GPD GROUP®

520 South Main Street, Suite 2531
Akron, Ohio 44311

Phone 330.572.2100
www.gpdgroup.com

PRELIMINARY STORMWATER CALCULATIONS

Grove City Villas

Grove City, Ohio

Southwest Blvd
Grove City, Ohio

Prepared For:
City of Grove City

Designer:
Lee Starr

Project Manager:
Todd Westover

Design Date:
May 2019

GPD Group, Professional Corporation Project Number:
2019175.04

_____ _____

Leonardo Sferra, P.E. Date

Project: Grove City Villas
Project Number: 2019175.04
Designer: LDS

Date: 05/16/19

Detention Pond Water Quality Calculations

WQv Required= R_v*P*A/12

i = percent post construction impervious surface =	49.79	%
Volumetric Runoff Coefficient = $\mathbf{R_v}$ = 0.05 + 0.9i	0.50	
Precipitation Depth = **P** =	0.9	in
Area Draining to BMP= A_0 =	4.72	Ac
Required WQ_{v0} = R_v*P*A_0/12	0.176	Ac-ft
=	7681	cf
Additional 20% storage required = WQ_v * 20%	1536	cf
Total Required WQ_v =	9217	cf
Total WQv Provided =	9287	cf

*See Incremental Storage

$\mathbf{Z_0}$=Bottom Water Quality Volume Elevation=	861.00	ft
$\mathbf{Z_{WQv}}$=Total Water Quality Volume Elevation=	862.25	ft
$\mathbf{Z_{1/2WQv}}$=Pond Elevation Distance Between WQv and half of WQv=	0.63	ft
Minimum WQv Drawdown Time	**24.00**	hrs
Minimum First 1/2 WQv Drawdown Time	**8.00**	hrs
Average Allowable Release Rate of WQv = $\mathbf{Q_{WQv}}$ = WQv / allowable time	0.107	ft^3/s
Average Allowable Release Rate of The First Half of WQv = $\mathbf{Q_{1/2WQv}}$ = 0.5 * WQv / allowable time	0.161	ft^3/s

Orifice Equation

Q = A*C*Sqrt(2*g*h)

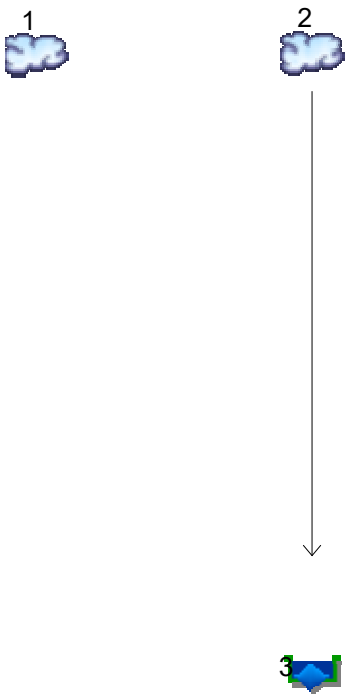
Orifice Diameter = **D** =	2.25	in	
C =	0.60		
Gravity = **g** =	32.2	ft/s^2	
A = Pi/4 * D^{2} =	0.0276	ft^2	
Average Head on Orifice for WQv = $\mathbf{H_{WQv}}$ = ((Z_{WQv} - Z_0) / 2) - 1/2D =	0.5313	ft	
Average Head on Orifice for First Half of the WQv = $\mathbf{H_{1/2WQv}}$ = ((Z_{WQv} - Z_0) + ($Z_{1/2WQv}$) / 2) - 1/2D =	0.8438	ft	
Actual Average Discharge Rate of WQv = $\mathbf{Q_{WQv}}$ = A * C * Sqrt(2*g*H_{WQv}) =	0.097	ft^3/s	
Actual Average Discharge Rate of First Half of WQv = $\mathbf{Q_{1/2WQv}}$ = A * C * Sqrt(2*g*$H_{1/2WQv}$) =	0.122	ft^3/s	
Actual WQv Drawdown Time = WQv / (Q_{WQv} * 3,600) =	26.62	hrs	**GOOD**
Actual Drawdown Time of the First Half of WQv = 1/2 * WQv / ($Q_{1/2WQv}$ * 3,600) =	10.56	hrs	**GOOD**

Detention Pond Water Quality Summary

Water Quality Volume (cf)	Minimum Drawdown time (hrs)	First Half Minimum Drawdown time (hrs)	Water Quality Elevation (ft)	Orifice Size (in)	Actual Drawdown Time (hrs)	First half Actual Drawdown time (hrs)
9287	24.00	8.00	862.25	2.25	26.62	10.56

Watershed Model Schematic

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

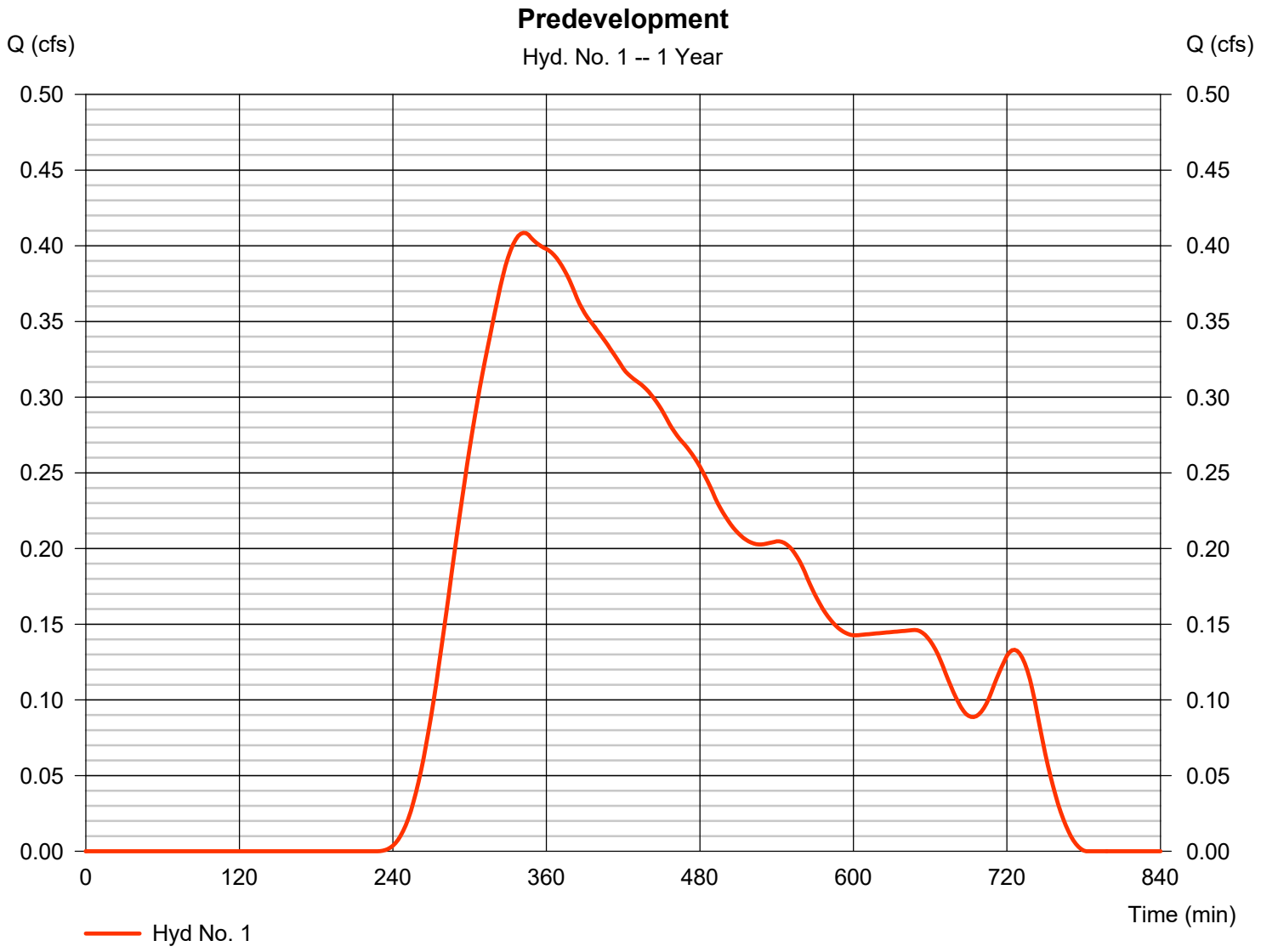


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 0.409 cfs
Storm frequency	= 1 yrs	Time to peak	= 342 min
Time interval	= 2 min	Hyd. volume	= 6,601 cuft
Drainage area	= 4.720 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.90 min
Total precip.	= 1.88 in	Distribution	= Huff-2nd
Storm duration	= 12.00 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 1

Predevelopment

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.20		0.00		0.00		
Land slope (%)	= 0.50		0.00		0.00		
Travel Time (min)	**= 29.97**	**+**	**0.00**	**+**	**0.00**	**=**	**29.97**
Shallow Concentrated Flow							
Flow length (ft)	= 677.00		0.00		0.00		
Watercourse slope (%)	= 0.60		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.25		0.00		0.00		
Travel Time (min)	**= 9.03**	**+**	**0.00**	**+**	**0.00**	**=**	**9.03**
Channel Flow							
X sectional flow area (sqft)	= 2.00		0.00		0.00		
Wetted perimeter (ft)	= 7.00		0.00		0.00		
Channel slope (%)	= 1.59		0.00		0.00		
Manning's n-value	= 0.025		0.015		0.015		
Velocity (ft/s)	=3.25						
			0.00				
					0.00		
Flow length (ft)	({0})170.0		0.0		0.0		
Travel Time (min)	**= 0.87**	**+**	**0.00**	**+**	**0.00**	**=**	**0.87**

