Stormwater Management Plan

Streets of West Pryor
Lee's Summit, MO
West Detention Pond

September 23, 2020
Revised November 1, 2020

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INTRODUCTION

This storm water report has been prepared to address the improvements associated with the preliminary development plan for Lot 7 and Tract C, Streets of West Pryor. This development is located north and northwest of the intersection of Black Twig Lane and Lowenstein Road within the Streets of West Pryor mixed use development. The preliminary development plan for Streets of West Pryor was approved in 2017 and included Lot 7 and Tract C. This report will address the required storm water improvements associated with the proposed preliminary development plan for Lot 7 and Tract C.

EXISTING APPROVED DEVELOPMENT PLAN

The original 2017 preliminary development showed Lot 7 being developed with a 165 unit senior housing facility along with multiple sport courts and associated parking. Tract C was shown to be comprised of 29 single family lots. Tract C is configured such that it is on 3 sides of an existing storm water detention pond that serves a 46.4 acre drainage area of which Lot 7 and Tract C are a part of. The detention pond has been constructed while the proposed improvements on Tract C and Lot 7 were never taken to the final development plan stage. Figure 1 shows the existing approved preliminary development plan for Lots 7 and Tract C.

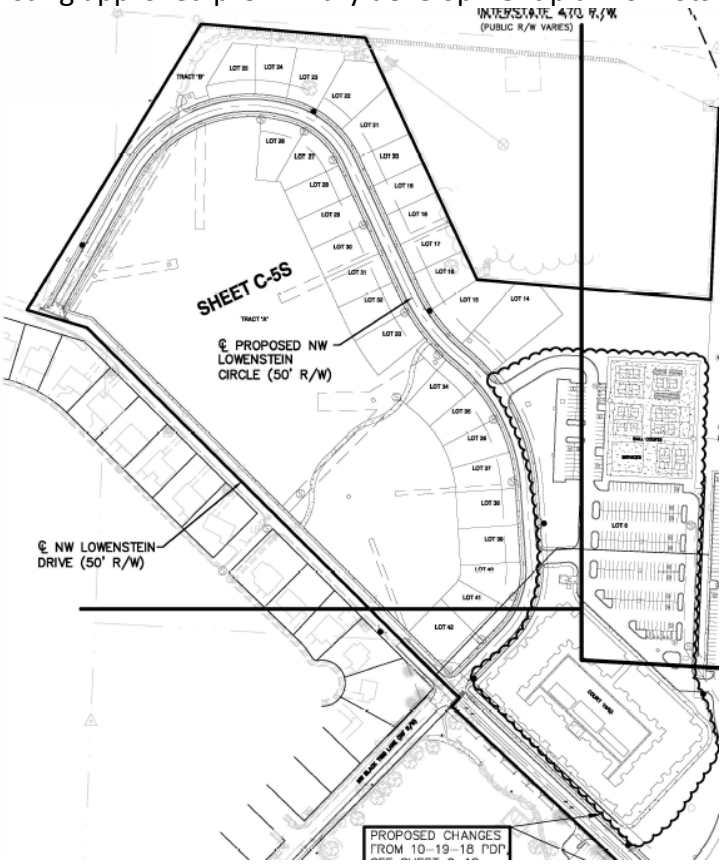


Figure 1. Existing Approved PDP For Lot 7 and Tract C

PROPOSED IMPROVEMENTS

Due to market demand and site costs associated with mine remediation the Streets of West Pryor development team is proposing to increase the density of Lot 7 and Tract C. On Lot 7 we are showing the construction of 2, multi family apartment structures with a total of 184 units along with an 88 unit hotel and shared amenity area. On Tract C we are showing to construct 83 townhome units. As a result of the increased density there will be an increase in the stormwater runoff. Figure 2 is an illustration of the proposed improvements.

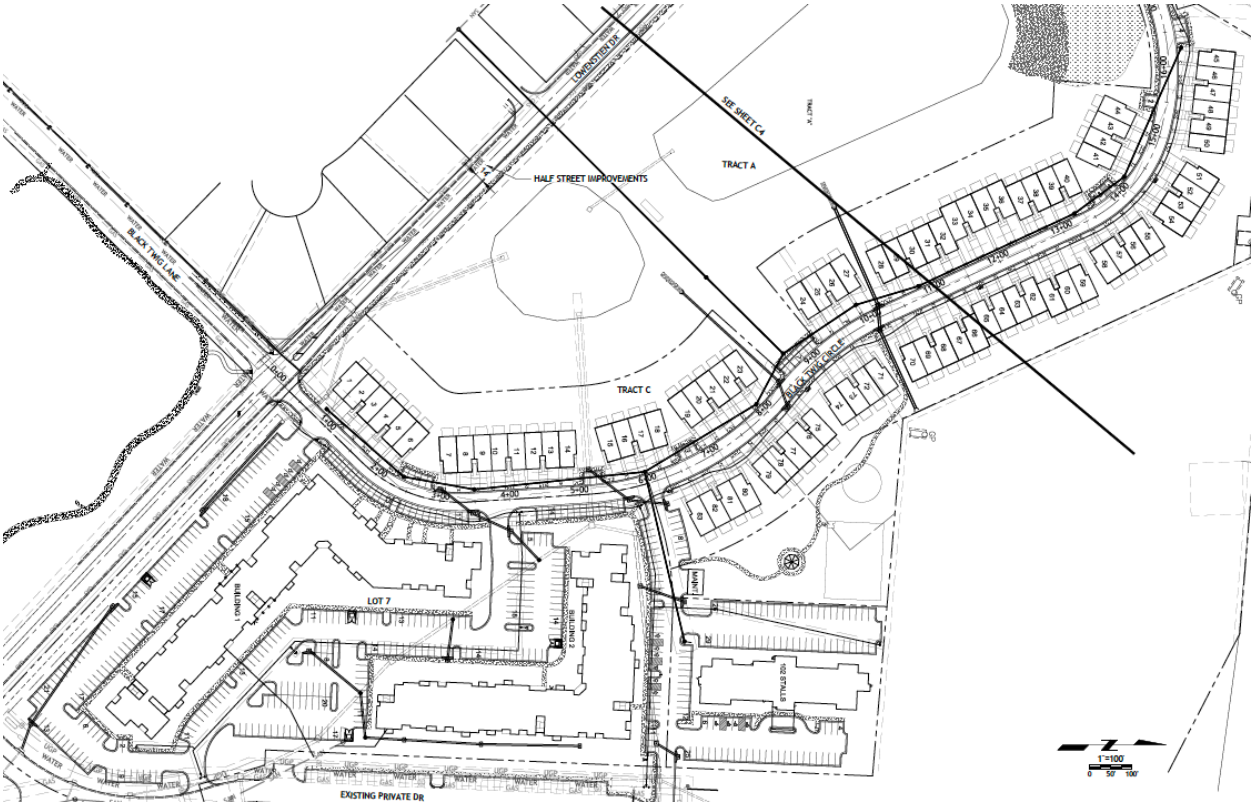


Figure 2. Proposed Improvements To Lot 7 And Tract C

DRAINAGE ANALYSIS METHODS AND CALCULATIONS

As discussed above the area draining to the west detention pond shown above in Figure 2 is 46.4 acres in size. To properly model the functionality of the existing detention pond required, input data was used from the original drainage study for the entire Streets of West Pryor of which Lot 7 and Tract C are a part. In the original drainage study a basin size of 46.9 acres was used. In order to properly model the affect of the increased density a 46.9 acre basin size was used in our calculations.

A curve number of 94 was used for both Lot 7 and Tract C as both of these lots are considered commercial in nature. This is an increase of 11 over the original CN value of 83 used for the single family housing that was proposed for Tract C and an increase of 3 over the mixed use CN of 91 for Lot 7.

As part of the original Streets of West Pryor development there were some modifications to the existing watersheds in order to facilitate the development. The original watershed that drained to the west was 24.9 acres in size. As such, this area is what dictates the amount of runoff that can be realized, post development. Per APWA 5608.4 the allowable release rates are listed in Table 1 below.

The drainage analysis was prepared using Hydrology Studio software to analyze the increased runoff and how it affected the pond outlet. The Hydrology Studio printouts are attached in Appendix A with a summary of the west basin discharge rates illustrated in the Table 1 below. The SCS method for determining runoff was used per APWA Section 5600, Storm Drainage Systems and Facilities – Kansas City Metropolitan Chapter.

Table 1: Summary of Discharge Rates

Design Storm	Allowable Release Rate (cfs/acre)	Proposed Pond Release Rates (cfs)	Proposed Pond Release Rates (cfs)
50% (2 yr)	0.5	1.67	1.67
10% (10 yr)	2.0	9.95	9.95
1% (100 yr)	3.0	23.85	23.85

As illustrated above, in all cases the total release rate is less than the allowable release rate. It should be noted that the pond release rates above are actually less than what was previously anticipated even though the CN values were increased. This is due to the fact that during pond construction the outlet orifices were raised up 2’ while maintaining the same pond volume. This in affect increased the size of the detention pond above the permanent pole resulting in reduced release rates.

CONCLUSION

As shown above if constructed as proposed the preliminary development plan improvements for Lot 7 and Tract C, Streets of West Pryor will not increase the storm water runoff over what is allowed per APWA.

