FINAL STORMWATER DRAINAGE STUDY FOR LEE'S SUMMIT SENIOR LIVING COMMUNITY

SE Oldham Parkway

Lee Summit, Missouri

South Prairie Lee Watershed

Prepared for:

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June 2019

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Olsson Project No. 018-1450

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1. GENERAL INFORMATION

The following stormwater report is for the Lee's Summit Senior Living Community located near the southern boundary of the South Prairie Lee Watershed on the south side of Oldham Parkway approximately 0.4 miles east of Todd George Parkway. The proposed 157,515-sqft facility will be on a 10.45 acre± site that is currently vacant pasture land. In the existing condition the site generally flows from south to the north towards Oldham Parkway. A subtle ridge line splits the site into two sub-drainage areas. The western onsite drainage area discharges to the Oldham Parkway drainage swale at the northwest corner of the site (POI #1). The swale drains to a 5'x5' RCB culvert that flows north underneath the Oldham Parkway, US Route 50, and Blue Parkway to the E. Fork Little Blue River through an unnamed tributary. The eastern onsite drainage area intercepts offsite runoff from approximately 5-acres of agricultural land from the east. Runoff continues to flow north and northeast to an existing 30" RCP culvert (POI #2) that discharges north underneath Oldham Parkway, US Route 50, and Blue Parkway. Storm water continues north to an existing wet detention facility located south of Shenandoah Drive.

Stormwater runoff from the proposed Lee's Summit Senior Living Community will be collected and conveyed through onsite storm sewer, that is routed to proposed bioretention and extended dry detention facilities. These facilities will discharge the water in compliance with the City of Lee Summit's design standards to the proposed public storm sewer that will be installed with the Oldham Parkway street improvements.

According the FEMA Flood Map Service Center the site is in an area of minimal flood hazard, Zone X, per map #29095C049G dated 01/20/2017. Zone X is the FEMA flood insurance rate zone that corresponds to "areas of 0.2% annual chance flood; areas of 1% chance flood with average depths less than 1 foot or within drainage areas of less than 1 square mile; and areas protected by levees from 1% annual chance flood." The FEMA FIRMette has been included in Appendix A.

Per the National Wetlands Inventory, the site has no "blue line" streams or wetlands located on site.

Soil data was taken from the USDA Natural Resources Conservation Service – Web Soil Survey of Jackson, County Missouri. The Web soil survey categorize soils on the proposed Lee's Summit Senior Living Community as:

TABLE 1. SITE SOIL CLASSIFICATION

Map Unit	Map Unit Name	Percent Slopes	Rating	Area in AOI (acres)	Percent of AOI
10000	**Arisburg Silt Loam**	1 to 5	C	15.9	85.9%
10082	**Arisburg-Urban land complex**	1 to 5	C	2.6	14.1%

*see Web Soil Survey pdf located in Appendix A

2. METHODOLOGY

This Stormwater Drainage Study has been prepared to evaluate the hydrologic impact generated by the development of the Lee's Summit Senior Living Community and adjacent public street improvements. The base data for models prepared for this report have been obtained through topographic surveys, online maps, and aerial imagery.

The following method was used to study and model existing and proposed conditions for stormwater runoff:

- TR-55 Unit Hydrograph Method
  - 2-year, 10-year, 100-year Return Frequency Storms
  - 24-Hour SCS Type II Rainfall Distribution
  - SCS Runoff Curve Numbers Per SCS TR-55
  - SCS TR-55 Methods for determining Time of Concentration and Travel Time

Rainfall depth & duration data were taken from the National Oceanic and Atmospheric Administration (NOAA). A summary of the rainfall data used in the calculations are presented in Table 2.

TABLE 2. RAINFALL PRECIPITATION

Annual Exceedance Probability (AEP)	**Rainfall Depth** (inches)
1-year	3.71
10-year	5.66
100-year	9.25

*Hydraflow reports have been provided in Appendix A

3. EXISTING CONDITIONS ANALYSIS

Existing conditions where modeled assuming pasture in good condition. This assumption was used to calculate existing condition flow rates and the level service required for proposed BMP implementation. Discharge from the proposed development will adhere to APWA and Lee's Summit discharge requirements. Refer to Figure 1 for existing condition sub-drainage area locations, runoff curve numbers, and sub-drainage area acreage.

In the existing condition, the site generally flows from south to the north towards Oldham Parkway. A subtle ridge line splits the site into two sub-drainage areas. The western onsite drainage area (EX10) discharges to the Oldham Parkway drainage swale at the northwest corner of the site (POI #1). The swale drains to a 5'x5' RCB culvert that flows north underneath the Oldham Parkway, US Route 50, and Blue Parkway to the E. Fork Little Blue River through an unnamed tributary.

The eastern onsite drainage area (EX20) intercepts offsite runoff from approximately 5-acres of pasture land from the east (OFF20). Runoff continues to flow north and northeast to an existing 30" RCP culvert (POI #2) that discharges north underneath Oldham Parkway, US Route 50, and Blue Parkway. Storm water continues north to an existing wet detention facility located south of Shenandoah Drive.

The following table(s), Table 3A & 3B, summarizes the results of the existing conditions analysis:

TABLE 3A. EXISTING CONDITIONS ANALYSIS SUMMARY POINT OF INTEREST #1

Subarea	Drainage Area (acres)	Curve Number	Tc (Minutes)	Existing $Q_{2\text{-year}}$ (cfs)	Existing $Q_{10\text{-year}}$ (cfs)	Existing $Q_{100\text{-year}}$ (cfs)
EX 10 (POI #1)	**3.98**	75	26.3	5.46	11.58	23.85

TABLE 3B. EXISTING CONDITIONS ANALYSIS SUMMARY POINT OF INTEREST #2

Subarea	Drainage Area (acres)	Curve Number	Tc (Minutes)	Existing $Q_{2\text{-year}}$ (cfs)	Existing $Q_{10\text{-year}}$ (cfs)	Existing $Q_{100\text{-year}}$ (cfs)
EX 20	**8.27**	74	25.1	10.77	23.27	48.62
OFF 20	**4.94**	75	28.9	6.31	13.39	27.64
PO1 #2				17.04	36.54	75.69

4. PROPOSED CONDITIONS ANALYSIS

The proposed conditions section of this analysis assumes completion of the Lee's Summit Senior Living Community and adjacent public street improvements. As in the existing conditions, the proposed conditions stormwater runoff model was created and ran for the 2, 10, and 100-year storm events. The complete output for the Hydraflow model has been included in Appendix A. Refer to Figure 2 for developed sub-drainage area locations, runoff curve numbers, and sub-drainage area acreage.

In the developed condition drainage area DEV 10 flows into Bio Detention Facility #1 before flowing into the proposed dry detention basin. Drainage area DEV 30 is conveyed into the dry detention basin through an underground storm sewer system. The detention facility discharges to Point of Interest #1, along with some of the existing flow from SE Oldham Parkway.

Point of Interest #2 accepts flow from the eastern half of the site. Drainage area DEV 20 is routed through Bio Detention Facility #2 before it is discharged to the point of interest. While drainage area DEV 21, which is the proposed public roadway to be constructed on the eastern edge of the site, is collected in an underground storm sewer system and conveyed to Point of Interest #2.

The following tables contain input data and summarize the computed results of the developed conditions analysis:

TABLE 4A. DEVELOPED CONDITIONS ANALYSIS SUMMARY POINT OF INTEREST #1

Subarea	Drainage Area (acres)	Curve Number	Tc (Minutes)	Developed $Q_{2\text{-year}}$ (cfs)	Developed $Q_{10\text{-year}}$ (cfs)	Developed $Q_{100\text{-year}}$ (cfs)
DEV 10	**2.99**	92	5	13.52	21.82	36.86
DEV 30	**4.19**	88	5	16.97	28.75	50.17
DRY DET. DISCHARGE	**7.18**			1.124	1.32	15.40
DA 11 (R/W)	**1.06**	87	5	4.161	7.144	12.58

TABLE 4B. DEVELOPED CONDITIONS ANALYSIS SUMMARY POINT OF INTEREST #2

Subarea	Drainage Area (acres)	Curve Number	Tc (Minutes)	Developed $Q_{2\text{-year}}$ (cfs)	Developed $Q_{10\text{-year}}$ (cfs)	Developed $Q_{100\text{-year}}$ (cfs)
DEV 20	**2.61**	90	5	11.20	18.51	31.75
BIO 2. DISCHARGE	**2.61**			3.027	10.48	25.26
DA 21 (R/W)	**1.78**	86	5	6.763	11.77	20.92
OFF 22 (R/W)	**0.56**	87	5	2.198	3.774	6.646
OFF 20	**4.94**	75	28.9	6.31	13.39	27.64

TABLE 5A. DRY DETENTION FACILITY SUMMARY

Return Frequency	Developed Q_{DEV} (cfs)	Detention Volume (cf)	WSE (ft)
2	1.124	33,570	1019.14
10	1.322	63,564	1020.26
100	15.40	88,888	1021.10

TABLE 5B. BIO DETENTION #1 FACILITY SUMMARY

Return Frequency	Developed Q_{DEV} (cfs)	Detention Volume (cf)	WSE (ft)
2	10.04	2,420	1020.06
10	11.33	6,698	1020.68
100	17.22	16,352	1021.76

TABLE 5C. BIO DETENTION #2 FACILITY SUMMARY

Return Frequency	Developed Q_{DEV} (cfs)	Detention Volume (cf)	WSE (ft)
2	3.027	6,506	1022.24
10	10.48	10,755	1022.84
100	25.26	14,416	1023.26

TABLE 6A. POINT OF INTEREST #1 SUMMARY

Return Frequency	Existing Q_{pre} (cfs)	Developed Q_{DEV} (cfs)
2	**5.462**	5.130
10	**11.58**	8.250
100	**23.85**	16.52

TABLE 6B. POINT OF INTEREST #2 SUMMARY

Return Frequency	Existing Q_{pre} (cfs)	Developed Q_{DEV} (cfs)
2	**17.04**	15.02
10	**36.54**	30.82
100	**75.69**	68.36

5. OFFSITE PUBLIC STREET STORM SEWER CALCULATIONS

The Rational Method was used to calculate storm sewer peak flow rates for the 10-year and 25-year storm frequencies. Rainfall intensities were taken from NOAA Atlas 14 and runoff coefficients were taken following the City of Lee's Summit design criteria. The Developed Offsite Drainage Area Map and Rational method calculations can be found in Figure 3 of this report.

Offsite stormwater runoff from the east will be intercepted by the new Princeton Drive public stormwater improvements. Public storm inlets and storm sewer in Princeton Drive were provided to maintain the required water spread during the 10-year storm event. Inlets and storm sewer in Oldham Parkway were sized to accommodate the 25-year storm event.
Storm sewer hydraulic and inlet calculations are in Appendix B.

6. POST CONSTRUCTION WATER QUALITY

Water quality volume treatment calculations were determined using the 2012 APWA/MARC BMP manual level of surface calculations. The level of surface calculation considered all onsite development. Existing offsite right-of-way and proposed public right-of-way will not be conveyed through onsite BMPs. Water quality level of service and water quality volume calculations are provided in Appendix C.

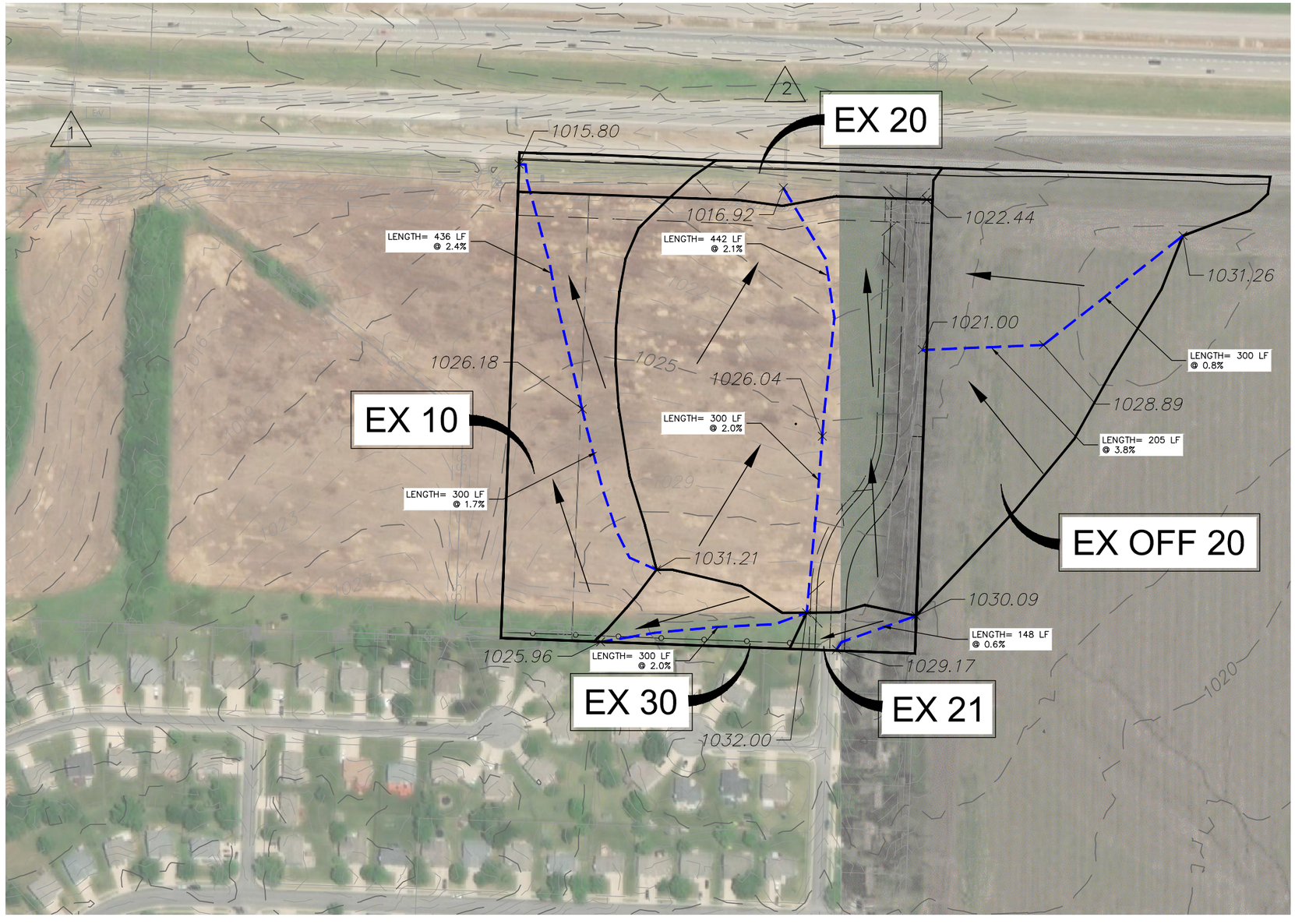
7. CONCLUSIONS & RECOMMENDATIONS

The Lee's Summit Senior Living Community has been evaluated in this report to show that the stormwater discharge from the site will remain within the acceptable levels. A new detention basin and two new biodetention basins are to be constructed to handle the increased runoff created from the development.

In conclusion, all peak discharges at the points of interest for all events are below the pre-development flow rates. Additionally, post construction storm water BMPs will be provided to

meet the required level of service for this development. See Appendix F for City of Lee's Summit BMP Level of Service Worksheet.

It is therefore requested that Lee's Summit, Missouri approve this "Lee's Summit Senior Living Community Final Stormwater Drainage Study." This study will be verified with the final construction documents for the construction with the development.



LEGEND

- DRAINAGE AREA BOUNDARY
- TC ROUTE
- FLOW DIRECTION
- 1 — POINT OF INTEREST

SUMMARY TABLE			
SUBBASIN	AREA (AC)	CN	TC (MIN.)
EX 10	3.98	75	26.30
EX 20	8.27	74	25.10
EX 21	0.31	74	18.81
EX30	0.69	74	19.75
EX OFF 20	4.94	75	28.90

N

0’ 100’ 200’ 400’

SCALE IN FEET

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PROJECT: 018-1450
DRAWN BY: TDD
DATE: 02/19/2019

EXISTING CONDITIONS DRAINAGE AREA MAP

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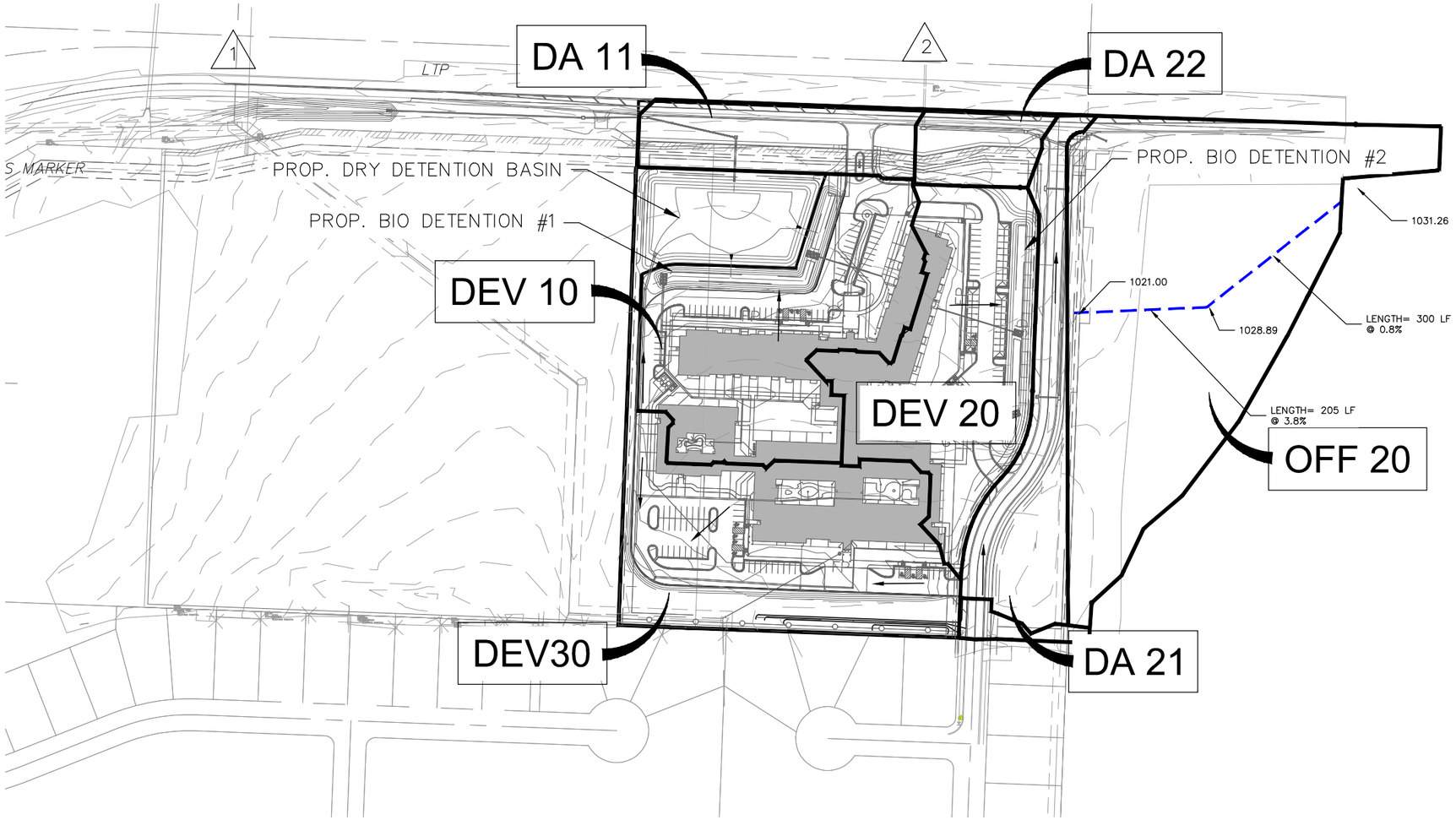
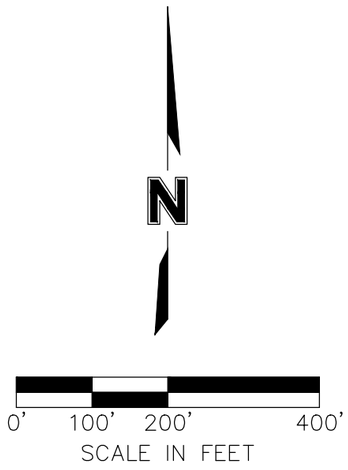
FIGURE
F-1

LEGEND

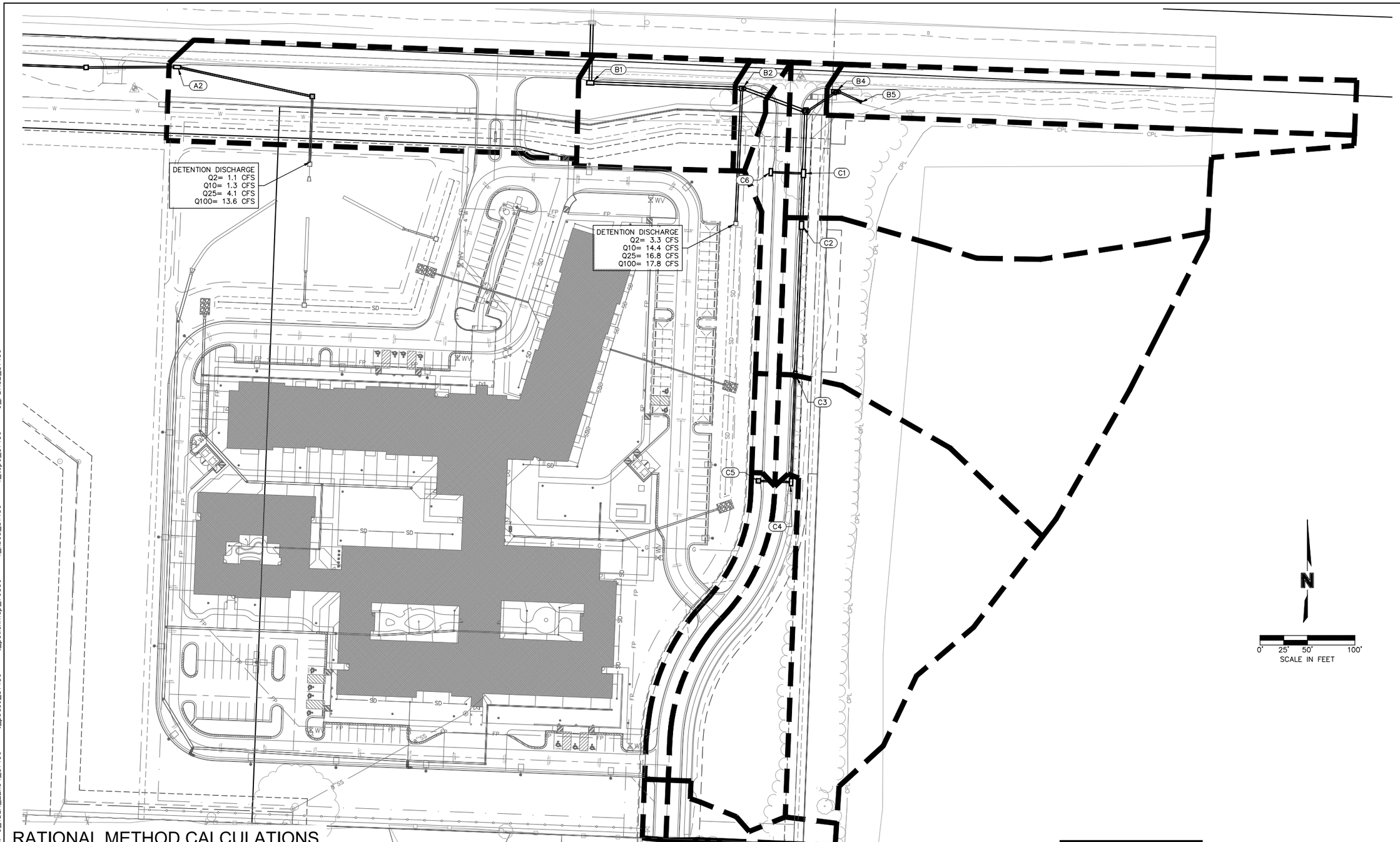
- DRAINAGE AREA BOUNDARY
- TC ROUTE
- FLOW DIRECTION
- 1 POINT OF INTEREST

SUMMARY TABLE			
SUBBASIN	AREA (AC)	CN	TC (MIN.)
DEV 10	2.99	92	5.00
DA 11	1.06	87	5.00
DEV 30	4.19	88	5.00
DEV 20	2.61	90	5.00
DA 21	1.78	86	5.00
OFF DA 22	0.56	87	5.00
OFF 20	4.94	75	28.90





PROJECT: 018-1450	DEVELOPED CONDITIONS DRAINAGE AREA MAP	olsson 550 St. Louis Street Springfield, MO 65806 TEL 417.890.8802 FAX 401.890.8805	FIGURE F-2
DRAWN BY: TDD			
DATE: 06/14/2019			



RATIONAL METHOD CALCULATIONS

INLET	DRAINAGE AREA (AC)	Pavement Area (AC) C=0.90	Open Space Area (AC) C=0.30	RUNOFF COEFFICIENT "C2" & "C10"	RUNOFF COEFFICIENT "C25" (1.1)	RUNOFF COEFFICIENT "C50" (1.20)	RUNOFF COEFFICIENT "C100" (1.25)	Time of Concentration "Tc" (min)	2-YEAR INTENSITY	10-YEAR INTENSITY	25-YEAR INTENSITY	50-YEAR INTENSITY	100-YEAR INTENSITY	Q2year (CFS)	Q10year (CFS)	Q25year (CFS)	Q50year (CFS)	Q100year (CFS)
A2 CURB INLET	1.06	0.38	0.68	0.52	0.57	0.62	0.65	5.00	5.41	7.35	8.53	9.40	10.32	2.96	4.03	5.14	6.18	7.07
B1 CURB INLET	0.44	0.12	0.32	0.46	0.50	0.55	0.57	5.00	5.41	7.35	8.53	9.40	10.32	1.09	1.48	1.89	2.27	2.60
B2 CURB INLET	0.08	0.03	0.05	0.54	0.59	0.65	0.68	5.00	5.41	7.35	8.53	9.40	10.32	0.23	0.32	0.41	0.49	0.56
B4 CURB INLET	0.52	0.29	0.23	0.64	0.70	0.77	0.80	5.00	5.41	7.35	8.53	9.40	10.32	1.80	2.44	3.11	3.74	4.28
B5 FES	0.19	0.10	0.09	0.63	0.69	0.75	0.78	5.00	5.41	7.35	8.53	9.40	10.32	0.64	0.87	1.11	1.34	1.53
C1 CURB INLET	1.42	0.09	1.33	0.34	0.37	0.41	0.42	15.00	3.72	5.18	6.01	6.70	7.36	1.79	2.49	3.18	3.87	4.43
C2 CURB INLET	1.93	0.07	1.86	0.32	0.36	0.39	0.40	15.00	3.72	5.18	6.01	6.70	7.36	2.32	3.23	4.12	5.01	5.73
C3 CURB INLET	1.67	0.05	1.62	0.32	0.35	0.38	0.40	15.00	3.72	5.18	6.01	6.70	7.36	1.97	2.74	3.50	4.26	4.87
C4 CURB INLET	0.66	0.15	0.51	0.44	0.48	0.53	0.55	5.00	5.41	7.35	8.53	9.40	10.32	1.57	2.13	2.72	3.27	3.74
C5 CURB INLET	0.20	0.13	0.07	0.68	0.75	0.82	0.85	5.00	5.41	7.35	8.53	9.40	10.32	0.74	1.00	1.28	1.53	1.76
C6 CURB INLET	0.26	0.14	0.12	0.62	0.68	0.75	0.78	5.00	5.41	7.35	8.53	9.40	10.32	0.88	1.19	1.52	1.82	2.09

FIGURE 3

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PROFESSIONAL ENGINEER
6.14.19
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PROFESSIONAL ENGINEER
MO# PE-2012024241

REVISIONS

REV. NO.	DATE	REVISIONS DESCRIPTION

SE OLDHAM PARKWAY & PRINCETON DRIVE
DRAINAGE AREA MAP

LEE'S SUMMIT SENIOR LIVING COMMUNITY
SE OLDHAM PARKWAY

LEE'S SUMMIT, MISSOURI

2019

drawn by: RPJ
designed by: RVJ
checked by: JLR
project no.: 018-1450
drawing no.: C_DRN_81450
date: 06.14.19

SHEET
ST3.0

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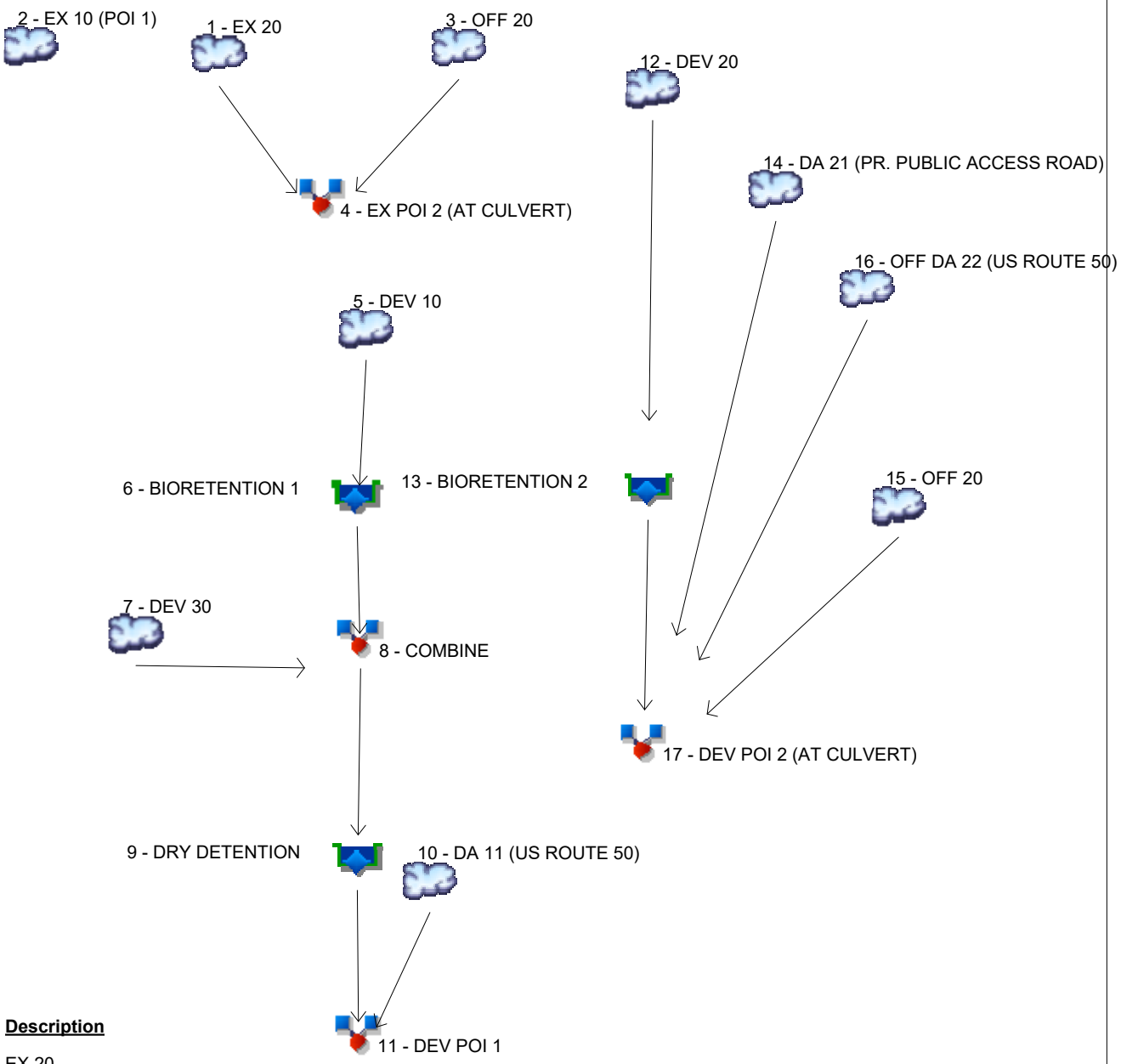
APPENDIX A

Hydrology & Detention Calculations

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX 20
2	SCS Runoff	EX 10 (POI 1)
3	SCS Runoff	OFF 20
4	Combine	EX POI 2 (AT CULVERT)
5	SCS Runoff	DEV 10
6	Reservoir	BIORETENTION 1
7	SCS Runoff	DEV 30
8	Combine	COMBINE
9	Reservoir	DRY DETENTION
10	SCS Runoff	DA 11 (US ROUTE 50)
11	Combine	DEV POI 1
12	SCS Runoff	DEV 20
13	Reservoir	BIORETENTION 2
14	SCS Runoff	DA 21 (PR. PUBLIC ACCESS ROAD)
15	SCS Runoff	OFF 20
16	SCS Runoff	OFF DA 22 (US ROUTE 50)
17	Combine	DEV POI 2 (AT CULVERT)

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	10.77	2	730	40,985	------	------	------	EX 20
2	SCS Runoff	5.462	2	730	20,656	------	------	------	EX 10 (POI 1)
3	SCS Runoff	6.315	2	732	26,046	------	------	------	OFF 20
4	Combine	17.04	2	730	67,031	1, 3	------	------	EX POI 2 (AT CULVERT)
5	SCS Runoff	13.52	2	716	28,879	------	------	------	DEV 10
6	Reservoir	10.04	2	720	28,879	5	1020.06	2,420	BIORETENTION 1
7	SCS Runoff	16.97	2	716	35,091	------	------	------	DEV 30
8	Combine	26.51	2	718	63,970	6, 7	------	------	COMBINE
9	Reservoir	1.124	2	816	63,970	8	1019.14	33,570	DRY DETENTION
10	SCS Runoff	4.161	2	716	8,557	------	------	------	DA 11 (US ROUTE 50)
11	Combine	5.130	2	716	72,526	9, 10	------	------	DEV POI 1
12	SCS Runoff	11.20	2	716	23,494	------	------	------	DEV 20
13	Reservoir	3.027	2	724	23,494	12	1022.24	6,506	BIORETENTION 2
14	SCS Runoff	6.763	2	716	13,843	------	------	------	DA 21 (PR. PUBLIC ACCESS ROAD)
15	SCS Runoff	6.315	2	732	26,046	------	------	------	OFF 20
16	SCS Runoff	2.198	2	716	4,521	------	------	------	OFF DA 22 (US ROUTE 50)
17	Combine	15.02	2	718	67,904	13, 14, 15, 16	------	------	DEV POI 2 (AT CULVERT)

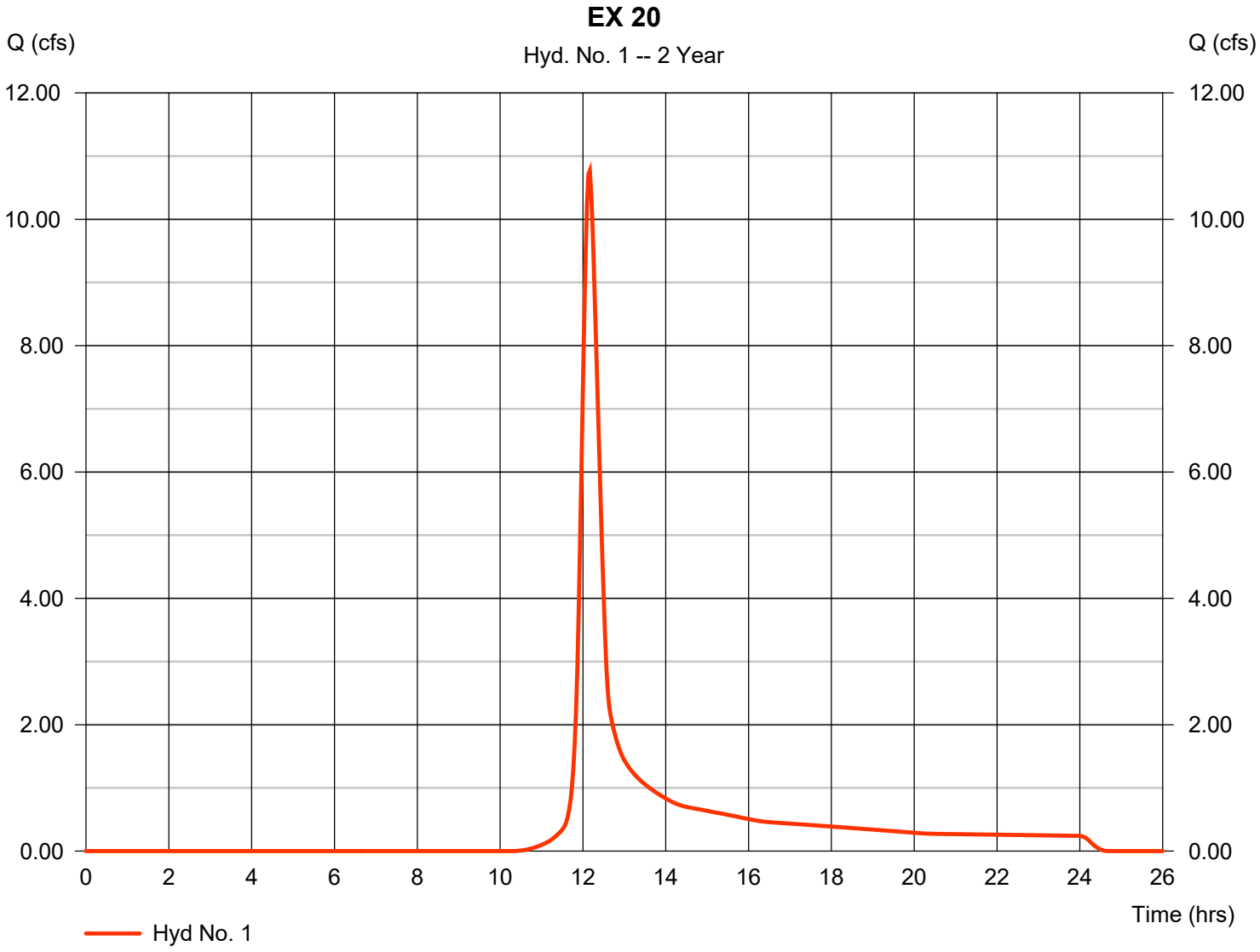
Hydrograph Report

Hyd. No. 1

EX 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.77 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	40,985 cuft
Drainage area	=	8.270 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.10 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.110 x 98) + (8.160 x 74)] / 8.270



TR55 Tc Worksheet

Hyd. No. 1

EX 20

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.71		0.00		0.00		
Land slope (%)	= 2.00		0.00		0.00		
Travel Time (min)	**= 21.91**	**+**	**0.00**	**+**	**0.00**	**=**	**21.91**
Shallow Concentrated Flow							
Flow length (ft)	= 440.00		0.00		0.00		
Watercourse slope (%)	= 2.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28		0.00		0.00		
Travel Time (min)	**= 3.21**	**+**	**0.00**	**+**	**0.00**	**=**	**3.21**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 25.10 min

