COMPUTATIONS BY:	Signature	C. Ty Brooks	Date	01/25/2024
	Name	C. Ty Brooks, E.I.		
	Title	Staff Professional II		
ASSUMPTIONS AND PROCEDURES CHECKED BY:	Signature	Andrew E. Wilmer	Date	01/25/2024
	Name	Andrew E. Wilmer, E.I.		
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COMPUTATIONS CHECKED BY:	Signature	Hannah E. Cupples	Date	01/25/2024
	Name	Hannah Cupples		
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REVIEWED BY:	Signature	[signature]	Date	01/25/2024
	Name	Christopher J. L. Stahl, P.E.		
	Title	Principal Engineer, Vice President		

REVIEW NOTES / COMMENTS: ______________________________

OBJECTIVE

This Sediment Basin Calculation package (package) was developed to evaluate the hydrologic and hydraulic performance of proposed sediment basins for Luck Edgefield. The sediment basins were designed in accordance with the South Carolina Department of Health and Environmental Control (SC DHEC) Stormwater Best Management Practice (BMP) Handbook.

SUMMARY

Proposed sediment basins were designed to pass the 10-year, 24-hour design storm through the principal spillway, and the 100-year, 24-hour design storm utilizing both principal and emergency spillways.

ATTACHMENTS

1. *Design Criteria Summary*
2. *Stage Storage Calculations*

REFERENCES

The following references were utilized during the development of this calculation package.

1. SC DHEC Stormwater BMP Handbook, Appendix F – South Carolina Rainfall Data, SC DHEC, Revised July 2005.
2. TR-55 Urban Hydrology for Small Watersheds, USDA-NRCS, June 1986.
3. *NRCS Soil Figures*, S&ME Inc., December 2022.
4. *Drainage Area Figures,* S&ME Inc., November 2023.
5. *Compiled HydroCAD Report*, S&ME Inc., November 2023.
6. *Compiled SEDIMOT IV Report,* S&ME, Inc., December 2023.
7. SC DHEC Stormwater BMP Handbook, SC DHEC, Revised March 2014.
8. Design Hydrology and Sedimentology for Small Catchments, Haan, C.T., Barfield, and Hayes, 1994. Pg. 147-148.
9. Determining the Skimmer Size and the Required Orifice, Faircloth Skimmer, November 2007.
10. ENG – Riprap Lined Plunge Pool for Cantilever Outlet, USDA SCS Design Note. No 6, 2nd Ed. March 5, 1986.
11. Riprap Lined Plunge Pool for Cantilever Outlet, NRCS Plunge Pool Sheets, December 2023.

DEFINITION OF VARIABLES

The following variables are defined or used as a part of this calculation package.

Q	=	flow rate (cfs)	D_{15} =	characteristic eroded particle size (mm)
CN	=	curve number (unitless)	V_{15} =	characteristic settling velocity (ft/s)
i	=	rainfall intensity (in./hr)	U_{riser} =	uplift force acting on riser (lbs)
A	=	drainage area (acres) or flow area (ft^2)	U_{AFB} =	uplift force acting on anti-flotation block (lbs)
T_c	=	time of concentration (min)	P =	wetted perimeter (ft)

T_x = T_c component number (min)
n = Manning's roughness coefficient
P_x = rainfall amount (in)
s = slope (ft/ft)
K_v = velocity factor (ft/s)
V = flow velocity (ft/s)
L = flow length (ft) or spillway length (ft)

KNOWN AND ASSUMED VARIABLES

P_2 = 3.1 in., P_{10} = 5.2 in., P_{25} = 6.3 in., P_{100} = 8.2 in. [**Ref. 1**]

DESIGN CRITERIA

Each sediment basin was designed in accordance with the SC DHEC Stormwater BMP Handbook with the following criteria:

- Total Suspended Solids (TSS) removal efficiency is greater than or equal to 80% or peak settable solids concentration is less than 0.5 milliliters per liter;
- Maximum drainage area is limited to 30 acres unless alternate sediment capture methodology is utilized (i.e., SEDIMOT IV software);
- Principal spillway discharge capacity developed for the 10-yr, 24-hr storm event;
- Emergency spillway capacity developed for the 100-yr, 24-hour storm event;
- Top of embankment elevation crest selected to be at least 2 ft height above the principal spillway crest and 1 ft above the emergency spillway crest;
- Maintain 0.5 ft of freeboard within the emergency spillway during 100-yr storm;
- Minimum sediment storage capacity of 3,600 cubic feet (ft^3) per drainage area acre;
- Dewatering time is maintained between 48 and 120 hours;
- Sediment basin designed with a bottom slope of at least 0.5%;
- Sediment basin length is at least two times the basin width;
- Sediment basin side slopes are constructed at 2 horizontal to 1 vertical (2H:1V) or flatter;
- 20 percent of the basin volume is maintained within the basin forebay; and
- Basin maintains a geometry that is accessible by maintenance equipment.

❖ 1.0 HYDROLOGIC EVALUATION

1.1 Define Drainage Area Characteristics

The drainage areas to the sediment basins were defined for existing conditions. The drainage areas for existing conditions are shown in **Figures 1 through 4 [Ref. 4]**.

The land use was conservatively assumed to consist of disturbed area during construction and the Web Soil Survey **[Ref. 3]** was used to determine the hydrologic soil group. See the table below for a summary of drainage area characteristics:

Table 1: Summary of Drainage Area Characteristics				
Sediment Basin ID	Pre-Construction Drainage Area {A} (ac)	Hydrologic Soil Group [Ref. 3]	Land Use	Curve Number {CN} [Ref. 2]
SB-OB-11	19.0	D	Newly Graded Area	94
SB-OB-12	18.9	D	Newly Graded Area	94
SB-PT-9	42.5	D	Newly Graded Area	94
SB-PT-1	22.3	D	Newly Graded Area	94
SB-P-8	15.5	D	Newly Graded Area	94
SB-P-2	47.5	D	Newly Graded Area	94
SB-OB-6	21.3	D	Newly Graded Area	94
SB-OB-5	17.9	D	Newly Graded Area	94
SB-OB-4	13.2	D	Newly Graded Area	94
SB-OB-3	15.6	D	Newly Graded Area	94
SB-OB-10	18.5	D	Newly Graded Area	94
SB-OB-7	16.9	D	Newly Graded Area	94

1.2 Define Time of Concentration

The time of concentration (T_c) is the time for stormwater flow to travel from the most hydrologically remote point in a drainage area to leave the watershed or to reach the point of interest and consists of sheet flow, shallow concentrated flow, and channel flow components. The time of concentration was estimated using the Technical Release 55 (TR-55) method **[Ref. 2]**.

1.2.1 Sheet Flow

Sheet flow occurs at the upper reaches of a drainage area prior to concentration of stormwater runoff into rills. The sheet flow length was assumed to be 100 feet. The equation to calculate sheet flow is presented below:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$ **[Ref. 2]**

The sheet flow component of the time of concentration was calculated for the sediment basins as presented in the following table:

Table 2: Sheet Flow Component of Time of Concentration					
Sediment Basin ID	Manning's n {n} [Ref. 5]	Flow Length {L} (ft)	Rainfall for 2-Year, 24-Hour Storm {P_2} (in) [Ref. 1]	Longitudinal Slope {s} (ft/ft)	Time of Concentration Due to Sheet Flow {T_{sheet}} (min)
SB-OB-11	0.05	100	3.1	0.0490	2.9
SB-OB-12	0.05	100	3.1	0.0138	4.8
SB-PT-9	0.05	100	3.1	0.0589	2.7
SB-PT-1	0.05	100	3.1	0.0425	3.1
SB-P-8	0.05	100	3.1	0.0293	3.5
SB-P-2	0.05	100	3.1	0.0607	2.7
SB-OB-6	0.05	100	3.1	0.1336	1.9
SB-OB-5	0.05	100	3.1	0.0540	2.8
SB-OB-4	0.05	100	3.1	0.0388	3.2
SB-OB-3	0.05	100	3.1	0.0683	2.5
SB-OB-10	0.05	100	3.1	0.1026	2.1
SB-OB-7	0.05	100	3.1	0.0206	4.1

1.2.2 *Shallow Concentrated Flow*

Shallow concentrated flow occurs when runoff accumulates into rills but is not sufficient enough to produce gullies. The equations to calculate shallow concentrated flow are presented below:

$$V_{unpaved} = K_v * (s)^{0.5}$$ **[Ref. 2]**

$$T_t = \frac{L}{V*60} \text{ (min)}$$ **[Ref. 2]**

The shallow concentrated flow component of the time of concentration was calculated for the sediment basins as presented in the following table:

Table 3: Shallow Concentrated Flow Component of Time of Concentration						
Sediment Basin ID	Land Use Type	Velocity {K_v} (ft/s) [Ref. 2]	Longitudinal Slope {s} (ft/ft)	Flow Velocity {V} (ft/s)	Flow Length {L} (ft)	Time of Concentration Due to Shallow Concentrated Flow {T_{scf}} (min)
SB-OB-11	Nearly Bare & Untilled	10	0.1400	3.7	621	2.8
SB-OB-12	Nearly Bare & Untilled	10	0.2700	5.2	401	1.3
SB-PT-9	Nearly Bare & Untilled	10	0.1230	3.5	1,028	4.9
SB-PT-1	Nearly Bare & Untilled	10	0.1870	4.3	291	1.1
SB-P-8	Nearly Bare & Untilled	10	0.1150	3.4	866	4.3
SB-P-2	Nearly Bare & Untilled	10	0.1131	3.4	918	4.5
SB-OB-6	Nearly Bare & Untilled	10	0.1290	3.6	567	2.6
SB-OB-5	Nearly Bare & Untilled	10	0.1060	3.3	479	2.5
SB-OB-4	Nearly Bare & Untilled	10	0.1500	3.9	370	1.6
SB-OB-3	Nearly Bare & Untilled	10	0.1660	4.1	608	2.5
SB-OB-10	Nearly Bare & Untilled	10	0.1090	3.3	1,179	6.0
SB-OB-7	Nearly Bare & Untilled	10	0.1225	3.5	674	3.2

1.2.3 Channel Flow

Channel flow occurs when runoff accumulation is sufficient enough to produce gullies. The channel flow contribution to the time of concentration is a function of flow length and velocity. The equation to calculate channel flow velocity is Manning's equation presented below:

$$V = \frac{1.49(R^{\frac{2}{3}} \times s^{\frac{1}{2}})}{n}$$ **[Ref. 2]**

The channel dimensions for the channel flow component of the time of concentration are presented in the following table:

Table 4: Channel Dimensions					
Sediment Basin ID	Land Use Type	Manning's n {n} [Ref. 5]	Channel Bottom Width {b} (ft)	Channel Sideslopes {ZH:1V}	Longitudinal Slope {s} (ft/ft)
SB-OB-11	Bare Soil	0.022	2	2	0.0100
SB-OB-12	Bare Soil	0.022	2	2	0.0617
SB-PT-9	Bare Soil	0.022	2	2	0.0000
SB-PT-1	Bare Soil	0.022	2	2	0.0100
SB-P-8	Bare Soil	0.022	2	2	0.0357
SB-P-2	Bare Soil	0.022	2	2	0.0180
SB-OB-6	Bare Soil	0.022	2	2	0.0072
SB-OB-5	Bare Soil	0.022	2	2	0.0370
SB-OB-4	Bare Soil	0.022	2	2	0.0245
SB-OB-3	Bare Soil	0.022	2	2	0.0140
SB-OB-10	Bare Soil	0.022	2	2	0.1080
SB-OB-7	Bare Soil	0.022	2	2	0.1220

The channel flow component of the time of concentration was calculated for the sediment basins assuming a full flow condition as presented in the following table:

Table 5: Channel Flow Component of Time of Concentration								
Sediment Basin ID	Flow Depth {d} (ft)	Flow Area {A} (ft^2)	Wetted Perimeter {P} (ft)	Hydraulic Radius {R} (ft)	Flow Velocity {V} (ft/s)	Calculated Flow Rate {Q} (cfs)	Flow Length {L} (ft)	Time of Concentration Due to Channel Flow {$T_{channel}$} (min)
SB-OB-11	2	12	11	1.1	7.2	86	475	0.8
SB-OB-12	2	12	11	1.1	17.9	215	813	0.8
SB-PT-9	2	12	11	1.1	0.0	0	0	0.0
SB-PT-1	2	12	11	1.1	7.2	86	1,241	2.9
SB-P-8	2	12	11	1.1	13.6	163	489	0.6
SB-P-2	2	12	11	1.1	9.7	116	1,328	2.3
SB-OB-6	2	12	11	1.1	6.1	73	123	0.3
SB-OB-5	2	12	11	1.1	13.9	166	528	0.6
SB-OB-4	2	12	11	1.1	11.3	135	446	0.7
SB-OB-3	2	12	11	1.1	8.5	102	731	1.4
SB-OB-10	2	12	11	1.1	23.7	284	305	0.2
SB-OB-7	2	12	11	1.1	25.2	302	436	0.3

1.2.4 Total Time of Concentration

The total calculated time of concentration is the summation of the sheet, shallow concentrated, and channel flow contributions. The minimum time of concentration is 6 minutes **[Ref. 2]**. The minimum time of concentration (6 minutes) was used if the calculated time of concentration was less than 6 minutes. The total time of concentration was calculated as shown in the following table:

Table 6: Total Time of Concentration						
Sediment Basin ID	Time of Concentration Due to Sheet Flow {T_{sheet}} (min)	Time of Concentration Due to Shallow Concentrated Flow {T_{scf}} (min)	Time of Concentration Due to Channel Flow {$T_{channel}$} (min)	Calculated Time of Concentration {T_c} (min)	Minimum Time of Concentration {$T_{c,min}$} (min)	Selected Time of Concentration {T_c} (min)
SB-OB-11	2.9	2.8	0.8	6.5	6.0	6.5
SB-OB-12	4.8	1.3	0.8	6.8	6.0	6.8
SB-PT-9	2.7	4.9	0.0	7.6	6.0	7.6
SB-PT-1	3.1	1.1	2.9	7.1	6.0	7.1
SB-P-8	3.5	4.3	0.6	8.4	6.0	8.4
SB-P-2	2.7	4.5	2.3	9.5	6.0	9.5
SB-OB-6	1.9	2.6	0.3	4.9	6.0	6.0
SB-OB-5	2.8	2.5	0.6	5.9	6.0	6.0
SB-OB-4	3.2	1.6	0.7	5.4	6.0	6.0
SB-OB-3	2.5	2.5	1.4	6.4	6.0	6.4
SB-OB-10	2.1	6.0	0.2	8.3	6.0	8.3
SB-OB-7	4.1	3.2	0.3	7.6	6.0	7.6

1.3 Hydrologic Evaluation Results

HydroCAD® modeling software **[Ref. 5]** was used to calculate the peak runoff rates for the 10-year, 25-year, and 100-year, 24-hour design storms as summarized in the following table:

Table 7: Hydrologic Evaluation Results						
Sediment Basin ID	10-Year, 24-Hour Design Storm		25-Year, 24-Hour Design Storm		100-Year, 24-Hour Design Storm	
	Peak Flow Rate {Q} (cfs) [Ref. 5]	Runoff Volume {V} (ac-ft) [Ref. 5]	Peak Flow Rate {Q} (cfs) [Ref. 5]	Runoff Volume {V} (ac-ft) [Ref. 5]	Peak Flow Rate {Q} (cfs) [Ref. 5]	Runoff Volume {V} (ac-ft) [Ref. 5]
SB-OB-11	129.39	6.651	158.55	8.237	208.61	10.969
SB-OB-12	127.81	6.615	156.62	8.192	206.06	10.910
SB-PT-9	285.00	14.923	349.23	18.481	459.46	24.612
SB-PT-1	153.61	7.841	188.23	9.710	247.65	12.931
SB-P-8	101.82	5.423	124.79	6.717	164.19	8.945
SB-P-2	305.79	16.647	374.81	20.618	493.26	27.458
SB-OB-6	147.81	7.460	181.12	9.238	238.29	12.302
SB-OB-5	124.16	6.266	152.14	7.760	200.16	10.333
SB-OB-4	91.82	4.634	112.51	5.739	148.03	7.642
SB-OB-3	108.51	5.476	132.97	6.782	174.94	9.031
SB-OB-10	121.69	6.501	149.13	8.051	196.24	10.723
SB-OB-7	111.03	5.914	136.06	7.324	179.04	9.754

❖ 2.0 SEDIMENT BASIN HYDRAULICS EVALUATION

The hydraulic performance of the sediment basins were evaluated as described below.

2.1 Define Sediment Basin Configuration

The hydraulic performance of the sediment basins is a function of the grading geometry, principal spillway, and emergency spillway.

The principal spillway characteristics for the sediment basins are defined in the following table:

Table 8: Principal Spillway Characteristics												
Sediment Basin ID	Riser					Barrel						
	Material	Inside Dimensions (ft)		Relative Crest El. (ft)	Relative Floor Elevation (ft)	Material	No. of Barrels	Barrel Diameter Dimensions (ft)	Relative Upstream Invert El. (ft)	Relative Downstream Invert El. (ft)	Length (ft)	Slope (ft/ft)
		L	W									
SB-OB-11	RCP	3.0	3.0	7.6	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-12	RCP	3.0	3.0	6.5	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-PT-9	RCP	3.0	3.0	7.3	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-PT-1	RCP	3.0	3.0	7.4	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-P-8	RCP	3.0	3.0	7.0	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-P-2	RCP	3.0	3.0	7.4	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-6	RCP	3.0	3.0	7.7	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-5	RCP	3.0	3.0	7.5	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-4	RCP	3.0	3.0	7.0	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-3	RCP	3.0	3.0	7.1	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-10	RCP	3.0	3.0	7.8	0.0	RCP	1	2	0.0	-1.0	100.0	0.010
SB-OB-7	RCP	3.0	3.0	7.2	0.0	RCP	1	2	0.0	-1.0	100.0	0.010

The emergency spillway characteristics for the sediment basins are defined in the following table:

Table 9: Emergency Spillway Characteristics						
Sediment Basin ID	Relative Invert El. (ft)	Relative Crest of Embankment (ft)	Spillway Width (ft)	Spillway Sideslopes {ZH:1V}	Spillway Length {L} (ft)	Longitudinal Slope {s} (ft/ft)
SB-OB-11	9.0	10.0	28.0	5	20.0	0.02
SB-OB-12	9.0	10.0	28.0	5	20.0	0.02
SB-PT-9	9.0	10.0	28.0	5	20.0	0.02
SB-PT-1	9.0	10.0	28.0	5	20.0	0.02
SB-P-8	9.0	10.0	28.0	5	20.0	0.02
SB-P-2	9.0	10.0	28.0	5	20.0	0.02
SB-OB-6	9.0	10.0	28.0	5	20.0	0.02
SB-OB-5	9.0	10.0	28.0	5	20.0	0.02
SB-OB-4	9.0	10.0	28.0	5	20.0	0.02
SB-OB-3	9.0	10.0	28.0	5	20.0	0.02
SB-OB-10	9.0	10.0	28.0	5	20.0	0.02
SB-OB-7	9.0	10.0	28.0	5	20.0	0.02

2.2 Sediment Basin Hydraulic Evaluation Results

HydroCAD® modeling software was used to estimate hydraulic performance for the sediment basins for the 10-year, 25-year, and 100-year, 24-hour design storms **[Ref. 5]**. The hydraulic results are summarized in the following table:

Table 10: Sediment Basin Hydraulic Performance Summary									
Sediment Basin ID	10-Year Design Storm			25-Year Design Storm			100-Year Design Storm		
	Peak Outflow (cfs) [Ref. 5]	Relative Peak Water Surface Elevation (ft) [Ref. 5]	Freeboard (ft)	Peak Outflow (cfs) [Ref. 5]	Relative Peak Water Surface Elevation (ft) [Ref. 5]	Freeboard (ft)	Peak Outflow (cfs) [Ref. 5]	Relative Peak Water Surface Elevation (ft) [Ref. 5]	Freeboard (ft)
SB-OB-11	1.17	7.54	2.46	6.39	7.86	2.14	39.17	8.58	1.42
SB-OB-12	1.17	6.44	3.56	6.19	6.75	3.25	35.39	7.42	2.58
SB-PT-9	2.34	7.27	2.73	11.74	7.69	2.31	41.95	8.69	1.31
SB-PT-1	1.17	7.38	2.62	6.90	7.68	2.32	39.89	8.39	1.61
SB-P-8	1.17	6.94	3.06	6.09	7.25	2.75	36.57	7.94	2.06
SB-P-2	2.34	7.37	2.63	12.14	7.80	2.20	42.32	8.83	1.17
SB-OB-6	1.17	7.65	2.35	6.66	7.97	2.03	39.88	8.69	1.31
SB-OB-5	1.17	7.49	2.51	6.60	7.77	2.23	40.47	8.50	1.50
SB-OB-4	1.17	6.96	3.04	6.10	7.25	2.75	38.50	7.97	2.03
SB-OB-3	1.17	7.00	3.00	5.85	7.34	2.66	36.46	8.03	1.97
SB-OB-10	1.17	7.74	2.26	6.40	8.06	1.94	39.05	8.78	1.22
SB-OB-7	1.17	7.12	2.88	6.10	7.45	2.55	36.93	8.14	1.86

2.3 Trapping Efficiency

Trapping efficiency for sediment basins with a drainage area of less than 30 acres is a function of the on-site soils' characteristic eroded particle diameter, settling velocity, and the peak outflow rate from the basin for the 10-year, 24-hour storm event. **[Ref. 7]**

The trapping efficiency of each basin with a drainage area less than 30 acres is summarized in the table below.

Table 11a: Sediment Basin Trapping Efficiency (Drainage Area < 30 acres)							
Sediment Basin ID	Soil Type [Ref. 3]	Soil Particle Size {D_{15}} (mm) [Ref. 7]	Characteristic Settling Velocity {V_{15}} (ft/s) [Ref. 7]	Surface Area of Basin at Riser Crest {A} (ft^2)	Peak Outflow from Basin for 10-year, 24-hour Design Storm {Q_{po}} (cfs)	Basin Ratio	Trapping Efficiency (%) [Ref. 7]
SB-OB-11	Cecil	0.0066	1.22E-04	44,000	1.17	9494	> 80%
SB-OB-12	Cecil	0.0066	1.22E-04	51,000	1.17	8191	> 80%
SB-PT-1	Cecil	0.0066	1.22E-04	52,000	1.17	8034	> 80%
SB-P-8	Cecil	0.0066	1.22E-04	37,000	1.17	11290	> 80%
SB-OB-6	Cecil	0.0066	1.22E-04	48,000	1.17	8703	> 80%
SB-OB-5	Cecil	0.0066	1.22E-04	42,000	1.17	9946	> 80%
SB-OB-4	Cecil	0.0066	1.22E-04	32,000	1.17	13055	> 80%
SB-OB-3	Cecil	0.0066	1.22E-04	40,000	1.17	10444	> 80%
SB-OB-10	Cecil	0.0066	1.22E-04	42,000	1.17	9946	> 80%
SB-OB-7	Cecil	0.0066	1.22E-04	42,000	1.17	9946	> 80%

For sediment basins with a drainage area greater than 30 acres, the computer model SEDIMOT IV was used to calculate the corresponding trapping efficiencies. **[Ref. 6]**

The trapping efficiency of each basin with a drainage area greater than 30 acres is summarized in the table below.

Table 11b: Sediment Basin Trapping Efficiency (Drainage Area > 30 acres)							
Sediment Basin ID	Clay Trapping Effeciency (%) [Ref. 6]	Silt Trapping Efficiency (%) [Ref. 6]	Sand Trapping Efficiency (%) [Ref. 6]	Small Aggregate Trapping Efficiency (%) [Ref. 6]	Large Aggregate Trapping Efficiency (%) [Ref. 6]	Overall Sediment Trapping Efficiency (%) [Ref. 6]	Trapping Efficiency (%) [Ref. 6]
SB-PT-9	43.9	90.9	100	100	100	98.1	> 80%
SB-P-2	45.1	91.7	100	100	100	98.2	> 80%

2.4 Skimmer Design and Dewatering Time

Skimmers were designed to drain the storage volume of water contained during a 10-yr, 24-hr storm event within two to five days (48-120 hours) **[Ref. 7]**.

The orifice size required to drain the proposed sediment storage volume in two to five days was computed by determining the required orifice area as a function of the volume below the principal spillway crest and a factor unique to each diameter. These factors can be found in the Faircloth Skimmer Design Guide **[Ref. 9]**. Once the required orifice area was determined, the required orifice diameter was calculated.

HydroCAD® was utilized to compute the drawdown time for the 10-year, 24-hour storm scenario **[Ref. 5]**. As such, different diameter skimmers with different orifice diameters will be installed in each sediment basin with an invert of the basin floor as outlined in the table below.

Table 12: Skimmer Characteristics				
Sediment Basin ID	Number of Skimmers	Skimmer Size (in) [Ref. 9]	Orifice Diameter (in)	Dewatering Time (hr)
SB-OB-11	1	8.0	8.0	71.6
SB-OB-12	1	8.0	8.0	81.1
SB-PT-9	2	8.0	8.0	82.7
SB-PT-1	1	8.0	8.0	86.9
SB-P-8	1	8.0	8.0	60.1
SB-P-2	2	8.0	8.0	92.3
SB-OB-6	1	8.0	8.0	78.8
SB-OB-5	1	8.0	8.0	66.4
SB-OB-4	1	8.0	8.0	51.4
SB-OB-3	1	8.0	8.0	60.7
SB-OB-10	1	8.0	8.0	67.2
SB-OB-7	1	8.0	8.0	65.6

2.5 Sediment Basin Comparison to Design Criteria

The sediment basins meet the required design criteria as summarized in **Table 13** in **Attachment 1**.

❖ 3.0 ANTI-FLOTATION BLOCK

An anti-flotation block was designed for each sediment basin such that the weight of the anti-flotation block (including the riser concrete walls) was at least 10% more than the weight of the water displaced **[Ref. 7]** (or uplift force on the riser). The anti-flotation block was estimated based on a rectangular base and thickness.

The anti-flotation block sizing was designed as shown in the following table:

Table 14: Anti-Flotation Block Characteristics

Sediment Basin ID	Riser Inside Dimensions (ft)			Assumed Riser Wall Thickness (in)	Uplift Force on Riser $\{U_{riser}\}$ (lb)	Riser Concrete Vol. (cf)	Riser Concrete Weight (lb)	AFB Dimensions {L, W, H} (ft)			AFB Weight (lb)	Uplift Force on AFB $\{U_{afb}\}$ (lb)	Factor of Safety Against Uplift [Ref. 7]
	L	W	H					L	W	H			
SB-OB-11	3	3	7.6	6	7,588	53.2	7,980	4	4	0.5	1,200	499	1.14
SB-OB-12	3	3	6.5	6	6,490	45.5	6,825	4	4	0.5	1,200	499	1.15
SB-PT-9	3	3	7.3	6	7,288	51.1	7,665	4	4	0.5	1,200	499	1.14
SB-PT-1	3	3	7.4	6	7,388	51.8	7,770	4	4	0.5	1,200	499	1.14
SB-P-8	3	3	7	6	6,989	49	7,350	4	4	0.5	1,200	499	1.14
SB-P-2	3	3	7.4	6	7,388	51.8	7,770	4	4	0.5	1,200	499	1.14
SB-OB-6	3	3	7.7	6	7,688	53.9	8,085	4	4	0.5	1,200	499	1.13
SB-OB-5	3	3	7.5	6	7,488	52.5	7,875	4	4	0.5	1,200	499	1.14
SB-OB-4	3	3	7	6	6,989	49	7,350	4	4	0.5	1,200	499	1.14
SB-OB-3	3	3	7.1	6	7,089	49.7	7,455	4	4	0.5	1,200	499	1.14
SB-OB-7	3	3	7.8	6	7,788	54.6	8,190	4	4	0.5	1,200	499	1.13

❖ DISCUSSION

Twelve (12) sediment basins were designed and will be implemented to control peak stormwater flows from the 10-yr, 25-yr, and 100-yr, 24-hr storm event. Sediment basin designs were found to meet the requirements outlined in **[Ref. 7].**

Attachments

Attachment 1

Design Criteria Summary

Table 13: Design Criteria Summary													
Design Criteria	Required	Provided											
		SB-OB-11	SB-OB-12	SB-PT-9	SB-PT-1	SB-P-8	SB-P-2	SB-OB-6	SB-OB-5	SB-OB-4	SB-OB-3	SB-OB-10	SB-OB-7
TSS Removal	min. 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%	> 80%
Drainage Area (ac)	max. 30 ac*	19.0	18.9	42.5	22.3	15.5	47.5	21.3	17.9	13.2	15.6	18.5	16.9
Principal Spillway Capacity	min. 10-yr, 24-hr design storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm	Activated for the 10-yr, 24-hr storm
Emergency Spillway Capacity	min. 100-yr, 24-hr design storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm	Not activated for the 100-yr, 24-hr storm
Embankment Crest Height Above Riser (ft.)	min. 2-ft higher than principal spillway	2.4	3.5	2.7	2.6	3.0	2.6	2.3	2.5	3.0	2.9	2.2	2.8
Embankment Crest Height Above Em. Spillway (ft.)	min. 1-ft higher than emergency spillway	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Emergency Spillway Freeboard (ft.)	min. 0.5-ft for 100-yr, 24-hr design storm	1.4	2.6	1.31	1.6	2.1	1.2	1.31	1.5	2.0	2.0	1.22	1.9
Sediment Basin Storage Capacity (cf/ac)	min. 3,600 cf/ac	15,906	19,333	16,609	16,715	17,173	16,593	15,876	15,877	16,697	17,012	15,298	16,818
Dewatering Time (hrs)	between 48 and 120 hrs	71.6	81.1	82.7	86.9	60.1	92.3	78.8	66.4	51.4	60.7	67.2	65.6
Length to Width Ratio	min. 2(L):1(W)	3:1	2:1	3:1	2:1	2:1	2:1	2:1	3:1	2:1	3:1	2:1	2:1

*For drainage areas greater than 30 ac., SEDIMOT IV Software was used to evaluate sediment basin trapping efficiency.

Attachment 2

Stage Storage Calculations

Table 15A: Sediment Basin SB-OB-11 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	20,000	0	0
1.0	23,000	21,500	21,500
2.0	26,000	24,500	46,000
3.0	29,000	27,500	73,500
4.0	32,000	30,500	104,000
5.0	35,000	33,500	137,500
6.0	38,000	36,500	174,000
7.0	41,000	39,500	213,500
8.0	44,000	42,500	256,000
9.0	47,000	45,500	301,500
10.0	50,000	48,500	350,000

Table 15B: Sediment Basin SB-OB-12 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	27,000	0	0
1.0	30,000	28,500	28,500
2.0	33,000	31,500	60,000
3.0	36,000	34,500	94,500
4.0	39,000	37,500	132,000
5.0	42,000	40,500	172,500
6.0	45,000	43,500	216,000
7.0	48,000	46,500	262,500
8.0	51,000	49,500	312,000
9.0	54,000	52,500	364,500
10.0	57,000	55,500	420,000

Table 15C: Sediment Basin SB-PT-1 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	28,000	0	0
1.0	31,000	29,500	29,500
2.0	34,000	32,500	62,000
3.0	37,000	35,500	97,500
4.0	40,000	38,500	136,000
5.0	43,000	41,500	177,500
6.0	46,000	44,500	222,000
7.0	49,000	47,500	269,500
8.0	52,000	50,500	320,000
9.0	55,000	53,500	373,500
10.0	58,000	56,500	430,000

Table 15D: Sediment Basin SB-P-8 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	16,000	0	0
1.0	19,000	17,500	17,500
2.0	22,000	20,500	38,000
3.0	25,000	23,500	61,500
4.0	28,000	26,500	88,000
5.0	31,000	29,500	117,500
6.0	34,000	32,500	150,000
7.0	37,000	35,500	185,500
8.0	40,000	38,500	224,000
9.0	43,000	41,500	265,500
10.0	46,000	44,500	310,000

Table 15E: Sediment Basin SB-OB-6 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	24,000	0	0
1.0	27,000	25,500	25,500
2.0	30,000	28,500	54,000
3.0	33,000	31,500	85,500
4.0	36,000	34,500	120,000
5.0	39,000	37,500	157,500
6.0	42,000	40,500	198,000
7.0	45,000	43,500	241,500
8.0	48,000	46,500	288,000
9.0	51,000	49,500	337,500
10.0	54,000	52,500	390,000

Table 15F: Sediment Basin SB-OB-5 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	18,000	0	0
1.0	21,000	19,500	19,500
2.0	24,000	22,500	42,000
3.0	27,000	25,500	67,500
4.0	30,000	28,500	96,000
5.0	33,000	31,500	127,500
6.0	36,000	34,500	162,000
7.0	39,000	37,500	199,500
8.0	42,000	40,500	240,000
9.0	45,000	43,500	283,500
10.0	48,000	46,500	330,000

Table 15G: Sediment Basin SB-OB-3 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	16,000	0	0
1.0	19,000	17,500	17,500
2.0	22,000	20,500	38,000
3.0	25,000	23,500	61,500
4.0	28,000	26,500	88,000
5.0	31,000	29,500	117,500
6.0	34,000	32,500	150,000
7.0	37,000	35,500	185,500
8.0	40,000	38,500	224,000
9.0	43,000	41,500	265,500
10.0	46,000	44,500	310,000

Table 15H: Sediment Basin SB-OB-10 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	18,000	0	0
1.0	21,000	19,500	19,500
2.0	24,000	22,500	42,000
3.0	27,000	25,500	67,500
4.0	30,000	28,500	96,000
5.0	33,000	31,500	127,500
6.0	36,000	34,500	162,000
7.0	39,000	37,500	199,500
8.0	42,000	40,500	240,000
9.0	45,000	43,500	283,500
10.0	48,000	46,500	330,000

Table 15I: Sediment Basin SB-PT-9 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	65,000	0	0
1.0	68,000	66,500	66,500
2.0	71,000	69,500	136,000
3.0	74,000	72,500	208,500
4.0	77,000	75,500	284,000
5.0	80,000	78,500	362,500
6.0	83,000	81,500	444,000
7.0	86,000	84,500	528,500
8.0	89,000	87,500	616,000
9.0	92,000	90,500	706,500
10.0	95,000	93,500	800,000

Table 15J: Sediment Basin SB-P-2 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	74,000	0	0
1.0	77,000	75,500	75,500
2.0	80,000	78,500	154,000
3.0	83,000	81,500	235,500
4.0	86,000	84,500	320,000
5.0	89,000	87,500	407,500
6.0	92,000	90,500	498,000
7.0	95,000	93,500	591,500
8.0	98,000	96,500	688,000
9.0	101,000	99,500	787,500
10.0	104,000	102,500	890,000

Table 15K: Sediment Basin SB-OB-4 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	11,000	0	0
1.0	14,000	12,500	12,500
2.0	17,000	15,500	28,000
3.0	20,000	18,500	46,500
4.0	23,000	21,500	68,000
5.0	26,000	24,500	92,500
6.0	29,000	27,500	120,000
7.0	32,000	30,500	150,500
8.0	35,000	33,500	184,000
9.0	38,000	36,500	220,500
10.0	41,000	39,500	260,000

Table 15L: Sediment Basin SB-OB-7 Stage Storage Calculations			
Depth (ft)	Surface Area (ft^2)	Stage Volume (ft^3)	Incremental Volume (ft^3)
0.0	18,000	0	0
1.0	21,000	19,500	19,500
2.0	24,000	22,500	42,000
3.0	27,000	25,500	67,500
4.0	30,000	28,500	96,000
5.0	33,000	31,500	127,500
6.0	36,000	34,500	162,000
7.0	39,000	37,500	199,500
8.0	42,000	40,500	240,000
9.0	45,000	43,500	283,500
10.0	48,000	46,500	330,000

References

Reference 1

SC DHEC Stormwater BMP Handbook, Appendix F – South Carolina Rainfall Data, SC DHEC, Revised July 2005.

APPENDIX F

SOUTH CAROLINA RAINFALL DATA

ADAPTED FROM

"Precipitation-Frequency Atlas of the United States"
NOAA Atlas 14, Volume 2, Version 2 (draft)
G.M. Bonnin, D. Todd, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

NOTE: Rainfall data for counties listed were averaged when multiple or no rainfall station data was available.

RETURN PERIOD 24 HOUR STORM EVENT (INCHES)

County Name	1	2	5	10	25	50	100	R Factors
Abbeville	3.2	3.5	4.4	5.2	6.5	7.7	9.2	250
Aiken	3.2	3.7	4.6	5.3	6.5	7.4	8.4	250
Allendale	3.4	3.8	5.1	6.0	7.0	7.8	8.9	300
Anderson	3.3	3.6	4.5	5.5	6.6	7.9	9.4	275
Bamberg	3.4	3.6	4.6	5.5	6.8	8.1	9.4	300
Barnwell	3.3	3.6	4.5	5.3	6.4	7.3	8.4	275
Beaufort	3.7	4.5	5.8	6.9	8.4	9.7	11.0	400
Berkeley (North)	3.5	3.8	5.0	5.9	7.2	8.2	9.4	350
Berkeley (South)	3.6	4.0	5.2	6.2	7.5	8.6	9.8	350
Calhoun	3.3	3.5	4.5	5.4	6.7	7.9	9.3	275
Charleston	3.8	4.3	5.5	6.6	8.0	9.2	10.4	400
Cherokee	3.0	3.7	4.7	5.4	6.4	7.3	8.1	275
Chester	2.9	3.6	4.6	5.3	6.3	7.1	8.0	250
Chesterfield	3.1	3.5	4.5	5.3	6.6	7.7	9.0	275
Clarendon	3.4	3.7	4.7	5.6	7.0	8.2	9.5	300
Colleton (North)	3.5	3.5	4.5	5.4	6.7	7.9	9.2	350
Colleton (South)	3.6	4.0	5.2	6.1	7.5	8.6	9.7	350
Darlington	3.2	3.5	4.5	5.4	6.7	8.0	9.3	300
Dillon	3.3	3.6	4.7	5.5	6.8	8.8	10.0	325
Dorchester(North)	3.4	3.8	4.9	5.8	7.1	8.1	9.3	325
Dorchester(South)	3.6	4.2	5.4	6.4	7.8	8.9	10.1	325
Edgefield	3.2	3.1	4.5	5.2	6.3	7.2	8.2	250
Fairfield	3.0	3.5	4.4	5.1	6.2	7.1	8.0	250
Florence (North)	3.3	3.5	4.5	5.4	6.7	7.9	9.2	325
Florence (South)	3.3	3.7	4.7	5.6	7.0	8.2	9.6	325
Georgetown (East)	3.6	4.6	5.9	7.0	8.5	9.8	11.1	350
Georgetown (West)	3.6	3.9	5.1	6.0	7.4	8.4	9.6	350
Greenville(North)	4.0	4.2	5.3	6.1	7.3	8.3	9.3	300
Greenville(South)	3.4	3.7	4.6	5.4	6.7	7.8	9.1	300
Greenwood	3.1	3.5	4.4	5.1	6.4	7.6	9.0	250
Hampton (North)	3.4	3.8	4.9	5.8	7.1	8.2	9.3	325
Hampton (South)	3.4	4.2	5.4	6.4	7.8	9.0	10.2	325
Horry (North)	3.4	4.1	5.3	6.3	7.9	9.3	10.8	350
Horry (South)	3.6	4.2	5.4	6.4	7.8	9.0	10.2	350
Jasper	3.5	4.2	5.4	6.4	7.8	9.0	10.2	350
Kershaw	3.1	3.5	4.4	5.1	6.2	7.1	8.1	275
Lancaster	3.0	3.5	4.4	5.2	6.2	7.0	7.9	250
Laurens	3.1	3.6	4.4	5.2	6.5	7.7	9.2	250
Lee	3.2	3.5	4.5	5.4	6.7	7.9	9.3	275
Lexington	3.1	3.6	4.5	5.3	6.4	7.3	8.3	250
Marion (North)	3.3	3.7	4.8	5.7	6.9	8.0	9.1	325
Marion (South)	3.4	4.2	5.5	6.5	7.9	9.1	10.3	325
Marlboro	3.2	3.5	4.5	5.4	6.5	7.5	8.5	300
McCormick	3.2	3.5	4.4	5.2	6.4	7.5	8.9	250
Newberry	3.0	3.6	4.5	5.3	6.4	7.3	8.4	250
Oconee (North)	4.5	4.7	5.8	6.7	7.8	8.8	9.8	300
Oconee (South)	3.5	3.8	4.7	5.5	6.6	7.6	8.6	300
Orangeburg (East)	3.3	3.8	4.9	5.8	7.1	8.1	9.3	275
Orangeburg (West)	3.3	3.6	4.5	5.4	6.8	8.0	9.3	275
Pickens (North)	4.2	5.1	6.2	7.2	8.5	9.5	10.6	300
Pickens (South)	3.7	4.1	5.0	5.8	6.9	7.8	8.8	300
Richland	3.1	3.6	4.5	5.3	6.4	7.3	8.3	275
Saluda	3.4	3.6	4.5	5.2	6.3	7.2	8.2	250
Spartanburg (NW)	3.4	4.5	5.5	6.3	7.5	8.5	9.5	300
Spartanburg (NE)	3.1	3.8	4.8	5.5	6.6	7.4	8.3	275
Spartanburg (SE)	3.1	3.6	4.5	5.5	6.4	7.8	9.3	275
Spartanburg (SW)	3.1	3.7	4.6	5.4	6.7	7.9	9.4	275
Sumter	3.2	3.6	4.6	5.5	6.9	8.1	9.5	275
Union	3.0	3.6	4.5	5.2	6.5	7.7	9.1	250
Williamsburg	3.4	4.1	5.3	6.2	7.6	8.7	9.9	325
York	2.8	3.6	4.5	5.3	6.3	7.1	7.9	250

Reference 2

TR-55 Urban Hydrology for Small Watersheds, USDA-NRCS, June 1986.

Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]}$$

where

- Q = runoff (in)
- P = rainfall (in)
- S = potential maximum retention after runoff begins (in) and
- I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

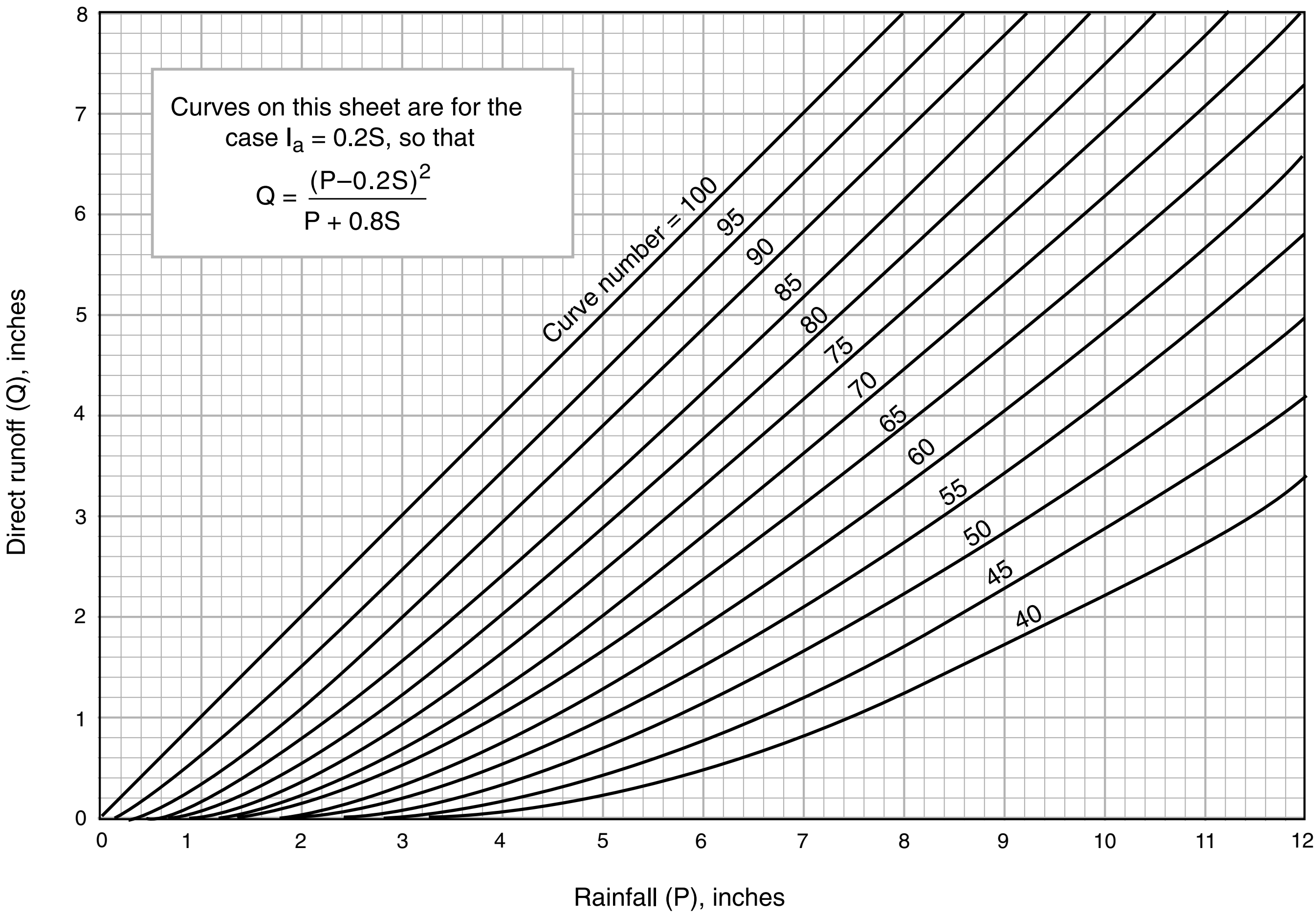
Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Figure 2-1 Solution of runoff equation.



Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Figure 2-2 Flow chart for selecting the appropriate figure or table for determining runoff curve numbers.

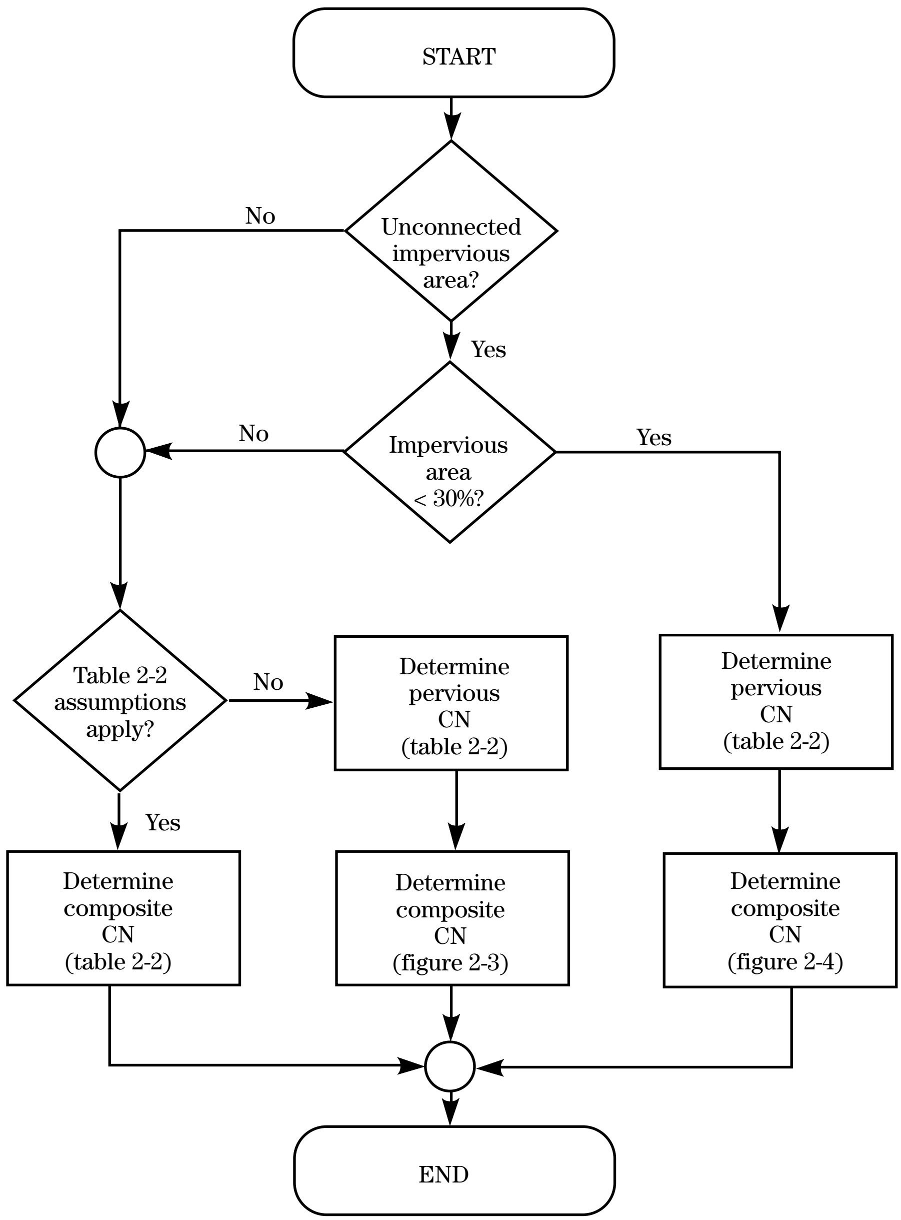


Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

1 Average runoff condition, and I_a=0.2S
2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Antecedent runoff condition

The index of runoff potential before a storm event is the antecedent runoff condition (ARC). ARC is an attempt to account for the variation in CN at a site from storm to storm. CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The CN's in table 2-2 are for the average ARC, which is used primarily for design applications. See NEH-4 (SCS 1985) and Rallison and Miller (1981) for more detailed discussion of storm-to-storm variation and a demonstration of upper and lower enveloping curves.

Urban impervious area modifications

Several factors, such as the percentage of impervious area and the means of conveying runoff from impervious areas to the drainage system, should be considered in computing CN for urban areas (Rawls et al., 1981). For example, do the impervious areas connect directly to the drainage system, or do they outlet onto lawns or other pervious areas where infiltration can occur?

Connected impervious areas — An impervious area is considered connected if runoff from it flows directly into the drainage system. It is also considered connected if runoff from it occurs as concentrated shallow flow that runs over a pervious area and then into the drainage system.

Urban CN's (table 2-2a) were developed for typical land use relationships based on specific assumed percentages of impervious area. These CN vales were developed on the assumptions that (a) pervious urban areas are equivalent to pasture in good hydrologic condition and (b) impervious areas have a CN of 98 and are directly connected to the drainage system. Some assumed percentages of impervious area are shown in table 2-2a

If all of the impervious area is directly connected to the drainage system, but the impervious area percentages or the pervious land use assumptions in table 2-2a are not applicable, use figure 2-3 to compute a composite CN. For example, table 2-2a gives a CN of 70 for a 1/2-acre lot in HSG B, with assumed impervious area of 25 percent. However, if the lot has 20 percent impervious area and a pervious area CN of 61, the composite CN obtained from figure 2-3 is 68. The CN difference between 70 and 68 reflects the difference in percent impervious area.

Unconnected impervious areas — Runoff from these areas is spread over a pervious area as sheet flow. To determine CN when all or part of the impervious area is not directly connected to the drainage system, (1) use figure 2-4 if total impervious area is less than 30 percent or (2) use figure 2-3 if the total impervious area is equal to or greater than 30 percent, because the absorptive capacity of the remaining pervious areas will not significantly affect runoff.

When impervious area is less than 30 percent, obtain the composite CN by entering the right half of figure 2-4 with the percentage of total impervious area and the ratio of total unconnected impervious area to total impervious area. Then move left to the appropriate pervious CN and read down to find the composite CN. For example, for a 1/2-acre lot with 20 percent total impervious area (75 percent of which is unconnected) and pervious CN of 61, the composite CN from figure 2-4 is 66. If all of the impervious area is connected, the resulting CN (from figure 2-3) would be 68.

Figure 2-3 Composite CN with connected impervious area.

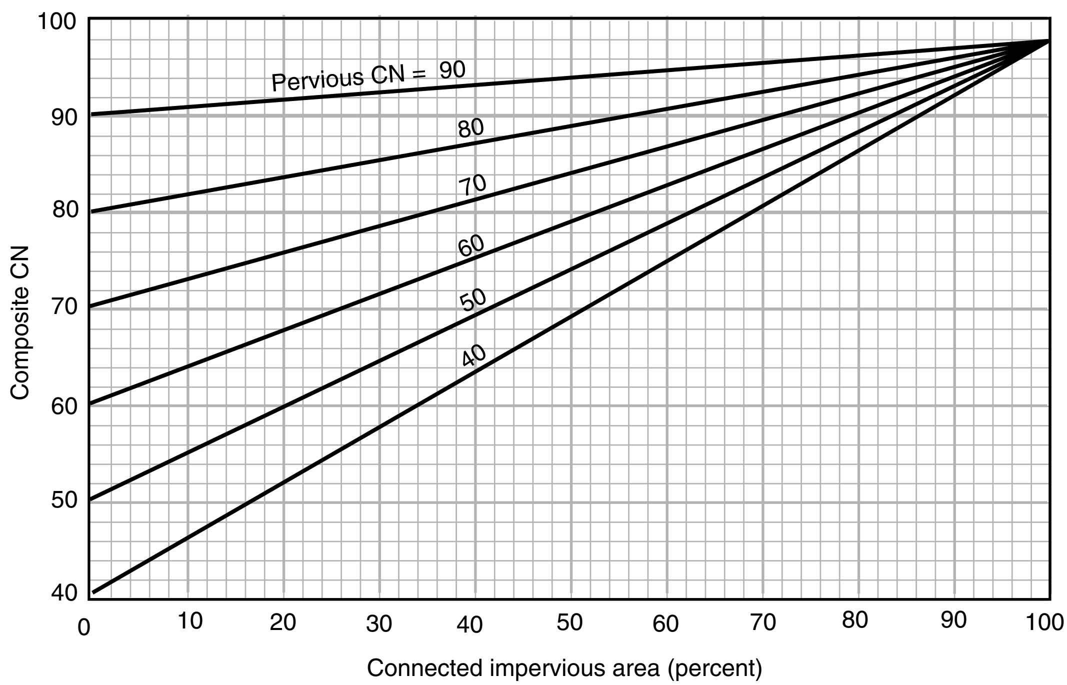
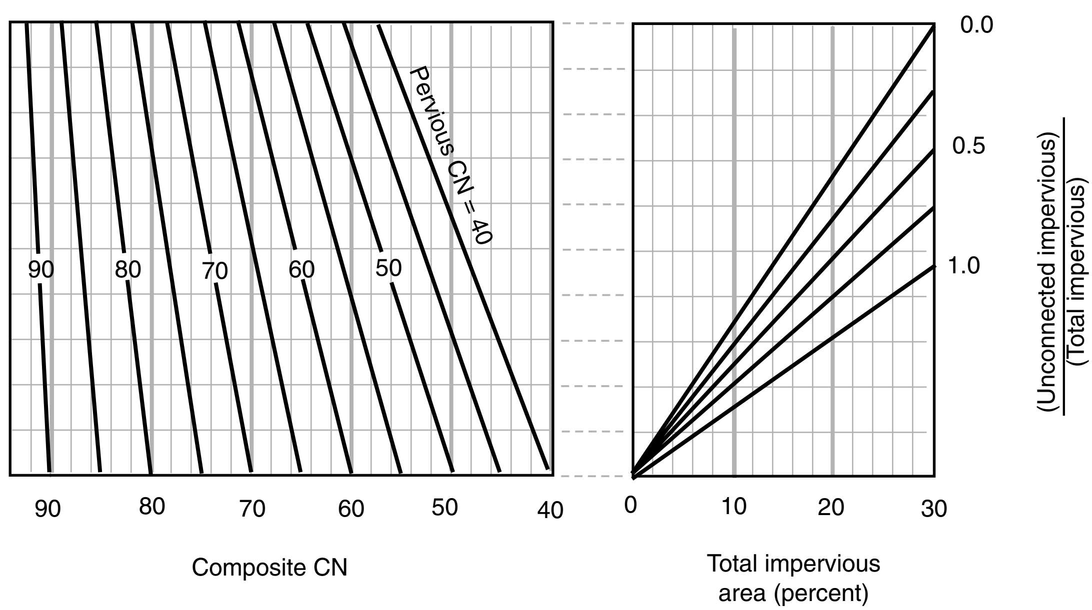


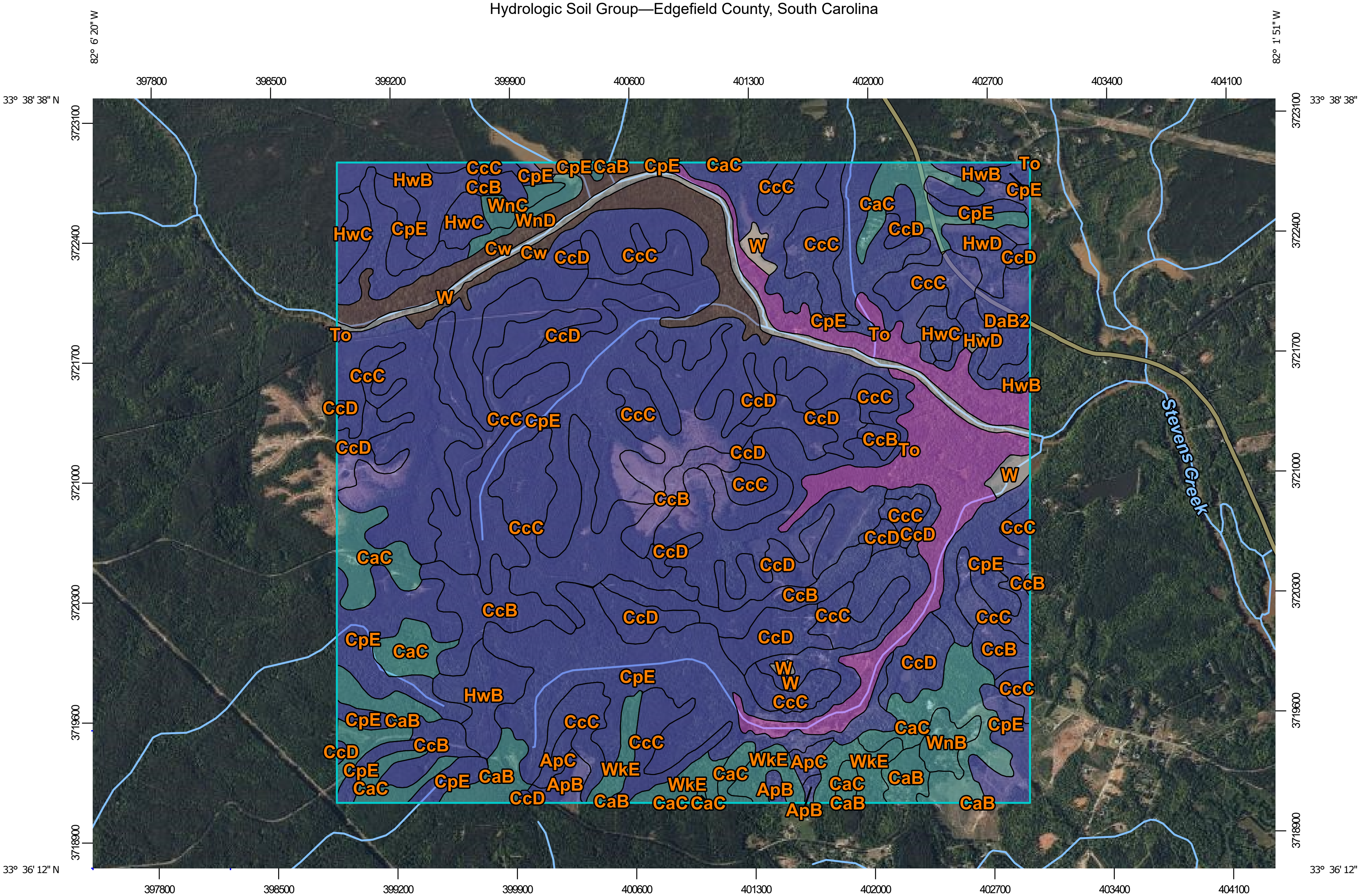
Figure 2-4 Composite CN with unconnected impervious areas and total impervious area less than 30%



Reference 3

NRCS Soil Figures, S&ME Inc., December 2022.

Hydrologic Soil Group—Edgefield County, South Carolina



Map Scale: 1:31,700 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 450 900 1800 2700

Feet: 0 1500 3000 6000 9000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

MAP INFORMATION

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

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: Edgefield County, South Carolina
Survey Area Data: Version 19, Sep 7, 2022

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

Date(s) aerial images were photographed: Apr 15, 2022—May 10, 2022

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
ApB	Appling sandy loam, 2 to 6 percent slopes	B	21.4	0.6%
ApC	Appling sandy loam, 6 to 10 percent slopes	B	16.3	0.4%
CaB	Cataula sandy loam, 2 to 6 percent slopes	C	80.3	2.1%
CaC	Cataula sandy loam, 6 to 10 percent slopes	C	225.2	6.0%
CcB	Cecil sandy loam, 2 to 6 percent slopes	B	194.2	5.2%
CcC	Cecil sandy loam, 6 to 10 percent slopes	B	663.5	17.6%
CcD	Cecil-Cataula complex, 10 to 15 percent slopes, moderately eroded	B	319.0	8.5%
CpE	Cecil-Pacolet complex, 15 to 25 percent slopes	B	1,394.9	37.0%
Cw	Chewacla loam, 0 to 2 percent slopes, frequently flooded	B/D	133.5	3.5%
DaB2	Davidson sandy clay loam, 2 to 6 percent slopes, eroded	B	34.1	0.9%
HwB	Hiwassee sandy loam, 2 to 6 percent slopes	B	119.3	3.2%
HwC	Hiwassee sandy loam, 6 to 10 percent slopes	B	45.6	1.2%
HwD	Hiwassee sandy loam, 10 to 15 percent slopes	B	67.8	1.8%
To	Toccoa sandy loam	A	243.9	6.5%
W	Water		73.6	2.0%
WkE	Wilkes sandy loam, 15 to 40 percent slopes	C	86.5	2.3%
WnB	Winnsboro fine sandy loam, 2 to 6 percent slopes	C	20.7	0.6%
WnC	Winnsboro fine sandy loam, 6 to 10 percent slopes	C	13.7	0.4%
WnD	Winnsboro fine sandy loam, 10 to 15 percent slopes	C	14.2	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Totals for Area of Interest			**3,767.8**	**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

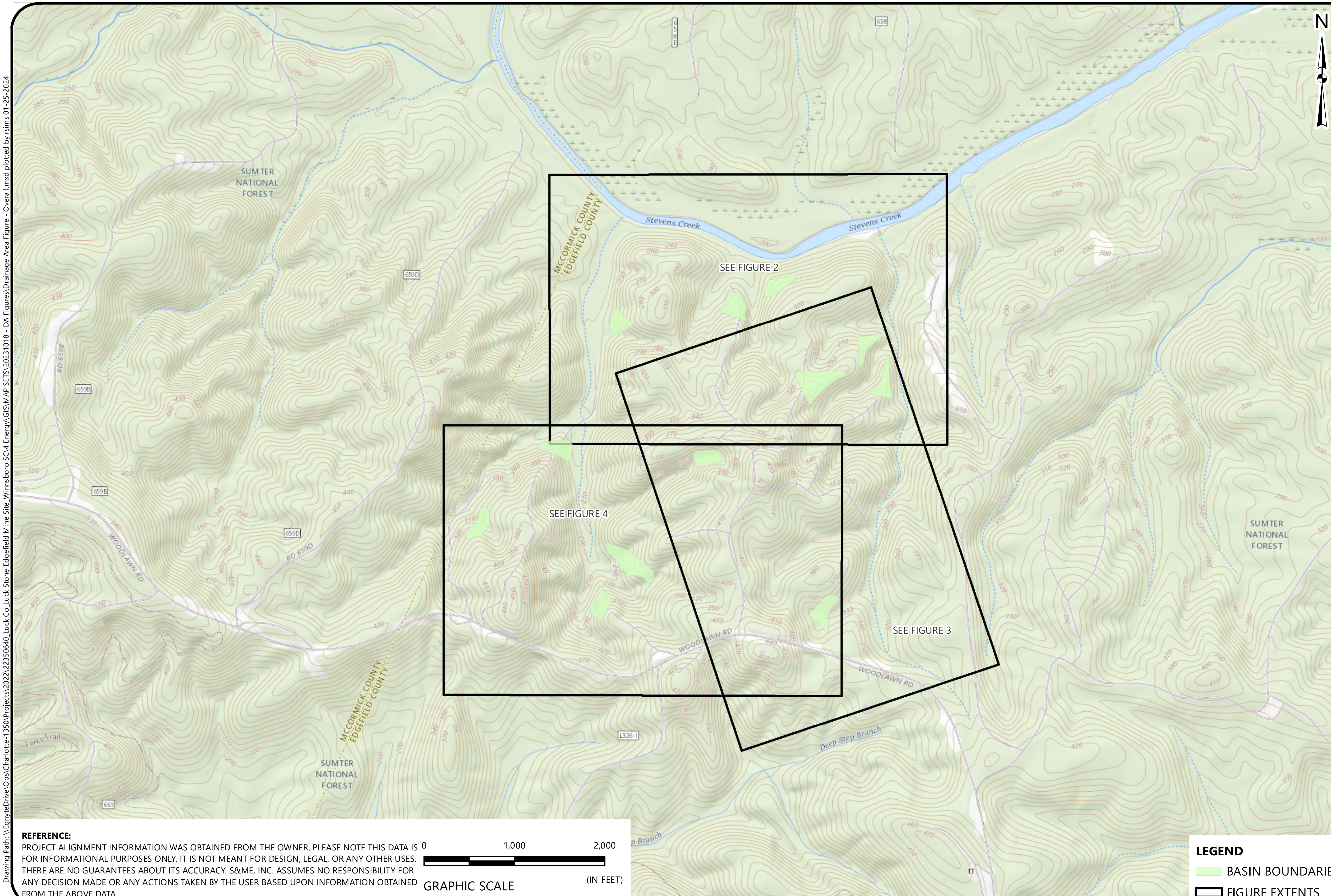
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Reference 4

Drainage Area Figures, S&ME Inc., November 2023.



REFERENCE:
PROJECT ALIGNMENT INFORMATION WAS OBTAINED FROM THE OWNER. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. S&ME, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.

DRAINAGE AREA FIGURES

LUCK EDGEFIELD
LUCK STONE CORPORATION
EDGEFIELD COUNTY, SOUTH CAROLINA

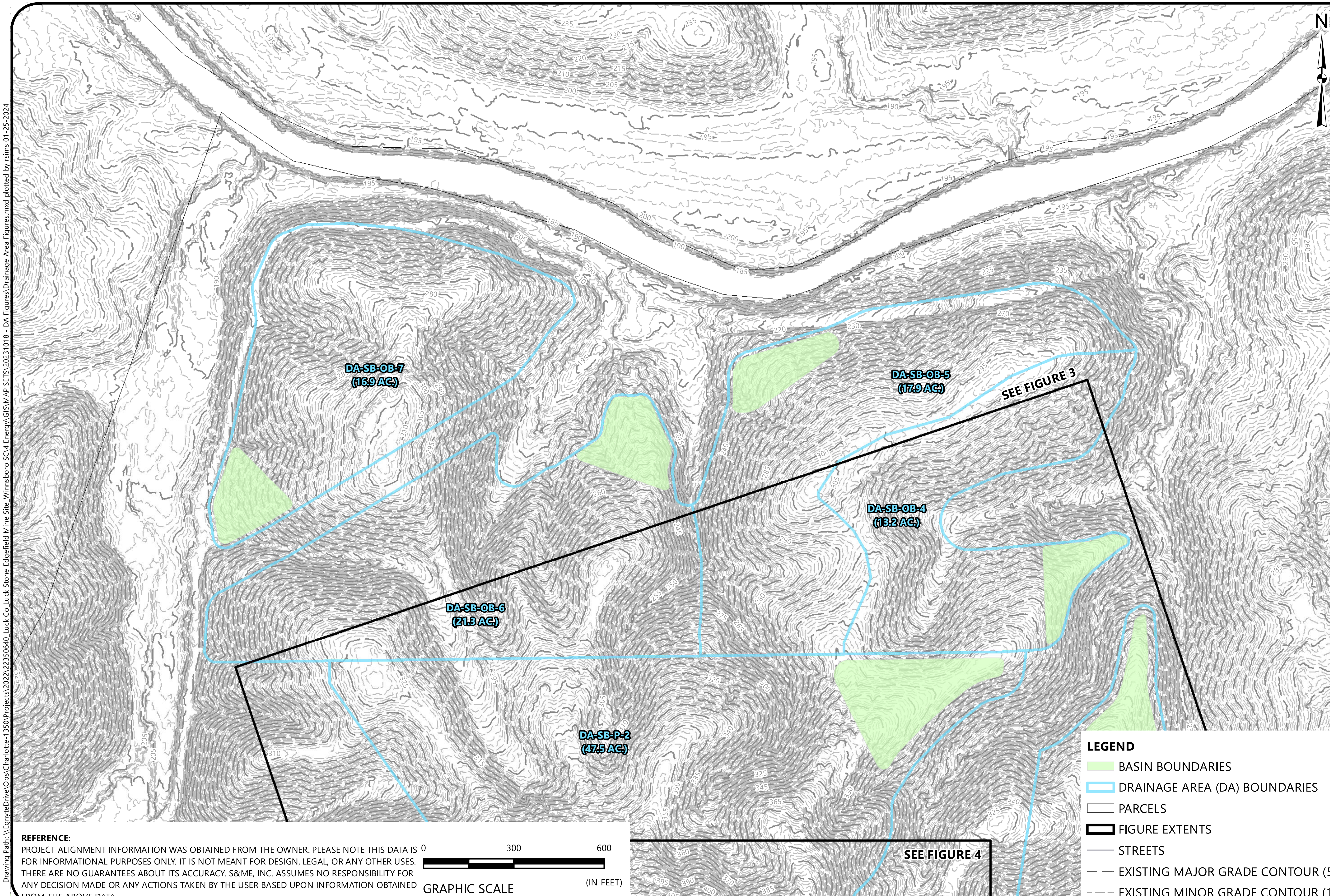
SCALE: 1 " = 1,000 '

DATE: 01-25-2024

PROJECT NUMBER: 22350640

FIGURE NO. 1

Drawing Path: \\EgnyteDrive\Ops\Charlotte-1350\Projects\2022\22350640_Luck Co_Luck Stone Edgefield Mine Site, Winnsboro SC\4 Energy\GIS\MAP SETS\20231018 - DA Figures\Drainage Area Figure - Overall.mxd plotted by rsims 01-25-2024



LEGEND

- BASIN BOUNDARIES
- DRAINAGE AREA (DA) BOUNDARIES
- PARCELS
- FIGURE EXTENTS
- STREETS
- EXISTING MAJOR GRADE CONTOUR (5')
- EXISTING MINOR GRADE CONTOUR (1')

REFERENCE:
PROJECT ALIGNMENT INFORMATION WAS OBTAINED FROM THE OWNER. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. S&ME, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.

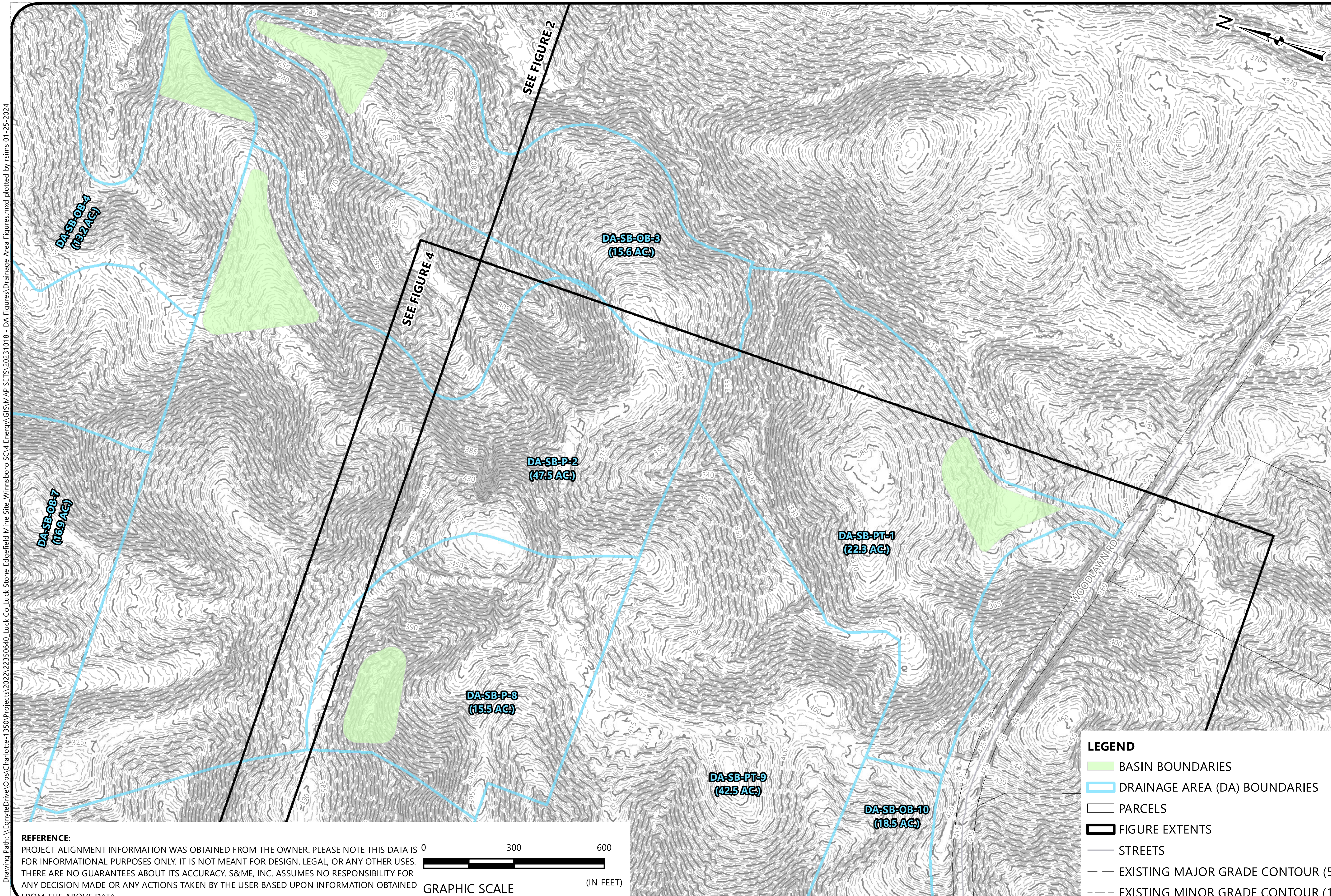
0 300 600
GRAPHIC SCALE (IN FEET)

DRAINAGE AREA FIGURES

LUCK EDGEFIELD
LUCK STONE CORPORATION
EDGEFIELD COUNTY, SOUTH CAROLINA

SCALE: 1 " = 300 '
DATE: 01-25-2024
PROJECT NUMBER: 22350640
FIGURE NO. 2

Drawing Path: \\EgnyteDrive\Ops\Charlotte-1350\Projects\2022\22350640_Luck Co_Luck Stone Edgefield Mine Site_Winnsboro SC\4 Energy\GIS\MAP SETS\20231018 - DA Figures\Drainage Area Figures.mxd plotted by rsims 01-25-2024



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REFERENCE:
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0 300 600
GRAPHIC SCALE (IN FEET)

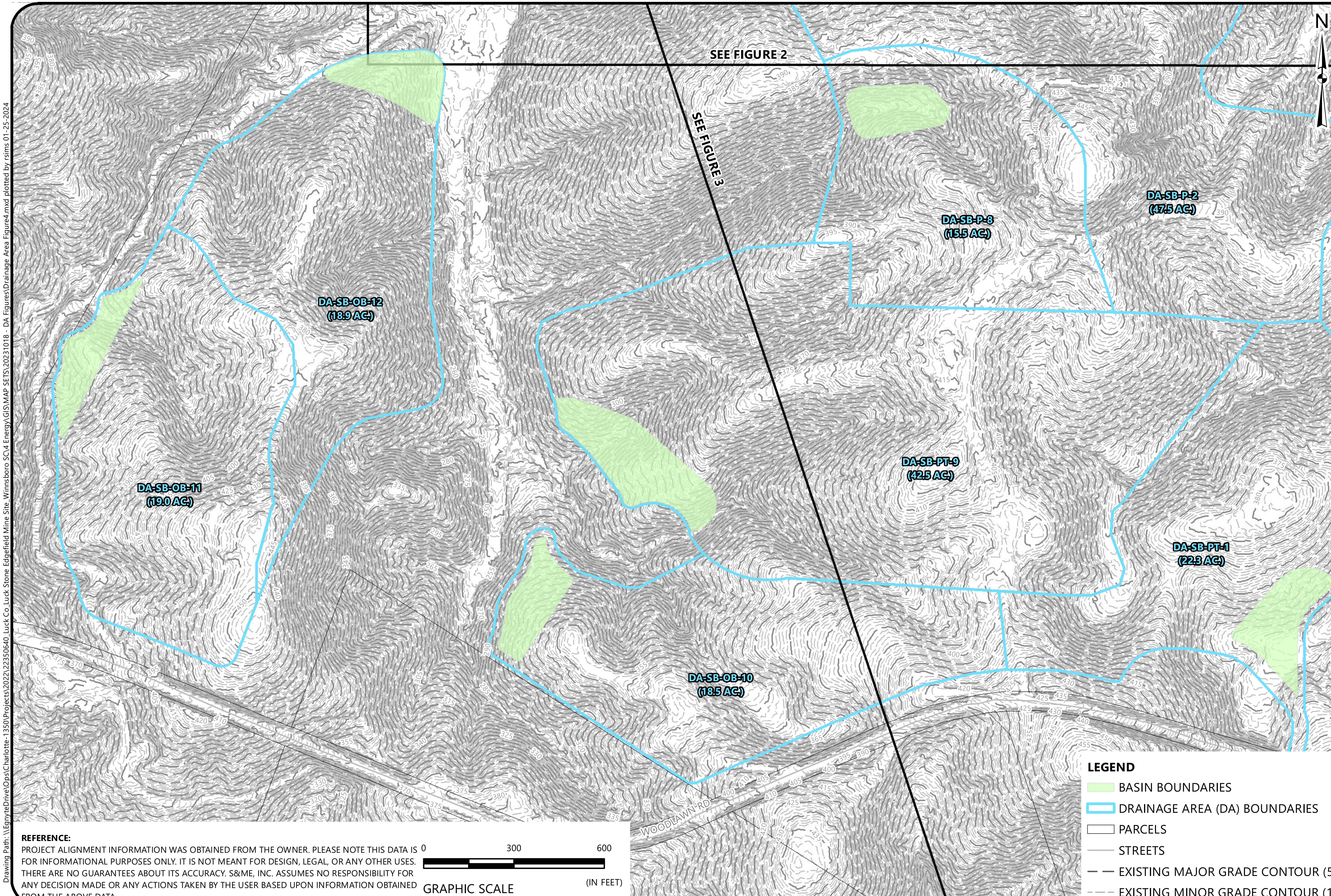
LEGEND
- BASIN BOUNDARIES
- DRAINAGE AREA (DA) BOUNDARIES
- PARCELS
- FIGURE EXTENTS
- STREETS
- EXISTING MAJOR GRADE CONTOUR (5')
- EXISTING MINOR GRADE CONTOUR (1')

S&ME

DRAINAGE AREA FIGURES

LUCK EDGEFIELD
LUCK STONE CORPORATION
EDGEFIELD COUNTY, SOUTH CAROLINA

SCALE: 1 " = 300 '
DATE: 01-25-2024
PROJECT NUMBER: 22350640
FIGURE NO. 3



Drawing Path: \\EgnyteDrive\Ops\Charlotte-1350\Projects\2022\22350640_Luck Co_Luck Stone Edgefield Mine Site_Winnsboro SC\4 Energy\GIS\MAP SETS\20231018 - DA Figures\Drainage Area Figure4.mxd plotted by rsims 01-25-2024

REFERENCE:
PROJECT ALIGNMENT INFORMATION WAS OBTAINED FROM THE OWNER. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. S&ME, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.

