DRAINAGE CALCULATIONS & STORMWATER MANAGEMENT PLAN

For:

PROPOSED COMMERCIAL DEVELOPMENT
OFF SPRING STREET
CARVER, MASSACHUSETTS

Located:

LOT 2
RICKETTS POND BUSINESS PARK
SPRING STREET
CARVER, MASSACHUSETTS

Submitted to:
TOWN OF CARVER

Prepared For:
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APPENDICES

APPENDIX A Post-Development Condition

- Post-Development 100-year storm HydroCAD Calculations
- Post-Development Watershed Plan

Project Summary

The project will consist of the construction of multiple commercial buildings located off Spring Street in Carver, Massachusetts at Lot 1 & Lot 2 of the Ricketts Pond Business Park Definitive Subdivision. The two lots will be comprised of five commercial buildings with associated driveways, parking lots, closed drainage system, septic systems and utility connections. Stormwater from the site development will be directed to an infiltration basin that was designed to accommodate runoff from the Ricketts Pond Business Park Definitive Subdivision.

The existing and proposed site conditions for the approved subdivision are illustrated on the project site plans entitled "Definitive Subdivision Plans, Ricketts Pond Business Park, Spring Street, Carver Massachusetts", prepared by McKenzie Engineering Group, Inc. dated January 10, 2019 and revised April 3, 2019. The hydrologic calculations for the subdivision can be found in a report entitled "Drainage Calculations & Stormwater Management Plan" prepared by McKenzie Engineering Group, Inc. dated January 10, 2019 (January 2019 Report). The proposed site development for Lot 1 of the Ricketts Pond Business Park Definitive Subdivision is illustrated on the project site plans entitled "Site Development Plans, Ricketts Pond Business Park, Lot 1, Off Spring Street, Carver, Massachusetts", dated February 28, 2022 prepared by McKenzie Engineering Group, Inc. (Site Plans). The proposed site development for Lot 2 of the Ricketts Pond Business Park Definitive Subdivision is illustrated on the project site plans entitled "Site Development Plans, Ricketts Pond Business Park, Lot 2, Off Spring Street, Carver, Massachusetts", dated February 28, 2022 prepared by McKenzie Engineering Group, Inc. (Site Plans).

This report contains stormwater runoff calculations for the post-development 100-year storm condition to confirm that the proposed stormwater infiltration basin originally designed for the subdivision can accommodate the entire 100-year runoff volume from the proposed commercial lot developments. All stormwater management facilities will be designed to mitigate peak rates of runoff, provide renovation of stormwater and fully meet the requirements of the DEP's Stormwater Management Regulations.

Post-Development Condition

The subject commercial developments are located at Lot 1 & Lot 2 of the Ricketts Pond Business Park Definitive Subdivision. Stormwater runoff from the proposed site development will be directed to the proposed stormwater infiltration basin designed for the subdivision (Infiltration Basin #1 & Infiltration Basin #2). The entire 100-year storm runoff volume from the proposed commercial lots will be contained within the infiltration basins so the project will not involve a connection to the municipal system located on Spring Street. A closed drainage system consisting of a series of catch basins and drainage manholes will direct stormwater runoff from both lots to the infiltration basin (2P) that will accept runoff from the western portion subdivision project, as specified in the "Drainage Calculations & Stormwater Management Plan" prepared for the Ricketts Pond Business Park Definitive Subdivision. A portion of the front yards of Lot 1 and Lot 2 will continue to sheet flow to Ricketts Pond Drive, where they will be captured by the closed drainage system for the roadway and be conveyed to Infiltration Basin 1P, as originally designed in the January 2019 Report. The stormwater management system will be designed to fully comply with all standards of the Department of Environmental Protection's Stormwater Management Regulations. Compliance with all standards is documented in the "Drainage Calculations & Stormwater Management Plan" prepared for the Ricketts Pond Business Park Definitive Subdivision.

Refer to the Post-Development Watershed Plan WS-2 for a delineation of post-development drainage subareas. The Post-Development Condition Drainage Calculations section of the previously submitted Drainage Calculations and Stormwater Management Plan dated January 10, 2019, has been revised to indicate an updated impervious areas for Lot 1 & Lot 2. These revisions are based on the proposed Site Plans for each lot which involve a reduction of impervious area from the assumed impervious surface in the January 2019 Report. The reduction in impervious area decreases the 100-year flood elevation of Basin 1 (1P) from elevation 138.45 (NAVD88) to 138.00, and Basin 2 (2P) from elevation 138.84 (NAVD88) to 138.75. Both infiltration basins, Basins 1 & 2, are still compliant with the requirements for infiltration basins in the Massachusetts Stormwater Handbook as greater than one (1) foot of freeboard is maintained above the calculated 100-year flood elevation.

The revisions to the January 2019 Report accounts for the addition of 5,300 S.F. of impervious area proposed by the approved Form A Lot Site Plan located Off Spring Street, which outlets into Basin 1 (1P).

Stormwater Infiltration Basins

The proposed stormwater infiltration basins was designed to attenuate peak flows generated by all storm events to ensure that post-development peak flows generated by all storm events are less than pre-development flows at the design point and allow for recharge to groundwater. The proposed facilities were analyzed using the Soil Conservation Service (now Natural Resources Conservation Service) Technical Release 20 (TR-20) based computer program, “HydroCAD”.

Stormwater Best Management Practices (BMP's)

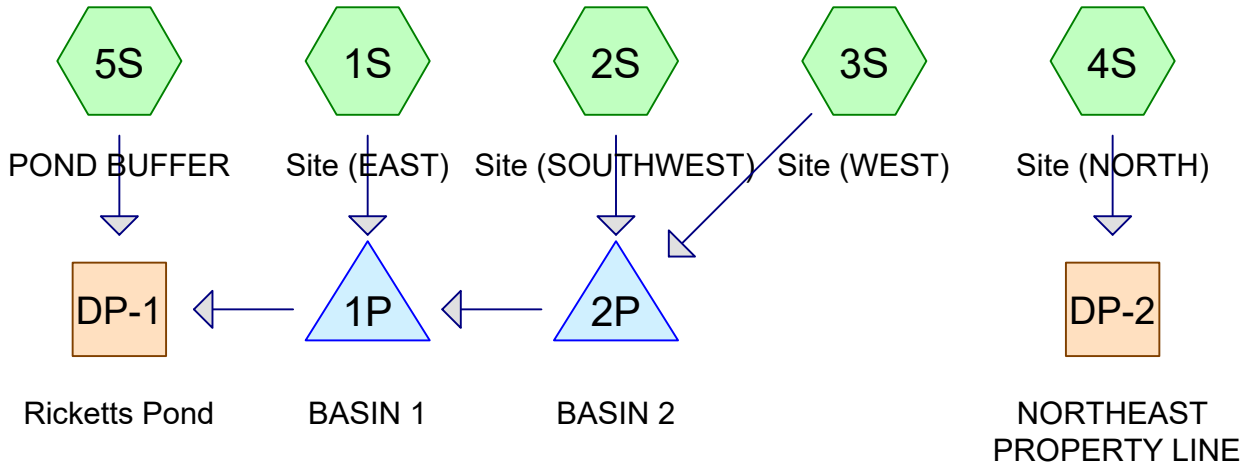
The treatment stream for the will consist of deep sump hooded catch basins, sediment forebay and an infiltration basin to achieve the required removal of a least 80% of the total suspended solids (TSS) and mitigate the anticipated pollutant loading.