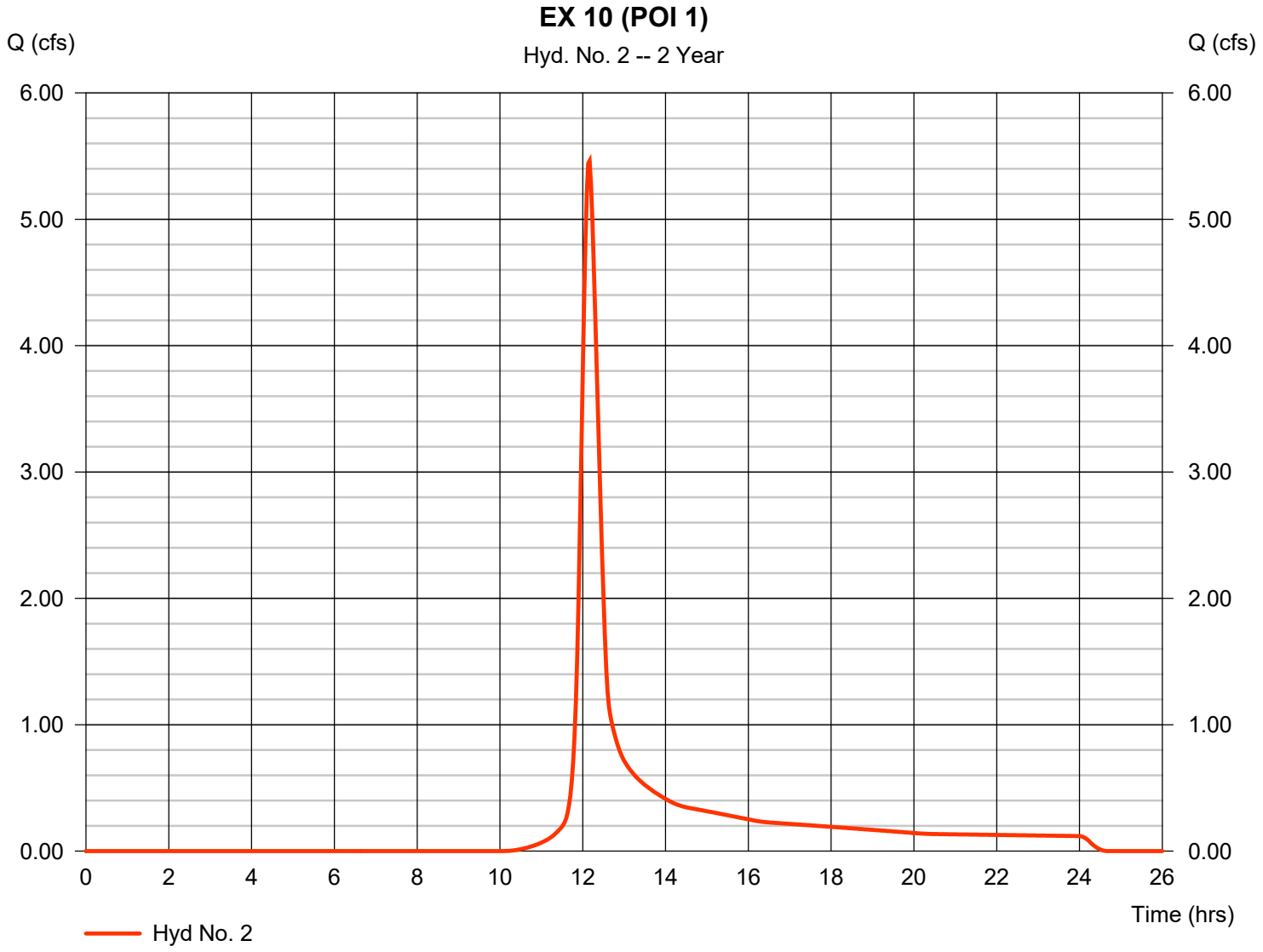
Hydrograph Report

Hyd. No. 2

EX 10 (POI 1)

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.462 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	20,656 cuft
Drainage area	=	3.980 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	26.30 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.090 x 98) + (3.890 x 74)] / 3.980



TR55 Tc Worksheet

Hyd. No. 2

EX 10 (POI 1)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.71		0.00		0.00		
Land slope (%)	= 1.70		0.00		0.00		
Travel Time (min)	**= 23.39**	**+**	**0.00**	**+**	**0.00**	**=**	**23.39**
Shallow Concentrated Flow							
Flow length (ft)	= 435.00		0.00		0.00		
Watercourse slope (%)	= 2.40		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.50		0.00		0.00		
Travel Time (min)	**= 2.90**	**+**	**0.00**	**+**	**0.00**	**=**	**2.90**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 26.30 min

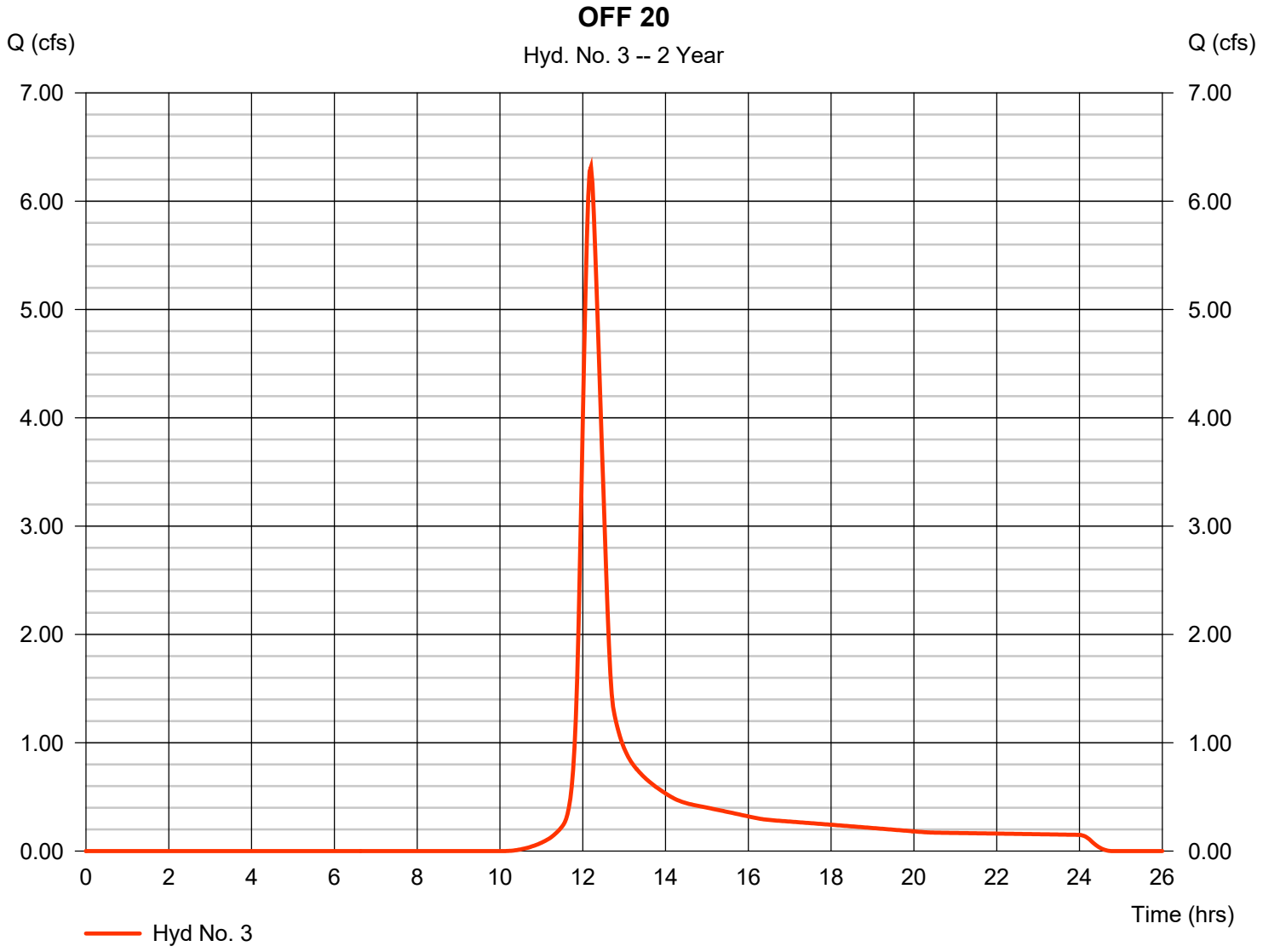
Hydrograph Report

Hyd. No. 3

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.315 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	26,046 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.90 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.140 x 98) + (4.800 x 74)] / 4.940



TR55 Tc Worksheet

Hyd. No. 3

OFF 20

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.71		0.00		0.00		
Land slope (%)	= 1.10		0.00		0.00		
Travel Time (min)	**= 27.83**	**+**	**0.00**	**+**	**0.00**	**=**	**27.83**
Shallow Concentrated Flow							
Flow length (ft)	= 205.00		0.00		0.00		
Watercourse slope (%)	= 3.80		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.15		0.00		0.00		
Travel Time (min)	**= 1.09**	**+**	**0.00**	**+**	**0.00**	**=**	**1.09**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

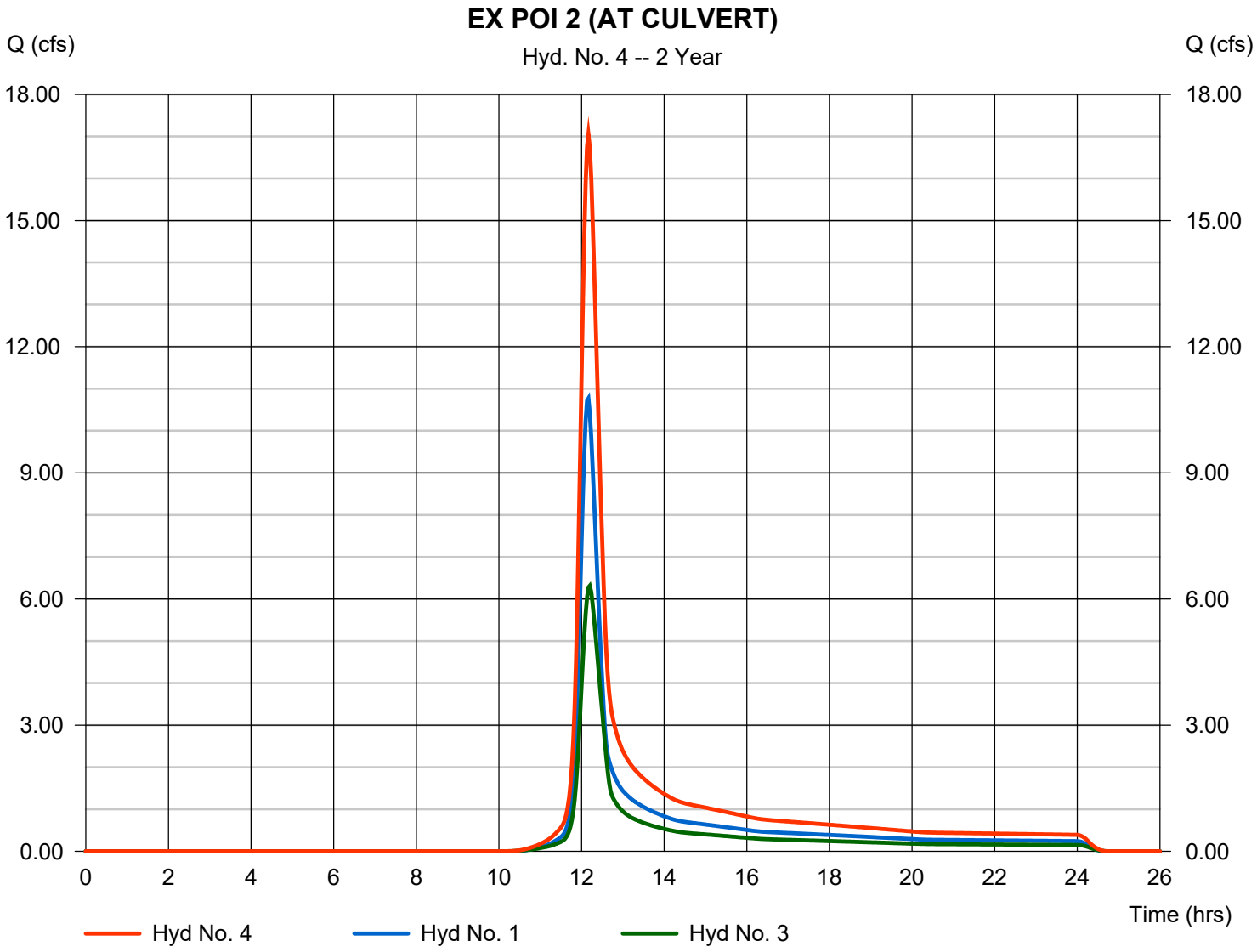
Total Travel Time, Tc ..... 28.90 min

Hydrograph Report

Hyd. No. 4

EX POI 2 (AT CULVERT)

Hydrograph type	= Combine	Peak discharge	= 17.04 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 67,031 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 13.210 ac



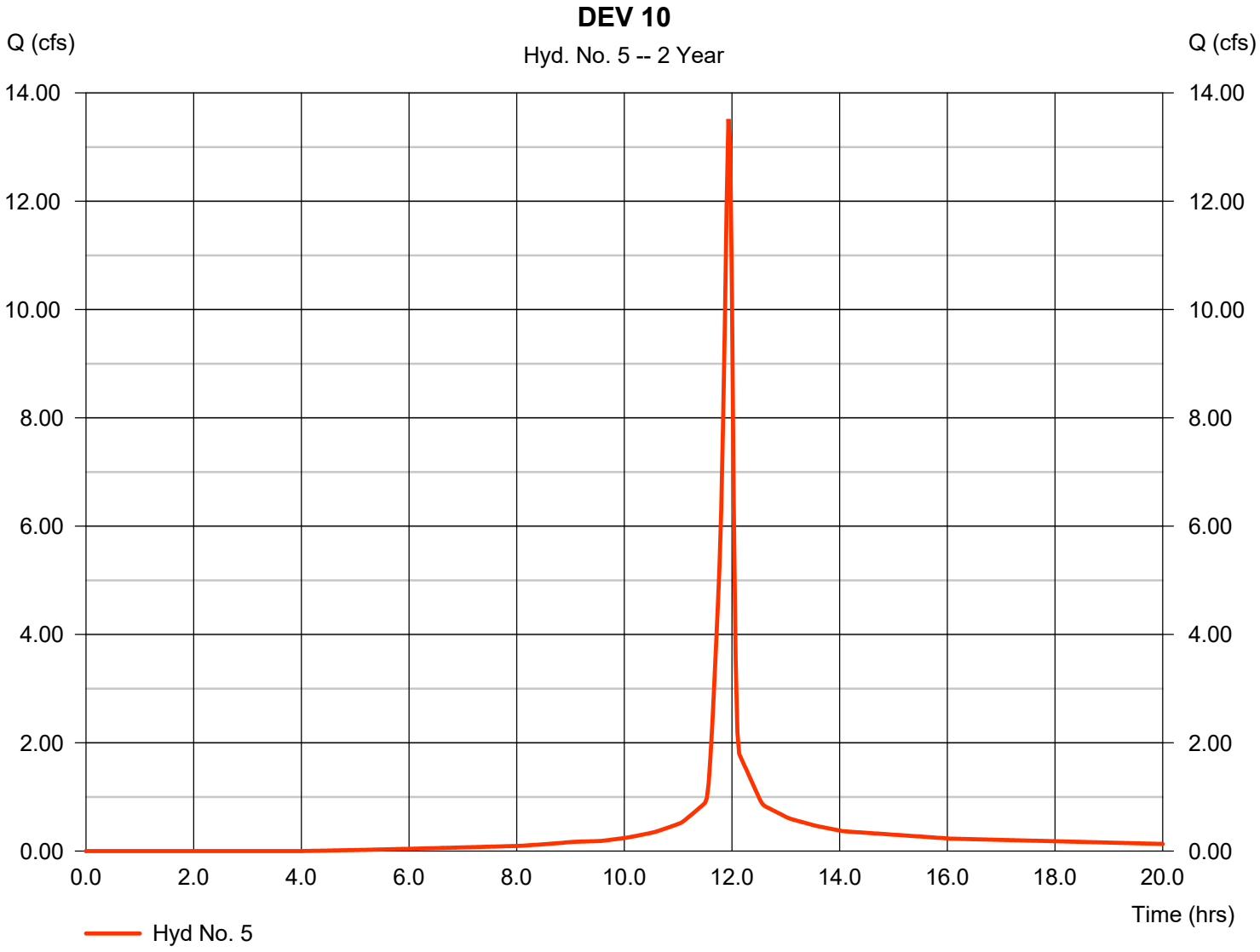
Hydrograph Report

Hyd. No. 5

DEV 10

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.52 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	28,879 cuft
Drainage area	=	2.990 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.950 x 98) + (1.040 x 80)] / 2.990



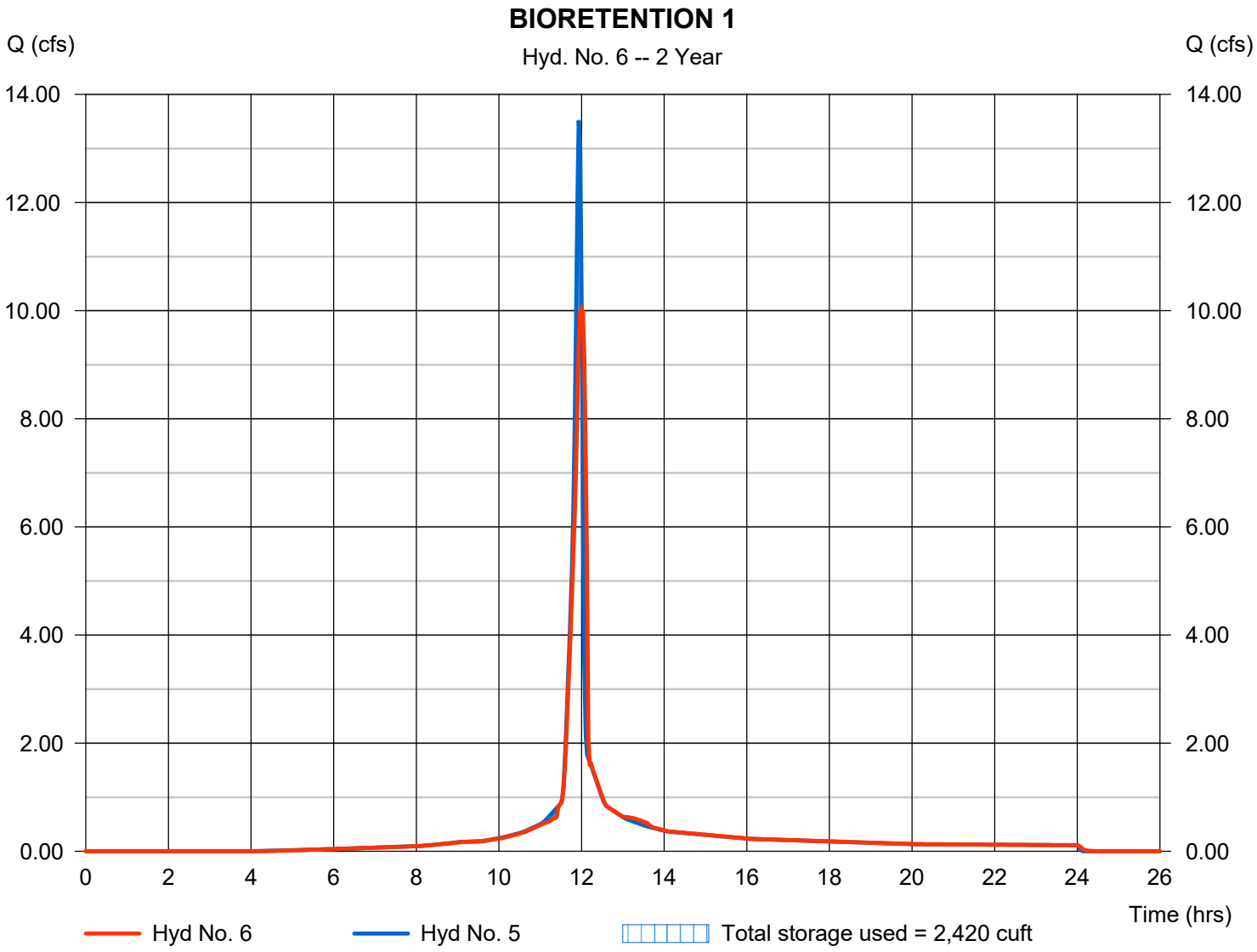
Hydrograph Report

Hyd. No. 6

BIORETENTION 1

Hydrograph type	=	Reservoir	Peak discharge	=	10.04 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	28,879 cuft
Inflow hyd. No.	=	5 - DEV 10	Max. Elevation	=	1020.06 ft
Reservoir name	=	BIORETENTION 1	Max. Storage	=	2,420 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - BIORETENTION 1

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1017.50	n/a	0	0
0.50	1018.00	n/a	100	100
1.00	1018.50	n/a	400	500
1.50	1019.00	n/a	500	1,000
2.00	1019.50	n/a	500	1,500
2.50	1020.00	n/a	500	2,000
3.00	1020.50	n/a	3,323	5,323
3.50	1021.00	n/a	3,909	9,232
4.00	1021.50	n/a	4,502	13,733
4.50	1022.00	n/a	5,101	18,834
5.00	1022.50	n/a	5,708	24,542
5.50	1023.00	n/a	6,322	30,864

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	8.00	0.00	0.00
Span (in)	= 12.00	8.00	0.00	0.00
No. Barrels	= 2	4	0	0
Invert El. (ft)	= 1017.50	1017.50	0.00	0.00
Length (ft)	= 36.50	0.50	0.00	0.00
Slope (%)	= 0.50	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

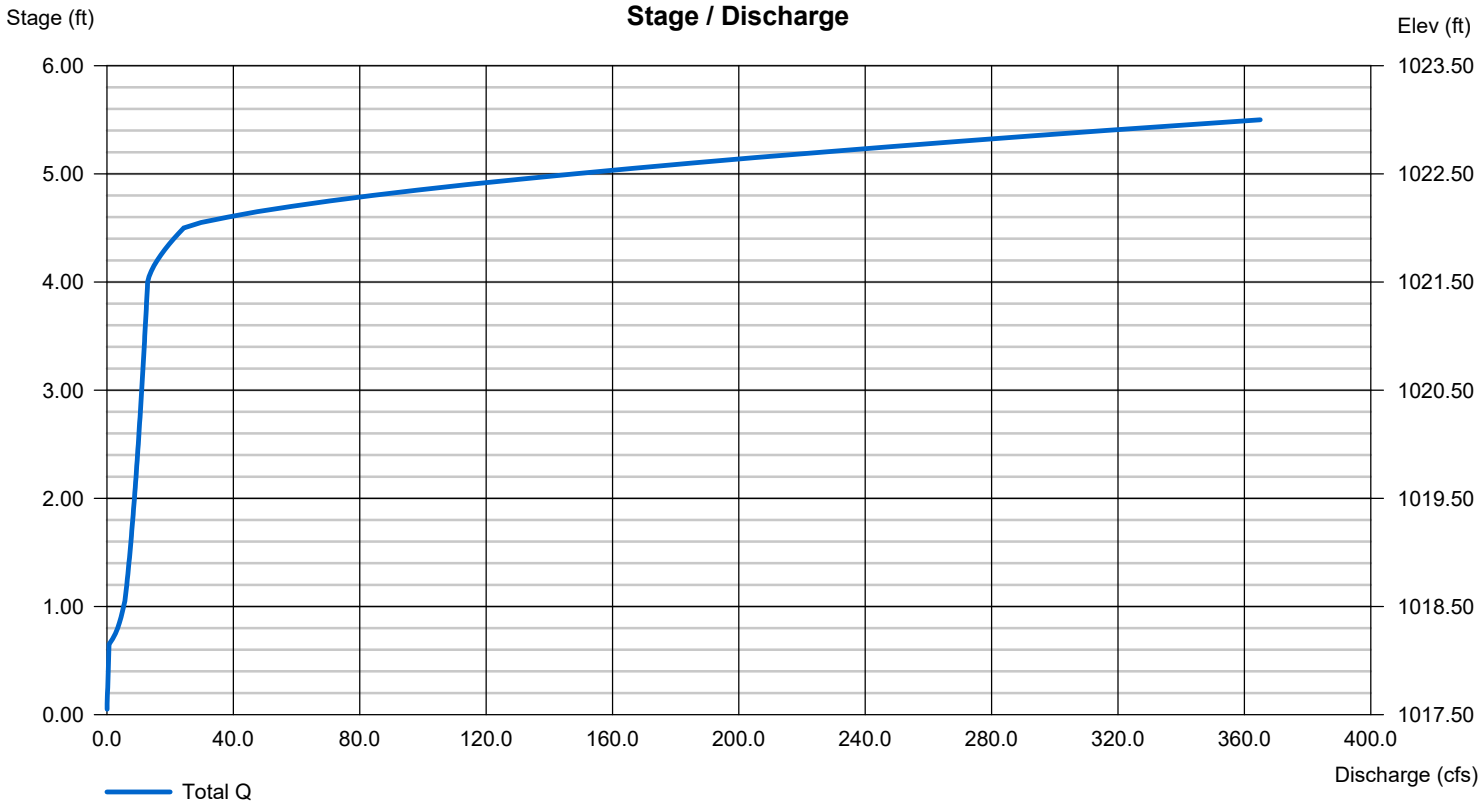
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 9.00	100.00	0.00	0.00
Crest El. (ft)	= 1021.50	1022.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	Broad	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



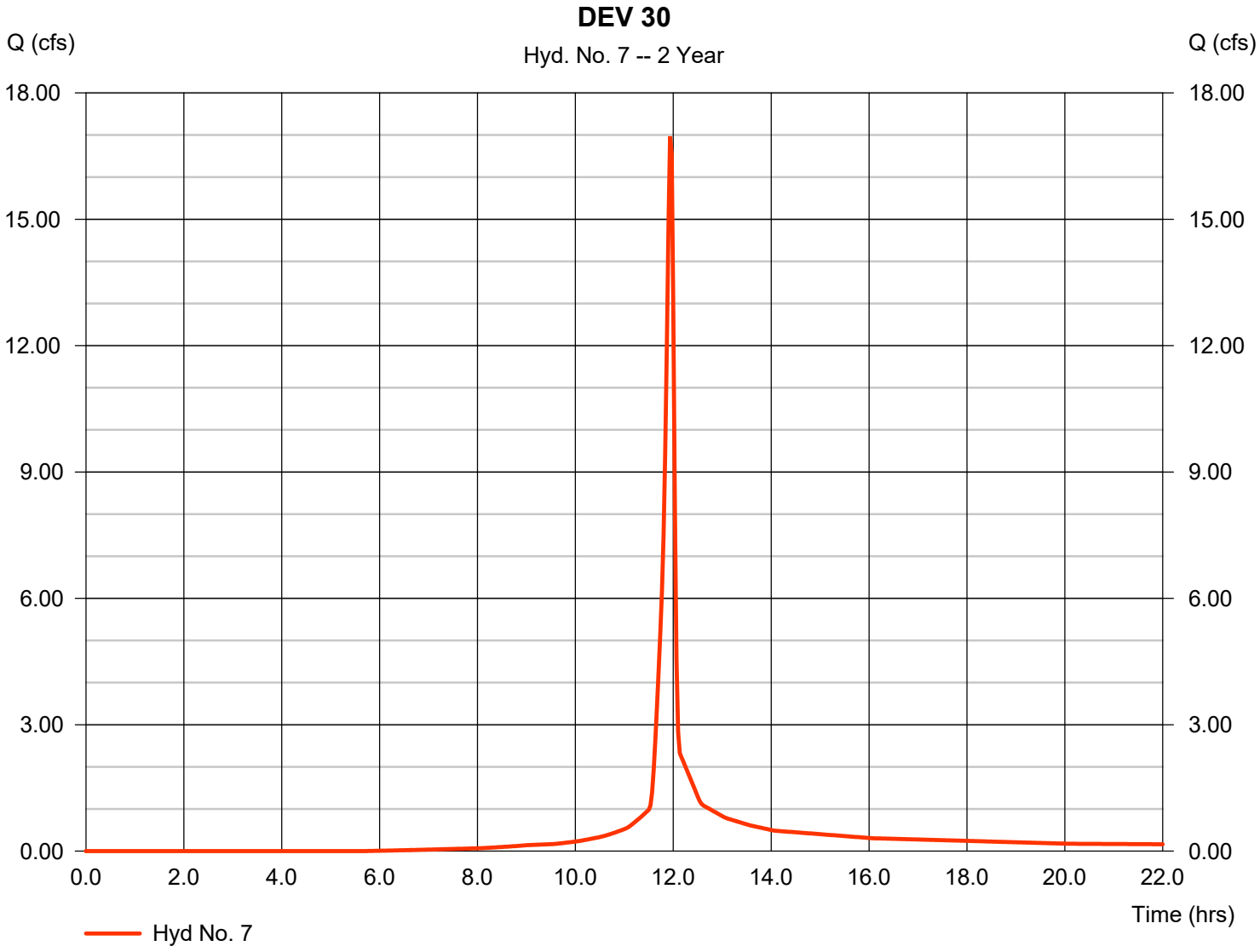
Hydrograph Report

Hyd. No. 7

DEV 30

Hydrograph type	=	SCS Runoff	Peak discharge	=	16.97 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	35,091 cuft
Drainage area	=	4.190 ac	Curve number	=	88*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.960 x 98) + (0.750 x 80) + (0.370 x 80) + (1.110 x 80)] / 4.190

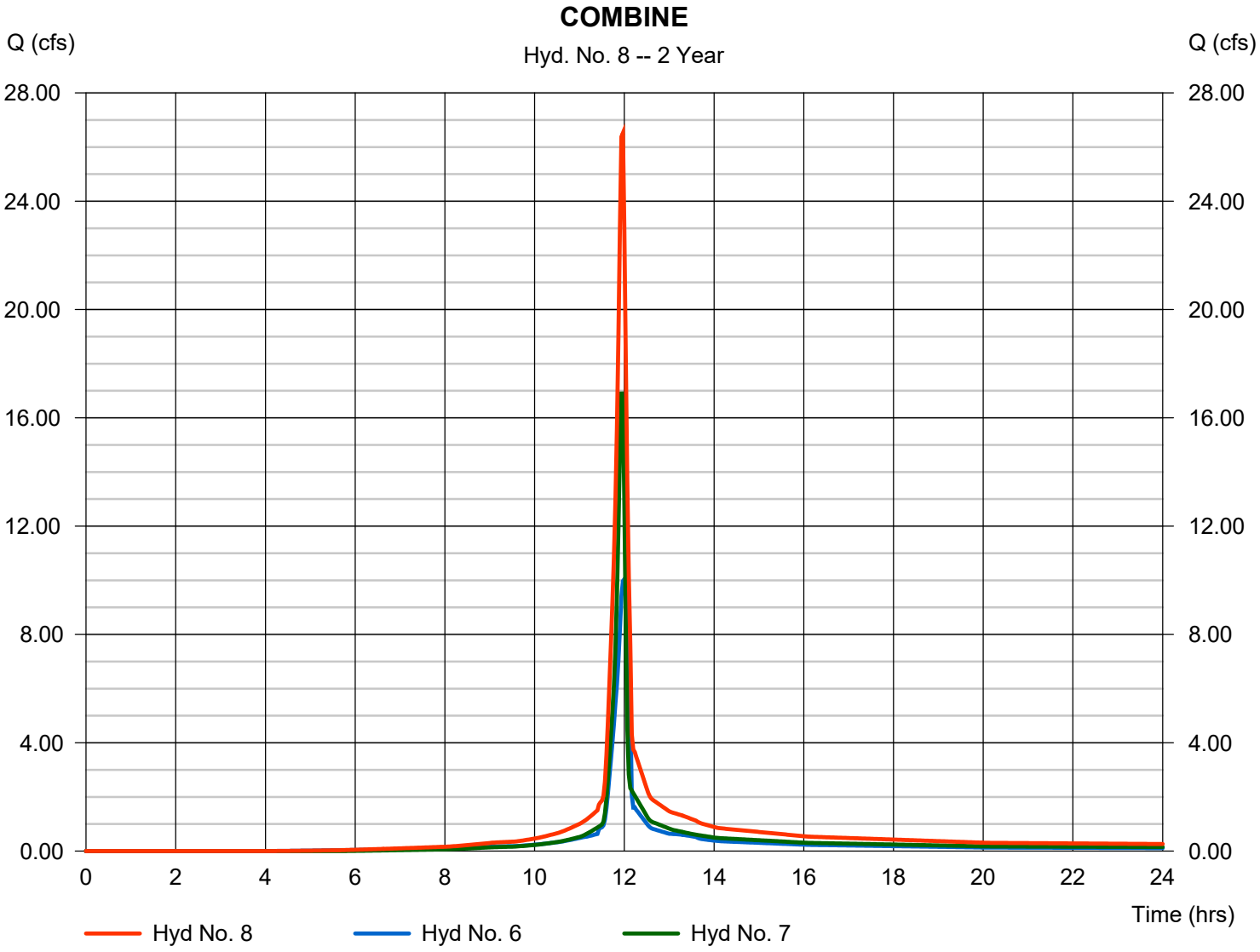


Hydrograph Report

Hyd. No. 8

COMBINE

Hydrograph type	=	Combine	Peak discharge	=	26.51 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	63,970 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	4.190 ac



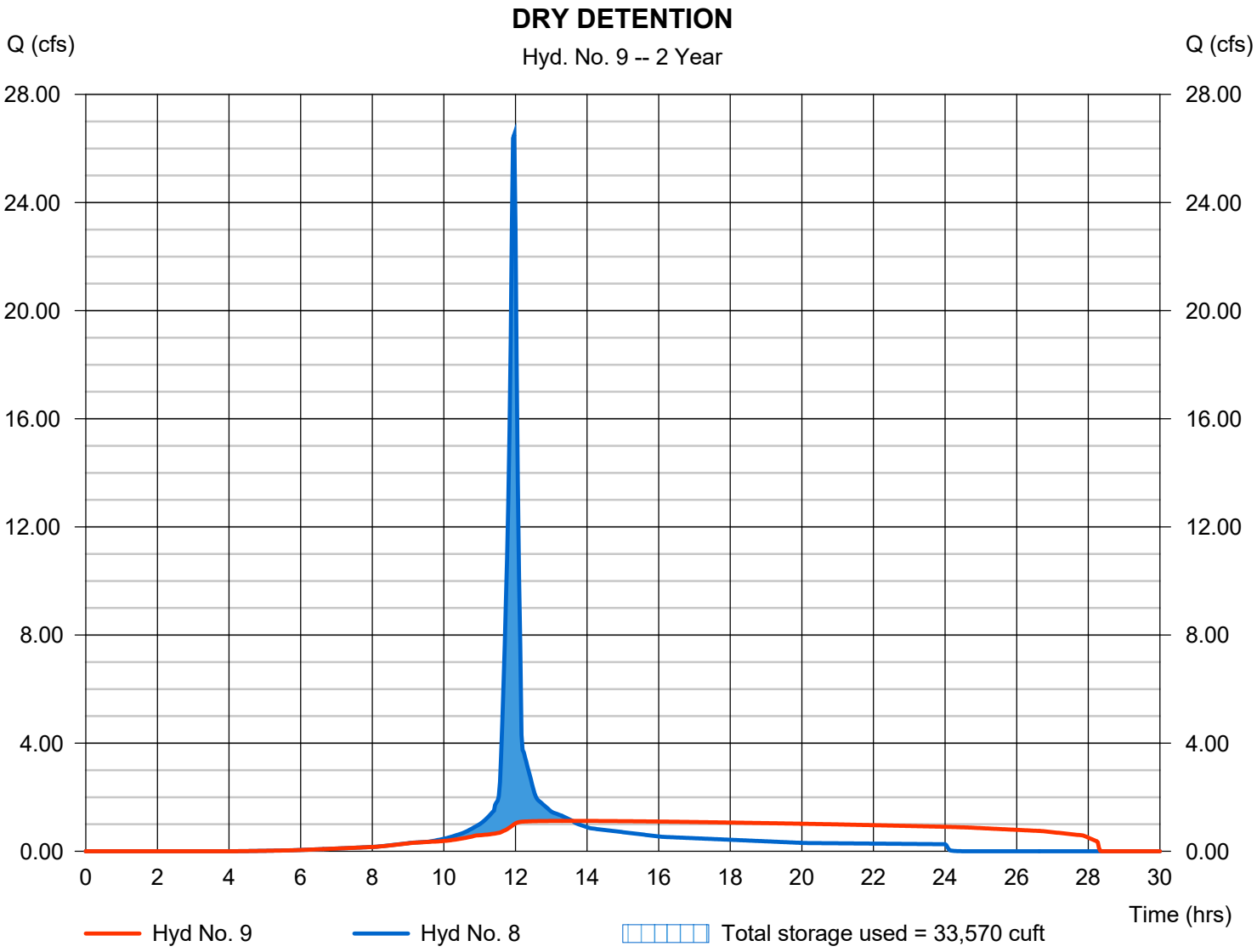
Hydrograph Report

Hyd. No. 9

DRY DETENTION

Hydrograph type	=	Reservoir	Peak discharge	=	1.124 cfs
Storm frequency	=	2 yrs	Time to peak	=	13.60 hrs
Time interval	=	2 min	Hyd. volume	=	63,970 cuft
Inflow hyd. No.	=	8 - COMBINE	Max. Elevation	=	1019.14 ft
Reservoir name	=	DRY DETENTION 1	Max. Storage	=	33,570 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - DRY DETENTION 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 1016.20 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1016.20	00	0	0
0.30	1016.50	415	41	41
0.80	1017.00	2,631	682	723
1.30	1017.50	8,945	2,738	3,461
1.80	1018.00	15,502	6,037	9,497
2.30	1018.50	21,442	9,195	18,692
2.80	1019.00	24,283	11,423	30,115
3.30	1019.50	25,945	12,553	42,669
3.80	1020.00	27,659	13,397	56,066
4.30	1020.50	29,526	14,292	70,358
4.80	1021.00	31,529	15,259	85,618
5.30	1021.50	33,430	16,236	101,854
5.80	1022.00	35,369	17,196	119,049

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	5.00	0.00	0.00
Span (in)	= 18.00	5.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 1011.63	1016.00	0.00	0.00
Length (ft)	= 69.50	0.50	0.00	0.00
Slope (%)	= 0.50	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