0 300 600
GRAPHIC SCALE (IN FEET)

LEGEND
- BASIN BOUNDARIES
- DRAINAGE AREA (DA) BOUNDARIES
- PARCELS
- STREETS
- EXISTING MAJOR GRADE CONTOUR (5')
- EXISTING MINOR GRADE CONTOUR (1')

DRAINAGE AREA FIGURES

LUCK EDGEFIELD
LUCK STONE CORPORATION
EDGEFIELD COUNTY, SOUTH CAROLINA

SCALE: 1 " = 300 '

DATE: 01-25-2024

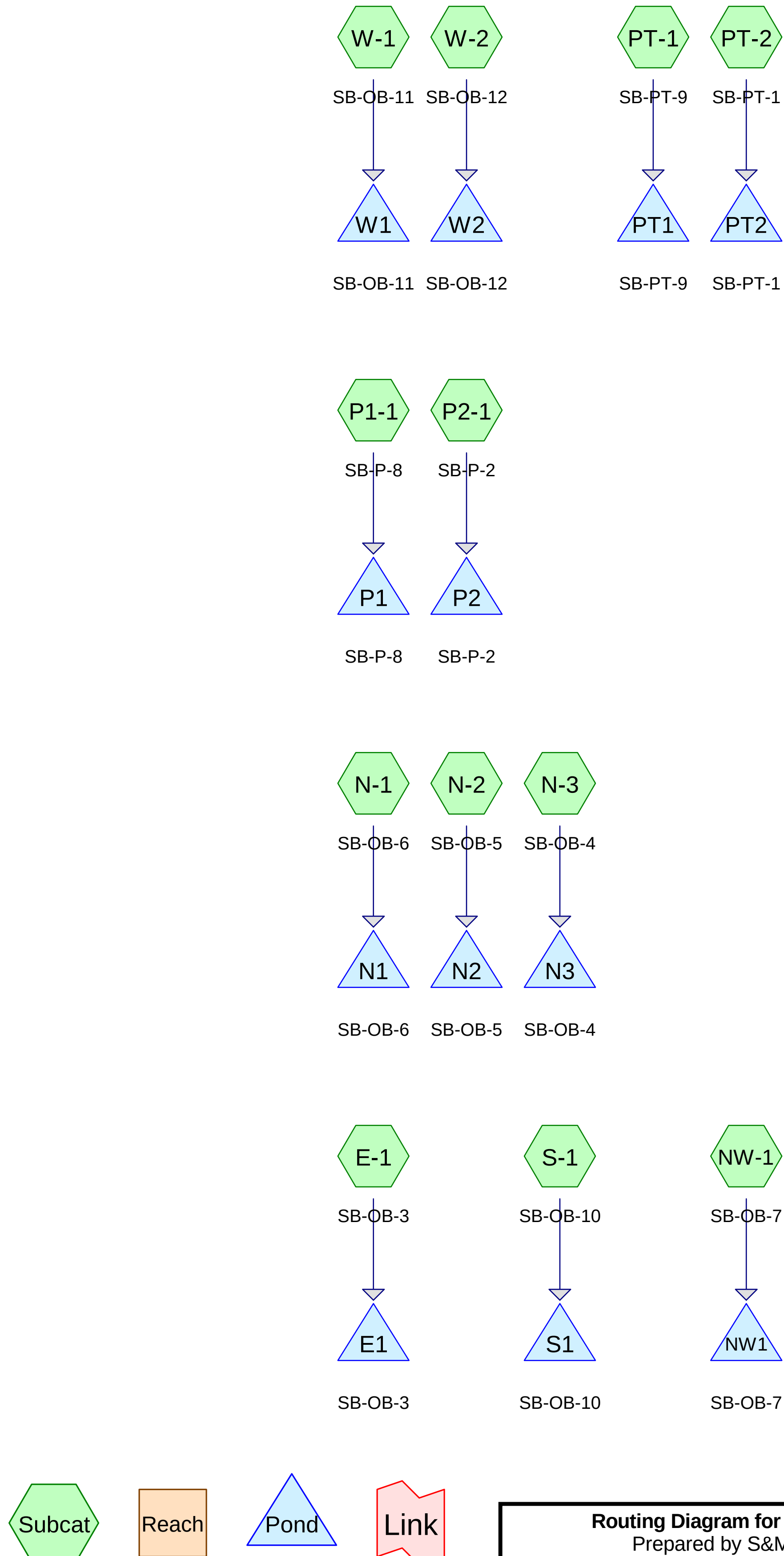
PROJECT NUMBER: 22350640

FIGURE NO.

4

Reference 5

Compiled HydroCAD Report, S&ME Inc., October 2023.



Routing Diagram for 22350640_SEDIMENT BASINS
Prepared by S&ME, Inc., Printed 1/25/2024
HydroCAD® 10.00-26 s/n 06707 © 2020 HydroCAD Software Solutions LLC

Project Notes

Defined 10 rainfall events from NOAA_I77_LUCKSTONE IDF
Defined 10 rainfall events from 22350640_NOAA PF_Depth IDF
Defined 10 rainfall events from 22350640_NOAA PF_Depth IDF

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
268.926	94	Newly graded area, HSG D (E-1, N-1, N-2, N-3, NW-1, P1-1, P2-1, PT-1, PT-2, S-1, W-1, W-2)
268.926	**94**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
268.926	HSG D	E-1, N-1, N-2, N-3, NW-1, P1-1, P2-1, PT-1, PT-2, S-1, W-1, W-2
0.000	Other	
268.926		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	268.926	0.000	268.926	Newly graded area	E-1, N-1, N-2, N-3, NW-1, P1-1, P2-1, PT-1, PT-2, S-1, W-1, W-2
0.000	**0.000**	**0.000**	**268.926**	**0.000**	**268.926**	**TOTAL AREA**	

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	E1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
2	N1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
3	N2	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
4	N3	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
5	NW1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
6	P1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
7	P2	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
8	PT1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
9	PT2	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
10	S1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
11	W1	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0
12	W2	390.00	389.00	100.0	0.0100	0.012	24.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: SB-OB-3 Runoff Area=679,818 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,439' Tc=6.0 min CN=94 Runoff=61.29 cfs 2.984 af

Subcatchment N-1: SB-OB-6 Runoff Area=926,011 sf 0.00% Impervious Runoff Depth>2.29"
Tc=6.0 min CN=94 Runoff=83.49 cfs 4.065 af

Subcatchment N-2: SB-OB-5 Runoff Area=777,820 sf 0.00% Impervious Runoff Depth>2.29"
Tc=6.0 min CN=94 Runoff=70.13 cfs 3.415 af

Subcatchment N-3: SB-OB-4 Runoff Area=575,239 sf 0.00% Impervious Runoff Depth>2.29"
Tc=6.0 min CN=94 Runoff=51.86 cfs 2.525 af

Subcatchment NW-1: SB-OB-7 Runoff Area=734,304 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,210' Tc=8.2 min CN=94 Runoff=62.68 cfs 3.222 af

Subcatchment P1-1: SB-P-8 Runoff Area=673,438 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,455' Tc=8.2 min CN=94 Runoff=57.48 cfs 2.955 af

Subcatchment P2-1: SB-P-2 Runoff Area=2,067,328 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=2,346' Tc=8.9 min CN=94 Runoff=172.51 cfs 9.070 af

Subcatchment PT-1: SB-PT-9 Runoff Area=1,852,884 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,128' Tc=7.6 min CN=94 Runoff=160.99 cfs 8.132 af

Subcatchment PT-2: SB-PT-1 Runoff Area=973,360 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,632' Tc=6.3 min CN=94 Runoff=86.75 cfs 4.273 af

Subcatchment S-1: SB-OB-10 Runoff Area=807,263 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,584' Tc=8.3 min CN=94 Runoff=68.69 cfs 3.542 af

Subcatchment W-1: SB-OB-11 Runoff Area=825,679 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,196' Tc=6.5 min CN=94 Runoff=73.07 cfs 3.624 af

Subcatchment W-2: SB-OB-12 Runoff Area=821,258 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=1,314' Tc=6.7 min CN=94 Runoff=73.02 cfs 3.605 af

Pond E1: SB-OB-3 Peak Elev=394.06' Storage=89,599 cf Inflow=61.29 cfs 2.984 af
Primary=1.17 cfs 1.032 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.032 af

Pond N1: SB-OB-6 Peak Elev=394.35' Storage=132,920 cf Inflow=83.49 cfs 4.065 af
Primary=1.17 cfs 1.041 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.041 af

Pond N2: SB-OB-5 Peak Elev=394.33' Storage=106,090 cf Inflow=70.13 cfs 3.415 af
Primary=1.17 cfs 1.044 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.044 af

Pond N3: SB-OB-4 Peak Elev=394.15' Storage=71,591 cf Inflow=51.86 cfs 2.525 af
Primary=1.17 cfs 1.037 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.037 af

Pond NW1: SB-OB-7 Peak Elev=394.10' Storage=98,963 cf Inflow=62.68 cfs 3.222 af
Primary=1.17 cfs 1.030 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.030 af

Pond P1: SB-P-8 Peak Elev=394.02' Storage=88,581 cf Inflow=57.48 cfs 2.955 af
Primary=1.17 cfs 1.027 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.027 af

Pond P2: SB-P-2 Peak Elev=393.93' Storage=314,121 cf Inflow=172.51 cfs 9.070 af
Primary=2.34 cfs 1.881 af Secondary=0.00 cfs 0.000 af Outflow=2.34 cfs 1.881 af

Pond PT1: SB-PT-9 Peak Elev=393.87' Storage=274,395 cf Inflow=160.99 cfs 8.132 af
Primary=2.34 cfs 1.885 af Secondary=0.00 cfs 0.000 af Outflow=2.34 cfs 1.885 af

Pond PT2: SB-PT-1 Peak Elev=394.15' Storage=142,157 cf Inflow=86.75 cfs 4.273 af
Primary=1.17 cfs 1.028 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.028 af

Pond S1: SB-OB-10 Peak Elev=394.49' Storage=110,993 cf Inflow=68.69 cfs 3.542 af
Primary=1.17 cfs 1.048 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.048 af

Pond W1: SB-OB-11 Peak Elev=394.33' Storage=114,657 cf Inflow=73.07 cfs 3.624 af
Primary=1.17 cfs 1.042 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.042 af

Pond W2: SB-OB-12 Peak Elev=393.57' Storage=115,646 cf Inflow=73.02 cfs 3.605 af
Primary=1.17 cfs 1.001 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.001 af

Total Runoff Area = 268.926 ac Runoff Volume = 51.413 af Average Runoff Depth = 2.29"
100.00% Pervious = 268.926 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E-1: SB-OB-3

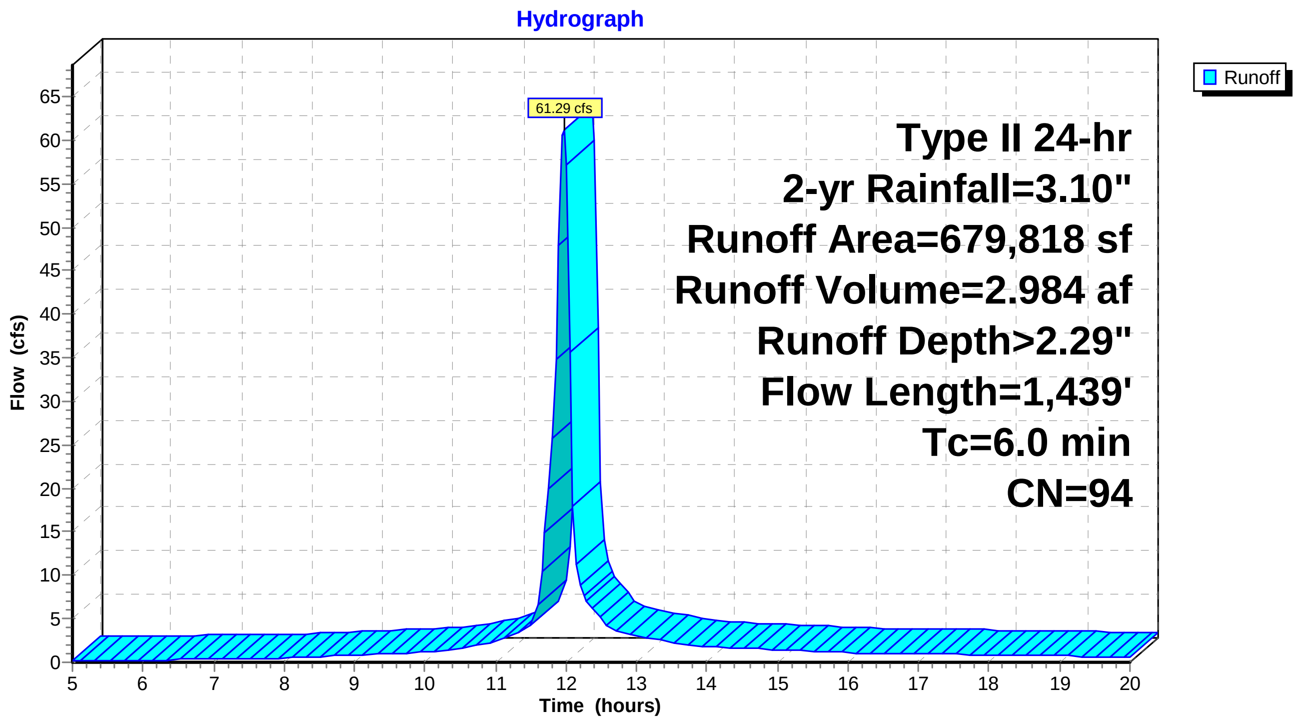
Runoff = 61.29 cfs @ 11.96 hrs, Volume= 2.984 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
679,818	94	Newly graded area, HSG D
679,818		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	100	0.0683	0.66		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.5	608	0.1660	4.07		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.0	731	0.0140	11.61	406.21	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.0	1,439	Total			

Subcatchment E-1: SB-OB-3



Summary for Subcatchment N-1: SB-OB-6

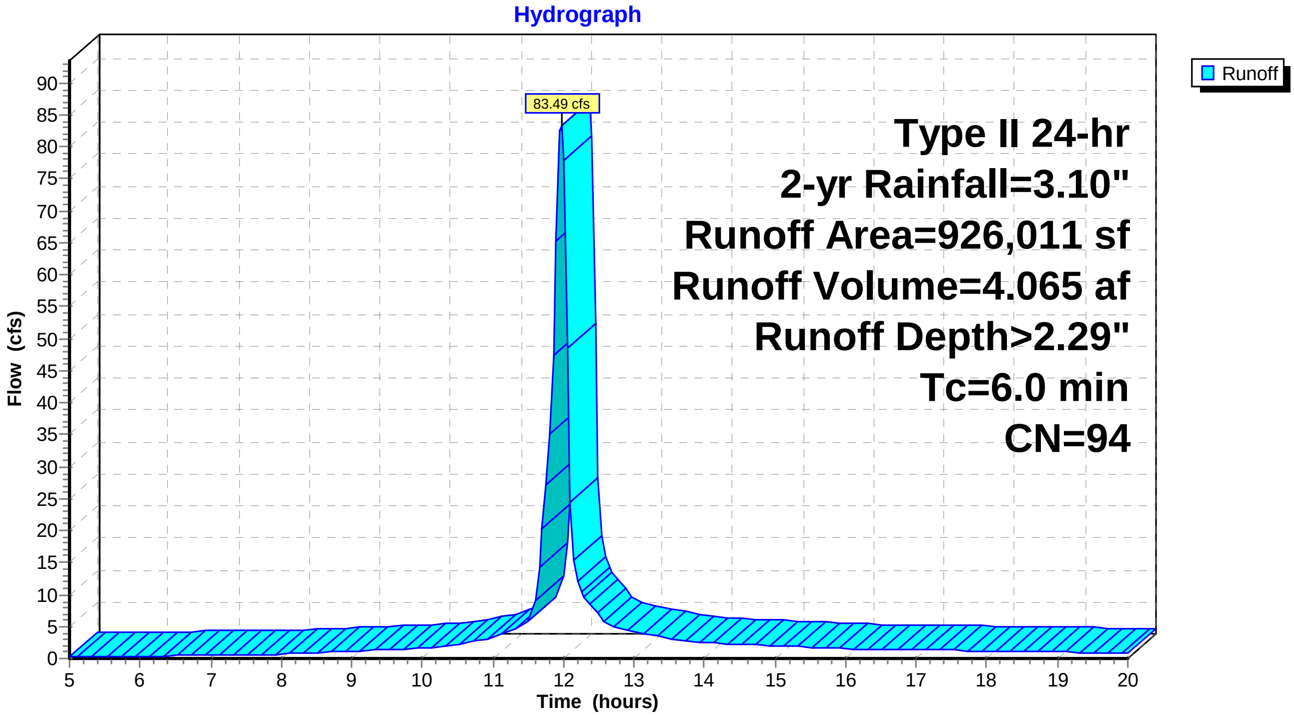
Runoff = 83.49 cfs @ 11.96 hrs, Volume= 4.065 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
926,011	94	Newly graded area, HSG D
926,011		100.00% Pervious Area

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

Subcatchment N-1: SB-OB-6



Summary for Subcatchment N-2: SB-OB-5

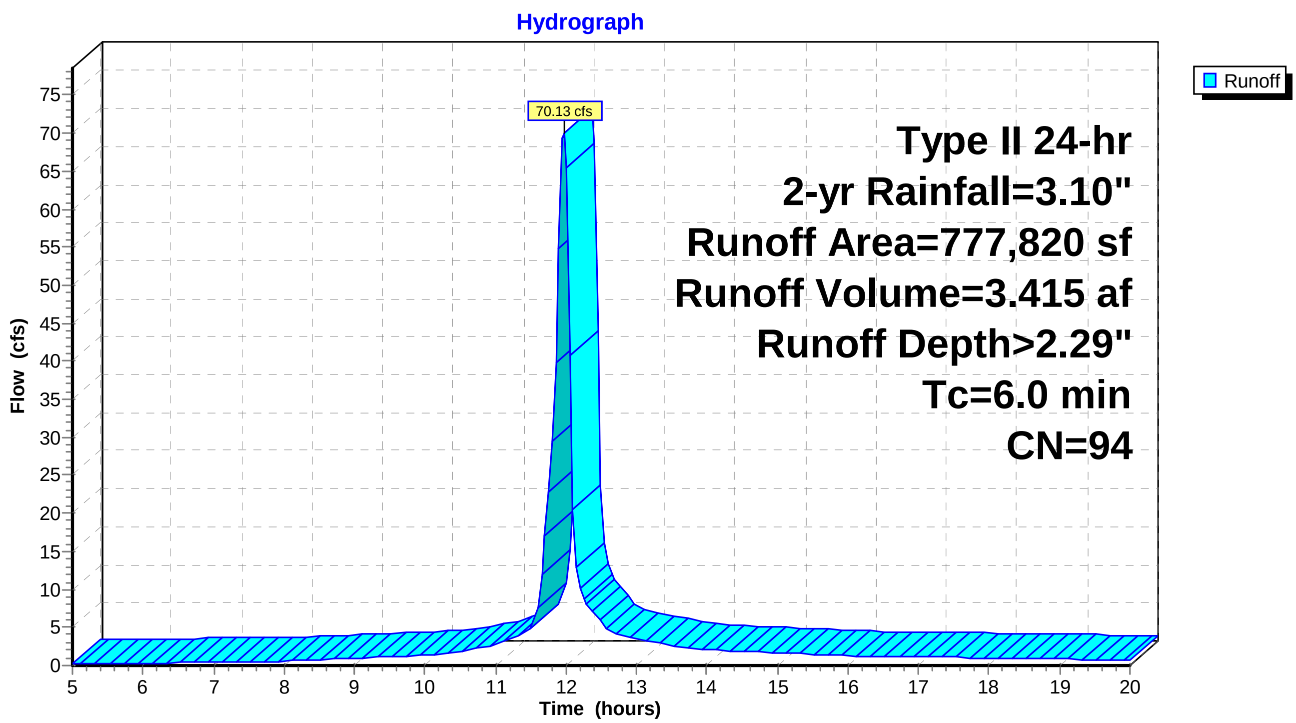
Runoff = 70.13 cfs @ 11.96 hrs, Volume= 3.415 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
777,820	94	Newly graded area, HSG D
777,820		100.00% Pervious Area

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

Subcatchment N-2: SB-OB-5



Summary for Subcatchment N-3: SB-OB-4

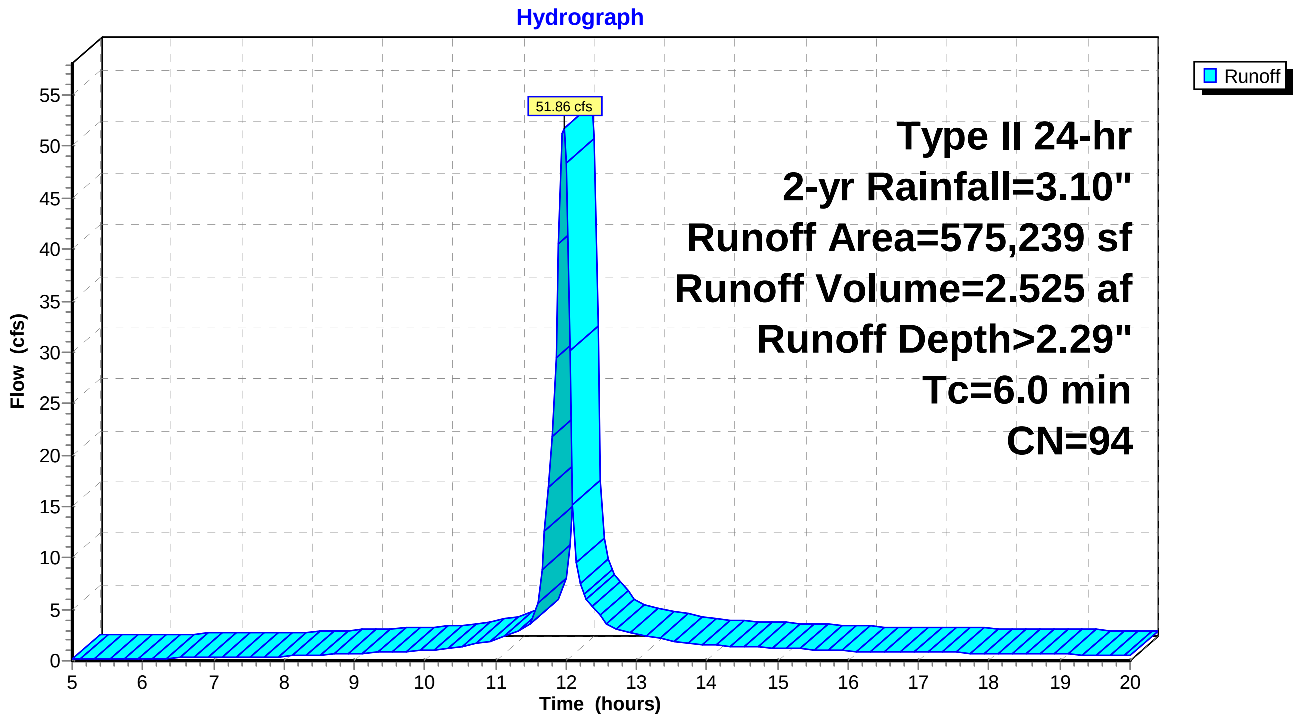
Runoff = 51.86 cfs @ 11.96 hrs, Volume= 2.525 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
575,239	94	Newly graded area, HSG D
575,239		100.00% Pervious Area

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

Subcatchment N-3: SB-OB-4



Summary for Subcatchment NW-1: SB-OB-7

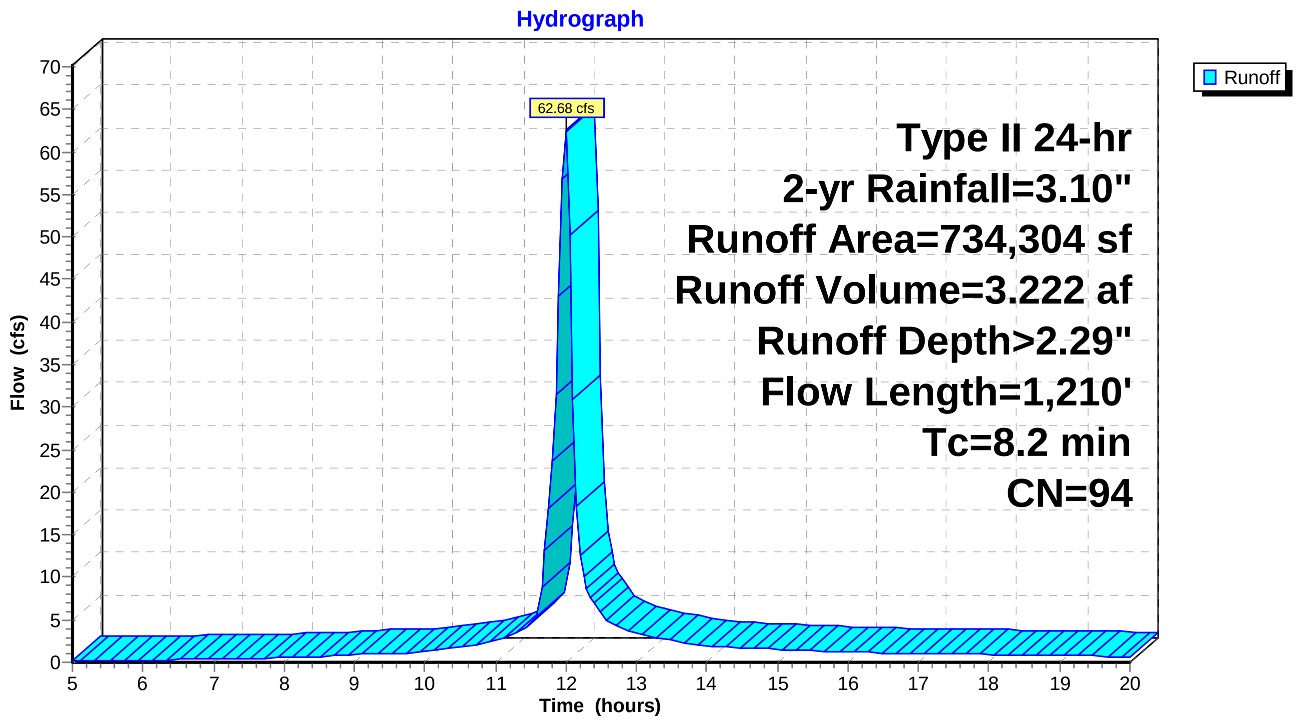
Runoff = 62.68 cfs @ 11.99 hrs, Volume= 3.222 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
734,304	94	Newly graded area, HSG D
734,304		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.0206	0.41		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
3.2	674	0.1225	3.50		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.9	436	0.0072	8.32	291.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,210	Total			

Subcatchment NW-1: SB-OB-7



Summary for Subcatchment P1-1: SB-P-8

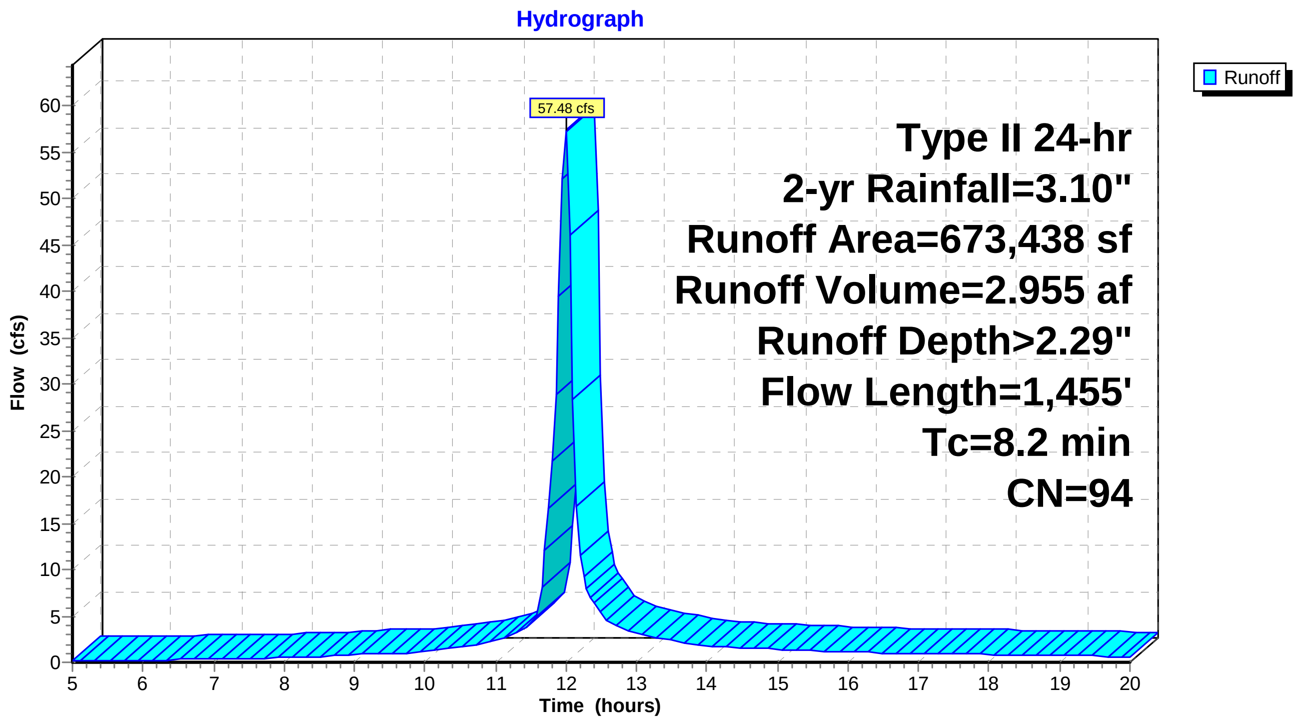
Runoff = 57.48 cfs @ 11.99 hrs, Volume= 2.955 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
673,438	94	Newly graded area, HSG D
673,438		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	100	0.0293	0.47		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.3	866	0.1150	3.39		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.4	489	0.0357	18.53	648.67	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,455	Total			

Subcatchment P1-1: SB-P-8



Summary for Subcatchment P2-1: SB-P-2

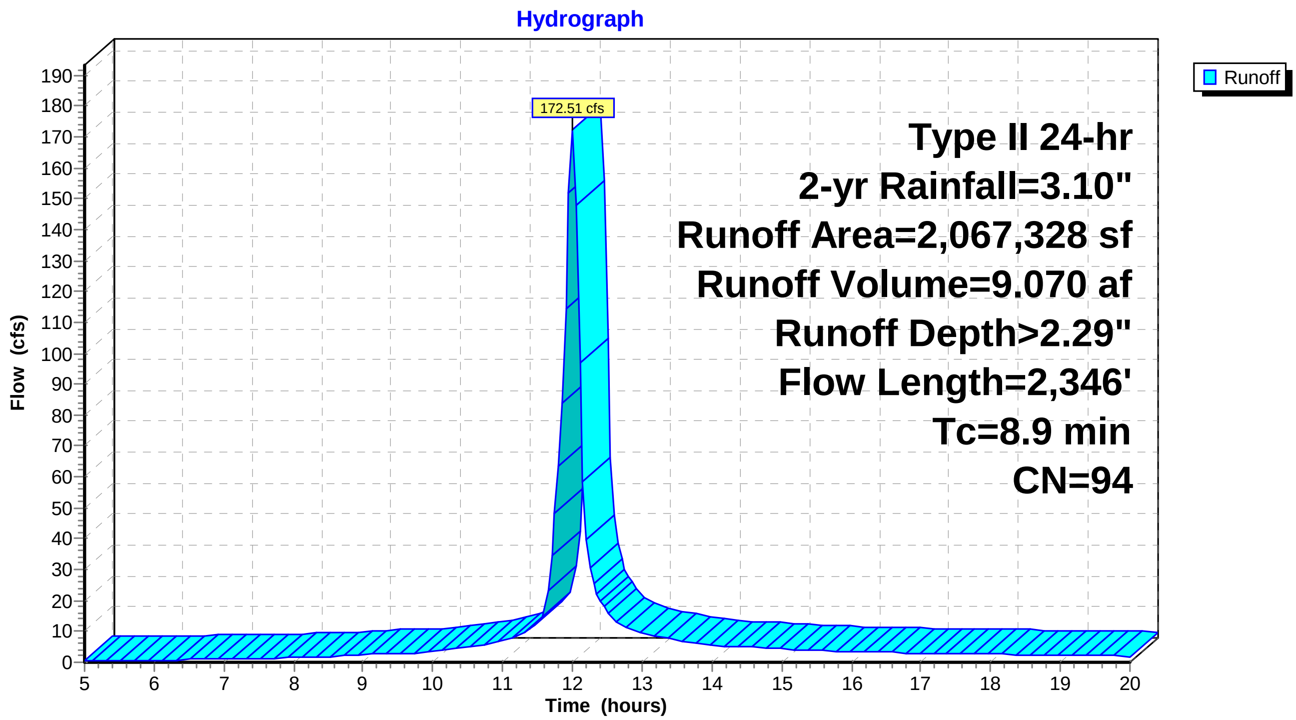
Runoff = 172.51 cfs @ 12.00 hrs, Volume= 9.070 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
2,067,328	94	Newly graded area, HSG D
2,067,328		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0607	0.63		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.5	918	0.1131	3.36		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.7	1,328	0.0180	13.16	460.60	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.9	2,346	Total			

Subcatchment P2-1: SB-P-2



Summary for Subcatchment PT-1: SB-PT-9

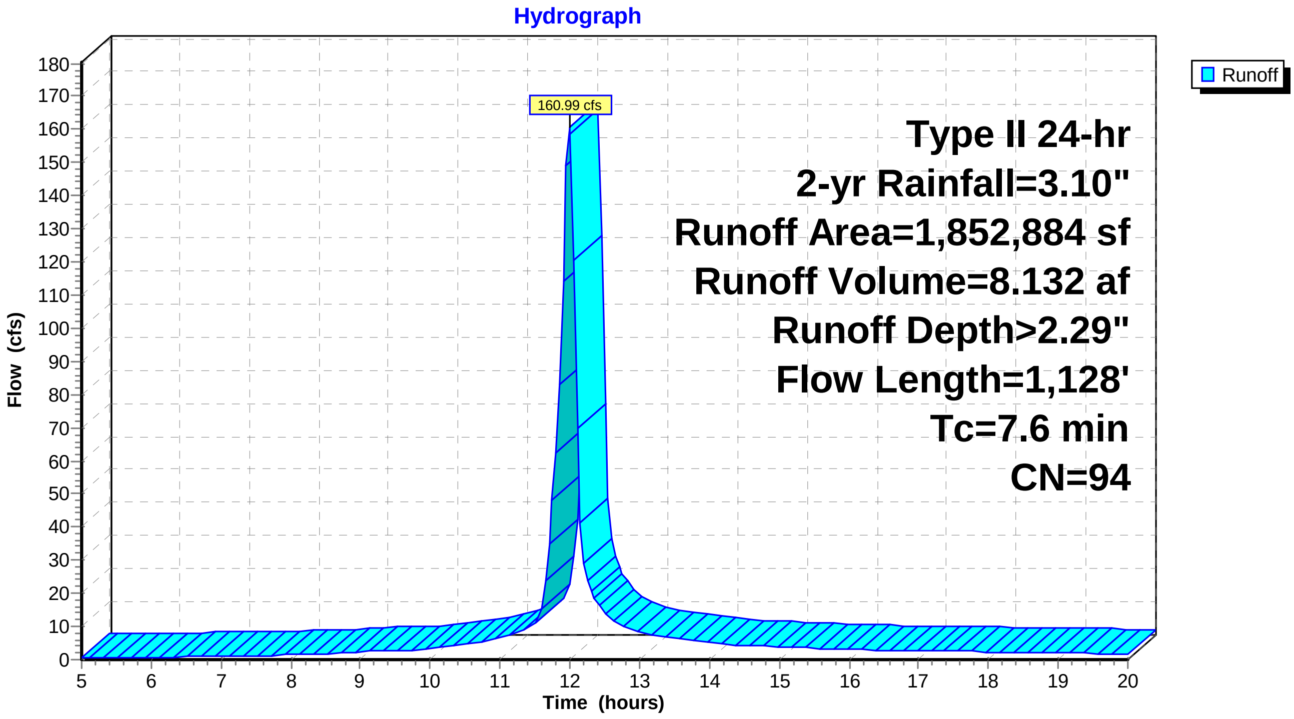
Runoff = 160.99 cfs @ 11.98 hrs, Volume= 8.132 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
1,852,884	94	Newly graded area, HSG D
1,852,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0589	0.62		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.9	1,028	0.1230	3.51		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
7.6	1,128	Total			

Subcatchment PT-1: SB-PT-9



Summary for Subcatchment PT-2: SB-PT-1

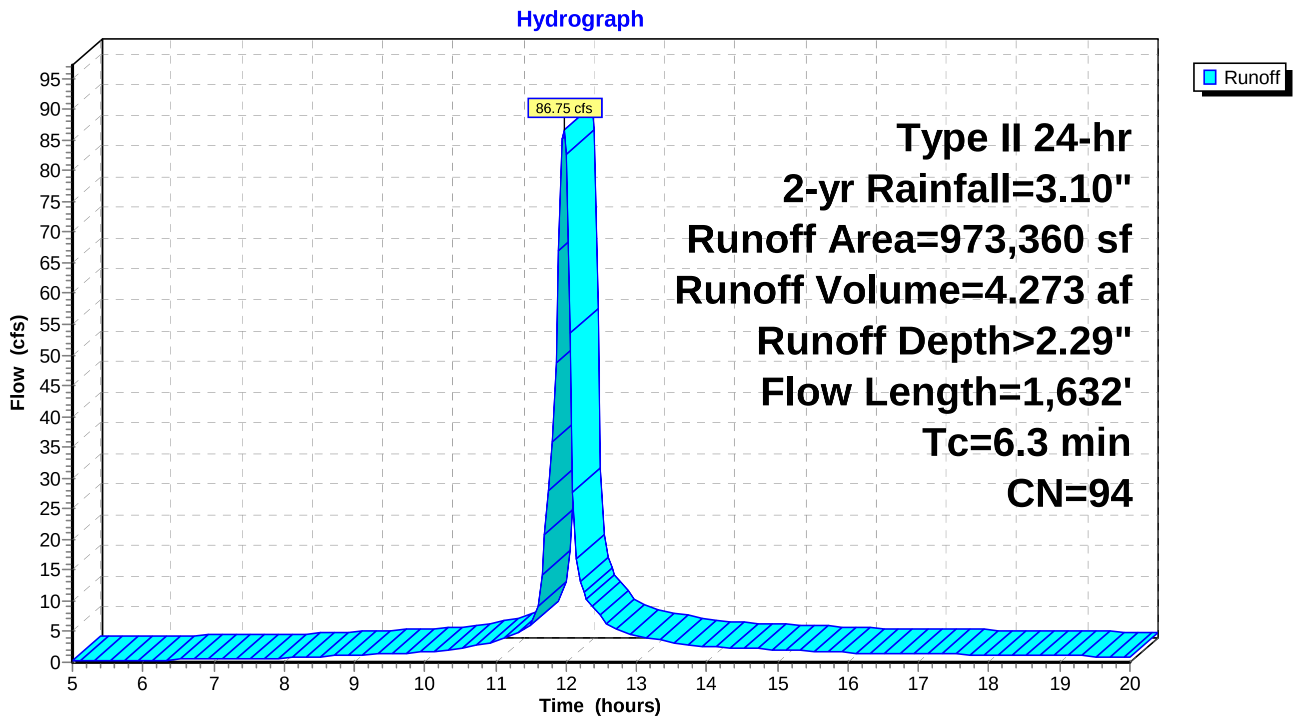
Runoff = 86.75 cfs @ 11.97 hrs, Volume= 4.273 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
973,360	94	Newly graded area, HSG D
973,360		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	100	0.0425	0.55		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.1	291	0.1870	4.32		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
2.1	1,241	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.3	1,632	Total			

Subcatchment PT-2: SB-PT-1



Summary for Subcatchment S-1: SB-OB-10

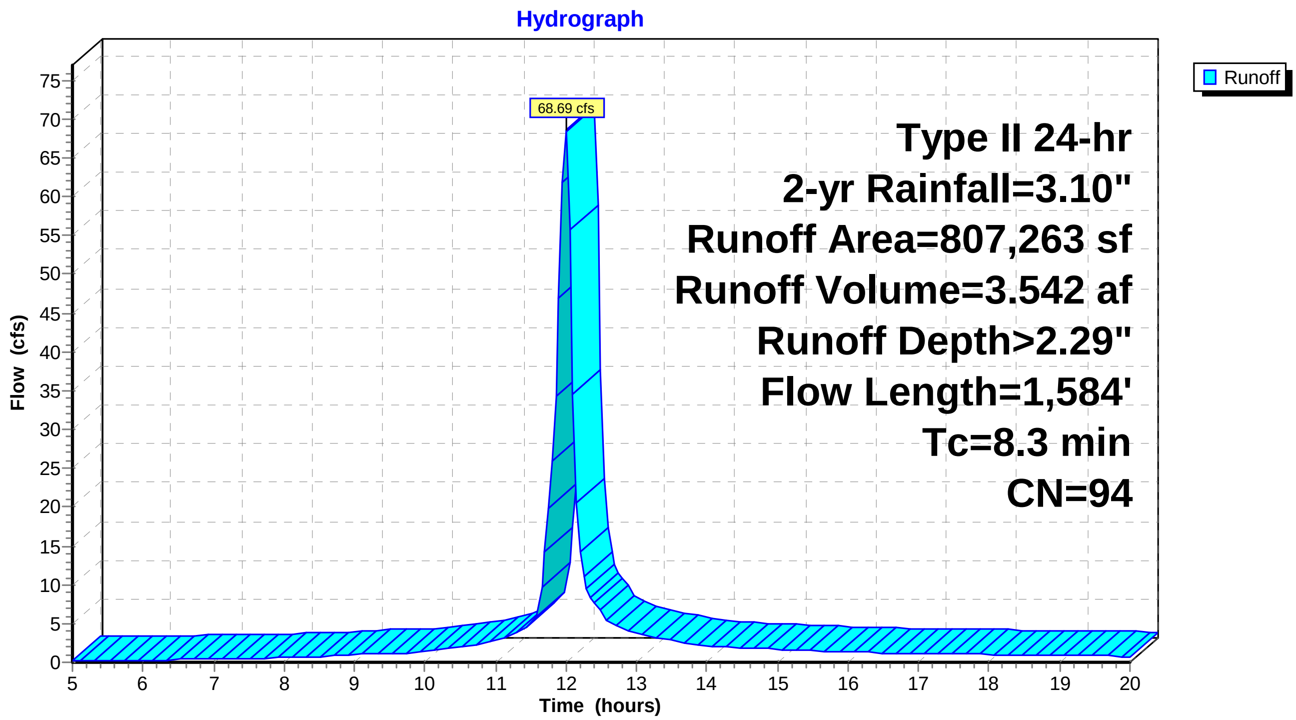
Runoff = 68.69 cfs @ 11.99 hrs, Volume= 3.542 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
807,263	94	Newly graded area, HSG D
807,263		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	100	0.1026	0.78		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
6.0	1,179	0.1090	3.30		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.2	305	0.1080	30.25	1,058.78	**Channel Flow,** Area= 35.0 sf Perim= 22.0' r= 1.59' n= 0.022
8.3	1,584	Total			

Subcatchment S-1: SB-OB-10



Summary for Subcatchment W-1: SB-OB-11

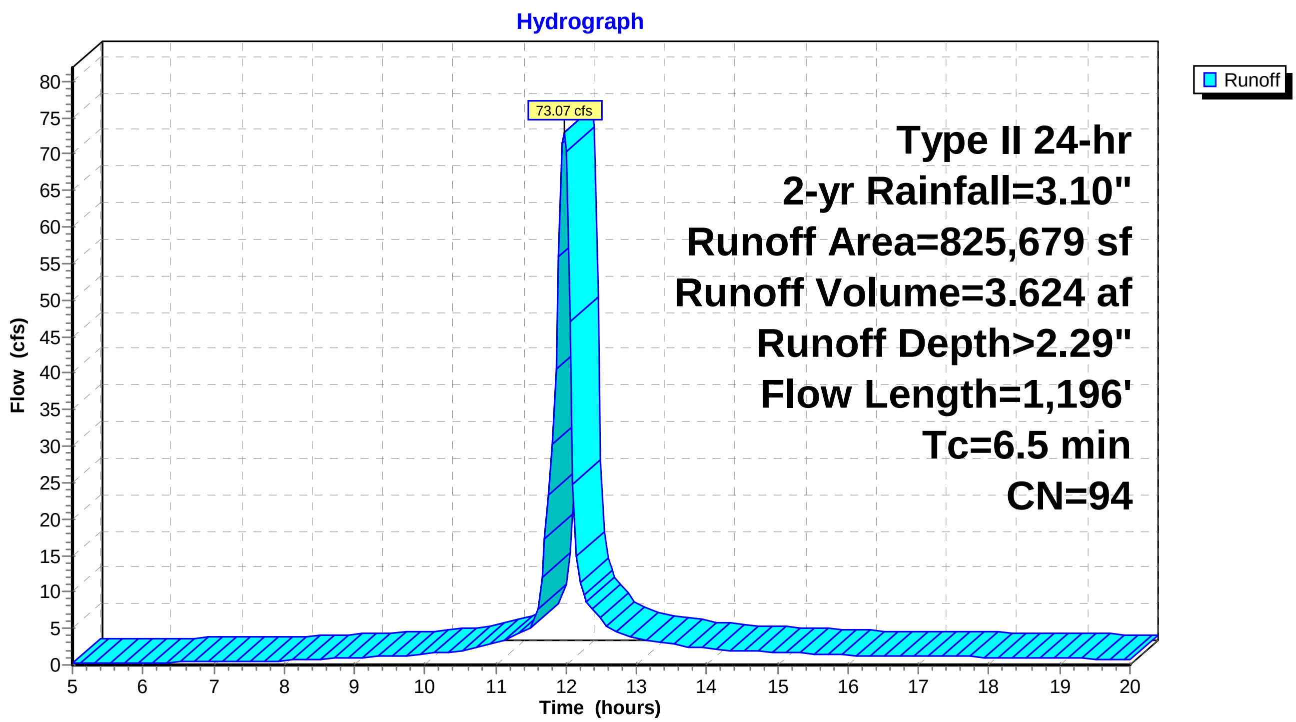
Runoff = 73.07 cfs @ 11.97 hrs, Volume= 3.624 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
825,679	94	Newly graded area, HSG D
825,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	100	0.0490	0.58		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.8	621	0.1400	3.74		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.8	475	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.5	1,196	Total			

Subcatchment W-1: SB-OB-11



Summary for Subcatchment W-2: SB-OB-12

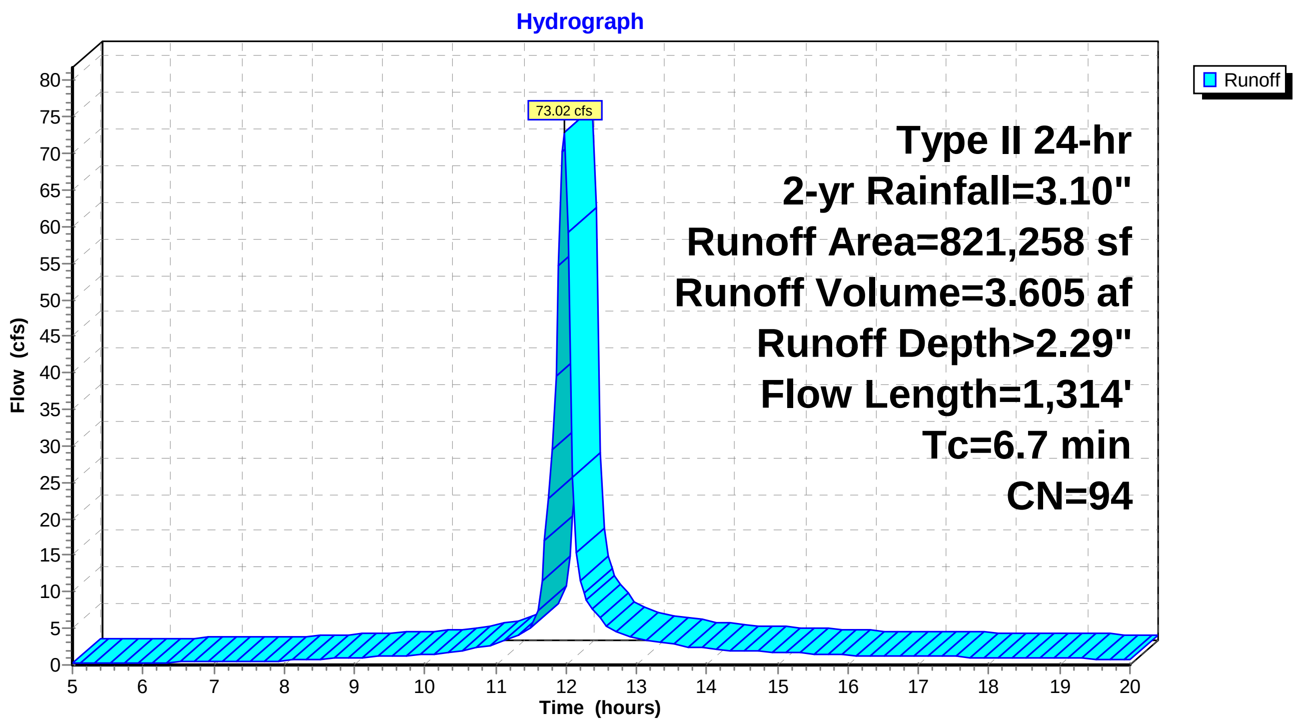
Runoff = 73.02 cfs @ 11.98 hrs, Volume= 3.605 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.10"

Area (sf)	CN	Description
821,258	94	Newly graded area, HSG D
821,258		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	100	0.0138	0.35		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.3	401	0.2700	5.20		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.6	813	0.0617	24.36	852.77	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.7	1,314	Total			

Subcatchment W-2: SB-OB-12



Summary for Pond E1: SB-OB-3

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =     15.606 ac,  0.00% Impervious,  Inflow Depth >  2.29"   for  2-yr event
Inflow      =     61.29 cfs @  11.96 hrs,  Volume=        2.984 af
Outflow     =      1.17 cfs @  11.05 hrs,  Volume=        1.032 af,  Atten= 98%,  Lag= 0.0 min
Primary     =      1.17 cfs @  11.05 hrs,  Volume=        1.032 af
Secondary   =      0.00 cfs @   5.00 hrs,  Volume=        0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.06' @ 15.82 hrs Surf.Area= 28,171 sf Storage= 89,599 cf

Plug-Flow detention time= 227.0 min calculated for 1.031 af (35% of inflow)
Center-of-Mass det. time= 124.3 min (876.3 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

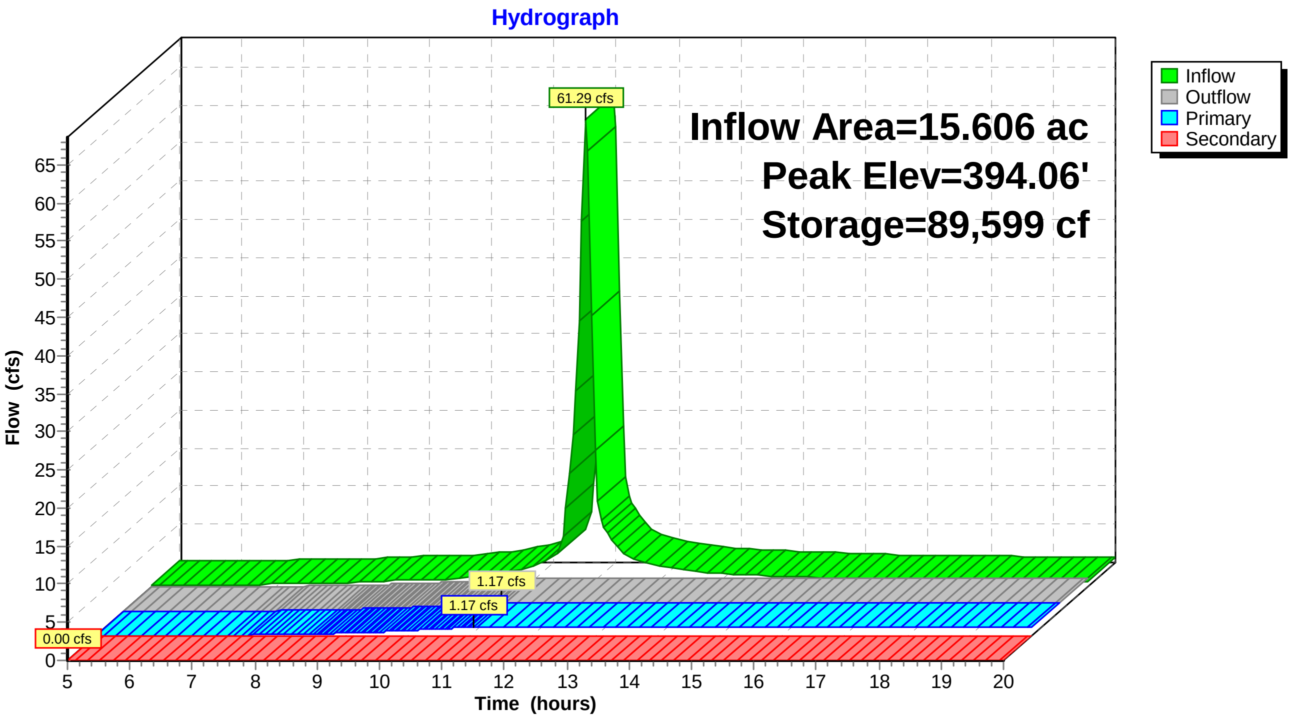
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.10'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 11.05 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.55 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1: SB-OB-3



Summary for Pond N1: SB-OB-6

[82] Warning: Early inflow requires earlier time span

Inflow Area =	21.258 ac,	0.00% Impervious, Inflow Depth >	2.29"	for 2-yr event
Inflow =	83.49 cfs @	11.96 hrs, Volume=	4.065 af	
Outflow =	1.17 cfs @	10.85 hrs, Volume=	1.041 af,	Atten= 99%, Lag= 0.0 min
Primary =	1.17 cfs @	10.85 hrs, Volume=	1.041 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.35' @ 18.00 hrs Surf.Area= 37,061 sf Storage= 132,920 cf

Plug-Flow detention time= 245.6 min calculated for 1.037 af (26% of inflow)
Center-of-Mass det. time= 122.2 min (874.1 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	390,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

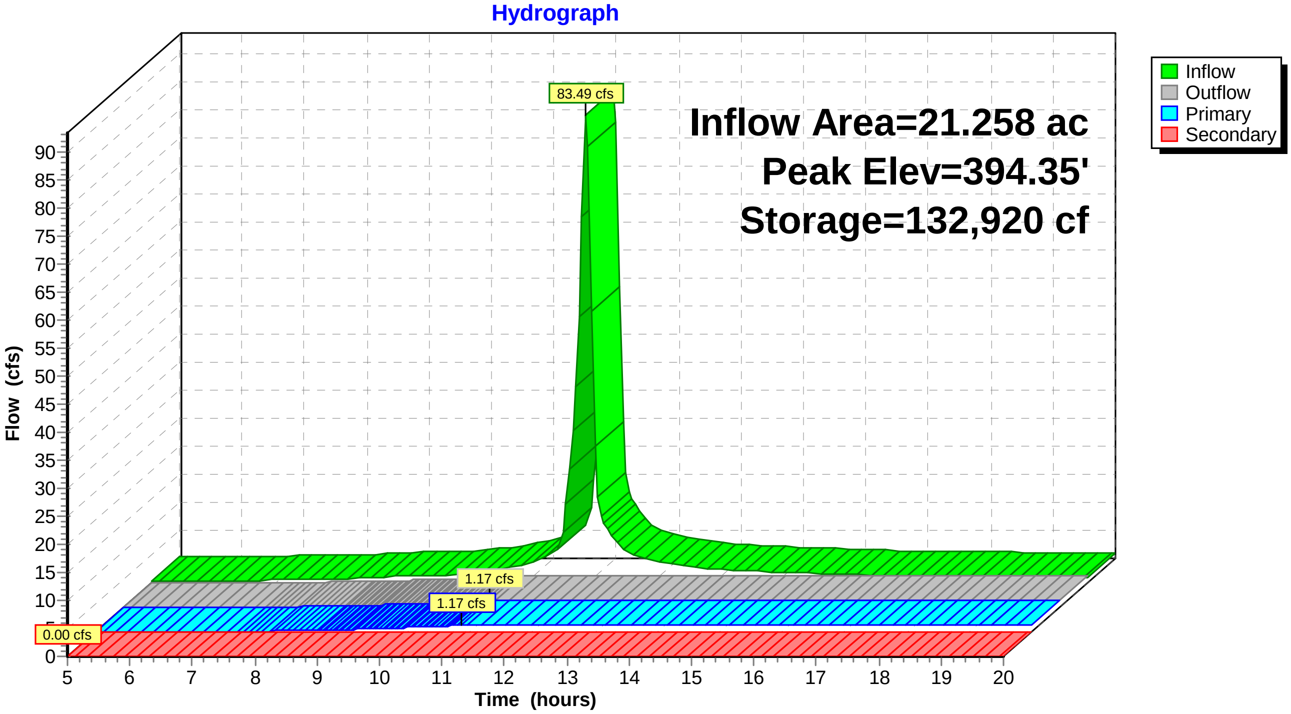
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	24,000	0	0
400.00	54,000	390,000	390,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.70'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 10.85 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.50 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N1: SB-OB-6



Summary for Pond N2: SB-OB-5

[82] Warning: Early inflow requires earlier time span

Inflow Area =	17.856 ac,	0.00% Impervious, Inflow Depth > 2.29"	for 2-yr event
Inflow =	70.13 cfs @ 11.96 hrs,	Volume=	3.415 af
Outflow =	1.17 cfs @ 10.90 hrs,	Volume=	1.044 af, Atten= 98%, Lag= 0.0 min
Primary =	1.17 cfs @ 10.90 hrs,	Volume=	1.044 af
Secondary =	0.00 cfs @ 5.00 hrs,	Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.33' @ 16.59 hrs Surf.Area= 30,993 sf Storage= 106,090 cf

Plug-Flow detention time= 230.9 min calculated for 1.040 af (30% of inflow)
Center-of-Mass det. time= 120.9 min (872.8 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

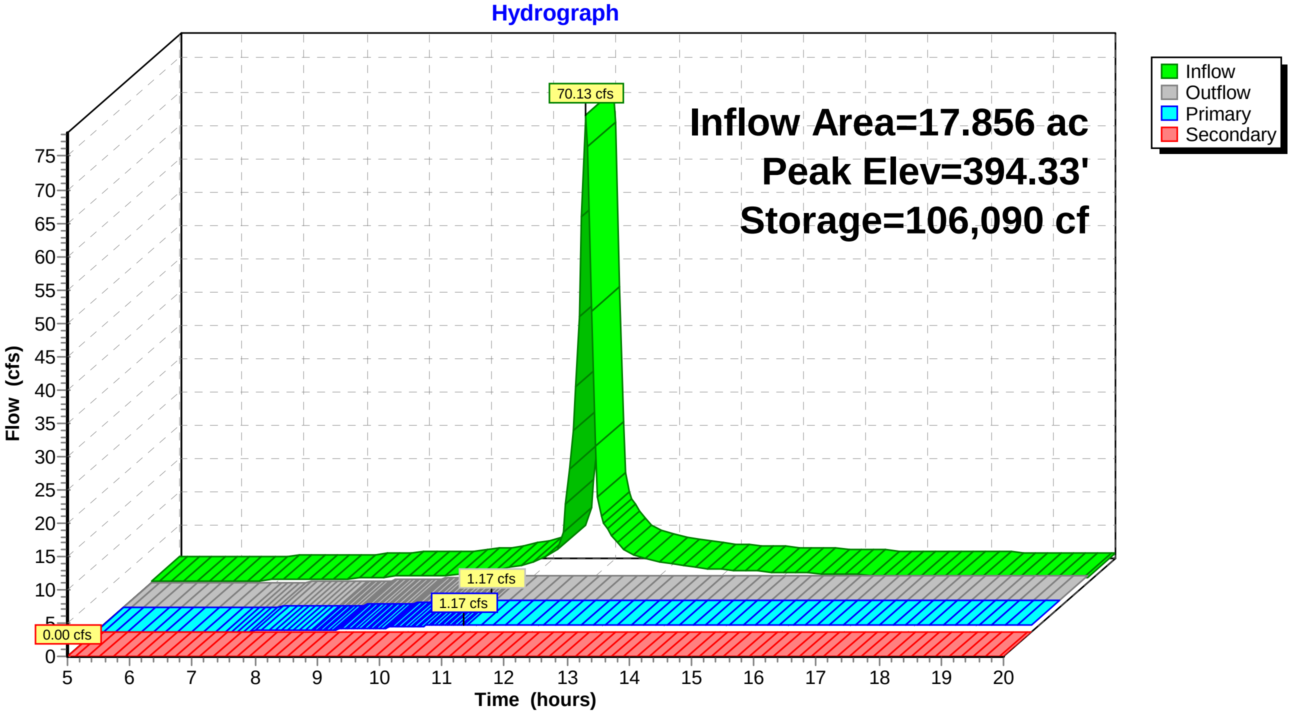
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 10.90 hrs HW=390.51' (Free Discharge)
↑—**2=Culvert** (Passes 1.17 cfs of 1.52 cfs potential flow)
  ↑—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N2: SB-OB-5



Summary for Pond N3: SB-OB-4

[82] Warning: Early inflow requires earlier time span

Inflow Area = 13.206 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 51.86 cfs @ 11.96 hrs, Volume= 2.525 af
Outflow = 1.17 cfs @ 11.05 hrs, Volume= 1.037 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 11.05 hrs, Volume= 1.037 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.15' @ 15.16 hrs Surf.Area= 23,464 sf Storage= 71,591 cf

Plug-Flow detention time= 213.4 min calculated for 1.034 af (41% of inflow)
Center-of-Mass det. time= 122.0 min (873.9 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	260,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

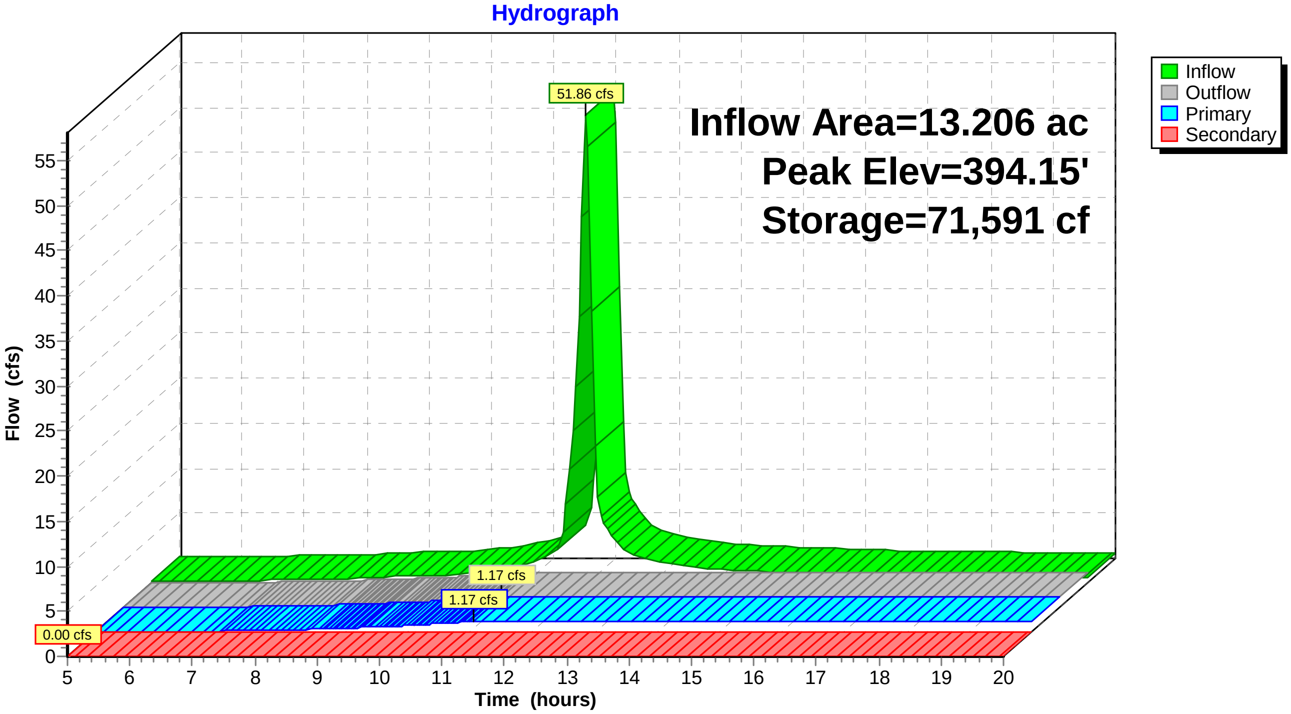
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	11,000	0	0
400.00	41,000	260,000	260,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 11.05 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.50 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N3: SB-OB-4



Summary for Pond NW1: SB-OB-7

[82] Warning: Early inflow requires earlier time span

Inflow Area = 16.857 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 62.68 cfs @ 11.99 hrs, Volume= 3.222 af
Outflow = 1.17 cfs @ 11.00 hrs, Volume= 1.030 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 11.00 hrs, Volume= 1.030 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.10' @ 16.14 hrs Surf.Area= 30,295 sf Storage= 98,963 cf

Plug-Flow detention time= 231.2 min calculated for 1.030 af (32% of inflow)
Center-of-Mass det. time= 123.3 min (877.0 - 753.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

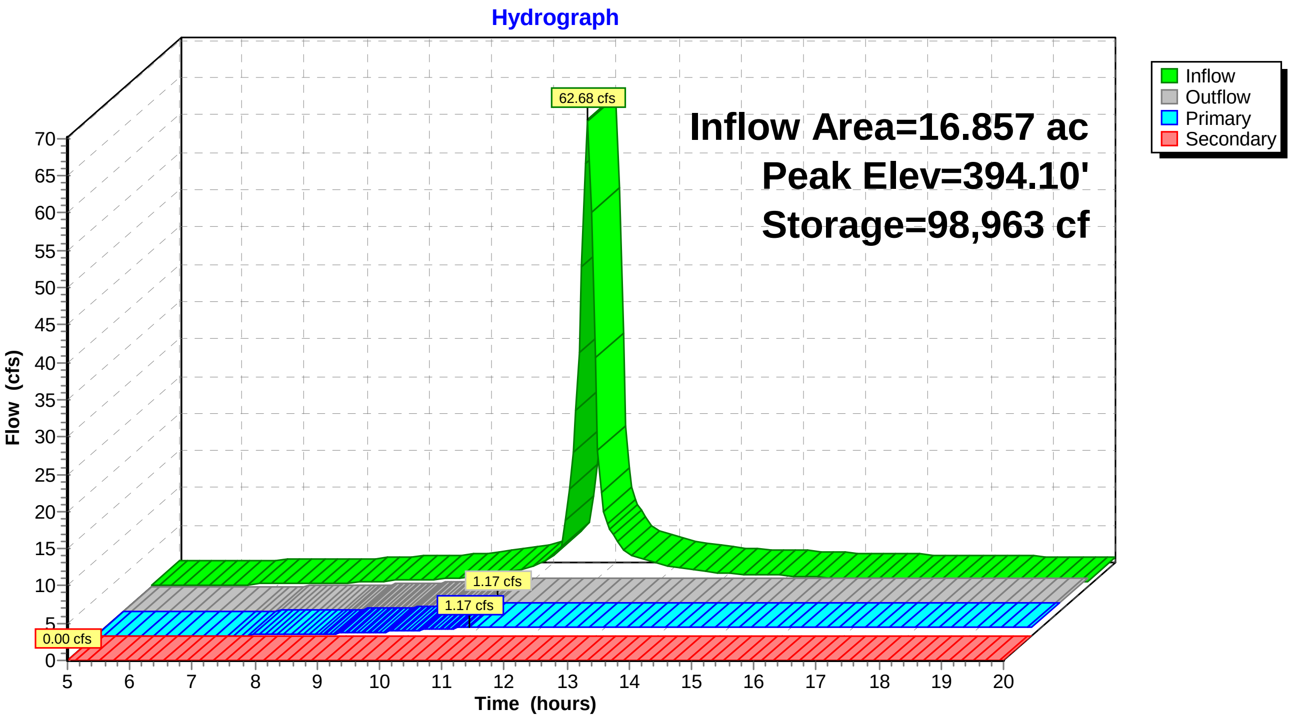
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 11.00 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.48 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond NW1: SB-OB-7



Summary for Pond P1: SB-P-8

[82] Warning: Early inflow requires earlier time span

Inflow Area = 15.460 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 57.48 cfs @ 11.99 hrs, Volume= 2.955 af
Outflow = 1.17 cfs @ 11.05 hrs, Volume= 1.027 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 11.05 hrs, Volume= 1.027 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.02' @ 15.82 hrs Surf.Area= 28,062 sf Storage= 88,581 cf

Plug-Flow detention time= 226.4 min calculated for 1.027 af (35% of inflow)
Center-of-Mass det. time= 124.0 min (877.7 - 753.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

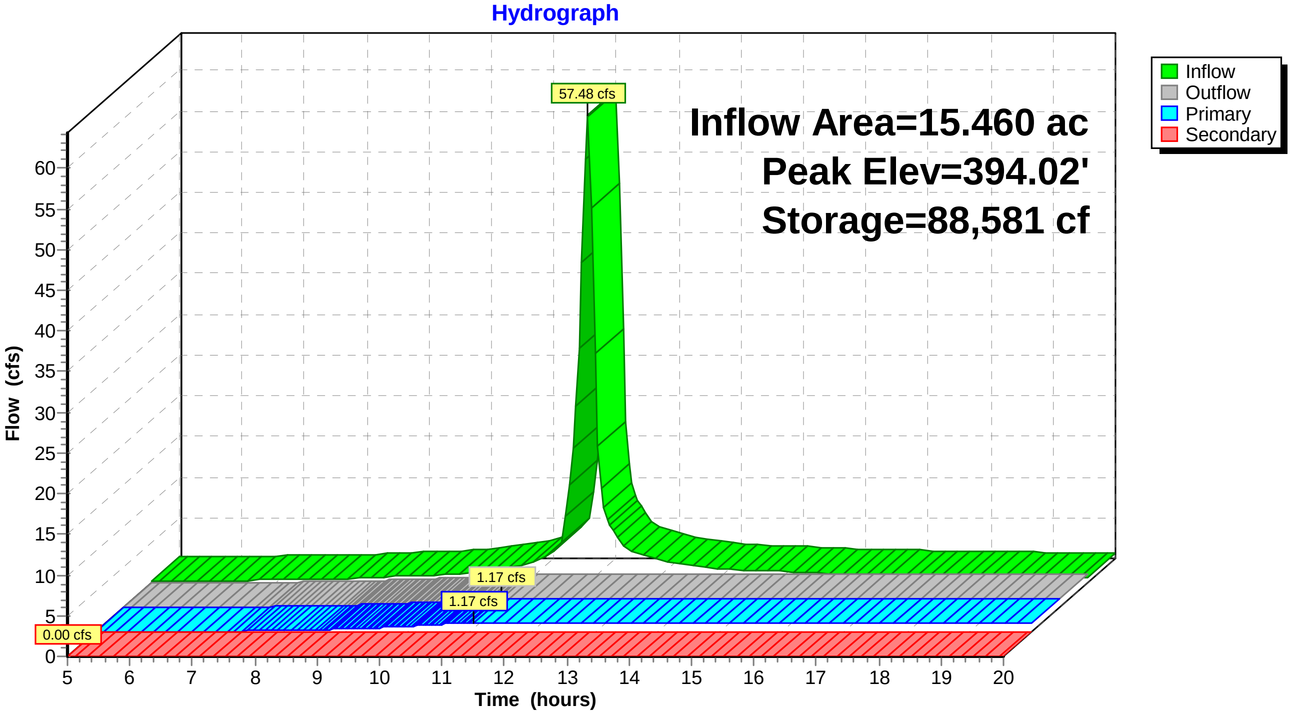
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 11.05 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.48 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1: SB-P-8


Hydrograph
57.48 cfs
Inflow Area=15.460 ac
Peak Elev=394.02'
Storage=88,581 cf
Inflow
Outflow
Primary
Secondary
1.17 cfs
1.17 cfs
0.00 cfs
Flow (cfs)
0
5
10
15
20
25
30
35
40
45
50
55
60
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Time (hours)

Summary for Pond P2: SB-P-2

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      47.459 ac,   0.00% Impervious,  Inflow Depth >   2.29"    for  2-yr event
Inflow      =    172.51 cfs @   12.00 hrs,  Volume=          9.070 af
Outflow     =      2.34 cfs @   11.55 hrs,  Volume=          1.881 af,  Atten= 99%,  Lag= 0.0 min
Primary     =      2.34 cfs @   11.55 hrs,  Volume=          1.881 af
Secondary   =      0.00 cfs @    5.00 hrs,  Volume=          0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 393.93' @ 18.81 hrs Surf.Area= 85,795 sf Storage= 314,121 cf