Total Travel Time, Tc ..... 39.90 min

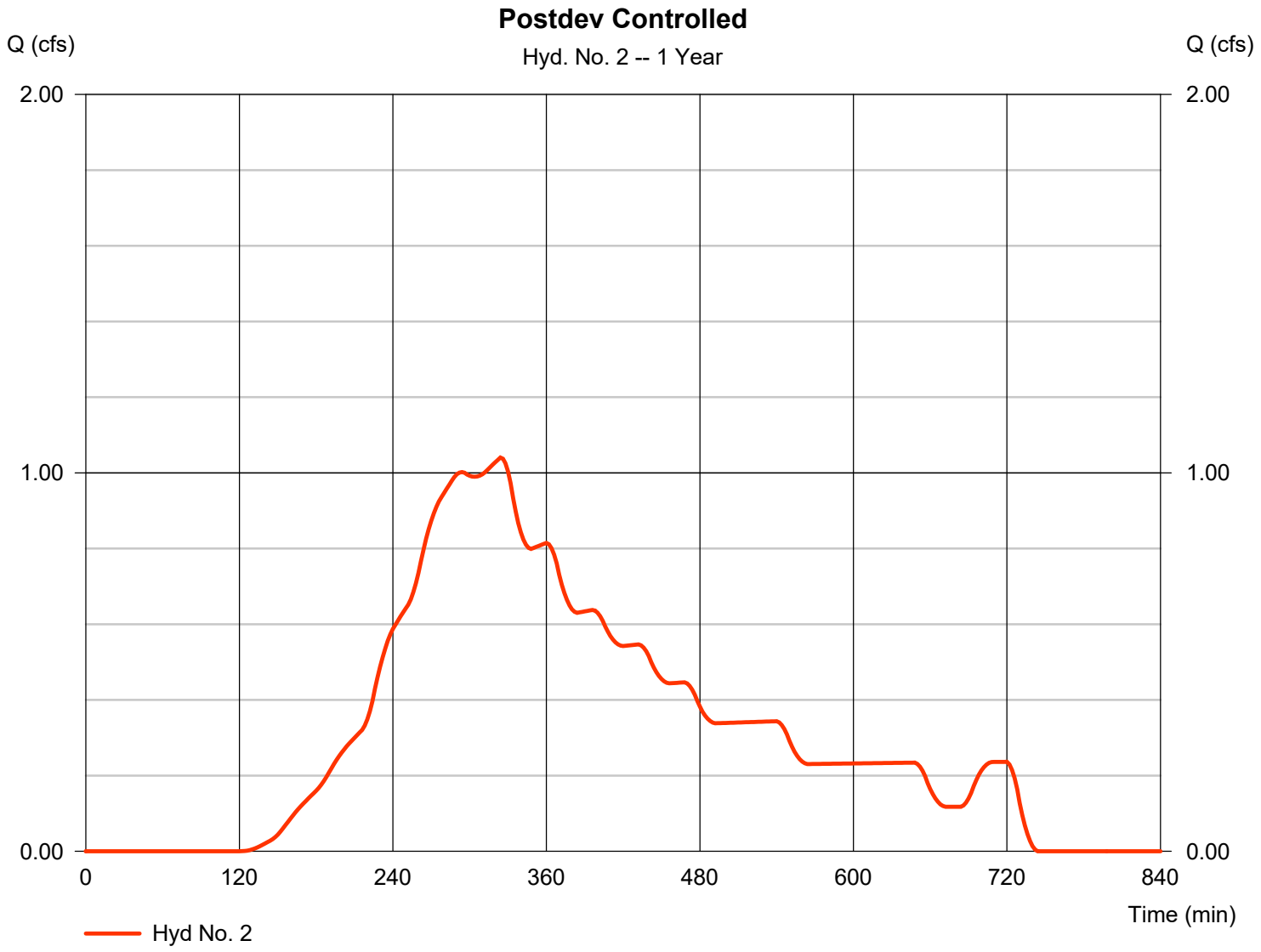
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.040 cfs
Storm frequency	=	1 yrs	Time to peak	=	324 min
Time interval	=	2 min	Hyd. volume	=	15,525 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	1.88 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



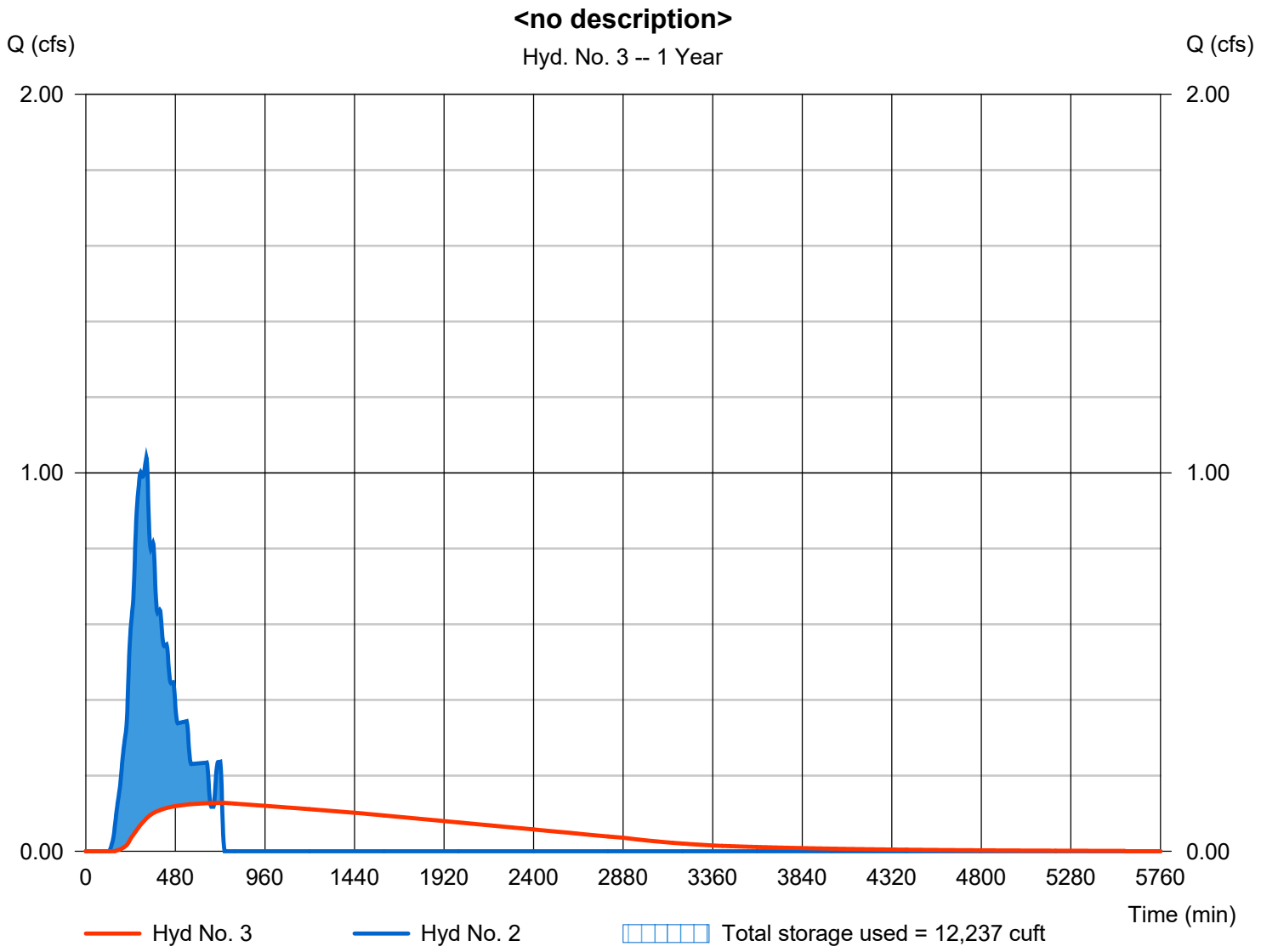
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.128 cfs
Storm frequency	=	1 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	15,476 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	862.57 ft
Reservoir name	=	Basin 1	Max. Storage	=	12,237 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Basin 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 861.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	861.00	6,197	0	0
1.00	862.00	8,224	7,186	7,186
1.25	862.25	8,584	2,101	9,287
2.00	863.00	9,702	6,852	16,139
3.00	864.00	11,280	10,480	26,619
4.00	865.00	12,958	12,108	38,727
4.33	865.33	13,835	4,420	43,147

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	2.00	2.50	0.00
Span (in)	= 12.00	2.00	2.50	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 860.75	861.00	862.67	0.00
Length (ft)	= 75.00	0.02	0.50	0.00
Slope (%)	= 0.45	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