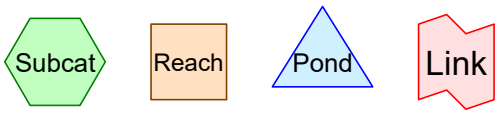
Erosion and Siltation Control

Compost filter tube erosion control barriers will be placed at the limit of work where indicated on the plans prior to the commencement of any construction activity. The integrity of the compost filter tube erosion control barrier will be maintained by periodic inspection and replacement as necessary. The compost filter tube erosion control barrier will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established.

A P P E N D I X A

Post-Development Condition





Routing Diagram for 217-182 Post Development_COMPILED
Prepared by McKenzie Engineering Group, Inc., Printed 2/25/2022
HydroCAD® 10.10-7a s/n 00452 © 2021 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	100-Year	Type III 24-hr		Default	24.00	1	6.70	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
7.753	39	>75% Grass cover, Good, HSG A (1S, 2S, 3S, 4S)
6.092	98	Paved parking, HSG A (1S, 2S, 3S, 4S)
2.170	98	Roofs, HSG A (1S, 2S, 3S)
4.430	32	Woods/grass comb., Good, HSG A (5S)
0.594	79	Woods/grass comb., Good, HSG D (5S)
21.040	**62**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
20.445	HSG A	1S, 2S, 3S, 4S, 5S
0.000	HSG B	
0.000	HSG C	
0.594	HSG D	5S
0.000	Other	
21.040		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
7.753	0.000	0.000	0.000	0.000	7.753	>75% Grass cover, Good	1S, 2S, 3S, 4S
6.092	0.000	0.000	0.000	0.000	6.092	Paved parking	1S, 2S, 3S, 4S
2.170	0.000	0.000	0.000	0.000	2.170	Roofs	1S, 2S, 3S
4.430	0.000	0.000	0.594	0.000	5.024	Woods/grass comb., Good	5S
20.445	**0.000**	**0.000**	**0.594**	**0.000**	**21.040**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	2P	138.50	137.50	100.0	0.0100	0.013	0.0	15.0	0.0

Time span=5.00-48.00 hrs, dt=0.05 hrs, 861 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Site (EAST) Runoff Area=442,519 sf 54.10% Impervious Runoff Depth=3.47"
Flow Length=636' Tc=8.2 min CN=71 Runoff=37.78 cfs 2.940 af

Subcatchment2S: Site (SOUTHWEST) Runoff Area=147,290 sf 51.06% Impervious Runoff Depth=3.27"
Flow Length=318' Tc=6.9 min CN=69 Runoff=12.36 cfs 0.921 af

Subcatchment3S: Site (WEST) Runoff Area=80,462 sf 52.60% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=70 Runoff=7.15 cfs 0.519 af

Subcatchment4S: Site (NORTH) Runoff Area=27,376 sf 10.93% Impervious Runoff Depth=1.10"
Tc=6.0 min CN=45 Runoff=0.58 cfs 0.058 af

Subcatchment5S: POND BUFFER Runoff Area=218,839 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=375' Tc=29.2 min CN=38 Runoff=1.01 cfs 0.250 af

Reach DP-1: Ricketts Pond Inflow=1.01 cfs 0.250 af
Outflow=1.01 cfs 0.250 af

Reach DP-2: NORTHEAST PROPERTY LINE Inflow=0.58 cfs 0.058 af
Outflow=0.58 cfs 0.058 af

Pond 1P: BASIN 1 Peak Elev=138.00' Storage=89,121 cf Inflow=37.78 cfs 3.076 af
Discarded=0.94 cfs 2.957 af Primary=0.00 cfs 0.000 af Outflow=0.94 cfs 2.957 af

Pond 2P: BASIN 2 Peak Elev=138.75' Storage=44,818 cf Inflow=19.48 cfs 1.440 af
Discarded=0.27 cfs 0.854 af Primary=0.30 cfs 0.137 af Outflow=0.57 cfs 0.991 af

Total Runoff Area = 21.040 ac Runoff Volume = 4.688 af Average Runoff Depth = 2.67"
60.73% Pervious = 12.777 ac 39.27% Impervious = 8.263 ac

Summary for Subcatchment 1S: Site (EAST)

