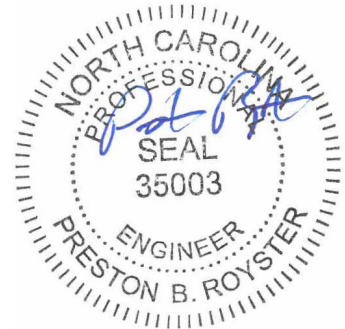




Putt-Putt Fun Center
STORMWATER IMPACT STATEMENT

PIN:
9870997083



Calculations By: Preston B. Royster, PE

2/19/2021

Coulter Jewell Thames, P.A.
111 West Main Street
Durham, NC 27701
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NC Board of Engineers & Surveyors License #C-1209

CJT Project # 1952

July 21, 2020
Revised: December 7, 2020
Revised: February 19, 2021

Project Description and Summary

The Putt-Putt Fun Center project is located on Chapel Point Rd north of Eubanks Rd and along the I-40 frontage in Chapel Hill. The project involves the construction of a miniature golf course, go-cart race rack, entertainment facility and storage building along with the associated parking and infrastructure. Calculations for peak discharge, runoff volume, and water quality treatment for all of the proposed improvements are provided.

Soils on the site include Georgeville, Herndon, and Tarrus (hydrologic soil group B). The proposed site is located in the Cape Fear River Basin within the Jordan Lake watershed protection district.

Per the Town of Chapel Hill stormwater ordinance, the stormwater runoff rate leaving the site under post-development conditions may not exceed the stormwater runoff rate under pre-development conditions for the 1-year, 2-year, and 25-year storms. The additional runoff volume from the pre-development to post-development conditions for the 2-year storm must also be captured on-site. In addition, added impervious surfaces must be treated for 85% total suspended solids (TSS) removal.

Methodology

- The Orange County Soil Survey is used to identify the soil types located on the site.
- HydroCAD software is used to calculate pre- and post-development peak flow rates and volumes for each sub-basin. HydroCAD uses the SCS TR-20 method to develop hydrographs.
- HydroCAD software is used to calculate the composite curve number for each sub-basin. HydroCAD uses the NRCS TR-55 method for calculation composite curve numbers.

Discussion of Results

Q1/Q2/Q25:

For the peak discharge calculations, the site was analyzed as two basins. Basin 1 includes the majority of the site and the bulk of the proposed development. An analysis point was set at the lowest point on the western property line where a stream exits the site. Under pre-development conditions, the time of concentration for the site was calculated to be 21.6 minutes. Under post-development conditions, the time of concentration reduced to 13.4 minutes. As a result of the proposed improvements, there is an increase in runoff from the 1-year, 2-year, and 25-year storms. A wet detention pond is proposed to provide attenuation.

With the addition of the wet detention pond, the peak flow rate still shows a small increase in flow for the 1-year and 2-year storms. This is due to the low pre-development flows and the reduction of the post-development time of concentration for the basin that bypasses the pond. The flows that will bypass the pond are slightly higher than the pre-development flows

for the entire basin. With that said, the increase in bypass flow is less than 0.50 cfs for both storm events. In fact, the outflow from the pond is minimal for both of these events (0.17 cfs and 0.19 cfs, respectively). If the pre- and post-development flows were rounded to the nearest whole cfs, there would be no increase in flow for the 1-yr and 2-yr storms as both the pre- and post-development peak flow rate would be 1 cfs and 4 cfs, respectively. Given that the increase in flow is minimal and the pond essentially reduces the flow to a negligible level, we feel the intent of the peak flow requirements are met. There is a reduction in peak flow rate for the 25-yr storm of 12.5%. The pond is also designed to safely pass the 100-yr storm.

Basin 2 includes the northern portion of the site. This area drains to the west into Old Field Creek. There is no development proposed in this basin. For both pre- and post-development, the time of concentration was calculated to be 22.8 minutes. Since no work is proposed, there is no change in the peak runoff rate for the 1-year, 2-year, and 25-year storms.

2-yr Runoff Volume:

Per the Town of Chapel Hill Design Manual, “the post-development stormwater runoff rate leaving the site shall not exceed the pre-development (existing conditions) stormwater runoff rate leaving the site for the local 1-year, 2-year, and 25-year storm events.” In addition, “the post-development stormwater runoff volume leaving the site shall not exceed the pre-development (existing conditions) stormwater runoff volume leaving the site for the local 2-year frequency, 24-hour duration storm event.” The stormwater runoff volume for the site under pre-development conditions was calculated to be 27,269 cf, and the post-development volume was calculated to be 71,395 cf. The post-development volume includes the volumes from both the area draining to the pond as well as the area that bypasses the pond rather than Basin 1 as a combined basin with a common time of concentration. Because there is an increase of 43,821 cf, stormwater control measures are proposed to provide detention. The proposed wet detention pond provides 42,933 cf of storage during the 2-yr storm. This is slightly less than the required volume. With that said, the proposed wet detention pond captures all of the runoff from the proposed impervious surfaces. The increase in volume is due to the reduction of the time of concentration for the bypass basin. It is not practical to install a BMP for the bypass basin.

85% TSS Removal:

The Town of Chapel Hill Design Manual states that BMP's shall be designed to remove 85% average total suspended solids from the post-development stormwater runoff.

The proposed project results in an increase in impervious surface of approximately 180,911 sf. As a result, a BMP must be installed to treat for 85% TSS removal for the additional impervious surface added.

In order to meet this requirement, a wet detention pond is proposed. The total impervious area that drains to the pond is 183,824 sf. Given that the pond captures runoff from all of the proposed impervious areas, this requirement is met.

Preliminary sizing calculations for the pond are included. The pond is also designed to release the water quality volume over a 2-5 day period. Additional calculations will be provided with the ZCP submittal.

Conclusion:

Because the increase in impervious surfaces as a result of this project resulted in an increase in peak flow for the 1-year, 2-year, and 25-year storms, and in runoff volume for the 2-year storm, detention and treatment are proposed in the form of a wet detention pond to meet the requirements of the Town's stormwater ordinance. In addition, the proposed pond will provide 85% TSS reduction for all of the proposed impervious areas.

STORMWATER PEAK RUNOFF CALCULATIONS

Run-off Summary

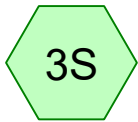
Drainage Basin	Pre-Dev						Post-Dev						Percentage Increase			Remark
	Tc	Area	CN	Q1	Q2	Q25	Tc	Area	CN	Q1	Q2	Q25	Q1	Q2	Q25	
	<i>min</i>	<i>ac</i>		<i>cfs</i>	<i>cfs</i>	<i>cfs</i>	<i>min</i>	<i>ac</i>		<i>cfs</i>	<i>cfs</i>	<i>cfs</i>	%	%	%	
Basin 1	21.6	17.16	55	1.03	3.62	29.15	13.6	17.16	67	11.47	19.35	65.94	1013.6	434.5	126.2	DETENTION REQUIRED
To Detention							5.0	6.46	86	0.17	0.19	2.83				
Bypass Detention							13.6	10.70	56	1.14	3.69	25.29				
Total (Combined Hydrograph)								17.16		1.28	3.84	25.51	24.3	6.1	-12.5	
Basin 2	22.8	2.18	58	0.28	0.71	4.25	22.8	2.18	58	0.28	0.71	4.25	0.0	0.0	0.0	NO DETENTION REQUIRED



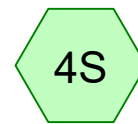
PRE-DEV BASIN 1



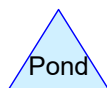
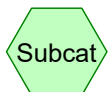
PRE-DEV BASIN 2



POST-DEV BASIN 1



POST-DEV BASIN 2



Routing Diagram for STORM STUDY - 1952

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STORM STUDY - 1952

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 1S: PRE-DEV BASIN 1

Runoff = 1.03 cfs @ 12.29 hrs, Volume= 0.279 af, Depth= 0.19"

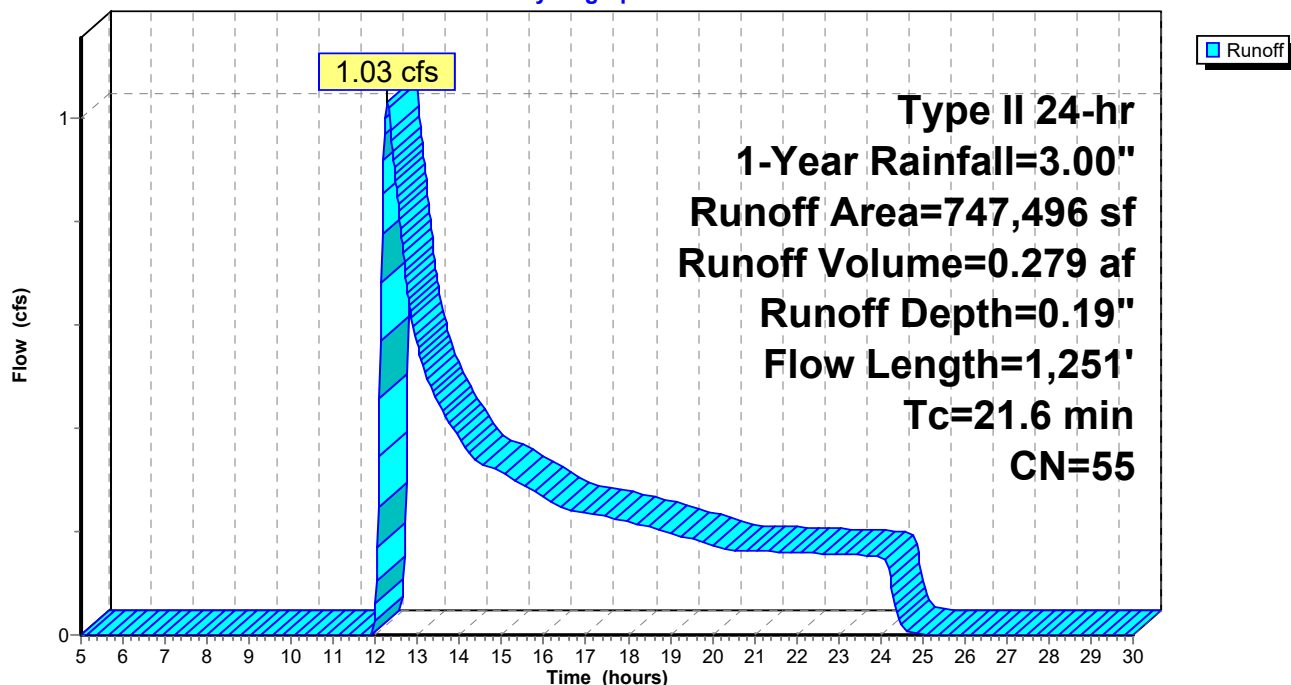
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
15,948	61	>75% Grass cover, Good, HSG B
731,548	55	Woods, Good, HSG B
747,496	55	Weighted Average
747,496		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0470	0.12		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
4.0	360	0.0880	1.48		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
3.2	791	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 ' Top.W=8.00' n= 0.030
21.6	1,251	Total			

Subcatchment 1S: PRE-DEV BASIN 1

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 2S: PRE-DEV BASIN 2

Runoff = 0.28 cfs @ 12.25 hrs, Volume= 0.050 af, Depth= 0.27"

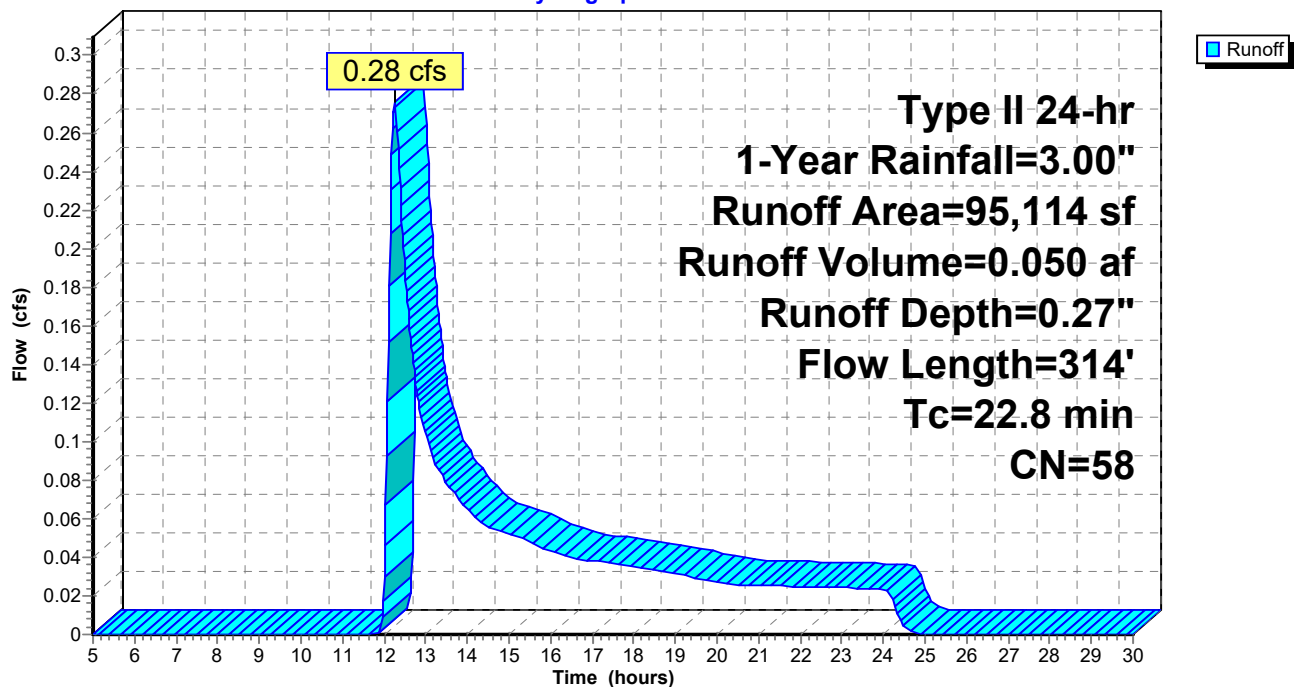
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 2S: PRE-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 3S: POST-DEV BASIN 1

Runoff = 11.47 cfs @ 12.08 hrs, Volume= 0.837 af, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
136,587	61	>75% Grass cover, Good, HSG B
417,758	55	Woods, Good, HSG B
9,327	98	Water Surface, HSG B
747,496	67	Weighted Average
554,345		74.16% Pervious Area
193,151		25.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	48	0.0310	0.19		Sheet Flow, Grass: Short n= 0.150 P2= 3.60"
1.8	195	0.0220	1.77	0.33	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.25' Z= 3.0 '/' Top.W=1.50' n= 0.030
2.9	310	0.0710	1.79	0.18	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.10' Z= 10.0 '/' Top.W=2.00' n= 0.030
4.6	1,126	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
13.6	1,679	Total			

STORM STUDY - 1952

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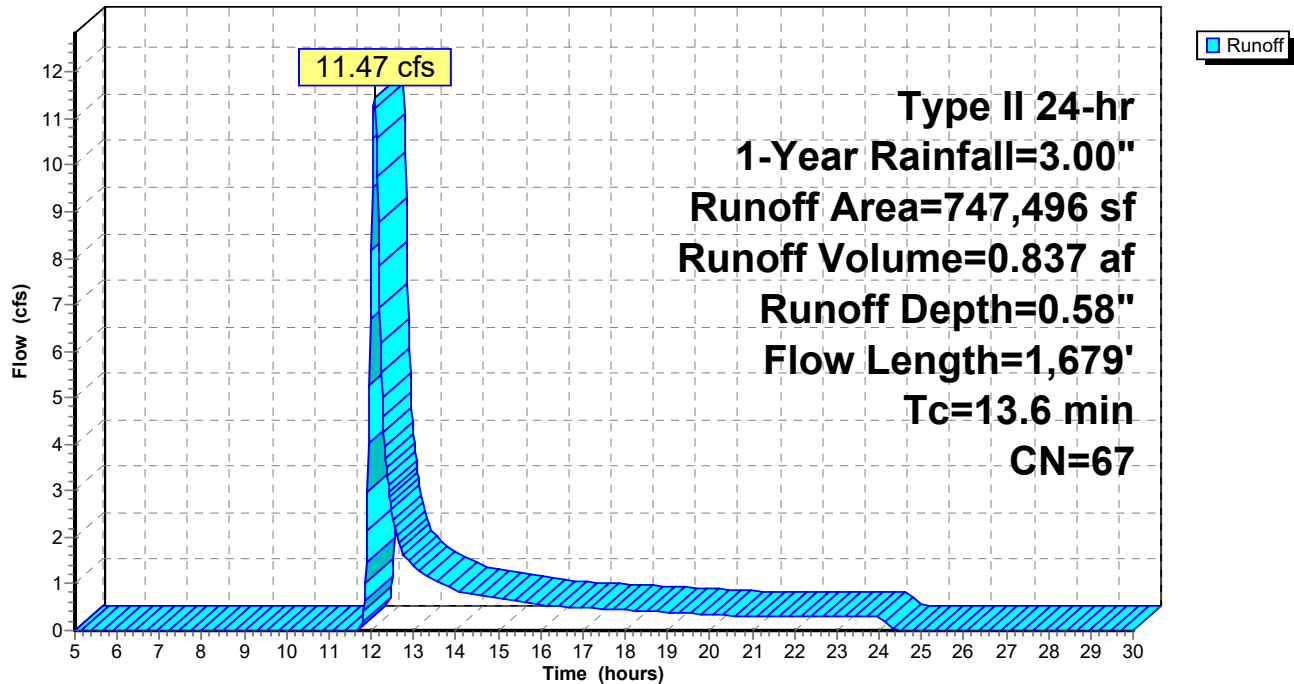
Type II 24-hr 1-Year Rainfall=3.00"

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Subcatchment 3S: POST-DEV BASIN 1

Hydrograph



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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 4S: POST-DEV BASIN 2

Runoff = 0.28 cfs @ 12.25 hrs, Volume= 0.050 af, Depth= 0.27"

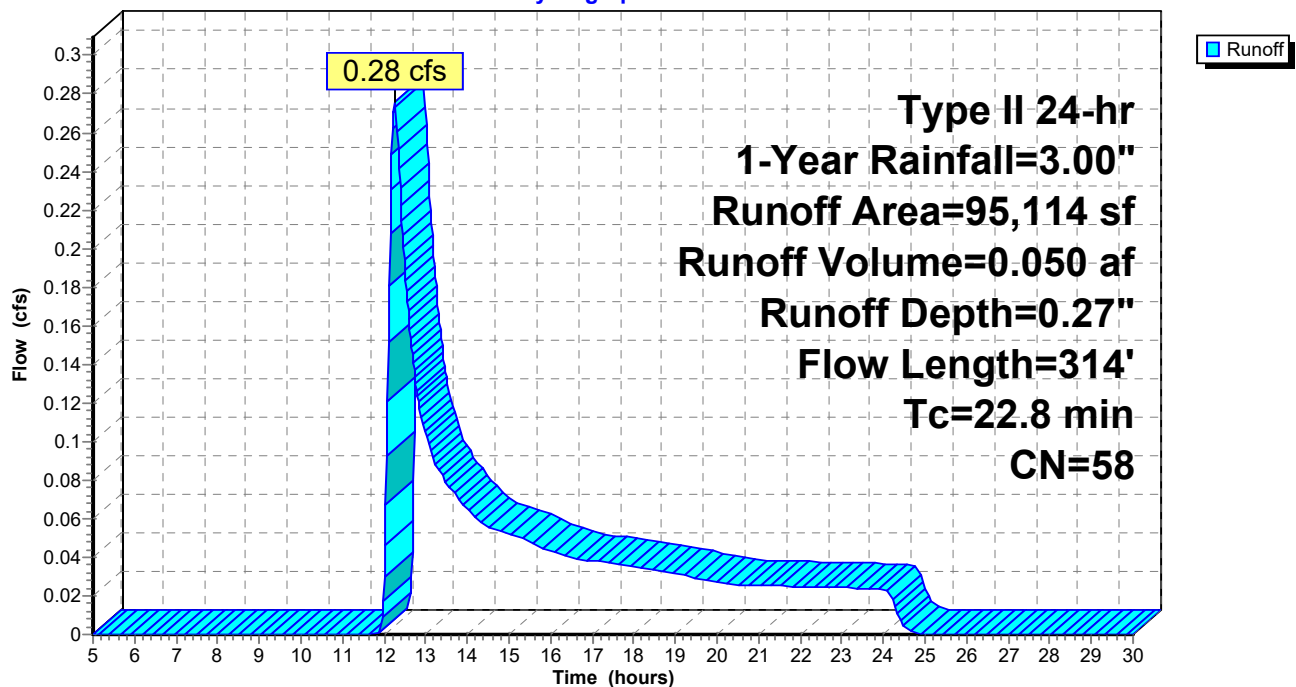
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 4S: POST-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 1S: PRE-DEV BASIN 1

Runoff = 3.62 cfs @ 12.22 hrs, Volume= 0.543 af, Depth= 0.38"

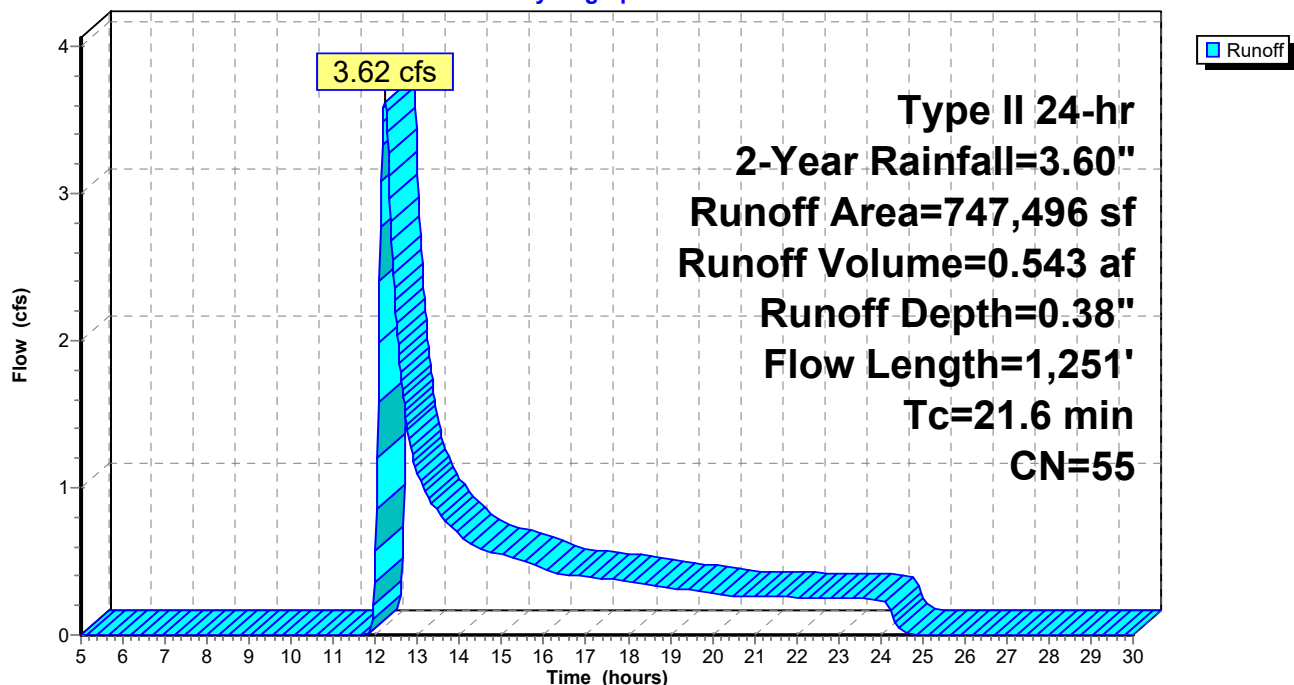
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
15,948	61	>75% Grass cover, Good, HSG B
731,548	55	Woods, Good, HSG B
747,496	55	Weighted Average
747,496		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0470	0.12		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
4.0	360	0.0880	1.48		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
3.2	791	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
21.6	1,251	Total			

Subcatchment 1S: PRE-DEV BASIN 1

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 2S: PRE-DEV BASIN 2

Runoff = 0.71 cfs @ 12.22 hrs, Volume= 0.090 af, Depth= 0.49"

