Merrill
Engineers and Land Surveyors

April 30, 2021
Revised October 29, 2021

Stormwater Management Report

Submitted To: Town of Norwell

15, 19, 27 & 35 High Street, Norwell MA

(508) 746-6060 / 26 Union Street, Plymouth, MA 02360
merrillinc.com / (781) 826-9200 / 427 Columbia Road, Hanover, MA 02339

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Proposed Residential Development
15, 19, 27 & 35 High Street
Norwell, MA

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Stormwater Management Report

- Project Description
- Existing Conditions
- Proposed Conditions
- Compliance with Stormwater Management Standards

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Stormwater Management Report

15, 19, 27 & 35 High Street
Norwell, Massachusetts

April 30, 2021

Project Summary

The project proponent, Northland Residential Corporation, proposes to redevelop multiple parcels containing approximately 3.9 acres (169,341 sf) of land along High Street in Norwell, Massachusetts. The proposed redevelopment consists a new mixed unit residential community containing 56 dwelling units including razing the existing four single family homes, construction of ten new buildings consisting of 28 townhomes and 28 flat style units, entrance driveways, sidewalk and parking, landscaping, stormwater facilities, onsite septic system, utility services and associated infrastructure.

The properties are located on the west side of High Street and consists of four (4) lots whose addresses are 15, 19, 27 and 35 High Street and are identified as Block 17, Lots 16, 17, 18 and 67 on the Town of Norwell Assessor's Map 11B. The property is currently developed with four single family homes with access from High Street. The property has frontage on High Street to the east and developed commercial property to the north and west and abuts residential property to the south. The property is located within the Business B4, Business C1 and Residence B Zoning Districts and the majority of the property is located with the Aquifer Protection Overlay District. Refer to the USGS Site Locus Map for the location of the parcel. The lot generally slopes to the southwest toward the abutting property and then to the bordering vegetated wetland area associated with Hatch Pond. The property is not located within a Zone A, or Land Subject to Flooding resource area as shown on the current FEMA Flood Map (250260092J, dated July 17, 2012). Refer to the FEMA Flood Map.

Drainage computations were performed using the Natural Resources Conservation Services (NRCS) TR-20 method and HydroCAD® Drainage Calculation Software. Watershed Delineation Area plans, the HydroCAD® Report, and copies of the calculation sheets are included as appendices to this report.

Existing Conditions

The site presently consists of four (4) single family homes and associated driveways and yard areas. The remainder of the site is comprised of wooded areas and open fields surrounding the residential homes which front High Street. The site's topography is gentle to moderate with slopes ranging from 0 to 8 percent draining towards the southwest off site. The site has frontage along High Street with four access drives.

Soil types were obtained from NRCS mapping and were found to be Canton fine sandy loam (3-8% slopes). The soil type is identified as Hydrologic Soil Group (HSG) B soils. In order to confirm the soil class and groundwater depth characteristics of the soil, soil testing was performed during June and December of 2020 within the approximate location of the proposed septic system and stormwater facilities. Based on the soil textures encountered at the time of testing, the overall site was found to have sandy soils (HSG A) with a transition into denser loamy sand texture in the northern portion of the site. Refer to NRCS Soils Map and Section 3 of this report for supporting soil testing results.

Under the existing conditions, the westerly portion of the site's stormwater runoff flows overland towards High Street with no stormwater controls (Design Point 1). The majority of the site's stormwater runoff flows overland toward the southwesterly property boundary (Design Point 2), while the remaining northerly portion of the site's stormwater runoff flows overland in a northwesterly direction towards an existing depression just off property (Design Point 3).

Existing conditions were established with supporting field inspections of the watershed areas and historic documentation of site conditions. Medium sand soil textures were identified and no indication of standing water was observed within the limits of the proposed stormwater infiltration system, therefore the hydraulic conductivity for sand (8.27 in/hr) listed by Rawls 1982 were utilized in the stormwater analysis.

Proposed Conditions

Under the post development condition, the proposed impervious surface runoff will be discharged into a subsurface infiltration chamber system with pretreatment. The drainage facility will collect and treat the proposed impervious surfaces through first defense pre-treatment units prior to discharge to the infiltration chambers. The stormwater management system was designed to be in compliance with the DEP Stormwater Management Regulations (SMR).

There will be an increase in runoff rates due to the additional impervious area proposed on the site. This increase is attenuated by the proposed subsurface infiltration systems by providing infiltration, storage volume and discharge controls. These measures will both detain and infiltrate runoff, help mitigate increased rates and volumes of runoff for the 2, 10, and 100-year storms events off site.

Compliance with Stormwater Management Standards

Standard 1 – No New Untreated Discharges

No new stormwater conveyances will discharge untreated impervious runoff into, or cause erosion to downgradient areas. A subsurface infiltration system is proposed to capture and treat runoff from the building roofs and paved driveway, parking and sidewalk areas, which will improve the quality of stormwater discharge from the site.

Standard 2 – Peak Rate Attenuation

Peak rates of runoff were calculated using the TR-20 methodology developed by the NRCS computer-based program, HydroCAD (refer to Section 3). The increase in runoff is attenuated by the proposed subsurface infiltration chamber system providing treatment, infiltration and storage volume controls. These measures will both detain and infiltrate runoff, mitigating increased rates of runoff for the 1, 2, 10, 25 and 100-year storms events.

All closed drainage structures were designed employing the rational method and the Norwell design regulations to accommodate peak flows generated by the 100-yr storm event where applicable. The stormwater facility has been designed to accommodate peak flows generated by the 100-year storm event. Refer to Section 3 for closed drainage system sizing design.

The following is a summary of pre- and post-construction peak rates and volume of runoff:

	PEAK RATES OF RUNOFF					
	Design Point 1 (High Street)		Design Point 2 (Southwest)		Design Point 3 (Northwest)	
	EXISTING (cfs)	PROPOSED (cfs)	EXISTING (cfs)	PROPOSED (cfs)	EXISTING (cfs)	PROPOSED (cfs)
1YR	0.01	0.01	0.00	0.00	0.00	0.00
2YR	0.05	0.05	0.00	0.00	0.00	0.00
10YR	0.40	0.29	0.04	0.00	0.00	0.00
25 YR	0.87	0.58	0.24	0.03	0.03	0.02
100YR	2.06	1.30	1.50	0.17	0.40	0.31

	PEAK VOLUME OF RUNOFF					
	Design Point 1 (High Street)		Design Point 2 (Southwest)		Design Point 3 (Northwest)	
	EXISTING (AF)	PROPOSED (AF)	EXISTING (AF)	PROPOSED (AF)	EXISTING (AF)	PROPOSED (AF)
1YR	0.005	0.004	0.000	0.000	0.000	0.000
2YR	0.012	0.010	0.000	0.000	0.000	0.000
10YR	0.046	0.034	0.025	0.003	0.002	0.002
25 YR	0.082	0.060	0.077	0.007	0.018	0.013
100YR	0.173	0.122	0.249	0.020	0.087	0.058

Standard 3 – Groundwater Recharge

Runoff will be infiltrated by a subsurface infiltration chamber system. The infiltration chamber system will be a minimum of four feet above seasonal high groundwater. The hydraulic conductivity was based on soil conditions found on the site via soil testing and DEP SMR Table 2.3.3 1982 Rawls Rates - values developed from Rawls, Brakensiek and Saxton, 1982 for sand, (HSG A) soils with an exfiltration rate of 8.27 in/hr. The total required groundwater recharge volume for the entire site was calculated to be 4,583 cubic feet. The proposed subsurface infiltration facilities will provide 27,110 cubic feet of recharge below the minimum outlet elevation. Refer to Section 5 for recharge volume, drawdown calculations and soil testing results.

Standard 4 – Water Quality

A Long-Term Source Control/Pollution Prevention Plan has been incorporated into the Operation and Maintenance Plan. The water quality volume was calculated using the one-inch rule for the total proposed impervious area of 2.10 acres. The total required water quality treatment volume was calculated to be 7,623 cubic feet. The proposed water quality treatment volume provided is 27,110 cubic feet through the subsurface infiltration system. Refer to Section 5 for water quality calculations for the treatment stream.

In accordance with the guidelines of the Stormwater Management Policy, the Total Suspended Solids (TSS) Removal was calculated to be 80% or greater for the new treatment train which will handle the stormwater runoff from the proposed project area. The treatment train consists of deep hooded catch basin, a pretreatment unit to subsurface infiltration chamber system to achieve the required removal rate of 80% total suspended soils. TSS removal calculations are included in Section 5.

Standard 5 – Land Use with Higher Potential Pollutants Loads (LUHPPL)

The proposed project is not considered a LUHPPL. Not Applicable.

Standard 6 – Critical Areas

The proposed project does not discharge to any critical areas. Not Applicable.

Standard 7 – Redevelopment and Other Projects Subject to the Standards only to the maximum extent practicable

This project is not considered a redevelopment project. Not Applicable. The project site is currently developed, and the proposed project consists of razing several existing structures and constructing new residential buildings. Portions of the site could be considered redevelopment, but for the purpose of stormwater design, the project was considered new development and has been designed to be in compliance with the stormwater standards.

Standard 8 – Construction Period Pollutions Prevention and Erosion and Sedimentation Control

Silt socks will be placed at the limit of work as erosion control barriers prior to commencement of any construction activity. A Construction Operation and Maintenance Plan and Construction Pollution Prevention Plan have been provided. Refer to the construction detail plan for erosion control details and the BMP Operation and Maintenance Plan.

Standard 9 – Operation and Maintenance Plan

The Long-Term Source Control/Pollution Prevention Plan and Operation and Maintenance Plan is provided.

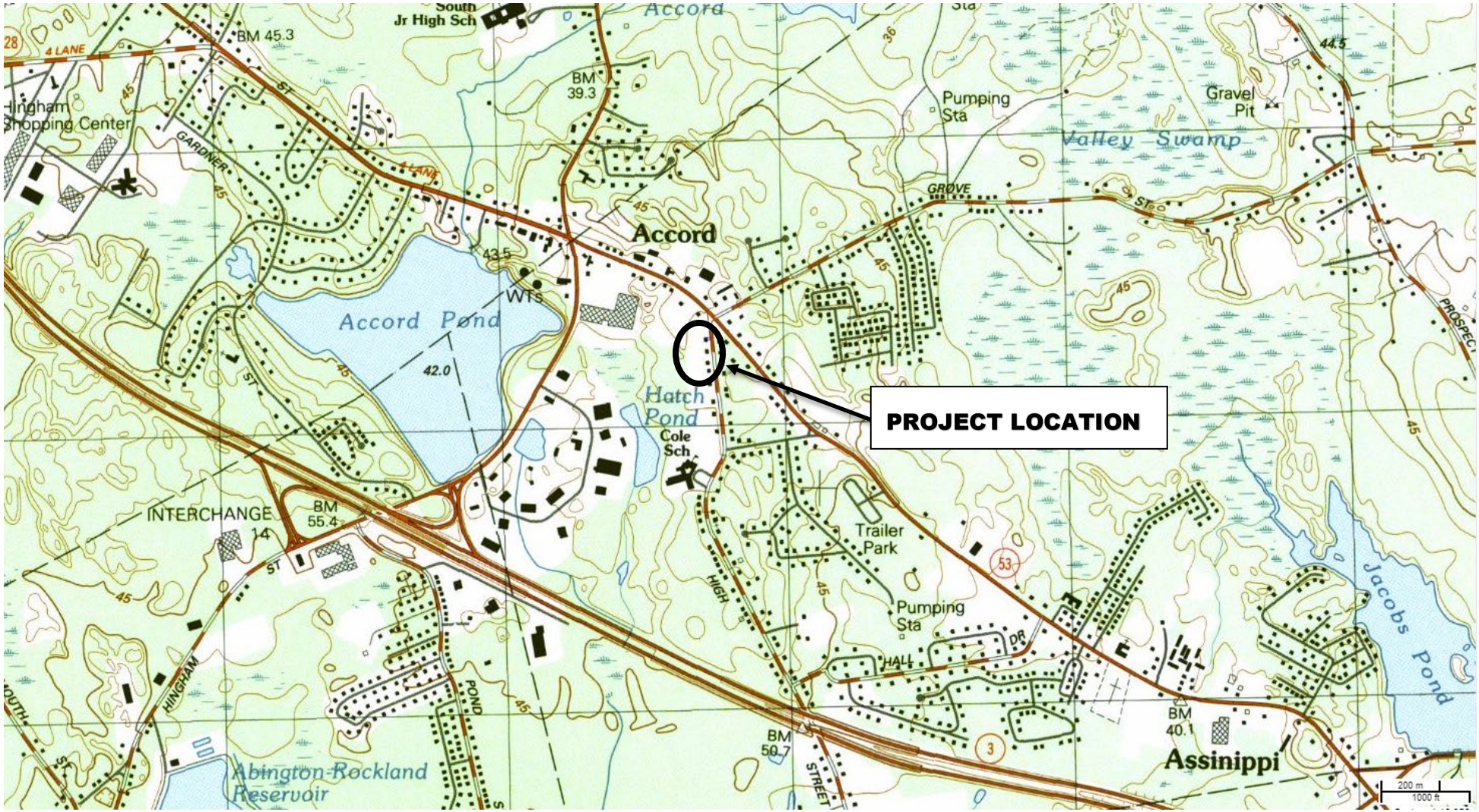
Standard 10 – Prohibition of Illicit Discharges

No illicit discharges are anticipated on site. Measures to prevent illicit discharges are included in the Long-Term Source Control/Pollution Prevention Plan.

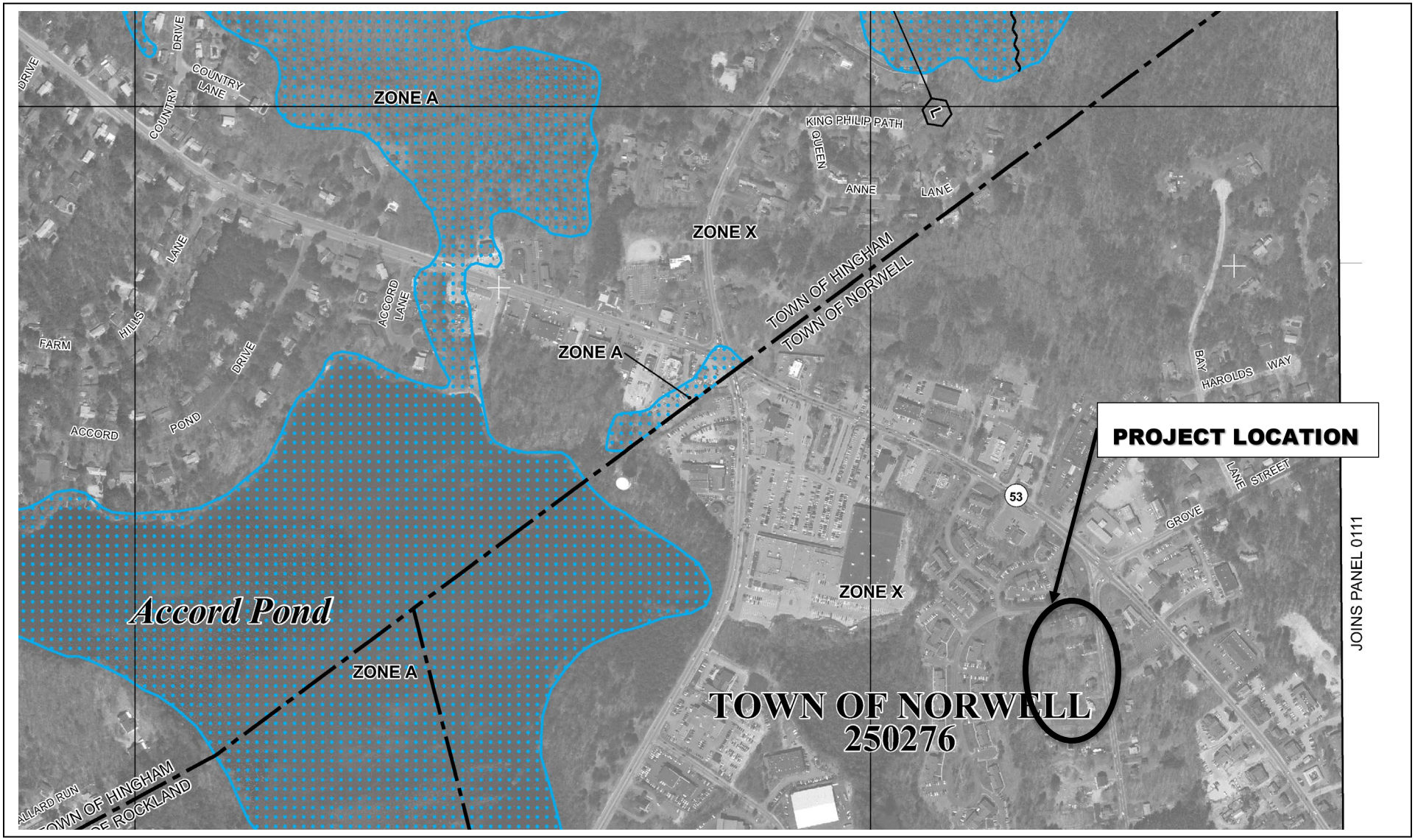
Figures

- USGS Map
- FEMA Flood Map
- NRCS Soil Survey Map
- MassGIS Wetland Map
- 2018 Google Earth Aerial Map

USGS Map


PROJECT LOCATION
South Jr High Sch
Accord
BM 45.3
4 LANE
Hingham Shopping Center
GARDNER
BM 39.3
Pumping Sta
Gravel Pit
44.5
Valley Swamp
GROVE
Accord
43.5
Wts
Accord Pond
42.0
Hatch Pond
Cole Sch
INTERCHANGE 14
BM 55.4
Trailer Park
Pumping Sta
HIGH
HALL
DR
Jacobs Pond
BM 40.1
Assinippi
BM 50.7
STREET
HINGHAM
POND
Abington-Rockland Reservoir
200 m
1000 ft

FEMA Flood Map



NRCS Soil Survey Map

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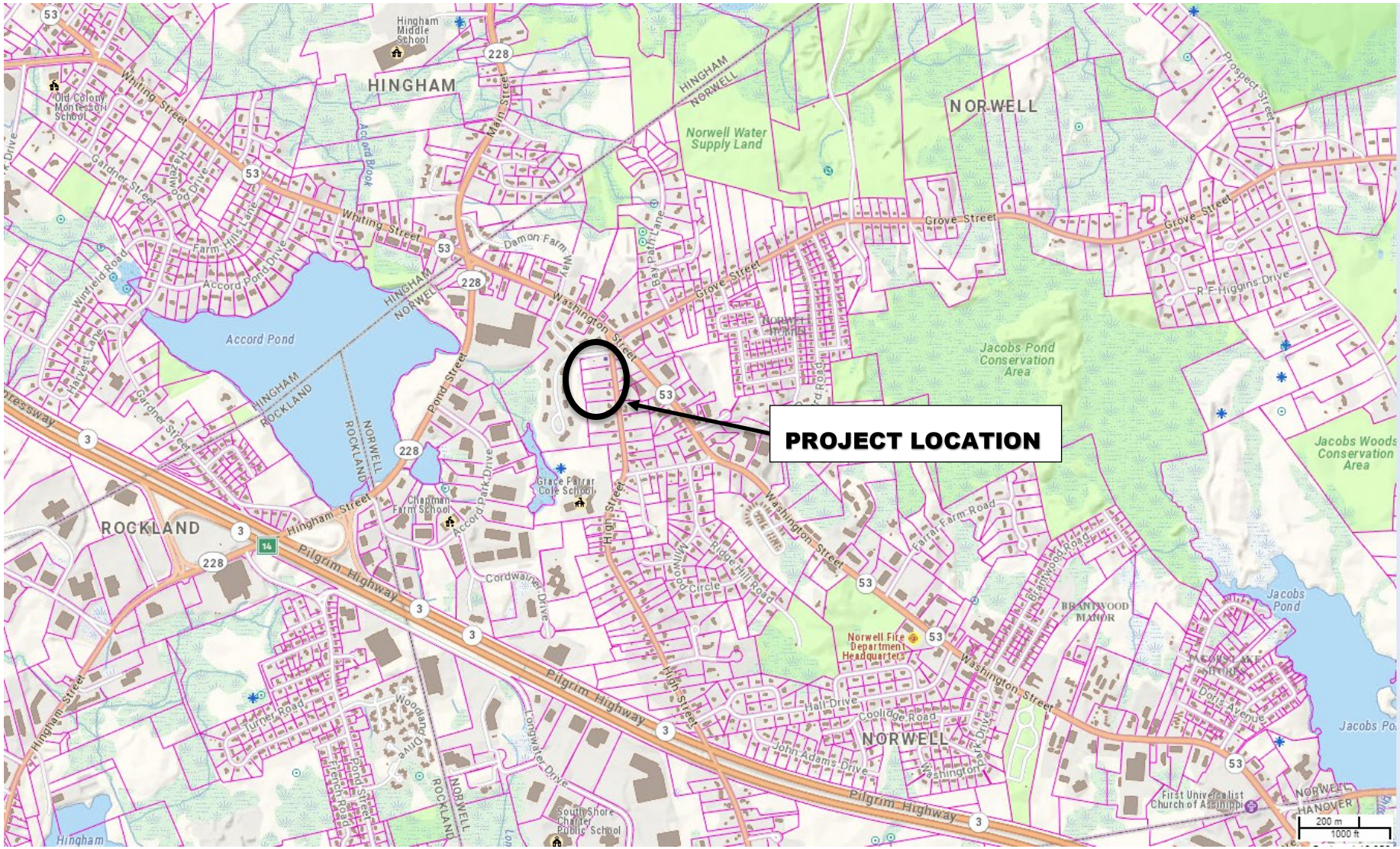
MassGIS Wetland Map



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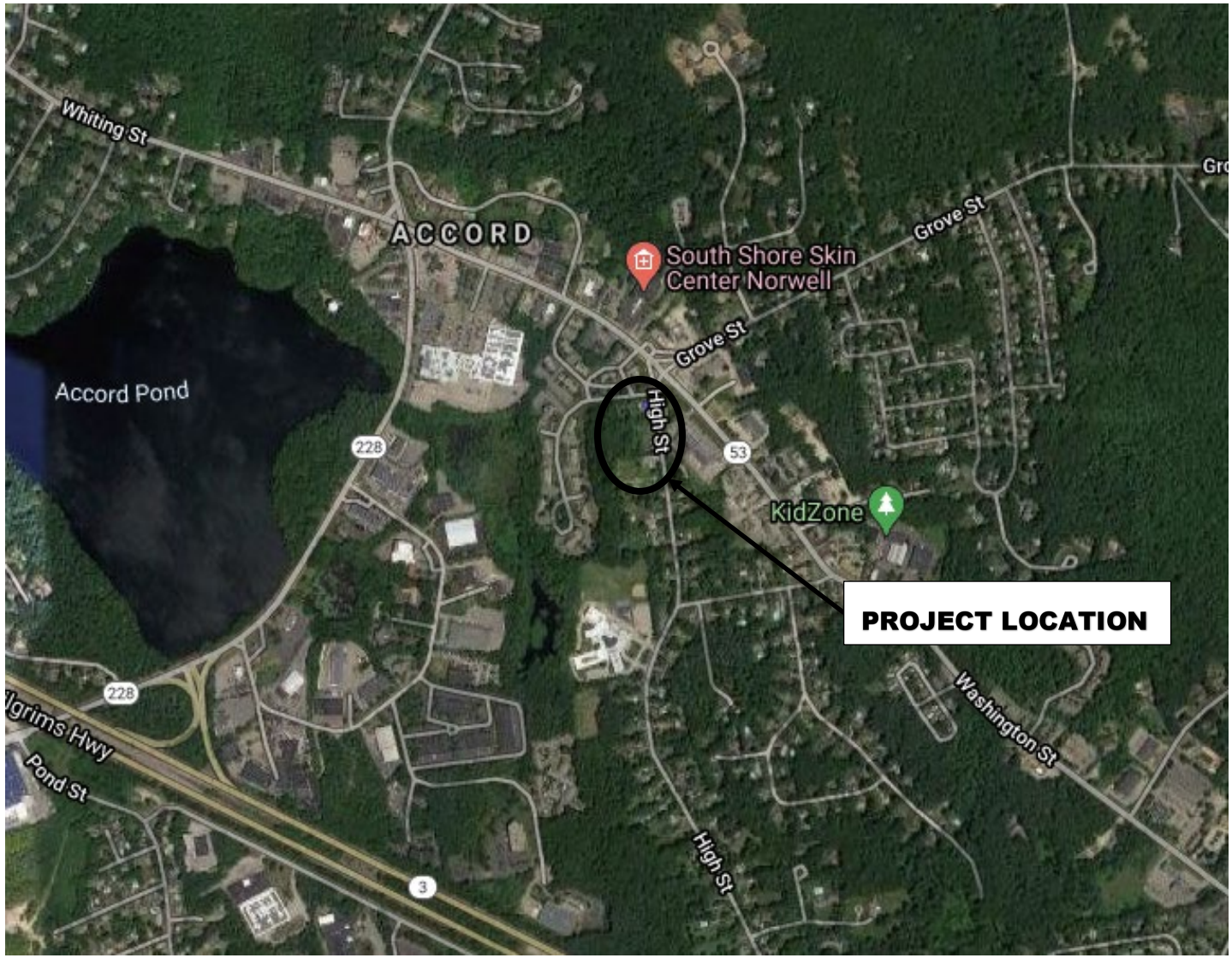
2018 Google Earth Aerial Map



Drainage Calculations

- Existing Conditions Model
- Proposed Conditions Model
- Supplemental Drainage Calculations
    - Groundwater Recharge Volume
    - Infiltration System Drawdown
    - Water Quality Volume
    - TSS Removal Rate
    - Closed Drainage System Sizing
- Soil Testing Results

EXISTING CONDITIONS WATERSHED

SUBCATCHMENT 1S

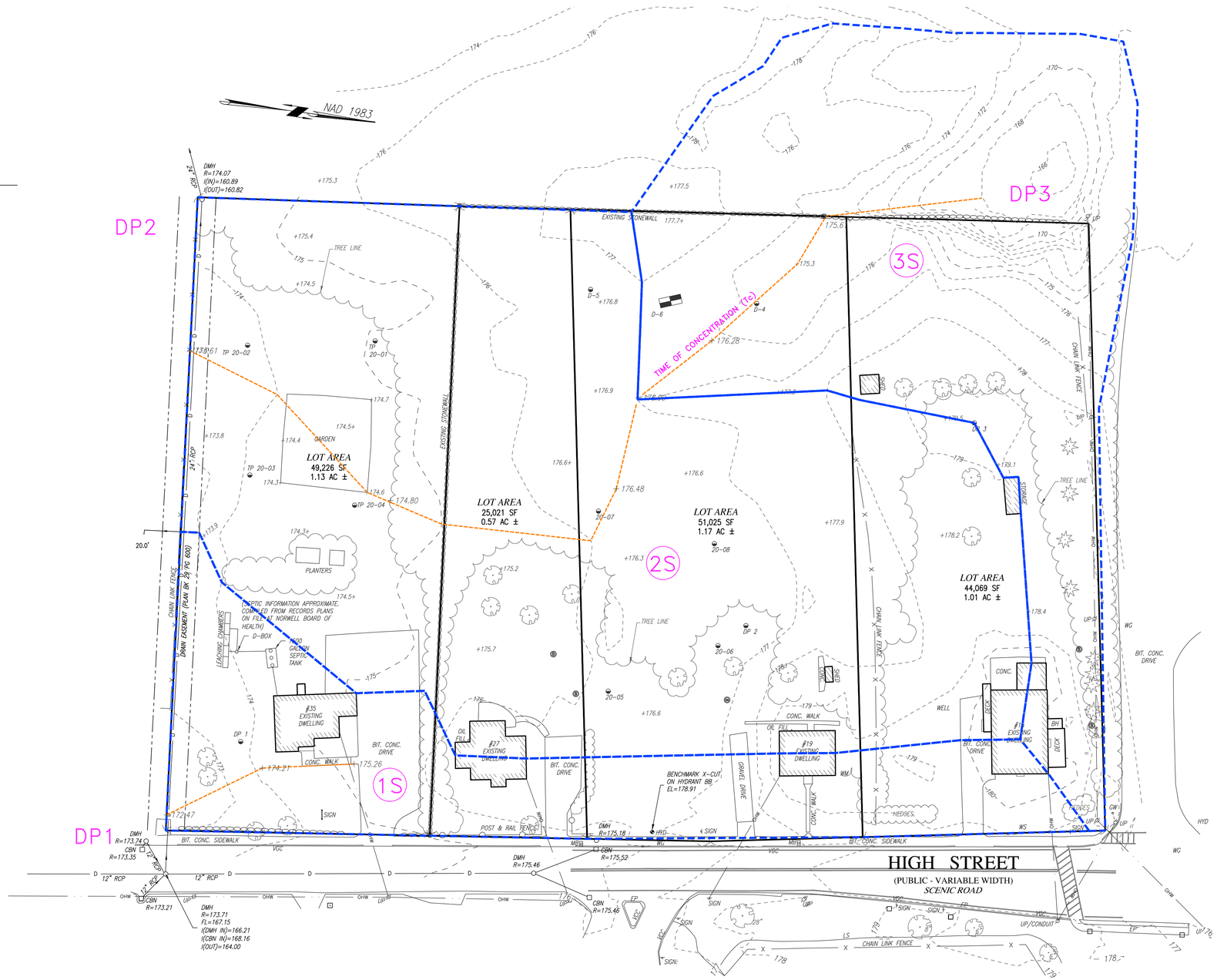
DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	2,321	S.F.
GRASS (HSG A)	21,690	S.F.
PAVEMENT (HSG A)	4,644	S.F.
ROOFS (HSG A)	2,377	S.F.
TOTAL AREA FOR 1S	31,032	S.F.

SUBCATCHMENT 2S

DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	57,084	S.F.
GRASS (HSG A)	42,279	S.F.
PAVEMENT (HSG A)	2,748	S.F.
ROOFS (HSG A)	1,641	S.F.
TOTAL AREA FOR 2S	104,202	S.F.

SUBCATCHMENT 3S

DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	28,340	S.F.
WOODS (HSG A)(OFFSITE)	25,237	S.F.
GRASS (HSG A)	4,777	S.F.
PAVEMENT (HSG A)	24	S.F.
ROOFS (HSG A)	967	S.F.
TOTAL AREA FOR 3S	59,345	S.F.



REVISIONS

2	10/29/21	SITE PLAN UPDATES
1	4/30/21	REVIEW & COORDINATION

DRAWN BY: JG

DESIGNED BY: DK

CHECKED BY: DK

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SITE PLAN

#15, 19, 27 & 35 HIGH STREET
NORWELL, MASSACHUSETTS 02061

OWNER/APPLICANT
NORTHLAND RESIDENTIAL CORPORATION
80 BEHARRELL STREET, SUITE E
CONCORD, MASSACHUSETTS 01742

JANUARY 29, 2021

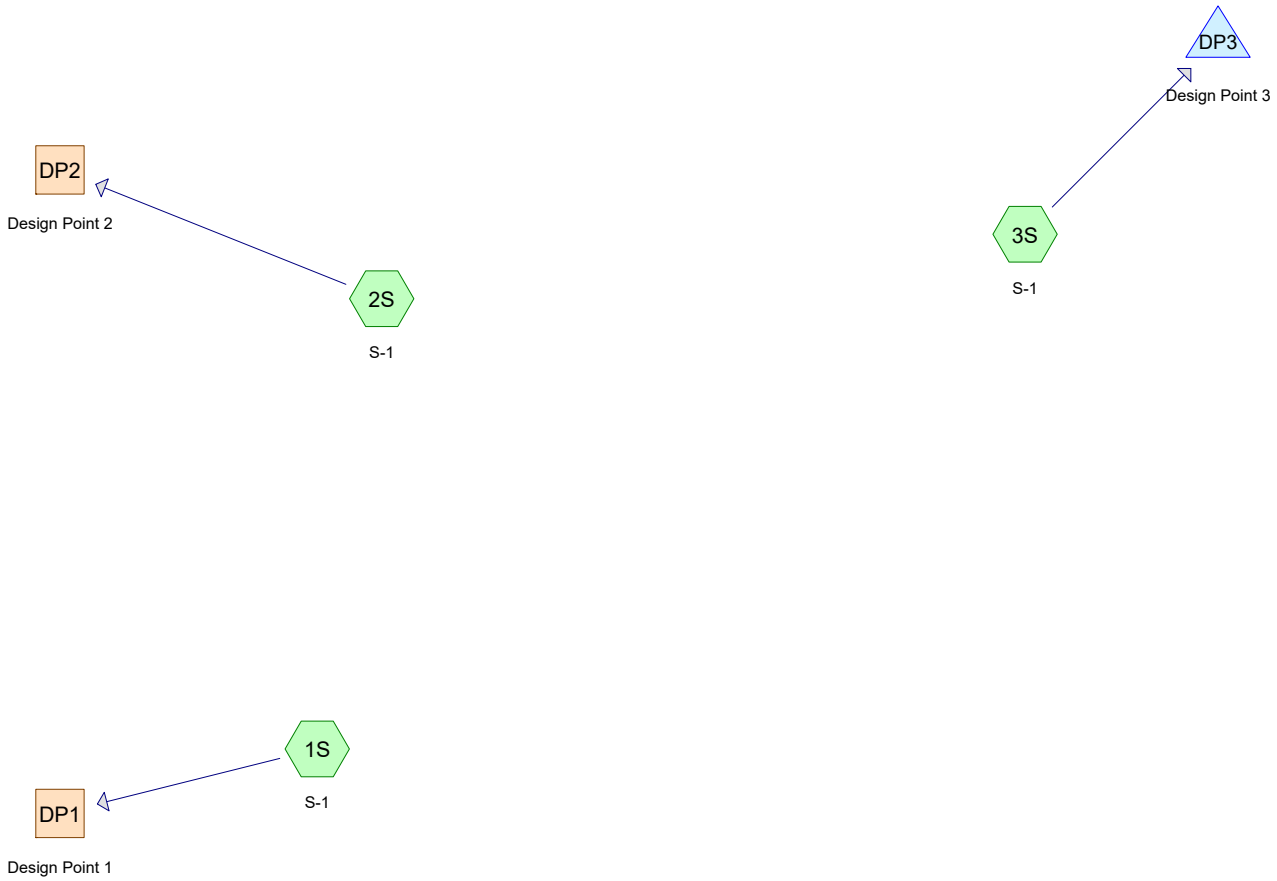
SCALE:

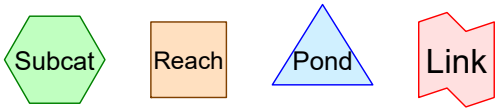
JOB NO. 20-127

LATEST REVISION:
APRIL 30, 2021

EXISTING CONDITIONS WATERSHED PLAN

SHEET 1 OF 1





Routing Diagram for 20-127 Pre DevRev
Prepared by Merrill Engineers and Land Surveyors, Printed 11/1/2021
HydroCAD® 10.00-25 s/n 02159 © 2019 HydroCAD Software Solutions LLC

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=31,032 sf 22.63% Impervious Runoff Depth=0.08"
Flow Length=108' Tc=8.7 min CN=52 Runoff=0.01 cfs 0.005 af

Subcatchment 2S: S-1 Runoff Area=104,202 sf 4.21% Impervious Runoff Depth=0.00"
Flow Length=332' Tc=23.7 min CN=37 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: S-1 Runoff Area=59,345 sf 1.67% Impervious Runoff Depth=0.00"
Flow Length=178' Tc=18.8 min CN=32 Runoff=0.00 cfs 0.000 af

Reach DP1: Design Point 1 Inflow=0.01 cfs 0.005 af
Outflow=0.01 cfs 0.005 af

Reach DP2: Design Point 2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.005 af Average Runoff Depth = 0.01"
93.63% Pervious = 4.182 ac 6.37% Impervious = 0.285 ac

Summary for Subcatchment 1S: S-1

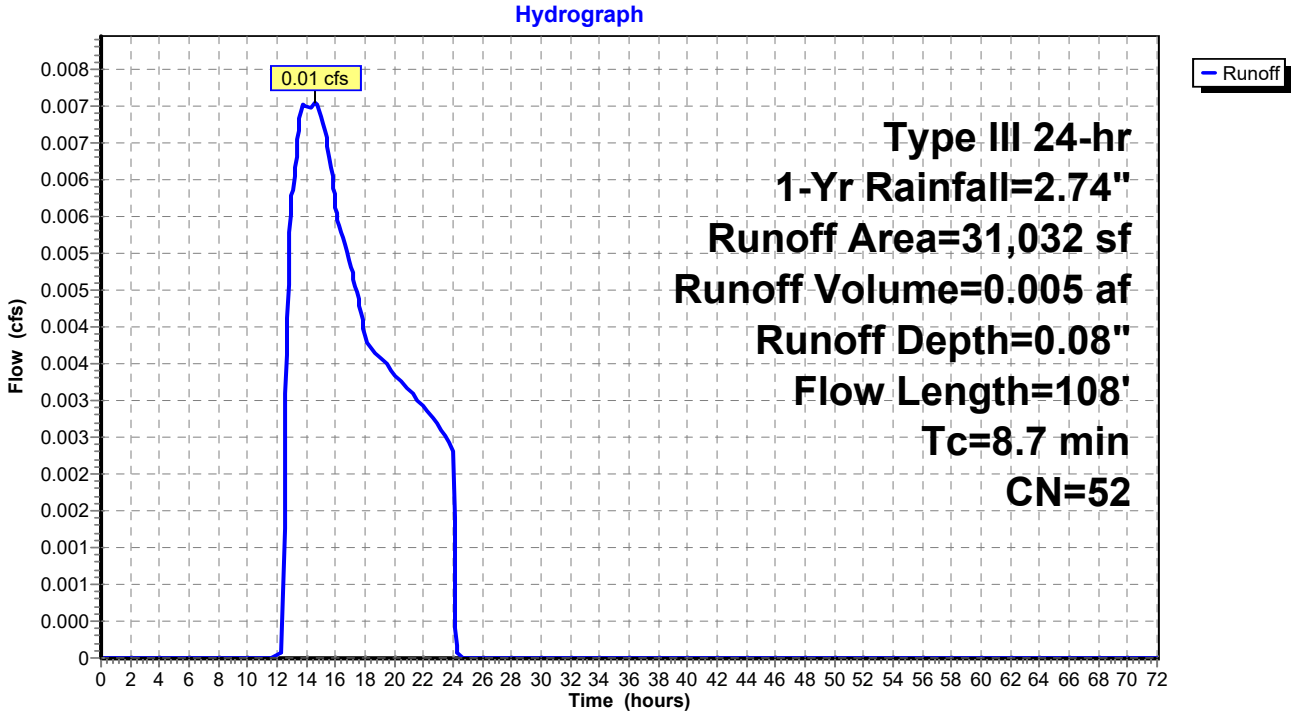
Runoff = 0.01 cfs @ 14.56 hrs, Volume= 0.005 af, Depth= 0.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

Area (sf)	CN	Description
2,321	30	Woods, Good, HSG A
21,690	39	>75% Grass cover, Good, HSG A
4,644	98	Paved parking, HSG A
2,377	98	Roofs, HSG A
31,032	52	Weighted Average
24,011		77.37% Pervious Area
7,021		22.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0210	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
0.8	58	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.7	108	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-1

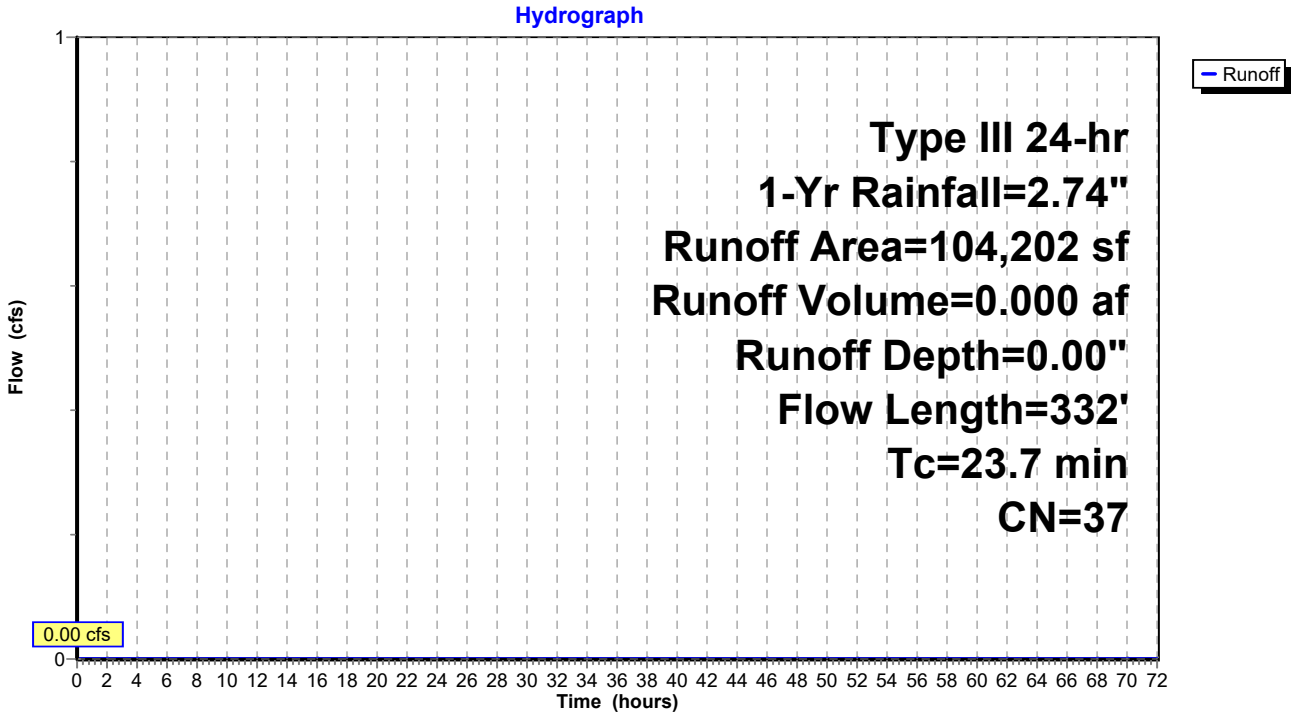
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

Area (sf)	CN	Description
57,084	30	Woods, Good, HSG A
42,729	39	>75% Grass cover, Good, HSG A
2,748	98	Paved parking, HSG A
1,641	98	Roofs, HSG A
104,202	37	Weighted Average
99,813		95.79% Pervious Area
4,389		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0102	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
4.4	143	0.0120	0.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	139	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.7	332	Total			

Subcatchment 2S: S-1



Summary for Subcatchment 3S: S-1

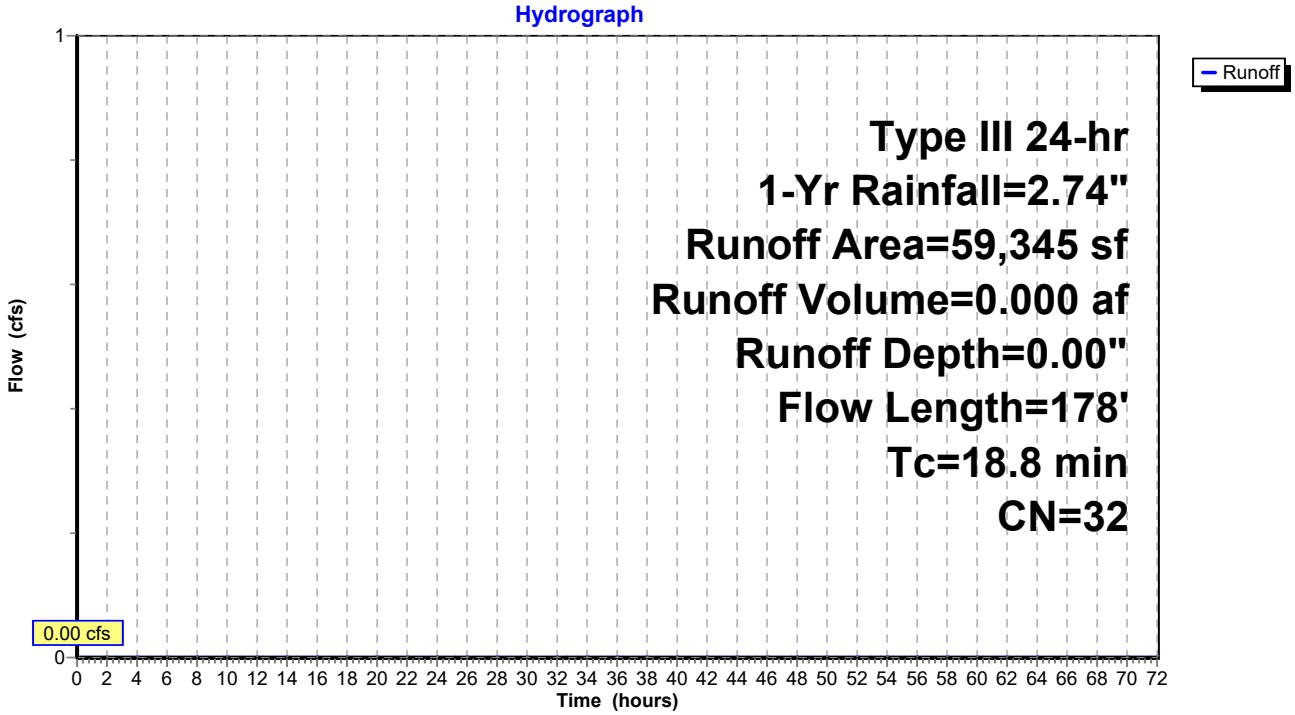
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