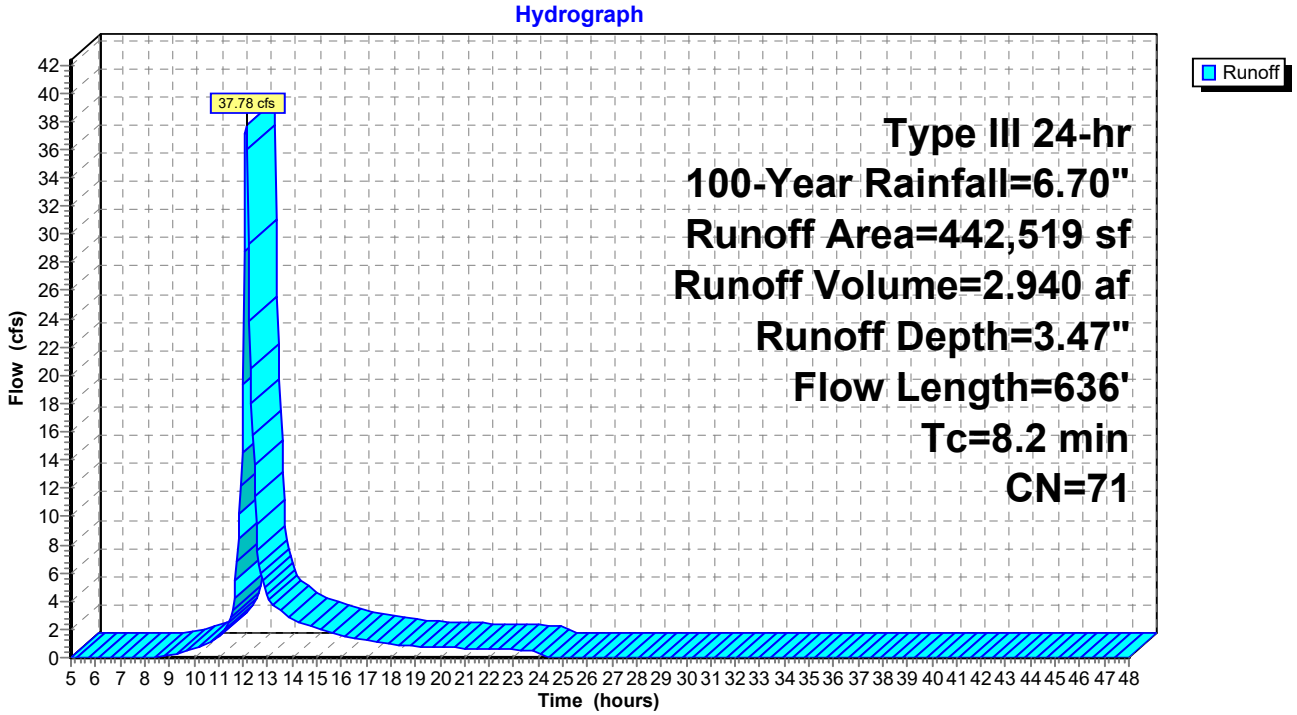
Runoff = 37.78 cfs @ 12.12 hrs, Volume= 2.940 af, Depth= 3.47"
Routed to Pond 1P : BASIN 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
58,376	98	Roofs, HSG A
181,022	98	Paved parking, HSG A
203,121	39	>75% Grass cover, Good, HSG A
442,519	71	Weighted Average
203,121		45.90% Pervious Area
239,398		54.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	50	0.3000	0.20		**Sheet Flow, SHEET** Woods: Light underbrush n= 0.400 P2= 3.20"
1.6	305	0.0400	3.22		**Shallow Concentrated Flow, SHALLOW CONC. FLOW** Unpaved Kv= 16.1 fps
2.4	281	0.0090	1.93		**Shallow Concentrated Flow, SHALLOW CONC. FLOW2** Paved Kv= 20.3 fps
8.2	636	Total			

Subcatchment 1S: Site (EAST)



Summary for Subcatchment 2S: Site (SOUTHWEST)

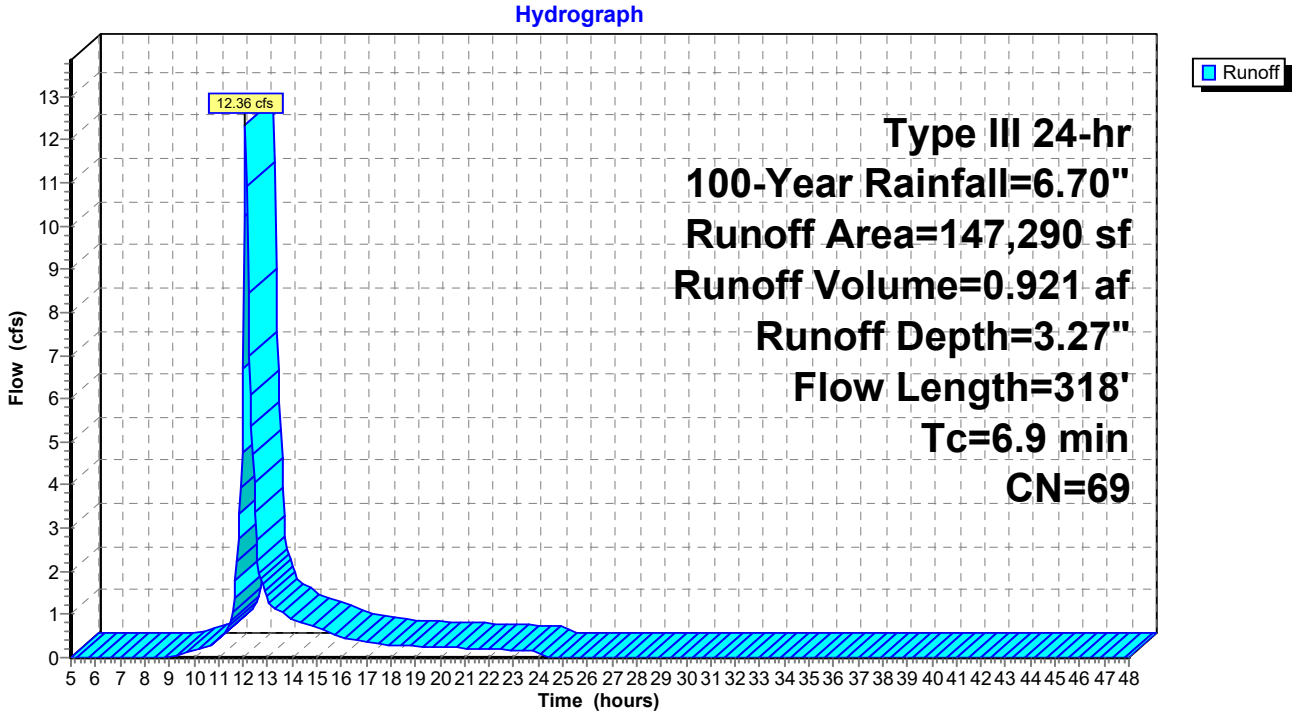
Runoff = 12.36 cfs @ 12.10 hrs, Volume= 0.921 af, Depth= 3.27"
Routed to Pond 2P : BASIN 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
25,000	98	Roofs, HSG A
50,199	98	Paved parking, HSG A
72,091	39	>75% Grass cover, Good, HSG A
147,290	69	Weighted Average
72,091		48.94% Pervious Area
75,199		51.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	50	0.2200	0.18		**Sheet Flow, SHEET** Woods: Light underbrush n= 0.400 P2= 3.20"
0.6	98	0.0300	2.79		**Shallow Concentrated Flow, SHALLOW CONC. FLOW** Unpaved Kv= 16.1 fps
1.6	170	0.0080	1.82		**Shallow Concentrated Flow, SHALLOW CONC. FLOW2** Paved Kv= 20.3 fps
6.9	318	Total			

Subcatchment 2S: Site (SOUTHWEST)



