

**434 McGrath Highway**  
**Somerville, Massachusetts**  
**August 27, 2014**  
DCI Project No 2013-009

# Stormwater Management Report

Prepared For:  
MBP Realty Trust

**Design Consultants, Inc.**

CIVIL ENGINEERS and LAND SURVEYORS

120 Middlesex Avenue, Suite 20

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*Wayne A. Keefner* 8-27-14



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## **INTRODUCTION**

The following report details the hydrologic study performed by Design Consultants, Inc. (DCI), on behalf of **MBP Realty Trust**, regarding an existing 0.840-acre site located at 434 McGrath Highway in Somerville, Massachusetts. The redevelopment of the site entails the construction of two mixed used buildings, containing a total of 47 residential units and 15,000 square feet (sf) of retail space.

The stormwater drainage system is designed to mitigate the stormwater runoff from the site and to provide a reduction in flows to the combined system. The proposed site will have connections to city water and sanitary sewer. There is no municipal stormwater system in the streets adjacent to the site.

## **EXISTING CONDITION**

The 36,569 sf site is located at the corner of McGrath Highway and Greenville Street. The site is situated on the east side of Prospect Hill. The elevation drop across the site is approximately 19 feet. Concrete walls retain a steeply sloped landscaped area on the west side of the site, creating a level area for a gas station with 8 gas pumps and a market. Impervious areas include the 1,500 sf convenience market and 18,250 sf of pavement, making the site 54% impervious. There is no existing onsite stormwater system. Stormwater sheetflows into McGrath Highway in a single catchment. A plan of existing drainage areas is included as **Appendix A**.

### **Soils**

Site specific soils are unknown at this time. A test pit will be performed to determine subsurface soils and establish mean high groundwater elevation prior to ordering and installation of stormwater management system components. Adjustments to system may be required per test results.

Based on the NRCS Web Soil Survey, this area is identified as Newport-Urban Land complex, which is a hydrologic soil group (HSG) C soil. This soil is generally composed of silt loam, which has an infiltration rate of 0.27 inches per hour, based on Table 2.3.3 1982 Rawls Rates, Volume 3, Chapter 1, page 22 of the Massachusetts Stormwater Handbook. The Web Soil Survey is attached as **Appendix B**.

## **PROPOSED CONDITION**

The proposed redevelopment of the site will entail the construction of two mixed use buildings with a total building footprint of approximately 15,157 sf. There are 11 surface parking spaces proposed with site access provided off McGrath Highway. A new curb cut is proposed for the south side of the site to accommodate a sloped driveway to access below grade parking. Landscape and open space areas are proposed at various locations around the site.

The proposed hydrologic characteristics are similar to the existing conditions. The proposed stormwater system improves on the existing condition by providing rate

mitigation, groundwater recharge, and treatment of runoff from vehicular areas. There remains one design point, which is the gutterline of McGrath Highway that is tributary to the Municipal system. No stormwater connection is proposed, as new connections are not allowed to a combined system in Somerville.

The south building has a flat roof that is utilized for stormwater detention. Controlled release roof drains will limit the discharge rate, allowing stormwater to be temporarily stored and released at a reduced rate. The north building does not have a flat roof, therefore storage is not an option. Stormwater will be allowed to drain, to grade, through downspouts.

Runoff from vehicular areas is collected by trench drains and treated by a particle separator prior to entering an infiltration trench. The infiltration trench is sized to satisfy the MassDEP Standards guideline for increased site imperviousness. Excess runoff will sheetflow out through the center driveway and into McGrath Highway. A plan of proposed drainage areas is attached as **Appendix C**.

Stormwater Management Policy

The project will comply with the City of Somerville’s Storm Water Management Policy.

Hydrologic Calculations

Drainage calculations were conducted to evaluate peak discharges from the project site under the pre-development and post-development conditions and are attached as **Appendix D**. As required under the City’s Stormwater Management Policy, peak discharges under post-development condition will be less than the pre-development conditions. The results of these calculations for the 2, 10, 25 and 100-Year, 24-Hour Storm events are shown in Table 1, below.

Table 1

		McGrath Highway	
		Rate (cfs)	Volume (cf)
2 Year (3.20")	<i>Pre</i>	2.04	6,343
	<b>Post</b>	<b>1.74</b>	<b>6,934</b>
10 Year (4.80")	<i>Pre</i>	3.43	10,912
	<b>Post</b>	<b>2.74</b>	<b>11,580</b>
25 Year (5.50")	<i>Pre</i>	4.04	12,958
	<b>Post</b>	<b>3.17</b>	<b>13,641</b>
100 Year (6.50")	<i>Pre</i>	4.91	15,910
	<b>Post</b>	<b>3.89</b>	<b>16,606</b>

#### 4:1 Infiltration/Inflow Calculation

The Developer must coordinate with the City of Somerville to satisfy the 4:1 I/I policy. The City is in the process of developing a fee for 4:1 I/I mitigation, based on the increased sewage flow from new development. The City has made it clear that the mitigation cannot be achieved through onsite stormwater storage, therefore, coordination between the Developer and City is necessary to determine how the mitigation will be achieved.

The volume required to be removed from the Municipal System, related to this proposed development, has been calculated and is included in this report as **Appendix E**.

#### **CONCLUSION**

The proposed site development incorporates a stormwater collection, storage and treatment system that reduces peak run-off rates, compared to the existing site. The site has been graded to prevent storm runoff from flowing onto abutting private properties. Runoff from all proposed surface parking will be collected and treated.



