STORMWATER MANAGEMENT CALCULATIONS

FOR

WHIPPLE DRIVE TOWNHOMES
REZONING APPLICATION

MOUNT TABOR MAGISTERIAL DISTRICT
TOWN OF BLACKSBURG, VIRGINIA

June 1, 2022

PREPARED BY:

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SECTION I: PROJECT NARRATIVE

Project Description

The purpose of this project is the rezoning of 3.08 acres of land for JJB Properties, LLC. The project area is currently made up of five (5) separate parcels. Four (4) of the parcels have existing houses located on them and one parcel is vacant. The applicant proposes to rezone the properties from R-5 (Transitional Residential) to a PRD (Planned Residential District) in order to construct a new townhome community.

Existing Site Conditions

The project site[1] is situated near the southeast corner of the intersection of Whipple Drive and Givens Lane. The site is bound by Ratcliff Corner Townhomes to the north, the property of Margaret Ann Evans to the east and south, and Whipple Drive to the west. Surrounding properties consist of multi-family residential, townhomes, single-family residential, commercial properties, and vacant land.

Existing soil conditions on site include the types listed below with slopes ranging from 2%-15%. There are currently no known environmental issues on site, however, prior to construction, the site will be fully investigated to determine if there are any jurisdictional waters on the property or within any of the areas of disturbance. If evidence is found, the property will be delineated, confirmed by the US Army Corps of Engineers, and all necessary permits will be filed.

Existing soil conditions on-site include the following types:
(See attached soils map for specific locations.)

11B - Duffield-Ernest Complex, 2 to 7 percent slopes
- K-Factor: 0.28
- Texture: Silt Loam
- HSG: B

13B - Frederick and Vertrees Gravelly Silt Loams, 2 to 7 percent slopes
- K-Factor: 0.24
- Texture: Gravelly Silt Loam
- HSG: B

13C - Frederick and Vertrees Gravelly Silt Loams, 7 to 15 percent slopes
- K-Factor: 0.24
- Texture: Gravelly Silt Loam
- HSG: B

[1] For the purposes of the Project Narrative, "site" shall be defined as the area within the subject property boundary, 3.08 acres, Tax Map #'s 197-1 50A, 51C, 5*; 197-1 51B, 52B, 5*; 197-1 51A, 52A, 5*; 167-24 53A, and 197-1 46A.

Development Plans

The proposed development will consist of 34 new townhomes with 2- or 3-bedrooms each. The townhomes will each be two (2) stories and built over a crawl space. Each unit will include a covered front porch and either an elevated deck or patio on grade in the rear. Parking will be provided in a surface parking lot built in a loop around the development. Water main and sanitary sewer main extensions are proposed to serve the development. Stormwater quantity management will be handled by an underground detention system. Water quality requirements will be met by purchasing nutrient credits.

During Construction

Neighboring areas are primarily developed urban land consisting of single- and multi-family residential and commercial properties. Any runoff from the site shall be controlled with temporary measures such as a construction entrance, silt fence, inlet protection, construction road stabilization, seeding and other measures per Virginia Erosion and Sediment Control Handbook standards.

SECTION II: STORMWATER MANAGEMENT SUMMARY

PRE-DEVELOPMENT SUMMARY

Please see Sheet SW3 for drainage area map.

In the pre-development condition, the site contains several single-family homes as well as some grassed areas and a few trees. The majority of the site drains naturally to a low spot in the northwestern corner of the site, where runoff from this site converges with runoff from the properties to the north as well as the outflow from the underground detention system located at Ratcliff Townhomes. All of this flow is conveyed through an existing storm pipe to a curb inlet located in Whipple Drive. A portion of the property (approximately 0.94 acres) drains directly into the right of way, where it is conveyed to the same curb inlet. From this point, runoff is carried across Whipple Drive and continues through a series of pipes and conveyance channels. The point of analysis has been set at this curb inlet where the majority runoff from the site converges before crossing under Whipple Drive.

A small area of the site is shown as a Direct Runoff Area. Water from this portion of the site flows towards the southwest corner of site and into a different curb inlet, where it is conveyed through a pipe system and eventually combines with the remainder of the site runoff.

See the following pages and the enclosed HydroCAD report for the peak flow rates and runoff volumes in the pre-development condition. All flows in the HydroCAD model have been analyzed using the SCS/TR-55, weighted Q method. See the included drainage map and HydroCAD report for time of concentration calculations. Where a subwatershed is predominantly impervious, a minimum time of concentration of 6 minutes has been assumed.

Pre-Development Land Cover

Area (acres)	CN	Description (subcatchment numbers)
0.115	70	1/2 acre lots, 25% imp, HSG B (2S)
4.665	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S)
0.881	98	Paved parking, HSG B (1S, 2S, 3S)
5.661	**67**	**TOTAL AREA**

Point of Analysis

Total Drainage Area= 5.09 acres

	Peak Flow	Runoff Volume
1-year	0.54 cfs	0.124 af
2-year	1.37 cfs	0.211 af
10-year	4.78 cfs	0.526 af
100-year	14.11 cfs	1.249 af

Direct Runoff Area

Total Drainage Area= 0.570 acres

	Runoff Volume
1-year	0.013 af
2-year	0.022 af
10-year	0.057 af
100-year	0.138 af

POST-DEVELOPMENT SUMMARY

Please see Sheet SW4 for drainage area map.

In the post-development condition, the proposed site will be graded to capture runoff via sheet flow, roof drains, curb inlets, and stormwater piping. Runoff will be collected in an underground detention basin. Outflow from this system will be managed by multiple flow control devices. As shown in the enclosed HydroCAD calculations, the underground system has been designed to manage peak flows and meet water quantity requirements. The system outlet structure will be fitted with a DI-7 top to allow water from the 100-year storm event to escape.

Outflow from the system will converge with the flow from Ratcliff Corner and be conveyed to the point of analysis, the curb inlet in Whipple Drive. The following pages and the HydroCAD report demonstrate that the site will be contributing less flow to the inlet in Whipple Drive than in the pre-development condition.

A small portion of the site will remain as direct runoff and continue to flow to the southeast corner. As in the pre-development condition, this flow will travel through the storm pipe system in Whipple Drive and combine with the flow from the new stormwater system before traveling downstream.

See the following pages and the enclosed HydroCAD report for the peak flow rates and runoff volumes in the post-development condition. All flows in this model have been analyzed using the SCS/TR-55, weighted Q method. See the included drainage map and HydroCAD report for time of concentration calculations. Where a subwatershed is predominantly impervious, a minimum time of concentration of 6 minutes has been assumed.

Post-Development Land Cover

Area (acres)	CN	Description
0.115	70	1/2 acre lots, 25% imp, HSG B (2S)
3.200	61	>75% Grass cover, HSG C (1S, 2S, 3S)
2.345	98	Paved parking, HSG C (1S-A, 1S-B)
5.660	**77**	**TOTAL AREA**

Point of Analysis

Total Drainage Area= 5.306 acres

The following table summarizes the pre- and post-development peak flow rates for the point of analysis and the percent change for each storm (see HydroCAD report).

	Pre-Dev Peak Flow Rate	Post-Dev Peak Flow Rate	Reduction
1-year	0.54 cfs	0.26 cfs	-51.8%
2-year	1.37 cfs	0.95 cfs	-30.7%
10-year	4.78 cfs	4.08 cfs	-14.6%

As shown above, the post-development peak flow rates are less than the pre-development peak flow rates for the 1-year, 2-year, and 10-year, thus meeting Town of Blacksburg requirements for stormwater quantity.

Direct Runoff Area

Total Drainage Area= 0.203 acres

The following table summarizes the pre- and post-development runoff volumes for Direct Runoff Area #1 and the percent change for each storm (See HydroCAD report).

	Pre-Dev Runoff Volume	Post-Dev Runoff Volume	Reduction
1-year	0.013 af	0.008 af	-38.5%
2-year	0.022 af	0.012 af	-45.5%
10-year	0.057 af	0.027 af	-52.6%
100-year	0.138 af	0.059 af	-57.2%

As shown above, the post-development runoff volumes for the direct runoff areas are less than the pre-development runoff volumes for the 1-year, 2-year, and 10-year, thus meeting the requirements of 9VAC25-870-66 subsection D.

Channel Protection

In accordance with 9VAC25-870-66 (B), concentrated stormwater flows will be discharged directly to a stormwater conveyance system. Runoff from this system will be discharged through a pipe into a channel. From this point, runoff will flow through a series of manmade and natural conveyance systems to the 1% analysis point of the site[2] (323 acres). No erosion of either the natural or the manmade system should be expected from stormwater flows. Per subdivision (3)(a), the maximum post-development peak flow rate from the 1-year 24-hour storm shall be calculated per the equations below to prevent erosion of the natural conveyance systems. Additionally, all analyzed storms will produce a post-development flow rate lower than the pre-development flow rate, therefore no erosion of the manmade system should be expected.

R_v Calculation

Pre-developed = 0.048 acre*ft – See HydroCAD "RV Calculation" Report
Developed = 0.209 acre*ft – See HydroCAD "RV Calculation" Report

$$Q_{Developed} \leq I.F. \times \left(Q_{Pre-developed} \times RV_{Pre-Developed}\right)/RV_{Developed}$$
$$Q_{Developed} \leq 0.8 \times \left(Q_{Pre-developed} \times 0.048\right)/0.209$$
$$Q_{Developed} \leq 0.18 \times Q_{Pre-developed}$$

The resulting maximum allowable peak flow rate for the one-year 24-hour storm at the Point of Analysis is 0.29 cfs. The actual post-development peak flow rate achieved is 0.26 cfs.

Flood Protection

In accordance with 9VAC25-870-66 (C), concentrated stormwater flows have been discharged to a stormwater conveyance system. The downstream conveyance systems are made up of a series of natural and manmade conveyance systems. As shown on the attached HydroCAD calculations, the point of discharge releases a post-development peak flow rate for the 10-year 24-hour storm event that is less than the pre-development peak flow rate from the 10-year 24-hour storm event, satisfying subdivision 2(b). Per subdivision (3) of these regulations, no further analysis of the downstream stormwater conveyance system is required.

[2] In the context of channel and flood protection, "site" shall be defined as the area where work is being performed, including any offsite disturbance (approximately 3.23 acres). See Sheets SW3-SW4.

SECTION III: STORMWATER QUALITY SUMMARY

Water quality compliance will be achieved through the purchase of nutrient credits in accordance with the criteria set forth in the Code of Virginia. Per §62.1-44.15:35(C)(2), the VSMP shall allow the use of nutrient credits when the area of disturbance is less than 5 acres or the water quality reduction requirement is less than 10 pounds per year. This site qualifies for nutrient credit purchase with a total disturbed area of approximately 3.23 acres and a reduction requirement of 2.85 pounds per year.

The existing site[3] has an impervious land cover of 0.36 acres (11%). The post-development site will have an impervious land cover of 1.82 acres (56%) resulting in a runoff coefficient (R_v) of 0.62. The required pollutant removal rate is 2.85 lb/year, all of which will be handled with nutrient credits.

[3] In the context of channel and flood protection, "site" shall be defined as the area where work is being performed, including any offsite disturbance (approximately 3.23 acres). See Sheets SW3-SW4.

SECTION IV: DOWNSTREAM ANALYSIS

Runoff from the proposed development is discharged directly into to a series of natural and manmade conveyance systems. These conveyance systems carry flows from the site downstream to the 1% analysis point (323 acres). The post-development peak runoff has been mitigated via underground detention facilities to prevent adverse impacts from this site to downstream properties in the form of channel erosion and flooding.

Per 9VAC25-870-66 subsection A, compliance with Minimum Standard 19 of the Virginia Erosion and Sediment Control Regulations has been satisfied by meeting the requirements of the for channel protection and flood protection as shown in the Post Development Summary. No adverse impacts to downstream properties are expected as a result of this development.

SECTION V: STORMWATER MANAGEMENT MAINTENANCE/INSPECTION PLAN

Generally

1. The owner is responsible for providing or coordinating all facility inspections and any required maintenance that may result from such inspections.
2. Requirements listed here are to be taken as a minimum and do not represent the limit of responsibility.
3. Any standing water pumped during the maintenance operation must be disposed of per the VESCH, 1992 edition and any local requirements.

Required Action

Underground Detention Facilities:

1. Every (12) months the responsible party shall complete and document a visual inspection of the underground facility and its components and make any repairs necessary to areas of failure or concern discovered during inspection. Typical maintenance tasks include:
    a. Cleanout of any debris or sediment accumulated in the structure that reduces the storage volume or otherwise hinders the performance of the facility.
    b. Visual inspection for structural deterioration, spalling, or cracking of the structural components.
2. The flow control manholes shall be inspected after each runoff producing storm event to check for debris and/or sediment accumulation that may compromise the performance of the structure. Such debris and sediments shall be removed immediately.

Per the Town of Blacksburg stormwater ordinance, a formal maintenance agreement shall be provided to the Town for review and ultimately recorded at the Montgomery County Courthouse legally binding the identified party to the maintenance/inspection responsibilities listed above.

APPENDIX A:
SOIL MAPS & SOIL DESCRIPTIONS

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Montgomery County, Virginia

May 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,110 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Montgomery County, Virginia
Survey Area Data: Version 14, Sep 14, 2021

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

Date(s) aerial images were photographed: Sep 29, 2019—Oct 4, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
11B	Duffield-Ernest complex, 2 to 7 percent slopes	1.4	37.0%
13B	Frederick and Vertrees gravelly silt loams, 2 to 7 percent slopes	0.3	8.3%
13C	Frederick and Vertrees gravelly silt loams, 7 to 15 percent slopes	2.0	54.7%
Totals for Area of Interest		**3.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate

pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Montgomery County, Virginia

11B—Duffield-Ernest complex, 2 to 7 percent slopes

Map Unit Setting

National map unit symbol: kc1q
Elevation: 1,300 to 3,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 117 to 185 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Duffield and similar soils: 45 percent
Ernest and similar soils: 35 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Duffield

Setting

Landform: Drainageways
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Loamy colluvial, alluvial, eolian sediments underlain by loamy and clayey residuum of limestone and shale

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 37 inches: silty clay loam
H3 - 37 to 79 inches: clay

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: 48 to 99 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Ernest

Setting

Landform: Drainageways

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Interbedded limestone and shale residuum

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 26 inches: silty clay loam
H3 - 26 to 50 inches: silty clay loam
H4 - 50 to 79 inches: silty clay loam

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: 20 to 35 inches to fragipan
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Purdy

Percent of map unit: 3 percent
Landform: Stream terraces, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

13B—Frederick and Vertrees gravelly silt loams, 2 to 7 percent slopes

Map Unit Setting

National map unit symbol: kc1v
Elevation: 1,700 to 3,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 117 to 185 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Frederick and similar soils: 40 percent
Vertrees and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Frederick

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Limestone interbedded with siltstone and shale residuum

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 22 inches: clay
H3 - 22 to 79 inches: clay

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Forage suitability group: Moist, Fertile Soils (G128XB001VA)
Other vegetative classification: Moist, Fertile Soils (G128XB001VA)
Hydric soil rating: No

Description of Vertrees

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Limestone, siltstone, and shale residuum

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 25 inches: silty clay
H3 - 25 to 50 inches: clay
H4 - 50 to 79 inches: clay

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Forage suitability group: Moist, Fertile Soils (G128XB001VA)
Other vegetative classification: Moist, Fertile Soils (G128XB001VA)
Hydric soil rating: No

13C—Frederick and Vertrees gravelly silt loams, 7 to 15 percent slopes

Map Unit Setting

National map unit symbol: kc1w
Elevation: 1,700 to 3,000 feet
Mean annual precipitation: 30 to 45 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 117 to 185 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Frederick and similar soils: 40 percent
Vertrees and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Frederick

Setting

Landform: Hills
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Limestone interbedded with siltstone and shale residuum

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 22 inches: clay
H3 - 22 to 79 inches: clay

Properties and qualities

Slope: 7 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Forage suitability group: Moist, Fertile Soils (G128XB001VA)
Other vegetative classification: Moist, Fertile Soils (G128XB001VA)
Hydric soil rating: No

Description of Vertrees

Setting

Landform: Hills
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Limestone, siltstone, and shale residuum

Typical profile

H1 - 0 to 10 inches: gravelly silt loam
H2 - 10 to 25 inches: silty clay
H3 - 25 to 50 inches: clay
H4 - 50 to 79 inches: clay

Properties and qualities

Slope: 7 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Forage suitability group: Moist, Fertile Soils (G128XB001VA)
Other vegetative classification: Moist, Fertile Soils (G128XB001VA)
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

K Factor, Whole Soil

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Factor K does not apply to organic horizons and is not reported for those layers.

Map Scale: 1:1,110 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Montgomery County, Virginia
Survey Area Data: Version 14, Sep 14, 2021

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

Date(s) aerial images were photographed: Sep 29, 2019—Oct 4, 2019

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

Table—K Factor, Whole Soil

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
11B	Duffield-Ernest complex, 2 to 7 percent slopes	.28	1.4	37.0%
13B	Frederick and Vertrees gravelly silt loams, 2 to 7 percent slopes	.24	0.3	8.3%
13C	Frederick and Vertrees gravelly silt loams, 7 to 15 percent slopes	.24	2.0	54.7%
Totals for Area of Interest			**3.7**	**100.0%**

Rating Options—K Factor, Whole Soil

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Surface Texture

This displays the representative texture class and modifier of the surface horizon.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Map Scale: 1:1,110 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Gravelly silt loam
- Silt loam
- Not rated or not available

Soil Rating Lines

- Gravelly silt loam
- Silt loam
- Not rated or not available

Soil Rating Points

- Gravelly silt loam
- Silt loam
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Montgomery County, Virginia
Survey Area Data: Version 14, Sep 14, 2021

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

Date(s) aerial images were photographed: Sep 29, 2019—Oct 4, 2019

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

Table—Surface Texture

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
11B	Duffield-Ernest complex, 2 to 7 percent slopes	Silt loam	1.4	37.0%
13B	Frederick and Vertrees gravelly silt loams, 2 to 7 percent slopes	Gravelly silt loam	0.3	8.3%
13C	Frederick and Vertrees gravelly silt loams, 7 to 15 percent slopes	Gravelly silt loam	2.0	54.7%
Totals for Area of Interest			**3.7**	**100.0%**

Rating Options—Surface Texture

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

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

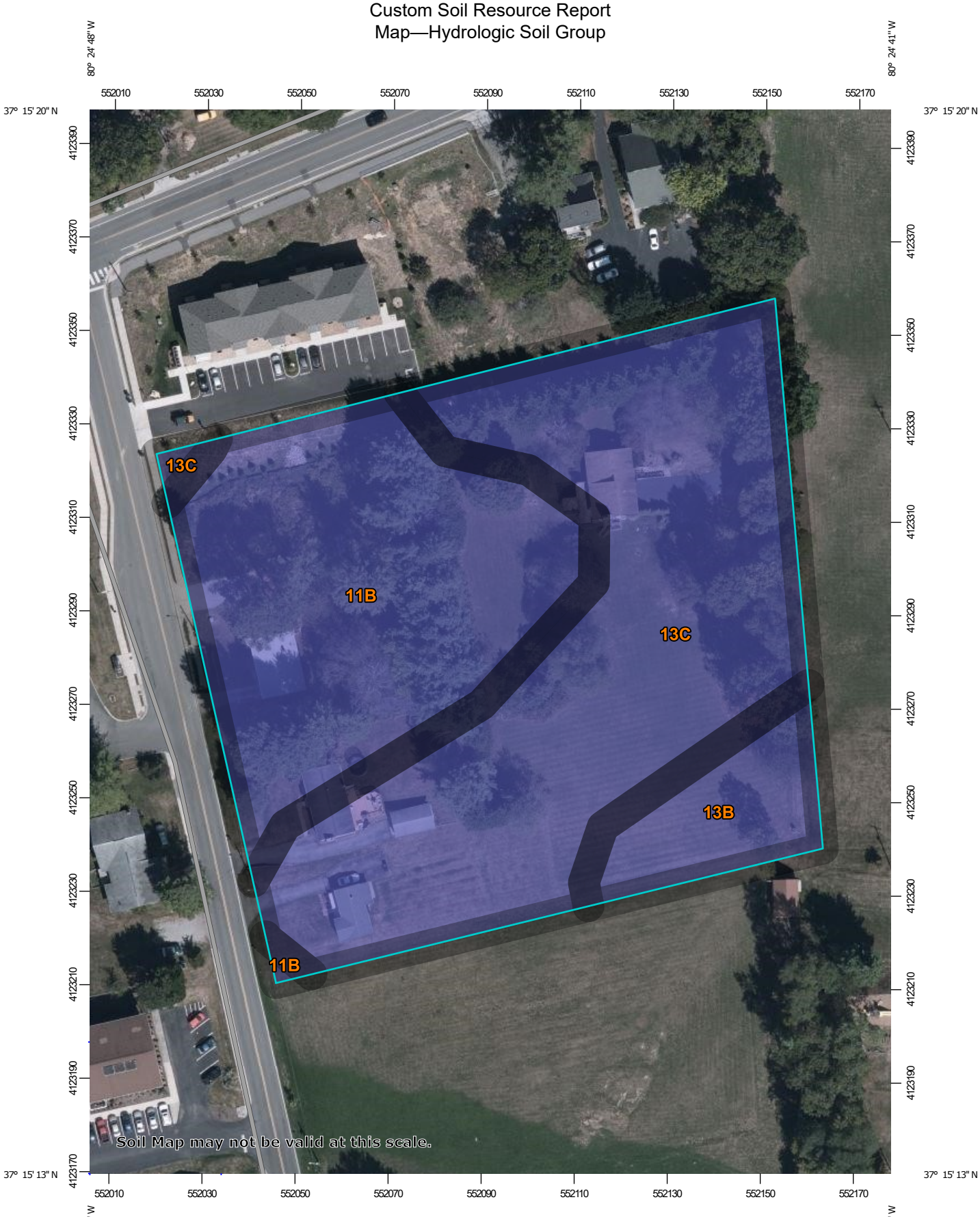
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

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

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

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



Map Scale: 1:1,110 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Montgomery County, Virginia
Survey Area Data: Version 14, Sep 14, 2021

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

Date(s) aerial images were photographed: Sep 29, 2019—Oct 4, 2019

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
11B	Duffield-Ernest complex, 2 to 7 percent slopes	B	1.4	37.0%
13B	Frederick and Vertrees gravelly silt loams, 2 to 7 percent slopes	B	0.3	8.3%
13C	Frederick and Vertrees gravelly silt loams, 7 to 15 percent slopes	B	2.0	54.7%
Totals for Area of Interest			**3.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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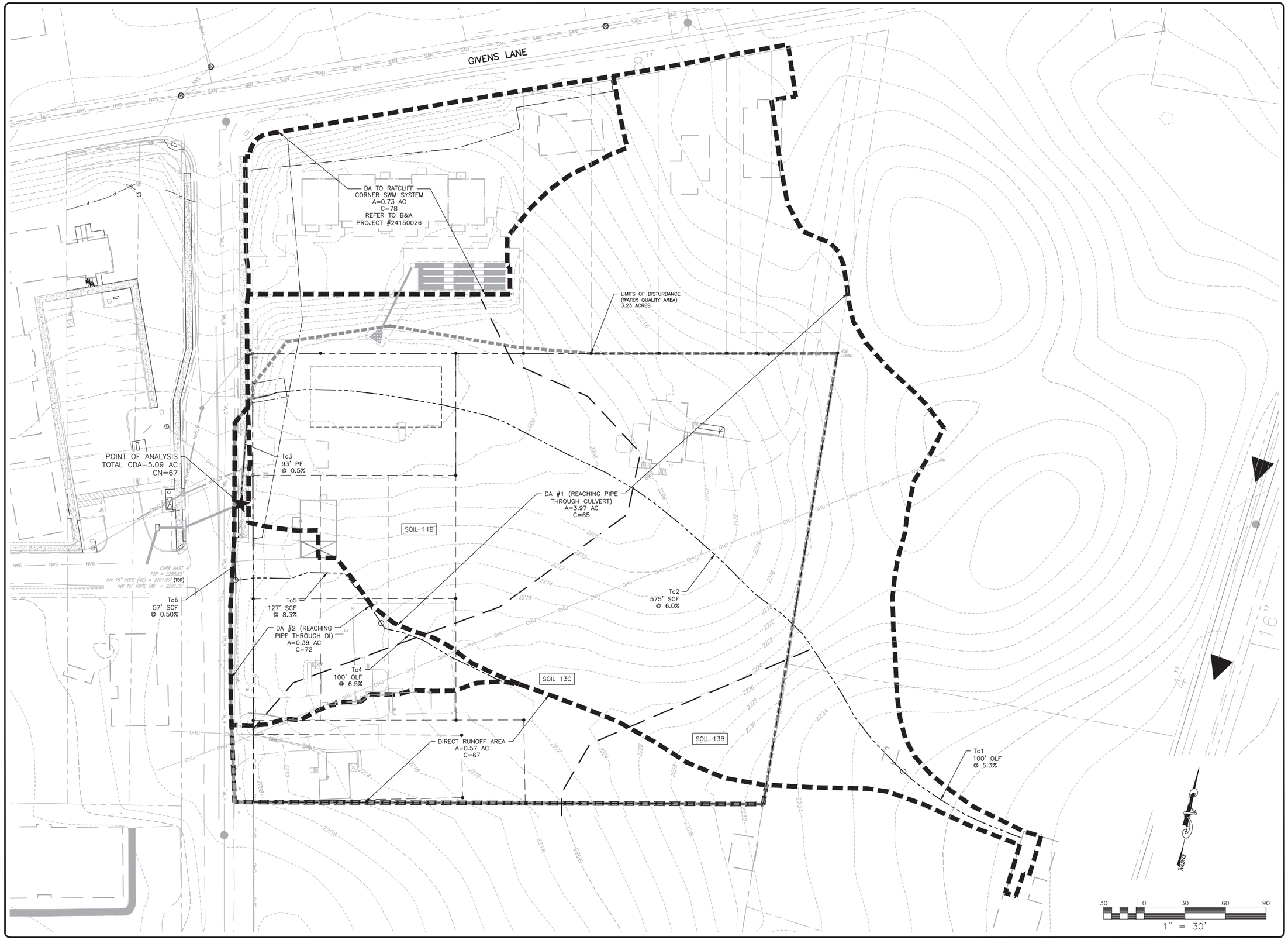
APPENDIX B:
DRAINAGE MAPS



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COMMONWEALTH OF VIRGINIA
GRETCHEN LEE MERIX
Lic. No. 63588
6/1/22
PROFESSIONAL ENGINEER

WHIPPLE DRIVE TOWNHOMES

PLANNED RESIDENTIAL DEVELOPMENT

PRE-DEVELOPMENT DRAINAGE AREA MAP

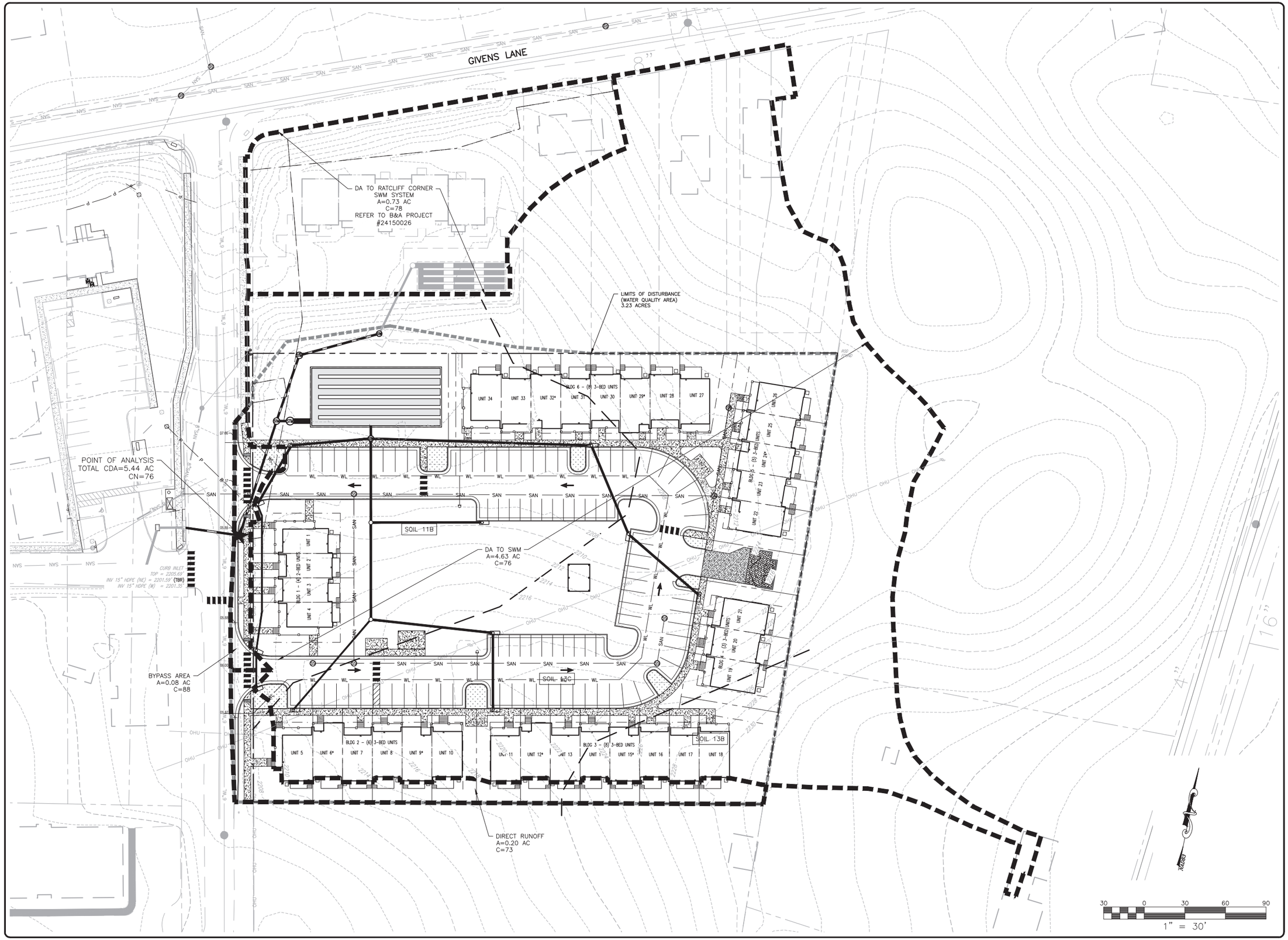
MOUNT TABOR MAGISTERIAL DISTRICT
TOWN OF BLACKSBURG, MONTGOMERY COUNTY, VIRGINIA

DRAWN BY	GLM
DESIGNED BY	GLM
CHECKED BY	SMS
DATE	6/1/22
SCALE	1" = 30'
REVISIONS	

SW3

PROJECT NO. 24210126.00

J:\24210126\24210126-00.sdf WHIPPLE DRIVE TOWNHOMES\CIVIL\dwg\24210126 REZONING.dwg PLOTTED: 5/31/2022 9:02:09 AM



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6/1/22
PROFESSIONAL ENGINEER

WHIPPLE DRIVE TOWNHOMES

PLANNED RESIDENTIAL DEVELOPMENT

POST-DEVELOPMENT DRAINAGE AREA MAP

MOUNT TABOR MAGISTERIAL DISTRICT
TOWN OF BLACKSBURG, MONTGOMERY COUNTY, VIRGINIA

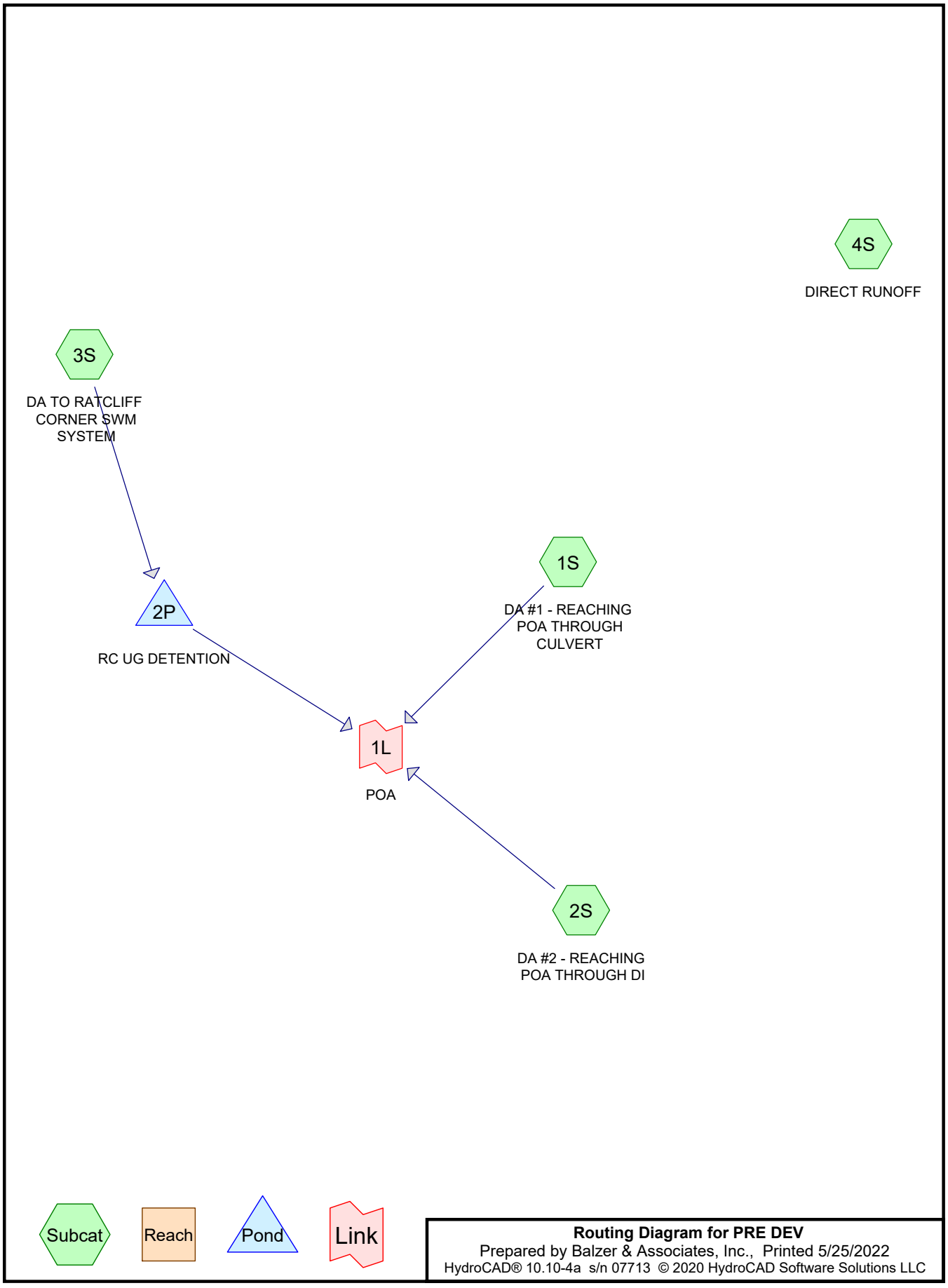
DRAWN BY	GLM
DESIGNED BY	GLM
CHECKED BY	SMS
DATE	6/1/22
SCALE	1" = 30'
REVISIONS	

SW4

PROJECT NO. 24210126.00

J:\2102\24\24210126.00 JJB WHIPPLE DRIVE TOWNHOMES\CIVIL\dwg\24210126 REZONING.dwg PLOTTED: 5/31/2022 9:02:13 AM

APPENDIX C:
STORMWATER QUANTITY CALCULATIONS



Routing Diagram for PRE DEV

Prepared by Balzer & Associates, Inc., Printed 5/25/2022

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.115	70	1/2 acre lots, 25% imp, HSG B (3S)
4.665	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S)
0.881	98	Paved parking, HSG B (1S, 2S, 3S, 4S)
5.661	**67**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA #1 - REACHING POA Runoff Area=3.973 ac 9.46% Impervious Runoff Depth=0.22"
Flow Length=768' Tc=9.9 min CN=65 Runoff=0.40 cfs 0.072 af

Subcatchment 2S: DA #2 - REACHING POA Runoff Area=0.393 ac 30.53% Impervious Runoff Depth=0.41"
Flow Length=284' Tc=7.8 min CN=72 Runoff=0.15 cfs 0.014 af

Subcatchment 3S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=0.64"
Tc=6.0 min CN=78 Runoff=0.60 cfs 0.039 af

Subcatchment 4S: DIRECT RUNOFF Runoff Area=0.570 ac 14.91% Impervious Runoff Depth=0.27"
Tc=0.0 min CN=67 Runoff=0.16 cfs 0.013 af

Pond 2P: RC UG DETENTION Peak Elev=2,205.39' Storage=0.018 af Inflow=0.60 cfs 0.039 af
Outflow=0.04 cfs 0.039 af

Link 1L: POA Inflow=0.54 cfs 0.124 af
Primary=0.54 cfs 0.124 af

Total Runoff Area = 5.661 ac Runoff Volume = 0.137 af Average Runoff Depth = 0.29"
83.93% Pervious = 4.751 ac 16.07% Impervious = 0.910 ac

Summary for Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT

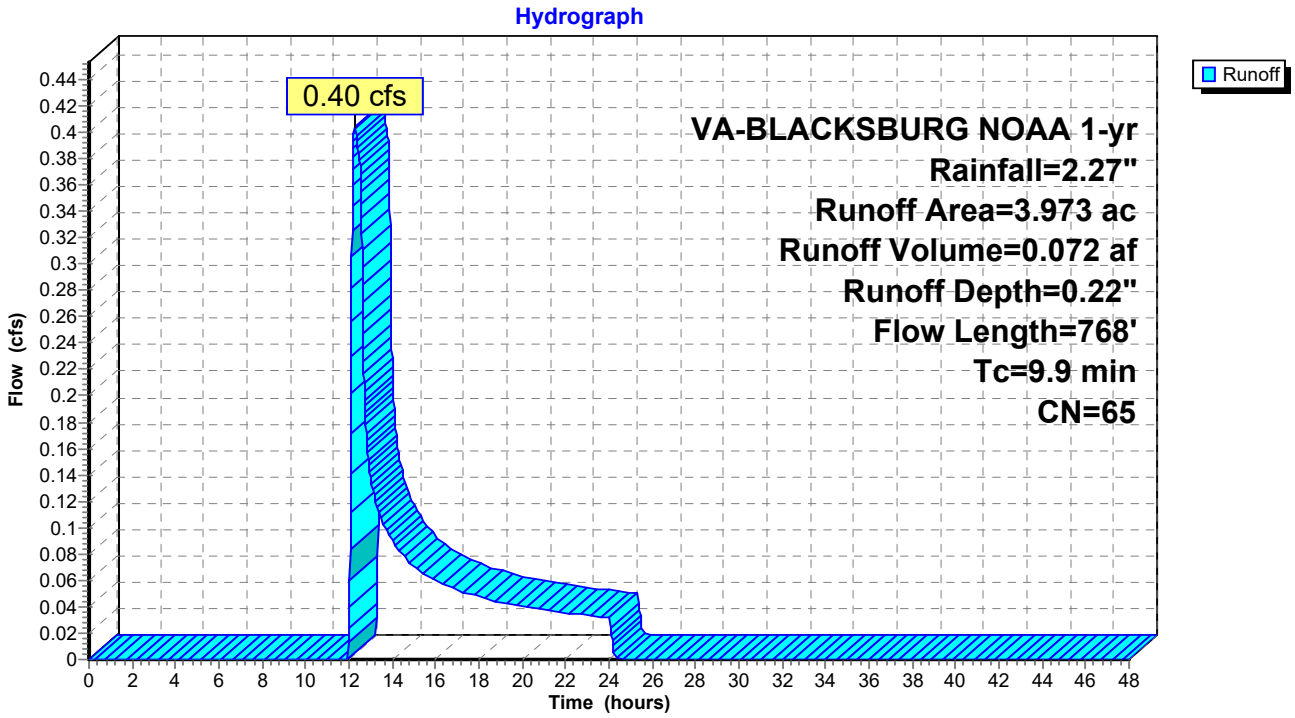
Runoff = 0.40 cfs @ 12.26 hrs, Volume= 0.072 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
3.597	61	>75% Grass cover, Good, HSG B
0.376	98	Paved parking, HSG B
3.973	65	Weighted Average
3.597		90.54% Pervious Area
0.376		9.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT



