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January 8, 2010

Maya van Rossum
The Riverkeeper
Delaware Riverkeeper Network
300 Pond Street, Second Floor
Bristol, PA 19007

RE: Christopher Estates
Block 1504 Lot 1.02
Hamilton Township, Mercer County, NJ

Dear Ms. Van Rossum,

As you requested, I have reviewed the stormwater management system for the development of Block 1504, Lot 1.02 in Hamilton Township, Mercer County, New Jersey -- otherwise known as Christopher Estates. My analysis focused upon the project's compliance with the New Jersey Stormwater Regulations at N.J.A.C. 7:8 (Rule) and Hamilton Township Stormwater Control Ordinance 158 (Ordinance).

I have utilized the following documents for this review:

"Revised Stormwater Management for Christopher Estates Subdivision, Hamilton Township; Map 1, Block 1504, Lot 1.02" dated August 1, 2005 and prepared by John DiMemmo, P.E.

"Site Investigation Report, Gres and Kaluzny Land Development, LLC, Laura and Evelyn Avenues, Block 1504, Lot 1.02, Hamilton, New Jersey" dated November 12, 2004 and prepared by Pioneer Environmental Group, LLC.

Plan Sheets for Christopher Estates, Lot 1.02, Block 1504, Hamilton Township, Mercer County, New Jersey, prepared by John DiMemmo, P.E. : Final Utilities and Grading Plan (Revised to 8/9/05), Final Construction Details (Revised to 8/9/05), Soil Erosion and Sediment Control Plan (Revised to 7/28/05), Soil Erosion and Sediment Control Notes (Revised to 7/28/05).

"Plan of Survey for Gres & Kaluzny Land Development, LLC, Located at Tax Map Lot 1.02 Block 1504 Sheet 1, Hamilton Township, Mercer County, NJ" revised to August 9, 2005 and prepared by Harris Surveying Inc.

Overview of Development Project

The Christopher Estates development plan would create 16 new single-family residences, a new roadway and cul-de-sac and associated facilities on an 8.78 acre lot at the corner of Laura and Evelyn Avenues in Hamilton Township. In the pre-existing condition, the site uses included meadow, woods, shrubs and several accessory structures that supported an agricultural use for the site. There are two major drainage areas for the site: a 2.3 acre northern portion whose runoff flows toward the Assunpink Creek and a 6.5 acre southern portion whose runoff drains toward an existing storm sewer system on Laura and Evelyn Avenues.

The proposed stormwater management system is designed to convey runoff from the southern drainage area and a portion of the northern area to an infiltration/detention basin located adjacent to the corner of Laura and Evelyn Avenues.

Stormwater Management Technical Review

The Christopher Estates stormwater management measures do not meet the following portions of the Rule (in boldface) and Ordinance (in brackets):

7:8-5.2 Stormwater management measures for major development [158.3. (a) (1)]
7:8-5.3 Nonstructural stormwater management strategies [158-4. (e)]
7:8-5.4 Erosion control, groundwater recharge and runoff quantity standards [158-4. (f)]
7:8-5.5 Stormwater runoff quality standards [158-4. (g)]
7:8-5.6 Calculation of stormwater runoff and groundwater recharge [158–5. (a)]
7:8-5.7 Standards for structural stormwater management measures [158-6. (a)]

This technical review is presented in the following format:

The Rule will be cited as underlined with text in *italics* and my comment in **bold preceded by a Capital Letter**. The citation for the Hamilton Township Ordinance will be in brackets [Chapter.subchapter] following the N.J.A.C. 7:8 citation.

7:8-5.2 Stormwater management measures for major development [158.3. (a) (1)]

(a) Stormwater management measures for major development shall be developed to meet the erosion control, groundwater recharge, stormwater runoff quantity, and stormwater runoff quality standards at N.J.A.C. 7:8-5.4 and 5.5. To the maximum extent practicable, these standards shall be met by incorporating nonstructural stormwater management strategies at N.J.A.C. 7:8-5.3 into the design. If these measures alone are not sufficient to meet these standards, structural stormwater management measures at N.J.A.C. 7:8-5.7 necessary to meet these standards shall be incorporated into the design.

A. The developer has not demonstrated compliance with N.J.A.C. 7:8- 5.3, N.J.A.C. 7:8-5.4 or N.J.A.C. 7:8-5.5 Therefore, the project does not comply with N.J.A.C. 7:8-5.2 since this section mandates compliance with the aforementioned portions of the Rule. The requirements of the corresponding sections of the Ordinance have also not been met.

7:8-5.3 Nonstructural stormwater management strategies [158-4. (e)]

(a) To the maximum extent practicable, the standards in N.J.A.C. 7:8-5.4 and 5.5 shall be met by incorporating nonstructural stormwater management strategies at N.J.A.C. 7:8- 5.3 into the design. The persons submitting an application for review shall identify the nonstructural strategies incorporated into the design of the project. If the applicant contends that it is not feasible for engineering, environmental, or safety reasons to incorporate any nonstructural stormwater management strategies identified in (b) below into the design of a particular project, the applicant shall identify the strategy and provide a basis for the contention.

B. The applicant has not provided information concerning the use or non-use of nonstructural stormwater strategies. Furthermore, they failed to submit a Low Impact Development Checklist that could have attempted to demonstrate compliance with this section of the Rule and Ordinance. Therefore, the developer has not demonstrated that they have used nonstructural stormwater strategies to the maximum extent practicable and is not in compliance with this section of the Rule or Ordinance.

7:8-5.4 Erosion control, groundwater recharge and runoff quantity standards [158-4. (f)]

(a) 2. The minimum design and performance standards for groundwater recharge are as follows:

i. The design engineer shall, using the assumptions and factors for stormwater runoff and groundwater recharge calculations at N.J.A.C. 7:8-5.6, either:

(1) Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures maintain 100 percent of the average annual pre- construction groundwater recharge volume for the site; or

C. The applicant performed the New Jersey Groundwater Recharge Spreadsheet Analysis to determine the recharge deficit for the site and to calculate the required size of the recharge facility. The Spreadsheet indicates that the proposed recharge basin has the capacity to infiltrate sufficient recharge to meet the Rule and Ordinance. However, it cannot be stated with certainty that the recharge facility will function as intended since it does not conform to the infiltration basin design guidelines as set forth in the New Jersey Stormwater Best Management Practices (BMP) Manual.

BMP Manual Requirements for Infiltration Basins

The BMP Manual requires that an infiltration facility be located in an area where the soils have a permeability rate of at least 0.5 inches per hour. Although the Manual permits the designer to utilize permeability rates from County Soil Surveys for the *preliminary* design, it requires field or laboratory testing of the onsite soils for the *final* design of the structure. Also, for the final design, the engineer is required to utilize a permeability rate that is ½ of the field-tested rate. Thus, if the testing indicates a permeability rate of 2" per hour, then the basin should be designed using a rate of 1" per hour.

The Manual recommends that an infiltration basin consist of a 6" layer of sand with no

topsoil placed above it. The sand layer would trap silt, sediment and debris that would otherwise clog the underlying soil layer. The bottom of the sand layer is required to be 2 feet higher than the elevation of the Seasonal High Water Table (SHWT). It is important that compaction of the underlying soils does not occur since this would compromise the ability of the soil to infiltrate the basin flows. In fact, the Manual states that prior to placing the sand layer in the basin, the basin soil should be deeply tilled with a rotary tiller or disc harrow and then smoothed out with a leveling drag.

Christopher Estates Infiltration Basin

The plans indicate that the infiltration basin is to be constructed with a 6" layer of sand at Elevation 50.0 feet. A 12" layer of topsoil would be placed above the sand. No permeability rate for the cover topsoil is specified on the plans or in the stormwater report. In fact, the plans indicate that the topsoil could either come from other areas of the site or be brought in from off-site. This topsoil layer is not consistent with the BMP Manual design standards and the plans provide no limitations on the permeability, or lack thereof, for this topsoil layer.

The stormwater report indicates that approximately 3 acres of ponding occurs in Drainage Area 2 (DA-2) along Evelyn Avenue in the existing condition. The report includes a ponding reduction for DA-2 in order to adjust for this situation. (DA-2 totals 6.77 acres and includes all of the houses, the roadway, the cul-de-sac, and most of the lawn areas of this development). It is reasonable to conclude that the ponded portions of this drainage area have soils that are not conducive to infiltration, have underlying clay layers that cause a perched condition, or that the soils have been compacted from the use of farm equipment through the years. The use of these soils for the topsoil layer above the basin's sand layer could prevent proper infiltration in the basin.

The design engineer has calculated a *final* permeability rate of 2" per hour based upon the County Soil Survey description of Birdsboro soils. The Soil Survey indicates that these soils have an infiltration rate that ranges from 2" to 6.3" per hour. The final design permeability for the soils under the basin is required to be field or laboratory tested. Furthermore, the rate is required to be reduced by ½ for the infiltration basin design calculations. Neither of these requirements has been fulfilled in the design of the basin. Therefore, the infiltration basin does not meet the design standards of the BMP Manual.

The Site Investigation Report prepared by Pioneer Environmental Group indicates that two test pits were performed on the site on January 13, 2004. One of these pits was located "about 100 feet from Laura Avenue". The infiltration basin is located within 100 feet of Laura Avenue but it is not clear whether the test pit was located in the basin area. This test pit indicated that groundwater seepage occurred at 10 feet below grade. The existing grade in the basin area is between 58 and 59 feet. Therefore, it is possible that groundwater is located at elevation 48 to 49 feet in this area. With a basin bottom of 50.0', it is possible that the 2' separation between the basin and the groundwater level is not achieved.

Finally, there is no note on the plans dictating that compaction must be avoided in the basin area, nor is there a note requiring that the basin area be tilled prior to placing the

sand layer. Compaction in the area of the basin would result in lower permeability rates and the required infiltration would not occur.

Based on all of the above, the infiltration basin's design does not conform to the design guidelines set forth in the New Jersey Stormwater Best Practices Manual. Furthermore, the design engineer has not demonstrated that this alternative design would accomplish the groundwater recharge requirement of the Rule as required at N.J.A.C. 7:8-5.7 (b). Therefore, the developer has not demonstrated compliance with the groundwater recharge portion of the Rule and the Ordinance.

(a) 3 iii. Design stormwater management measures so that the post-construction peak runoff rates for the two, 10 and 100-year storm events are 50, 75 and 80 percent, respectively, of the pre-construction peak runoff rates.

D. The developer's hydrologic analysis concludes that this project will meet the required peak flow reductions for the 2, 10 and 100 year storm events. The hydrological analysis was correctly performed for the existing condition of the site. However, the engineer utilized an incorrect Runoff Curve Number (RCN) for Drainage Area 1 (DA-1 Un-Routed Flows) in the analysis of the developed condition.

In Appendix B of the Stormwater Management Report, the engineer rightly used an RCN of 61 for Open Space Areas in a Hydrologic Soil Group B. However, the hydrological analysis performed by the engineer and included in Appendix C, mistakenly assumed a RCN of 59.5 instead. This error underestimated the peak flows in the developed condition.

I have performed a hydrological analysis using HydroCAD 9.0 for the post-developed condition of the site. This analysis uses the proper RCN of 61 for the Open Space areas in DA-1. In my analysis, I have called this area "Point of Analysis 1 – Flows to Assunpink Creek" because all of the flows from DA-1 flow offsite to the north and drain to the Assunpink Creek. These results are illustrated in Table 1. The HydroCAD analysis can be found in Attachment A of this letter.

TABLE 1
REVISED RUNOFF CALCULATIONS DA-1 (Peak Flows (cfs))
POST DEVELOPED CONDITION

POINT OF ANALYSIS 1	2 Yr Storm	10 Yr Storm	100 Yr Storm
Improper RCN = 59.5	.24	0.95	2.89
Revised RCN = 61	.30	1.09	3.29

On page 4 of the Stormwater Report, the designer added the routed flows, i.e. runoff from

Drainage Areas 2 and 3, to the DA- 1 flows to calculate the total peak flows for the site in the developed condition. When this calculation is revised with the proper DA-1 flows from Table 1, the project *does not* meet the peak flow reductions for the 2, 10 or 100 year storms. This change is illustrated in Table 2.

TABLE 2
POST DEVELOPED PEAK FLOWS (CFS)

	Using Improper DA-1 Flows			Using Proper DA-1 Flows				
Storm Event	**(Routed + DA-1) =**		**TOTAL**	**(Routed + Revised DA-1) =**		**REVISED TOTAL**		**ALLOWABLE FLOWS***
2 Year	**(0.37 + 0.24)**	**=**	**0.61**	**(0 .37 + 0.30)**	**=**	**0.67**	**>**	**0.61**
10 Year	**(1.81 + 0.95)**	**=**	**2.76**	**(1.81 + 1.09)**	**=**	**2.90**	**>**	**2.76**
100 Year	**(6.89 + 2.89)**	**=**	**9.78**	**(6.89 + 3.29)**	**=**	**10.18**	**>**	**9.81**

* Allowable Flows Derived from the Developer's Stormwater Management Report

In addition, as discussed below in paragraphs F through H, the engineer's hydrological analysis was based on two other design assumptions that were not consistent with the Rule or the Ordinance. These assumptions serve to further underestimate the increase in peak flows with this development.

7:8-5.5 Stormwater runoff quality standards [158-4. (g)]

Stormwater management measures shall be designed to reduce the post-construction load of total suspended solids (TSS) in stormwater runoff generated from the water quality design storm by 80 percent of the anticipated load from the developed site, expressed as an annual average.

E. The Rule assigns a TSS removal rate of 80% for infiltration basins. Therefore, if the proposed basin were to function properly, the project would meet the requirements of this portion of the Rule and Ordinance. However, as stated above in Paragraph C, the infiltration basin is not designed following the BMP Manual's guidelines. Furthermore, if the basin does not infiltrate properly, then it is possible that portions of runoff from the water quality storm will be discharged from the outlet structure. This would result in less than 80% TSS removal rate for the basin. For these reasons, it cannot be concluded that this project meets the water quality requirements of the Rule and Ordinance.

7:8-5.6 Calculation of stormwater runoff and groundwater recharge [158–5. (a)]

(a) Stormwater runoff shall be calculated in accordance with the following:

2. For the purpose of calculating runoff coefficients and groundwater recharge, there is a presumption that the pre-construction condition of a site or portion thereof is a wooded land use with good hydrologic condition. The term "runoff coefficient" applies to both the NRCS methodology at N.J.A.C. 7:8-5.6(a)1i and the Rational and Modified Rational Methods at N.J.A.C. 7:8-5.6(a)1i. A runoff coefficient or a groundwater recharge land cover for an existing condition may be used on all or a portion of the site if the design engineer verifies that the hydrologic condition has existed on the site or portion of the site for at least five years without interruption prior to the time of application.

F. The design engineer has performed the hydrological analysis assuming the entire development site contained either meadow or impervious surfaces in the existing condition. Not only do these assumptions conflict with the Boundary and Topographic Survey, but they also conflict with aerial photographs that document the land covers of the site prior to development.

Attachment B contains two aerial photographs that were obtained from Terraserver[1]. These photos were taken on February 1, 2002 and July 22, 2001. The photos indicate that one of the outbuildings shown on the survey did not exist at these times. They also show that approximately .4 acres of the site is wooded and .13 acres of the site is covered with bushes and shrubs. This error overestimates the existing flows on the site and thus it underestimates the increase in peak flows after development. The calculations should be revised to reflect the land features of the site in order to comply with the Rule and the Ordinance.

3. In computing pre-construction stormwater runoff, the design engineer shall account for all significant land features and structures, such as ponds, wetlands, depressions, hedgerows, or culverts, that may reduce pre-construction stormwater runoff rates and volumes.

G. As stated in paragraph F, the hydrological analysis was performed assuming that the entire site had land covers of either meadow or impervious surfaces. This assumption does not take into account the wooded and shrubby areas that existed on the site.

4. In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes of pervious and impervious surfaces separately to accurately compute the rates and volume of stormwater runoff from the site.

H. The engineer did not route the pervious and impervious areas separately. Instead, a composite or weighted RCN was used for the analysis. This error has the effect of underestimating the peak flows in the post-developed condition for some of the storm events and has resulted in less peak flow reduction than is required by the Rule and the Ordinance.

I. Attachment A includes my hydrological analysis for the post development runoff condition for Drainage Area 1 as referenced in Paragraph D above. This Attachment also includes the hydrological analysis for Drainage Areas 2 and 3. Flows from these areas are

[1]

routed to the infiltration basin and from there, the overflows are conveyed to an existing storm sewer system on Evelyn Avenue. In my report I refer to this receiving system as "Point of Analysis 2 Evelyn Ave Storm System".

My analysis has used the same input data as the design engineer's analysis, however, it routes the pervious and impervious areas separately. In order to be conservative, I have not revised the existing land covers. The revised peak flows for the routed flows from Drainage Areas 2 and 3, are illustrated in Table 3. The HydroCAD Analysis is included in Attachment A.

TABLE 3
REVISED RUNOFF CALCULATIONS -- ROUTED FLOWS (Peak Flows (cfs))

POINT OF ANALYSIS 2	2 Yr Storm	10 Yr Storm	100 Yr Storm
Weighted RCN Runoff	.37	1.81	6.89
Runoff Routing Pervious And Impervious Areas Separately	.81	2.24	6.86

As mentioned in Paragraph D above, the developer summed the runoff flows for the routed and un-detained portions of the site to determine the peak flows for the site. In Table 1, I revised this calculation to reflect the proper RCN for Drainage Area 1. In Table 4, I further revise this calculation to reflect the Rule and Ordinance requirement to route the pervious and impervious areas separately in the hydrological analysis.

TABLE 4
POST DEVELOPED PEAK FLOWS (CFS)

	Using Improper Flows For DA -1, DA-2, DA-3			Using Proper Flows For DA-1, DA-2, DA-3				
Storm Event	(Routed + DA-1) =		TOTAL	(Revised Routed	+ Revised DA-1) =	REVISED TOTAL		ALLOW-ABLE
2 Year	(0.37 + 0.24)	=	0.61	(0.81 + 0.30)	=	1.11	>	0.61
10 Year	(1.81 + 0.95)	=	2.76	(2.24 + 1.09)	=	3.33	>	2.76
100 Year	(6.89 + 2.89)	=	9.78	(6.86 + 3.29)	=	10.15	>	9.81

My hydrological analysis demonstrates that the peak flow reductions are not met for the 2, 10 and 100-year storm events.

7:8-5.7 Standards for structural stormwater management measures [158-6. (a)]

(a) Standards for structural stormwater management measures are as follows:

1. Structural stormwater management measures shall be designed to take into account the existing site conditions, including, for example, environmentally critical areas; wetlands; flood-prone areas; slopes; depth to seasonal high water table; soil type, permeability and texture; drainage area and drainage patterns; and the presence of solution-prone carbonate rocks (limestone).

J. The design engineer provided no documentation to show that the location of the Seasonal High Water Table was taken into account in the design of the infiltration basin. In addition, the permeability rate was assumed from the Mercer County Soil Survey rather than being field or laboratory tested.

2. Structural stormwater management measures shall be designed to minimize maintenance, facilitate maintenance and repairs, and ensure proper functioning.

K. The infiltration basin has not been designed to insure proper functioning in accordance with the BMP Manual guidelines. On the contrary, based on the issues discussed in sections C and E, the design will likely result in less infiltration and water quality treatment than required to meet the groundwater recharge and water quality requirements of the Rule and Ordinance, respectively.

(b) Stormwater management measure guidelines are available in the New Jersey Stormwater Best Management Practices Manual. Other stormwater management measures may be utilized provided the design engineer demonstrates that the proposed measure and its design will accomplish the required water quantity, ground water recharge and water quality design and performance standards established by this subchapter.

L. The design of the infiltration basin deviates from the guidelines of the NJ Stormwater BMP Manual. Neither the Stormwater Management Report nor information on the Plan Sheets demonstrate that the infiltration basin will accomplish the water quantity, groundwater recharge or water quality requirements of the Rule and Ordinance.

