Sullivan, Connors & Associates
Land Surveying and Civil Engineering

Sudbury Zoning Board of Appeals
Flynn Building
278 Old Sudbury Road
Sudbury, MA 01776

July 14, 2016

Subject: **The Village at Sudbury Crossing**
Response to Peer Review – Stormwater Management Plan

Dear Chairman O'Brien and Members of the Board;

Sullivan Connors & Associates (SCA) is in receipt of peer review comments provide by Hancock Associates dated June 29, 2016 related to the stormwater management design for the Village at Sudbury Crossing. On behalf of the applicant, Sudbury Station LLC, SCA offers the following responses and additional documentation we believe addresses each item in the peer review. Numbering below corresponds to those listed in the peer review.

1. General: Wetland resource Area delineation and Sewage Treatment

1.1 No additional information required. Comment acknowledges a Negative Determination of Applicability has been issued by MassDEP.

1.2 No additional information required on the sewage disposal system.

2. General: Rainfall Rates for Stormwater Management Design

2.1 No additional information required. The peer review has confirmed the rates utilized in the design calculations.

3. General: Completeness of Plans – Proposed Grading

3.1 The peer review requested additional detail on the grading plan to show two foot contours and floor elevation at all building entrances. The revised plan has included two foot contours throughout the entire site development. The floor elevations and spot grades have been provided at all of the required ADA accessible doors. At the larger multifamily buildings the required accessible doors are limited to the main entrance. This additional detail did not result in a substantive change to the overall layout and did not impact the drainage subcatchment areas.

4. General: Completeness of Plans – Proposed Drainage Piping

4.1 The peer review requested an analysis of the pipe and catch basin capacities to verify there would not be unintended overflows off of the site. The requested information has been provided including an analysis of the pipe sizing, inlet capacities, and depiction of the system on the roadway profiles. This system has been designed to safely collect and convey the 100 year storm event.

5. Existing, Proposed, and Off-site Drainage Areas

5.1 No additional information required. The peer review has confirmed the delineation of the drainage areas utilized in the design. Those areas remain unchanged on the current plans.

6. Preliminary Site Plan, Sheet 1

6.1 The parking summary has been updated to account for the accessible parking spaces located within the under-building parking. Each building will include two accessible spaces. The total number of accessible spaces on-site is 24, which is above the minimum requirement of 9 spaces.

6.2 The accessible parking spaces and cross walk for Building #3 have been shifted slightly to a section of Access Drive-3 with a slope of 2%. Changes to the profile were not required.

6.3 The cross walk across Access Drive-2 has been shifted slightly and the 2% leveling area has been extended through the limits of the cross walk.

6.4 The cross walk running across the drive to Building 2 has been shifted slightly to an area with less than 5% running slopes and less than 2% cross slopes. Revisions to the profile were not required.

6.5 The westerly parking spaces at building #5 were not necessary and have been deleted.

7. Preliminary Site Plan, Sheet 2

7.1 The main entrance shown on the plans is the required accessible entrance required for the multifamily buildings. The finish floor elevation at each entrance has been provided with spot grades to verify the slope requirements.

7.2 As requested, additional detail on the roof drainage has been provided. Most of the roof areas will be piped to the drainage system. Those areas not directly piped to the drainage system are directed to areas with sufficient grade to convey runoff.

7.3 There was a concern related to the parking islands along the rear of Building 2 potential blocking the drainage flow path of surface runoff. These islands have been deleted to eliminate potential issues.

7.4 Potential ponding was a concern to the rear of Building 12 and 13. This issue has been mitigated through the use of site grading, area drains, and trench drains along the rear of Buildings 12 and 13, plus Buildings 9, 10, and 11.

8. Preliminary Site Plan, Sheet 3

8.1 The temporary grading easement has been shown as a precaution to allow any incidental work that may be required outside the permanent easement during the construction of Access Drive 1. The existing garage and driveway on #30 are to remain. The temporary easement would be extinguished once construction was completed.

9. Preliminary Site Plan, Sheet 4

9.1 As requested, the proposed drainage piping, first floor building doors, and accessible parking locations have been shown on the profile.

10. Preliminary Site Plan, Sheet 5

10.1 As requested, the proposed drainage piping, first floor building doors, and accessible parking locations have been shown on the profile.

11. Preliminary Site Plan, Sheet 6

11.1 As requested, the proposed drainage piping has been shown on the profile.

11.2 As requested, a typical roadway section has been added to the plan set.

12. Preliminary Site Plan, Sheet 7

12.1 There was concern related to the water and drain crossing at the 60-inch line from detention system A. At this location the drain line has an invert elevation of 183.5 (top of pipe at 188.5), and the water line has an invert elevation of 192.0. The elevations have also been added to the plans.

12.2 The detail has been updated to reflect the current grading plan, and has been revised to show a minimum cover elevation of 198. This provides 24 inches of cover, which is greater than the manufacturer's minimum recommendations.

12.3 The peer review had requested additional detail on the operation and maintenance of the outlet control structure to the two detention systems. Three items were recommended: (1) Upstream screening has been added prior to the detention system with monthly inspection and cleaning; (2) Monthly inspection of the outlet structure has been specified along with manual cleaning of the 4-inch outlet; and (3) An emergency drawdown valve has been added to the outlet structure with an extension handle that can be operated from the surface.

13. Preliminary Site plan, Sheet 8

13.1 The detailed grading has shown positive grading away from all buildings. Also, area drainage has been provided in the yard area between buildings 2, 4, and 5.

14. Hydrologic and Hydraulic Analysis

14.1 The typographical error noted in the comment has been revised to state "elevation 173.5" in place of "elevation 193.5."

14.2 The conversation factor utilized in the calculations and noted in the comment has been listed in the revised summary sheet.

We trust the additional information and details provided address the concerns and comments of the peer review. If you have any additional questions please contact our office at 508-393-9727.

Sincerely,
Sullivan Connors & Associates, Inc.

Vito Colonna, PE

cc: Robert A. Chrusciel, PE, Hancock Associates

2.10 Stormwater Recharge (revised 7/14/2016)

The proposed stormwater management system has provided groundwater recharge through a subsurface drywells located in the lower portion of the site. This drywell will receive pretreated runoff from the two detention and treatment systems. This drywell will consist of precast concrete galleys set in a bed of crushed stone. The sizing has been based upon the existing soil types and overall increase in site impervious area.

The proposed drywell has been located in an area of highly permeable soils with sufficient depth to groundwater. Testing in this location was performed during the design of the wastewater leach field and was witnessed by MassDEP and the Town of Sudbury Board of Health. Field permeability tests were also performed to verify the rates used in the design. The testing results showed coarse sand with permeability rates of 100 inches per hour. Groundwater was encountered 66-inches below grade, or at approximately elevation *173.5*.