Summary for Subcatchment 2S: DA #2 - REACHING POA THROUGH DI

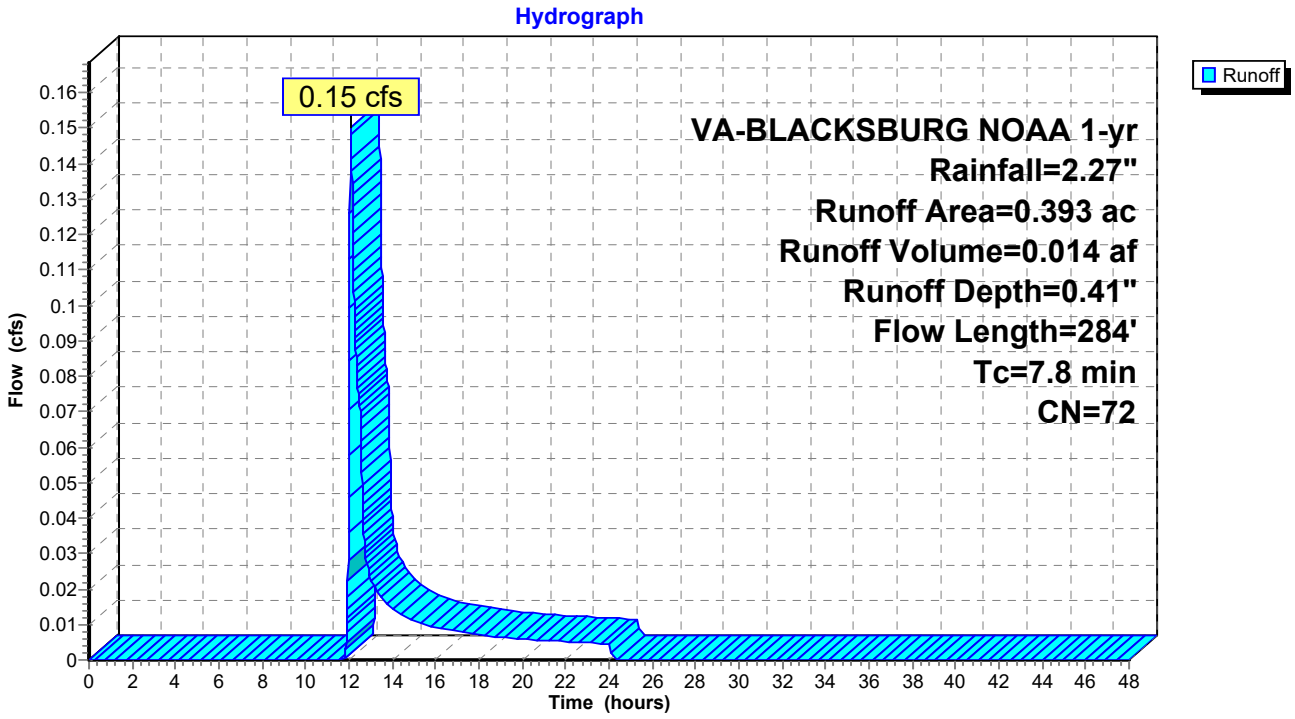
Runoff = 0.15 cfs @ 12.08 hrs, Volume= 0.014 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.273	61	>75% Grass cover, Good, HSG B
0.120	98	Paved parking, HSG B
0.393	72	Weighted Average
0.273		69.47% Pervious Area
0.120		30.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	100	0.0650	0.25		**Sheet Flow, Tc4** Grass: Short n= 0.150 P2= 2.76"
0.5	127	0.0830	4.64		**Shallow Concentrated Flow, Tc5** Unpaved Kv= 16.1 fps
0.7	57	0.0050	1.44		**Shallow Concentrated Flow, Tc6** Paved Kv= 20.3 fps
7.8	284	Total			

Subcatchment 2S: DA #2 - REACHING POA THROUGH DI



Summary for Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM

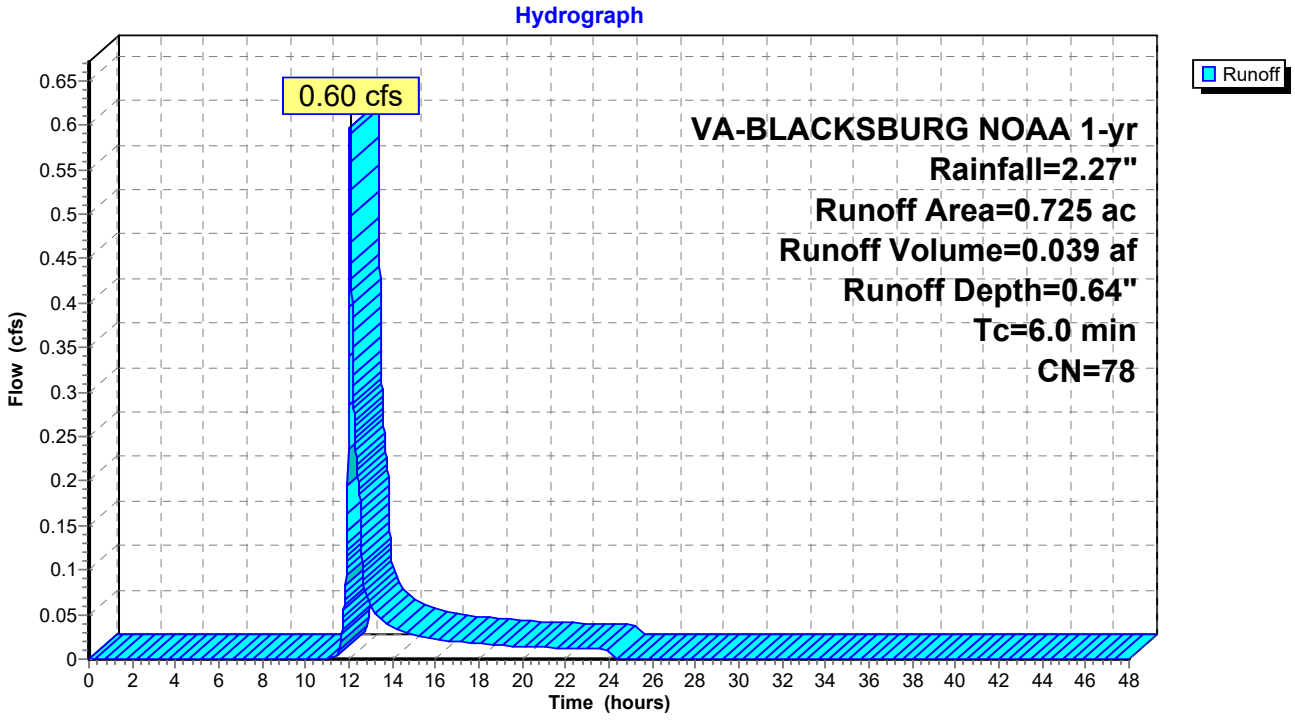
Runoff = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 4S: DIRECT RUNOFF

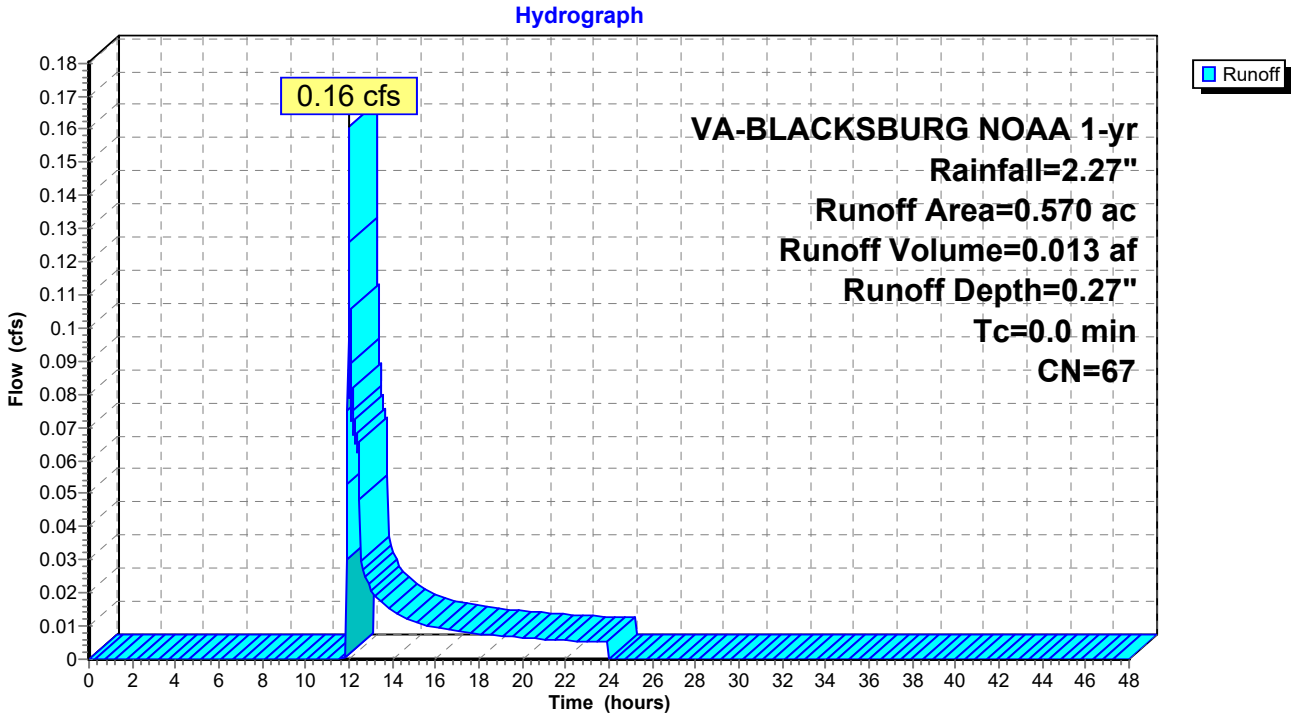
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.16 cfs @ 11.99 hrs, Volume= 0.013 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.485	61	>75% Grass cover, Good, HSG B
0.085	98	Paved parking, HSG B
0.570	67	Weighted Average
0.485		85.09% Pervious Area
0.085		14.91% Impervious Area

Subcatchment 4S: DIRECT RUNOFF



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 0.64" for 1-yr event
Inflow = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af
Outflow = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af, Atten= 94%, Lag= 114.9 min
Primary = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.39' @ 13.96 hrs Surf.Area= 0.032 ac Storage= 0.018 af

Plug-Flow detention time= 252.5 min calculated for 0.039 af (100% of inflow)
Center-of-Mass det. time= 252.5 min (1,125.6 - 873.2)

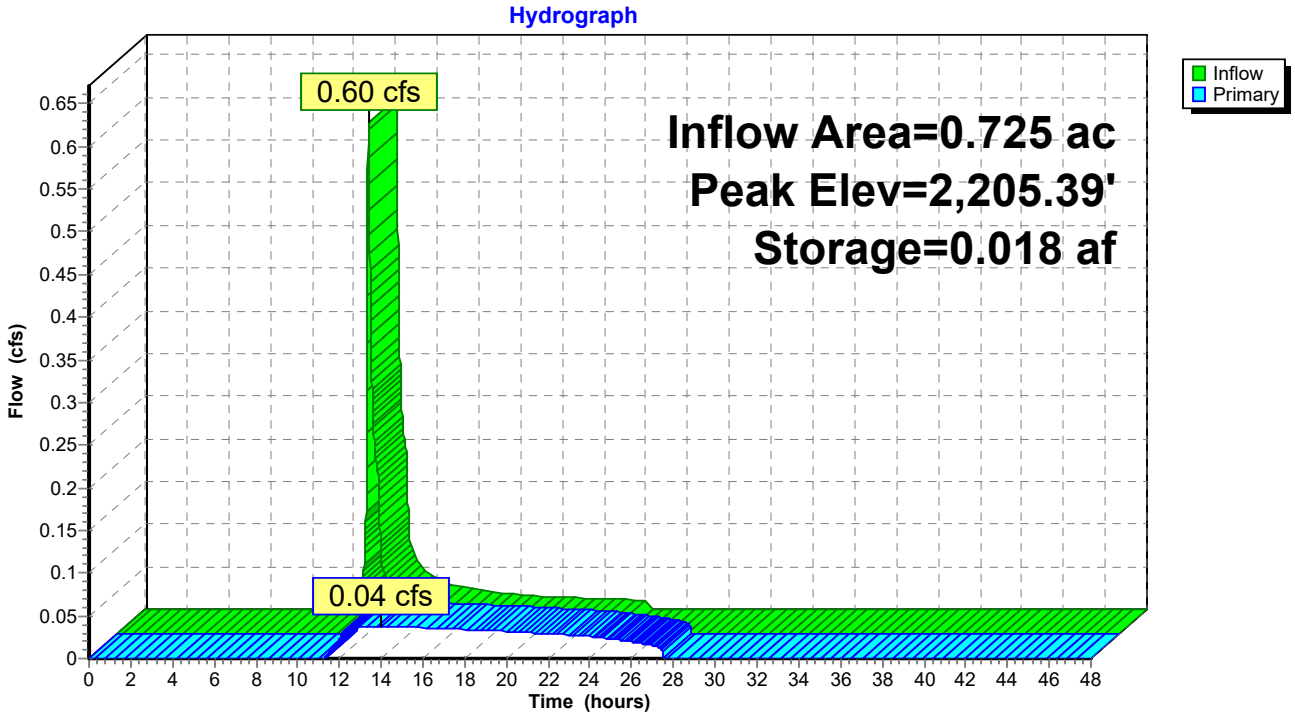
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

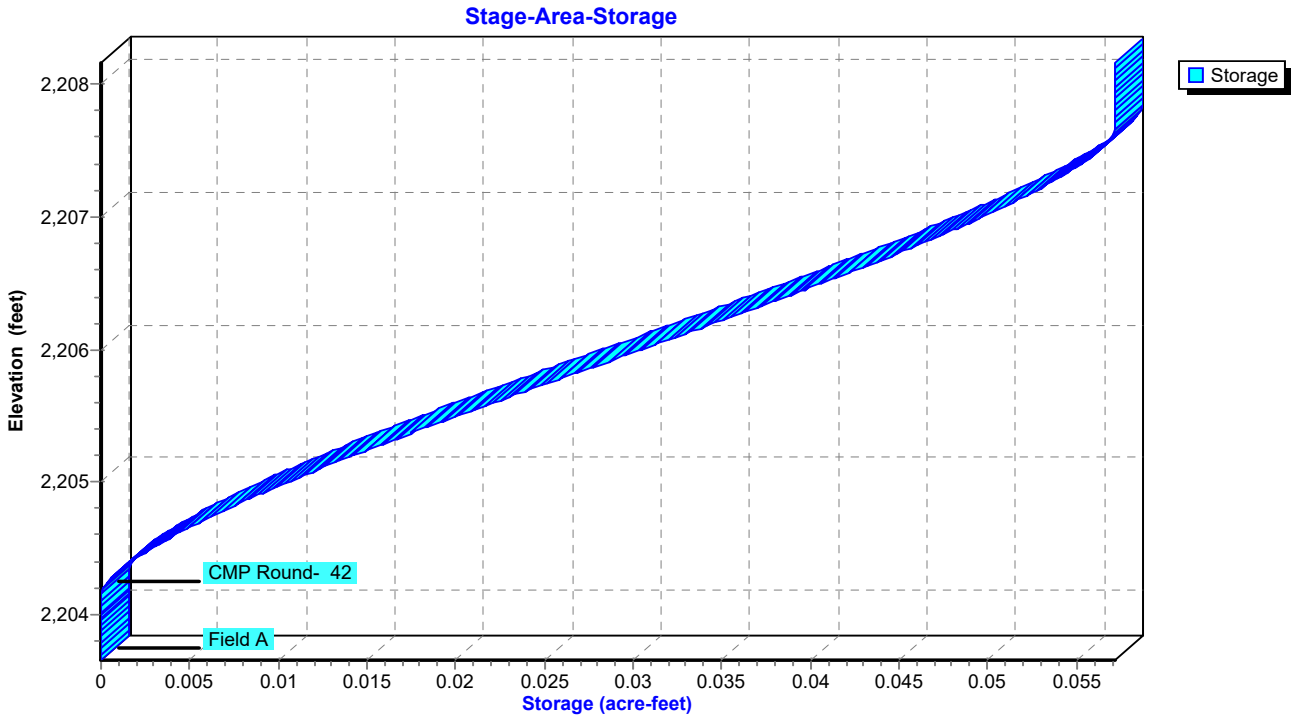
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#2	Device 1	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.04 cfs @ 13.96 hrs HW=2,205.39' (Free Discharge)
└**1=15" Culvert** (Passes 0.04 cfs of 4.43 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 5.57 fps)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

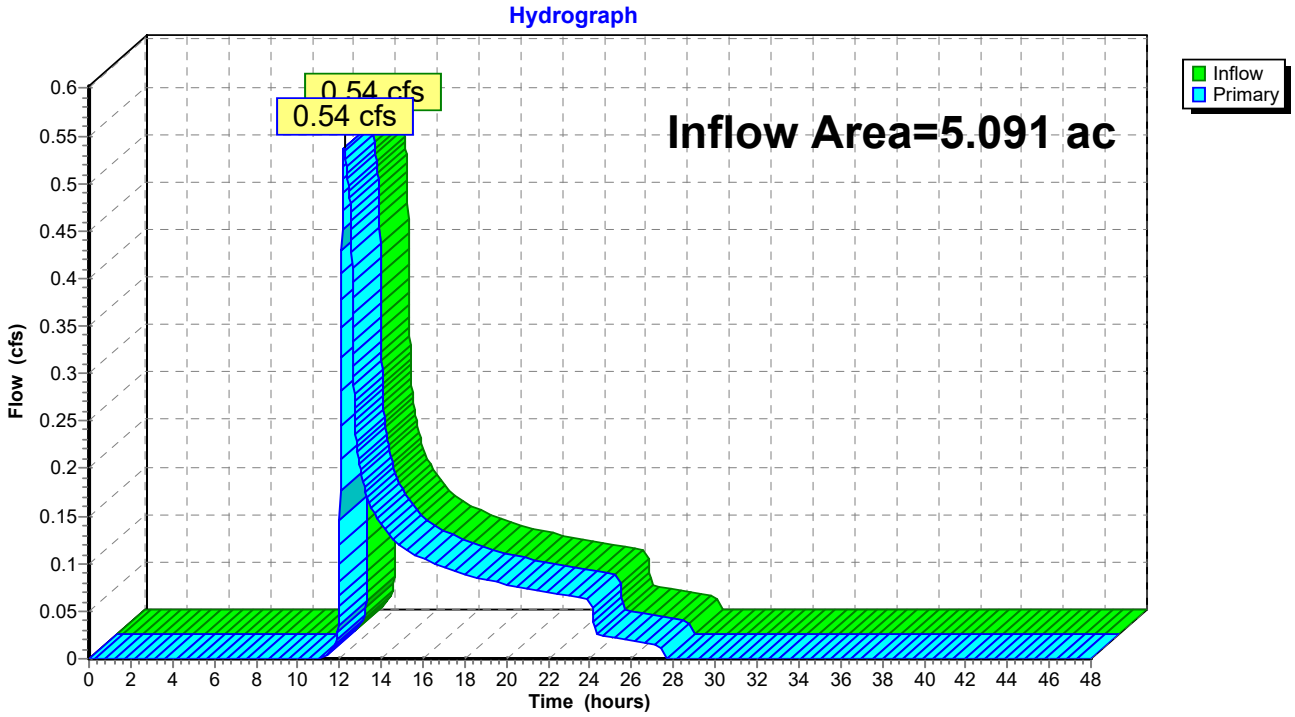


Summary for Link 1L: POA

Inflow Area = 5.091 ac, 16.20% Impervious, Inflow Depth = 0.29" for 1-yr event
Inflow = 0.54 cfs @ 12.22 hrs, Volume= 0.124 af
Primary = 0.54 cfs @ 12.22 hrs, Volume= 0.124 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA #1 - REACHING POA Runoff Area=3.973 ac 9.46% Impervious Runoff Depth=0.40"
Flow Length=768' Tc=9.9 min CN=65 Runoff=1.10 cfs 0.131 af

Subcatchment 2S: DA #2 - REACHING POA Runoff Area=0.393 ac 30.53% Impervious Runoff Depth=0.66"
Flow Length=284' Tc=7.8 min CN=72 Runoff=0.28 cfs 0.022 af

Subcatchment 3S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=0.95"
Tc=6.0 min CN=78 Runoff=0.94 cfs 0.058 af

Subcatchment 4S: DIRECT RUNOFF Runoff Area=0.570 ac 14.91% Impervious Runoff Depth=0.47"
Tc=0.0 min CN=67 Runoff=0.38 cfs 0.022 af

Pond 2P: RC UG DETENTION Peak Elev=2,205.97' Storage=0.030 af Inflow=0.94 cfs 0.058 af
Outflow=0.04 cfs 0.058 af

Link 1L: POA Inflow=1.37 cfs 0.211 af
Primary=1.37 cfs 0.211 af

Total Runoff Area = 5.661 ac Runoff Volume = 0.233 af Average Runoff Depth = 0.49"
83.93% Pervious = 4.751 ac 16.07% Impervious = 0.910 ac

Summary for Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT

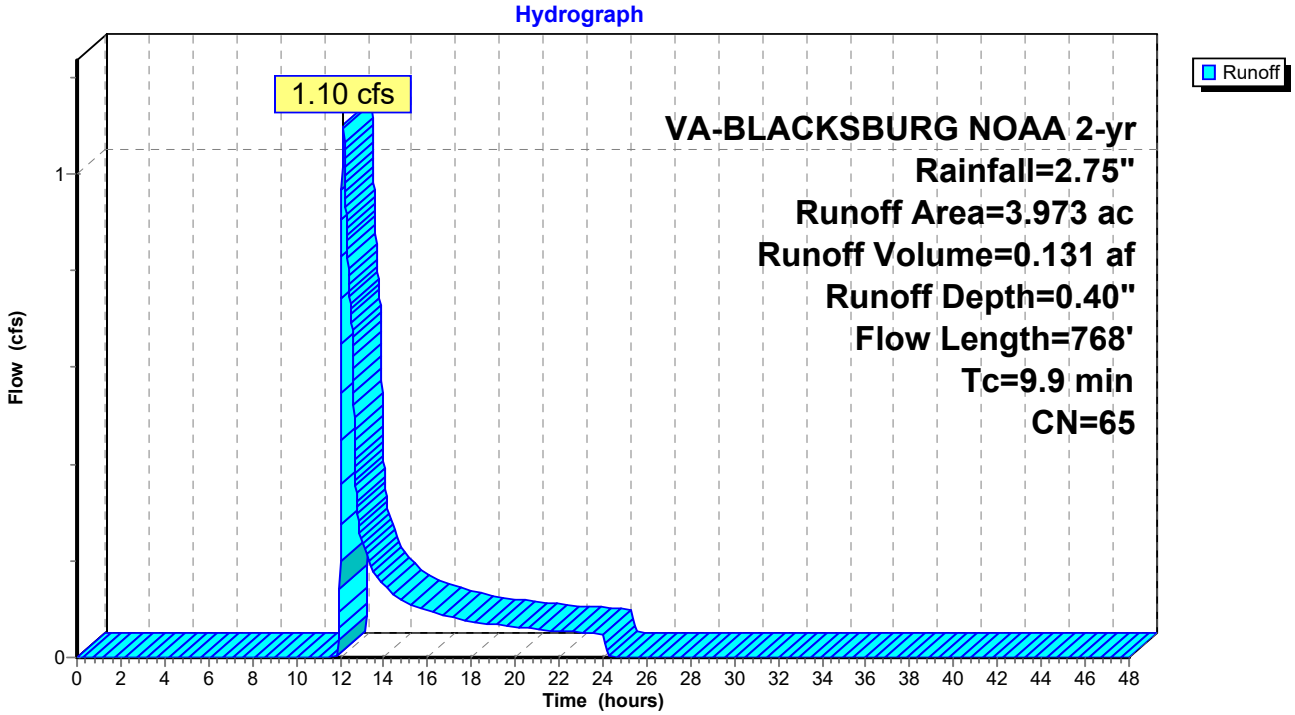
Runoff = 1.10 cfs @ 12.15 hrs, Volume= 0.131 af, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
3.597	61	>75% Grass cover, Good, HSG B
0.376	98	Paved parking, HSG B
3.973	65	Weighted Average
3.597		90.54% Pervious Area
0.376		9.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT



Summary for Subcatchment 2S: DA #2 - REACHING POA THROUGH DI

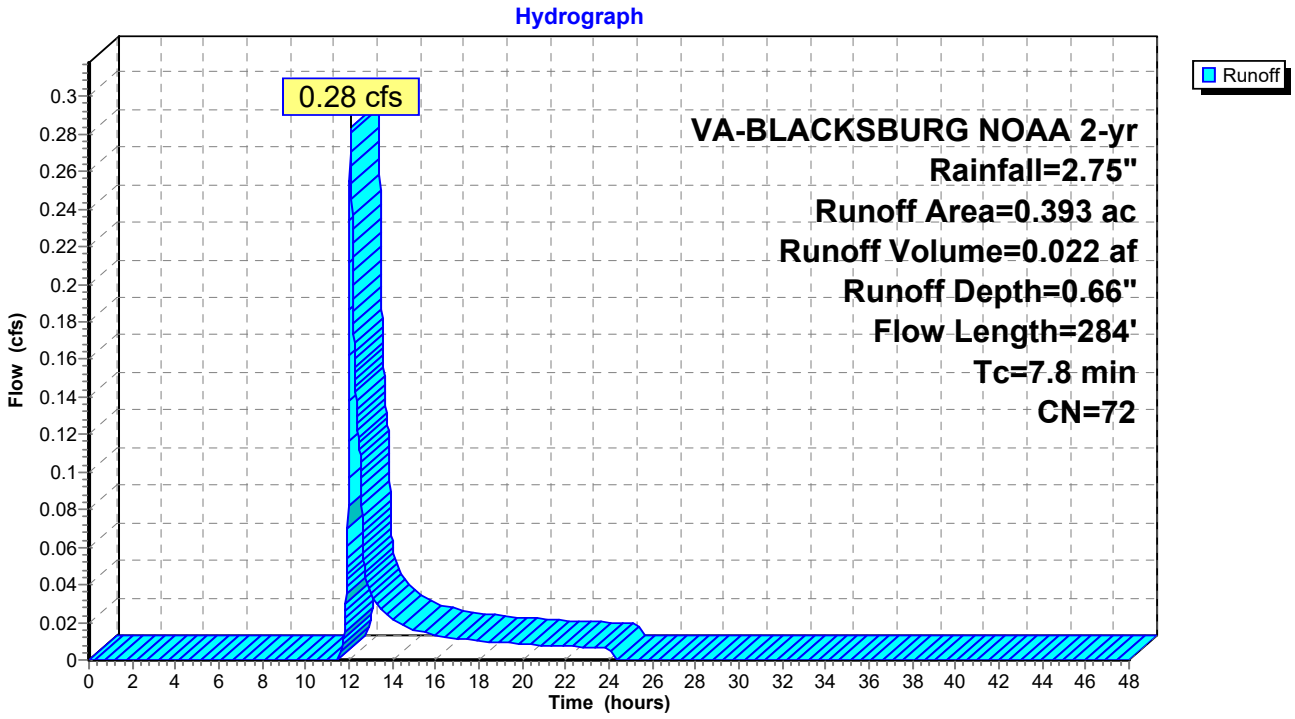
Runoff = 0.28 cfs @ 12.07 hrs, Volume= 0.022 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
0.273	61	>75% Grass cover, Good, HSG B
0.120	98	Paved parking, HSG B
0.393	72	Weighted Average
0.273		69.47% Pervious Area
0.120		30.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	100	0.0650	0.25		**Sheet Flow, Tc4** Grass: Short n= 0.150 P2= 2.76"
0.5	127	0.0830	4.64		**Shallow Concentrated Flow, Tc5** Unpaved Kv= 16.1 fps
0.7	57	0.0050	1.44		**Shallow Concentrated Flow, Tc6** Paved Kv= 20.3 fps
7.8	284	Total			

Subcatchment 2S: DA #2 - REACHING POA THROUGH DI



Summary for Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM

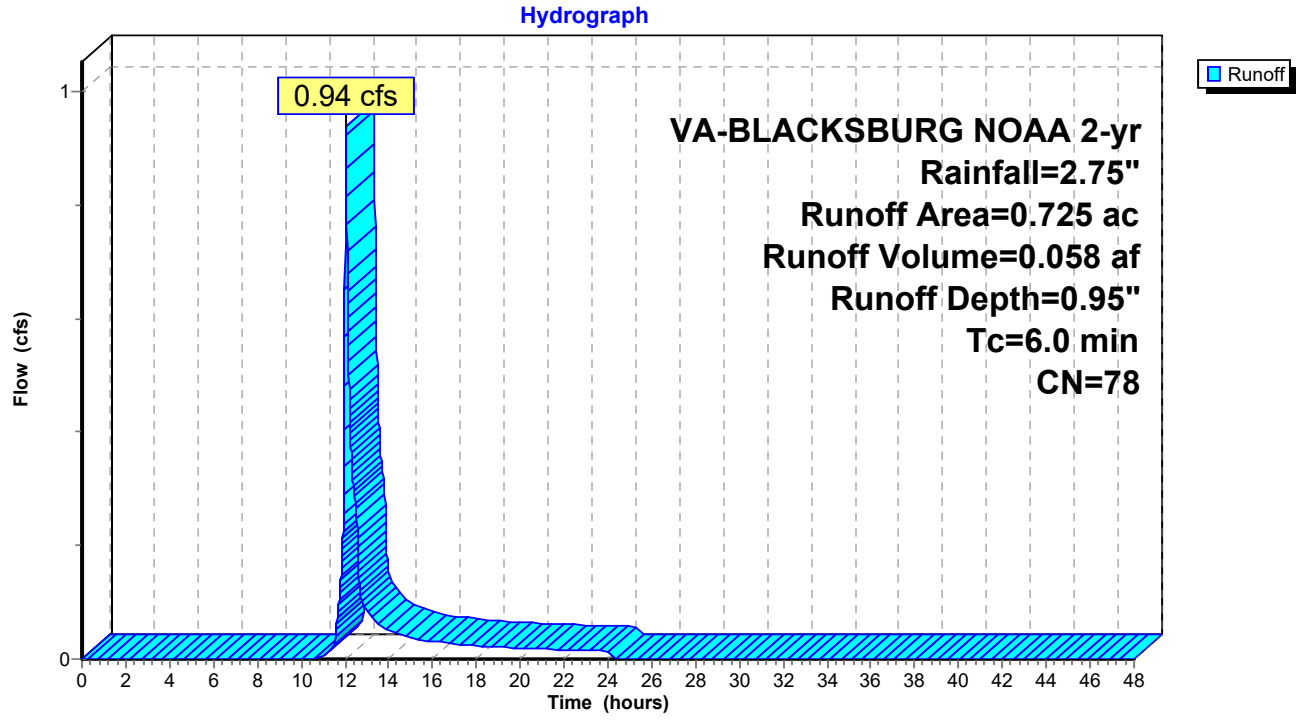
Runoff = 0.94 cfs @ 12.04 hrs, Volume= 0.058 af, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 4S: DIRECT RUNOFF

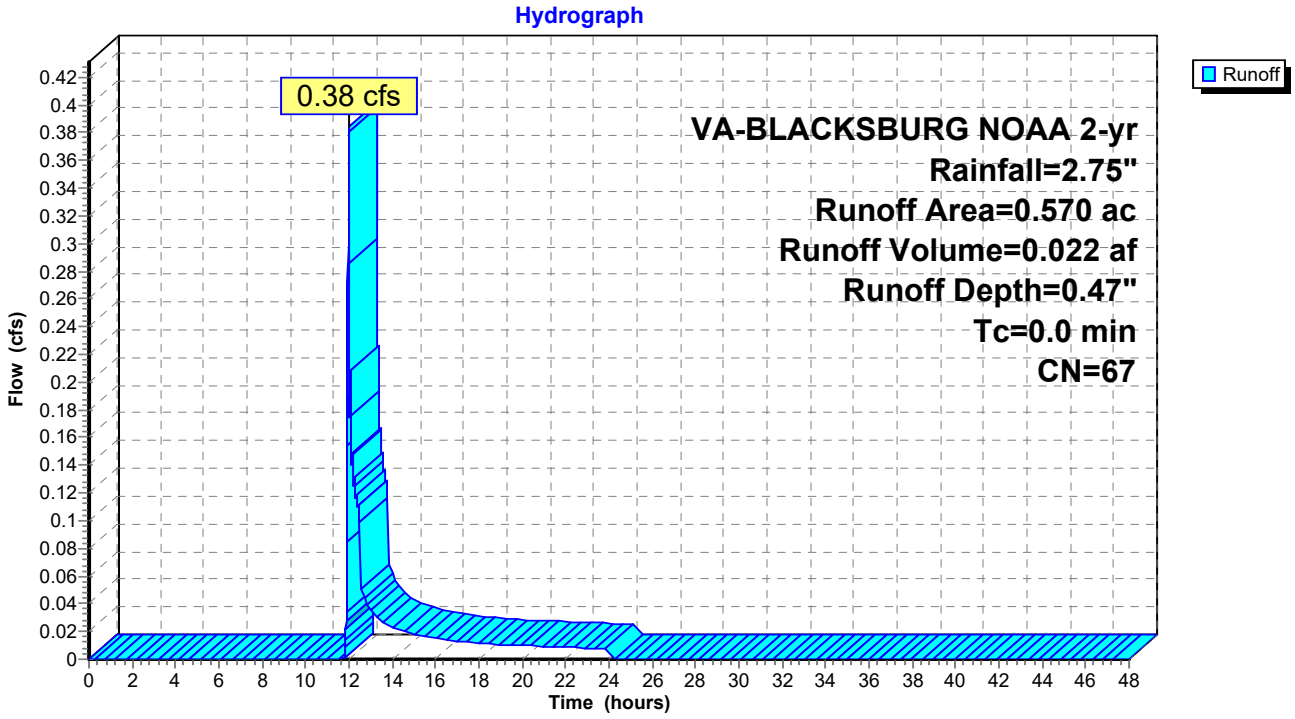
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.38 cfs @ 11.99 hrs, Volume= 0.022 af, Depth= 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
0.485	61	>75% Grass cover, Good, HSG B
0.085	98	Paved parking, HSG B
0.570	67	Weighted Average
0.485		85.09% Pervious Area
0.085		14.91% Impervious Area

Subcatchment 4S: DIRECT RUNOFF



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 0.95" for 2-yr event
Inflow = 0.94 cfs @ 12.04 hrs, Volume= 0.058 af
Outflow = 0.04 cfs @ 14.42 hrs, Volume= 0.058 af, Atten= 95%, Lag= 142.4 min
Primary = 0.04 cfs @ 14.42 hrs, Volume= 0.058 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.97' @ 14.42 hrs Surf.Area= 0.032 ac Storage= 0.030 af

Plug-Flow detention time= 357.8 min calculated for 0.058 af (100% of inflow)
Center-of-Mass det. time= 357.8 min (1,217.8 - 859.9)

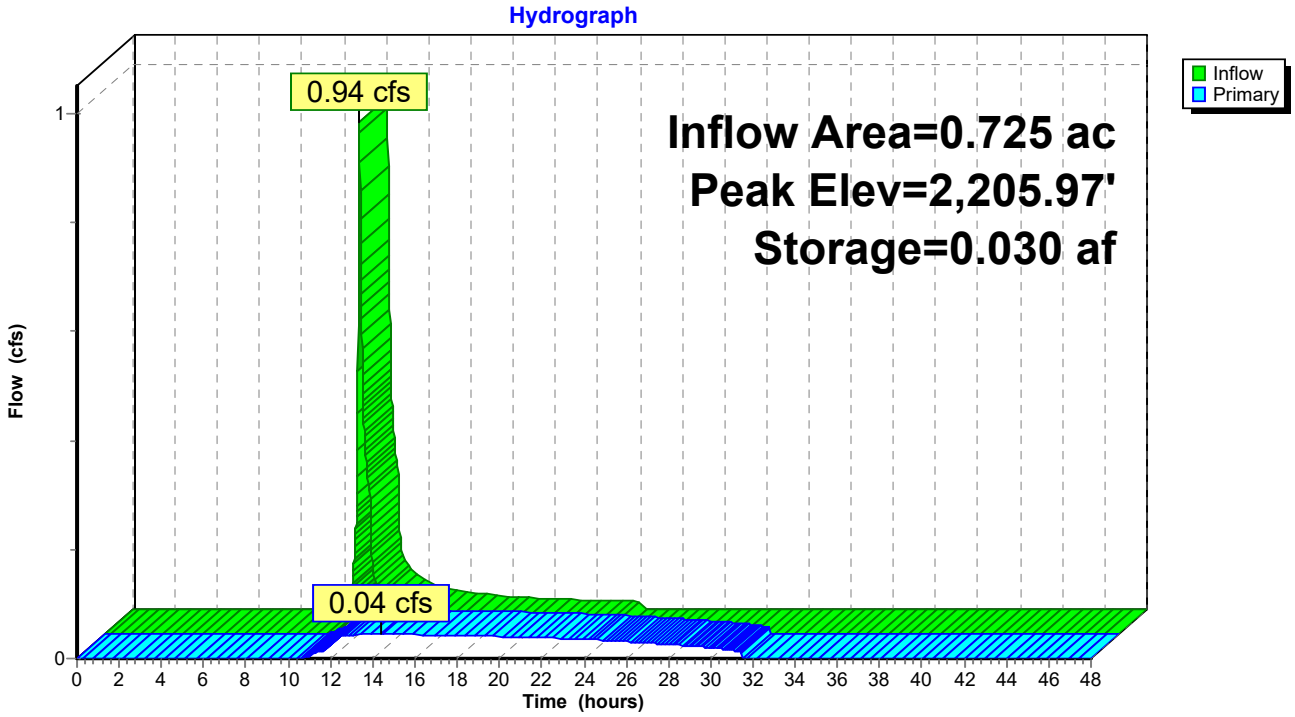
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