	Area (sf)	CN	Description
	28,340	30	Woods, Good, HSG A
	4,777	39	>75% Grass cover, Good, HSG A
	24	98	Paved parking, HSG A
	967	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	59,345	32	Weighted Average
	58,354		98.33% Pervious Area
	991		1.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	50	0.0120	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
3.7	93	0.0070	0.42		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	35	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.8	178	Total			

Subcatchment 3S: S-1

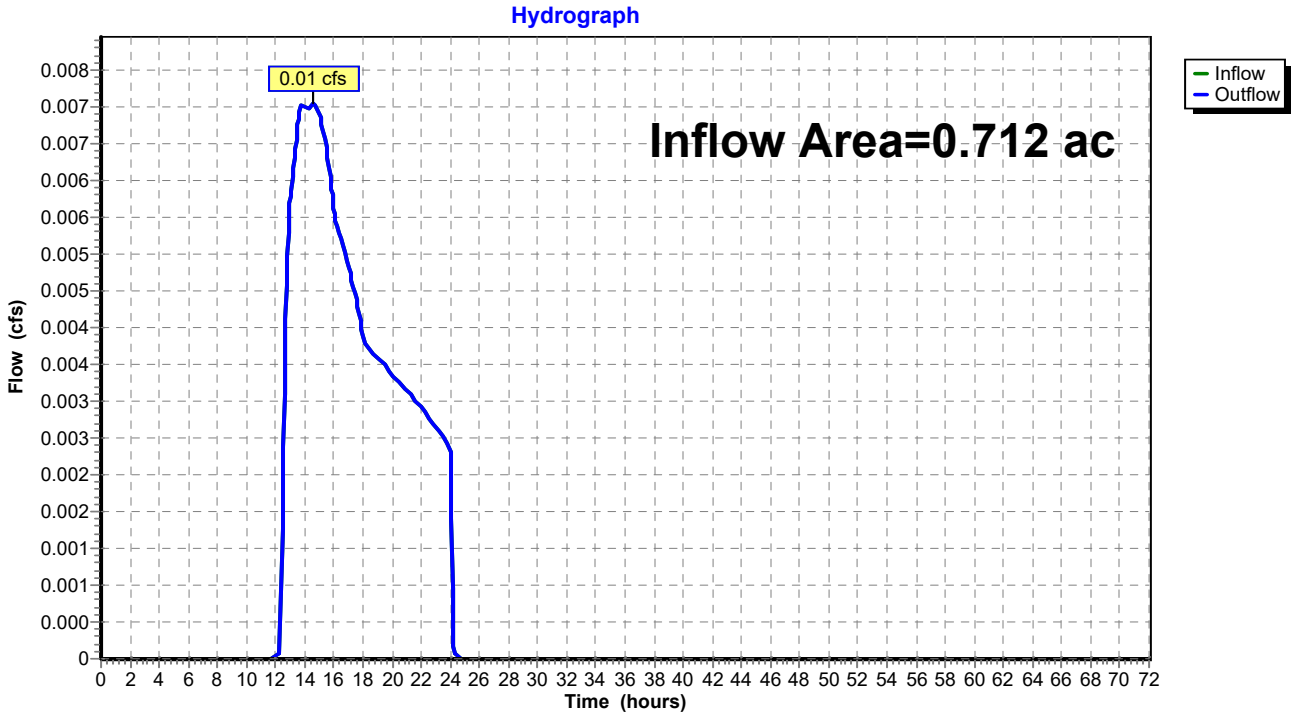


Summary for Reach DP1: Design Point 1

Inflow Area = 0.712 ac, 22.63% Impervious, Inflow Depth = 0.08" for 1-Yr event
Inflow = 0.01 cfs @ 14.56 hrs, Volume= 0.005 af
Outflow = 0.01 cfs @ 14.56 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

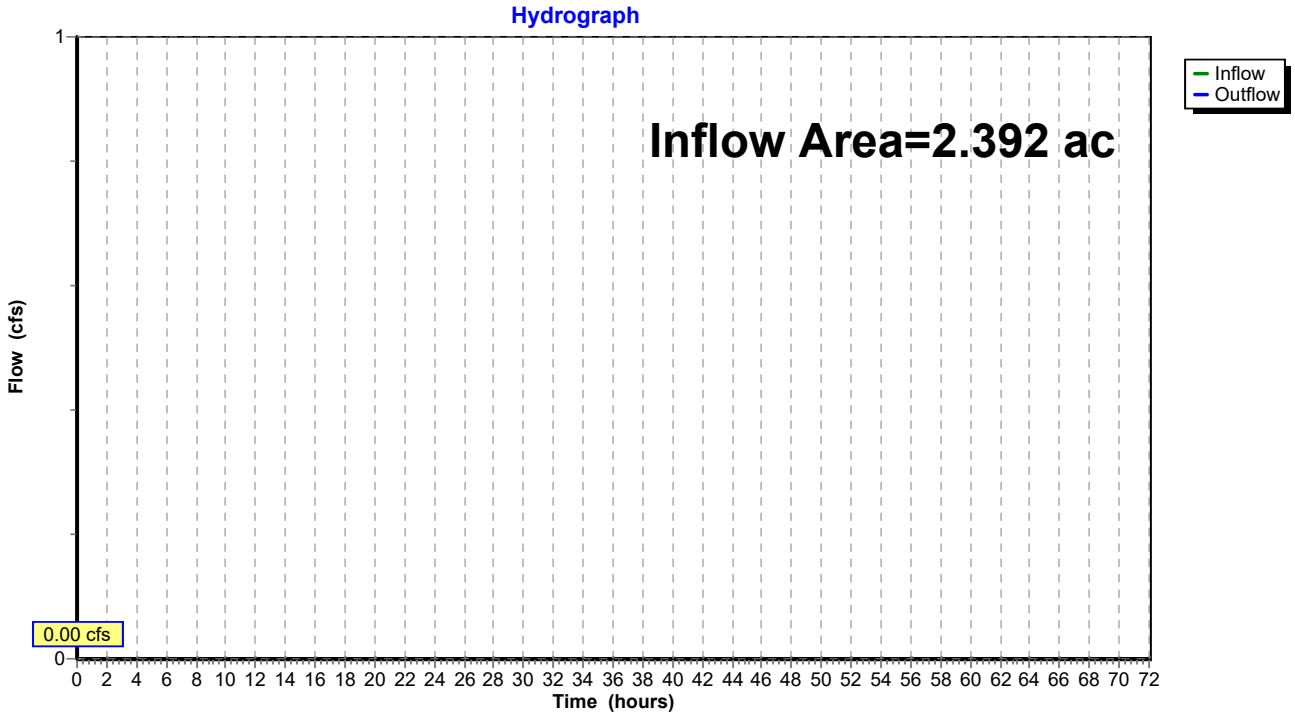


Summary for Reach DP2: Design Point 2

Inflow Area = 2.392 ac, 4.21% Impervious, Inflow Depth = 0.00" for 1-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond DP3: Design Point 3

Inflow Area = 1.362 ac, 1.67% Impervious, Inflow Depth = 0.00" for 1-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

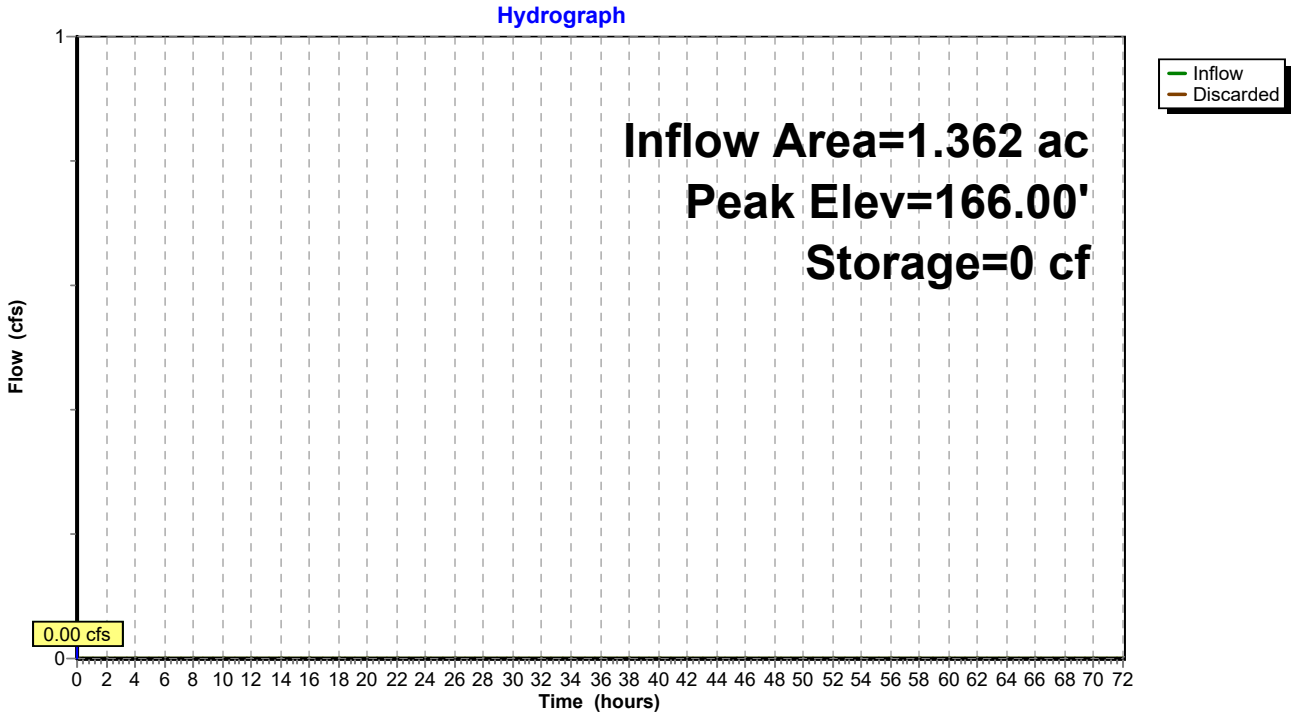
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=31,032 sf 22.63% Impervious Runoff Depth=0.21"
Flow Length=108' Tc=8.7 min CN=52 Runoff=0.05 cfs 0.012 af

Subcatchment 2S: S-1 Runoff Area=104,202 sf 4.21% Impervious Runoff Depth=0.00"
Flow Length=332' Tc=23.7 min CN=37 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: S-1 Runoff Area=59,345 sf 1.67% Impervious Runoff Depth=0.00"
Flow Length=178' Tc=18.8 min CN=32 Runoff=0.00 cfs 0.000 af

Reach DP1: Design Point 1 Inflow=0.05 cfs 0.012 af
Outflow=0.05 cfs 0.012 af

Reach DP2: Design Point 2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.012 af Average Runoff Depth = 0.03"
93.63% Pervious = 4.182 ac 6.37% Impervious = 0.285 ac

Summary for Subcatchment 1S: S-1

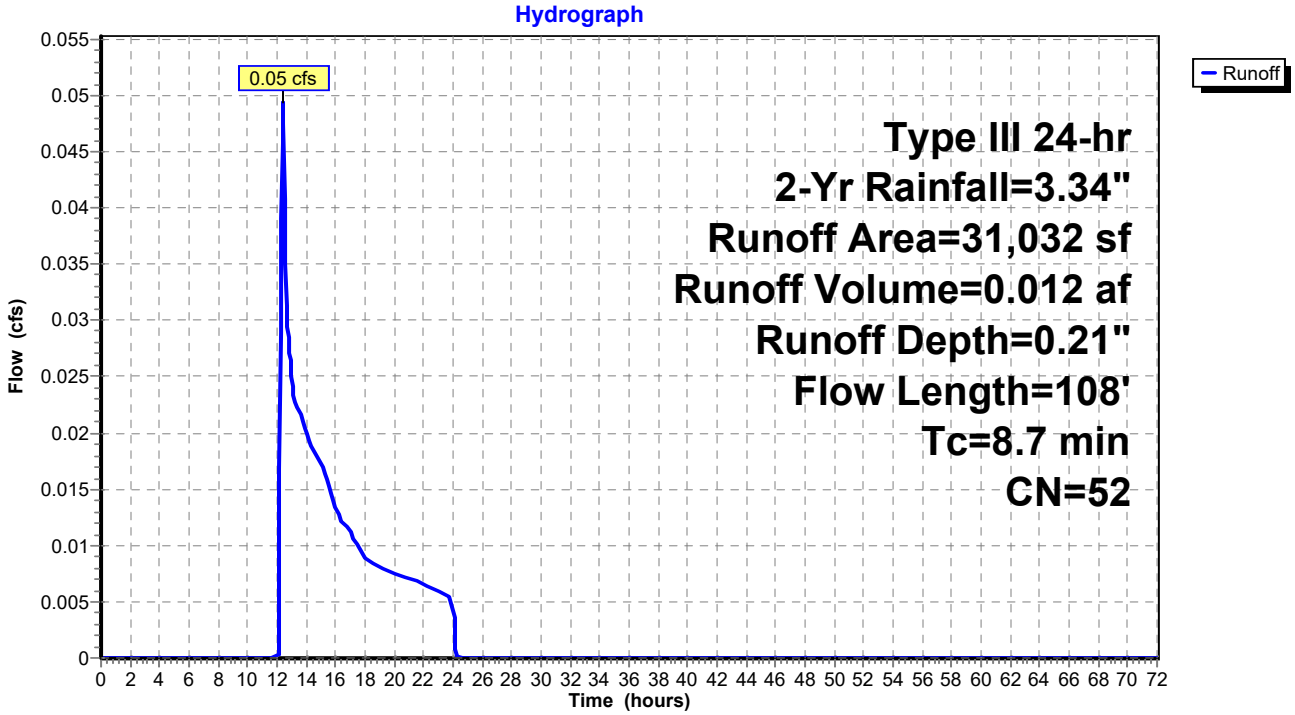
Runoff = 0.05 cfs @ 12.42 hrs, Volume= 0.012 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

Area (sf)	CN	Description
2,321	30	Woods, Good, HSG A
21,690	39	>75% Grass cover, Good, HSG A
4,644	98	Paved parking, HSG A
2,377	98	Roofs, HSG A
31,032	52	Weighted Average
24,011		77.37% Pervious Area
7,021		22.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0210	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
0.8	58	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.7	108	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-1

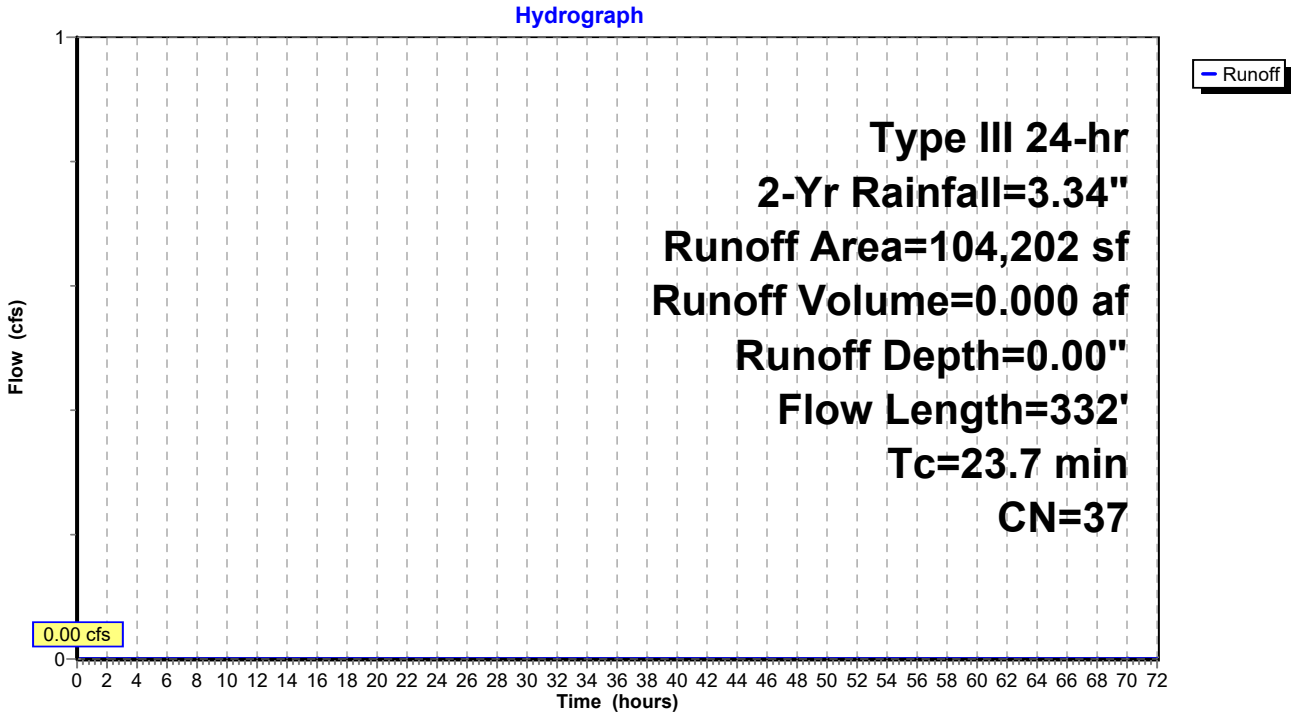
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

Area (sf)	CN	Description
57,084	30	Woods, Good, HSG A
42,729	39	>75% Grass cover, Good, HSG A
2,748	98	Paved parking, HSG A
1,641	98	Roofs, HSG A
104,202	37	Weighted Average
99,813		95.79% Pervious Area
4,389		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0102	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
4.4	143	0.0120	0.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	139	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.7	332	Total			

Subcatchment 2S: S-1



Summary for Subcatchment 3S: S-1

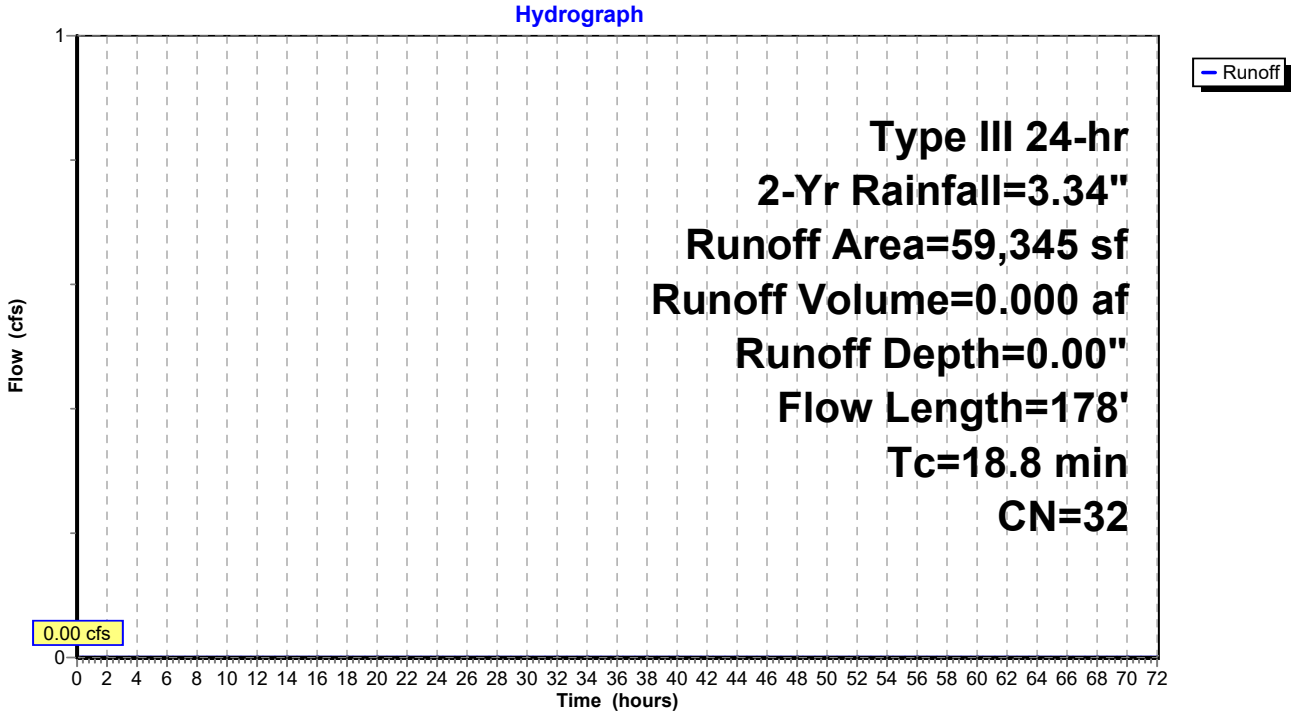
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

	Area (sf)	CN	Description
	28,340	30	Woods, Good, HSG A
	4,777	39	>75% Grass cover, Good, HSG A
	24	98	Paved parking, HSG A
	967	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	59,345	32	Weighted Average
	58,354		98.33% Pervious Area
	991		1.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	50	0.0120	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
3.7	93	0.0070	0.42		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	35	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.8	178	Total			

Subcatchment 3S: S-1

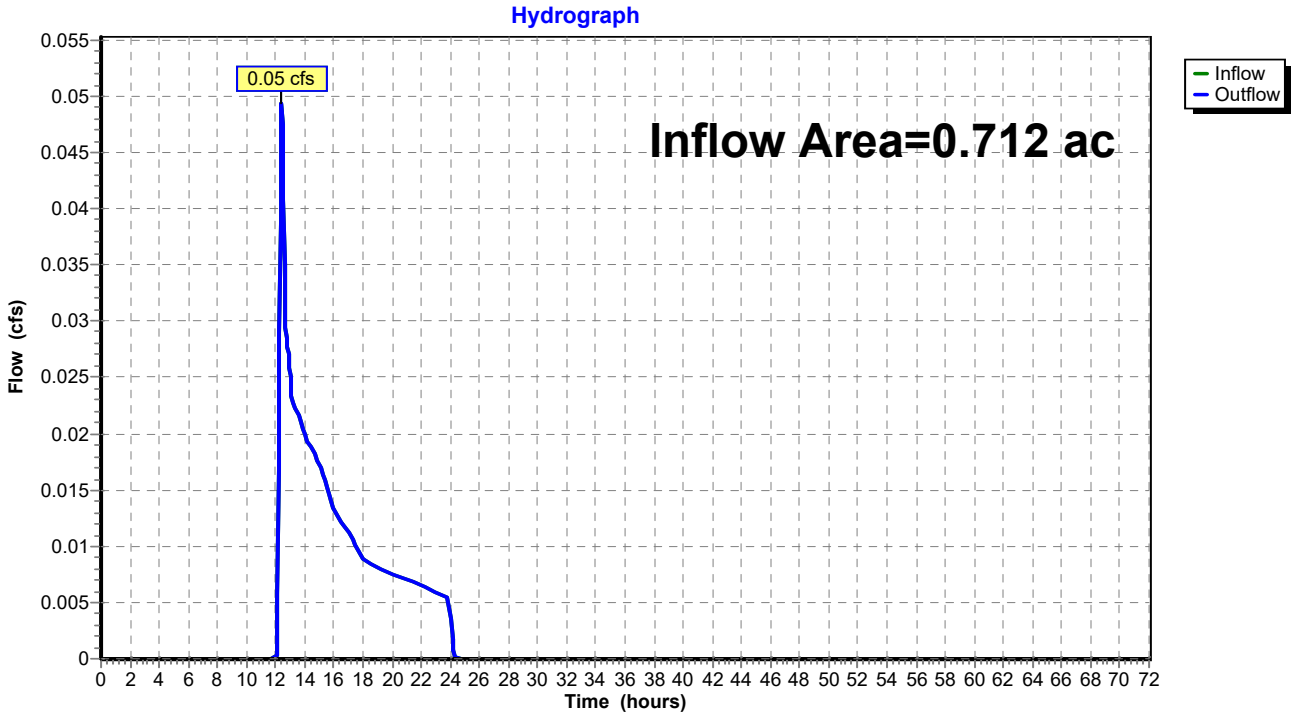


Summary for Reach DP1: Design Point 1

Inflow Area = 0.712 ac, 22.63% Impervious, Inflow Depth = 0.21" for 2-Yr event
Inflow = 0.05 cfs @ 12.42 hrs, Volume= 0.012 af
Outflow = 0.05 cfs @ 12.42 hrs, Volume= 0.012 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

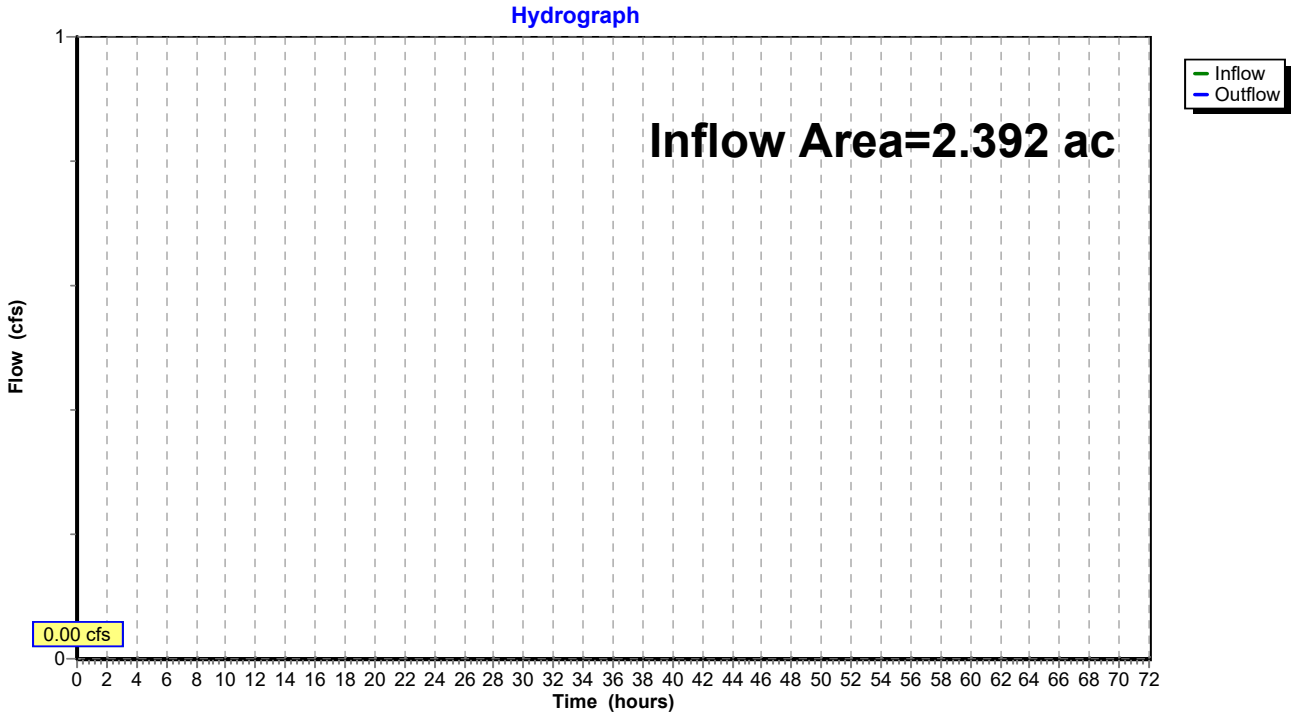


Summary for Reach DP2: Design Point 2

Inflow Area = 2.392 ac, 4.21% Impervious, Inflow Depth = 0.00" for 2-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond DP3: Design Point 3

Inflow Area = 1.362 ac, 1.67% Impervious, Inflow Depth = 0.00" for 2-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

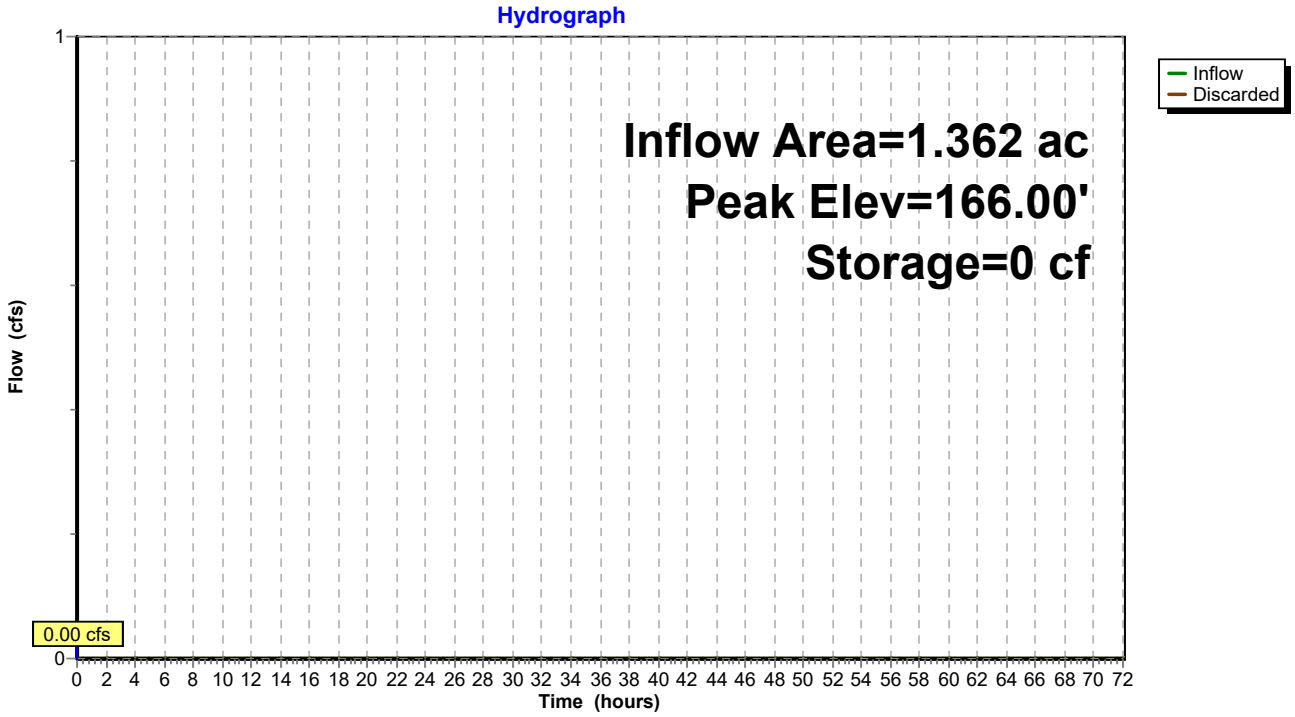
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=31,032 sf 22.63% Impervious Runoff Depth=0.77"
Flow Length=108' Tc=8.7 min CN=52 Runoff=0.40 cfs 0.046 af

Subcatchment 2S: S-1 Runoff Area=104,202 sf 4.21% Impervious Runoff Depth=0.13"
Flow Length=332' Tc=23.7 min CN=37 Runoff=0.04 cfs 0.025 af

Subcatchment 3S: S-1 Runoff Area=59,345 sf 1.67% Impervious Runoff Depth=0.02"
Flow Length=178' Tc=18.8 min CN=32 Runoff=0.00 cfs 0.002 af

Reach DP1: Design Point 1 Inflow=0.40 cfs 0.046 af
Outflow=0.40 cfs 0.046 af

Reach DP2: Design Point 2 Inflow=0.04 cfs 0.025 af
Outflow=0.04 cfs 0.025 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.002 af
Outflow=0.00 cfs 0.002 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.073 af Average Runoff Depth = 0.20"
93.63% Pervious = 4.182 ac 6.37% Impervious = 0.285 ac

Summary for Subcatchment 1S: S-1

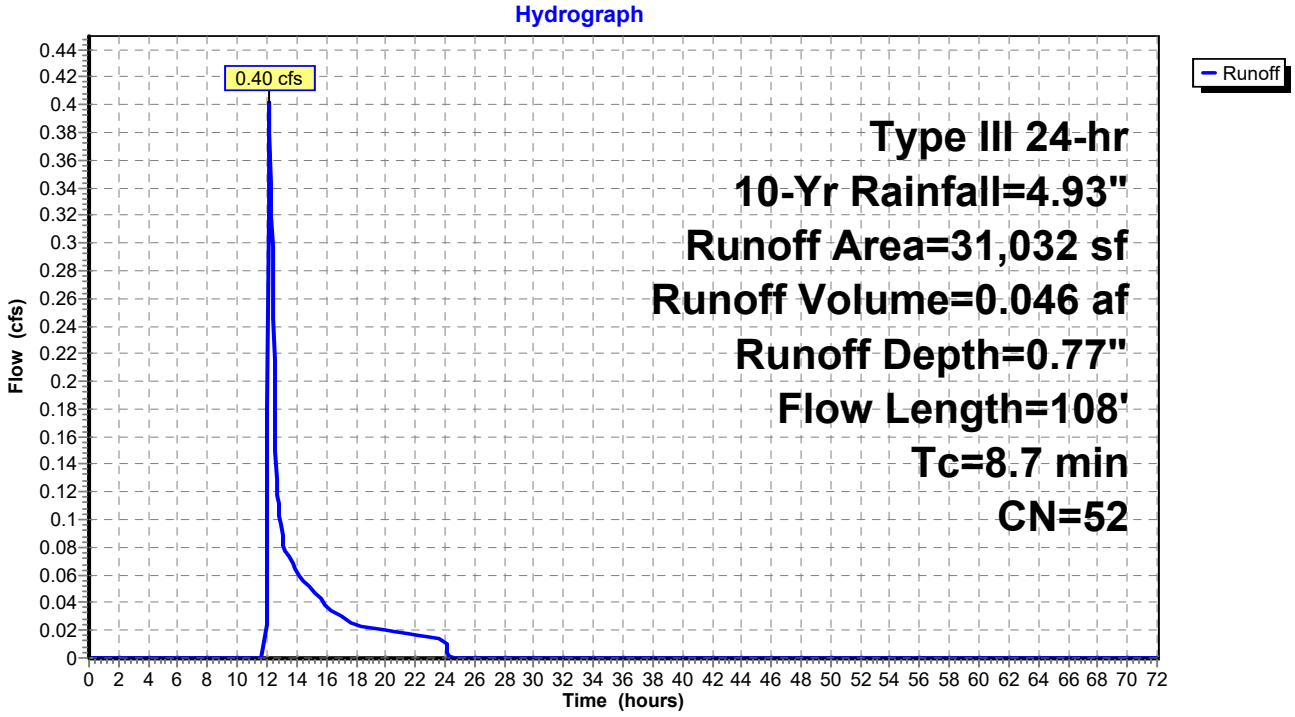
Runoff = 0.40 cfs @ 12.16 hrs, Volume= 0.046 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

Area (sf)	CN	Description
2,321	30	Woods, Good, HSG A
21,690	39	>75% Grass cover, Good, HSG A
4,644	98	Paved parking, HSG A
2,377	98	Roofs, HSG A
31,032	52	Weighted Average
24,011		77.37% Pervious Area
7,021		22.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0210	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
0.8	58	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.7	108	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-1

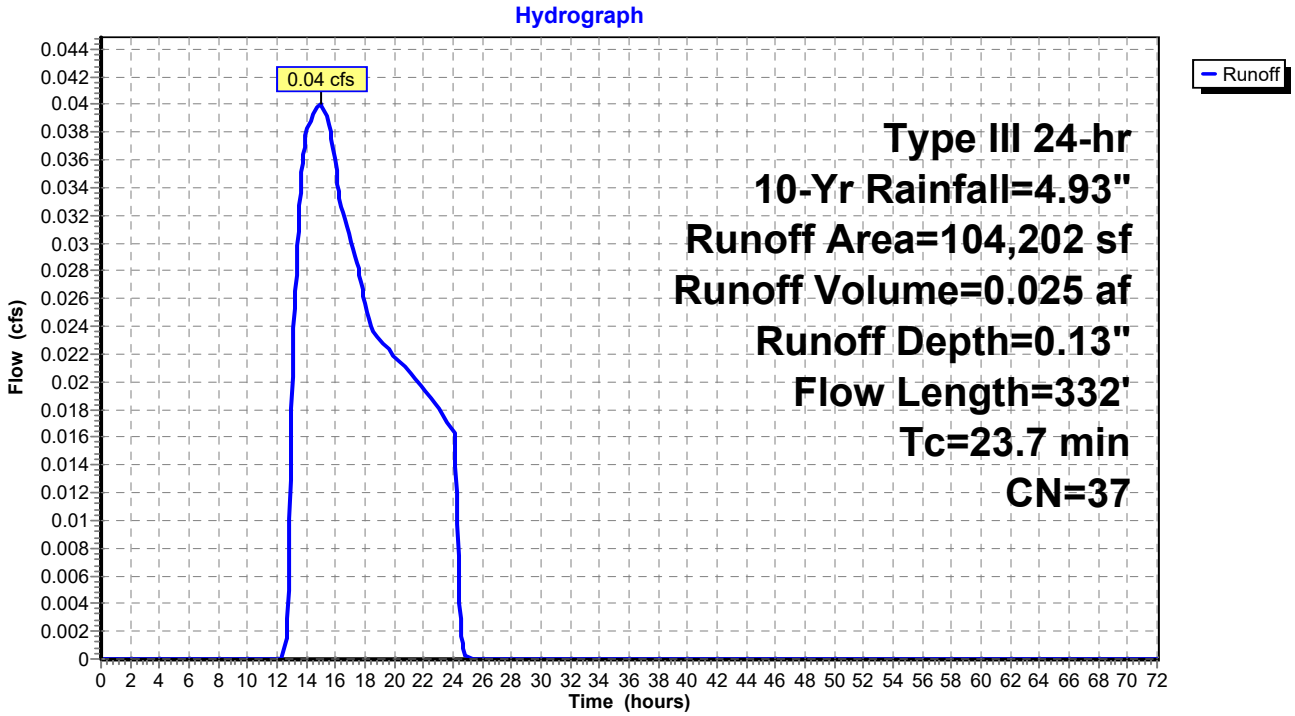
Runoff = 0.04 cfs @ 14.94 hrs, Volume= 0.025 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

Area (sf)	CN	Description
57,084	30	Woods, Good, HSG A
42,729	39	>75% Grass cover, Good, HSG A
2,748	98	Paved parking, HSG A
1,641	98	Roofs, HSG A
104,202	37	Weighted Average
99,813		95.79% Pervious Area
4,389		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0102	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
4.4	143	0.0120	0.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	139	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.7	332	Total			

Subcatchment 2S: S-1



Summary for Subcatchment 3S: S-1

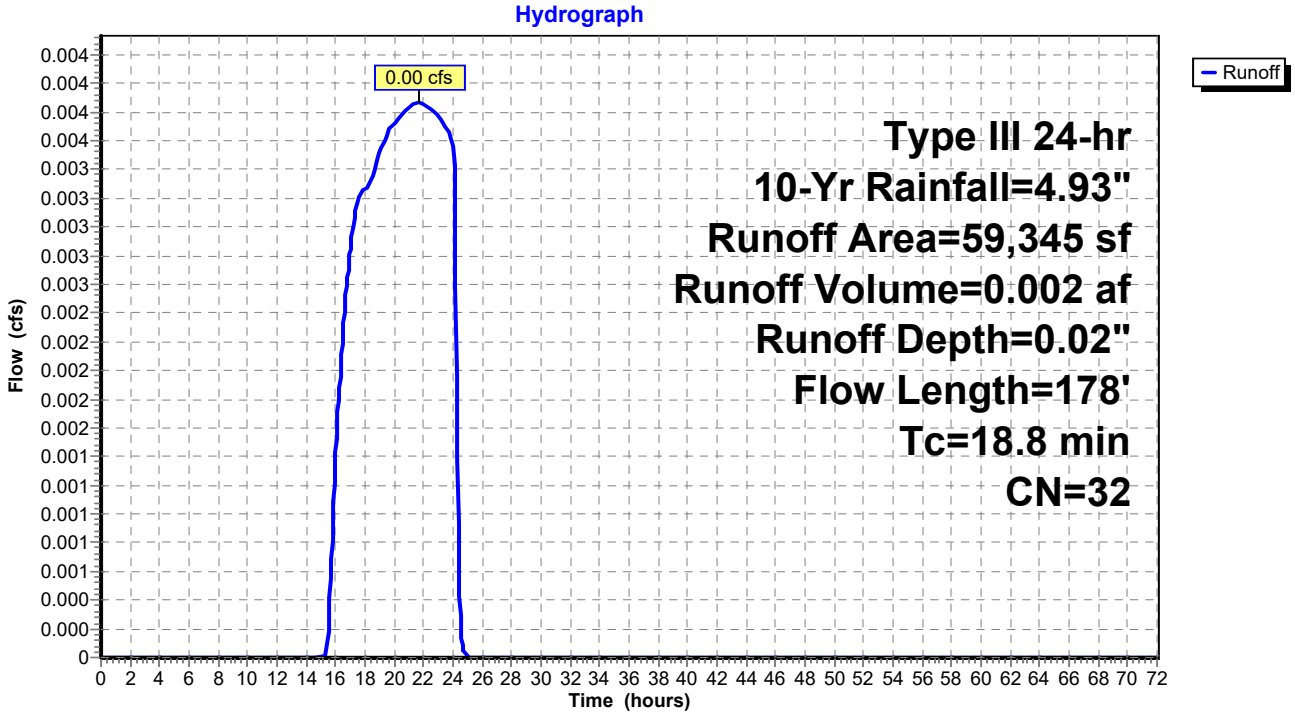
Runoff = 0.00 cfs @ 21.62 hrs, Volume= 0.002 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

	Area (sf)	CN	Description
	28,340	30	Woods, Good, HSG A
	4,777	39	>75% Grass cover, Good, HSG A
	24	98	Paved parking, HSG A
	967	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	59,345	32	Weighted Average
	58,354		98.33% Pervious Area
	991		1.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	50	0.0120	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
3.7	93	0.0070	0.42		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	35	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.8	178	Total			

Subcatchment 3S: S-1

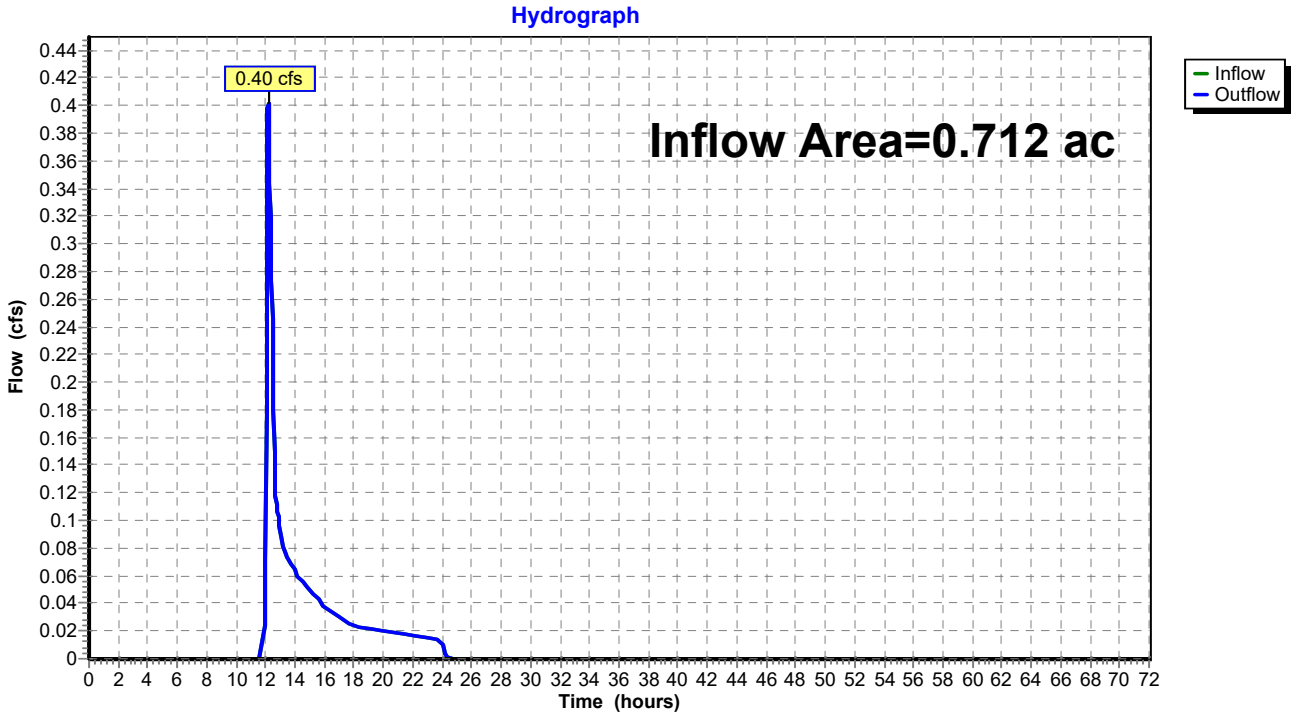


Summary for Reach DP1: Design Point 1

Inflow Area = 0.712 ac, 22.63% Impervious, Inflow Depth = 0.77" for 10-Yr event
Inflow = 0.40 cfs @ 12.16 hrs, Volume= 0.046 af
Outflow = 0.40 cfs @ 12.16 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

