Stormwater Report

Sanofi ICBF Project

2-8 New York Avenue
Framingham, Massachusetts

Project No.: 63RR3101

Document No. 63RR3101-C-RE-0005

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Rev. A

Storm Water Management Report

Introduction:

The new Sanofi ICBF project is located at 8 New York Avenue, at the intersection of New York Avenue and California Avenue. The project property lot area is approximately 5.54 acres (241,326-sf).

The project was originally submitted as the Genzyme Fabrazyme DSP Manufacturing Facility in 2014. The project was approved and construction started. The project was halted prior to completion. Underground utilities and storm drainage were installed and are in service. All of the site improvements were not completed prior to the project being halted.

A subsequent plan was prepared by Tetra Tech in 2015 to stabilize the site. The Loading Dock Concrete and heavy duty asphalt paving were installed. Additionally the parking lot Asphalt base course was installed. Sediment and erosion control measures were installed and are currently in place on site.

The current project site work is generally the same as the DSP project. Changes to the original plan include the relocation of on-site utilities on the north side of the building to provide for the future expansion of the building. The Tank farm has been expanded for to support the buildings new function and include four 9,500 gallon tanks located within a spill containment dike. A new screen wall will be constructed around the tank farm to minimize visual exposure of the tanks from the public streets.

The drainage system changes occur within the site and do not impact the two outfall points. The Water Quality Structures were installed as planned and will not be relocated for the ICBF project. Storm drainage piping internal to the site was relocated to accommodate a future building addition.

Hydrological Information

The 24 hour rainfall depths used in these calculations for 2, 10, 25 & 100 year storm events were 3.1", 4.6", 5.4" and 6.4" respectively. Type III rainfall distribution was used. Natural Resources Conservation Service (NRCS) methodologies (TR-55) were used to calculate Runoff Curve Number (CN) and the Time of Concentration (Tc) for the drainage areas. Pondpack software (version 10) by Haestad Methods was used in these calculations to calculate the peak rate of runoff, storage requirement etc. Pondpack software uses NRCS (previous known as SCS) methodology.

The proposed storm drainage collection system has been designed for a twenty five (25) year storm frequency utilizing the Rational Method and Manning's Equation. StomCAD was used to perform the hydraulic analysis of the proposed stormwater management system (Appendix C).

The Existing systems that needed to be verified used the following: Flow quantity development for each Catch Basin (CB) and Manhole (MH) is determined by a modified Rational Method. The areas contributing to each collection structure (CB or MH) is determined using the Rational Method of;

$Q = CiA$

Where: Q = Flow (cfs)

C = Average Coefficient of Runoff based on the surface conditions (found in Attachment A)

For Lawn area largest "C" values was used for conservatism

i – Rainfall intensity (in / hour) using;

Drainage IDF curves provided by Massachusetts Department of Transportation (MASSDOT) see Appendix D.

A = Drainage area contributing to flow (acres)

The Time of Concentration (T_c) is calculated using a formula developed by the Army Corps of Engineers for use by the Federal Aviation Administration (FAA). This formula was selected because of its accuracy when slopes of the contributing areas are relatively shallow (0 to 5 percent).

$Tc = [1.8\ (1.1 - C)L^{0.5}]/S^{1/3}$

Where: C = Average Coefficient of runoff (dimensionless)

L = Flow length (collecting structure to furthest point in contributing area) (feet)

S = Average slope of contributing area along Flow Length (%)

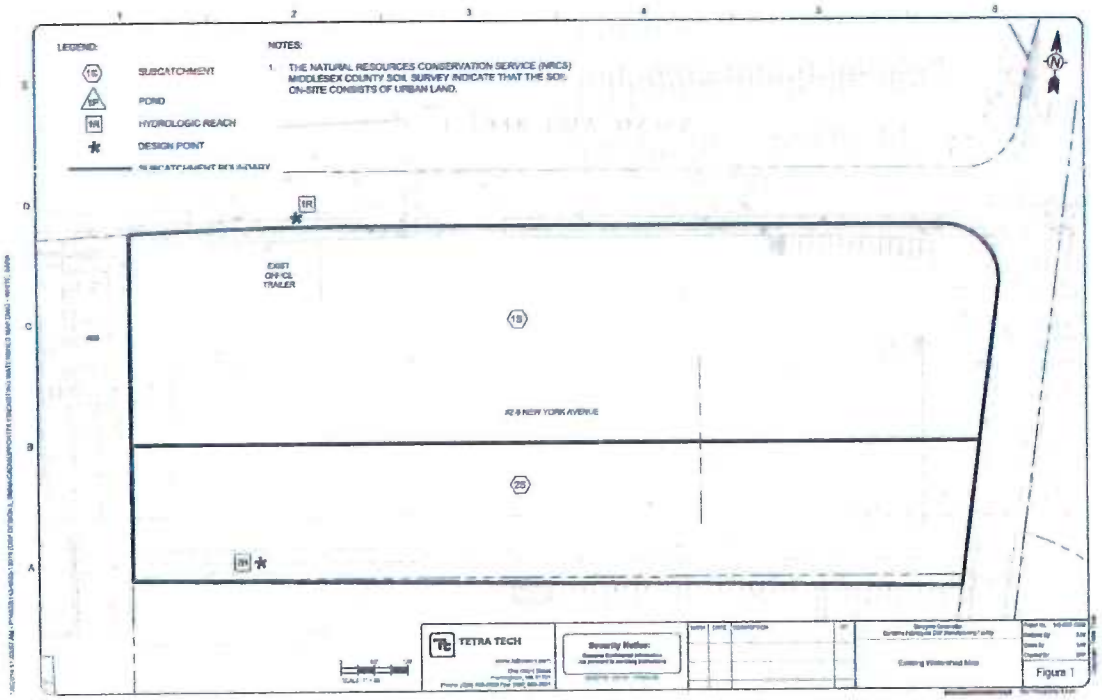
Stormwater Management For The Pre-developed Condition

There are (2) two existing drainage outlet locations on the project site (1) one is north west of the site, which drains into an existing catch basin in New York Ave.. The (2nd) second outlet location is south west into a ditch that flows off site.