Conclusions

The stormwater management system for the Christopher Estates development is not in compliance with the New Jersey Stormwater Regulations at N.J.A.C. 7:8 and the Hamilton Township Stormwater Ordinance and has not been suitably designed based upon the following findings:

- The project has not demonstrated compliance with N.J.A.C. 7:8 – 5.4 and 5.5. Therefore, the project does not comply with N.J.A.C. 7:8-5.2 and Ordinance Section

158.3. (a) (1).

- This project has **not** demonstrated that nonstructural stormwater strategies have been used to the maximum extent practicable as required at N.J.A.C. 7:8-5.3 and Ordinance Section 158-4. (e).

- The infiltration basin has not been designed in accordance with the New Jersey Stormwater BMP Manual. The applicant has not demonstrated that the alternative basin design will meet the groundwater recharge requirements of N.J.A.C. 7:8-5.4 and Ordinance Section 158-4. (f)

- The peak flow reductions of 50%, 75% and 80% for the 2, 10 and 100 year storms, respectively, have not been met for the development as required by N.J.A.C. 7:8-5.4 and Ordinance Section 159-4. (f).

- The infiltration basin has not been designed in accordance with the New Jersey Stormwater BMP Manual. The applicant has not demonstrated that the alternative basin design will meet the 80% TSS Removal Rate as required at N.J.A.C. 7:8-5.5 and Ordinance Section 158-5. (a).

- The hydrological calculations did not account for the existing land covers on the site and did not route the pervious and impervious areas separately. Therefore, the project does not comply with N.J.A.C. 7:8-5.6 and Ordinance Section 158-5. (a).

- The infiltration basin has not been designed in accordance with the New Jersey Stormwater BMP Manual. The design engineer has not, alternatively, demonstrated that the basin will accomplish the water quality, groundwater recharge or water quantity requirements of the Rule. Therefore, the project does not comply with N.J.A.C. 7:8-5.7 and Ordinance Section 158-6. (a).

Please feel free to contact me if you would like to discuss these issues.

Sincerely,

Margaret Y. Snyder

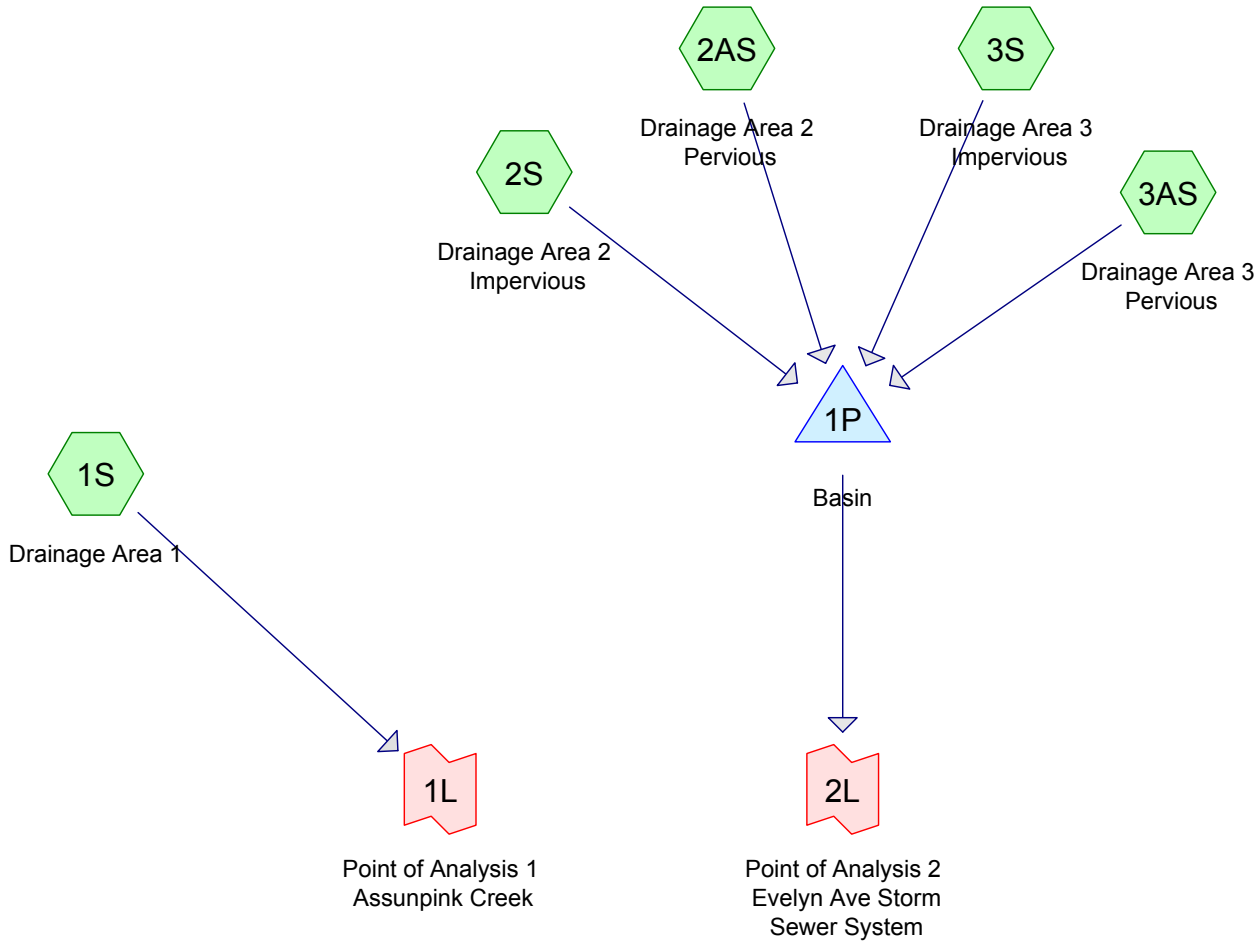
Margaret Y. Snyder, P.E.
Principal

ATTACHMENT A

Post Development Hydrological Analysis

Using Proper Rcns for Drainage Area 1

Routing Pervious and Impervious Areas Separately



Subcat Reach Pond Link

Drainage Diagram for Christopher Estates Proposed
Prepared by Emerald Environmental Solutions, Printed 12/18/2009

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.160	61	Open Space (1S, 2AS, 3AS)
2.620	98	Impervious (2S, 3S)
8.780		**TOTAL AREA**

Notes Listing (all nodes)

Line#	Node Number	Notes
1	1S	Curve Number revised to 61 to be consistent with stormwater report and post-developed land cover.
2	2L	Pervious and impervious areas routed separately.

Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=Delmarva
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Drainage Area 1 Runoff Area=1.330 ac 0.00% Impervious Runoff Depth>0.42"
Flow Length=132' Tc=12.6 min CN=61 Runoff=0.30 cfs 0.047 af

Subcatchment 2AS: Drainage Area 2 Runoff Area=4.740 ac 0.00% Impervious Runoff Depth>0.42"
Flow Length=255' Tc=14.8 min CN=61 Runoff=1.00 cfs 0.166 af

Subcatchment 2S: Drainage Area 2 Runoff Area=2.030 ac 100.00% Impervious Runoff Depth>2.92"
Tc=10.0 min CN=98 Runoff=4.34 cfs 0.493 af

Subcatchment 3AS: Drainage Area 3 Runoff Area=0.090 ac 0.00% Impervious Runoff Depth>0.42"
Tc=10.0 min CN=61 Runoff=0.02 cfs 0.003 af

Subcatchment 3S: Drainage Area 3 Runoff Area=0.590 ac 100.00% Impervious Runoff Depth>2.92"
Tc=10.0 min CN=98 Runoff=1.26 cfs 0.143 af

Pond 1P: Basin Peak Elev=54.01' Storage=22,883 cf Inflow=6.17 cfs 0.806 af
Outflow=0.81 cfs 0.358 af

Link 1L: Point of Analysis 1 Assunpink Creek Inflow=0.30 cfs 0.047 af
Primary=0.30 cfs 0.047 af

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System Inflow=0.81 cfs 0.358 af
Primary=0.81 cfs 0.358 af

Total Runoff Area = 8.780 ac Runoff Volume = 0.853 af Average Runoff Depth = 1.17"
70.16% Pervious = 6.160 ac 29.84% Impervious = 2.620 ac

Summary for Subcatchment 1S: Drainage Area 1

Curve Number revised to 61 to be consistent with stormwater report and post-developed land cover.

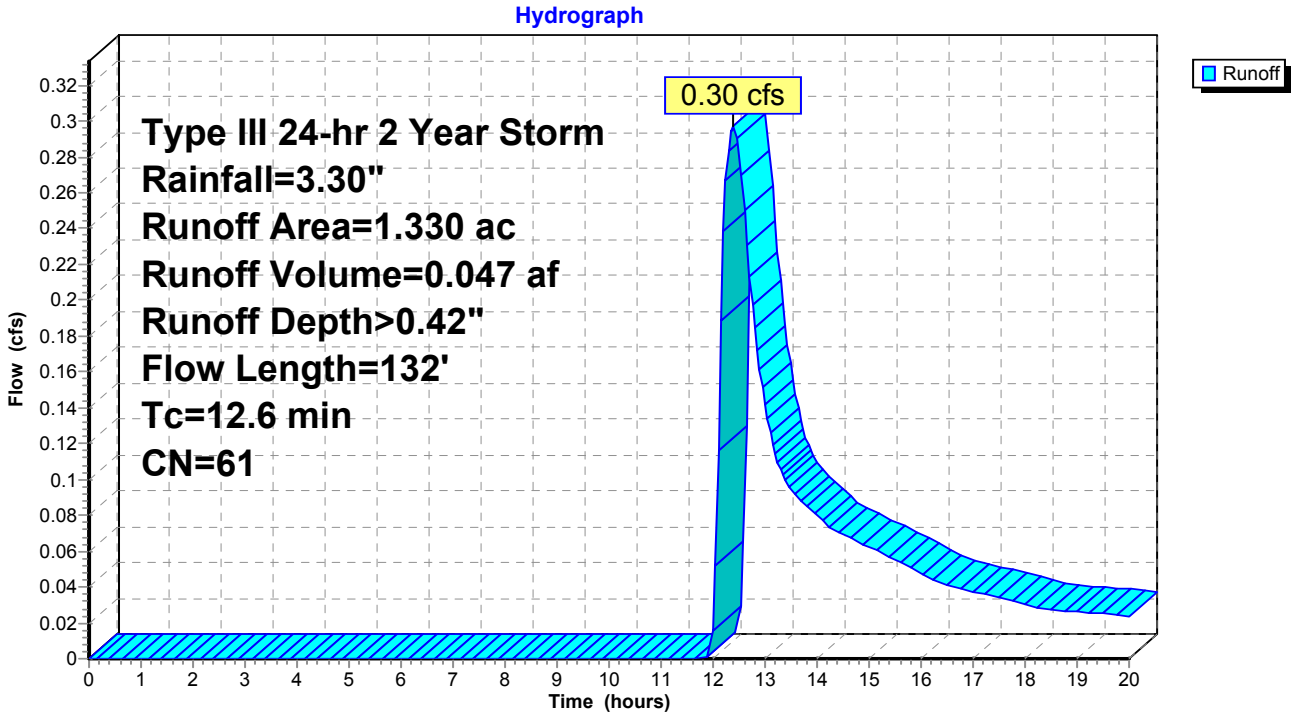
Runoff = 0.30 cfs @ 12.40 hrs, Volume= 0.047 af, Depth> 0.42"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Storm Rainfall=3.30"

	Area (ac)	CN	Description
*	1.330	61	Open Space
	1.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0200	0.10		**Sheet Flow, Segment 1** Grass: Dense n= 0.240 P2= 3.30"
4.3	50	0.0370	0.19		**Sheet Flow, Segment 2** n= 0.150 P2= 3.30"
0.2	32	0.0400	3.22		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
12.6	132	Total			

Subcatchment 1S: Drainage Area 1



Summary for Subcatchment 2AS: Drainage Area 2 Pervious

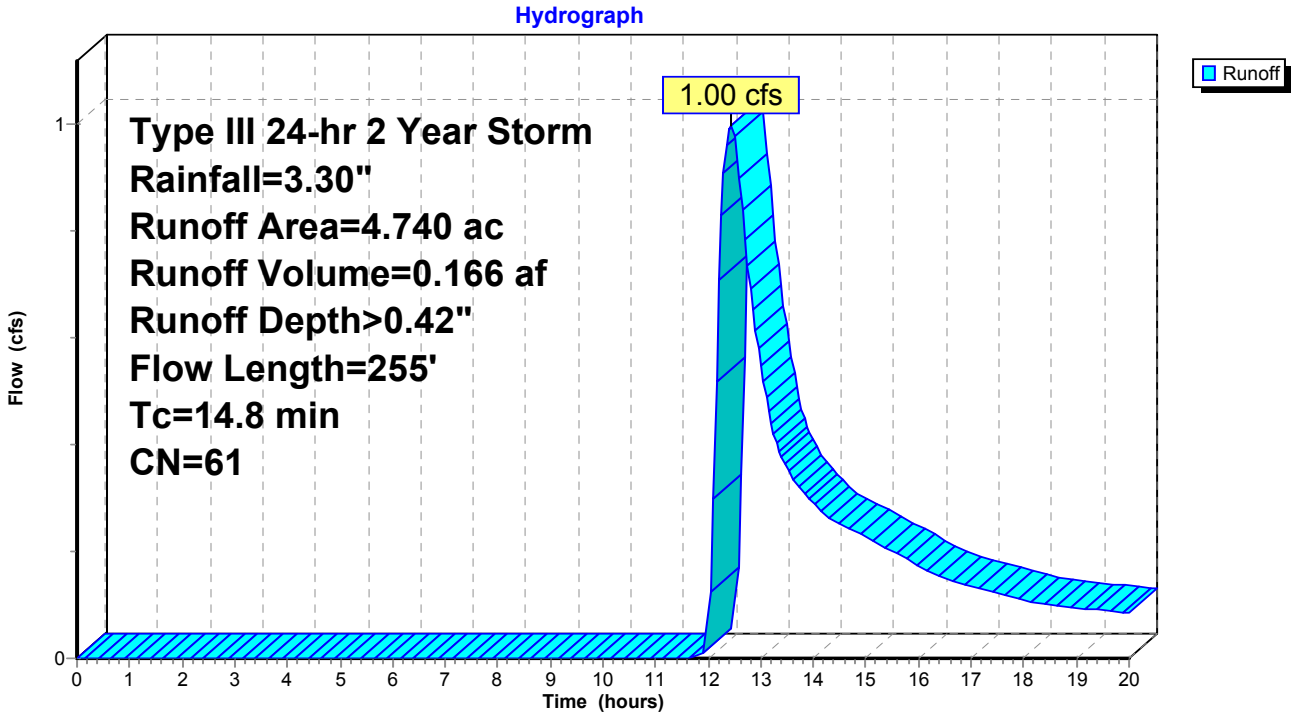
Runoff = 1.00 cfs @ 12.44 hrs, Volume= 0.166 af, Depth> 0.42"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Storm Rainfall=3.30"

	Area (ac)	CN	Description
*	4.740	61	Open Space
	4.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.13		**Sheet Flow, Segment 1** Grass: Short n= 0.150 P2= 3.30"
2.1	155	0.0060	1.25		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
14.8	255	Total			

Subcatchment 2AS: Drainage Area 2 Pervious



Summary for Subcatchment 2S: Drainage Area 2 Impervious

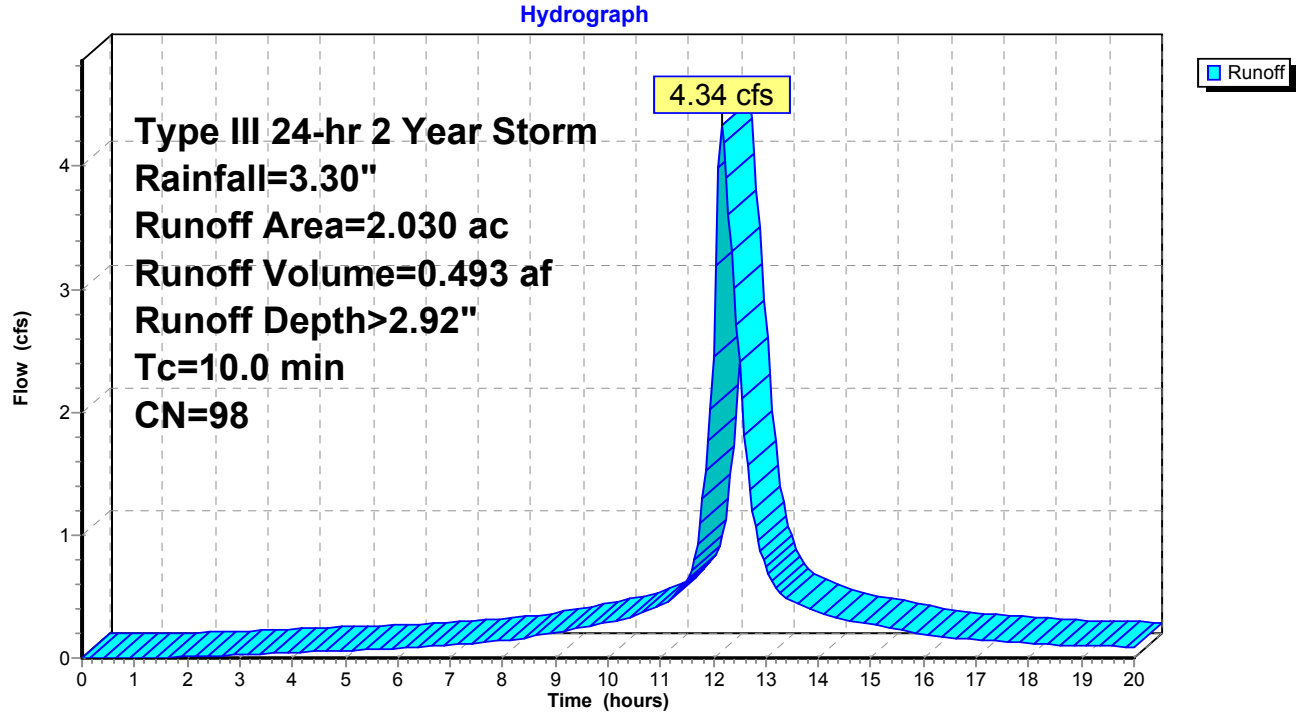
Runoff = 4.34 cfs @ 12.16 hrs, Volume= 0.493 af, Depth> 2.92"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Storm Rainfall=3.30"

