ENGINEERING SUCCESS TOGETHER

MEMORANDUM

Date:	October 18, 2012
To:	Merrick Turner
From:	Andrew Dennehy — BETA Project #: 4410
Subject:	University Station – Utility Information Required

The purpose of the memorandum is to provide review comments regarding utilities for the October 9th, 2012 preliminary plan submission made by the Proponent in connection with the University Station Development Project.

Sewer

The following is a summation of the items that the proponent will need to provide for advance the sewer analysis for University Station:

1. Flow estimates from development, including a breakdown by building/service

2. Analysis of effect of low-flow fixtures on building flows

3. Review of the existing flow metering data and an evaluation of the potential need for new flow metering

4. Sewer design information such as:
   - Pipe diameters
   - Pipe lengths
   - Pipe Slopes
   - Invert elevations
   - Manhole locations
   - Service locations
   - Drawings, including plan and profile views

5. Hydraulic Analysis, including:
   - System information, such as pipe diameters, slopes, lengths, etc.
   - Pipe capacities
   - High (Peak Hour), Average (Max. Day), Minimum (Min. Day) Flows
   - Velocities

BETA GROUP, INC.
315 Norwood Park South, 2nd Floor, Norwood, MA 02062
P: 781.255.1982 | F: 781.255.1974 | W: www.BETA-Inc.com

6. A sewer evaluation report, similar to the previous report developed by BETA in April 2007 (attached).

Water

It is assumed that Dedham Westwood Water will provide review comments on the water system. It is assumed that all details for water construction will be reviewed and approved by DWWD.

The following is a summation of the items that we'll need to complete the water analysis for University Station:

1. Plans showing all proposed water systems in accordance with DWWD requirements

2. A copy of review comments from DWWD

3. A copy of Fire Department review comments

4. An analysis of domestic and fire service flow requirements for the development

5. Pipe sizing calculations for water mains and services (both fire and domestic)

Private Utilities

Private utility companies will review and approve of the private utilities proposed plans. A copy of their approval should be submitted to the peer review team.

Town of Westwood, Massachusetts

DRAFT REPORT

Westwood Station
Sewer Extension Evaluation

April 2007

BETA Group, Inc.
Engineers • Scientists • Planners
315 Norwood Park South Norwood, MA 02062 781.255.1982

J-03386

University Avenue Sewer Extension Review
Town of Westwood, Massachusetts

1. Introduction

This report summarizes BETA's evaluation of the proposed sewer collection system within the Westwood Station University Avenue area. The layout and condition of the existing sewer system, the proposed layout, and existing and future sewer flows were evaluated to determine the feasibility of the proposed sewer extension as part of the Westwood Station University Avenue project. The two objectives of the evaluation were to determine the feasibility of the proposed layout and to determine the amount of maintenance the proposed design may require over the life of the project. Results of the investigation were used to provide a determination of feasibility, and recommendations for, improvement of the proposed layout.

In addition, the report summarizes BETA's evaluation of two existing conditions within the sewer collection system that have in the past caused problems. These are the siphon near Canton Street and the "disappearing" manhole on Harvard Street.

2. Overview

The Westwood Station project is a development that will add office, retail, residential space, as well as restaurant and public utility space. Prior to this work being completed, the Town has requested a review of the proposed sewer collection system that will service the new development to determine if it will have the capacity needed for such a development.

In evaluating the modified collection system, two separate conditions were considered. The first condition was peak flow through the proposed sewer system. This analysis determined whether the pipe sizes were sufficient to handle the maximum flows in the system.

The second condition was a "low flow" condition. This analysis determined whether low-flow events would cause deposition of sand, silt, and other materials resulting in blockage of the sewer mains, and increased regular maintenance.

Existing flows and estimated future flows were determined for each pipe segment. Maximum capacity, peak hour flow, average day flow, and minimum day flow were developed to determine maximum, average, and minimum velocities within each pipe segment.

Based on this analysis, each pipe segment has a calculated maximum capacity, proposed flow, and anticipated velocity. This analysis forms the basis for recommendations for changes that should be made to the design to increase the reliability and functionality of the system.

3. Current Conditions

There are three sub-areas that flow through the existing sewer system in the University Avenue area as shown in **Figure 1**.

Sub-Area 1 (University Avenue)
Sub-Area 1 encompasses University Avenue, Rosemont Road, Harvard Street, Yale Street, NStar Way, and Pear Tree Drive. The existing sewer in this area ranges in size from 8" to 20". The sewer meets the MWRA interceptor on University Avenue approximately 500' from Canton Street. This area is primarily industrial buildings, but also includes the Amtrak train station. This area is the location of the proposed Westwood Station development.

Sub-Area 2 (Blue Hill Drive)
Sub-Area 2 encompasses Weatherbee Drive, Whitewood Drive, Juniper Ridge Road, Porter Street, Nancy Drive, Walker Road, and Endicott Street. This is a residential area north of the University Avenue Sub-Area 1. Flow from this neighborhood enters the University Avenue Sub-Area 1 at the intersection of Juniper Hill Road and Blue Hill Drive. This area is comprised mainly of 8" sewer mains.