The pre development drainage areas were completed by Tetra Tech for the DSP Project and are shown in Figure 1. The chart below shows the results from Pond Pack.

Pre-developed Condition		
	Area 1 North West Located at an existing catch basin	Area 2 South west Located in a swale
Drainage Area (ac)	3.44	2.17
CN Number	95.14	87.935
Time of Concertation (hr)	0.083	0.083
2 year storm flow (cfs)	8.44	4.25
10 year storm flow (cfs)	12.92	7.15
25 year storm flow (cfs)	15.29	8.69
100 year storm flow (cfs)	18.24	10.62

Figure 1



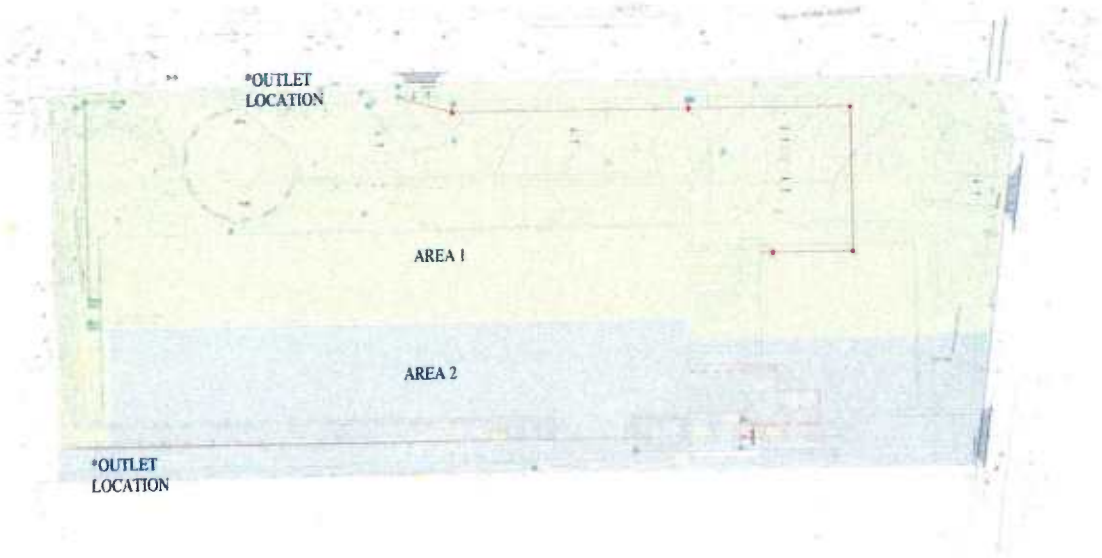
Stormwater Management For The Proposed Condition:

There are no modifications to the drainage locations from the pre-condition. The drainage areas and CN values have slightly been modified as shown in figure 2.

Following is the summary of the drainage area in the proposed condition.

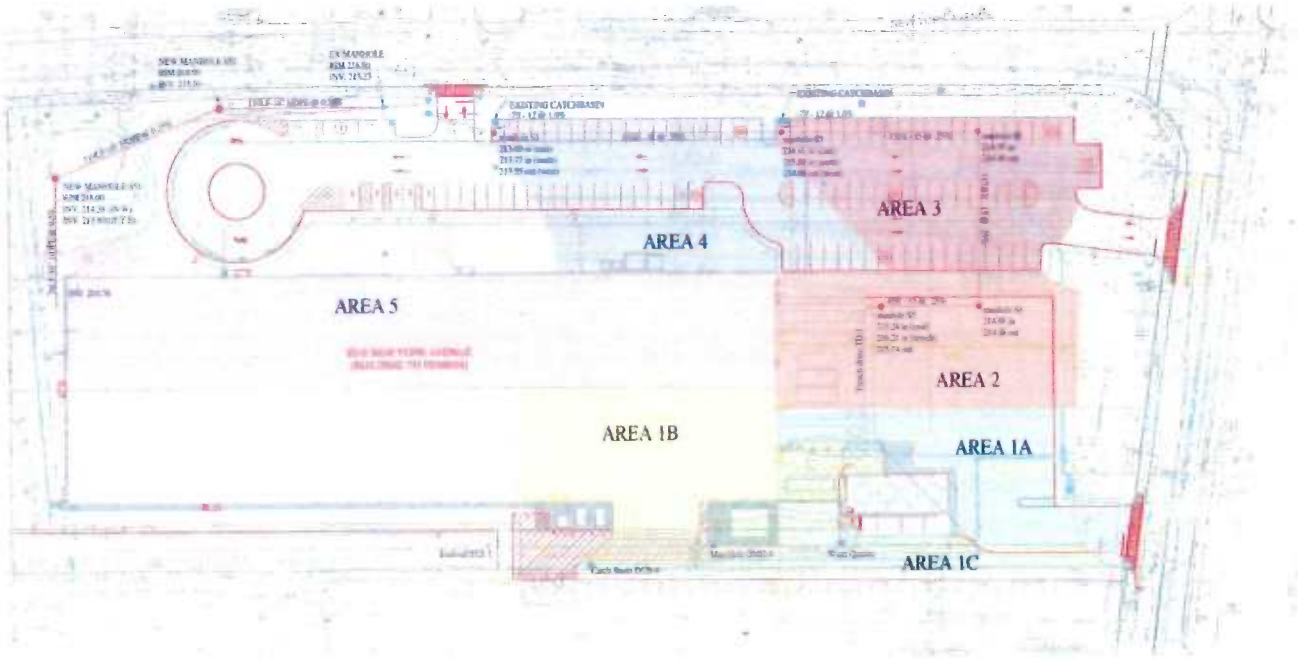
Post-developed Condition		
	Area 1 North West Located at an existing catch basin	Area 2 South west Located in a swale
Drainage Area (ac)	3.60	2.00
CN Number	89.69	89.36
Time of Concertation (hr)	0.083	0.083
2 year storm flow (cfs)	7.53	4.12
10 year storm flow (cfs)	12.36	6.80
25 year storm flow (cfs)	14.92	8.22
100 year storm flow (cfs)	18.10	9.99

