STORMWATER DRAINAGE REPORT

THE CROSSINGS AT FOSTER STREET

ASSESSORS MAP R11 PARCEL 3
245 FOSTER STREET
LITTLETON, MA

March 24, 2018

Prepared for:
GS HOLDINGS
256 GREAT ROAD SUITE 11
LITTLETON, MASSACHUSETTS

Prepared by:
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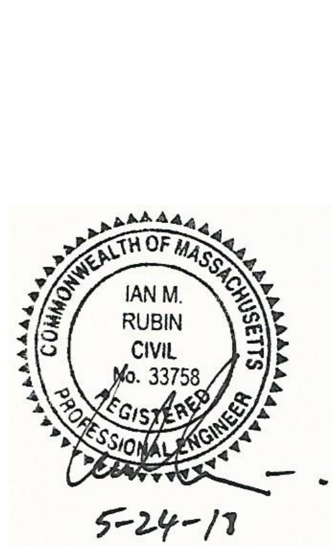

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1. DRAINAGE REPORT

1.1 Introduction

The purpose of these calculations is to show that with development there is no increase in peak flow of runoff when comparing pre- vs. post-development conditions.

1.2 Site Description

The parcel of land is an undeveloped lot on Foster Street. The land is covered with brush and scattered trees with a large portion of wetlands through the center of the land. An existing bridge connects one upland portion to the other.

Upland soils are all C-soils; wetlands are treated as D-soils.

1.3 Comparison of Pre- and Post-Development Areas

In the calculations, only land outside of the wetlands and on the lot is analyzed. See drainage sketches for subcatchment areas.

On the site for land analyzed, comparing pre-development to post-development, here are the areas in percentages:

Current Conditions

Woods/Brush	74.9%
Wetlands	25.1%

(Note: Wetlands in the calculations pertain to both jurisdictional and non-jurisdictional wetlands.)

Proposed Conditions

Woods/Brush	37.7%
Wetlands	25.5%
Buildings	2.9%
Standard Pavement	9.2%

Porous Pavement	7.0%
Lawn/Gardens	17.7%

1.4 Methods of Calculations

Calculations are based upon standard methodologies set forth in U.S. Soil Conservation Service TR-55 and TR-20 and performed by *HydroCAD Software*. More specifically, the rainfall is based upon a design storm in 24 hours, and a Type III Rainfall. The size of storm is as follows:

Storm Event	24-hr Precipitation
100-yr	6.5”
10-yr	4.6”
2-yr	3.0”

As in standard practice, the Antecedent Moisture Content (AMC) is assumed normal in the calculations, that being AMC 2.

Formulae Used:

Unconnected Impervious Surfaces. If runoff from an impervious surface occurs as sheet flow over an adjacent pervious area, the impervious area is considered as *unconnected*, and its runoff may be reduced as it flows over the pervious surface. This effect is considered to be significant only if less than 30% of the subcatchment is impervious. When these conditions are met, the runoff is reduced by using a modified curve number weighting procedure (see TR-55):

$$CN_C = (CN_{Per}(A_{Per} + A_{Unc}/2) + CN_{Imp}(A_{Imp} - A_{Unc}/2))/A_{Total}$$

where:

CN_C = Composite CN for total area
CN_{Per} = Composite CN for all pervious surfaces
CN_{Imp} = Composite CN for impervious surfaces (typically 98)
A_{Total} = Total Area
A_{Imp} = Total Impervious Area
A_{Unc} = Unconnected Impervious Area
A_{Per} = Total Pervious Area

Time of Concentration, $\mathbf{T_c}$, is calculated by summing different travel times, T_t, for each consecutive different type of flow from runoff. The types of flow in the design considered are as follows:
TR-55 Sheet Flow,

$$T_t = 0.007(nL)^{0.8} /(P_2^{0.5}.s^{0.4})$$

where:

T_t =Travel time [hours]
n = Manning's coefficient for sheet flow (See table)
L = Flow length [feet]
P_2 = 2-year, 24-hour rainfall [inches]
S = Land slope (along flow path) [ft/ft]

TR-55 Shallow Concentrated Flow,
$T_t = L/V$ and $V = K_v.S^{1/2}$

where:
V = Average velocity
K_v = Velocity factor
S = Land slope (along flow path) [rise/run]

and Channel Flow which is calculated using Manning's Equation.

The minimum Time of Concentration for a subcatchment is taken as 0.1 hrs as defined in TR-55.

The **amount of runoff** for a given storm event is determined by the SCS Runoff Equation is:

$Q = (P-0.2S)^2/(P+0.8S)$ and $S = 1000/CN – 10$,

where:
Q = Precipitation excess (runoff) [inches or mm]
P = Cumulative precipitation [inches or mm]
S = Potential maximum retention [inches]
CN = Curve number (TR-55)

1.5 Drainage Subcatchment Areas

In the predevelopment conditions, the land is divided into two sections, two design points. It's the same for the post-development conditions except one subcatchment area is divided into many smaller subcatchment areas.

In post-development conditions, two infiltration basins are proposed as a means to control some of the runoff. The runoff from the office building is directed towards infiltration beds with Cultec Chambers. One parking lot, the furthest parking lot, is designed with porous pavement. All of these sections go towards Design Point 1.

Design Point 2 in post-development conditions receives runoff from essentially the same catchment area except the area is slightly less. Some of this land though is used for the septic system and is finished with grass as opposed to brush as in existing conditions.

Predevelopment Conditions

	Sub 1		Sub 2	
	Area(S.F.)	CN	Area(S.F.)	CN
Brush	356377	65	307246	65
Wetlands	222909	83	0	83
Total	579286	72	307246	65

Post-development Conditions

	Sub 1		Sub 2		Sub 3		Sub 5	
	Area(S.F.)	CN	Area(S.F.)	CN	Area(S.F.)	CN	Area(S.F.)	CN
Brush	105424	65	38789	65	165157	65	17644	65
Wetlands	192767	83	33301	83	0	83	0	83
Building	0	98	0	98	0	98	0	98
Pavement	0	98	0	98	0	98	19078	98
Grass	0	74	0	74	52000	74	38441	74
Total	298191	77	72090	73	217157	67	75163	78

	Sub 6		Sub 7		Sub 8	
	Area(S.F.)	CN	Area(S.F.)	CN	Area(S.F.)	CN
Building	0	98	0	98	0	98
Pavement	11215	98	15707	98	35486	98
Grass	12320	74	7774	74	47245	74
Total	23535	85	23481	90	82731	84

	Sub 9		Sub 10	
	Area(S.F.)	CN	Area(S.F.)	CN
Building	25283	98	0	98
Pavement	0	98	251	98
Grass	0	74	6558	74
Total	25283	98	6809	75

1.6 Runoff Tabulated Results

The tables below show the pre-development versus post-development results from the calculations in *HydroCAD*, for a 72-hour time span.

	PRE		POST	
	1	2	1	2
	Flow (cfs)	Flow (cfs)	Flow (cfs)	Flow (cfs)
2	8.26	2.22	7.397	2.04
10	21.09	7.79	18.74	6.40
100	38.67	16.10	38.23	12.73

1.7 Conclusion

By comparing the existing versus proposed results above, all post-development results are equal to or lower than pre-development results.

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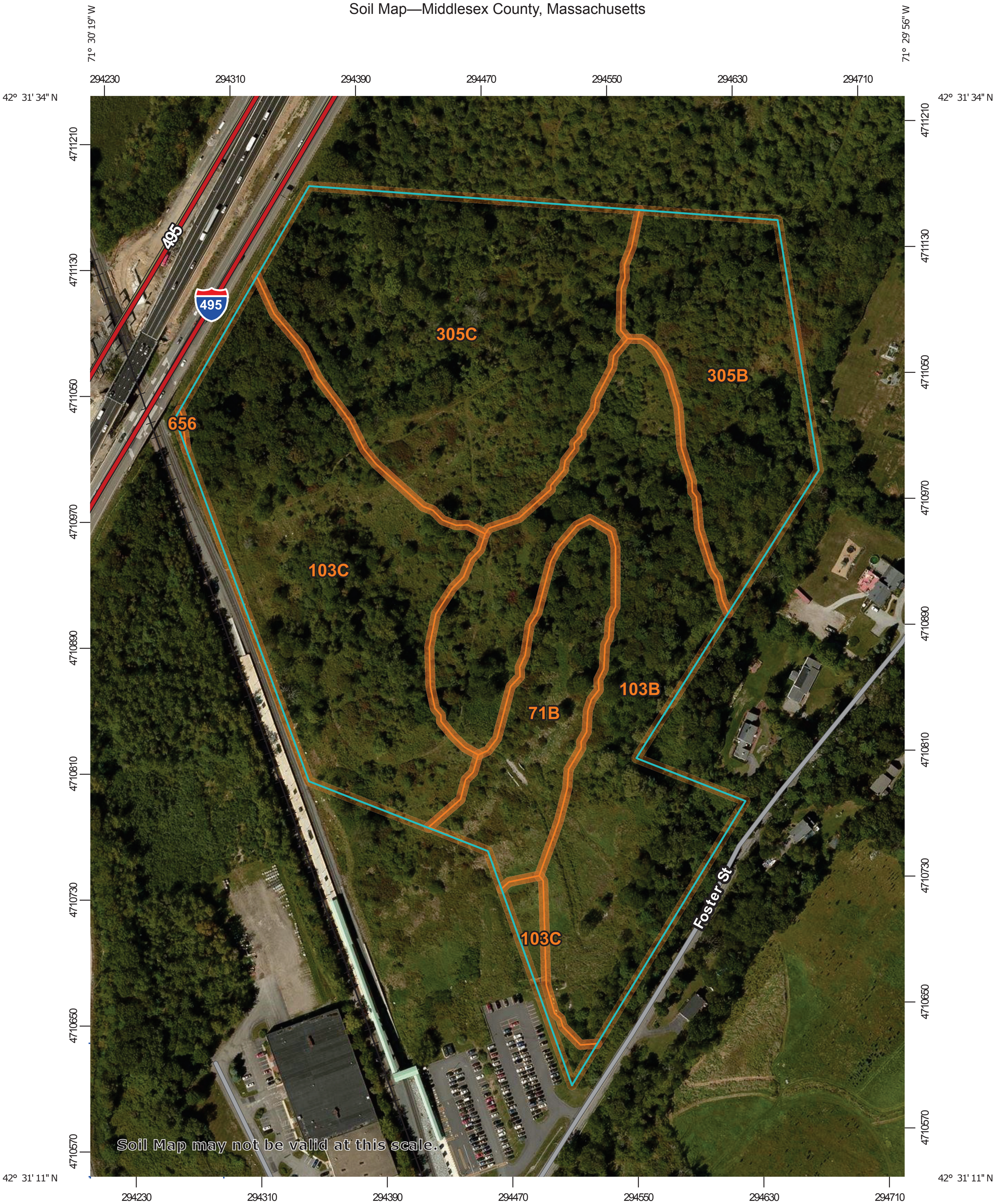
APPENDIX 2.1
NRCS SOIL MAP



