DRAINAGE ANALYSIS

for

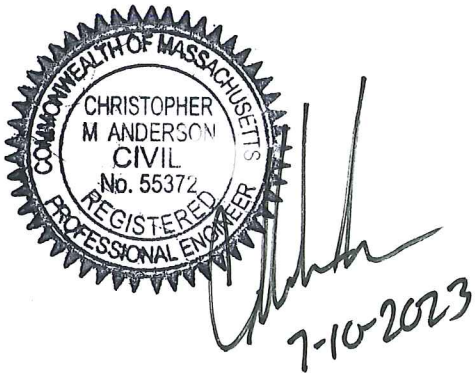
ZP Battery DevCo, LLC

0 Murdock Avenue

Winchendon, Massachusetts

March 27, 2023

Revised July 10, 2023



Prepared for: ***ZP BatteryDev Co, LLC***
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DRAINAGE NARRATIVE

1.0 NARRATIVE
Revised Through July 10, 2023

1.1 INTRODUCTION

On behalf of our client, ZP Battery DevCo, LLC, Hannigan Engineering, Inc. has prepared this Drainage Analysis and Report as part of the submittal package for Site Plan Review for a Solar Energy Storage System (ESS) at #0 Murdock Avenue in Winchendon, Massachusetts (Map/Parcel 5A2/25 and 5A2/26). The Project will be situated on a piece of property on the easterly side of Murdock Avenue in Winchendon, Massachusetts. The proposed construction will entail the general regarding of the land in order to facilitate the construction of the ESS sytem including provisions for access and drainage infrastructure.

The purpose of this analysis is to compare the pre-development and post-development peak flow rates to certain design points from the project. In particular, changes in peak rates of runoff generally associated with alterations of land use were studied. These alterations include land being transformed from areas of landscape (grass), woods, and brush to areas of grass, landscape, and impervious areas (rooftops, sidewalks and pavement). The effects of stormwater being re-directed to new areas as a result of the proposed construction and the associated drainage system were reviewed as well. For the purposes of this report, any developed areas which are not impervious will be considered to consist of lawn and landscape areas.

The U.S. Soil Conservation Sevice (SCS) methods were utilized for this analysis in order to establish land use and run-off characteristics in the determination of pre- and post-developement peak run-off rates. All proposed development areas and subsequent impacts on stormwater runoff relative to this development have been incorporated within this analysis and report.

The drainage from the site currently flows to single design point along the westerly side of the overall development, to a large expansive wetland area exists. In the area of the proposed development, an increase in impervious areas due the construction of the concrete pads to store the ESS along with the general clearing of the land will occur, requiring additional provisions be made to provide compliance with the Massachusetts Stormwater Regulations. These measures include the implementation of a rain garden feature to capture and detain a portion of the anticpated runoff from the development.

1.2 METHOD OF ANALYSIS

The enclosed hydrologic calculations utilize the runoff estimating techniques developed by the USDA Soil Conservation Service (SCS). The following publications were used in the preparation of this report:

1. "Urban Hydrology for Small Watersheds"[1]
2. "National Engineering Handbook, Hydrology, Section 4" (NEH-4)[2]
3. "Handbook of Hydraulics" 6th ed. - E.F. Brater & H. Williams[3]
4. "Soil Survey Report for Northeastern Worcester County" 1985 ed. - USDA NRCS[4]

Using SCS publications and other texts on surface water hydrology, in conjunction with drainage software *HydroCAD* developed by Applied Microcomputer Systems[5], Hannigan Engineering, Inc. has calculated peak rates of runoff relative to the subject site for conditions prior to development as well as conditions upon the completion of construction. The drainage software program *HydroCAD* calculates peak rates of runoff similarly to the computer program known as *Computer Programs for Project Formulations-Hydrology, Technical Release Number 20 (TR-20),* developed by SCS. This program and series of programs are the technical standard utilized by engineers, Planning Boards, Conservation Commission, and Municipal Agencies throughout the region and across the country for the evaluation of storm water conditions.

The analysis reviews certain parameters of sub-watersheds surrounding the subject site and how these parameters are affected by various rainfall conditions. These parameters include land cover and use, soil strata and permeability, and variations in slope. These parameters are used to develop rainfall runoff characteristics, which are used to analyze both pre and post development conditions within and surrounding the proposed construction activity. Some of these characteristics include times of concentration (Tc), peak rates of runoff, runoff volume, and the time the peak rate of runoff occurs within the particular storm event.

Times of concentration were computed by using the SCS "Upland Method" as described in the aforementioned National Engineering Handbook and were utilized for the analysis of the individual watersheds. The Upland Method computes the time of travel of storm waters over segments of the watershed depending upon land conditions, such as surface roughness, channel configuration, slope of land, and flow patterns. The addition of these travel times determines the individual watershed Time of Concentration. This method translates to more accurate Tc's than other more general methods.

1.3 SITE DESCRIPTION

The site is located along either side of Murdock Avenue in Winchendon on two properies with a combined area of approximately 8-acres. The main components of the site are located on the easterly side of Murdock Avenue on Parcel 5A2/26. Portions of the drainage system are located on the westerly side of Murdock Avenue on Parcel 5A2/25. Currently the portions of the property to be developed are comprised of woodland area with no standing structures on the property. Areas subject to protection under the Wetlands Protection Act were reviewed by LEC Environmental Consultants and are depicted on the Site Plans. These areas include Bordering Vegetated Wetlands (BVW) located along the easterly and westerly sides of Murdock Avenue and hydraulically connected via a stone culvert within the roadway with the area generally flowing in a westerly direction.

The project entails the construction of a standalone solar Energy Storage System (ESS) with an estimated capacity of approximately 10-Megawatt AC on the property. The proposed storage systems will be located along the easterly side of Murdock Avenue on Parcel 5A2/26, with Parcel 5A2/25 along the westerly side being utilized for a rain garden for stormwater management. Unlike ground-mounted Solar Energy Systems that involve the generation of energy, this facility is utilized purely for the storage of energy generated from area solar systems connected to the grid.

As part of the initial site preparation, appropriate erosion control measures will be installed to prevent the transport of soils and sediments to the lower elevations of the site. The site development will consist of the installation of eight (8) concrete pads on which the sixteen (16) ESS units will be situated. Additional electrical components and transformer pads will also be installed to allow the eventual interconnection to the grid. The electrical equipment has been separated into two fenced in areas, each containing four concrete pads with a central area between the two sites to utilize a single common electrical connection. The total area of alteration associated with the project will be approximately an acre along the easterly side and 15,000 square feet along the westerly side of Murdock Avenue.

Access to the site will be provided via Murdock Avenue by a 24-foot-wide gravel driveway that extends easterly into the development and then runs parallel to Murdock Avenue. This driveway will provide access between the two fenced areas with three access points to Murdock Avenue. Access points are located at the terminal ends of the driveway and at the center of the project near the connection equipment. The gravel driveway is intended to provide access to the site on a periodic basis for general maintenance and inspections of the facility.

For the purpose of the analysis, certain design points were reviewed. The design points are where the pre-development drainage for the subcatchment areas of the watershed over the property are directed. The same design points have been utilized and reviewed for both pre- and post-development runoff conditions. The drainage from the site currently flows to a single point located at the wetland area along the westerly side of Murdock Avenue, this area has been designated as Design Point #1 (DP#1).

1.4 SOIL CHARACTERISTICS

Soil types for this analysis were based upon review of soils information contained in the SCS publication *Hyrdrologic Soil Group-Worcester County Northwestern Part, Massachusetts.* The original mapping has been reestablished via the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) as part of the National Cooperative Soil Survey under the Natural Resource Conservation Service and its website This mapping is the basis for the soil type determinations for this analysis.

The soils are classified by number and name by SCS and, subsequently, the Hydrological Soil Group has been designated within the Urban Hydrology for Small Watersheds manual. Soils within the subject watersheds are also hydrologically classified into different soil groups as defined by the Soil Conservation Service

Soil Designation	Name	Hydrological Group
908C	Becket-Skerry Association	C
917B	Pillsbury-Peacham Association	C/D

1.5 RUNOFF CURVE NUMBERS

The SCS runoff curve numbers used in all watershed modeling contained in this report are based on the Hydrologic Soil Groups and land uses below:

Land Use	Hydrologic Soil Group	Curve #	
Grass Cover (good)	C	74	
Woods (good)	C	70	
Woods (good)	D	77	*within wetland areas*
Gravel Roads	C	89	
Gravel Surface	NA	96	
Impervious Area	NA	98	

1.6 DESIGN CRITERIA

This drainage analysis was developed utilizing NRCS, 24-hour storm as required by the Local Stormwater Bylaw. The storm frequencies and the corresponding 24-hour rainfall amounts are as follows:

Storm Frequency (years)	Rainfall (inches)
2	3.13
10	4.68
25	5.88
100	8.34

1.7 THE PROPOSED DRAINAGE SYSTEM

As with any development, changes in land use such as the transformation of woodland areas to lawn, landscape and impervious areas cause increased peak rates of runoff to the design points. These areas on this site consist of access drives and pad areas for ESS, as well as alterations in land use from woodland areas to open lawn and landscaped areas. In order to mitigate increases in peak rate of runoff, the site grading has been carefully designed to direct these land alterations to the storm drainage system.

The proposed drainage system captures stormwater runoff the project area via a series of deep-sump catchbasins and directs it towards a central drainage trunkline within the development. This trunkline discharges the runoff to the opposite side of Murdock Avenue to a proposed detention/rain garden feature. The system will be equipped with a PVC sub-drain system and an outlet structure consisting of various orifices to control the discharge rate of the flow. During smaller storm events, the stormwater will back up in the garden controlled by the discharge flow allowed by the subdrain system and outlet control structure.

Upon the completion of the storm event, these discharge control features will control the flow at or below pre-development levels until the stormwater has drained from the basin. It is noted that this subdrain system has a dual purpose of draining the basin between storm events and preventing groundwater from entering the basin from below. In addition to the subdrain and outlet structure, the rain garden will also be equipped with an emergency spillway. Based on the calculations, the emergency spillway will not experience flow in any storm event. Peak rate mitigation has been achieved during all storm events for the design point.

1.8 CONCLUSIONS

As stated above, a single Design Points have been established. Design Point #1 (DP#1) has been designated at a low point in the adjancent vegetated wetladn located along the westerly side of Murdock Ave. Changes in land use are the predominant cause of increases in peak rate of runoff to these design points. Under proposed conditions, the majority of stormwater runoff will be captured by a proposed rain garded before being directed towards DP#1. The results of the Drainage Analysis and resulting decreases in peak rates of runoff are below.

Table #1: Peak Rates of Runoff

Design Point		2-yr Storm	10-yr Storm	25-yr Storm	100-yr Storm
#1	Pre-	7.29	15.49	22.35	36.93
	Post-	7.14	14.21	20.66	34.00

As outlined above, the post-development peak rates of runoff show an decrease in peak rate of runoff for the design point. The storm water management as outlined herein and as shown on the accompanying plans has the following positive values relative to storm water management:

A) Attenuation of the 2-, 10-, 25- and 100-year storm events has mitigated increases in peak rates of runoff, or has been justified herein.
B) The Stormwater Operation and Maintenance Plan (OMP) attached, has been prepared to ensure long-term function of the system, as designed.

[1]"Urban Hydrology for Small Watersheds (Technical Release Number 55); Engineering Division, United States Dept. of Agriculture ,Soil Conservation Service (Jan. 1975)

[2]"National Engineering Handbook Section 4- Hydrology" ; United States Dept. of Agriculture, Soil Conservation Service (March 1985)

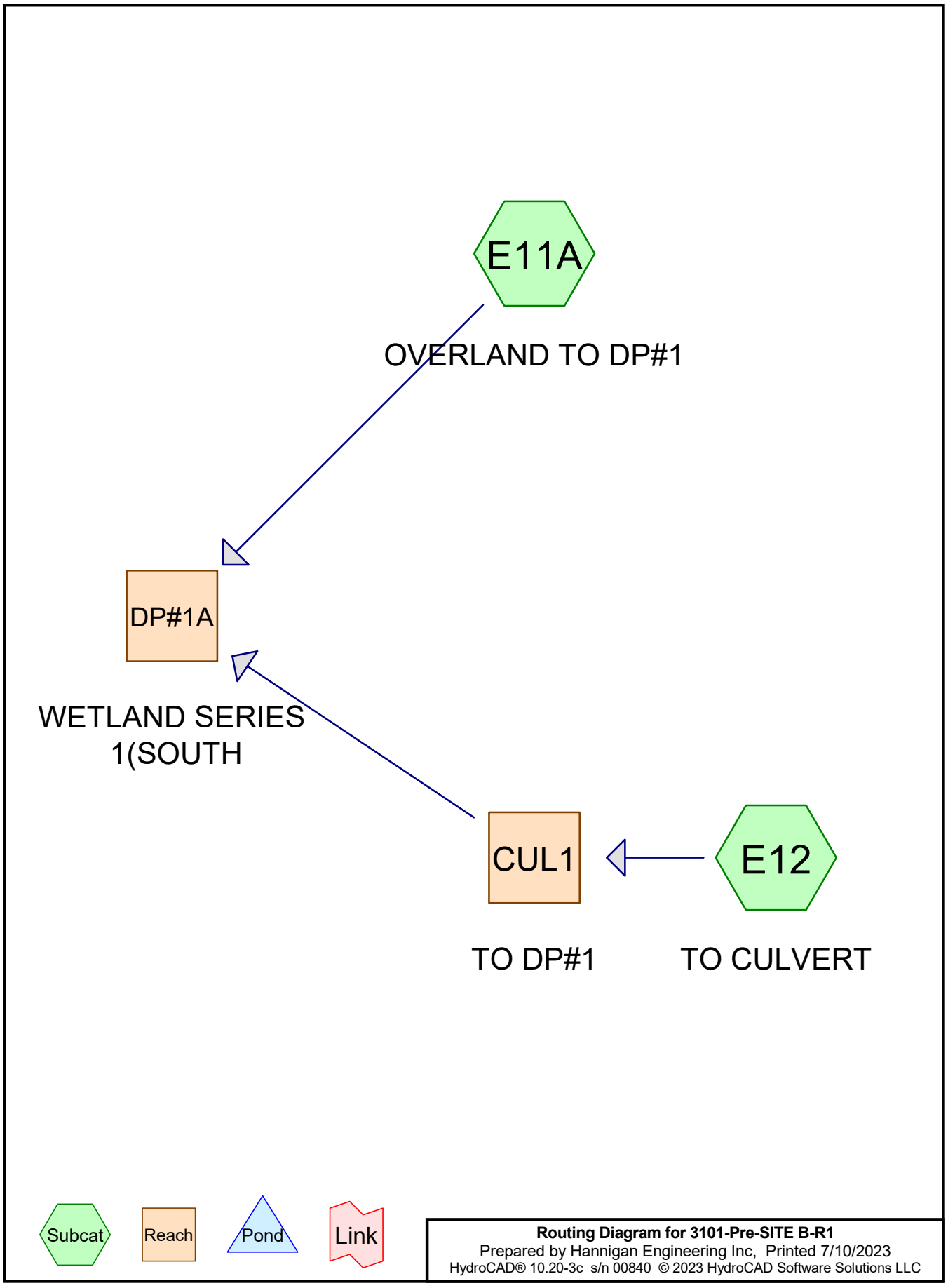
[3]"Handbook of Hydraulics" - 6th ed., E.F. Brater & H. Williams (1976)

[4]"Interim Soil Report for Southern Worcester County" 1995 ed., Published by the Southern Worcester County Conservation District, in cooperation with the United States Department of Agriculture, Natural Resources Conservation Service (1995)

[5] "HydroCAD" Drainage software developed by Applied Microcomputer, Page Hill Road, Chocorua, NH

2.0
HYDROLOGICAL CALCULATIONS

2.1
PRE-DEVELOPMENT CALCULATIONS



Routing Diagram for 3101-Pre-SITE B-R1
Prepared by Hannigan Engineering Inc, Printed 7/10/2023

Project Notes

Rainfall events imported from "Atlas-14-Rain.txt" for 449 MA Worcester North

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	NRCC 24-hr	D	Default	24.00	1	3.13	2
2	10-Year	NRCC 24-hr	D	Default	24.00	1	4.68	2
3	25-Year	NRCC 24-hr	D	Default	24.00	1	5.88	2
4	100-Year	NRCC 24-hr	D	Default	24.00	1	8.34	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.081	74	>75% Grass cover, Good, HSG C (E11A)
0.691	96	Gravel surface, HSG C (E11A)
0.305	98	Paved parking, HSG C (E11A)
4.364	70	Woods, Good, HSG C (E11A, E12)
3.757	77	Woods, Good, HSG D (E11A, E12)
9.198	**76**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
5.441	HSG C	E11A, E12
3.757	HSG D	E11A, E12
0.000	Other	
9.198		**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
0.000	0.000	0.081	0.000	0.000	0.081	>75% Grass cover, Good	E11A
0.000	0.000	0.691	0.000	0.000	0.691	Gravel surface	E11A
0.000	0.000	0.305	0.000	0.000	0.305	Paved parking	E11A
0.000	0.000	4.364	3.757	0.000	8.120	Woods, Good	E11A, E12
0.000	**0.000**	**5.441**	**3.757**	**0.000**	**9.198**	**TOTAL AREA**	

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E11A: OVERLAND TO DP#1 Runoff Area=264,550 sf 5.03% Impervious Runoff Depth=1.16"
Flow Length=331' Tc=12.2 min CN=77 Runoff=6.01 cfs 0.588 af

Subcatchment E12: TO CULVERT Runoff Area=136,113 sf 0.00% Impervious Runoff Depth=0.99"
Flow Length=805' Tc=24.0 min CN=74 Runoff=1.88 cfs 0.258 af

Reach CUL1: TO DP#1 Avg. Flow Depth=0.42' Max Vel=2.24 fps Inflow=1.88 cfs 0.258 af
n=0.025 L=36.0' S=0.0072 '/' Capacity=15.42 cfs Outflow=1.88 cfs 0.258 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=7.29 cfs 0.846 af
Outflow=7.29 cfs 0.846 af

Total Runoff Area = 9.198 ac Runoff Volume = 0.846 af Average Runoff Depth = 1.10"
96.68% Pervious = 8.892 ac 3.32% Impervious = 0.305 ac

Summary for Subcatchment E11A: OVERLAND TO DP#1

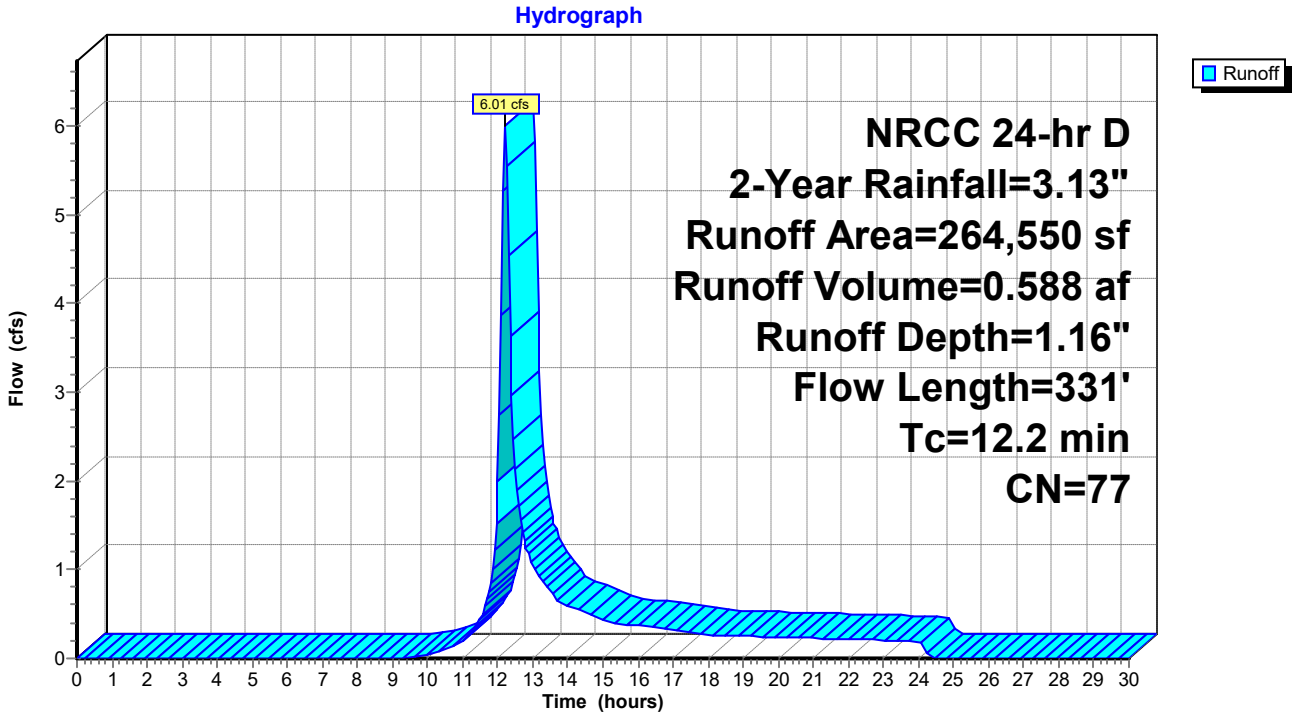
Runoff = 6.01 cfs @ 12.21 hrs, Volume= 0.588 af, Depth= 1.16"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
3,520	74	>75% Grass cover, Good, HSG C
137,884	70	Woods, Good, HSG C
30,113	96	Gravel surface, HSG C
13,307	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
264,550	77	Weighted Average
251,243		94.97% Pervious Area
13,307		5.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.4	25	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	100	0.0840	1.45		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	32	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	124	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	331	Total			

Subcatchment E11A: OVERLAND TO DP#1



Summary for Subcatchment E12: TO CULVERT

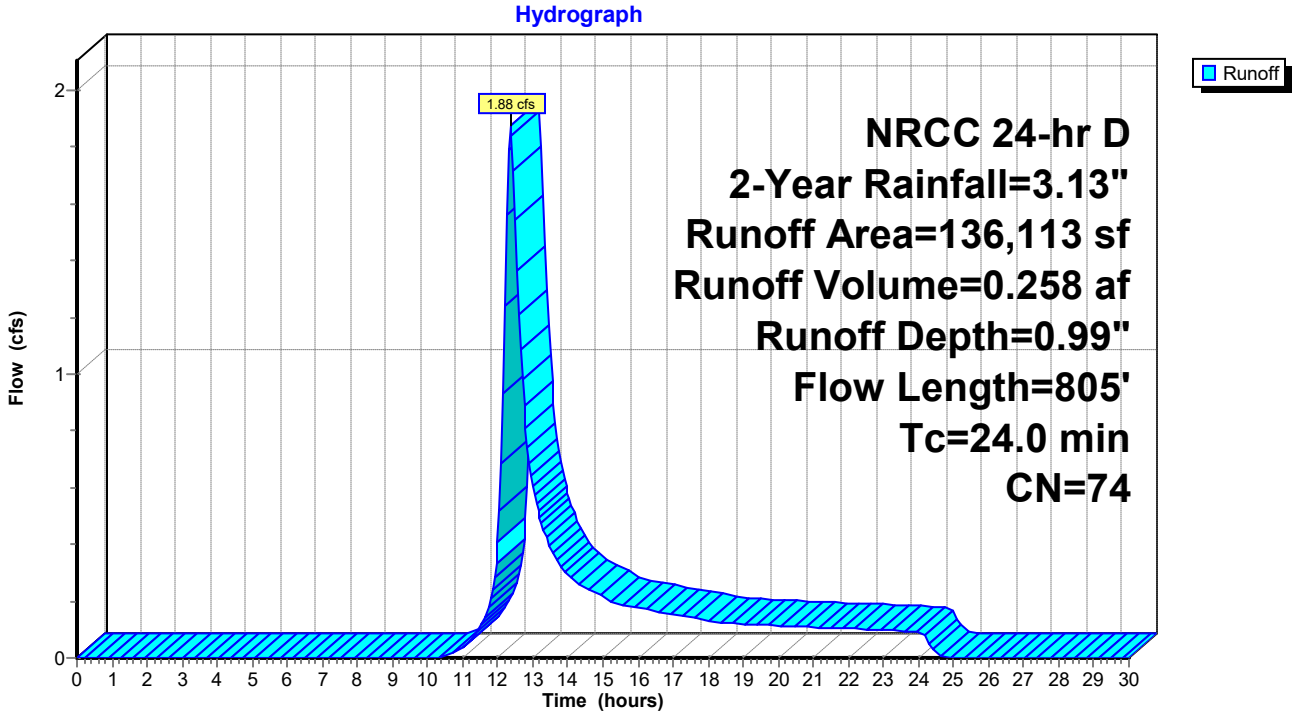
Runoff = 1.88 cfs @ 12.36 hrs, Volume= 0.258 af, Depth= 0.99"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
52,192	70	Woods, Good, HSG C
83,921	77	Woods, Good, HSG D
136,113	74	Weighted Average
136,113		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment E12: TO CULVERT



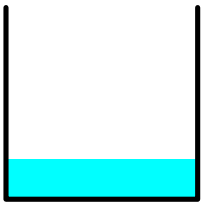
Summary for Reach CUL1: TO DP#1

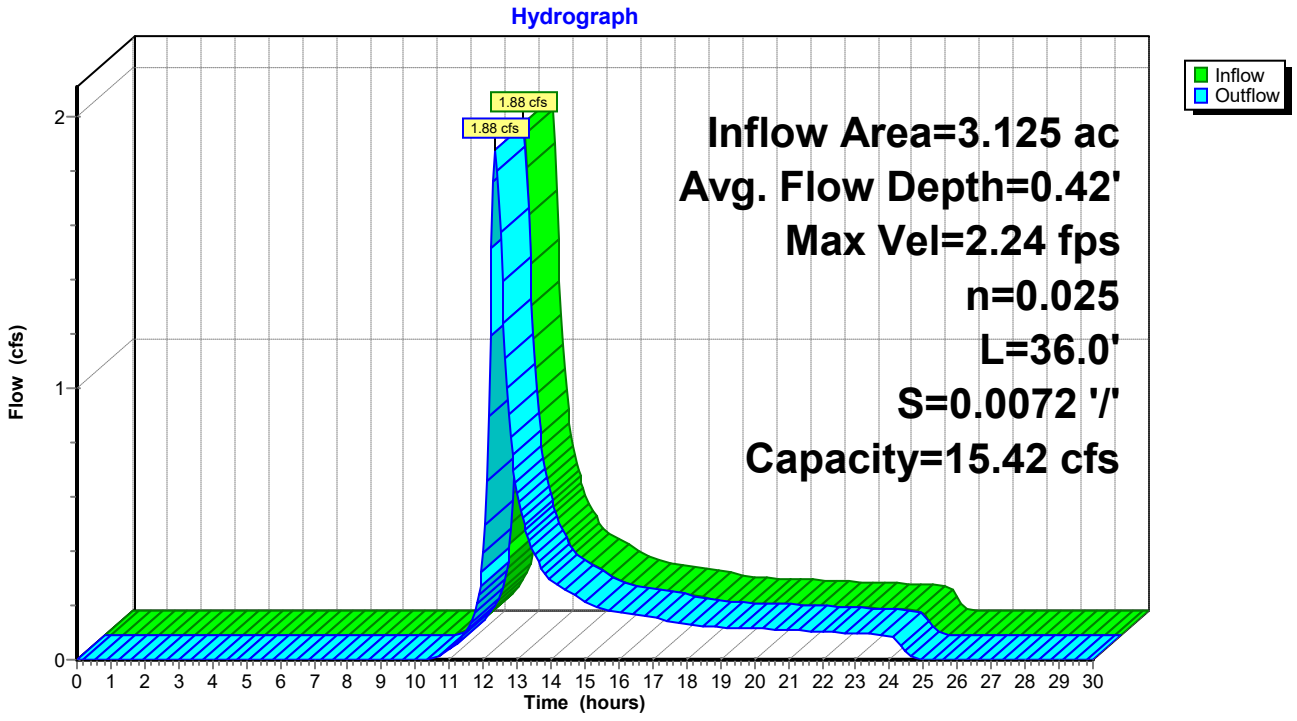
Inflow Area = 3.125 ac, 0.00% Impervious, Inflow Depth = 0.99" for 2-Year event
Inflow = 1.88 cfs @ 12.36 hrs, Volume= 0.258 af
Outflow = 1.88 cfs @ 12.37 hrs, Volume= 0.258 af, Atten= 0%, Lag= 0.4 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.24 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 0.7 min

Peak Storage= 30 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.42' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 15.42 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0072 '/'
Inlet Invert= 104.26', Outlet Invert= 104.00'





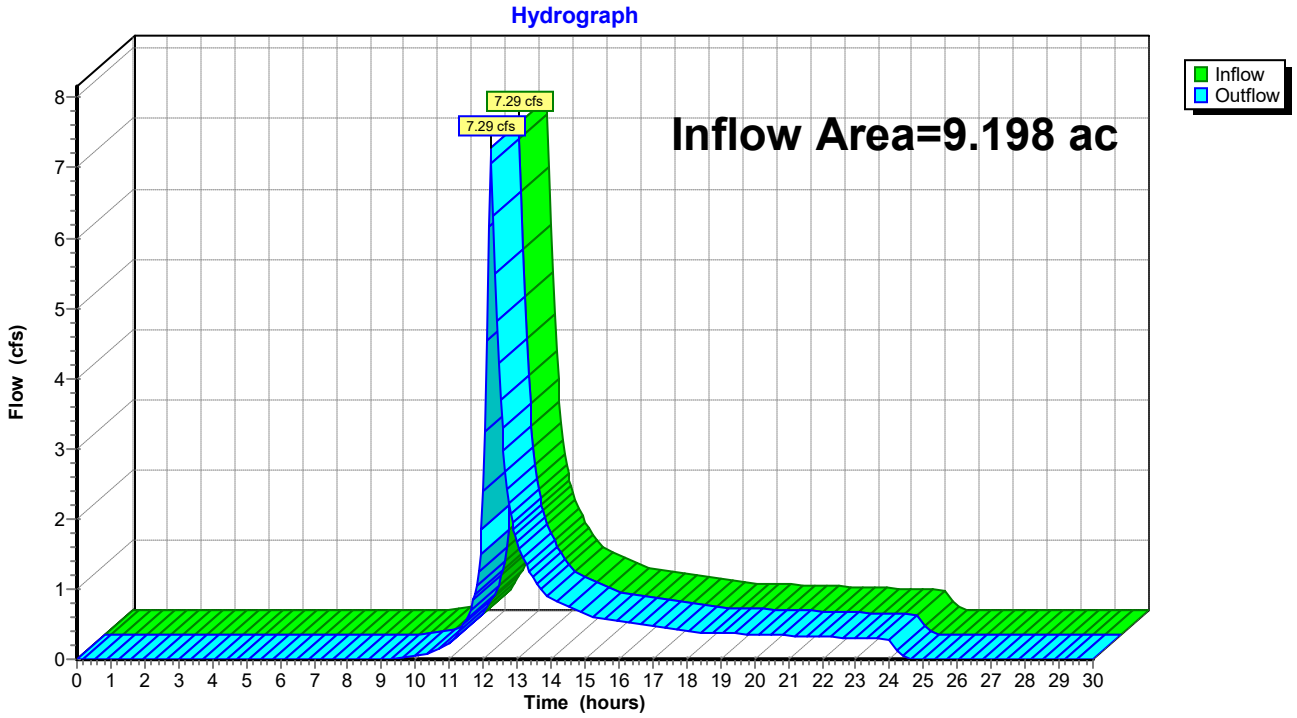
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 3.32% Impervious, Inflow Depth = 1.10" for 2-Year event
Inflow = 7.29 cfs @ 12.22 hrs, Volume= 0.846 af
Outflow = 7.29 cfs @ 12.22 hrs, Volume= 0.846 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E11A: OVERLAND TO DP#1 Runoff Area=264,550 sf 5.03% Impervious Runoff Depth=2.36"
Flow Length=331' Tc=12.2 min CN=77 Runoff=12.47 cfs 1.193 af

Subcatchment E12: TO CULVERT Runoff Area=136,113 sf 0.00% Impervious Runoff Depth=2.11"
Flow Length=805' Tc=24.0 min CN=74 Runoff=4.22 cfs 0.550 af

Reach CUL1: TO DP#1 Avg. Flow Depth=0.74' Max Vel=2.86 fps Inflow=4.22 cfs 0.550 af
n=0.025 L=36.0' S=0.0072 '/' Capacity=15.42 cfs Outflow=4.21 cfs 0.550 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=15.49 cfs 1.743 af
Outflow=15.49 cfs 1.743 af

Total Runoff Area = 9.198 ac Runoff Volume = 1.743 af Average Runoff Depth = 2.27"
96.68% Pervious = 8.892 ac 3.32% Impervious = 0.305 ac

Summary for Subcatchment E11A: OVERLAND TO DP#1

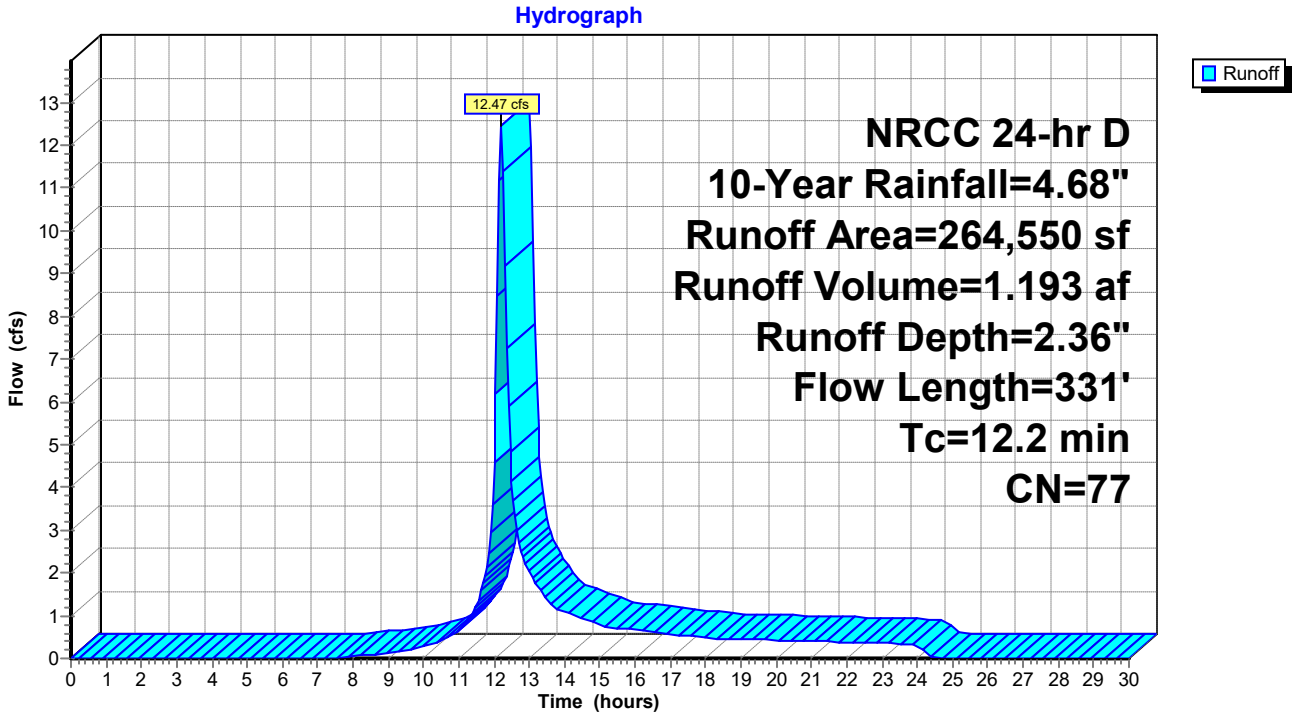
Runoff = 12.47 cfs @ 12.20 hrs, Volume= 1.193 af, Depth= 2.36"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
3,520	74	>75% Grass cover, Good, HSG C
137,884	70	Woods, Good, HSG C
30,113	96	Gravel surface, HSG C
13,307	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
264,550	77	Weighted Average
251,243		94.97% Pervious Area
13,307		5.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.4	25	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	100	0.0840	1.45		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	32	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	124	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	331	Total			

Subcatchment E11A: OVERLAND TO DP#1



Summary for Subcatchment E12: TO CULVERT

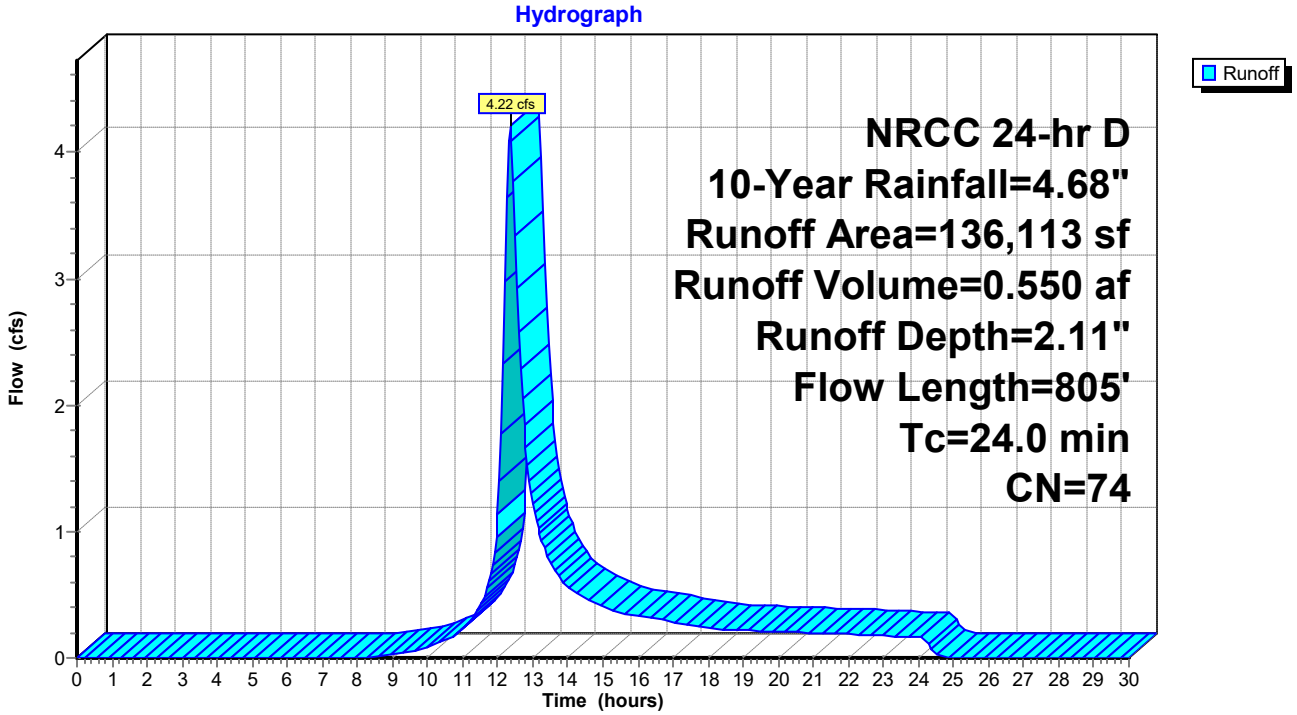
Runoff = 4.22 cfs @ 12.35 hrs, Volume= 0.550 af, Depth= 2.11"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
52,192	70	Woods, Good, HSG C
83,921	77	Woods, Good, HSG D
136,113	74	Weighted Average
136,113		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment E12: TO CULVERT



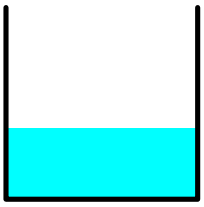
Summary for Reach CUL1: TO DP#1

Inflow Area = 3.125 ac, 0.00% Impervious, Inflow Depth = 2.11" for 10-Year event
Inflow = 4.22 cfs @ 12.35 hrs, Volume= 0.550 af
Outflow = 4.21 cfs @ 12.36 hrs, Volume= 0.550 af, Atten= 0%, Lag= 0.4 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

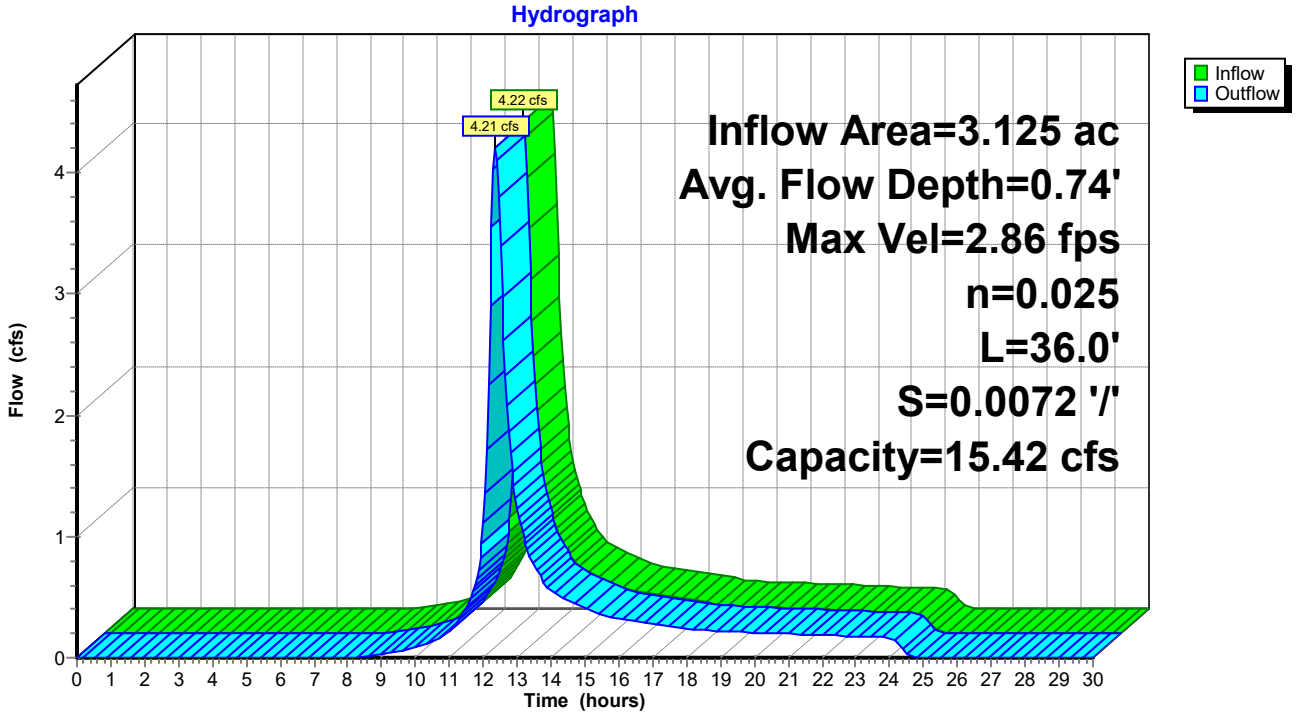
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.86 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 0.5 min

Peak Storage= 53 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.74' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 15.42 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0072 '/'
Inlet Invert= 104.26', Outlet Invert= 104.00'



Reach CUL1: TO DP#1



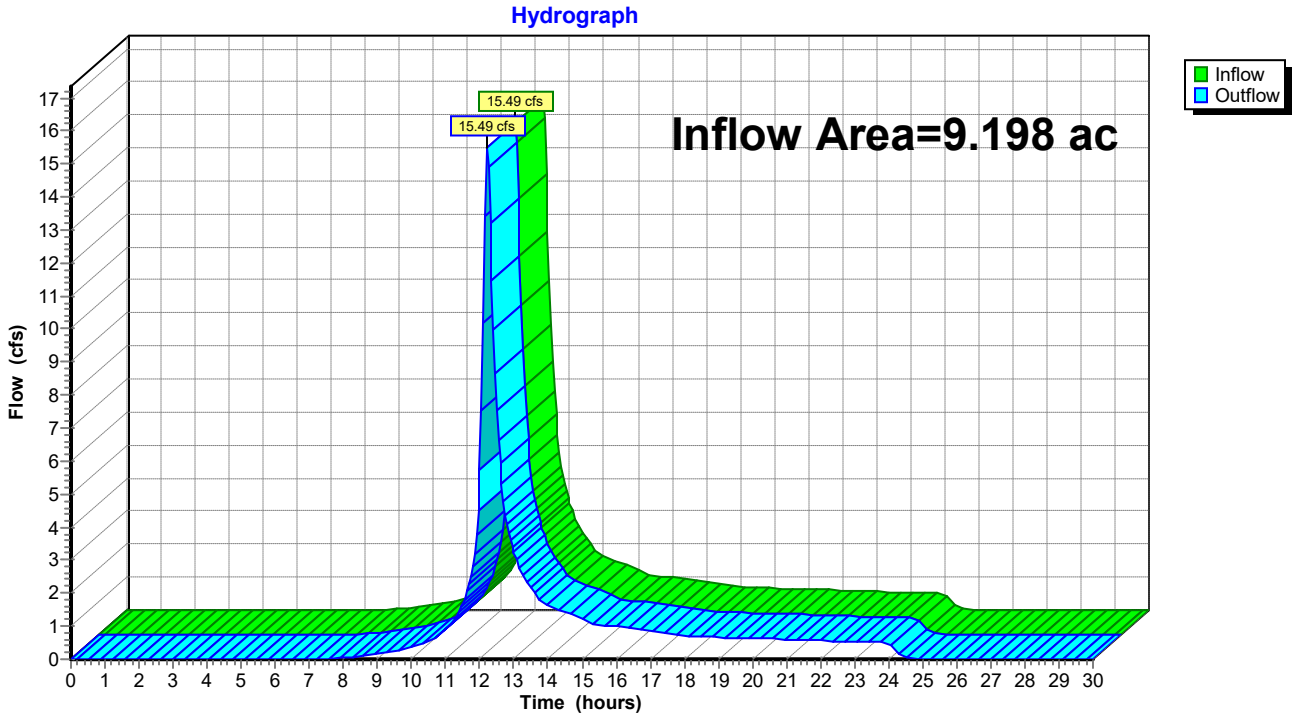
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 3.32% Impervious, Inflow Depth = 2.27" for 10-Year event
Inflow = 15.49 cfs @ 12.22 hrs, Volume= 1.743 af
Outflow = 15.49 cfs @ 12.22 hrs, Volume= 1.743 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E11A: OVERLAND TO DP#1 Runoff Area=264,550 sf 5.03% Impervious Runoff Depth=3.37"
Flow Length=331' Tc=12.2 min CN=77 Runoff=17.83 cfs 1.708 af

Subcatchment E12: TO CULVERT Runoff Area=136,113 sf 0.00% Impervious Runoff Depth=3.08"
Flow Length=805' Tc=24.0 min CN=74 Runoff=6.21 cfs 0.803 af

Reach CUL1: TO DP#1 Avg. Flow Depth=0.98' Max Vel=3.16 fps Inflow=6.21 cfs 0.803 af
n=0.025 L=36.0' S=0.0072 '/' Capacity=15.42 cfs Outflow=6.20 cfs 0.803 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=22.35 cfs 2.511 af
Outflow=22.35 cfs 2.511 af

Total Runoff Area = 9.198 ac Runoff Volume = 2.511 af Average Runoff Depth = 3.28"
96.68% Pervious = 8.892 ac 3.32% Impervious = 0.305 ac

Summary for Subcatchment E11A: OVERLAND TO DP#1

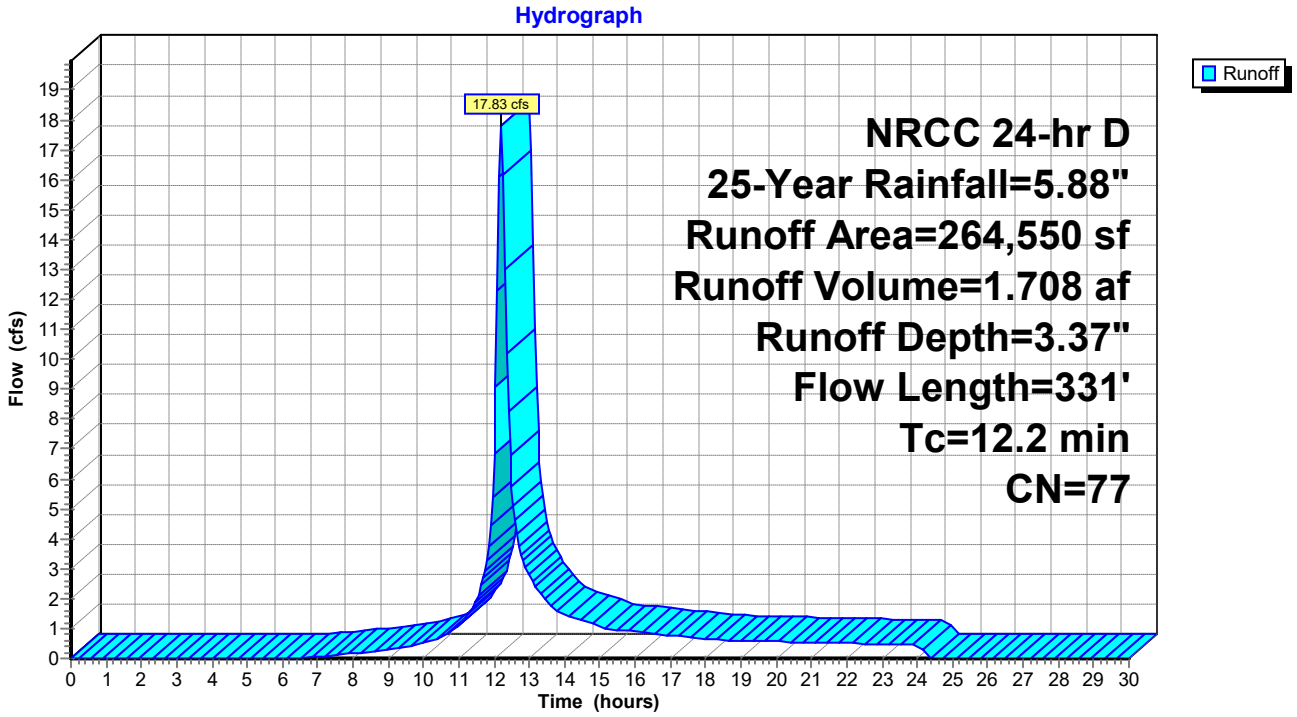
Runoff = 17.83 cfs @ 12.20 hrs, Volume= 1.708 af, Depth= 3.37"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
3,520	74	>75% Grass cover, Good, HSG C
137,884	70	Woods, Good, HSG C
30,113	96	Gravel surface, HSG C
13,307	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
264,550	77	Weighted Average
251,243		94.97% Pervious Area
13,307		5.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.4	25	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	100	0.0840	1.45		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	32	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	124	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	331	Total			