Sub-Area 3 (Canton Street)
Sub-Area 3 encompasses a portion of Canton Street, Partridge Drive, White Lane, and Hemlock Drive. This is a residential area west of the University Avenue Sub-Area 1. Flow from these residences enters the University Avenue Sub-Area 1 just upstream of the connection to the MWRA interceptor.

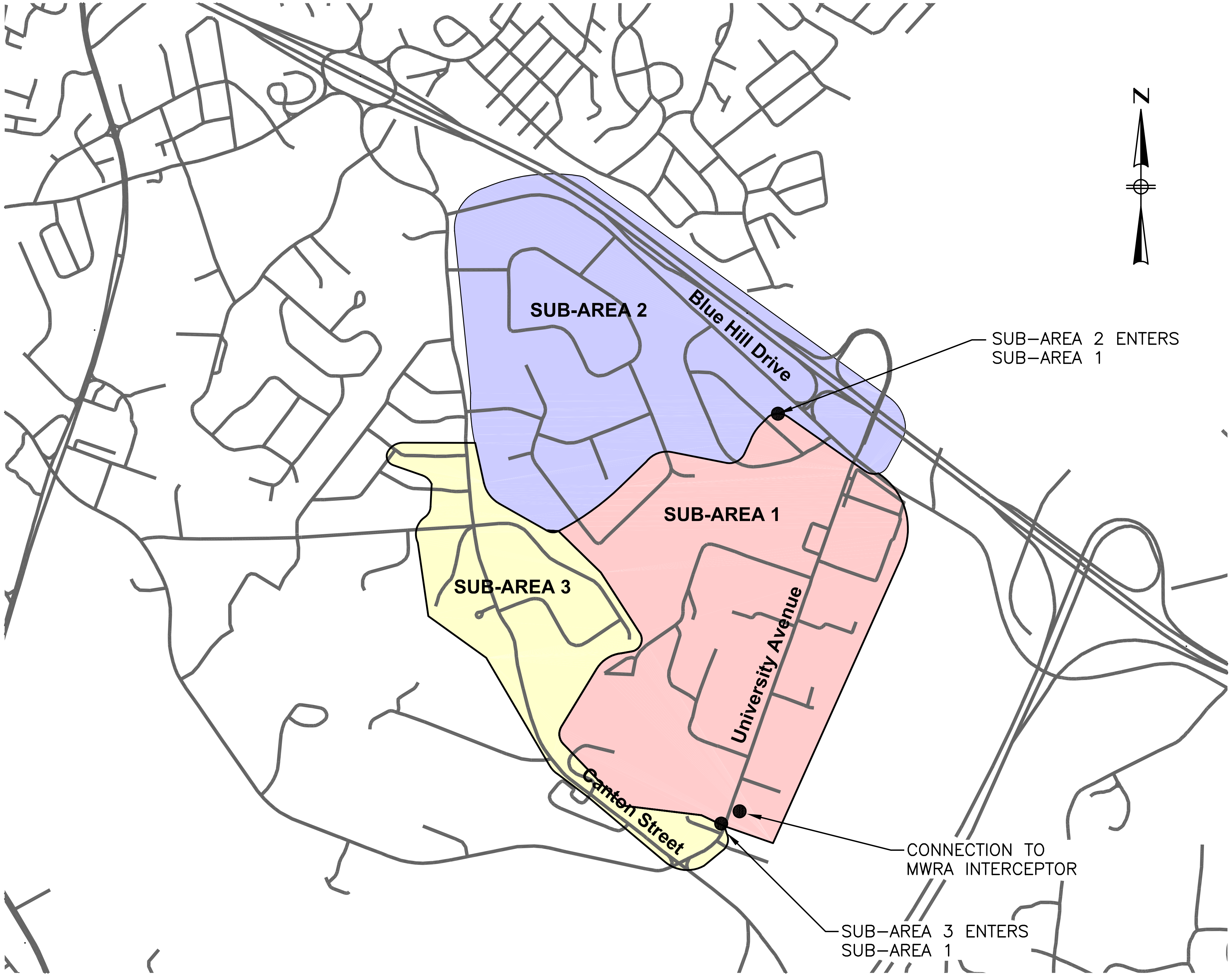
4. Proposed Project/Development

The proposed Westwood Station development is a mixed-use development featuring new office, retail, residential and open space located adjacent to the Westwood MBTA/Amtrak Station and in close proximity to Route 128 and Interstate 95. The 135-acre development includes: 1.5 million square feet of office, lab and R&D space; 1.35 million square feet of retail space devoted to specialty retailers and restaurants; 1,000 residential units; and up to two hotels with a total of 330 rooms.

Construction of this development will take place over a number of years. This report has examined the total proposed construction, and not each phase of construction separately. **Figure 2** shows the proposed Westwood Station development and sewer collection system.