Summary for Subcatchment 3S: Site (WEST)

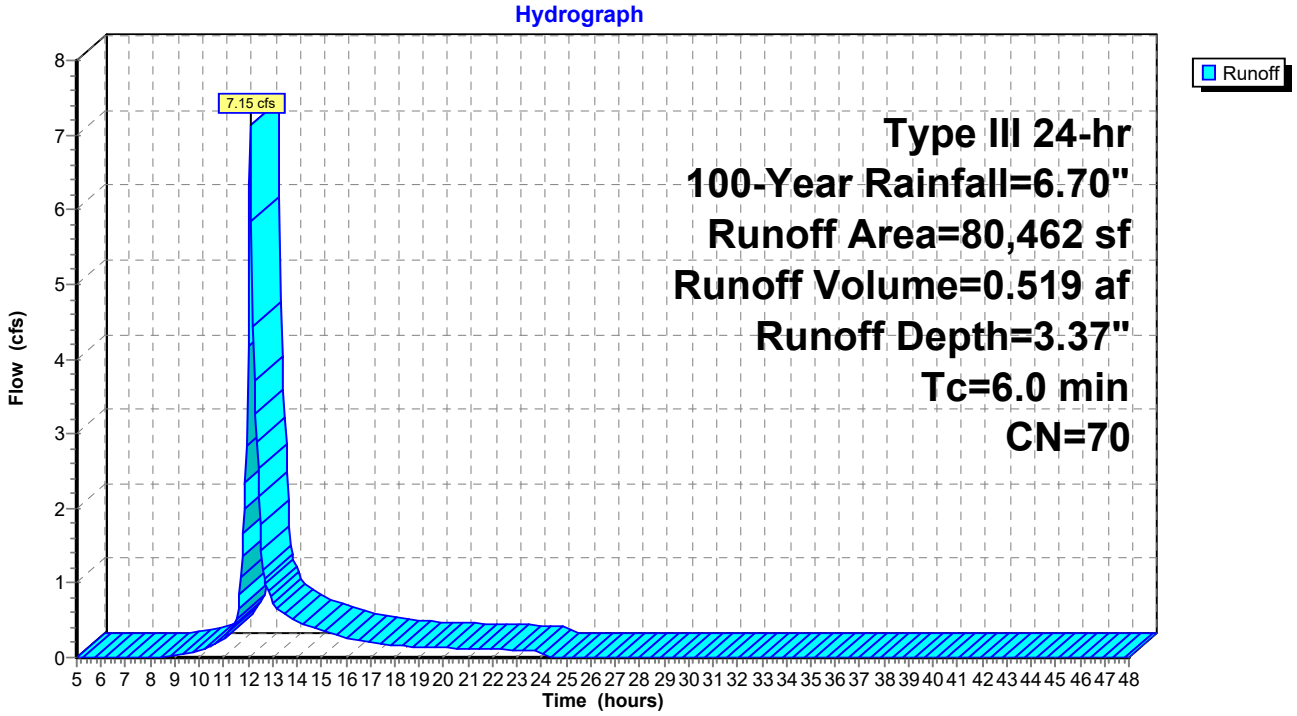
Runoff = 7.15 cfs @ 12.09 hrs, Volume= 0.519 af, Depth= 3.37"
Routed to Pond 2P : BASIN 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
11,160	98	Roofs, HSG A
31,167	98	Paved parking, HSG A
38,135	39	>75% Grass cover, Good, HSG A
80,462	70	Weighted Average
38,135		47.40% Pervious Area
42,327		52.60% Impervious Area

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

Subcatchment 3S: Site (WEST)



Summary for Subcatchment 4S: Site (NORTH)

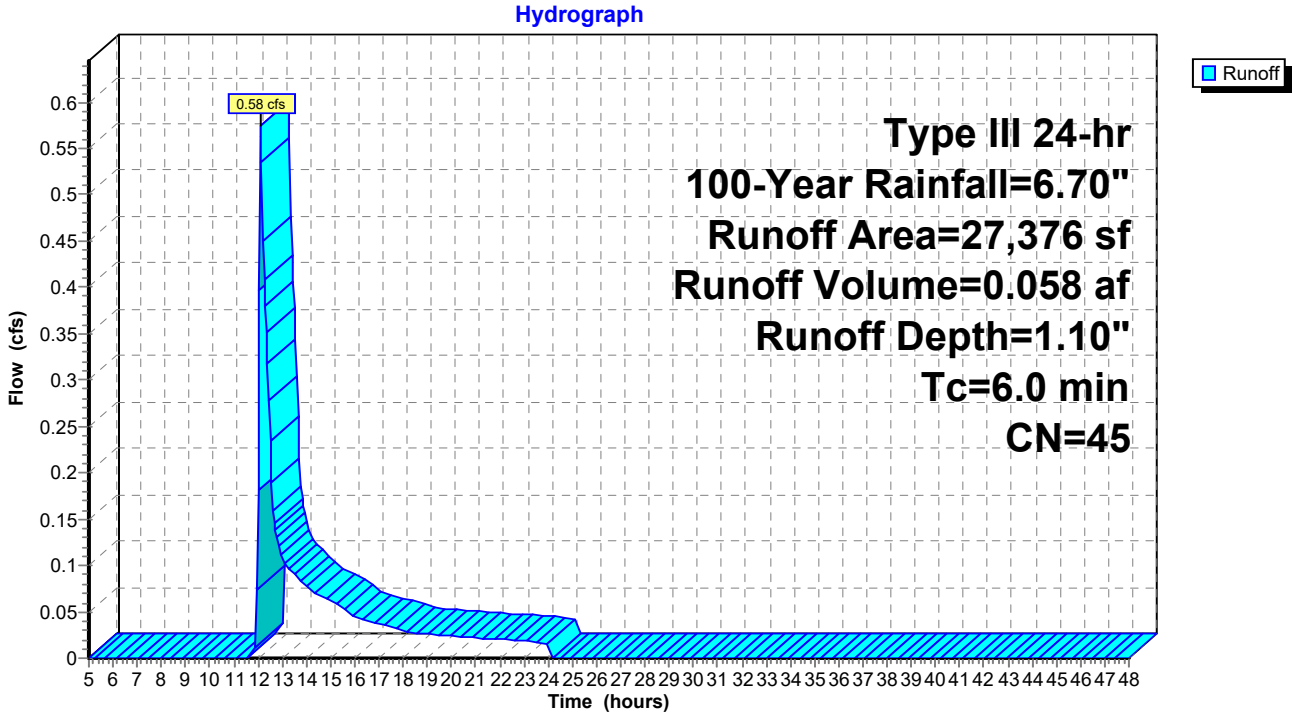
Runoff = 0.58 cfs @ 12.12 hrs, Volume= 0.058 af, Depth= 1.10"
Routed to Reach DP-2 : NORTHEAST PROPERTY LINE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
2,991	98	Paved parking, HSG A
24,385	39	>75% Grass cover, Good, HSG A
27,376	45	Weighted Average
24,385		89.07% Pervious Area
2,991		10.93% Impervious Area

