facility			2,476
Pool Renovation			2,170
Total			**11,116**

Sewer generation rates for the proposed First Year Residence Hall were determined using 314 CMR 7.15. Based on the daily flow estimates within the regulations, it is assumed that each person boarding in the building will generate 65 gallons per day (GPD), the ground level amphitheater/auditorium will generate 3 GPD per person and the public workshop space will generate 10 GPD per person. Table 2 below summarizes the expected sanitary flow rates given the proposed uses of the building.

Table 2: Proposed Residence Hall Sanitary Sewer Generation Rates

Type of Use/Generation	# of People	Flow Generation Rate (GPD/Person)	Total Daily Flow (GPD)
Building Residents	200	65	13,000
Amphitheater/Auditorium	286	3	858
Workshop Space	219	10	2,190
Total			**16,048**

Per Table 2, the proposed residence hall is expected to generate 16,048 gallons per day of new sanitary flow. However, some of the students using the workshop space or amphitheater room are also residents of the building and therefore the sewer generation rates listed above are slightly conservative. In addition, the building will incorporate low flow fixtures into the base design so the expected generation rate of 65 GPD per resident is conservative.

Flow rates for the proposed system can be found in Figure 3 – Proposed Flow Generation.

Peaking factors of 3.7 and 3.5 were applied to the Fuller Brook and Brookside Trunk systems, respectively. These factors were used to determine expected peak daily flows. Peaking factors were generated using the in-field sewer monitoring results shown in Appendix B. Infiltration and inflow (I/I) was calculated using 3,300 GPD I/I per inch diameter of sewer pipe per mile length of sewer pipe. Dwelling laterals were assumed to be 80 feet in length, on average.

EXISTING SYSTEM ANALYSIS

The existing municipal sewer system flows were modeled for both the Brookside Trunk and Fuller Brook Trunk. Results of this analysis can be found in Figure 4 – Existing Pipe Flow Analysis. Full velocity and flow of the pipes were calculated using Manning's Equation:

$$V_c = (1.486/n)*R^{0.67}S^{0.5}$$

and,

$$Q_c = A/V_c$$

Where, V_c = Full flow velocity
n = Manning's roughness coefficient (0.013 was used)
R = Hydraulic Radius (A/WP)
A = Area of Pipe
WP = Wetted perimeter of pipe
S = Slope of Pipe (feet per foot)
Q_c = Flow (cubic feet per second)

The Fuller Brook Trunk system is nearing or above 50% capacity from manhole #398 to manhole #116.

The majority of the Brookside Trunk line is below 50% capacity with the exception of the pipe segment between Town manhole #831 and #841 which crosses under Academy Brook. This segment is at 57% of its full capacity.

IMPACT OF THE PROPOSED RESIDENCE HALL

The proposed municipal sewer system flows were modeled for both the Brookside Trunk and Fuller Brook Trunk incorporating the expected new residence hall flows. Results of this analysis can be found in Figure 5 – Proposed Pipe Flow Analysis. Full velocity and flow of the pipes were calculated using Manning's Equation as described above.

Segments of the Fuller Brook system between Town manhole #403 and #116 are calculated to be above 50% capacity. No segments are calculated to be in a surcharge condition.