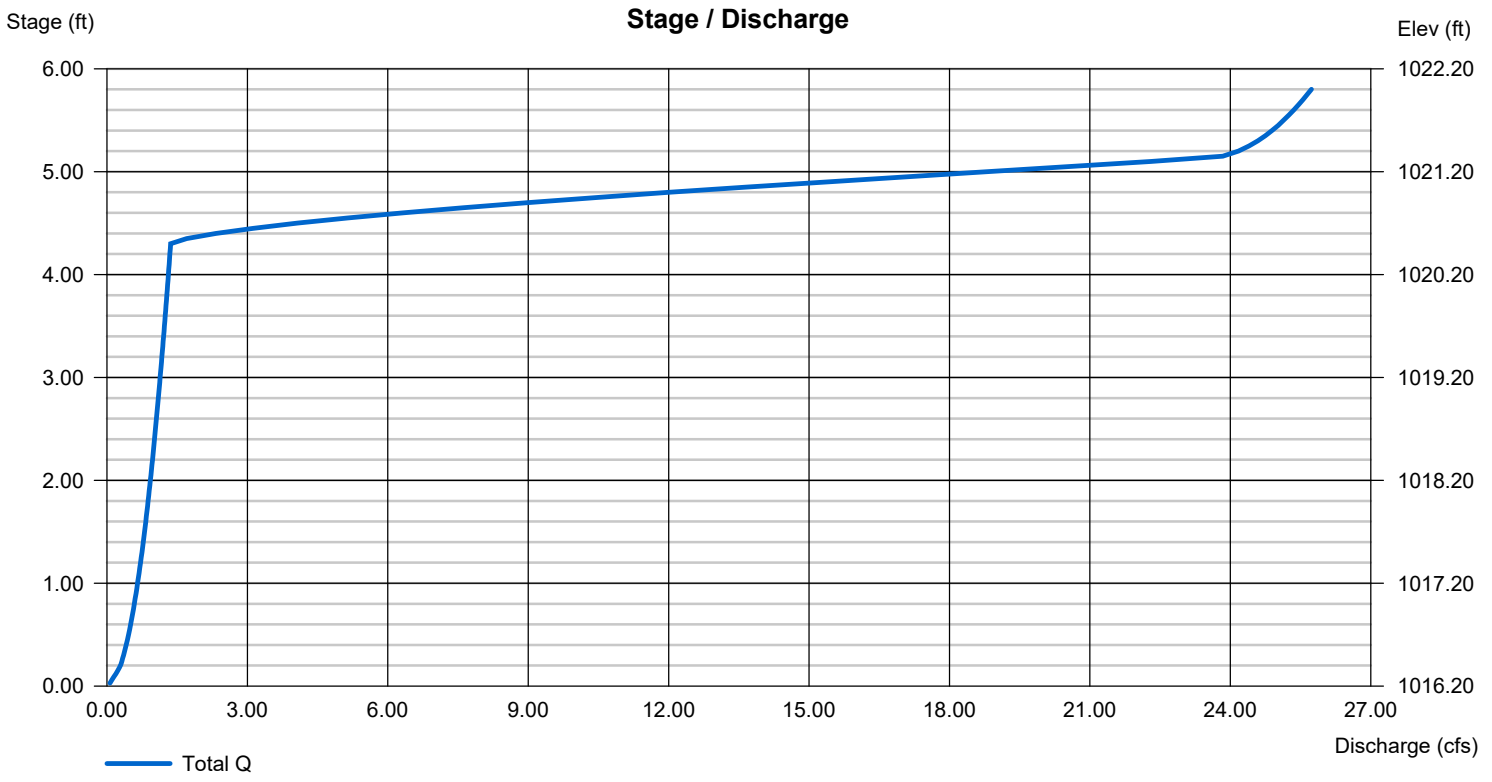
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 9.00	0.00	0.00	0.00
Crest El. (ft)	= 1020.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



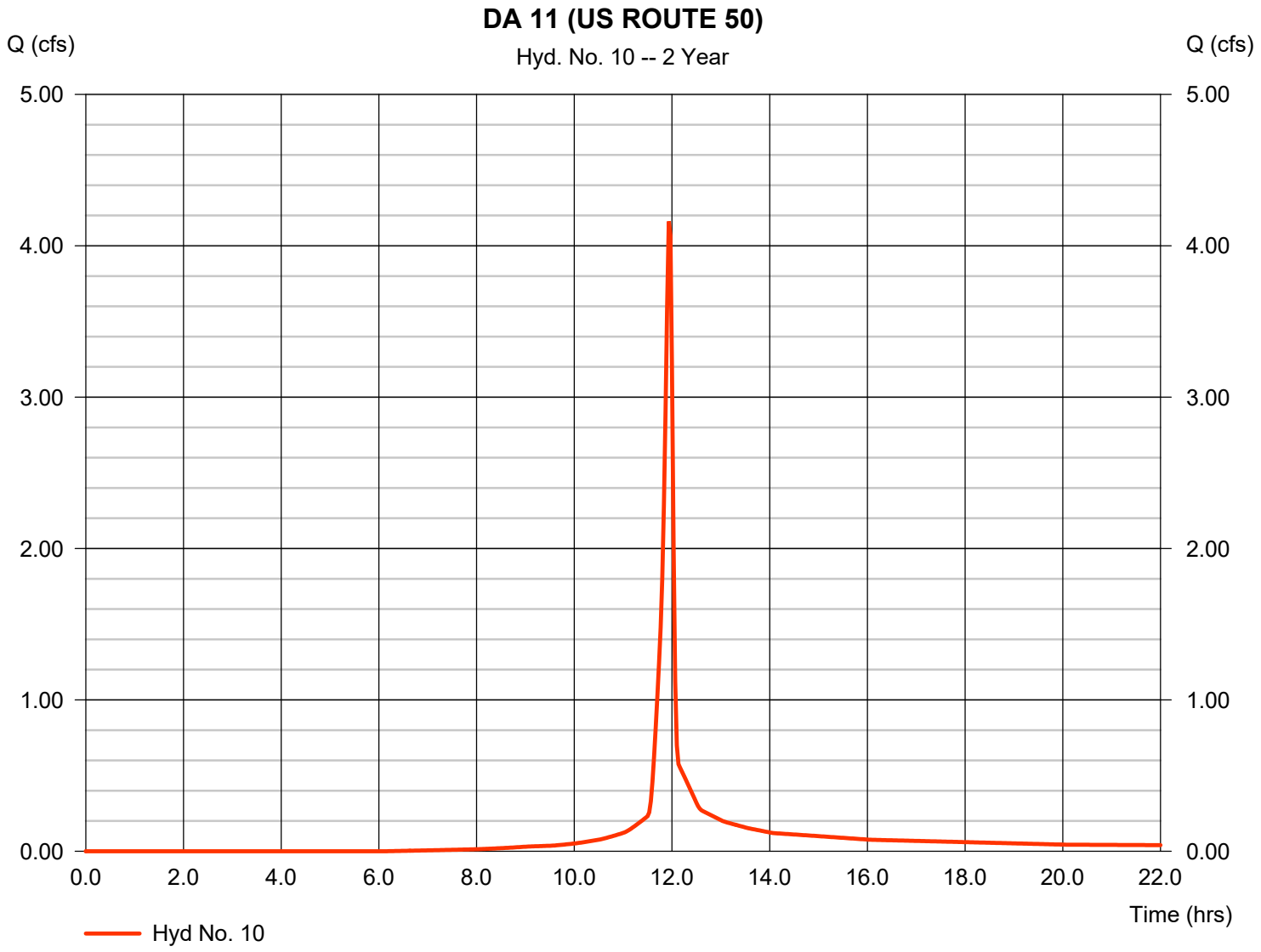
Hydrograph Report

Hyd. No. 10

DA 11 (US ROUTE 50)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.161 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 8,557 cuft
Drainage area	= 1.060 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.400 x 98) + (0.660 x 80)] / 1.060

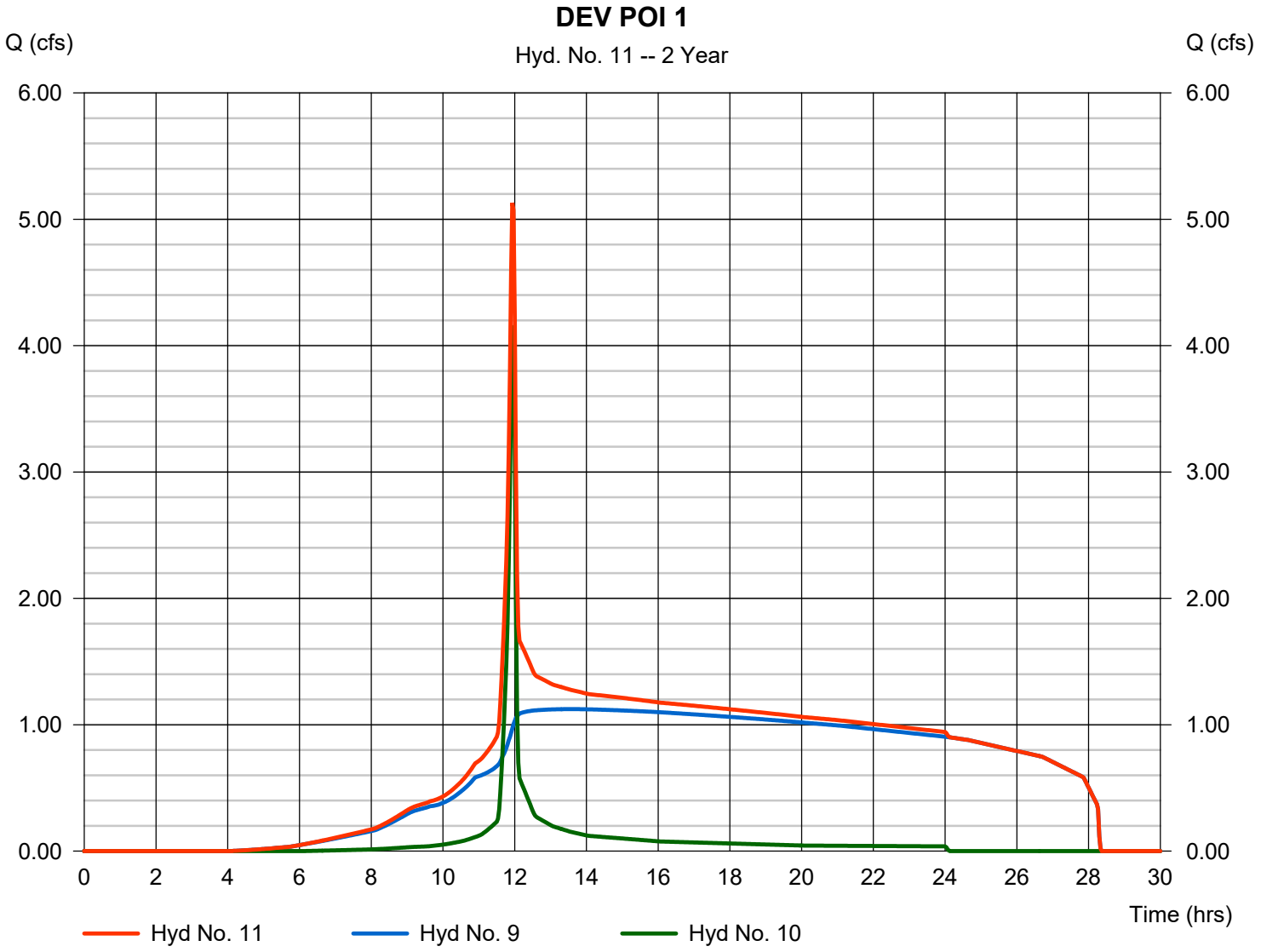


Hydrograph Report

Hyd. No. 11

DEV POI 1

Hydrograph type	=	Combine	Peak discharge	=	5.130 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	72,526 cuft
Inflow hyds.	=	9, 10	Contrib. drain. area	=	1.060 ac



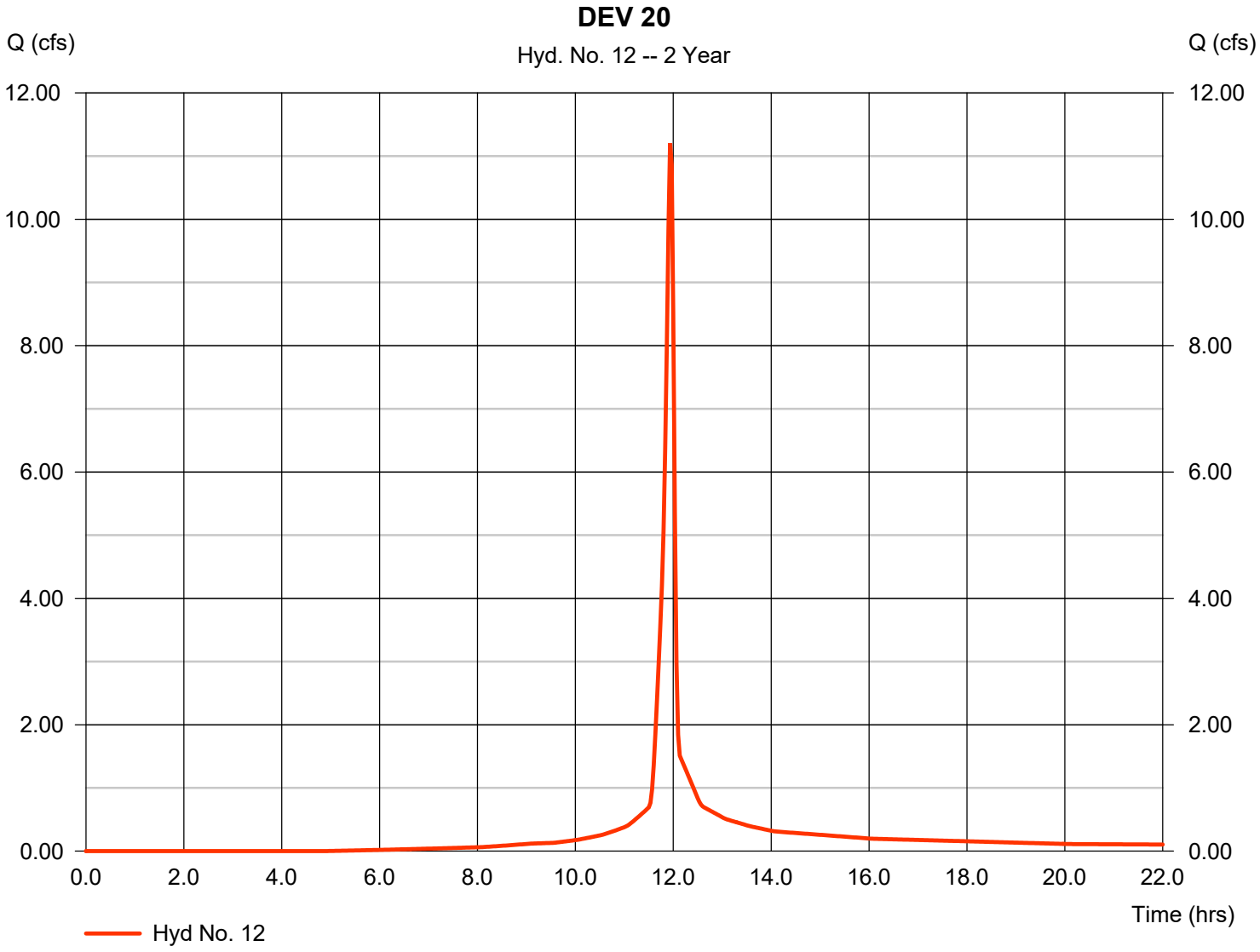
Hydrograph Report

Hyd. No. 12

DEV 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.20 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	23,494 cuft
Drainage area	=	2.610 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.440 x 98) + (1.170 x 80)] / 2.610



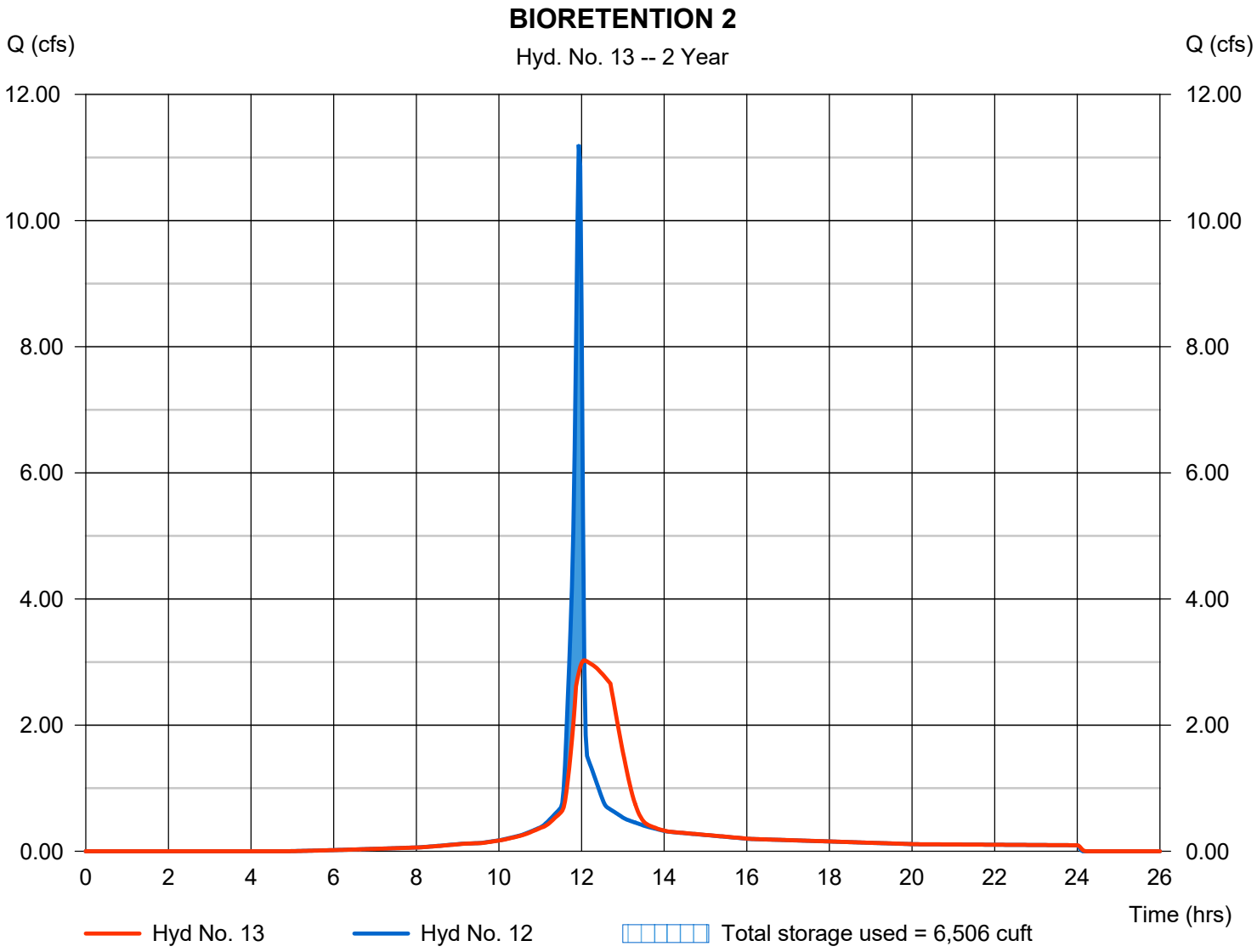
Hydrograph Report

Hyd. No. 13

BIORETENTION 2

Hydrograph type	=	Reservoir	Peak discharge	=	3.027 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	23,494 cuft
Inflow hyd. No.	=	12 - DEV 20	Max. Elevation	=	1022.24 ft
Reservoir name	=	BIORETENTION 2	Max. Storage	=	6,506 cuft

Storage Indication method used.



Pond Report

Pond No. 3 - BIORETENTION 2

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1019.00	n/a	0	0
0.50	1019.50	n/a	500	500
1.00	1020.00	n/a	501	1,001
1.50	1020.50	n/a	501	1,502
2.00	1021.00	n/a	501	2,003
2.50	1021.50	n/a	501	2,504
3.00	1022.00	n/a	2,428	4,932
3.50	1022.50	n/a	3,230	8,162
4.00	1023.00	n/a	3,954	12,116
4.50	1023.50	n/a	4,690	16,806
5.00	1024.00	n/a	5,439	22,245

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	8.00	0.00	0.00
Span (in)	= 24.00	8.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 1018.17	1018.17	0.00	0.00
Length (ft)	= 140.61	0.50	0.00	0.00
Slope (%)	= 0.50	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

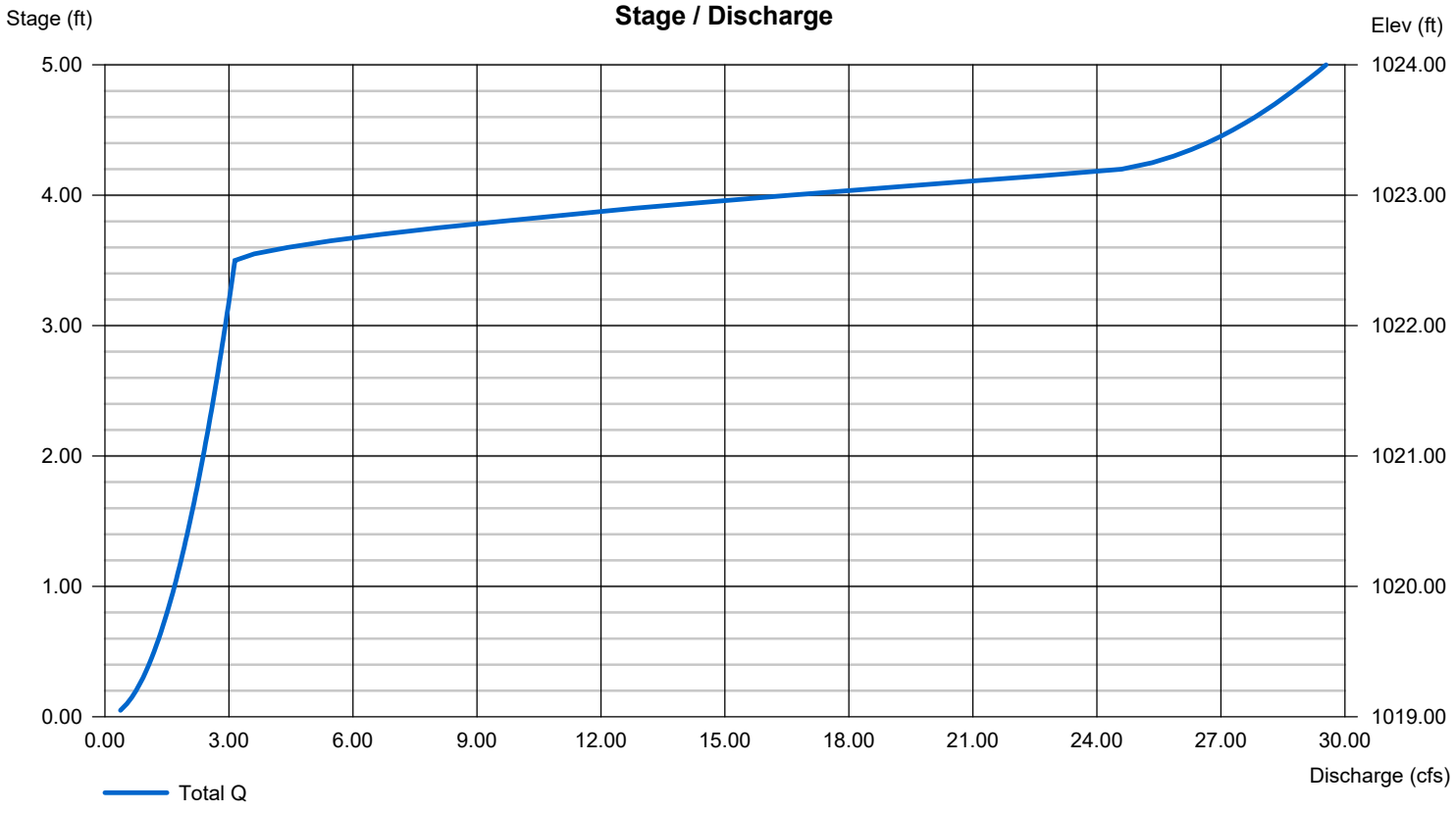
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 12.00	0.00	0.00	0.00
Crest El. (ft)	= 1022.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



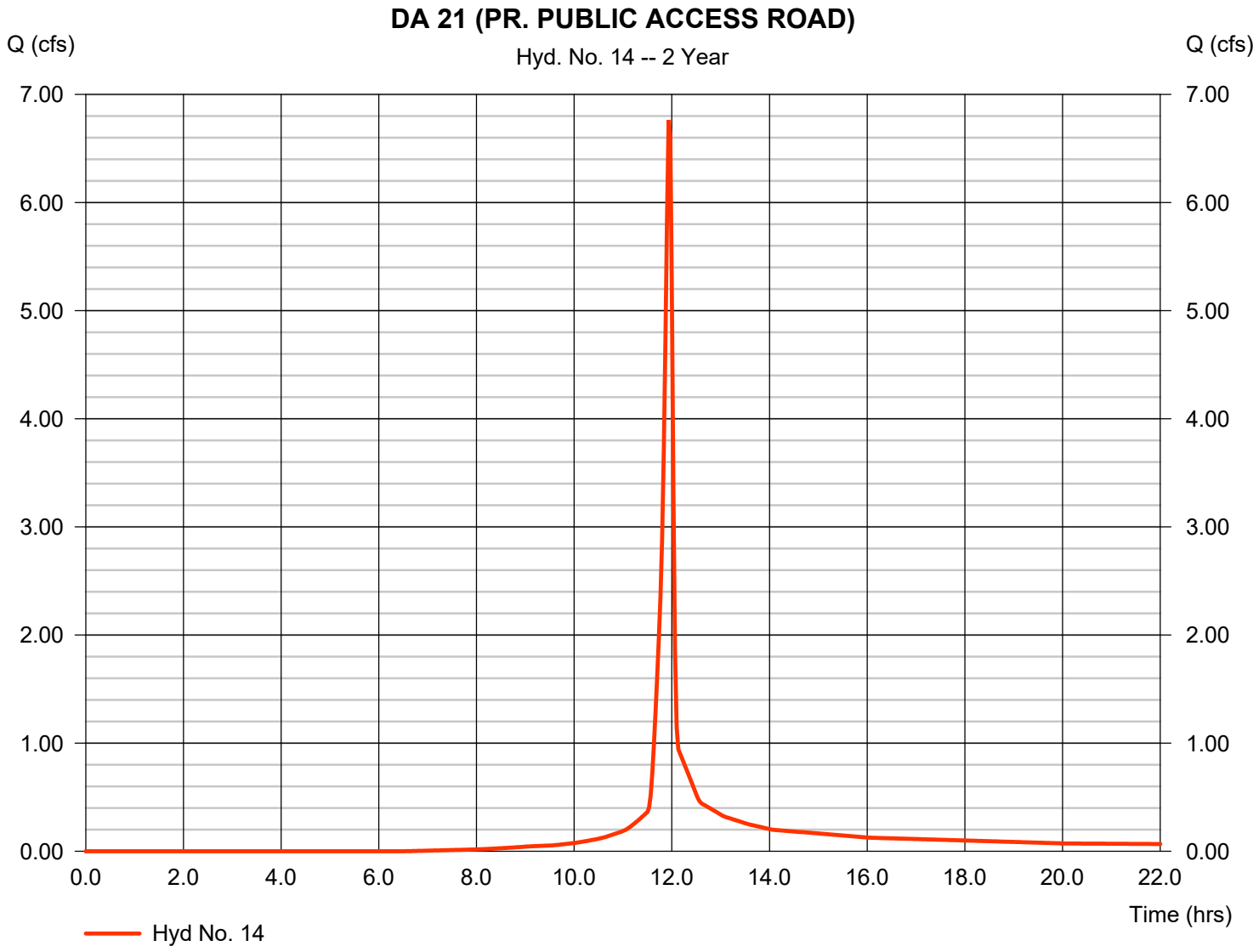
Hydrograph Report

Hyd. No. 14

DA 21 (PR. PUBLIC ACCESS ROAD)

Hydrograph type	= SCS Runoff	Peak discharge	= 6.763 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 13,843 cuft
Drainage area	= 1.780 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.630 x 98) + (1.150 x 80)] / 1.780



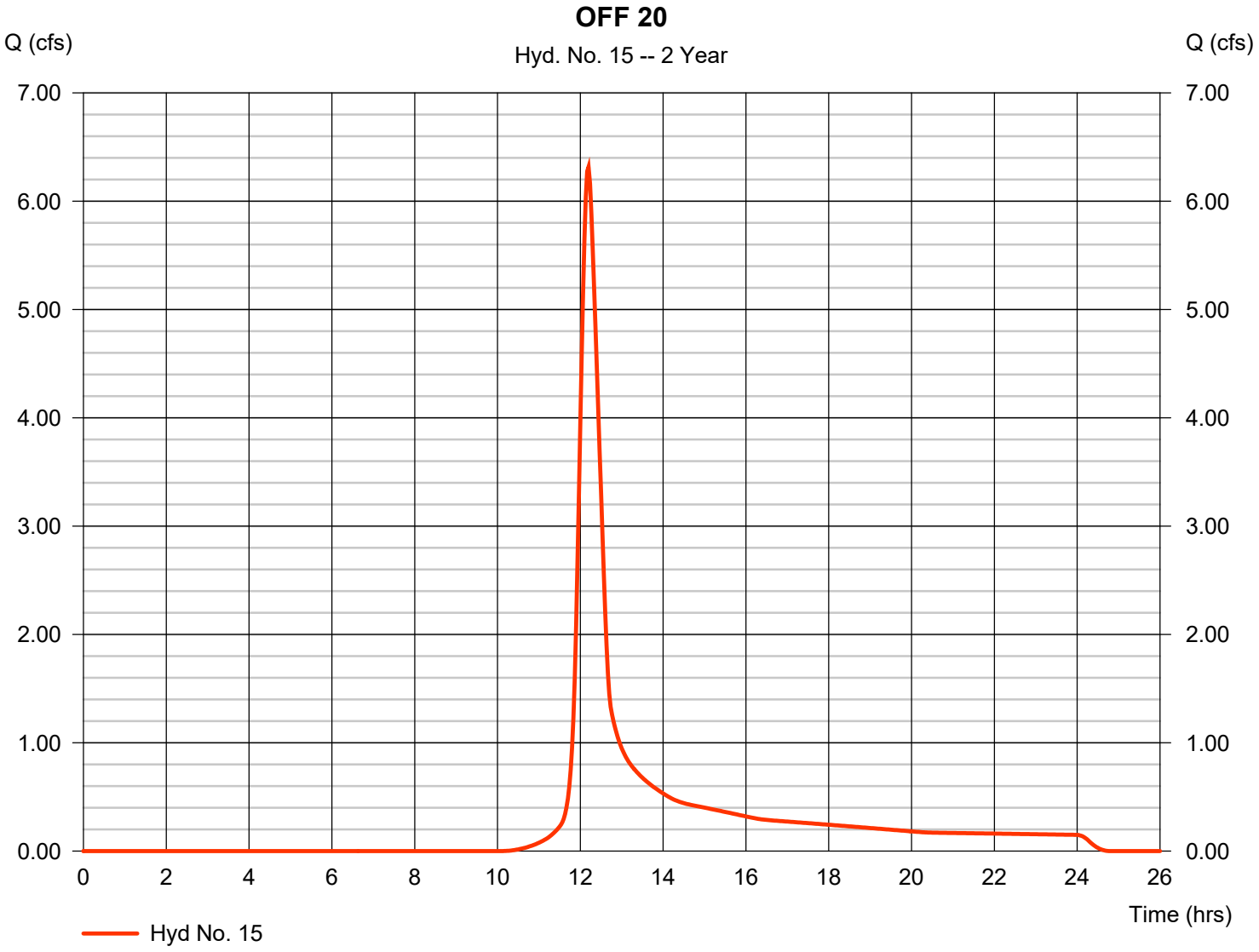
Hydrograph Report

Hyd. No. 15

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.315 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.20 hrs
Time interval	=	2 min	Hyd. volume	=	26,046 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.90 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.190 x 98) + (4.750 x 74)] / 4.940



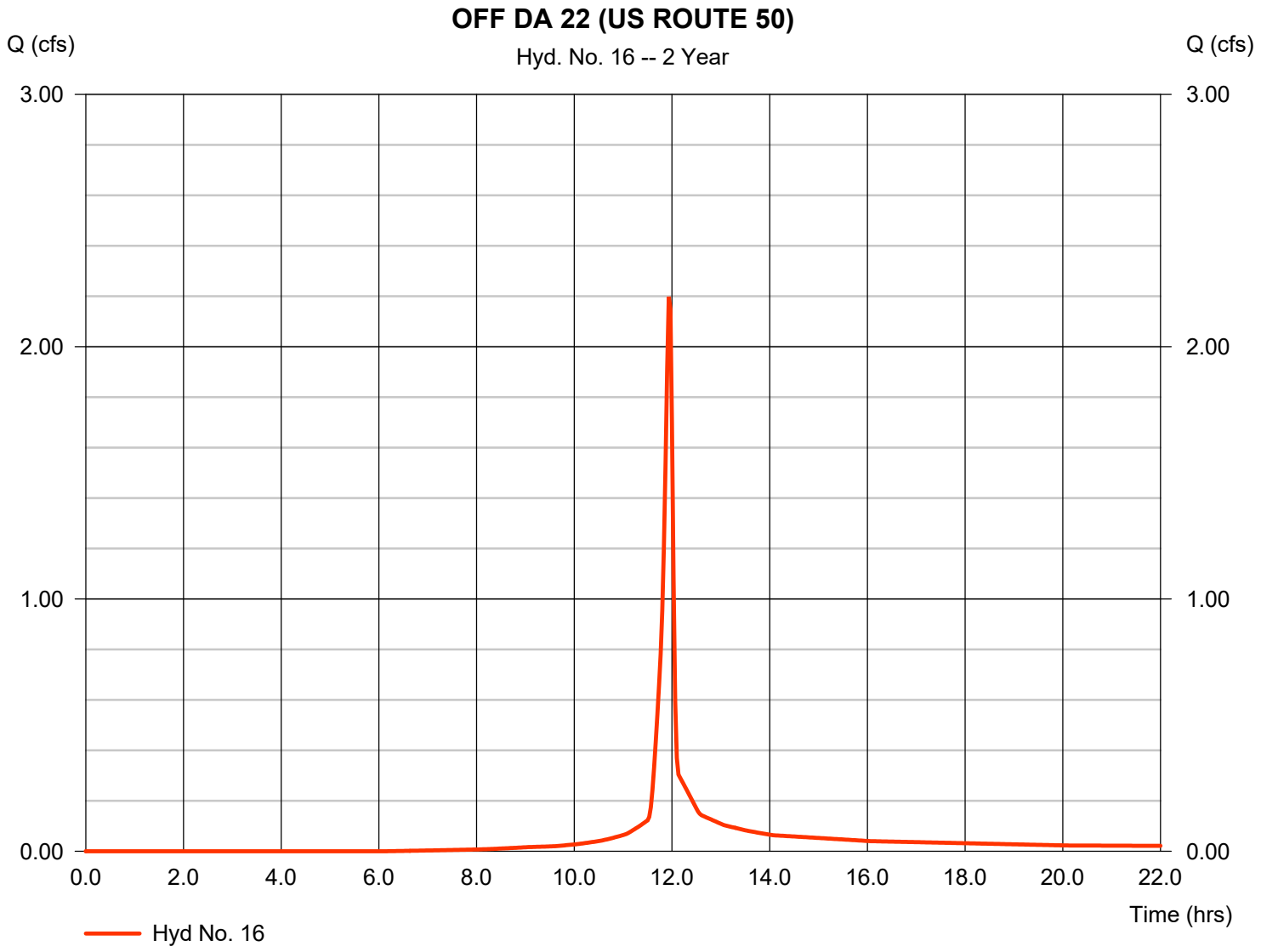
Hydrograph Report

Hyd. No. 16

OFF DA 22 (US ROUTE 50)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.198 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	4,521 cuft
Drainage area	=	0.560 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.210 x 98) + (0.350 x 80)] / 0.560

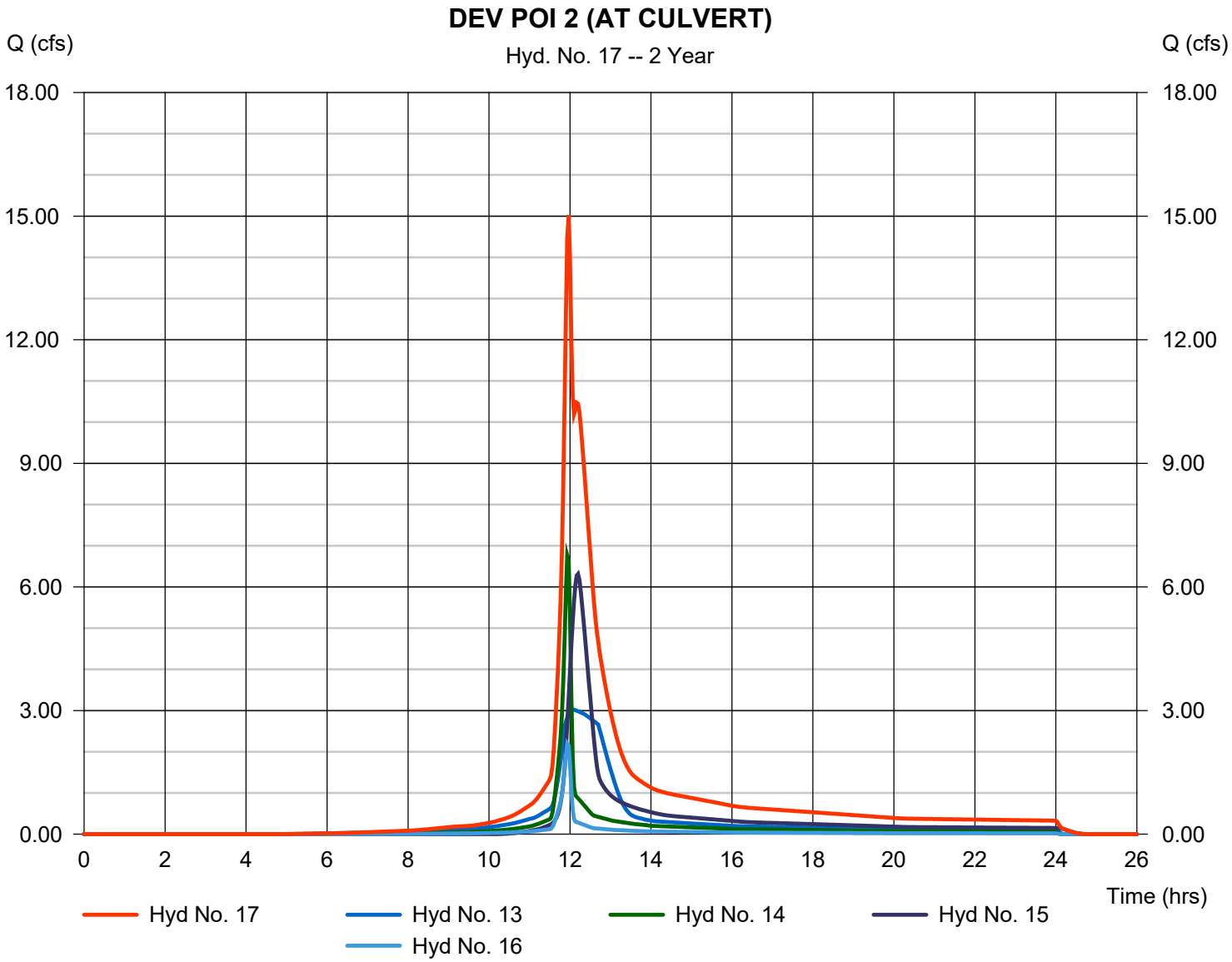


Hydrograph Report

Hyd. No. 17

DEV POI 2 (AT CULVERT)

Hydrograph type	=	Combine	Peak discharge	=	15.02 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	67,904 cuft
Inflow hyds.	=	13, 14, 15, 16	Contrib. drain. area	=	7.280 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	23.27	2	728	85,731	------	------	------	EX 20
2	SCS Runoff	11.58	2	728	42,585	------	------	------	EX 10 (POI 1)
3	SCS Runoff	13.39	2	730	53,696	------	------	------	OFF 20
4	Combine	36.54	2	730	139,427	1, 3	------	------	EX POI 2 (AT CULVERT)
5	SCS Runoff	21.82	2	716	48,185	------	------	------	DEV 10
6	Reservoir	11.33	2	722	48,185	5	1020.68	6,698	BIORETENTION 1
7	SCS Runoff	28.75	2	716	61,301	------	------	------	DEV 30
8	Combine	39.41	2	716	109,486	6, 7	------	------	COMBINE
9	Reservoir	1.322	2	862	109,486	8	1020.26	63,564	DRY DETENTION
10	SCS Runoff	7.144	2	716	15,124	------	------	------	DA 11 (US ROUTE 50)
11	Combine	8.250	2	716	124,610	9, 10	------	------	DEV POI 1
12	SCS Runoff	18.51	2	716	40,105	------	------	------	DEV 20
13	Reservoir	10.48	2	722	40,104	12	1022.84	10,755	BIORETENTION 2
14	SCS Runoff	11.77	2	716	24,758	------	------	------	DA 21 (PR. PUBLIC ACCESS ROAD)
15	SCS Runoff	13.39	2	730	53,696	------	------	------	OFF 20
16	SCS Runoff	3.774	2	716	7,990	------	------	------	OFF DA 22 (US ROUTE 50)
17	Combine	30.82	2	720	126,549	13, 14, 15, 16	------	------	DEV POI 2 (AT CULVERT)