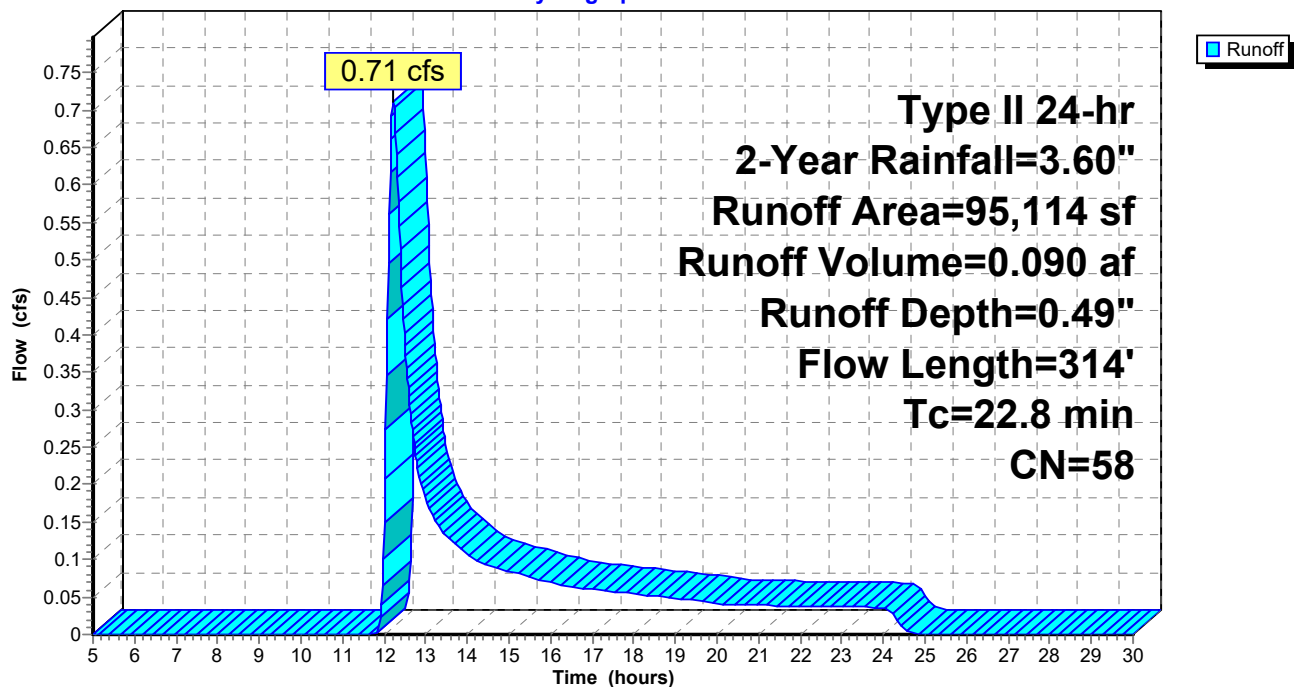
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 2S: PRE-DEV BASIN 2

Hydrograph



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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 3S: POST-DEV BASIN 1

Runoff = 19.35 cfs @ 12.07 hrs, Volume= 1.297 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
136,587	61	>75% Grass cover, Good, HSG B
417,758	55	Woods, Good, HSG B
9,327	98	Water Surface, HSG B
747,496	67	Weighted Average
554,345		74.16% Pervious Area
193,151		25.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	48	0.0310	0.19		Sheet Flow, Grass: Short n= 0.150 P2= 3.60"
1.8	195	0.0220	1.77	0.33	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.25' Z= 3.0 '/' Top.W=1.50' n= 0.030
2.9	310	0.0710	1.79	0.18	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.10' Z= 10.0 '/' Top.W=2.00' n= 0.030
4.6	1,126	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
13.6	1,679	Total			

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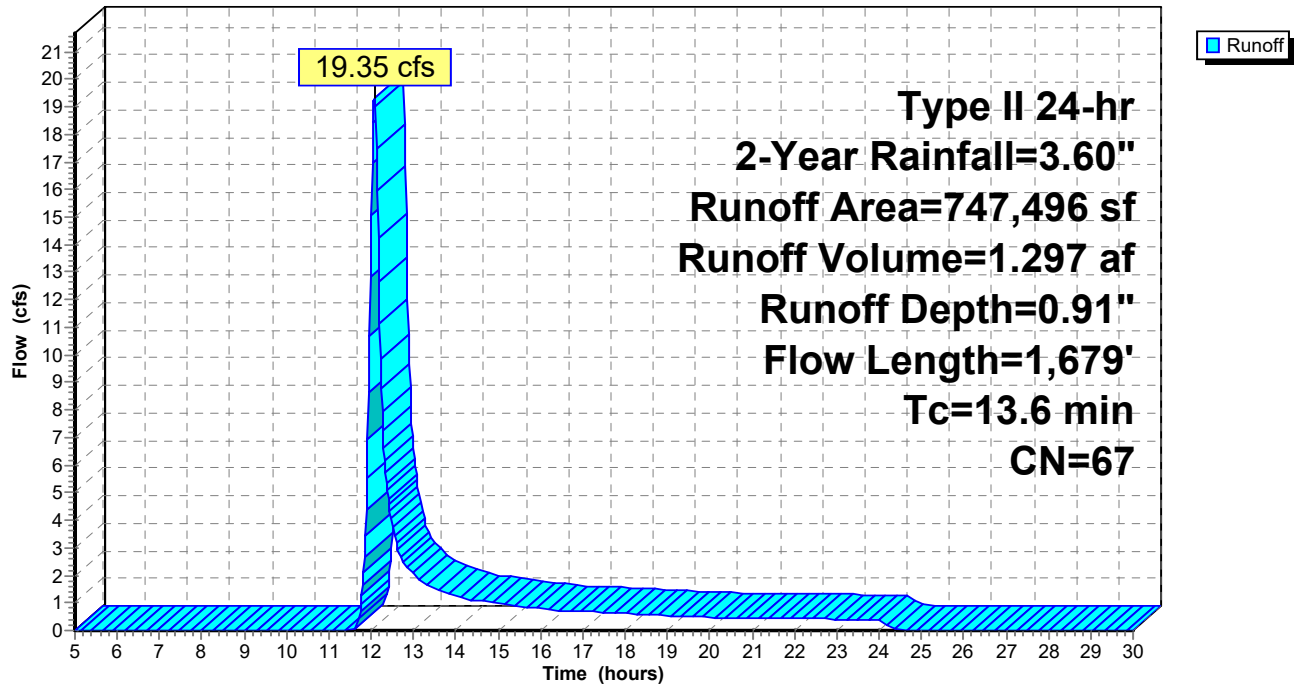
Type II 24-hr 2-Year Rainfall=3.60"

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Subcatchment 3S: POST-DEV BASIN 1

Hydrograph



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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 4S: POST-DEV BASIN 2

Runoff = 0.71 cfs @ 12.22 hrs, Volume= 0.090 af, Depth= 0.49"

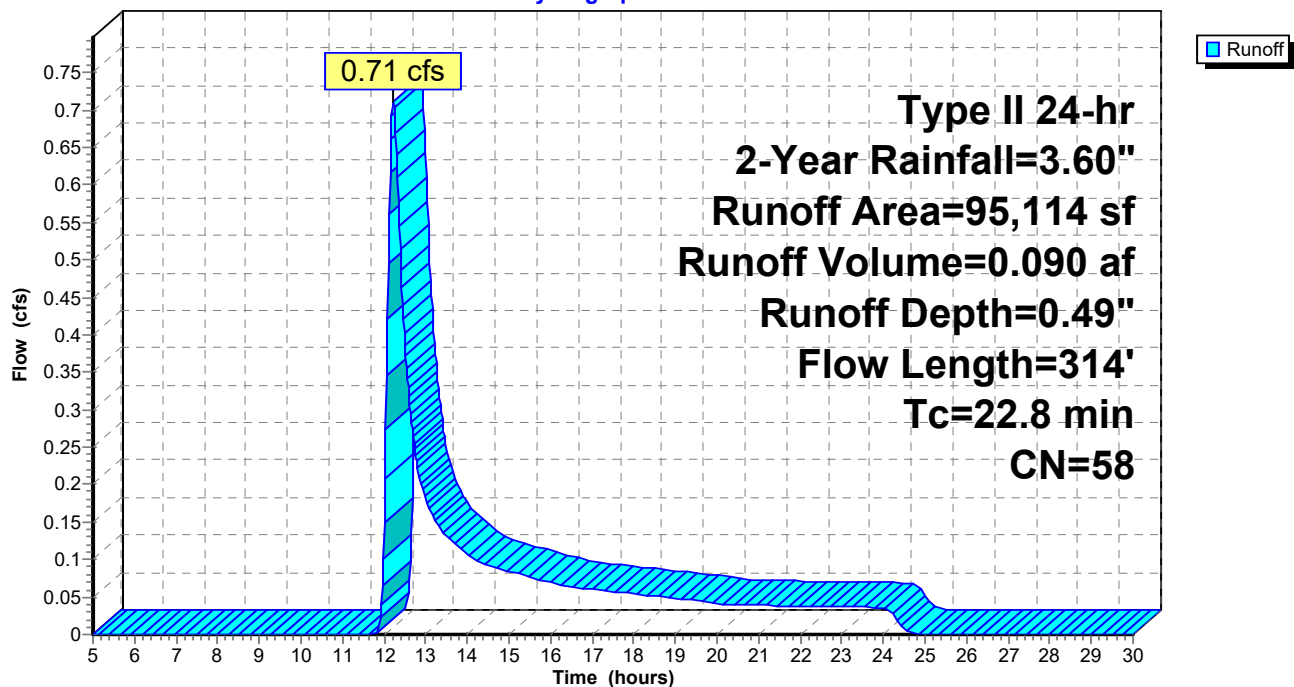
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 4S: POST-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 25-Year Rainfall=6.41"

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Summary for Subcatchment 1S: PRE-DEV BASIN 1

Runoff = 29.15 cfs @ 12.16 hrs, Volume= 2.515 af, Depth= 1.76"

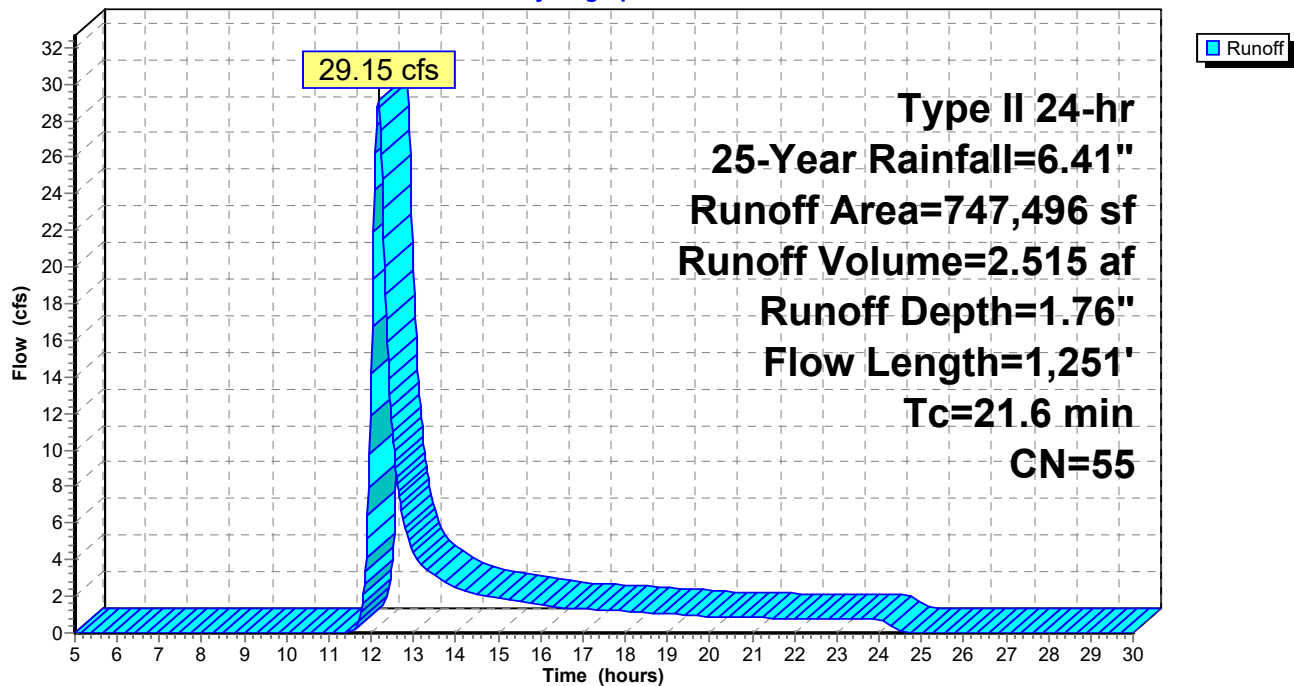
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=6.41"

Area (sf)	CN	Description
15,948	61	>75% Grass cover, Good, HSG B
731,548	55	Woods, Good, HSG B
747,496	55	Weighted Average
747,496		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0470	0.12		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
4.0	360	0.0880	1.48		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
3.2	791	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
21.6	1,251	Total			

Subcatchment 1S: PRE-DEV BASIN 1

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 25-Year Rainfall=6.41"

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Summary for Subcatchment 2S: PRE-DEV BASIN 2

Runoff = 4.25 cfs @ 12.18 hrs, Volume= 0.367 af, Depth= 2.02"

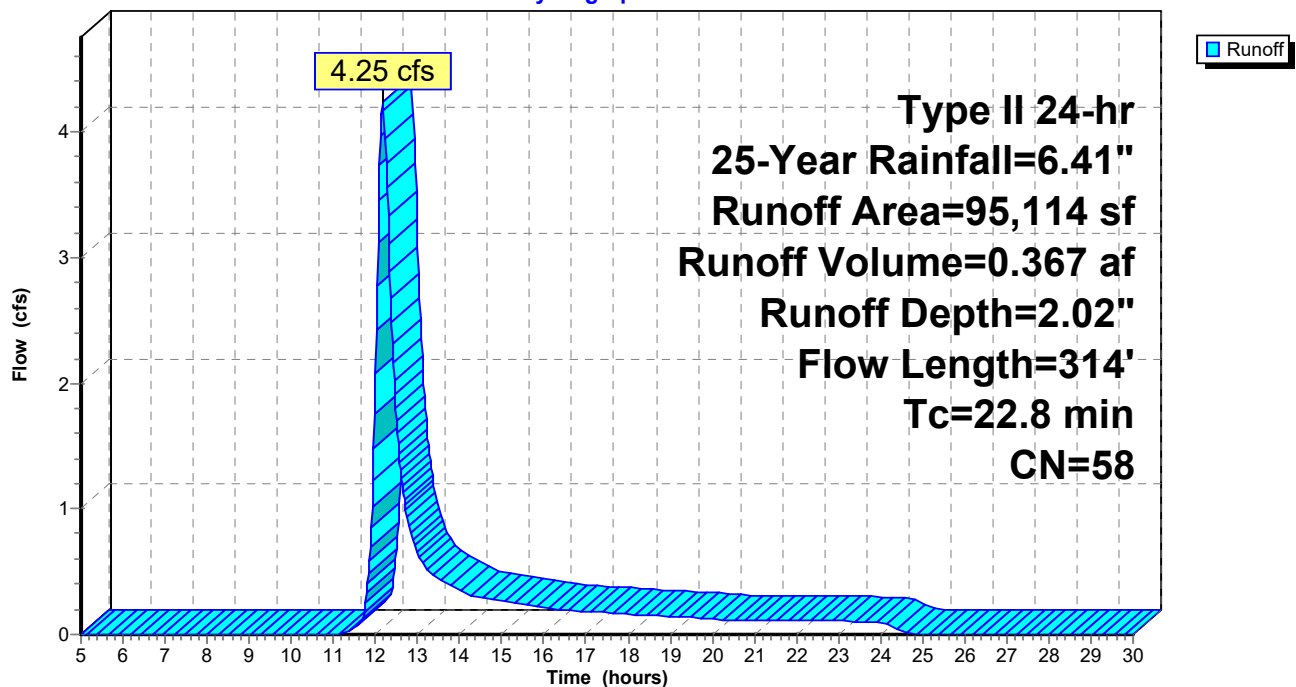
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=6.41"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 2S: PRE-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 25-Year Rainfall=6.41"

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Summary for Subcatchment 3S: POST-DEV BASIN 1

Runoff = 65.94 cfs @ 12.06 hrs, Volume= 4.066 af, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=6.41"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
136,587	61	>75% Grass cover, Good, HSG B
417,758	55	Woods, Good, HSG B
9,327	98	Water Surface, HSG B
747,496	67	Weighted Average
554,345		74.16% Pervious Area
193,151		25.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	48	0.0310	0.19		Sheet Flow, Grass: Short n= 0.150 P2= 3.60"
1.8	195	0.0220	1.77	0.33	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.25' Z= 3.0 '/' Top.W=1.50' n= 0.030
2.9	310	0.0710	1.79	0.18	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.10' Z= 10.0 '/' Top.W=2.00' n= 0.030
4.6	1,126	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
13.6	1,679	Total			

STORM STUDY - 1952

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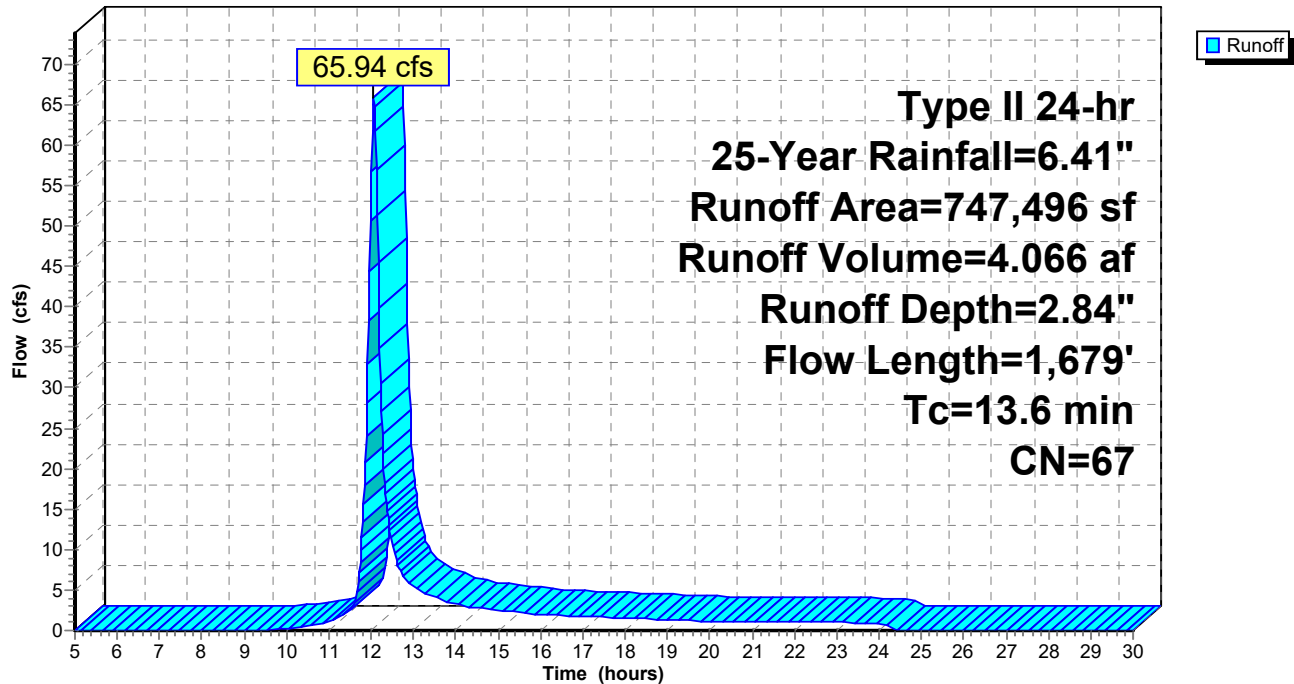
Type II 24-hr 25-Year Rainfall=6.41"

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Subcatchment 3S: POST-DEV BASIN 1

Hydrograph



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Type II 24-hr 25-Year Rainfall=6.41"

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Summary for Subcatchment 4S: POST-DEV BASIN 2

Runoff = 4.25 cfs @ 12.18 hrs, Volume= 0.367 af, Depth= 2.02"

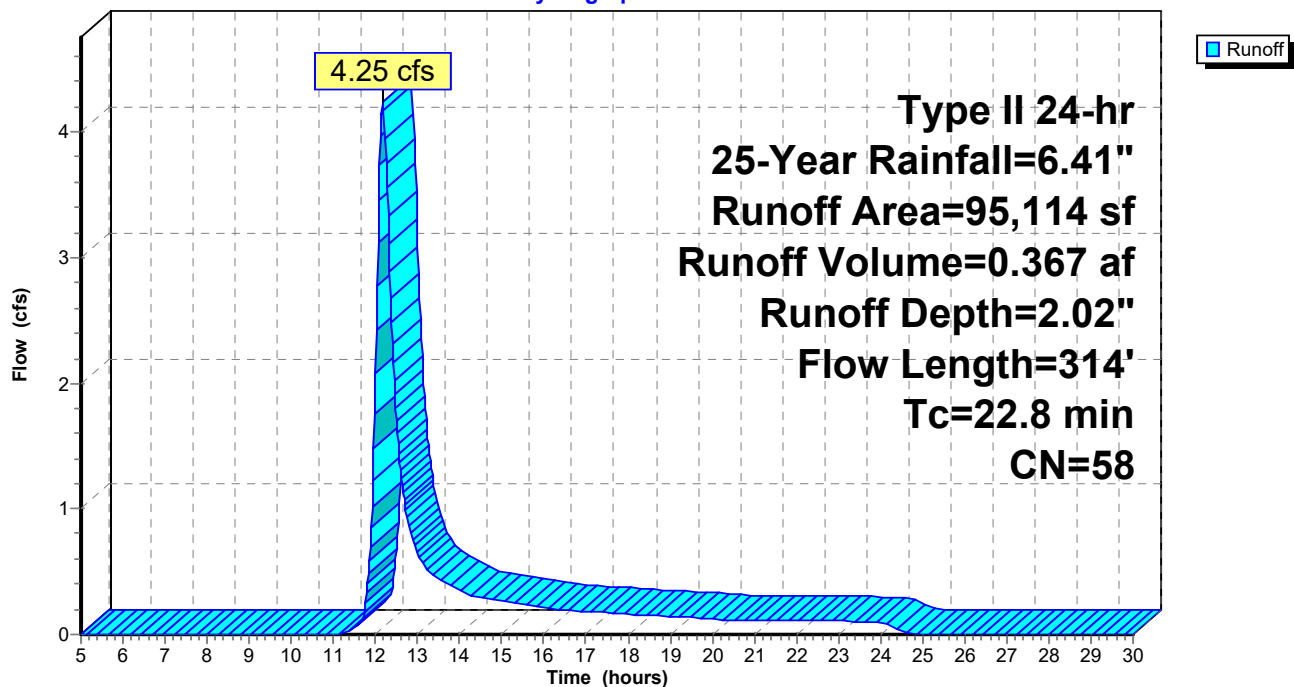
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Type II 24-hr 25-Year Rainfall=6.41"