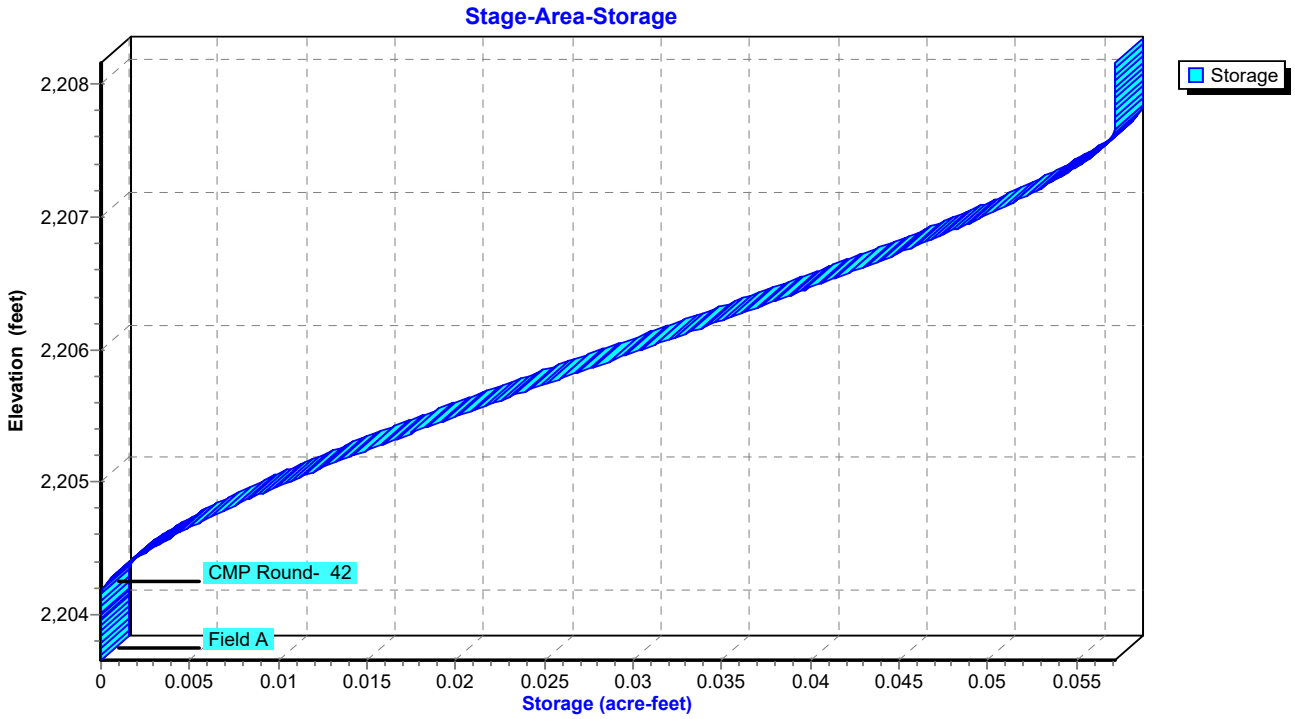
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#2	Device 1	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.04 cfs @ 14.42 hrs HW=2,205.97' (Free Discharge)
└**1=15" Culvert** (Passes 0.04 cfs of 6.15 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 6.67 fps)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

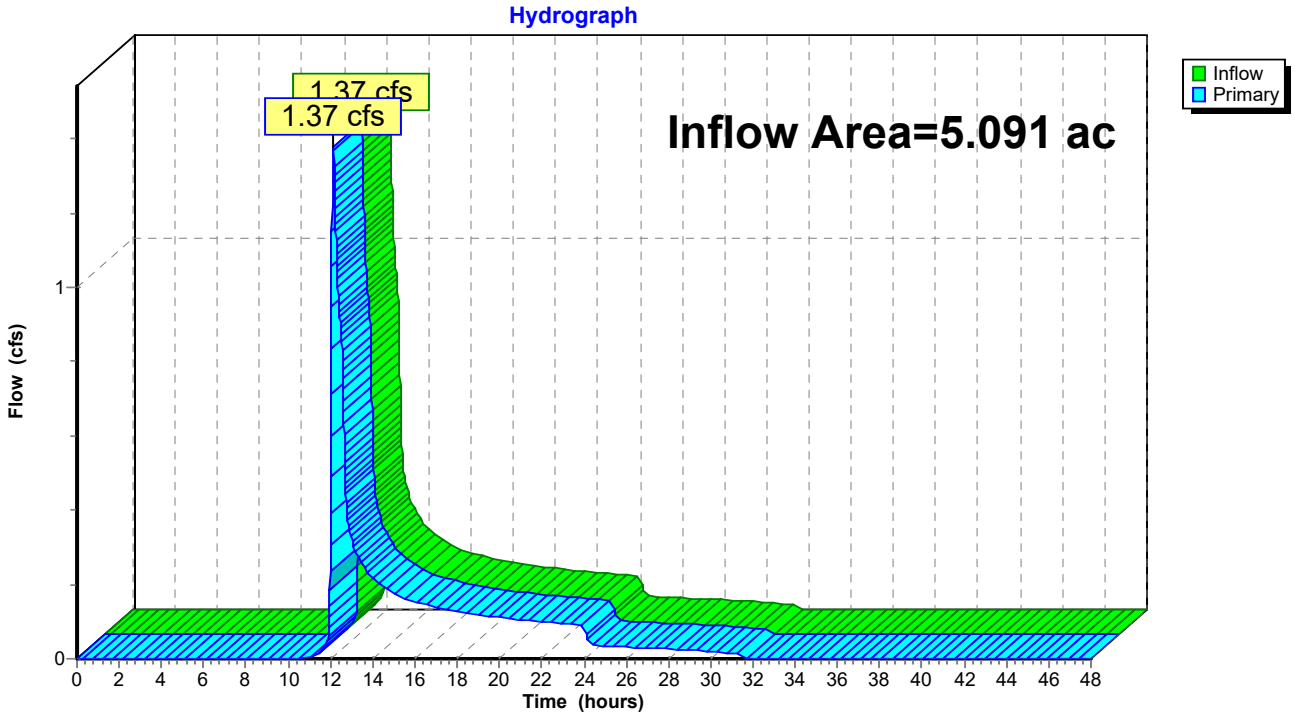


Summary for Link 1L: POA

Inflow Area = 5.091 ac, 16.20% Impervious, Inflow Depth = 0.50" for 2-yr event
Inflow = 1.37 cfs @ 12.14 hrs, Volume= 0.211 af
Primary = 1.37 cfs @ 12.14 hrs, Volume= 0.211 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA #1 - REACHING POA Runoff Area=3.973 ac 9.46% Impervious Runoff Depth=1.08"
Flow Length=768' Tc=9.9 min CN=65 Runoff=4.10 cfs 0.358 af

Subcatchment 2S: DA #2 - REACHING POA Runoff Area=0.393 ac 30.53% Impervious Runoff Depth=1.52"
Flow Length=284' Tc=7.8 min CN=72 Runoff=0.69 cfs 0.050 af

Subcatchment 3S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=1.96"
Tc=6.0 min CN=78 Runoff=1.86 cfs 0.118 af

Subcatchment 4S: DIRECT RUNOFF Runoff Area=0.570 ac 14.91% Impervious Runoff Depth=1.20"
Tc=0.0 min CN=67 Runoff=1.07 cfs 0.057 af

Pond 2P: RC UG DETENTION Peak Elev=2,207.01' Storage=0.050 af Inflow=1.86 cfs 0.118 af
Outflow=0.45 cfs 0.118 af

Link 1L: POA Inflow=4.78 cfs 0.526 af
Primary=4.78 cfs 0.526 af

Total Runoff Area = 5.661 ac Runoff Volume = 0.583 af Average Runoff Depth = 1.24"
83.93% Pervious = 4.751 ac 16.07% Impervious = 0.910 ac

Summary for Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT

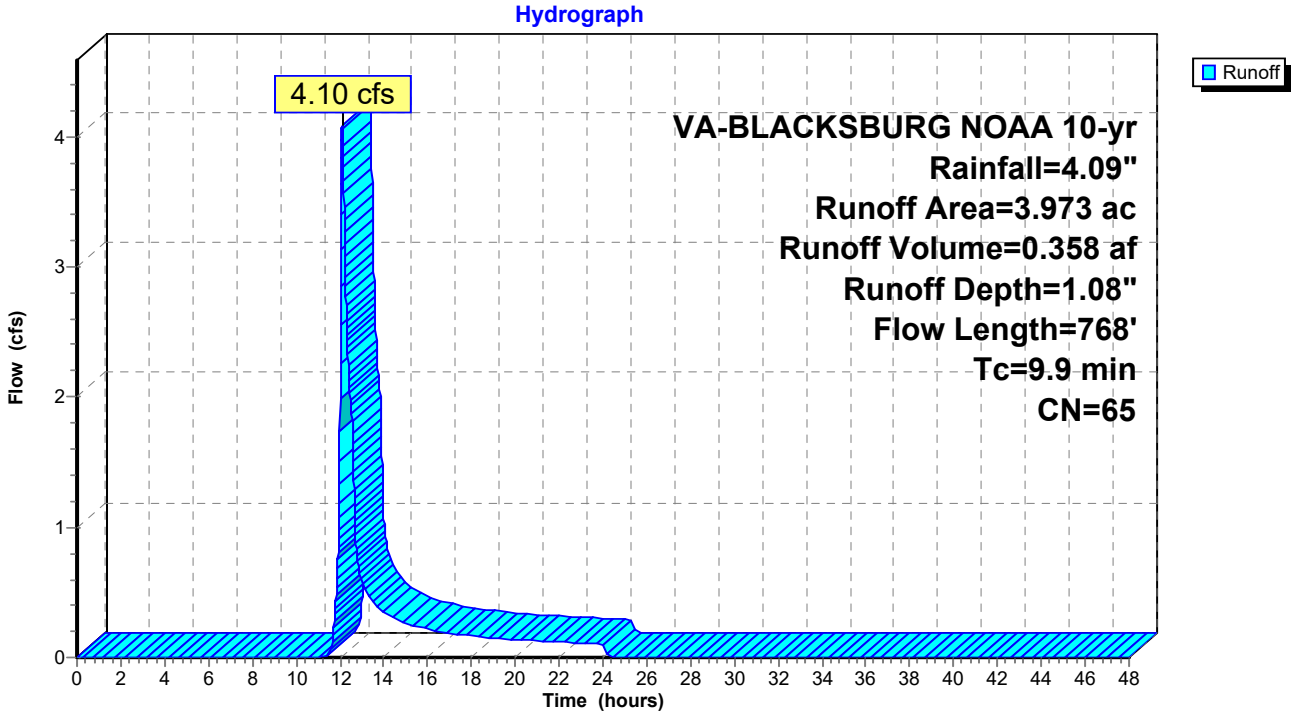
Runoff = 4.10 cfs @ 12.11 hrs, Volume= 0.358 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
3.597	61	>75% Grass cover, Good, HSG B
0.376	98	Paved parking, HSG B
3.973	65	Weighted Average
3.597		90.54% Pervious Area
0.376		9.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT



Summary for Subcatchment 2S: DA #2 - REACHING POA THROUGH DI

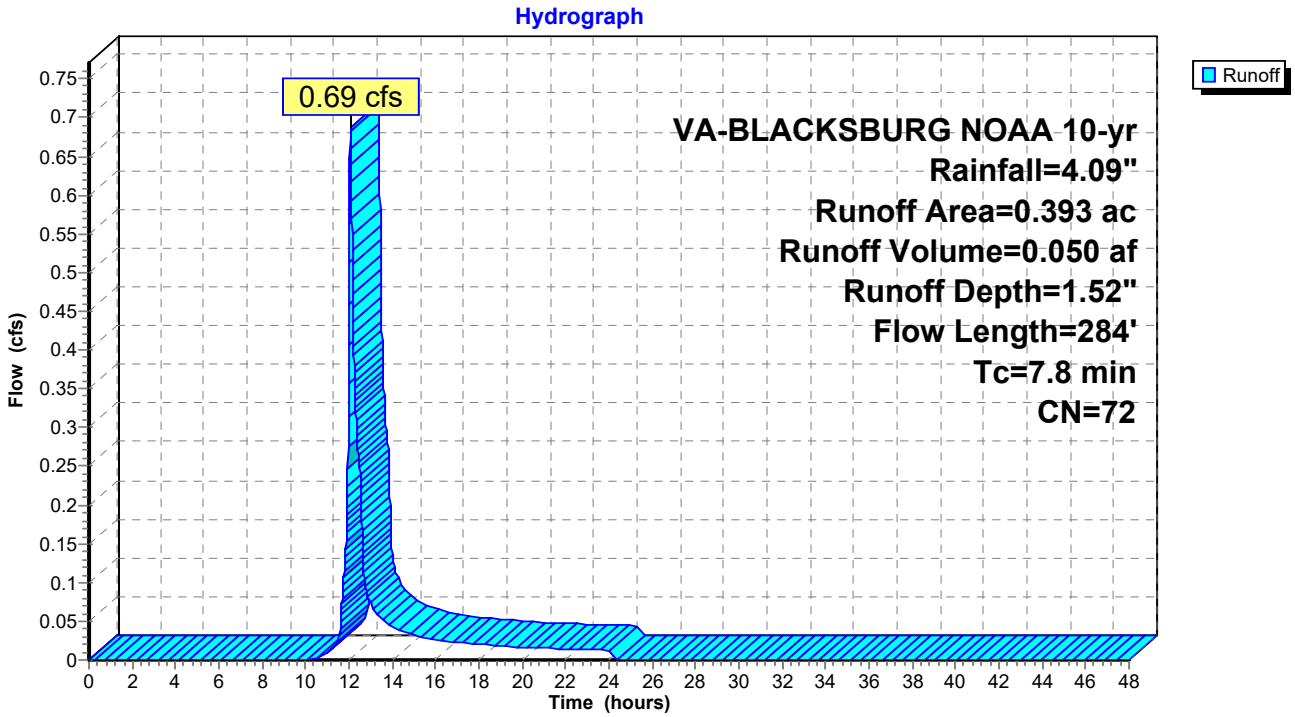
Runoff = 0.69 cfs @ 12.07 hrs, Volume= 0.050 af, Depth= 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
0.273	61	>75% Grass cover, Good, HSG B
0.120	98	Paved parking, HSG B
0.393	72	Weighted Average
0.273		69.47% Pervious Area
0.120		30.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	100	0.0650	0.25		**Sheet Flow, Tc4** Grass: Short n= 0.150 P2= 2.76"
0.5	127	0.0830	4.64		**Shallow Concentrated Flow, Tc5** Unpaved Kv= 16.1 fps
0.7	57	0.0050	1.44		**Shallow Concentrated Flow, Tc6** Paved Kv= 20.3 fps
7.8	284	Total			

Subcatchment 2S: DA #2 - REACHING POA THROUGH DI



Summary for Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM

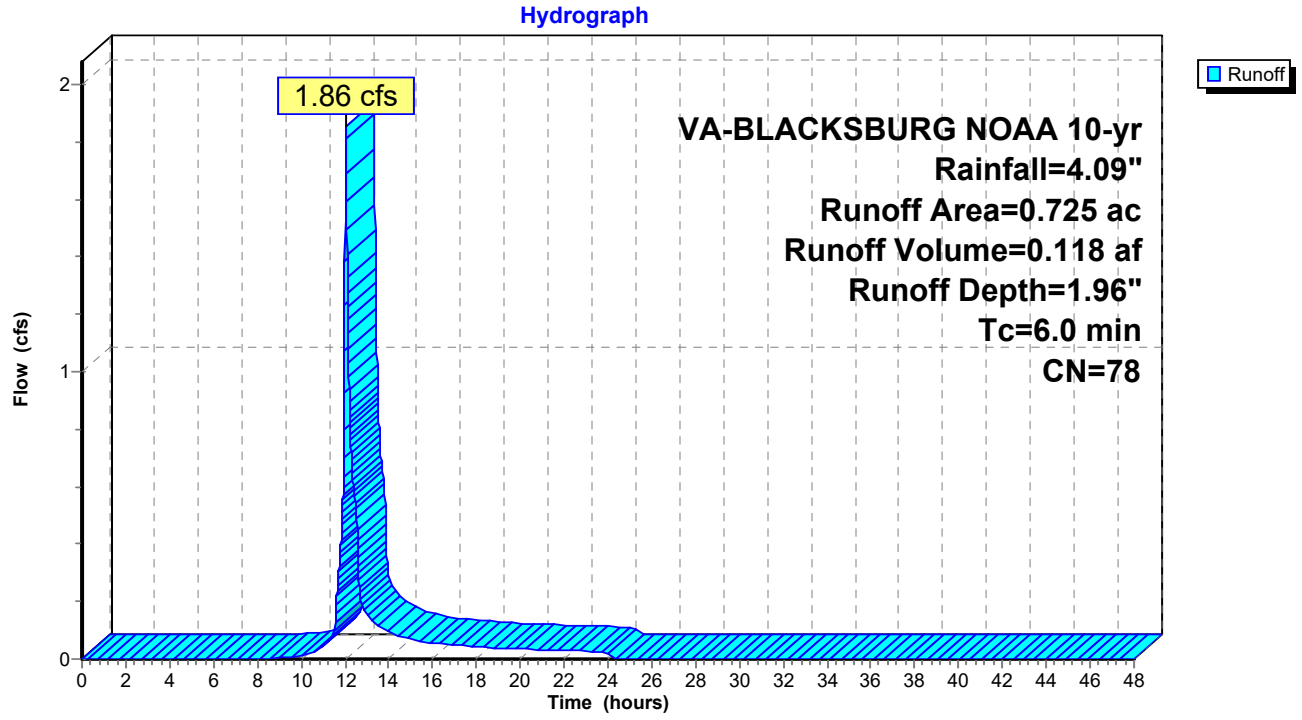
Runoff = 1.86 cfs @ 12.04 hrs, Volume= 0.118 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 4S: DIRECT RUNOFF

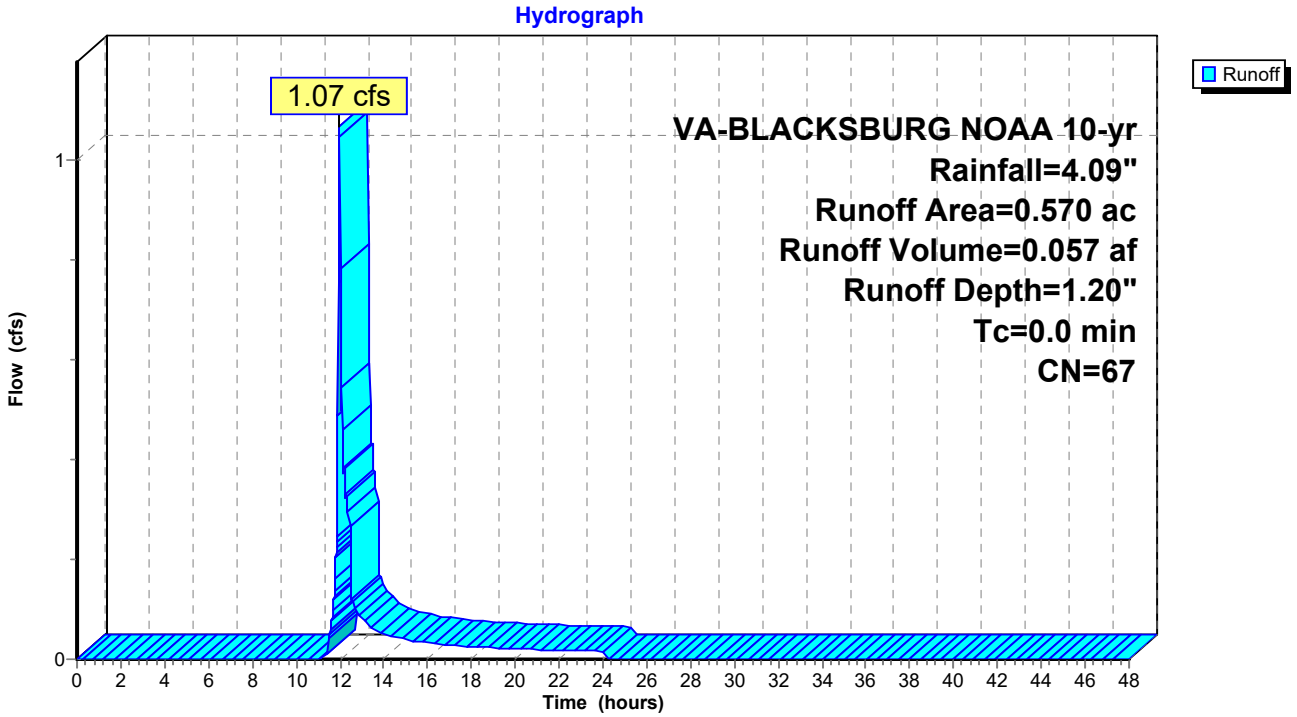
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 1.07 cfs @ 11.99 hrs, Volume= 0.057 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
0.485	61	>75% Grass cover, Good, HSG B
0.085	98	Paved parking, HSG B
0.570	67	Weighted Average
0.485		85.09% Pervious Area
0.085		14.91% Impervious Area

Subcatchment 4S: DIRECT RUNOFF



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 1.96" for 10-yr event
Inflow = 1.86 cfs @ 12.04 hrs, Volume= 0.118 af
Outflow = 0.45 cfs @ 12.56 hrs, Volume= 0.118 af, Atten= 76%, Lag= 31.0 min
Primary = 0.45 cfs @ 12.56 hrs, Volume= 0.118 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,207.01' @ 12.56 hrs Surf.Area= 0.032 ac Storage= 0.050 af

Plug-Flow detention time= 325.9 min calculated for 0.118 af (100% of inflow)
Center-of-Mass det. time= 326.0 min (1,166.2 - 840.2)

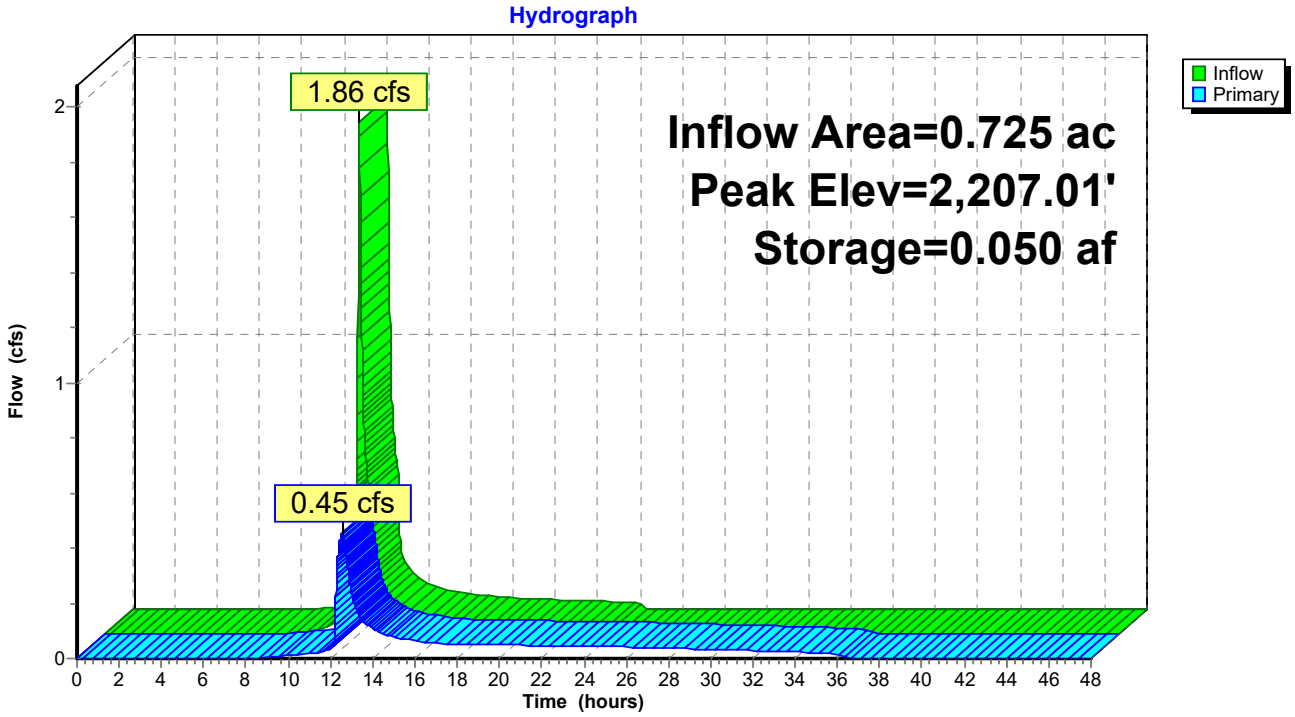
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

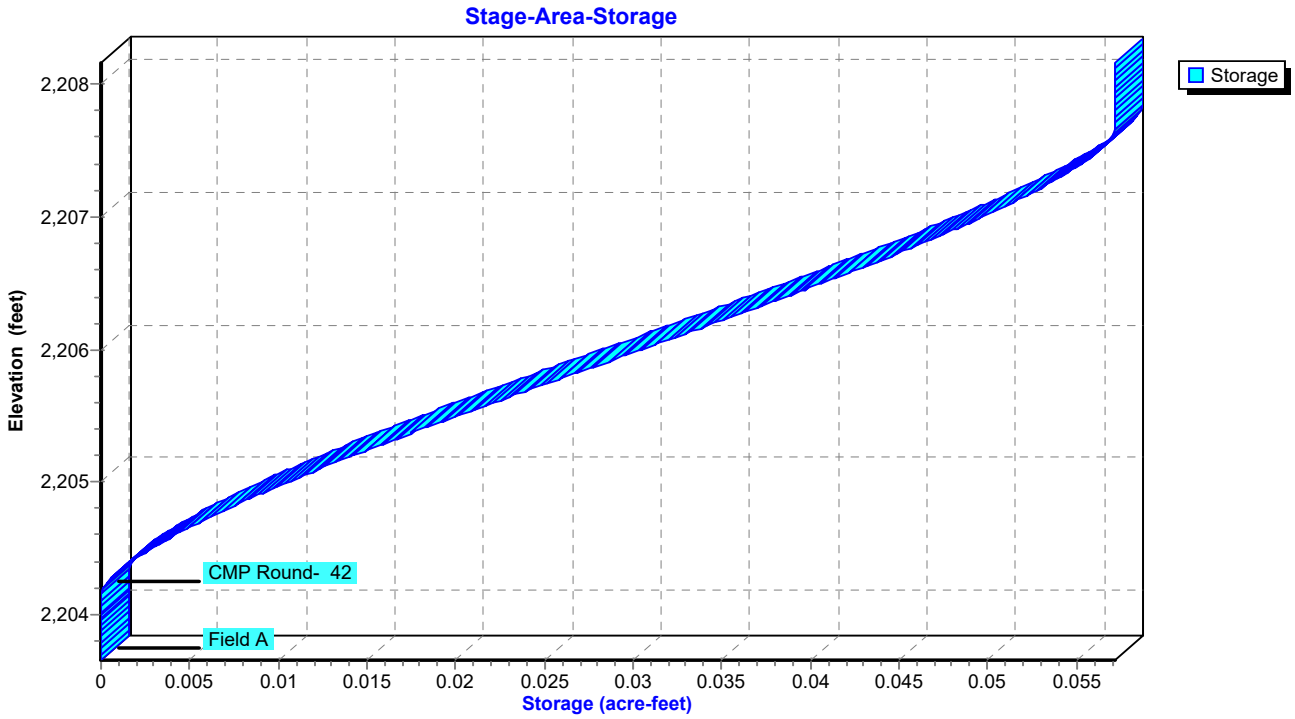
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#2	Device 1	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.45 cfs @ 12.56 hrs HW=2,207.01' (Free Discharge)
└**1=15" Culvert** (Passes 0.45 cfs of 8.95 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.05 cfs @ 8.29 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.40 cfs @ 2.91 fps)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

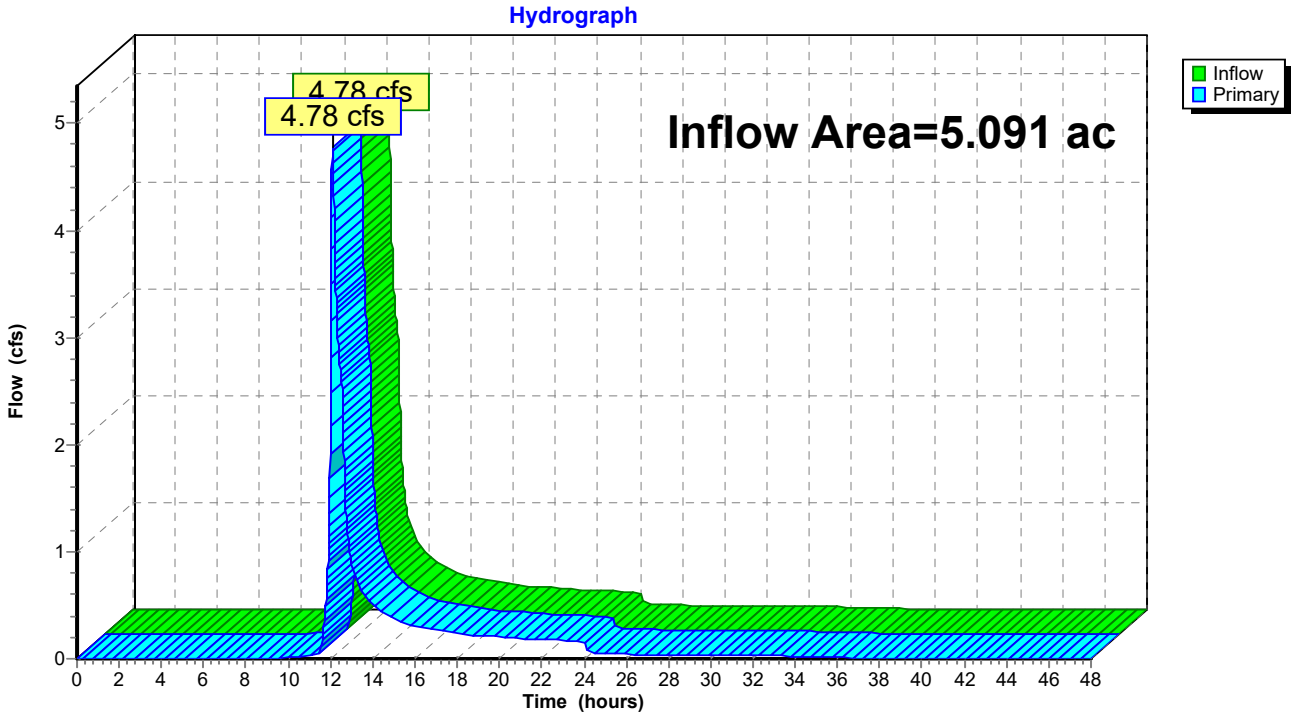


Summary for Link 1L: POA

Inflow Area = 5.091 ac, 16.20% Impervious, Inflow Depth = 1.24" for 10-yr event
Inflow = 4.78 cfs @ 12.10 hrs, Volume= 0.526 af
Primary = 4.78 cfs @ 12.10 hrs, Volume= 0.526 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA #1 - REACHING POA Runoff Area=3.973 ac 9.46% Impervious Runoff Depth=2.71"
Flow Length=768' Tc=9.9 min CN=65 Runoff=9.95 cfs 0.896 af

Subcatchment 2S: DA #2 - REACHING POA Runoff Area=0.393 ac 30.53% Impervious Runoff Depth=3.39"
Flow Length=284' Tc=7.8 min CN=72 Runoff=1.37 cfs 0.111 af

Subcatchment 3S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=4.01"
Tc=6.0 min CN=78 Runoff=3.25 cfs 0.242 af

Subcatchment 4S: DIRECT RUNOFF Runoff Area=0.570 ac 14.91% Impervious Runoff Depth=2.90"
Tc=0.0 min CN=67 Runoff=2.23 cfs 0.138 af

Pond 2P: RC UG DETENTION Peak Elev=2,207.47' Storage=0.056 af Inflow=3.25 cfs 0.242 af
Outflow=3.16 cfs 0.242 af

Link 1L: POA Inflow=14.11 cfs 1.249 af
Primary=14.11 cfs 1.249 af

Total Runoff Area = 5.661 ac Runoff Volume = 1.387 af Average Runoff Depth = 2.94"
83.93% Pervious = 4.751 ac 16.07% Impervious = 0.910 ac

Summary for Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT

[47] Hint: Peak is 212% of capacity of segment #3

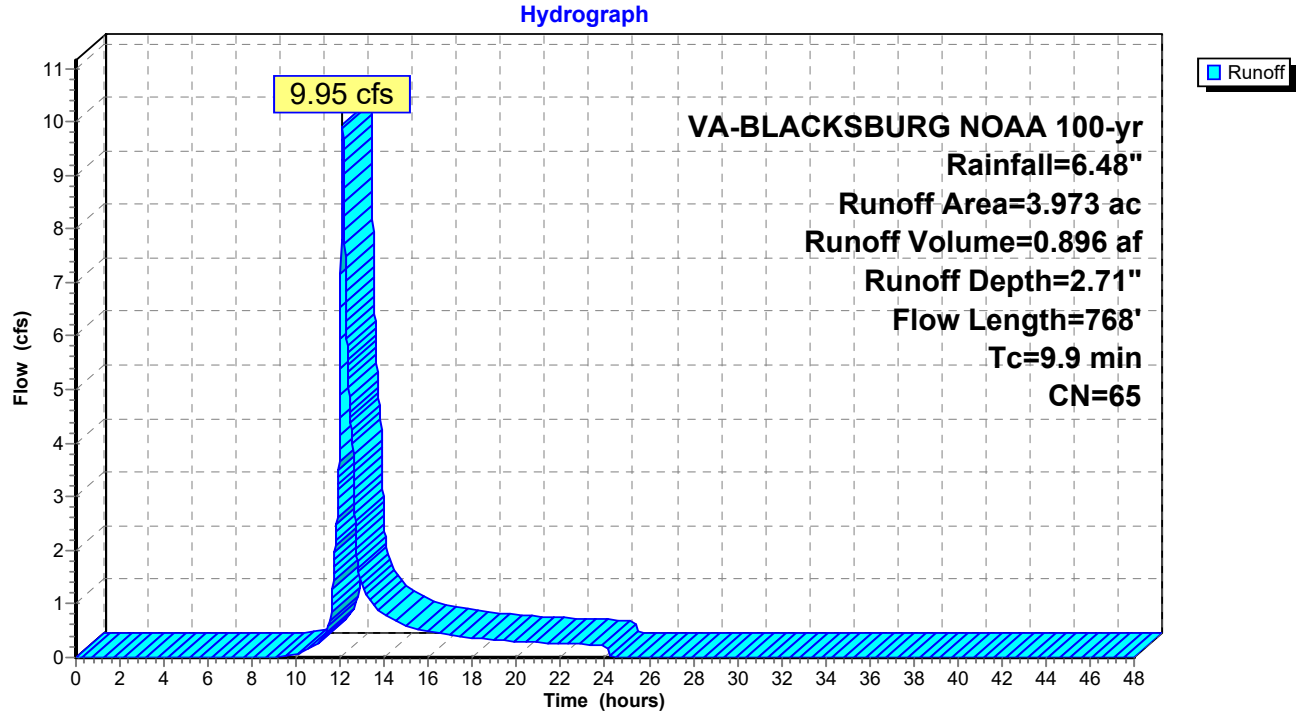
Runoff = 9.95 cfs @ 12.09 hrs, Volume= 0.896 af, Depth= 2.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
3.597	61	>75% Grass cover, Good, HSG B
0.376	98	Paved parking, HSG B
3.973	65	Weighted Average
3.597		90.54% Pervious Area
0.376		9.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S: DA #1 - REACHING POA THROUGH CULVERT



Summary for Subcatchment 2S: DA #2 - REACHING POA THROUGH DI

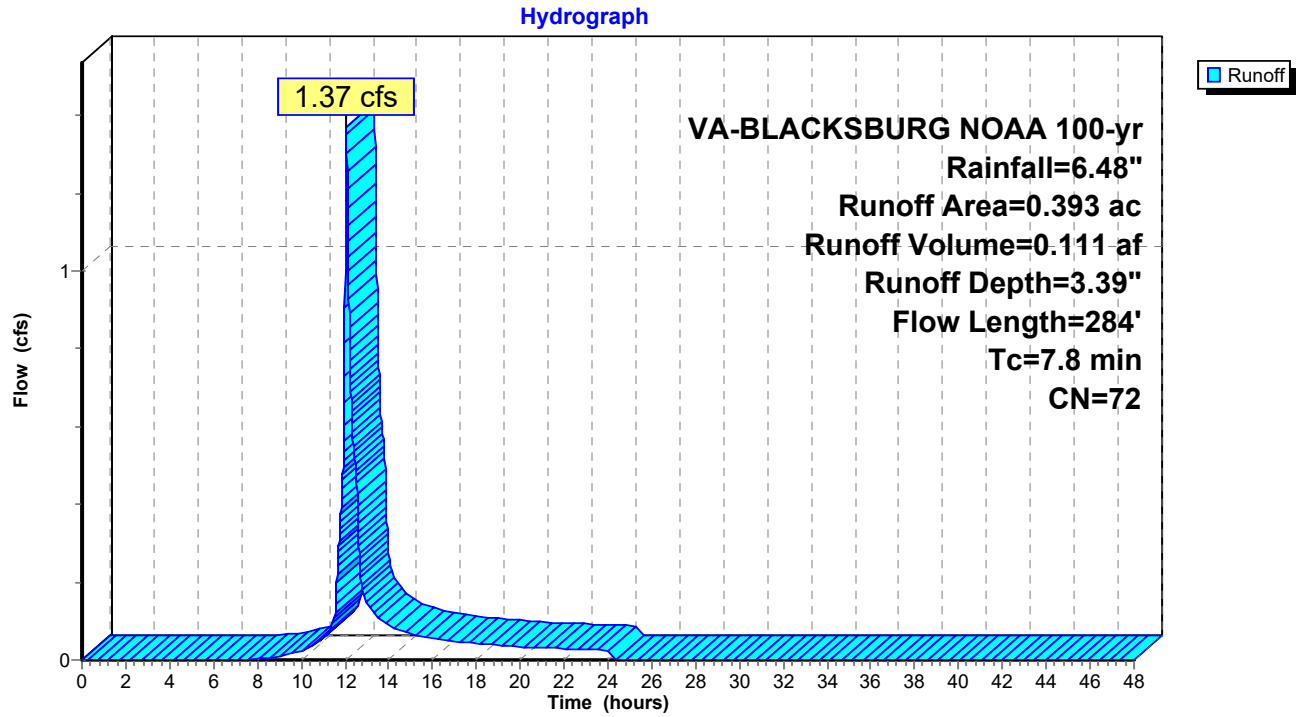
Runoff = 1.37 cfs @ 12.06 hrs, Volume= 0.111 af, Depth= 3.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
0.273	61	>75% Grass cover, Good, HSG B
0.120	98	Paved parking, HSG B
0.393	72	Weighted Average
0.273		69.47% Pervious Area
0.120		30.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	100	0.0650	0.25		**Sheet Flow, Tc4** Grass: Short n= 0.150 P2= 2.76"
0.5	127	0.0830	4.64		**Shallow Concentrated Flow, Tc5** Unpaved Kv= 16.1 fps
0.7	57	0.0050	1.44		**Shallow Concentrated Flow, Tc6** Paved Kv= 20.3 fps
7.8	284	Total			