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

Subcatchment 4S: Site (NORTH)



Summary for Subcatchment 5S: POND BUFFER

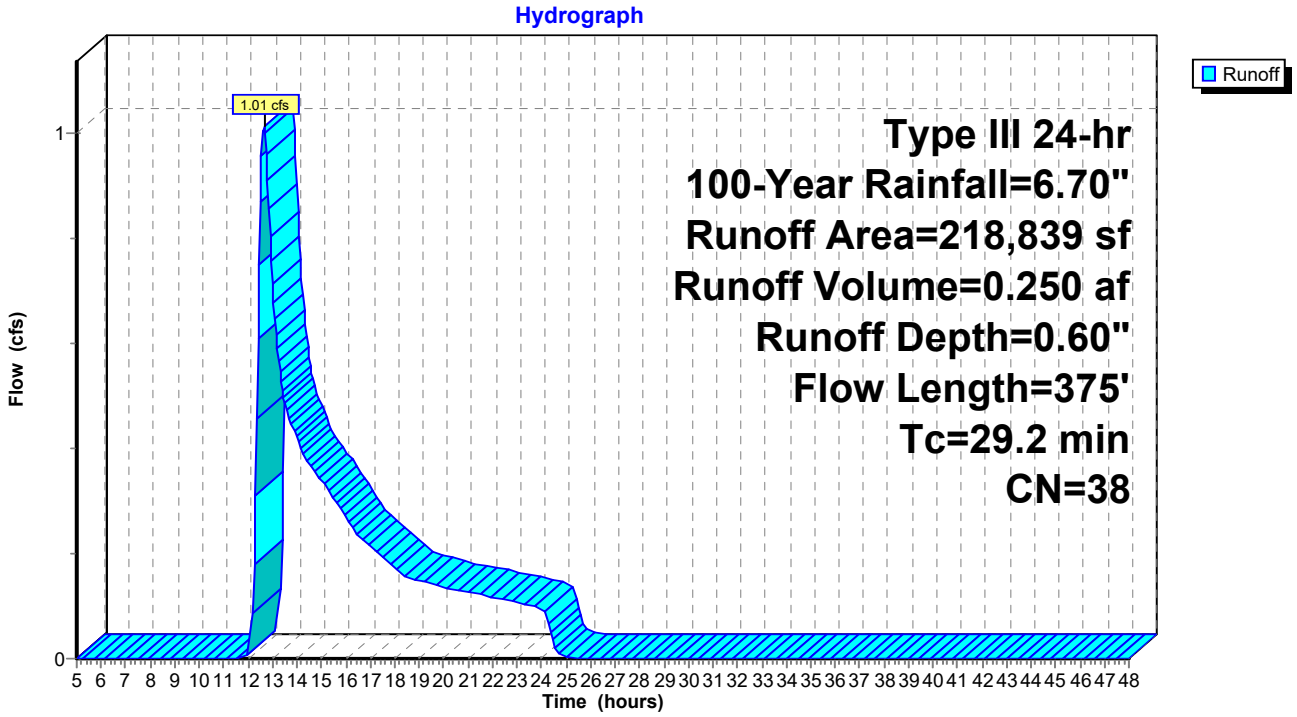
Runoff = 1.01 cfs @ 12.65 hrs, Volume= 0.250 af, Depth= 0.60"
Routed to Reach DP-1 : Ricketts Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
25,887	79	Woods/grass comb., Good, HSG D
192,952	32	Woods/grass comb., Good, HSG A
218,839	38	Weighted Average
218,839		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	50	0.0100	0.03		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.9	325	0.1300	5.80		**Shallow Concentrated Flow, SHALLOW CONC. FLOW** Unpaved Kv= 16.1 fps
29.2	375	Total			