Figure 2



Stormwater Collection Drainage Areas

Figure 3



Area 1A (South loading dock)

Q = CiA

0.26	x	0.98	=	0.25	asphalt
0.00		0.85		0.00	stone
0.02	x	0.35		0.01	grass
0.28 ac				0.26	

C AVE = 0.935

L ft	=	195 ft	Elev Change	=	2.00	ft
				=	0.0103	ft/ft
T c	=	(1.8*(1.1-C)*(L)^0.5)/(S)^1/3		=	4.11	min

C = .92

i = 6.0 in/hr (based on 10 year worst case)

A = 0.35 ac

Q = (.935) (6.0) (.28)

Q = 1.57 cfs

Loading dock flow to be routed into an existing storm water conveyance system

Area 1B (South Roof)

Q = CiA

0.34	x	0.98	=	0.33	asphalt
0.00		0.85		0.00	stone
0.00	x	0.35		0.01	grass
0.34 ac				0.33	

C AVE = 0.98

L ft = 137 ft

Elev Change = 0.50 ft

= 0.0036 ft/ft

T c = (1.8*(1.1-C)*(L)^0.5)/(S)^1/3 = 3.54 min

C = .98

i = 6.0 in/hr (based on 25 year worst case)

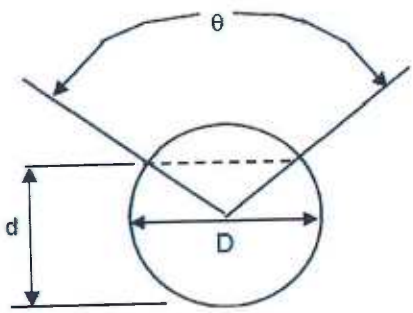
A = 0.34 ac

Q = (.98) (6.0) (.34)

Q = 1.99 cfs

South Site - Pipe Sizing

Trench TD-1 to Manhole Water Quality Structure (STC 450)



INPUT

D=	8	inches
d=	7	inches
n=	0.01	mannings coeff
θ=	82.8	degrees
S=	0.0100	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

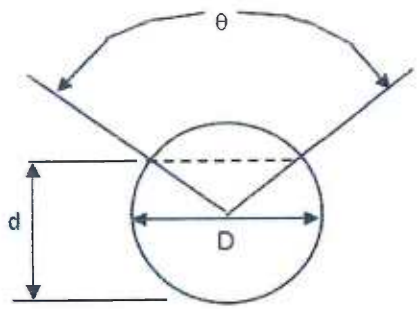
Q=V x A

Solution to Mannings Equation					
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
0.32	1.61	0.20	5.10	1.65	1.57

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		85	ft
Elevation 1	=	214.64	ft
Elevation 2	=	213.79	ft
Delta Elevation	=	0.8	ft
S- Slope (Delta Elev/L)	=	0.0100	ft/ft
Slope (%)	=	1.00	%

Manhole Water Quality Structure (STC 450) to Manhole DMH-8



INPUT

D=	12	inches
d=	11	inches
n=	0.011	mannings coeff
θ=	67.1	degrees
S=	0.0100	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

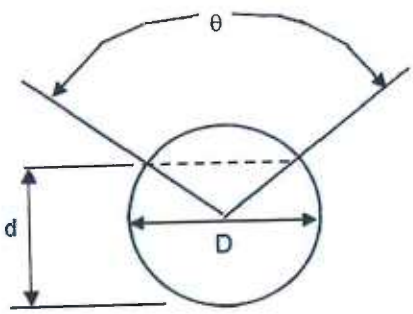
Q=V x A

Solution to Mannings Equation					
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
0.75	2.56	0.30	5.99	4.52	1.57

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		86	ft
Elevation 1	=	213.54	ft
Elevation 2	=	212.68	ft
Delta Elevation	=	0.9	ft
S- Slope (Delta Elev/L)	=	0.0100	ft/ft
Slope (%)	=	1.00	%

Roof to Manhole DMH-8



INPUT

D=	12	inches
d=	11	inches
n=	0.011	mannings coeff
θ=	67.1	degrees
S=	0.0100	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

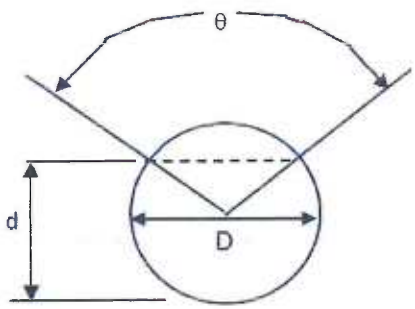
Q=V x A

Area, ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	Solution to Mannings Equation: velocity ft/s	flow, cfs	proposed flow
0.75	2.56	0.30	5.99	4.52	1.99

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		29	ft
Elevation 1	=	212.97	ft
Elevation 2	=	212.68	ft
Delta Elevation	=	0.3	ft
S- Slope (Delta Elev/L)	=	0.0100	ft/ft
Slope (%)	=	1.00	%

Manhole DMH-8 to Endwall FES-1



INPUT

D=	15	inches
d=	14	inches
n=	0.011	mannings coeff
θ=	59.9	degrees
S=	0.0100	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

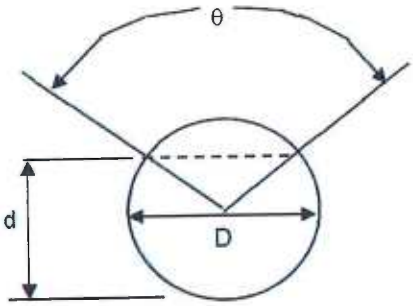
Q=V x A

			Solution to Mannings Equation		
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
1.19	3.27	0.36	6.89	8.21	4.12

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		149	ft
Elevation 1	=	212.68	ft
Elevation 2	=	211.20	ft
Delta Elevation	=	1.5	ft
S- Slope (Delta Elev/L)	=	0.0099	ft/ft
Slope (%)	=	0.99	%