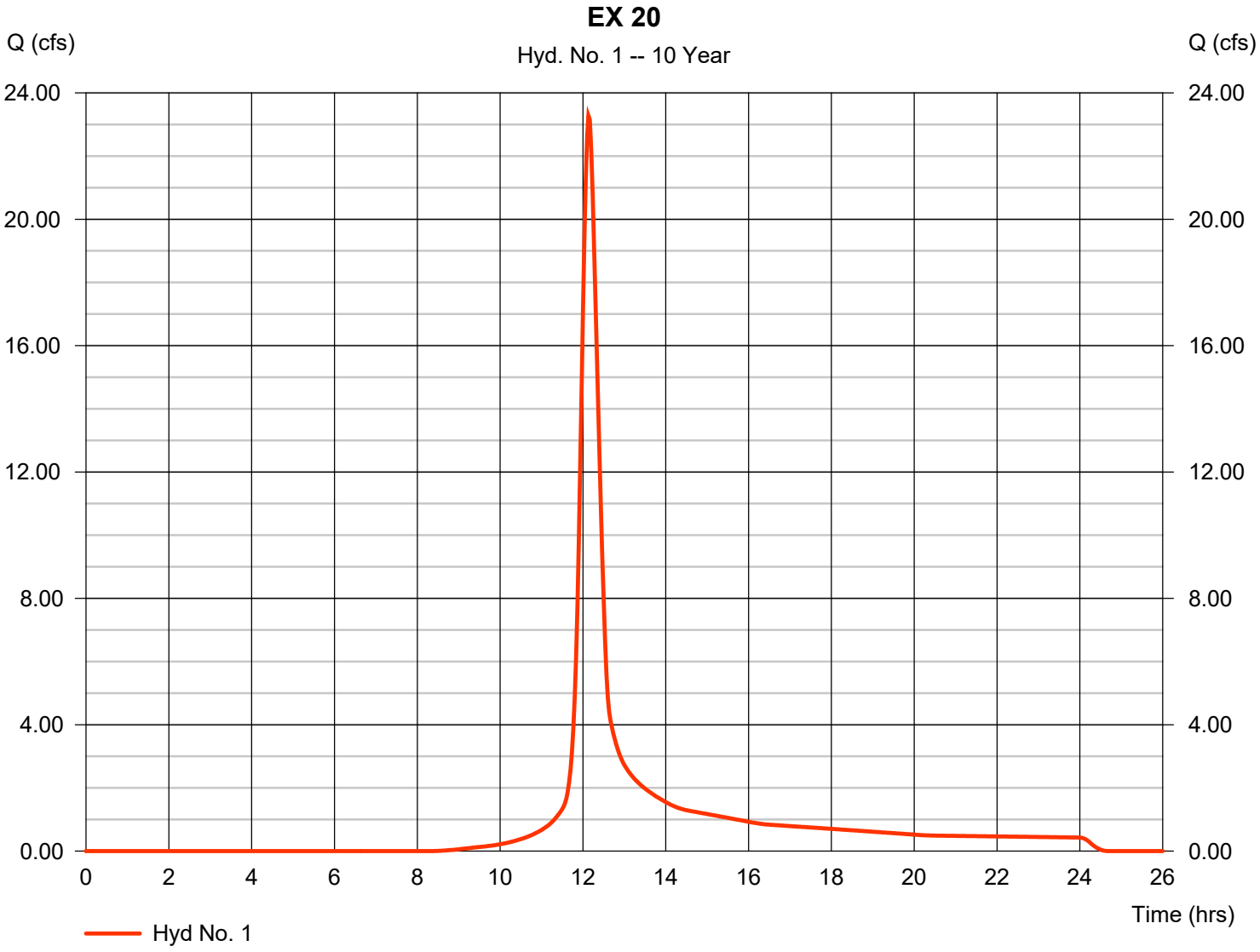
Hydrograph Report

Hyd. No. 1

EX 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.27 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	85,731 cuft
Drainage area	=	8.270 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.10 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.110 x 98) + (8.160 x 74)] / 8.270



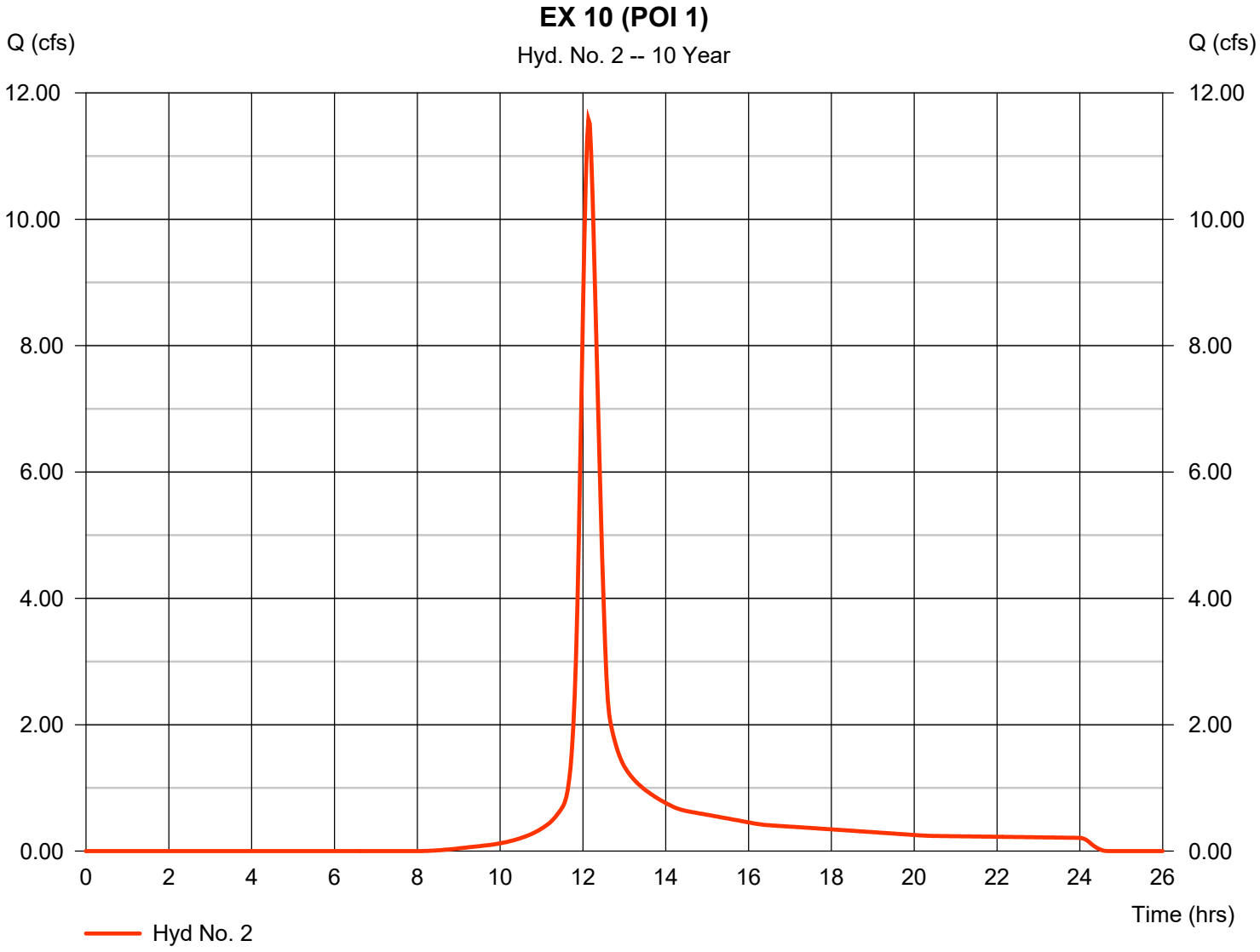
Hydrograph Report

Hyd. No. 2

EX 10 (POI 1)

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.58 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	42,585 cuft
Drainage area	=	3.980 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	26.30 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.090 x 98) + (3.890 x 74)] / 3.980



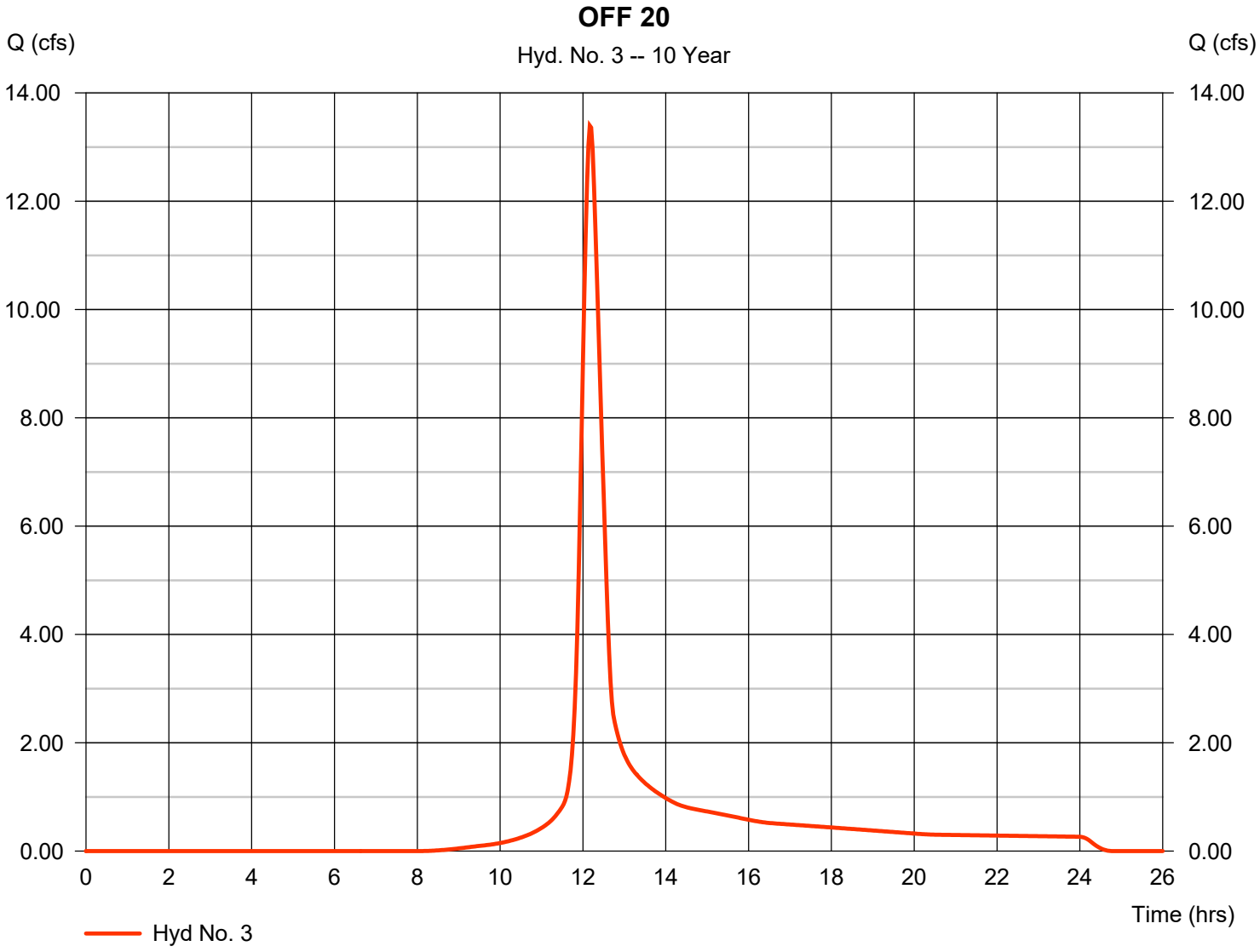
Hydrograph Report

Hyd. No. 3

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.39 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	53,696 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.90 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.140 x 98) + (4.800 x 74)] / 4.940

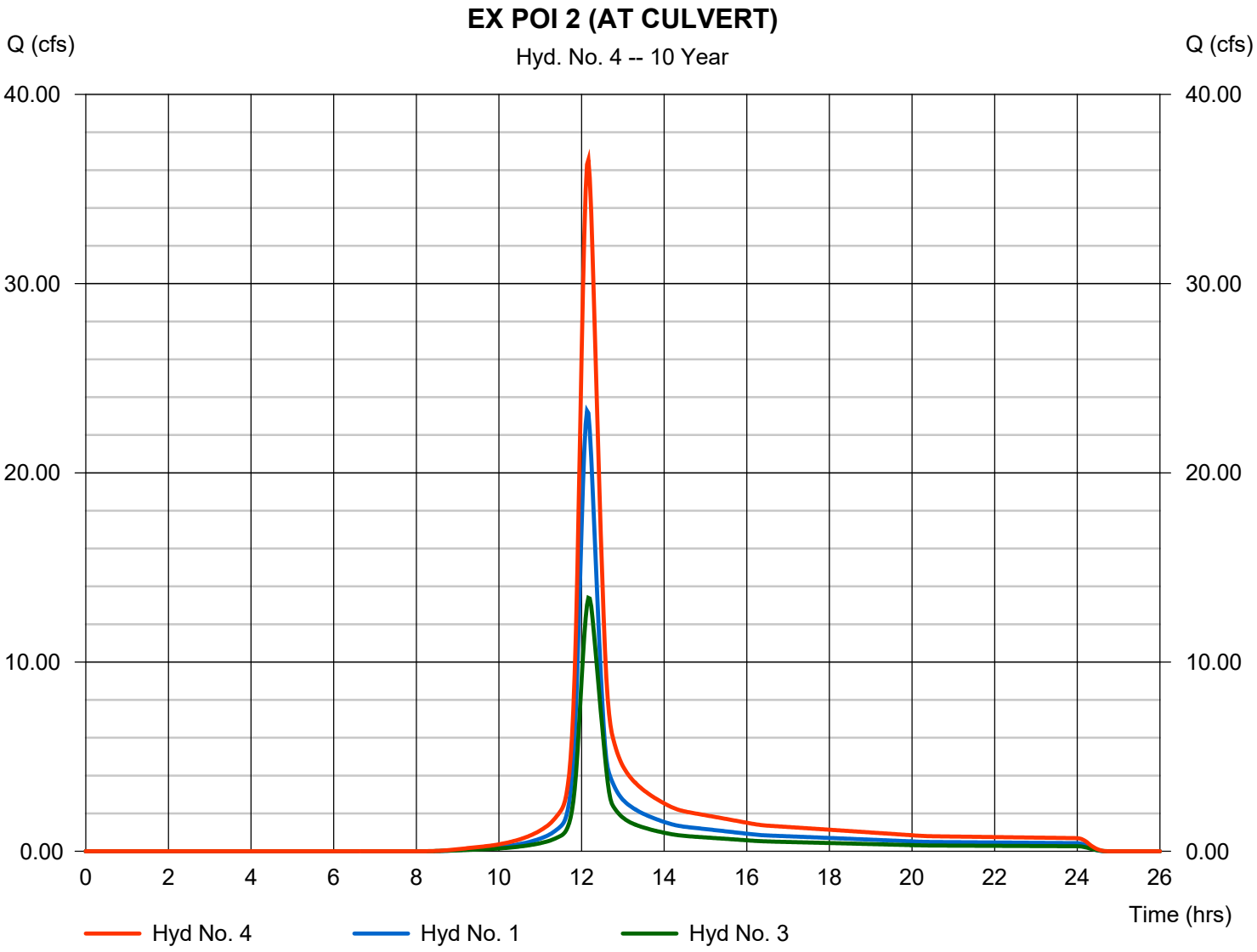


Hydrograph Report

Hyd. No. 4

EX POI 2 (AT CULVERT)

Hydrograph type	=	Combine	Peak discharge	=	36.54 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	139,427 cuft
Inflow hyds.	=	1, 3	Contrib. drain. area	=	13.210 ac



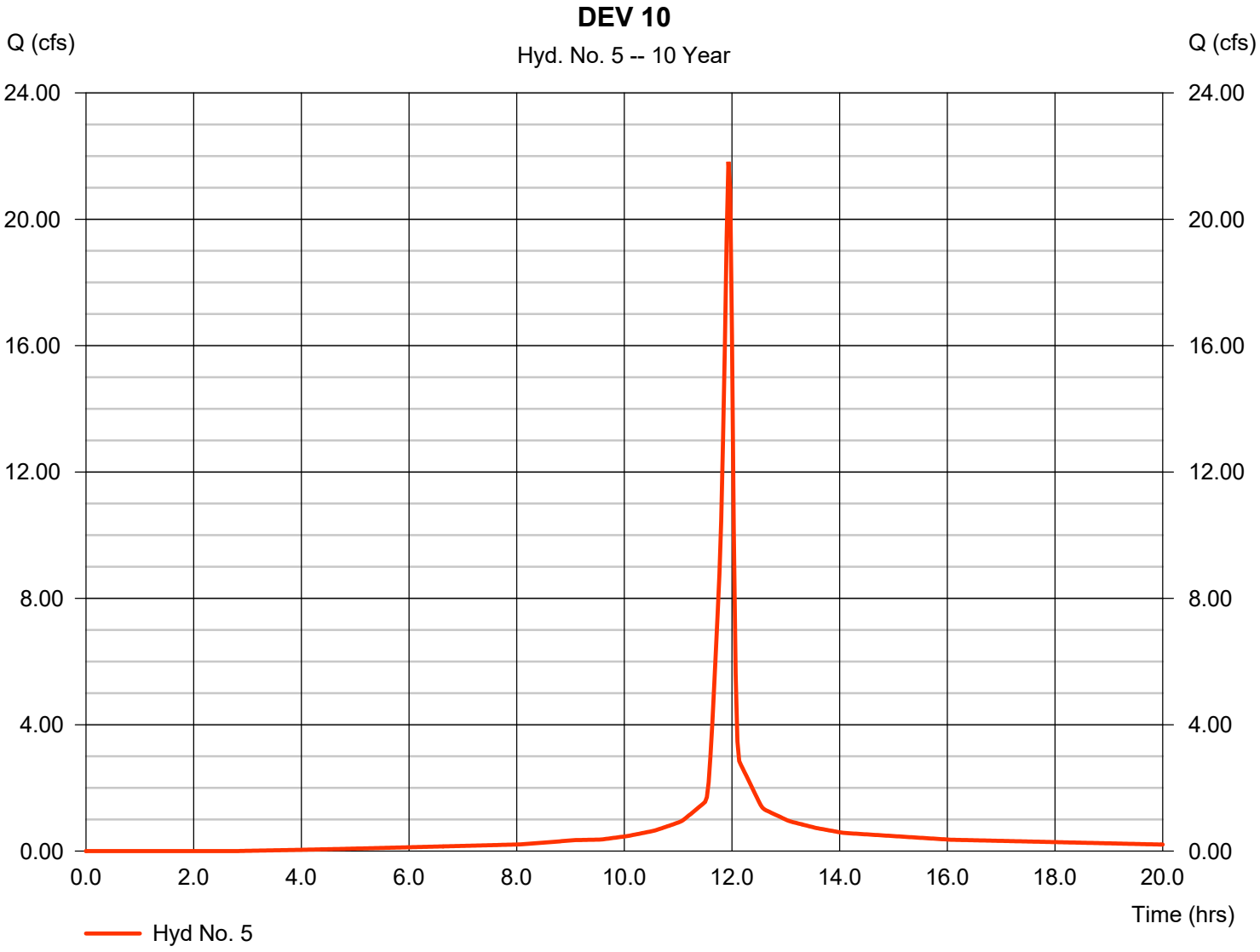
Hydrograph Report

Hyd. No. 5

DEV 10

Hydrograph type	=	SCS Runoff	Peak discharge	=	21.82 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	48,185 cuft
Drainage area	=	2.990 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.950 x 98) + (1.040 x 80)] / 2.990



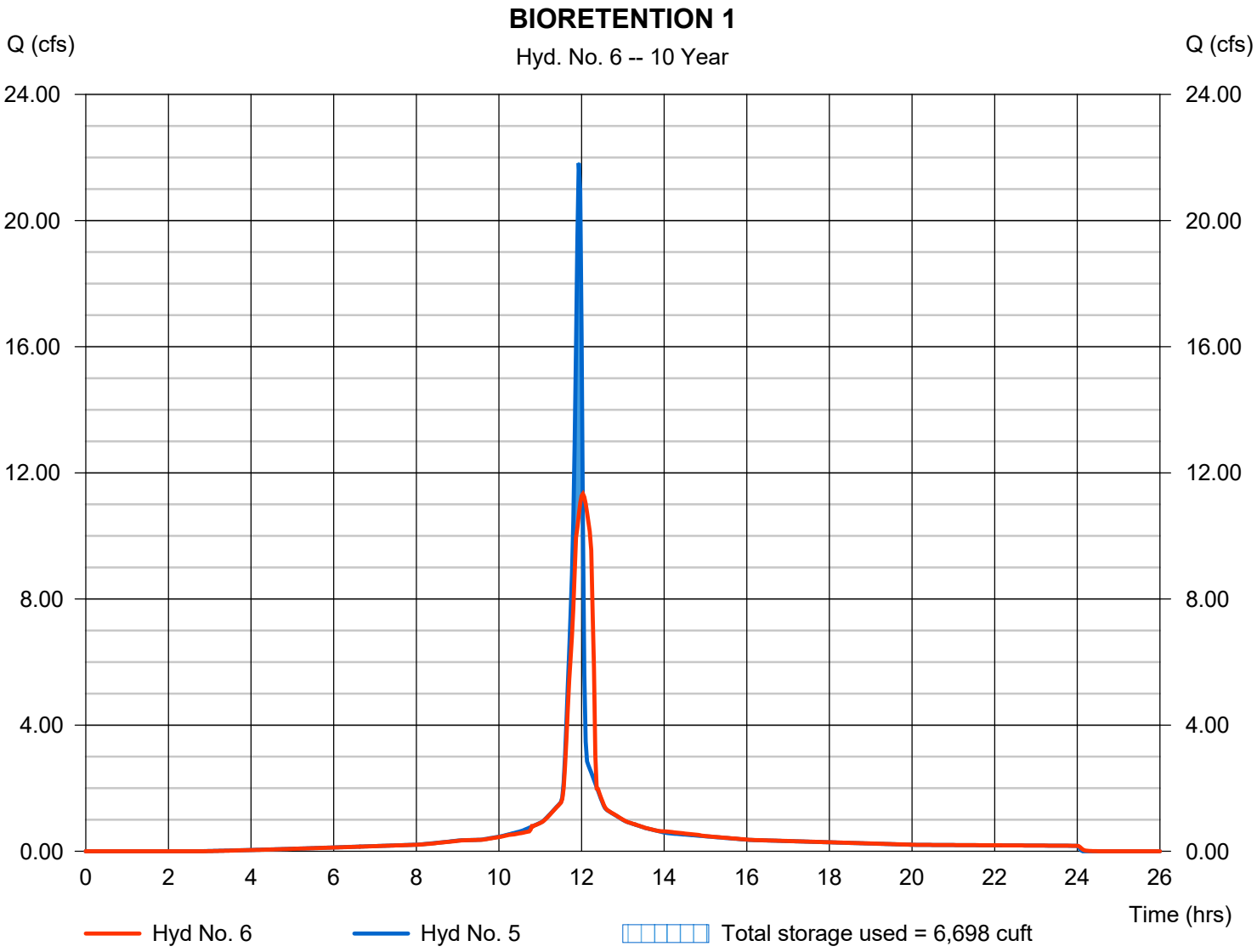
Hydrograph Report

Hyd. No. 6

BIORETENTION 1

Hydrograph type	=	Reservoir	Peak discharge	=	11.33 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	48,185 cuft
Inflow hyd. No.	=	5 - DEV 10	Max. Elevation	=	1020.68 ft
Reservoir name	=	BIORETENTION 1	Max. Storage	=	6,698 cuft

Storage Indication method used.



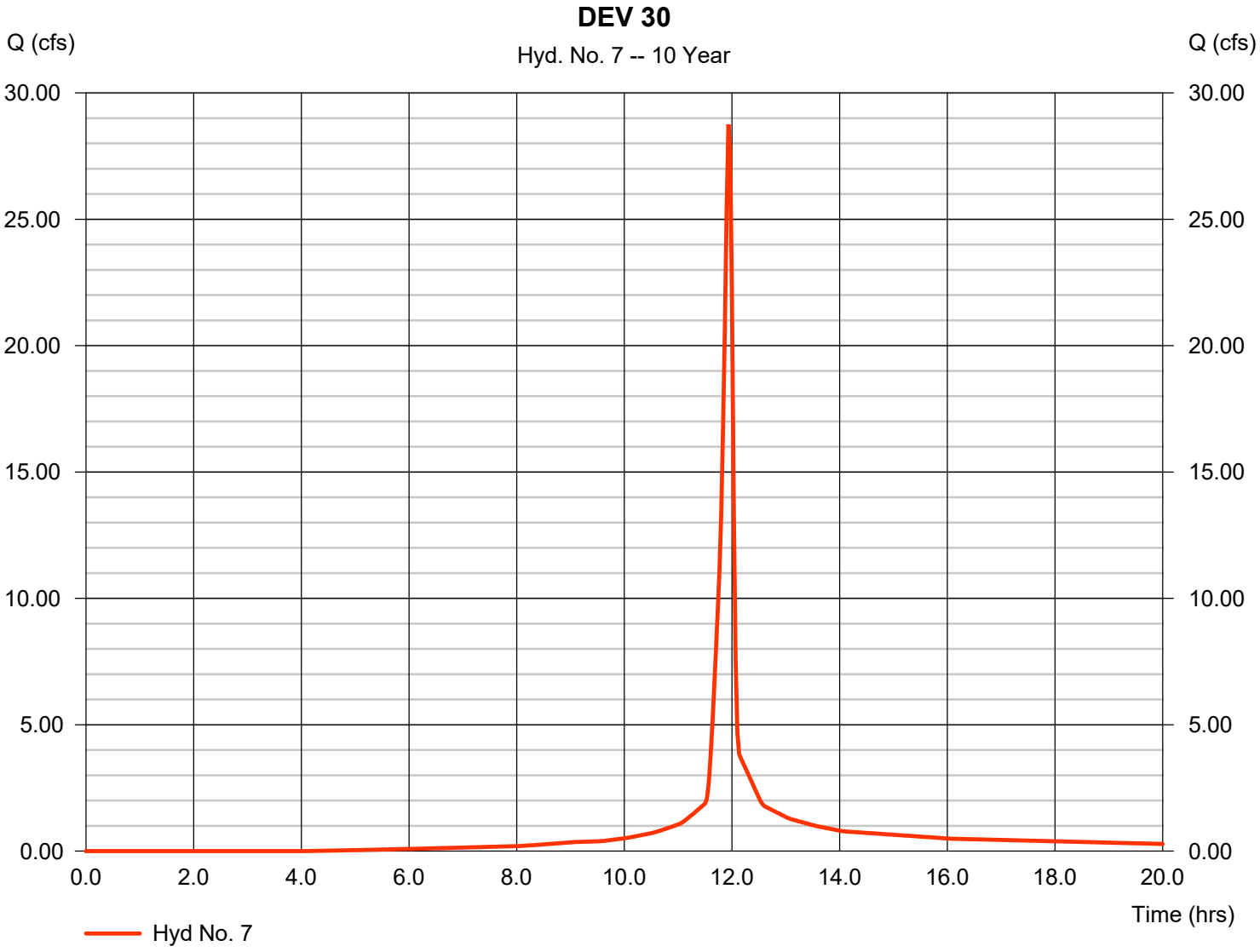
Hydrograph Report

Hyd. No. 7

DEV 30

Hydrograph type	=	SCS Runoff	Peak discharge	=	28.75 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	61,301 cuft
Drainage area	=	4.190 ac	Curve number	=	88*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.960 x 98) + (0.750 x 80) + (0.370 x 80) + (1.110 x 80)] / 4.190

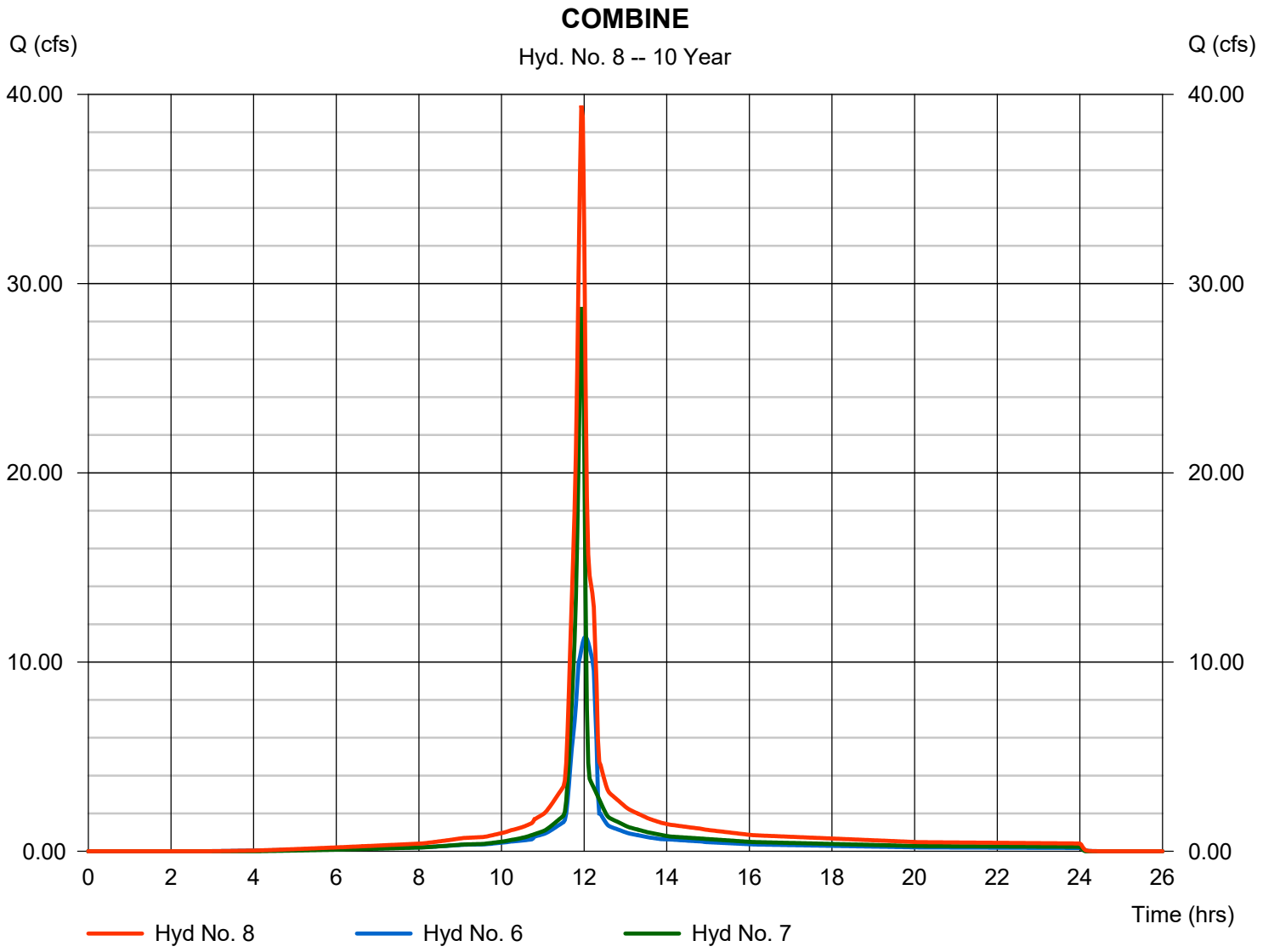


Hydrograph Report

Hyd. No. 8

COMBINE

Hydrograph type	=	Combine	Peak discharge	=	39.41 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	109,486 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	4.190 ac



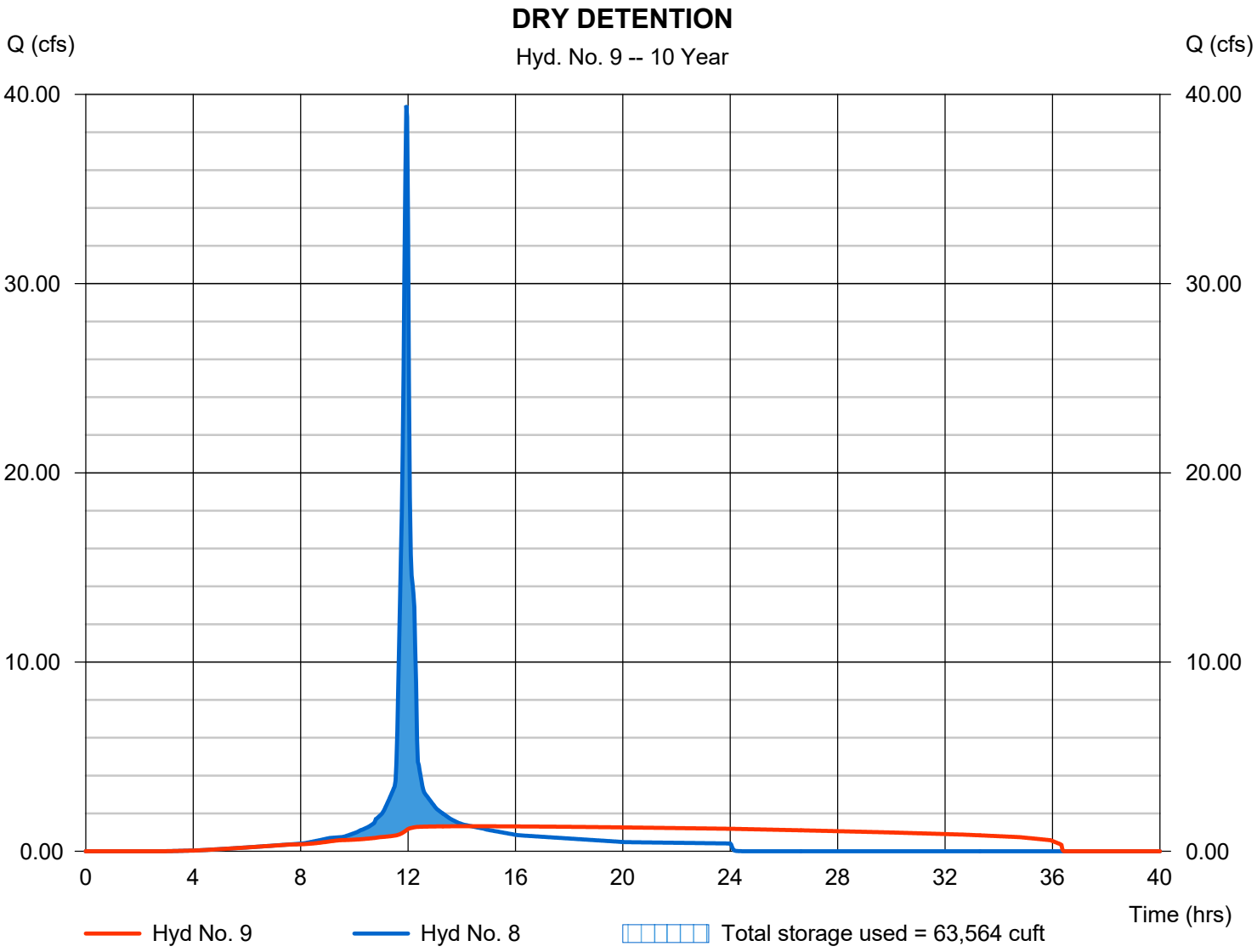
Hydrograph Report

Hyd. No. 9

DRY DETENTION

Hydrograph type	=	Reservoir	Peak discharge	=	1.322 cfs
Storm frequency	=	10 yrs	Time to peak	=	14.37 hrs
Time interval	=	2 min	Hyd. volume	=	109,486 cuft
Inflow hyd. No.	=	8 - COMBINE	Max. Elevation	=	1020.26 ft
Reservoir name	=	DRY DETENTION 1	Max. Storage	=	63,564 cuft

Storage Indication method used.