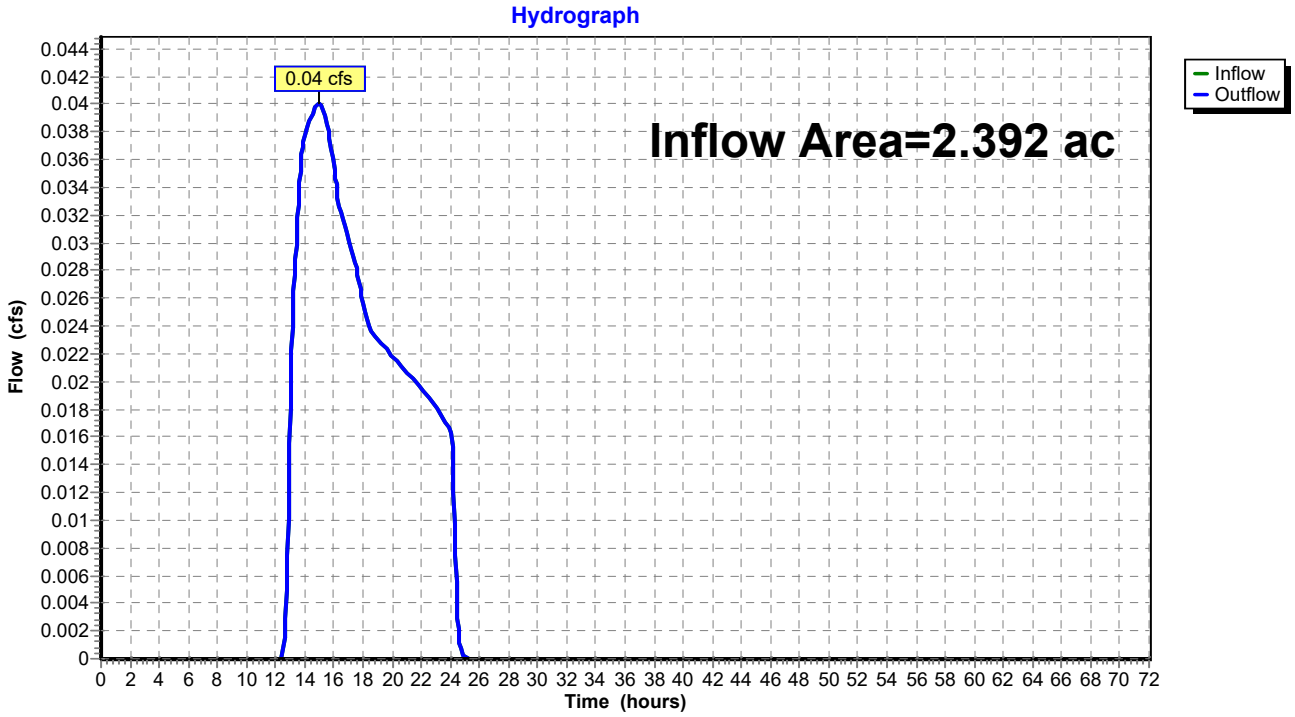


Summary for Reach DP2: Design Point 2

Inflow Area = 2.392 ac, 4.21% Impervious, Inflow Depth = 0.13" for 10-Yr event
Inflow = 0.04 cfs @ 14.94 hrs, Volume= 0.025 af
Outflow = 0.04 cfs @ 14.94 hrs, Volume= 0.025 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond DP3: Design Point 3

Inflow Area = 1.362 ac, 1.67% Impervious, Inflow Depth = 0.02" for 10-Yr event
Inflow = 0.00 cfs @ 21.62 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 21.62 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 21.62 hrs, Volume= 0.002 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,221.6 - 1,221.6)

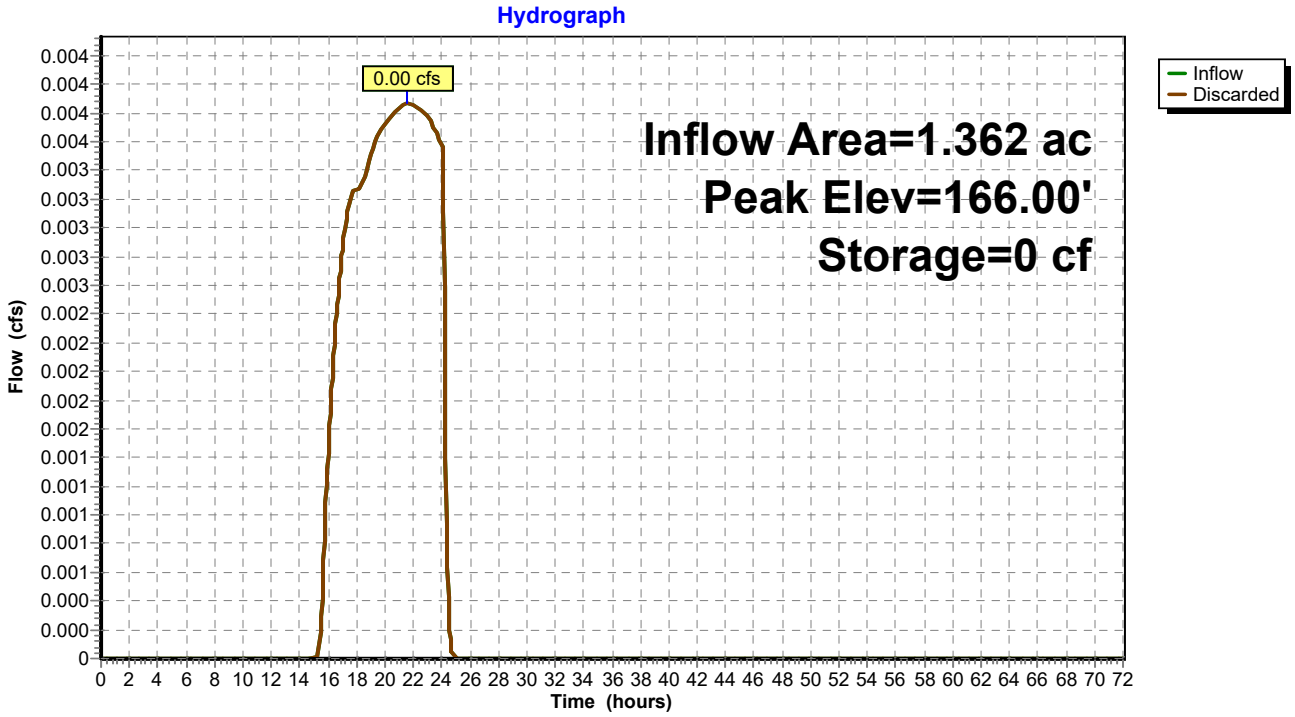
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 21.62 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=31,032 sf 22.63% Impervious Runoff Depth=1.38"
Flow Length=108' Tc=8.7 min CN=52 Runoff=0.87 cfs 0.082 af

Subcatchment 2S: S-1 Runoff Area=104,202 sf 4.21% Impervious Runoff Depth=0.39"
Flow Length=332' Tc=23.7 min CN=37 Runoff=0.24 cfs 0.077 af

Subcatchment 3S: S-1 Runoff Area=59,345 sf 1.67% Impervious Runoff Depth=0.16"
Flow Length=178' Tc=18.8 min CN=32 Runoff=0.03 cfs 0.018 af

Reach DP1: Design Point 1 Inflow=0.87 cfs 0.082 af
Outflow=0.87 cfs 0.082 af

Reach DP2: Design Point 2 Inflow=0.24 cfs 0.077 af
Outflow=0.24 cfs 0.077 af

Pond DP3: Design Point 3 Peak Elev=166.04' Storage=18 cf Inflow=0.03 cfs 0.018 af
Outflow=0.03 cfs 0.018 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.177 af Average Runoff Depth = 0.48"
93.63% Pervious = 4.182 ac 6.37% Impervious = 0.285 ac

Summary for Subcatchment 1S: S-1

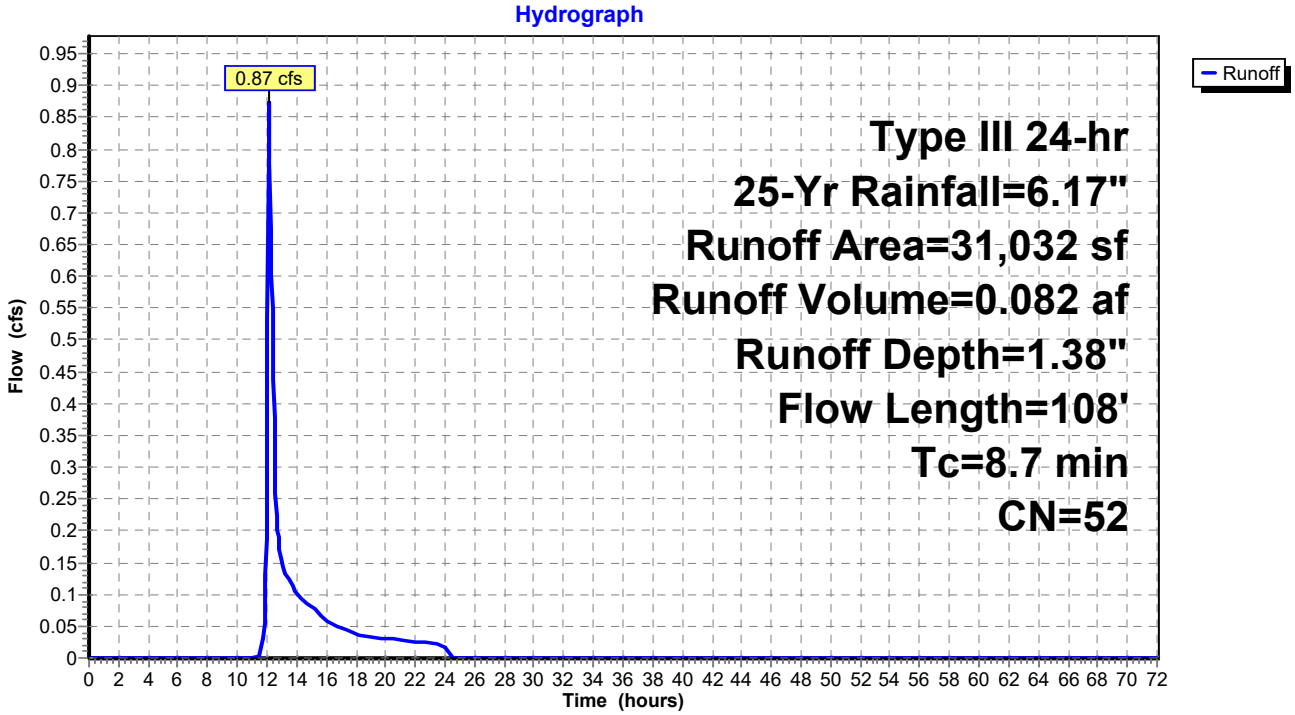
Runoff = 0.87 cfs @ 12.15 hrs, Volume= 0.082 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

Area (sf)	CN	Description
2,321	30	Woods, Good, HSG A
21,690	39	>75% Grass cover, Good, HSG A
4,644	98	Paved parking, HSG A
2,377	98	Roofs, HSG A
31,032	52	Weighted Average
24,011		77.37% Pervious Area
7,021		22.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0210	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
0.8	58	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.7	108	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-1

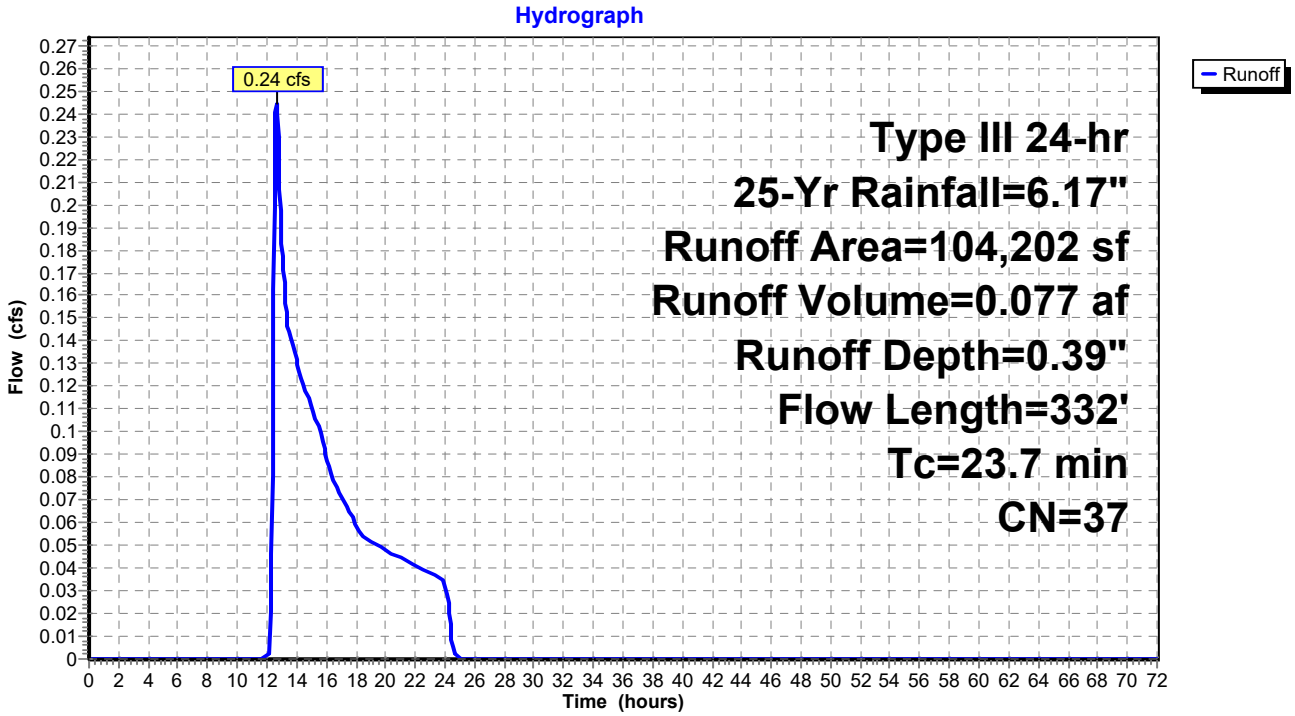
Runoff = 0.24 cfs @ 12.65 hrs, Volume= 0.077 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

Area (sf)	CN	Description
57,084	30	Woods, Good, HSG A
42,729	39	>75% Grass cover, Good, HSG A
2,748	98	Paved parking, HSG A
1,641	98	Roofs, HSG A
104,202	37	Weighted Average
99,813		95.79% Pervious Area
4,389		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0102	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
4.4	143	0.0120	0.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	139	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.7	332	Total			

Subcatchment 2S: S-1



Summary for Subcatchment 3S: S-1

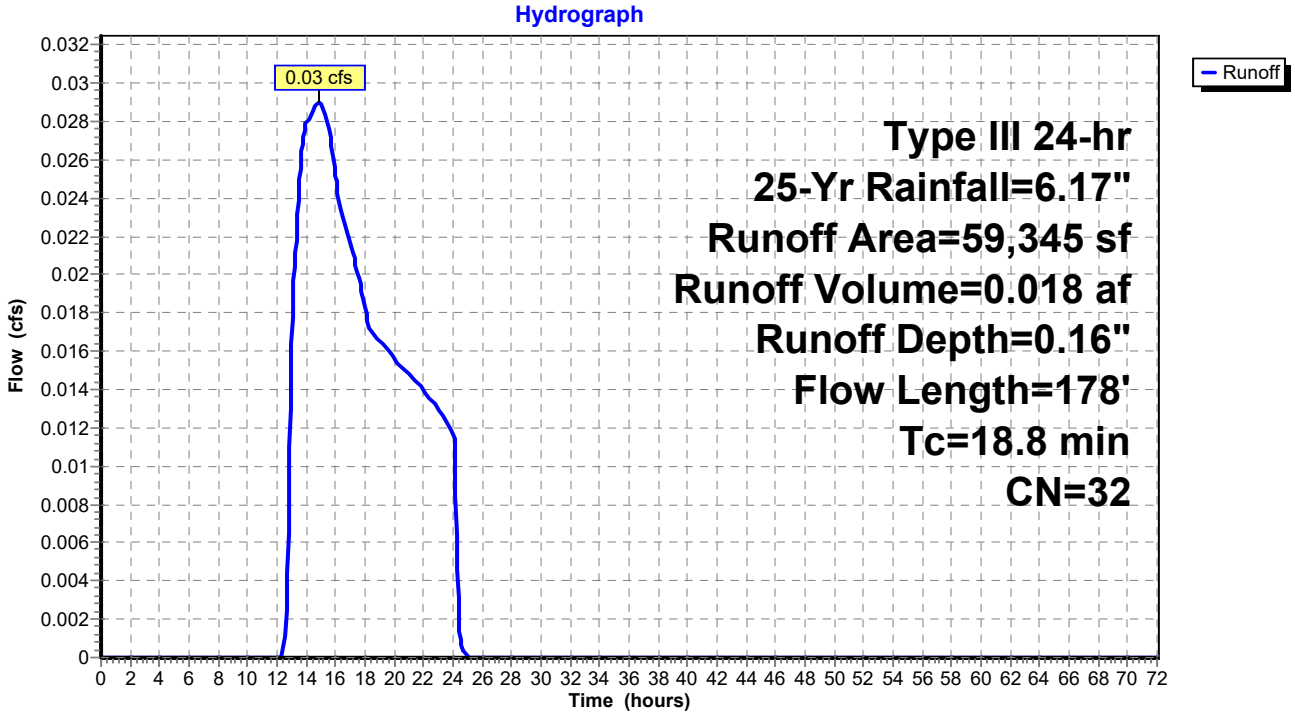
Runoff = 0.03 cfs @ 14.85 hrs, Volume= 0.018 af, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

	Area (sf)	CN	Description
	28,340	30	Woods, Good, HSG A
	4,777	39	>75% Grass cover, Good, HSG A
	24	98	Paved parking, HSG A
	967	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	59,345	32	Weighted Average
	58,354		98.33% Pervious Area
	991		1.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	50	0.0120	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
3.7	93	0.0070	0.42		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	35	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.8	178	Total			

Subcatchment 3S: S-1

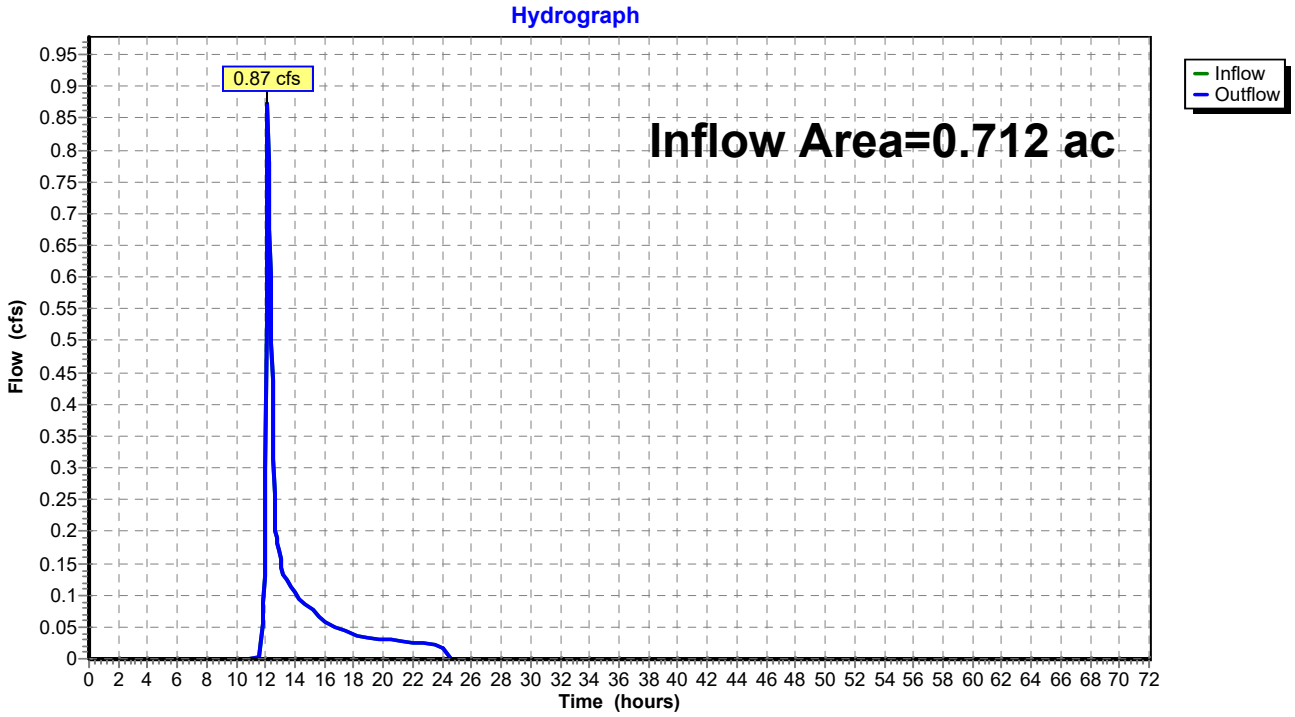


Summary for Reach DP1: Design Point 1

Inflow Area = 0.712 ac, 22.63% Impervious, Inflow Depth = 1.38" for 25-Yr event
Inflow = 0.87 cfs @ 12.15 hrs, Volume= 0.082 af
Outflow = 0.87 cfs @ 12.15 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

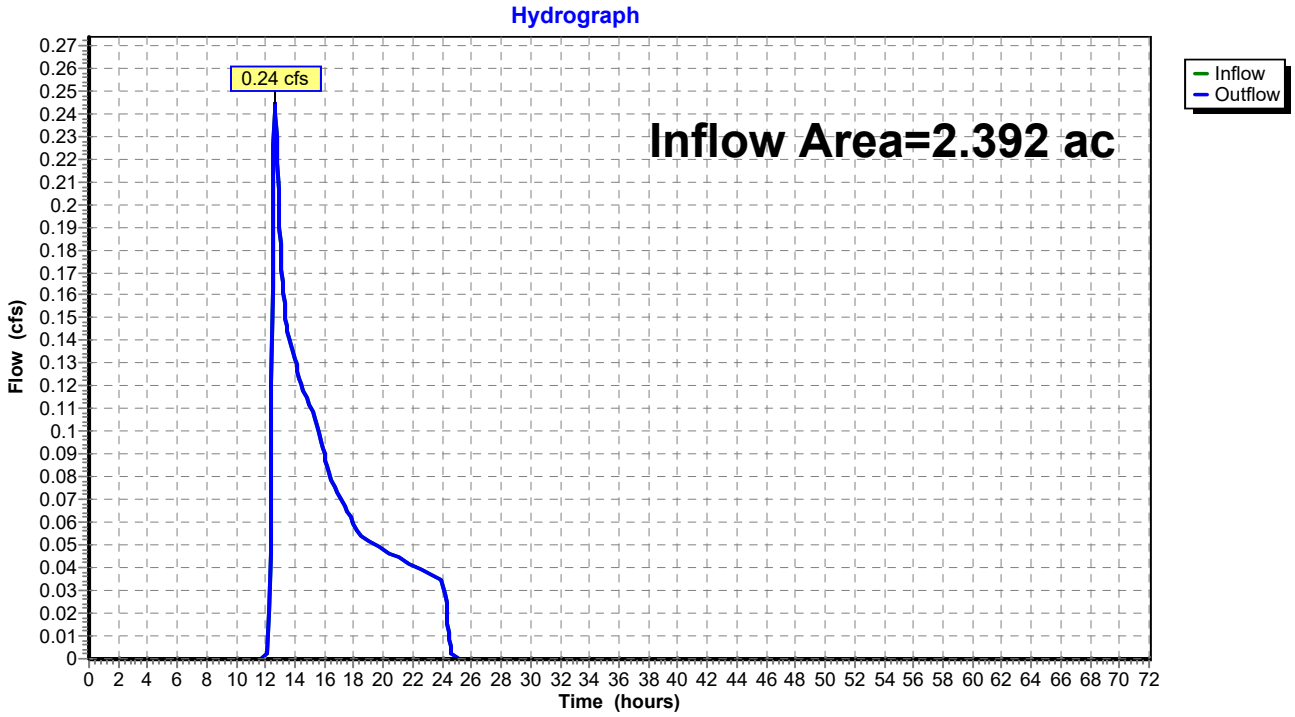


Summary for Reach DP2: Design Point 2

Inflow Area = 2.392 ac, 4.21% Impervious, Inflow Depth = 0.39" for 25-Yr event
Inflow = 0.24 cfs @ 12.65 hrs, Volume= 0.077 af
Outflow = 0.24 cfs @ 12.65 hrs, Volume= 0.077 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond DP3: Design Point 3

Inflow Area = 1.362 ac, 1.67% Impervious, Inflow Depth = 0.16" for 25-Yr event
Inflow = 0.03 cfs @ 14.85 hrs, Volume= 0.018 af
Outflow = 0.03 cfs @ 15.67 hrs, Volume= 0.018 af, Atten= 7%, Lag= 49.4 min
Discarded = 0.03 cfs @ 15.67 hrs, Volume= 0.018 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.04' @ 15.67 hrs Surf.Area= 480 sf Storage= 18 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 3.2 min (1,064.5 - 1,061.3)

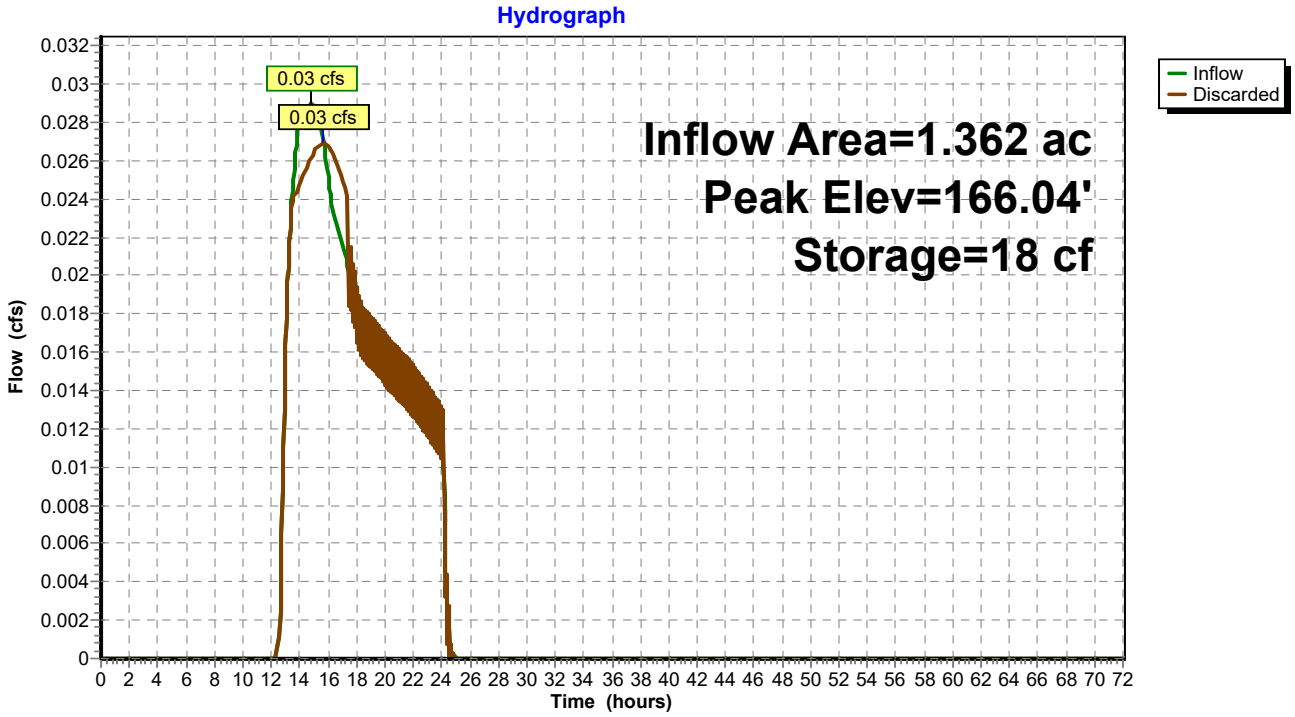
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.03 cfs @ 15.67 hrs HW=166.04' (Free Discharge)
└**1=Exfiltration** (Controls 0.03 cfs)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=31,032 sf 22.63% Impervious Runoff Depth=2.91"
Flow Length=108' Tc=8.7 min CN=52 Runoff=2.06 cfs 0.173 af

Subcatchment 2S: S-1 Runoff Area=104,202 sf 4.21% Impervious Runoff Depth=1.25"
Flow Length=332' Tc=23.7 min CN=37 Runoff=1.50 cfs 0.249 af

Subcatchment 3S: S-1 Runoff Area=59,345 sf 1.67% Impervious Runoff Depth=0.76"
Flow Length=178' Tc=18.8 min CN=32 Runoff=0.40 cfs 0.087 af

Reach DP1: Design Point 1 Inflow=2.06 cfs 0.173 af
Outflow=2.06 cfs 0.173 af

Reach DP2: Design Point 2 Inflow=1.50 cfs 0.249 af
Outflow=1.50 cfs 0.249 af

Pond DP3: Design Point 3 Peak Elev=167.00' Storage=1,031 cf Inflow=0.40 cfs 0.087 af
Outflow=0.10 cfs 0.087 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.508 af Average Runoff Depth = 1.36"
93.63% Pervious = 4.182 ac 6.37% Impervious = 0.285 ac

Summary for Subcatchment 1S: S-1

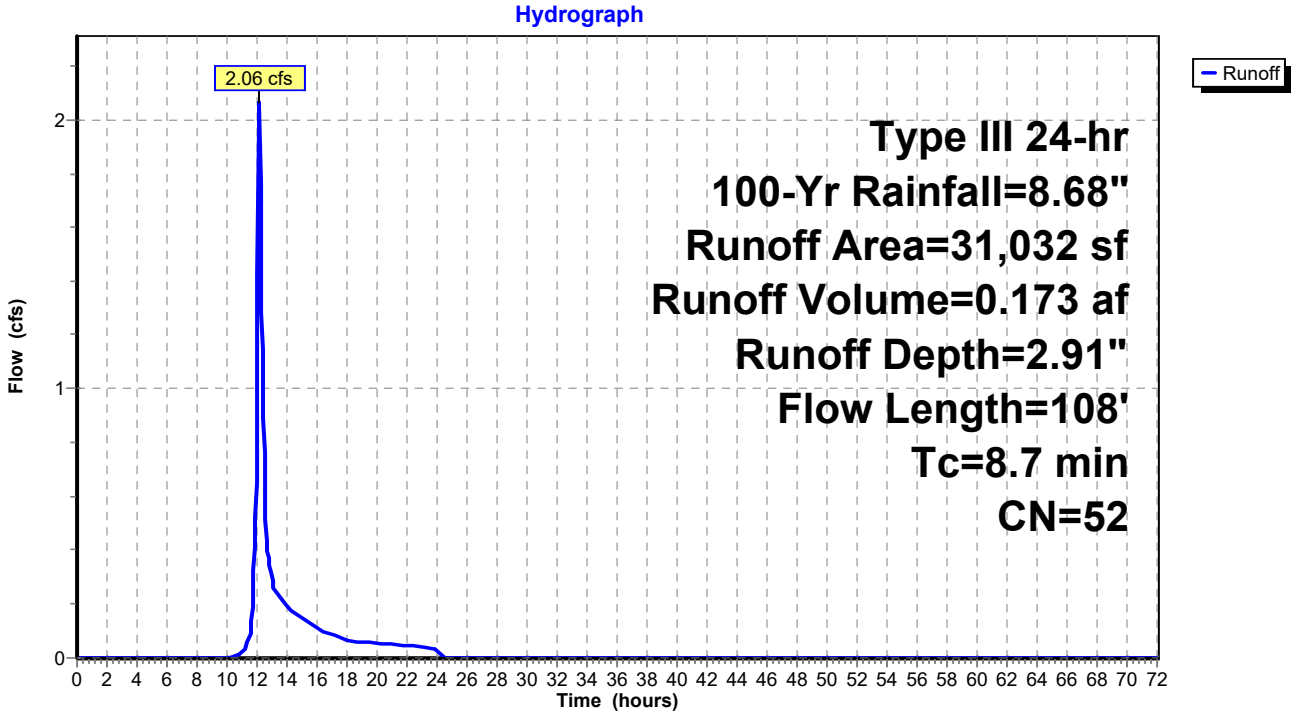
Runoff = 2.06 cfs @ 12.14 hrs, Volume= 0.173 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

Area (sf)	CN	Description
2,321	30	Woods, Good, HSG A
21,690	39	>75% Grass cover, Good, HSG A
4,644	98	Paved parking, HSG A
2,377	98	Roofs, HSG A
31,032	52	Weighted Average
24,011		77.37% Pervious Area
7,021		22.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0210	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
0.8	58	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.7	108	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-1

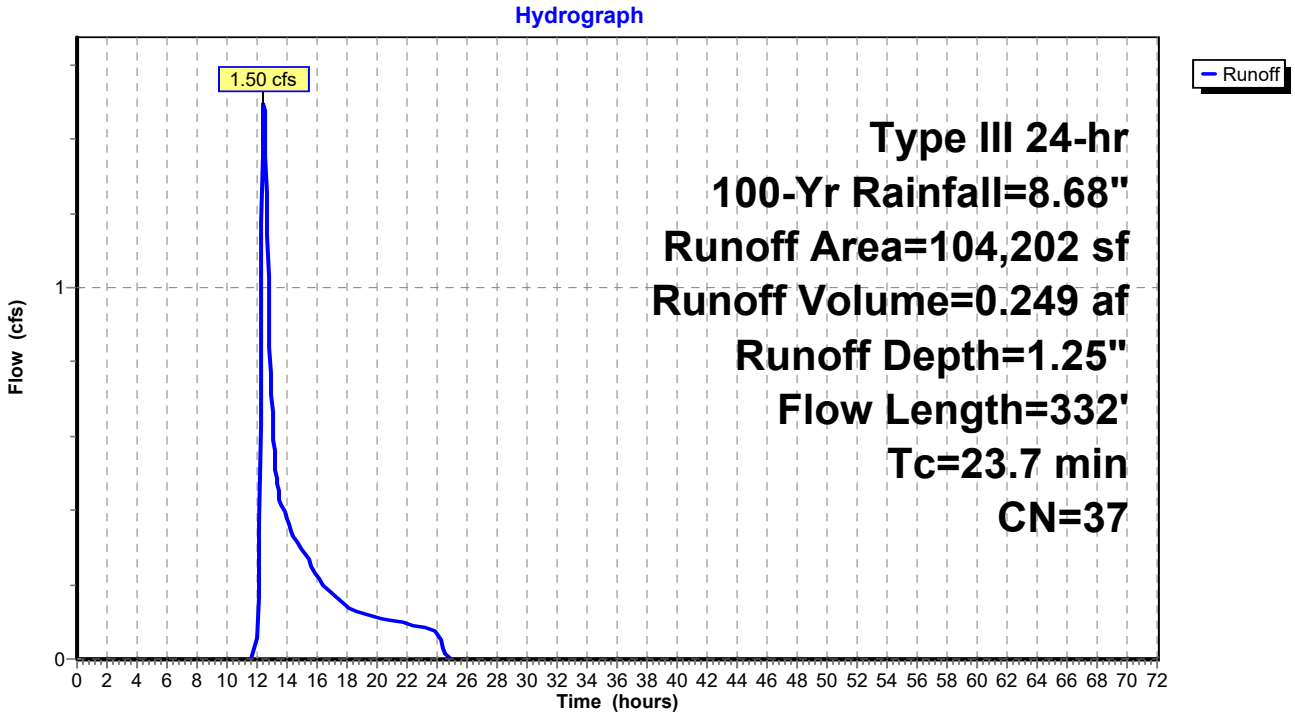
Runoff = 1.50 cfs @ 12.46 hrs, Volume= 0.249 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

Area (sf)	CN	Description
57,084	30	Woods, Good, HSG A
42,729	39	>75% Grass cover, Good, HSG A
2,748	98	Paved parking, HSG A
1,641	98	Roofs, HSG A
104,202	37	Weighted Average
99,813		95.79% Pervious Area
4,389		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0102	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
4.4	143	0.0120	0.55		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.5	139	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.7	332	Total			

Subcatchment 2S: S-1



Summary for Subcatchment 3S: S-1

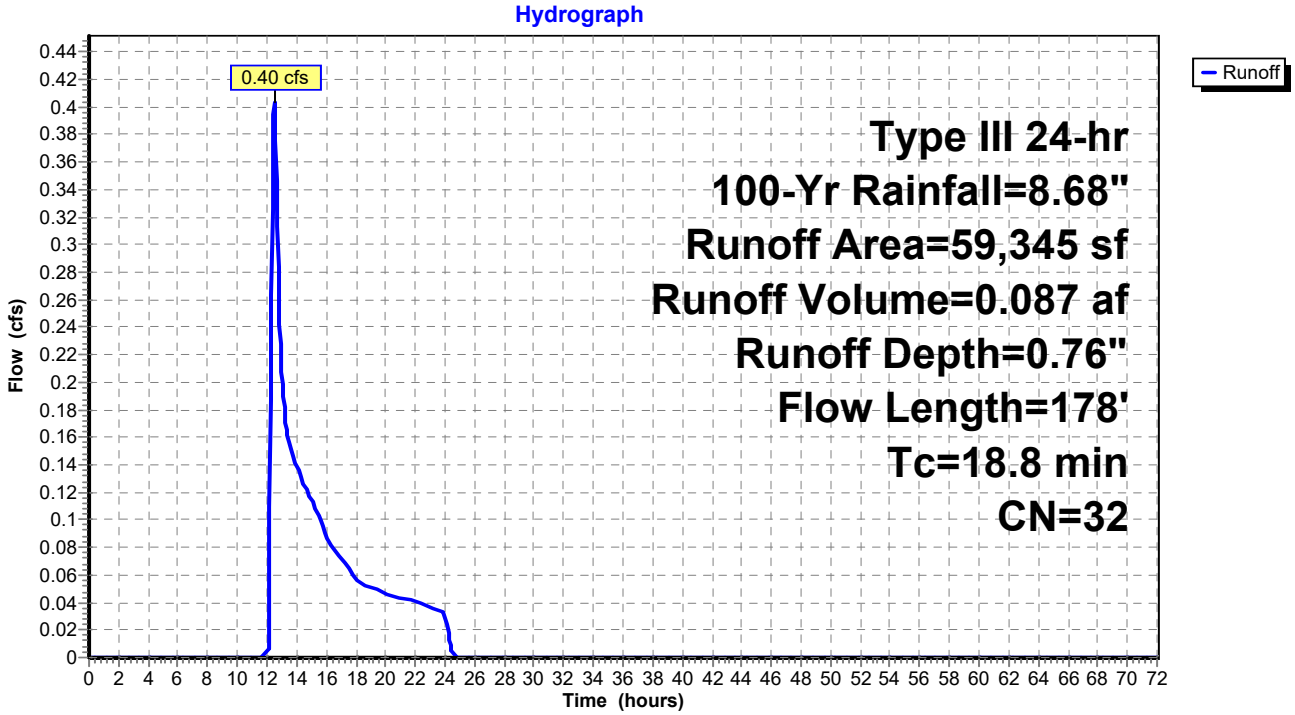
Runoff = 0.40 cfs @ 12.50 hrs, Volume= 0.087 af, Depth= 0.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

	Area (sf)	CN	Description
	28,340	30	Woods, Good, HSG A
	4,777	39	>75% Grass cover, Good, HSG A
	24	98	Paved parking, HSG A
	967	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	59,345	32	Weighted Average
	58,354		98.33% Pervious Area
	991		1.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	50	0.0120	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.34"
3.7	93	0.0070	0.42		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	35	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
18.8	178	Total			

Subcatchment 3S: S-1

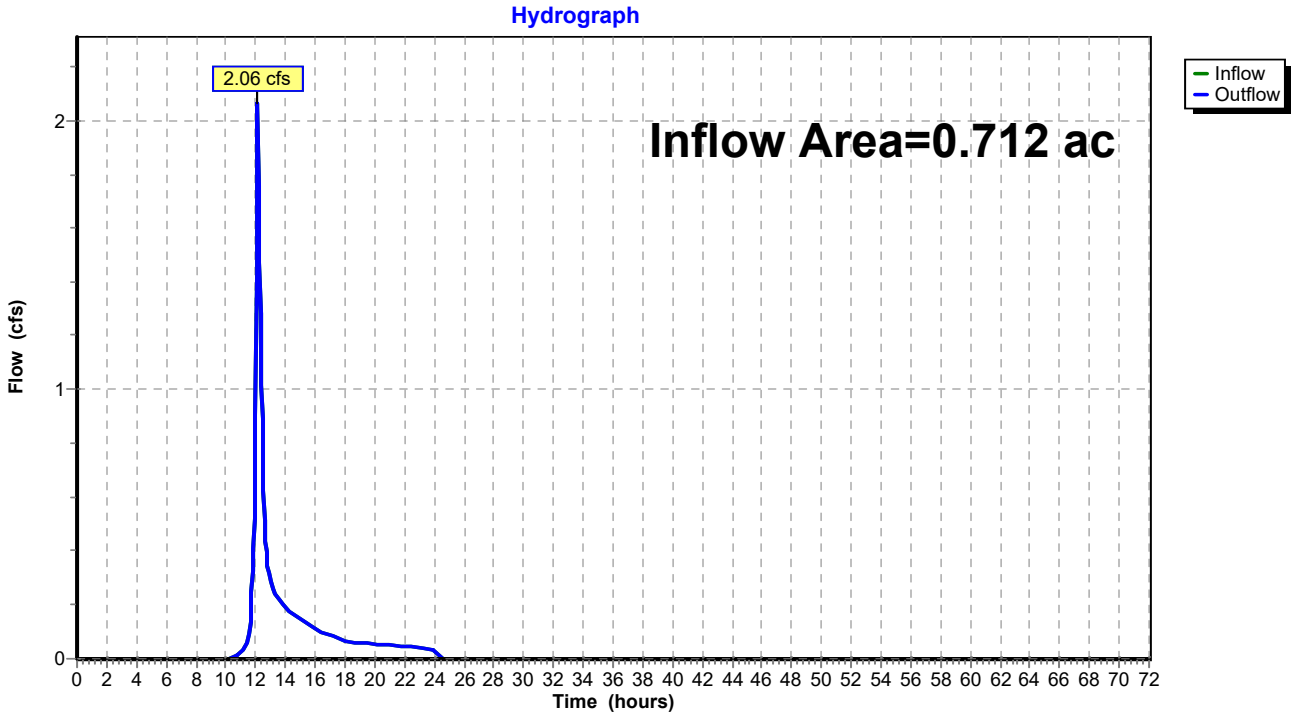


Summary for Reach DP1: Design Point 1

Inflow Area = 0.712 ac, 22.63% Impervious, Inflow Depth = 2.91" for 100-Yr event
Inflow = 2.06 cfs @ 12.14 hrs, Volume= 0.173 af
Outflow = 2.06 cfs @ 12.14 hrs, Volume= 0.173 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