Plug-Flow detention time= 293.1 min calculated for 1.874 af (21% of inflow)
Center-of-Mass det. time= 151.3 min (905.5 - 754.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	890,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

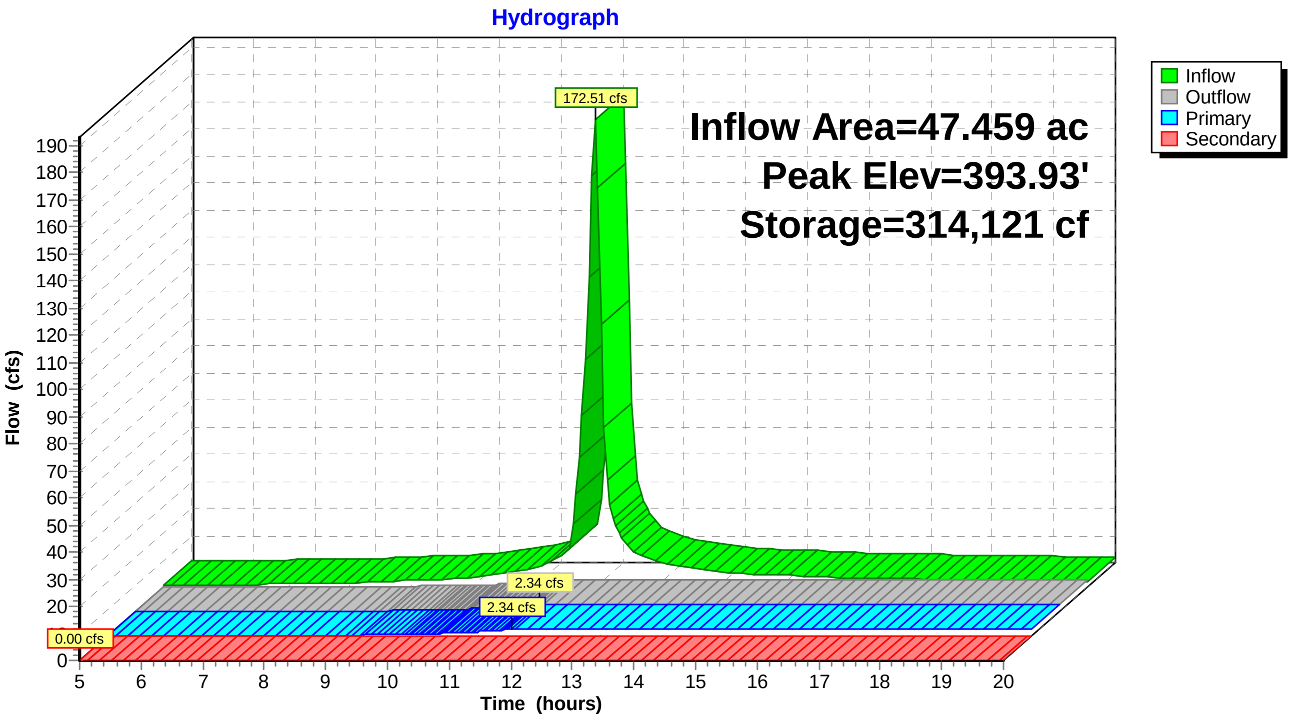
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	74,000	0	0
400.00	104,000	890,000	890,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.34 cfs @ 11.55 hrs HW=390.72' (Free Discharge)
└─**2=Culvert** (Passes 2.34 cfs of 2.95 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P2: SB-P-2


Hydrograph
172.51 cfs
Inflow Area=47.459 ac
Peak Elev=393.93'
Storage=314,121 cf
2.34 cfs
2.34 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
Time (hours)
0
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Summary for Pond PT1: SB-PT-9

[82] Warning: Early inflow requires earlier time span

Inflow Area = 42.536 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 160.99 cfs @ 11.98 hrs, Volume= 8.132 af
Outflow = 2.34 cfs @ 11.50 hrs, Volume= 1.885 af, Atten= 99%, Lag= 0.0 min
Primary = 2.34 cfs @ 11.50 hrs, Volume= 1.885 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 393.87' @ 18.03 hrs Surf.Area= 76,625 sf Storage= 274,395 cf

Plug-Flow detention time= 283.4 min calculated for 1.878 af (23% of inflow)
Center-of-Mass det. time= 151.6 min (904.8 - 753.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	800,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

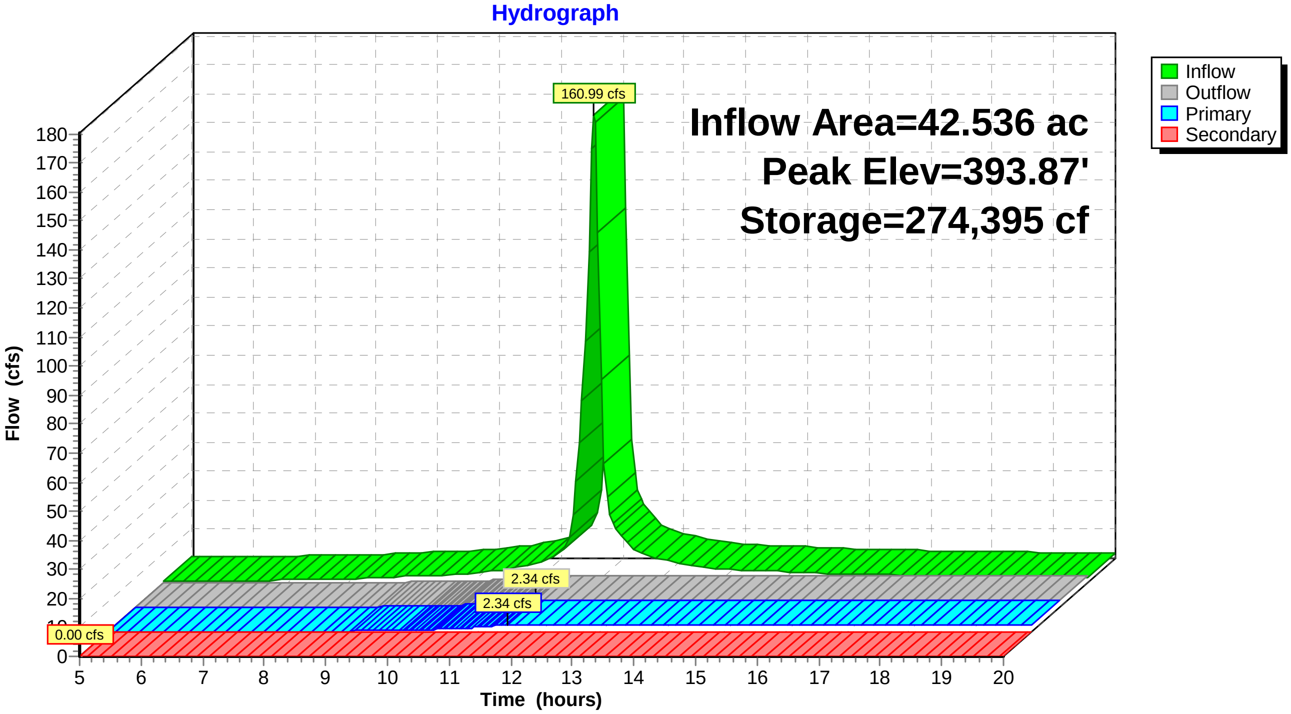
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	65,000	0	0
400.00	95,000	800,000	800,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.30'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.34 cfs @ 11.50 hrs HW=390.70' (Free Discharge)
└─**2=Culvert** (Passes 2.34 cfs of 2.80 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT1: SB-PT-9



Summary for Pond PT2: SB-PT-1

[82] Warning: Early inflow requires earlier time span

Inflow Area = 22.345 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 86.75 cfs @ 11.97 hrs, Volume= 4.273 af
Outflow = 1.17 cfs @ 10.95 hrs, Volume= 1.028 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 10.95 hrs, Volume= 1.028 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.15' @ 18.36 hrs Surf.Area= 40,459 sf Storage= 142,157 cf

Plug-Flow detention time= 254.3 min calculated for 1.025 af (24% of inflow)
Center-of-Mass det. time= 125.8 min (878.0 - 752.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	430,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

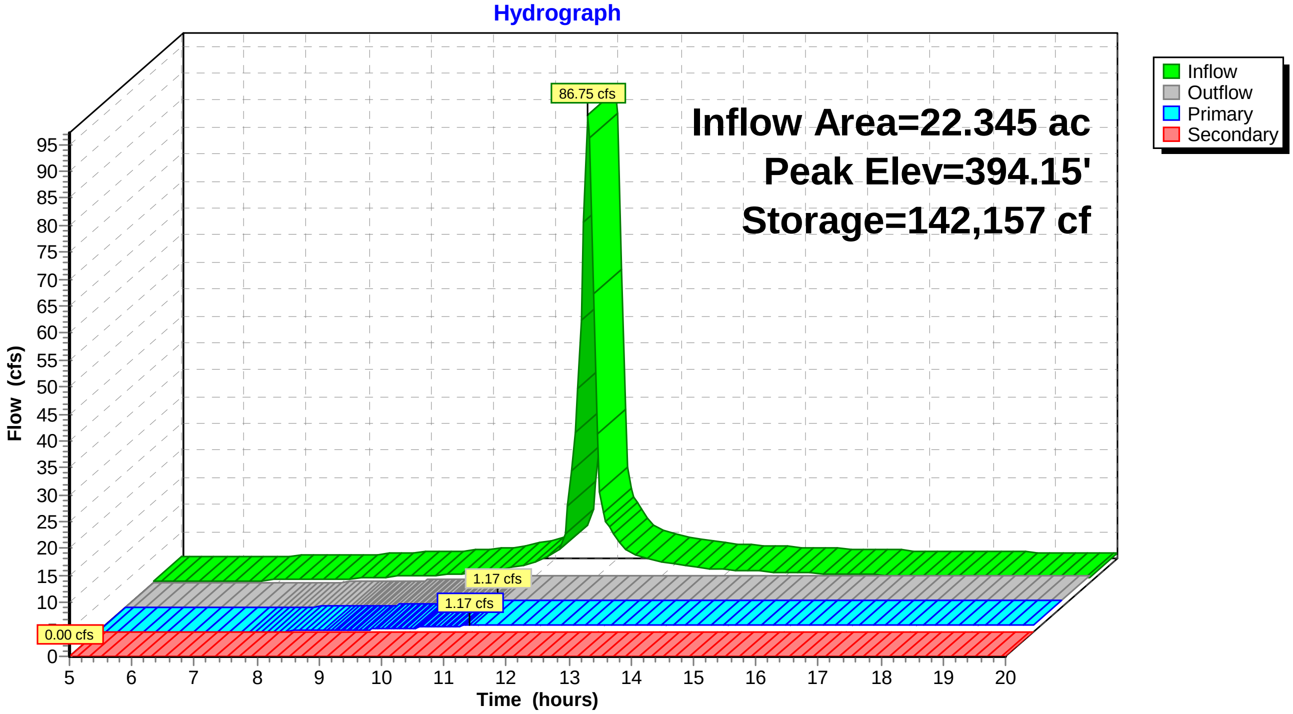
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	28,000	0	0
400.00	58,000	430,000	430,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 10.95 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.54 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT2: SB-PT-1



Summary for Pond S1: SB-OB-10

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.532 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 68.69 cfs @ 11.99 hrs, Volume= 3.542 af
Outflow = 1.17 cfs @ 10.85 hrs, Volume= 1.048 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 10.85 hrs, Volume= 1.048 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.49' @ 16.95 hrs Surf.Area= 31,464 sf Storage= 110,993 cf

Plug-Flow detention time= 230.2 min calculated for 1.044 af (29% of inflow)
Center-of-Mass det. time= 117.8 min (871.5 - 753.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

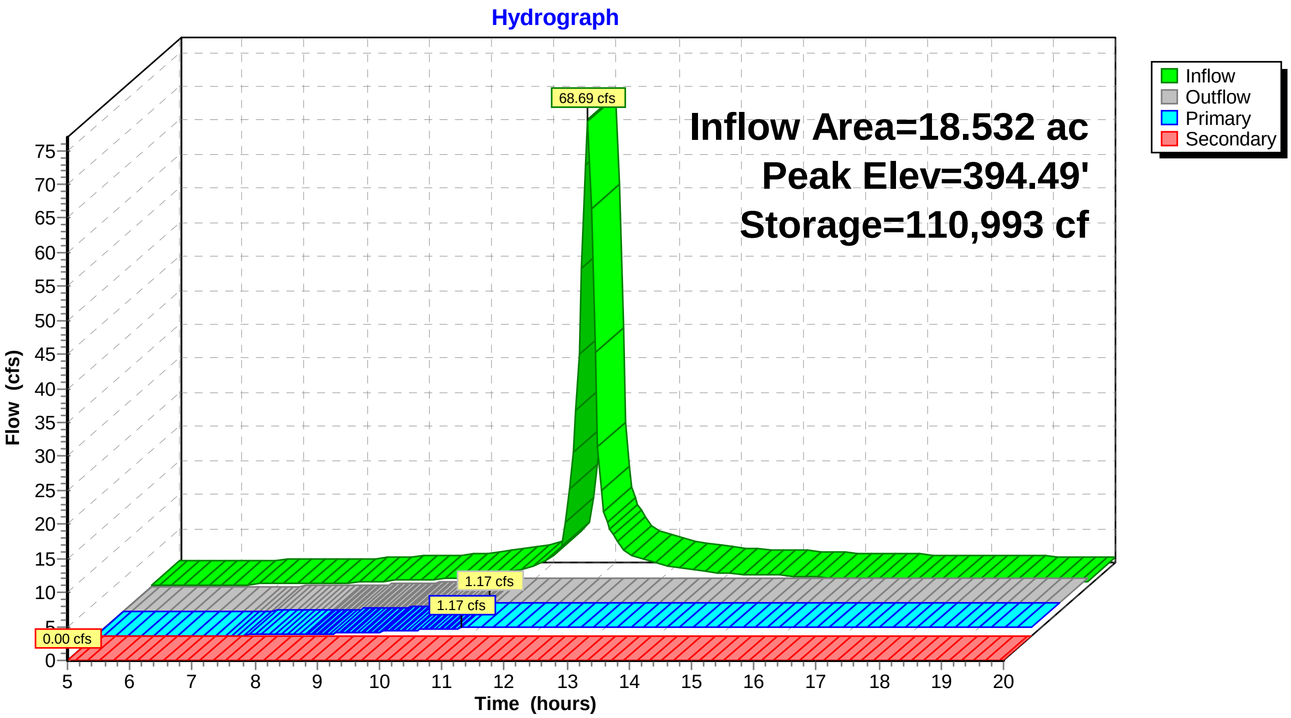
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.80'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 10.85 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.49 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S1: SB-OB-10



Summary for Pond W1: SB-OB-11

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.955 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 73.07 cfs @ 11.97 hrs, Volume= 3.624 af
Outflow = 1.17 cfs @ 10.90 hrs, Volume= 1.042 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 10.90 hrs, Volume= 1.042 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 394.33' @ 17.11 hrs Surf.Area= 32,984 sf Storage= 114,657 cf

Plug-Flow detention time= 235.7 min calculated for 1.038 af (29% of inflow)
Center-of-Mass det. time= 121.2 min (873.6 - 752.3)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	350,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

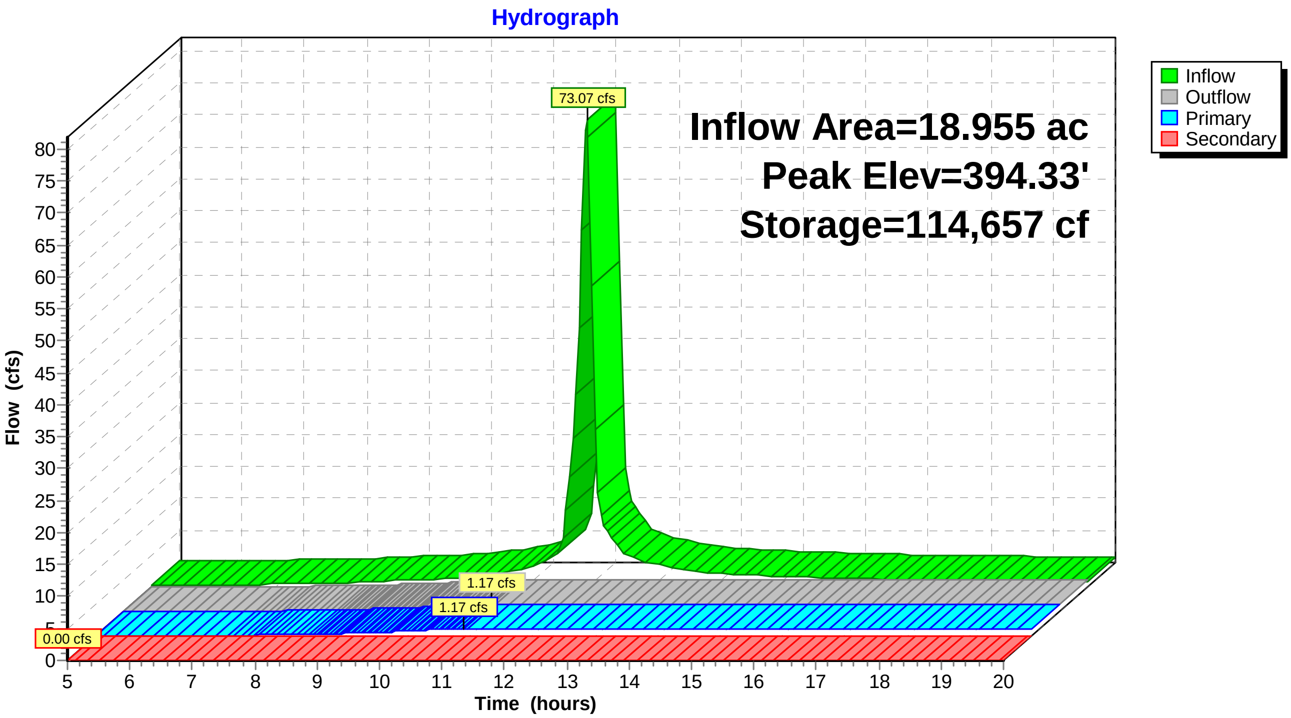
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	20,000	0	0
400.00	50,000	350,000	350,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.60'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 10.90 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.53 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1: SB-OB-11



Summary for Pond W2: SB-OB-12

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.853 ac, 0.00% Impervious, Inflow Depth > 2.29" for 2-yr event
Inflow = 73.02 cfs @ 11.98 hrs, Volume= 3.605 af
Outflow = 1.17 cfs @ 11.20 hrs, Volume= 1.001 af, Atten= 98%, Lag= 0.0 min
Primary = 1.17 cfs @ 11.20 hrs, Volume= 1.001 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 393.57' @ 17.07 hrs Surf.Area= 37,721 sf Storage= 115,646 cf

Plug-Flow detention time= 251.7 min calculated for 1.000 af (28% of inflow)
Center-of-Mass det. time= 133.8 min (886.3 - 752.5)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	420,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

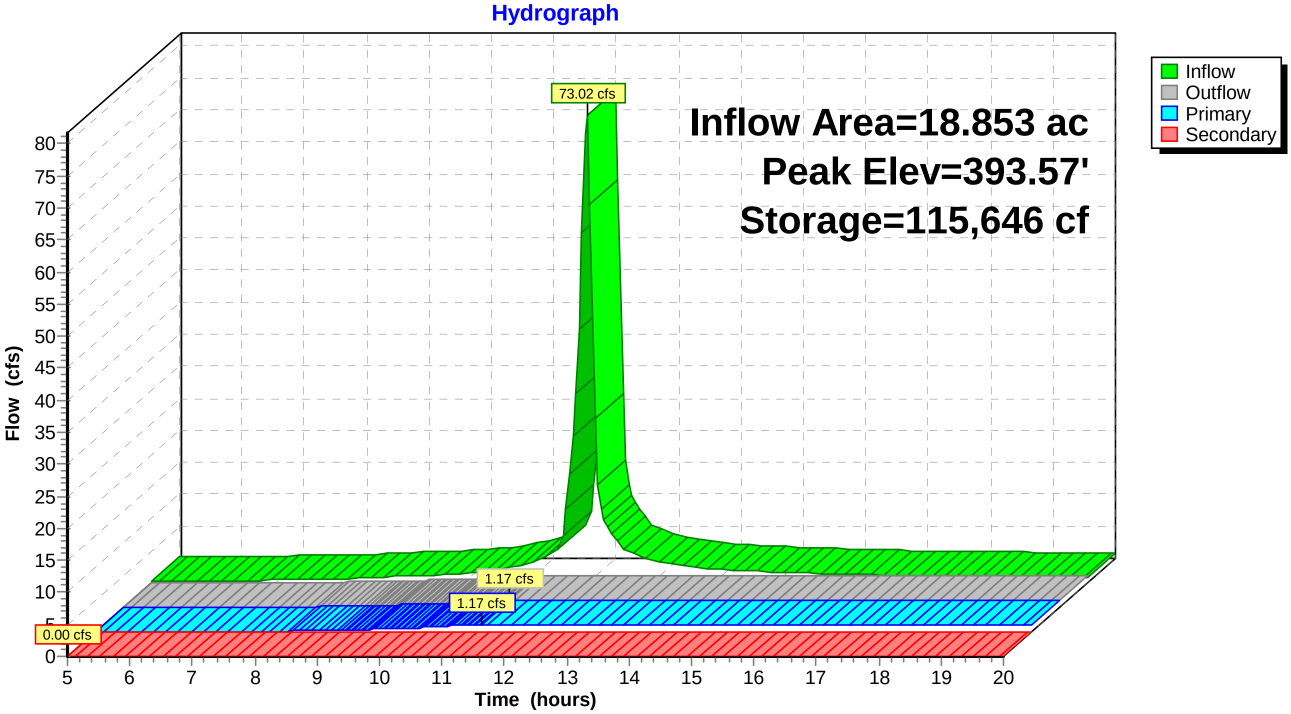
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	27,000	0	0
400.00	57,000	420,000	420,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	396.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 11.20 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.56 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2: SB-OB-12



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: SB-OB-3 Runoff Area=679,818 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,439' Tc=6.0 min CN=94 Runoff=108.51 cfs 5.476 af

Subcatchment N-1: SB-OB-6 Runoff Area=926,011 sf 0.00% Impervious Runoff Depth>4.21"
Tc=6.0 min CN=94 Runoff=147.81 cfs 7.460 af

Subcatchment N-2: SB-OB-5 Runoff Area=777,820 sf 0.00% Impervious Runoff Depth>4.21"
Tc=6.0 min CN=94 Runoff=124.16 cfs 6.266 af

Subcatchment N-3: SB-OB-4 Runoff Area=575,239 sf 0.00% Impervious Runoff Depth>4.21"
Tc=6.0 min CN=94 Runoff=91.82 cfs 4.634 af

Subcatchment NW-1: SB-OB-7 Runoff Area=734,304 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,210' Tc=8.2 min CN=94 Runoff=111.03 cfs 5.914 af

Subcatchment P1-1: SB-P-8 Runoff Area=673,438 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,455' Tc=8.2 min CN=94 Runoff=101.82 cfs 5.423 af

Subcatchment P2-1: SB-P-2 Runoff Area=2,067,328 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=2,346' Tc=8.9 min CN=94 Runoff=305.79 cfs 16.647 af

Subcatchment PT-1: SB-PT-9 Runoff Area=1,852,884 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,128' Tc=7.6 min CN=94 Runoff=285.00 cfs 14.923 af

Subcatchment PT-2: SB-PT-1 Runoff Area=973,360 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,632' Tc=6.3 min CN=94 Runoff=153.61 cfs 7.841 af

Subcatchment S-1: SB-OB-10 Runoff Area=807,263 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,584' Tc=8.3 min CN=94 Runoff=121.69 cfs 6.501 af

Subcatchment W-1: SB-OB-11 Runoff Area=825,679 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,196' Tc=6.5 min CN=94 Runoff=129.39 cfs 6.651 af

Subcatchment W-2: SB-OB-12 Runoff Area=821,258 sf 0.00% Impervious Runoff Depth>4.21"
Flow Length=1,314' Tc=6.7 min CN=94 Runoff=127.81 cfs 6.615 af

Pond E1: SB-OB-3 Peak Elev=397.00' Storage=185,389 cf Inflow=108.51 cfs 5.476 af
Primary=1.17 cfs 1.223 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.223 af

Pond N1: SB-OB-6 Peak Elev=397.65' Storage=271,329 cf Inflow=147.81 cfs 7.460 af
Primary=1.17 cfs 1.230 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.230 af

Pond N2: SB-OB-5 Peak Elev=397.49' Storage=219,159 cf Inflow=124.16 cfs 6.266 af
Primary=1.17 cfs 1.234 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.234 af

Pond N3: SB-OB-4 Peak Elev=396.96' Storage=149,080 cf Inflow=91.82 cfs 4.634 af
Primary=1.17 cfs 1.229 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.229 af

Pond NW1: SB-OB-7 Peak Elev=397.12' Storage=204,382 cf Inflow=111.03 cfs 5.914 af
Primary=1.17 cfs 1.222 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.222 af

Pond P1: SB-P-8 Peak Elev=396.94' Storage=183,253 cf Inflow=101.82 cfs 5.423 af
Primary=1.17 cfs 1.219 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.219 af

Pond P2: SB-P-2 Peak Elev=397.37' Storage=626,998 cf Inflow=305.79 cfs 16.647 af
Primary=2.34 cfs 2.251 af Secondary=0.00 cfs 0.000 af Outflow=2.34 cfs 2.251 af

Pond PT1: SB-PT-9 Peak Elev=397.27' Storage=551,803 cf Inflow=285.00 cfs 14.923 af
Primary=2.34 cfs 2.254 af Secondary=0.00 cfs 0.000 af Outflow=2.34 cfs 2.254 af

Pond PT2: SB-PT-1 Peak Elev=397.38' Storage=288,462 cf Inflow=153.61 cfs 7.841 af
Primary=1.17 cfs 1.218 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.218 af

Pond S1: SB-OB-10 Peak Elev=397.74' Storage=229,178 cf Inflow=121.69 cfs 6.501 af
Primary=1.17 cfs 1.240 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.240 af

Pond W1: SB-OB-11 Peak Elev=397.54' Storage=236,025 cf Inflow=129.39 cfs 6.651 af
Primary=1.17 cfs 1.232 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.232 af

Pond W2: SB-OB-12 Peak Elev=396.44' Storage=236,300 cf Inflow=127.81 cfs 6.615 af
Primary=1.17 cfs 1.190 af Secondary=0.00 cfs 0.000 af Outflow=1.17 cfs 1.190 af

Total Runoff Area = 268.926 ac Runoff Volume = 94.350 af Average Runoff Depth = 4.21"
100.00% Pervious = 268.926 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E-1: SB-OB-3

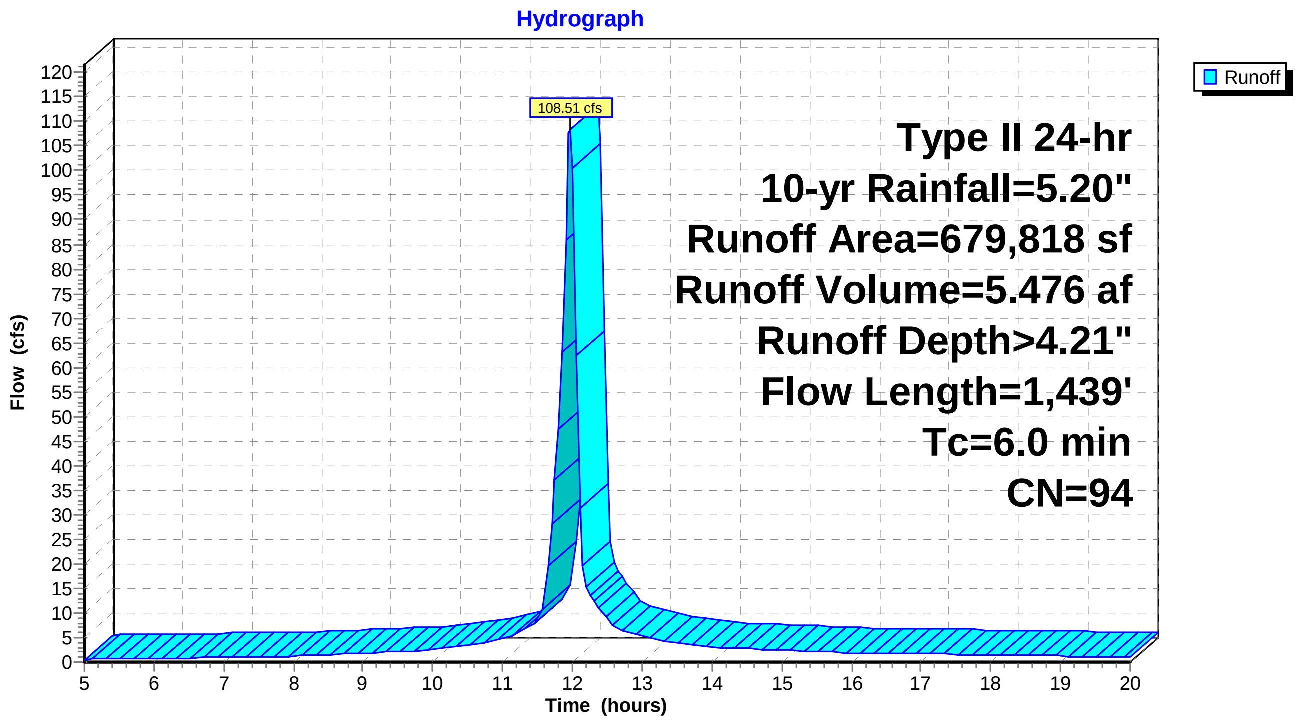
Runoff = 108.51 cfs @ 11.96 hrs, Volume= 5.476 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
679,818	94	Newly graded area, HSG D
679,818		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	100	0.0683	0.66		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.5	608	0.1660	4.07		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.0	731	0.0140	11.61	406.21	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.0	1,439	Total			

Subcatchment E-1: SB-OB-3



Summary for Subcatchment N-1: SB-OB-6

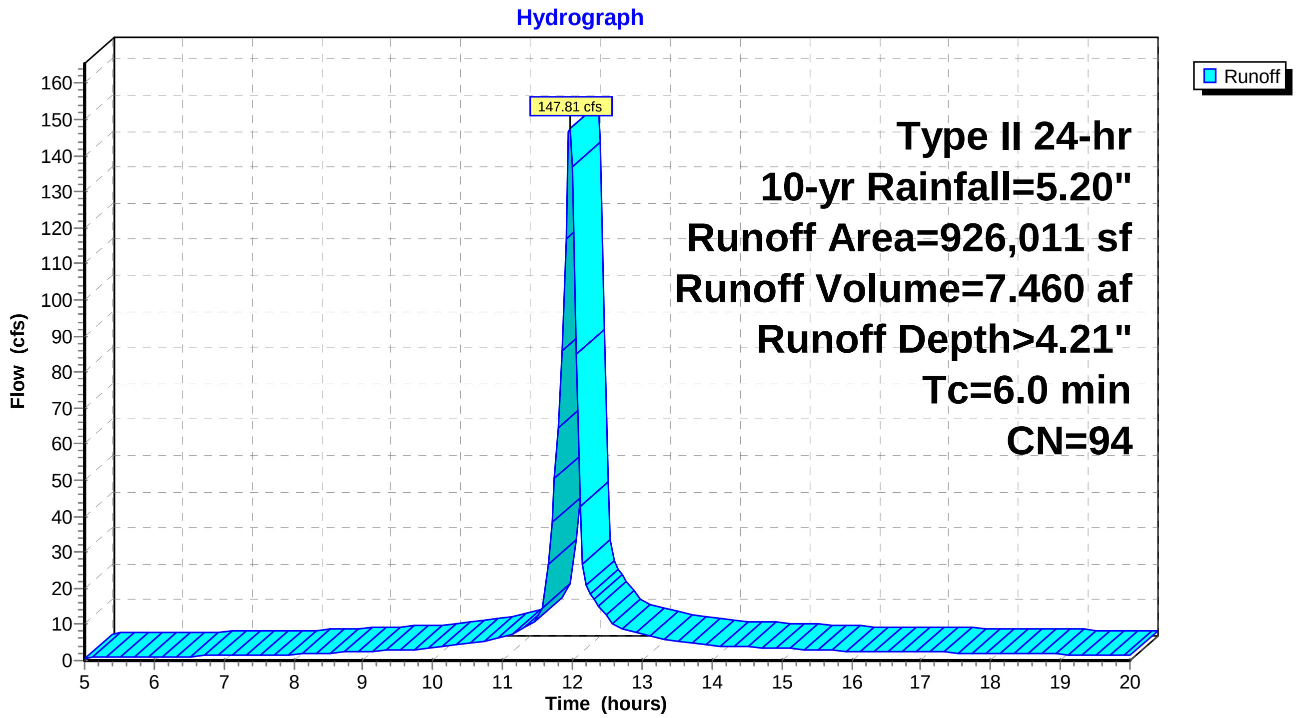
Runoff = 147.81 cfs @ 11.96 hrs, Volume= 7.460 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
926,011	94	Newly graded area, HSG D
926,011		100.00% Pervious Area

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

Subcatchment N-1: SB-OB-6



Summary for Subcatchment N-2: SB-OB-5

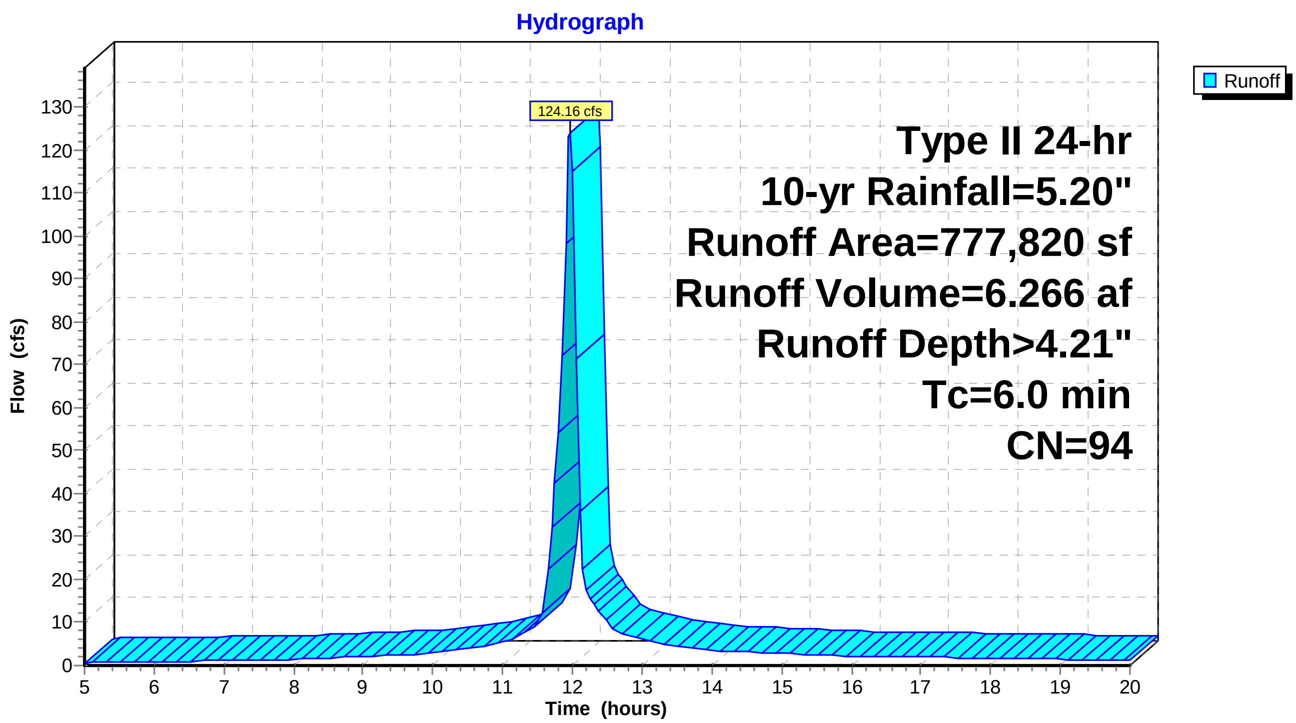
Runoff = 124.16 cfs @ 11.96 hrs, Volume= 6.266 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
777,820	94	Newly graded area, HSG D
777,820		100.00% Pervious Area

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

Subcatchment N-2: SB-OB-5



Summary for Subcatchment N-3: SB-OB-4

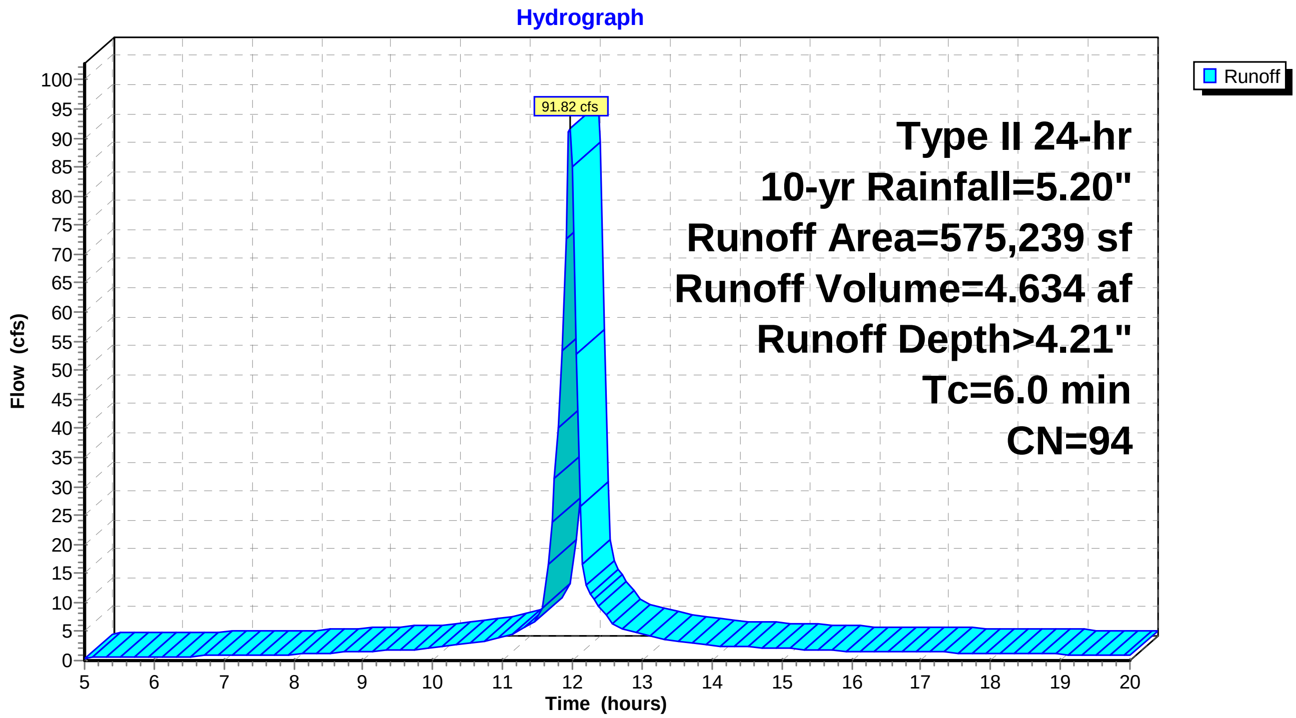
Runoff = 91.82 cfs @ 11.96 hrs, Volume= 4.634 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
575,239	94	Newly graded area, HSG D
575,239		100.00% Pervious Area

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

Subcatchment N-3: SB-OB-4



Summary for Subcatchment NW-1: SB-OB-7

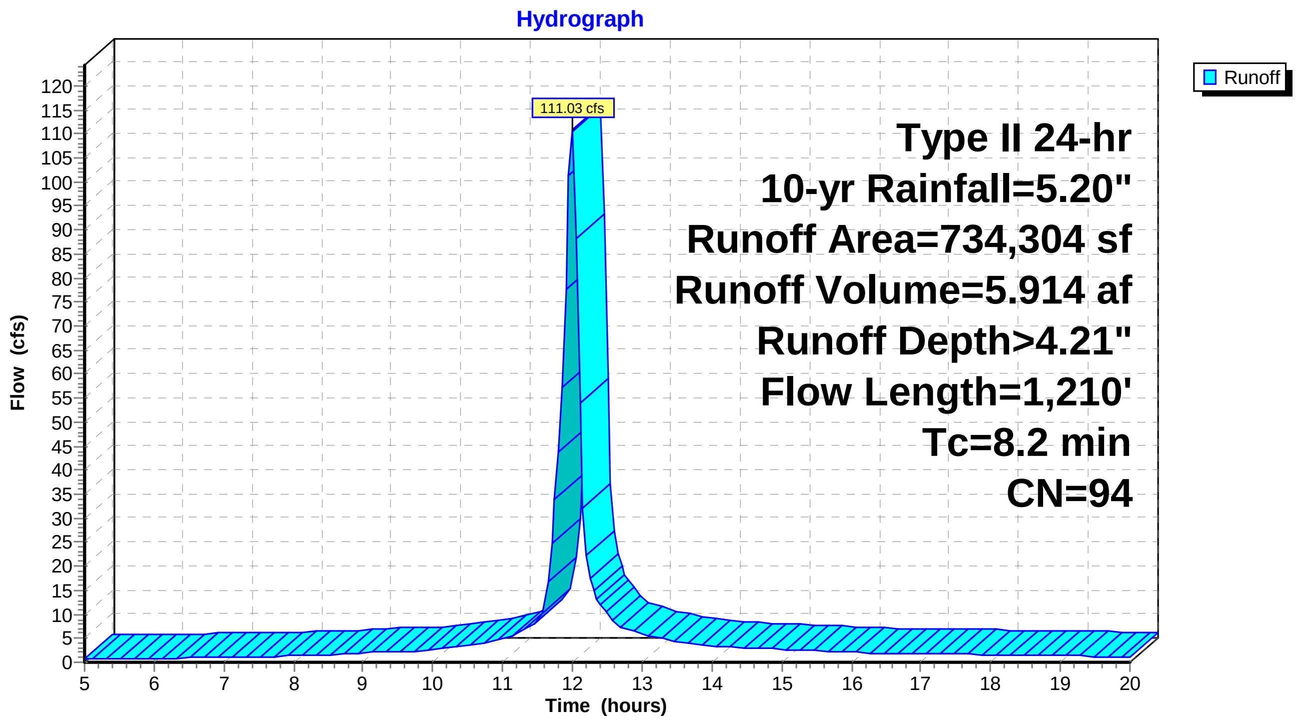
Runoff = 111.03 cfs @ 11.99 hrs, Volume= 5.914 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
734,304	94	Newly graded area, HSG D
734,304		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.0206	0.41		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
3.2	674	0.1225	3.50		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.9	436	0.0072	8.32	291.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,210	Total			

Subcatchment NW-1: SB-OB-7



Summary for Subcatchment P1-1: SB-P-8

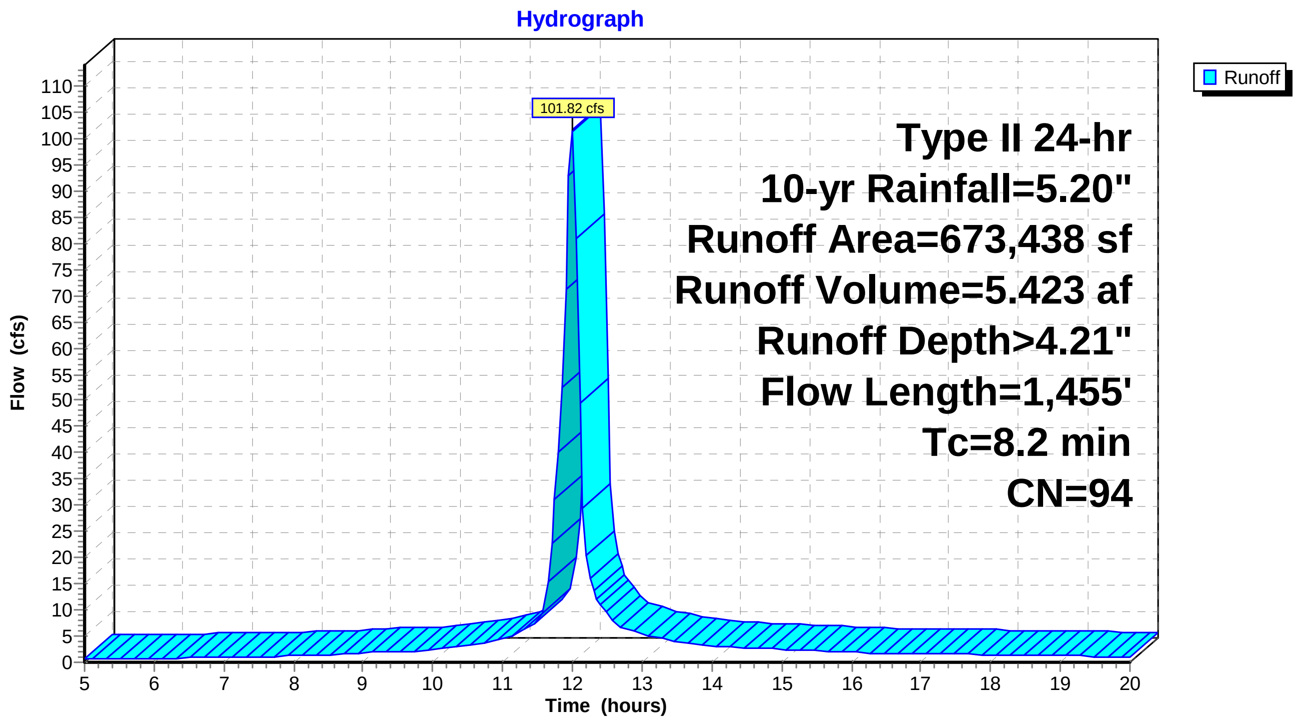
Runoff = 101.82 cfs @ 11.99 hrs, Volume= 5.423 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
673,438	94	Newly graded area, HSG D
673,438		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	100	0.0293	0.47		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.3	866	0.1150	3.39		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.4	489	0.0357	18.53	648.67	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,455	Total			

Subcatchment P1-1: SB-P-8



Summary for Subcatchment P2-1: SB-P-2

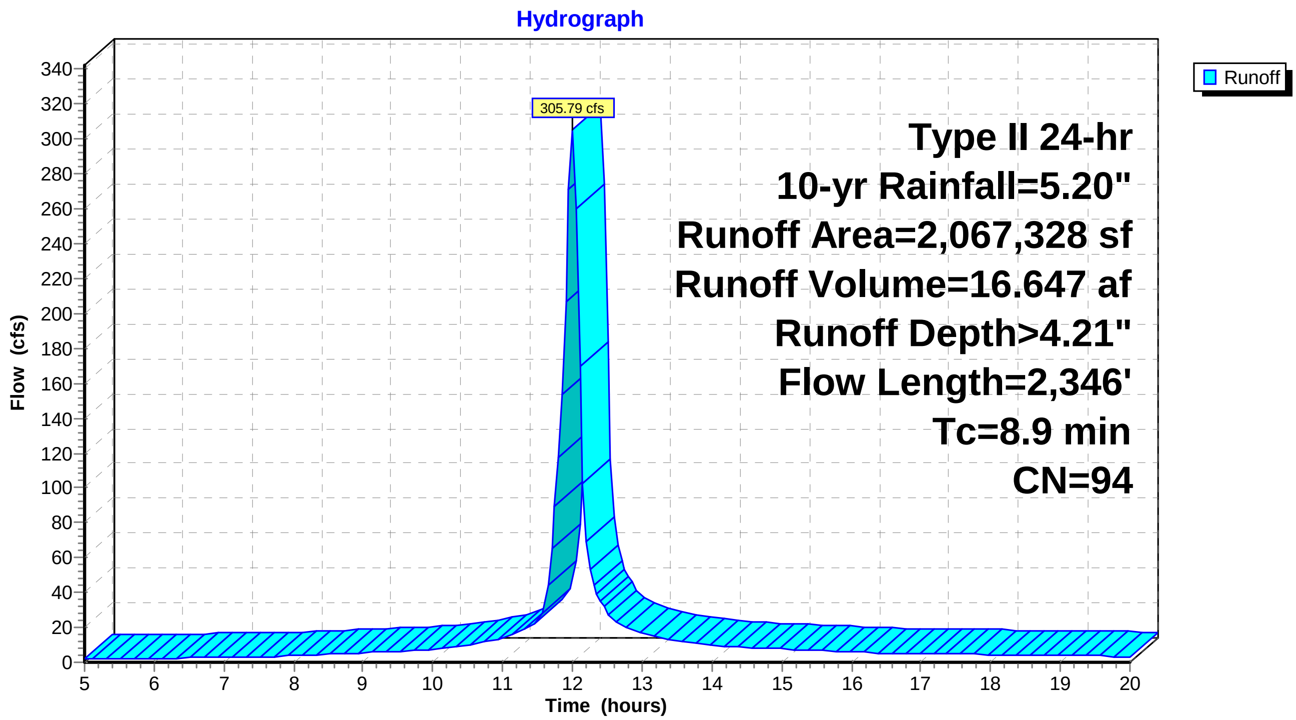
Runoff = 305.79 cfs @ 12.00 hrs, Volume= 16.647 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
2,067,328	94	Newly graded area, HSG D
2,067,328		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0607	0.63		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.5	918	0.1131	3.36		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.7	1,328	0.0180	13.16	460.60	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.9	2,346	Total			

Subcatchment P2-1: SB-P-2



Summary for Subcatchment PT-1: SB-PT-9

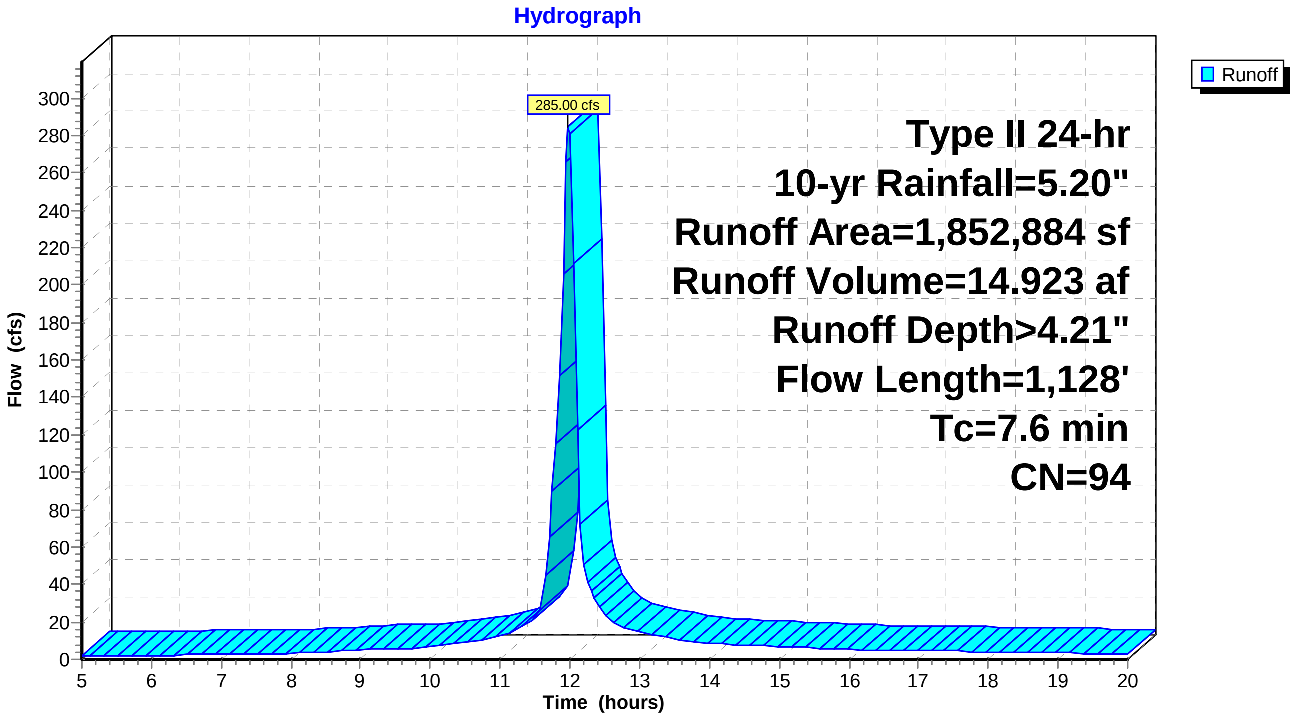
Runoff = 285.00 cfs @ 11.98 hrs, Volume= 14.923 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
1,852,884	94	Newly graded area, HSG D
1,852,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0589	0.62		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.9	1,028	0.1230	3.51		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
7.6	1,128	Total			

Subcatchment PT-1: SB-PT-9



Summary for Subcatchment PT-2: SB-PT-1

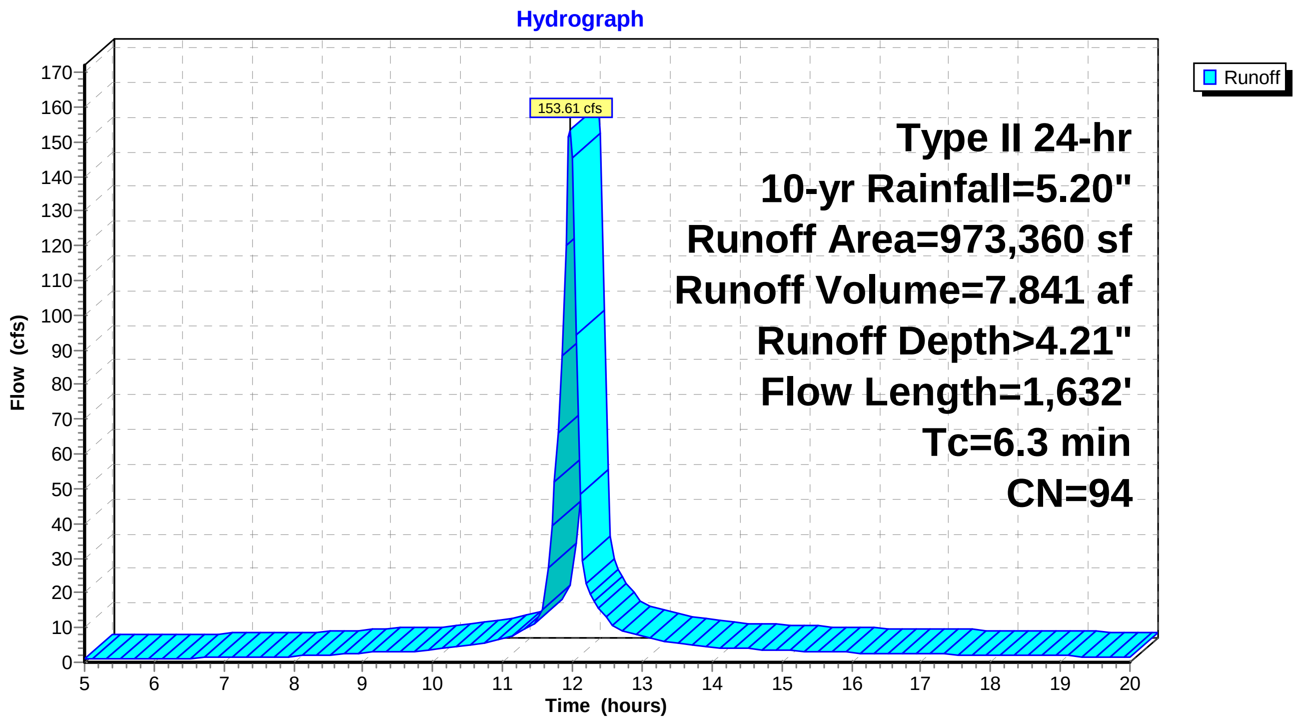
Runoff = 153.61 cfs @ 11.97 hrs, Volume= 7.841 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
973,360	94	Newly graded area, HSG D
973,360		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	100	0.0425	0.55		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.1	291	0.1870	4.32		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
2.1	1,241	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.3	1,632	Total			

Subcatchment PT-2: SB-PT-1



Summary for Subcatchment S-1: SB-OB-10

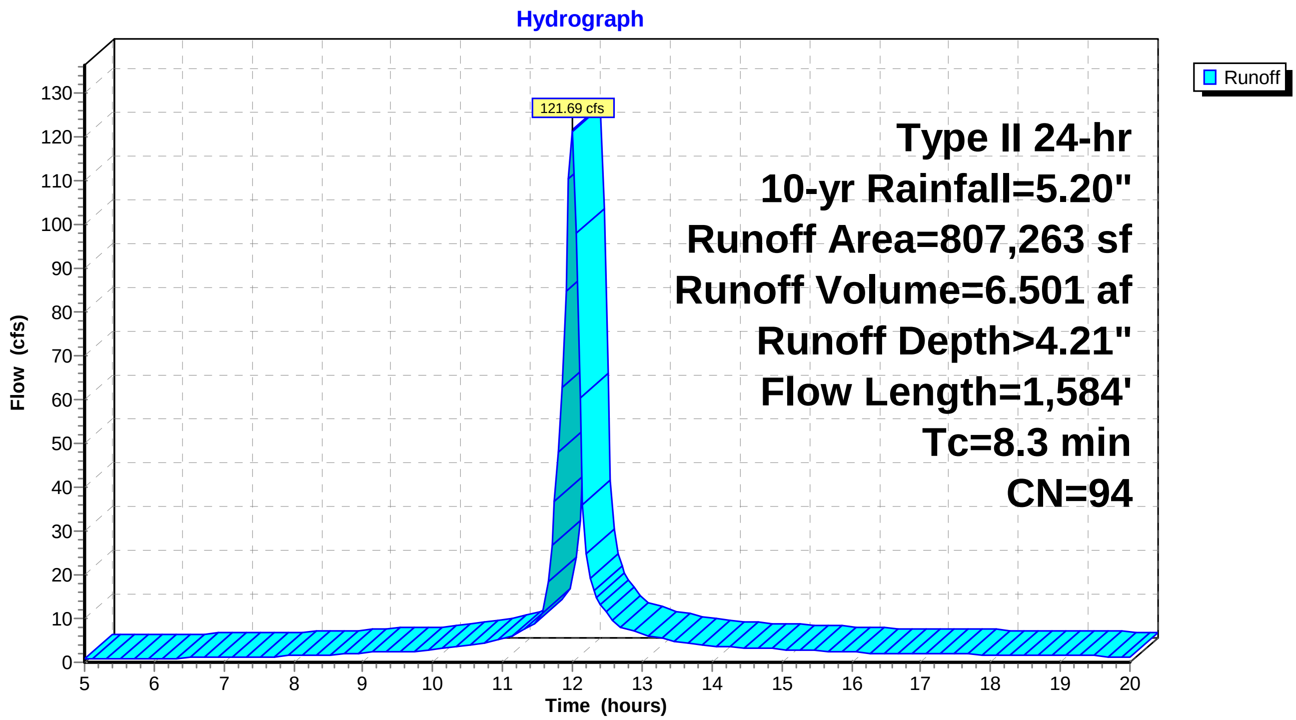
Runoff = 121.69 cfs @ 11.99 hrs, Volume= 6.501 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
807,263	94	Newly graded area, HSG D
807,263		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	100	0.1026	0.78		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
6.0	1,179	0.1090	3.30		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.2	305	0.1080	30.25	1,058.78	**Channel Flow,** Area= 35.0 sf Perim= 22.0' r= 1.59' n= 0.022
8.3	1,584	Total			

Subcatchment S-1: SB-OB-10



Summary for Subcatchment W-1: SB-OB-11

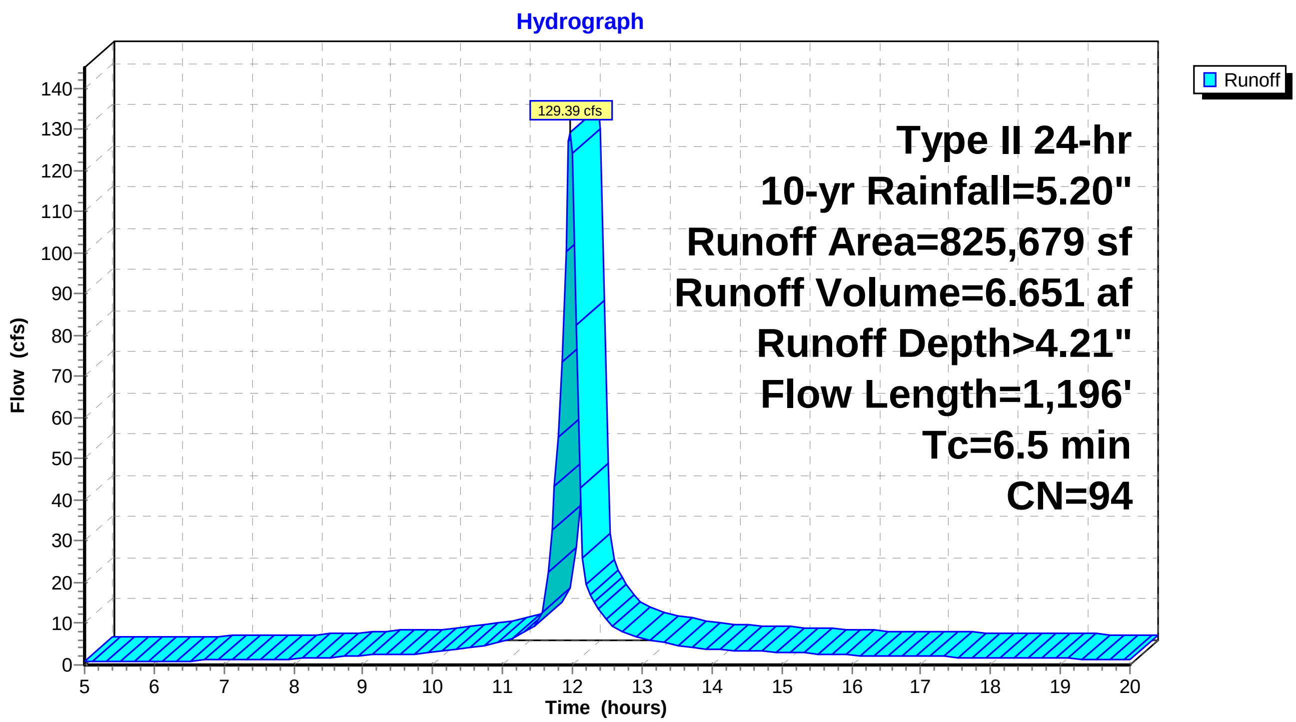
Runoff = 129.39 cfs @ 11.97 hrs, Volume= 6.651 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
825,679	94	Newly graded area, HSG D
825,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	100	0.0490	0.58		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.8	621	0.1400	3.74		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.8	475	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.5	1,196	Total			

Subcatchment W-1: SB-OB-11



Summary for Subcatchment W-2: SB-OB-12

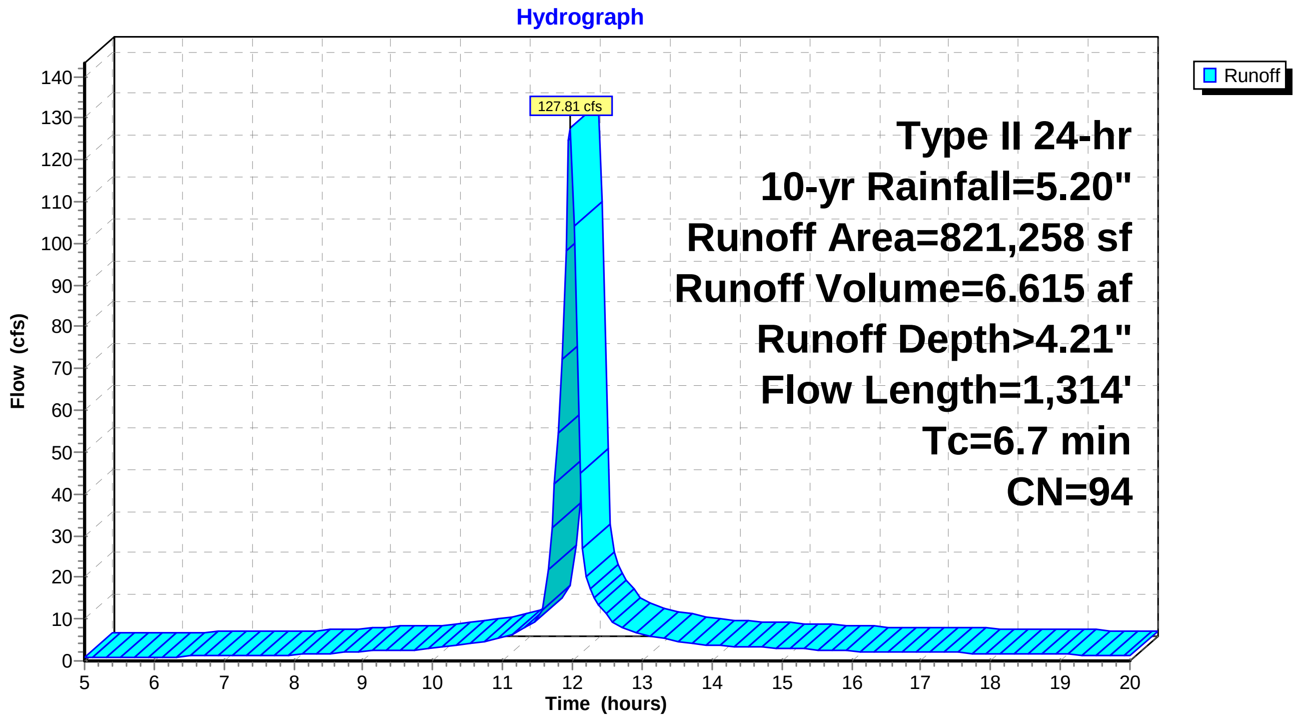
Runoff = 127.81 cfs @ 11.97 hrs, Volume= 6.615 af, Depth> 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.20"

Area (sf)	CN	Description
821,258	94	Newly graded area, HSG D
821,258		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	100	0.0138	0.35		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.3	401	0.2700	5.20		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.6	813	0.0617	24.36	852.77	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.7	1,314	Total			

Subcatchment W-2: SB-OB-12



Summary for Pond E1: SB-OB-3

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =     15.606 ac,  0.00% Impervious,  Inflow Depth >  4.21"   for  10-yr event
Inflow      =   108.51 cfs @  11.96 hrs,  Volume=        5.476 af
Outflow     =     1.17 cfs @   9.15 hrs,  Volume=        1.223 af,  Atten= 99%,  Lag= 0.0 min
Primary     =     1.17 cfs @   9.15 hrs,  Volume=        1.223 af
Secondary   =     0.00 cfs @   5.00 hrs,  Volume=        0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.00' @ 19.50 hrs Surf.Area= 36,991 sf Storage= 185,389 cf

Plug-Flow detention time= 230.5 min calculated for 1.217 af (22% of inflow)
Center-of-Mass det. time= 77.6 min (819.1 - 741.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

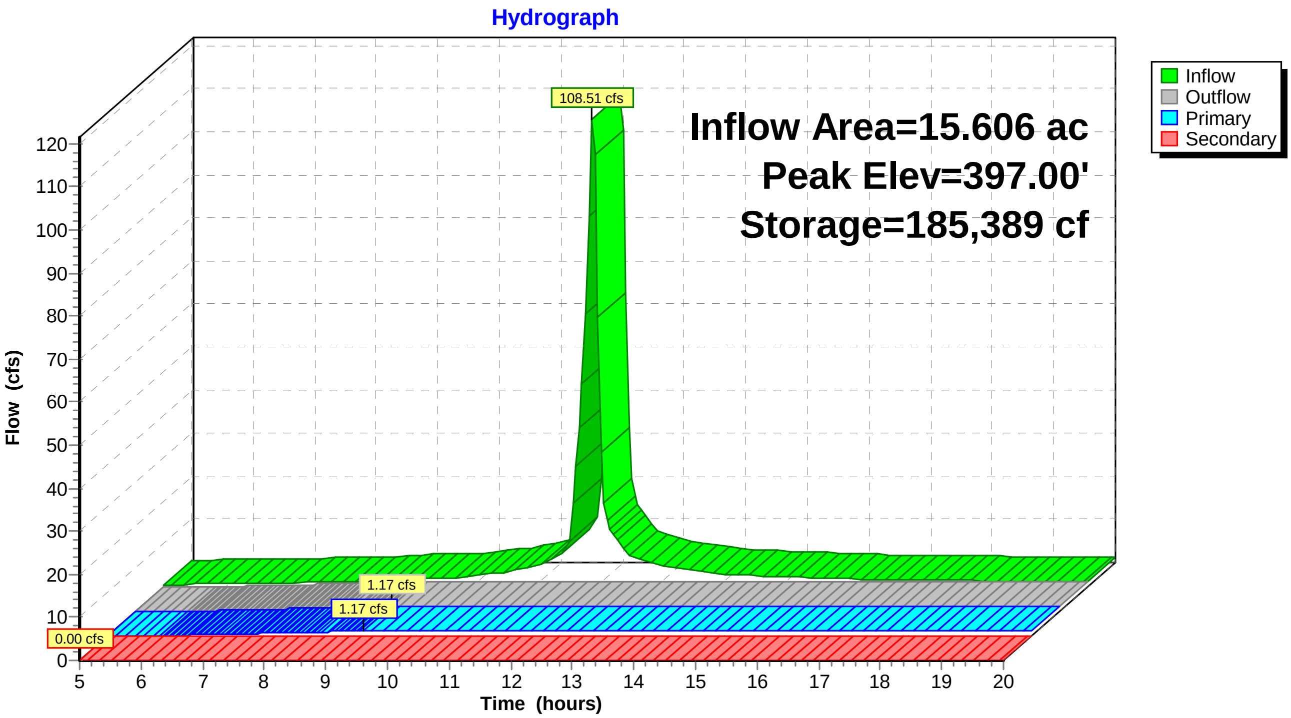
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.10'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.15 hrs HW=390.50' (Free Discharge)
└—**2=Culvert** (Passes 1.17 cfs of 1.49 cfs potential flow)
  ├—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1: SB-OB-3



Summary for Pond N1: SB-OB-6

[82] Warning: Early inflow requires earlier time span

Inflow Area =	21.258 ac,	0.00% Impervious, Inflow Depth > 4.21"	for 10-yr event	
Inflow =	147.81 cfs @	11.96 hrs, Volume=	7.460 af	
Outflow =	1.17 cfs @	8.90 hrs, Volume=	1.230 af,	Atten= 99%, Lag= 0.0 min
Primary =	1.17 cfs @	8.90 hrs, Volume=	1.230 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.65' @ 20.00 hrs Surf.Area= 46,946 sf Storage= 271,329 cf

Plug-Flow detention time= 264.6 min calculated for 1.224 af (16% of inflow)
Center-of-Mass det. time= 75.9 min (817.3 - 741.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	390,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

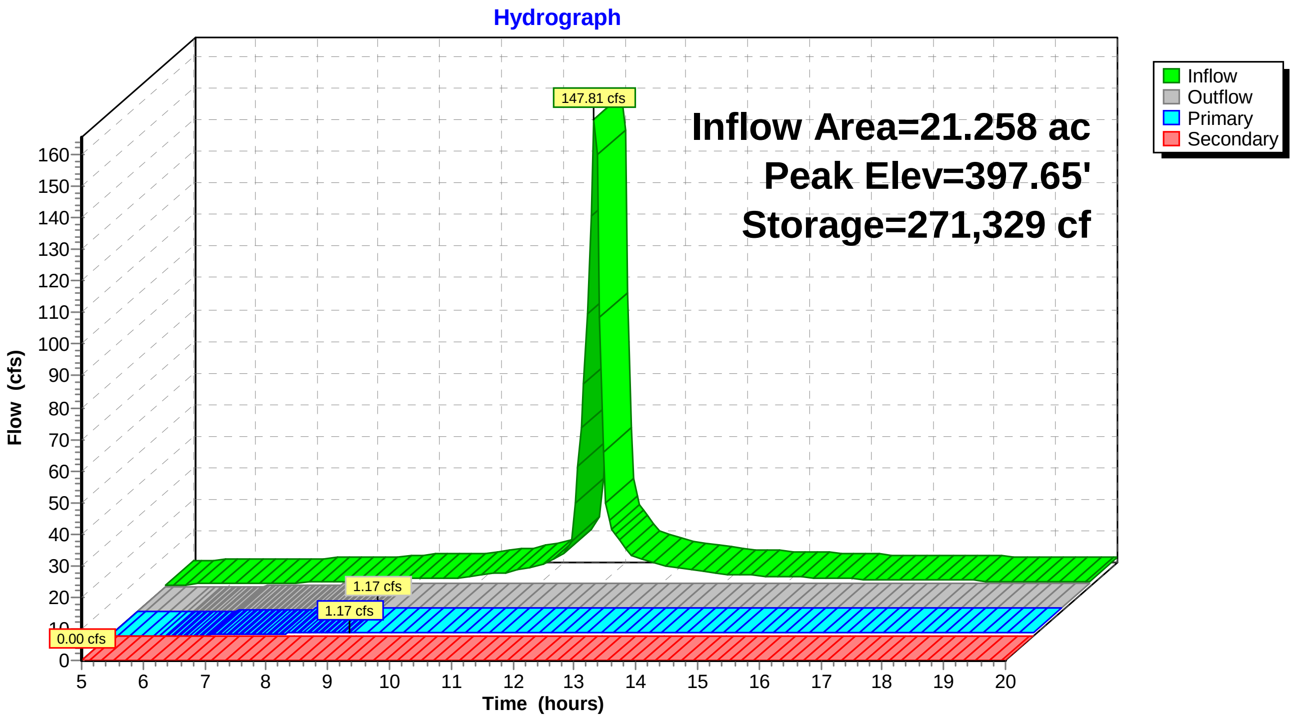
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	24,000	0	0
400.00	54,000	390,000	390,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.70'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 8.90 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.53 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N1: SB-OB-6



Summary for Pond N2: SB-OB-5

[82] Warning: Early inflow requires earlier time span

Inflow Area = 17.856 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 124.16 cfs @ 11.96 hrs, Volume= 6.266 af
Outflow = 1.17 cfs @ 8.95 hrs, Volume= 1.234 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 8.95 hrs, Volume= 1.234 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.49' @ 20.00 hrs Surf.Area= 40,484 sf Storage= 219,159 cf

Plug-Flow detention time= 242.6 min calculated for 1.233 af (20% of inflow)
Center-of-Mass det. time= 74.3 min (815.8 - 741.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

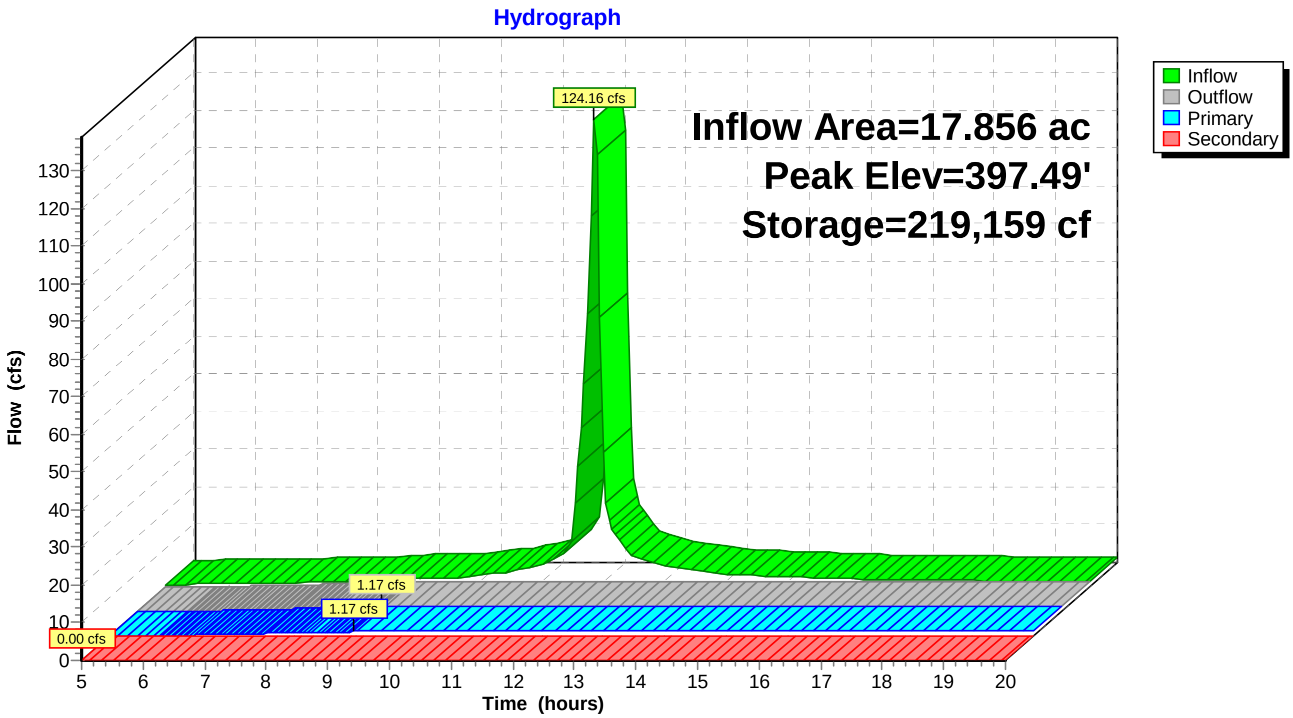
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 8.95 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.50 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N2: SB-OB-5