	Area (ac)	CN	Description
*	2.030	98	Impervious
	2.030		100.00% Impervious Area

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

Subcatchment 2S: Drainage Area 2 Impervious



Summary for Subcatchment 3AS: Drainage Area 3 Pervious

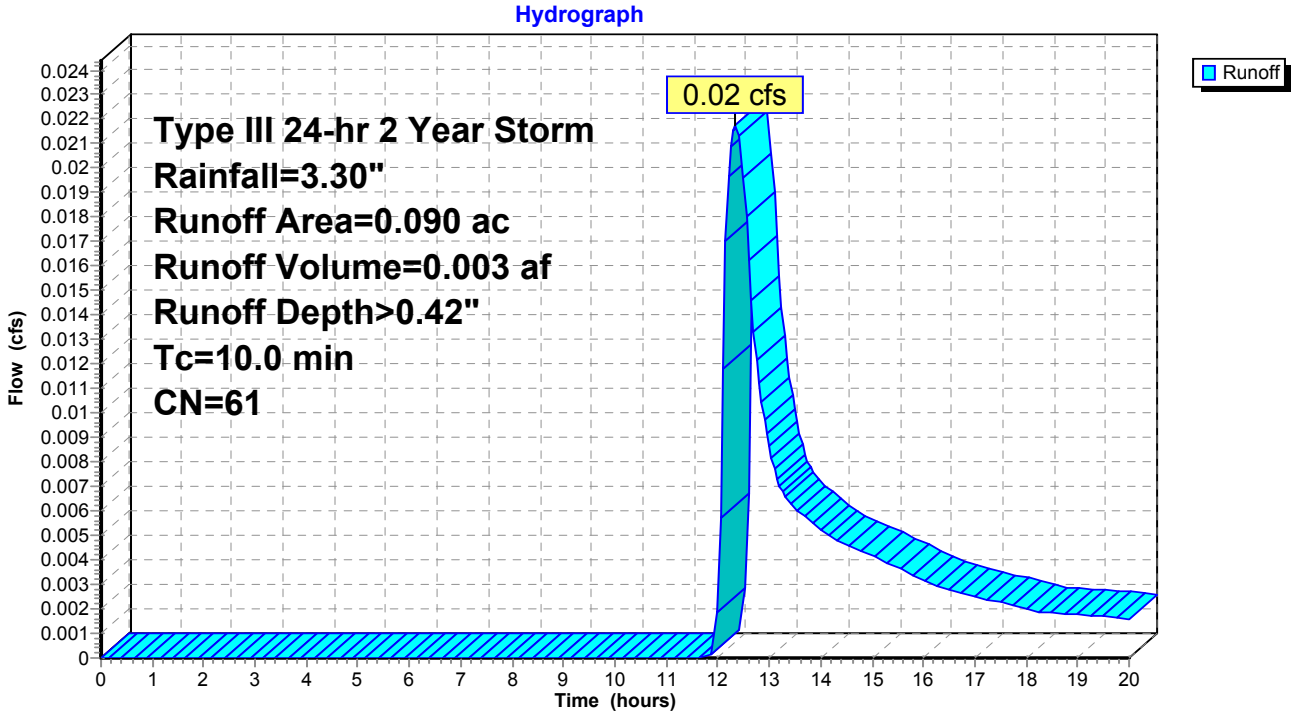
Runoff = 0.02 cfs @ 12.35 hrs, Volume= 0.003 af, Depth> 0.42"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Storm Rainfall=3.30"

	Area (ac)	CN	Description
*	0.090	61	Open Space
	0.090		100.00% Pervious Area

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

Subcatchment 3AS: Drainage Area 3 Pervious



Summary for Subcatchment 3S: Drainage Area 3 Impervious

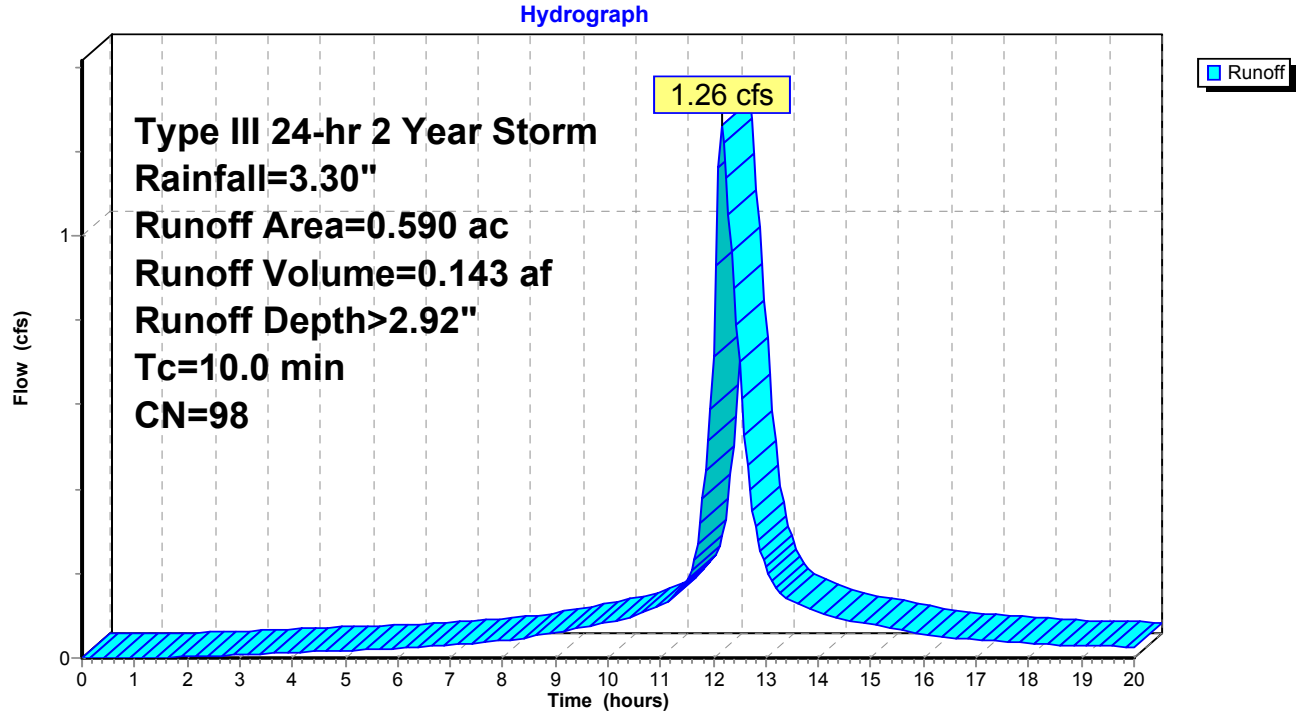
Runoff = 1.26 cfs @ 12.16 hrs, Volume= 0.143 af, Depth> 2.92"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Storm Rainfall=3.30"

	Area (ac)	CN	Description
*	0.590	98	Impervious
	0.590		100.00% Impervious Area

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

Subcatchment 3S: Drainage Area 3 Impervious



Summary for Pond 1P: Basin

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 1.30" for 2 Year Storm event
Inflow = 6.17 cfs @ 12.18 hrs, Volume= 0.806 af
Outflow = 0.81 cfs @ 13.88 hrs, Volume= 0.358 af, Atten= 87%, Lag= 101.9 min
Primary = 0.81 cfs @ 13.88 hrs, Volume= 0.358 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 54.01' @ 13.88 hrs Surf.Area= 0 sf Storage= 22,883 cf

Plug-Flow detention time= 295.8 min calculated for 0.357 af (44% of inflow)
Center-of-Mass det. time= 178.2 min (942.3 - 764.1)

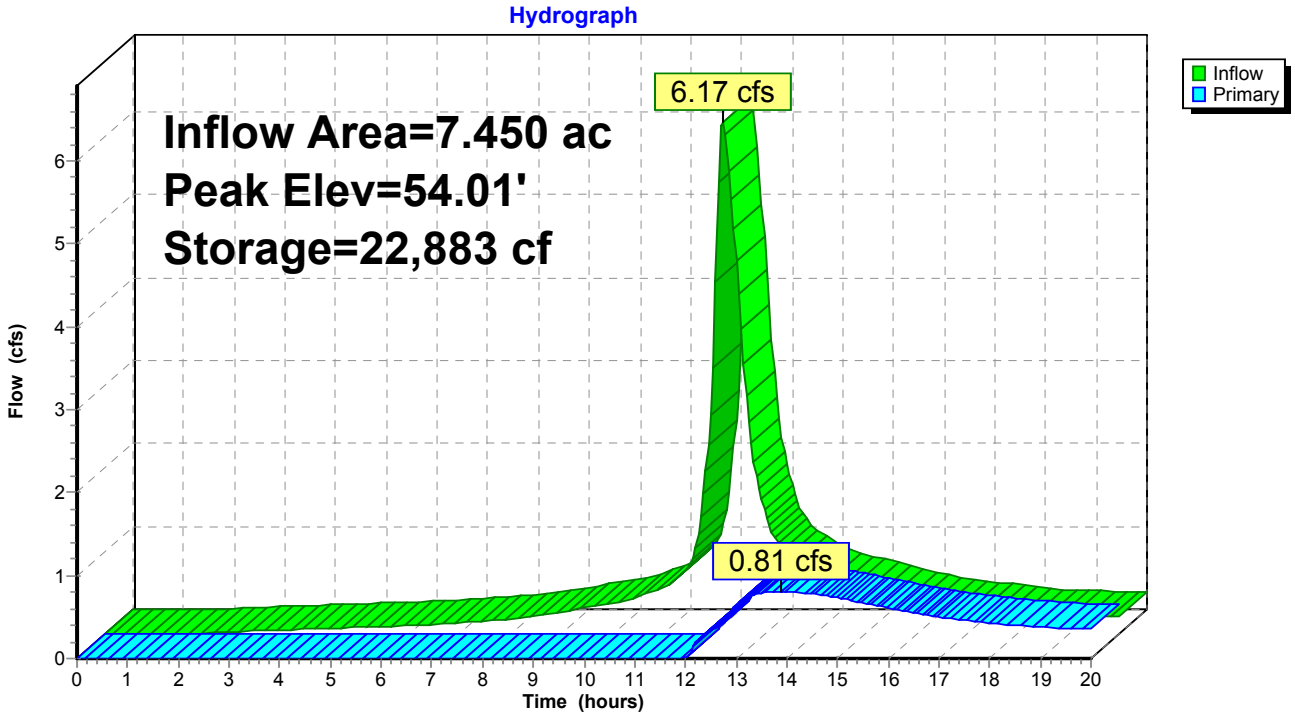
Volume	Invert	Avail.Storage	Storage Description
#1	51.50'	76,060 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
51.50	0
52.00	4,013
53.00	12,850
54.00	22,818
55.00	33,970
56.00	46,368
57.00	60,295
58.00	76,060

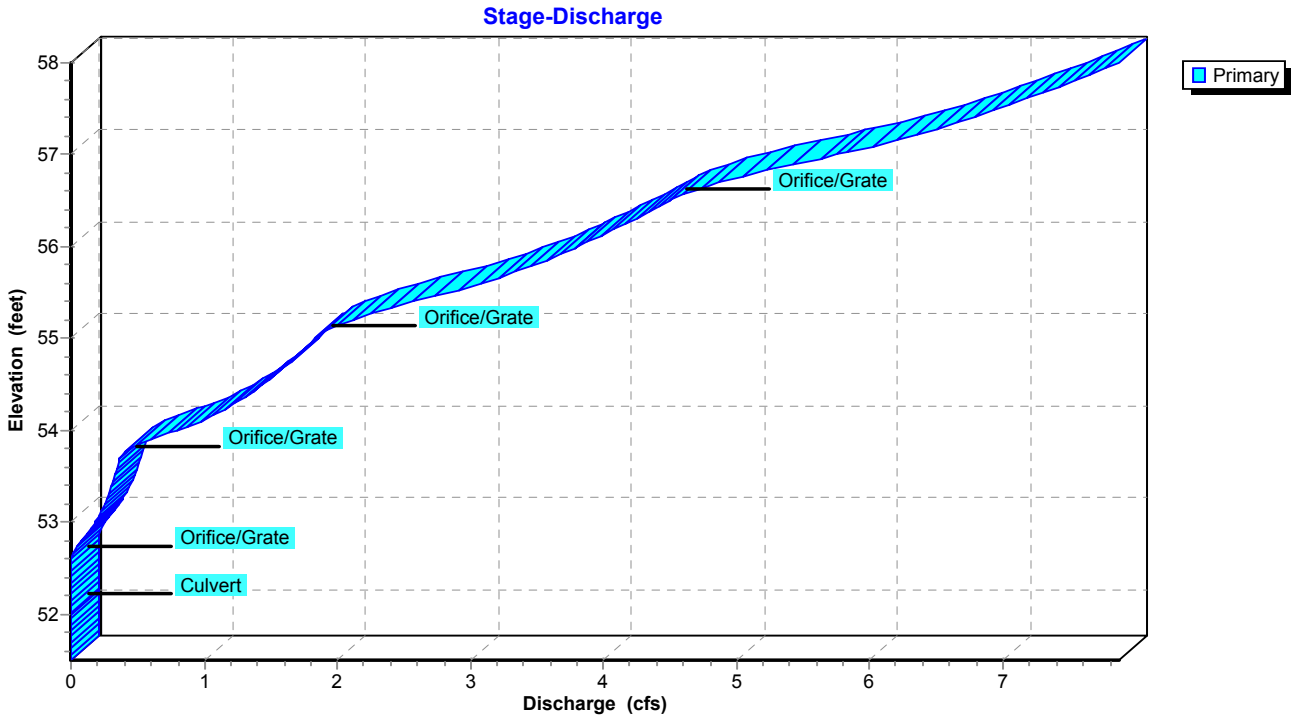
Device	Routing	Invert	Outlet Devices
#1	Primary	52.10'	**24.0" Round Culvert** L= 50.0' Ke= 0.600 Outlet Invert= 51.90' S= 0.0040 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.60'	**3.8" Vert. Orifice/Grate** C= 0.600
#3	Device 1	53.70'	**4.8" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	55.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	56.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.81 cfs @ 13.88 hrs HW=54.01' (Free Discharge)
└**1=Culvert** (Passes 0.81 cfs of 10.96 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.42 cfs @ 5.38 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.39 cfs @ 1.88 fps)
  ├**4=Orifice/Grate** (Controls 0.00 cfs)
  └**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Basin



Pond 1P: Basin

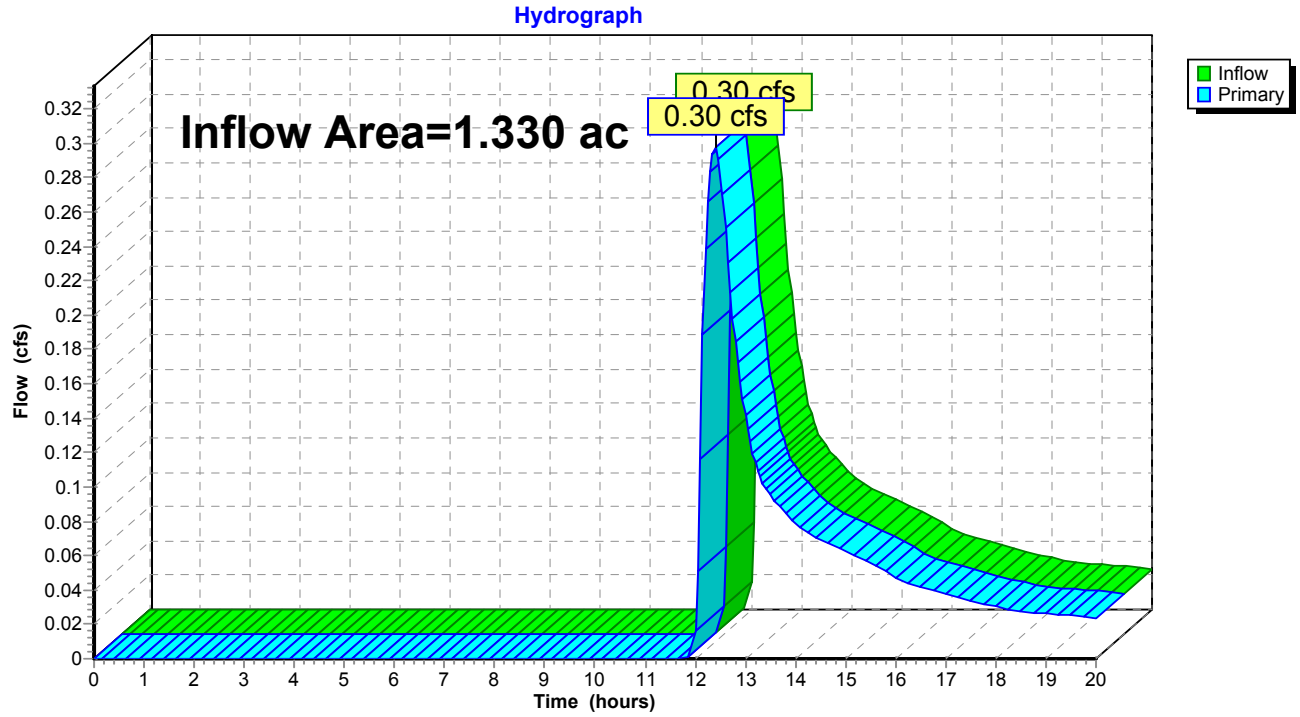


Summary for Link 1L: Point of Analysis 1 Assunpink Creek

Inflow Area = 1.330 ac, 0.00% Impervious, Inflow Depth > 0.42" for 2 Year Storm event
Inflow = 0.30 cfs @ 12.40 hrs, Volume= 0.047 af
Primary = 0.30 cfs @ 12.40 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 1L: Point of Analysis 1 Assunpink Creek



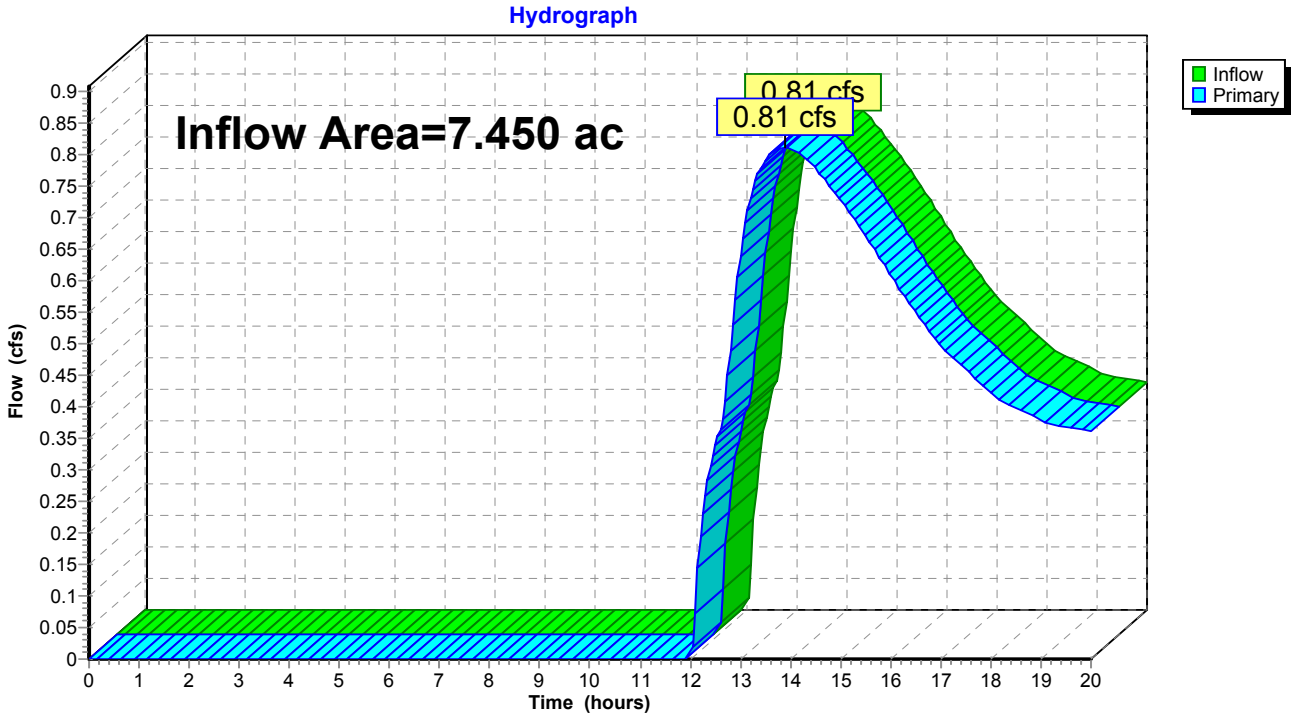
Summary for Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System

Pervious and impervious areas routed separately.