Map Scale: 1:3,350 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

N

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

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:
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 17, Oct 6, 2017

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	2.9	8.3%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	9.3	26.7%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	9.0	25.6%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	4.7	13.6%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	9.0	25.8%
656	Udorthents-Urban land complex	0.0	0.0%
Totals for Area of Interest		**35.0**	**100.0%**

APPENDIX 2.2
DRAINAGE CALCULATIONS

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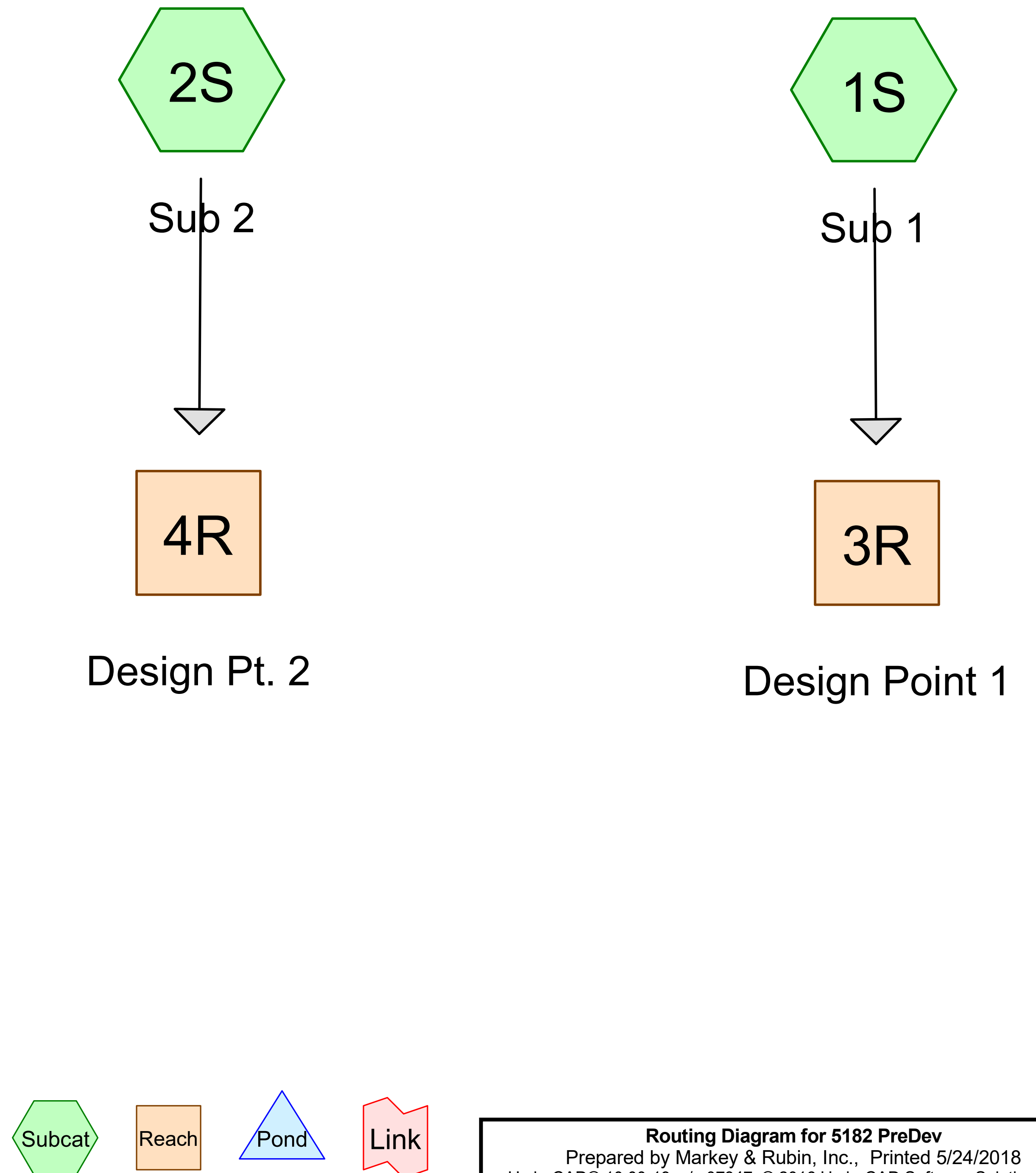


Routing Diagram for 5182 PreDev
Prepared by Markey & Rubin, Inc., Printed 5/24/2018
HydroCAD® 10.00-19 s/n 07347 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Sub 1

Runoff = 38.67 cfs @ 12.23 hrs, Volume= 3.500 af, Depth> 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=6.50"

	Area (sf)	CN	Description
	356,377	65	Brush, Good, HSG C
*	222,909	83	Wetlands (Brush)
	579,286	72	Weighted Average
	579,286		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
2.7	685	0.0710	4.29		**Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps
16.2	735	Total			

Summary for Subcatchment 2S: Sub 2

Runoff = 16.10 cfs @ 12.23 hrs, Volume= 1.469 af, Depth> 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=6.50"

Area (sf)	CN	Description
307,246	65	Brush, Good, HSG C
307,246		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
2.7	685	0.0710	4.29		**Shallow Concentrated Flow, Shallow Conc.** Unpaved Kv= 16.1 fps
16.2	735	Total			

Summary for Reach 3R: Design Point 1

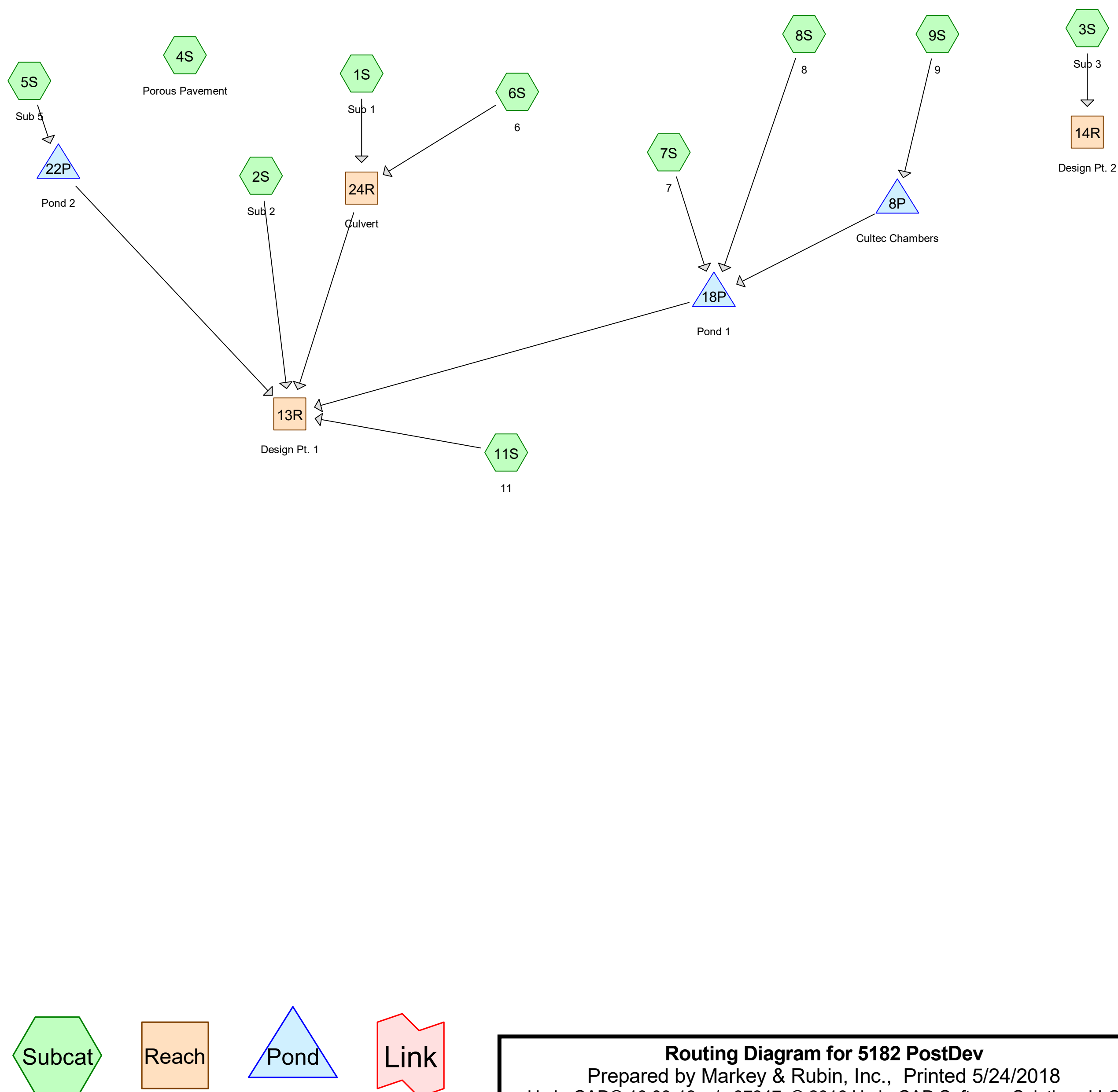
Inflow Area = 13.299 ac, 0.00% Impervious, Inflow Depth > 3.16" for 100-yr event
Inflow = 38.67 cfs @ 12.23 hrs, Volume= 3.500 af
Outflow = 38.67 cfs @ 12.23 hrs, Volume= 3.500 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach 4R: Design Pt. 2

Inflow Area =	7.053 ac,	0.00% Impervious,	Inflow Depth > 2.50"	for 100-yr event
Inflow =	16.10 cfs @	12.23 hrs, Volume=	1.469 af	
Outflow =	16.10 cfs @	12.23 hrs, Volume=	1.469 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs



Routing Diagram for 5182 PostDev
Prepared by Markey & Rubin, Inc., Printed 5/24/2018
HydroCAD® 10.00-19 s/n 07347 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Sub 1

Runoff = 6.07 cfs @ 12.23 hrs, Volume= 0.611 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
	105,424	65	Brush, Good, HSG C
*	186,449	83	
*	6,318	83	
	298,191	77	Weighted Average
	298,191		100.00% Pervious Area

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

Summary for Subcatchment 2S: Sub 2

Runoff = 1.36 cfs @ 12.14 hrs, Volume= 0.118 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

Area (sf)	CN	Description
38,789	65	Brush, Good, HSG C
33,301	83	Brush, Poor, HSG D
72,090	73	Weighted Average
72,090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0600	0.10		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.00"
1.0	200	0.0400	3.22		**Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps
9.2	250	Total			

Summary for Subcatchment 3S: Sub 3

Runoff = 2.04 cfs @ 12.25 hrs, Volume= 0.243 af, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

Area (sf)	CN	Description
165,157	65	Brush, Good, HSG C
52,000	74	>75% Grass cover, Good, HSG C
217,157	67	Weighted Average
217,157		100.00% Pervious Area

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

Summary for Subcatchment 4S: Porous Pavement

Runoff = 5.05 cfs @ 12.00 hrs, Volume= 0.328 af, Depth= 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	62,017	98	Paved
	62,017		100.00% Impervious Area

Summary for Subcatchment 5S: Sub 5

Runoff = 1.84 cfs @ 12.10 hrs, Volume= 0.138 af, Depth= 0.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

Area (sf)	CN	Adj	Description
17,644	65		Brush, Good, HSG C
38,441	74		>75% Grass cover, Good, HSG C
19,078	98		Unconnected roofs, HSG C
75,163	78	75	Weighted Average, UI Adjusted
56,085			74.62% Pervious Area
19,078			25.38% Impervious Area
19,078			100.00% Unconnected

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

Summary for Subcatchment 6S: 6

Runoff = 1.01 cfs @ 12.09 hrs, Volume= 0.072 af, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	11,215	98	Paved
*	12,320	74	Grass
	23,535	85	Weighted Average
	12,320		52.35% Pervious Area
	11,215		47.65% Impervious Area

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

Summary for Subcatchment 7S: 7

Runoff = 1.24 cfs @ 12.09 hrs, Volume= 0.089 af, Depth= 1.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	15,707	98	Paved
*	7,774	74	Grass
	23,481	90	Weighted Average
	7,774		33.11% Pervious Area
	15,707		66.89% Impervious Area

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

Summary for Subcatchment 8S: 8

Runoff = 3.14 cfs @ 12.12 hrs, Volume= 0.240 af, Depth= 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	35,486	98	Paved
*	47,245	74	
	82,731	84	Weighted Average
	47,245		57.11% Pervious Area
	35,486		42.89% Impervious Area

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

Summary for Subcatchment 9S: 9

Runoff = 1.69 cfs @ 12.08 hrs, Volume= 0.134 af, Depth= 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	25,283	98	Building
	25,283		100.00% Impervious Area

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

Summary for Subcatchment 11S: 11

Runoff = 0.14 cfs @ 12.18 hrs, Volume= 0.013 af, Depth= 0.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.00"

	Area (sf)	CN	Description
*	251	98	Paved
*	6,558	74	Grass
	6,809	75	Weighted Average
	6,558		96.31% Pervious Area
	251		3.69% Impervious Area

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

Summary for Reach 13R: Design Pt. 1

Inflow Area = 13.941 ac, 17.62% Impervious, Inflow Depth = 0.87" for 2-yr event
Inflow = 7.97 cfs @ 12.22 hrs, Volume= 1.006 af
Outflow = 7.97 cfs @ 12.22 hrs, Volume= 1.006 af, 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 Reach 14R: Design Pt. 2

Inflow Area = 4.985 ac, 0.00% Impervious, Inflow Depth = 0.58" for 2-yr event
Inflow = 2.04 cfs @ 12.25 hrs, Volume= 0.243 af
Outflow = 2.04 cfs @ 12.25 hrs, Volume= 0.243 af, 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 Reach 24R: Culvert

Inflow Area = 7.386 ac, 3.49% Impervious, Inflow Depth = 1.11" for 2-yr event
Inflow = 6.61 cfs @ 12.22 hrs, Volume= 0.682 af
Outflow = 6.61 cfs @ 12.23 hrs, Volume= 0.682 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.36 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 0.4 min

Peak Storage= 46 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 74.67 cfs

4.00' x 2.00' deep channel, n= 0.013
Length= 30.0' Slope= 0.0067 '/'
Inlet Invert= 262.70', Outlet Invert= 262.50'

Summary for Pond 8P: Cultec Chambers

Inflow Area = 0.580 ac,100.00% Impervious, Inflow Depth = 2.77" for 2-yr event
Inflow = 1.69 cfs @ 12.08 hrs, Volume= 0.134 af
Outflow = 0.10 cfs @ 13.70 hrs, Volume= 0.134 af, Atten= 94%, Lag= 96.7 min
Discarded = 0.02 cfs @ 6.61 hrs, Volume= 0.110 af
Primary = 0.08 cfs @ 13.70 hrs, Volume= 0.024 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 270.94' @ 13.70 hrs Surf.Area= 3,375 sf Storage= 3,576 cf

Plug-Flow detention time= 1,171.7 min calculated for 0.134 af (100% of inflow)
Center-of-Mass det. time= 1,171.9 min (1,929.7 - 757.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	269.29'	2,433 cf	**45.00'W x 75.00'L x 2.54'H Field A** 8,578 cf Overall - 2,497 cf Embedded = 6,081 cf x 40.0% Voids
#2A	269.79'	2,497 cf	**Cultec R-150XLHD** x 91 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 13 rows
		4,929 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	269.29'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	270.80'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.02 cfs @ 6.61 hrs HW=269.32' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.08 cfs @ 13.70 hrs HW=270.94' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.26 fps)

Summary for Pond 18P: Pond 1

Inflow Area = 3.019 ac, 58.16% Impervious, Inflow Depth = 1.40" for 2-yr event
Inflow = 4.34 cfs @ 12.11 hrs, Volume= 0.353 af
Outflow = 0.54 cfs @ 12.97 hrs, Volume= 0.353 af, Atten= 88%, Lag= 51.7 min
Discarded = 0.05 cfs @ 12.97 hrs, Volume= 0.160 af
Primary = 0.49 cfs @ 12.97 hrs, Volume= 0.193 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 265.91' @ 12.97 hrs Surf.Area= 8,474 sf Storage= 7,052 cf

Plug-Flow detention time= 480.5 min calculated for 0.353 af (100% of inflow)
Center-of-Mass det. time= 480.5 min (1,314.7 - 834.2)

Volume	Invert	Avail.Storage	Storage Description
#1	265.00'	28,345 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
265.00	7,066	0	0
266.00	8,617	7,842	7,842
268.00	11,886	20,503	28,345

Device	Routing	Invert	Outlet Devices
#1	Discarded	265.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	266.50'	**4.5' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	265.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.05 cfs @ 12.97 hrs HW=265.91' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.49 cfs @ 12.97 hrs HW=265.91' (Free Discharge)
├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**3=Orifice/Grate** (Orifice Controls 0.49 cfs @ 2.17 fps)

Summary for Pond 22P: Pond 2

Inflow Area =	1.726 ac,	25.38% Impervious,	Inflow Depth = 0.96"	for 2-yr event
Inflow =	1.84 cfs @	12.10 hrs, Volume=	0.138 af	
Outflow =	0.03 cfs @	24.02 hrs, Volume=	0.123 af,	Atten= 98%, Lag= 715.3 min
Discarded =	0.03 cfs @	24.02 hrs, Volume=	0.123 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 262.37' @ 24.02 hrs Surf.Area= 4,660 sf Storage= 4,760 cf

Plug-Flow detention time= 1,545.3 min calculated for 0.123 af (89% of inflow)
Center-of-Mass det. time= 1,493.4 min (2,356.2 - 862.8)

Volume	Invert	Avail.Storage	Storage Description
#1	261.00'	28,122 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

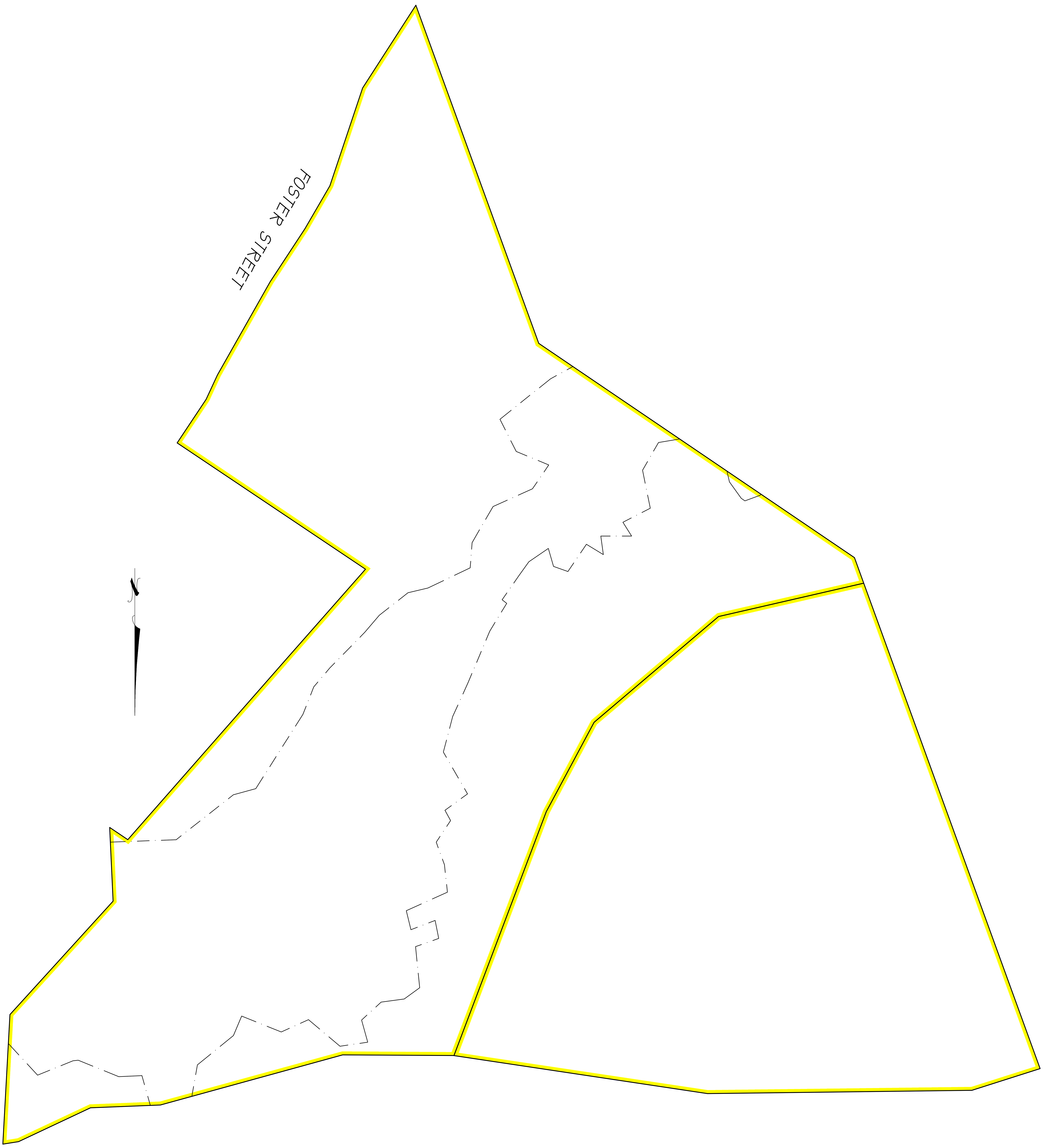
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
261.00	1,903	0	0
262.00	4,313	3,108	3,108
264.00	6,197	10,510	13,618
266.00	8,307	14,504	28,122

