FINAL
STORMWATER REPORT
for
STREETS OF WEST PRYOR

NWQ PRYOR ROAD AND LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

Revisions:
Initial Issue: 1/16/2019

Prepared By:

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KVE Project No. A14D7067-1

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INTRODUCTION

This drainage report was prepared to accompany the submittal of final construction documents for the overall drainage improvements for the Streets of West Pryor development. The proposed development includes approximately 72.7 acres of mixed--use commercial development and multi-family and single-family housing.

DESIGN CRITERIA

- Adopted design Criteria
  - APWA - Division V - Section 5600 – Storm Drainage Systems and Facilities

PROJECT LOCATION

Figure 1: Project Location Map

As shown in Figure 1, the project is located in the NWC of NW Lowenstein Drive and NW Pryor Road. The project site is bound by NW Pryor Road and Summit Woods Crossing shopping center to the East, Lowenstein Park and residential properties to the south and southwest, and by Interstate 470 to the north.

EXISTING CONDITIONS

The project site is mostly undeveloped with the exception of some single family residential homes that are being removed. The project site is well covered with a low scrubby vegetation interspersed with dense stands of trees. See **APPENDIX A** for existing and proposed drainage area maps.

FEMA FIRM

The site is currently located on FIRM Map Number 29095C0291F Panel 291 of 6480. The project site is located in Areas determined to be outside the 1% and 0.2% annual chance floodplains. See **APPENDIX B** for a FEMA Firmette encompassing the project site.

Existing Watershed

The project site is located within Cedar Creek and Boggs Hollow Watersheds and discharges in several directions.

The South watershed discharges to the roadside ditch along Lowenstein Drive and into the drainage way through the City Park. The West watershed drains to the west into a roadside ditch and concrete channel that proceeds along Lowenstein Drive and through open ditches to the west towards Cedar Creek. Both systems are part of the Cedar Creek watershed.

The East watershed ultimately discharges to several crossroad culverts under I-470. A portion of the roadside flow on Pryor, up to the inlet capacities, is directed via storm sewers into the detention pond on the Summit Woods development, which then drains via pipe system under I-470 on the east side of US-50. The remainder of the area, including all overflow beyond inlet capacities on Pryor, drains to the existing MoDOT ditch on I-470 until it reaches the box culvert crossing I-470 and ramps approximately 1,100 feet west of Pryor Road. The East watershed is tributary to the Boggs Hollow watershed, which then ultimately joins Cedar Creek.

The total pre-project acreages tributary of each of these three primary sub-basins is as follows:

Table 1: Pre-Project Tributary Areas

	Subwatershed Area (acres)
East (Boggs Hollow)	23.0
South (Cedar Creek)	24.0
West (Cedar Creek)	24.9
Total	71.9

The difference between this total and the formal site size of 72.7 acres is attributable to excluding Lowenstein Road right-of-way from the drainage area and the addition of a sliver of the cell tower tract that drains into the West watershed.

Existing Soils

Soils data for the site was obtained from the NRCS soil survey. A summary of the site soils and their properties is shown on the chart below. According to the NRCS, the on-site soils are predominately Type D soils (17%), Type C soils (66%) or Type C/D (17%). The composite CN values used for rainfall mass calculations reflect a conservative estimate of the predominant Type D soils contained onsite.

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	D	5.6	8.2%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	11.3	16.7%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	C	27.3	40.2%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	D	5.2	7.6%
10141	Snead-Rock outcrop complex, 14 to 30 percent slopes	D	0.6	0.9%
10179	Udarents-Urban land-Oska complex, 5 to 9 percent slopes	C	0.4	0.5%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	C	17.6	25.9%
Totals for Area of Interest			**67.9**	**100.0%**

Existing Stormwater Appurtenances

There are three existing small ponds on the project that capture and detain an undetermined amount of storm water. The existing watersheds discharging to the ponds and their respective outlet structures have not been investigated as the ponds will be removed and larger detention basins will be provided to accommodate the proposed development. There are miscellaneous culverts located on the project site allowing storm water to pass under residential driveways and through other existing features. No other storm water appurtenances are present on the project site.

Offsite Drainage Areas

The project site sits at the upper portion of the Cedar Creek and Boggs Hollow Watersheds and therefore has minimal offsite drainage areas passing through the project site. The only offsite area is a sliver of land from the cell tower property which drains into the western basin, as shown on the Existing Drainage Area exhibit in **APPENDIX A**.

PRE- AND POST-DEVELOPMENT SITE CONDITIONS

Due to space constraints on the eastern portion of the site, the project proposes to transfer a substantial portion of the East and South watersheds via storm sewer into the West watershed,

where it can be detained in a larger regional detention basin (the "West Basin"). The basin will capture 46.4 acres, an increase from the 24.9 acres that are tributary to west side now.

To transfer this area, two main trunk lines (A & B) of storm sewer will pass under the ridge lines to discharge into the West basin. These trunk lines and the inlets and lateral pipes leading to them are designed to capture up to the 100-year flow, so that they can be directed into the West basin.

A remaining portion of the South watershed located near the relocated intersection of Lowenstein Road and Pryor Avenue will be directed to a basin at the corner of Chipman Road and Pryor Ave (the "South Basin"). This basin captures 11.0 acres.

Cumulatively, the two detention basins capture 57.4 acres. The remaining, un-detained 14.5 acres is primarily from the fringes of the development as shown on the Proposed Drainage Area Map in Appendix A.

Portions of Lots 12 and 13 are also designed to remain in the East watershed and be discharged primarily through an outlet into the MoDOT ditch at a point approximately 430 ft west of Pryor Road.

A small portion of the remaining area will drain to storm sewer which connects into the drain system on Pryor Road near the northernmost entrance to the site, which will then connect to the detention pond in the Summit Woods development.

The area has been limited so that the predevelopment peak runoff from the East watershed is not exceeded in post-development conditions.

Per APWA 5600, pre- and post-development site flows will be analyzed for the 2-, 10-, and 100-year design storms.

Pre / Post Site Land use

The pre-project CN is estimated for preliminary study purposes as 77. The post-project curve number is estimated as 94 for commercial areas, and 83 in the single-family residential portion of the West watershed. The composite CN for the areas to the West Basin was estimated at 91. The composite CN to the South Basin is estimated at 94.

Allowable Release Rates by Watershed

The allowable release rates for three watersheds were calculated by considering both the pre-development versus post-development peaks and by the detention basin release rate guidance given in APWA 5608.4. Considering the changes made to watershed boundaries, the allowable release rates were based on pre-project drainage areas to each outlet.

Table 2: Allowable Release Rates

Drainage Area	Area (Acres) (Pre-Project)	Design Storm	APWA Allowable Release Rate (cfs/acre)	Total Allowable Release Rate (cfs) from Watershed – per APWA	Pre-Development Release Rate (cfs)
West Watershed	24.9	50% (2 yr)	0.5	12.5	43
		10% (10 yr)	2	49.8	83
		1% (100 yr)	3	74.7	167
South Watershed	24	50% (2 yr)	0.5	12	41
		10% (10 yr)	2	48	80
		1% (100 yr)	3	72	161
East Watershed	23	50% (2 yr)	0.5	11.5	41
		10% (10 yr)	2	46	80
		1% (100 yr)	3	69	160

Actual Detention Pond Release Rates

The calculation of the actual release rates from each watershed was based on the size of the adjusted watersheds and the proposed detention basins. Runoff from the undetained areas was added to the detention basin outflows to calculate an equivalent total watershed release rate. For the post-project area of the East basin, there is no detention structure, but the total contributory area is less than before the project.

The detention areas were analyzed using Hydraflow Hydrographs. The detailed calculations are found in **APPENDIX D**. The SCS method was used to generate hydrographs, and then routed through standard methods in each pond. Orifice and weir structures were estimated to control the release rate. Storage volumes were obtained from the grading plan. Each basin contains a wet pond as a water feature/amenity, as well as an excess volume above the permanent pool to be used for detention. The West watershed contains a second upper pond that will act as an additional amenity and a sediment forebay.

As shown in the charts below, the proposed extended wet detention basins adequately accommodate and reduce post-development storm water flows to APWA required levels for the West and South watersheds. The only exception is in the net release rate from the 2-year storm for the West watershed, which is exceeded slightly. This is unavoidable due to impact from the undetained residual areas. However, in all cases, the net release rate is less than the pre-development flows from the original drainage areas, as can be seen in the data in **APPENDIX D**.

The APWA release rates set as the target were impractical as a control for the East watershed, since there was no detention basin proposed in that area. In the case of the East watershed, the area is draining into MoDOT's right of way and then ultimately into the much larger Bogg's

Hollow watershed. There are no habitable structures or neighborhoods through which this flow would pass first before joining the larger watershed. For these reasons, it is proposed to use the pre-development limit from the full watershed area as the controlling target in the East watershed. This target is met for all storm events analyzed. No adverse impact is anticipated to the downstream system as a result.

Table 3: Summary of Discharge Rates

Water-shed	Post-Project Area to Detention (acres)	Post-Project Area Un-Detained (acres)	Design Storm	Actual Release Rate from Detention Area (cfs)	Total Release Rate from Watershed (including un-detained area) (cfs)	Allowable Release Rate from Water-shed - APWA (cfs)	Pre-Develop-ment Release Rate (cfs)
West Water-shed	46.4	4.4	50% (2 yr)	7.3	17.9*	12.5	42.9
			10% (10 yr)	15.4	37.4	49.8	83.2
			1% (100 yr)	41.0	69.4	74.7	166.8
South Water-shed	11.0	2.22	50% (2 yr)	4.8	11.7	12	41.4
			10% (10 yr)	15.3	22.0	48	80.2
			1% (100 yr)	43.8	62.1	72	160.8
East Waters-hed	0	7.7	50% (2 yr)	n/a	31.3 *	11.5	41.4
			10% (10 yr)	n/a	49.2 *	46	80.2
			1% (100 yr)	n/a	83.5 *	69	160.3

* Release rate from the combination of detained and undetained areas exceeds APWA but is less than pre-development condition. Variance requested.

PROPOSED STORM SEWER SYSTEM

The proposed storm sewer system is comprised of several general systems that direct site storm sewer flows to the proposed extended wet detention basins located in the west and south watersheds. A particular feature of the storm sewer system is the two main trunk lines needed to carry flows from the East and South watersheds to the West basin for detention. These pipes are sized to carry up to the 100-year flow. Due to the crossing of the ridge line, they become deep in places, with corresponding deep junction structures. See **APPENDIX C** for sizing and layout of

the primary trunk line for this system. The pipe system feeding the South basin from north of Lowenstein will also be sized for the 100-year flow, since otherwise any overland swale flow would be intercepted at Lowenstein and bypass the detention area.

PROPOSED EXTENDED WET DETENTION

Wet detention ponds are proposed for the West and South watersheds to reduce the increase in post-development storm water flows and to provide aesthetic water features for the proposed development. See **APPENDIX D** for wet detention pond routing. See the information below for design information. The wet detention ponds will hold water at their design wet pond elevation and storm water detention and water quality treatment will occur above this elevation.

West Wet Detention Pond

Top Elevation = 962.0
Bottom elevation = 940.0
Wet Pond Elevation = 950.0
Storage Volume at Wet Pond Elevation = 746,323 Cubic Feet
Primary Outlet
Elevation 952: (3 x 12" orifices)
Elevation 955: (3 x 15" orifices)
Emergency Overflow
Elevation 958.5 (80-ft broad-crested weir)
Max 100 yr WSE = 956.65
Max 100 yr Storage Volume = 1,540,590 Cubic Feet

South Wet Detention Pond

Top Elevation = 978.0
Bottom elevation = 960.0
Wet Pond Elevation = 966.0
Storage Volume at Wet Pond Elevation = 71,763 Cubic Feet
Primary Outlet
Elevation 968: (2 x 8" orifices)
Elevation 969: (2 x 8" orifices)
Elevation 970.50: (2' x 2' Square Grate Riser)
Emergency Overflow
Elevation = 973.5 (20-ft broad-crested weir)
Max 100 yr WSE = 972.57
Max 100 yr Storage Volume = 153,332 Cubic Feet

MARC/APWA BMP CALCULATIONS

Per APWA 5608.4, the project site is required to provide 40-hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). As mentioned above, both of the detention basins will be designed as extended wet detention basins (EWDBs) that will be maintained to have a permanent pool elevation. The water quality event will be stored between the permanent water pool surface and the lowest primary outlet elevation. See Appendix E for detailed orifice calculations and a summary below.

West Basin
Water Quality Volume = 108,239 ft^3
Permanent Pool Elevation/Water Quality Orifice Elevation = 950
Lowest Primary Outlet Elevation = 952
Storage Provided from Elevation 950 to 952: 194,229 ft^3
Water Quality Orifice Diameter = 4.63 inches

South Basin
Water Quality Volume = 32,770 ft^3
Permanent Pool Elevation/Water Quality Orifice Elevation = 966
Lowest Primary Outlet Elevation = 968
Storage Provided from Elevation 966 to 968: 35,859 ft^3
Water Quality Orifice Diameter = 2.55 inches

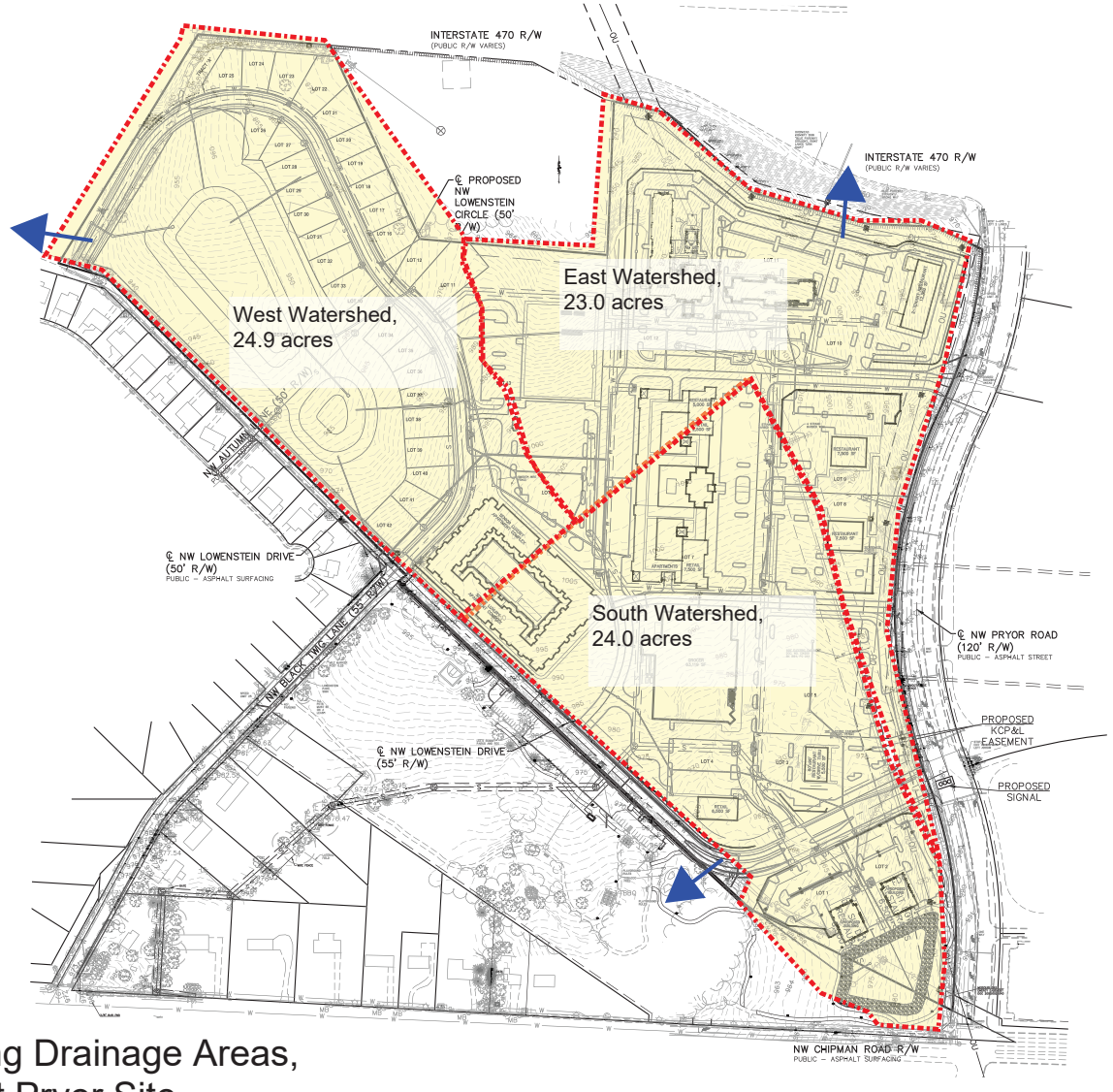
DOWNSTREAM CONDITIONS

The proposed development will mitigate for changes to the watershed by providing significant detention and addressing the water quality storm. Release rates from detention areas are in line with APWA allowable release rates, except for deviations as reported for the West Watershed 2-year storm and for the East Watershed. Release rates from all watersheds under proposed conditions are less than those of existing conditions.

CONCLUSION

The proposed development will effectively capture, detain and treat stormwater from the proposed development in substantial accordance with the requirements set forth by the City of Lee's Summit. A waiver from the strict application of the APWA 5608.4 release rate standard is requested for the combined releases in the 2-year storm for the West Watershed and for all events from the East Watershed, based on both conditions remaining below the pre-development peak of the existing watershed.

APPENDIX A – EXISTING AND PROPOSED DRAINAGE AREA MAPS



0 75 150 300
SCALE: 1" = 150'

Exhibit: Existing Drainage Areas, Streets of West Pryor Site

REV	DATE	DESCRIPTION	DSN	DWN	CHK

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KAW VALLEY ENGINEERING

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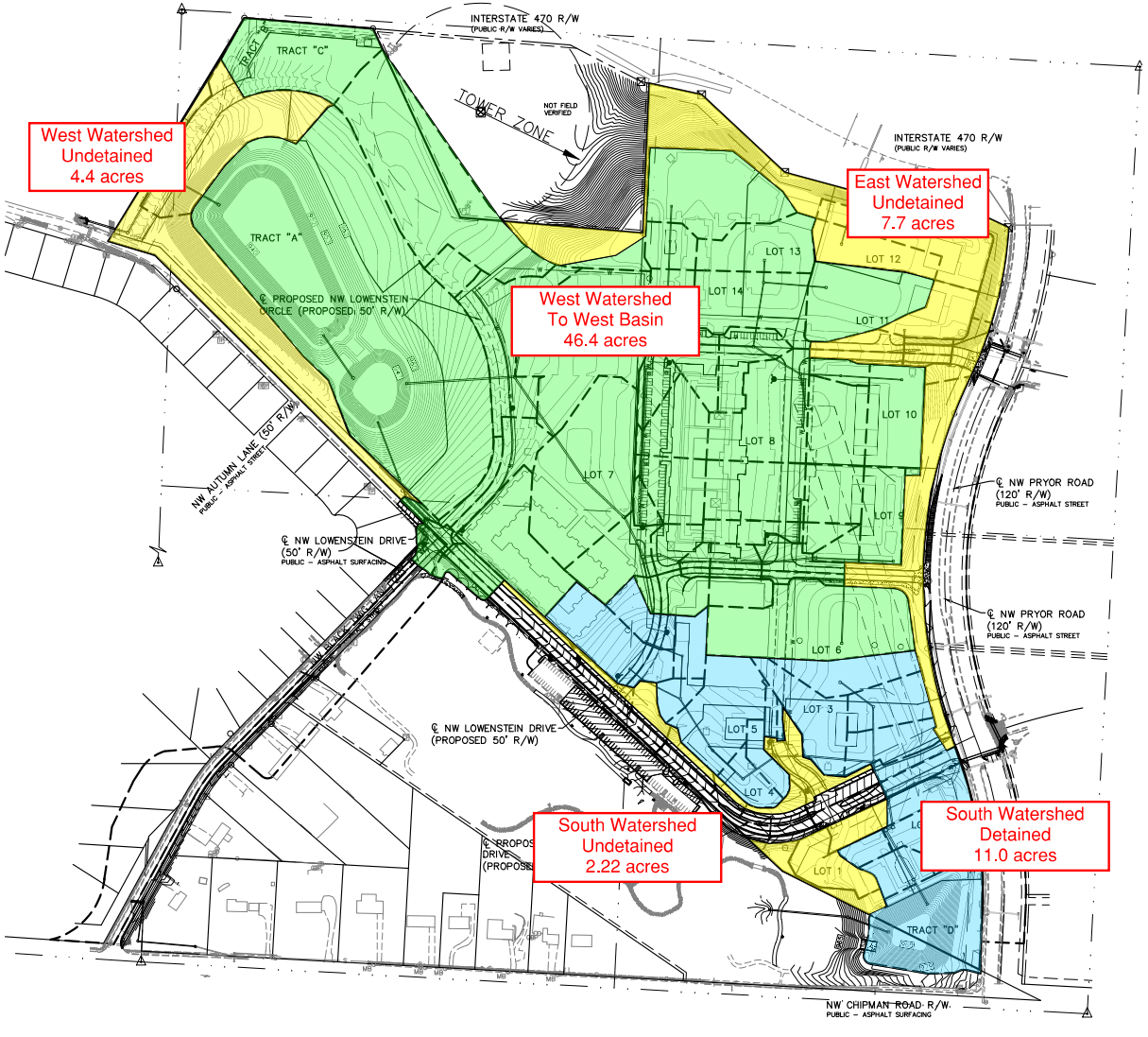
STREETS OF WEST PRYOR
NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

PRELIMINARY DEVELOPMENT PLAN
DRAINAGE AREA MAP

PROJ. NO.	A14_7067-1
DESIGNER	LDO
DRAWN BY	JT
CFN	7067-1PSDP_DAM
SHEET	.
REV	



REV	DATE	DESCRIPTION	DSN	DWN	CHK

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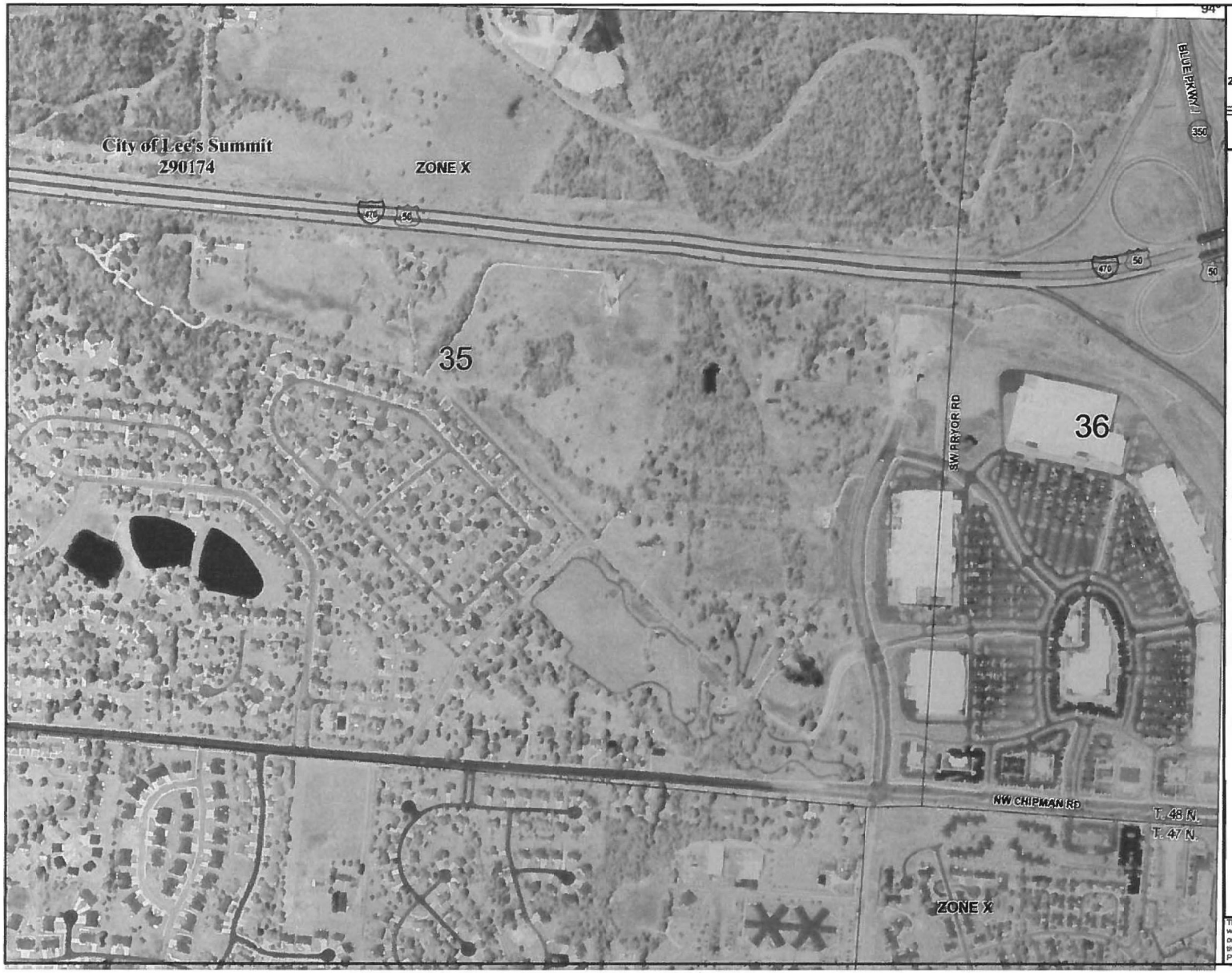
STREETS OF WEST PRYOR

NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

DRAINAGE AREA MAP

PROJ. NO.	A14_7067-1
DESIGNER	LDO
DRAWN BY	JT
CFN	7067-1DAM
SHEET	1 OF 1
REV	

APPENDIX B – FEMA FIRMETTE MAP



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METE

NFIP

PANEL 0291F

FIRM

FLOOD INSURANCE RATE MAP

JACKSON COUNTY, MISSOURI

AND INCORPORATED AREAS

PANEL 291 OF 480

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LEE'S SUMMIT, CITY OF	290174	0291	F

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community

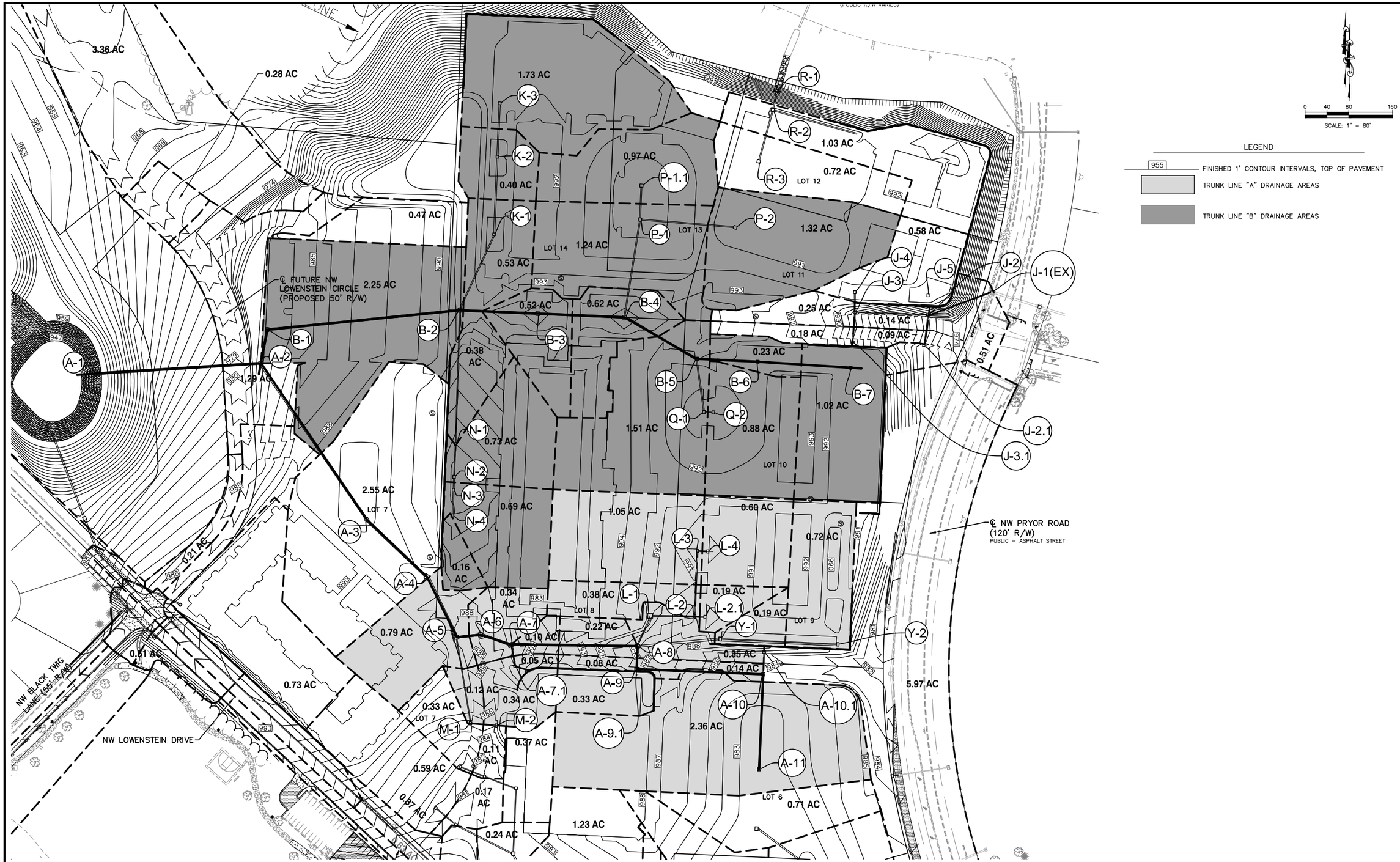
MAP NUMBER
29095C0291F

EFFECTIVE DATE
SEPTEMBER 29, 2006

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

APPENDIX C – STORM SEWER DESIGN



REV	DATE	DESCRIPTION	DSN	DWN	CHK
0	1-16-19	INITIAL ISSUE	LDO	JT	LDO

STATE OF MISSOURI
LEON D. OSBOURN NUMBER E-21726
REGISTERED PROFESSIONAL ENGINEER

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STREETS OF WEST PRYOR
NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