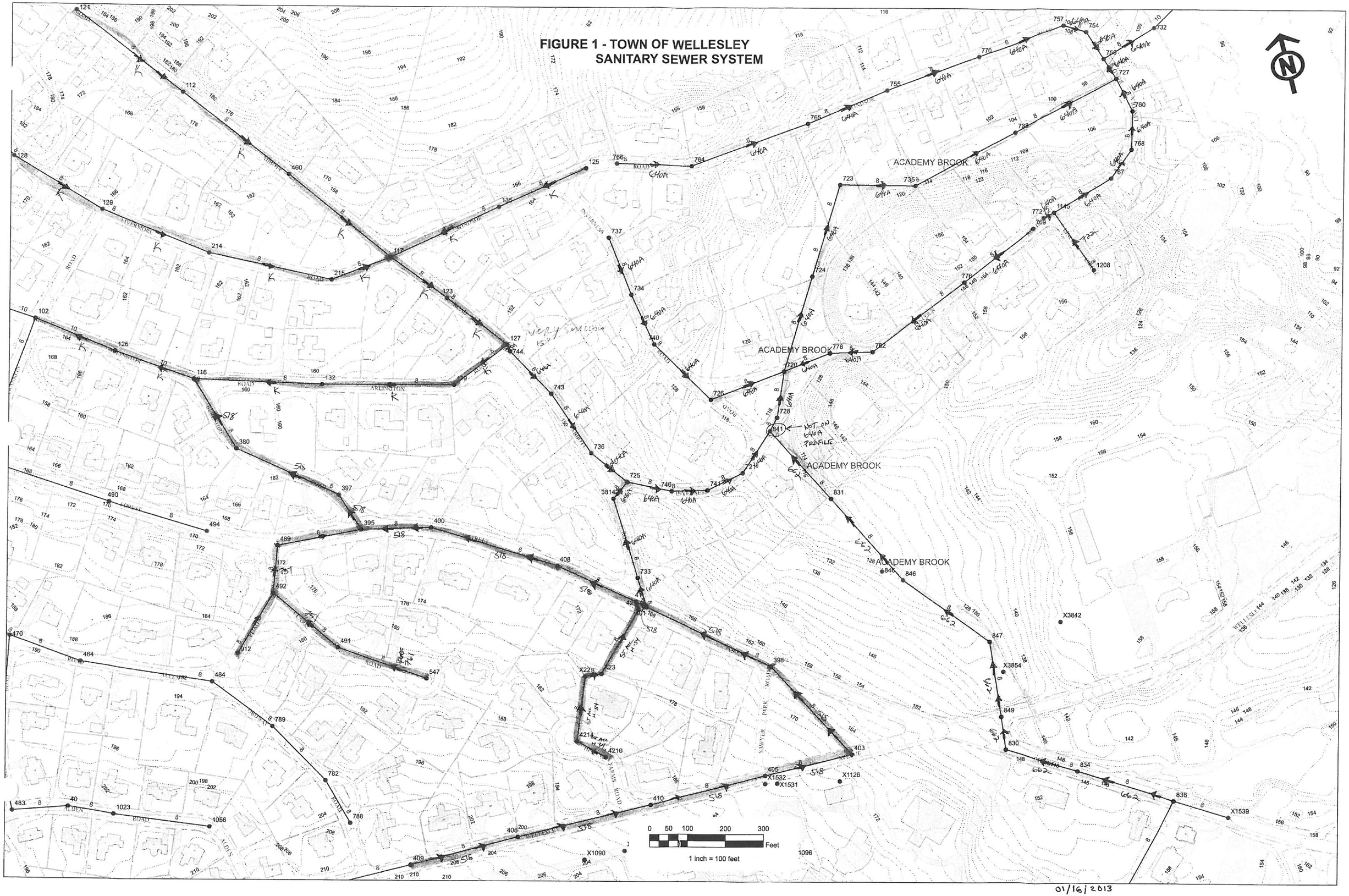
With the addition of the proposed residence hall flows, the Brookside Trunk system continues to be below 50% capacity with the exception of the segment between Town manhole #831 and #841, which is at 69% of its capacity.

CONCLUSIONS

Given that the Brookside Trunk system generally has no capacity issues as modeled in the proposed conditions, the applicant proposes to pursue a sanitary sewer connection to Town manhole #830. While the segment between Town manhole #831 and #841 would be at 69% of its capacity during peak flow conditions, it would not be in a state of surcharge. To mitigate for the additional flows, Babson will pursue reducing inflow and infiltration (I/I) in segments upstream of the point of connection. At this time, Babson will pursue I/I reductions to both the Brookside Trunk and/or the Fuller Brook Trunk and will work with the Town Engineering Department to determine the preferred point of connection.