Device	Routing	Invert	Outlet Devices
#1	Discarded	261.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	264.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	262.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.03 cfs @ 24.02 hrs HW=262.37' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=261.00' (Free Discharge)
├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**3=Orifice/Grate** (Controls 0.00 cfs)

APPENDIX 2.3
DRAINAGE SKETCHES



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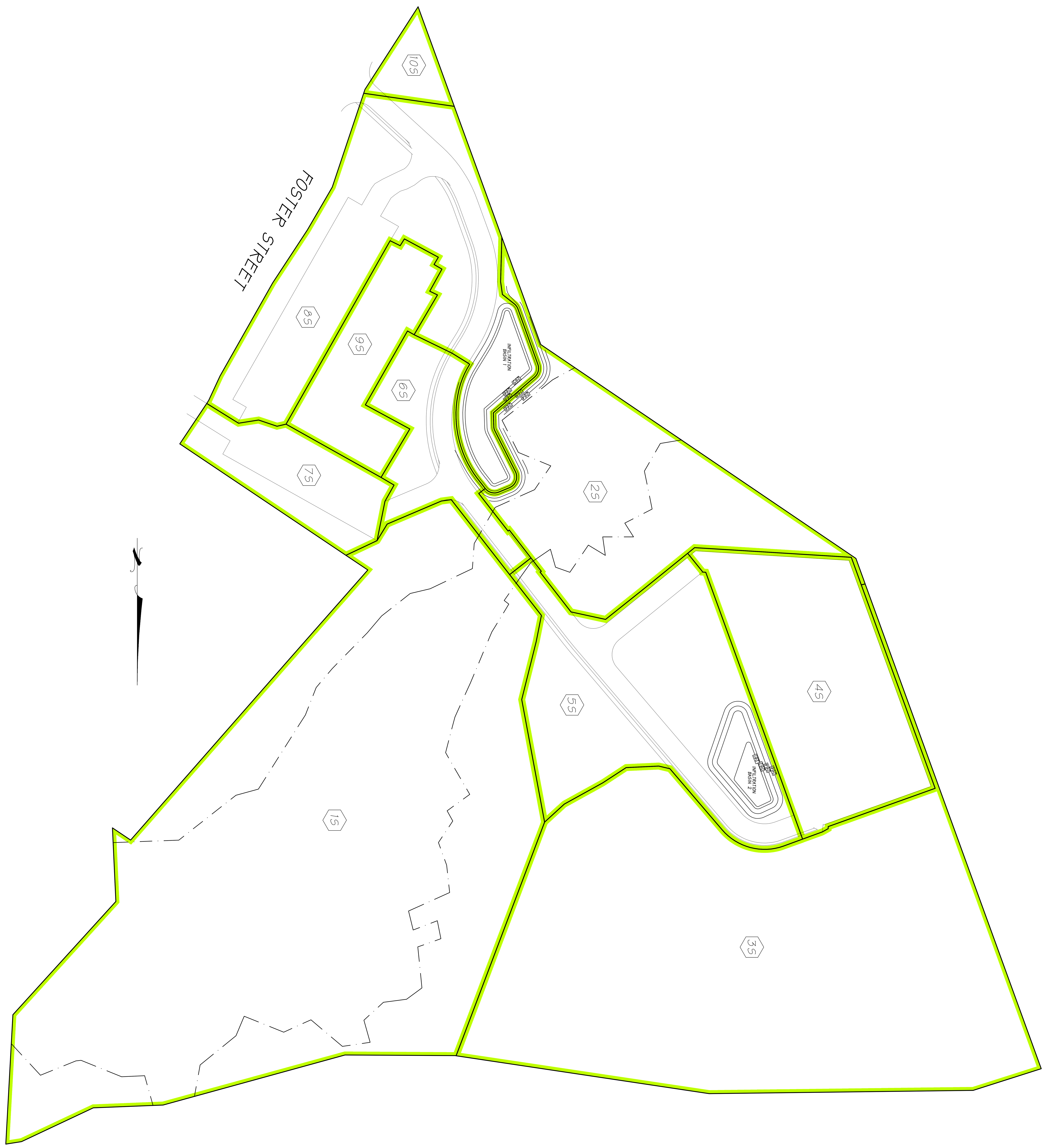
LITTLETON, MASSACHUSETTS

DRAINAGE - EXISTING
245 FOSTER STREET
LITTLETON, MASSACHUSETTS

#	DATE	REVISION COMMENT

DATE: 5/24/18



PD	360 MASSACHUSETTS AVE, SUITE 202 ACTON, MASSACHUSETTS 01720 P(978) 264-4600 F(978) 263-0447 www.MarkeyAndRubin.com **Markey & Rubin** CIVIL ENGINEERING	CLIENT: **GS HOLDINGS** 256 GREAT ROAD SUITE 11 LITTLETON, MASSACHUSETTS	**DRAINAGE - PROPOSED** 245 FOSTER STREET LITTLETON, MASSACHUSETTS	

#	DATE	REVISION COMMENT

DATE: 5/24/18

3. MASSACHUSETTS STORMWATER MANAGEMENT STANDARDS

Standard 1: *No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth*.

To prevent erosion from runoff towards wetlands, rip-rap is provided and flow rate is controlled by other means like pipe slope and size. Treatment of runoff from pavement is provided by the use of Stormceptors. Where necessary, calculations are provided below.

Standard 2: *Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates.*

See Drainage Report where results show to be in conformance with this standard.

Standard 3: *Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.*

Hydrologic Group Volume to Recharge (x Total Impervious Area)	
Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

Infiltration structures must be able to drain fully within 72 hours. In addition, there must be at least a two-foot separation between the bottom of the infiltration structure and the seasonal high groundwater table.

Total impervious area on site with development = 12.1% (or 107,020 sq. ft.) of the site. This covers group C soils.

The required recharge volume is then 107,020*.25/12 = 2,230 cu. ft.

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Volume is retained by Infiltration Basins 1 & 2 and Infiltration Beds.

Infiltration Basin 1 retains 18" of water over an area of 7,066 sq. ft., or volume = 10,599 cu. ft.

Infiltration Basin 2 retains 18" of water over an area of 1,903 sq. ft., or volume = 2,854 cu. ft.

For Infiltration Beds, the volume of water retained below outlet pipes = 3,368 cu. ft.

The total volume recharged way exceeds the required volume.

To ensure that all drainage structures can dissipate the retained volumes within 72 hours, the depth of must be less than

72 hrs x 0.27 in/hr. = 19.4".

The depth in the infiltration basins is 18". For the infiltration bed, depth is also 18" though 6" is with crushed stone. The effective depth is .40 x 6" = 2.4", or total effective depth = 14.4".

Standard 4: *Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). The required water quality volume equals 0.5 inches of runoff times the total impervious area of the post-development site.*

All standard paved roads and parking have a minimum of deep sump catch basins and Stormceptors. For Stormceptors, a TSS removal rate of 77% can be used.

Total removal of TSS is calculated as below:

BMP	TSS Removal	Starting TSS Load	Amount Removed	Remaining Load
Deep Sump and Hooded Catch Basin	0.25	1	0.25	0.75
Stormceptor	0.77	0.75	0.58	0.17
Total TSS Removal =			83%	

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Standard 5: *For land uses with higher potential pollutant loads.*

In the case of Bradford Pond Drive, the LUHPPLs do not exist.

Standard 6: *Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply or other Critical Areas.*

None of these conditions prevail here.

Standard 7: *For redevelopment projects.*

This project is not a Redevelopment Project.

Standard 8: *A plan to control construction-related impacts, including erosion, sedimentation, and other pollutant sources during construction.*

See Erosion and Sedimentation Control Plans.

Standard 9: A *Long -Term Operation and Maintenance (O&M) Plan.*

See Operations & Maintenance Plan.

Standard 10: *All illicit discharges to the stormwater management system are prohibited*.

This is addressed in Operations & Maintenance Plan.

OPERATIONS & MAINTENANCE PLAN

THE CROSSINGS AT FOSTER STREET

ASSESSORS MAP R11 PARCEL 3
245 FOSTER STREET
LITTLETON, MA

March 24, 2018

Prepared for:
GS HOLDINGS
256 GREAT ROAD SUITE 11
LITTLETON, MASSACHUSETTS

Prepared by:
MARKEY & RUBIN, INC.
360 MASSACHUSETTS AVENUE
ACTON, MASSACHUSETTS 01720

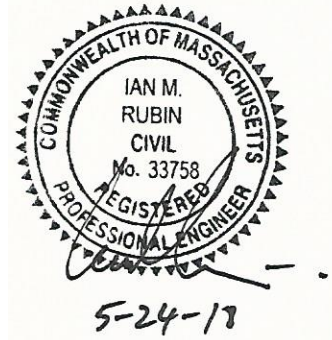

TABLE OF CONTENTS

1. INTRODUCTION

In general, stormwater runoff from developed areas contains a number of contaminants which can have an adverse impact on receiving waters. The installation of stormwater management systems that are properly designed, installed and maintained can significantly reduce the point and non-point discharges from developed areas.