Subcatchment 2S: DA #2 - REACHING POA THROUGH DI



Summary for Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM

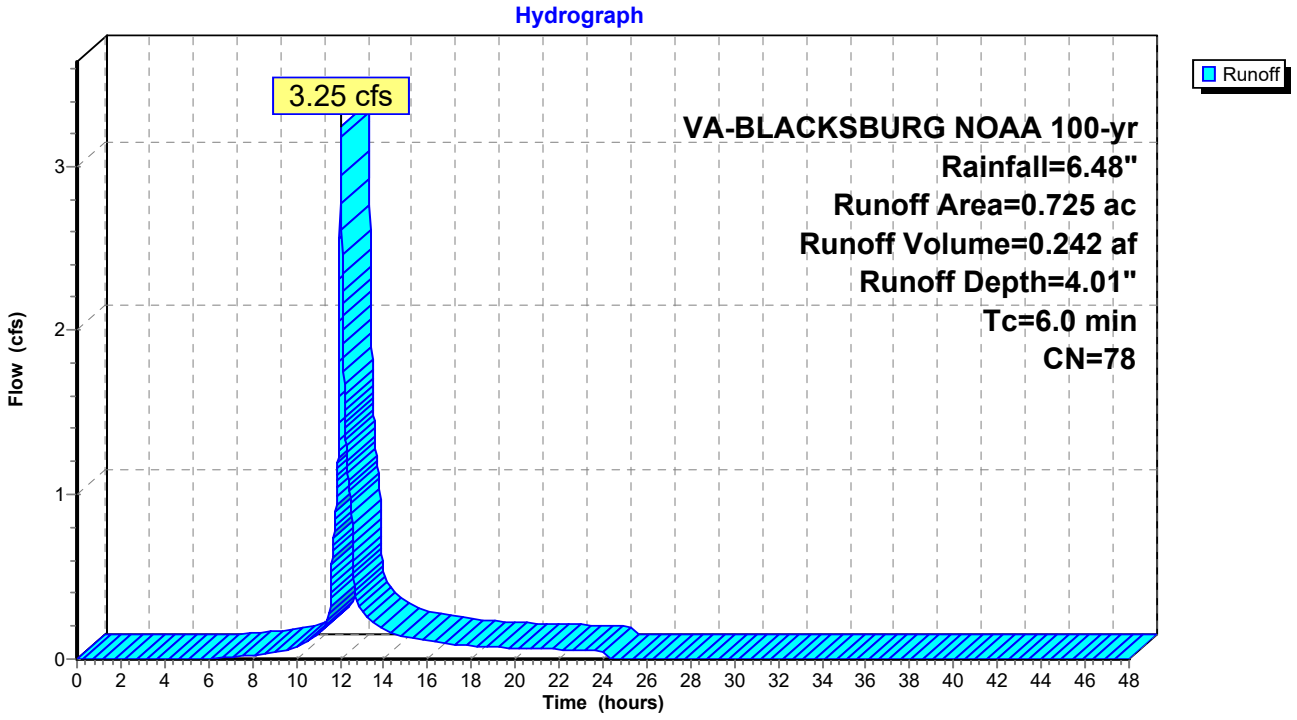
Runoff = 3.25 cfs @ 12.04 hrs, Volume= 0.242 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 4S: DIRECT RUNOFF

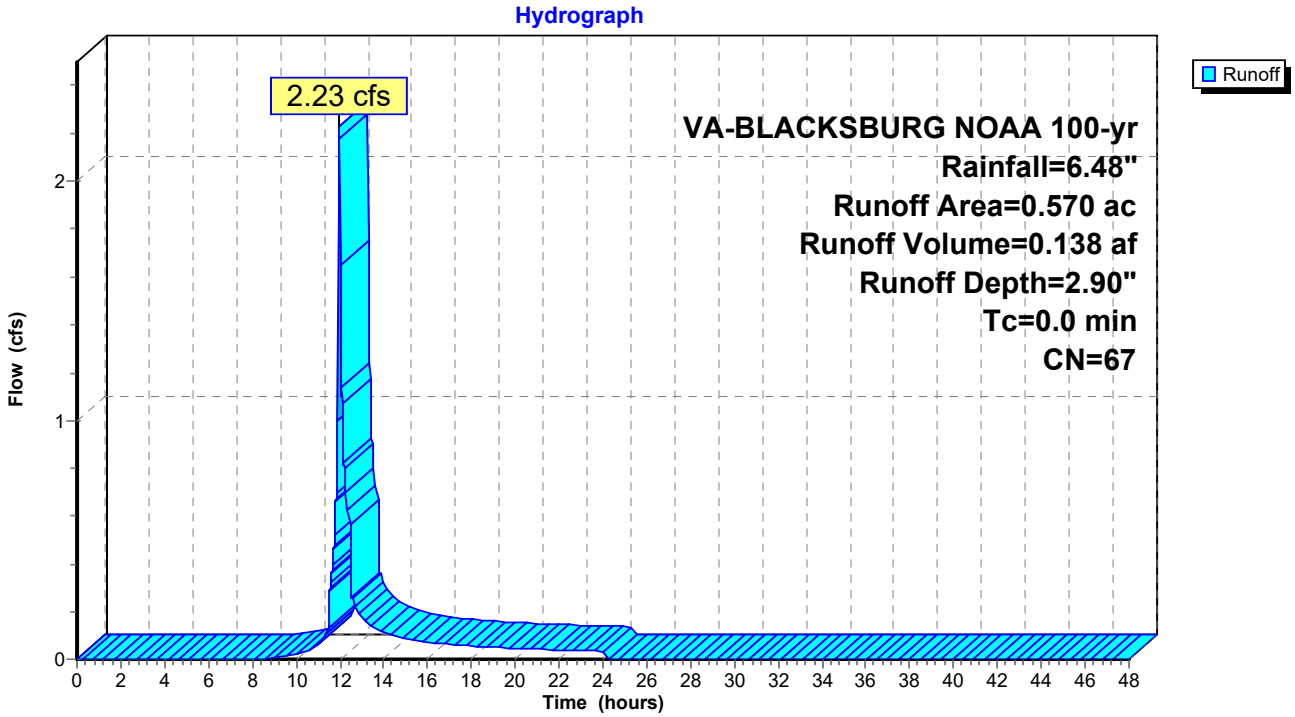
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 2.23 cfs @ 11.99 hrs, Volume= 0.138 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
0.485	61	>75% Grass cover, Good, HSG B
0.085	98	Paved parking, HSG B
0.570	67	Weighted Average
0.485		85.09% Pervious Area
0.085		14.91% Impervious Area

Subcatchment 4S: DIRECT RUNOFF



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 4.01" for 100-yr event
Inflow = 3.25 cfs @ 12.04 hrs, Volume= 0.242 af
Outflow = 3.16 cfs @ 12.06 hrs, Volume= 0.242 af, Atten= 3%, Lag= 1.0 min
Primary = 3.16 cfs @ 12.06 hrs, Volume= 0.242 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,207.47' @ 12.06 hrs Surf.Area= 0.032 ac Storage= 0.056 af

Plug-Flow detention time= 195.8 min calculated for 0.242 af (100% of inflow)
Center-of-Mass det. time= 195.9 min (1,021.2 - 825.3)

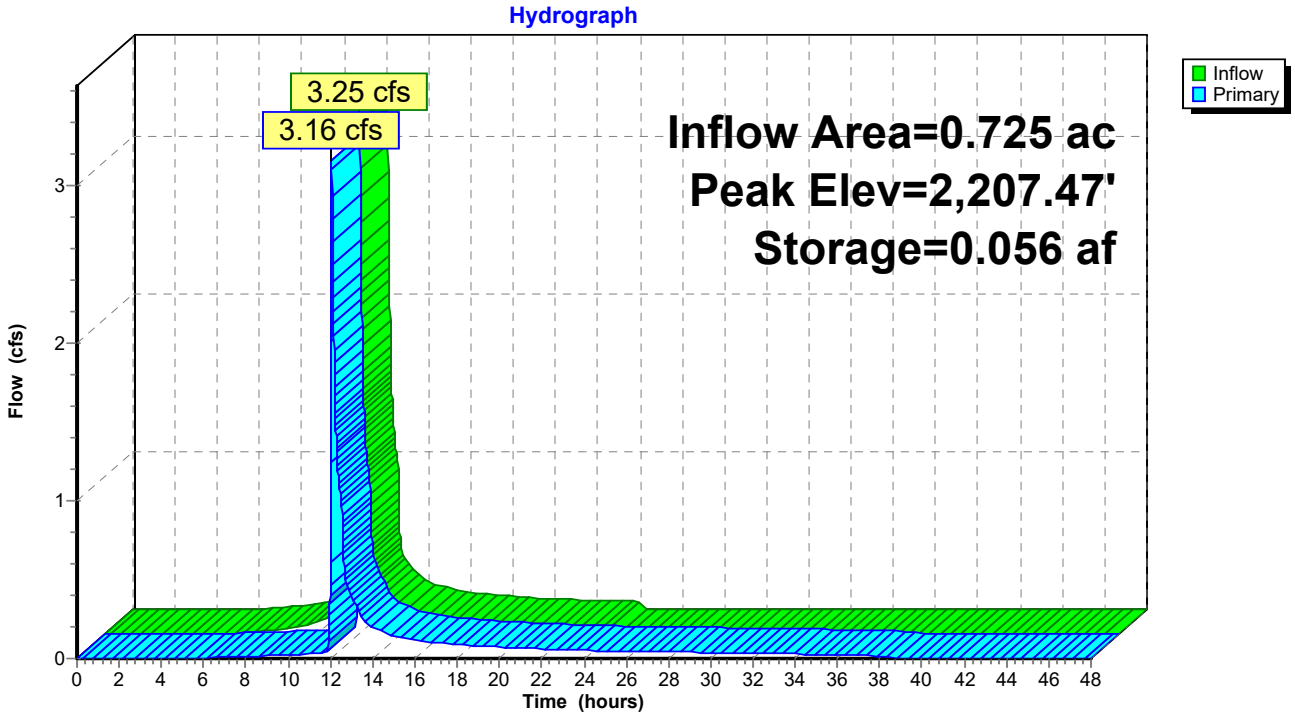
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

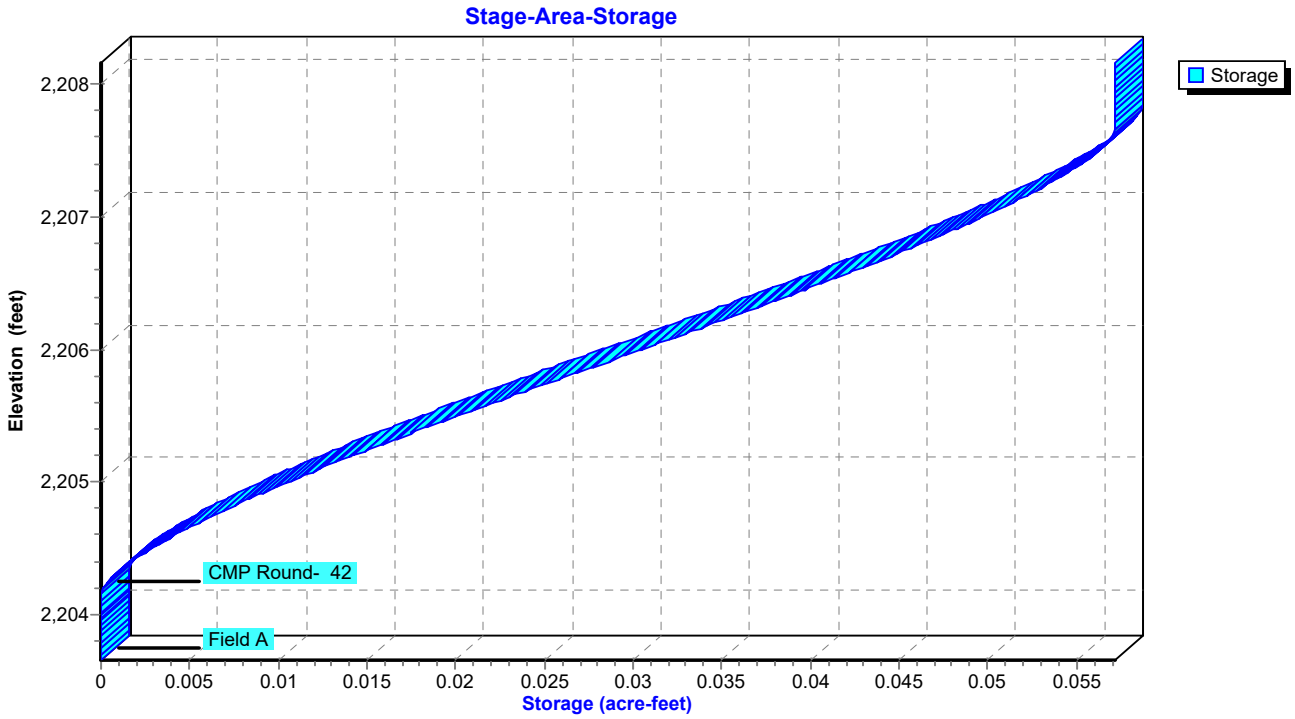
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#2	Device 1	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=3.15 cfs @ 12.06 hrs HW=2,207.47' (Free Discharge)
└**1=15" Culvert** (Passes 3.15 cfs of 9.92 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.06 cfs @ 8.91 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.59 cfs @ 4.36 fps)
  └**4=Broad-Crested Rectangular Weir** (Weir Controls 2.49 cfs @ 1.74 fps)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

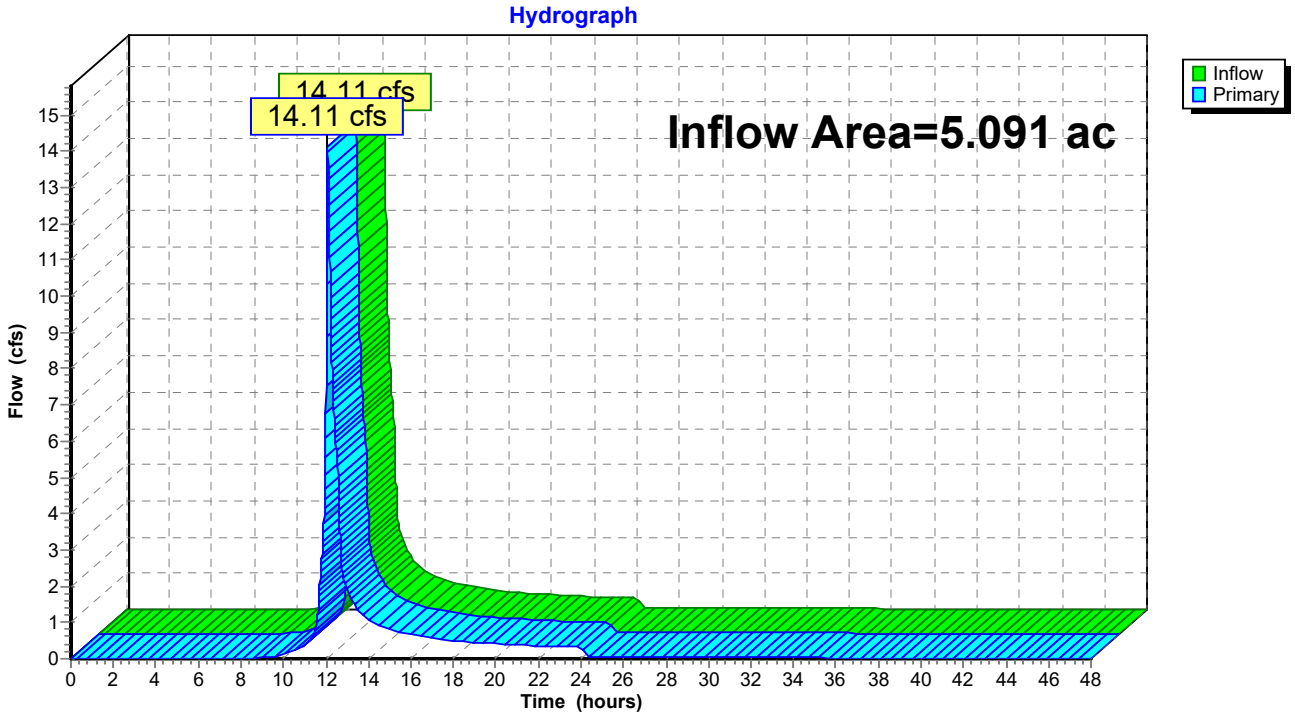


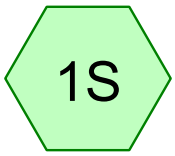
Summary for Link 1L: POA

Inflow Area = 5.091 ac, 16.20% Impervious, Inflow Depth = 2.94" for 100-yr event
Inflow = 14.11 cfs @ 12.08 hrs, Volume= 1.249 af
Primary = 14.11 cfs @ 12.08 hrs, Volume= 1.249 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA





PRE DEV

POST DEV

Subcat Reach Pond Link

Routing Diagram for RV CALC

Prepared by Balzer & Associates, Inc., Printed 5/25/2022

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: PRE DEV Runoff Area=2.662 ac 10.29% Impervious Runoff Depth=0.22"
Tc=0.0 min CN=65 Runoff=0.43 cfs 0.048 af

Subcatchment 2S: POST DEV Runoff Area=3.014 ac 57.83% Impervious Runoff Depth=0.83"
Tc=0.0 min CN=82 Runoff=4.51 cfs 0.209 af

Summary for Subcatchment 1S: PRE DEV

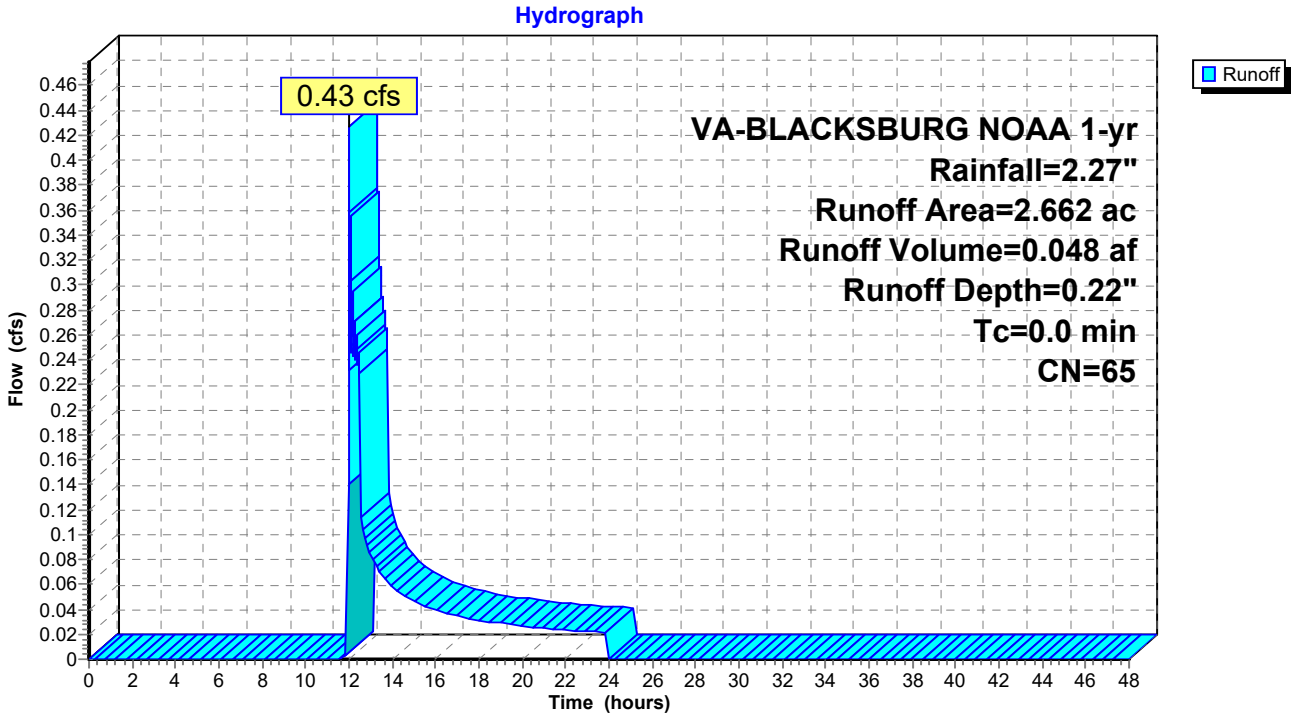
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.43 cfs @ 11.99 hrs, Volume= 0.048 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
2.388	61	>75% Grass cover, Good, HSG B
0.274	98	Paved parking, HSG B
2.662	65	Weighted Average
2.388		89.71% Pervious Area
0.274		10.29% Impervious Area

Subcatchment 1S: PRE DEV



Summary for Subcatchment 2S: POST DEV

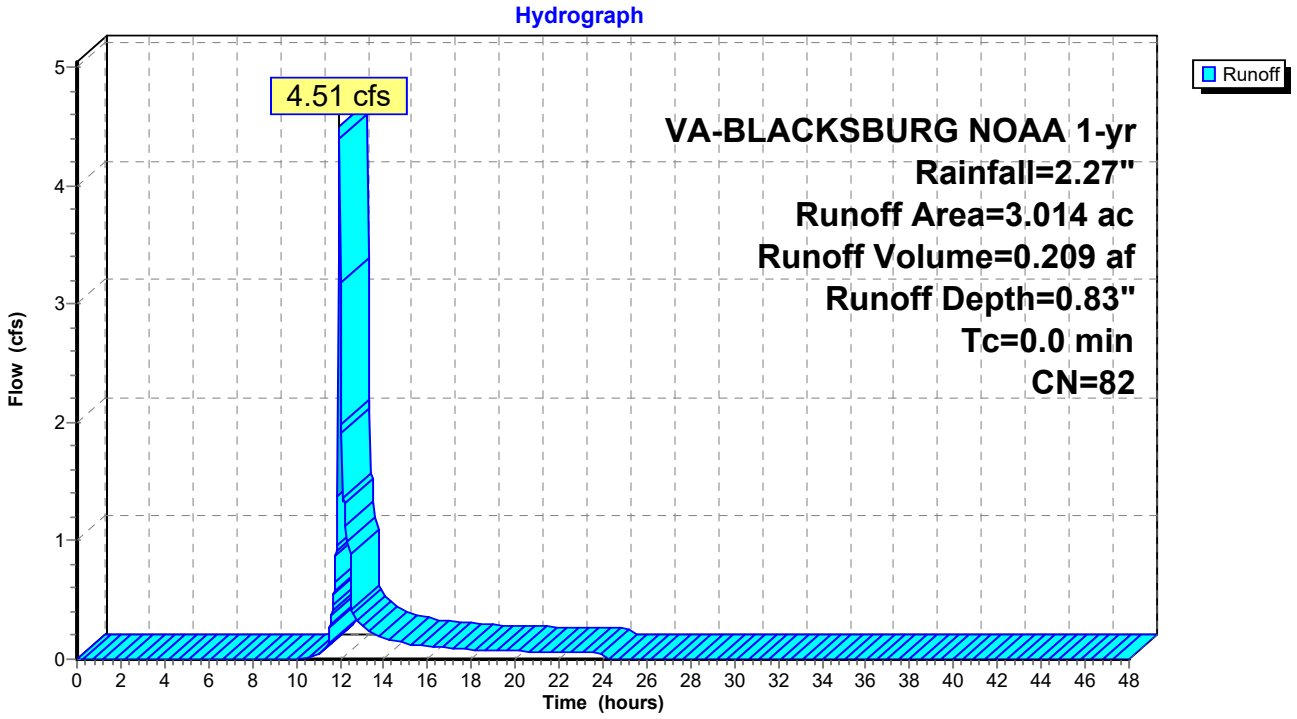
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

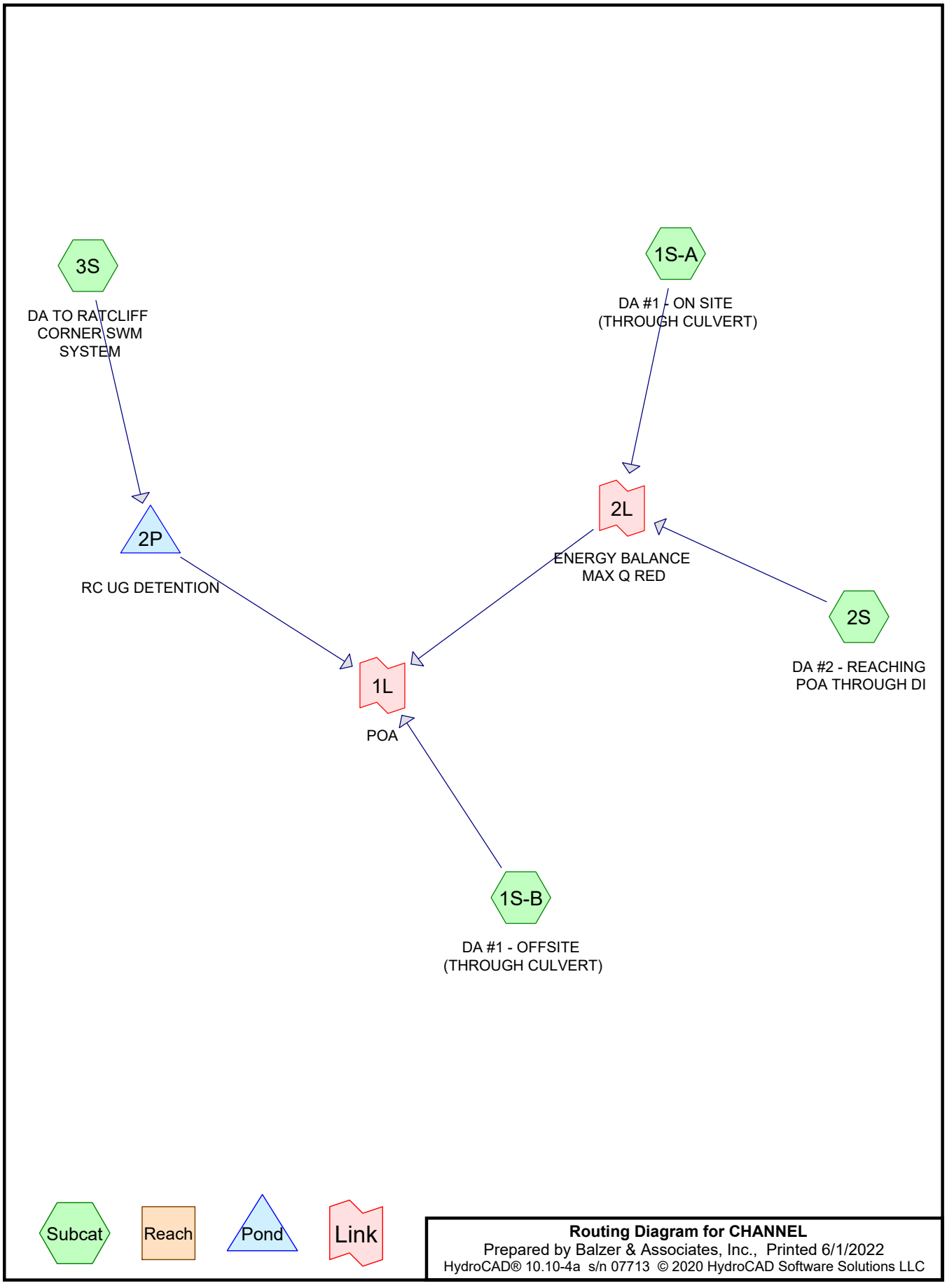
Runoff = 4.51 cfs @ 11.99 hrs, Volume= 0.209 af, Depth= 0.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
1.271	61	>75% Grass cover, Good, HSG B
1.743	98	Paved parking, HSG B
3.014	82	Weighted Average
1.271		42.17% Pervious Area
1.743		57.83% Impervious Area

Subcatchment 2S: POST DEV





Routing Diagram for CHANNEL
Prepared by Balzer & Associates, Inc., Printed 6/1/2022

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S-A: DA #1 - ON SITE Runoff Area=2.269 ac 6.79% Impervious Runoff Depth=0.19"
Flow Length=768' Tc=9.9 min CN=64 Runoff=0.19 cfs 0.037 af

Subcatchment 1S-B: DA #1 - OFFSITE Runoff Area=1.704 ac 13.03% Impervious Runoff Depth=0.24"
Flow Length=768' Tc=9.9 min CN=66 Runoff=0.21 cfs 0.034 af

Subcatchment 2S: DA #2 - REACHING POA Runoff Area=0.393 ac 30.53% Impervious Runoff Depth=0.41"
Flow Length=284' Tc=7.8 min CN=72 Runoff=0.15 cfs 0.014 af

Subcatchment 3S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=0.64"
Tc=6.0 min CN=78 Runoff=0.60 cfs 0.039 af

Pond 2P: RC UG DETENTION Peak Elev=2,205.39' Storage=0.018 af Inflow=0.60 cfs 0.039 af
Outflow=0.04 cfs 0.039 af

Link 1L: POA Inflow=0.29 cfs 0.082 af
Primary=0.29 cfs 0.082 af

Link 2L: ENERGY BALANCE MAX Q RED x 0.18 Inflow=0.28 cfs 0.050 af
Primary=0.05 cfs 0.009 af Secondary=0.23 cfs 0.041 af

Summary for Subcatchment 1S-A: DA #1 - ON SITE (THROUGH CULVERT)

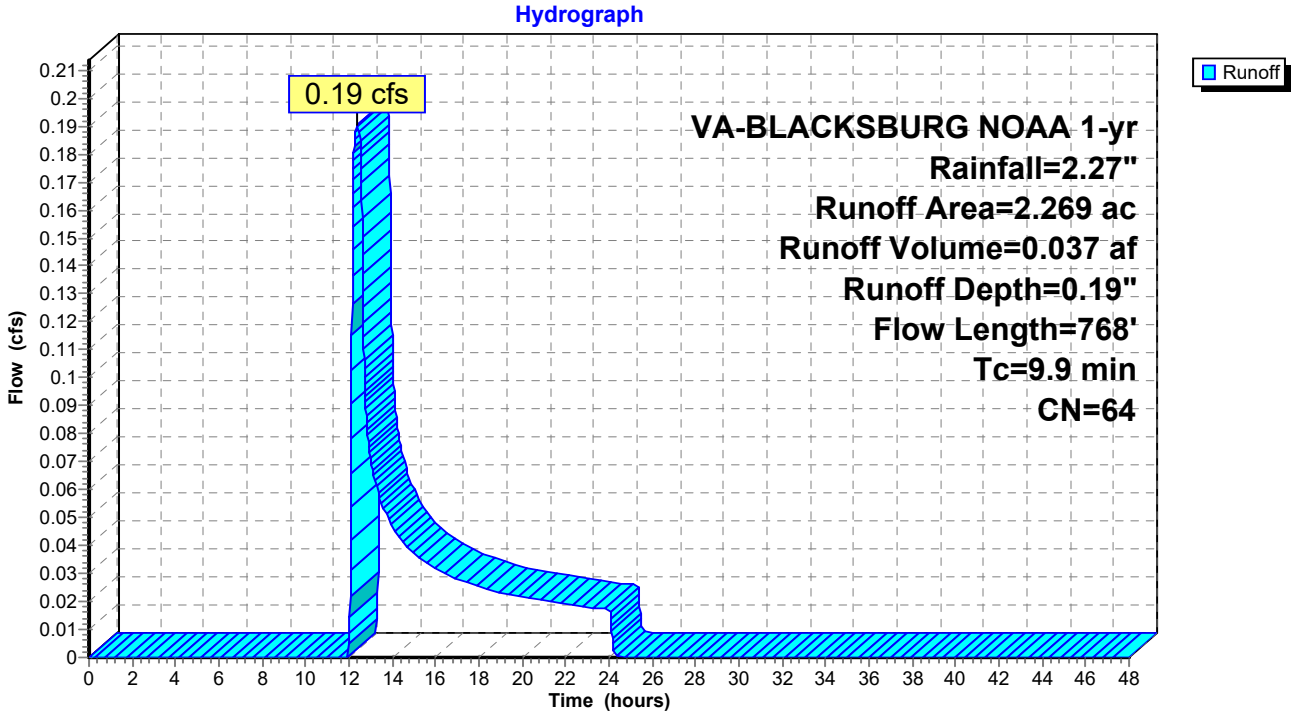
Runoff = 0.19 cfs @ 12.37 hrs, Volume= 0.037 af, Depth= 0.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
2.115	61	>75% Grass cover, Good, HSG B
0.154	98	Paved parking, HSG B
2.269	64	Weighted Average
2.115		93.21% Pervious Area
0.154		6.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S-A: DA #1 - ON SITE (THROUGH CULVERT)



Summary for Subcatchment 1S-B: DA #1 - OFFSITE (THROUGH CULVERT)

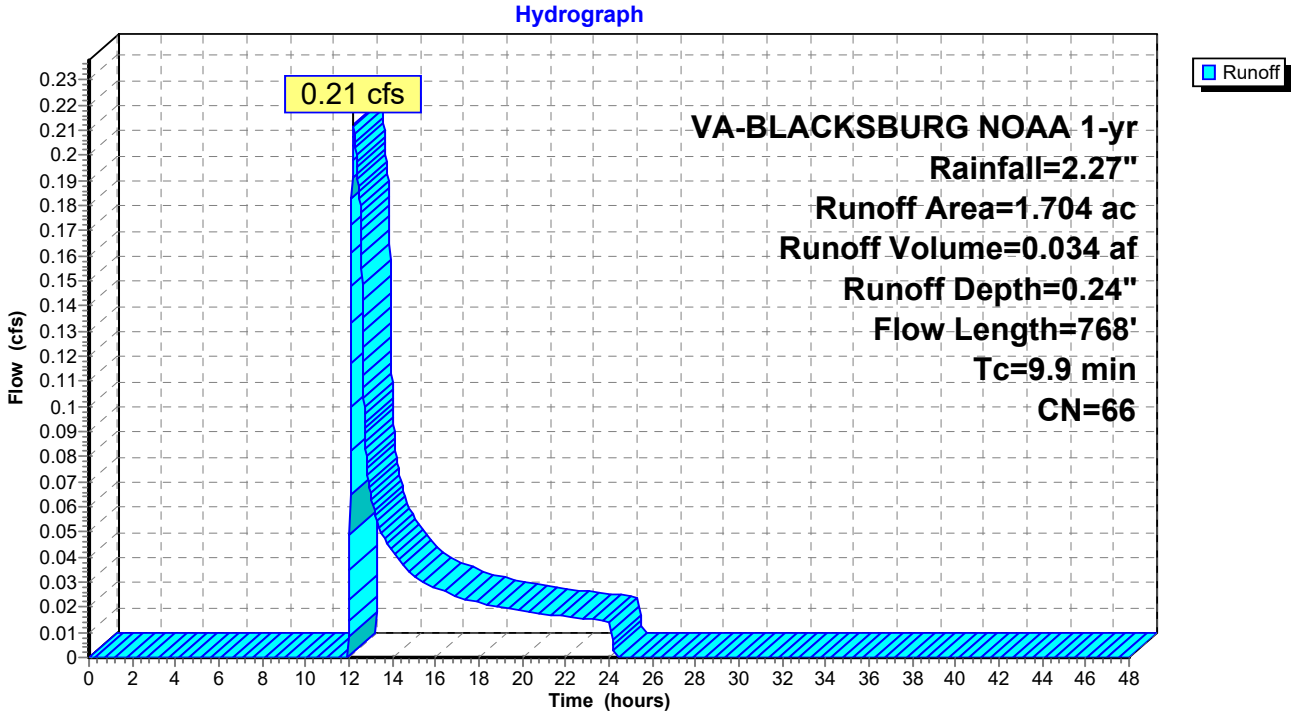
Runoff = 0.21 cfs @ 12.22 hrs, Volume= 0.034 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
1.482	61	>75% Grass cover, Good, HSG B
0.222	98	Paved parking, HSG B
1.704	66	Weighted Average
1.482		86.97% Pervious Area
0.222		13.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0530	0.23		**Sheet Flow, Tc1** Grass: Short n= 0.150 P2= 2.76"
2.4	575	0.0600	3.94		**Shallow Concentrated Flow, Tc2** Unpaved Kv= 16.1 fps
0.4	93	0.0053	3.83	4.70	**Pipe Channel, Tc3** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
9.9	768	Total			

Subcatchment 1S-B: DA #1 - OFFSITE (THROUGH CULVERT)



Summary for Subcatchment 2S: DA #2 - REACHING POA THROUGH DI

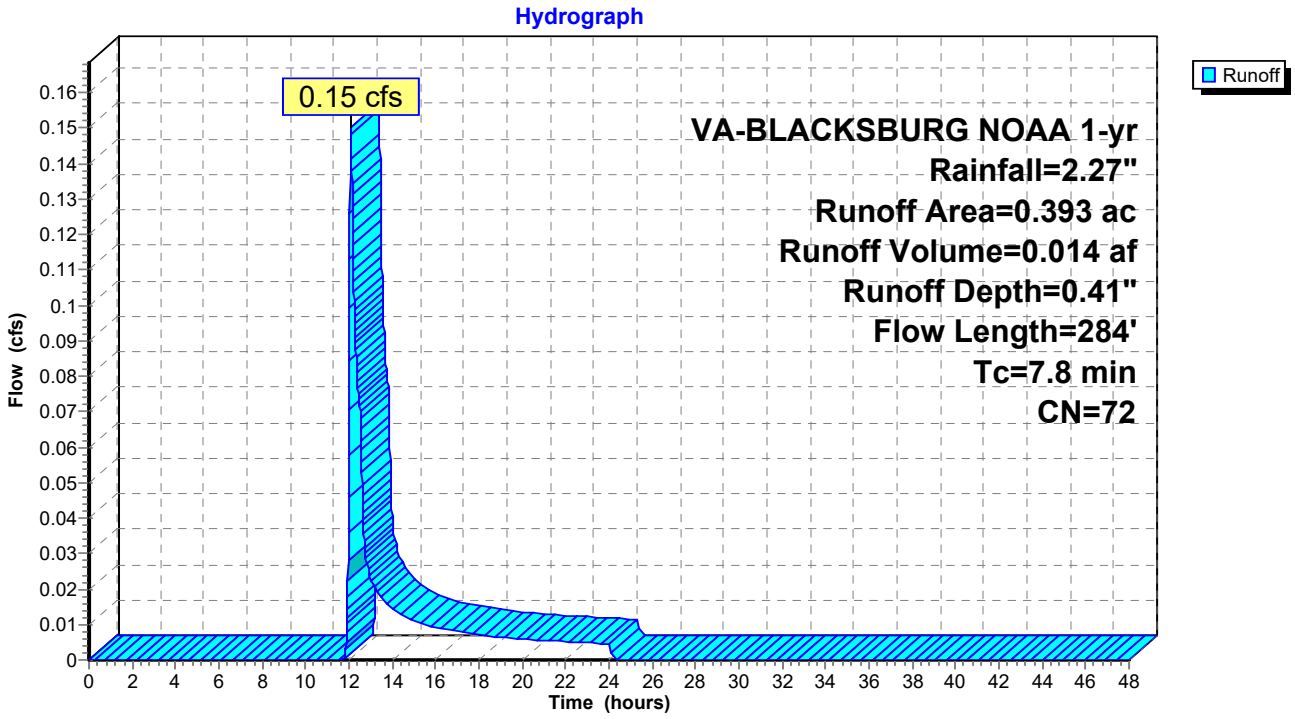
Runoff = 0.15 cfs @ 12.08 hrs, Volume= 0.014 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.273	61	>75% Grass cover, Good, HSG B
0.120	98	Paved parking, HSG B
0.393	72	Weighted Average
0.273		69.47% Pervious Area
0.120		30.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	100	0.0650	0.25		**Sheet Flow, Tc4** Grass: Short n= 0.150 P2= 2.76"
0.5	127	0.0830	4.64		**Shallow Concentrated Flow, Tc5** Unpaved Kv= 16.1 fps
0.7	57	0.0050	1.44		**Shallow Concentrated Flow, Tc6** Paved Kv= 20.3 fps
7.8	284	Total			