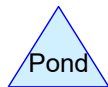
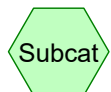
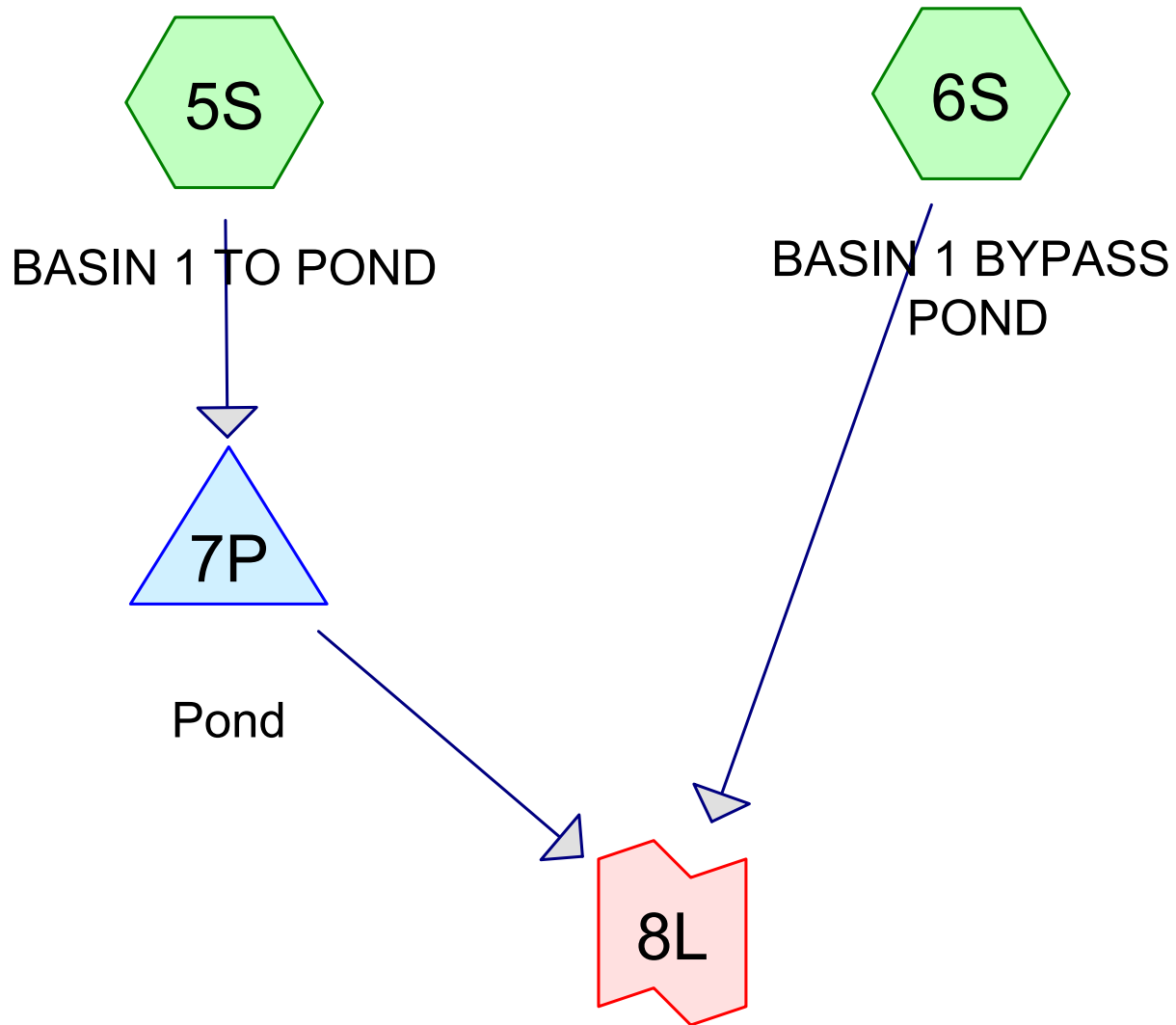
Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 4S: POST-DEV BASIN 2

Hydrograph





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Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Subcatchment 5S: BASIN 1 TO POND

Runoff = 19.70 cfs @ 11.96 hrs, Volume= 0.895 af, Depth= 1.66"

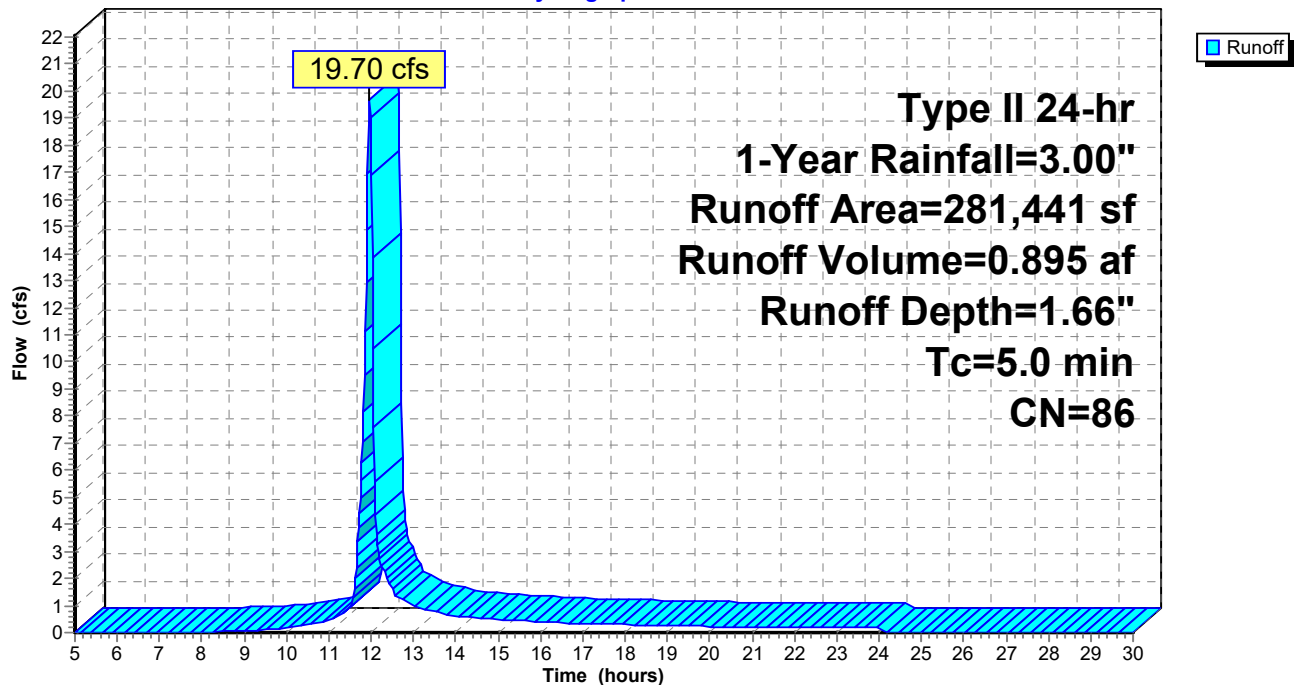
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
83,420	61	>75% Grass cover, Good, HSG B
9,327	98	Water Surface, HSG B
4,870	55	Woods, Good, HSG B
281,441	86	Weighted Average
88,290		31.37% Pervious Area
193,151		68.63% Impervious Area

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

Subcatchment 5S: BASIN 1 TO POND

Hydrograph



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Type II 24-hr 1-Year Rainfall=3.00"

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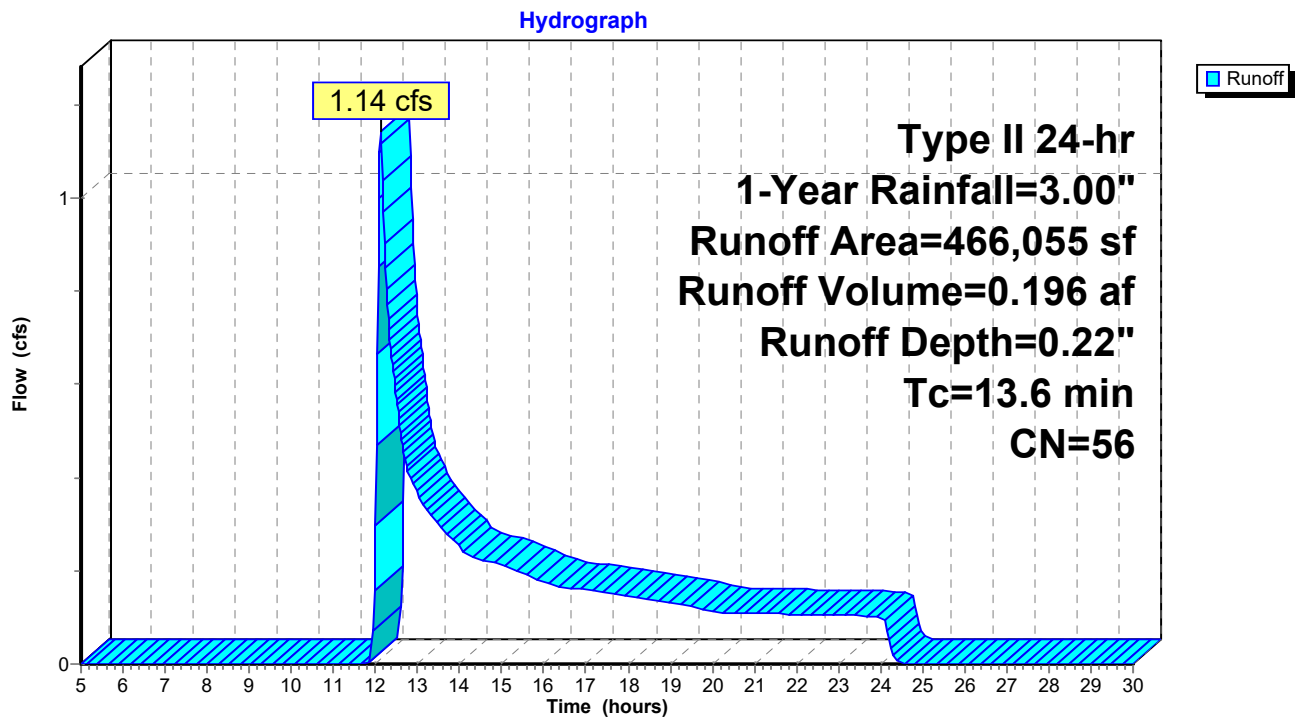
Summary for Subcatchment 6S: BASIN 1 BYPASS POND

Runoff = 1.14 cfs @ 12.13 hrs, Volume= 0.196 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (sf)	CN	Description
53,167	61	>75% Grass cover, Good, HSG B
412,888	55	Woods, Good, HSG B
466,055	56	Weighted Average
466,055		100.00% Pervious Area

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

Subcatchment 6S: BASIN 1 BYPASS POND

STORM STUDY - 1952

Type II 24-hr 1-Year Rainfall=3.00"

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Summary for Pond 7P: Pond

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth = 1.66" for 1-Year event
 Inflow = 19.70 cfs @ 11.96 hrs, Volume= 0.895 af
 Outflow = 0.17 cfs @ 24.03 hrs, Volume= 0.245 af, Atten= 99%, Lag= 724.4 min
 Primary = 0.17 cfs @ 24.03 hrs, Volume= 0.245 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 483.58' @ 24.03 hrs Surf.Area= 14,445 sf Storage= 31,758 cf

Plug-Flow detention time= 562.1 min calculated for 0.245 af (27% of inflow)
 Center-of-Mass det. time= 430.6 min (1,251.9 - 821.3)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=0.17 cfs @ 24.03 hrs HW=483.58' (Free Discharge)

1=Culvert (Passes 0.17 cfs of 76.72 cfs potential flow)
 2=Orifice/Grate (Controls 0.00 cfs)
 3=Orifice/Grate (Orifice Controls 0.17 cfs @ 7.61 fps)

STORM STUDY - 1952

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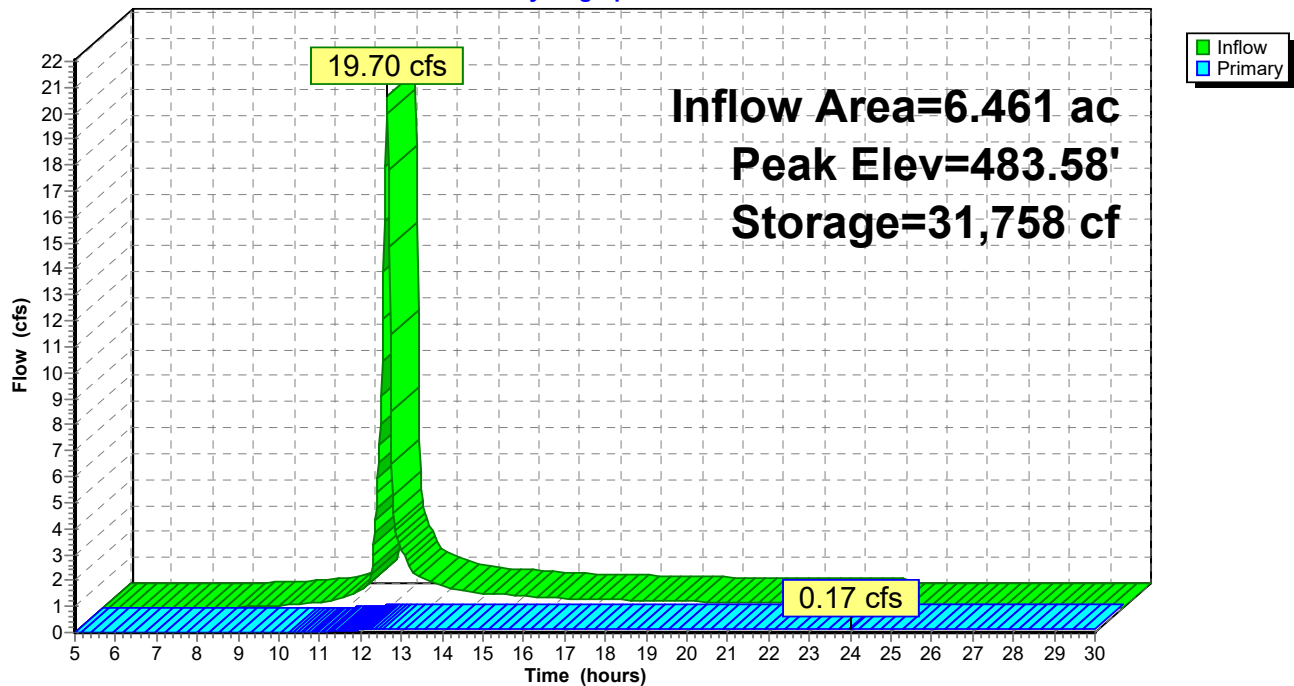
Type II 24-hr 1-Year Rainfall=3.00"

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Pond 7P: Pond

Hydrograph



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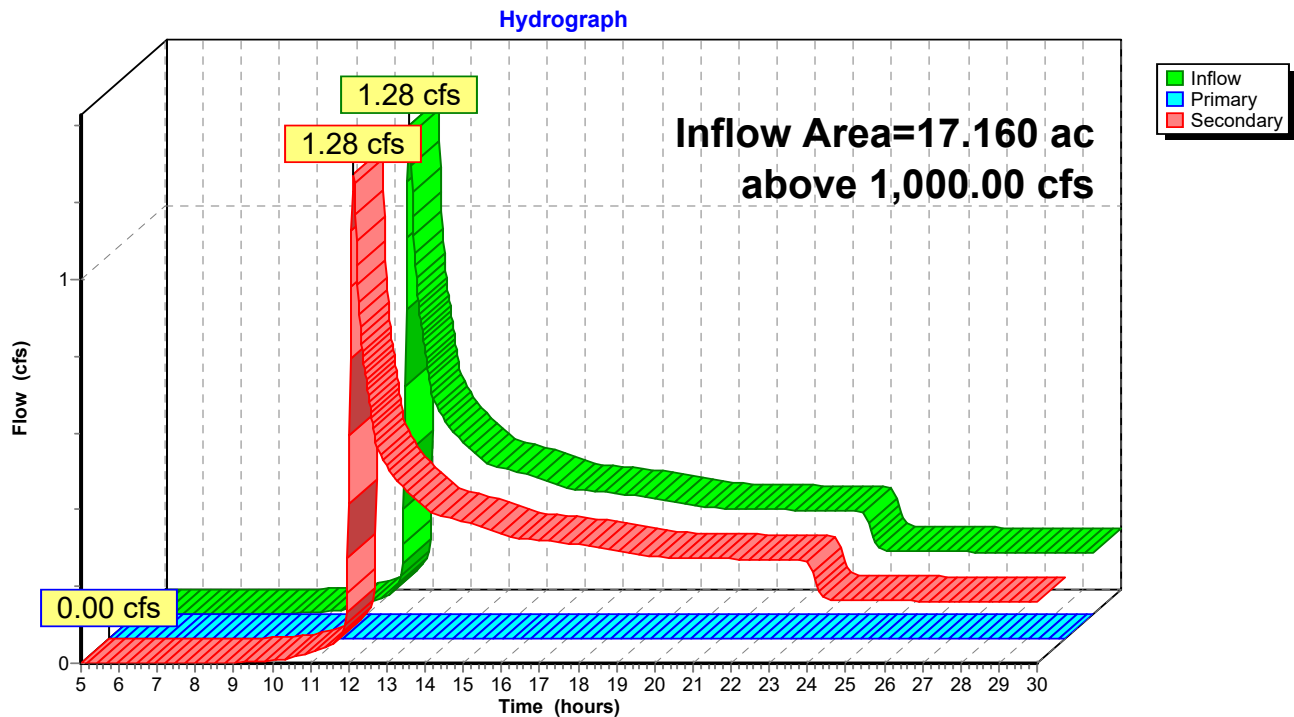
Page 6

Summary for Link 8L: Combined Hydrograph

Inflow Area = 17.160 ac, 25.84% Impervious, Inflow Depth > 0.31" for 1-Year event
Inflow = 1.28 cfs @ 12.13 hrs, Volume= 0.441 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Secondary = 1.28 cfs @ 12.13 hrs, Volume= 0.441 af

Primary outflow = Inflow above 1,000.00 cfs, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs

Link 8L: Combined Hydrograph



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Type II 24-hr 2-Year Rainfall=3.60"

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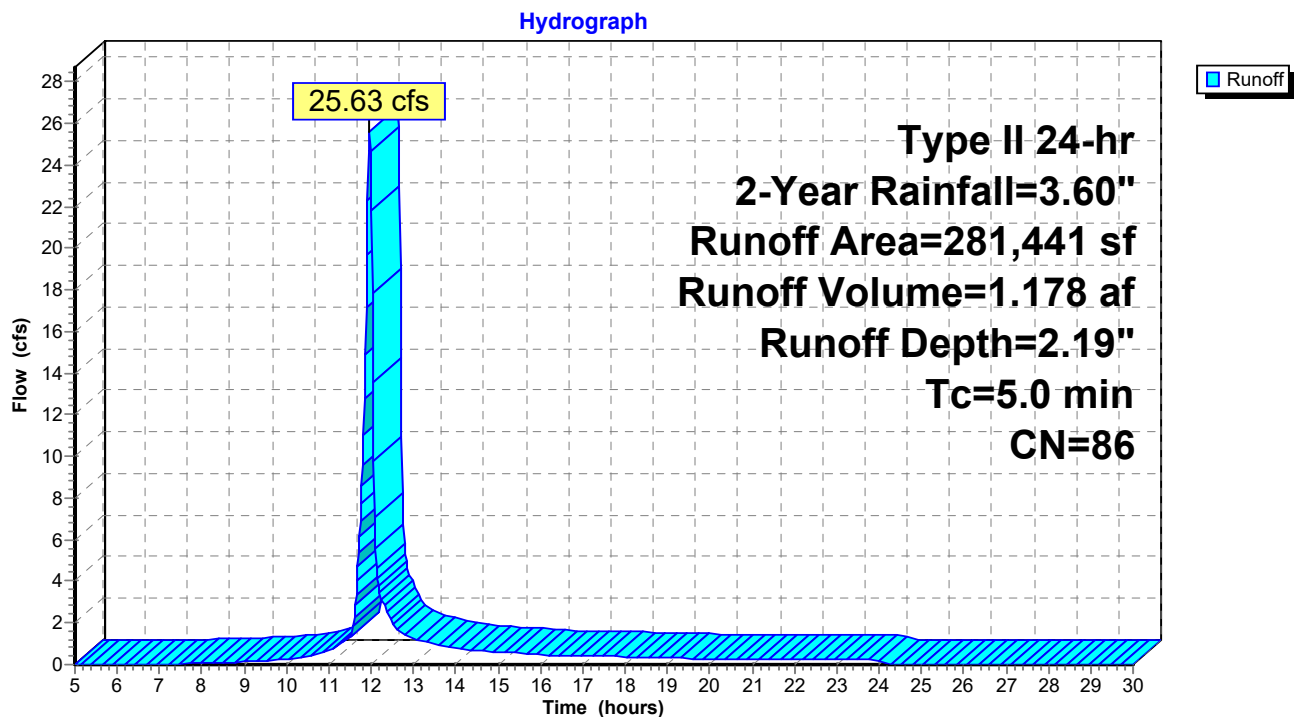
Summary for Subcatchment 5S: BASIN 1 TO POND

Runoff = 25.63 cfs @ 11.96 hrs, Volume= 1.178 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
83,420	61	>75% Grass cover, Good, HSG B
9,327	98	Water Surface, HSG B
4,870	55	Woods, Good, HSG B
281,441	86	Weighted Average
88,290		31.37% Pervious Area
193,151		68.63% Impervious Area

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

Subcatchment 5S: BASIN 1 TO POND

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Type II 24-hr 2-Year Rainfall=3.60"

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Page 8

Summary for Subcatchment 6S: BASIN 1 BYPASS POND

Runoff = 3.69 cfs @ 12.10 hrs, Volume= 0.371 af, Depth= 0.42"

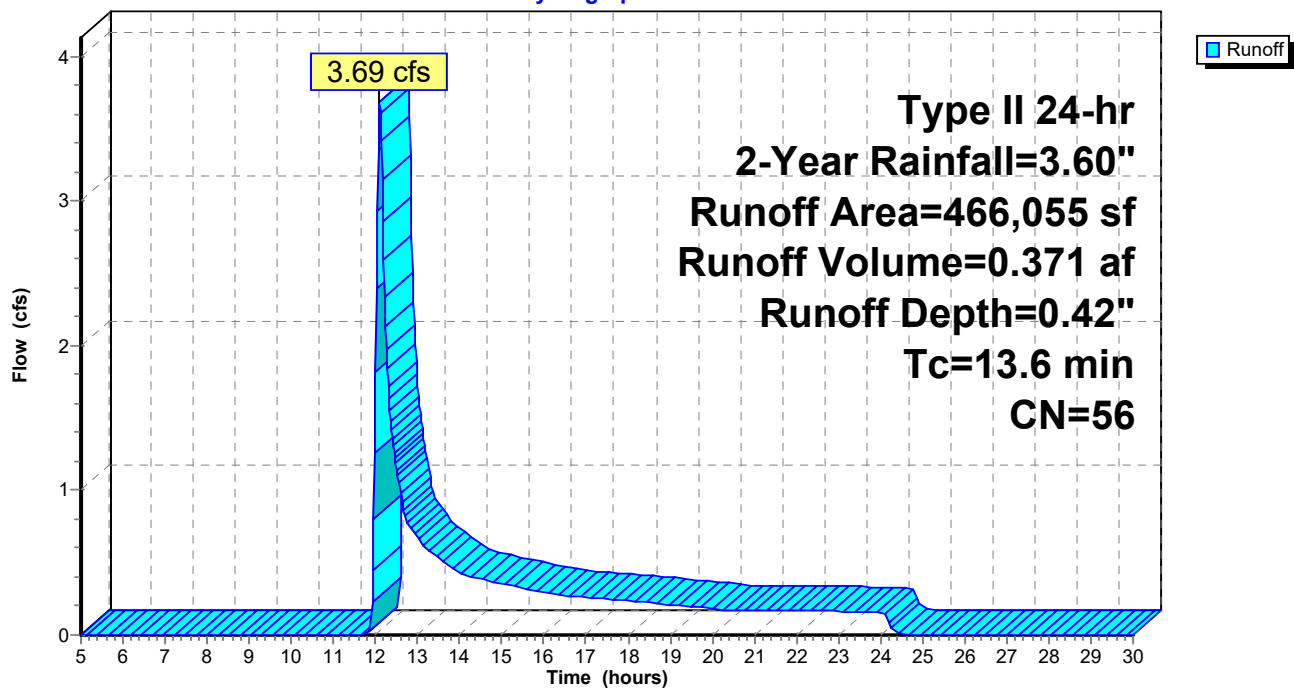
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
53,167	61	>75% Grass cover, Good, HSG B
412,888	55	Woods, Good, HSG B
466,055	56	Weighted Average
466,055		100.00% Pervious Area

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

Subcatchment 6S: BASIN 1 BYPASS POND

Hydrograph



STORM STUDY - 1952

Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Pond 7P: Pond

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth = 2.19" for 2-Year event
 Inflow = 25.63 cfs @ 11.96 hrs, Volume= 1.178 af
 Outflow = 0.19 cfs @ 24.04 hrs, Volume= 0.283 af, Atten= 99%, Lag= 725.0 min
 Primary = 0.19 cfs @ 24.04 hrs, Volume= 0.283 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 484.32' @ 24.04 hrs Surf.Area= 15,625 sf Storage= 42,933 cf

Plug-Flow detention time= 569.2 min calculated for 0.282 af (24% of inflow)
 Center-of-Mass det. time= 432.6 min (1,246.1 - 813.5)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=0.19 cfs @ 24.04 hrs HW=484.32' (Free Discharge)

1=Culvert (Passes 0.19 cfs of 82.14 cfs potential flow)
 2=Orifice/Grate (Controls 0.00 cfs)
 3=Orifice/Grate (Orifice Controls 0.19 cfs @ 8.67 fps)