## **APPENDIX A**

### **EXISTING DRAINAGE AREAS**



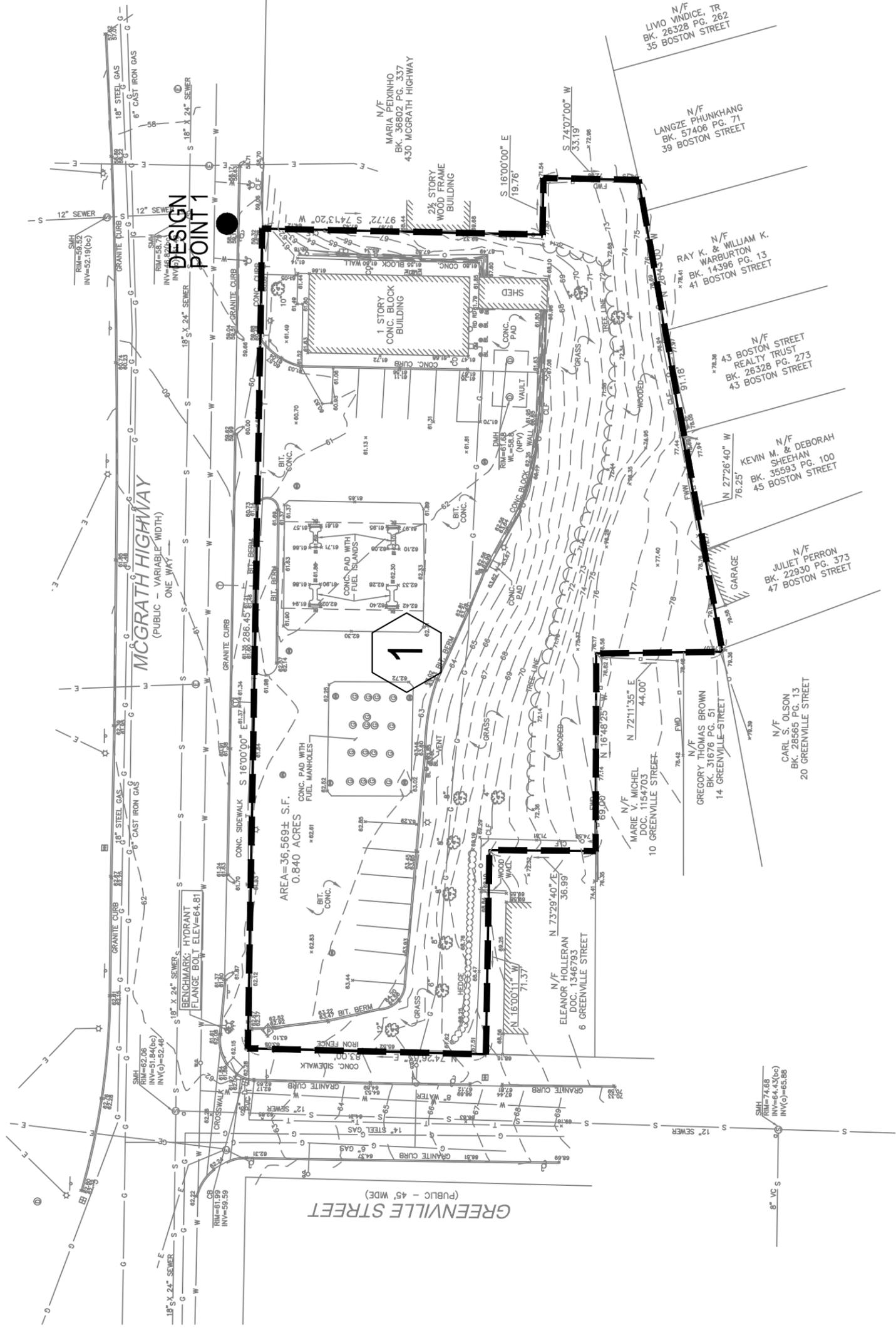
**LEGEND**



SUBCATCHMENT NUMBER



SUBCATCHMENT AREA



**Design Consultants, Inc.**  
 CIVIL ENGINEERS and LAND SURVEYORS  
 120 Middlesex Avenue, Suite 20  
 Somerville, MA 02145  
 617-776-3350p 617-776-7710f