5. Flows – Existing and Proposed

Existing flows from Sub-Areas 2 and 3 were estimated using two sets of meter data. One meter was placed by the Town's sub-consultant in the manhole on University Avenue where Sub-Area 3 enters the sewer on University Avenue. The meter was monitored during the period 2/20/2007 through 3/1/2007. The second meter is an MWRA meter, which is located



K:\Westwood, MA\3386 – University Avenue Sewer Review\AutoCAD\Plan Set\Sub–Areas.dwg Apr 26,2007 11:48am

BETA Group, Inc.
Engineers • Scientists • Planners
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-inc.com

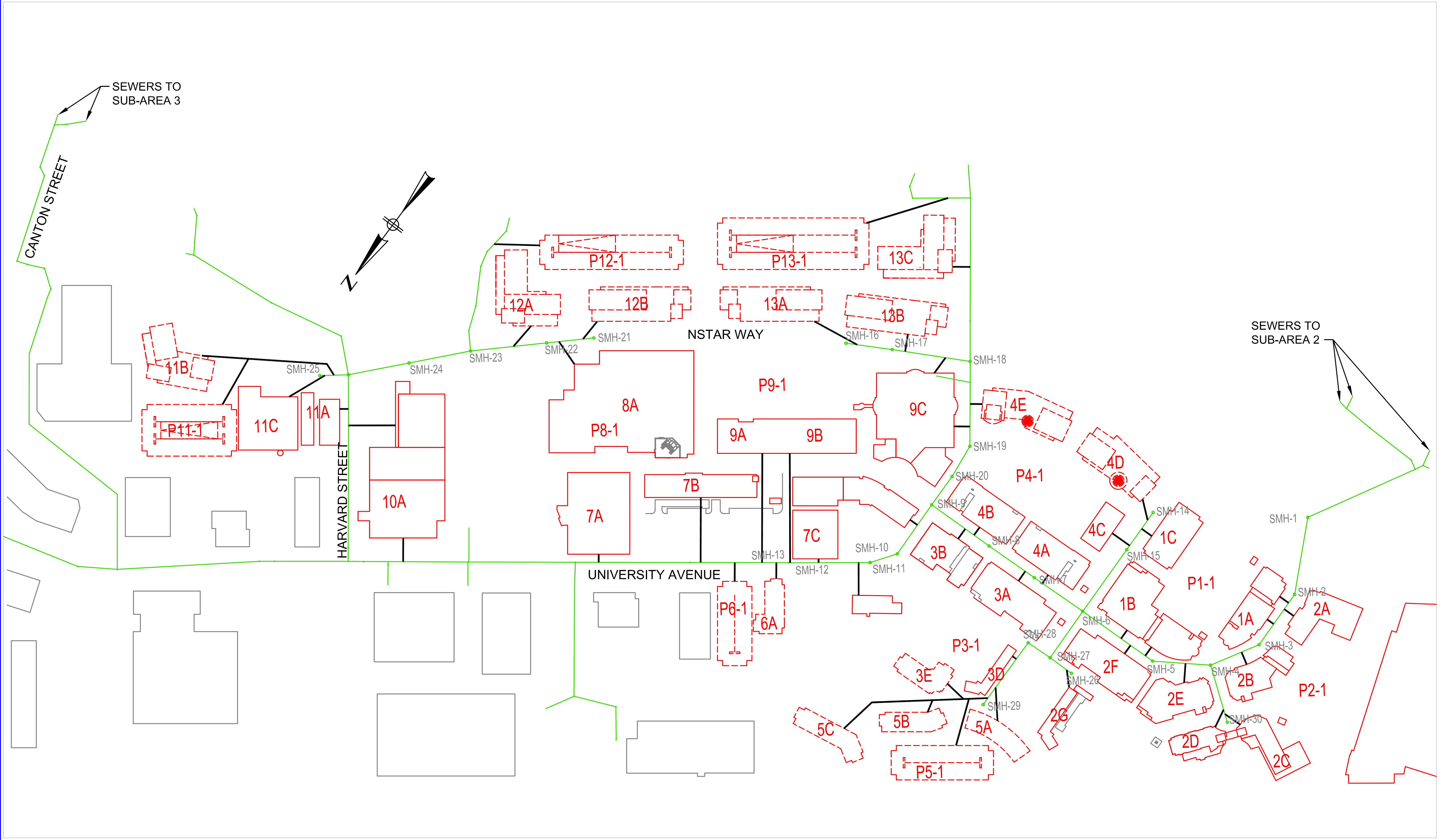
Westwood Station Sewer Extension

Westwood, Ma

Scale: 1"=400'

Figure No. 1

Sewer Sub-Areas



BETA Group, Inc.
Engineers • Scientists • Planners

315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-inc.com

Westwood Station Sewer Extension

Westwood, Ma

Scale: Not to Scale

Figure No. 2

Proposed Building Layout

K:\Westwood, MA\3386 – University Avenue Sewer Review\AutoCAD\Miscellaneous\2000 CAD Files\Future Sewer Layout.dwg Apr 26,2007 11:53am at 341 University Avenue. MWRA meter data from 2005 and 2006 measures flow upstream of the point that Sub-Area 3 enters the MWRA system.