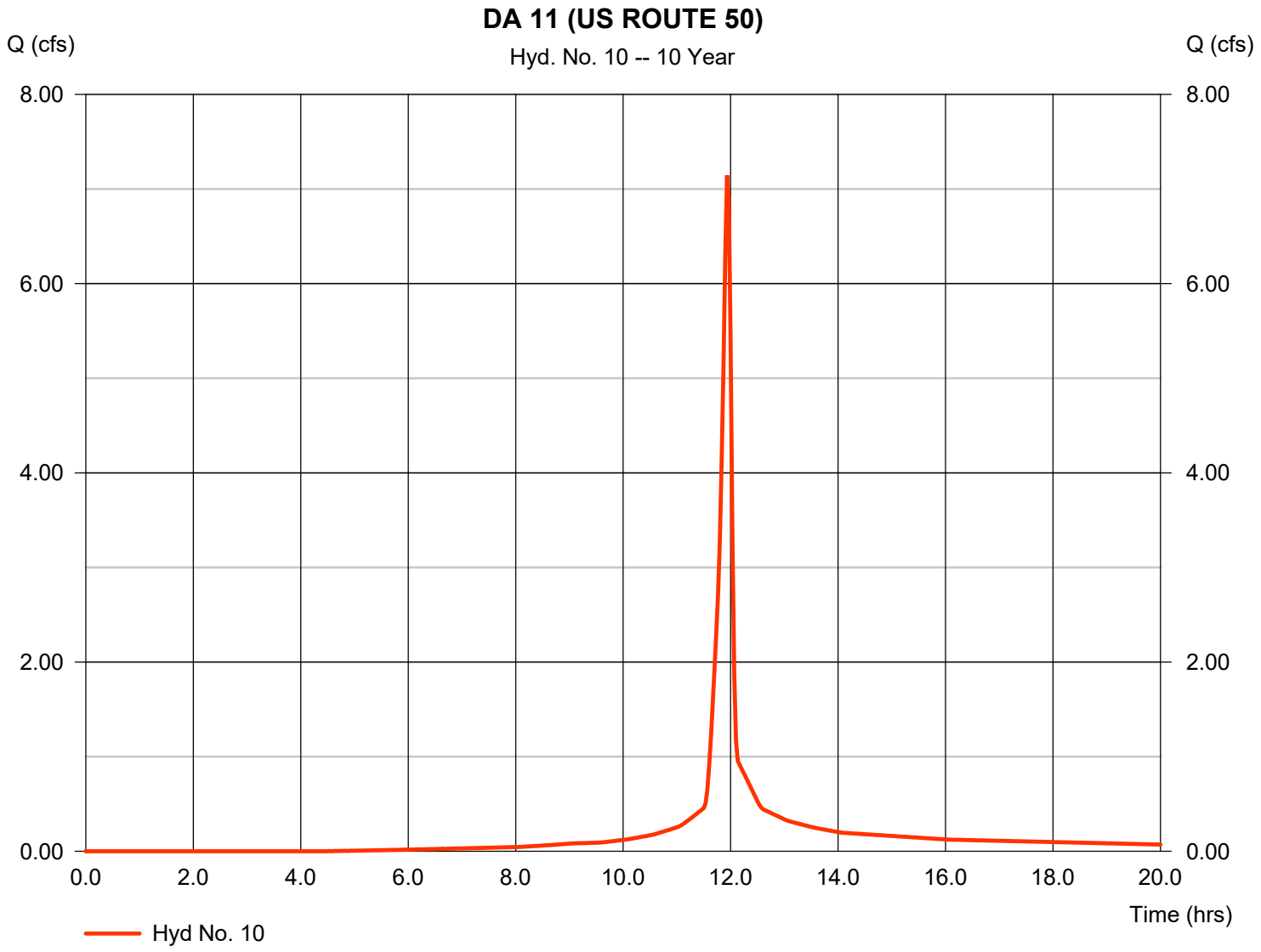
Hydrograph Report

Hyd. No. 10

DA 11 (US ROUTE 50)

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.144 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	15,124 cuft
Drainage area	=	1.060 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.400 x 98) + (0.660 x 80)] / 1.060

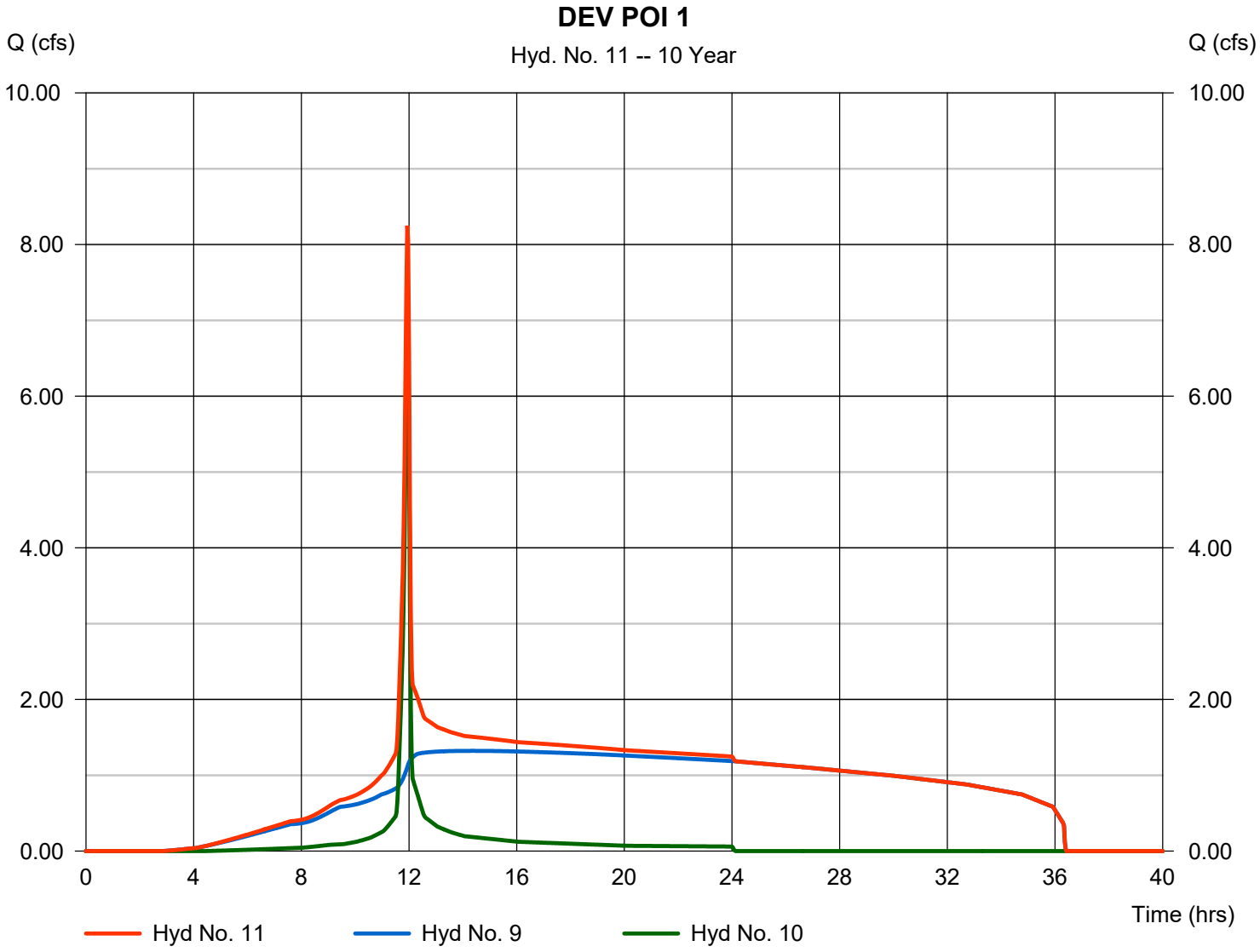


Hydrograph Report

Hyd. No. 11

DEV POI 1

Hydrograph type	=	Combine	Peak discharge	=	8.250 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	124,610 cuft
Inflow hyds.	=	9, 10	Contrib. drain. area	=	1.060 ac



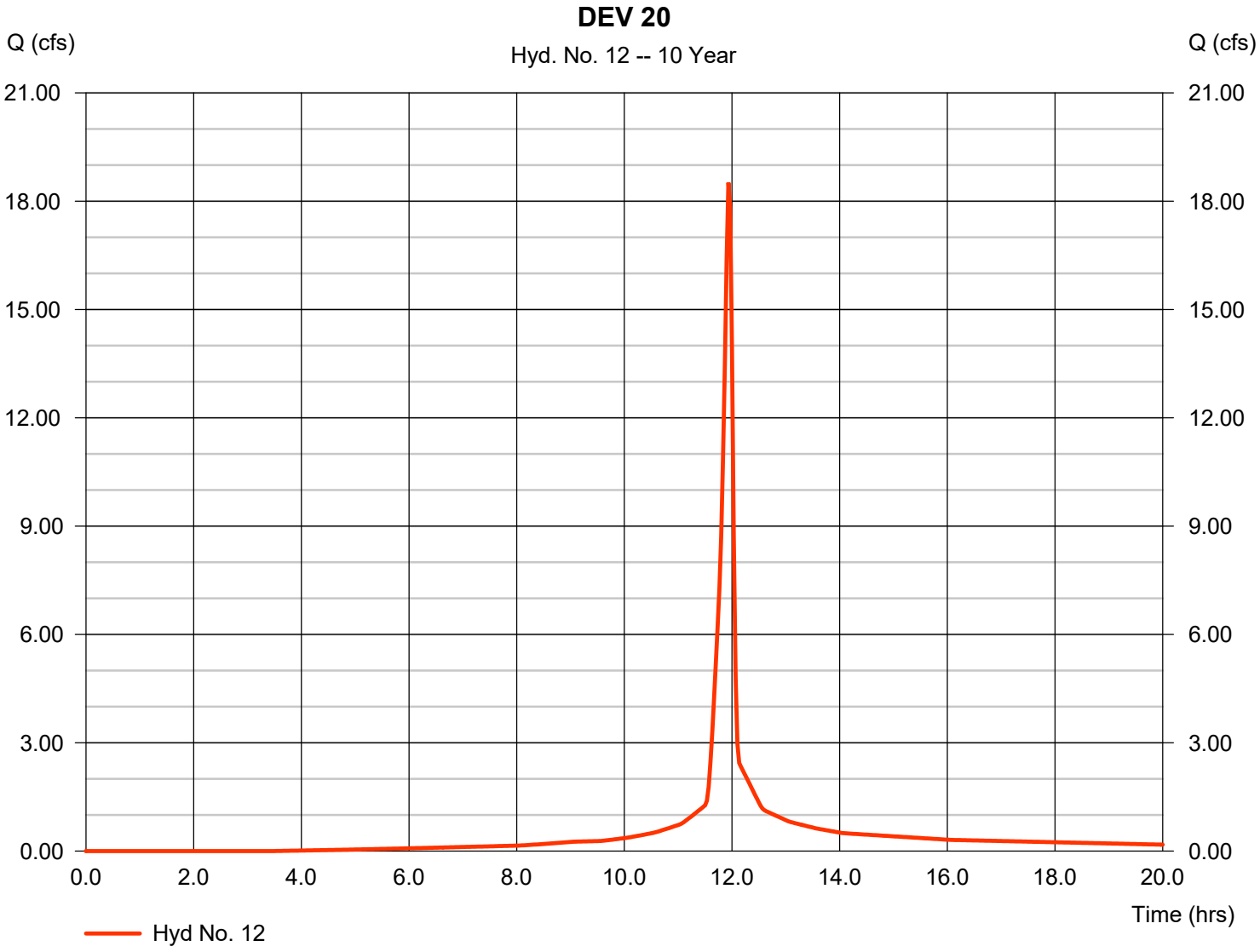
Hydrograph Report

Hyd. No. 12

DEV 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	18.51 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	40,105 cuft
Drainage area	=	2.610 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.440 x 98) + (1.170 x 80)] / 2.610



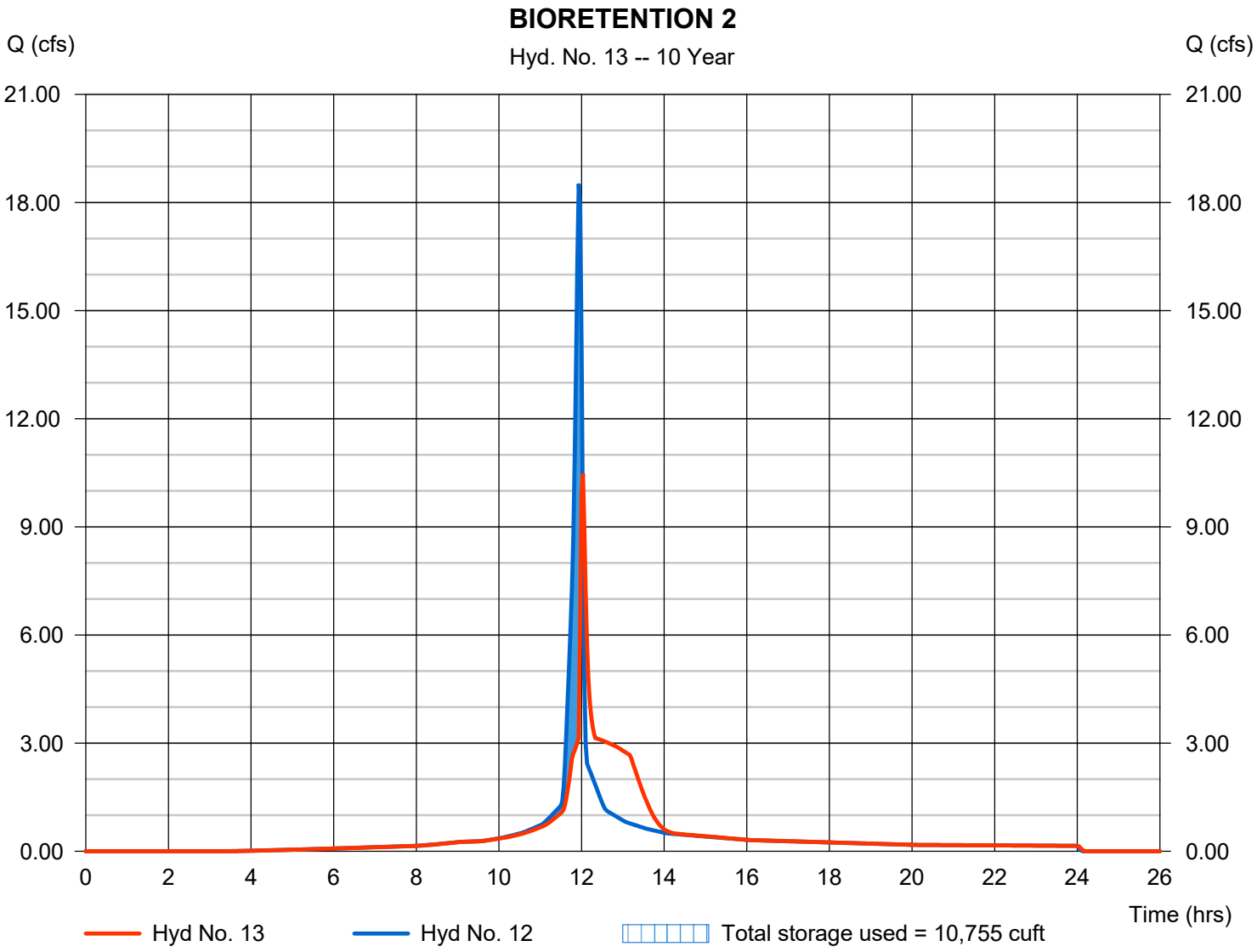
Hydrograph Report

Hyd. No. 13

BIORETENTION 2

Hydrograph type	=	Reservoir	Peak discharge	=	10.48 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	40,104 cuft
Inflow hyd. No.	=	12 - DEV 20	Max. Elevation	=	1022.84 ft
Reservoir name	=	BIORETENTION 2	Max. Storage	=	10,755 cuft

Storage Indication method used.



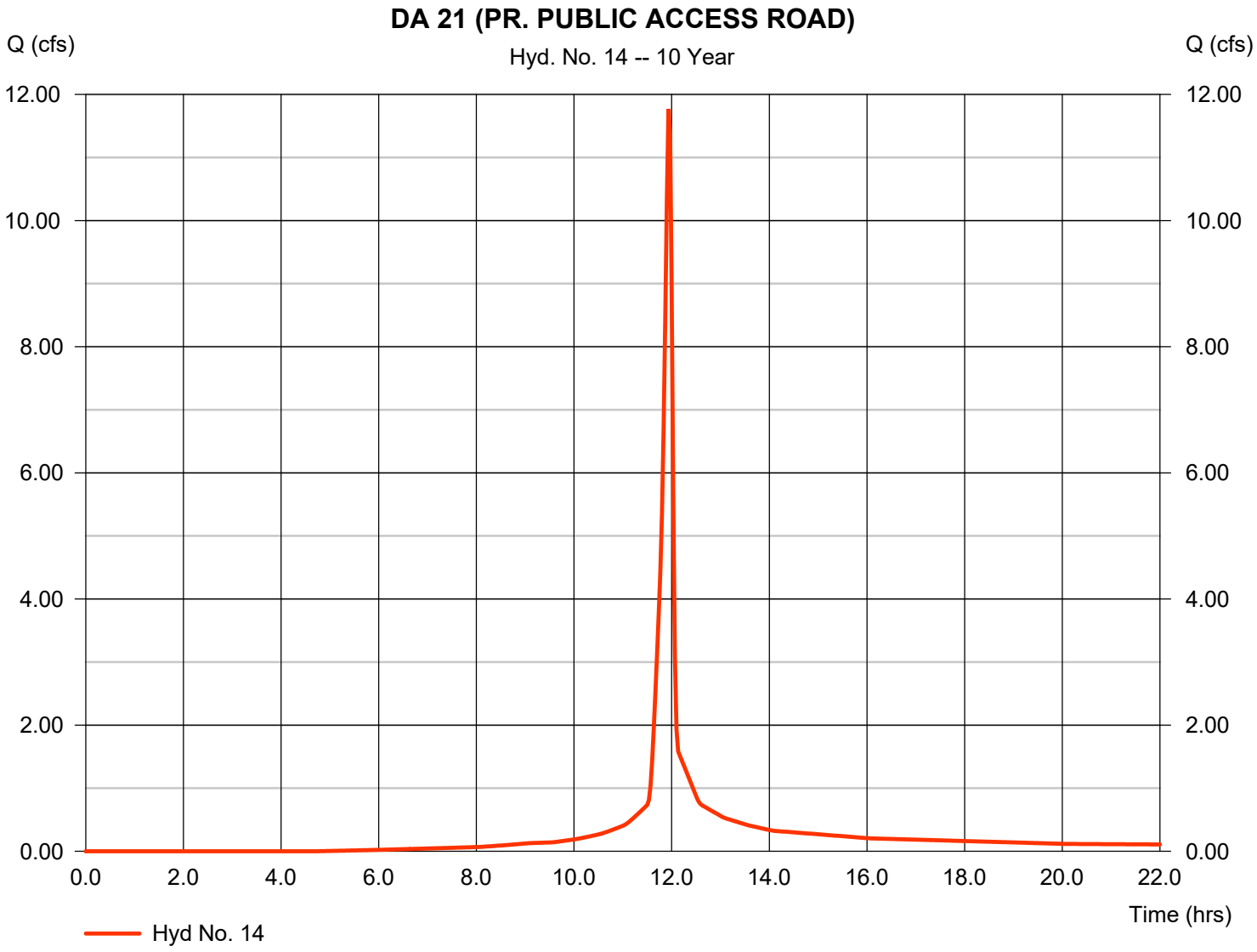
Hydrograph Report

Hyd. No. 14

DA 21 (PR. PUBLIC ACCESS ROAD)

Hydrograph type	= SCS Runoff	Peak discharge	= 11.77 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 24,758 cuft
Drainage area	= 1.780 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.630 x 98) + (1.150 x 80)] / 1.780



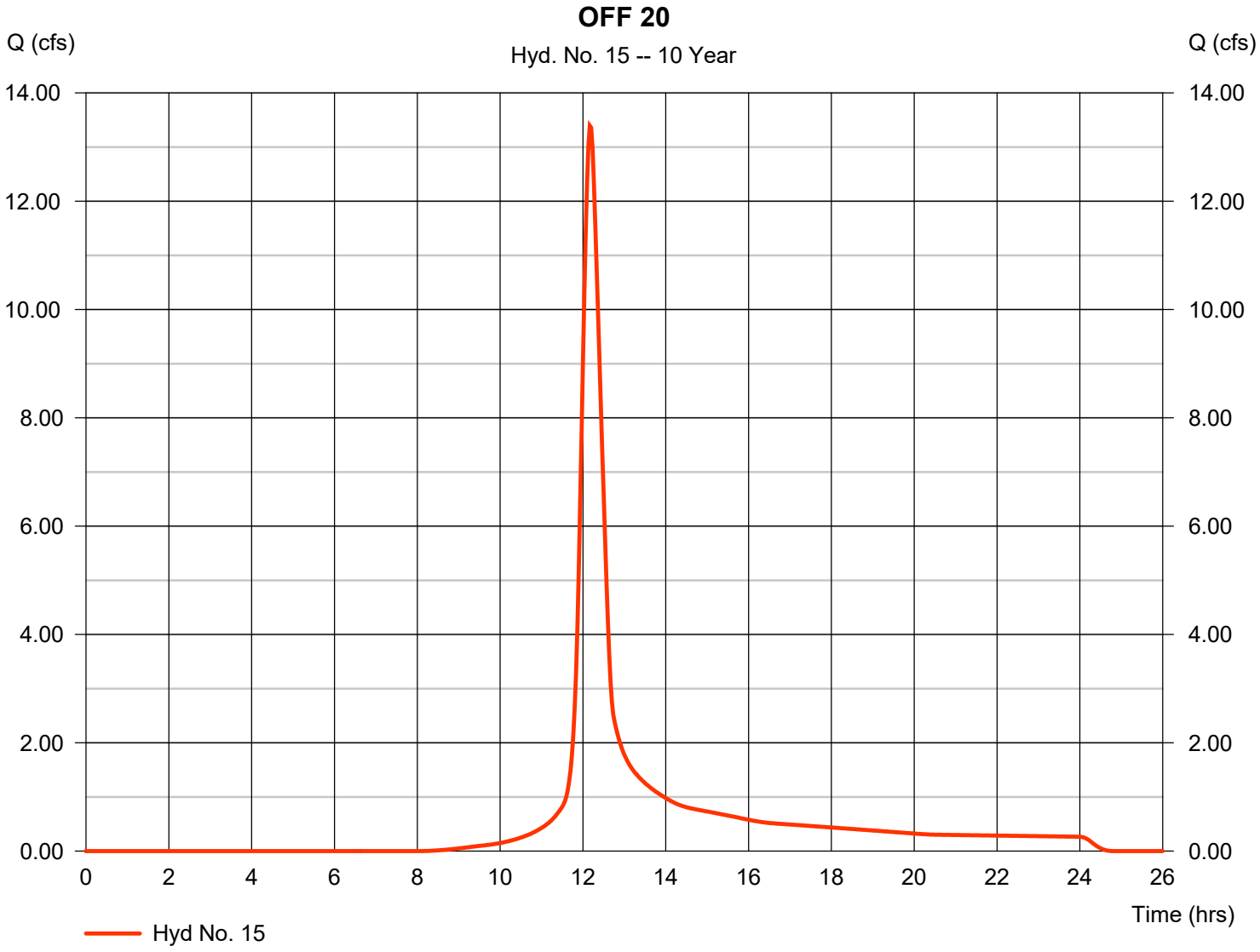
Hydrograph Report

Hyd. No. 15

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.39 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	53,696 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.90 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.190 x 98) + (4.750 x 74)] / 4.940



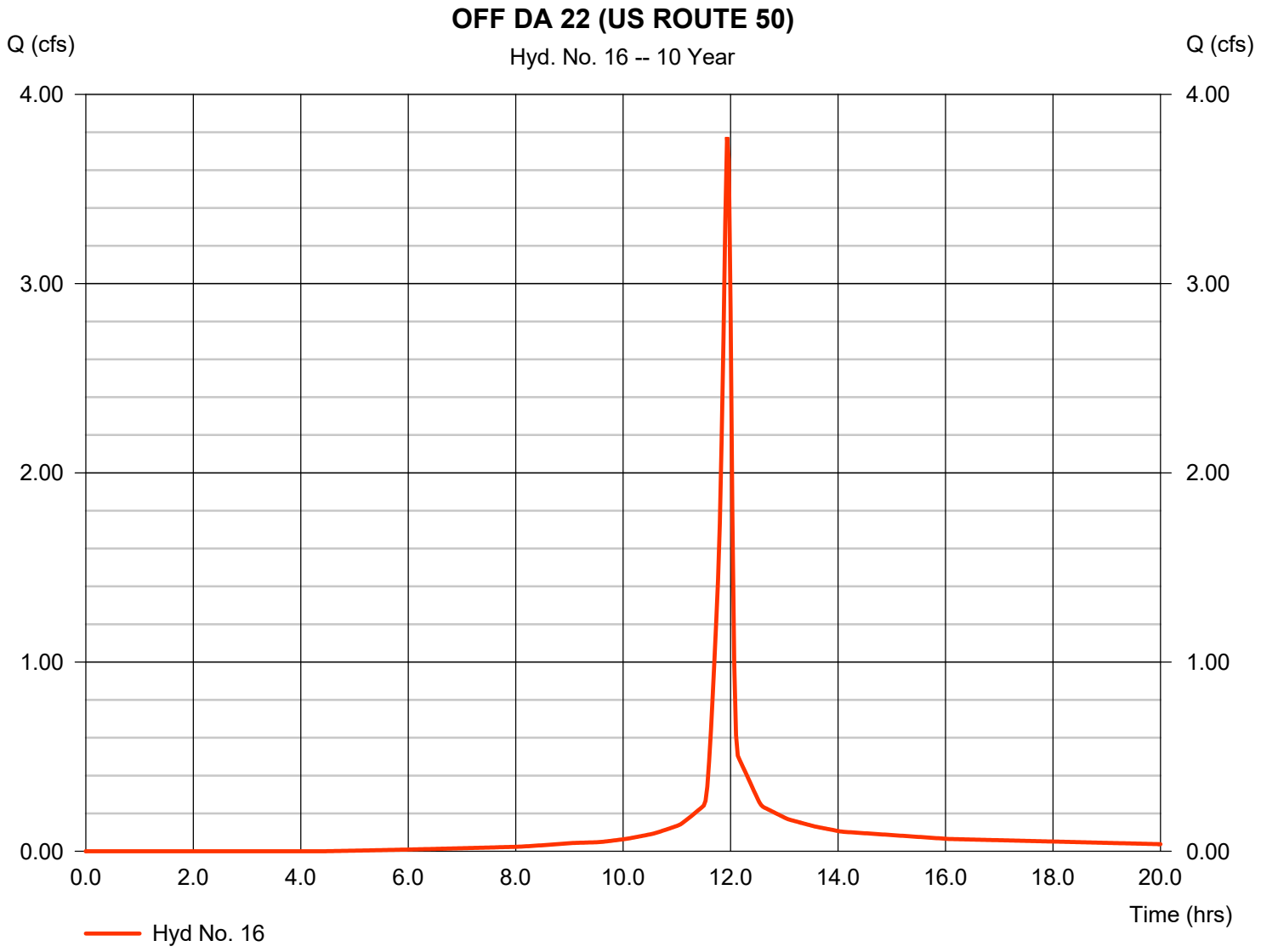
Hydrograph Report

Hyd. No. 16

OFF DA 22 (US ROUTE 50)

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.774 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	7,990 cuft
Drainage area	=	0.560 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.210 x 98) + (0.350 x 80)] / 0.560

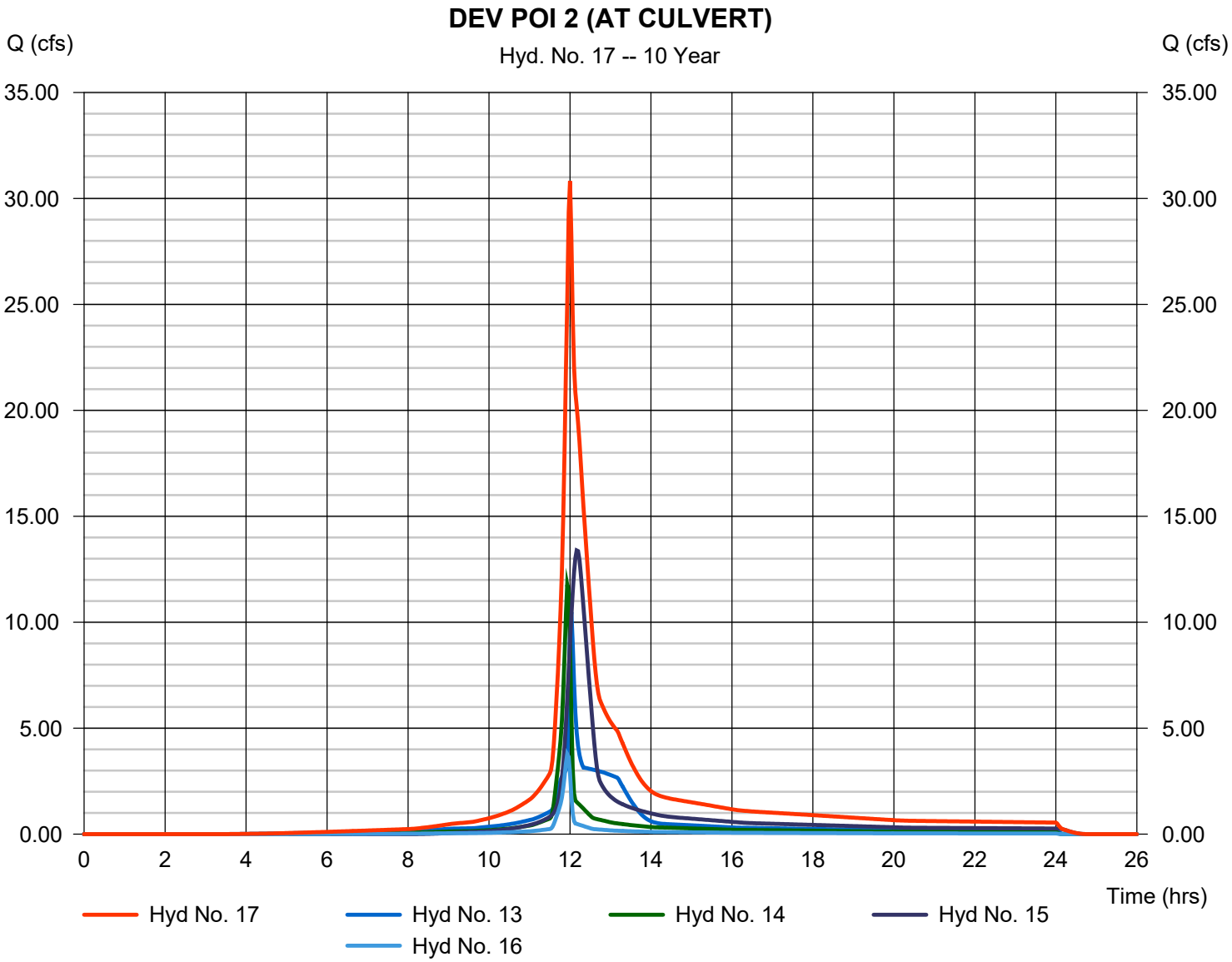


Hydrograph Report

Hyd. No. 17

DEV POI 2 (AT CULVERT)

Hydrograph type	=	Combine	Peak discharge	=	30.82 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	126,549 cuft
Inflow hyds.	=	13, 14, 15, 16	Contrib. drain. area	=	7.280 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	48.62	2	728	179,000	------	------	------	EX 20
2	SCS Runoff	23.85	2	728	87,924	------	------	------	EX 10 (POI 1)
3	SCS Runoff	27.64	2	730	110,864	------	------	------	OFF 20
4	Combine	75.69	2	728	289,864	1, 3	------	------	EX POI 2 (AT CULVERT)
5	SCS Runoff	36.86	2	716	84,278	------	------	------	DEV 10
6	Reservoir	17.22	2	722	84,277	5	1021.76	16,352	BIORETENTION 1
7	SCS Runoff	50.17	2	716	111,128	------	------	------	DEV 30
8	Combine	62.45	2	716	195,405	6, 7	------	------	COMBINE
9	Reservoir	15.40	2	744	195,405	8	1021.10	88,888	DRY DETENTION
10	SCS Runoff	12.58	2	716	27,670	------	------	------	DA 11 (US ROUTE 50)
11	Combine	16.52	2	742	223,075	9, 10	------	------	DEV POI 1
12	SCS Runoff	31.75	2	716	71,399	------	------	------	DEV 20
13	Reservoir	25.26	2	720	71,399	12	1023.26	14,416	BIORETENTION 2
14	SCS Runoff	20.92	2	716	45,720	------	------	------	DA 21 (PR. PUBLIC ACCESS ROAD)
15	SCS Runoff	27.64	2	730	110,864	------	------	------	OFF 20
16	SCS Runoff	6.646	2	716	14,618	------	------	------	OFF DA 22 (US ROUTE 50)
17	Combine	68.36	2	718	242,601	13, 14, 15, 16	------	------	DEV POI 2 (AT CULVERT)

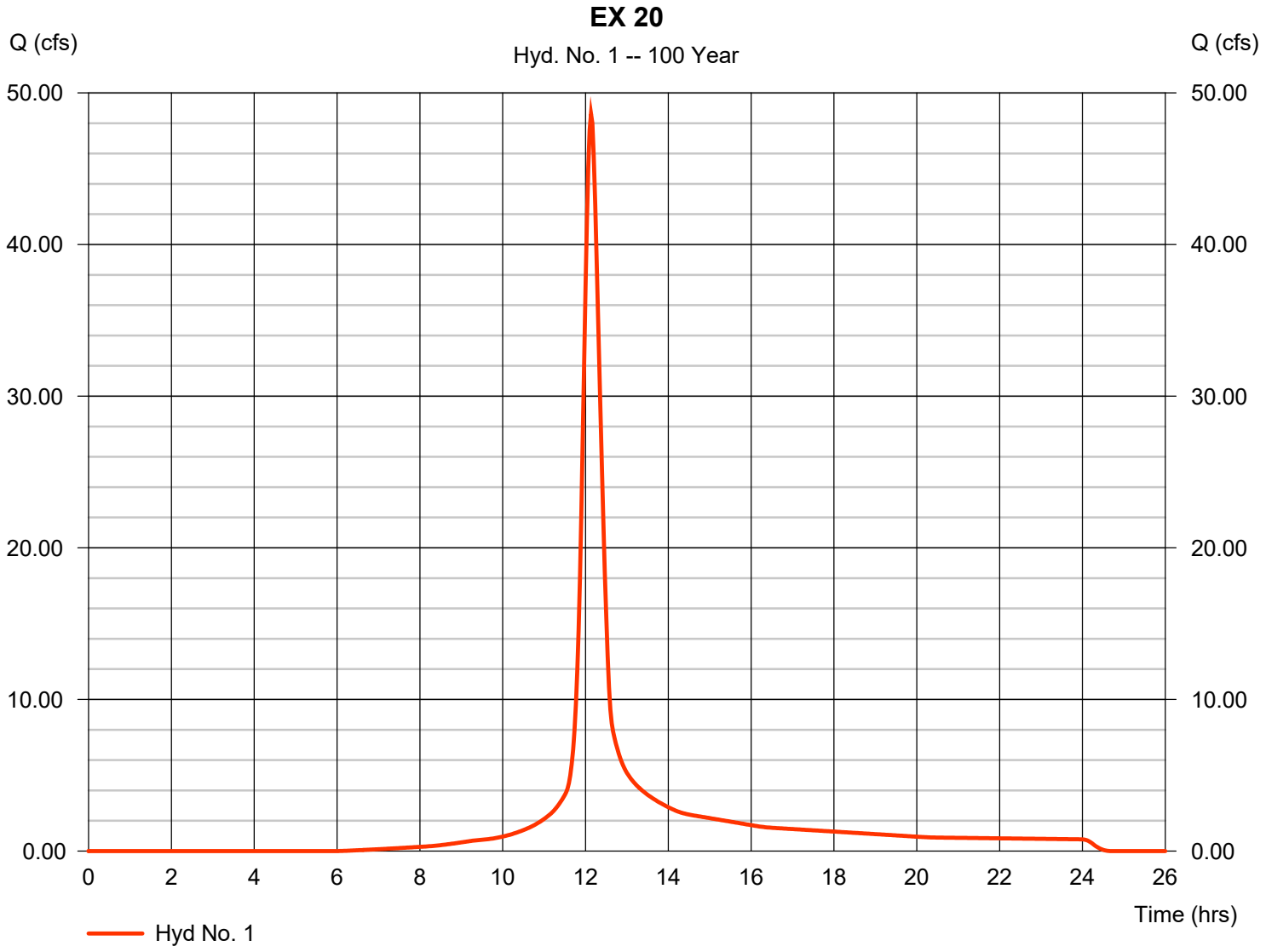
Hydrograph Report

Hyd. No. 1

EX 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	48.62 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	179,000 cuft
Drainage area	=	8.270 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	25.10 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.110 x 98) + (8.160 x 74)] / 8.270



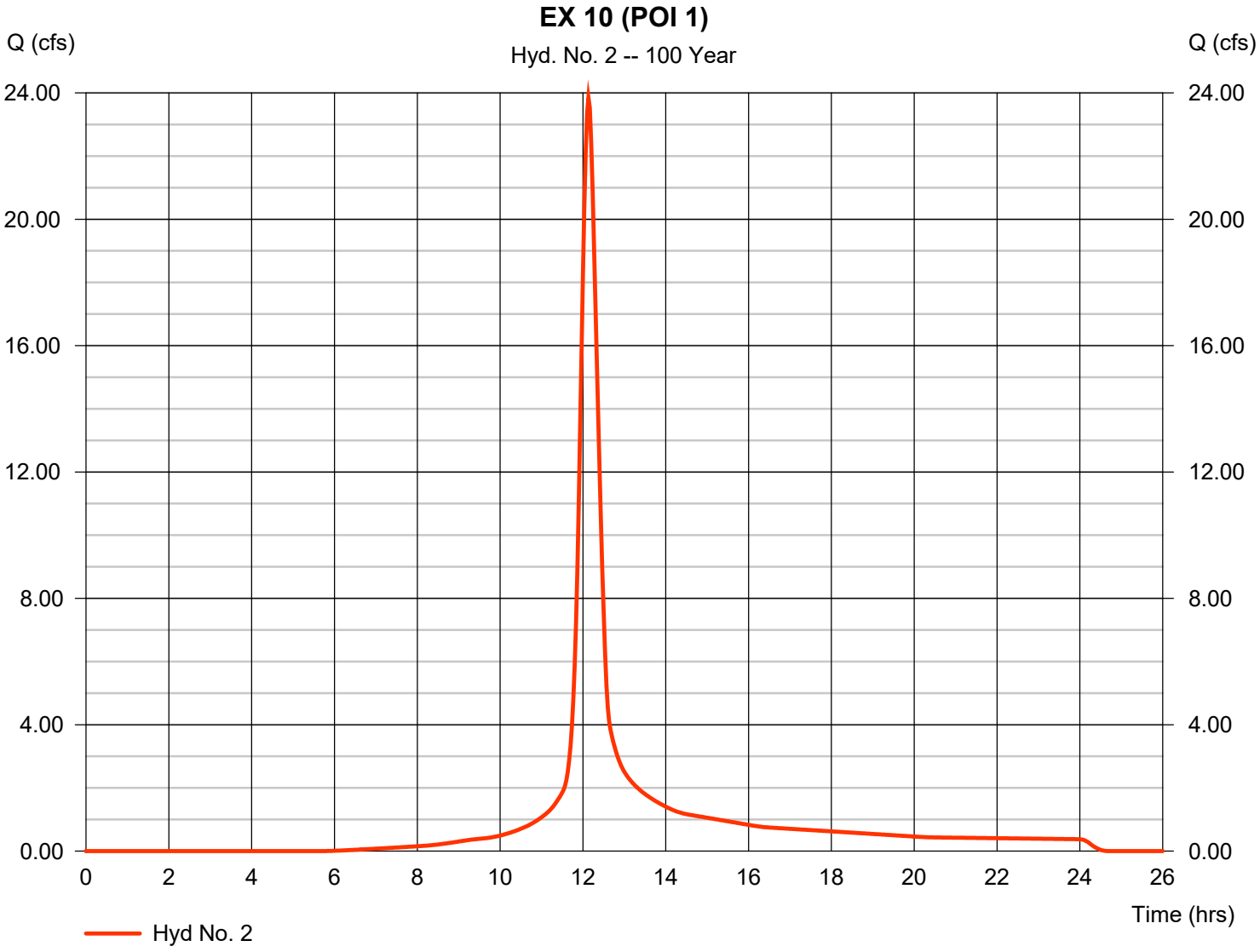
Hydrograph Report

Hyd. No. 2

EX 10 (POI 1)

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.85 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	87,924 cuft
Drainage area	=	3.980 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	26.30 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.090 x 98) + (3.890 x 74)] / 3.980



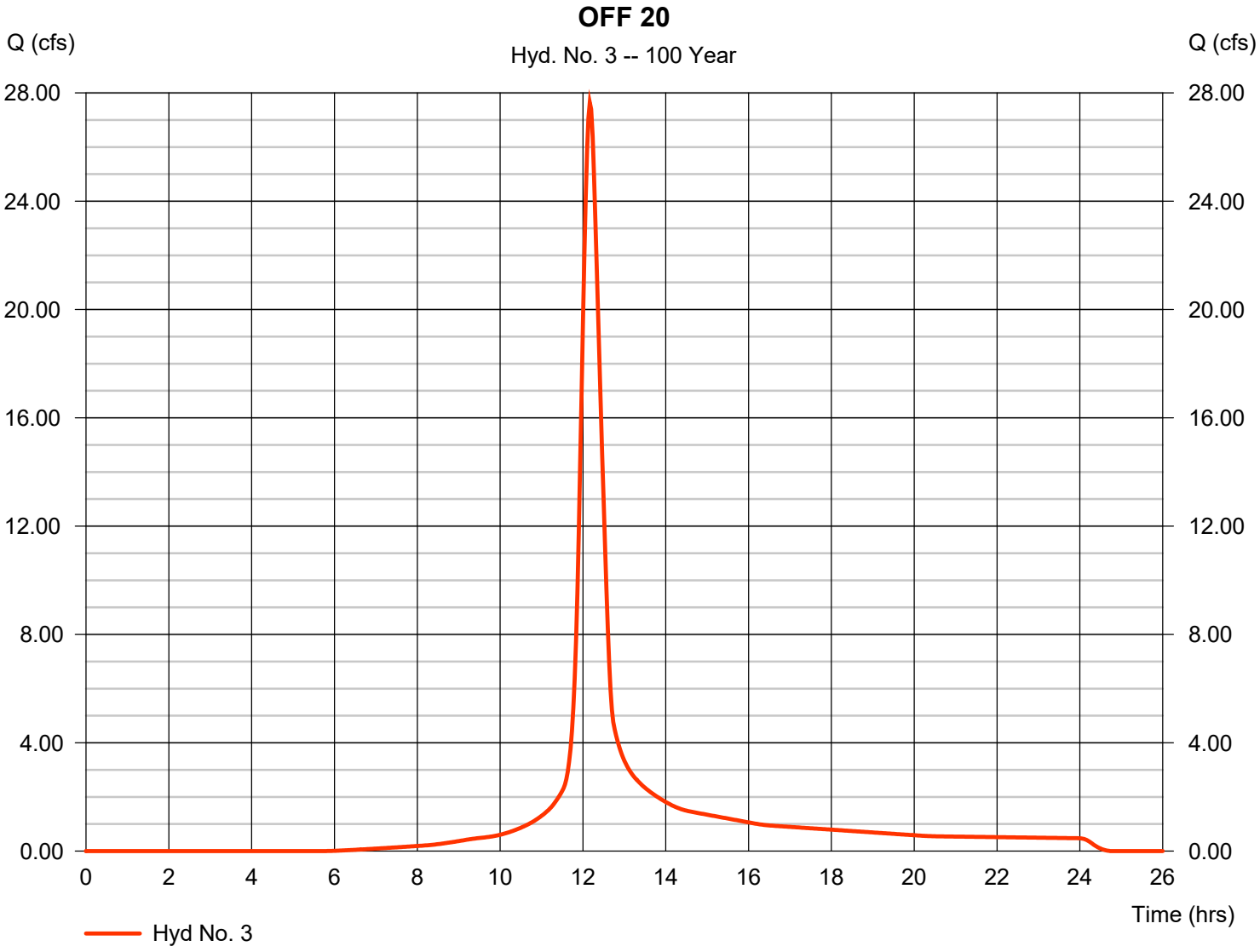
Hydrograph Report

Hyd. No. 3

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	27.64 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	110,864 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	28.90 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.140 x 98) + (4.800 x 74)] / 4.940