Subcatchment 2S: DA #2 - REACHING POA THROUGH DI



Summary for Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM

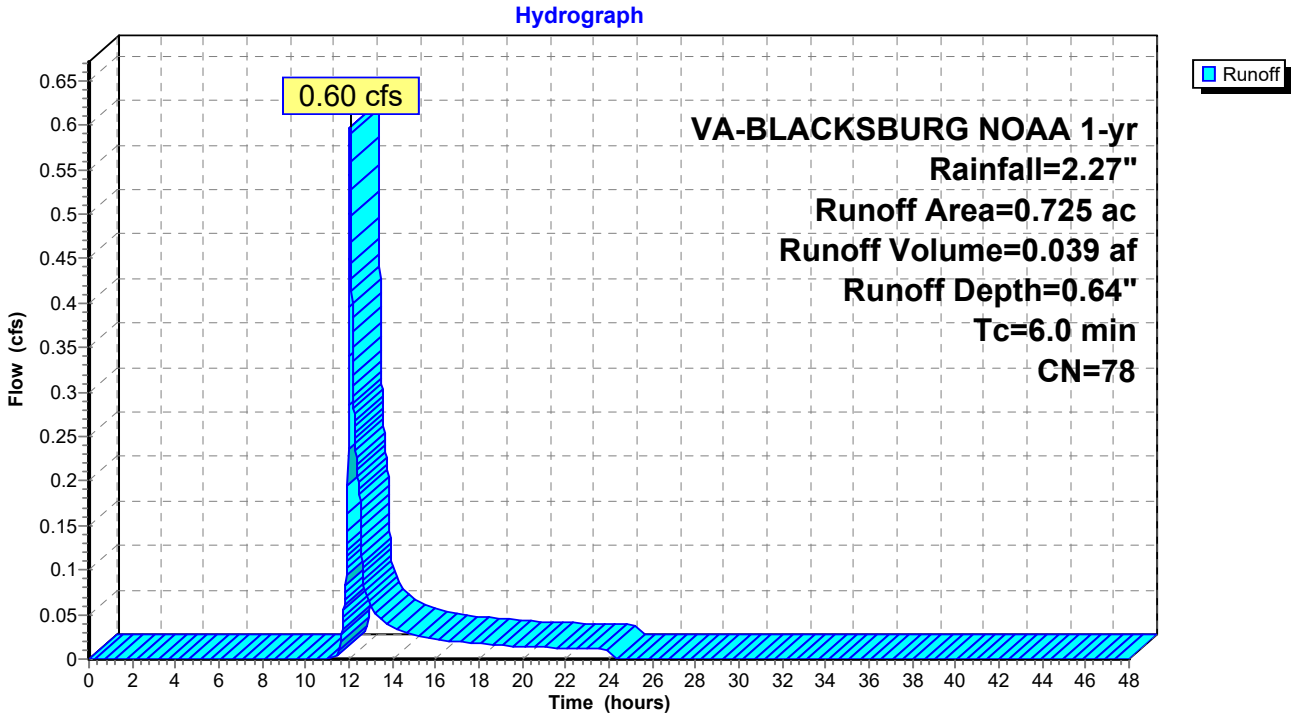
Runoff = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 3S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 0.64" for 1-yr event
Inflow = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af
Outflow = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af, Atten= 94%, Lag= 114.9 min
Primary = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.39' @ 13.96 hrs Surf.Area= 0.032 ac Storage= 0.018 af

Plug-Flow detention time= 252.5 min calculated for 0.039 af (100% of inflow)
Center-of-Mass det. time= 252.5 min (1,125.6 - 873.2)

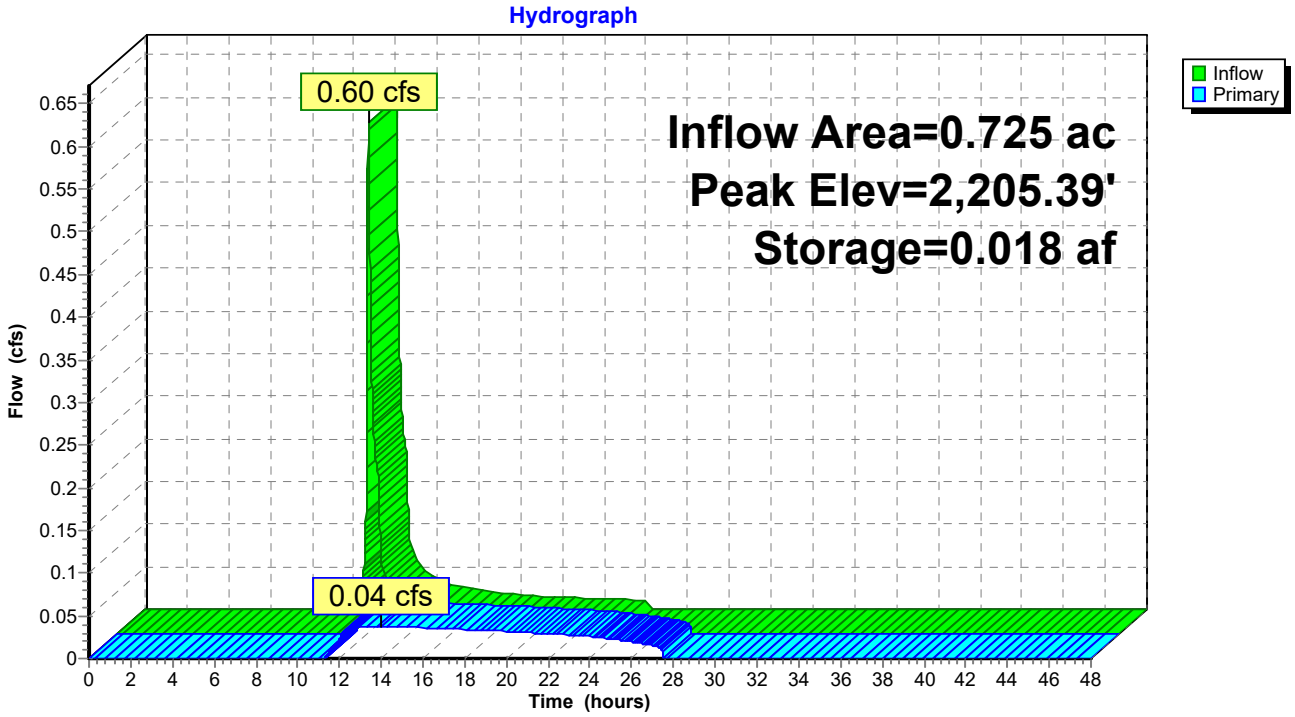
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

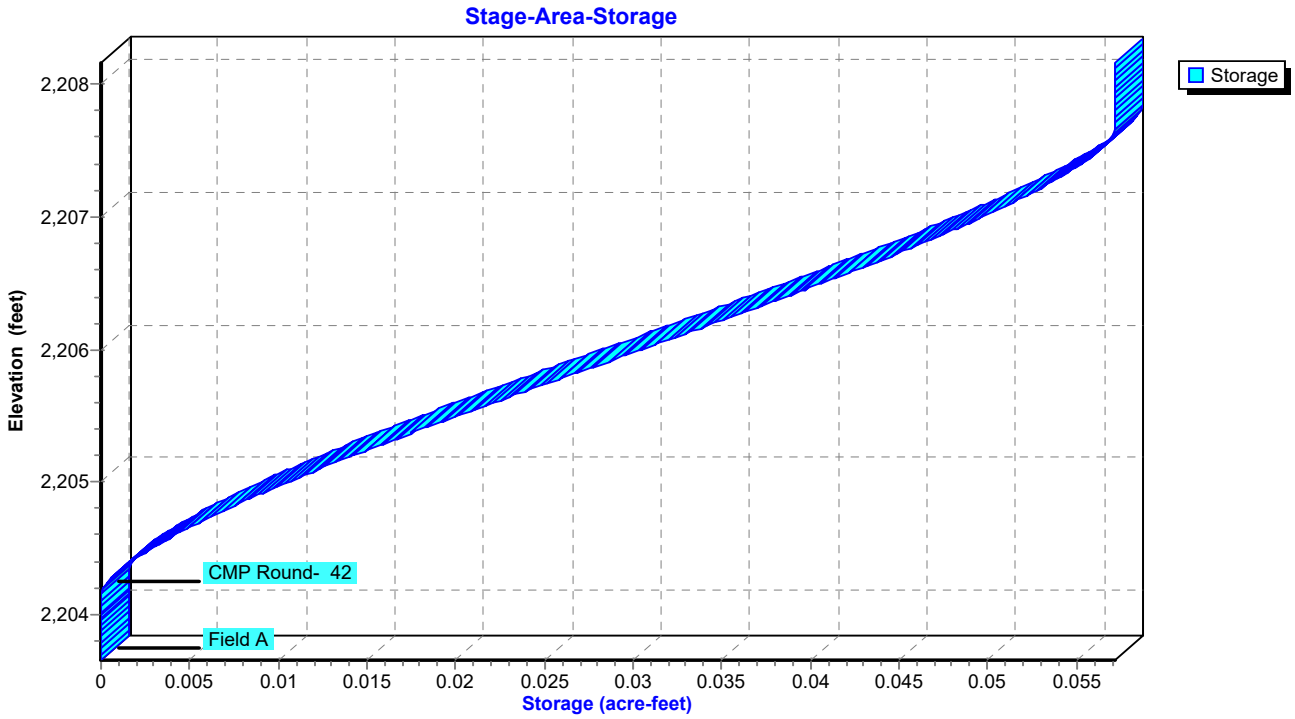
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#2	Device 1	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.04 cfs @ 13.96 hrs HW=2,205.39' (Free Discharge)
└**1=15" Culvert** (Passes 0.04 cfs of 4.43 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 5.57 fps)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

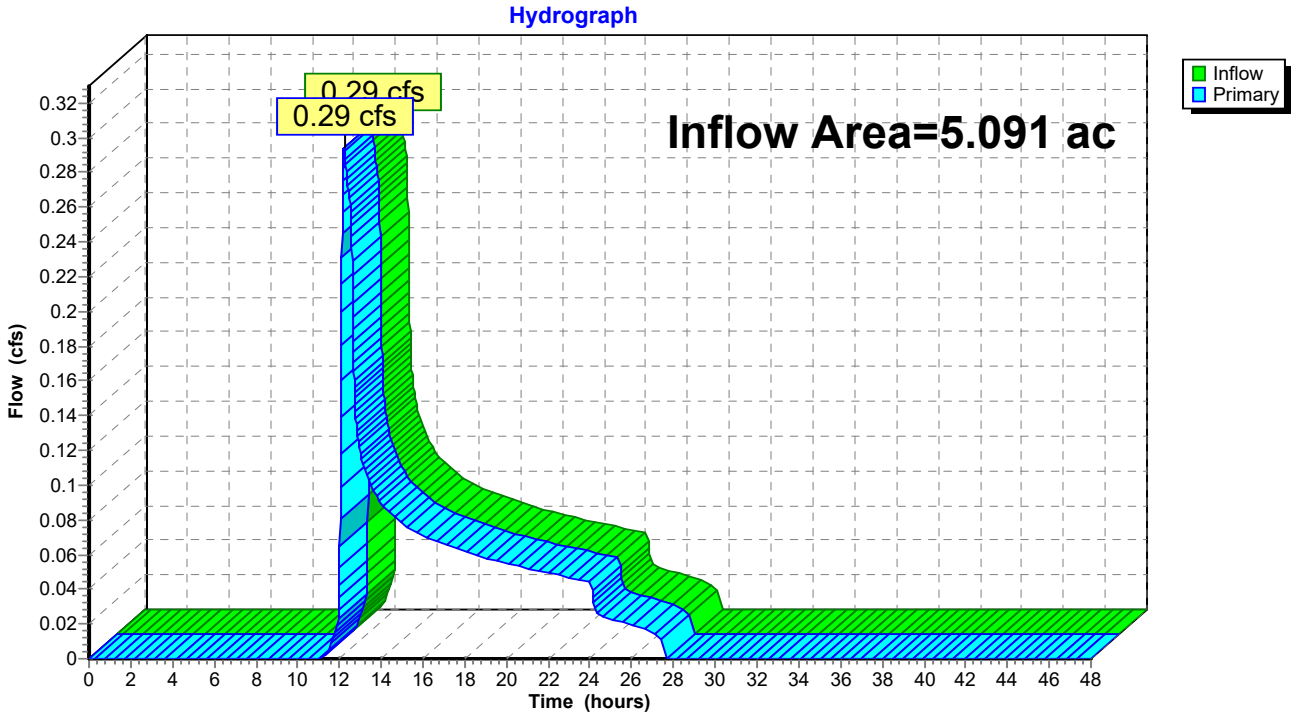


Summary for Link 1L: POA

Inflow Area = 5.091 ac, 16.20% Impervious, Inflow Depth = 0.19" for 1-yr event
Inflow = 0.29 cfs @ 12.22 hrs, Volume= 0.082 af
Primary = 0.29 cfs @ 12.22 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA

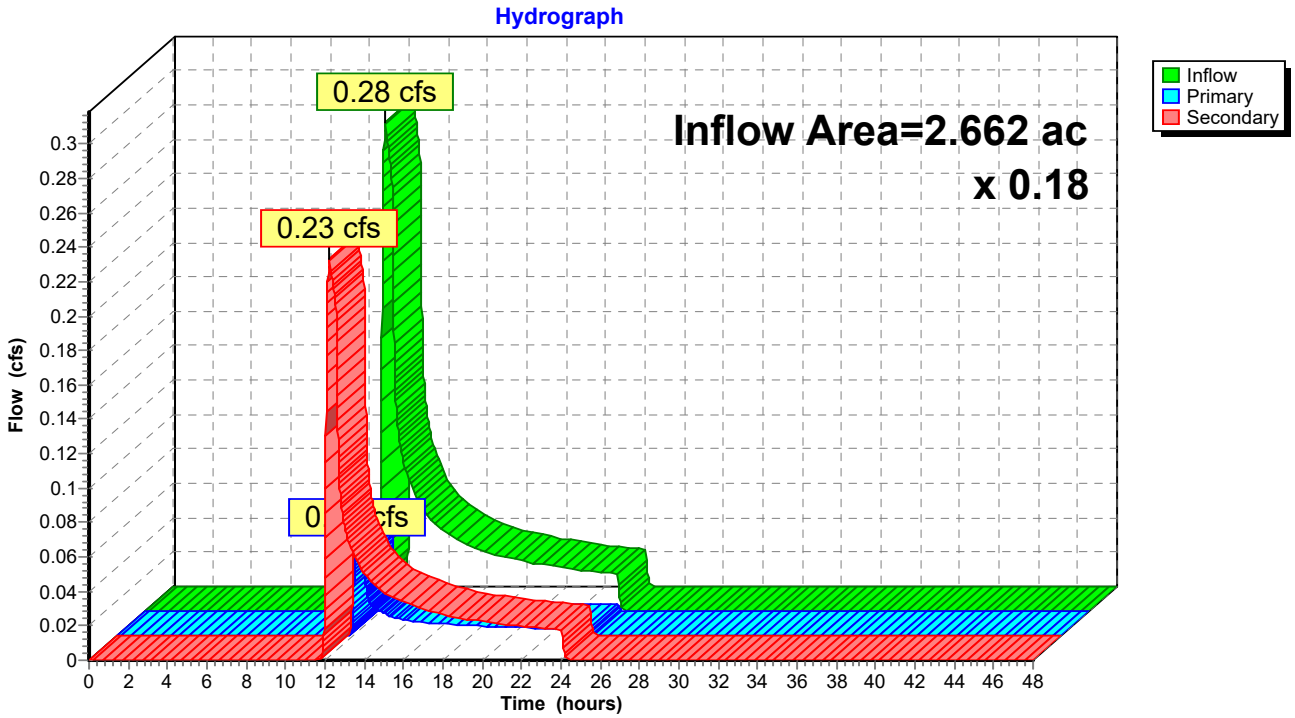


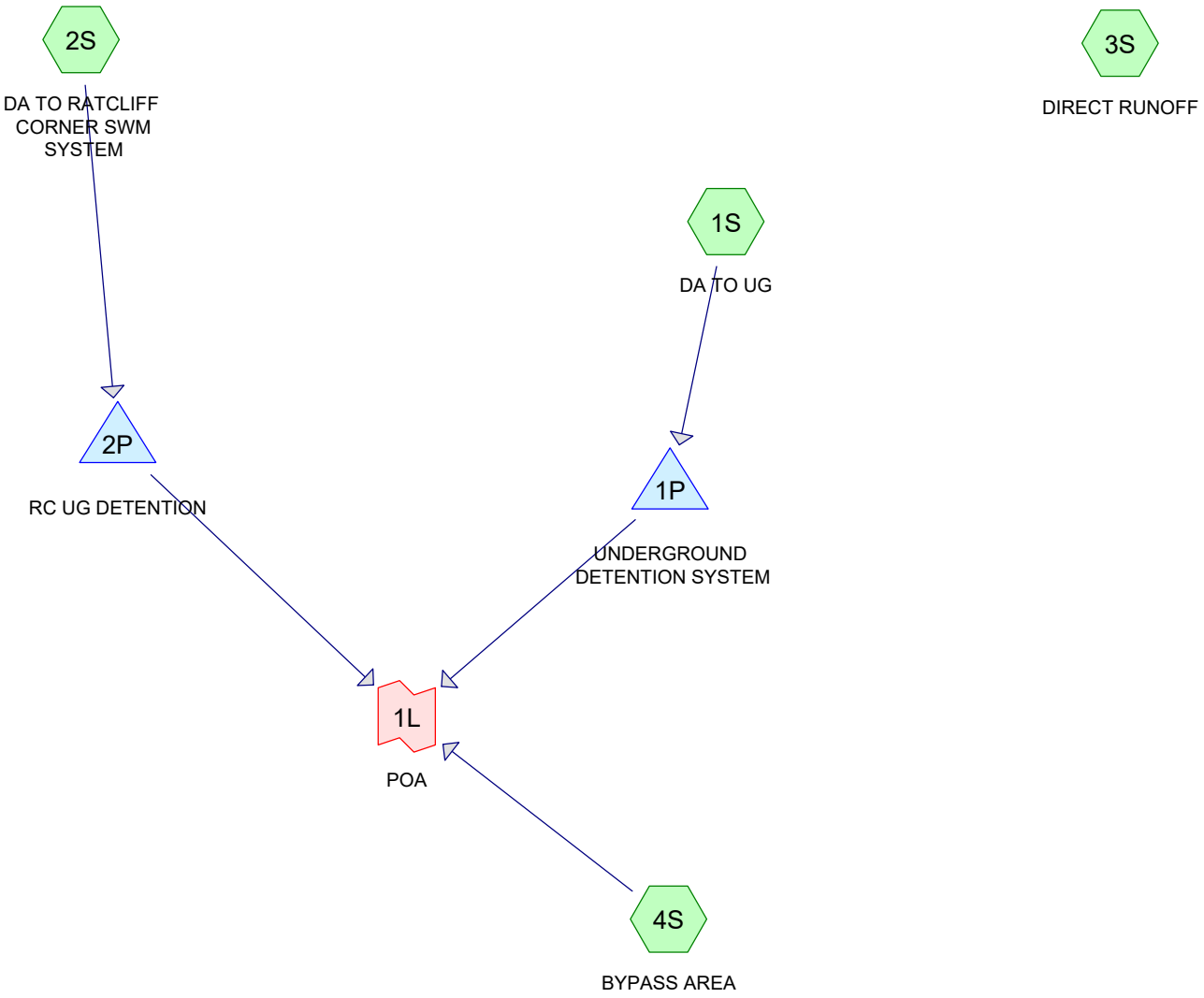
Summary for Link 2L: ENERGY BALANCE MAX Q RED

Inflow Area = 2.662 ac, 10.29% Impervious, Inflow Depth = 0.23" for 1-yr event
Inflow = 0.28 cfs @ 12.22 hrs, Volume= 0.050 af
Primary = 0.05 cfs @ 12.22 hrs, Volume= 0.009 af, Atten= 82%, Lag= 0.0 min
Secondary = 0.23 cfs @ 12.22 hrs, Volume= 0.041 af

Primary outflow = Inflow x 0.18, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 2L: ENERGY BALANCE MAX Q RED





Subcat Reach Pond Link

Routing Diagram for POST DEV
Prepared by Balzer & Associates, Inc., Printed 5/25/2022

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.115	70	1/2 acre lots, 25% imp, HSG B (2S)
3.200	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S)
2.345	98	Paved parking, HSG B (1S, 2S, 3S, 4S)
5.660	**77**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA TO UG Runoff Area=4.657 ac 41.34% Impervious Runoff Depth=0.56"
Tc=6.0 min CN=76 Runoff=3.18 cfs 0.217 af

Subcatchment 2S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=0.64"
Tc=6.0 min CN=78 Runoff=0.60 cfs 0.039 af

Subcatchment 3S: DIRECT RUNOFF Runoff Area=0.203 ac 32.51% Impervious Runoff Depth=0.45"
Tc=0.0 min CN=73 Runoff=0.14 cfs 0.008 af

Subcatchment 4S: BYPASS AREA Runoff Area=0.075 ac 72.00% Impervious Runoff Depth=1.19"
Tc=6.0 min CN=88 Runoff=0.13 cfs 0.007 af

Pond 1P: UNDERGROUND DETENTION Peak Elev=2,204.91' Storage=0.102 af Inflow=3.18 cfs 0.217 af
Outflow=0.18 cfs 0.217 af

Pond 2P: RC UG DETENTION Peak Elev=2,205.39' Storage=0.018 af Inflow=0.60 cfs 0.039 af
Outflow=0.04 cfs 0.039 af

Link 1L: POA Inflow=0.26 cfs 0.263 af
Primary=0.26 cfs 0.263 af

Total Runoff Area = 5.660 ac Runoff Volume = 0.271 af Average Runoff Depth = 0.57"
58.06% Pervious = 3.286 ac 41.94% Impervious = 2.374 ac

Summary for Subcatchment 1S: DA TO UG

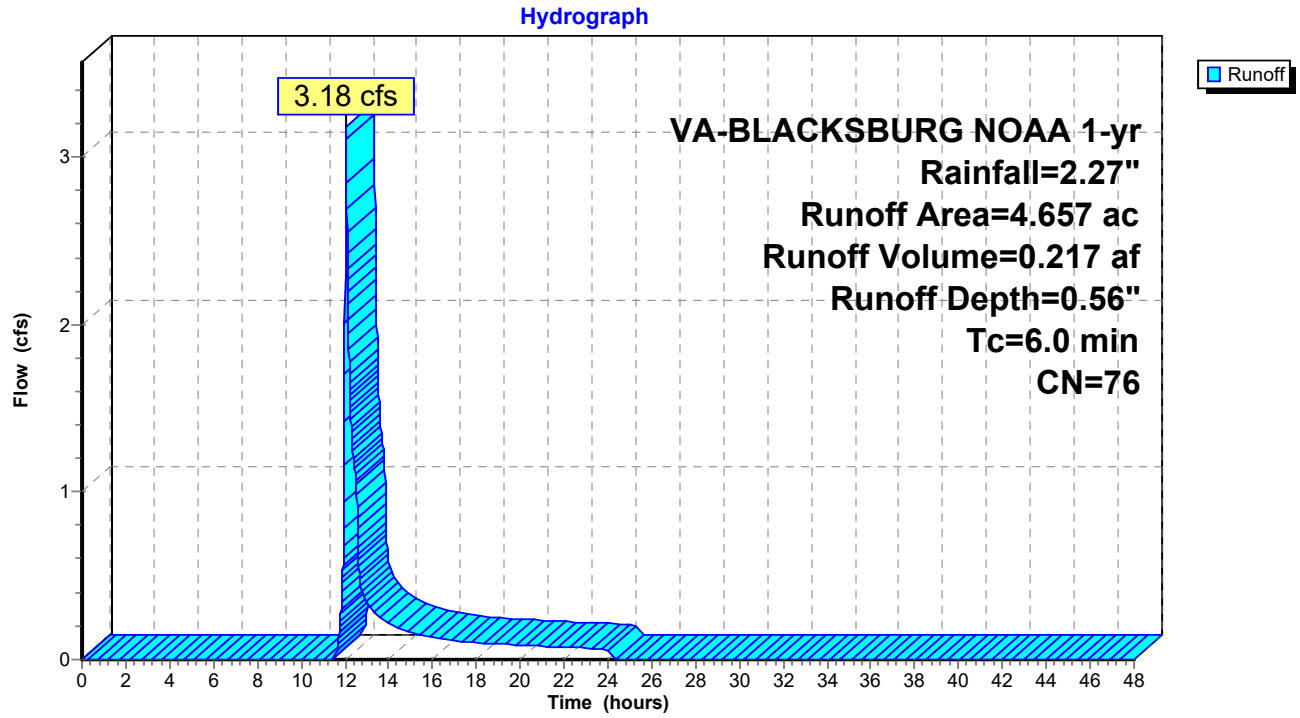
Runoff = 3.18 cfs @ 12.05 hrs, Volume= 0.217 af, Depth= 0.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
2.732	61	>75% Grass cover, Good, HSG B
1.925	98	Paved parking, HSG B
4.657	76	Weighted Average
2.732		58.66% Pervious Area
1.925		41.34% Impervious Area

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

Subcatchment 1S: DA TO UG



Summary for Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM

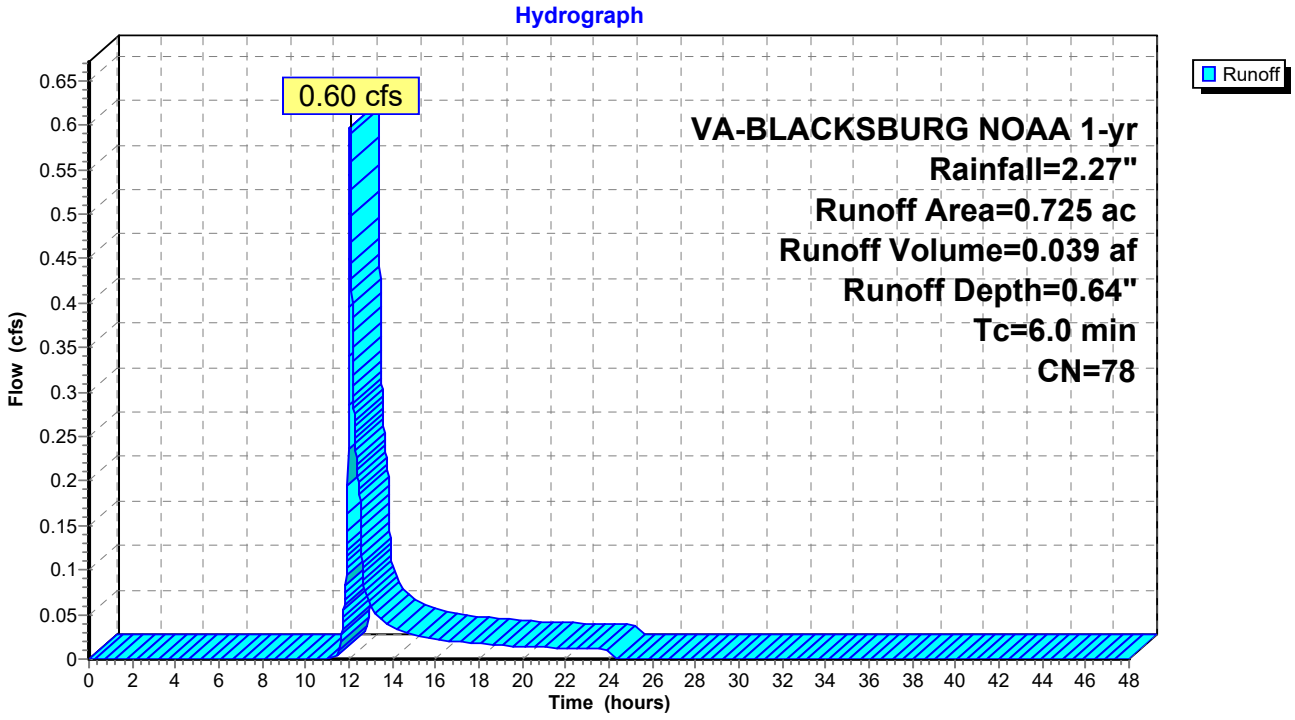
Runoff = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 3S: DIRECT RUNOFF

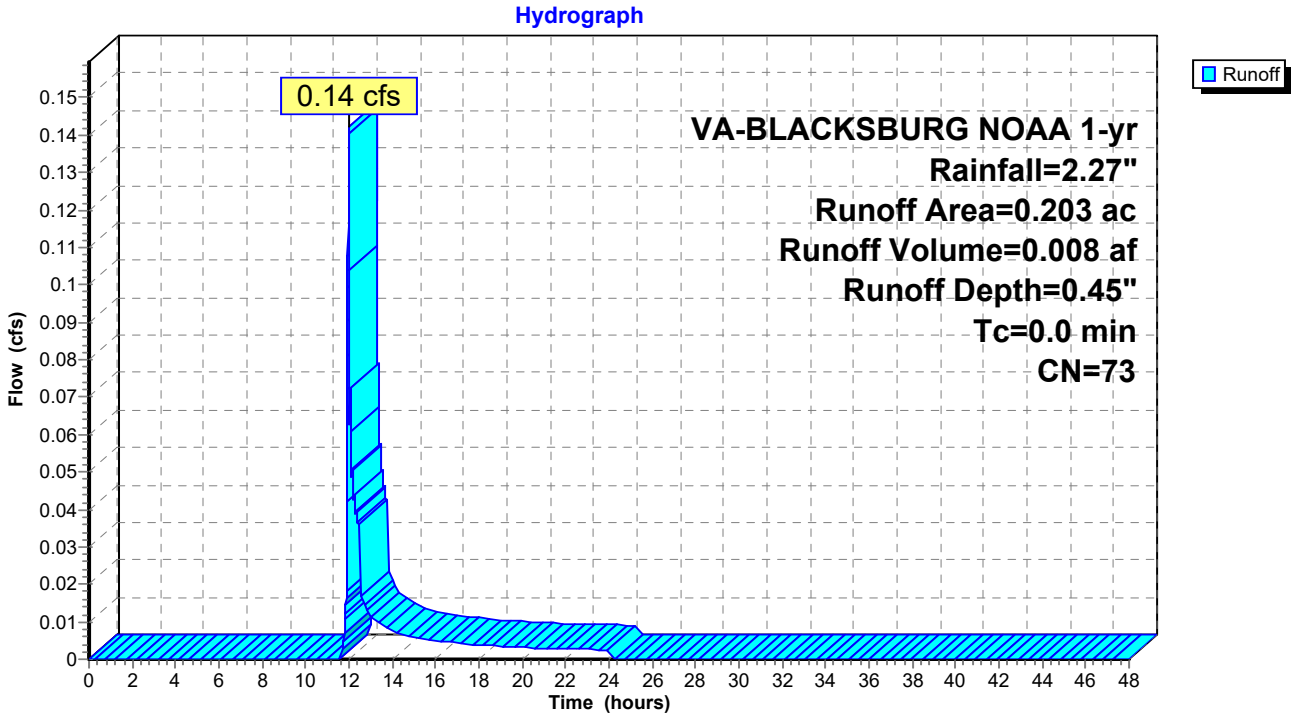
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.14 cfs @ 11.99 hrs, Volume= 0.008 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

	Area (ac)	CN	Description
	0.137	61	>75% Grass cover, Good, HSG B
*	0.066	98	Paved parking, HSG B
	0.203	73	Weighted Average
	0.137		67.49% Pervious Area
	0.066		32.51% Impervious Area

Subcatchment 3S: DIRECT RUNOFF



Summary for Subcatchment 4S: BYPASS AREA

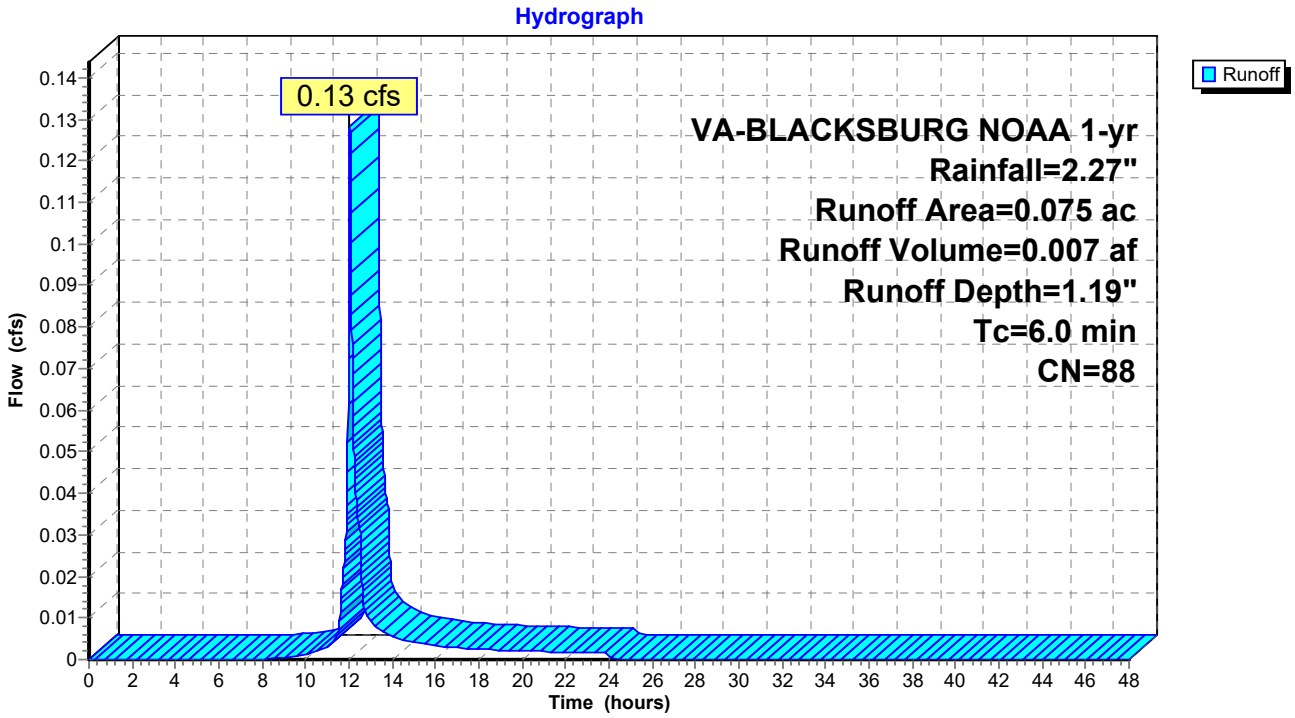
Runoff = 0.13 cfs @ 12.04 hrs, Volume= 0.007 af, Depth= 1.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 1-yr Rainfall=2.27"

Area (ac)	CN	Description
0.021	61	>75% Grass cover, Good, HSG B
0.054	98	Paved parking, HSG B
0.075	88	Weighted Average
0.021		28.00% Pervious Area
0.054		72.00% Impervious Area

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

Subcatchment 4S: BYPASS AREA



Summary for Pond 1P: UNDERGROUND DETENTION SYSTEM

Inflow Area = 4.657 ac, 41.34% Impervious, Inflow Depth = 0.56" for 1-yr event
Inflow = 3.18 cfs @ 12.05 hrs, Volume= 0.217 af
Outflow = 0.18 cfs @ 14.48 hrs, Volume= 0.217 af, Atten= 94%, Lag= 145.7 min
Primary = 0.18 cfs @ 14.48 hrs, Volume= 0.217 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,204.91' @ 14.48 hrs Surf.Area= 0.099 ac Storage= 0.102 af

Plug-Flow detention time= 305.1 min calculated for 0.217 af (100% of inflow)
Center-of-Mass det. time= 305.1 min (1,186.8 - 881.7)

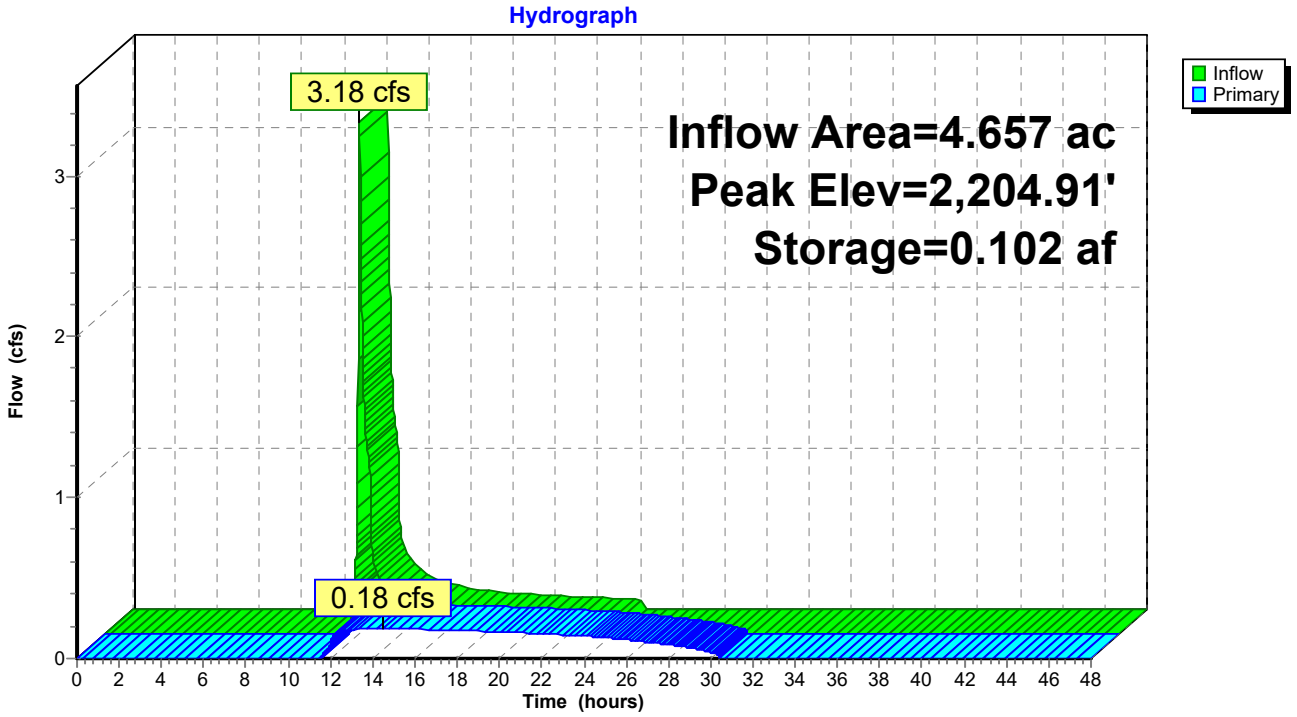
Volume	Invert	Avail.Storage	Storage Description
#1A	2,202.35'	0.000 af	**44.50'W x 97.00'L x 6.00'H Field A** 0.595 af Overall - 0.263 af Embedded = 0.332 af x 0.0% Voids
#2A	2,202.85'	0.263 af	**CMP Round 60** x 30 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.63 sf x 20.00'L = 392.7 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= -10.00' x 19.63 sf x 6 rows 42.50' Header x 19.63 sf x 1 = 834.5 cf Inside
		0.263 af	Total Available Storage