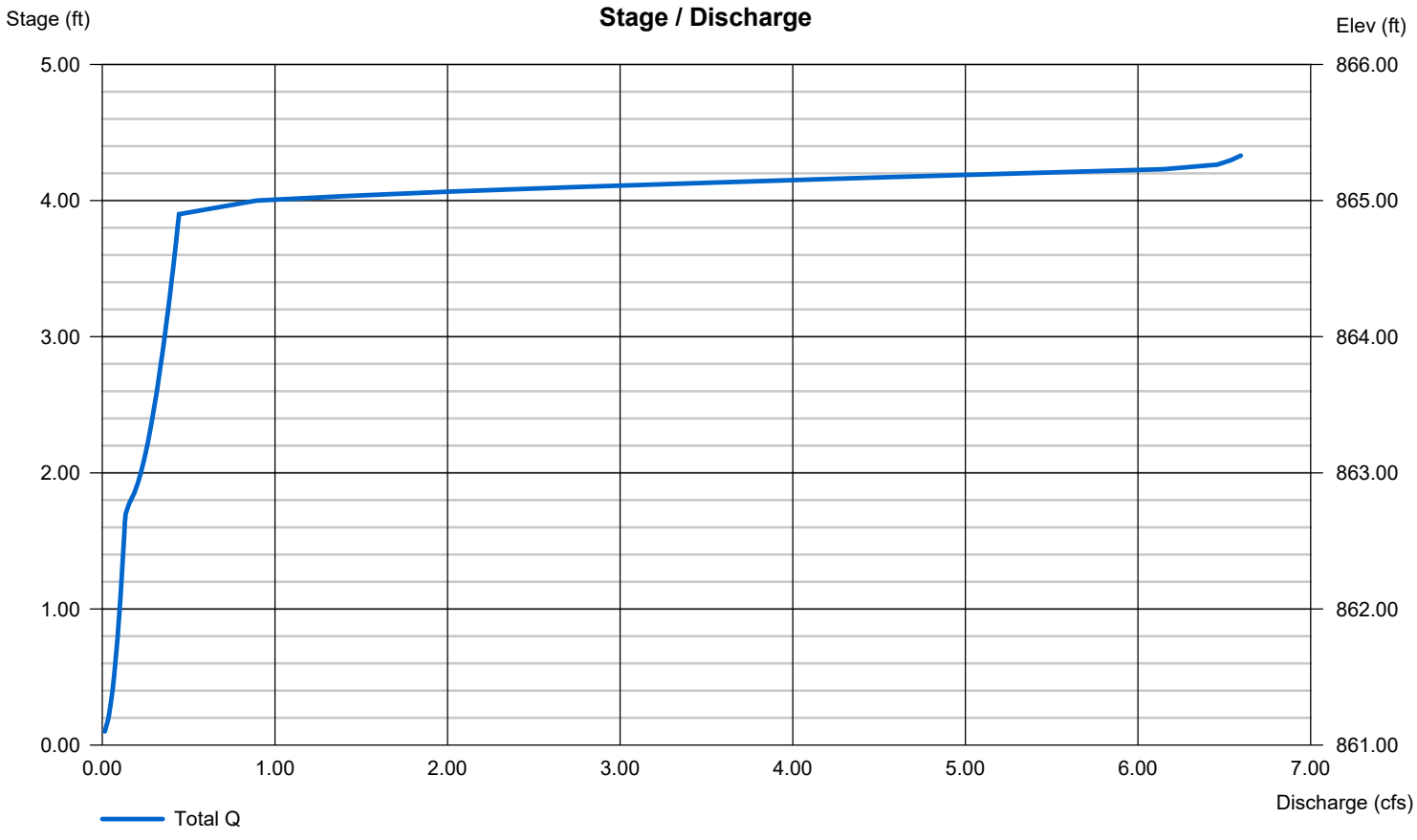
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 12.00	0.00	0.00	0.00
Crest El. (ft)	= 864.95	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
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).

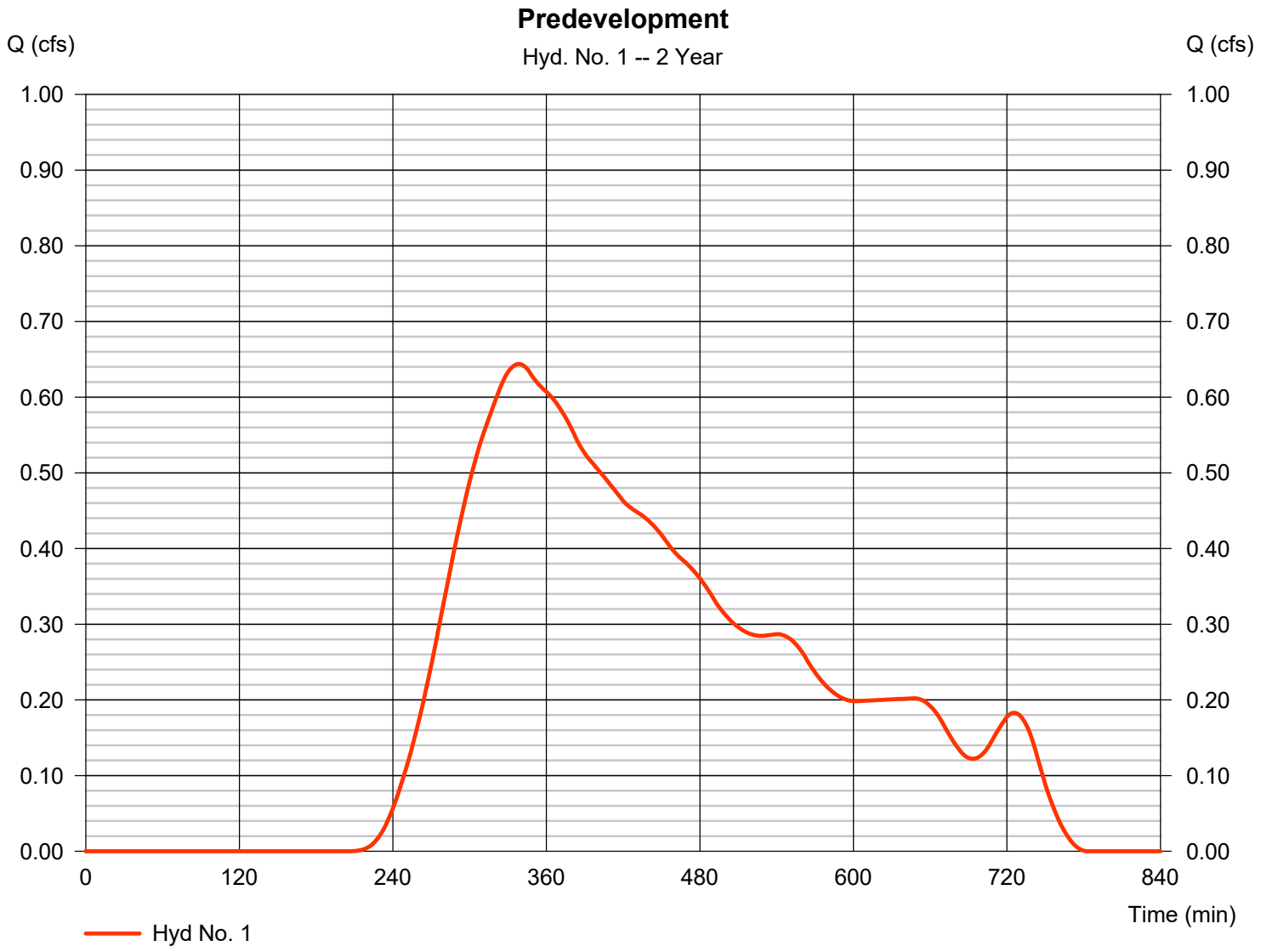


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 0.644 cfs
Storm frequency	= 2 yrs	Time to peak	= 338 min
Time interval	= 2 min	Hyd. volume	= 10,086 cuft
Drainage area	= 4.720 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.90 min
Total precip.	= 2.25 in	Distribution	= Huff-2nd
Storm duration	= 12.00 hrs	Shape factor	= 484



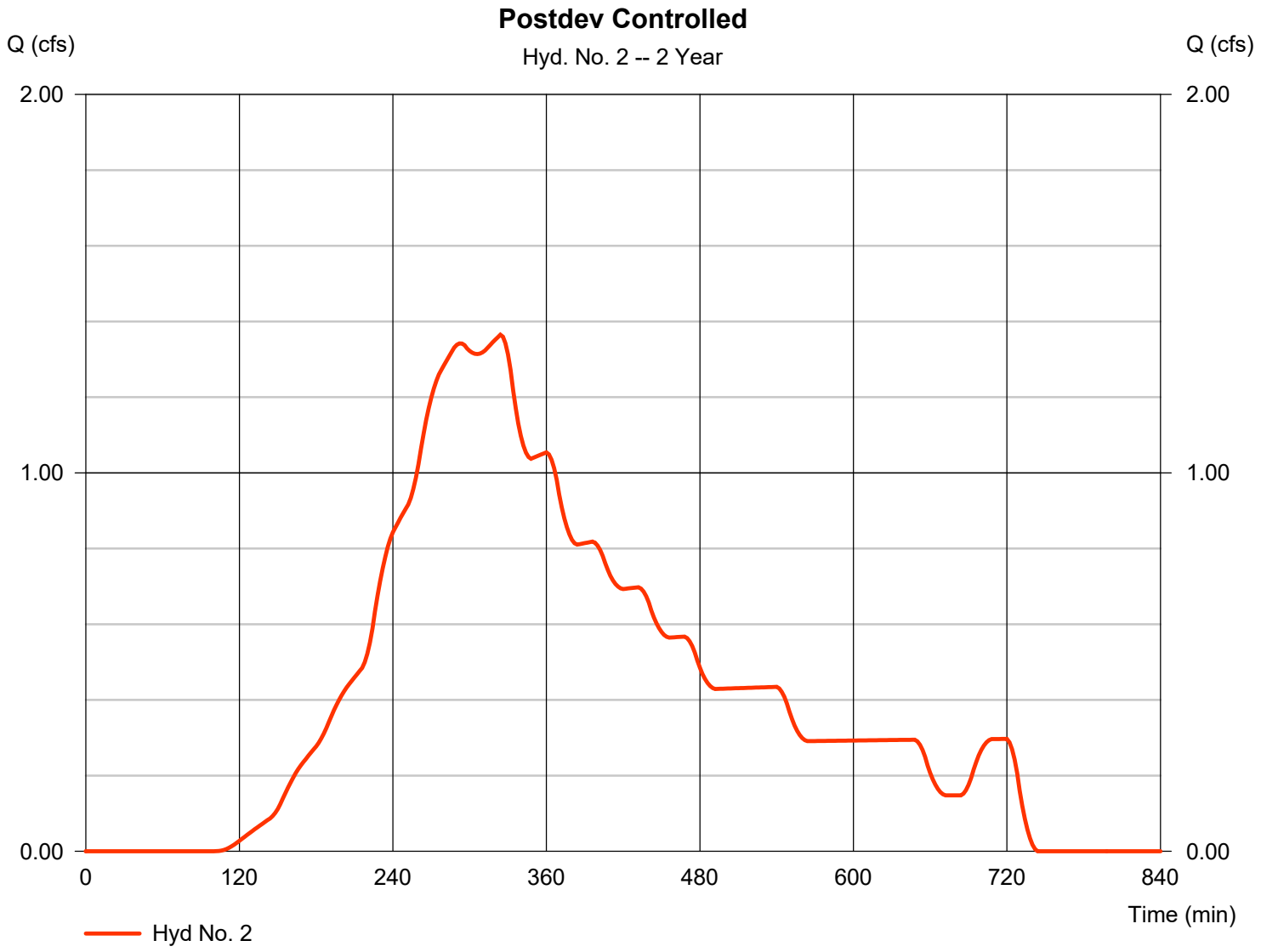
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.365 cfs
Storm frequency	=	2 yrs	Time to peak	=	324 min
Time interval	=	2 min	Hyd. volume	=	20,690 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	2.25 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