STORM STUDY - 1952

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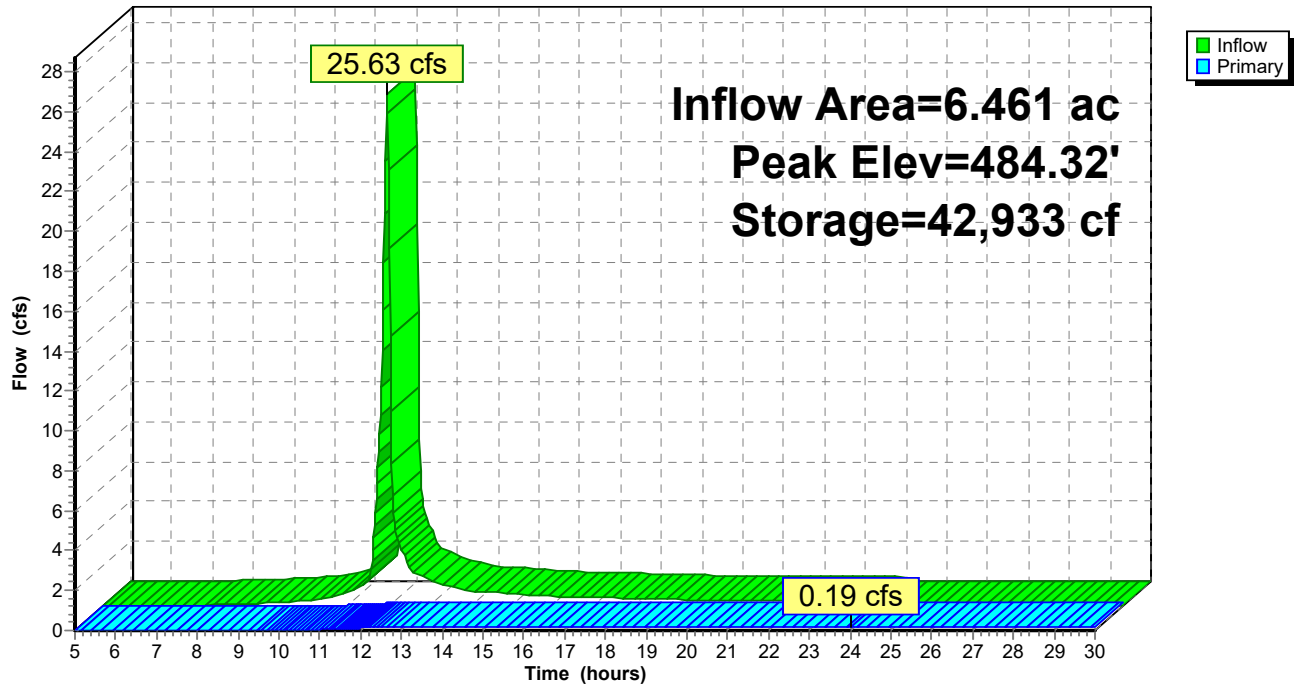
Type II 24-hr 2-Year Rainfall=3.60"

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Pond 7P: Pond

Hydrograph



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Type II 24-hr 2-Year Rainfall=3.60"

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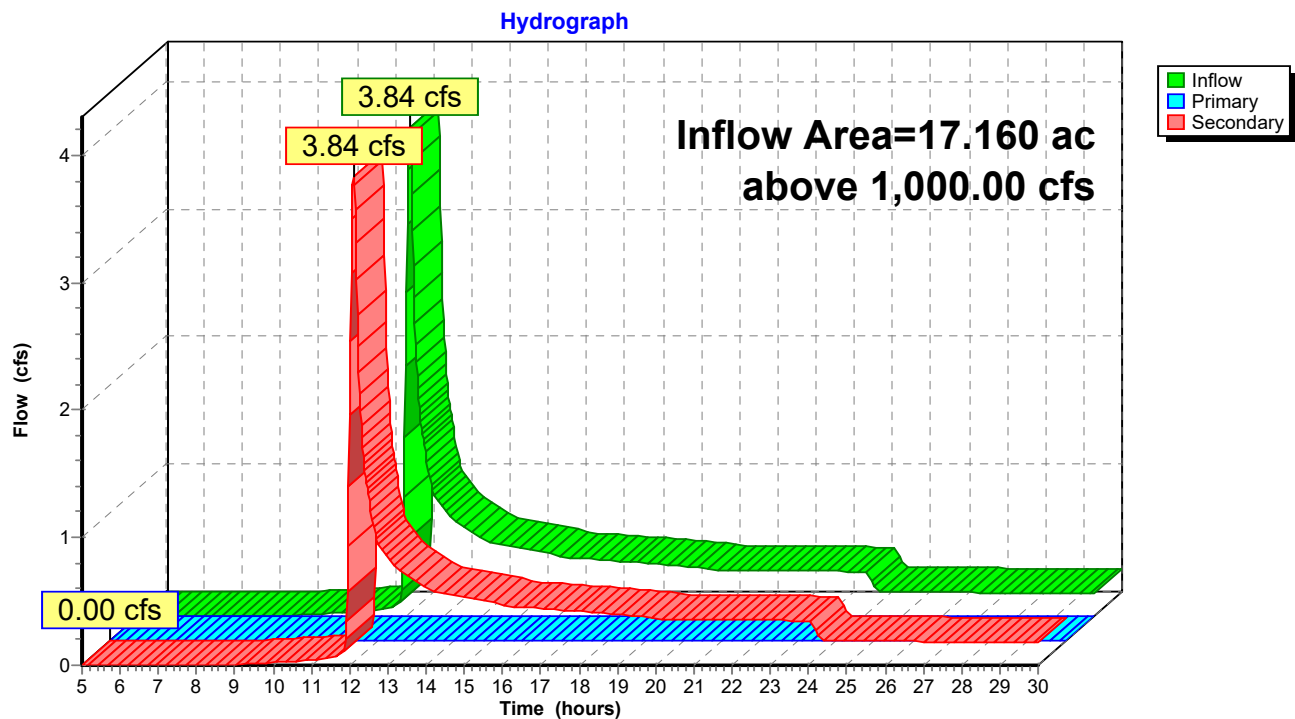
Page 11

Summary for Link 8L: Combined Hydrograph

Inflow Area = 17.160 ac, 25.84% Impervious, Inflow Depth > 0.46" for 2-Year event
Inflow = 3.84 cfs @ 12.10 hrs, Volume= 0.654 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Secondary = 3.84 cfs @ 12.10 hrs, Volume= 0.654 af

Primary outflow = Inflow above 1,000.00 cfs, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs

Link 8L: Combined Hydrograph



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Type II 24-hr 25-Year Rainfall=6.41"

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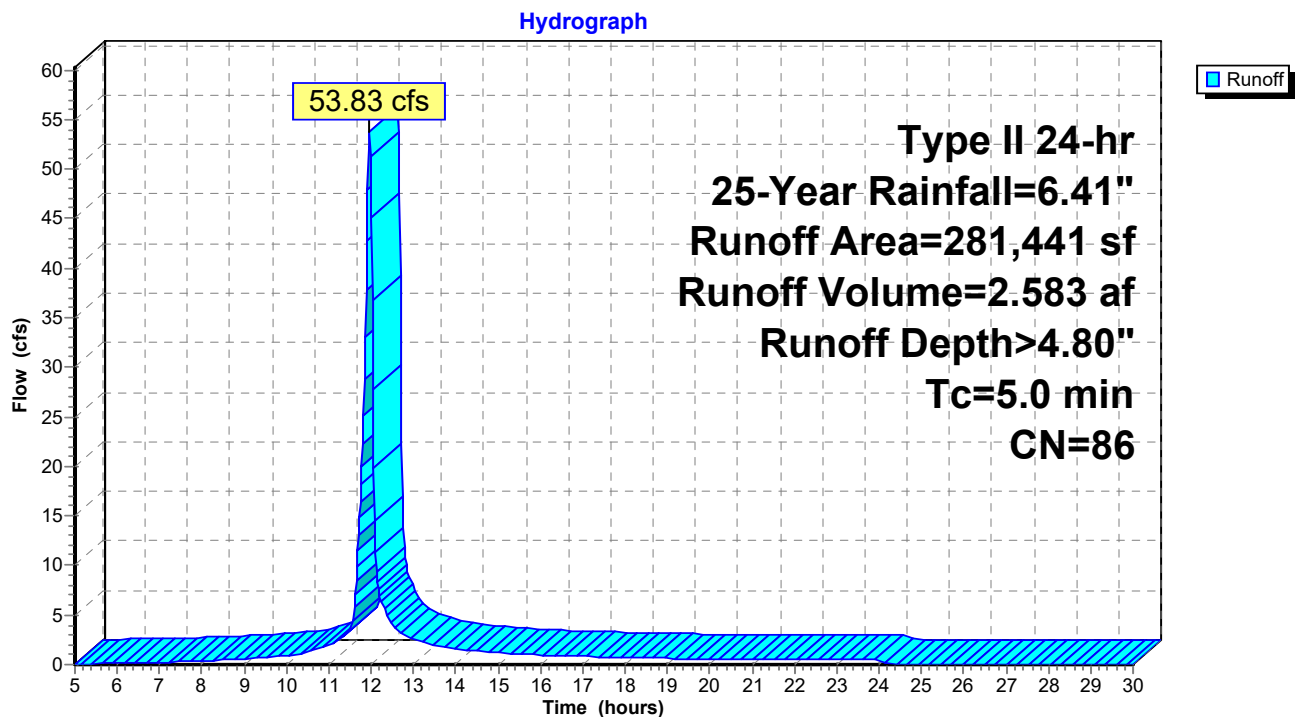
Summary for Subcatchment 5S: BASIN 1 TO POND

Runoff = 53.83 cfs @ 11.96 hrs, Volume= 2.583 af, Depth> 4.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=6.41"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
83,420	61	>75% Grass cover, Good, HSG B
9,327	98	Water Surface, HSG B
4,870	55	Woods, Good, HSG B
281,441	86	Weighted Average
88,290		31.37% Pervious Area
193,151		68.63% Impervious Area

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

Subcatchment 5S: BASIN 1 TO POND

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Type II 24-hr 25-Year Rainfall=6.41"

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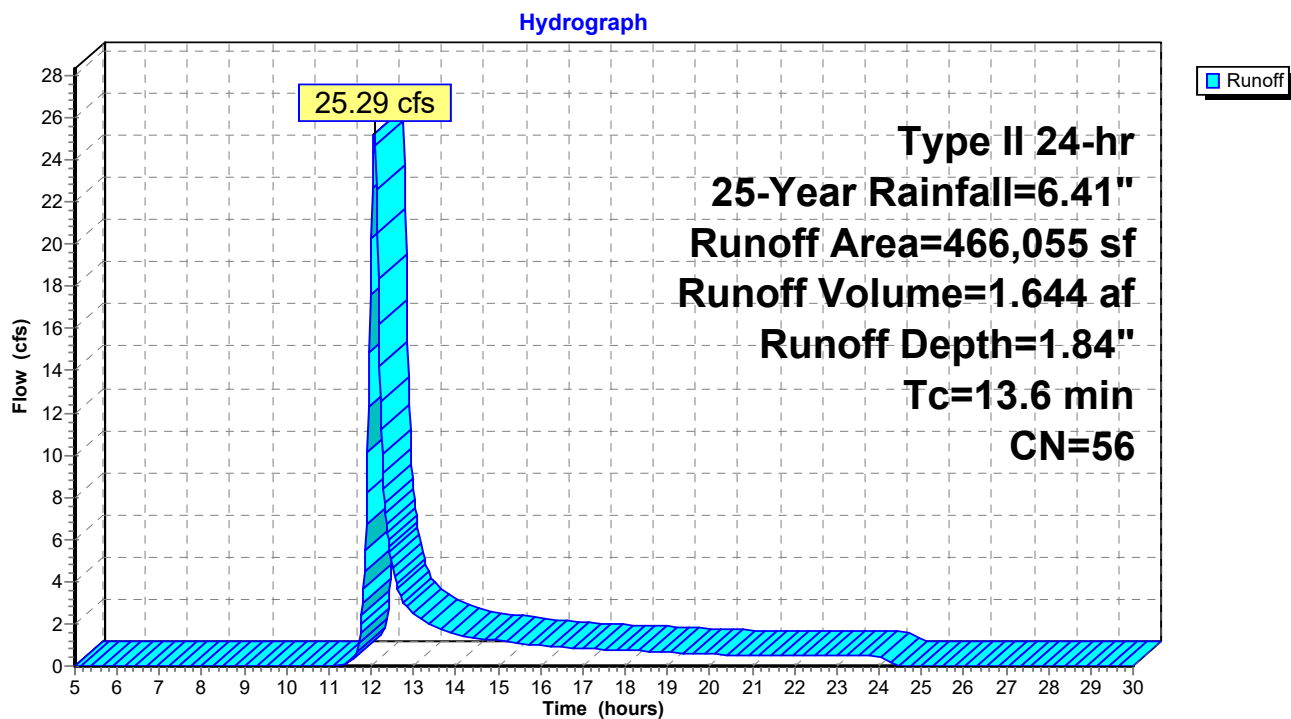
Summary for Subcatchment 6S: BASIN 1 BYPASS POND

Runoff = 25.29 cfs @ 12.07 hrs, Volume= 1.644 af, Depth= 1.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=6.41"

Area (sf)	CN	Description
53,167	61	>75% Grass cover, Good, HSG B
412,888	55	Woods, Good, HSG B
466,055	56	Weighted Average
466,055		100.00% Pervious Area

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

Subcatchment 6S: BASIN 1 BYPASS POND

STORM STUDY - 1952

Type II 24-hr 25-Year Rainfall=6.41"

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Summary for Pond 7P: Pond

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth > 4.80" for 25-Year event
 Inflow = 53.83 cfs @ 11.96 hrs, Volume= 2.583 af
 Outflow = 2.83 cfs @ 12.85 hrs, Volume= 1.052 af, Atten= 95%, Lag= 53.5 min
 Primary = 2.83 cfs @ 12.85 hrs, Volume= 1.052 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 486.10' @ 12.85 hrs Surf.Area= 18,571 sf Storage= 73,287 cf

Plug-Flow detention time= 374.0 min calculated for 1.051 af (41% of inflow)
 Center-of-Mass det. time= 252.8 min (1,044.3 - 791.5)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 ' S= 0.0143 ' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=2.78 cfs @ 12.85 hrs HW=486.10' (Free Discharge)

1=Culvert (Passes 2.78 cfs of 93.84 cfs potential flow)
 2=Orifice/Grate (Weir Controls 2.54 cfs @ 1.04 fps)
 3=Orifice/Grate (Orifice Controls 0.24 cfs @ 10.79 fps)

STORM STUDY - 1952

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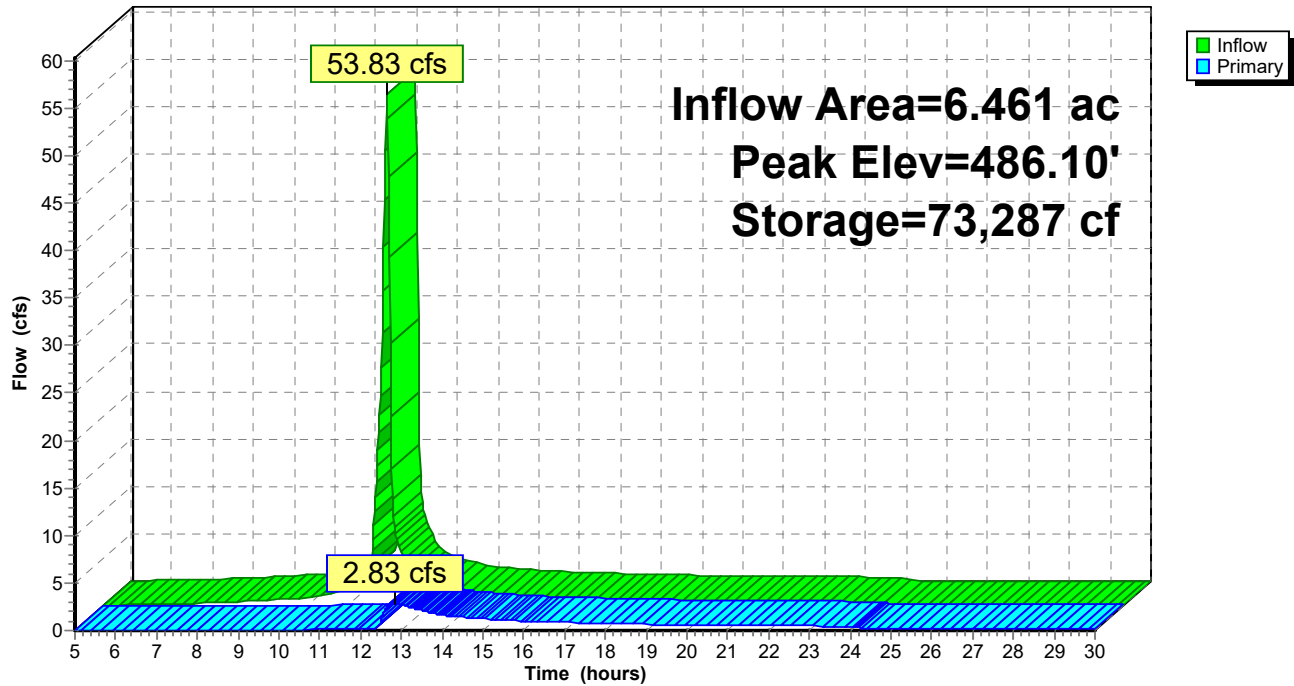
Type II 24-hr 25-Year Rainfall=6.41"

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Pond 7P: Pond

Hydrograph



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Type II 24-hr 25-Year Rainfall=6.41"

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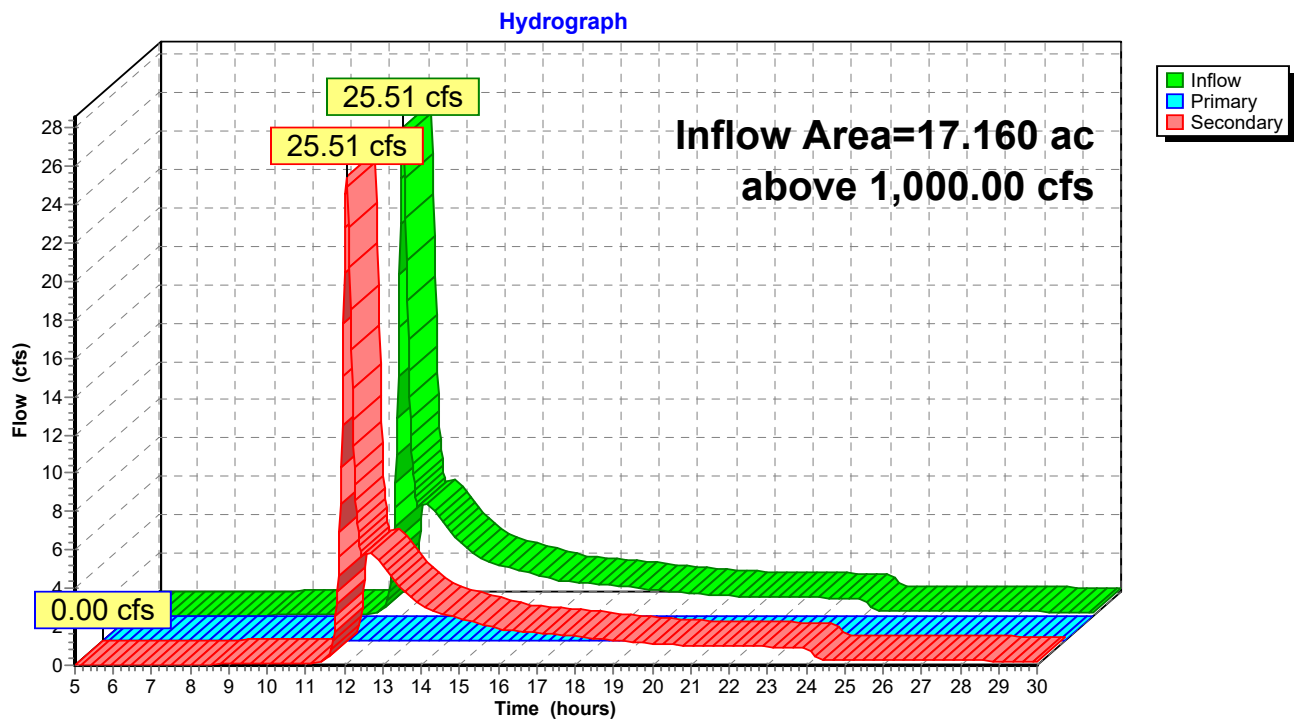
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Summary for Link 8L: Combined Hydrograph

Inflow Area = 17.160 ac, 25.84% Impervious, Inflow Depth > 1.89" for 25-Year event
Inflow = 25.51 cfs @ 12.07 hrs, Volume= 2.696 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Secondary = 25.51 cfs @ 12.07 hrs, Volume= 2.696 af

Primary outflow = Inflow above 1,000.00 cfs, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs

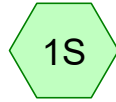
Link 8L: Combined Hydrograph



**STORMWATER VOLUME
CALCULATIONS (2-YR STORM)**

2-YEAR VOLUME SUMMARY

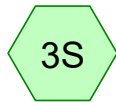
	2-YEAR VOLUME							
	PRE-DEVELOPMENT		POST-DEVELOPMENT					
BASIN 1	23653	CF		CF				
BASIN 1 - TO POND		CF	51314	CF				
BASIN 1 - BYPASS POND		CF	16161	CF				
BASIN 2	3920	CF	3920	CF				
	27573	CF	71395	CF		43821	CF	INCREASE
					WET DETENTION POND	42933	CF	
						42933	CF	PROVIDED
						888	CF	REMAINING



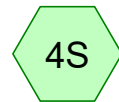
PRE-DEV BASIN 1



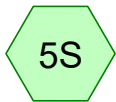
PRE-DEV BASIN 2



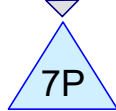
POST-DEV BASIN 1



POST-DEV BASIN 2



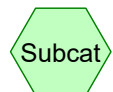
BASIN 1 TO POND



Pond



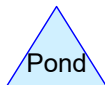
BASIN 1 BYPASS
POND



Subcat



Reach



Pond



Link

Routing Diagram for STORM STUDY - 1952

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STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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Type II 24-hr 2-Year Rainfall=3.60"

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Page 2

Summary for Subcatchment 1S: PRE-DEV BASIN 1

Runoff = 3.62 cfs @ 12.22 hrs, Volume= 0.543 af, Depth= 0.38"

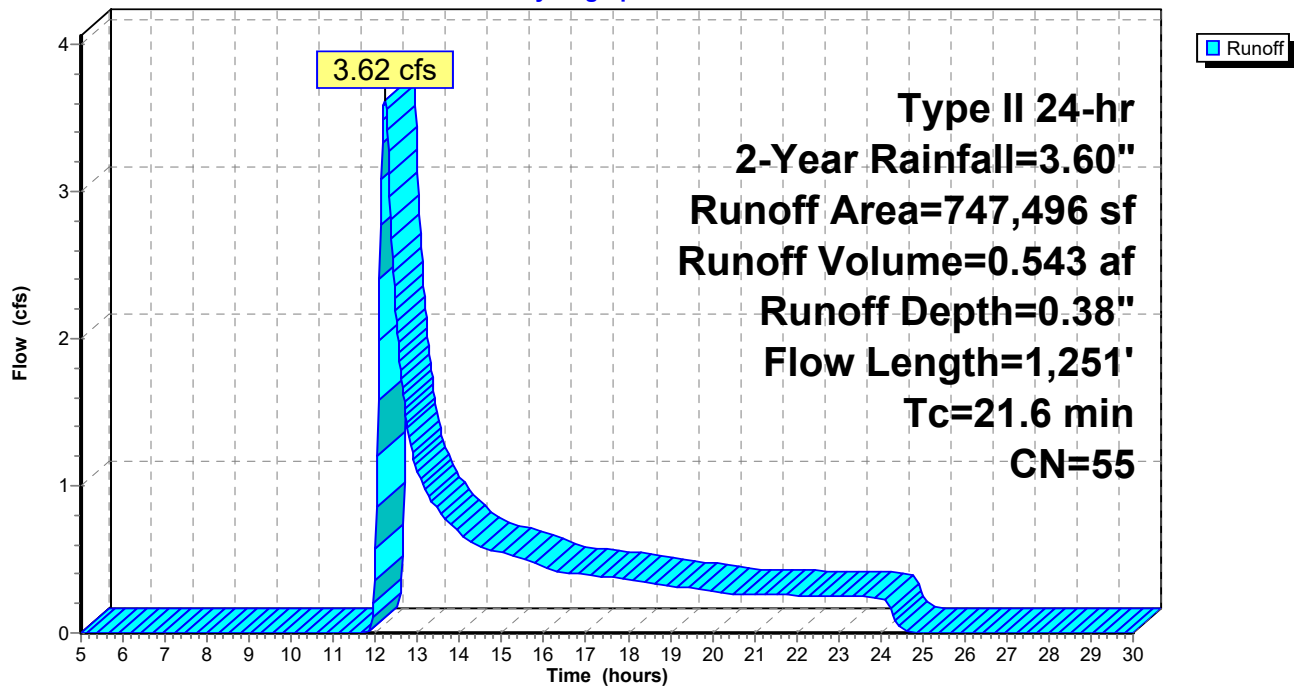
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
15,948	61	>75% Grass cover, Good, HSG B
731,548	55	Woods, Good, HSG B
747,496	55	Weighted Average
747,496		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0470	0.12		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
4.0	360	0.0880	1.48		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
3.2	791	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
21.6	1,251	Total			