They drywell has been sized per the Dynamic Field Method as outlined below:

Total increase in impervious area = 324,210 sq. ft.
Area of Hydrologic Soil Group B = 70,240 sq. ft. (0.35 inches x impervious area)
Area of Hydrologic Soil Group C = 253,970 sq. ft. (0.25 inches x impervious area)
Required Recharge Volume =
Group B: 70,240 x 0.35 inches / *12 inches per foot* = 2,049 cubic feet
Group C: 253,970 x 0.25 inches / *12 inches per foot* = 5,291 cubic ft.
Total = 7,340 cubic feet
On-site Impervious Collected Area = 93%
Adjusted Required Volume 7,340 / 93% = 7,893 cubic feet
Total Required Recharge = **7,893 cubic feet**

Proposed Recharge Volume: (Dynamic Field Method)
Required Volume = 7,893 c.f. (0.181 acre feet)

1. Verify minimum sizing:
   Equivalent 24-hour storm over 12 hours = 1.18 inches
   Proposed bottom area = 1,620 sq. ft. (54'x30')
   Design exfiltration rate = 25 inches/hour (lowest field value = 96 in/hr)
   Maximum ponding depth = <0.1 feet

2. Calculate actual recharge volume:
   Equivalent 24-hour storm over 12 hours = 2.35 inches
   Proposed bottom area = 1,620 sq. ft. (54'x30')
   Design exfiltration rate = 25 inches/hour (lowest field value = 96 in/hr)
   Maximum ponding depth = 2.5 feet
   Available recharge = **22,000 cubic feet**

Pretreatment Provided: >80%
Depth to Groundwater: 4' Min.
Drawdown Calculation: Total storage volume = 3,600 C.F.
(3,600 C.F.) / (25 in/hr x 1/12 x 1,620 sf) = 1.1 hour

2.11 Storm Drainage System Sizing Calculations (revised 7/14/2016)

The proposed storm drainage system has been designed from calculations based upon the 100-year storm frequency to ensure safe collection of runoff and conveyance to downstream discharge points.

2.11.1 Rate of Runoff Calculation

The proposed storm drainage system has been designed in accordance with the procedures outlined in THE Federal Highway Administration HEC 22, Urban Drainage design Manual. The peak discharge for design of the pavement drainage was determined using the Rational Method.

The formula for the Rational Method is: Q = CiA

Where: Q = peak discharge, cfs
C = runoff coefficient
i = average rainfall intensity, in./hr, for a storm duration equal to the time of concentration, Tc
A = drainage area, acres

The average intensity (i) utilized in the calculations was based upon exhibit 8-14 *Intensity – Duration – Frequency Curve for Worcester, MA.* The peak rate of runoff discharging from the subsurface detention systems was based upon HydroCAD model attached to the project Hydrologic and Hydraulic Analysis. The proposed drainage area (A) was based upon a field survey within the project limits and available GIS information for those upgradient areas.

2.11.2 Inlet Grates / Capacities

The plans provided inlet spaced at sufficient intervals along the running slopes and at low points to safely collect and convey surface runoff. Massachusetts standard cascade grates are used on all locations on continuous grades. At low points, rectangular bar rates are used because they efficiently accept flow from both directions and are safe for bicycles. Curb inlets have also been specified at critical low points as shown in the plan.

The inlet capacity of a typical cascade grate is 0.9 cfs for a single grate and 1.8 cfs for a double grate assuming a ponding depth of 0.2' and a wetted perimeter of 4.1' per grate. The 0.2' of head accounts for the grates to be set 0.1' below adjacent grade and 0.1' of flow depth. The inlet capacity of a standard bar grate to be used at low points would be 1.9 cfs for a single grate and 3.8 cfs for a double grate assuming a deeper depth of ponding of up to 4 inches and a wetted perimeter of 3.5 feet per grate. At double grates with curb inlets the capacity is increased to 5.2 cfs. The calculations and values listed above have assumed the grates will be 25% clogged.

Calculations are based upon the standard weir flow equation:

$Q = 3.33 \times L \times H^{3/2}$
Q = flow (ft^3/s)
L = perimeter of grate where flow is present (ft)
H = depth of water above grate (ft)

The inlet capacity of the two drop inlets would be 9.5 cfs prior to any surcharge above the cover. With 6 inches of surcharge the capacity increases to 15.6 cfs. The results are based upon the weir equation with two openings of 28 inches wide by 9 inches tall.

2.11.3 Summary of Drainage System Sizing Calculations

The following table presents the hydraulic calculations performed for sizing the site drainage system. The structure references refer to those as shown on the site plan submitted with this report.

DRAIN PIPE SIZING CALCULATIONS

PROJECT The Village at Sudbury Crossing
Residential Development

LOCATION Off Hudson & Concord Road
Sudbury, MA

BY: VC
DATE: 7/8/2016

n= 0.012
RETURN PERIOD **100 YEAR**
Impervious Area C = 0.95
Pervious Area C = 0.30

Line		Area	% Imperv.	C	CA	Tc	rain	Inlet flow Q	Pipe flow Qd	Pipe Size	Pipe Length	Slope	flowing full		Rim (feet)		Inv. El.	
FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
ACCESS DRIVE - 1																		
CB 0+10 R	DMH 0+40	0.35	45%	0.59	0.21	5.0	8.0	1.66	**1.66**	12	30	0.020	**5.46**	7.0	194.10	195.10	190.60	190.00
CB 0+27 L	DMH 0+40	0.08	100%	0.95	0.08	5.0	8.0	0.61	**0.61**	12	18	0.033	**7.05**	9.0	194.40	195.10	190.60	190.00
DMH 0+40	DMH 1+56				0.28	5.1	8.0		**2.27**	12	112	0.006	**2.94**	3.7	195.10	199.10	189.90	189.25
CB 1+46 R	DMH 1+56	0.50	25%	0.46	0.23	5.0	8.0	1.85	**1.85**	12	10	0.030	**6.69**	8.5	198.30	199.10	194.20	193.90
CB 1+46 L	DMH 1+56	0.06	100%	0.95	0.06	5.0	8.0	0.46	**0.46**	12	12	0.025	**6.11**	7.8	198.20	199.10	194.20	193.90
DMH 1+56	DMH 2+77				0.57	5.6	7.9	4.52	**4.52**	15	116	0.006	**5.24**	4.3	199.10	205.10	189.00	188.35
CB 2+67 R	DMH 2+77	0.25	30%	0.50	0.12	5.0	8.0	0.99	**0.99**	12	10	0.035	**7.22**	9.2	204.35	205.10	200.35	200.00
CB 2+67 L	DMH 2+77	0.08	100%	0.95	0.08	5.0	8.0	0.61	**0.61**	12	10	0.035	**7.22**	9.2	204.35	205.10	200.35	200.00
DMH 2+77	DMH 3+59				0.77	6.0	7.8		**6.02**	18	79	0.005	**8.10**	4.6	205.10	207.35	188.10	187.70
DMH 3+59	DMH 3+76				0.08	6.3	7.8		**0.59**	18	20	0.005	**8.05**	4.6	207.35	207.50	187.60	187.50
DMH 3+76	DMH 4+97				0.77	6.4	7.8		**6.02**	18	166	0.005	**7.90**	4.5	207.50	192.50	187.40	186.60