The MWRA meter has an average day flow of 240,000 gpd. The sub-consultant's meter in the manhole on University Avenue where Sub-Area 3 enters the Sub-Area 1's sewer on University Avenue shows a combined flow from Sub Areas 1, 2 and 3 to be 194,000 gpd. Based on flow percentages from the sub-consultant's meter, it was determined that Sub-Areas 1 and 2 make up 83% of the flow to the MWRA meter, while Sub-Area 3 makes up 17% of the flow. While no flow isolation was conducted for Sub-Areas 1 and 2, based on the number of homes, an average day flow of 50,000 gpd for Sub-Area 1 and 150,000 gpd for Sub-Area 2 was estimated. Sub-Area 3 has an average daily flow of 40,000 gpd.

A peaking factor was used to determine maximum day flow. Based on the flows, a peaking factor of 2.7 was used to determine maximum day flow for Sub-Areas 1, 2, and 3 to be 648,000 gpd. Sub-Area 2 has an estimated maximum day flow of 405,000 gpd, while Sub-Area 1 has an estimated maximum day flow of 135,000 gpd. Sub-Area 2 has an estimated maximum day flow of 108,000 gpd. These flows have been added to the hydraulic analysis as they enter the system, while Sub-Area 1 flows have been replaced with the proposed flows.

Proposed flows from the development have been calculated in **Table 1**. Flows have been estimated using eight different categories of users. These categories are residential, hotel, retail, restaurant, office, fitness, public utility, and garages. Each of these categories uses a different unit and quantity/unit to estimate future flows. These flow estimates are based on Title V requirements.

Proposed flows from each of the proposed buildings within the development were estimated as a percentage of the total estimated proposed flows. There are no flow estimates for individual buildings given by TetraTech Rizzo's sewer extension permit. There are also no plans showing exact locations of service connections. The flows for each building are shown in **Table 2**. These flows were added to the hydraulic analysis as they enter the system, based on a hypothetical location of the building service connection. It is possible that certain buildings may have their flows added at a different location, or have their flows added at several different locations.

6. System Capacity

The capacity of a sewer pipe is a function of the size, slope and relative roughness. Sewers are typically designed to minimize the risk of sewer surcharges. The design capacity of the sewer is typically 50-75% of the full pipe capacity.

Our analysis indicates each pipe segment has enough capacity to handle the peak hour flow. Some segments are very close to 100% of their capacity during this peak hour flow. This is not an ideal situation, although this may provide scouring velocities that may help clean the sewers. Full pipe capacity and peak hour, maximum day, and minimum day flows are shown in **Table 3**.

TABLE 1 - PROPOSED FLOWS

Description	Title V		Area	Planned Development		Max Day Flow (GPD)	Peak Hour Flow (MGD)	Minimum Day Flow (MGD)
	Unit	GPD	SF	Quantity	Units			
Residential	per bedroom	110	1,370,500	1700	bedrooms	187,000	374,000	23,375
Hotel	per bedroom	110	230,000	328	keys	36,080	72,160	4,510
Retail	per 1000 SF	50	1,144,000	1,144,000	SF	57,200	114,400	7,150
Restaurant	per seat	35	81,000	2600	seats	91,000	182,000	11,375
Office	per 1000 SF	75	1,490,000	1490000	SF	111,750	223,500	13,969
Fitness	per locker	20	35,000	125	SF	2,500	5,000	313
Public Utility	per 1000 SF	75	80,000	80000	SF	6,000	12,000	750
Garages	each	5		18	SF	90	180	11
		Totals	**4,430,500**			**491,620**	**983,240**	**61,453**