Subcatchment 1S: PRE-DEV BASIN 1

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 2S: PRE-DEV BASIN 2

Runoff = 0.71 cfs @ 12.22 hrs, Volume= 0.090 af, Depth= 0.49"

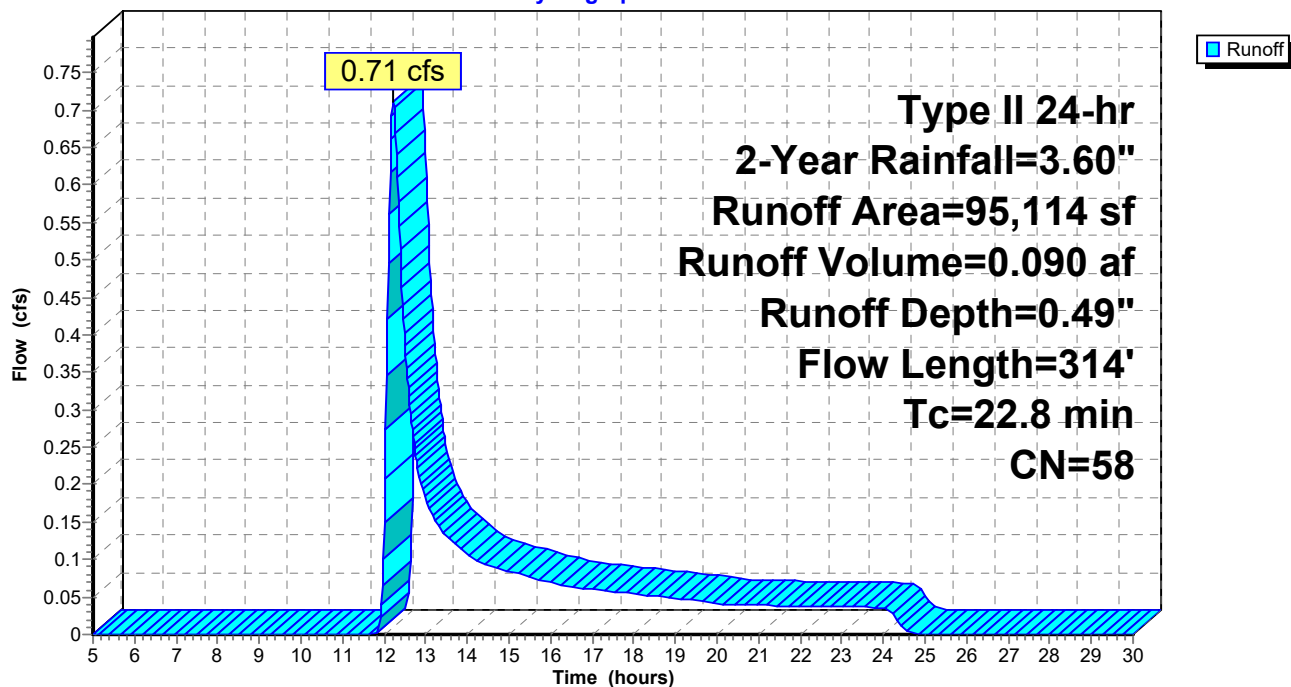
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 2S: PRE-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Page 4

Summary for Subcatchment 3S: POST-DEV BASIN 1

Runoff = 19.35 cfs @ 12.07 hrs, Volume= 1.297 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
136,587	61	>75% Grass cover, Good, HSG B
417,758	55	Woods, Good, HSG B
9,327	98	Water Surface, HSG B
747,496	67	Weighted Average
554,345		74.16% Pervious Area
193,151		25.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	48	0.0310	0.19		Sheet Flow, Grass: Short n= 0.150 P2= 3.60"
1.8	195	0.0220	1.77	0.33	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.25' Z= 3.0 '/' Top.W=1.50' n= 0.030
2.9	310	0.0710	1.79	0.18	Trap/Vee/Rect Channel Flow, Bot.W=0.00' D=0.10' Z= 10.0 '/' Top.W=2.00' n= 0.030
4.6	1,126	0.0190	4.06	15.22	Trap/Vee/Rect Channel Flow, Bot.W=2.00' D=0.75' Z= 4.0 '/' Top.W=8.00' n= 0.030
13.6	1,679	Total			

STORM STUDY - 1952

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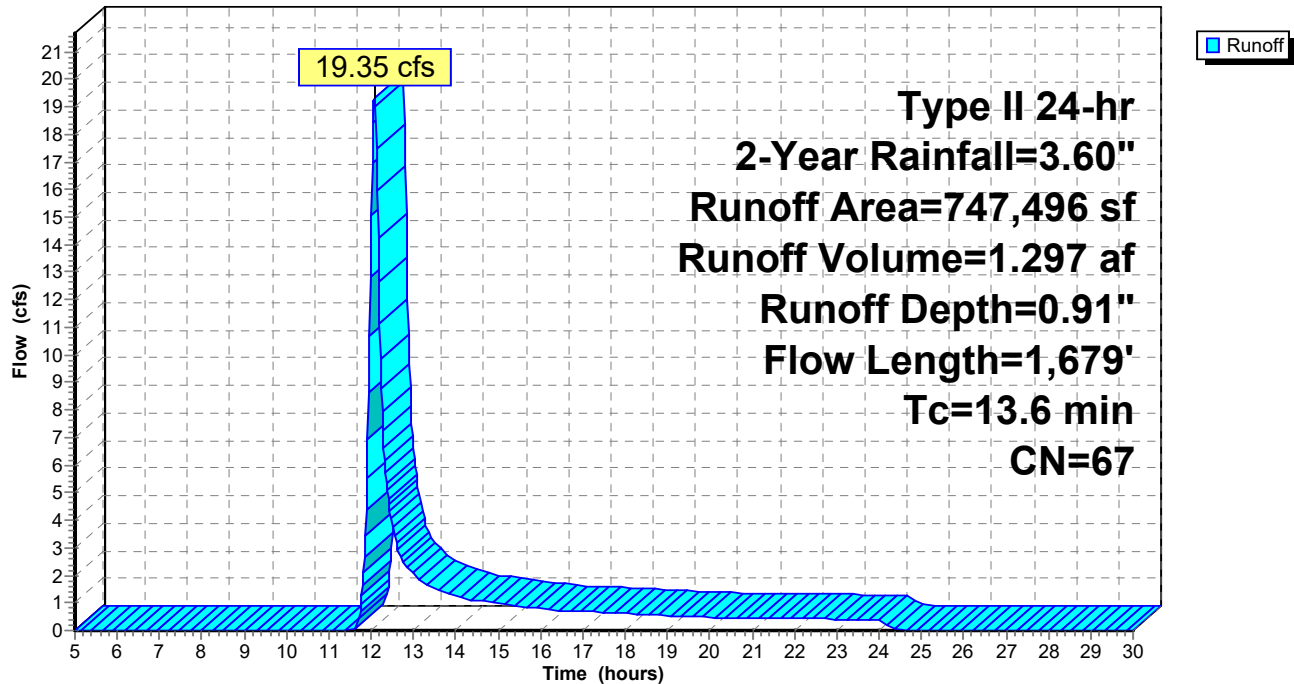
Type II 24-hr 2-Year Rainfall=3.60"

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Subcatchment 3S: POST-DEV BASIN 1

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Subcatchment 4S: POST-DEV BASIN 2

Runoff = 0.71 cfs @ 12.22 hrs, Volume= 0.090 af, Depth= 0.49"

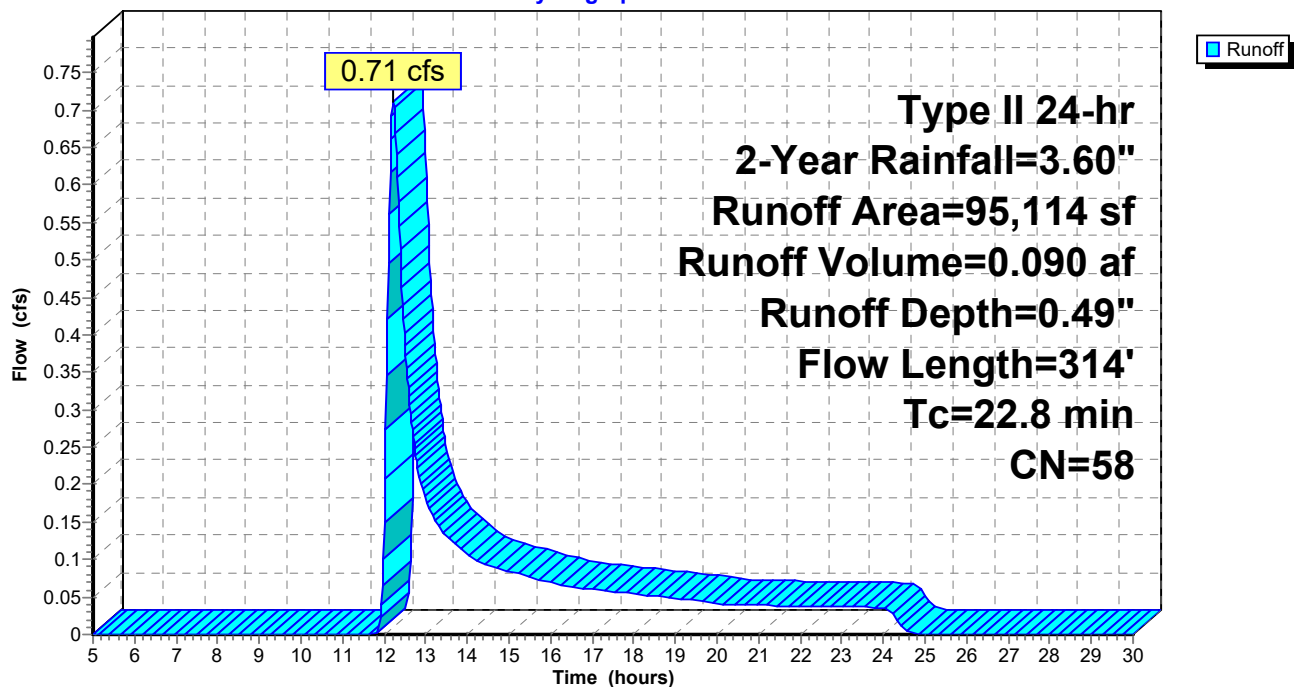
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
45,950	61	>75% Grass cover, Good, HSG B
49,164	55	Woods, Good, HSG B
95,114	58	Weighted Average
95,114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0200	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.60"
0.3	11	0.0200	0.71		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.7	165	0.0550	1.64		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.6	38	0.0530	1.15		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
22.8	314	Total			

Subcatchment 4S: POST-DEV BASIN 2

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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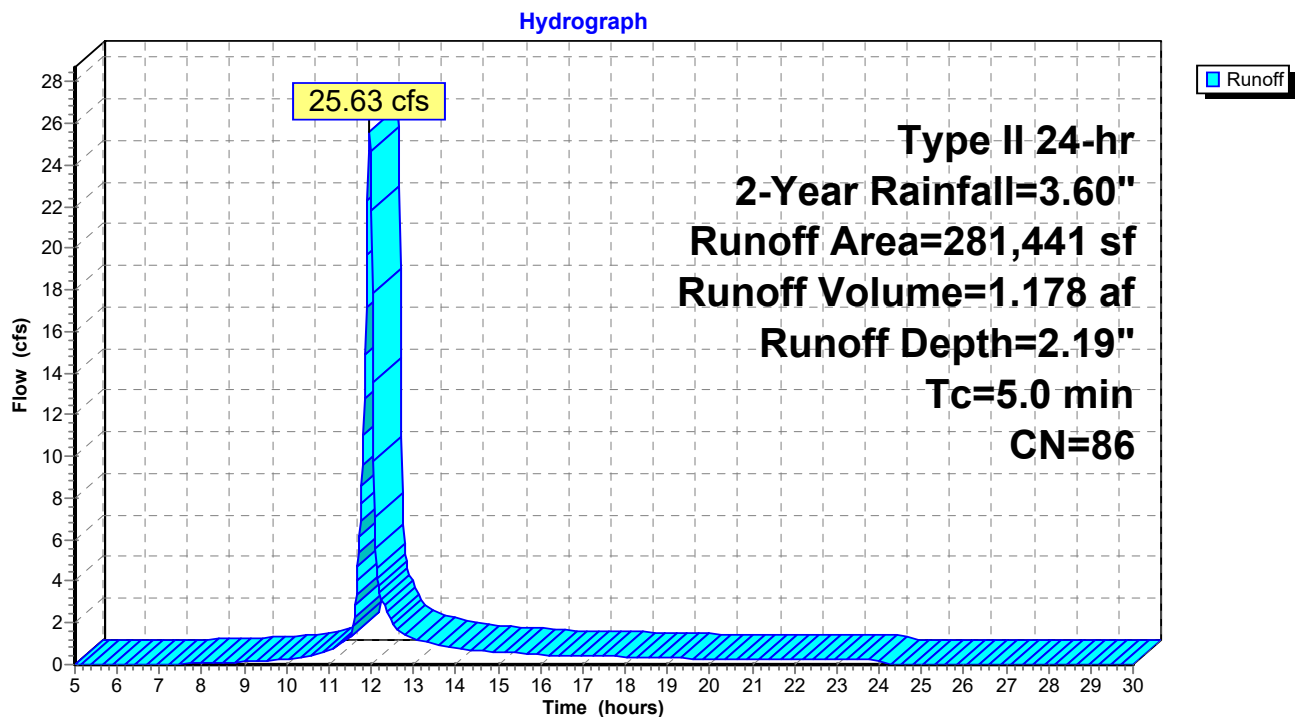
Summary for Subcatchment 5S: BASIN 1 TO POND

Runoff = 25.63 cfs @ 11.96 hrs, Volume= 1.178 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
83,420	61	>75% Grass cover, Good, HSG B
9,327	98	Water Surface, HSG B
4,870	55	Woods, Good, HSG B
281,441	86	Weighted Average
88,290		31.37% Pervious Area
193,151		68.63% Impervious Area

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

Subcatchment 5S: BASIN 1 TO POND

STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Page 8

Summary for Subcatchment 6S: BASIN 1 BYPASS POND

Runoff = 3.69 cfs @ 12.10 hrs, Volume= 0.371 af, Depth= 0.42"

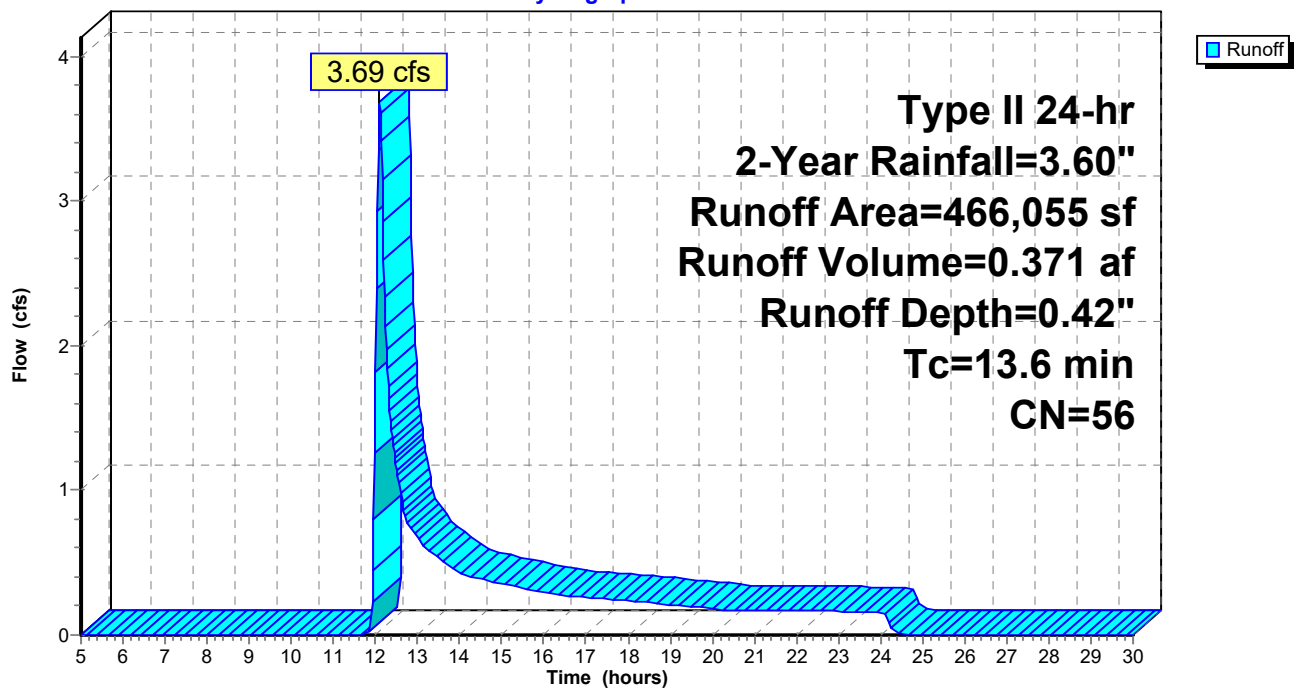
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
53,167	61	>75% Grass cover, Good, HSG B
412,888	55	Woods, Good, HSG B
466,055	56	Weighted Average
466,055		100.00% Pervious Area

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

Subcatchment 6S: BASIN 1 BYPASS POND

Hydrograph



STORM STUDY - 1952

Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Pond 7P: Pond

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth = 2.19" for 2-Year event
 Inflow = 25.63 cfs @ 11.96 hrs, Volume= 1.178 af
 Outflow = 0.19 cfs @ 24.04 hrs, Volume= 0.283 af, Atten= 99%, Lag= 725.0 min
 Primary = 0.19 cfs @ 24.04 hrs, Volume= 0.283 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 484.32' @ 24.04 hrs Surf.Area= 15,625 sf Storage= 42,933 cf

Plug-Flow detention time= 569.2 min calculated for 0.282 af (24% of inflow)
 Center-of-Mass det. time= 432.6 min (1,246.1 - 813.5)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=0.19 cfs @ 24.04 hrs HW=484.32' (Free Discharge)

1=Culvert (Passes 0.19 cfs of 82.14 cfs potential flow)
 2=Orifice/Grate (Controls 0.00 cfs)
 3=Orifice/Grate (Orifice Controls 0.19 cfs @ 8.67 fps)

STORM STUDY - 1952

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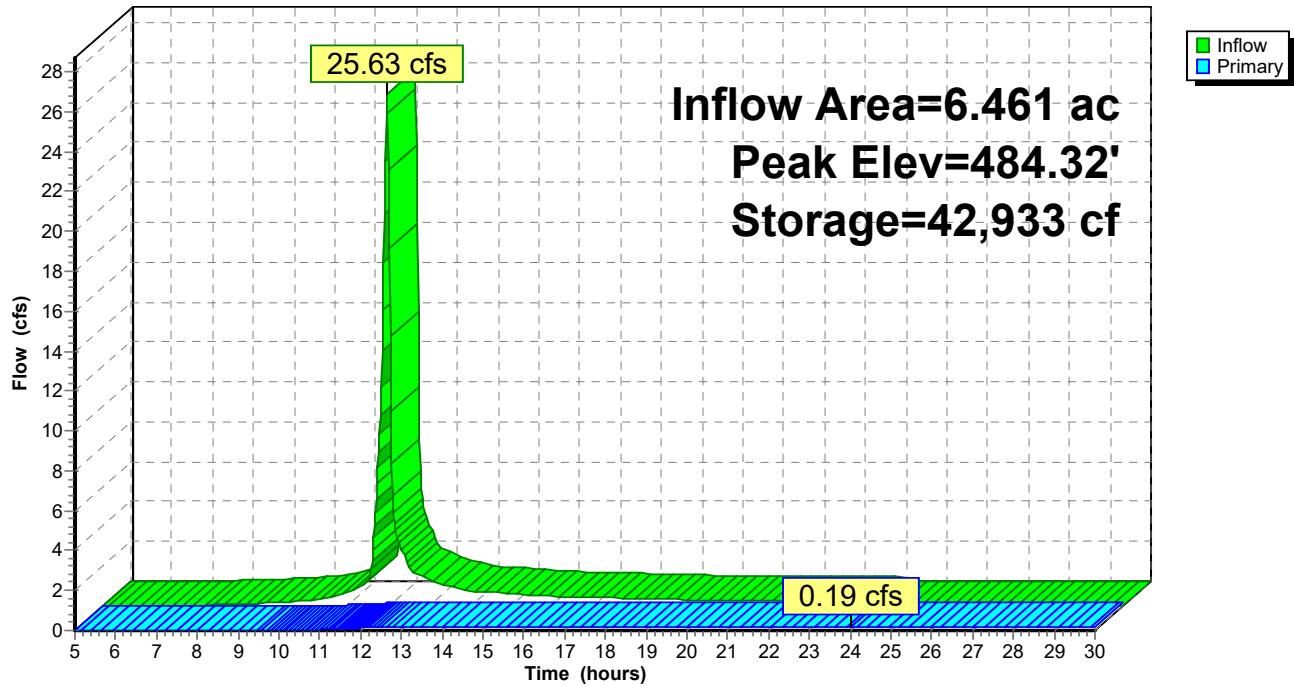
Type II 24-hr 2-Year Rainfall=3.60"