REV. No.	DESCRIPTION	DATE	STAMP

**434 McGRATH HIGHWAY  
 SOMERVILLE, MA**

DATE: 08.27.14  
 SCALE: 1"=40'  
 DR. BY: RB  
 CHK. BY: WK  
 PROJECT No.: 2013-009



**EXISTING  
 CATCHMENT  
 AREAS**

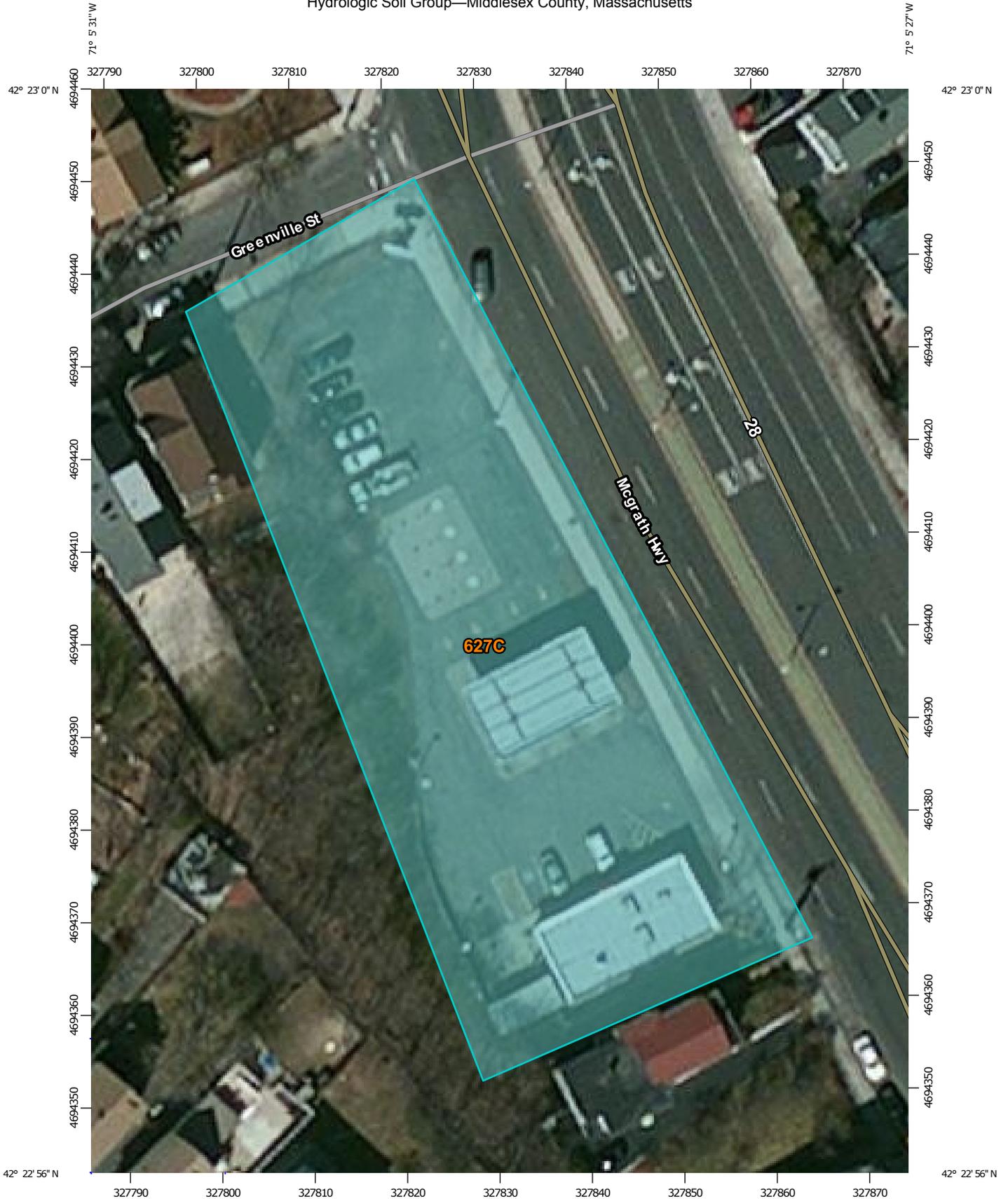


## **APPENDIX B**

### **SOIL INFORMATION**



Hydrologic Soil Group—Middlesex County, Massachusetts



Map Scale: 1:570 if printed on A portrait (8.5" x 11") sheet.

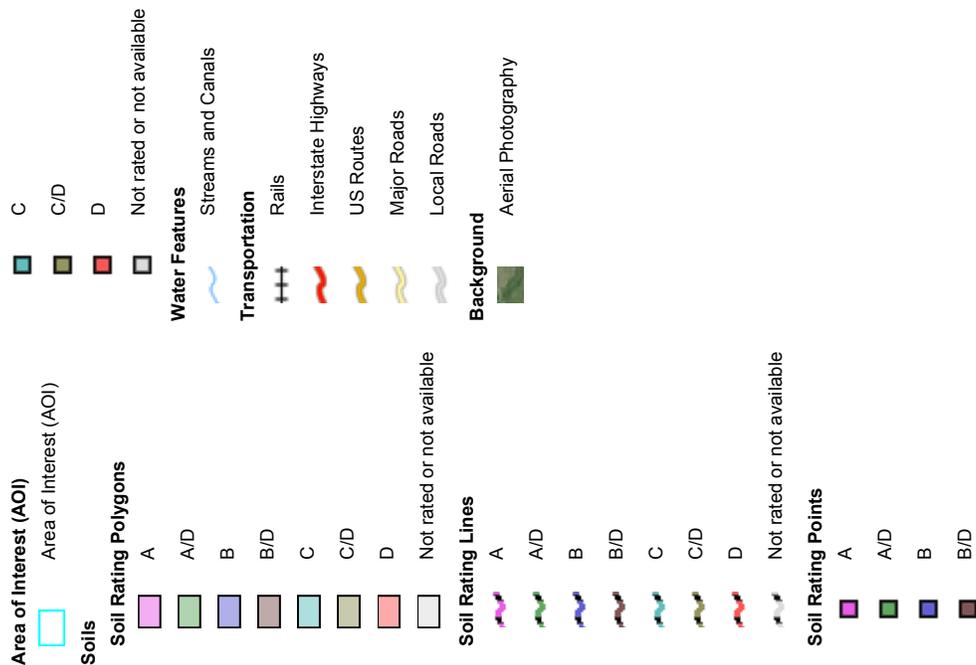
0 5 10 20 30 Meters

0 25 50 100 150 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84



## MAP LEGEND



## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

**Warning:** Soil Map may not be valid at this scale.  
 Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts  
 Survey Area Data: Version 13, Dec 17, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
627C	Newport-Urban land complex, 3 to 15 percent slopes	C	0.8	100.0%
<b>Totals for Area of Interest</b>			<b>0.8</b>	<b>100.0%</b>

### Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

### Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified



## **APPENDIX C**

### **PROPOSED DRAINAGE AREAS**



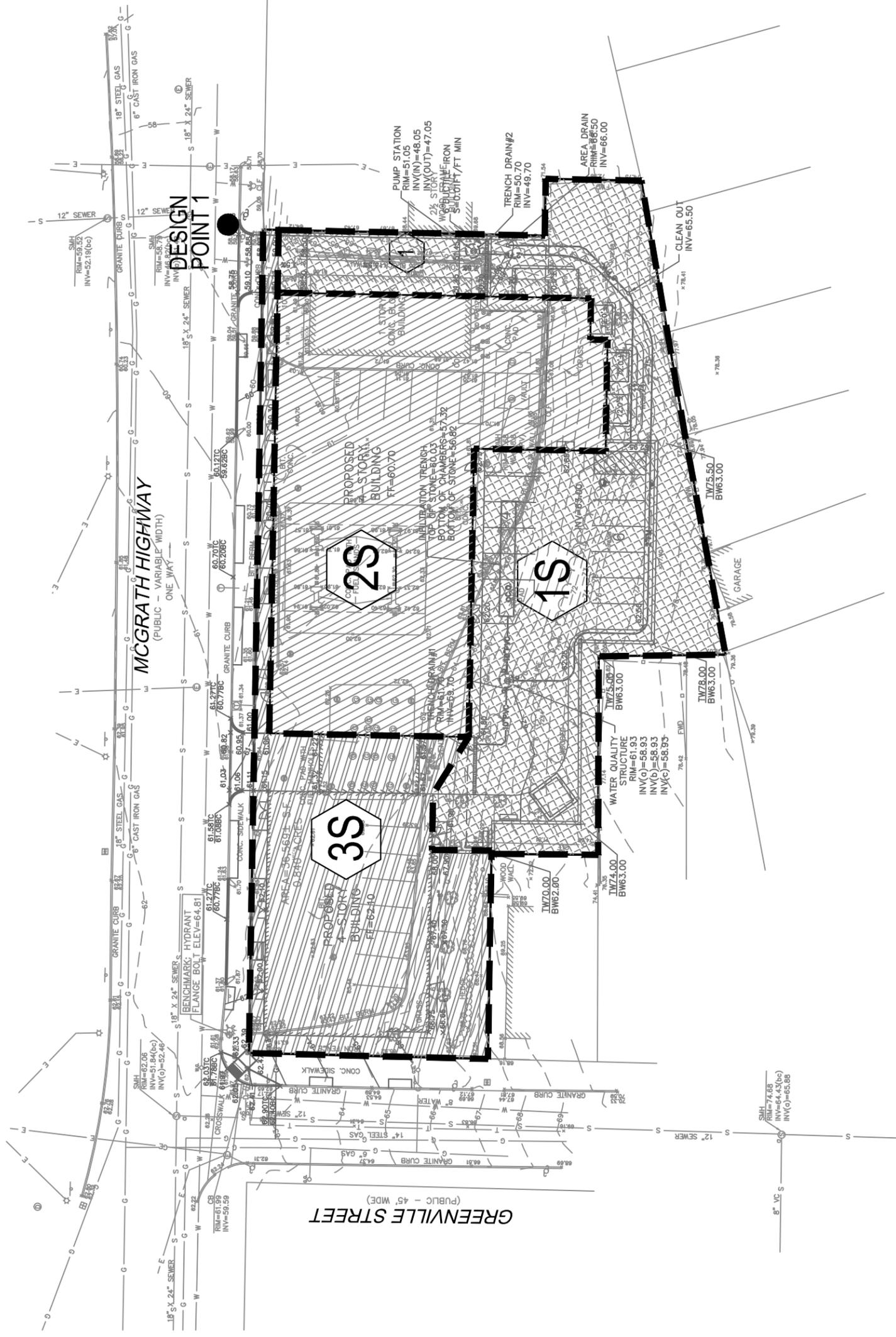
**LEGEND**



SUBCATCHMENT NUMBER  
(CORRESPONDS TO HYDROCAD)



SUBCATCHMENT AREA



**Design Consultants, Inc.**  
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617-776-3350p 617-776-7710f

REV. No.	DESCRIPTION	DATE	STAMP

434 McGRATH HIGHWAY  
SOMERVILLE,, MA

DATE: 07.28.14  
SCALE: 1"=40'  
DR. BY: RB  
CHK. BY: WK  
PROJECT No.: 2013-009



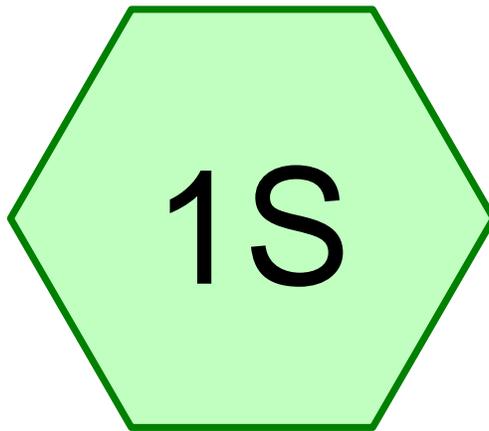
**PROPOSED  
CATCHMENT  
AREAS**



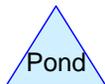
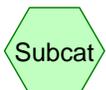
## **APPENDIX D**

### **DRAINAGE CALCULATIONS**





Existing



**Drainage Diagram for 13-009 EXISTING**  
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**13-009 EXISTING**

Prepared by Microsoft

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**Summary for Subcatchment 1S: Existing**

Runoff = 2.04 cfs @ 12.09 hrs, Volume= 6,343 cf, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 2yr Rainfall=3.20"

Area (sf)	CN	Description
19,750	98	Paved parking, HSG C
16,819	79	50-75% Grass cover, Fair, HSG C
36,569	89	Weighted Average
16,819		45.99% Pervious Area
19,750		54.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**13-009 EXISTING**

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**Summary for Subcatchment 1S: Existing**

Runoff = 3.43 cfs @ 12.09 hrs, Volume= 10,912 cf, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.80"

Area (sf)	CN	Description
19,750	98	Paved parking, HSG C
16,819	79	50-75% Grass cover, Fair, HSG C
36,569	89	Weighted Average
16,819		45.99% Pervious Area
19,750		54.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**13-009 EXISTING**

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**Summary for Subcatchment 1S: Existing**

Runoff = 4.04 cfs @ 12.09 hrs, Volume= 12,958 cf, Depth= 4.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25yr Rainfall=5.50"

Area (sf)	CN	Description
19,750	98	Paved parking, HSG C
16,819	79	50-75% Grass cover, Fair, HSG C
36,569	89	Weighted Average
16,819		45.99% Pervious Area
19,750		54.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**13-009 EXISTING**

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**Summary for Subcatchment 1S: Existing**