Appendix A

- Hydrology Studio Printouts

Pond Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

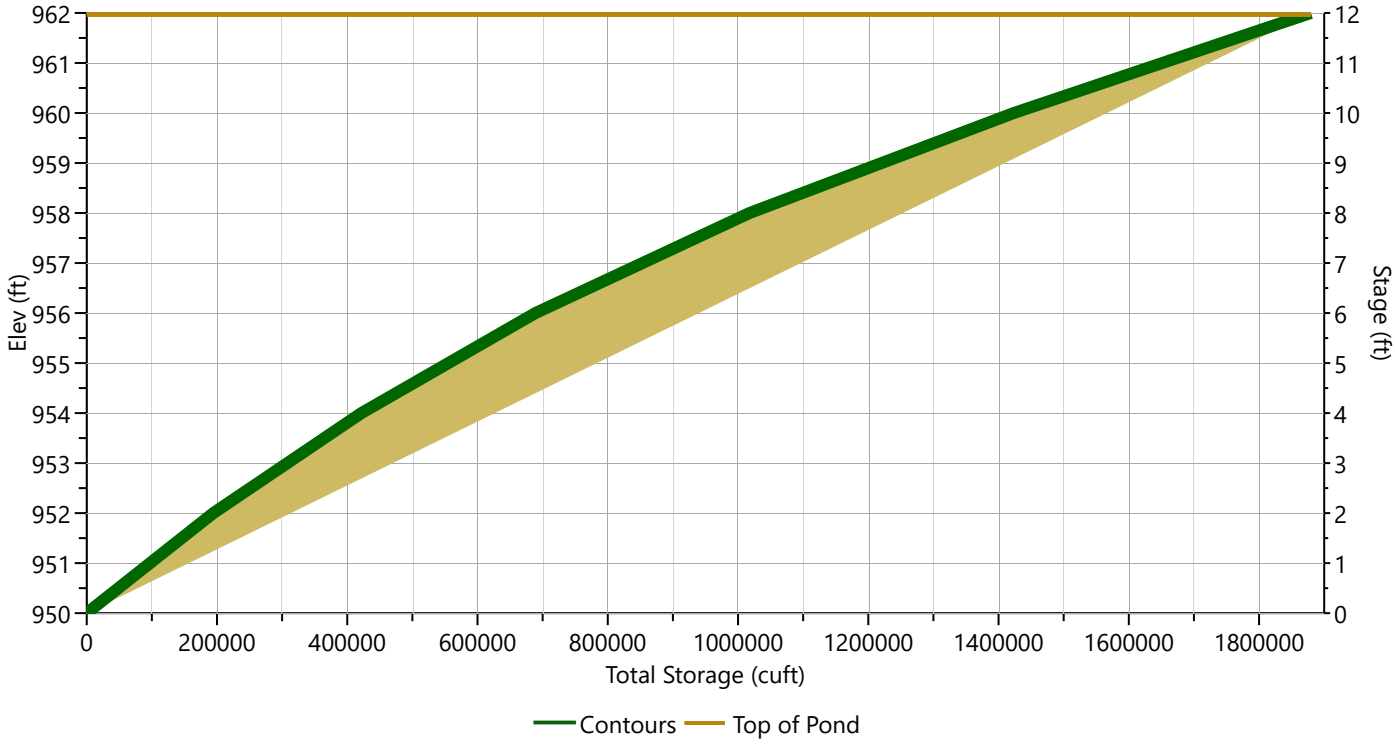
West

Stage-Storage

User Defined Contours	
Description	**Input**
Bottom Elevation, ft	950.00
Voids (%)	100.00
Volume Calc	Ave End Area

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour Area (sqft)	Incr. Storage (cuft)	Total Storage (cuft)
0.00	950.00	93,176	0.000	0.000
2.00	952.00	101,126	194,302	194,302
4.00	954.00	126,218	227,344	421,646
6.00	956.00	141,067	267,285	688,931
8.00	958.00	187,658	328,725	1,017,656
10.00	960.00	218,192	405,850	1,423,506
12.00	962.00	237,915	456,107	1,879,613



Pond Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

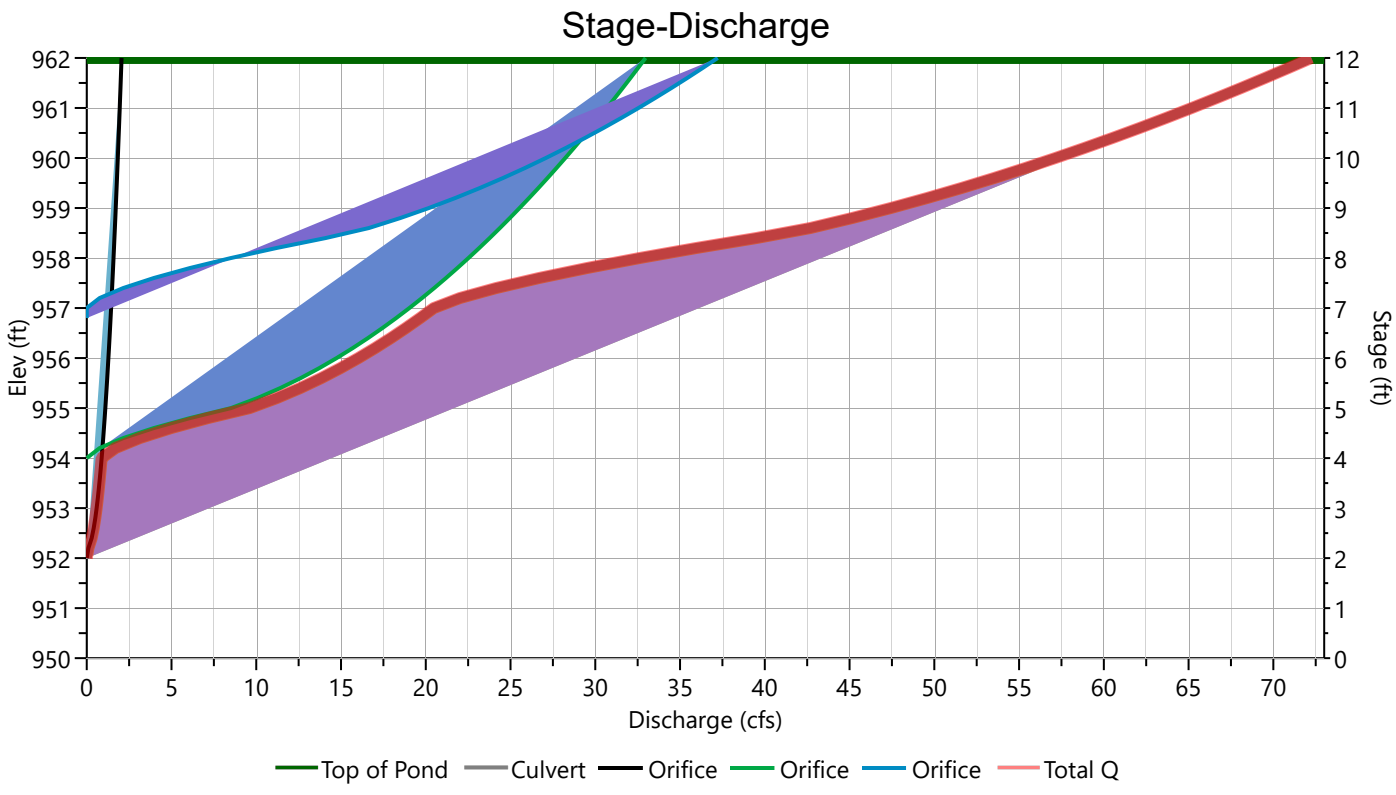
West

Stage-Discharge

Culvert / Orifices	Culvert	Orifices			Perforated Riser	
		1*	2*	3*		
Rise, in	36	5	12	18	Hole Diameter, in	
Span, in	36	5	30	30	No. holes	
No. Barrels	1	1	1	1	Invert Elevation, ft	
Invert Elevation, ft	940.00	952.00	954.00	957.00	Height, ft	
Orifice Coefficient, Co	0.60	0.60	0.60	0.60	Orifice Coefficient, Co	
Length, ft	200					
Barrel Slope, %	2					
N-Value, n	0.013					

Weirs	Riser*	Weirs			Ancillary	
		1	2	3		
Shape / Type					Exfiltration, in/hr	
Crest Elevation, ft						
Crest Length, ft						
Angle, deg						
Weir Coefficient, Cw						

**Routes through Culvert.*



Pond Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

West

Stage-Storage-Discharge Summary

Stage (ft)	Elev. (ft)	Storage (cuft)	Culvert (cfs)	Orifices, cfs			Riser (cfs)	Weirs, cfs			Pf Riser (cfs)	Exfil (cfs)	User (cfs)	Total (cfs)
				1	2	3		1	2	3				
0.00	950.00	0.000	0.000	0.000	0.000	0.000								0.000
2.00	952.00	194,302	0.000 ic	0.000	0.000	0.000								0.000
4.00	954.00	421,646	0.879 ic	0.879	0.000	0.000								0.879
6.00	956.00	688,931	16.02 ic	1.278	14.74	0.000								16.02
8.00	958.00	1,017,656	32.61 ic	1.580	22.52	8.512								32.61
10.00	960.00	1,423,506	57.15 ic	1.832	28.23	27.08								57.15
12.00	962.00	1,879,613	72.24 ic	2.054	32.97	37.22								72.24

Suffix key: ic = inlet control, oc = outlet control, s = submerged weir

Hydrograph 2-yr Summary

Project Name: SOWP West Pond

09-22-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Post West	204.9	11.98	499,361	----		
2	NRCS Runoff	Pre West	33.46	12.37	192,014	----		
3	Pond Route	West Pond	1.664	24.03	130,684	1	954.19	447,586