Subcatchment E11A: OVERLAND TO DP#1



Summary for Subcatchment E12: TO CULVERT

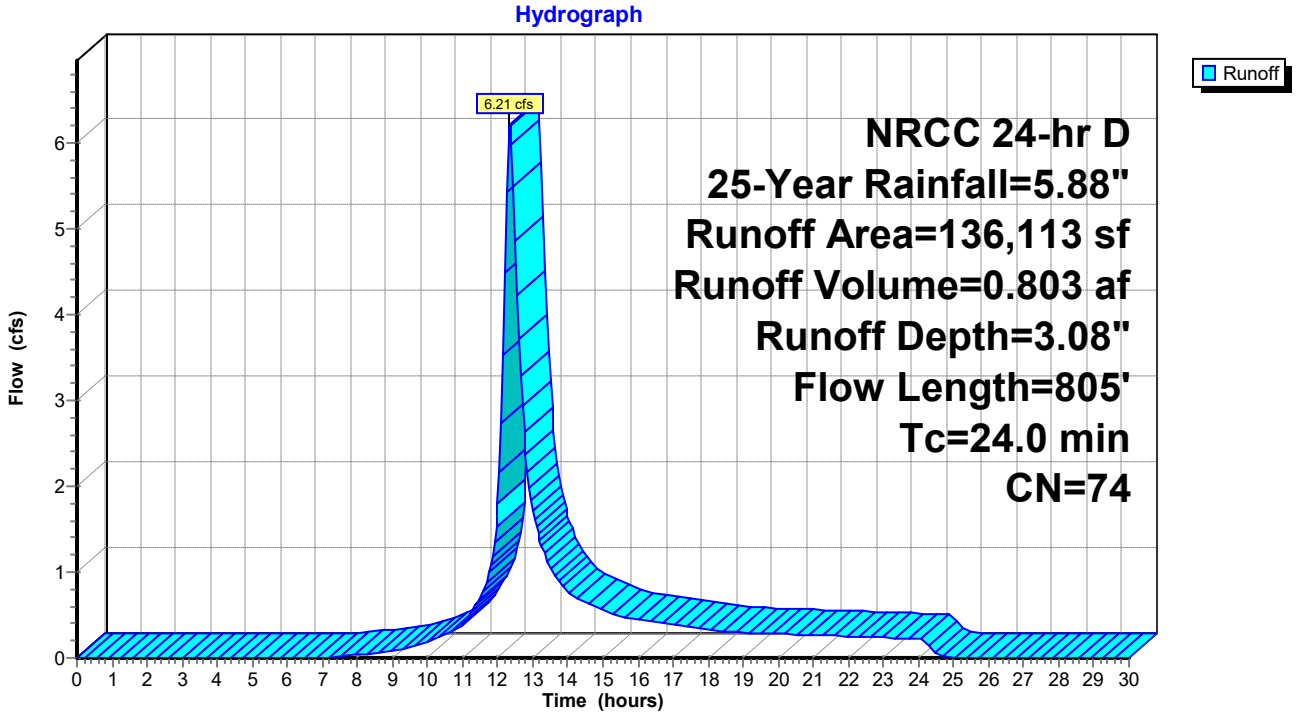
Runoff = 6.21 cfs @ 12.35 hrs, Volume= 0.803 af, Depth= 3.08"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
52,192	70	Woods, Good, HSG C
83,921	77	Woods, Good, HSG D
136,113	74	Weighted Average
136,113		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment E12: TO CULVERT



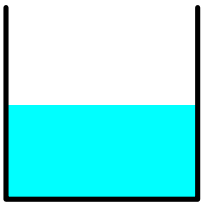
Summary for Reach CUL1: TO DP#1

Inflow Area = 3.125 ac, 0.00% Impervious, Inflow Depth = 3.08" for 25-Year event
Inflow = 6.21 cfs @ 12.35 hrs, Volume= 0.803 af
Outflow = 6.20 cfs @ 12.35 hrs, Volume= 0.803 af, Atten= 0%, Lag= 0.3 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

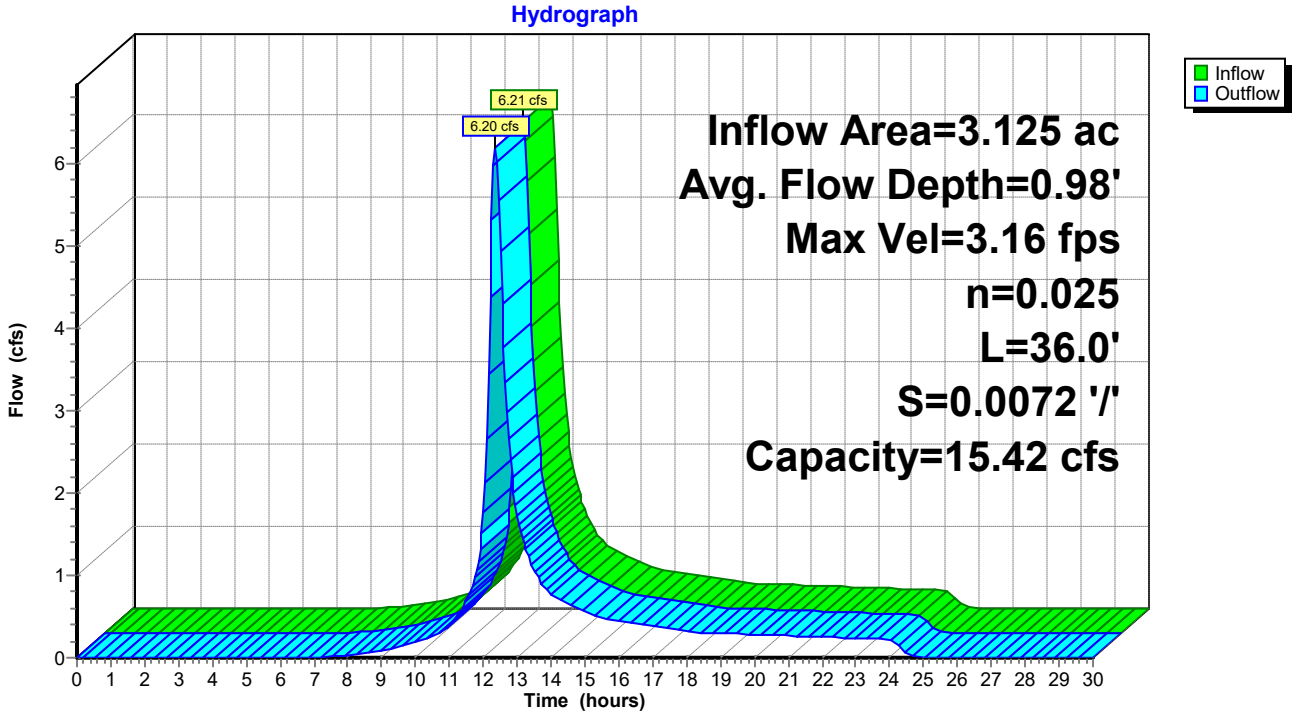
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.16 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 0.5 min

Peak Storage= 71 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 15.42 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0072 '/'
Inlet Invert= 104.26', Outlet Invert= 104.00'



Reach CUL1: TO DP#1



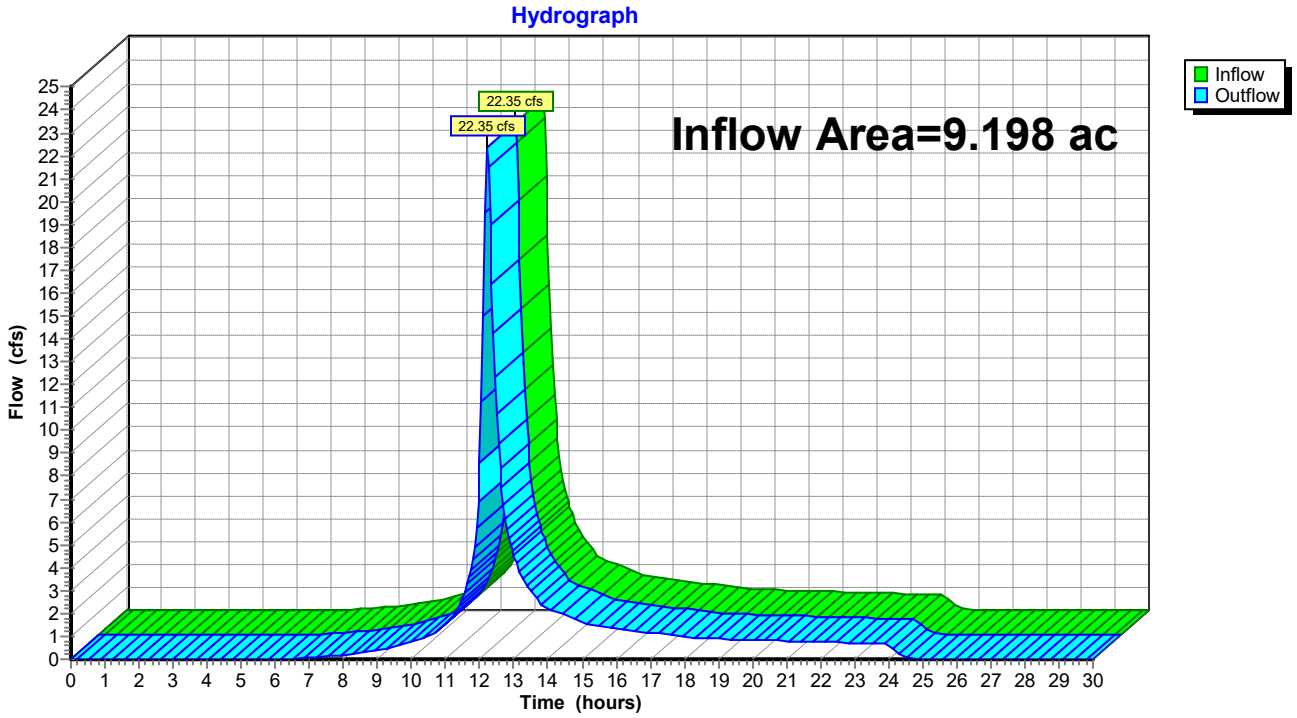
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 3.32% Impervious, Inflow Depth = 3.28" for 25-Year event
Inflow = 22.35 cfs @ 12.21 hrs, Volume= 2.511 af
Outflow = 22.35 cfs @ 12.21 hrs, Volume= 2.511 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E11A: OVERLAND TO DP#1 Runoff Area=264,550 sf 5.03% Impervious Runoff Depth=5.59"
Flow Length=331' Tc=12.2 min CN=77 Runoff=29.14 cfs 2.828 af

Subcatchment E12: TO CULVERT Runoff Area=136,113 sf 0.00% Impervious Runoff Depth=5.23"
Flow Length=805' Tc=24.0 min CN=74 Runoff=10.51 cfs 1.362 af

Reach CUL1: TO DP#1 Avg. Flow Depth=1.47' Max Vel=3.57 fps Inflow=10.51 cfs 1.362 af
n=0.025 L=36.0' S=0.0072 '/' Capacity=15.42 cfs Outflow=10.49 cfs 1.362 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=36.93 cfs 4.190 af
Outflow=36.93 cfs 4.190 af

Total Runoff Area = 9.198 ac Runoff Volume = 4.190 af Average Runoff Depth = 5.47"
96.68% Pervious = 8.892 ac 3.32% Impervious = 0.305 ac

Summary for Subcatchment E11A: OVERLAND TO DP#1

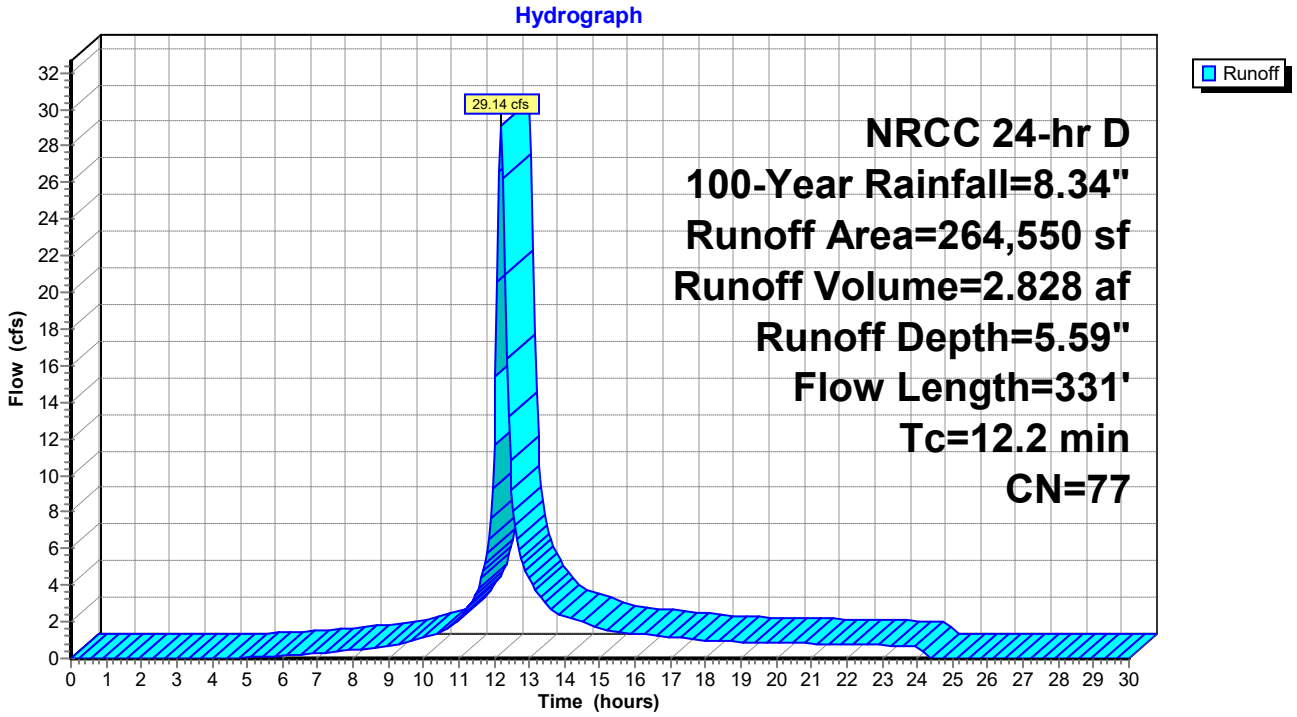
Runoff = 29.14 cfs @ 12.20 hrs, Volume= 2.828 af, Depth= 5.59"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
3,520	74	>75% Grass cover, Good, HSG C
137,884	70	Woods, Good, HSG C
30,113	96	Gravel surface, HSG C
13,307	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
264,550	77	Weighted Average
251,243		94.97% Pervious Area
13,307		5.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.4	25	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	100	0.0840	1.45		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	32	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	124	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	331	Total			

Subcatchment E11A: OVERLAND TO DP#1



Summary for Subcatchment E12: TO CULVERT

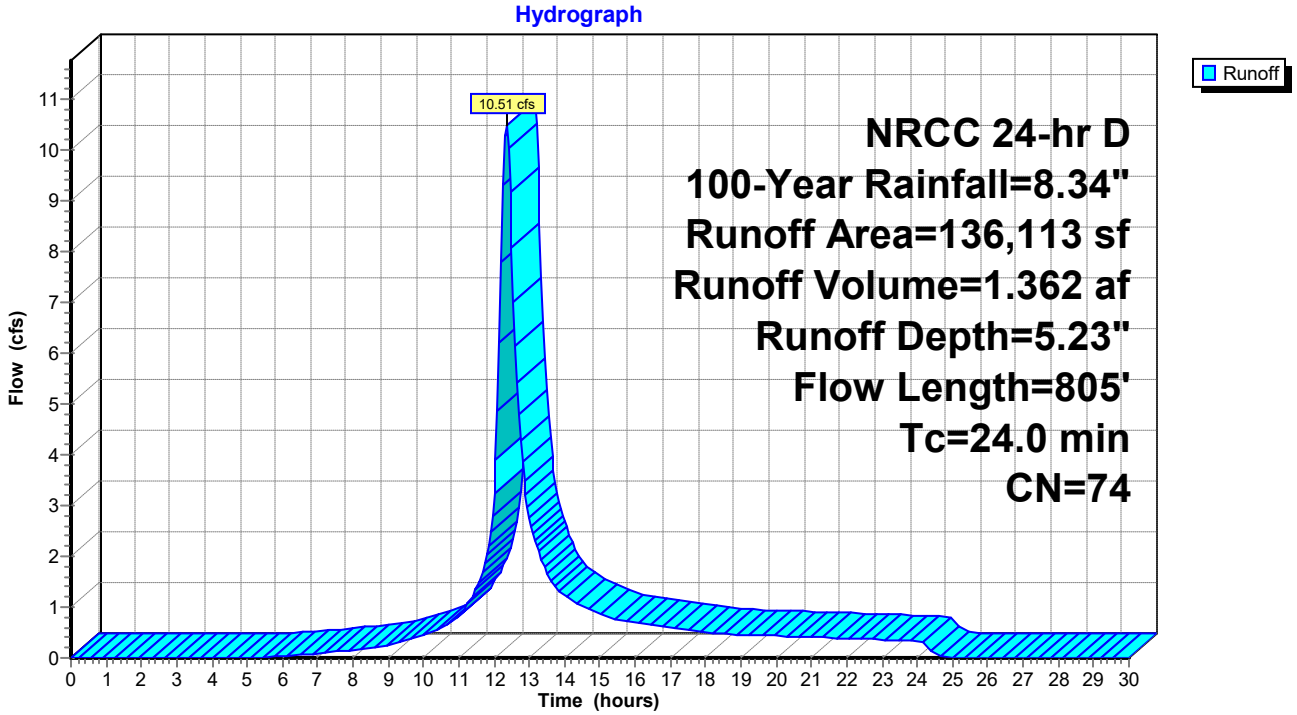
Runoff = 10.51 cfs @ 12.34 hrs, Volume= 1.362 af, Depth= 5.23"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
52,192	70	Woods, Good, HSG C
83,921	77	Woods, Good, HSG D
136,113	74	Weighted Average
136,113		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment E12: TO CULVERT



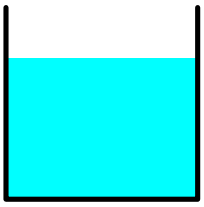
Summary for Reach CUL1: TO DP#1

Inflow Area = 3.125 ac, 0.00% Impervious, Inflow Depth = 5.23" for 100-Year event
Inflow = 10.51 cfs @ 12.34 hrs, Volume= 1.362 af
Outflow = 10.49 cfs @ 12.35 hrs, Volume= 1.362 af, Atten= 0%, Lag= 0.3 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

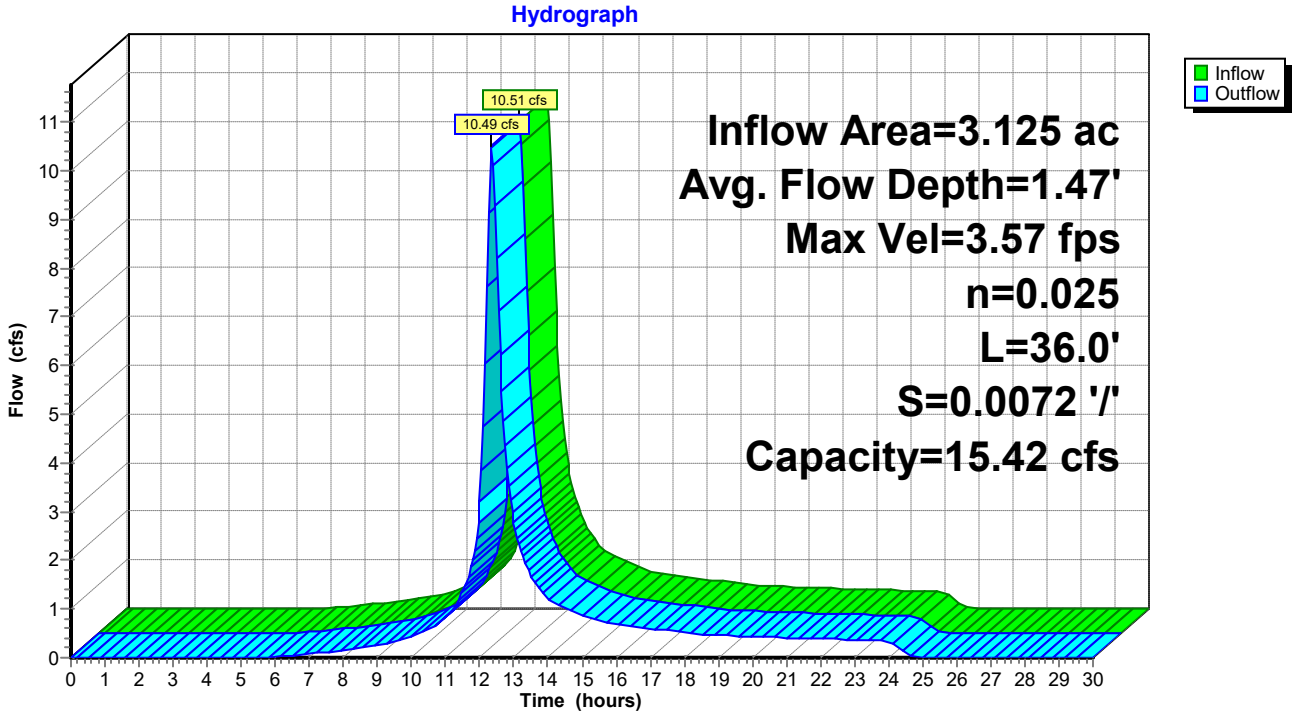
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.57 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.40 fps, Avg. Travel Time= 0.4 min

Peak Storage= 106 cf @ 12.34 hrs
Average Depth at Peak Storage= 1.47' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 15.42 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0072 '/'
Inlet Invert= 104.26', Outlet Invert= 104.00'



Reach CUL1: TO DP#1



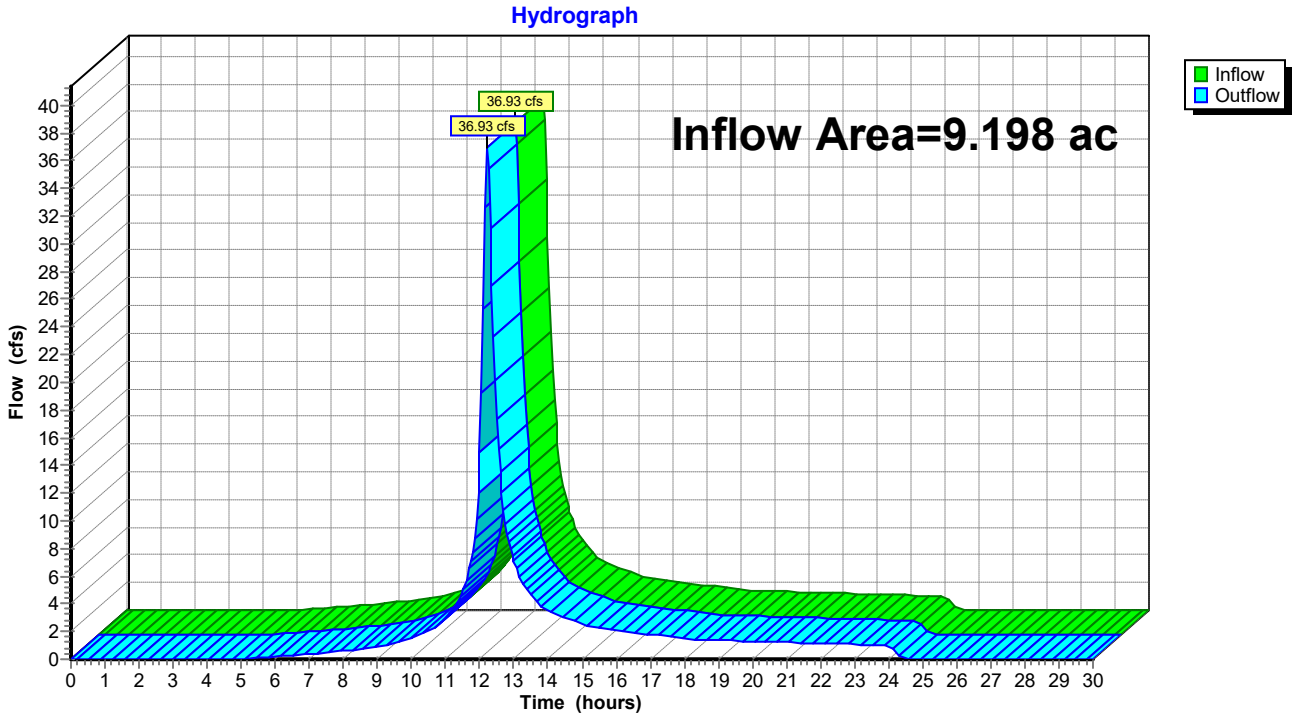
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

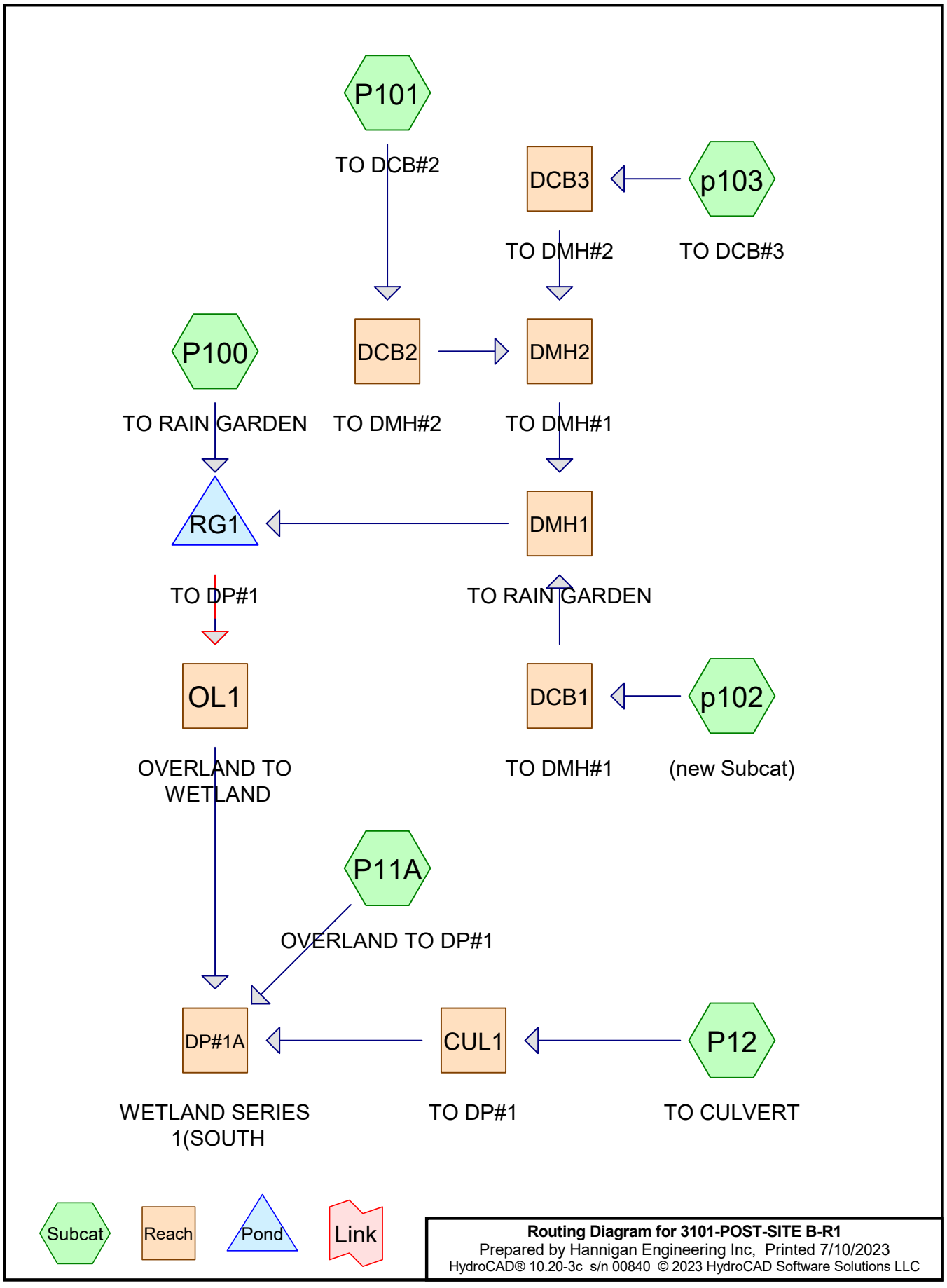
Inflow Area = 9.198 ac, 3.32% Impervious, Inflow Depth = 5.47" for 100-Year event
Inflow = 36.93 cfs @ 12.21 hrs, Volume= 4.190 af
Outflow = 36.93 cfs @ 12.21 hrs, Volume= 4.190 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



2.2
POST DEVELOPMENT CALCULATIONS



Routing Diagram for 3101-POST-SITE B-R1
Prepared by Hannigan Engineering Inc, Printed 7/10/2023

Project Notes

Rainfall events imported from "Atlas-14-Rain.txt" for 449 MA Worcester North

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	NRCC 24-hr	D	Default	24.00	1	3.13	2
2	10-Year	NRCC 24-hr	D	Default	24.00	1	4.68	2
3	25-Year	NRCC 24-hr	D	Default	24.00	1	5.88	2
4	100-Year	NRCC 24-hr	D	Default	24.00	1	8.34	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.326	74	>75% Grass cover, Good, HSG C (P100, P101, p102, p103, P11A, P12)
0.230	89	Gravel roads, HSG C (P100, P101, p102, p103, P11A)
1.078	96	Gravel surface, HSG C (P100, P101, p102, p103, P11A)
0.381	98	Paved parking, HSG C (P100, P101, p102, p103, P11A)
2.426	70	Woods, Good, HSG C (P100, P101, p102, p103, P11A, P12)
3.757	77	Woods, Good, HSG D (P11A, P12)
9.198	**78**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
5.441	HSG C	P100, P101, p102, p103, P11A, P12
3.757	HSG D	P11A, P12
0.000	Other	
9.198		**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
0.000	0.000	1.326	0.000	0.000	1.326	>75% Grass cover, Good	P100, P101, p102, p103, P11A, P12
0.000	0.000	0.230	0.000	0.000	0.230	Gravel roads	P100, P101, p102, p103, P11A
0.000	0.000	1.078	0.000	0.000	1.078	Gravel surface	P100, P101, p102, p103, P11A
0.000	0.000	0.381	0.000	0.000	0.381	Paved parking	P100, P101, p102, p103, P11A
0.000	0.000	2.426	3.757	0.000	6.183	Woods, Good	P100, P101, p102, p103, P11A, P12
0.000	**0.000**	**5.441**	**3.757**	**0.000**	**9.198**	**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)	Node Name
1	DCB1	1,012.20	1,011.90	34.0	0.0088	0.013	0.0	12.0	0.0	TO DMH#1
2	DCB2	1,015.70	1,015.50	5.0	0.0400	0.013	0.0	12.0	0.0	TO DMH#2
3	DCB3	1,016.60	1,014.10	165.0	0.0152	0.013	0.0	12.0	0.0	TO DMH#2
4	DMH1	1,011.70	1,010.80	85.0	0.0106	0.011	0.0	15.0	0.0	TO RAIN GARDEN
5	DMH2	1,014.00	1,011.90	187.0	0.0112	0.013	0.0	12.0	0.0	TO DMH#1
6	RG1	1,006.40	1,006.00	42.0	0.0095	0.013	0.0	12.0	0.0	TO DP#1

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P100: TO RAIN GARDEN Runoff Area=28,854 sf 11.64% Impervious Runoff Depth=1.28"
Flow Length=290' Tc=6.0 min CN=79 Runoff=0.91 cfs 0.071 af

Subcatchment P101: TO DCB#2 Runoff Area=7,181 sf 5.51% Impervious Runoff Depth=1.77"
Flow Length=173' Tc=5.3 min CN=86 Runoff=0.32 cfs 0.024 af

Subcatchment p102: (new Subcat) Runoff Area=19,100 sf 5.97% Impervious Runoff Depth=1.85"
Flow Length=272' Tc=5.0 min CN=87 Runoff=0.89 cfs 0.068 af

Subcatchment p103: TO DCB#3 Runoff Area=6,235 sf 14.56% Impervious Runoff Depth=1.77"
Flow Length=143' Tc=8.3 min CN=86 Runoff=0.25 cfs 0.021 af

Subcatchment P11A: OVERLAND TO DP#1 Runoff Area=207,622 sf 5.20% Impervious Runoff Depth=1.28"
Flow Length=307' Tc=12.2 min CN=79 Runoff=5.27 cfs 0.510 af

Subcatchment P12: TO CULVERT Runoff Area=131,668 sf 0.00% Impervious Runoff Depth=1.05"
Flow Length=805' Tc=24.0 min CN=75 Runoff=1.94 cfs 0.264 af

Reach CUL1: TO DP#1 Avg. Flow Depth=0.48' Max Vel=2.03 fps Inflow=1.94 cfs 0.264 af
n=0.025 L=36.0' S=0.0053 '/' Capacity=13.18 cfs Outflow=1.94 cfs 0.264 af

Reach DCB1: TO DMH#1 Avg. Flow Depth=0.35' Max Vel=3.58 fps Inflow=0.89 cfs 0.068 af
12.0" Round Pipe n=0.013 L=34.0' S=0.0088 '/' Capacity=3.35 cfs Outflow=0.88 cfs 0.068 af

Reach DCB2: TO DMH#2 Avg. Flow Depth=0.14' Max Vel=4.54 fps Inflow=0.32 cfs 0.024 af
12.0" Round Pipe n=0.013 L=5.0' S=0.0400 '/' Capacity=7.13 cfs Outflow=0.32 cfs 0.024 af

Reach DCB3: TO DMH#2 Avg. Flow Depth=0.16' Max Vel=3.01 fps Inflow=0.25 cfs 0.021 af
12.0" Round Pipe n=0.013 L=165.0' S=0.0152 '/' Capacity=4.39 cfs Outflow=0.24 cfs 0.021 af

Reach DMH1: TO RAIN GARDEN Avg. Flow Depth=0.35' Max Vel=4.79 fps Inflow=1.36 cfs 0.113 af
15.0" Round Pipe n=0.011 L=85.0' S=0.0106 '/' Capacity=7.86 cfs Outflow=1.35 cfs 0.113 af

Reach DMH2: TO DMH#1 Avg. Flow Depth=0.25' Max Vel=3.39 fps Inflow=0.53 cfs 0.046 af
12.0" Round Pipe n=0.013 L=187.0' S=0.0112 '/' Capacity=3.78 cfs Outflow=0.51 cfs 0.046 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=7.14 cfs 0.958 af
Outflow=7.14 cfs 0.958 af

Reach OL1: OVERLAND TO WETLAND Avg. Flow Depth=0.11' Max Vel=0.24 fps Inflow=0.55 cfs 0.184 af
n=0.400 L=62.0' S=0.0839 '/' Capacity=26.60 cfs Outflow=0.55 cfs 0.184 af

Pond RG1: TO DP#1 Peak Elev=1,009.46' Storage=1,586 cf Inflow=2.26 cfs 0.184 af
Primary=0.55 cfs 0.184 af Secondary=0.00 cfs 0.000 af Outflow=0.55 cfs 0.184 af

Total Runoff Area = 9.198 ac Runoff Volume = 0.958 af Average Runoff Depth = 1.25"
95.86% Pervious = 8.817 ac 4.14% Impervious = 0.381 ac

Summary for Subcatchment P100: TO RAIN GARDEN

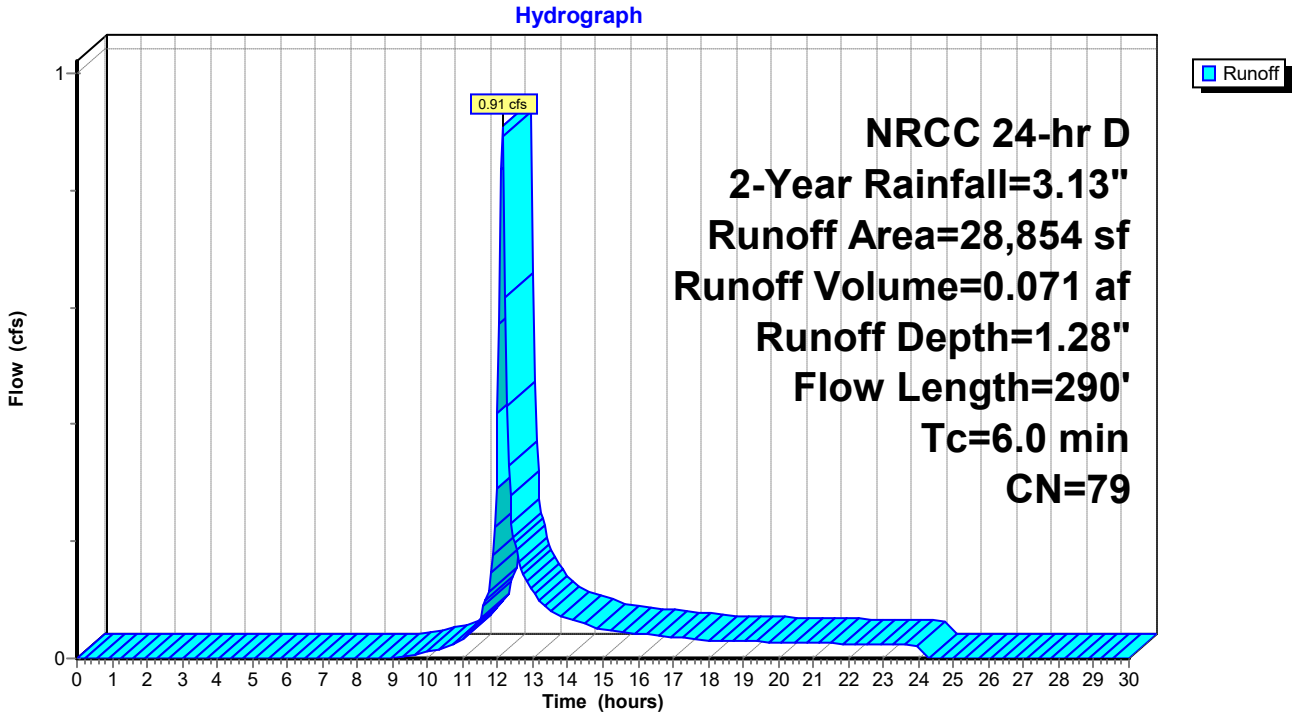
Runoff = 0.91 cfs @ 12.13 hrs, Volume= 0.071 af, Depth= 1.28"
Routed to Pond RG1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
21,444	74	>75% Grass cover, Good, HSG C
161	70	Woods, Good, HSG C
3,358	98	Paved parking, HSG C
2,891	96	Gravel surface, HSG C
1,000	89	Gravel roads, HSG C
28,854	79	Weighted Average
25,496		88.36% Pervious Area
3,358		11.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	15	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	29	0.3330	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.1	6	0.0300	0.89		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	113	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	81	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	46	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	290	Total			

Subcatchment P100: TO RAIN GARDEN



Summary for Subcatchment P101: TO DCB#2

[49] Hint: Tc<2dt may require smaller dt

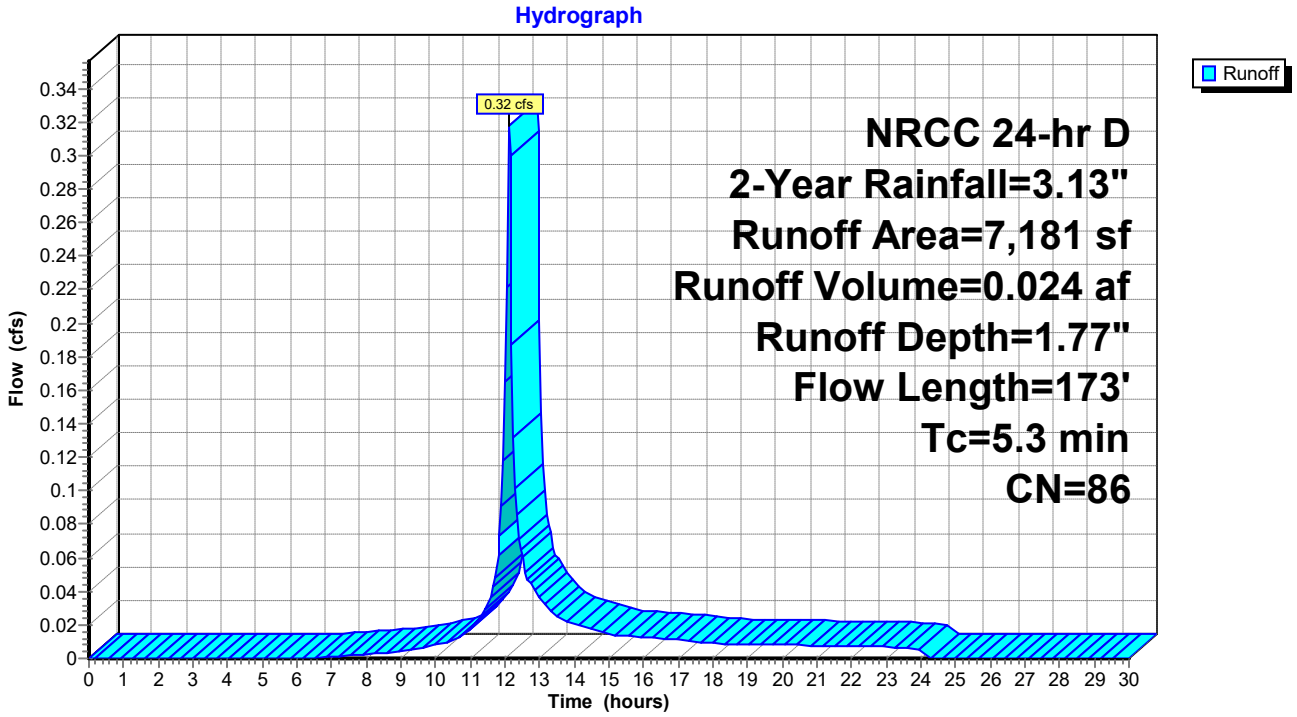
Runoff = 0.32 cfs @ 12.12 hrs, Volume= 0.024 af, Depth= 1.77"
Routed to Reach DCB2 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
1,897	74	>75% Grass cover, Good, HSG C
715	70	Woods, Good, HSG C
396	98	Paved parking, HSG C
2,020	96	Gravel surface, HSG C
2,153	89	Gravel roads, HSG C
7,181	86	Weighted Average
6,785		94.49% Pervious Area
396		5.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	16	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.2	14	0.0300	1.06		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	123	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.3	173	Total			

Subcatchment P101: TO DCB#2



Summary for Subcatchment p102: (new Subcat)

[49] Hint: Tc<2dt may require smaller dt

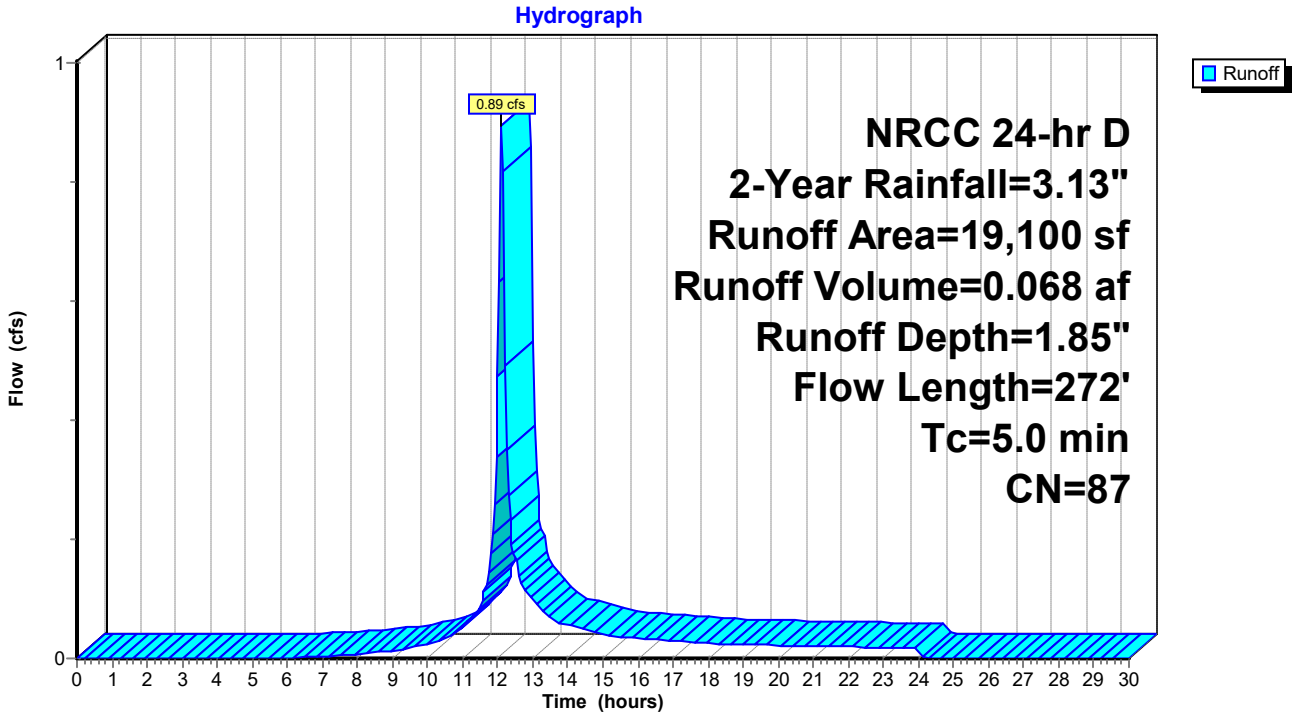
Runoff = 0.89 cfs @ 12.11 hrs, Volume= 0.068 af, Depth= 1.85"
Routed to Reach DCB1 : TO DMH#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
5,623	74	>75% Grass cover, Good, HSG C
528	70	Woods, Good, HSG C
1,140	98	Paved parking, HSG C
7,733	96	Gravel surface, HSG C
4,076	89	Gravel roads, HSG C
19,100	87	Weighted Average
17,960		94.03% Pervious Area
1,140		5.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.4	30	0.0250	1.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
1.6	222	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	272	Total, Increased to minimum Tc = 5.0 min			

Subcatchment p102: (new Subcat)



Summary for Subcatchment p103: TO DCB#3

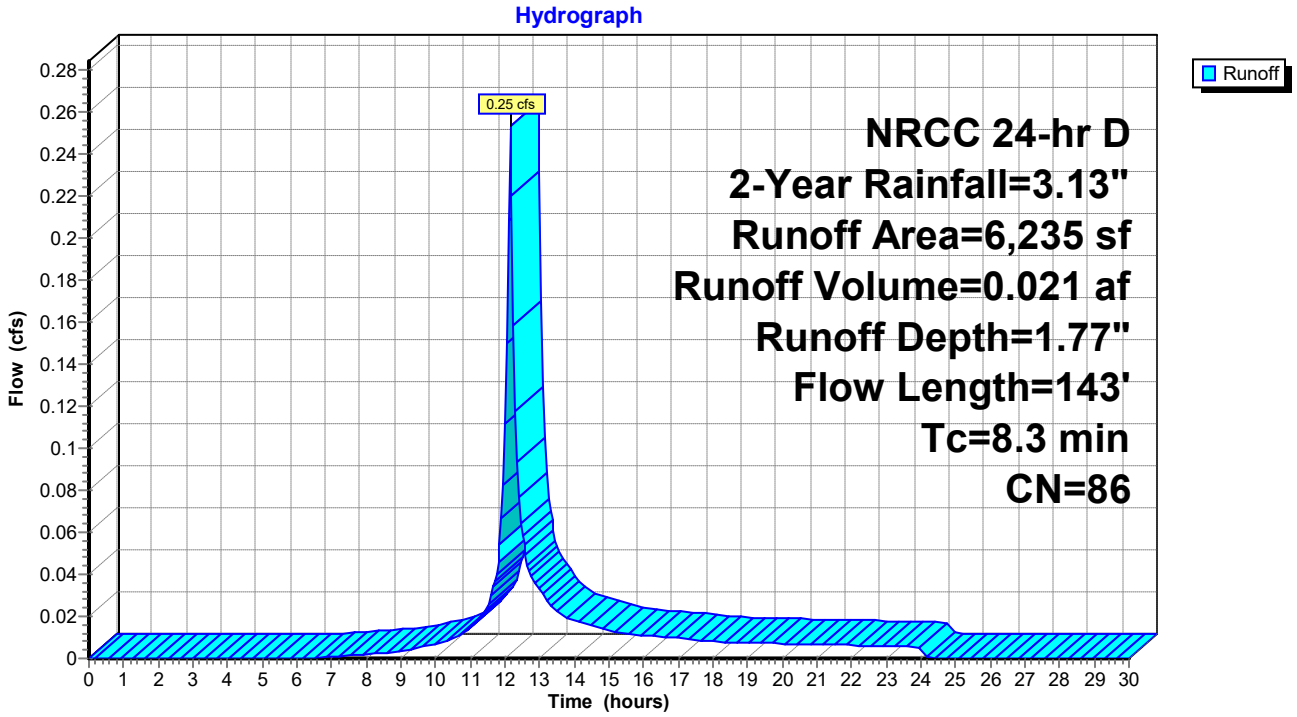
Runoff = 0.25 cfs @ 12.15 hrs, Volume= 0.021 af, Depth= 1.77"
Routed to Reach DCB3 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
1,601	74	>75% Grass cover, Good, HSG C
855	70	Woods, Good, HSG C
908	98	Paved parking, HSG C
1,705	96	Gravel surface, HSG C
1,166	89	Gravel roads, HSG C
6,235	86	Weighted Average
5,327		85.44% Pervious Area
908		14.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	40	0.0540	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.5	10	0.3300	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.6	93	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	143	Total			