MASS GRADING PLANS
DRAINAGE AREA MAP - STORM SEWER LINES A, B, J & R

PROJ. NO.	
A14_7067-1	
DESIGNER	DRAWN BY
LDO	JT
CFN	
7067-1G_DAM_AB	
SHEET	REV
C-10	0

KVE

Overland Flow													System Flow					Node	Pipe Design																			Structure Design	Hydraulic Grade Line (100-YR)	
Design Storm	Structure	Downstream Structure	Pipe	Tributary Area (A)	Runoff coefficient ("C")	A x C	Antecedent Precipitation (K)	A x C x K	Time of Concentration Tc	Rainfall Intensity	Tributary Runoff (cfs)	Total Runoff (cfs)	Total Area	Summation of Inlet A x C x K	System Tc	System Rainfall Intensity	System Discharge1	Node Condition	Pipe Material	Pipe Shape	Pipe Size	Manning's Coefficient	Upstream Invert	Downstream Invert	Length	Pipe Slope	**Design Flow**	Full Flow Capacity	Design Velocity	Full Flow Velocity	Depth (in.)	Flow Time (sec)	Upstream Crown Elevations	Downstream Crown Elevations	Upstream Depth of Cover	Downstream Depth of Cover	Rim Elevation	Downstream	Upstream
LINE A																																							
25-year	A11	A10	A11 - A10	2.36	0.90	2.12	1.1	2.34	5.0	8.5	19.9	19.9	2.36	2.34	5.0	8.5	19.9	Inlet	RCP	Circular	30	0.013	978.00	977.10	174.0	0.52%	**27.4**	29.5	6.825	6.0	22.869	25.5	980.5	979.6	1.5	4.9	982.00	978.88	979.79
100-year							1.25	2.66		10.3	27.4	27.4		2.66		10.3	27.4																					
25-year	A10	A9	A10 - A9	0.49	0.90	0.44	1.1	0.49	5.0	8.5	4.1	24.1	2.85	2.82	5.4	8.4	23.6	Inlet	RCP	Circular	30	0.013	976.90	975.40	232.0	0.65%	**32.5**	33.0	7.659	6.7	24.231	30.3	979.4	977.9	5.1	11.6	984.50	977.27	978.84
100-year							1.25	0.55		10.3	5.7	33.1		3.21		10.1	32.5																					
25-year	A9	A8	A9 - A8	0.41	0.90	0.37	1.1	0.41	5.0	8.5	3.5	27.5	3.26	3.23	5.9	8.2	26.5	Inlet	RCP	Circular	30	0.013	975.20	974.80	42.0	0.95%	**36.5**	40.0	9.243	8.2	22.494	4.5	977.7	977.3	11.8	12.2	989.50	976.55	977.24
100-year							1.25	0.46		10.3	4.8	37.9		3.67		9.9	36.5																					
25-year	A8	A7	A8 - A7	3.35	0.90	3.02	1.1	3.32	5.0	8.5	28.3	55.8	6.61	6.54	6.0	8.2	53.6	Inlet	RCP	Circular	42	0.013	973.80	972.50	231.0	0.56%	**73.8**	75.5	8.941	7.8	33.596	25.8	977.3	976.0	12.2	14.0	989.50	975.09	976.48
100-year							1.25	3.77		10.3	38.9	76.8		7.44		9.9	73.8																					
25-year	A7	A6	A7 - A6	0.15	0.90	0.14	1.1	0.15	5.0	8.5	1.3	57.1	6.76	6.69	6.4	8.0	53.8	Inlet	RCP	Circular	42	0.013	972.30	971.90	59.0	0.68%	**74.2**	82.8	9.738	8.6	31.025	6.1	975.8	975.4	14.2	11.8	990.00	974.44	974.99
100-year							1.25	0.17		10.3	1.7	78.5		7.61		9.8	74.2																					
25-year	A6	A5	A6 - A5	0.34	0.90	0.31	1.1	0.34	5.0	8.5	2.9	60.0	7.10	7.03	6.5	8.0	56.3	Inlet	RCP	Circular	42	0.013	971.70	971.40	44.0	0.68%	**77.6**	83.1	9.812	8.6	32.189	4.5	975.2	974.9	12.0	12.3	987.20	973.89	974.44
100-year							1.25	0.38		10.3	3.9	82.5		7.99		9.7	77.6																					
25-year	A5	A4	A5 - A4	1.25	0.90	1.13	1.1	1.24	5.0	8.5	10.6	70.5	8.35	8.27	6.6	8.0	66.0	Inlet	RCP	Circular	48	0.013	970.90	970.20	123.0	0.57%	**91.1**	108.4	9.662	8.6	33.691	12.7	974.9	974.2	12.3	15.8	987.20	972.86	973.78
100-year							1.25	1.41		10.3	14.5	97.0		9.39		9.7	91.1																					
25-year	A4	A3	A4 - A3			0.00	1.1	0.00	5.0	8.5	0.0	70.5	8.35	8.27	6.8	7.9	65.5	Junction Box	RCP	Circular	48	0.013	970.00	969.20	152.0	0.53%	**90.3**	104.2	9.336	8.3	34.517	16.3	974.0	973.2	16.0	14.3	990.00	972.23	972.86
100-year							1.25	0.00		10.3	0.0	97.0		9.39		9.6	90.3																					
25-year	A3	A2	A3 - A2	2.55	0.90	2.30	1.1	2.52	5.0	8.5	21.5	92.0	10.90	10.79	7.1	7.8	84.6	Inlet	RCP	Circular	48	0.013	969.00	966.70	345.0	0.67%	**116.7**	117.3	10.640	9.3	39.130	32.4	973.0	970.7	14.5	12.3	987.50	970.45	972.23
100-year							1.25	2.87		10.3	29.6	126.6		12.26		9.5	116.7																					
25-year	A2	A1	A2 - A1	15.02	0.90	13.52	1.1	14.87	5.0	8.5	126.8	218.9	25.92	25.66	7.6	7.7	197.0	Junction Box	RCP	Circular	48	0.013	966.50	954.85	305.0	3.82%	**272.1**	280.7	25.454	22.3	38.074	12.0	970.5	958.9	12.5	0.0	983.00	958.82	970.45
100-year							1.25	16.90		10.3	174.4	301.0		29.16		9.3	272.1																					
25-year	L4	L3	L4 - L3	0.60	0.90	0.54	1.1	0.59	5.0	8.5	5.1	5.1	0.60	0.59	5.0	8.5	5.1	Inlet	HDPE	Circular	18	0.01	985.50	985.30	19.0	1.05%	**7.0**	14.0	7.917	7.9	8.971	2.4	987.0	986.8	2.5	2.7	989.50		
100-year							1.25	0.68		10.3	7.0	7.0		0.68		10.3	7.0																					
25-year	L3	L2	L3 - L2	1.05	0.90	0.95	1.1	1.04	5.0	8.5	8.9	13.9	1.65	1.63	5.0	8.5	13.9	Inlet	HDPE	Circular	24	0.01	984.80	983.90	120.0	0.75%	**19.1**	25.5	8.900	8.1	15.523	13.5	986.8	985.9	2.7	3.6	989.50		
100-year							1.25	1.18		10.3	12.2	19.2		1.86		10.3	19.1																					
25-year	L2	L1	L2 - L1	0.57	0.90	0.51	1.1	0.56	5.0	8.5	4.8	18.7	2.22	2.20	5.3	8.4	18.5	Inlet	RCP	Circular	30	0.013	983.40	982.90	82.0	0.61%	**25.5**	32.0	7.243	6.5	20.229	11.3	985.9	985.4	3.6	6.6	989.50		
100-year							1.25	0.64		10.3	6.6	25.8		2.50		10.2	25.5																					
25-year	L1	A8	L1 - A8			0.00	1.1	0.00	5.0	8.5	0.0	18.7	2.22	2.20	5.5	8.4	18.4	Junction Box	RCP	Circular	30	0.013	982.70	982.40	60.0	0.50%	**25.3**	29.0	6.659	5.9	21.696	9.0	985.2	984.9	6.8	4.6	992.00		
100-year							1.25	0.00		10.3	0.0	25.8		2.50		10.1	25.3																					
25-year	L2.1	L2	L2.1 - L2	0.19	0.90	0.17	1.1	0.19	5.0	8.5	1.6	1.6	0.19	0.19	5.0	8.5	1.6	Inlet	HDPE	Circular	18	0.01	985.50	985.30	19.0	1.05%	**2.2**	14.0	5.783	7.9	4.829	3.3	987.0	986.8	2.5	2.7	989.50		
100-year							1.25	0.21		10.3	2.2	2.2		0.21		10.3	2.2																					
25-year	A9.1	A9	A9.1 - A9	0.33	0.90	0.30	1.1	0.33	5.0	8.5	2.8	2.8	0.33	0.33	5.0	8.5	2.8	Inlet	HDPE	Circular	18	0.01	982.50	982.20	11.0	2.73%	**3.8**	22.6	9.513	12.8	5.020	1.2	984.0	983.7	2.5	5.8	986.50		
100-year							1.25	0.37		10.3	3.8	3.8		0.37		10.3	3.8																					
25-year	A10.1	A10	A10.1 - A10	0.35	0.90	0.32	1.1	0.35	5.0	8.5	3.0	3.0	0.35	0.35	5.0	8.5	3.0	Inlet	HDPE	Circular	18	0.01	978.10	977.90	11.0	1.82%	**4.1**	18.4	8.365	10.4	5.746	1.3	979.6	979.4	4.9	5.1	984.50		
100-year							1.25	0.39		10.3	4.1	4.1		0.39		10.3	4.1																					
25-year	A7.1	A7	A7.1 - A7	0.05	0.90	0.05	1.1	0.05	5.0	8.5	0.4	0.4	0.05	0.05	5.0	8.5	0.4	Inlet	HDPE	Circular	15	0.01	986.50	986.00	41.0	1.22%	**0.6**	9.3	4.210	7.6	2.544	9.7	987.8	987.3	2.3	2.8	990.00		
100-year							1.25	0.06		10.3	0.6	0.6		0.06		10.3	0.6																					
25-year	M2	M1	M2 - M1	0.34	0.90	0.31	1.1	0.34	5.0	8.5	2.9	2.9	0.34	0.34	5.0	8.5	2.9	Inlet	HDPE	Circular	15	0.01	982.70	982.20	47.5	1.05%	**3.9**	8.6	6.868	7.0	7.128	6.9	984.0	983.5	1.3	1.8	985.20		
100-year							1.25	0.38		10.3	3.9	3.9		0.38		10.3	3.9																					
25-year	M1	A5	M1 - A5	0.12	0.90	0.11	1.1	0.12	5.0	8.5	1.0	3.9	0.46	0.46	5.1	8.5	3.9	Inlet	HDPE	Circular	18	0.01	981.90	980.60	159.5	0.82%	**5.3**	12.3	6.718	7.0	8.260	23.7	983.4	982.1	1.8	5.1	985.20		
100-year							1.25	0.14		10.3	1.4	5.3		0.52		10.3	5.3																					
LINE R																																							
25-year	R3	R2	R3 - R2	0.72	0.90	0.65	1.1	0.71	5.0	8.5	6.1	6.1	0.72	0.71	5.0	8.5	6.1	Inlet	HDPE	Circular	18	0.01	983.20	982.50	98.0	0.71%	**8.4**	11.5	7.117	6.5	11.356	13.8	984.7	984.0	5.3	6.0	990.00	983.61	984.32
100-year							1.25	0.81		10.3	8.4	8.4		0.81		10.3	8.4																					
25-year	R2	R1	R2 - R1	1.03	0.90	0.93	1.1	1.02	5.0	8.5	8.7	14.8	1.75	1.73	5.2	8.4	14.6	Inlet	HDPE	Circular	24	0.01	982.00	981.70	33.6	0.89%	**20.1**	27.8	9.640	8.8	15.144	3.5	984.0	983.7	6.0		990.00	983.31	983.61
100-year							1.25	1.16		10.3	12.0	20.3		1.97		10.2	20.1																					
LINE J																																							
25-year	J4	J3	J4 - J3	0.58	0.90	0.52	1.1	0.57	5.0	8.5	4.9	4.9	0.58	0.57	5.0	8.5	4.9	Inlet	HDPE	Circular	18	0.01	984.70	984.40	37.0	0.81%	**6.7**	12.3	7.116	7.0	9.502	5.2	986.2	985.9	3.8	2.0	990.00	985.50	985.7
100-year							1.25	0.65		10.3	6.7	6.7		0.65		10.3	6.7																					
25-year	J3	J2	J3 - J2	0.43	0.90	0.39	1.1	0.43	5.0	8.5	3.6	8.5	1.01	1.00	5.1	8.5	8.5	Inlet	HDPE	Circular	18	0.01	984.20	974.50	134.1	7.23%	**11.7**	36.7	18.461	20.8	6.979	7.3	985.7	976.0	2.2	2.6	987.88	975.14	985.5
100-year							1.25	0.48		10.3	5.0	11.7		1.14		10.3	11.7																					
25-year	J2	J1Ex	J2 - J1Ex	0.23	0.90	0.21	1.1	0.23	5.0	8.5	1.9	10.5	1.24	1.23	5.2	8.5	10.4	Inlet	HDPE	Circular	18	0.01	967.10	963.70	123.9	2.74%	**14.3**	22.6	13.538	12.8	10.375	9.2	968.6	965.2	10.0	6.0	978.60	964.67	968.48
100-year							1.25	0.26		10.3	2.7	14.4		1.40		10.2	14.3																					
25-year	J1Ex	J0Ex	J1Ex - J0Ex	6.48	0.90	5.83	1.1	6.42	5.0	8.5	54.7	65.2	7.72	7.64	5.4	8.4	64.2	Inlet	RCP	Circular	42	0.013	958.66	956.07	91.4	2.83%	**88.4**	169.4	17.789	17.6	21.533	5.1	962.2	959.6	9.1	11.1	971.21	958.97	961.56
100-year							1.25	7.29		10.3	75.3	89.7		8.69		10.2	88.4																					
25-year	J3.1	J3	J3.1 - J3	0.18	0.90	0.16	1.1	0.18	5.0	8.5	1.5	1.5	0.18	0.18	5.0	8.5	1.5	Inlet	HDPE	Circular	15	0.01	984.50	984.20	54.4	0.55%	**2.1**	6.2	4.578	5.1	5.982	11.9	985.8	985.5	2.1	2.4	987.88		
100-year							1.25	0.20		10.3	2.1	2.1		0.20		10.3	2.1																					
25-year	J2.1	J2	J2.1 - J2	0.09	0.90	0.08	1.1	0.09	5.0	8.5	0.8	0.8	0.09	0.09	5.0	8.5	0.8	Inlet	HDPE	Circular	15	0.01	975.00	974.70	56.0	0.54%	**1.0**	6.1	3.734	5.0	4.185	15.0	976.3	976.0	2.4	2.6	978.60		
100-year							1.25	0.10		10.3	1.0	1.0		0.10		10.3	1.0																					
25-year	Y2	Y1	Y2 - Y1	0.72	0.90	0.65	1.1	0.71	5.0	8.5	6.1	6.1	0.72	0.71	5.0	8.5	6.1	Inlet	HDPE	Circular	18	0.01	985.50	984.10	215.0	0.65%	**8.4**	11.0	6.859	6.2	11.725	31.3	987.0	985.6	2.5	3.9	989.50		
100-year							1.25	0.81		10.3	8.4	8.4		0.81		10.3	8.4																					
25-year	Y1	A8	Y1 - A8	0.19	0.90	0.17	1.1	0.19	5.0	8.5	1.6	7.7	0.91	0.90	5.5	8.3	7.5	Inlet	HDPE	Circular	24	0.01	983.60	982.70	151.0	0.60%	**10.3**	22.7	7.059	7.2	11.369	21.4	985.6	984.7	3.9	4.8	989.50		
100-year							1.25	0.21		10.3	2.2	10.6		1.02		10.1	10.3																					
LINE B																																							
25-year	B7	B6	B7 - B6	1.02	0.90	0.92	1.1	1.01	5.0	8.5	8.6	8.6	1.02	1.01	5.0	8.5	8.6	Inlet	RCP	Circular	24	0.013	987.00	986.00	170.0	0.59%	**11.8**	17.4	5.943	5.5	14.551	28.6	989.0	988.0	2.0	3.0	991.00	987.15	988.23
100-year							1.25	1.15		10.3	11.8	11.8		1.15		10.3	11.8																					
25-year	B6	B5	B6 - B5	0.23	0.90	0.21	1.1	0.23	5.0	8.5	1.9	10.6	1.25	1.24	5.5	8.4	10.3	Inlet	RCP	Circular	24	0.013	985.80	985.20	112.0	0.54%	**14.2**	16.6	5.927	5.3	17.155	18.9	987.8	987.2	3.2	5.3	991.00	986.54	987.15
100-year							1.25	0.26		10.3	2.7	14.5		1.41		10.1	14.2																					
25-year	B5	B4	B5 - B4	2.39	0.90	2.15	1.1	2.37	5.0	8.5	20.2	30.7	3.64	3.60	5.8	8.3	29.7	Junction Box	RCP	Circular	36	0.013	984.20	983.40	153.0	0.52%	**41.0**	48.2	7.658	6.8	25.477	20.0	987.2	986.4	5.3	5.1	992.50	985.38	986.27
100-year							1.25	2.69		10.3	27.8	42.3		4.10		10.0	41.0																					
25-year	B4	B3	B4 - B3	4.15	0.90	3.74	1.1	4.11	5.0	8.5	35.0	65.8	7.79	7.71	6.1	8.1	62.8	Inlet	RCP	Circular	42	0.013	981.20	980.00	159.0	0.75%	**86.5**	87.4	10.357	9.1	34.049	15.4	984.7	983.5	6.8	8.0	991.50	982.64	984.07
100-year							1.25	4.67		10.3	48.2	90.5		8.76		9.9	86.5																					
25-year	B3	B2	B3 - B2	0.52	0.90	0.47	1.1	0.51	5.0	8.5	4.4	70.2	8.31	8.23	6.4	8.1	66.3	Inlet	RCP	Circular	48	0.013	979.50	978.90	143.0	0.42%	**91.4**	93.0	8.440	7.4	38.602	16.9	983.5	982.9	8.0	10.1	991.50	981.84	982.45
100-year							1.25	0.59		10.3	6.0	96.5		9.35		9.8	91.4																					
25-year	B2	B1	B2 - B1	4.46	0.90	4.01	1.1	4.42	5.0	8.5	37.7	107.8	12.77	12.64	6.7	8.0	100.8	Junction Box	RCP	Circular	48	0.013	972.00	968.60	354.0	0.96%	**139.0**	140.8	12.771	11.2	38.794	27.7	976.0	972.6	17.0	10.4	993.00	972.05	975.48
100-year							1.25	5.02		10.3	51.8	148.3		14.37		9.7	139.0																					
25-year	B1	A2	B1 - A2	2.25	0.90	2.03	1.1	2.23	5.0	8.5	19.0	126.8	15.02	14.87	7.1	7.8	116.4	Inlet	RCP	Circular	48	0.013	968.40	967.60	62.8	1.27%	**160.7**	162.1	14.708	12.9	38.952	4.3	972.4	971.6	10.6	11.4	983.00	970.56	972.05
100-year							1.25	2.53		10.3	26.1	174.4		16.90		9.5	160.7																					
25-year	Q2	Q1	Q2 - Q1	0.88	0.90	0.79	1.1	0.87	5.0	8.5	7.4	7.4	0.88	0.87	5.0	8.5	7.4	Inlet	RCP	Circular	18	0.013	986.40	986.20	17.7	1.13%	**10.2**	11.2	7.165	6.3	13.541	2.5	987.9	987.7	2.1	2.3	990.00		
100-year							1.25	0.99		10.3	10.2	10.2		0.99		10.3	10.2																					
25-year	Q1	B5	Q1 - B5	1.51	0.90	1.36	1.1	1.49	5.0	8.5	12.8	20.2	2.39	2.37	5.0	8.5	20.1	Inlet	RCP	Circular	30	0.013	985.20	984.70	98.0	0.51%	**27.7**	29.3	6.790	6.0	23.244	14.4	987.7	987.2	2.3	5.3	990.00		
100-year							1.25	1.70		10.3	17.5	27.8		2.69		10.3	27.7																					
25-year	P2	P1	P2 - P1	1.32	0.90	1.19	1.1	1.31	5.0	8.5	11.1	11.1	1.32	1.31	5.0	8.5	11.1	Inlet	RCP	Circular	24	0.013	985.50	984.50	175.0	0.57%	**15.3**	17.1	6.157	5.4	17.738	28.4	987.5	986.5	2.5	2.5	990.00		
100-year							1.25	1.49		10.3	15.3	15.3		1.49		10.3	15.3																					
25-year	P1	B4	P1 - B4	2.21	0.90	1.99	1.1	2.19	5.0	8.5	18.7	29.8	3.53	3.49	5.5	8.4	29.2	Inlet	RCP	Circular	30	0.013	984.00	982.20	181.0	0.99%	**40.2**	40.9	9.499	8.3	24.150	19.1	986.5	984.7	2.5	8.3	989.00		
100-year							1.25	2.49		10.3	25.7	41.0		3.97		10.1	40.2																					
25-year	P1.1	P1	P1.1 - P1	0.97	0.90	0.87	1.1	0.96	5.0	8.5	8.2	8.2	0.97	0.96	5.0	8.5	8.2	Inlet	RCP	Circular	24	0.013	984.90	984.50	65.0	0.62%	**11.3**	17.7	5.981	5.6	13.882	10.9	986.9	986.5	2.1	5.0	989.00		
100-year							1.25	1.09		10.3	11.3	11.3		1.09		10.3	11.3																					
25-year	K3	K2	K3 - K2	1.73	0.90	1.56	1.1	1.71	5.0	8.5	14.6	14.6	1.73	1.71	5.0	8.5	14.6	Inlet	RCP	Circular	24	0.013	983.40	982.60	98.0	0.82%	**20.1**	20.4	7.416	6.5	19.308	13.2	985.4	984.6	4.6	5.9	990.00		
100-year							1.25	1.95		10.3	20.1	20.1		1.95		10.3	20.1																					
25-year	K2	K1	K2 - K1	0.40	0.90	0.36	1.1	0.40	5.0	8.5	3.4	18.0	2.13	2.11	5.2	8.5	17.8	Inlet	RCP	Circular	30	0.013	982.10	981.30	142.0	0.56%	**24.5**	30.8	6.962	6.3	20.229	20.4	984.6	983.8	5.9	6.7	990.50		
100-year							1.25	0.45		10.3	4.6	24.7		2.40		10.2	24.5																					
25-year	K1	B2	K1 - B2	0.53	0.90	0.48	1.1	0.52	5.0	8.5	4.5	22.5	2.66	2.63	5.6	8.3	21.9	Inlet	RCP	Circular	30	0.013	981.10	980.20	153.0	0.59%	**30.2**	31.5	7.298	6.4	23.580	21.0	983.6	982.7	6.9	10.3	990.50		
100-year							1.25	0.60		10.3	6.2	30.9		2.99		10.1	30.2																					
25-year	N4	N3	N4 - N3	0.16	0.90	0.14	1.1	0.16	5.0	8.5	1.4	1.4	0.16	0.16	5.0	8.5	1.4	Inlet	RCP	Circular	18	0.013	982.00	981.60	46.0	0.87%	**1.9**	9.8	4.263	5.5	5.312	10.8	983.5	983.1	2.5	1.9	986.00		
100-year							1.25	0.18		10.3	1.9	1.9		0.18		10.3	1.9																					
25-year	N3	N2	N3 - N2	0.69	0.90	0.62	1.1	0.68	5.0	8.5	5.8	7.2	0.85	0.84	5.2	8.5	7.1	Inlet	RCP	Circular	18	0.013	976.50	976.20	24.0	1.25%	**9.8**	11.7	7.438	6.6	12.568	3.2	978.0	977.7	7.0	7.3	985.00		
100-year							1.25	0.78		10.3	8.0	9.9		0.96		10.2	9.8																					
25-year	N2	N1	N2 - N1	0.73	0.90	0.66	1.1	0.72	5.0	8.5	6.2	13.3	1.58	1.56	5.2	8.4	13.2	Inlet	RCP	Circular	24	0.013	975.70	975.30	61.0	0.66%	**18.2**	18.3	6.648	5.8	19.502	9.2	977.7	977.3	7.3	8.7	985.00		
100-year							1.25	0.82		10.3	8.5	18.3		1.78		10.2	18.2																					
25-year	N1	B2	N1 - B2	0.38	0.90	0.34	1.1	0.38	5.0	8.5	3.2	16.6	1.96	1.94	5.4	8.4	16.3	Inlet	RCP	Circular	30	0.013	974.80	973.50	245.0	0.53%	**22.4**	29.9	6.680	6.1	19.386	36.7	977.3	976.0	8.7	17.0	986.00		
100-year							1.25	0.43		10.3	4.4	22.8		2.21		10.2	22.4																					

REV	DATE	DESCRIPTION	DSN	DWN	CHK
0	1-16-19	INITIAL ISSUE	LDO	JT	LDO

STATE OF MISSOURI
LEON D. OSBOURN
NUMBER
E-21726
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LEON D. OSBOURN
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KAW VALLEY ENGINEERING

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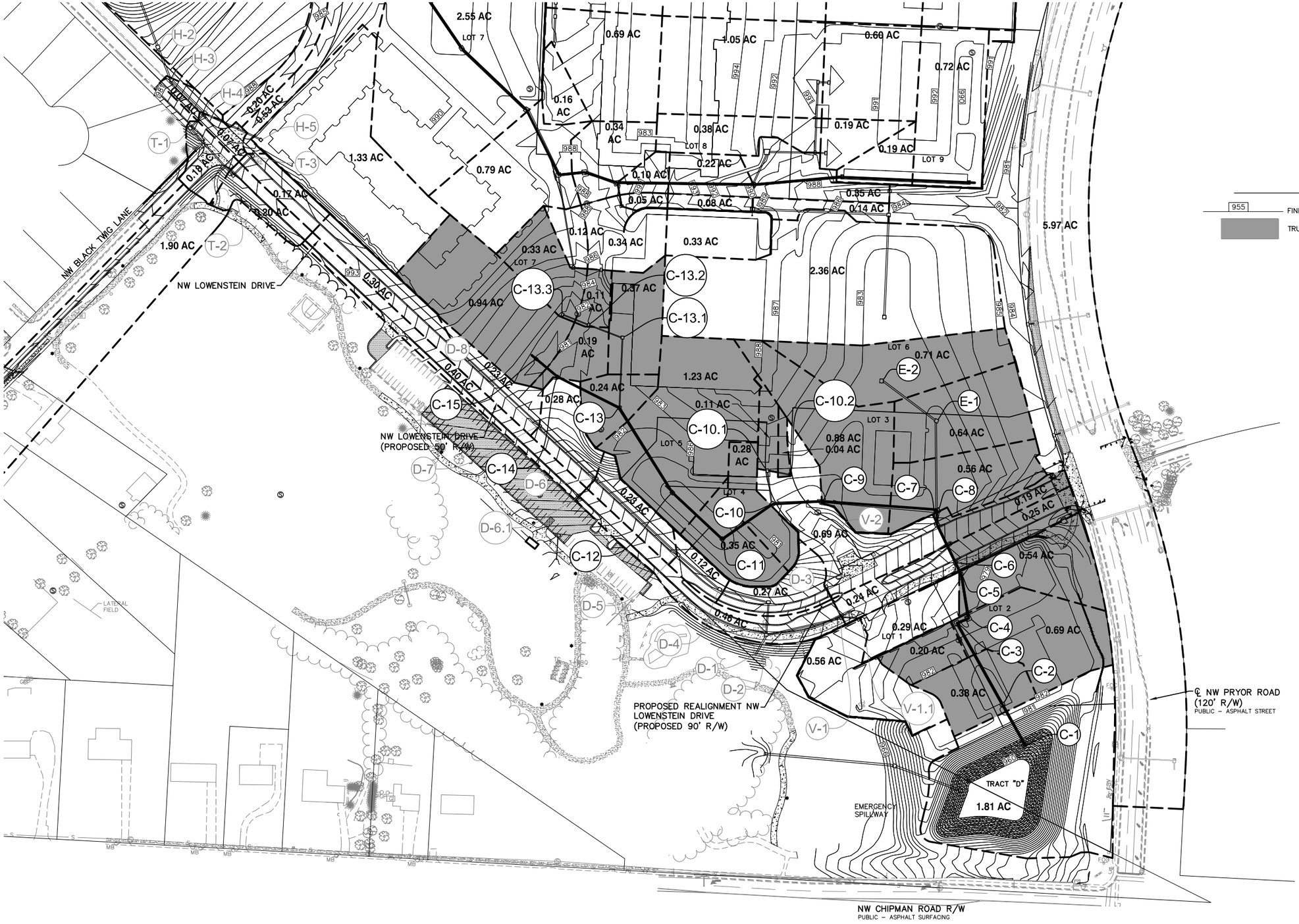
STREETS OF WEST PRYOR
NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

MASS GRADING PLANS
DRAINAGE AREA MAP - DESIGN TABLES STORM LINES A, B, J, & R

PROJ. NO. A14_7067-1
DESIGNER LDO | DRAWN BY JT
CFN 7067-1G_DAM_CHART
SHEET C-12 | REV 0



CONTRACTOR TO COORDINATE WITH CONSTRUCTION OF STORM LINES, D, V, T, H – SEE SEPARATE NW LOWENSTIEN DRIVE STREET PLANS

REV	DATE	DESCRIPTION	DSN	DWN	CHK
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STREETS OF WEST PRYOR
NWQ NW PRYOR ROAD & NW LOWENSTEIN DRIVE
LEE'S SUMMIT, MISSOURI

MASS GRADING PLANS
DRAINAGE AREA MAP - STORM SEWER LINE C

PROJ. NO.	
A14_7067-1	
DESIGNER	DRAWN BY
LDO	JT
CFN	
7067-1G_DAM_C	
SHEET	REV
C-12	0

		Overland Flow												System Flow					Node	Pipe Design																		Structure Design	Hydraulic Grade Line (100-YR)	
	Design Storm	Structure	Downstream Structure	Pipe	Tributary Area (A)	Runoff coefficient ("C")	A x C	Antecedent Precipitation	A x C x K	Time of Concentration	Rainfall Intensity	Tributary Runoff (cfs)	Total Runoff (cfs)	Total Area	Summation of A x C x K	System Tc	System Rainfall Intensity	System Discharge	Node Condition	Pipe Material	Pipe Shape	Pipe Size	Manning's Coefficient	Upstream Invert	Downstream Invert	Length	Pipe Slope	Design Flow	Full Flow Capacity	Design Velocity	Full Flow Velocity	Depth (in.)	Flow Time (sec)	Upstream Crown Elevations	Downstream Crown Elevations	Upstream Depth of Cover	Downstream Depth of Cover	Rim Elevation	Downstream	Upstream
KVE	25-year	C15	C14	C15 - C14	0.95	0.60	0.57	1.1	0.63	5.0	8.5	5.3	5.3	0.95	0.63	5.0	8.5	5.3	Inlet	RCP	Circular	18	0.013	977.10	976.80	47.0	0.64%	**7.4**	8.4	5.355	4.7	13.059	8.8	978.6	978.3	1.8	2.1	980.40	979.73	980.17
	100-year							1.25	0.71		10.3	7.4	7.4		0.71		10.3	7.4																						
	25-year	C14	C13	C14 - C13	0.17	0.90	0.15	1.1	0.17	5.0	8.5	1.4	6.8	1.12	0.80	5.1	8.5	6.7	Inlet	RCP	Circular	24	0.013	976.30	975.70	118.0	0.51%	**9.3**	16.1	5.313	5.1	13.049	22.2	978.3	977.7	2.1	4.3	980.40	979.33	979.65
	100-year							1.25	0.19		10.3	2.0	9.3		0.90		10.3	9.3																						
	25-year	C13	C12	C13 - C12	1.05	0.90	0.95	1.1	1.04	5.0	8.5	8.9	15.6	2.17	1.83	5.5	8.3	15.3	Inlet	RCP	Circular	30	0.013	975.20	974.30	170.0	0.53%	**21.1**	29.8	6.591	6.1	18.606	25.8	977.7	976.8	4.3	2.2	982.00	978.58	979.1
	100-year							1.25	1.18		10.3	12.2	21.5		2.09		10.1	21.1																						
	25-year	C12	C11	C12 - C11	1.23	0.90	1.11	1.1	1.22	5.0	8.5	10.4	26.0	3.40	3.05	5.9	8.2	25.0	Inlet	RCP	Circular	36	0.013	973.80	973.20	116.0	0.52%	**34.5**	48.0	7.384	6.8	22.594	15.7	976.8	976.2	2.2	2.8	979.00	978.12	978.44
	100-year							1.25	1.38		10.3	14.3	35.8		3.47		9.9	34.5																						
	25-year	C11	C10	C11 - C10	0.35	0.90	0.32	1.1	0.35	5.0	8.5	3.0	29.0	3.75	3.40	6.2	8.1	27.6	Inlet	RCP	Circular	36	0.013	973.10	972.50	104.0	0.58%	**38.0**	50.7	7.866	7.2	23.270	13.2	976.1	975.5	2.9	5.0	979.00	977.27	977.61
	100-year							1.25	0.39		10.3	4.1	39.9		3.86		9.8	38.0																						
	25-year	C10	C9	C10 - C9	0.43	0.90	0.39	1.1	0.43	5.0	8.5	3.6	32.6	4.18	3.82	6.4	8.0	30.8	Junction Box	RCP	Circular	36	0.013	972.30	971.80	84.0	0.60%	**42.4**	51.5	8.131	7.3	24.905	10.3	975.3	974.8	5.2	4.9	980.50	976.56	976.9
	100-year							1.25	0.48		10.3	5.0	44.9		4.35		9.8	42.4																						
	25-year	C9	C8	C9 - C8	0.88	0.90	0.79	1.1	0.87	5.0	8.5	7.4	40.1	5.06	4.70	6.6	8.0	37.5	Inlet	RCP	Circular	42	0.013	971.30	970.40	195.0	0.46%	**51.7**	68.4	7.811	7.1	27.313	25.0	974.8	973.9	4.9	7.1	979.70	975.99	976.48
	100-year							1.25	0.99		10.3	10.2	55.1		5.34		9.7	51.7																						
	25-year	C8	C7	C8 - C7	1.91	0.90	1.72	1.1	1.89	5.0	8.5	16.1	56.2	6.97	6.50	7.0	7.9	51.8	Inlet	RCP	Circular	42	0.013	970.20	970.00	25.0	0.80%	**71.5**	90.0	10.377	9.4	28.262	2.4	973.7	973.5	7.3	6.0	981.00	974.97	975.09
	100-year							1.25	2.15		10.3	22.2	77.3		7.49		9.5	71.5																						
	25-year	C7	C6	C7 - C6	0.19	0.90	0.17	1.1	0.19	5.0	8.5	1.6	57.8	7.16	6.77	7.1	7.9	53.2	Inlet	RCP	Circular	48	0.013	969.50	969.10	72.0	0.56%	**73.4**	107.1	9.177	8.5	29.179	7.8	973.5	973.1	6.0	6.4	979.50	974.53	974.7
	100-year							1.25	0.21		10.3	2.2	79.5		7.70		9.5	73.4																						
	25-year	C6	C5	C6 - C5	0.25	0.90	0.23	1.1	0.25	5.0	8.5	2.1	59.9	7.41	7.02	7.2	7.8	54.9	Inlet	RCP	Circular	48	0.013	968.90	968.80	22.0	0.45%	**75.7**	96.8	8.525	7.7	31.930	2.6	972.9	972.8	6.6	4.6	979.50	974.39	974.44
	100-year							1.25	0.28		10.3	2.9	82.4		7.98		9.5	75.7																						
	25-year	C5	C4	C5 - C4	0.54	0.90	0.49	1.1	0.53	5.0	8.5	4.6	64.5	7.95	7.56	7.2	7.8	58.9	Inlet	RCP	Circular	48	0.013	968.60	968.20	76.0	0.53%	**81.3**	104.2	9.171	8.3	31.896	8.3	972.6	972.2	4.8	7.9	977.35	973.95	974.17
	100-year							1.25	0.61		10.3	6.3	88.6		8.59		9.5	81.3																						
	25-year	C4	C3	C4 - C3	0.69	0.90	0.62	1.1	0.68	5.0	8.5	5.8	70.3	8.64	8.24	7.4	7.8	63.9	Inlet	RCP	Circular	54	0.013	967.70	967.60	21.5	0.47%	**88.2**	134.1	9.001	8.4	31.957	2.4	972.2	972.1	7.9	7.6	980.10	973.43	973.47
	100-year							1.25	0.78		10.3	8.0	96.7		9.36		9.4	88.2																						
	25-year	C3	C2	C3 - C2	0.20	0.90	0.18	1.1	0.20	5.0	8.5	1.7	72.0	8.84	8.44	7.4	7.7	65.4	Junction Box	RCP	Circular	54	0.013	967.40	966.60	158.0	0.51%	**90.2**	139.9	9.349	8.8	31.547	16.9	971.9	971.1	7.9	10.3	979.75	972.63	972.92
	100-year							1.25	0.23		10.3	2.3	99.0		9.59		9.4	90.2																						
	25-year	C2	C1	C2 - C1	0.38	0.90	0.34	1.1	0.38	5.0	8.5	3.2	75.2	9.22	8.81	7.7	7.7	67.5	Inlet	RCP	Circular	54	0.013	966.40	966.00	80.6	0.50%	**93.3**	138.5	9.345	8.7	32.443	8.6	970.9	970.5	10.5		981.36	972.39	972.55
	100-year							1.25	0.43		10.3	4.4	103.4		10.02		9.3	93.3																						
	25-year	C13.3	C13.2	C13.3 - C13.2	0.33	0.90	0.30	1.1	0.33	5.0	8.5	2.8	2.8	0.33	0.33	5.0	8.5	2.8	Inlet	RCP	Circular	15	0.013	978.00	977.60	48.0	0.83%	**3.8**	5.9	5.115	4.8	8.808	9.4	979.3	978.9	2.3	2.6	981.50		
	100-year							1.25	0.37		10.3	3.8	3.8		0.37		10.3	3.8																						
	25-year	C13.2	C13.1	C13.2 - C13.1	0.11	0.90	0.10	1.1	0.11	5.0	8.5	0.9	3.7	0.44	0.44	5.2	8.5	3.7	Inlet	RCP	Circular	15	0.013	977.40	976.20	61.0	1.97%	**5.1**	9.1	7.593	7.4	8.030	8.0	978.7	977.5	2.9	4.5	981.50		
	100-year							1.25	0.12		10.3	1.3	5.1		0.50		10.3	5.1																						
	25-year	C13.1	C13	C13.1 - C13	0.37	0.90	0.33	1.1	0.37	5.0	8.5	3.1	6.8	0.81	0.80	5.3	8.4	6.8	Inlet	RCP	Circular	18	0.013	975.90	974.90	119.0	0.84%	**9.3**	9.6	6.207	5.4	14.224	19.2	977.4	976.4	4.6	5.6	982.00		
	100-year							1.25	0.42		10.3	4.3	9.4		0.91		10.2	9.3																						
	25-year	C10.2	C10.1	C10.2 - C10.1	0.04	0.90	0.04	1.1	0.04	5.0	8.5	0.3	0.3	0.04	0.04	5.0	8.5	0.3	Inlet	RCP	Circular	15	0.013	978.00	977.60	39.0	1.03%	**0.5**	6.5	3.083	5.3	2.706	12.7	979.3	978.9	2.3	3.1	981.50		
	100-year							1.25	0.05		10.3	0.5	0.5		0.05		10.3	0.5																						
	25-year	C10.1	C10	C10.1 - C10	0.11	0.90	0.10	1.1	0.11	5.0	8.5	0.9	1.3	0.15	0.15	5.2	8.5	1.3	Inlet	RCP	Circular	15	0.013	977.40	977.00	57.5	0.70%	**1.7**	5.4	3.907	4.4	5.838	14.7	978.7	978.3	3.4	2.3	982.00		
	100-year							1.25	0.12		10.3	1.3	1.7		0.17		10.2	1.7																						
	25-year	E2	E1	E2 - E1	0.71	0.90	0.64	1.1	0.70	5.0	8.5	6.0	6.0	0.71	0.70	5.0	8.5	6.0	Inlet	RCP	Circular	18	0.013	977.50	976.70	115.0	0.70%	**8.2**	8.8	5.638	5.0	13.882	20.4	979.0	978.2	3.0	2.8	982.00		
	100-year							1.25	0.80		10.3	8.2	8.2		0.80		10.3	8.2																						
	25-year	E1	C8	E1 - C8	0.64	0.90	0.58	1.1	0.63	5.0	8.5	5.4	11.4	1.35	1.34	5.3	8.4	11.2	Inlet	RCP	Circular	24	0.013	976.20	975.30	151.0	0.60%	**15.5**	17.5	6.278	5.6	17.561	24.1	978.2	977.3	2.8	3.7	981.00		
	100-year							1.25	0.72		10.3	7.4	15.7		1.52		10.2	15.5																						