Hydrograph Report

Project Name: SOWP West Pond

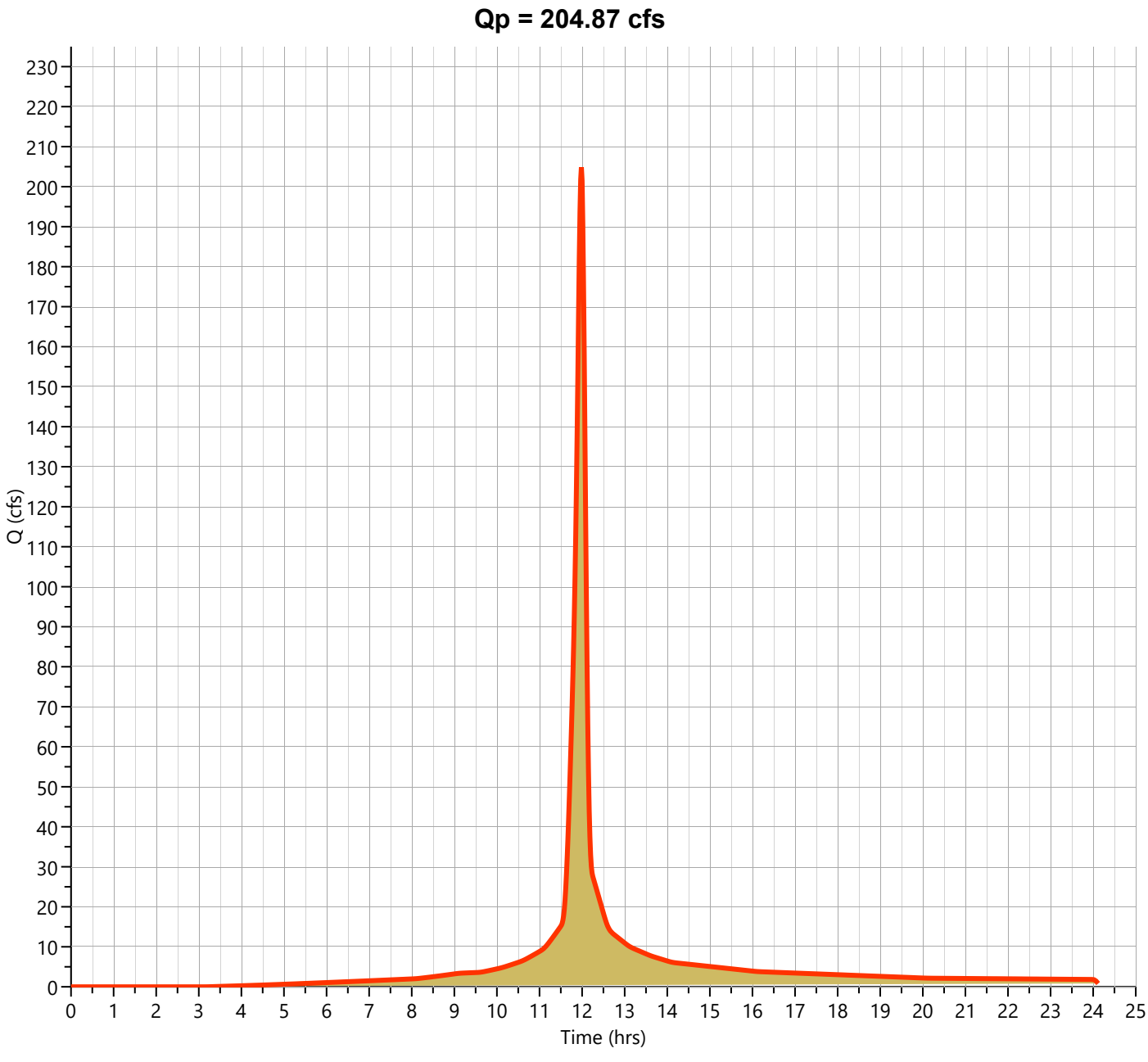
Hydrology Studio v 3.0.0.16

09-22-2020

Post West

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 204.9 cfs
Storm Frequency	= 2-yr	Time to Peak	= 11.98 hrs
Time Interval	= 1 min	Runoff Volume	= 499,361 cuft
Drainage Area	= 46.9 ac	Curve Number	= 94
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
Total Rainfall	= 3.60 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

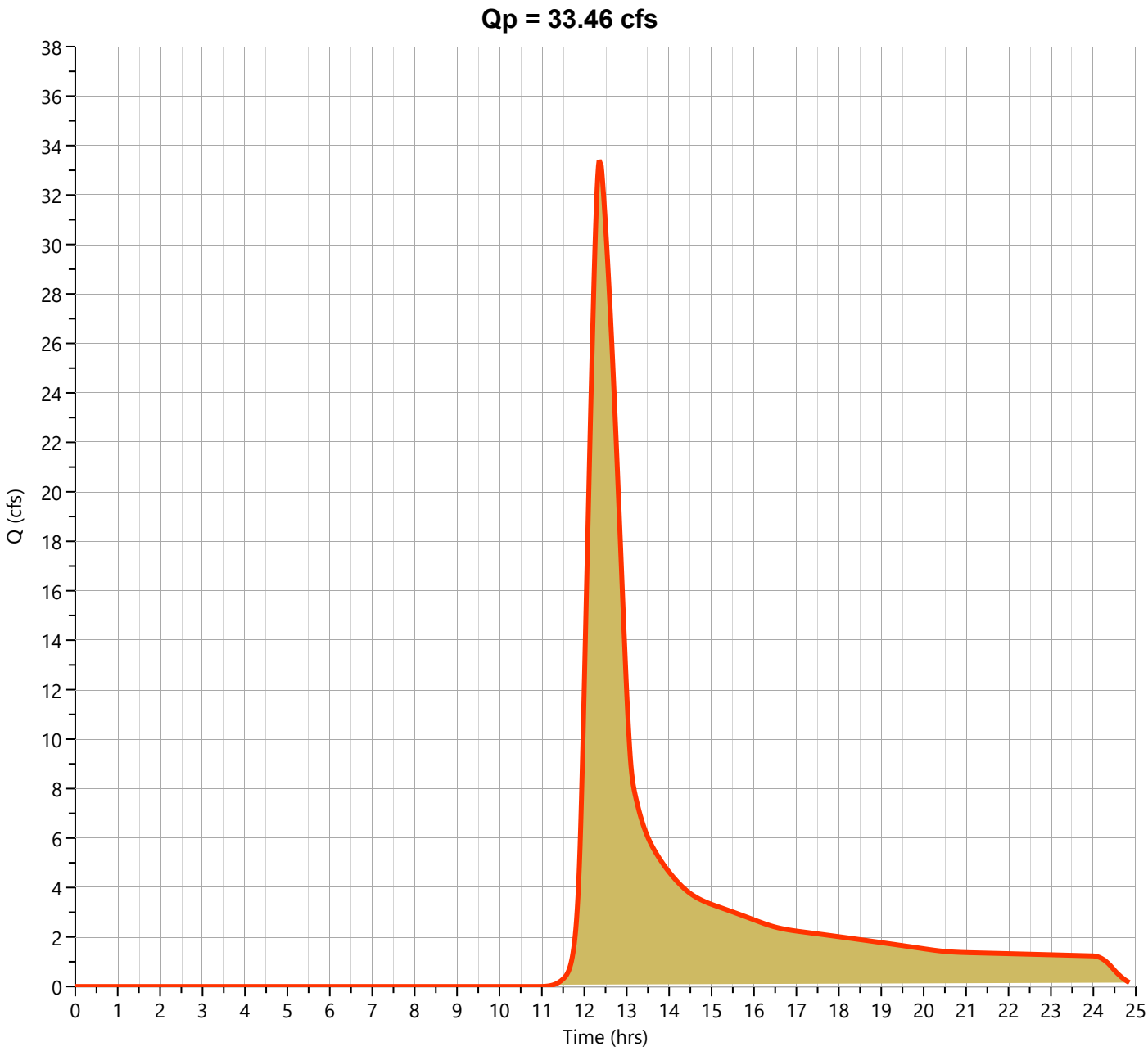
Hydrology Studio v 3.0.0.16

09-22-2020

Pre West

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 33.46 cfs
Storm Frequency	= 2-yr	Time to Peak	= 12.37 hrs
Time Interval	= 1 min	Runoff Volume	= 192,014 cuft
Drainage Area	= 46.9 ac	Curve Number	= 71
Tc Method	= User	Time of Conc. (Tc)	= 45.0 min
Total Rainfall	= 3.60 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