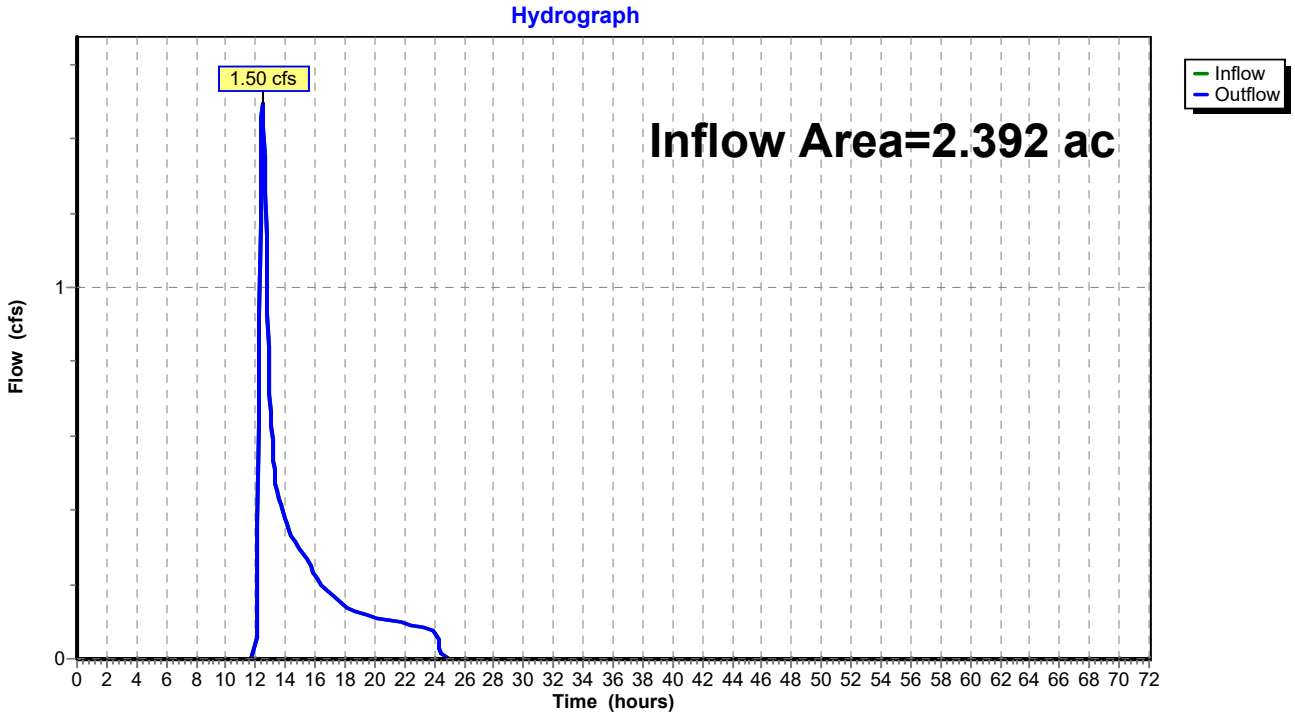


Summary for Reach DP2: Design Point 2

Inflow Area = 2.392 ac, 4.21% Impervious, Inflow Depth = 1.25" for 100-Yr event
Inflow = 1.50 cfs @ 12.46 hrs, Volume= 0.249 af
Outflow = 1.50 cfs @ 12.46 hrs, Volume= 0.249 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond DP3: Design Point 3

Inflow Area = 1.362 ac, 1.67% Impervious, Inflow Depth = 0.76" for 100-Yr event
Inflow = 0.40 cfs @ 12.50 hrs, Volume= 0.087 af
Outflow = 0.10 cfs @ 15.45 hrs, Volume= 0.087 af, Atten= 74%, Lag= 176.9 min
Discarded = 0.10 cfs @ 15.45 hrs, Volume= 0.087 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 167.00' @ 15.45 hrs Surf.Area= 1,641 sf Storage= 1,031 cf

Plug-Flow detention time= 130.1 min calculated for 0.087 af (100% of inflow)
Center-of-Mass det. time= 130.1 min (1,088.6 - 958.5)

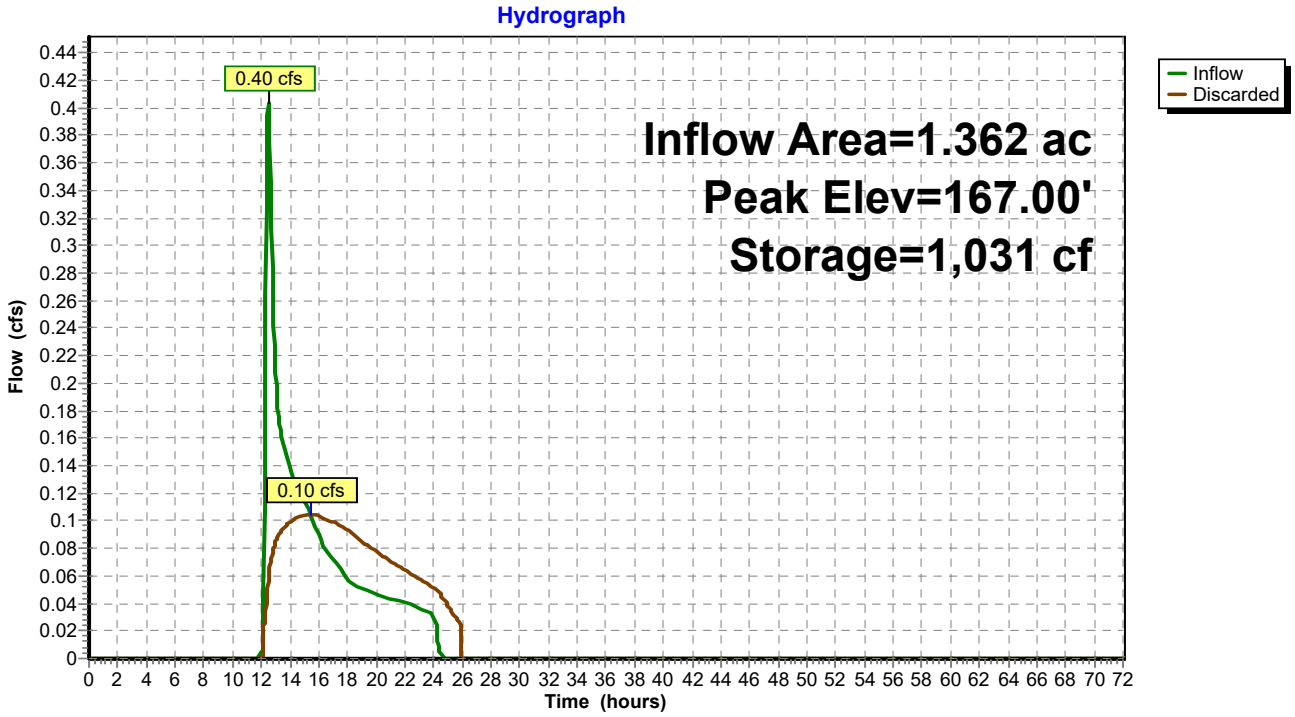
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.10 cfs @ 15.45 hrs HW=167.00' (Free Discharge)
└**1=Exfiltration** (Controls 0.10 cfs)

Pond DP3: Design Point 3



POST–DEVELOPMENT WATERSHED

SUBCATCHMENT 1S

DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	0	S.F.
GRASS (HSG A)	15,137	S.F.
PAVEMENT (HSG A)	2,323	S.F.
ROOFS (HSG A)	2,860	S.F.
TOTAL AREA FOR 1S	20,320	S.F.

SUBCATCHMENT 2S

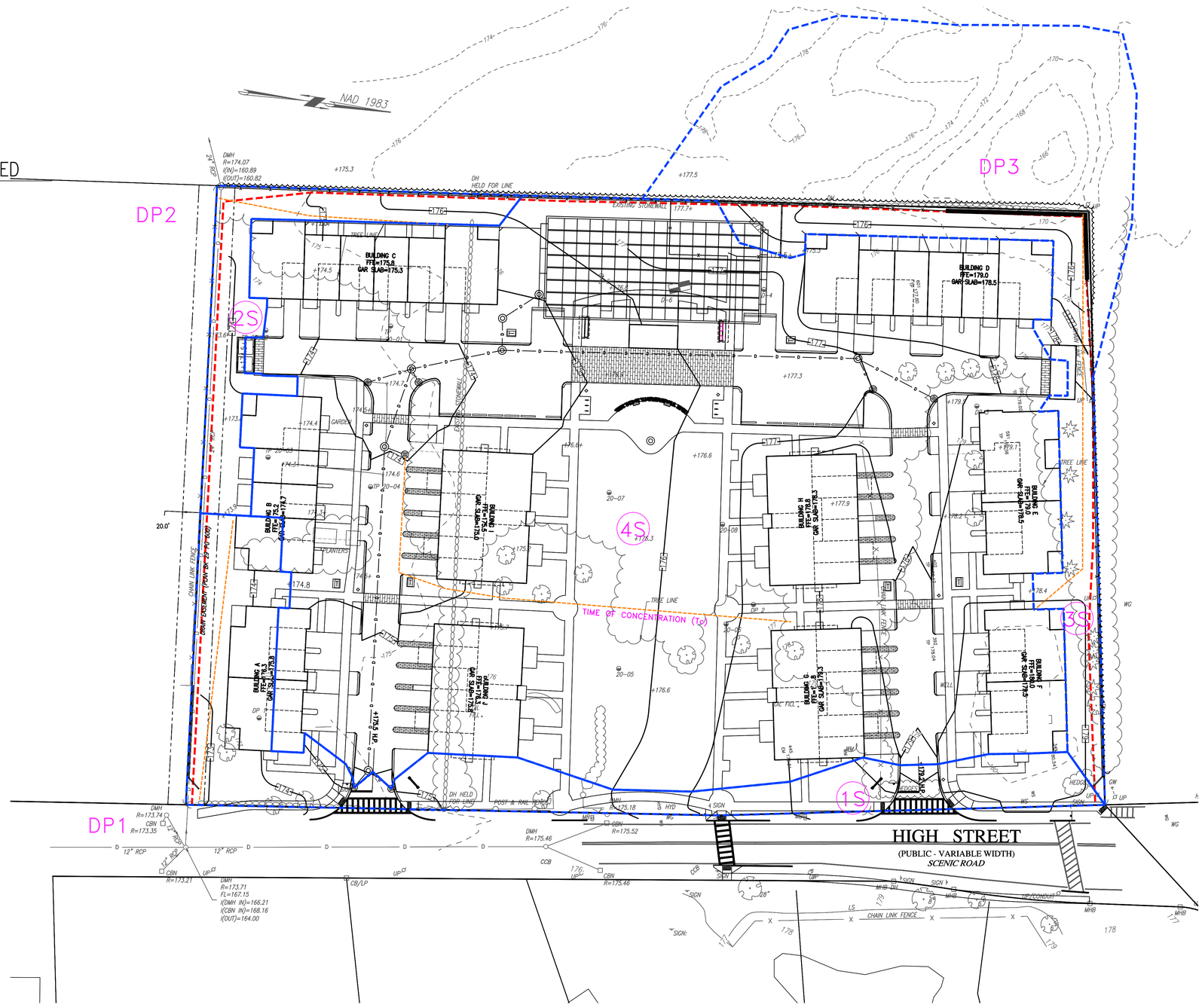
DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	0	S.F.
GRASS (HSG A)	7,079	S.F.
PAVEMENT (HSG A)	0	S.F.
ROOFS (HSG A)	0	S.F.
TOTAL AREA FOR 2S	7,079	S.F.

SUBCATCHMENT 3S

DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	0	S.F.
WOODS (HSG A)(OFFSITE)	25,237	S.F.
GRASS (HSG A)	10,177	S.F.
PAVEMENT (HSG A)	0	S.F.
ROOFS (HSG A)	0	S.F.
TOTAL AREA FOR 3S	35,414	S.F.

SUBCATCHMENT 4S

DESCRIPTION	AREA (S.F.)	
WOODS (HSG A)	0	S.F.
GRASS (HSG A)	45,302	S.F.
PAVEMENT (HSG A)	45,338	S.F.
ROOFS (HSG A)	41,147	S.F.
TOTAL AREA FOR 4S	131,787	S.F.



REVISIONS

2	10/29/21	SITE PLAN UPDATES
1	4/30/21	REVIEW & COORDINATION

DRAWN BY: JG

DESIGNED BY: DK

CHECKED BY: DK

Merrill Engineers and Land Surveyors
427 COLUMBIA ROAD, HANOVER, MA 02339 / T: (781) 826-9200
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SITE PLAN

#15, 19, 27 & 35 HIGH STREET
NORWELL, MASSACHUSETTS 02061

OWNER/APPLICANT
NORTHLAND RESIDENTIAL CORPORATION
80 BEHARRELL STREET, SUITE E
CONCORD, MASSACHUSETTS 01742

JANUARY 29, 2021

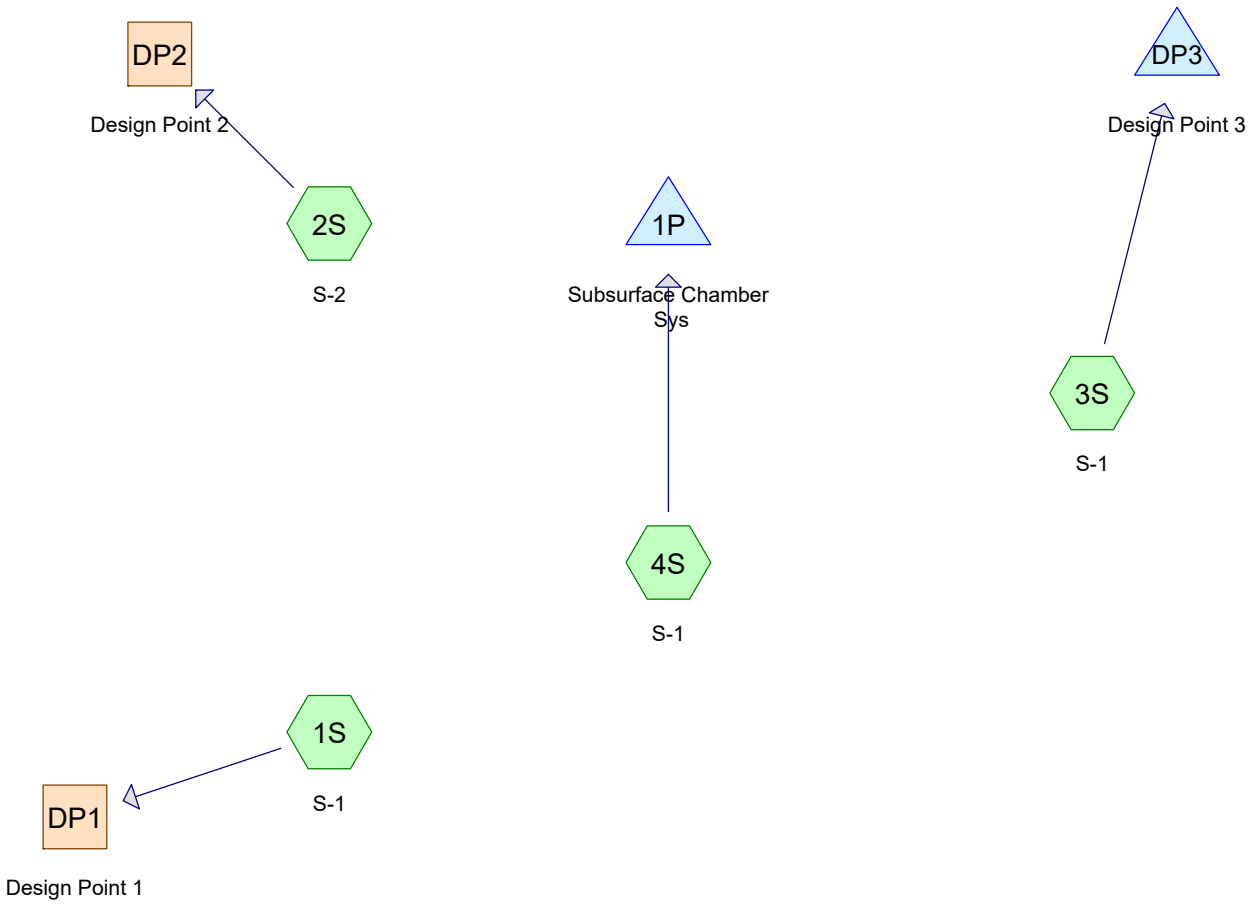
SCALE:

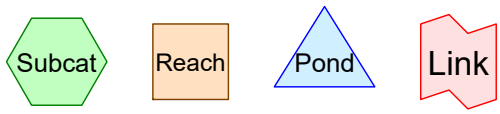
JOB NO. 20–127

LATEST REVISION:
APRIL 30, 2021

POST–DEVELOPMENT WATERSHED PLAN

SHEET 1 OF 1





Routing Diagram for 20-127 Post DevRev
Prepared by Merrill Engineers and Land Surveyors, Printed 11/1/2021
HydroCAD® 10.00-25 s/n 02159 © 2019 HydroCAD Software Solutions LLC

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=20,320 sf 25.51% Impervious Runoff Depth=0.11"
Flow Length=156' Slope=0.0100 '/' Tc=13.1 min CN=54 Runoff=0.01 cfs 0.004 af

Subcatchment 2S: S-2 Runoff Area=7,079 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=131' Tc=10.6 min CN=39 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: S-1 Runoff Area=35,414 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=237' Tc=13.5 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: S-1 Runoff Area=131,787 sf 65.62% Impervious Runoff Depth=0.95"
Flow Length=284' Tc=12.8 min CN=78 Runoff=2.55 cfs 0.239 af

Reach DP1: Design Point 1 Inflow=0.01 cfs 0.004 af
Outflow=0.01 cfs 0.004 af

Reach DP2: Design Point 2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 1P: Subsurface Chamber Sys Peak Elev=166.02' Storage=51 cf Inflow=2.55 cfs 0.239 af
Outflow=2.37 cfs 0.239 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.243 af Average Runoff Depth = 0.65"
52.89% Pervious = 2.363 ac 47.11% Impervious = 2.104 ac

Summary for Subcatchment 1S: S-1

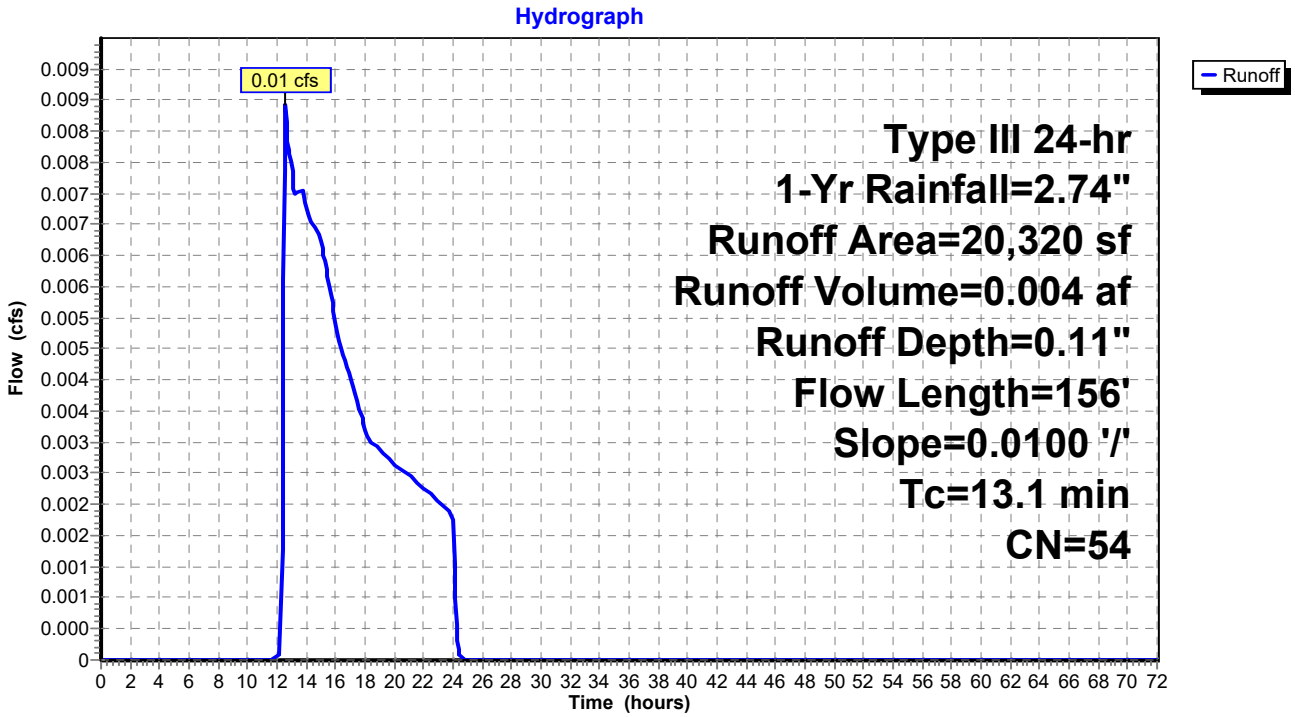
Runoff = 0.01 cfs @ 12.59 hrs, Volume= 0.004 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
15,137	39	>75% Grass cover, Good, HSG A
2,323	98	Paved parking, HSG A
2,860	98	Roofs, HSG A
20,320	54	Weighted Average
15,137		74.49% Pervious Area
5,183		25.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.5	106	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.1	156	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-2

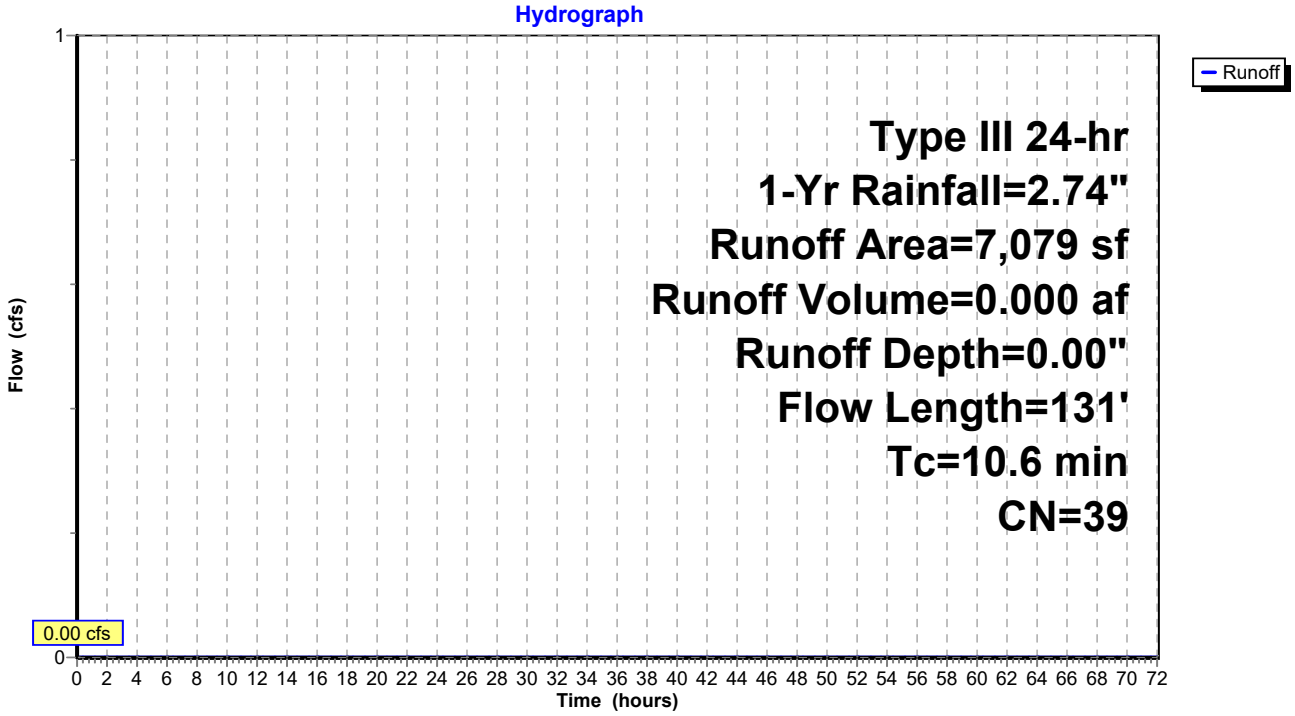
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
7,079	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
0	98	Roofs, HSG A
7,079	39	Weighted Average
7,079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0160	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
1.8	81	0.0120	0.77		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.6	131	Total			

Subcatchment 2S: S-2



Summary for Subcatchment 3S: S-1

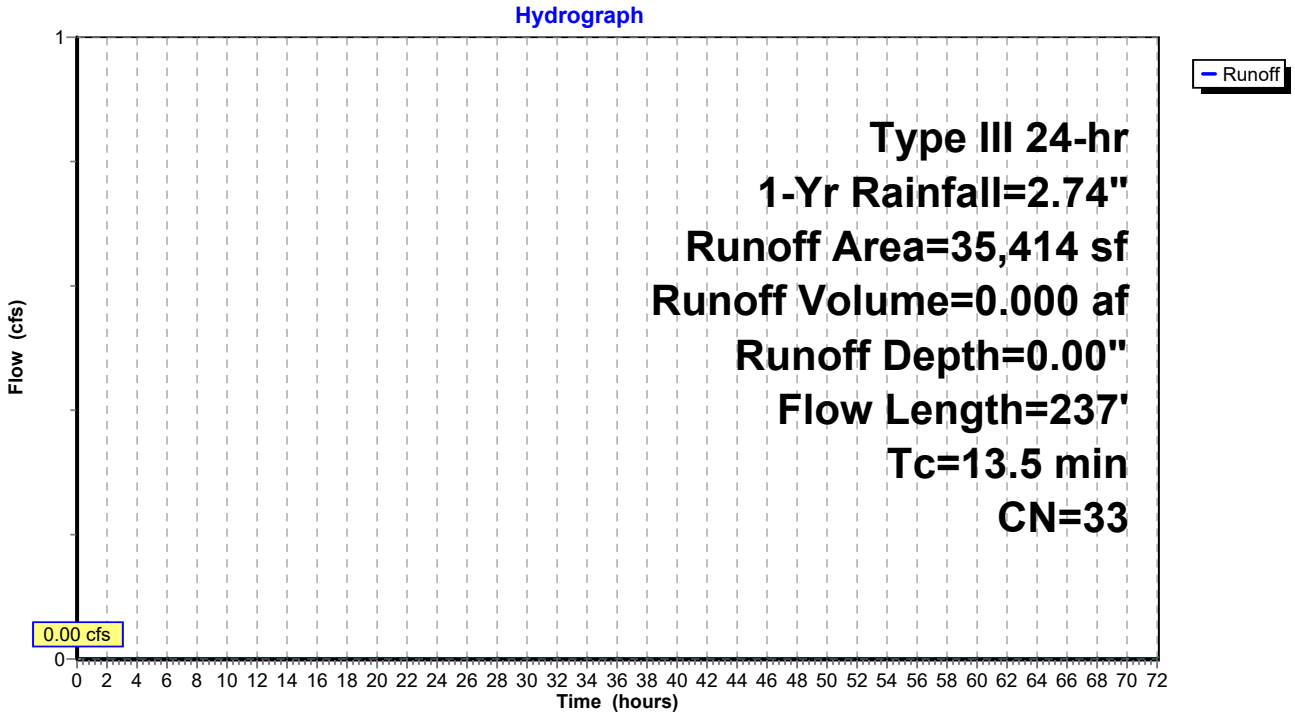
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

	Area (sf)	CN	Description
	0	30	Woods, Good, HSG A
	10,177	39	>75% Grass cover, Good, HSG A
	0	98	Paved parking, HSG A
	0	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	35,414	33	Weighted Average
	35,414		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.1	87	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	237	Total			

Subcatchment 3S: S-1



Summary for Subcatchment 4S: S-1

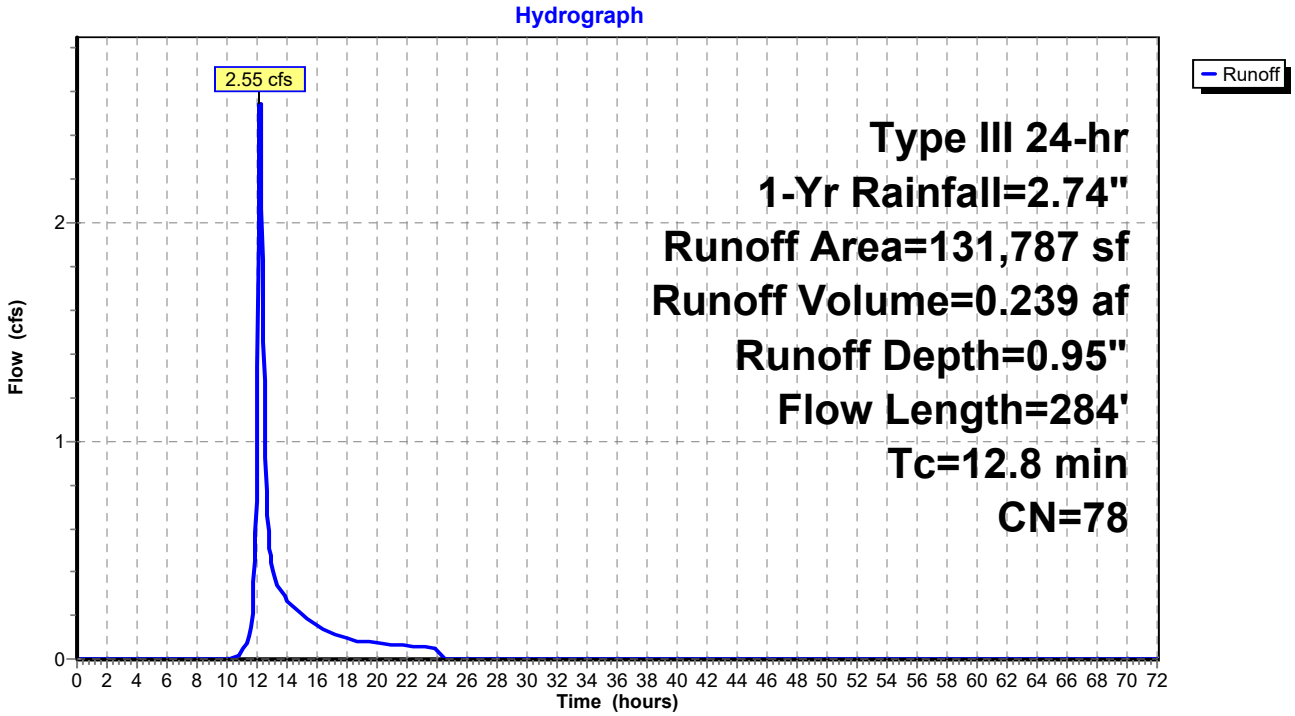
Runoff = 2.55 cfs @ 12.19 hrs, Volume= 0.239 af, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.74"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
45,302	39	>75% Grass cover, Good, HSG A
45,338	98	Paved parking, HSG A
41,147	98	Roofs, HSG A
131,787	78	Weighted Average
45,302		34.38% Pervious Area
86,485		65.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
4.3	171	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	63	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.8	284	Total			

Subcatchment 4S: S-1

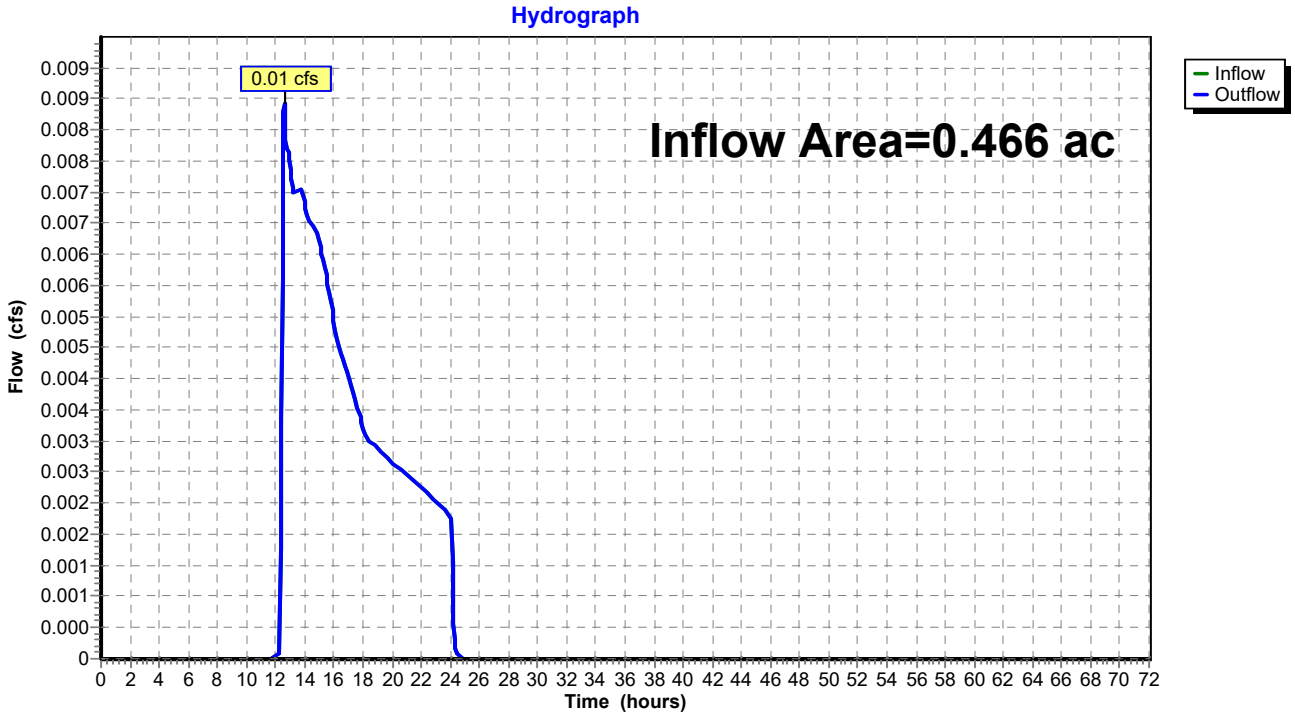


Summary for Reach DP1: Design Point 1

Inflow Area = 0.466 ac, 25.51% Impervious, Inflow Depth = 0.11" for 1-Yr event
Inflow = 0.01 cfs @ 12.59 hrs, Volume= 0.004 af
Outflow = 0.01 cfs @ 12.59 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

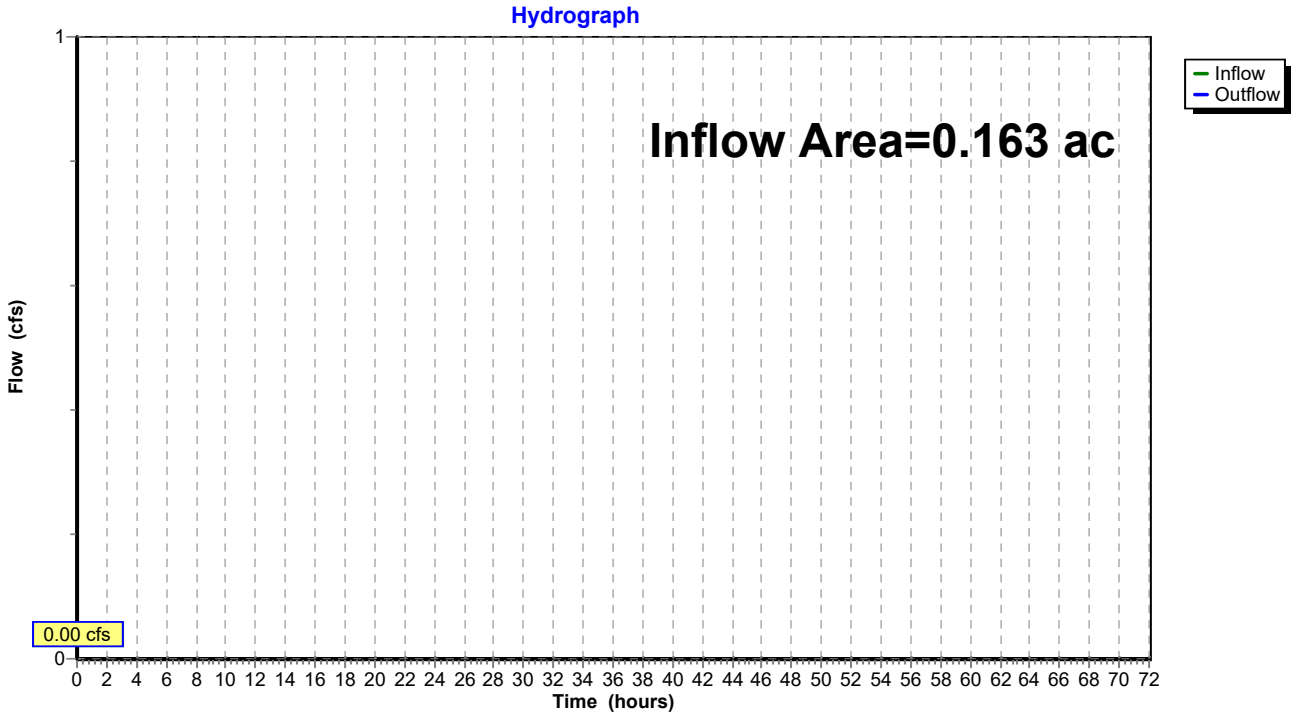


Summary for Reach DP2: Design Point 2

Inflow Area = 0.163 ac, 0.00% Impervious, Inflow Depth = 0.00" for 1-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond 1P: Subsurface Chamber Sys

Inflow Area = 3.025 ac, 65.62% Impervious, Inflow Depth = 0.95" for 1-Yr event
Inflow = 2.55 cfs @ 12.19 hrs, Volume= 0.239 af
Outflow = 2.37 cfs @ 12.24 hrs, Volume= 0.239 af, Atten= 7%, Lag= 2.6 min
Discarded = 2.37 cfs @ 12.24 hrs, Volume= 0.239 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.02' @ 12.24 hrs Surf.Area= 6,369 sf Storage= 51 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.3 min (864.7 - 864.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	166.00'	8,057 cf	**49.92'W x 127.59'L x 5.25'H Field A** 33,437 cf Overall - 13,293 cf Embedded = 20,144 cf x 40.0% Voids
#2A	166.75'	13,293 cf	**ADS_StormTech MC-3500 d +Cap** x 119 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 119 Chambers in 7 Rows Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf
		21,350 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**16.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=2.37 cfs @ 12.24 hrs HW=166.02' (Free Discharge)
└**1=Exfiltration** (Controls 2.37 cfs)

Pond 1P: Subsurface Chamber Sys - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-3500 d +Cap (ADS StormTech® MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf

77.0" Wide + 6.0" Spacing = 83.0" C-C Row Spacing

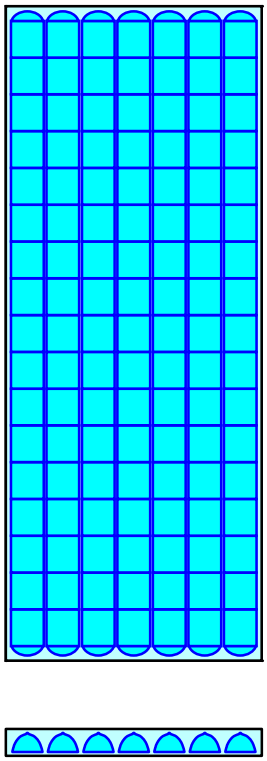
17 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 125.59' Row Length +12.0" End Stone x 2 = 127.59' Base Length
7 Rows x 77.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 49.92' Base Width
9.0" Base + 45.0" Chamber Height + 9.0" Cover = 5.25' Field Height

119 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 7 Rows = 13,292.9 cf Chamber Storage

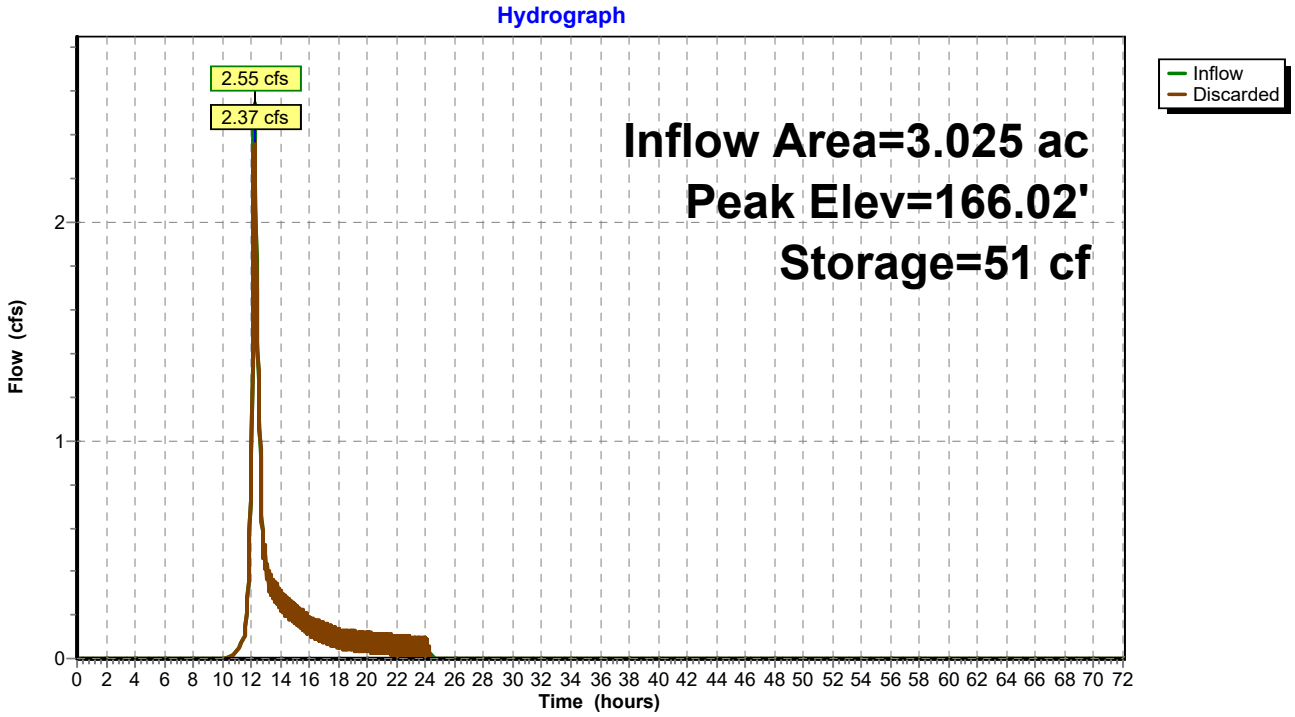
33,436.6 cf Field - 13,292.9 cf Chambers = 20,143.7 cf Stone x 40.0% Voids = 8,057.5 cf Stone Storage

Chamber Storage + Stone Storage = 21,350.4 cf = 0.490 af
Overall Storage Efficiency = 63.9%
Overall System Size = 127.59' x 49.92' x 5.25'

119 Chambers
1,238.4 cy Field
746.1 cy Stone



Pond 1P: Subsurface Chamber Sys



Summary for Pond DP3: Design Point 3

Inflow Area = 0.813 ac, 0.00% Impervious, Inflow Depth = 0.00" for 1-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