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 0.58" for 2 Year Storm event
Inflow = 0.81 cfs @ 13.88 hrs, Volume= 0.358 af
Primary = 0.81 cfs @ 13.88 hrs, Volume= 0.358 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=Delmarva
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Drainage Area 1 Runoff Area=1.330 ac 0.00% Impervious Runoff Depth>1.23"
Flow Length=132' Tc=12.6 min CN=61 Runoff=1.09 cfs 0.136 af

Subcatchment 2AS: Drainage Area 2 Runoff Area=4.740 ac 0.00% Impervious Runoff Depth>1.23"
Flow Length=255' Tc=14.8 min CN=61 Runoff=3.63 cfs 0.485 af

Subcatchment 2S: Drainage Area 2 Runoff Area=2.030 ac 100.00% Impervious Runoff Depth>4.53"
Tc=10.0 min CN=98 Runoff=6.63 cfs 0.767 af

Subcatchment 3AS: Drainage Area 3 Runoff Area=0.090 ac 0.00% Impervious Runoff Depth>1.23"
Tc=10.0 min CN=61 Runoff=0.08 cfs 0.009 af

Subcatchment 3S: Drainage Area 3 Runoff Area=0.590 ac 100.00% Impervious Runoff Depth>4.53"
Tc=10.0 min CN=98 Runoff=1.93 cfs 0.223 af

Pond 1P: Basin Peak Elev=55.27' Storage=37,273 cf Inflow=11.70 cfs 1.484 af
Outflow=2.24 cfs 0.981 af

Link 1L: Point of Analysis 1 Assunpink Creek Inflow=1.09 cfs 0.136 af
Primary=1.09 cfs 0.136 af

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System Inflow=2.24 cfs 0.981 af
Primary=2.24 cfs 0.981 af

Total Runoff Area = 8.780 ac Runoff Volume = 1.620 af Average Runoff Depth = 2.21"
70.16% Pervious = 6.160 ac 29.84% Impervious = 2.620 ac

Summary for Subcatchment 1S: Drainage Area 1

Curve Number revised to 61 to be consistent with stormwater report and post-developed land cover.

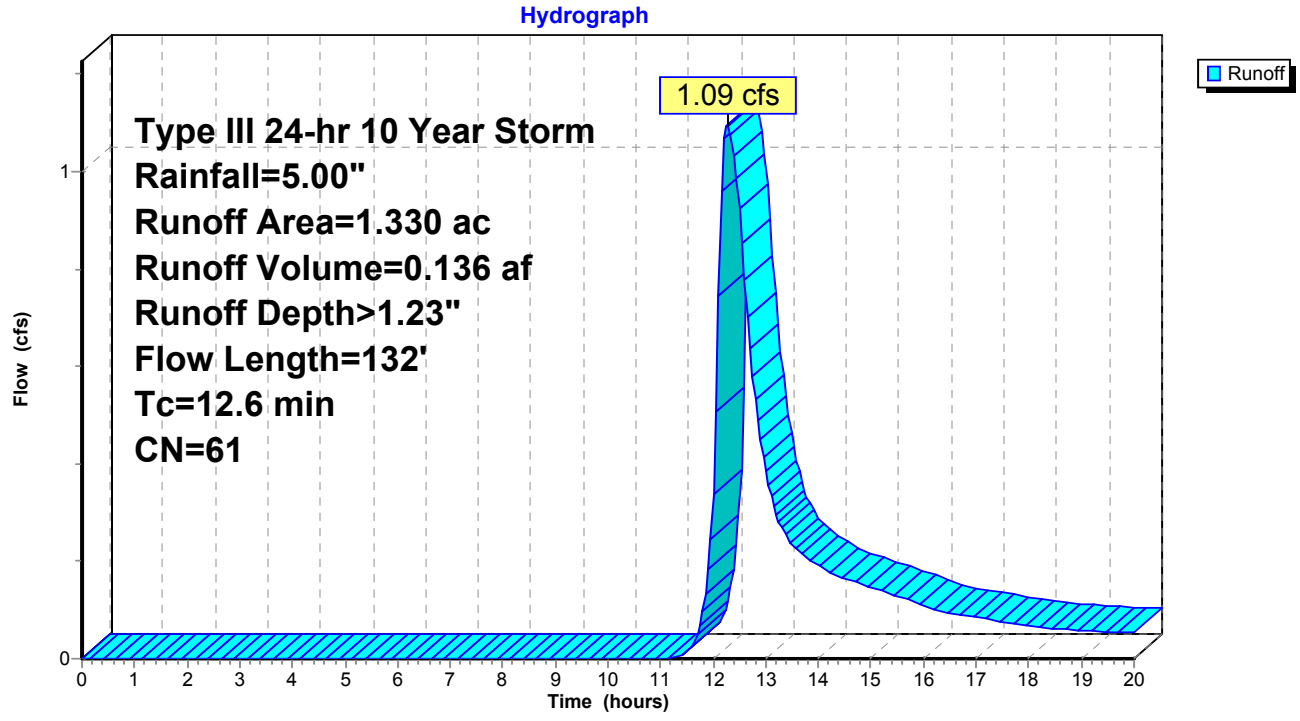
Runoff = 1.09 cfs @ 12.27 hrs, Volume= 0.136 af, Depth> 1.23"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 Year Storm Rainfall=5.00"

	Area (ac)	CN	Description
*	1.330	61	Open Space
	1.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0200	0.10		**Sheet Flow, Segment 1** Grass: Dense n= 0.240 P2= 3.30"
4.3	50	0.0370	0.19		**Sheet Flow, Segment 2** n= 0.150 P2= 3.30"
0.2	32	0.0400	3.22		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
12.6	132	Total			

Subcatchment 1S: Drainage Area 1



Summary for Subcatchment 2AS: Drainage Area 2 Pervious

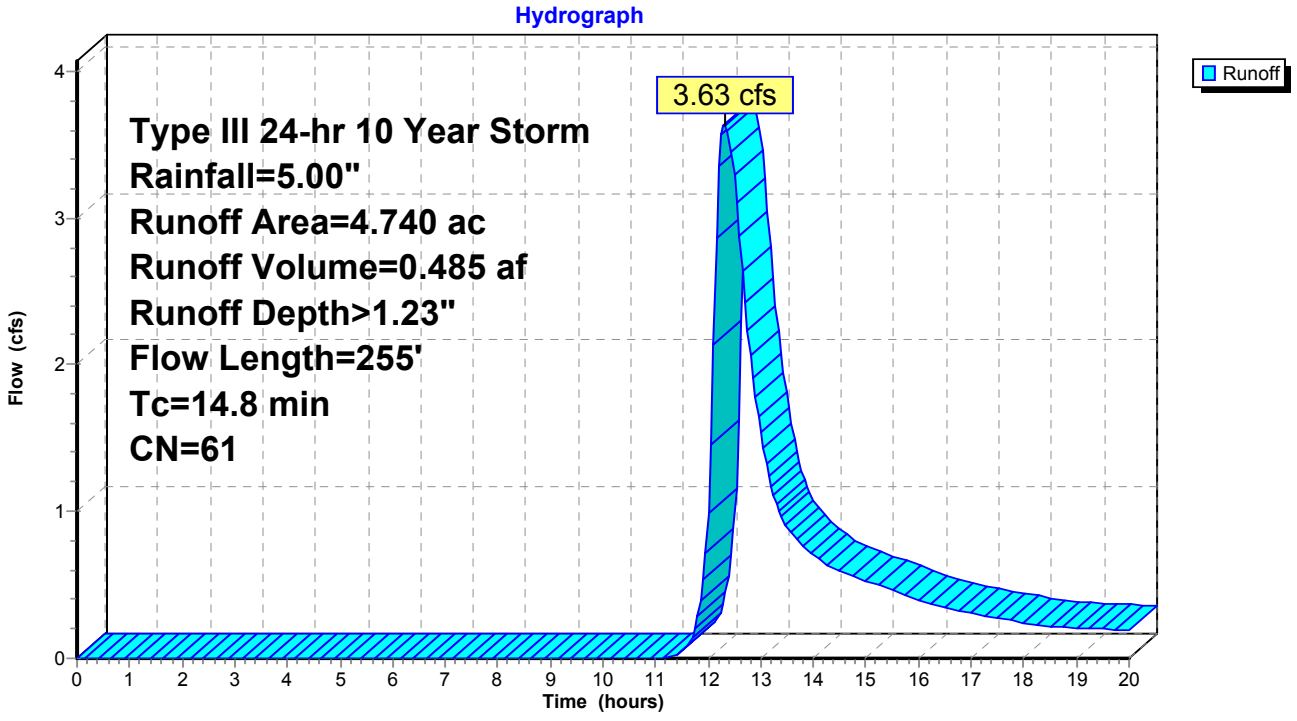
Runoff = 3.63 cfs @ 12.32 hrs, Volume= 0.485 af, Depth> 1.23"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 Year Storm Rainfall=5.00"

	Area (ac)	CN	Description
*	4.740	61	Open Space
	4.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.13		**Sheet Flow, Segment 1** Grass: Short n= 0.150 P2= 3.30"
2.1	155	0.0060	1.25		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
14.8	255	Total			

Subcatchment 2AS: Drainage Area 2 Pervious



Summary for Subcatchment 2S: Drainage Area 2 Impervious

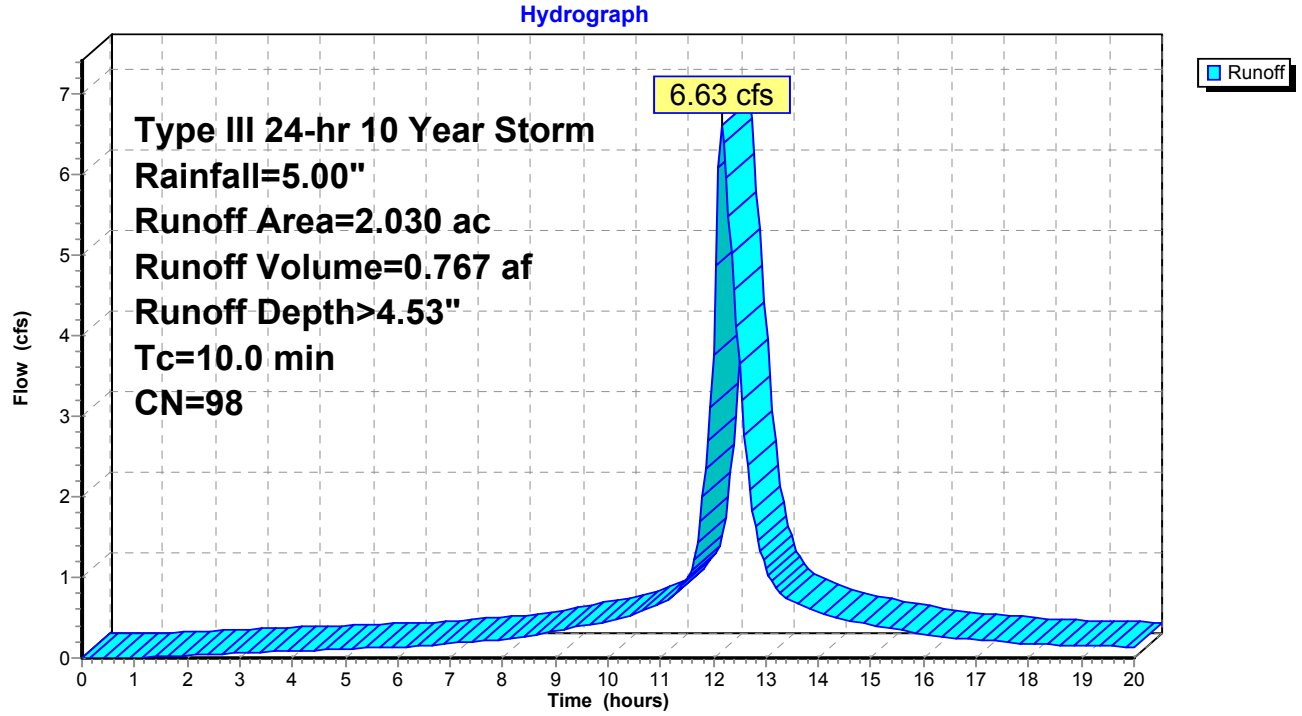
Runoff = 6.63 cfs @ 12.16 hrs, Volume= 0.767 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 Year Storm Rainfall=5.00"

	Area (ac)	CN	Description
*	2.030	98	Impervious
	2.030		100.00% Impervious Area

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

Subcatchment 2S: Drainage Area 2 Impervious



Summary for Subcatchment 3AS: Drainage Area 3 Pervious

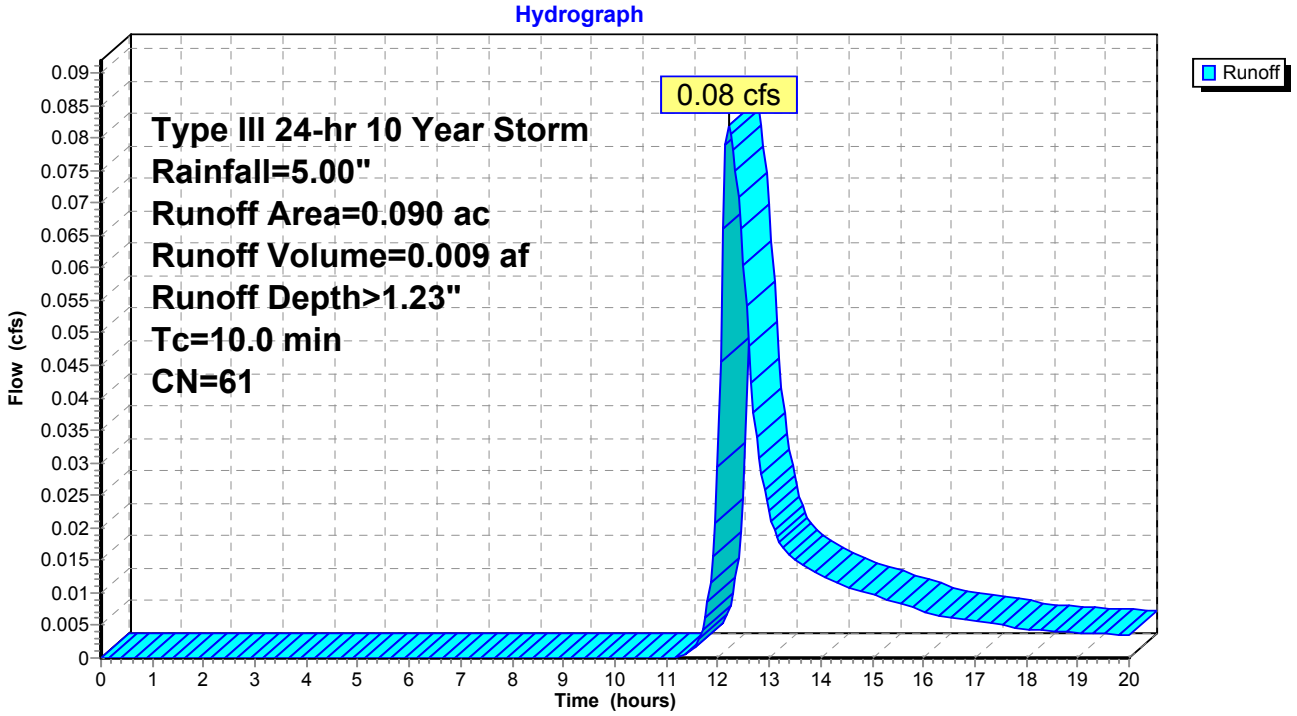
Runoff = 0.08 cfs @ 12.21 hrs, Volume= 0.009 af, Depth> 1.23"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 Year Storm Rainfall=5.00"

	Area (ac)	CN	Description
*	0.090	61	Open Space
	0.090		100.00% Pervious Area

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

Subcatchment 3AS: Drainage Area 3 Pervious



Summary for Subcatchment 3S: Drainage Area 3 Impervious

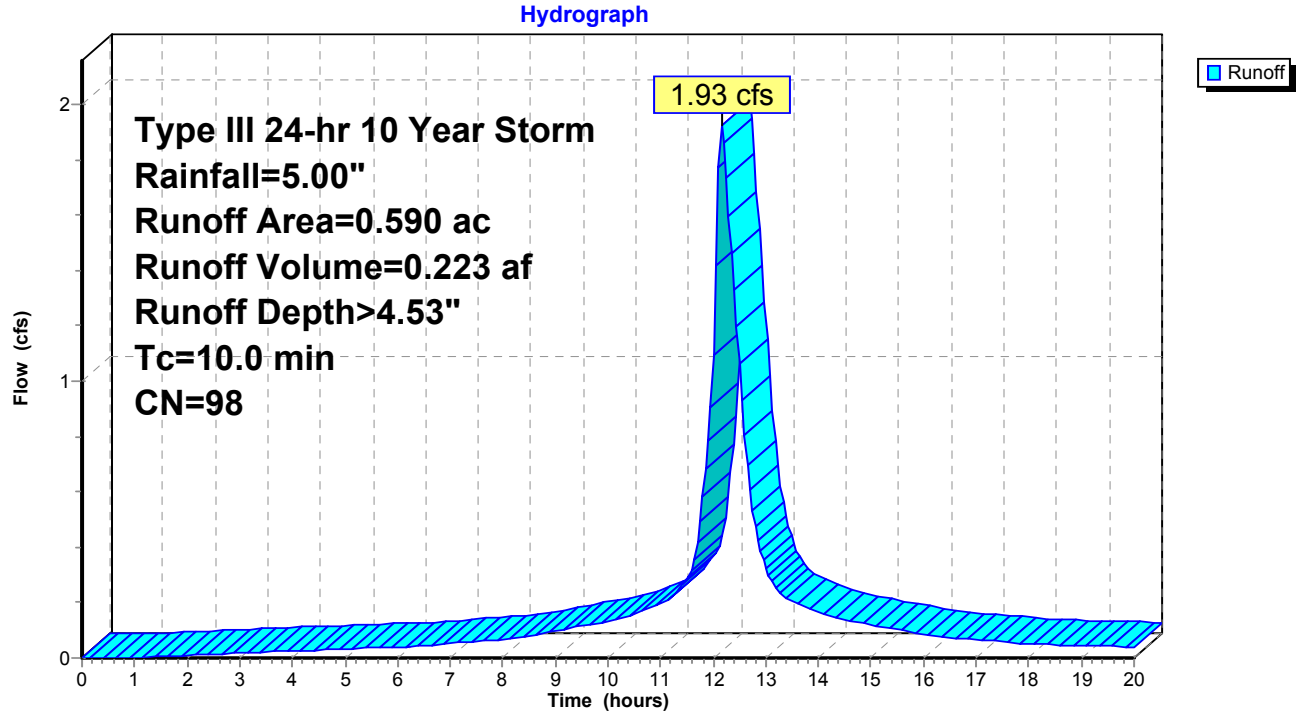
Runoff = 1.93 cfs @ 12.16 hrs, Volume= 0.223 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 Year Storm Rainfall=5.00"

	Area (ac)	CN	Description
*	0.590	98	Impervious
	0.590		100.00% Impervious Area

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

Subcatchment 3S: Drainage Area 3 Impervious



Summary for Pond 1P: Basin

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 2.39" for 10 Year Storm event
Inflow = 11.70 cfs @ 12.19 hrs, Volume= 1.484 af
Outflow = 2.24 cfs @ 13.22 hrs, Volume= 0.981 af, Atten= 81%, Lag= 61.4 min
Primary = 2.24 cfs @ 13.22 hrs, Volume= 0.981 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 55.27' @ 13.22 hrs Surf.Area= 0 sf Storage= 37,273 cf

Plug-Flow detention time= 240.1 min calculated for 0.981 af (66% of inflow)
Center-of-Mass det. time= 159.3 min (925.4 - 766.1)