Catch Basin DCB-4 to Wye Connection



INPUT

D=	12	inches
d=	11	inches
n=	0.011	mannings coeff
θ=	67.1	degrees
S=	0.0100	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

$Q=V \times A$

Area, ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	Solution to Mannings Equation: velocity ft/s	flow, cfs	proposed flow
0.75	2.56	0.30	5.99	4.52	0.55

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		20	ft
Elevation 1	=	211.91	ft
Elevation 2	=	211.71	ft
Delta Elevation	=	0.2	ft
S- Slope (Delta Elev/L)	=	0.0100	ft/ft
Slope (%)	=	1.00	%

South Site -Channel Sizing

Area 1C (South ditch)

Q = CiA

0.07	x	0.98	=	0.07	asphalt
0.03		0.85		0.03	stone
0.19	x	0.35		0.07	grass
0.29 ac				0.17	

C AVE = 0.56

L ft = 336 ft

Elev Change = 3.00 ft

= 0.0089 ft/ft

T c = (1.8*(1.1-C)*(L)^0.5)/(S)^1/3 = 18.48 min

C = .56

i = 3.4 in/hr (based on 25 year)

A = 0.29 ac

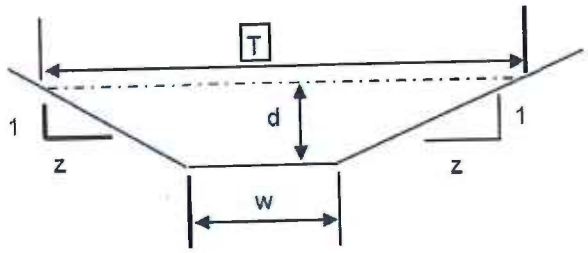
Q = (.56) (3.4) (.29)

Q = 0.55 cfs

Channel flow to existing Catch Basin

Channel flow Capacity

Mannings Formula



INPUT	
z (sideslope)=	3
z (sideslope)=	3
b (btm width, ft)=	1
d (depth, ft)=	0.5
S (slope, ft/ft)	0.0075
n_{low} =	0.017
n_{high} =	0.035

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	1.25	4.16	0.30	3.394708	4.243385	1.648858	2.061073	T =	4
								Dm =	0.313

Proposed Channel Depth – 0.5'

Proposed Channel Capacity – 2.06 cfs

Required Channel Capacity – 0.55 cfs

North West Side

Area 5 (North Roof)

Q = CiA

1.03	x	0.95	=	0.98	asphalt
0.00		0.85		0.00	stone
0.00	x	0.35		0.00	grass
1.03 ac				0.98	

C AVE = 0.95

C = .95

i = 6.0 in/hr (based on 25 year)

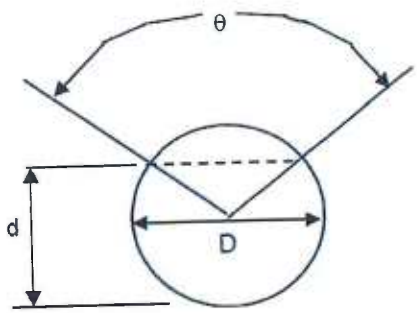
A = 1.03 ac

Q = (.95) (6.0) (1.03)

Q = 5.87 cfs

Roof drainage

Roof to MH S51



INPUT

D=	18	inches
d=	17	inches
n=	0.012	mannings coeff
θ=	54.5	degrees
S=	0.0050	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

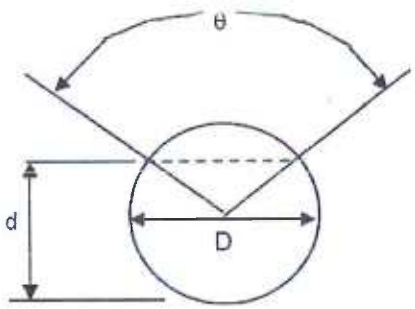
Q=V x A

			Solution to Mannings Equation		
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
1.73	4.00	0.43	5.01	8.65	5.87

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		76	ft
Elevation 1	=	214.76	ft
Elevation 2	=	214.38	ft
Delta Elevation	=	0.4	ft
S- Slope (Delta Elev/L)	=	0.0050	ft/ft
Slope (%)	=	0.50	%

MH S51 to MH S52



INPUT

D=	18	inches
d=	17	inches
n=	0.012	mannings coeff
θ=	54.5	degrees
S=	0.0025	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

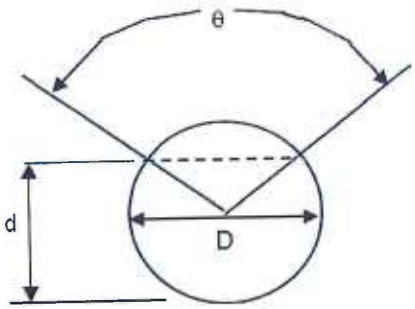
Q=V x A

Solution to Mannings Equation					
Area,ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
1.73	4.00	0.43	3.54	6.12	5.87

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		119	ft
Elevation 1	=	213.80	ft
Elevation 2	=	213.50	ft
Delta Elevation	=	0.3	ft
S- Slope (Delta Elev/L)	=	0.0025	ft/ft
Slope (%)	=	0.25	%

MH S52 to DMH 3



INPUT

D=	18	inches
d=	17	inches
n=	0.012	mannings coeff
θ=	54.5	degrees
S=	0.0025	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

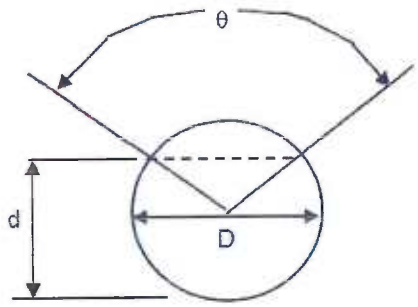
Q=V x A

Solution to Mannings Equation					
Area,ft²	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
1.73	4.00	0.43	3.54	6.12	5.87

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		110	ft
Elevation 1	=	213.50	ft
Elevation 2	=	213.23	ft
Delta Elevation	=	0.3	ft
S- Slope (Delta Elev/L)	=	0.0025	ft/ft
Slope (%)	=	0.25	%