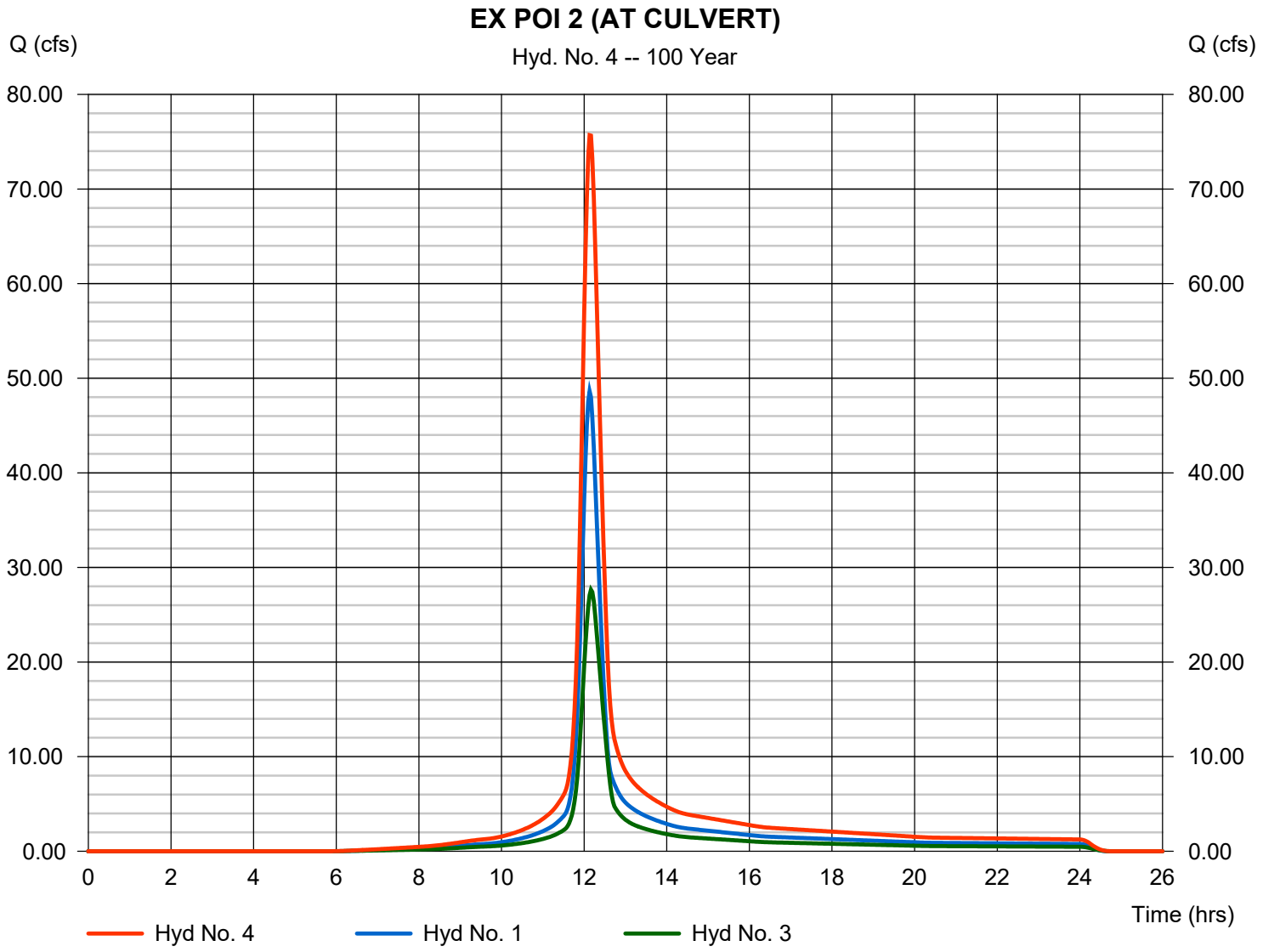


Hydrograph Report

Hyd. No. 4

EX POI 2 (AT CULVERT)

Hydrograph type	=	Combine	Peak discharge	=	75.69 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	289,864 cuft
Inflow hyds.	=	1, 3	Contrib. drain. area	=	13.210 ac



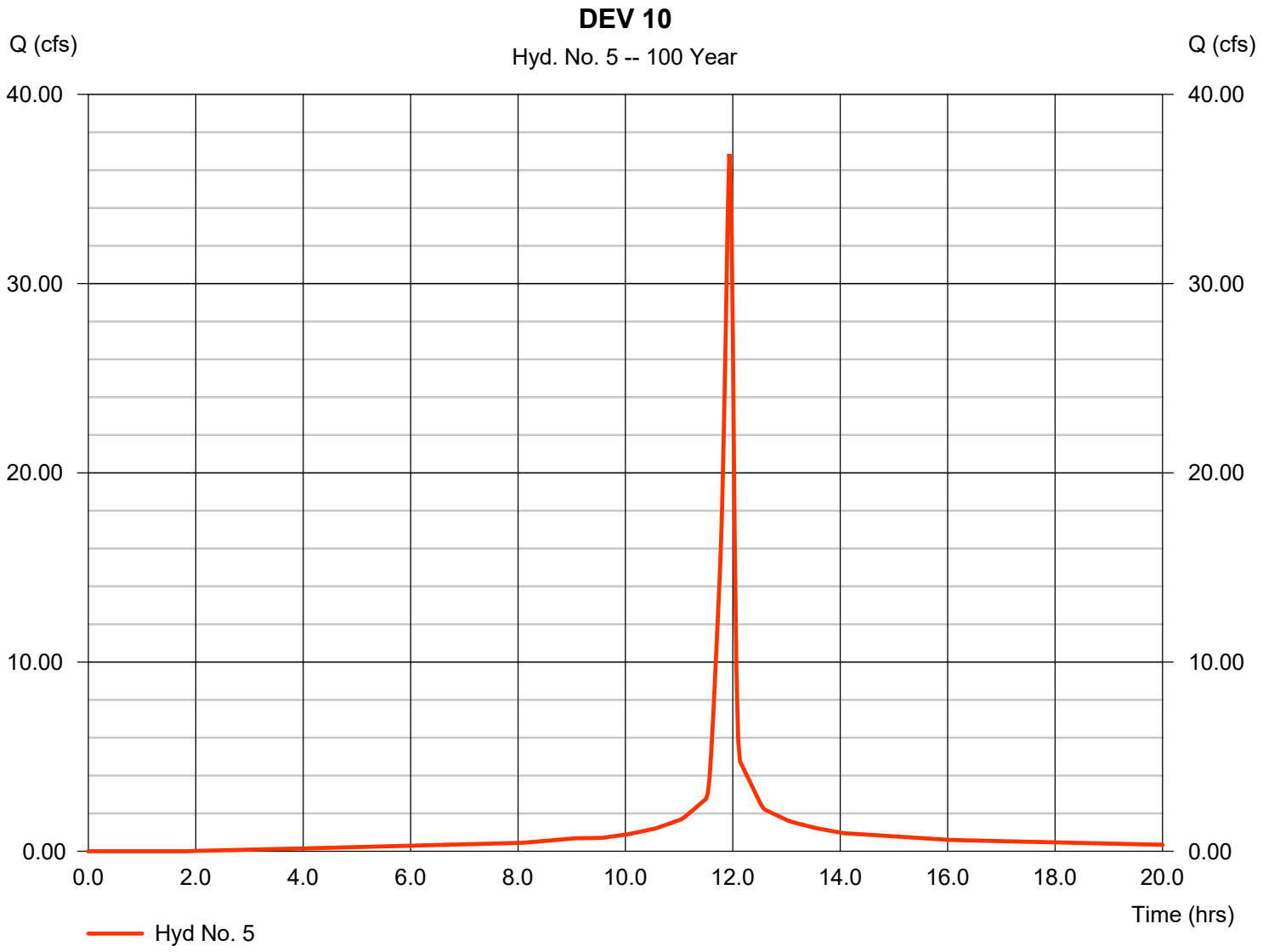
Hydrograph Report

Hyd. No. 5

DEV 10

Hydrograph type	=	SCS Runoff	Peak discharge	=	36.86 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	84,278 cuft
Drainage area	=	2.990 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.950 x 98) + (1.040 x 80)] / 2.990



Hydrograph Report

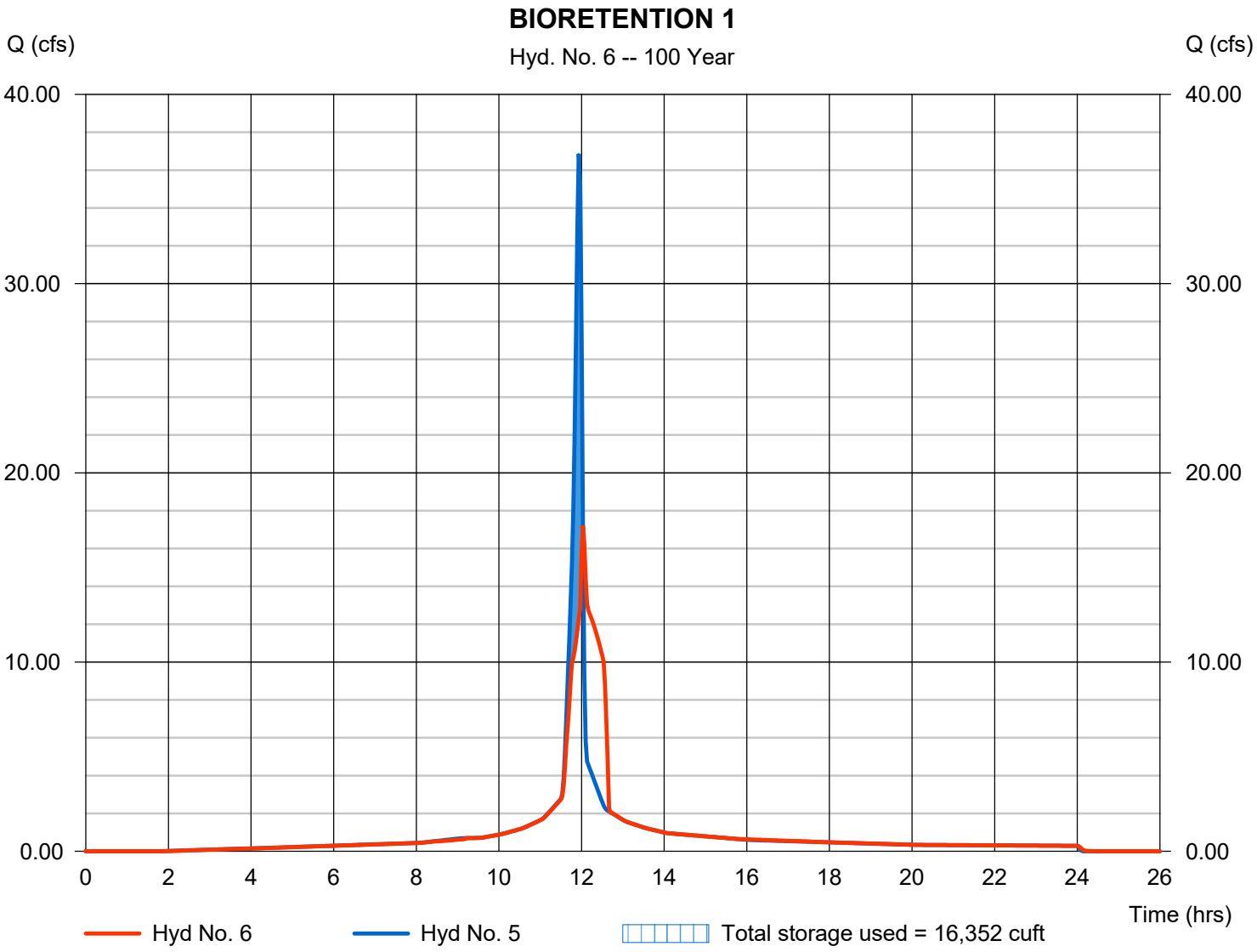
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 06 / 13 / 2019

Hyd. No. 6

BIORETENTION 1

Hydrograph type	= Reservoir	Peak discharge	= 17.22 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 84,277 cuft
Inflow hyd. No.	= 5 - DEV 10	Max. Elevation	= 1021.76 ft
Reservoir name	= BIORETENTION 1	Max. Storage	= 16,352 cuft

Storage Indication method used.



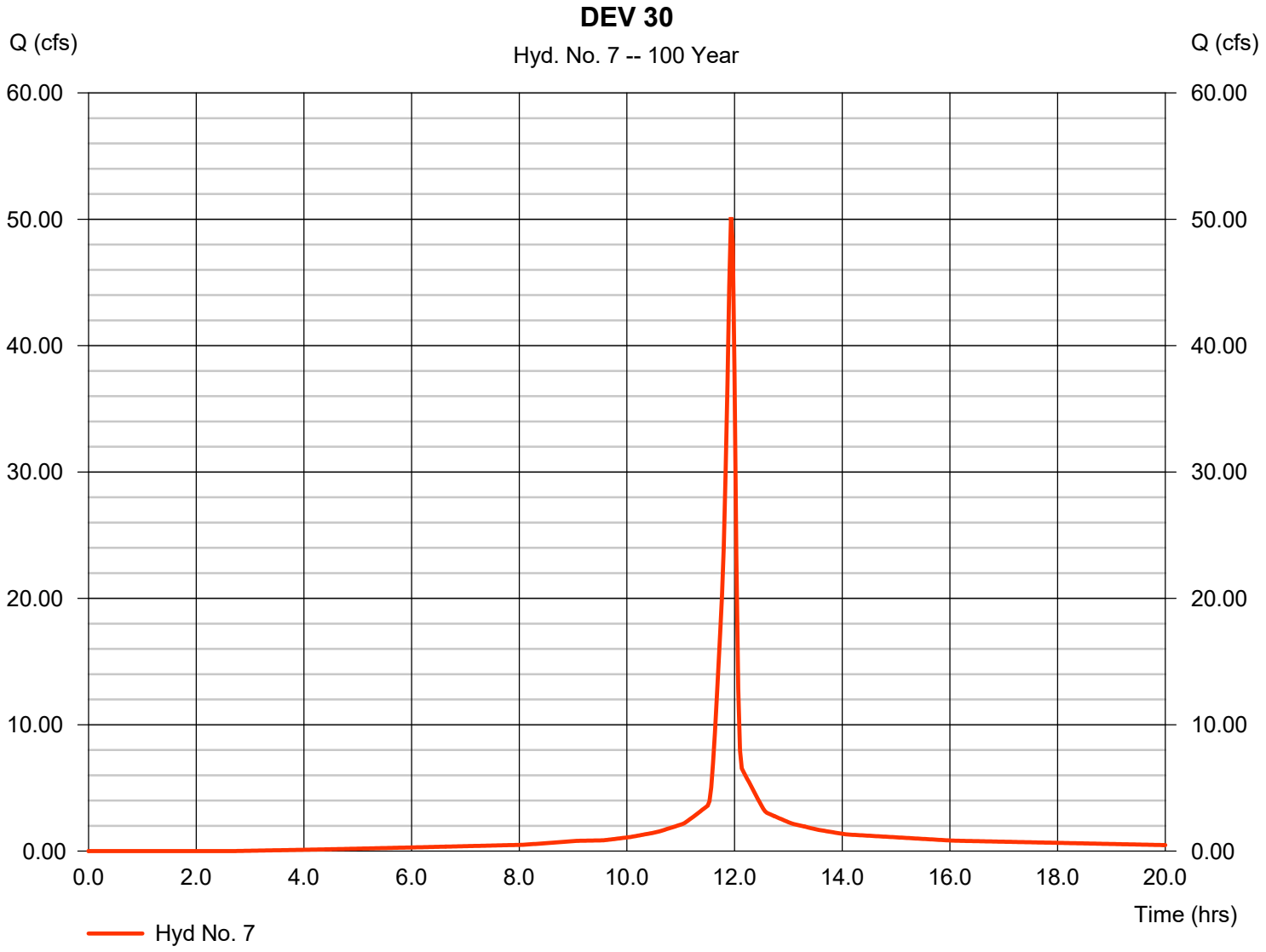
Hydrograph Report

Hyd. No. 7

DEV 30

Hydrograph type	=	SCS Runoff	Peak discharge	=	50.17 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	111,128 cuft
Drainage area	=	4.190 ac	Curve number	=	88*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.960 x 98) + (0.750 x 80) + (0.370 x 80) + (1.110 x 80)] / 4.190

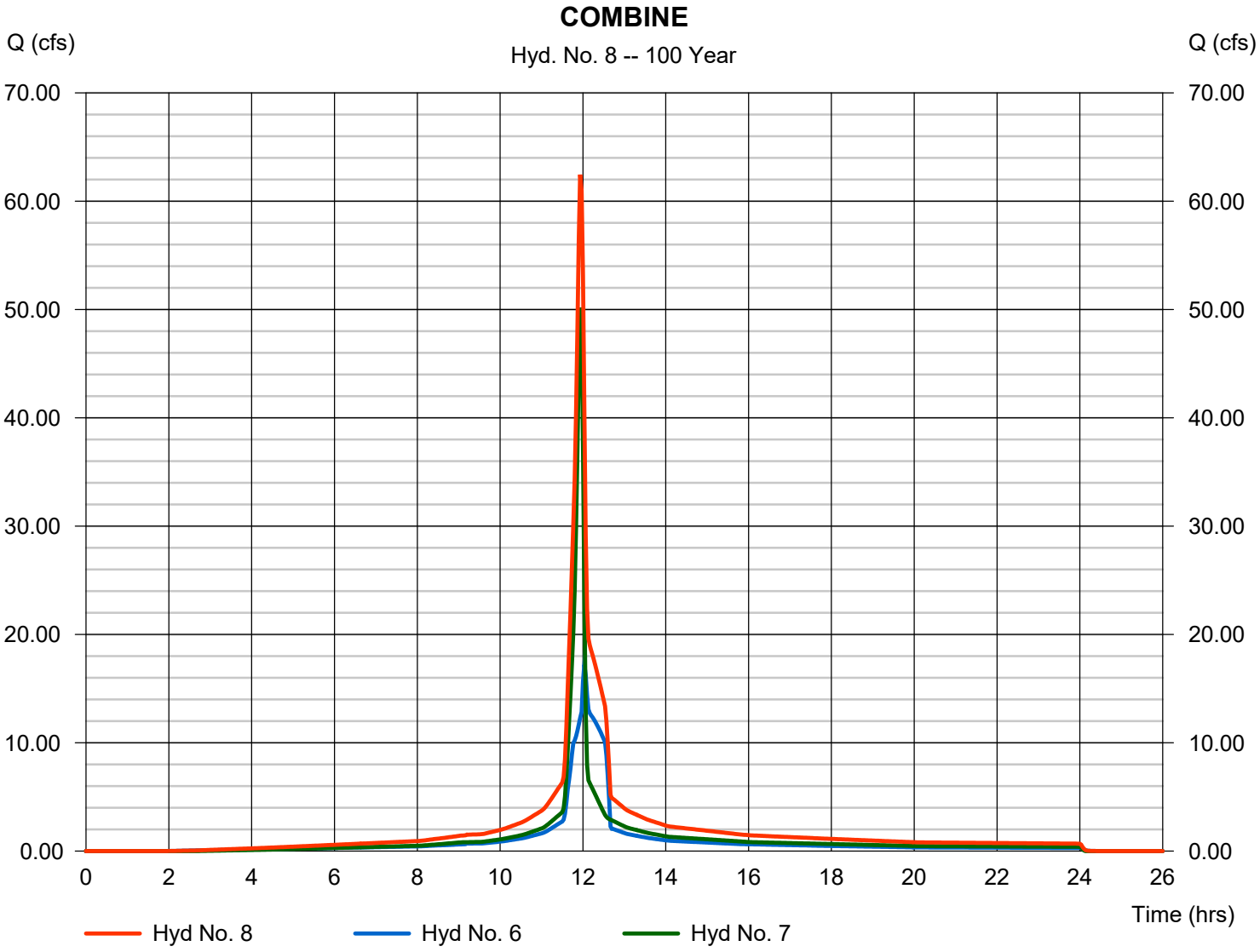


Hydrograph Report

Hyd. No. 8

COMBINE

Hydrograph type	=	Combine	Peak discharge	=	62.45 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	195,405 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	4.190 ac



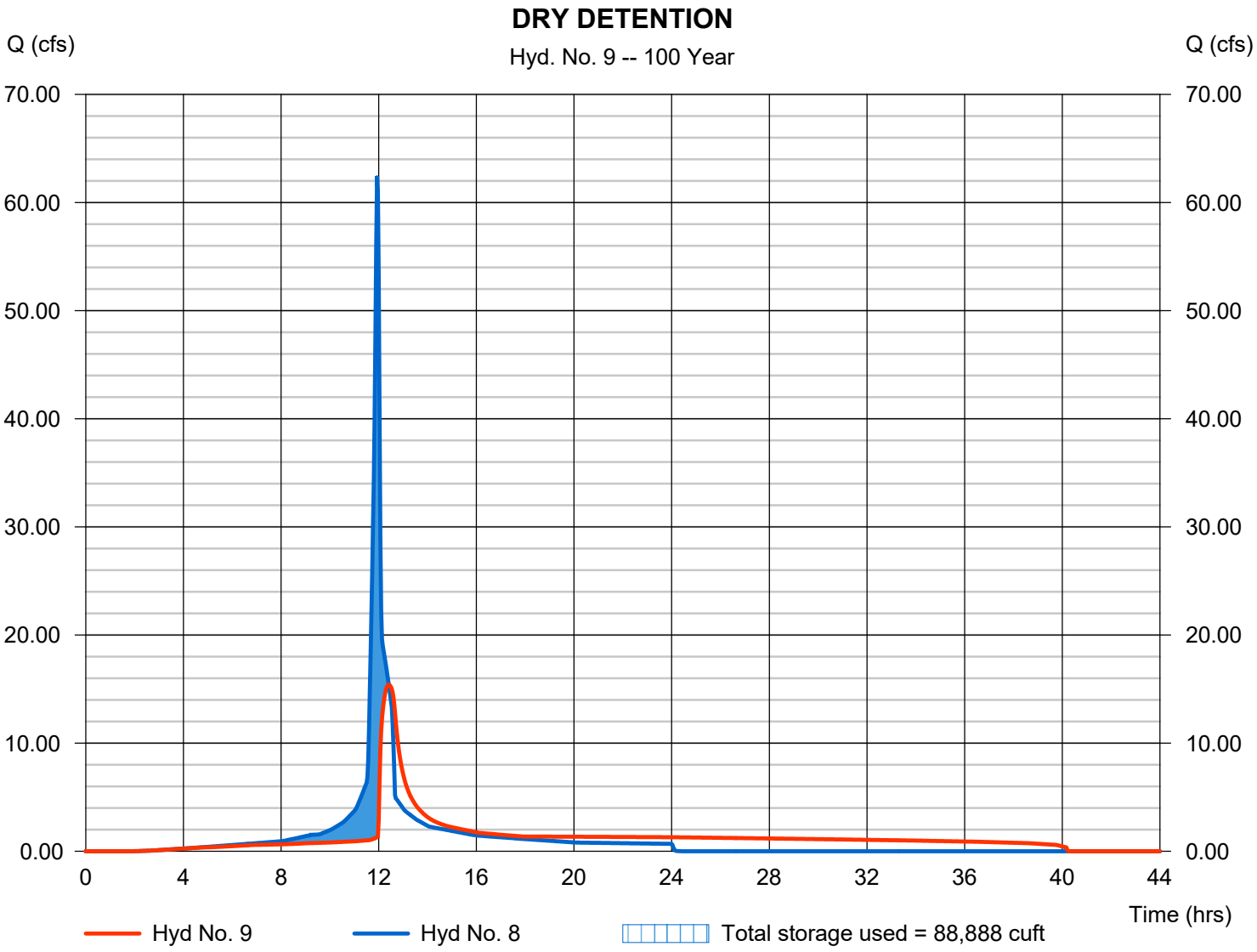
Hydrograph Report

Hyd. No. 9

DRY DETENTION

Hydrograph type	=	Reservoir	Peak discharge	=	15.40 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	195,405 cuft
Inflow hyd. No.	=	8 - COMBINE	Max. Elevation	=	1021.10 ft
Reservoir name	=	DRY DETENTION 1	Max. Storage	=	88,888 cuft

Storage Indication method used.



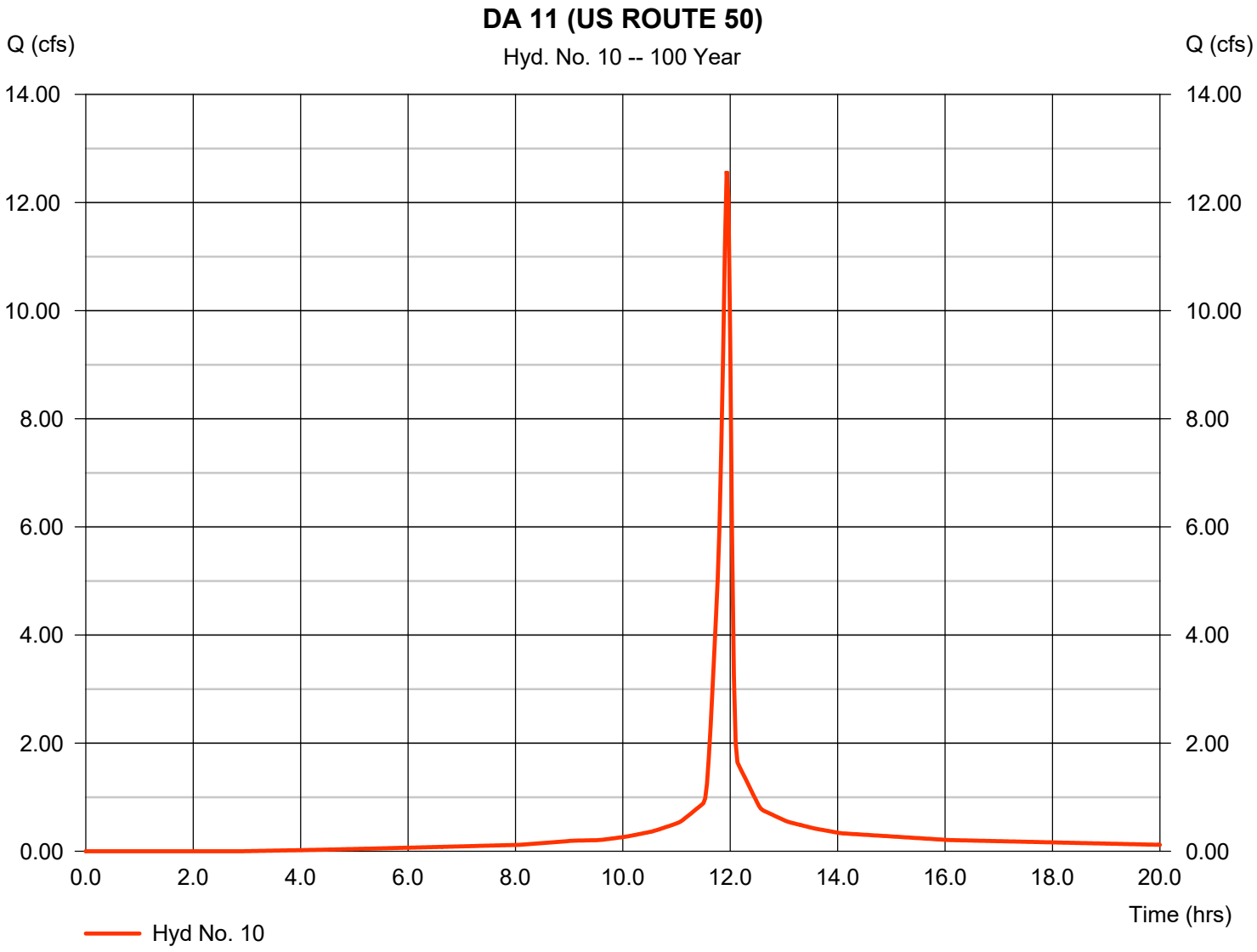
Hydrograph Report

Hyd. No. 10

DA 11 (US ROUTE 50)

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.58 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	27,670 cuft
Drainage area	=	1.060 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.400 x 98) + (0.660 x 80)] / 1.060

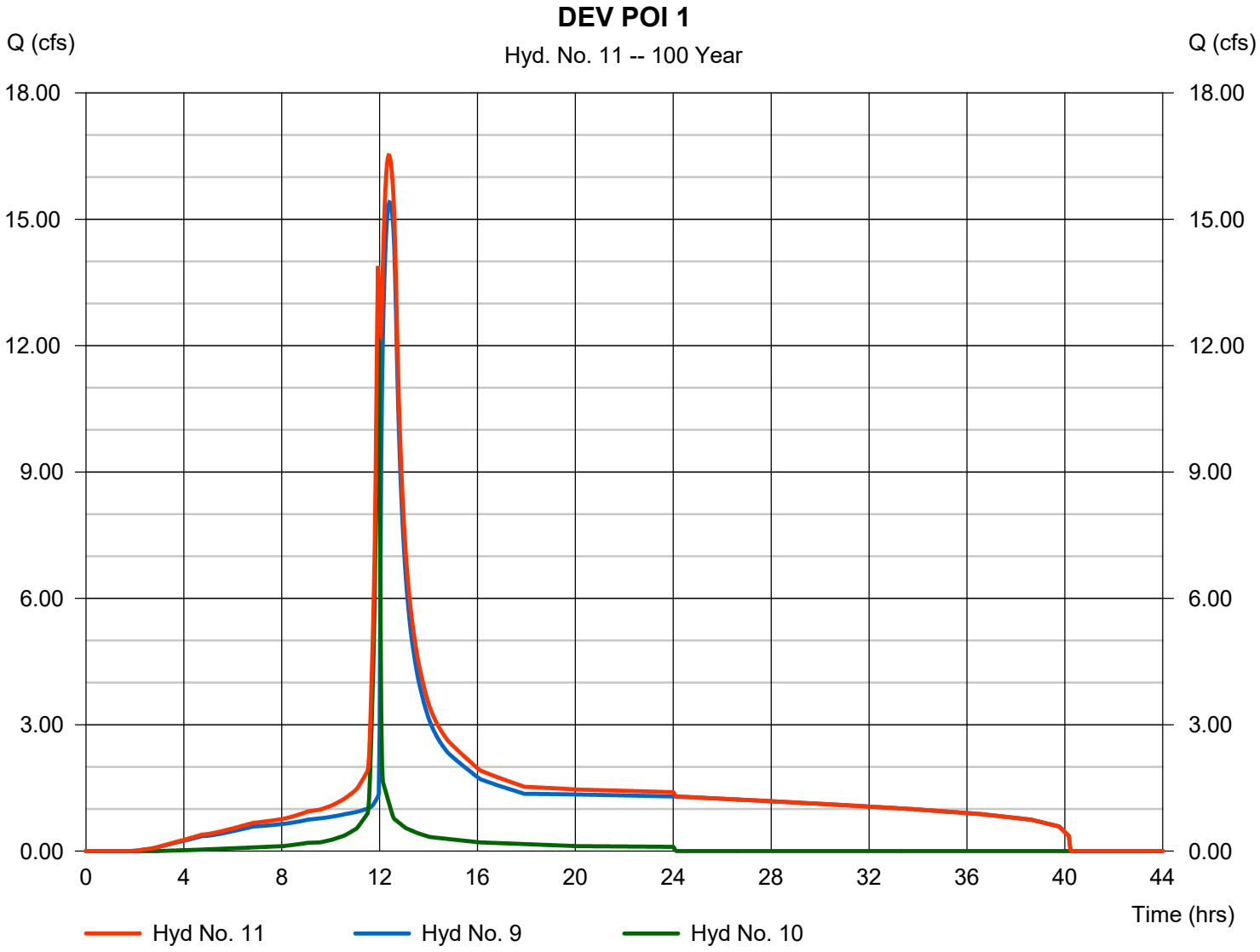


Hydrograph Report

Hyd. No. 11

DEV POI 1

Hydrograph type	=	Combine	Peak discharge	=	16.52 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.37 hrs
Time interval	=	2 min	Hyd. volume	=	223,075 cuft
Inflow hyds.	=	9, 10	Contrib. drain. area	=	1.060 ac



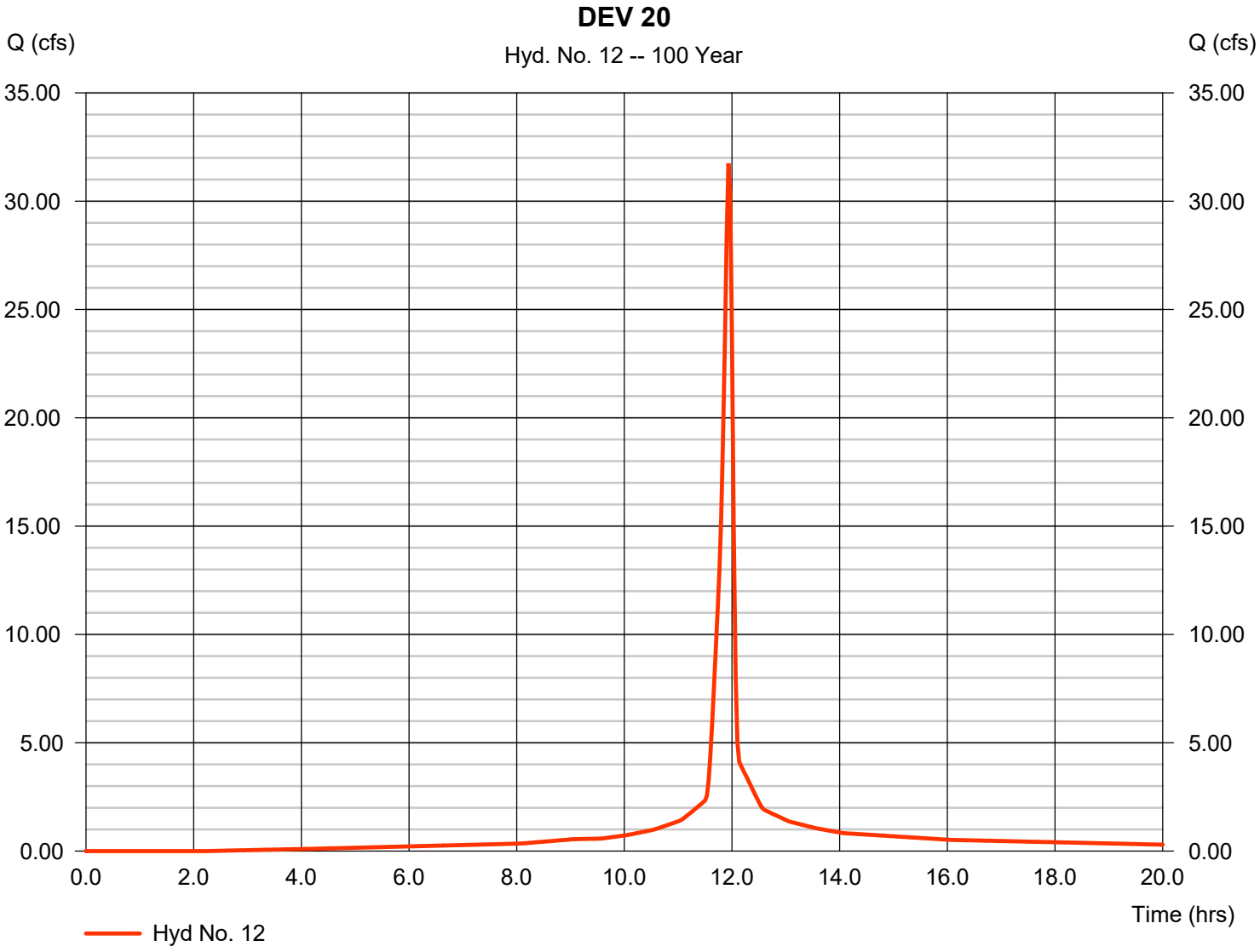
Hydrograph Report

Hyd. No. 12

DEV 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	31.75 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	71,399 cuft
Drainage area	=	2.610 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.440 x 98) + (1.170 x 80)] / 2.610



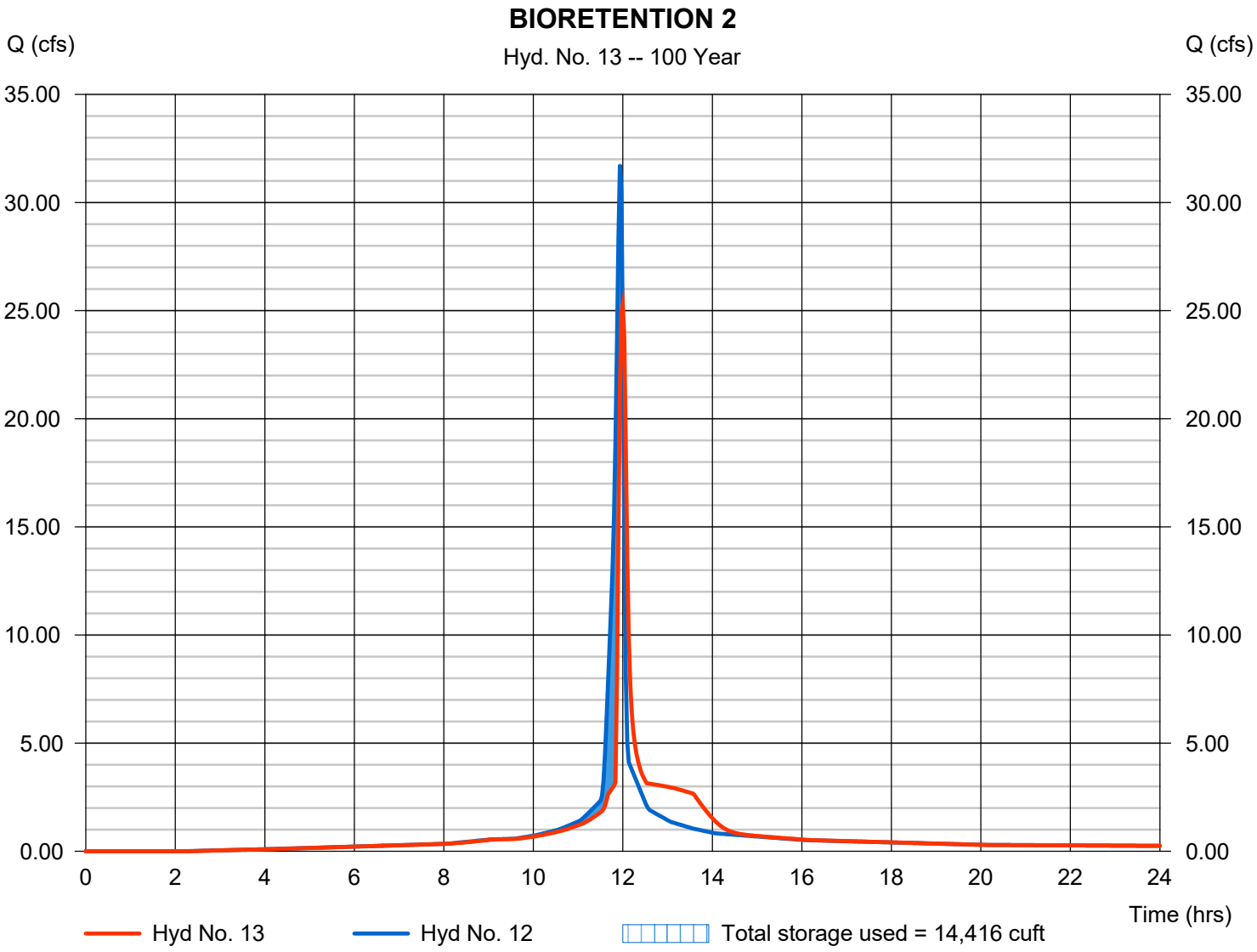
Hydrograph Report

Hyd. No. 13

BIORETENTION 2

Hydrograph type	=	Reservoir	Peak discharge	=	25.26 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	71,399 cuft
Inflow hyd. No.	=	12 - DEV 20	Max. Elevation	=	1023.26 ft
Reservoir name	=	BIORETENTION 2	Max. Storage	=	14,416 cuft

Storage Indication method used.