Summary for Pond N3: SB-OB-4

[82] Warning: Early inflow requires earlier time span

Inflow Area = 13.206 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 91.82 cfs @ 11.96 hrs, Volume= 4.634 af
Outflow = 1.17 cfs @ 9.30 hrs, Volume= 1.229 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 9.30 hrs, Volume= 1.229 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 396.96' @ 18.45 hrs Surf.Area= 31,867 sf Storage= 149,080 cf

Plug-Flow detention time= 209.9 min calculated for 1.224 af (26% of inflow)
Center-of-Mass det. time= 75.3 min (816.7 - 741.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	260,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

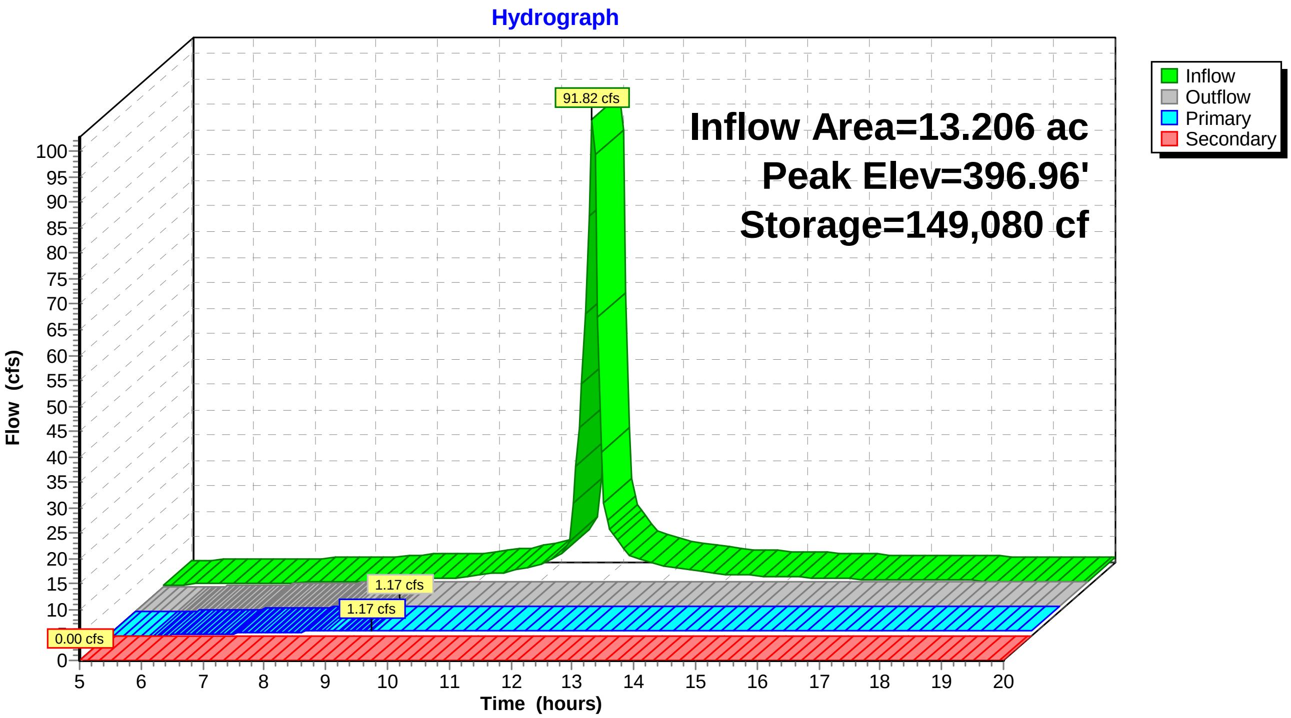
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	11,000	0	0
400.00	41,000	260,000	260,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.30 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.52 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N3: SB-OB-4



Summary for Pond NW1: SB-OB-7

[82] Warning: Early inflow requires earlier time span

Inflow Area = 16.857 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 111.03 cfs @ 11.99 hrs, Volume= 5.914 af
Outflow = 1.17 cfs @ 9.10 hrs, Volume= 1.222 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 9.10 hrs, Volume= 1.222 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.12' @ 19.95 hrs Surf.Area= 39,374 sf Storage= 204,382 cf

Plug-Flow detention time= 238.4 min calculated for 1.216 af (21% of inflow)
Center-of-Mass det. time= 76.4 min (819.5 - 743.1)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

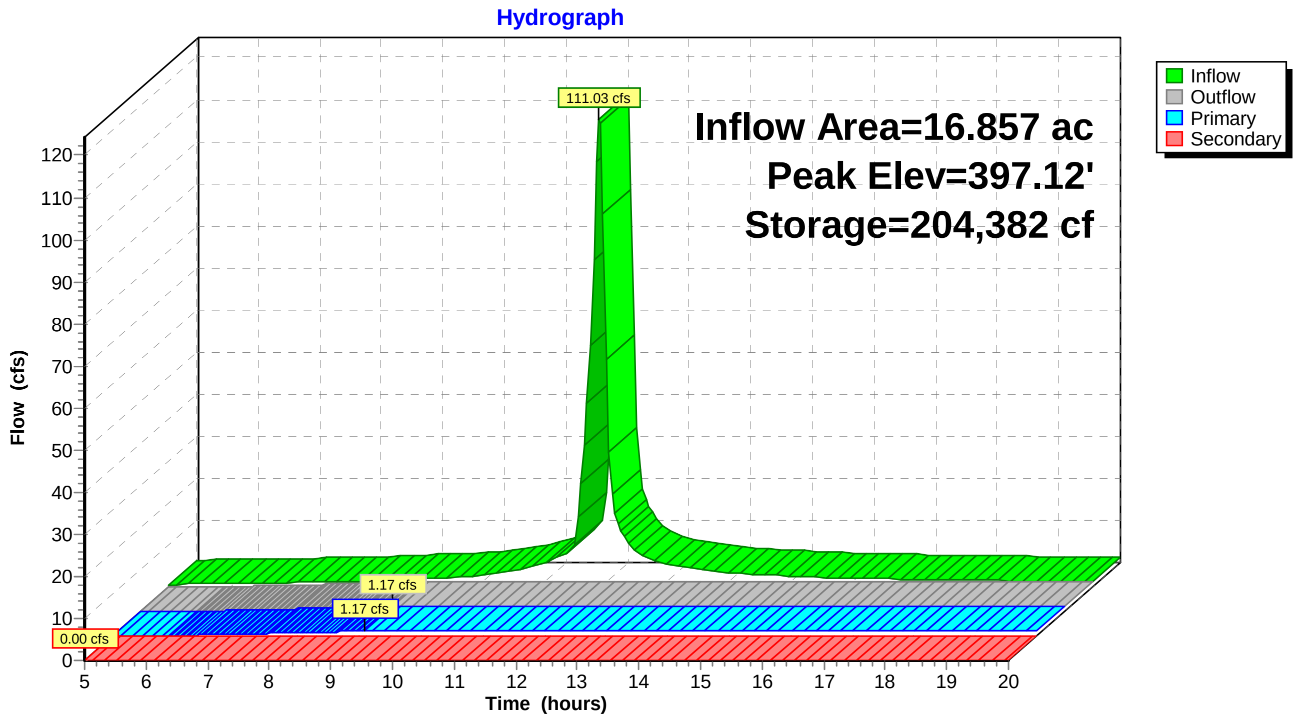
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.10 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.48 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond NW1: SB-OB-7



Summary for Pond P1: SB-P-8

[82] Warning: Early inflow requires earlier time span

Inflow Area = 15.460 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 101.82 cfs @ 11.99 hrs, Volume= 5.423 af
Outflow = 1.17 cfs @ 9.20 hrs, Volume= 1.219 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 9.20 hrs, Volume= 1.219 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 396.94' @ 19.48 hrs Surf.Area= 36,817 sf Storage= 183,253 cf

Plug-Flow detention time= 229.4 min calculated for 1.214 af (22% of inflow)
Center-of-Mass det. time= 77.1 min (820.2 - 743.1)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

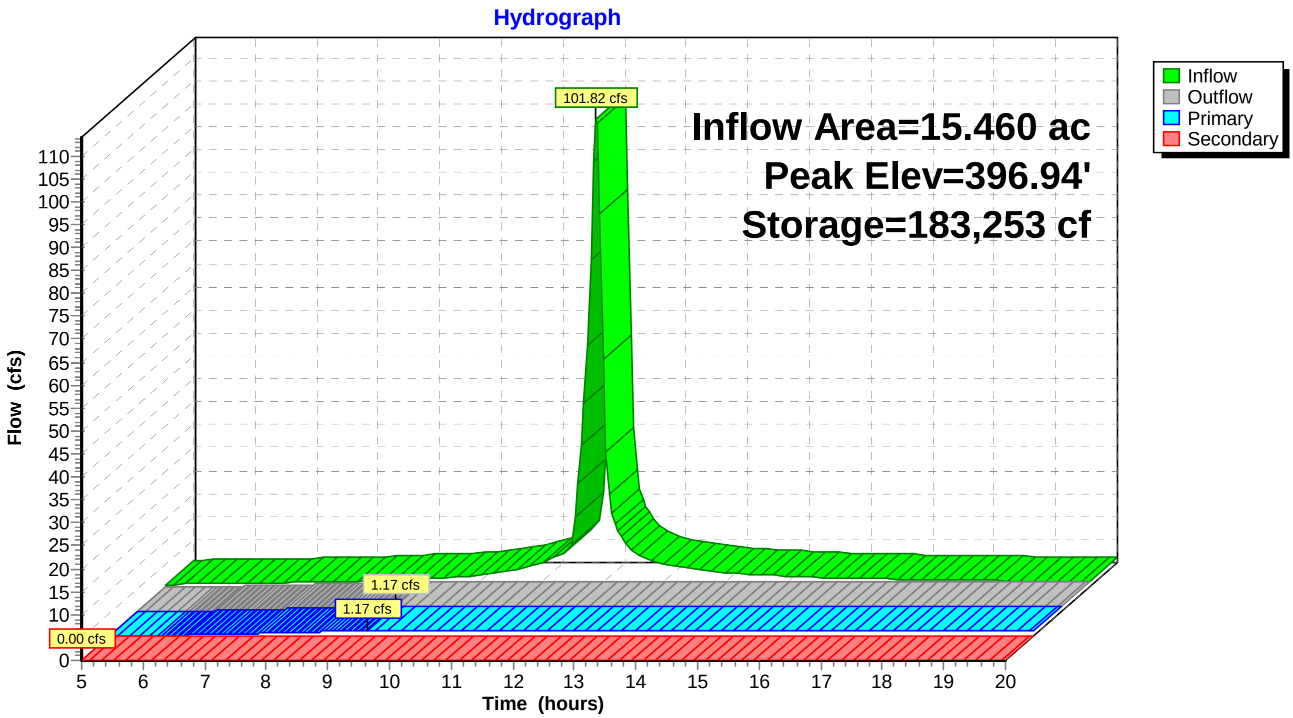
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.20 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.49 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1: SB-P-8


Hydrograph
101.82 cfs
Inflow Area=15.460 ac
Peak Elev=396.94'
Storage=183,253 cf
1.17 cfs
1.17 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Time (hours)

Summary for Pond P2: SB-P-2

[82] Warning: Early inflow requires earlier time span

Inflow Area = 47.459 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 305.79 cfs @ 12.00 hrs, Volume= 16.647 af
Outflow = 2.34 cfs @ 9.95 hrs, Volume= 2.251 af, Atten= 99%, Lag= 0.0 min
Primary = 2.34 cfs @ 9.95 hrs, Volume= 2.251 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.37' @ 20.00 hrs Surf.Area= 96,114 sf Storage= 626,998 cf

Plug-Flow detention time= 318.8 min calculated for 2.241 af (13% of inflow)
Center-of-Mass det. time= 105.2 min (848.9 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	890,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

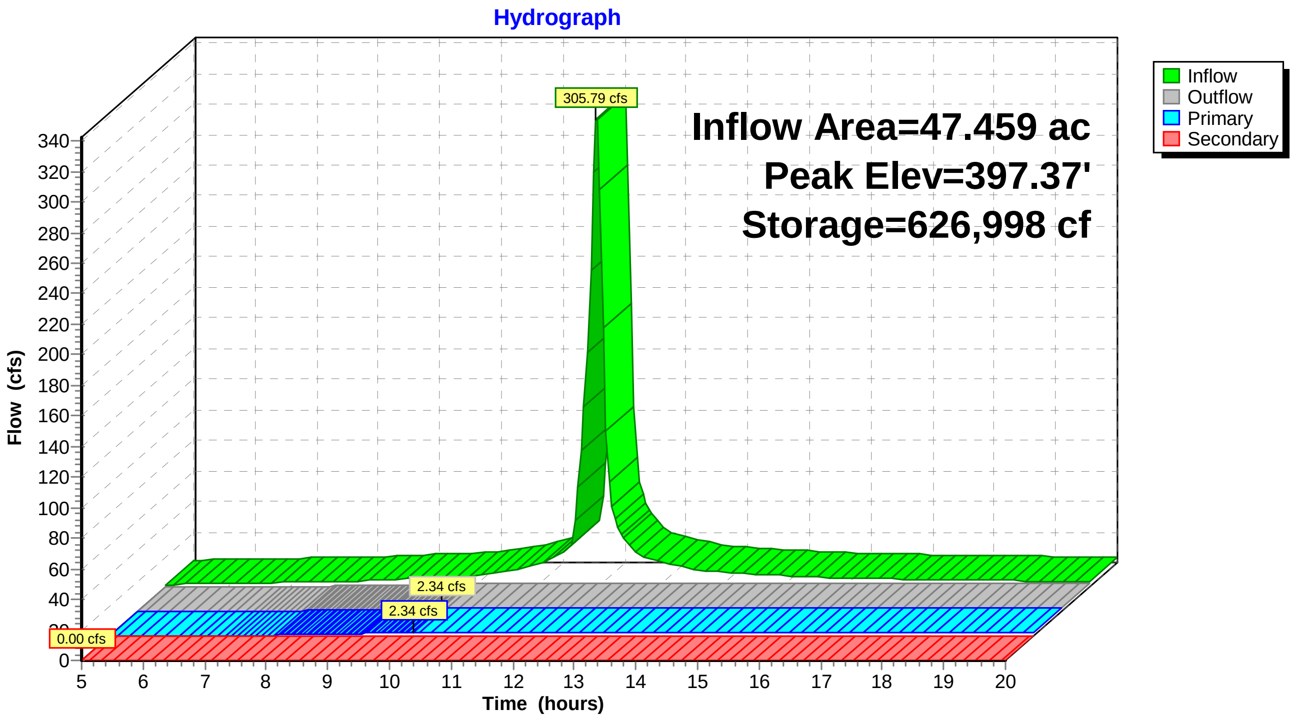
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	74,000	0	0
400.00	104,000	890,000	890,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.34 cfs @ 9.95 hrs HW=390.70' (Free Discharge)
└─**2=Culvert** (Passes 2.34 cfs of 2.81 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P2: SB-P-2


Hydrograph
305.79 cfs
Inflow Area=47.459 ac
Peak Elev=397.37'
Storage=626,998 cf
2.34 cfs
2.34 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
Time (hours)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Summary for Pond PT1: SB-PT-9

[82] Warning: Early inflow requires earlier time span

Inflow Area = 42.536 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 285.00 cfs @ 11.98 hrs, Volume= 14.923 af
Outflow = 2.34 cfs @ 10.00 hrs, Volume= 2.254 af, Atten= 99%, Lag= 0.0 min
Primary = 2.34 cfs @ 10.00 hrs, Volume= 2.254 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.27' @ 20.00 hrs Surf.Area= 86,809 sf Storage= 551,803 cf

Plug-Flow detention time= 305.5 min calculated for 2.244 af (15% of inflow)
Center-of-Mass det. time= 105.7 min (848.4 - 742.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	800,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

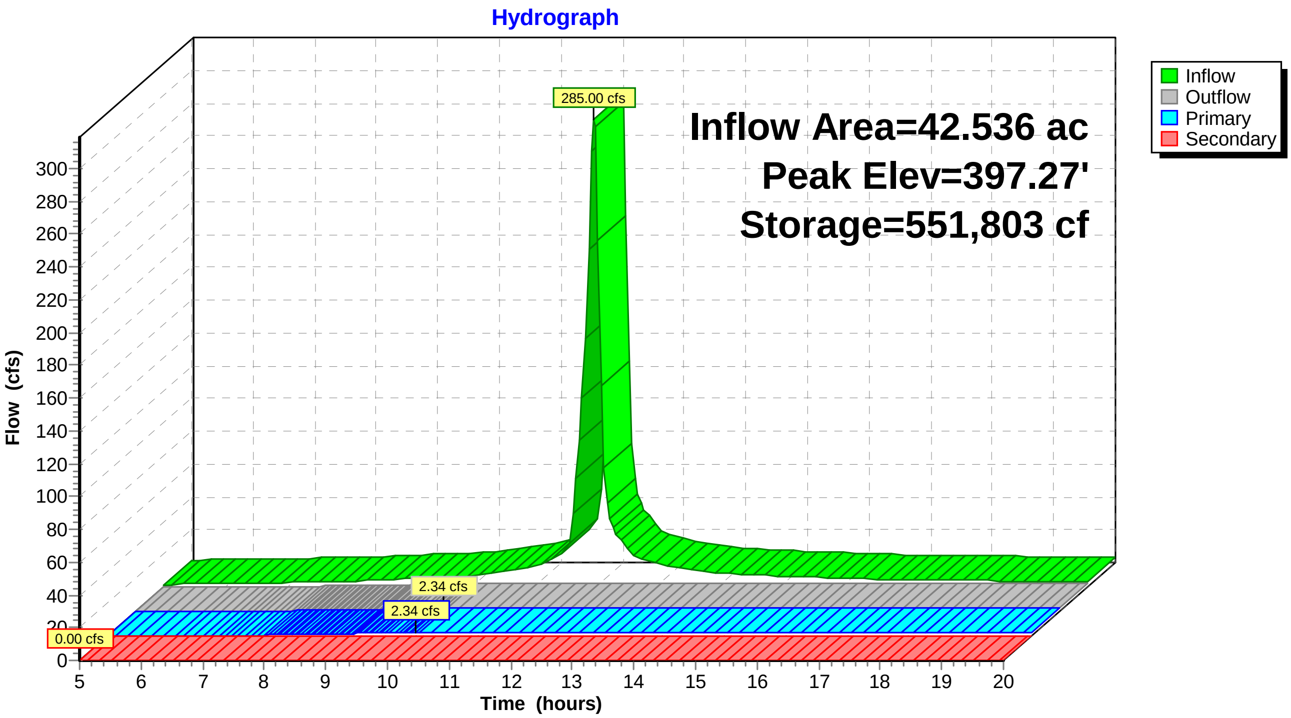
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	65,000	0	0
400.00	95,000	800,000	800,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.30'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.34 cfs @ 10.00 hrs HW=390.71' (Free Discharge)
└─**2=Culvert** (Passes 2.34 cfs of 2.87 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT1: SB-PT-9



Summary for Pond PT2: SB-PT-1

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      22.345 ac,   0.00% Impervious,  Inflow Depth >   4.21"    for  10-yr event
Inflow      =    153.61 cfs @   11.97 hrs,  Volume=          7.841 af
Outflow     =      1.17 cfs @    9.00 hrs,  Volume=          1.218 af,  Atten= 99%,  Lag= 0.0 min
Primary     =      1.17 cfs @    9.00 hrs,  Volume=          1.218 af
Secondary =        0.00 cfs @    5.00 hrs,  Volume=          0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.38' @ 20.00 hrs Surf.Area= 50,148 sf Storage= 288,462 cf

Plug-Flow detention time= 275.5 min calculated for 1.212 af (15% of inflow)
Center-of-Mass det. time= 79.4 min (821.1 - 741.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	430,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

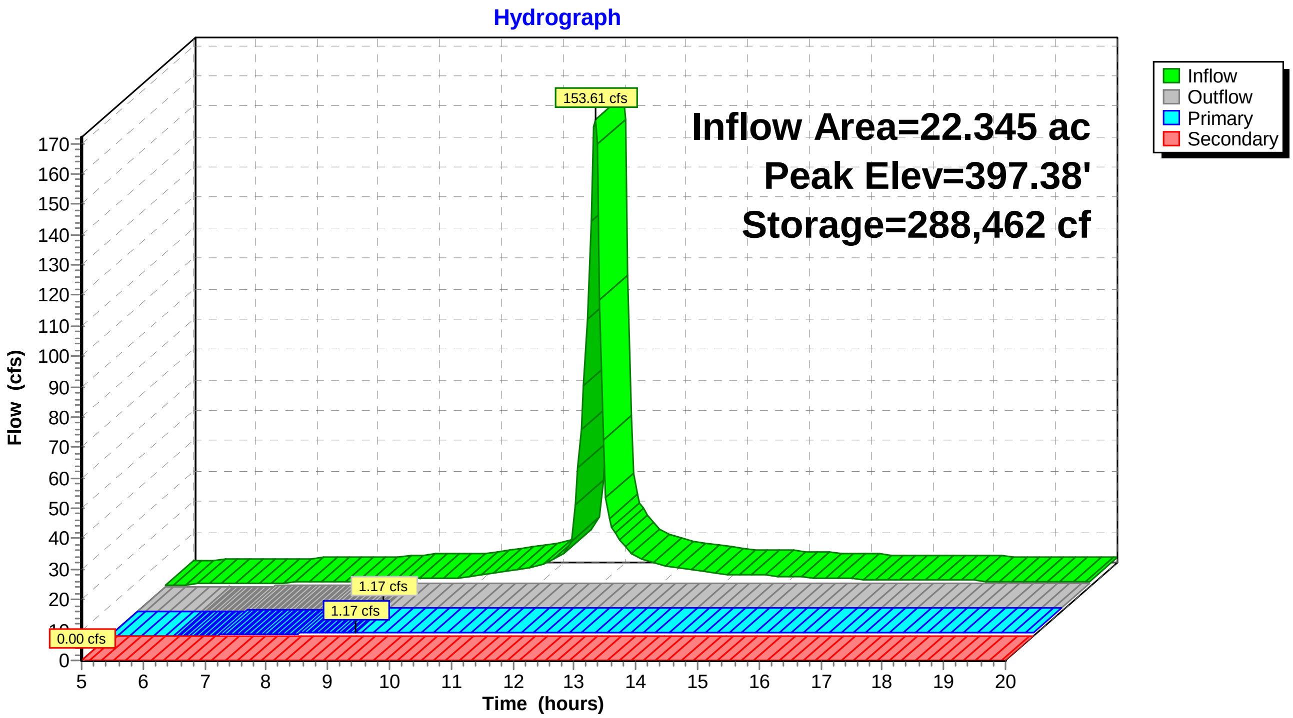
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	28,000	0	0
400.00	58,000	430,000	430,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.00 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.53 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT2: SB-PT-1



Summary for Pond S1: SB-OB-10

[82] Warning: Early inflow requires earlier time span

Inflow Area =	18.532 ac,	0.00% Impervious, Inflow Depth >	4.21"	for 10-yr event
Inflow =	121.69 cfs @	11.99 hrs, Volume=	6.501 af	
Outflow =	1.17 cfs @	8.90 hrs, Volume=	1.240 af,	Atten= 99%, Lag= 0.0 min
Primary =	1.17 cfs @	8.90 hrs, Volume=	1.240 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.74' @ 20.00 hrs Surf.Area= 41,220 sf Storage= 229,178 cf

Plug-Flow detention time= 242.6 min calculated for 1.234 af (19% of inflow)
Center-of-Mass det. time= 71.1 min (814.3 - 743.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

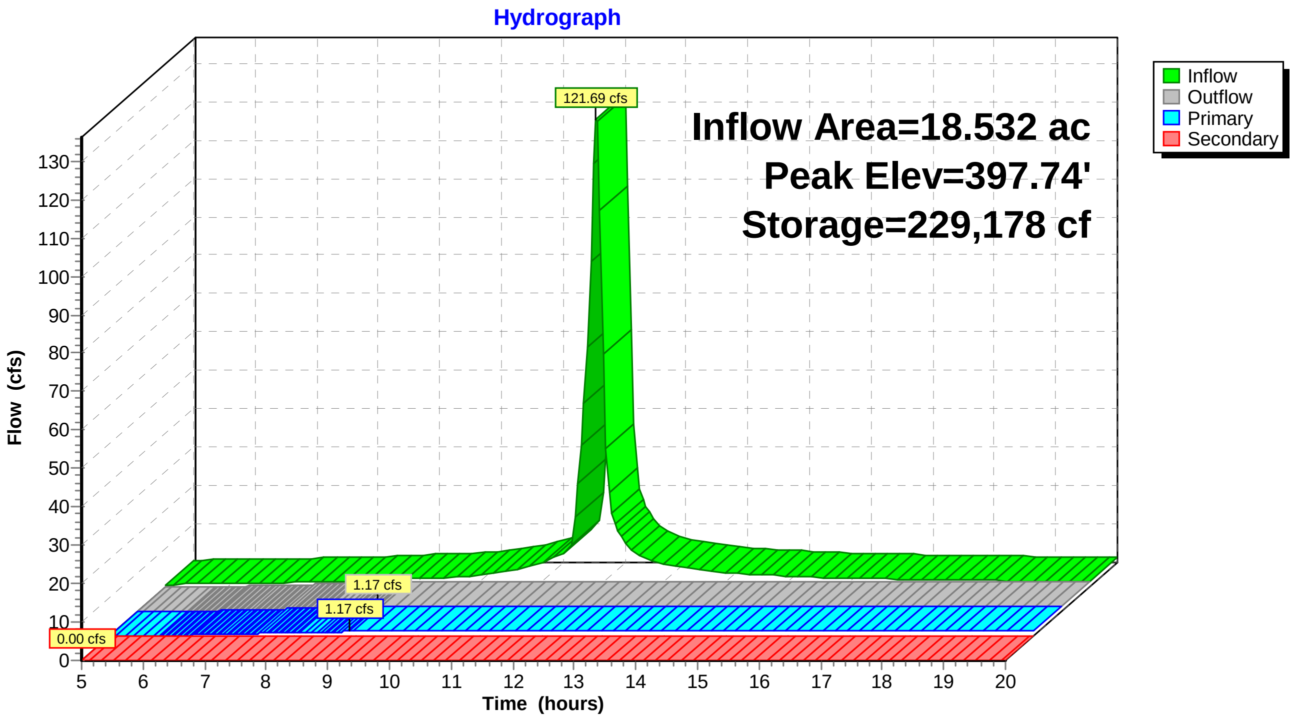
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.80'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 8.90 hrs HW=390.51' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.51 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S1: SB-OB-10



Summary for Pond W1: SB-OB-11

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.955 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 129.39 cfs @ 11.97 hrs, Volume= 6.651 af
Outflow = 1.17 cfs @ 8.95 hrs, Volume= 1.232 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 8.95 hrs, Volume= 1.232 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.54' @ 20.00 hrs Surf.Area= 42,616 sf Storage= 236,025 cf

Plug-Flow detention time= 250.3 min calculated for 1.231 af (19% of inflow)
Center-of-Mass det. time= 74.7 min (816.5 - 741.8)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	350,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

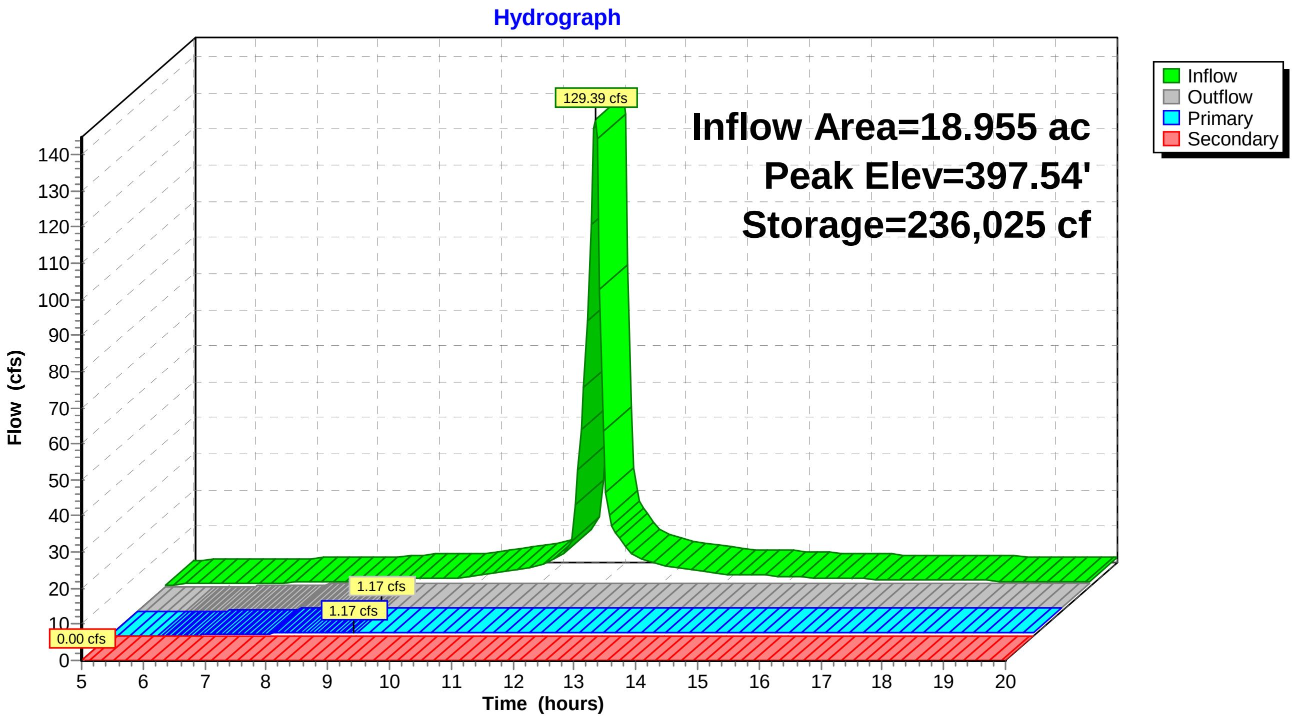
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	20,000	0	0
400.00	50,000	350,000	350,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.60'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 8.95 hrs HW=390.51' (Free Discharge)
↑—**2=Culvert** (Passes 1.17 cfs of 1.52 cfs potential flow)
  ↑—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1: SB-OB-11



Summary for Pond W2: SB-OB-12

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.853 ac, 0.00% Impervious, Inflow Depth > 4.21" for 10-yr event
Inflow = 127.81 cfs @ 11.97 hrs, Volume= 6.615 af
Outflow = 1.17 cfs @ 9.35 hrs, Volume= 1.190 af, Atten= 99%, Lag= 0.0 min
Primary = 1.17 cfs @ 9.35 hrs, Volume= 1.190 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 396.44' @ 20.00 hrs Surf.Area= 46,334 sf Storage= 236,300 cf

Plug-Flow detention time= 265.5 min calculated for 1.185 af (18% of inflow)
Center-of-Mass det. time= 87.2 min (829.2 - 742.0)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	420,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

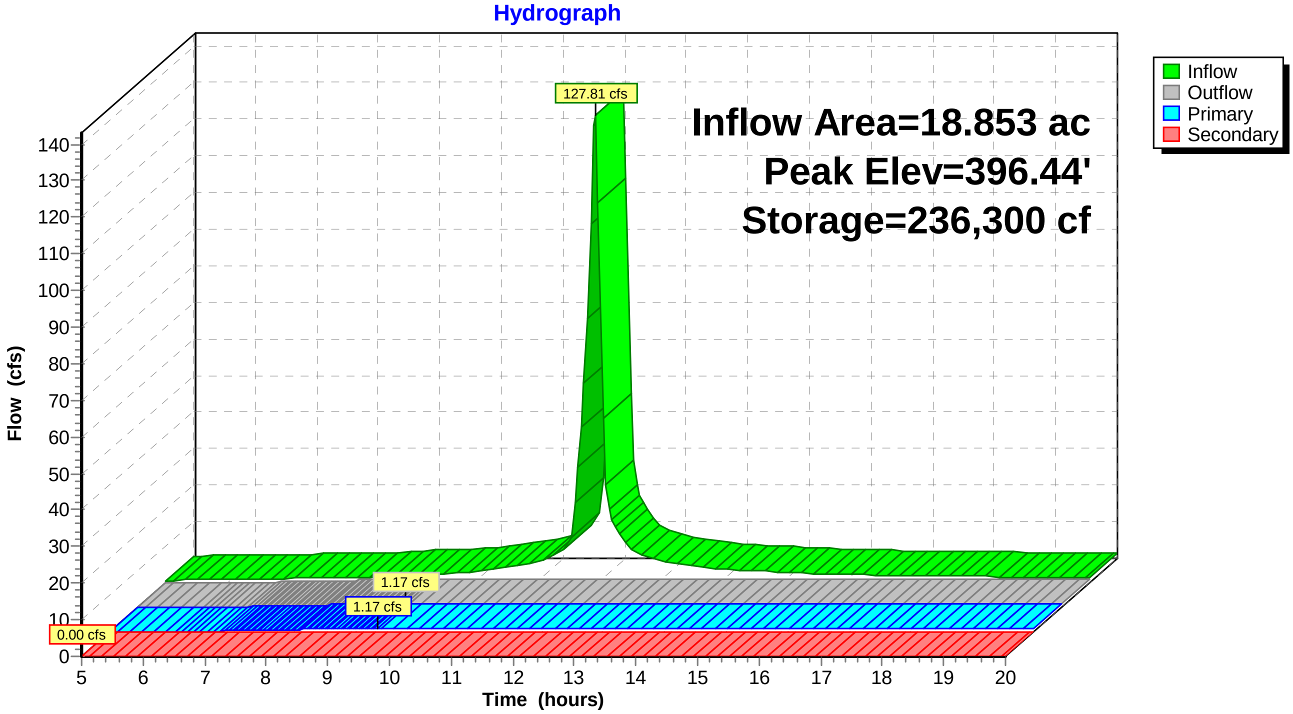
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	27,000	0	0
400.00	57,000	420,000	420,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	396.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.17 cfs @ 9.35 hrs HW=390.50' (Free Discharge)
└─**2=Culvert** (Passes 1.17 cfs of 1.50 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2: SB-OB-12



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: SB-OB-3 Runoff Area=679,818 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,439' Tc=6.0 min CN=94 Runoff=132.97 cfs 6.782 af

Subcatchment N-1: SB-OB-6 Runoff Area=926,011 sf 0.00% Impervious Runoff Depth>5.21"
Tc=6.0 min CN=94 Runoff=181.12 cfs 9.238 af

Subcatchment N-2: SB-OB-5 Runoff Area=777,820 sf 0.00% Impervious Runoff Depth>5.21"
Tc=6.0 min CN=94 Runoff=152.14 cfs 7.760 af

Subcatchment N-3: SB-OB-4 Runoff Area=575,239 sf 0.00% Impervious Runoff Depth>5.21"
Tc=6.0 min CN=94 Runoff=112.51 cfs 5.739 af

Subcatchment NW-1: SB-OB-7 Runoff Area=734,304 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,210' Tc=8.2 min CN=94 Runoff=136.06 cfs 7.324 af

Subcatchment P1-1: SB-P-8 Runoff Area=673,438 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,455' Tc=8.2 min CN=94 Runoff=124.79 cfs 6.717 af

Subcatchment P2-1: SB-P-2 Runoff Area=2,067,328 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=2,346' Tc=8.9 min CN=94 Runoff=374.81 cfs 20.618 af

Subcatchment PT-1: SB-PT-9 Runoff Area=1,852,884 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,128' Tc=7.6 min CN=94 Runoff=349.23 cfs 18.481 af

Subcatchment PT-2: SB-PT-1 Runoff Area=973,360 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,632' Tc=6.3 min CN=94 Runoff=188.23 cfs 9.710 af

Subcatchment S-1: SB-OB-10 Runoff Area=807,263 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,584' Tc=8.3 min CN=94 Runoff=149.13 cfs 8.051 af

Subcatchment W-1: SB-OB-11 Runoff Area=825,679 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,196' Tc=6.5 min CN=94 Runoff=158.55 cfs 8.237 af

Subcatchment W-2: SB-OB-12 Runoff Area=821,258 sf 0.00% Impervious Runoff Depth>5.21"
Flow Length=1,314' Tc=6.7 min CN=94 Runoff=156.62 cfs 8.192 af

Pond E1: SB-OB-3 Peak Elev=397.34' Storage=198,253 cf Inflow=132.97 cfs 6.782 af
Primary=5.85 cfs 2.415 af Secondary=0.00 cfs 0.000 af Outflow=5.85 cfs 2.415 af

Pond N1: SB-OB-6 Peak Elev=397.97' Storage=286,442 cf Inflow=181.12 cfs 9.238 af
Primary=6.66 cfs 2.875 af Secondary=0.00 cfs 0.000 af Outflow=6.66 cfs 2.875 af

Pond N2: SB-OB-5 Peak Elev=397.77' Storage=230,236 cf Inflow=152.14 cfs 7.760 af
Primary=6.60 cfs 2.681 af Secondary=0.00 cfs 0.000 af Outflow=6.60 cfs 2.681 af

Pond N3: SB-OB-4 Peak Elev=397.25' Storage=158,541 cf Inflow=112.51 cfs 5.739 af
Primary=6.10 cfs 2.279 af Secondary=0.00 cfs 0.000 af Outflow=6.10 cfs 2.279 af

Pond NW1: SB-OB-7 Peak Elev=397.45' Storage=217,283 cf Inflow=136.06 cfs 7.324 af
Primary=6.10 cfs 2.529 af Secondary=0.00 cfs 0.000 af Outflow=6.10 cfs 2.529 af

Pond P1: SB-P-8 Peak Elev=397.25' Storage=194,769 cf Inflow=124.79 cfs 6.717 af
Primary=6.09 cfs 2.436 af Secondary=0.00 cfs 0.000 af Outflow=6.09 cfs 2.436 af

Pond P2: SB-P-2 Peak Elev=397.80' Storage=668,108 cf Inflow=374.81 cfs 20.618 af
Primary=12.14 cfs 5.819 af Secondary=0.00 cfs 0.000 af Outflow=12.14 cfs 5.819 af

Pond PT1: SB-PT-9 Peak Elev=397.69' Storage=588,121 cf Inflow=349.23 cfs 18.481 af
Primary=11.74 cfs 5.494 af Secondary=0.00 cfs 0.000 af Outflow=11.74 cfs 5.494 af

Pond PT2: SB-PT-1 Peak Elev=397.68' Storage=303,284 cf Inflow=188.23 cfs 9.710 af
Primary=6.90 cfs 2.974 af Secondary=0.00 cfs 0.000 af Outflow=6.90 cfs 2.974 af

Pond S1: SB-OB-10 Peak Elev=398.06' Storage=242,463 cf Inflow=149.13 cfs 8.051 af
Primary=6.40 cfs 2.684 af Secondary=0.00 cfs 0.000 af Outflow=6.40 cfs 2.684 af

Pond W1: SB-OB-11 Peak Elev=397.86' Storage=249,788 cf Inflow=158.55 cfs 8.237 af
Primary=6.39 cfs 2.704 af Secondary=0.00 cfs 0.000 af Outflow=6.39 cfs 2.704 af

Pond W2: SB-OB-12 Peak Elev=396.75' Storage=250,658 cf Inflow=156.62 cfs 8.192 af
Primary=6.19 cfs 2.649 af Secondary=0.00 cfs 0.000 af Outflow=6.19 cfs 2.649 af

Total Runoff Area = 268.926 ac Runoff Volume = 116.848 af Average Runoff Depth = 5.21"
100.00% Pervious = 268.926 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E-1: SB-OB-3

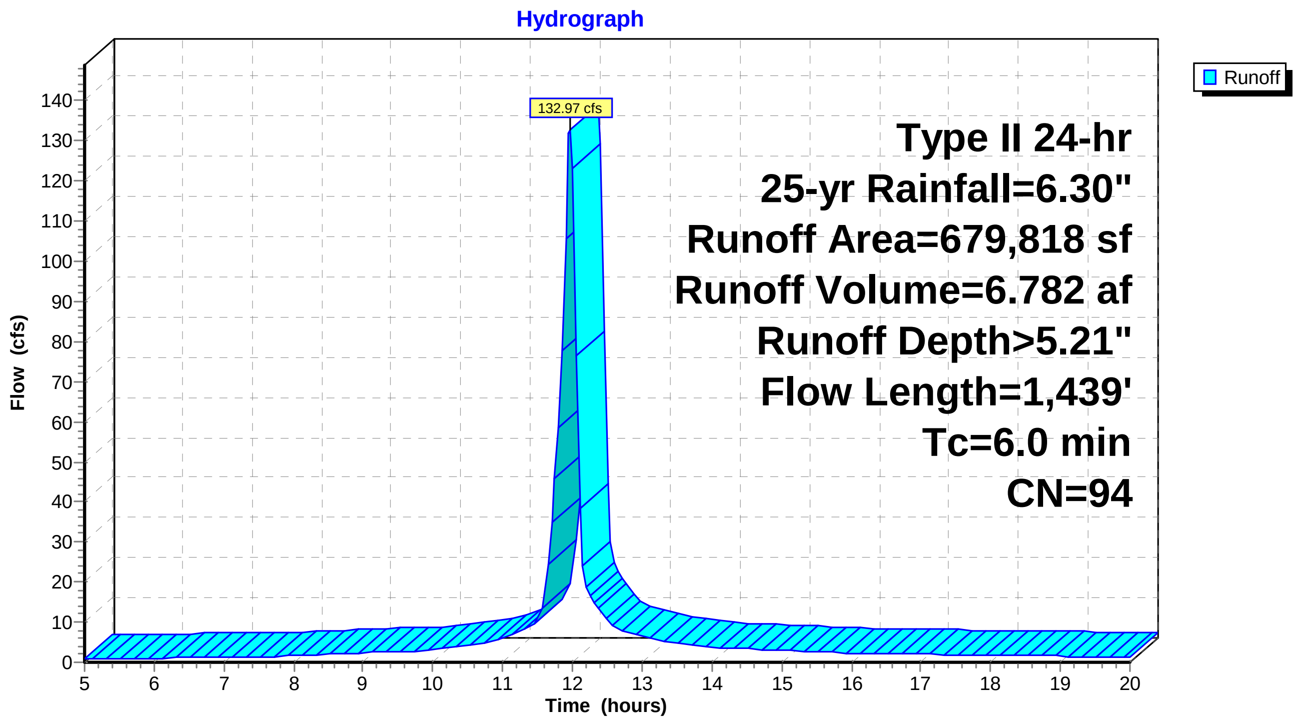
Runoff = 132.97 cfs @ 11.96 hrs, Volume= 6.782 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
679,818	94	Newly graded area, HSG D
679,818		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	100	0.0683	0.66		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.5	608	0.1660	4.07		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.0	731	0.0140	11.61	406.21	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.0	1,439	Total			

Subcatchment E-1: SB-OB-3



Summary for Subcatchment N-1: SB-OB-6

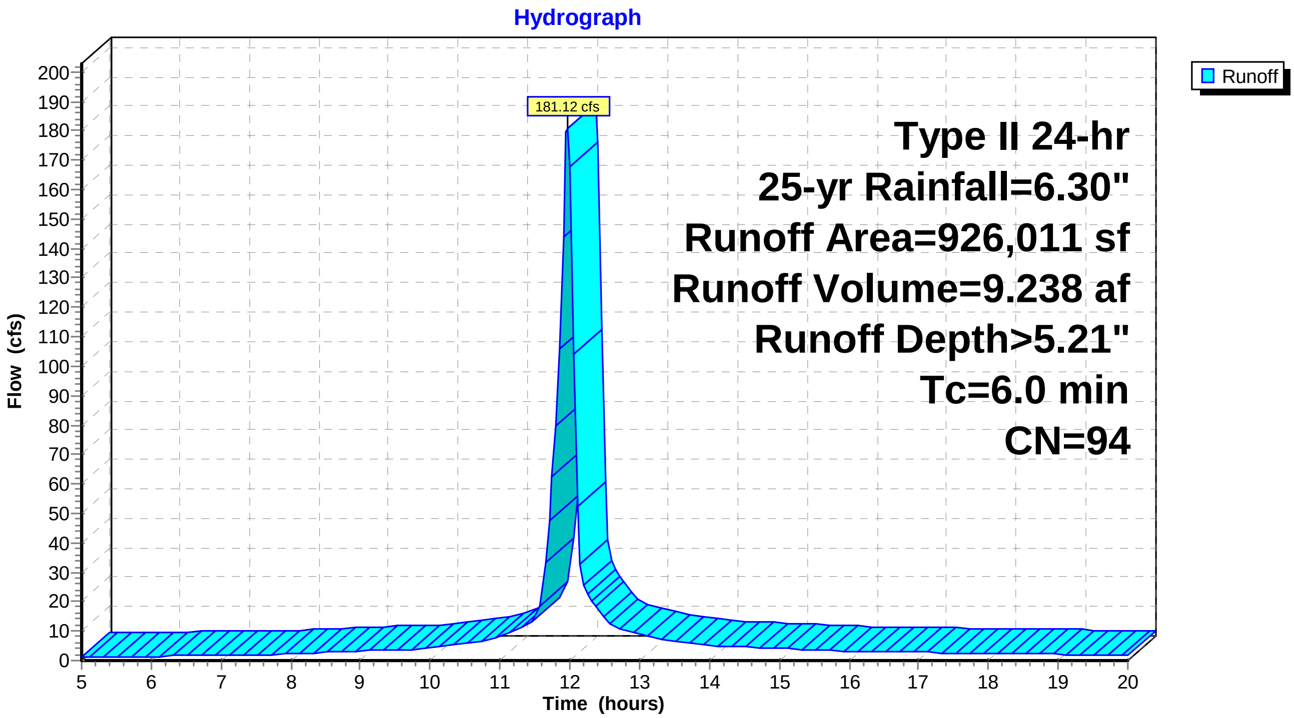
Runoff = 181.12 cfs @ 11.96 hrs, Volume= 9.238 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
926,011	94	Newly graded area, HSG D
926,011		100.00% Pervious Area

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

Subcatchment N-1: SB-OB-6



Summary for Subcatchment N-2: SB-OB-5

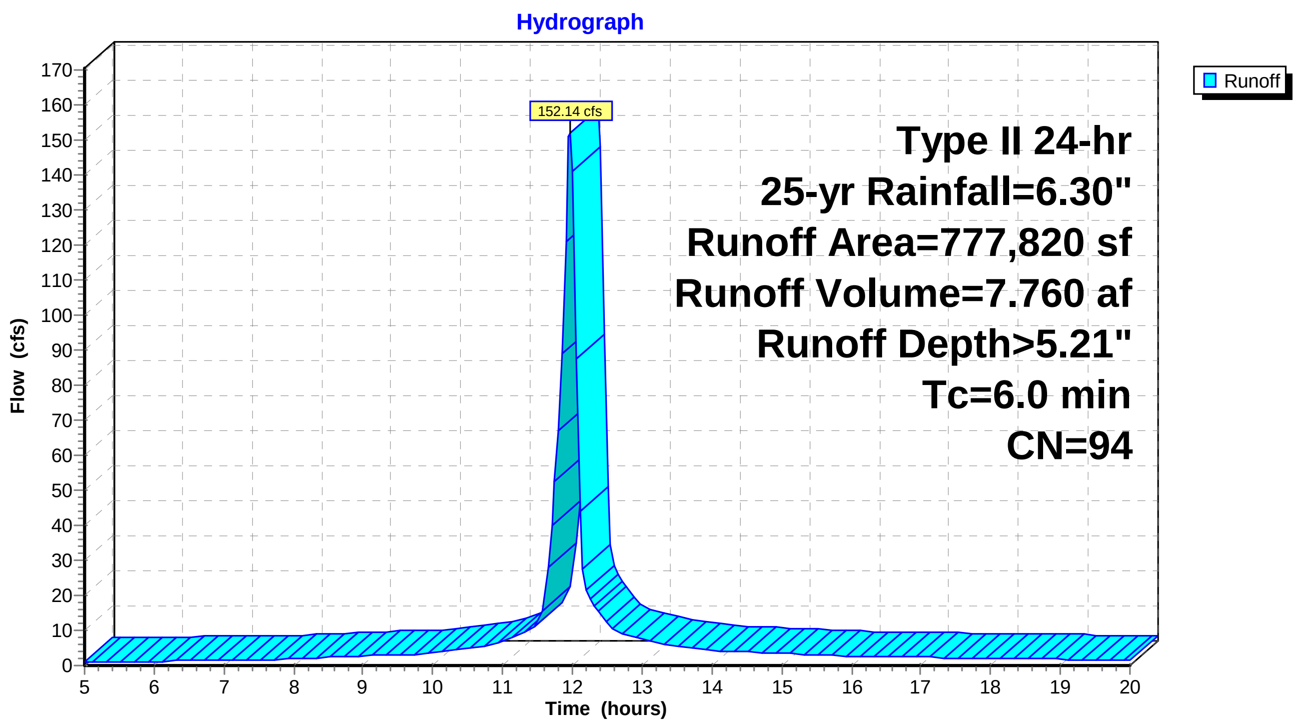
Runoff = 152.14 cfs @ 11.96 hrs, Volume= 7.760 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
777,820	94	Newly graded area, HSG D
777,820		100.00% Pervious Area

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

Subcatchment N-2: SB-OB-5



Summary for Subcatchment N-3: SB-OB-4

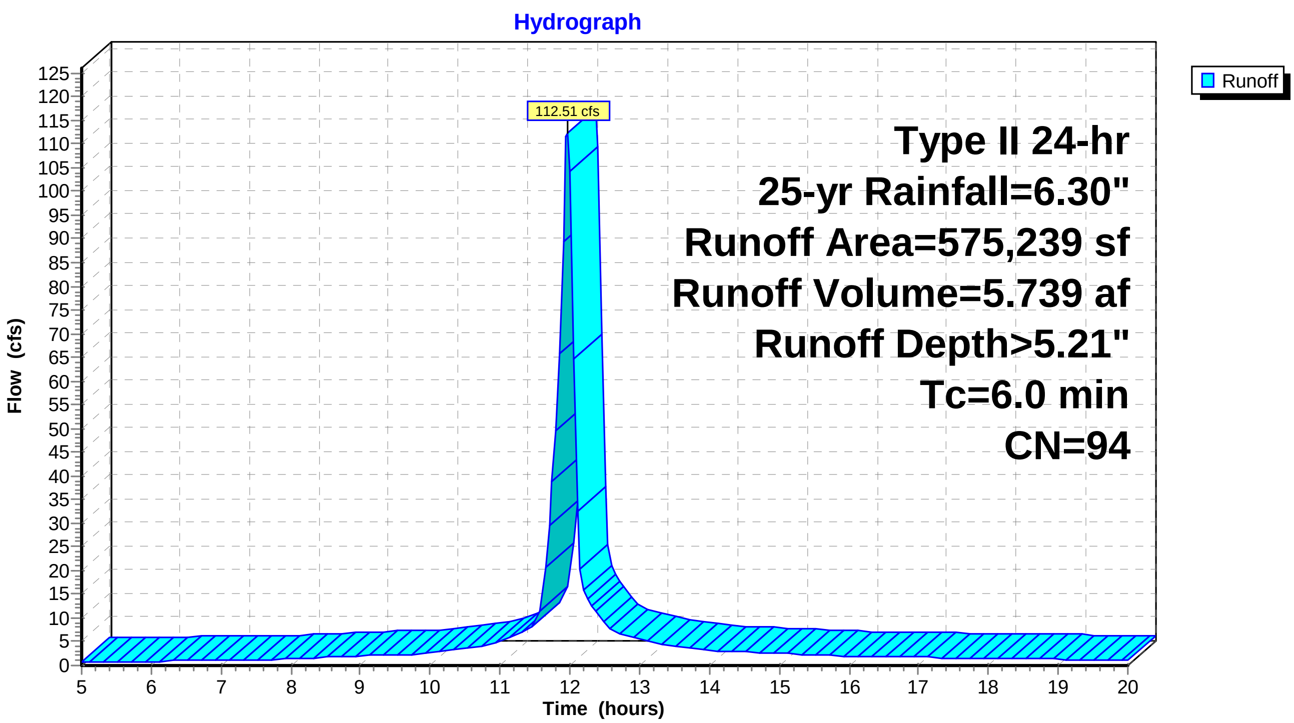
Runoff = 112.51 cfs @ 11.96 hrs, Volume= 5.739 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
575,239	94	Newly graded area, HSG D
575,239		100.00% Pervious Area

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

Subcatchment N-3: SB-OB-4



Summary for Subcatchment NW-1: SB-OB-7

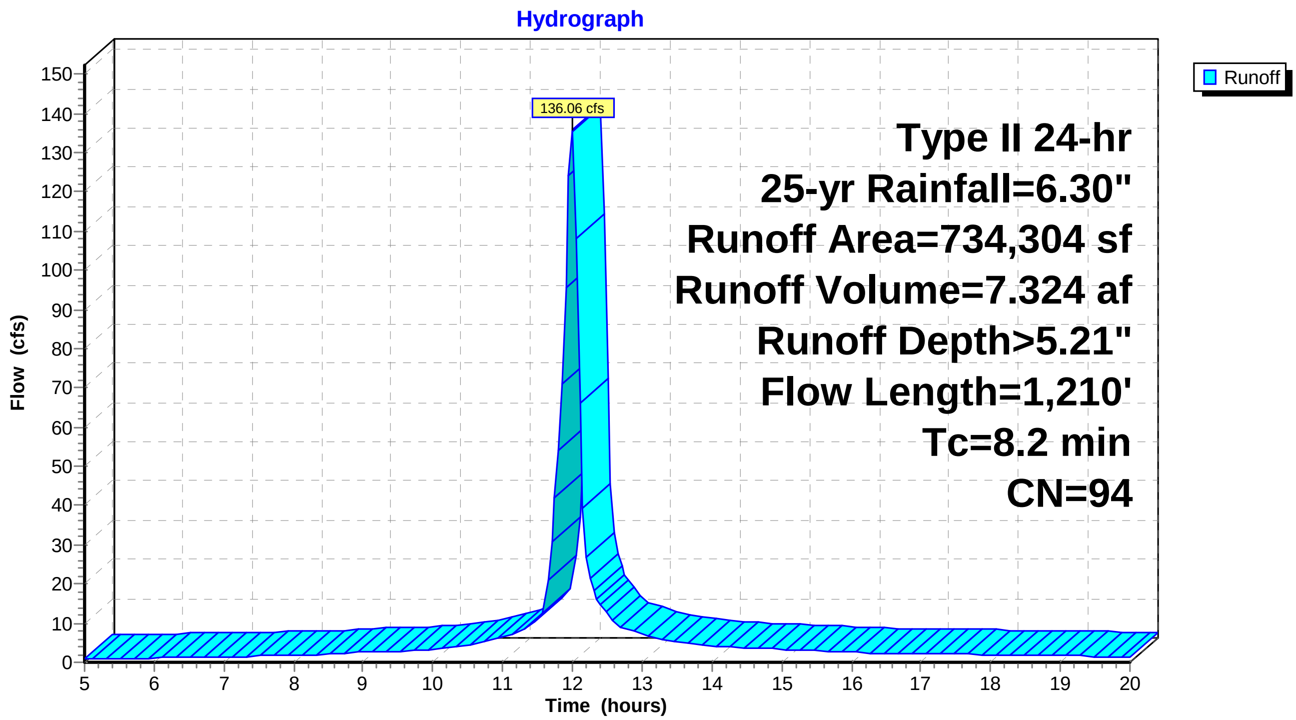
Runoff = 136.06 cfs @ 11.99 hrs, Volume= 7.324 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
734,304	94	Newly graded area, HSG D
734,304		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.0206	0.41		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
3.2	674	0.1225	3.50		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.9	436	0.0072	8.32	291.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,210	Total			

Subcatchment NW-1: SB-OB-7



Summary for Subcatchment P1-1: SB-P-8

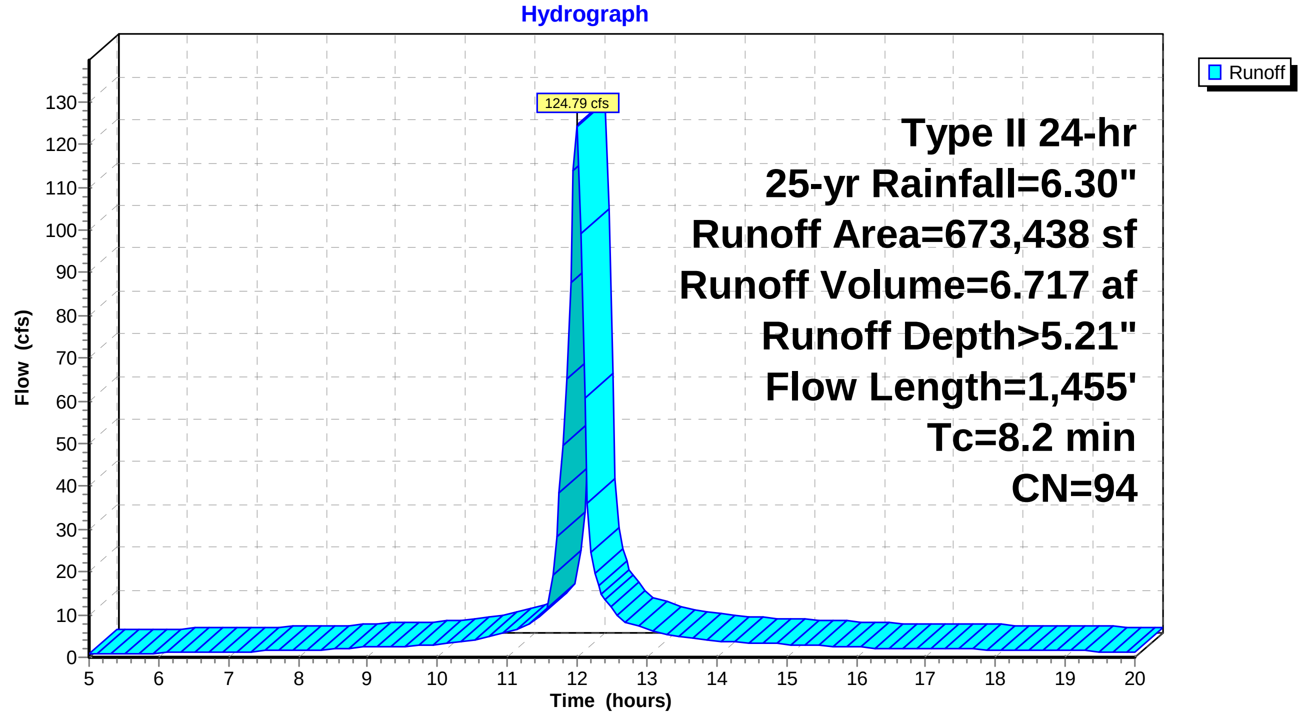
Runoff = 124.79 cfs @ 11.99 hrs, Volume= 6.717 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
673,438	94	Newly graded area, HSG D
673,438		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	100	0.0293	0.47		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.3	866	0.1150	3.39		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.4	489	0.0357	18.53	648.67	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,455	Total			

Subcatchment P1-1: SB-P-8



Summary for Subcatchment P2-1: SB-P-2

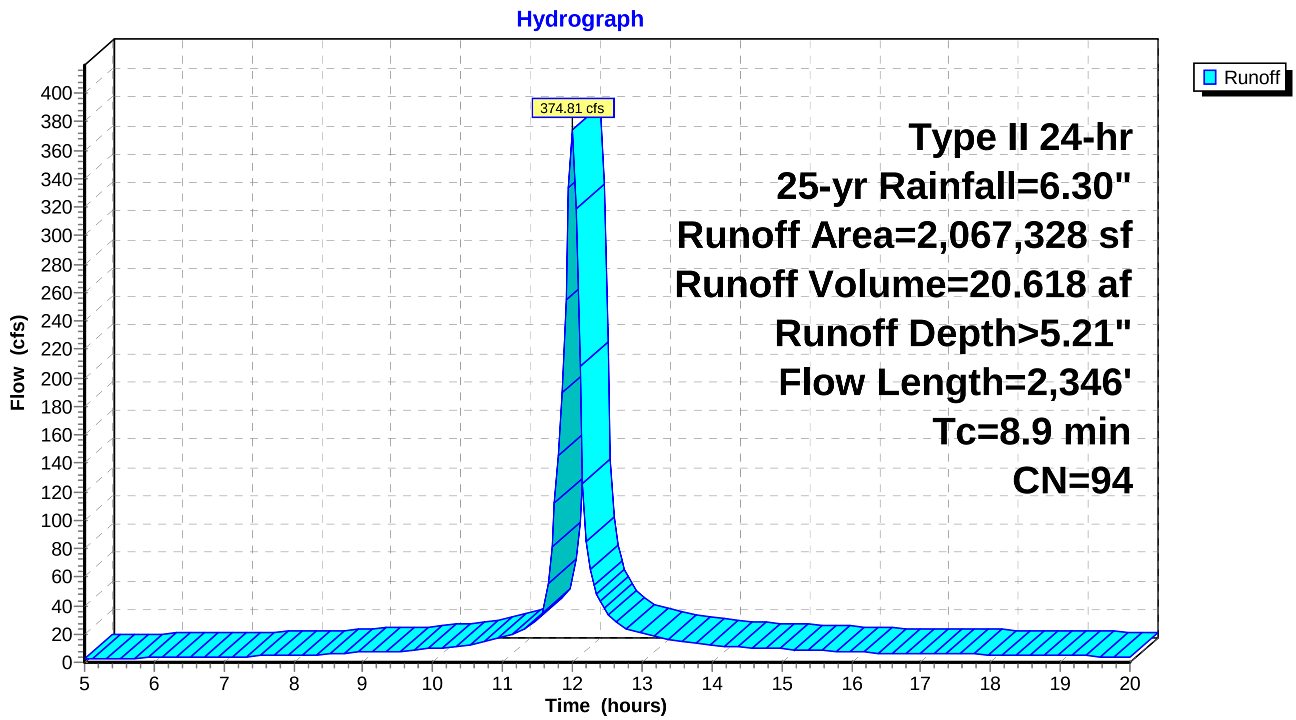
Runoff = 374.81 cfs @ 12.00 hrs, Volume= 20.618 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
2,067,328	94	Newly graded area, HSG D
2,067,328		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0607	0.63		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.5	918	0.1131	3.36		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.7	1,328	0.0180	13.16	460.60	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.9	2,346	Total			

Subcatchment P2-1: SB-P-2



Summary for Subcatchment PT-1: SB-PT-9

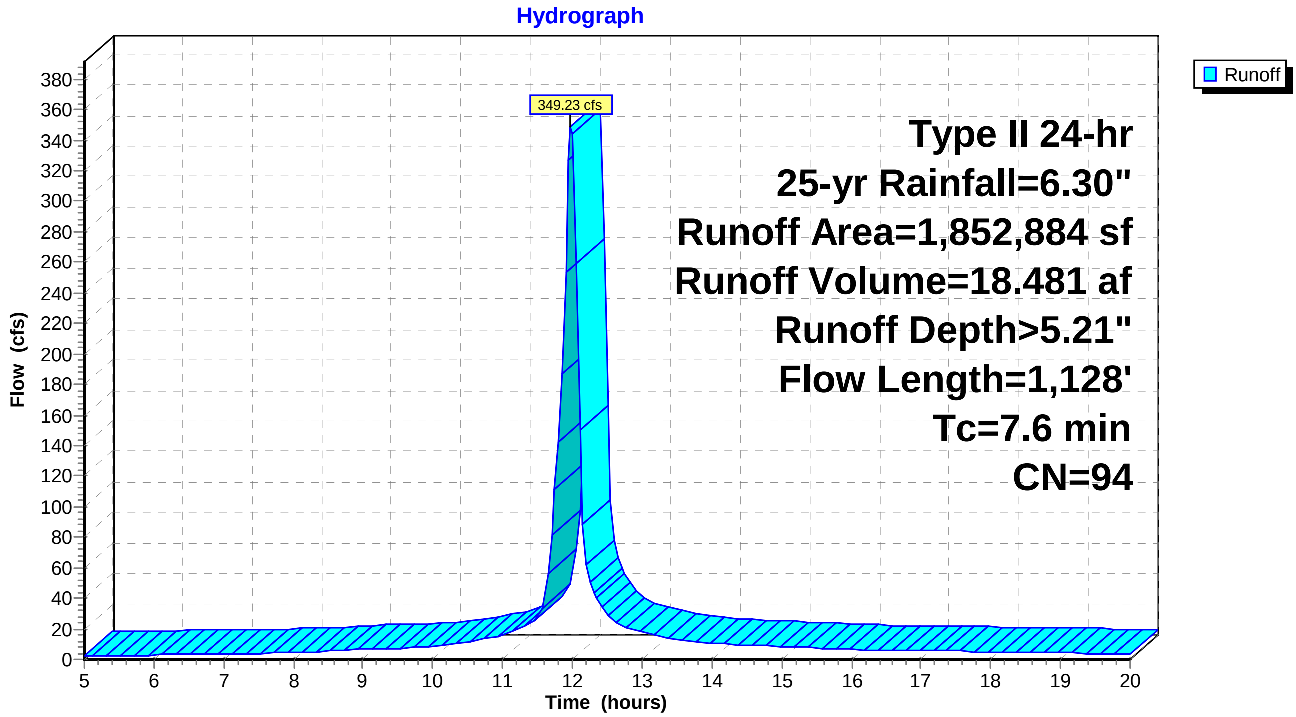
Runoff = 349.23 cfs @ 11.98 hrs, Volume= 18.481 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
1,852,884	94	Newly graded area, HSG D
1,852,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0589	0.62		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.9	1,028	0.1230	3.51		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
7.6	1,128	Total			

Subcatchment PT-1: SB-PT-9



Summary for Subcatchment PT-2: SB-PT-1

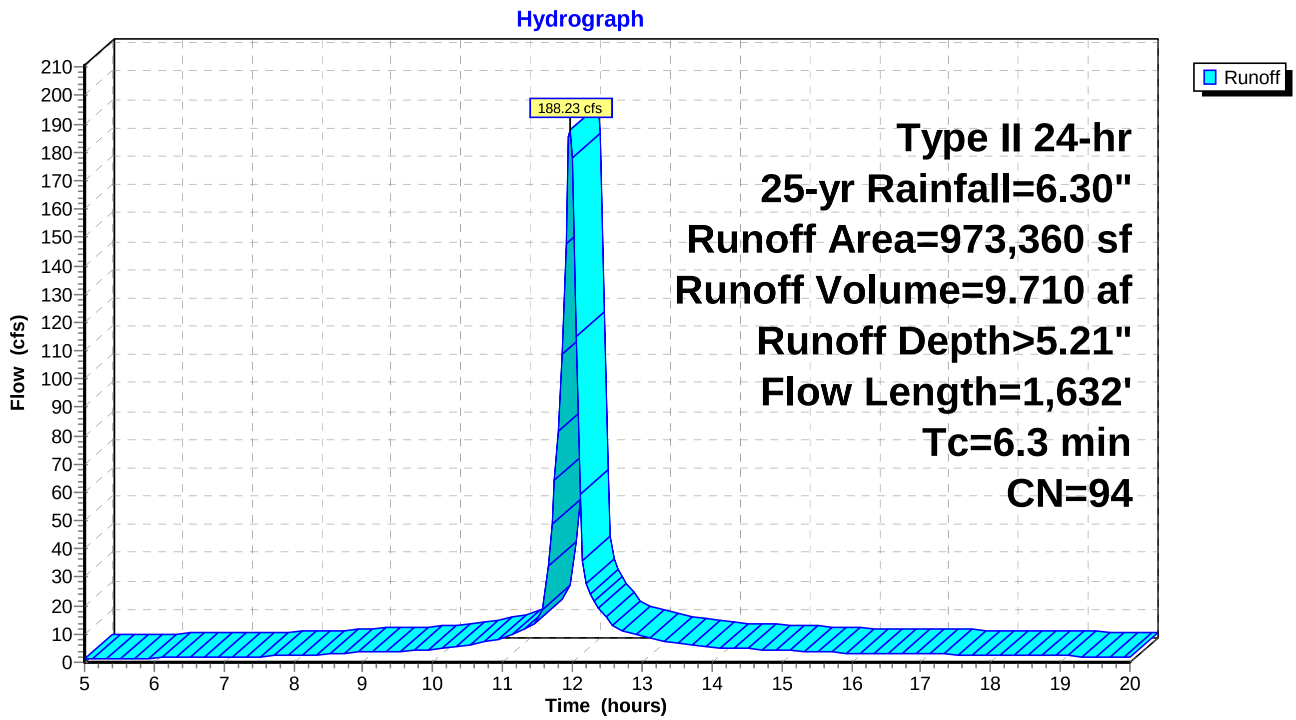
Runoff = 188.23 cfs @ 11.97 hrs, Volume= 9.710 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
973,360	94	Newly graded area, HSG D
973,360		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	100	0.0425	0.55		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.1	291	0.1870	4.32		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
2.1	1,241	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.3	1,632	Total			

Subcatchment PT-2: SB-PT-1



Summary for Subcatchment S-1: SB-OB-10

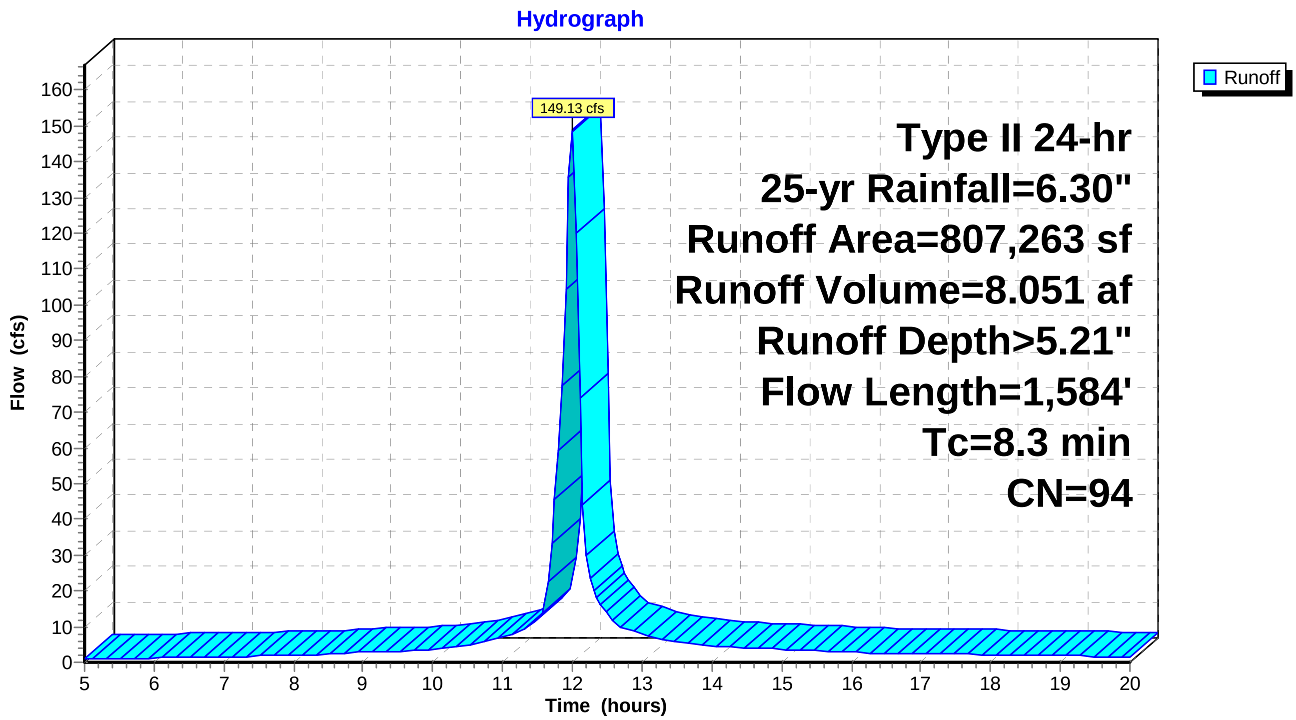
Runoff = 149.13 cfs @ 11.99 hrs, Volume= 8.051 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
807,263	94	Newly graded area, HSG D
807,263		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	100	0.1026	0.78		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
6.0	1,179	0.1090	3.30		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.2	305	0.1080	30.25	1,058.78	**Channel Flow,** Area= 35.0 sf Perim= 22.0' r= 1.59' n= 0.022
8.3	1,584	Total			

Subcatchment S-1: SB-OB-10



Summary for Subcatchment W-1: SB-OB-11

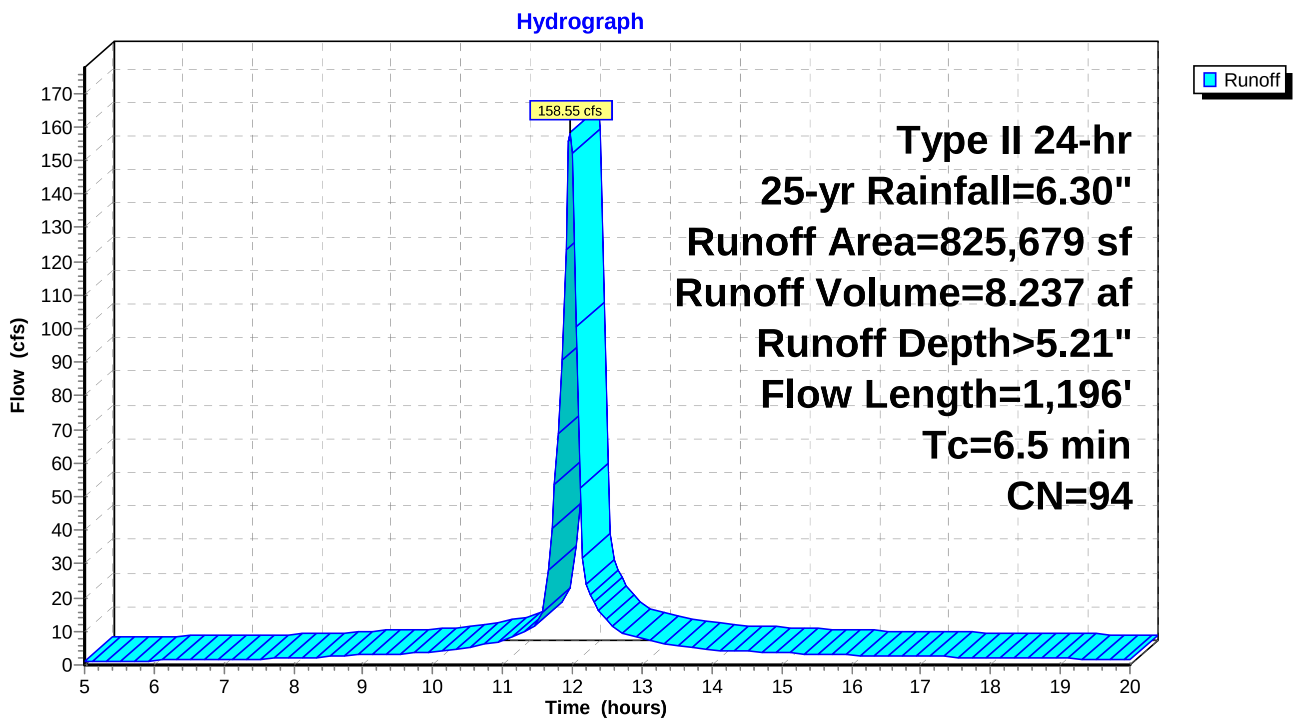
Runoff = 158.55 cfs @ 11.97 hrs, Volume= 8.237 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
825,679	94	Newly graded area, HSG D
825,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	100	0.0490	0.58		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.8	621	0.1400	3.74		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.8	475	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.5	1,196	Total			