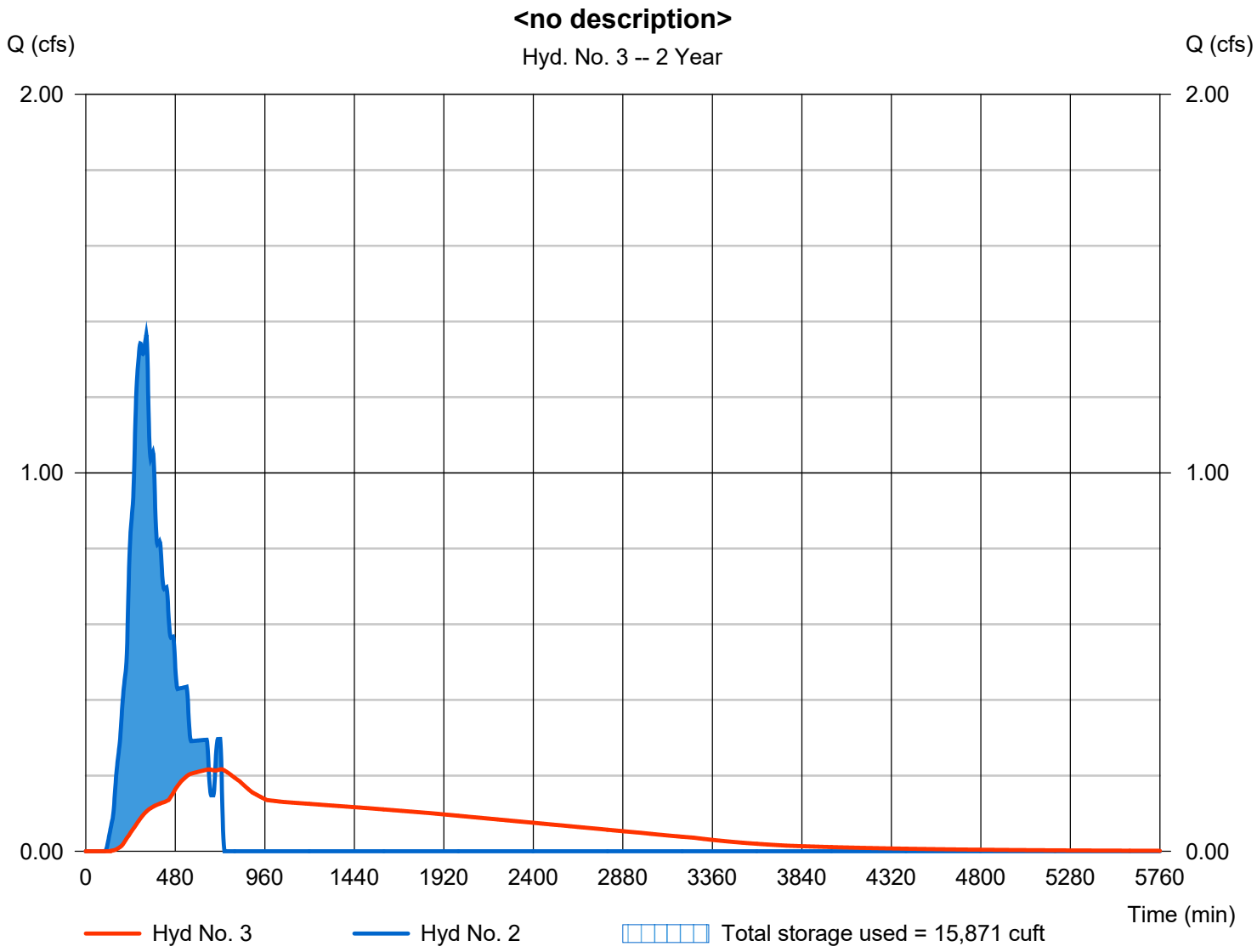
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.217 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	20,628 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	862.97 ft
Reservoir name	=	Basin 1	Max. Storage	=	15,871 cuft

Storage Indication method used.

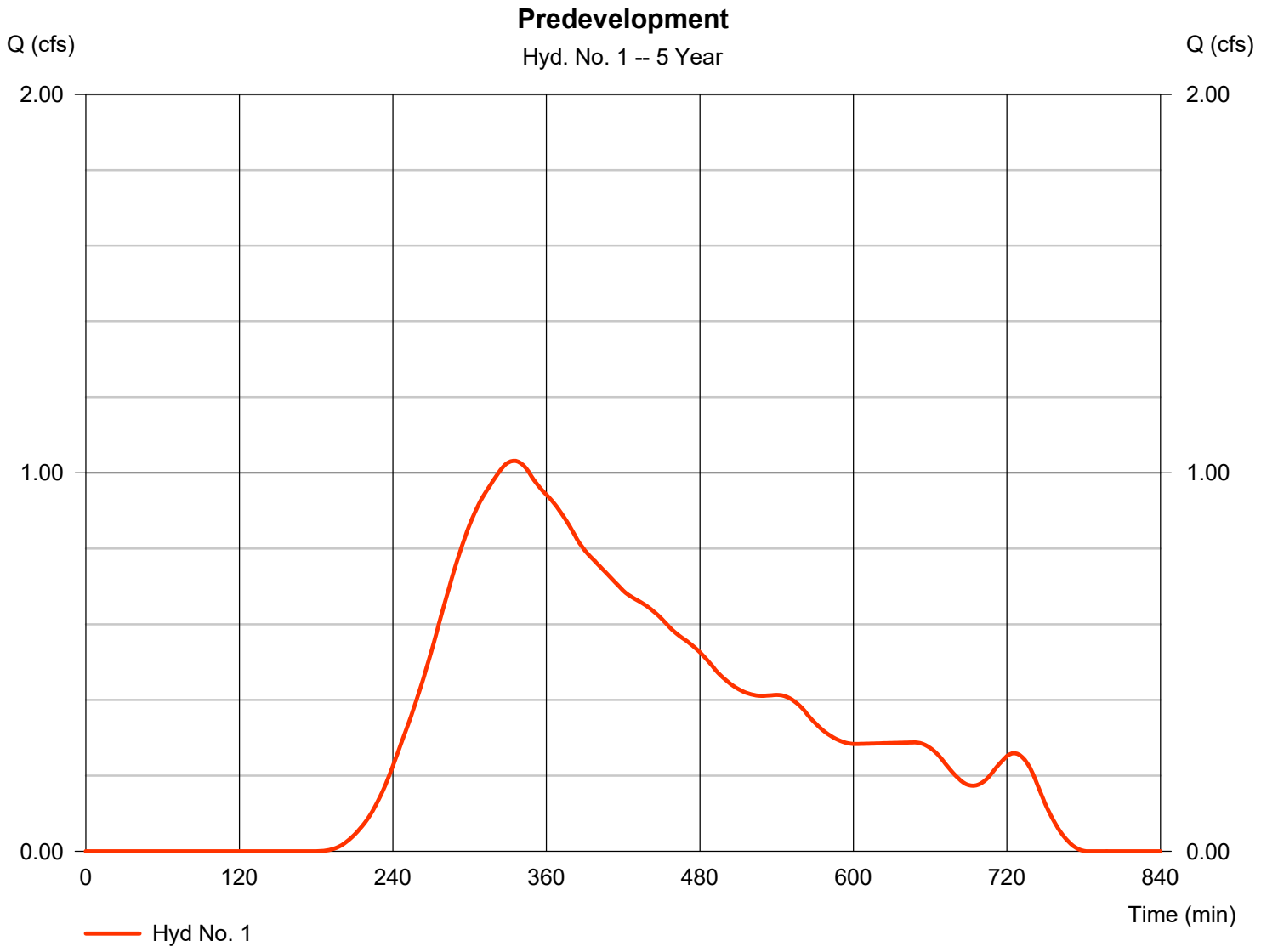


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 1.032 cfs
Storm frequency	= 5 yrs	Time to peak	= 334 min
Time interval	= 2 min	Hyd. volume	= 15,903 cuft
Drainage area	= 4.720 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.90 min
Total precip.	= 2.79 in	Distribution	= Huff-2nd
Storm duration	= 12.00 hrs	Shape factor	= 484