DRAIN PIPE SIZING CALCULATIONS

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Residential Development

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BY: VC
DATE: 7/8/2016

n= 0.012
RETURN PERIOD **100 YEAR**
Impervious Area C = 0.95
Pervious Area C = 0.30

Line		Area	% Imperv.	C	CA	Tc	rain	Inlet flow Q	Pipe flow Qd	Pipe Size	Pipe Length	Slope	flowing full		Rim (feet)		Inv. El.	
FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
AD-4	AD-3	4.00	25%	0.46	1.85	15.0	5.5	10.18	**10.18**	18	8	0.031	**20.13**	11.4	228.00	223.00	219.25	219.00
AD-3	DMH E	0.10	0%	0.30	1.88	15.0	5.5	10.34	**10.34**	18	26	0.031	**19.97**	11.3	223.00	222.00	217.30	216.50
ROOF 12	DMH E	0.06	100%	0.95	0.06	5.0	8.0	0.46	**0.46**	6	175	0.035	**1.14**	5.8	---	222.00	223.00	216.90
DMH E	DMH 8+83	0.06	100%	0.95	1.99	15.0	5.5		**10.97**	18	65	0.029	**19.47**	11.0	222.00	214.60	211.50	209.60
CB 9+02 R	DMH 8+83	0.12	90%	0.89	0.11	5.0	8.0	0.85	**0.85**	12	24	0.035	**7.27**	9.3	214.95	214.60	210.95	210.10
CB 9+06 L	DMH 8+83	0.16	75%	0.79	0.13	5.0	8.0	1.01	**1.01**	12	28	0.021	**5.65**	7.2	214.70	214.60	210.70	210.10
DMH 8+83	DMH 7+93				2.23	15.1	5.5		**12.24**	18	86	0.035	**21.27**	12.0	214.60	211.50	209.50	206.50
CB 8+03 R	DMH 7+93	0.13	85%	0.85	0.11	5.0	8.0	0.89	**0.89**	12	15	0.057	**9.19**	11.7	211.80	211.50	207.80	206.95
CB 8+03 L	DMH 7+93	0.13	85%	0.85	0.11	5.0	8.0	0.89	**0.89**	12	21	0.021	**5.65**	7.2	211.40	211.50	207.40	206.95
DMH 7+93	DMH 7+05				2.45	15.2	5.5	13.46	**13.46**	18	85	0.041	**23.11**	13.1	211.50	207.46	206.40	202.90
AD-2	DMH D	0.52	0%	0.30	0.16	7.5	7.3	1.14	**1.14**	12	32	0.037	**7.48**	9.5	216.50	216.00	211.50	210.30
ROOF 11	DMH D	0.06	100%	0.95	0.06	5.0	8.0	0.46	**0.46**	6	175	0.054	**1.41**	7.2	---	216.00	220.00	210.60
DMH D	DMH 7+05	0.06	100%	0.95	0.27	7.6	7.3		**1.97**	12	66	0.029	**6.55**	8.3	216.00	207.46	205.30	203.40
CB 7+26 R	DMH 7+05	0.05	100%	0.95	0.05	5.0	8.0	0.38	**0.38**	12	23	0.026	**6.24**	7.9	208.20	207.46	204.00	203.40
CB 7+26 L	DMH 7+05	0.07	100%	0.95	0.07	5.0	8.0	0.53	**0.53**	12	28	0.021	**5.65**	7.2	207.80	207.46	204.00	203.40
DMH 7+05	DMH 6+83				2.72	7.7	7.3		**19.84**	24	18	0.028	**40.87**	13.0	207.46	206.66	202.30	201.80
AD-1	DMH C	1.70	0%	0.30	0.51	12.0	6.2	3.16	**3.16**	12	24	0.050	**8.63**	11.0	214.50	214.00	209.50	208.30
ROOF 9	DMH C	0.06	100%	0.95	0.06	5.0	8.0	0.46	**0.46**	6	175	0.031	**1.07**	5.4	---	214.00	214.00	208.60
ROOF 10	DMH C	0.06	100%	0.95	0.06	5.0	8.0	0.46	**0.46**	6	175	0.031	**1.07**	5.4	---	214.00	214.00	208.60
DMH C	DMH 5+26	0.12	100%	0.95	0.74	12.0	6.2		**4.58**	12	64	0.039	**7.63**	9.7	214.00	204.70	203.30	200.80
DMH 5+26	DMH 5+71				0.74	12.1	6.2		**4.58**	12	42	0.012	**4.21**	5.4	204.80	204.70	200.70	200.20
CB 5+60 R	DMH 5+71	0.38	85%	0.85	0.32	5.0	8.0	2.59	**2.59**	12	14	0.021	**5.65**	7.2	204.50	204.70	201.00	200.70
CB 5+60 L	DMH 5+71	0.32	85%	0.85	0.27	5.0	8.0	2.18	**2.18**	12	10	0.030	**6.69**	8.5	204.50	204.70	201.00	200.70
DMH 5+71	DMH 6+83				1.33	12.3	6.1		**8.14**	18	108	0.011	**11.75**	6.6	204.70	206.66	199.95	198.80