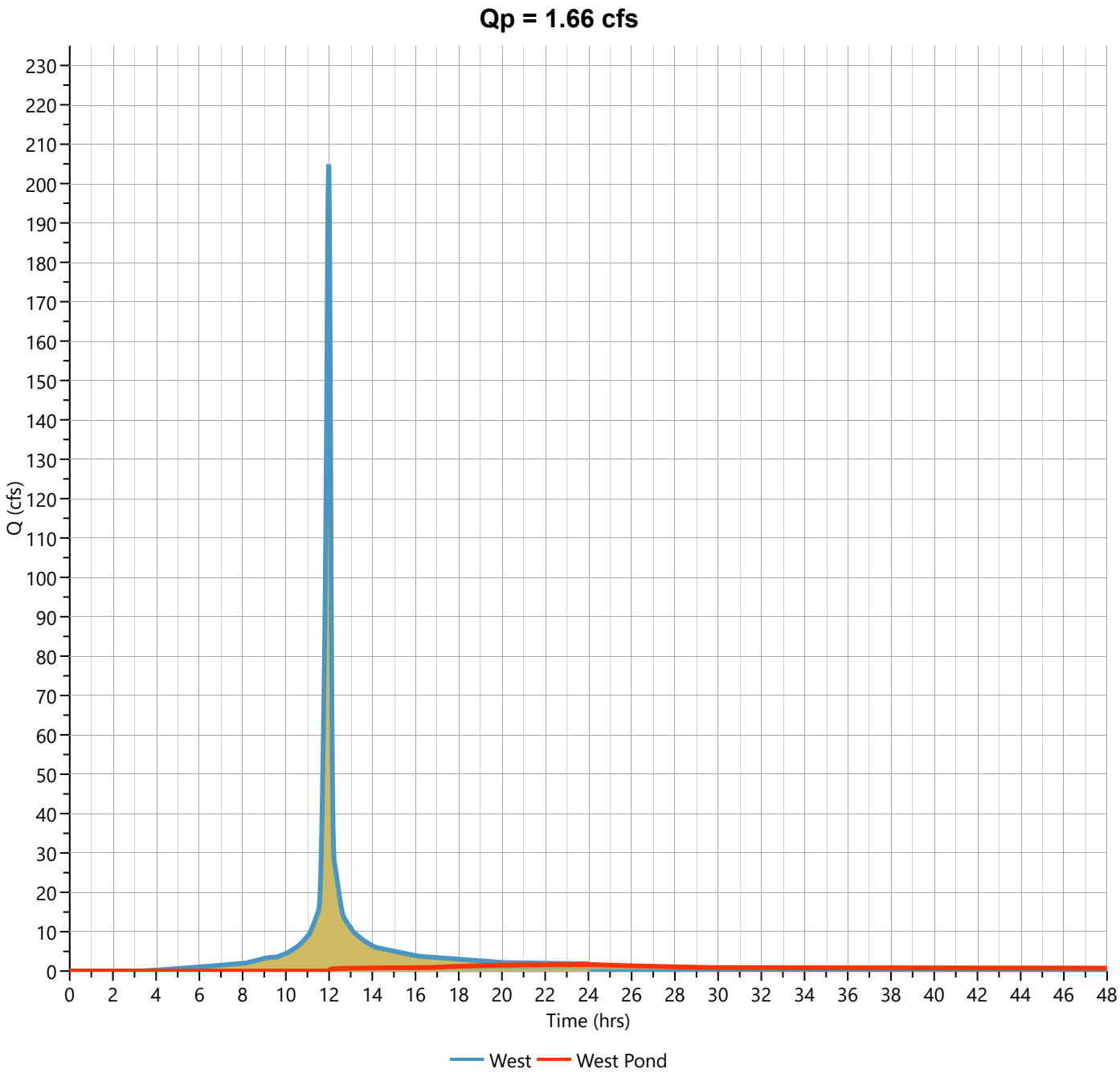
West Pond

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 1.664 cfs
Storm Frequency	= 2-yr	Time to Peak	= 24.03 hrs
Time Interval	= 1 min	Hydrograph Volume	= 130,684 cuft
Inflow Hydrograph	= 1 - West	Max. Elevation	= 954.19 ft
Pond Name	= West	Max. Storage	= 447,586 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 15.96 hrs



Hydrograph 10-yr Summary

Project Name: SOWP West Pond

09-22-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Post West	312.5	11.98	783,845	----		
2	NRCS Runoff	Pre West	74.48	12.35	399,371	----		
3	Pond Route	West Pond	9.949	13.95	403,665	1	955.04	560,965

Hydrograph Report

Project Name: SOWP West Pond

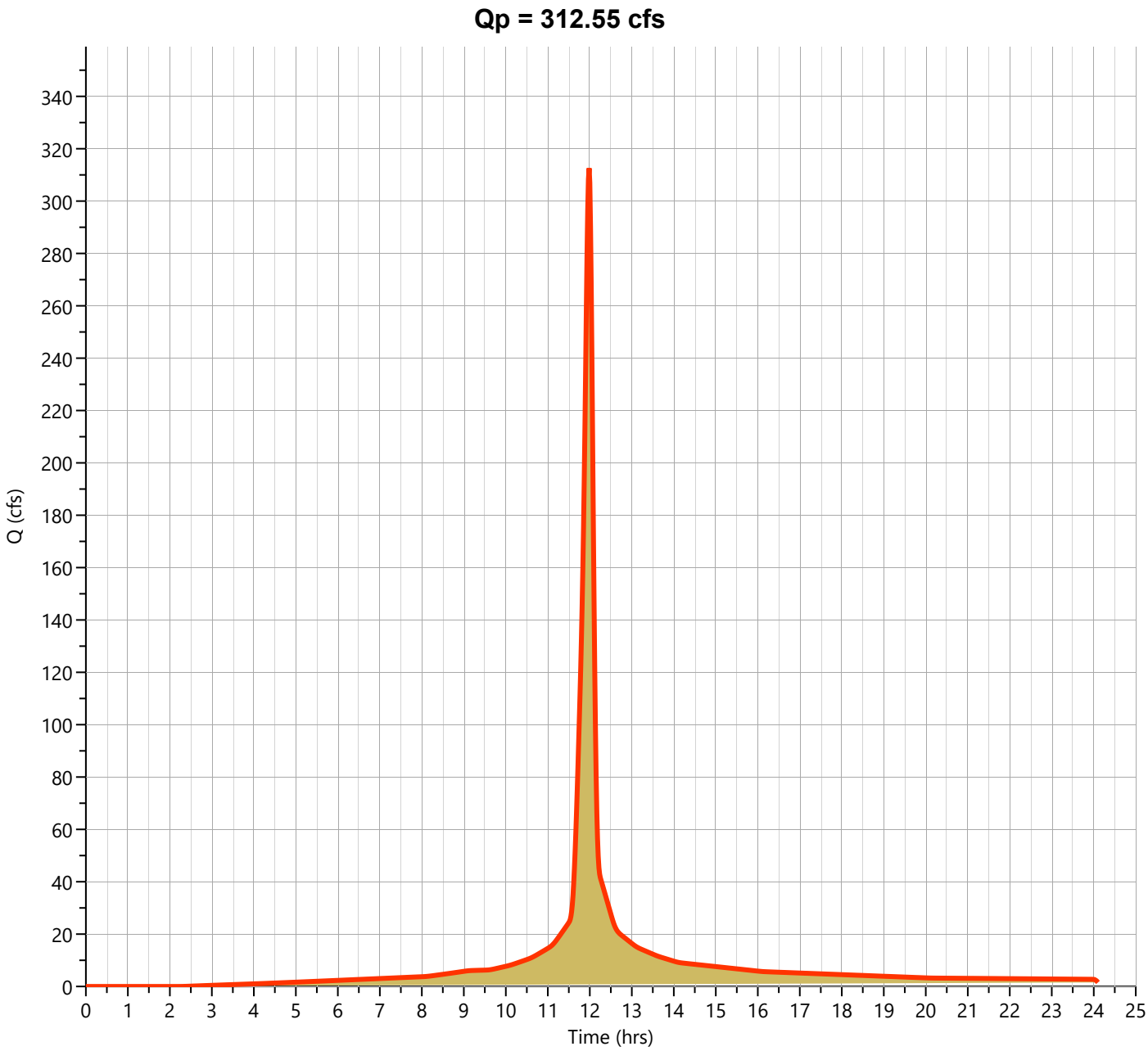
Hydrology Studio v 3.0.0.16

09-22-2020

Post West

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 312.5 cfs
Storm Frequency	= 10-yr	Time to Peak	= 11.98 hrs
Time Interval	= 1 min	Runoff Volume	= 783,845 cuft
Drainage Area	= 46.9 ac	Curve Number	= 94
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
Total Rainfall	= 5.30 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

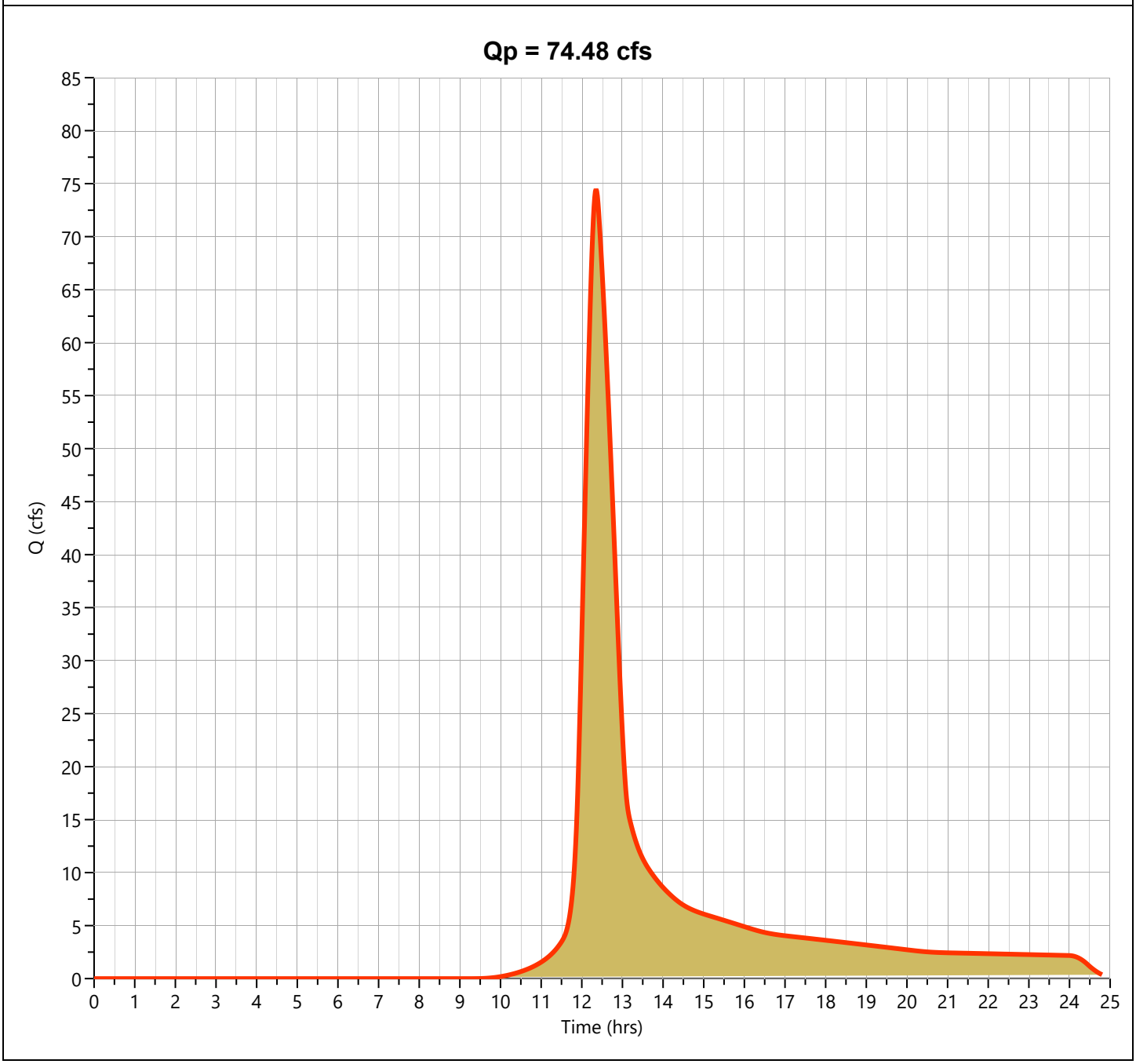
Hydrology Studio v 3.0.0.16

09-22-2020

Pre West

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 74.48 cfs
Storm Frequency	= 10-yr	Time to Peak	= 12.35 hrs
Time Interval	= 1 min	Runoff Volume	= 399,371 cuft
Drainage Area	= 46.9 ac	Curve Number	= 71
Tc Method	= User	Time of Conc. (Tc)	= 45.0 min
Total Rainfall	= 5.30 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