Given that the expected flows from the proposed building exceed 15,000 GPD, a Mass DEP Bureau of Resource Protection Sewer Connection Permit will be required. The design team intends to prepare and submit this permit in coordination with the Town of Wellesley Department of Public Works at a later date in the permit process.

FIGURE 1 - TOWN OF WELLESLEY SANITARY SEWER SYSTEM



01/16/2013

Title: Wellesley Sanitary Sewer Analysis
Project No.: SA #26208.00
Description: Babson College - New Residence Hall

By: ZPC Date: 1/24/2013
Checked: SE Revised: 2/4/2013

FIGURE 2 - EXISTING FLOW GENERATION

Peaking Factor Fuller Brook[3] 3.7
Peaking Factor Brookside[3] 3.5

Pipe Segment	Number of Dwellings	Rooms per Dwelling	Gallons per Day per bedroom	Known Addl. Flows[2] (gpd)	Segment Flow[5] (gpd)	Total System Flow (gpd)	I&I Dwelling Lateral[1] (GPD)	Segment Inflow and Infiltration (gpd)	Contributing I & I (gpd)[5]	Peak System Flow (gpd)	Notes
Fuller Brook Trunk											
SMH-121						51,740				191,438	Note: No I/I reductions assumed for this segment
SMH-120				1,400	1,400	51,740				191,438	Note: No I/I reductions assumed for this segment
SMH-115				1,500	1,500	53,140				196,618	Note: No I/I reductions assumed for this segment
SMH-114						54,640				202,168	Note: No I/I reductions assumed for this segment
SMH-113						54,640				202,168	Note: No I/I reductions assumed for this segment
SMH-111 (WM-403)	6	5	110	10,060	13,360	54,640				202,168	Note: No I/I reductions assumed for this segment
WM-398						**68,000**		1,590		251,600	See Appendix B, Summary Flow Report Meter 398
WM-401	8	5	110		4,400	72,400	1,600	1,815	2,500	275,385	
WM-408	3	5	110		1,650	74,050	600	1,248		283,338	
WM-400	4	5	110		2,200	76,250	800	1,731		294,009	
WM-395	14	5	110		7,700	83,950	2,800	910	4,500	330,709	
WM-397	1	5	110		550	84,500	200	555		333,499	
WM-380	4	5	110		2,200	86,700	800	1,501		343,940	
WM-116	10	5	110		5,500	92,200	2,000	1,000	4,250	371,540	
WM-126	4	5	110		2,200	94,400	800	1,628		382,107	
WM-102	2	5	110		1,100	95,500	400	1,658		388,235	
Brookside Trunk											
SMH-127 (WM-X1539)				22,500	22,500	8,745				30,608	Note: No I/I reductions assumed for this segment
SMH-126 (WM-836)				8,620	8,620	31,245				109,358	Note: No I/I reductions assumed for this segment
SMH-131 (WM-834)				1,495	1,495	39,865				139,528	Note: No I/I reductions assumed for this segment
SMH-130 (WM-830)				640	640	41,360				144,760	Note: No I/I reductions assumed for this segment
WM-849						**42,000**		457		147,457	See Appendix B, Summary Flow Report Meter 849
WM-847						42,000		969		148,425	
WM-846				11,116	11,116	53,116		1,400		188,731	[4]Wellesley Country Club
WM-831						53,116		1,434		190,165	
WM-841	49	5	110		26,950	80,066	9,800	1,173	20,250	315,713	
WM-728						80,066		210		315,923	

[1]Assume 80ft length, 4" dia. Lateral (@ 3,300GPD / 4" / (80'/5280)MI = 200GPD/Dwelling)
[2]Known Flow is per Babson College Sanitary Sewer System Model completed by ENSR (See Appendix A)
[3]See Appendix B, Summary Flow Reports Printed 1/13/2013. Peaking Factor = Max/Avg.
[4]Flows from Wellesley Country Club are per Table 1 of the Sewer System Impact Analysis memo included in this report
[5] Additional I&I contributing to pipe segment flow at node (@ 3300GPD * 8" dia. * [upstream pipe length]ft / 5280)