DRAIN PIPE SIZING CALCULATIONS

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FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
CB 11+19 R	DMH 11+29	0.11	75%	0.79	0.09	5.0	8.0	0.69	**0.69**	12	7	0.036	**7.30**	9.3	215.70	216.04	211.70	211.45
CB 11+19 L	DMH 11+29	0.10	85%	0.85	0.09	5.0	8.0	0.68	**0.68**	12	33	0.020	**5.42**	6.9	216.10	216.04	212.10	211.45
DMH 11+29	DMH 12+38				0.17	5.1	8.0		**1.38**	12	108	0.032	**6.95**	8.9	216.04	212.33	211.30	207.80
CB 12+22 L	DMH 12+38	0.15	65%	0.72	0.11	5.0	8.0	0.87	**0.87**	12	34	0.021	**5.54**	7.1	212.50	212.33	208.50	207.80
DMH 12+38	DMH 12+54				0.41	5.3	8.0		**3.31**	12	14	0.029	**6.53**	8.3	212.33	211.70	207.70	207.30
CB 12+52 R	DMH 12+54	0.14	100%	0.95	0.13	5.0	8.0	1.06	**1.06**	12	6	0.033	**7.05**	9.0	211.50	211.70	207.50	207.30
DMH 12+54	DMH 13+02				0.55	5.3	7.9		**4.32**	15	46	0.029	**12.00**	9.8	211.70	209.15	206.25	204.90
AD-6	DMH-A	3.50	20%	0.43	1.51	9.7	6.7	10.08	**10.08**	18	43	0.030	**19.80**	11.2	228.00	226.00	222.00	220.70
DMH-A	DMH-B				1.51	9.8	6.7		**10.08**	18	12	0.029	**19.45**	11.0	226.00	218.00	213.80	213.45
ROOF 13	AD-5	0.07	100%	0.95	0.07	5.0	8.0	0.53	**0.53**	8	180	0.022	**1.95**	5.6	---	222.50	223.00	219.00
AD-5	DMH-B	0.11	0%	0.30	0.10	5.0	8.0	0.80	**0.80**	8	66	0.068	**3.42**	9.8	222.50	218.00	218.50	214.00
DMH-B	DMH 13+02	0.06	100%	0.95	1.66	9.8	6.7		**11.13**	18	66	0.029	**19.32**	10.9	218.00	209.15	206.55	204.65
DMH 13+02	DMH 14+23				2.21	9.9	6.6	14.57	**14.57**	18	118	0.037	**21.86**	12.4	209.15	204.82	204.15	199.80
CB 14+11R	DMH 14+23	0.52	30%	0.50	0.26	5.0	8.0	2.06	**2.06**	12	24	0.021	**5.57**	7.1	204.50	204.82	200.70	200.20
CB 14+04 L	DMH 14+23	0.17	70%	0.76	0.13	5.0	8.0	1.03	**1.03**	12	21	0.038	**7.54**	9.6	205.00	204.82	201.00	200.20
DMH 14+23	DMH 0+41 D3				2.59	10.0	6.5	16.86	**16.86**	18	79	0.028	**19.00**	10.8	204.82	203.03	199.20	197.00

DRAIN PIPE SIZING CALCULATIONS

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FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
PETERS WAY																		
Existing FE	DMH 0+17	2.25	15%	0.40	0.89	8.0	7.0	6.26	**6.26**	12	26	0.037	**7.42**	9.4	---	222.58	217.46	216.50
DMH 0+17	DMH 1+00				0.89	8.0	7.0		**6.26**	15	80	0.020	**9.90**	8.1	222.58	220.36	216.40	214.80
DMH 1+00	DMH 2+48				0.89	8.2	7.0		**6.26**	15	145	0.020	**9.82**	8.0	220.36	217.96	214.70	211.85
CB 2+36 R	DMH 2+48	0.25	100%	0.95	0.24	5.0	8.0	1.90	**1.90**	12	11	0.023	**5.82**	7.4	217.60	217.96	213.65	213.40
CB 2+36 L	DMH 2+48	0.62	40%	0.56	0.35	8.3	6.9	2.40	**2.40**	12	11	0.023	**5.82**	7.4	217.60	217.96	213.65	213.40
DMH 2+48	DMH 2+87				1.48	8.3	6.9		**10.21**	18	34	0.016	**14.48**	8.2	217.96	218.30	211.50	210.95
HW 2+87	DMH 2+87	1.75	10%	0.37	0.64	7.2	7.4	4.73	**4.73**	18	14	0.014	**13.61**	7.7	---	218.30	211.00	210.80
DMH 2+87	DMH 4+25				2.12	8.4	6.9		**14.61**	24	135	0.005	**17.66**	5.6	218.30	222.22	210.55	209.85
DMH 4+25	DMH 6+88				2.12	8.8	6.8		**14.40**	24	260	0.005	**17.67**	5.6	222.22	221.08	209.75	208.40
CB 6+75 R	DMH 6+88	0.08	100%	0.95	0.08	5.0	8.0	0.61	**0.61**	12	10	0.050	**8.63**	11.0	221.00	221.08	217.00	216.50
CB 6+75 L	DMH 6+88	0.61	20%	0.43	0.26	9.7	6.7	1.76	**1.76**	12	16	0.031	**6.83**	8.7	221.00	221.08	217.00	216.50
DMH 6+88	DMH 7+72				2.46	9.7	6.7		**16.46**	24	80	0.005	**17.34**	5.5	221.08	220.05	208.30	207.90
DMH 7+72	DMH 8+79				2.46	9.8	6.7		**16.46**	24	104	0.010	**24.05**	7.7	220.05	215.54	207.80	206.80
CB 8+74 R	DMH 8+79	0.09	100%	0.95	0.09	5.0	8.0	0.68	**0.68**	12	8	0.031	**6.83**	8.7	215.00	215.54	211.00	210.75
CB 8+74 L	DMH 8+79	0.38	35%	0.53	0.20	6.3	7.7	1.54	**1.54**	12	8	0.031	**6.83**	8.7	215.00	215.54	211.00	210.75
DMH 8+79	DMH 10+63				2.74	10.0	6.5		**17.82**	24	180	0.030	**42.48**	13.5	215.54	206.18	206.25	200.85
CB 10+58 R	DMH 10+63	0.08	100%	0.95	0.08	5.0	8.0	0.61	**0.61**	12	8	0.025	**6.11**	7.8	206.05	206.18	202.05	201.85
CB 10+58 L	DMH 10+63	0.17	60%	0.69	0.12	5.0	8.0	0.94	**0.94**	12	8	0.025	**6.11**	7.8	206.05	206.18	202.05	201.85
DMH 10+63	DMH 10+96				2.94	10.2	6.5	19.08	**19.08**	24	30	0.022	**36.10**	11.5	206.18	205.14	200.75	200.10
DI 10+85 L	DMH 10+96	2.10	25%	0.46	0.97	10.6	6.4	6.22	**6.22**	15	32	0.020	**9.98**	8.1	203.50	205.14	200.00	199.35
DMH 10+96	DMH 0+41 D3				3.91	10.7	6.4	25.00	**25.00**	24	82	0.020	**34.79**	11.1	205.14	203.03	198.35	196.70