Subcatchment p103: TO DCB#3



Summary for Subcatchment P11A: OVERLAND TO DP#1

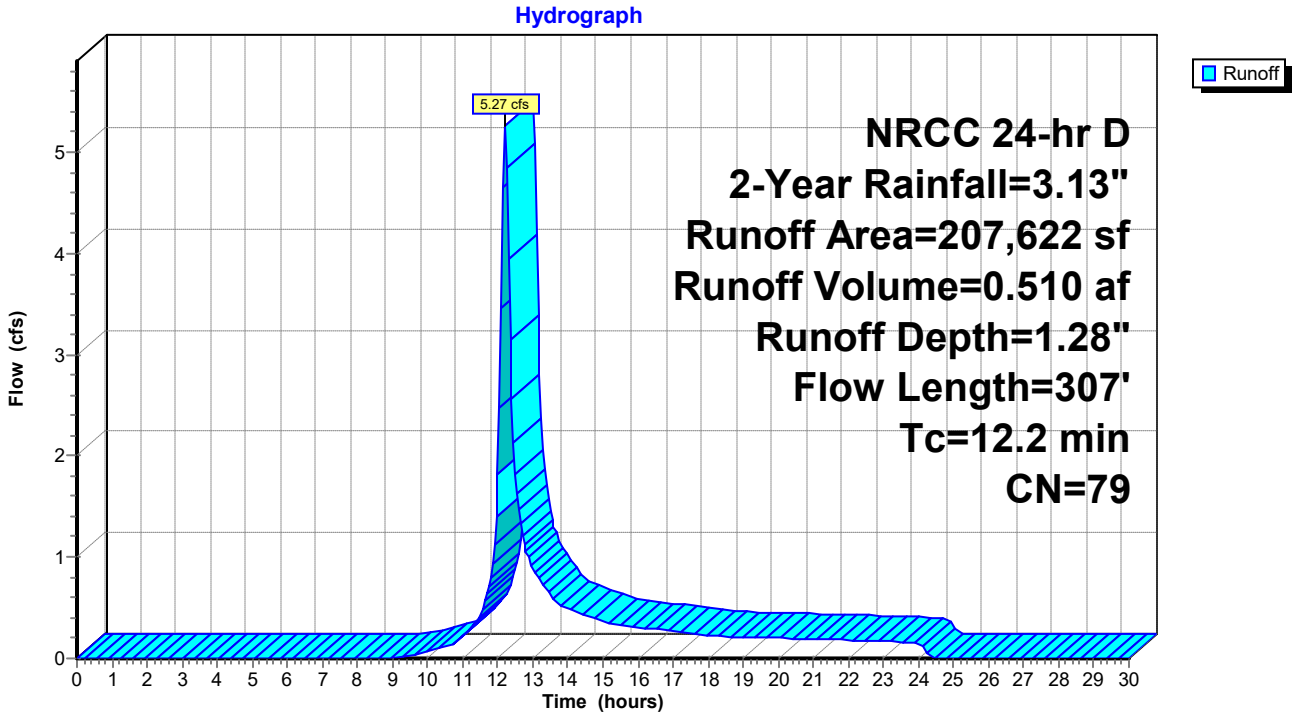
Runoff = 5.27 cfs @ 12.20 hrs, Volume= 0.510 af, Depth= 1.28"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
24,929	74	>75% Grass cover, Good, HSG C
57,953	70	Woods, Good, HSG C
32,603	96	Gravel surface, HSG C
10,055	98	Paved parking, HSG C
1,617	89	Gravel roads, HSG C
739	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
207,622	79	Weighted Average
196,828		94.80% Pervious Area
10,794		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.0	68	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	38	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	27	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.1	124	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	307	Total			

Subcatchment P11A: OVERLAND TO DP#1



Summary for Subcatchment P12: TO CULVERT

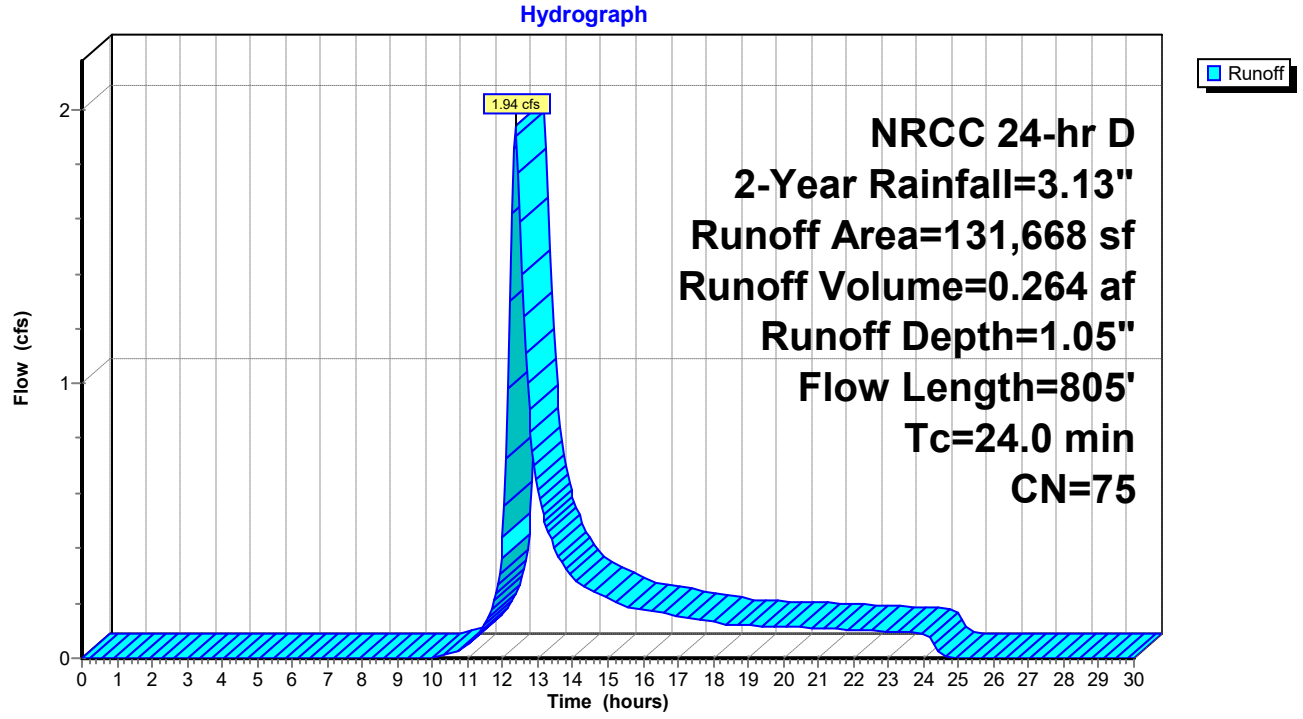
Runoff = 1.94 cfs @ 12.36 hrs, Volume= 0.264 af, Depth= 1.05"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.13"

Area (sf)	CN	Description
45,486	70	Woods, Good, HSG C
2,261	74	>75% Grass cover, Good, HSG C
83,921	77	Woods, Good, HSG D
131,668	75	Weighted Average
131,668		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment P12: TO CULVERT



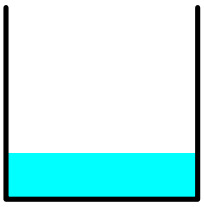
Summary for Reach CUL1: TO DP#1

Inflow Area = 3.023 ac, 0.00% Impervious, Inflow Depth = 1.05" for 2-Year event
Inflow = 1.94 cfs @ 12.36 hrs, Volume= 0.264 af
Outflow = 1.94 cfs @ 12.37 hrs, Volume= 0.264 af, Atten= 0%, Lag= 0.5 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

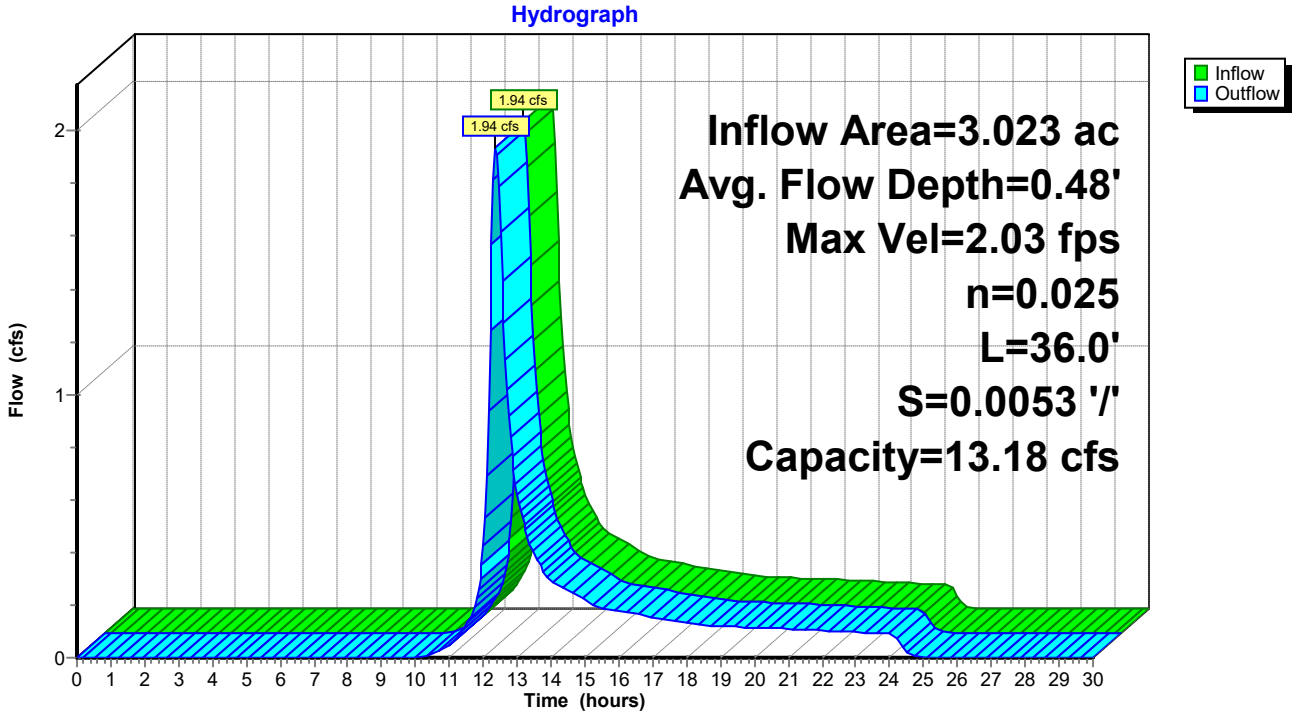
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.03 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 0.82 fps, Avg. Travel Time= 0.7 min

Peak Storage= 34 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.48' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 13.18 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0053 '/'
Inlet Invert= 1,003.98', Outlet Invert= 1,003.79'



Reach CUL1: TO DP#1



Summary for Reach DCB1: TO DMH#1

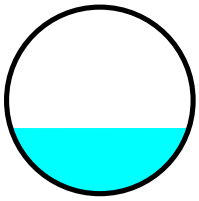
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.438 ac, 5.97% Impervious, Inflow Depth = 1.85" for 2-Year event
Inflow = 0.89 cfs @ 12.11 hrs, Volume= 0.068 af
Outflow = 0.88 cfs @ 12.12 hrs, Volume= 0.068 af, Atten= 2%, Lag= 0.4 min
Routed to Reach DMH1 : TO RAIN GARDEN

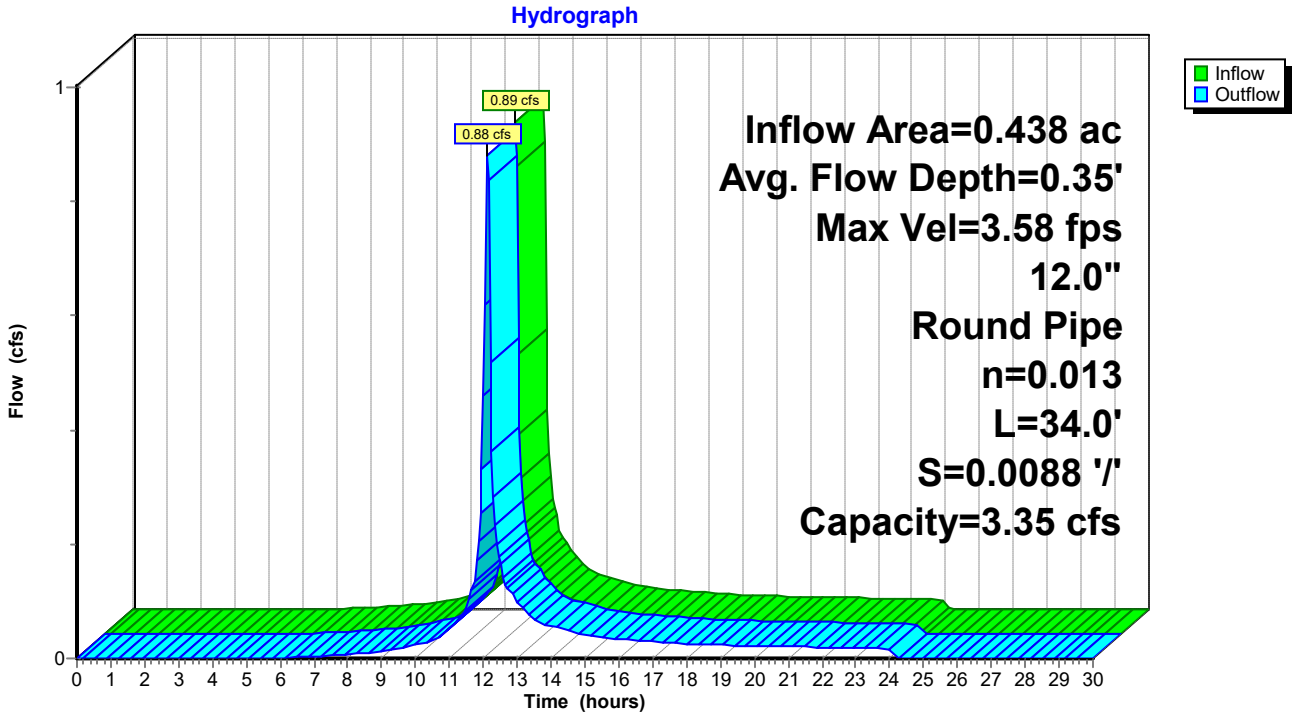
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.58 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 0.4 min

Peak Storage= 8 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.35' , Surface Width= 0.96'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.35 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 34.0' Slope= 0.0088 '/'
Inlet Invert= 1,012.20', Outlet Invert= 1,011.90'



Reach DCB1: TO DMH#1



Summary for Reach DCB2: TO DMH#2

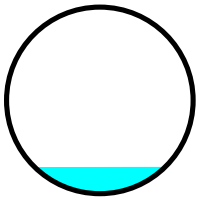
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.165 ac, 5.51% Impervious, Inflow Depth = 1.77" for 2-Year event
Inflow = 0.32 cfs @ 12.12 hrs, Volume= 0.024 af
Outflow = 0.32 cfs @ 12.12 hrs, Volume= 0.024 af, Atten= 0%, Lag= 0.1 min
Routed to Reach DMH2 : TO DMH#1

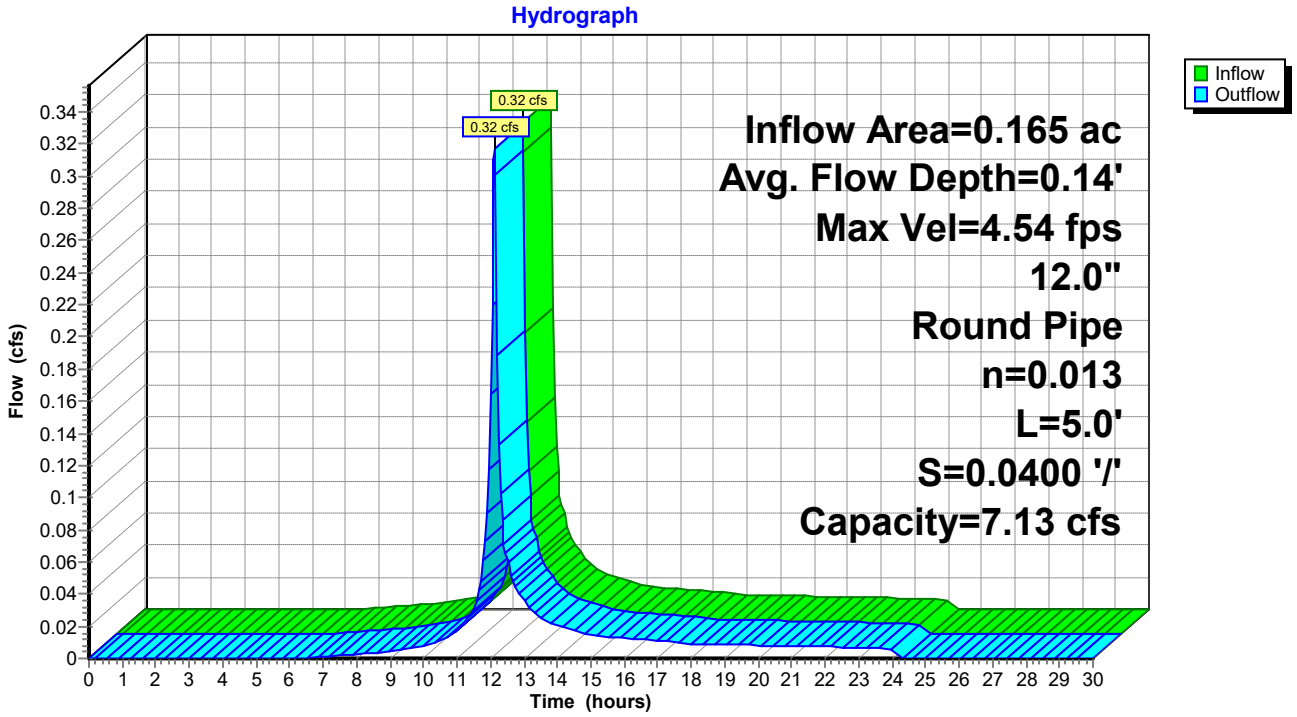
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.54 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.65 fps, Avg. Travel Time= 0.1 min

Peak Storage= 0 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 0.70'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.13 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 5.0' Slope= 0.0400 '/'
Inlet Invert= 1,015.70', Outlet Invert= 1,015.50'



Reach DCB2: TO DMH#2



Summary for Reach DCB3: TO DMH#2

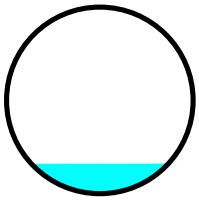
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.143 ac, 14.56% Impervious, Inflow Depth = 1.77" for 2-Year event
Inflow = 0.25 cfs @ 12.15 hrs, Volume= 0.021 af
Outflow = 0.24 cfs @ 12.18 hrs, Volume= 0.021 af, Atten= 5%, Lag= 1.7 min
Routed to Reach DMH2 : TO DMH#1

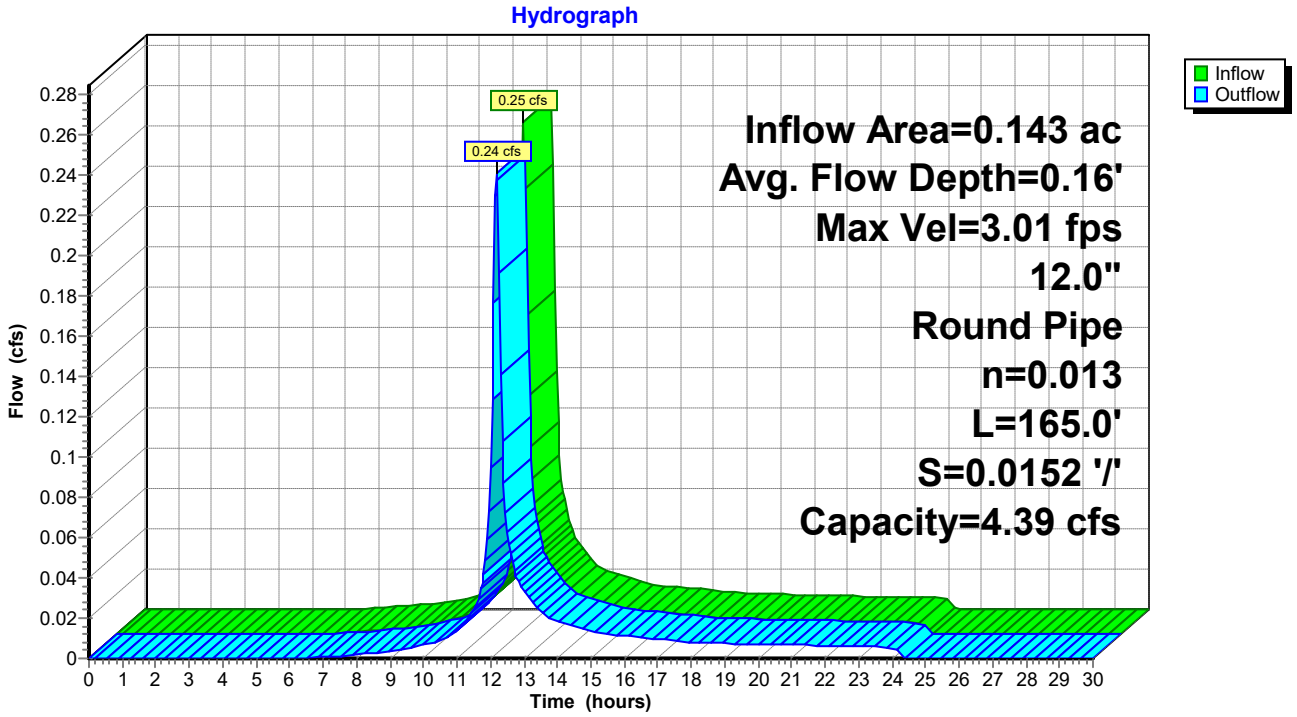
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.01 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 2.5 min

Peak Storage= 14 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.16' , Surface Width= 0.74'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.39 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 165.0' Slope= 0.0152 '/'
Inlet Invert= 1,016.60', Outlet Invert= 1,014.10'



Reach DCB3: TO DMH#2



Summary for Reach DMH1: TO RAIN GARDEN

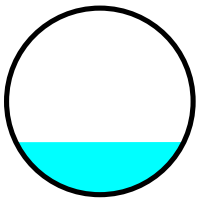
[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach DCB1 outlet invert by 0.15' @ 12.15 hrs
[61] Hint: Exceeded Reach DMH2 outlet invert by 0.15' @ 12.15 hrs

Inflow Area = 0.746 ac, 7.52% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 1.36 cfs @ 12.13 hrs, Volume= 0.113 af
Outflow = 1.35 cfs @ 12.14 hrs, Volume= 0.113 af, Atten= 1%, Lag= 0.5 min
Routed to Pond RG1 : TO DP#1

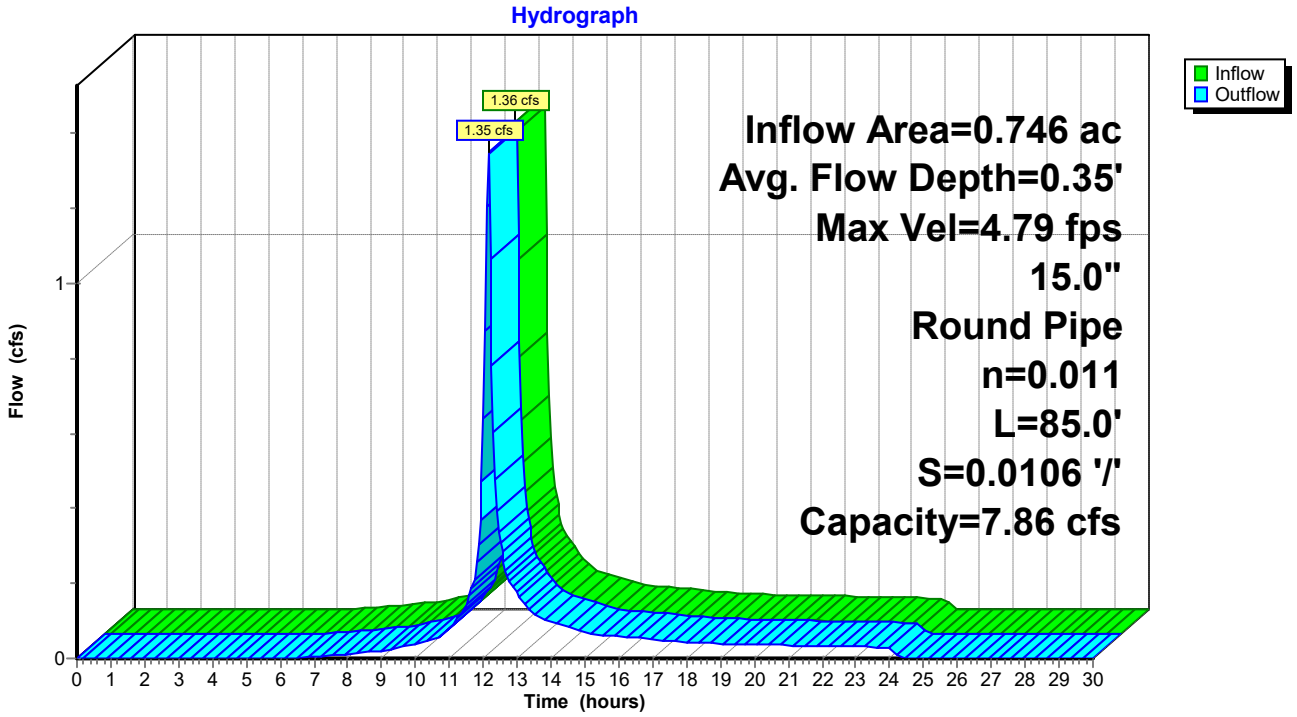
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.79 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.72 fps, Avg. Travel Time= 0.8 min

Peak Storage= 24 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.35' , Surface Width= 1.13'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.86 cfs

15.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 85.0' Slope= 0.0106 '/'
Inlet Invert= 1,011.70', Outlet Invert= 1,010.80'



Reach DMH1: TO RAIN GARDEN



Summary for Reach DMH2: TO DMH#1

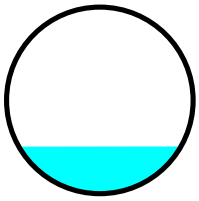
[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach DCB3 outlet invert by 0.15' @ 12.15 hrs

Inflow Area = 0.308 ac, 9.72% Impervious, Inflow Depth = 1.77" for 2-Year event
Inflow = 0.53 cfs @ 12.14 hrs, Volume= 0.046 af
Outflow = 0.51 cfs @ 12.16 hrs, Volume= 0.046 af, Atten= 4%, Lag= 1.5 min
Routed to Reach DMH1 : TO RAIN GARDEN

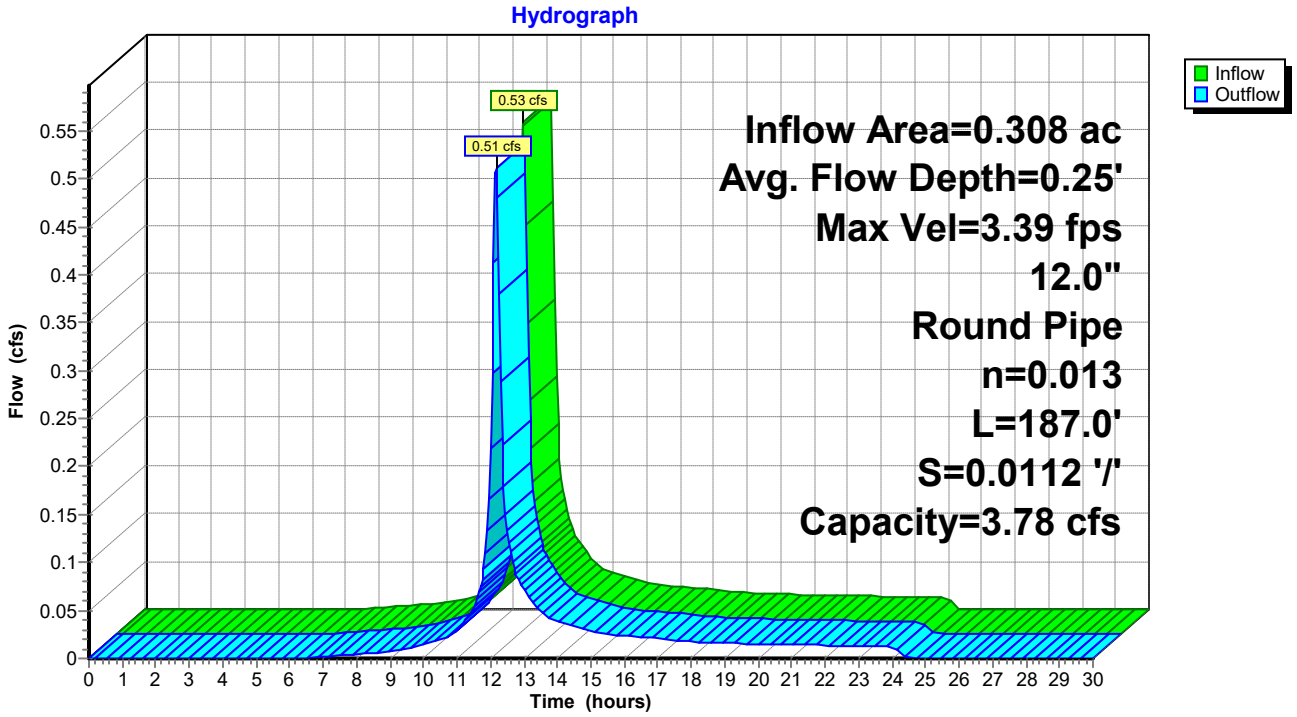
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.39 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 2.5 min

Peak Storage= 29 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.25' , Surface Width= 0.87'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.78 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 187.0' Slope= 0.0112 '/'
Inlet Invert= 1,014.00', Outlet Invert= 1,011.90'



Reach DMH2: TO DMH#1



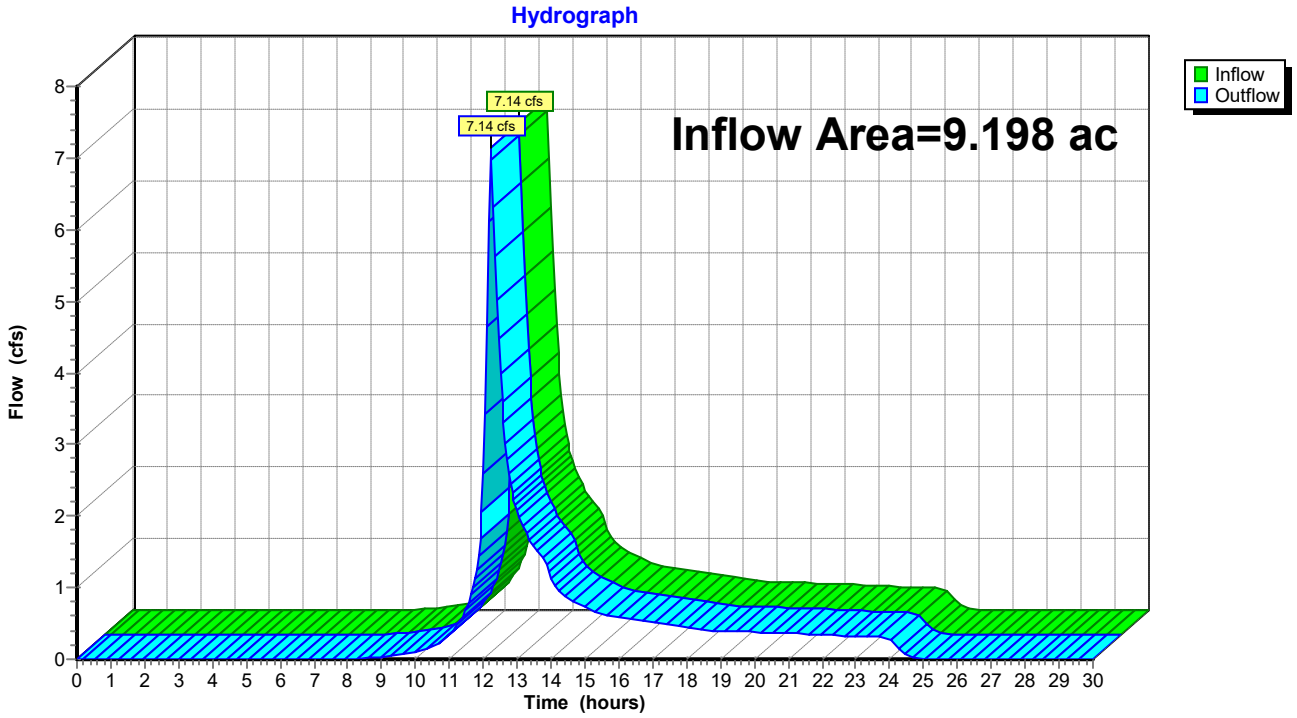
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 4.14% Impervious, Inflow Depth = 1.25" for 2-Year event
Inflow = 7.14 cfs @ 12.22 hrs, Volume= 0.958 af
Outflow = 7.14 cfs @ 12.22 hrs, Volume= 0.958 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Summary for Reach OL1: OVERLAND TO WETLAND

[79] Warning: Submerged Pond RG1 Primary device # 4 OUTLET by 0.11'

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 1.57" for 2-Year event
Inflow = 0.55 cfs @ 12.00 hrs, Volume= 0.184 af
Outflow = 0.55 cfs @ 13.50 hrs, Volume= 0.184 af, Atten= 0%, Lag= 90.0 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

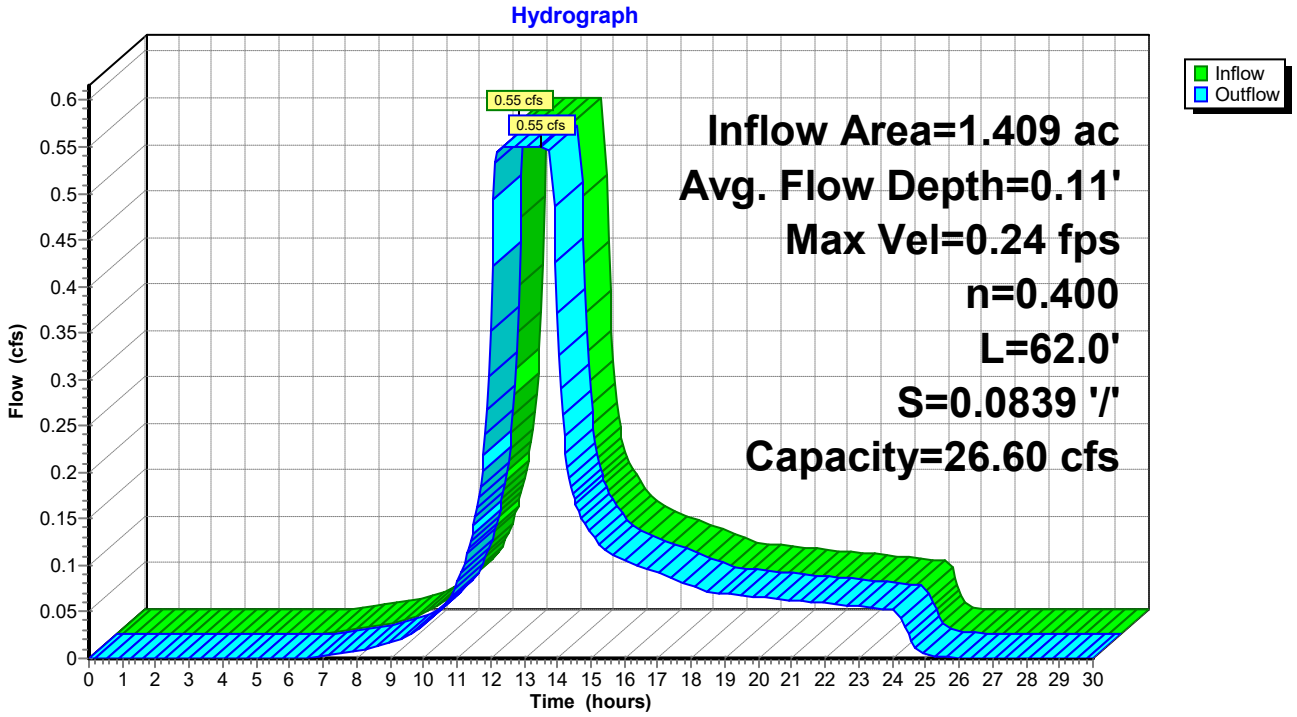
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.24 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 0.11 fps, Avg. Travel Time= 9.7 min

Peak Storage= 143 cf @ 13.40 hrs
Average Depth at Peak Storage= 0.11' , Surface Width= 22.19'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 26.60 cfs

20.00' x 1.00' deep channel, n= 0.400 Sheet flow: Woods+light brush
Side Slope Z-value= 10.0 '/' Top Width= 40.00'
Length= 62.0' Slope= 0.0839 '/'
Inlet Invert= 1,006.00', Outlet Invert= 1,000.80'

‡

Reach OL1: OVERLAND TO WETLAND



Summary for Pond RG1: TO DP#1

[44] Hint: Outlet device #2 is below defined storage

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 1.57" for 2-Year event
Inflow = 2.26 cfs @ 12.14 hrs, Volume= 0.184 af
Outflow = 0.55 cfs @ 12.00 hrs, Volume= 0.184 af, Atten= 76%, Lag= 0.0 min
Primary = 0.55 cfs @ 12.00 hrs, Volume= 0.184 af
Routed to Reach OL1 : OVERLAND TO WETLAND
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach OL1 : OVERLAND TO WETLAND

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 1,009.46' @ 12.45 hrs Surf.Area= 4,134 sf Storage= 1,586 cf

Plug-Flow detention time= 21.0 min calculated for 0.184 af (100% of inflow)
Center-of-Mass det. time= 21.0 min (878.3 - 857.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,009.00'	23,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

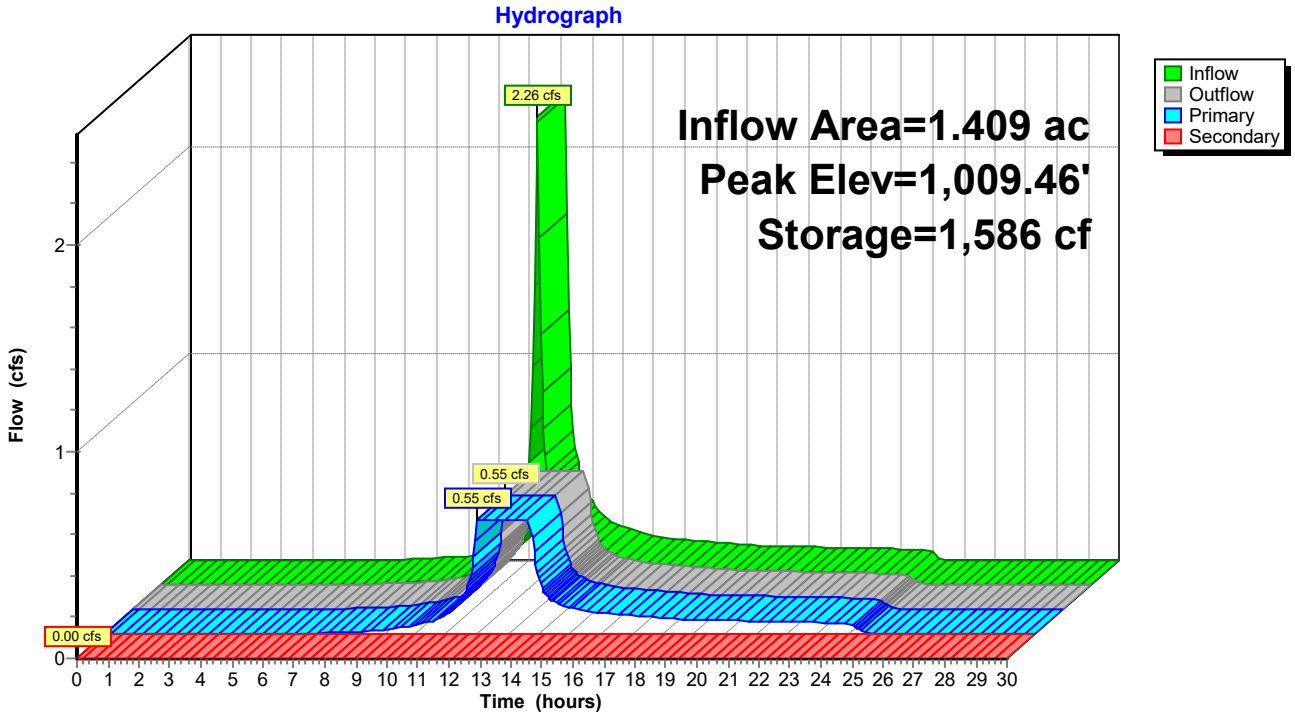
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,009.00	2,750	0	0
1,010.00	5,753	4,252	4,252
1,012.00	10,411	16,164	20,416
1,012.25	12,677	2,886	23,302

Device	Routing	Invert	Outlet Devices
#1	Secondary	1,011.25'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Device 4	1,006.50'	**Special & User-Defined** Head (feet) 0.00 1.00 15.00 Disch. (cfs) 0.000 0.550 0.550
#3	Device 4	1,010.50'	**2.6' long Sharp-Crested Rectangular Weir X 3.00** 2 End Contraction(s) 0.5' Crest Height
#4	Primary	1,006.40'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,006.40' / 1,006.00' S= 0.0095 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#5	Device 4	1,009.50'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.55 cfs @ 12.00 hrs HW=1,009.13' (Free Discharge)
└**4=Culvert** (Passes 0.55 cfs of 4.45 cfs potential flow)
├**2=Special & User-Defined** (Custom Controls 0.55 cfs)
├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**5=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,009.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond RG1: TO DP#1



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P100: TO RAIN GARDEN Runoff Area=28,854 sf 11.64% Impervious Runoff Depth=2.53"
Flow Length=290' Tc=6.0 min CN=79 Runoff=1.80 cfs 0.140 af

Subcatchment P101: TO DCB#2 Runoff Area=7,181 sf 5.51% Impervious Runoff Depth=3.17"
Flow Length=173' Tc=5.3 min CN=86 Runoff=0.56 cfs 0.044 af

Subcatchment p102: (new Subcat) Runoff Area=19,100 sf 5.97% Impervious Runoff Depth=3.27"
Flow Length=272' Tc=5.0 min CN=87 Runoff=1.55 cfs 0.119 af

Subcatchment p103: TO DCB#3 Runoff Area=6,235 sf 14.56% Impervious Runoff Depth=3.17"
Flow Length=143' Tc=8.3 min CN=86 Runoff=0.45 cfs 0.038 af

Subcatchment P11A: OVERLAND TO DP#1 Runoff Area=207,622 sf 5.20% Impervious Runoff Depth=2.53"
Flow Length=307' Tc=12.2 min CN=79 Runoff=10.50 cfs 1.004 af

Subcatchment P12: TO CULVERT Runoff Area=131,668 sf 0.00% Impervious Runoff Depth=2.19"
Flow Length=805' Tc=24.0 min CN=75 Runoff=4.25 cfs 0.552 af

Reach CUL1: TO DP#1 Avg. Flow Depth=0.83' Max Vel=2.55 fps Inflow=4.25 cfs 0.552 af
n=0.025 L=36.0' S=0.0053 '/' Capacity=13.18 cfs Outflow=4.24 cfs 0.552 af

Reach DCB1: TO DMH#1 Avg. Flow Depth=0.48' Max Vel=4.15 fps Inflow=1.55 cfs 0.119 af
12.0" Round Pipe n=0.013 L=34.0' S=0.0088 '/' Capacity=3.35 cfs Outflow=1.52 cfs 0.119 af

Reach DCB2: TO DMH#2 Avg. Flow Depth=0.19' Max Vel=5.37 fps Inflow=0.56 cfs 0.044 af
12.0" Round Pipe n=0.013 L=5.0' S=0.0400 '/' Capacity=7.13 cfs Outflow=0.56 cfs 0.044 af

Reach DCB3: TO DMH#2 Avg. Flow Depth=0.21' Max Vel=3.56 fps Inflow=0.45 cfs 0.038 af
12.0" Round Pipe n=0.013 L=165.0' S=0.0152 '/' Capacity=4.39 cfs Outflow=0.42 cfs 0.038 af

Reach DMH1: TO RAIN GARDEN Avg. Flow Depth=0.47' Max Vel=5.60 fps Inflow=2.39 cfs 0.201 af
15.0" Round Pipe n=0.011 L=85.0' S=0.0106 '/' Capacity=7.86 cfs Outflow=2.37 cfs 0.201 af

Reach DMH2: TO DMH#1 Avg. Flow Depth=0.34' Max Vel=3.99 fps Inflow=0.94 cfs 0.081 af
12.0" Round Pipe n=0.013 L=187.0' S=0.0112 '/' Capacity=3.78 cfs Outflow=0.91 cfs 0.081 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=14.21 cfs 1.897 af
Outflow=14.21 cfs 1.897 af

Reach OL1: OVERLAND TO WETLAND Avg. Flow Depth=0.18' Max Vel=0.33 fps Inflow=1.30 cfs 0.340 af
n=0.400 L=62.0' S=0.0839 '/' Capacity=26.60 cfs Outflow=1.29 cfs 0.340 af

Pond RG1: TO DP#1 Peak Elev=1,009.81' Storage=3,238 cf Inflow=4.17 cfs 0.340 af
Primary=1.30 cfs 0.340 af Secondary=0.00 cfs 0.000 af Outflow=1.30 cfs 0.340 af

Total Runoff Area = 9.198 ac Runoff Volume = 1.897 af Average Runoff Depth = 2.47"
95.86% Pervious = 8.817 ac 4.14% Impervious = 0.381 ac

Summary for Subcatchment P100: TO RAIN GARDEN

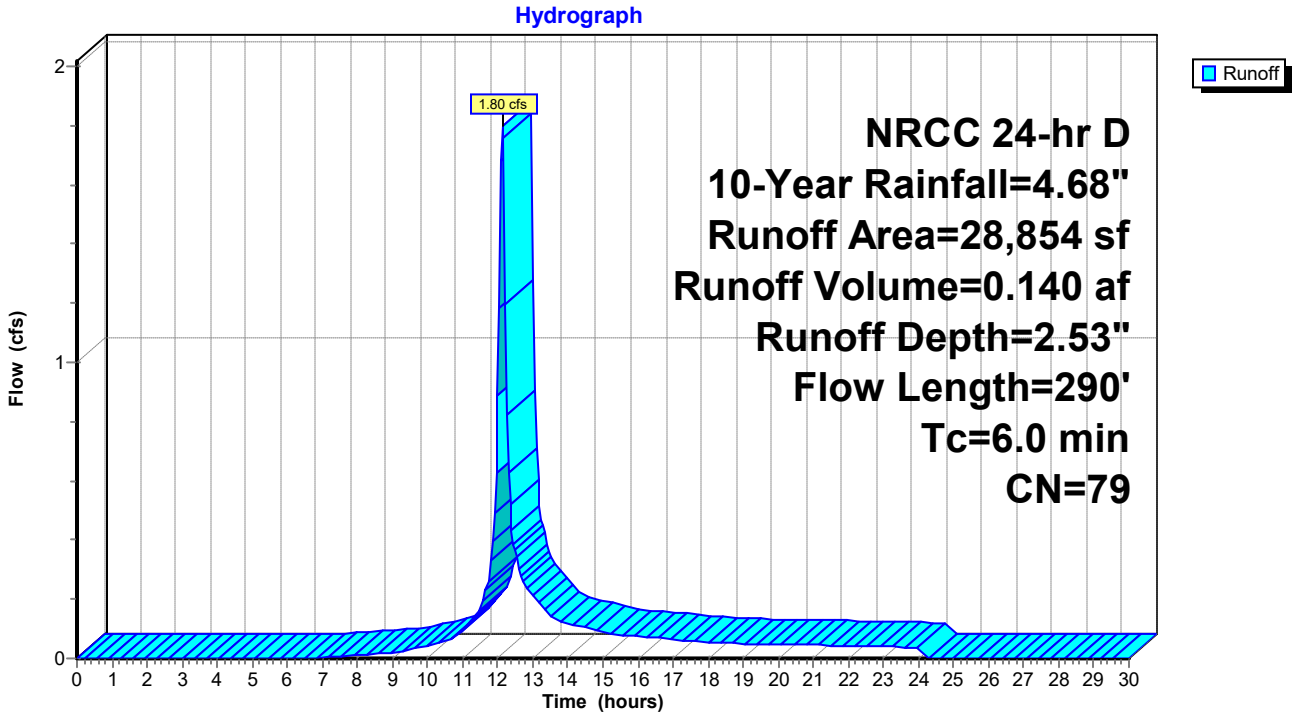
Runoff = 1.80 cfs @ 12.13 hrs, Volume= 0.140 af, Depth= 2.53"
Routed to Pond RG1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
21,444	74	>75% Grass cover, Good, HSG C
161	70	Woods, Good, HSG C
3,358	98	Paved parking, HSG C
2,891	96	Gravel surface, HSG C
1,000	89	Gravel roads, HSG C
28,854	79	Weighted Average
25,496		88.36% Pervious Area
3,358		11.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	15	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	29	0.3330	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.1	6	0.0300	0.89		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	113	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	81	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	46	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	290	Total			