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FIGURE 3 - PROPOSED FLOW GENERATION

Peaking Factor Fuller Brook[3] 3.7
Peaking Factor Brookside[3] 3.5

Pipe Segment	Number of Dwellings	Rooms per Dwelling	Gallons per Day per bedroom	Known Addl. Flows[2] (gpd)	Total Segment Flow[5] (gpd)	Total System Flow (gpd)	I&I Dwelling Lateral[1] (GPD)	Segment Inflow and Infiltration (gpd)	Contributing I & I (gpd)	Peak System Flow (gpd)	Notes
Fuller Brook Trunk											
SMH-121				37,000	37,000	14,740				54,538	Note: No I/I reductions assumed for this segment
SMH-120				2,900	2,900	51,740				191,438	Note: No I/I reductions assumed for this segment
SMH-115A						54,640				202,168	Note: No I/I reductions assumed for this segment
SMH-114A				16,048	16,048	54,640				202,168	Note: No I/I reductions assumed for this segment
SMH-114B						70,688				261,546	Note: No I/I reductions assumed for this segment
SMH-113						70,688				261,546	Note: No I/I reductions assumed for this segment
SMH-111 (WM-403)	6	5	110	10,060	13,360	70,688				261,546	Note: No I/I reductions assumed for this segment
WM-398						**84,048**		1,590		312,568	Proposed res. hall plus Appendix B, Summary Flow Report Meter 398
WM-401	8	5	110		4,400	88,448	3,200	1,815	2,500	336,363	
WM-408	3	5	110		1,650	90,098	1,200	1,250		344,918	
WM-400	4	5	110		2,200	92,298	1,600	1,730		356,388	
WM-395	14	5	110		7,700	99,998	5,600	910	4,500	395,888	
WM-397	1	5	110		550	100,548	400	555		398,878	
WM-380	4	5	110		2,200	102,748	1,600	1,500		410,118	
WM-116	10	5	110		5,500	108,248	4,000	1,000	4,250	439,718	
WM-126	4	5	110		2,200	110,448	1,600	1,628		451,085	
WM-102	2	5	110		1,100	111,548	800	1,658		457,613	
Brookside Trunk											
SMH-127 (WM-X1539)				22,500	22,500	8,745				30,608	Note: No I/I reductions assumed for this segment
SMH-126 (WM-836)				8,620	8,620	31,245				109,358	Note: No I/I reductions assumed for this segment
SMH-131 (WM-834)				1,495	1,495	39,865				139,528	Note: No I/I reductions assumed for this segment
SMH-130 (WM-830)				16,688	16,688	41,360				144,760	Note: No I/I reductions assumed for this segment
WM-849						**58,048**		457		203,625	Proposed res. hall plus Appendix B, Summary Flow Report Meter 849
WM-847						58,048		969		204,593	
WM-846				11,116	11,116	69,164		1,400		244,899	[4]Wellesley Country Club
WM-831						69,164		1,434		246,333	
WM-841	49	5	110		26,950	96,114	19,600	1,173	20,250	381,681	
WM-728						96,114		210		381,891	

[1]Assume 80ft length, 4" dia. Lateral (@ 3,300GPD / 4" / (80'/5280)MI = 200GPD/Dwelling)
[2]Known Flow is per Babson College Sanitary Sewer System Model completed by ENSR (See Appendix A)
[3]See Appendix B, Summary Flow Reports Printed 1/13/2013. Peaking Factor = Max/Avg.
[4]Flows from Wellesley Country Club are per Table 1 of the Sewer System Impact Analysis memo included in this report
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Title: Wellesley Sanitary Sewer Analysis
Project No.: SA #26208.00
Description: Babson College - New Residence Hall