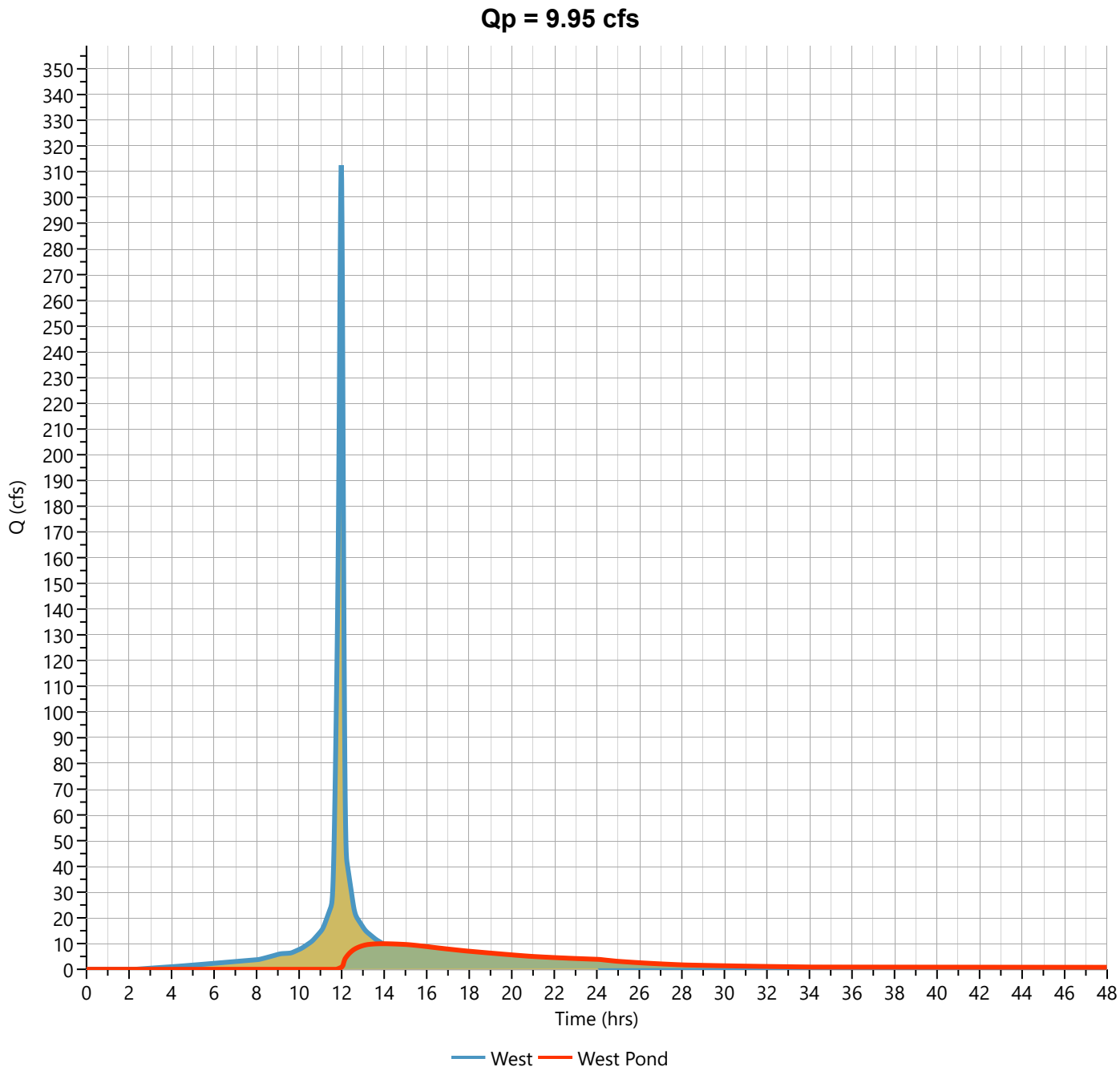
West Pond

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 9.949 cfs
Storm Frequency	= 10-yr	Time to Peak	= 13.95 hrs
Time Interval	= 1 min	Hydrograph Volume	= 403,665 cuft
Inflow Hydrograph	= 1 - West	Max. Elevation	= 955.04 ft
Pond Name	= West	Max. Storage	= 560,965 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 8.95 hrs



Hydrograph 25-yr Summary

Project Name: SOWP West Pond

09-22-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Post West	369.0	11.98	935,466	----		
2	NRCS Runoff	Pre West	98.33	12.35	521,080	----		
3	Pond Route	West Pond	14.38	13.52	552,832	1	955.70	648,318

Hydrograph Report

Project Name: SOWP West Pond

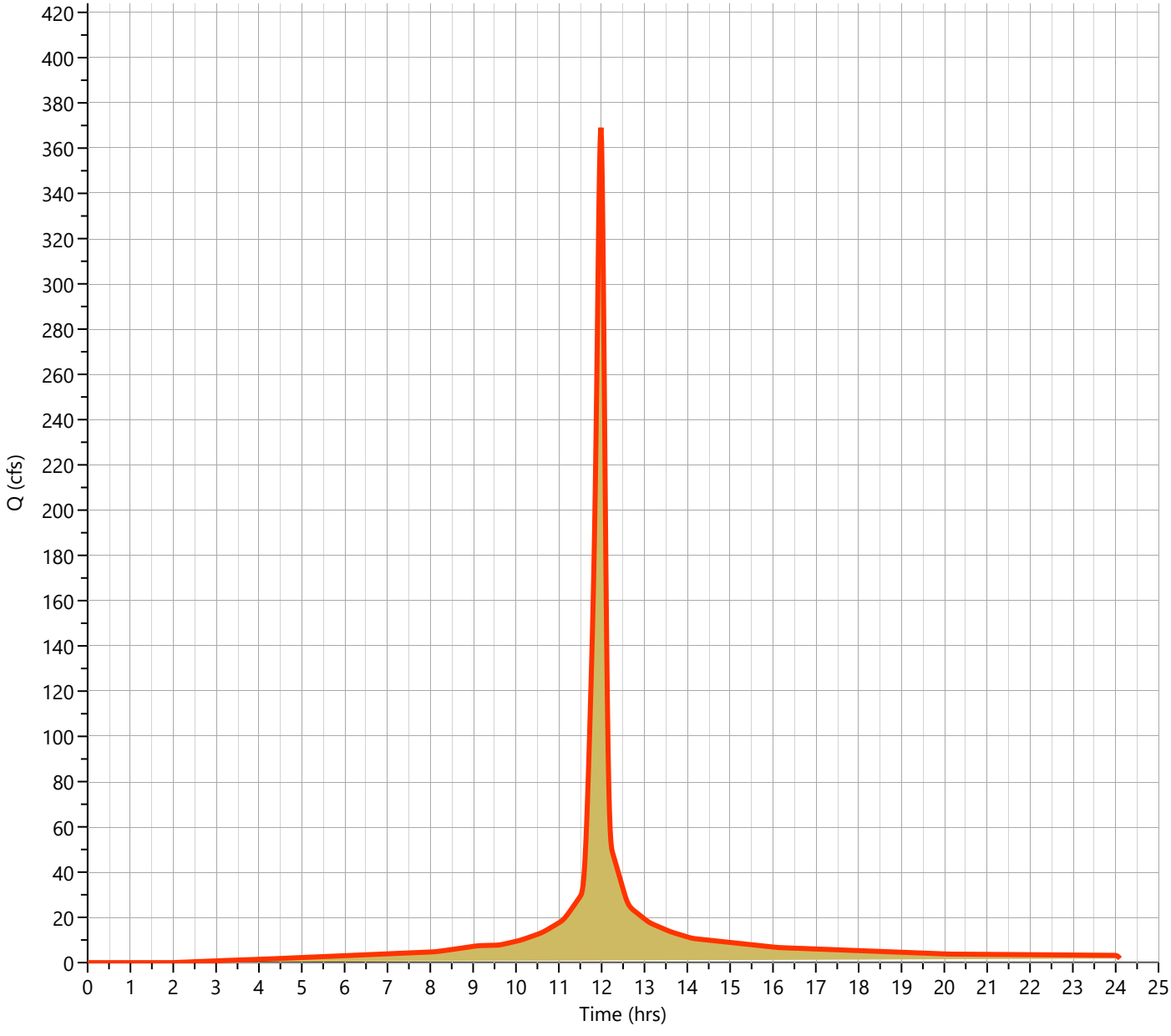
Hydrology Studio v 3.0.0.16

09-22-2020

Post West

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 369.0 cfs
Storm Frequency	= 25-yr	Time to Peak	= 11.98 hrs
Time Interval	= 1 min	Runoff Volume	= 935,466 cuft
Drainage Area	= 46.9 ac	Curve Number	= 94
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
Total Rainfall	= 6.20 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