DRAIN PIPE SIZING CALCULATIONS

PROJECT The Village at Sudbury Crossing
Residential Development

LOCATION Off Hudson & Concord Road
Sudbury, MA

BY: VC
DATE: 7/8/2016

n= 0.012
RETURN PERIOD **100 YEAR**
Impervious Area C = 0.95
Pervious Area C = 0.30

Line		Area	% Imperv.	C	CA	Tc	rain	Inlet flow Q	Pipe flow Qd	Pipe Size	Pipe Length	Slope	flowing full		Rim (feet)		Inv. El.	
FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
ACCESS DRIVE 3																		
CB 0+61 R	DMH 0+41	0.14	100%	0.95	0.13	5.0	8.0	1.06	**1.06**	12	22	0.023	**5.82**	7.4	202.40	202.45	198.40	197.90
DMH 0+41	DMH 0+66				6.50	10.8	6.4		**41.60**	30	29	0.021	**63.97**	13.0	202.45	203.00	192.90	192.30
CB 0+66 L	DMH 0+66	0.20	80%	0.82	0.16	5.0	8.0	1.31	**1.31**	12	8	0.038	**7.48**	9.5	202.40	203.00	198.40	198.10
DMH 0+66	DET. A				6.66	10.8	6.4		**42.65**	30	15	0.020	**62.89**	12.8	203.00	---	186.30	186.00
DET. A	WQ-A	From Hyrdo Model						10.50	**10.50**	36	5	0.020	**102.27**	14.5	200.75	199.50	183.00	182.90
DET. B	WQ-B	From Hydro Model						3.80	**3.80**	24	5	0.020	**34.68**	11.0	201.50	199.70	182.10	182.00
WQ-A	DMH 2+22								**10.50**	36	25	0.010	**72.32**	10.2	199.50	199.00	182.80	182.55
WQ-B	DMH 2+22								**3.80**	24	10	0.010	**24.52**	7.8	199.70	199.00	181.90	181.80
DMH 2+22	DMH 2+76								**14.30**	36	47	0.0053	**52.74**	7.5	199.00	196.55	181.60	181.35
DMH 2+76	DMH 3+35								**14.30**	36	52	0.0054	**53.07**	7.5	196.55	194.50	181.25	180.97
DMH 3+35	DMH 3+51								**14.30**	36	60	0.0053	**52.81**	7.5	194.50	192.20	180.87	180.55
DMH 3+51	36" HW								**14.30**	36	37	0.0054	**53.17**	7.5	192.20	---	180.45	180.25
CB 2+77 L	DMH 2+38	0.46	70%	0.76	0.35	5.0	8.0	2.78	**2.78**	12	34	0.010	**3.92**	5.0	196.25	198.20	192.85	192.50
ROOF 2F	DMH 2+38	0.20	100%	0.95	0.19	5.0	8.0	1.52	**1.52**	12	265	0.010	**3.90**	5.0	---	198.20	195.20	192.50
DMH 2+38	DMH 1+88				0.54	5.0	8.0		**4.30**	15	44	0.010	**7.08**	5.8	198.20	199.90	192.40	191.95
ROOF 3F	DMH 1+88	0.20	100%	0.95	0.19	5.0	8.0	1.52	**1.52**	12	150	0.017	**4.99**	6.3	---	199.90	195.00	192.50
DMH 1+88	DET. A				0.54	5.0	8.0		**4.30**	15	14	0.014	**8.37**	6.8	199.90	---	191.85	191.65
CB 3+61 R	12" HW	0.40	80%	0.82	0.33	5.0	8.0	2.62	**2.62**	12	8	0.050	**8.63**	11.0	190.50	---	181.40	181.00

DRAIN PIPE SIZING CALCULATIONS

PROJECT The Village at Sudbury Crossing
Residential Development

LOCATION Off Hudson & Concord Road
Sudbury, MA

BY: VC
DATE: 7/8/2016

n= 0.012
RETURN PERIOD **100 YEAR**
Impervious Area C = 0.95
Pervious Area C = 0.30

Line		Area	% Imperv.	C	CA	Tc	rain	Inlet flow Q	Pipe flow Qd	Pipe Size	Pipe Length	Slope	flowing full		Rim (feet)		Inv. El.	
FROM	TO	ac				min.	in/hr	cfs	cfs	in	ft	ft/ft	Qf	Vf	Upper	Lower	Upper	Lower
ACCESS DRIVE - 2																		
DMH 6+83 D1	DMH 0+40				4.05	12.5	6.1		**24.72**	24	30	0.023	**37.46**	11.9	206.66	205.65	198.30	197.60
ROOF 6	DMH 0+40	0.04	100%	0.95	0.04	5.0	8.0	0.30	**0.30**	8	150	0.013	**1.47**	4.2	---	205.65	201.50	199.60
DMH 0+40	DMH 0+98				4.09	12.6	6.1		**24.95**	24	57	0.023	**37.04**	11.8	205.65	203.33	197.40	196.10
DMH 0+98	DMH 1+67				4.09	12.7	6.1		**24.95**	24	67	0.021	**35.45**	11.3	203.33	201.25	195.90	194.50
CB 1+57R	DMH 1+67	0.20	65%	0.72	0.14	5.0	8.0	1.16	**1.16**	12	15	0.033	**7.05**	9.0	201.45	201.25	197.45	196.95
CB 1+57 L	DMH 1+67	0.17	65%	0.72	0.12	5.0	8.0	0.98	**0.98**	12	21	0.024	**5.96**	7.6	201.10	201.25	197.45	196.95
DMH 1+67	DMH 2+21				4.36	12.8	6.1		**26.58**	24	50	0.025	**38.78**	12.3	201.25	198.00	194.25	193.00
CB 2+44 L	DMH 2+21	0.11	80%	0.82	0.09	5.0	8.0	0.72	**0.72**	12	29	0.010	**3.93**	5.0	195.90	198.00	192.90	192.60
ROOF 1F	DMH 2+21	0.17	100%	0.95	0.16	5.0	8.0	1.29	**1.29**	12	180	0.033	**7.05**	9.0	---	198.00	199.00	193.00
DMH 2+21	DMH 2+39				4.61	12.8	6.1		**28.12**	30	29	0.007	**36.93**	7.5	198.00	199.00	191.60	191.40
CB 2+44 R	DMH 2+39	0.08	85%	0.85	0.07	5.0	8.0	0.55	**0.55**	12	10	0.030	**6.69**	8.5	196.35	199.00	192.90	192.60
DMH 2+39	DMH 2+90				4.68	12.9	6.0		**28.07**	30	100	0.007	**37.21**	7.6	199.00	202.25	191.30	190.60
ROOF 5	C/O	0.33	100%	0.95	0.31	5.0	8.0	2.51	**2.51**	12	420	0.033	**7.05**	9.0	---	203.50	212.00	198.00
ROOF 4	C/O	0.33	100%	0.95	0.31	5.0	8.0	2.51	**2.51**	12	600	0.025	**6.11**	7.8	---	203.50	213.00	198.00
C/O	DMH 2+90				0.63	5.0	8.0		**5.02**	12	24	0.042	**7.88**	10.0	203.50	202.25	197.60	196.60
DMH 2+90	DMH 3+11				4.99	13.1	6.0		**29.95**	30	60	0.008	**40.60**	8.3	203.50	202.25	190.50	190.00
DMH 3+11	DET. A				4.99	13.1	6.0		**29.95**	30	10	0.020	**62.89**	12.8	202.25	---	186.20	186.00
CB 3+10 R	DET. B	1.20	10%	0.37	0.44	10.0	6.4	2.80	**2.80**	12	8	0.050	**8.63**	11.0	197.50	---	186.90	186.50
ROOF 2R	DET. B	0.20	100%	0.95	0.19	5.0	8.0	1.52	**1.52**	12	275	0.013	**4.36**	5.5	---	---	190.00	186.50
ROOF 1R	DET. B	0.17	100%	0.95	0.16	5.0	8.0	1.29	**1.29**	12	230	0.010	**3.86**	4.9	---	---	188.50	186.20
CB A	DMH F	0.57	75%	0.79	0.45	5.0	8.0	3.59	**3.59**	12	9	0.033	**7.05**	9.0	189.50	190.25	186.50	186.20
CB B	DMH F	0.60	90%	0.89	0.53	5.0	8.0	4.25	**4.25**	12	21	0.014	**4.62**	5.9	189.50	190.25	186.50	186.20
DMH F	DET. B				0.98	5.0	8.0	7.84	**7.84**	18	30	0.010	**11.39**	6.4	190.25	---	186.10	185.80