BETA Group, Inc.
Engineers • Scientists • Planners

TABLE 2 - ESTIMATED BUILDING FLOWS

		Estimated Flow			Enters System	
Building #	Type	Max Day (gpd)	Peak Hour (gpd)	Min Day (gpd)	Upstream MH	Downstream MH
1A	4-Story Retail/Residential	10,065	20,129	1,258	2	3
2A	2-Story Retail	6,670	13,340	834	2	3
2B	4-Story Retail/Residential	10,606	21,212	1,326	3	4
2C	10-Story Hotel	24,378	48,757	3,047	30	4
2D	7-Story Hotel	11,702	23,403	1,463	30	4
2E	5-Story Retail/Residential	12,951	25,902	1,619	4	5
1B	5-Story Retail/Residential	22,726	45,451	2,841	5	6
1C	5-Story Office	9,327	18,653	1,166	14	15
2F	4-Story Retail/Residential	14,894	29,788	1,862	5	6
2G	4-Story Residential	4,330	8,659	541	26	27
3D	4-Story Residential	4,330	8,659	541	29	28
3E	10-Story Residential	21,735	43,469	2,717	29	28
5C	10-Story Residential	26,580	53,159	3,322	29	28
5B	6-Story Residential	13,033	26,066	1,629	29	28
5A	6-Story Residential	13,935	27,871	1,742	29	28
3A	4-Story Retail/Residential	17,629	35,259	2,204	7	8
4A	2-Story Retail/Residential	12,320	24,639	1,540	6	7
4C	Fitness	2,500	5,000	313	14	15
4D	5-Story Office	13,186	26,371	1,648	14	15
4E	5-Story Office	13,225	26,449	1,653	Existing	19
3B	2-Story Retail	6,919	13,838	865	8	9
4B	2-Story Retail/Residential	12,410	24,820	1,551	8	9
WDC	Westwood Water District	-	-	-	11	12
7C	2-Story Retail	6,896	13,793	862	11	12
		6,896	13,793	862	9	10
9C	2-Story Retail	8,659	17,317	1,082	Existing	19
		8,659	17,317	1,082	17	18
9A	1-Story Retail	2,623	5,247	328	13	Existing
9B	1-Story Retail	2,849	5,697	356	11	12
8A	2-Story Retail	18,854	37,709	2,357	21	22
7B	1-Story Retail	4,386	8,771	548	13	Existing
7A	2-Story Retail	14,243	28,487	1,780	Existing	Existing
6A	10-Story Residential	21,517	43,034	2,690	13	Existing
13B	5-Story Office	14,960	29,920	1,870	17	18
13A	4-Story Office	11,968	23,936	1,496	16	17
12B	4-Story Office	11,968	23,936	1,496	21	22
12A	4-Story Office	12,010	24,020	1,501	22	23
10A	2-Story Retail	14,243	28,487	1,780	Existing	Existing
		14,243	28,487	1,780	Existing	Existing
11C	3-Story Utility	-	-	-	25	Existing
11A	Public	6,000	12,000	750	Existing	Existing
11B	5-Story Office	13,111	26,223	1,639	25	Existing
13C	4-Story Office	11,995	23,991	1,499	Existing	18
P11-1	Parking Garage	6	12	1	25	Existing
P6-1	Parking Garage	1	3	0	13	Existing
P5-1	Parking Garage	4	9	1	29	28
P3-1	Parking Garage	6	12	1	29	28
P13-1	Parking Garage	18	36	2	Existing	18
P12-1	Parking Garage	11	22	1	Existing	23
P2-1	Parking Garage	4	9	1	2	3
P1-1	Parking Garage	8	16	1	3	4
P4-1	Parking Garage	14	29	2	19	20
P9-1	Parking Garage	11	23	1	16	17
P8-1	Parking Garage	5	10	1	21	22
	Totals (gpd)	**491,620**	**983,240**	**61,453**		

BETA Group, Inc.
Engineers • Scientists • Planners

TABLE 3 - HYDRAULIC ANALYSIS

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
Exist SMH	SMH1	405,000	48.00	46.61	10	410	0.0034	0.82	810,000	405,000	50,625	2.67	2.33	1.30
SMH1	SMH2	-	46.54	46.03	12	235	0.0022	1.07	810,000	405,000	50,625	2.32	1.97	1.08
SMH2	SMH3	16739	45.96	45.56	15	236	0.0017	1.72	843,478	421,739	52,717	2.16	1.79	0.95
SMH3	SMH4	10614	45.49	45.19	15	177	0.0017	1.72	864,706	432,353	54,044	2.17	1.81	0.95
SMH4	SMH5	49,031	45.12	44.8	15	191	0.0017	1.71	962,769	481,384	60,173	2.22	1.84	0.99
SMH5	SMH6	37620	44.73	44.22	15	296	0.0017	1.73	1,038,008	519,004	64,876	2.27	1.89	1.01
SMH6	SMH7	121,284	44.15	43.8	15	207	0.0017	1.72	1,280,577	640,289	80,036	2.37	1.99	1.10
SMH7	SMH8	17629	43.73	43.42	15	185	0.0017	1.71	1,315,836	657,918	82,240	2.38	2.01	1.10
SMH8	SMH9	19,329	43.35	42.94	15	243	0.0017	1.71	1,354,493	677,247	84,656	2.40	2.04	1.10
SMH9	SMH10	76,394	42.87	42.53	15	197	0.0017	1.73	1,507,281	753,641	94,205	2.46	2.11	1.13
SMH10	SMH11	-	42.46	42.3	15	94	0.0017	1.72	1,507,281	753,641	94,205	2.45	2.11	1.12
SMH11	SMH12	9,745	42.23	41.77	15	286	0.0016	1.67	1,526,771	763,385	95,423	2.39	2.06	1.15
SMH12	SMH13	-	41.70	41.68	15	11	0.0018	1.78	1,526,771	763,385	95,423	2.52	2.16	1.16

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
SMH14	SMH15	25012	51.41	49.98	12	143	0.0100	2.30	50,025	25,012	3,127	1.70	1.31	0.83
SMH15	SMH6	-	49.88	47.2	12	254	0.0106	2.36	50,025	25,012	3,127	1.75	1.35	0.86

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
SMH16	SMH17	11968	76.68	75.1	8	158	0.0100	0.78	23,936	11,968	1,496	1.52	1.20	0.64
SMH17	SMH18	23619	75	72.23	8	277	0.0100	0.78	71,173	35,587	4,448	2.20	1.77	0.70