Storage Group A created with Chamber Wizard

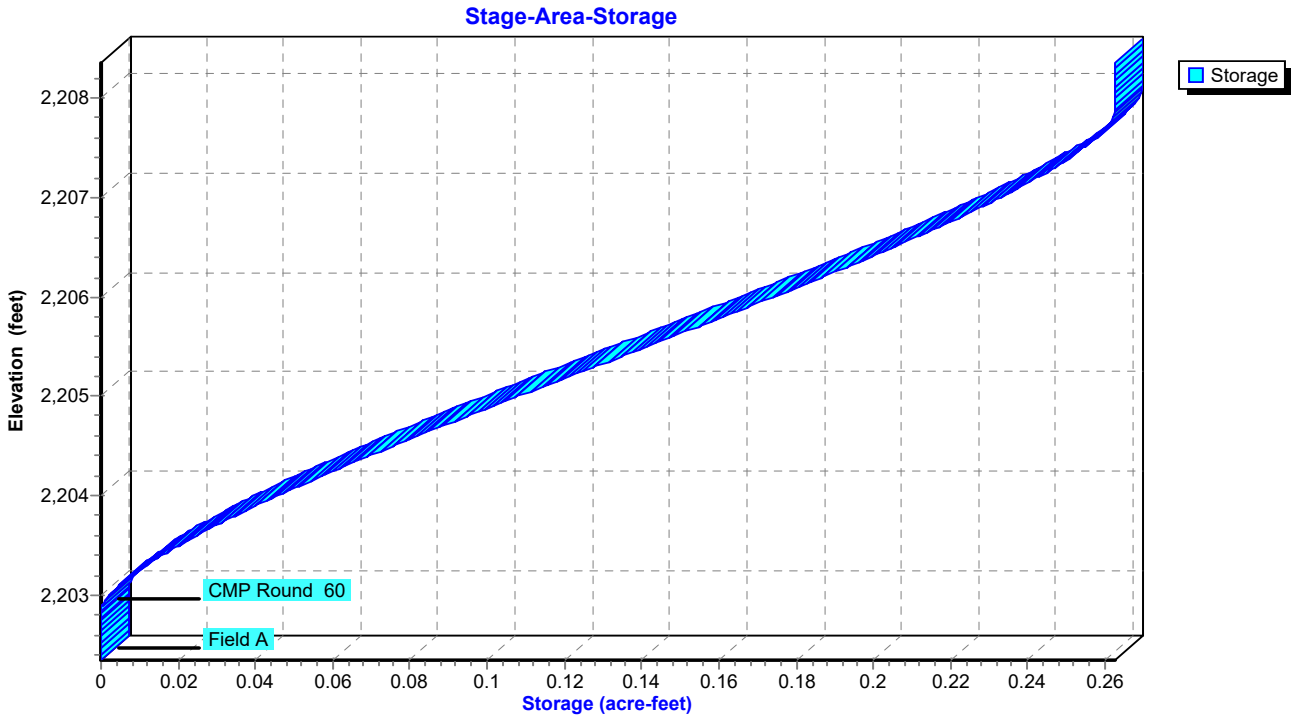
Device	Routing	Invert	Outlet Devices
#1	Primary	2,202.65'	**15.0" Round 15" HDPE Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,202.65' / 2,202.45' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,202.75'	**2.2" Vert. 2.25" Dia. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,204.95'	**12.0" W x 3.0" H Vert. 10" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,205.45'	**16.0" W x 3.0" H Vert. 18" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#5	Device 1	2,206.85'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.18 cfs @ 14.48 hrs HW=2,204.91' (Free Discharge)
└**1=15" HDPE Culvert** (Passes 0.18 cfs of 7.56 cfs potential flow)
  ├**2=2.25" Dia. Orifice** (Orifice Controls 0.18 cfs @ 6.92 fps)
  ├**3=10" x 3" Rect. Orifice** (Controls 0.00 cfs)
  ├**4=18" x 3" Rect. Orifice** (Controls 0.00 cfs)
  └**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: UNDERGROUND DETENTION SYSTEM



Pond 1P: UNDERGROUND DETENTION SYSTEM



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 0.64" for 1-yr event
Inflow = 0.60 cfs @ 12.05 hrs, Volume= 0.039 af
Outflow = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af, Atten= 94%, Lag= 114.9 min
Primary = 0.04 cfs @ 13.96 hrs, Volume= 0.039 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.39' @ 13.96 hrs Surf.Area= 0.032 ac Storage= 0.018 af

Plug-Flow detention time= 252.5 min calculated for 0.039 af (100% of inflow)
Center-of-Mass det. time= 252.5 min (1,125.6 - 873.2)

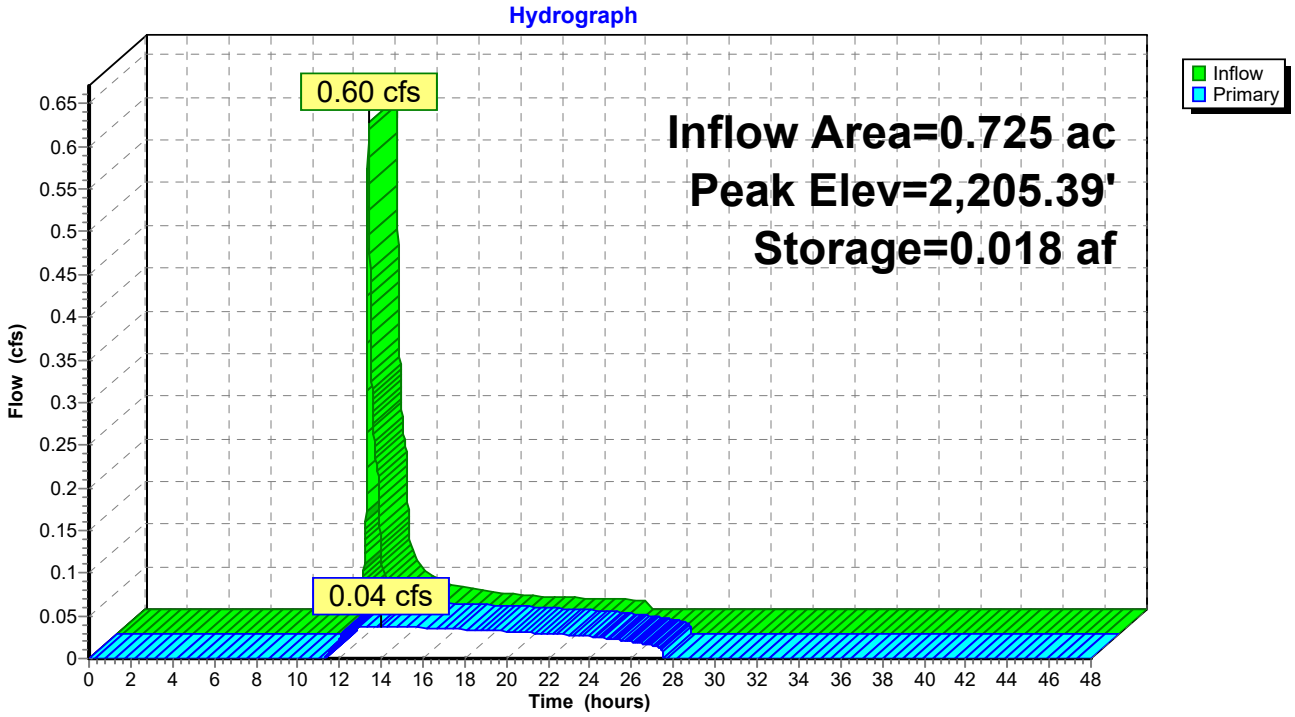
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

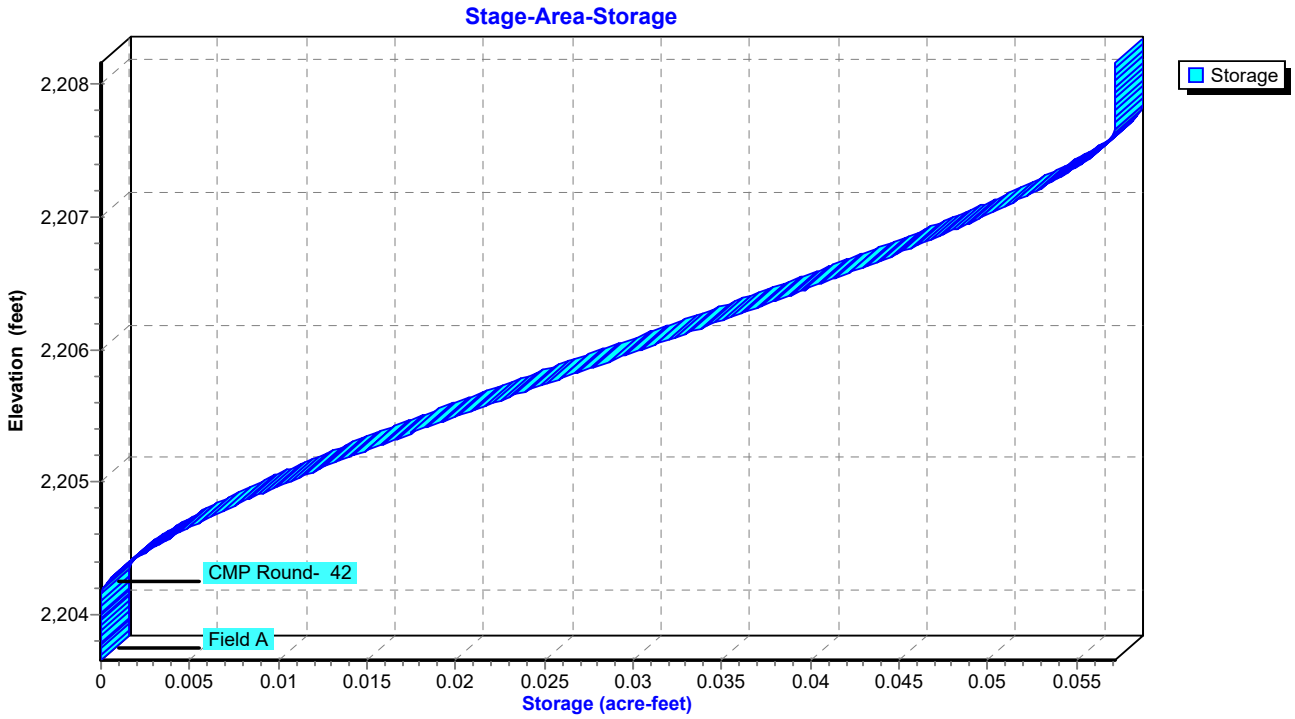
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.78'	**15.0" Round 15" Culvert Extension** L= 133.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.78' / 2,202.67' S= 0.0083 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#3	Device 2	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.04 cfs @ 13.96 hrs HW=2,205.39' (Free Discharge)
└**1=15" Culvert Extension** (Passes 0.04 cfs of 5.85 cfs potential flow)
└**2=15" Culvert** (Passes 0.04 cfs of 4.43 cfs potential flow)
├**3=Orifice/Grate** (Orifice Controls 0.04 cfs @ 5.57 fps)
├**4=Orifice/Grate** (Controls 0.00 cfs)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

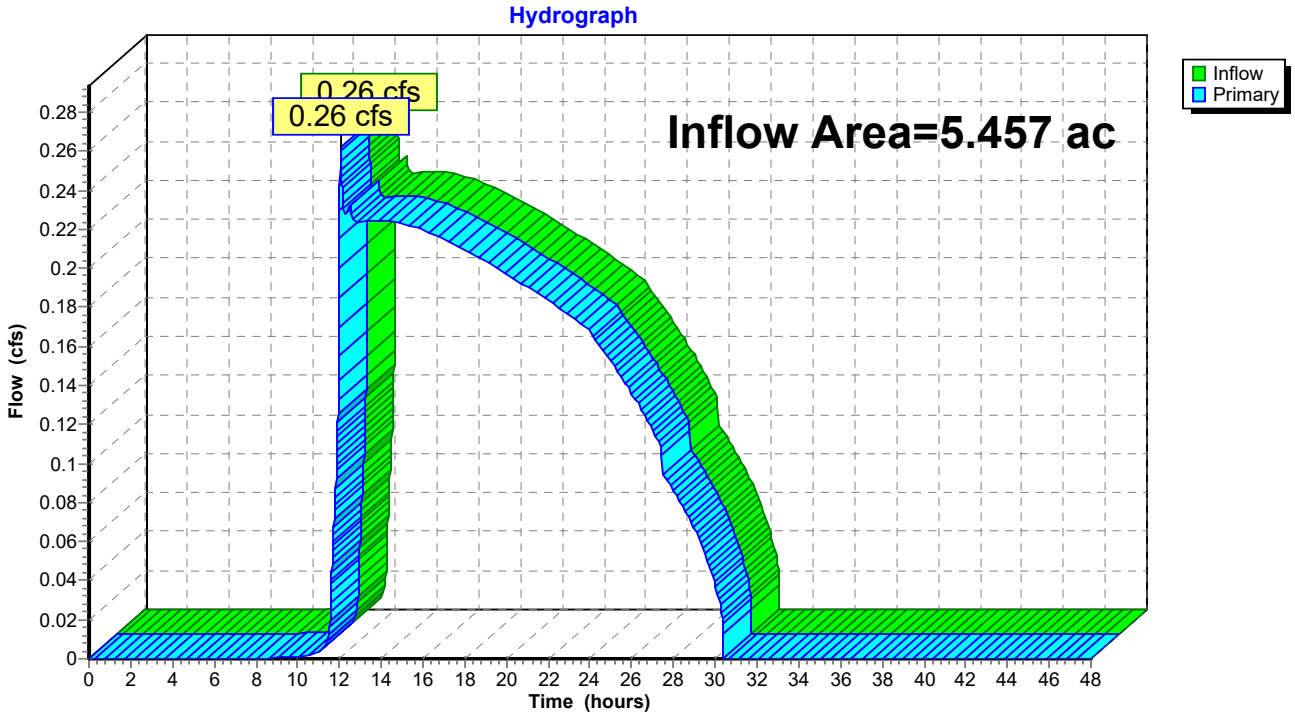


Summary for Link 1L: POA

Inflow Area = 5.457 ac, 42.29% Impervious, Inflow Depth = 0.58" for 1-yr event
Inflow = 0.26 cfs @ 12.05 hrs, Volume= 0.263 af
Primary = 0.26 cfs @ 12.05 hrs, Volume= 0.263 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA TO UG Runoff Area=4.657 ac 41.34% Impervious Runoff Depth=0.85"
Tc=6.0 min CN=76 Runoff=5.22 cfs 0.330 af

Subcatchment 2S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=0.95"
Tc=6.0 min CN=78 Runoff=0.94 cfs 0.058 af

Subcatchment 3S: DIRECT RUNOFF Runoff Area=0.203 ac 32.51% Impervious Runoff Depth=0.71"
Tc=0.0 min CN=73 Runoff=0.24 cfs 0.012 af

Subcatchment 4S: BYPASS AREA Runoff Area=0.075 ac 72.00% Impervious Runoff Depth=1.60"
Tc=6.0 min CN=88 Runoff=0.17 cfs 0.010 af

Pond 1P: UNDERGROUND DETENTION Peak Elev=2,205.40' Storage=0.135 af Inflow=5.22 cfs 0.330 af
Outflow=0.88 cfs 0.330 af

Pond 2P: RC UG DETENTION Peak Elev=2,205.97' Storage=0.030 af Inflow=0.94 cfs 0.058 af
Outflow=0.04 cfs 0.058 af

Link 1L: POA Inflow=0.95 cfs 0.398 af
Primary=0.95 cfs 0.398 af

Total Runoff Area = 5.660 ac Runoff Volume = 0.410 af Average Runoff Depth = 0.87"
58.06% Pervious = 3.286 ac 41.94% Impervious = 2.374 ac

Summary for Subcatchment 1S: DA TO UG

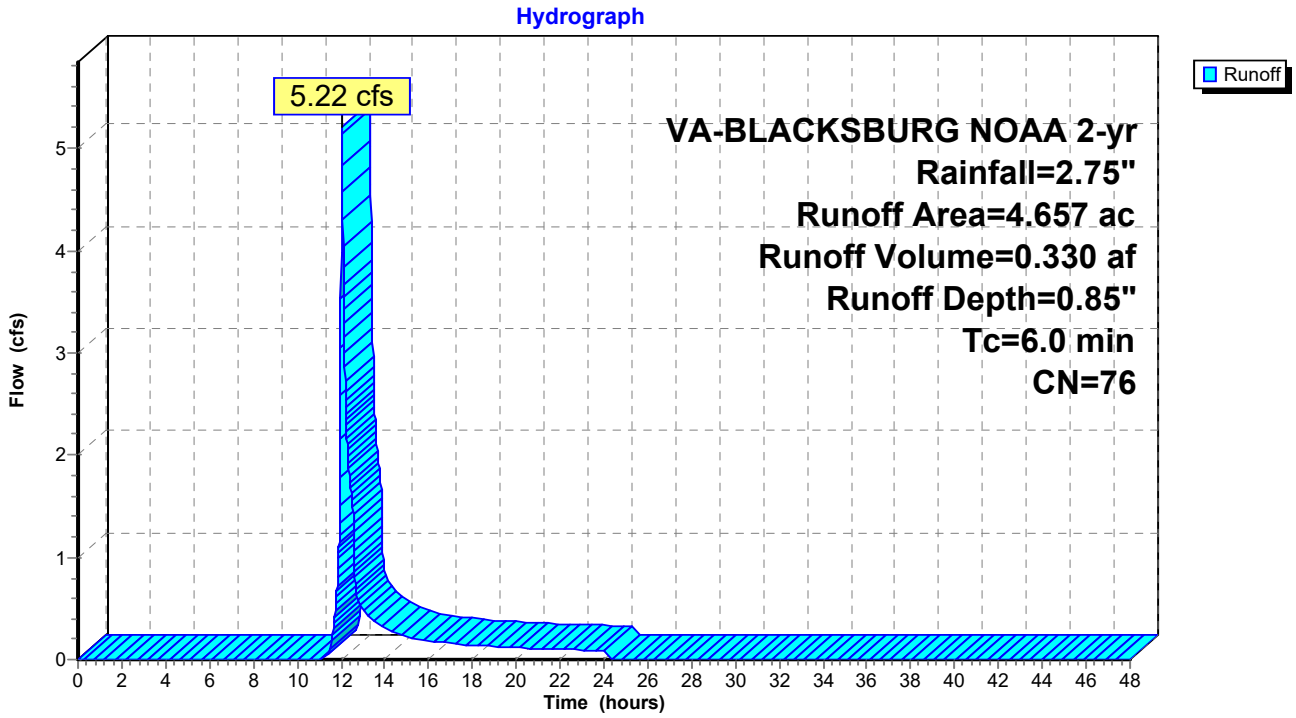
Runoff = 5.22 cfs @ 12.05 hrs, Volume= 0.330 af, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
2.732	61	>75% Grass cover, Good, HSG B
1.925	98	Paved parking, HSG B
4.657	76	Weighted Average
2.732		58.66% Pervious Area
1.925		41.34% Impervious Area

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

Subcatchment 1S: DA TO UG



Summary for Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM

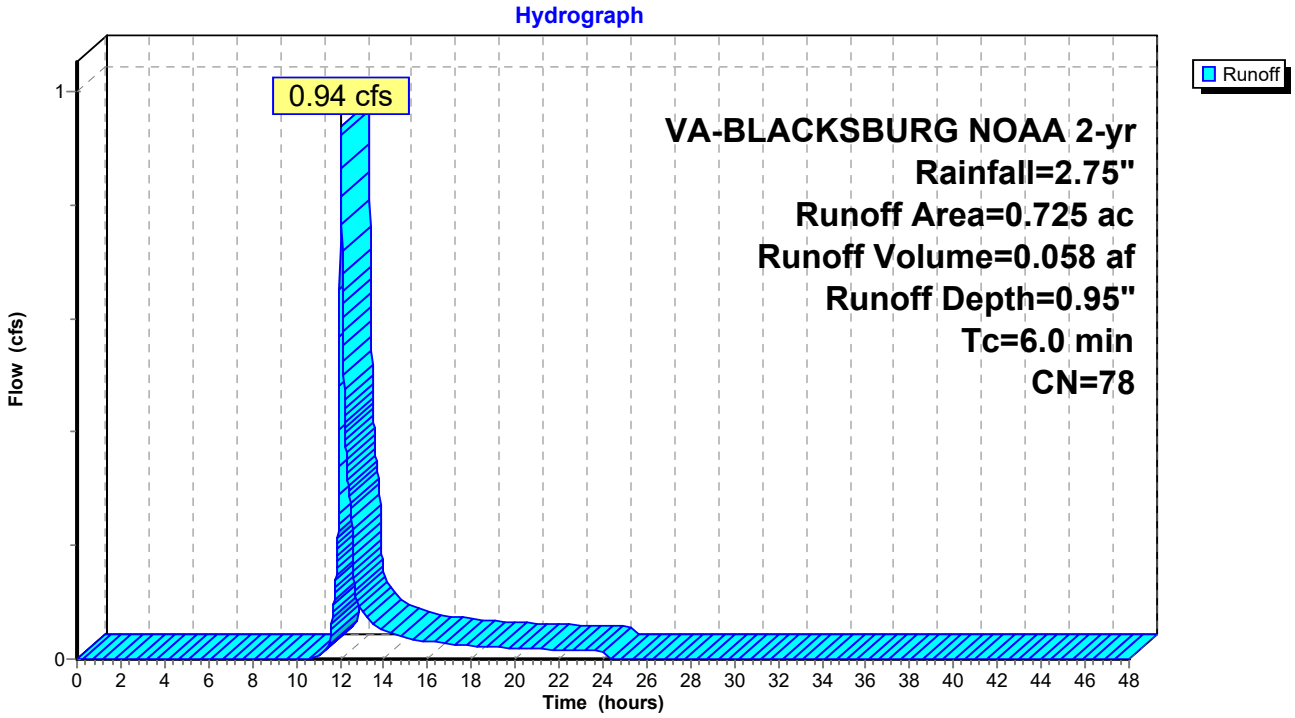
Runoff = 0.94 cfs @ 12.04 hrs, Volume= 0.058 af, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 3S: DIRECT RUNOFF

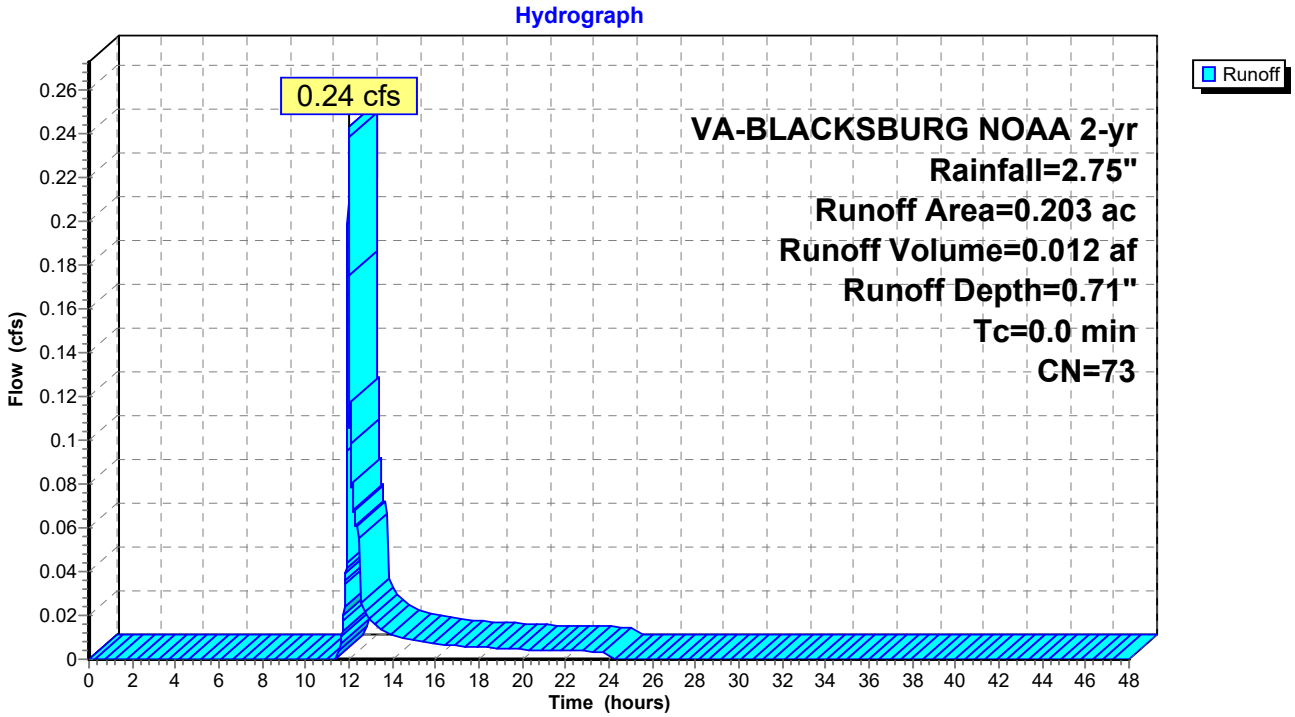
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.24 cfs @ 11.99 hrs, Volume= 0.012 af, Depth= 0.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

	Area (ac)	CN	Description
	0.137	61	>75% Grass cover, Good, HSG B
*	0.066	98	Paved parking, HSG B
	0.203	73	Weighted Average
	0.137		67.49% Pervious Area
	0.066		32.51% Impervious Area

Subcatchment 3S: DIRECT RUNOFF



Summary for Subcatchment 4S: BYPASS AREA

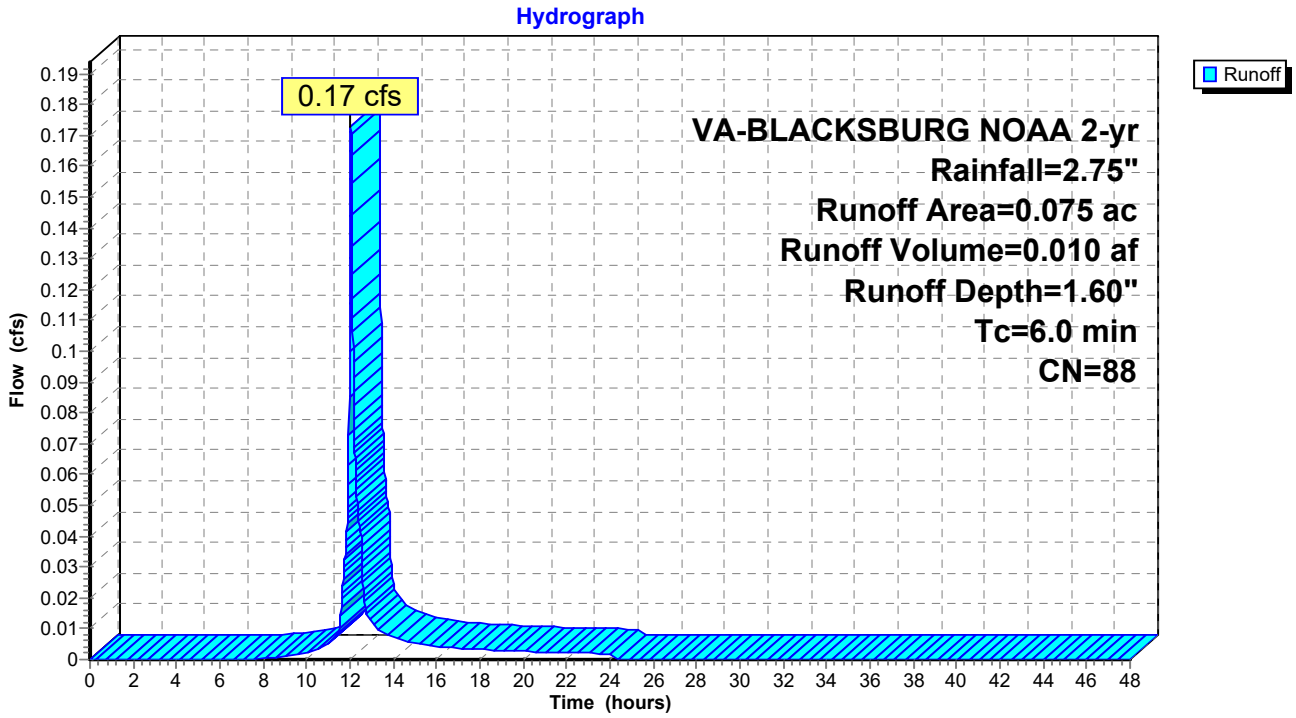
Runoff = 0.17 cfs @ 12.04 hrs, Volume= 0.010 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 2-yr Rainfall=2.75"

Area (ac)	CN	Description
0.021	61	>75% Grass cover, Good, HSG B
0.054	98	Paved parking, HSG B
0.075	88	Weighted Average
0.021		28.00% Pervious Area
0.054		72.00% Impervious Area

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

Subcatchment 4S: BYPASS AREA



Summary for Pond 1P: UNDERGROUND DETENTION SYSTEM

Inflow Area = 4.657 ac, 41.34% Impervious, Inflow Depth = 0.85" for 2-yr event
Inflow = 5.22 cfs @ 12.05 hrs, Volume= 0.330 af
Outflow = 0.88 cfs @ 12.62 hrs, Volume= 0.330 af, Atten= 83%, Lag= 34.2 min
Primary = 0.88 cfs @ 12.62 hrs, Volume= 0.330 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.40' @ 12.62 hrs Surf.Area= 0.099 ac Storage= 0.135 af

Plug-Flow detention time= 259.0 min calculated for 0.330 af (100% of inflow)
Center-of-Mass det. time= 259.0 min (1,126.1 - 867.1)

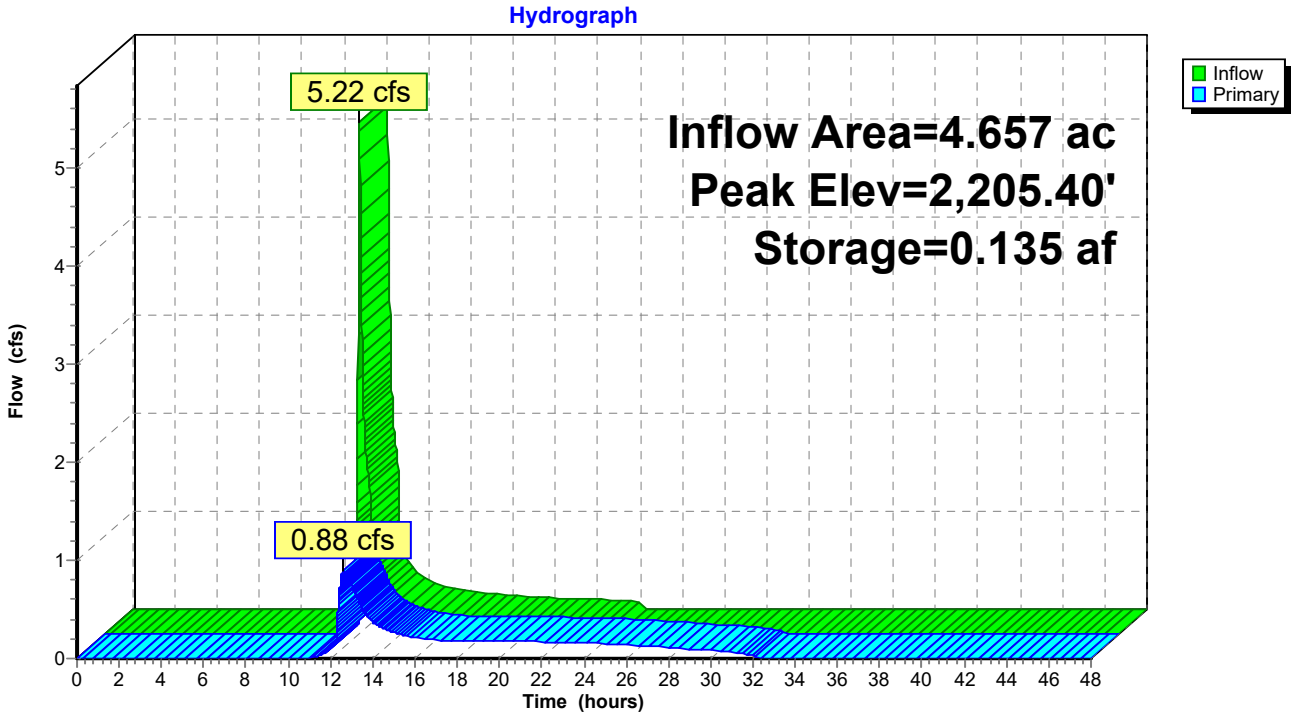
Volume	Invert	Avail.Storage	Storage Description
#1A	2,202.35'	0.000 af	**44.50'W x 97.00'L x 6.00'H Field A** 0.595 af Overall - 0.263 af Embedded = 0.332 af x 0.0% Voids
#2A	2,202.85'	0.263 af	**CMP Round 60** x 30 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.63 sf x 20.00'L = 392.7 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= -10.00' x 19.63 sf x 6 rows 42.50' Header x 19.63 sf x 1 = 834.5 cf Inside
		0.263 af	Total Available Storage

Storage Group A created with Chamber Wizard

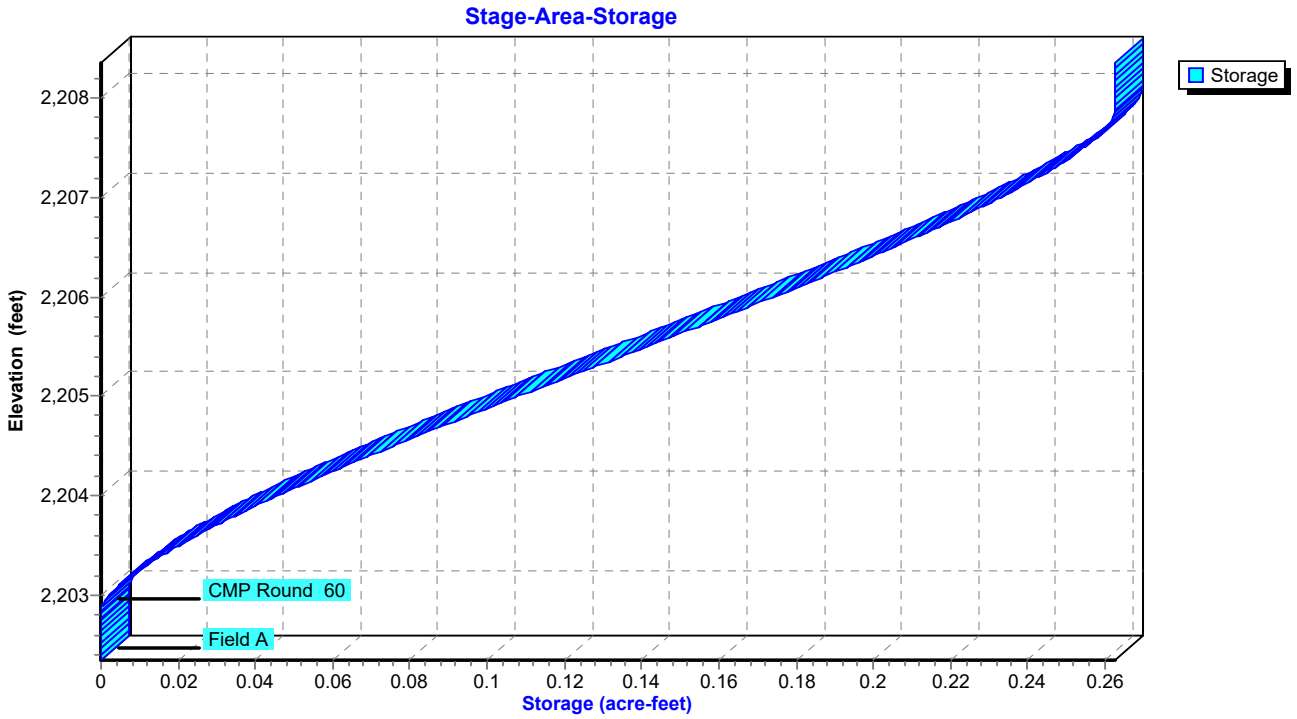
Device	Routing	Invert	Outlet Devices
#1	Primary	2,202.65'	**15.0" Round 15" HDPE Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,202.65' / 2,202.45' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,202.75'	**2.2" Vert. 2.25" Dia. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,204.95'	**12.0" W x 3.0" H Vert. 10" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,205.45'	**16.0" W x 3.0" H Vert. 18" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#5	Device 1	2,206.85'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.88 cfs @ 12.62 hrs HW=2,205.40' (Free Discharge)
└**1=15" HDPE Culvert** (Passes 0.88 cfs of 8.61 cfs potential flow)
  ├**2=2.25" Dia. Orifice** (Orifice Controls 0.20 cfs @ 7.70 fps)
  ├**3=10" x 3" Rect. Orifice** (Orifice Controls 0.68 cfs @ 2.73 fps)
  ├**4=18" x 3" Rect. Orifice** (Controls 0.00 cfs)
  └**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: UNDERGROUND DETENTION SYSTEM



Pond 1P: UNDERGROUND DETENTION SYSTEM



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 0.95" for 2-yr event
Inflow = 0.94 cfs @ 12.04 hrs, Volume= 0.058 af
Outflow = 0.04 cfs @ 14.42 hrs, Volume= 0.058 af, Atten= 95%, Lag= 142.4 min
Primary = 0.04 cfs @ 14.42 hrs, Volume= 0.058 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,205.97' @ 14.42 hrs Surf.Area= 0.032 ac Storage= 0.030 af

Plug-Flow detention time= 357.8 min calculated for 0.058 af (100% of inflow)
Center-of-Mass det. time= 357.8 min (1,217.8 - 859.9)

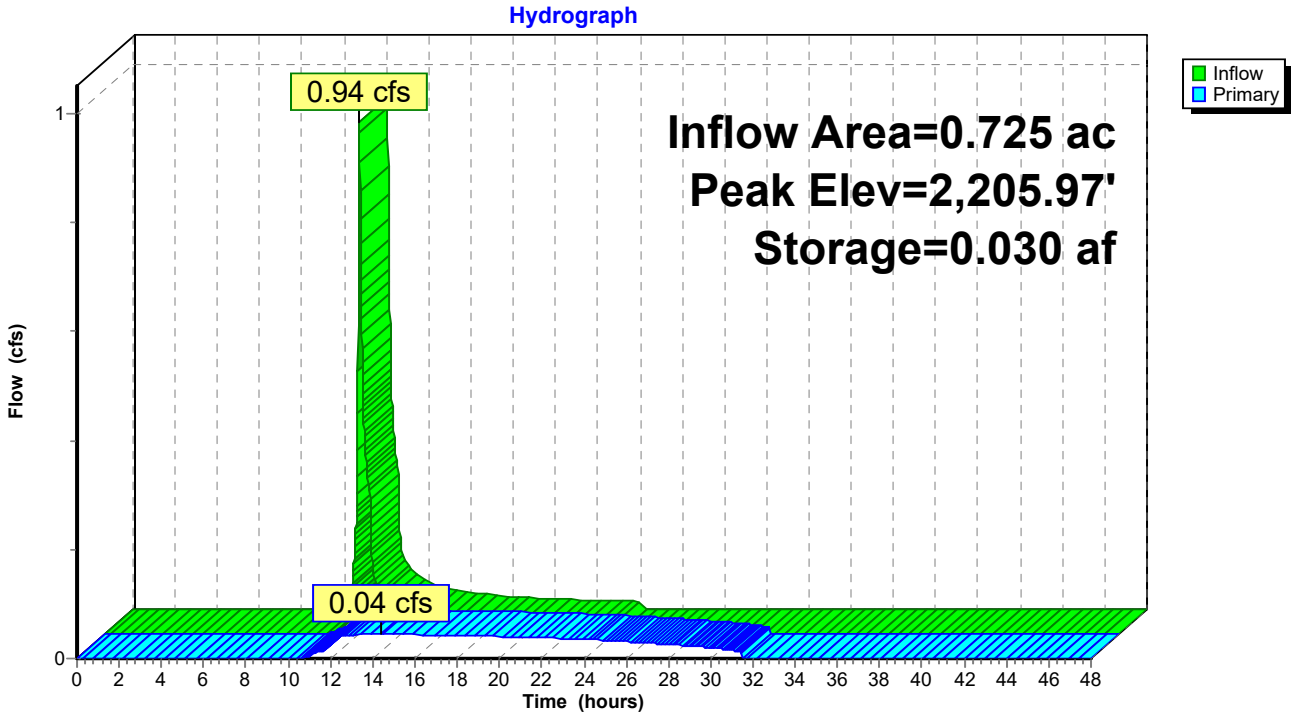
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