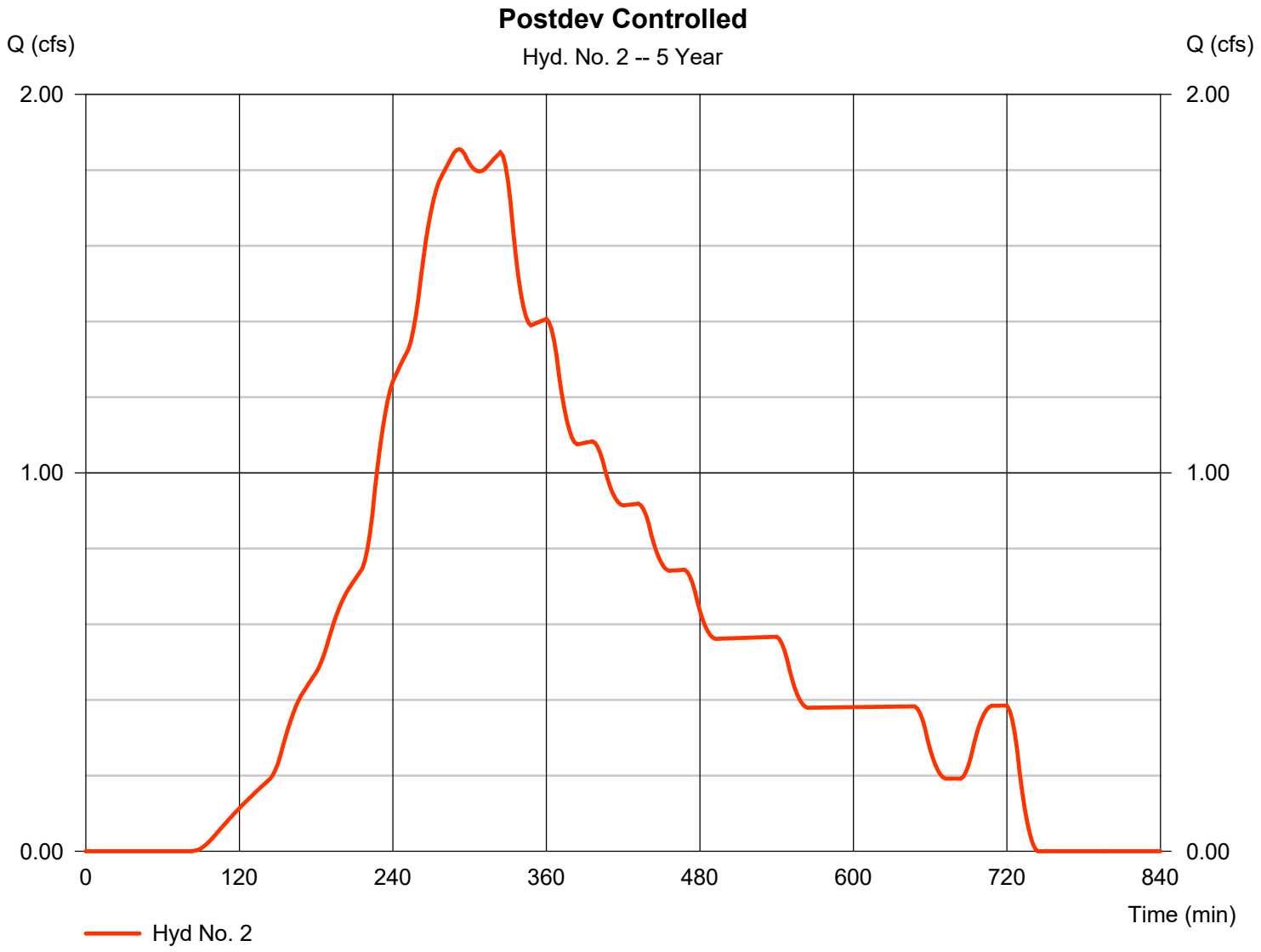
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.855 cfs
Storm frequency	=	5 yrs	Time to peak	=	292 min
Time interval	=	2 min	Hyd. volume	=	28,585 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	2.79 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



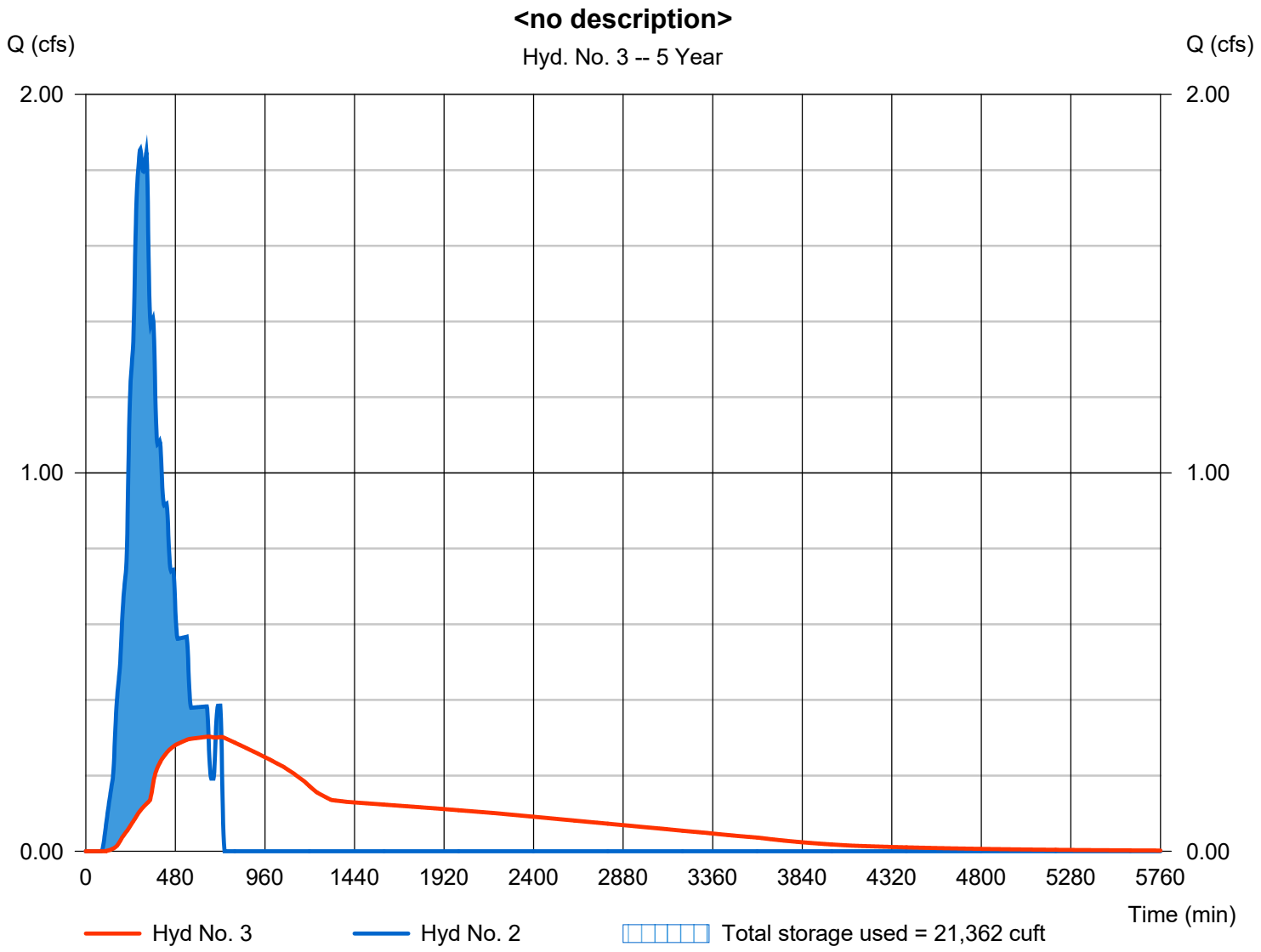
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.303 cfs
Storm frequency	=	5 yrs	Time to peak	=	658 min
Time interval	=	2 min	Hyd. volume	=	28,491 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	863.50 ft
Reservoir name	=	Basin 1	Max. Storage	=	21,362 cuft

Storage Indication method used.

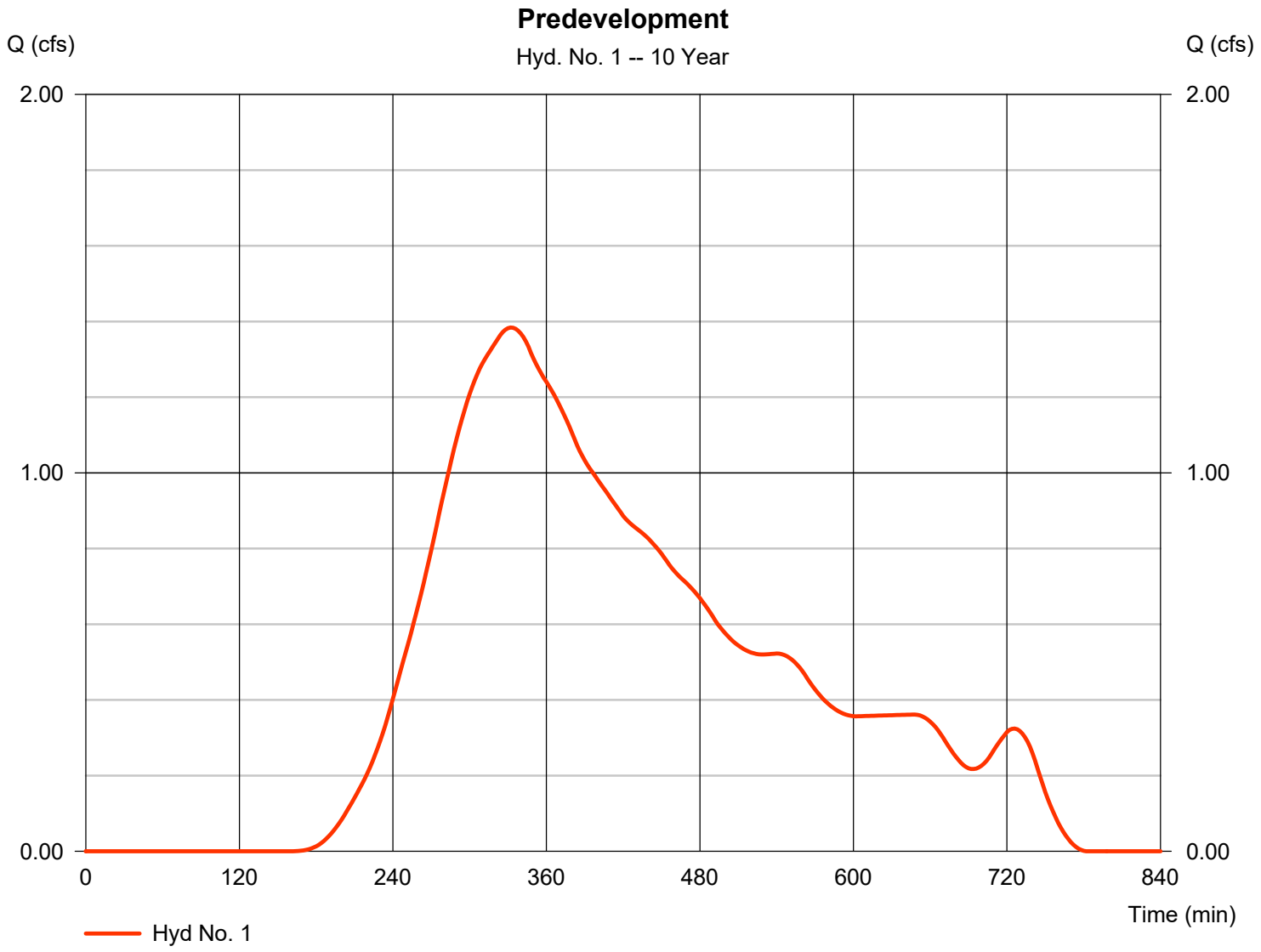


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.384 cfs
Storm frequency	=	10 yrs	Time to peak	=	332 min
Time interval	=	2 min	Hyd. volume	=	21,254 cuft
Drainage area	=	4.720 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	39.90 min
Total precip.	=	3.24 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484