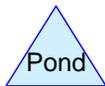
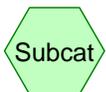
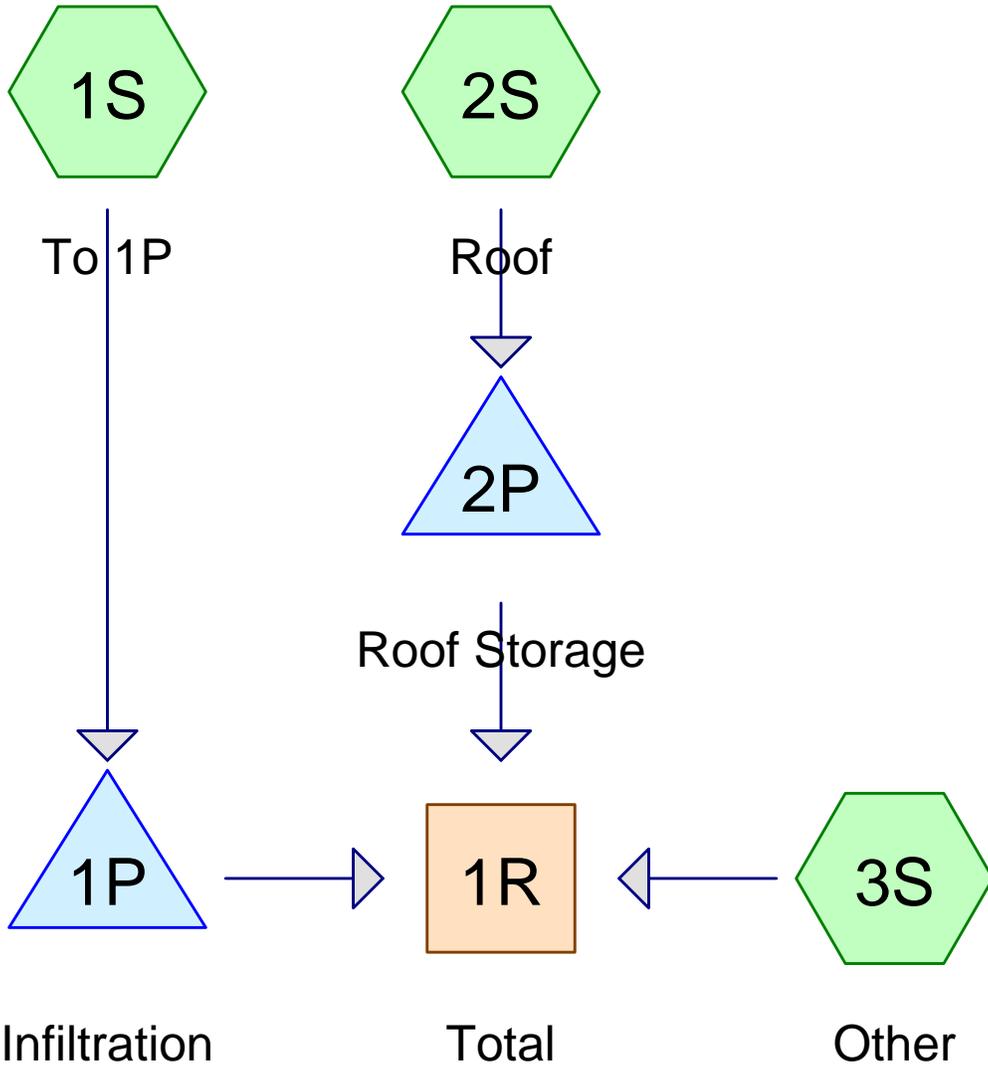
Runoff = 4.91 cfs @ 12.08 hrs, Volume= 15,910 cf, Depth= 5.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100yr Rainfall=6.50"

Area (sf)	CN	Description
19,750	98	Paved parking, HSG C
16,819	79	50-75% Grass cover, Fair, HSG C
36,569	89	Weighted Average
16,819		45.99% Pervious Area
19,750		54.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>





**Drainage Diagram for 13-009 PR**  
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**13-009 PR**

Type III 24-hr 2-Year Rainfall=3.20"

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**Summary for Subcatchment 1S: To 1P**

Runoff = 0.75 cfs @ 12.09 hrs, Volume= 2,339 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
3,679	74	>75% Grass cover, Good, HSG C
6,498	98	Paved parking, HSG C
* 1,500	98	Garage Drive
* 310	98	Patios
2,068	74	>75% Grass cover, Good, HSG C
14,055	88	Weighted Average
5,747		40.89% Pervious Area
8,308		59.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 2S: Roof**

Runoff = 0.92 cfs @ 12.08 hrs, Volume= 3,202 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
12,950	98	Unconnected roofs, HSG C
12,950		100.00% Impervious Area
12,950		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 3S: Other**

Runoff = 0.60 cfs @ 12.09 hrs, Volume= 1,931 cf, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-Year Rainfall=3.20"

**13-009 PR**

Type III 24-hr 2-Year Rainfall=3.20"

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Area (sf)	CN	Description
2,700	98	Paved parking, HSG C
* 4,832	98	North Building
1,940	74	>75% Grass cover, Good, HSG C
9,472	93	Weighted Average
1,940		20.48% Pervious Area
7,532		79.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**Summary for Reach 1R: Total**

Inflow Area = 36,477 sf, 78.93% Impervious, Inflow Depth = 2.28" for 2-Year event  
 Inflow = 1.74 cfs @ 12.11 hrs, Volume= 6,934 cf  
 Outflow = 1.74 cfs @ 12.11 hrs, Volume= 6,934 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

**Summary for Pond 1P: Infiltration**

Inflow Area = 14,055 sf, 59.11% Impervious, Inflow Depth = 2.00" for 2-Year event  
 Inflow = 0.75 cfs @ 12.09 hrs, Volume= 2,339 cf  
 Outflow = 0.72 cfs @ 12.11 hrs, Volume= 2,122 cf, Atten= 4%, Lag= 1.5 min  
 Discarded = 0.01 cfs @ 12.11 hrs, Volume= 322 cf  
 Primary = 0.71 cfs @ 12.11 hrs, Volume= 1,801 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2  
 Peak Elev= 61.75' @ 12.11 hrs Surf.Area= 1,681 sf Storage= 469 cf

Plug-Flow detention time= 287.7 min calculated for 2,122 cf (91% of inflow)  
 Center-of-Mass det. time= 242.3 min ( 1,057.3 - 815.1 )

Volume	Invert	Avail.Storage	Storage Description
#1A	56.82'	164 cf	<b>5.00'W x 39.98'L x 2.71'H Field A</b> 541 cf Overall - 131 cf Embedded = 411 cf x 40.0% Voids
#2A	57.32'	131 cf	<b>Cultec R-180 x 6</b> Inside #1 Effective Size= 33.6"W x 20.0"H => 3.44 sf x 6.33'L = 21.8 cf Overall Size= 36.0"W x 20.5"H x 7.33'L with 1.00' Overlap
#3	53.20'	137 cf	<b>5.00'D x 7.00'H WQS</b> -Impervious
#4	61.70'	150 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		583 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
61.70	4	0	0
61.80	3,000	150	150

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Device	Routing	Invert	Outlet Devices
#1	Discarded	53.20'	<b>0.270 in/hr Exfiltration over Surface area</b>
#2	Primary	61.70'	<b>20.0' long x 2.0' breadth Broad-Crested Rectangular Weir</b>
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
			2.50 3.00 3.50
			Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88
			2.85 3.07 3.20 3.32

**Discarded OutFlow** Max=0.01 cfs @ 12.11 hrs HW=61.75' (Free Discharge)  
 ↑1=Exfiltration (Exfiltration Controls 0.01 cfs)

**Primary OutFlow** Max=0.56 cfs @ 12.11 hrs HW=61.75' (Free Discharge)  
 ↑2=Broad-Crested Rectangular Weir (Weir Controls 0.56 cfs @ 0.56 fps)