Stormwater Operations and Management Plan

The Village at Sudbury Station
Hudson & Concord Road
Sudbury, MA

June 10, 2016
Revised July 14, 2016

Stormwater Management System Owner and Responsible Party: Name: Sudbury Station LLC

Signature: _____

Title: _____

This Operation and Maintenance Plan has been prepared in accordance with the MA Department of Environmental Protection stormwater standards and recommendations outlined in the stormwater handbook. Though these Standards do not apply to the project site because there are no discharges into any wetland or water body resulting from the operation of the Stormwater Management System, nor any other discharge which triggers the application of the Massachusetts Stormwater Standards. This plan outlines the minimum efforts necessary to ensure that the stormwater collection and detention system for this site operates in accordance with the proposed design and will bind the operation and management of the system. Efforts in addition to the minimum listed herein may be required to ensure adequate stormwater management.

This plan includes (1) general site restrictions, (2) routine/non-routine operation & maintenance, (3) reporting and record keeping, and (4) emergency response. The locations of stormwater components are shown on the Site Plans for "The Village at Sudbury Station," and are made part of this document.

1. General Site Restrictions

The following conditions are imposed as part of this Plan.

- Illicit discharges into stormwater management system are perpetually prohibited.
- The use of fertilizers should be limited to slow-release, low-nitrogen fertilizers.

2. Operation and Maintenance:

At a minimum, **the Subsurface Detention System and trach racks shall be inspected monthly and all other stormwater management facilities should be inspected a minimum of two times per year, and following at least one major storm per year.** Upon completion of inspection, the inspector should specify any necessary corrective actions to be taken by ownership of the facility. The items to be inspected and maintained are described in the following sections.

Based on the observed conditions, the Responsible Party shall immediately schedule the appropriate maintenance. Some minor maintenance, such as the removal of blockages, debris and saplings in the basins may be conducted at the time of the inspection. More difficult maintenance activities, requiring special equipment, will have to be scheduled, such as the removal of excessive sediment or the repair of eroded areas. All sediment must be removed at least once per year.

Subsurface Detention System

Detention structures shall be inspected after every major storm for the first three months after construction. After the initial period, the system, outlet structure and trash racks shall be inspected monthly, or at increased frequency as dictated by the initial inspection period. The rate at which the system collects pollutants will depend on site activities rather than the size or configuration of the system. The outlet structure and trash racks will be checked for sediment accumulation and structural condition of the weir wall.

Inspection is the key to effective maintenance and is easily performed. Ongoing monthly inspections of the accumulated sediment should be performed. Sediment deposition and transport may vary from year to year and monthly inspections will help insure that systems are cleaned out at the appropriate time. Inspections may need to be performed more often in the winter months in climates where sanding operations may lead to rapid accumulations.

Systems shall be cleaned when inspection reveals that accumulated sediment has reached a depth that may impact the functionality of the system, and trash racks shall be cleaned monthly. Any clogging or accumulated debris that may restrict flow through the outlet structure or orifices shall be removed immediately. A 24-foot aluminum pole with 8-inch 'tee' suitable for manually cleaning the 4-inch orifice from the surface shall be provided by the contractor and kept in the maintenance building at all times. An emergency drawdown valve is provided to allow drawdown of stormwater in the event of a blockage. The vavle can be manually controlled from the surface and accessed through the manhole cover.

The system should be inspected during the high groundwater periods for any evidence of inflow, if such inflow is found the condition should be reported to a qualified engineer. The systems have been designed with an access/inspection manhole situated at or near the inlet and the outlet orifice. Should it be necessary to get inside the system to perform maintenance activities, all appropriate precautions regarding confined space entry and OSHA regulations should be followed. A record of each inspection shall be kept on file at the maintenance facility. A sample inspection log is included.

Maintaining an underground detention or retention system is easiest when there is no flow entering the system. For this reason, it is a good idea to schedule the cleanout during dry weather. Accumulated sediment and trash can typically be evacuated through the manhole over the outlet orifice. If maintenance is not performed as recommended, sediment and trash may accumulate in front of the outlet orifice. Manhole covers should be securely seated following cleaning activities.

Catch Basins and Manholes

The actual removal of sediments and associated pollutants and trash occurs only when sumps are cleaned out; therefore, regular maintenance is required. The more frequent the cleaning, the less likely sediments will be re-suspended and subsequently discharged. Frequent cleaning also results in more volume available for future storms and enhances the overall performance.

Deep sumps shall be inspected four times annually, and cleaned whenever sediment accumulation exceeds half the sump depth (typically two feet). Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. At each inspection, inspect gas trap hoods and repair as necessary. Inspect outlet pipe and remove debris.

Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Pipe Inlets / Outlets

Outlet structures shall be checked for: (1) signs of seepage, (2) separation of joints, (3) cracks, breaks, or deterioration of materials, and (4) differential settlement. The outlet channel itself shall be free from obstruction (e.g., fallen trees) and bank scour, or the undermining of riprap. The level spreader should be checked for settlement, damage, cracks, etc. to ensure a level uniform discharge. Downgradient areas should be checked for signs of flow concentration.

The inspector shall ensure that there are no signs of scour around the inlets. Vegetation and riprap shall be in good condition (e.g., grass shall be dense and healthy looking; riprap shall be free from undermining and/or deterioration). Outlet channels should be free from obstruction (e.g., fallen trees) and bank scour, or the undermining of riprap. Damaged natural areas along the outlet channel should be filled, compacted, and reseeded, to lined with geotextile fabric. Damaged rip rapped areas should be replaced and supplemented.

Vegetation

The initial vegetation inspection shall occur four (4) weeks after final stabilization of the site; vegetation shall be dense (and aesthetically acceptable on all portions of the project, including the side slopes, buffer strips and the embankments). The inspector shall determine and document: (1) whether fertilizing is required (2) the areas where grass shall be mowed, and (3) the areas which shall be protected against erosion. In addition, recently seeded areas shall be inspected for failures.

Eroded areas shall be filled and compacted, if necessary, and reseeded as soon as possible. If an area erodes twice, then a geotextile fabric is to be installed to stabilize the area to allow vegetation to be established. These maintenance activities shall take place during the planting season. Areas affected by lack of rainfall shall be watered. If a recently established vegetated area is determined to be inadequate for erosion control it shall be re-fertilized with microbial release, not sulfur encapsulated, fertilizer, (using half of the rate originally applied). If the stand is more than 60% damaged, it shall be reestablished, following the original preparation and seeding instructions. Areas of repeated erosion/scour problems shall be lined with riprap only after twice attempting to stabilize the area with geotextile fabric.

Debris Accumulation

The inspector shall check basins and channels for both sediment and debris accumulations. Debris and sediment shall be removed at the time of the inspection, if feasible. Sediment shall not be allowed to accumulate and restrict flows. Most debris can be removed by hand or with hand tools (e.g. shovel). Some larger objects, such as fallen tree limbs, may have to be cut up before removal by hand is possible.

Snow Removal

Snow windrows located within the sight triangle areas of internal driveways and at the intersections of Hudson Road and Concord Road that exceed 2-feet in height or that would otherwise inhibit sight lines shall be promptly removed. Snow shall not be plowed onto abutting properties or the Agricultural Preservation Land along Peter's Way nor stockpiled or stored within 125 feet of the buffer zone of bordering vegetated wetlands adjacent to Mineway Brook at the intersection of Concord Road until Peter's Way exits said buffer zone. The responsible party shall delineate this location on-site. All inlets shall be uncovered and functional immediately after snow plowing. Snow storage shall be managed to maintain access to all hydrants, building utilities, emergency exits, etc. Any snow in excess of that which can be stored on-site shall be legally disposed of off-site.

Street Sweeping

Street sweeping of the roadway should be performed at least twice per year, preferably in the spring after the snow has melted and in the fall, prior to snowfall. Disposal of the sweepings must be in accordance with applicable local, state, and federal guidelines and regulations.

Infiltration Drywell

Infiltration Drywells shall be inspected after every major storm in the first three months after construction. After this initial period, the systems shall be inspected at least twice annually (spring and fall) and after at least one major storm to see if they have fully drained. The Inspection ports or covers should be opened and the infiltration system checked for accumulated debris and sediment. If any sediment is present and/or if the infiltration system does not drain within 72 hours of the end of a storm, then remediation may be necessary. It may be possible to flood the system to suspend sediment and debris and remove it with a vacuum truck. Otherwise replacement of the soil around and under the infiltration system may be required.

Stormceptor Water Quality Structures

The Stormceptor Water Quality structures shall be maintained in accordance with the manufactures recommendations (see attached). Structures should be inspected four times annually, and cleaned whenever sediment accumulation exceeds a depth of 12 inches. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. At each inspection, the responsible party shall inspect the inlet/outlet pipe and structural condition.

3. Reporting and Record Keeping

The responsible party will be responsible for maintaining accurate Maintenance Logs for all maintenance and inspections. The maintenance logs shall be kept on site for a minimum of TEN (10) years and be available for inspection by the Town municipal departments or other auditing authority, including inspections, repairs, replacement and disposal (for disposal, the log shall indicate the type of material and the disposal location). This will be a perpetual requirement of the Owners or their Designated Party.

The Site Maintenance Log will be completed as described above, and at a minimum will include the following items:

- Date activity performed;
- Last rain event;
- BMP's inspected and condition;
- Specific maintenance task;
- Staff or contractor performing activity;
- Verification of maintenance activity;
- For disposal include type of material and the disposal location; and
- Recommended additional maintenance tasks.

4. Emergency Response Plan / Spill Control Practices

Outdoor on-site storage of hazardous materials shall not be allowed. A spill cleanup kit shall be kept in the maintenance building at all times.

In the event of a spill or other accident on-site where a significant amount of gasoline, petroleum, chemicals, or other hazardous product is released, the following procedure should be followed:

1. Immediately contact the following agencies:

Sudbury Fire Department	(978) 443-2239
MassDEP Emergency Response	(888) 304-1133

2. Provide support to agencies listed above, which may include contacting an outside contractor to provide clean-up or contacting a Licensed Site Professional (LSP) to lead the clean-up.

If the volume of spill has reached the catch basins or detention system, these structures should be cleaned by a licensed liquid waste hauler. The outlet to the drainage system should be inspected. If there is evidence of discharge from the drainage system, additional corrective actions must be taken extending to the receiving water or beyond.

The MassDEP fact sheet summarizing the management of spills of oil and hazardous materials can be found at http://www.mass.gov/eea/docs/dep/cleanup/laws/spillmgm.pdf.

Attachments: Snow Storage Exhibit
O&M Inspection forms
MassDEP Fact Sheet - Managing spills of oil and hazardous material
CMP Detention and Infiltration Inspection and Maintenance Guide.
Stormceptor System Owners' Manual

MAINTENANCE INSPECTION FORM
The Village at Sudbury Crossing
Sudbury, MA

Date:____________ Inspector:_______________________ Signature:_________________

General Summary	Inspected	Date inspected	Action Required
1. Inspect Catch Basins	_________	___________	_____.
2. Inspect Area Drains	_________	___________	_____.
3. Inspect Treatment Structures	_________	___________	_____.
4. Inspect Subsurface Detention Systems	_________	___________	_____.
5. Inspect Subsurface Infiltration System	_________	___________	_____.
6. Inspect Trash Rack Manholes	_________	___________	_____.
7. Inspect Surface Conditions on Site	_________	___________	_____.
8. Pipe outfalls	_________	___________	_____.