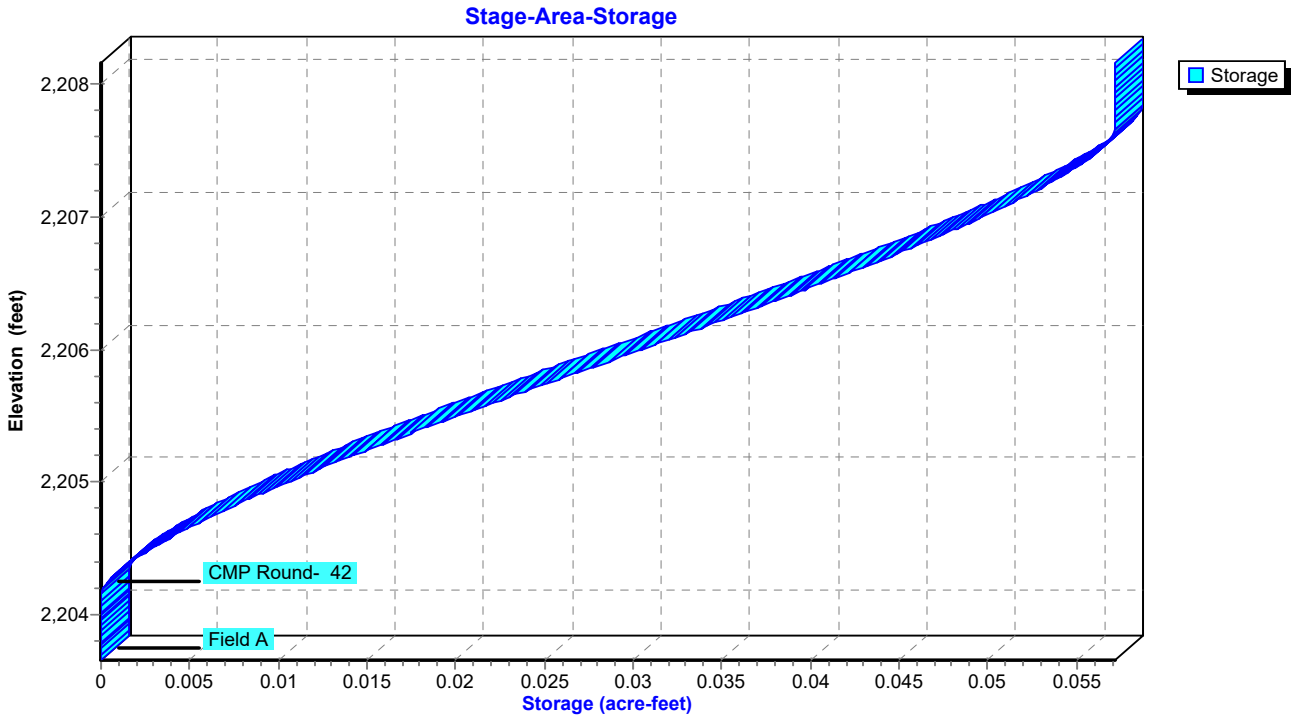
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.78'	**15.0" Round 15" Culvert Extension** L= 133.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.78' / 2,202.67' S= 0.0083 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#3	Device 2	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.04 cfs @ 14.42 hrs HW=2,205.97' (Free Discharge)
└**1=15" Culvert Extension** (Passes 0.04 cfs of 6.56 cfs potential flow)
└**2=15" Culvert** (Passes 0.04 cfs of 6.15 cfs potential flow)
├**3=Orifice/Grate** (Orifice Controls 0.04 cfs @ 6.67 fps)
├**4=Orifice/Grate** (Controls 0.00 cfs)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

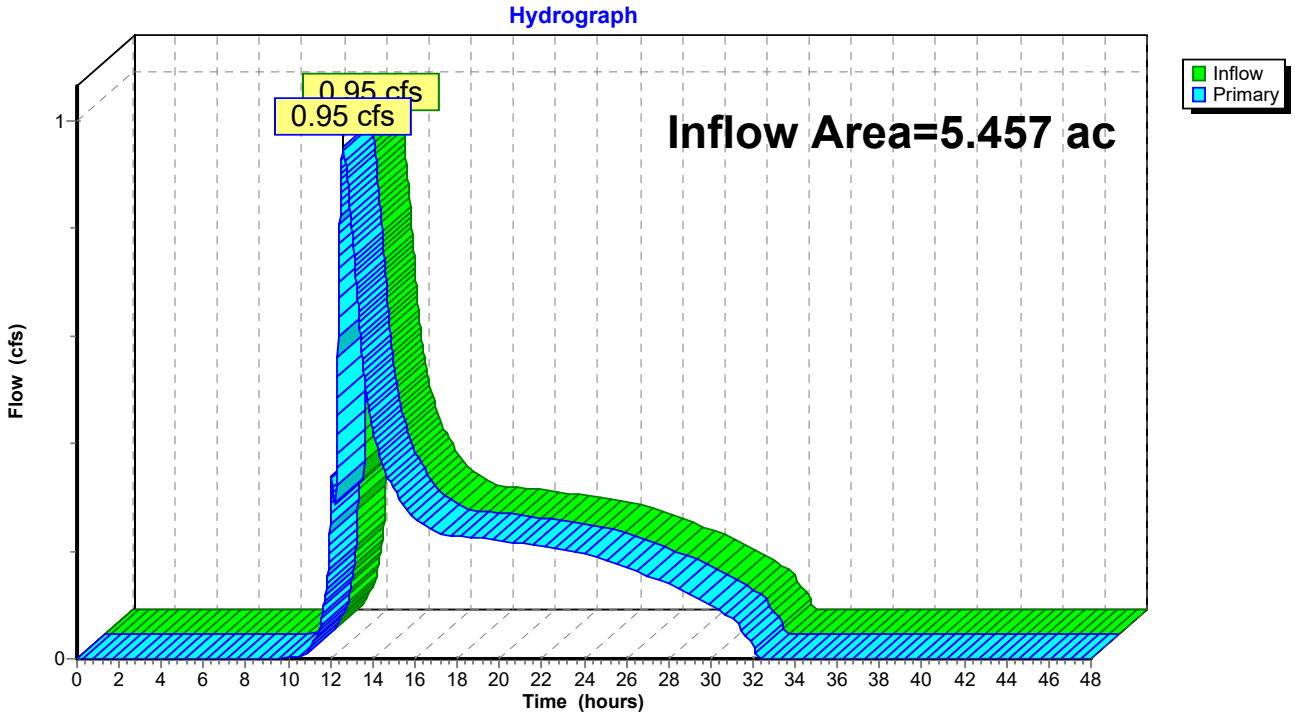


Summary for Link 1L: POA

Inflow Area = 5.457 ac, 42.29% Impervious, Inflow Depth = 0.87" for 2-yr event
Inflow = 0.95 cfs @ 12.59 hrs, Volume= 0.398 af
Primary = 0.95 cfs @ 12.59 hrs, Volume= 0.398 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA TO UG Runoff Area=4.657 ac 41.34% Impervious Runoff Depth=1.81"
Tc=6.0 min CN=76 Runoff=10.90 cfs 0.702 af

Subcatchment 2S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=1.96"
Tc=6.0 min CN=78 Runoff=1.86 cfs 0.118 af

Subcatchment 3S: DIRECT RUNOFF Runoff Area=0.203 ac 32.51% Impervious Runoff Depth=1.59"
Tc=0.0 min CN=73 Runoff=0.52 cfs 0.027 af

Subcatchment 4S: BYPASS AREA Runoff Area=0.075 ac 72.00% Impervious Runoff Depth=2.81"
Tc=6.0 min CN=88 Runoff=0.28 cfs 0.018 af

Pond 1P: UNDERGROUND DETENTION Peak Elev=2,206.79' Storage=0.222 af Inflow=10.90 cfs 0.702 af
Outflow=3.59 cfs 0.702 af

Pond 2P: RC UG DETENTION Peak Elev=2,207.01' Storage=0.050 af Inflow=1.86 cfs 0.118 af
Outflow=0.45 cfs 0.118 af

Link 1L: POA Inflow=4.08 cfs 0.837 af
Primary=4.08 cfs 0.837 af

Total Runoff Area = 5.660 ac Runoff Volume = 0.864 af Average Runoff Depth = 1.83"
58.06% Pervious = 3.286 ac 41.94% Impervious = 2.374 ac

Summary for Subcatchment 1S: DA TO UG

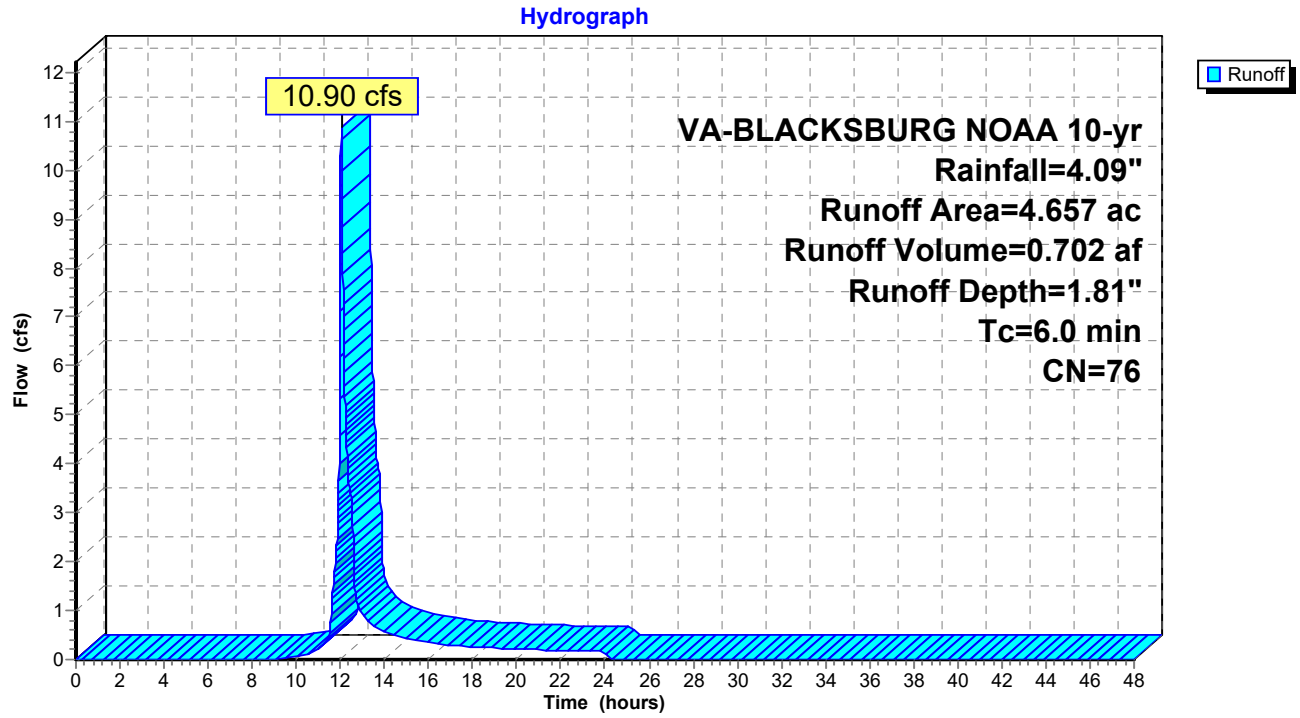
Runoff = 10.90 cfs @ 12.04 hrs, Volume= 0.702 af, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
2.732	61	>75% Grass cover, Good, HSG B
1.925	98	Paved parking, HSG B
4.657	76	Weighted Average
2.732		58.66% Pervious Area
1.925		41.34% Impervious Area

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

Subcatchment 1S: DA TO UG



Summary for Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM

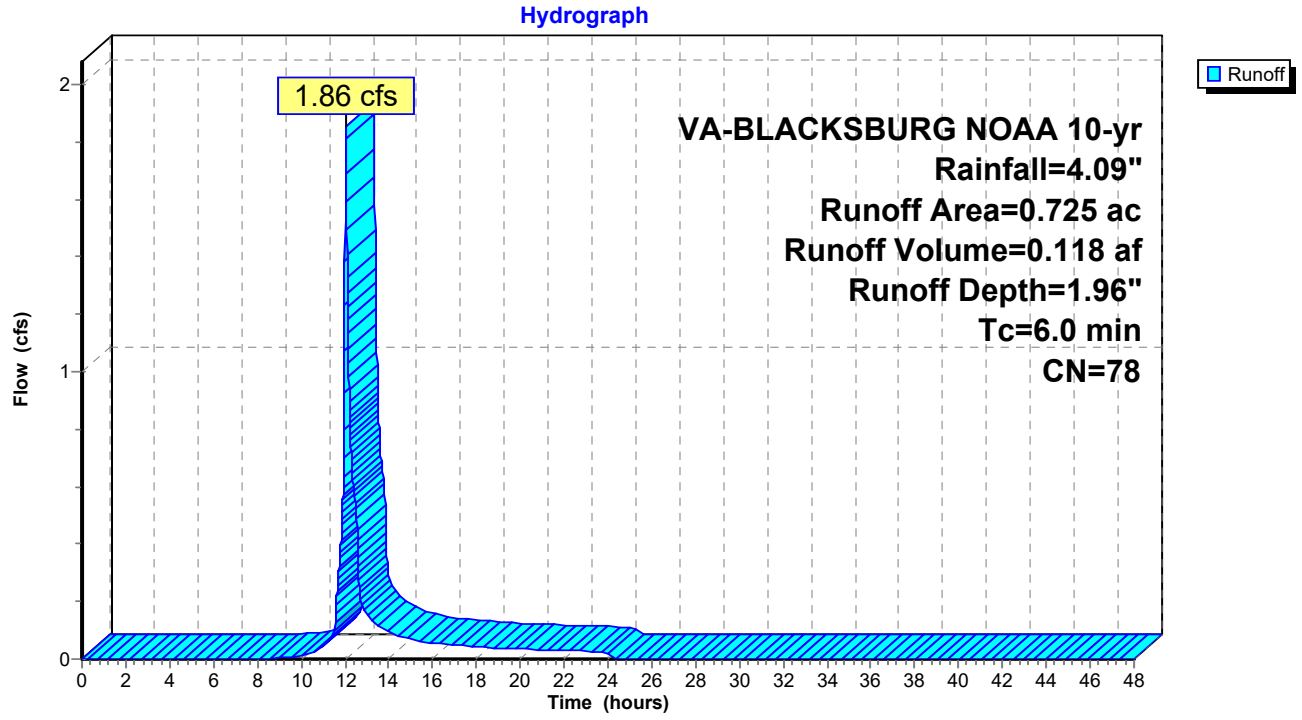
Runoff = 1.86 cfs @ 12.04 hrs, Volume= 0.118 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 3S: DIRECT RUNOFF

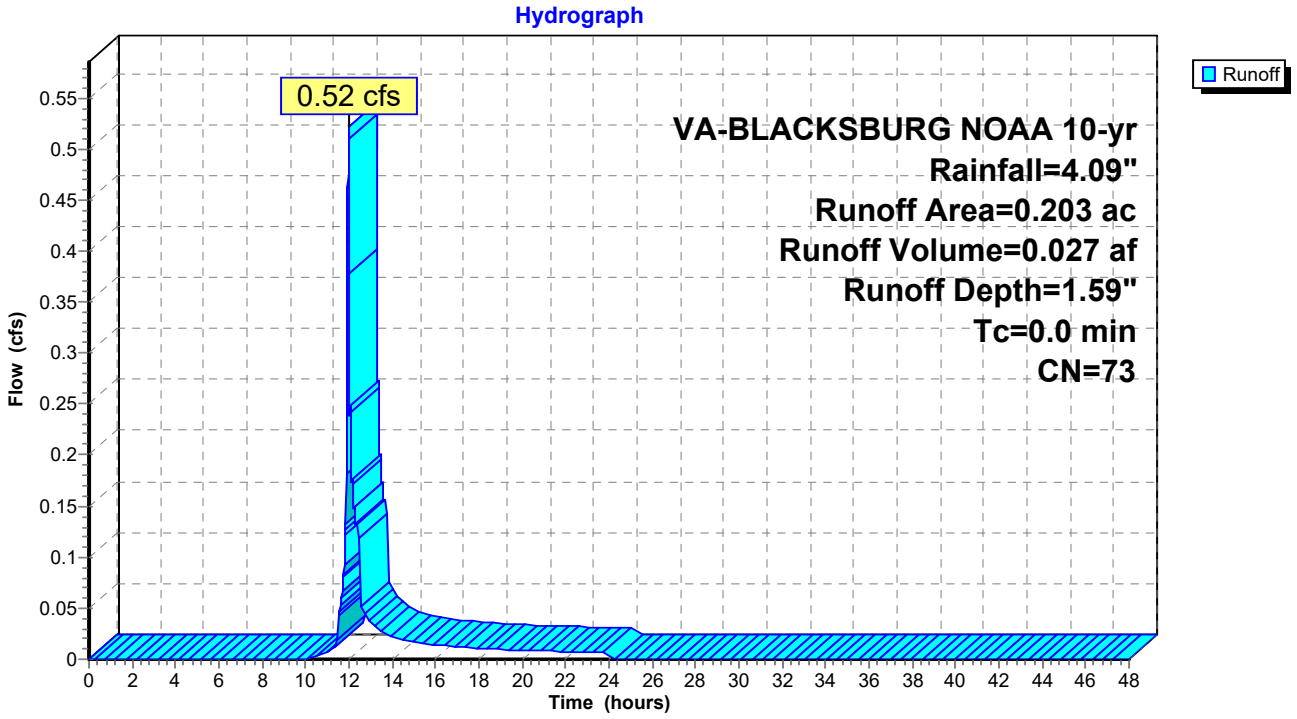
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.52 cfs @ 11.99 hrs, Volume= 0.027 af, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

	Area (ac)	CN	Description
	0.137	61	>75% Grass cover, Good, HSG B
*	0.066	98	Paved parking, HSG B
	0.203	73	Weighted Average
	0.137		67.49% Pervious Area
	0.066		32.51% Impervious Area

Subcatchment 3S: DIRECT RUNOFF



Summary for Subcatchment 4S: BYPASS AREA

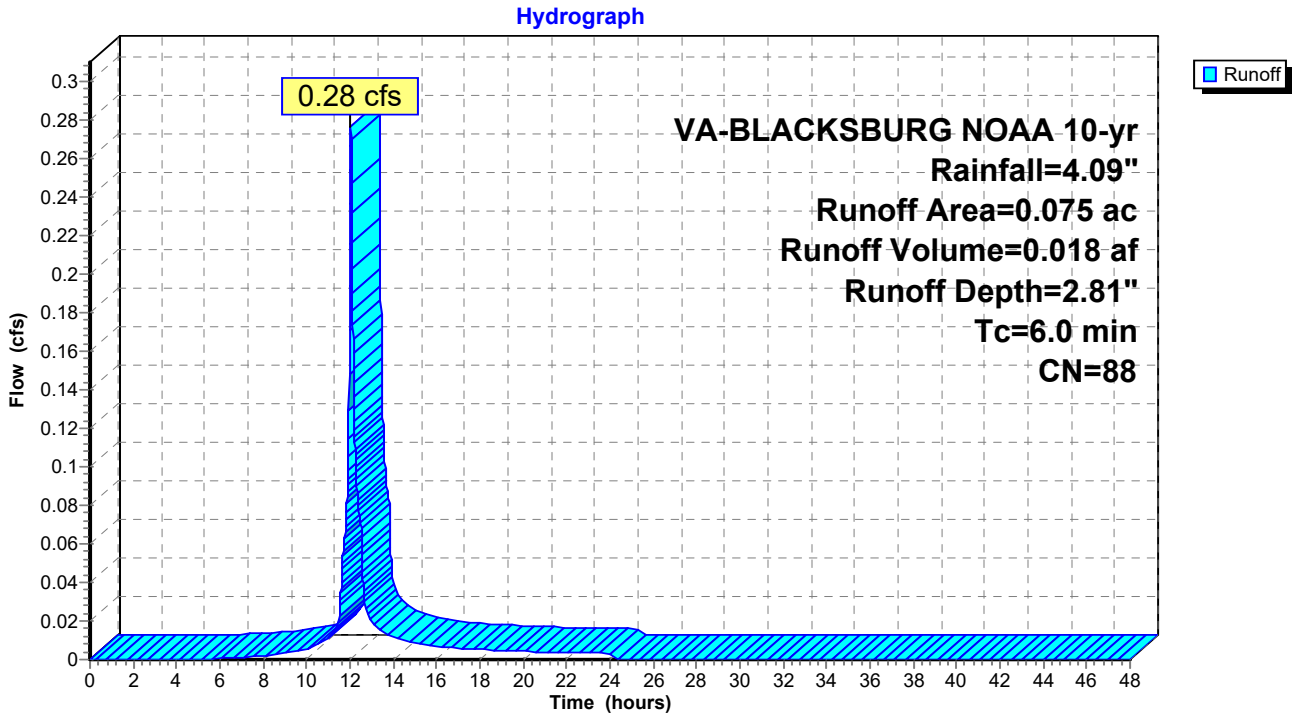
Runoff = 0.28 cfs @ 12.04 hrs, Volume= 0.018 af, Depth= 2.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 10-yr Rainfall=4.09"

Area (ac)	CN	Description
0.021	61	>75% Grass cover, Good, HSG B
0.054	98	Paved parking, HSG B
0.075	88	Weighted Average
0.021		28.00% Pervious Area
0.054		72.00% Impervious Area

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

Subcatchment 4S: BYPASS AREA



Summary for Pond 1P: UNDERGROUND DETENTION SYSTEM

Inflow Area = 4.657 ac, 41.34% Impervious, Inflow Depth = 1.81" for 10-yr event
Inflow = 10.90 cfs @ 12.04 hrs, Volume= 0.702 af
Outflow = 3.59 cfs @ 12.39 hrs, Volume= 0.702 af, Atten= 67%, Lag= 21.0 min
Primary = 3.59 cfs @ 12.39 hrs, Volume= 0.702 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,206.79' @ 12.39 hrs Surf.Area= 0.099 ac Storage= 0.222 af

Plug-Flow detention time= 163.1 min calculated for 0.701 af (100% of inflow)
Center-of-Mass det. time= 163.2 min (1,009.1 - 846.0)

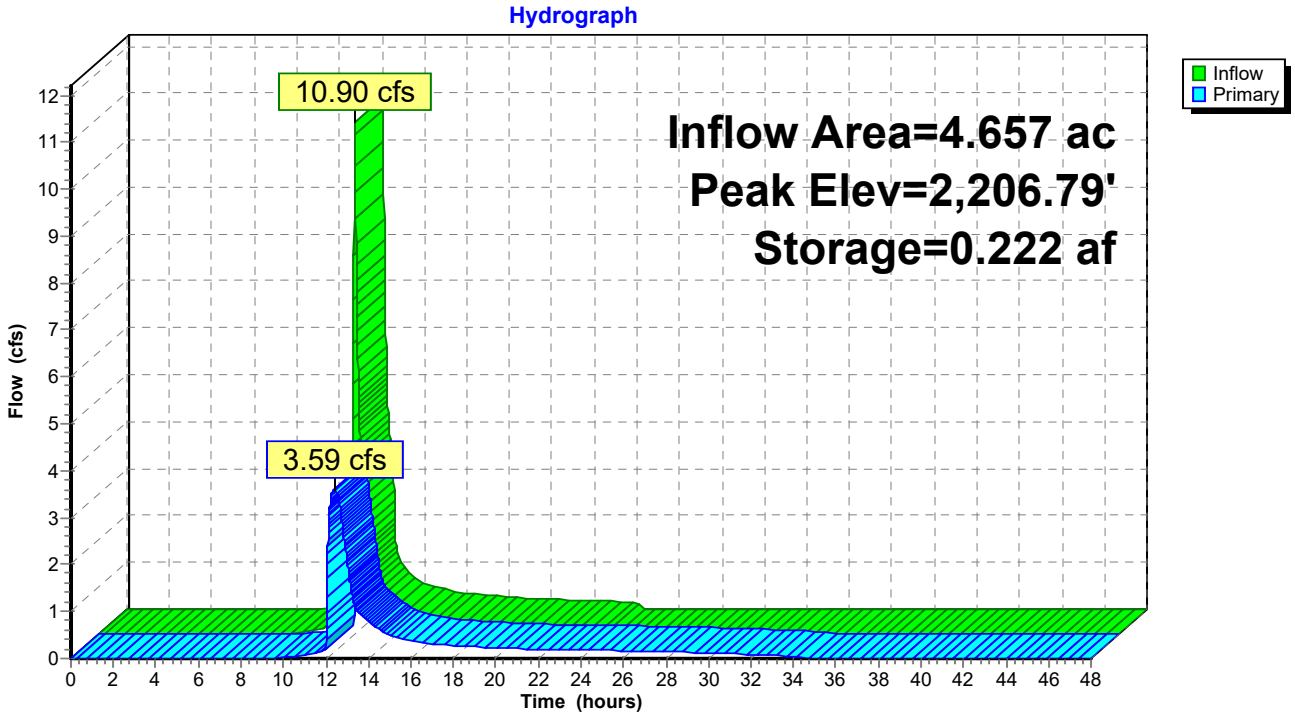
Volume	Invert	Avail.Storage	Storage Description
#1A	2,202.35'	0.000 af	**44.50'W x 97.00'L x 6.00'H Field A** 0.595 af Overall - 0.263 af Embedded = 0.332 af x 0.0% Voids
#2A	2,202.85'	0.263 af	**CMP Round 60** x 30 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.63 sf x 20.00'L = 392.7 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= -10.00' x 19.63 sf x 6 rows 42.50' Header x 19.63 sf x 1 = 834.5 cf Inside
		0.263 af	Total Available Storage

Storage Group A created with Chamber Wizard

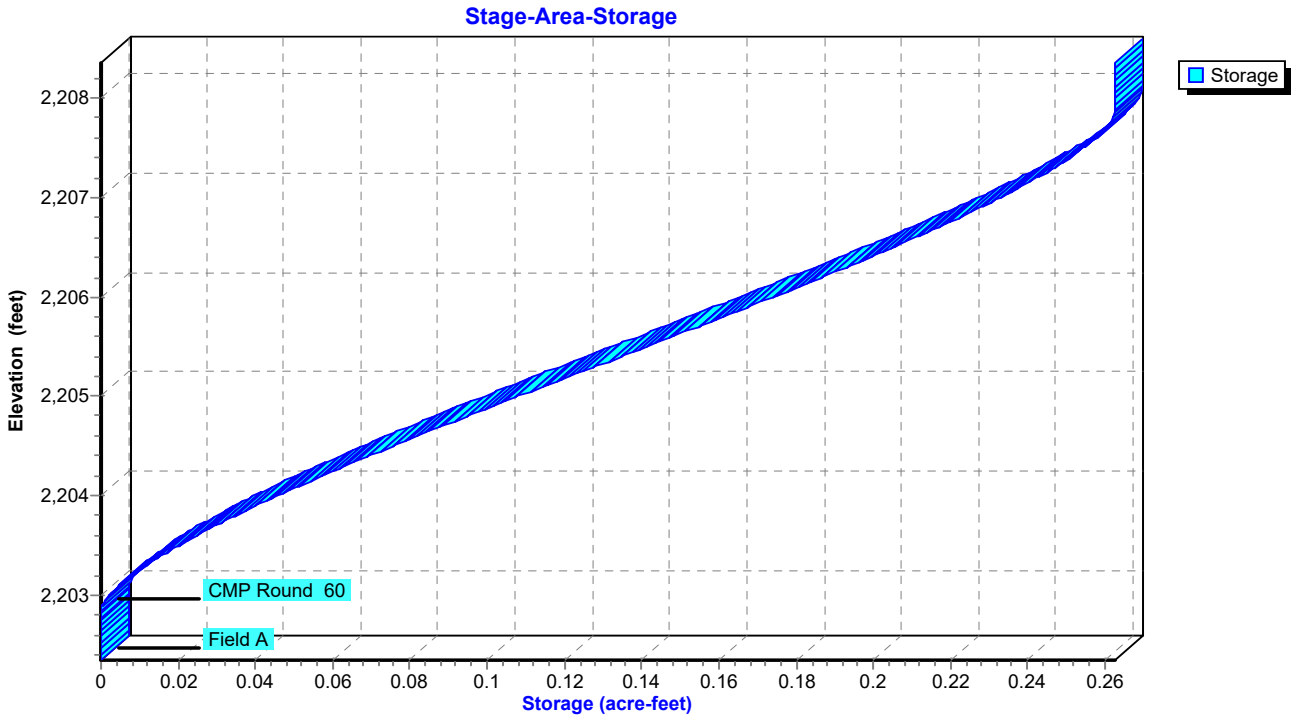
Device	Routing	Invert	Outlet Devices
#1	Primary	2,202.65'	**15.0" Round 15" HDPE Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,202.65' / 2,202.45' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,202.75'	**2.2" Vert. 2.25" Dia. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,204.95'	**12.0" W x 3.0" H Vert. 10" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,205.45'	**16.0" W x 3.0" H Vert. 18" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#5	Device 1	2,206.85'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=3.59 cfs @ 12.39 hrs HW=2,206.79' (Free Discharge)
└**1=15" HDPE Culvert** (Passes 3.59 cfs of 11.07 cfs potential flow)
  ├**2=2.25" Dia. Orifice** (Orifice Controls 0.25 cfs @ 9.56 fps)
  ├**3=10" x 3" Rect. Orifice** (Orifice Controls 1.57 cfs @ 6.30 fps)
  ├**4=18" x 3" Rect. Orifice** (Orifice Controls 1.77 cfs @ 5.30 fps)
  └**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: UNDERGROUND DETENTION SYSTEM



Pond 1P: UNDERGROUND DETENTION SYSTEM



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 1.96" for 10-yr event
Inflow = 1.86 cfs @ 12.04 hrs, Volume= 0.118 af
Outflow = 0.45 cfs @ 12.56 hrs, Volume= 0.118 af, Atten= 76%, Lag= 31.0 min
Primary = 0.45 cfs @ 12.56 hrs, Volume= 0.118 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,207.01' @ 12.56 hrs Surf.Area= 0.032 ac Storage= 0.050 af

Plug-Flow detention time= 325.9 min calculated for 0.118 af (100% of inflow)
Center-of-Mass det. time= 326.0 min (1,166.2 - 840.2)

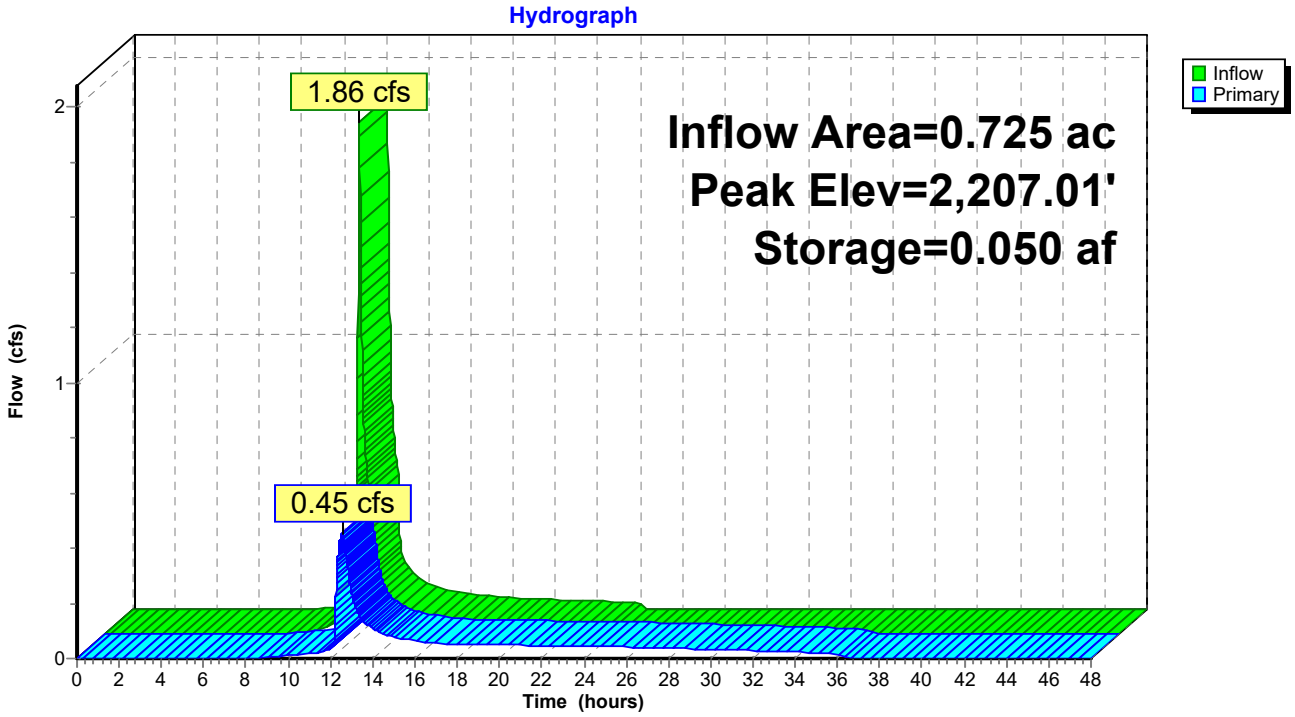
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

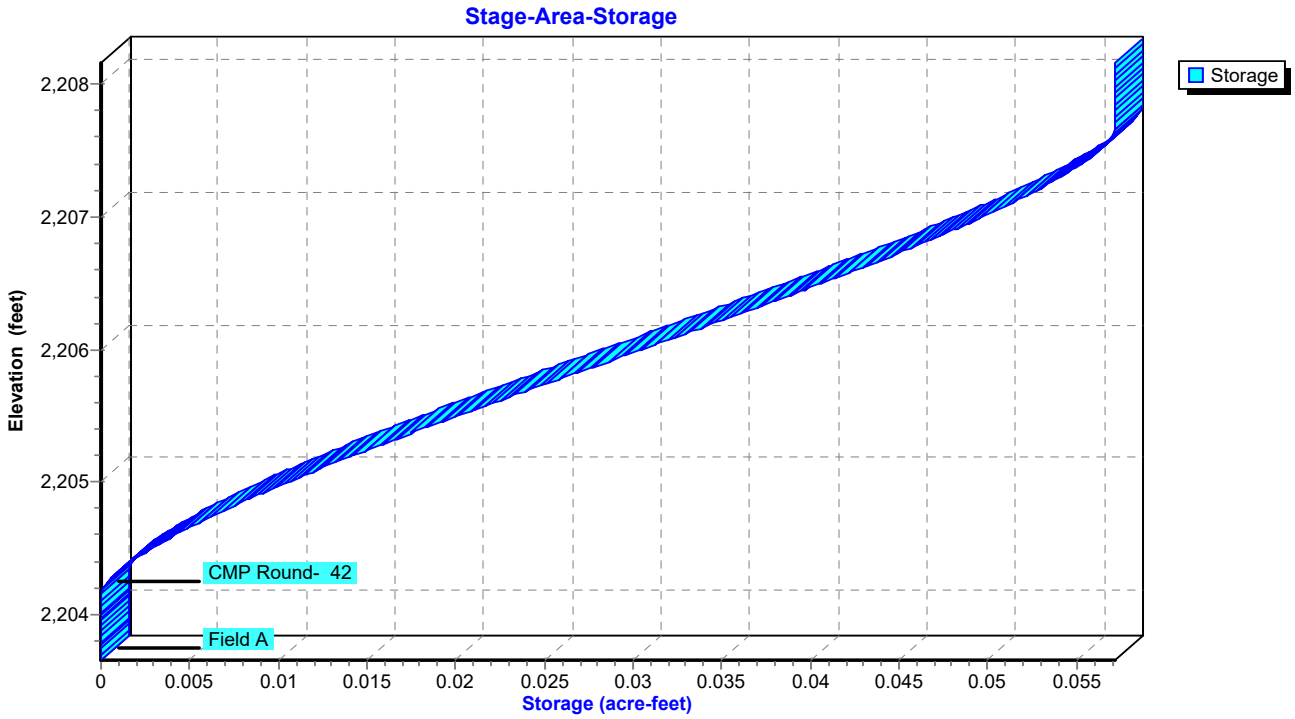
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.78'	**15.0" Round 15" Culvert Extension** L= 133.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.78' / 2,202.67' S= 0.0083 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#3	Device 2	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.45 cfs @ 12.56 hrs HW=2,207.01' (Free Discharge)
- **1=15" Culvert Extension** (Passes 0.45 cfs of 8.06 cfs potential flow)
  - **2=15" Culvert** (Passes 0.45 cfs of 8.95 cfs potential flow)
    - **3=Orifice/Grate** (Orifice Controls 0.05 cfs @ 8.29 fps)
    - **4=Orifice/Grate** (Orifice Controls 0.40 cfs @ 2.91 fps)
    - **5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

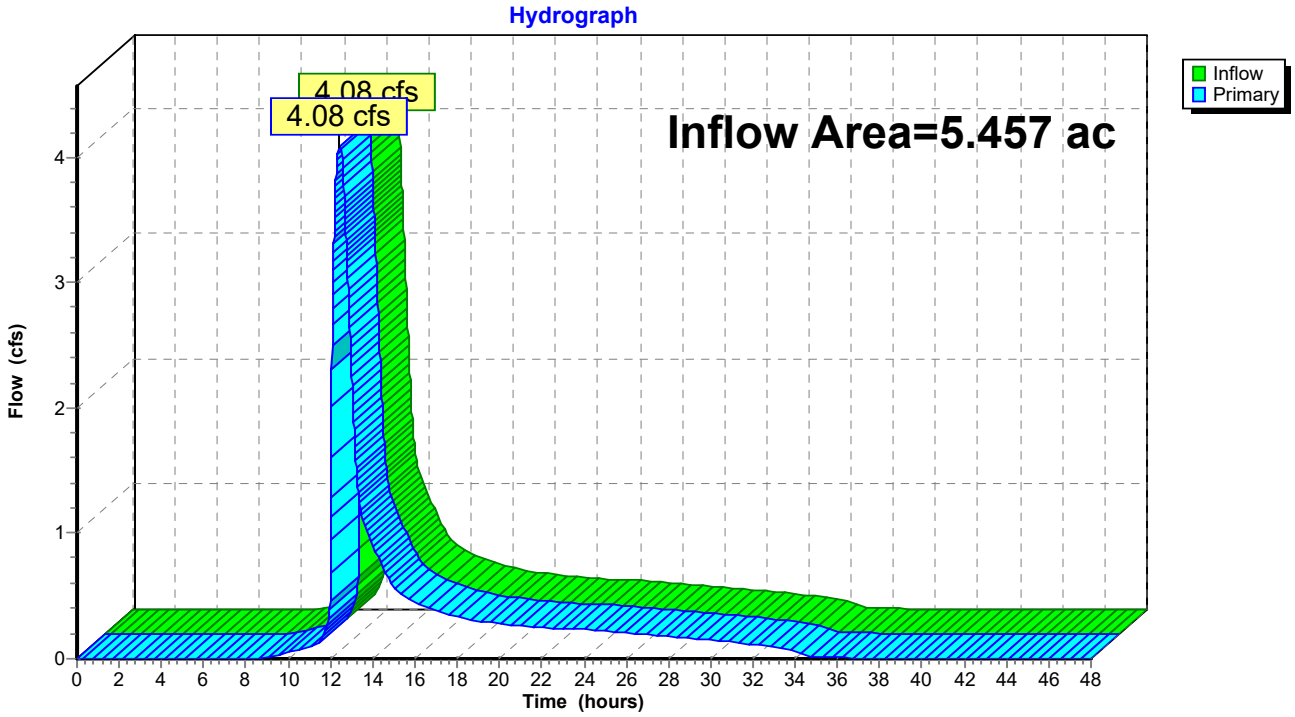


Summary for Link 1L: POA

Inflow Area = 5.457 ac, 42.29% Impervious, Inflow Depth = 1.84" for 10-yr event
Inflow = 4.08 cfs @ 12.45 hrs, Volume= 0.837 af
Primary = 4.08 cfs @ 12.45 hrs, Volume= 0.837 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: DA TO UG Runoff Area=4.657 ac 41.34% Impervious Runoff Depth=3.80"
Tc=6.0 min CN=76 Runoff=19.78 cfs 1.474 af