The stormwater management system can protect and enhance the stormwater runoff water quality through the removal of sediments and pollutants, and source control significantly reduces the amount of pollutants entering the system. Preventative maintenance of the system will include a comprehensive source reduction program of regular vacuuming and litter removal, prohibitions on the use of pesticides and maintenance of designated waste and recycling areas.

This long-term Operations and Maintenance (O&M) Plan, filed with the Town of Littleton, shall be implemented at the 245 Foster Street development site to ensure that the stormwater management system functions as designed. The Owner possesses the primary responsibility for overseeing and implementing the O&M plan and assigning a property manager who will be responsible for the proper operation and maintenance of the stormwater structures.

In case of the transfer of property ownership, future property owners shall be notified of the presence of the stormwater management system and the requirements for proper implementation of the O&M plan. This project will also subject to an Order of Conditions from the Littleton Conservation Commission, a copy of which will be recorded at the Middlesex South Registry of Deeds and will run with the property to future owners.
Included in this manual is an overall site plan which identifies the locations of the key components of the stormwater management system and a log for tracking the inspections and maintenance.

1.1 Responsibility

The purpose of the O&M Plan is to ensure the inspection of the system, removal of accumulated sediments, oils and debris, and implementation of corrective action and record keeping activities. The ongoing responsibility is the Owner, its successors and assignees. Adequate maintenance is defined in this document as good working condition.

Contact information is provided below:

Responsibility for Operation and Maintenance

Name:	GS Holdings
Address:	256 Great Road Suite 11
City, State:	Littleton, Massachusetts
Contact:	Doug Shaw

These documents shall be signed by owner below:

“I have read these documents and shall be responsible for their implementation:

Signed______________________________ Date____________________”

In the event that the responsible party changes, these records shall be changed accordingly and signed by new party in charge.

1.2 Annual Report Submittal

The Responsible Parties must submit an annual report by September 1st to the Planning Board documenting the inspection and maintenance of the BMPs for which they are responsible. The reports must include:

1.2.1 Descriptions of the condition of the BMPs,

1.2.2 Descriptions of maintenance performed and,

1.2.3 Receipts showing payment for maintenance performed.

2. MAINTENANCE PROGRAM

The Owner shall conduct the Operation and Maintenance program set forth in this document. The Owner will ensure that inspections timely and accurate and that cleaning and maintenance are performed in accordance with the recommended frequency for each stormwater component.

2.1 Inspection and Maintenance Frequency and Corrective Measures

The following areas, facilities and measures will be inspected by the Owner maintained as specified below. Identified deficiencies will be corrected. Accumulated sediments and debris will be properly handled and disposed of off-site, in accordance with local, state and federal guidelines and regulations.

2.1.1 Routine Maintenance Tasks

Routine maintenance of lawns, gardens, and other landscaped areas shall occur as necessary to maintain the property in a neat and orderly fashion. Clippings and/or mulch shall not be washed into the drainage infrastructure.

Maintenance of the Stormwater Management System shall be in accordance with the Operations and Maintenance Checklist below.

Snow shall be stored on the site in designated areas.

Good housekeeping – all areas should be kept free of trash and debris. Any storage of materials and waste products shall be inside or under cover. Fertilizers, herbicides and pesticides, if stored on site, shall be stored properly contained and under cover. Storage of salt or deicing chemicals, if any, shall be on impervious area, covered and protected from runoff.

2.1.2 Illicit Discharges

During construction, all illicit connections from the property, if in existence, shall be cut and capped. The proposed site stormwater management system shall be checked for signs of illicit discharge during regular operation and maintenance activities. This will include but not be limited to checking for connections other than stormwater to the drainage system. Should connections other than stormwater be found, they will be immediately removed.

2.1.3 Catch Basins and Manholes

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. Once 50% of the sump volume is filled, the catch basin may not be able to retain additional sediment.

Inspect or clean deep sumps at least four times per year and at the end of the foliage and snow removal seasons. Sediments must also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Clamshell buckets are typically used to remove sediment; however, vacuum trucks are preferable as they remove more trapped sediment than clamshells. Vacuuming is also a speedier process and is less likely to damage the hood within the deep sump catch basin.

Cleaning a deep sump catch basin within a road with active traffic is dangerous and a police detail may be necessary to safeguard workers.

Although catch basin debris often contains oil and hazardous material such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin cleanings may be taken to a landfill of other facility permitted by MassDEP to accept solid waste, without any prior approval by MassDEP; however, some landfills may require testing before they are accepted.

2.1.4 Porous Paving

Porous Paving surfaces shall be monitored to ensure that the runoff drains properly after storms.

Surfaces shall be cleaned using power washer to dislodge trapped particles and then vacuum swept.

Surfaces must be inspected annually for deterioration.

Exfiltration capability shall be checked at least once a year, and when found declining, measures are to be implemented to restore infiltration capacity including repaving if necessary.

See Winter Maintenance Program below for further information on Porous Pavement.

2.2 Winter Maintenance Program

Ensure structures are not blocked by ice, snow, debris or trash during winter months. Snow storage locations must be designated and drainage from melting well understood to ensure no scouring or erosion. All locations must be outside of the 100-foot wetland buffer zone.

2.2.1 Winter Maintenance Guidelines for Porous Paving

Road surfaces, porous and non-porous, are commonly not treated and plowed until 2 or more inches of snow accumulation.

Plow after every storm. If possible plow with a slightly raised blade, while not necessary, this will help prevent pavement scarring.

Up to ~75% salt reduction for porous asphalt can be achieved. Salt reduction amounts are site specific and are affected by degree of shading.
USE SALT REDUCTION NUMBERS WITH CAUTION!!!

Porous paving salt reduction will vary and is heavily dependent upon shading. For shaded areas, porous paving may not achieve salt reduction.

Apply anti-icing treatments prior to storms. Anti-icing has the potential to provide the benefit of increased traffic safety at the lowest cost and with less environmental impact.

Deicing is NOT required for black ice development. Melt-water readily drains through porous surfaces thereby preventing black ice.

Apply deicing treatments during, and after storms as necessary to control compact snow and ice not removed by plowing.
Sand application should be limited since its use will increase the need for vacuuming.

Vacuum porous areas a minimum of 2-4 times per year, especially after winter and fall seasons when debris accumulation and deposition is greatest.

If ponding of water is observed during precipitation cleaning is recommended.

2.2.2 Winter Maintenance Challenges

Mixed precipitation and compact snow or ice is problematic for all paved surfaces, but is particularly problematic for porous surfaces. This is corrected by application of excess deicing chemicals.

De-icing chemicals work by lowering the freezing point of water. Generally, the longer a de-icing chemical has to react, the greater the amount of melting.

Melt-water readily drains through porous surfaces thereby reducing chemical contact time. This is corrected by excess salt application.

Excess salt application in these instances is offset by the overall reduced salt during routine winter maintenance and salt reduction.

2.2.3 Additional Resources

The UNH Stormwater Center: http://www.unh.edu/erg/cstev/ Pennsylvania Asphalt Pavement Association (PAPA) Porous Asphalt Pavements Guide: http://www.pahotmix.org/PDF/porous1.pdf

National Asphalt Pavement Association (NAPA) Porous Asphalt Pavements for Stormwater Management Revised 11/2008, Information Series 131

2.3 Fertilizer Selection and Use

The goal of fertilizer use should be to enhance the ground cover of the facility, yet not result in adverse water quality impacts. The following guidelines are recommended.

2.3.1. Fertilizer Selection

The selection of fertilizer should be based upon site-specific requirements. Recommendations for the fertilizer will be made upon completion of the project and actual tests of the soil mix. The benefit of the use of a soil mix is the ability of the soil to absorb and store nutrients for subsequent plant growth better than a sandy loam.

It is recommended that the soil be re-sampled every three (3) years and the plan adjusted accordingly.

In locations considered a sensitive natural area only slow-release organic low phosphorus fertilizers should be used in any landscaped areas to limit the amount of nutrients that could enter the stormwater management system.

2.3.2. Fertilizer Storage

Fertilizer should be stored in a weatherproof area with containers protected from damage. Fertilizer from any damaged containers should be placed in appropriate weatherproof containers.

2.3.3. Fertilizer Application

Fertilizer should be applied with appropriate mechanical equipment properly calibrated t meet the recommended application rates of the soil tests and manufacturer. The Owner or his agents should instruct personnel on the use of equipment and the proper measurement of the fertilizer.

Personnel assigned to application should be instructed that over-application of fertilizer is adverse to the landscaped areas and environment. Fertilizer should not be applied to steep slopes, saturated ground, during periods of precipitation, or immediately prior to major rain events.