By: ZPC
Chk'd: SE

Date: 1/22/2013
Revised: 2/4/2013

FIGURE 4 - EXISTING PIPE FLOW ANALYSIS

Pipe Capacity = $Q_c=AV_c$ as determined by Continuity Equation

Full Velocity = $V_c=(1.486/n)*R^{0.67}S^{0.5}$ Manning's Equation

Design Manning's n-value: 0.013

From	Rim/*pvmt* feet	Inv feet	To	Inv feet	D inches	L feet	S ft/ft	Q_d gpd	Q_c gpd	Q_c-Q_d gpd	Percent Full %	V_c fps	Cover ft
Fuller Brook Trunk													
SMH-121	170.97	166.90	SMH-120	165.73	8	230	0.005	191,438	553,763	362,325	35%	2.5	3.28
SMH-120	172.06	165.73	SMH-115	165.27	8	53	0.009	196,618	723,329	526,711	27%	3.2	5.54
SMH-115	172.72	165.27	SMH-114	164.99	8	120	0.002	202,168	375,045	172,877	54%	1.7	6.66
SMH-114	176.26	164.99	SMH-113	163.52	8	331	0.004	202,168	517,416	315,248	39%	2.3	10.48
SMH-113	174.32	163.52	SMH-111	160.01	8	123	0.029	202,168	1,311,583	1,109,415	15%	5.8	10.01
SMH-111 (WM-403)	173.49	165.8	WM-398	164.20	8	318	0.005	251,600	550,733	299,133	46%	2.4	6.90
WM-398	169.03	164.25	WM-401	163.05	8	363	0.003	275,385	446,408	171,023	62%	2.0	3.99
WM-401	173.22	163.05	WM-408	162.15	8	250	0.004	283,338	466,317	182,979	61%	2.1	9.38
WM-408	173.89	162.15	WM-400	160.80	8	346	0.004	294,009	484,840	190,831	61%	2.1	10.95
WM-400	174.75	160.80	WM-395	160.00	8	182	0.004	330,709	514,759	184,051	64%	2.3	13.16
WM-395	174.65	159.90	WM-397	159.00	8	111	0.008	333,499	699,125	365,626	48%	3.1	13.96
WM-397	169.52	159.00	WM-380	157.05	8	300	0.01	343,940	625,686	281,746	55%	2.8	9.73
WM-380	164.85	157.05	WM-116	155.40	8	200	0.008	371,540	705,216	333,676	53%	3.1	7.01
WM-116	164.60	154.58	WM-126	154.12	12	217	0.002	382,107	1,055,377	673,270	36%	2.1	8.89
WM-126	166.94	154.12	WM-102	153.68	12	221	0.002	388,235	1,022,795	634,560	38%	2.0	11.70
WM-102	166.52	153.68											
Brookside Trunk													
X1539	156.60	150.68	WM-836	148.38	8	151	0.015	109,358	958,231	848,874	11%	4.2	5.13
WM-836	158.35	148.38	WM-834	147.00	8	272	0.005	139,528	552,727	413,199	25%	2.4	9.18
WM-834	153.40	147.00	WM-830	146.00	8	199	0.005	144,760	550,664	405,904	26%	2.4	5.61
WM-830	154.90	146.00	WM-849	145.00	8	91	0.011	147,457	812,568	665,111	18%	3.6	8.11
WM-849	151.55	141.00	WM-847	134.00	8	194	0.036	148,425	1,475,747	1,327,321	10%	6.5	9.76
WM-847	138.78	134.00	WM-846	125.25	8	280	0.031	188,731	1,372,573	1,183,842	14%	6.1	3.99
WM-846	131.1	124.00	WM-831	120.60	8	287	0.01	190,165	845,513	655,349	22%	3.7	6.31
WM-831	127.45	120.60	WM-841	119.40	8	235	0.005	315,713	555,292	239,579	57%	2.5	6.06
WM-841	123.95	119.40	WM-728	116.40	8	42	0.071	315,923	2,075,061	1,759,138	15%	9.2	3.76
WM-728	123.30	116.40											

Sasaki Associates, Inc. — Computation Sheet

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Description: Babson College - New Residence Hall