Subcatchment 5S: POND BUFFER



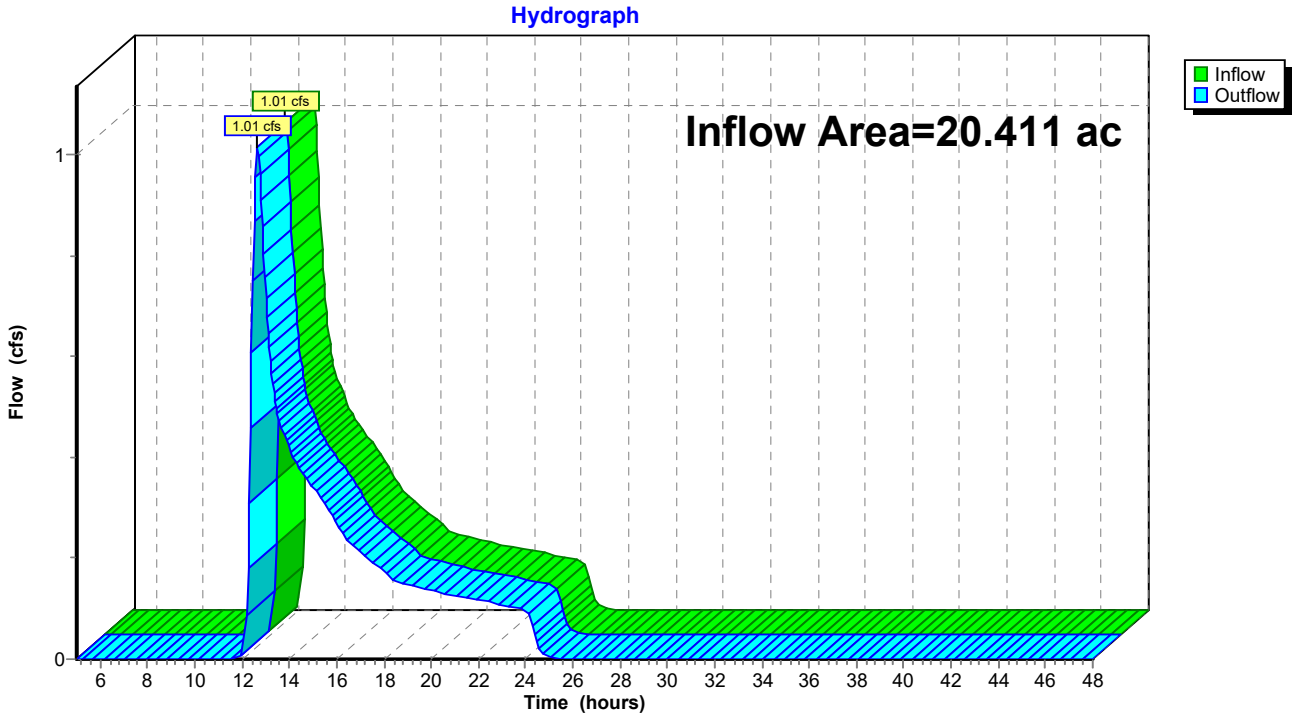
Summary for Reach DP-1: Ricketts Pond

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 20.411 ac, 40.14% Impervious, Inflow Depth = 0.15" for 100-Year event
Inflow = 1.01 cfs @ 12.65 hrs, Volume= 0.250 af
Outflow = 1.01 cfs @ 12.65 hrs, Volume= 0.250 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Reach DP-1: Ricketts Pond



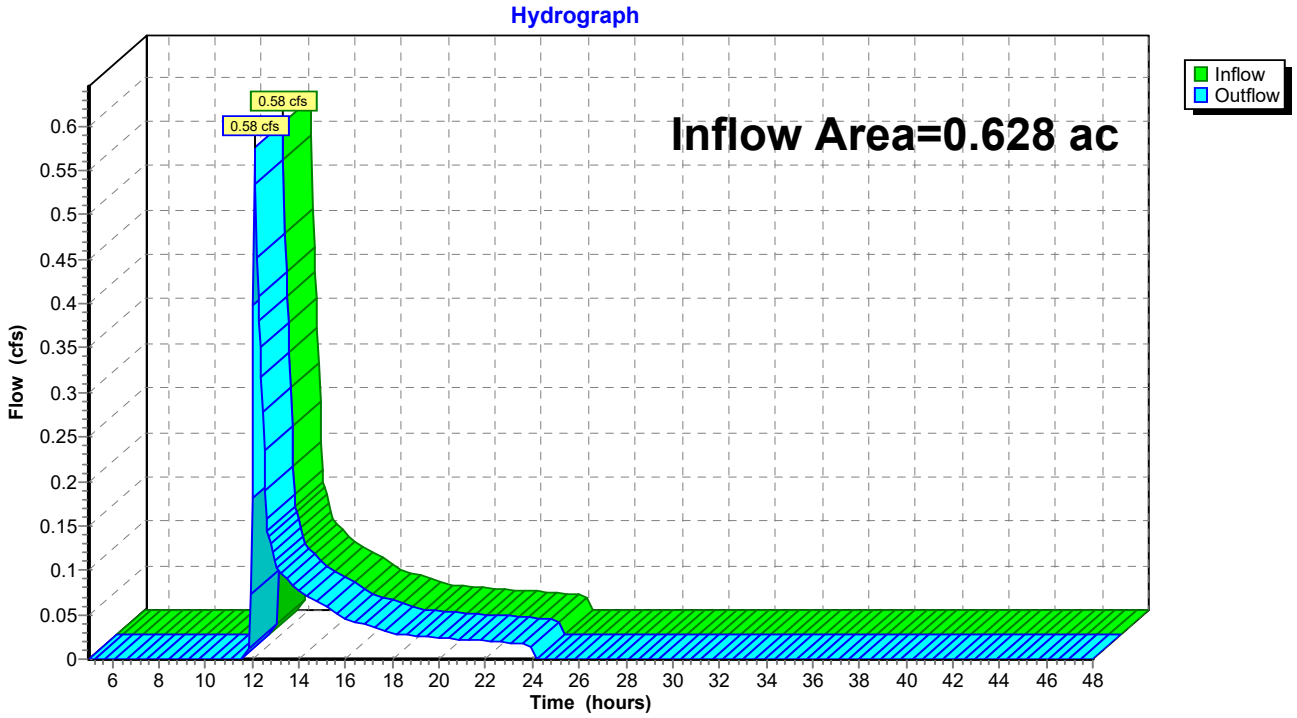
Summary for Reach DP-2: NORTHEAST PROPERTY LINE

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.628 ac, 10.93% Impervious, Inflow Depth = 1.10" for 100-Year event
Inflow = 0.58 cfs @ 12.12 hrs, Volume= 0.058 af
Outflow = 0.58 cfs @ 12.12 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs

Reach DP-2: NORTHEAST PROPERTY LINE



Summary for Pond 1P: BASIN 1

[79] Warning: Submerged Pond 2P Primary device # 2 OUTLET by 0.50'

Inflow Area = 15.387 ac, 53.25% Impervious, Inflow Depth = 2.40" for 100-Year event
Inflow = 37.78 cfs @ 12.12 hrs, Volume= 3.076 af
Outflow = 0.94 cfs @ 10.80 hrs, Volume= 2.957 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.94 cfs @ 10.80 hrs, Volume= 2.957 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af
Routed to Reach DP-1 : Ricketts Pond

Routing by Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 138.00' @ 19.90 hrs Surf.Area= 26,635 sf Storage= 89,121 cf

Plug-Flow detention time= 915.0 min calculated for 2.957 af (96% of inflow)
Center-of-Mass det. time= 893.4 min (1,739.5 - 846.1)

Volume	Invert	Avail.Storage	Storage Description
#1	134.00'	146,199 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