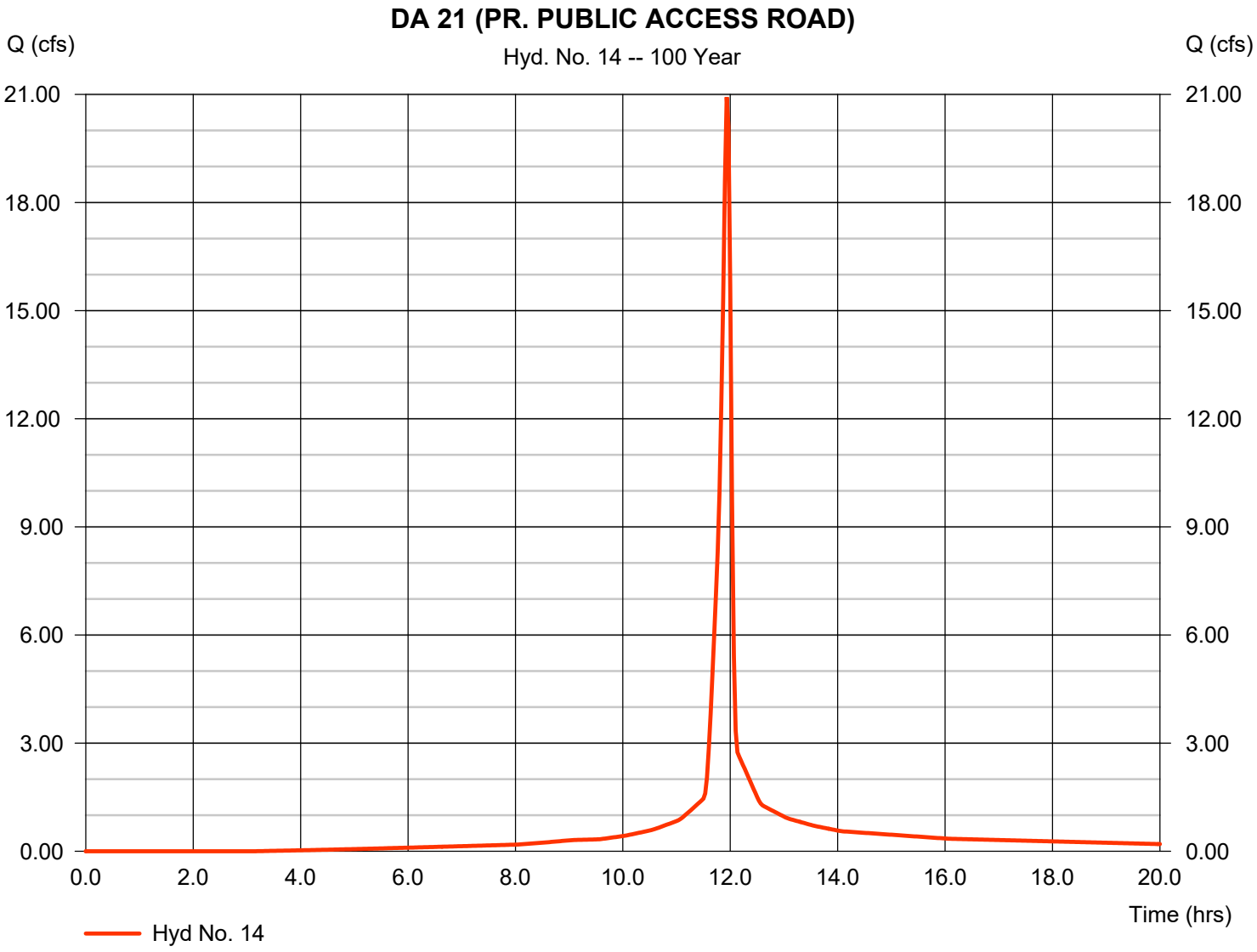
Hydrograph Report

Hyd. No. 14

DA 21 (PR. PUBLIC ACCESS ROAD)

Hydrograph type	=	SCS Runoff	Peak discharge	=	20.92 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	45,720 cuft
Drainage area	=	1.780 ac	Curve number	=	86*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.630 x 98) + (1.150 x 80)] / 1.780



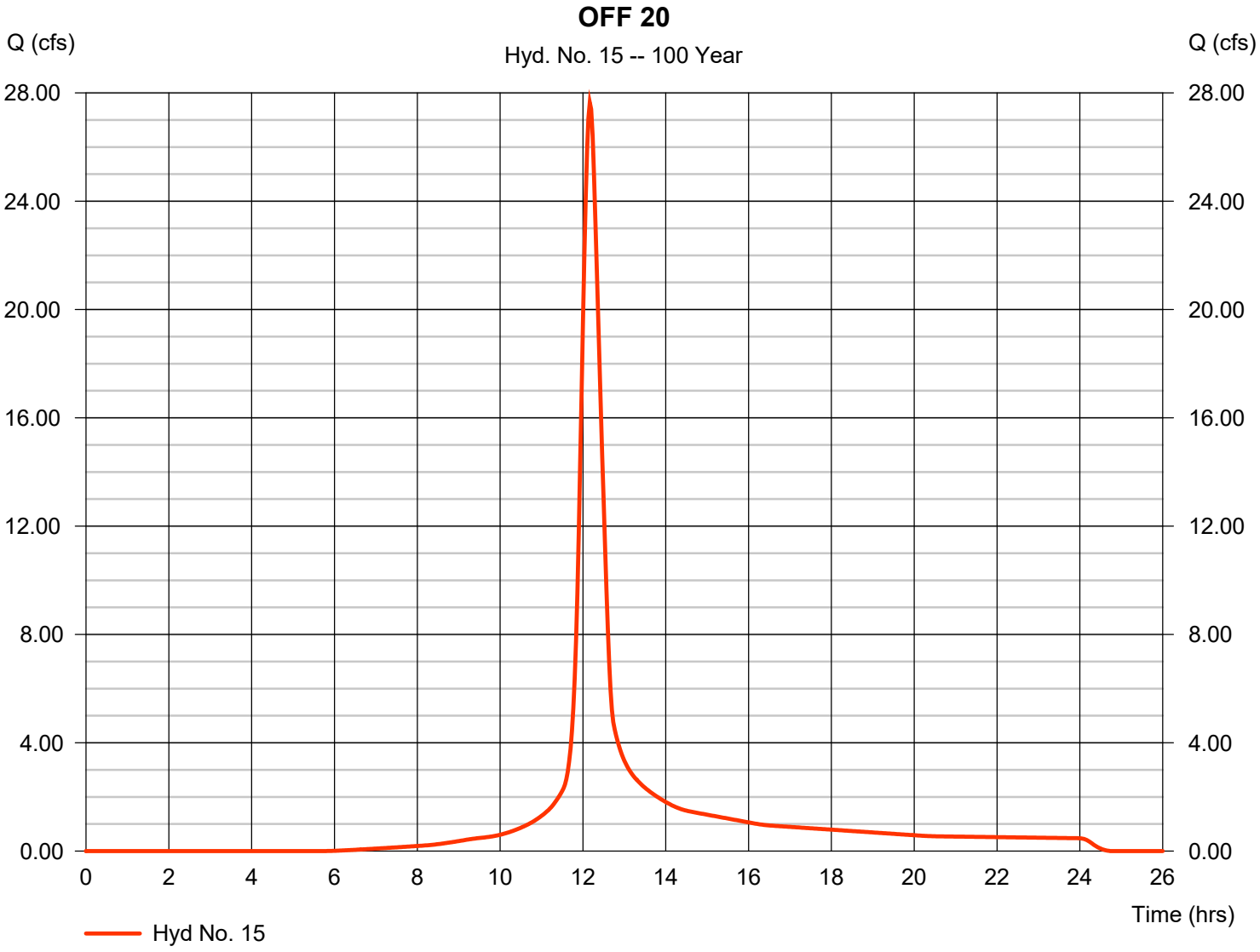
Hydrograph Report

Hyd. No. 15

OFF 20

Hydrograph type	=	SCS Runoff	Peak discharge	=	27.64 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	110,864 cuft
Drainage area	=	4.940 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.90 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.190 x 98) + (4.750 x 74)] / 4.940



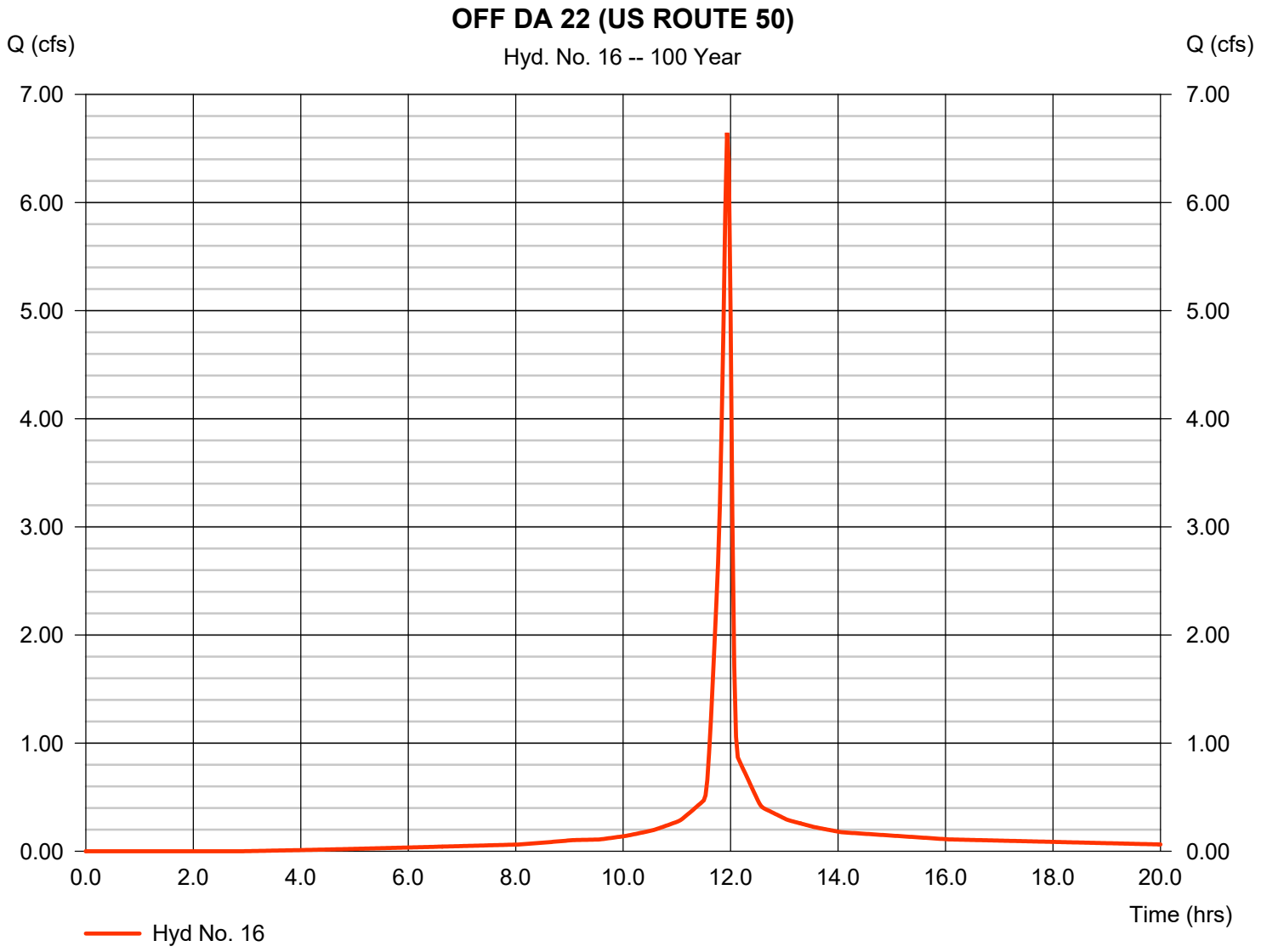
Hydrograph Report

Hyd. No. 16

OFF DA 22 (US ROUTE 50)

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.646 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	14,618 cuft
Drainage area	=	0.560 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.25 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.210 x 98) + (0.350 x 80)] / 0.560

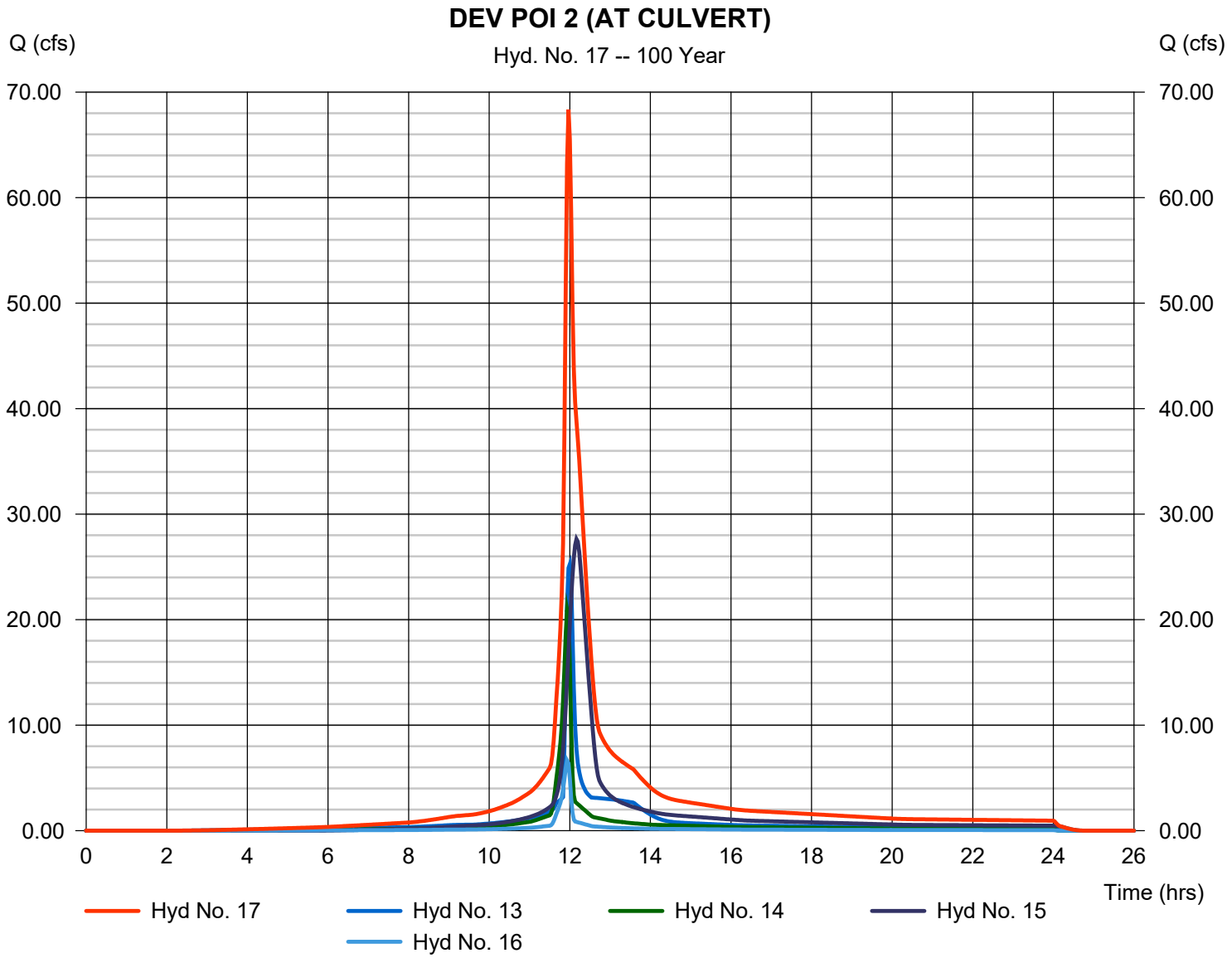


Hydrograph Report

Hyd. No. 17

DEV POI 2 (AT CULVERT)

Hydrograph type	=	Combine	Peak discharge	=	68.36 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	242,601 cuft
Inflow hyds.	=	13, 14, 15, 16	Contrib. drain. area	=	7.280 ac



Hydraflow Table of Contents

81450_24-HR ANALYSIS.gpw

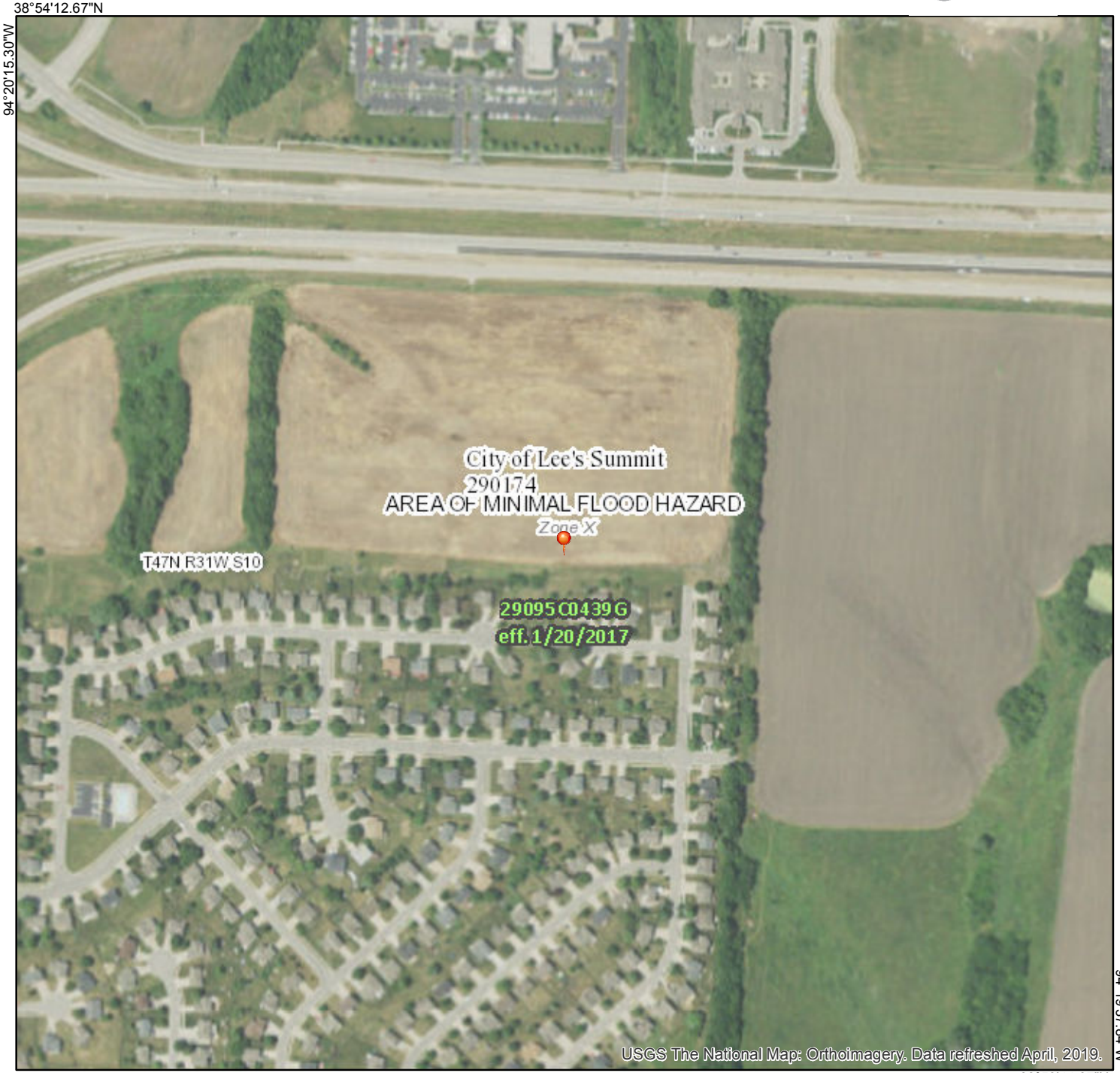
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 06 / 13 / 2019

National Flood Hazard Layer FIRMette

FEMA

38°54'12.67"N

94°20'15.30"W



94°19'37.84"W

38°53'44.67"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	Coastal Transect
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/3/2019 at 9:52:30 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Hydrologic Soil Group—Jackson County, Missouri
(EXISTING DRAINAGE AREA)

Map Scale: 1:2,370 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 35 70 140 210

Feet
0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N 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 1:24,000.

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

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

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

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

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

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

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 19, Sep 13, 2018

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

Date(s) aerial images were photographed: Jun 11, 2017—Sep 22, 2017

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
10000	Arisburg silt loam, 1 to 5 percent slopes	C	14.9	80.7%
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	C	3.6	19.3%
Totals for Area of Interest			**18.4**	**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

NOAA Atlas 14, Volume 8, Version 2
Location name: Lees Summit, Missouri, USA*
Latitude: 38.9004°, Longitude: -94.3314°
Elevation: 1024.15 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.415 (0.324-0.529)	0.484 (0.378-0.618)	0.599 (0.466-0.767)	0.696 (0.539-0.894)	0.832 (0.625-1.10)	0.938 (0.691-1.25)	1.05 (0.748-1.43)	1.16 (0.798-1.62)	1.31 (0.871-1.87)	1.42 (0.926-2.07)
10-min	0.607 (0.474-0.775)	0.709 (0.553-0.905)	0.877 (0.682-1.12)	1.02 (0.789-1.31)	1.22 (0.916-1.61)	1.37 (1.01-1.84)	1.53 (1.10-2.09)	1.70 (1.17-2.37)	1.92 (1.27-2.75)	2.08 (1.36-3.03)
15-min	0.740 (0.578-0.945)	0.864 (0.674-1.10)	1.07 (0.832-1.37)	1.24 (0.962-1.60)	1.49 (1.12-1.96)	1.68 (1.23-2.24)	1.87 (1.34-2.55)	2.07 (1.43-2.89)	2.34 (1.56-3.35)	2.54 (1.65-3.69)
30-min	1.02 (0.800-1.31)	1.20 (0.939-1.54)	1.50 (1.17-1.92)	1.75 (1.35-2.24)	2.09 (1.57-2.76)	2.36 (1.74-3.15)	2.63 (1.88-3.59)	2.91 (2.00-4.07)	3.28 (2.18-4.70)	3.57 (2.32-5.18)
60-min	1.34 (1.05-1.71)	1.57 (1.23-2.01)	1.97 (1.53-2.52)	2.30 (1.78-2.95)	2.76 (2.08-3.66)	3.13 (2.31-4.20)	3.51 (2.51-4.80)	3.90 (2.69-5.46)	4.43 (2.95-6.35)	4.83 (3.14-7.02)
2-hr	1.66 (1.30-2.10)	1.95 (1.53-2.47)	2.43 (1.91-3.09)	2.85 (2.22-3.63)	3.44 (2.61-4.53)	3.91 (2.90-5.20)	4.39 (3.16-5.97)	4.89 (3.40-6.81)	5.57 (3.74-7.94)	6.10 (4.00-8.80)
3-hr	1.87 (1.48-2.36)	2.20 (1.74-2.78)	2.76 (2.17-3.49)	3.24 (2.54-4.11)	3.93 (3.00-5.16)	4.48 (3.35-5.95)	5.06 (3.67-6.86)	5.66 (3.95-7.85)	6.48 (4.38-9.22)	7.13 (4.70-10.3)
6-hr	2.26 (1.80-2.82)	2.66 (2.12-3.34)	3.37 (2.67-4.22)	3.98 (3.14-5.01)	4.88 (3.76-6.37)	5.60 (4.22-7.39)	6.36 (4.65-8.57)	7.16 (5.05-9.89)	8.27 (5.63-11.7)	9.15 (6.07-13.1)
12-hr	2.66 (2.13-3.30)	3.16 (2.54-3.93)	4.04 (3.23-5.03)	4.81 (3.83-6.02)	5.94 (4.62-7.72)	6.86 (5.21-9.00)	7.83 (5.77-10.5)	8.86 (6.30-12.2)	10.3 (7.06-14.5)	11.4 (7.64-16.2)
24-hr	3.11 (2.51-3.82)	3.71 (2.99-4.57)	4.74 (3.82-5.86)	5.66 (4.54-7.02)	7.00 (5.48-9.03)	8.10 (6.20-10.5)	9.25 (6.88-12.3)	10.5 (7.51-14.3)	12.2 (8.44-17.0)	13.5 (9.14-19.1)
2-day	3.66 (2.98-4.47)	4.31 (3.50-5.26)	5.43 (4.41-6.66)	6.43 (5.19-7.91)	7.90 (6.24-10.1)	9.10 (7.03-11.8)	10.4 (7.77-13.7)	11.7 (8.47-15.9)	13.6 (9.50-18.9)	15.1 (10.3-21.2)
3-day	4.06 (3.33-4.94)	4.71 (3.85-5.73)	5.84 (4.76-7.12)	6.85 (5.55-8.38)	8.33 (6.61-10.6)	9.55 (7.41-12.3)	10.8 (8.16-14.3)	12.2 (8.87-16.5)	14.1 (9.92-19.5)	15.7 (10.7-21.9)
4-day	4.40 (3.61-5.33)	5.05 (4.14-6.12)	6.17 (5.05-7.50)	7.18 (5.84-8.76)	8.65 (6.89-11.0)	9.87 (7.68-12.7)	11.1 (8.42-14.6)	12.5 (9.12-16.8)	14.4 (10.2-19.9)	16.0 (10.9-22.2)
7-day	5.21 (4.30-6.27)	5.89 (4.86-7.10)	7.07 (5.82-8.53)	8.09 (6.62-9.80)	9.56 (7.64-12.0)	10.8 (8.41-13.7)	12.0 (9.11-15.6)	13.3 (9.74-17.7)	15.1 (10.7-20.6)	16.5 (11.4-22.9)
10-day	5.90 (4.89-7.07)	6.66 (5.52-7.99)	7.93 (6.55-9.53)	9.00 (7.40-10.9)	10.5 (8.43-13.1)	11.7 (9.20-14.8)	13.0 (9.87-16.7)	14.2 (10.5-18.9)	16.0 (11.3-21.7)	17.3 (12.0-23.9)
20-day	7.87 (6.58-9.35)	8.89 (7.43-10.6)	10.5 (8.78-12.6)	11.9 (9.85-14.2)	13.7 (11.0-16.8)	15.1 (11.9-18.7)	16.4 (12.5-20.9)	17.7 (13.1-23.2)	19.4 (13.9-26.1)	20.7 (14.5-28.3)
30-day	9.51 (7.99-11.3)	10.8 (9.03-12.7)	12.7 (10.7-15.1)	14.3 (11.9-17.1)	16.4 (13.2-19.9)	17.9 (14.1-22.1)	19.3 (14.9-24.5)	20.8 (15.4-27.0)	22.5 (16.1-30.1)	23.7 (16.7-32.4)
45-day	11.6 (9.80-13.7)	13.1 (11.1-15.5)	15.5 (13.0-18.3)	17.3 (14.5-20.6)	19.7 (15.9-23.8)	21.4 (17.0-26.3)	23.0 (17.7-28.9)	24.5 (18.2-31.6)	26.3 (18.9-34.9)	27.5 (19.4-37.3)
60-day	13.4 (11.4-15.7)	15.1 (12.8-17.8)	17.8 (15.0-21.0)	19.9 (16.7-23.5)	22.5 (18.2-27.0)	24.3 (19.3-29.7)	26.0 (20.1-32.5)	27.5 (20.5-35.4)	29.3 (21.1-38.7)	30.5 (21.6-41.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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NOAA Atlas 14, Volume 8, Version 2
Location name: Lees Summit, Missouri, USA*
Latitude: 38.9004°, Longitude: -94.3314°
Elevation: 1024.15 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.98 (3.89-6.35)	5.81 (4.54-7.42)	7.19 (5.59-9.20)	8.35 (6.47-10.7)	9.98 (7.50-13.2)	11.3 (8.29-15.1)	12.6 (8.98-17.2)	13.9 (9.58-19.4)	15.7 (10.5-22.5)	17.1 (11.1-24.8)
10-min	3.64 (2.84-4.65)	4.25 (3.32-5.43)	5.26 (4.09-6.74)	6.11 (4.73-7.85)	7.31 (5.50-9.66)	8.24 (6.07-11.0)	9.19 (6.57-12.6)	10.2 (7.01-14.2)	11.5 (7.65-16.5)	12.5 (8.13-18.2)
15-min	2.96 (2.31-3.78)	3.46 (2.70-4.42)	4.28 (3.33-5.48)	4.97 (3.85-6.39)	5.94 (4.47-7.86)	6.70 (4.94-8.97)	7.48 (5.34-10.2)	8.27 (5.70-11.6)	9.34 (6.22-13.4)	10.2 (6.61-14.8)
30-min	2.05 (1.60-2.62)	2.41 (1.88-3.07)	3.00 (2.33-3.83)	3.49 (2.70-4.48)	4.18 (3.14-5.52)	4.72 (3.47-6.31)	5.26 (3.76-7.18)	5.82 (4.01-8.13)	6.56 (4.37-9.40)	7.13 (4.64-10.4)
60-min	1.34 (1.05-1.71)	1.57 (1.23-2.01)	1.97 (1.53-2.52)	2.30 (1.78-2.95)	2.76 (2.08-3.66)	3.13 (2.31-4.20)	3.51 (2.51-4.80)	3.90 (2.69-5.46)	4.43 (2.95-6.35)	4.83 (3.14-7.02)
2-hr	0.828 (0.652-1.05)	0.973 (0.764-1.23)	1.22 (0.953-1.55)	1.42 (1.11-1.82)	1.72 (1.30-2.26)	1.95 (1.45-2.60)	2.19 (1.58-2.98)	2.44 (1.70-3.40)	2.79 (1.87-3.97)	3.05 (2.00-4.40)
3-hr	0.623 (0.493-0.786)	0.733 (0.578-0.924)	0.918 (0.723-1.16)	1.08 (0.845-1.37)	1.31 (0.999-1.72)	1.49 (1.12-1.98)	1.68 (1.22-2.28)	1.88 (1.32-2.62)	2.16 (1.46-3.07)	2.37 (1.56-3.41)
6-hr	0.377 (0.300-0.471)	0.445 (0.354-0.557)	0.562 (0.446-0.706)	0.665 (0.525-0.838)	0.814 (0.627-1.06)	0.935 (0.705-1.23)	1.06 (0.776-1.43)	1.20 (0.843-1.65)	1.38 (0.940-1.95)	1.53 (1.01-2.18)
12-hr	0.220 (0.177-0.274)	0.263 (0.210-0.326)	0.335 (0.268-0.418)	0.400 (0.318-0.499)	0.493 (0.383-0.641)	0.570 (0.433-0.747)	0.650 (0.479-0.871)	0.735 (0.522-1.01)	0.854 (0.586-1.20)	0.948 (0.634-1.35)
24-hr	0.129 (0.105-0.159)	0.154 (0.125-0.190)	0.198 (0.159-0.244)	0.236 (0.189-0.292)	0.292 (0.229-0.376)	0.338 (0.258-0.440)	0.386 (0.286-0.513)	0.437 (0.313-0.595)	0.508 (0.352-0.710)	0.565 (0.381-0.796)
2-day	0.076 (0.062-0.093)	0.090 (0.073-0.110)	0.113 (0.092-0.139)	0.134 (0.108-0.165)	0.165 (0.130-0.211)	0.190 (0.146-0.245)	0.216 (0.162-0.286)	0.244 (0.176-0.331)	0.284 (0.198-0.393)	0.315 (0.214-0.441)
3-day	0.056 (0.046-0.069)	0.065 (0.053-0.080)	0.081 (0.066-0.099)	0.095 (0.077-0.116)	0.116 (0.092-0.147)	0.133 (0.103-0.171)	0.151 (0.113-0.198)	0.170 (0.123-0.229)	0.196 (0.138-0.272)	0.218 (0.149-0.304)
4-day	0.046 (0.038-0.056)	0.053 (0.043-0.064)	0.064 (0.053-0.078)	0.075 (0.061-0.091)	0.090 (0.072-0.114)	0.103 (0.080-0.132)	0.116 (0.088-0.152)	0.130 (0.095-0.175)	0.150 (0.106-0.207)	0.166 (0.114-0.231)
7-day	0.031 (0.026-0.037)	0.035 (0.029-0.042)	0.042 (0.035-0.051)	0.048 (0.039-0.058)	0.057 (0.045-0.071)	0.064 (0.050-0.081)	0.071 (0.054-0.093)	0.079 (0.058-0.105)	0.090 (0.064-0.123)	0.098 (0.068-0.136)
10-day	0.025 (0.020-0.029)	0.028 (0.023-0.033)	0.033 (0.027-0.040)	0.038 (0.031-0.045)	0.044 (0.035-0.055)	0.049 (0.038-0.062)	0.054 (0.041-0.070)	0.059 (0.044-0.079)	0.067 (0.047-0.090)	0.072 (0.050-0.099)
20-day	0.016 (0.014-0.019)	0.019 (0.015-0.022)	0.022 (0.018-0.026)	0.025 (0.021-0.030)	0.029 (0.023-0.035)	0.031 (0.025-0.039)	0.034 (0.026-0.044)	0.037 (0.027-0.048)	0.040 (0.029-0.054)	0.043 (0.030-0.059)
30-day	0.013 (0.011-0.016)	0.015 (0.013-0.018)	0.018 (0.015-0.021)	0.020 (0.017-0.024)	0.023 (0.018-0.028)	0.025 (0.020-0.031)	0.027 (0.021-0.034)	0.029 (0.021-0.037)	0.031 (0.022-0.042)	0.033 (0.023-0.045)
45-day	0.011 (0.009-0.013)	0.012 (0.010-0.014)	0.014 (0.012-0.017)	0.016 (0.013-0.019)	0.018 (0.015-0.022)	0.020 (0.016-0.024)	0.021 (0.016-0.027)	0.023 (0.017-0.029)	0.024 (0.017-0.032)	0.025 (0.018-0.035)
60-day	0.009 (0.008-0.011)	0.011 (0.009-0.012)	0.012 (0.010-0.015)	0.014 (0.012-0.016)	0.016 (0.013-0.019)	0.017 (0.013-0.021)	0.018 (0.014-0.023)	0.019 (0.014-0.025)	0.020 (0.015-0.027)	0.021 (0.015-0.029)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

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APPENDIX B

Offsite Public Storm Sewer Hydraulic Calculations

10-year Storm Sewer Calculations

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	1.48*	0.00	1.48	0.00	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.18	7.55	0.79	0.00	9.5	14
2	B2	0.32*	0.00	0.32	0.00	Curb	0.5	4.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.11	4.03	0.79	0.00	9.5	1
3	B3	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
4	C1	2.49*	0.00	2.49	0.00	Curb	0.5	6.40	0.00	0.00	0.00	Sag	1.33	0.039	0.020	0.000	0.27	12.37	1.06	12.37	9.5	Off
5	C2	3.23*	0.00	3.23	0.00	Curb	0.5	8.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.23	10.22	0.81	0.49	9.5	4
6	C3	2.74*	0.00	2.74	0.00	Curb	0.5	8.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.22	9.59	0.79	0.00	9.5	5
7	C4	2.13*	0.00	2.13	0.00	Curb	0.5	7.00	0.00	0.00	0.00	0.013	1.33	0.039	0.020	0.013	0.19	8.27	0.79	0.00	9.5	6
8	C5	1.00*	0.00	1.00	0.00	Curb	0.5	4.00	0.00	0.00	0.00	0.013	1.33	0.039	0.020	0.013	0.15	6.13	0.81	0.52	9.5	11
9	B4	2.44*	0.00	2.44	0.00	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.21	9.17	0.79	0.00	9.5	4
10	B5	0.87*	0.00	0.87	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
11	C6	1.19*	0.00	1.19	0.00	Curb	0.5	5.60	0.00	0.00	0.00	Sag	1.33	0.039	0.020	0.000	0.19	8.07	0.98	8.07	9.5	Off
12	BIORETENTION	14.40*	0.00	0.00	14.40	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off
13	A1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
14	A2	4.03*	0.00	3.69	0.34	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.25	11.12	0.90	4.12	9.5	Off
15	A3	0.00	1.30	0.00	1.30	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off
16	DRY DETENTION	1.30*	0.00	0.00	1.30	MH	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.013	0.00	0.00	0.00	0.00	0.0	15

Project File: PUBLIC STORM 10-YR.stm | Number of lines: 16 | Run Date: 6/12/2019

NOTES: Inlet N-Values = 0.016; Known Qs only; * Indicates Known Q added. All curb inlets are throat.