Subcatchment P100: TO RAIN GARDEN



Summary for Subcatchment P101: TO DCB#2

[49] Hint: Tc<2dt may require smaller dt

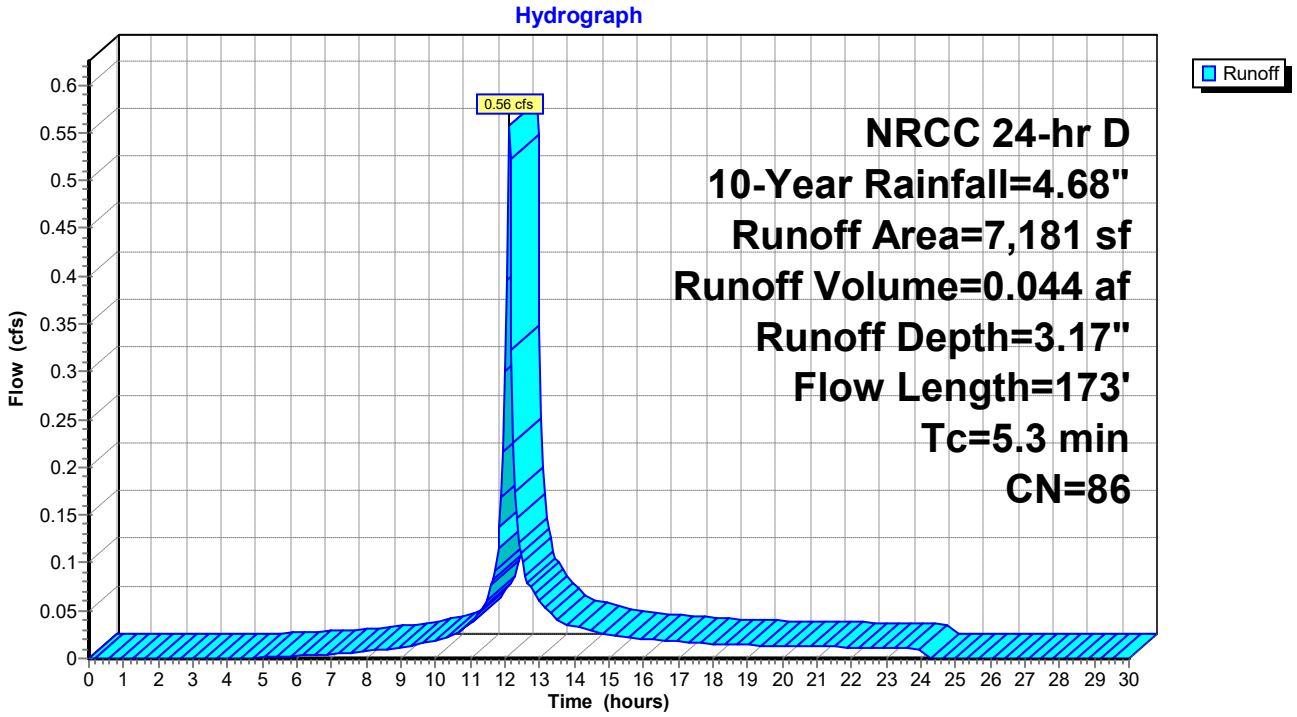
Runoff = 0.56 cfs @ 12.12 hrs, Volume= 0.044 af, Depth= 3.17"
Routed to Reach DCB2 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
1,897	74	>75% Grass cover, Good, HSG C
715	70	Woods, Good, HSG C
396	98	Paved parking, HSG C
2,020	96	Gravel surface, HSG C
2,153	89	Gravel roads, HSG C
7,181	86	Weighted Average
6,785		94.49% Pervious Area
396		5.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	16	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.2	14	0.0300	1.06		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	123	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.3	173	Total			

Subcatchment P101: TO DCB#2



Summary for Subcatchment p102: (new Subcat)

[49] Hint: Tc<2dt may require smaller dt

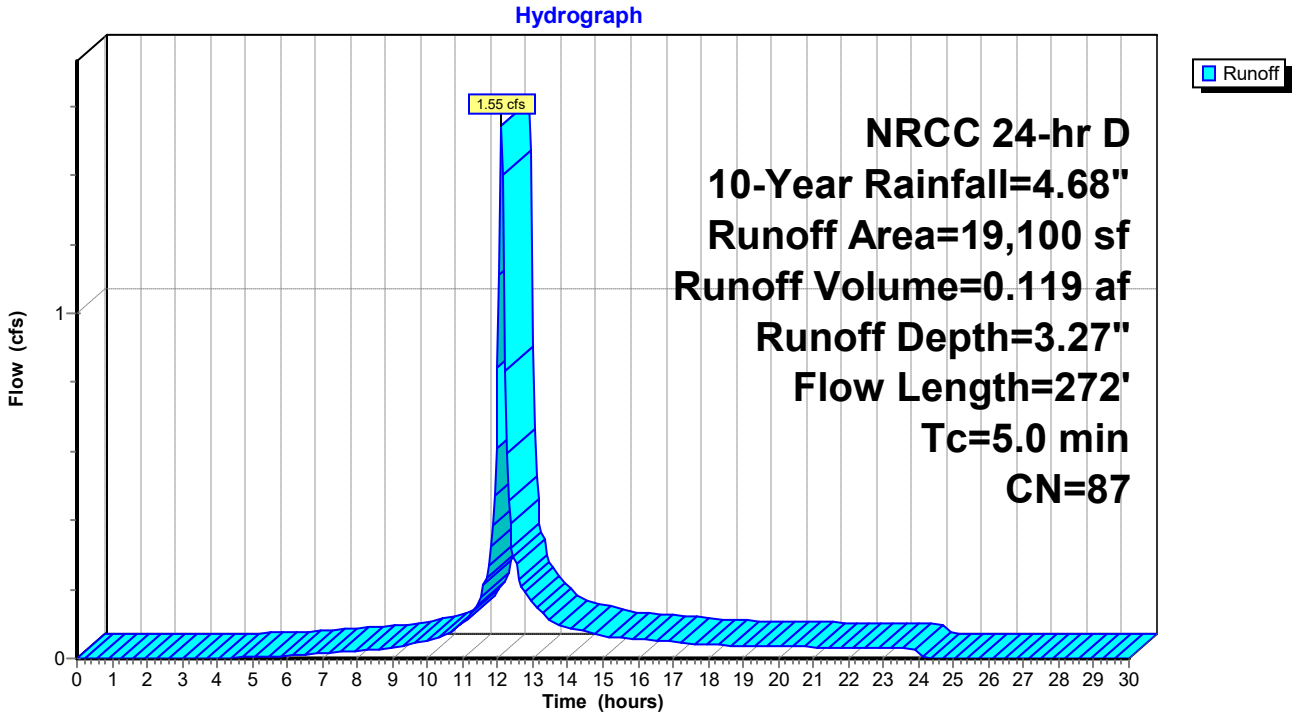
Runoff = 1.55 cfs @ 12.11 hrs, Volume= 0.119 af, Depth= 3.27"
Routed to Reach DCB1 : TO DMH#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
5,623	74	>75% Grass cover, Good, HSG C
528	70	Woods, Good, HSG C
1,140	98	Paved parking, HSG C
7,733	96	Gravel surface, HSG C
4,076	89	Gravel roads, HSG C
19,100	87	Weighted Average
17,960		94.03% Pervious Area
1,140		5.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.4	30	0.0250	1.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
1.6	222	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	272	Total, Increased to minimum Tc = 5.0 min			

Subcatchment p102: (new Subcat)



Summary for Subcatchment p103: TO DCB#3

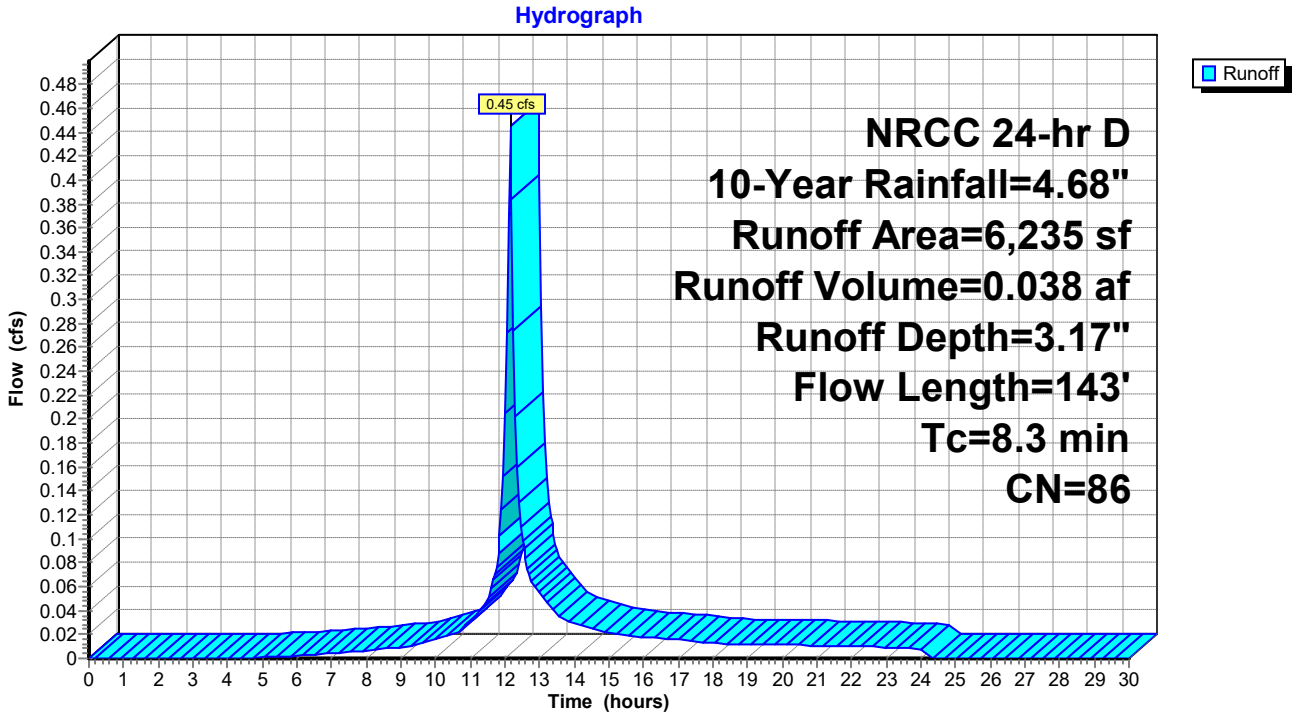
Runoff = 0.45 cfs @ 12.15 hrs, Volume= 0.038 af, Depth= 3.17"
Routed to Reach DCB3 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
1,601	74	>75% Grass cover, Good, HSG C
855	70	Woods, Good, HSG C
908	98	Paved parking, HSG C
1,705	96	Gravel surface, HSG C
1,166	89	Gravel roads, HSG C
6,235	86	Weighted Average
5,327		85.44% Pervious Area
908		14.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	40	0.0540	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.5	10	0.3300	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.6	93	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	143	Total			

Subcatchment p103: TO DCB#3



Summary for Subcatchment P11A: OVERLAND TO DP#1

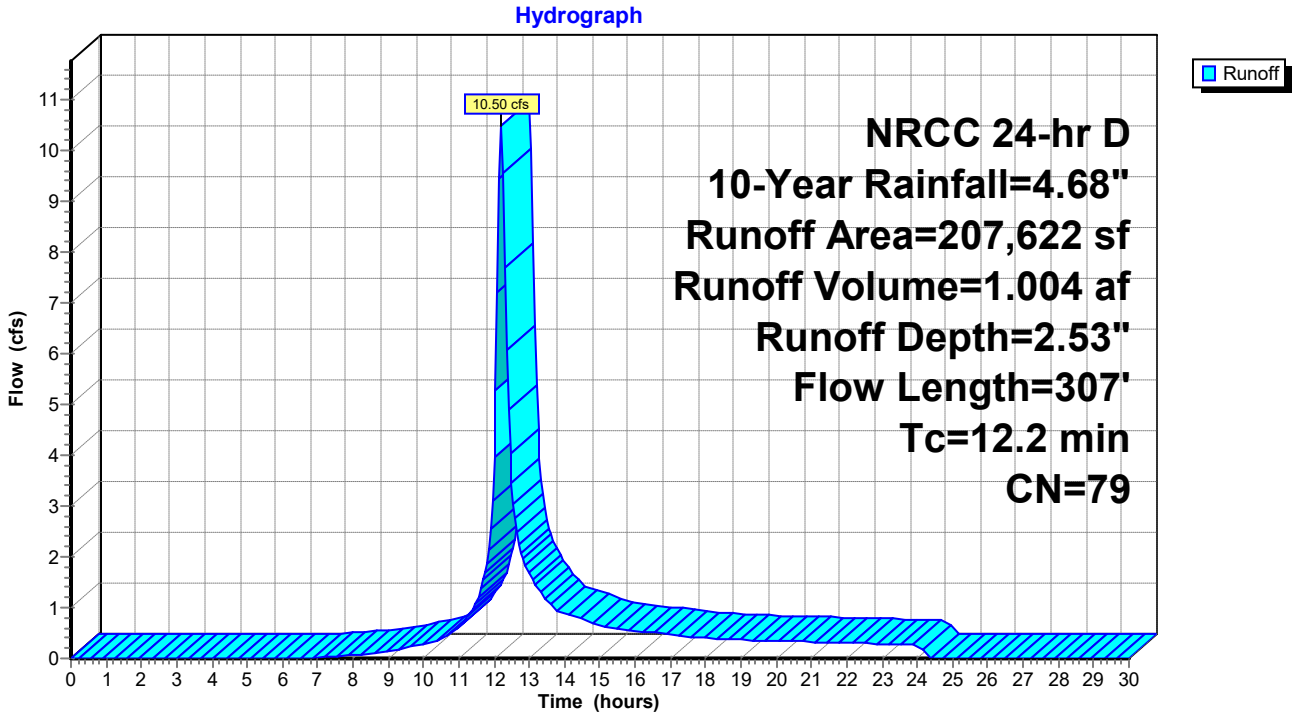
Runoff = 10.50 cfs @ 12.20 hrs, Volume= 1.004 af, Depth= 2.53"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
24,929	74	>75% Grass cover, Good, HSG C
57,953	70	Woods, Good, HSG C
32,603	96	Gravel surface, HSG C
10,055	98	Paved parking, HSG C
1,617	89	Gravel roads, HSG C
739	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
207,622	79	Weighted Average
196,828		94.80% Pervious Area
10,794		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.0	68	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	38	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	27	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.1	124	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	307	Total			

Subcatchment P11A: OVERLAND TO DP#1



Summary for Subcatchment P12: TO CULVERT

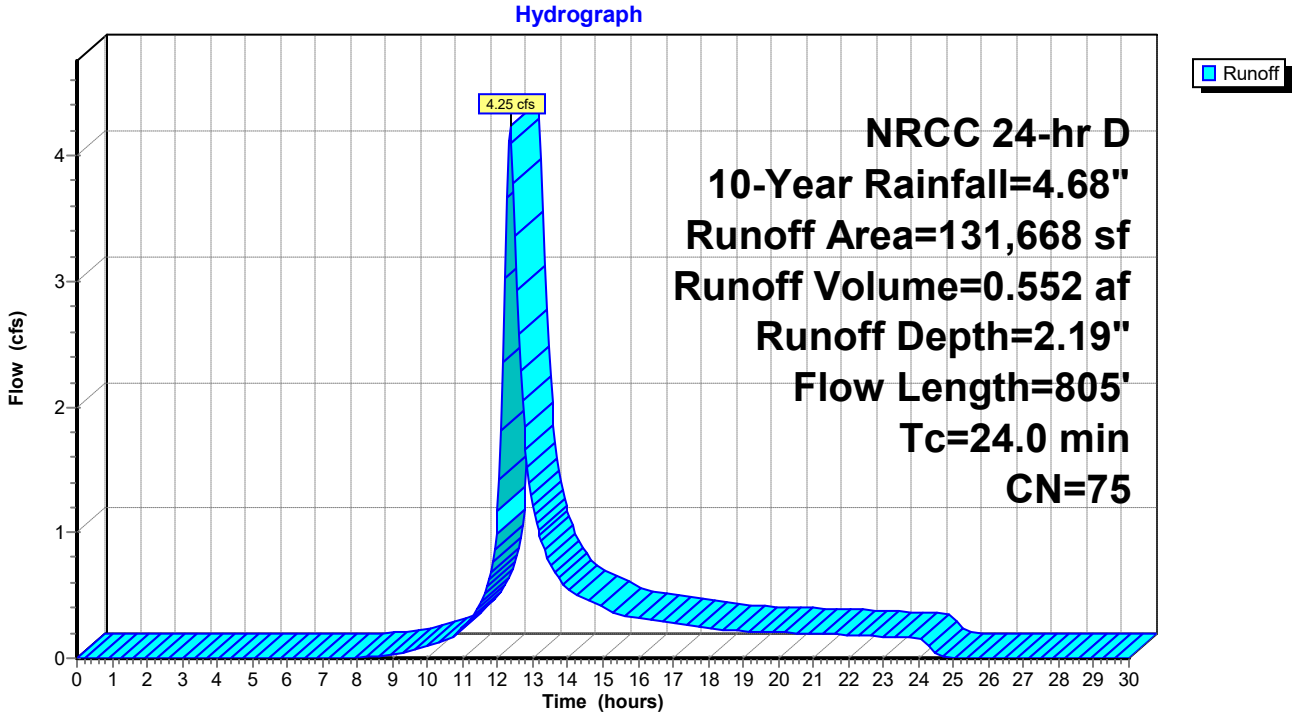
Runoff = 4.25 cfs @ 12.35 hrs, Volume= 0.552 af, Depth= 2.19"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.68"

Area (sf)	CN	Description
45,486	70	Woods, Good, HSG C
2,261	74	>75% Grass cover, Good, HSG C
83,921	77	Woods, Good, HSG D
131,668	75	Weighted Average
131,668		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment P12: TO CULVERT



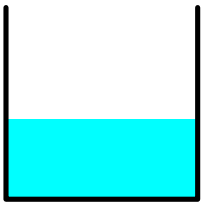
Summary for Reach CUL1: TO DP#1

Inflow Area = 3.023 ac, 0.00% Impervious, Inflow Depth = 2.19" for 10-Year event
Inflow = 4.25 cfs @ 12.35 hrs, Volume= 0.552 af
Outflow = 4.24 cfs @ 12.36 hrs, Volume= 0.552 af, Atten= 0%, Lag= 0.4 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

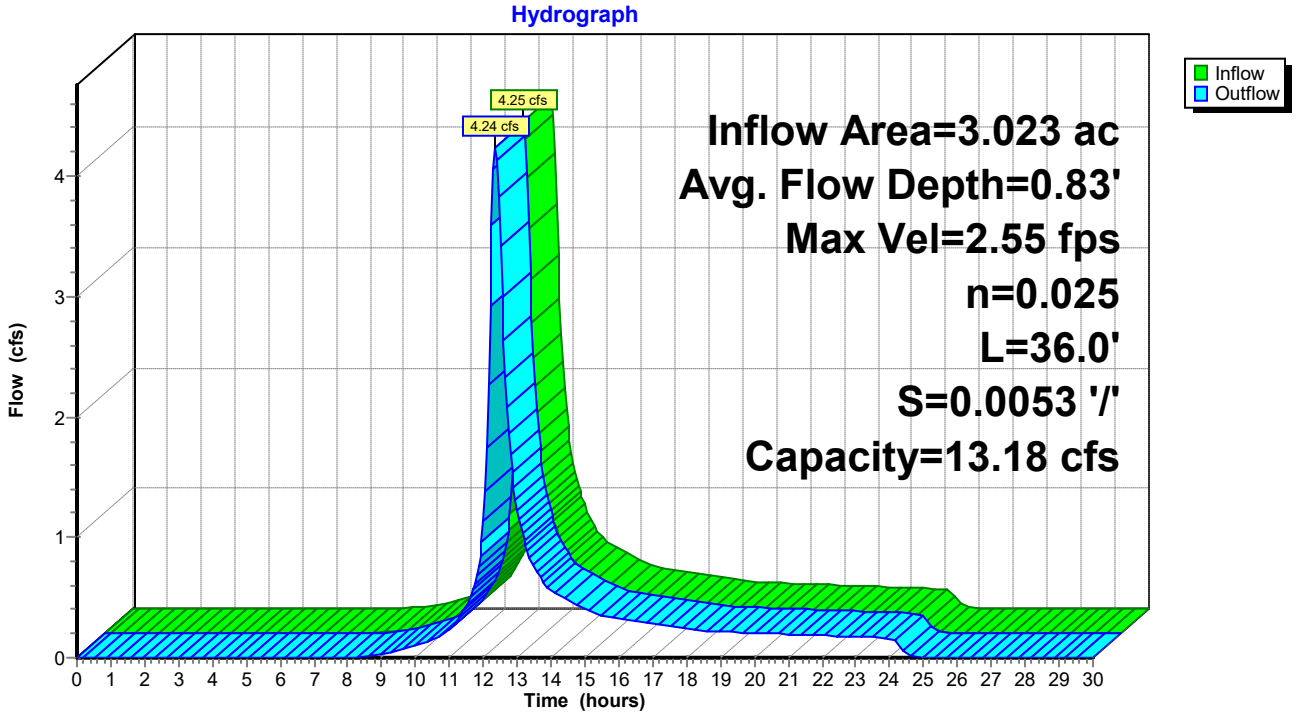
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.55 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 0.6 min

Peak Storage= 60 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.83' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 13.18 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0053 '/'
Inlet Invert= 1,003.98', Outlet Invert= 1,003.79'



Reach CUL1: TO DP#1



Summary for Reach DCB1: TO DMH#1

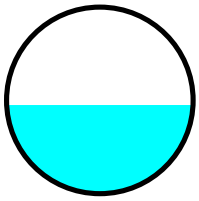
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.438 ac, 5.97% Impervious, Inflow Depth = 3.27" for 10-Year event
Inflow = 1.55 cfs @ 12.11 hrs, Volume= 0.119 af
Outflow = 1.52 cfs @ 12.12 hrs, Volume= 0.119 af, Atten= 2%, Lag= 0.3 min
Routed to Reach DMH1 : TO RAIN GARDEN

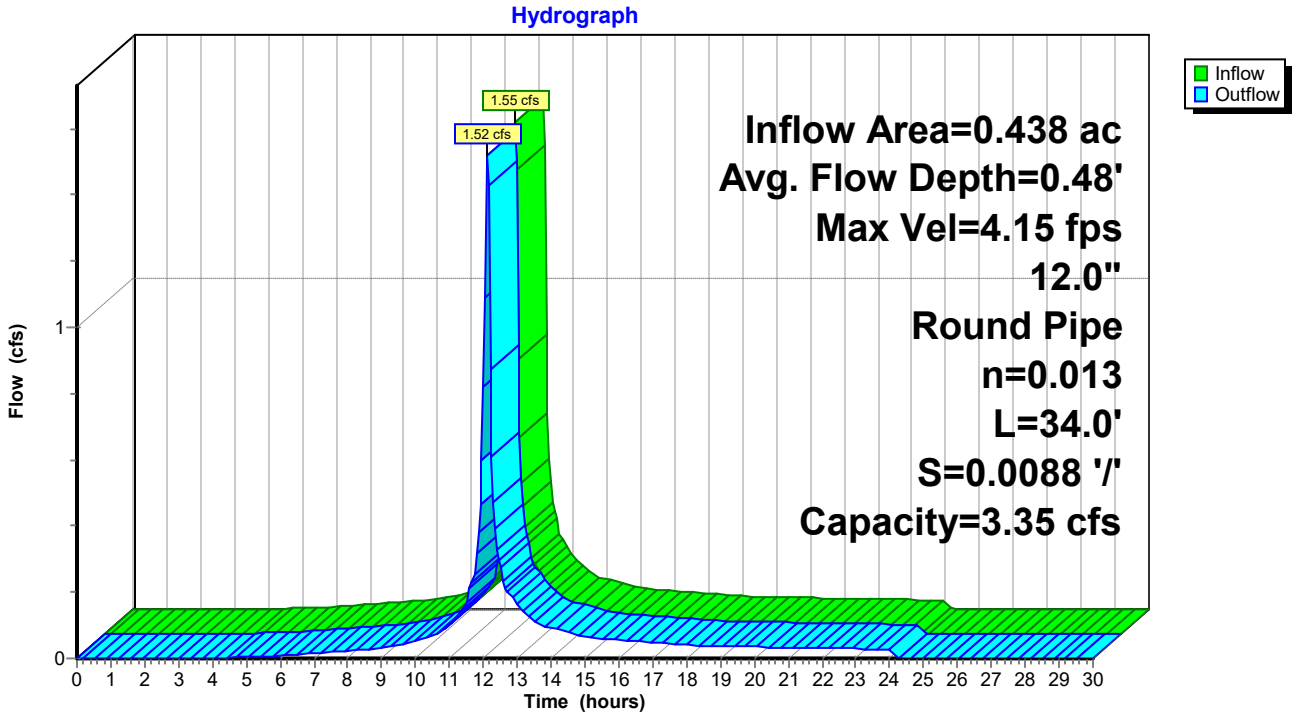
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.15 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.48 fps, Avg. Travel Time= 0.4 min

Peak Storage= 13 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.48' , Surface Width= 1.00'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.35 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 34.0' Slope= 0.0088 '/'
Inlet Invert= 1,012.20', Outlet Invert= 1,011.90'



Reach DCB1: TO DMH#1



Summary for Reach DCB2: TO DMH#2

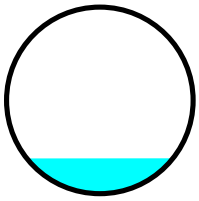
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.165 ac, 5.51% Impervious, Inflow Depth = 3.17" for 10-Year event
Inflow = 0.56 cfs @ 12.12 hrs, Volume= 0.044 af
Outflow = 0.56 cfs @ 12.12 hrs, Volume= 0.044 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DMH2 : TO DMH#1

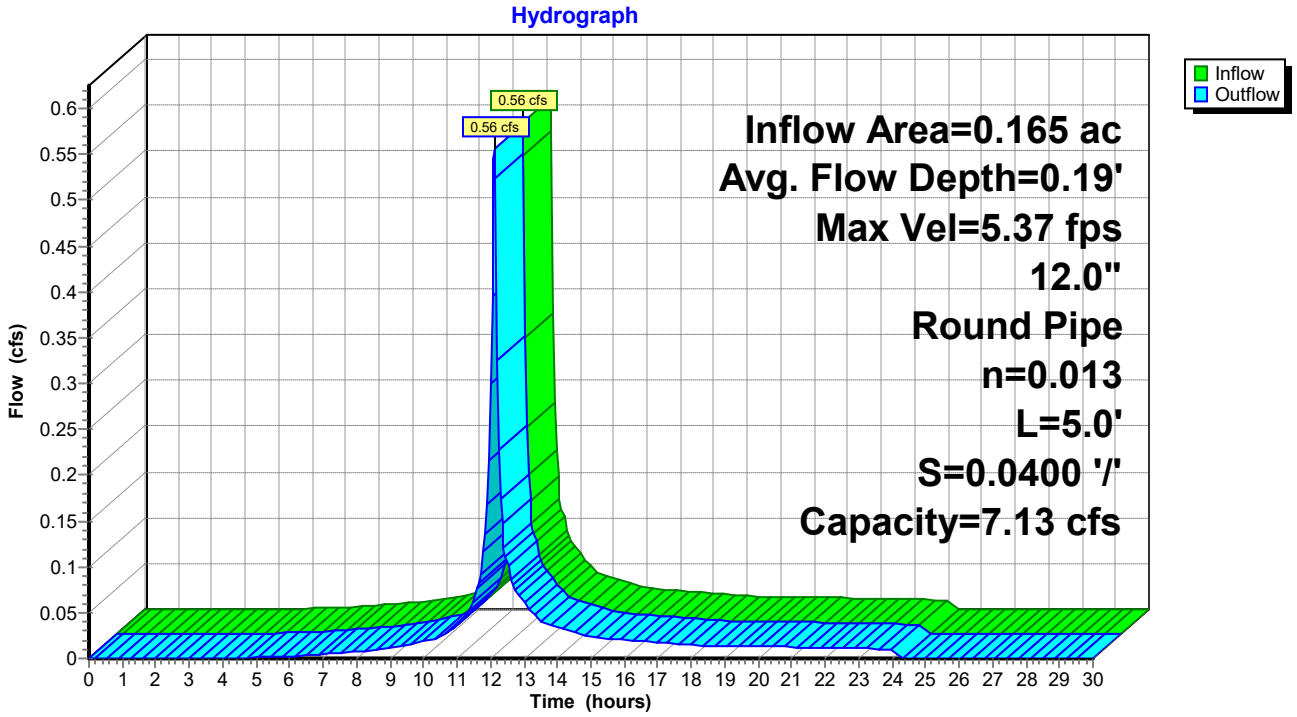
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.37 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.88 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 0.78'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.13 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 5.0' Slope= 0.0400 '/'
Inlet Invert= 1,015.70', Outlet Invert= 1,015.50'



Reach DCB2: TO DMH#2



Summary for Reach DCB3: TO DMH#2

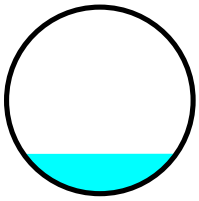
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.143 ac, 14.56% Impervious, Inflow Depth = 3.17" for 10-Year event
Inflow = 0.45 cfs @ 12.15 hrs, Volume= 0.038 af
Outflow = 0.42 cfs @ 12.18 hrs, Volume= 0.038 af, Atten= 5%, Lag= 1.4 min
Routed to Reach DMH2 : TO DMH#1

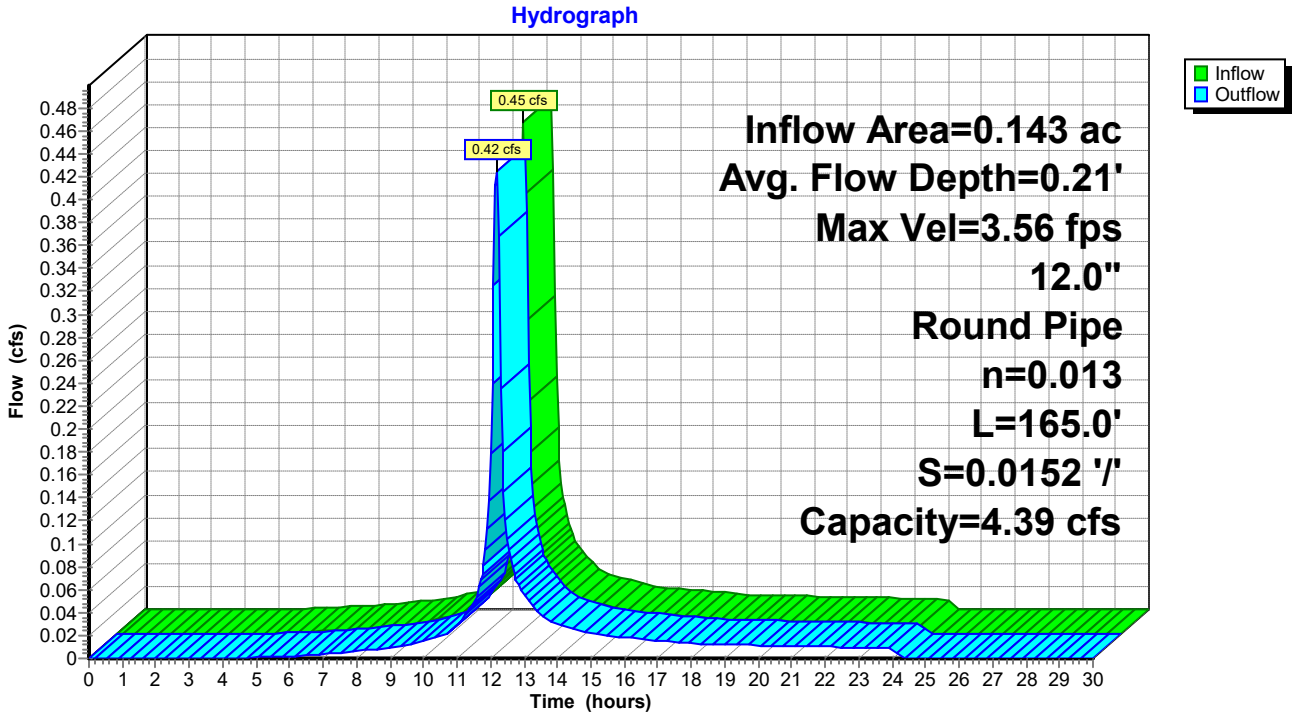
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.56 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 2.2 min

Peak Storage= 20 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.21' , Surface Width= 0.82'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.39 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 165.0' Slope= 0.0152 '/'
Inlet Invert= 1,016.60', Outlet Invert= 1,014.10'



Reach DCB3: TO DMH#2



Summary for Reach DMH1: TO RAIN GARDEN

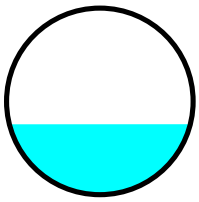
[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach DCB1 outlet invert by 0.27' @ 12.15 hrs
[61] Hint: Exceeded Reach DMH2 outlet invert by 0.27' @ 12.15 hrs

Inflow Area = 0.746 ac, 7.52% Impervious, Inflow Depth = 3.23" for 10-Year event
Inflow = 2.39 cfs @ 12.13 hrs, Volume= 0.201 af
Outflow = 2.37 cfs @ 12.14 hrs, Volume= 0.201 af, Atten= 1%, Lag= 0.4 min
Routed to Pond RG1 : TO DP#1

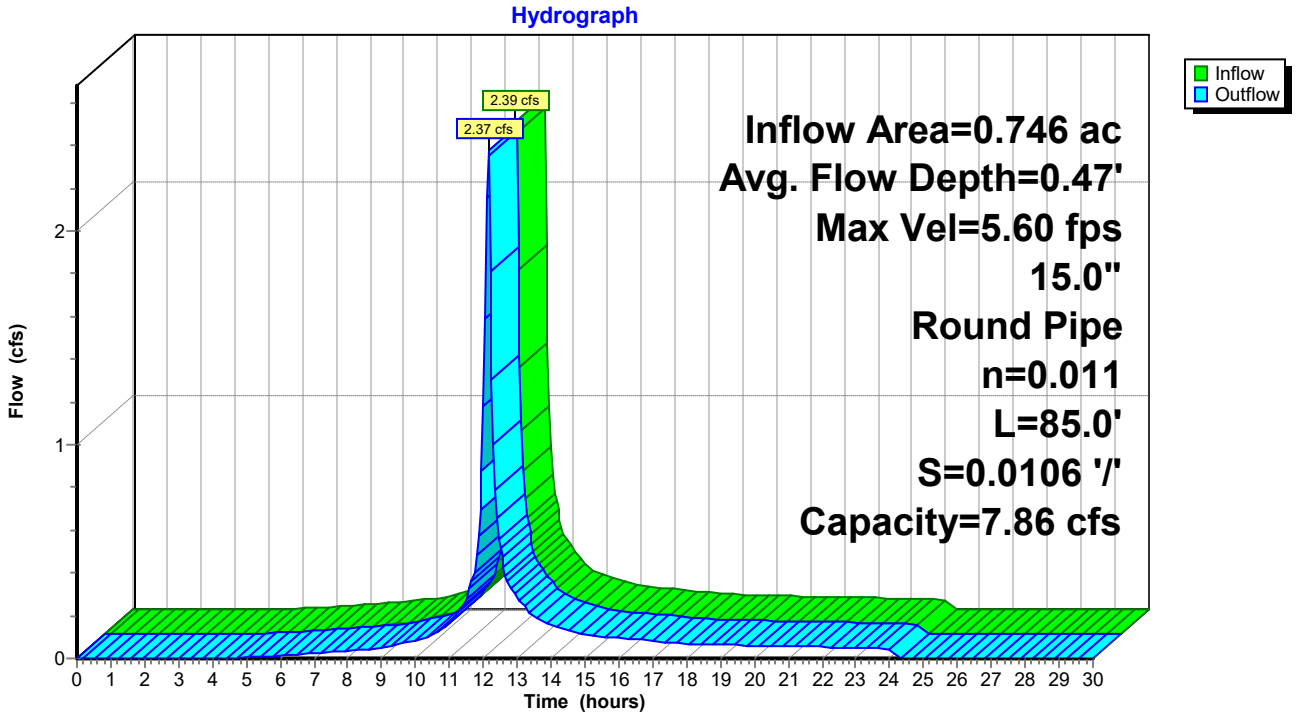
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.60 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.98 fps, Avg. Travel Time= 0.7 min

Peak Storage= 36 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.47' , Surface Width= 1.21'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.86 cfs

15.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 85.0' Slope= 0.0106 '/'
Inlet Invert= 1,011.70', Outlet Invert= 1,010.80'



Reach DMH1: TO RAIN GARDEN



Summary for Reach DMH2: TO DMH#1

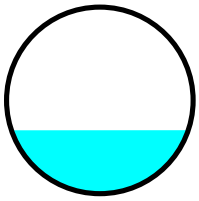
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach DCB3 OUTLET depth by 0.03' @ 12.15 hrs

Inflow Area = 0.308 ac, 9.72% Impervious, Inflow Depth = 3.17" for 10-Year event
Inflow = 0.94 cfs @ 12.14 hrs, Volume= 0.081 af
Outflow = 0.91 cfs @ 12.16 hrs, Volume= 0.081 af, Atten= 3%, Lag= 1.2 min
Routed to Reach DMH1 : TO RAIN GARDEN

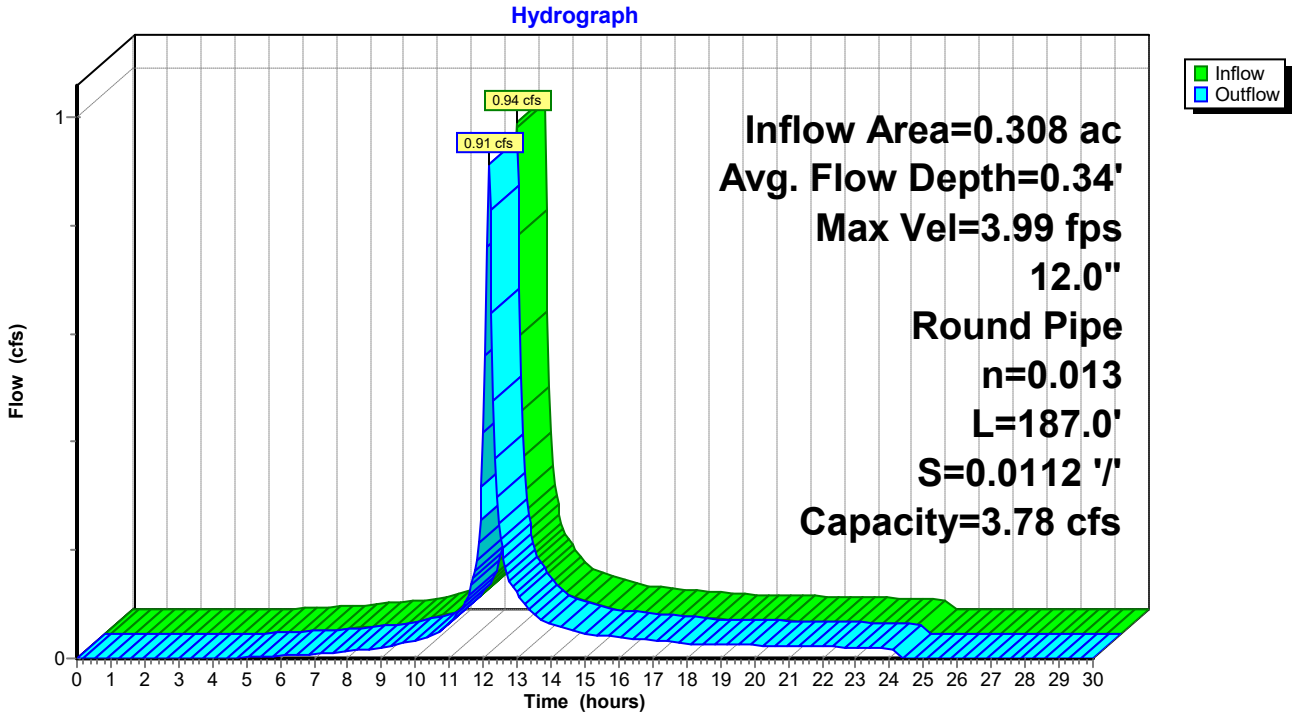
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.99 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 2.2 min

Peak Storage= 44 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.34' , Surface Width= 0.95'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.78 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 187.0' Slope= 0.0112 '/'
Inlet Invert= 1,014.00', Outlet Invert= 1,011.90'



Reach DMH2: TO DMH#1



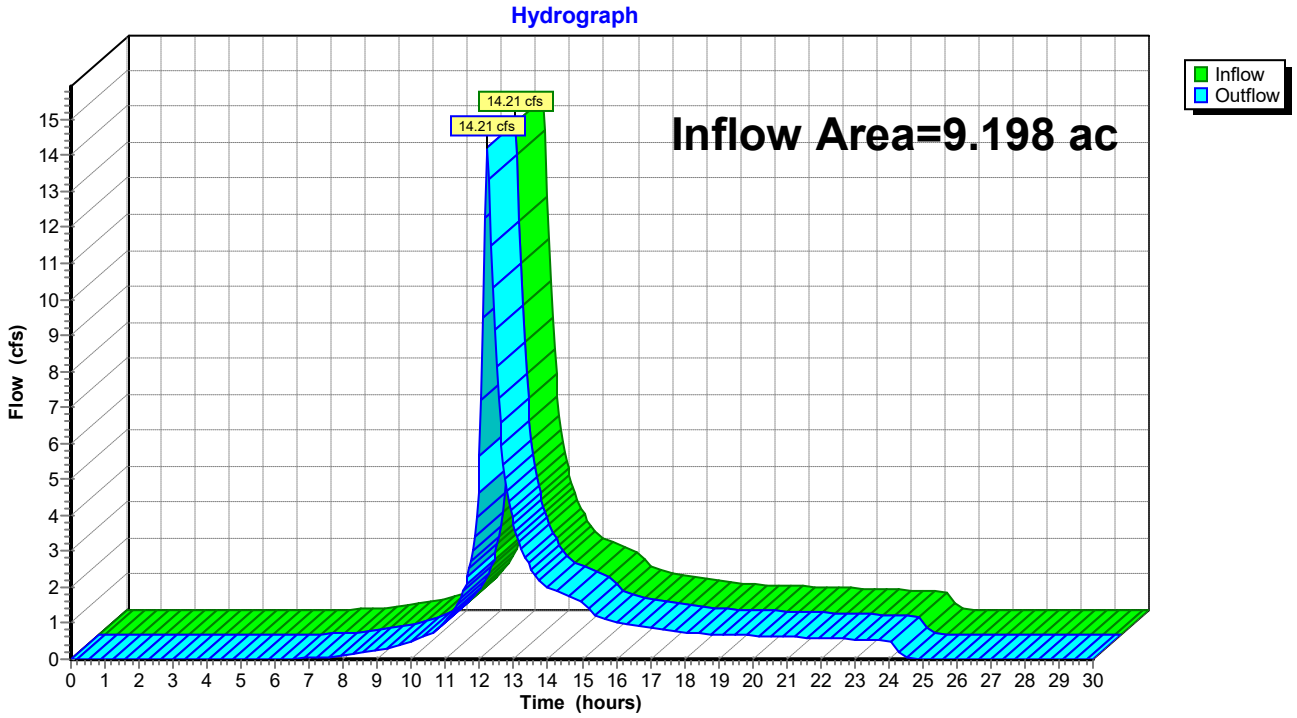
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 4.14% Impervious, Inflow Depth = 2.47" for 10-Year event
Inflow = 14.21 cfs @ 12.22 hrs, Volume= 1.897 af
Outflow = 14.21 cfs @ 12.22 hrs, Volume= 1.897 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Summary for Reach OL1: OVERLAND TO WETLAND

[79] Warning: Submerged Pond RG1 Primary device # 4 OUTLET by 0.18'

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 2.90" for 10-Year event
Inflow = 1.30 cfs @ 12.36 hrs, Volume= 0.340 af
Outflow = 1.29 cfs @ 12.45 hrs, Volume= 0.340 af, Atten= 1%, Lag= 5.7 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

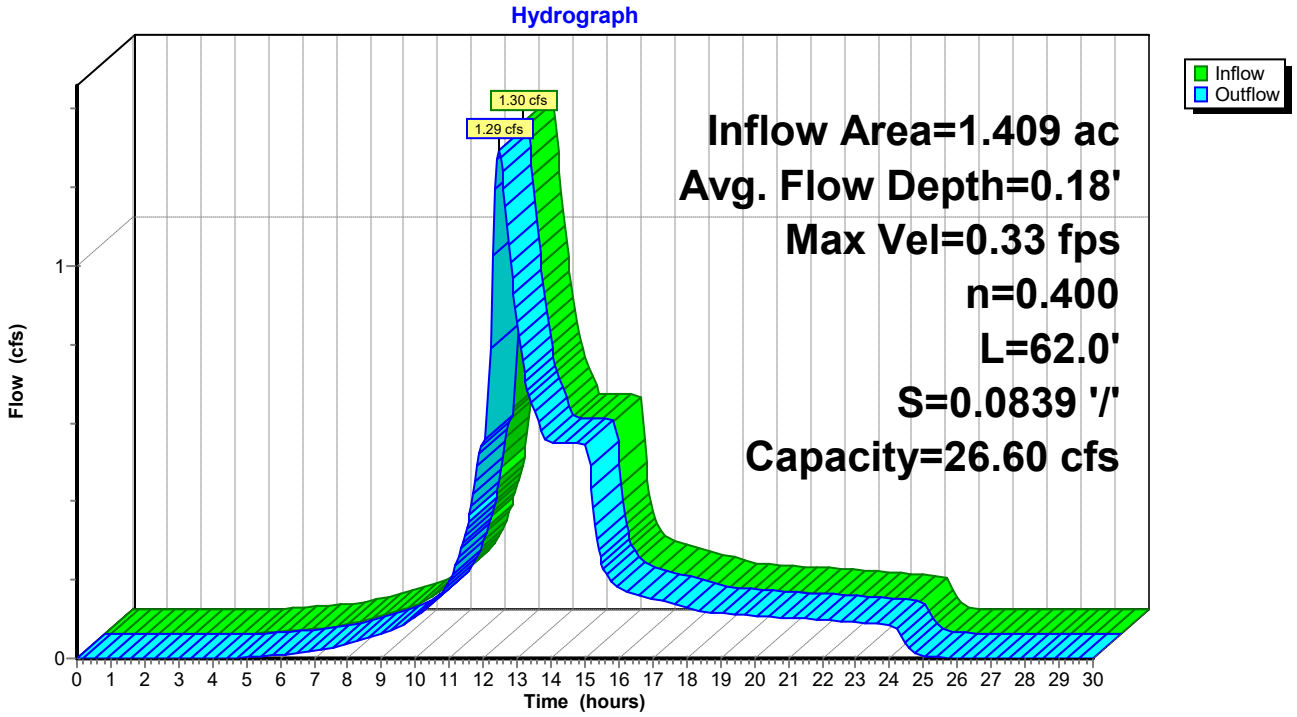
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.33 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 0.13 fps, Avg. Travel Time= 8.0 min

Peak Storage= 245 cf @ 12.40 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 23.63'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 26.60 cfs

20.00' x 1.00' deep channel, n= 0.400 Sheet flow: Woods+light brush
Side Slope Z-value= 10.0 '/' Top Width= 40.00'
Length= 62.0' Slope= 0.0839 '/'
Inlet Invert= 1,006.00', Outlet Invert= 1,000.80'

‡

Reach OL1: OVERLAND TO WETLAND



Summary for Pond RG1: TO DP#1

[44] Hint: Outlet device #2 is below defined storage

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 2.90" for 10-Year event
Inflow = 4.17 cfs @ 12.13 hrs, Volume= 0.340 af
Outflow = 1.30 cfs @ 12.36 hrs, Volume= 0.340 af, Atten= 69%, Lag= 13.3 min
Primary = 1.30 cfs @ 12.36 hrs, Volume= 0.340 af
Routed to Reach OL1 : OVERLAND TO WETLAND
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach OL1 : OVERLAND TO WETLAND

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 1,009.81' @ 12.36 hrs Surf.Area= 5,197 sf Storage= 3,238 cf

Plug-Flow detention time= 28.5 min calculated for 0.340 af (100% of inflow)
Center-of-Mass det. time= 28.5 min (863.4 - 835.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,009.00'	23,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

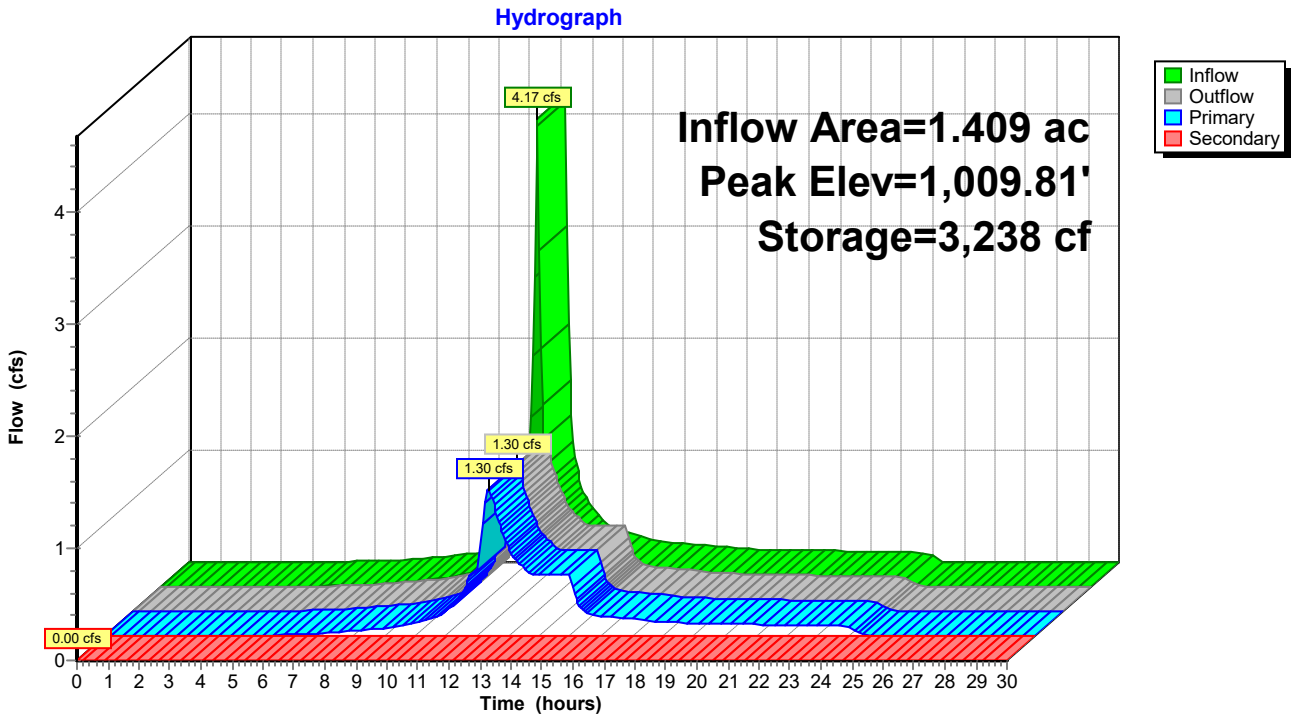
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,009.00	2,750	0	0
1,010.00	5,753	4,252	4,252
1,012.00	10,411	16,164	20,416
1,012.25	12,677	2,886	23,302