Printed 2/19/2021

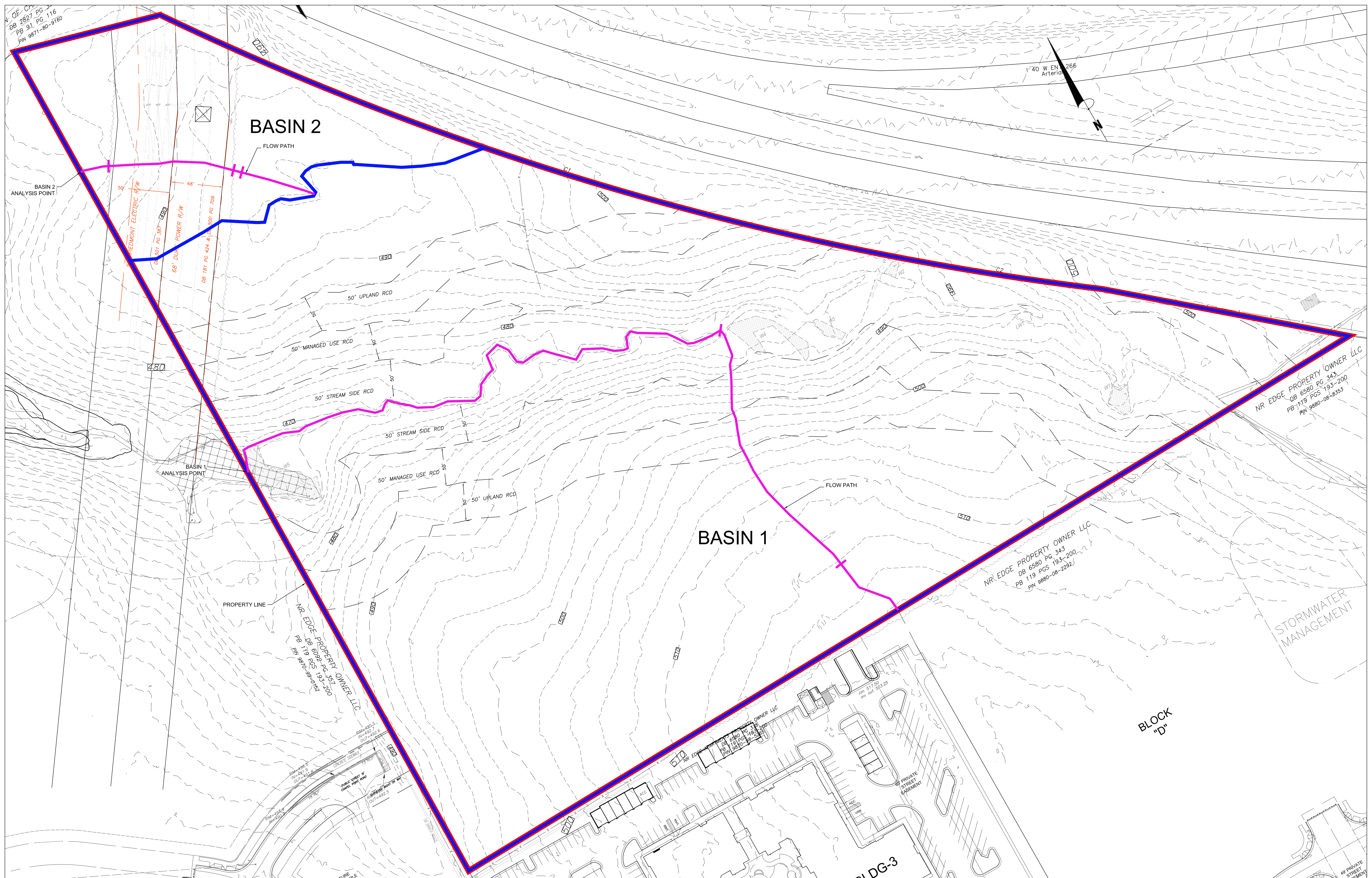
Page 10

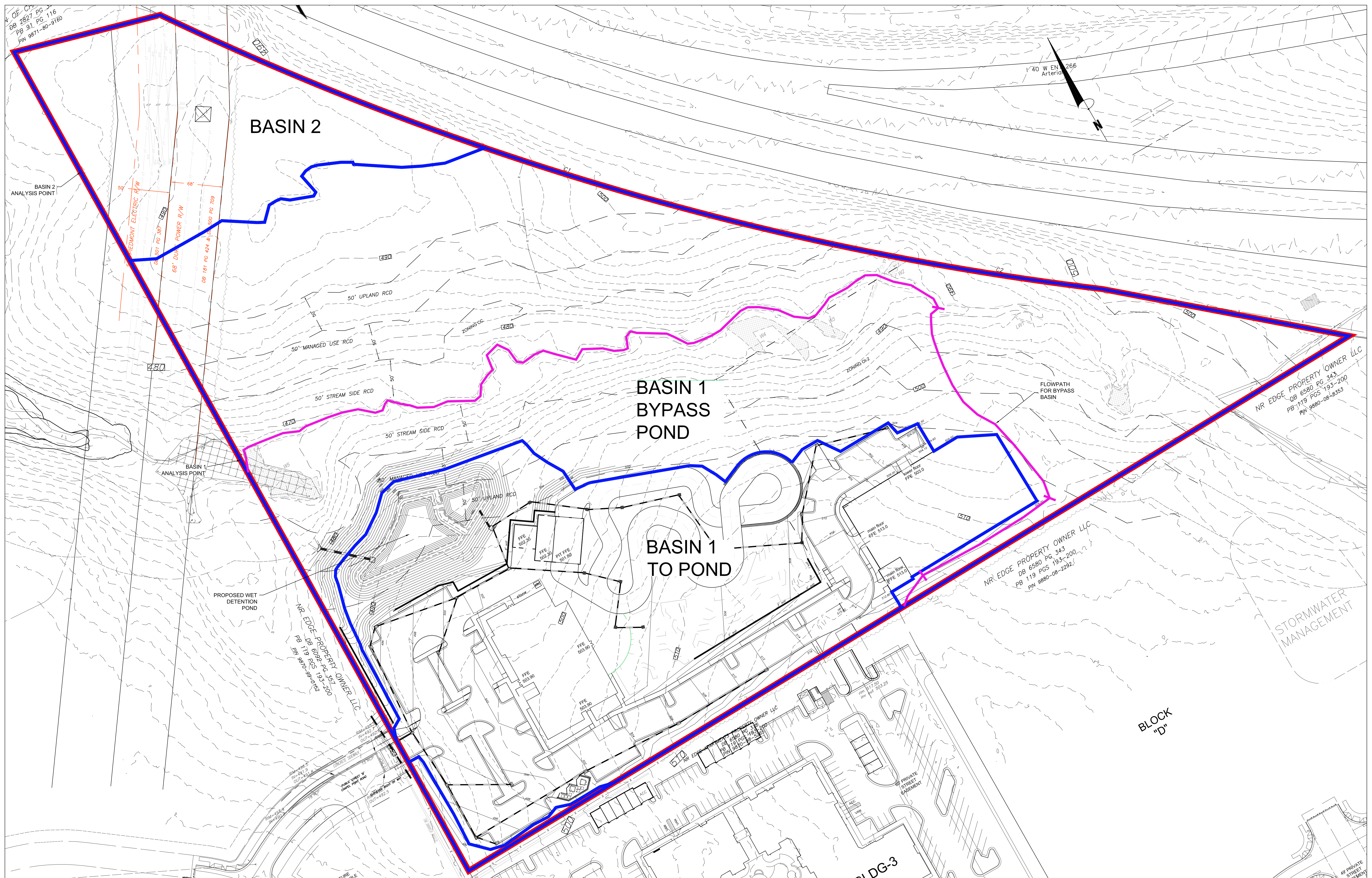
Pond 7P: Pond

Hydrograph



DRAINAGE AREA MAPS





140 W ENT 266
Arterial

NR EDGE PROPERTY OWNER LLC
DB 6580 PG 343
PB 119 PGS 193-200
PIN 9880-08-8353

NR EDGE PROPERTY OWNER LLC
DB 6580 PG 343
PB 119 PGS 193-200
PIN 9580-08-2292

PROPERTY LINE

MR. EOC

DB 682-PO 351

PO 113-200

PIN 11308070800152

PROPERTY OWNER LLC

[illegible]

STORMWATER
MANAGEMENT

BLOCK
"D"

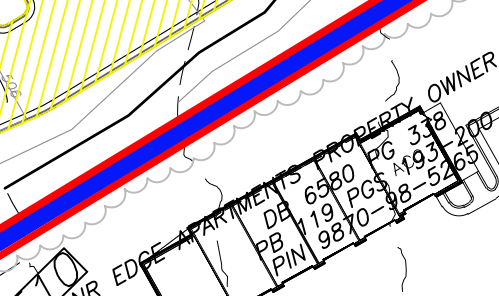
	Roof = 0 SF		Forest = 780,711 SF
	Parking/Driveway/Sidewalk = 0 SF		BMP = 0 SF
	Roadway = 0 SF		Other Pervious/Landscaping = 61,899 SF

DATE: 11/30/2020
SCALE: 1"= 50'
DRAWN BY: PBR,MTC

✓ 40 W ENT 2
Arterial

NR EDGE PROPERTY OWNER (LL)
DB 6580 PG 343
PB 119 PGS 193-200
PIN 9880-08-8353

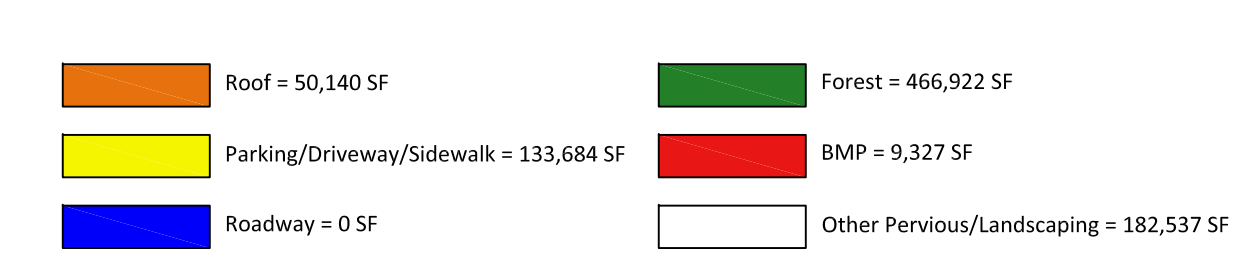
NR EDGE PROPERTY OWNER LLC
DB 6580 PG 343
PB 119 PGS 193-200
PIN 9680-08-2292



Hand-drawn map of the property showing the road, driveway, and building footprint. The building footprint is labeled with dimensions: 6380 (length) and 3638 (width). The driveway is labeled 'DR'. The road is labeled 'NR EDGE'. The property is labeled 'PROPERTY OWNER LLC'. The map also shows a 'PB' (Public Boundary) and a 'PIN' (Public Intersection Number) of 9870. The map is drawn on a grid with a blue and red diagonal line.

STORMWATER
MANAGEMENT

BLOCK
"D"



DATE: 11/30/2020
SCALE: 1"= 50'
DRAWN BY: PBR, MTC

PRELIMINARY POND CALCULATIONS



Coulter Jewell Thames, PA

Project Name: Putt-Putt Fun Center
Project Number: 1952

By:
Date:

Revised:
Date:

Wet Pond Calculations - BASIN 6D

Runoff Volume: Simple Method

Drainage Area = 6.46 ac
Impervious Area = 4.22 ac

$$\text{Runoff volume } V = 3630 * R_d * R_v * A$$

R_d = Design storm rainfall depth (1.0 in)

R_v = Runoff coefficient (unitless)

A = Drainage area (ac)

$$\text{Runoff coefficient } R_v = 0.05 + 0.9 * I_a$$

Impervious fraction (I_a) = 0.65

$$R_v = 0.6378$$

Water Quality Volume Required:

$$V = 14,959 \text{ cf} \quad \text{min 3,630 for wetland}$$

Water Quality Volume Provided:

$$V = 14,960 \text{ cf} \quad \text{OK}$$

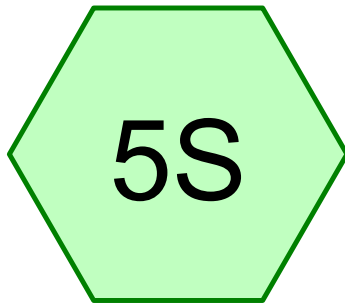
Total Drainage Area to Pond:	6.46	ac
Impervious Area:	4.22	ac
Impervious Percentage:	65.32%	
Assumed Pond Depth:	3.50	ft

SA/DA Ratio Calculation

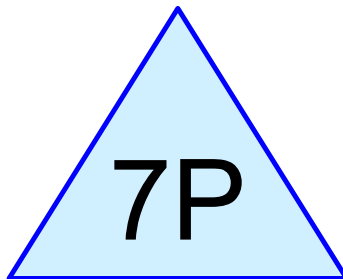
% Impervious	Pond Depth (ft)				Assumed Depth
	3	4	5	6	3.50
20%	0.97	0.79	0.70	0.59	0.88
30%	1.34	1.08	0.97	0.83	1.21
40%	1.73	1.43	1.25	1.05	1.58
50%	2.06	1.73	1.50	1.30	1.90
60%	2.40	2.03	1.71	1.51	2.22
70%	2.88	2.40	2.07	1.79	2.64
80%	3.36	2.78	2.38	2.10	3.07
90%	3.74	3.10	2.60	2.34	3.42
% Impervious =	65.32%	→		SA/DA =	2.44

Required Permanent Pool SA =	0.158 ac 6870 sf
For a 3:1 length to width ratio:	
Required width	47.9 ft
Required length	143.6 ft
Required Storage Volume (Runoff from 1st 1" of rain)	
Rv =	0.638 in/in
Volume =	14959 cf

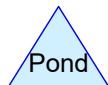
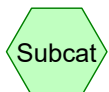
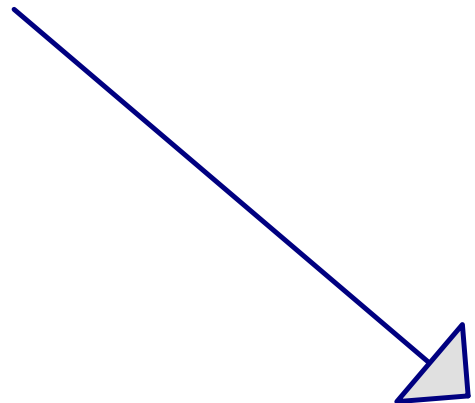
Permanent Pool SA Proposed =	6884 sf 0.158 ac OK
WQV Storage Provided =	14960 cf OK



BASIN 1 TO POND



Pond



Routing Diagram for STORM STUDY - 1952

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STORM STUDY - 1952

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Type II 24-hr 100-Year Rainfall=7.40"

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Page 2

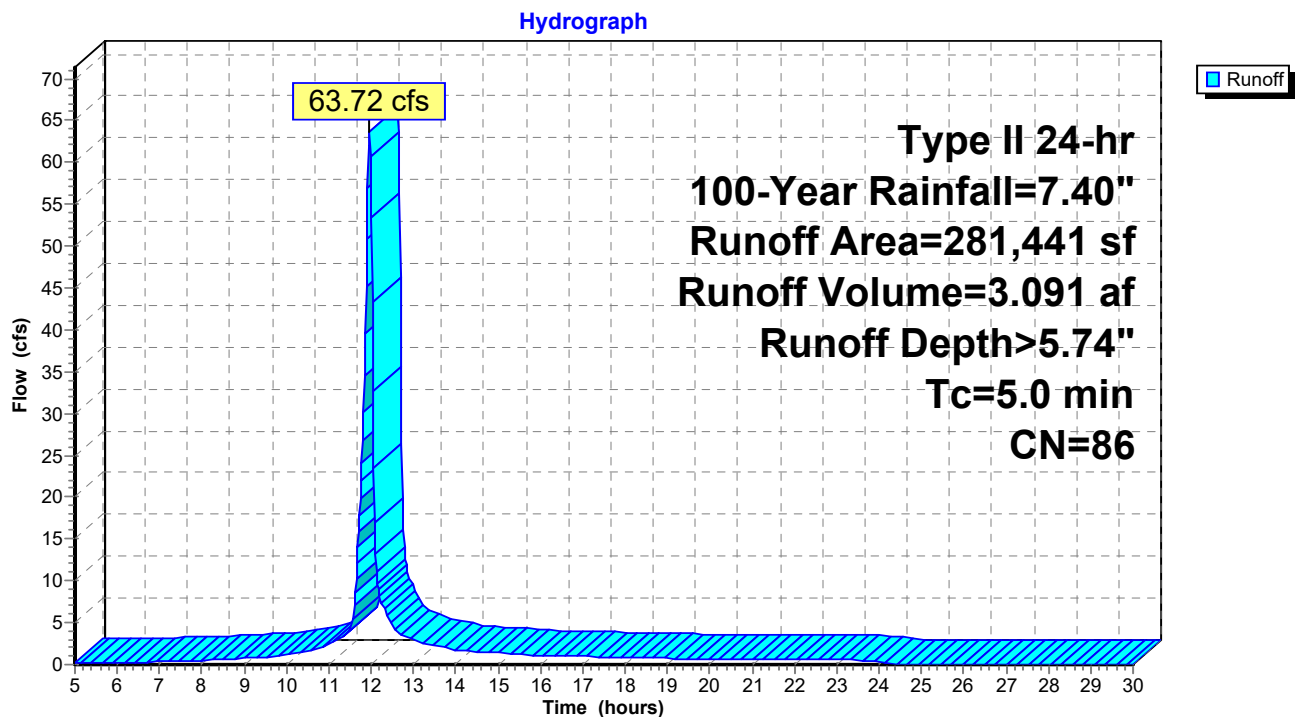
Summary for Subcatchment 5S: BASIN 1 TO POND

Runoff = 63.72 cfs @ 11.96 hrs, Volume= 3.091 af, Depth> 5.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
Type II 24-hr 100-Year Rainfall=7.40"

Area (sf)	CN	Description
183,824	98	Paved parking, HSG B
83,420	61	>75% Grass cover, Good, HSG B
9,327	98	Water Surface, HSG B
4,870	55	Woods, Good, HSG B
281,441	86	Weighted Average
88,290		31.37% Pervious Area
193,151		68.63% Impervious Area

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

Subcatchment 5S: BASIN 1 TO POND

STORM STUDY - 1952

Type II 24-hr 100-Year Rainfall=7.40"

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Page 3

Summary for Pond 7P: Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth > 5.74" for 100-Year event
 Inflow = 63.72 cfs @ 11.96 hrs, Volume= 3.091 af
 Outflow = 10.48 cfs @ 12.13 hrs, Volume= 1.560 af, Atten= 84%, Lag= 10.3 min
 Primary = 10.48 cfs @ 12.13 hrs, Volume= 1.560 af

Routing by Stor-Ind method, Time Span= 5.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 486.26' @ 12.13 hrs Surf.Area= 18,840 sf Storage= 76,192 cf

Plug-Flow detention time= 293.1 min calculated for 1.558 af (50% of inflow)
 Center-of-Mass det. time= 181.3 min (968.4 - 787.1)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=10.40 cfs @ 12.13 hrs HW=486.26' (Free Discharge)

1=Culvert (Passes 10.40 cfs of 94.79 cfs potential flow)
 2=Orifice/Grate (Weir Controls 10.16 cfs @ 1.65 fps)
 3=Orifice/Grate (Orifice Controls 0.24 cfs @ 10.95 fps)

STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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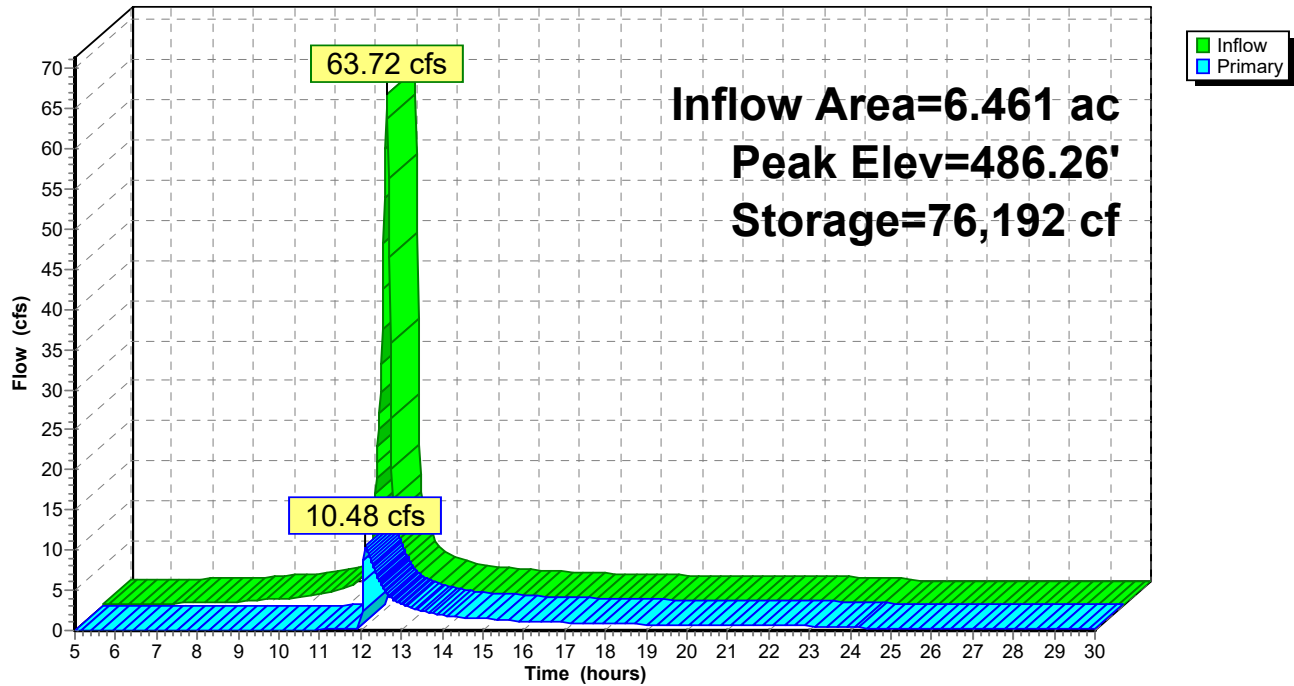
Type II 24-hr 100-Year Rainfall=7.40"

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Pond 7P: Pond

Hydrograph



Pond - 2-yr Drawdown Calculations

STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Summary for Pond 7P: Pond

Inflow Area = 6.461 ac, 68.63% Impervious, Inflow Depth = 2.19" for 2-Year event
 Inflow = 25.63 cfs @ 11.96 hrs, Volume= 1.178 af
 Outflow = 0.19 cfs @ 24.04 hrs, Volume= 1.171 af, Atten= 99%, Lag= 725.0 min
 Primary = 0.19 cfs @ 24.04 hrs, Volume= 1.171 af

Routing by Stor-Ind method, Time Span= 5.00-160.00 hrs, dt= 0.02 hrs
 Peak Elev= 484.32' @ 24.04 hrs Surf.Area= 15,625 sf Storage= 42,933 cf

Plug-Flow detention time= 2,610.2 min calculated for 1.171 af (99% of inflow)
 Center-of-Mass det. time= 2,606.9 min (3,420.4 - 813.5)

Volume	Invert	Avail.Storage	Storage Description
#1	481.00'	111,692 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
481.00	9,347	0	0
481.50	10,993	5,085	5,085
482.00	12,031	5,756	10,841
483.00	13,537	12,784	23,625
484.00	15,099	14,318	37,943
485.00	16,719	15,909	53,852
486.00	18,395	17,557	71,409
487.00	20,127	19,261	90,670
488.00	21,917	21,022	111,692

Device	Routing	Invert	Outlet Devices
#1	Primary	477.00'	36.0" Round Culvert L= 70.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 477.00' / 476.00' S= 0.0143 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	486.00'	72.0" x 72.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Device 1	481.00'	2.0" Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=0.19 cfs @ 24.04 hrs HW=484.32' (Free Discharge)

1=Culvert (Passes 0.19 cfs of 82.14 cfs potential flow)
 2=Orifice/Grate (Controls 0.00 cfs)
 3=Orifice/Grate (Orifice Controls 0.19 cfs @ 8.67 fps)

STORM STUDY - 1952

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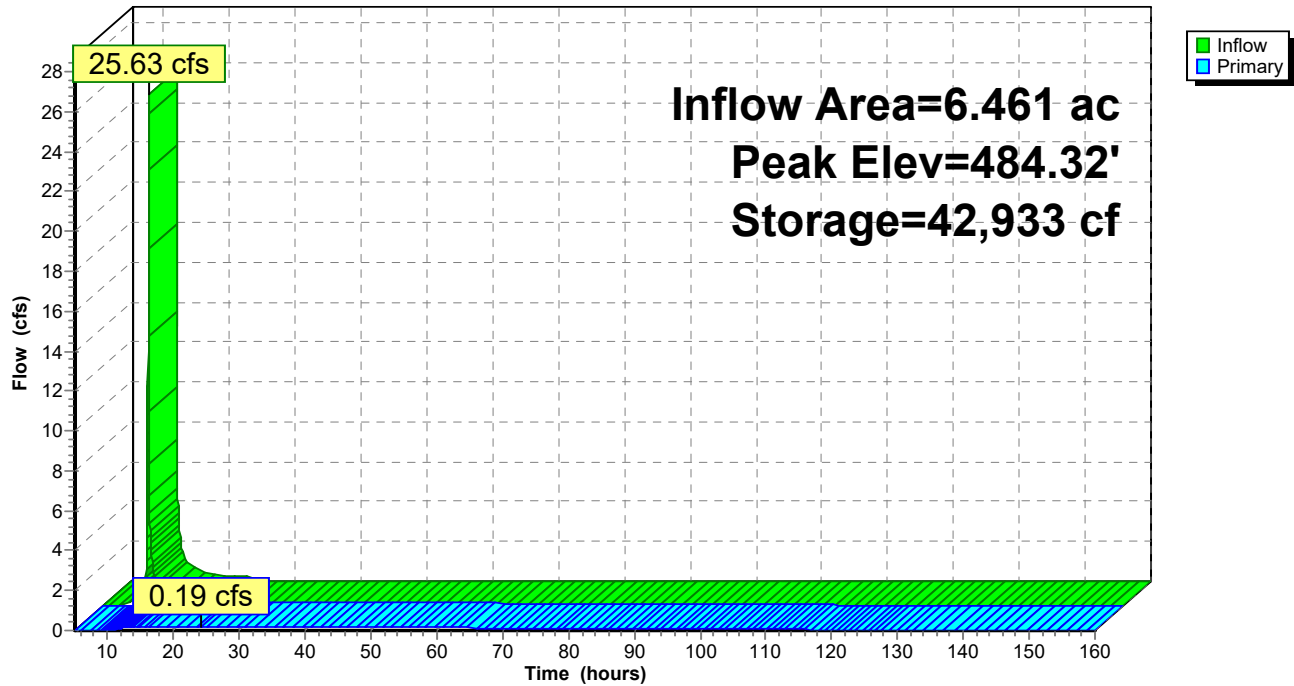
Type II 24-hr 2-Year Rainfall=3.60"