Subcatchment W-1: SB-OB-11



Summary for Subcatchment W-2: SB-OB-12

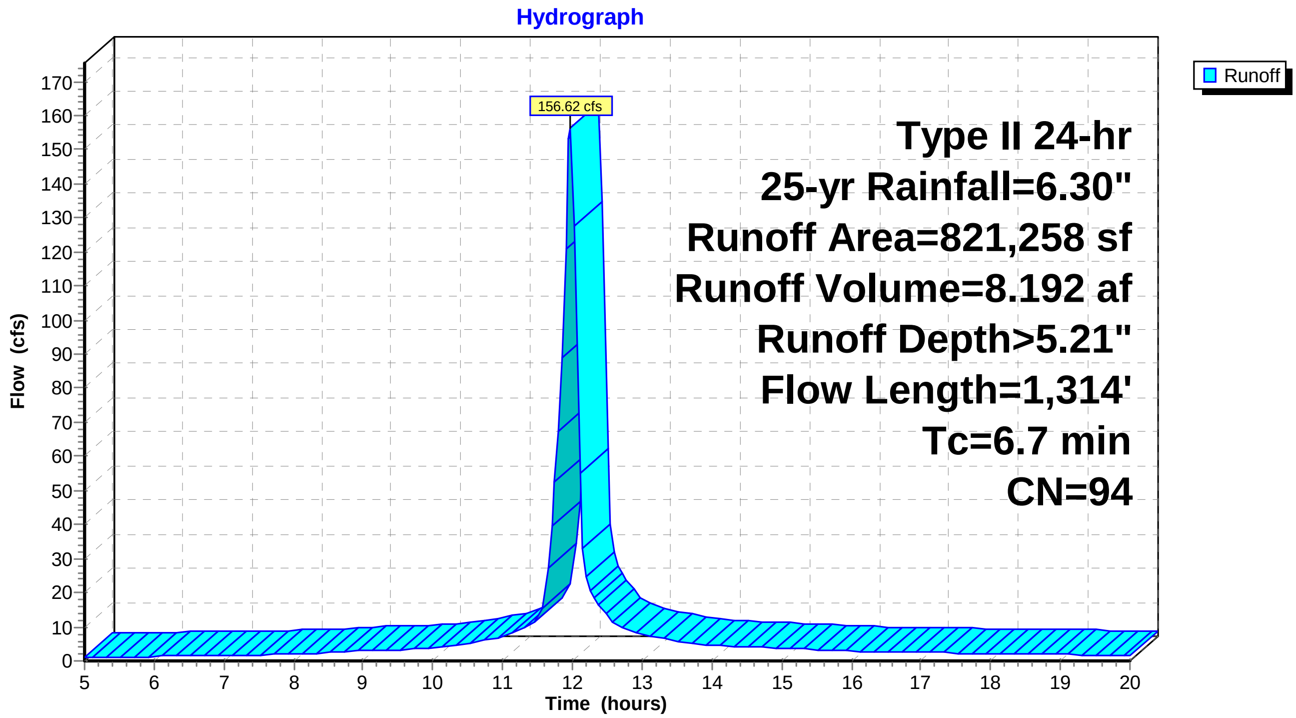
Runoff = 156.62 cfs @ 11.97 hrs, Volume= 8.192 af, Depth> 5.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.30"

Area (sf)	CN	Description
821,258	94	Newly graded area, HSG D
821,258		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	100	0.0138	0.35		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.3	401	0.2700	5.20		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.6	813	0.0617	24.36	852.77	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.7	1,314	Total			

Subcatchment W-2: SB-OB-12



Summary for Pond E1: SB-OB-3

[82] Warning: Early inflow requires earlier time span

Inflow Area =	15.606 ac,	0.00% Impervious, Inflow Depth >	5.21"	for 25-yr event
Inflow =	132.97 cfs @	11.96 hrs, Volume=	6.782 af	
Outflow =	5.85 cfs @	13.14 hrs, Volume=	2.415 af,	Atten= 96%, Lag= 70.7 min
Primary =	5.85 cfs @	13.14 hrs, Volume=	2.415 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.34' @ 13.14 hrs Surf.Area= 38,020 sf Storage= 198,253 cf

Plug-Flow detention time= 217.5 min calculated for 2.414 af (36% of inflow)
Center-of-Mass det. time= 105.6 min (844.0 - 738.5)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

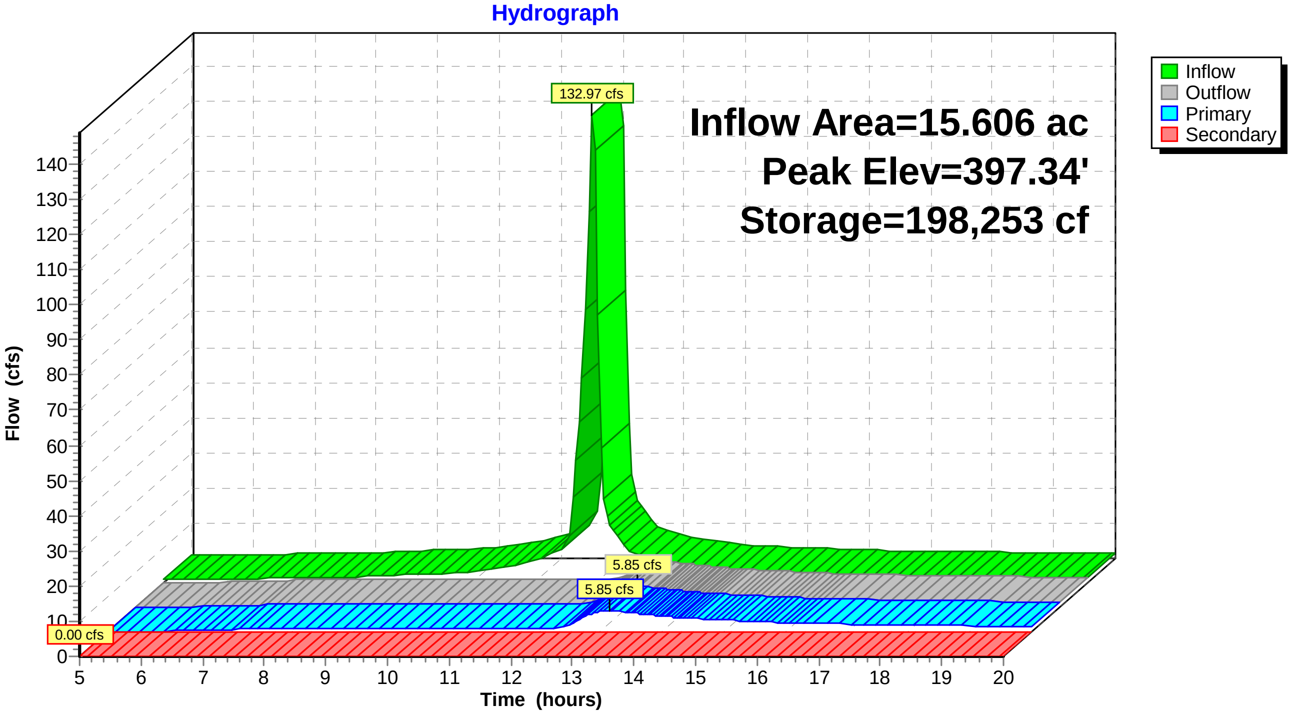
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.10'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=5.78 cfs @ 13.14 hrs HW=397.34' (Free Discharge)
└—**2=Culvert** (Passes 5.78 cfs of 38.09 cfs potential flow)
  ├—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Weir Controls 4.61 cfs @ 1.60 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1: SB-OB-3



Summary for Pond N1: SB-OB-6

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      21.258 ac,   0.00% Impervious,  Inflow Depth >   5.21"    for  25-yr event
Inflow      =     181.12 cfs @  11.96 hrs,  Volume=          9.238 af
Outflow     =       6.66 cfs @  13.49 hrs,  Volume=          2.875 af,  Atten= 96%,  Lag= 91.5 min
Primary     =       6.66 cfs @  13.49 hrs,  Volume=          2.875 af
Secondary =         0.00 cfs @   5.00 hrs,  Volume=          0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.97' @ 13.49 hrs Surf.Area= 47,903 sf Storage= 286,442 cf

Plug-Flow detention time= 251.5 min calculated for 2.863 af (31% of inflow)
Center-of-Mass det. time= 128.3 min (866.8 - 738.5)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	390,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

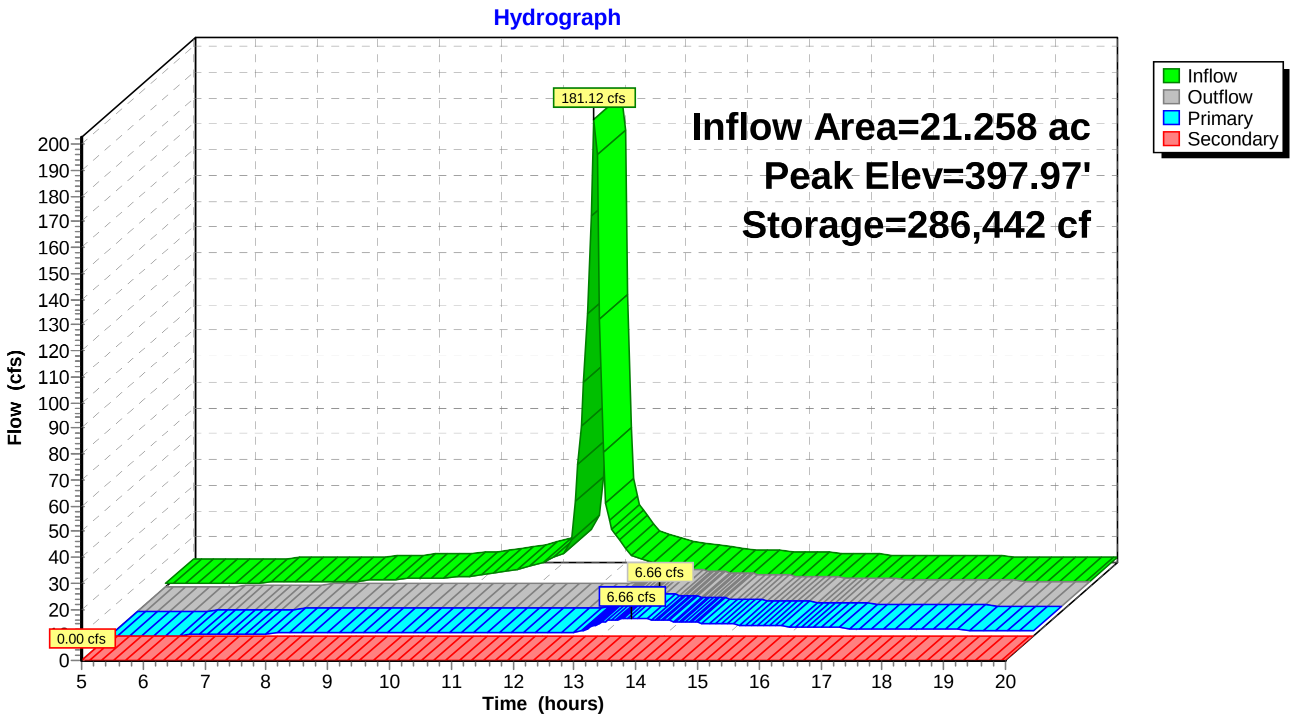
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	24,000	0	0
400.00	54,000	390,000	390,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.70'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.60 cfs @ 13.49 hrs HW=397.97' (Free Discharge)
└─**2=Culvert** (Passes 6.60 cfs of 39.93 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 5.43 cfs @ 1.69 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N1: SB-OB-6



Summary for Pond N2: SB-OB-5

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =     17.856 ac,   0.00% Impervious,  Inflow Depth >  5.21"   for 25-yr event
Inflow      =    152.14 cfs @  11.96 hrs,  Volume=        7.760 af
Outflow     =      6.60 cfs @  13.17 hrs,  Volume=        2.681 af,  Atten= 96%,  Lag= 72.3 min
Primary     =      6.60 cfs @  13.17 hrs,  Volume=        2.681 af
Secondary =        0.00 cfs @   5.00 hrs,  Volume=        0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.77' @ 13.17 hrs Surf.Area= 41,297 sf Storage= 230,236 cf

Plug-Flow detention time= 226.7 min calculated for 2.679 af (35% of inflow)
Center-of-Mass det. time= 112.2 min (850.7 - 738.5)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

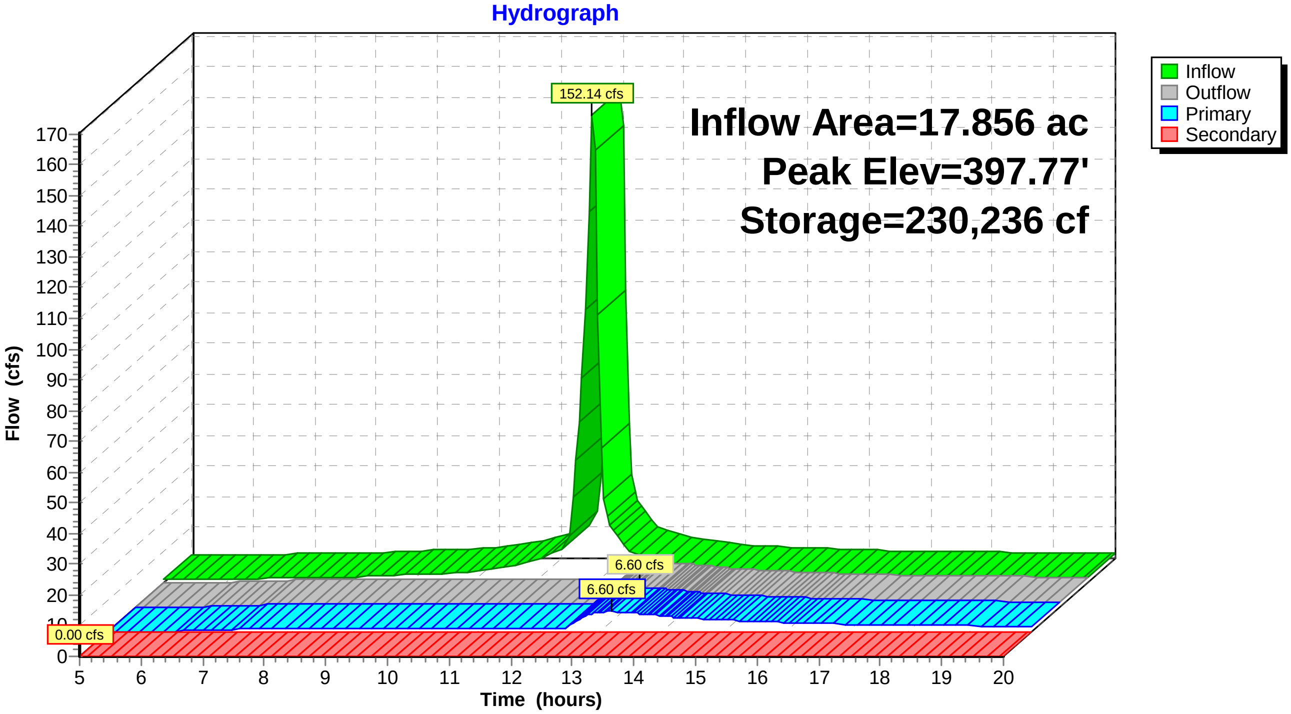
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.54 cfs @ 13.17 hrs HW=397.77' (Free Discharge)
└─**2=Culvert** (Passes 6.54 cfs of 39.35 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 5.37 cfs @ 1.68 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N2: SB-OB-5



Summary for Pond N3: SB-OB-4

[82] Warning: Early inflow requires earlier time span

Inflow Area =	13.206 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event		
Inflow =	112.51 cfs @ 11.96 hrs,	Volume=	5.739 af
Outflow =	6.10 cfs @ 12.85 hrs,	Volume=	2.279 af, Atten= 95%, Lag= 53.2 min
Primary =	6.10 cfs @ 12.85 hrs,	Volume=	2.279 af
Secondary =	0.00 cfs @ 5.00 hrs,	Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.25' @ 12.85 hrs Surf.Area= 32,745 sf Storage= 158,541 cf

Plug-Flow detention time= 191.3 min calculated for 2.278 af (40% of inflow)
Center-of-Mass det. time= 88.3 min (826.8 - 738.5)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	260,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

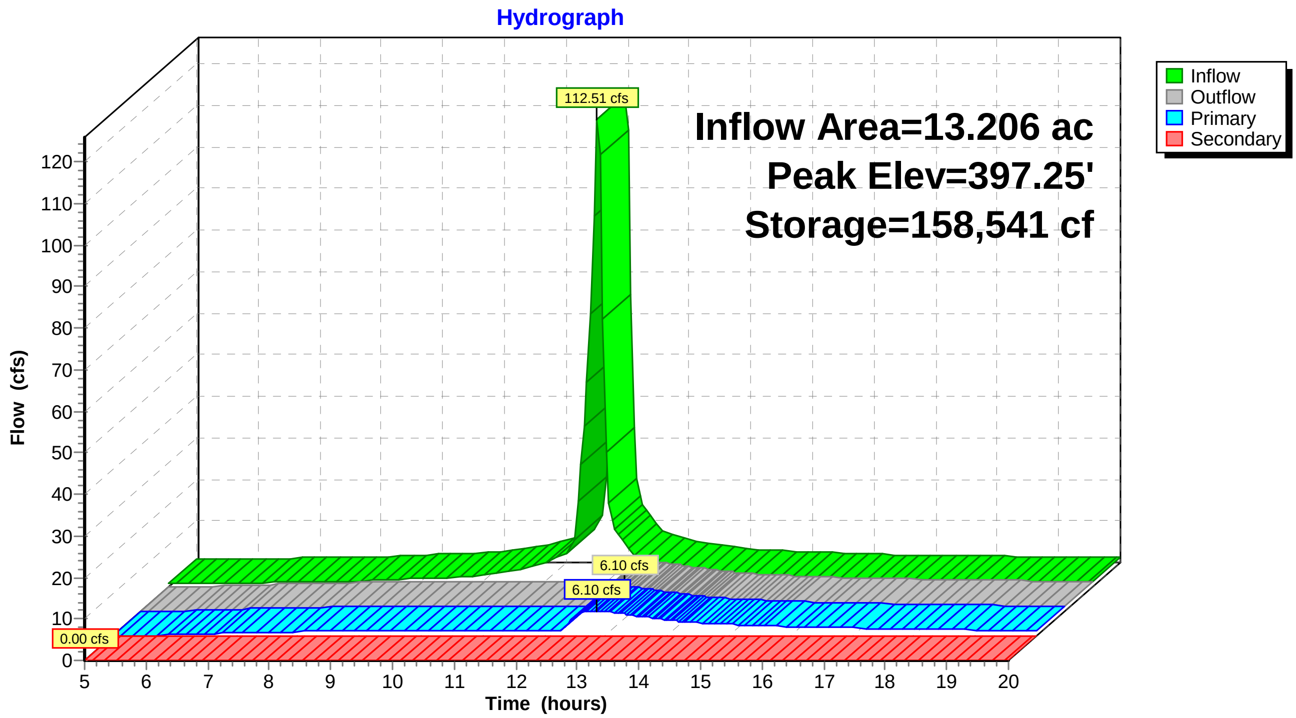
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	11,000	0	0
400.00	41,000	260,000	260,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.03 cfs @ 12.85 hrs HW=397.25' (Free Discharge)
└─**2=Culvert** (Passes 6.03 cfs of 37.81 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 4.86 cfs @ 1.63 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N3: SB-OB-4



Summary for Pond NW1: SB-OB-7

[82] Warning: Early inflow requires earlier time span

Inflow Area = 16.857 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event
Inflow = 136.06 cfs @ 11.99 hrs, Volume= 7.324 af
Outflow = 6.10 cfs @ 13.25 hrs, Volume= 2.529 af, Atten= 96%, Lag= 75.5 min
Primary = 6.10 cfs @ 13.25 hrs, Volume= 2.529 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.45' @ 13.25 hrs Surf.Area= 40,345 sf Storage= 217,283 cf

Plug-Flow detention time= 224.5 min calculated for 2.519 af (34% of inflow)
Center-of-Mass det. time= 110.7 min (850.8 - 740.1)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

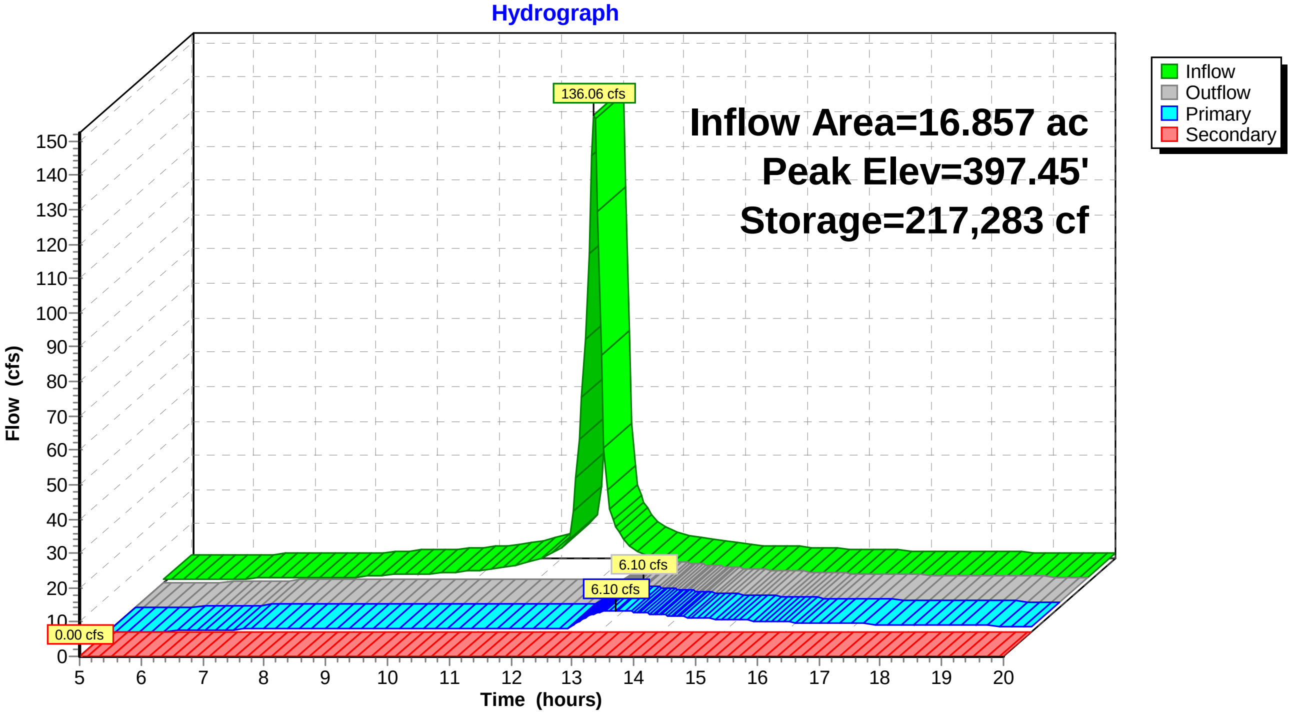
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.02 cfs @ 13.25 hrs HW=397.45' (Free Discharge)
└─**2=Culvert** (Passes 6.02 cfs of 38.41 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 4.85 cfs @ 1.63 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond NW1: SB-OB-7



Summary for Pond P1: SB-P-8

[82] Warning: Early inflow requires earlier time span

Inflow Area = 15.460 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event
Inflow = 124.79 cfs @ 11.99 hrs, Volume= 6.717 af
Outflow = 6.09 cfs @ 13.10 hrs, Volume= 2.436 af, Atten= 95%, Lag= 66.6 min
Primary = 6.09 cfs @ 13.10 hrs, Volume= 2.436 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.25' @ 13.10 hrs Surf.Area= 37,744 sf Storage= 194,769 cf

Plug-Flow detention time= 213.0 min calculated for 2.426 af (36% of inflow)
Center-of-Mass det. time= 103.4 min (843.6 - 740.1)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

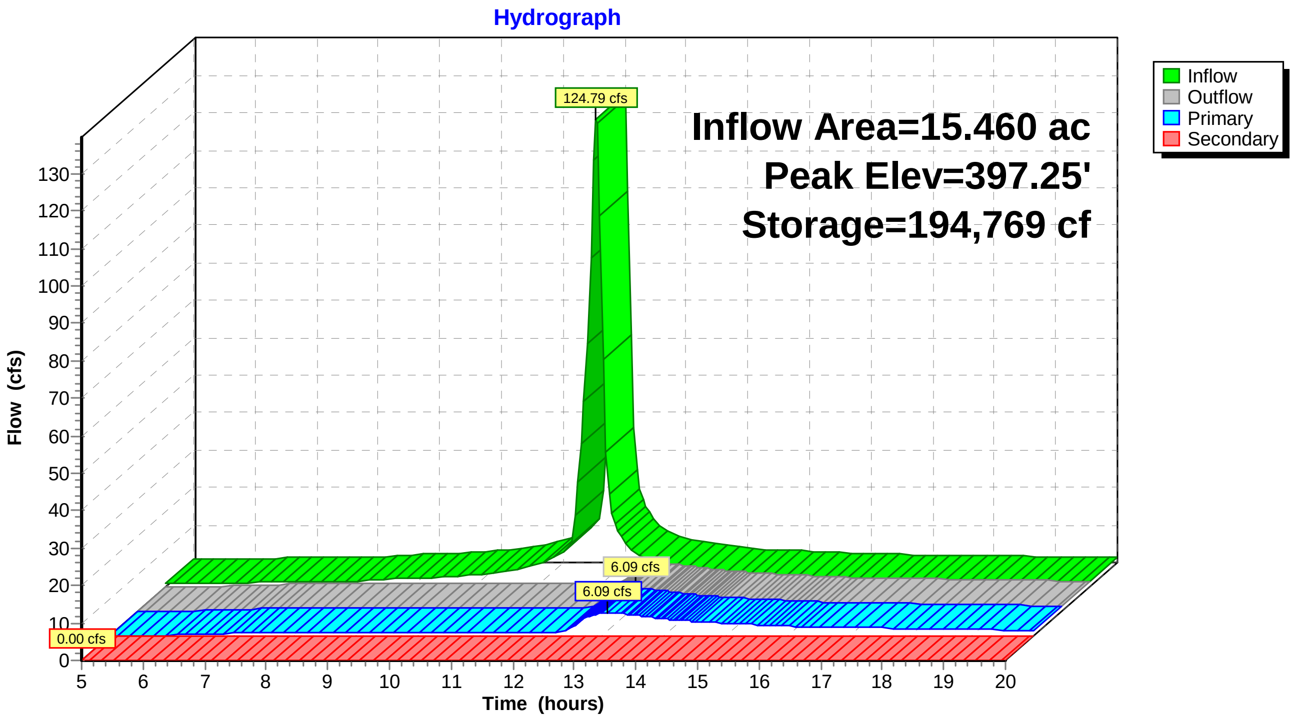
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.01 cfs @ 13.10 hrs HW=397.25' (Free Discharge)
└─**2=Culvert** (Passes 6.01 cfs of 37.81 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 4.85 cfs @ 1.63 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1: SB-P-8


Hydrograph
Inflow
Outflow
Primary
Secondary
124.79 cfs
6.09 cfs
6.09 cfs
0.00 cfs
Inflow Area=15.460 ac
Peak Elev=397.25'
Storage=194,769 cf
Flow (cfs)
Time (hours)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Summary for Pond P2: SB-P-2

[82] Warning: Early inflow requires earlier time span

Inflow Area = 47.459 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event
Inflow = 374.81 cfs @ 12.00 hrs, Volume= 20.618 af
Outflow = 12.14 cfs @ 13.95 hrs, Volume= 5.819 af, Atten= 97%, Lag= 117.2 min
Primary = 12.14 cfs @ 13.95 hrs, Volume= 5.819 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.80' @ 13.95 hrs Surf.Area= 97,389 sf Storage= 668,108 cf

Plug-Flow detention time= 290.5 min calculated for 5.814 af (28% of inflow)
Center-of-Mass det. time= 156.8 min (897.4 - 740.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	890,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

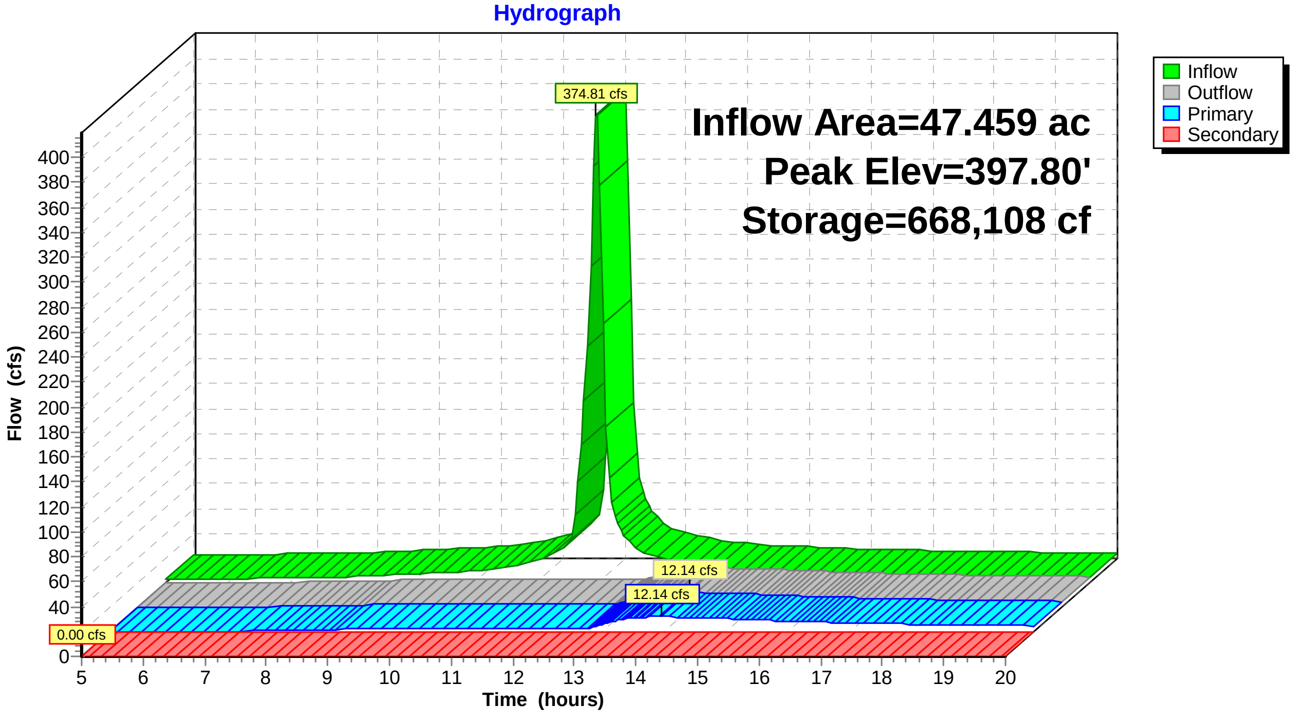
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	74,000	0	0
400.00	104,000	890,000	890,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=12.13 cfs @ 13.95 hrs HW=397.80' (Free Discharge)
└─**2=Culvert** (Passes 12.13 cfs of 39.44 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Weir Controls 9.79 cfs @ 2.06 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P2: SB-P-2


Hydrograph
374.81 cfs
Inflow Area=47.459 ac
Peak Elev=397.80'
Storage=668,108 cf
12.14 cfs
12.14 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
Time (hours)
0
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
5
6
7
8
9
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20

Summary for Pond PT1: SB-PT-9

[82] Warning: Early inflow requires earlier time span

Inflow Area = 42.536 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event
Inflow = 349.23 cfs @ 11.98 hrs, Volume= 18.481 af
Outflow = 11.74 cfs @ 13.77 hrs, Volume= 5.494 af, Atten= 97%, Lag= 107.0 min
Primary = 11.74 cfs @ 13.77 hrs, Volume= 5.494 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.69' @ 13.77 hrs Surf.Area= 88,055 sf Storage= 588,121 cf

Plug-Flow detention time= 276.2 min calculated for 5.471 af (30% of inflow)
Center-of-Mass det. time= 148.5 min (888.2 - 739.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	800,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

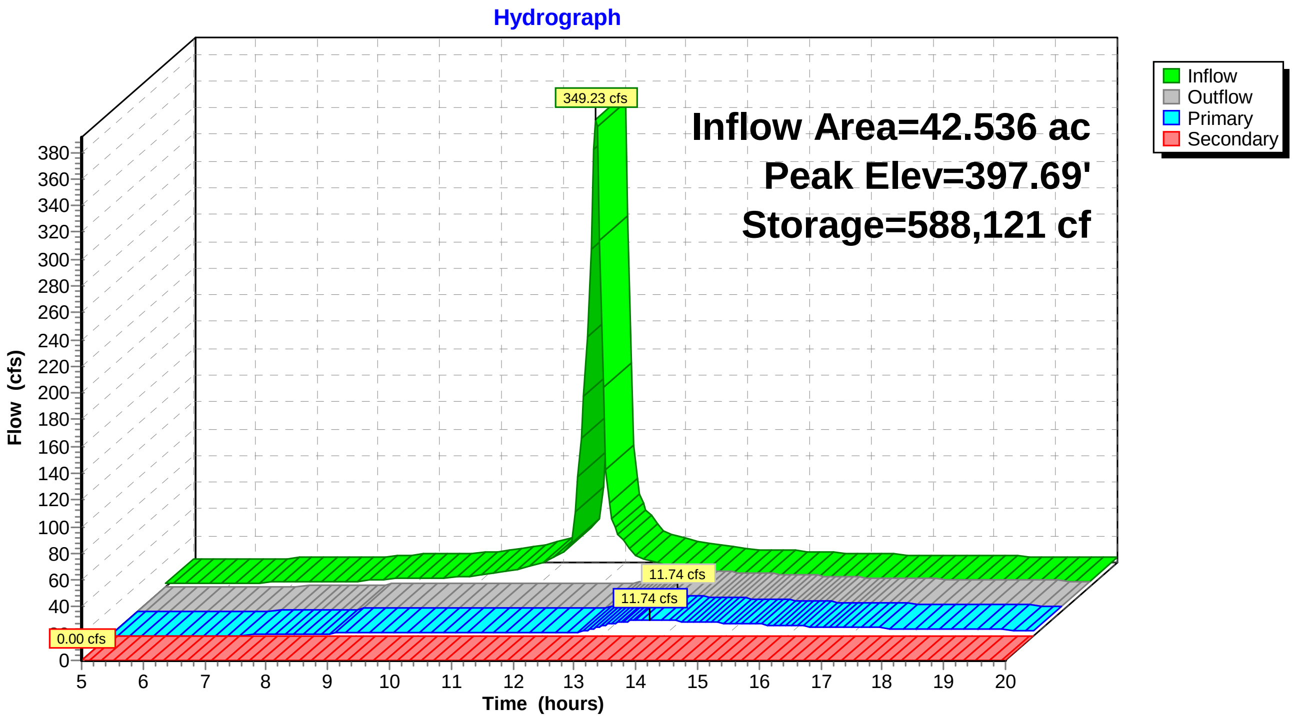
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	65,000	0	0
400.00	95,000	800,000	800,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.30'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=11.71 cfs @ 13.77 hrs HW=397.69' (Free Discharge)
└─**2=Culvert** (Passes 11.71 cfs of 39.11 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 2.34 cfs)
  └─**3=Orifice/Grate** (Weir Controls 9.37 cfs @ 2.03 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT1: SB-PT-9



Summary for Pond PT2: SB-PT-1

[82] Warning: Early inflow requires earlier time span

Inflow Area = 22.345 ac, 0.00% Impervious, Inflow Depth > 5.21" for 25-yr event
Inflow = 188.23 cfs @ 11.97 hrs, Volume= 9.710 af
Outflow = 6.90 cfs @ 13.52 hrs, Volume= 2.974 af, Atten= 96%, Lag= 93.1 min
Primary = 6.90 cfs @ 13.52 hrs, Volume= 2.974 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.68' @ 13.52 hrs Surf.Area= 51,027 sf Storage= 303,284 cf

Plug-Flow detention time= 258.7 min calculated for 2.972 af (31% of inflow)
Center-of-Mass det. time= 133.1 min (871.9 - 738.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	430,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

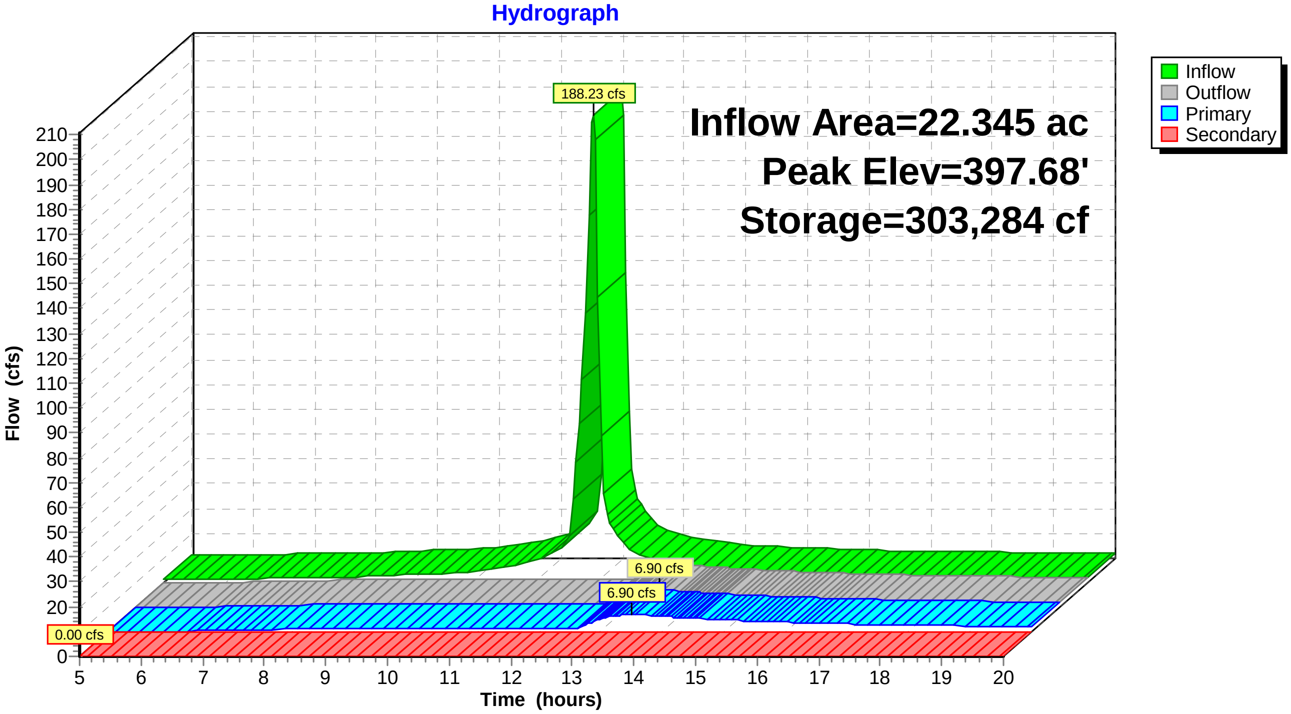
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	28,000	0	0
400.00	58,000	430,000	430,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.84 cfs @ 13.52 hrs HW=397.68' (Free Discharge)
└─**2=Culvert** (Passes 6.84 cfs of 39.08 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 5.67 cfs @ 1.72 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT2: SB-PT-1



Summary for Pond S1: SB-OB-10

[82] Warning: Early inflow requires earlier time span

Inflow Area =	18.532 ac,	0.00% Impervious,	Inflow Depth > 5.21"	for 25-yr event
Inflow =	149.13 cfs @	11.99 hrs, Volume=	8.051 af	
Outflow =	6.40 cfs @	13.34 hrs, Volume=	2.684 af,	Atten= 96%, Lag= 81.0 min
Primary =	6.40 cfs @	13.34 hrs, Volume=	2.684 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.06' @ 13.34 hrs Surf.Area= 42,176 sf Storage= 242,463 cf

Plug-Flow detention time= 232.7 min calculated for 2.682 af (33% of inflow)
Center-of-Mass det. time= 114.9 min (855.1 - 740.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

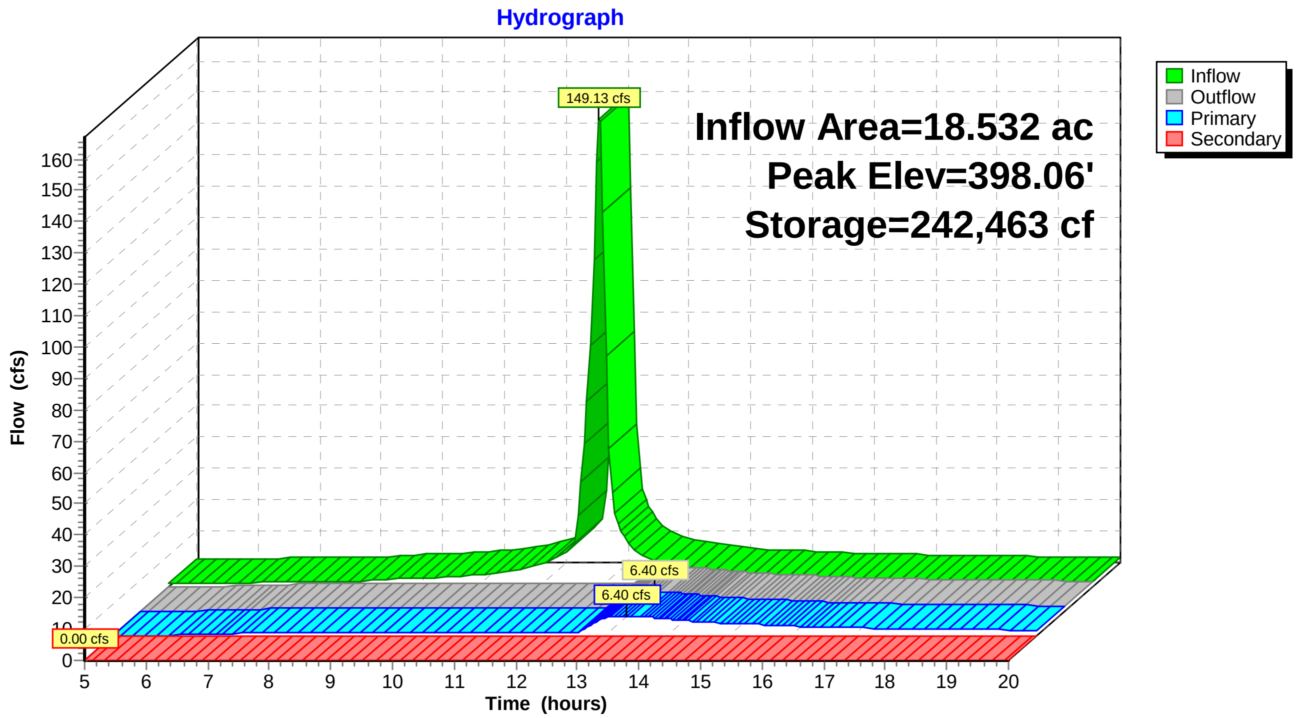
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.80'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.32 cfs @ 13.34 hrs HW=398.06' (Free Discharge)
└─**2=Culvert** (Passes 6.32 cfs of 40.19 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 5.16 cfs @ 1.66 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S1: SB-OB-10



Summary for Pond W1: SB-OB-11

[82] Warning: Early inflow requires earlier time span

Inflow Area =	18.955 ac,	0.00% Impervious, Inflow Depth >	5.21"	for 25-yr event
Inflow =	158.55 cfs @	11.97 hrs, Volume=	8.237 af	
Outflow =	6.39 cfs @	13.36 hrs, Volume=	2.704 af,	Atten= 96%, Lag= 83.4 min
Primary =	6.39 cfs @	13.36 hrs, Volume=	2.704 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.86' @ 13.36 hrs Surf.Area= 43,574 sf Storage= 249,788 cf

Plug-Flow detention time= 237.1 min calculated for 2.693 af (33% of inflow)
Center-of-Mass det. time= 118.8 min (857.7 - 738.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	350,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

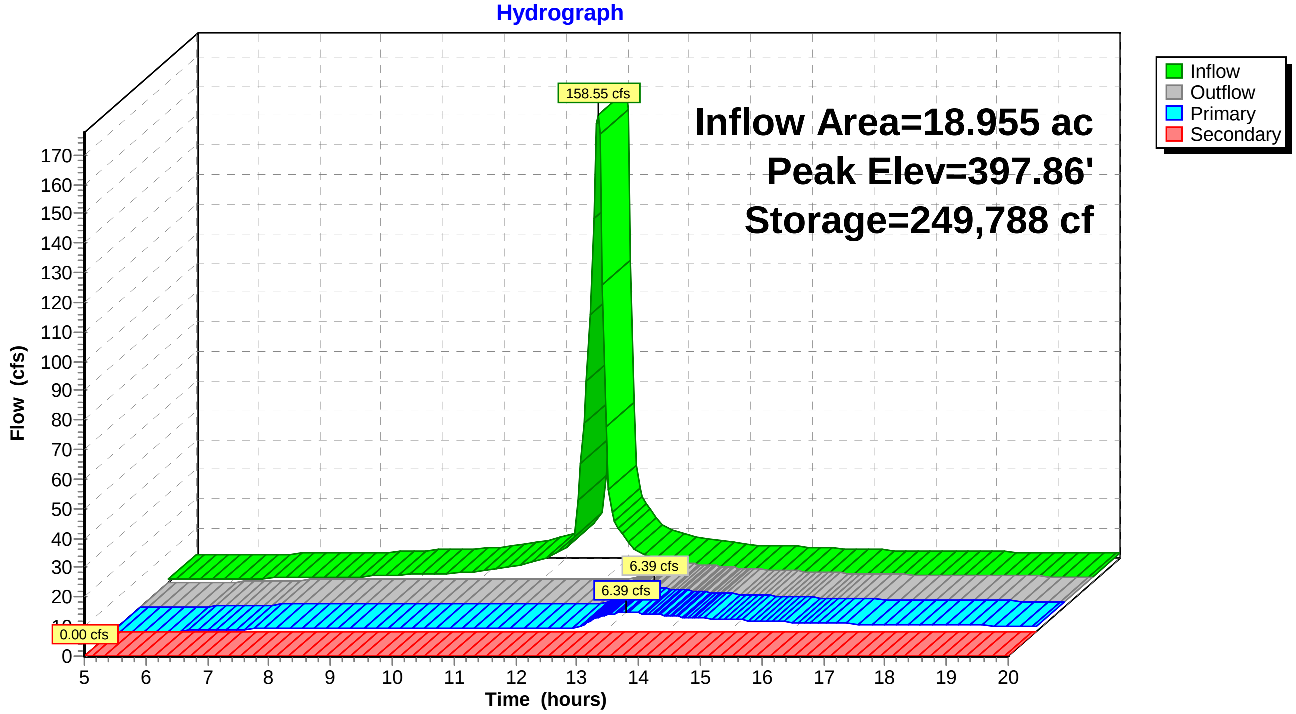
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	20,000	0	0
400.00	50,000	350,000	350,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.60'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.31 cfs @ 13.36 hrs HW=397.86' (Free Discharge)
└—**2=Culvert** (Passes 6.31 cfs of 39.61 cfs potential flow)
  ├—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Weir Controls 5.14 cfs @ 1.66 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1: SB-OB-11



Summary for Pond W2: SB-OB-12

[82] Warning: Early inflow requires earlier time span

Inflow Area =	18.853 ac,	0.00% Impervious, Inflow Depth > 5.21"	for 25-yr event
Inflow =	156.62 cfs @ 11.97 hrs, Volume=	8.192 af	
Outflow =	6.19 cfs @ 13.41 hrs, Volume=	2.649 af,	Atten= 96%, Lag= 86.4 min
Primary =	6.19 cfs @ 13.41 hrs, Volume=	2.649 af	
Secondary =	0.00 cfs @ 5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 396.75' @ 13.41 hrs Surf.Area= 47,254 sf Storage= 250,658 cf

Plug-Flow detention time= 245.6 min calculated for 2.638 af (32% of inflow)
Center-of-Mass det. time= 125.9 min (865.0 - 739.0)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	420,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

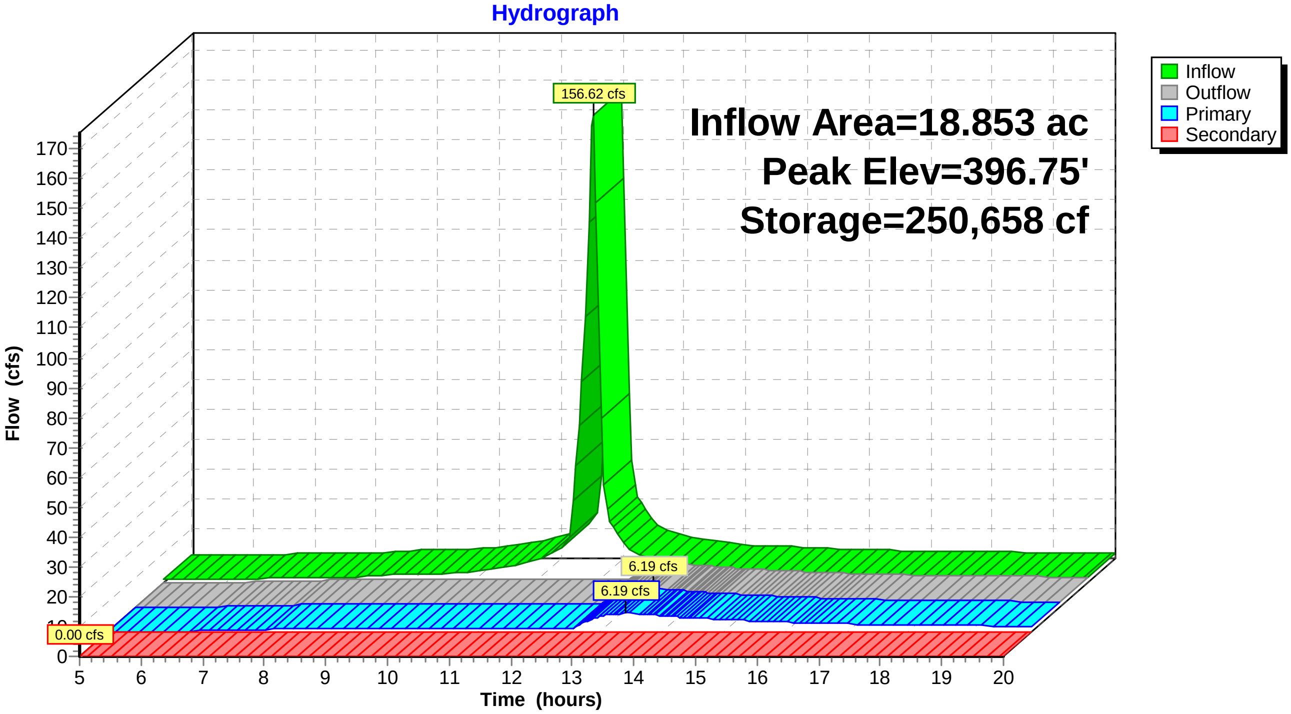
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	27,000	0	0
400.00	57,000	420,000	420,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	396.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.11 cfs @ 13.41 hrs HW=396.75' (Free Discharge)
└─**2=Culvert** (Passes 6.11 cfs of 36.28 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 4.94 cfs @ 1.64 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2: SB-OB-12



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: SB-OB-3 Runoff Area=679,818 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,439' Tc=6.0 min CN=94 Runoff=174.94 cfs 9.031 af

Subcatchment N-1: SB-OB-6 Runoff Area=926,011 sf 0.00% Impervious Runoff Depth>6.94"
Tc=6.0 min CN=94 Runoff=238.29 cfs 12.302 af

Subcatchment N-2: SB-OB-5 Runoff Area=777,820 sf 0.00% Impervious Runoff Depth>6.94"
Tc=6.0 min CN=94 Runoff=200.16 cfs 10.333 af

Subcatchment N-3: SB-OB-4 Runoff Area=575,239 sf 0.00% Impervious Runoff Depth>6.94"
Tc=6.0 min CN=94 Runoff=148.03 cfs 7.642 af

Subcatchment NW-1: SB-OB-7 Runoff Area=734,304 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,210' Tc=8.2 min CN=94 Runoff=179.04 cfs 9.754 af

Subcatchment P1-1: SB-P-8 Runoff Area=673,438 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,455' Tc=8.2 min CN=94 Runoff=164.19 cfs 8.945 af

Subcatchment P2-1: SB-P-2 Runoff Area=2,067,328 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=2,346' Tc=8.9 min CN=94 Runoff=493.26 cfs 27.458 af

Subcatchment PT-1: SB-PT-9 Runoff Area=1,852,884 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,128' Tc=7.6 min CN=94 Runoff=459.46 cfs 24.612 af

Subcatchment PT-2: SB-PT-1 Runoff Area=973,360 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,632' Tc=6.3 min CN=94 Runoff=247.65 cfs 12.931 af

Subcatchment S-1: SB-OB-10 Runoff Area=807,263 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,584' Tc=8.3 min CN=94 Runoff=196.24 cfs 10.723 af

Subcatchment W-1: SB-OB-11 Runoff Area=825,679 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,196' Tc=6.5 min CN=94 Runoff=208.61 cfs 10.969 af

Subcatchment W-2: SB-OB-12 Runoff Area=821,258 sf 0.00% Impervious Runoff Depth>6.94"
Flow Length=1,314' Tc=6.7 min CN=94 Runoff=206.06 cfs 10.910 af

Pond E1: SB-OB-3 Peak Elev=398.03' Storage=225,274 cf Inflow=174.94 cfs 9.031 af
Primary=36.46 cfs 4.634 af Secondary=0.00 cfs 0.000 af Outflow=36.46 cfs 4.634 af

Pond N1: SB-OB-6 Peak Elev=398.69' Storage=321,876 cf Inflow=238.29 cfs 12.302 af
Primary=39.88 cfs 5.902 af Secondary=0.00 cfs 0.000 af Outflow=39.88 cfs 5.902 af

Pond N2: SB-OB-5 Peak Elev=398.50' Storage=261,579 cf Inflow=200.16 cfs 10.333 af
Primary=40.47 cfs 5.219 af Secondary=0.00 cfs 0.000 af Outflow=40.47 cfs 5.219 af

Pond N3: SB-OB-4 Peak Elev=397.97' Storage=183,002 cf Inflow=148.03 cfs 7.642 af
Primary=38.50 cfs 4.160 af Secondary=0.00 cfs 0.000 af Outflow=38.50 cfs 4.160 af

Pond NW1: SB-OB-7 Peak Elev=398.14' Storage=245,879 cf Inflow=179.04 cfs 9.754 af
Primary=36.93 cfs 4.924 af Secondary=0.00 cfs 0.000 af Outflow=36.93 cfs 4.924 af

Pond P1: SB-P-8 Peak Elev=397.94' Storage=221,428 cf Inflow=164.19 cfs 8.945 af
Primary=36.57 cfs 4.634 af Secondary=0.00 cfs 0.000 af Outflow=36.57 cfs 4.634 af

Pond P2: SB-P-2 Peak Elev=398.83' Storage=770,045 cf Inflow=493.26 cfs 27.458 af
Primary=42.32 cfs 12.541 af Secondary=0.00 cfs 0.000 af Outflow=42.32 cfs 12.541 af

Pond PT1: SB-PT-9 Peak Elev=398.69' Storage=678,112 cf Inflow=459.46 cfs 24.612 af
Primary=41.95 cfs 11.520 af Secondary=0.00 cfs 0.000 af Outflow=41.95 cfs 11.520 af

Pond PT2: SB-PT-1 Peak Elev=398.39' Storage=340,558 cf Inflow=247.65 cfs 12.931 af
Primary=39.89 cfs 6.157 af Secondary=0.00 cfs 0.000 af Outflow=39.89 cfs 6.157 af

Pond S1: SB-OB-10 Peak Elev=398.78' Storage=273,511 cf Inflow=196.24 cfs 10.723 af
Primary=39.05 cfs 5.319 af Secondary=0.00 cfs 0.000 af Outflow=39.05 cfs 5.319 af

Pond W1: SB-OB-11 Peak Elev=398.58' Storage=281,952 cf Inflow=208.61 cfs 10.969 af
Primary=39.17 cfs 5.399 af Secondary=0.00 cfs 0.000 af Outflow=39.17 cfs 5.399 af

Pond W2: SB-OB-12 Peak Elev=397.42' Storage=282,847 cf Inflow=206.06 cfs 10.910 af
Primary=35.39 cfs 5.326 af Secondary=0.00 cfs 0.000 af Outflow=35.39 cfs 5.326 af

Total Runoff Area = 268.926 ac Runoff Volume = 155.609 af Average Runoff Depth = 6.94"
100.00% Pervious = 268.926 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E-1: SB-OB-3

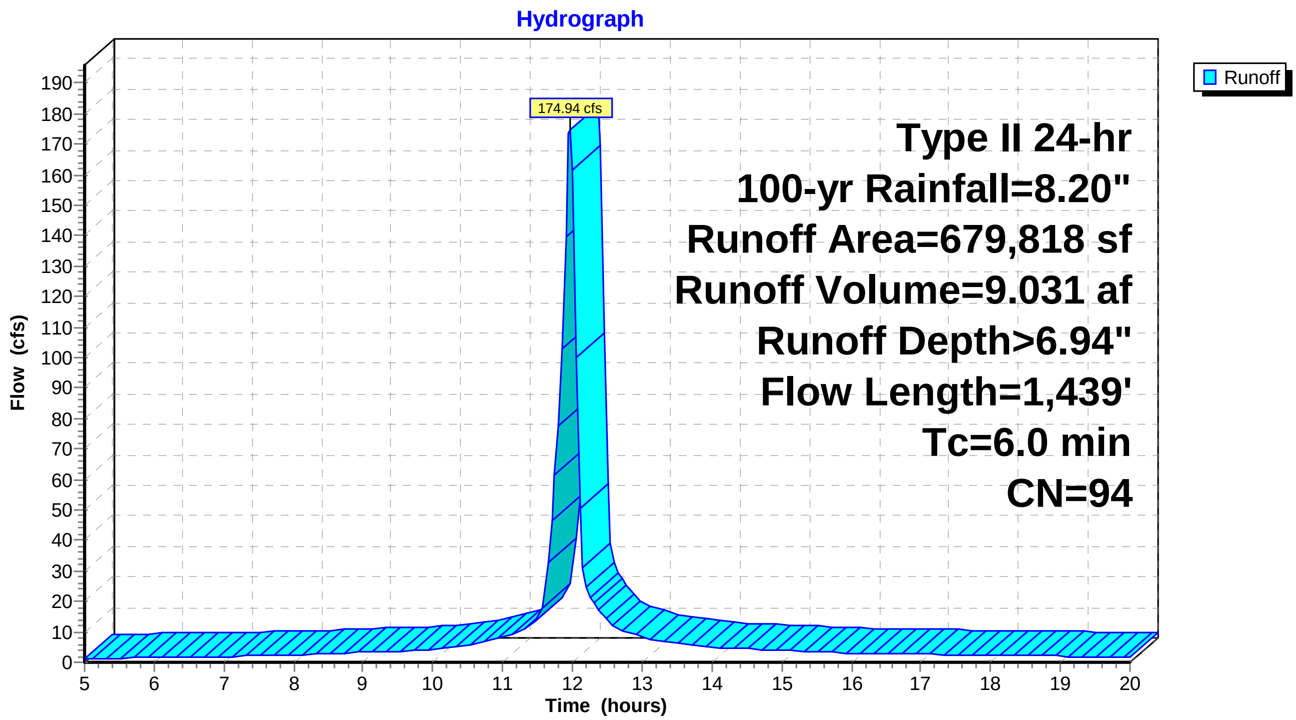
Runoff = 174.94 cfs @ 11.96 hrs, Volume= 9.031 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
679,818	94	Newly graded area, HSG D
679,818		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	100	0.0683	0.66		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.5	608	0.1660	4.07		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.0	731	0.0140	11.61	406.21	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.0	1,439	Total			

Subcatchment E-1: SB-OB-3



Summary for Subcatchment N-1: SB-OB-6

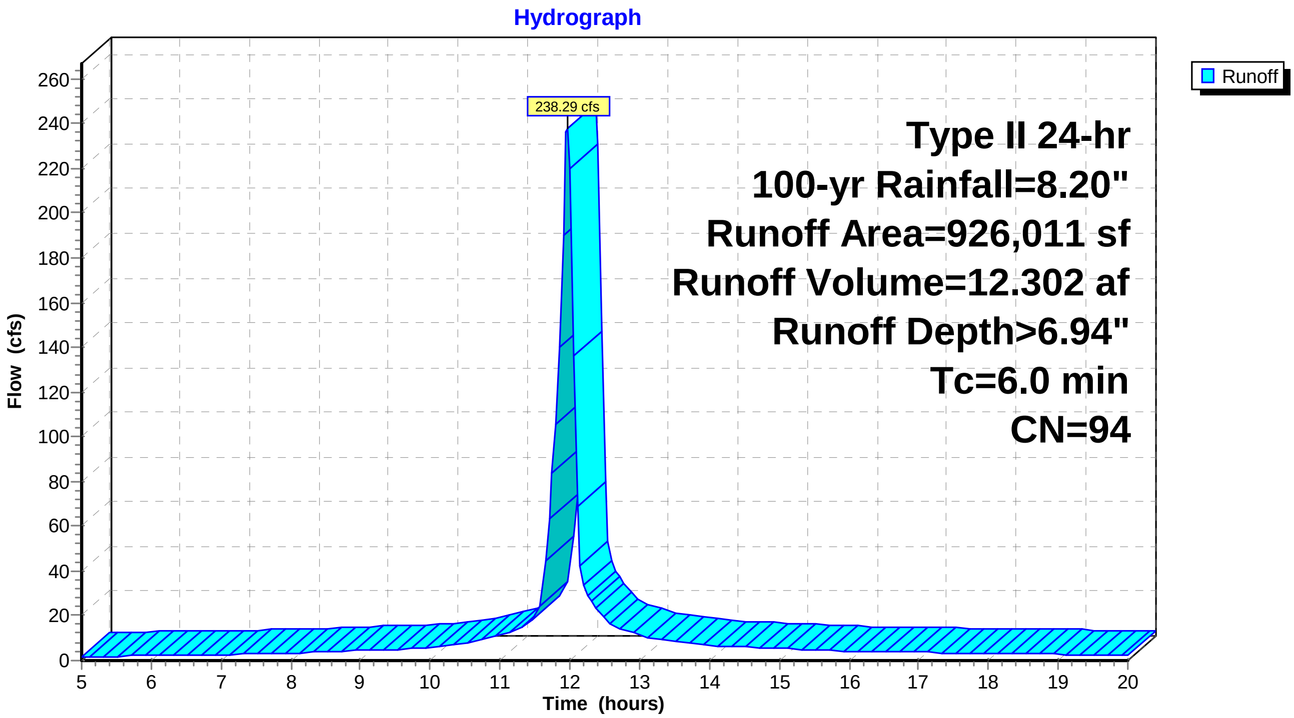
Runoff = 238.29 cfs @ 11.96 hrs, Volume= 12.302 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
926,011	94	Newly graded area, HSG D
926,011		100.00% Pervious Area

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

Subcatchment N-1: SB-OB-6



Summary for Subcatchment N-2: SB-OB-5

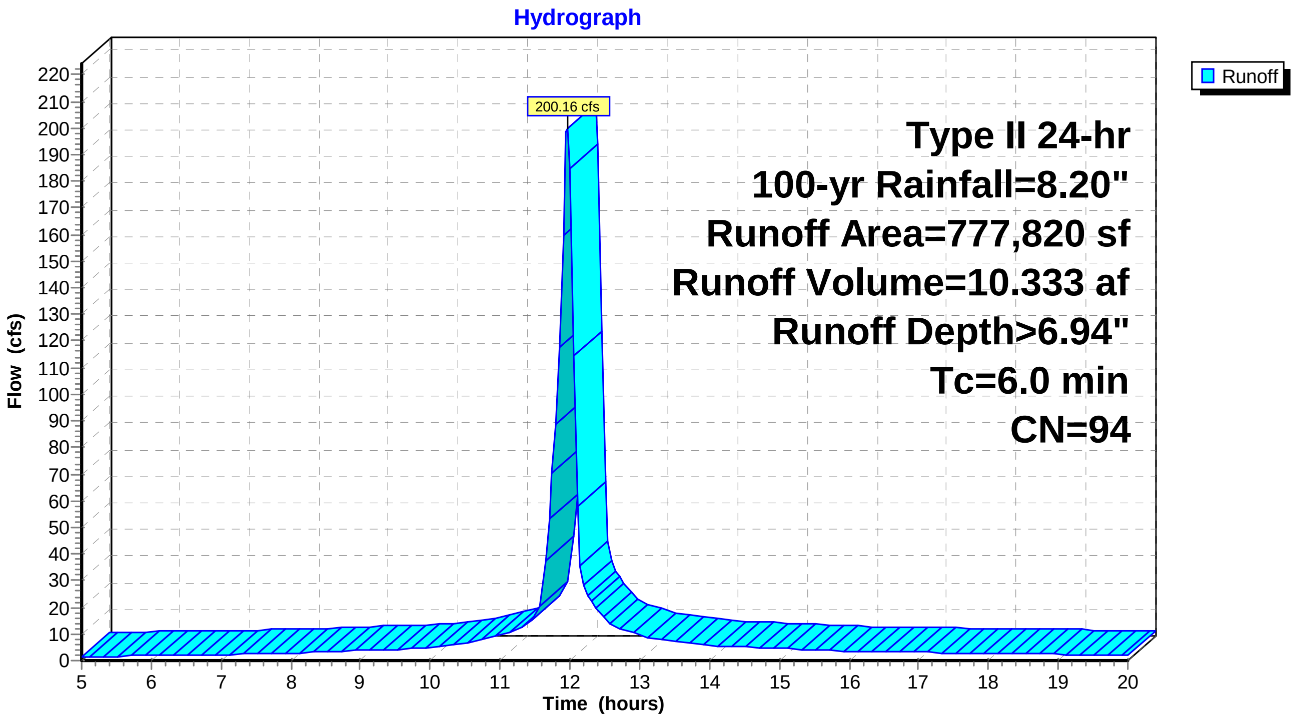
Runoff = 200.16 cfs @ 11.96 hrs, Volume= 10.333 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
777,820	94	Newly graded area, HSG D
777,820		100.00% Pervious Area

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

Subcatchment N-2: SB-OB-5



Summary for Subcatchment N-3: SB-OB-4

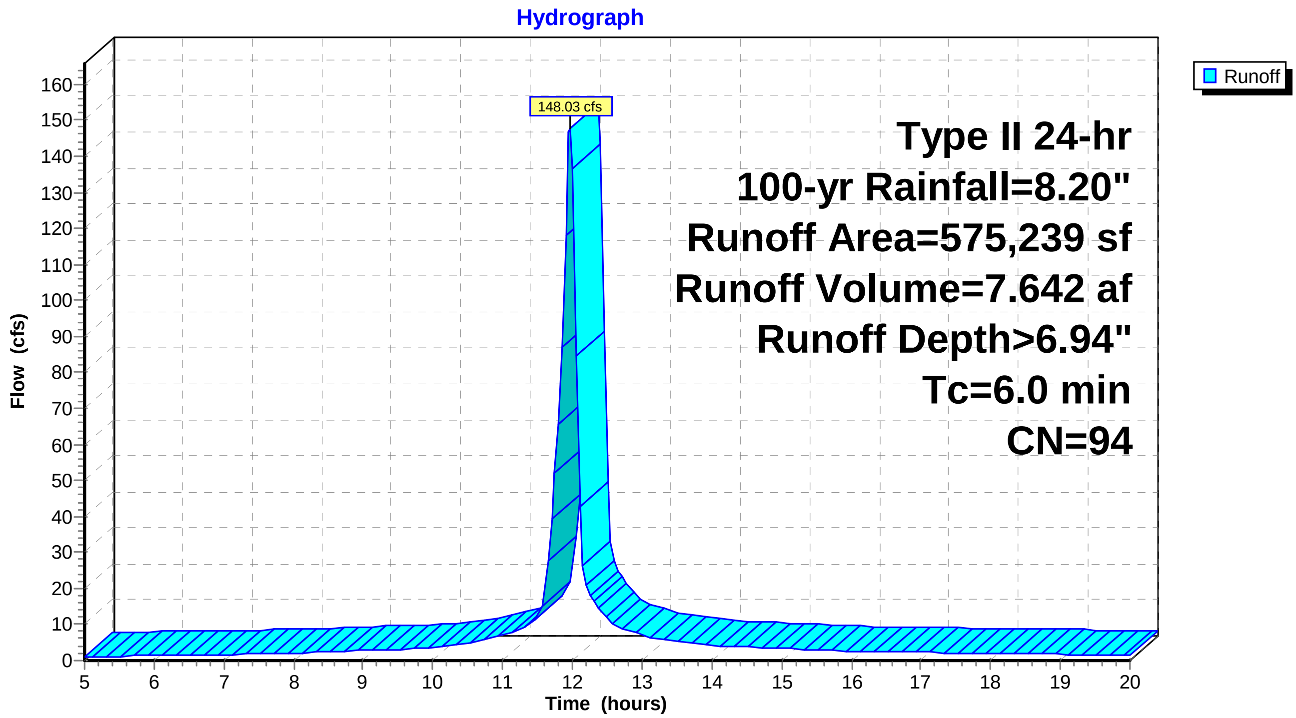
Runoff = 148.03 cfs @ 11.96 hrs, Volume= 7.642 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
575,239	94	Newly graded area, HSG D
575,239		100.00% Pervious Area

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

Subcatchment N-3: SB-OB-4



Summary for Subcatchment NW-1: SB-OB-7

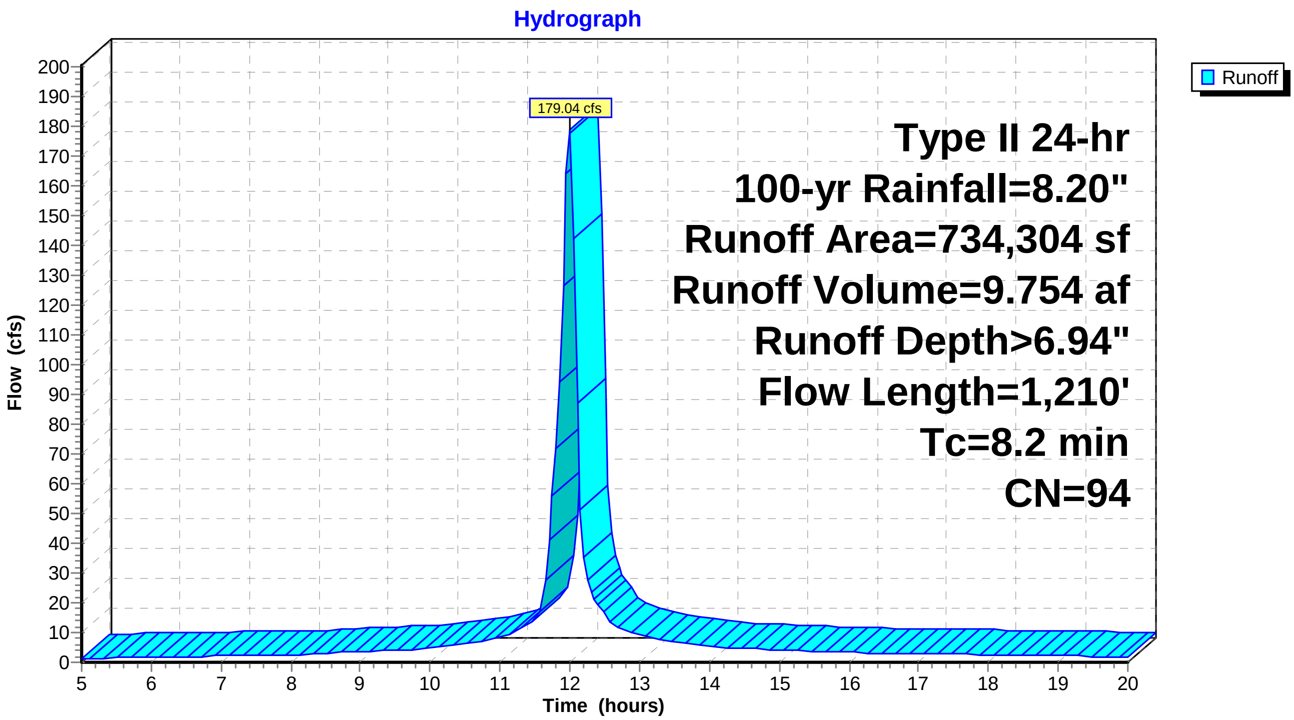
Runoff = 179.04 cfs @ 11.99 hrs, Volume= 9.754 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
734,304	94	Newly graded area, HSG D
734,304		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.0206	0.41		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
3.2	674	0.1225	3.50		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.9	436	0.0072	8.32	291.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,210	Total			

Subcatchment NW-1: SB-OB-7



Summary for Subcatchment P1-1: SB-P-8

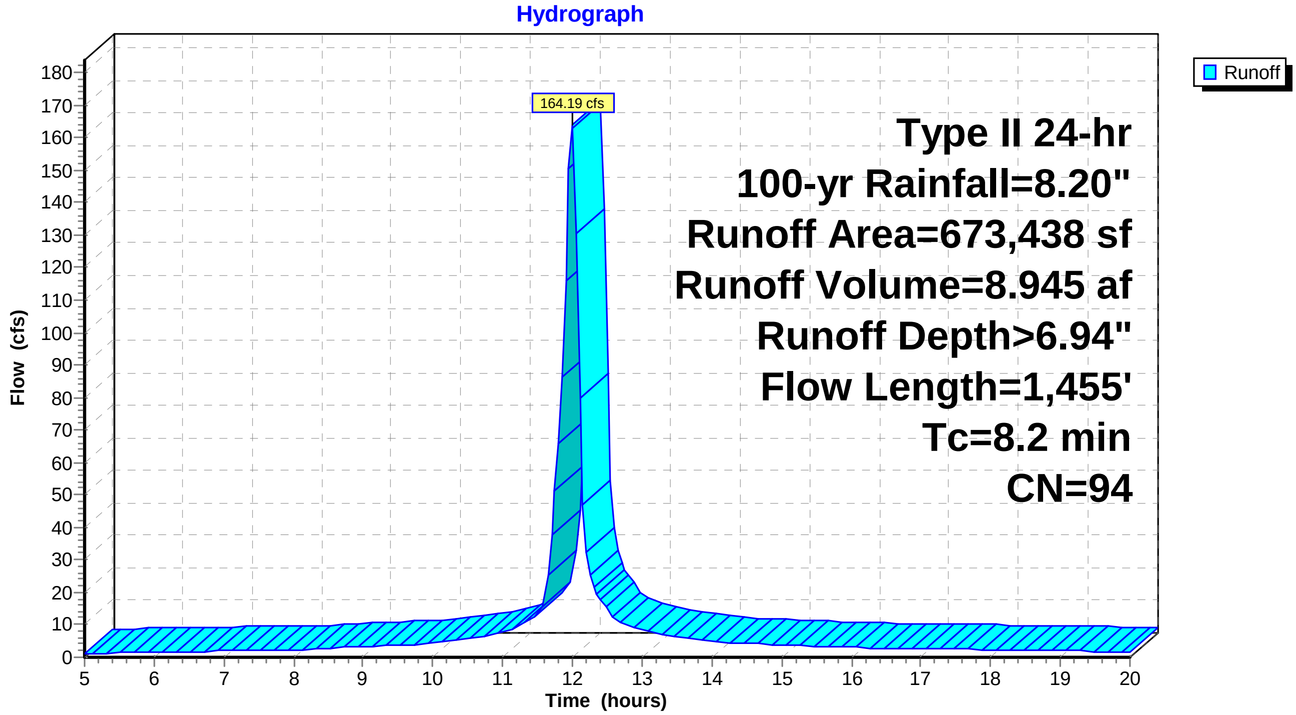
Runoff = 164.19 cfs @ 11.99 hrs, Volume= 8.945 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
673,438	94	Newly graded area, HSG D
673,438		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	100	0.0293	0.47		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.3	866	0.1150	3.39		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.4	489	0.0357	18.53	648.67	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.2	1,455	Total			