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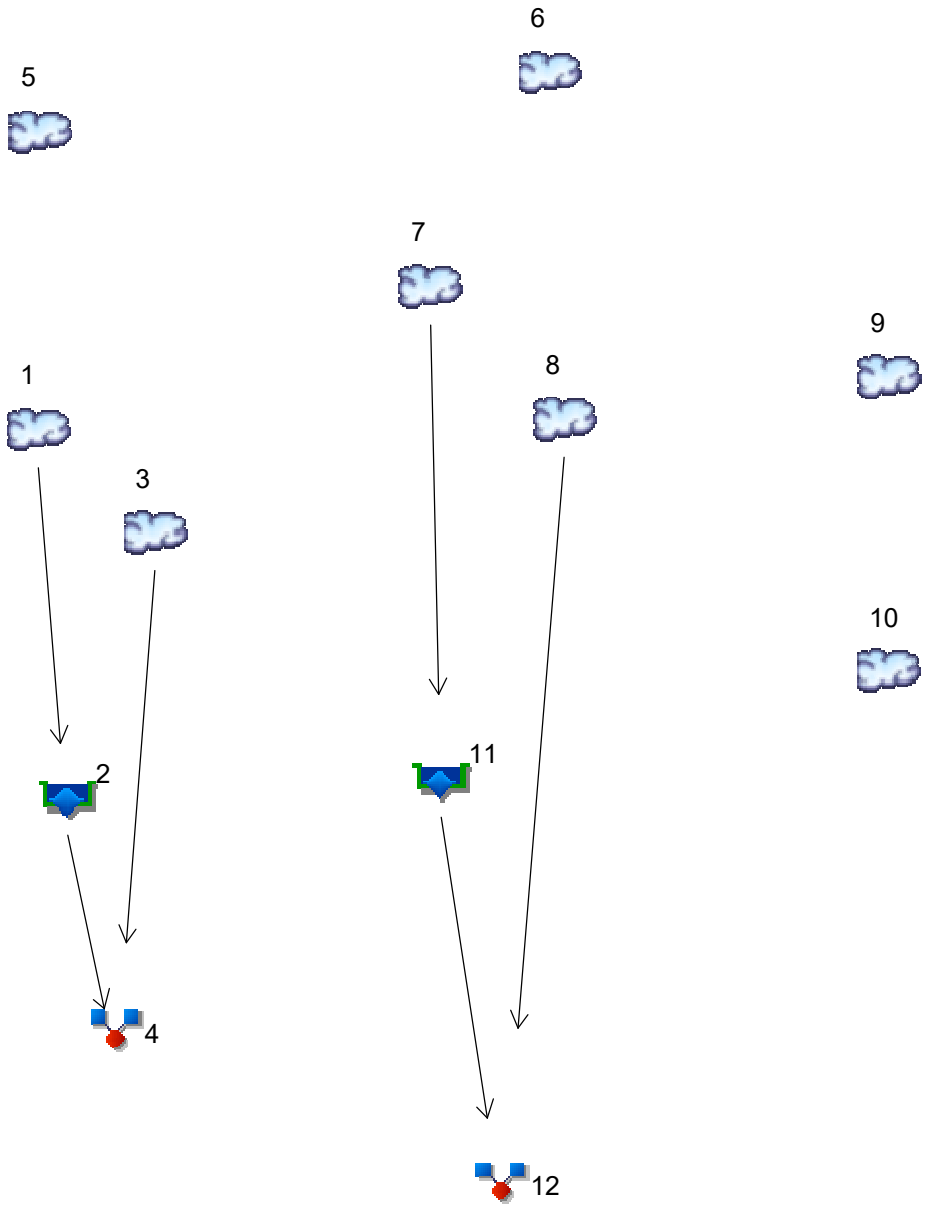
SHEET C-13 | REV 0

APPENDIX D – HYDRAFLOW HYDROGRAPH DETENTION CALCULATIONS

Hydraflow Table of Contents

Watershed Model Schematic

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



Legend

Hyd.	Origin	Description
1	SCS Runoff	South (portion to detention)
2	Reservoir	South Basin Routing
3	SCS Runoff	South (portion undetained)
4	Combine	Combined South Basin Post Dev
5	SCS Runoff	South - PreDev
6	SCS Runoff	West Basin - PreDev
7	SCS Runoff	To West Basin
8	SCS Runoff	West (undetained)
9	SCS Runoff	East Basin - PreDev
10	SCS Runoff	East Watershed Post Dev
11	Reservoir	West Basin Routing
12	Combine	Combined West Post Dev

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	14.35	48.06	-------	-------	73.32	-------	-------	121.68	South (portion to detention)
2	Reservoir	1	0.000	4.784	-------	-------	15.27	-------	-------	43.84	South Basin Routing
3	SCS Runoff	------	2.897	9.699	-------	-------	14.80	-------	-------	24.56	South (portion undetained)
4	Combine	2, 3	2.897	11.70	-------	-------	22.04	-------	-------	62.07	Combined South Basin Post Dev
5	SCS Runoff	------	2.533	41.36	-------	-------	80.24	-------	-------	160.78	South - PreDev
6	SCS Runoff	------	2.628	42.91	-------	-------	83.24	-------	-------	166.81	West Basin - PreDev
7	SCS Runoff	------	47.84	190.33	-------	-------	299.73	-------	-------	508.76	To West Basin
8	SCS Runoff	------	4.488	17.86	-------	-------	28.12	-------	-------	47.73	West (undetained)
9	SCS Runoff	------	2.573	41.43	-------	-------	80.18	-------	-------	160.31	East Basin - PreDev
10	SCS Runoff	------	7.854	31.25	-------	-------	49.21	-------	-------	83.53	East Watershed Post Dev
11	Reservoir	7	0.000	7.252	-------	-------	15.40	-------	-------	41.01	West Basin Routing
12	Combine	8, 11	4.488	17.86	-------	-------	37.36	-------	-------	69.36	Combined West Post Dev

Hydrograph Summary Report

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

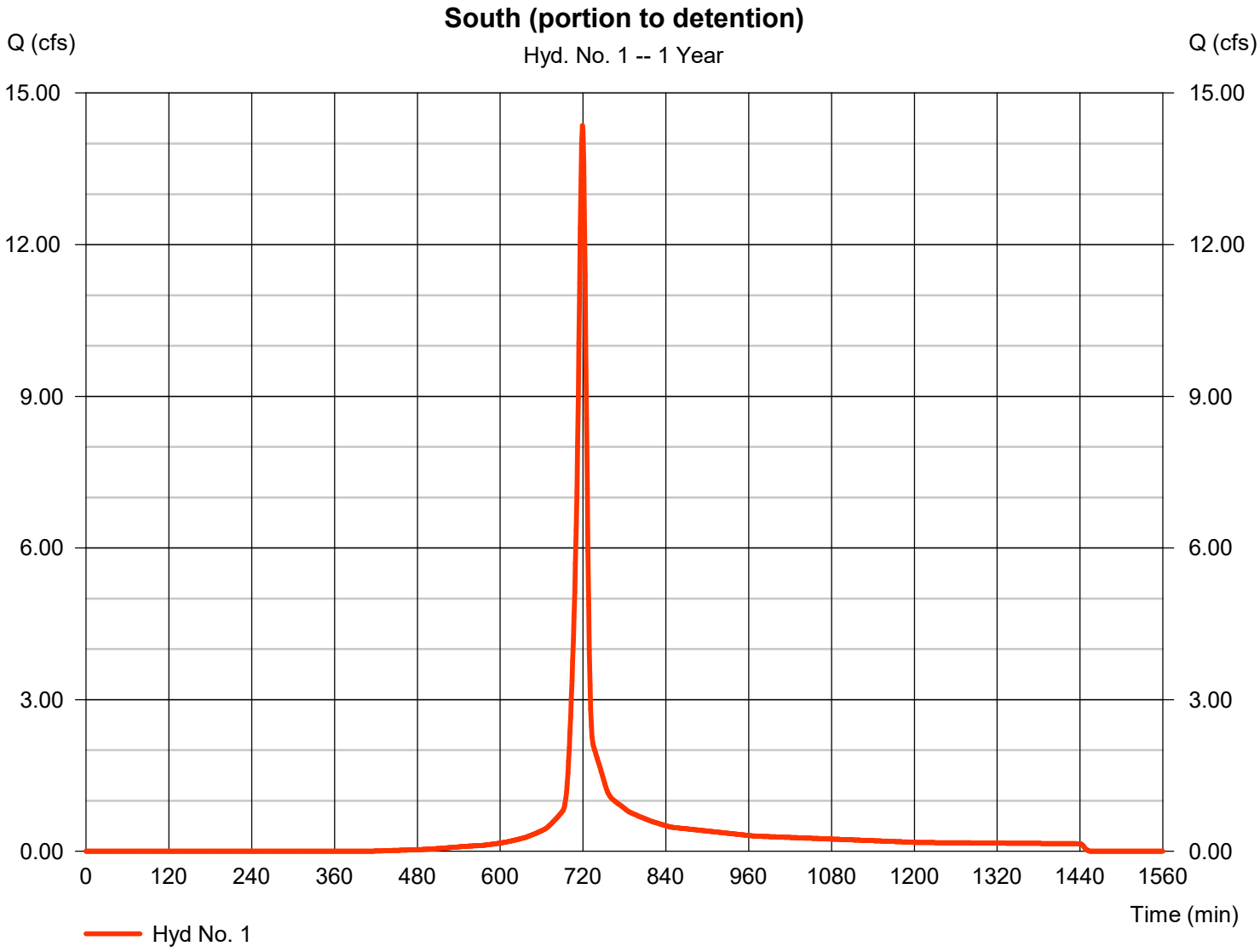
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	14.35	1	719	32,770	------	------	------	South (portion to detention)
2	Reservoir	0.000	1	n/a	0	1	967.74	32,770	South Basin Routing
3	SCS Runoff	2.897	1	719	6,614	------	------	------	South (portion undetained)
4	Combine	2.897	1	719	6,614	2, 3	------	------	Combined South Basin Post Dev
5	SCS Runoff	2.533	1	729	13,830	------	------	------	South - PreDev
6	SCS Runoff	2.628	1	729	14,349	------	------	------	West Basin - PreDev
7	SCS Runoff	47.84	1	719	108,239	------	------	------	To West Basin
8	SCS Runoff	4.488	1	719	10,155	------	------	------	West (undetained)
9	SCS Runoff	2.573	1	727	13,103	------	------	------	East Basin - PreDev
10	SCS Runoff	7.854	1	719	17,771	------	------	------	East Watershed Post Dev
11	Reservoir	0.000	1	n/a	0	7	951.11	854,563	West Basin Routing
12	Combine	4.488	1	719	10,155	8, 11	------	------	Combined West Post Dev

Hydrograph Report

Hyd. No. 1

South (portion to detention)

Hydrograph type	= SCS Runoff	Peak discharge	= 14.35 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 32,770 cuft
Drainage area	= 11.000 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.37 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



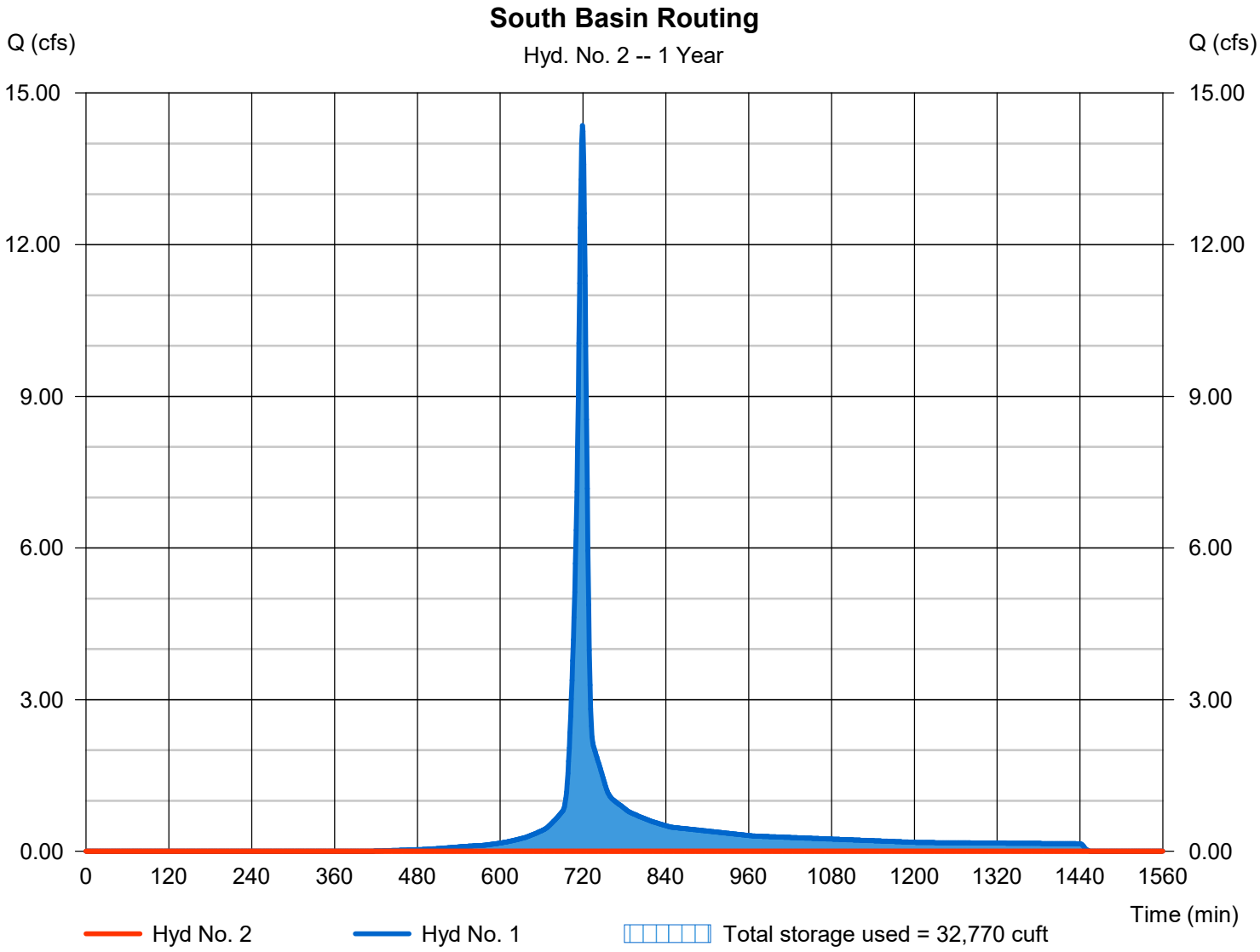
Hydrograph Report

Hyd. No. 2

South Basin Routing

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	1 yrs	Time to peak	=	n/a
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	1 - South (portion to detention)	Max. Elevation	=	967.74 ft
Reservoir name	=	South Basin	Max. Storage	=	32,770 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - South Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 966.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	966.00	17,238	0	0
1.00	967.00	18,967	18,094	18,094
2.00	968.00	20,772	19,861	37,954
3.00	969.00	22,653	21,704	59,658
4.00	970.00	24,606	23,620	83,278
5.00	971.00	26,631	25,609	108,888
6.00	972.00	28,724	27,668	136,556
7.00	973.00	30,921	29,813	166,369
8.00	974.00	31,439	31,177	197,545
9.00	975.00	33,672	32,546	230,091
10.00	976.00	35,979	34,816	264,907
11.00	977.00	38,362	37,160	302,067
12.00	978.00	40,812	39,577	341,644

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	8.00	8.00	0.00
Span (in)	= 36.00	8.00	8.00	0.00
No. Barrels	= 1	2	2	0
Invert El. (ft)	= 960.00	968.00	969.00	0.00
Length (ft)	= 50.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	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	Yes	No

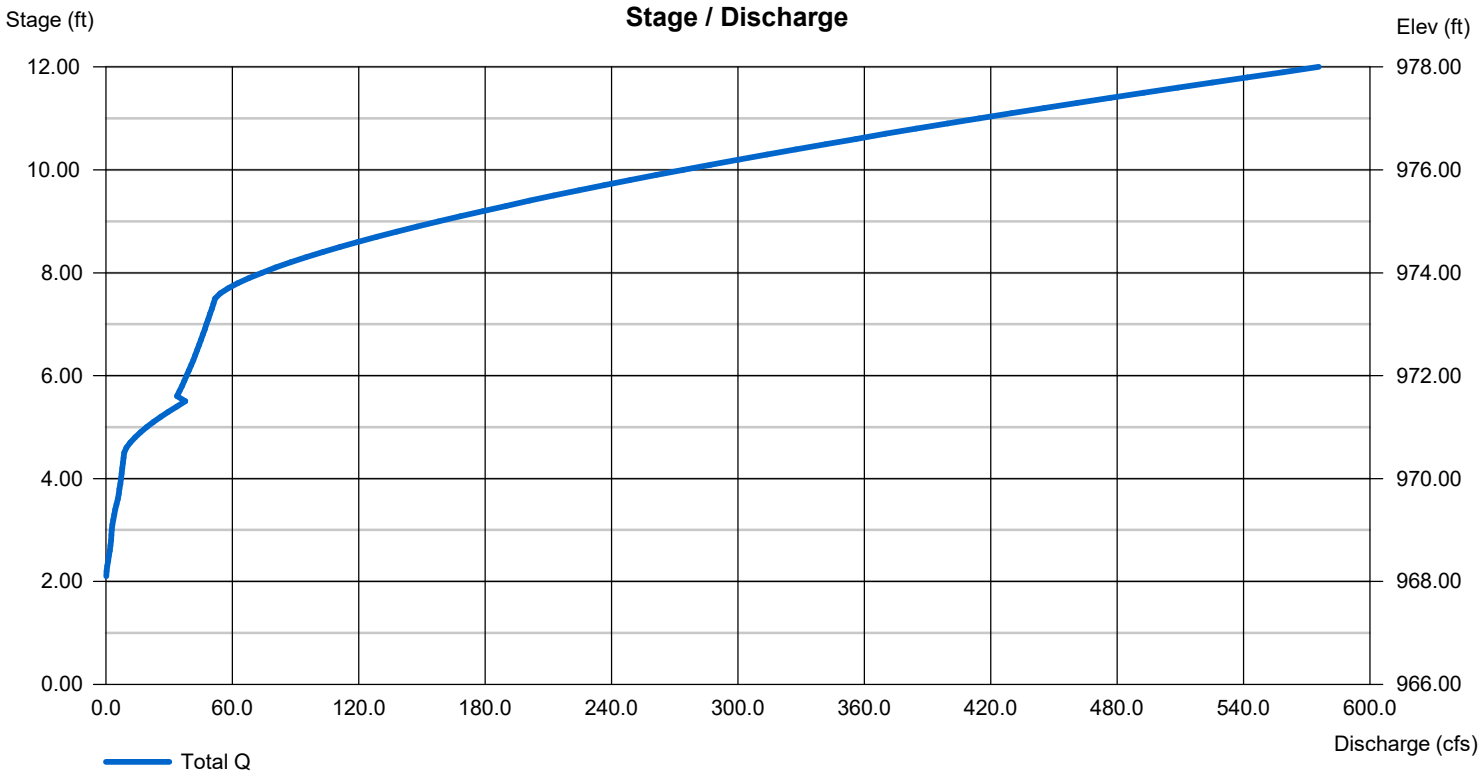
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	20.00	0.00	0.00
Crest El. (ft)	= 970.50	973.50	0.00	0.00
Weir Coeff.	= 3.33	2.60	3.33	3.33
Weir Type	= 1	Broad	---	---
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).

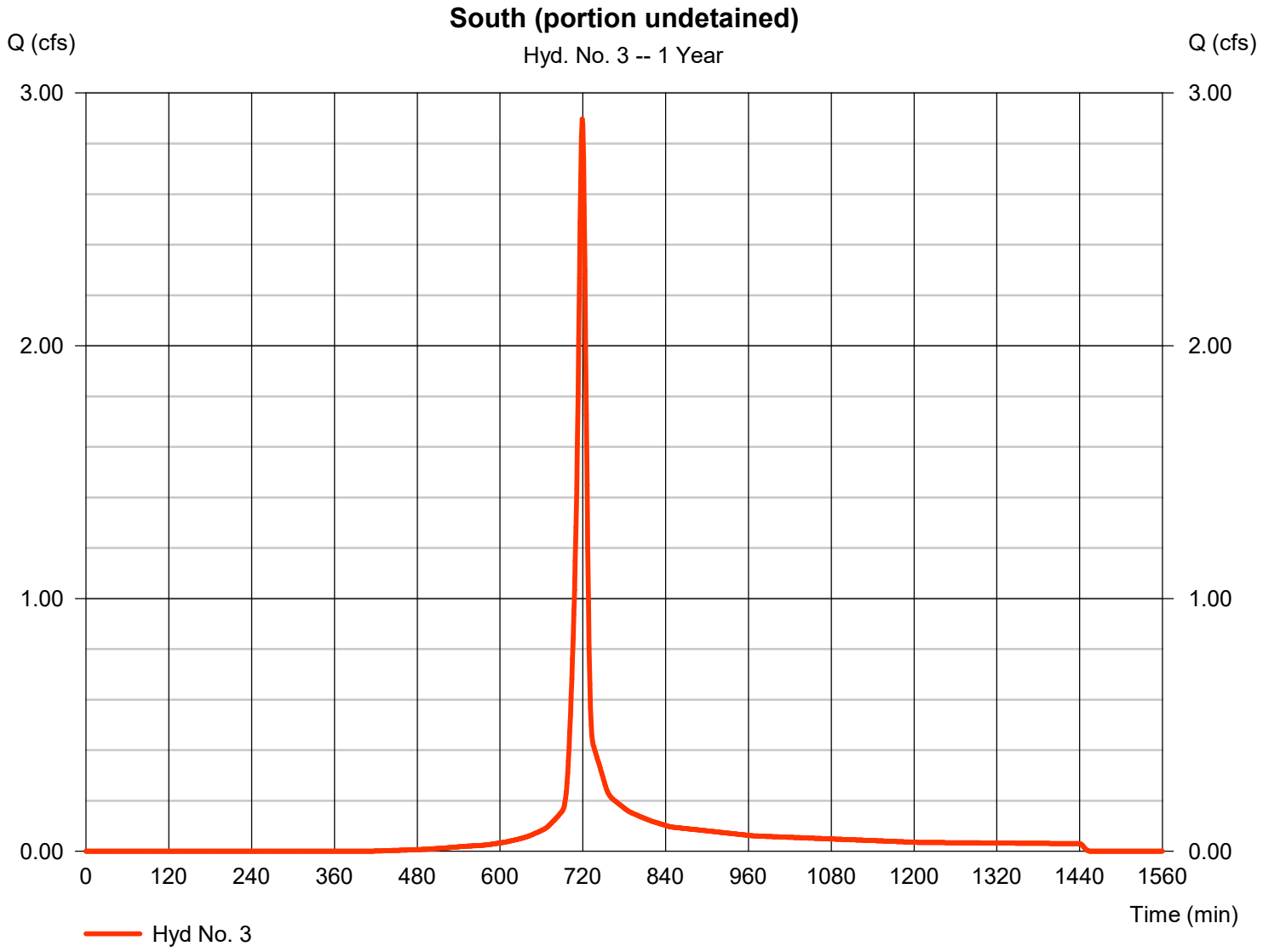


Hydrograph Report

Hyd. No. 3

South (portion undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.897 cfs
Storm frequency	=	1 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	6,614 cuft
Drainage area	=	2.220 ac	Curve number	=	94
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

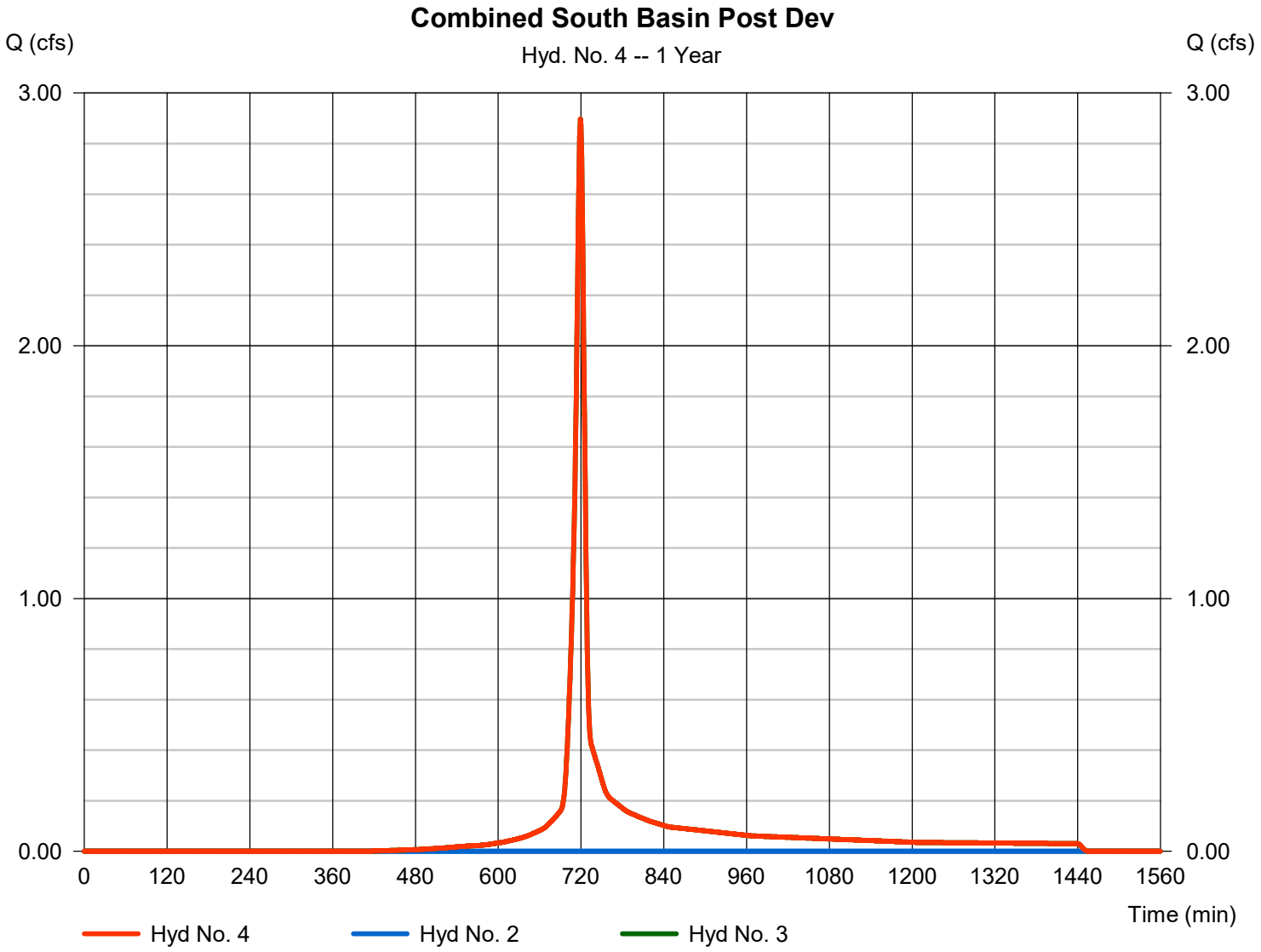


Hydrograph Report

Hyd. No. 4

Combined South Basin Post Dev

Hydrograph type	= Combine	Peak discharge	= 2.897 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 6,614 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 2.220 ac

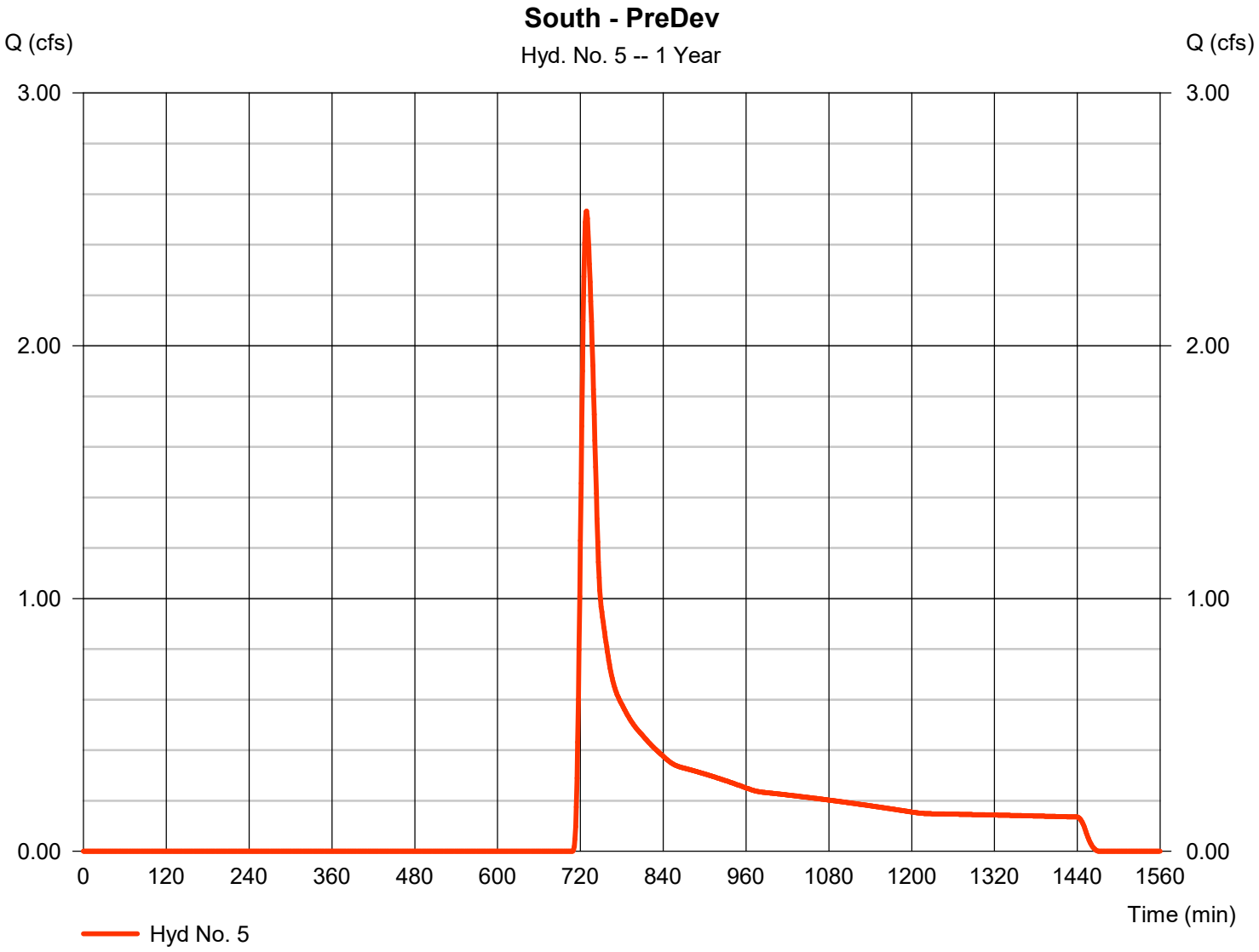


Hydrograph Report

Hyd. No. 5

South - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.533 cfs
Storm frequency	=	1 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	13,830 cuft
Drainage area	=	24.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

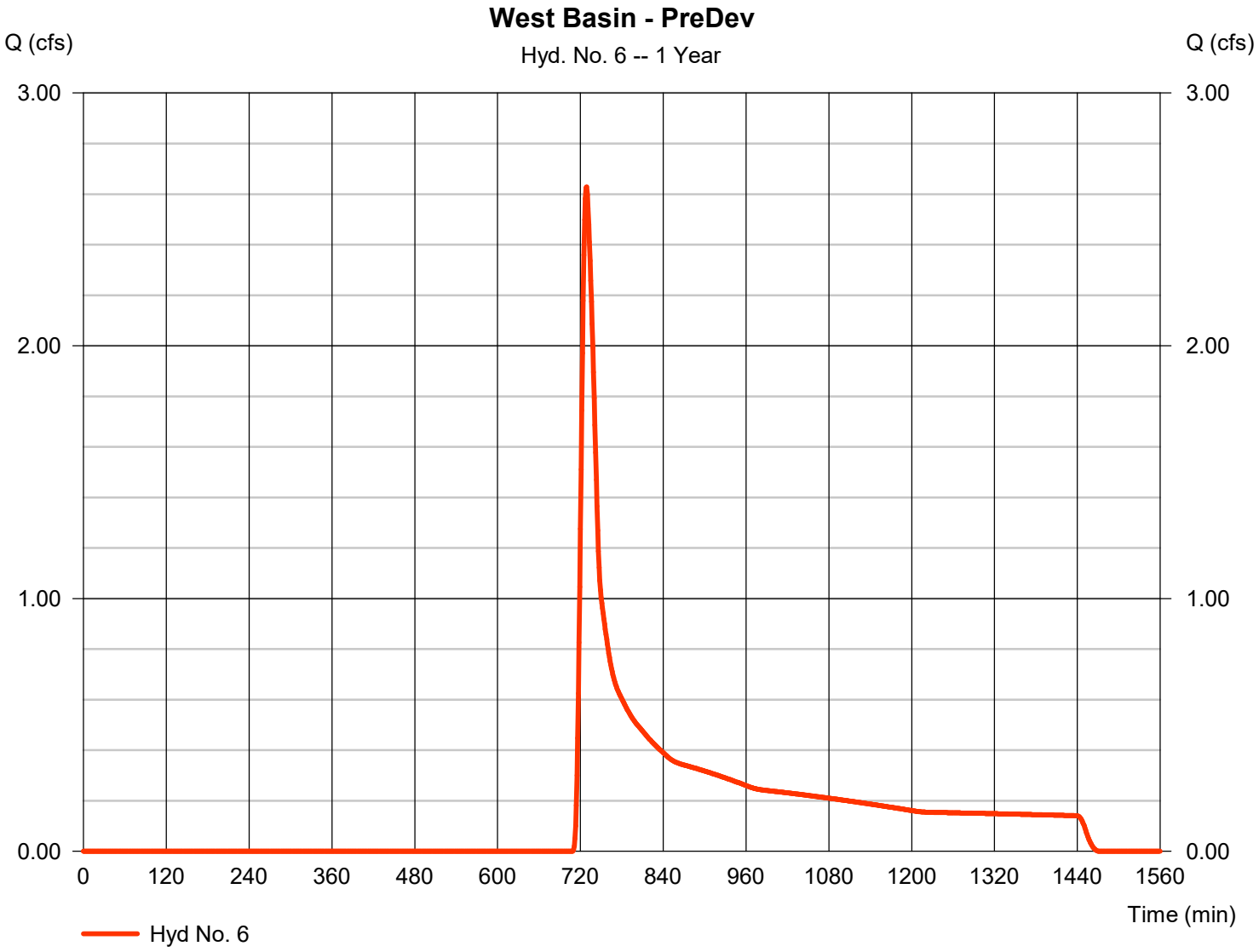


Hydrograph Report

Hyd. No. 6

West Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.628 cfs
Storm frequency	=	1 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	14,349 cuft
Drainage area	=	24.900 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