DMH 3 to DMH 2



INPUT

D=	18	inches
d=	17	inches
n=	0.013	mannings coeff
θ=	54.5	degrees
S=	0.0050	slope in/in

Mannings Formula

$Q=(1.486/n)AR_h^{2/3}S^{1/2}$

R=A/P

A=cross sectional area

P=wetted perimeter

S=slope of channel

n=Manning's roughness coefficient

$V=(1.49/n)R_h^{2/3}S^{1/2}$

Q=V x A

Solution to Mannings Equation					
Area, ft^2	Wetted Perimeter, ft	Hydraulic Radius, ft	velocity ft/s	flow, cfs	proposed flow
1.73	4.00	0.43	4.62	7.99	5.87

Manning's n-values	
PVC	0.011
PE (<9"dia)	0.015
PE (>12"dia)	0.02
PE(9-12"dia)	0.017
CMP	0.025
ADS N12	0.012
HCMP	0.023
Conc	0.013

Length of pipe		30	ft
Elevation 1	=	213.23	ft
Elevation 2	=	213.08	ft
Delta Elevation	=	0.1	ft
S- Slope (Delta Elev/L)	=	0.0050	ft/ft
Slope (%)	=	0.50	%

Summary and Conclusion:

Following is the summary of the computations for the pre-developed and post developed condition for this project.

The Post condition for Area 1 and Area 2 do not exceed the flows from the Pre condition as shown in the tables below. With the information provided there is no need for modifications for the existing drainage locations shown in figure 2 and 3

Pre vs. Post-developed Condition Area 1 (North West)			
	Pre-Condition	Post-Condition	Δ
Drainage Area (ac)	3.44	3.60	0.16
CN Number	95.14	89.69	-5.45
Time of Concertation (hr)	0.083	0.083	0
2 year storm flow (cfs)	8.44	7.53	-0.91
10 year storm flow (cfs)	12.92	12.36	-0.56
25 year storm flow (cfs)	15.29	14.92	-0.37
100 year storm flow (cfs)	18.24	18.10	-0.14

Pre vs. Post-developed Condition Area 2 (South West)			
	Pre-Developed Condition	Post-Developed Condition	Δ
Drainage Area (ac)	2.17	2.00	-0.17
CN Number	87.935	89.36	1.425
Time of Concertation (hr)	0.083	0.083	0
2 year storm flow (cfs)	4.25	4.12	-0.13
10 year storm flow (cfs)	7.15	6.80	-0.35
25 year storm flow (cfs)	8.69	8.22	-0.47
100 year storm flow (cfs)	10.62	9.99	-0.63

Pipe Summary

FROM	TO	TOTAL AREA (AC)	TOTAL Q (CFS)	PIPE SLOPE (FT PER FT)	PIPE DIAMETER (IN)	PIPE LENGTH (FT)	PIPE CAPACITY (CFS)	INVERT ELEVATION	
								UP STREAM	DOWN STREAM
Trench	Ex WQS	0.35	1.57	0.01	8	85	1.65	214.64	213.79
Ex WQS	Ex MH 8	0.35	1.57	0.01	12	86	4.52	213.54	212.68
Roof	Ex MH 8	0.34	1.99	0.01	12	29	4.52	212.97	212.68
Ex MH 8	Outfall	0.69	4.12	0.01	15	149	8.21	212.68	211.20
Ex CB 4	Wye connection	0.98	0.55	0.01	12	20	4.52	211.91	211.71

South Existing condition

Roof	S5	0.01	0.08	0.005	12	107	2.91	215.77	215.24
Trench	S5	0.42	2.12	0.01	12	11.5	4.14	216.32	216.21
S5	S4	0.42	2.12	0.0025	15	65	3.73	215.14	214.98
S4	S3	0.42	2.10	0.0025	15	117	3.75	214.88	214.59
S3	S2	0.42	2.06	0.0025	15	131	3.78	214.49	214.16
DCB-3	S2	0.40	2.30	0.01	12	7	4.14	215.95	215.88
S2	S1	0.82	4.18	0.0025	18	193	5.97	214.06	213.60
DCB-2	S1	0.48	2.36	0.01	12	7	4.14	213.84	213.77
S1	STC 900	1.30	6.22	0.0032	18	46	6.91	213.55	213.40

North East Proposed Condition

FROM	TO	TOTAL AREA (AC)	TOTAL Q (CFS)	PIPE SLOPE (FT PER FT)	PIPE DIAMETER (IN)	PIPE LENGTH (FT)	PIPE CAPACITY (CFS)	INVERT ELEVATION	
								UP STREAM	DOWN STREAM
Roof	S51	1.03	5.87	0.005	18	76	8.65	214.76	214.38
S51	S52	1.03	5.87	0.0025	18	119	6.12	213.80	213.50
S52	DMH 3	1.03	5.87	0.0025	18	110	6.12	213.50	213.23
DMH 3	DMH 2	1.03	5.87	0.005	18	30	7.99	213.23	213.08

North West Proposed Condition

Appendix A Pond Pack Model Calculation (Pre-Development Condition)

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
2-8 NYA NORTH	Pre-Development 2 year	2	0.734	12.100	8.44
2-8 NYA NORTH	Pre-Development 10 year	10	1.157	12.100	12.92
2-8 NYA NORTH	Pre-Development 25 year	25	1.384	12.100	15.29
2-8 NYA NORTH	Pre-Development 100 year	100	1.669	12.100	18.24
2-8 NYA SOUTH	Pre-Development 2 year	2	0.341	12.600	2.09
2-8 NYA SOUTH	Pre-Development 10 year	10	0.589	12.550	3.57
2-8 NYA SOUTH	Pre-Development 25 year	25	0.731	12.100	8.69
2-8 NYA SOUTH	Pre-Development 100 year	100	0.904	12.100	10.62