Subcatchment 2S: DA TO RATCLIFF Runoff Area=0.725 ac 45.34% Impervious Runoff Depth=4.01"
Tc=6.0 min CN=78 Runoff=3.25 cfs 0.242 af

Subcatchment 3S: DIRECT RUNOFF Runoff Area=0.203 ac 32.51% Impervious Runoff Depth=3.49"
Tc=0.0 min CN=73 Runoff=0.93 cfs 0.059 af

Subcatchment 4S: BYPASS AREA Runoff Area=0.075 ac 72.00% Impervious Runoff Depth=5.09"
Tc=6.0 min CN=88 Runoff=0.41 cfs 0.032 af

Pond 1P: UNDERGROUND DETENTION Peak Elev=2,216.57' Storage=0.263 af Inflow=19.78 cfs 1.474 af
Outflow=21.55 cfs 1.474 af

Pond 2P: RC UG DETENTION Peak Elev=2,207.47' Storage=0.056 af Inflow=3.25 cfs 0.242 af
Outflow=3.16 cfs 0.242 af

Link 1L: POA Inflow=24.96 cfs 1.748 af
Primary=24.96 cfs 1.748 af

Total Runoff Area = 5.660 ac Runoff Volume = 1.807 af Average Runoff Depth = 3.83"
58.06% Pervious = 3.286 ac 41.94% Impervious = 2.374 ac

Summary for Subcatchment 1S: DA TO UG

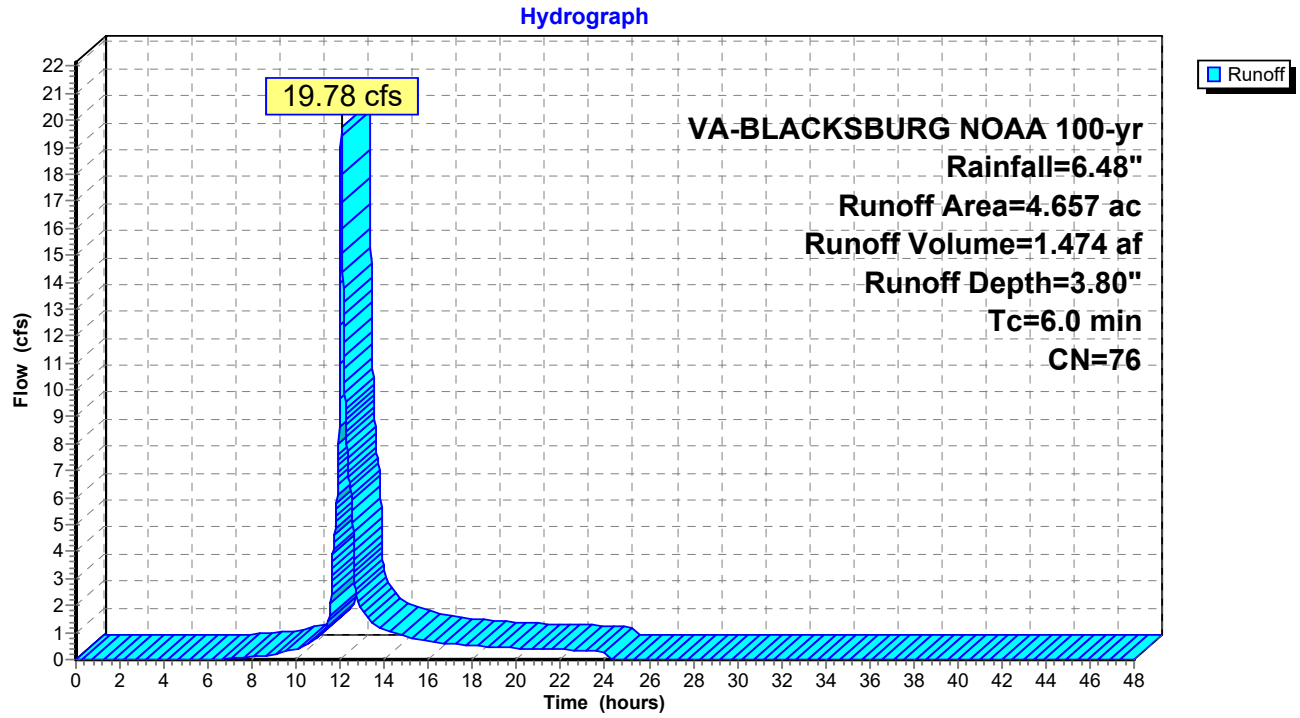
Runoff = 19.78 cfs @ 12.04 hrs, Volume= 1.474 af, Depth= 3.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
2.732	61	>75% Grass cover, Good, HSG B
1.925	98	Paved parking, HSG B
4.657	76	Weighted Average
2.732		58.66% Pervious Area
1.925		41.34% Impervious Area

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

Subcatchment 1S: DA TO UG



Summary for Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM

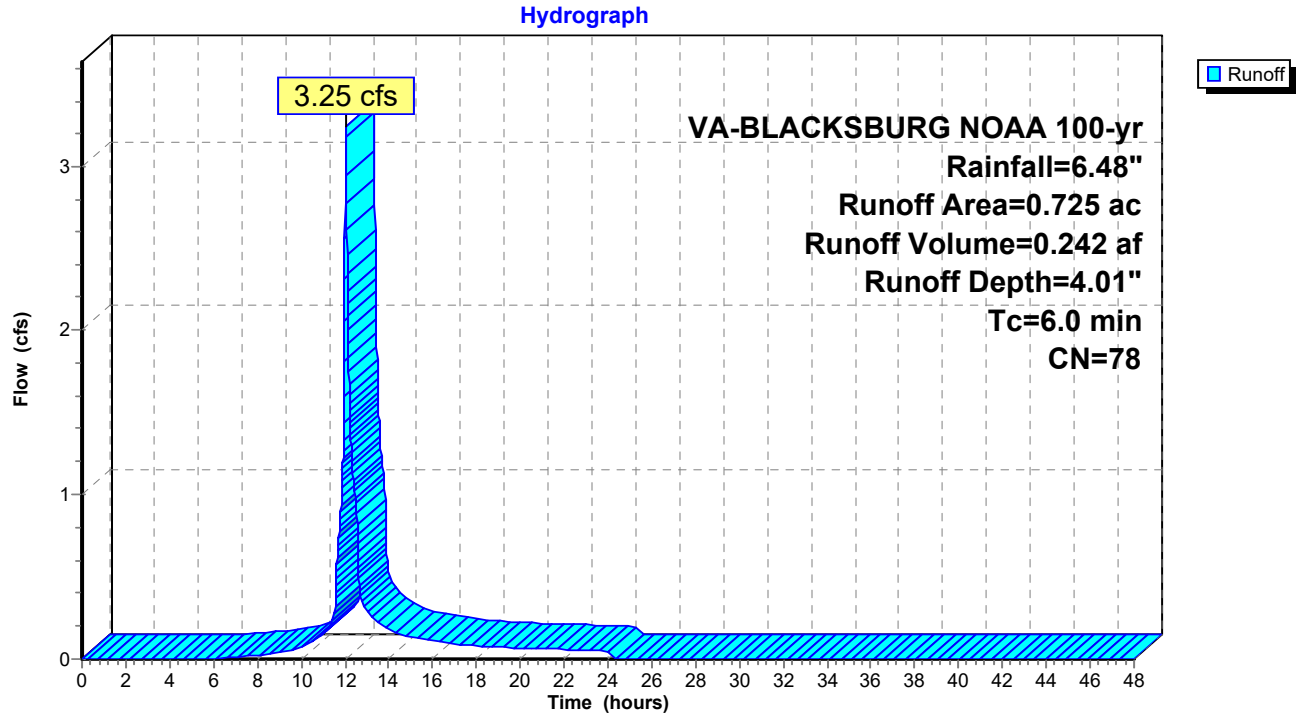
Runoff = 3.25 cfs @ 12.04 hrs, Volume= 0.242 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
0.310	61	>75% Grass cover, Good, HSG B
0.300	98	Paved parking, HSG B
0.115	70	1/2 acre lots, 25% imp, HSG B
0.725	78	Weighted Average
0.396		54.66% Pervious Area
0.329		45.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55**

Subcatchment 2S: DA TO RATCLIFF CORNER SWM SYSTEM



Summary for Subcatchment 3S: DIRECT RUNOFF

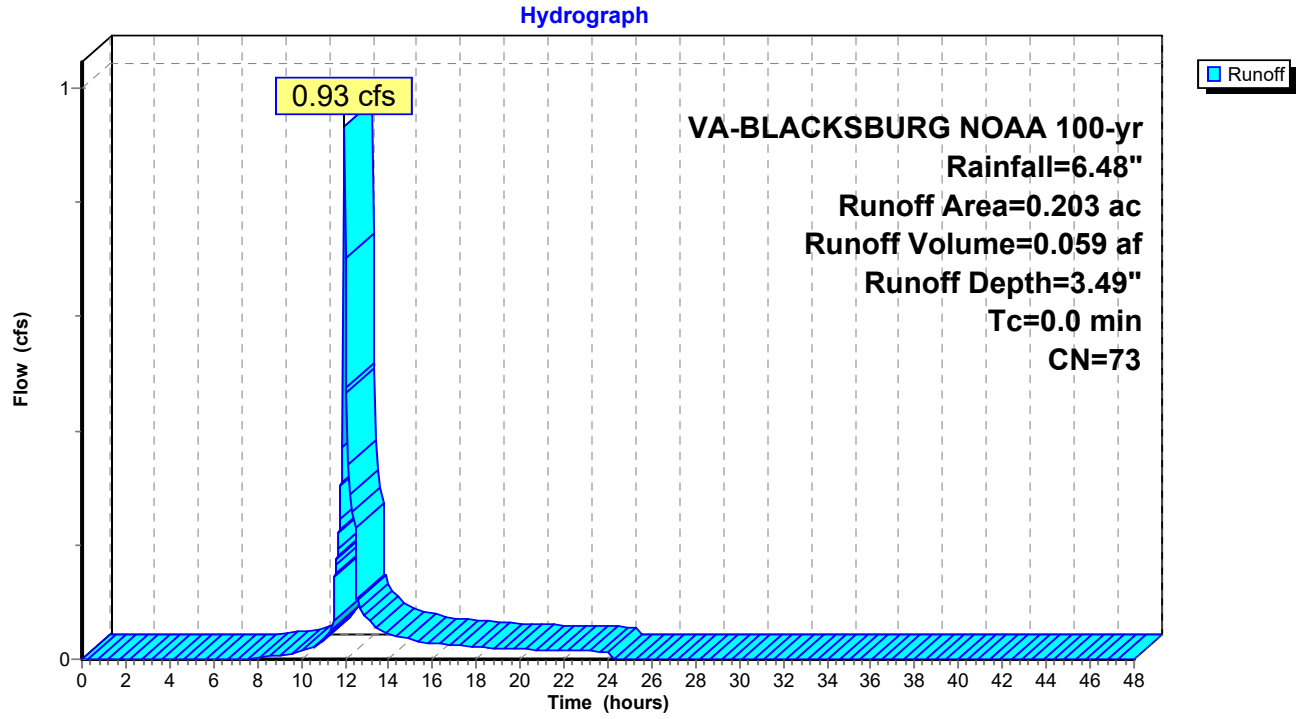
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.93 cfs @ 11.99 hrs, Volume= 0.059 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

	Area (ac)	CN	Description
	0.137	61	>75% Grass cover, Good, HSG B
*	0.066	98	Paved parking, HSG B
	0.203	73	Weighted Average
	0.137		67.49% Pervious Area
	0.066		32.51% Impervious Area

Subcatchment 3S: DIRECT RUNOFF



Summary for Subcatchment 4S: BYPASS AREA

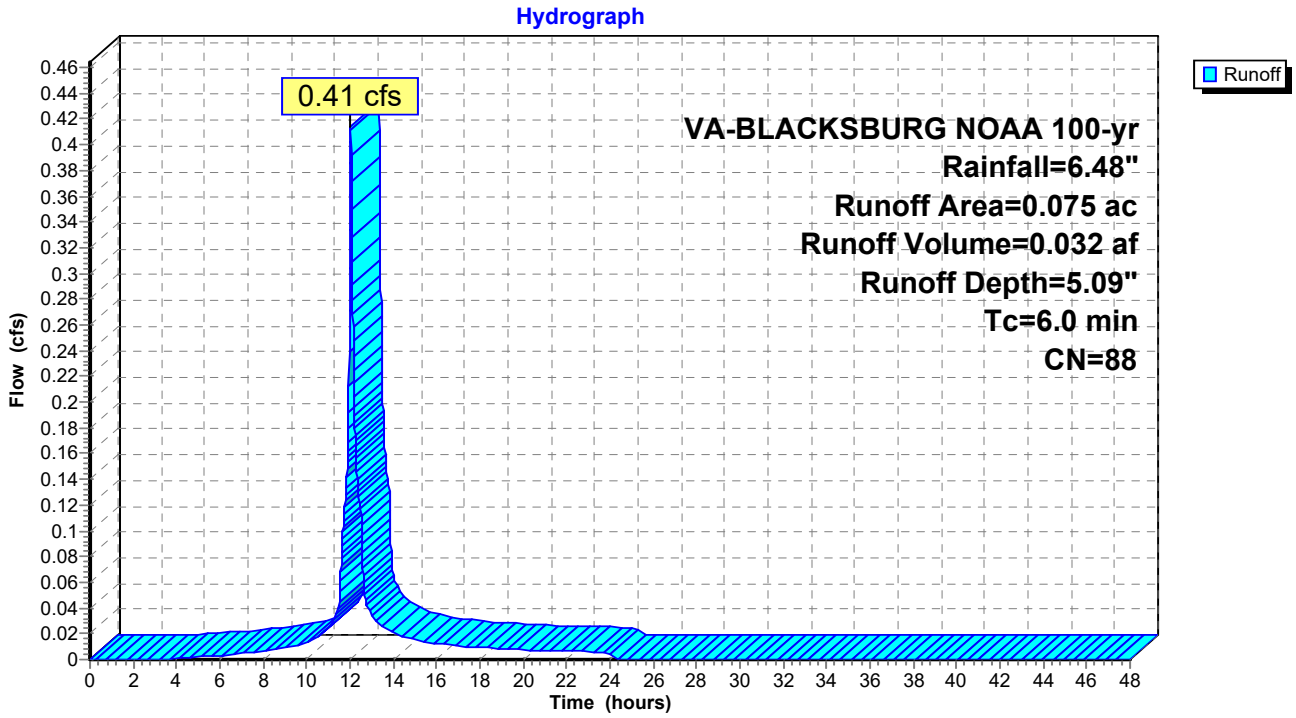
Runoff = 0.41 cfs @ 12.04 hrs, Volume= 0.032 af, Depth= 5.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
VA-BLACKSBURG NOAA 100-yr Rainfall=6.48"

Area (ac)	CN	Description
0.021	61	>75% Grass cover, Good, HSG B
0.054	98	Paved parking, HSG B
0.075	88	Weighted Average
0.021		28.00% Pervious Area
0.054		72.00% Impervious Area

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

Subcatchment 4S: BYPASS AREA



Summary for Pond 1P: UNDERGROUND DETENTION SYSTEM

[93] Warning: Storage range exceeded by 8.22'
[88] Warning: Qout>Qin may require smaller dt or Finer Routing
[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=2)

Inflow Area = 4.657 ac, 41.34% Impervious, Inflow Depth = 3.80" for 100-yr event
Inflow = 19.78 cfs @ 12.04 hrs, Volume= 1.474 af
Outflow = 21.55 cfs @ 12.04 hrs, Volume= 1.474 af, Atten= 0%, Lag= 0.0 min
Primary = 21.55 cfs @ 12.04 hrs, Volume= 1.474 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,216.57' @ 12.04 hrs Surf.Area= 0.099 ac Storage= 0.263 af

Plug-Flow detention time= 93.1 min calculated for 1.474 af (100% of inflow)
Center-of-Mass det. time= 93.3 min (923.9 - 830.7)

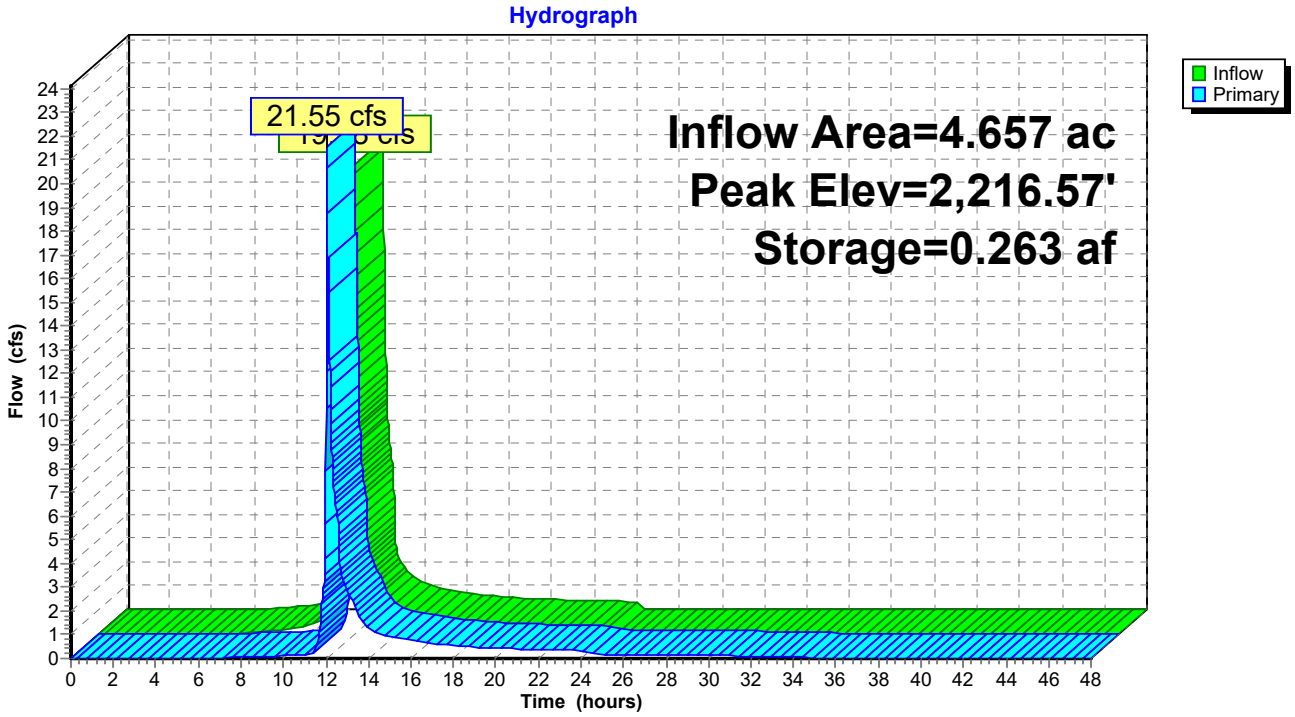
Volume	Invert	Avail.Storage	Storage Description
#1A	2,202.35'	0.000 af	**44.50'W x 97.00'L x 6.00'H Field A** 0.595 af Overall - 0.263 af Embedded = 0.332 af x 0.0% Voids
#2A	2,202.85'	0.263 af	**CMP Round 60** x 30 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.63 sf x 20.00'L = 392.7 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= -10.00' x 19.63 sf x 6 rows 42.50' Header x 19.63 sf x 1 = 834.5 cf Inside
		0.263 af	Total Available Storage

Storage Group A created with Chamber Wizard

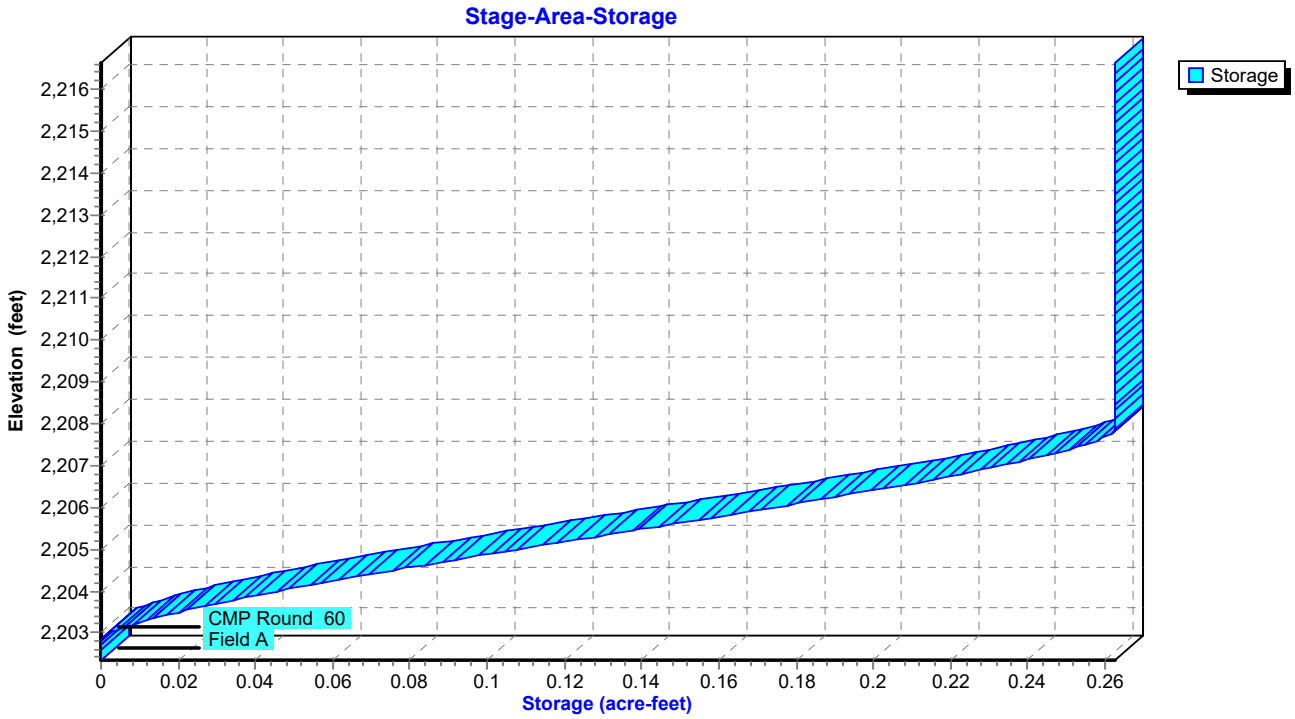
Device	Routing	Invert	Outlet Devices
#1	Primary	2,202.65'	**15.0" Round 15" HDPE Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,202.65' / 2,202.45' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,202.75'	**2.2" Vert. 2.25" Dia. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	2,204.95'	**12.0" W x 3.0" H Vert. 10" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	2,205.45'	**16.0" W x 3.0" H Vert. 18" x 3" Rect. Orifice** C= 0.600 Limited to weir flow at low heads
#5	Device 1	2,206.85'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=21.54 cfs @ 12.04 hrs HW=2,216.56' (Free Discharge)
└**1=15" HDPE Culvert** (Inlet Controls 21.54 cfs @ 17.55 fps)
- **2=2.25" Dia. Orifice** (Passes < 0.47 cfs potential flow)
- **3=10" x 3" Rect. Orifice** (Passes < 4.08 cfs potential flow)
- **4=18" x 3" Rect. Orifice** (Passes < 5.32 cfs potential flow)
- **5=Broad-Crested Rectangular Weir** (Passes < 602.57 cfs potential flow)

Pond 1P: UNDERGROUND DETENTION SYSTEM



Pond 1P: UNDERGROUND DETENTION SYSTEM



Summary for Pond 2P: RC UG DETENTION

Inflow Area = 0.725 ac, 45.34% Impervious, Inflow Depth = 4.01" for 100-yr event
Inflow = 3.25 cfs @ 12.04 hrs, Volume= 0.242 af
Outflow = 3.16 cfs @ 12.06 hrs, Volume= 0.242 af, Atten= 3%, Lag= 1.0 min
Primary = 3.16 cfs @ 12.06 hrs, Volume= 0.242 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 2,207.47' @ 12.06 hrs Surf.Area= 0.032 ac Storage= 0.056 af

Plug-Flow detention time= 195.8 min calculated for 0.242 af (100% of inflow)
Center-of-Mass det. time= 195.9 min (1,021.2 - 825.3)

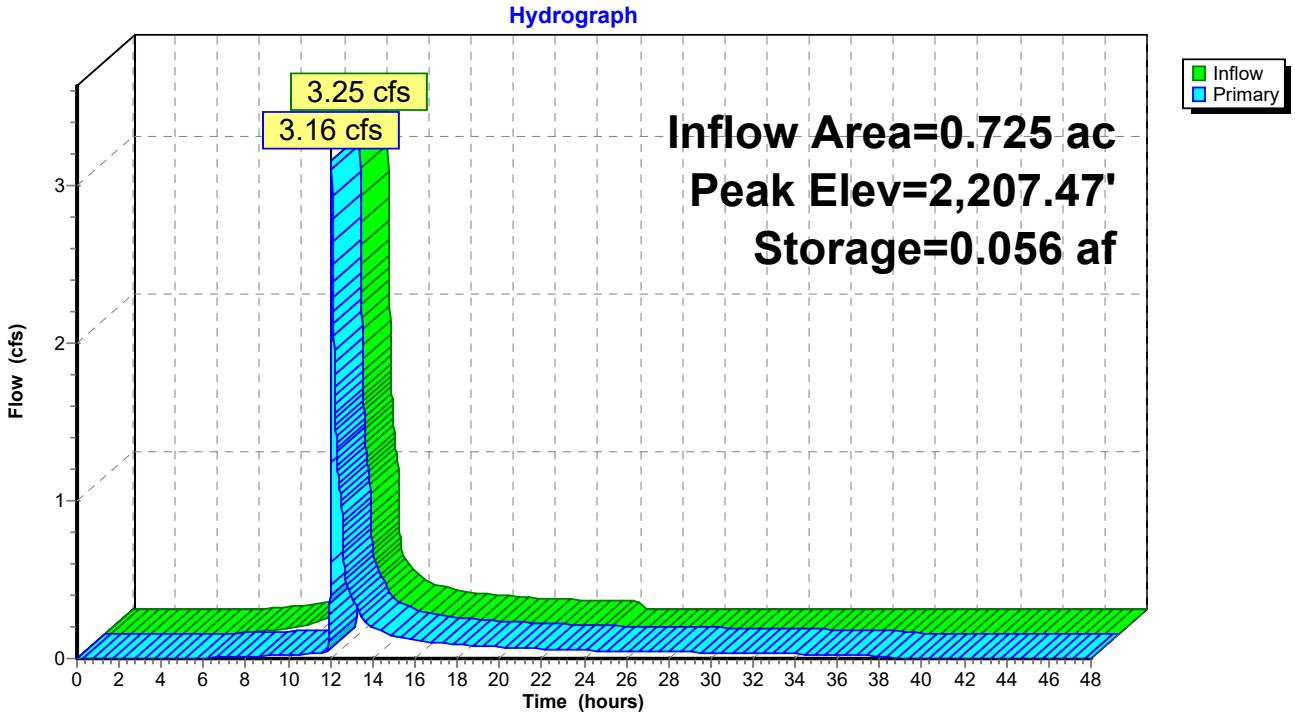
Volume	Invert	Avail.Storage	Storage Description
#1A	2,203.66'	0.000 af	**21.25'W x 65.50'L x 4.50'H Field A** 0.144 af Overall - 0.057 af Embedded = 0.087 af x 0.0% Voids
#2A	2,204.16'	0.057 af	**CMP Round- 42** x 12 Inside #1 Effective Size= 42.0"W x 42.0"H => 9.61 sf x 20.00'L = 192.2 cf Overall Size= 42.0"W x 42.0"H x 20.00'L 12 Chambers in 4 Rows 19.25' Header x 9.61 sf x 1 = 185.0 cf Inside
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

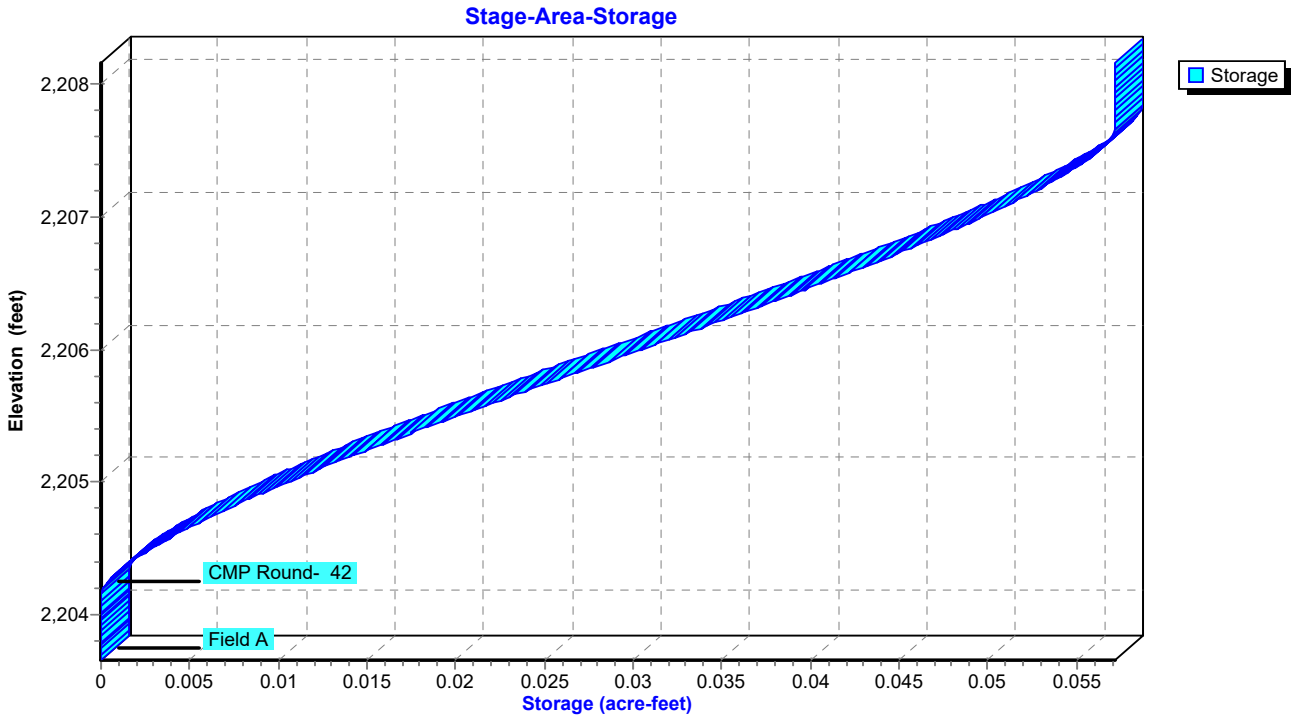
Device	Routing	Invert	Outlet Devices
#1	Primary	2,203.78'	**15.0" Round 15" Culvert Extension** L= 133.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.78' / 2,202.67' S= 0.0083 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	2,203.96'	**15.0" Round 15" Culvert** L= 54.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2,203.96' / 2,203.78' S= 0.0033 '/' Cc= 0.900 n= 0.011, Flow Area= 1.23 sf
#3	Device 2	2,204.00'	**1.1" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	2,206.44'	**5.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	2,207.11'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=3.15 cfs @ 12.06 hrs HW=2,207.47' (Free Discharge)
- **1=15" Culvert Extension** (Passes 3.15 cfs of 8.64 cfs potential flow)
  - **2=15" Culvert** (Passes 3.15 cfs of 9.92 cfs potential flow)
    - **3=Orifice/Grate** (Orifice Controls 0.06 cfs @ 8.91 fps)
    - **4=Orifice/Grate** (Orifice Controls 0.59 cfs @ 4.36 fps)
    - **5=Broad-Crested Rectangular Weir** (Weir Controls 2.49 cfs @ 1.74 fps)

Pond 2P: RC UG DETENTION



Pond 2P: RC UG DETENTION

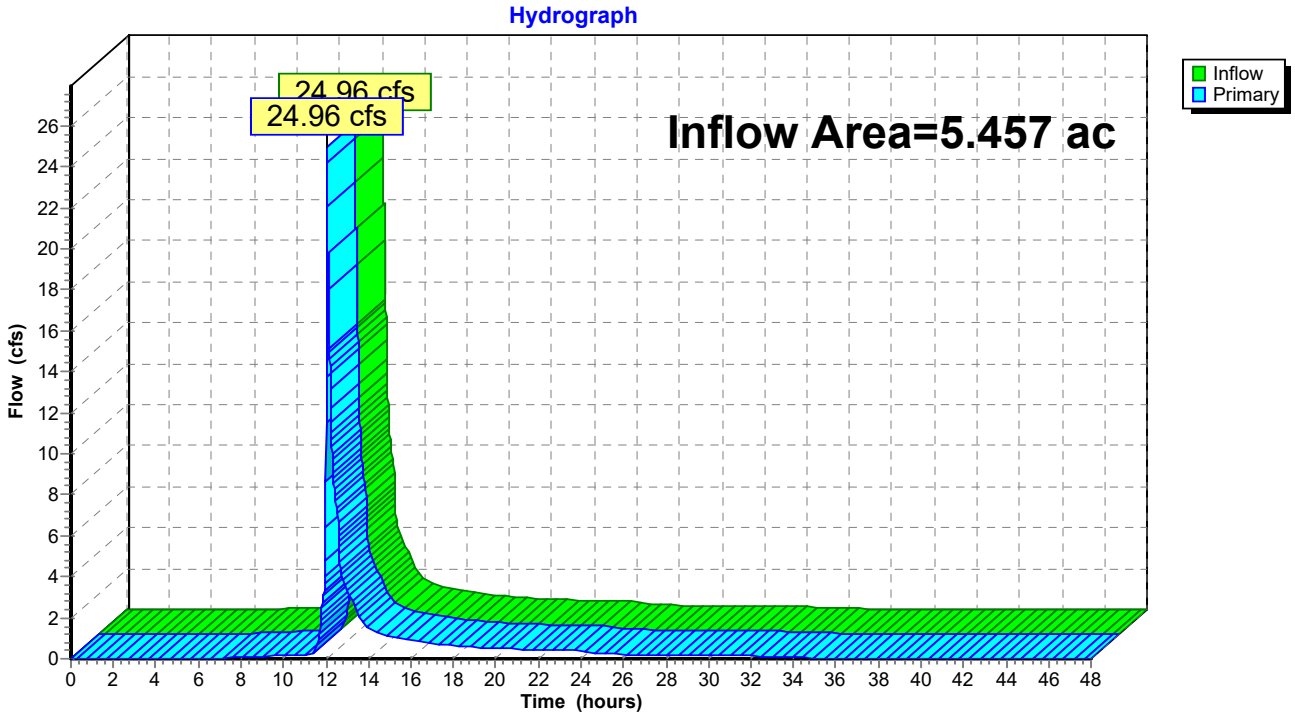


Summary for Link 1L: POA

Inflow Area = 5.457 ac, 42.29% Impervious, Inflow Depth = 3.84" for 100-yr event
Inflow = 24.96 cfs @ 12.04 hrs, Volume= 1.748 af
Primary = 24.96 cfs @ 12.04 hrs, Volume= 1.748 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: POA



APPENDIX D:
STORMWATER QUALITY CALCULATIONS

Project Name:	Whipple Drive Townhomes	CLEAR ALL	data input cells
Date:	6/1/2022		constant values
	Linear Development Project? No		calculation cells
Site Information			final results

Post-Development Project (Treatment Volume and Loads)

Enter Total Disturbed Area *(acres)* → 3.23

Maximum reduction required: 20%
The site's net increase in impervious cover (acres) is: 1.46
Post-Development TP Load Reduction for Site (lb/yr): 2.85

Check:
BMP Design Specifications List: 2013 Draft Stds & Specs
Linear project? No
Land cover areas entered correctly? ✓
Total disturbed area entered? ✓

Pre-ReDevelopment Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed forest/open space					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed		2.87			2.87
Impervious Cover (acres)		0.36			0.36
					3.23

Post-Development Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed		1.41			1.41
Impervious Cover (acres)		1.82			1.82
Area Check	OK.	OK.	OK.	OK.	3.23

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

LAND COVER SUMMARY -- PRE-REDEVELOPMENT

Land Cover Summary-Pre		
Pre-ReDevelopment	**Listed**	**Adjusted[1]**
Forest/Open Space Cover (acres)	0.00	0.00
Weighted Rv(forest)	0.00	0.00
% Forest	0%	0%
Managed Turf Cover (acres)	2.87	1.41
Weighted Rv(turf)	0.20	0.20
% Managed Turf	89%	80%
Impervious Cover (acres)	0.36	0.36
Rv(impervious)	0.95	0.95
% Impervious	11%	20%
Total Site Area (acres)	**3.23**	**1.77**
Site Rv	**0.28**	**0.35**

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary-Post (Final)	
Post ReDev. & New Impervious	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	1.41
Weighted Rv (turf)	0.20
% Managed Turf	44%
Impervious Cover (acres)	1.82
Rv(impervious)	0.95
% Impervious	56%
Final Site Area (acres)	**3.23**
Final Post Dev Site Rv	**0.62**

Land Cover Summary-Post	
Post-ReDevelopment	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	1.41
Weighted Rv (turf)	0.20
% Managed Turf	80%
ReDev. Impervious Cover (acres)	0.36
Rv(impervious)	0.95
% Impervious	20%
Total ReDev. Site Area (acres)	**1.77**
ReDev Site Rv	**0.35**

Land Cover Summary-Post	
Post-Development New Impervious	
New Impervious Cover (acres)	1.46
Rv(impervious)	0.95

Treatment Volume and Nutrient Load

Pre-ReDevelopment Treatment Volume (acre-ft)	0.0763	0.0520
Pre-ReDevelopment Treatment Volume (cubic feet)	3,325	2,265
Pre-ReDevelopment TP Load (lb/yr)	**2.09**	**1.42**
Pre-ReDevelopment TP Load per acre (lb/acre/yr)	0.65	0.80
Baseline TP Load (lb/yr) (**0.41 lbs/acre/yr** applied to pre-redevelopment area excluding pervious land proposed for new impervious cover)		*0.73*

Final Post-Development Treatment Volume (acre-ft)	0.1676
Final Post-Development Treatment Volume (cubic feet)	7,300
Final Post-Development TP Load (lb/yr)	**4.59**
Final Post-Development TP Load per acre (lb/acre/yr)	1.42

Treatment Volume and Nutrient Load

Post-ReDevelopment Treatment Volume (acre-ft)	0.0520
Post-ReDevelopment Treatment Volume (cubic feet)	2,265
Post-ReDevelopment Load (TP) (lb/yr)*	**1.42**
Post-ReDevelopment TP Load per acre (lb/acre/yr)	0.80
Max. Reduction Required (Below Pre-ReDevelopment Load)	**20%**
TP Load Reduction Required for Redeveloped Area (lb/yr)	**0.28**

Post-Development Treatment Volume (acre-ft)	0.1156
Post-Development Treatment Volume (cubic feet)	5,035
Post-Development TP Load (lb/yr)	**3.16**
TP Load Reduction Required for New Impervious Area (lb/yr)	**2.56**

[1] *Adjusted Land Cover Summary:*
Pre ReDevelopment land cover minus pervious land cover (forest/open space or managed turf) acreage proposed for new impervious cover.

Adjusted total acreage is consistent with Post-ReDevelopment acreage (minus acreage of new impervious cover).

Column I shows load reduction requriement for new impervious cover (based on new development load limit, 0.41 lbs/acre/year).

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	**2.85**

Nitrogen Loads (Informational Purposes Only)

Pre-ReDevelopment TN Load (lb/yr)	14.95	Final Post-Development TN Load (Post-ReDevelopment & New Impervious) (lb/yr)	32.81