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
Exist SMH	SMH18	12013	78.2	72.23	8	146	0.0409	1.58	24,027	12,013	1,502	2.44	1.42	1.29
SMH18	Exist SMH	35,587	72.13	69.3	8	68	0.0416	1.59	95,200	47,600	5,950	3.84	2.83	1.30
Exist SMH	SMH19	21883	69.3	61.36	8	194	0.0409	1.58	138,967	69,483	8,685	4.43	3.39	1.43
SMH19	SMH20	14	61.26	55.58	12	142	0.0400	4.60	138,995	69,498	8,687	3.97	3.16	1.67
SMH20	SMH9	-	55.48	50.8	12	118	0.0397	4.58	138,995	69,498	8,687	3.96	3.14	1.66

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
SMH21	SMH22	30,827	83.52	79.32	12	140	0.0300	3.99	61,654	30,827	3,853	2.73	1.60	1.45
SMH22	SMH23	12,010	79.22	70.1	12	228	0.0400	4.60	85,675	42,837	5,355	3.16	1.85	1.67
SMH23	SMH24	11	70	59.92	12	219	0.0460	4.94	85,697	42,848	5,356	3.39	1.98	1.79
SMH24	Exist SMH	-	59.82	50	12	209	0.0470	4.99	85,697	42,848	5,356	3.42	2.00	1.81
SMH25	Exist SMH	13,129	51.89	50	12	118	0.0160	2.91	26,257	13,129	1,641	1.17	1.06	1.06

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
Exist SMH	SMH23	11	71.3	70.1	12	66	0.0182	3.10	22	11	1	1.12	1.12	1.12

TABLE 3 - HYDRAULIC ANALYSIS

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
SMH30	SMH4	36080	46.09	45.19	12	181	0.0050	1.62	72,160	36,080	4,510	1.55	1.20	0.59

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
SMH29	SMH28	79623	49	47.74	12	252	0.0050	1.63	159,246	79,623	9,953	2.07	1.64	0.65
SMH28	SMH27	-	47.64	47.16	12	96	0.0050	1.63	159,246	79,623	9,953	2.07	1.64	0.65
SMH26	SMH27	4330	49	47.16	12	77	0.0239	3.56	8,659	4,330	541	1.29	1.29	1.29
SMH27	SMH6	-	47.06	46.07	12	198	0.0050	1.63	167,905	83,952	10,494	2.09	1.66	0.65

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
Exist SMH	Exist SMH	76,220	45	42.8	12	264	0.0083	2.10	152,441	76,220	9,528	2.42	1.91	0.76
Exist SMH	Exist SMH	-	42.8	40.6	12	335	0.0066	1.87	152,441	76,220	9,528	2.25	1.78	0.75
Exist SMH	Exist SMH	-	40.6	39.7	12	44	0.0205	3.29	152,441	76,220	9,528	3.31	2.43	1.19

Upstream Manhole	Downstream Manhole	Max. Day Flow Added	Upstream Invert Elev. (ft)	Downstream Invert Elev. (ft)	Pipe Size (in)	Length (ft)	Slope (ft/ft)	Flow Capacity Full (mgd)	Proposed Flow (gpd)			Velocity (ft/s)		
									High (Peak Hour)	Average (max day)	Low (Min. Day)	High	Average	Low
13	Exist SMH	791,913	41.7	41.4	16	342	0.0008	1.42	1,583,825	791,913	98,989	1.79	1.61	0.91
Exist SMH	Exist SMH	14,243	41.4	40.6	16	397	0.0020	2.23	1,612,312	806,156	100,770	2.68	2.25	1.26
Exist SMH	Exist SMH	-	40.6	40.3	20	375	0.0008	2.54	1,612,312	806,156	100,770	1.91	1.60	0.85
Exist SMH	Exist SMH	14,243	40.3	39.9	20	365	0.0011	2.98	1,640,799	820,399	102,550	2.16	1.81	0.92
Exist SMH	Exist SMH	-	39.9	39.7	20	52	0.0038	5.57	1,640,799	820,399	102,550	3.42	2.83	1.38
Exist SMH	Exist SMH	76,220	39.7	39.5	20	254	0.0008	2.52	1,793,239	896,620	112,077	1.94	1.63	0.87
Exist SMH	MWRA SMH	108,000	39.5	38.84	20	688	0.0010	2.78	2,009,239	1,004,620	125,577	2.15	1.80	1.01

*n=.013 for all sewers

Insufficient Capacity or Velocity

BETA Group, Inc.
Engineers • Scientists • Planners

7. Velocities

If wastewater flows for an extended period of time at low velocities, solids may be deposited in the sewer. This can cause maintenance issues. A velocity of 2 ft/sec is considered to be sufficient to prevent deposition within the sewer. High velocities may cause scouring of the pipe if solids are flowing at a high rate of speed and actually scour the pipe.

Velocities are greatly affected by the relative roughness coefficient. For this analysis, we have used a Manning's n-value of 0.013 for both new and existing sewers. In reviewing the proponent's original calculations, a Manning's n-value of 0.009 was used in the original analysis. That is an accurate n-value assumption for new pipe. However, conditions 20 years from now need to be assumed. Therefore, for this evaluation a Manning's n-value of 0.013 was used for all sewer pipes.