Subcatchment P1-1: SB-P-8



Summary for Subcatchment P2-1: SB-P-2

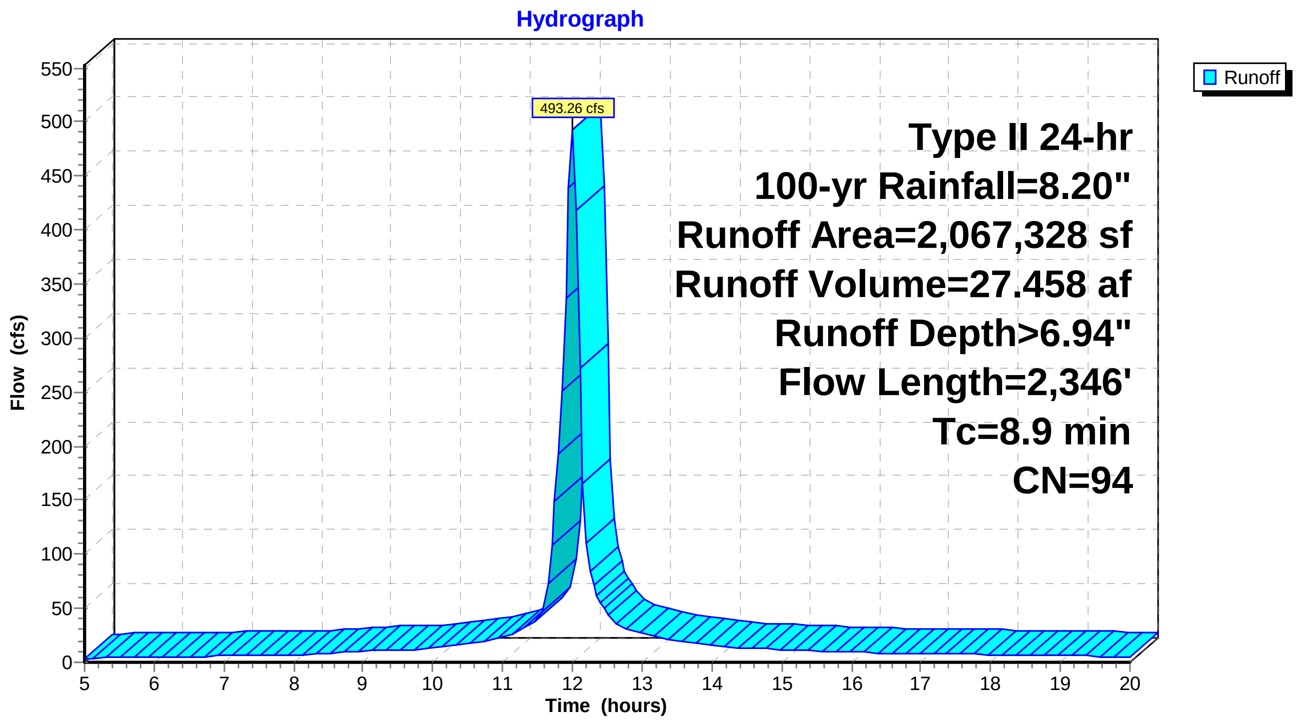
Runoff = 493.26 cfs @ 12.00 hrs, Volume= 27.458 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
2,067,328	94	Newly graded area, HSG D
2,067,328		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0607	0.63		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.5	918	0.1131	3.36		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.7	1,328	0.0180	13.16	460.60	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
8.9	2,346	Total			

Subcatchment P2-1: SB-P-2



Summary for Subcatchment PT-1: SB-PT-9

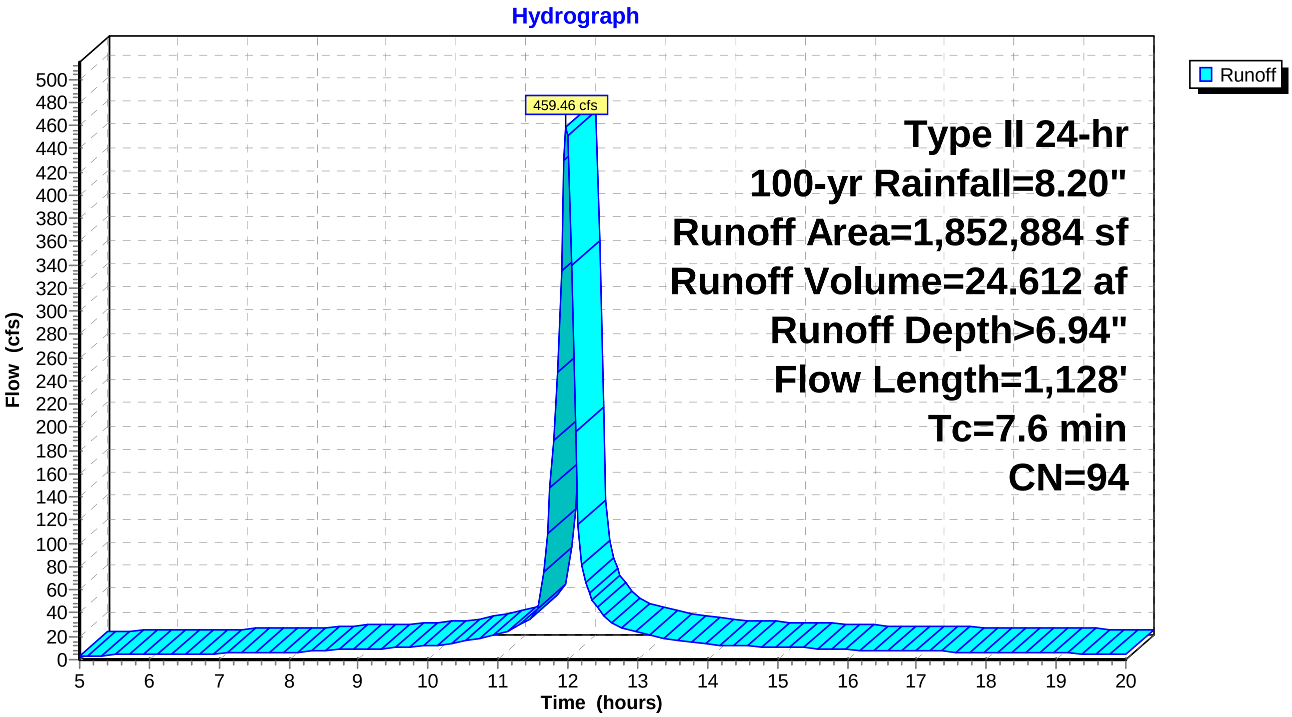
Runoff = 459.46 cfs @ 11.98 hrs, Volume= 24.612 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
1,852,884	94	Newly graded area, HSG D
1,852,884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	100	0.0589	0.62		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
4.9	1,028	0.1230	3.51		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
7.6	1,128	Total			

Subcatchment PT-1: SB-PT-9



Summary for Subcatchment PT-2: SB-PT-1

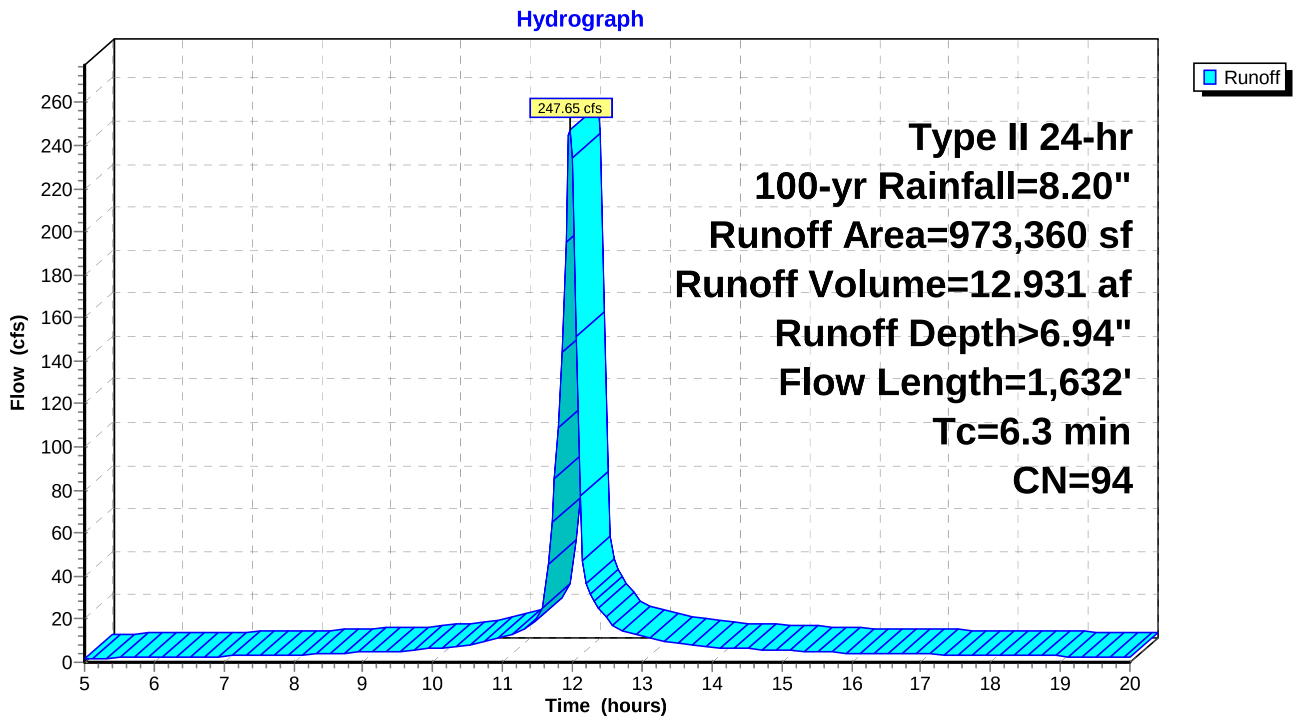
Runoff = 247.65 cfs @ 11.97 hrs, Volume= 12.931 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
973,360	94	Newly graded area, HSG D
973,360		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	100	0.0425	0.55		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.1	291	0.1870	4.32		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
2.1	1,241	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022
6.3	1,632	Total			

Subcatchment PT-2: SB-PT-1



Summary for Subcatchment S-1: SB-OB-10

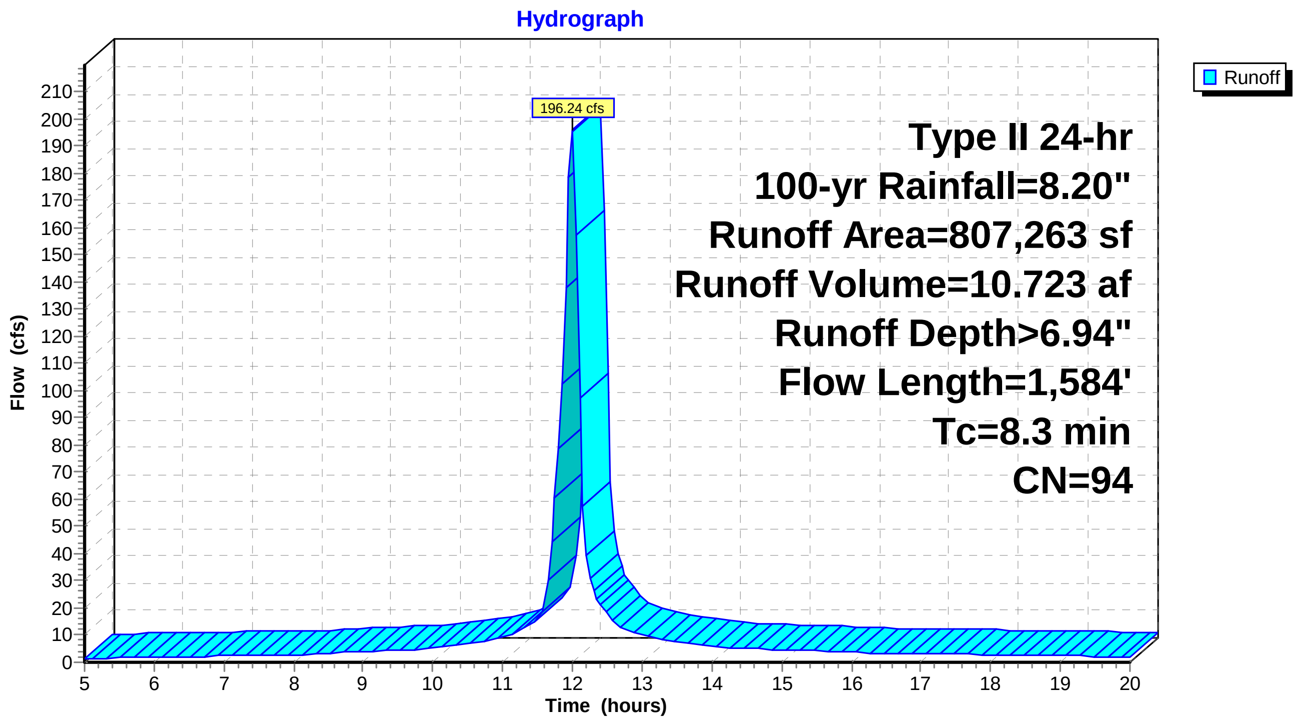
Runoff = 196.24 cfs @ 11.99 hrs, Volume= 10.723 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
807,263	94	Newly graded area, HSG D
807,263		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	100	0.1026	0.78		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
6.0	1,179	0.1090	3.30		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.2	305	0.1080	30.25	1,058.78	**Channel Flow,** Area= 35.0 sf Perim= 22.0' r= 1.59' n= 0.022
8.3	1,584	Total			

Subcatchment S-1: SB-OB-10



Summary for Subcatchment W-1: SB-OB-11

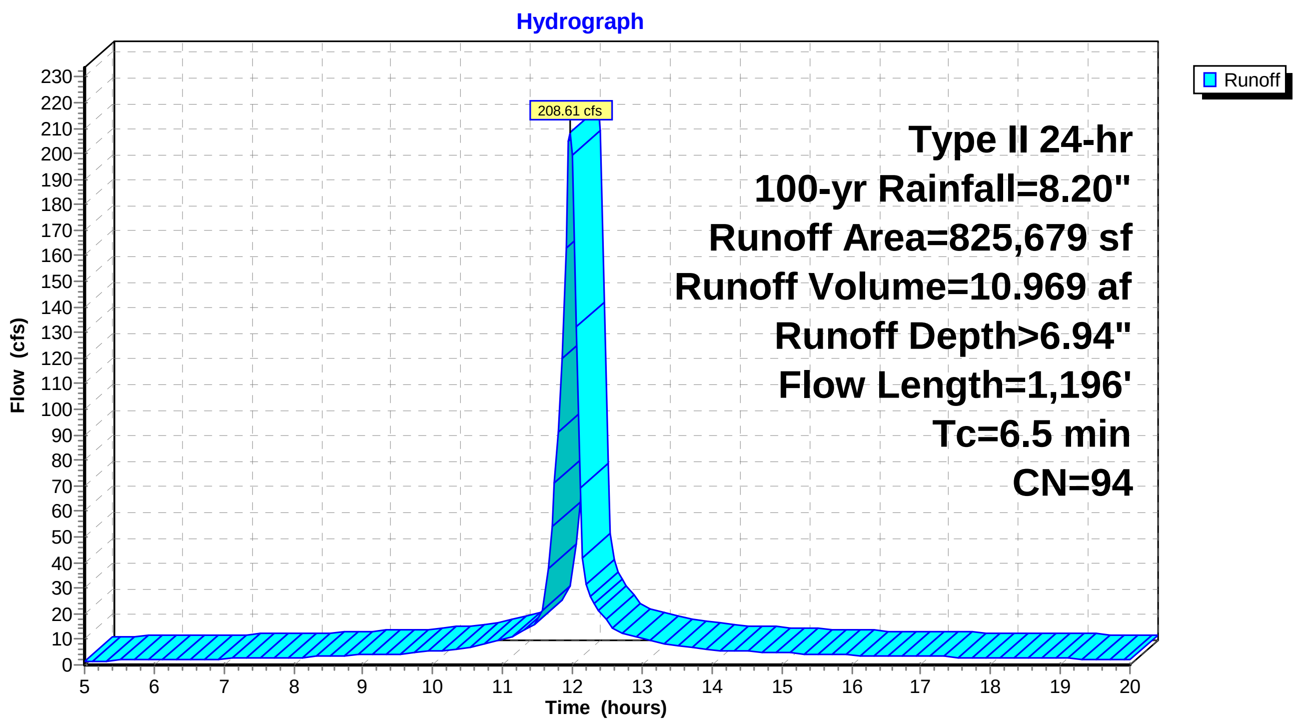
Runoff = 208.61 cfs @ 11.97 hrs, Volume= 10.969 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
825,679	94	Newly graded area, HSG D
825,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	100	0.0490	0.58		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
2.8	621	0.1400	3.74		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.8	475	0.0100	9.81	343.31	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.5	1,196	Total			

Subcatchment W-1: SB-OB-11



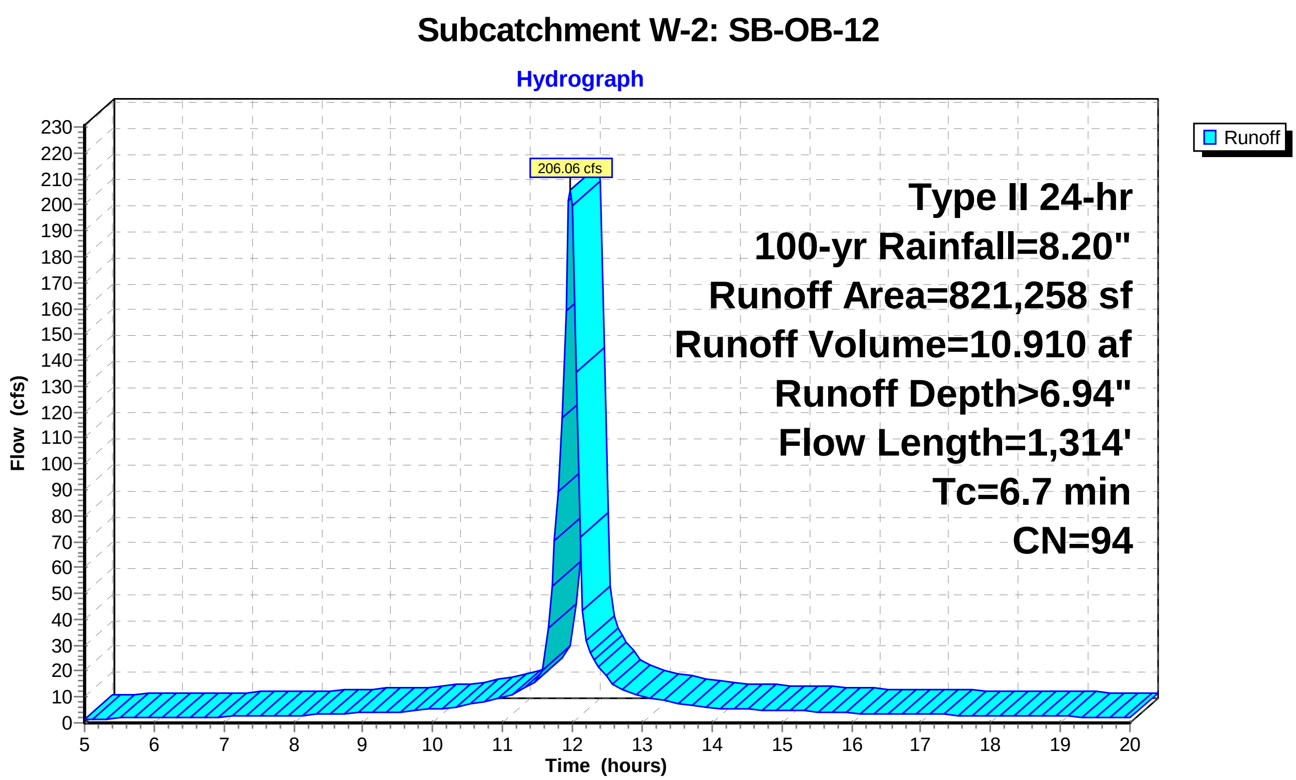
Summary for Subcatchment W-2: SB-OB-12

Runoff = 206.06 cfs @ 11.97 hrs, Volume= 10.910 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=8.20"

Area (sf)	CN	Description
821,258	94	Newly graded area, HSG D
821,258		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	100	0.0138	0.35		**Sheet Flow,** Fallow n= 0.050 P2= 3.10"
1.3	401	0.2700	5.20		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.6	813	0.0617	24.36	852.77	**Channel Flow,** Area= 35.0 sf Perim= 20.0' r= 1.75' n= 0.022 Earth, clean & straight
6.7	1,314	Total			



Summary for Pond E1: SB-OB-3

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      15.606 ac,   0.00% Impervious,  Inflow Depth >  6.94"    for  100-yr event
Inflow      =     174.94 cfs @  11.96 hrs,  Volume=          9.031 af
Outflow     =      36.46 cfs @  12.14 hrs,  Volume=          4.634 af,  Atten= 79%,  Lag= 11.0 min
Primary     =      36.46 cfs @  12.14 hrs,  Volume=          4.634 af
Secondary =         0.00 cfs @   5.00 hrs,  Volume=          0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.03' @ 12.14 hrs Surf.Area= 40,095 sf Storage= 225,274 cf

Plug-Flow detention time= 162.3 min calculated for 4.616 af (51% of inflow)
Center-of-Mass det. time= 77.4 min (812.6 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

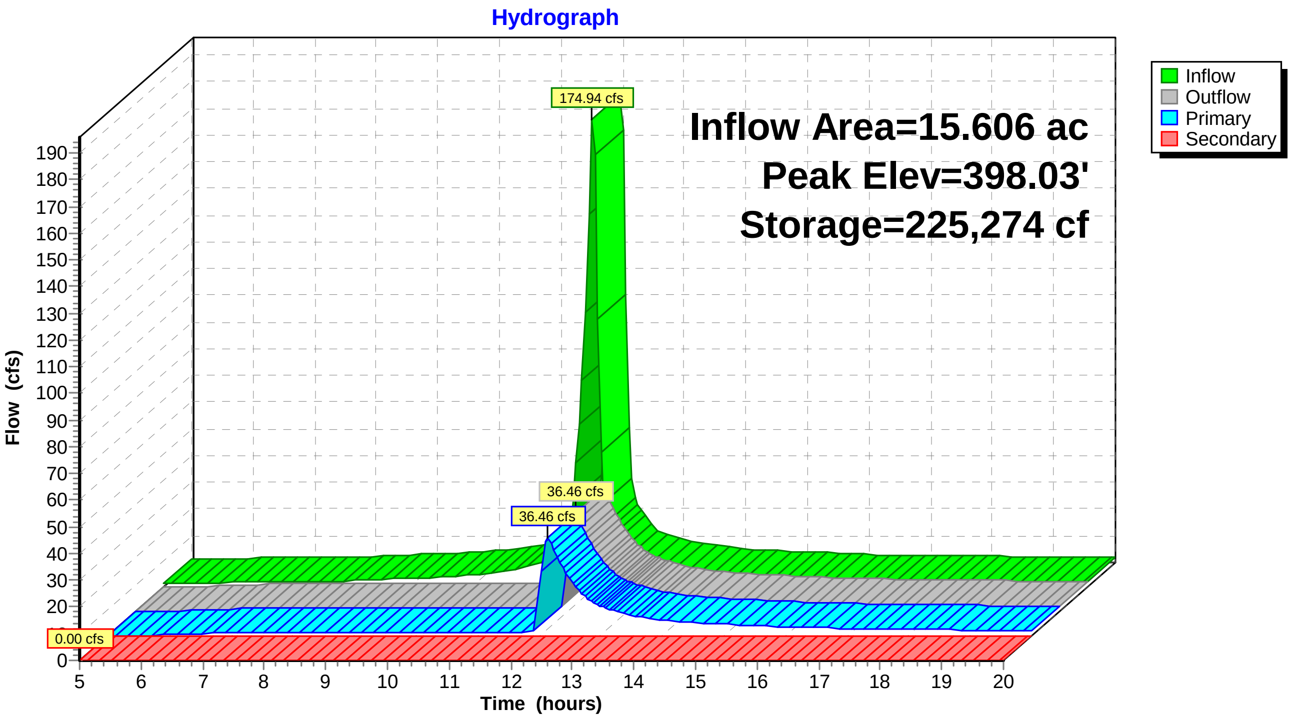
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.10'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=36.31 cfs @ 12.14 hrs HW=398.03' (Free Discharge)
└─**2=Culvert** (Passes 36.31 cfs of 40.10 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 35.15 cfs @ 3.15 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1: SB-OB-3



Summary for Pond N1: SB-OB-6

[82] Warning: Early inflow requires earlier time span

Inflow Area = 21.258 ac, 0.00% Impervious, Inflow Depth > 6.94" for 100-yr event
Inflow = 238.29 cfs @ 11.96 hrs, Volume= 12.302 af
Outflow = 39.88 cfs @ 12.17 hrs, Volume= 5.902 af, Atten= 83%, Lag= 12.6 min
Primary = 39.88 cfs @ 12.17 hrs, Volume= 5.902 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.69' @ 12.17 hrs Surf.Area= 50,073 sf Storage= 321,876 cf

Plug-Flow detention time= 180.4 min calculated for 5.879 af (48% of inflow)
Center-of-Mass det. time= 90.6 min (825.8 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	390,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

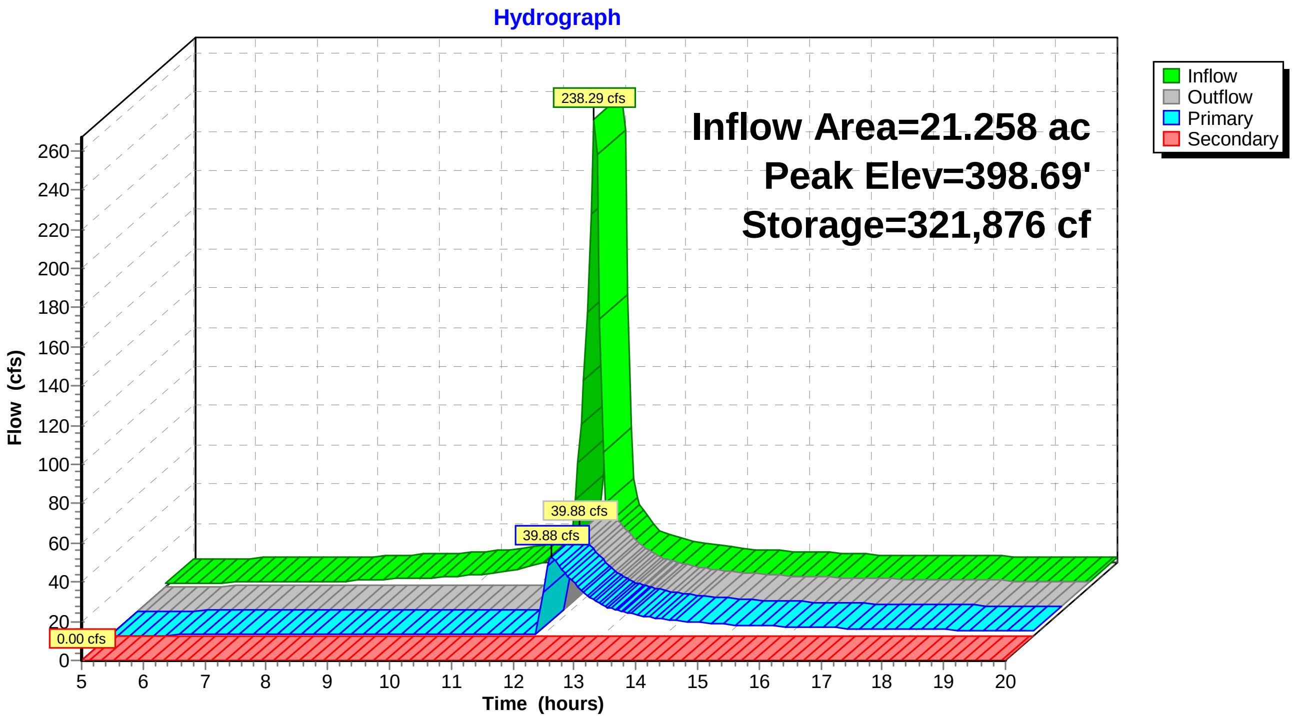
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	24,000	0	0
400.00	54,000	390,000	390,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.70'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=39.37 cfs @ 12.17 hrs HW=398.68' (Free Discharge)
↑—**2=Culvert** (Passes 39.37 cfs of 41.93 cfs potential flow)
  ↑—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Weir Controls 38.21 cfs @ 3.24 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N1: SB-OB-6



Summary for Pond N2: SB-OB-5

[82] Warning: Early inflow requires earlier time span

Inflow Area =	17.856 ac,	0.00% Impervious,	Inflow Depth > 6.94"	for 100-yr event
Inflow =	200.16 cfs @	11.96 hrs, Volume=	10.333 af	
Outflow =	40.47 cfs @	12.15 hrs, Volume=	5.219 af,	Atten= 80%, Lag= 11.2 min
Primary =	40.47 cfs @	12.15 hrs, Volume=	5.219 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.50' @ 12.15 hrs Surf.Area= 43,514 sf Storage= 261,579 cf

Plug-Flow detention time= 167.3 min calculated for 5.199 af (50% of inflow)
Center-of-Mass det. time= 81.2 min (816.4 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

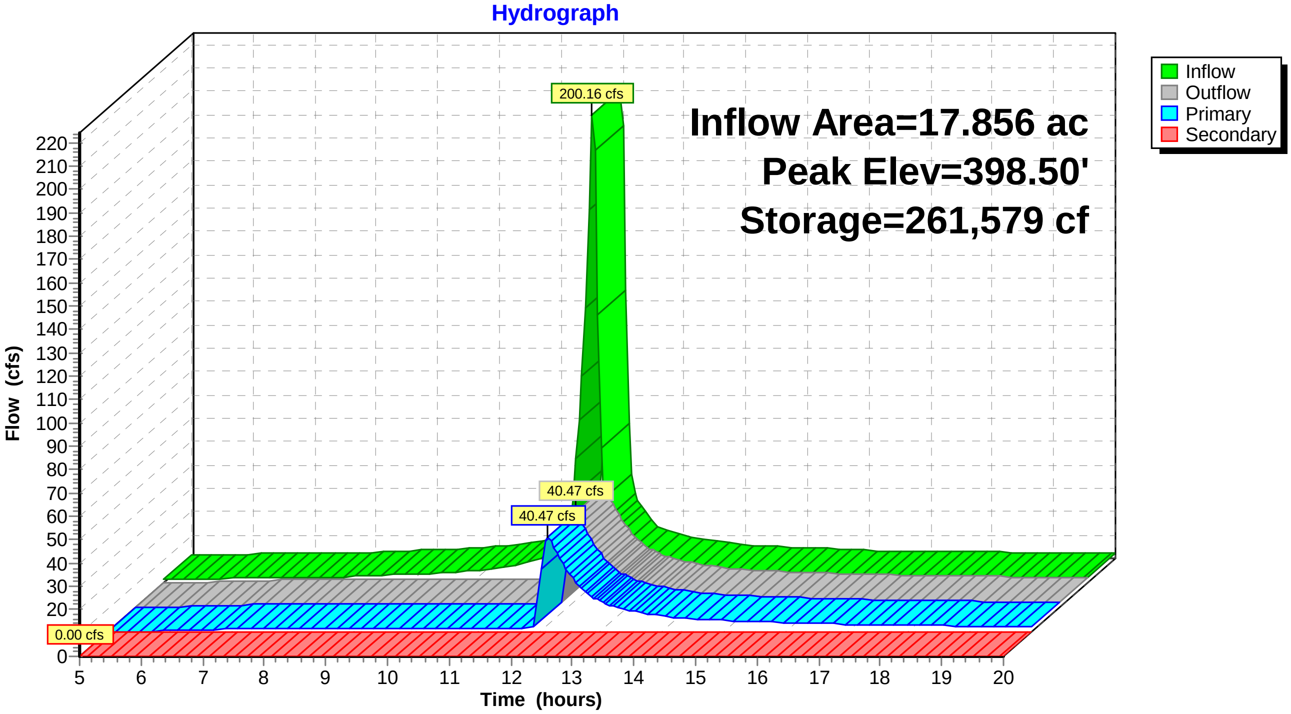
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=40.63 cfs @ 12.15 hrs HW=398.50' (Free Discharge)
└─**2=Culvert** (Passes 40.63 cfs of 41.44 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 39.46 cfs @ 3.28 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N2: SB-OB-5



Summary for Pond N3: SB-OB-4

[82] Warning: Early inflow requires earlier time span

Inflow Area = 13.206 ac, 0.00% Impervious, Inflow Depth > 6.94" for 100-yr event
Inflow = 148.03 cfs @ 11.96 hrs, Volume= 7.642 af
Outflow = 38.50 cfs @ 12.12 hrs, Volume= 4.160 af, Atten= 74%, Lag= 9.5 min
Primary = 38.50 cfs @ 12.12 hrs, Volume= 4.160 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.97' @ 12.12 hrs Surf.Area= 34,914 sf Storage= 183,002 cf

Plug-Flow detention time= 148.2 min calculated for 4.144 af (54% of inflow)
Center-of-Mass det. time= 67.3 min (802.5 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	260,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

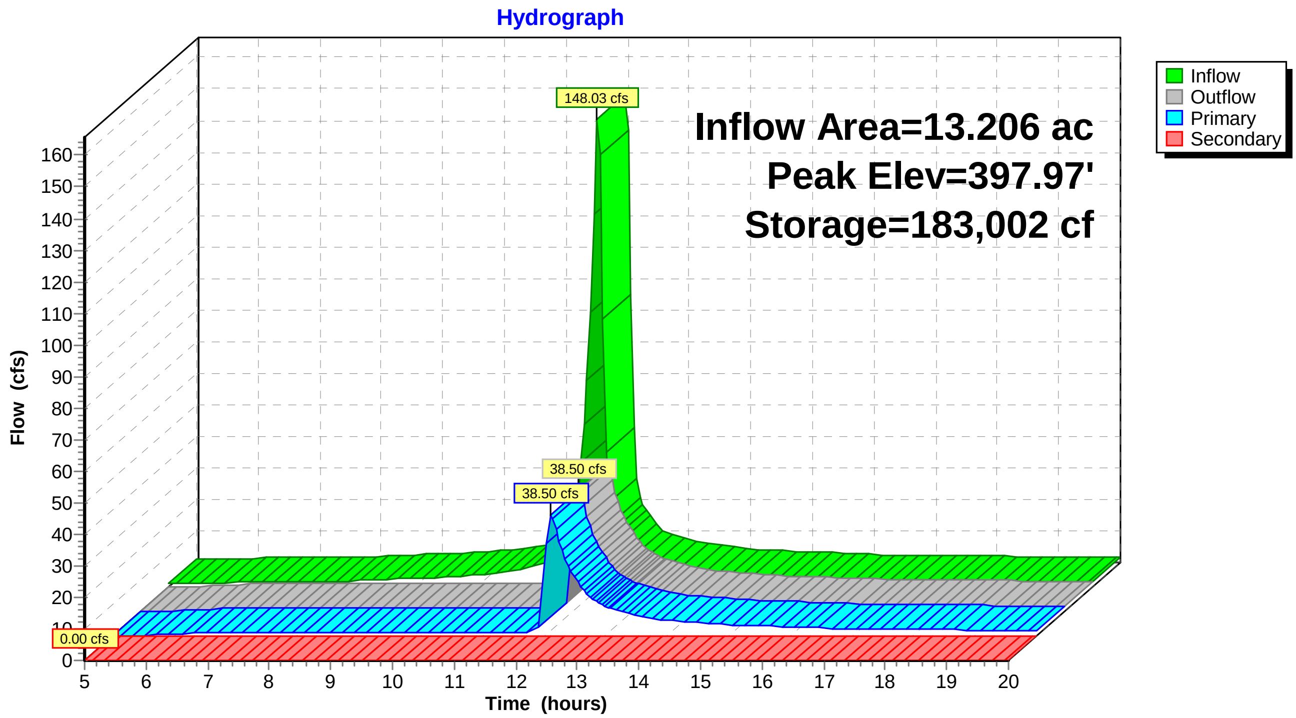
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	11,000	0	0
400.00	41,000	260,000	260,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=37.54 cfs @ 12.12 hrs HW=397.95' (Free Discharge)
└─**2=Culvert** (Passes 37.54 cfs of 39.88 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 36.37 cfs @ 3.19 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond N3: SB-OB-4



Summary for Pond NW1: SB-OB-7

[82] Warning: Early inflow requires earlier time span

Inflow Area = 16.857 ac, 0.00% Impervious, Inflow Depth > 6.94" for 100-yr event
Inflow = 179.04 cfs @ 11.99 hrs, Volume= 9.754 af
Outflow = 36.93 cfs @ 12.21 hrs, Volume= 4.924 af, Atten= 79%, Lag= 13.0 min
Primary = 36.93 cfs @ 12.21 hrs, Volume= 4.924 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.14' @ 12.21 hrs Surf.Area= 42,418 sf Storage= 245,879 cf

Plug-Flow detention time= 167.7 min calculated for 4.921 af (50% of inflow)
Center-of-Mass det. time= 80.4 min (817.3 - 736.8)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

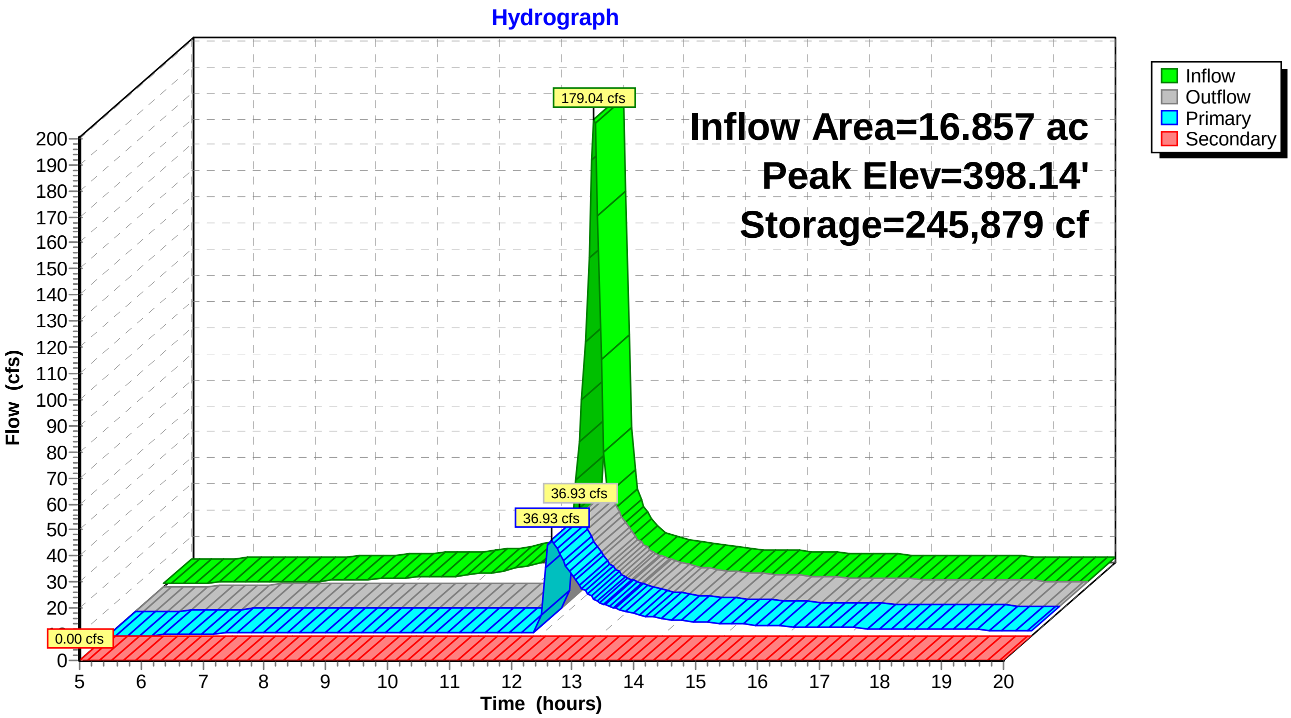
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=36.75 cfs @ 12.21 hrs HW=398.14' (Free Discharge)
└—**2=Culvert** (Passes 36.75 cfs of 40.41 cfs potential flow)
  ├—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Weir Controls 35.58 cfs @ 3.16 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond NW1: SB-OB-7



Summary for Pond P1: SB-P-8

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      15.460 ac,   0.00% Impervious,  Inflow Depth >  6.94"   for  100-yr event
Inflow      =     164.19 cfs @  11.99 hrs,  Volume=         8.945 af
Outflow     =      36.57 cfs @  12.19 hrs,  Volume=         4.634 af,  Atten= 78%,  Lag= 12.2 min
Primary     =      36.57 cfs @  12.19 hrs,  Volume=         4.634 af
Secondary =         0.00 cfs @   5.00 hrs,  Volume=         0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.94' @ 12.19 hrs Surf.Area= 39,807 sf Storage= 221,428 cf

Plug-Flow detention time= 161.7 min calculated for 4.631 af (52% of inflow)
Center-of-Mass det. time= 76.3 min (813.1 - 736.8)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	310,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

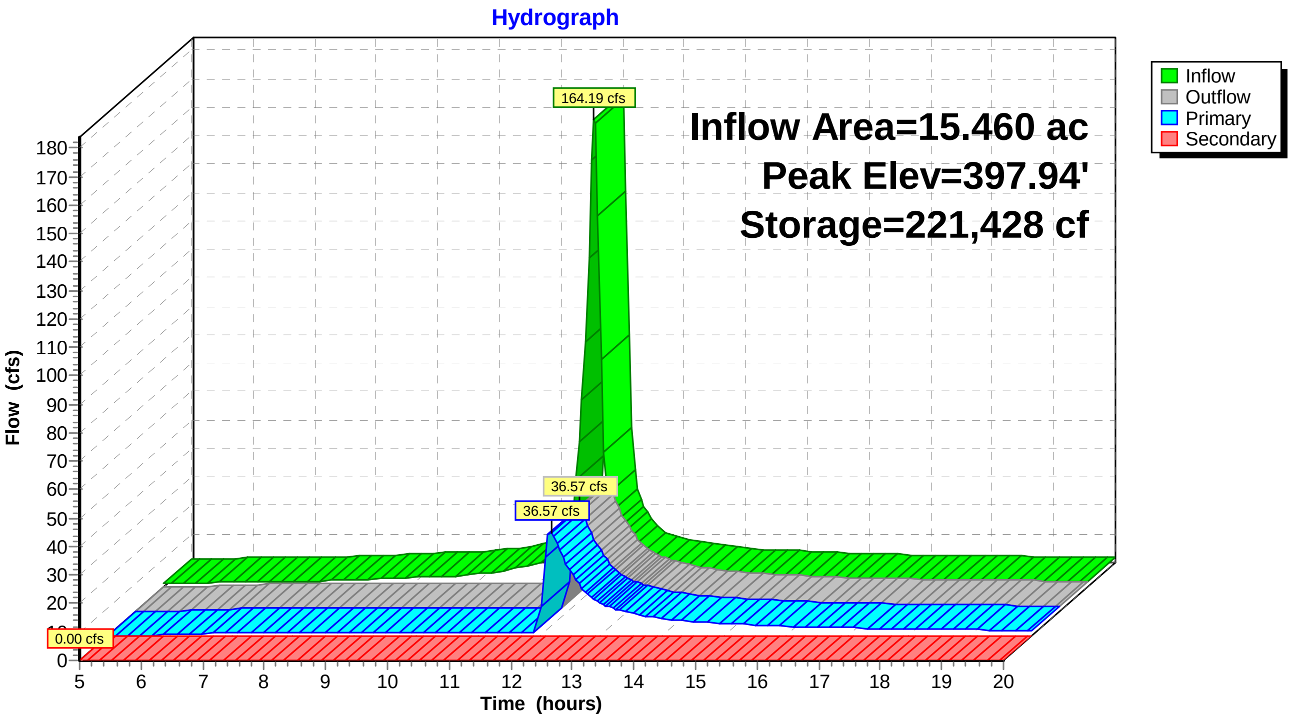
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	16,000	0	0
400.00	46,000	310,000	310,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=36.51 cfs @ 12.19 hrs HW=397.93' (Free Discharge)
└─**2=Culvert** (Passes 36.51 cfs of 39.83 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 35.34 cfs @ 3.16 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1: SB-P-8


Hydrograph
164.19 cfs
Inflow Area=15.460 ac
Peak Elev=397.94'
Storage=221,428 cf
36.57 cfs
36.57 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
0
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Time (hours)

Summary for Pond P2: SB-P-2

[82] Warning: Early inflow requires earlier time span

Inflow Area =	47.459 ac,	0.00% Impervious, Inflow Depth > 6.94"	for 100-yr event
Inflow =	493.26 cfs @	12.00 hrs, Volume=	27.458 af
Outflow =	42.32 cfs @	12.54 hrs, Volume=	12.541 af, Atten= 91%, Lag= 32.8 min
Primary =	42.32 cfs @	12.54 hrs, Volume=	12.541 af
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.83' @ 12.54 hrs Surf.Area= 100,480 sf Storage= 770,045 cf

Plug-Flow detention time= 208.0 min calculated for 12.533 af (46% of inflow)
Center-of-Mass det. time= 113.4 min (850.8 - 737.3)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	890,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

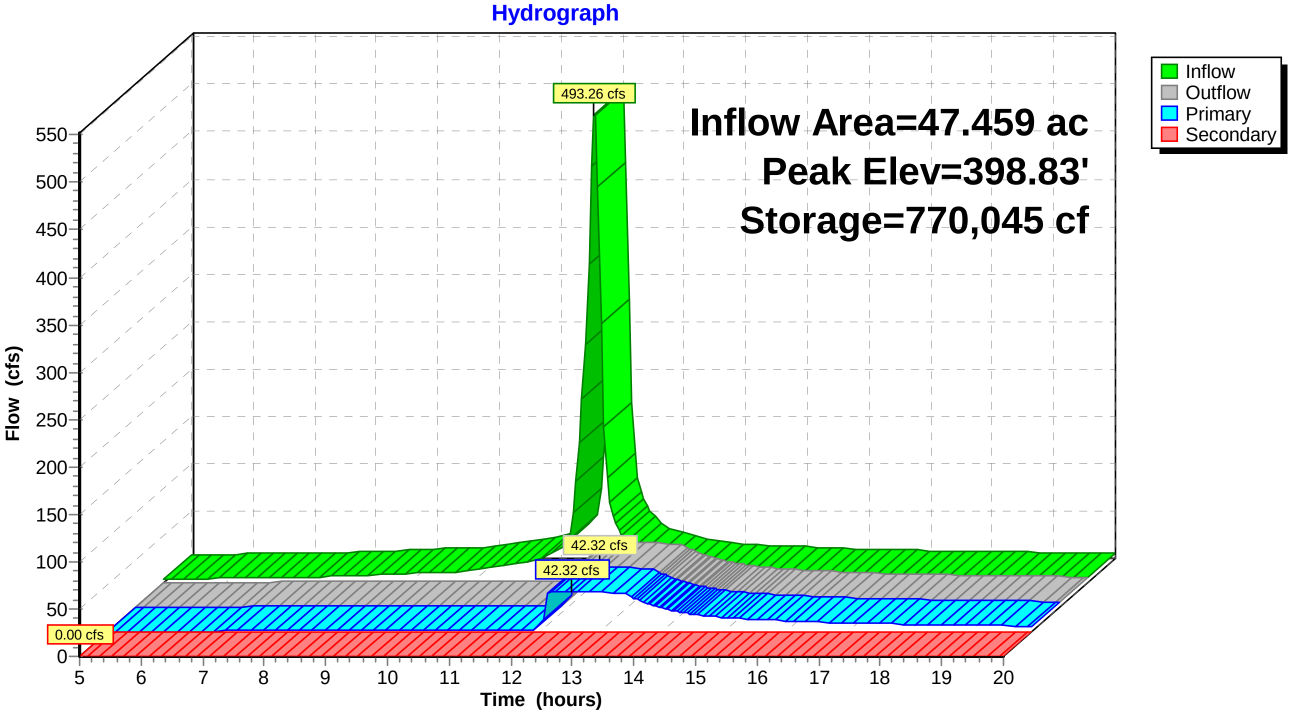
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	74,000	0	0
400.00	104,000	890,000	890,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=42.32 cfs @ 12.54 hrs HW=398.83' (Free Discharge)
└─**2=Culvert** (Inlet Controls 42.32 cfs @ 13.47 fps)
  ├─**1=Constant Flow/Skimmer** (Passes < 2.34 cfs potential flow)
  └─**3=Orifice/Grate** (Passes < 51.75 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P2: SB-P-2


Hydrograph
493.26 cfs
Inflow Area=47.459 ac
Peak Elev=398.83'
Storage=770,045 cf
42.32 cfs
42.32 cfs
0.00 cfs
Inflow
Outflow
Primary
Secondary
Flow (cfs)
0
50
100
150
200
250
300
350
400
450
500
550
Time (hours)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Summary for Pond PT1: SB-PT-9

[82] Warning: Early inflow requires earlier time span

Inflow Area = 42.536 ac, 0.00% Impervious, Inflow Depth > 6.94" for 100-yr event
Inflow = 459.46 cfs @ 11.98 hrs, Volume= 24.612 af
Outflow = 41.95 cfs @ 12.47 hrs, Volume= 11.520 af, Atten= 91%, Lag= 29.3 min
Primary = 41.95 cfs @ 12.47 hrs, Volume= 11.520 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.69' @ 12.47 hrs Surf.Area= 91,070 sf Storage= 678,112 cf

Plug-Flow detention time= 200.0 min calculated for 11.513 af (47% of inflow)
Center-of-Mass det. time= 107.4 min (843.7 - 736.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	800,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

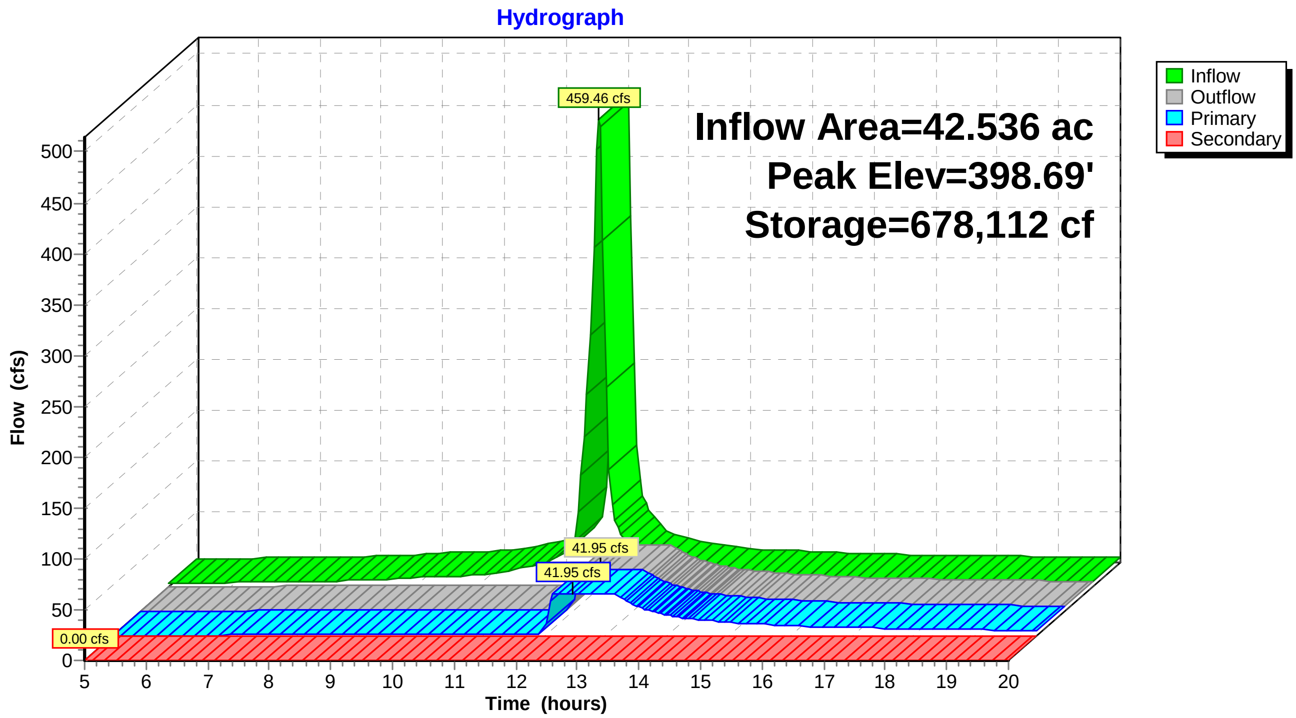
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	65,000	0	0
400.00	95,000	800,000	800,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer X 2.00**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.30'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=41.94 cfs @ 12.47 hrs HW=398.69' (Free Discharge)
└─**2=Culvert** (Inlet Controls 41.94 cfs @ 13.35 fps)
  ├─**1=Constant Flow/Skimmer** (Passes < 2.34 cfs potential flow)
  └─**3=Orifice/Grate** (Passes < 51.07 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT1: SB-PT-9



Summary for Pond PT2: SB-PT-1

[82] Warning: Early inflow requires earlier time span

Inflow Area = 22.345 ac, 0.00% Impervious, Inflow Depth > 6.94" for 100-yr event
Inflow = 247.65 cfs @ 11.97 hrs, Volume= 12.931 af
Outflow = 39.89 cfs @ 12.19 hrs, Volume= 6.157 af, Atten= 84%, Lag= 13.4 min
Primary = 39.89 cfs @ 12.19 hrs, Volume= 6.157 af
Secondary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.39' @ 12.19 hrs Surf.Area= 53,173 sf Storage= 340,558 cf

Plug-Flow detention time= 183.8 min calculated for 6.133 af (47% of inflow)
Center-of-Mass det. time= 93.4 min (828.8 - 735.4)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	430,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

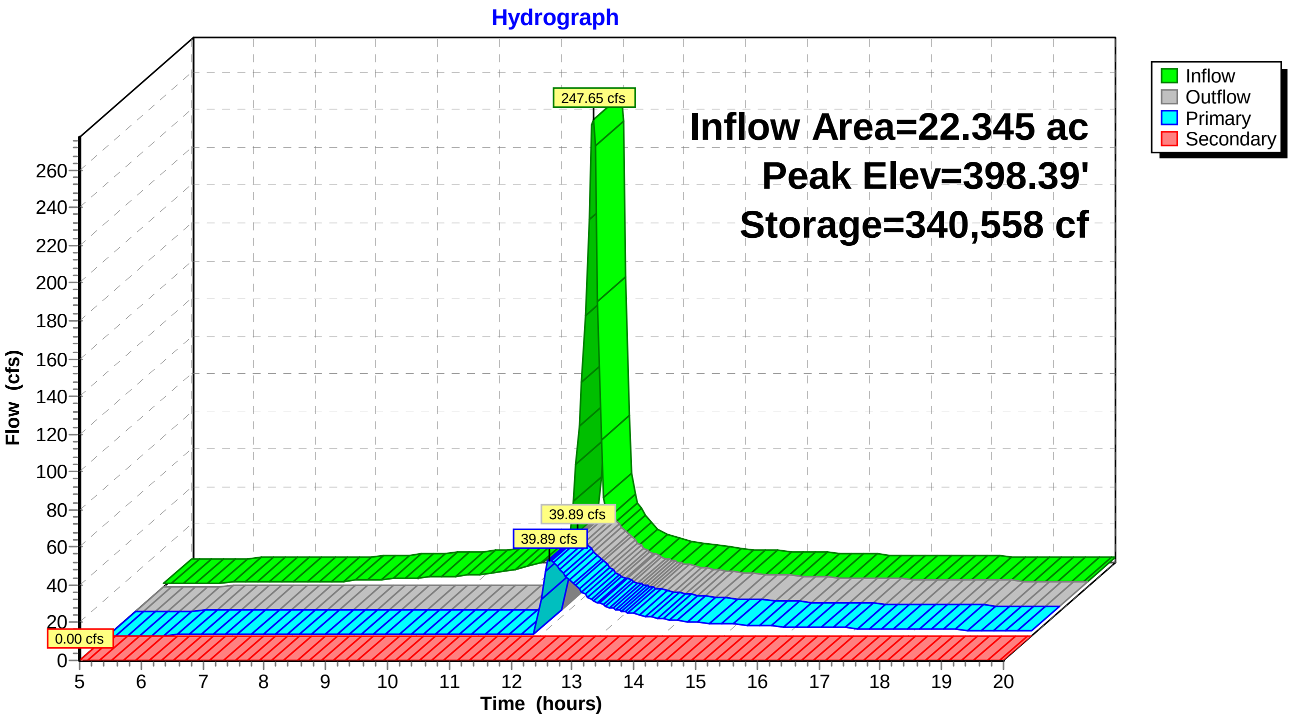
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	28,000	0	0
400.00	58,000	430,000	430,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.40'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=39.74 cfs @ 12.19 hrs HW=398.39' (Free Discharge)
└─**2=Culvert** (Passes 39.74 cfs of 41.12 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 38.58 cfs @ 3.25 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond PT2: SB-PT-1



Summary for Pond S1: SB-OB-10

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      18.532 ac,   0.00% Impervious,  Inflow Depth >   6.94"    for  100-yr event
Inflow      =     196.24 cfs @  11.99 hrs,  Volume=        10.723 af
Outflow     =      39.05 cfs @  12.21 hrs,  Volume=         5.319 af,  Atten= 80%,  Lag= 13.4 min
Primary     =      39.05 cfs @  12.21 hrs,  Volume=         5.319 af
Secondary =         0.00 cfs @   5.00 hrs,  Volume=         0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.78' @ 12.21 hrs Surf.Area= 44,329 sf Storage= 273,511 cf

Plug-Flow detention time= 170.5 min calculated for 5.298 af (49% of inflow)
Center-of-Mass det. time= 83.0 min (819.9 - 736.9)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	330,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

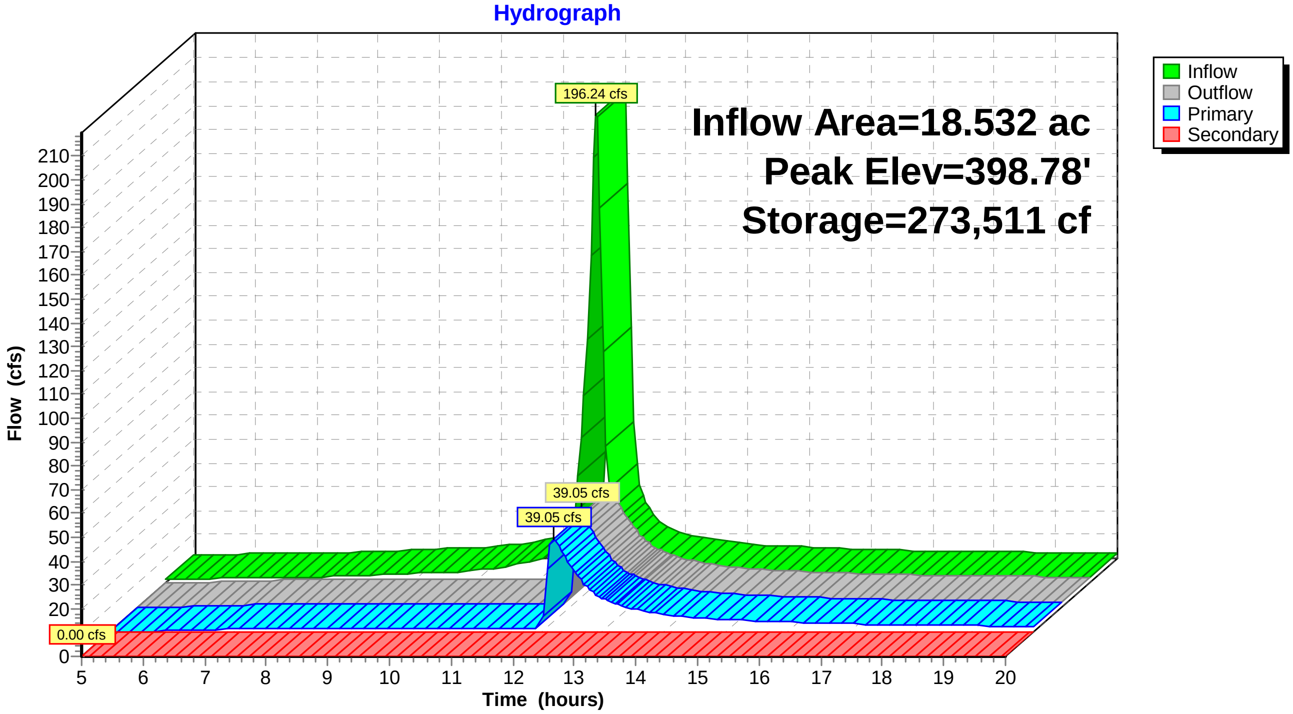
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	18,000	0	0
400.00	48,000	330,000	330,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.80'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=38.70 cfs @ 12.21 hrs HW=398.77' (Free Discharge)
└─**2=Culvert** (Passes 38.70 cfs of 42.17 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 37.53 cfs @ 3.22 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S1: SB-OB-10



Summary for Pond W1: SB-OB-11

[82] Warning: Early inflow requires earlier time span

Inflow Area =	18.955 ac,	0.00% Impervious,	Inflow Depth > 6.94"	for 100-yr event
Inflow =	208.61 cfs @	11.97 hrs, Volume=	10.969 af	
Outflow =	39.17 cfs @	12.17 hrs, Volume=	5.399 af,	Atten= 81%, Lag= 12.1 min
Primary =	39.17 cfs @	12.17 hrs, Volume=	5.399 af	
Secondary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 398.58' @ 12.17 hrs Surf.Area= 45,735 sf Storage= 281,952 cf

Plug-Flow detention time= 173.0 min calculated for 5.378 af (49% of inflow)
Center-of-Mass det. time= 85.1 min (820.6 - 735.6)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	350,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

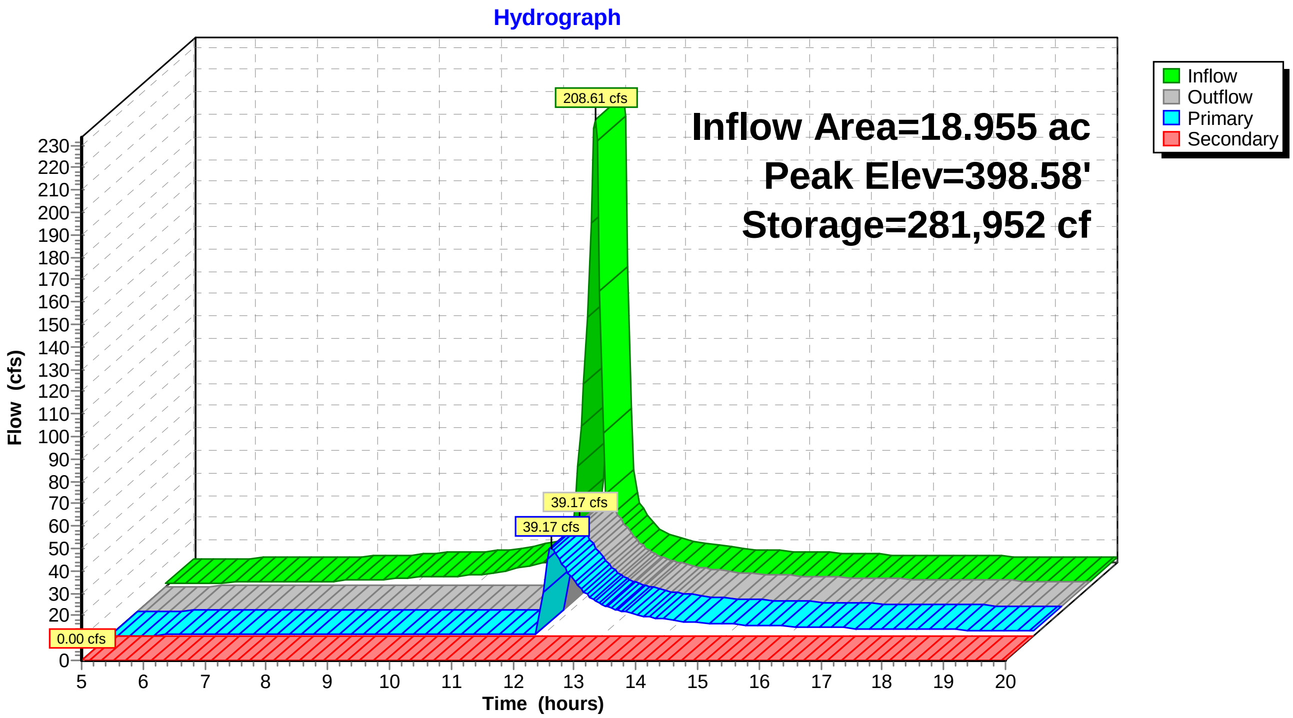
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	20,000	0	0
400.00	50,000	350,000	350,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	397.60'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=38.57 cfs @ 12.17 hrs HW=398.57' (Free Discharge)
└—**2=Culvert** (Passes 38.57 cfs of 41.62 cfs potential flow)
  ├—**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └—**3=Orifice/Grate** (Weir Controls 37.41 cfs @ 3.22 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.01' (Free Discharge)
└—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1: SB-OB-11



Summary for Pond W2: SB-OB-12

[82] Warning: Early inflow requires earlier time span

```
Inflow Area =      18.853 ac,   0.00% Impervious,  Inflow Depth >   6.94"    for  100-yr event
Inflow      =     206.06 cfs @  11.97 hrs,  Volume=        10.910 af
Outflow     =      35.39 cfs @  12.19 hrs,  Volume=         5.326 af,  Atten= 83%,  Lag= 13.0 min
Primary     =      35.39 cfs @  12.19 hrs,  Volume=         5.326 af
Secondary   =       0.00 cfs @   5.00 hrs,  Volume=         0.000 af
```

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 397.42' @ 12.19 hrs Surf.Area= 49,255 sf Storage= 282,847 cf

Plug-Flow detention time= 177.4 min calculated for 5.306 af (49% of inflow)
Center-of-Mass det. time= 88.9 min (824.6 - 735.7)

Volume	Invert	Avail.Storage	Storage Description
#1	390.00'	420,000 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

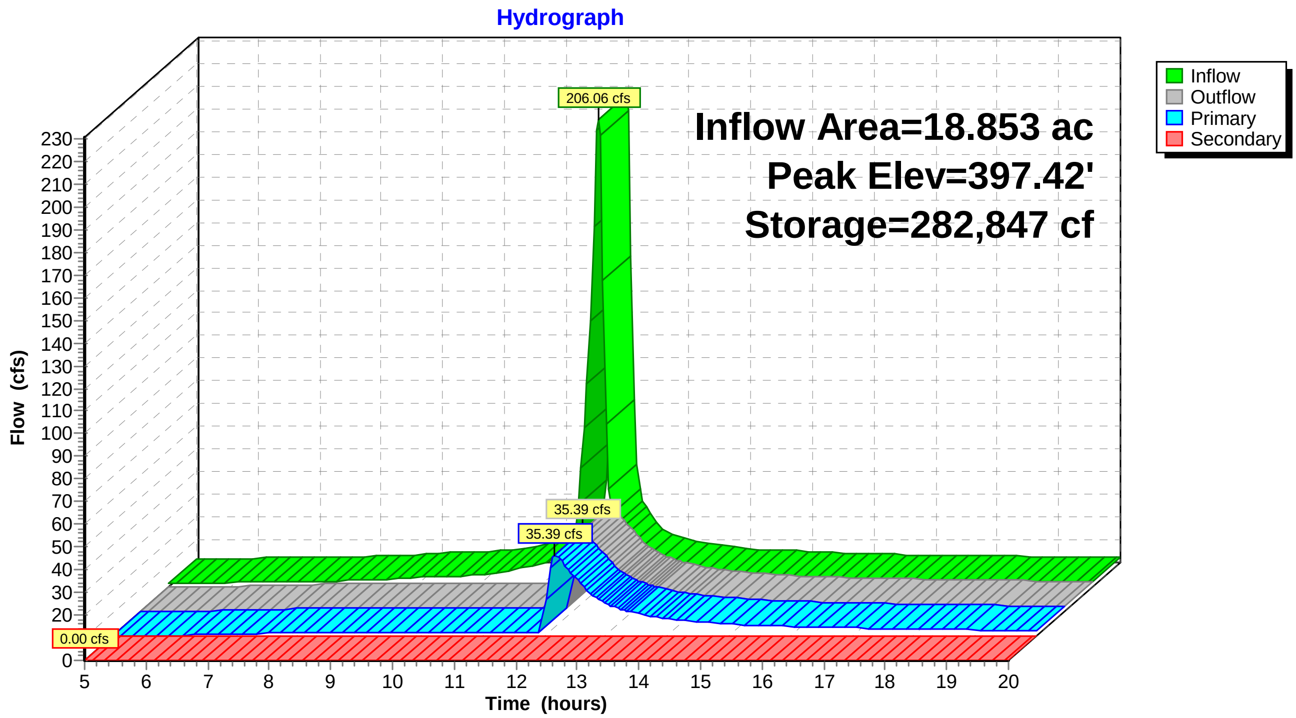
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
390.00	27,000	0	0
400.00	57,000	420,000	420,000

Device	Routing	Invert	Outlet Devices
#1	Device 2	390.00'	**1.168 cfs Constant Flow/Skimmer**
#2	Primary	390.00'	**24.0" Round Culvert** L= 100.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 390.00' / 389.00' S= 0.0100 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#3	Device 2	396.50'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	399.00'	**20.0' long x 26.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=35.58 cfs @ 12.19 hrs HW=397.42' (Free Discharge)
└─**2=Culvert** (Passes 35.58 cfs of 38.32 cfs potential flow)
  ├─**1=Constant Flow/Skimmer** (Constant Controls 1.17 cfs)
  └─**3=Orifice/Grate** (Weir Controls 34.41 cfs @ 3.13 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=390.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2: SB-OB-12



Reference 6

Compiled SEDIMOT IV Report, S&ME Inc., December 2023.

Location Text Results

Inputs

Name	Value
Location	Northern Greenville County, SC
Region	Greenville Spartanburg

Design Storm Text Results

Inputs

Name	Value
Return Period (yr)	10
Type	Type II
Precipitation (in.)	6.1
Duration (hrs.)	24.0

PT-SB-1 Text Results

Hydrology

Name	Value
Peak Flow (cfs)	261.3
Total Runoff Volume (ac-ft)	17.9

Sediment

Name	Value
Total Sediment Yield (lb)	6949067.6
Average Sediment Discharge Concentration (mg/l)	142720.4
Peak Sediment Discharge Concentration (mg/l)	427012.5
Average Sediment Discharge Turbidity (NTU)	38354.1
Peak Sediment Discharge Turbidity (NTU)	114753.6

PT-SB-1 Text Results

Hydrology

Name	Value
Total Inflow Volume (ft^3)	779869.5
Total Outflow Volume (ft^3)	590640.5
Total Infiltration Volume (ft^3)	189234.9
Peak Outflow (cfs)	9.4
Drain Time (Hours)	8.32
Peak Stage Elevation (ft)	7.09

Sediment

Name	Value

Total Sediment Mass Inflow (lb)	6949067.6
Clay Mass Inflow (lb)	216810.9
Silt Mass Inflow (lb)	111772.1
Sand Mass Inflow (lb)	2420381.6
SmAgg Mass Inflow (lb)	1417022.7
LgAgg Mass Inflow (lb)	2783080.3
Total Sediment Mass Trapped (lb)	6817138.2
Total Sediment Mass Discharged (lb)	131929.4
Clay Mass Discharged (lb)	121606.9
Silt Mass Discharged (lb)	10143.3
Sand Mass Discharged (lb)	63.2
SmAgg Mass Discharged (lb)	98
LgAgg Mass Discharged (lb)	18
Sediment Trapping Efficiency (%)	98.1
Clay Trapping Efficiency (%)	43.9
Silt Trapping Efficiency (%)	90.9
Sand Trapping Efficiency (%)	100
SmAgg Trapping Efficiency (%)	100
LgAgg Trapping Efficiency (%)	100
Average Sediment Discharge Concentration (mg/l)	3577.7
Peak Sediment Discharge Concentration (mg/l)	12152.4
Average Sediment Discharge Turbidity (NTU)	2921.1
Peak Sediment Discharge Turbidity (NTU)	13101

Location Text Results

Inputs

Name	Value
Location	Northern Greenville County, SC
Region	Greenville Spartanburg

Design Storm Text Results

Inputs

Name	Value
Return Period (yr)	10
Type	Type II
Precipitation (in.)	6.1
Duration (hrs.)	24.0

P-SB-2 Text Results

Hydrology

Name	Value
Peak Flow (cfs)	270.4
Total Runoff Volume (ac-ft)	20.0

Sediment

Name	Value
Total Sediment Yield (lb)	1674909.3
Average Sediment Discharge Concentration (mg/l)	30778.2
Peak Sediment Discharge Concentration (mg/l)	89472.2
Average Sediment Discharge Turbidity (NTU)	8271.2
Peak Sediment Discharge Turbidity (NTU)	24044.4

P-SB-2 Text Results

Hydrology

Name	Value
Total Inflow Volume (ft^3)	871625.6
Total Outflow Volume (ft^3)	646675.3
Total Infiltration Volume (ft^3)	224952.1
Peak Outflow (cfs)	9.5
Drain Time (Hours)	10.23
Peak Stage Elevation (ft)	7.21

Sediment

Name	Value

Total Sediment Mass Inflow (lb)	1674909.3
Clay Mass Inflow (lb)	52257.2
Silt Mass Inflow (lb)	26940
Sand Mass Inflow (lb)	583376
SmAgg Mass Inflow (lb)	341540
LgAgg Mass Inflow (lb)	670796
Total Sediment Mass Trapped (lb)	1643952.9
Total Sediment Mass Discharged (lb)	30956.4
Clay Mass Discharged (lb)	28680.1
Silt Mass Discharged (lb)	2235.3
Sand Mass Discharged (lb)	16.2
SmAgg Mass Discharged (lb)	17.3
LgAgg Mass Discharged (lb)	7.5
Sediment Trapping Efficiency (%)	98.2
Clay Trapping Efficiency (%)	45.1
Silt Trapping Efficiency (%)	91.7
Sand Trapping Efficiency (%)	100
SmAgg Trapping Efficiency (%)	100
LgAgg Trapping Efficiency (%)	100
Average Sediment Discharge Concentration (mg/l)	766.7
Peak Sediment Discharge Concentration (mg/l)	2617.6
Average Sediment Discharge Turbidity (NTU)	614.8
Peak Sediment Discharge Turbidity (NTU)	2829

Reference 7

SC DHEC Stormwater BMP Handbook, Sediment Control BMPs – Sediment Basins, SC DHEC, Revised March 2014.

Sediment Basins

Introduction

Sediment Basins are a Best Management Practice (BMP) used to collect and impound stormwater runoff from disturbed areas (typically 5 acres or more) at construction sites to restrict sediments and other pollutants from being discharged off-site. These basins may also be used to control the volume and velocity of the runoff through a timed release by utilizing multiple spillways. It is through this attenuation of runoff that sediment basins may be capable of meeting South Carolina's Design Requirements, specifically the Total Suspended Solids (TSS) removal efficiency of 80%.

These basins work most effectively in conjunction with additional sediment and erosion control BMPs installed and maintained up gradient of the basins.

Guidance Disclaimer

This is a guidance document and may not be feasible in all situations. Alternative means and methods for sediment basin design and construction also may be employed.

All means and methods must comply with the DHEC South Carolina NPDES General Permit for Stormwater Discharges from Construction Activities (Permit). Approved means and methods include those published and approved by an MS4 in compliance with the Permit.

In addition, a licensed Professional Engineer may design a sediment basin that, when constructed, accommodates the anticipated sediment loading from the land-disturbing activity and meets a removal efficiency of 80% suspended solids or 0.5 ML/L peak settable solids concentration, whichever is less, while remaining in compliance with the Permit.

FEATURES

- Sediment Control
- Volume Control
- Velocity Control

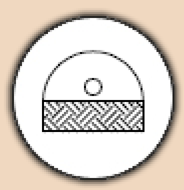
SECTIONS

- General Design
- Forebays
- Porous Baffles
- Basin Dewatering
- Skimmers
- Spillways
- Permanent Pools
- Maintenance
- Design Aids

ALSO ADDRESSED

- Inlet Protection
- Basin Safety
- Sediment Storage
- Slope Stabilization
- Rock Berms
- Outlet Protection
- Basin Removal

PLAN SYMBOL



General Information

Located near the site's perimeters, sediment basins can be created by the building of an embankment or through excavation, when the topography is relatively flat. Careful planning is necessary, during both design and construction phases, to ensure that sediment basins are not placed within Waters of the State (WoS) and are installed prior to the implementation of mass clearing, grubbing, and grading activities.