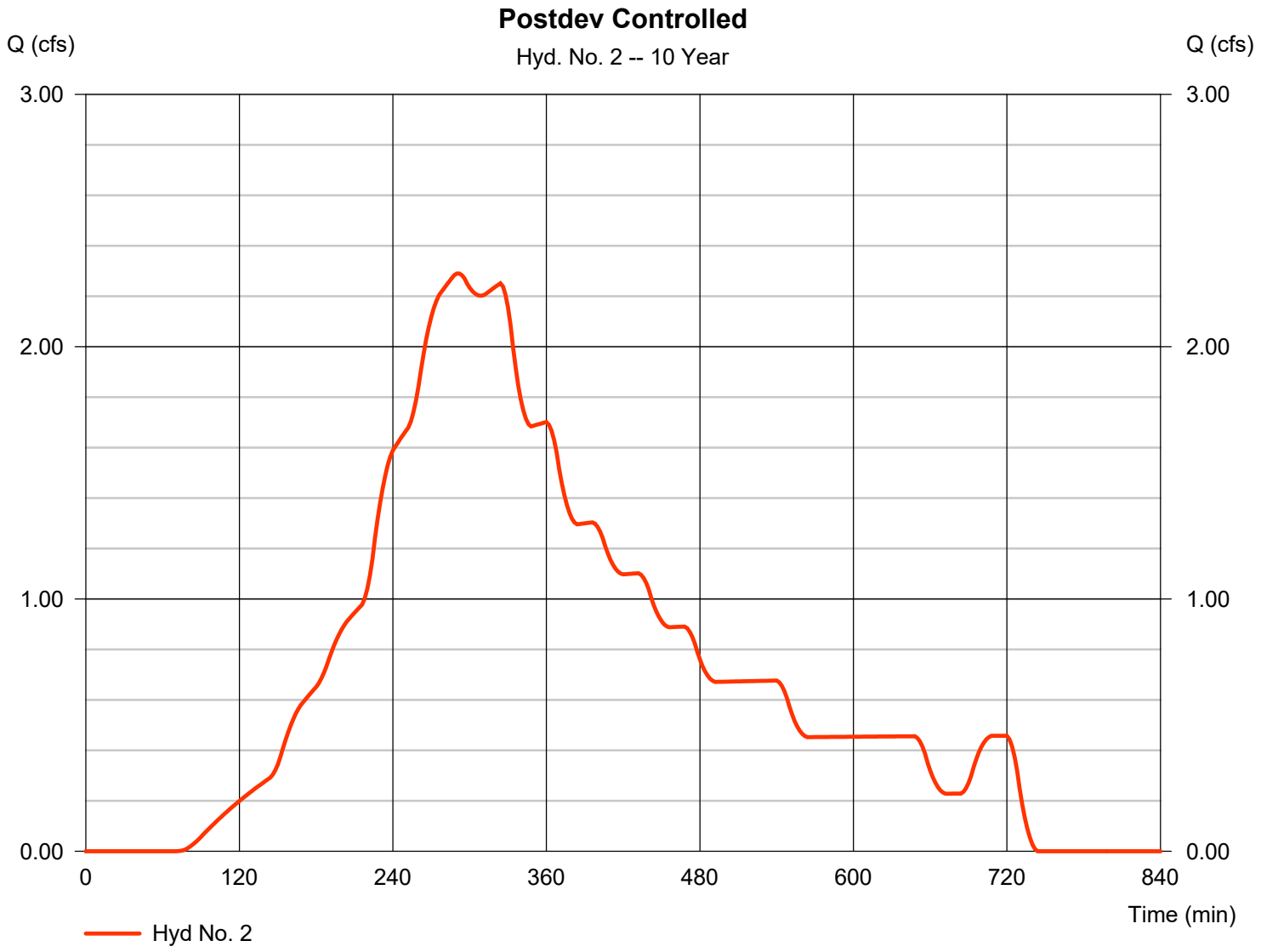
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.290 cfs
Storm frequency	=	10 yrs	Time to peak	=	290 min
Time interval	=	2 min	Hyd. volume	=	35,383 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	3.24 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



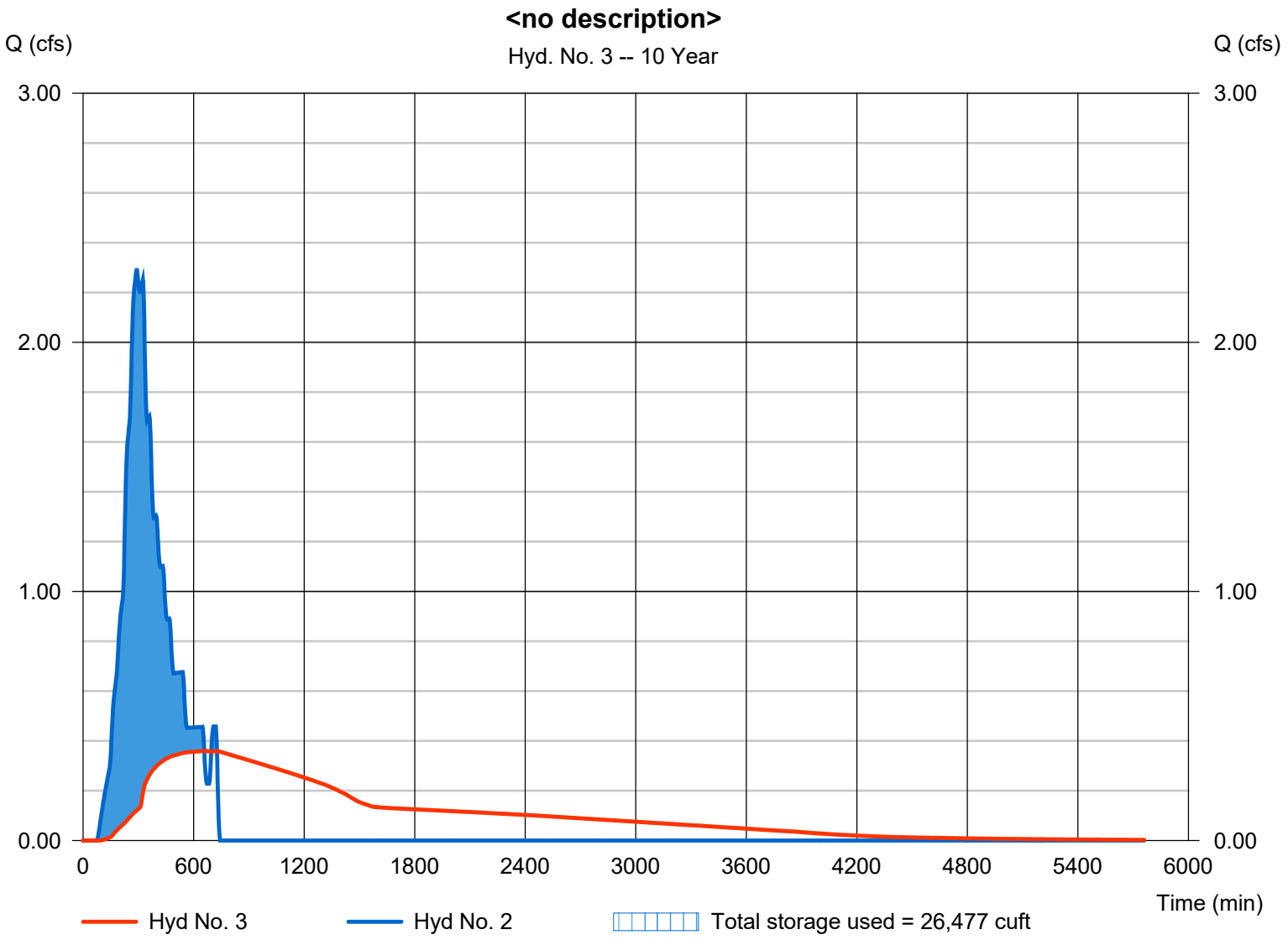
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.360 cfs
Storm frequency	=	10 yrs	Time to peak	=	658 min
Time interval	=	2 min	Hyd. volume	=	35,254 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	863.99 ft
Reservoir name	=	Basin 1	Max. Storage	=	26,477 cuft

Storage Indication method used.