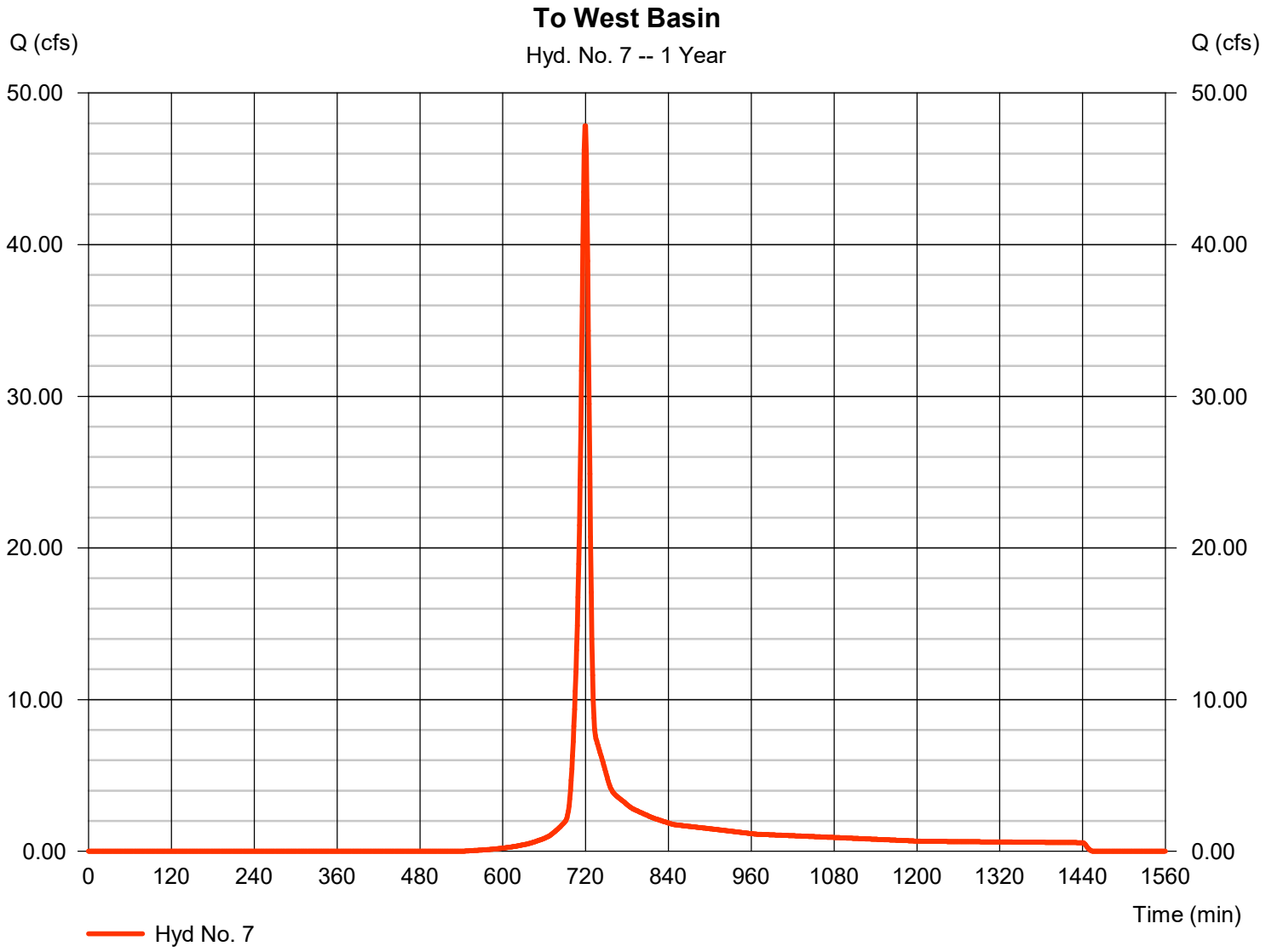


Hydrograph Report

Hyd. No. 7

To West Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 47.84 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 108,239 cuft
Drainage area	= 46.900 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.37 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

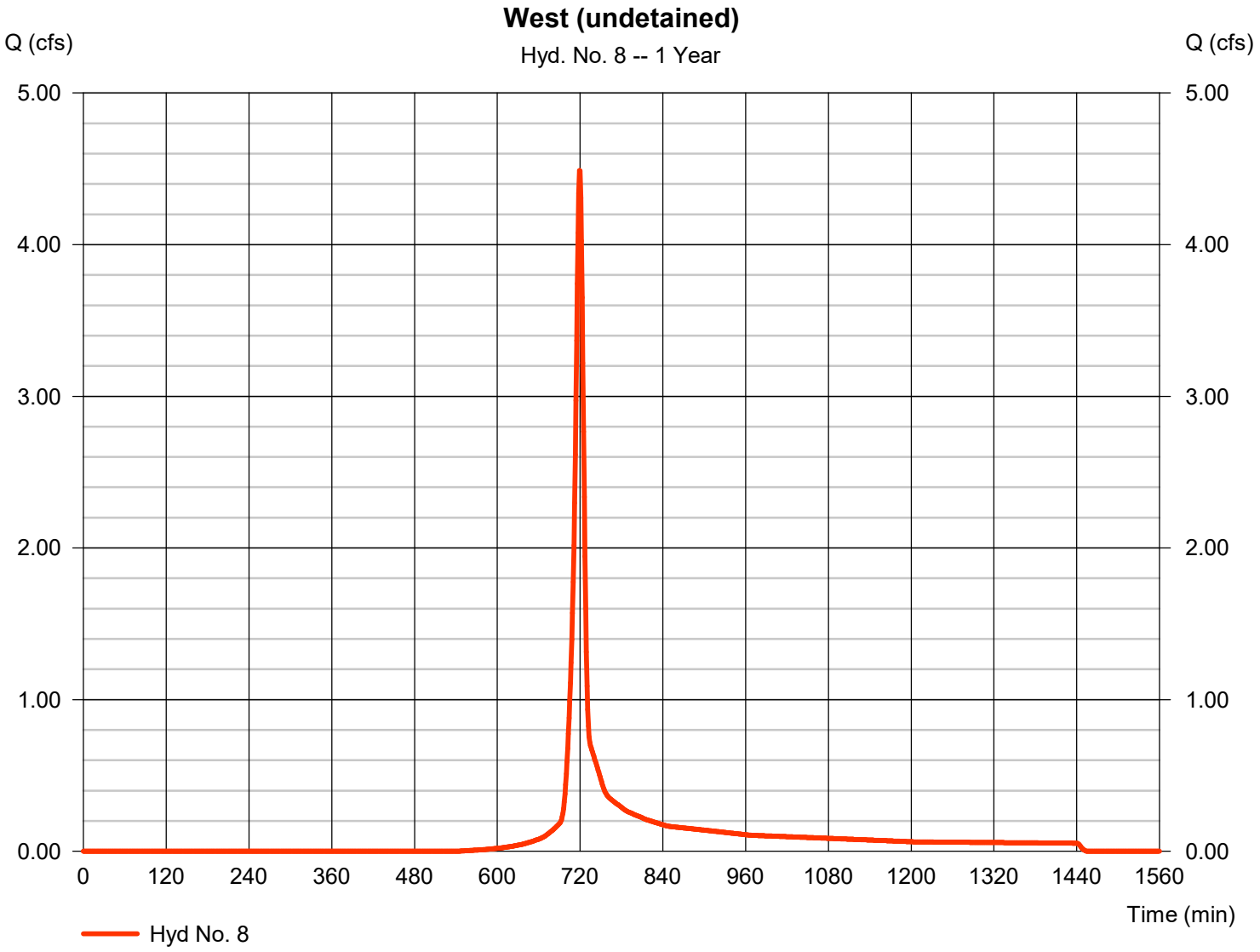


Hydrograph Report

Hyd. No. 8

West (undetained)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.488 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 10,155 cuft
Drainage area	= 4.400 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.37 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

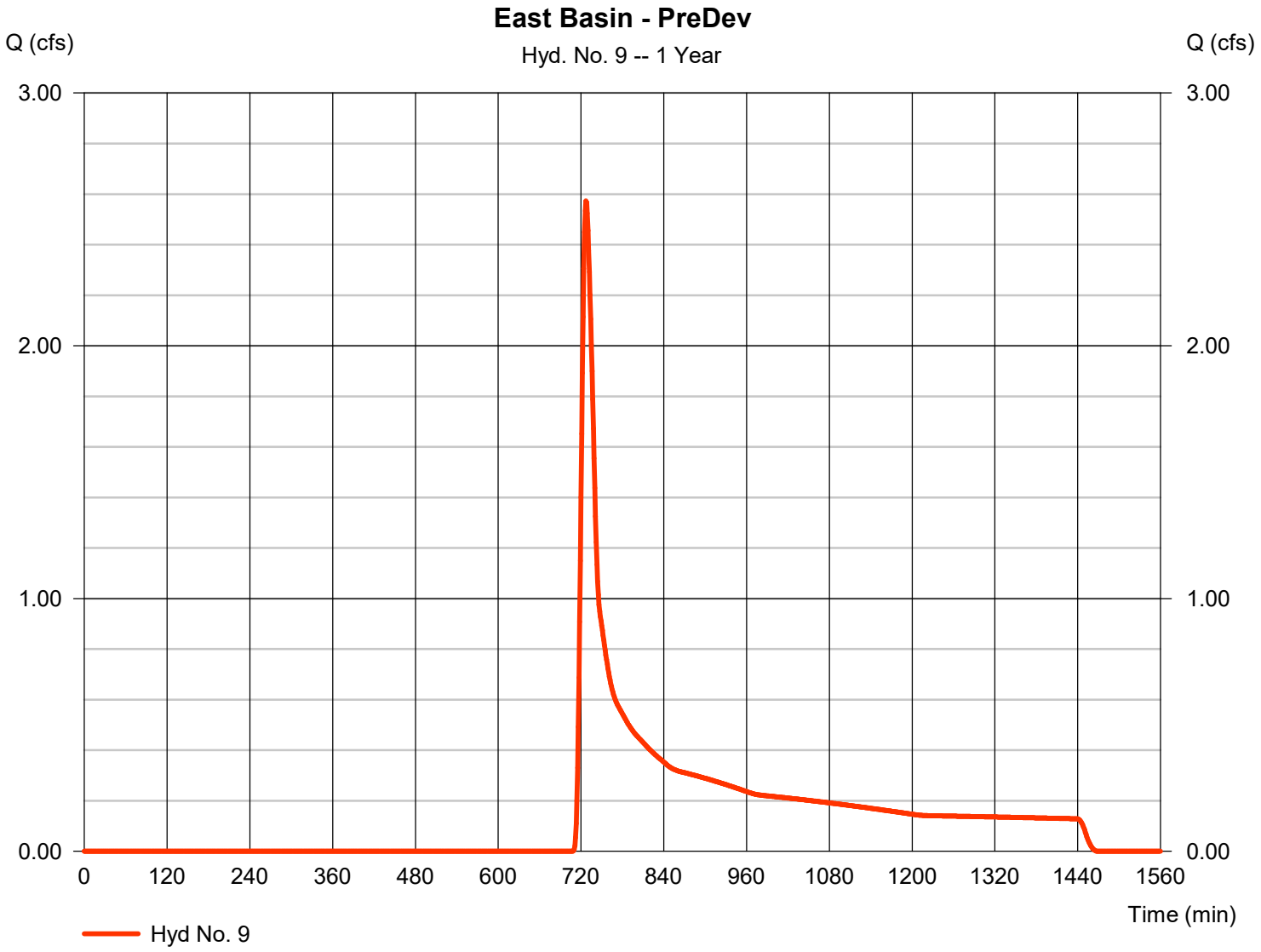


Hydrograph Report

Hyd. No. 9

East Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.573 cfs
Storm frequency	=	1 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	13,103 cuft
Drainage area	=	23.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

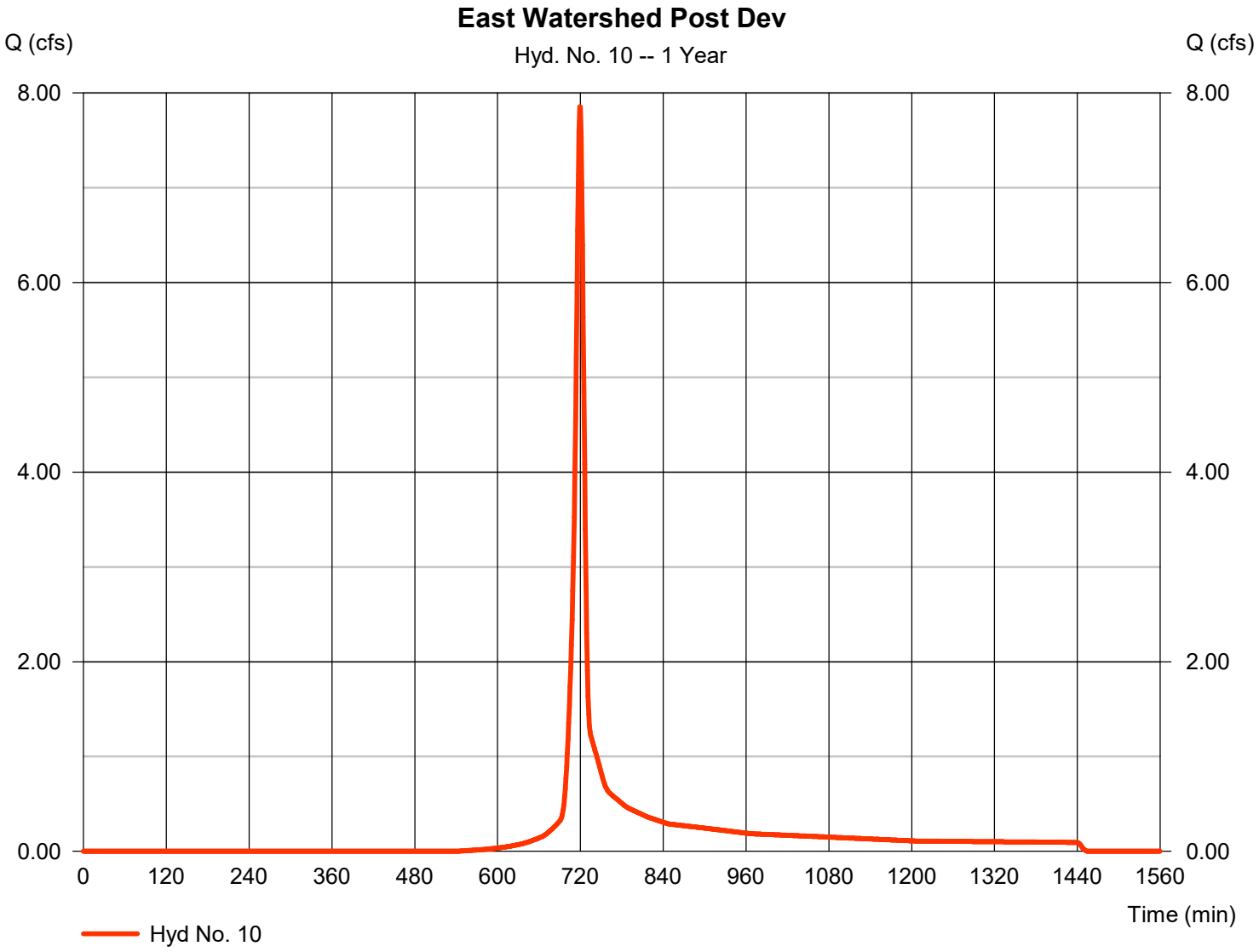


Hydrograph Report

Hyd. No. 10

East Watershed Post Dev

Hydrograph type	= SCS Runoff	Peak discharge	= 7.854 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 17,771 cuft
Drainage area	= 7.700 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 1.37 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



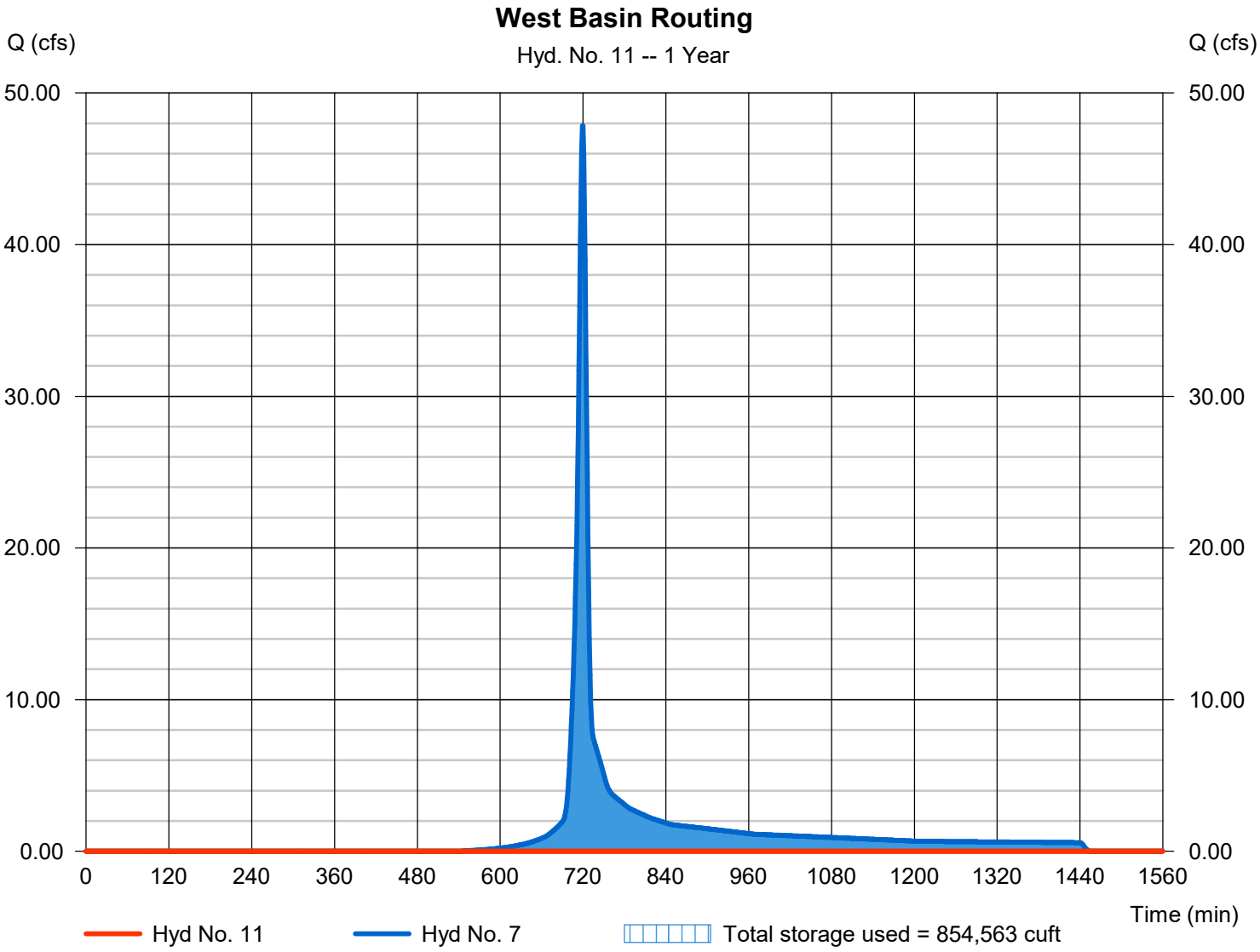
Hydrograph Report

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 1 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 951.11 ft
Reservoir name	= West Basin	Max. Storage	= 854,563 cuft

Storage Indication method used. Wet pond routing start elevation = 950.00 ft.



Pond Report

Pond No. 1 - West Basin

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 940.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	940.00	57,158	0	0
2.00	942.00	63,864	120,948	120,948
4.00	944.00	70,818	134,609	255,557
6.00	946.00	78,022	148,767	404,324
8.00	948.00	85,474	163,423	567,747
10.00	950.00	93,176	178,577	746,323
12.00	952.00	101,126	194,228	940,552
14.00	954.00	126,218	226,858	1,167,410
16.00	956.00	141,067	267,121	1,434,531
18.00	958.00	187,658	327,586	1,762,117
20.00	960.00	218,192	405,426	2,167,543
22.00	962.00	237,915	455,919	2,623,462

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	12.00	15.00	0.00
Span (in)	= 36.00	12.00	15.00	0.00
No. Barrels	= 1	3	3	0
Invert El. (ft)	= 940.00	952.00	955.00	0.00
Length (ft)	= 300.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	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	Yes	No

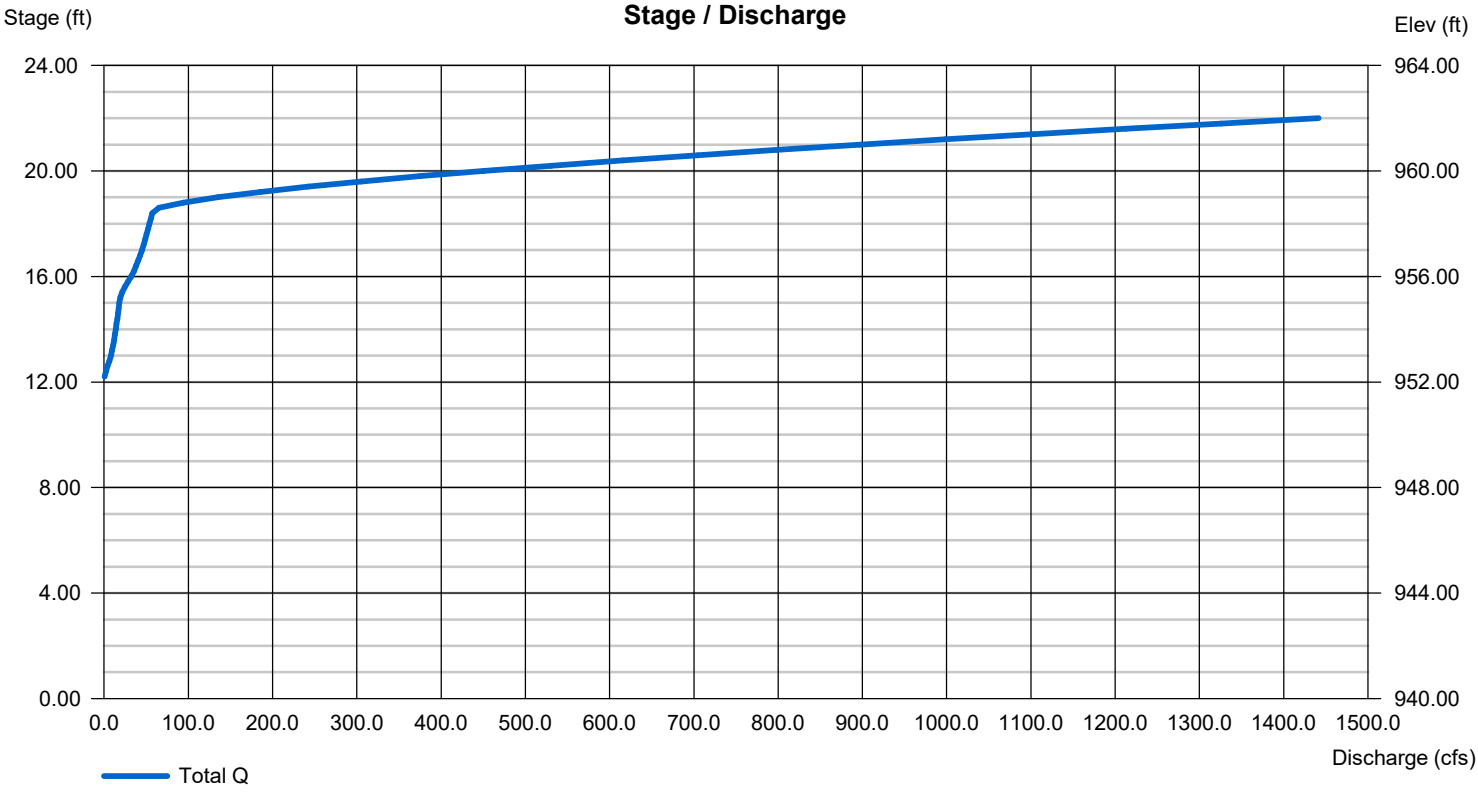
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	80.00	0.00	0.00
Crest El. (ft)	= 0.00	958.50	0.00	0.00
Weir Coeff.	= 3.33	2.60	3.33	3.33
Weir Type	= ---	Broad	---	---
Multi-Stage	= No	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).

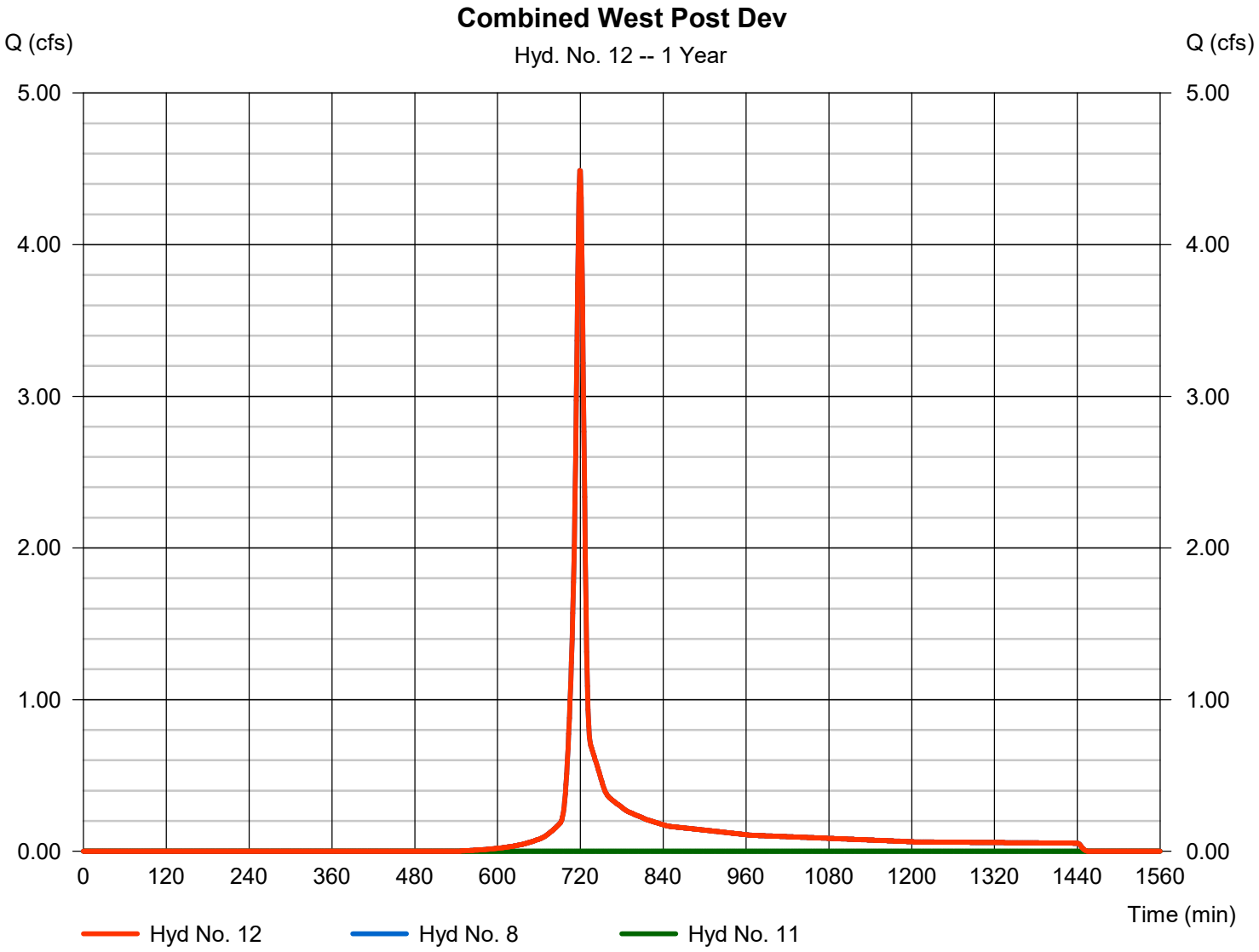


Hydrograph Report

Hyd. No. 12

Combined West Post Dev

Hydrograph type	= Combine	Peak discharge	= 4.488 cfs
Storm frequency	= 1 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 10,155 cuft
Inflow hyds.	= 8, 11	Contrib. drain. area	= 4.400 ac



Hydrograph Summary Report

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

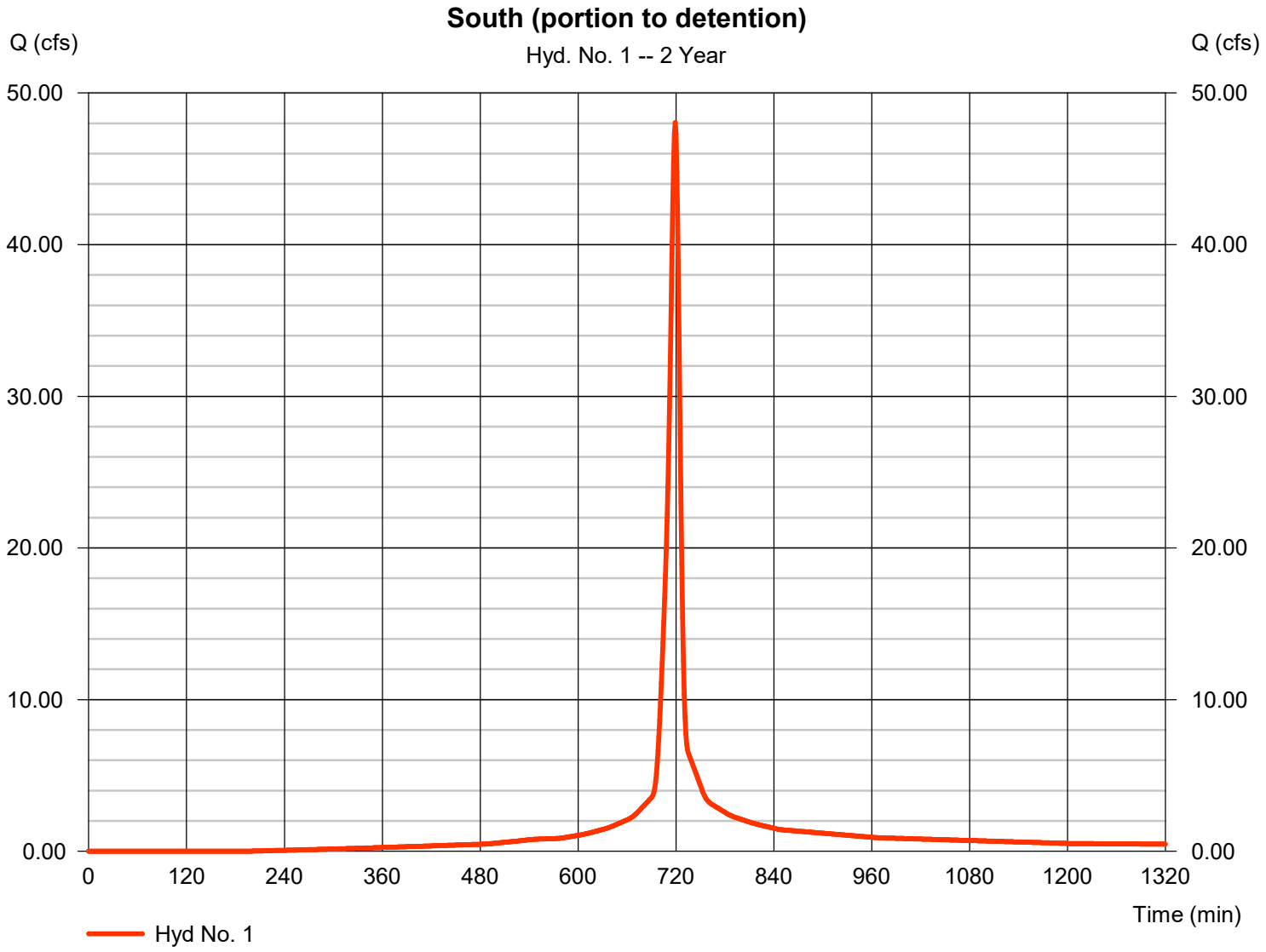
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	48.06	1	719	117,121	------	------	------	South (portion to detention)
2	Reservoir	4.784	1	747	78,935	1	969.46	70,622	South Basin Routing
3	SCS Runoff	9.699	1	719	23,637	------	------	------	South (portion undetained)
4	Combine	11.70	1	720	102,572	2, 3	------	------	Combined South Basin Post Dev
5	SCS Runoff	41.36	1	725	131,134	------	------	------	South - PreDev
6	SCS Runoff	42.91	1	725	136,051	------	------	------	West Basin - PreDev
7	SCS Runoff	190.33	1	719	448,761	------	------	------	To West Basin
8	SCS Runoff	17.86	1	719	42,101	------	------	------	West (undetained)
9	SCS Runoff	41.43	1	724	124,242	------	------	------	East Basin - PreDev
10	SCS Runoff	31.25	1	719	73,677	------	------	------	East Watershed Post Dev
11	Reservoir	7.252	1	820	249,349	7	952.92	1,044,620	West Basin Routing
12	Combine	17.86	1	719	291,450	8, 11	------	------	Combined West Post Dev

Hydrograph Report

Hyd. No. 1

South (portion to detention)

Hydrograph type	= SCS Runoff	Peak discharge	= 48.06 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 117,121 cuft
Drainage area	= 11.000 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



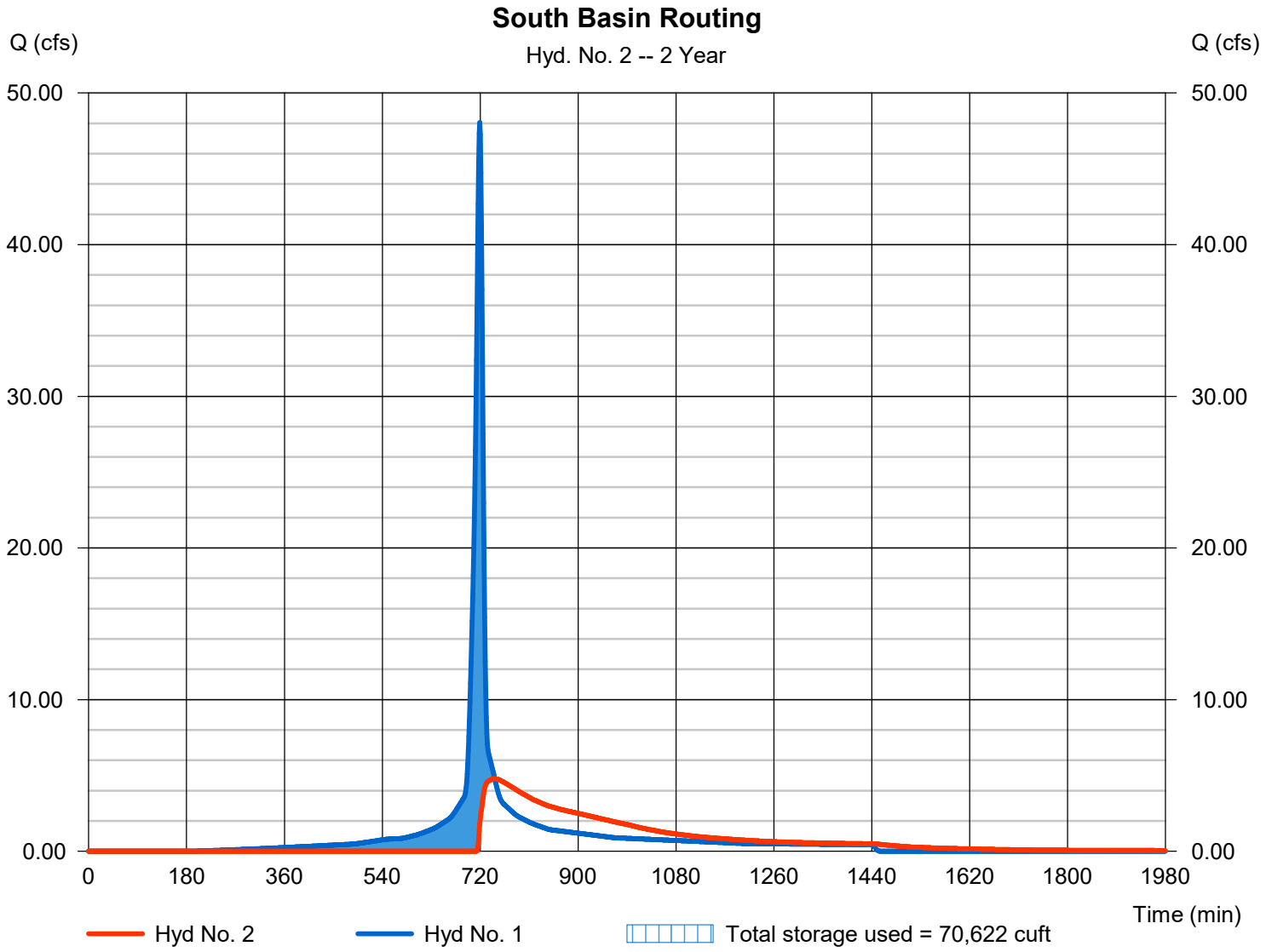
Hydrograph Report

Hyd. No. 2

South Basin Routing

Hydrograph type	=	Reservoir	Peak discharge	=	4.784 cfs
Storm frequency	=	2 yrs	Time to peak	=	747 min
Time interval	=	1 min	Hyd. volume	=	78,935 cuft
Inflow hyd. No.	=	1 - South (portion to detention)	Max. Elevation	=	969.46 ft
Reservoir name	=	South Basin	Max. Storage	=	70,622 cuft

Storage Indication method used.