As runoff discharges into a sediment basin, specific mechanisms are used to reduce the velocity and turbulence of the runoff to allow for settling of suspended particles, a process known as sedimentation. Examples of these mechanisms include sediment forebays, porous baffles, and spillways with outlet structures that only discharge water from near the surface of the water column impounded within the basin.

After construction of the basin, routine inspection and maintenance of sediment basins along with the implementation of additional sediment and erosion control BMPs up gradient of the basin is essential to maintain the required trapping efficiency.

Image Source: Alabama NRCS

Design Requirements

- TSS Removal Efficiency* – ≥ 80%
- Peak Settleable Solids Conc.* – ≤ 0.5 mL/L
- Discharge Capacity – 10-yr, 24-hr Storm Event
- Inspections and Maintenance** – Weekly
- Internal Components***
  - Sediment Forebay – Basin Inlets
  - Porous Baffles – Between Inlets & Outlets
  - Water Surface Dewatering – Basin Outlets

** Whichever is less. ** Maintenance as necessary per inspection. ***Unless Infeasible.*

The above requirements shall serve as a baseline for all sediment basin design within the state of South Carolina. For further reference see SC State Regulations 72.300 Standards for Stormwater Management and Sediment Reduction (Section 72-307.C.5) and the SC NPDES General Permit for Stormwater Discharges from Construction Activities SCR100000 (Section 3.2.6.II).

The following sections of this guidance can be used to aid in the design of a sediment basin capable of meeting, if not exceeding, the above requirements. The selection and implementation of these practices should be based on the best professional judgment and the conditions expected at the construction site during the lifespan of each sediment basin.

`

Additional Design Considerations

- Drainage Area – 5-30 Acres*
- Sediment Storage – 3600 ft^3/Acre Draining
- Min Dewatering Time – 2 days (48 hours)
- Max Dewatering Time – 5 days (120 hours)
- Basin Shape - L = 2W (Minimum)
- Cleanout Height - 1/2 Sediment Storage
- Forebay Volume – 20% Sediment Storage
- Porous Baffles –3 Rows (Minimum)
- Basin Inlets – Stabilized to Prevent Scour
- Basin's Bottom Slope – 0.5% or Steeper
- Embankments – 2H:1V or Flatter

***30 Acre Limitation –** *Based off Design Aids Section. Larger drainage areas may be acceptable when using an alternative methodology to calculated trapping efficiencies.*

Location

The location of sediment basins at a construction site will vary due to site-specific conditions, but the following items should be used as guidance to determine the most appropriate location:

- **Not within Waters of the State:** It is prohibited to construct in or use Waters of the State as a sediment basin.
- **Down Gradient from Major Grading Activities:** Locations down gradient of large scale grading operations will promote sediment control during construction activities.
- **Near Identified Outfalls:** Locations near the determined site outfall will allow sediment basins to collect the majority of the runoff from the disturbed area.
- **Multipurpose Use:** Many construction sites will utilize a sediment basin as a detention pond after construction activities are completed. Selection of an area that allows for the installation of a sediment basin that can be converted to a detention pond post-construction is recommended.
- **Exclude Runoff from Off-Site and Undisturbed Areas:** The placement of sediment basins are recommended at a location that restricts the amount of stormwater runoff impounded from off-site and other undisturbed areas. Placement of temporary diversions berms, swales, or other conveyance measures may be required to divert the "clean" stormwater runoff away from the basin. This practice will minimize the drainage area being served by the sediment basin and may decrease the surface area required by the sediment basin.

Safety

Incorporate all possible safety precautions, such as signs and fencing, for sediment basins that are readily accessible to populated areas. For Example, a lateral shelf that is located above the sediment cleanout elevation may prevent entry onto the accumulated sediment and may also help with maintenance of the basin. In some circumstances, vector control may be necessary for sediment basins that routinely have a standing pool of water. This is especially important around residential areas to inhibit a rise in mosquito populations and the spread of disease. Maintaining a water depth of at least 3 feet within basins with permanent pools may also help prevent a rise in mosquito populations.

All other applicable safety criteria as outlined by the USDA Soil Conservation Service (previously the Natural Resources Conservation Service), the U.S. Army Corps of Engineers, and state Dam Safety Regulations should also be followed during design and construction of sediment basins.

Basin Design Criteria

Properly sizing a sediment basin is crucial to improving sediment control during construction conditions. When designing a basin the following criteria should be addressed:

- **Storage Volume:** The minimum sediment storage volume recommended within a sediment basin is equal to 3,600 cubic feet per acre draining to the basin. Twenty percent (20%) of this volume should be provided within the sediment forebay. (*Basin Volumes of 50 ac-ft or more may be subject to Dam Safety Regulations and Permits.*)
- **Shape:** Sediment basins should be designed to maximize the flow length between the basins' inlets and outlets. To accomplish this, the minimum length-to-width ratio of each basin should be no less than 2:1. This results with an effective flow length that is at least twice the width of the basin. Additional (non-porous) baffling may be required if site constraints prevents the basin from meeting this minimum ratio. In each circumstance, measures must be taken to prevent short-circuiting of the sediment basin. Length and width measurements may be measured from top of embankment.
- **Surface Area:** The surface area within a sediment basin can have a substantial impact on the basin's trapping efficiency. Maximizing the surface area may lead to higher trapping efficiencies and may prove to be very beneficial when employed with multiple rows of porous baffles.
- **Depth:** The provided depth in a sediment basin will be directly linked to the required storage volumes and the appropriate surface area. It is recommended that a depth of 5 - 10 ft be provided in order to maximize surface area within the basin. (*Basin Depths resulting in an embankment height of 25 ft or more may be subject to Dam Safety Regulations and Permits.*)
- **Slope:** The sediment basin's bottom must be graded to have a slope of not less than 0.5%.

Basin Dewatering

Sediment basins must be designed to have the capability to discharge the 10-yr, NRCS 24-hr storm event through the principle spillway while under **during construction** conditions. This spillway must employ a mechanism to withdraw the impounded stormwater runoff from near the surface of the water column impounded within a basin.

This volume of water should discharge through the principle spillway within a time frame of 2-5 days, with 3 days being the recommended target. Meeting this recommended dewatering time allows for finer particulates to fall from suspension, improving the trapping efficiency of the sediment basin.

Embankments

Proper construction and stabilization of basin embankments are important factors of sediment basin design. When designing a basin the following criteria on embankments should be addressed:

- **Construction:** The foundation of the embankment should be stripped and grubbed of all vegetation, stumps, topsoil and other organic matter prior to construction of the dam. Machine compact the soil material used to construct the dam.
- **Minimum Width:** The top width of the embankment should be no less than 5 feet.
- **Side Slopes**: All side slopes, including those located within basin areas that are not part of the embankment, shall be 2:1 (H:V) or flatter. The recommended slope is 3:1 to allow for ease of maintenance.

- **Penetrations**: Any penetrations, including conduits, through the embankment shall be equipped with anti-seep mechanisms, such as anti-seep collars or a core/key trench.
- **Top of Embankment:** Keep the top of the embankment at a minimum of 2 feet above the crest of the principle spillway's riser. (This minimum elevation provides an emergency spillway that is at least 1 foot in height and has a 1-foot separation between its crest and the principle spillway's crest.)
- **Stabilization:** Promptly stabilize all areas disturbed by the construction of the embankment including embankment side slopes and access areas. Temporary or permanent stabilization measures should be conducted as necessary.

Excavations

All sediment basins created or expanded through excavation shall retain side slopes of 2:1 or flatter, and all side slopes should be promptly stabilized to prevent the formation of rills and gullies. The recommended slope is 3:1 (H:V) to allow for ease of maintenance.

Inlet Protection

Inlets into a sediment basin shall be equipped with energy dissipation measures to prevent scour by reducing runoff velocities and/or shall be equipped with stabilization measures designed to handle peak flow conditions. This can be accomplished through the selection and use of BMPs such as riprap aprons, turf reinforcement matting, and plunge pools.

These BMPs should be provided at all inlets into the basin, including inlets that are submerged, and it is recommended that the invert of each inlet is cited to be at the bottom of the sediment basin to prevent erosion along side slopes. When an invert of a basin inlet is not cited at the bottom of the basin, proper conveyance measures should be proposed to allow runoff to enter the basin without eroding the basin's side slopes.

Sediment Forebay

Each sediment basin should be designed to incorporate the use of a sediment forebay, a settling area or impoundment constructed at the incoming points of stormwater runoff that promotes the settling of coarse particulates away from the basin's outlets. Inclusion of a sediment forebay may also help ease maintenance by allowing for the deposition of the larger suspended particles into an easily accessible area away from the principle spillway.

Proper design, construction, and stabilization of each sediment forebay will promote the required functions of sediment basins. When designing a basin the following criteria on forebays should be addressed:

- **Construction:** A riprap berm, gabion, or an earthen berm with a rock filled outlet should be constructed across the bottom of the sediment basin to create a cell within the basin for use as the sediment forebay. The location and height of this berm should be designed to meet the appropriate sediment forebay volume and depth criteria. Alternatively, plunge pools or rock berms may be constructed around each inlet to create a combined volume behind the berms equal to the minimum sediment forebay volume recommendation.
- **Volume:** The minimum volume provided within the forebay(s) should be twenty percent (20%) of the provided sediment storage volume of the basin.

- **Depth:** The depth of the forebay will be dependant upon the required volume. It is recommended to keep the depth between 2 and 4 feet.
- **Accessibility:** Direct access to the forebay will be necessary to allow for routine cleanout of the accumulated sediment. Side slopes adjacent to the forebay may be graded to create a safe path for equipment to access the forebay, or a maintenance ramp or shelf can be incorporated into the basin's design to allow for direct and easy access to all areas of the sediment basin.
- **Clean Out:** A fixed cleanout stake, solely for use within the sediment forebay is recommended near the forebay berm. This cleanout stake is beneficial since the forebay may become inundated with sediment faster than the rest of the basin. The recommended cleanout height for sediment forebays is 1/2 the height of the forebay's berm.

Photo: Sediment Forebay

Porous Baffles

Located between the sediment forebay and the basin's spillways (outlets), porous baffles must be installed to aid in the dispersion of runoff across the entire width of the basin and to promote sedimentation by reducing turbulence. Baffles function in basins with or without permanent pools.

Proper design, construction, and stabilization of porous baffles will promote the required functions of sediment basins. When designing a basin the following criteria on porous baffles should be addressed:

- **Height:** The recommended height of each baffle is 3 feet. When possible, the height of each baffle should be equal to or above the 10-yr, 24-hour NRCS Storm's design water surface elevation within the sediment basin.
- **Width:** The width of each baffle shall be equal to the entire width of the sediment basin, including the side slopes up to where the height of the baffle intersects the slope.
- **Spacing:** The minimum spacing between baffles should be 10 feet. Baffles should ultimately be placed to maximize the space between each of the rows of baffles and the basin's sediment forebay/spillways and the adjacent baffle row.
- **Materials:** All porous baffles not composed of turf reinforcement matting (TRM) material should consist of materials derived from coir (coconut fibers) products. An example is coir woven

matting. TRMs should consist of materials that do not have loose Straw fibers. The selected material should have a light penetration (open space) between 10-30%. **Silt Fence may not be used.**

- **Posts:** The posts used to install porous baffles should be steel posts with a minimum weight of 1.25 lb. per liner foot. Install steel posts at a maximum of 4-feet on center.
- **Rows:** A minimum of three (3) porous baffle rows should be installed across the width of the entire basin (including side slopes) where the basin length is greater than 50 feet. For basins with a length of 50 ft or less, only two rows of (2) porous baffles are necessary to be installed.
- **Installation:** All baffles are to be trenched or anchored into the basin's bottom and tied into side slopes to prevent bypass. A rope or wire can be used along the top of the baffle to prevent excessive sagging between the posts.

Photo: Porous Baffles

Rock Berm

A rock berm, typically provided in a horseshoe orientation around the principle spillway, may be provided to restrict the deposition of sediment within the area directly adjacent to the principle spillway. Restriction of sedimentation within this area will promote proper skimmer function. This rock berm is not recommended when a permanent pool of water is designed to remain within the basin during construction.

Proper design and construction of a rock berm around the principle spillway will promote the desired functions of sediment basins. When designing a basin the following criteria on rock berms should be addressed:

- **Installation:** The rock berm is to be installed outside the scopes of the skimmer and associated mechanisms required for proper skimmer performance, such as skimmer pits and/or skimmer rock pads. The berm should completely surround the principle spillway and should be installed upon the sediment basin's embankment slopes up to the elevation where the height of the berm intersects the slope.

- **Width:** The width along the crest of the rock berm should be at a minimum of 2 feet. Wider rock berms may be necessary in larger basins.
- **Height:** The height of a rock berm should range between 2-4 feet, dependent upon the height of the basin.

Photo: Horseshoe Rock Berm Around Principle Spillway with Skimmer

Skimmers

The most common devices used to meet a sediment basin's surface water dewatering requirements are floating skimmers. These skimmers allow for the dewatering of a basin from the top of the water column up to a specified design elevation, which in South Carolina is the 10-yr, NRCS 24-hr Storm's design Water Surface Elevation (WSE).

The discharge through skimmers will approach a somewhat constant flow rate as the water surface elevation rises within the basin. As the elevation of water rises, the skimmer will remain at the top of the water's surface due to a floatation mechanisms incorporated into skimmer designs by the manufacturer. This floatation is typically designed to keep the depth of water above the skimmer's orifice constant as the water surface elevation rises.

Proper design and installation of skimmers will promote the desired functions of sediment basins. When designing a basin the following criteria on skimmers should be addressed:

- **Installation:** All skimmers should be installed based on manufacturer's recommendation. The skimmer should also be installed prior to clearing and grading of a basin’s drainage area.
- **Discharge Capacity:** Each skimmer must be designed/selected to allow the sediment basin to have the capacity to pass the 10-yr, NRCS 24-hr storm event within the recommended time of 2-5 days.
- **Skimmer Size:** The size of the skimmer device, which typically reflects the skimmer’s orifice size, should be selected to meet the basin discharge capacity requirements. Most skimmer manufacturers provided skimmer sizes ranging from 1.5" up to 8". Orifice size and associated flow rates are product specific and should be based off product-specific testing.

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- **Skimmer Orifice Sizing:** In addition to skimmer size, some skimmer manufacturers provide the option to modify the intake orifice of a skimmer through the use of a plug or flap. These modifications are place within or over the skimmer's orifice to provide a smaller orifice size.
- **Additional Options:** Dependent on the skimmer manufacturer's recommendations, additional measures may need to be implemented around, near, or under the skimmer to prevent the skimmer from becoming clogged or stuck within deposited sediment. These additional measures included, and may not be limited to, skimmer pits, rock pads, and rope that is attached to the skimmer and then tied to a secure point along the basin's embankment.

A detail of the selected skimmer should be included on the construction site plans that should reference the skimmer's manufacturer, the Daily Discharge Capacity (ft^3/day), the Average Discharge Rate (cfs), and the Dewatering Time (days). Listing these parameters for each proposed skimmer allows the selection of an equivalent skimmer from an alternative manufacturer, when the need arises.

When selecting an equivalent skimmer, from what was specified on the approved plans, it is important to comply with the following guidance to ensure an "equivalent" skimmer is selected.

- **The Average Discharge Rate (cfs) from the selected skimmer should be equal to or greater than that discharge rate of the approved skimmer.** Any skimmer with a lower Average Discharge Rate would case the peak water surface elevation within the basin to rise during a given storm event.
- **The Daily Discharge Capacity (ft^3/day) from the selected skimmer should be equal to or greater than the discharge capacity of the approved skimmer.** Any skimmer with a Daily Discharge Capacity lower than the approved skimmer would case the peak water surface elevation within the basin to rise during a given storm event.
- **The Dewatering Time should remain within a time frame of 2-5 days.** It is recommended to keep the dewatering time as close to possible to that of the approved skimmer, but complying with this item keeps the basin from dewatering too quickly. The Dewatering Time is equal to the time it takes the skimmer(s) to completely dewater the basin.

Any rise in water surface elevation may allow for more water to flow over the riser crest, increasing the discharge rate of the basin. This potential for increased discharge may reduce the trapping efficiency below the required 80% efficiency.

Failing to follow this guidance would require review and approval of the "equivalent" skimmer prior to implementation (in most cases requiring a Major Modification of the approved plans). All skimmer data should be based off product-specific testing.

Photo: Skimmer with Attached Rope for Ease of Maintenance

Principle Spillway

The Principle Spillway is the primary discharge mechanism for sediment basins. This spillway consists of a riser structure, a barrel (outlet pipe), and surface water dewatering mechanisms (typically a skimmer). The riser structure should also be equipped with a trash rack, an anti-vortex device, and an anti-floatation mechanism.

Proper design and installation of the principle spillway will promote the desired functions of sediment basins. When designing a basin the following criteria on principle spillways should be addressed:

- **Riser:** May be provided as a concrete box/pipe or corrugated pipe. Recommended heights range between 3 and 6 feet.
- **Barrel:** The barrel connects into the riser structure and extends through the basin's embankment to allow impounded stormwater runoff to discharge from the basin. Anti-seep mechanisms must be provided along the barrel to prevent embankment failure.
- **Orifices:** Limit orifices on the riser to those necessary to connect the skimmer device(s). Orifices along the riser in which a skimmer is not connected are not considered to meet the water surface dewatering requirements.
- **Weirs:** Limit the use of weirs along the riser to within 1-foot of the riser crest. Weirs below this elevation are not considered to meet the water surface dewatering requirements.
- **Trash Rack and Anti-Vortex Device:** Equip the riser structure with a trash rack and anti-vortex device to prevent clogging of the principle spillway and non-weir flow over the riser crest.
- **Anti-Floatation Mechanism:** Provide an anchor to prevent floatation of the riser structure. Recommended weight of the anti-floatation mechanism is 1.1 times greater than the weight of the volume of water displaced by the riser structure.
- **10-Yr Design WSE:** The 10-yr design WSE should target the crest of the riser. The maximum head above the riser crest should be limited to 1 foot to maintain water surface dewatering requirements. Basins with permanent pools subject to high ground water tables may be accepted with the 10-yr design WSE more than 1 foot above the riser crest.

Photo: Principle Spillway's Riser Structure with Skimmer

Emergency Spillway

The Emergency Spillway is the secondary discharge mechanism for the sediment basin designed to discharge larger storm events, such as the 100-yr, NRCS 24-hr storm event, from the basin. This spillway consists of a stabilized, open channel along the top of the basin's embankment.

Proper design and installation of the emergency spillway will promote the desired functions of sediment basins. When designing a basin the following criteria on emergency spillways should be addressed:

- **Location:** Where feasible, construct the emergency spillway in natural ground and not over fill material.
- **Elevation:** The crest of the emergency spillway should be at least 1 foot below the top of the basin's embankment. This spillway should also be located 1 foot above the crest of the principle spillway's riser or the 10-yr design WSE whichever is higher.
- **Height:** The height should be at least 1 foot and should be designed to successfully pass the 100-yr, NRCS 24-hr storm event with a freeboard of no less than 0.5 feet between the maximum water surface elevation from this storm event and the basin's embankment.
- **Width:** The width of the emergency spillway should be at a minimum of 10 feet.
- **Side Slopes:** The side slopes of the emergency spillway should be no steeper than a 2:1 slope.
- **Stabilization:** The entirety of the emergency spillway, including side slopes and the embankment's slopes, should be properly stabilized. When located on fill material, this stabilization should consist of rip-rap with underlying geotextile fabric or erosion prevention BMPs capable of conveying the expected velocities without failure.

Outlet Protection

Each of the sediment basin's outlets shall be designed to prevent scour and to reduce velocities during peak flow conditions. This can be accomplished through the selection and design of energy dissipation structures such as riprap aprons. Each outlet should also be directed towards pre-existing point source discharges or be equipped with a mechanism to release the discharge as close to sheet flow as possible, to prevent the creation of new point source discharges. Try to restrict the outlets from being placed within 20 linear feet of adjacent properties lines.

Photo: Principle Spillway's Barrel (Outlet Pipe) with Plunge Pool and Level Spreader

Permanent Pools

Sediment basins located in low-lying areas or areas with high ground water tables may be incapable of avoiding a standing pool of water within the basin. These conditions may result in a permanent pool of water within the basin during the course of construction activities. Under such conditions, the following design criteria will need to be re-evaluated:

- **Sediment Forebay:** The forebay should be located above the permanent pool elevation when possible. If site-specific constraints are limiting, a forebay may not be capable of being provided. Forebays may not be beneficial when the basin's inlets are submerged and there is little to no overland flow to basin during construction.
- **Rock Berm:** The rock berm may prove ineffective under these circumstances and is not recommended to be provided.
- **Cleanout Height:** Sediment should be removed when approximately ½ of the sediment storage volume is lost due to accumulated sediment. Removal of sediment will also need to be conducted when the skimmer mechanism fails to rise and fall with the water surface elevation due to sediment accumulation along riser structure.

Additionally many other aspects, including baffles and skimmers, of a sediment basin may prove challenging or infeasible to provide and may require other solutions to design a basin that remains in compliance with South Carolina requirements. This is especially true along the coastal regions of South Carolina where relatively flat topography and high water tables limit the depth of basins.

One option to address such circumstances is the use of a single weir as water surface dewatering mechanism. Allowance of this practice may be dependent upon the following:

- The basin's length-to-width ratio;
- The prevention of short-circuiting between the basin's inlets and outlets;
- Whether or not the basin's inlets are submerged;
- The dispersion of flow within the basin;
- The depth of the permanent pool; and
- The maximum head on the weir crest during the 10-yr, NRCS 24-hr storm event.

Another practice to consider when designing a sediment basin with a permanent pool is turbidity curtains. This practice provides an impermeable liner along the entirety of the water column and only allows flow to discharge near the top of the water surface. Upon proper selection and implementation, turbidity curtains may be capable of enhancing the sedimentation process, dispersion of flow, dewatering from the top of the water surface, and restricting the accumulation of sediment near or around the outlet structure.

The use of these suggested practices must be approved prior to being implemented at the construction site.

Inspections & Maintenance

The key to a functional sediment basin is continual inspections, routine maintenance and regular sediment removal. Each sediment basin should be inspected at a minimum of once every calendar week. It is also recommended to inspect sediment basins within 24 hours of a storm event producing 0.5" of precipitation or greater.

Any deficiencies noted during an inspection of the basin must be addressed within 7 calendar days, before the next scheduled inspection, or before the next storm event.

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Over the course of the construction project, accumulated sediment will need to be removed from the basin. Ultimately, the accumulated sediment will need to be removed once it reaches ½ of the provided sediment storage volume within the sediment basin but it is recommended to cleanout certain sections of the sediment basin (such as the sediment forebay and the cells between the porous baffles) more frequently. For this reason the following sediment removal procedures may be necessary.

- **Sediment Forebay:** Accumulated sediment should be removed from the forebay when the elevation of the deposited sediment reaches 1/2 the height of the forebay's berm.
- **Porous Baffles' Cells:** Accumulated sediment should be removed from the cells created by each row of baffles when the elevation of the deposited sediment reaches 1/2 the height of the baffles or the cleanout mark located on the cleanout stake, whichever is lower.
- **Rock Berm:** Accumulated sediment should be removed from in front of the rock berm when the elevation of the deposited sediment reaches 1/2 the height of the berm or the cleanout mark located on the cleanout stake, whichever is lower.

When accumulated sediment is removed from a sediment basin, it should be placed in designated stockpile storage areas or spread thinly across the disturbed area and promptly stabilized.

Accumulate sediment is not the only issue that may prevent proper sediment basin functions. Additional maintenance issues that are commonly required to maintain sediment basins are listed in the table located on the following page.

Identified Sediment Basin Condition	Maintenance Measures To Be Taken
Outlet pipe (barrel) is clogged with debris.	Remove debris. Modify trash rack at top of riser structure to restrict larger debris particles from entering the outlet pipe.
Emergency Spillway has eroded due to high discharge velocities during recent storm event.	Stabilize spillway with Erosion Control Blankets (ECBs) or Turf Reinforcement Mats (TRMs) with higher sheer stress capabilities. Alternatively, stabilize spillway with Rip-Rap sized to address anticipated velocities. Extend stabilization down the embankment's interior and exterior slopes, if not already provided.
Basin's side slopes are eroding. The formation of rills and gullies are evident.	Re-grade slopes and provide proper tracking techniques. Seed slopes and stabilize with ECBs, TRMs, or equivalent erosion prevention BMPs, as necessary. Ensure that the slopes are graded correctly. **Do not fill rills/gullies with rip-rap.** Inspect upland areas for evidence of concentrated flows towards slopes. If evident provide a stabilized conveyance method to prevent further erosion along the slope.
Excessive accumulated sediment identified in basin.	Remove sediment to the elevations as denoted on the plans. Place removed sediment in stockpiles or across disturbed areas.
Principle Spillway and Embankment Failure.	Contact regulatory inspection agency. Install temporary BMP measures and stabilize disturbed areas to keep additional impacts to a minimum. Removal of any off-site sediment impacts should be done so at adjacent property owner's consent.
Skimmer is stuck or is clogged with debris.	Use rope to free skimmer from mud. Clear debris from skimmer orifice and install anti-clog mechanism.
Inlets of basin cited for scouring which is increasing erosion within basin.	Stabilize each inlet with Rip-Rap Aprons. Be sure to extend rip-rap above inlet pipe or into inlet channel.

Basin Removal

Sediment Basin may be removed when all areas discharging to the basin have reached final stabilization or when the conditions listed within the approved On-Site SWPPP have been met. In most circumstances, the basin will not be removed but converted to a detention pond to serve the site post-construction.

When a basin is to be removed, it should be completed within 30 days after final site stabilization is achieved or when the approved conditions indicate removal requirements have been met. All areas disturbed as a result of the sediment basin removal will need to be permanently stabilized. Additional BMPs, such as silt fence may need to be utilized to accept runoff from this area until final stabilization is reached.

Design Aids

The following design methodology (Hayes et al. 1995) may be used to design sediment basins to meet the 80 percent trapping efficiency requirements for TSS, which has a drainage area limitation of 30 acres. Alternatively computer models that utilize eroded particle size distributions to calculate a corresponding trapping efficiency may also be used; these models may allow larger drainage areas.

The listed methodology utilizes an eroded particle diameter from on-site soils to determine the settling velocity associated with the soil's specified particle diameter, the surface area of the basin at the riser crest, and the 10-yr, NRCS 24-hr peak outflow from the basin. These three parameters will then be used to calculate a Basin Ratio that can then be used to determine the trapping efficiency from **Figure SB-1** or **SB-2** located in **Appendix K** of SC DHEC's Stormwater BMP Handbook.

Unfortunately, the majority of the available methodologies and computer models may not take into account the anticipated benefits of the various components of the sediment basin, such as water surface withdrawal, porous baffles, and the sediment forebay.

The suggested procedure to determine the trapping efficiency is outlined below.

Calculating the Trapping Efficiency of a Sediment Basin

1. **Determine on-site soils' characteristic eroded particle diameter.** Each soil has a unique eroded particle diameter and the D_{15} (the particle diameter in which only 15% of the soil particle diameters are less than). To determine the D_{15} use **Appendix E** of SC DHEC's Stormwater BMP Handbook to look up the smallest D_{15} listed for all soils identified on-site.
2. **Determine the characteristic settling velocity of on-site soils.** Use **Figure SV-1**, found in **Appendix K**, which plots eroded particle diameter (D_{15}) versus settling velocity (V_{15}), to determine the value of the settling velocity. This unit is provided in feet per second (fps).
3. **Calculate the Basin Ratio.** Use the provided formula to calculate the Basin Ratio (BR).

$$\text{Basin Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where:
$\mathbf{q_{po}}$ = Peak Outflow Rate from the Basin for the 10-yr, NRCS 24-hr Storm Event (cfs),
A = Surface Area of the Basin at the Riser Crest (acres),
$\mathbf{V_{15}}$ = Characteristic Settling Velocity (fps) of the Characteristic D_{15} Eroded Particle (mm).

4. **Determine Trapping Efficiency.** Use **Figure SB-1** or **Figure SB-2** to determine the trapping efficiency with the Basin Ratio calculated in step 3. These figures plot trapping efficiency versus the basin ratio, and each figure is for separate conditions identified as follows:
    - **Figure SB-1** is for basins not located in low lying areas and/or not having a high water table.
    - **Figure SB-2** is for basin located in low lying areas and/or having a high water table. This figure is appropriate for Hydrologic Soil Group (HSG) D soils classified as such due to the presence of a high water table. HSGs A/D, B/D, and C/D are also considered to have high water tables based upon the characteristics of dual hydrologic soil groups.

When using this methodology the following design constraints must be considered:

- Drainage Area to the Sediment Basin must be less than or equal to 30 Acres.
- Overland slope of this drainage area must be less than or equal to 20 percent.
- The sediment basin's Barrel (outlet pipe) must be less than or equal to 6 feet in diameter.
- Any Basin Ratios above the design curves on **Figures SB-1** and **SB-2** are not recommended for any application of the design aids.
- This methodology is not applicable to sediment basins in series.

Additional design guidance on this methodology is as follows:

- If the Basin Ratio intersects the design curve at a point having a trapping efficiency of less than the desired value, the design is inadequate and must be revised.
- A basin, **not** located in low lying area and not having a high water table, has a basin ratio equal to 2.20 E5 at 80 percent trapping efficiency as shown in **Figure SB-1**.
- A basin that **is** located in low lying area and does not have a high water table, has a basin ratio equal to 4.7 E3 at 80 percent trapping efficiency as shown in **Figure SB-2**.

Design Example

Design a sediment basin to accept stormwater runoff from a 14-acre (0.0219 mi2) construction site during construction conditions. Assume the entire area is disturbed and discharges into the sediment basin. (There are no additional discharges to the basin.) The proposed location of the sediment basin is not located in low-lying areas and does not have a high water table. The only constraint on the size of the basin is to limit the surface area at the basin's riser crest to 0.75 acres. Soil Maps indicate that both Cecil and Edisto soil types are found on-site. Calculate the trapping efficiency of the basin for a 10-year, NRCS 24-hour storm event with and without the use of a skimmer. (The peak discharge from the basin is 8.5 cfs when a skimmer is not employed. Assume that no weir flow occurs across riser crest when skimmer is employed.)

Skimmer Manufacturer Information

Skimmer Size	1.5"	2"	2.5"	3"	4"	5"	6"	8"
3 Day Discharge Capacity (Cubic Feet)	5500	10200	19500	31250	64500	102250	165580	298500

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Design Example's Given and Find Information

Given:

- Drainage Area = 14 Acres (0.0219 mi2)
- A = 0.75 Acres (at Riser Crest)
- Cecil and Edisto Soil Types
- Not in Low-Lying Areas.
- There is not a High Water Table.
- Peak Discharge without Skimmer = 8.5 cfs

Find:

- Trapping Efficiency with Skimmer
- Trapping Efficiency without Skimmer

Solution 1 (No Skimmer):

1. **Determine D_{15}.** From Appendix E, determine the smallest D_{15} for both Cecil and Edisto Type Soils.
   a. For Cecil Soils, D_{15} = 0.0043 mm
   b. For Edisto Soils, D_{15} = 0.0093 mm

   Since Cecil has the smallest D_{15}, use **0.0043 mm**.

2. **Determine V_{15}.** From Appendix K, use Figure SV-1 to determine the V_{15}. From this figure and use a D_{15} = 0.0043 mm (from step 1), the V_{15} will be approximately **5.19 E-05 fps**.

   Alternatively, this may be calculated from the following equation $V_{15}=2.81(D_{15})^2$. (This equation may only be used if D_{15} is less than 0.01 mm.)

3. **Calculate Basin Ratio.** Calculate the Basin Ratio using the given information and the V_{15} determined is step 2.

$$\textbf{BR} = \frac{\textbf{(8.5 cfs)}}{\textbf{(0.75 Acres)(5.19 E-05 fps)}}$$

BR = 218,368.65

4. **Determine Trapping Efficiency.** Determine the trapping efficiency using the calculated BR from step 3 and Figure SB-1 from Appendix K.

Trapping Efficiency = ~80%

Solution 2 (Skimmer):

1. **Discharge Volume.** The discharge volume could be estimated using the recommended sediment storage volume (3600 cubic feet per acre draining) as the discharge volume but, when known, the volume beneath the riser crest should be used as the discharge volume. For this example the sediment storage volume will be used.

   Calculate the required volume that the skimmer must have the capacity to discharge.

$$\textbf{Discharge Volume} = \frac{3600\ ft^3}{Acre} \times 14\ Acres = 50{,}400\ ft^3$$

2. **Calculate 3-Day Skimmer Dewatering Discharge.** Use the calculated discharge volume to select a skimmer based off the provided manufacturer's 3-Day Discharge Capacity. In order to

discharge 50,400 cubic feet within 3 days, select the 4" skimmer since it can discharge 64,500 cubic feet in 3 days.

Determine the average discharge rate through the skimmer in cubic feet per second (cfs) using the 4" skimmer's discharge capacity. (The manufacturer may directly cite the average discharge rate.)

$$\frac{\textbf{64,500 ft3}}{\textbf{3 days}} \times \frac{\textbf{1 day}}{\textbf{24 hrs}} \times \frac{\textbf{1 hour}}{\textbf{60 mins}} \times \frac{\textbf{1 min}}{\textbf{60 secs}} = \textbf{0.249 cfs}$$

Note: This average discharge rate of 0.249 cfs assumes that water does not overtop the riser crest during the 10-yr storm event. Basin routing should be conducted to confirm this. The peak discharge from the basin will be greater if the Water Surface Elevation (WSE) during this storm event overtops the riser crest. If the WSE is more than 1 foot above the riser crest, a larger or multiple skimmers may be necessary.

3. **Determine D15.** From Appendix E, determine the smallest D_{15} for both Cecil and Edisto Type Soils.
   - **a.** For Cecil Soils, D_{15} = 0.0043 mm
   - **b.** For Edisto Soils, D_{15} = 0.0093 mm

   Since Cecil has the smallest D_{15}, use **0.0043 mm**.

4. **Determine V15.** From Appendix K, use Figure SV-1 to determine the V_{15}. From this figure and use a D_{15} = 0.0043 mm (from step 1), the V_{15} will be approximately **5.19 E-05 fps**.

   Alternatively, this may be calculated from the following equation $V_{15}=2.81(D_{15})^2$. (This equation may only be used if D_{15} is less than 0.01 mm.)

5. **Calculate Basin Ratio.** Calculate the Basin Ratio using the given information and the V_{15} determined is step 2.

$$\textbf{BR} = \frac{\textbf{(0.249 cfs)}}{\textbf{(0.75 Acres)(5.19 E-05 fps)}}$$

BR = 6396.92

6. **Determine Trapping Efficiency.** Determine the trapping efficiency using the calculated BR from step 3 and Figure SB-1 from Appendix K.

Trapping Efficiency = ~92.5%

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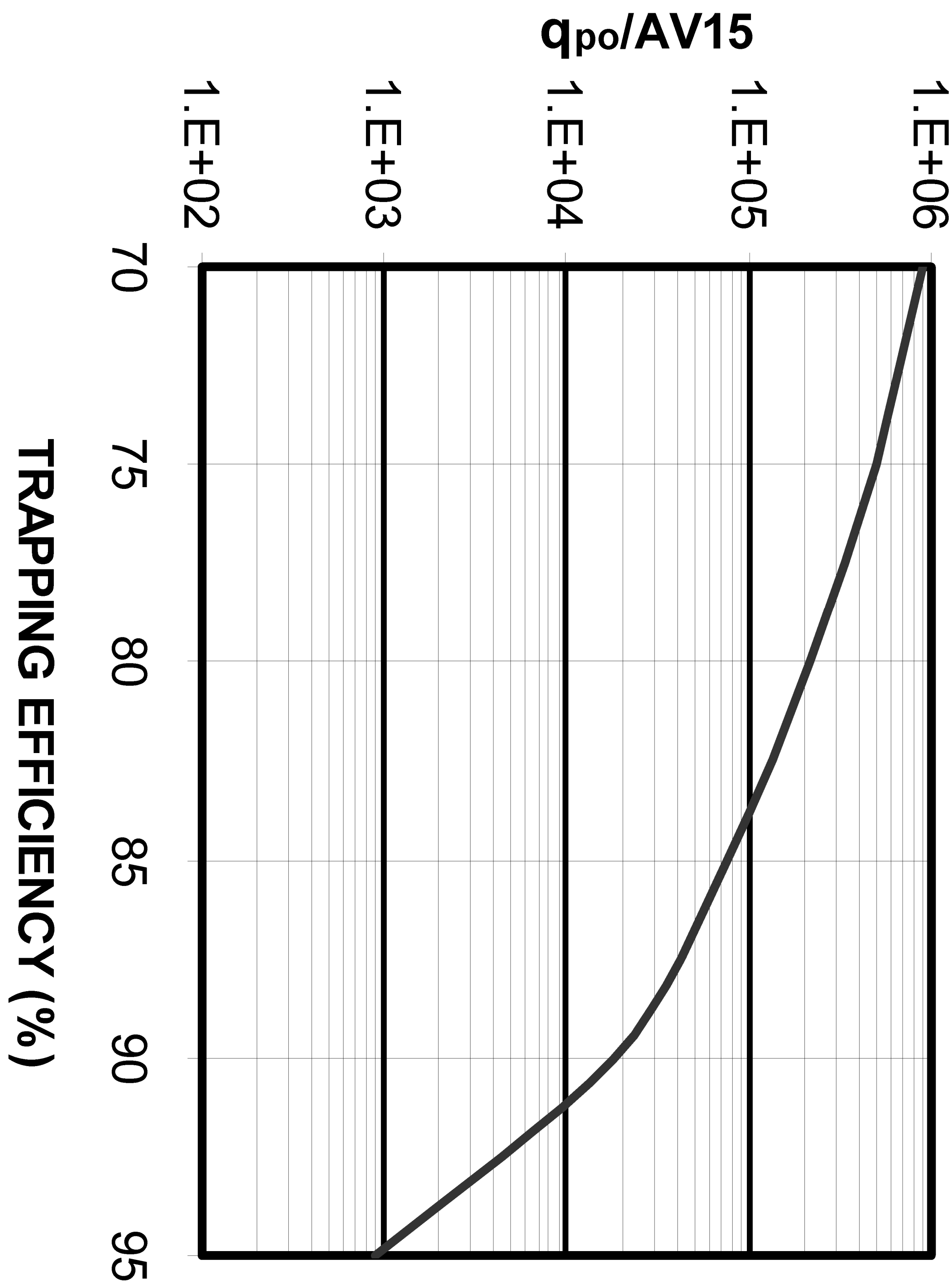
Depth	D15(mm)	K	1.4	1.0	0.063	0.044	0.038	0.004	0.003	0.001
			|---------------- ---------- Particle Sizes (mm) ----------------------------|							
SOIL: CECIL (B)										
0 - 7	0.0066	0.28	100.0	84.1	47.9	39.0	39.0	8.1	5.4	0.0
7 - 11	0.0066	0.28	100.0	84.1	47.9	39.0	39.0	8.1	5.4	0.0
11 - 50	0.0043	0.28	100.0	81.0	37.6	36.1	36.1	14.3	10.2	0.0
SOIL: CENTENARY (A)										
0 - 9	0.0465	0.10	100.0	93.3	77.9	3.7	3.7	1.2	0.9	0.0
9 - 58	0.0454	0.10	100.0	93.6	78.9	8.7	8.7	1.4	0.9	0.0
58 - 72	0.0460	0.10	100.0	91.6	72.4	7.1	7.1	1.7	1.2	0.0
SOIL: CHANDLER (B)										
0 - 4	0.0101	0.32	100.0	89.9	66.8	32.7	31.4	3.6	2.2	0.0
4 - 66	0.0101	0.32	100.0	89.9	66.8	32.7	31.4	3.6	2.2	0.0
SOIL: CHARLESTON (C)										
0 - 16	0.0125	0.15	100.0	88.8	63.0	26.4	26.1	3.6	2.2	0.0
16 - 44	0.0128	0.20	100.0	86.4	55.1	25.1	25.1	4.3	2.7	0.0
44 - 80	0.0458	0.15	100.0	89.0	63.7	8.7	8.7	2.4	1.7	0.0
SOIL: CHASTAIN (C)										
0 - 5	0.0049	0.28	100.0	87.8	59.8	54.7	53.6	11.1	7.5	0.0
5 – 52	0.0044	0.37	100.0	87.0	57.3	52.6	51.3	13.3	9.3	0.0
52 - 72	0.0453	0.10	100.0	91.8	73.2	10.1	10.1	1.8	1.2	0.0
SOIL: CHENNEBYPO (C)										
0 – 16	0.0052	0.32	100.0	90.6	69.1	61.8	60.0	9.3	6.0	0.0
16 - 55	0.0056	0.32	100.0	91.5	71.9	61.8	59.9	7.3	4.6	0.0
55 - 72	0.0092	0.24	100.0	84.8	49.9	30.9	30.9	5.7	3.7	0.0
SOIL: CHEWACLA (C)										
0 - 8	0.0056	0.28	100.0	91.1	70.7	59.7	58.8	7.2	4.4	0.0
8 - 24	0.0056	0.32	100.0	88.5	62.1	54.9	54.5	8.2	5.2	0.0
24 - 34	0.0074	0.28	100.0	83.4	45.5	34.6	34.6	7.7	5.2	0.0
34 - 58	0.0056	0.28	100.0	88.5	62.1	54.9	54.5	8.2	5.2	0.0
SOIL: CHIPLEY (C)										
0 - 6	0.0457	0.10	100.0	95.5	85.1	6.6	6.5	0.9	0.6	0.0
6 - 77	0.0459	0.10	100.0	94.1	80.5	6.0	6.0	1.2	0.8	0.0

			Particle Sizes (mm)							
Depth	**D15(mm)**	**K**	**1.4**	**1.0**	**0.063**	**0.044**	**0.038**	**0.004**	**0.003**	**0.001**
SOIL: ORTEGA (A)										
0 - 5	0.0461	0.15	100.0	96.8	89.6	4.0	4.0	0.6	0.4	0.0
5 - 82	0.0462	0.15	100.0	96.8	89.5	3.0	3.0	0.6	0.4	0.0
SOIL: OSIER (A/D)										
0 - 8	0.0460	0.15	100.0	85.4	52.0	9.8	9.8	3.4	2.4	0.0
8 - 48	0.0456	0.10	100.0	92.3	74.7	8.4	8.4	1.6	1.1	0.0
48 - 75	0.0464	0.05	100.0	94.6	82.3	3.4	3.4	1.0	0.7	0.0
SOIL: OSIERFL (D)										
0 - 8	0.0460	0.15	100.0	85.4	52.0	9.8	9.8	3.4	2.4	0.0
8 - 48	0.0456	0.10	100.0	92.3	74.7	8.4	8.4	1.6	1.1	0.0
48 - 75	0.0464	0.05	100.0	94.6	82.3	3.4	3.4	1.0	0.7	0.0
SOIL: OSIERPO (A/D)										
0 - 8	0.0460	0.15	100.0	85.4	52.0	9.8	9.8	3.4	2.4	0.0
8 - 48	0.0462	0.10	100.0	89.9	66.7	7.0	7.0	2.1	1.5	0.0
48 - 75	0.0464	0.05	100.0	94.6	82.3	3.4	3.4	1.0	0.7	0.0
SOIL: PACOLET (B)										
0 - 3	0.0121	0.24	100.0	80.2	35.0	22.6	22.6	7.6	5.4	0.0
3 - 29	0.0053	0.28	100.0	78.1	28.2	26.0	26.0	13.4	9.8	0.0
29 - 52	0.0092	0.28	100.0	83.4	45.6	29.4	29.4	6.5	4.4	0.0
52 - 70	0.0113	0.28	100.0	84.7	49.6	25.0	25.0	5.1	3.4	0.0
SOIL: PACOLETGR (B)										
0 - 3	0.0143	0.20	100.0	78.7	30.0	20.1	20.1	8.4	6.0	0.0
3 – 29	0.0053	0.28	100.0	78.1	28.2	26.0	26.0	13.4	9.8	0.0
29 - 52	0.0092	0.28	100.0	83.4	45.6	29.4	29.4	6.5	4.4	0.0
52 - 70	0.0113	0.28	100.0	84.8	50.1	26.4	26.4	5.2	3.4	0.0
SOIL: PACTOLUS (A)										
0 – 40	0.0444	0.10	100.0	91.2	71.0	13.6	13.6	2.2	1.4	0.0
40 - 80	0.0445	0.10	100.0	91.2	71.1	13.3	13.3	2.2	1.4	0.0

South Carolina
Department of Health
and Environmental Control

FIGURE SB-1
TRAPPING EFFIENCY FOR BASINS NOT IN LOW LYING AREAS

EFFECTIVE DATE: AUGUST, 2005

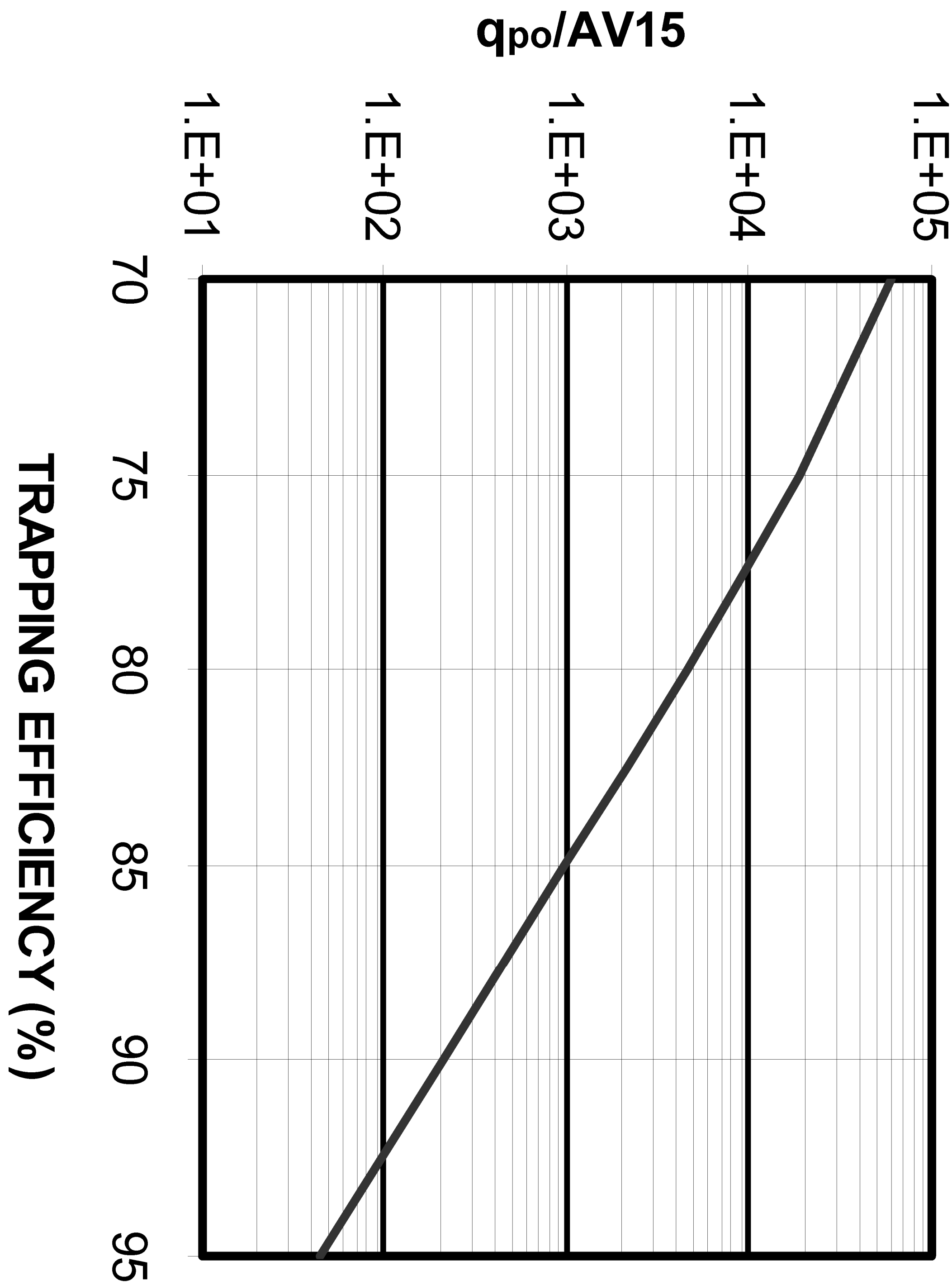


DESIGN AID FOR ESTIMATING TRAPPING EFFICIENCY FOR SEDIMENT BASINS NOT LOCATED IN LOW LYING AREAS AND/OR NOT HAVING A HIGH WATER TABLE

South Carolina
Department of Health
and Environmental Control

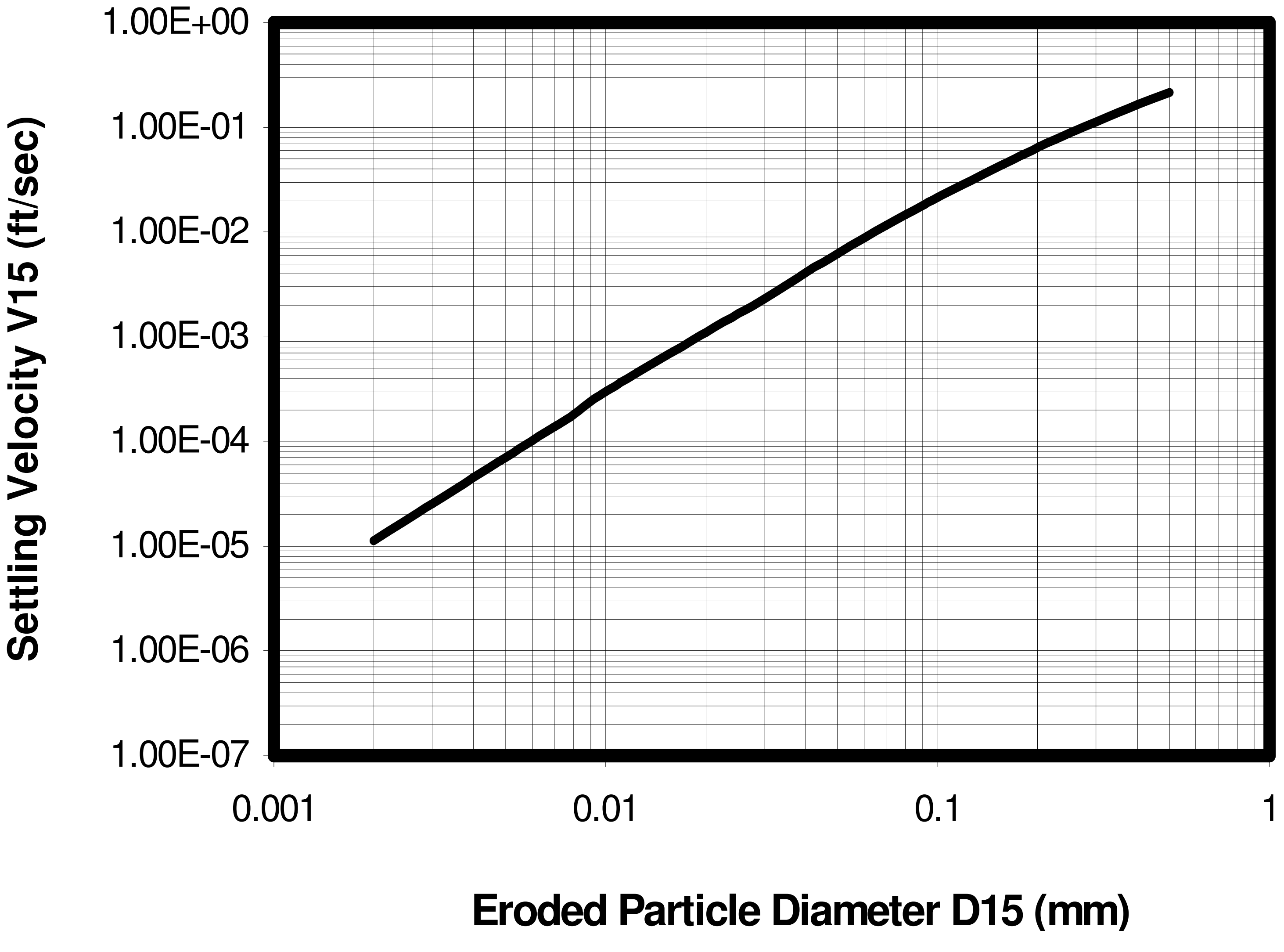
FIGURE SB-2
TRAPPING EFFIENCY FOR BASINS IN LOW LYING AREAS

EFFECTIVE DATE: AUGUST, 2005



DESIGN AID FOR ESTIMATING TRAPPING EFFICIENCY FOR SEDIMENT BASINS LOCATED IN LOW LYING AREAS AND/OR HAVING A HIGH WATER TABLE

FIGURE SV-1
CHARACTERISTIC SETTLING VELOCITY AS A FUNCTION OF ERODED PARTICLE DIAMETER



Reference 8

Design Hydrology and Sedimentology for Small Catchments, Haan, C.T., Barfield and Hayes, 1994. Pg. 147-148.

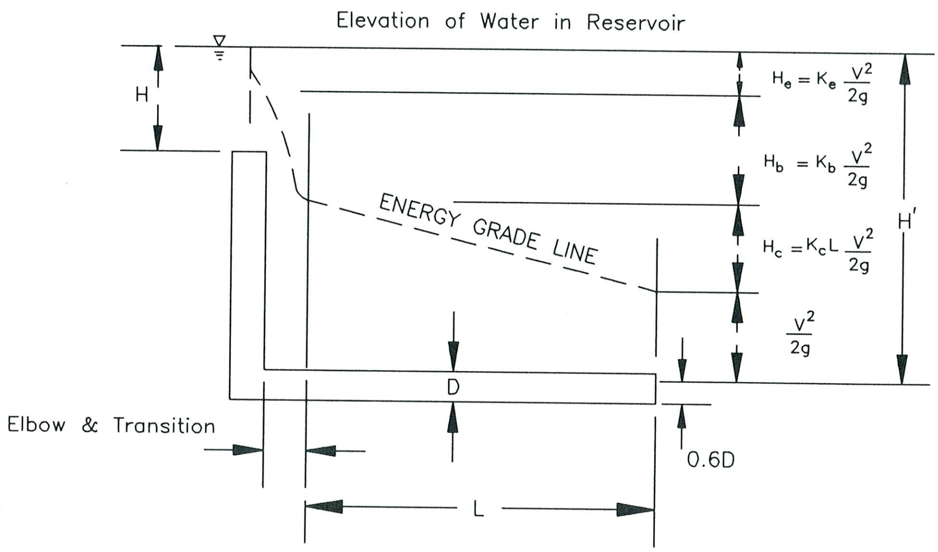


Figure 5.2 Energy losses for flow in a drop inlet spillway considering bend losses and entrance losses separately.

Solution: The discharge under orifice flow will equal

$$Q = C'a(2gH)^{1/2}.$$

The area of 24-in. pipe is 3.14 ft^2. Assuming a value of 0.6 for C' since the riser is corrugated metal pipe and substituting values including the gravitational constant, we have

$$Q = 0.6(3.14)\sqrt{2(32.2)H},$$

which reduces to

$$Q = 15.1H^{1/2}.$$

Substituting a head equal to 1 ft into the equation yields $Q = 15.1$ cfs for orifice flow.

Pipes as Flow Control Devices

A drop inlet spillway consists of a vertical pipe called a riser and a nearly horizontal pipe called a barrel. This spillway can serve as a flow control device, even when operating under pipe flow. A schematic showing energy losses with pipe flow is given in Fig. 5.2. When the water level shown in Fig. 5.2 rises to a point such that the pipe flows full, the total head causing flow is given by H' (as shown in Fig. 5.2) instead of H as it was for weir and orifice control. This head is dissipated as entrance head loss, transition head loss, bend head loss, friction head loss, and velocity head. Frequently, in pipes used to drain detention reservoirs, the only transitions and bends are at the connection between the drop inlet and the bottom pipe. If head losses are given in terms of a head loss coefficient times the velocity head, $V^2/2g$, and the transition and bend head losses are combined into a single head loss term, then the total head H' can be written as

$$H' = \frac{V^2}{2g}(1 + K_e + K_b + K_c L), \tag{5.4}$$

where H' is the head on the pipe as shown in Fig. 5.2, K_e is the entrance head loss coefficient, K_b is the bend head loss coefficient, K_c is the head loss coefficient due to friction, L is the length of the pipe (including the riser), and V is the mean velocity in the pipe. A schematic showing the head loss terms is given in Fig. 5.2. Since discharge through the pipe is equal to velocity times area, Eq. (5.4) can be solved for discharge as

$$Q = \frac{a(2gH')^{1/2}}{(1 + K_e + K_b + K_c L)^{1/2}}, \tag{5.5}$$

where Q is discharge and a is cross-sectional area of the pipe. Values for K_c are given in Tables 5.1 and 5.2 for circular and square pipes. Values for K_e and K_b depend on the configuration of the entrance and the bend. Typical values for K_e and K_b are 1.0 and 0.5, respectively. Brater and King (1976), as well as Hoffman (1974), can be consulted for further details.

For risers with rectangular inlets, the bend head losses are frequently combined with the entrance head losses into one term. The total head dissipated through the riser can then be written as

$$H' = \left(\frac{V^2}{2g}\right)(1 + K_e' + K_c L) \tag{5.6}$$

Table 5.1 Head Loss Coefficients for Circular Conduits Flowing Full[a]

Head loss coefficient, K_c, for circular pipe flowing full
$K_c = 5087\, n^2/D^{4/3}$
(Note: Pipe diameter, D, is in inches)

Pipe diameter (in.)	Flow area (ft²)	Manning's coefficient of roughness, n															
		0.010	0.011	0.012	0.013	0.014	0.015	0.016	0.017	0.018	0.019	0.020	0.021	0.022	0.023	0.024	0.025
6	0.196	0.0467	0.0565	0.0672	0.0789	0.0914	0.1050	0.1194	0.1348	0.1510	0.1680	0.1870	0.2060	0.2260	0.2470	0.2690	0.2920
8	0.349	0.0318	0.0385	0.0458	0.0537	0.0623	0.0715	0.0814	0.0919	0.1030	0.1148	0.1272	0.1400	0.1540	0.1680	0.1830	0.1990
10	0.545	0.0236	0.0286	0.0340	0.0399	0.0463	0.0531	0.0604	0.0682	0.0765	0.0852	0.0944	0.1041	0.1143	0.1249	0.1360	0.1480
12	0.785	0.0185	0.0224	0.0267	0.0313	0.0363	0.0417	0.0474	0.0535	0.0600	0.0668	0.0741	0.0817	0.0896	0.0980	0.1067	0.1157
14	1.069	0.0151	0.0182	0.0217	0.0255	0.0295	0.0339	0.0386	0.0436	0.0488	0.0544	0.0603	0.0665	0.0730	0.0798	0.0868	0.0942
15	1.230	0.0138	0.0166	0.0198	0.0232	0.0270	0.0309	0.0352	0.0397	0.0446	0.0496	0.0550	0.0606	0.0666	0.0727	0.0792	0.0859
16	1.400	0.0126	0.0153	0.0182	0.0213	0.0247	0.0284	0.0323	0.0365	0.0409	0.0455	0.0505	0.0556	0.0611	0.0667	0.0727	0.0789
18	1.770	0.01078	0.0130	0.0155	0.0182	0.0211	0.0243	0.0276	0.0312	0.0349	0.0389	0.0431	0.0476	0.0522	0.0570	0.0621	0.0674
21	2.410	0.00878	0.01062	0.0126	0.0148	0.0172	0.0198	0.0225	0.0254	0.0284	0.0317	0.0351	0.0387	0.0425	0.0464	0.0506	0.0549
24	3.140	0.00735	0.00889	0.01058	0.0124	0.0144	0.0165	0.0188	0.0212	0.0238	0.0265	0.0294	0.0324	0.0356	0.0389	0.0423	0.0459
27	3.980	0.00628	0.00760	0.00904	0.01061	0.0123	0.0141	0.0161	0.0181	0.0203	0.0227	0.0251	0.0277	0.0304	0.0332	0.0362	0.0393
30	4.910	0.00546	0.00660	0.00786	0.00922	0.01070	0.01228	0.0140	0.0158	0.0177	0.0197	0.0218	0.0241	0.0264	0.0289	0.0314	0.0341
36	7.070	0.00428	0.00518	0.00616	0.00723	0.00839	0.00963	0.01096	0.0124	0.0139	0.0154	0.0171	0.0189	0.0207	0.0226	0.0246	0.0267
42	9.620	0.00348	0.00422	0.00502	0.00589	0.00683	0.00784	0.00892	0.01007	0.01129	0.0126	0.0139	0.0154	0.0169	0.0184	0.0201	0.0218
48	12.570	0.00292	0.00353	0.00420	0.00493	0.00572	0.00656	0.00747	0.00843	0.00945	0.01053	0.01166	0.0129	0.0141	0.0154	0.0168	0.0182
54	15.900	0.00249	0.00302	0.00359	0.00421	0.00488	0.00561	0.00638	0.00720	0.00808	0.00900	0.00997	0.01099	0.0121	0.0132	0.0144	0.0156
60	19.630	0.00217	0.00262	0.00312	0.00366	0.00424	0.00487	0.00554	0.00622	0.00702	0.00782	0.00866	0.00955	0.01048	0.0115	0.0125	0.0135

[a] From Soil Conservation Service (1951).

or

$$Q = \frac{a(2gH')^{1/2}}{(1 + K'_e + K_c L)^{1/2}}, \qquad (5.7)$$

where K'_e is the combined entrance and bend head loss term. By providing a smooth transition, the value for K'_e can be reduced. Typical values of K'_e are given in Table 5.3.

Frequently when the drop inlet is the same size as the remainder of the pipe, orifice flow will control, and the pipe will never flow full. In this case, it may be necessary to increase the size of the drop inlet in order to utilize the full capacity of the pipe.

Example Problem 5.3 Pipe flow

An 24-in.-diameter corrugated metal pipe (CMP) is attached to the 24-in. vertical riser described in Problems 5.1 and 5.2. It is being used as the principal spillway for a detention structure. The pipe is 60 ft long and has one 90° bend. The top of the inlet riser is 15 ft above the bottom of the outlet. Assume a free outfall and estimate the discharge under pipe flow if the water elevation 30 ft from the inlet is 1 ft higher than the top of the riser.

Solution: For pipe flow, we have

$$Q = \frac{a(2gH')^{1/2}}{(1 + K_e + K_b + K_c L)^{1/2}}$$

where $K_e \approx 1.0$ for most entrances of interest and $K_b = 0.5$. Manning's n for CMP is approximately 0.024 (see Table 4.1 for a range of values for CMP). Using this value in Table 5.1, $K_c = 0.042$. Head for pipe flow is the distance from the water surface to a point $0.6D$ above the outlet as shown in Fig. 5.2 and 5.3. H' then is given in terms of the stage, H, by

$$H' = H + 15 - 0.6(2.0) = H + 13.8.$$

Reference 9

Determining the Skimmer Size and the Required Orifice, Faircloth Skimmer, November 2007.

Determining the Skimmer Size and the Required Orifice for the *Faircloth Skimmer®* Surface Drain

November 2007

Important note: *The <u>orifice sizing chart</u> in the Pennsylvania Erosion Control Manual and reproduced in the North Carolina Design Manual* ***DOES NOT APPLY*** *to our skimmers. It will give the wrong size orifice and not specify which size skimmer is required. Please use the information below to choose the size skimmer required for the basin volume <u>provided</u> and determine the orifice size required for the drawdown time, typically 4-7 days in Pennsylvania and 3 days in North Carolina.*

The **size** of a Faircloth Skimmer®, for example a 4" skimmer, refers to the maximum diameter of the skimmer inlet. The inlet on each of the 8 sizes offered can be reduced to adjust the flow rate by cutting a hole or ***orifice*** in a plug using an adjustable cutter (both supplied).

Determining the skimmer size needed and the orifice for that skimmer required to drain the sediment basin's volume in the required time involves two steps: **First**, determining the size skimmer required based on the volume <u>to be drained</u> and the number of days to drain it; and **Second,** calculate the orifice size to adjust the flow rate and "customize" the skimmer for the basin's volume. *The second step is not always necessary* if the flow rate for the skimmer with the inlet wide open equals or is close to the flow rate required for the basin volume and the drawdown time.

Both the skimmer size and the required orifice radius for the skimmer should be shown for each basin on the erosion and sediment control plan. <u>Make it clear that the dimension is either the radius or the diameter.</u> It is also helpful to give the basin volume in case there are questions. During the skimmer installation the required orifice can be cut in the plastic plug using the supplied adjustable cutter and installed in the skimmer using the instructions provided.

The plan review and enforcement authority may require the calculations showing that the skimmer used can drain the basin in the required time.

Determining the Skimmer Size

Step 1. Below are approximate **skimmer maximum flow capacities** based on typical draw down requirements, which can vary between States and jurisdictions and watersheds. If one 6" skimmer does not provide enough capacity, multiple skimmers can be used to drain the basin. For drawdown times not shown, multiply the 24-hour figure by the number of days required.

Example: A basin's volume is 29,600 cubic feet and it must be drained in 3 days. A 3" skimmer with the inlet wide open will work perfectly. (Actually, the chart below gives 29,322 cubic feet but this is well within the accuracy of the calculations and the basin's constructed volume.)
Example: A basin's volume is 39,000 cubic feet and it must be drained in 3 days. The 3" skimmer is too small; a 4" skimmer has enough capacity but it is too large, so the inlet will need

to be reduced using step 2 to adjust the flow rate for the basin's volume. (It needs a 3.2" diameter orifice.)

1½" skimmer:	1,728 cubic feet in **24 hours**	6,912 cubic feet in **4 days**
with a 1½" head	3,456 cubic feet in **2 days**	12,096 cubic feet in **7 days**
	5,184 cubic feet in **3 days**	
2" skimmer:	3,283 cubic feet in **24 hours**	13,132 cubic feet in **4 days**
with a 2" head	6,566 cubic feet in **2 days**	22,982 cubic feet in **7 days**
	9,849 cubic feet in **3 days**	
2½" skimmer:	6,234 cubic feet in **24 hours**	24,936 cubic feet in **4 days**
with a 2.5" head	12,468 cubic feet in **2 days**	43,638 cubic feet in **7 days**
Revised 11-6-07	18,702 cubic feet in **3 days**	
3" skimmer:	9,774 cubic feet in **24 hours**	39,096 cubic feet in **4 days**
with a 3" head	19,547 cubic feet in **2 days**	68,415 cubic feet in **7 days**
	29,322 cubic feet in **3 days**	
4" skimmer:	20,109 cubic feet in **24 hours**	80,436 cubic feet in **4 days**
with a 4" head	40,218 cubic feet in **2 days**	140,763 cubic feet in **7 days**
Revised 11-6-07	60,327 cubic feet in **3 days**	
5" skimmer:	32,832 cubic feet in **24 hours**	131,328 cubic feet in **4 days**
with a 4" head	65,664 cubic feet in **2 days**	229,824 cubic feet in **7 days**
	98,496 cubic feet in **3 days**	
6" skimmer:	51,840 cubic feet in **24 hours**	207,360 cubic feet in **4 days**
with a 5" head	103,680 cubic feet in **2 days**	362,880 cubic feet in **7 days**
	155,520 cubic feet in **3 days**	
8" skimmer:	97,978 cubic feet in **24 hours**	391,912 cubic feet in **4 days**
with a 6" head	195,956 cubic feet in **2 days**	685,846 cubic feet in **7 days**
CUSTOM	293,934 cubic feet in **3 days**	
MADE BY ORDER	**CALL!**	

Determining the Orifice

Step 2. To determine the orifice required to reduce the flow rate for the basin's volume and the number of days to drain the basin, simply use the formula volume ÷ **factor** (from the chart below) for the same size skimmer chosen in the first step and the same number of days. This calculation will give the **area** of the required orifice. Then calculate the orifice radius using Area = πr^2 and solving for *r*, $r = \sqrt{(Area/3.14)}$ .The supplied cutter can be adjusted to this radius to cut the orifice in the plug. The instructions with the plug and cutter has a ruler divided into tenths of inches. Again, this step is not always necessary as explained above.

An alternative method is to use the orifice equation with the head for a particular skimmer shown on the previous page and determine the orifice needed to give the required flow for the volume and draw down time. C = 0.59 is used in this chart.

Example: A 4" skimmer is the smallest skimmer that will drain 39,000 cubic feet in 3 days but a 4" inlet will drain the basin too fast (in 1.9 days) To determine the orifice required use the factor of 4,803 from the chart below for a 4" skimmer and a drawdown time of 3 days. 39,000 cubic feet ÷ 4,803 = 8.12 square inches of orifice required. Calculate the orifice radius using Area = πr^2 and solving for r, $r = \sqrt{(8.12/3.14)}$ and r = 1.61". As a practical matter 1.6" is about as close as the cutter can be adjusted and the orifice cut..

Factors (in cubic feet of flow per square inch of opening through a **round** orifice with the head for that skimmer and for the drawdown times shown) for determining the **orifice radius** for a basin's volume to be drained. This quick method works because the orifice is centered and has a constant head (given above in Step 1).

1½" skimmer:	960 to drain in **24 hours**	3,840 to drain in **4 days**
	1,920 to drain in **2 days**	6,720 to drain in **7 days**
	2,880 to drain in **3 days**	
2" skimmer:	1,123 to drain in **24 hours**	4,492 to drain in **4 days**
	2,246 to drain in **2 days**	7,861 to drain in **7 days**
	3,369 to drain in **3 days**	
2½" skimmer:	1,270 to drain in **24 hours**	5,080 to drain in **4 days**
Revised 11-6-07	2,540 to drain in **2 days**	8,890 to drain in **7 days**
	3,810 to drain in **3 days**	
3" skimmer:	1,382 to drain in **24 hours**	5,528 to drain in **4 days**
	2,765 to drain in **2 days**	9,677 to drain in **7 days**
	4,146 to drain in **3 days**	
4" skimmer:	1,601 to drain in **24 hours**	6,404 to drain in **4 days**
Revised 11-6-07	3,202 to drain in **2 days**	11,207 to drain in **7 days**
	4,803 to drain in **3 days**	
5" skimmer:	1,642 to drain in **24 hours**	6,568 to drain in **4 days**
	3,283 to drain in **2 days**	11,491 to drain in **7 days**
	4,926 to drain in **3 days**	
6" skimmer:	1,814 to drain in **24 hours**	7,256 to drain in **4 days**
	3,628 to drain in **2 days**	12,701 to drain in **7 days**
	5,442 to drain in **3 days**	
8" skimmer:	1,987 to drain in **24 hours**	7,948 to drain in **4 days**
	3,974 to drain in **2 days**	13,909 to drain in **7 days**
	5,961 to drain in **3 days**	

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Orifice sizing Revised 2-2-01; 3-3-05; 2-1-07; 11-6-07

Reference 10

ENG – Riprap Lined Plunge Pool for Cantilever Outlet, USDA SCS Design Note. No. 6, 2nd Ed. March 5, 1986.