MyReport

Line No.	Line ID	Line Length (ft)	Line Size (in)	n-val Pipe	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	Gnd/Rim El Dn (ft)	Gnd/Rim El Up (ft)	HGL Dn (ft)	HGL Up (ft)	Vel Ave (ft/s)	Defl Ang (Deg)	J-Loss Coeff	Minor Loss (ft)	Energy Loss (ft)	Known Q (cfs)	Flow Rate (cfs)
1	EX 30-IN. RCP	61.411	30	0.013	1014.45	1015.77	2.15	0.00	1021.46	1015.76	1017.70	10.20	91.614	1.50 z	1.47	0.000	1.48	32.29
2	P-B2	159.969	30	0.012	1015.97	1016.77	0.50	1021.46	1023.10	1017.98	1018.77	7.30	-89.493	1.50	1.24	0.801	0.32	30.81
3	P-B3	71.746	30	0.012	1016.97	1017.33	0.50	1023.10	1022.94	1020.02	1020.11	3.28	17.292	0.96	0.16	0.094	0.00	16.09
4	P-C1	65.881	30	0.012	1017.53	1017.86	0.50	1022.94	1022.24	1020.27	1020.32	2.61	72.806	1.50	0.16	0.052	2.49	12.78
5	P-C2	54.775	30	0.012	1018.06	1018.33	0.49	1022.24	1022.61	1020.48	1019.34	3.40	0.524	0.50 z	n/a	0.000	3.23	9.10
6	C3	158.006	24	0.012	1018.83	1019.62	0.50	1022.61	1024.19	1019.63	1020.48	4.78	-0.523	0.50 z	0.16	0.000	2.74	5.87
7	P-C4	113.126	18	0.012	1020.12	1020.69	0.50	1024.19	1025.49	1020.77	1021.36	4.18	0.000	1.50 z	0.39	0.000	2.13	3.13
8	P-C5	34.500	15	0.013	1021.19	1021.54	1.01	1025.49	1025.50	1021.52	1021.93	3.43	90.000	1.00 z	n/a	0.000	1.00	1.00
9	P-B4	37.097	18	0.012	1018.33	1019.07	1.99	1022.94	1024.22	1020.27	1020.29	2.01	-53.320	1.09	0.08	0.032	2.44	3.31
10	P-B5	28.622	18	0.012	1019.57	1021.05	5.17	1024.22	1022.70	1020.37	1021.40 j	1.86	43.121	1.00 z	n/a	0.000	0.87	0.87
11	C6	34.500	15	0.012	1018.36	1018.53	0.49	1022.24	1022.23	1020.48	1020.49	0.97	90.004	1.00	0.01	0.010	1.19	1.19
12	BIORETENTION	140.610	24	0.012	1017.47	1018.17	0.50	1023.10	1022.00	1020.02	1020.50	4.58	90.609	1.00	0.33	0.486	14.40	14.40
13	P-A1	300.530	18	0.012	1007.98	1009.48	0.50	1010.98	1014.10	1008.87	1010.37	4.86	2.122	0.15	0.06	1.500	0.00	5.33
14	P-A2	96.040	18	0.012	1009.68	1010.16	0.50	1014.10	1016.73	1010.57	1011.05	4.86	0.000	0.63	0.23	0.479	4.03	5.33
15	P-A3	145.940	18	0.012	1010.36	1011.09	0.50	1016.73	1016.73	1011.28	1011.52 j	2.14	21.462	0.94 z	n/a	0.000	0.00	1.30
16	DRY DETENTION	69.000	18	0.012	1011.29	1011.64	0.51	1016.73	1019.15	1011.70	1012.07	3.25	67.320	1.00 z	0.15	0.000	1.30	1.30

Project File: PUBLIC STORM 10-YR.stm | Number of lines: 16 | Date: 6/12/2019

NOTES: ** Critical depth

MyReport

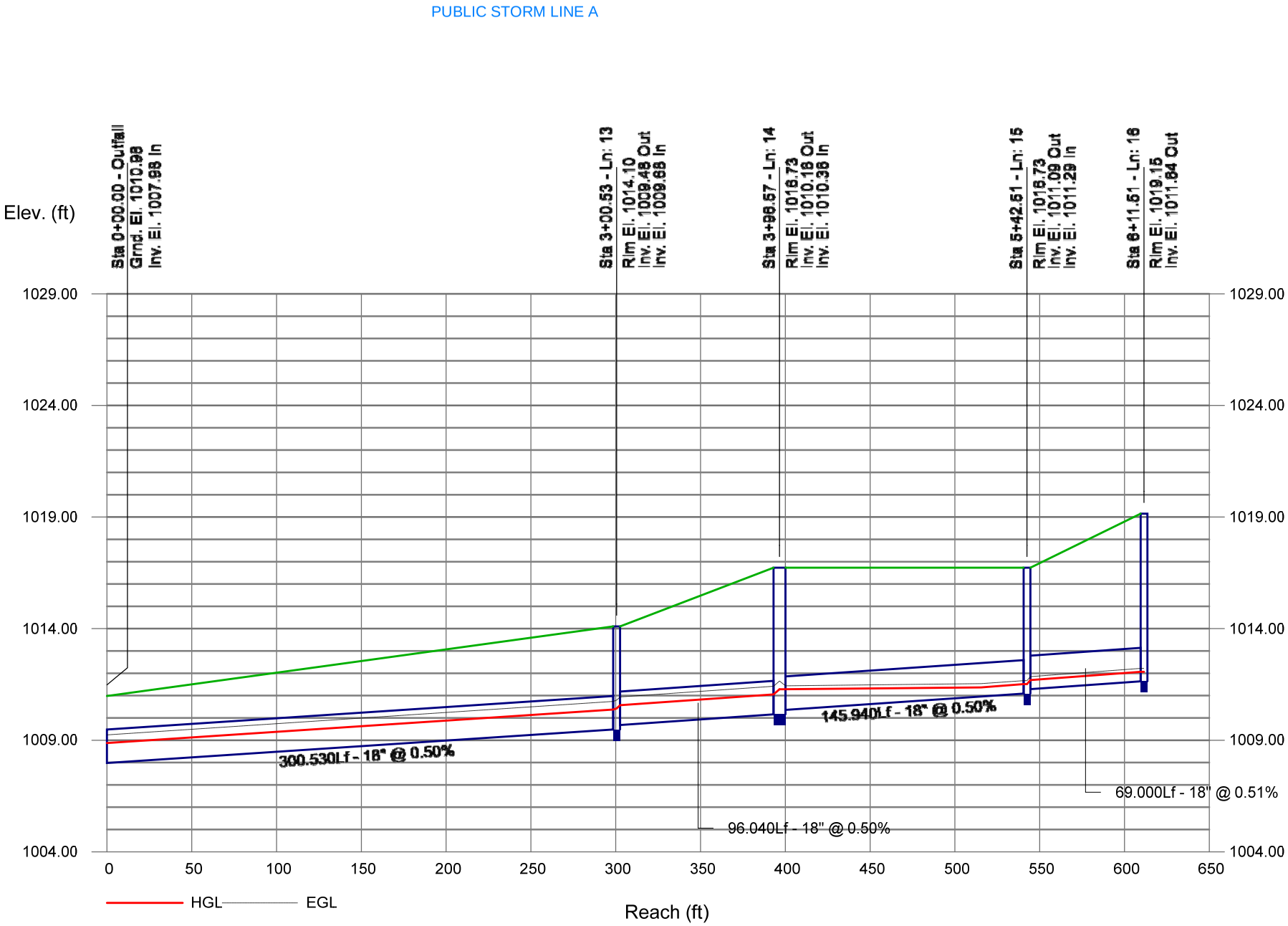
Capac Full (cfs)	
60.13	
31.42	
31.47	
31.44	
31.19	
17.33	
8.08	
6.50	
16.07	
25.87	
4.91	
17.29	
8.04	
8.04	
8.05	
8.10	

Project File: PUBLIC STORM 10-YR.stm	Number of lines: 16	Date: 6/12/2019

NOTES: ** Critical depth

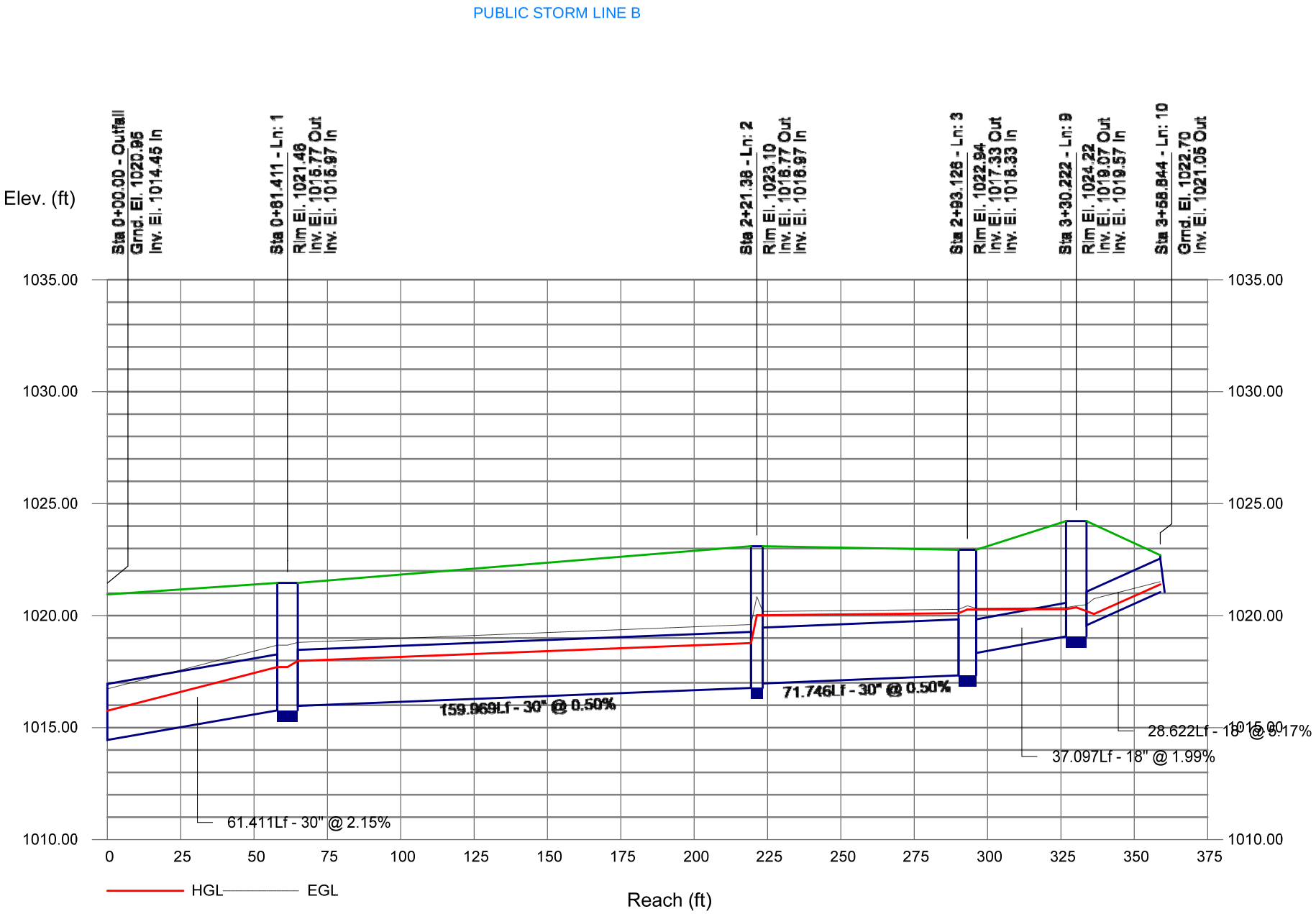
Storm Sewer Profile

Proj. file: PUBLIC STORM 10-YR.stm



Storm Sewer Profile

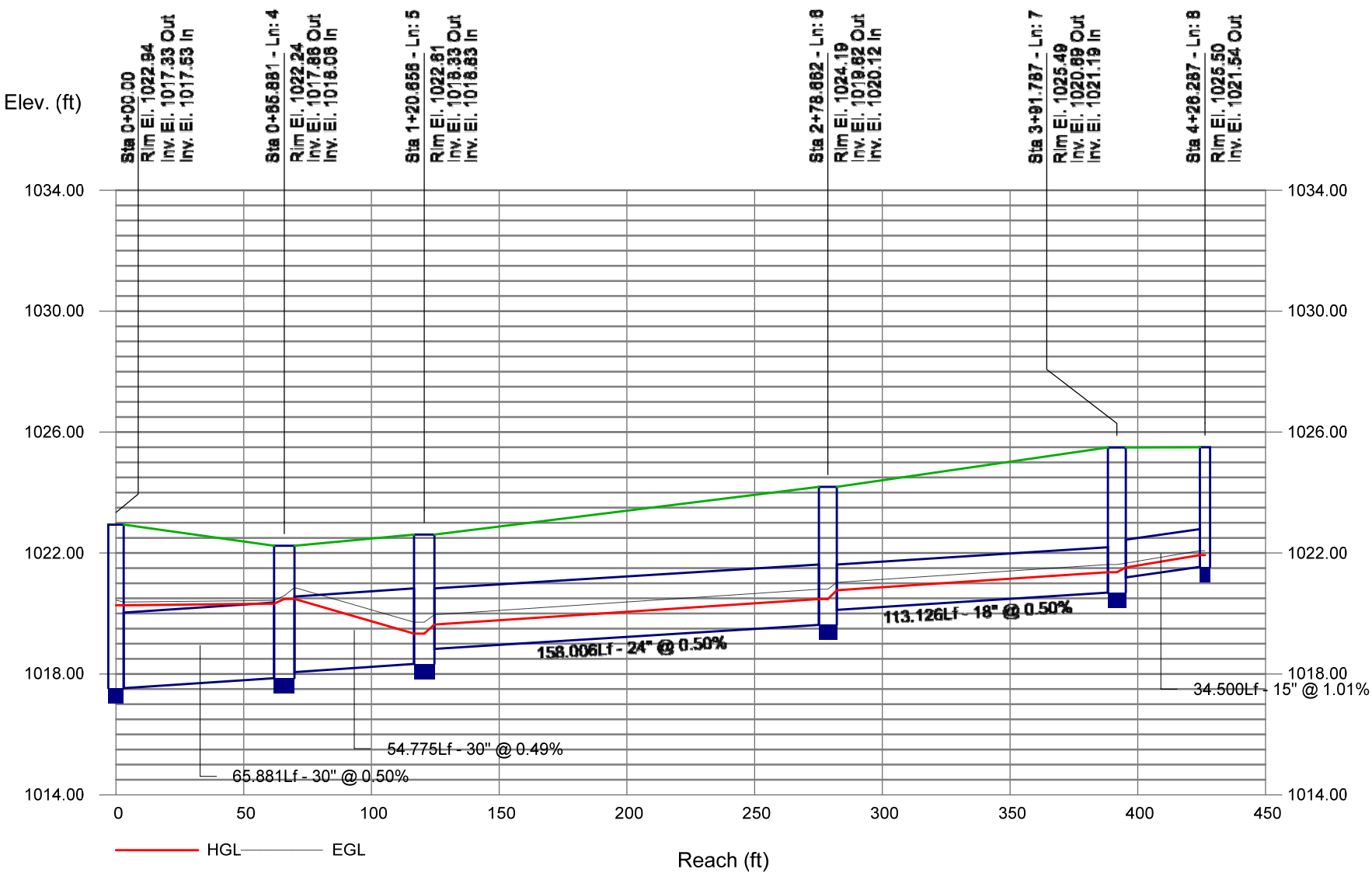
Proj. file: PUBLIC STORM 10-YR.stm



Storm Sewer Profile

Proj. file: PUBLIC STORM 10-YR.stm

PUBLIC STORM LINE C



25-year Storm Sewer Calculations

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	1.89*	0.00	1.89	0.00	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.19	8.30	0.79	0.00	9.5	14
2	B2	0.41*	0.00	0.41	0.00	Curb	0.5	4.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.11	4.48	0.79	0.00	9.5	1
3	B3	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
4	C1	3.18*	0.22	3.40	0.00	Curb	0.5	6.40	0.00	0.00	0.00	Sag	1.33	0.039	0.020	0.000	0.33	15.23	1.12	15.23	9.5	Off
5	C2	4.12*	0.03	4.00	0.15	Curb	0.5	8.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.25	11.25	0.87	2.88	9.5	4
6	C3	3.50*	0.04	3.51	0.03	Curb	0.5	8.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.24	10.58	0.84	1.22	9.5	5
7	C4	2.72*	0.00	2.68	0.04	Curb	0.5	7.00	0.00	0.00	0.00	0.013	1.33	0.039	0.020	0.013	0.21	9.09	0.84	1.25	9.5	6
8	C5	1.28*	0.00	1.22	0.06	Curb	0.5	4.00	0.00	0.00	0.00	0.013	1.33	0.039	0.020	0.013	0.16	6.77	0.85	1.54	9.5	11
9	B4	3.11*	0.00	3.04	0.07	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.23	10.07	0.85	1.90	9.5	4
10	B5	1.11*	0.00	1.11	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
11	C6	1.52*	0.06	1.58	0.00	Curb	0.5	5.60	0.00	0.00	0.00	Sag	1.33	0.039	0.020	0.000	0.22	9.72	1.01	9.72	9.5	Off
12	BIORETENTION	16.80*	0.00	0.00	16.80	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off
13	A1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
14	A2	5.14*	0.00	4.34	0.80	Curb	0.5	7.00	0.00	0.00	0.00	0.010	1.33	0.039	0.020	0.013	0.27	12.21	0.94	5.91	9.5	Off
15	A3	0.00	4.13	0.00	4.13	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	Off
16	DRY DETENTION	4.13*	0.00	0.00	4.13	MH	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.013	0.00	0.00	0.00	0.00	0.0	15

Project File: PUBLIC STORM 25-YR.stm | Number of lines: 16 | Run Date: 6/12/2019

NOTES: Inlet N-Values = 0.016; Known Qs only; * Indicates Known Q added. All curb inlets are throat.

MyReport

Line No.	Line ID	Line Length (ft)	Line Size (in)	n-val Pipe	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	Gnd/Rim El Dn (ft)	Gnd/Rim El Up (ft)	HGL Dn (ft)	HGL Up (ft)	Vel Ave (ft/s)	Defl Ang (Deg)	J-Loss Coeff	Minor Loss (ft)	Energy Loss (ft)	Known Q (cfs)	Flow Rate (cfs)
1	EX 30-IN. RCP	61.411	30	0.013	1014.45	1015.77	2.15	0.00	1021.46	1015.93	1017.89	11.01	91.614	1.50 z	1.86	0.000	1.89	39.64
2	P-B2	159.969	30	0.012	1015.97	1016.77	0.50	1021.46	1023.10	1018.47	1019.63	7.69	-89.493	1.50	1.38	1.155	0.41	37.75
3	P-B3	71.746	30	0.012	1016.97	1017.33	0.50	1023.10	1022.94	1021.01	1021.16	4.18	17.292	0.96	0.26	0.153	0.00	20.54
4	P-C1	65.881	30	0.012	1017.53	1017.86	0.50	1022.94	1022.24	1021.42	1021.51	3.32	72.806	1.50	0.26	0.089	3.18	16.32
5	P-C2	54.775	30	0.012	1018.06	1018.33	0.49	1022.24	1022.61	1021.77	1021.80	2.37	0.524	0.50	0.04	0.037	4.12	11.62
6	C3	158.006	24	0.012	1018.83	1019.62	0.50	1022.61	1024.19	1021.85	1022.00	2.39	-0.523	0.50	0.04	0.148	3.50	7.50
7	P-C4	113.126	18	0.012	1020.12	1020.69	0.50	1024.19	1025.49	1022.04	1022.17	2.27	0.000	1.50	0.12	0.134	2.72	4.00
8	P-C5	34.500	15	0.013	1021.19	1021.54	1.01	1025.49	1025.50	1022.29	1021.99	2.19	90.000	1.00 z	0.16	0.000	1.28	1.28
9	P-B4	37.097	18	0.012	1018.33	1019.07	1.99	1022.94	1024.22	1021.42	1021.47	2.39	-53.320	1.09	0.10	0.051	3.11	4.22
10	P-B5	28.622	18	0.012	1019.57	1021.05	5.17	1024.22	1022.70	1021.57	1021.52	1.49	43.121	1.00	0.09	0.032	1.11	1.11
11	C6	34.500	15	0.012	1018.36	1018.53	0.49	1022.24	1022.23	1021.77	1021.78	1.24	90.004	1.00	0.02	0.016	1.52	1.52
12	BIORETENTION	140.610	24	0.012	1017.47	1018.17	0.50	1023.10	1022.00	1021.01	1021.67	5.35	90.609	1.00	0.44	0.661	16.80	16.80
13	P-A1	300.530	18	0.012	1007.98	1009.48	0.50	1010.98	1014.10	1009.48	1011.48	5.25	2.122	0.15	0.06	1.996	0.00	9.27
14	P-A2	96.040	18	0.012	1009.68	1010.16	0.50	1014.10	1016.73	1011.54	1012.18	5.25	0.000	0.63	0.27	0.638	5.14	9.27
15	P-A3	145.940	18	0.012	1010.36	1011.09	0.50	1016.73	1016.73	1012.45	1012.59	2.34	21.462	0.94	0.08	0.190	0.00	4.13
16	DRY DETENTION	69.000	18	0.012	1011.29	1011.64	0.51	1016.73	1019.15	1012.67	1012.42	3.45	67.320	1.00 z	0.31	0.000	4.13	4.13

Project File: PUBLIC STORM 25-YR.stm | Number of lines: 16 | Date: 6/12/2019

NOTES: ** Critical depth

MyReport

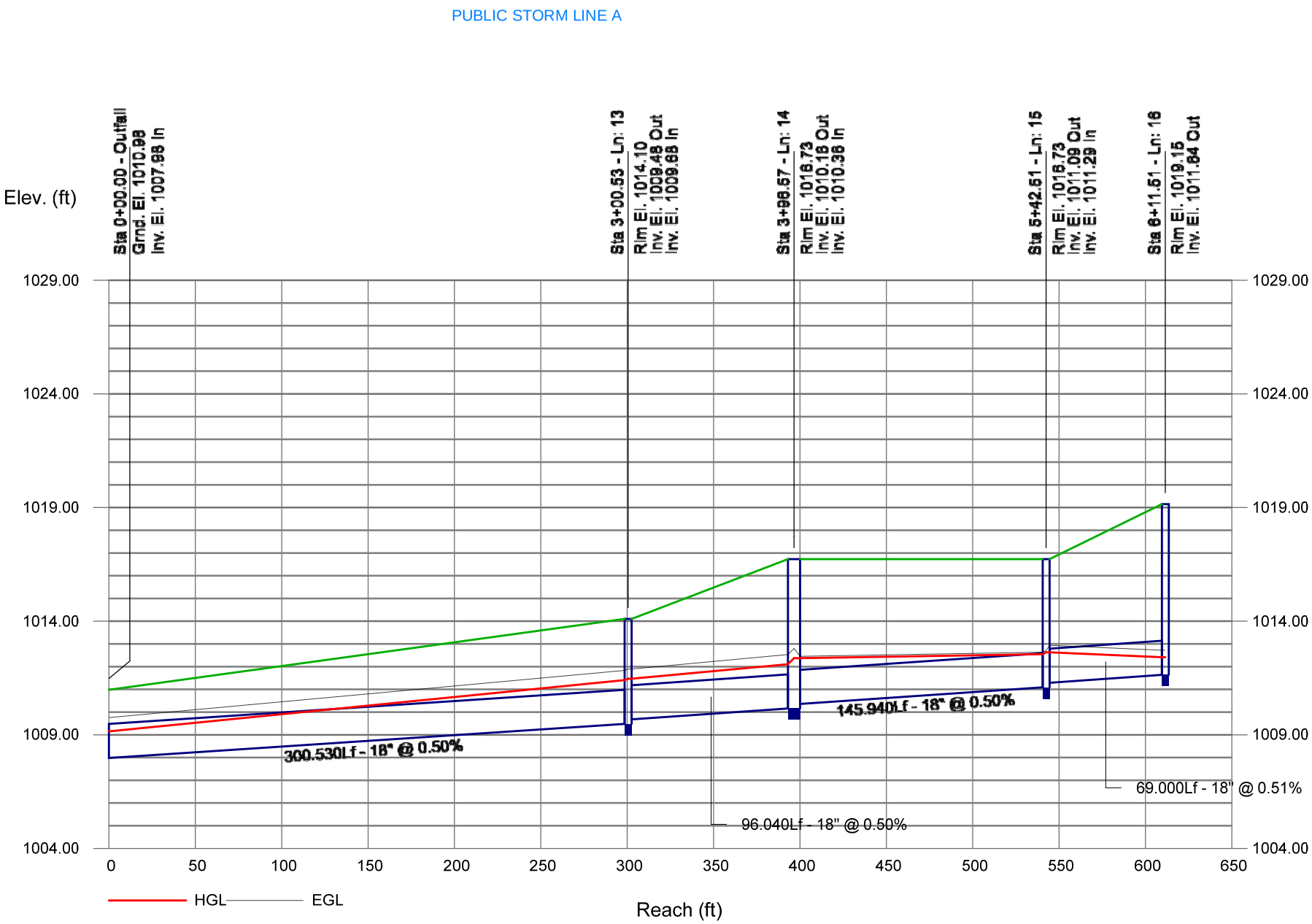
Capac Full (cfs)	
60.13	
31.42	
31.47	
31.44	
31.19	
17.33	
8.08	
6.50	
16.07	
25.87	
4.91	
17.29	
8.04	
8.04	
8.05	
8.10	

Project File: PUBLIC STORM 25-YR.stm	Number of lines: 16	Date: 6/12/2019

NOTES: ** Critical depth

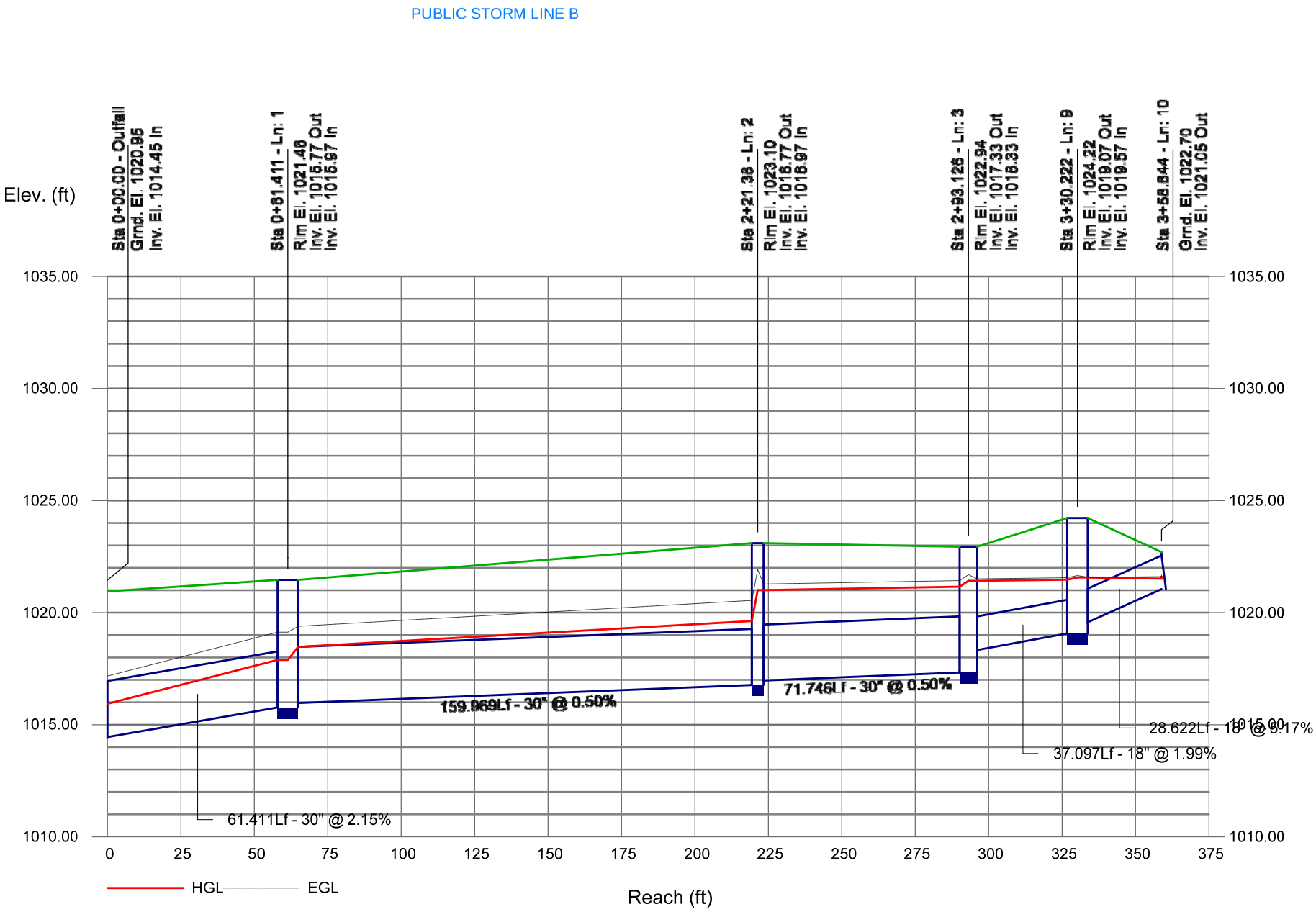
Storm Sewer Profile

Proj. file: PUBLIC STORM 25-YR.stm



Storm Sewer Profile

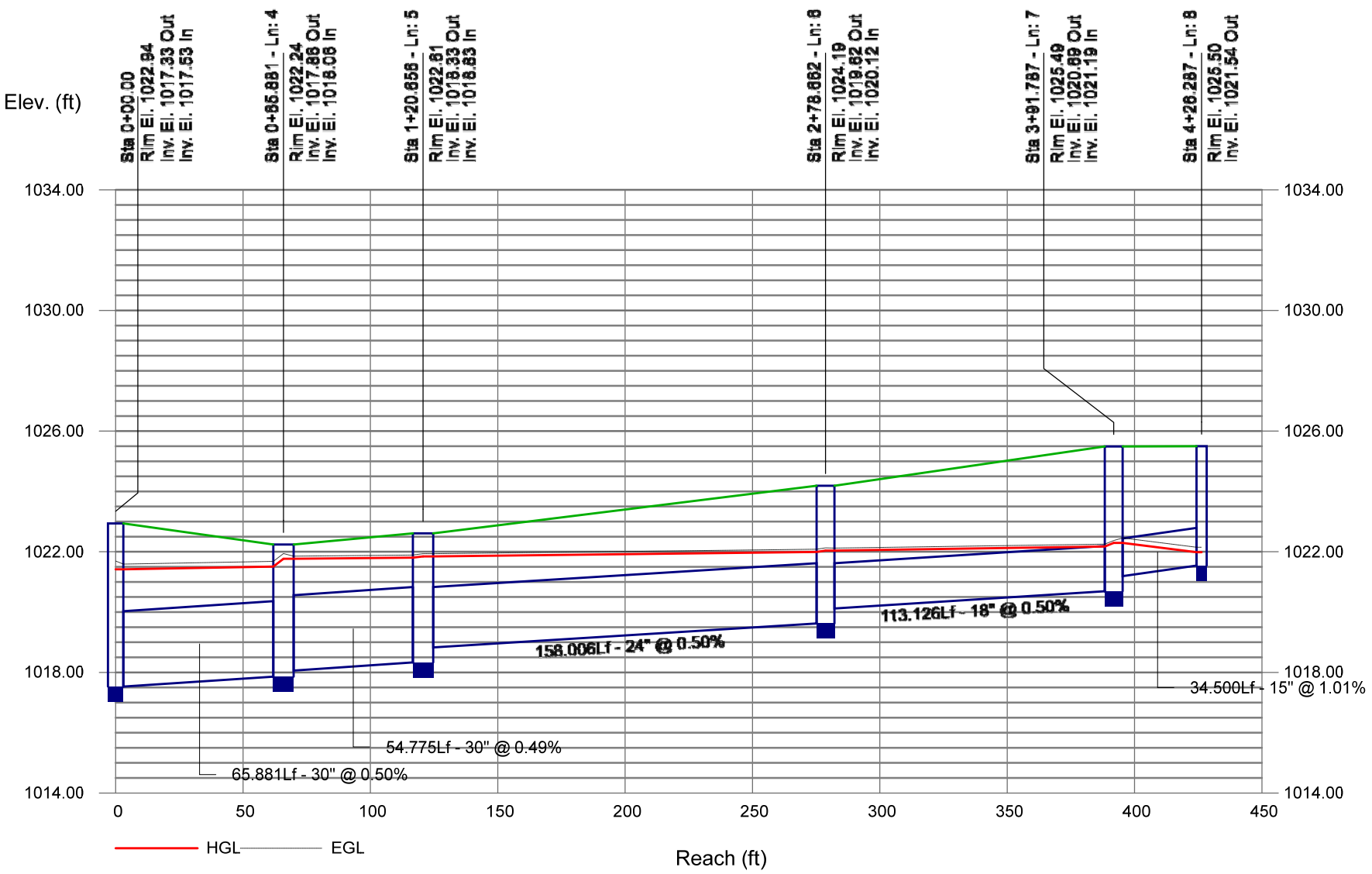
Proj. file: PUBLIC STORM 25-YR.stm



Storm Sewer Profile

Proj. file: PUBLIC STORM 25-YR.stm

PUBLIC STORM LINE C



APPENDIX C

APWA\MARC BMP Level of Service & Water Quality Calculations

WORKSHEET 1: REQUIRED LEVEL OF SERVICE - UNDEVELOPED SITE

Project: By: Date:
Location: Checked: Date:

1. Runoff Curve Number

A. Predevelopment CN

Cover Description	Soil HSG	CN from Table 1	Area (ac.)	Product of CN x Area
Pasture (GOOD)	C	74	9.79	
		Totals:		

Area-Weighted CN = total product/total area = 74 (Round to integer)

B. Postdevelopment CN

Cover Description	Soil HSG[1]	CN from Table 1	Area (ac.)	Product of CN x Area
PAVEMENT/ROOFS	NA	98	5.28	517.44
OPEN SPACE (TURF,GOOD)	D	80	4.51	360.8
		Totals:	9.79	878.24

[1] Postdevelopment CN is one HSG higher for all cover types except preserved vegetation, absent documentation showing how postdevelopment soil structure will be preserved.

Area-Weighted CN = total product/total area = 90 (Round to integer)

C. Level of Service (LS) Calculation

Predevelopment CN: 74
Postdevelopment CN: 90
Difference: 16
LS Required (see scale at right): 7

Change in CN	LS
17+	8
7 to 16	7
4 to 6	6
1 to 3	5
0	4
-7 to -1	3
-8 to -17	2
-18 to -21	1
-22 -	0

WORKSHEET 2: DEVELOP MITIGATION PACKAGE(S) THAT MEET THE REQUIRED LS

Project: By: Date:
Location: Checked: Date:
Sheet __ of __

1. **Required LS (New Development, Wksht 1) or Total VR (Redevelopment, Wksht 1A):** 7

   Note: Various BMPs may alter CN of proposed development, and LS; recalculate both if applicable.

2. **Proposed BMP Option Package No. ___**

Cover/BMP Description	Treatment Area	VR from Table 4.4 or 4.6[1]	Product of VR x Area
Extended Dry Detention Area	3.44	4.0	13.76
Bioretention 1 DA10	2.99	8.5	25.42
Bioretention 2 DA 20	2.61	8.5	22.19
Establish Native Vegetation	0.75	9.5	7.13
Total[2]:	9.79	**Total:**	68.50
		***Weighted VR:**	7.00

= total product/total a

[1] VR calculated for final BMP only in Treatment Train.
[2] Total treatment area cannot exceed 100 percent of the actual site area.
* Blank In Redevelopment

Meets required LS (Yes/No)? YES (If No, or if additional options are being tested, proceed below.)

3. **Proposed BMP Option Package No. ___**

Cover/BMP Description	Treatment Area	VR from Table 4.4 or 4.6[1]	Product of VR x Area
Total[2]:		**Total:**	
		***Weighted VR:**	

= total product/total a

[1] VR calculated for final BMP only in Treatment Train.
[2] Total treatment area cannot exceed 100 percent of the actual site area.
* Blank In Redevelopment

Meets required LS (Yes/No)? (If No, or if additional options are being tested, move to next sheet.)

DA 10 - Water Quality Volume Calculation Worksheet
Short Cut Method (Claytor and Schueler, 1996)
Date: 06/14/2019

Project Name: Lee's Summit Senior Living Facility
Description: DA 10 Water Quality Volume
Drainage Areas to Pond 1

$$WQV\ (ft^3) = (P/12)(R_v)(A*43{,}560)$$

Where

P = rainfall depth = 1.37 inches
R_v = volumetric runoff coefficient = 0.05 + 0.009I
I = percent impervious cover (in percent, e.g. 80% = 80)
A = total site area in acres

P=	1.37	inch
A=	2.99	acres
Impervious Area=	1.95	acres
I=	66	%
Rv=	0.644	

WQV=	**9576**	**cubic feet**
	0.220	ac-ft

DA 20 - Water Quality Volume Calculation Worksheet
Short Cut Method (Claytor and Schueler, 1996)
Date:

Project Name:
Description: DA 20 Water Quality Volume

$$WQV\ (ft^3) = (P/12)(R_v)(A*43{,}560)$$

Where

P = rainfall depth = 1 1.37 inches
R_v = volumetric runoff coefficient = 0.05 + 0.009I
I = percent impervious cover (in percent, e.g. 80% = 80)
A = total site area in acres

P=	1.37	inch
A=	2.61	acres
Impervious Area=	1.44	acres
I=	56	%
Rv=	0.554	

WQV=	**7191**	**cubic feet**
	0.165	ac-ft

Designer Ryan Jeppson
Checked By: Ryan Jeppson
Company: Olsson
Date: 6/14/2019
Project: Lee's Summit Senior Living Community
Location: Bioretention 1

WQv= 9576

III.Planting Soil Bed and Ponding Area

Step 1)	Planting bed soil depth, df(ft) (Df should be between 2.5 feet and 4 feet)	df(ft)=	2.5
Step 2)	Coefficient of permeability for planting soil bed, k (ft/day) (k should be at least 1 ft/day)	k(ft/day)=	1
Step 3)	Maximum ponding depth, hmax(ft) (hmax should be between 0.25 ft and 1.0 ft)	hmax (ft)=	1
Step 4)	Avergae height of water above bioretention bed, havg(ft) havg= hmax/2	havg(ft)=	0.5
Step 5)	Time required for WQv to filter through planting soil bed, tf(days) (tf of 1 to 3 days recommended)	tf(days)=	2
Step 6)	Required filter bed surface area, A_f (sf) Af=(WQv*df)/[k*tf*(havg+df)]	A_f(sf)=	3990
Step 7)	Approximate filter bed length, Lf (ft), assuming a length to width ratio of 2:1 (Lf, should be at least 40-ft)	Lf(ft)=	266
Step 8)	Approximate filter bed width, Wf (ft), assuming a length to with ratio of 2:1 (Wf should be at least 15 feet, and optimally half of Lf)	Wf(ft)	15
Step 9)	Required Ponding Area, Ap (sf) Ap= WQV/Hmax	Ap(sf)=	9576

Designer Ryan Jeppson
Checked By: Ryan Jeppson
Company: Olsson
Date: 6/14/2019
Project: Lee's Summit Senior Living Community
Location: Bioretention 2

WQv= 7191

III.Planting Soil Bed and Ponding Area

Step 1)	Planting bed soil depth, df(ft) (Df should be between 2.5 feet and 4 feet)	df(ft)=	2.5
Step 2)	Coefficient of permeability for planting soil bed, k (ft/day) (k should be at least 1 ft/day)	k(ft/day)=	1
Step 3)	Maximum ponding depth, hmax(ft) (hmax should be between 0.25 ft and 1.0 ft)	hmax (ft)=	1
Step 4)	Avergae height of water above bioretention bed, havg(ft) havg= hmax/2	havg(ft)=	0.5
Step 5)	Time required for WQv to filter through planting soil bed, tf(days) (tf of 1 to 3 days recommended)	tf(days)=	2
Step 6)	Required filter bed surface area, A_f (sf) Af=(WQv*df)/[k*tf*(havg+df)]	A_f(sf)=	2996
Step 7)	Approximate filter bed length, Lf (ft), assuming a length to width ratio of 2:1 (Lf, should be at least 40-ft)	Lf(ft)=	200
Step 8)	Approximate filter bed width, Wf (ft), assuming a length to with ratio of 2:1 (Wf should be at least 15 feet, and optimally half of Lf)	Wf(ft)	15
Step 9)	Required Ponding Area, Ap (sf) Ap= WQV/Hmax	Ap(sf)=	7191

LEE'S SUMMIT SENIOR LIVING COMMUNITY

Lee's Summit, MO - 2019

June 2019

Olsson Project No. 018-1450