**Summary for Pond 2P: Roof Storage**

Inflow Area = 12,950 sf, 100.00% Impervious, Inflow Depth = 2.97" for 2-Year event  
 Inflow = 0.92 cfs @ 12.08 hrs, Volume= 3,202 cf  
 Outflow = 0.50 cfs @ 12.21 hrs, Volume= 3,202 cf, Atten= 46%, Lag= 7.4 min  
 Primary = 0.50 cfs @ 12.21 hrs, Volume= 3,202 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
 Peak Elev= 40.17' @ 12.21 hrs Surf.Area= 4,724 sf Storage= 392 cf

Plug-Flow detention time= 5.0 min calculated for 3,202 cf (100% of inflow)  
 Center-of-Mass det. time= 5.0 min ( 761.4 - 756.4 )

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	3,563 cf	<b>Roof Storage - 6 (Prismatic)</b> Listed below (Recalc) x 6
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	0	0	0
40.50	2,375	594	594

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	<b>Roof Drains X 6.00</b>
			Head (feet) 0.00 0.50
			Disch. (cfs) 0.000 0.250

**Primary OutFlow** Max=0.50 cfs @ 12.21 hrs HW=40.17' (Free Discharge)  
 ↑1=Roof Drains (Custom Controls 0.50 cfs)

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**Summary for Subcatchment 1S: To 1P**

Runoff = 1.29 cfs @ 12.09 hrs, Volume= 4,075 cf, Depth= 3.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
3,679	74	>75% Grass cover, Good, HSG C
6,498	98	Paved parking, HSG C
* 1,500	98	Garage Drive
* 310	98	Patios
2,068	74	>75% Grass cover, Good, HSG C
14,055	88	Weighted Average
5,747		40.89% Pervious Area
8,308		59.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 2S: Roof**

Runoff = 1.40 cfs @ 12.08 hrs, Volume= 4,925 cf, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
12,950	98	Unconnected roofs, HSG C
12,950		100.00% Impervious Area
12,950		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 3S: Other**

Runoff = 0.96 cfs @ 12.08 hrs, Volume= 3,159 cf, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-year Rainfall=4.80"

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Area (sf)	CN	Description
2,700	98	Paved parking, HSG C
* 4,832	98	North Building
1,940	74	>75% Grass cover, Good, HSG C
9,472	93	Weighted Average
1,940		20.48% Pervious Area
7,532		79.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**Summary for Reach 1R: Total**

Inflow Area = 36,477 sf, 78.93% Impervious, Inflow Depth = 3.81" for 10-year event  
 Inflow = 2.74 cfs @ 12.10 hrs, Volume= 11,580 cf  
 Outflow = 2.74 cfs @ 12.10 hrs, Volume= 11,580 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

**Summary for Pond 1P: Infiltration**

Inflow Area = 14,055 sf, 59.11% Impervious, Inflow Depth = 3.48" for 10-year event  
 Inflow = 1.29 cfs @ 12.09 hrs, Volume= 4,075 cf  
 Outflow = 1.23 cfs @ 12.11 hrs, Volume= 3,858 cf, Atten= 4%, Lag= 1.5 min  
 Discarded = 0.02 cfs @ 12.11 hrs, Volume= 361 cf  
 Primary = 1.22 cfs @ 12.11 hrs, Volume= 3,496 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2  
 Peak Elev= 61.78' @ 12.11 hrs Surf.Area= 2,540 sf Storage= 524 cf

Plug-Flow detention time= 171.0 min calculated for 3,857 cf (95% of inflow)  
 Center-of-Mass det. time= 141.9 min ( 941.2 - 799.4 )

Volume	Invert	Avail.Storage	Storage Description
#1A	56.82'	164 cf	<b>5.00'W x 39.98'L x 2.71'H Field A</b> 541 cf Overall - 131 cf Embedded = 411 cf x 40.0% Voids
#2A	57.32'	131 cf	<b>Cultec R-180</b> x 6 Inside #1 Effective Size= 33.6"W x 20.0"H => 3.44 sf x 6.33'L = 21.8 cf Overall Size= 36.0"W x 20.5"H x 7.33'L with 1.00' Overlap
#3	53.20'	137 cf	<b>5.00'D x 7.00'H WQS</b> -Impervious
#4	61.70'	150 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		583 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
61.70	4	0	0
61.80	3,000	150	150

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Device	Routing	Invert	Outlet Devices
#1	Discarded	53.20'	<b>0.270 in/hr Exfiltration over Surface area</b>
#2	Primary	61.70'	<b>20.0' long x 2.0' breadth Broad-Crested Rectangular Weir</b>
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50			
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88			
2.85 3.07 3.20 3.32			

**Discarded OutFlow** Max=0.02 cfs @ 12.11 hrs HW=61.78' (Free Discharge)  
 ↑1=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=1.11 cfs @ 12.11 hrs HW=61.78' (Free Discharge)  
 ↑2=Broad-Crested Rectangular Weir (Weir Controls 1.11 cfs @ 0.71 fps)

**Summary for Pond 2P: Roof Storage**

Inflow Area = 12,950 sf, 100.00% Impervious, Inflow Depth = 4.56" for 10-year event  
 Inflow = 1.40 cfs @ 12.08 hrs, Volume= 4,925 cf  
 Outflow = 0.67 cfs @ 12.24 hrs, Volume= 4,925 cf, Atten= 52%, Lag= 9.1 min  
 Primary = 0.67 cfs @ 12.24 hrs, Volume= 4,925 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
 Peak Elev= 40.22' @ 12.24 hrs Surf.Area= 6,333 sf Storage= 704 cf

Plug-Flow detention time= 6.9 min calculated for 4,924 cf (100% of inflow)  
 Center-of-Mass det. time= 6.9 min ( 755.6 - 748.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	3,563 cf	<b>Roof Storage - 6 (Prismatic)</b> Listed below (Recalc) x 6
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	0	0	0
40.50	2,375	594	594

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	<b>Roof Drains X 6.00</b>
Head (feet) 0.00 0.50			
Disch. (cfs) 0.000 0.250			

**Primary OutFlow** Max=0.67 cfs @ 12.24 hrs HW=40.22' (Free Discharge)  
 ↑1=Roof Drains (Custom Controls 0.67 cfs)

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**Summary for Subcatchment 1S: To 1P**

