

Stormwater Summary

Service Restoration
300 W 83rd Street
Bloomington, MN 55420

Prepared September 20, 2023

The project consists of adding parking stalls to meet the zoning code requirements. The project size is relatively small, but triggers the requirement of a watershed permit since it exceeds 5,000 SF of land-disturbing activities. This disturbed area is less than 50% of the entire parcel, thus Section 4.3 will only apply to the new impervious. The total increased impervious area is 6,632 SF. This project requires 1.1" capture and infiltration for the additional 6,632 SF of impervious which computes to 608 CF.

To meet the stormwater requirements, an underground retention system comprised of tire derived aggregate (TDA) is proposed to capture 9,116 SF of impervious runoff from the existing front parking lot since it is nearly impossible to capture the runoff from the new impervious surfaces. Both areas drain to the same storm sewer, so the net effect is the same. The benefit is that the proposed system will capture nearly 1.5 times the area of the additional impervious.

A new catch basin is added in the existing parking lot and a solid cover is to be placed on the existing catch basin structure to keep the pipe draining through that structure off-line. The new catch basin will have both a Flogard filter and 24" sump to provide pre-treatment for the parking lot runoff prior to draining into the underground system. The underground system is comprised of a 1,200 SF footprint with three feet of TDA below grade to store stormwater. At 50% void space, that provides a total of 1,800 SF of storage. The outlet pipe is set 18" above the bottom (net 9" due to 50% voids) of the system which provides 900 CF of infiltration storage which exceeds the required 608 CF of storage by almost 1.5 times to provide a factor of safety.

The existing soil type is SP-SM with a classification of soil type B which will allow for full infiltration of the net 9" depth of water in the system in less than 24 hours based on 0.5" per hour which allows for a factor of safety of more than two based on the 48 hour requirement.

In addition to meeting the infiltration requirement, the chart below shows that the proposed runoff rates from the site are less than existing.

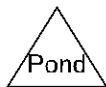
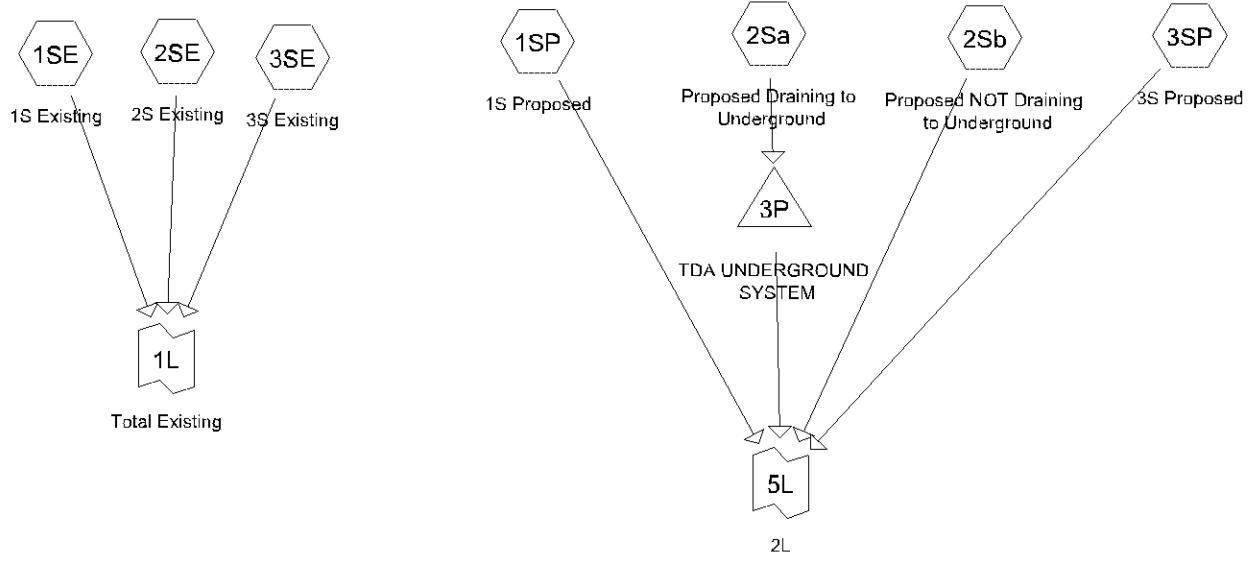
Runoff Rates Existing vs Proposed			
	2-Year	10-Year	100-Year
1L Existing	4.42	7.4	14.36
2L Proposed	4.06	7.19	13.93

Please see the civil plans, enclosed drainage maps and HydroCad report for more information related to the project.

Thank you for your consideration,



Lance A. Elliott, PE



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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
22,786	61	>75% Grass cover, Good, HSG B (1SE, 1SP, 2Sb, 2SE, 3SE, 3SP)
35,467	98	Parking (2Sb, 2SE, 3SE, 3SP)
9,116	98	Parking Lot (2Sa)
4,865	98	Roofs (2Sb)
33,485	98	Roofs, HSG A (1SE, 1SP, 2SE)
2,402	98	Walks (2Sb, 2SE)
108,121	90	TOTAL AREA

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Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
33,485	HSG A	1SE, 1SP, 2SE
22,786	HSG B	1SE, 1SP, 2Sb, 2SE, 3SE, 3SP
0	HSG C	
0	HSG D	
51,850	Other	2Sa, 2Sb, 2SE, 3SE, 3SP
108,121		TOTAL AREA

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Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcat Number
0	22,786	0	0	0	22,786	>75% Grass cover, Good	
0	0	0	0	35,467	35,467	Parking	
0	0	0	0	9,116	9,116	Parking Lot	
33,485	0	0	0	4,865	38,350	Roofs	
0	0	0	0	2,402	2,402	Walks	
33,485	22,786	0	0	51,850	108,121	TOTAL AREA	

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	825.50	824.60	18.0	0.0500	0.010	12.0	0.0	0.0

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MSE 24-hr 3 2-Year Rainfall=2.85"

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

Subcatchment1SE: 1S Existing Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=1.93"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=1.63 cfs 2,882 cf

Subcatchment1SP: 1S Proposed Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=1.93"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=1.63 cfs 2,882 cf

Subcatchment2Sa: ProposedDrainngto Runoff Area=9,116 sf 100.00% Impervious Runoff Depth=2.62"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=98 Runoff=0.97 cfs 1,990 cf

Subcatchment2Sb: ProposedNOT Drainingto Runoff Area=24,328 sf 91.69% Impervious Runoff Depth=2.30"
 Flow Length=100' Slope=0.0500 '/' Tc=0.9 min CN=95 Runoff=2.46 cfs 4,669 cf

Subcatchment2SE: 2S Existing Runoff Area=33,445 sf 73.39% Impervious Runoff Depth=1.69"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=88 Runoff=2.73 cfs 4,698 cf

Subcatchment3SE: 3S Existing Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=0.47"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.06 cfs 107 cf

Subcatchment3SP: 3S Proposed Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=0.47"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.06 cfs 107 cf

Pond 3P: TDA UNDERGROUND SYSTEM Peak Elev=825.70' Storage=1,019 cf Inflow=0.97 cfs 1,990 cf
 Discarded=0.01 cfs 1,141 cf Primary=0.17 cfs 464 cf Outflow=0.18 cfs 1,606 cf

Link 1L: Total Existing Inflow=4.42 cfs 7,687 cf
 Primary=4.42 cfs 7,687 cf

Link 5L: 2L Inflow=4.06 cfs 8,123 cf
 Primary=4.06 cfs 8,123 cf

Total Runoff Area = 108,121 sf Runoff Volume = 17,335 cf Average Runoff Depth = 1.92"
21.07% Pervious = 22,786 sf 78.93% Impervious = 85,335 sf

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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 1SE: 1S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 1.63 cfs @ 12.08 hrs, Volume= 2,882 cf, Depth= 1.93"

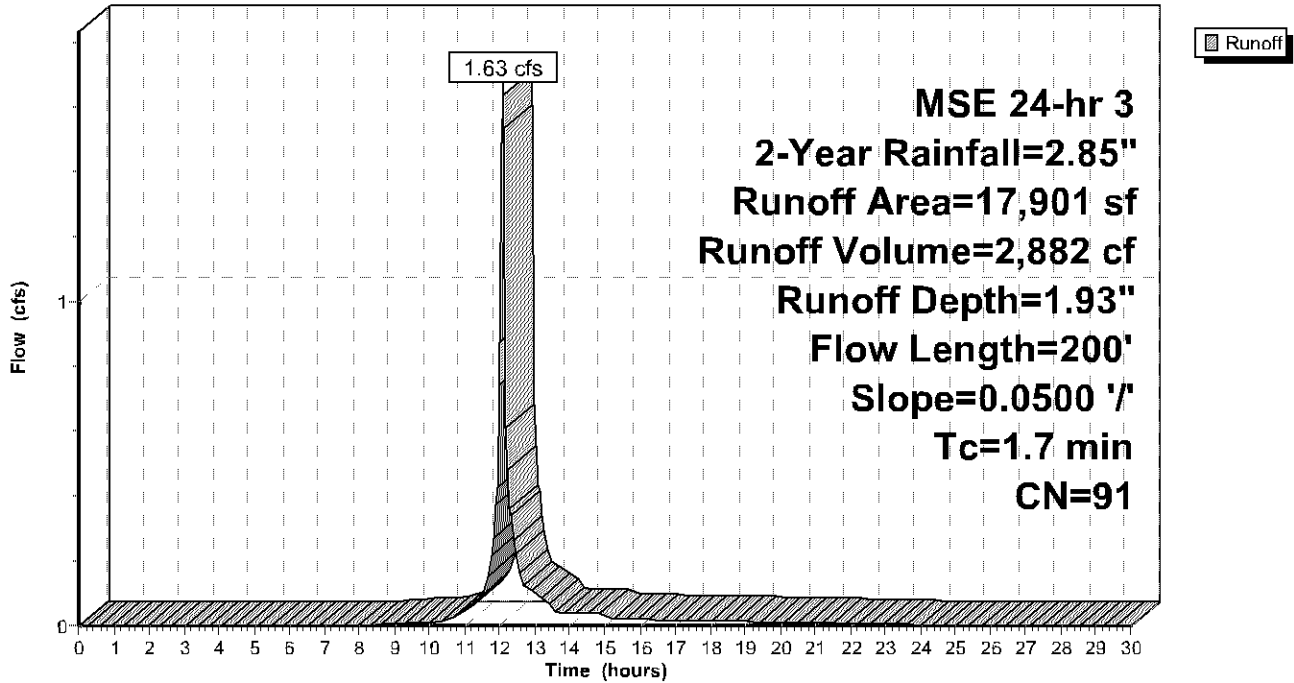
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
 MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SE: 1S Existing

Hydrograph



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 1SP: 1S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

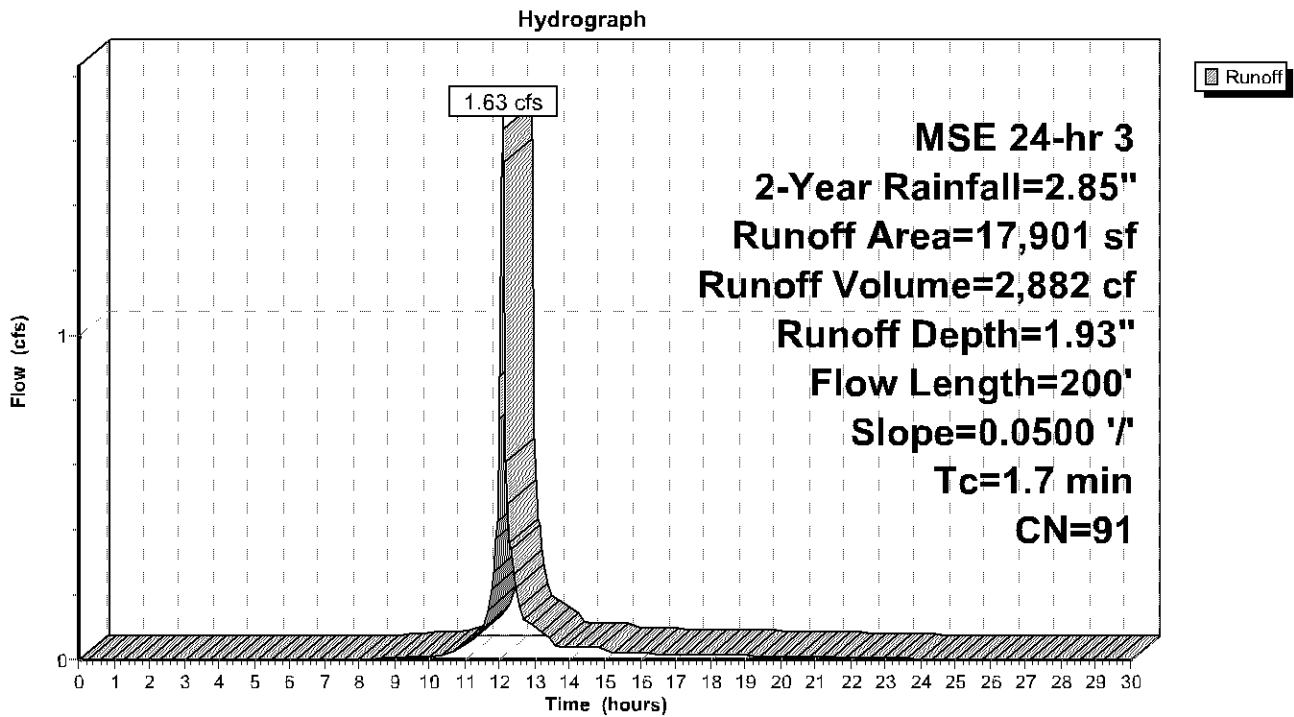
Runoff = 1.63 cfs @ 12.08 hrs, Volume= 2,882 cf, Depth= 1.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SP: 1S Proposed



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 2Sa: Proposed Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