Peak hour, maximum day, and minimum day velocities are shown in **Table 3.** Some velocities are lower than the minimum 2 ft/sec. These velocities will likely result in increased maintenance. Maximum velocities during peak hour are within acceptable limits to prevent scouring of the sewer pipe.

8. Siphon Options

There is a siphon located between Canton Street and University Avenue. This siphon was constructed to allow sewer to flow under a drainage ditch in the area. In the past, this siphon has created a maintenance issue for the town.

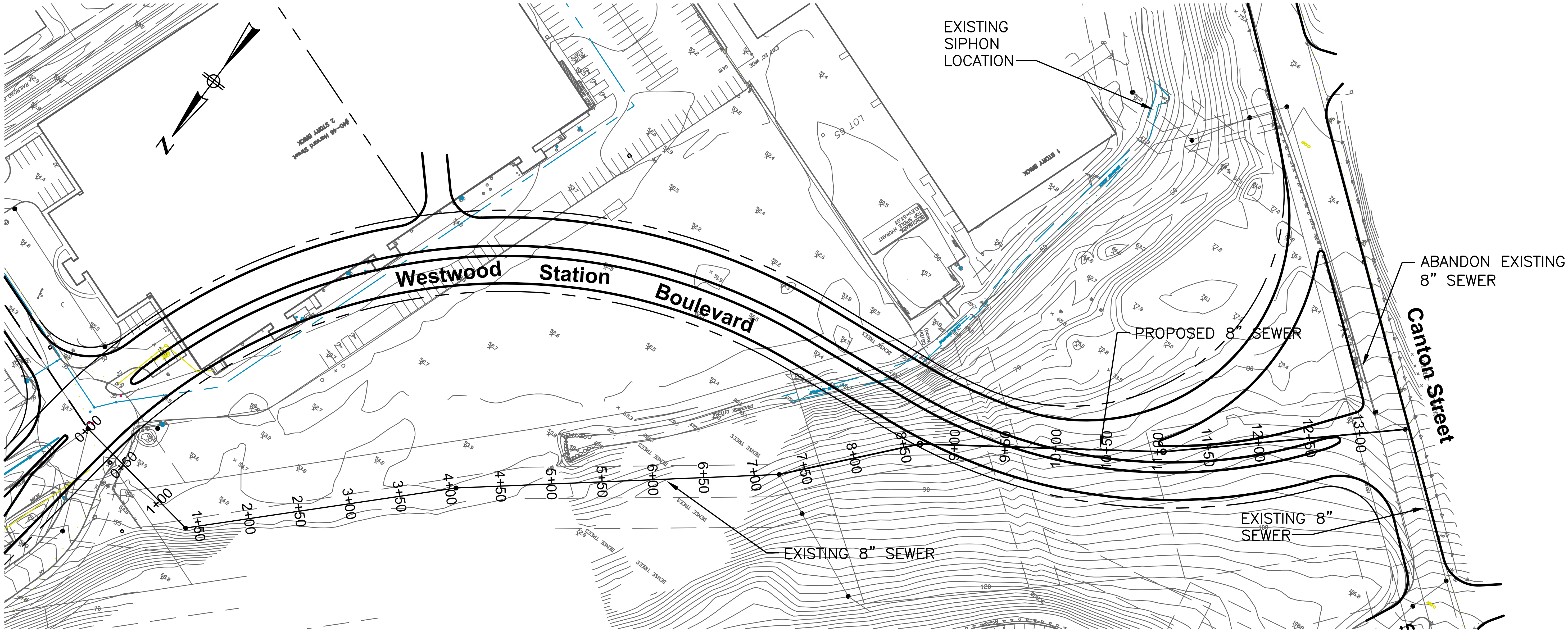
Our analysis of this siphon indicates it is likely feasible to eliminate this siphon. Outlined in **Figures 3 and 4** is a plan and profile for eliminating the need for the siphon. This is not a final design. Should there be any services within the abandoned section of sewer, these services would need to be redirected.

A field investigation was conducted to verify existing record drawings. Approximately 600' of new 8" sewer could be installed to eliminate the siphon.

There are a number of unknowns that need to be addressed in final design. These include determining existing flow in the 8" sewer on Canton Street, and a capacity analysis on the 8" sewer that continues cross-country to Harvard Street. Our field investigation shows that the sewer on Canton Street is flowing 1/3 to ½ full, while the sewer running cross-country has minimal flow at the manhole where a new connection would be made. It may be necessary to upgrade sewer sizes. This may be a viable option for eliminating the siphon, and may be worth the cost of upgrade.