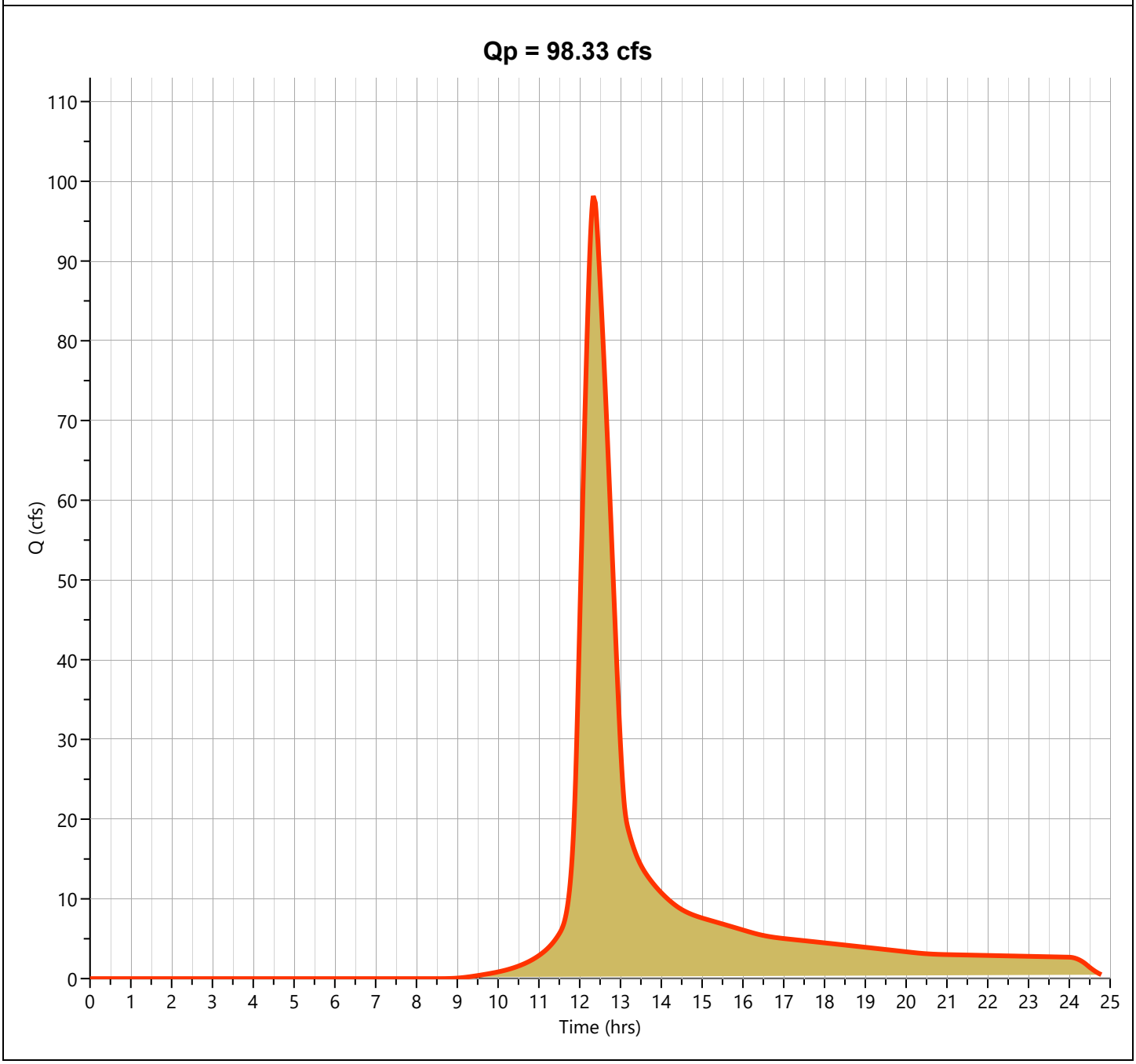
Hydrology Studio v 3.0.0.16

09-22-2020

Pre West

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 98.33 cfs
Storm Frequency	= 25-yr	Time to Peak	= 12.35 hrs
Time Interval	= 1 min	Runoff Volume	= 521,080 cuft
Drainage Area	= 46.9 ac	Curve Number	= 71
Tc Method	= User	Time of Conc. (Tc)	= 45.0 min
Total Rainfall	= 6.20 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

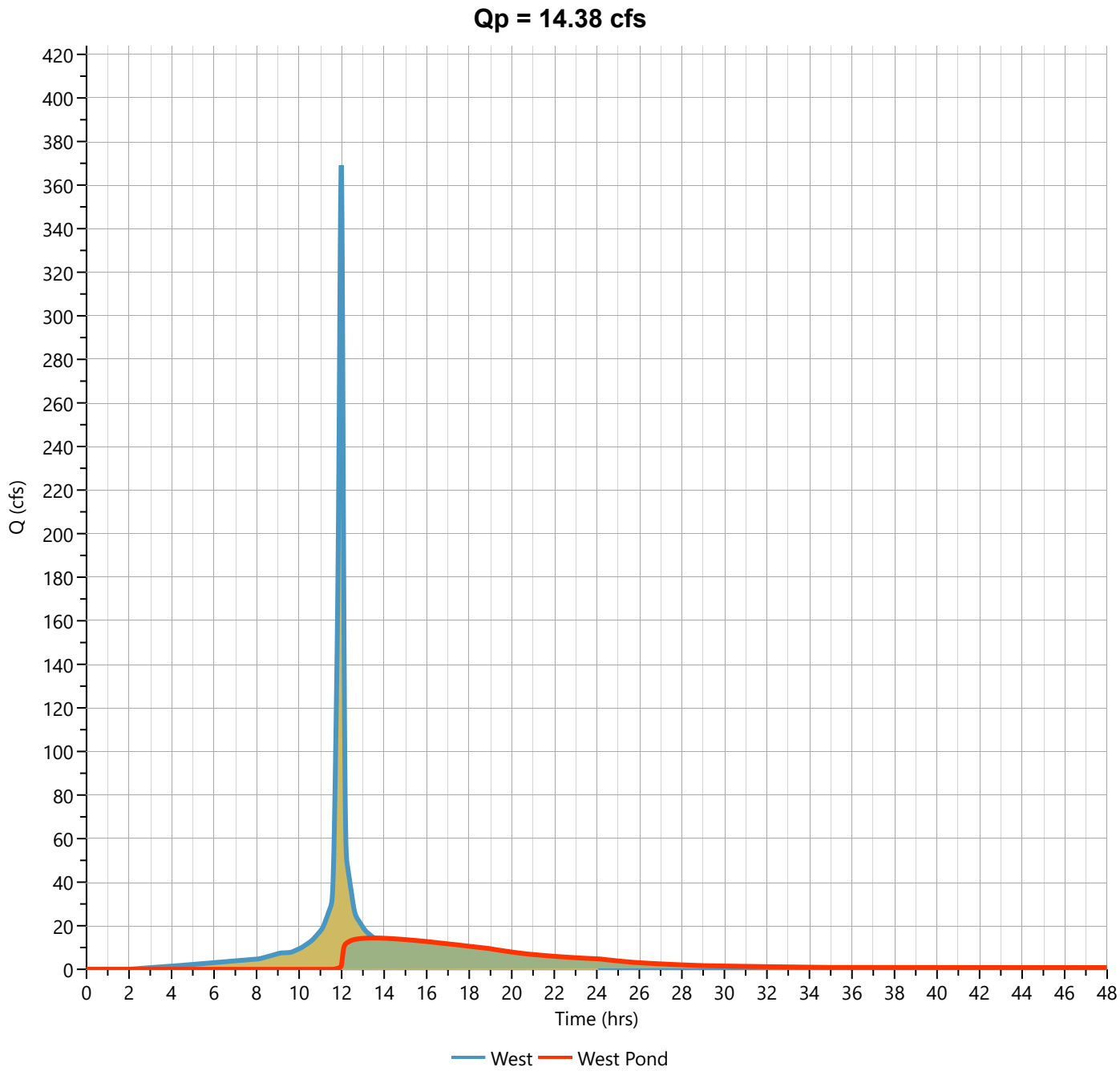
West Pond

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 14.38 cfs
Storm Frequency	= 25-yr	Time to Peak	= 13.52 hrs
Time Interval	= 1 min	Hydrograph Volume	= 552,832 cuft
Inflow Hydrograph	= 1 - West	Max. Elevation	= 955.70 ft
Pond Name	= West	Max. Storage	= 648,318 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 7.95 hrs



Hydrograph 100-yr Summary

Project Name: SOWP West Pond

09-22-2020

Hydrology Studio v 3.0.0.16

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Post West	518.7	11.98	1,341,337	----		
2	NRCS Runoff	Pre West	165.5	12.33	869,005	----		
3	Pond Route	West Pond	23.85	13.18	951,369	1	957.37	914,515