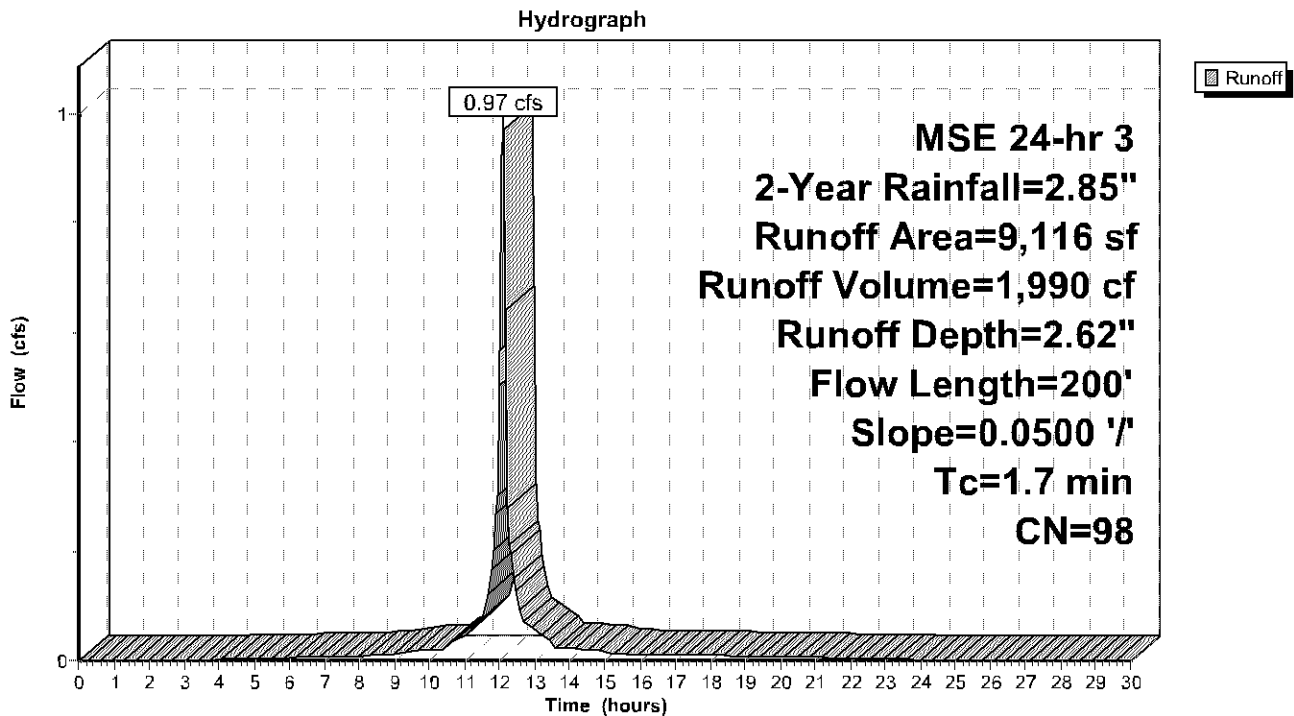
Runoff = 0.97 cfs @ 12.07 hrs, Volume= 1,990 cf, Depth= 2.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
9,116	98	Parking Lot
9,116		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2Sa: Proposed Draining to Underground



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Summary for Subcatchment 2Sb: Proposed NOT Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

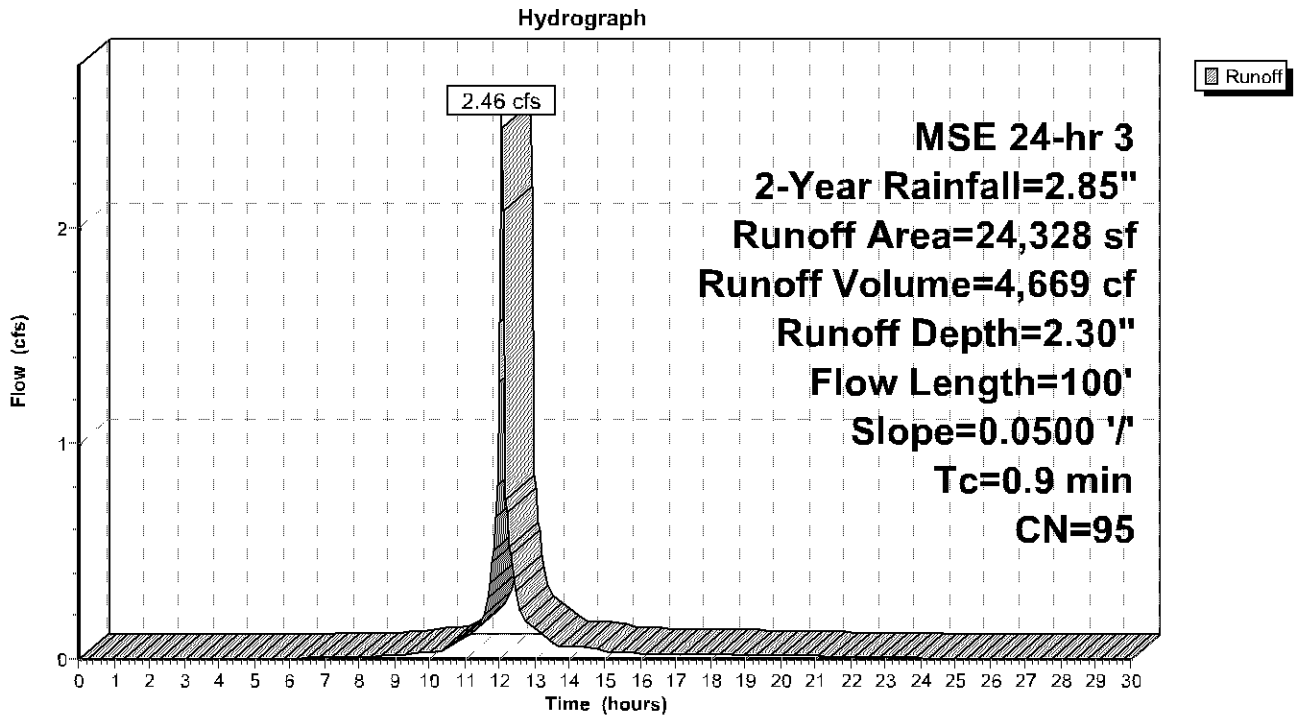
Runoff = 2.46 cfs @ 12.06 hrs, Volume= 4,669 cf, Depth= 2.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 2-Year Rainfall=2.85"

	Area (sf)	CN	Description
*	4,865	98	Roofs
*	1,812	98	Walks
*	15,630	98	Parking
	2,021	61	>75% Grass cover, Good, HSG B
	24,328	95	Weighted Average
	2,021		8.31% Pervious Area
	22,307		91.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0500	1.86		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"

Subcatchment 2Sb: Proposed NOT Draining to Underground



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 2SE: 2S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

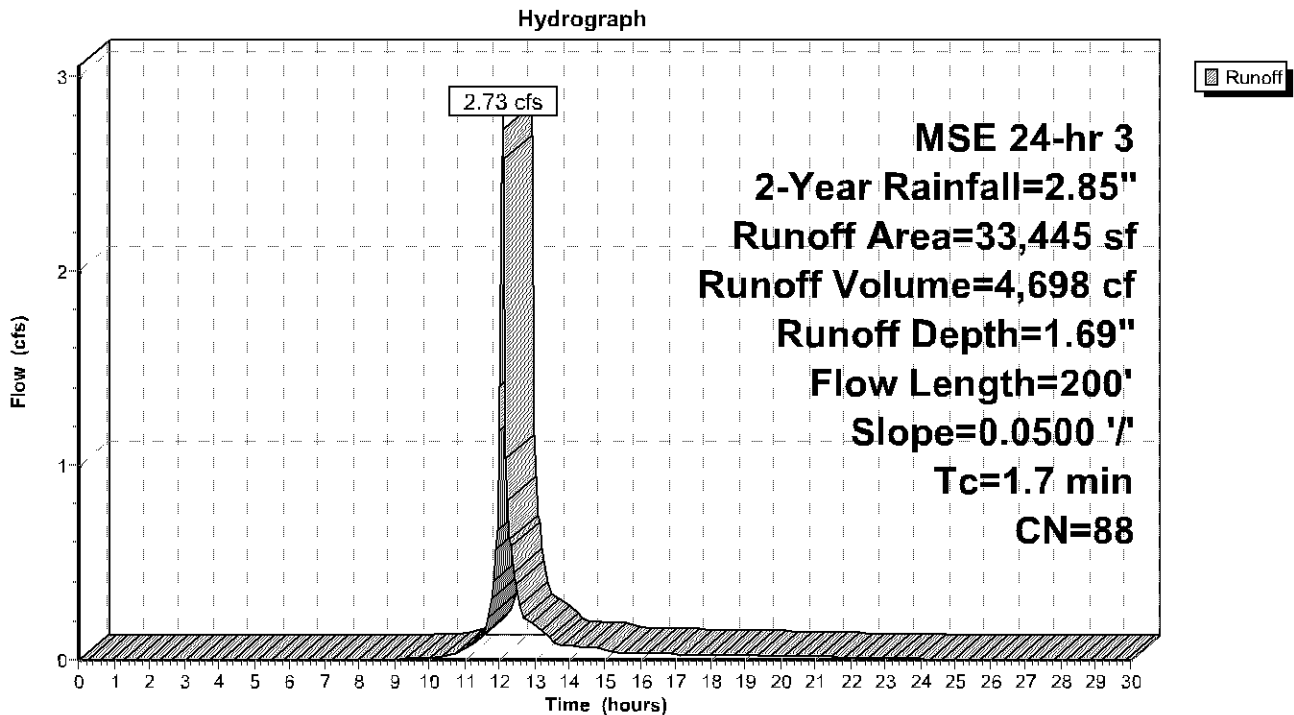
Runoff = 2.73 cfs @ 12.08 hrs, Volume= 4,698 cf, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
4,865	98	Roofs, HSG A
* 590	98	Walks
* 19,091	98	Parking
8,899	61	>75% Grass cover, Good, HSG B
33,445	88	Weighted Average
8,899		26.61% Pervious Area
24,546		73.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.62		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
1.2	150	0.0500	2.01		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2SE: 2S Existing



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 3SE: 3S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

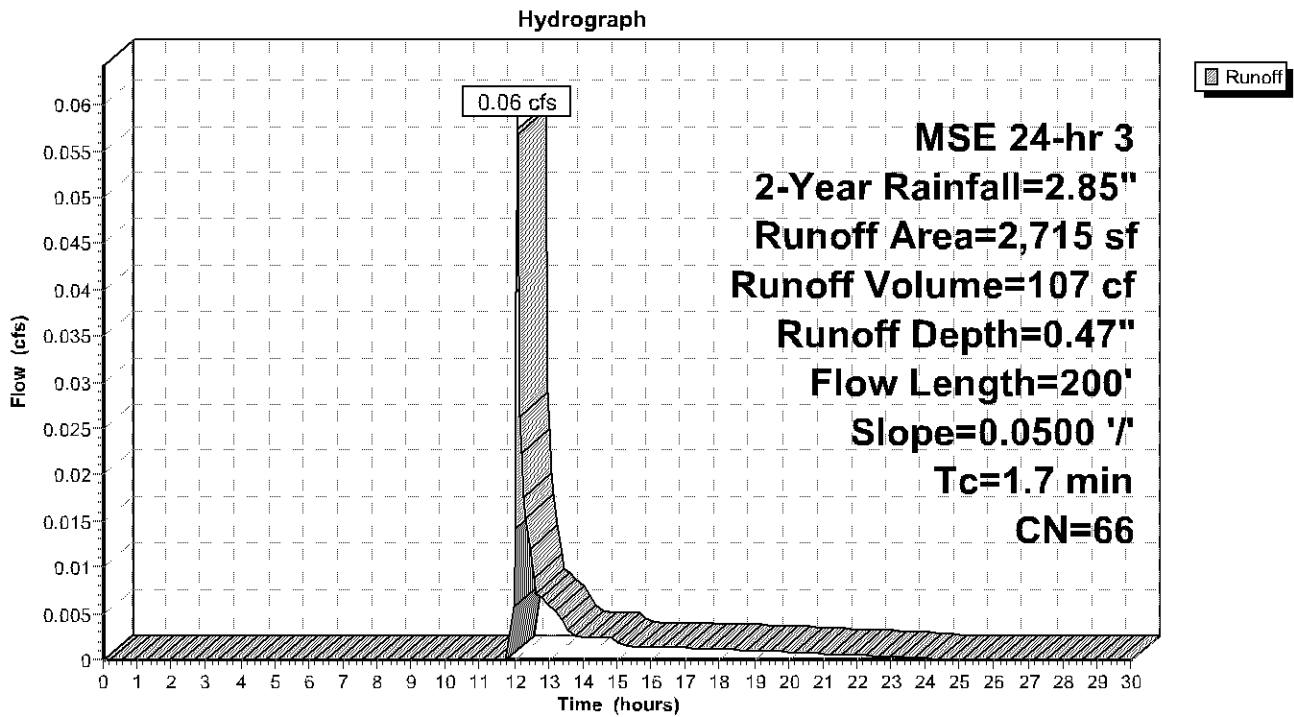
Runoff = 0.06 cfs @ 12.09 hrs, Volume= 107 cf, Depth= 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SE: 3S Existing



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Subcatchment 3SP: 3S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