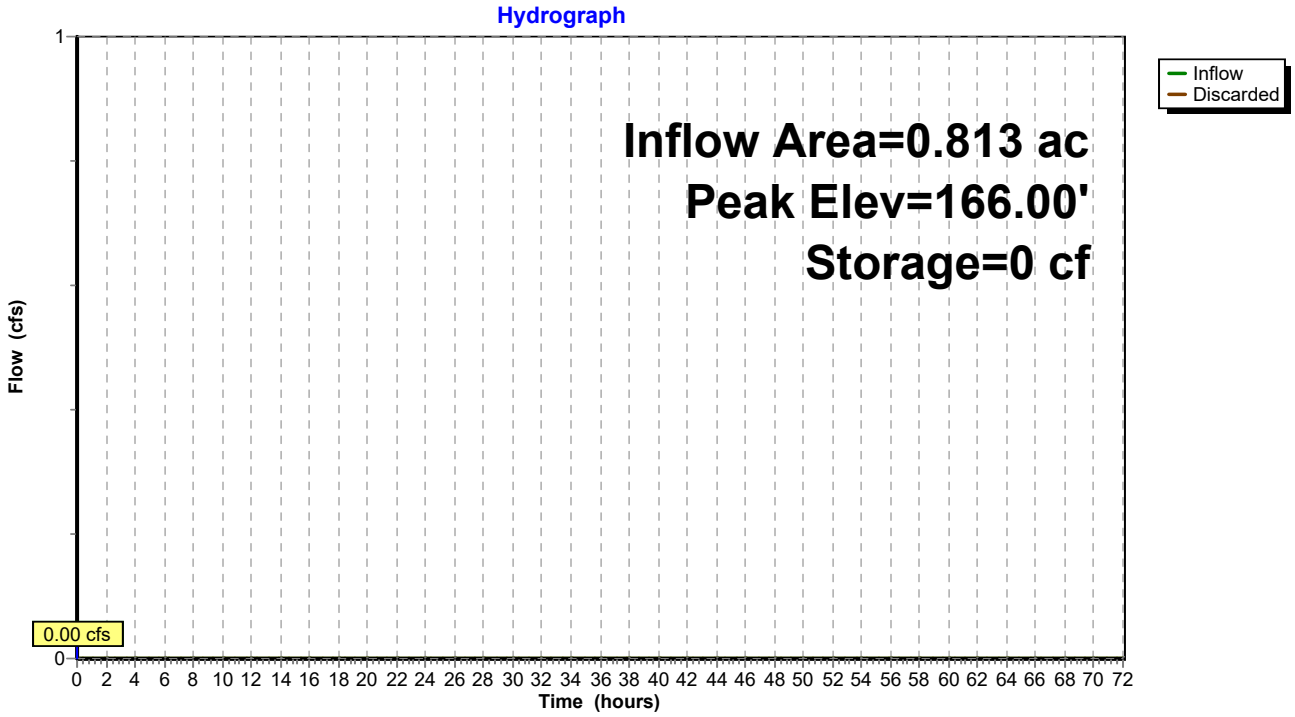
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=20,320 sf 25.51% Impervious Runoff Depth=0.26"
Flow Length=156' Slope=0.0100 '/' Tc=13.1 min CN=54 Runoff=0.05 cfs 0.010 af

Subcatchment 2S: S-2 Runoff Area=7,079 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=131' Tc=10.6 min CN=39 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: S-1 Runoff Area=35,414 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=237' Tc=13.5 min CN=33 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: S-1 Runoff Area=131,787 sf 65.62% Impervious Runoff Depth=1.38"
Flow Length=284' Tc=12.8 min CN=78 Runoff=3.80 cfs 0.347 af

Reach DP1: Design Point 1 Inflow=0.05 cfs 0.010 af
Outflow=0.05 cfs 0.010 af

Reach DP2: Design Point 2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 1P: Subsurface Chamber Sys Peak Elev=166.33' Storage=847 cf Inflow=3.80 cfs 0.347 af
Outflow=2.55 cfs 0.347 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.357 af Average Runoff Depth = 0.96"
52.89% Pervious = 2.363 ac 47.11% Impervious = 2.104 ac

Summary for Subcatchment 1S: S-1

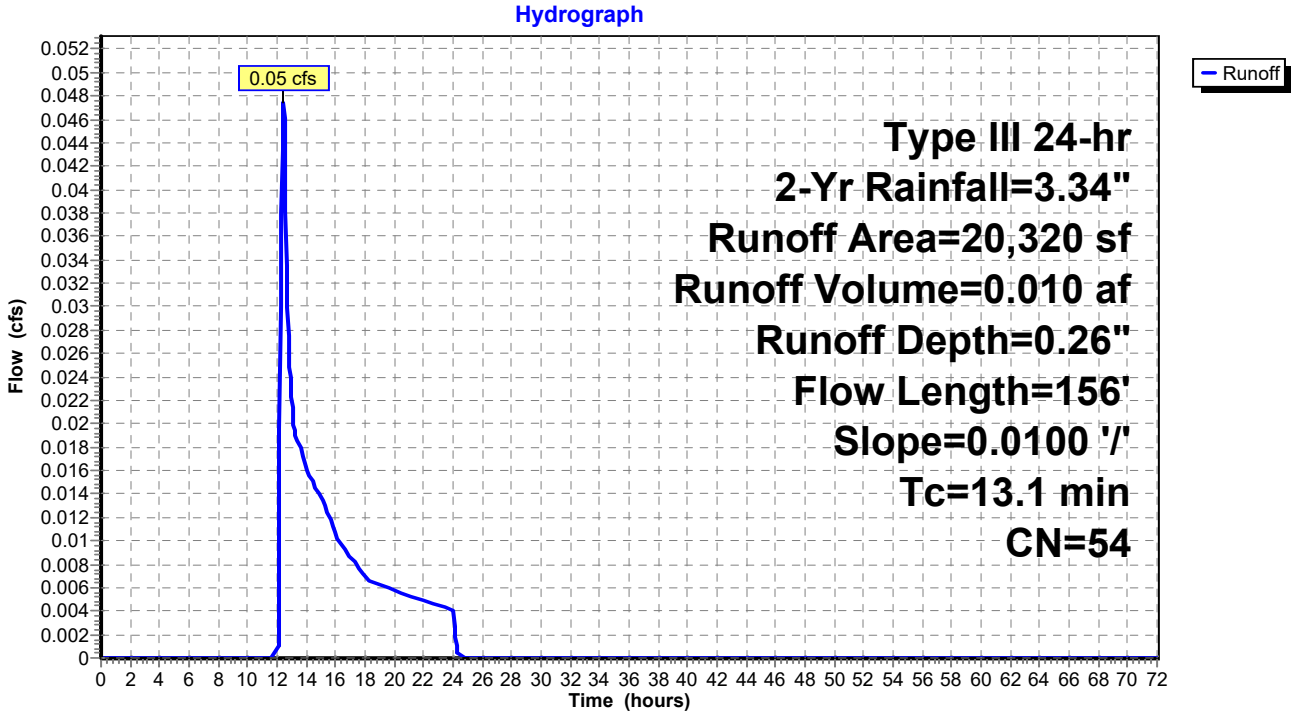
Runoff = 0.05 cfs @ 12.44 hrs, Volume= 0.010 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
15,137	39	>75% Grass cover, Good, HSG A
2,323	98	Paved parking, HSG A
2,860	98	Roofs, HSG A
20,320	54	Weighted Average
15,137		74.49% Pervious Area
5,183		25.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.5	106	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.1	156	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-2

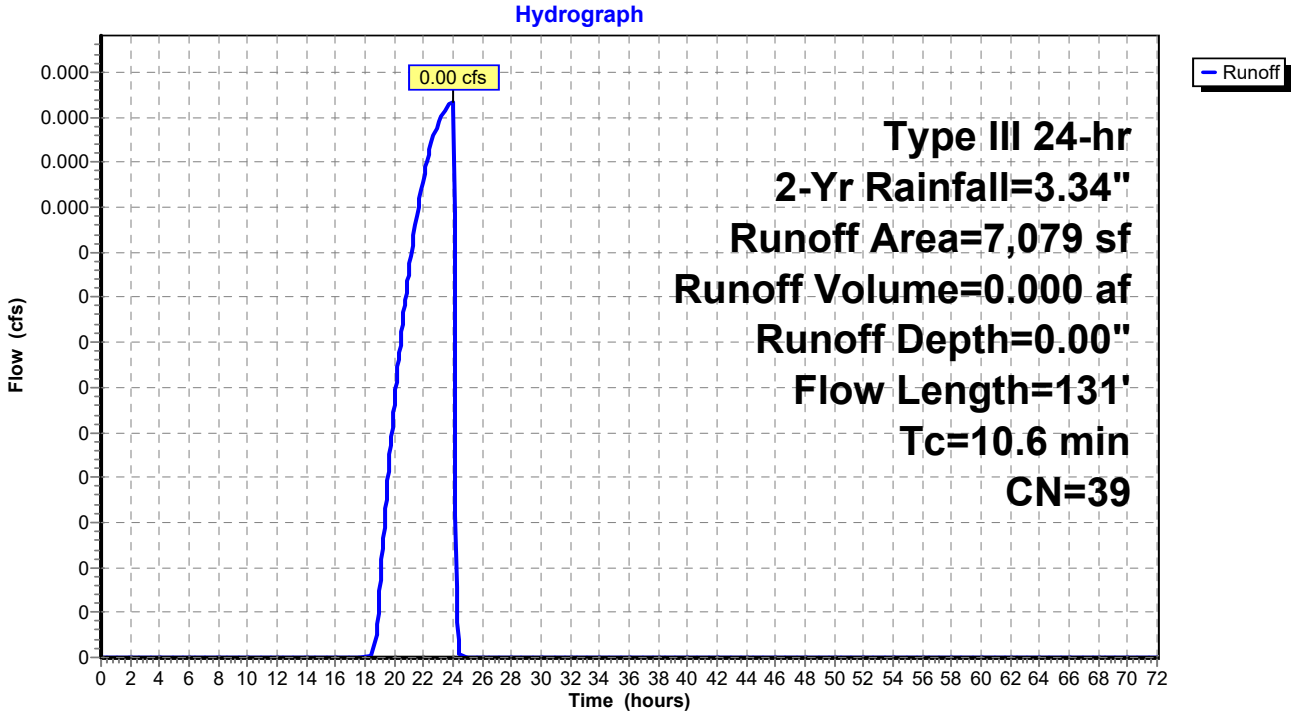
Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
7,079	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
0	98	Roofs, HSG A
7,079	39	Weighted Average
7,079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0160	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
1.8	81	0.0120	0.77		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.6	131	Total			

Subcatchment 2S: S-2



Summary for Subcatchment 3S: S-1

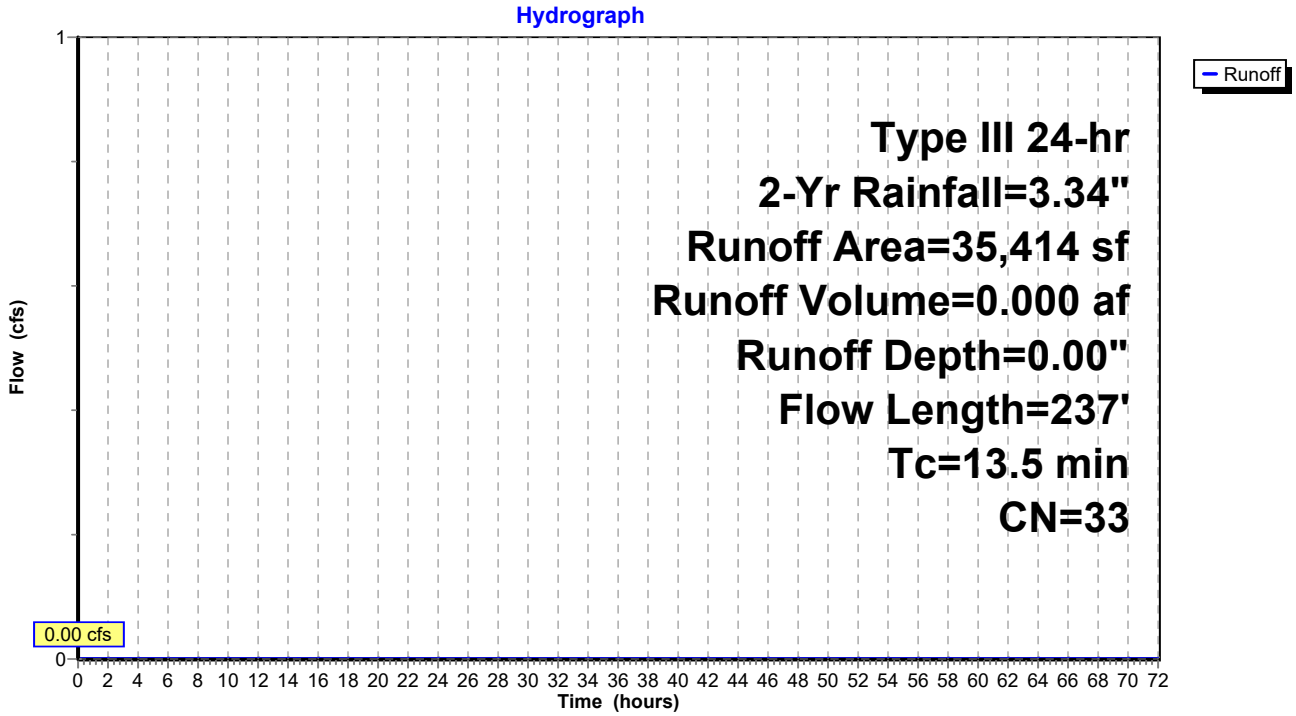
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

	Area (sf)	CN	Description
	0	30	Woods, Good, HSG A
	10,177	39	>75% Grass cover, Good, HSG A
	0	98	Paved parking, HSG A
	0	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	35,414	33	Weighted Average
	35,414		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.1	87	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	237	Total			

Subcatchment 3S: S-1



Summary for Subcatchment 4S: S-1

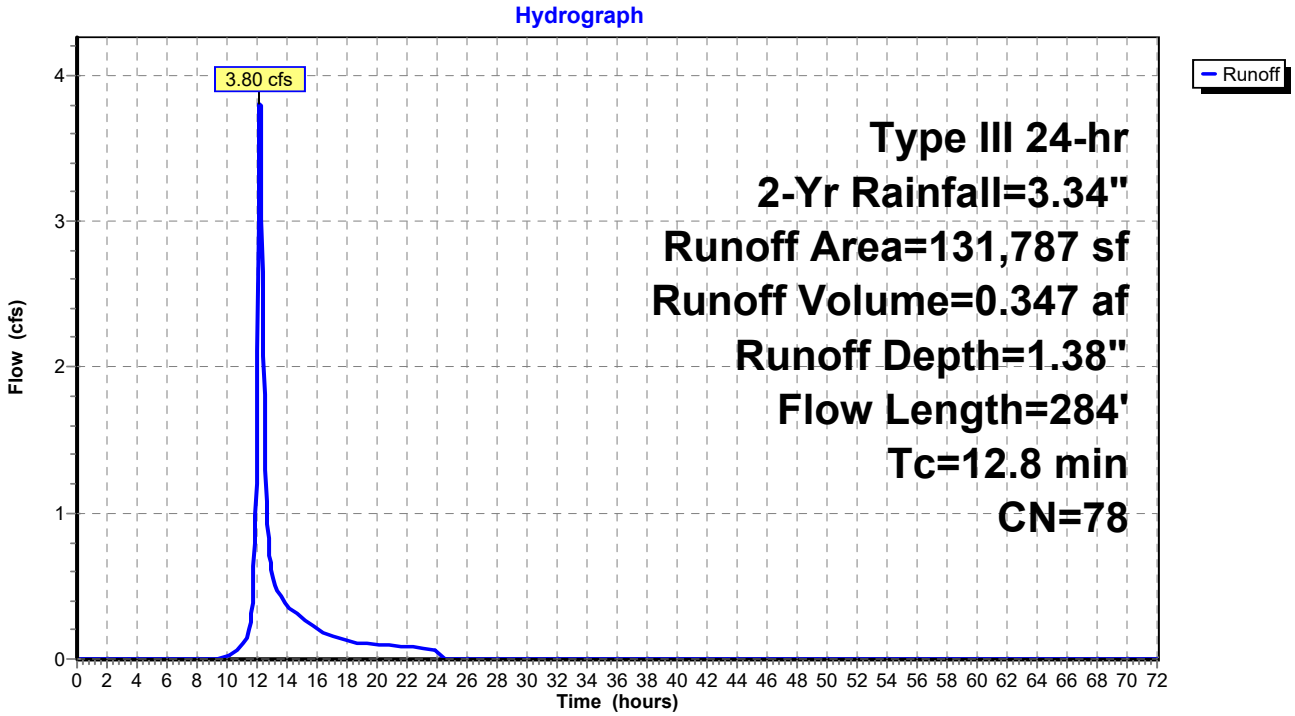
Runoff = 3.80 cfs @ 12.19 hrs, Volume= 0.347 af, Depth= 1.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Yr Rainfall=3.34"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
45,302	39	>75% Grass cover, Good, HSG A
45,338	98	Paved parking, HSG A
41,147	98	Roofs, HSG A
131,787	78	Weighted Average
45,302		34.38% Pervious Area
86,485		65.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
4.3	171	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	63	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.8	284	Total			

Subcatchment 4S: S-1

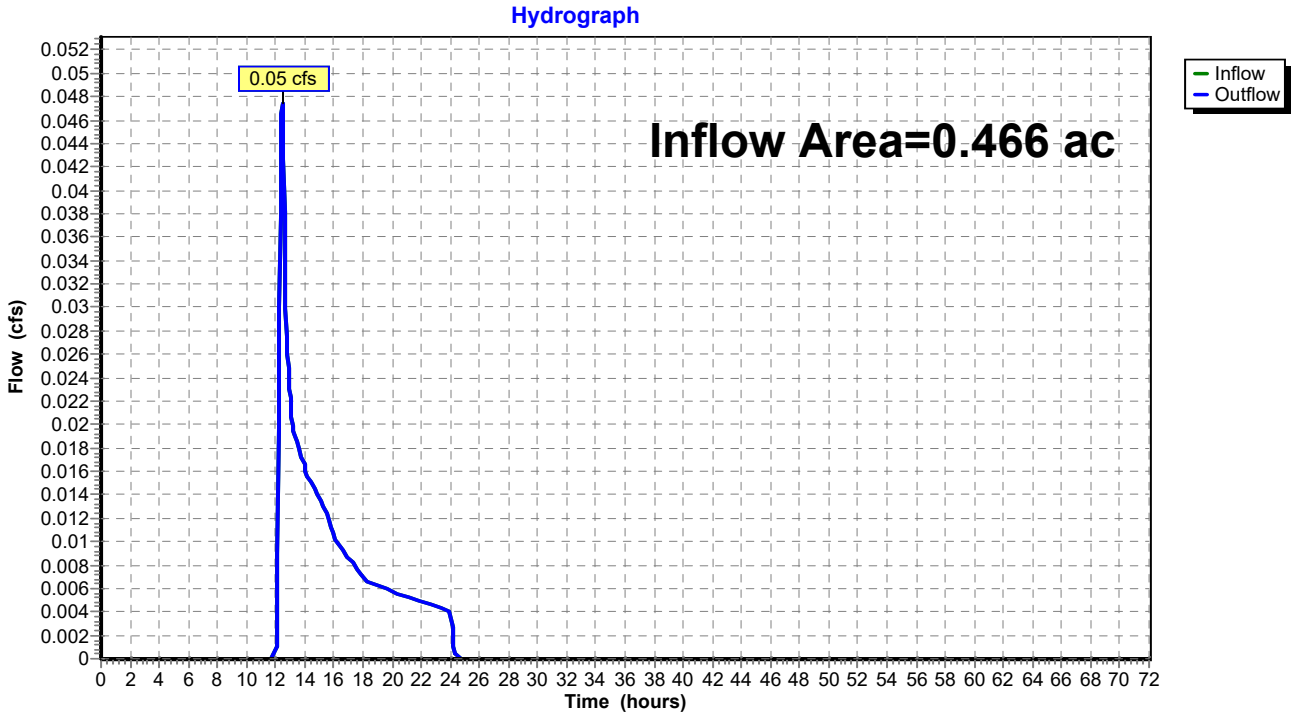


Summary for Reach DP1: Design Point 1

Inflow Area = 0.466 ac, 25.51% Impervious, Inflow Depth = 0.26" for 2-Yr event
Inflow = 0.05 cfs @ 12.44 hrs, Volume= 0.010 af
Outflow = 0.05 cfs @ 12.44 hrs, Volume= 0.010 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

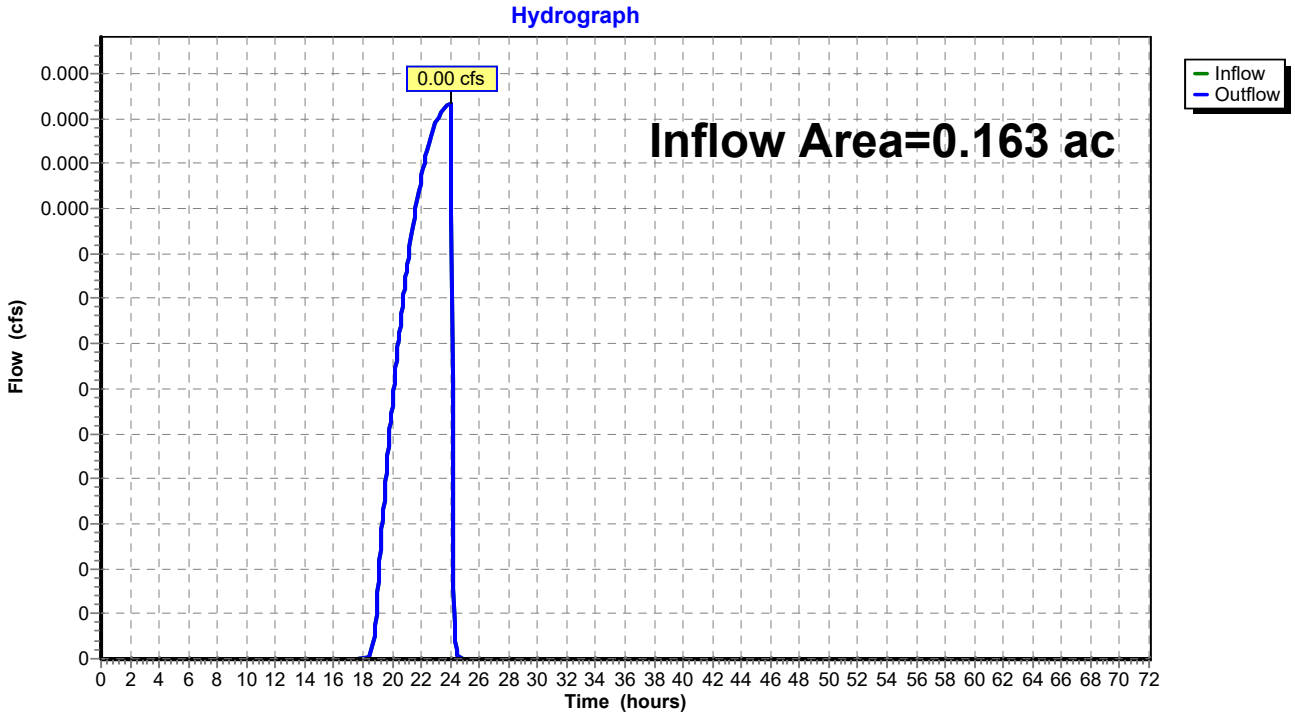


Summary for Reach DP2: Design Point 2

Inflow Area = 0.163 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Yr event
Inflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond 1P: Subsurface Chamber Sys

Inflow Area = 3.025 ac, 65.62% Impervious, Inflow Depth = 1.38" for 2-Yr event
Inflow = 3.80 cfs @ 12.19 hrs, Volume= 0.347 af
Outflow = 2.55 cfs @ 12.37 hrs, Volume= 0.347 af, Atten= 33%, Lag= 10.9 min
Discarded = 2.55 cfs @ 12.37 hrs, Volume= 0.347 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.33' @ 12.37 hrs Surf.Area= 6,369 sf Storage= 847 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.5 min (854.6 - 853.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	166.00'	8,057 cf	**49.92'W x 127.59'L x 5.25'H Field A** 33,437 cf Overall - 13,293 cf Embedded = 20,144 cf x 40.0% Voids
#2A	166.75'	13,293 cf	**ADS_StormTech MC-3500 d +Cap** x 119 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 119 Chambers in 7 Rows Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf
		21,350 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**16.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=2.54 cfs @ 12.37 hrs HW=166.33' (Free Discharge)
└**1=Exfiltration** (Controls 2.54 cfs)

Pond 1P: Subsurface Chamber Sys - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-3500 d +Cap (ADS StormTech® MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf

77.0" Wide + 6.0" Spacing = 83.0" C-C Row Spacing

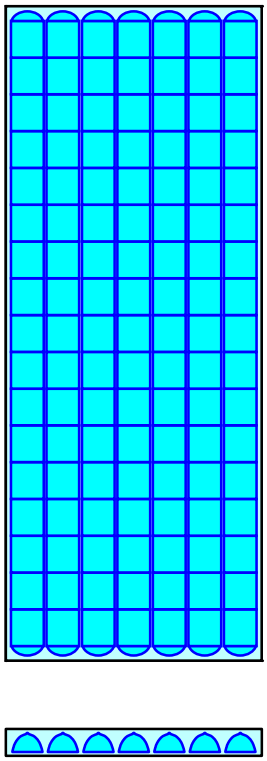
17 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 125.59' Row Length +12.0" End Stone x 2 = 127.59' Base Length
7 Rows x 77.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 49.92' Base Width
9.0" Base + 45.0" Chamber Height + 9.0" Cover = 5.25' Field Height

119 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 7 Rows = 13,292.9 cf Chamber Storage

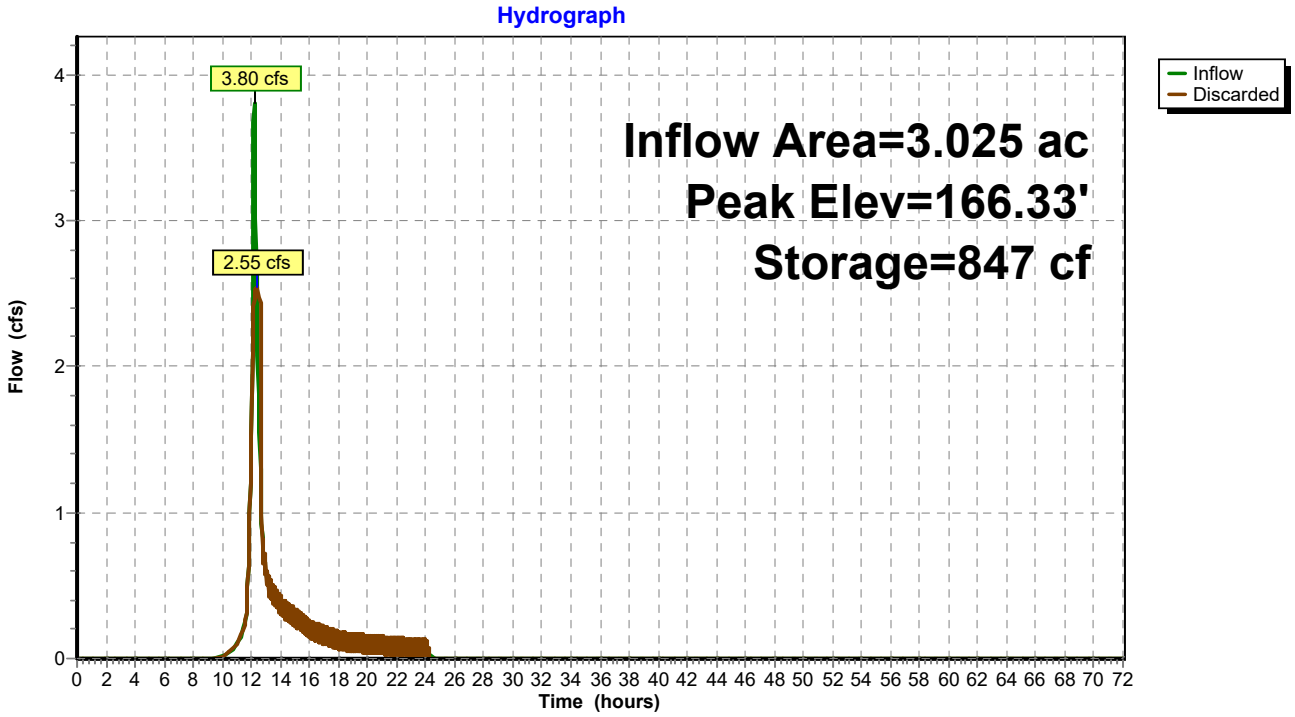
33,436.6 cf Field - 13,292.9 cf Chambers = 20,143.7 cf Stone x 40.0% Voids = 8,057.5 cf Stone Storage

Chamber Storage + Stone Storage = 21,350.4 cf = 0.490 af
Overall Storage Efficiency = 63.9%
Overall System Size = 127.59' x 49.92' x 5.25'

119 Chambers
1,238.4 cy Field
746.1 cy Stone



Pond 1P: Subsurface Chamber Sys



Summary for Pond DP3: Design Point 3

Inflow Area = 0.813 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

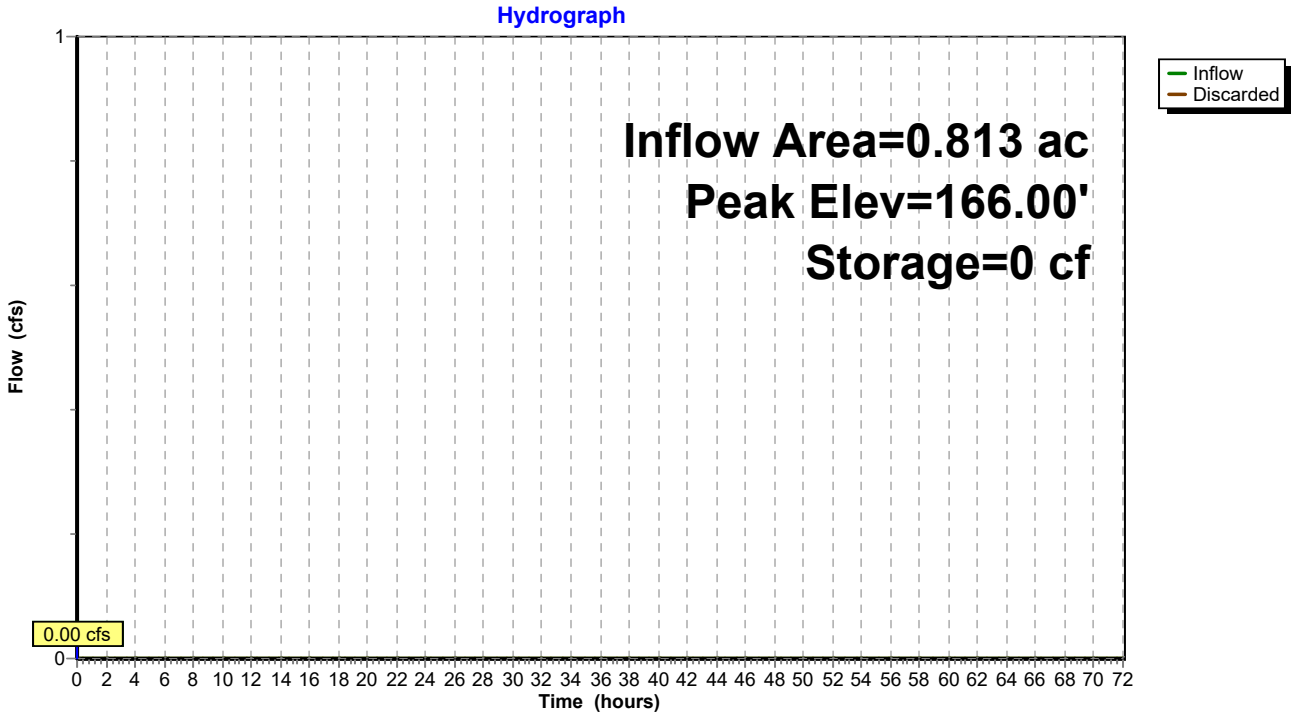
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=20,320 sf 25.51% Impervious Runoff Depth=0.89"
Flow Length=156' Slope=0.0100 '/' Tc=13.1 min CN=54 Runoff=0.29 cfs 0.034 af

Subcatchment 2S: S-2 Runoff Area=7,079 sf 0.00% Impervious Runoff Depth=0.19"
Flow Length=131' Tc=10.6 min CN=39 Runoff=0.00 cfs 0.003 af

Subcatchment 3S: S-1 Runoff Area=35,414 sf 0.00% Impervious Runoff Depth=0.04"
Flow Length=237' Tc=13.5 min CN=33 Runoff=0.00 cfs 0.002 af

Subcatchment 4S: S-1 Runoff Area=131,787 sf 65.62% Impervious Runoff Depth=2.65"
Flow Length=284' Tc=12.8 min CN=78 Runoff=7.46 cfs 0.669 af

Reach DP1: Design Point 1 Inflow=0.29 cfs 0.034 af
Outflow=0.29 cfs 0.034 af

Reach DP2: Design Point 2 Inflow=0.00 cfs 0.003 af
Outflow=0.00 cfs 0.003 af

Pond 1P: Subsurface Chamber Sys Peak Elev=167.27' Storage=4,786 cf Inflow=7.46 cfs 0.669 af
Outflow=3.07 cfs 0.671 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.00 cfs 0.002 af
Outflow=0.00 cfs 0.002 af

Total Runoff Area = 4.467 ac Runoff Volume = 0.708 af Average Runoff Depth = 1.90"
52.89% Pervious = 2.363 ac 47.11% Impervious = 2.104 ac

Summary for Subcatchment 1S: S-1

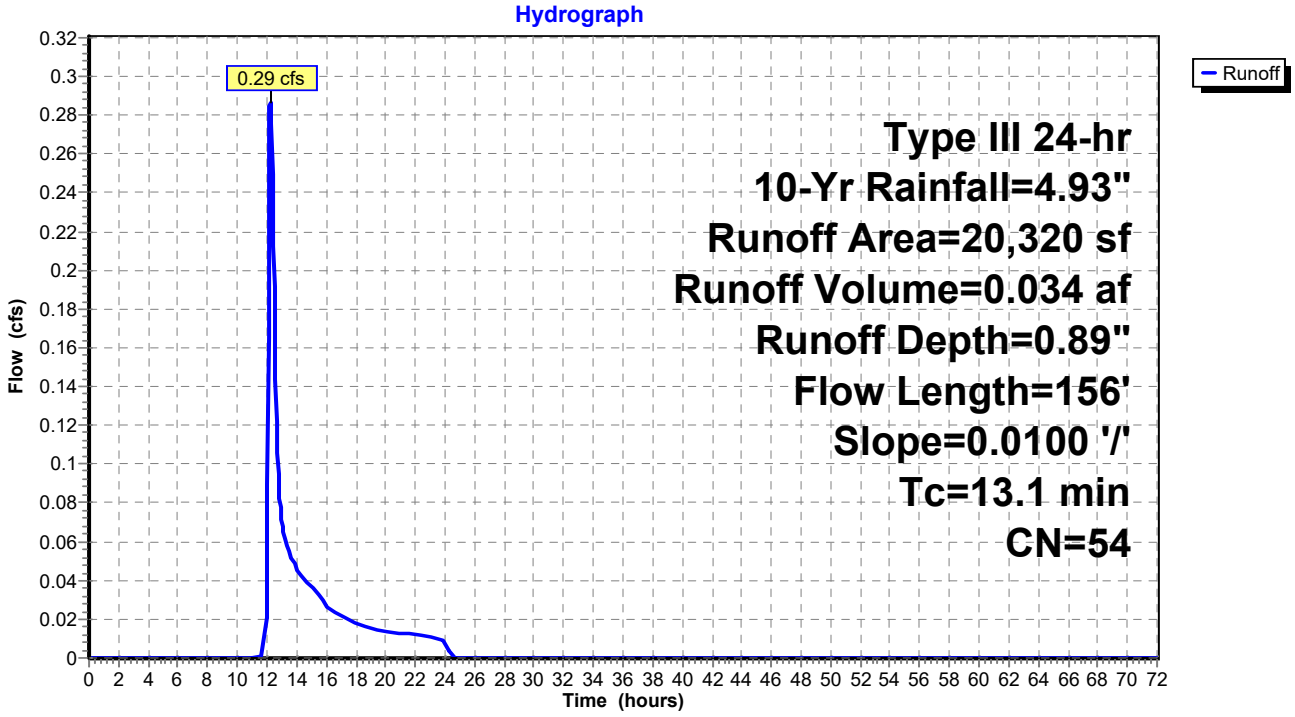
Runoff = 0.29 cfs @ 12.23 hrs, Volume= 0.034 af, Depth= 0.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
15,137	39	>75% Grass cover, Good, HSG A
2,323	98	Paved parking, HSG A
2,860	98	Roofs, HSG A
20,320	54	Weighted Average
15,137		74.49% Pervious Area
5,183		25.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.5	106	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.1	156	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-2

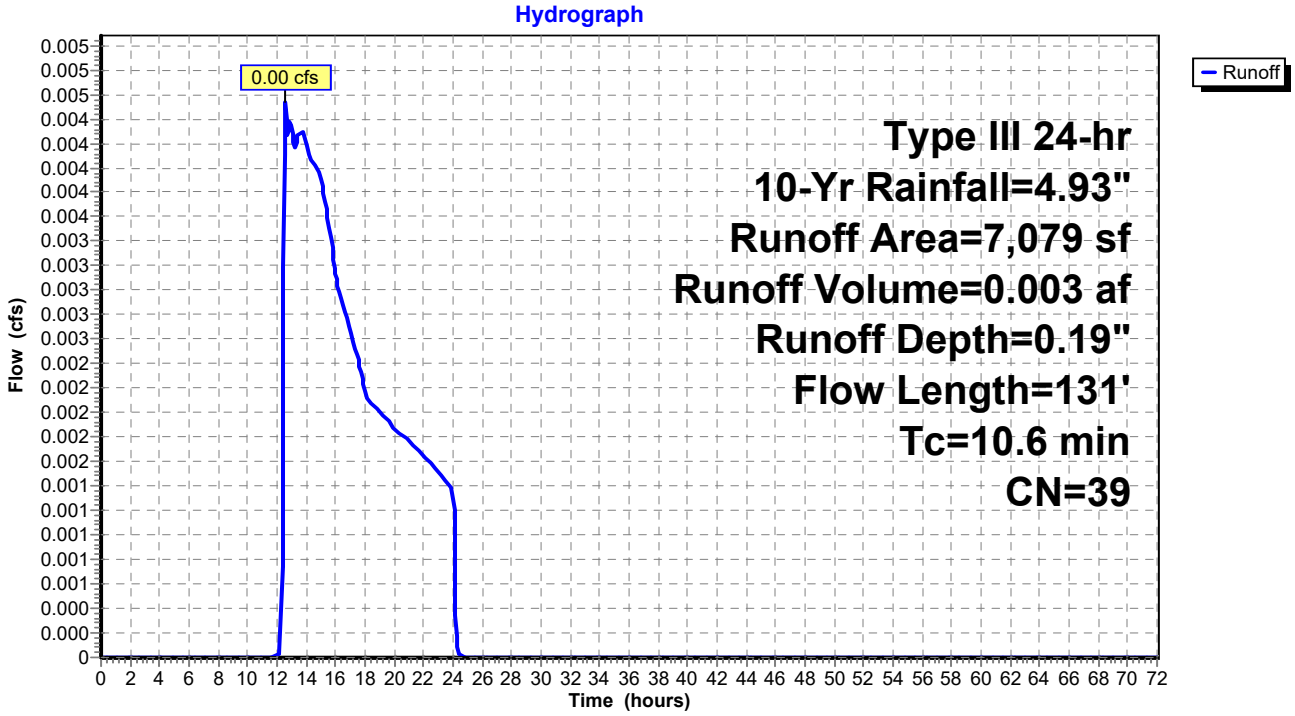
Runoff = 0.00 cfs @ 12.57 hrs, Volume= 0.003 af, Depth= 0.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
7,079	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
0	98	Roofs, HSG A
7,079	39	Weighted Average
7,079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0160	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
1.8	81	0.0120	0.77		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.6	131	Total			

Subcatchment 2S: S-2



Summary for Subcatchment 3S: S-1

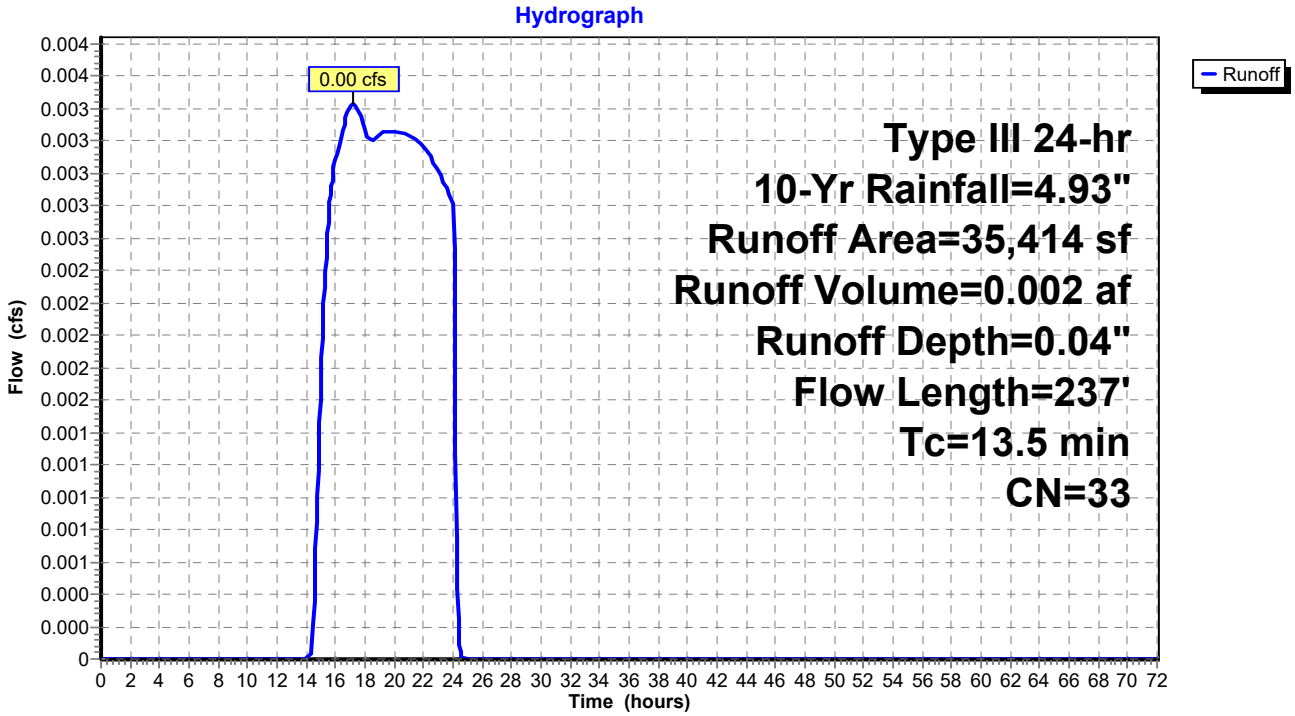
Runoff = 0.00 cfs @ 17.22 hrs, Volume= 0.002 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

	Area (sf)	CN	Description
	0	30	Woods, Good, HSG A
	10,177	39	>75% Grass cover, Good, HSG A
	0	98	Paved parking, HSG A
	0	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	35,414	33	Weighted Average
	35,414		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.1	87	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	237	Total			

Subcatchment 3S: S-1



Summary for Subcatchment 4S: S-1

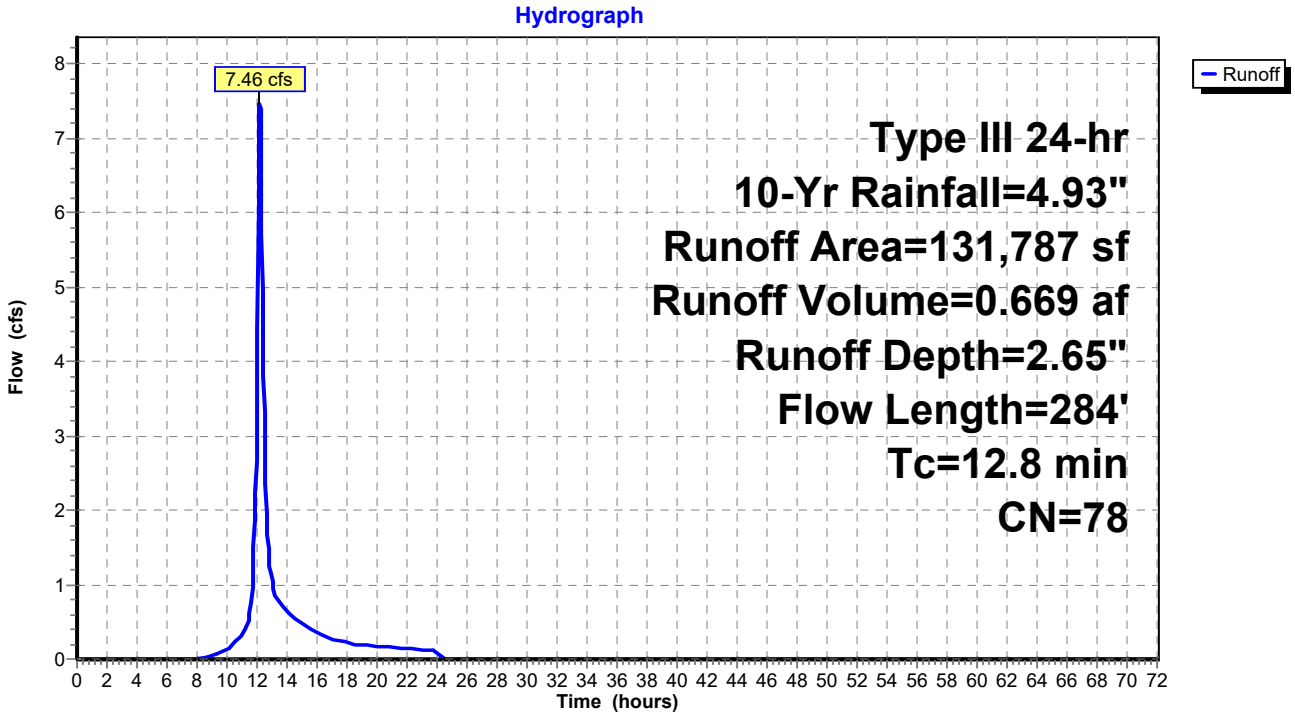
Runoff = 7.46 cfs @ 12.18 hrs, Volume= 0.669 af, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=4.93"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
45,302	39	>75% Grass cover, Good, HSG A
45,338	98	Paved parking, HSG A
41,147	98	Roofs, HSG A
131,787	78	Weighted Average
45,302		34.38% Pervious Area
86,485		65.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
4.3	171	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	63	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.8	284	Total			