By: ZPC
Chk'd: SE

Date: 1/22/2013
Revised: 02/04/2013

FIGURE 5 - PROPOSED PIPE FLOW ANALYSIS

Pipe Capacity = $Q_c = AV_c$ as determined by Continuity Equation

Full Velocity = $V_c = (1.486/n)*R^{0.67}S^{0.5}$ Manning's Equation

Design Manning's n-value: 0.013

From	Rim/*pvmt* feet	Inv feet	To	Inv feet	D inches	L feet	S ft/ft	Q_d gpd	Q_c gpd	Q_c-Q_d gpd	Percent Full %	V_c fps	Cover ft
Fuller Brook Trunk													
SMH-121	170.97	166.90	SMH-120	165.73	8	230	0.005	191,438	553,763	362,325	35%	2.5	3.28
SMH-120	172.06	165.73	SMH-115A	165.38	8	82	0.004	202,168	507,250	305,082	40%	2.2	5.54
SMH-115A	168.00	165.38	SMH-114A	164.71	8	155	0.004	202,168	510,466	308,298	40%	2.3	1.83
SMH-114A	173.00	164.71	SMH-114B	164.05	8	156	0.004	261,546	505,015	243,470	52%	2.2	7.50
SMH-114B	172.25	164.05	SMH-113	163.52	8	124	0.004	261,546	507,600	246,055	52%	2.2	7.41
SMH-113	174.32	163.52	SMH-111	160.01	8	123	0.029	261,546	1,311,583	1,050,038	20%	5.8	10.01
SMH-111 (WM-403)	173.49	165.80	WM-398	164.20	8	318	0.005	312,568	550,733	238,166	57%	2.4	6.90
WM-398	169.03	164.25	WM-401	163.05	8	363	0.003	336,363	446,408	110,046	75%	2.0	3.99
WM-401	173.22	163.05	WM-408	162.15	8	250	0.004	344,918	465,850	120,932	74%	2.1	9.38
WM-408	173.89	162.15	WM-400	160.80	8	346	0.004	356,388	484,980	128,592	73%	2.1	10.95
WM-400	174.75	160.80	WM-395	160.00	8	182	0.004	395,888	514,759	118,872	77%	2.3	13.16
WM-395	174.65	159.90	WM-397	159.00	8	111	0.008	398,878	699,125	300,247	57%	3.1	13.96
WM-397	169.52	159.00	WM-380	157.05	8	300	0.01	410,118	625,967	215,850	66%	2.8	9.73
WM-380	164.85	157.05	WM-116	155.40	8	200	0.008	439,718	705,216	265,498	62%	3.1	7.01
WM-116	164.60	154.58	WM-126	154.12	12	217	0.002	451,085	1,055,377	604,292	43%	2.1	8.89
WM-126	166.94	154.12	WM-102	153.68	12	221	0.002	457,613	1,022,795	565,183	45%	2.0	11.70
WM-102	166.52	153.68											
Brookside Trunk													
X1539	156.60	150.68	WM-836	148.38	8	151	0.015	109,358	958,231	848,874	11%	4.2	5.13
WM-836	158.35	148.38	WM-834	147.00	8	272	0.005	139,528	552,727	413,199	25%	2.4	9.18
WM-834	153.40	147.00	WM-830	146.00	8	199	0.005	144,760	550,664	405,904	26%	2.4	5.61
WM-830	154.90	146.00	WM-849	145.00	8	91	0.011	203,625	812,568	608,943	25%	3.6	8.11
WM-849	151.55	141.00	WM-847	134.00	8	194	0.036	204,593	1,475,747	1,271,153	14%	6.5	9.76
WM-847	138.78	134.00	WM-846	125.25	8	280	0.031	244,899	1,372,573	1,127,674	18%	6.1	3.99
WM-846	131.10	124.00	WM-831	120.60	8	287	0.01	246,333	845,513	599,181	29%	3.7	6.31
WM-831	127.45	120.60	WM-841	119.40	8	235	0.005	381,681	555,292	173,611	69%	2.5	6.06
WM-841	123.95	119.40	WM-728	116.40	8	42	0.071	381,891	2,075,061	1,693,170	18%	9.2	3.76
WM-728	123.30	116.40											