Hydrograph Report

Project Name: SOWP West Pond

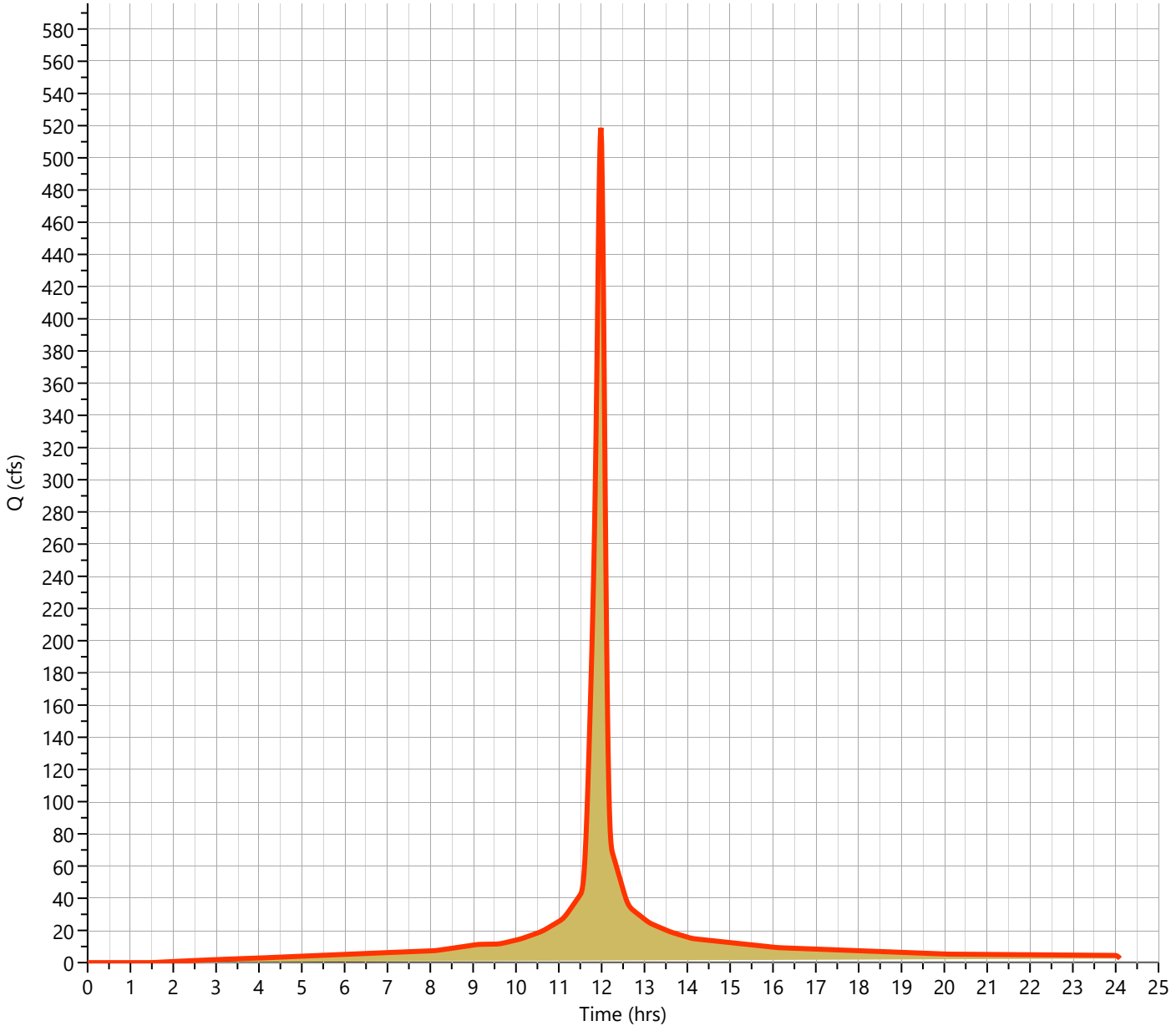
Hydrology Studio v 3.0.0.16

09-22-2020

Post West

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 518.7 cfs
Storm Frequency	= 100-yr	Time to Peak	= 11.98 hrs
Time Interval	= 1 min	Runoff Volume	= 1,341,337 cuft
Drainage Area	= 46.9 ac	Curve Number	= 94
Tc Method	= User	Time of Conc. (Tc)	= 10.0 min
Total Rainfall	= 8.60 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

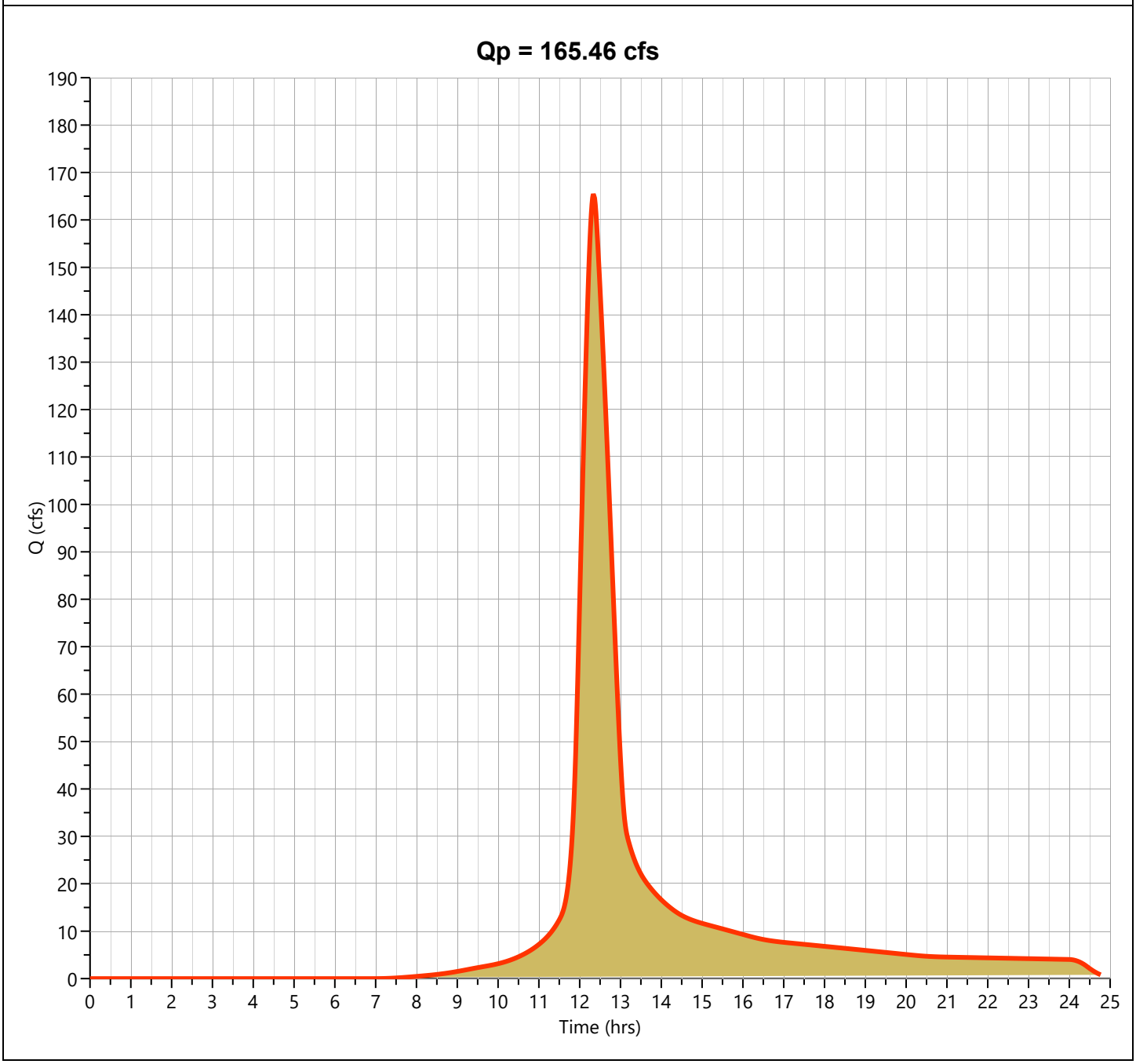
Hydrology Studio v 3.0.0.16

09-22-2020

Pre West

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 165.5 cfs
Storm Frequency	= 100-yr	Time to Peak	= 12.33 hrs
Time Interval	= 1 min	Runoff Volume	= 869,005 cuft
Drainage Area	= 46.9 ac	Curve Number	= 71
Tc Method	= User	Time of Conc. (Tc)	= 45.0 min
Total Rainfall	= 8.60 in	Design Storm	= Type II
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name: SOWP West Pond