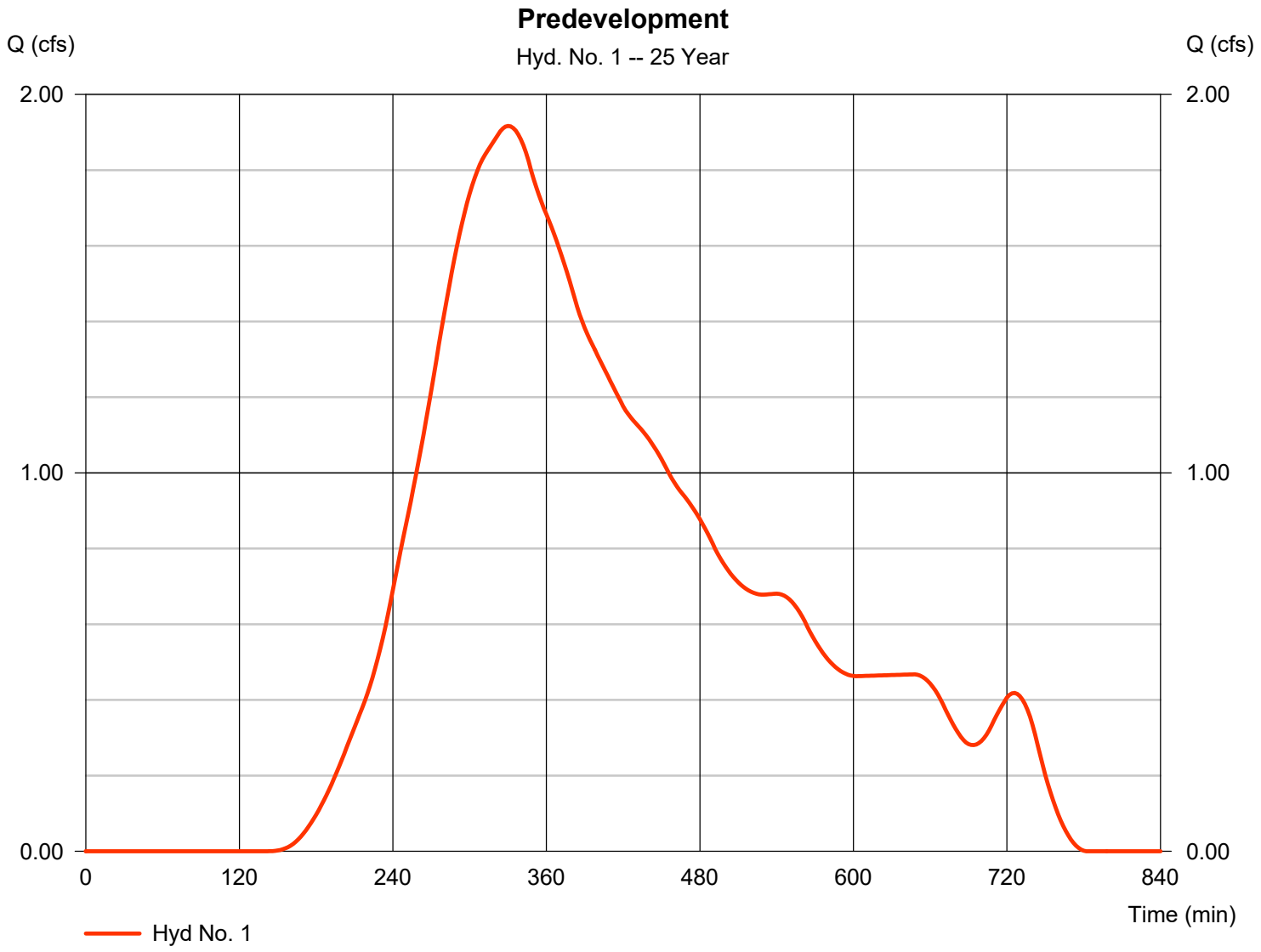


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	= SCS Runoff	Peak discharge	= 1.917 cfs
Storm frequency	= 25 yrs	Time to peak	= 330 min
Time interval	= 2 min	Hyd. volume	= 29,447 cuft
Drainage area	= 4.720 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 39.90 min
Total precip.	= 3.88 in	Distribution	= Huff-2nd
Storm duration	= 12.00 hrs	Shape factor	= 484



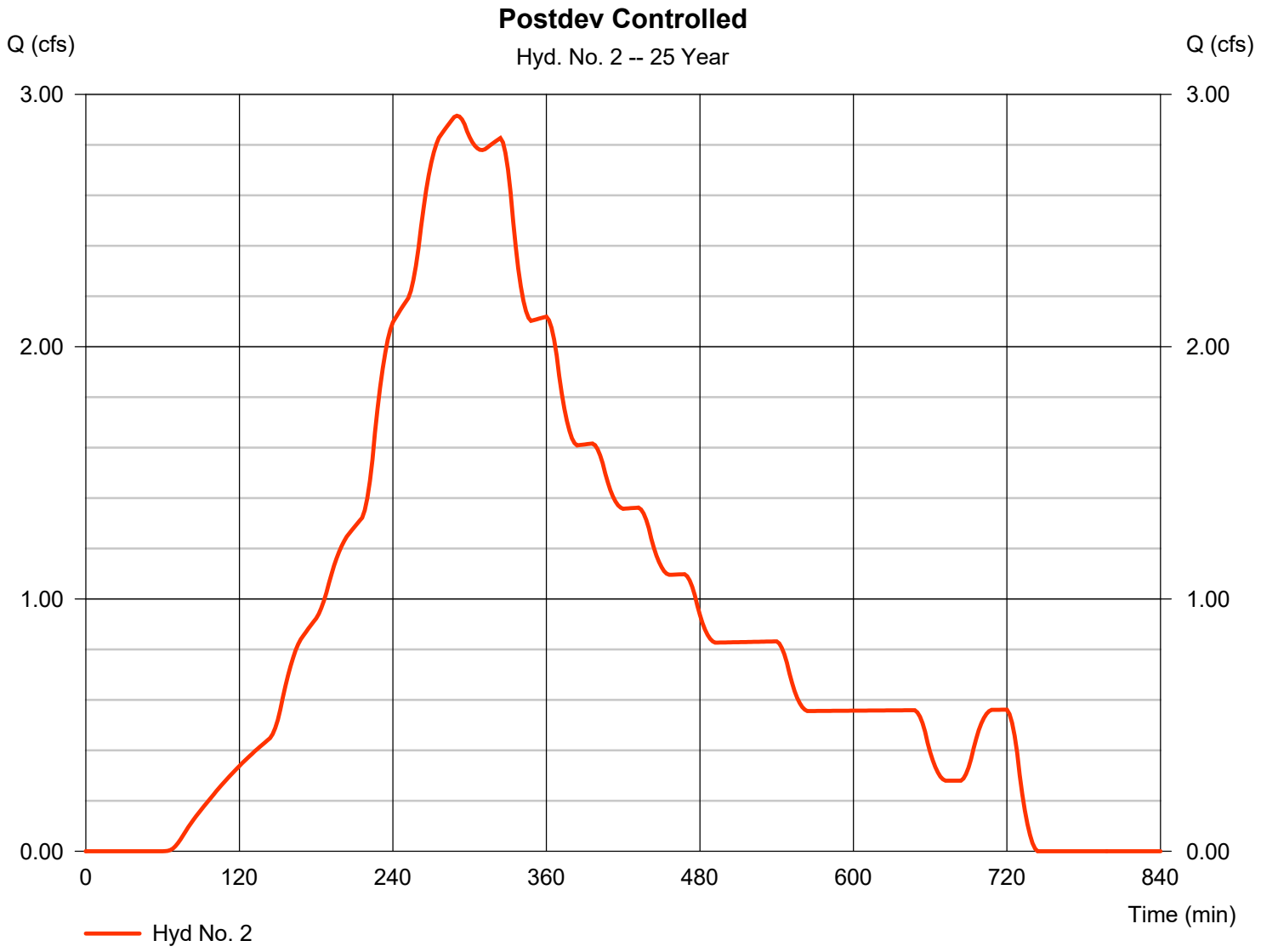
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.915 cfs
Storm frequency	=	25 yrs	Time to peak	=	290 min
Time interval	=	2 min	Hyd. volume	=	45,281 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	3.88 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



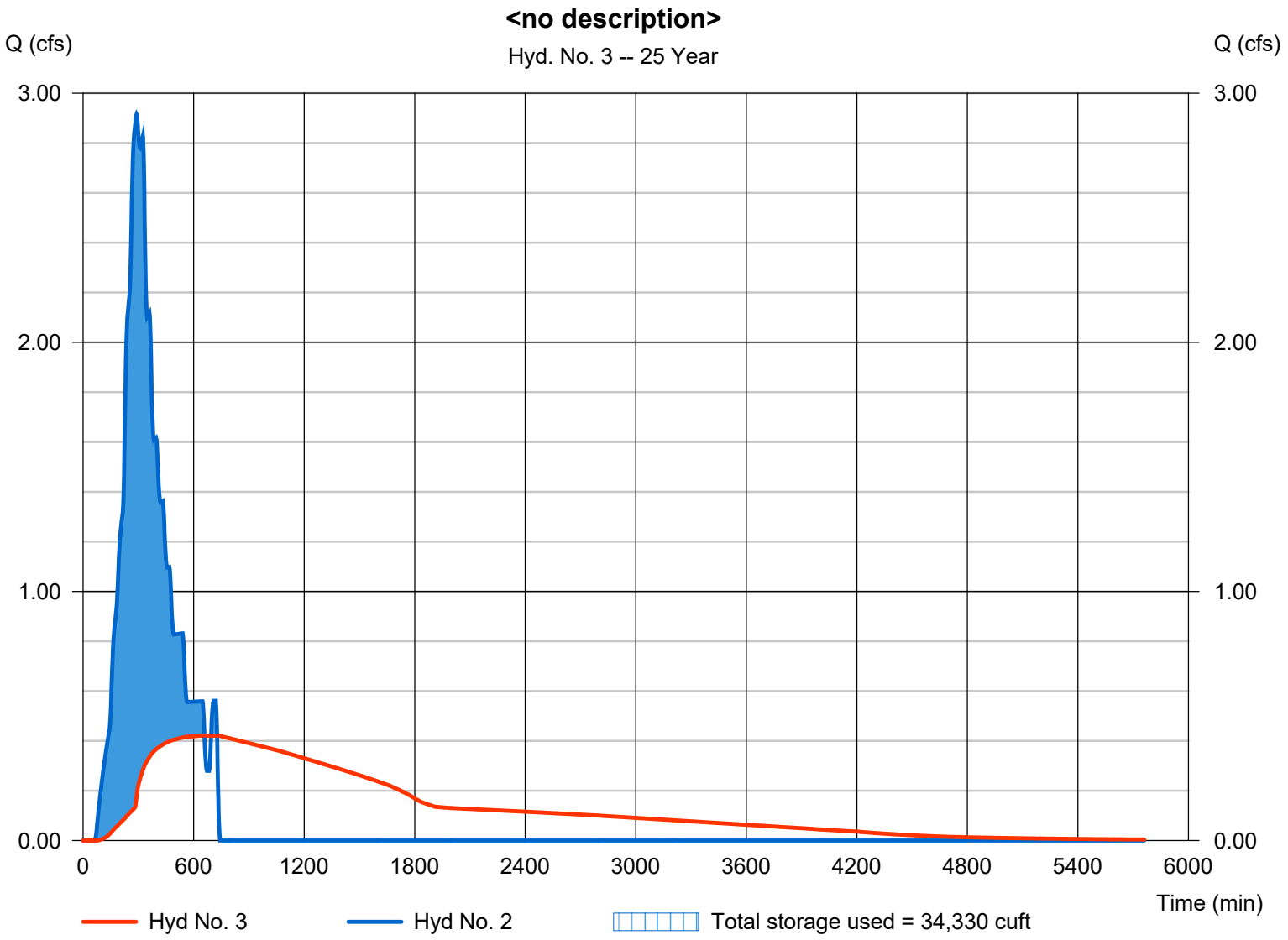
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.422 cfs
Storm frequency	=	25 yrs	Time to peak	=	658 min
Time interval	=	2 min	Hyd. volume	=	45,086 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	864.64 ft
Reservoir name	=	Basin 1	Max. Storage	=	34,330 cuft