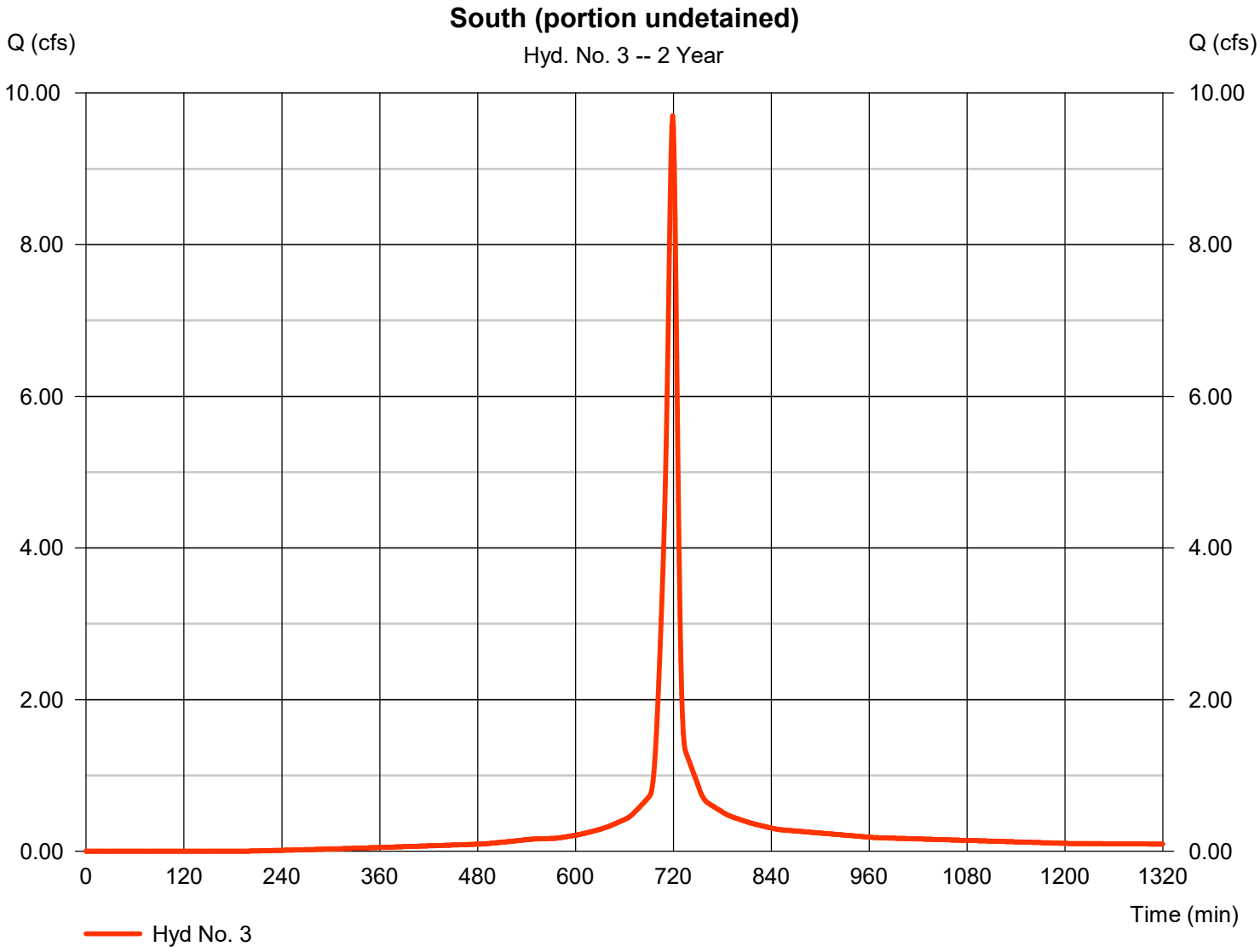


Hydrograph Report

Hyd. No. 3

South (portion undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.699 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	23,637 cuft
Drainage area	=	2.220 ac	Curve number	=	94
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

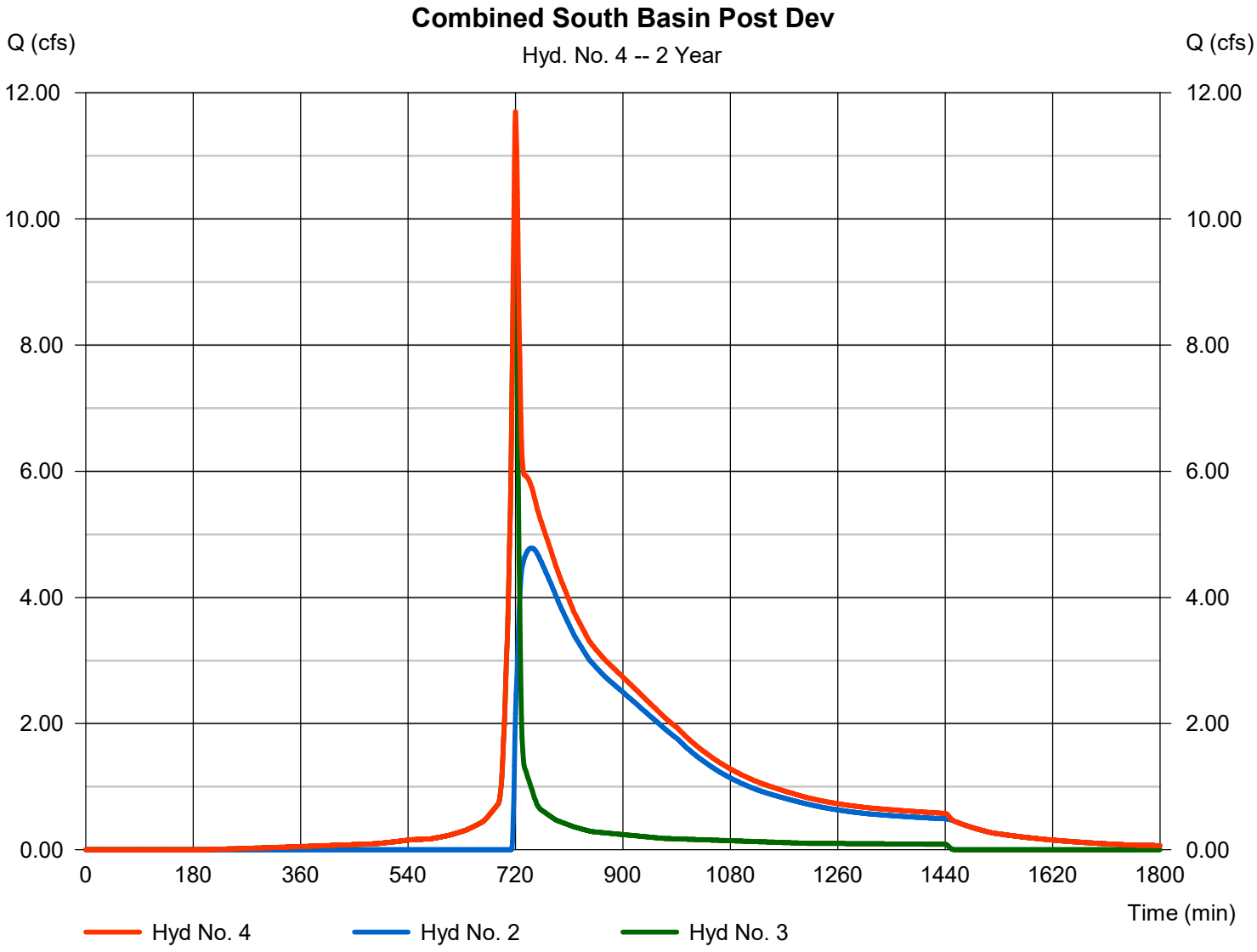


Hydrograph Report

Hyd. No. 4

Combined South Basin Post Dev

Hydrograph type	= Combine	Peak discharge	= 11.70 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 102,572 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 2.220 ac

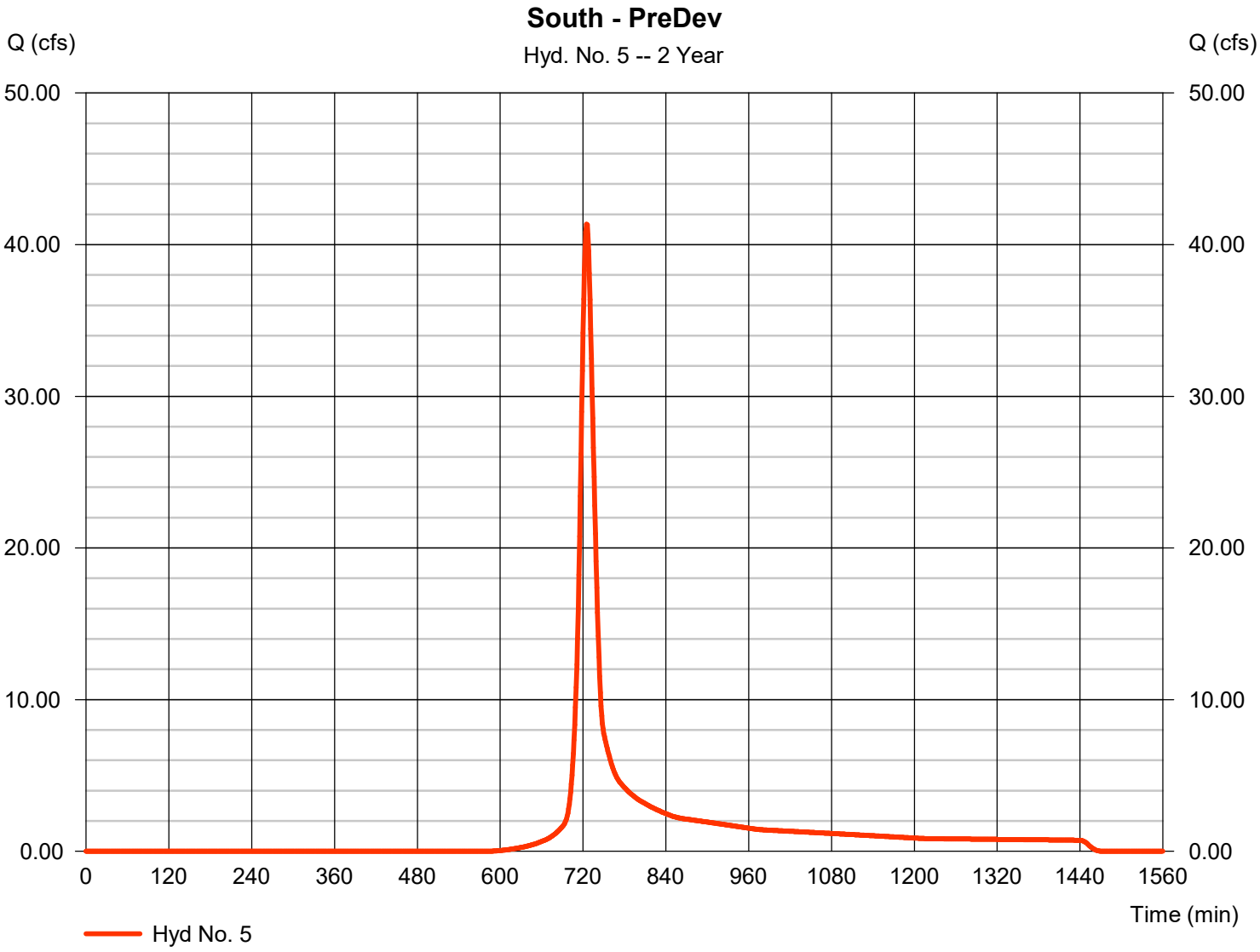


Hydrograph Report

Hyd. No. 5

South - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	41.36 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	131,134 cuft
Drainage area	=	24.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

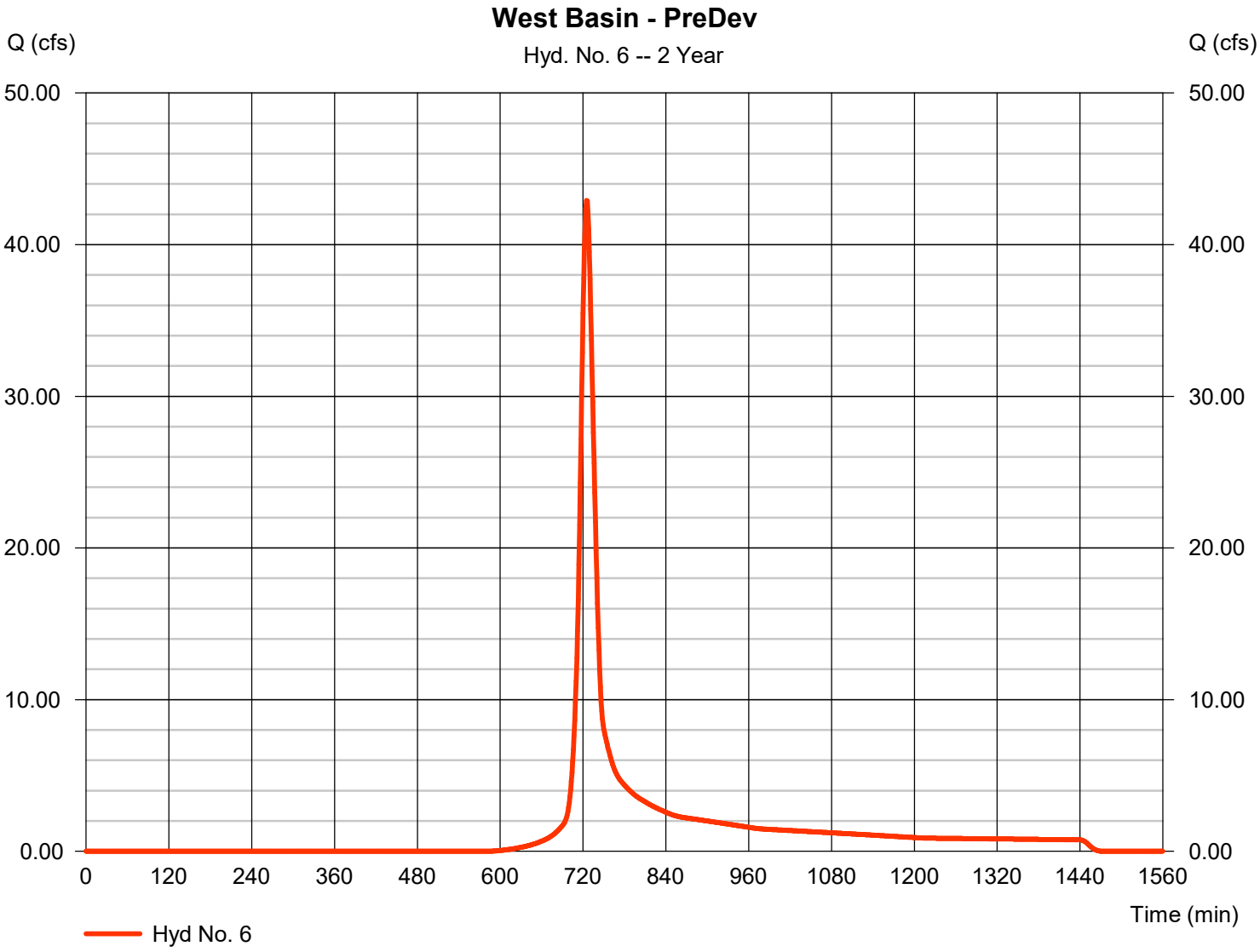


Hydrograph Report

Hyd. No. 6

West Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	42.91 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	136,051 cuft
Drainage area	=	24.900 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

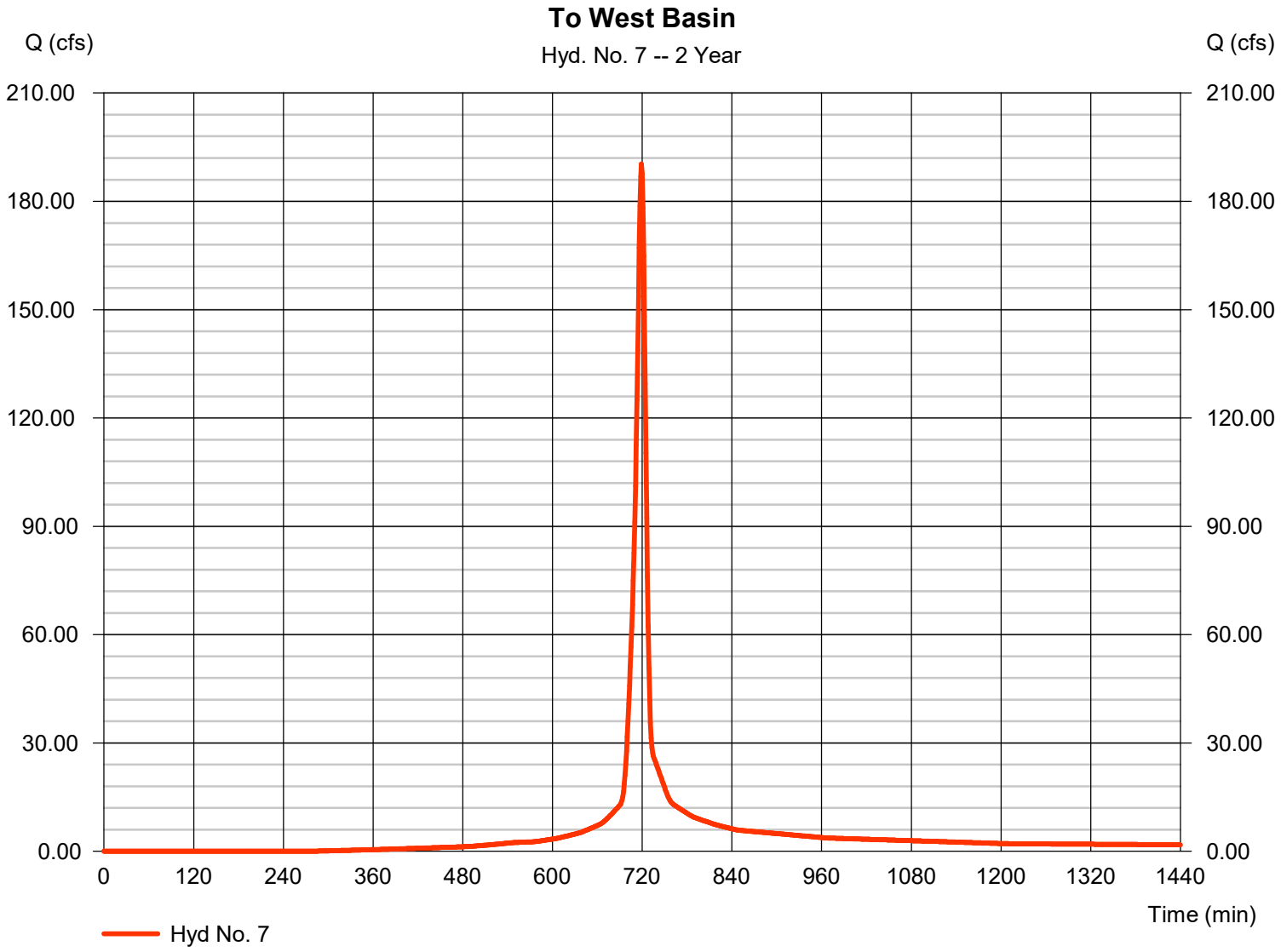


Hydrograph Report

Hyd. No. 7

To West Basin

Hydrograph type	=	SCS Runoff	Peak discharge	=	190.33 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	448,761 cuft
Drainage area	=	46.900 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

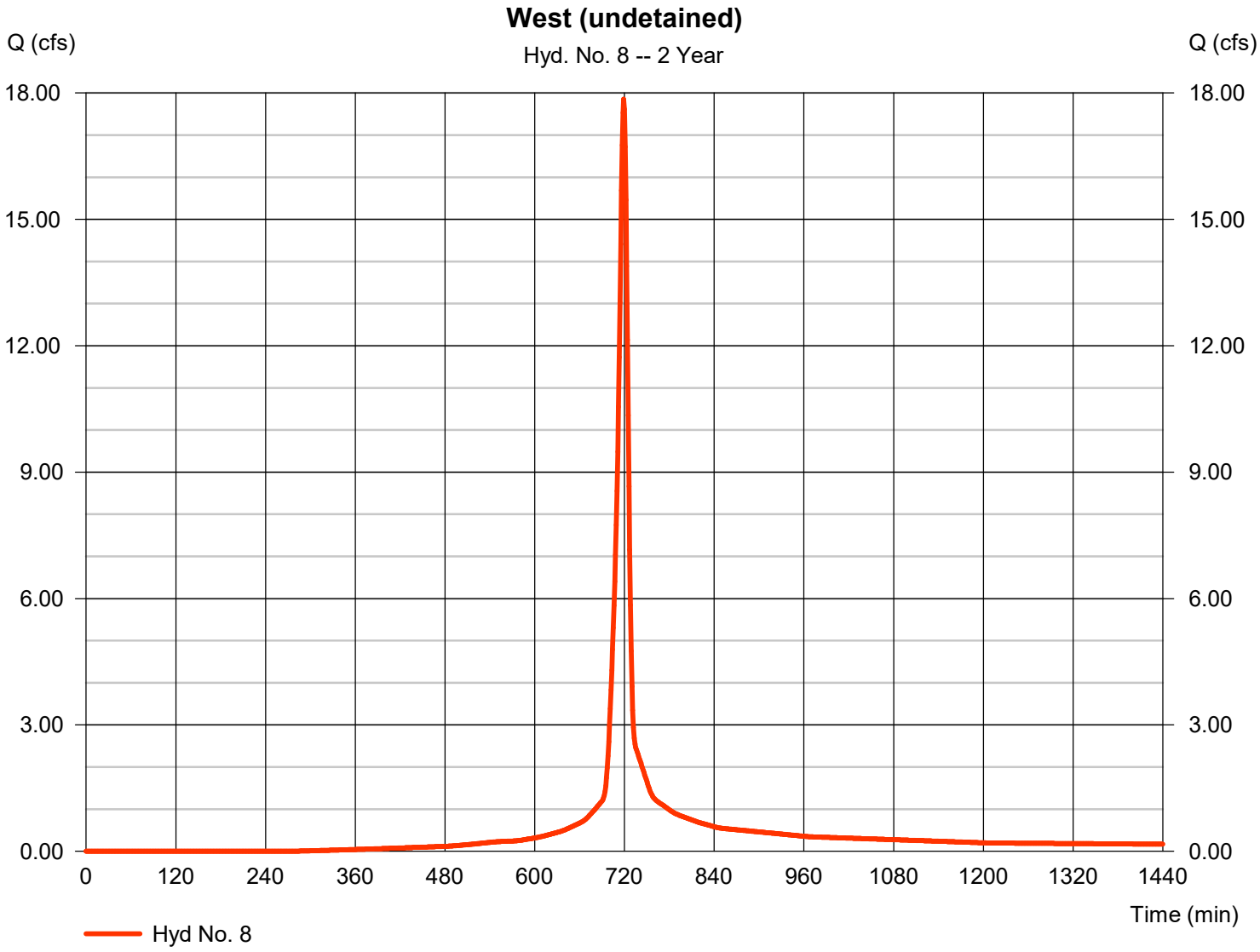


Hydrograph Report

Hyd. No. 8

West (undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.86 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	42,101 cuft
Drainage area	=	4.400 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

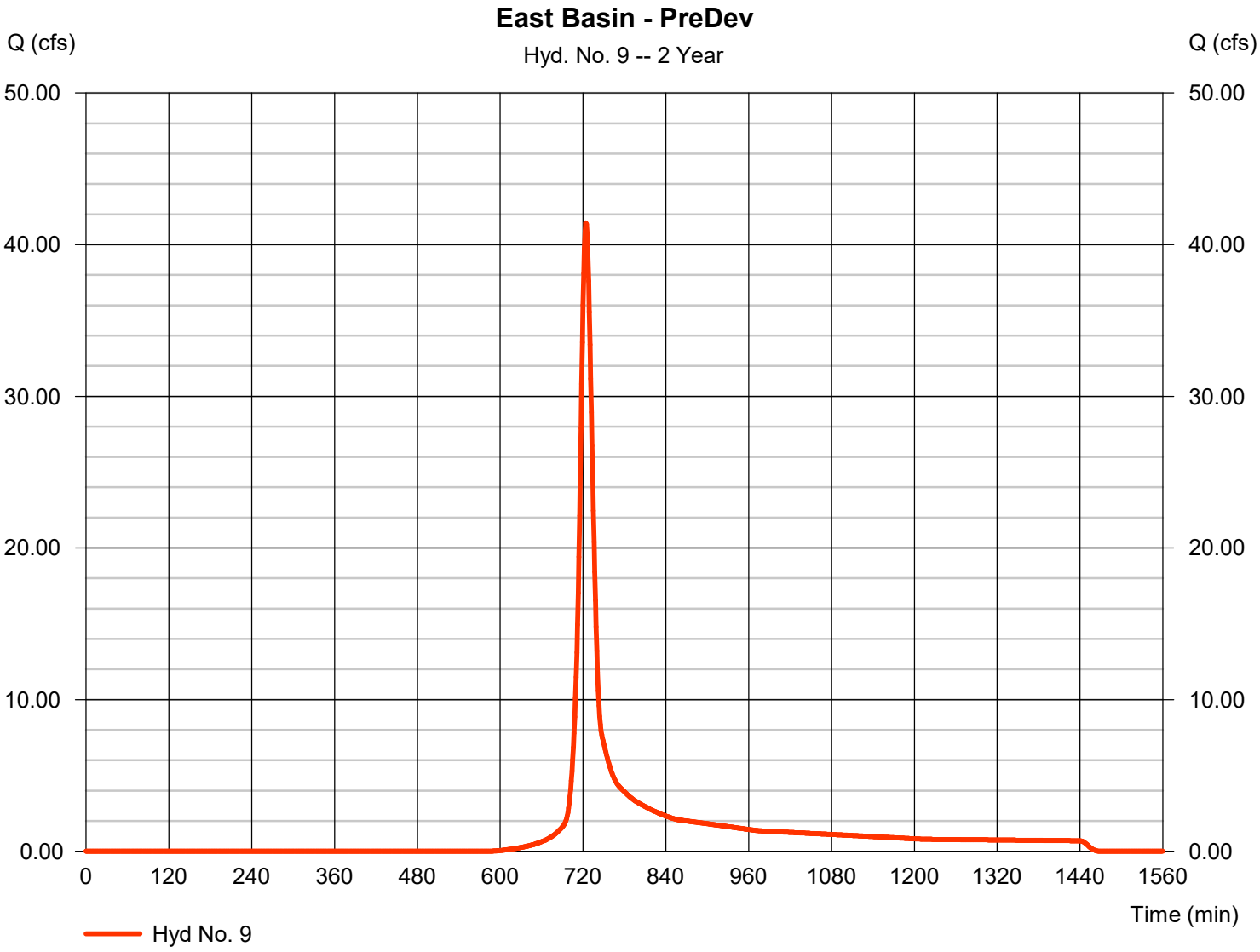


Hydrograph Report

Hyd. No. 9

East Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	41.43 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	124,242 cuft
Drainage area	=	23.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

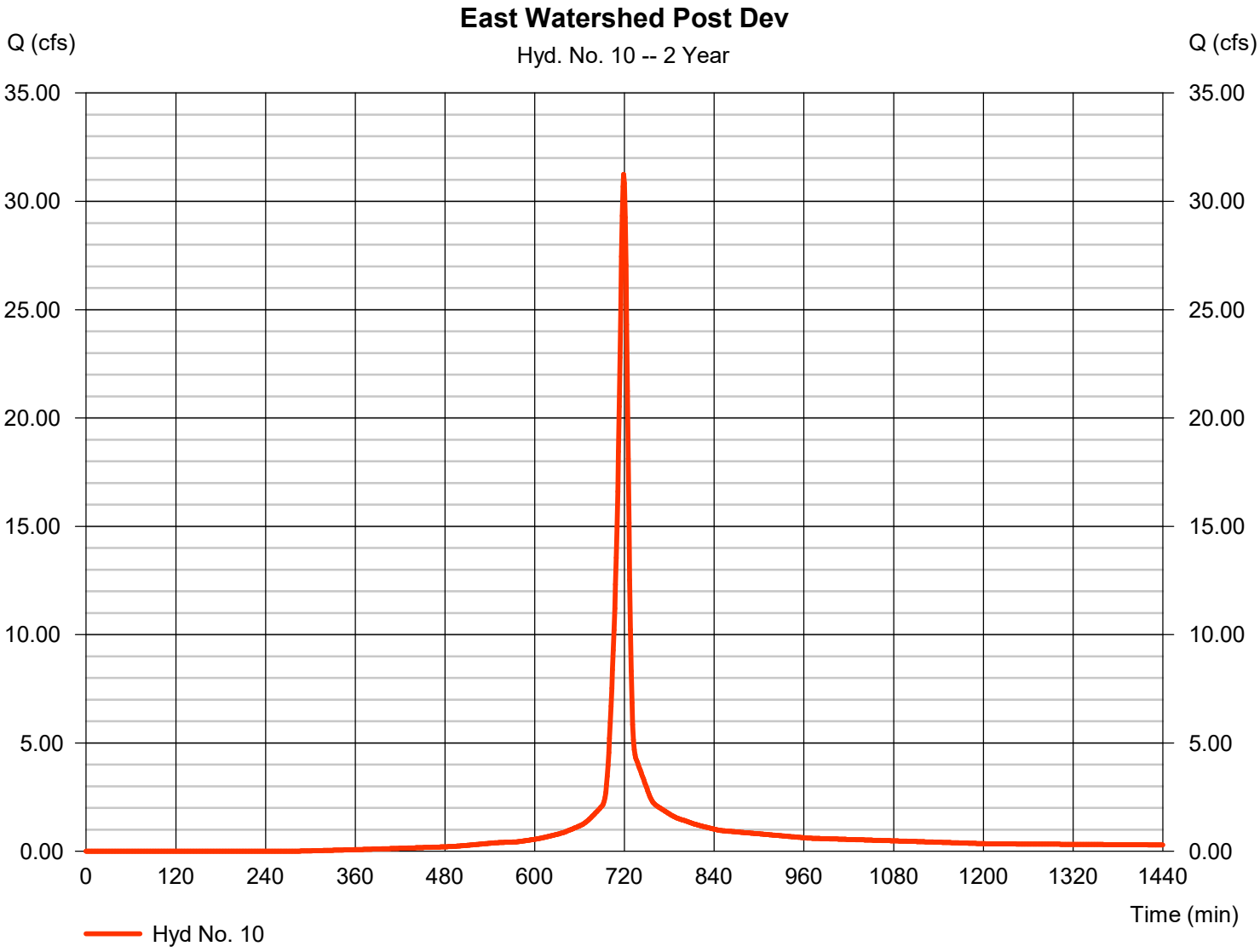


Hydrograph Report

Hyd. No. 10

East Watershed Post Dev

Hydrograph type	=	SCS Runoff	Peak discharge	=	31.25 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	73,677 cuft
Drainage area	=	7.700 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



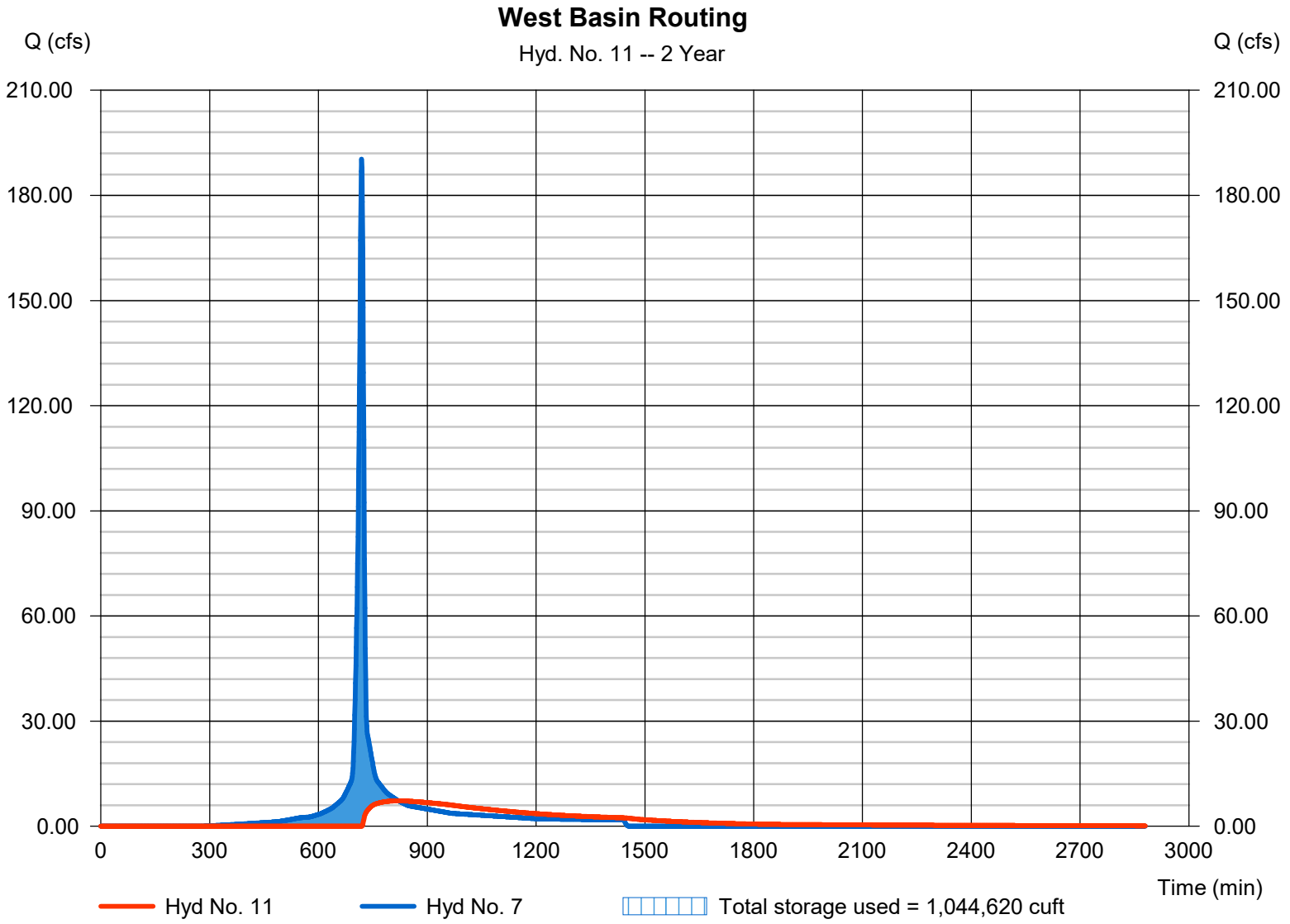
Hydrograph Report

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 7.252 cfs
Storm frequency	= 2 yrs	Time to peak	= 820 min
Time interval	= 1 min	Hyd. volume	= 249,349 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 952.92 ft
Reservoir name	= West Basin	Max. Storage	= 1,044,620 cuft

Storage Indication method used. Wet pond routing start elevation = 950.00 ft.