Runoff = 1.52 cfs @ 12.09 hrs, Volume= 4,856 cf, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-year Rainfall=5.50"

Area (sf)	CN	Description
3,679	74	>75% Grass cover, Good, HSG C
6,498	98	Paved parking, HSG C
* 1,500	98	Garage Drive
* 310	98	Patios
2,068	74	>75% Grass cover, Good, HSG C
14,055	88	Weighted Average
5,747		40.89% Pervious Area
8,308		59.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 2S: Roof**

Runoff = 1.60 cfs @ 12.08 hrs, Volume= 5,679 cf, Depth= 5.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-year Rainfall=5.50"

Area (sf)	CN	Description
12,950	98	Unconnected roofs, HSG C
12,950		100.00% Impervious Area
12,950		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 3S: Other**

Runoff = 1.12 cfs @ 12.08 hrs, Volume= 3,702 cf, Depth= 4.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-year Rainfall=5.50"

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Area (sf)	CN	Description
2,700	98	Paved parking, HSG C
* 4,832	98	North Building
1,940	74	>75% Grass cover, Good, HSG C
9,472	93	Weighted Average
1,940		20.48% Pervious Area
7,532		79.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**Summary for Reach 1R: Total**

Inflow Area = 36,477 sf, 78.93% Impervious, Inflow Depth = 4.49" for 25-year event  
 Inflow = 3.17 cfs @ 12.10 hrs, Volume= 13,641 cf  
 Outflow = 3.17 cfs @ 12.10 hrs, Volume= 13,641 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

**Summary for Pond 1P: Infiltration**

Inflow Area = 14,055 sf, 59.11% Impervious, Inflow Depth = 4.15" for 25-year event  
 Inflow = 1.52 cfs @ 12.09 hrs, Volume= 4,856 cf  
 Outflow = 1.46 cfs @ 12.11 hrs, Volume= 4,638 cf, Atten= 4%, Lag= 1.5 min  
 Discarded = 0.02 cfs @ 12.11 hrs, Volume= 378 cf  
 Primary = 1.44 cfs @ 12.11 hrs, Volume= 4,260 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2  
 Peak Elev= 61.79' @ 12.11 hrs Surf.Area= 2,916 sf Storage= 555 cf

Plug-Flow detention time= 146.4 min calculated for 4,638 cf (96% of inflow)  
 Center-of-Mass det. time= 120.9 min ( 915.4 - 794.5 )

Volume	Invert	Avail.Storage	Storage Description
#1A	56.82'	164 cf	<b>5.00'W x 39.98'L x 2.71'H Field A</b> 541 cf Overall - 131 cf Embedded = 411 cf x 40.0% Voids
#2A	57.32'	131 cf	<b>Cultec R-180 x 6</b> Inside #1 Effective Size= 33.6"W x 20.0"H => 3.44 sf x 6.33'L = 21.8 cf Overall Size= 36.0"W x 20.5"H x 7.33'L with 1.00' Overlap
#3	53.20'	137 cf	<b>5.00'D x 7.00'H WQS</b> -Impervious
#4	61.70'	150 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		583 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
61.70	4	0	0
61.80	3,000	150	150

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Device	Routing	Invert	Outlet Devices
#1	Discarded	53.20'	<b>0.270 in/hr Exfiltration over Surface area</b>
#2	Primary	61.70'	<b>20.0' long x 2.0' breadth Broad-Crested Rectangular Weir</b>
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
			2.50 3.00 3.50
			Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88
			2.85 3.07 3.20 3.32

**Discarded OutFlow** Max=0.02 cfs @ 12.11 hrs HW=61.79' (Free Discharge)  
 ↑1=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=1.38 cfs @ 12.11 hrs HW=61.79' (Free Discharge)  
 ↑2=Broad-Crested Rectangular Weir (Weir Controls 1.38 cfs @ 0.76 fps)

**Summary for Pond 2P: Roof Storage**

Inflow Area = 12,950 sf, 100.00% Impervious, Inflow Depth = 5.26" for 25-year event  
 Inflow = 1.60 cfs @ 12.08 hrs, Volume= 5,679 cf  
 Outflow = 0.73 cfs @ 12.25 hrs, Volume= 5,679 cf, Atten= 54%, Lag= 9.9 min  
 Primary = 0.73 cfs @ 12.25 hrs, Volume= 5,679 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
 Peak Elev= 40.24' @ 12.25 hrs Surf.Area= 6,972 sf Storage= 853 cf

Plug-Flow detention time= 7.7 min calculated for 5,678 cf (100% of inflow)  
 Center-of-Mass det. time= 7.7 min ( 754.2 - 746.5 )

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	3,563 cf	<b>Roof Storage - 6 (Prismatic)</b> Listed below (Recalc) x 6
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	0	0	0
40.50	2,375	594	594

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	<b>Roof Drains X 6.00</b>
			Head (feet) 0.00 0.50
			Disch. (cfs) 0.000 0.250

**Primary OutFlow** Max=0.73 cfs @ 12.25 hrs HW=40.24' (Free Discharge)  
 ↑1=Roof Drains (Custom Controls 0.73 cfs)

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Type III 24-hr 100-year Rainfall=6.50"

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**Summary for Subcatchment 1S: To 1P**

Runoff = 1.86 cfs @ 12.08 hrs, Volume= 5,983 cf, Depth= 5.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-year Rainfall=6.50"

Area (sf)	CN	Description
3,679	74	>75% Grass cover, Good, HSG C
6,498	98	Paved parking, HSG C
* 1,500	98	Garage Drive
* 310	98	Patios
2,068	74	>75% Grass cover, Good, HSG C
14,055	88	Weighted Average
5,747		40.89% Pervious Area
8,308		59.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 2S: Roof**

Runoff = 1.89 cfs @ 12.08 hrs, Volume= 6,757 cf, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-year Rainfall=6.50"

Area (sf)	CN	Description
12,950	98	Unconnected roofs, HSG C
12,950		100.00% Impervious Area
12,950		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

**Summary for Subcatchment 3S: Other**

Runoff = 1.34 cfs @ 12.08 hrs, Volume= 4,481 cf, Depth= 5.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-year Rainfall=6.50"