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
NEW YORK AVE	Pre-Development 2 year	2	0.734	12.100	8.44
NEW YORK AVE	Pre-Development 10 year	10	1.157	12.100	12.92
NEW YORK AVE	Pre-Development 25 year	25	1.384	12.100	15.29
NEW YORK AVE	Pre-Development 100 year	100	1.669	12.100	18.24
EXISTING DRAINAGE SWALE	Pre-Development 2 year	2	0.341	12.600	2.09
EXISTING DRAINAGE SWALE	Pre-Development 10 year	10	0.589	12.550	3.57
EXISTING DRAINAGE SWALE	Pre-Development 25 year	25	0.731	12.100	8.69
EXISTING DRAINAGE SWALE	Pre-Development 100 year	100	0.904	12.100	10.62

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 2 years
Storm Event: 2 year

Storm Event	2 year
Return Event	2 years
Duration	24.000 hours
Depth	3.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.440 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	8.44 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	8.44 ft^3/s

Drainage Area	
SCS CN (Composite)	95.140
Area (User Defined)	3.440 acres
Maximum Retention (Pervious)	0.5 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.6 in
Runoff Volume (Pervious)	0.734 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.734 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	46.77 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 10 years
Storm Event: 10 year

Storm Event	10 year
Return Event	10 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.440 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	12.92 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	12.92 ft^3/s

Drainage Area	
SCS CN (Composite)	95.140
Area (User Defined)	3.440 acres
Maximum Retention (Pervious)	0.5 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.0 in
Runoff Volume (Pervious)	1.158 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.157 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	46.77 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 25 years
Storm Event: 25 year

Storm Event	25 year
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.440 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	15.29 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	15.29 ft³/s

Drainage Area	
SCS CN (Composite)	95.140
Area (User Defined)	3.440 acres
Maximum Retention (Pervious)	0.5 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.8 in
Runoff Volume (Pervious)	1.385 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.384 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	46.77 ft³/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 100 years
Storm Event: 100 year

Storm Event	100 year
Return Event	100 years
Duration	24.000 hours
Depth	6.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.440 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	18.24 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	18.24 ft^3/s

Drainage Area	
SCS CN (Composite)	95.140
Area (User Defined)	3.440 acres
Maximum Retention (Pervious)	0.5 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.8 in
Runoff Volume (Pervious)	1.670 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.669 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	46.77 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 2 years
Storm Event: 2 year

Storm Event	2 year
Return Event	2 years
Duration	24.000 hours
Depth	3.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.170 acres

Computational Time Increment	0.111 hours
Time to Peak (Computed)	12.616 hours
Flow (Peak, Computed)	2.09 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.600 hours
Flow (Peak Interpolated Output)	2.09 ft^3/s

Drainage Area	
SCS CN (Composite)	87.935
Area (User Defined)	2.170 acres
Maximum Retention (Pervious)	1.4 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.9 in
Runoff Volume (Pervious)	0.344 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.341 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.111 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.96 ft^3/s
Unit peak time, Tp	0.553 hours
Unit receding limb, Tr	2.213 hours
Total unit time, Tb	2.767 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 10 years
Storm Event: 10 year

Storm Event	10 year
Return Event	10 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.170 acres
Computational Time Increment	0.111 hours
Time to Peak (Computed)	12.505 hours
Flow (Peak, Computed)	3.57 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.550 hours
Flow (Peak Interpolated Output)	3.57 ft³/s
Drainage Area	
SCS CN (Composite)	87.935
Area (User Defined)	2.170 acres
Maximum Retention (Pervious)	1.4 in
Maximum Retention (Pervious, 20 percent)	0.3 in
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.3 in
Runoff Volume (Pervious)	0.594 ac-ft
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.589 ac-ft
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.111 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.96 ft³/s
Unit peak time, Tp	0.553 hours
Unit receding limb, Tr	2.213 hours
Total unit time, Tb	2.767 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 25 years
Storm Event: 25 year

Storm Event	25 year
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.170 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	8.69 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	8.69 ft^3/s

Drainage Area	
SCS CN (Composite)	87.935
Area (User Defined)	2.170 acres
Maximum Retention (Pervious)	1.4 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.0 in
Runoff Volume (Pervious)	0.731 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.731 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	29.50 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 100 years
Storm Event: 100 year

Storm Event	100 year
Return Event	100 years
Duration	24.000 hours
Depth	6.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.170 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	10.62 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	10.62 ft³/s

Drainage Area	
SCS CN (Composite)	87.935
Area (User Defined)	2.170 acres
Maximum Retention (Pervious)	1.4 in
Maximum Retention (Pervious, 20 percent)	0.3 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.0 in
Runoff Volume (Pervious)	0.905 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.904 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	29.50 ft³/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Appendix B Pond Pack Model Calculation (Post-Development Condition)

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
2-8 NYA NORTH	Post-Development 2 YEAR	2	0.616	12.100	7.53
2-8 NYA NORTH	Post-Development 10 YEAR	10	1.040	12.100	12.36
2-8 NYA NORTH	Post-Development 25 YEAR	25	1.271	12.100	14.92
2-8 NYA NORTH	Post-Development 100 YEAR	100	1.564	12.100	18.10
2-8 NYA SOUTH	Post-Development 2 YEAR	2	0.337	12.100	4.12
2-8 NYA SOUTH	Post-Development 10 YEAR	10	0.571	12.100	6.80
2-8 NYA SOUTH	Post-Development 25 YEAR	25	0.699	12.100	8.22
2-8 NYA SOUTH	Post-Development 100 YEAR	100	0.860	12.100	9.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
NEW YORK AVE	Post-Development 2 YEAR	2	0.616	12.100	7.53
NEW YORK AVE	Post-Development 10 YEAR	10	1.040	12.100	12.36
NEW YORK AVE	Post-Development 25 YEAR	25	1.271	12.100	14.92
NEW YORK AVE	Post-Development 100 YEAR	100	1.564	12.100	18.10
EXISTING DRAINAGE SWALE	Post-Development 2 YEAR	2	0.337	12.100	4.12
EXISTING DRAINAGE SWALE	Post-Development 10 YEAR	10	0.571	12.100	6.80
EXISTING DRAINAGE SWALE	Post-Development 25 YEAR	25	0.699	12.100	8.22
EXISTING DRAINAGE SWALE	Post-Development 100 YEAR	100	0.860	12.100	9.99