Subcatchment 4S: S-1

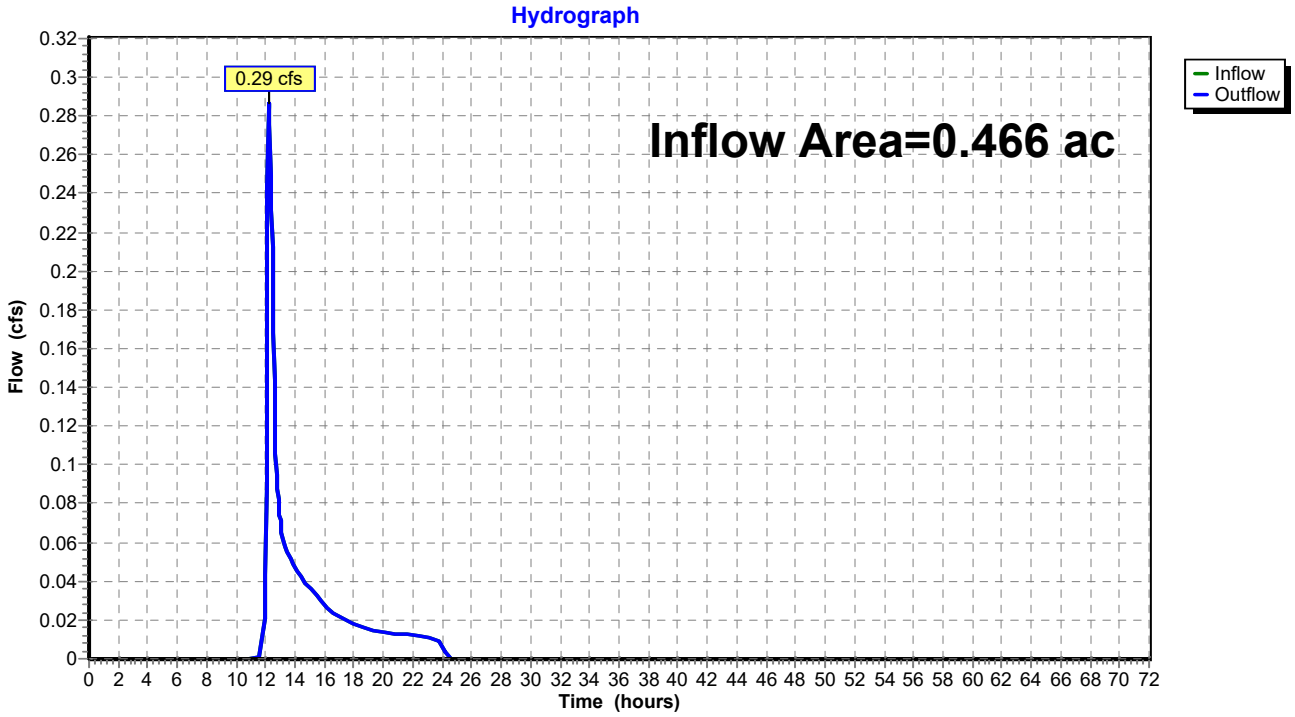


Summary for Reach DP1: Design Point 1

Inflow Area = 0.466 ac, 25.51% Impervious, Inflow Depth = 0.89" for 10-Yr event
Inflow = 0.29 cfs @ 12.23 hrs, Volume= 0.034 af
Outflow = 0.29 cfs @ 12.23 hrs, Volume= 0.034 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

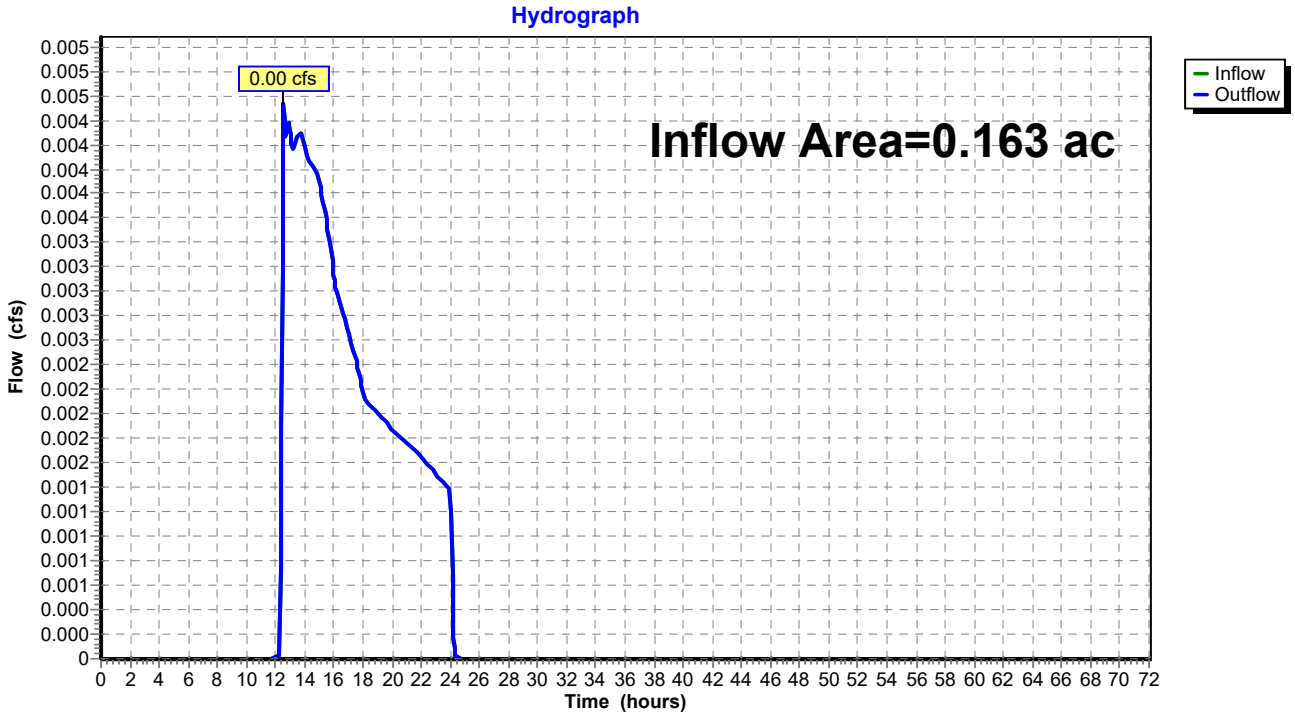


Summary for Reach DP2: Design Point 2

Inflow Area = 0.163 ac, 0.00% Impervious, Inflow Depth = 0.19" for 10-Yr event
Inflow = 0.00 cfs @ 12.57 hrs, Volume= 0.003 af
Outflow = 0.00 cfs @ 12.57 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond 1P: Subsurface Chamber Sys

Inflow Area = 3.025 ac, 65.62% Impervious, Inflow Depth = 2.65" for 10-Yr event
Inflow = 7.46 cfs @ 12.18 hrs, Volume= 0.669 af
Outflow = 3.07 cfs @ 12.52 hrs, Volume= 0.671 af, Atten= 59%, Lag= 20.7 min
Discarded = 3.07 cfs @ 12.52 hrs, Volume= 0.671 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 167.27' @ 12.52 hrs Surf.Area= 6,369 sf Storage= 4,786 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 8.4 min (842.5 - 834.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	166.00'	8,057 cf	**49.92'W x 127.59'L x 5.25'H Field A** 33,437 cf Overall - 13,293 cf Embedded = 20,144 cf x 40.0% Voids
#2A	166.75'	13,293 cf	**ADS_StormTech MC-3500 d +Cap** x 119 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 119 Chambers in 7 Rows Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf
		21,350 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**16.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=3.07 cfs @ 12.52 hrs HW=167.27' (Free Discharge)
└**1=Exfiltration** (Controls 3.07 cfs)

Pond 1P: Subsurface Chamber Sys - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-3500 d +Cap (ADS StormTech® MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf

77.0" Wide + 6.0" Spacing = 83.0" C-C Row Spacing

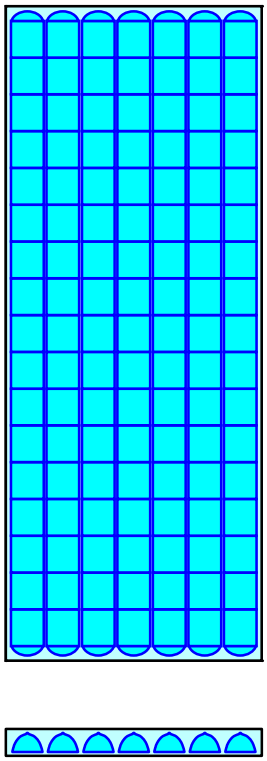
17 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 125.59' Row Length +12.0" End Stone x 2 = 127.59' Base Length
7 Rows x 77.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 49.92' Base Width
9.0" Base + 45.0" Chamber Height + 9.0" Cover = 5.25' Field Height

119 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 7 Rows = 13,292.9 cf Chamber Storage

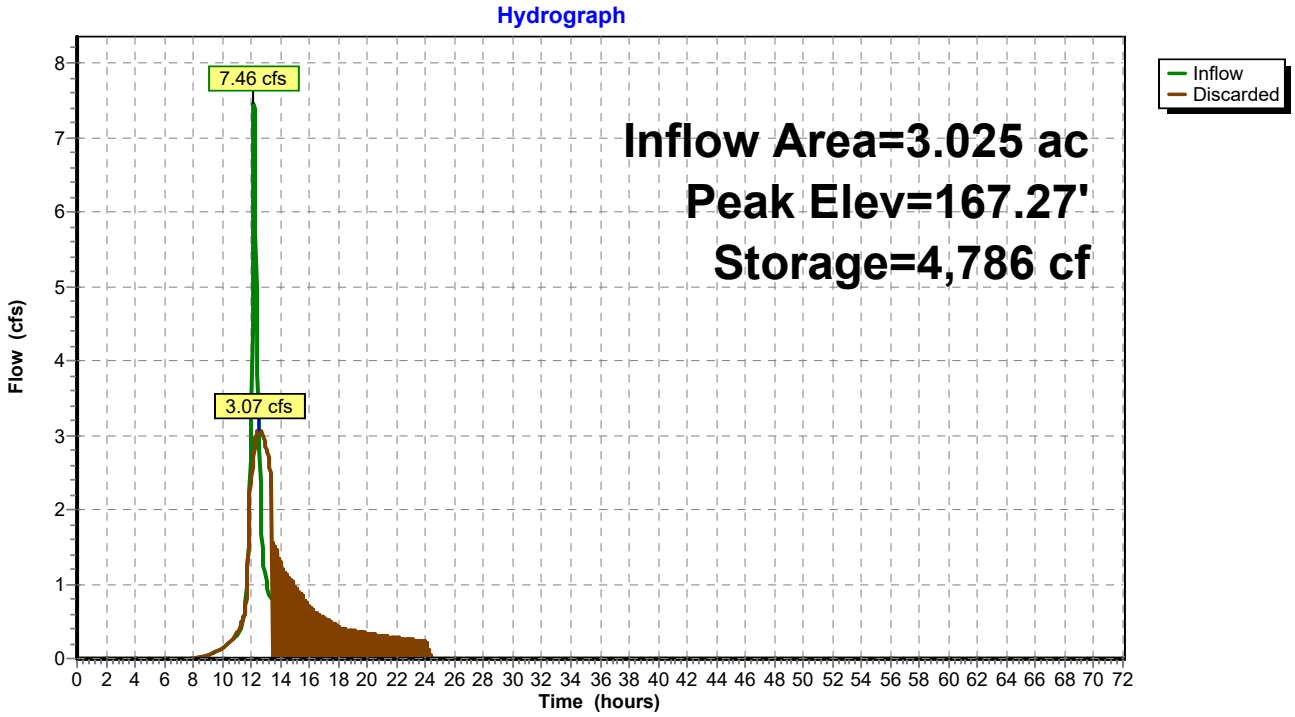
33,436.6 cf Field - 13,292.9 cf Chambers = 20,143.7 cf Stone x 40.0% Voids = 8,057.5 cf Stone Storage

Chamber Storage + Stone Storage = 21,350.4 cf = 0.490 af
Overall Storage Efficiency = 63.9%
Overall System Size = 127.59' x 49.92' x 5.25'

119 Chambers
1,238.4 cy Field
746.1 cy Stone



Pond 1P: Subsurface Chamber Sys



Summary for Pond DP3: Design Point 3

Inflow Area = 0.813 ac, 0.00% Impervious, Inflow Depth = 0.04" for 10-Yr event
Inflow = 0.00 cfs @ 17.22 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 17.22 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 17.22 hrs, Volume= 0.002 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 0.00 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,171.7 - 1,171.7)

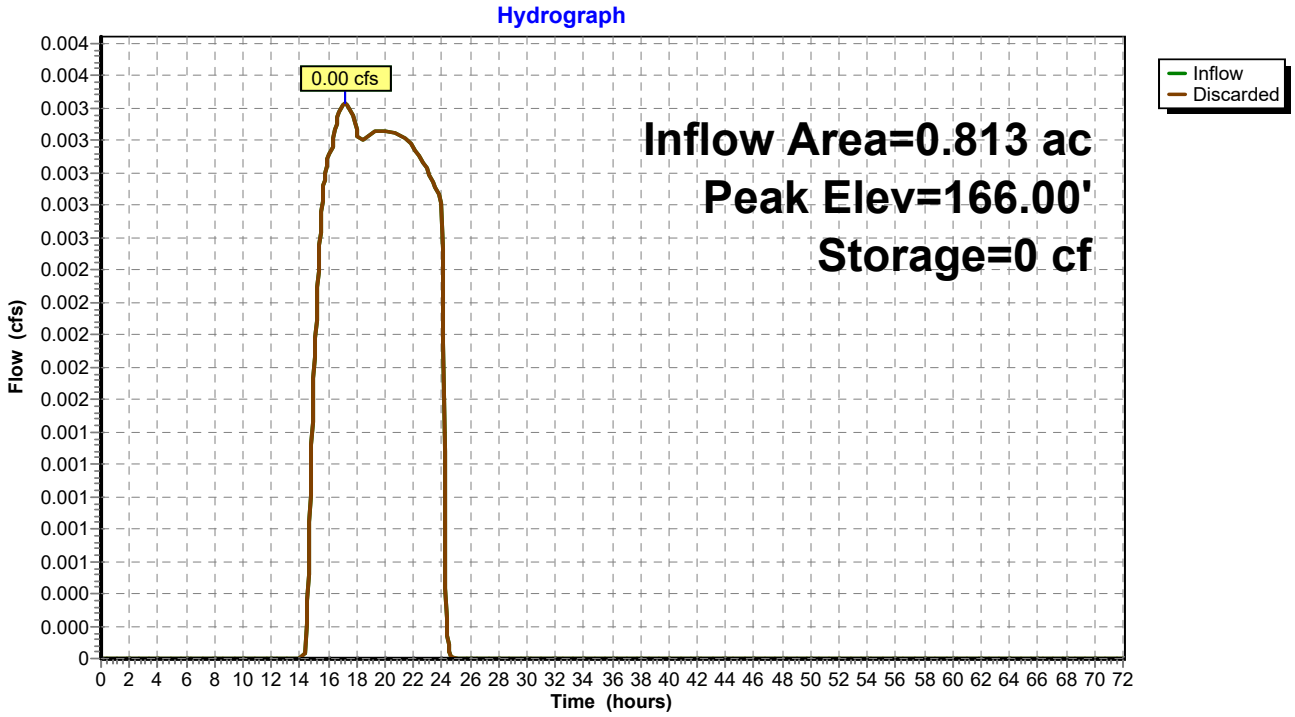
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.00 cfs @ 17.22 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.02 cfs potential flow)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=20,320 sf 25.51% Impervious Runoff Depth=1.54"
Flow Length=156' Slope=0.0100 '/' Tc=13.1 min CN=54 Runoff=0.58 cfs 0.060 af

Subcatchment 2S: S-2 Runoff Area=7,079 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=131' Tc=10.6 min CN=39 Runoff=0.03 cfs 0.007 af

Subcatchment 3S: S-1 Runoff Area=35,414 sf 0.00% Impervious Runoff Depth=0.20"
Flow Length=237' Tc=13.5 min CN=33 Runoff=0.02 cfs 0.013 af

Subcatchment 4S: S-1 Runoff Area=131,787 sf 65.62% Impervious Runoff Depth=3.73"
Flow Length=284' Tc=12.8 min CN=78 Runoff=10.49 cfs 0.940 af

Reach DP1: Design Point 1 Inflow=0.58 cfs 0.060 af
Outflow=0.58 cfs 0.060 af

Reach DP2: Design Point 2 Inflow=0.03 cfs 0.007 af
Outflow=0.03 cfs 0.007 af

Pond 1P: Subsurface Chamber Sys Peak Elev=168.03' Storage=8,871 cf Inflow=10.49 cfs 0.940 af
Outflow=3.50 cfs 0.941 af

Pond DP3: Design Point 3 Peak Elev=166.00' Storage=0 cf Inflow=0.02 cfs 0.013 af
Outflow=0.02 cfs 0.013 af

Total Runoff Area = 4.467 ac Runoff Volume = 1.020 af Average Runoff Depth = 2.74"
52.89% Pervious = 2.363 ac 47.11% Impervious = 2.104 ac

Summary for Subcatchment 1S: S-1

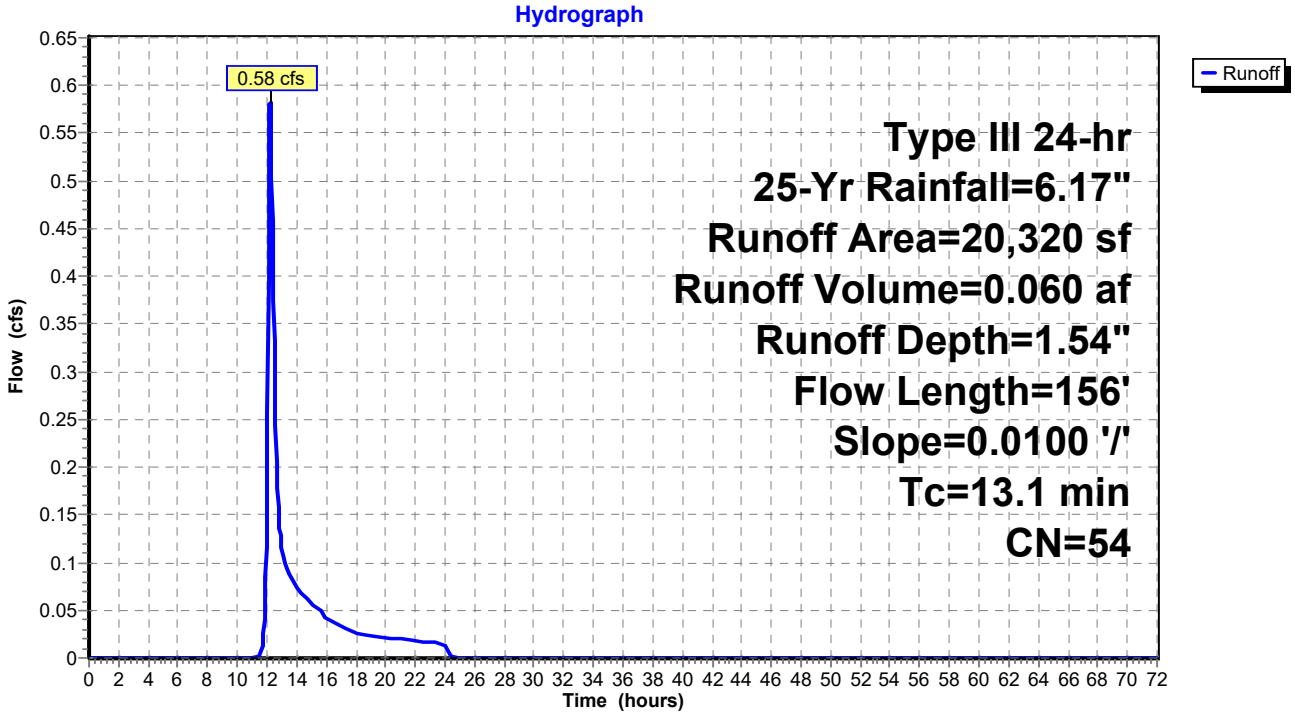
Runoff = 0.58 cfs @ 12.21 hrs, Volume= 0.060 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
15,137	39	>75% Grass cover, Good, HSG A
2,323	98	Paved parking, HSG A
2,860	98	Roofs, HSG A
20,320	54	Weighted Average
15,137		74.49% Pervious Area
5,183		25.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.5	106	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.1	156	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-2

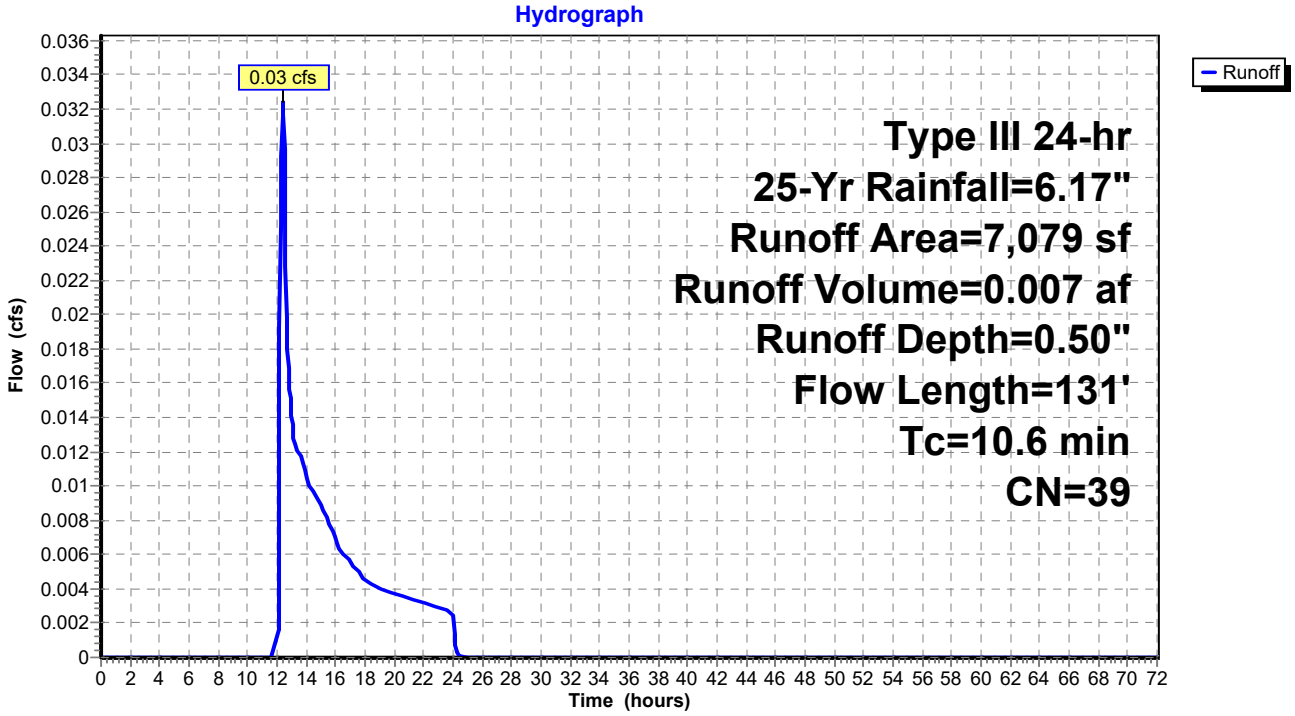
Runoff = 0.03 cfs @ 12.40 hrs, Volume= 0.007 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
7,079	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
0	98	Roofs, HSG A
7,079	39	Weighted Average
7,079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0160	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
1.8	81	0.0120	0.77		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.6	131	Total			

Subcatchment 2S: S-2



Summary for Subcatchment 3S: S-1

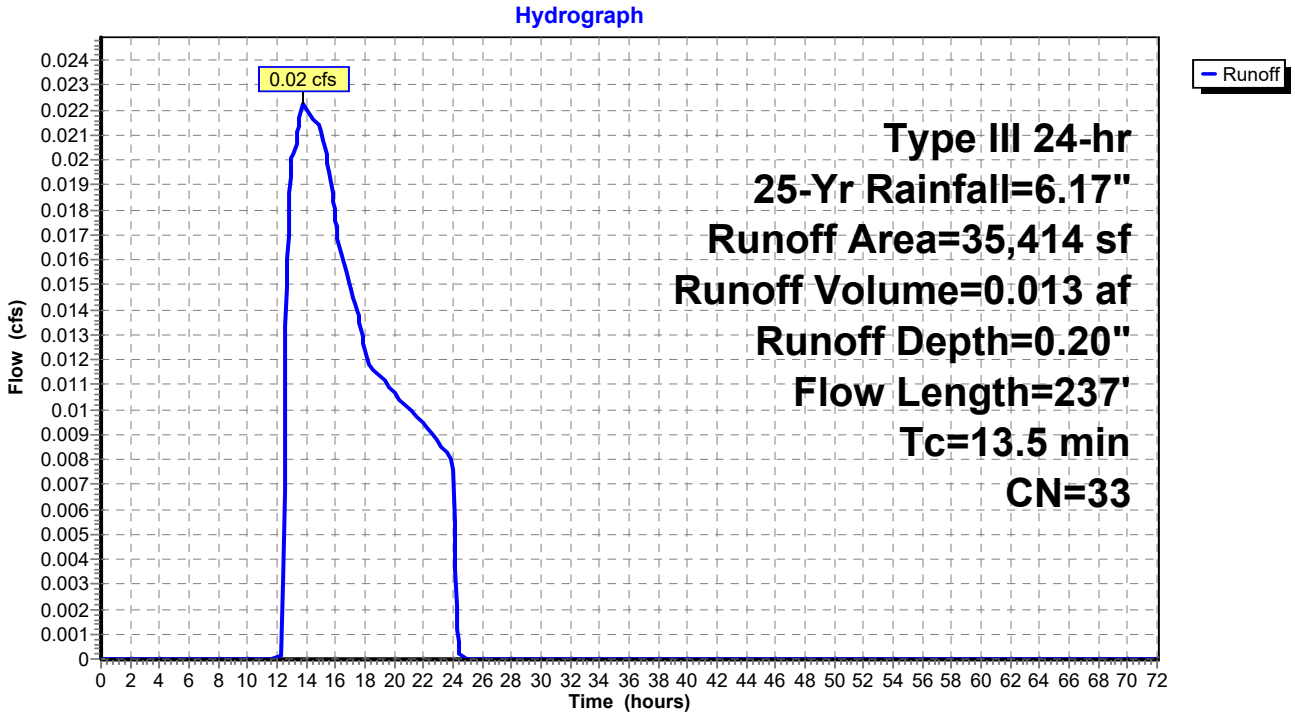
Runoff = 0.02 cfs @ 13.83 hrs, Volume= 0.013 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

	Area (sf)	CN	Description
	0	30	Woods, Good, HSG A
	10,177	39	>75% Grass cover, Good, HSG A
	0	98	Paved parking, HSG A
	0	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	35,414	33	Weighted Average
	35,414		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.1	87	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	237	Total			

Subcatchment 3S: S-1



Summary for Subcatchment 4S: S-1

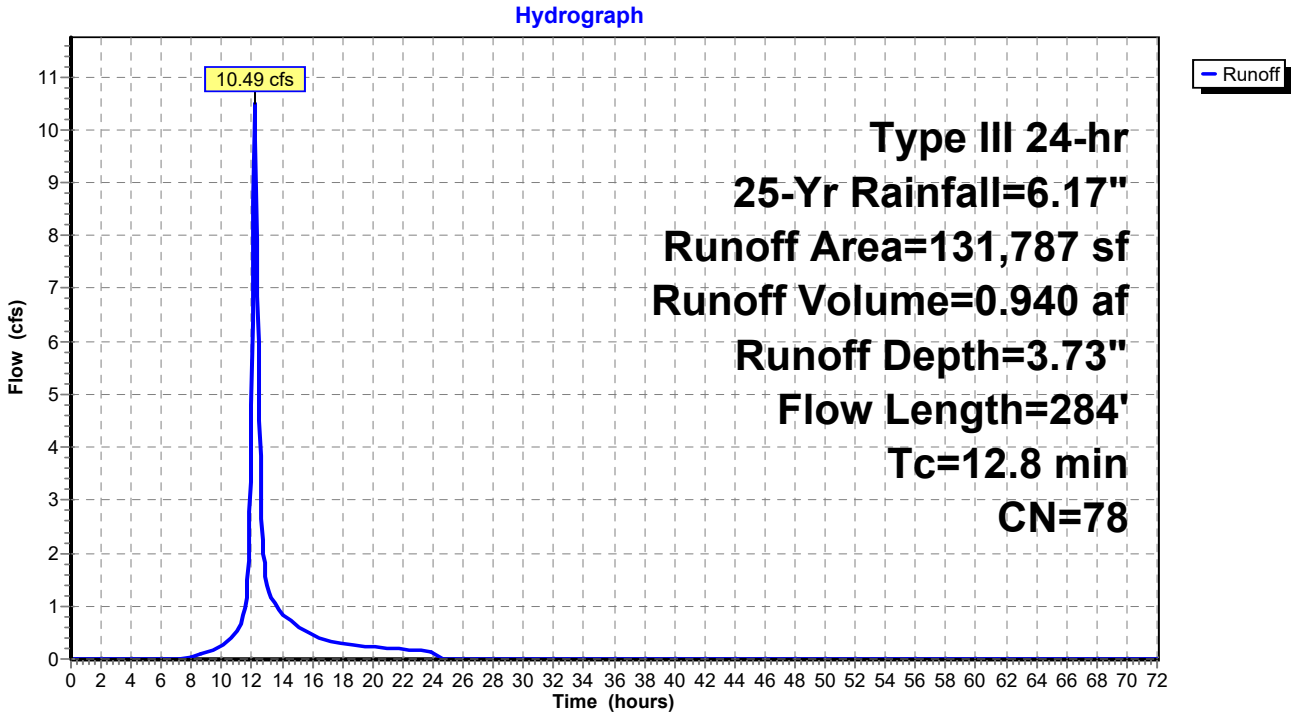
Runoff = 10.49 cfs @ 12.18 hrs, Volume= 0.940 af, Depth= 3.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Yr Rainfall=6.17"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
45,302	39	>75% Grass cover, Good, HSG A
45,338	98	Paved parking, HSG A
41,147	98	Roofs, HSG A
131,787	78	Weighted Average
45,302		34.38% Pervious Area
86,485		65.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
4.3	171	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	63	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.8	284	Total			

Subcatchment 4S: S-1

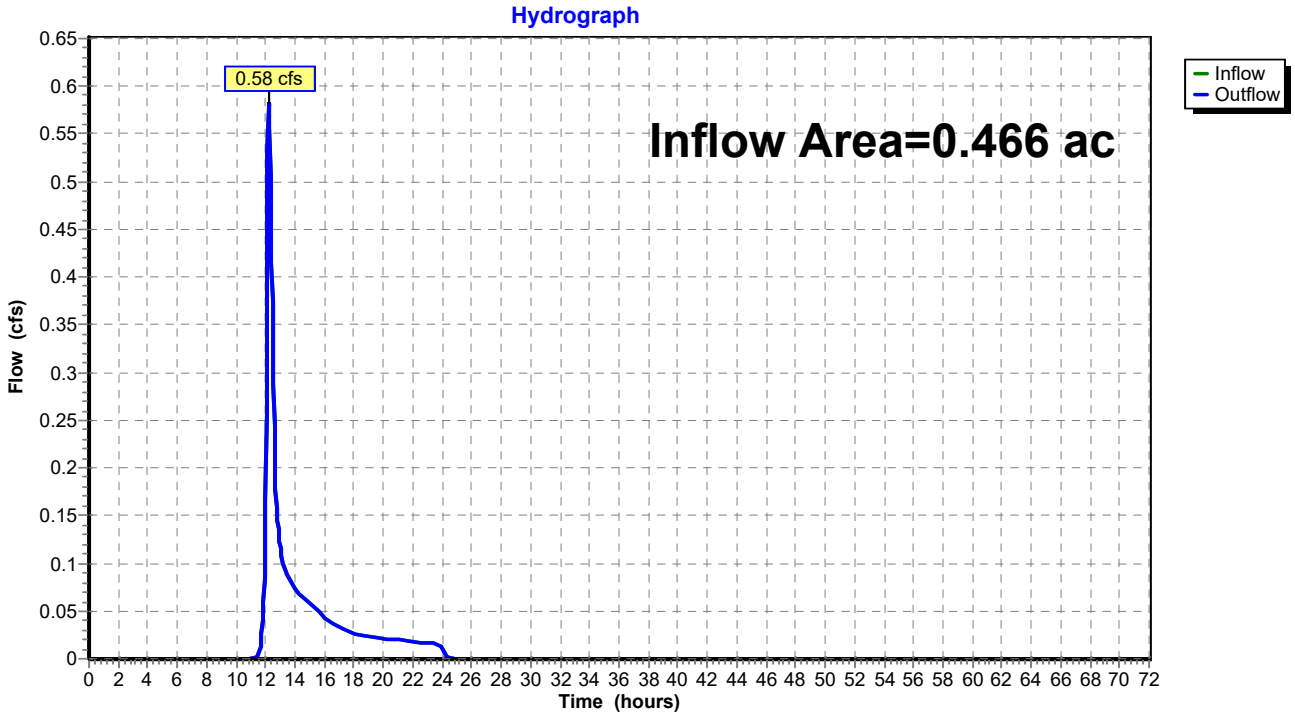


Summary for Reach DP1: Design Point 1

Inflow Area = 0.466 ac, 25.51% Impervious, Inflow Depth = 1.54" for 25-Yr event
Inflow = 0.58 cfs @ 12.21 hrs, Volume= 0.060 af
Outflow = 0.58 cfs @ 12.21 hrs, Volume= 0.060 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

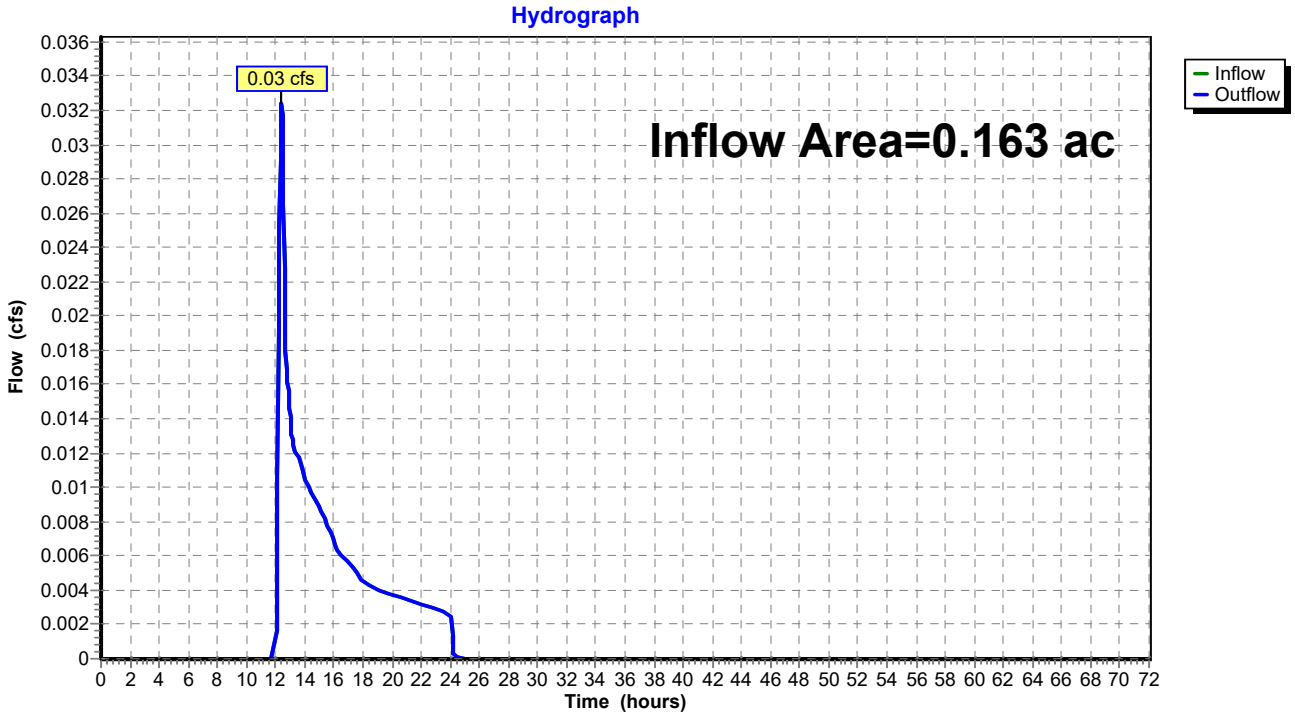


Summary for Reach DP2: Design Point 2

Inflow Area = 0.163 ac, 0.00% Impervious, Inflow Depth = 0.50" for 25-Yr event
Inflow = 0.03 cfs @ 12.40 hrs, Volume= 0.007 af
Outflow = 0.03 cfs @ 12.40 hrs, Volume= 0.007 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond 1P: Subsurface Chamber Sys

Inflow Area = 3.025 ac, 65.62% Impervious, Inflow Depth = 3.73" for 25-Yr event
Inflow = 10.49 cfs @ 12.18 hrs, Volume= 0.940 af
Outflow = 3.50 cfs @ 12.58 hrs, Volume= 0.941 af, Atten= 67%, Lag= 23.9 min
Discarded = 3.50 cfs @ 12.58 hrs, Volume= 0.941 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 168.03' @ 12.58 hrs Surf.Area= 6,369 sf Storage= 8,871 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 15.3 min (839.6 - 824.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	166.00'	8,057 cf	**49.92'W x 127.59'L x 5.25'H Field A** 33,437 cf Overall - 13,293 cf Embedded = 20,144 cf x 40.0% Voids
#2A	166.75'	13,293 cf	**ADS_StormTech MC-3500 d +Cap** x 119 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 119 Chambers in 7 Rows Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf
		21,350 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**16.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=3.50 cfs @ 12.58 hrs HW=168.03' (Free Discharge)
└**1=Exfiltration** (Controls 3.50 cfs)

Pond 1P: Subsurface Chamber Sys - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-3500 d +Cap (ADS StormTech® MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf

77.0" Wide + 6.0" Spacing = 83.0" C-C Row Spacing

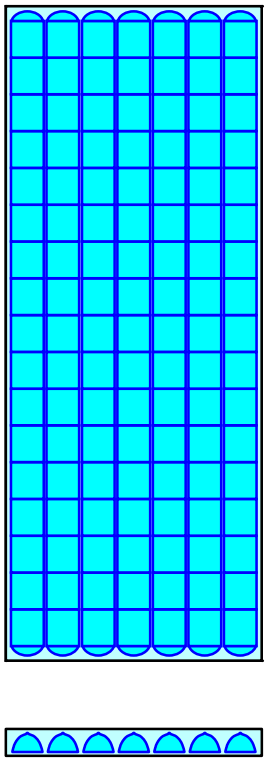
17 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 125.59' Row Length +12.0" End Stone x 2 = 127.59' Base Length
7 Rows x 77.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 49.92' Base Width
9.0" Base + 45.0" Chamber Height + 9.0" Cover = 5.25' Field Height

119 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 7 Rows = 13,292.9 cf Chamber Storage

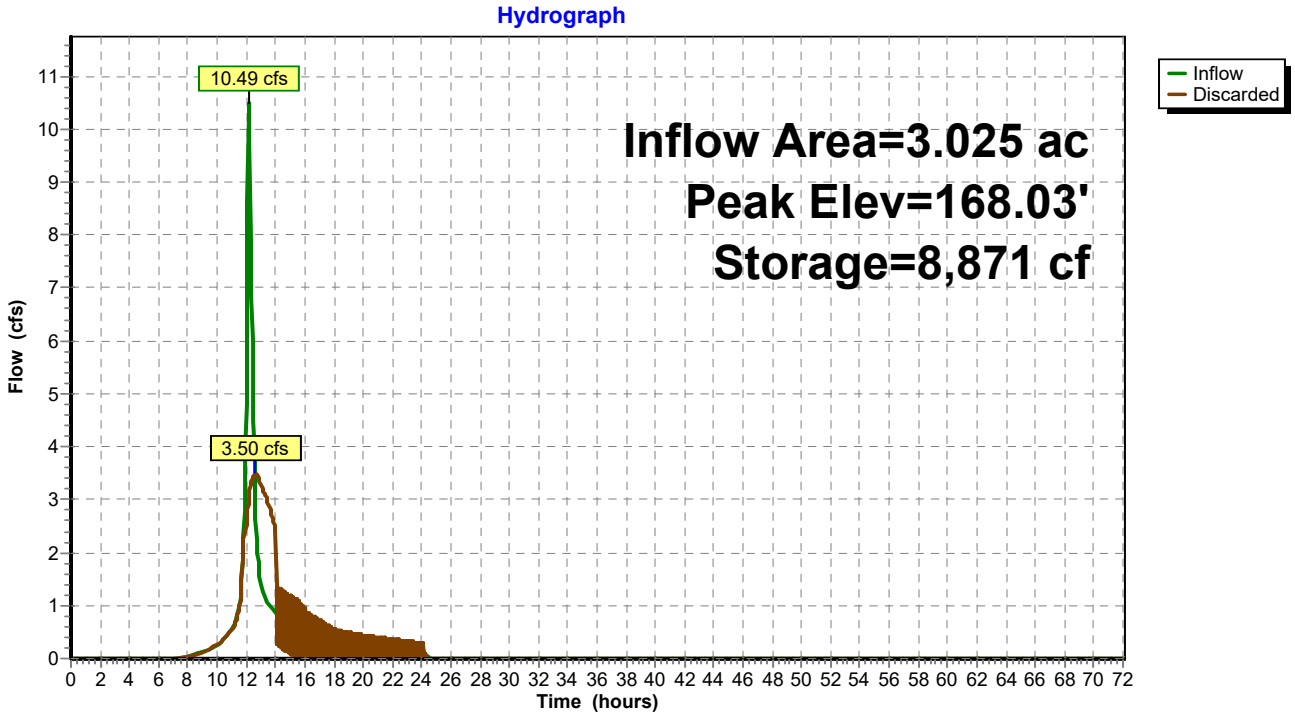
33,436.6 cf Field - 13,292.9 cf Chambers = 20,143.7 cf Stone x 40.0% Voids = 8,057.5 cf Stone Storage

Chamber Storage + Stone Storage = 21,350.4 cf = 0.490 af
Overall Storage Efficiency = 63.9%
Overall System Size = 127.59' x 49.92' x 5.25'

119 Chambers
1,238.4 cy Field
746.1 cy Stone



Pond 1P: Subsurface Chamber Sys



Summary for Pond DP3: Design Point 3

Inflow Area = 0.813 ac, 0.00% Impervious, Inflow Depth = 0.20" for 25-Yr event
Inflow = 0.02 cfs @ 13.83 hrs, Volume= 0.013 af
Outflow = 0.02 cfs @ 13.83 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.5 min
Discarded = 0.02 cfs @ 13.83 hrs, Volume= 0.013 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.00' @ 13.83 hrs Surf.Area= 432 sf Storage= 0 cf