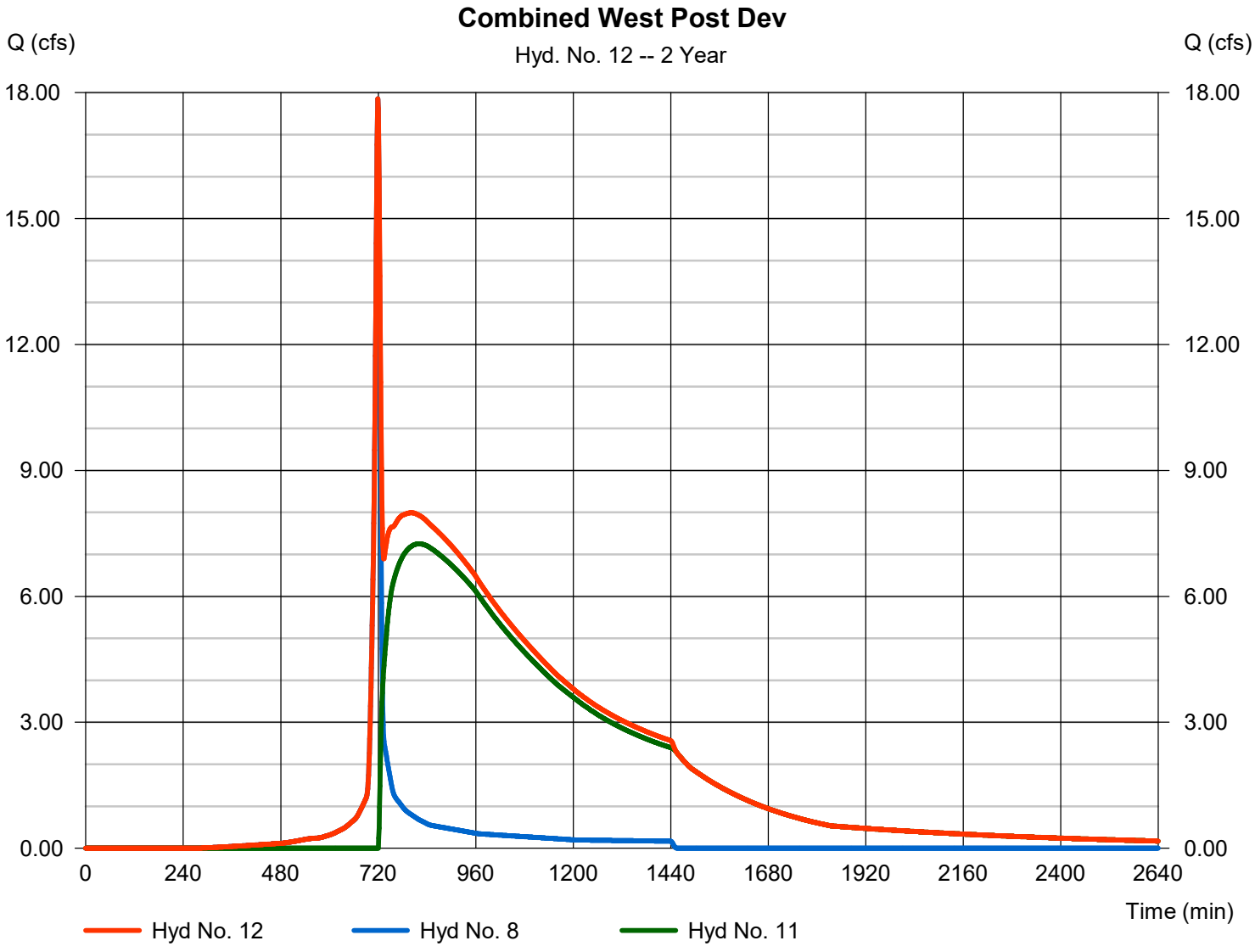


Hydrograph Report

Hyd. No. 12

Combined West Post Dev

Hydrograph type	= Combine	Peak discharge	= 17.86 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 291,450 cuft
Inflow hyds.	= 8, 11	Contrib. drain. area	= 4.400 ac



Hydrograph Summary Report

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

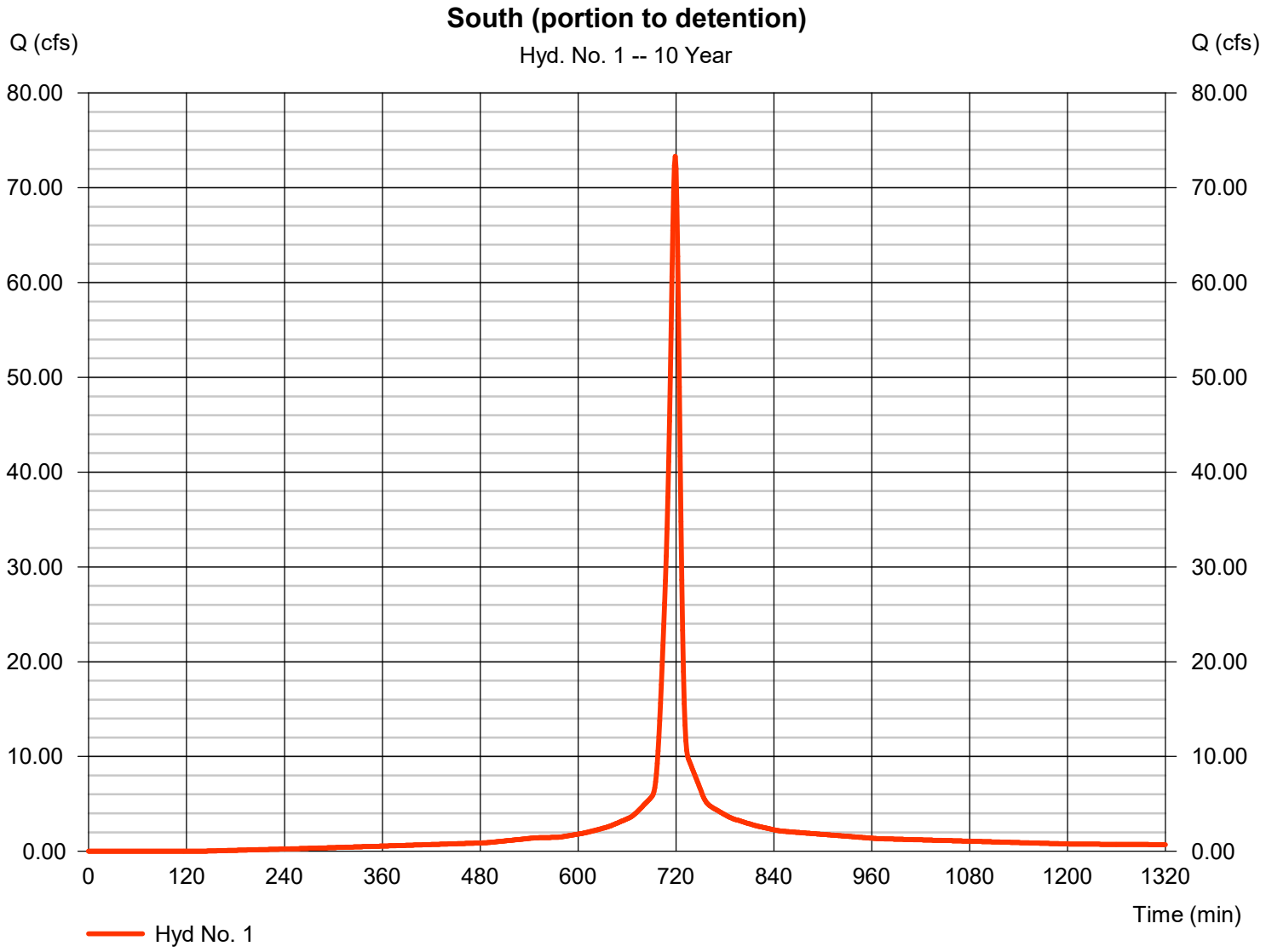
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	73.32	1	719	183,844	------	------	------	South (portion to detention)
2	Reservoir	15.27	1	730	145,638	1	970.86	105,294	South Basin Routing
3	SCS Runoff	14.80	1	719	37,103	------	------	------	South (portion undetained)
4	Combine	22.04	1	720	182,741	2, 3	------	------	Combined South Basin Post Dev
5	SCS Runoff	80.24	1	725	250,547	------	------	------	South - PreDev
6	SCS Runoff	83.24	1	725	259,942	------	------	------	West Basin - PreDev
7	SCS Runoff	299.73	1	719	727,597	------	------	------	To West Basin
8	SCS Runoff	28.12	1	719	68,261	------	------	------	West (undetained)
9	SCS Runoff	80.18	1	724	237,379	------	------	------	East Basin - PreDev
10	SCS Runoff	49.21	1	719	119,456	------	------	------	East Watershed Post Dev
11	Reservoir	15.40	1	783	527,286	7	954.34	1,213,461	West Basin Routing
12	Combine	37.36	1	720	595,546	8, 11	------	------	Combined West Post Dev

Hydrograph Report

Hyd. No. 1

South (portion to detention)

Hydrograph type	= SCS Runoff	Peak discharge	= 73.32 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 183,844 cuft
Drainage area	= 11.000 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



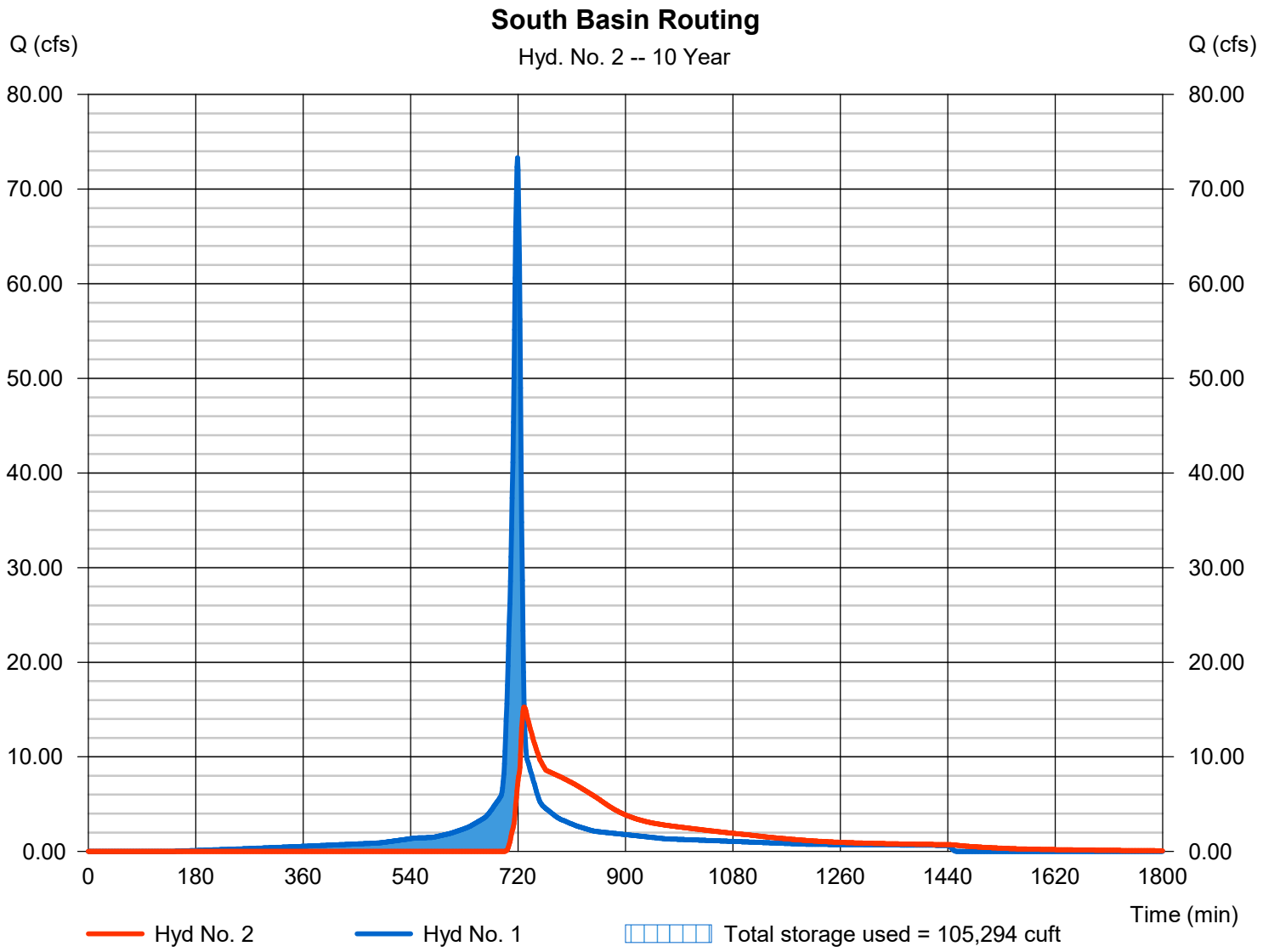
Hydrograph Report

Hyd. No. 2

South Basin Routing

Hydrograph type	=	Reservoir	Peak discharge	=	15.27 cfs
Storm frequency	=	10 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	145,638 cuft
Inflow hyd. No.	=	1 - South (portion to detention)	Max. Elevation	=	970.86 ft
Reservoir name	=	South Basin	Max. Storage	=	105,294 cuft

Storage Indication method used.

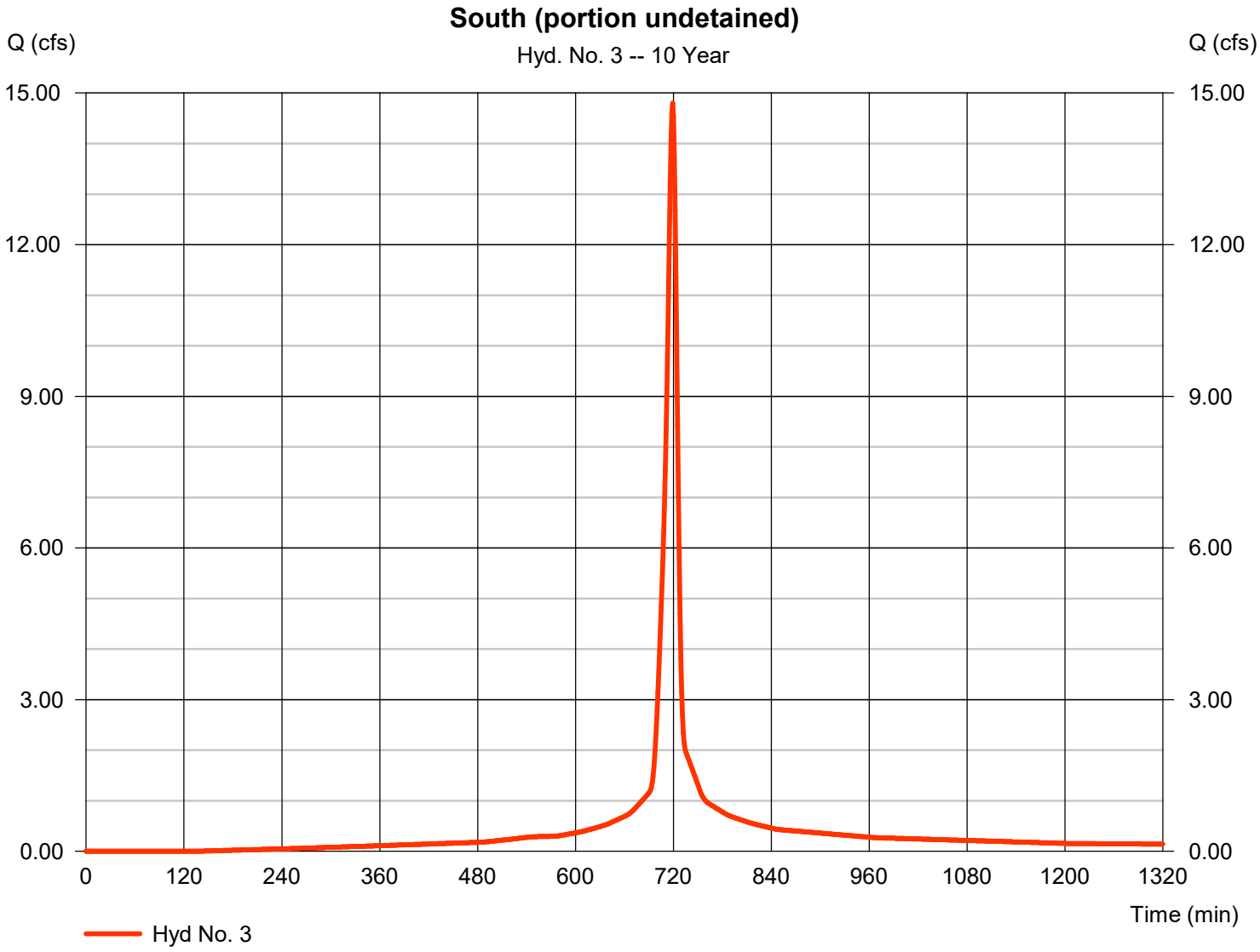


Hydrograph Report

Hyd. No. 3

South (portion undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.80 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	37,103 cuft
Drainage area	=	2.220 ac	Curve number	=	94
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

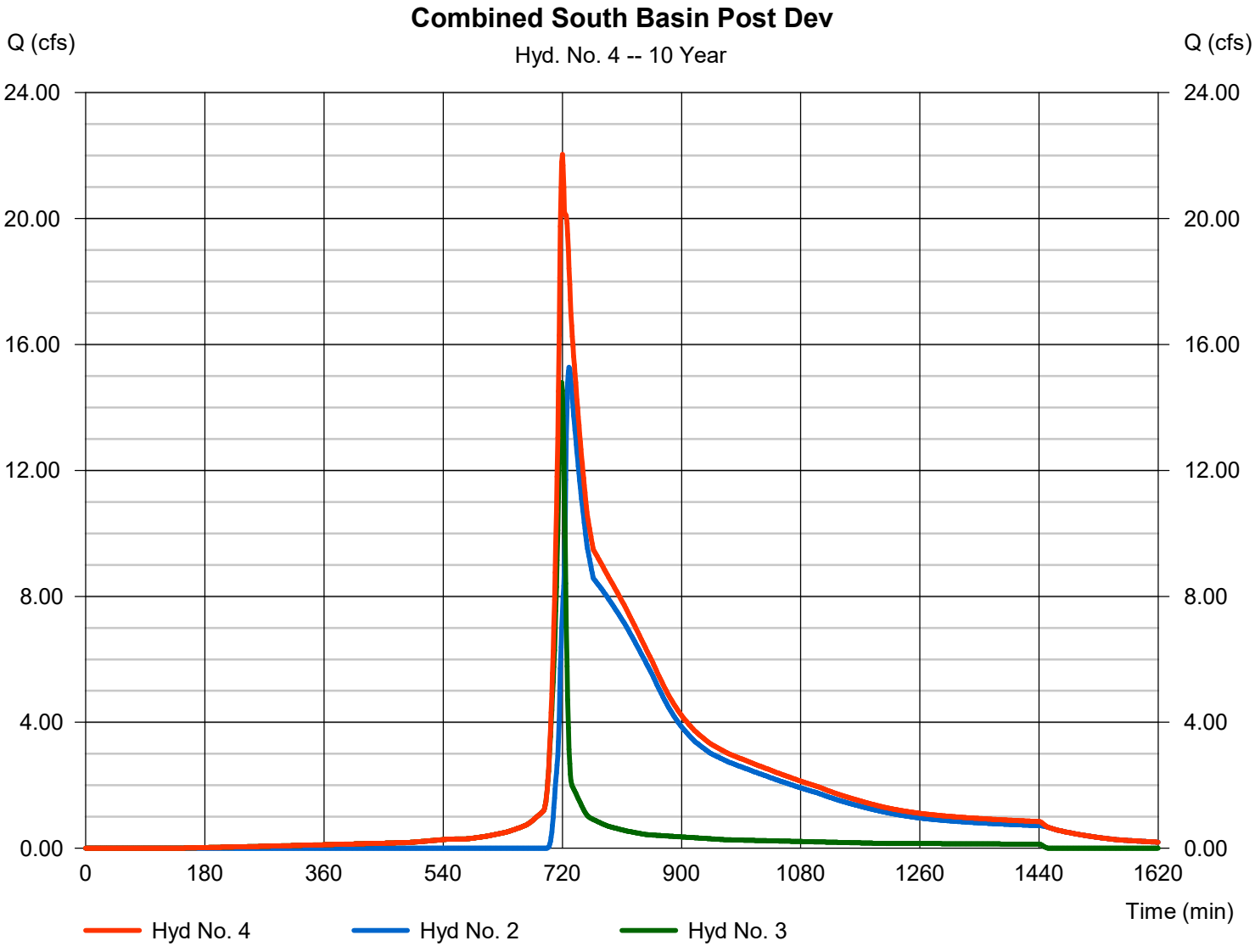


Hydrograph Report

Hyd. No. 4

Combined South Basin Post Dev

Hydrograph type	=	Combine	Peak discharge	=	22.04 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	182,741 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	2.220 ac

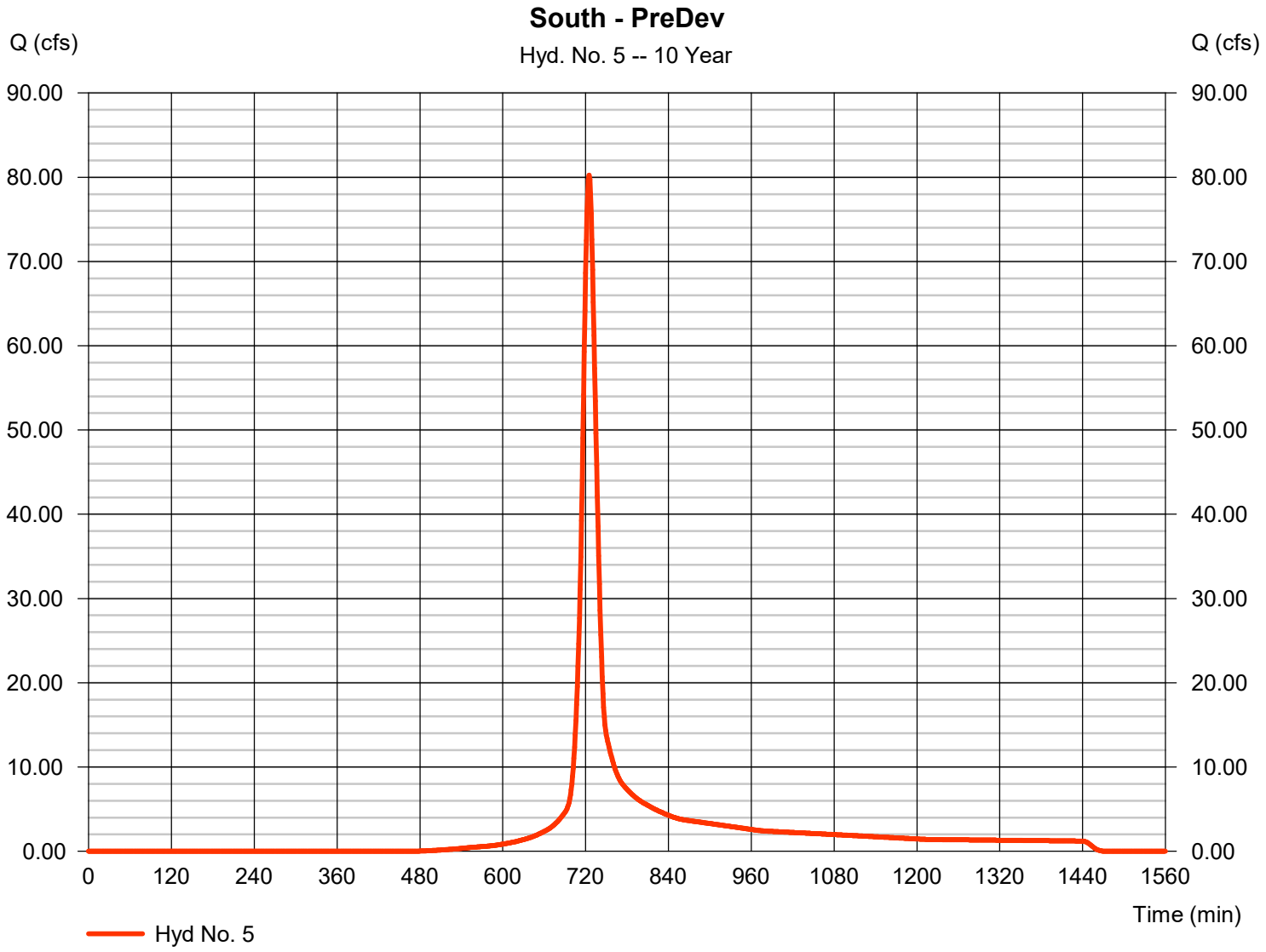


Hydrograph Report

Hyd. No. 5

South - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	80.24 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	250,547 cuft
Drainage area	=	24.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

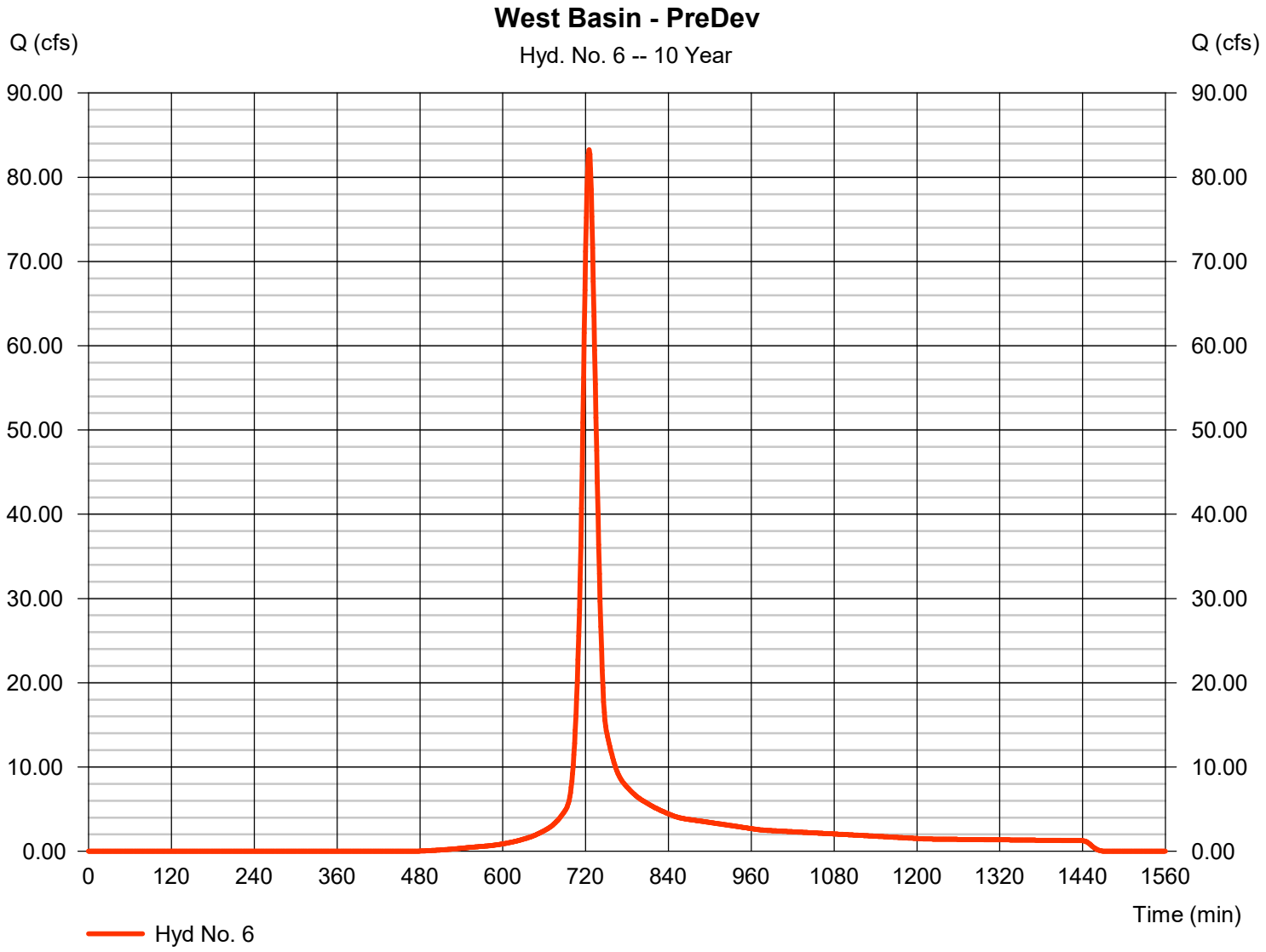


Hydrograph Report

Hyd. No. 6

West Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	83.24 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	259,942 cuft
Drainage area	=	24.900 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

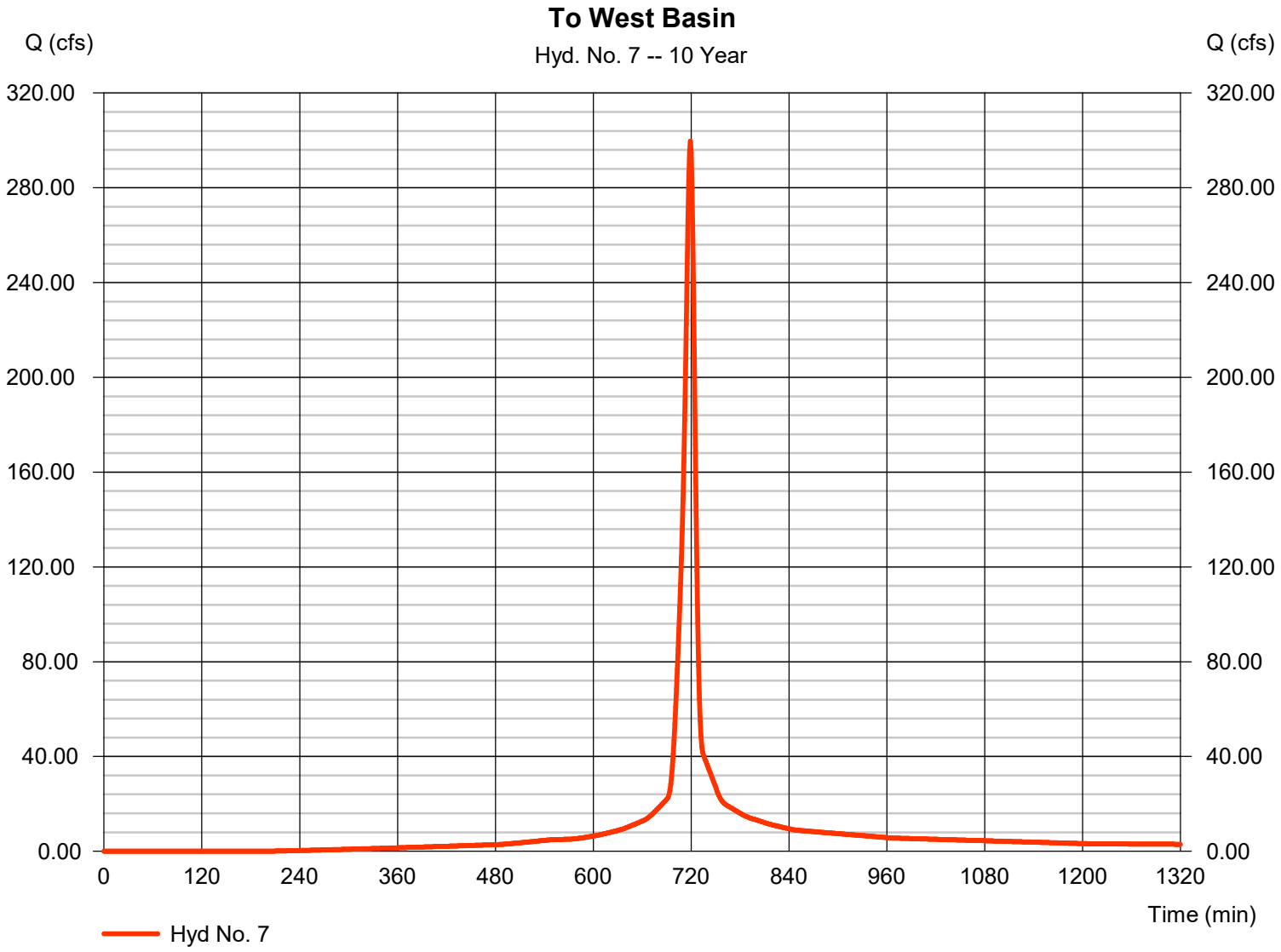


Hydrograph Report

Hyd. No. 7

To West Basin

Hydrograph type	=	SCS Runoff	Peak discharge	=	299.73 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	727,597 cuft
Drainage area	=	46.900 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