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-11 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:

Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.39	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft

Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:

Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.22	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.85	ft
Pool Bottom Elev:	El,PB =	533.15	ft
Pool Bottom Length:	2Lr2 =	1.45	ft
Pool Bottom Width:	2Wr2 =	1.41	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.26	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.26	ft
Pool Width at Tailwater Elev.:	2Wr =	8.80	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.53	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.03	ft

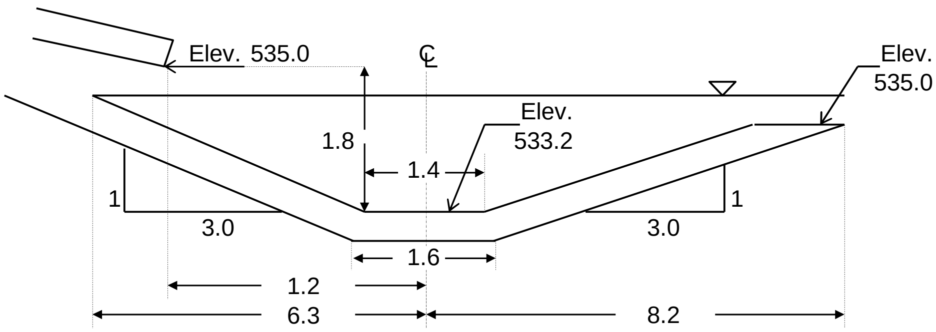
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:

Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	11.1	cu yd
Volume of Rock Riprap:	V,rs =	3.7	cu yd
Volume of Bedding:	V,bs =	4.5	cu yd

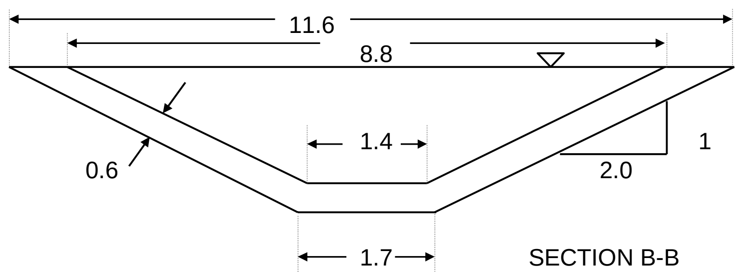
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

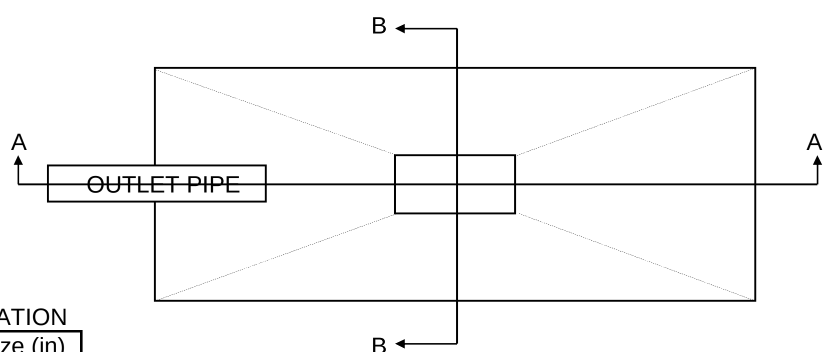
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-11 Plunge Pool

LANDOWNER

DESIGNER: AEW

SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

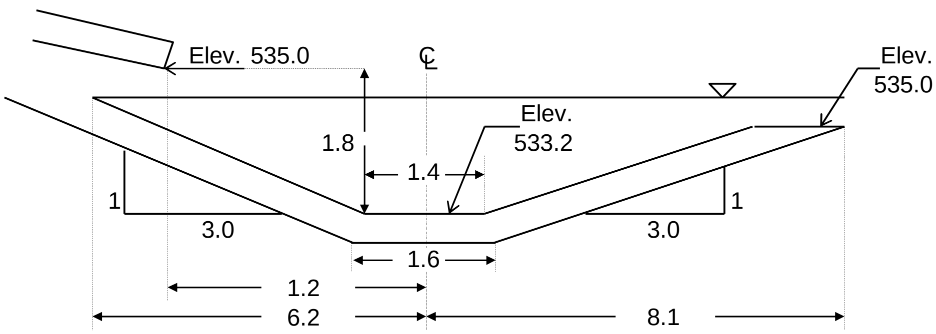
JOB:	Luck Stone SB-OB-12 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.19	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

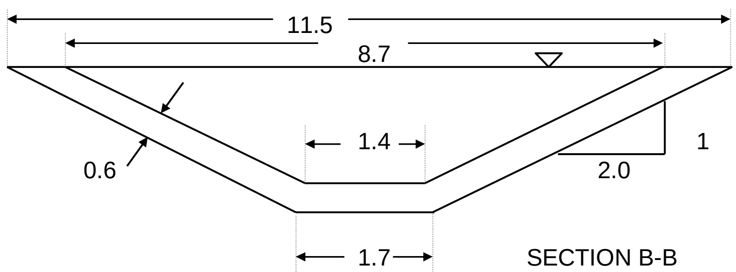
OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.17	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.82	ft
Pool Bottom Elev:	El,PB =	533.18	ft
Pool Bottom Length:	2Lr2 =	1.42	ft
Pool Bottom Width:	2Wr2 =	1.39	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.17	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.17	ft
Pool Width at Tailwater Elev.:	2Wr =	8.67	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.55	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.05	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	10.8	cu yd
Volume of Rock Riprap:	V,rs =	3.6	cu yd
Volume of Bedding:	V,bs =	4.4	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

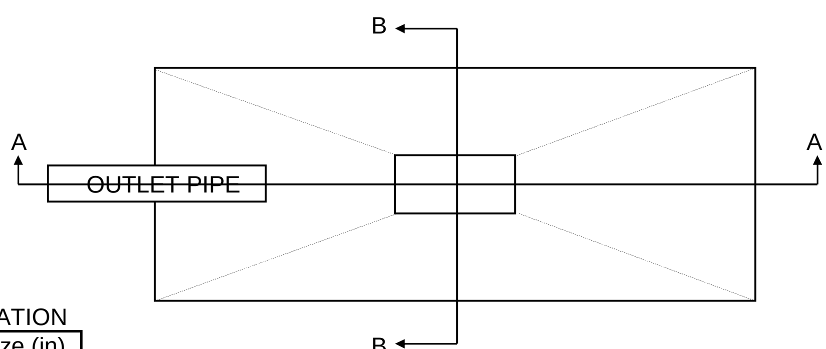
RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-12 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-PT-9 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

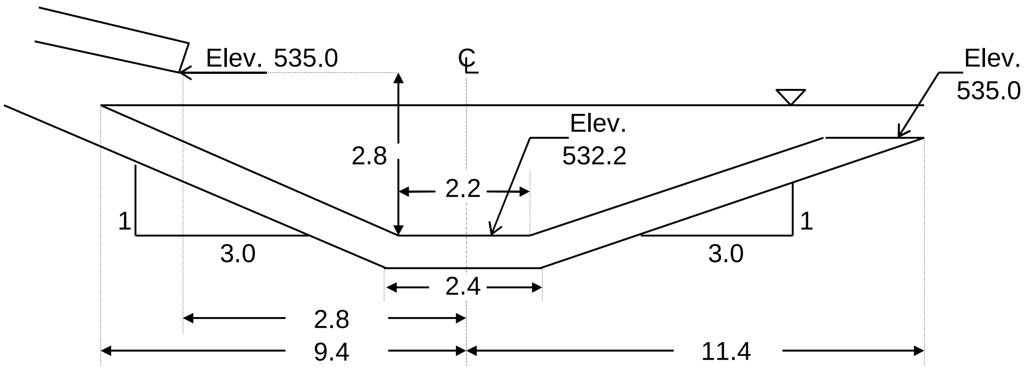
INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	11.74	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	2.76	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	2.76	ft
Pool Bottom Elev:	El,PB =	532.24	ft
Pool Bottom Length:	2Lr2 =	2.24	ft
Pool Bottom Width:	2Wr2 =	2.15	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	9.41	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	9.41	ft
Pool Width at Tailwater Elev.:	2Wr =	13.20	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	531.61	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	531.11	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	25.7	cu yd
Volume of Rock Riprap:	V,rs =	7.6	cu yd
Volume of Bedding:	V,bs =	8.2	cu yd

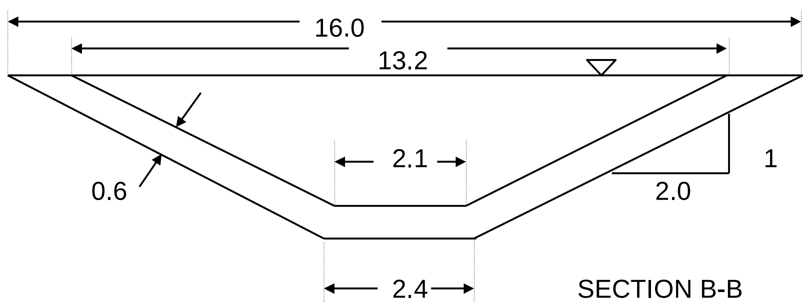
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

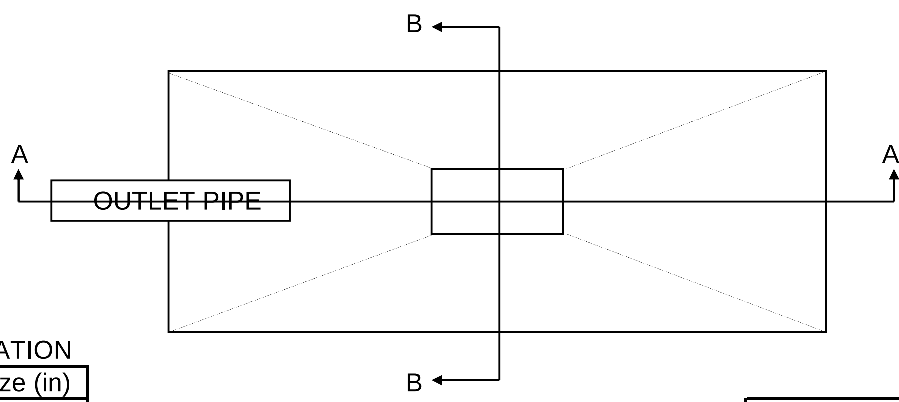
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-PT-9 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

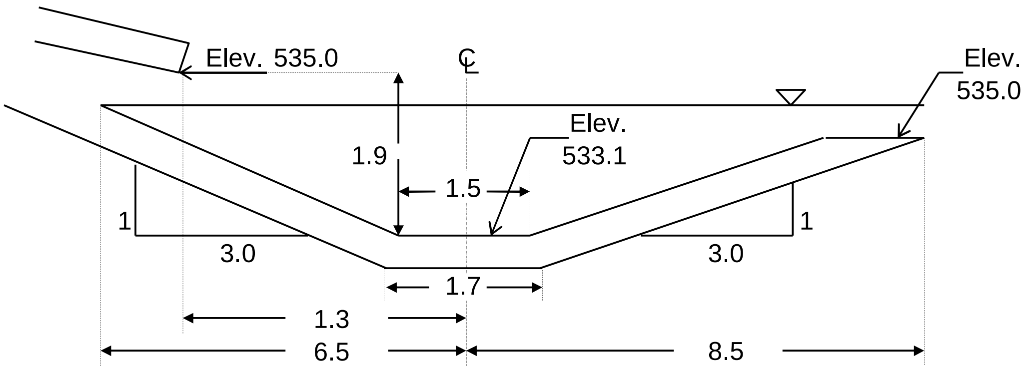
JOB:	Luck Stone SB-PT-1 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.90	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

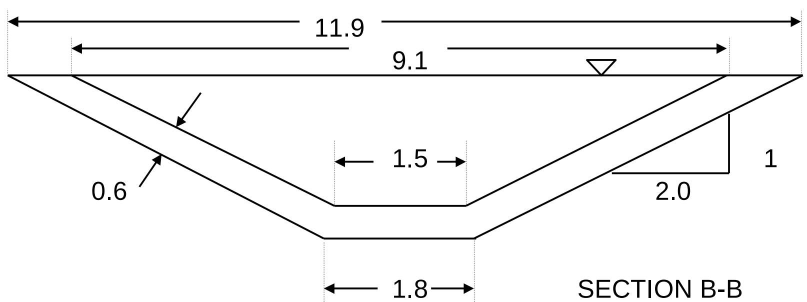
OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.34	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.92	ft
Pool Bottom Elev:	El,PB =	533.08	ft
Pool Bottom Length:	2Lr2 =	1.51	ft
Pool Bottom Width:	2Wr2 =	1.47	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.50	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.50	ft
Pool Width at Tailwater Elev.:	2Wr =	9.13	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.46	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	531.96	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	12.0	cu yd
Volume of Rock Riprap:	V,rs =	4.0	cu yd
Volume of Bedding:	V,bs =	4.8	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

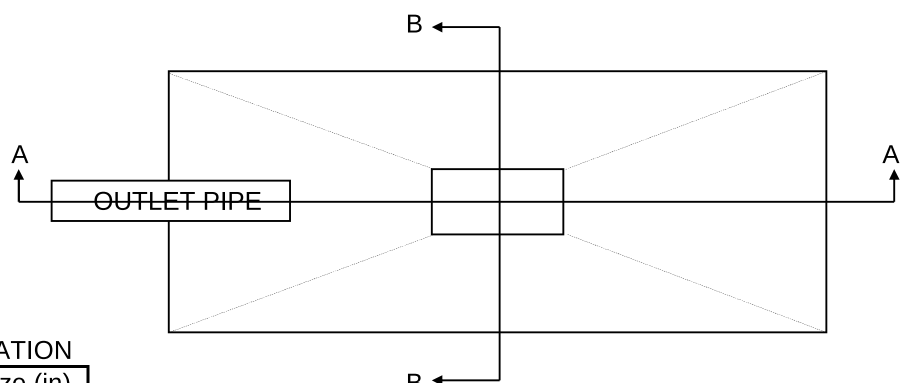
RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-PT-1 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

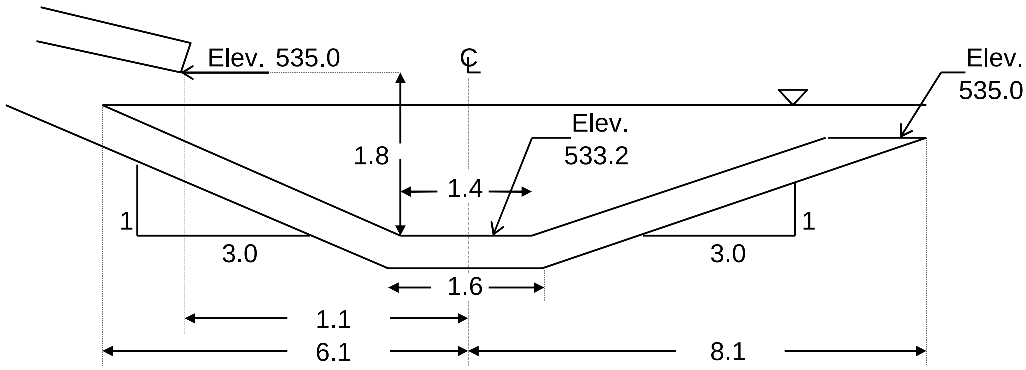
JOB:	Luck Stone SB-P-8 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.09	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

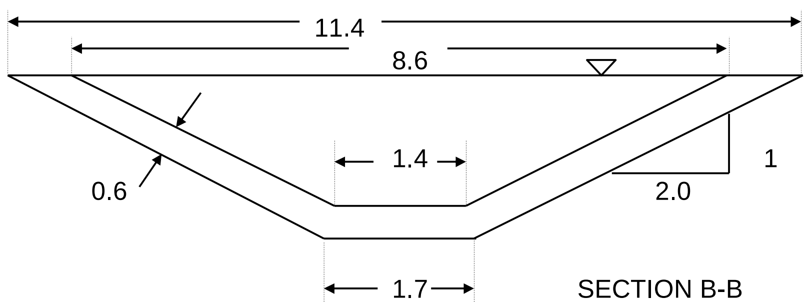
OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.15	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.81	ft
Pool Bottom Elev:	El,PB =	533.19	ft
Pool Bottom Length:	2Lr2 =	1.41	ft
Pool Bottom Width:	2Wr2 =	1.38	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.13	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.13	ft
Pool Width at Tailwater Elev.:	2Wr =	8.61	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.57	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.07	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	10.7	cu yd
Volume of Rock Riprap:	V,rs =	3.6	cu yd
Volume of Bedding:	V,bs =	4.4	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

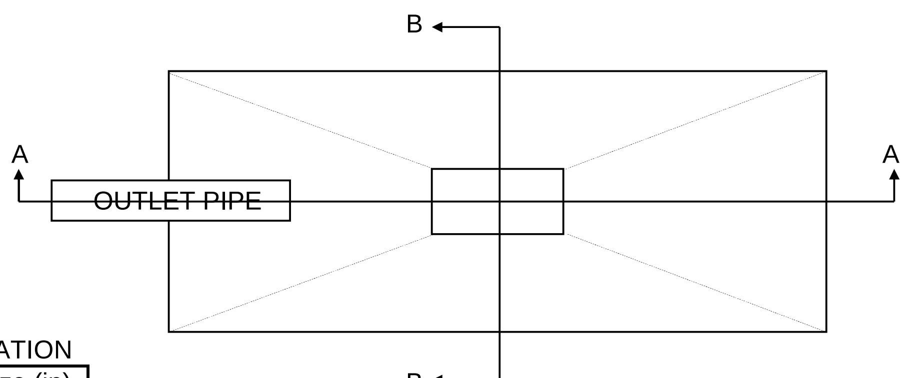
RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-P-8 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-P-2 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

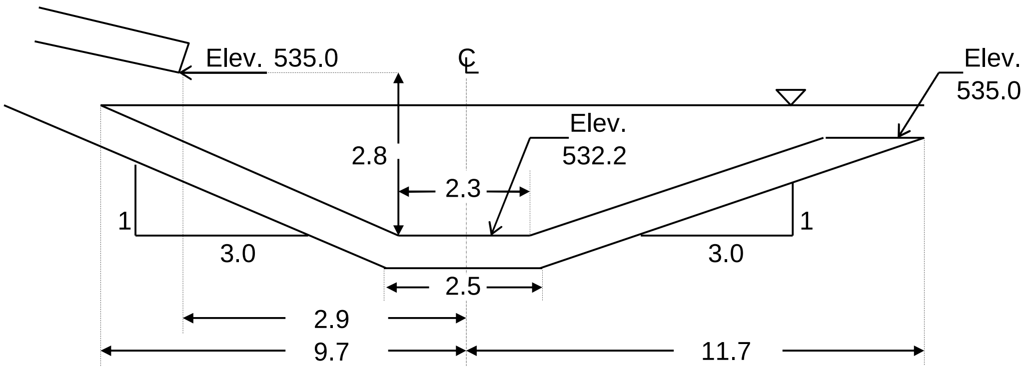
INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	12.14	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	2.90	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	2.85	ft
Pool Bottom Elev:	El,PB =	532.15	ft
Pool Bottom Length:	2Lr2 =	2.31	ft
Pool Bottom Width:	2Wr2 =	2.22	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	9.70	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	9.70	ft
Pool Width at Tailwater Elev.:	2Wr =	13.60	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	531.53	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	531.03	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	27.4	cu yd
Volume of Rock Riprap:	V,rs =	8.0	cu yd
Volume of Bedding:	V,bs =	8.6	cu yd

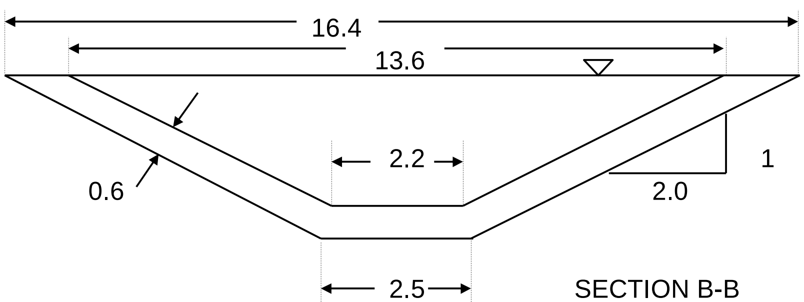
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

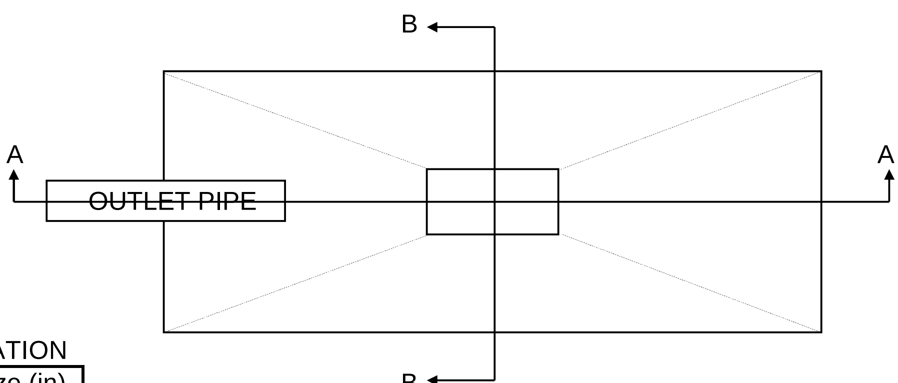
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-P-2 Plunge Pool

LANDOWNER

DESIGNER: AEW

SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-6 Plunge Pool		
DESIGNER:	AEW	Date:	1/25/2024
CHECKER:	CTB	Date:	1/25/2024

INPUT DATA:

Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.66	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft

Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:

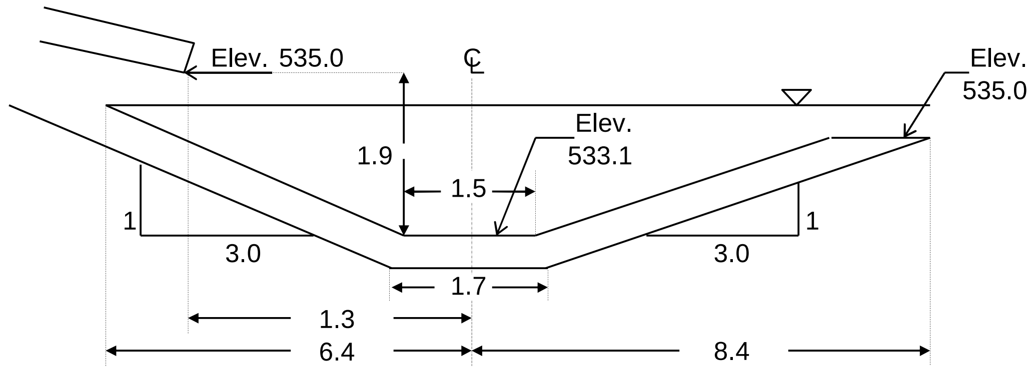
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.28	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.88	ft
Pool Bottom Elev:	El,PB =	533.12	ft
Pool Bottom Length:	2Lr2 =	1.48	ft
Pool Bottom Width:	2Wr2 =	1.44	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.38	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.38	ft
Pool Width at Tailwater Elev.:	2Wr =	8.97	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.49	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	531.99	ft

OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:

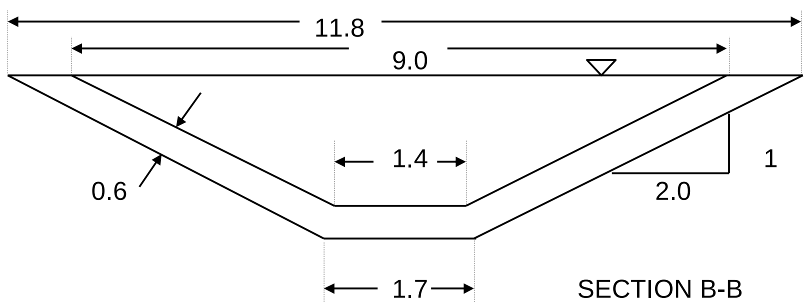
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	11.6	cu yd
Volume of Rock Riprap:	V,rs =	3.8	cu yd
Volume of Bedding:	V,bs =	4.6	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

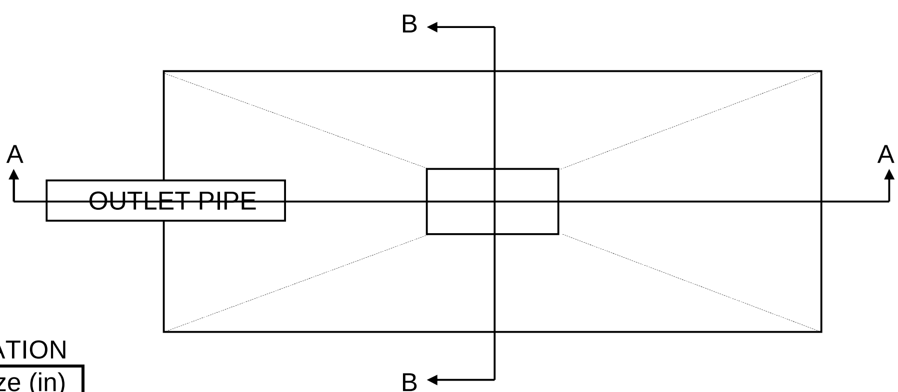
RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-6 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

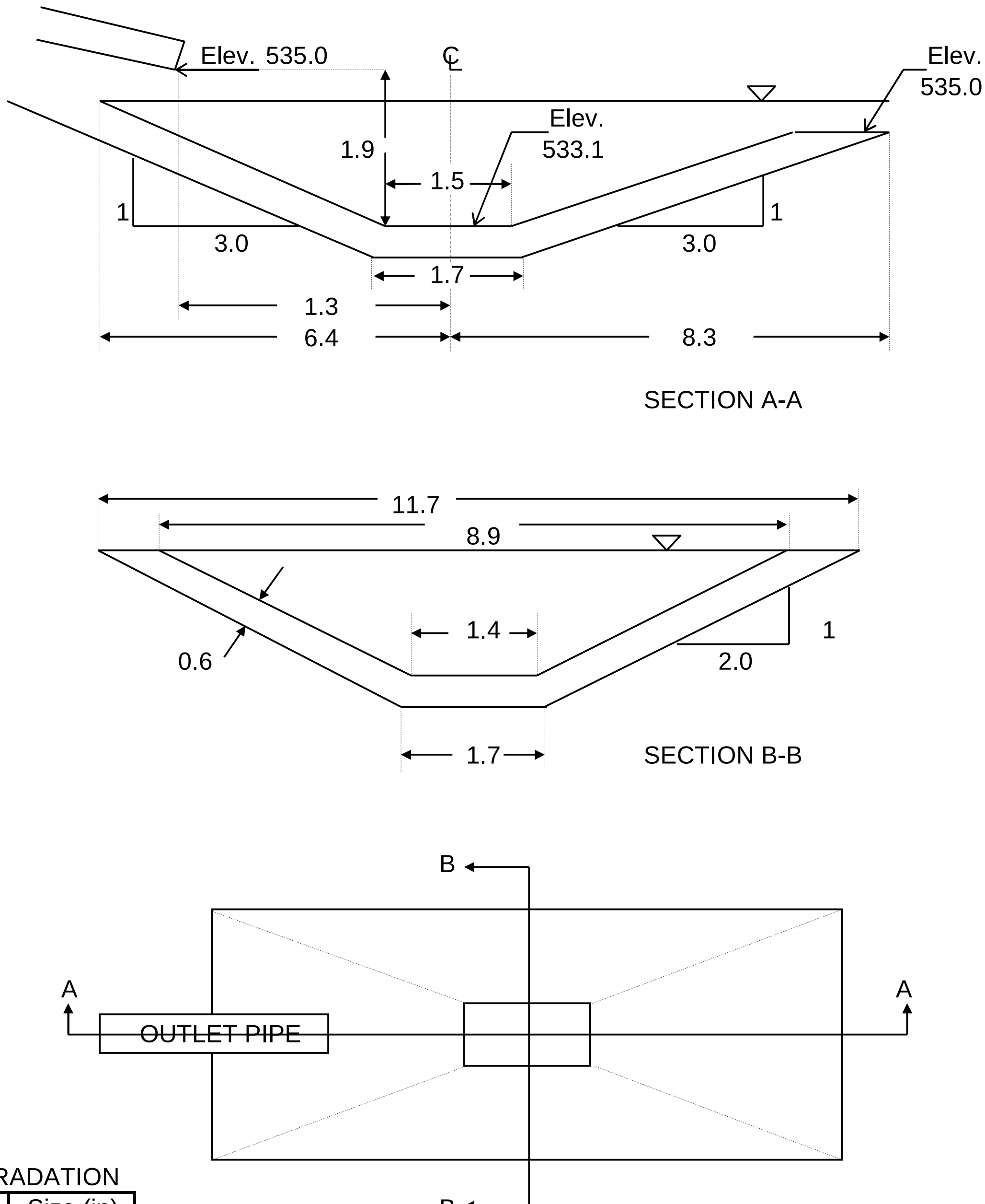
JOB:	Luck Stone SB-OB-5 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.60	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.27	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.87	ft
Pool Bottom Elev:	El,PB =	533.13	ft
Pool Bottom Length:	2Lr2 =	1.47	ft
Pool Bottom Width:	2Wr2 =	1.43	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.36	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.36	ft
Pool Width at Tailwater Elev.:	2Wr =	8.93	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.50	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.00	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	11.5	cu yd
Volume of Rock Riprap:	V,rs =	3.8	cu yd
Volume of Bedding:	V,bs =	4.6	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-5 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-4 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

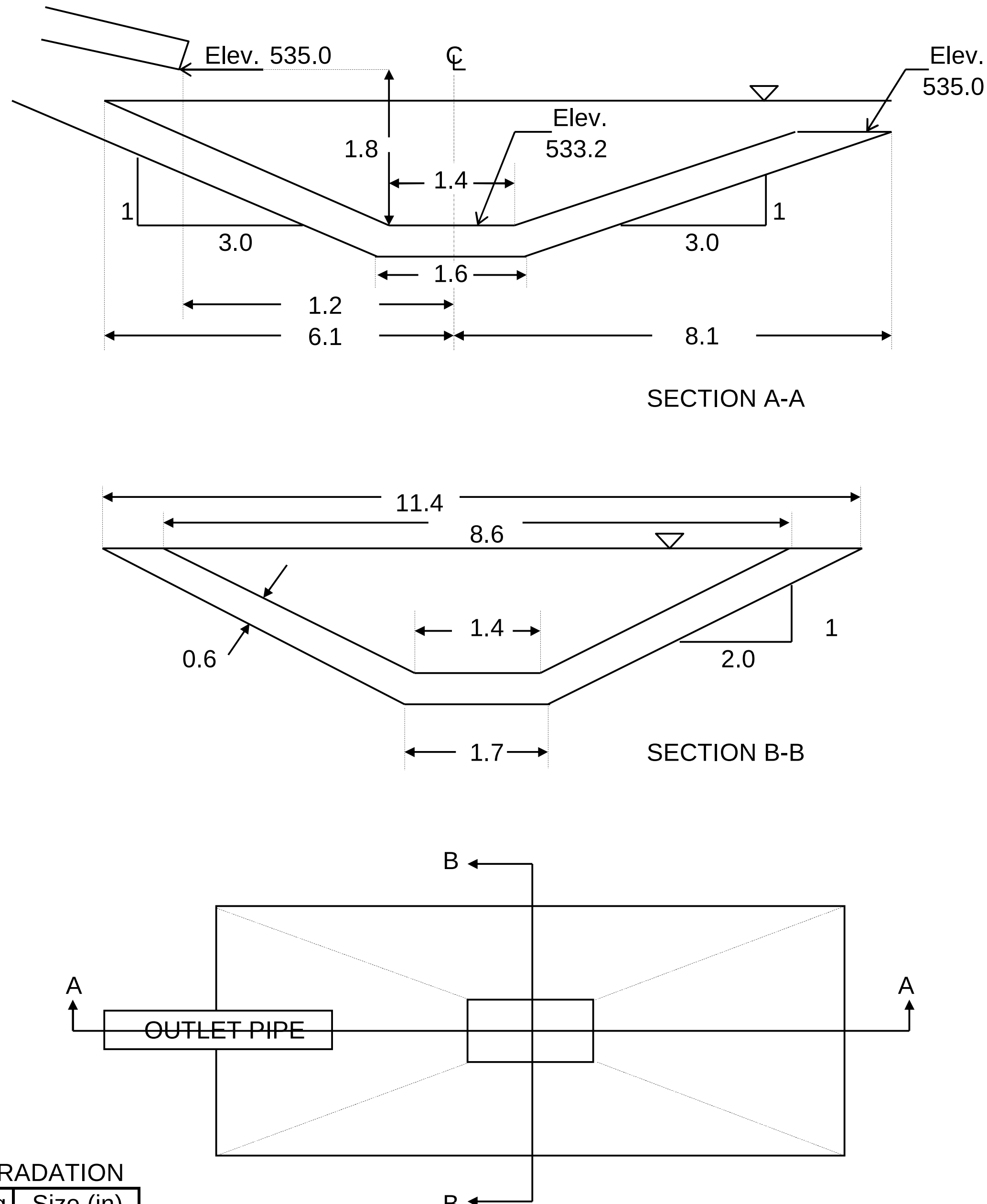
INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.10	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.15	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.81	ft
Pool Bottom Elev:	El,PB =	533.19	ft
Pool Bottom Length:	2Lr2 =	1.41	ft
Pool Bottom Width:	2Wr2 =	1.38	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.13	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.13	ft
Pool Width at Tailwater Elev.:	2Wr =	8.62	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.57	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.07	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	10.7	cu yd
Volume of Rock Riprap:	V,rs =	3.6	cu yd
Volume of Bedding:	V,bs =	4.4	cu yd

Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-4 Plunge Pool

LANDOWNER

DESIGNER: AEW

SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-3 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

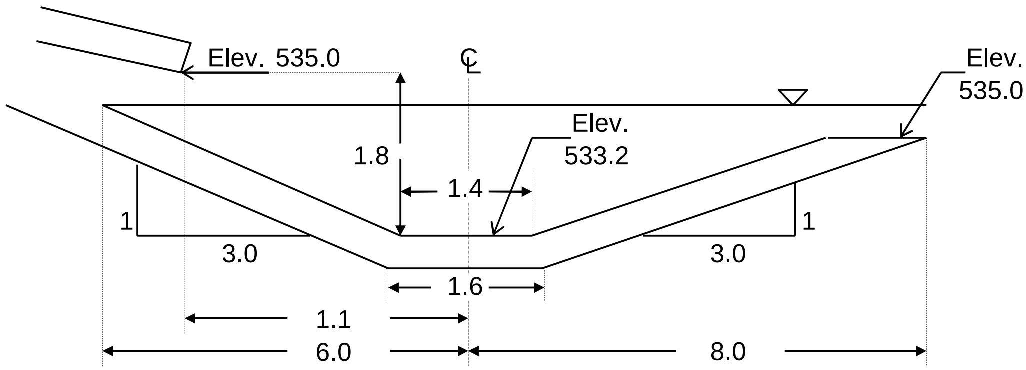
INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	5.85	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.10	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.78	ft
Pool Bottom Elev:	El,PB =	533.22	ft
Pool Bottom Length:	2Lr2 =	1.39	ft
Pool Bottom Width:	2Wr2 =	1.36	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.03	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.03	ft
Pool Width at Tailwater Elev.:	2Wr =	8.47	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.60	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.10	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	10.4	cu yd
Volume of Rock Riprap:	V,rs =	3.5	cu yd
Volume of Bedding:	V,bs =	4.3	cu yd

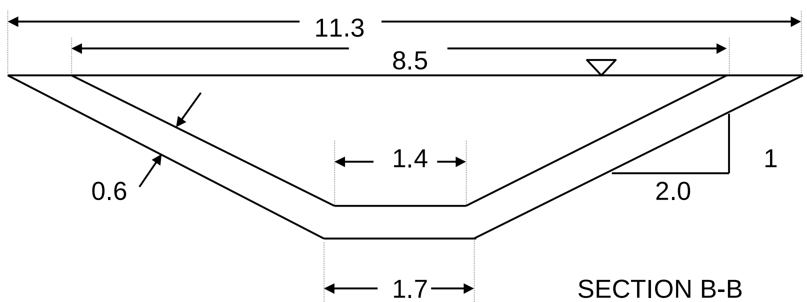
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

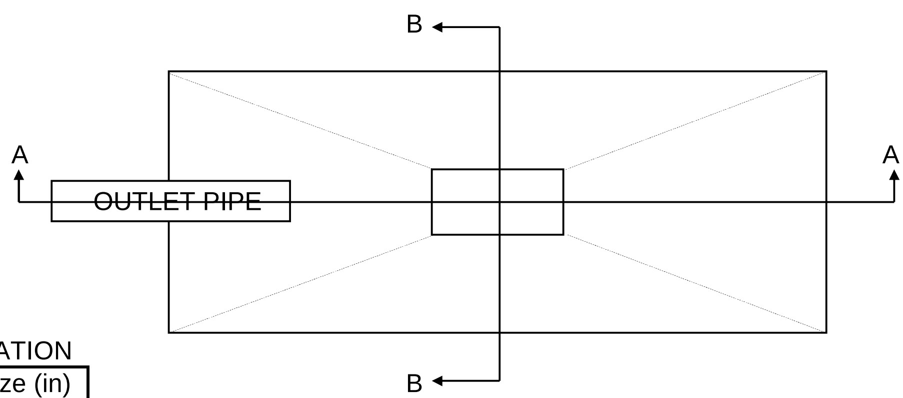
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-3 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-10 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.40	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.22	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.85	ft
Pool Bottom Elev:	El,PB =	533.15	ft
Pool Bottom Length:	2Lr2 =	1.45	ft
Pool Bottom Width:	2Wr2 =	1.41	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.27	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.27	ft
Pool Width at Tailwater Elev.:	2Wr =	8.80	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.53	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.03	ft

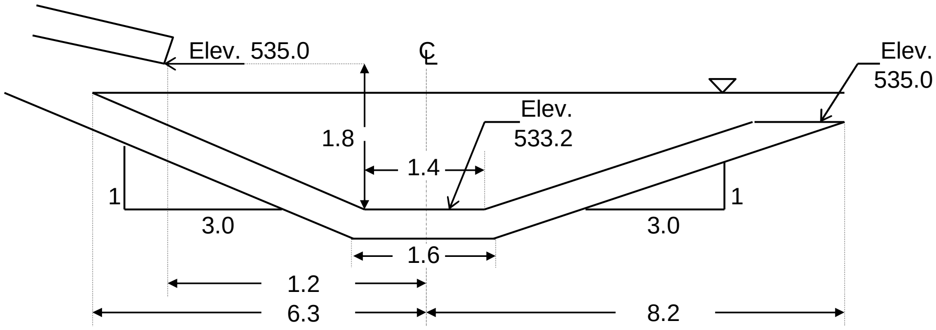
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:

Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	11.2	cu yd
Volume of Rock Riprap:	V,rs =	3.7	cu yd
Volume of Bedding:	V,bs =	4.5	cu yd

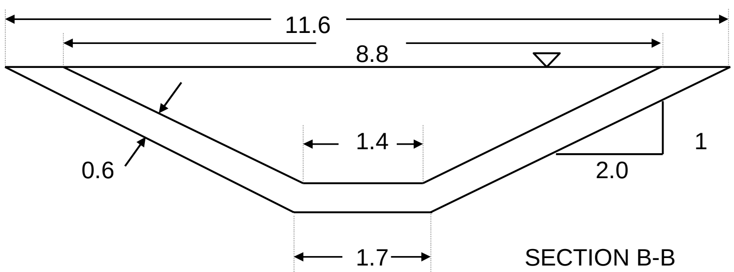
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

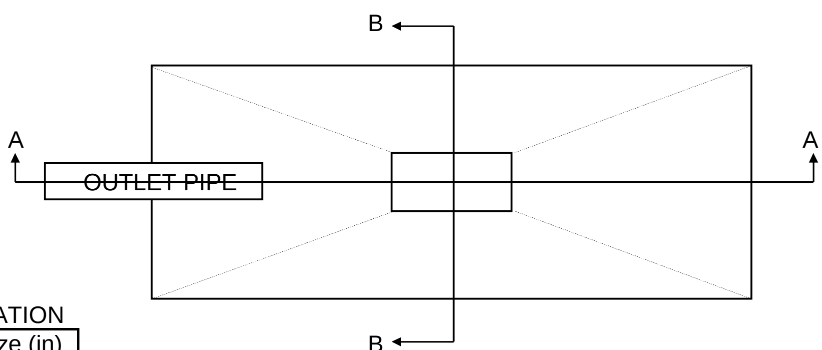
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-10 Plunge Pool

LANDOWNER

DESIGNER: AEW

SHEET ___ OF ___

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET (Version 8.99)
(Reference Design Note No. 6 (Second Edition), Jan. 23, 1986

JOB:	Luck Stone SB-OB-7 Plunge Pool			
DESIGNER:	AEW	Date:	1/25/2024	
CHECKER:	CTB	Date:	1/25/2024	

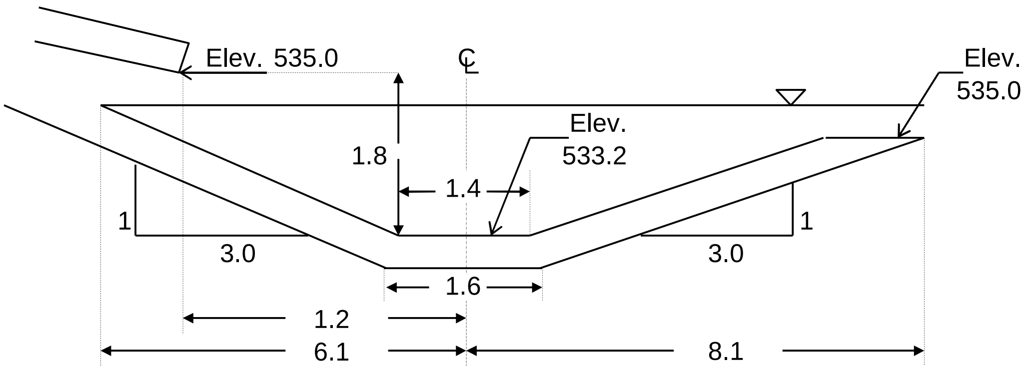
INPUT DATA:			
Conduit Diameter	D =	2.00	ft
Conduit Discharge:	Q =	6.10	cfs
Conduit Slope at Outlet:	S =	0.01	ft/ft
Conduit Outlet Invert Elevation:	El, CO =	535.00	ft
Tailwater Elevation:	El, TW =	535.00	ft
Outlet Channel Invert Elevation:	El, CH =	535.00	ft
Water Density:	RHO =	1.00	
Bed/Riprap Particle Density: (Default 2.64)	RHOS =	2.64	
D, 50 Riprap Size:	RS =	0.25	ft
Riprap Thickness: (2.5*D, 50 recommended)	RT =	0.63	ft
Bedding Thickness: (6 inch min. rec.) (Enter **0** for geotextile)	BT =	0.50	ft
Side Slope Ratio:	Zw =	2.00	ft/ft
Upstream End Slope Ratio:	Zlu =	3.00	ft/ft
Downstream End Slope Ratio:	Zld =	3.00	ft/ft
Combined End Slope Ratio:	Z1 =	3.00	ft/ft

OUTPUT---POOL LOCATION AND DIMENSIONS:			
Vert. Dist. from Tailwater to Conduit Invert:	Zp =	0.00	ft
Submergence Check: (If Zp < 0 , Use Zp = 0)	Use Zp =	0.00	ft
Beaching Check: [Q/(gD^5)^0.5 <= (1.0+25*D,50/D)]		O.K.	
Beaching Controlled			
Distance from Conduit Exit to C/L Pool:	Xm =	1.15	ft
Pool depth at C/L Below Conduit Invert:	Zp+0.8Zm =	1.81	ft
Pool Bottom Elev:	El,PB =	533.19	ft
Pool Bottom Length:	2Lr2 =	1.41	ft
Pool Bottom Width:	2Wr2 =	1.38	ft
Upstream Pool Length at Tailwater Elev.:	Lru =	6.13	ft
Downstream Pool Length at Tailwater Elev.:	Lrd =	6.13	ft
Pool Width at Tailwater Elev.:	2Wr =	8.62	ft
Check Side Slope Ratio: (Wr>=We)		O.K.	
Side Slope Ratio Zw O.K.			
Check Min. End Slope Ratio: (Lru & Lrd >= Le)		O.K.	
End Slope Ratios O.K.			
Check Upstream Length: (Lru >= Xm)		O.K.	
End Slope Ratio Zlu O.K.			
Pool Bottom Elev. at Bottom of Riprap:	El, BR =	532.57	ft
Pool Bottom Elev. at Bottom of Bedding:	El, BB =	532.07	ft
OUTPUT---VOLUMES BELOW WATER SURFACE ELEVATION:			
Volume of Excavation (measured from bottom surface of bedding):	V,pbs =	10.7	cu yd
Volume of Rock Riprap:	V,rs =	3.6	cu yd
Volume of Bedding:	V,bs =	4.4	cu yd

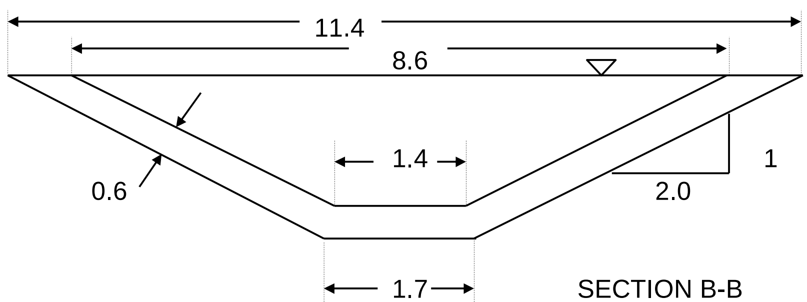
Spreadsheet developed by D. Hurtz, Midwest NTC, 1/90
Spreadsheet modified by M. Dreischmeier, Eau Claire TC, Wis., 3/98
Design Note No. 6 (Second Edition), Jan. 23, 1986

RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

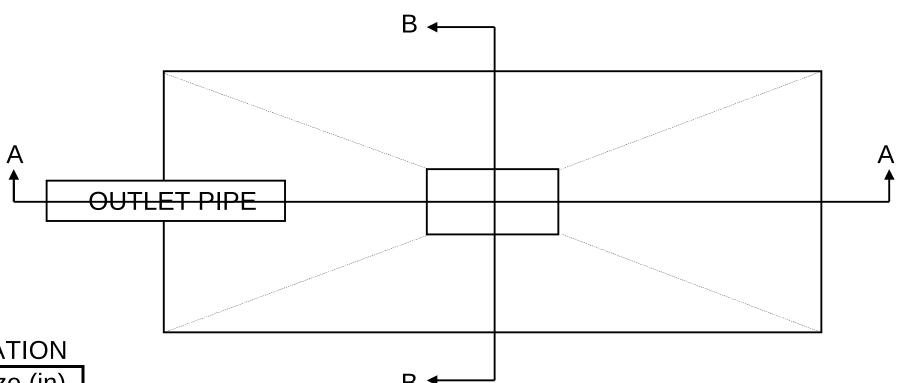
Reference Design Note No. 6 (Second Edition), Jan. 23, 1986



SECTION A-A



SECTION B-B



ROCK GRADATION

% Passing	Size (in)
100	6
60-85	4.5
25-50	3
5-20	1.5
0-5	0.6

Luck Stone SB-OB-7 Plunge Pool
LANDOWNER

DESIGNER: AEW
SHEET ___ OF ___

Reference 11

Riprap Lined Plunge Pool for Cantilever Outlet, NRCS Plunge Pool Sheets, December 2023.

United States Department of Agriculture
Soil Conservation Service
P.O. Box 2890
Washington, D.C.
20013

March 5, 1986

DESIGN NOTE NO. 6 (Second Edition)
210-VI

SUBJECT: ENG - RIPRAP LINED PLUNGE POOL FOR CANTILEVER OUTLET

Purpose. To distribute Design Note No. 6 (Second Edition), "Riprap Lined Plunge Pool for Cantilever Outlet."

Effective Date. Effective when received.

Explanation. Design Note No. 6 was originally issued in 1969 and was based on research reported in 1967. This second edition was developed based on recently reported research by Fred W. Blaisdell of the Agricultural Research Service. The need for a revision of the original Design Note No. 6 has been identified by several reported situations of riprap being displaced from the plunge pool.

The Blaisdell developed mathematical model is in overall agreement with the experimental data. The purpose of this edition of the design note is to present Blaisdell's final design equations with modifications to facilitate construction and still meet the minimum design requirement.

Filing Instructions. Discard the 1969 edition of Design Note No. 6 and file this second edition with other design notes.

Distribution. The design note should be useful to professionals designing or reviewing the design of an energy dissipator at the downstream end of a conduit spillway. Initial distribution is shown on the reverse side. Additional copies may be obtained from Central Supply.

JOSEPH W. HAAS
Deputy Chief for Technology

Enclosure

DIST: DN-6

United States Department of Agriculture
Soil Conservation Service
Engineering Division

January 23, 1986

Design Note No. 6 (Second Edition)*

Subject: Riprap Lined Plunge Pool for Cantilever Outlet

INTRODUCTION

The energy in flow exiting from a spillway usually requires dissipation before being released to the outlet channel. For flow exiting from a conduit, when an open plunge pool is acceptable, an excavated riprap-lined hole at the downstream end of the conduit can be an economical energy dissipator. However, the size of plunge pool, location relative to the conduit outlet, and size of riprap must be properly designed for the plunge pool to operate successfully. Successful operation consists of negligible kinetic energy in the outflow, no erosion or loss of the plunge pool foundation soil due to the turbulence in the process of energy dissipation, and no displacement of the riprap.

Design Note No. 6, originally issued in 1969, was based on research reported in 1967. This second edition was developed based on recently reported research (Blaisdell and Anderson 1984). The need for a revision was identified by several reported situations of riprap being displaced from the plunge pool.

Fred W. Blaisdell, Research Hydraulic Engineer, of the Agricultural Research Service conducted experiments at the Saint Anthony Falls Hydraulic Laboratory of the University of Minnesota in Minneapolis to evaluate the scour at cantilevered pipe spillway outlets. The Blaisdell developed mathematical model indicates an overall agreement with the experimental data. The final equations for the design of plunge pool energy dissipators for cantilevered pipe spillways were presented at the ASCE Hydraulic Division Conference in Coeur d'Alene, Idaho, August, 1984. The purpose of this edition of the design note is to present the final design equations with modifications to facilitate the evaluation of plunge pool shape, length, width, depth, position in relation to the outlet end of the conduit, and plunge pool volumes. Figures 1 and 2 illustrate the plunge pool layout dimensions.

DISCHARGE PARAMETER

The plunge pool dimensions were developed using a discharge parameter. The parameter is based on the design discharge, Q, pipe diameter, D, and combined with the acceleration of gravity, g, resulting in a

*Prepared by H. J. Goon, Design Unit, Engineering Division, Washington, D.C.

dimensionless parameter of $\frac{Q}{\sqrt{gD^5}}$. This is very convenient since Q and D are known prior to the plunge pool design.

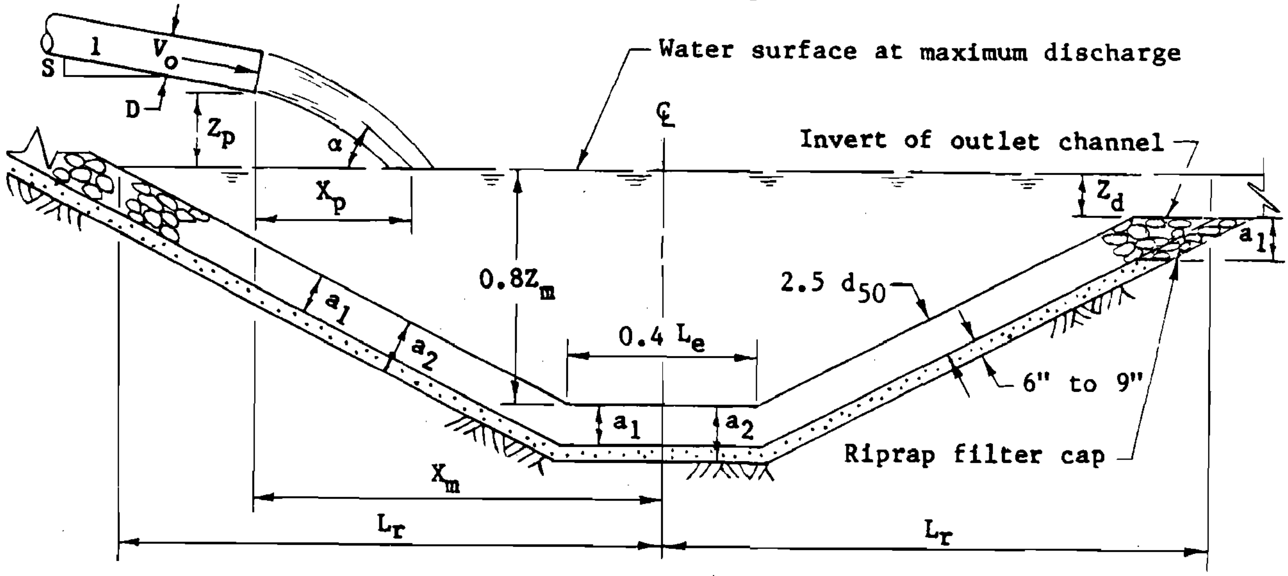


Figure 1 — Plunge pool definition sketch

DISCHARGE JET TRAJECTORY

The plunge pool location is determined by the discharge jet trajectory. The location of the plunge pool centerline downstream from the discharge end of the pipe is dependent on the jet velocity and angle of impingement with the pool surface as well as the plunge pool depth.

The jet impingement velocity and angle of entry into the pool can be determined from the pipe exit slope, pipe discharge velocity, and height of pipe invert above the water surface. The height of pipe invert above the water surface, Z_p, should be measured from the tailwater elevation for the associated discharge used for the plunge pool design. The discharge should be the maximum prior to any secondary spillway flow. The pipe slope is $\frac{S}{\sqrt{1 - S^2}}$, where S is the sine of the angle whose tangent is the slope of the pipe. The discharge velocity, V_o, is computed based on the design discharge and the conduit cross-sectional area. The path of the free falling jet is a parabola between the pipe exit and tailwater surface where the jet enters the water with the impingement velocity, V_p, and the slope, tan α. The horizontal distance, X_p, from the pipe exit to where the jet plunges into the tailwater with horizontal velocity, V_h, and vertical velocity, V_v, is given in Eq. 5; where

$$V_h = V_o \cos (\sin^{-1} S) \qquad \text{Eq. 1}$$

$$V_v = \sqrt{(V_o\ S)^2 + 2g\ [Z_p + \frac{D}{2} \cos (\sin^{-1} S)]} \qquad \text{Eq. 2}$$

$$\tan \alpha = \frac{V_v}{V_h} \qquad \text{Eq. 3}$$

$$V_p = \sqrt{V_h^2 + V_v^2} \qquad \text{Eq. 4}$$

$$X_p = \frac{V_h}{g} (V_v - V_o S) \qquad \text{Eq. 5}$$

PLUNGE POOL DEPTH

The depth of erosion created by the discharging jet can be controlled by the bed material size. The bed material is represented by its mean grain size, d_{50}, the size of which 50 percent by weight is finer in diameter. The research tests were run on noncohesive materials. Therefore, this design procedure is appropriate for soil and rock bed material that perform as single grain material in resisting erosion. The d_{50} size for riprap lining material may be varied to adjust the erosion depth. The plunge pool depth is computed using a densimetric Froude number, F_d, as follows:

$$F_d = \frac{V_p}{\sqrt{gd_{50}\ (\rho_s - \rho)/\rho}} \qquad \text{Eq. 6}$$

where: ρ_s = Bed material or riprap particle density

ρ = Water density

For $\frac{Z_p}{D} < 1$, the maximum eroded depth is computed by the equation

$$Z_m = 7.5\ D\ [\ 1- e^{-0.6\ (F_d\ -\ 2)}\ ] \qquad \text{Eq. 7a}$$

For $\frac{Z_p}{D} > 1$, the maximum eroded depth is computed by the equation

$$Z_m = 10.5\ D\ [\ 1- e^{-0.35\ (F_d\ -\ 2)}\ ] \qquad \text{Eq. 7b}$$

The effect of a horizontal ledge or a nonerodible layer on the shape of the plunge pool above the layer was tested and found to be a minimal.

The dimensions of the plunge pool are functions of $\frac{Z_m}{D}$. When the plunge pool dimensions are based on the value of Z_m, the designed contours above the ledge conform to the plunge pool shape. Therefore, it is acceptable to size and construct the plunge pool to 0.8 of the computed maximum depth, Z_m. However, the full value of the computed Z_m, as determined by equation 7a or 7b, must be used in subsequent equations 9, 10, and 11.

The d_{50} bed material size must be checked to assure that it is adequate to control shallow beach type erosion at the top edge of the plunge pool. High flow rates during research testing caused flow to circulate upstream along both sides of the plunge pool. When these circulating flows exceeded the bed material's critical tractive stress, beach erosion at the top edge of the plunge pool occurred. The check for adequate bed material size up to the tailwater elevation is by equation 8. The d_{50} size is adequate and beach erosion will not occur if

$$\frac{Q}{\sqrt{gD^5}} < \left[1.0 + 25 \frac{d_{50}}{D}\right] \qquad \text{Eq. 8}$$

If the bed material d_{50} is not large enough, protection will need to be added. In the case of riprap, a larger particle gradation will be required.

LOCATION OF PLUNGE POOL

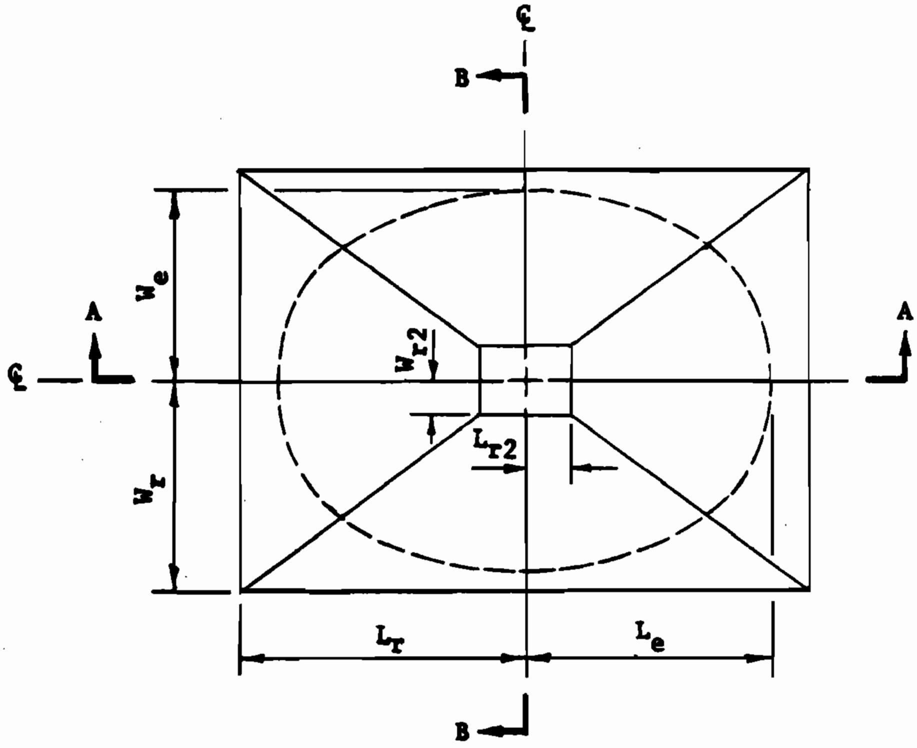
The horizontal distance, X_m, from the pipe exit to the center of the plunge pool, i.e., where maximum scour depth occurs is

$$X_m = \left[X_p + \frac{Z_m}{\tan \alpha}\right] 1.15\ e^{-0.15\ [Q/(gD^5)^{1/2}]} \qquad \text{Eq. 9}$$

DIMENSION OF PLUNGE POOL

The plunge pool natural shape is an ellipse with the greater length parallel to the pipe flow. The minimum size based on laboratory tests is the result of flow turbulence, boundary tractive stresses and submerged angle of repose of granular material. The test material d_{50} sizes ranged from 0.5 to 8 mm. The minimum horizontal distance from the center of the plunge pool to the water surface contour at the upstream end of the pool is equal to L_e.

$$L_e = Z_m \left[\frac{3}{2} + \frac{1}{3} \frac{Q}{\sqrt{gD^5}}\right] \qquad \text{Eq. 10}$$



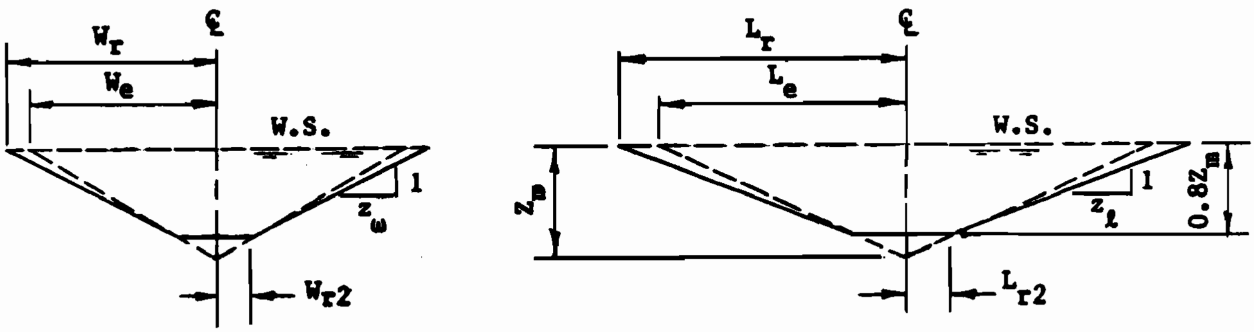


Figure 2 — Plunge Pool

Since the plunge pool shape is that of an ellipse, the distance from the center of the plunge pool to the water surface contour at the projected scour hole slope at the downstream end is also equal to the minimum L_e.

The minimum width of the plunge pool at the center of the pool is equal to $2W_e$.

$$W_e = Z_m \left[1.5 + 0.15 \frac{Q}{\sqrt{gD^5}}\right] \qquad \text{Eq. 11}$$

Once the minimum width, length, depth and the distance from the end of the pipe to the center of the plunge pool are determined for a given spillway layout and d_{50} particle size, the final design shape and dimensions can be established. It is suggested that a comparable rectangular shape with length equal to $2L_e$ and width equal to $2W_e$ be specified thus facilitating construction and still meeting the minimum design requirement. The dimensions of the rectangular base at the bottom of the plunge pool, 0.8 Z_m below the water surface, are length, $2L_{r2}$, and width, $2W_{r2}$ where;

$$2\ L_{r2} = 0.4\ L_e \qquad \text{Eq. 12}$$

$$2\ W_{r2} = 0.4\ W_e \qquad \text{Eq. 13}$$

It is recommended that the excavated side slopes of the plunge pool along the length, z_ℓ and along the width, z_ω, be adjusted to acceptable grades for layout and riprap placement purposes, e.g., 3 horizontal to 1 vertical. The final length and width of the plunge pool at the water surface are $2L_r$ and $2W_r$, respectively. Where;

$$L_r = 0.8Z_m z_\ell + L_{r2} \qquad \text{Eq. 14}$$

$$W_r = 0.8Z_m z_\omega + W_{r2} \qquad \text{Eq. 15}$$

If L_r is less than X_m, the water surface contour at the upstream end of the pool is downstream from the end of the conduit. Therefore, L_r should be increased to equal to or greater than X_m.

PLUNGE POOL VOLUMES

The volume, V, in cu. yds. of the plunge pool and lining materials, such as riprap and granular filter, can be determined as frustums of pyramids. For convenience, the appropriate equation is listed below

$$V = \frac{1}{81}\left[A_1 + A_2 + \sqrt{A_1 A_2}\ \right]Z$$

where A_1 is the plan rectangular area of the plunge pool at the invert elevation of the outlet channel, ft^2

A_2 is the plan rectangular area at the bottom of the plunge pool at a distance Z below the invert elevation of the outlet channel, ft^2

Z is either equal to $0.8Z_m - Z_d$, $0.8Z_m - Z_d + a_1$, or $0.8Z_m - Z_d + a_2$ below the invert elevation of the outlet channel, ft.
a_1 is the thickness of the riprap lining, ft.
a_2 is the thickness of the riprap lining and granular filter material, ft.
Z_d is the water depth above the invert elevation of the outlet channel, ft.

The volumes of riprap and filter material above the invert elevation of the outlet channel depend on the site topography.

PROCEDURE

The step procedure given below is in a form that can easily be programmed on either programmable calculators or microcomputers.

1. Compute $\dfrac{Q}{\sqrt{gD^5}}$

2. Compute $V_o = \dfrac{4Q}{\pi D^2}$

3. Compute $V_h = V_o \cos(\sin^{-1} S)$ Eq. 1

$$V_v = \sqrt{(V_o S)^2 + 2g\left[Z_p + \frac{D}{2}\cos(\sin^{-1} S)\right]} \quad \text{Eq. 2}$$

$$\tan \alpha = \frac{V_v}{V_h} \quad \text{Eq. 3}$$

$$V_p = \sqrt{V_h^2 + V_v^2} \quad \text{Eq. 4}$$

$$X_p = \frac{V_h}{g}(V_v - V_o S) \quad \text{Eq. 5}$$

4. Compute $F_d = \dfrac{V_p}{\sqrt{gd_{50}(\rho_s - \rho)/\rho}}$ Eq. 6

5. Compute $\dfrac{Z_p}{D}$; if < 1, Go to step 6a ; if > 1, Go to step 6b

6a. Compute $Z_m = 7.5\, D\left[1 - e^{-0.6(F_d - 2)}\right]$; Go to step 7 Eq. 7a

6b. Compute $Z_m = 10.5\ D\ [1 - e^{-0.35\ (F_d - 2)}]$ Eq. 7b

7. Compute $1.0 + 25 \frac{d_{50}}{D}$ Eq. 8

8. If $\frac{Q}{\sqrt{gD^5}} < 1.0 + 25 \frac{d_{50}}{D}$, then go to step 9; otherwise, make design adjustments to increase d_{50} and return to step 4.

9. Compute $X_m = [X_p + \frac{Z_m}{\tan \alpha}]\ 1.15\ e^{-0.15\ [Q/(gD^5)^{1/2}]}$ Eq. 9

10. Compute $L_e = Z_m \left[\frac{3}{2} + \frac{1}{3} \frac{Q}{\sqrt{gD^5}} \right]$ Eq. 10

$W_e = Z_m \left[1.5 + 0.15 \frac{Q}{\sqrt{gD^5}} \right]$ Eq. 11

11. Determine A_2, plan rectangular area of the plunge pool bottom at $0.8Z_m$ below the water surface

$L_{r2} = 0.2\ L_e$

$W_{r2} = 0.2\ W_e$

$A_2 = 4\ L_{r2}\ W_{r2}$

12. Check the side slopes of the plunge pool and adjust, if necessary to acceptable grades, z_ℓ and z_ω. The final length and width of the plunge pool at the water surface are $2L_r$ and $2W_r$, respectively.

$L_r = 0.8\ Z_m\ z_\ell + L_{r2}$

$W_r = 0.8\ Z_m\ z_\omega + W_{r2}$

13. If $L_r < X_m$, increase side slope, z_ℓ, so that $L_r > X_m$

14. Determine A_1, plan rectangular area of the plunge pool at the invert elevation of the outlet channel

$A_1 = 4\ (L_r - z_\ell Z_d)\ (W_r - z_\omega Z_d)$

15. Plunge Pool Volume:
The Volume between a horizontal plane at the invert elevation of the outlet channel and the exposed riprap surface is V_{ao}.

$$V_{ao} = \frac{1}{81} [A_1 + A_2 + \sqrt{A_1 A_2}][0.8Z_m - Z_d], \text{ cu. yds.}$$

The volume between a horizontal plane at the invert elevation of the outlet channel and a surface at a thickness, a_1, below the exposed riprap surface is V_{a1}.

$$V_{a1} = \frac{1}{81} [A_{1a1} + A_{2a1} + \sqrt{A_{1a1} A_{2a1}}] [0.8Z_m - Z_d + a_1], \text{ cu. yds.}$$

where $A_{1a1} = 4 [L_r - z_\ell Z_d + a_1 \sqrt{1 + z_\ell^2}] [W_r - z_\omega Z_d + a_1 \sqrt{1 + z_\omega^2}]$

and

$$A_{2a1} = 4[L_{r2} + a_1 (\sqrt{1 + z_\ell^2} - z_\ell)] [W_{r2} + a_1 (\sqrt{1 + z_\omega^2} - z_\omega)]$$

The volume of riprap at thickness, a_1, below a horizontal plane at the invert elevation of the outlet channel, exclusive of the volume of the riprap filter cap is $V_{a1} - V_{ao}$, cu. yds.

The volume between a horizontal plane at the invert elevation of the outlet channel and a surface at a thickness, a_2, below the exposed riprap surface is V_{a2}

$$V_{a2} = \frac{1}{81} [A_{1a2} + A_{2a2} + \sqrt{A_{1a2} A_{2a2}}] [0.8Z_m - Z_d + a_2], \text{ cu. yds.}$$

where $A_{1a2} = 4 [L_r - z_\ell Z_d + a_2 \sqrt{1 + z_\ell^2}] [W_r - z_\omega Z_d + a_2 \sqrt{1 + z_\omega^2}]$

and

$$A_{2a2} = 4 [L_{r2} + a_2 (\sqrt{1 + z_\ell^2} - z_\ell)] [W_{r2} + a_2 (\sqrt{1 + z_\omega^2} - z_\omega)]$$

The volume of filter material of thickness, $a_2 - a_1$, below a horizontal plane at the invert elevation of the outlet channel, including the volume of the riprap filter cap, is equal to $V_{a2} - V_{a1}$, cu. yds.

EXAMPLE

Given:

Invert elevation at outlet end of conduit = 102.5
Invert elevation of outlet channel = 100.0
Elevation of tailwater for maximum conduit discharge = 101.5
Q = 147 cfs, D = 2.5 ft., S = 0
Riprap size, d_{50} = 1.0 ft., ρ_s = 2.64
Thickness of filter material bed = 0.75 ft.

Determine:

I. Plunge pool position with respect to outlet end of conduit
II. Plunge pool depth, length, and width
III. Plunge pool volumes below the invert elevation of outlet channel

Solution:

1. $$\frac{Q}{\sqrt{gD^5}} = \frac{147}{\sqrt{32.16(2.5)^5}} = 2.62$$

2. $$V_o = \frac{4Q}{\pi D^2} = \frac{4(147)}{3.14(2.5)^2} = 30 \text{ ft/sec}$$

3. $$V_h = V_o \cos(\sin^{-1} S) = 30 \text{ ft/sec}$$

$$V_v = [(V_o S)^2 + 2g(Z_p + \frac{D}{2}\cos(\sin^{-1} S))]^{1/2} = [0 + 64.32\ (1.0 + \frac{2.5}{2})]^{1/2}$$

$$= 12.0 \text{ ft/sec}$$

$$\tan\alpha = \frac{V_v}{V_h} = \frac{12.0}{30} = 0.40$$

$$V_p = \sqrt{V_h^2 + V_v^2} = \sqrt{(30)^2 + (12.0)^2} = 32.3 \text{ ft/sec}$$

$$X_p = \frac{V_h}{g}(V_v - V_o S) = \frac{30}{32.16}(12.0) = 11.2 \text{ ft}$$

4. $$F_d = \frac{V_p}{\sqrt{gd_{50}(\rho_s - \rho)/\rho}} = \frac{32.3}{\sqrt{32.16(1)\ (2.64 - 1)/1}} = 4.45$$

5. $$\frac{Z_p}{D} = \frac{1}{2.5} = 0.4 < 1, \text{ therefore use Equation 6a}$$

6. $$Z_m = 7.5D\ [1 - e^{-0.6\ (F_d - 2)}] = 7.5\ (2.5)\ [1 - e^{-1.47}] = 14.4 \text{ ft}$$

7. $1.0 + 25 \frac{d_{50}}{D} = 1.0 + 25 \frac{1}{2.5} = 11$

8. $\frac{Q}{\sqrt{gD^5}} < [1.0 + 25 \frac{d_{50}}{D}]$; therefore riprap size is adequate to prevent significant shallow erosion enlargement at water surface elevation.

9. Plunge pool position from outlet end of pipe to center of pool, X_m

$$X_m = [X_p + \frac{Z_m}{\tan \alpha}]\ 1.15\ e^{-0.15\ (Q/\sqrt{gD^5})}$$

$$X_m = [11.2 + \frac{14.4}{0.40}]\ 1.15\ e^{-0.15(2.62)} = 36.6 \text{ ft}$$

10. Plunge Pool Dimensions
depth at center = $0.8\ Z_m = 0.8\ (14.4) = 11.5$ ft

$$L_e = Z_m\ [\frac{3}{2} + \frac{1}{3} \frac{Q}{\sqrt{gD^5}}] = 14.4\ [\frac{3}{2} + \frac{2.62}{3}] = 34.2 \text{ ft}$$

$$W_e = Z_m\ [1.5 + 0.15 \frac{Q}{\sqrt{gD^5}}] = 14.4\ [1.5 + 0.15\ (2.62)] = 27.3 \text{ ft}$$

11. $L_{r2} = 0.2\ L_e = 0.2(34.2) = 6.8$ ft.

$W_{r2} = 0.2\ W_e = 0.2(27.3) = 5.5$ ft.

$A_2 = 4\ L_{r2}\ W_{r2} = 4(6.8)(5.5) = 150 \text{ ft}^2$

12. $z_\ell = \frac{L_e - L_{r2}}{0.8Z_m} = \frac{34.2 - 6.8}{11.5} = 2.4$; Adjust z_ℓ to 3.0

$\therefore L_r = 0.8Z_m\ z_\ell + L_{r2} = 11.5\ (3.0) + 6.8 = 41.3$ ft.

$z_\omega = \frac{W_e - W_{r2}}{0.8Z_m} = \frac{27.3 - 5.5}{11.5} = 1.9$; Adjust z_ω to 2.0

$\therefore W_r = 0.8Z_m\ z_\omega + W_{r2} = 11.5\ (2.0) + 5.5 = 28.5$ ft.

13. $L_r = 41.3 > X_m = 36.6$ O.K.

14. $A_1 = 4\ (L_r - z_\ell Z_d)\ (W_r - z_\omega Z_d) = 4\ [41.3 - 3(1.5)]\ [28.5 - 2(1.5)]$

$= 3754 \text{ ft}^2$

15. $V_{ao} = \frac{1}{81}\ [A_1 + A_2 + \sqrt{A_1\ A_2}\ ][0.8Z_m - Z_d]$

$= \frac{1}{81}\ [3754 + 150 + \sqrt{3754 \times 150}\ ][11.5 - 1.5] = 574$ cu. yds.

$$A_{1a1} = 4\left[L_r - z_\ell Z_d + a_1\sqrt{1 + z_\ell^2}\right]\left[W_r - z_\omega Z_d + a_1\sqrt{1 + z_\omega^2}\right]$$

$$= 4\left[41.3 - 3(1.5) + 2.5\sqrt{1 + 3^2}\right]\left[28.5 - 2(1.5) + 2.5\sqrt{1 + 2^2}\right]$$

$$= 5560 \text{ ft}^2$$

$$A_{2a1} = 4\left[L_{r2} + a_1\left(\sqrt{1 + z_\ell^2} - z_\ell\right)\right]\left[W_{r2} + a_1\left(\sqrt{1 + z_\omega^2} - z_\omega\right)\right]$$

$$= 4\left[6.8 + 2.5\left(\sqrt{1 + 3^2} - 3\right)\right]\left[5.5 + 2.5\left(\sqrt{1 + 2^2} - 2\right)\right] = 176 \text{ ft}^2$$

$$V_{a1} = \frac{1}{81}\left[A_{1a1} + A_{2a1} + \sqrt{A_{1a1}A_{2a1}}\right]\left[0.8Z_m - Z_d + a_1\right]$$

$$= \frac{1}{81}\left[5560 + 176 + \sqrt{5560 \times 176}\right]\left[11.5 - 1.5 + 2.5\right] = 1038 \text{ cu. yds.}$$

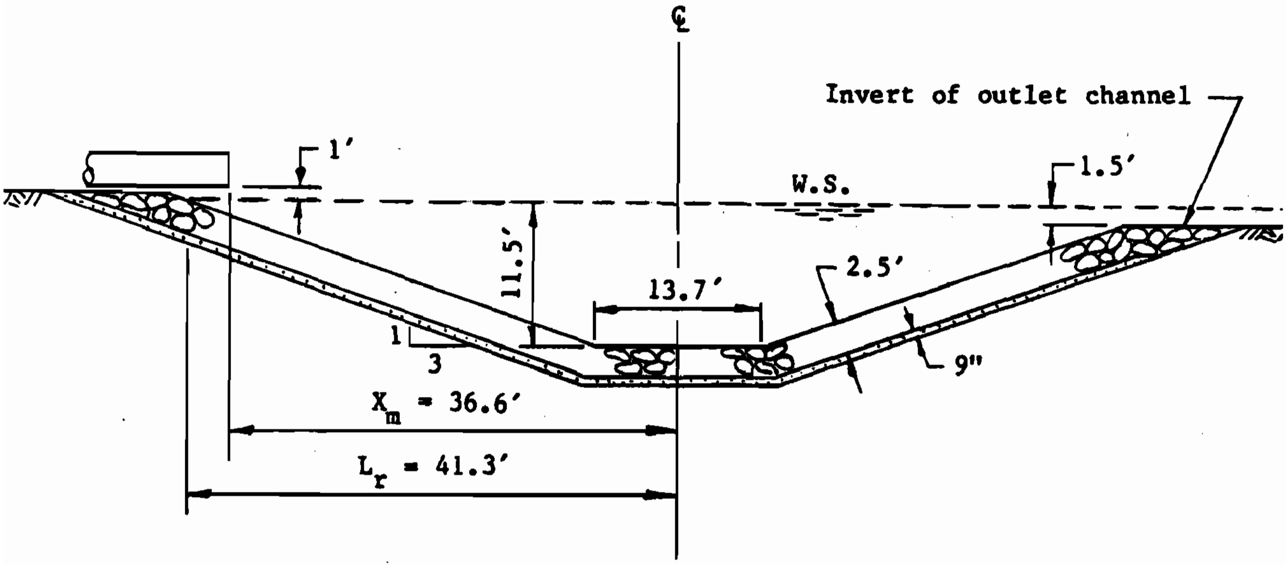
Volume of riprap = $V_{a1} - V_{ao}$ = 1038 - 574 = 464 cu. yds.

$$A_{1a2} = 4\left[41.3 - 4.5 + 3.25\sqrt{10}\right]\left[28.5 - 3 + 3.25\sqrt{5}\right] = 6170 \text{ ft}^2$$

$$A_{2a2} = 4\left[6.8 + 3.25\left(\sqrt{10} - 3\right)\right]\left[5.5 + 3.25\left(\sqrt{5} - 2\right)\right] = 184 \text{ ft}^2$$

$$V_{a2} = \frac{1}{81}\left[6170 + 184 + \sqrt{6170 \times 184}\right]\left[11.5 - 1.5 + 3.25\right] = 1214 \text{ cu. yds.}$$

Volume of filter = $V_{a2} - V_{a1}$ = 1214 - 1038 = 176 cu. yds.



NOMENCLATURE

a_1	≡	Thickness of riprap, ft
a_2	≡	Thickness of riprap and filter material, ft
A_1	≡	Plan rectangular area of the plunge pool at the invert elevation of the outlet channel, ft^2
A_2	≡	Plan rectangular area at the bottom of the plunge pool at a distance Z below the invert elevation of the outlet channel, ft^2.
d_{50}	≡	Size of rock in riprap of which 50 percent by weight is finer, ft
D	≡	Cantilever outlet pipe diameter, ft
e	≡	Base of natural logarithms
F_d	≡	Densimetric Froude number
g	≡	Acceleration of gravity, ft/sec^2
L_e	≡	Minimum horizontal distance from the center of the pool to the water surface contour at the upstream or downstream end of an elliptical-shape plunge pool, ft
L_r	≡	Adjusted horizontal distance from the center of the pool to the water surface contour at the upstream or downstream end of the rectangular-shape plunge pool, ft
L_{r2}	≡	One-half the length of the bottom of a rectangular-shape plunge pool, ft
Q	≡	Design discharge, cfs
S	≡	Sine of the angle whose tangent is the slope of the pipe
V_{ao}	≡	Volume of the plunge pool between the invert elevation of the outlet channel and the exposed riprap surface, cu. yds.
V_{a1}	≡	Volume of the plunge pool between the invert elevation of the outlet channel and a surface at a thickness, a_1, below the exposed riprap surface, cu. yds.
V_{a2}	≡	Volume of the plunge pool between the invert elevation of the outlet channel and a surface at a thickness, a_2, below the exposed riprap surface, cu. yds.

V_h ≡ Horizontal component of the jet impingement velocity, V_p, ft/sec

V_o ≡ Velocity in the pipe corresponding to the design discharge, Q, ft/sec

V_p ≡ Velocity where the jet plunges into the water surface, ft/sec

V_v ≡ Vertical component of the jet impingement velocity, V_p, ft/sec

W_e ≡ One-half the minimum width at the center of the elliptical-shape plunge pool at the water surface elevation, ft

W_r ≡ One-half the adjusted width at the center of the rectangular-shape plunge pool at the water surface elevation, ft

W_{r2} ≡ One-half the width of the bottom of a rectangular plunge pool, ft

X_m ≡ Horizontal distance from the pipe exit to the center of the plunge pool, ft

X_p ≡ Horizontal distance from the pipe exit to the center of the jet plunging into the water surface, ft

z_ℓ ≡ Side slope ratio of the upstream or downstream slope of the rectangular-shape plunge pool

Z_ω ≡ Side slope ratio of the side slopes of the rectangular-shape plunge pool

Z_d ≡ Water depth above the invert elevation of the outlet channel, ft

Z_m ≡ Maximum computed depth of the plunge pool, ft

Z_p ≡ Vertical distance from the tailwater surface to the cantilever pipe invert, ft

ρ ≡ Water density

ρ_s ≡ Bed material or riprap particle density

α ≡ Jet impingement angle where the jet plunges into the water surface

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