Plug-Flow detention time= 0.0 min calculated for 0.013 af (100% of inflow)
Center-of-Mass det. time= 0.0 min (1,036.5 - 1,036.5)

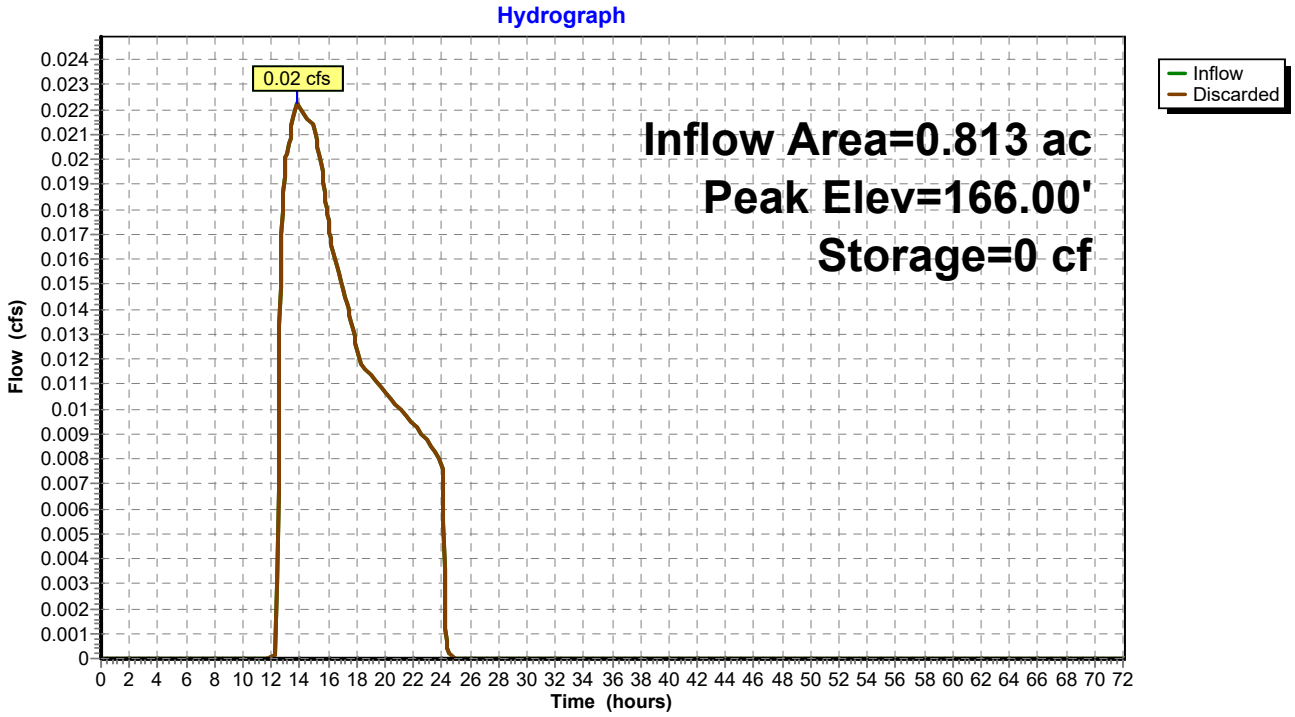
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.02 cfs @ 13.83 hrs HW=166.00' (Free Discharge)
└**1=Exfiltration** (Controls 0.02 cfs)

Pond DP3: Design Point 3



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: S-1 Runoff Area=20,320 sf 25.51% Impervious Runoff Depth=3.14"
Flow Length=156' Slope=0.0100 '/' Tc=13.1 min CN=54 Runoff=1.30 cfs 0.122 af

Subcatchment 2S: S-2 Runoff Area=7,079 sf 0.00% Impervious Runoff Depth=1.45"
Flow Length=131' Tc=10.6 min CN=39 Runoff=0.17 cfs 0.020 af

Subcatchment 3S: S-1 Runoff Area=35,414 sf 0.00% Impervious Runoff Depth=0.86"
Flow Length=237' Tc=13.5 min CN=33 Runoff=0.31 cfs 0.058 af

Subcatchment 4S: S-1 Runoff Area=131,787 sf 65.62% Impervious Runoff Depth=6.02"
Flow Length=284' Tc=12.8 min CN=78 Runoff=16.85 cfs 1.518 af

Reach DP1: Design Point 1 Inflow=1.30 cfs 0.122 af
Outflow=1.30 cfs 0.122 af

Reach DP2: Design Point 2 Inflow=0.17 cfs 0.020 af
Outflow=0.17 cfs 0.020 af

Pond 1P: Subsurface Chamber Sys Peak Elev=170.00' Storage=17,955 cf Inflow=16.85 cfs 1.518 af
Outflow=4.60 cfs 1.519 af

Pond DP3: Design Point 3 Peak Elev=166.71' Storage=609 cf Inflow=0.31 cfs 0.058 af
Outflow=0.08 cfs 0.058 af

Total Runoff Area = 4.467 ac Runoff Volume = 1.718 af Average Runoff Depth = 4.62"
52.89% Pervious = 2.363 ac 47.11% Impervious = 2.104 ac

Summary for Subcatchment 1S: S-1

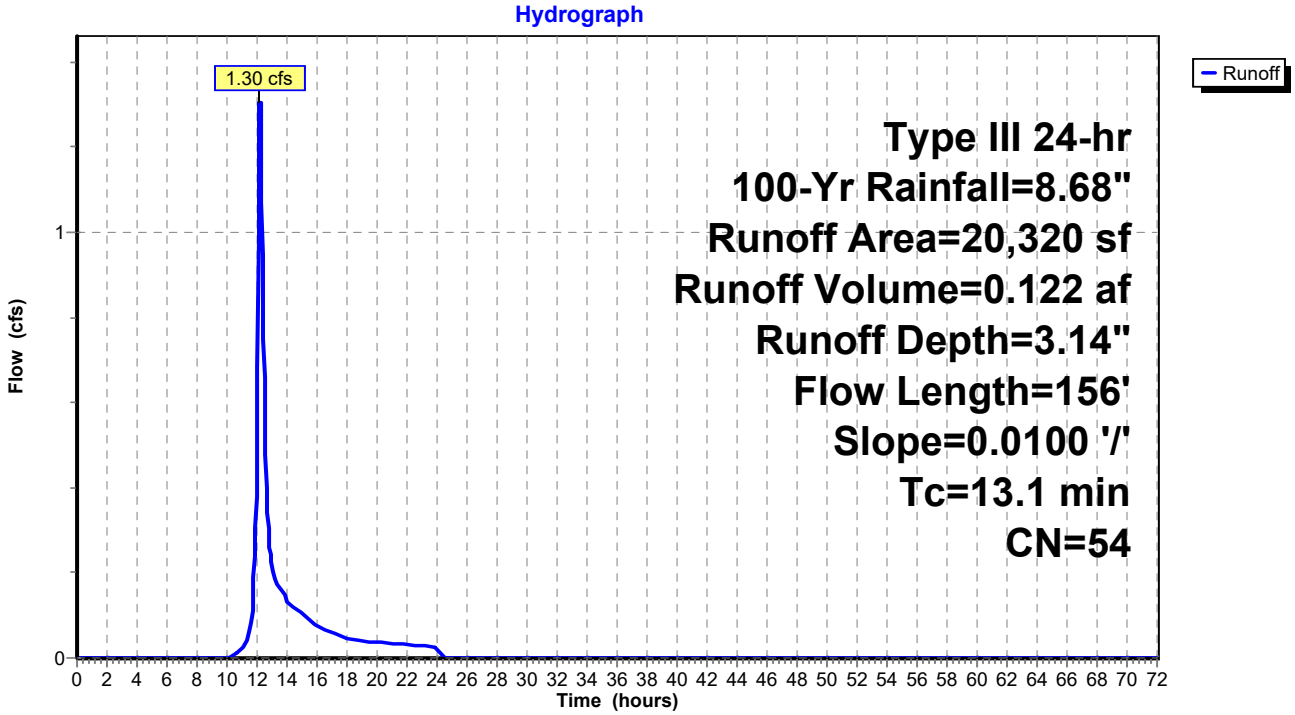
Runoff = 1.30 cfs @ 12.20 hrs, Volume= 0.122 af, Depth= 3.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
15,137	39	>75% Grass cover, Good, HSG A
2,323	98	Paved parking, HSG A
2,860	98	Roofs, HSG A
20,320	54	Weighted Average
15,137		74.49% Pervious Area
5,183		25.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.5	106	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.1	156	Total			

Subcatchment 1S: S-1



Summary for Subcatchment 2S: S-2

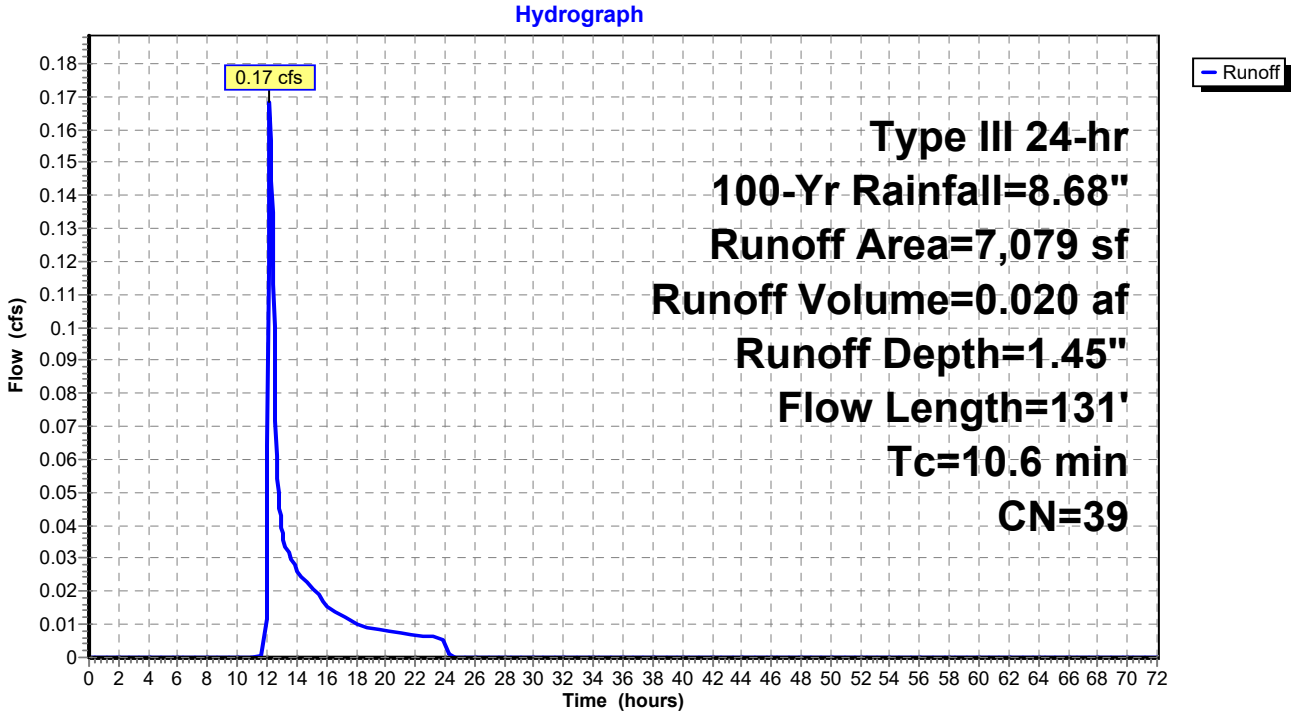
Runoff = 0.17 cfs @ 12.19 hrs, Volume= 0.020 af, Depth= 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
7,079	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
0	98	Roofs, HSG A
7,079	39	Weighted Average
7,079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.8	50	0.0160	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
1.8	81	0.0120	0.77		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.6	131	Total			

Subcatchment 2S: S-2



Summary for Subcatchment 3S: S-1

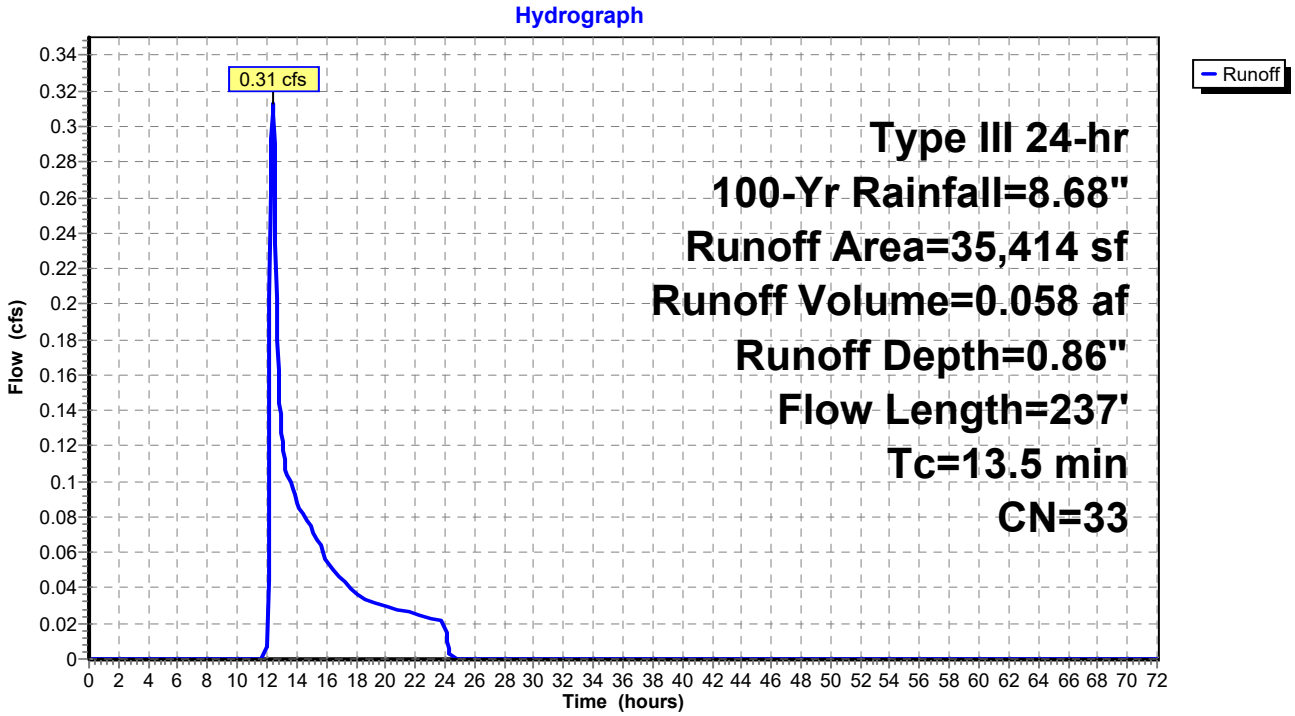
Runoff = 0.31 cfs @ 12.40 hrs, Volume= 0.058 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

	Area (sf)	CN	Description
	0	30	Woods, Good, HSG A
	10,177	39	>75% Grass cover, Good, HSG A
	0	98	Paved parking, HSG A
	0	98	Roofs, HSG A
*	25,237	30	Woods, Good, HSG A (off site)
	35,414	33	Weighted Average
	35,414		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
2.1	87	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.5	237	Total			

Subcatchment 3S: S-1



Summary for Subcatchment 4S: S-1

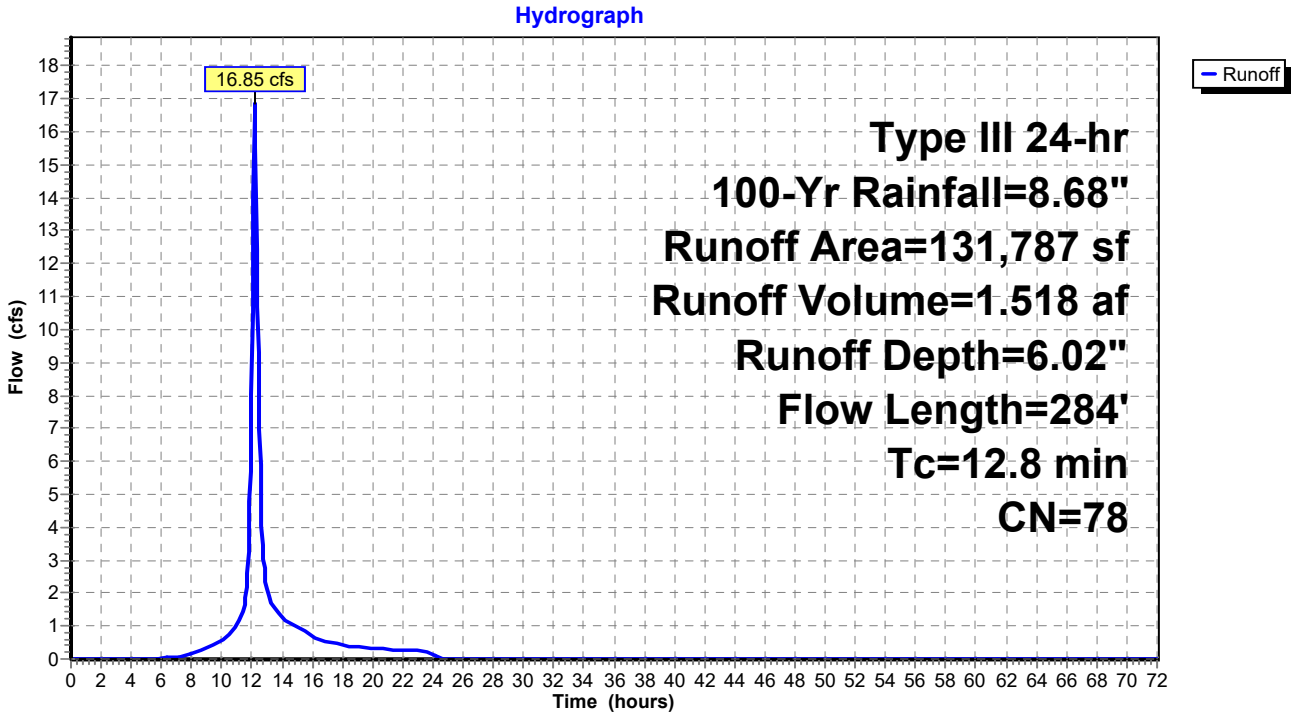
Runoff = 16.85 cfs @ 12.17 hrs, Volume= 1.518 af, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.68"

Area (sf)	CN	Description
0	30	Woods, Good, HSG A
45,302	39	>75% Grass cover, Good, HSG A
45,338	98	Paved parking, HSG A
41,147	98	Roofs, HSG A
131,787	78	Weighted Average
45,302		34.38% Pervious Area
86,485		65.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.34"
4.3	171	0.0090	0.66		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	63	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
12.8	284	Total			

Subcatchment 4S: S-1

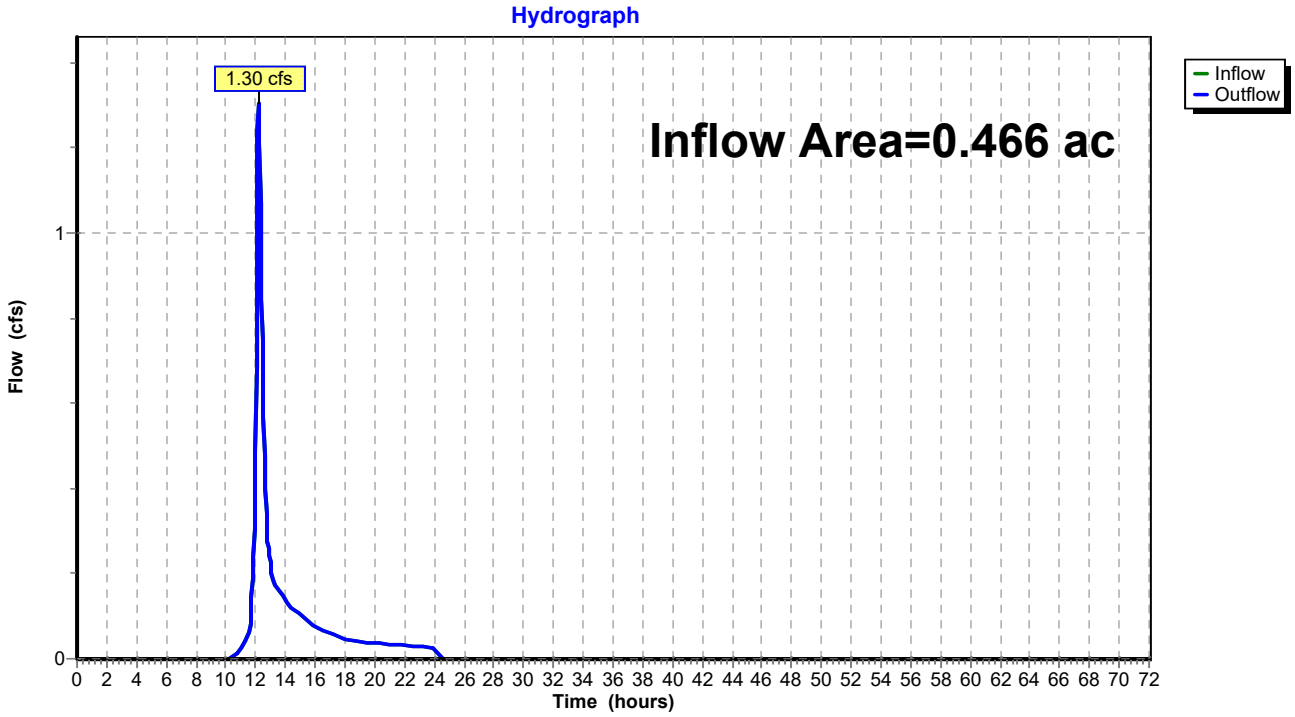


Summary for Reach DP1: Design Point 1

Inflow Area = 0.466 ac, 25.51% Impervious, Inflow Depth = 3.14" for 100-Yr event
Inflow = 1.30 cfs @ 12.20 hrs, Volume= 0.122 af
Outflow = 1.30 cfs @ 12.20 hrs, Volume= 0.122 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP1: Design Point 1

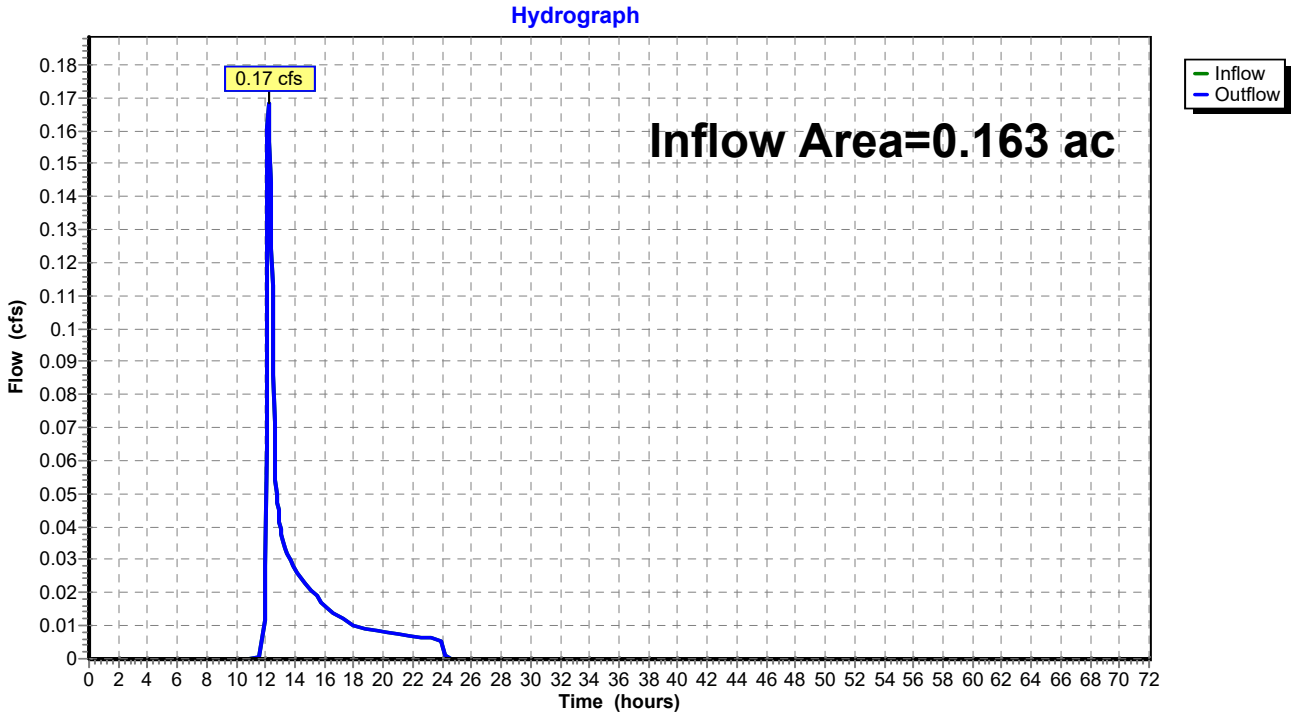


Summary for Reach DP2: Design Point 2

Inflow Area = 0.163 ac, 0.00% Impervious, Inflow Depth = 1.45" for 100-Yr event
Inflow = 0.17 cfs @ 12.19 hrs, Volume= 0.020 af
Outflow = 0.17 cfs @ 12.19 hrs, Volume= 0.020 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach DP2: Design Point 2



Summary for Pond 1P: Subsurface Chamber Sys

Inflow Area = 3.025 ac, 65.62% Impervious, Inflow Depth = 6.02" for 100-Yr event
Inflow = 16.85 cfs @ 12.17 hrs, Volume= 1.518 af
Outflow = 4.60 cfs @ 12.62 hrs, Volume= 1.519 af, Atten= 73%, Lag= 26.7 min
Discarded = 4.60 cfs @ 12.62 hrs, Volume= 1.519 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 170.00' @ 12.62 hrs Surf.Area= 6,369 sf Storage= 17,955 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 27.9 min (838.6 - 810.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	166.00'	8,057 cf	**49.92'W x 127.59'L x 5.25'H Field A** 33,437 cf Overall - 13,293 cf Embedded = 20,144 cf x 40.0% Voids
#2A	166.75'	13,293 cf	**ADS_StormTech MC-3500 d +Cap** x 119 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 119 Chambers in 7 Rows Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf
		21,350 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**16.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=4.60 cfs @ 12.62 hrs HW=169.99' (Free Discharge)
└**1=Exfiltration** (Controls 4.60 cfs)

Pond 1P: Subsurface Chamber Sys - Chamber Wizard Field A

Chamber Model = ADS_StormTech MC-3500 d +Cap (ADS StormTech® MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 7 rows = 208.6 cf

77.0" Wide + 6.0" Spacing = 83.0" C-C Row Spacing

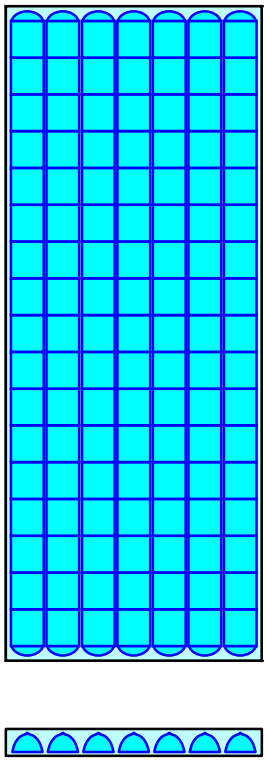
17 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 125.59' Row Length +12.0" End Stone x 2 = 127.59' Base Length
7 Rows x 77.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 49.92' Base Width
9.0" Base + 45.0" Chamber Height + 9.0" Cover = 5.25' Field Height

119 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 7 Rows = 13,292.9 cf Chamber Storage

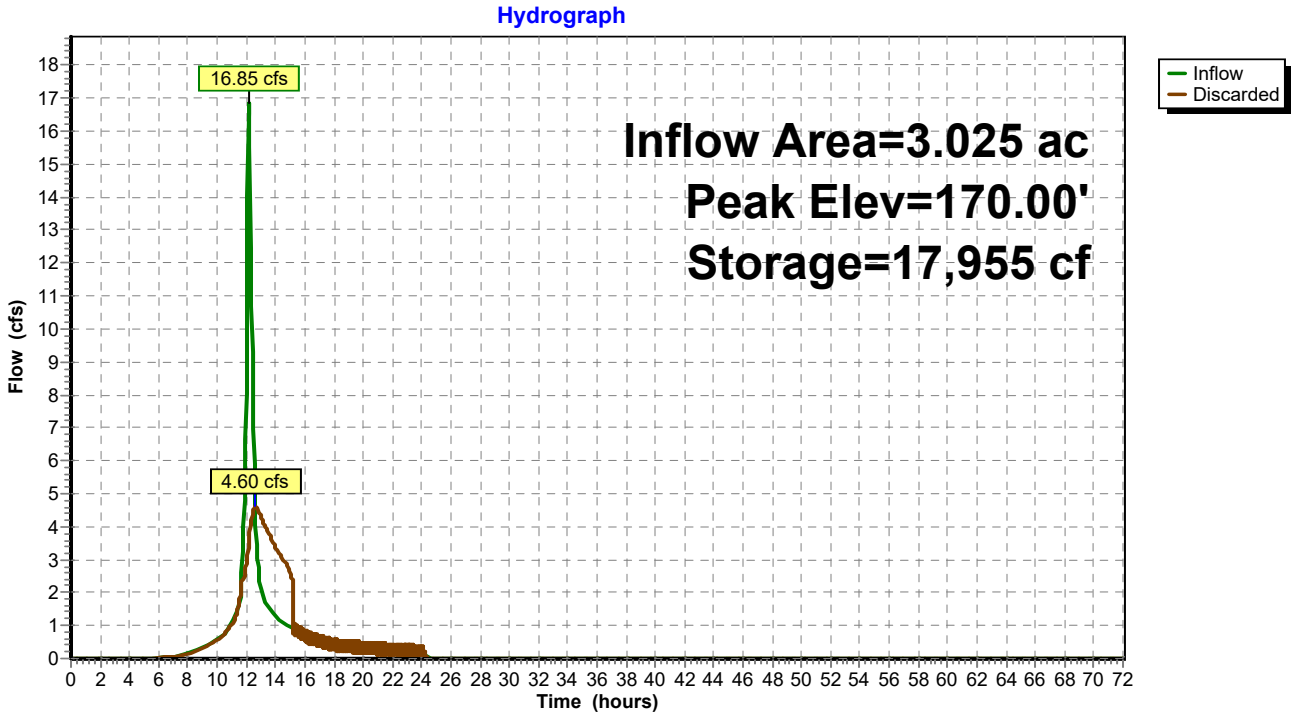
33,436.6 cf Field - 13,292.9 cf Chambers = 20,143.7 cf Stone x 40.0% Voids = 8,057.5 cf Stone Storage

Chamber Storage + Stone Storage = 21,350.4 cf = 0.490 af
Overall Storage Efficiency = 63.9%
Overall System Size = 127.59' x 49.92' x 5.25'

119 Chambers
1,238.4 cy Field
746.1 cy Stone



Pond 1P: Subsurface Chamber Sys



Summary for Pond DP3: Design Point 3

Inflow Area = 0.813 ac, 0.00% Impervious, Inflow Depth = 0.86" for 100-Yr event
Inflow = 0.31 cfs @ 12.40 hrs, Volume= 0.058 af
Outflow = 0.08 cfs @ 14.55 hrs, Volume= 0.058 af, Atten= 75%, Lag= 129.2 min
Discarded = 0.08 cfs @ 14.55 hrs, Volume= 0.058 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 166.71' @ 14.55 hrs Surf.Area= 1,291 sf Storage= 609 cf

Plug-Flow detention time= 94.4 min calculated for 0.058 af (100% of inflow)
Center-of-Mass det. time= 94.7 min (1,040.0 - 945.3)

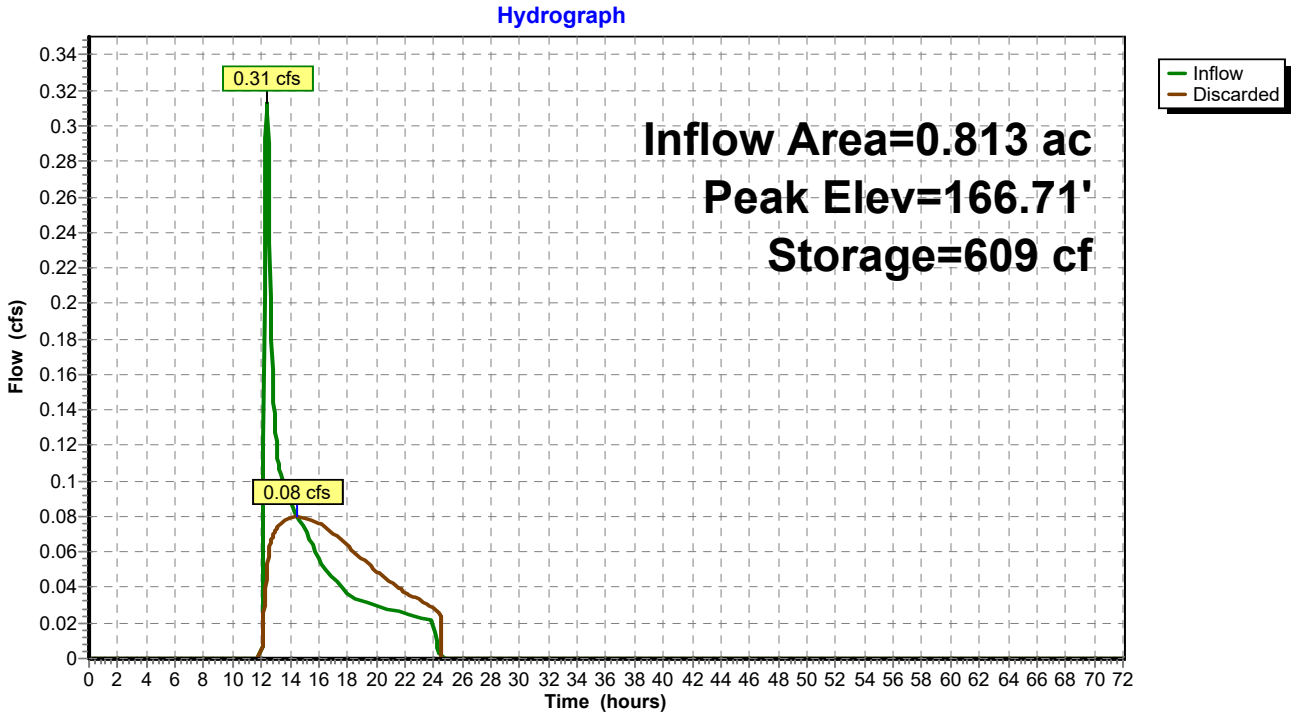
Volume	Invert	Avail.Storage	Storage Description
#1	166.00'	11,944 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
166.00	432	0	0
168.00	2,861	3,293	3,293
170.00	5,790	8,651	11,944

Device	Routing	Invert	Outlet Devices
#1	Discarded	166.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 161.80'

Discarded OutFlow Max=0.08 cfs @ 14.55 hrs HW=166.71' (Free Discharge)
└**1=Exfiltration** (Controls 0.08 cfs)

Pond DP3: Design Point 3



MERRILL ENGINEERS AND LAND SURVEYORS
427 COLUMBIA ROAD, HANOVER, MA. 02339
TEL. (781) 826-9200

JOB	20-127		
SHEET N0.	1	of 2	
CALCULATED BY	JG		
CHECKED BY	DK		4/30/2021

GROUNDWATER RECHARGE VOLUMES (STANDARD #3)

Location: **High Street, Norwell MA**

Total Area (Ac.)=	2.10	(Total impervious watershed area)
Total Impervious Area A Soil (Ac.)=	2.10	
Total Impervious Area B Soil (Ac.)=	0.00	
Total Impervious Area C Soil (Ac.)=	0.00	
Total Impervious Area D Soil (Ac.)=	0.00	Roofs, Drives, Road and Sidewalk

	Vol. To Recharge (inches per Imp. Acre)	Volume (Imp. Area x inches per Acre)
Recharge Volume (A soil)	0.60	1.26
Recharge Volume (B soil)	0.35	0.00
Recharge Volume (C soil)	0.25	0.00
Recharge Volume (D soil)	0.10	0.00

	1.26	AC-IN
Total Required Recharge Volume:	0.105	AC-FT
	4583	C.F.

Recharge volume provided within Infiltration Facilities (basin and subsurface chambers)	**27,110**	C.F.

(Rv will be total storage volume below lowest outlet elevation)

Groundwater Recharge Volume Calculation Per Infiltration System:

Subsurface Infiltration Chamber

Total Impervious Area A Soil (SF.)=	89345	
Total Impervious Area B Soil (SF.)=	0	
Total Impervious Area C Soil (SF.)=	0	
Total Impervious Area D Soil (SF.)=	0	Roofs, Drives, Road and Sidewalk

	Vol. To Recharge (inches per Imp. SF)	Volume (Imp. Area x inches per SF)	
Recharge Volume (A soil)	0.60	53607	SF-IN
Recharge Volume (B soil)	0.35	0	
Recharge Volume (C soil)	0.25	0	
Recharge Volume (D soil)	0.10	0	

Required Recharge Volume:	**4467**	C.F.
Proposed Recharge Volume:	**27,110**	C.F.

Drawdown Calculations for Infiltration Systems:

Drawdown Time = Rv/(k)(basin bottom area) where Rv will be total storage volume below lowest outlet elevation

Subsurface Infiltration System			4.88	< 72 hrs.
	Rv =	27110	cf	
	k=	8.27	in/hr (convert to ft)	
	Bot. Area=	8066	sf	

Minimum Bottom Area Calculation

A = Rv / (D+kT)

Rv = Required Recharge Volume k = Saturated hydraulic conductivity rate

D = Depth of facility (ft) T = Allowable drawdown during peak, Use 2 hrs

Subsurface Infiltration System	Rv =	4467	cf	
	D =	5.25		
	k=	8.27	in/hr (convert to ft)	
	T =	2		
	A (Min. Bottom Area) =	674	sf	
	Proposed Bottom Area =	8066	sf	Ok

MERRILL ENGINEERS AND LAND SURVEYORS	JOB	20-127		
427 COLUMBIA ROAD, HANOVER, MA. 02339	SHEET N0.	1	of	1
TEL. (781) 826-9200	CALCULATED BY	JG		
	CHECKED BY	DK		4/30/2021

WATER QUALITY VOLUME (STANDARD #4)

Location: **High Street, Norwell, MA**

Subsurface Chamber System

First Defense Unit (DMH-4):

Proprietary Treatment Unit: Q=(qu)(A)(WQV)

qu for Tc of 8 min.	739	(csm/in)	
Impervious Area: AC*0.0015625mi^2/AC	0.0032	mi^2	2.05 AC
WQV Treated:	1.00	in	
Q (Peak flow rate for 1" WQV):	**2.37**	cfs	
Proposed FD-6HC Max. Treated Flow Rate:	**3.38**	cfs	
	Max flow rate = 32 cfs		

Volume using: 0.5 or 1.0 inch x Imp. Area (per S.W. Mgmt Policy)

1 inch x Imp. Area **7,445** CF (min)

WQ Treatment within FD Unit = **= included in total system**

Recharge volume provided by Infiltration System = **27,110**

Total Walter Quality Volume Provided = **27,110** CF (Proposed)

Water Quality Volume - Total Site Improvements

Total Impervious Area:

Proposed Roof	1.01	
Proposed Pavement/Sidewalk	1.09	
Total Area:	2.10	AC

Water Quality Volume using: 0.5 or 1.0 inch x Imp. Area (per S.W. Mgmt Policy)

1 inch x Imp. Area **7,623** CF (min)

Total Walter Quality Volume Provided = **27,110** CF

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: High Street, Norwell MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary Treatment Practice	**0.00**	**0.75**	**0.00**	**0.75**
Subsurface Infiltration Structure	**0.80**	**0.75**	**0.60**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Total TSS Removal = **85%**

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

Project: 20-127
Prepared By: DWK
Date: 4/30/2021

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

TSS Removal Calculation Worksheet

For Pretreatment: Subsurface Chamber System Proj. No.: 20-127
Date: 4/30/2021
Location: Wolcott Woods, Milton MA Computed by: DWK

A BMP	B TSS Removal Rate	C Starting TSS Load*	D Amount Removed (BxC)	E Remaining Load (C-D)
Deep Sump & Hooded Catch Basin	25	1.00	0.25	0.75
First Defense Unit	50	0.75	0.38	0.38

Total TSS Removal= **63%** > 44% Pre-treatment

Notes:
*Starting TSS Load for first BMP= 1.00. TSS load for subsequent BMP's is equal to the Remaining Load (E) from the previous BMP.

First Defense® High Capacity

A Simple Solution for your Trickiest Sites

Verified by NJCAT and NJDEP

Product Profile

The First Defense® High Capacity is an enhanced vortex separator that combines an effective stormwater treatment chamber with an integral peak flow bypass. It efficiently removes sediment total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® High Capacity is available in several model configurations to accommodate a wide range of pipe sizes, peak flows and depth constraints (**Table 1**, next page).

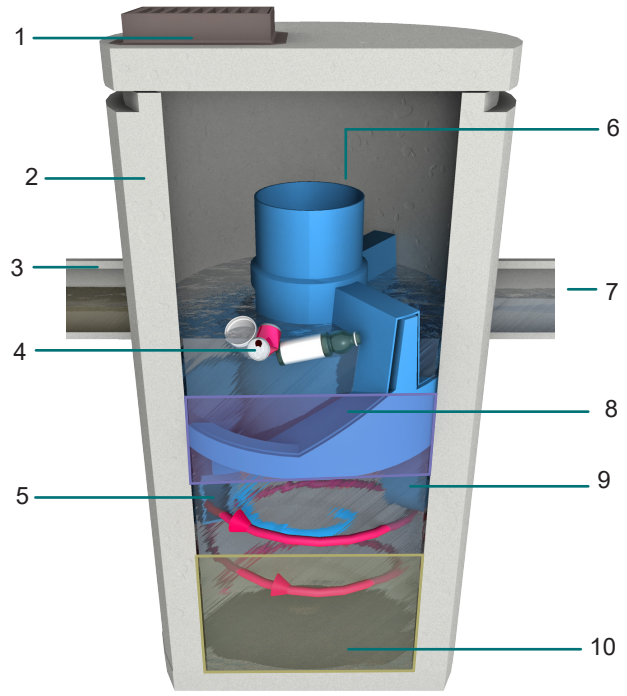
Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for "offline" arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 450% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

Fig.1 The First Defense® High Capacity has internal components designed to efficiently capture pollutants and prevent washout at peak flows.



Components

1. Inlet Grate (optional)
2. Precast chamber
3. Inlet Pipe (optional)
4. Floatables Draw Off Slot (not pictured)
5. Inlet Chute
6. Internal Bypass
7. Outlet pipe
8. Oil and Floatables Storage
9. Outlet chute
10. Sediment Storage Sump

How it Works

The First Defense® High Capacity has internal components designed to remove and retain gross debris, total suspended solids (TSS) and hydrocarbons (**Fig.1**).

Contaminated stormwater runoff enters the inlet chute from a surface grate and/or inlet pipe. The inlet chute introduces flow into the chamber tangentially to create a low energy vortex flow regime (magenta arrow) that directs sediment into the sump while oils, floating trash and debris rise to the surface.

Treated stormwater exits through a submerged outlet chute located opposite to the direction of the rotating flow (blue arrow). Enhanced vortex separation is provided by forcing the rotating flow within the vessel to follow the longest path possible rather than directly from inlet to outlet.

Higher flows bypass the treatment chamber to prevent turbulence and washout of captured pollutants. An internal bypass conveys infrequent peak flows directly to the outlet eliminating the need for, and expense of, external bypass control structures. A floatables draw off slot functions to convey floatables into the treatment chamber prior to bypass.

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com

First Defense® High Capacity

Sizing & Design

This adaptable online treatment system works easily with large pipes, multiple inlet pipes, inlet grates and now, contains a high capacity bypass for the conveyance of large peak flows. Designed with site flexibility in mind, the First Defense® High Capacity allows engineers to maximize available site space without compromising treatment level.