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 2 years
Storm Event: 2 year

Storm Event	2 year
Return Event	2 years
Duration	24.000 hours
Depth	3.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.610 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	7.53 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	7.53 ft^3/s

Drainage Area	
SCS CN (Composite)	89.690
Area (User Defined)	3.610 acres
Maximum Retention (Pervious)	1.1 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.0 in
Runoff Volume (Pervious)	0.616 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.616 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	49.08 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 10 years
Storm Event: 10 year

Storm Event	10 year
Return Event	10 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.610 acres
Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	12.36 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	12.36 ft^3/s
Drainage Area	
SCS CN (Composite)	89.690
Area (User Defined)	3.610 acres
Maximum Retention (Pervious)	1.1 in
Maximum Retention (Pervious, 20 percent)	0.2 in
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.5 in
Runoff Volume (Pervious)	1.041 ac-ft
Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.040 ac-ft
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	49.08 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 25 years
Storm Event: 25 year

Storm Event	25 year
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.610 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	14.92 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	14.92 ft^3/s

Drainage Area	
SCS CN (Composite)	89.690
Area (User Defined)	3.610 acres
Maximum Retention (Pervious)	1.1 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.2 in
Runoff Volume (Pervious)	1.272 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.271 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	49.08 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA NORTH

Return Event: 100 years
Storm Event: 100 year

Storm Event	100 year
Return Event	100 years
Duration	24.000 hours
Depth	6.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	3.610 acres
Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	18.10 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	18.10 ft³/s
Drainage Area	
SCS CN (Composite)	89.690
Area (User Defined)	3.610 acres
Maximum Retention (Pervious)	1.1 in
Maximum Retention (Pervious, 20 percent)	0.2 in
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.2 in
Runoff Volume (Pervious)	1.565 ac-ft
Hydrograph Volume (Area under Hydrograph curve)	
Volume	1.564 ac-ft
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	49.08 ft³/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 2 years
Storm Event: 2 year

Storm Event	2 year
Return Event	2 years
Duration	24.000 hours
Depth	3.1 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.000 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	4.12 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	4.12 ft^3/s

Drainage Area	
SCS CN (Composite)	89.360
Area (User Defined)	2.000 acres
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.0 in
Runoff Volume (Pervious)	0.337 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.337 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	27.19 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 10 years
Storm Event: 10 year

Storm Event	10 year
Return Event	10 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.000 acres
Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	6.80 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	6.80 ft^3/s
Drainage Area	
SCS CN (Composite)	89.360
Area (User Defined)	2.000 acres
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.4 in
Runoff Volume (Pervious)	0.571 ac-ft
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.571 ac-ft
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	27.19 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 25 years
Storm Event: 25 year

Storm Event	25 year
Return Event	25 years
Duration	24.000 hours
Depth	5.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.000 acres

Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	8.22 ft^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	8.22 ft^3/s

Drainage Area	
SCS CN (Composite)	89.360
Area (User Defined)	2.000 acres
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.2 in
Runoff Volume (Pervious)	0.699 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.699 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	27.19 ft^3/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Subsection: Unit Hydrograph Summary
Label: 2-8 NYA SOUTH

Return Event: 100 years
Storm Event: 100 year

Storm Event	100 year
Return Event	100 years
Duration	24.000 hours
Depth	6.4 in
Time of Concentration (Composite)	0.083 hours
Area (User Defined)	2.000 acres
Computational Time Increment	0.011 hours
Time to Peak (Computed)	12.100 hours
Flow (Peak, Computed)	9.99 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	9.99 ft³/s
Drainage Area	
SCS CN (Composite)	89.360
Area (User Defined)	2.000 acres
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in
Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.2 in
Runoff Volume (Pervious)	0.861 ac-ft
Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.860 ac-ft
SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.083 hours
Computational Time Increment	0.011 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	27.19 ft³/s
Unit peak time, Tp	0.056 hours
Unit receding limb, Tr	0.222 hours
Total unit time, Tb	0.278 hours

Appendix C Storm CAD Model Calculation
Proposed North Pipe Collection System

Calculation Detailed Summary

Element Details			
ID	13	Notes	
Label	Base Calculation Options		

Hydraulic Summary			
Flow Profile Method	Backwater Analysis	Average Velocity Method	Actual Uniform Flow Velocity
Number of Flow Profile Steps	5	Minimum Structure Headloss	0.00 ft
Hydraulic Grade Convergence Test	0.001 ft	Minimum Time of Concentration	5.000 min

Inlets			
Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	True	Active Components for Combination Inlets on Grade	Grate and Curb

HEC-22			
Elevations Considered Equal Within	0.50 ft	Depressed Unsubmerged	1.000
Consider Non-Piped Plunging Flow	False	Half Bench Submerged	0.950
Flat Submerged	1.000	Half Bench Unsubmerged	0.150
Flat Unsubmerged	1.000	Full Bench Submerged	0.750
Depressed Submerged	1.000	Full Bench Unsubmerged	0.070

AASHTO			
Expansion, Ke	0.350	Shaping Adjustment, Cs	0.500
Contraction, Kc	0.250	Non-Piped Flow Adjustment, Cn	1.300

Bend Angle vs. Bend Loss Curve

Bend Angle (degrees)	Bend Loss Coefficient, Kb
0.00	0.000
15.00	0.190
30.00	0.350
45.00	0.470
60.00	0.560
75.00	0.640
90.00	0.700

Calculation Detailed Summary

Generic Structure Loss	
Governing Upstream Pipe Selection Method	Pipe with Maximum QV

Catchment Summary

Label	Area (acres)	Time of Concentration (min)	Rational C	Catchment CA (acres)	Catchment Intensity (in/hr)	Catchment Rational Flow (ft³/s)
AREA 2	0.420	5.000	0.836	0.351	6.000	2.12
AREA 3	0.400	5.000	0.950	0.380	6.000	2.30
AREA 4	0.480	5.000	0.813	0.390	6.000	2.36