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Area (sf)	CN	Description
2,700	98	Paved parking, HSG C
* 4,832	98	North Building
1,940	74	>75% Grass cover, Good, HSG C
9,472	93	Weighted Average
1,940		20.48% Pervious Area
7,532		79.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					<b>Direct Entry,</b>

**Summary for Reach 1R: Total**

Inflow Area = 36,477 sf, 78.93% Impervious, Inflow Depth = 5.46" for 100-year event  
 Inflow = 3.89 cfs @ 12.09 hrs, Volume= 16,606 cf  
 Outflow = 3.89 cfs @ 12.09 hrs, Volume= 16,606 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

**Summary for Pond 1P: Infiltration**

Inflow Area = 14,055 sf, 59.11% Impervious, Inflow Depth = 5.11" for 100-year event  
 Inflow = 1.86 cfs @ 12.08 hrs, Volume= 5,983 cf  
 Outflow = 1.91 cfs @ 12.08 hrs, Volume= 5,769 cf, Atten= 0%, Lag= 0.0 min  
 Discarded = 0.02 cfs @ 12.08 hrs, Volume= 401 cf  
 Primary = 1.89 cfs @ 12.08 hrs, Volume= 5,368 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2  
 Peak Elev= 61.81' @ 12.08 hrs Surf.Area= 3,200 sf Storage= 583 cf

Plug-Flow detention time= 121.2 min calculated for 5,769 cf (96% of inflow)  
 Center-of-Mass det. time= 100.2 min ( 888.9 - 788.8 )

Volume	Invert	Avail.Storage	Storage Description
#1A	56.82'	164 cf	<b>5.00'W x 39.98'L x 2.71'H Field A</b> 541 cf Overall - 131 cf Embedded = 411 cf x 40.0% Voids
#2A	57.32'	131 cf	<b>Cultec R-180 x 6</b> Inside #1 Effective Size= 33.6"W x 20.0"H => 3.44 sf x 6.33'L = 21.8 cf Overall Size= 36.0"W x 20.5"H x 7.33'L with 1.00' Overlap
#3	53.20'	137 cf	<b>5.00'D x 7.00'H WQS</b> -Impervious
#4	61.70'	150 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		583 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
61.70	4	0	0
61.80	3,000	150	150

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Type III 24-hr 100-year Rainfall=6.50"

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Device	Routing	Invert	Outlet Devices
#1	Discarded	53.20'	<b>0.270 in/hr Exfiltration over Surface area</b>
#2	Primary	61.70'	<b>20.0' long x 2.0' breadth Broad-Crested Rectangular Weir</b>
Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00			
2.50 3.00 3.50			
Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88			
2.85 3.07 3.20 3.32			

**Discarded OutFlow** Max=0.02 cfs @ 12.08 hrs HW=61.81' (Free Discharge)  
 ↳1=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=1.82 cfs @ 12.08 hrs HW=61.81' (Free Discharge)  
 ↳2=Broad-Crested Rectangular Weir (Weir Controls 1.82 cfs @ 0.84 fps)

**Summary for Pond 2P: Roof Storage**

Inflow Area = 12,950 sf, 100.00% Impervious, Inflow Depth = 6.26" for 100-year event  
 Inflow = 1.89 cfs @ 12.08 hrs, Volume= 6,757 cf  
 Outflow = 0.82 cfs @ 12.26 hrs, Volume= 6,757 cf, Atten= 56%, Lag= 10.9 min  
 Primary = 0.82 cfs @ 12.26 hrs, Volume= 6,757 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs  
 Peak Elev= 40.27' @ 12.26 hrs Surf.Area= 7,834 sf Storage= 1,077 cf

Plug-Flow detention time= 8.8 min calculated for 6,756 cf (100% of inflow)  
 Center-of-Mass det. time= 8.8 min ( 752.7 - 744.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	3,563 cf	<b>Roof Storage - 6 (Prismatic)</b> Listed below (Recalc) x 6
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	0	0	0
40.50	2,375	594	594

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	<b>Roof Drains X 6.00</b>
Head (feet) 0.00 0.50			
Disch. (cfs) 0.000 0.250			

**Primary OutFlow** Max=0.82 cfs @ 12.26 hrs HW=40.27' (Free Discharge)  
 ↳1=Roof Drains (Custom Controls 0.82 cfs)



## **APPENDIX E**

### **SANITARY SEWER CALCULATIONS & 4:1 I/I CALCULATIONS**



**I. INTRODUCTION**

The following sewerage calculations are based upon 310 CMR 15.203, 314 CMR 7.15 and architectural floor plans provided by KDI.

**II. CALCULATIONS**

Number of Bedrooms	81
Retail Space	14,975
Average Daily Flow: 110 gal/day/bedroom; 50 gal/day/1,000sf Retail	8,910 gpd 300 gpd
<b>Total</b>	<b>9,210 gpd</b>
Peaking Factor	5.5
Total Peak Flow	35.2 gal/min
Slope	0.020
Pipe Size	6"

**III. DESIGN**

PVC pipe (Manning's roughness coefficient = 0.011) at the calculated slope and diameter is adequate for flows of 385 gal/min and less.

**IV. CONCLUSION**

Six-inch (6") PVC, SDR 35, ASTM D3034 is proposed for the sewer line.

## INFILTRATION/INFLOW REMOVAL CALCULATIONS

### I. INTRODUCTION

The following infiltration/inflow removal calculations are based upon 310 CMR 15.203, the sewer calculations presented above, and the storm drainage calculations summarized in Table I. The City of Somerville requires that, for qualifying projects, infiltration/inflow removal of four times the proposed additional average daily sewer flow must be provided by the project.

### II. CALCULATIONS

Existing Average Daily Sewer Flow Service Station: 75gpd/island (8)	600 gpd
Proposed Average Daily Sewer Flow (Residential & Retail)	9,210 gpd
Increased Average Daily Flow	8,610 gpd
Four Times Additional Average Daily Flow	34,440 gpd

### III. REMOVAL

The Developer must coordinate with the City of Somerville to satisfy the 4:1 I/I policy. This can be achieved in two ways:

- Undertaking a project in the City, at the expense of the developer, to repair a portion of the sewer system where I/I is equal to the volume of I/I that must be removed under our Stormwater Policy; or
- Write a check to the City equal to the cost of removing the volume of I/I from the sewer system.

## **APPENDIX F**

### **DOMESTIC WATER DEMAND CALCULATIONS AND PIPE SIZING**