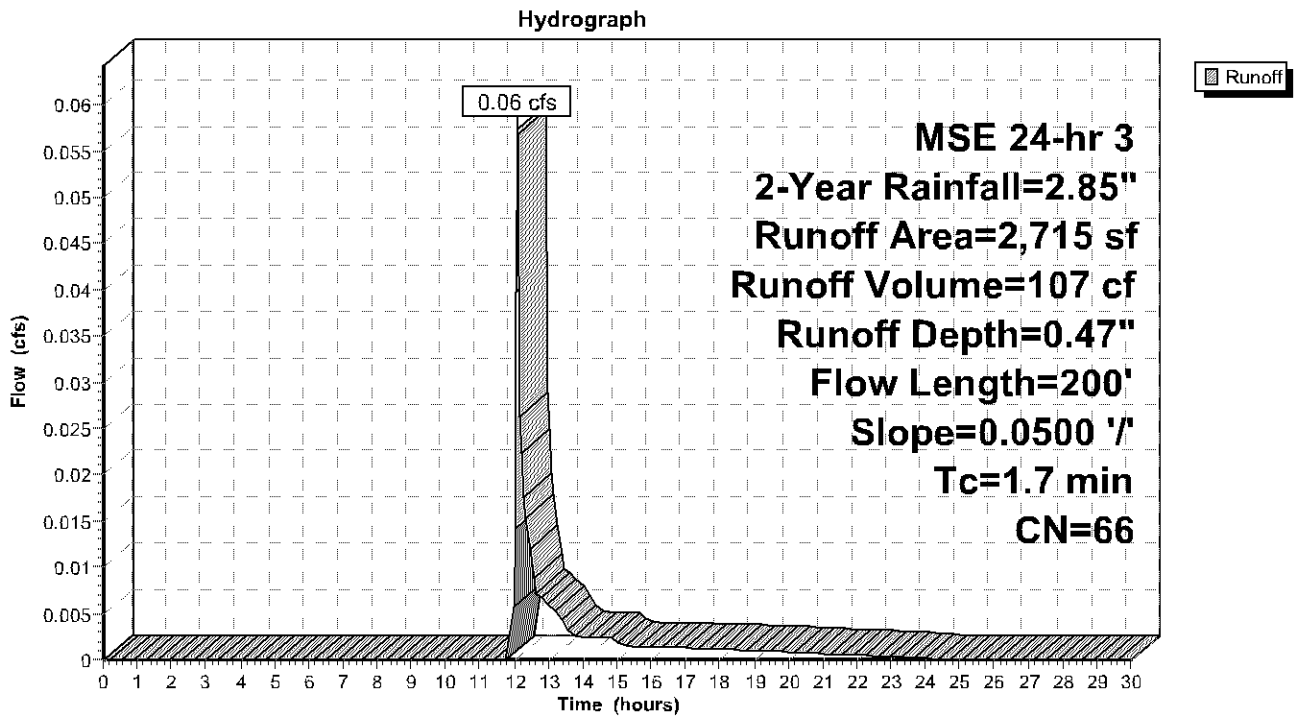
Runoff = 0.06 cfs @ 12.09 hrs, Volume= 107 cf, Depth= 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 2-Year Rainfall=2.85"

Area (sf)	CN	Description
* 373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SP: 3S Proposed



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MSE 24-hr 3 2-Year Rainfall=2.85"

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Summary for Pond 3P: TDA UNDERGROUND SYSTEM

Inflow Area = 9,116 sf, 100.00% Impervious, Inflow Depth = 2.62" for 2-Year event
 Inflow = 0.97 cfs @ 12.07 hrs, Volume= 1,990 cf
 Outflow = 0.18 cfs @ 12.31 hrs, Volume= 1,606 cf, Atten= 81%, Lag= 14.4 min
 Discarded = 0.01 cfs @ 9.45 hrs, Volume= 1,141 cf
 Primary = 0.17 cfs @ 12.31 hrs, Volume= 464 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
 Peak Elev= 825.70' @ 12.31 hrs Surf.Area= 1,200 sf Storage= 1,019 cf

Plug-Flow detention time=320.8 min calculated for 1,603 cf (81% of inflow)
 Center-of-Mass det. time=264.2 min (1,014.0 - 749.8)

Volume	Invert	Avail.Storage	Storage Description
#1	824.00'	1,800 cf	Custom Stage Data (Prismatic) listed below (Recalc) 3,600 cf Overall x 50.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
824.00	1,200	0	0
825.50	1,200	1,800	1,800
827.00	1,200	1,800	3,600

Device	Routing	Invert	Outlet Devices
#1	Device 2	825.50'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	825.50'	12.0" Round Culvert L= 18.0' Ke= 0.500 Inlet / Outlet Invert= 825.50' / 824.60' S= 0.0500'/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.79 sf
#3	Discarded	824.00'	0.500 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.01 cfs @ 9.45 hrs HW=824.03' (Free Discharge)
 ↑ **3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.17 cfs @ 12.31 hrs HW=825.70' (Free Discharge)
 ↑ **2=Culvert** (Controls 0.17 cfs)
 ↑ **1=Orifice/Grate** (Orifice Controls 0.17 cfs @ 1.52 fps)

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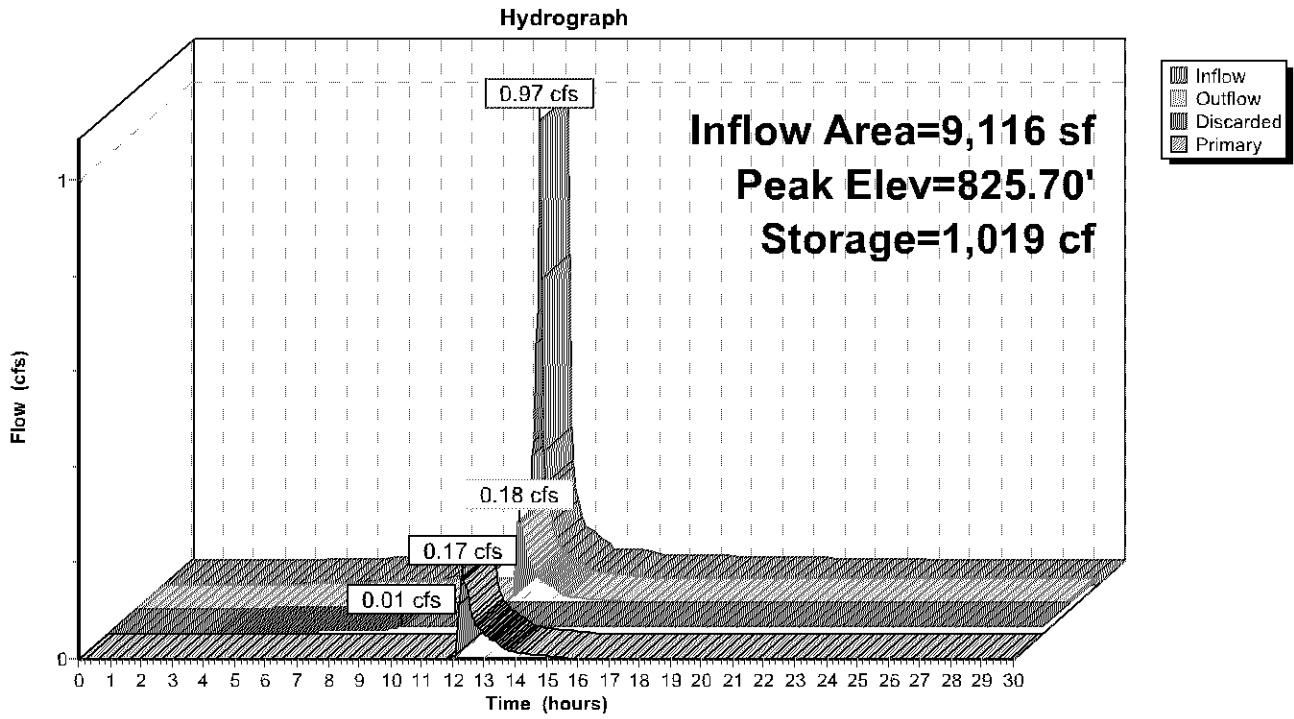
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Pond 3P: TDA UNDERGROUND SYSTEM



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MSE 24-hr 3 2-Year Rainfall=2.85"

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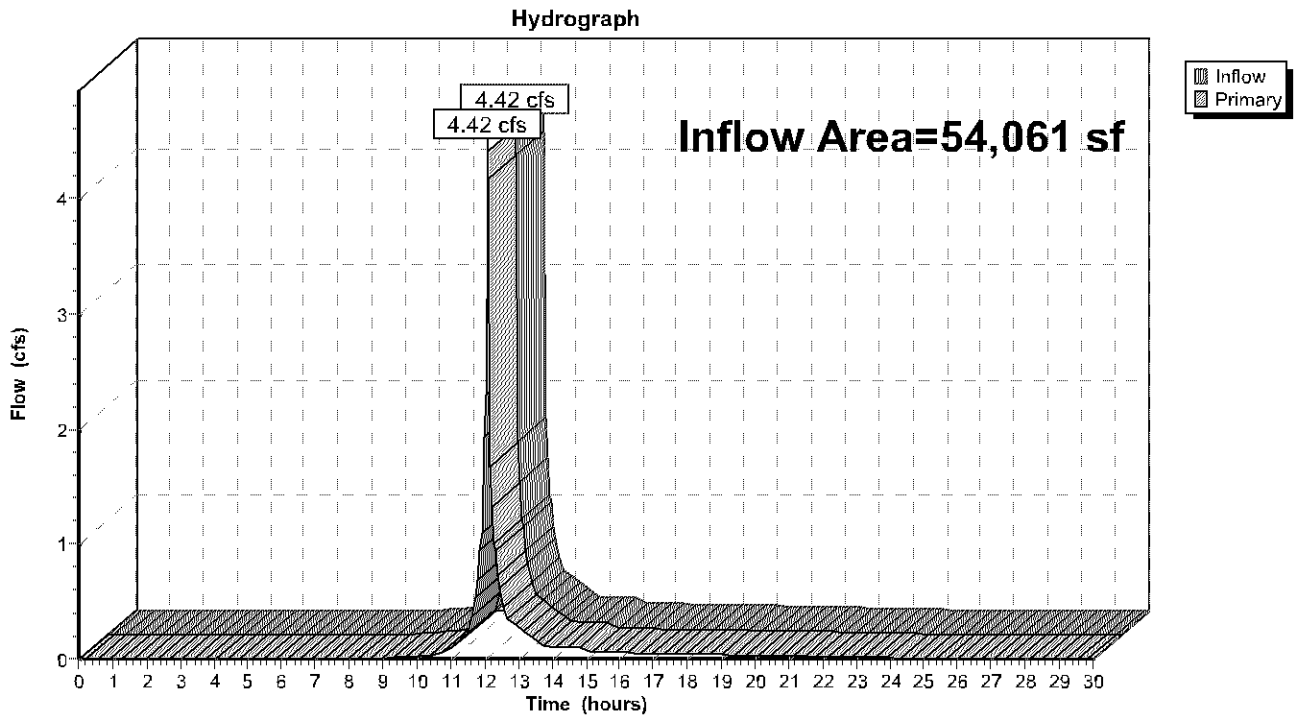
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Summary for Link 1L: Total Existing

Inflow Area = 54,061 sf, 72.56% Impervious, Inflow Depth = 1.71" for 2-Year event
Inflow = 4.42 cfs @ 12.08 hrs, Volume= 7,687 cf
Primary = 4.42 cfs @ 12.08 hrs, Volume= 7,687 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Total Existing



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MSE 24-hr 3 2-Year Rainfall=2.85"

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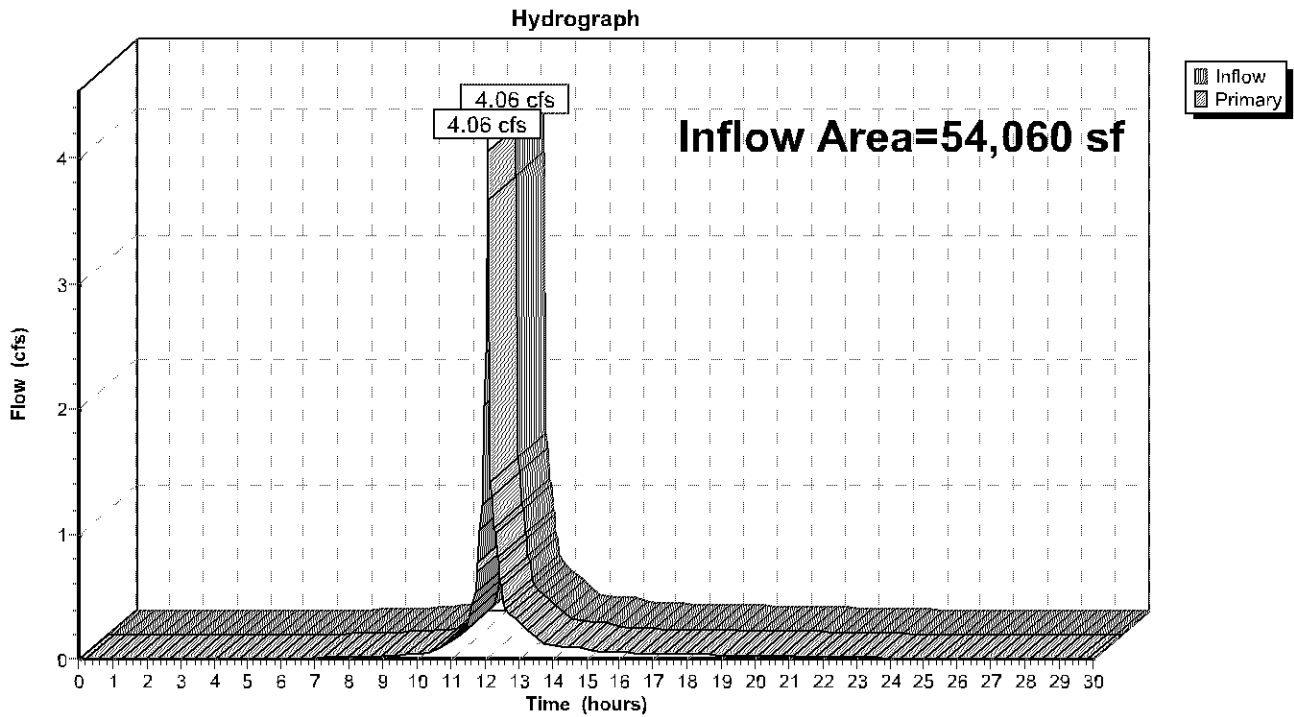
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Summary for Link 5L: 2L