3. APPENDICES

Appendix A – Maintenance Program Summary Checklist
Appendix B – Operation and Maintenance Forms
Appendix C – Stormceptor Owner's Manual

APPENDIX A
Maintenance Program Summary Checklist

245 FOSTER STREET

Maintenance Program Summary Checklist					
Item	Commentary	Frequency			
		Monthly	Quarterly	Semi-Annual	Annual
Porous Paving Sweeping	Sweep to remove small debris and sediments; large debris should be removed by hand prior to sweeping actions.	X			
Catch Basins & Manholes	Inspect for sediment quarterly; inspect at tend of foliage and at end of snowmelt; remove upon accumulation		X		

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APPENDIX B

Operation and Maintenance Forms

245 FOSTER STREET

POROUS PAVING SWEEPING

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date for Maintenance
	Yes	No	N/A			

245 FOSTER STREET

CATCH BASINS AND MANHOLES

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date for Maintenance
	Yes	No	N/A			

APPENDIX C

Stormceptor Owner's Manual

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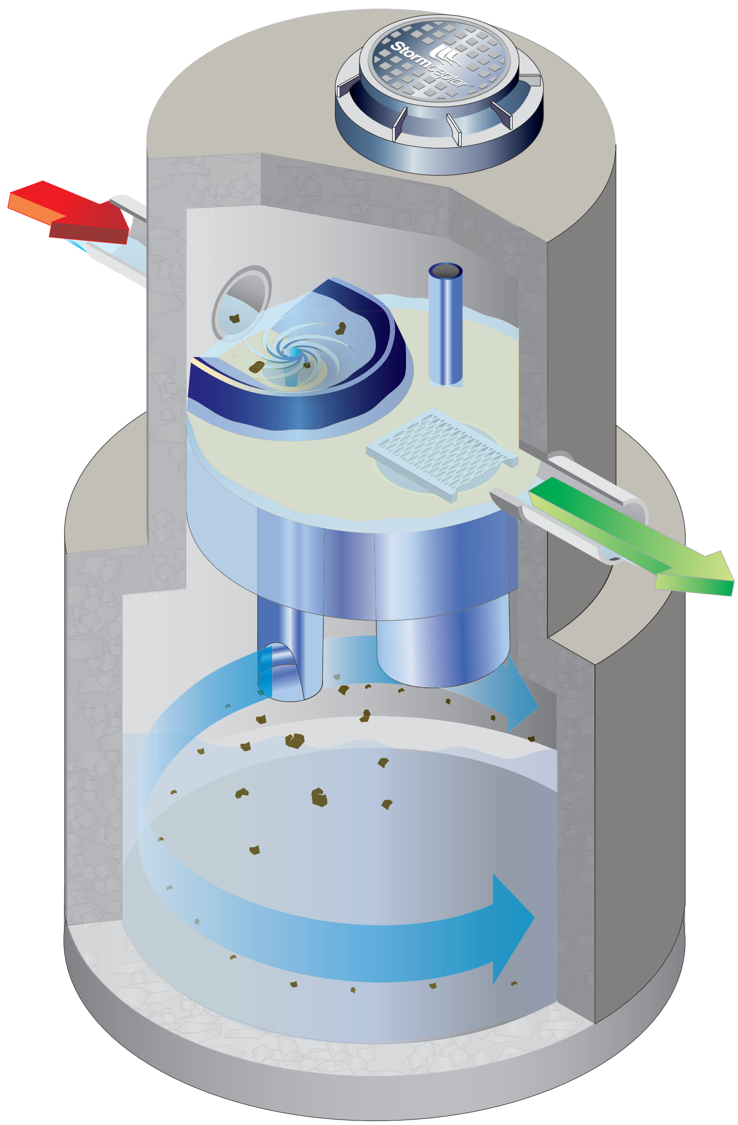
Stormceptor®

Owner's Manual



Stormceptor is protected by one or more of the following patents:

Canadian Patent No. 2,137,942
Canadian Patent No. 2,175,277
Canadian Patent No. 2,180,305
Canadian Patent No. 2,180,338
Canadian Patent No. 2,206,338
Canadian Patent No. 2,327,768
U.S. Patent No. 5,753,115
U.S. Patent No. 5,849,181
U.S. Patent No. 6,068,765
U.S. Patent No. 6,371,690
U.S. Patent No. 7,582,216
U.S. Patent No. 7,666,303
Australia Patent No. 693.164
Australia Patent No. 707,133
Australia Patent No. 729,096
Australia Patent No. 779,401
Australia Patent No. 2008,279,378
Australia Patent No. 2008,288,900
Indonesia Patent No. 0007058
Japan Patent No. 3581233
Japan Patent No. 9-11476
Korean Patent No. 0519212
Malaysia Patent No. 118987
New Zealand Patent No. 314,646
New Zealand Patent No. 583,008
New Zealand Patent No. 583,583
South African Patent No. 2010/00682
South African Patent No. 2010/01796
Other Patents Pending

Table of Contents

Congratulations!

Your selection of a Stormceptor® means that you have chosen the most recognized and efficient stormwater oil/sediment separator available for protecting the environment. Stormceptor is a pollution control device often referred to as a “Hydrodynamic Separator (HDS)” or an “Oil Grit Separator (OGS)”, engineered to remove and retain pollutants from stormwater runoff to protect our lakes, rivers and streams from the harmful effects of non-point source pollution.

1 – Stormceptor Overview

Stormceptor is a patented stormwater quality structure most often utilized as a treatment component of the underground storm drain network for stormwater pollution prevention. Stormceptor is designed to remove sediment, total suspended solids (TSS), other pollutants attached to sediment, hydrocarbons and free oil from stormwater runoff. Collectively the Stormceptor provides spill protection and prevents non-point source pollution from entering downstream waterways.

Key benefits of Stormceptor include:

- Removes sediment, suspended solids, debris, nutrients, heavy metals, and hydrocarbons (oil and grease) from runoff and snowmelt.
- Will not scour or re-suspend trapped pollutants.
- Provides sediment and oil storage.
- Provides spill control for accidents, commercial and industrial developments.
- Easy to inspect and maintain (vacuum truck).
- “STORMCEPTOR” is *clearly* marked on the access cover (excluding inlet designs).
- Relatively small footprint.
- 3rd Party tested and independently verified.
- Dedicated team of experts available to provide support.

Model Types:

- STC (Standard)
- STF (Fiberglass)
- EOS (Extended Oil Storage)
- OSR (Oil and Sand Removal)
- MAX (Custom designed unit, specific to site)

Configuration Types:

- Inlet unit (accommodates inlet flow entry, and multi-pipe entry)
- In-Line (accommodates multi-pipe entry)
- Submerged Unit (accommodates the site’s tailwater conditions)
- Series Unit (combines treatment in two systems)

Please Maintain Your Stormceptor

To ensure long-term environmental protection through continued performance as originally designed for your site, **Stormceptor must be maintained**, as any stormwater treatment practice does. The need for maintenance is determined through inspection of the Stormceptor. Procedures for inspection are provided within this document. Maintenance of the Stormceptor is performed from the surface via vacuum truck.

If you require information about Stormceptor, or assistance in finding resources to facilitate inspections or maintenance of your Stormceptor please call your local Stormceptor Licensee or Imbrium® Systems.

2 – Stormceptor Operation & Components

Stormceptor is a flexibly designed underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention using patented flow separation technology.

Stormceptor creates a non-turbulent treatment environment below the insert platform within the system. The insert diverts water into the lower chamber, allowing free oils and debris to rise, and sediment to settle under relatively low velocity conditions. These pollutants are trapped and stored below the insert and protected from large runoff events for later removal during the maintenance procedure.

With thousands of units operating worldwide, Stormceptor delivers reliable protection every day, in every storm. The patented Stormceptor design prohibits the scour and release of captured pollutants, ensuring superior water quality treatment and protection during even the most extreme storm events. Stormceptor's proven performance is backed by the longest record of lab and field verification in the industry.

Stormceptor Schematic and Component Functions

Below are schematics of two common Stormceptor configurations with key components identified and their functions briefly described.

Figure 1.

Inline Stormceptor

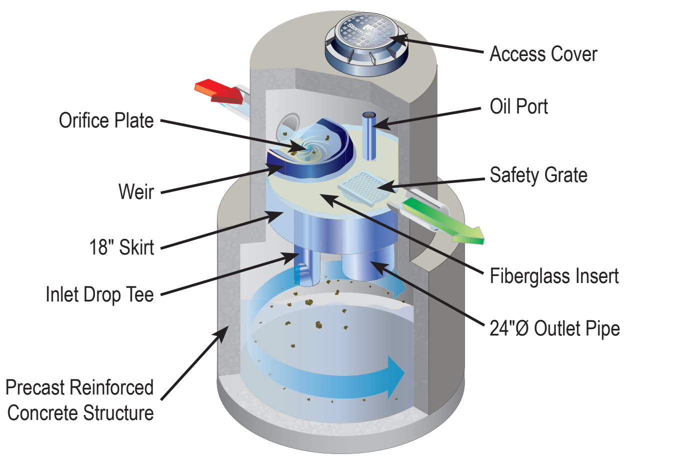
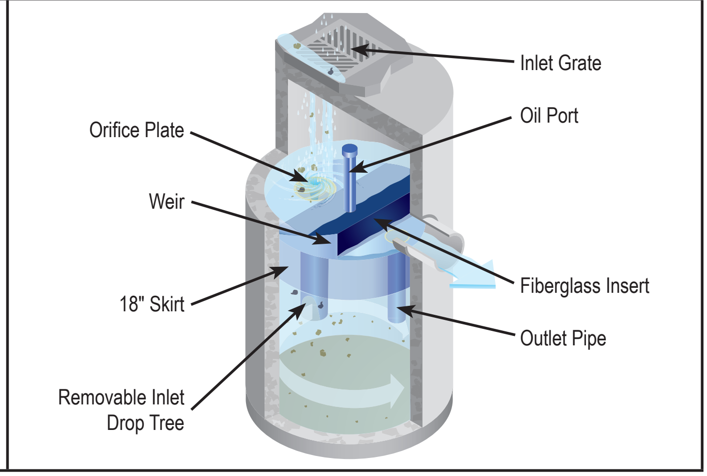


Figure 2.

Inlet Stormceptor



- **Manhole access cover** – provides access to the subsurface components
- **Precast reinforced concrete structure** – provides the vessel's watertight structural support
- **Fiberglass insert** – separates vessel into upper and lower chambers
- **Weir** – directs incoming stormwater and oil spills into the lower chamber
- **Orifice plate** – prevents scour of accumulated pollutants
- **Inlet drop tee** – conveys stormwater into the lower chamber
- **Fiberglass skirt** – provides double-wall containment of hydrocarbons
- **Outlet riser pipe** – conveys treated water to the upper chamber; primary vacuum line access port for sediment removal
- **Oil inspection port** – primary access for measuring oil depth and oil removal
- **Safety grate** – safety measure to cover riser pipe in the event of manned entry into vessel

3 – Stormceptor Identification

Stormceptor is available in both precast concrete and fiberglass vessels, with precast concrete often being the dominant material of construction.

In the Stormceptor, a patented, engineered fiberglass insert separates the structure into an upper chamber and lower chamber. The lower chamber will remain full of water, as this is where the pollutants are sequestered for later removal. Multiple Stormceptor model (STC, OSR, EOS, MAX and STF) configurations exist, each to be inspected and maintained in a similar fashion.