1. Catch Basins

Number	Sediment Depth	Floatables Depth	Structural Condition	Inlet Condition	Last Cleaned	Action Required

2. Area Drains

Number	Sediment Depth	Floatables Depth	Structural Condition	Inlet Condition	Last Cleaned	Action Required

3. Treatment Structures (Stormceptor 2400)

Number	Sediment Depth	Structural Condition	Inlet Condition	Last Cleaned	Action Required

4. Detention System

Number	Sediment Depth	Depth Trash	Outlet Condition	Last Cleaned	Action Required

5. Infiltration Systems

	Depth of Sediment	Inlet / Outlet Condition	Depth of Water	Action required
Drywell –1				

6. Surface Conditions

	Condition	Action Required
Pavement		
Vegetation		

7. Pipe Outfall

	Depth of Sediment	Outlet Condition	Level Spreader Condition	Downstream Condition	Action required
Level Spreader					

8. Trash-Rack Manholes

Number	Sediment Depth	Debris Present	Screed Condition	Inlet Condition	Last Cleaned	Action Required

COMMENTS / MAINTENANCE REQUIRED:

NOTES:

1. SNOW STORAGE SHALL BE MANAGED TO MAINTAIN ACCESS TO ALL HYDRANTS, BUILDING UTILITIES, EMERGENCY EXITS, ETC.

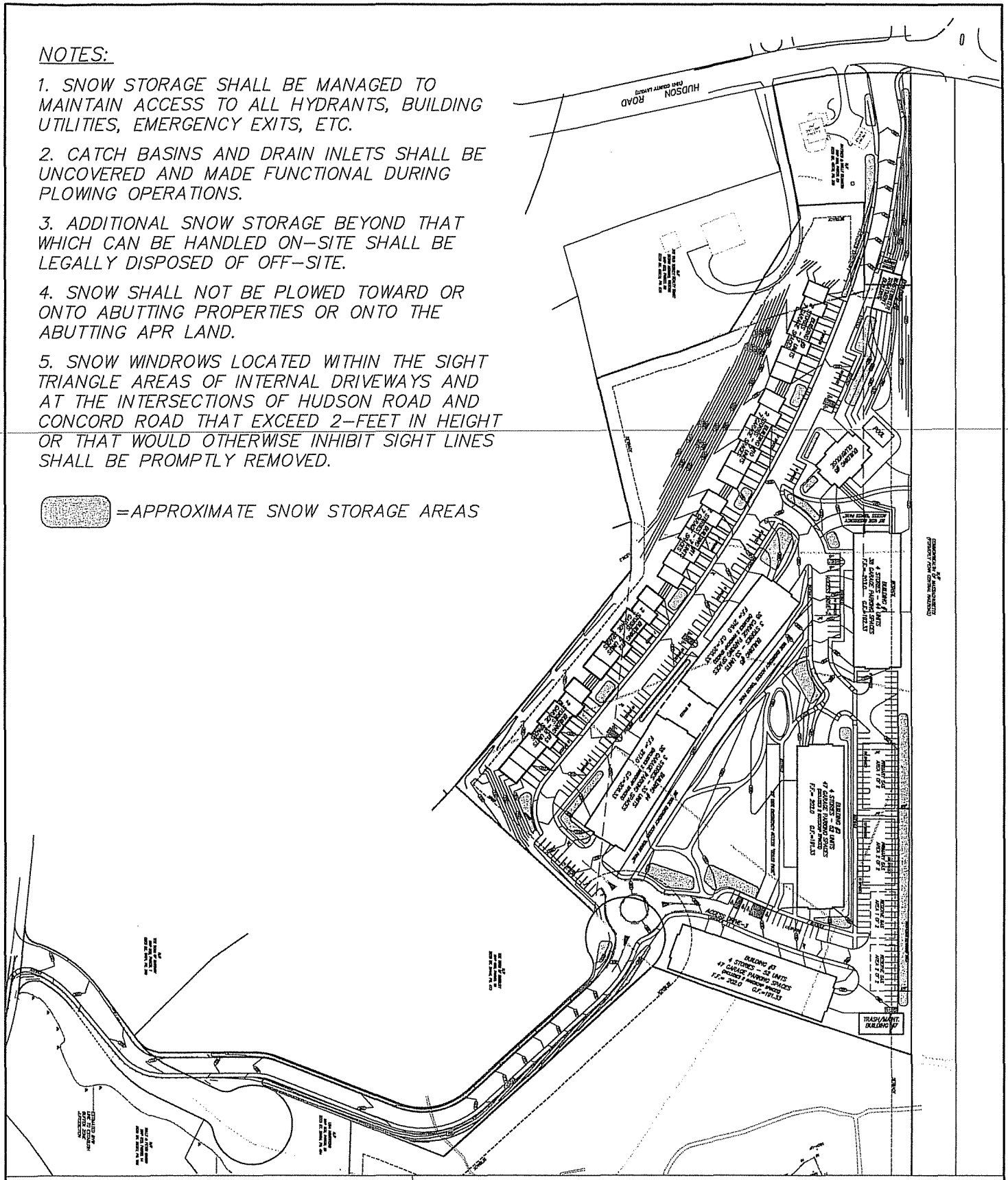
2. CATCH BASINS AND DRAIN INLETS SHALL BE UNCOVERED AND MADE FUNCTIONAL DURING PLOWING OPERATIONS.

3. ADDITIONAL SNOW STORAGE BEYOND THAT WHICH CAN BE HANDLED ON-SITE SHALL BE LEGALLY DISPOSED OF OFF-SITE.

4. SNOW SHALL NOT BE PLOWED TOWARD OR ONTO ABUTTING PROPERTIES OR ONTO THE ABUTTING APR LAND.

5. SNOW WINDROWS LOCATED WITHIN THE SIGHT TRIANGLE AREAS OF INTERNAL DRIVEWAYS AND AT THE INTERSECTIONS OF HUDSON ROAD AND CONCORD ROAD THAT EXCEED 2-FEET IN HEIGHT OR THAT WOULD OTHERWISE INHIBIT SIGHT LINES SHALL BE PROMPTLY REMOVED.

=APPROXIMATE SNOW STORAGE AREAS



SNOW STORAGE EXHIBIT

DATE:	SCALE:
JUNE 8, 2016	NONE

SULLIVAN, CONNORS & ASSOC.
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