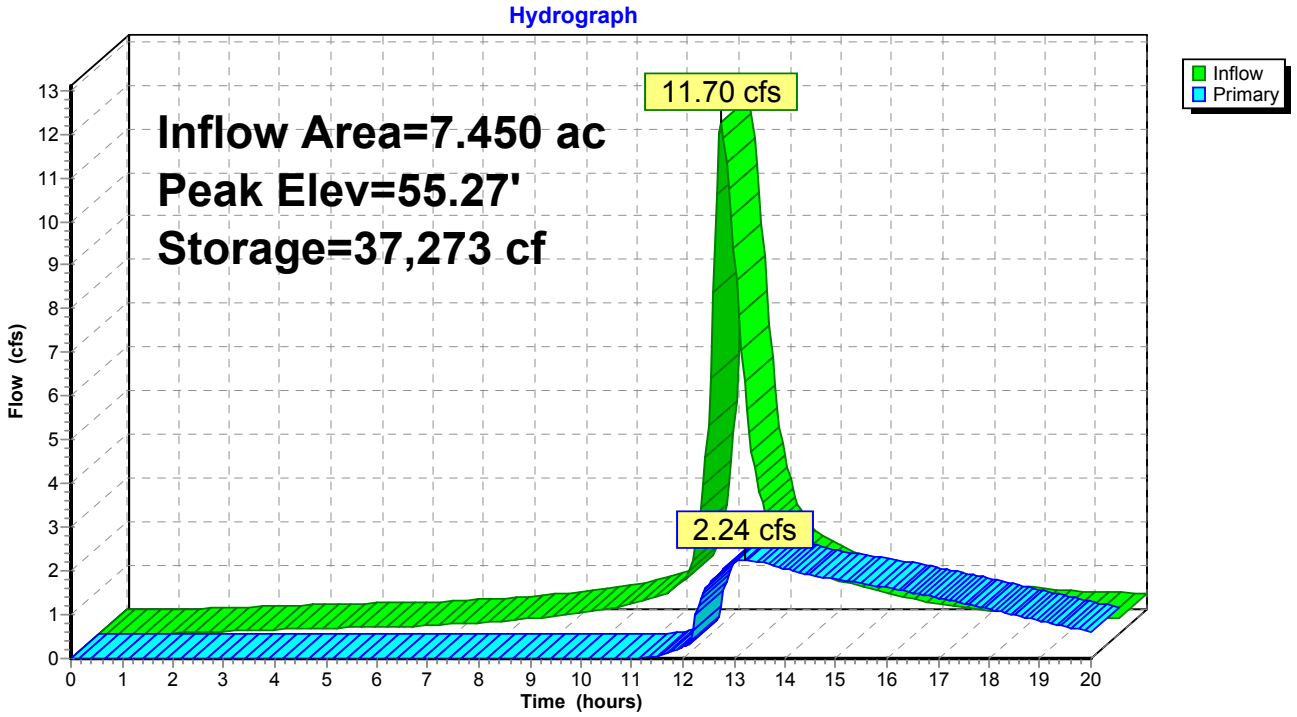
Volume	Invert	Avail.Storage	Storage Description
#1	51.50'	76,060 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
51.50	0
52.00	4,013
53.00	12,850
54.00	22,818
55.00	33,970
56.00	46,368
57.00	60,295
58.00	76,060

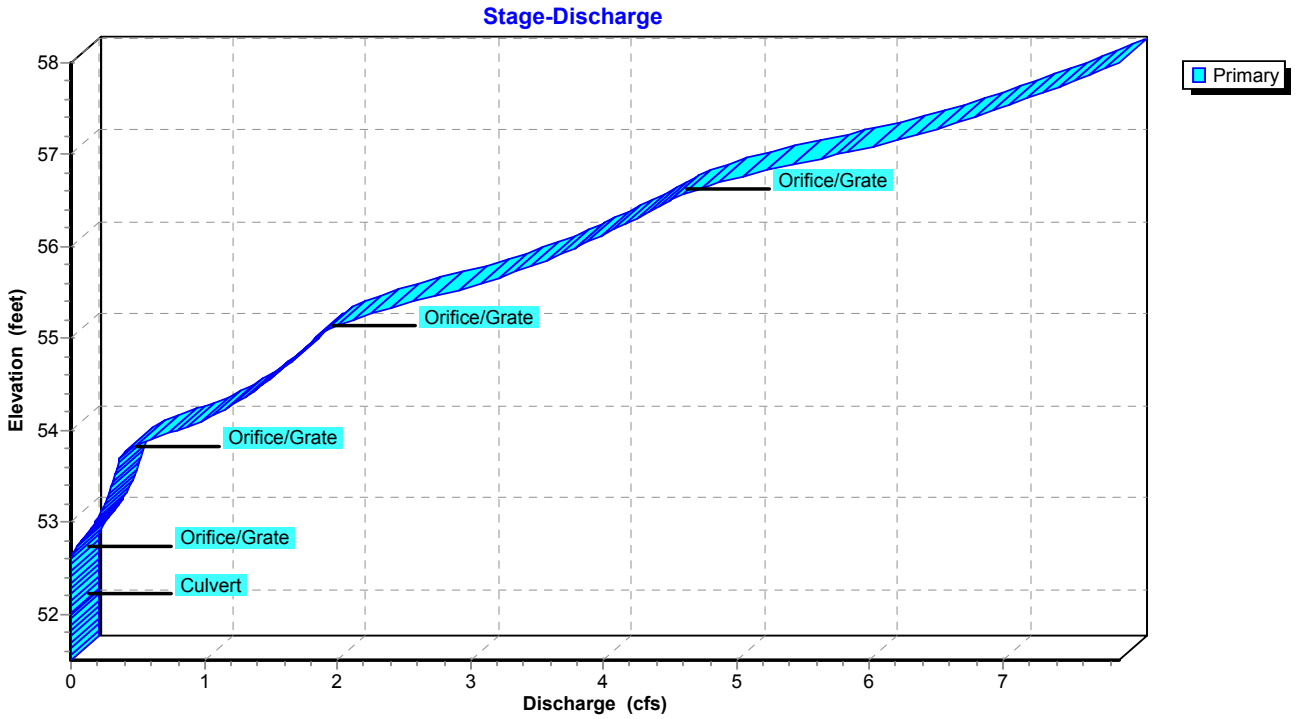
Device	Routing	Invert	Outlet Devices
#1	Primary	52.10'	**24.0" Round Culvert** L= 50.0' Ke= 0.600 Outlet Invert= 51.90' S= 0.0040 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.60'	**3.8" Vert. Orifice/Grate** C= 0.600
#3	Device 1	53.70'	**4.8" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	55.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	56.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=2.24 cfs @ 13.22 hrs HW=55.27' (Free Discharge)
└**1=Culvert** (Passes 2.24 cfs of 19.76 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.60 cfs @ 7.63 fps)
  ├**3=Orifice/Grate** (Orifice Controls 1.41 cfs @ 5.63 fps)
  ├**4=Orifice/Grate** (Orifice Controls 0.23 cfs @ 1.76 fps)
  └**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Basin



Pond 1P: Basin

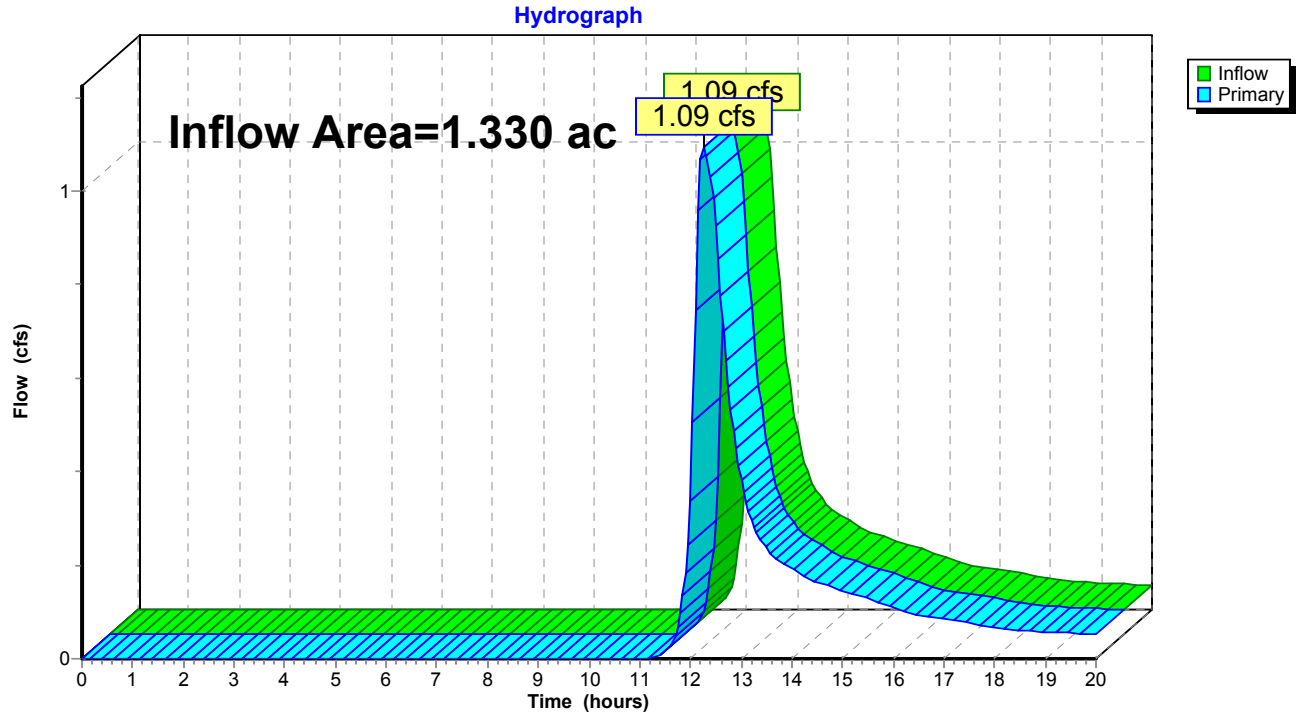


Summary for Link 1L: Point of Analysis 1 Assunpink Creek

Inflow Area = 1.330 ac, 0.00% Impervious, Inflow Depth > 1.23" for 10 Year Storm event
Inflow = 1.09 cfs @ 12.27 hrs, Volume= 0.136 af
Primary = 1.09 cfs @ 12.27 hrs, Volume= 0.136 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 1L: Point of Analysis 1 Assunpink Creek



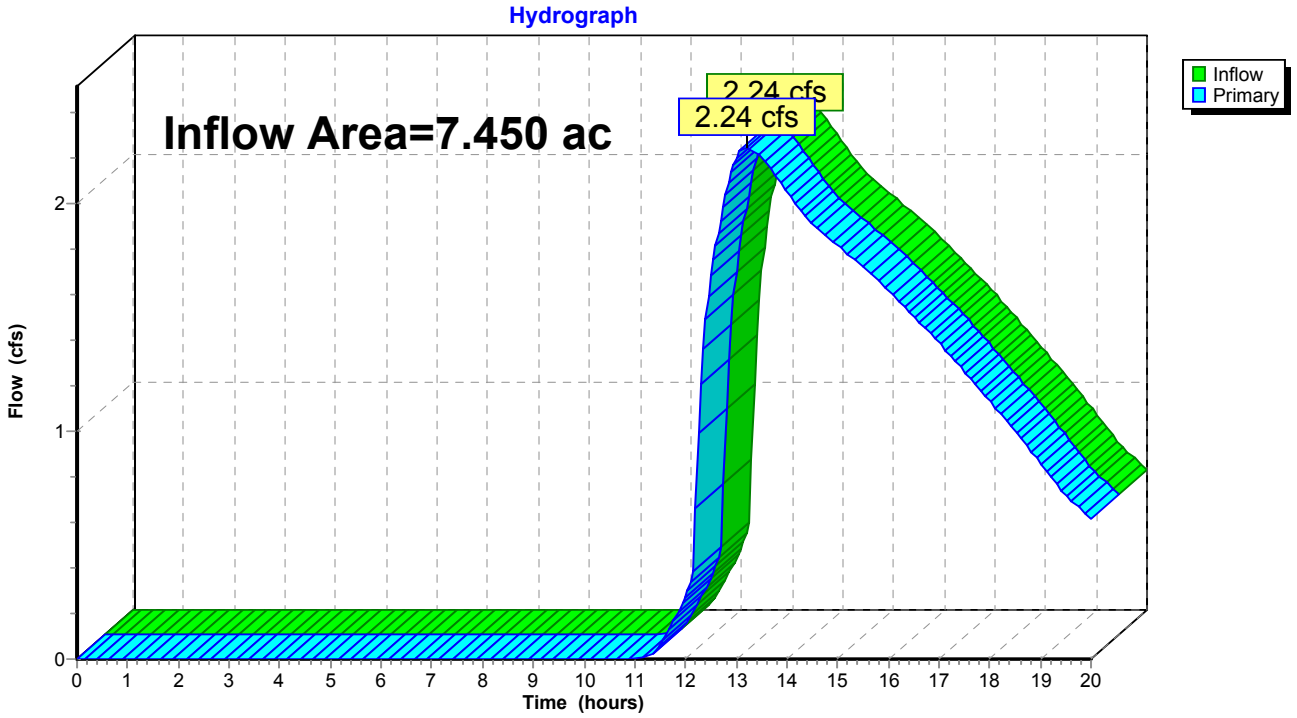
Summary for Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System

Pervious and impervious areas routed separately.

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 1.58" for 10 Year Storm event
Inflow = 2.24 cfs @ 13.22 hrs, Volume= 0.981 af
Primary = 2.24 cfs @ 13.22 hrs, Volume= 0.981 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=Delmarva
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Drainage Area 1 Runoff Area=1.330 ac 0.00% Impervious Runoff Depth>3.38"
Flow Length=132' Tc=12.6 min CN=61 Runoff=3.29 cfs 0.374 af

Subcatchment 2AS: Drainage Area 2 Runoff Area=4.740 ac 0.00% Impervious Runoff Depth>3.37"
Flow Length=255' Tc=14.8 min CN=61 Runoff=10.86 cfs 1.332 af

Subcatchment 2S: Drainage Area 2 Runoff Area=2.030 ac 100.00% Impervious Runoff Depth>7.68"
Tc=10.0 min CN=98 Runoff=11.05 cfs 1.299 af

Subcatchment 3AS: Drainage Area 3 Runoff Area=0.090 ac 0.00% Impervious Runoff Depth>3.38"
Tc=10.0 min CN=61 Runoff=0.25 cfs 0.025 af

Subcatchment 3S: Drainage Area 3 Runoff Area=0.590 ac 100.00% Impervious Runoff Depth>7.68"
Tc=10.0 min CN=98 Runoff=3.21 cfs 0.377 af

Pond 1P: Basin Peak Elev=57.44' Storage=67,306 cf Inflow=24.53 cfs 3.033 af
Outflow=6.86 cfs 2.389 af

Link 1L: Point of Analysis 1 Assunpink Creek Inflow=3.29 cfs 0.374 af
Primary=3.29 cfs 0.374 af

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System Inflow=6.86 cfs 2.389 af
Primary=6.86 cfs 2.389 af

Total Runoff Area = 8.780 ac Runoff Volume = 3.408 af Average Runoff Depth = 4.66"
70.16% Pervious = 6.160 ac 29.84% Impervious = 2.620 ac

Summary for Subcatchment 1S: Drainage Area 1

Curve Number revised to 61 to be consistent with stormwater report and post-developed land cover.

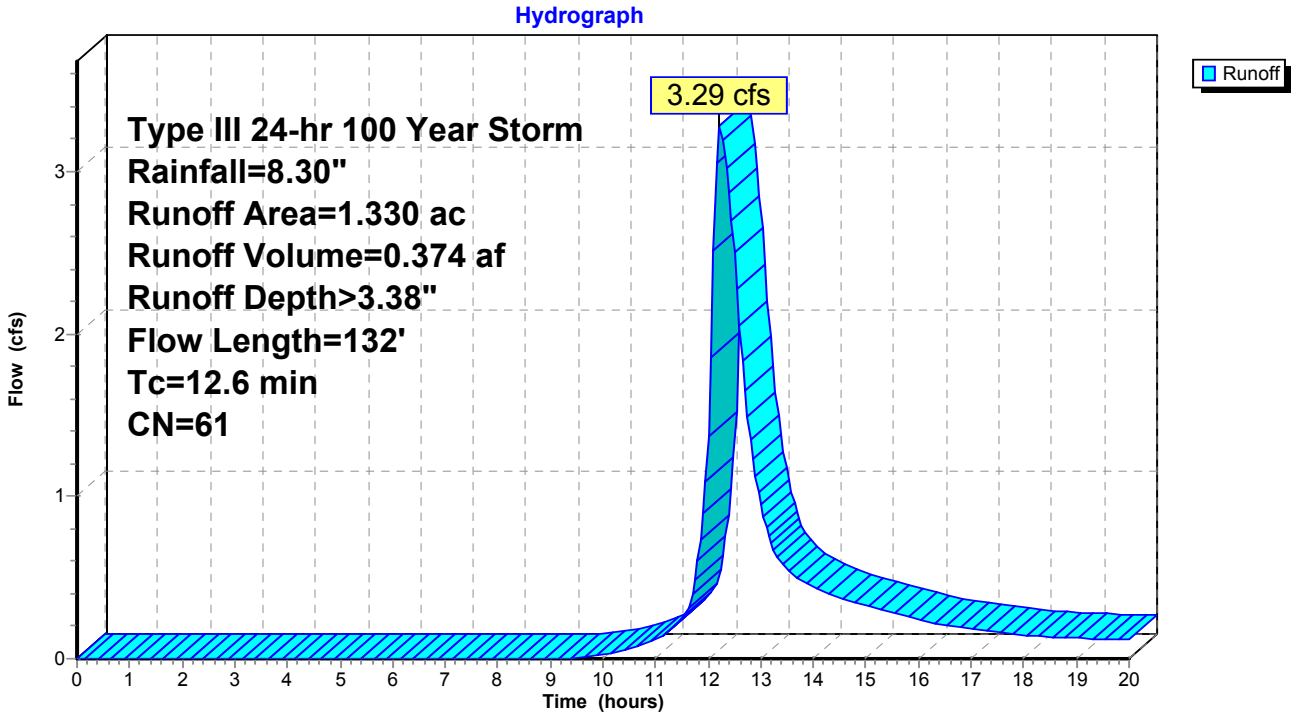
Runoff = 3.29 cfs @ 12.22 hrs, Volume= 0.374 af, Depth> 3.38"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 Year Storm Rainfall=8.30"

	Area (ac)	CN	Description
*	1.330	61	Open Space
	1.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0200	0.10		**Sheet Flow, Segment 1** Grass: Dense n= 0.240 P2= 3.30"
4.3	50	0.0370	0.19		**Sheet Flow, Segment 2** n= 0.150 P2= 3.30"
0.2	32	0.0400	3.22		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
12.6	132	Total			