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Pond 7P: Pond

Hydrograph



STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Hydrograph for Pond 7P: Pond

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
5.00	0.00	0	481.00	0.00
5.40	0.00	0	481.00	0.00
5.80	0.00	0	481.00	0.00
6.20	0.00	0	481.00	0.00
6.60	0.00	0	481.00	0.00
7.00	0.01	9	481.00	0.00
7.40	0.03	41	481.00	0.00
7.80	0.05	97	481.01	0.00
8.20	0.07	179	481.02	0.00
8.60	0.10	300	481.03	0.00
9.00	0.15	474	481.05	0.01
9.40	0.18	703	481.07	0.01
9.80	0.23	976	481.10	0.02
10.20	0.32	1,340	481.14	0.02
10.60	0.45	1,849	481.19	0.03
11.00	0.67	2,595	481.27	0.04
11.40	1.15	3,795	481.38	0.06
11.80	9.61	8,720	481.82	0.09
12.20	3.37	28,030	483.32	0.16
12.60	1.70	31,350	483.55	0.17
13.00	1.28	33,239	483.68	0.17
13.40	1.03	34,638	483.78	0.17
13.80	0.85	35,731	483.85	0.17
14.20	0.72	36,595	483.91	0.18
14.60	0.67	37,345	483.96	0.18
15.00	0.62	38,014	484.00	0.18
15.40	0.56	38,604	484.04	0.18
15.80	0.51	39,112	484.08	0.18
16.20	0.46	39,542	484.11	0.18
16.60	0.44	39,929	484.13	0.18
17.00	0.42	40,288	484.15	0.18
17.40	0.40	40,617	484.18	0.18
17.80	0.38	40,918	484.19	0.19
18.20	0.36	41,188	484.21	0.19
18.60	0.34	41,429	484.23	0.19
19.00	0.32	41,641	484.24	0.19
19.40	0.30	41,823	484.25	0.19
19.80	0.28	41,976	484.26	0.19
20.20	0.27	42,100	484.27	0.19
20.60	0.26	42,212	484.28	0.19
21.00	0.26	42,318	484.29	0.19
21.40	0.26	42,419	484.29	0.19
21.80	0.25	42,514	484.30	0.19
22.20	0.25	42,602	484.30	0.19
22.60	0.24	42,685	484.31	0.19
23.00	0.24	42,762	484.31	0.19
23.40	0.24	42,834	484.32	0.19
23.80	0.23	42,899	484.32	0.19
24.20	0.00	42,857	484.32	0.19
24.60	0.00	42,585	484.30	0.19
25.00	0.00	42,314	484.29	0.19
25.40	0.00	42,044	484.27	0.19
25.80	0.00	41,774	484.25	0.19

Pond - 2-yr Drawdown
Calculations

Peak water surface
elevation for the 2-
yr storm

STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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Type II 24-hr 2-Year Rainfall=3.60"

Printed 2/19/2021

Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
26.20	0.00	41,506	484.23	0.19
26.60	0.00	41,237	484.22	0.19
27.00	0.00	40,970	484.20	0.19
27.40	0.00	40,703	484.18	0.18
27.80	0.00	40,438	484.16	0.18
28.20	0.00	40,173	484.15	0.18
28.60	0.00	39,908	484.13	0.18
29.00	0.00	39,645	484.11	0.18
29.40	0.00	39,382	484.09	0.18
29.80	0.00	39,120	484.08	0.18
30.20	0.00	38,858	484.06	0.18
30.60	0.00	38,598	484.04	0.18
31.00	0.00	38,338	484.03	0.18
31.40	0.00	38,079	484.01	0.18
31.80	0.00	37,820	483.99	0.18
32.20	0.00	37,563	483.97	0.18
32.60	0.00	37,306	483.96	0.18
33.00	0.00	37,050	483.94	0.18
33.40	0.00	36,794	483.92	0.18
33.80	0.00	36,540	483.91	0.18
34.20	0.00	36,286	483.89	0.18
34.60	0.00	36,033	483.87	0.18
35.00	0.00	35,781	483.86	0.17
35.40	0.00	35,529	483.84	0.17
35.80	0.00	35,279	483.82	0.17
36.20	0.00	35,029	483.81	0.17
36.60	0.00	34,780	483.79	0.17
37.00	0.00	34,531	483.77	0.17
37.40	0.00	34,284	483.75	0.17
37.80	0.00	34,037	483.74	0.17
38.20	0.00	33,791	483.72	0.17
38.60	0.00	33,545	483.70	0.17
39.00	0.00	33,301	483.69	0.17
39.40	0.00	33,057	483.67	0.17
39.80	0.00	32,814	483.65	0.17
40.20	0.00	32,572	483.64	0.17
40.60	0.00	32,331	483.62	0.17
41.00	0.00	32,090	483.60	0.17
41.40	0.00	31,850	483.59	0.17
41.80	0.00	31,611	483.57	0.17
42.20	0.00	31,373	483.55	0.17
42.60	0.00	31,136	483.54	0.16
43.00	0.00	30,899	483.52	0.16
43.40	0.00	30,663	483.51	0.16
43.80	0.00	30,428	483.49	0.16
44.20	0.00	30,194	483.47	0.16
44.60	0.00	29,961	483.46	0.16
45.00	0.00	29,728	483.44	0.16
45.40	0.00	29,496	483.42	0.16
45.80	0.00	29,266	483.41	0.16
46.20	0.00	29,035	483.39	0.16
46.60	0.00	28,806	483.37	0.16
47.00	0.00	28,577	483.36	0.16

STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
47.40	0.00	28,350	483.34	0.16
47.80	0.00	28,123	483.33	0.16
48.20	0.00	27,897	483.31	0.16
48.60	0.00	27,671	483.29	0.16
49.00	0.00	27,447	483.28	0.16
49.40	0.00	27,223	483.26	0.16
49.80	0.00	27,000	483.25	0.15
50.20	0.00	26,778	483.23	0.15
50.60	0.00	26,557	483.21	0.15
51.00	0.00	26,337	483.20	0.15
51.40	0.00	26,117	483.18	0.15
51.80	0.00	25,898	483.17	0.15
52.20	0.00	25,680	483.15	0.15
52.60	0.00	25,463	483.13	0.15
53.00	0.00	25,247	483.12	0.15
53.40	0.00	25,032	483.10	0.15
53.80	0.00	24,817	483.09	0.15
54.20	0.00	24,603	483.07	0.15
54.60	0.00	24,391	483.06	0.15
55.00	0.00	24,179	483.04	0.15
55.40	0.00	23,967	483.03	0.15
55.80	0.00	23,757	483.01	0.15
56.20	0.00	23,547	482.99	0.15
56.60	0.00	23,339	482.98	0.14
57.00	0.00	23,131	482.96	0.14
57.40	0.00	22,924	482.95	0.14
57.80	0.00	22,718	482.93	0.14
58.20	0.00	22,513	482.92	0.14
58.60	0.00	22,308	482.90	0.14
59.00	0.00	22,105	482.89	0.14
59.40	0.00	21,902	482.87	0.14
59.80	0.00	21,700	482.86	0.14
60.20	0.00	21,499	482.84	0.14
60.60	0.00	21,299	482.83	0.14
61.00	0.00	21,100	482.81	0.14
61.40	0.00	20,901	482.80	0.14
61.80	0.00	20,704	482.78	0.14
62.20	0.00	20,507	482.77	0.14
62.60	0.00	20,311	482.75	0.14
63.00	0.00	20,116	482.74	0.14
63.40	0.00	19,922	482.72	0.13
63.80	0.00	19,729	482.71	0.13
64.20	0.00	19,537	482.69	0.13
64.60	0.00	19,345	482.68	0.13
65.00	0.00	19,155	482.66	0.13
65.40	0.00	18,965	482.65	0.13
65.80	0.00	18,776	482.63	0.13
66.20	0.00	18,588	482.62	0.13
66.60	0.00	18,401	482.61	0.13
67.00	0.00	18,215	482.59	0.13
67.40	0.00	18,030	482.58	0.13
67.80	0.00	17,845	482.56	0.13
68.20	0.00	17,662	482.55	0.13

STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
68.60	0.00	17,479	482.53	0.13
69.00	0.00	17,297	482.52	0.13
69.40	0.00	17,117	482.51	0.13
69.80	0.00	16,937	482.49	0.12
70.20	0.00	16,758	482.48	0.12
70.60	0.00	16,579	482.46	0.12
71.00	0.00	16,402	482.45	0.12
71.40	0.00	16,226	482.44	0.12
71.80	0.00	16,050	482.42	0.12
72.20	0.00	15,876	482.41	0.12
72.60	0.00	15,702	482.39	0.12
73.00	0.00	15,529	482.38	0.12
73.40	0.00	15,358	482.37	0.12
73.80	0.00	15,187	482.35	0.12
74.20	0.00	15,017	482.34	0.12
74.60	0.00	14,848	482.33	0.12
75.00	0.00	14,679	482.31	0.12
75.40	0.00	14,512	482.30	0.12
75.80	0.00	14,346	482.29	0.12
76.20	0.00	14,180	482.27	0.11
76.60	0.00	14,016	482.26	0.11
77.00	0.00	13,852	482.25	0.11
77.40	0.00	13,690	482.23	0.11
77.80	0.00	13,528	482.22	0.11
78.20	0.00	13,367	482.21	0.11
78.60	0.00	13,207	482.19	0.11
79.00	0.00	13,048	482.18	0.11
79.40	0.00	12,890	482.17	0.11
79.80	0.00	12,733	482.16	0.11
80.20	0.00	12,577	482.14	0.11
80.60	0.00	12,422	482.13	0.11
81.00	0.00	12,267	482.12	0.11
81.40	0.00	12,114	482.11	0.11
81.80	0.00	11,962	482.09	0.11
82.20	0.00	11,810	482.08	0.10
82.60	0.00	11,660	482.07	0.10
83.00	0.00	11,510	482.06	0.10
83.40	0.00	11,361	482.04	0.10
83.80	0.00	11,214	482.03	0.10
84.20	0.00	11,067	482.02	0.10
84.60	0.00	10,921	482.01	0.10
85.00	0.00	10,776	481.99	0.10
85.40	0.00	10,632	481.98	0.10
85.80	0.00	10,489	481.97	0.10
86.20	0.00	10,347	481.96	0.10
86.60	0.00	10,206	481.95	0.10
87.00	0.00	10,066	481.94	0.10
87.40	0.00	9,927	481.92	0.10
87.80	0.00	9,789	481.91	0.10
88.20	0.00	9,652	481.90	0.09
88.60	0.00	9,516	481.89	0.09
89.00	0.00	9,380	481.88	0.09
89.40	0.00	9,246	481.87	0.09

STORM STUDY - 1952

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Type II 24-hr 2-Year Rainfall=3.60"

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Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
89.80	0.00	9,113	481.85	0.09
90.20	0.00	8,980	481.84	0.09
90.60	0.00	8,849	481.83	0.09
91.00	0.00	8,719	481.82	0.09
91.40	0.00	8,589	481.81	0.09
91.80	0.00	8,461	481.80	0.09
92.20	0.00	8,334	481.79	0.09
92.60	0.00	8,207	481.78	0.09
93.00	0.00	8,082	481.77	0.09
93.40	0.00	7,957	481.76	0.09
93.80	0.00	7,834	481.74	0.09
94.20	0.00	7,711	481.73	0.08
94.60	0.00	7,590	481.72	0.08
95.00	0.00	7,469	481.71	0.08
95.40	0.00	7,350	481.70	0.08
95.80	0.00	7,231	481.69	0.08
96.20	0.00	7,114	481.68	0.08
96.60	0.00	6,998	481.67	0.08
97.00	0.00	6,882	481.66	0.08
97.40	0.00	6,768	481.65	0.08
97.80	0.00	6,654	481.64	0.08
98.20	0.00	6,542	481.63	0.08
98.60	0.00	6,431	481.62	0.08
99.00	0.00	6,320	481.61	0.08
99.40	0.00	6,211	481.60	0.08
99.80	0.00	6,103	481.59	0.07
100.20	0.00	5,995	481.58	0.07
100.60	0.00	5,889	481.57	0.07
101.00	0.00	5,784	481.56	0.07
101.40	0.00	5,679	481.55	0.07
101.80	0.00	5,576	481.54	0.07
102.20	0.00	5,474	481.54	0.07
102.60	0.00	5,373	481.53	0.07
103.00	0.00	5,273	481.52	0.07
103.40	0.00	5,174	481.51	0.07
103.80	0.00	5,076	481.50	0.07
104.20	0.00	4,979	481.49	0.07
104.60	0.00	4,883	481.48	0.07
105.00	0.00	4,788	481.47	0.07
105.40	0.00	4,694	481.46	0.06
105.80	0.00	4,601	481.46	0.06
106.20	0.00	4,510	481.45	0.06
106.60	0.00	4,419	481.44	0.06
107.00	0.00	4,330	481.43	0.06
107.40	0.00	4,241	481.42	0.06
107.80	0.00	4,154	481.41	0.06
108.20	0.00	4,067	481.41	0.06
108.60	0.00	3,982	481.40	0.06
109.00	0.00	3,898	481.39	0.06
109.40	0.00	3,815	481.38	0.06
109.80	0.00	3,733	481.37	0.06
110.20	0.00	3,652	481.37	0.06
110.60	0.00	3,572	481.36	0.06

STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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Type II 24-hr 2-Year Rainfall=3.60"

Printed 2/19/2021

Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
111.00	0.00	3,493	481.35	0.05
111.40	0.00	3,415	481.34	0.05
111.80	0.00	3,338	481.34	0.05
112.20	0.00	3,263	481.33	0.05
112.60	0.00	3,189	481.32	0.05
113.00	0.00	3,115	481.32	0.05
113.40	0.00	3,043	481.31	0.05
113.80	0.00	2,972	481.30	0.05
114.20	0.00	2,902	481.30	0.05
114.60	0.00	2,833	481.29	0.05
115.00	0.00	2,765	481.28	0.05
115.40	0.00	2,699	481.28	0.05
115.80	0.00	2,633	481.27	0.05
116.20	0.00	2,569	481.26	0.04
116.60	0.00	2,505	481.26	0.04
117.00	0.00	2,443	481.25	0.04
117.40	0.00	2,382	481.24	0.04
117.80	0.00	2,323	481.24	0.04
118.20	0.00	2,264	481.23	0.04
118.60	0.00	2,207	481.23	0.04
119.00	0.00	2,150	481.22	0.04
119.40	0.00	2,095	481.22	0.04
119.80	0.00	2,040	481.21	0.04
120.20	0.00	1,987	481.21	0.04
120.60	0.00	1,935	481.20	0.04
121.00	0.00	1,884	481.19	0.03
121.40	0.00	1,835	481.19	0.03
121.80	0.00	1,787	481.18	0.03
122.20	0.00	1,740	481.18	0.03
122.60	0.00	1,695	481.18	0.03
123.00	0.00	1,650	481.17	0.03
123.40	0.00	1,607	481.17	0.03
123.80	0.00	1,565	481.16	0.03
124.20	0.00	1,524	481.16	0.03
124.60	0.00	1,483	481.15	0.03
125.00	0.00	1,444	481.15	0.03
125.40	0.00	1,406	481.15	0.03
125.80	0.00	1,369	481.14	0.03
126.20	0.00	1,333	481.14	0.02
126.60	0.00	1,298	481.14	0.02
127.00	0.00	1,264	481.13	0.02
127.40	0.00	1,232	481.13	0.02
127.80	0.00	1,200	481.13	0.02
128.20	0.00	1,170	481.12	0.02
128.60	0.00	1,141	481.12	0.02
129.00	0.00	1,113	481.12	0.02
129.40	0.00	1,086	481.11	0.02
129.80	0.00	1,060	481.11	0.02
130.20	0.00	1,034	481.11	0.02
130.60	0.00	1,010	481.11	0.02
131.00	0.00	987	481.10	0.02
131.40	0.00	964	481.10	0.02
131.80	0.00	942	481.10	0.01

STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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Type II 24-hr 2-Year Rainfall=3.60"

Printed 2/19/2021

Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
132.20	0.00	921	481.10	0.01
132.60	0.00	901	481.09	0.01
133.00	0.00	881	481.09	0.01
133.40	0.00	862	481.09	0.01
133.80	0.00	844	481.09	0.01
134.20	0.00	827	481.09	0.01
134.60	0.00	810	481.09	0.01
135.00	0.00	793	481.08	0.01
135.40	0.00	778	481.08	0.01
135.80	0.00	762	481.08	0.01
136.20	0.00	748	481.08	0.01
136.60	0.00	734	481.08	0.01
137.00	0.00	720	481.08	0.01
137.40	0.00	707	481.07	0.01
137.80	0.00	694	481.07	0.01
138.20	0.00	682	481.07	0.01
138.60	0.00	670	481.07	0.01
139.00	0.00	659	481.07	0.01
139.40	0.00	648	481.07	0.01
139.80	0.00	637	481.07	0.01
140.20	0.00	626	481.07	0.01
140.60	0.00	616	481.07	0.01
141.00	0.00	605	481.06	0.01
141.40	0.00	595	481.06	0.01
141.80	0.00	585	481.06	0.01
142.20	0.00	575	481.06	0.01
142.60	0.00	565	481.06	0.01
143.00	0.00	556	481.06	0.01
143.40	0.00	546	481.06	0.01
143.80	0.00	537	481.06	0.01
144.20	0.00	528	481.06	0.01
144.60	0.00	519	481.05	0.01
145.00	0.00	510	481.05	0.01
145.40	0.00	502	481.05	0.01
145.80	0.00	493	481.05	0.01
146.20	0.00	485	481.05	0.01
146.60	0.00	477	481.05	0.01
147.00	0.00	469	481.05	0.01
147.40	0.00	461	481.05	0.01
147.80	0.00	453	481.05	0.01
148.20	0.00	445	481.05	0.01
148.60	0.00	438	481.05	0.01
149.00	0.00	430	481.05	0.01
149.40	0.00	423	481.04	0.01
149.80	0.00	416	481.04	0.00
150.20	0.00	409	481.04	0.00
150.60	0.00	402	481.04	0.00
151.00	0.00	395	481.04	0.00
151.40	0.00	389	481.04	0.00
151.80	0.00	382	481.04	0.00
152.20	0.00	376	481.04	0.00
152.60	0.00	369	481.04	0.00
153.00	0.00	363	481.04	0.00

0 cfs outflow at 126
hrs after peak
elevation

STORM STUDY - 1952

Prepared by Coulter Jewell Thames, PA

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Type II 24-hr 2-Year Rainfall=3.60"

Printed 2/19/2021

Hydrograph for Pond 7P: Pond (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
153.40	0.00	357	481.04	0.00
153.80	0.00	351	481.04	0.00
154.20	0.00	345	481.04	0.00
154.60	0.00	339	481.04	0.00
155.00	0.00	333	481.04	0.00
155.40	0.00	328	481.03	0.00
155.80	0.00	322	481.03	0.00
156.20	0.00	317	481.03	0.00
156.60	0.00	311	481.03	0.00
157.00	0.00	306	481.03	0.00
157.40	0.00	301	481.03	0.00
157.80	0.00	296	481.03	0.00
158.20	0.00	291	481.03	0.00
158.60	0.00	286	481.03	0.00
159.00	0.00	281	481.03	0.00
159.40	0.00	276	481.03	0.00
159.80	0.00	272	481.03	0.00

SEASONAL HIGH WATER TABLE DETERMINATION



Soil & Environmental Consultants, PA

8412 Falls of Neuse Road, Suite 104, Raleigh, NC 27615 • Phone: (919) 846-5900 • Fax: (919) 846-9467
sandec.com

GeoTechnologies, PA
Attn: Mr. Sean Corcoran
3200 Wellington Court, Suite 108
Raleigh, NC 27615

August 12, 2020
S&EC Project # 14363.S1

Re: Soil Evaluation on Carraway Village, Chapel Hill, NC.

Dear Mr. Corcoran:

Soil & Environmental Consultants, PA (S&EC) performed a detailed soil profile description on the project mentioned above. The purpose of this evaluation was to provide soil data to determine depth to Seasonal High Water Table (SHWT). This report discusses S&EC's methods and testing results and was completed as per our proposal dated August 3, 2020.

Soil/Site Evaluation Methodology

The site evaluation was performed by reviewing one drill rig auger boring to a target depth of 10 feet at boring location B-12 (see attached site map). The soil boring location was determined by the engineer prior to S&EC's field evaluation. Soil morphological conditions were described at these locations using standard techniques outlined in the "Field Book for Describing and Sampling Soils" published by the Natural Resources Conservation Service (NRCS, 2012). A detailed soil profile description for the boring is included in Attachment 1 to this report.

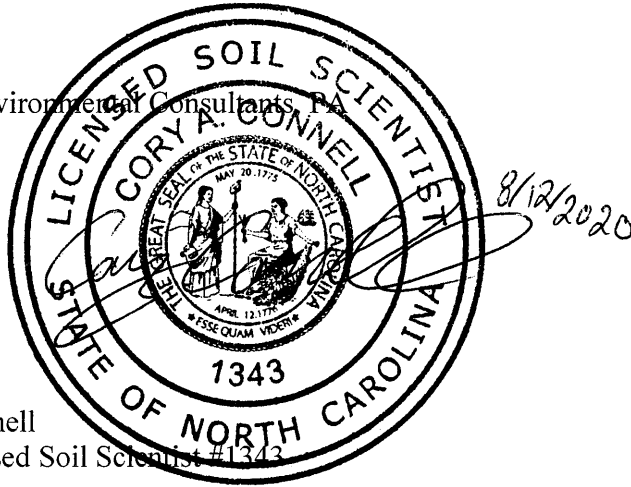
Soil/Site Conditions

This site is located in the Slate Belt region of Orange County, NC. Soils observed at the sample location are similar to a Herndon series. These soils are well drained with moderate permeability in the subsurface. No SHWT indicators were observed within 10 feet of the land surface at boring location B-12 and there was no apparent water table observed within 10 feet of the land surface at this location.

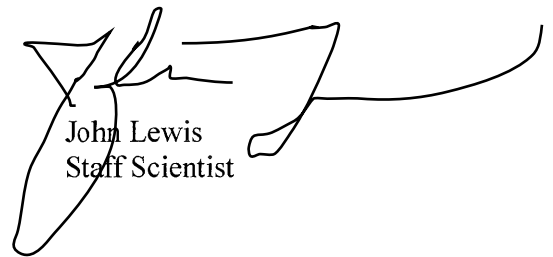
Given the site topography and sloping conditions, the seasonal high water table, (if present at other locations), could vary across the site and the soil boring description (noted below) was only one location within the site boundaries. If needed, S&EC can conduct additional soil borings in the area, however arrangements will need to be made with the drill rig. Each storm water device has different requirements with regard to in-situ soils. S&EC made no attempt to measure soil saturated hydraulic conductivity (Ksat) in the underlying soil at this time.

Soil & Environmental Consultants, PA is pleased to be of service in this matter and we look forward to assisting in the successful completion of the project. If requested, S&EC can meet on-site with NC-DWR or the design engineer to discuss our findings. Please feel free to call with any questions or comments you may have.