Hydrology Studio v 3.0.0.16

09-22-2020

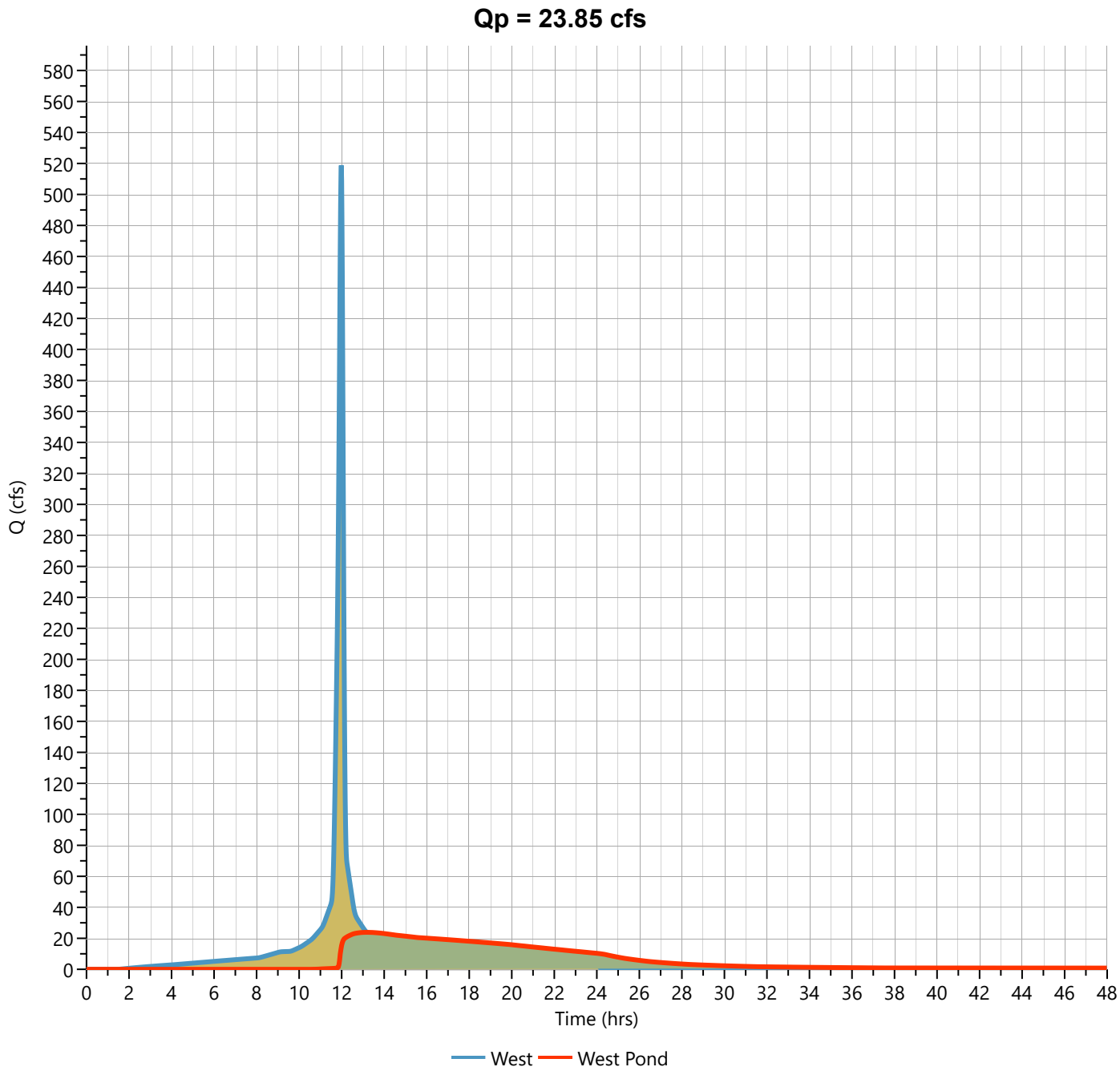
West Pond

Hyd. No. 3

Hydrograph Type	= Pond Route	Peak Flow	= 23.85 cfs
Storm Frequency	= 100-yr	Time to Peak	= 13.18 hrs
Time Interval	= 1 min	Hydrograph Volume	= 951,369 cuft
Inflow Hydrograph	= 1 - West	Max. Elevation	= 957.37 ft
Pond Name	= West	Max. Storage	= 914,515 cuft

Pond Routing by Storage Indication Method

Center of mass detention time = 7.5□ hrs



IDF Report

IDF filename: Lees Summit MO Test.idf

Hydrology Studio v 3.0.0.16

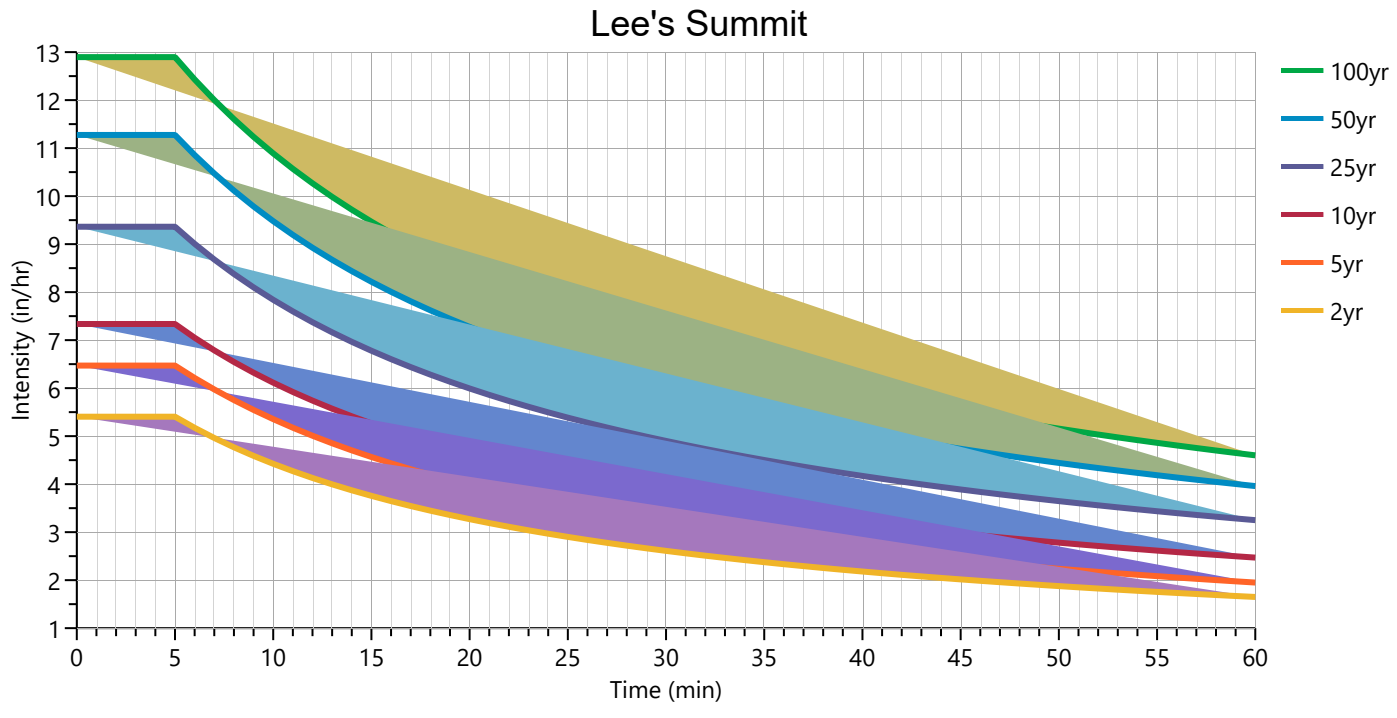
09-22-2020

Equation Coefficients	Intensity = B / (Tc + D)^E (in/hr)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
B	0.0000	79.5706	0.0000	168.3971	91.3625	107.4824	135.5891	160.7297	
D	0.0000	15.0000	0.0000	19.5000	15.5000	15.4000	16.1000	16.8000	
E	0.0000	0.8977	0.0000	1.0189	0.8350	0.8094	0.8156	0.8186	

Minimum Tc = 5 minutes

Tc (min)	Intensity Values (in/hr)								
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
Cf	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
5	0	5.41	0	6.47	7.34	9.36	11.27	12.90	
10	0	4.42	0	5.35	6.11	7.84	9.48	10.89	
15	0	3.76	0	4.56	5.26	6.78	8.22	9.47	
20	0	3.27	0	3.98	4.64	5.99	7.28	8.40	
25	0	2.90	0	3.52	4.15	5.39	6.55	7.57	
30	0	2.61	0	3.16	3.77	4.90	5.96	6.90	
35	0	2.37	0	2.86	3.46	4.50	5.48	6.35	
40	0	2.18	0	2.62	3.19	4.17	5.08	5.89	
45	0	2.02	0	2.41	2.97	3.89	4.74	5.50	
50	0	1.88	0	2.24	2.78	3.65	4.44	5.16	
55	0	1.76	0	2.08	2.62	3.44	4.19	4.86	
60	0	1.65	0	1.95	2.47	3.25	3.96	4.60	

Cf = Correction Factor applied to Rational Method runoff coefficient.



Precipitation Report

Precipitation filename: Lee Summit West.pcp

Hydrology Studio v 3.0.0.16 (Rainfall totals in Inches)

09-22-2020

	Active	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Active			✔			✔	✔		✔
SCS Storms	**> SCS Dimensionless Storms**								
SCS 6hr		1.20	1.50	0	1.86	2.18	2.64	3.01	4.60
Type I, 24-hr		0	0	0	0	0	0	0	0
Type IA, 24-hr		0	0	0	0	0	0	0	0
Type II, 24-hr	✔	0	3.60	0	4.50	5.30	6.20	7.00	8.60
Type II FL, 24-hr		0	0	0	0	0	0	0	0
Type III, 24-hr		0	0	0	0	0	0	0	0
Synthetic Storms	**> IDF-Based Synthetic Storms**								
1-hr		0	1.65	0	1.95	2.47	3.25	3.96	4.60
2-hr		0	1.95	0	2.20	3.03	4.05	4.93	5.74
3-hr		0	2.10	0	2.29	3.35	4.51	5.49	6.39
6-hr		0	2.33	0	2.38	3.88	5.32	6.45	7.51
12-hr		0	2.55	0	2.41	4.43	6.17	7.46	8.67
24-hr		0	2.76	0	2.41	5.01	7.11	8.56	9.93
Huff Distribution	**> 1st Quartile (0 to 6 hrs)**								
1-hr		0.76	0.98	0	1.33	1.61	2.01	2.34	2.69
2-hr		0.89	1.14	0	1.50	1.80	2.24	2.60	2.99
3-hr		0.98	1.24	0	1.59	1.90	2.33	2.68	3.07
6-hr		1.20	1.50	0	1.86	2.18	2.64	3.01	3.41
Huff Distribution	**> 2nd Quartile (>6 to 12 hrs)**								
8-hr		0	0	0	0	0	0	0	0
12-hr		0	0	0	0	0	0	0	0
Huff Distribution	**> 3rd Quartile (>12 to 24 hrs)**								
18-hr		0	0	0	0	0	0	0	0
24-hr		0	0	0	0	0	0	0	0
Custom Storms	**> Custom Storm Distributions**								
My Custom Storm 1		0	0	0	0	0	0	0	0
My Custom Storm 2		0	0	0	0	0	0	0	0
My Custom Storm 3		0	0	0	0	0	0	0	0
My Custom Storm 4		0	0	0	0	0	0	0	0
My Custom Storm 5		0	0	0	0	0	0	0	0
My Custom Storm 6		0	0	0	0	0	0	0	0
My Custom Storm 7		0	0	0	0	0	0	0	0
My Custom Storm 8		0	0	0	0	0	0	0	0
My Custom Storm 9		0	0	0	0	0	0	0	0
My Custom Storm 10		0	0	0	0	0	0	0	0