Subcatchment 1S: Drainage Area 1



Summary for Subcatchment 2AS: Drainage Area 2 Pervious

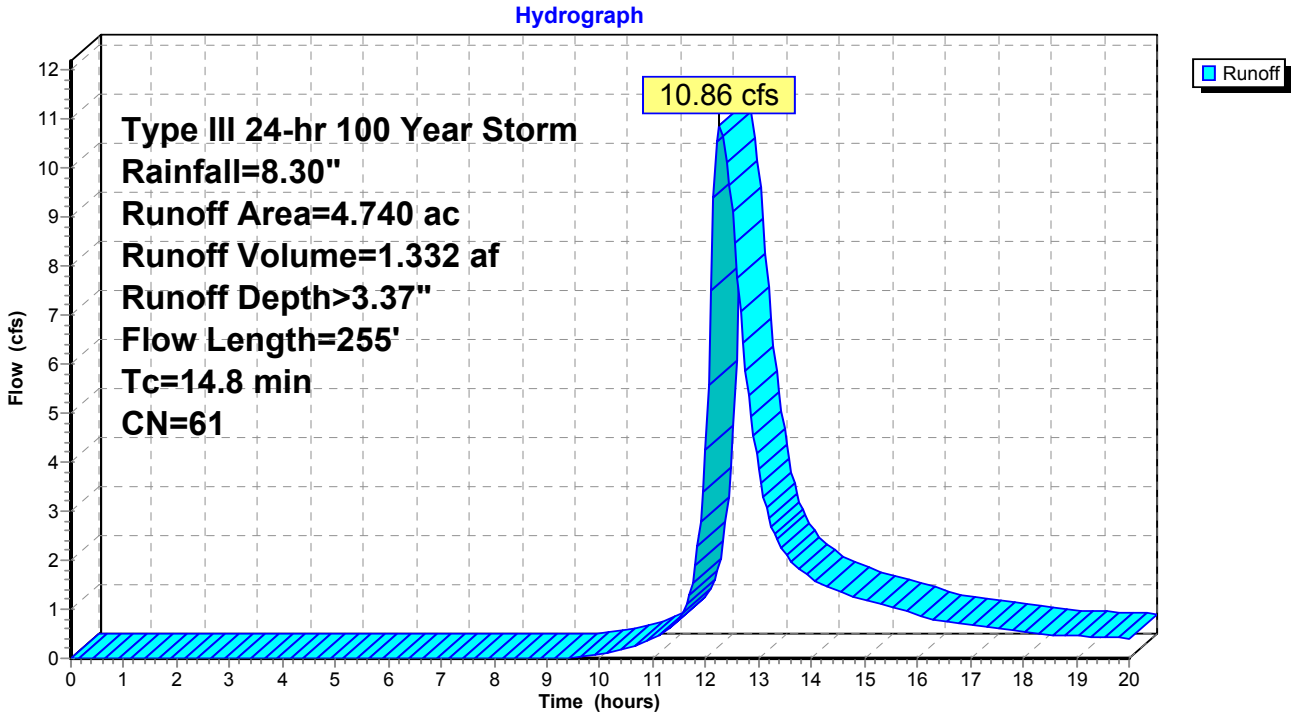
Runoff = 10.86 cfs @ 12.26 hrs, Volume= 1.332 af, Depth> 3.37"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 Year Storm Rainfall=8.30"

	Area (ac)	CN	Description
*	4.740	61	Open Space
	4.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.13		**Sheet Flow, Segment 1** Grass: Short n= 0.150 P2= 3.30"
2.1	155	0.0060	1.25		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
14.8	255	Total			

Subcatchment 2AS: Drainage Area 2 Pervious



Summary for Subcatchment 2S: Drainage Area 2 Impervious

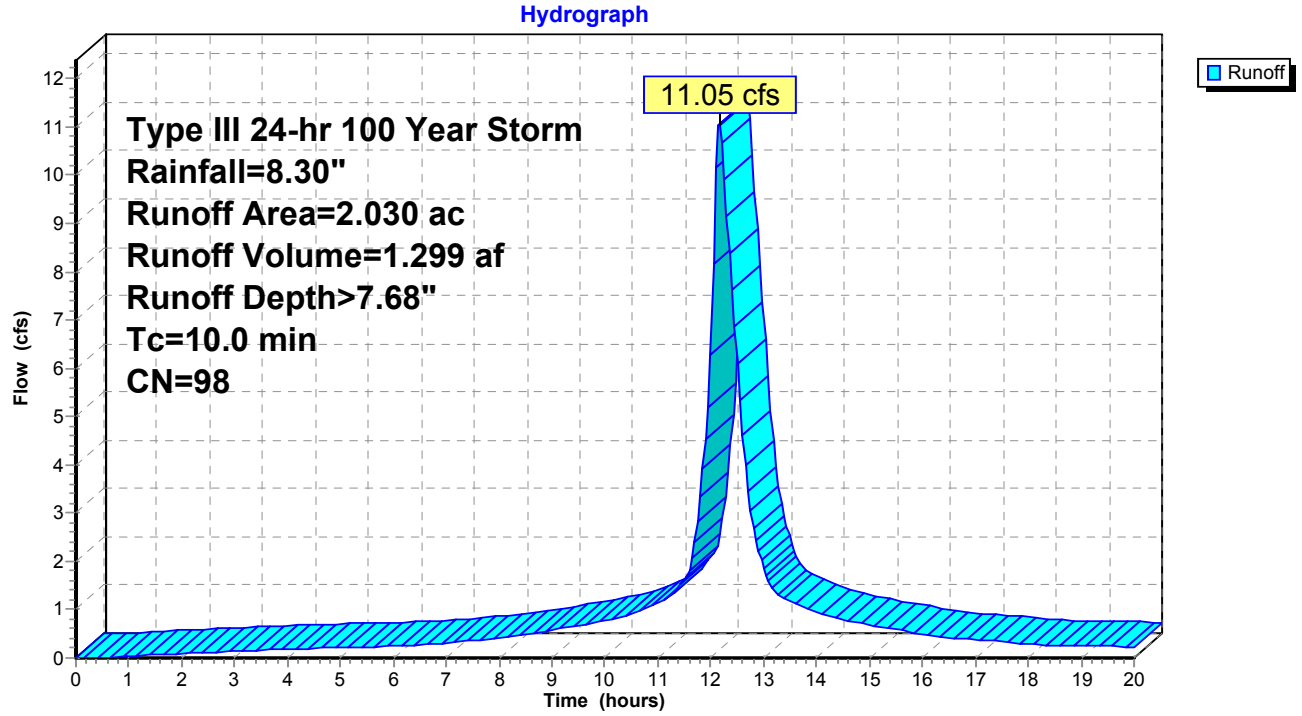
Runoff = 11.05 cfs @ 12.16 hrs, Volume= 1.299 af, Depth> 7.68"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 Year Storm Rainfall=8.30"

	Area (ac)	CN	Description
*	2.030	98	Impervious
	2.030		100.00% Impervious Area

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

Subcatchment 2S: Drainage Area 2 Impervious



Summary for Subcatchment 3AS: Drainage Area 3 Pervious

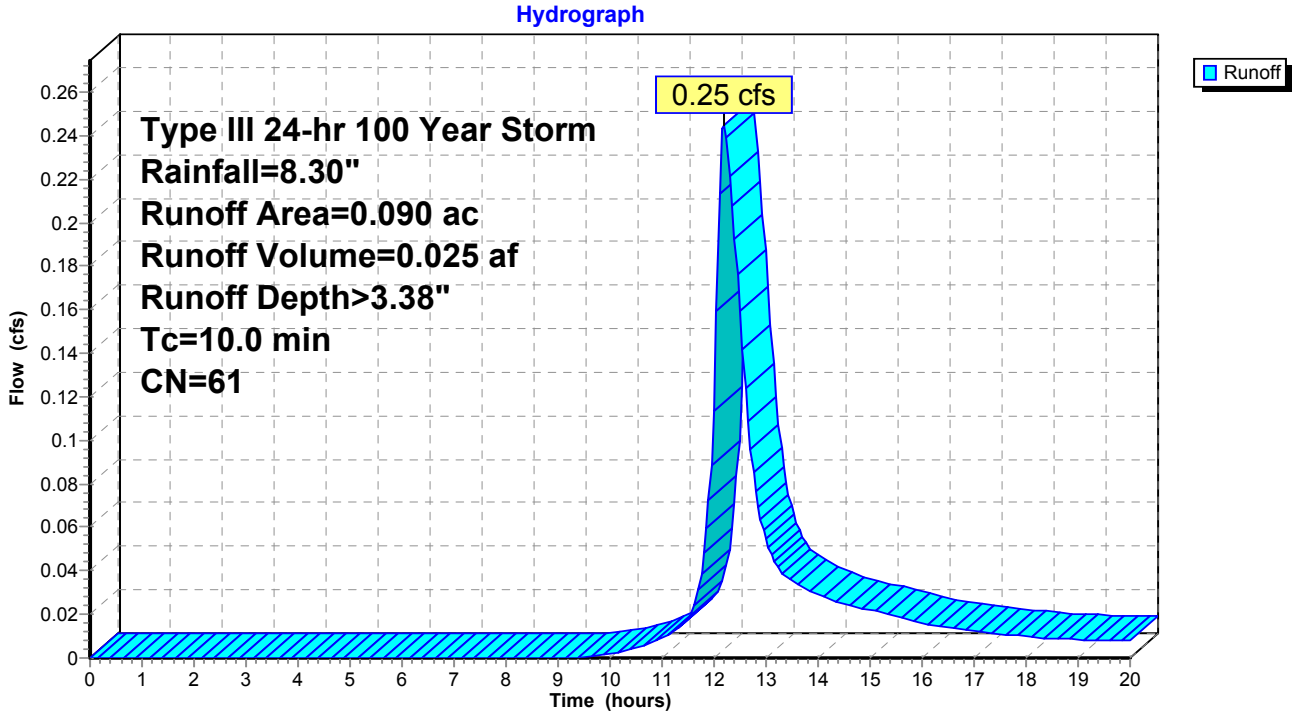
Runoff = 0.25 cfs @ 12.18 hrs, Volume= 0.025 af, Depth> 3.38"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 Year Storm Rainfall=8.30"

	Area (ac)	CN	Description
*	0.090	61	Open Space
	0.090		100.00% Pervious Area

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

Subcatchment 3AS: Drainage Area 3 Pervious



Summary for Subcatchment 3S: Drainage Area 3 Impervious

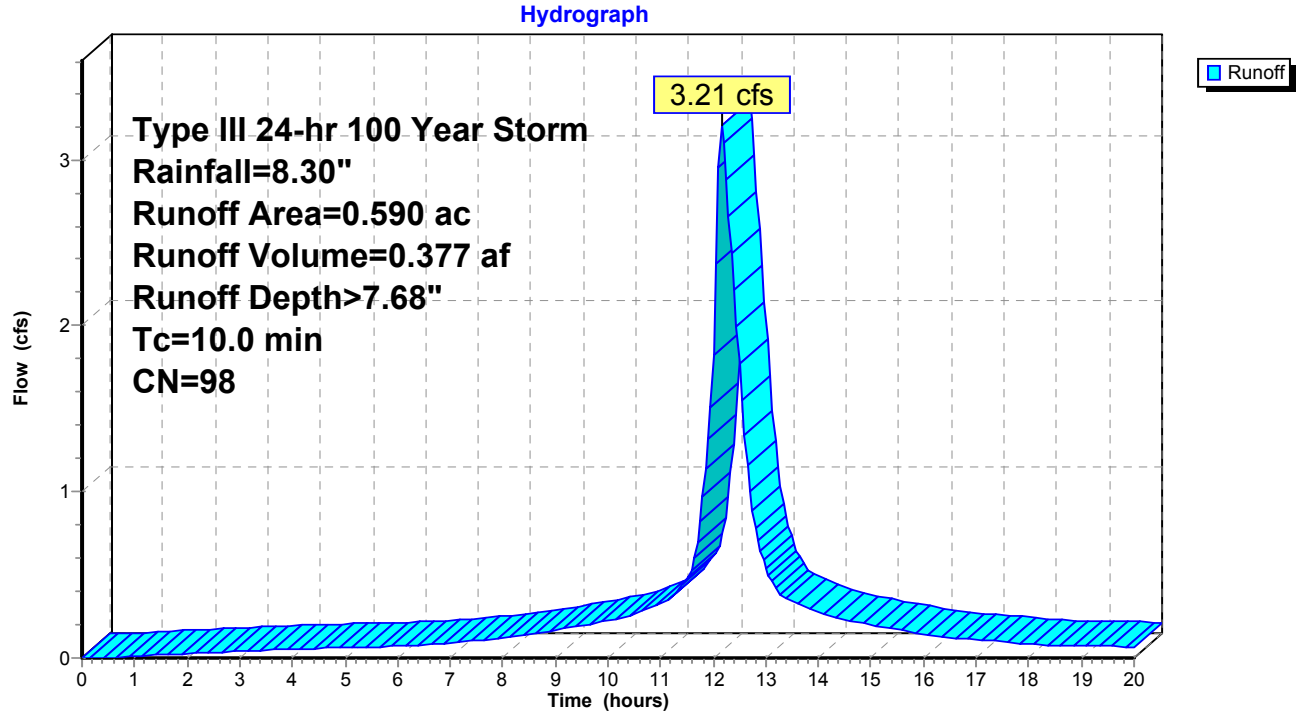
Runoff = 3.21 cfs @ 12.16 hrs, Volume= 0.377 af, Depth> 7.68"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 Year Storm Rainfall=8.30"

	Area (ac)	CN	Description
*	0.590	98	Impervious
	0.590		100.00% Impervious Area

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

Subcatchment 3S: Drainage Area 3 Impervious



Summary for Pond 1P: Basin

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 4.89" for 100 Year Storm event
Inflow = 24.53 cfs @ 12.20 hrs, Volume= 3.033 af
Outflow = 6.86 cfs @ 12.95 hrs, Volume= 2.389 af, Atten= 72%, Lag= 45.0 min
Primary = 6.86 cfs @ 12.95 hrs, Volume= 2.389 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 57.44' @ 12.95 hrs Surf.Area= 0 sf Storage= 67,306 cf

Plug-Flow detention time= 187.6 min calculated for 2.389 af (79% of inflow)
Center-of-Mass det. time= 129.1 min (893.9 - 764.8)

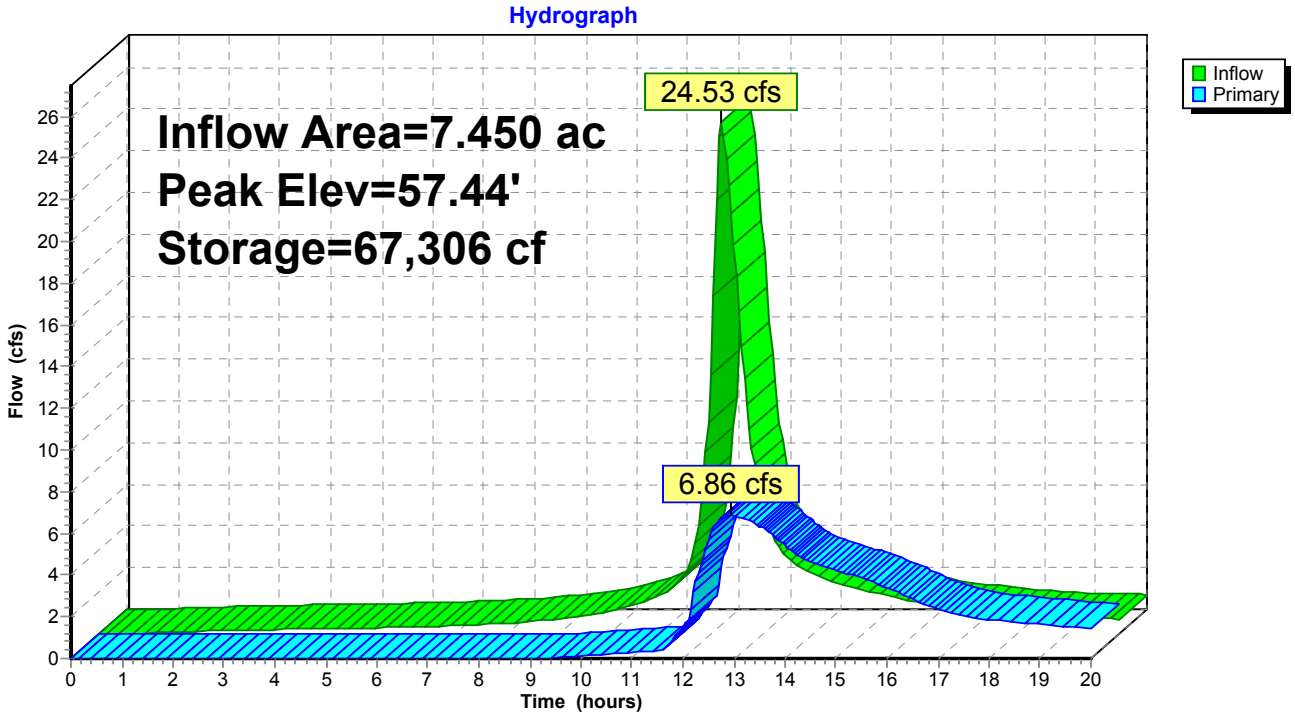
Volume	Invert	Avail.Storage	Storage Description
#1	51.50'	76,060 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
51.50	0
52.00	4,013
53.00	12,850
54.00	22,818
55.00	33,970
56.00	46,368
57.00	60,295
58.00	76,060

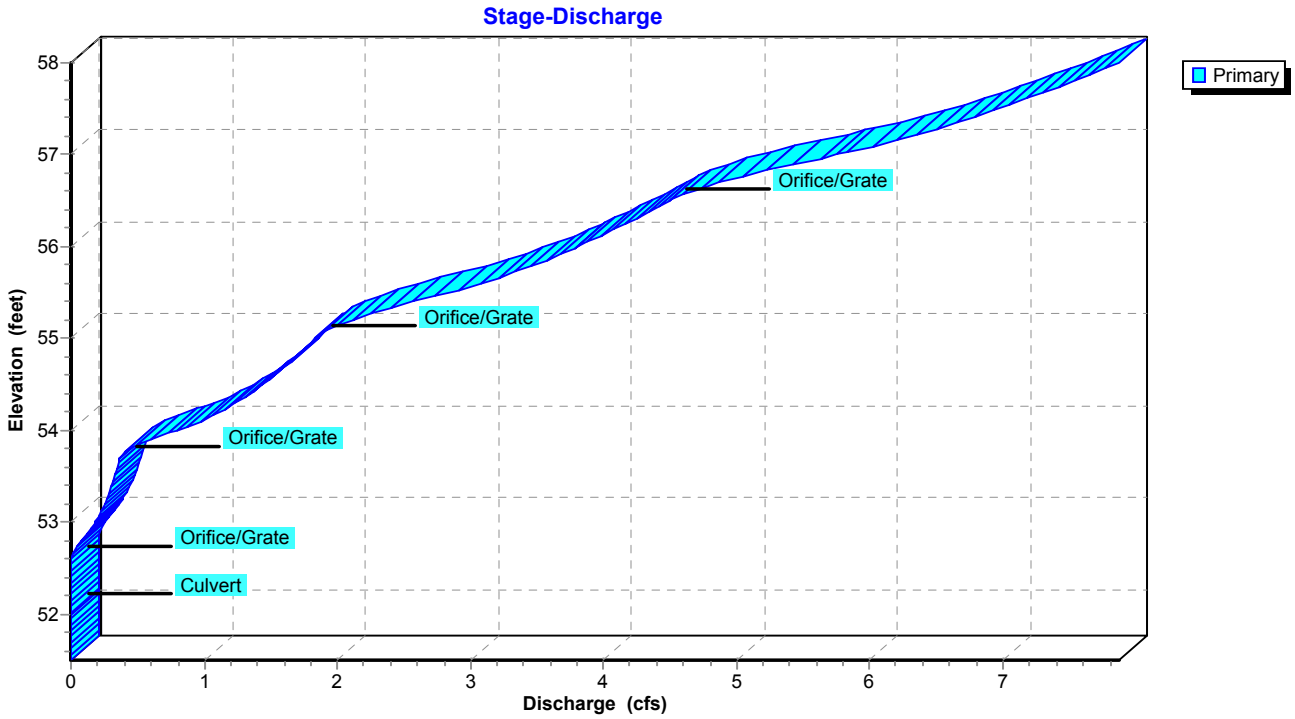
Device	Routing	Invert	Outlet Devices
#1	Primary	52.10'	**24.0" Round Culvert** L= 50.0' Ke= 0.600 Outlet Invert= 51.90' S= 0.0040 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.60'	**3.8" Vert. Orifice/Grate** C= 0.600
#3	Device 1	53.70'	**4.8" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	55.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	56.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=6.86 cfs @ 12.95 hrs HW=57.44' (Free Discharge)
- **1=Culvert** (Passes 6.86 cfs of 29.56 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.82 cfs @ 10.42 fps)
  - **3=Orifice/Grate** (Orifice Controls 2.28 cfs @ 9.07 fps)
  - **4=Orifice/Grate** (Orifice Controls 2.44 cfs @ 7.00 fps)
  - **5=Orifice/Grate** (Orifice Controls 1.31 cfs @ 3.76 fps)