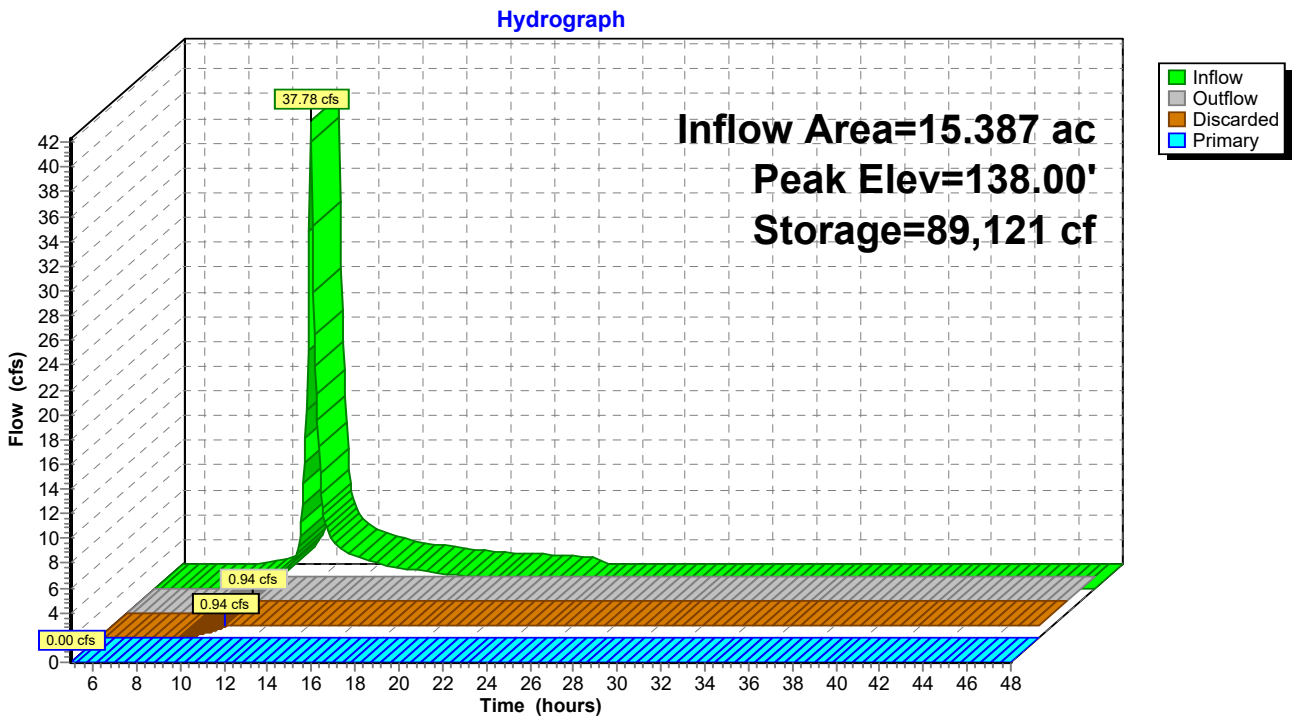
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.00	16,836	0	0
135.00	18,254	17,545	17,545
135.01	21,121	197	17,742
136.00	22,883	21,782	39,524
137.00	24,726	23,805	63,328
138.00	26,626	25,676	89,004
139.00	28,583	27,605	116,609
140.00	30,597	29,590	146,199

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.00'	**0.94 cfs Exfiltration at all elevations**
#2	Primary	138.60'	**10.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.94 cfs @ 10.80 hrs HW=134.06' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.94 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=134.00' (Free Discharge)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: BASIN 1



Summary for Pond 2P: BASIN 2

Inflow Area = 5.228 ac, 51.60% Impervious, Inflow Depth = 3.31" for 100-Year event
Inflow = 19.48 cfs @ 12.10 hrs, Volume= 1.440 af
Outflow = 0.57 cfs @ 17.23 hrs, Volume= 0.991 af, Atten= 97%, Lag= 307.7 min
Discarded = 0.27 cfs @ 10.40 hrs, Volume= 0.854 af
Primary = 0.30 cfs @ 17.23 hrs, Volume= 0.137 af
Routed to Pond 1P : BASIN 1

Routing by Stor-Ind method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 138.75' @ 17.23 hrs Surf.Area= 13,704 sf Storage= 44,818 cf

Plug-Flow detention time= 914.6 min calculated for 0.989 af (69% of inflow)
Center-of-Mass det. time= 815.9 min (1,650.7 - 834.9)

Volume	Invert	Avail.Storage	Storage Description
#1	134.00'	63,393 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

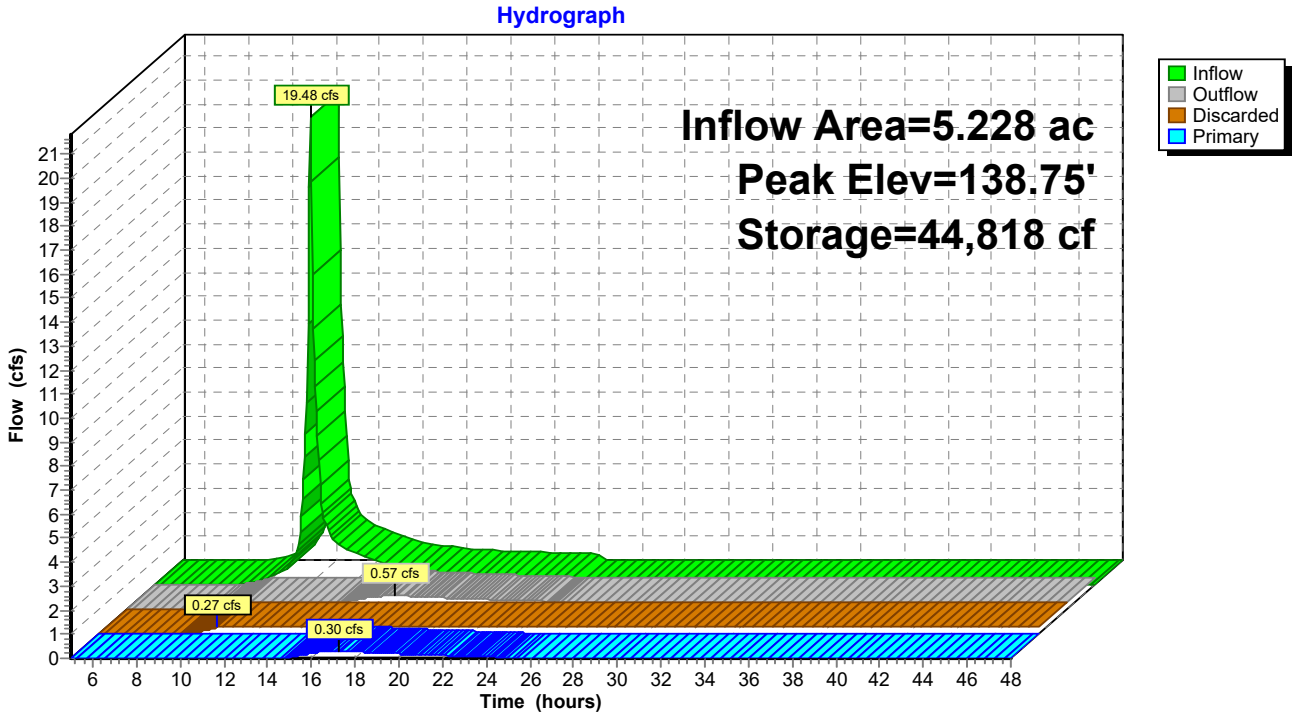
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
134.00	4,914	0	0
135.00	6,275	5,595	5,595
135.01	7,540	69	5,664
136.00	8,924	8,150	13,813
137.00	10,604	9,764	23,577
138.00	12,350	11,477	35,054
139.00	14,156	13,253	48,307
140.00	16,016	15,086	63,393