9. "Disappearing" Manhole

On Harvard Street, there is a sewer manhole which has been reported to be "disappearing". This manhole has been replaced recently. A field investigation of this manhole was made,



K:\Westwood, MA\3386 – University Avenue Sewer Review\AutoCAD\Plan Set\Plan and Profile – Siphon.dwg Apr 26,2007 11:55am

BETA Group, Inc.
Engineers • Scientists • Planners
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-inc.com

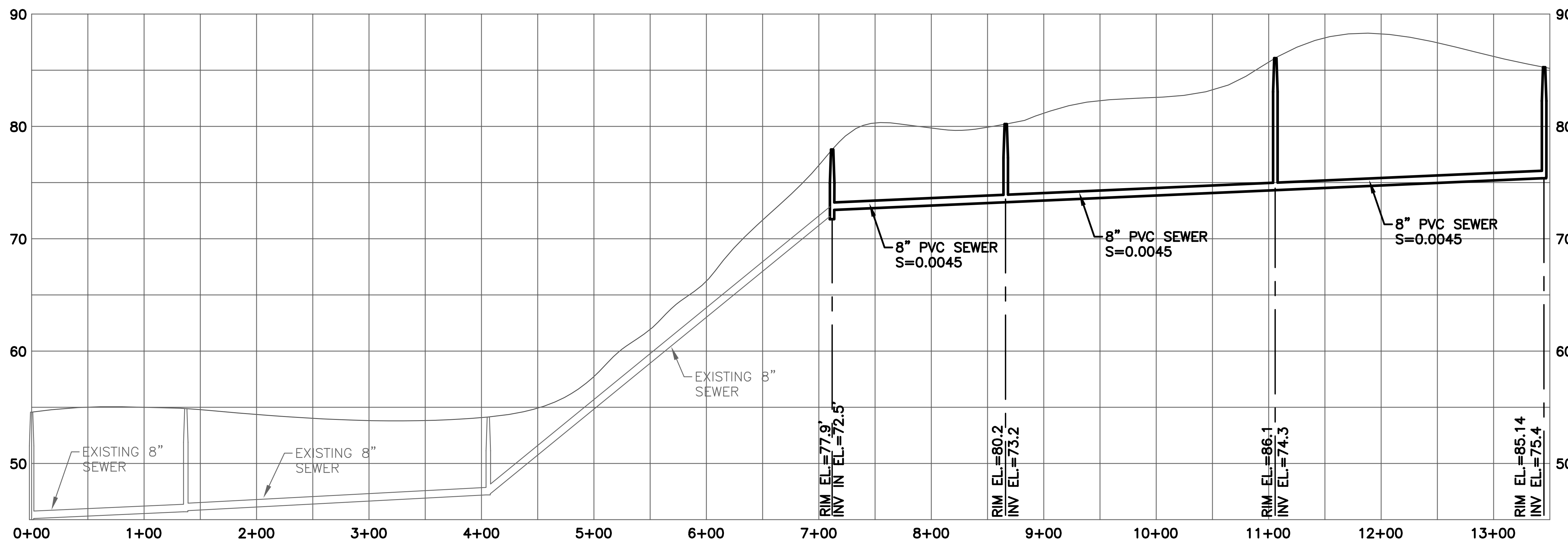
Westwood Station Sewer Extension

Westwood, Ma

Scale: 1"=100'

Figure No. 3

Siphon Relocation Plan



BETA Group, Inc.
Engineers • Scientists • Planners
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-inc.com

Westwood Station Sewer Extension

Westwood, Ma

Scale: Horizontal: 1"=100'

Vertical: 1"=10'

Figure No. 4

Siphon Relocation Profile

and it appears that the invert of the manhole was never built. The pre-cast concrete sections of the manhole appear to be in good condition, and there is no separation of the joints.

An internal manhole inspection would need to be made in order to discover exactly what the problem is within the manhole. From the surface observation, flow seems to be entering and leaving the manhole, although this is not done through an invert, which leads BETA to conclude that an invert was never built in this manhole.

TV inspection shows that there is a large offset joint within the stretch upstream of the "disappearing" manhole. This offset joint is most likely the result of settling of the manhole and pipe section. To fix this problem entirely, this stretch would most likely need to be replaced, with any peat removed before the pipe is replaced. It is also possible that the pipe section and manhole would require piles in order to prevent future settlement.

10. Findings

In response to the upcoming Westwood Station development project, the Town expects the proposed sewer to be fully functional, requiring as little maintenance as possible. This report has examined the feasibility of the proposed sewer alignment to be constructed as part of the new development.

Based on the hydraulic analysis, the proposed sewer collection system has the capacity to carry the increased flow from the Westwood Station development. We do not find there to be a need to increase pipe sizes, or to alter the design as part of the plans for the development.

However, based on velocities that are not sufficient to prevent deposition of solids within the sewer, we do anticipate increased maintenance in the University Avenue area as a result of development.

11. Recommendations

BETA recommends the Town require sewer metering, at the developer's expense, in the University Avenue area to determine exact flows post-development until two years after the completion of the entire project. The Town should require a plan to be put in place if future flows are greater than or less than estimated proposed flows. If future flows provide increased velocities during low-flow events, maintenance requirements may not be as significant. If flows are greater than estimated future flows, the Town may want to require more stringent requirements from retail, residential, or office buildings to limit flows.

BETA recommends that the Town require the owner of the development to purchase a Vactor truck for the Town, which can be used to flush the sewer mains identified as having velocities low enough to cause a problem with deposition. There are some reaches where decreasing the pipe size may result in increased velocities, but in other sections, it appears that deposition cannot be prevented, and therefore will need to be maintained with periodic flushing.