Device	Routing	Invert	Outlet Devices
#1	Secondary	1,011.25'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Device 4	1,006.50'	**Special & User-Defined** Head (feet) 0.00 1.00 15.00 Disch. (cfs) 0.000 0.550 0.550
#3	Device 4	1,010.50'	**2.6' long Sharp-Crested Rectangular Weir X 3.00** 2 End Contraction(s) 0.5' Crest Height
#4	Primary	1,006.40'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,006.40' / 1,006.00' S= 0.0095 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#5	Device 4	1,009.50'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.29 cfs @ 12.36 hrs HW=1,009.81' (Free Discharge)
└**4=Culvert** (Passes 1.29 cfs of 5.10 cfs potential flow)
├**2=Special & User-Defined** (Custom Controls 0.55 cfs)
├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**5=Orifice/Grate** (Orifice Controls 0.74 cfs @ 1.91 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,009.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond RG1: TO DP#1



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P100: TO RAIN GARDEN Runoff Area=28,854 sf 11.64% Impervious Runoff Depth=3.57"
Flow Length=290' Tc=6.0 min CN=79 Runoff=2.53 cfs 0.197 af

Subcatchment P101: TO DCB#2 Runoff Area=7,181 sf 5.51% Impervious Runoff Depth=4.30"
Flow Length=173' Tc=5.3 min CN=86 Runoff=0.75 cfs 0.059 af

Subcatchment p102: (new Subcat) Runoff Area=19,100 sf 5.97% Impervious Runoff Depth=4.40"
Flow Length=272' Tc=5.0 min CN=87 Runoff=2.05 cfs 0.161 af

Subcatchment p103: TO DCB#3 Runoff Area=6,235 sf 14.56% Impervious Runoff Depth=4.30"
Flow Length=143' Tc=8.3 min CN=86 Runoff=0.60 cfs 0.051 af

Subcatchment P11A: OVERLAND TO DP#1 Runoff Area=207,622 sf 5.20% Impervious Runoff Depth=3.57"
Flow Length=307' Tc=12.2 min CN=79 Runoff=14.77 cfs 1.419 af

Subcatchment P12: TO CULVERT Runoff Area=131,668 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=805' Tc=24.0 min CN=75 Runoff=6.20 cfs 0.801 af

Reach CUL1: TO DP#1 Avg. Flow Depth=1.10' Max Vel=2.81 fps Inflow=6.20 cfs 0.801 af
n=0.025 L=36.0' S=0.0053 '/' Capacity=13.18 cfs Outflow=6.19 cfs 0.801 af

Reach DCB1: TO DMH#1 Avg. Flow Depth=0.56' Max Vel=4.45 fps Inflow=2.05 cfs 0.161 af
12.0" Round Pipe n=0.013 L=34.0' S=0.0088 '/' Capacity=3.35 cfs Outflow=2.02 cfs 0.161 af

Reach DCB2: TO DMH#2 Avg. Flow Depth=0.22' Max Vel=5.84 fps Inflow=0.75 cfs 0.059 af
12.0" Round Pipe n=0.013 L=5.0' S=0.0400 '/' Capacity=7.13 cfs Outflow=0.74 cfs 0.059 af

Reach DCB3: TO DMH#2 Avg. Flow Depth=0.25' Max Vel=3.88 fps Inflow=0.60 cfs 0.051 af
12.0" Round Pipe n=0.013 L=165.0' S=0.0152 '/' Capacity=4.39 cfs Outflow=0.57 cfs 0.051 af

Reach DMH1: TO RAIN GARDEN Avg. Flow Depth=0.56' Max Vel=6.05 fps Inflow=3.19 cfs 0.271 af
15.0" Round Pipe n=0.011 L=85.0' S=0.0106 '/' Capacity=7.86 cfs Outflow=3.17 cfs 0.271 af

Reach DMH2: TO DMH#1 Avg. Flow Depth=0.40' Max Vel=4.33 fps Inflow=1.27 cfs 0.110 af
12.0" Round Pipe n=0.013 L=187.0' S=0.0112 '/' Capacity=3.78 cfs Outflow=1.23 cfs 0.110 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=20.66 cfs 2.688 af
Outflow=20.66 cfs 2.688 af

Reach OL1: OVERLAND TO WETLAND Avg. Flow Depth=0.24' Max Vel=0.38 fps Inflow=2.05 cfs 0.468 af
n=0.400 L=62.0' S=0.0839 '/' Capacity=26.60 cfs Outflow=2.04 cfs 0.468 af

Pond RG1: TO DP#1 Peak Elev=1,010.03' Storage=4,431 cf Inflow=5.69 cfs 0.468 af
Primary=2.05 cfs 0.468 af Secondary=0.00 cfs 0.000 af Outflow=2.05 cfs 0.468 af

Total Runoff Area = 9.198 ac Runoff Volume = 2.688 af Average Runoff Depth = 3.51"
95.86% Pervious = 8.817 ac 4.14% Impervious = 0.381 ac

Summary for Subcatchment P100: TO RAIN GARDEN

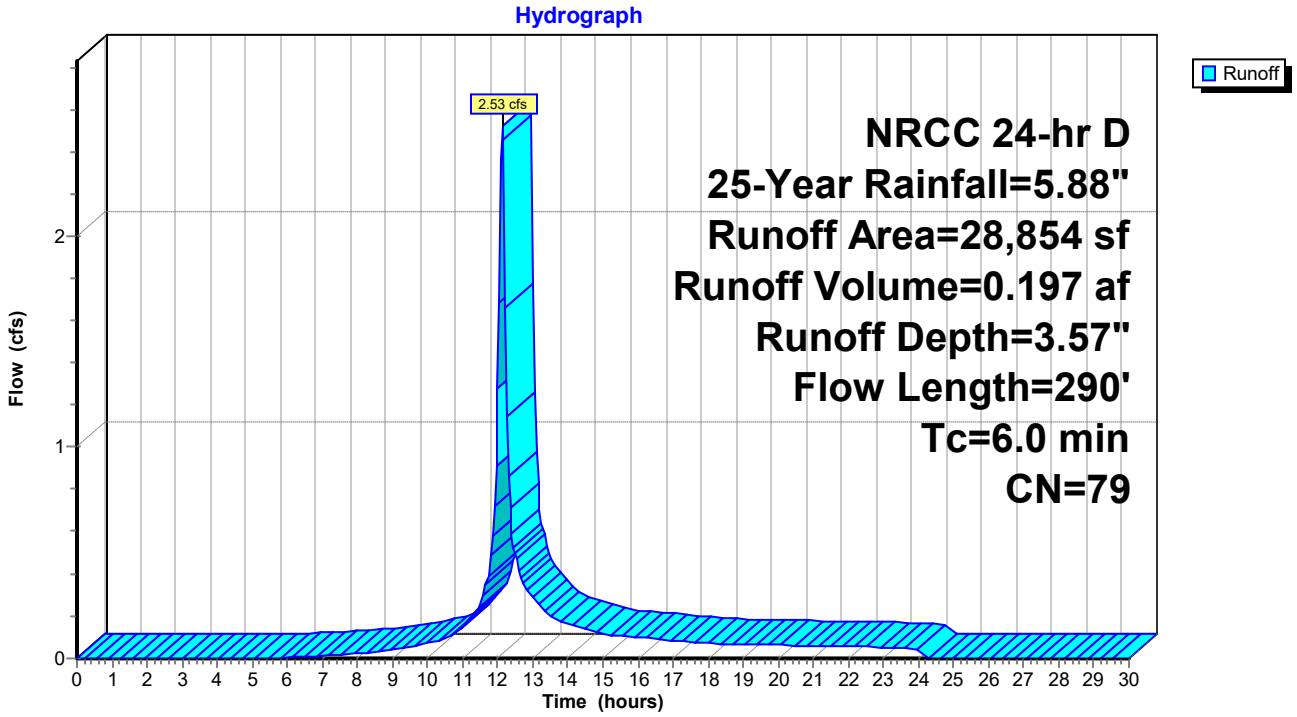
Runoff = 2.53 cfs @ 12.13 hrs, Volume= 0.197 af, Depth= 3.57"
Routed to Pond RG1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
21,444	74	>75% Grass cover, Good, HSG C
161	70	Woods, Good, HSG C
3,358	98	Paved parking, HSG C
2,891	96	Gravel surface, HSG C
1,000	89	Gravel roads, HSG C
28,854	79	Weighted Average
25,496		88.36% Pervious Area
3,358		11.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	15	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	29	0.3330	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.1	6	0.0300	0.89		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	113	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	81	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	46	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	290	Total			

Subcatchment P100: TO RAIN GARDEN



Summary for Subcatchment P101: TO DCB#2

[49] Hint: Tc<2dt may require smaller dt

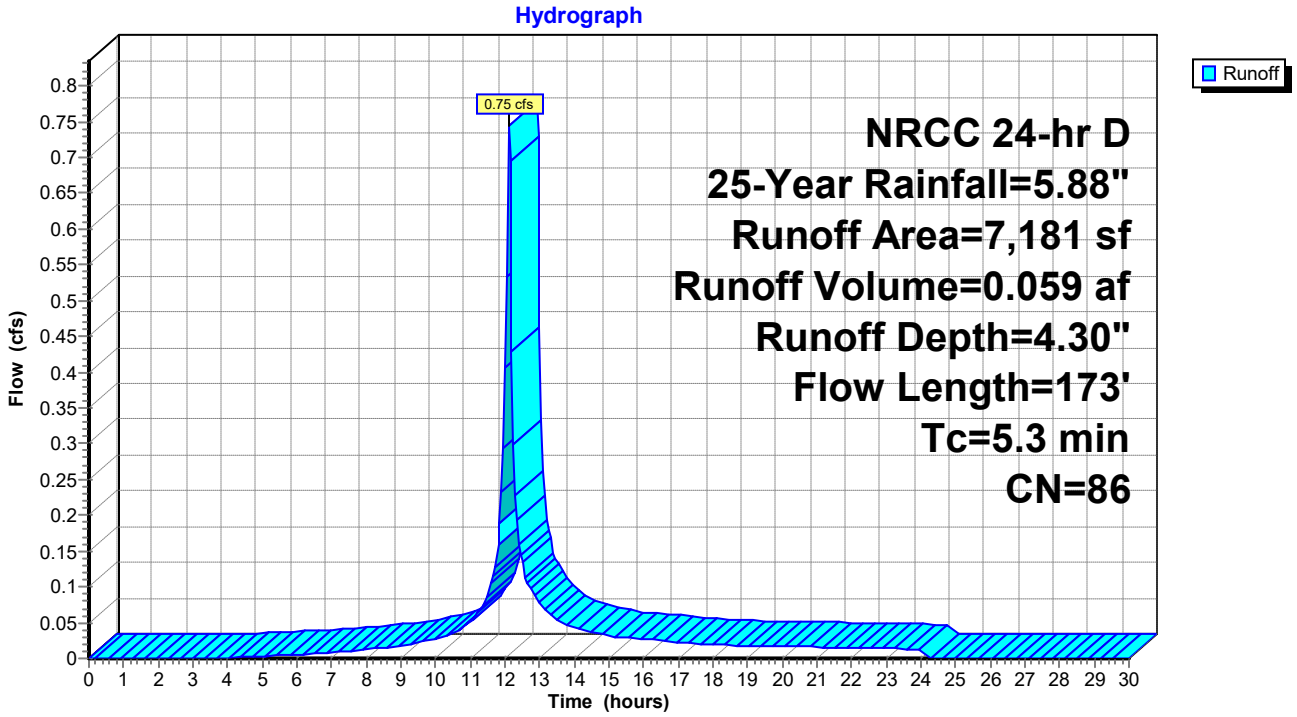
Runoff = 0.75 cfs @ 12.12 hrs, Volume= 0.059 af, Depth= 4.30"
Routed to Reach DCB2 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
1,897	74	>75% Grass cover, Good, HSG C
715	70	Woods, Good, HSG C
396	98	Paved parking, HSG C
2,020	96	Gravel surface, HSG C
2,153	89	Gravel roads, HSG C
7,181	86	Weighted Average
6,785		94.49% Pervious Area
396		5.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	16	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.2	14	0.0300	1.06		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	123	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.3	173	Total			

Subcatchment P101: TO DCB#2



Summary for Subcatchment p102: (new Subcat)

[49] Hint: Tc<2dt may require smaller dt

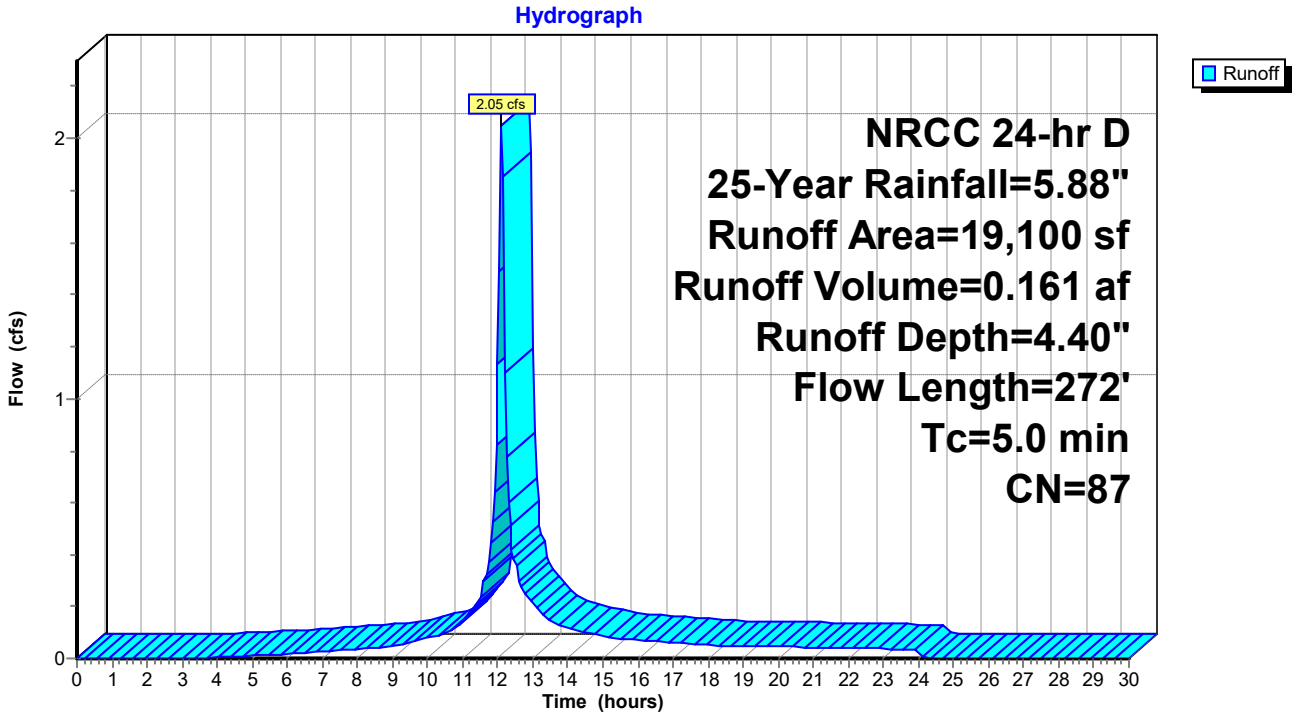
Runoff = 2.05 cfs @ 12.11 hrs, Volume= 0.161 af, Depth= 4.40"
Routed to Reach DCB1 : TO DMH#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
5,623	74	>75% Grass cover, Good, HSG C
528	70	Woods, Good, HSG C
1,140	98	Paved parking, HSG C
7,733	96	Gravel surface, HSG C
4,076	89	Gravel roads, HSG C
19,100	87	Weighted Average
17,960		94.03% Pervious Area
1,140		5.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.4	30	0.0250	1.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
1.6	222	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	272	Total, Increased to minimum Tc = 5.0 min			

Subcatchment p102: (new Subcat)



Summary for Subcatchment p103: TO DCB#3

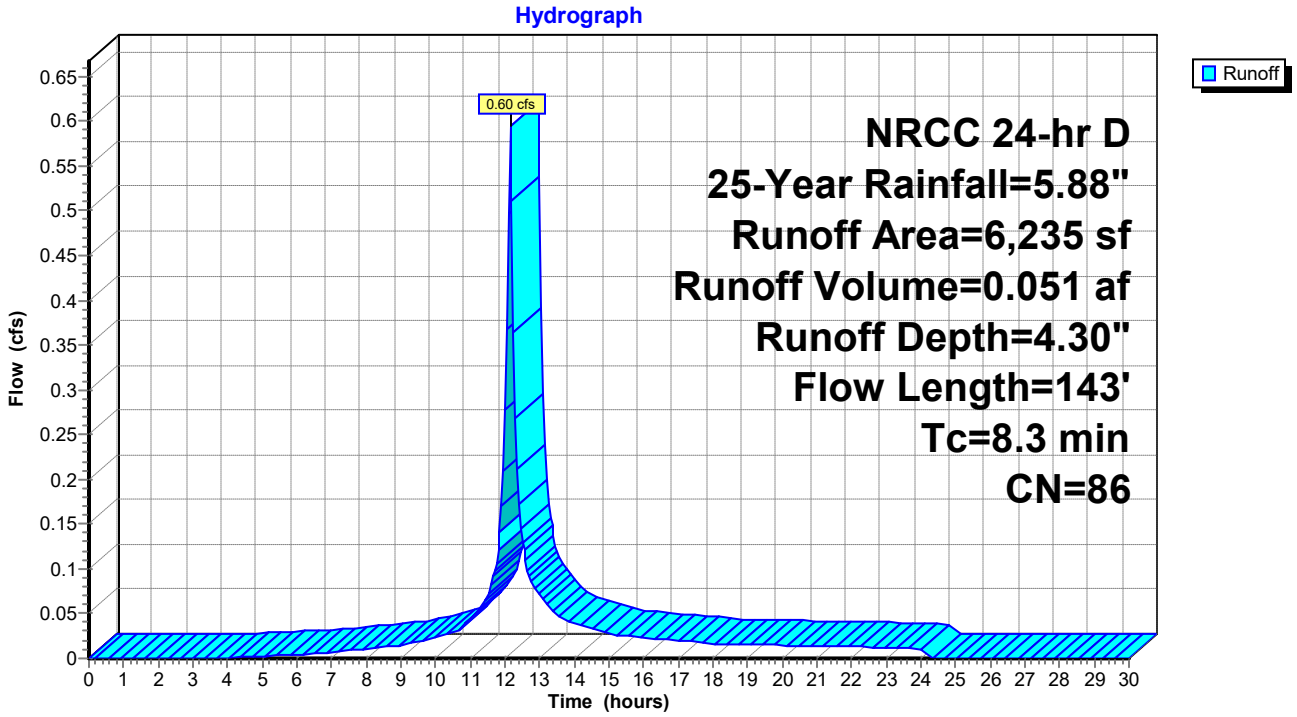
Runoff = 0.60 cfs @ 12.15 hrs, Volume= 0.051 af, Depth= 4.30"
Routed to Reach DCB3 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
1,601	74	>75% Grass cover, Good, HSG C
855	70	Woods, Good, HSG C
908	98	Paved parking, HSG C
1,705	96	Gravel surface, HSG C
1,166	89	Gravel roads, HSG C
6,235	86	Weighted Average
5,327		85.44% Pervious Area
908		14.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	40	0.0540	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.5	10	0.3300	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.6	93	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	143	Total			

Subcatchment p103: TO DCB#3



Summary for Subcatchment P11A: OVERLAND TO DP#1

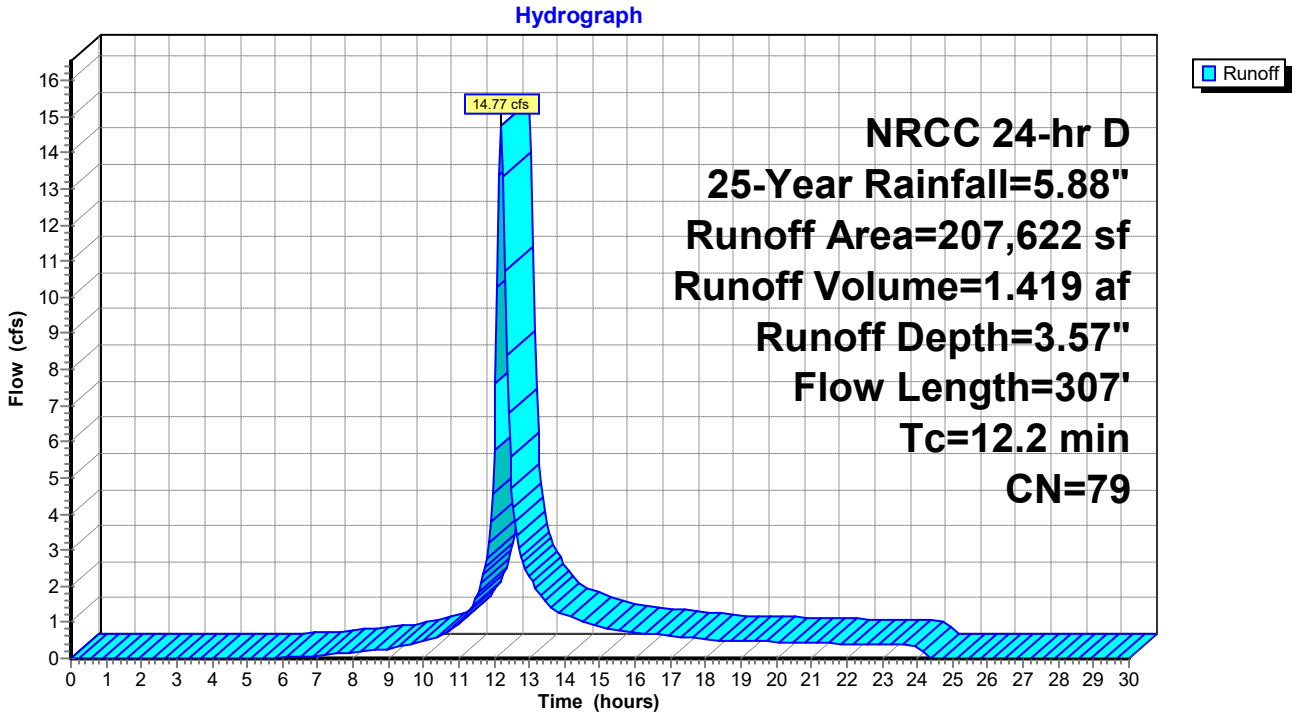
Runoff = 14.77 cfs @ 12.20 hrs, Volume= 1.419 af, Depth= 3.57"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
24,929	74	>75% Grass cover, Good, HSG C
57,953	70	Woods, Good, HSG C
32,603	96	Gravel surface, HSG C
10,055	98	Paved parking, HSG C
1,617	89	Gravel roads, HSG C
739	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
207,622	79	Weighted Average
196,828		94.80% Pervious Area
10,794		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.0	68	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	38	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	27	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.1	124	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	307	Total			

Subcatchment P11A: OVERLAND TO DP#1



Summary for Subcatchment P12: TO CULVERT

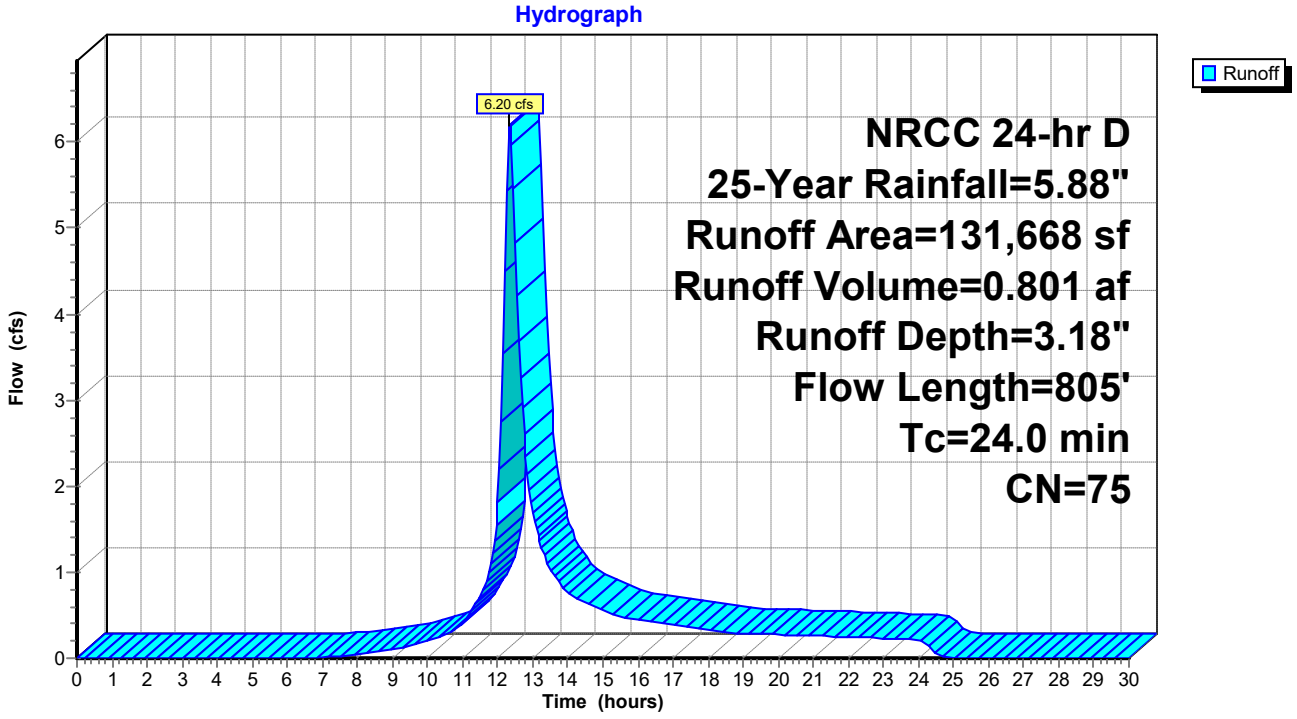
Runoff = 6.20 cfs @ 12.34 hrs, Volume= 0.801 af, Depth= 3.18"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 25-Year Rainfall=5.88"

Area (sf)	CN	Description
45,486	70	Woods, Good, HSG C
2,261	74	>75% Grass cover, Good, HSG C
83,921	77	Woods, Good, HSG D
131,668	75	Weighted Average
131,668		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment P12: TO CULVERT



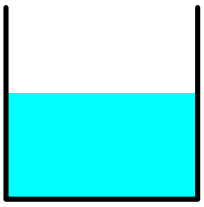
Summary for Reach CUL1: TO DP#1

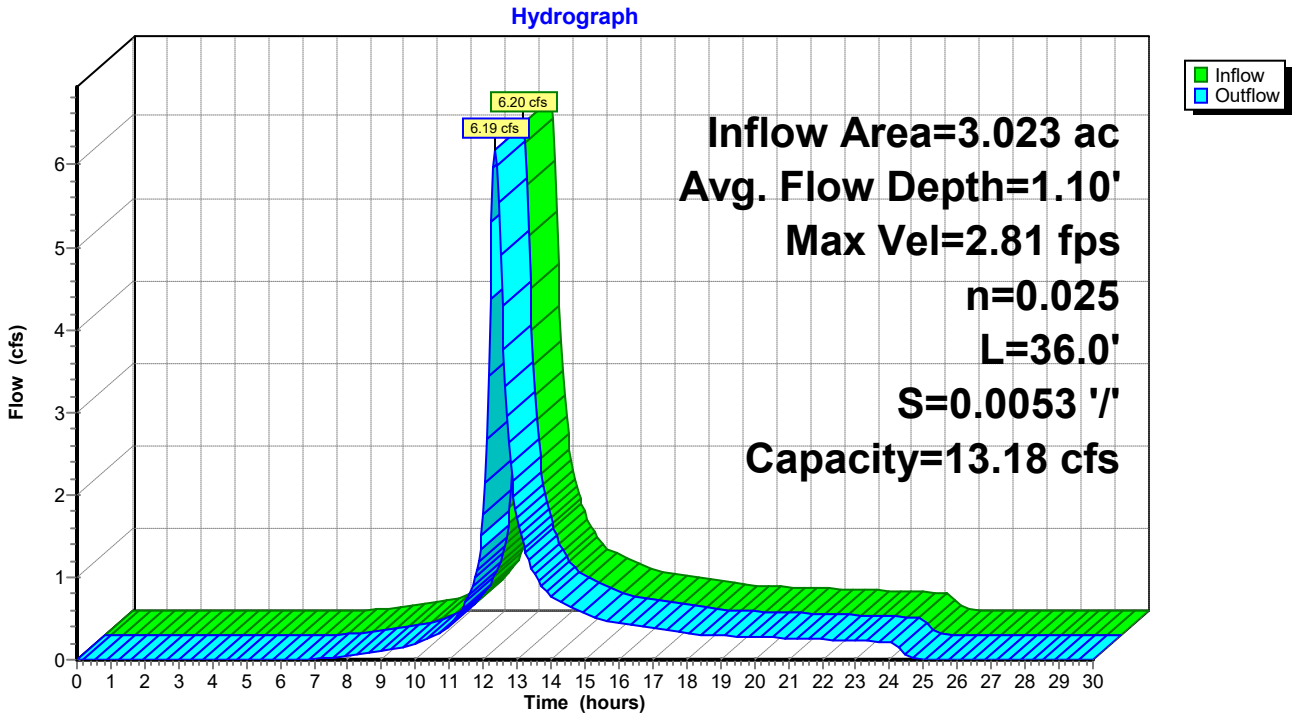
Inflow Area = 3.023 ac, 0.00% Impervious, Inflow Depth = 3.18" for 25-Year event
Inflow = 6.20 cfs @ 12.34 hrs, Volume= 0.801 af
Outflow = 6.19 cfs @ 12.35 hrs, Volume= 0.801 af, Atten= 0%, Lag= 0.4 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.81 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 0.6 min

Peak Storage= 79 cf @ 12.35 hrs
Average Depth at Peak Storage= 1.10' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 13.18 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0053 '/'
Inlet Invert= 1,003.98', Outlet Invert= 1,003.79'





Summary for Reach DCB1: TO DMH#1

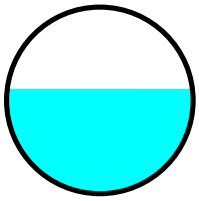
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.438 ac, 5.97% Impervious, Inflow Depth = 4.40" for 25-Year event
Inflow = 2.05 cfs @ 12.11 hrs, Volume= 0.161 af
Outflow = 2.02 cfs @ 12.12 hrs, Volume= 0.161 af, Atten= 2%, Lag= 0.3 min
Routed to Reach DMH1 : TO RAIN GARDEN

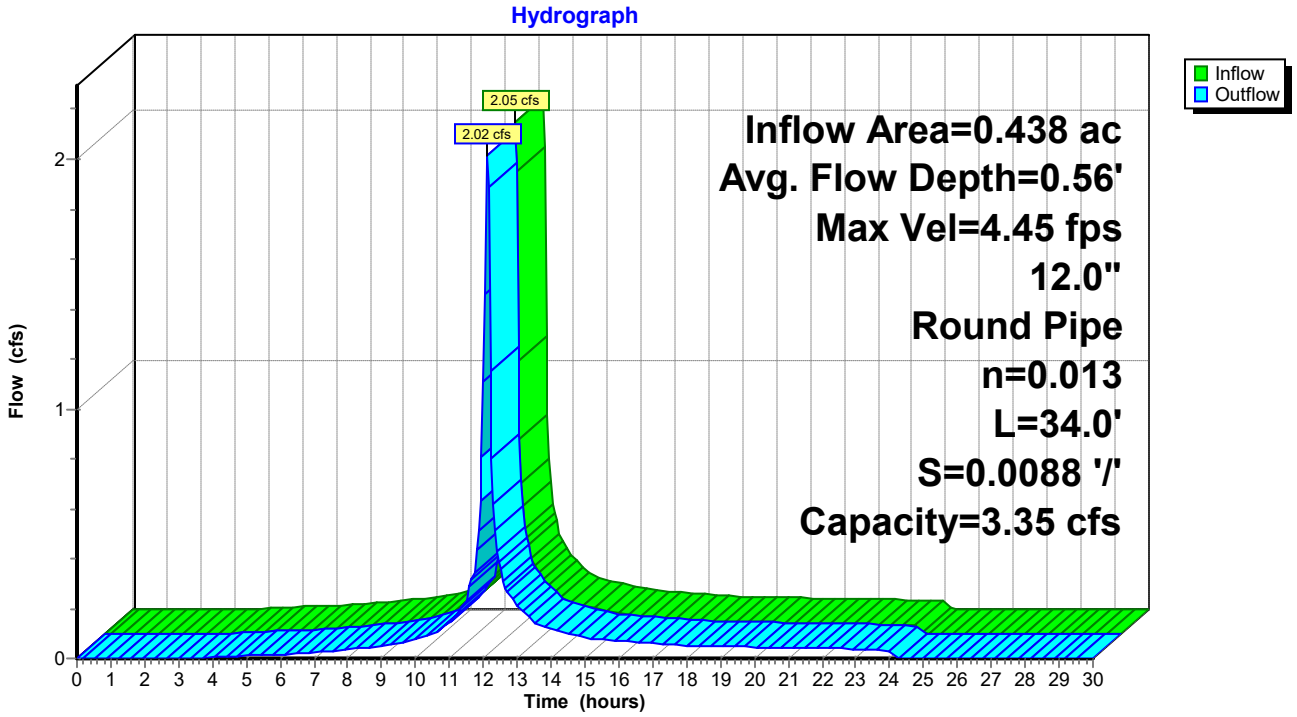
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.45 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 0.4 min

Peak Storage= 15 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.56' , Surface Width= 0.99'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.35 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 34.0' Slope= 0.0088 '/'
Inlet Invert= 1,012.20', Outlet Invert= 1,011.90'



Reach DCB1: TO DMH#1



Summary for Reach DCB2: TO DMH#2

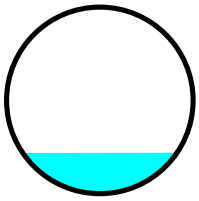
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.165 ac, 5.51% Impervious, Inflow Depth = 4.30" for 25-Year event
Inflow = 0.75 cfs @ 12.12 hrs, Volume= 0.059 af
Outflow = 0.74 cfs @ 12.12 hrs, Volume= 0.059 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DMH2 : TO DMH#1

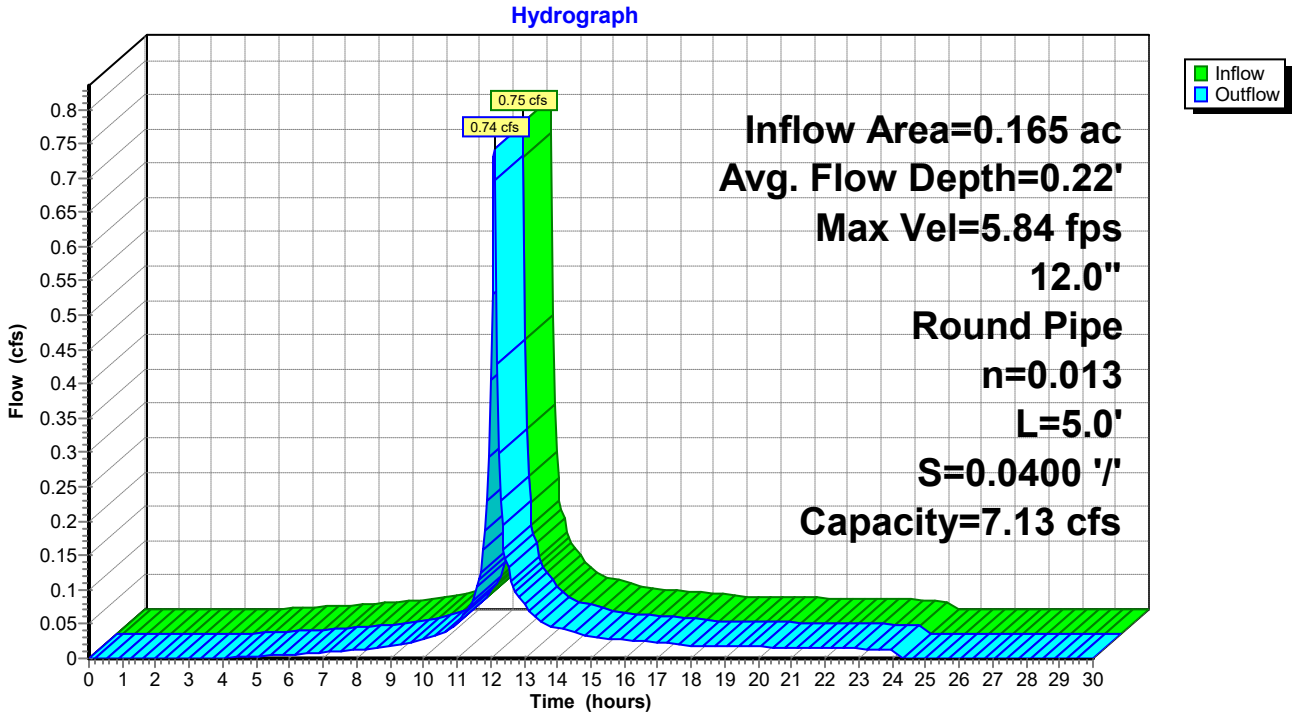
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.84 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.04 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.22' , Surface Width= 0.83'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.13 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 5.0' Slope= 0.0400 '/'
Inlet Invert= 1,015.70', Outlet Invert= 1,015.50'



Reach DCB2: TO DMH#2



Summary for Reach DCB3: TO DMH#2

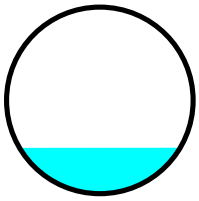
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.143 ac, 14.56% Impervious, Inflow Depth = 4.30" for 25-Year event
Inflow = 0.60 cfs @ 12.15 hrs, Volume= 0.051 af
Outflow = 0.57 cfs @ 12.17 hrs, Volume= 0.051 af, Atten= 5%, Lag= 1.2 min
Routed to Reach DMH2 : TO DMH#1

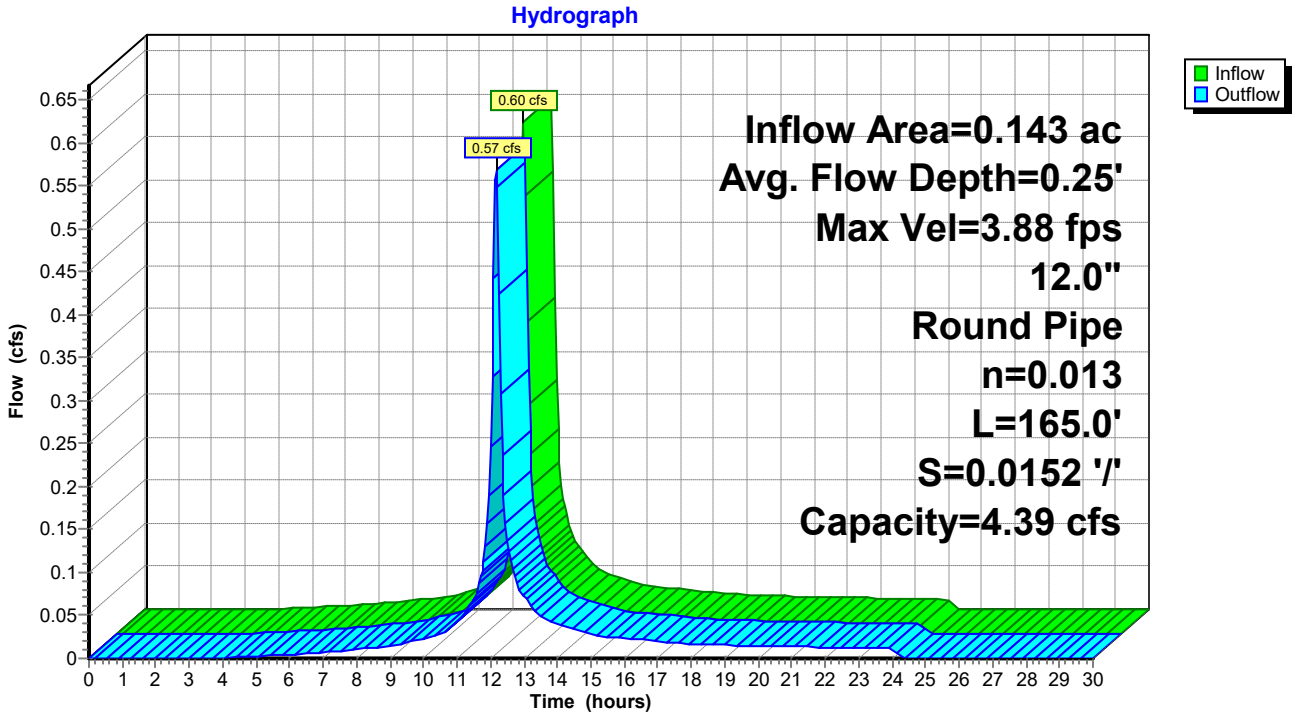
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.88 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 2.0 min

Peak Storage= 25 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.25' , Surface Width= 0.86'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.39 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 165.0' Slope= 0.0152 '/'
Inlet Invert= 1,016.60', Outlet Invert= 1,014.10'



Reach DCB3: TO DMH#2



Summary for Reach DMH1: TO RAIN GARDEN

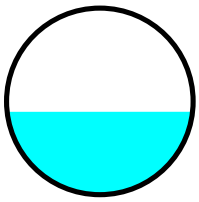
[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach DCB1 outlet invert by 0.35' @ 12.15 hrs
[61] Hint: Exceeded Reach DMH2 outlet invert by 0.35' @ 12.15 hrs

Inflow Area = 0.746 ac, 7.52% Impervious, Inflow Depth = 4.36" for 25-Year event
Inflow = 3.19 cfs @ 12.13 hrs, Volume= 0.271 af
Outflow = 3.17 cfs @ 12.14 hrs, Volume= 0.271 af, Atten= 1%, Lag= 0.4 min
Routed to Pond RG1 : TO DP#1

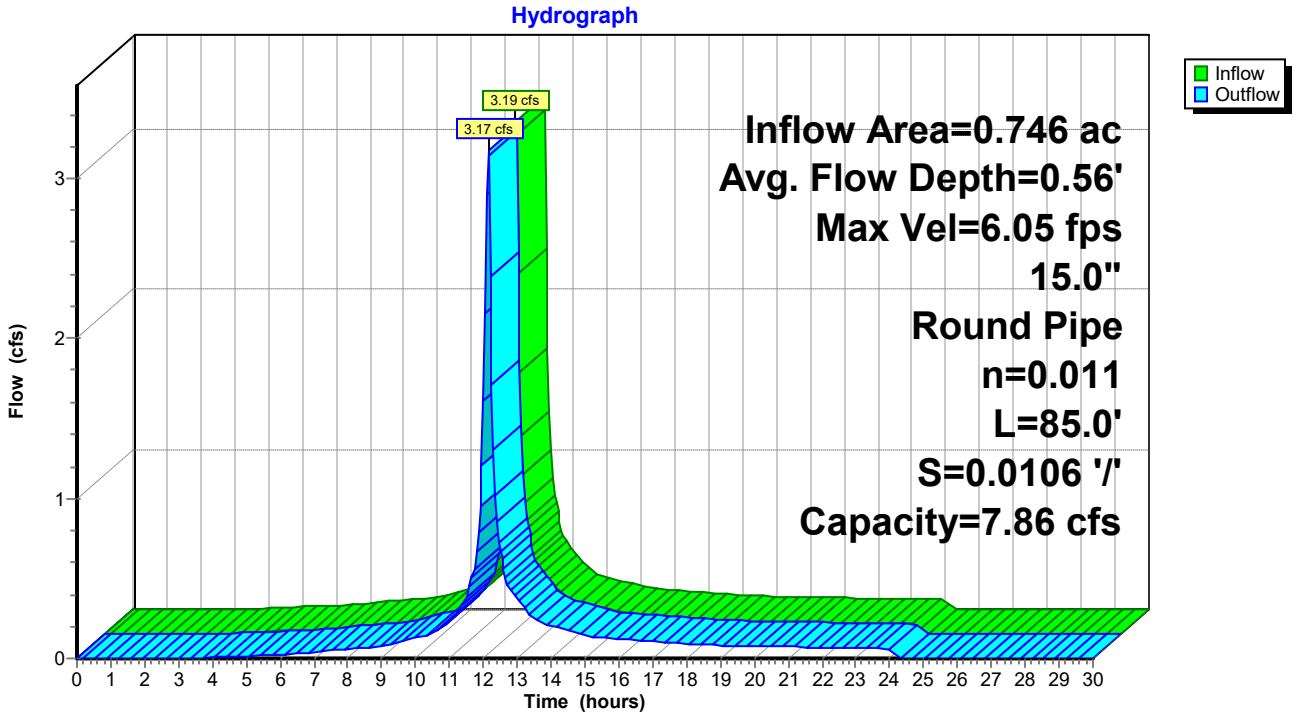
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.14 fps, Avg. Travel Time= 0.7 min

Peak Storage= 45 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.56' , Surface Width= 1.24'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.86 cfs

15.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 85.0' Slope= 0.0106 '/'
Inlet Invert= 1,011.70', Outlet Invert= 1,010.80'



Reach DMH1: TO RAIN GARDEN



Summary for Reach DMH2: TO DMH#1

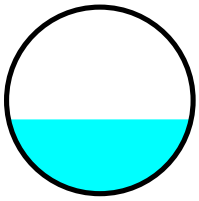
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach DCB3 OUTLET depth by 0.05' @ 12.15 hrs

Inflow Area = 0.308 ac, 9.72% Impervious, Inflow Depth = 4.30" for 25-Year event
Inflow = 1.27 cfs @ 12.14 hrs, Volume= 0.110 af
Outflow = 1.23 cfs @ 12.15 hrs, Volume= 0.110 af, Atten= 3%, Lag= 1.1 min
Routed to Reach DMH1 : TO RAIN GARDEN

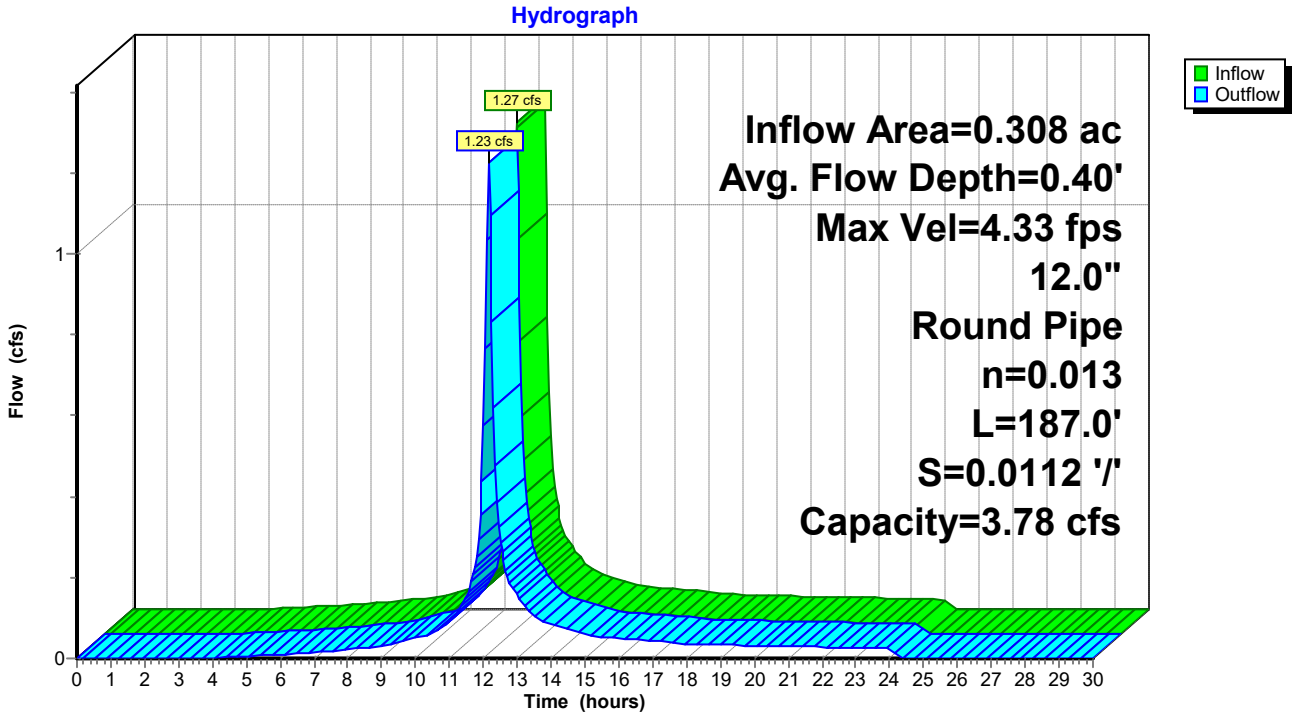
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.33 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 2.0 min

Peak Storage= 55 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.40' , Surface Width= 0.98'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.78 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 187.0' Slope= 0.0112 '/'
Inlet Invert= 1,014.00', Outlet Invert= 1,011.90'