Inflow Area = 54,060 sf, 85.29% Impervious, Inflow Depth = 1.80" for 2-Year event
Inflow = 4.06 cfs @ 12.07 hrs, Volume= 8,123 cf
Primary = 4.06 cfs @ 12.07 hrs, Volume= 8,123 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 5L: 2L



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MSE 24-hr 3 10-Year Rainfall=4.22"

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

Subcatchment1SE: 1S Existing Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=3.23"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=2.64 cfs 4,816 cf

Subcatchment1SP: 1S Proposed Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=3.23"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=2.64 cfs 4,816 cf

Subcatchment2Sa: ProposedDrainngto Runoff Area=9,116 sf 100.00% Impervious Runoff Depth=3.98"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=98 Runoff=1.45 cfs 3,027 cf

Subcatchment2Sb: ProposedNOT Drainingto Runoff Area=24,328 sf 91.69% Impervious Runoff Depth=3.65"
 Flow Length=100' Slope=0.0500 '/' Tc=0.9 min CN=95 Runoff=3.78 cfs 7,396 cf

Subcatchment2SE: 2S Existing Runoff Area=33,445 sf 73.39% Impervious Runoff Depth=2.93"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=88 Runoff=4.60 cfs 8,177 cf

Subcatchment3SE: 3S Existing Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=1.22"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.16 cfs 276 cf

Subcatchment3SP: 3S Proposed Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=1.22"
 Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.16 cfs 276 cf

Pond 3P: TDA UNDERGROUND SYSTEM Peak Elev=826.03' Storage=1,220 cf Inflow=1.45 cfs 3,027 cf
 Discarded=0.01 cfs 1,226 cf Primary=1.04 cfs 1,335 cf Outflow=1.06 cfs 2,561 cf

Link 1L: Total Existing Inflow=7.40 cfs 13,269 cf
 Primary=7.40 cfs 13,269 cf

Link 5L: 2L Inflow=7.19 cfs 13,822 cf
 Primary=7.19 cfs 13,822 cf

Total Runoff Area = 108,121 sf Runoff Volume = 28,783 cf Average Runoff Depth = 3.19"
21.07% Pervious = 22,786 sf 78.93% Impervious = 85,335 sf

9-19-23

MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 1SE: 1S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

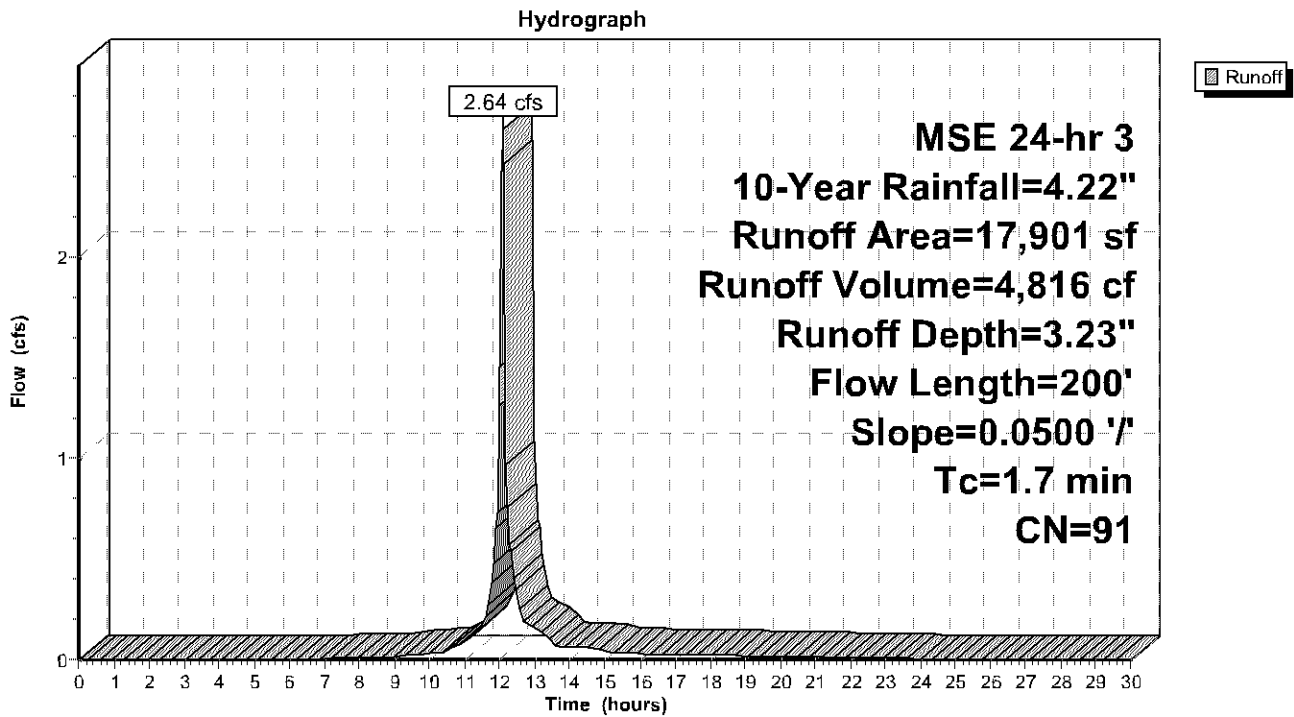
Runoff = 2.64 cfs @ 12.08 hrs, Volume= 4,816 cf, Depth= 3.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SE: 1S Existing



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 1SP: 1S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

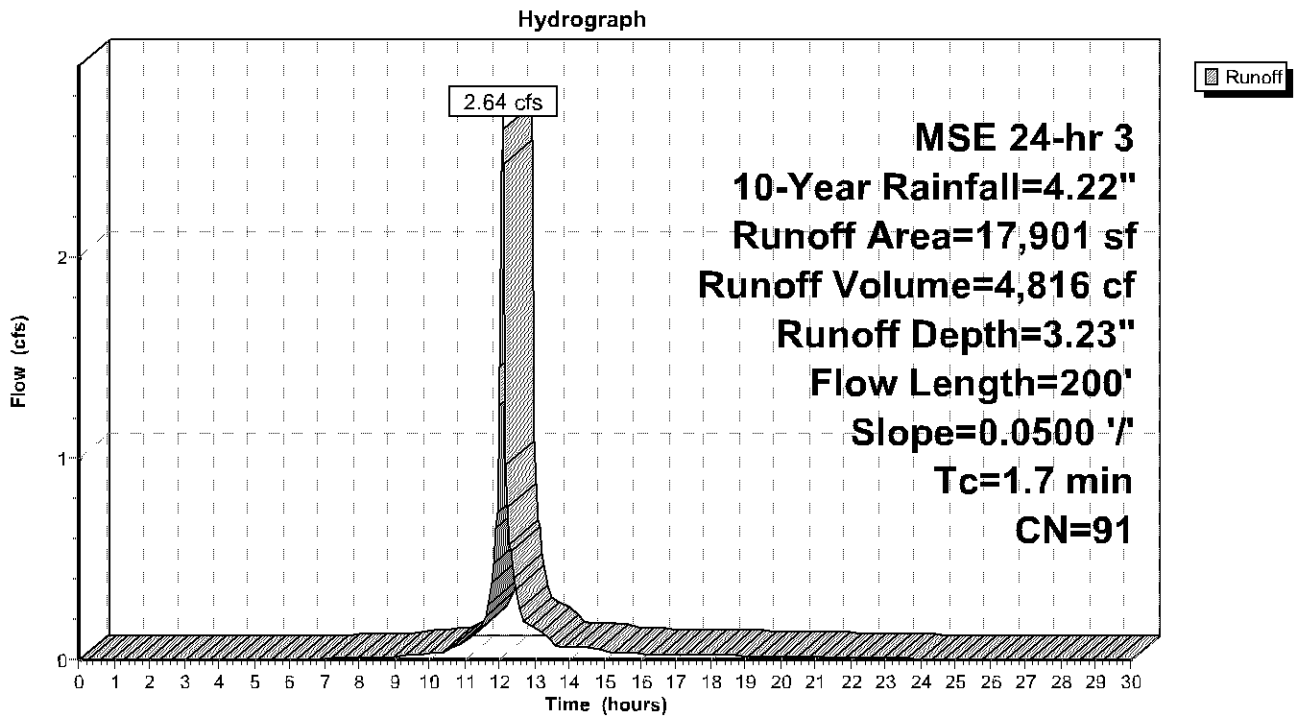
Runoff = 2.64 cfs @ 12.08 hrs, Volume= 4,816 cf, Depth= 3.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SP: 1S Proposed



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 2Sa: Proposed Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

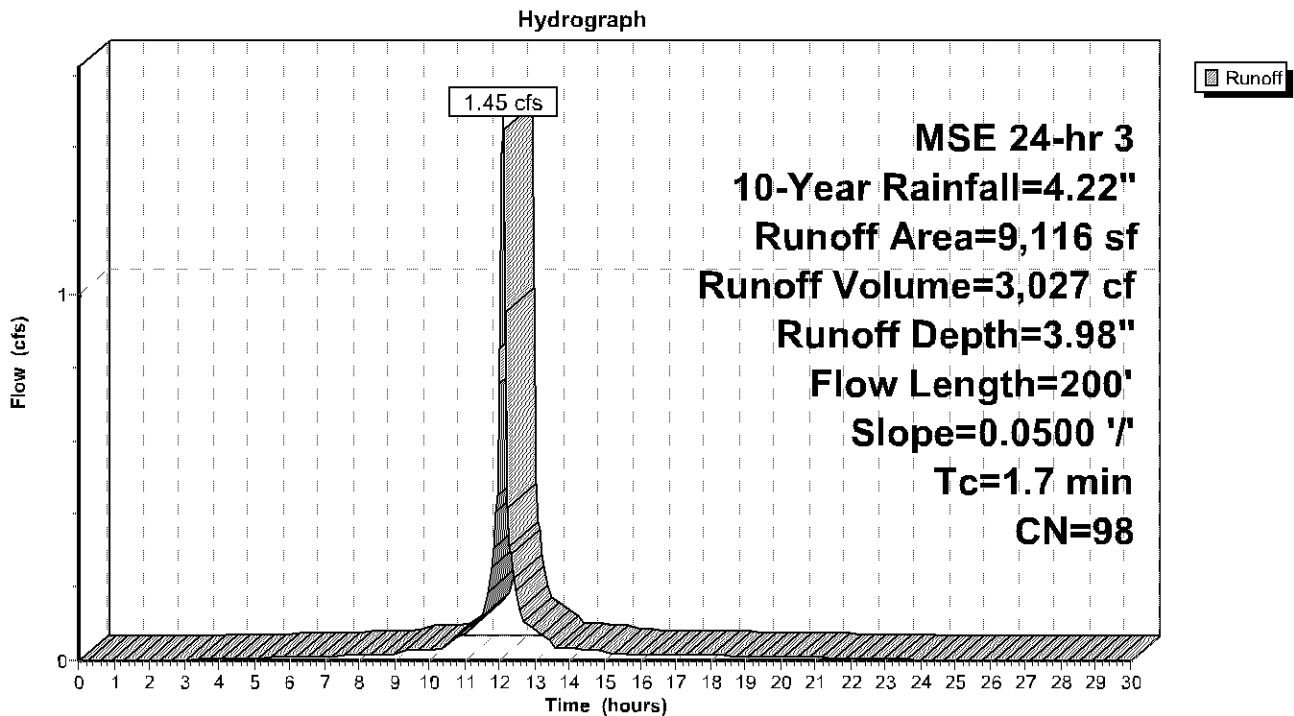
Runoff = 1.45 cfs @ 12.07 hrs, Volume= 3,027 cf, Depth= 3.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
* 9,116	98	Parking Lot
9,116		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2Sa: Proposed Draining to Underground



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 2Sb: Proposed NOT Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 3.78 cfs @ 12.06 hrs, Volume= 7,396 cf, Depth= 3.65"

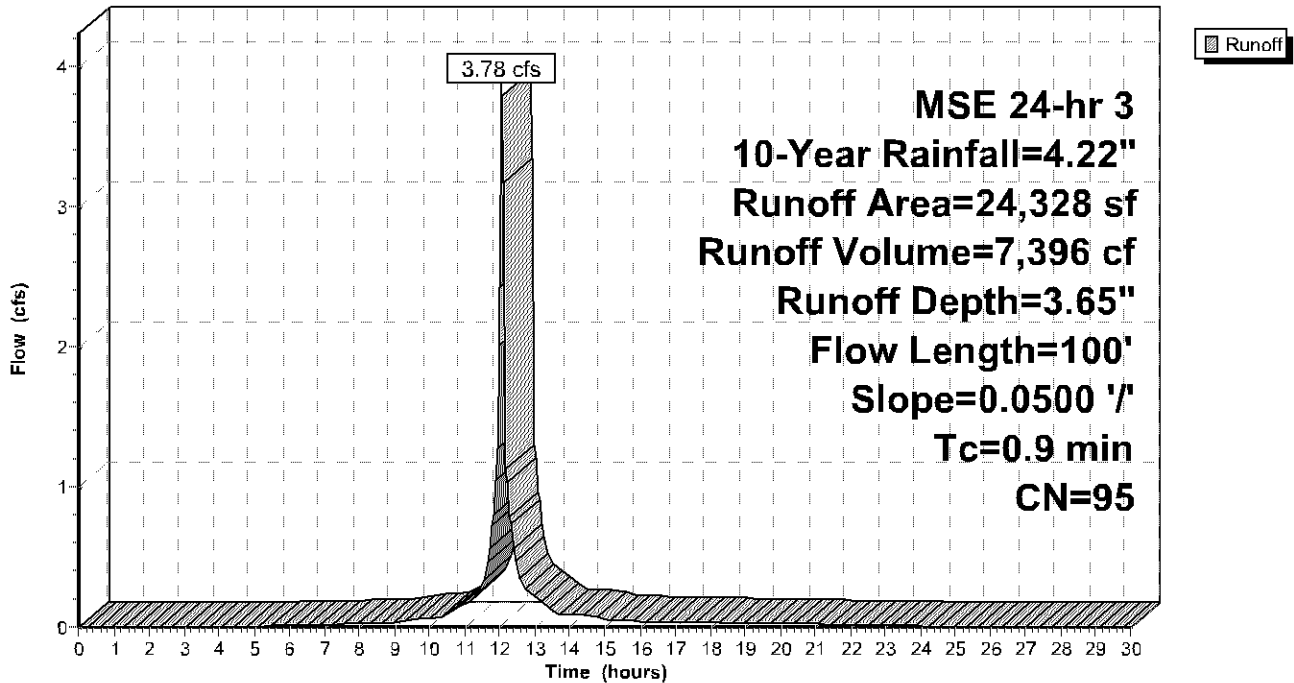
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 10-Year Rainfall=4.22"