Each unit is easily identifiable as a Stormceptor by the trade name "Stormceptor" embossed on each access cover at the surface. To determine the location of "inlet" Stormceptor units with horizontal catch basin inlet, look down into the grate as the Stormceptor insert will be visible. The name "Stormceptor" is not embossed on inlet models due to the variability of inlet grates used/approved across North America.

Once the location of the Stormceptor is determined, the model number may be identified by comparing the measured depth from the fiberglass insert level at the outlet pipe's invert (water level) to the bottom of the tank using **Table 1**.

In addition, starting in 1996 a metal serial number tag containing the model number has been affixed to the inside of the unit, on the fiberglass insert. If the unit does not have a serial number, or if there is any uncertainty regarding the size of the unit using depth measurements, please contact your local Stormceptor Representative for assistance.

Sizes/Models
Typical general dimensions and capacities of the standard precast STC, EOS & OSR Stormceptor models in both USA and Canada/International (excluding South East Asia and Australia) are provided in **Tables 1 and 2**. Typical rim to invert measurements are provided later in this document. The total depth for cleaning will be the sum of the depth from outlet pipe invert (generally the water level) to rim (grade) and the depth from outlet pipe invert to the precast bottom of the unit. Note that depths and capacities may vary slightly between regions.

Table 1A. (US) Stormceptor Dimensions – Insert to Base of Structure

STC Model	Insert to Base (in.)
450	60
900	55
1200	71
1800	105
2400	94
3600	134
4800	128
6000	150
7200	134
11000*	128
13000*	150
16000*	134

EOS Model	Insert to Base (in.)
4-175	60
9-365	55
12-590	71
18-1000	105
24-1400	94
36-1700	134
48-2000	128
60-2500	150
72-3400	134
110-5000*	128
130-6000*	150
160-7800*	134

OSR Model	Insert to Base (in.)
65	60
140	55
250	94
390	128
560	134
780*	128
1125*	134

Typical STF m (in.)
1.5 (60)
1.5 (61)
1.8 (73)
2.9 (115)
2.3 (89)
3.2 (127)
2.9 (113)
3.5 (138)
3.3 (128)

Notes:

1. *Depth Below Pipe Inlet Invert to the Bottom of Base Slab can vary slightly by manufacturing facility, and can be modified to accommodate specific site designs, pollutant loads or site conditions. Contact your local representative for assistance.*

   **Consist of two chamber structures in series.*

Table 1B. (CA & Int'l) Stormceptor Dimensions – Insert to Base of Structure

STC Model	Insert to Base (m)	EOS Model	Insert to Base (m)	OSR Model	Insert to Base (m)	Typical STF m (in.)
300	1.5	300	1.5	300	1.7	1.5 (60)
750	1.5	750	1.5	750	1.6	1.5 (61)
1000	1.8	1000	1.8			1.8 (73)
1500	2.8					2.9 (115)
2000	2.8	2000	2.8	2000	2.6	2.3 (89)
3000	3.7	3000	3.7			3.2 (127)
4000	3.4	4000	3.4	4000	3.6	2.9 (113)
5000	4.0	5000	4.0			3.5 (138)
6000	3.7	6000	3.7	6000	3.7	3.3 (128)
9000*	3.4	9000*	3.4	9000*	3.6	
11000*	4.0	10000*	4.0			
14000*	3.7	14000*	3.7	14000*	3.7	

Notes:

1. *Depth Below Pipe Inlet Invert to the Bottom of Base Slab can vary slightly by manufacturing facility, and can be modified to accommodate specific site designs, pollutant loads or site conditions. Contact your local representative for assistance.*

   **Consist of two chamber structures in series.*

Table 2A. (US) Storage Capacities

STC Model	Hydrocarbon Storage Capacity gal	Sediment Capacity ft³	EOS Model	Hydrocarbon Storage Capacity gal	OSR Model	Hydrocarbon Storage Capacity gal	Sediment Capacity ft³
450	86	46	**4-175**	175	**065**	115	46
900	251	89	**9-365**	365	**140**	233	58
1200	251	127	**12-590**	591			
1800	251	207	**18-1000**	1198			
2400	840	205	**24-1400**	1457	**250**	792	156
3600	840	373	**36-1700**	1773			
4800	909	543	**48-2000**	2005	**390**	1233	465
6000	909	687	**60-2500**	2514			
7200	1059	839	**72-3400**	3418	**560**	1384	690
11000*	2797	1089	**110-5000***	5023	**780***	2430	930
13000*	2797	1374	**130-6000***	6041			
16000*	3055	1677	**160-7800***	7850	**1125***	2689	1378

Notes:

1. *Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.*

   **Consist of two chamber structures in series.*

Table 2B. (CA & Int'l) Storage Capacities

STC Model	Hydrocarbon Storage Capacity L	Sediment Capacity L	EOS Model	Hydrocarbon Storage Capacity L	OSR Model	Hydrocarbon Storage Capacity L	Sediment Capacity L
300	300	1450	**300**	662	**300**	300	1500
750	915	3000	**750**	1380	**750**	900	3000
1000	915	3800	**1000**	2235			
1500	915	6205					
2000	2890	7700	**2000**	5515	**2000**	2790	7700
3000	2890	11965	**3000**	6710			
4000	3360	16490	**4000**	7585	**4000**	4700	22200
5000	3360	20940	**5000**	9515			
6000	3930	26945	**6000**	12940	**6000**	5200	26900
9000*	10555	32980	**9000***	19010	**9000***	9300	33000
11000*	10555	37415	**10000***	22865			
14000*	11700	53890	**14000***	29715	**14000***	10500	53900

Notes:

1. *Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.*

**Consist of two chamber structures in series.*

4 – Stormceptor Inspection & Maintenance

Regular inspection and maintenance is a proven, cost-effective way to maximize water resource protection for all stormwater pollution control practices, and is required to insure proper functioning of the Stormceptor. Both inspection and maintenance of the Stormceptor is easily performed from the surface. Stormceptor's patented technology has no moving parts, simplifying the inspection and maintenance process.

Please refer to the following information and guidelines before conducting inspection and maintenance activities.

When is inspection needed?

- Post-construction inspection is required prior to putting the Stormceptor into service.
- Routine inspections are recommended during the first year of operation to accurately assess the sediment accumulation.
- Inspection frequency in subsequent years is based on the maintenance plan developed in the first year.
- Inspections should also be performed immediately after oil, fuel, or other chemical spills.

When is maintenance cleaning needed?

- For optimum performance, the unit should be cleaned out once the sediment depth reaches the recommended maintenance sediment depth, which is approximately 15% of the unit's total storage capacity (see **Table 2**). The frequency should be adjusted based on historical inspection results due to variable site pollutant loading.

- Sediment removal is easier when removed on a regular basis at or prior to the recommended maintenance sediment depths, as sediment build-up can compact making removal more difficult.
- The unit should be cleaned out immediately after an oil, fuel or chemical spill.

What conditions can compromise Stormceptor performance?

- If construction sediment and debris is not removed prior to activating the Stormceptor unit, maintenance frequency may be reduced.
- If the system is not maintained regularly and fills with sediment and debris beyond the capacity as indicated in **Table 2**, pollutant removal efficiency may be reduced.
- If an oil spill(s) exceeds the oil capacity of the system, subsequent spills may not be captured.
- If debris clogs the inlet of the system, removal efficiency of sediment and hydrocarbons may be reduced.
- If a downstream blockage occurs, a backwater condition may occur for the Stormceptor and removal efficiency of sediment and hydrocarbons may be reduced.

What training is required?

The Stormceptor is to be inspected and maintained by professional vacuum cleaning service providers with experience in the maintenance of underground tanks, sewers and catch basins. For typical inspection and maintenance activities, no specific supplemental training is required for the Stormceptor. Information provided within this Manual (provided to the site owner) contains sufficient guidance to maintain the system properly.

In unusual circumstances, such as if a damaged component needs replacement or some other condition requires manned entry into the vessel, confined space entry procedures must be followed. Only professional maintenance service providers trained in these procedures should enter the vessel. Service provider companies typically have personnel who are trained and certified in confined space entry procedures according to local, state, and federal standards.

What equipment is typically required for inspection?

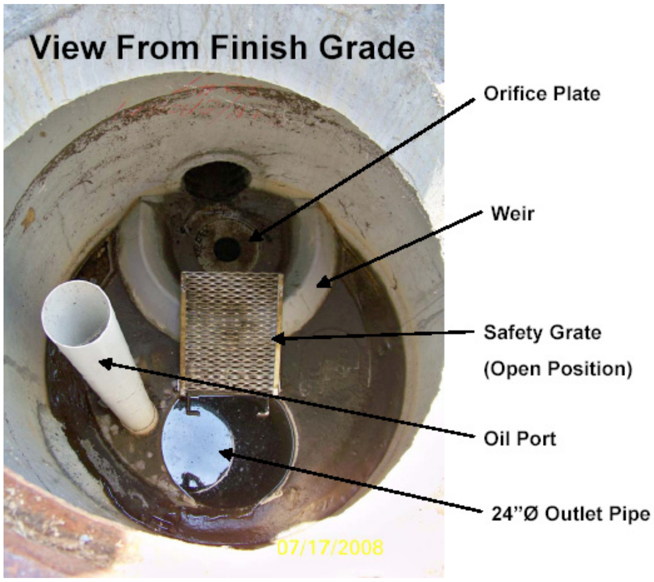
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones and caution tape
- Hard hat, safety shoes, safety glasses, and chemical-resistant gloves

Recommended Stormceptor Inspection Procedure:

- Stormceptor is to be inspected from grade through a standard surface manhole access cover.
- Sediment and oil depth inspections are performed with a sediment probe and oil dipstick.
- Oil depth is measured through the oil inspection port, either a 4-inch (100 mm) or 6-inch (150 mm) diameter port.
- Sediment depth can be measured through the oil inspection port or the 24-inch (610 mm) diameter outlet riser pipe.
- Inspections also involve a visual inspection of the internal components of the system.

Figure 3.

Figure 4.



What equipment is typically required for maintenance?

- Vacuum truck equipped with water hose and jet nozzle
- Small pump and tubing for oil removal
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Gas analyzer, respiratory gear, and safety harness for specially trained personnel if confined space entry is required

Recommended Stormceptor Maintenance Procedure

Maintenance of Stormceptor is performed using a vacuum truck.