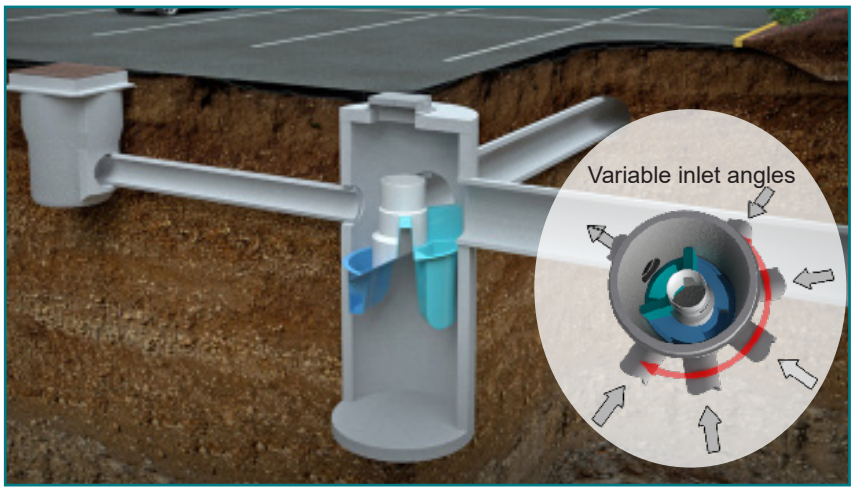


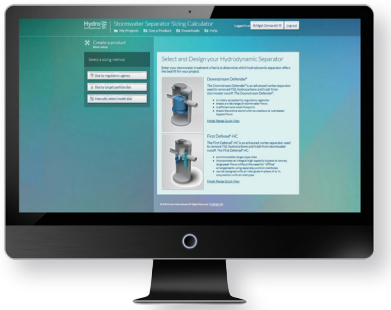
Fig 2. Works with multiple inlet pipes and grates

Inspection and Maintenance

Nobody maintains our systems better than we do. To ensure optimal, ongoing device performance, be sure to recommend Hydro International as a preferred service and maintenance provider to your clients.

Call **1 (800) 848-2706** to schedule an inspection and cleanout or learn more at **hydro-int.com/service**

Sizing Calculator for Engineers



This simple online tool will recommend the best separatror, model size and online/offline arrangement based on site-specific data entered by the user.

Go to hydro-int.com/sizing to access the tool.

Fig 3. Maintenance is done with a vactor truck

Table 1. First Defense® High Capacity Design Criteria.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates		Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Standard Distance from Outlet Invert to Sump Floor
		NJDEP Certified	110µm						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.84 / 23.7	1.06 / 30.0	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FD-4HC	4 / 1.2	1.50 / 42.4	1.88 / 53.2	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FD-5HC*	5 / 1.5	2.34 / 66.2	2.94 / 83.2	20 / 566	24 / 600	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FD-6HC	6 / 1.8	3.38 / 95.7	4.23 / 119.8	32 / 906	30 / 750	496 / 1,878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FD-8HC	8 / 2.4	6.00 / 169.9	7.52 / 212.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	7.40 / 2.2

***Coming soon**
[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com

Stormwater Solutions
hydro-int.com/firstdefensehc

Center for Environmental Systems
Stevens Institute of Technology
One Castle Point
Hoboken, NJ 07030-0000

January 9, 2016

Titus Magnanao
NJDEP
Division of Water Quality
Bureau of Non-Point Pollution Control
401-02B
PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Magnanao,

Based on my review, evaluation and assessment of the testing conducted on the First Defense® HC (FDHC) Stormwater Treatment Device by Hydro International and observed by FB Environmental Associates, the test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (NJDEP HDS Protocol) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of Hydro Internationals test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The Hydro International removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be slightly finer than the sediment blend specified by the protocol. The Hydro International scour test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification and shown to be much finer than specified by the protocol.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the 4-ft. laboratory unit in order to establish the ability of the FDHC to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. Prior to the start of testing Hydro International reviewed existing data and decided to utilize a target MTFR of 675 gpm (1.50 cfs). This target was chosen based on the ultimate goal of demonstrating greater than 50% annualized weighted solids removal as defined in the NJDEP HDS Protocol. The flow rates, feed rates and influent concentration all met the NJDEP HDS test protocol's coefficient of variance requirements and the background concentration for all five test runs never exceeded 20 mg/L.

Scour Testing

In order to demonstrate the ability of the FDHC to be used as an online treatment device scour testing was conducted at greater than 200% of MTFR in accordance with the NJDEP HDS Protocol. The average flow rate during the online scour test was 3.24 cfs, which represents 216% of the MTFR (MTFR = 1.50 cfs). Background concentrations were 2 mg/L throughout the scour testing, which complies with the 20 mg/L maximum background concentration specified by the test protocol. Unadjusted effluent concentrations ranged from 2 mg/L to 4 mg/L with a mean of 2.1 mg/L. When adjusted for background concentrations, the effluent concentrations range from 0 to 2 mg/L with a mean of 0.1 mg/L. These results confirm that the 4-ft. FDHC did not scour at 216% MTFR and meets the criteria for online use.

Maintenance Frequency

The predicted maintenance frequency for all models is 44 months.

Sincerely,

Richard S. Magee, Sc.D., P.E., BCEE

Stormwater Solutions

Hydro International

Turning Water Around...®

December 21, 2015

Dr. Richard Magee, Sc.D., P.E., BCEE
Technical Director
New Jersey Corporation for Advanced Technology
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

Re: Verification of First Defense® HC to NJDEP HDS Laboratory Testing Protocol

Dear Dr. Magee:

Hydro International's First Defense® HC (FDHC) vortex separator for stormwater treatment recently underwent verification testing according to the NJDEP HDS Laboratory Testing Protocol. As required by the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology", this letter serves as Hydro International's statement that all procedures and requirements identified in the aforementioned protocol and process document were met or exceeded. The 4-ft FDHC removal efficiency and scour tests conducted at Hydro International's laboratory facility in Portland, Maine were done so under the direct supervision of FB Environmental Associates. All water quality samples were analyzed by the independent analytical lab, Maine Environmental Laboratory. The removal efficiency particle size distribution was analyzed by the independent analytical laboratory, GeoTesting Express. The scour test particle size distribution was analyzed at Hydro International's facility under the supervision of FB Environmental Associates. Additionally, the preparation of the verification report and the documentation contained therein fulfill the submission requirements of the process document and protocol.

If you have any questions or comments regarding the verification of the FDHC, please do not hesitate to contact us.

Sincerely,

Lisa Lemont, CPSWQ
Business Development Manager

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Statement of Third Party Observer

STATEMENT OF THIRD PARTY OBSERVER

To: Lisa Lemont, Hydro International, Portland, Maine

From: Forrest Bell, FB Environmental Associates

Subject: Third Party Review under *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]

Date: December 31, 2015

cc: Andrew Anastasio, Hydro International; Jeremy Fink, Hydro International
Margaret Burns, FB Environmental Associates

Statement of Third Party Observer

FB Environmental has served as the third-party observer for tests performed by Hydro International in October through December 2015. The tests assessed the First Defense HC Stormwater Treatment Device as a 50% Total Suspended Solids (TSS) removal device under the New Jersey Department of Environmental Protection certification. Tests were performed by Hydro International staff at their laboratory located at 94 Hutchinson Drive in Portland, Maine, to meet the standards described in *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]. On May 10, 2014, we also submitted a statement of qualifications, as required by NJCAT MTD process.

A member of our staff verified compliance with the laboratory test protocol above, and our staff member was physically present to observe the full duration of all laboratory testing. We have also reviewed the data, calculations, and conclusions associated with the removal efficiency testing in the *Verification Testing Report for the First Defense® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015, and state that they conform to what we saw during our supervision as third-party observer.

Forrest Bell

Signed: Date: December 31, 2015

[1] Available at http://www.nj.gov/dep/stormwater/treatment.html

1 of 1

Statement of Disclosure

STATEMENT OF DISCLOSURE – THIRD PARTY OBSERVER

To: Lisa Lemont, Hydro International, Portland, Maine

From: Forrest Bell, FB Environmental Associates

Subject: Third Party Observer Statement of Disclosure under *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]

Date: December 31, 2015

cc: Andrew Anastasio, Hydro International
Margaret Burns, FB Environmental Associates

Statement of Disclosure – Third Party Observer

FB Environmental has no financial conflict of interest regarding the test results of the stormwater device testing outlined in the *Verification Testing Report for the First Defense ® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015.

Disclosure Record

FB Environmental has provided the service of third party observer for tests performed by Hydro International in October through December of 2015. The tests assessed the First Defense HC Stormwater Treatment Device as a 50% Total Suspended Solids (TSS) removal device under the New Jersey Department of Environmental Protection certification as outlined in the *Verification Testing Report for the First Defense ® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015. Beyond this, FB Environmental and Hydro International have no relationships that would constitute a conflict of interest, as outlined in *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP 2013). For example, we have no ownership stake, do not receive commissions, do not have licensing agreements, and do not receive funds or grants beyond those associated with the testing program.

Forrest Bell

Signed: Date: December 31, 2015

[1] Available at http://www.nj.gov/dep/stormwater/treatment.html

1 of 1

Weighted Runoff Coefficients

Name:	15 High Street	Proj. No.:	20-127
	Norwell, MA	Date:	4/30/2021
Client:	Northland Residential Corp	Computed by:	JG
		Checked by:	DK

Description of Area **CB1**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.024	0.90	0.02
Pervious (G)	0.004	0.30	0.00
Pervious (W)	0.000	0.20	0.00
Totals =	0.028		0.02

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.81**

Description of Area **CB2**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.026	0.90	0.02
Pervious (G)	0.006	0.30	0.00
Pervious (W)	0.000	0.20	0.00
Totals =	0.032		0.03

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.79**

Description of Area **CB3**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.208	0.90	0.19
Pervious (G)	0.396	0.30	0.12
Pervious (W)	0.000	0.20	0.00
Totals =	0.604		0.31

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.51**

Description of Area **CB4**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.204	0.90	0.18
Pervious (G)	0.092	0.30	0.03
Pervious (W)	0.000	0.20	0.00
Totals =	0.296		0.21

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.71**

Description of Area **CB5**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.155	0.90	0.14
Pervious (G)	0.058	0.30	0.02
Pervious (W)	0.000	0.20	0.00
Totals =	0.213		0.16

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.74**

Description of Area **CB6**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.153	0.90	0.14
Pervious (G)	0.082	0.30	0.02
Pervious (W)	0.000	0.20	0.00
Totals =	0.235		0.16

Weighted Runoff Coefficient : **Σ(AxC) / ΣA =** **0.69**

Weighted Runoff Coefficients

Name:	15 High Street Norwell, MA	Proj. No.:	**20-127**
		Date:	**4/30/2021**
Client:	Northland Residential Corp	Computed by:	**JG**
		Checked by:	**DK**

Description of Area **CB7**	Area (acres)	Runoff Coefficient	A x C
Impervious	0.284	0.90	0.26
Pervious (G)	0.540	0.30	0.16
Pervious (W)	0.000	0.20	0.00
Totals =	0.824		0.42

Weighted Runoff Coefficient = **Σ(AxC) / ΣA =** **0.51**

Time of Concentration

Name:	15 High Street Norwell, MA	Proj. No.:	20-127
		Date:	4/30/2021
Client:	Northland Residential Corp	Computed by:	JG
		Checked by:	DK

CB 1	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Impervious)	2.20%	22	-	0.34
Shallow Concentrated Flow (Impervious)	1.20%	36	2.3	0.26
			Time of Concentration, T_c =	0.60
			Use T_c =	6.00

CB 2	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Impervious)	1.70%	13	-	3.00
Shallow Concentrated Flow (Impervious)	1.20%	49	2.3	0.36
			Time of Concentration, T_c =	3.36
			Use T_c =	6.00

CB 3	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Pervious)	2.50%	50	-	7.56
Shallow Concentrated Flow (Pervious)	1.50%	80	2	0.67
Shallow Concentrated Flow (Impervious)	1.60%	70	2.6	0.45
			Time of Concentration, T_c =	8.67
			Use T_c =	8.67

CB 4	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Pervious)	1.70%	13	-	3.00
Shallow Concentrated Flow (Imervious)	1.00%	172	2	1.43
			Time of Concentration, T_c =	4.44
			Use T_c =	6.00

CB 5	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Pervious)	2.30%	13	-	2.66
Shallow Concentrated Flow (Impervious)	1.00%	192	2	1.60
			Time of Concentration, T_c =	4.26
			Use T_c =	6.00

CB 6	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (pervious)	1.00%	31	-	7.44
Shallow Concentrated Flow (Impervious)	1.00%	110	2	0.92
			Time of Concentration, T_c =	8.36
			Use T_c =	8.36

Time of Concentration

Name:	15 High Street Norwell, MA	Proj. No.:	20-127
		Date:	4/30/2021
Client:	Northland Residential Corp	Computed by:	JG
		Checked by:	DK

CB 7	Slope (%)	Length (feet)	Velocity* (ft/sec)	Travel Time, Tt (L/V) / 60 (min)
Sheet Flow (Pervious)	2.00%	50	-	8.26
Shallow Concentrated Flow (Pervious)	0.90%	171	1.5	1.90
Shallow Concentrated Flow (Impervious)	1.30%	63	2.4	0.44
			Time of Concentration, T_c =	10.60
			Use T_c =	10.60

Storm Drainage Computations

Name: 15, 19, 27 & 35 High Street
Norwell MA

Client: Northland Residential Corp.

Proj. No.: **20-127**
Date: 4/30/2021
Computed by: **JG**
Checked by: **DK**

Design Parameters:
10 **Year Storm** Boston, MA

k_e= **0.5**

DESCRIPTION	LOCATION FROM	LOCATION TO	AREA (AC.)	C	C x A	SUM C x A	FLOW TIME (MIN) PIPE	FLOW TIME (MIN) CONC TIME	i*	DESIGN Q cfs	DESIGN V fps	DESIGN n	DESIGN PIPE SIZE	DESIGN SLOPE	CAPACITY Q full ft^3/s	CAPACITY V full ft/s	PROFILE LENGTH ft	PROFILE FALL ft	PROFILE RIM	PROFILE INV UPPER	PROFILE INV LOWER	PROFILE W.S.E. ft	PROFILE Freeboard ft
	CB 1	DMH1	0.03	0.81	0.02	0.02	0.11	6.0	5.0	0.1	1.9	0.013	12	0.0205	5.1	6.5	12	0.25	174.70	170.70	170.45	170.7	4.0
	CB 2	DMH1	0.03	0.79	0.03	0.03	0.06	6.0	5.0	0.1	2.1	0.013	12	0.0250	5.6	7.2	8	0.20	174.70	170.70	170.50	170.6	4.1
	DMH1	DMH2	---	---	---	0.05	1.75	6.1	5.0	0.2	1.7	0.013	12	0.0062	2.8	3.6	176	1.09	175.00	170.45	169.35	170.4	4.6
	CB7	DMH2	0.82	0.51	0.42	0.42	0.03	10.6	4.2	1.7	5.3	0.013	12	0.0250	5.6	7.2	8	0.20	173.95	170.25	170.05	169.9	4.0
	DMH2	DMH3	---	---	---	0.47	0.18	10.6	4.2	1.9	3.7	0.013	12	0.0090	3.4	4.3	40	0.36	173.85	169.35	168.99	169.2	4.7
	CB 3	DMH3	0.60	0.51	0.31	0.31	0.02	8.7	4.5	1.4	5.3	0.013	12	0.0300	6.2	7.9	5	0.15	173.50	169.80	169.65	169.5	4.0
	CB 4	DMH3	0.30	0.71	0.21	0.21	0.09	6.0	5.0	1.1	3.4	0.013	12	0.0105	3.7	4.6	19	0.20	173.50	169.80	169.60	169.7	3.8
	DMH3	DMH4	---	---	---	0.98	0.18	10.8	4.1	4.1	4.7	0.013	15	0.0100	6.5	5.3	50	0.50	173.60	168.75	168.25	168.5	5.1
	DMH4	DMH5	---	---	---	1.30	0.05	11.0	4.1	5.4	5.1	0.013	18	0.0100	10.5	5.9	14	0.14	174.40	168.00	167.86	167.7	6.7
	DMH5	DMH6	---	---	---	1.30	0.05	11.0	4.1	5.3	5.0	0.013	18	0.0100	10.5	5.9	16	0.16	174.70	167.86	167.70	167.6	7.1
																	li						
	CB 5	DMH 6	0.21	0.74	0.16	0.16	0.21	6.0	5.0	0.8	3.5	0.013	12	0.0158	4.5	5.7	44	0.70	177.50	173.50	172.80	173.3	4.2
	CB 6	DMH6	0.24	0.69	0.16	0.16	0.09	8.4	4.5	0.7	3.1	0.013	12	0.0120	3.9	5.0	16	0.19	177.00	173.00	172.80	172.9	4.1
	DMH7	DMH4	---	---	---	0.32	0.72	8.4	4.5	1.4	4.5	0.013	12	0.0180	4.8	6.1	194	3.49	177.00	172.70	169.20	172.4	4.6

Storm Drainage Computations

Name: 15, 19, 27 & 35 High Street
Norwell MA

Client: Northland Residential Corp.

Proj. No.: **20-127**
Date: 4/30/2021
Computed by: **JG**
Checked by: **DK**

Design Parameters:
7 **Year Storm** Boston MA

k_e= **0.5**

DESCRIPTION	LOCATION FROM	LOCATION TO	AREA (AC.)	C	C x A	SUM C x A	FLOW TIME (MIN) PIPE	FLOW TIME (MIN) CONC TIME	i*	DESIGN Q cfs	DESIGN V fps	DESIGN n	DESIGN PIPE SIZE	DESIGN SLOPE	CAPACITY Q full ft^3/s	CAPACITY V full ft/s	PROFILE LENGTH ft	PROFILE FALL ft	PROFILE RIM	PROFILE INV UPPER	PROFILE INV LOWER	PROFILE W.S.E. ft	PROFILE Freeboard ft
	CB 1	DMH1	0.03	0.81	0.02	0.02	0.09	6.0	7.0	0.2	2.1	0.013	12	0.0205	5.1	6.5	12	0.25	174.70	170.70	170.45	170.6	4.1
	CB 2	DMH1	0.03	0.79	0.03	0.03	0.06	6.0	7.0	0.2	2.4	0.013	12	0.0250	5.6	7.2	8	0.20	174.70	170.70	170.50	170.6	4.1
	DMH1	DMH2	---	---	---	0.05	1.55	6.1	7.0	0.3	1.9	0.013	12	0.0062	2.8	3.6	176	1.09	175.00	170.45	169.35	170.4	4.6
	CB7	DMH2	0.82	0.51	0.42	0.42	0.02	10.6	6.0	2.5	5.9	0.013	12	0.0250	5.6	7.2	8	0.20	173.95	170.25	170.05	169.8	4.1
	DMH2	DMH3	---	---	---	0.47	0.16	10.6	6.0	2.8	4.3	0.013	12	0.0090	3.4	4.3	40	0.36	173.85	169.35	168.99	169.1	4.7
	CB 3	DMH3	0.60	0.51	0.31	0.31	0.01	8.7	6.4	1.9	5.9	0.013	12	0.0300	6.2	7.9	5	0.15	173.50	169.80	169.65	169.4	4.1
	CB 4	DMH3	0.30	0.71	0.21	0.21	0.09	6.0	7.0	1.5	3.7	0.013	12	0.0105	3.7	4.6	19	0.20	173.50	169.80	169.60	169.6	3.9
	DMH3	DMH4	---	---	---	0.98	0.16	10.8	5.9	5.8	5.4	0.013	15	0.0100	6.5	5.3	50	0.50	173.60	168.75	168.25	168.4	5.2
	DMH4	DMH5	---	---	---	1.30	0.04	10.9	5.9	7.7	5.6	0.013	18	0.0100	10.5	5.9	14	0.14	174.40	168.00	167.86	167.6	6.8
	DMH5	DMH6	---	---	---	1.30	0.05	11.0	5.9	7.7	5.6	0.013	18	0.0100	10.5	5.9	16	0.16	174.70	167.86	167.70	167.5	7.2
																	li						
	CB 5	DMH 6	0.21	0.74	0.16	0.16	0.19	6.0	7.0	1.1	3.9	0.013	12	0.0158	4.5	5.7	44	0.70	177.50	173.50	172.80	173.3	4.2
	CB 6	DMH6	0.24	0.69	0.16	0.16	0.08	8.4	6.4	1.0	3.5	0.013	12	0.0120	3.9	5.0	16	0.19	177.00	173.00	172.80	172.8	4.2
	DMH7	DMH4	---	---	---	0.32	0.66	8.4	6.4	2.0	4.9	0.013	12	0.0180	4.8	6.1	194	3.49	177.00	172.70	169.20	172.4	4.6

Merrill
Engineers and Land Surveyors

April 22, 2021

Soil Testing Forms for Drainage and Septic Systems

15,19,27 & 35 High Street, Norwell MA

Merrill Engineers- Land Surveyors
427 Columbia Rd., Hanover, MA. 02339
781-826-9200
26 Union St., Plymouth, MA. 02360
508-746-6060

Project No. 20-127

Date: 18-Jun-20
Revision:

Commonwealth of Massachusetts
Norwell , Massachusetts

Soil Suitability Assessment for On-site Sewage Disposal

Performed By: Joshua Green — Test Dates: Thursday, June 18, 2020
Performed By: — Test Dates: Sunday, December 20, 2020
Witnessed By: Ralph Cole — Testhole #:
Witnessed By: — Testhole #:

FACILITY INFORMATION

Site Location:
Builder's lot #:
Street Address: 15,19,27,35 High Street
Town, State, Zip: Norwell, MA
Assessor's Map:

Owner/ Applicant Information:
Name:
Address:
Town, State, Zip:
Telephone no.:

SITE INFORMATION

Construction Type:

New Construction: [X] Repair: [ ] Upgrade: [ ] Drainage: [ ]

Published Soil Survey Available: No: [ ] Yes: [X]

Year Published: 2020 Publication Scale: 1:1,950 a. Soil Map Unit: 420B Drainage Class: B
b. Soil Map Unit: Drainage Class:

Soil Name: a. Canton F.S.L. b. Soil Limitations: None

Surficial Geologic Report Available: No: [ ] Yes: [X]

Year Published: 2018 Publication Scale: 1:24,000

Geological Material/map unit: Coarse Deposits

Landform: Hills, Ridges, Moraines

Flood Insurance Rate Map:

Above 500 year flood boundary? No: [ ] Yes: [X] Within a velocity zone? No: [X] Yes: [ ]

Within 500 year flood boundary? No: [X] Yes: [ ] Within 100 year flood boundary? No: [X] Yes: [ ]

Wetland Area:

National Wetland Inventory Map: (map unit) n/a Name:

Wetlands Conservancy Program Map: (map unit) n/a Name:

Current Water Resource Conditions (USGS): (Month/year) May-2020

Range: Above Normal: [X] Normal: [ ] Below Normal: [ ]

Other References Reviewed:
Comments:

Merrill Engineers Land Surveyors
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26 Union St., Plymouth, MA. 02360

Project No.: 20-127

Date: 6/18/20
Revised:

***Deep Hole #** 20-01

Builder's lot #:
Street Address: 15,19,27,35 High Street
Town: Norwell, MA
Assessor's Map:

DETERMINATION OF HIGH GROUNDWATER ELEVATION

Method Used:

- [X] Depth observed standing in observation hole: A: 210 inches B: _____ inches
- [ ] Depth weeping from side of observation hole: A: _____ inches B: _____ inches
- [ ] Depth to soil mottles: _____ inches
- [ ] Ground water adjustment: _____ inches

Index Well Number: _____ Reading Date: _____ Index well level: _____

Adjustment factor: None Adjustment groundwater level: _

DEPTH OF PERVIOUS MATERIAL

Depth of Naturally Occurring Pervious Material

Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes: [x] No: [ ]

If yes, at what depth was it observed? Upper Boundary (inches): see logs
Lower Boundary (inches): see logs

CERTIFICATION

I certify that I have passed the soil evaluator examination approved by the Department of Environtmental Protection and that the above analysis was performed by me conistent with the required training, expertise and experience described in 310 CMR 15.017.

Signature of Soil Evaluator: _____ Date: June 18, 2020
Typed or Printed Name of Soil Evaluator: Joshua Green
Date of Soil Evaluator Exam: May 2019

Name of Board of Health Witness: Ralph Cole
Board of Health: Norwell Board of Health

*If applicable, only deep hole with shallowest ESHGW listed.

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-01 DATE: 18-Jun-20 TIME: 8:00 WEATHER: Sunny 75°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: [ ] No: [X] SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 45 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-9	Ap	Loamy Sand	10YR 3/2		Massive, Friable
9-20	Bw	Loamy Sand	10YR 5/6		Massive, Friable
20-210	C	Medium Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 10% Stone, Large Boulders present in face of test pit

PARENT MATERIAL: Till Unsuitable Material Present? Yes: [ ] No: [X] If Yes:
Disturbed Soil: [ ] Fill Mat'l: [ ] Impervious Layer(s): [ ] Weathered/Fractured Rock: [ ] Bedrock: [ ]

GROUNDWATER OBSERVED: Yes: [X] No: [ ] If Yes: What is the depth of Groundwater:
Standing in Hole: 210" Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water : 210"

PERCOLATION TEST

Percolation Hole #:	20-01		Percolation Hole #:		
Test Date:	6/18/2020		Test Date:		
Depth of Perc:	33"-51"		Depth of Perc:		
Start of Presoak:	8:19 AM		Start of Presoak:		
End of Presoak:	8:26 AM		End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min/in		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

An indication that the "site passed" indicates only that the basic criteria for a soil evaluation and percolation test under Title 5 have been met in the area tested. Further soil evaluations and design work are necessary to determine whether a septic system for a particular use, meeting the requirements of Title5 and applicable local bylaws, will in fact be feasible on this site.

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-02 DATE: 18-Jun-20 TIME: 8:35 WEATHER: Sunny 75°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 45 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-13	Ap	Loamy Sand	10YR 3/2		Massive, Friable
13-37	Bw	Loamy Sand	10YR 5/6		Massive, Friable
37-144	C	Medium Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 10% Stone, Large Boulders present in face of test pit

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	20-02		Percolation Hole #:		
Test Date:	6/18/2020		Test Date:		
Depth of Perc:	34"-52"		Depth of Perc:		
Start of Presoak:	8:38 AM		Start of Presoak:		
End of Presoak:	8:43 AM		End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min/in		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-03 DATE: 18-Jun-20 TIME: 9:00 WEATHER: Sunny 80°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: [ ] No: [X] SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 45 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-8	Ap	Loamy Sand	10YR 3/2		Massive, Friable
8-23	Bw	Loamy Sand	10YR 5/6		Massive, Friable
23-138	C	Medium Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 45% Stone, Large Boulders present in face of test pit

PARENT MATERIAL: Till Unsuitable Material Present? Yes: [ ] No: [X] If Yes:
Disturbed Soil: [ ] Fill Mat'l: [ ] Impervious Layer(s): [ ] Weathered/Fractured Rock: [ ] Bedrock: [ ]

GROUNDWATER OBSERVED: Yes: [ ] No: [X] If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	20-03		Percolation Hole #:		
Test Date:	6/18/2020		Test Date:		
Depth of Perc:	29"-47"		Depth of Perc:		
Start of Presoak:	9:21 AM		Start of Presoak:		
End of Presoak:	9:36 AM		End of Presoak:		
Time @ 12":	9:36 AM		Time @ 12":		
Time @ 9":	9:38 AM		Time @ 9":		
Time Elapse:(12"-9")	2 min		Time Elapse:(12"-9")		
Time AT 6":	9:42 AM		Time AT 6":		
Time Elapse: (9"-6"):	4 min		Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min/in		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments: This test pit conisted of mostly stone and gravel. The C layer had varying size stones through out and boulders down at the bottom of the test pit.

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-04 DATE: 18-Jun-20 TIME: 10:00 WEATHER: Sunny 75°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 45 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-7	Ap	Loamy Sand	10YR 3/2		Massive, Friable
7-26	Bw	Loamy Sand	10YR 5/6		Massive, Friable
26-127	C1	Medium Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 10% Stone, Large Boulders present in face of test pit
127-150	C2	Medium Sand	2.5Y 5/4		Clean Sand layer, No stones present 0-2% gravel

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	20-04		Percolation Hole #:		
Test Date:	6/18/2020		Test Date:		
Depth of Perc:	27"-45"		Depth of Perc:		
Start of Presoak:	10:05 AM		Start of Presoak:		
End of Presoak:	10:12 AM		End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min/in		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: D1 DATE: 18-Jun-20 TIME: 10:20 WEATHER: Sunny 80°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: [ ] No: [X] SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-8	Ap	Loamy Sand	10YR 3/3		Massive, Friable
8-24	Bw	Loamy Sand	10YR 5/6		Massive, Friable
24-150	C	Sand	2.5Y 5/3		Loose Single Grain, pockets firm in face of of test pit, 10% Gravel 10% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: [ ] No: [X] If Yes:
Disturbed Soil: [ ] Fill Mat'l: [ ] Impervious Layer(s): [ ] Weathered/Fractured Rock: [ ] Bedrock: [ ]

GROUNDWATER OBSERVED: Yes: [ ] No: [X] If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:			Percolation Hole #:		
Test Date:			Test Date:		
Depth of Perc:			Depth of Perc:		
Start of Presoak:			Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):			Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: D2 DATE: 18-Jun-20 TIME: 10:40 WEATHER: Sunny 80°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-10	Ap	Loamy Sand	10YR 3/2		Massive, Friable
10-18	Bw	Loamy Sand	10YR 4/6		Massive, Friable
18-80	C1	Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 10% Stone
80-100	Cd	Loamy Sand	2.5Y 6/2		Massive, Friable 10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:			Percolation Hole #:		
Test Date:			Test Date:		
Depth of Perc:			Depth of Perc:		
Start of Presoak:			Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):			Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: D3 DATE: 18-Jun-20 TIME: 11:10 WEATHER: Sunny 80°
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-7	Ap	Loamy Sand	10YR 3/3		Massive, Friable
7-20	Bw	Loamy Sand	10YR 5/6		Massive, Friable
20-84	C1	Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 10% Stone
84-108	C2	Medium Sand	2.5Y 5/2		Loose, Single Grain, 5% Gravel 2% Stone
108-124	Cd	Loamy Sand	2.5Y 5/2		Massive, Firm, 10% Gravel 10% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: Weeping from Face: Saturating the Face: Mottling:
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:			Percolation Hole #:		
Test Date:			Test Date:		
Depth of Perc:			Depth of Perc:		
Start of Presoak:			Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):			Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: D4 DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-8	Ap	Loamy Sand	10YR 3/2		Massive, Friable
8-27	Bw	Loamy Sand	10YR 5/6		Massive, Friable
27-108	C1	Medium Sand	2.5Y 5/4		Loose, Single Grain, 15% Gravel 10% Stone
108-216	C2	Medium Sand	2.5Y 6/3		Loose, Single Grain, 10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: - Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:			Percolation Hole #:		
Test Date:			Test Date:		
Depth of Perc:			Depth of Perc:		
Start of Presoak:			Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):			Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: D5 DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-7	Ap	Loamy Sand	10YR 3/2		Massive, Friable
7-21	Bw	Loamy Sand	10YR 5/6		Massive, Friable
21-98	C1	Medium Sand	2.5Y 5/4		Loose, Single Grain, 15% Gravel 5% Stone
98-180	C2	Medium Sand	2.5Y 5/4		Loose, Single Grain, 10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: - Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:			Percolation Hole #:		
Test Date:			Test Date:		
Depth of Perc:			Depth of Perc:		
Start of Presoak:			Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):			Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments: Less defined difference between C1 and C2.

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: **20-05** DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-7	Ap	Loamy Sand	10YR 3/2		Massive, Granular
7-25	Bw	Loamy Sand	10YR 5/6		Massive, Friable
25-84	C1	Medium Sand	2.5Y 5/4		Loose, Single Grain, 15% Gravel 5% Stone
84-156	C2	Medium Sand	2.5Y 6/3		Loose, Single Grain, 10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: - Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	5		Percolation Hole #:		
Test Date:	12/10/2020		Test Date:		
Depth of Perc:	45"-63"		Depth of Perc:		
Start of Presoak:	9:18 AM		Start of Presoak:		
End of Presoak:	9:24 AM		End of Presoak:		
Time @ 12":	24 gal		Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	52 min/in		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-06 DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-6	Ap	Loamy Sand	10YR 3/2		Massive, Granular
6-18	Bw	Loamy Sand	10YR 5/6		Massive, Friable
18-80	C1	Medium Sand	2.5Y 5/4		25% Gravel 15% Stone
68-80	C2	Loamy Sand	10YR 5/4		0%-0% Massive
80-176	C2	Medium Sand	2.5Y 6/3		10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: 176 weeping Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	6		Percolation Hole #:		
Test Date:	12/10/2020		Test Date:		
Depth of Perc:	48"-66"		Depth of Perc:		
Start of Presoak:	9:54 AM		Start of Presoak:		
End of Presoak:			End of Presoak:		
Time @ 12":	10:09 AM		Time @ 12":		
Time @ 9":	10:22 AM		Time @ 9":		
Time Elapse:(12"-9")	13		Time Elapse:(12"-9")		
Time AT 6":	10:36 AM		Time AT 6":		
Time Elapse: (9"-6"):	14		Time Elapse: (9"-6"):		
Rate: (min/in.):	5		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-07 DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-8	Ap	Loamy Sand	10YR 3/2		Massive, Granular
8-28	Bw	Loamy Sand	10YR 5/6		Massive, Friable
28-96	C1	Medium Sand	2.5Y 5/4		Friable, 15% Gravel 5% Stone
96-200	C2	Medium Sand	2.5Y 6/3		Friable, 10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: - Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	7		Percolation Hole #:		
Test Date:	12/10/2020		Test Date:		
Depth of Perc:	38"-56"		Depth of Perc:		
Start of Presoak:	11:20 AM		Start of Presoak:		
End of Presoak:	11:26 AM		End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")	24		Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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FORMS 11 AND 12
SOIL EVALUATOR FORM

ON-SITE REVIEW

DEEP HOLE #: 20-08 DATE: 10-Dec-20 TIME: WEATHER:
SITE ADDRESS or MAP/LOT #: 15,19,27,35 High Street Norwell, MA
OWNER: JOB NO.: 20-127
LOCATION (Identify on Plan): GROUND ELEVATION AT SURFACE OF HOLE:

LAND USE: Residential SURFACE STONES: Yes: ☐ No: ☒ SLOPE (%): 0-3%

VEGETATION: Lawn LANDFORM: Hills/Moraine
DISTANCES FROM:
OPEN WATER BODY: >100 ft PROPERTY LINE: 100 ft POSSIBLE WET AREA: >100 ft DRAINAGEWAY: >100 ft
DRINKING WATER WELL: >100 ft OTHER:
DEEP OBSERVATION HOLE LOG

Depth (inches)	Soil Hor./ Layer	Soil Texture (USDA)	Soil Color (Munsell)	Redoximorphic Features	Other (Structure, Consistency,% Gravels, Stones, Boulders
0-8	Ap	Loamy Sand	10YR 3/2		Massive, Granular
8-20	Bw	Loamy Sand	10YR 5/6		Massive, Friable
20-101	C1	Medium Sand	2.5Y 5/4		15% Gravel 5% Stone
101-204	C2	Medium Sand	2.5Y 6/3		10% Gravel 5% Stone

PARENT MATERIAL: Till Unsuitable Material Present? Yes: ☐ No: ☒ If Yes:
Disturbed Soil: ☐ Fill Mat'l: ☐ Impervious Layer(s): ☐ Weathered/Fractured Rock: ☐ Bedrock: ☐

GROUNDWATER OBSERVED: Yes: ☐ No: ☒ If Yes: What is the depth of Groundwater:
Standing in Hole: - Weeping from Face: - Saturating the Face: - Mottling: -
Estimated Depth to Seasonal High Ground Water :

PERCOLATION TEST

Percolation Hole #:	8		Percolation Hole #:		
Test Date:	12/10/2020		Test Date:		
Depth of Perc:	38"-56"		Depth of Perc:		
Start of Presoak:	11:52 AM		Start of Presoak:		
End of Presoak:	11:59 AM		End of Presoak:		
Time @ 12":			Time @ 12":		
Time @ 9":			Time @ 9":		
Time Elapse:(12"-9")			Time Elapse:(12"-9")		
Time AT 6":			Time AT 6":		
Time Elapse: (9"-6"):			Time Elapse: (9"-6"):		
Rate: (min/in.):	<2 min		Rate: (min/in.):		
Test Passed/ Failed/ Discon/ Add. Test Req'd:			Test Passed/ Failed/ Discon/ Add. Testing Req'd:		

Performed By: Joshua Green Witnessed By: Ralph Cole Mach./Oper.: T. A. Iaria
Comments:

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Project No.: 19-055

Date: 8/7/20
Revised:

PROBABLE HIGH GROUNDWATER LEVELS IN MASSACHUSETTS

FACILITY INFORMATION

Site Location:		Owner/ Applicant Information:	
Builder's lot #:		Name:	985 Plain Street Realty Trust
Street Address:	985 Plain Street	Address:	40 Lone Street
Town, State, Zip:	Marshfield, MA 02050	Town, State, Zip:	Marshfield, MA 02050
Assessor's Map:	C10	Telephone no.:	

REFERENCE:

Probable High Groundwater Levels in Massachusetts
U.S. Geological Survey
Water Resource and Investigation
Open File Report 80 - 1205

FIELD DATA:

Date of Test/ Reading:
Use Test Area:

Ground Elevation =	176.80
Depth of Water =	14.70
Observed Water Table Elev=	162.10

REFERENCE WELL DATA:

Reference Well:	D4W 79 Duxbury
Data Category:	Real - Time Data for USGS (Refer to attachments)
Topographic setting:	Valley
Lithology:	Sand
Date of Reading:	

FORMULA:

Sh=Sc-[(Sr/Owr)(OWc-OWmax)]

Where:

Sc =	14.70	ft.	Measured depth to water at site
Owc =	9.55	ft.	Measured depth to water in observation well
Owmax =	5.86	ft.	Depth to recorded maximum water level in observation well
Sr =	4.20	ft.	Range in water level at site (see charts) USE: 5% Exceedence
Owr =	4.11	ft.	Recorded upper limit of annual range at observation well
Adjustment =	3.77	ft.	
Sh=	#####	ft.	Estimated depth to probable high water level at the site
E.S.H.G.W =	**165.87**	**MSL**	**(Adjusted- Assumed)**

Briggs Engineering & Testing
A Division of PK Associates, Inc.

Merrill Engineers and Land Surveyors
c/o Ms. Deborah Keller, PE
427 Columbia Road
Hanover, MA 02339

September 29, 2021
Briggs Project No. 31782

RE: Field Infiltrometer Tests – August 27, 2021
Proposed Infiltration Area
35 High Street, Norwell, MA

Briggs completed one double ring infiltrometer test at the proposed stormwater disposal system area in the west central part of the site. Refer to attached Figure 1 for locations. Test locations, methods, results, discussions and conclusions are summarized as follows:

Proposed Construction

A single infiltration area is proposed along the west boundary of the subject property. The infiltration area is rectangular shaped and approximately 60 by 130 feet in plan area based on the "Site Plan" dated Jan 29, 2021 with graphical scale provided by Merrill to Briggs. Refer to Briggs' Figure 1 for proposed infiltration area and site features presented on the above noted Site Plan from Merrill.

Test Pits and Soil Conditions

A single test pit was excavated about 12 feet below current site grade within the proposed infiltration area. The test pit is labelled D-6 by Merrill and is located on the attached Figure 1. The excavation extended through topsoil and subsoil into undisturbed gravelly sands with trace silt content based on textural examination by Briggs.

Test Procedure

Briggs completed infiltrometer tests via ASTM method D3385-16. The test was accomplished in the center of the test pit at the base of excavation. Briggs hand shovel excavated about 4 inches below the base of excavation to access undisturbed soils that were not loosened by the teeth of the excavator bucket. Per method ASTM method D3385-16, retained water height (head) in the infiltrometer rings was maintained at 4 to 6 inches for all tests satisfying the specified water head at 1 to 6 inches. Multiple flow rates were measured until consistent infiltration rates were recorded for a least two successive readings for a total of at least 30 minutes of water flow at the 4 to 6 inch water head.

The infiltrometer test revealed a stabilized rate of 32 inches per hor (IPH).

Conclusions

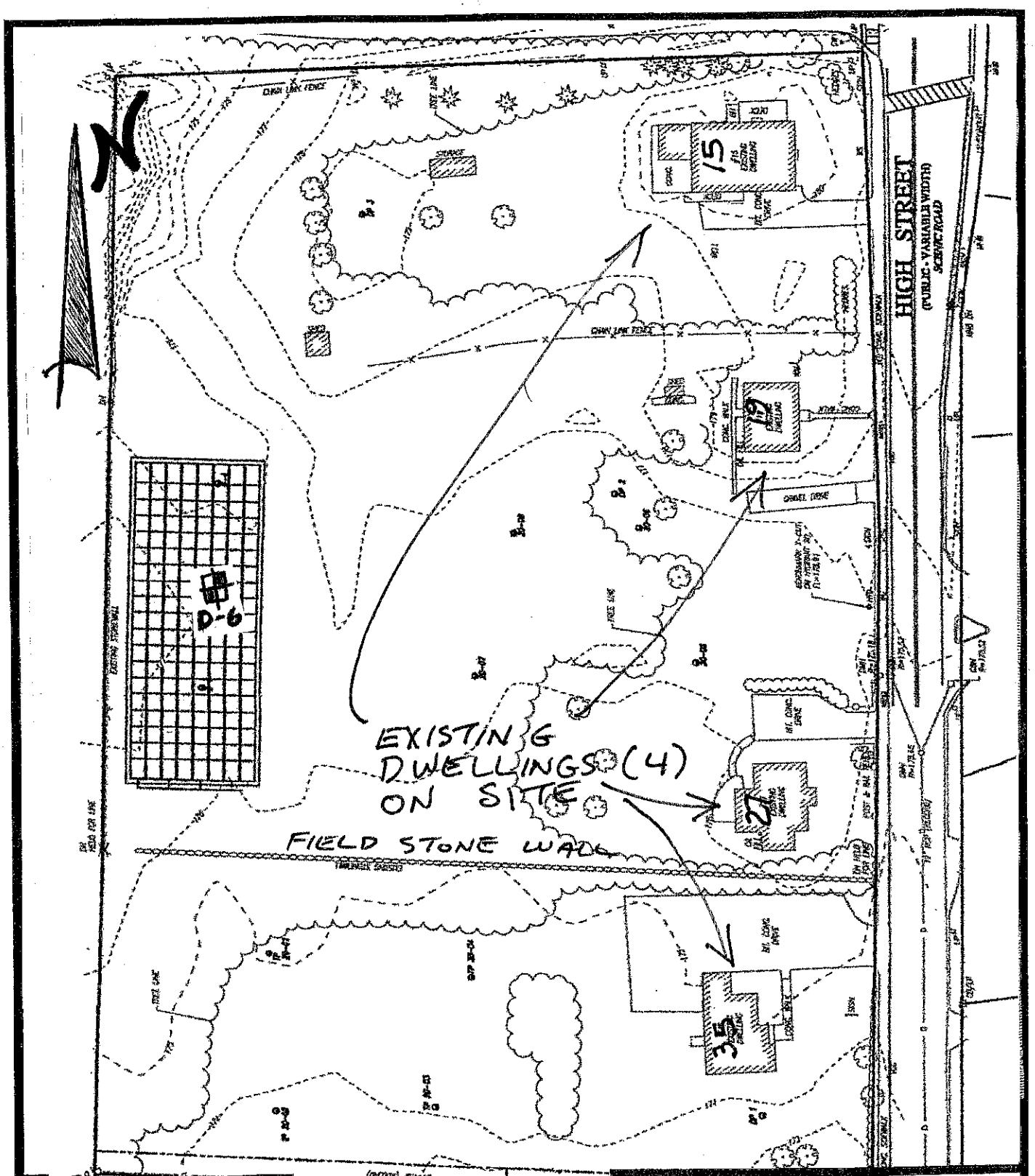
Merrill states that the design infiltration rate was 20 IPH. Measure rate is 32 IPH. The measured rate exceeds the design rate assigned by Merrill to their drainage area calculations, therefore the soil at the infiltrometer test location will drain faster than estimated by Merrill.

If you have any questions, please do not hesitate to contact us at your convenience.

Very truly yours,
Briggs Engineering & Testing

David W. Geisser
Geotechnical Department Manager

DWG:dg
Enclosure: Figure 1



Briggs Engineering & Testing
A Division of PK Associates, Inc.

LEGEND:
D6 Number and approximate location of test pit.

PROPOSED INFILTRATION AREA
35 HIGH STREET
NORWELL, MASS.

Scale: N.T.S.	Drawn: DWG	FIG. 1
8-27-21	Check: DWG	

Operation and Maintenance Plans – Separate Document

- Construction Operation and Maintenance Plan & Pollution Prevention Plan
- Long Term Source Control / Pollution Prevention Plan & Operation and Maintenance Plan

Site Plan – Attached