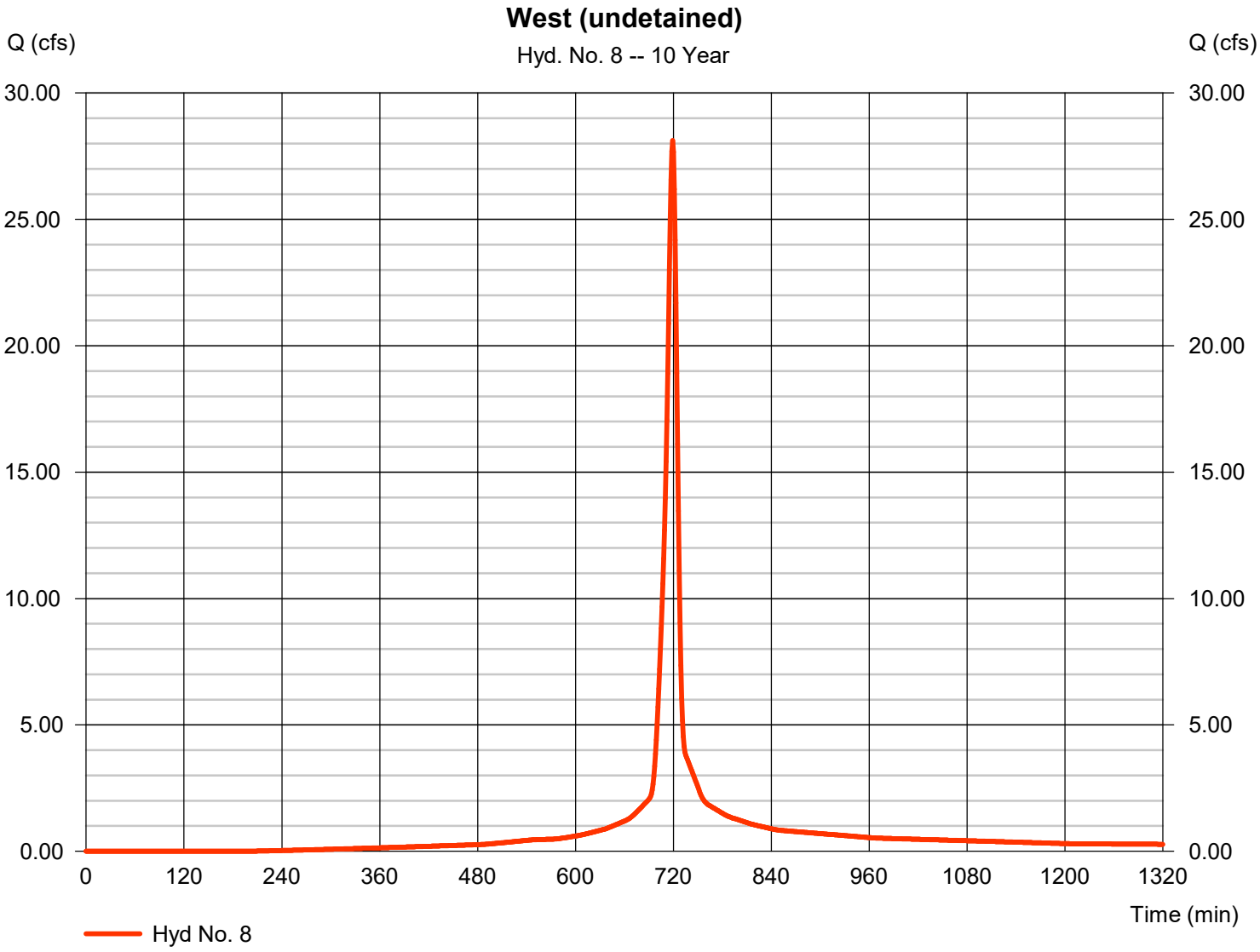


Hydrograph Report

Hyd. No. 8

West (undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	28.12 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	68,261 cuft
Drainage area	=	4.400 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

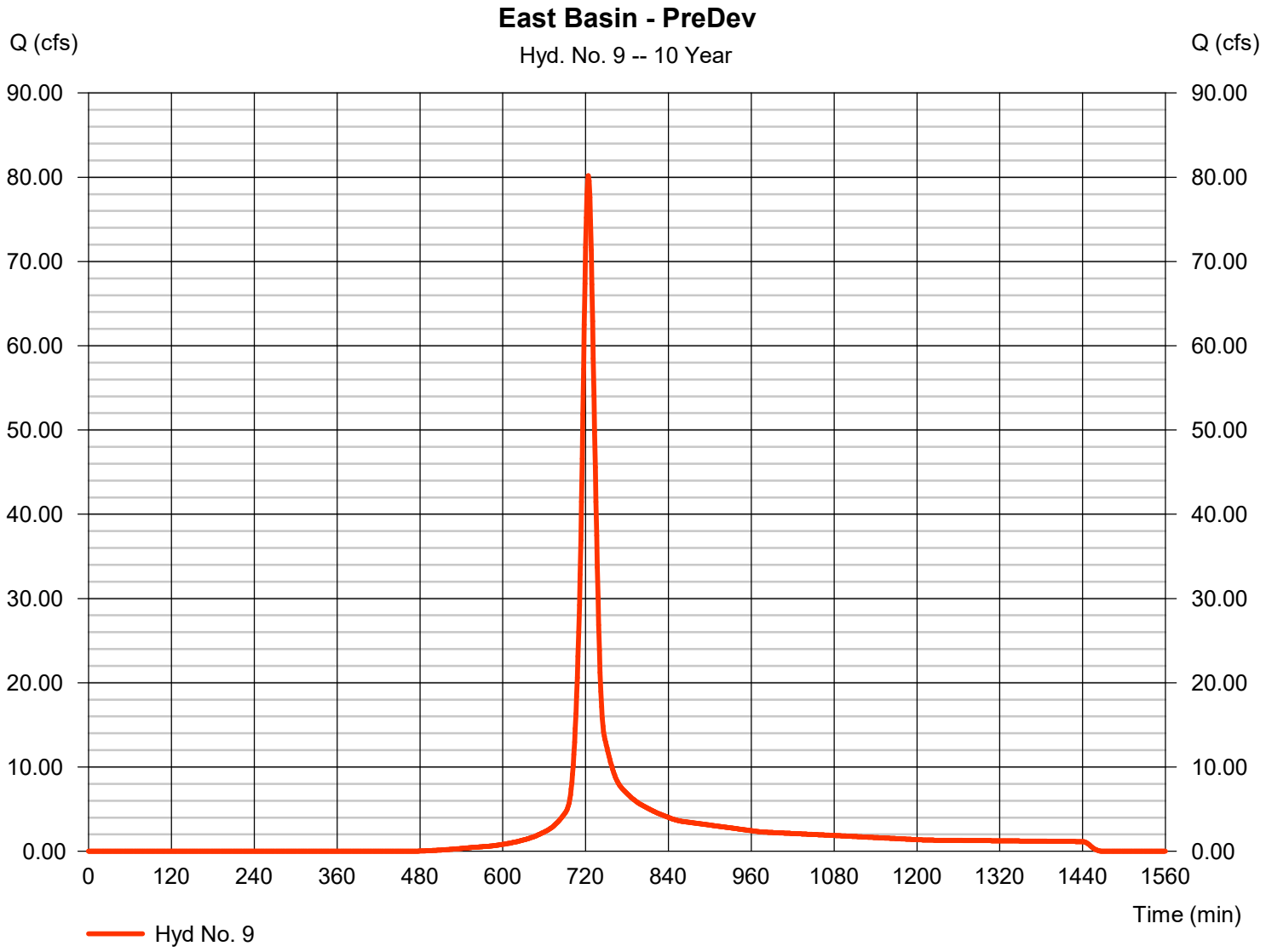


Hydrograph Report

Hyd. No. 9

East Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	80.18 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	237,379 cuft
Drainage area	=	23.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

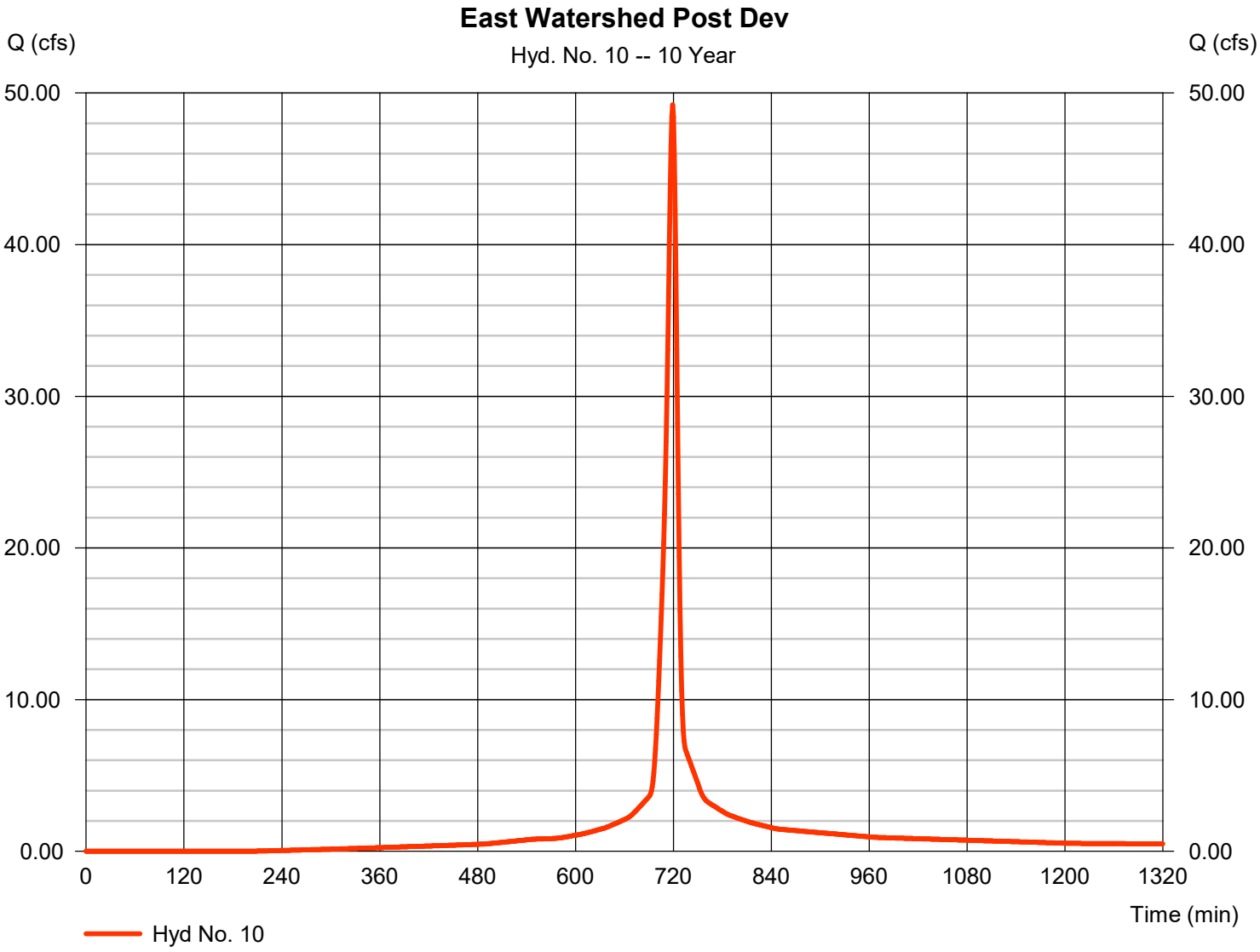


Hydrograph Report

Hyd. No. 10

East Watershed Post Dev

Hydrograph type	=	SCS Runoff	Peak discharge	=	49.21 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	119,456 cuft
Drainage area	=	7.700 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



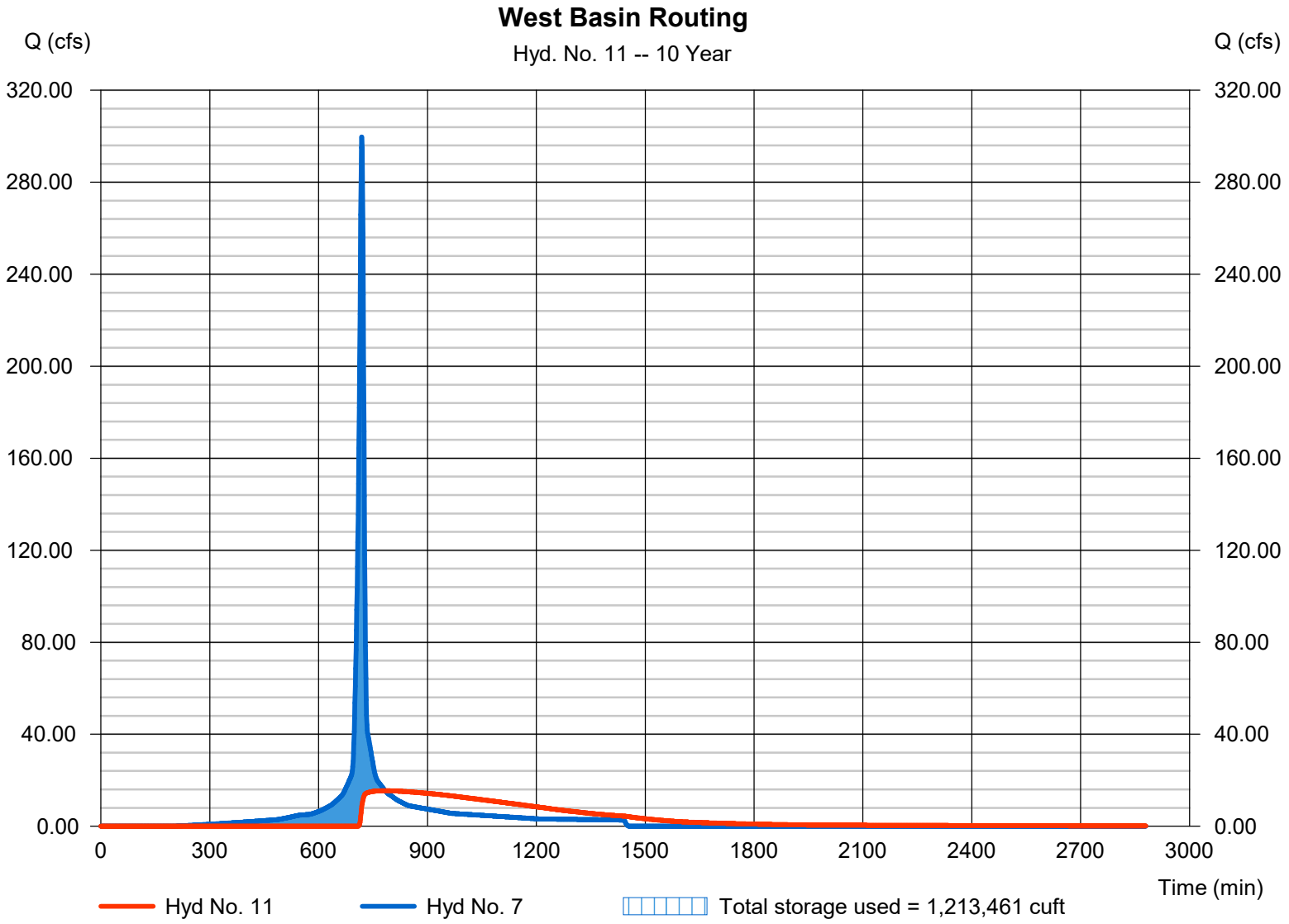
Hydrograph Report

Hyd. No. 11

West Basin Routing

Hydrograph type	= Reservoir	Peak discharge	= 15.40 cfs
Storm frequency	= 10 yrs	Time to peak	= 783 min
Time interval	= 1 min	Hyd. volume	= 527,286 cuft
Inflow hyd. No.	= 7 - To West Basin	Max. Elevation	= 954.34 ft
Reservoir name	= West Basin	Max. Storage	= 1,213,461 cuft

Storage Indication method used. Wet pond routing start elevation = 950.00 ft.

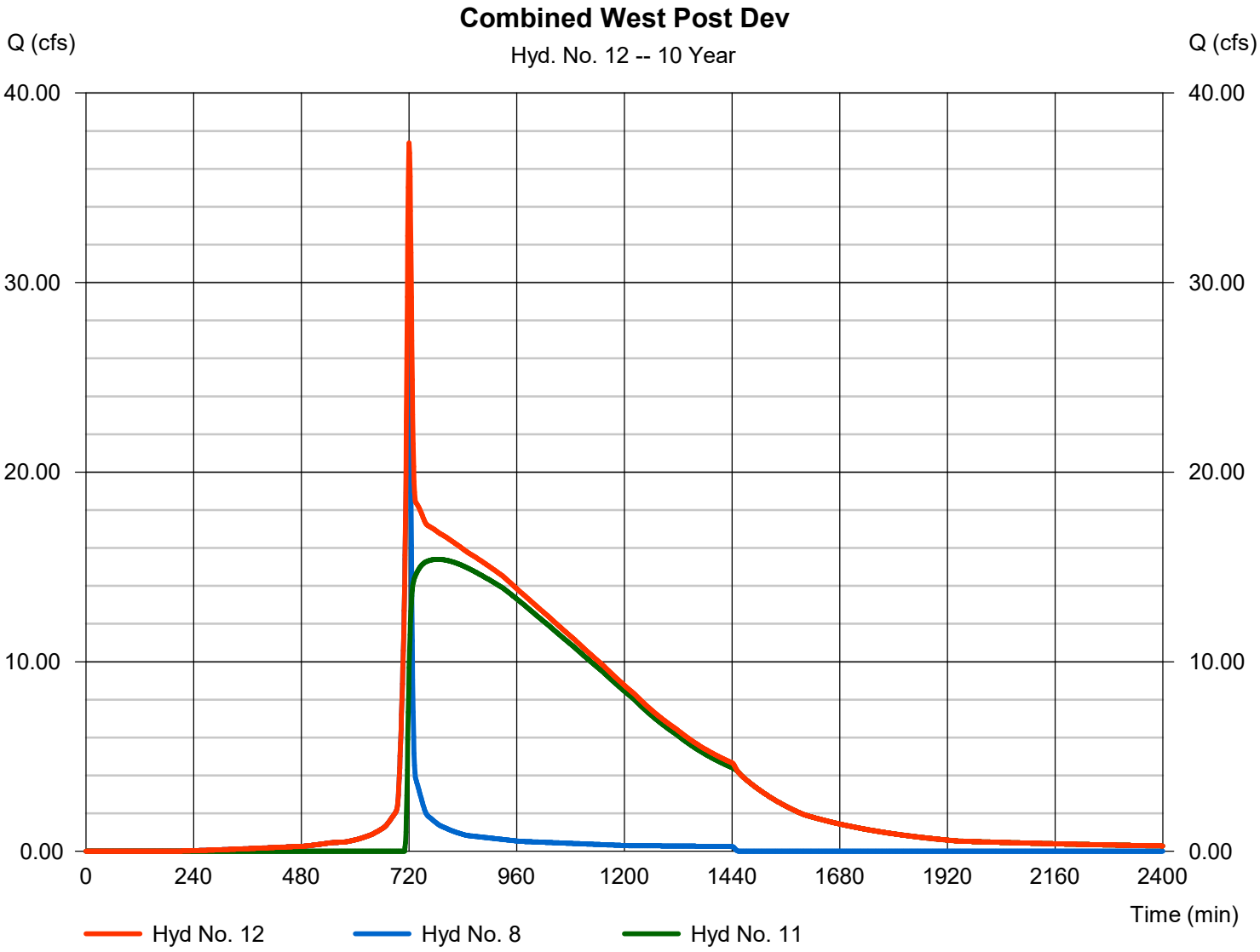


Hydrograph Report

Hyd. No. 12

Combined West Post Dev

Hydrograph type	= Combine	Peak discharge	= 37.36 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 595,546 cuft
Inflow hyds.	= 8, 11	Contrib. drain. area	= 4.400 ac



Hydrograph Summary Report

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

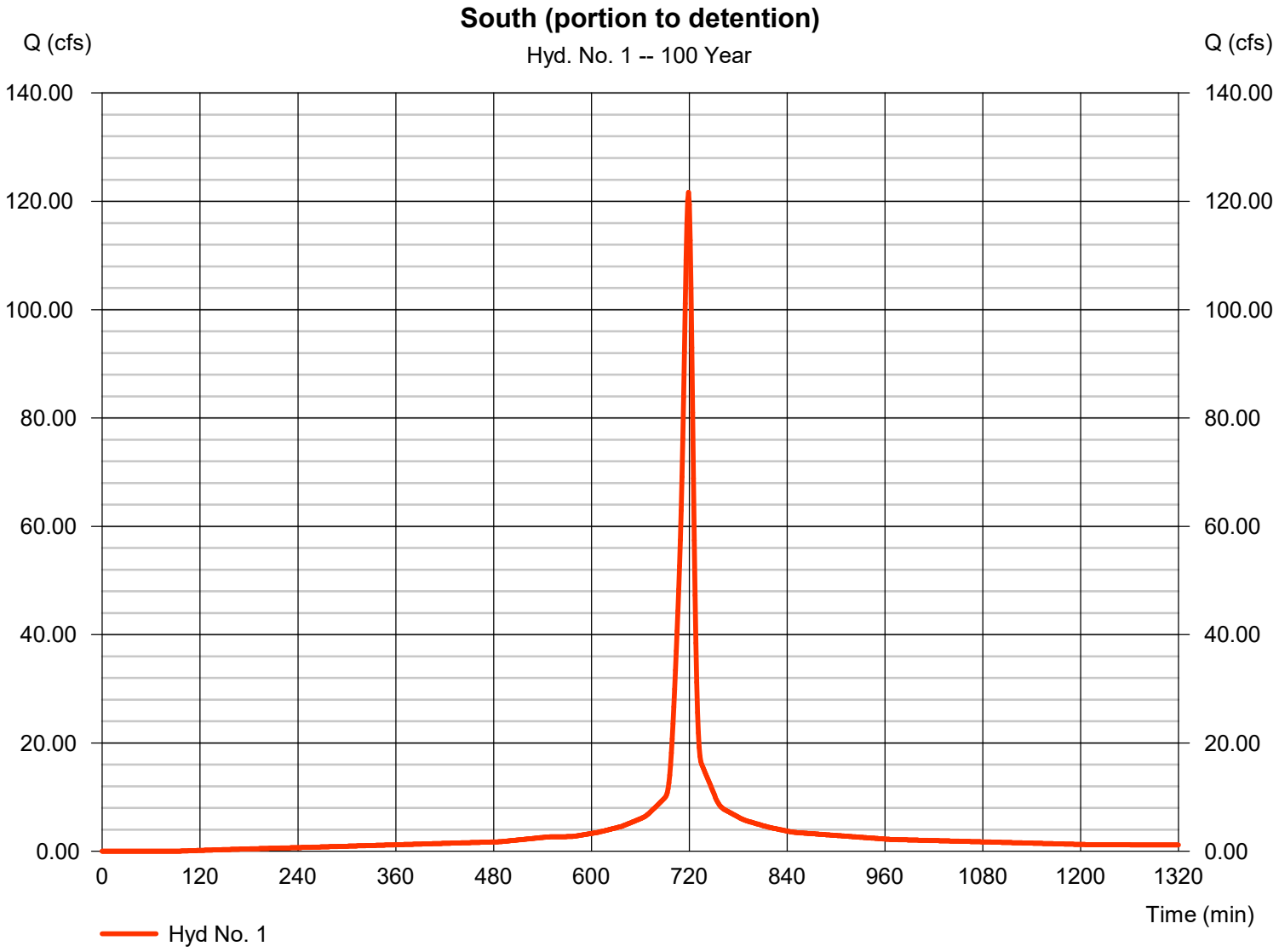
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	121.68	1	719	314,599	------	------	------	South (portion to detention)
2	Reservoir	43.84	1	727	276,369	1	972.57	153,332	South Basin Routing
3	SCS Runoff	24.56	1	719	63,492	------	------	------	South (portion undetained)
4	Combine	62.07	1	721	339,861	2, 3	------	------	Combined South Basin Post Dev
5	SCS Runoff	160.78	1	725	507,689	------	------	------	South - PreDev
6	SCS Runoff	166.81	1	725	526,727	------	------	------	West Basin - PreDev
7	SCS Runoff	508.76	1	719	1,279,803	------	------	------	To West Basin
8	SCS Runoff	47.73	1	719	120,067	------	------	------	West (undetained)
9	SCS Runoff	160.31	1	724	481,006	------	------	------	East Basin - PreDev
10	SCS Runoff	83.53	1	719	210,117	------	------	------	East Watershed Post Dev
11	Reservoir	41.01	1	753	1,077,764	7	956.65	1,540,590	West Basin Routing
12	Combine	69.36	1	722	1,197,831	8, 11	------	------	Combined West Post Dev

Hydrograph Report

Hyd. No. 1

South (portion to detention)

Hydrograph type	=	SCS Runoff	Peak discharge	=	121.68 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	314,599 cuft
Drainage area	=	11.000 ac	Curve number	=	94
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



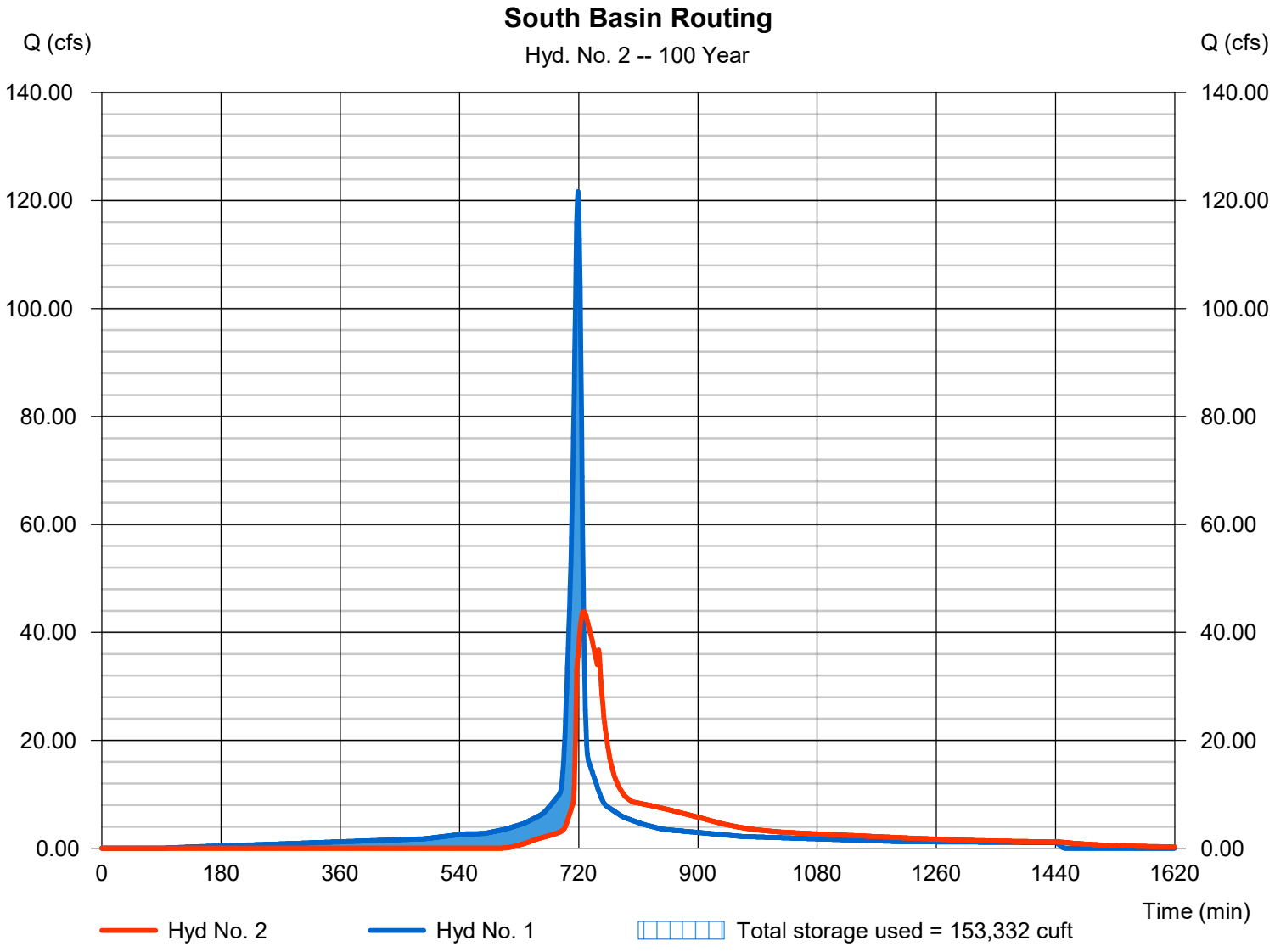
Hydrograph Report

Hyd. No. 2

South Basin Routing

Hydrograph type	=	Reservoir	Peak discharge	=	43.84 cfs
Storm frequency	=	100 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	276,369 cuft
Inflow hyd. No.	=	1 - South (portion to detention)	Max. Elevation	=	972.57 ft
Reservoir name	=	South Basin	Max. Storage	=	153,332 cuft

Storage Indication method used.

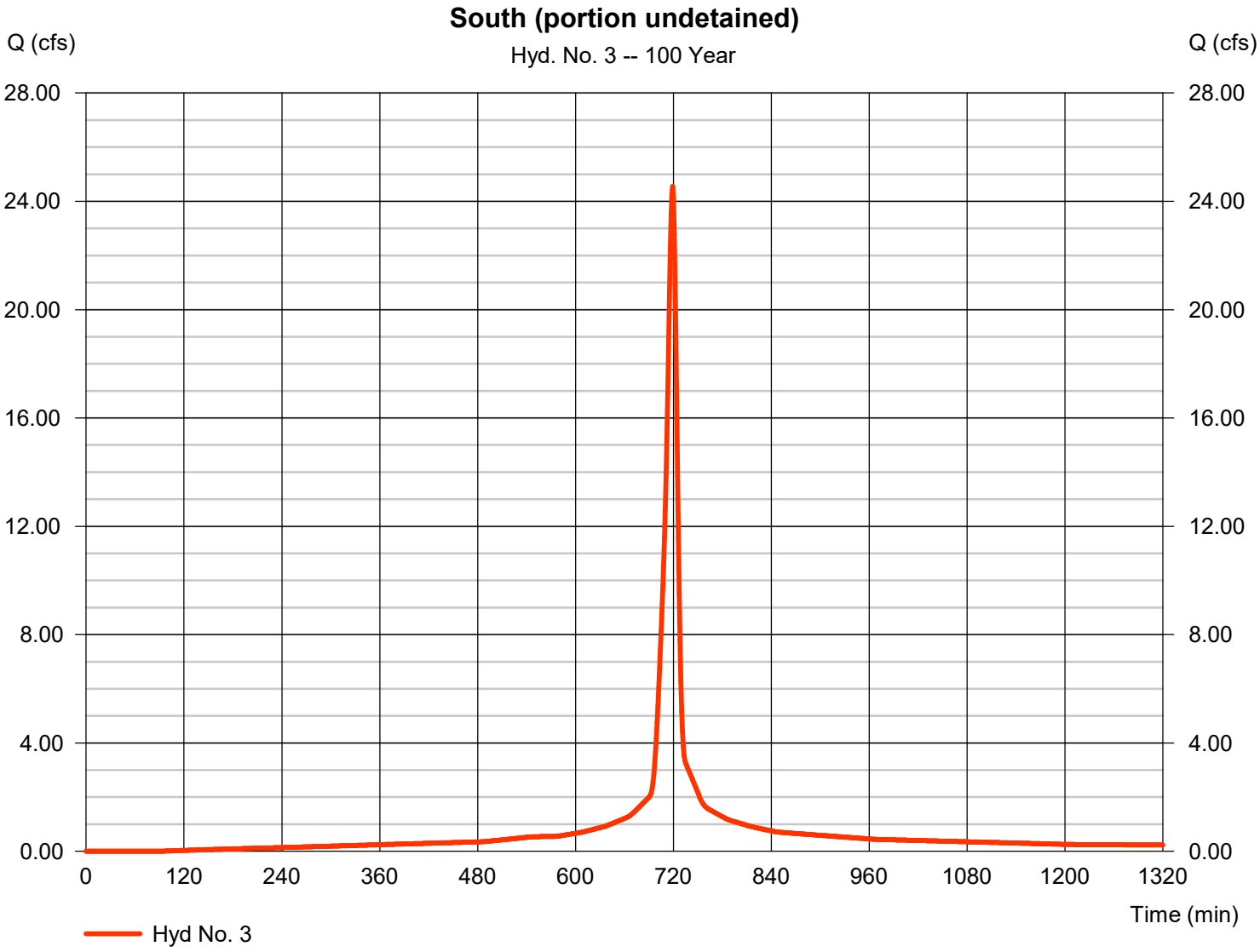


Hydrograph Report

Hyd. No. 3

South (portion undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	24.56 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	63,492 cuft
Drainage area	=	2.220 ac	Curve number	=	94
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

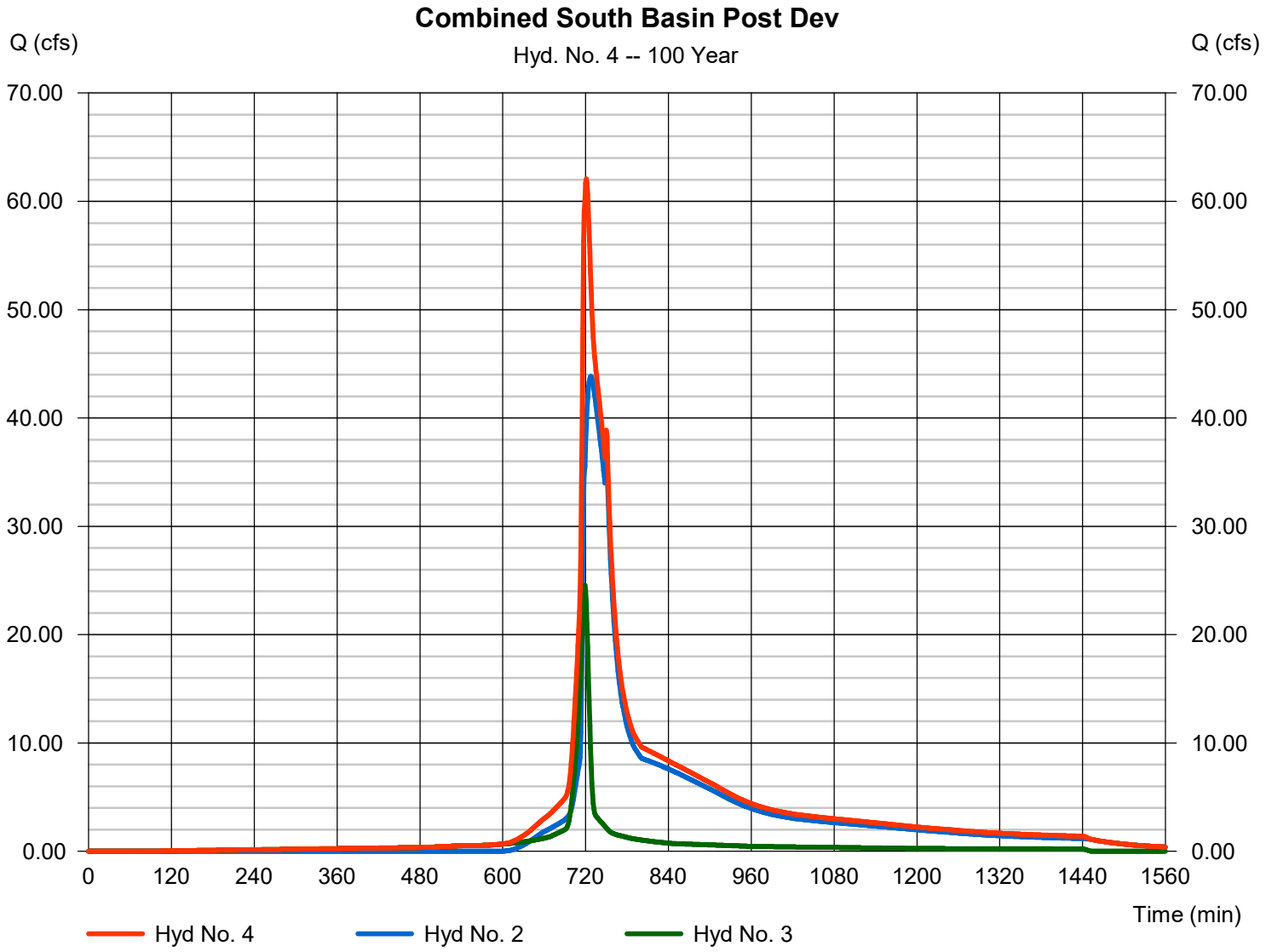


Hydrograph Report

Hyd. No. 4

Combined South Basin Post Dev

Hydrograph type	= Combine	Peak discharge	= 62.07 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 339,861 cuft
Inflow hyds.	= 2, 3	Contrib. drain. area	= 2.220 ac