Conduit Summary

Label	Conduit Description	Conduit Shape	Branch ID	Subnetwork Outfall	Flow (ft³/s)	Velocity (Average) (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Depth (In) (ft)	Depth (Out) (ft)
CO-16	Circular Pipe - 12.0 in	Circular Pipe	1	OF-2	2.12					
CO-17	Circular Pipe - 15.0 in	Circular Pipe	1	OF-2	2.12					
CO-18	Circular Pipe - 15.0 in	Circular Pipe	1	OF-2	2.10					
CO-19	Circular Pipe - 15.0 in	Circular Pipe	1	OF-2	2.06					
CO-20	Circular Pipe - 18.0 in	Circular Pipe	1	OF-2	4.18					
CO-21	Circular Pipe - 18.0 in	Circular Pipe	1	OF-2	6.22					
CO-22	Circular Pipe - 18.0 in	Circular Pipe	1	OF-2	6.18					
CO-23	Circular Pipe - 12.0 in	Circular Pipe	3	OF-2	2.36					
CO-24	Circular Pipe - 12.0 in	Circular Pipe	2	OF-2	2.30					

Calculation Detailed Summary

Conduit Summary

Velocity (Average) (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Depth (In) (ft)	Depth (Out) (ft)
4.65	216.94	216.78	0.62	0.57
3.17	215.81	215.56	0.67	0.58
3.55	215.49	215.16	0.61	0.67
3.18	215.16	214.99	0.67	0.83
3.70	214.99	214.66	0.93	1.06
4.19	214.66	214.36	1.11	0.96
5.97	214.11	213.97	0.96	0.89
5.51	214.66	214.66	0.82	0.89
5.48	216.60	216.45	0.65	0.57

Node Summary

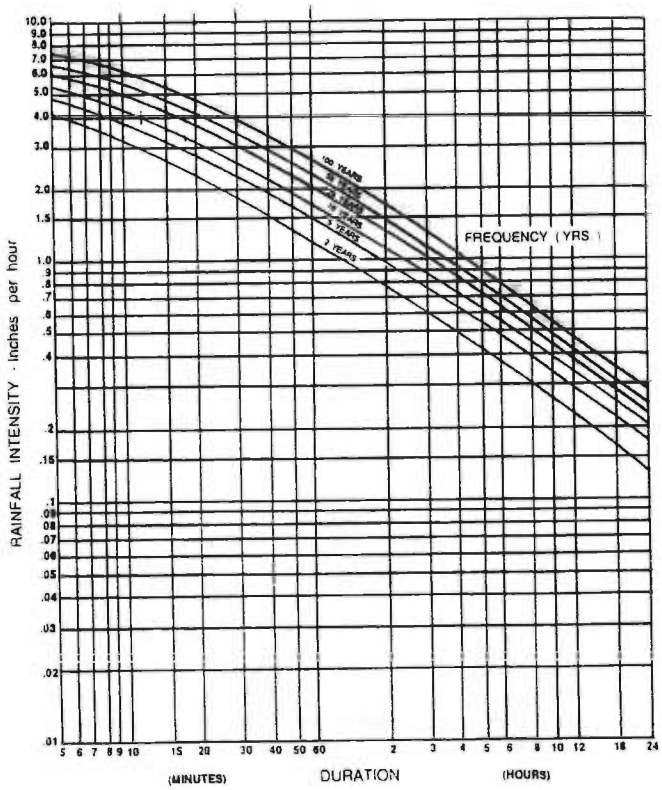
Label	Element Type	Subnetwork Outfall	Flow (Total Surface) (ft^3/s)	Flow (Total Out) (ft^3/s)	Elevation (Ground) (ft)
CB-1	Catch Basin	OF-2	2.30	2.30	220.25
CB-2	Catch Basin	OF-2	2.36	2.36	217.00
td-1	Catch Basin	OF-2	2.12	2.12	217.75
s5	Manhole	OF-2	0.00	2.12	218.00
s4	Manhole	OF-2	0.00	2.10	218.50
s3	Manhole	OF-2	0.00	2.06	222.50
s2	Manhole	OF-2	0.00	4.18	220.25
s1	Manhole	OF-2	0.00	6.22	217.00
MH-6	Manhole	OF-2	0.00	6.18	217.00

Elevation (Invert) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
0.00	216.88	216.88
0.00	214.84	214.84
0.00	217.21	217.21
0.00	215.96	215.96
0.00	215.68	215.68
0.00	215.31	215.31
0.00	215.20	215.20
0.00	214.97	214.97
0.00	214.53	214.53

Appendix D Boston, MA IDF Curve

As indicated by Mass Department of Transportation

Exhibit 8-12
Intensity - Duration - Frequency Curve for Boston, MA



Source. TR55 - Urban Hydrology for Small Wetlands, NRCS

Appendix E

Typical "C" values

As indicated in Massachusetts's Storm Water Management For Construction Activates Manual

Exhibit 8-8
Recommended Runoff Coefficients (C) for Rational Method
(By Overall Character of Area)

Description of Area	Runoff Coefficients
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-Family	0.30 to 0.50
Multi-Family, Detached	0.40 to 0.60
Multi-Family, Attached	0.60 to 0.75
Residential (Suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad Yard	0.20 to 0.35
Unimproved	0.10 to 0.30
Woodland	0.15 to 0.25
Cultivated	0.40 to 0.60

Source: Design Manual for Storm Drainage, ASCE 1960

Exhibit 8-9
Recommended Runoff Coefficients (C) For Rational Method
(For Surface Type)

Character of Surface	Runoff Coefficients
Pavement	
Asphaltic and Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, Sandy Soil	
Flat, 2 Percent	0.05 to 0.10 0.
Average, 2 to 7 Percent	10 to 0.15
Steep, 7 Percent	0.15 to 0.20
Lawns, Heavy Soil	
Flat, 2 Percent	0.13 to 0.17
Average, 2 to 7 Percent	0.18 to 0.22
Steep, 7 Percent	0.25 to 0.35

Source: Design Manual for Storm Drainage, ASCE 1960