Reach DMH2: TO DMH#1



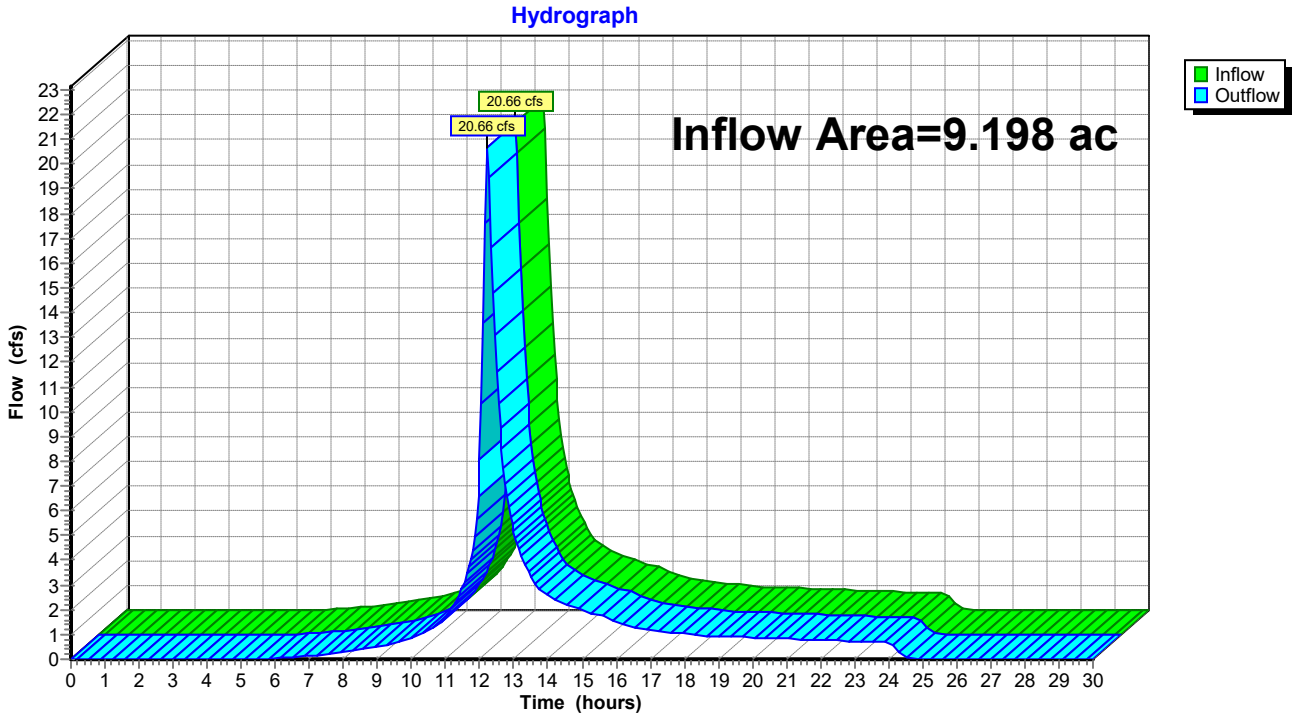
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 4.14% Impervious, Inflow Depth = 3.51" for 25-Year event
Inflow = 20.66 cfs @ 12.22 hrs, Volume= 2.688 af
Outflow = 20.66 cfs @ 12.22 hrs, Volume= 2.688 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Summary for Reach OL1: OVERLAND TO WETLAND

[79] Warning: Submerged Pond RG1 Primary device # 4 OUTLET by 0.24'

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 3.99" for 25-Year event
Inflow = 2.05 cfs @ 12.32 hrs, Volume= 0.468 af
Outflow = 2.04 cfs @ 12.40 hrs, Volume= 0.468 af, Atten= 0%, Lag= 4.9 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

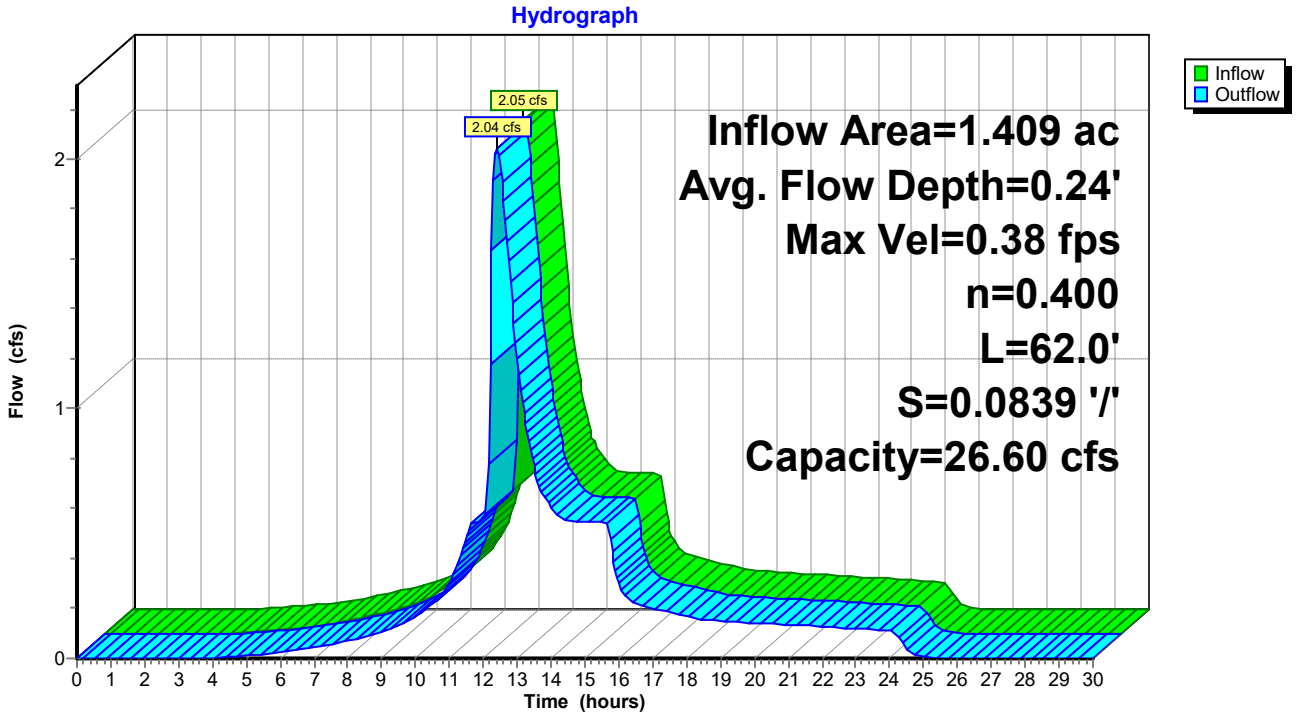
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.38 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.14 fps, Avg. Travel Time= 7.3 min

Peak Storage= 328 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.24' , Surface Width= 24.74'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 26.60 cfs

20.00' x 1.00' deep channel, n= 0.400 Sheet flow: Woods+light brush
Side Slope Z-value= 10.0 '/' Top Width= 40.00'
Length= 62.0' Slope= 0.0839 '/'
Inlet Invert= 1,006.00', Outlet Invert= 1,000.80'

‡

Reach OL1: OVERLAND TO WETLAND



Summary for Pond RG1: TO DP#1

[44] Hint: Outlet device #2 is below defined storage

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 3.99" for 25-Year event
Inflow = 5.69 cfs @ 12.13 hrs, Volume= 0.468 af
Outflow = 2.05 cfs @ 12.32 hrs, Volume= 0.468 af, Atten= 64%, Lag= 11.0 min
Primary = 2.05 cfs @ 12.32 hrs, Volume= 0.468 af
Routed to Reach OL1 : OVERLAND TO WETLAND
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach OL1 : OVERLAND TO WETLAND

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 1,010.03' @ 12.32 hrs Surf.Area= 5,825 sf Storage= 4,431 cf

Plug-Flow detention time= 28.6 min calculated for 0.468 af (100% of inflow)
Center-of-Mass det. time= 28.6 min (852.0 - 823.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,009.00'	23,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

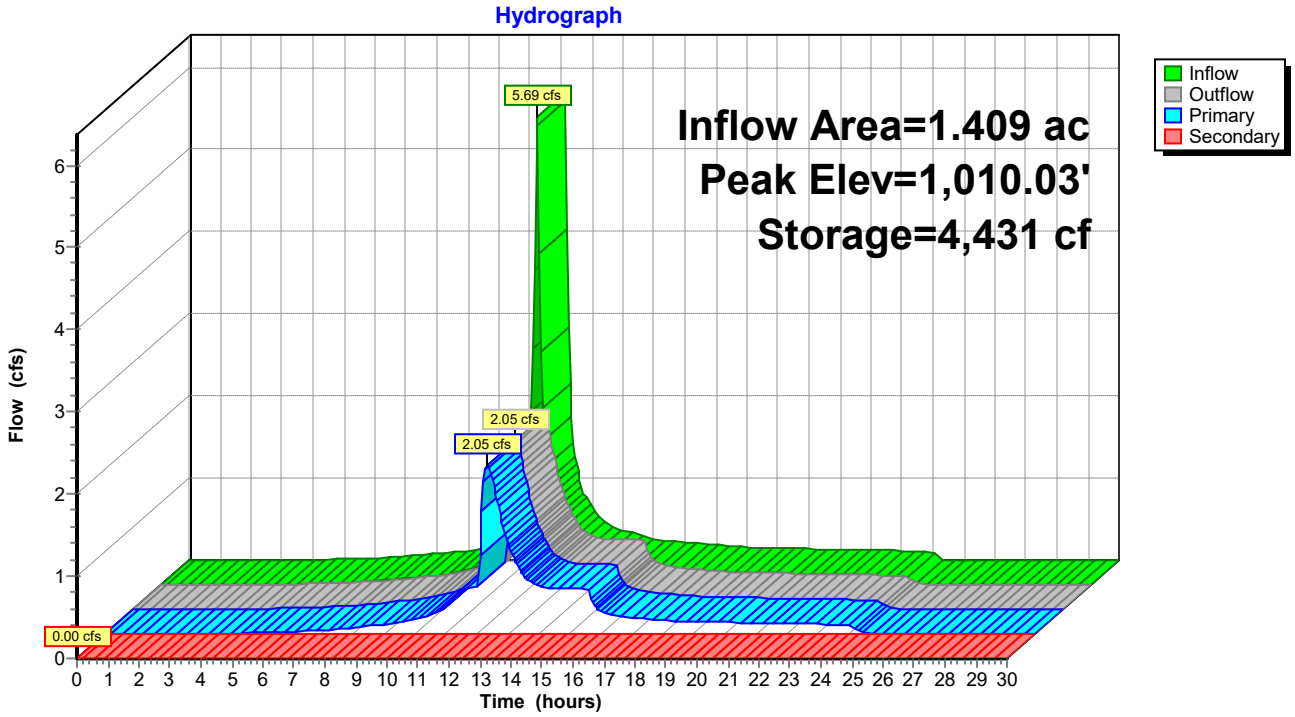
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,009.00	2,750	0	0
1,010.00	5,753	4,252	4,252
1,012.00	10,411	16,164	20,416
1,012.25	12,677	2,886	23,302

Device	Routing	Invert	Outlet Devices
#1	Secondary	1,011.25'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Device 4	1,006.50'	**Special & User-Defined** Head (feet) 0.00 1.00 15.00 Disch. (cfs) 0.000 0.550 0.550
#3	Device 4	1,010.50'	**2.6' long Sharp-Crested Rectangular Weir X 3.00** 2 End Contraction(s) 0.5' Crest Height
#4	Primary	1,006.40'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,006.40' / 1,006.00' S= 0.0095 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#5	Device 4	1,009.50'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.05 cfs @ 12.32 hrs HW=1,010.03' (Free Discharge)
└**4=Culvert** (Passes 2.05 cfs of 5.28 cfs potential flow)
├**2=Special & User-Defined** (Custom Controls 0.55 cfs)
├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**5=Orifice/Grate** (Orifice Controls 1.50 cfs @ 2.54 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,009.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond RG1: TO DP#1



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P100: TO RAIN GARDEN Runoff Area=28,854 sf 11.64% Impervious Runoff Depth=5.83"
Flow Length=290' Tc=6.0 min CN=79 Runoff=4.04 cfs 0.322 af

Subcatchment P101: TO DCB#2 Runoff Area=7,181 sf 5.51% Impervious Runoff Depth=6.66"
Flow Length=173' Tc=5.3 min CN=86 Runoff=1.13 cfs 0.092 af

Subcatchment p102: (new Subcat) Runoff Area=19,100 sf 5.97% Impervious Runoff Depth=6.78"
Flow Length=272' Tc=5.0 min CN=87 Runoff=3.08 cfs 0.248 af

Subcatchment p103: TO DCB#3 Runoff Area=6,235 sf 14.56% Impervious Runoff Depth=6.66"
Flow Length=143' Tc=8.3 min CN=86 Runoff=0.90 cfs 0.079 af

Subcatchment P11A: OVERLAND TO DP#1 Runoff Area=207,622 sf 5.20% Impervious Runoff Depth=5.83"
Flow Length=307' Tc=12.2 min CN=79 Runoff=23.69 cfs 2.314 af

Subcatchment P12: TO CULVERT Runoff Area=131,668 sf 0.00% Impervious Runoff Depth=5.35"
Flow Length=805' Tc=24.0 min CN=75 Runoff=10.38 cfs 1.347 af

Reach CUL1: TO DP#1 Avg. Flow Depth=1.65' Max Vel=3.15 fps Inflow=10.38 cfs 1.347 af
n=0.025 L=36.0' S=0.0053 '/' Capacity=13.18 cfs Outflow=10.36 cfs 1.347 af

Reach DCB1: TO DMH#1 Avg. Flow Depth=0.75' Max Vel=4.82 fps Inflow=3.08 cfs 0.248 af
12.0" Round Pipe n=0.013 L=34.0' S=0.0088 '/' Capacity=3.35 cfs Outflow=3.03 cfs 0.248 af

Reach DCB2: TO DMH#2 Avg. Flow Depth=0.27' Max Vel=6.59 fps Inflow=1.13 cfs 0.092 af
12.0" Round Pipe n=0.013 L=5.0' S=0.0400 '/' Capacity=7.13 cfs Outflow=1.12 cfs 0.092 af

Reach DCB3: TO DMH#2 Avg. Flow Depth=0.31' Max Vel=4.37 fps Inflow=0.90 cfs 0.079 af
12.0" Round Pipe n=0.013 L=165.0' S=0.0152 '/' Capacity=4.39 cfs Outflow=0.86 cfs 0.079 af

Reach DMH1: TO RAIN GARDEN Avg. Flow Depth=0.71' Max Vel=6.70 fps Inflow=4.83 cfs 0.419 af
15.0" Round Pipe n=0.011 L=85.0' S=0.0106 '/' Capacity=7.86 cfs Outflow=4.80 cfs 0.419 af

Reach DMH2: TO DMH#1 Avg. Flow Depth=0.51' Max Vel=4.83 fps Inflow=1.92 cfs 0.171 af
12.0" Round Pipe n=0.013 L=187.0' S=0.0112 '/' Capacity=3.78 cfs Outflow=1.87 cfs 0.171 af

Reach DP#1A: WETLAND SERIES 1(SOUTH Inflow=34.00 cfs 4.402 af
Outflow=34.00 cfs 4.402 af

Reach OL1: OVERLAND TO WETLAND Avg. Flow Depth=0.30' Max Vel=0.44 fps Inflow=3.00 cfs 0.740 af
n=0.400 L=62.0' S=0.0839 '/' Capacity=26.60 cfs Outflow=2.99 cfs 0.740 af

Pond RG1: TO DP#1 Peak Elev=1,010.50' Storage=7,385 cf Inflow=8.83 cfs 0.740 af
Primary=3.00 cfs 0.740 af Secondary=0.00 cfs 0.000 af Outflow=3.00 cfs 0.740 af

Total Runoff Area = 9.198 ac Runoff Volume = 4.402 af Average Runoff Depth = 5.74"
95.86% Pervious = 8.817 ac 4.14% Impervious = 0.381 ac

Summary for Subcatchment P100: TO RAIN GARDEN

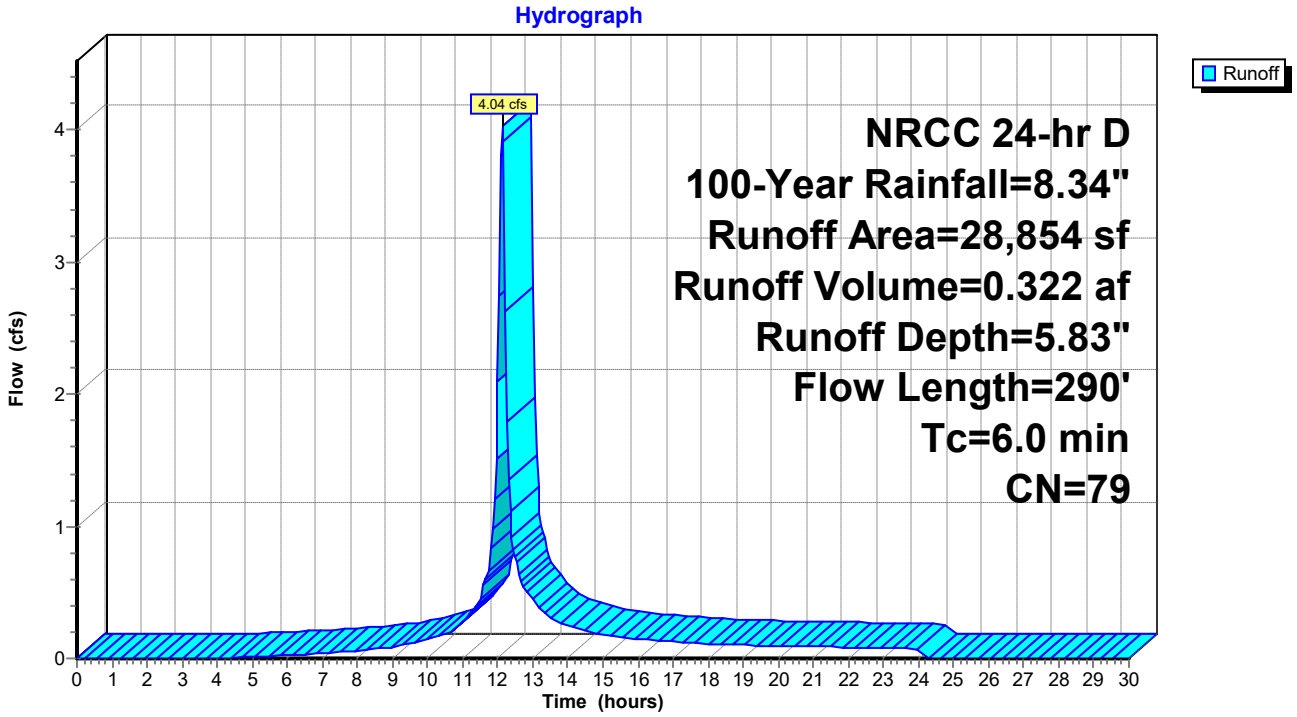
Runoff = 4.04 cfs @ 12.13 hrs, Volume= 0.322 af, Depth= 5.83"
Routed to Pond RG1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
21,444	74	>75% Grass cover, Good, HSG C
161	70	Woods, Good, HSG C
3,358	98	Paved parking, HSG C
2,891	96	Gravel surface, HSG C
1,000	89	Gravel roads, HSG C
28,854	79	Weighted Average
25,496		88.36% Pervious Area
3,358		11.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	15	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	29	0.3330	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.1	6	0.0300	0.89		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	113	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	81	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	46	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	290	Total			

Subcatchment P100: TO RAIN GARDEN



Summary for Subcatchment P101: TO DCB#2

[49] Hint: Tc<2dt may require smaller dt

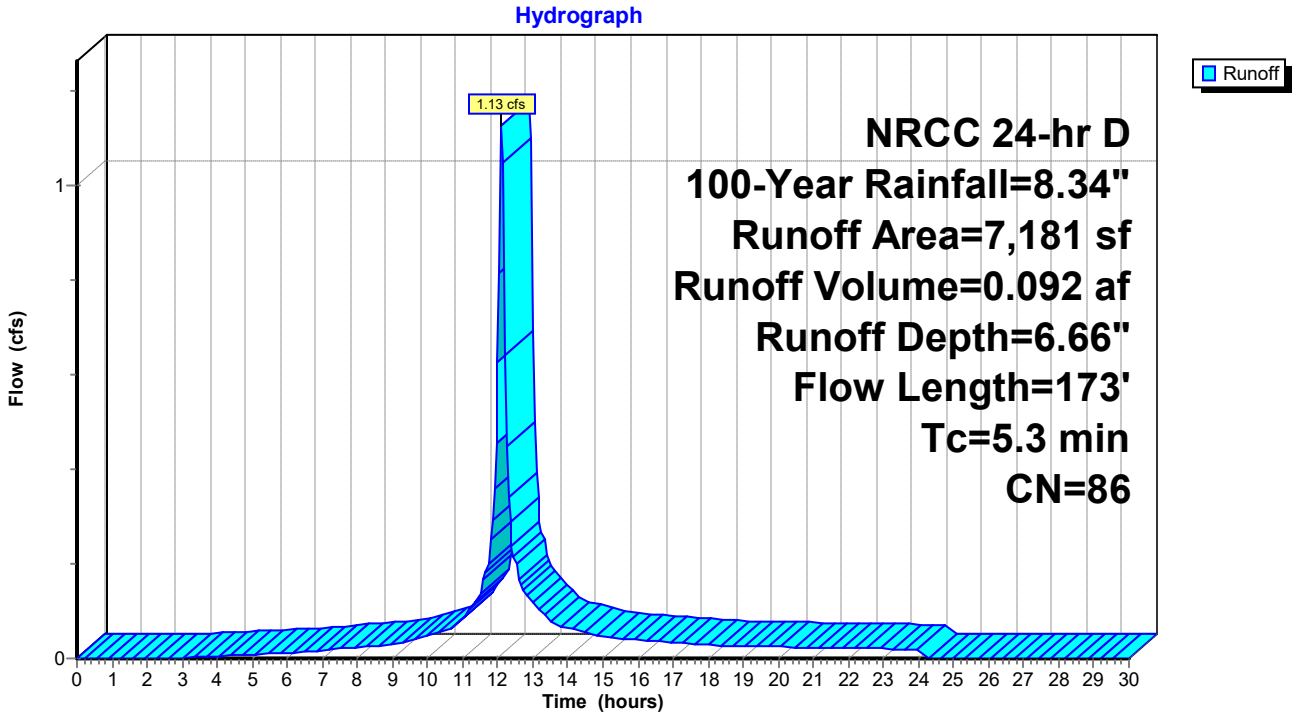
Runoff = 1.13 cfs @ 12.12 hrs, Volume= 0.092 af, Depth= 6.66"
Routed to Reach DCB2 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
1,897	74	>75% Grass cover, Good, HSG C
715	70	Woods, Good, HSG C
396	98	Paved parking, HSG C
2,020	96	Gravel surface, HSG C
2,153	89	Gravel roads, HSG C
7,181	86	Weighted Average
6,785		94.49% Pervious Area
396		5.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	16	0.0530	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.2	14	0.0300	1.06		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
0.7	123	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.3	173	Total			

Subcatchment P101: TO DCB#2



Summary for Subcatchment p102: (new Subcat)

[49] Hint: Tc<2dt may require smaller dt

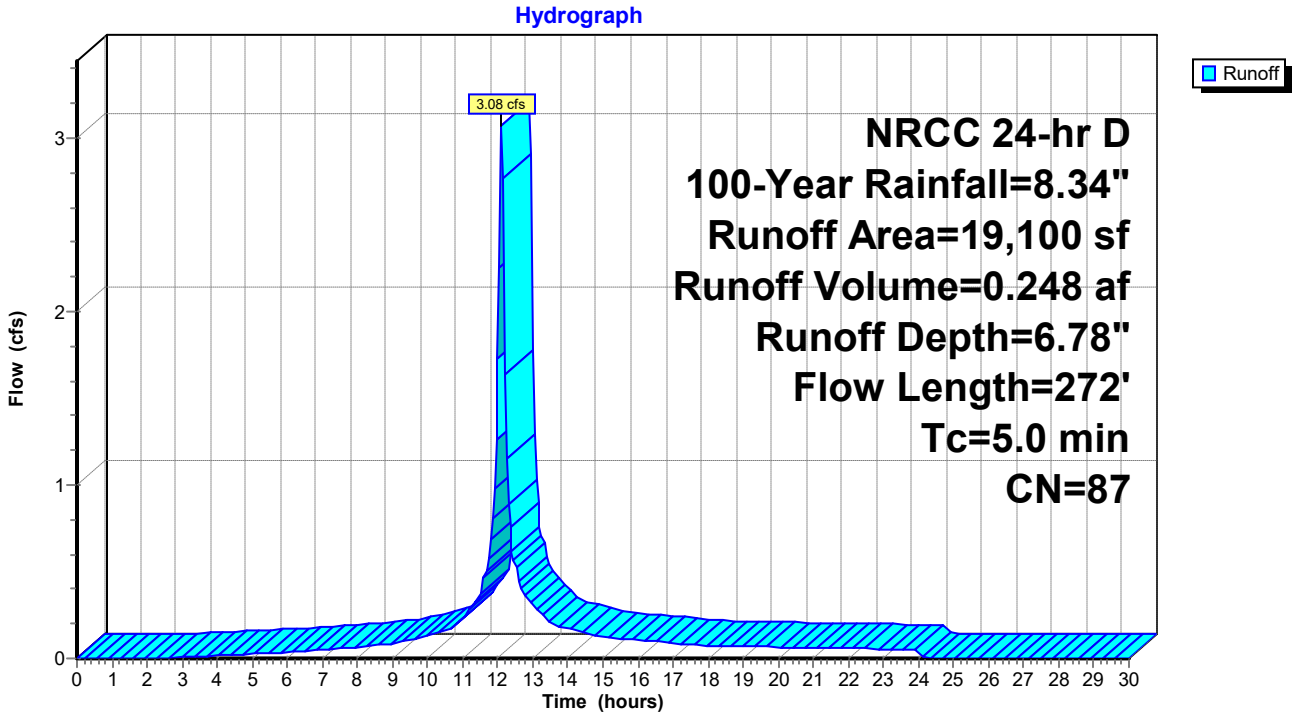
Runoff = 3.08 cfs @ 12.11 hrs, Volume= 0.248 af, Depth= 6.78"
Routed to Reach DCB1 : TO DMH#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
5,623	74	>75% Grass cover, Good, HSG C
528	70	Woods, Good, HSG C
1,140	98	Paved parking, HSG C
7,733	96	Gravel surface, HSG C
4,076	89	Gravel roads, HSG C
19,100	87	Weighted Average
17,960		94.03% Pervious Area
1,140		5.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.4	30	0.0250	1.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.00"
1.6	222	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	272	Total, Increased to minimum Tc = 5.0 min			

Subcatchment p102: (new Subcat)



Summary for Subcatchment p103: TO DCB#3

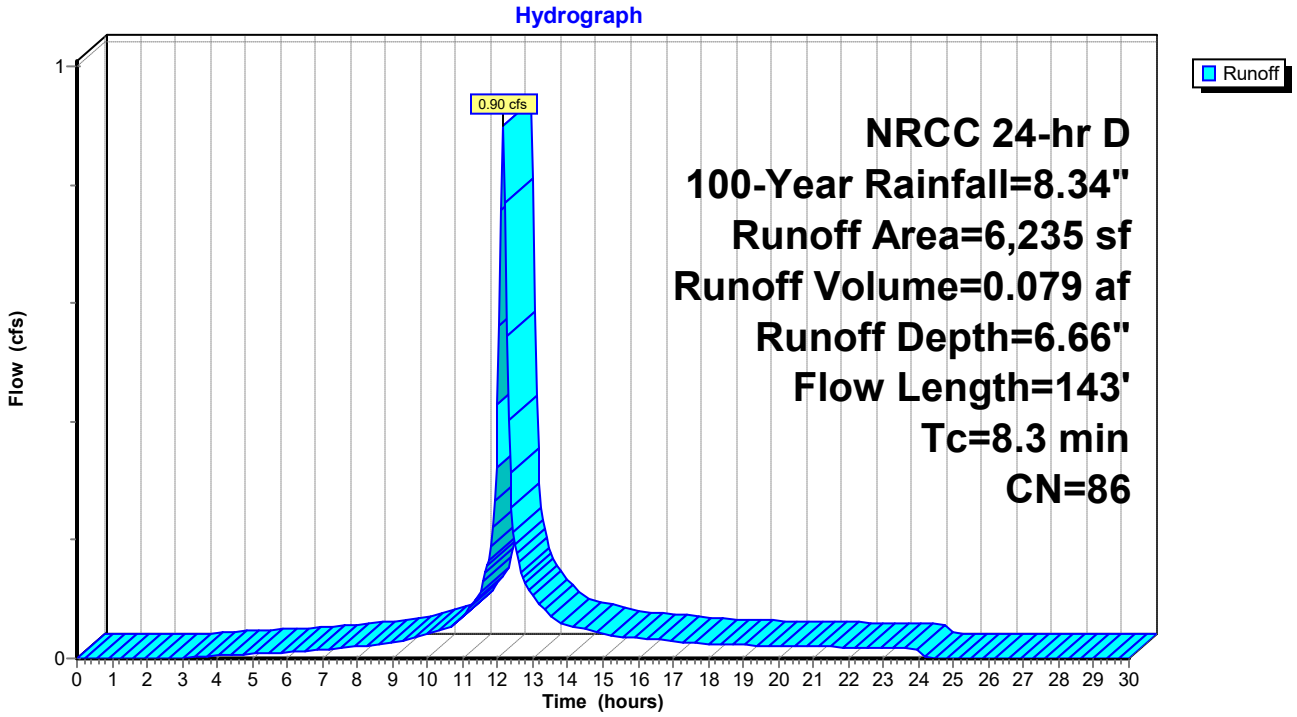
Runoff = 0.90 cfs @ 12.15 hrs, Volume= 0.079 af, Depth= 6.66"
Routed to Reach DCB3 : TO DMH#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
1,601	74	>75% Grass cover, Good, HSG C
855	70	Woods, Good, HSG C
908	98	Paved parking, HSG C
1,705	96	Gravel surface, HSG C
1,166	89	Gravel roads, HSG C
6,235	86	Weighted Average
5,327		85.44% Pervious Area
908		14.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	40	0.0540	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
0.5	10	0.3300	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
0.6	93	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	143	Total			

Subcatchment p103: TO DCB#3



Summary for Subcatchment P11A: OVERLAND TO DP#1

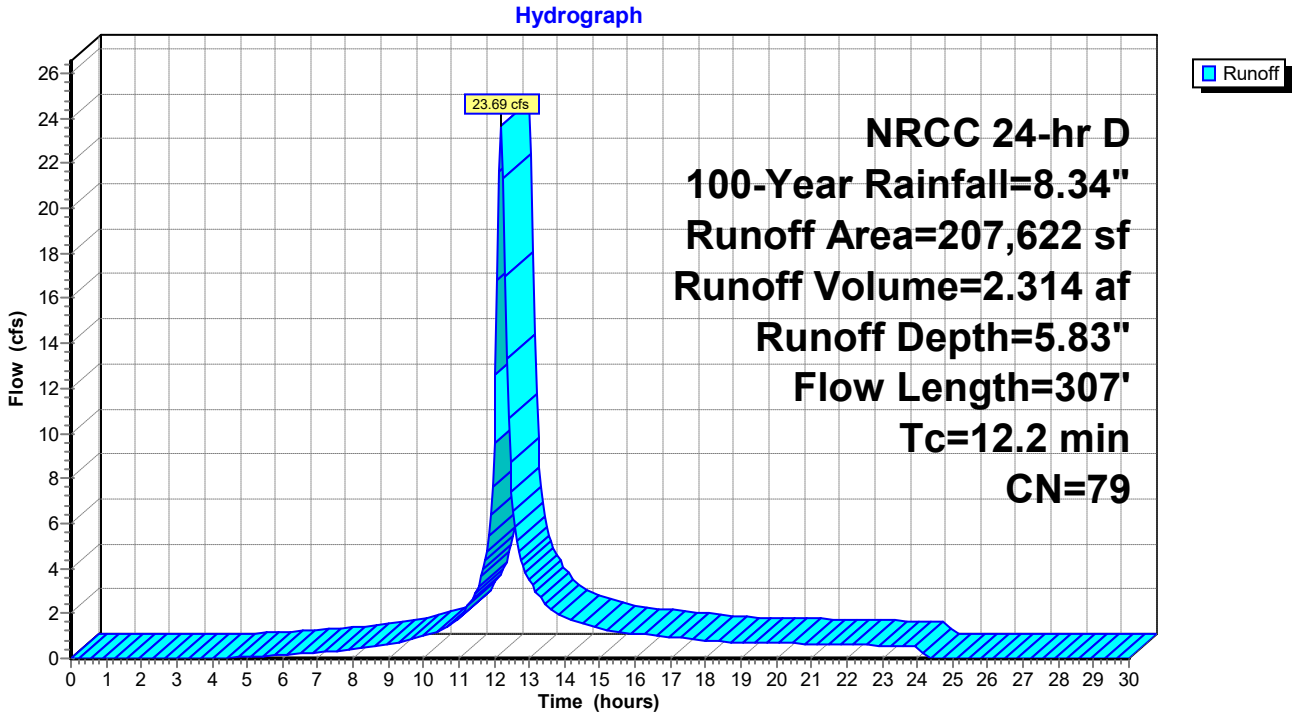
Runoff = 23.69 cfs @ 12.20 hrs, Volume= 2.314 af, Depth= 5.83"
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
24,929	74	>75% Grass cover, Good, HSG C
57,953	70	Woods, Good, HSG C
32,603	96	Gravel surface, HSG C
10,055	98	Paved parking, HSG C
1,617	89	Gravel roads, HSG C
739	98	Paved parking, HSG C
79,726	77	Woods, Good, HSG D
207,622	79	Weighted Average
196,828		94.80% Pervious Area
10,794		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.0	68	0.0540	1.16		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	38	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	27	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.1	124	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.2	307	Total			

Subcatchment P11A: OVERLAND TO DP#1



Summary for Subcatchment P12: TO CULVERT

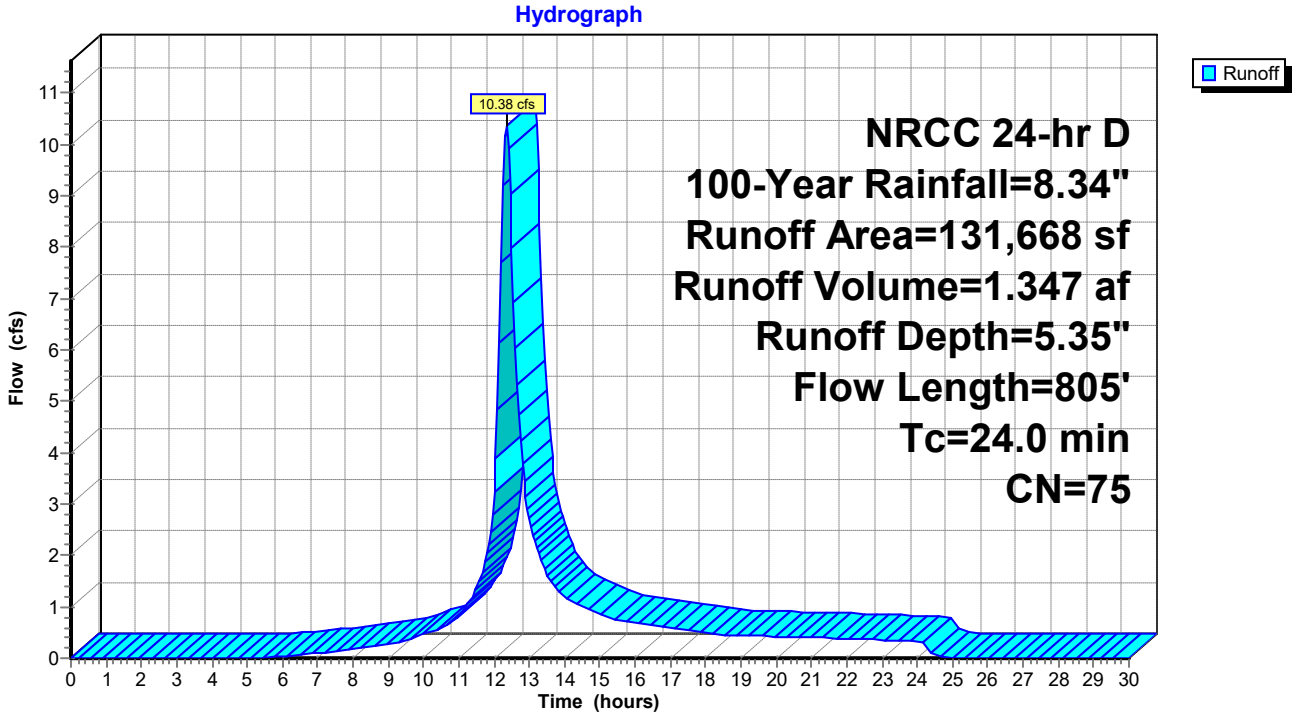
Runoff = 10.38 cfs @ 12.34 hrs, Volume= 1.347 af, Depth= 5.35"
Routed to Reach CUL1 : TO DP#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.34"

Area (sf)	CN	Description
45,486	70	Woods, Good, HSG C
2,261	74	>75% Grass cover, Good, HSG C
83,921	77	Woods, Good, HSG D
131,668	75	Weighted Average
131,668		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0580	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.4	104	0.0580	1.20		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.3	651	0.0229	0.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.0	805	Total			

Subcatchment P12: TO CULVERT



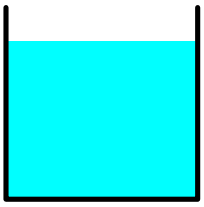
Summary for Reach CUL1: TO DP#1

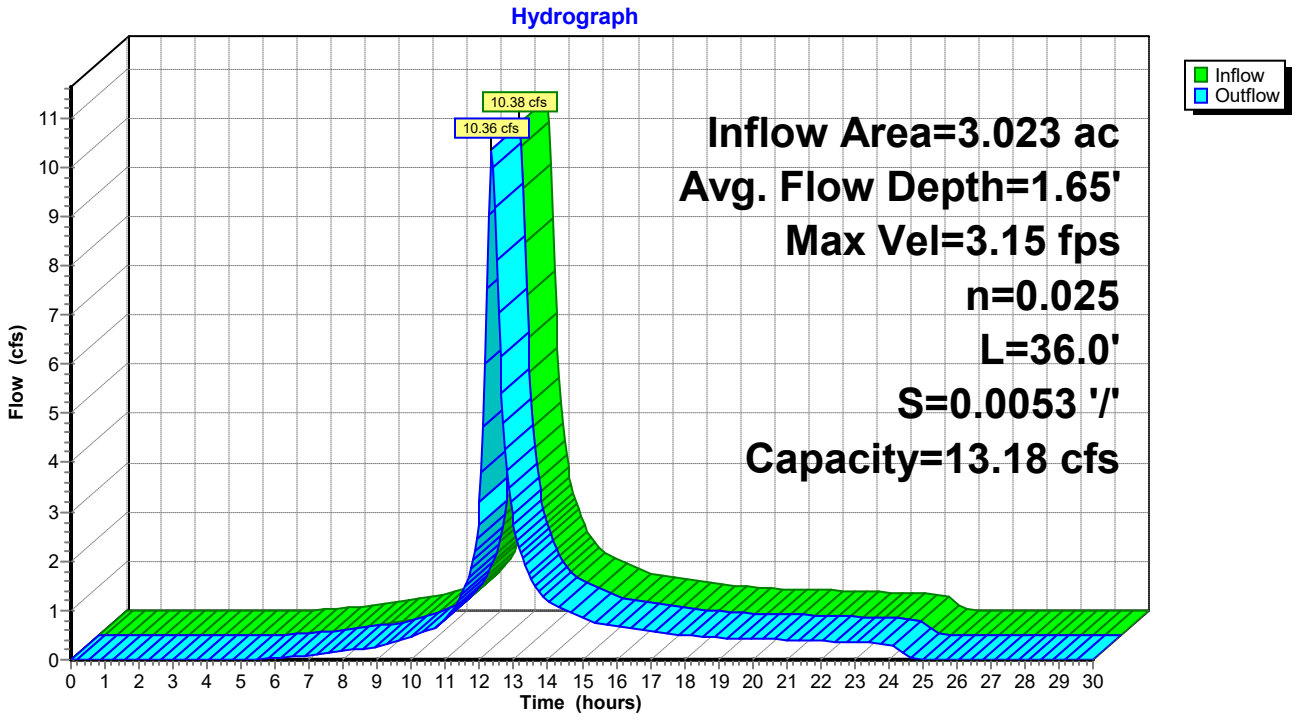
Inflow Area = 3.023 ac, 0.00% Impervious, Inflow Depth = 5.35" for 100-Year event
Inflow = 10.38 cfs @ 12.34 hrs, Volume= 1.347 af
Outflow = 10.36 cfs @ 12.35 hrs, Volume= 1.347 af, Atten= 0%, Lag= 0.4 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.15 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 0.5 min

Peak Storage= 119 cf @ 12.34 hrs
Average Depth at Peak Storage= 1.65' , Surface Width= 2.00'
Bank-Full Depth= 2.00' Flow Area= 4.0 sf, Capacity= 13.18 cfs

2.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Length= 36.0' Slope= 0.0053 '/'
Inlet Invert= 1,003.98', Outlet Invert= 1,003.79'





Summary for Reach DCB1: TO DMH#1

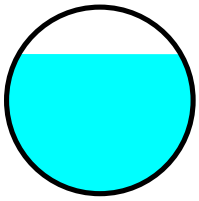
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.438 ac, 5.97% Impervious, Inflow Depth = 6.78" for 100-Year event
Inflow = 3.08 cfs @ 12.11 hrs, Volume= 0.248 af
Outflow = 3.03 cfs @ 12.12 hrs, Volume= 0.248 af, Atten= 2%, Lag= 0.3 min
Routed to Reach DMH1 : TO RAIN GARDEN

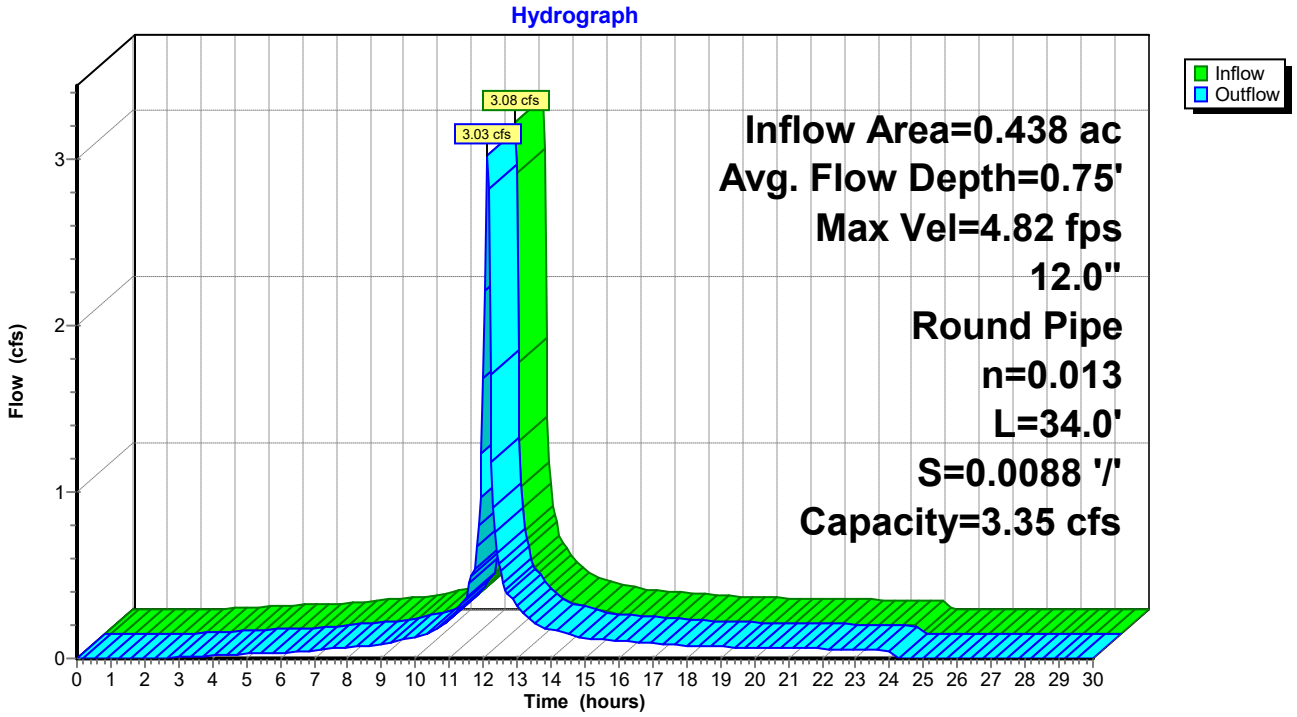
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.82 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.81 fps, Avg. Travel Time= 0.3 min

Peak Storage= 21 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.75' , Surface Width= 0.87'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.35 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 34.0' Slope= 0.0088 '/'
Inlet Invert= 1,012.20', Outlet Invert= 1,011.90'



Reach DCB1: TO DMH#1



Summary for Reach DCB2: TO DMH#2

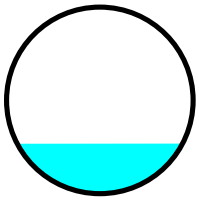
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.165 ac, 5.51% Impervious, Inflow Depth = 6.66" for 100-Year event
Inflow = 1.13 cfs @ 12.12 hrs, Volume= 0.092 af
Outflow = 1.12 cfs @ 12.12 hrs, Volume= 0.092 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DMH2 : TO DMH#1

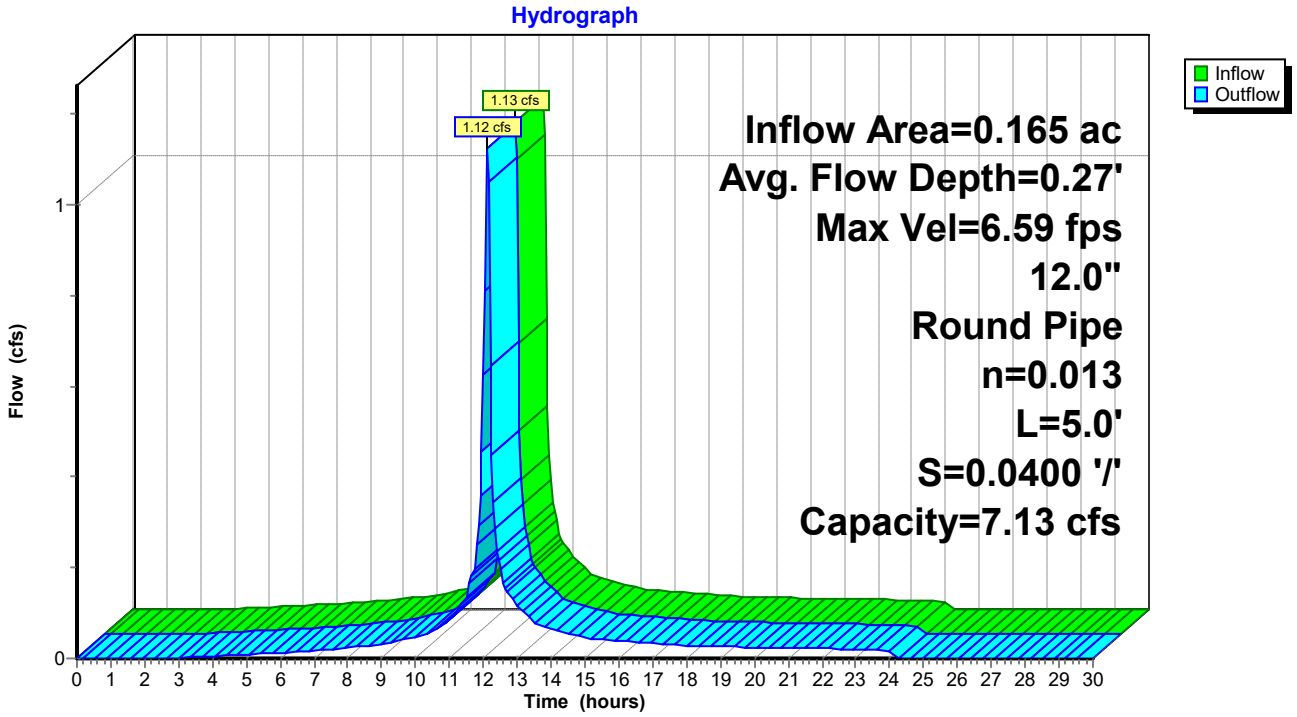
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.59 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 0.0 min

Peak Storage= 1 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 0.89'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 7.13 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 5.0' Slope= 0.0400 '/'
Inlet Invert= 1,015.70', Outlet Invert= 1,015.50'



Reach DCB2: TO DMH#2



Summary for Reach DCB3: TO DMH#2

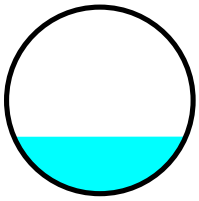
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 0.143 ac, 14.56% Impervious, Inflow Depth = 6.66" for 100-Year event
Inflow = 0.90 cfs @ 12.15 hrs, Volume= 0.079 af
Outflow = 0.86 cfs @ 12.17 hrs, Volume= 0.079 af, Atten= 4%, Lag= 1.0 min
Routed to Reach DMH2 : TO DMH#1

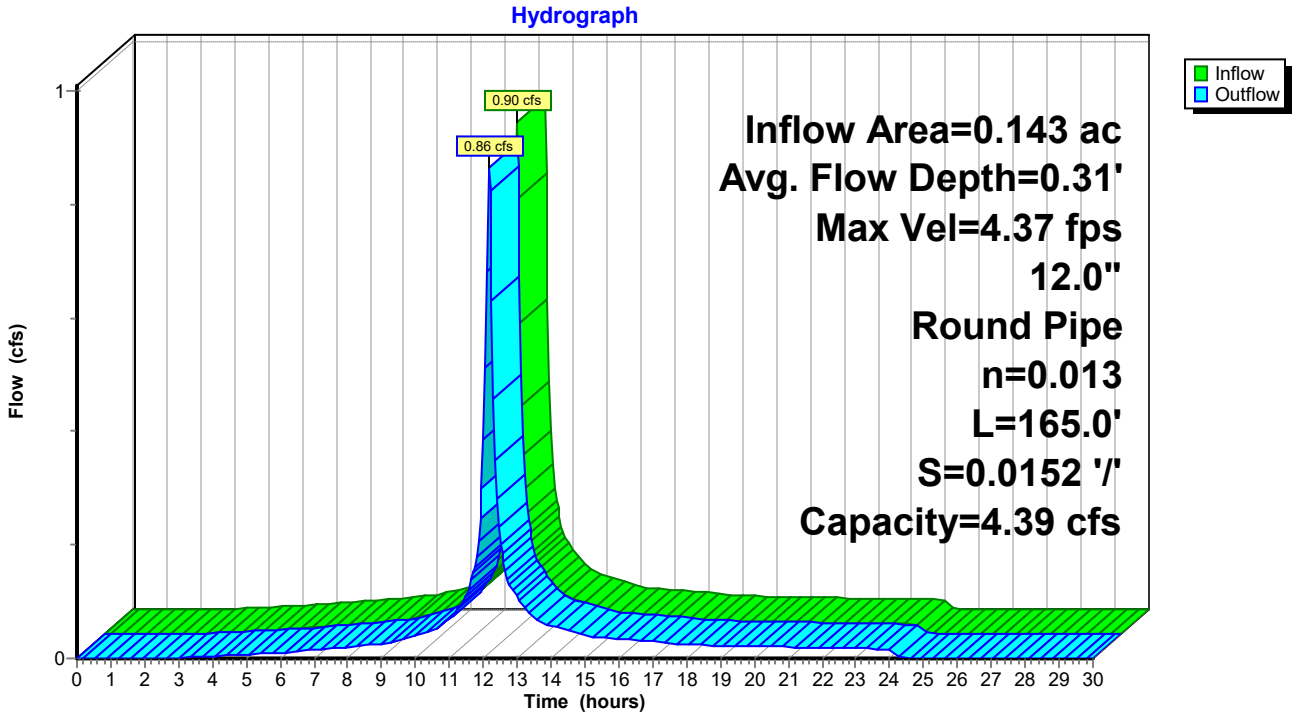
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.37 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.55 fps, Avg. Travel Time= 1.8 min