	Area (sf)	CN	Description
*	4,865	98	Roofs
*	1,812	98	Walks
*	15,630	98	Parking
	2,021	61	>75% Grass cover, Good, HSG B
	24,328	95	Weighted Average
	2,021		8.31% Pervious Area
	22,307		91.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0500	1.86		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"

Subcatchment 2Sb: Proposed NOT Draining to Underground

Hydrograph



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 2SE: 2S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 4.60 cfs @ 12.08 hrs, Volume= 8,177 cf, Depth= 2.93"

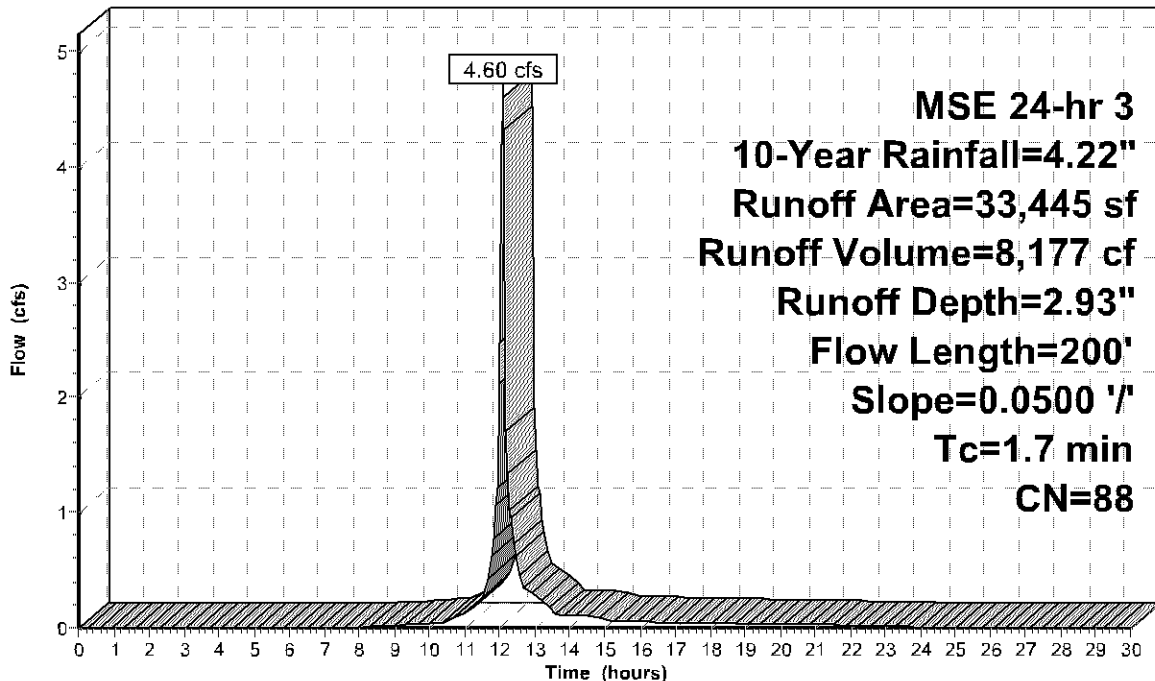
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
4,865	98	Roofs, HSG A
* 590	98	Walks
* 19,091	98	Parking
8,899	61	>75% Grass cover, Good, HSG B
33,445	88	Weighted Average
8,899		26.61% Pervious Area
24,546		73.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.62		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
1.2	150	0.0500	2.01		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2SE: 2S Existing

Hydrograph



9-19-23

MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 3SE: 3S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

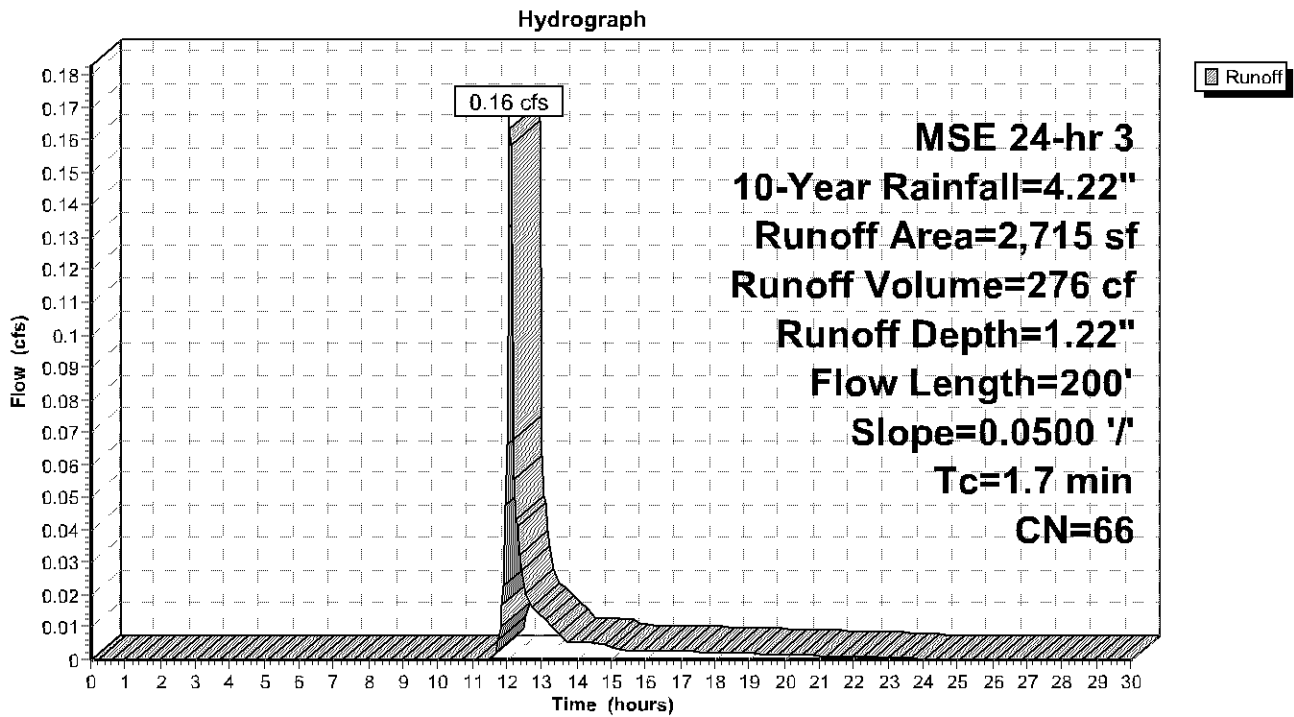
Runoff = 0.16 cfs @ 12.09 hrs, Volume= 276 cf, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SE: 3S Existing



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Subcatchment 3SP: 3S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

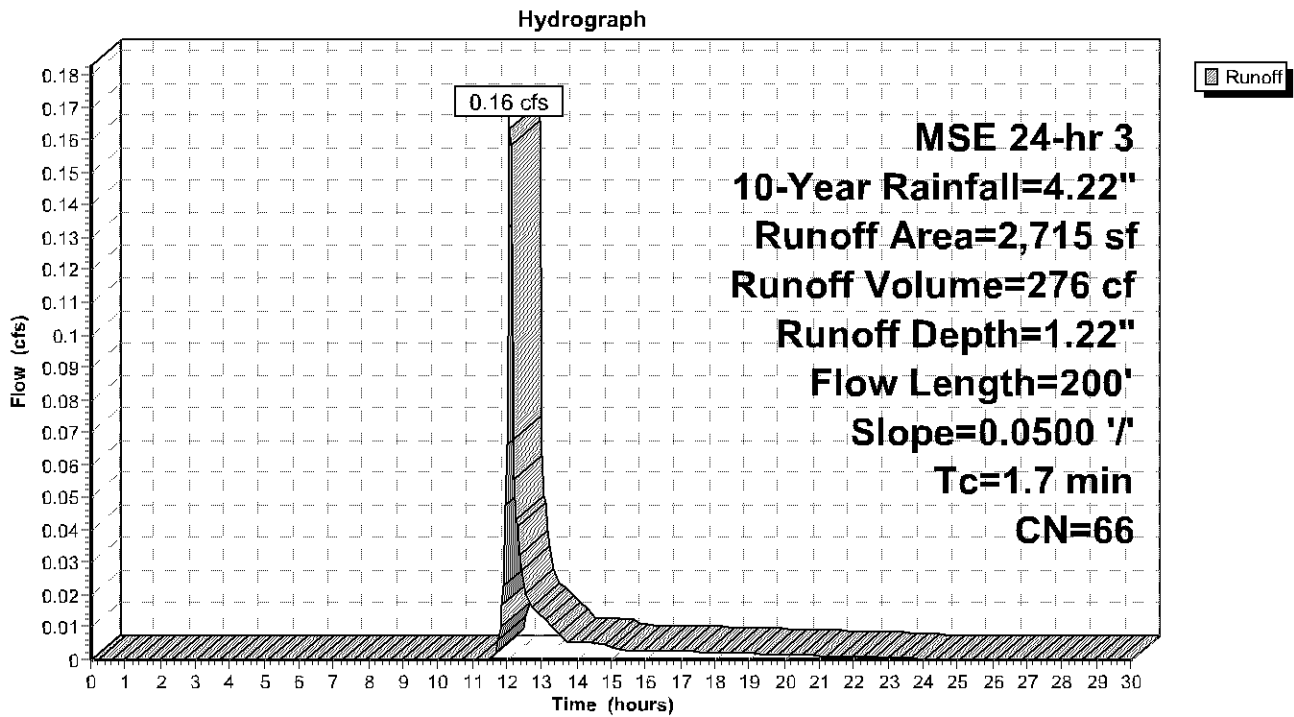
Runoff = 0.16 cfs @ 12.09 hrs, Volume= 276 cf, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-Year Rainfall=4.22"

Area (sf)	CN	Description
* 373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SP: 3S Proposed



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MSE 24-hr 3 10-Year Rainfall=4.22"

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Summary for Pond 3P: TDA UNDERGROUND SYSTEM

Inflow Area = 9,116 sf, 100.00% Impervious, Inflow Depth = 3.98" for 10-Year event
 Inflow = 1.45 cfs @ 12.07 hrs, Volume= 3,027 cf
 Outflow = 1.06 cfs @ 12.12 hrs, Volume= 2,561 cf, Atten= 27%, Lag= 2.9 min
 Discarded = 0.01 cfs @ 8.45 hrs, Volume= 1,226 cf
 Primary = 1.04 cfs @ 12.12 hrs, Volume= 1,335 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
 Peak Elev= 826.03' @ 12.12 hrs Surf.Area= 1,200 sf Storage= 1,220 cf

Plug-Flow detention time=214.6 min calculated for 2,561 cf (85% of inflow)
 Center-of-Mass det. time=162.1 min (905.6 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1	824.00'	1,800 cf	Custom Stage Data (Prismatic) listed below (Recalc) 3,600 cf Overall x 50.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
824.00	1,200	0	0
825.50	1,200	1,800	1,800
827.00	1,200	1,800	3,600

Device	Routing	Invert	Outlet Devices
#1	Device 2	825.50'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	825.50'	12.0" Round Culvert L= 18.0' Ke= 0.500 Inlet / Outlet Invert= 825.50' / 824.60' S= 0.0500' /' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.79 sf
#3	Discarded	824.00'	0.500 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.01 cfs @ 8.45 hrs HW=824.03' (Free Discharge)
 ↑ **3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.97 cfs @ 12.12 hrs HW=826.01' (Free Discharge)
 ↑ **2=Culvert** (Controls 0.97 cfs)
 ↑ **1=Orifice/Grate** (Orifice Controls 0.97 cfs @ 2.42 fps)

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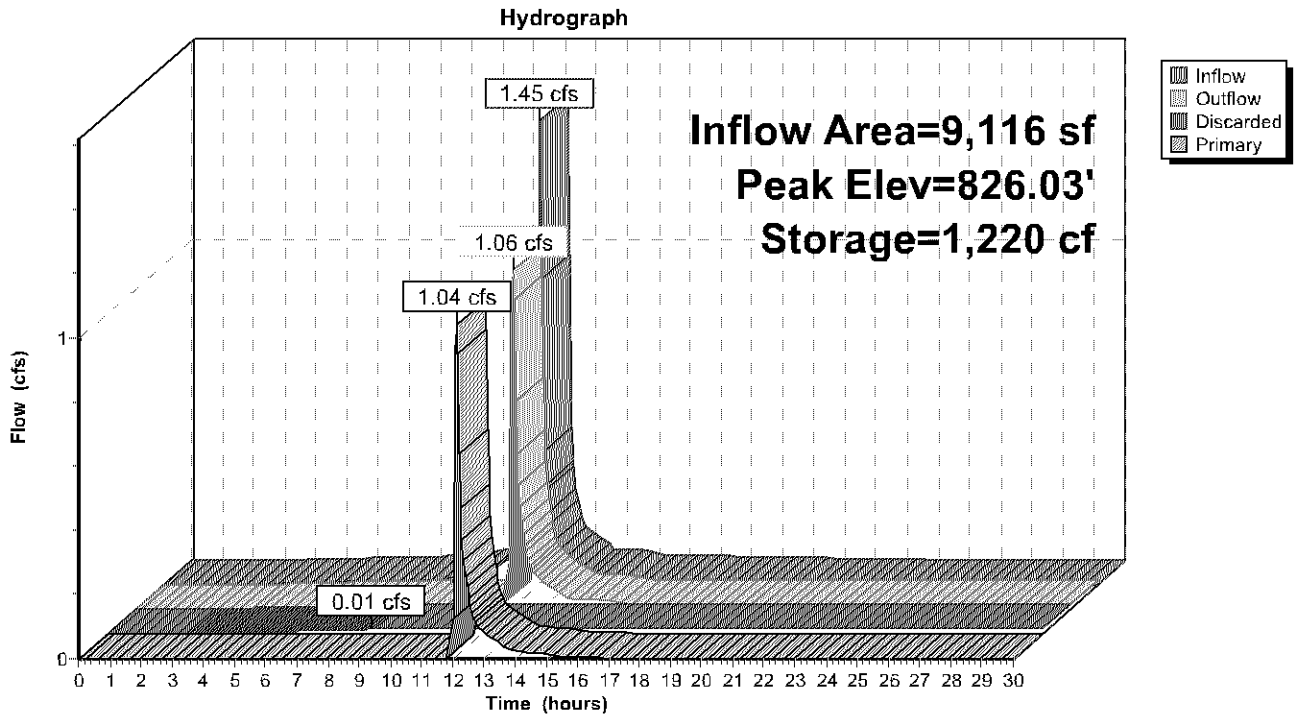
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MSE 24-hr 3 10-Year Rainfall=4.22"