No entry into the unit is required for maintenance. ***DO NOT ENTER THE STORMCEPTOR CHAMBER*** unless you have the proper personal safety equipment, have been trained and are qualified to enter a confined space, as identified by local Occupational Safety and Health Regulations (e.g. 29 CFR 1910.146 or Canada Occupational Safety and Health Regulations – SOR/86-304). Without the proper equipment, training and permit, entry into confined spaces can result in serious bodily harm and potentially death. Consult local, provincial, and/or state regulations to determine the requirements for confined space entry. Be aware, and take precaution that the Stormceptor fiberglass insert may be slippery. In addition, be aware that some units do not have a safety grate to cover the outlet riser pipe that leads to the submerged, lower chamber.

- Ideally maintenance should be conducted during dry weather conditions when no flow is entering the unit.
- Stormceptor is to be maintained through a standard surface manhole access cover.
- Insert the oil dipstick into the oil inspection port. If oil is present, pump off the oil layer into separate containment using a small pump and tubing.
- Maintenance cleaning of accumulated sediment is performed with a vacuum truck.
    - For 6-ft (1800 mm) diameter models and larger, the vacuum hose is inserted into the lower chamber via the 24-inch (610 mm) outlet riser pipe.
    - For 4-ft (1200 mm) diameter model, the removable drop tee is lifted out, and the vacuum hose is inserted into the lower chamber via the 12-inch (305 mm) drop tee hole.

Figure 5.

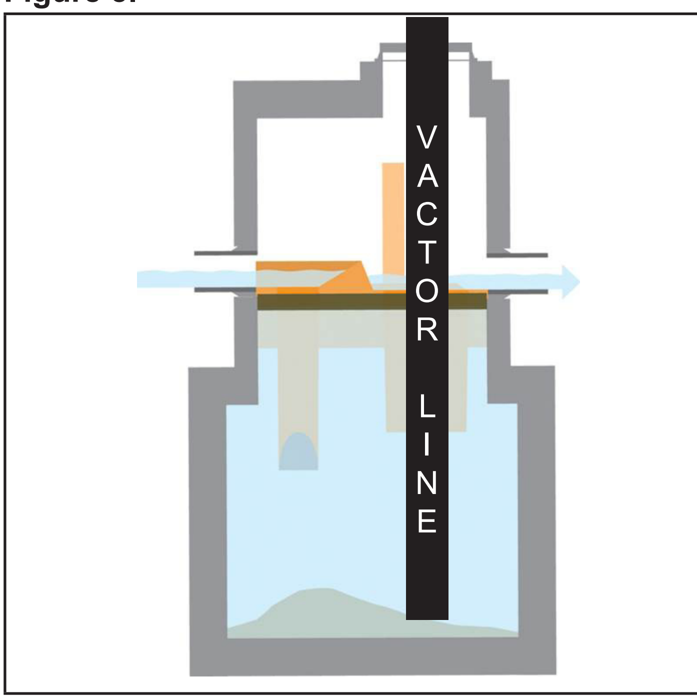
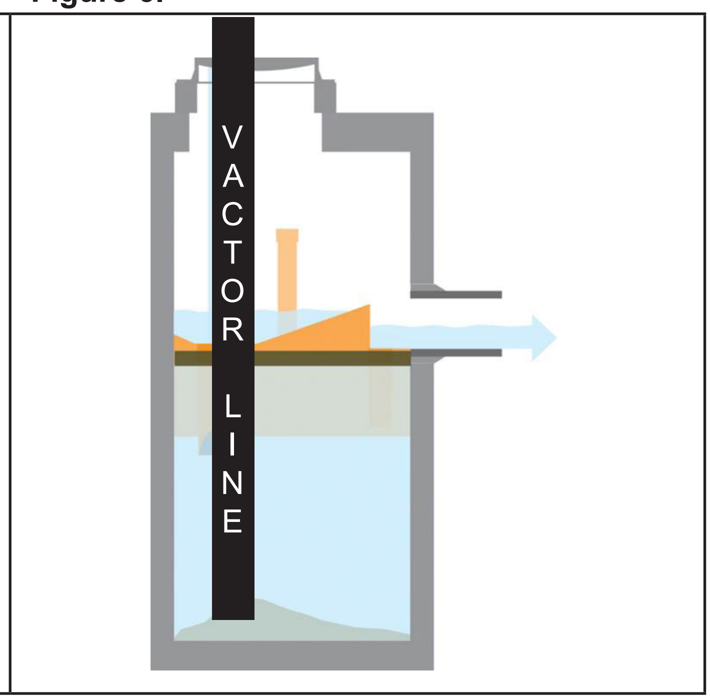


Figure 6.



- Using the vacuum hose, decant the water from the lower chamber into a separate containment tank or to the sanitary sewer, if permitted by the local regulating authority.
- Remove the sediment sludge from the bottom of the unit using the vacuum hose. For large Stormceptor units, a flexible hose is often connected to the primary vacuum line for ease of movement in the lower chamber.
- Units that have not been maintained regularly, have surpassed the maximum recommended sediment capacity, or contain damaged components may require manned entry by trained personnel using safe and proper confined space entry procedures.

Figure 7.

Figure 8.

A maintenance worker stationed at the above ground surface uses a vacuum hose to evacuate water, sediment, and debris from the system.

What is required for proper disposal?
The requirements for the disposal of material removed from Stormceptor units are similar to that of any other stormwater treatment Best Management Practices (BMP). Local guidelines should be consulted prior to disposal of the separator contents. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste. This could be site and pollutant dependent. In some cases, approval from the disposal facility operator/agency may be required.

What about oil spills?
Stormceptor is often implemented in areas where there is high potential for oil, fuel or other hydrocarbon or chemical spills. Stormceptor units should be cleaned immediately after a spill occurs by a licensed liquid waste hauler. You should also notify the appropriate regulatory agencies as required in the event of a spill.

What if I see an oil rainbow or sheen at the Stormceptor outlet?
With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a hydrocarbon rainbow or sheen can be seen at

very small oil concentrations (< 10 ppm). Stormceptor is effective at removing 95% of free oil, and the appearance of a sheen at the outlet with high influent oil concentrations does not mean that the unit is not working to this level of removal. In addition, if the influent oil is emulsified, the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified or dissolved oil conditions.

What factors affect the costs involved with inspection/maintenance?
The Vacuum Service Industry for stormwater drainage and sewer systems is a well-established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean Stormceptor units will vary. Inspection and maintenance costs are most often based on unit size, the number of units on a site, sediment/oil/hazardous material loads, transportation distances, tipping fees, disposal requirements and other local regulations.

What factors predict maintenance frequency?
Maintenance frequency will vary with the amount of pollution on your site (number of hydrocarbon spills, amount of sediment, site activity and use, etc.). It is recommended that the frequency of maintenance be increased or reduced based on local conditions. If the sediment load is high from an unstable site or sediment loads transported from upstream catchments, maintenance may be required semi-annually. Conversely once a site has stabilized, maintenance may be required less frequently (for example: two to seven year, site and situation dependent). Maintenance should be performed immediately after an oil spill or once the sediment depth in Stormceptor reaches the value specified in **Table 3** based on the unit size.

Table 3A. (US) Recommended Sediment Depths Indicating Maintenance

STC Model	Maintenance Sediment depth (in)	EOS Model	Maintenance Sediment depth (in)	Oil Storage Depth (in)	OSR Model	Maintenance Sediment depth (in)
450	8	**4-175**	9	24	**065**	8
900	8	**9-365**	9	24	**140**	8
1200	10	**12-590**	11	39		
1800	15					
2400	12	**24-1400**	14	68	**250**	12
3600	17	**36-1700**	19	79		
4800	15	**48-2000**	16	68	**390**	17
6000	18	**60-2500**	20	79		
7200	15	**72-3400**	17	79	**560**	17
11000*	17	**110-5000***	16	68	**780***	17
13000*	20	**130-6000***	20	79		
16000*	17	**160-7800***	17	79	**1125***	17

Note:

1. *The values above are for typical standard units.*

**Per structure.*

Table 3B. (CA & Int'l) Recommended Sediment Depths Indicating Maintenance

STC Model	Maintenance Sediment depth (mm)	EOS Model	Maintenance Sediment depth (mm)	Oil Storage Depth (mm)	OSR Model	Maintenance Sediment depth (mm)
300	225	**300**	225	610	**300**	200
750	230	**750**	230	610	**750**	200
1000	275	**1000**	275	990		
1500	400					
2000	350	**2000**	350	1727	**2000**	300
3000	475	**3000**	475	2006		
4000	400	**4000**	400	1727	**4000**	375
5000	500	**5000**	500	2006		
6000	425	**6000**	425	2006	**6000**	375
9000*	400	**9000***	400	1727	**9000***	425
11000*	500	**10000***	500	2006		
14000*	425	**14000***	425	2006	**14000***	425

Note:

1. *The values above are for typical standard units.*

   **Per structure.*

Replacement parts

Since there are no moving parts during operation in a Stormceptor, broken, damaged, or worn parts are not typically encountered. Therefore, inspection and maintenance activities are generally focused on pollutant removal. However, if replacements parts are necessary, they may be purchased by contacting your local Stormceptor Representative, or Imbrium Systems.

The benefits of regular inspection and maintenance are many – from ensuring maximum operation efficiency, to keeping maintenance costs low, to the continued protection of natural waterways – and provide the key to Stormceptor's long and effective service life.

Stormceptor Inspection and Maintenance Log

Stormceptor Model No: ____________________

Allowable Sediment Depth: ____________________

Serial Number: ____________________

Installation Date: ____________________

Location Description of Unit: ____________________

Other Comments: ____________________

Contact Information

Questions regarding the Stormceptor can be addressed by contacting your area Stormceptor Licensee, Imbrium Systems, or visit our website at www.stormceptor.com.

Stormceptor Licensees:

CANADA

Lafarge Canada Inc.	
www.lafargepipe.com	
403-292-9502 / 1-888-422-4022	Calgary, AB
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Langley Concrete Group	
www.langleyconcretegroup.com	
604-502-5236	BC
Hanson Pipe & Precast Inc.	
www.hansonpipeandprecast.com	
519-622-7574 / 1-888-888-3222	ON
Lécuyer et Fils Ltée.	
www.lecuyerbeton.com	
450-454-3928 / 1-800-561-0970	QC
Strescon Limited	
www.strescon.com	
902-494-7400	NS, NF
506-633-8877	NB, PE

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