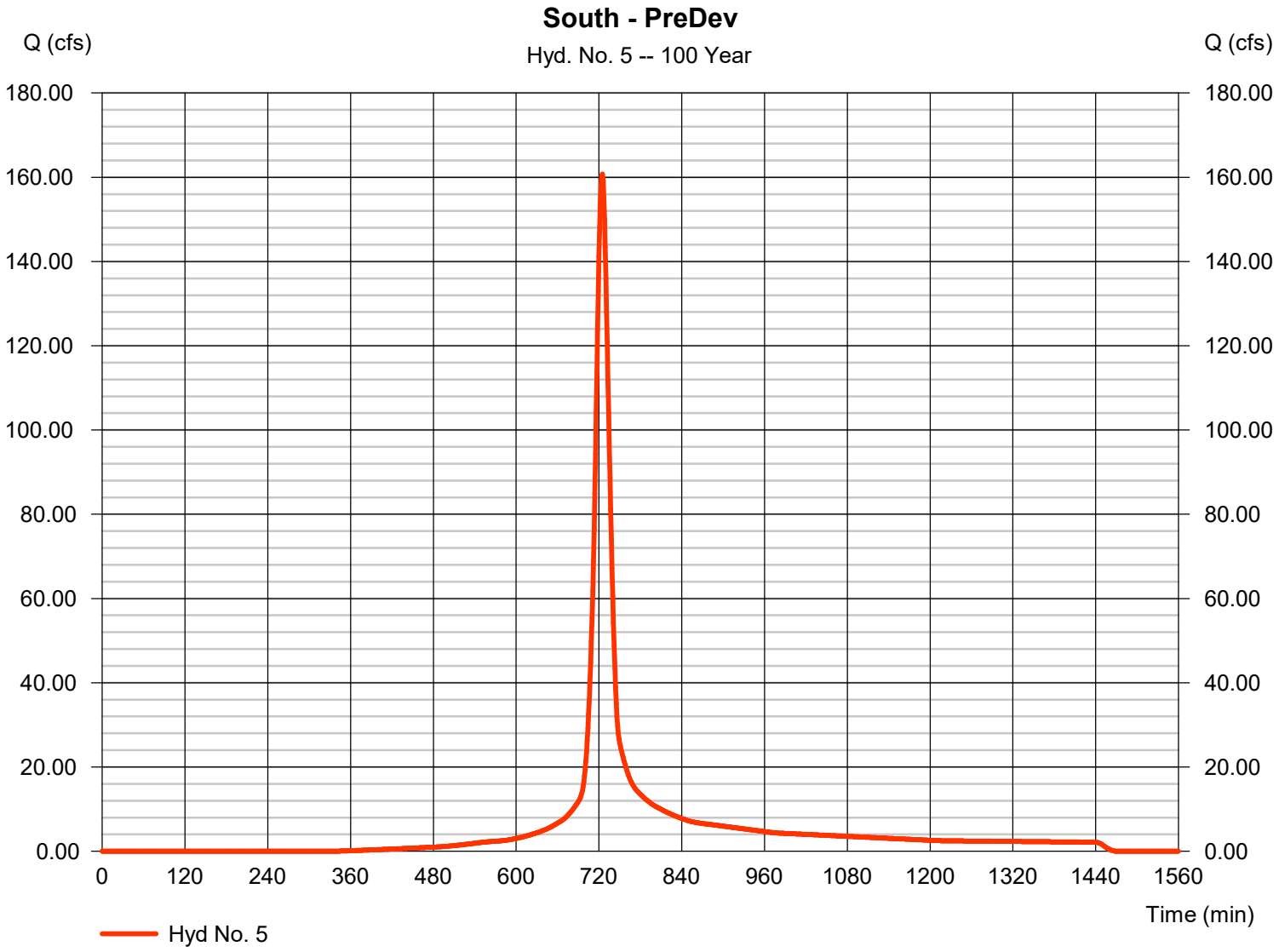


Hydrograph Report

Hyd. No. 5

South - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	160.78 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	507,689 cuft
Drainage area	=	24.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

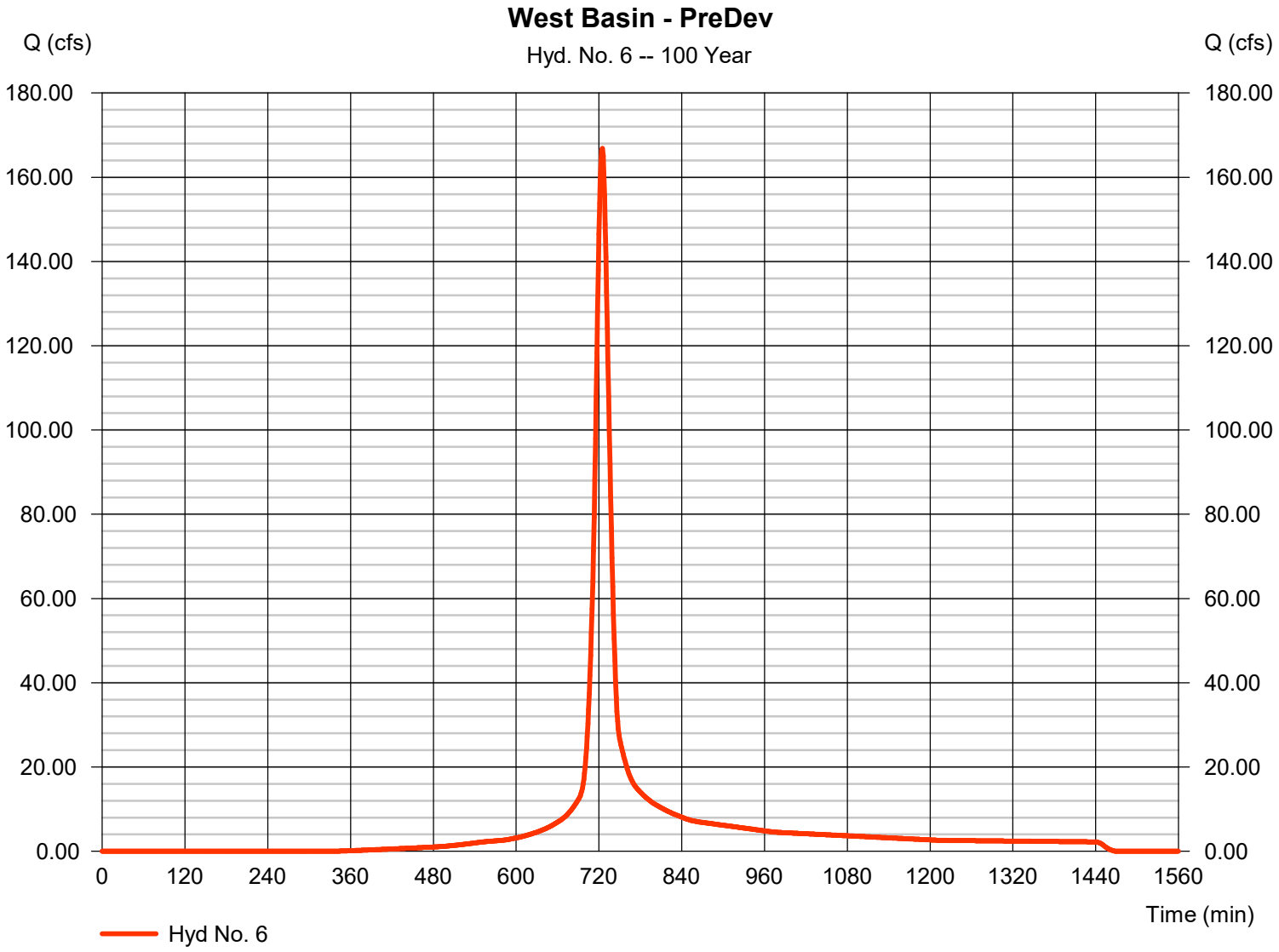


Hydrograph Report

Hyd. No. 6

West Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	166.81 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	526,727 cuft
Drainage area	=	24.900 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	20.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

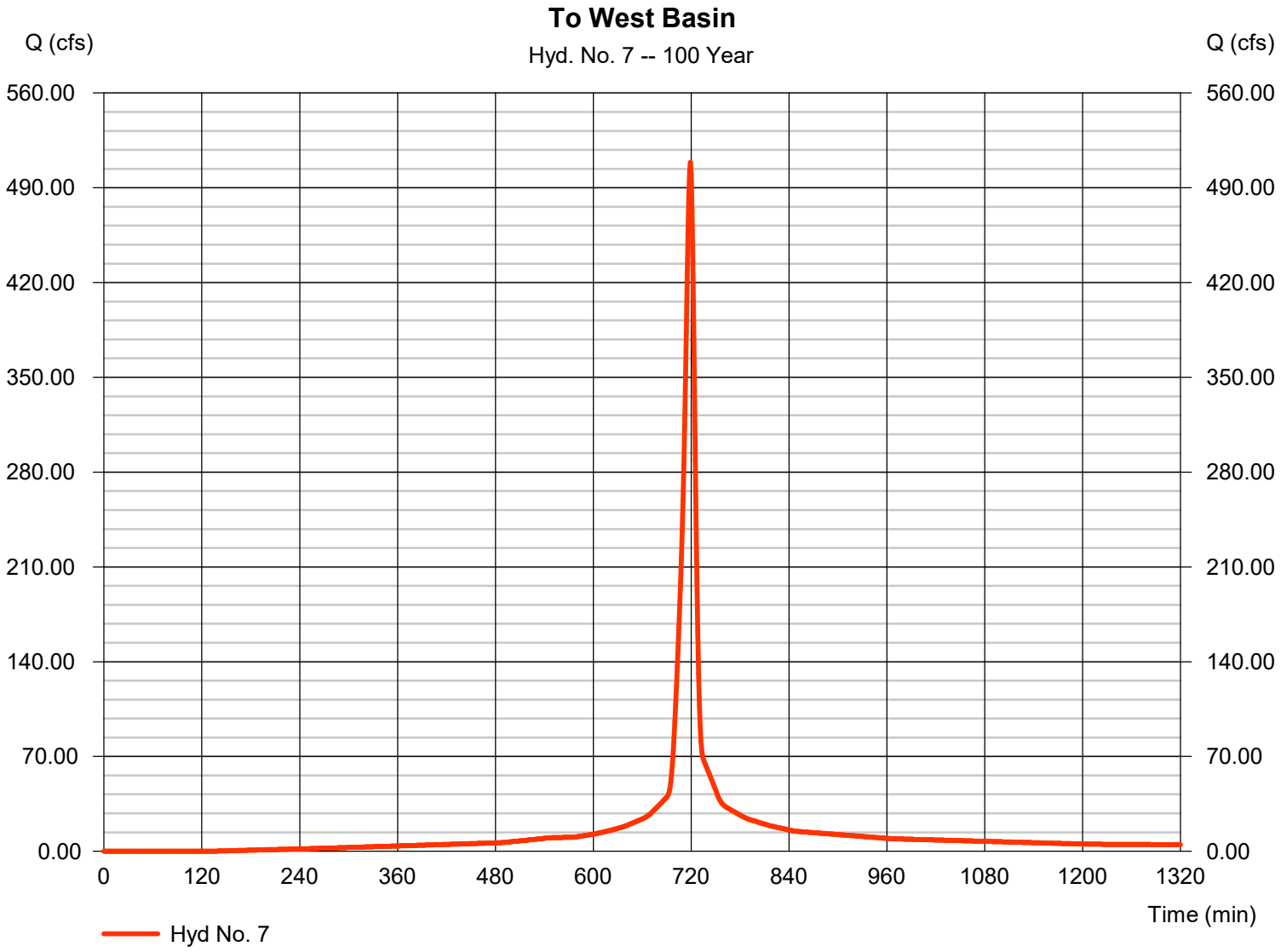


Hydrograph Report

Hyd. No. 7

To West Basin

Hydrograph type	=	SCS Runoff	Peak discharge	=	508.76 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	1,279,803 cuft
Drainage area	=	46.900 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

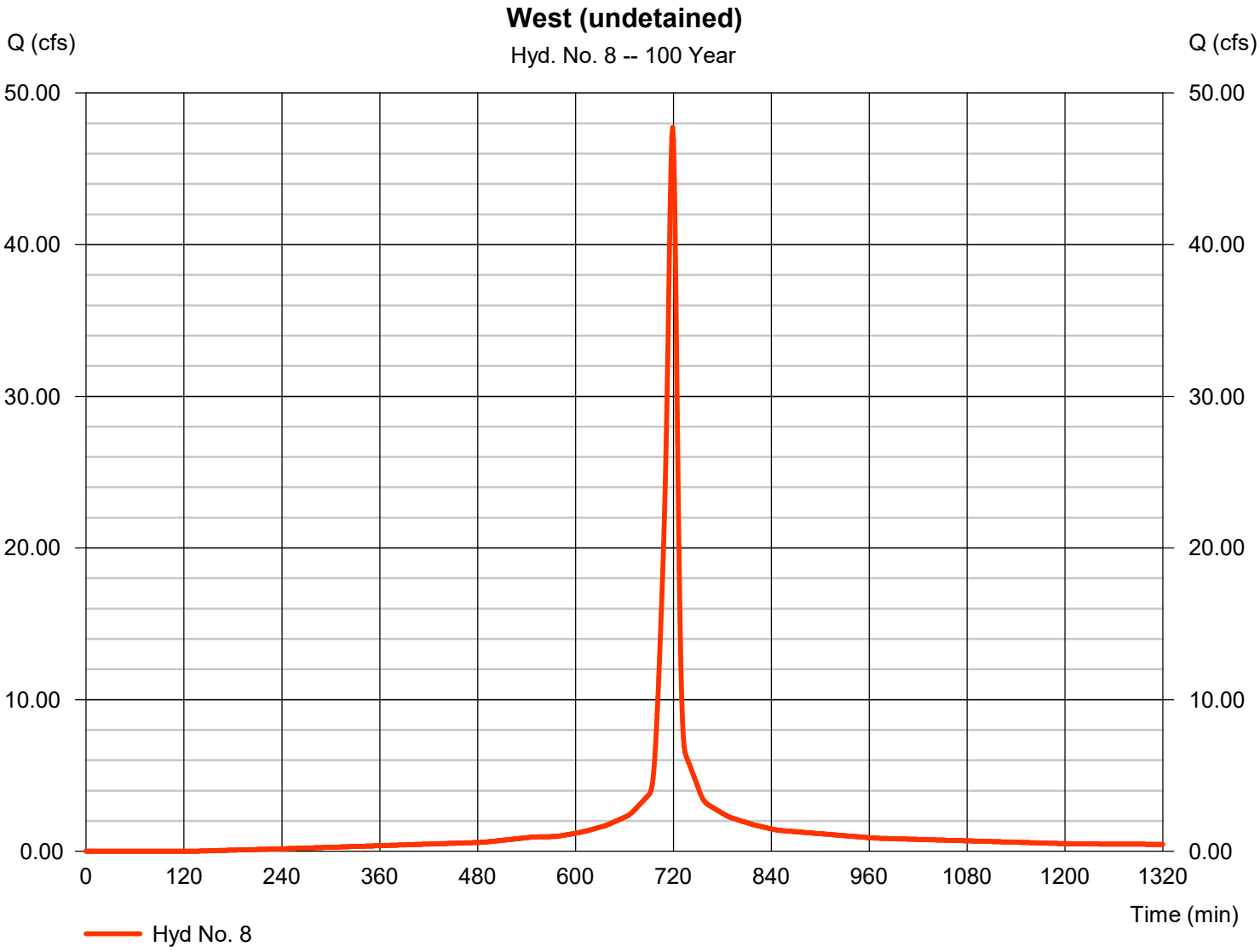


Hydrograph Report

Hyd. No. 8

West (undetained)

Hydrograph type	=	SCS Runoff	Peak discharge	=	47.73 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	120,067 cuft
Drainage area	=	4.400 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

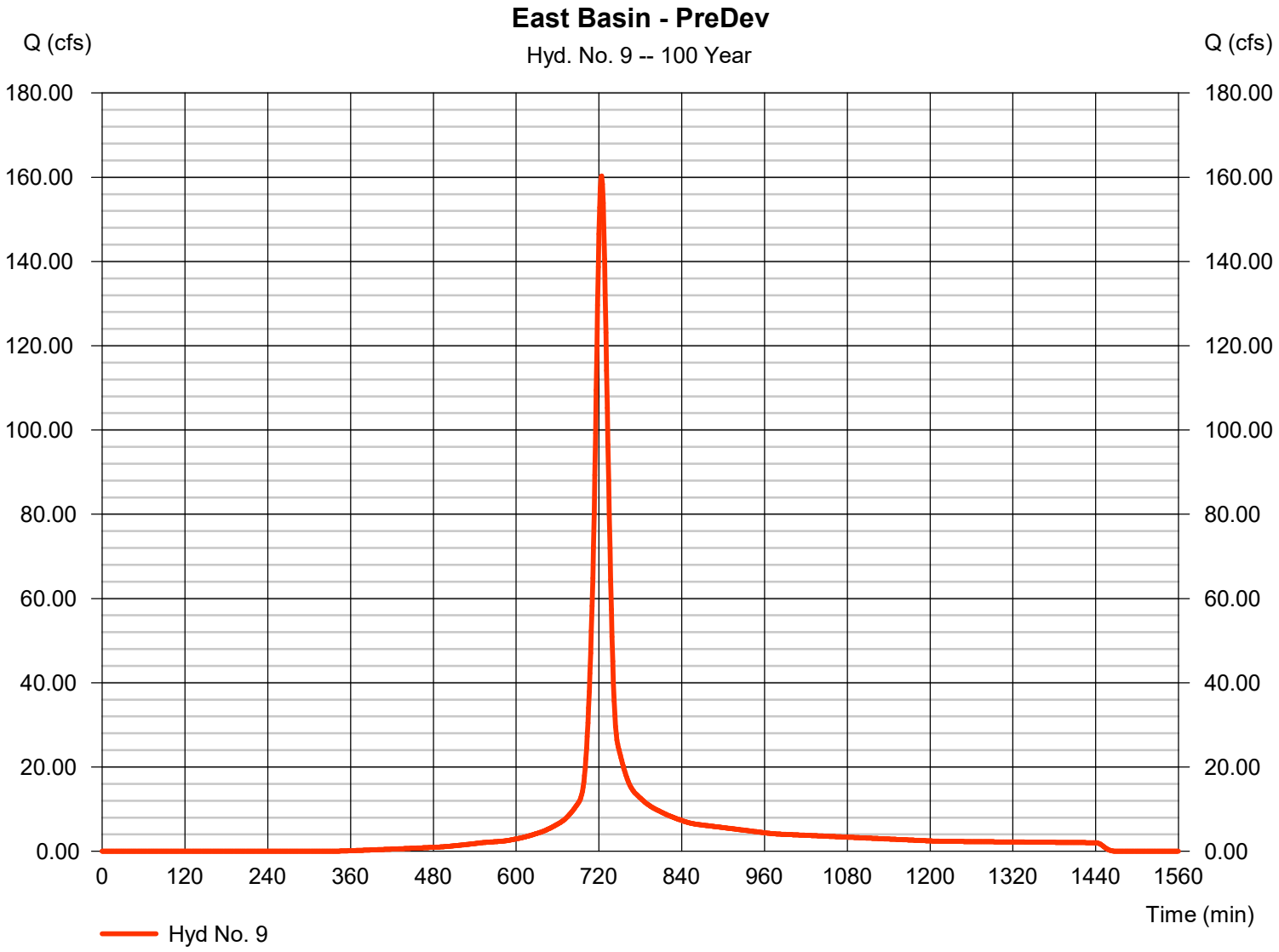


Hydrograph Report

Hyd. No. 9

East Basin - PreDev

Hydrograph type	=	SCS Runoff	Peak discharge	=	160.31 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	481,006 cuft
Drainage area	=	23.000 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

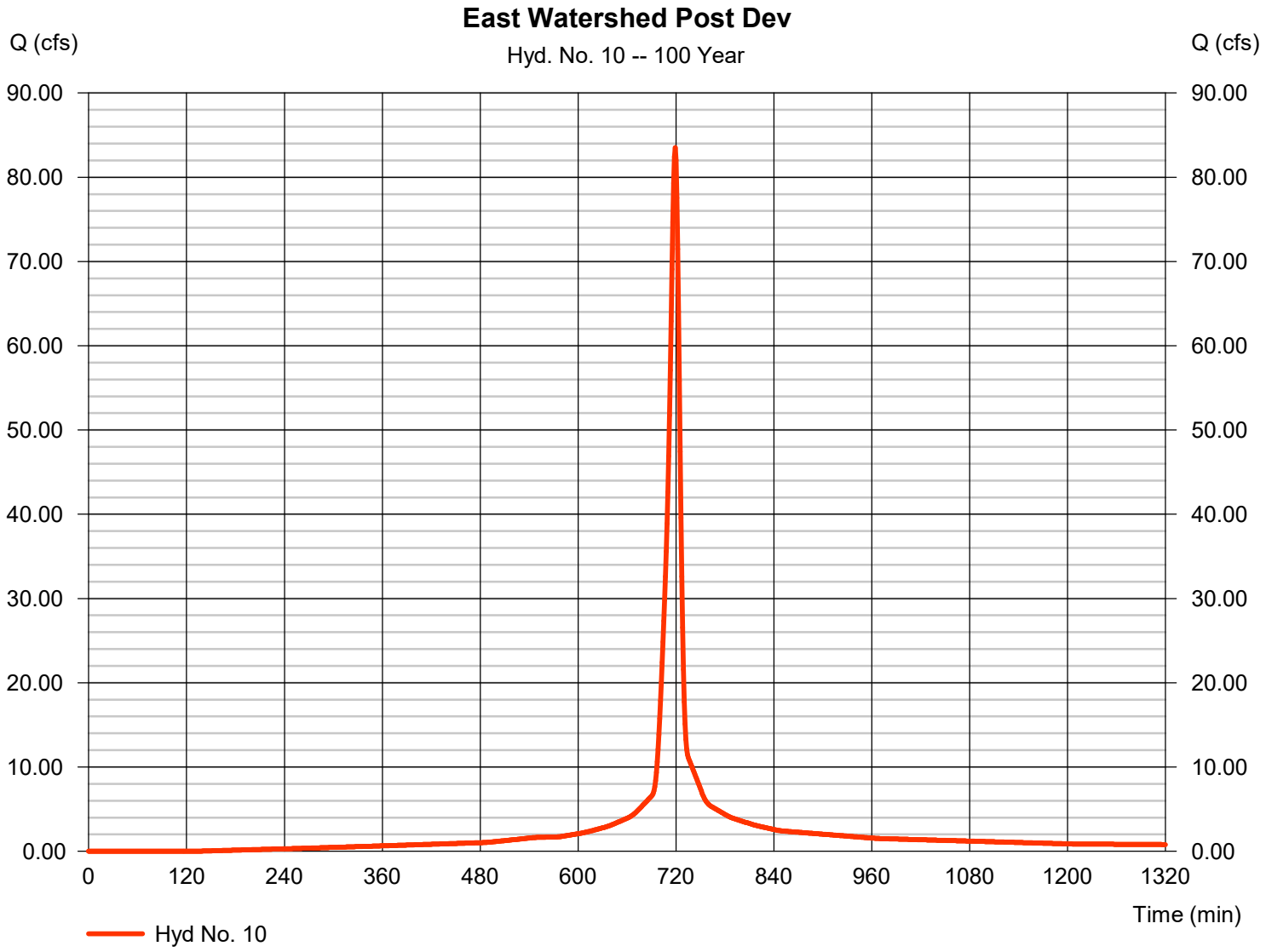


Hydrograph Report

Hyd. No. 10

East Watershed Post Dev

Hydrograph type	=	SCS Runoff	Peak discharge	=	83.53 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	210,117 cuft
Drainage area	=	7.700 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.00 min
Total precip.	=	8.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



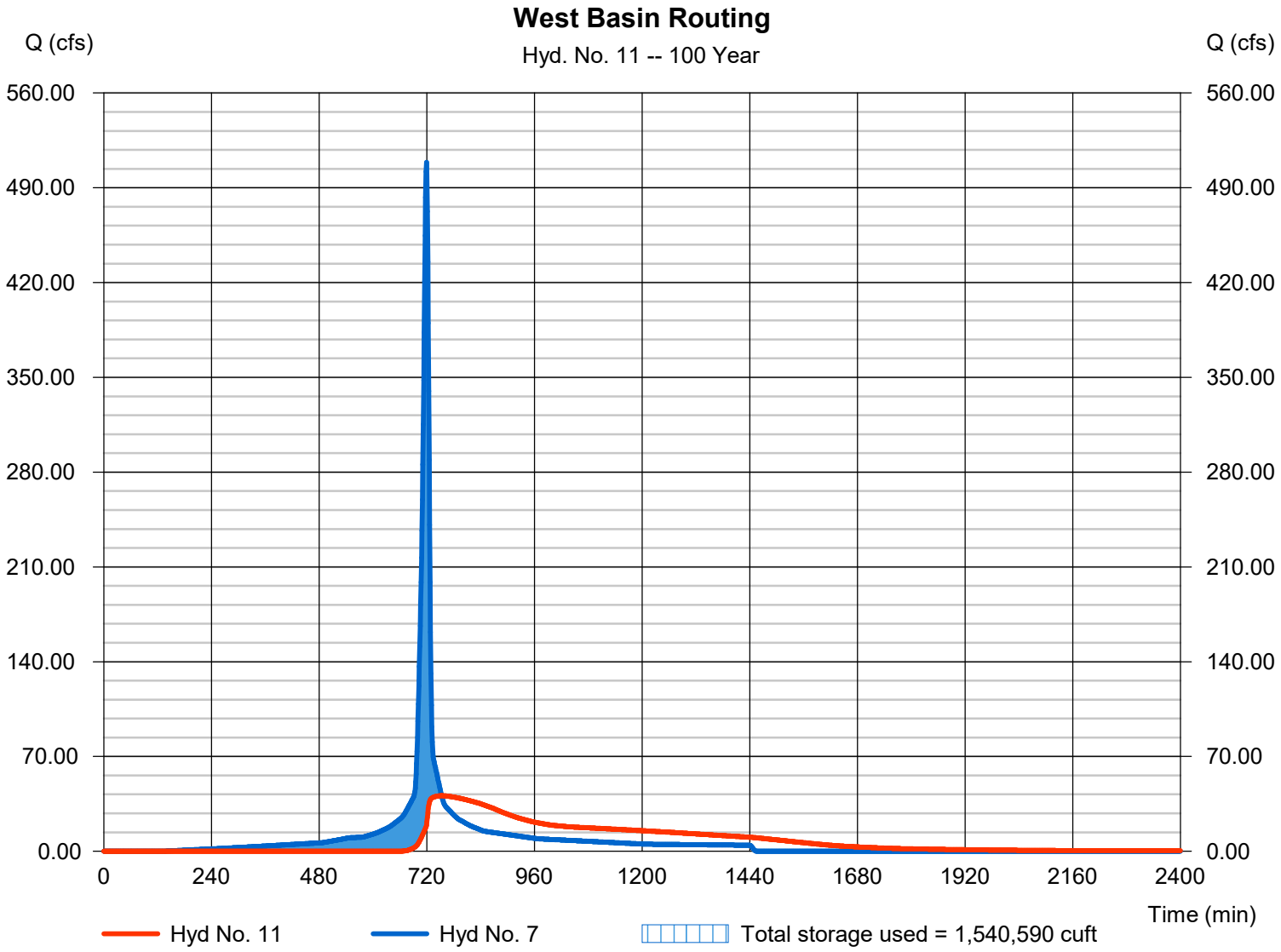
Hydrograph Report

Hyd. No. 11

West Basin Routing

Hydrograph type	=	Reservoir	Peak discharge	=	41.01 cfs
Storm frequency	=	100 yrs	Time to peak	=	753 min
Time interval	=	1 min	Hyd. volume	=	1,077,764 cuft
Inflow hyd. No.	=	7 - To West Basin	Max. Elevation	=	956.65 ft
Reservoir name	=	West Basin	Max. Storage	=	1,540,590 cuft

Storage Indication method used. Wet pond routing start elevation = 950.00 ft.

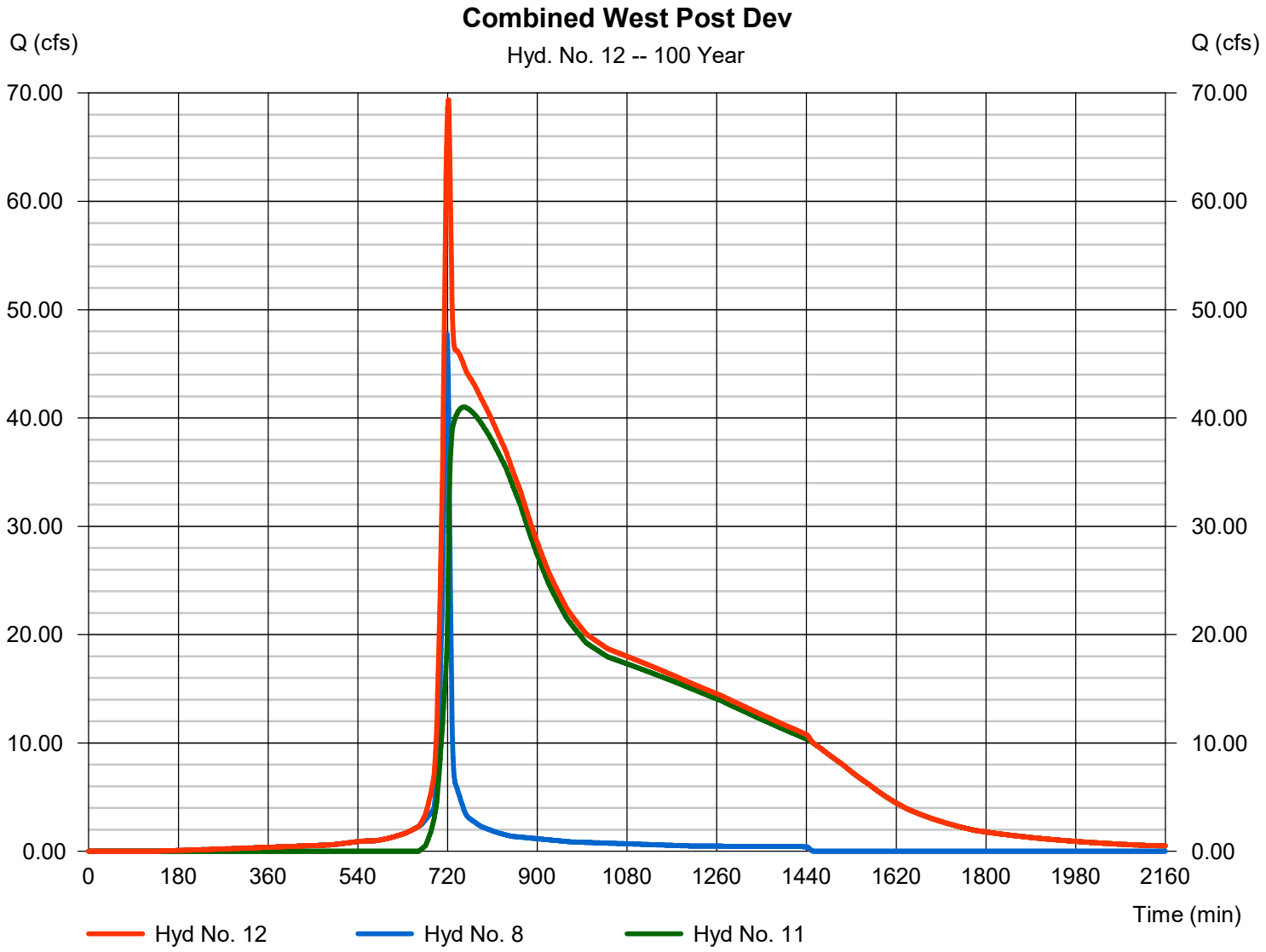


Hydrograph Report

Hyd. No. 12

Combined West Post Dev

Hydrograph type	= Combine	Peak discharge	= 69.36 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 1,197,831 cuft
Inflow hyds.	= 8, 11	Contrib. drain. area	= 4.400 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	79.5706	15.0000	0.8977	--------
3	0.0000	0.0000	0.0000	--------
5	168.3971	19.5000	1.0189	--------
10	90.6951	15.4000	0.8336	--------
25	106.7203	15.3000	0.8080	--------
50	136.5555	16.2000	0.8170	--------
100	160.7297	16.8000	0.8186	--------

File name: KC APWA 5600 Adjusted for K.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.41	4.42	3.76	3.27	2.90	2.61	2.37	2.18	2.02	1.88	1.76	1.65
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.98	3.52	3.16	2.86	2.62	2.41	2.24	2.08	1.95
10	7.34	6.12	5.27	4.64	4.16	3.77	3.46	3.19	2.97	2.78	2.62	2.47
25	9.37	7.84	6.78	5.99	5.39	4.90	4.50	4.17	3.89	3.65	3.44	3.25
50	11.26	9.47	8.21	7.27	6.54	5.96	5.48	5.08	4.74	4.44	4.19	3.96
100	12.90	10.89	9.47	8.40	7.57	6.90	6.35	5.89	5.50	5.16	4.86	4.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: \\VMJC-FILE\engineering\Hydroflow IDF Curves\SCS Numbers PCP files\Lee's Summit MO.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.60	0.00	0.00	5.30	0.00	0.00	8.60
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX E – WATER QUALITY ORIFICE CALCULATIONS

South Basin

Water Quality Outlet, Single Orifice

Known:			Automatically calculated:		
Z_{WQ} =	2	ft	t_{plate} =	6	in
WQ_V =	32770	ft^3	Q_{WQ} =	0.23	cfs
			g=	32.2	ft/s^2

Step	Description	Symbol	Value	Units
1	Depth of water quality volume at outlet	Z_{WQ}	2	ft
2	Average head of water quality volume over invert of orifice	H_{WQ}	1	ft
3	Average water quality outflow rate	Q_{WQ}	0.23	cfs
4	Orifice dishcharge coefficient	C_0	0.66	
5	Water quality outlet orifice diameter	D_0	2.55	in

West Basin

Water Quality Outlet, Single Orifice

Known:			Automatically calculated:		
Z_{WQ} =	2	ft	t_{plate} =	6	in
WQ_V =	108239	ft^3	Q_{WQ} =	0.75	cfs
			g=	32.2	ft/s^2

Step	Description	Symbol	Value	Units	
1	Depth of water quality volume at outlet	Z_{WQ}	2	ft	
2	Average head of water quality volume over invert of orifice	H_{WQ}	1	ft	
3	Average water quality outflow rate	Q_{WQ}	0.75	cfs	
4	Orifice dishcharge coefficient	C_0	0.8	$\geq$	0.8
5	Water quality outlet orifice diameter	D_0	4.63	in	