Pond 1P: Basin



Pond 1P: Basin

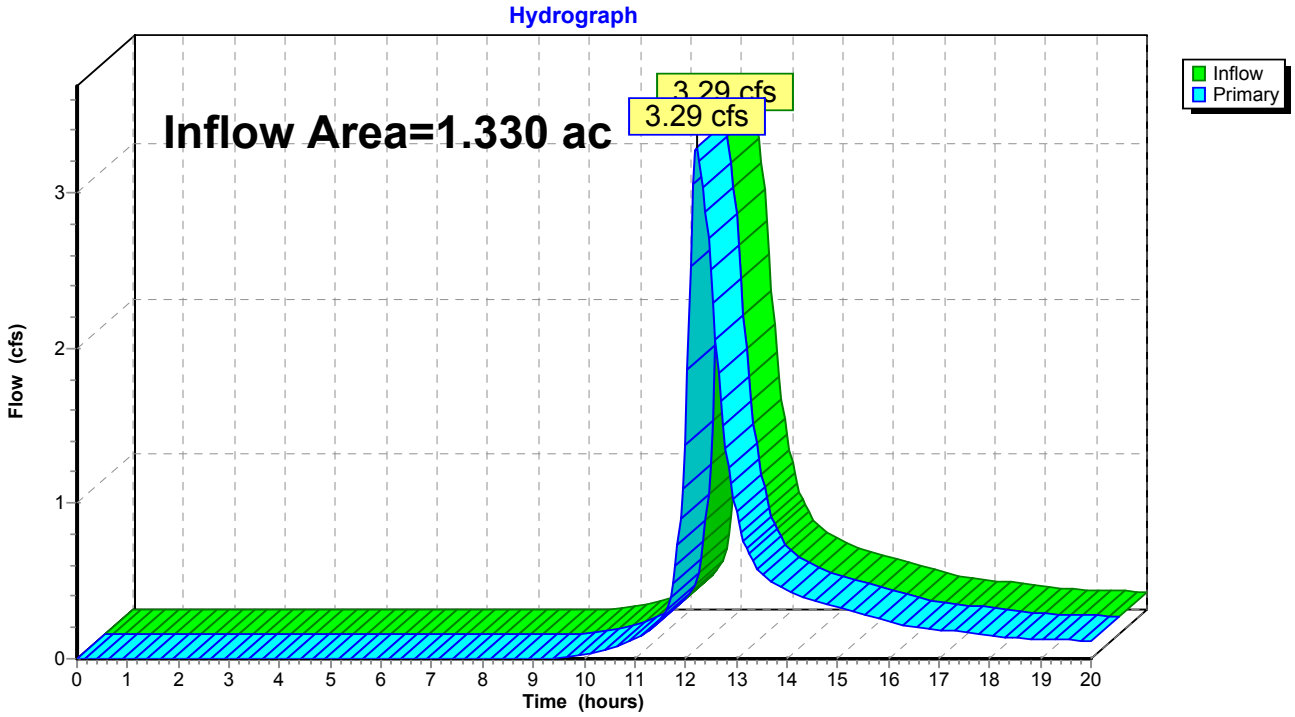


Summary for Link 1L: Point of Analysis 1 Assunpink Creek

Inflow Area = 1.330 ac, 0.00% Impervious, Inflow Depth > 3.38" for 100 Year Storm event
Inflow = 3.29 cfs @ 12.22 hrs, Volume= 0.374 af
Primary = 3.29 cfs @ 12.22 hrs, Volume= 0.374 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 1L: Point of Analysis 1 Assunpink Creek



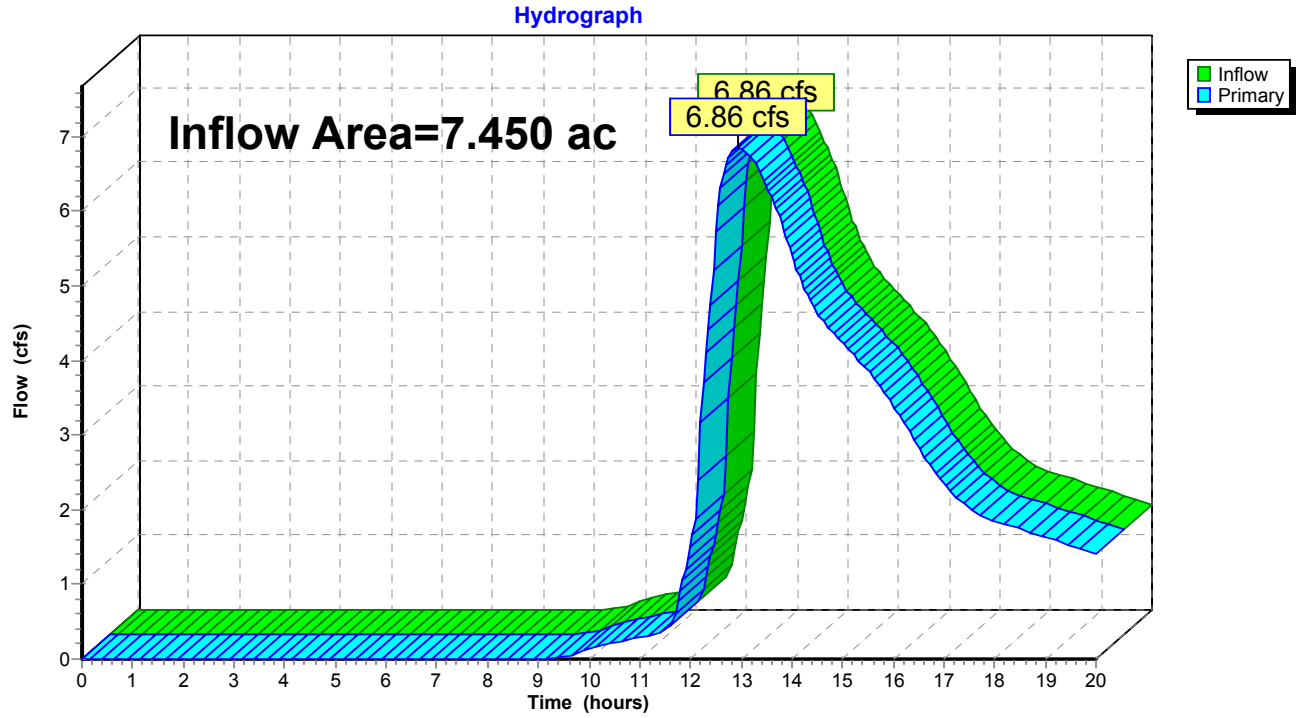
Summary for Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System

Pervious and impervious areas routed separately.

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 3.85" for 100 Year Storm event
Inflow = 6.86 cfs @ 12.95 hrs, Volume= 2.389 af
Primary = 6.86 cfs @ 12.95 hrs, Volume= 2.389 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=Delmarva
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Drainage Area 1 Runoff Area=1.330 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=132' Tc=12.6 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment 2AS: Drainage Area 2 Runoff Area=4.740 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=255' Tc=14.8 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: Drainage Area 2 Runoff Area=2.030 ac 100.00% Impervious Runoff Depth=1.03"
Tc=10.0 min CN=98 Runoff=5.33 cfs 0.175 af

Subcatchment 3AS: Drainage Area 3 Runoff Area=0.090 ac 0.00% Impervious Runoff Depth=0.00"
Tc=10.0 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: Drainage Area 3 Runoff Area=0.590 ac 100.00% Impervious Runoff Depth=1.03"
Tc=10.0 min CN=98 Runoff=1.55 cfs 0.051 af

Pond 1P: Basin Peak Elev=52.66' Storage=9,820 cf Inflow=6.88 cfs 0.226 af
Outflow=0.01 cfs 0.008 af

Link 1L: Point of Analysis 1 Assunpink Creek Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System Inflow=0.01 cfs 0.008 af
Primary=0.01 cfs 0.008 af

Total Runoff Area = 8.780 ac Runoff Volume = 0.226 af Average Runoff Depth = 0.31"
70.16% Pervious = 6.160 ac 29.84% Impervious = 2.620 ac

Summary for Subcatchment 1S: Drainage Area 1

Curve Number revised to 61 to be consistent with stormwater report and post-developed land cover.

[45] Hint: Runoff=Zero

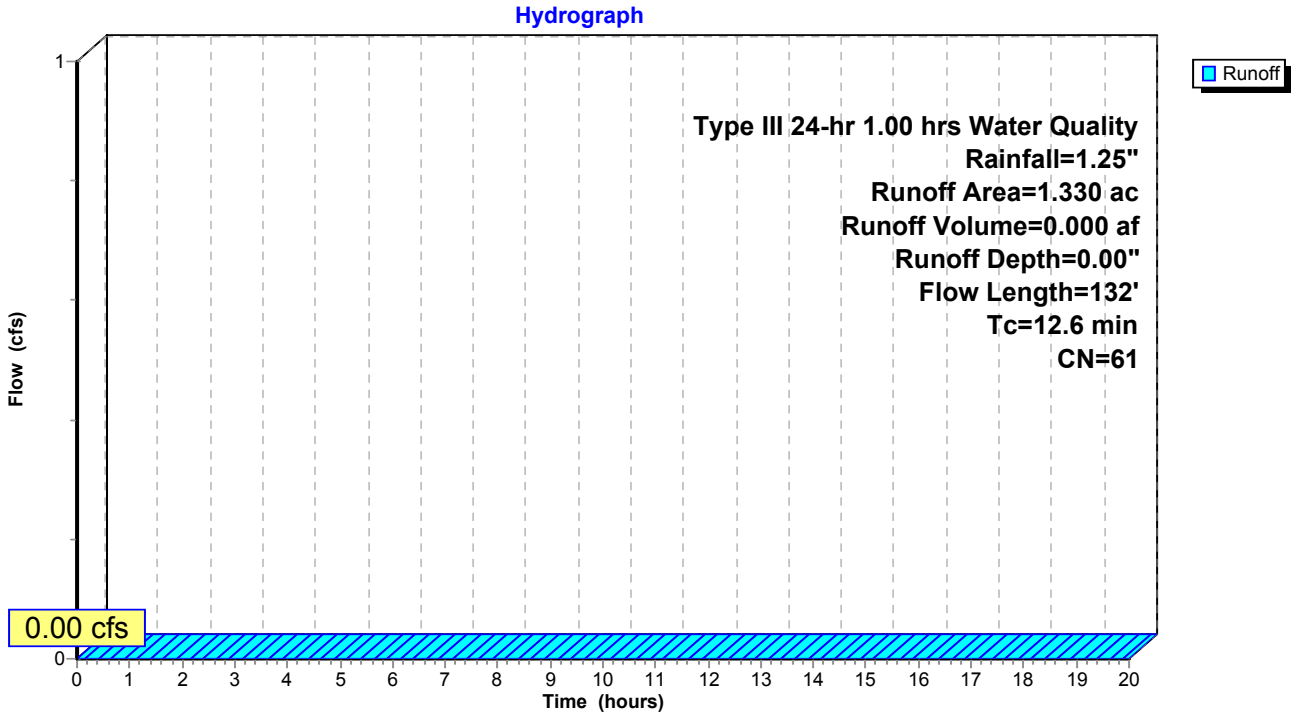
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.00 hrs Water Quality Rainfall=1.25"

	Area (ac)	CN	Description
*	1.330	61	Open Space
	1.330		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	50	0.0200	0.10		**Sheet Flow, Segment 1** Grass: Dense n= 0.240 P2= 3.30"
4.3	50	0.0370	0.19		**Sheet Flow, Segment 2** n= 0.150 P2= 3.30"
0.2	32	0.0400	3.22		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
12.6	132	Total			

Subcatchment 1S: Drainage Area 1



Summary for Subcatchment 2AS: Drainage Area 2 Pervious

[45] Hint: Runoff=Zero

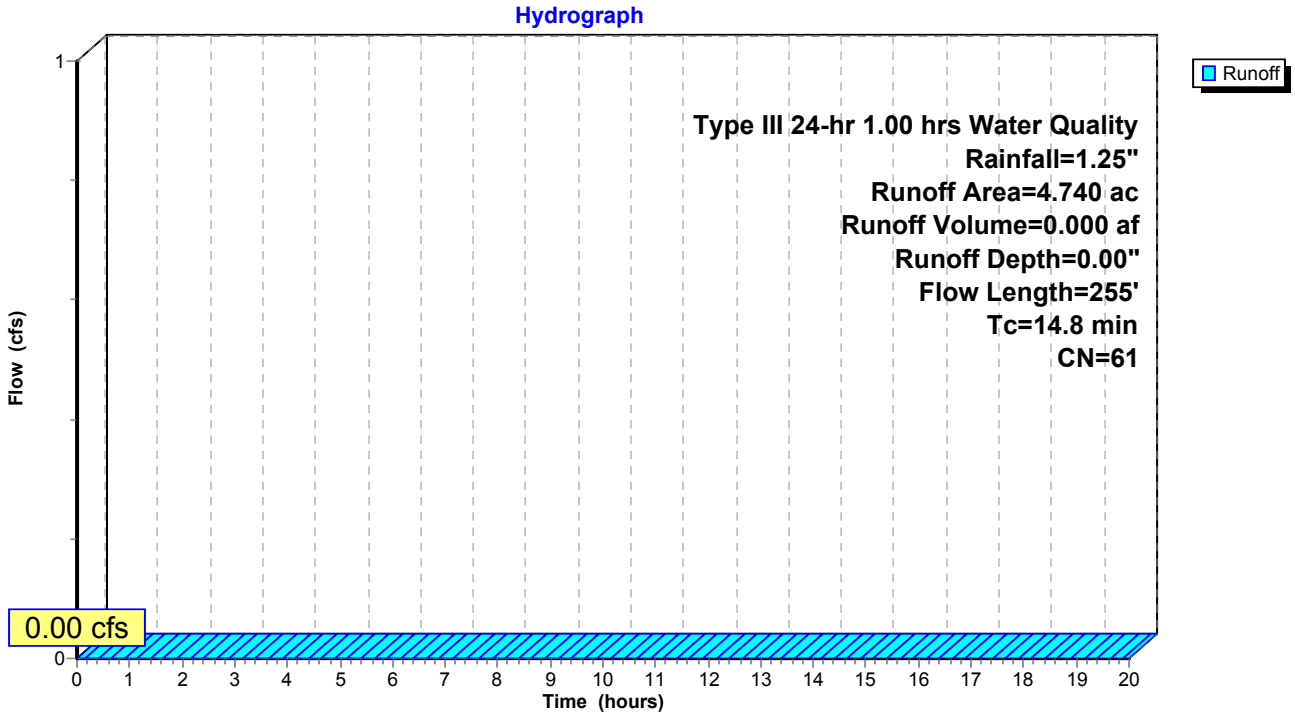
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.00 hrs Water Quality Rainfall=1.25"

	Area (ac)	CN	Description
*	4.740	61	Open Space
	4.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	100	0.0100	0.13		**Sheet Flow, Segment 1** Grass: Short n= 0.150 P2= 3.30"
2.1	155	0.0060	1.25		**Shallow Concentrated Flow, Segment 2** Unpaved Kv= 16.1 fps
14.8	255	Total			

Subcatchment 2AS: Drainage Area 2 Pervious



Summary for Subcatchment 2S: Drainage Area 2 Impervious

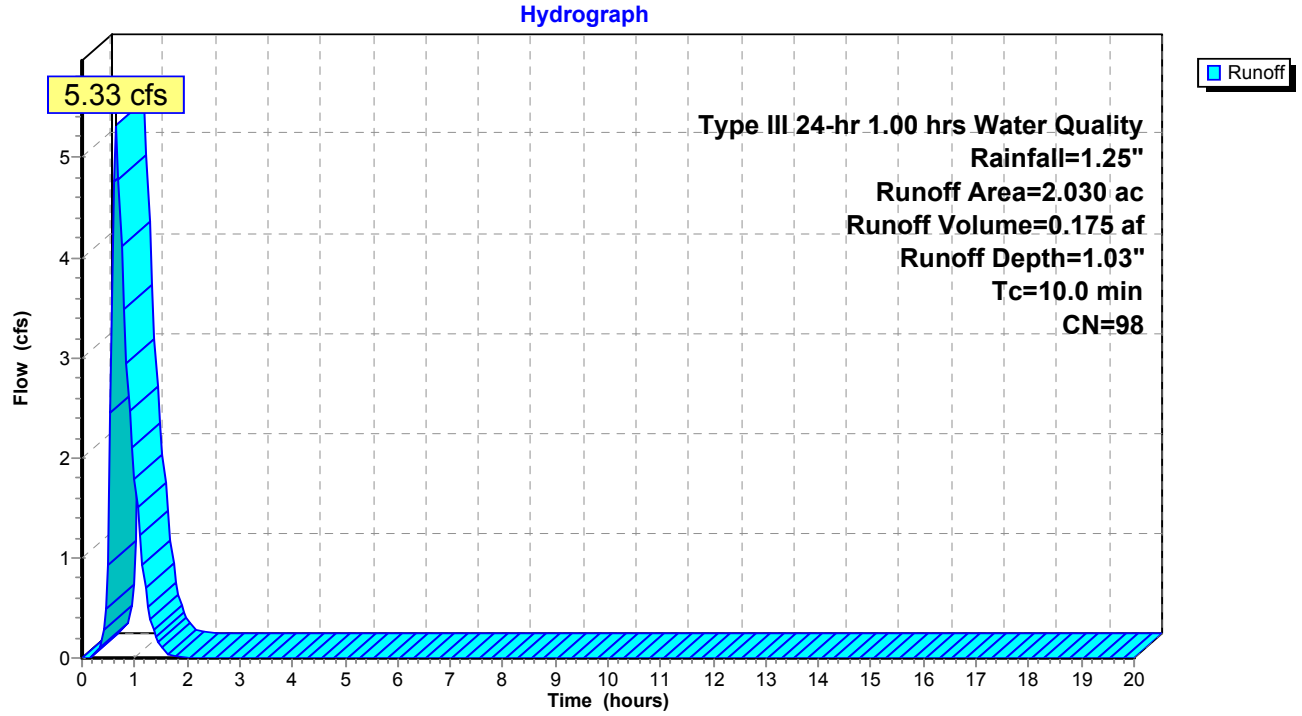
Runoff = 5.33 cfs @ 0.65 hrs, Volume= 0.175 af, Depth= 1.03"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.00 hrs Water Quality Rainfall=1.25"