Peak Storage= 34 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.31' , Surface Width= 0.92'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.39 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 165.0' Slope= 0.0152 '/'
Inlet Invert= 1,016.60', Outlet Invert= 1,014.10'



Reach DCB3: TO DMH#2



Summary for Reach DMH1: TO RAIN GARDEN

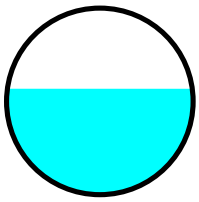
[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach DCB1 outlet invert by 0.50' @ 12.15 hrs
[62] Hint: Exceeded Reach DMH2 OUTLET depth by 0.01' @ 12.10 hrs

Inflow Area = 0.746 ac, 7.52% Impervious, Inflow Depth = 6.73" for 100-Year event
Inflow = 4.83 cfs @ 12.13 hrs, Volume= 0.419 af
Outflow = 4.80 cfs @ 12.14 hrs, Volume= 0.419 af, Atten= 1%, Lag= 0.4 min
Routed to Pond RG1 : TO DP#1

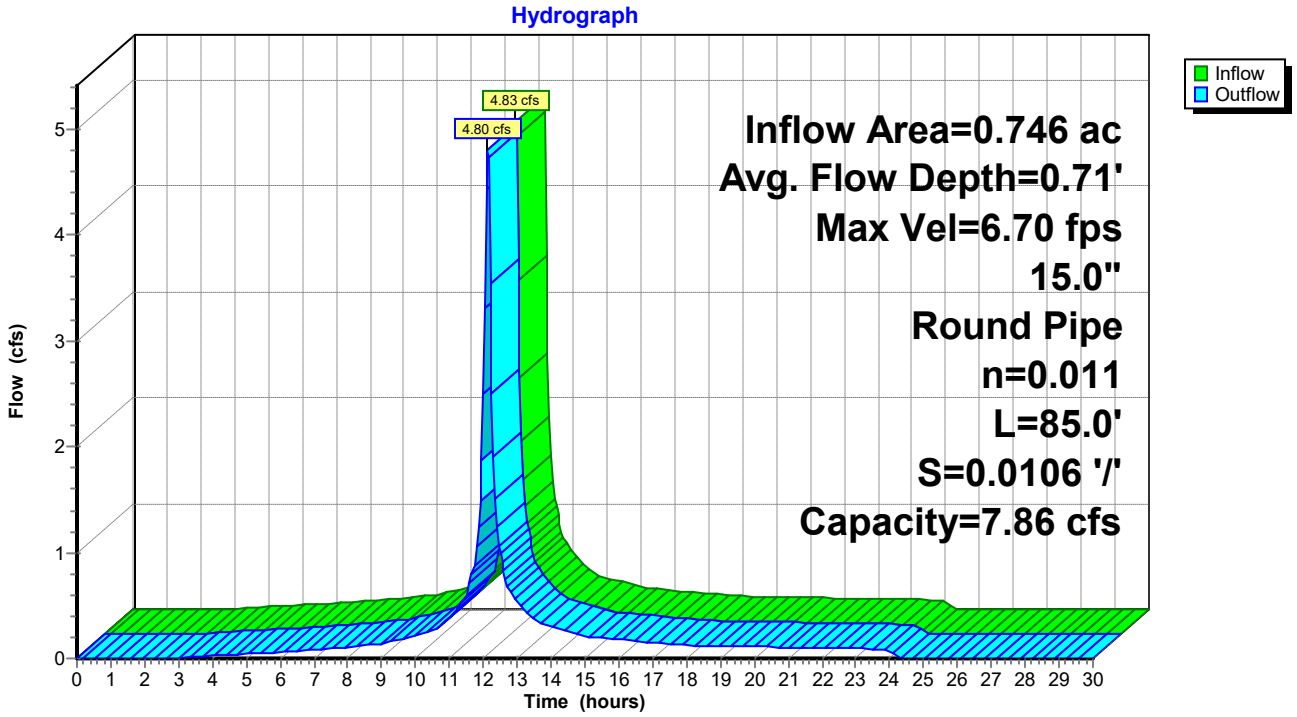
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.70 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.41 fps, Avg. Travel Time= 0.6 min

Peak Storage= 61 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.71' , Surface Width= 1.24'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.86 cfs

15.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 85.0' Slope= 0.0106 '/'
Inlet Invert= 1,011.70', Outlet Invert= 1,010.80'



Reach DMH1: TO RAIN GARDEN



Summary for Reach DMH2: TO DMH#1

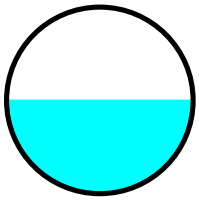
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach DCB3 OUTLET depth by 0.10' @ 12.15 hrs

Inflow Area = 0.308 ac, 9.72% Impervious, Inflow Depth = 6.66" for 100-Year event
Inflow = 1.92 cfs @ 12.14 hrs, Volume= 0.171 af
Outflow = 1.87 cfs @ 12.15 hrs, Volume= 0.171 af, Atten= 3%, Lag= 1.0 min
Routed to Reach DMH1 : TO RAIN GARDEN

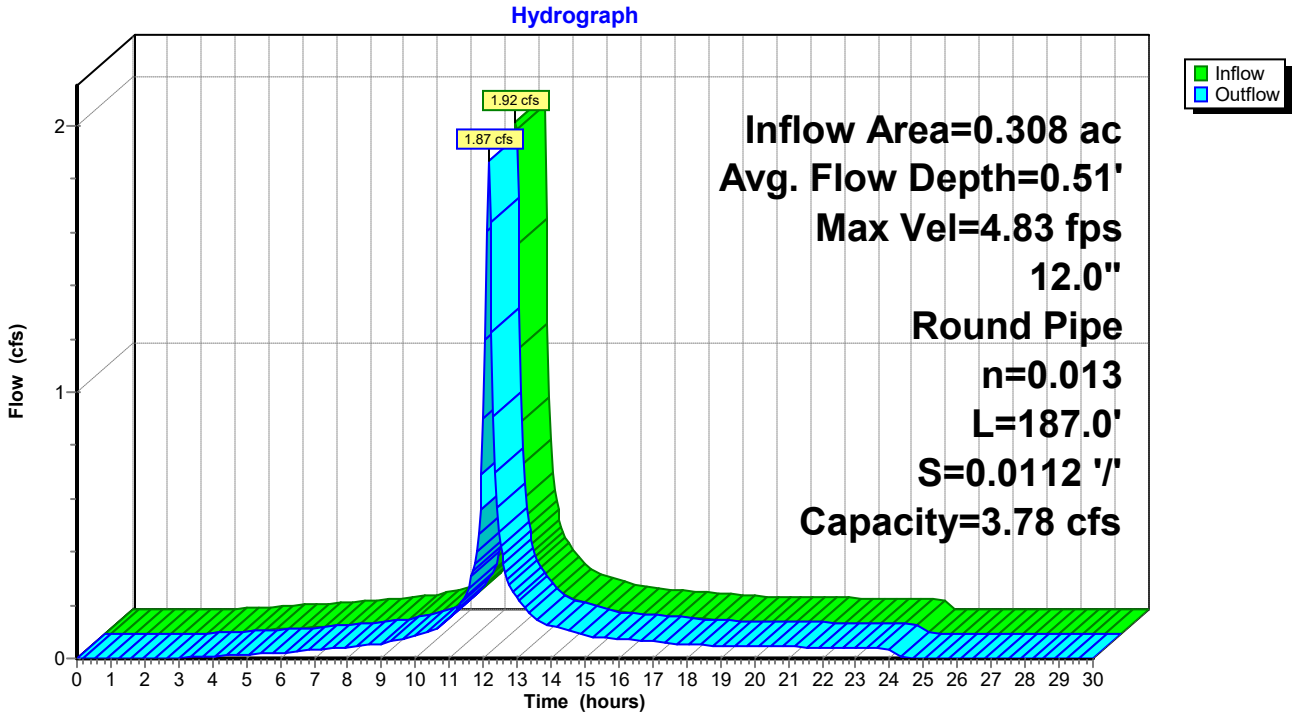
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.83 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.74 fps, Avg. Travel Time= 1.8 min

Peak Storage= 74 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.51' , Surface Width= 1.00'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.78 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 187.0' Slope= 0.0112 '/'
Inlet Invert= 1,014.00', Outlet Invert= 1,011.90'



Reach DMH2: TO DMH#1



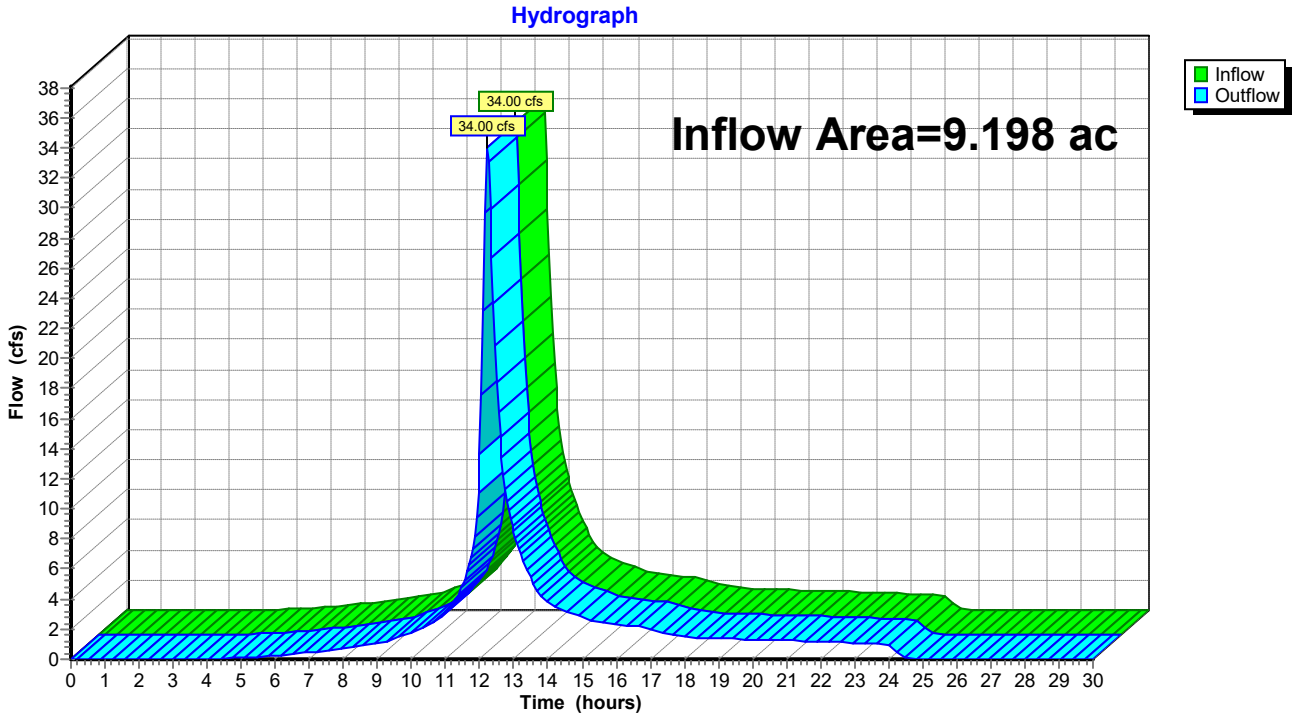
Summary for Reach DP#1A: WETLAND SERIES 1(SOUTH

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

Inflow Area = 9.198 ac, 4.14% Impervious, Inflow Depth = 5.74" for 100-Year event
Inflow = 34.00 cfs @ 12.22 hrs, Volume= 4.402 af
Outflow = 34.00 cfs @ 12.22 hrs, Volume= 4.402 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP#1A: WETLAND SERIES 1(SOUTH



Summary for Reach OL1: OVERLAND TO WETLAND

[79] Warning: Submerged Pond RG1 Primary device # 4 OUTLET by 0.30'

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 6.31" for 100-Year event
Inflow = 3.00 cfs @ 12.32 hrs, Volume= 0.740 af
Outflow = 2.99 cfs @ 12.39 hrs, Volume= 0.740 af, Atten= 0%, Lag= 4.3 min
Routed to Reach DP#1A : WETLAND SERIES 1(SOUTH

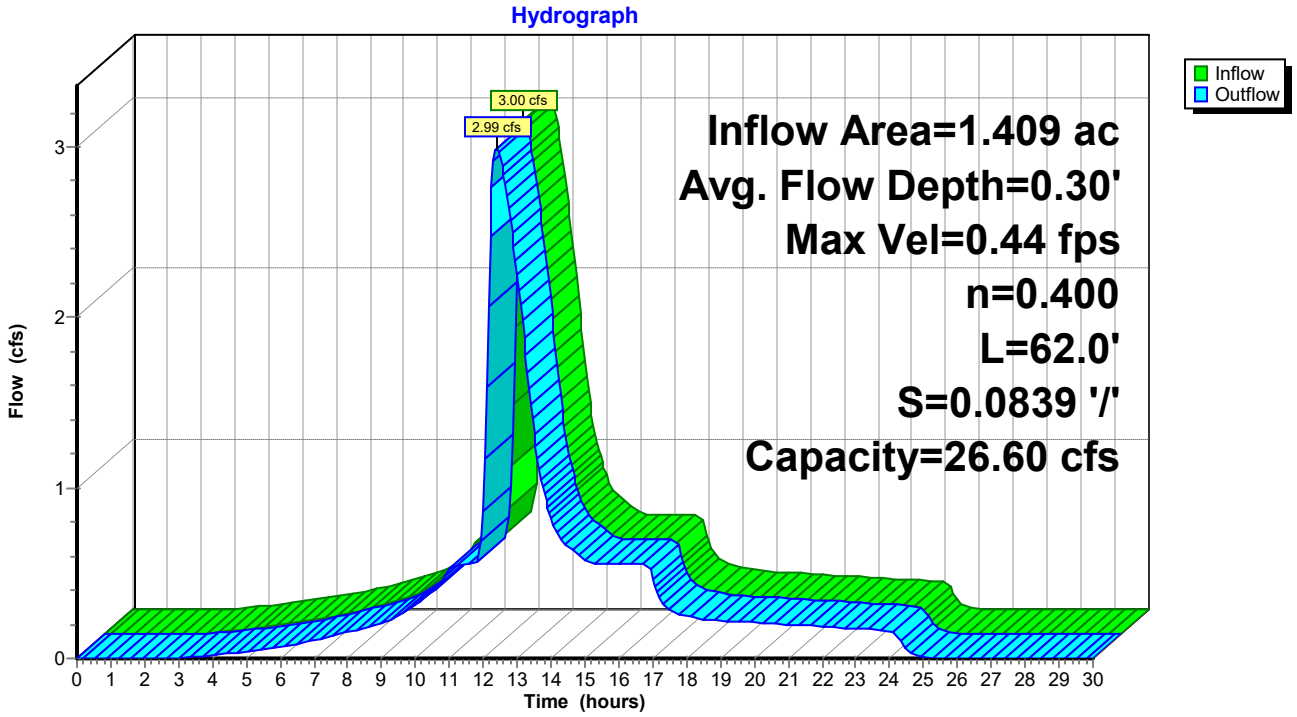
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.44 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.17 fps, Avg. Travel Time= 6.2 min

Peak Storage= 421 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.30' , Surface Width= 25.92'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 26.60 cfs

20.00' x 1.00' deep channel, n= 0.400 Sheet flow: Woods+light brush
Side Slope Z-value= 10.0 '/' Top Width= 40.00'
Length= 62.0' Slope= 0.0839 '/'
Inlet Invert= 1,006.00', Outlet Invert= 1,000.80'

‡

Reach OL1: OVERLAND TO WETLAND



Summary for Pond RG1: TO DP#1

[44] Hint: Outlet device #2 is below defined storage

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 6.31" for 100-Year event
Inflow = 8.83 cfs @ 12.13 hrs, Volume= 0.740 af
Outflow = 3.00 cfs @ 12.32 hrs, Volume= 0.740 af, Atten= 66%, Lag= 11.4 min
Primary = 3.00 cfs @ 12.32 hrs, Volume= 0.740 af
Routed to Reach OL1 : OVERLAND TO WETLAND
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach OL1 : OVERLAND TO WETLAND

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 1,010.50' @ 12.32 hrs Surf.Area= 6,906 sf Storage= 7,385 cf

Plug-Flow detention time= 30.8 min calculated for 0.739 af (100% of inflow)
Center-of-Mass det. time= 30.7 min (838.0 - 807.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,009.00'	23,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

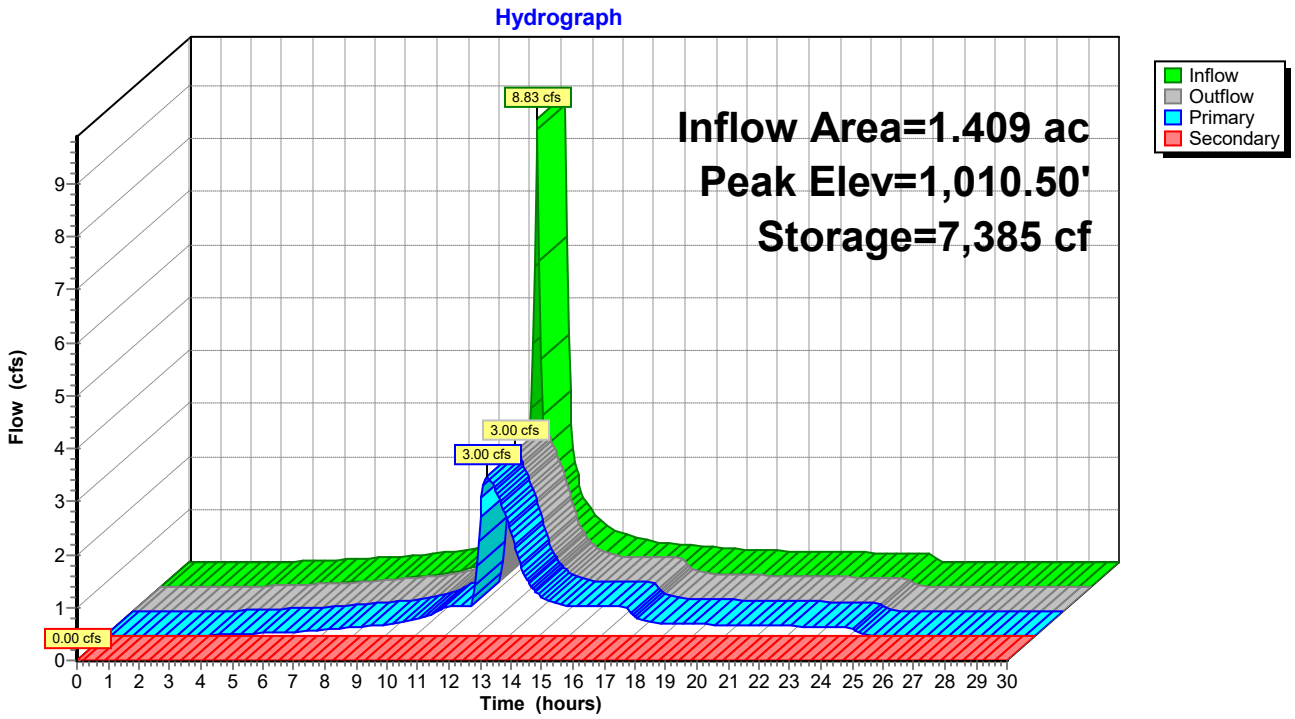
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,009.00	2,750	0	0
1,010.00	5,753	4,252	4,252
1,012.00	10,411	16,164	20,416
1,012.25	12,677	2,886	23,302

Device	Routing	Invert	Outlet Devices
#1	Secondary	1,011.25'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Device 4	1,006.50'	**Special & User-Defined** Head (feet) 0.00 1.00 15.00 Disch. (cfs) 0.000 0.550 0.550
#3	Device 4	1,010.50'	**2.6' long Sharp-Crested Rectangular Weir X 3.00** 2 End Contraction(s) 0.5' Crest Height
#4	Primary	1,006.40'	**12.0" Round Culvert** L= 42.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,006.40' / 1,006.00' S= 0.0095 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#5	Device 4	1,009.50'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.99 cfs @ 12.32 hrs HW=1,010.49' (Free Discharge)
└**4=Culvert** (Passes 2.99 cfs of 5.66 cfs potential flow)
├**2=Special & User-Defined** (Custom Controls 0.55 cfs)
├**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
└**5=Orifice/Grate** (Orifice Controls 2.44 cfs @ 4.15 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,009.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond RG1: TO DP#1



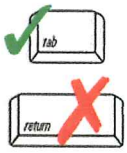
3.0
STORMWATER MANAGEMENT FORMS

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

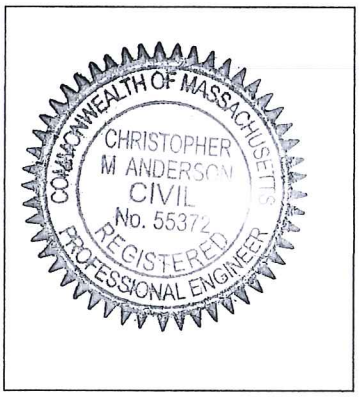
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



7-10-2023

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☒ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☒ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Deep Sump Catchbasins, Rain Garden, Forebay

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☐ Calculations provided to reveal increases in the peak rate of runoff occur in the 2-year and 10-year 24-hour storms If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided. (per Web Soil Survey & Soil Observation Logs)

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☒ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

Checklist for Stormwater Report

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs) ***(Not Applicable)***

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas ***(Not Applicable)***

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable.

☐ *Portions of the project are* subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

☐ Limited Project

☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.

☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area

☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff

☐ Bike Path and/or Foot Path

☐ Redevelopment Project

☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
-
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Stormwater Compliance Documentation

0 Murdock Ave, Winchendon

March 27, 2023

Revised Through July 10, 2023

Standard 1: No Untreated Discharges or Erosion to Wetlands

The drainage from the site currently flows to a single point located at the wetland area along the westerly side of Murdock Avenue, this area has been designated as Design Point #1 (DP#1).

The proposed project develops a single discharge point from a proposed rain garden which capture the majority of the ESS Site. This area is comprised of a series concrete pads that support the battery containers and are serviced by a gravel access drive. No other areas of impervious surfaces (i.e. pavement) occur on the site. Because these pads are not associated with activities that typically generate sediment, for the purposes of this analysis they are also considered similar to roofs. Furthermore, the project will not utilize de-icing chemicals or sand during the winter months as traffic to the development does not occur on a regular basis. As such the development does not generate an Untreated Discharge.

As part of the project the majority of the runoff will be directed towards a small raingarden located along the westerly portion of the project. This will then discharge towards Design Point #1. Provided are the computations showing the calculations per the Connecticut DOT Drainage Manual, Section 11.13 that the proposed rip-rap aprons will provide adequate protection from scouring.

Equation-11.31
L=1.80(Q-5)/Sp^(1.5) + 10

Equation-11.33
W2=3Sp +0.7La

For 15-inch HDPE pipe (FE#1)

Qmax=4.80 cfs (100-Year) Sp=15/12 → 1.25 ft

L=1.8(4.80-5)/(1.25^1.5) + 10 → -0.25 + 10 = 9.75 → 10 feet

W2=3(1.25) +0.7(10) → 3.75 + 7 = 10.75 → 12.0 feet

Provide an apron 10-feet long with a terminus width of 12 feet wide.

For 12-inch HDPE pipe (FE#2)

Qmax=4.95 cfs (100-Year) Sp=12/12 → 1.25 ft

L=1.8(4.95-5)/(1.05^1.5) + 10 → -0.1 + 10 = 9.9 → 10 feet

W2=3(1.0) +0.7(10) → 3.0 + 7 = 10.0 → 10.0 feet

Provide an apron 10-feet long with a terminus width of 10 feet wide.

Standard 2: Peak Rate Attenuation

Table #1: Peak Rate of Runoff

Design Point		2-yr Storm	10-yr Storm	25-yr Storm	100-yr Storm
#1	Pre-	7.29	15.49	22.35	36.93
	Post-	7.14	14.21	20.66	34.00

All flows are in cubic feet per second.

As outline above, the post-development peak rates are of runoff have been mitigated for all Storm Events.

Standard 3: Stormwater Recharge

Impervious Area Proposed: (This area includes all proposed concrete pads and gravel ways, driveways, etc.)

The soils within the project area classified as HSG C:
Existing Impervious HSG-C: 0 s.f.
Proposed Impervious HSG-C: 20,671 s.f.
Net New Impervious HSG-C: +20,671 s.f.

Total New Impervious area = 20,671 s.f.
Total Project Impervious = 20,671 s.f.

Required Recharge Volume:

Net Increase HSG Soil C

Net New Impervious HSG C= 20,671 s.f.
HSG C: 20,671 s.f. x (0.25 in/12) = 431 c.f.

Required Recharge Volume = 431 c.f.

Capture Rate:

Total Impervious to RG#1	17,793 sf
Net Captured Impervious	**17,793 sf**

Capture Rate = 17,793 s.f. / 20,671 s.f. = 86%

Portions of existing roadway are captured by proposed rain garden.

Compliance provided.

Storage Volume Provided:

Volume below lowest outlet within detention facility.

RG-1: 1,753 c.f. of storage volume provided

Recharge Provided:

Total Volume Required: 431 c.f.

Storage Volume
RG-1: 1,753 c.f. of storage volume provided

Required Recharge Volume = 431 c.f.
Provided Recharge Volume = 1,753 c.f.

Compliance is provided

Drawdown Time: (72 Hours Max.)

Time = Storage Volume / (K x Bottom Area)

Where K = Saturated Hydraulic Conductivity (inches/hour) (From table 2.3.3 1982 Rawls Rates – Mass Stormwater Handbook)

RG #1: 1,753 c.f. of storage volume provided.
Time = 1,753 c.f. / (0.27 in/hr x (1 ft/ 12 in) x 2,750 s.f.) = **28.3 hrs**

Compliance is provided

Standard 4: Water Quality

Water Quality Volume (WQV) = Water Quality Depth x Impervious Area

Water Quality Depth = 1/2 inch
WQV = [(1/2 inch) / 12 inches/foot] x (20,671 s.f.) = 861 cf

Water Quality Depth -TP = 1 inch
WQV -TP = [(1-inch) / 12 inches/foot] x (20,671 s.f.) = 1,723 cf

The total new impervious surfaces created by the project are associated with the concrete pads that are used for the transformers and batteries. Because these pads are not associated with activities that typically generate sediment, for the purposes of this analysis they are also considered similar to roofs. Furthermore, the need for regular winter road treatments such as de-icing chemical and sand are not required for this type of development. Therefore, Water Quality Volume is not warranted under Stormwater Management Regulations.

In addition, as required under the Local Stormwater Bylaw, the proposed stormwater management system must be capable of retaining the volumetric runoff equivalent to 1-inch per square foot of post construction impervious areas as a means of providing the 60% Total Phosphorus (TP) removal. To provide compliance, a Rain Garden has been designed in order to capture runoff from the development, these BMP by default provide an area for vegetation to treat runoff and provide the appropriate level of TP removal. Per Volume 2, Chapter 2 of Rain gardens provide between 30% and 90% of TP removal, providing compliance with the regulation. In addition there is a constant ponding depth of approximately 6" which equates to a storage volume of 1,753 c.f. which contributes to providing compliance with the intent of regulation.

Forebay #1:

Contributing Impervious Area	=	2443 square feet +/-	
Water Quality Inlet Sizing	=	0.1" volume over contributing area	
	=	0.1"/12 x 2,443 square feet	
	=	20 ft^3	(Required Volume)
Volume Provided within Forebay #1:			
	=	700 ft^3	(Provided Volume)

Standard 5: Land Uses with Higher Potential Pollutant Loads

Not Applicable

Standard 6: Critical Areas

Not Applicable

Standard 7: Redevelopment

Not Applicable - New Development

Standard 8: Construction Period Controls

Proper erosion controls have been incorporated into the submitted plans and details to ensure compliance with the standard.

Standard 9: Operation and Maintenance Plan

Operation and Maintenance plans for the project have been incorporated into the submitted plans and details to ensure compliance with the standard.

Standard 10: Illicit Discharges to Drainage System

No Illicit discharges to the drainage system will occur as a result of this proposed project. A No Illicit discharge statement shall be provided prior to construction.

INSTRUCTIONS:

Non-automated: Jan. 31, 2019

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Rain Garden - Pipe Discharge

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Catchbasin	**0.25**	**1.00**	**0.25**	**0.75**
Rain Garden with Forebay	**0.90**	**0.75**	**0.68**	**0.08**

Total TSS Removal = **93%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Murdock Avenue, Winchendon**

Prepared By: **Hannigan Engineering, Inc.**

Date: **6/26/2023**

*Equals remaining load from previous BMP (E) which enters the BMP

Massachusetts Department of Environmental Protection

Stormwater Management Standard 10:
Illicit Discharge Compliance Statement

I, as Owner/Applicant, certify, that; the property located at:

_____
(Locus Address)

In, _____, Massachusetts;
(City/Town)

The property does not have any illicit or unauthorized stormwater drainage discharges including, but not limited to non-stormwater discharges occurring due to spills, dumping and improper connections to the system from residential, industrial commercial nor institutional establishments.

The plan/map of record clearly identifies the following:

- The location of all on-site systems for conveying wastewater, stormwater and/or groundwater
- The location of any measures taken to prevent the entry of illicit discharges into the storm drain system.
- That there are no connections between the wastewater management system and the on-site/off-site drainage system.

Plan/Map of Record:

_____

Prepared by Hannigan Engineering, Inc., dated _____

Property/System Owner:

Name: _____

Address: _____

Signature: _____

ZP Battery DevCO, LLC
0 Murdock Ave
Winchendon, Massachusetts

Drainage Piping Mannings Equation Review

Prepared by:
Hannigan Engineering, Inc.
8 Mounment Square
Leominster, MA 01453

Drainage Mains					**mh-mh**	**Pipe**	**Pipe**	**Pipe**	**Manning**	**PIPE**	**A**	**P**	**R**	**Pipe**	**Pipe**	**Pipe**
					length	**Length**	Size	type	n	**slope**	sq.ft.	ft.	ft.	Q	Q	**v**
	From	**To**	INV HI	INV LO	(ft.)	(ft.)	(in.)			(ft./ft.)			(A/P)	cfs	GPD	**ft/sec**
														capacity	capacity	**velocity**
Pipe 1	DCB#1	DMH#1	1012.20	1011.90	38	34	12	HDPE	0.013	0.0088	0.79	3.14	0.25	3.35	289,269	**4.26**
Pipe 2	DCB#2	DMH#2	1015.70	1015.50	9	5	12	HDPE	0.013	0.0400	0.79	3.14	0.25	7.13	615,900	**9.07**
Pipe 3	DCB#3	DMH#2	1016.60	1014.10	169	165	12	hdpe	0.013	0.0152	0.79	3.14	0.25	4.39	379,061	**5.58**
Pipe 4	DMH#2	DMH#1	1014.00	1011.90	191	187	12	HDPE	0.013	0.0112	0.79	3.14	0.25	3.78	326,339	**4.81**
Pipe 5	DMH#1	FE#1	1011.70	1010.80	87	85	15	RCP	0.011	0.0106	1.23	3.93	0.31	7.86	679,000	**6.40**
Pipe 6	OS#1	FE#2	1006.40	1006.00	42	40	12	HDPE	0.013	0.0100	0.79	3.14	0.25	3.56	307,950	**4.54**

"flow full" pipe capacity = **$Q = (1.486/n) \times AR^{2/3} \times S^{1/2}$**

where:

n = (0.01), typical for PVC

A = area (ft^2)

R = A/P

S = slope of pipe (ft./ft.)

P = wetted perimeter, ft. (flowing full equals πD)

Summary for Pond RG1: TO DP#1

[44] Hint: Outlet device #2 is below defined storage

Inflow Area = 1.409 ac, 9.45% Impervious, Inflow Depth = 1.67" for Custom event
Inflow = 2.40 cfs @ 12.14 hrs, Volume= 0.196 af
Outflow = 0.55 cfs @ 12.48 hrs, Volume= 0.196 af, Atten= 77%, Lag= 20.7 min
Primary = 0.55 cfs @ 12.48 hrs, Volume= 0.196 af
Routed to Reach OL1 : OVERLAND TO WETLAND
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach OL1 : OVERLAND TO WETLAND

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 1,009.50' @ 12.48 hrs Surf.Area= 4,254 sf Storage= 1,753 cf <=Storage volume

Plug-Flow detention time= 22.8 min calculated for 0.195 af (100% of inflow)
Center-of-Mass det. time= 22.8 min (877.9 - 855.1)

Volume	Invert	Avail.Storage	Storage Description
#1	1,009.00'	23,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,009.00	2,750	0	0
1,010.00	5,753	4,252	4,252
1,012.00	10,411	16,164	20,416
1,012.25	12,677	2,886	23,302

Device	Routing	Invert	Outlet Devices
#1	Secondary	1,011.25'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Device 4	1,006.50'	**Special & User-Defined**
			Head (feet) 0.00 1.00 15.00
			Disch. (cfs) 0.000 0.550 0.550
#3	Device 4	1,010.50'	**2.6' long Sharp-Crested Rectangular Weir X 3.00** 2 End Contraction(s) 0.5' Crest Height

3.1
OPERATION AND MAINTENANCE

STORMWATER OPERATION, MAINTENANCE AND POLLUTION PREVENTION PLAN

ZP Battery DevCo, LLC
#0 Murdock Avenue
Winchendon, MA

RESPONSIBLE PARTY DURING CONSTRUCTION:
(To be determined)

RESPONSIBLE PARTY POST CONSTRUCTION:
System Owner:

ZPB 2020-16, LLC
10 E. Worcester Street, Suite 3A
Worcester, Massachusetts 01604
508-210-6367
pforte@zpeenergy.com

(or subsequent owner)

ASSOCIATED PARTY
Land Owner:

Bostwock Realty Trust
256 Murdock Avenue
Winchendon, Massachusetts 01475
1-800-297-1901

BEST MANAGEMENT PRACTICES

To prevent the migration of soils, Best Management Practices (BMP's) shall be employed. During construction, hay bales and silt fence will be installed as shown on the plans and also at additional locations on an as needed basis to provide sufficient erosion controls on the site. These components shall be installed to catch and trap the migrating soil materials and pollutants.

All applicable BMP's listed below and in the Department of Environmental Protection's Stormwater Management Handbooks (Volume1: Overview of Massachusetts Stormwater Management Standards and Volume 2: Technical Guide for Compliance with Massachusetts Stormwater Management Standards) dated January 2008 (as amended), shall be incorporated in this project.

INSPECTION AND MAINTENANCE (DURING CONSTRUCTION)

1. At all times, hay bales, siltation fabric fencing and wooden stakes sufficient to construct sedimentation control barrier a minimum of 50 feet long will be stockpiled on the site in order to repair established barriers which may have been damaged or breached.

2. Necessary erosion controls shall be in place prior to any clearing or construction on the site. Construction sequence shall be phased in such a manner that the on-site detention basins are stabilized and functioning prior to the establishment of any new impervious areas on the site. The Contractor shall provide temporary stilling or settling basins as needed to catch and trap any migrating soil materials and pollutants from the construction areas.

3. An inspection of all erosion control and stormwater management systems shall be conducted at least once every fourteen (14) calendar days and following significant storm events. Where sites have been finally or temporarily stabilized, or runoff is unlikely due to winter conditions, such inspections shall be conducted at least once every month. (EPA SWPPP IS REQUIRED FOR THIS PROJECT)

   In case of any noted breach or failure, the General Contractor shall immediately make appropriate repairs to any erosion control system and notify the engineer of any problems involving storm water management systems.

   A significant storm event shall be defined as all or one of the following thresholds.

   a. Any storm in which rain is predicted to last for twelve consecutive hours or more.
   b. Any storm for which a flash flood watch or warning is issued.
   c. Any single storm predicted to have a cumulative rainfall of greater than one inch.
   d. Any storm not meeting the previous three thresholds but which would mark a third consecutive day of measurable rainfall.

4. If site inspections identify BMPs not operating effectively, maintenance must be performed as soon as possible and before the next storm event.

5. If BMPs need modification or additional BMPs need to be added, implementation must be completed before the next storm if practicable. If implementation before the next storm event is impracticable, the situation must be documented in the construction log and alternative BMPs must be implemented as soon as possible

6. The General Contractor shall also inspect the erosion control and stormwater management systems at times of significant increase in surface water runoff due to rapid thawing when the risk of failure of erosion control measures is significant.

7. In such instances as remedial action is necessary, the General Contractor shall repair any and all significant deficiencies in erosion control systems within two days.

8. The Department of Public Works and/or Conservation Commission shall be notified of any significant failure of storm water management systems and erosion and sediment control measures and shall be notified of any release of pollutants to a water body (stream, brook, pond, etc.).

9. The General Contractor shall remove the sediment from behind the fence of the sedimentation control barrier when the accumulated sediment has reached one-half of the original installed height of the barrier.

INSPECTION AND MAINTENANCE (POST-CONSTRUCTION)

It is the agreement of the responsible parties to finance, inspect, and perform (respectfully) the long-term maintenance of the erosion control devices and the stormwater management systems within the limits stated below.

1. A visual inspection of all erosion control and stormwater management systems shall be conducted by the above identified person(s) a minimum of once per month and after every major storm during the first six months of operation (a portion of that time must be in the growing season). Thorough investigations shall be conducted twice a year. Monthly maintenance requirements may be adjusted based upon the results obtained from the first year of operation.

2. Roads and parking lots shall be swept at least twice per year and on a more frequent basis depending on sanding operations. All resulting sweepings shall be collected and properly disposed of off-site in accordance with MADEP and other applicable requirements.

3. Accumulated sediment shall be removed a minimum of one time per year by means of a clamshell bucket or equivalent from the bottom of the deep sump catch basins and manhole. Disposal of accumulated sediment and pollutants must be in accordance with local, state, and federal guidelines and requirements.

4. All resulting sweepings or sediment removed from catch basins, and manhole connections shall be collected and properly disposed of off-site in accordance with MADEP and other applicable requirements.

5. **Maintenance Schedule**

Structure Type	Inspection	Maintenance	Task
Outfall Structures	Twice a Year	Every 10 Years	Remove Debris & Add Stone
Subdrain	Twice a Year	Every 10 Years	Replaced peastone
Deep Sump Catchbasin	Quarterly and at the end of the foliage and snow removal seasons	Quarterly, 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	Clean/Remove Debris and Sediment

Rain Garden Maintenance Schedule		
Activity	**Time of Year**	**Frequency**
Inspect & Remove Trash	Year Round	Monthly
Mulch	Spring	Annually
Remove Dead Vegetation	Fall or Spring	Annually
Replace Dead Vegetation	Spring	Annually
Prune	Spring or fall	Annually
Replace entire media & all vegetation	Late Spring/Early Summer	As needed

5. The following structures are to be inspected as part of the Post-Construction Operation and Maintenance. They are depicted on the attached sketches as noted below.

SKETCH #1
DCB#3
DCB#2

SKETCH #2
DCB#2
DCB#1
DMH#1
SEDIMENT FOREBAY

SKETCH #3
SEDIMENT FOREBAY
RAIN GARDEN
EMERGENCY SPILLWAY
SUBDRAIN
OUTLET STRUCTURE

LONG TERM POLLUTION PREVENTION PLAN

1. Access drives to the site shall be swept on an annual basis with a commercial cleaning unit. Any sediment removed shall be disposed of in accordance with applicable local and state requirements.

2. Trash and other debris shall be removed from the drives periodically as needed. Full inspection of the site shall be made on a semi-annual basis to ensure clean and neat appearance to the site. This measure will help in the overall performance of the onsite systems.

3. Trash and other debris shall be removed from landscaped and planted areas periodically as needed. Full inspection of the site shall be made on a semi-annual basis to ensure clean and neat appearance to the site. This measure will help in the overall performance of the onsite systems.

4. Reseed any bare areas as soon as they occur. Erosion control measures shall be installed in these areas to prevent deposits of sediment from entering the drainage system

5. Grass shall be maintained at a minimum blade height of two to three inches and only 1/3 of the plant height shall be removed at a time.

6. Pet waste shall be disposed of in accordance with local regulations. Pet waste shall not be disposed of in a storm drain or catch basin.

7. Winter Access Treatment: Access drives during winter months shall be cleared by mechanical means only (i.e. plowing, etc…). No application of sand or de-icing chemicals shall be applied to drive or other areas associated with the ESS Battery Station.

Inspection Log

0 Murdock Avenue, Winchendon, Massachusetts

DATE	ACTION	RESULT	PERFORMED BY

Maintenance Log

0 Murdock Avenue, Winchendon, Massachusetts

DATE	ACTION	PERFORMED BY

STORMWATER MANAGEMENT OPERATION, MAINTENANCE, AND INSPECTION AGREEMENT

Town of Winchendon, MA
Department of Public Works
(978) 297-1212

THIS AGREEMENT, made and entered into this 26 day of June, 2023, by and between (Insert Full Name of Owner) ZP Battery DevCo, LLC hereinafter called the "Project Owner", and the Town of Winchendon, hereinafter called the "Town".

WITNESSETH, that WHEREAS, the Project Owner is the Lessee of certain real property at (Street Address) 256 Murdock Ave as described as (Town of Winchendon Assessors Map/Parcel/Lot Number) 5A2-0-25, 5A2-0-26 as recorded by notice in the land records of Worcester County, Massachusetts, Deed Book 17143 Page 339, hereinafter called the "Property". WHEREAS, the Project Owner is proceeding to build on and develop a portion the property; and WHEREAS, the Site Plan/Subdivision Plan known as Site Development Plan- Solar Energy Storage System- 0 Murdock Ave, (Name of Plan/Development) hereinafter called the "Plan", which is expressly made a part hereof, as approved or to be approved by the Town, which provides for the conveyance, treatment, and/or detention of stormwater within the confines of the Property; and

WHEREAS, the Town and the Project Owner, its successors and assigns agree that the health, safety, and welfare of the residents of the Town of Winchendon, Massachusetts, require that on-site stormwater management facilities be constructed and maintained on the Property; and

WHEREAS, the Town requires that on-site stormwater management facilities as shown on the Plan be constructed and adequately maintained by the Project Owner, its successors and assigns.

NOW, THEREFORE, in consideration of the foregoing premises, in accordance with the Winchendon Stormwater Management Ordinance, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The on-site stormwater management facilities shall be constructed by the Project Owner, its successors and assigns, in accordance with the plans and specifications identified in the Plans and documents reviewed and approved by the Winchendon Planning Board.

2. The Project Owner, its successors and assigns shall adequately maintain the stormwater management facilities according to the maintenance schedule described in **Attachment A**. This includes all pipes and channels built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions and so that water quality standards are met in all seasons and throughout the life of the stormwater system.

3. The Project Owner, its successors and asigns, shall notify the Planning Board of any changes in ownership. assignments, reconstruction of the approved stormwater management facilities and/or amendments to the maintenance schedule described in Attachment A.

4. The Project Owner, its successors and assigns, shall provide stormwater management easements as necessary for all areas used for off-site stormwater control, preservation of stormwater runoff conveyance, infiltration, and detention areas and facilities, including flood routes for the 100-year storm event, and access for facility maintenance and inspection. The Project Owner, its successors and assigns shall record all easements in the land records of the Worcester County Registry of Deeds, Commonwealth of Massachusetts.

5. This Agreement shall be recorded by the Project Owner or at the Project Owners expense among the land records of Worcester County, Commonwealth of Massachusetts, and shall constitute a covenant running with the land, and shall be binding on the Project Owner, its administrators, executors, assigns, heirs and any other successors in interests.

WITNESS the following signatures and seals:

ZP Battery DevCo LLC
Company/Corporation/Partnership Name (Seal)

By: _____

Peter Forte
(Type Name)

Vice President
(Type Title)

COMMONWEALTH OF MASSACHUSETTS

County of Worcester

On this 26 day of June, 2023, before me, the undersigned notary public, personally appeared Peter Forte, proved to me through satisfactory evidence of identification, which was MA DL to be the person whose name is signed on the proceeding document, and acknowledged to me that he signed it voluntarily for its stated purpose.

Thomas M Corbett
NOTARY PUBLIC Thomas M Corbett

My Commission Expires: 6-16-2028

Town of Winchendon

By: _____

(Type Name)

(Type Title)

COMMONWEALTH OF MASSACHUSETTS

County of Worcester

On this _____ day of _____, 20___, before me, the undersigned notary public, personally appeared _____, proved to me through satisfactory evidence of identification, which was _____, to be the person whose name is signed on the proceeding document, and acknowledged to me that he signed it voluntarily for its stated purpose.

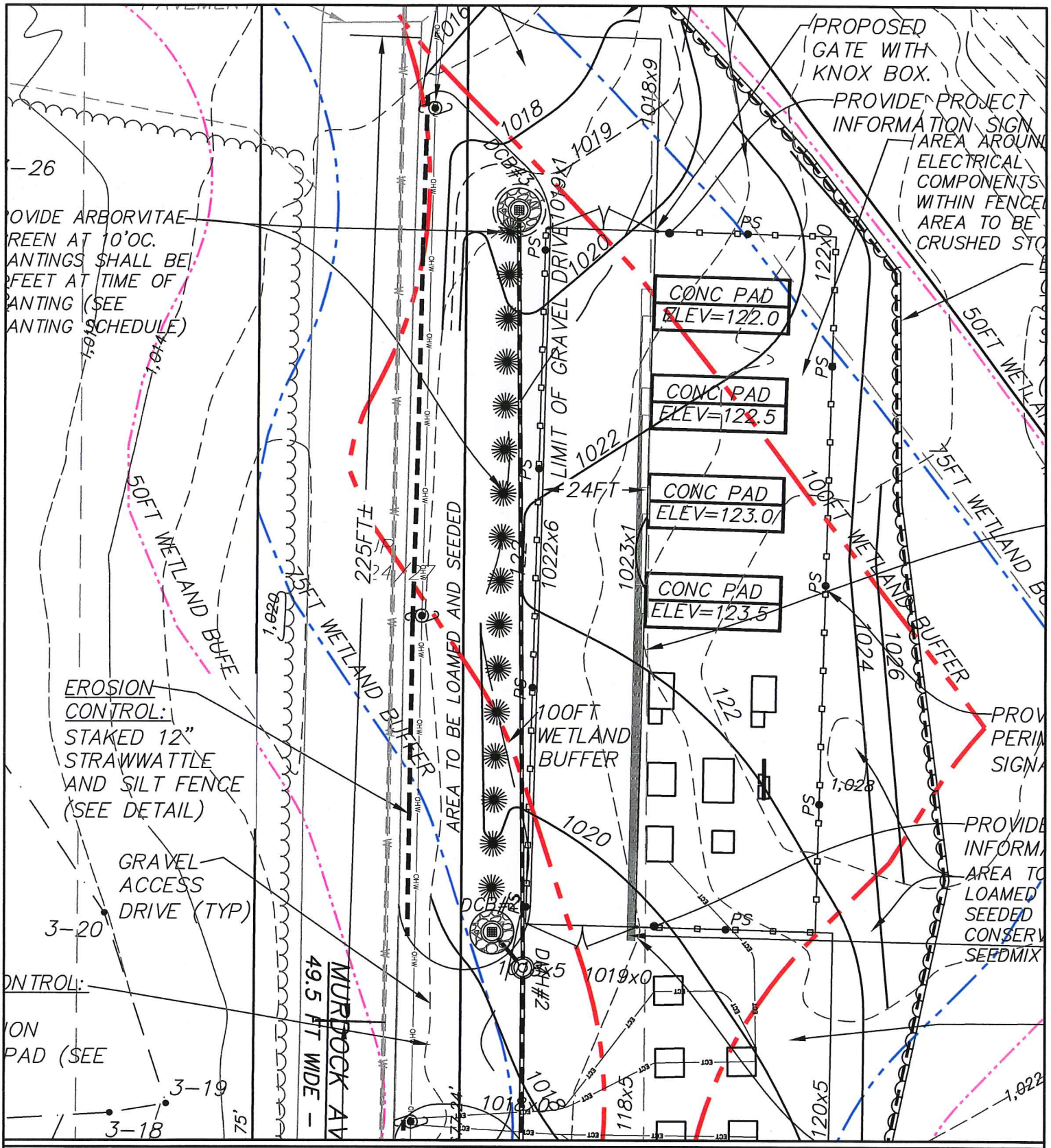
NOTARY PUBLIC

My Commission Expires: _____

ATTACHMENT A

Maintenance Schedule

Structure Type	Inspection	Maintenance	Task
Rip/Rap Aprons	Twice a Year	Every 10 Years	Remove Debris & Add Stone
Subdrains	Twice a Year	Every 4 Years	Replace Peastone
Detention Basins	Monthly (May-Oct)	Monthly (May-Oct)	Mow Grass Areas & Remove Debris Remove Sediment if present
Outfall Structures	Twice a Year	Every 10 Years	Remove Debris & Add Stone
Drainage Swale	Twice a Year	Monthly	Remove debris and vegetation. Mow Grass and replace stone as necessary
Access Roads	Twice a Year	Yearly	Replace gravel as necessary
Full Site Inspection	Twice a Year	As Needed	Remove Trash & Debris
Mowing	Four Times a Year	As Needed	Grass max height of 18" and cut to height of 4-6" Reseed bare spots as needed
Vegetated Buffer	Twice a Year	Every 4 Years	Pruned as needed



HANNIGAN ENGINEERING, INC.