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Pond 3P: TDA UNDERGROUND SYSTEM



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MSE 24-hr 3 10-Year Rainfall=4.22"

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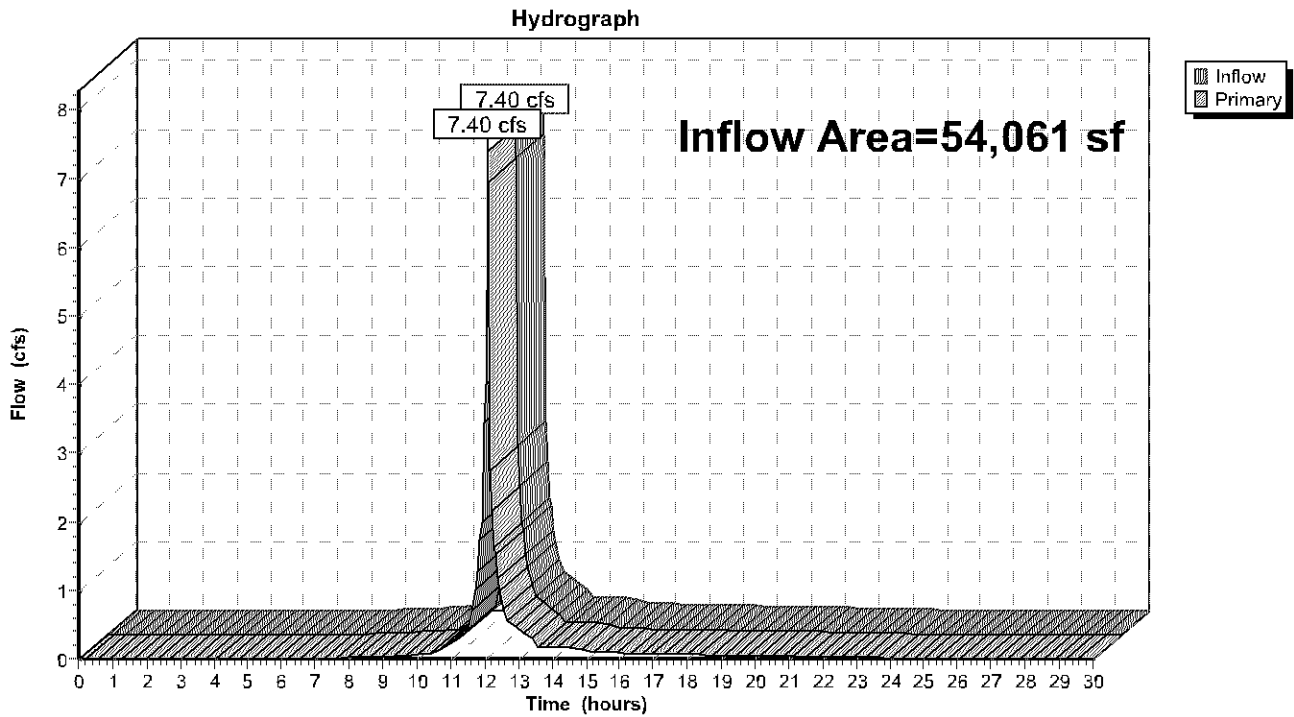
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Summary for Link 1L: Total Existing

Inflow Area = 54,061 sf, 72.56% Impervious, Inflow Depth = 2.95" for 10-Year event
Inflow = 7.40 cfs @ 12.08 hrs, Volume= 13,269 cf
Primary = 7.40 cfs @ 12.08 hrs, Volume= 13,269 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Total Existing



9-19-23

MSE 24-hr 3 10-Year Rainfall=4.22"

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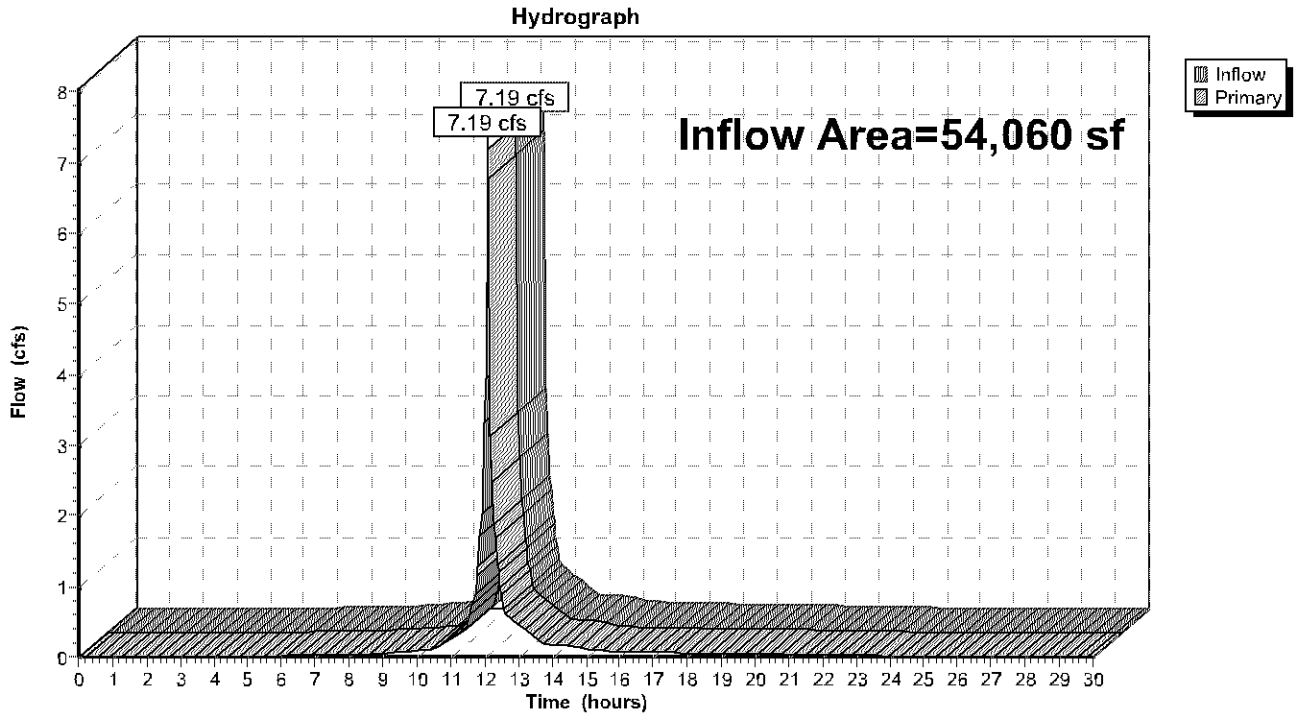
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Summary for Link 5L: 2L

Inflow Area = 54,060 sf, 85.29% Impervious, Inflow Depth = 3.07" for 10-Year event
Inflow = 7.19 cfs @ 12.08 hrs, Volume= 13,822 cf
Primary = 7.19 cfs @ 12.08 hrs, Volume= 13,822 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 5L: 2L



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MSE 24-hr 3 50-Year Rainfall=6.25"

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

Subcatchment1SE: 1S Existing Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=5.20"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=4.10 cfs 7,760 cf

Subcatchment1SP: 1S Proposed Runoff Area=17,901 sf 79.94% Impervious Runoff Depth=5.20"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=91 Runoff=4.10 cfs 7,760 cf

Subcatchment2Sa: ProposedDrainingt Runoff Area=9,116 sf 100.00% Impervious Runoff Depth=6.01"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=98 Runoff=2.15 cfs 4,567 cf

Subcatchment2Sb: ProposedNOT Drainingt Runoff Area=24,328 sf 91.69% Impervious Runoff Depth=5.66"
Flow Length=100' Slope=0.0500 '/' Tc=0.9 min CN=95 Runoff=5.71 cfs 11,475 cf

Subcatchment2SE: 2S Existing Runoff Area=33,445 sf 73.39% Impervious Runoff Depth=4.87"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=88 Runoff=7.38 cfs 13,565 cf

Subcatchment3SE: 3S Existing Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=2.63"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.36 cfs 594 cf

Subcatchment3SP: 3S Proposed Runoff Area=2,715 sf 13.74% Impervious Runoff Depth=2.63"
Flow Length=200' Slope=0.0500 '/' Tc=1.7 min CN=66 Runoff=0.36 cfs 594 cf

Pond 3P: TDA UNDERGROUND SYSTEM Peak Elev=826.25' Storage=1,352 cf Inflow=2.15 cfs 4,567 cf
Discarded=0.01 cfs 1,303 cf Primary=1.88 cfs 2,735 cf Outflow=1.89 cfs 4,037 cf

Link 1L: Total Existing Inflow=11.83 cfs 21,919 cf
Primary=11.83 cfs 21,919 cf

Link 5L: 2L Inflow=11.60 cfs 22,564 cf
Primary=11.60 cfs 22,564 cf

Total Runoff Area = 108,121 sf Runoff Volume = 46,315 cf Average Runoff Depth = 5.14"
21.07% Pervious = 22,786 sf 78.93% Impervious = 85,335 sf

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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 1SE: 1S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 4.10 cfs @ 12.08 hrs, Volume= 7,760 cf, Depth= 5.20"

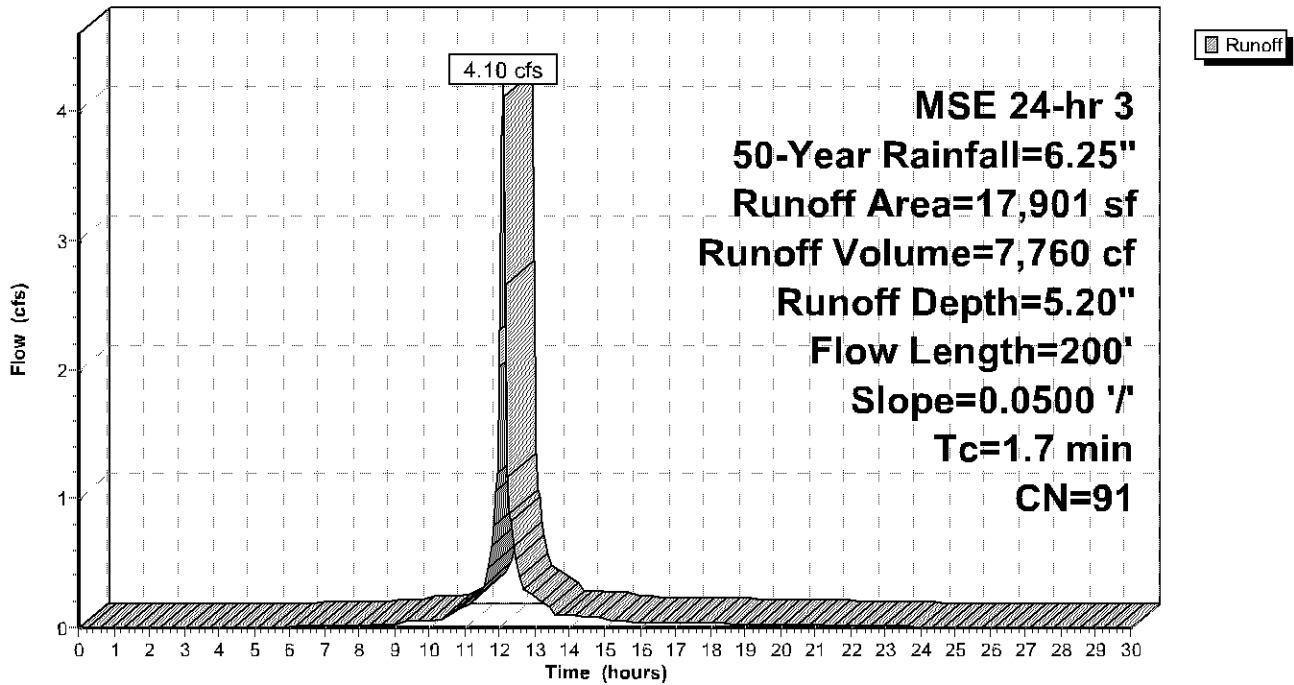
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SE: 1S Existing

Hydrograph



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 1SP: 1S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 4.10 cfs @ 12.08 hrs, Volume= 7,760 cf, Depth= 5.20"