	Area (ac)	CN	Description
*	2.030	98	Impervious
	2.030		100.00% Impervious Area

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

Subcatchment 2S: Drainage Area 2 Impervious



Summary for Subcatchment 3AS: Drainage Area 3 Pervious

[45] Hint: Runoff=Zero

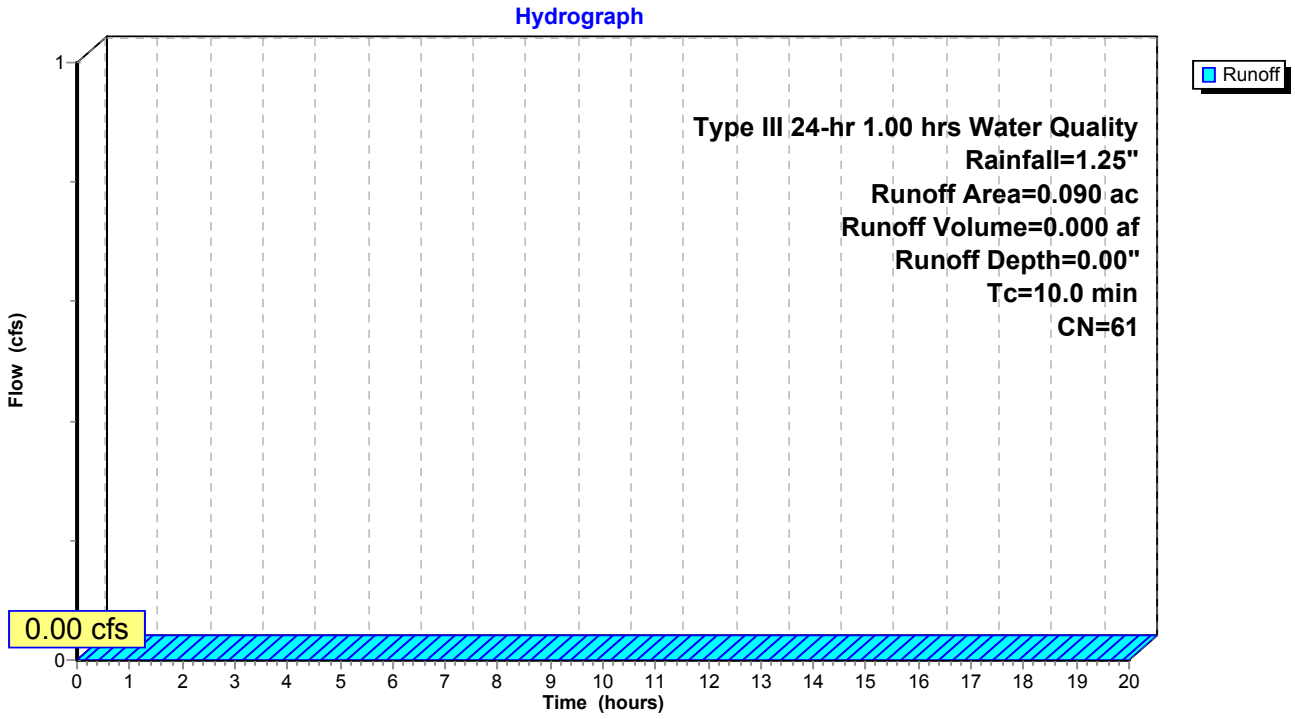
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.00 hrs Water Quality Rainfall=1.25"

	Area (ac)	CN	Description
*	0.090	61	Open Space
	0.090		100.00% Pervious Area

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

Subcatchment 3AS: Drainage Area 3 Pervious



Summary for Subcatchment 3S: Drainage Area 3 Impervious

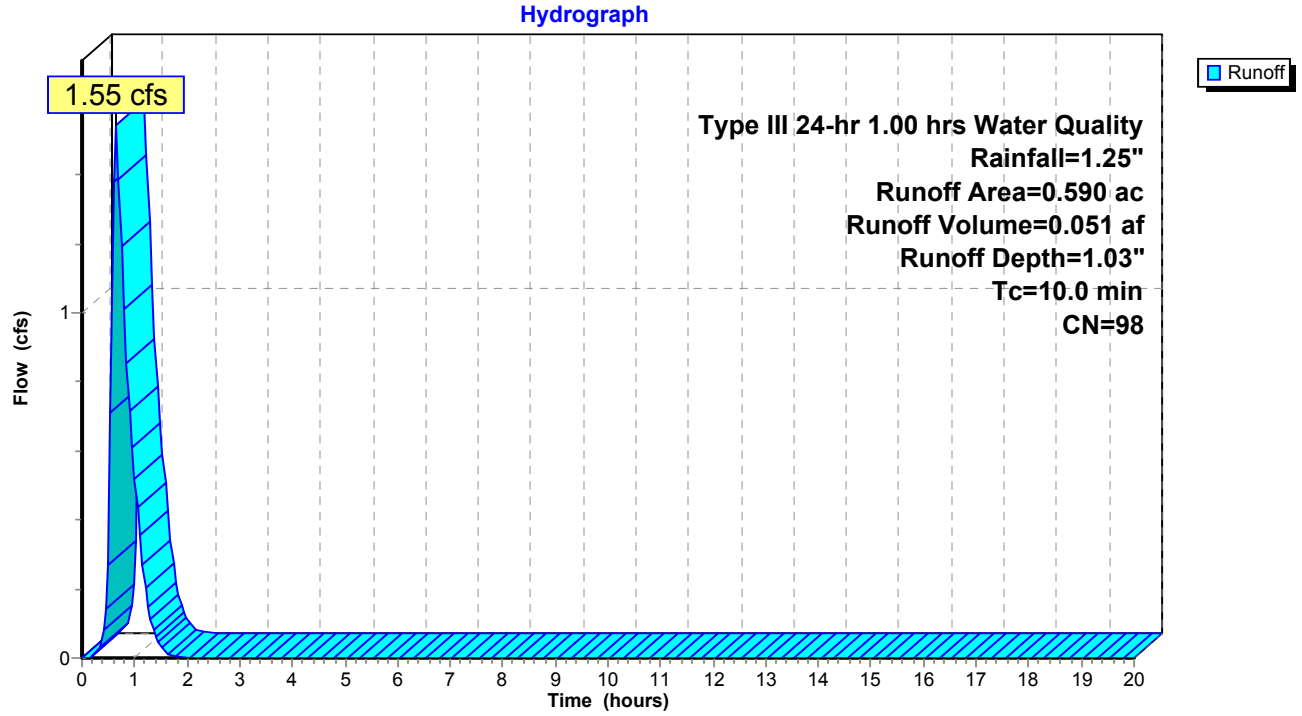
Runoff = 1.55 cfs @ 0.65 hrs, Volume= 0.051 af, Depth= 1.03"

Runoff by SCS TR-20 method, UH=Delmarva, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 1.00 hrs Water Quality Rainfall=1.25"

	Area (ac)	CN	Description
*	0.590	98	Impervious
	0.590		100.00% Impervious Area

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

Subcatchment 3S: Drainage Area 3 Impervious



Summary for Pond 1P: Basin

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth = 0.36" for Water Quality event
Inflow = 6.88 cfs @ 0.65 hrs, Volume= 0.226 af
Outflow = 0.01 cfs @ 1.82 hrs, Volume= 0.008 af, Atten= 100%, Lag= 70.3 min
Primary = 0.01 cfs @ 1.82 hrs, Volume= 0.008 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 52.66' @ 1.82 hrs Surf.Area= 0 sf Storage= 9,820 cf

Plug-Flow detention time= 492.2 min calculated for 0.008 af (4% of inflow)
Center-of-Mass det. time= 470.8 min (518.5 - 47.7)

Volume	Invert	Avail.Storage	Storage Description
#1	51.50'	76,060 cf	**Custom Stage Data** Listed below

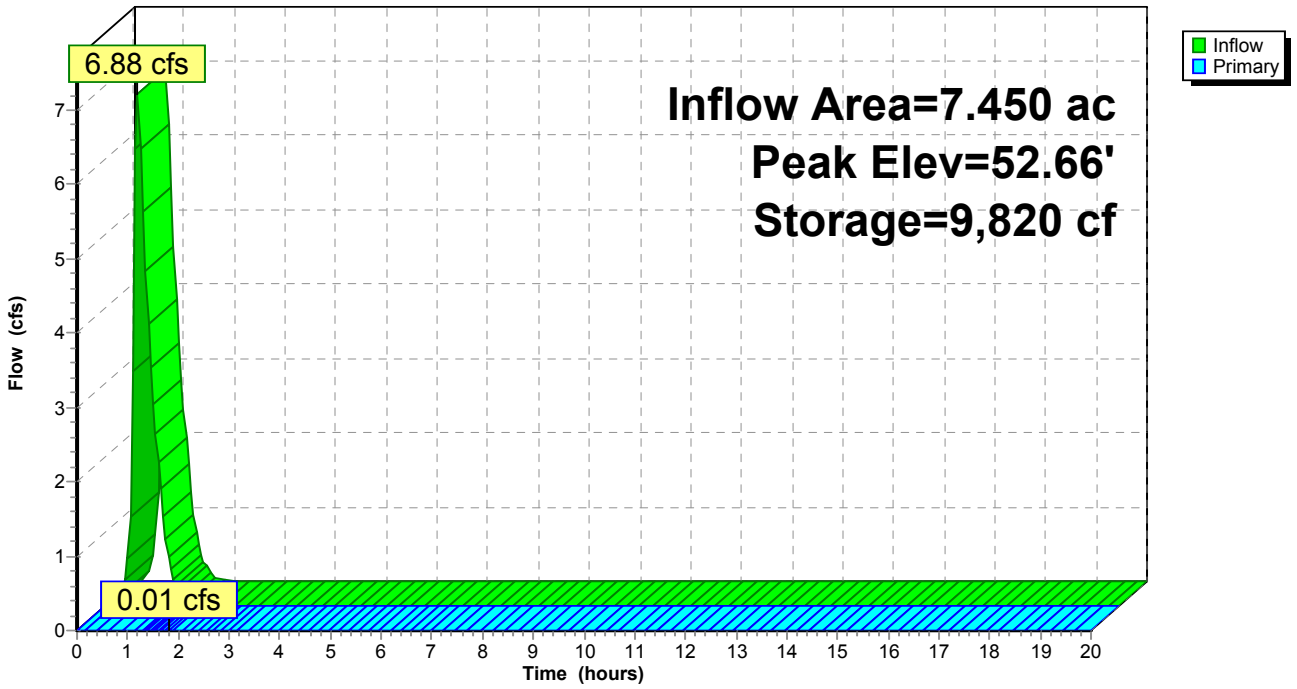
Elevation (feet)	Cum.Store (cubic-feet)
51.50	0
52.00	4,013
53.00	12,850
54.00	22,818
55.00	33,970
56.00	46,368
57.00	60,295
58.00	76,060

Device	Routing	Invert	Outlet Devices
#1	Primary	52.10'	**24.0" Round Culvert** L= 50.0' Ke= 0.600 Outlet Invert= 51.90' S= 0.0040 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.60'	**3.8" Vert. Orifice/Grate** C= 0.600
#3	Device 1	53.70'	**4.8" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	55.00'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	56.50'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.01 cfs @ 1.82 hrs HW=52.66' (Free Discharge)
└**1=Culvert** (Passes 0.01 cfs of 1.25 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.81 fps)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  ├**4=Orifice/Grate** (Controls 0.00 cfs)
  └**5=Orifice/Grate** (Controls 0.00 cfs)

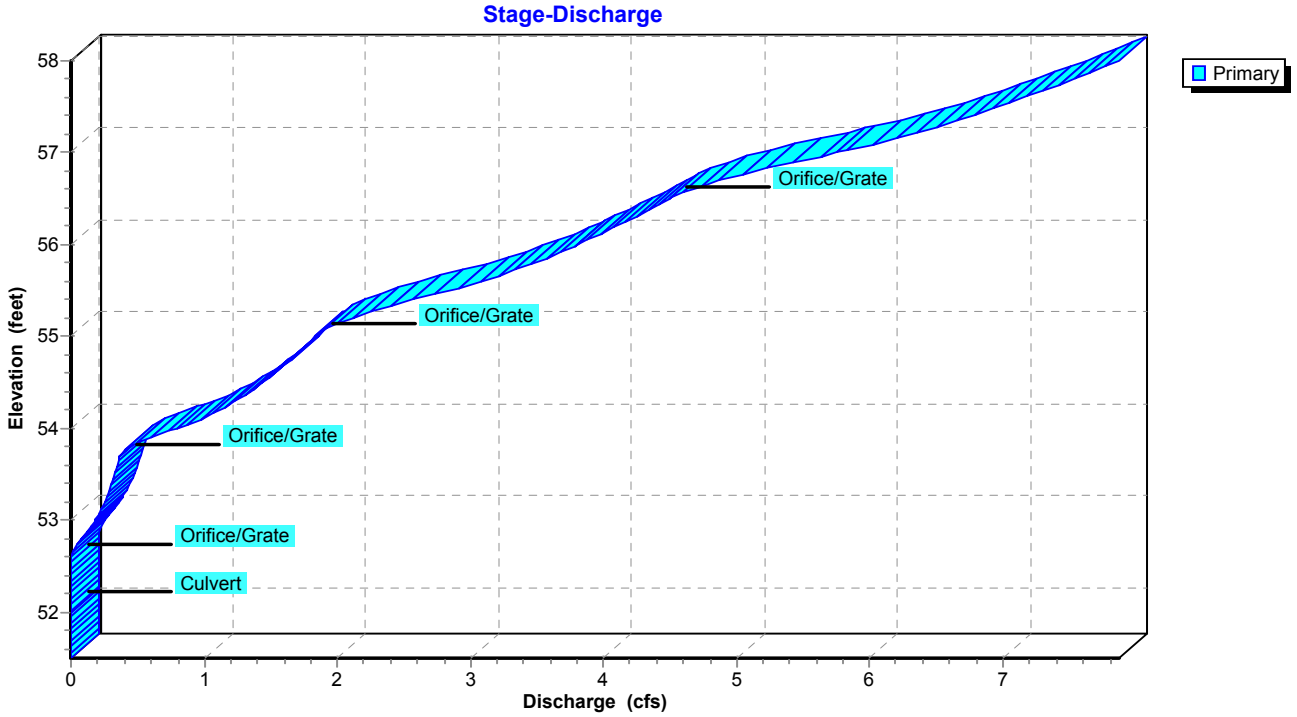
Pond 1P: Basin

Hydrograph



Pond 1P: Basin

Stage-Discharge

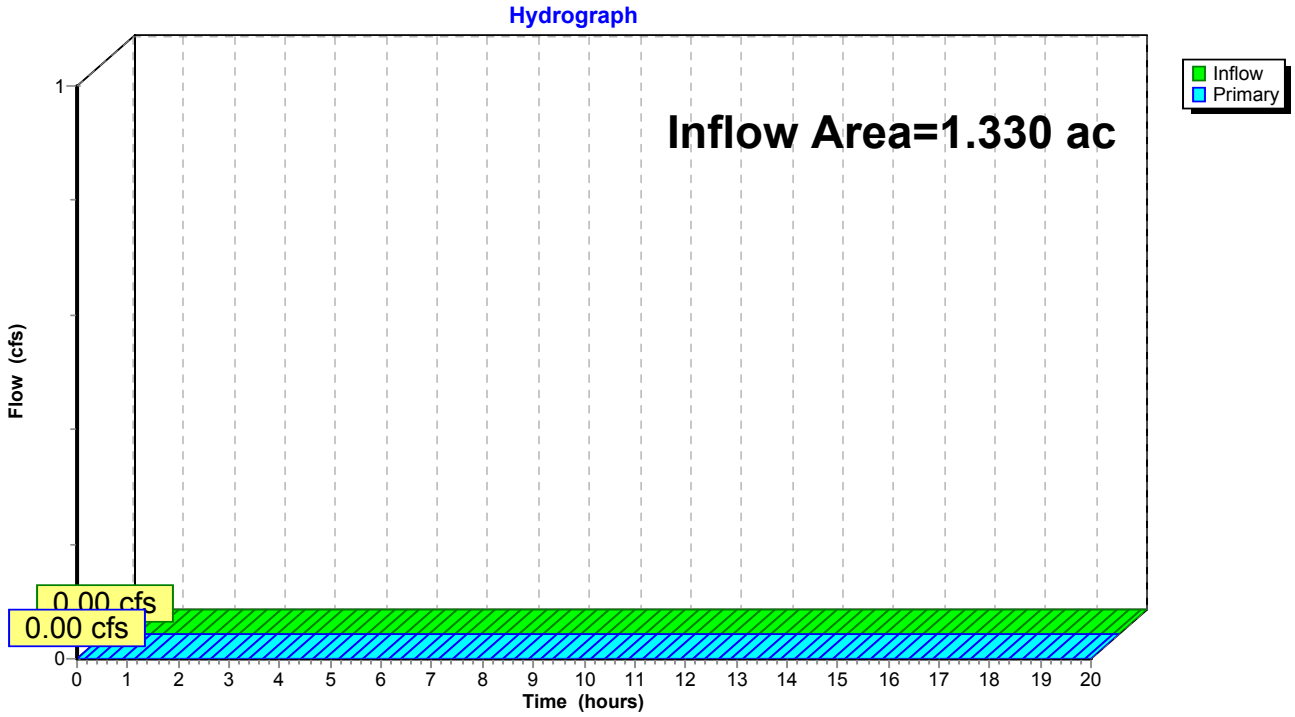


Summary for Link 1L: Point of Analysis 1 Assunpink Creek

Inflow Area = 1.330 ac, 0.00% Impervious, Inflow Depth = 0.00" for Water Quality event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 1L: Point of Analysis 1 Assunpink Creek



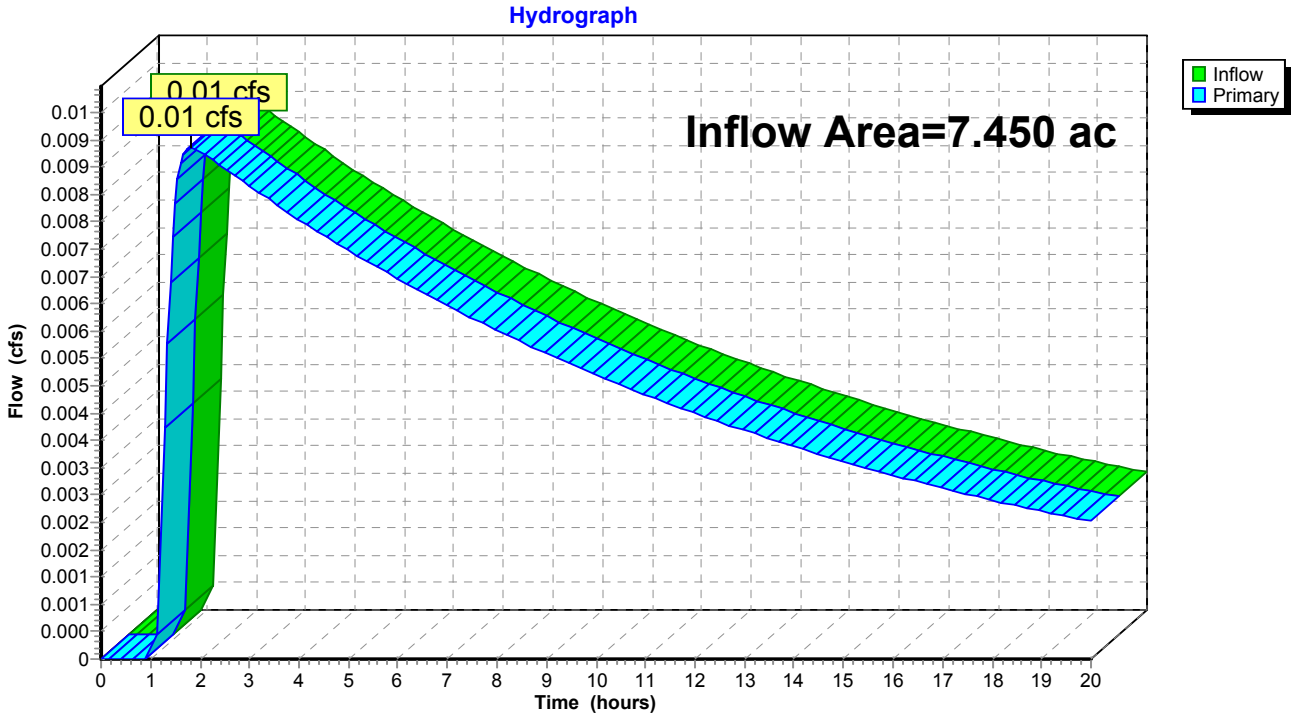
Summary for Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System

Pervious and impervious areas routed separately.

Inflow Area = 7.450 ac, 35.17% Impervious, Inflow Depth > 0.01" for Water Quality event
Inflow = 0.01 cfs @ 1.82 hrs, Volume= 0.008 af
Primary = 0.01 cfs @ 1.82 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 2L: Point of Analysis 2 Evelyn Ave Storm Sewer System



ATTACHMENT B

Aerial Photographs of Pre-existing Conditions

Terraserver Image – February 1, 2002

Terraserver Image – July 22, 2001