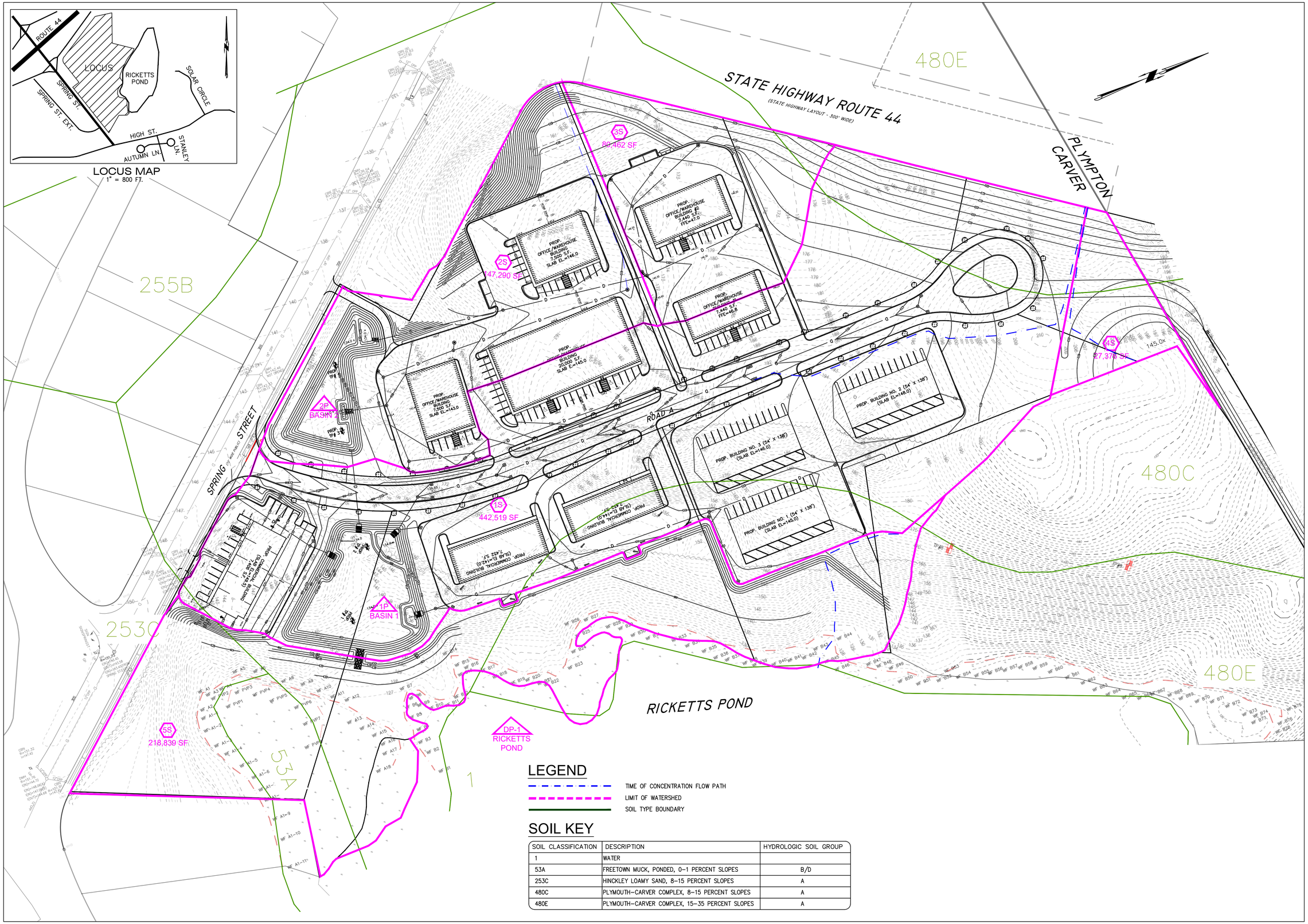
Device	Routing	Invert	Outlet Devices
#1	Discarded	134.00'	**0.27 cfs Exfiltration at all elevations**
#2	Primary	138.50'	**15.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 138.50' / 137.50' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.27 cfs @ 10.40 hrs HW=134.06' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=0.30 cfs @ 17.23 hrs HW=138.75' (Free Discharge)
└─**2=Culvert** (Inlet Controls 0.30 cfs @ 1.70 fps)

Pond 2P: BASIN 2





LEGEND

- TIME OF CONCENTRATION FLOW PATH
- LIMIT OF WATERSHED
- SOIL TYPE BOUNDARY

SOIL KEY

SOIL CLASSIFICATION	DESCRIPTION	HYDROLOGIC SOIL GROUP
1	WATER	
53A	FREETOWN MUCK, PONDED, 0-1 PERCENT SLOPES	B/D
253C	HINCKLEY LOAMY SAND, 8-15 PERCENT SLOPES	A
480C	PLYMOUTH-CARVER COMPLEX, 8-15 PERCENT SLOPES	A
480E	PLYMOUTH-CARVER COMPLEX, 15-35 PERCENT SLOPES	A

REV	DATE	DESCRIPTION	BY	APP

MCKENZIE ENGINEERING GROUP
Assinippi Office Park
150 Longwater Drive, Suite 101
Norwell, MA 02061
P: 781.792.3900
F: 781.792.0333
www.mckeng.com

PROPOSED COMMERCIAL DEVELOPMENT
RICKETTS POND BUSINESS PARK

OFF SPRING STREET
CARVER, MASSACHUSETTS

PROFESSIONAL ENGINEER:

PERMIT PLAN SET

OWNER/APPLICANT:
RPBP, LLC
3 MARION DRIVE
CARVER, MA 02330

DRAWN BY:	ESS
DESIGNED BY:	ESS
CHECKED BY:	BCM
APPROVED BY:	BCM
DATE:	FEBRUARY 25, 2022
SCALE:	1"=60'
PROJECT NO.:	217-182

DWG. TITLE:
POST-DEV. WATERSHED PLAN

DWG. NO: WS-2

M:\MEG\2017 PROJECTS\217-182 (SLT CARVER)\RESEARCH\SLT\INDIVIDUAL LOT DEVELOPMENT\217-182 COMPILED LOTS.DWG