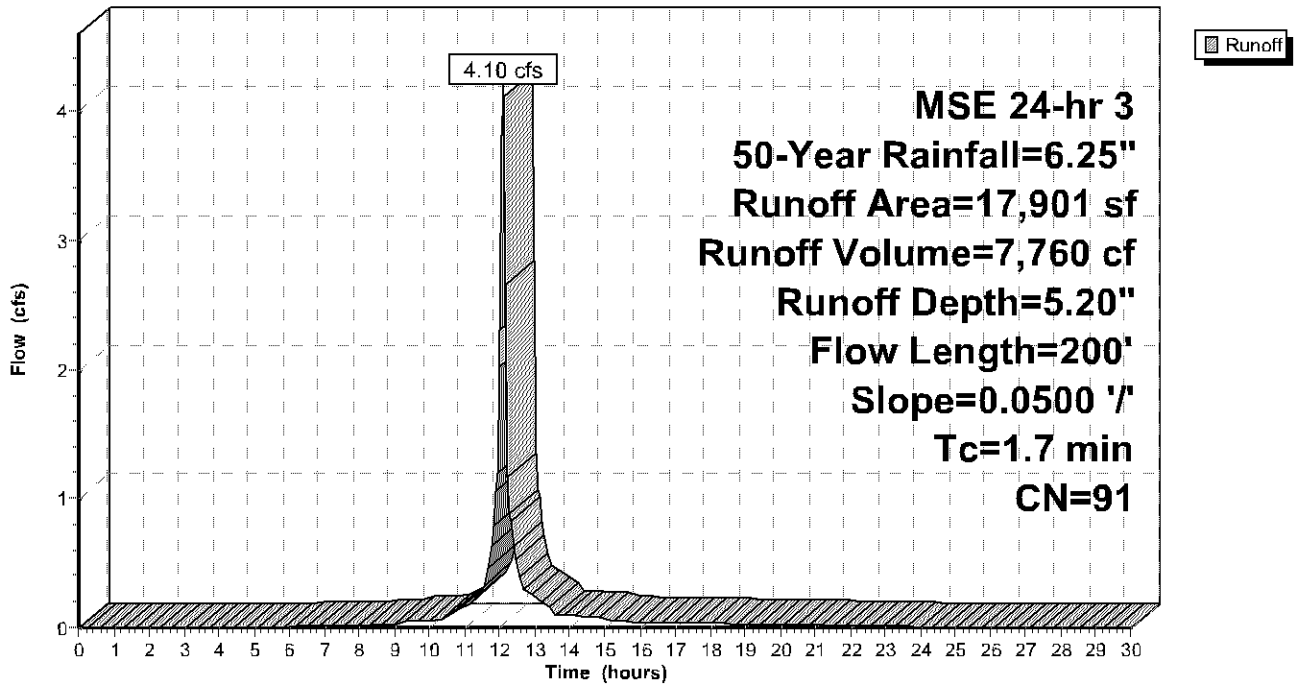
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
14,310	98	Roofs, HSG A
3,591	61	>75% Grass cover, Good, HSG B
17,901	91	Weighted Average
3,591		20.06% Pervious Area
14,310		79.94% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 1SP: 1S Proposed

Hydrograph



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 2Sa: Proposed Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

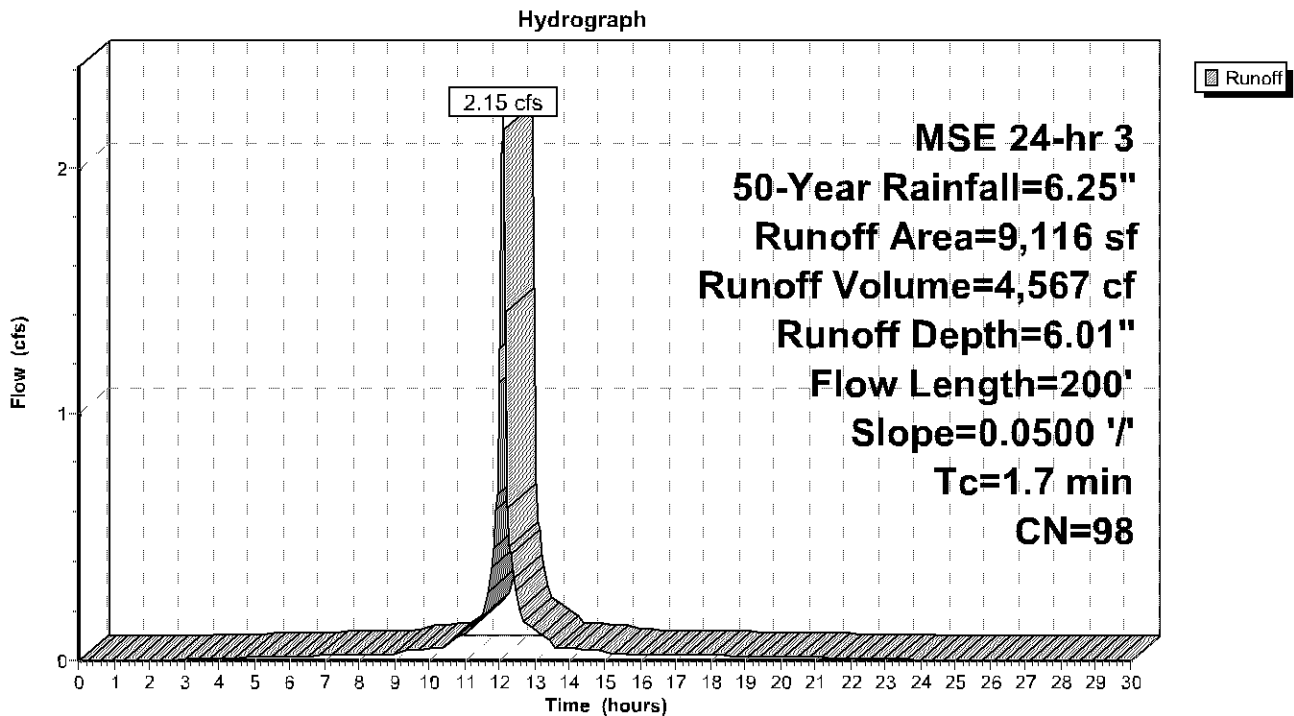
Runoff = 2.15 cfs @ 12.07 hrs, Volume= 4,567 cf, Depth= 6.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
* 9,116	98	Parking Lot
9,116		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2Sa: Proposed Draining to Underground



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 2Sb: Proposed NOT Draining to Underground

[49] Hint: $T_c < 2dt$ may require smaller dt

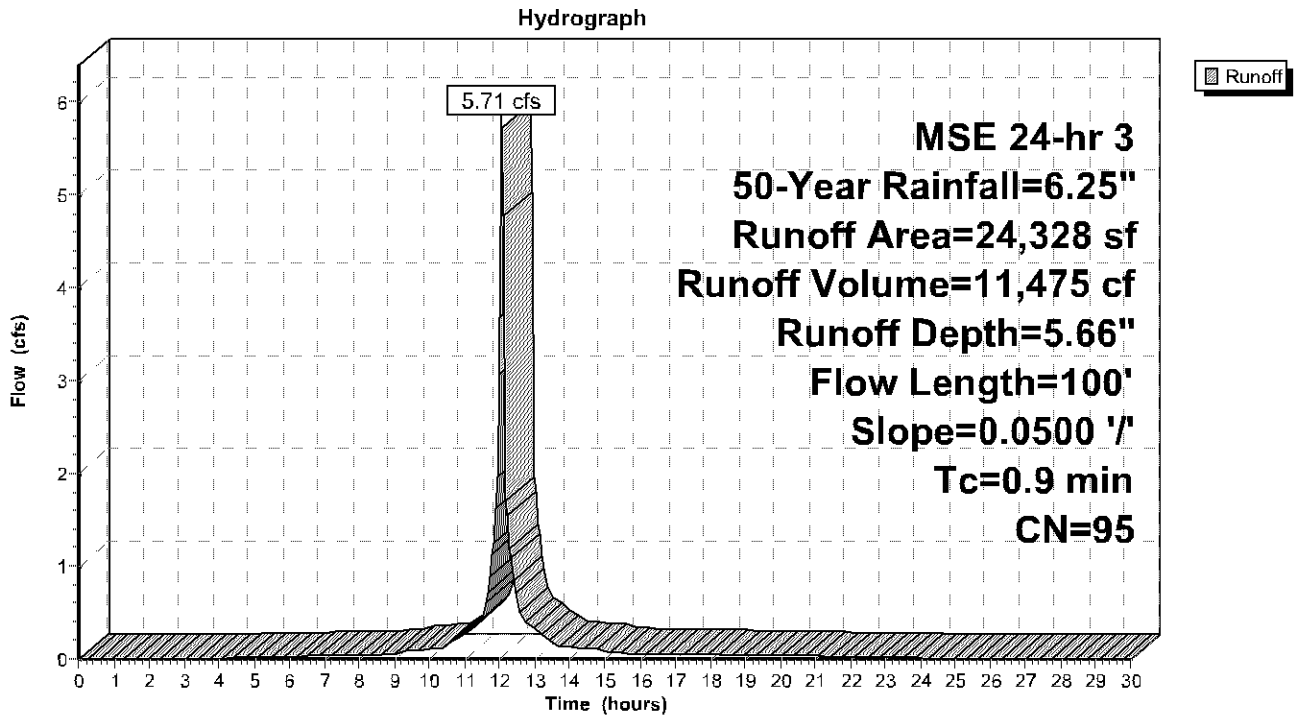
Runoff = 5.71 cfs @ 12.06 hrs, Volume= 11,475 cf, Depth= 5.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 50-Year Rainfall=6.25"

	Area (sf)	CN	Description
*	4,865	98	Roofs
*	1,812	98	Walks
*	15,630	98	Parking
	2,021	61	>75% Grass cover, Good, HSG B
	24,328	95	Weighted Average
	2,021		8.31% Pervious Area
	22,307		91.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0500	1.86		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"

Subcatchment 2Sb: Proposed NOT Draining to Underground



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 2SE: 2S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 7.38 cfs @ 12.08 hrs, Volume= 13,565 cf, Depth= 4.87"

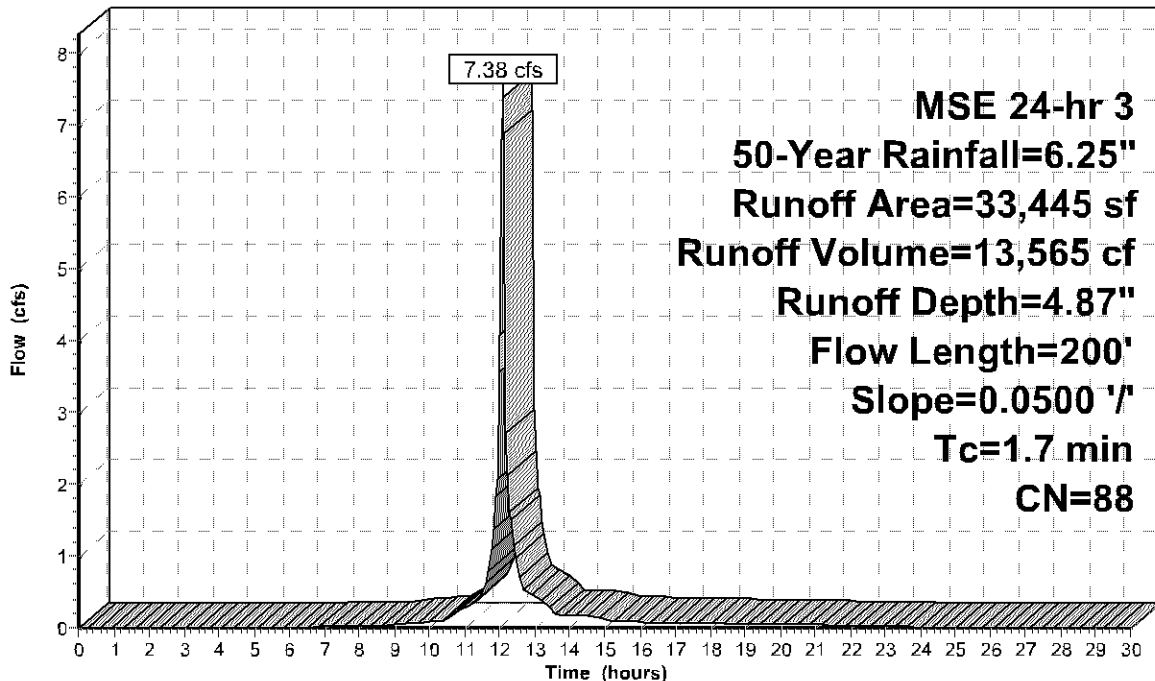
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
4,865	98	Roofs, HSG A
* 590	98	Walks
* 19,091	98	Parking
8,899	61	>75% Grass cover, Good, HSG B
33,445	88	Weighted Average
8,899		26.61% Pervious Area
24,546		73.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.62		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
1.2	150	0.0500	2.01		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 2SE: 2S Existing

Hydrograph



9-19-23

MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 3SE: 3S Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.36 cfs @ 12.08 hrs, Volume= 594 cf, Depth= 2.63"