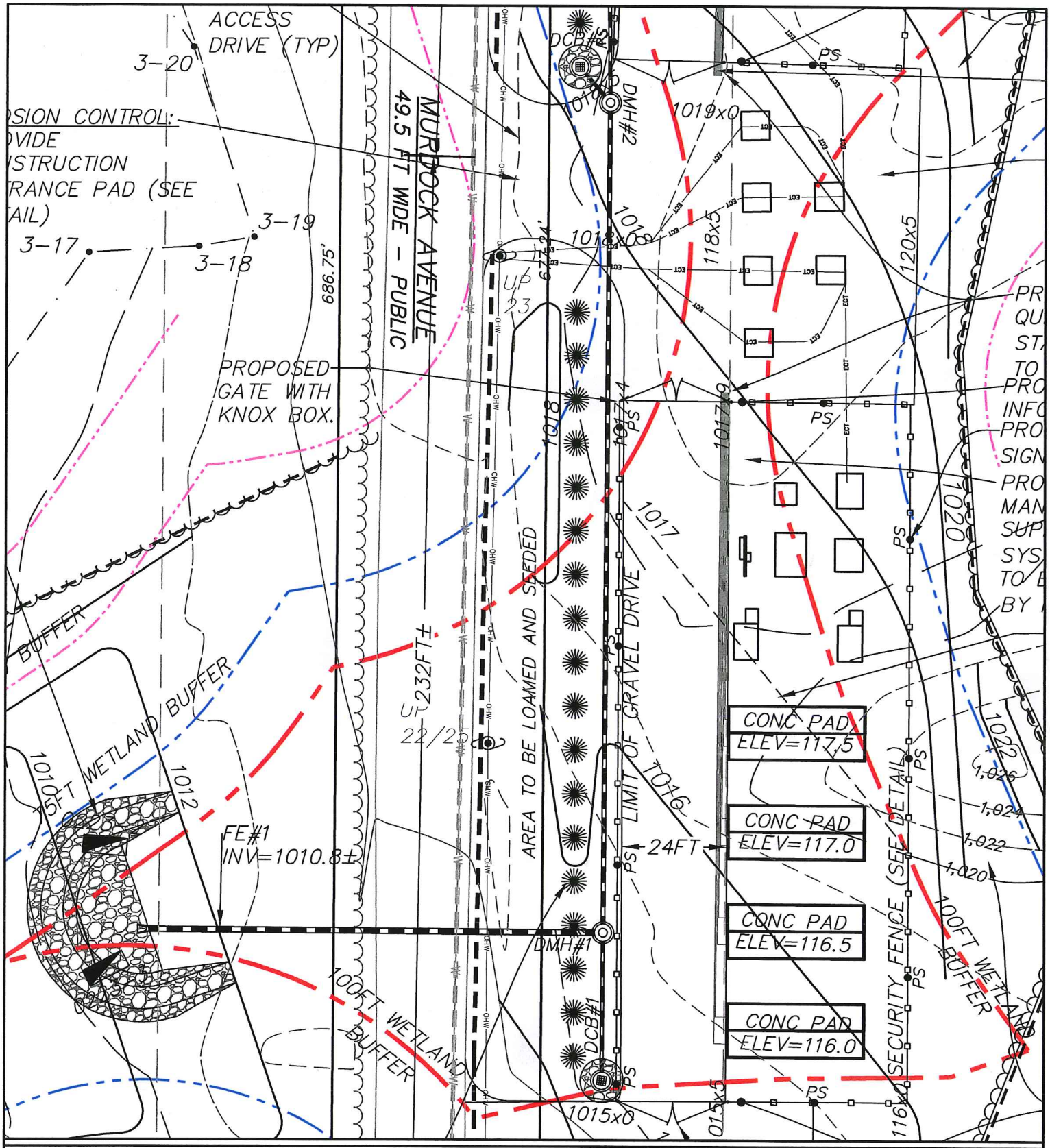
CIVIL ENGINEERS & LAND SURVEYORS

8 MONUMENT SQUARE
LEOMINSTER, MASSACHUSETTS 01453
(978) 534-1234 (T)
(978) 534-6060 (F)
WWW.HANNIGANENGINEERING.COM

STORMWATER OPERATION AND MAINTENANCE PLAN#1

JUNE 28, 2023
SCALE: 1": 30'

PREPARED FOR:
ZP BATTERY DEVCO, LLC
1 MERCANTILE STREET, SUITE 630
WORCESTER, MASSACHUSETTS 01608



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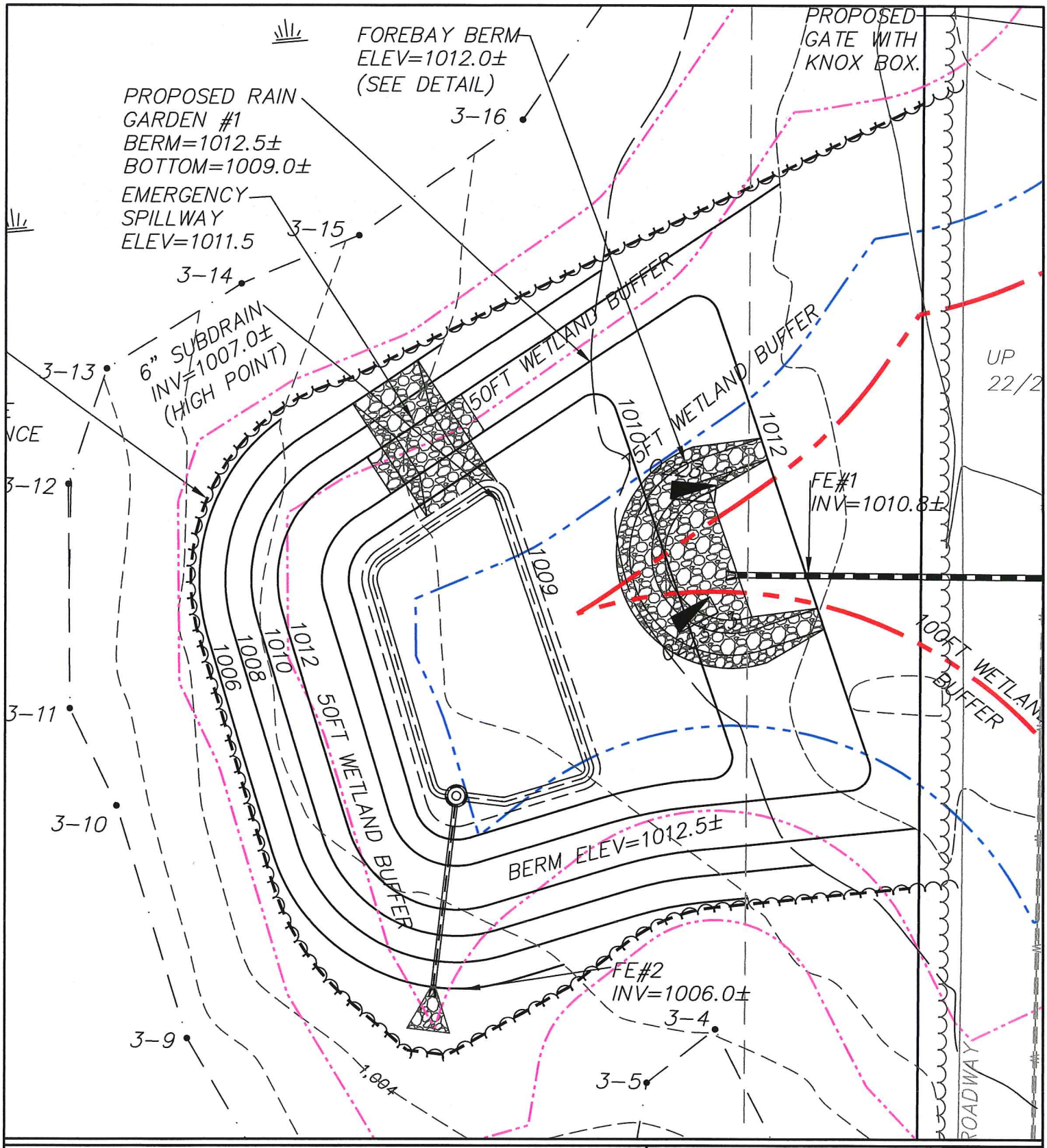
STORMWATER OPERATION AND MAINTENANCE PLAN#2

JUNE 28, 2023

SCALE: 1": 30'

PREPARED FOR:
ZP BATTERY DEVCO, LLC
1 MERCANTILE STREET, SUITE 630
WORCESTER, MASSACHUSETTS 01608



HANNIGAN ENGINEERING, INC.

CIVIL ENGINEERS & LAND SURVEYORS

8 MONUMENT SQUARE
LEOMINSTER, MASSACHUSETTS 01453

(978) 534-1234 (T)
(978) 534-6060 (F)

WWW.HANNIGANENGINEERING.COM

STORMWATER OPERATION AND MAINTENANCE PLAN#3

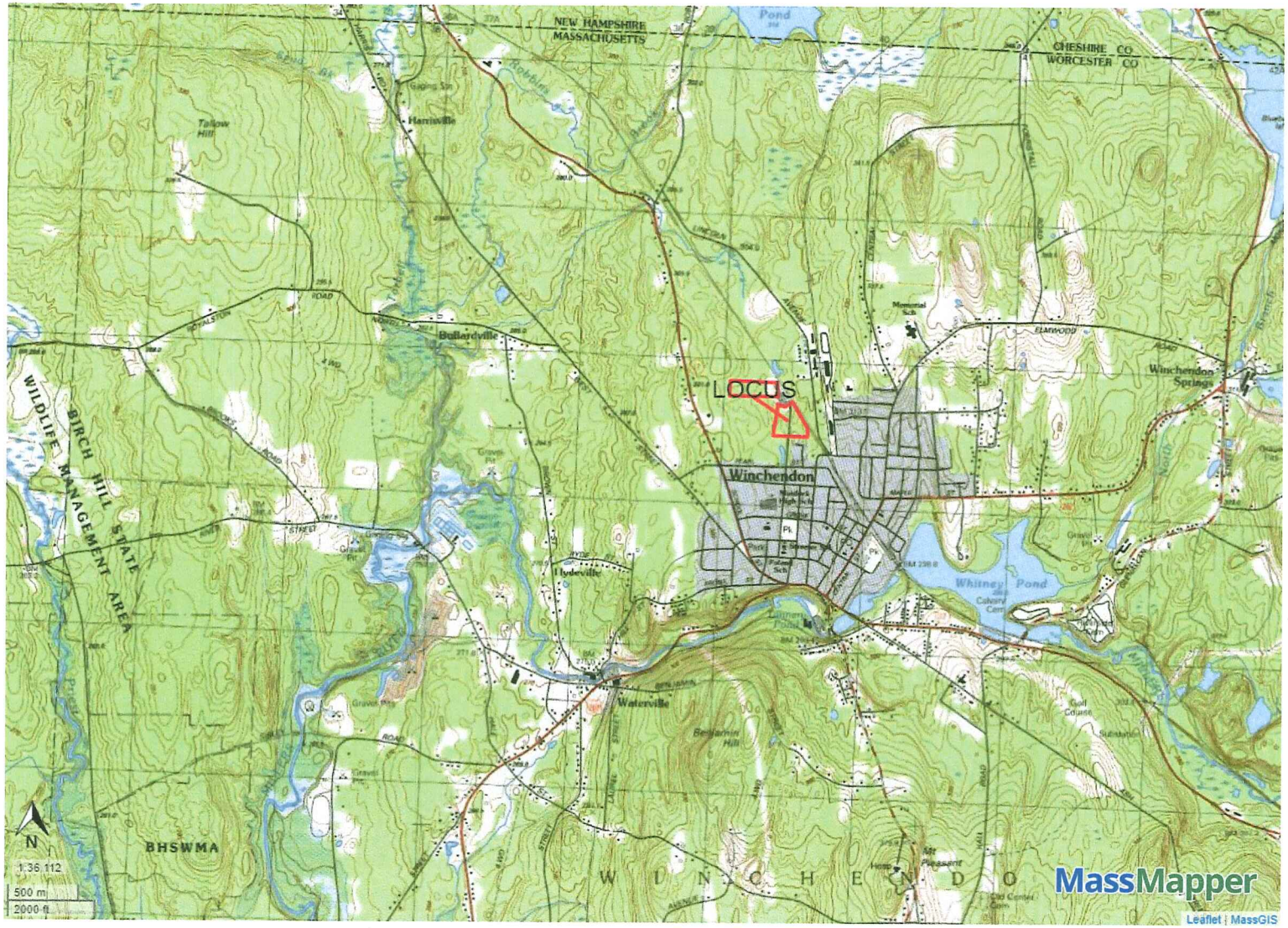
JUNE 28, 2023

SCALE: 1": 30'

PREPARED FOR:
ZP BATTERY DEVCO, LLC
1 MERCANTILE STREET, SUITE 630
WORCESTER, MASSACHUSETTS 01608

FIGURE 1
LOCUS MAP AND SOILS MAP

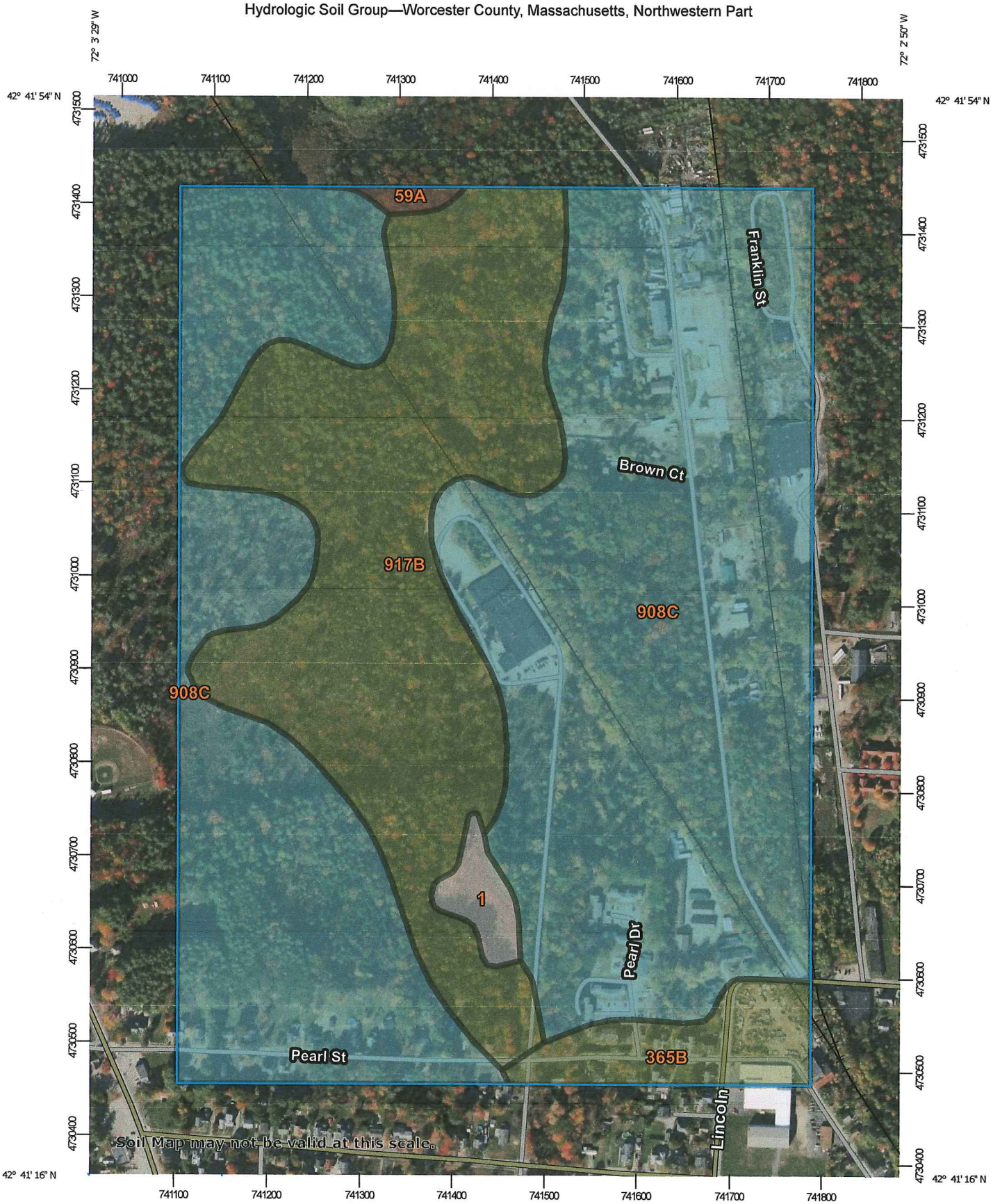
MURDOCK AVENUE, WINCHENDON, MA



Property Tax Parcels

USGS Topographic Maps

Hydrologic Soil Group—Worcester County, Massachusetts, Northwestern Part



Map Scale: 1:5,640 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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: Worcester County, Massachusetts, Northwestern Part
Survey Area Data: Version 16, Sep 9, 2022

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

Date(s) aerial images were photographed: Oct 15, 2020—Oct 31, 2020

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		1.9	1.2%
59A	Bucksport and Wonsqueak mucks, 0 to 2 percent slopes	B/D	0.6	0.4%
365B	Skerry fine sandy loam, 3 to 8 percent slopes	C/D	6.1	3.8%
908C	Becket-Skerry association, 0 to 15 percent slopes, extremely stony	C	110.5	67.6%
917B	Pillsbury-Peacham association, 0 to 8 percent slopes, extremely stony	C/D	44.3	27.1%
Totals for Area of Interest			**163.5**	**100.0%**

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.

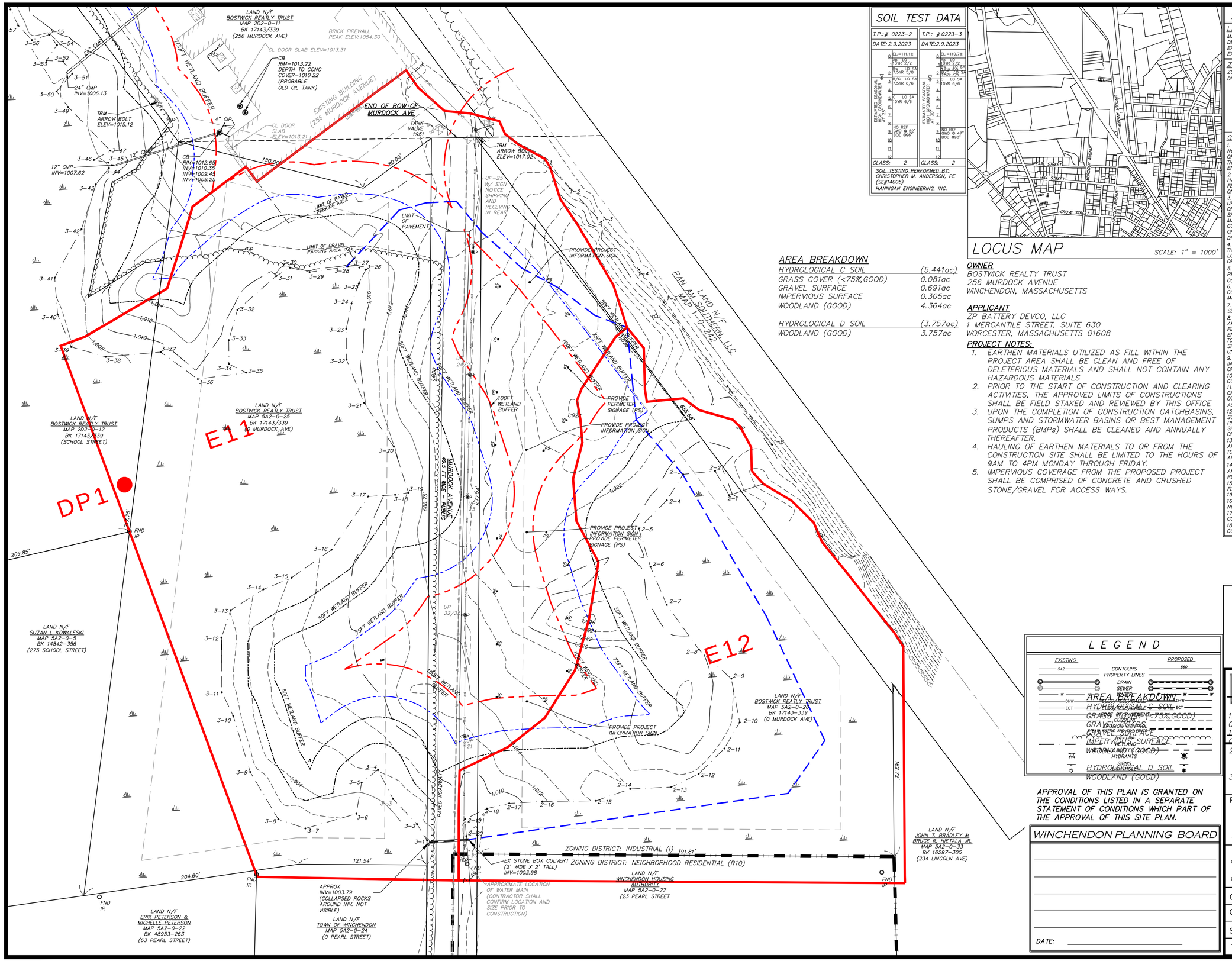
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

FIGURE 2
PRE-DEVELOMPENT WATERSHED MAP



SOIL TEST DATA

T.P.: # 0223-2	T.P.: # 0223-3
DATE: 2.9.2023	DATE:2.9.2023
EL.=111.18	EL.=110.78
10YR 7/2	10YR 7/2
7.5YR 5/8	7.5YR 5/8
7.5YR 5/6	7.5YR 5/6
10YR 6/6	10YR 6/6
NO REF	NO REF
CLASS: 2	CLASS: 2

ESTIMATED SEASONAL HIGH GROUNDWATER AT 3.0'

ESTIMATED SEASONAL HIGH GROUNDWATER AT 3.0'

SOIL TESTING PERFORMED BY:
CHRISTOPHER M. ANDERSON, PE
(SE#14005)
HANNIGAN ENGINEERING, INC.

LOCUS MAP SCALE: 1" = 1000'

AREA BREAKDOWN

HYDROLOGICAL C SOIL	(5.441ac)
GRASS COVER (<75%,GOOD)	0.081ac
GRAVEL SURFACE	0.691ac
IMPERVIOUS SURFACE	0.305ac
WOODLAND (GOOD)	4.364ac
HYDROLOGICAL D SOIL	(3.757ac)
WOODLAND (GOOD)	3.757ac

OWNER
BOSTWICK REALTY TRUST
256 MURDOCK AVENUE
WINCHENDON, MASSACHUSETTS

APPLICANT
ZP BATTERY DEVCO, LLC
1 MERCANTILE STREET, SUITE 630
WORCESTER, MASSACHUSETTS 01608

PROJECT NOTES:

1. EARTHEN MATERIALS UTILIZED AS FILL WITHIN THE PROJECT AREA SHALL BE CLEAN AND FREE OF DELETERIOUS MATERIALS AND SHALL NOT CONTAIN ANY HAZARDOUS MATERIALS
2. PRIOR TO THE START OF CONSTRUCTION AND CLEARING ACTIVITIES, THE APPROVED LIMITS OF CONSTRUCTIONS SHALL BE FIELD STAKED AND REVIEWED BY THIS OFFICE
3. UPON THE COMPLETION OF CONSTRUCTION CATCHBASINS, SUMPS AND STORMWATER BASINS OR BEST MANAGEMENT PRODUCTS (BMPs) SHALL BE CLEANED AND ANNUALLY THEREAFTER.
4. HAULING OF EARTHEN MATERIALS TO OR FROM THE CONSTRUCTION SITE SHALL BE LIMITED TO THE HOURS OF 9AM TO 4PM MONDAY THROUGH FRIDAY.
5. IMPERVIOUS COVERAGE FROM THE PROPOSED PROJECT SHALL BE COMPRISED OF CONCRETE AND CRUSHED STONE/GRAVEL FOR ACCESS WAYS.

PROJECT INFORMATION

LAND INFORMATION

MAP/PARCEL:	5A2/25; 5A2/26
DEED BOOK/PAGE:	17143/339
EXISTING FRONTAGE:	686.75 FT (5A2/25); 677.24 FT (5A2/26)
EXISTING AREA:	4.33 ACRES± (5A2/25); 3.67 ACRES±(5A2/26

ZONING INFORMATION

ZONING DISTRICT: INDUSTRIAL
DIMENSIONAL REQUIREMENTS:

MINIMUM AREA:	43,560 SF
MINIMUM FRONTAGE:	150 FEET
MAXIMUM HEIGHT:	50FT
MAXIMUM COVERAGE:	NA
MINIMUM SETBACKS:	
FRONT YARD:	40 FT
SIDE YARD:	25 FT
REAR YARD:	50 FT

GENERAL NOTES:

1. PROPERTY LINE INFORMATION BASED DEEDS AND PLANS OF RECORD. NO CERTIFICATION OF PROPERTY LINES SHOWN ON THIS PLAN IS INTENDED OR IMPLIED BY HANNIGAN ENGINEERING, INC. TOPOGRAPHIC INFORMATION IS THE RESULT OF AN ON-THE-GROUND TOPOGRAPHIC SURVEY BY HANNIGAN ENGINEERING, INC. IN MAY OF 2022.
2. AREAS SUBJECT TO PROTECTION UNDER THE WETLANDS PROTECTION ACT HAVE BEEN DELINEATED BY LEC ENVIRONMENTAL CONSULTANTS IN FEBRUARY OF 2022. THESE AREAS ARE DEPICTED ON THE PLANS BASED ON FIELD SURVEY LOCATION DURING THE TOPOGRAPHIC SURVEY.
3. LOCATION OF ALL UTILITIES ARE APPROXIMATE AS SHOWN AND BASED UPON VISIBLE STRUCTURES AT THE TIME OF THE FIELD SURVEY. LOCATION OF EXISTING UTILITIES AND SUBSURFACE STRUCTURES, WHETHER OR NOT SHOWN ON THESE PLANS, SHALL BE DETERMINED BY THE CONTRACTOR, MARKED IN THE FIELD, AND REVIEWED BY THE ENGINEER PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. THE CONTRACTOR SHALL BE AWARE OF THE OBLIGATION TO ALL UTILITY COMPANIES AND AGENCY AS WELL AS DIG-SAFE PRIOR TO EXCAVATION. (SEE NOTE)
4. NOTIFICATION REQUIREMENTS SHOWN ON THIS PLAN SHALL NOT RELIEVE THE CONTRACTOR OF ANY OTHER REQUIREMENTS WHICH MAY EXIST UNDER LOCAL, STATE, OR FEDERAL JURISDICTION TO WHICH THE CONTRACTOR IS OBLIGATED.
5. RELOCATION OF AND/OR CONNECTION TO EXISTING UTILITIES SHALL BE PERFORMED IN ACCORDANCE WITH PROVISIONS OF THE APPROPRIATE UTILITY COMPANY AND/OR REGULATORY AGENCY.
6. UNLESS OTHERWISE SPECIFIED, ALL MATERIALS AND WORKMANSHIP SHALL CONFORM WITH THE REQUIREMENTS OF THE TOWN OF WINCHENDON AND THE MASS DOT SPECIFICATIONS OF HIGHWAYS AND BRIDGES.
7. ALL SLOPES UNLESS OTHERWISE SPECIFIED, SHALL BE LOAMED AND SEEDED FOR STABILIZATION.
8. ANY DEVIATIONS IN DESIGN AS SHOWN SHALL REQUIRE A REVIEW AND APPROVAL OF THE DESIGN ENGINEER OR FIRM. CHANGES MADE IN THE FIELD MADE WITHOUT AUTHORIZATION SHALL BE SUBJECT TO REVIEW BY THE ENGINEER AND APPROPRIATE APPROVING AUTHORITY. EXPENSES INCURRED TO BRING THE UNAUTHORIZED CHANGES TO ACCEPTABLE CONFORMANCE SHALL BE BORNE BY THE COMPANY OR CONTRACTOR MAKING THE UNAUTHORIZED CHANGE.
9. ANY MATERIALS DISCOVERED ON-SITE WHICH ARE NOT SUITABLE FOR USE IN THE PROJECT AS SHOWN ON THIS PLAN SHALL BE REMOVED AND HAULED OFF-SITE TO AN APPROPRIATELY LICENSED FACILITY.
10. PLANS TO BE REVIEWED BY APPLICABLE UTILITY AGENCIES FOR COMPLIANCE WITH REGULATIONS. FINAL LOCATION IS SUBJECT TO CHANGE.
11. APPLICANT SHOULD BE AWARE OF OBLIGATIONS TO COMPLY WITH CHAPTER 131, SECTION 40 OF THE MASSACHUSETTS GENERAL LAWS, OTHERWISE KNOWN AS THE WETLANDS PROTECTION ACT, AND THE ASSOCIATED REGULATIONS (310 CMR 10.00)
12. STOCKPILING OF MATERIAL SHALL NOT BE PERMITTED WITHIN ANY AREAS SUBJECT TO PROTECTION UNDER THE WETLANDS PROTECTION ACT WITHOUT PRIOR APPROVAL BY THE LOCAL CONSERVATION COMMISSION. STOCKPILES SHALL BE PLACED IN A SUITABLE LOCATION AND SURROUNDED BY A ROW OF STAKED HAY BALES FOR EROSION CONTROL.
13. AREAS OF FILL TO BE COMPACTED TO A MINIMUM 95% DRY DENSITY IN AREAS WITHIN ROADWAYS AND UTILITY EASEMENTS. OTHER AREAS OF FILL TO BE COMPACTED TO A MINIMUM 90% DRY DENSITY. ALL FILL MATERIALS ARE TO BE CLEAN FILL, FREE OF DELETERIOUS MATERIALS AND DEBRIS.
14. ALL SIDEWALKS AND RAMPS TO CONFORM TO REQUIREMENTS OF THE AMERICANS WITH DISABILITIES ACT (ADA), AS REQUIRED. SEE ARCHITECTURAL PLANS FOR CONFORMANCE REQUIREMENTS FOR PROPOSED BUILDINGS.
15. THE AREA PROPOSED FOR DEVELOPMENT IS NOT WITHIN A 100 YEAR FLOOD PLAIN PER F.E.M.A. FIRM PANEL #250348-0016B, DATED: JUNE 15, 1982. COMPLIANCE WITH APPLICABLE REGULATIONS IS REQUIRED.
16. ALL REINFORCED CONCRETE PIPE TO BE CLASS III UNLESS OTHERWISE NOTED.
17. PRE-CONSTRUCTION CONFERENCE SHALL BE HELD PRIOR TO THE COMMENCEMENT OF CONSTRUCTION.
18. ALL UTILITIES ARE TO BE INSTALLED BY A LICENSED UTILITY CONTRACTOR LICENSED BY THE TOWN OF WINCHENDON.

LEGEND

EXISTING		PROPOSED
542	CONTOURS	560
	PROPERTY LINES	
	DRAIN	
	SEWER	
W	WATER	W
OHW	ELEC. OVERHEAD	OHW
ECT	HYDROLOGICAL C SOIL	ECT
	GRASS (<75%,GOOD)	
	GRAVEL SURFACE	
	IMPERVIOUS SURFACE	
	WOODLAND (GOOD)	
	HYDROLOGICAL D SOIL	
	WOODLAND (GOOD)	
	CURBING	
	EDGE OF PAVEMENT	
	TREELINE	
	WETLAND	
	HYDRANTS	
	SIGNS	

APPROVAL OF THIS PLAN IS GRANTED ON THE CONDITIONS LISTED IN A SEPARATE STATEMENT OF CONDITIONS WHICH PART OF THE APPROVAL OF THIS SITE PLAN.

WINCHENDON PLANNING BOARD

DATE: _____

HANNIGAN ENGINEERING, INC.
CIVIL ENGINEERS & LAND SURVEYORS
Oakmont Square (978) 534-1234 (T)
Leominster, Massachusetts 01453 (978) 534-6060 (F)
www.hanniganengineering.com

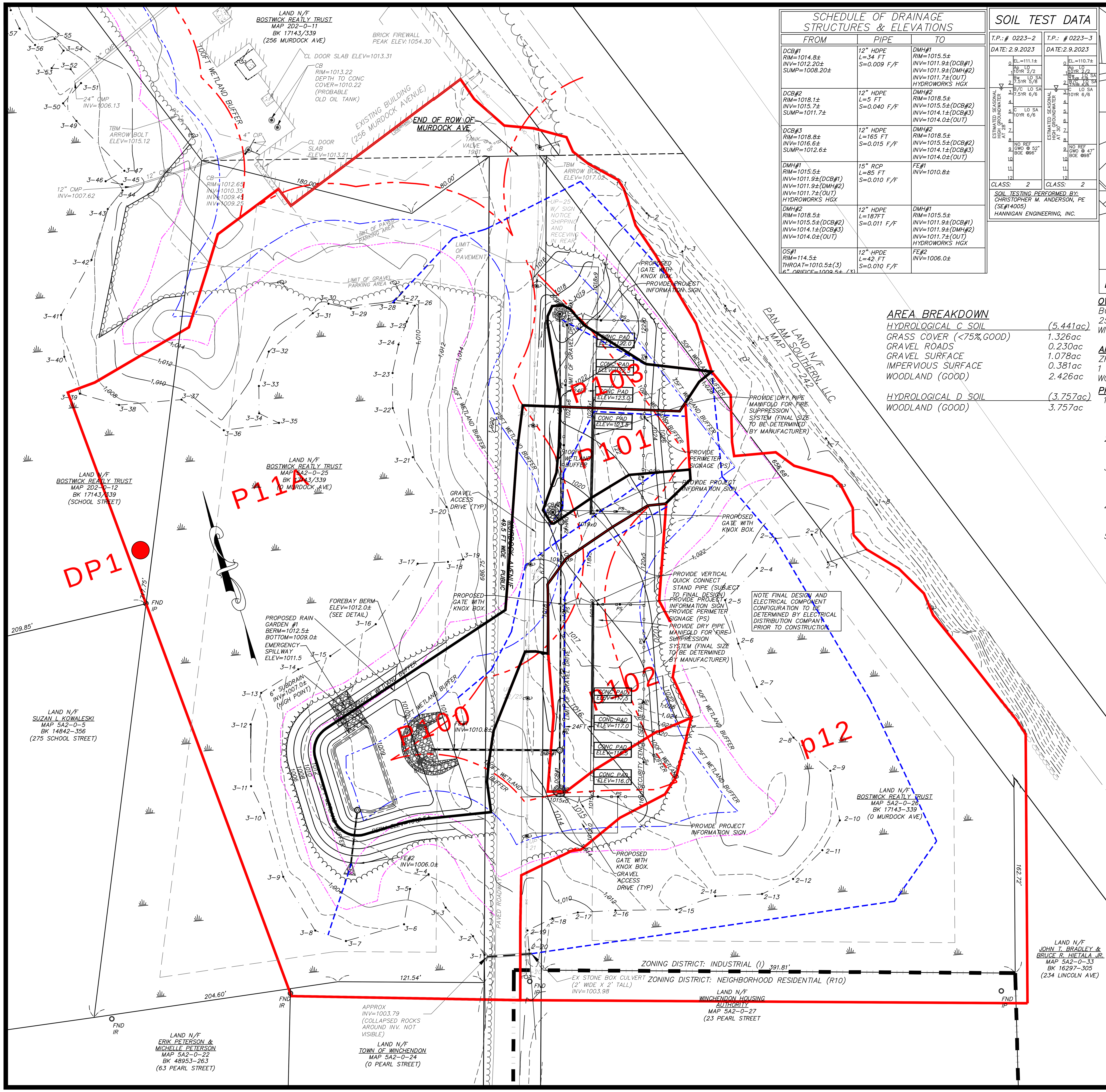
EXISTING WATERSHED PLAN
IN
WINCHENDON, MASSACHUSETTS

PREPARED FOR:
ZP BATTERY DEVCO, LLC
PETE FORTE
1 MERCANTILE STREET, SUIT 630
WORCESTER, MASSACHUSETTS 01608
TEL:

GRAPHIC SCALE: 1"=40'
0 10 20 30 40 50 75 100 150 FEET
0 5 10 15 20 30 40 50 METERS

CALC: CMA	DRWN: CMA	SCALE: 1"=40'
CHKD: WDH	APPD: CMA	DATE: MAR 27,2023
SRV: JEF	FB: 75-130	JOB NO: 3101
TAB: WS	SHEET 1 OF 2	PLAN NO:C-18-41

FIGURE 3
POST-DEVELOMPENT WATERSHED MAP



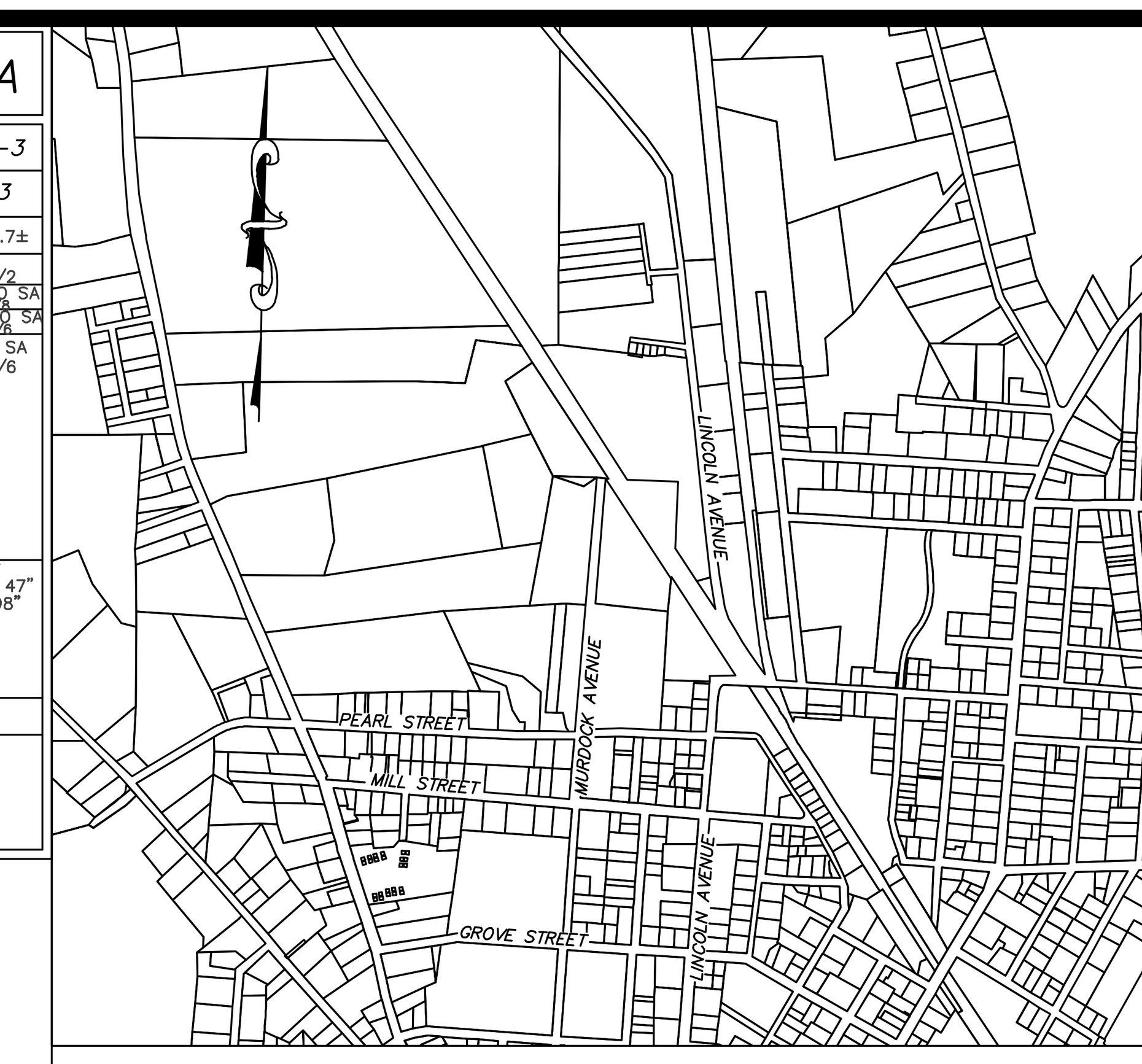
SCHEDULE OF DRAINAGE STRUCTURES & ELEVATIONS

FROM	PIPE	TO
DCB#1 RIM=1014.8± INV=1012.20± SUMP=1008.20±	12" HDPE L=34 FT S=0.009 F/F	DMH#1 RIM=1015.5± INV=1011.9±(DCB#1) INV=1011.9±(DMH#2) INV=1011.7±(OUT) HYDROWORKS HGX
DCB#2 RIM=1018.1± INV=1015.7± SUMP=1011.7±	12" HDPE L=5 FT S=0.040 F/F	DMH#2 RIM=1018.5± INV=1015.5±(DCB#2) INV=1014.1±(DCB#3) INV=1014.0±(OUT)
DCB#3 RIM=1018.8± INV=1016.6± SUMP=1012.6±	12" HDPE L=165 FT S=0.015 F/F	DMH#2 RIM=1018.5± INV=1015.5±(DCB#2) INV=1014.1±(DCB#3) INV=1014.0±(OUT)
DMH#1 RIM=1015.5± INV=1011.9±(DCB#1) INV=1011.9±(DMH#2) INV=1011.7±(OUT) HYDROWORKS HGX	15" RCP L=85 FT S=0.010 F/F	FE#1 INV=1010.8±
DMH#2 RIM=1018.5± INV=1015.5±(DCB#2) INV=1014.1±(DCB#3) INV=1014.0±(OUT)	12" HDPE L=187FT S=0.011 F/F	DMH#1 RIM=1015.5± INV=1011.9±(DCB#1) INV=1011.9±(DMH#2) INV=1011.7±(OUT) HYDROWORKS HGX
OS#1 RIM=114.5± THROAT=1010.5±(3) 6" ORIFICE=1009.5± (3)	12" HPDE L=42 FT S=0.010 F/F	FE#2 INV=1006.0±

SOIL TEST DATA

T.P.:# 0223-2	T.P.: # 0223-3
DATE: 2.9.2023	DATE:2.9.2023
EL.=111.1±	EL.=110.7±
Ap LO 10YR 2/2	Ap LO 10YR 2/2
Bw LO SA 7.5YR 5/8	Bw LO SA 7.5YR 5/8
B/C LO SA 7.5YR 6/6	B/C LO SA 7.5YR 6/6
C LO SA 10YR 6/6	C LO SA 10YR 6/6
NO REF GWO @ 52" BOE @96"	NO REF GWO @ 47" BOE @98"
ESTIMATED SEASONAL HIGH GROUNDWATER AT 28"	ESTIMATED SEASONAL HIGH GROUNDWATER AT 30"
CLASS: 2	CLASS: 2

SOIL TESTING PERFORMED BY:
CHRISTOPHER M. ANDERSON, PE
(SE#14005)
HANNIGAN ENGINEERING, INC.



LOCUS MAP SCALE: 1" = 1000'

PROJECT INFORMATION

LAND INFORMATION

MAP/PARCEL:	5A2/25; 5A2/26
DEED BOOK/PAGE:	17143/339
EXISTING FRONTAGE:	686.75 FT (5A2/25); 677.24 FT (5A2/26)
EXISTING AREA:	4.33 ACRES± (5A2/25); 3.67 ACRES±(5A2/26

ZONING INFORMATION

ZONING DISTRICT: INDUSTRIAL

DIMENSIONAL REQUIREMENTS:

MINIMUM AREA:	43,560 SF
MINIMUM FRONTAGE:	150 FEET
MAXIMUM HEIGHT:	50FT
MAXIMUM COVERAGE:	NA
MINIMUM SETBACKS:	
FRONT YARD:	40 FT
SIDE YARD:	25 FT
REAR YARD:	50 FT

GENERAL NOTES:

1. PROPERTY LINE INFORMATION BASED DEEDS AND PLANS OF RECORD. NO CERTIFICATION OF PROPERTY LINES SHOWN ON THIS PLAN IS INTENDED OR IMPLIED BY HANNIGAN ENGINEERING, INC. TOPOGRAPHIC INFORMATION IS THE RESULT OF AN ON-THE-GROUND TOPOGRAPHIC SURVEY BY HANNIGAN ENGINEERING, INC. IN MAY OF 2022.
2. AREAS SUBJECT TO PROTECTION UNDER THE WETLANDS PROTECTION ACT HAVE BEEN DELINEATED BY LEC ENVIRONMENTAL CONSULTANTS IN FEBRUARY OF 2022. THESE AREAS ARE DEPICTED ON THE PLANS BASED ON FIELD SURVEY LOCATION DURING THE TOPOGRAPHIC SURVEY.
3. LOCATION OF ALL UTILITIES ARE APPROXIMATE AS SHOWN AND BASED UPON VISIBLE STRUCTURES AT THE TIME OF THE FIELD SURVEY. LOCATION OF EXISTING UTILITIES AND SUBSURFACE STRUCTURES, WHETHER OR NOT SHOWN ON THESE PLANS, SHALL BE DETERMINED BY THE CONTRACTOR, MARKED IN THE FIELD, AND REVIEWED BY THE ENGINEER PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. THE CONTRACTOR SHALL BE AWARE OF THE OBLIGATION TO ALL UTILITY COMPANIES AND AGENCY AS WELL AS DIG-SAFE PRIOR TO EXCAVATION. (SEE NOTE)
4. NOTIFICATION REQUIREMENTS SHOWN ON THIS PLAN SHALL NOT RELIEVE THE CONTRACTOR OF ANY OTHER REQUIREMENTS WHICH MAY EXIST UNDER LOCAL, STATE, OR FEDERAL JURISDICTION TO WHICH THE CONTRACTOR IS OBLIGATED.
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AREA BREAKDOWN

HYDROLOGICAL C SOIL	(5.441ac)
GRASS COVER (<75%,GOOD)	1.326ac
GRAVEL ROADS	0.230ac
GRAVEL SURFACE	1.078ac
IMPERVIOUS SURFACE	0.381ac
WOODLAND (GOOD)	2.426ac
HYDROLOGICAL D SOIL	(3.757ac)
WOODLAND (GOOD)	3.757ac

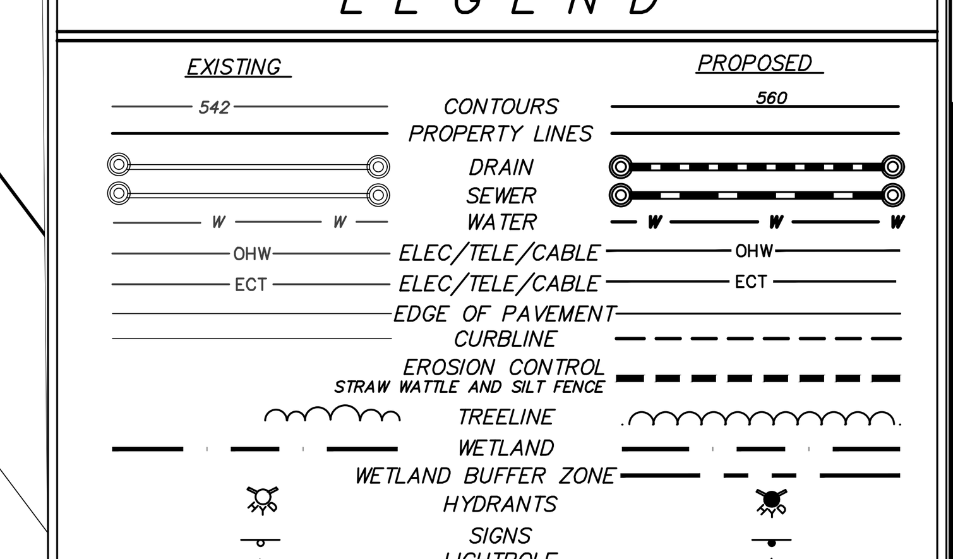
OWNER
BOSTWICK REALTY TRUST
256 MURDOCK AVENUE
WINCHENDON, MASSACHUSETTS

APPLICANT
ZP BATTERY DEVCO, LLC
1 MERCANTILE STREET, SUITE 630
WORCESTER, MASSACHUSETTS 01608

PROJECT NOTES:

1. EARTHEN MATERIALS UTILIZED AS FILL WITHIN THE PROJECT AREA SHALL BE CLEAN AND FREE OF DELETERIOUS MATERIALS AND SHALL NOT CONTAIN ANY HAZARDOUS MATERIALS
2. PRIOR TO THE START OF CONSTRUCTION AND CLEARING ACTIVITIES, THE APPROVED LIMITS OF CONSTRUCTIONS SHALL BE FIELD STAKED AND REVIEWED BY THIS OFFICE
3. UPON THE COMPLETION OF CONSTRUCTION CATCHBASINS, SUMPS AND STORMWATER BASINS OR BEST MANAGEMENT PRODUCTS (BMPs) SHALL BE CLEANED AND ANNUALLY THEREAFTER.
4. HAULING OF EARTHEN MATERIALS TO OR FROM THE CONSTRUCTION SITE SHALL BE LIMITED TO THE HOURS OF 9AM TO 4PM MONDAY THROUGH FRIDAY.
5. IMPERVIOUS COVERAGE FROM THE PROPOSED PROJECT SHALL BE COMPRISED OF CONCRETE AND CRUSHED STONE/GRAVEL FOR ACCESS WAYS.

LEGEND



APPROVAL OF THIS PLAN IS GRANTED ON THE CONDITIONS LISTED IN A SEPARATE STATEMENT OF CONDITIONS WHICH PART OF THE APPROVAL OF THIS SITE PLAN.

WINCHENDON PLANNING BOARD

DATE: ______

HANNIGAN ENGINEERING, INC.
CIVIL ENGINEERS & LAND SURVEYORS
8 Monument Square
Leominster, Massachusetts 01453
(978) 534-1234 (T)
(978) 534-6060 (F)
www.hanniganengineering.com

PROPOSED WATERSHED PLAN IN WINCHENDON, MASSACHUSETTS

PREPARED FOR:
ZP BATTERY DEVCO, LLC
PETE FORTE
1 MERCANTILE STREET, SUIT 630
WORCESTER, MASSACHUSETTS 01608
TEL:

GRAPHIC SCALE: 1"=40'

CALC: CMA	DRWN: CMA	SCALE: 1"=40'
CHKD: WDH	APPD: CMA	DATE: MAR 27,2023
SRV: JEF	FB: 75-130	JOB NO: 3101
TAB: WS	SHEET 2 OF 2	PLAN NO: C-18-41