Sincerely,
Soil & Environmental Consultants, PA



Cory Connell
NC Licensed Soil Scientist #1343



John Lewis
Staff Scientist

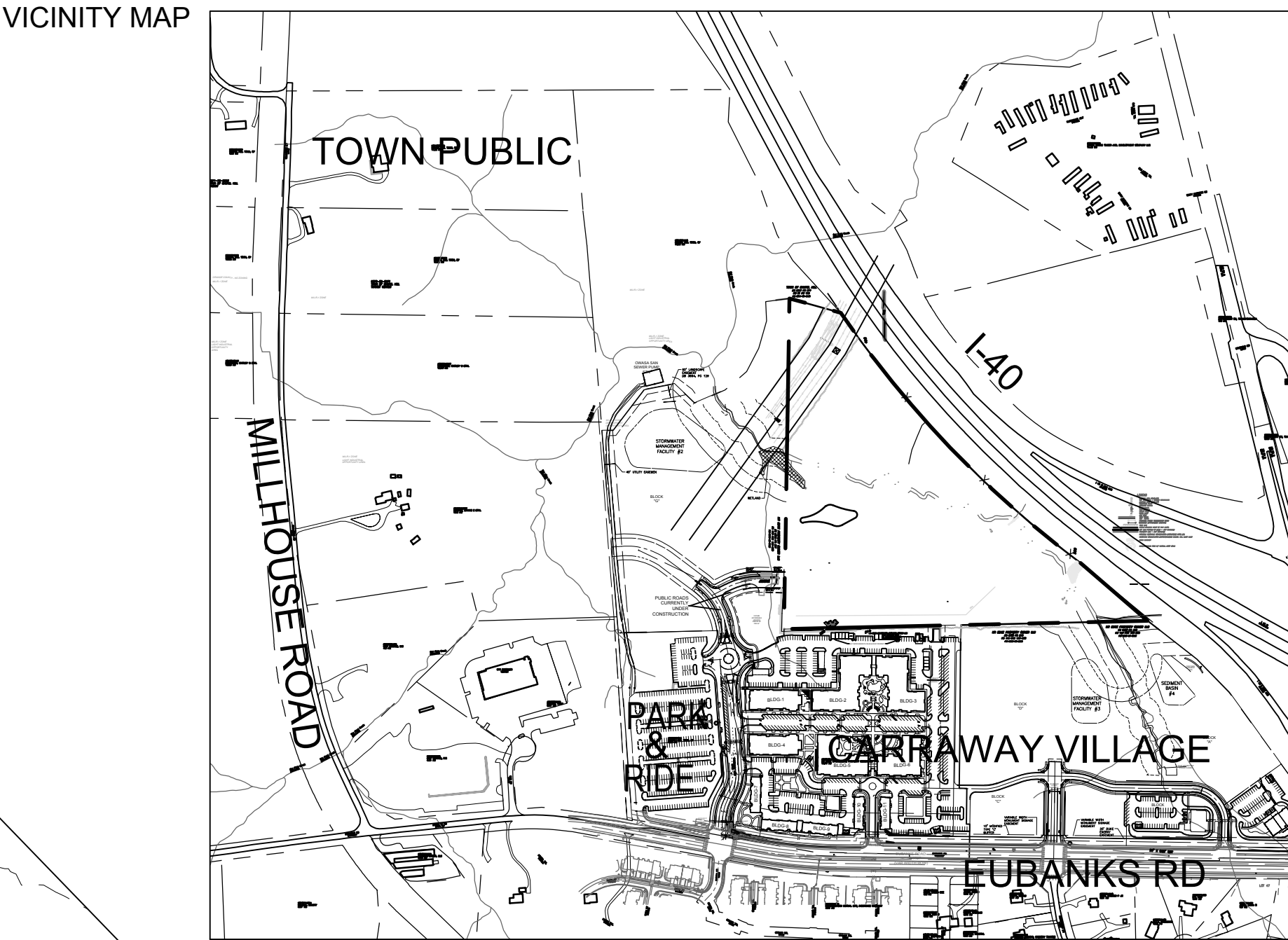
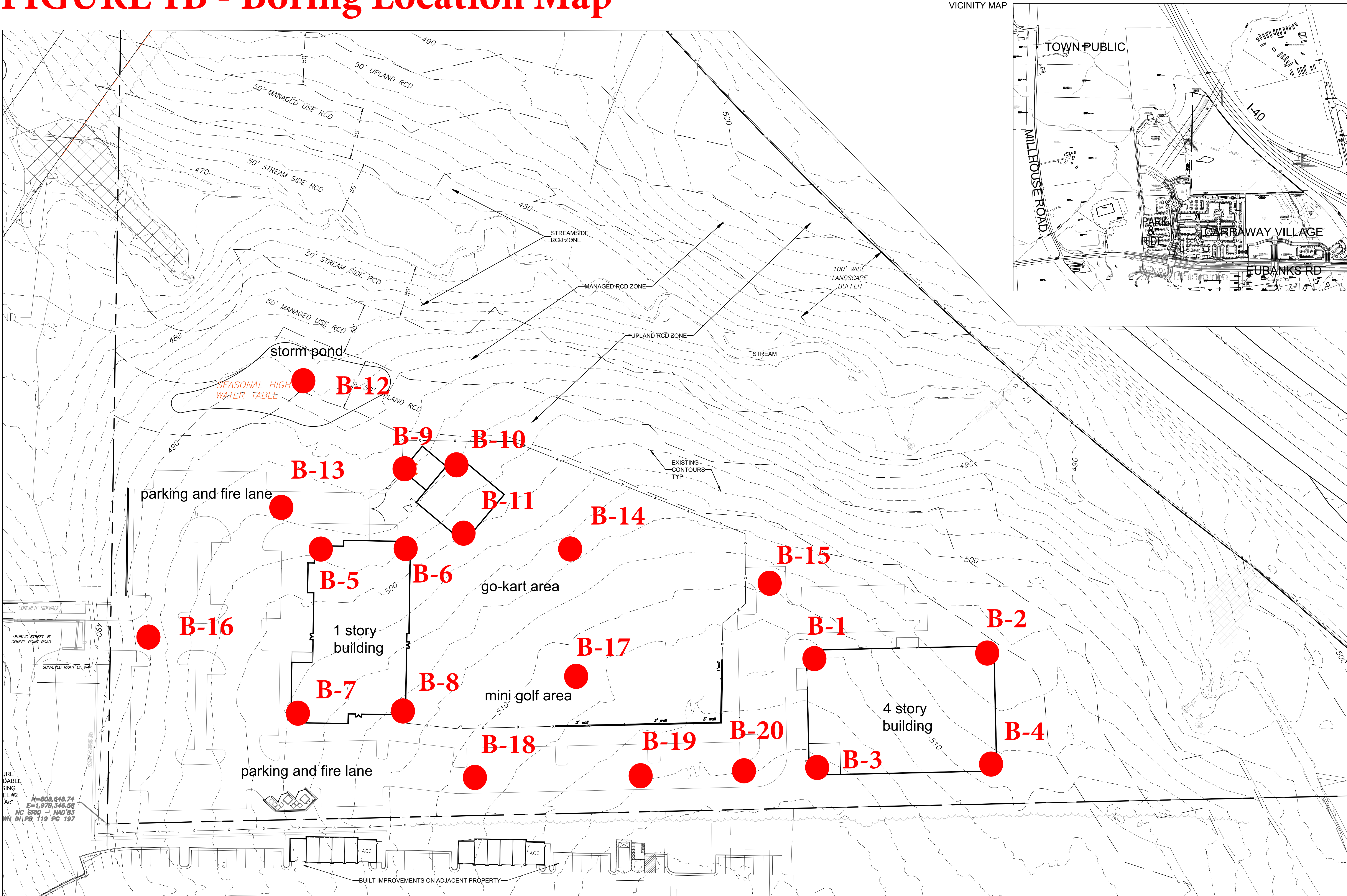
Encl: Attachment 1
Soil Boring Location Map Provided by client

Attachment 1.
Soil Boring Profile Description

B-12

Horizon & Depth	Texture, & Structure	Munsell Color	Notes	
A 0 – 10 in	Loam Weak, Granular	5YR 3/2		
Bt1 10 – 36 in	Clay Loam Weak, Subangular Blocky	5YR 5/8		
Bt2 36 – 60 in	Clay Weak, Subangular Blocky	5YR 5/6		
BC 60 – 78 in	Silty Clay Loam Weak, Subangular Blocky	5YR 5/6 7.5YR 5/8	Clay Lenses	
Cr 78 – 90 in	Silt Loam Massive	10YR 7/6 10YR 7/3 5YR 5/8	Saprolite, cemented rock fragments	
C 90 – 120 in	Sandy Loam/Silt Loam Massive	10YR 8/1 10YR 6/6 7.5YR 6/8 5YR 4/6 10YR 2/1	Saprolite, mica, cemented rock fragments, clay lenses	
			No SHWT indicators observed within 120 inches below land surface	
			No Apparent Water Table Observed within 120 inches of land surface	

FIGURE 1B - Boring Location Map



SOILS, FLOOD, and USGS MAPS



SITE

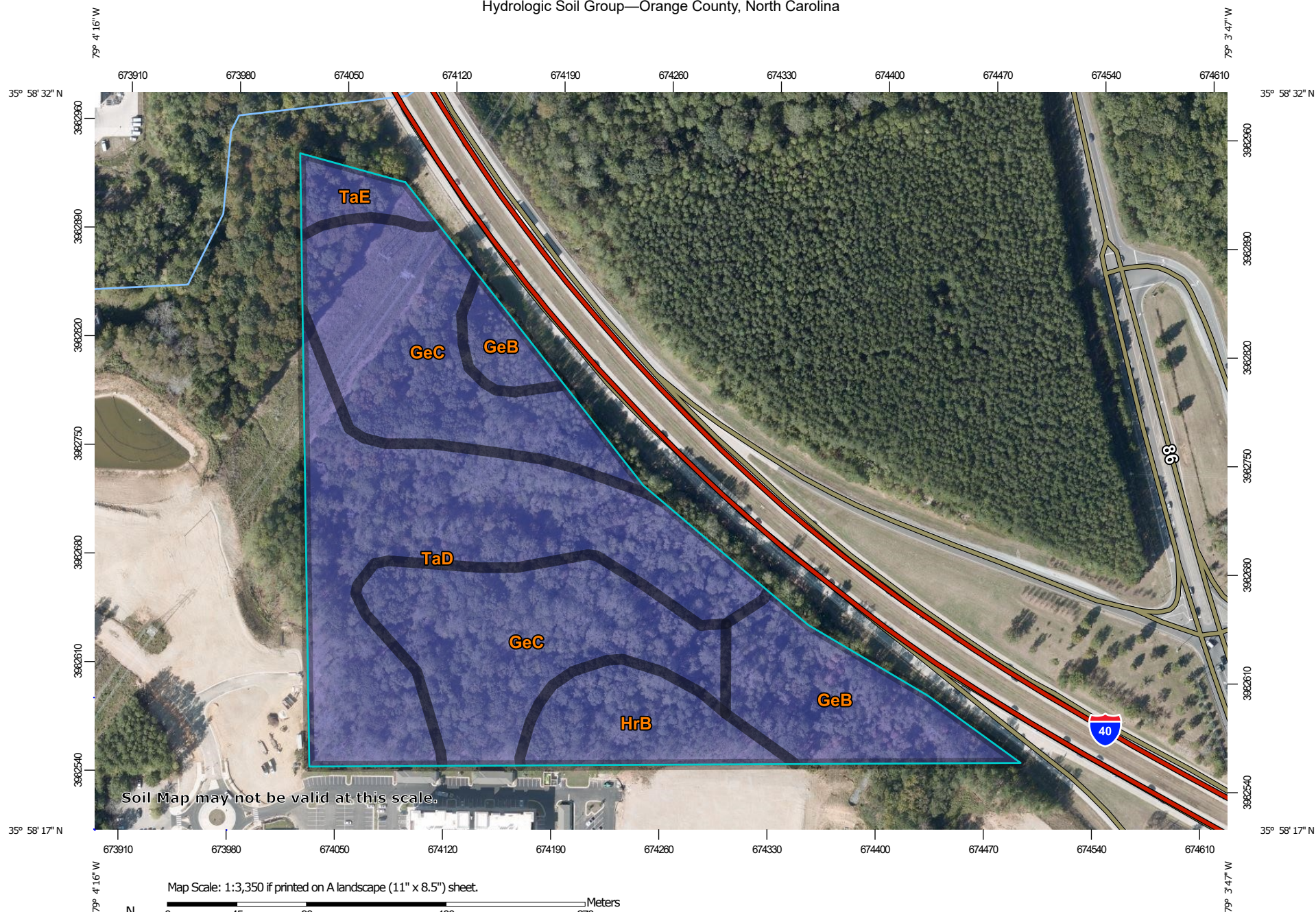
Orange County Soil Survey
Map 23

SITE

ORANGE COUNTY, NORTH CAROLINA — SHEET NUMBER 26



Hydrologic Soil Group—Orange County, North Carolina



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

6/26/2020
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Orange County, North Carolina
 Survey Area Data: Version 19, Sep 16, 2019

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

Date(s) aerial images were photographed: Oct 9, 2019—Oct 19, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
GeB	Georgeville silt loam, 2 to 6 percent slopes	B	3.4	15.4%
GeC	Georgeville silt loam, 6 to 10 percent slopes	B	8.9	40.5%
HrB	Herndon silt loam, 2 to 6 percent slopes	B	2.0	8.9%
TaD	Tarrus silt loam, 8 to 15 percent slopes	B	7.1	32.2%
TaE	Tarrus silt loam, 15 to 25 percent slopes	B	0.7	3.0%
Totals for Area of Interest			22.0	100.0%

Description

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

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

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

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

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

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

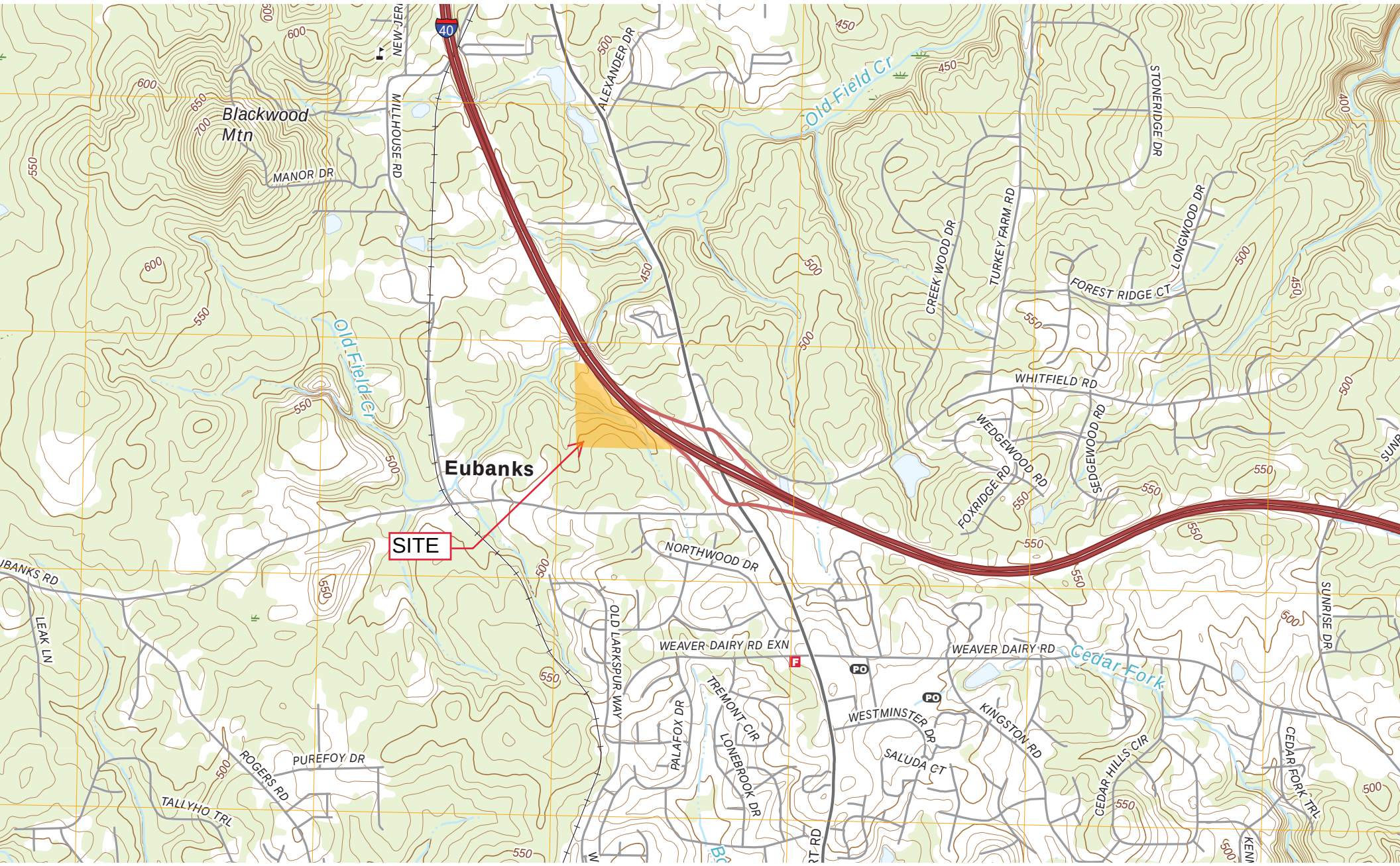
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



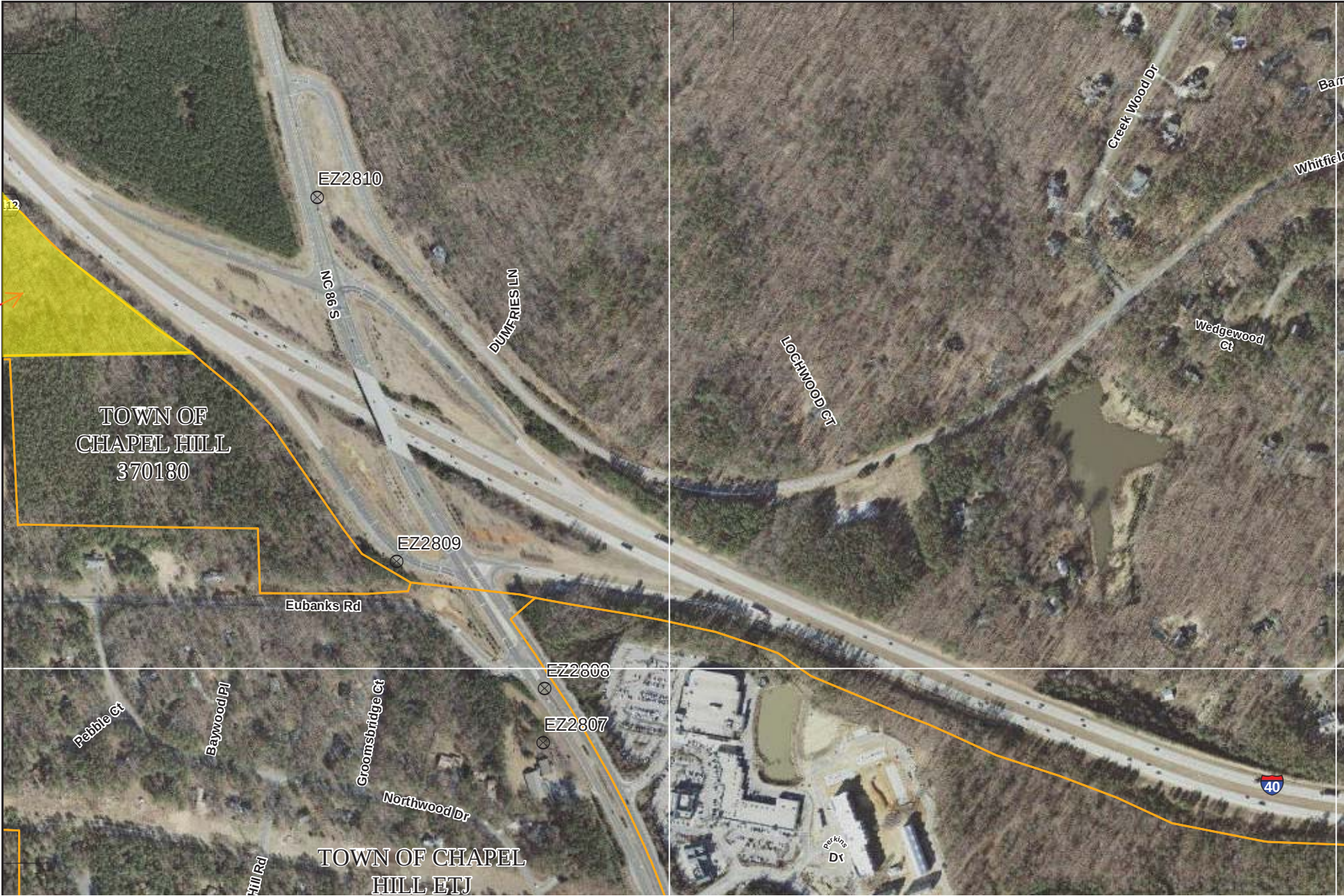
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Panel 9880
11/17/2017

1980000 FEET
79°4'0"W

79°3'30"W

35°58'30"N

SITE



35°58'0"N

Map Number 3710987000K
Panel 9870
11/17/2017

SITE

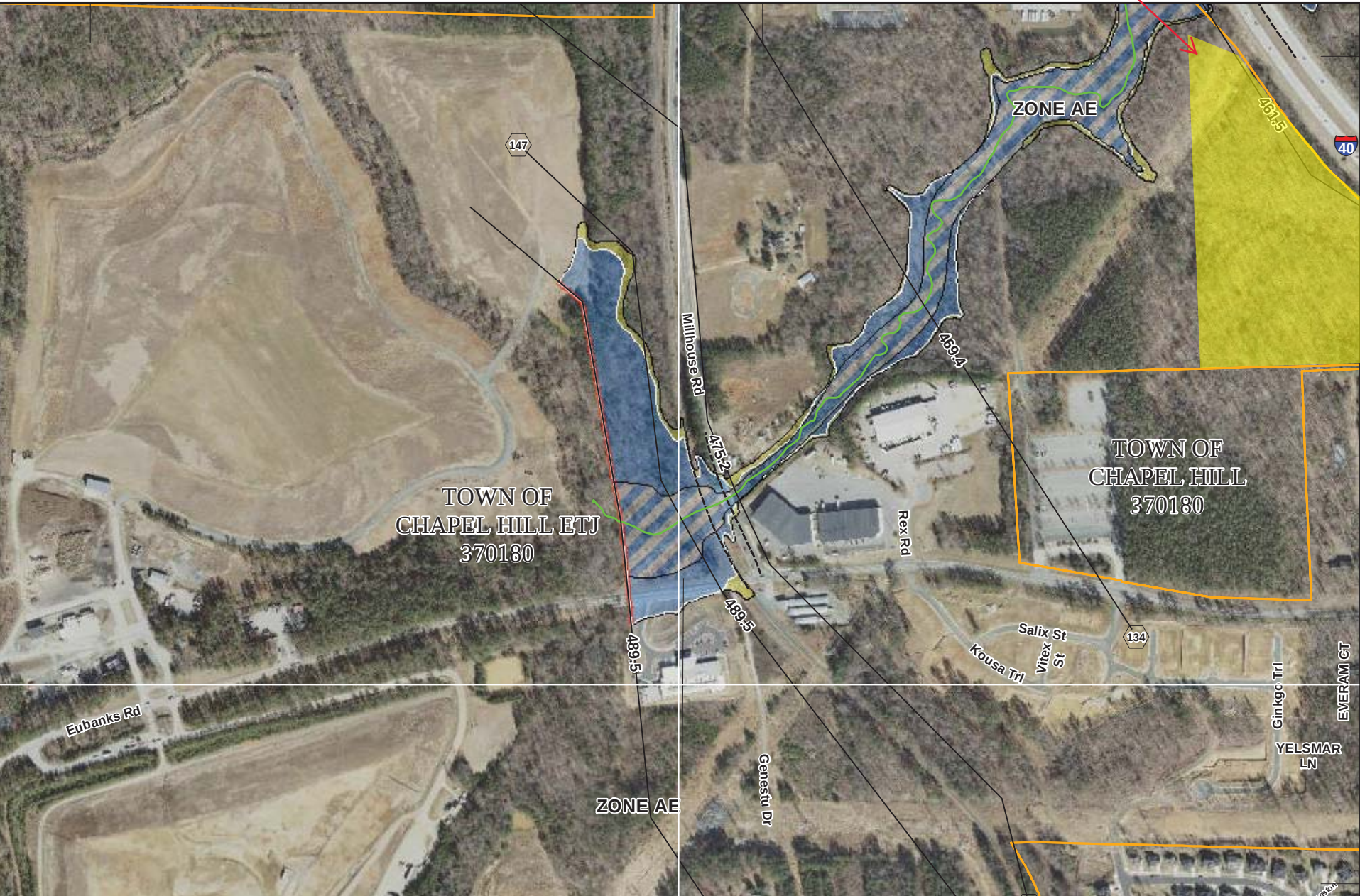
79°5'0"W

79°4'30"W

1980000 FEET

810000

35°58'30"N



35°58'0"N