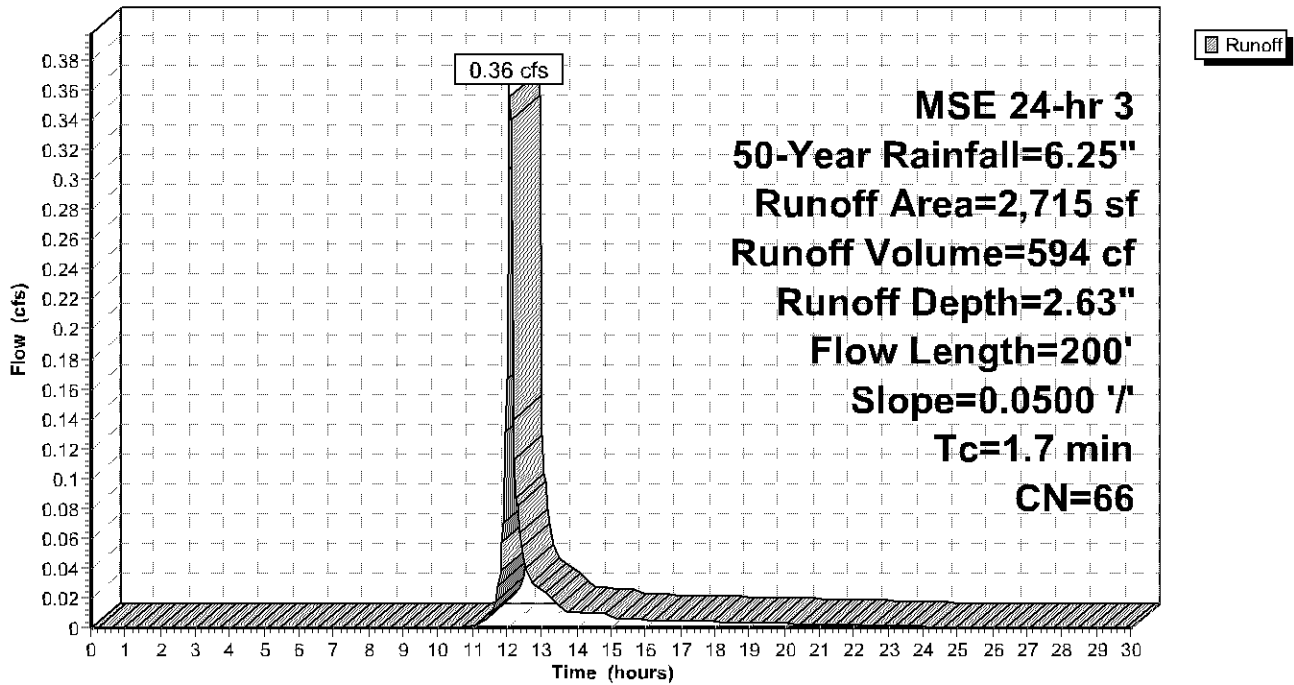
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SE: 3S Existing

Hydrograph



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Subcatchment 3SP: 3S Proposed

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.36 cfs @ 12.08 hrs, Volume= 594 cf, Depth= 2.63"

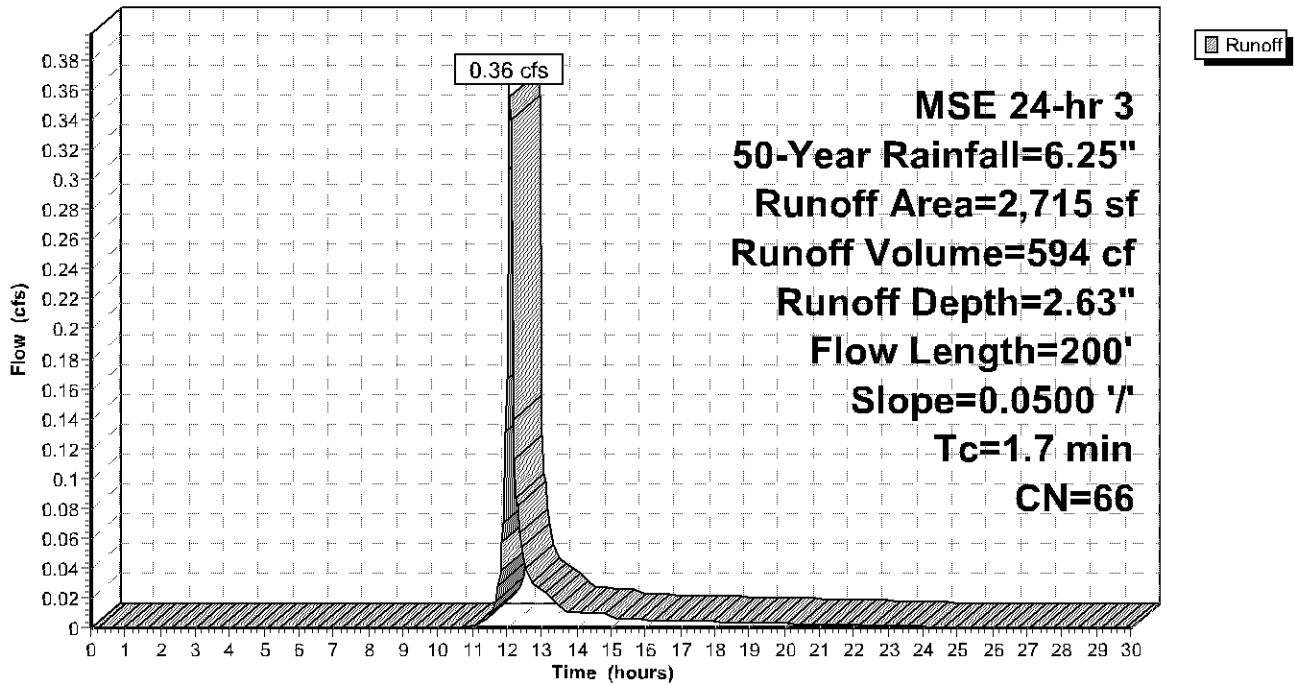
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, $dt= 0.05$ hrs
 MSE 24-hr 3 50-Year Rainfall=6.25"

Area (sf)	CN	Description
373	98	Parking
2,342	61	>75% Grass cover, Good, HSG B
2,715	66	Weighted Average
2,342		86.26% Pervious Area
373		13.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	150	0.0500	2.01		Sheet Flow, Roof Smooth surfaces n= 0.011 P2= 2.80"
0.5	50	0.0500	1.62		Sheet Flow, Parking Smooth surfaces n= 0.011 P2= 2.80"
1.7	200	Total			

Subcatchment 3SP: 3S Proposed

Hydrograph



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Pond 3P: TDA UNDERGROUND SYSTEM

Inflow Area = 9,116 sf, 100.00% Impervious, Inflow Depth = 6.01" for 50-Year event
 Inflow = 2.15 cfs @ 12.07 hrs, Volume= 4,567 cf
 Outflow = 1.89 cfs @ 12.10 hrs, Volume= 4,037 cf, Atten= 12%, Lag= 1.7 min
 Discarded = 0.01 cfs @ 5.90 hrs, Volume= 1,303 cf
 Primary = 1.88 cfs @ 12.10 hrs, Volume= 2,735 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
 Peak Elev= 826.25' @ 12.10 hrs Surf.Area= 1,200 sf Storage= 1,352 cf

Plug-Flow detention time=151.9 min calculated for 4,037 cf (88% of inflow)
 Center-of-Mass det. time=106.3 min (844.7 - 738.4)

Volume	Invert	Avail.Storage	Storage Description
#1	824.00'	1,800 cf	Custom Stage Data (Prismatic) listed below (Recalc) 3,600 cf Overall x 50.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
824.00	1,200	0	0
825.50	1,200	1,800	1,800
827.00	1,200	1,800	3,600

Device	Routing	Invert	Outlet Devices
#1	Device 2	825.50'	12.0" Vert. Orifice/Grate C= 0.600
#2	Primary	825.50'	12.0" Round Culvert L= 18.0' Ke= 0.500 Inlet / Outlet Invert= 825.50' / 824.60' S= 0.0500' /' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.79 sf
#3	Discarded	824.00'	0.500 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.01 cfs @ 5.90 hrs HW=824.03' (Free Discharge)
 ↑ **3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.86 cfs @ 12.10 hrs HW=826.25' (Free Discharge)
 ↑ **2=Culvert** (Controls 1.86 cfs)
 ↑ **1=Orifice/Grate** (Orifice Controls 1.86 cfs @ 2.95 fps)

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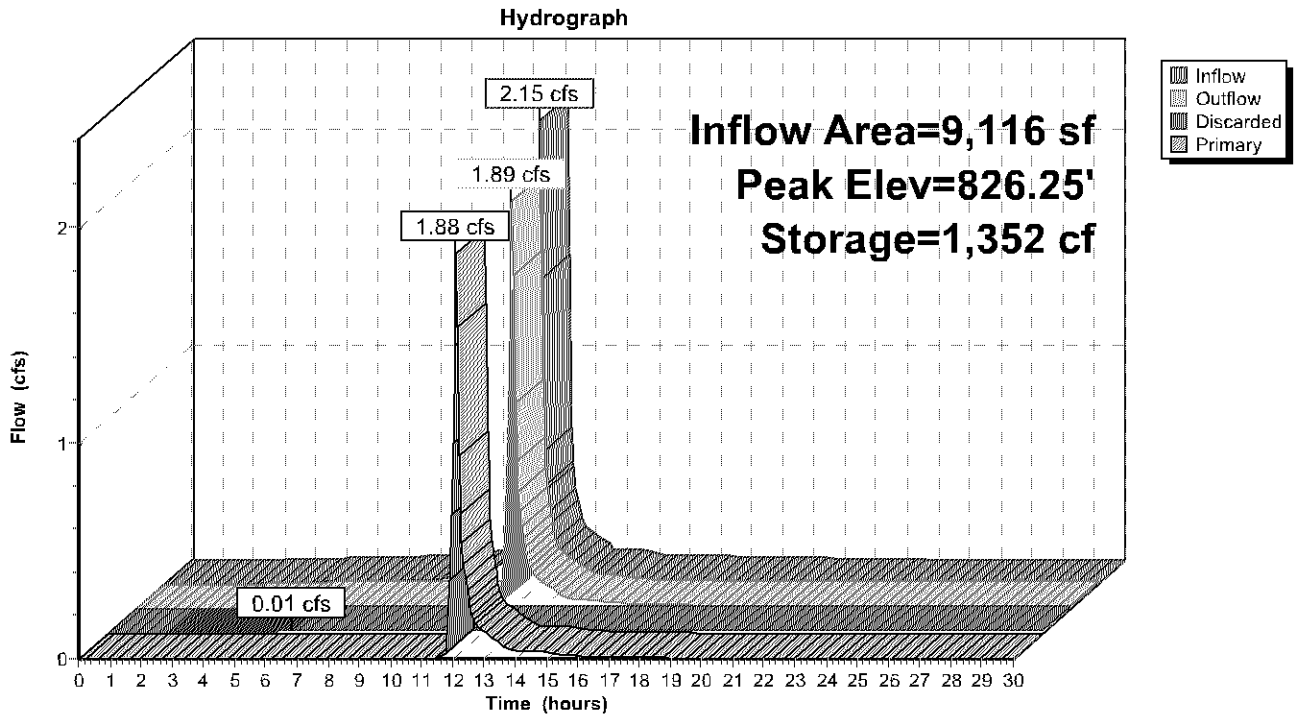
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MSE 24-hr 3 50-Year Rainfall=6.25"

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Pond 3P: TDA UNDERGROUND SYSTEM



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MSE 24-hr 3 50-Year Rainfall=6.25"

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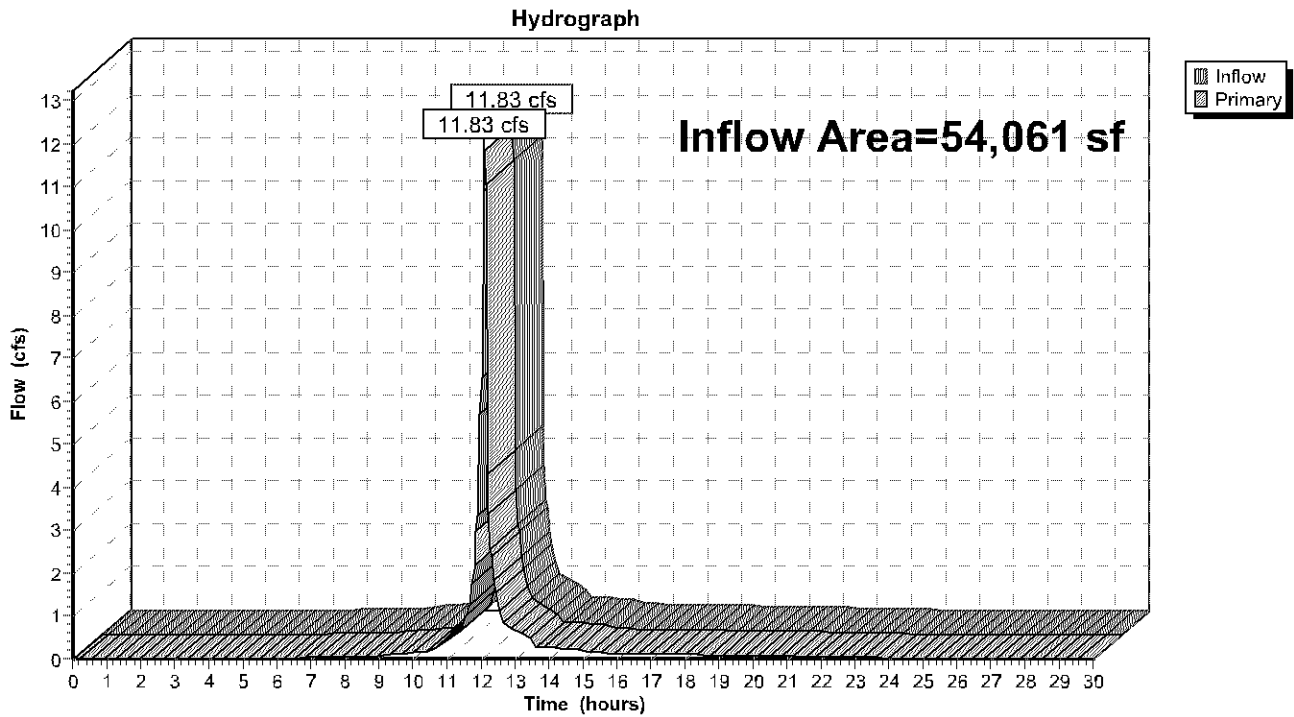
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Summary for Link 1L: Total Existing

Inflow Area = 54,061 sf, 72.56% Impervious, Inflow Depth = 4.87" for 50-Year event
Inflow = 11.83 cfs @ 12.08 hrs, Volume= 21,919 cf
Primary = 11.83 cfs @ 12.08 hrs, Volume= 21,919 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Total Existing



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MSE 24-hr 3 50-Year Rainfall=6.25"

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Summary for Link 5L: 2L

Inflow Area = 54,060 sf, 85.29% Impervious, Inflow Depth = 5.01" for 50-Year event
Inflow = 11.60 cfs @ 12.07 hrs, Volume= 22,564 cf
Primary = 11.60 cfs @ 12.07 hrs, Volume= 22,564 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 5L: 2L