Storage Indication method used.

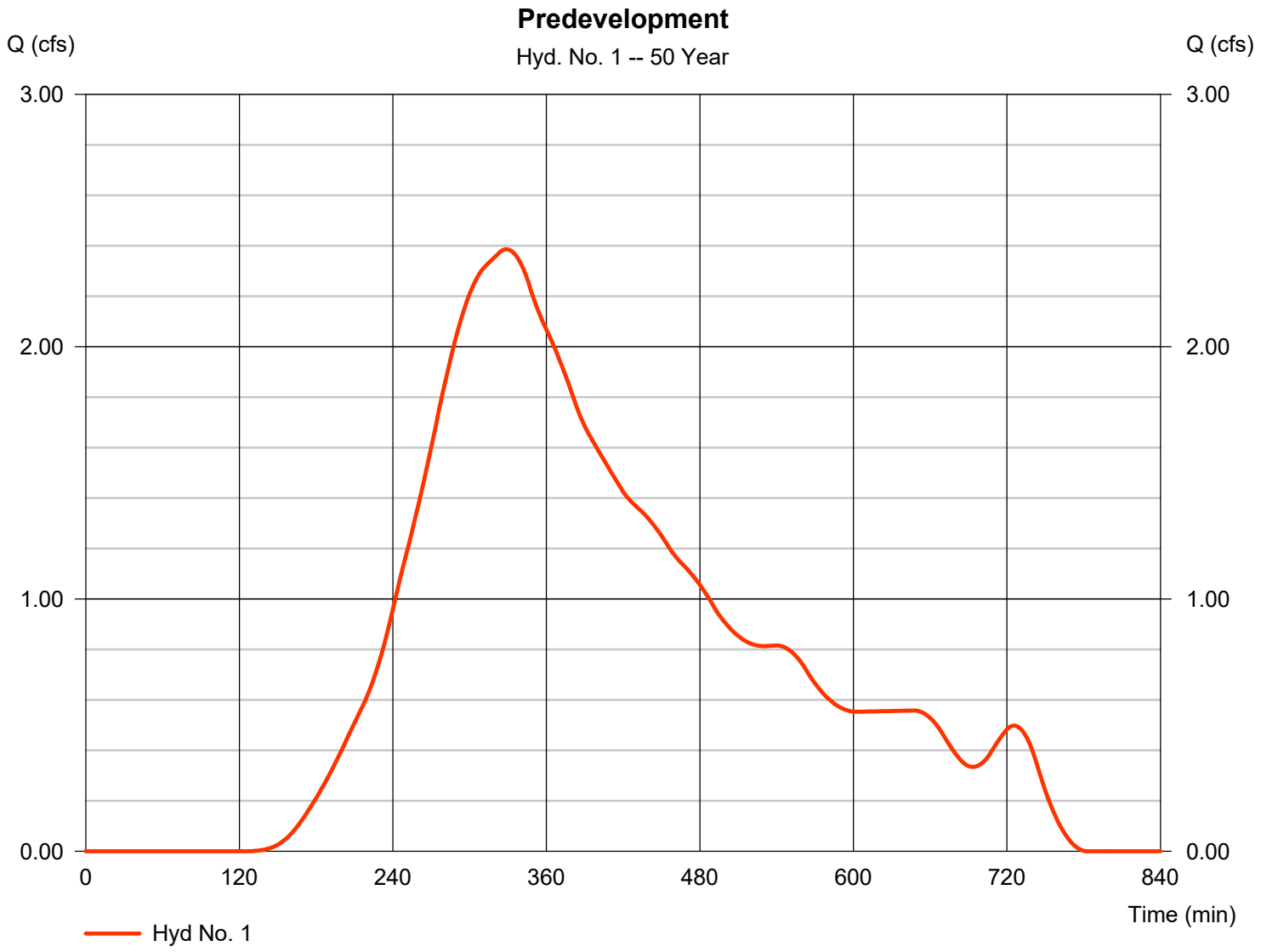


Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.386 cfs
Storm frequency	=	50 yrs	Time to peak	=	328 min
Time interval	=	2 min	Hyd. volume	=	36,766 cuft
Drainage area	=	4.720 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	39.90 min
Total precip.	=	4.42 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484



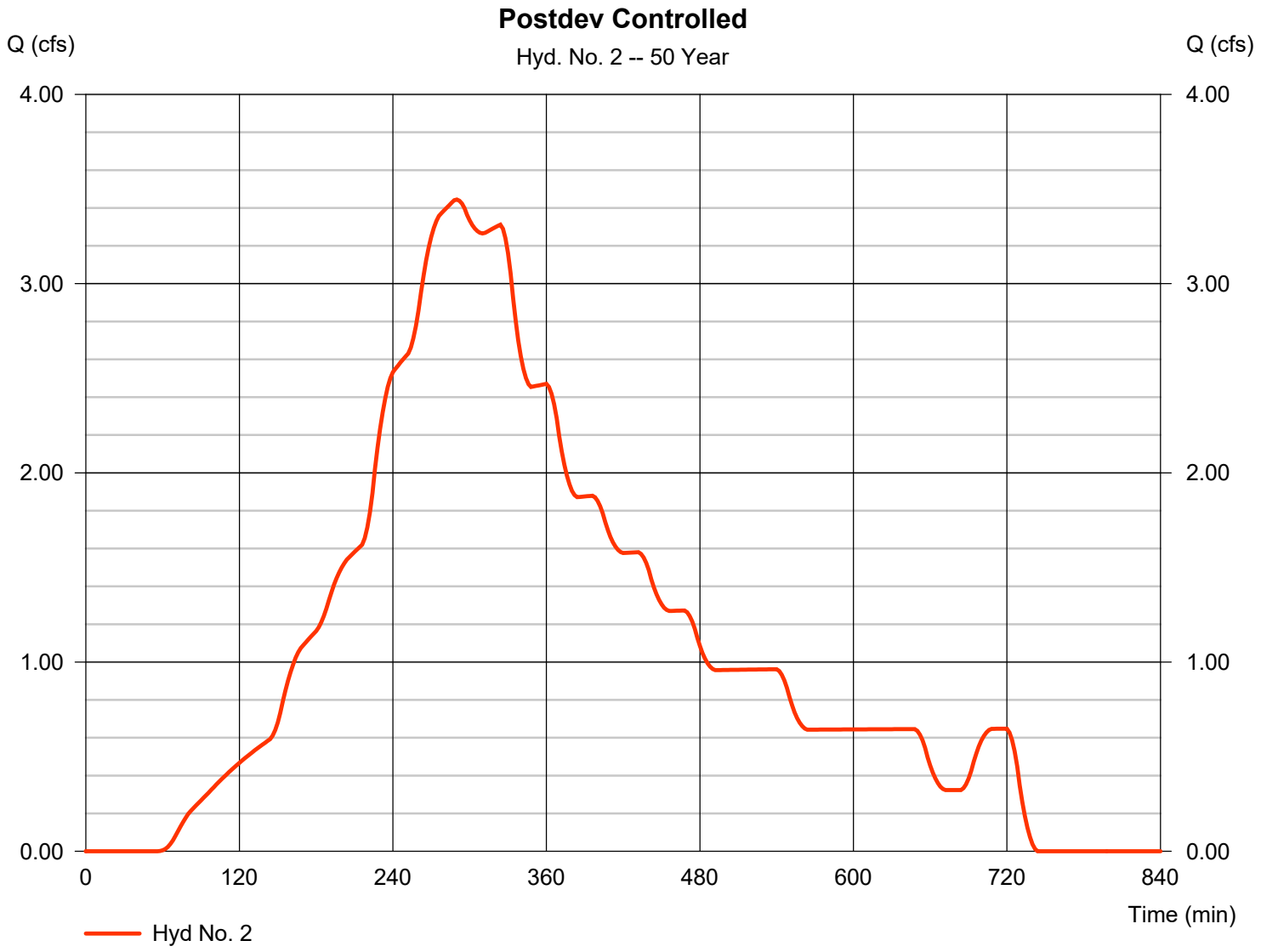
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.444 cfs
Storm frequency	=	50 yrs	Time to peak	=	290 min
Time interval	=	2 min	Hyd. volume	=	53,779 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	4.42 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



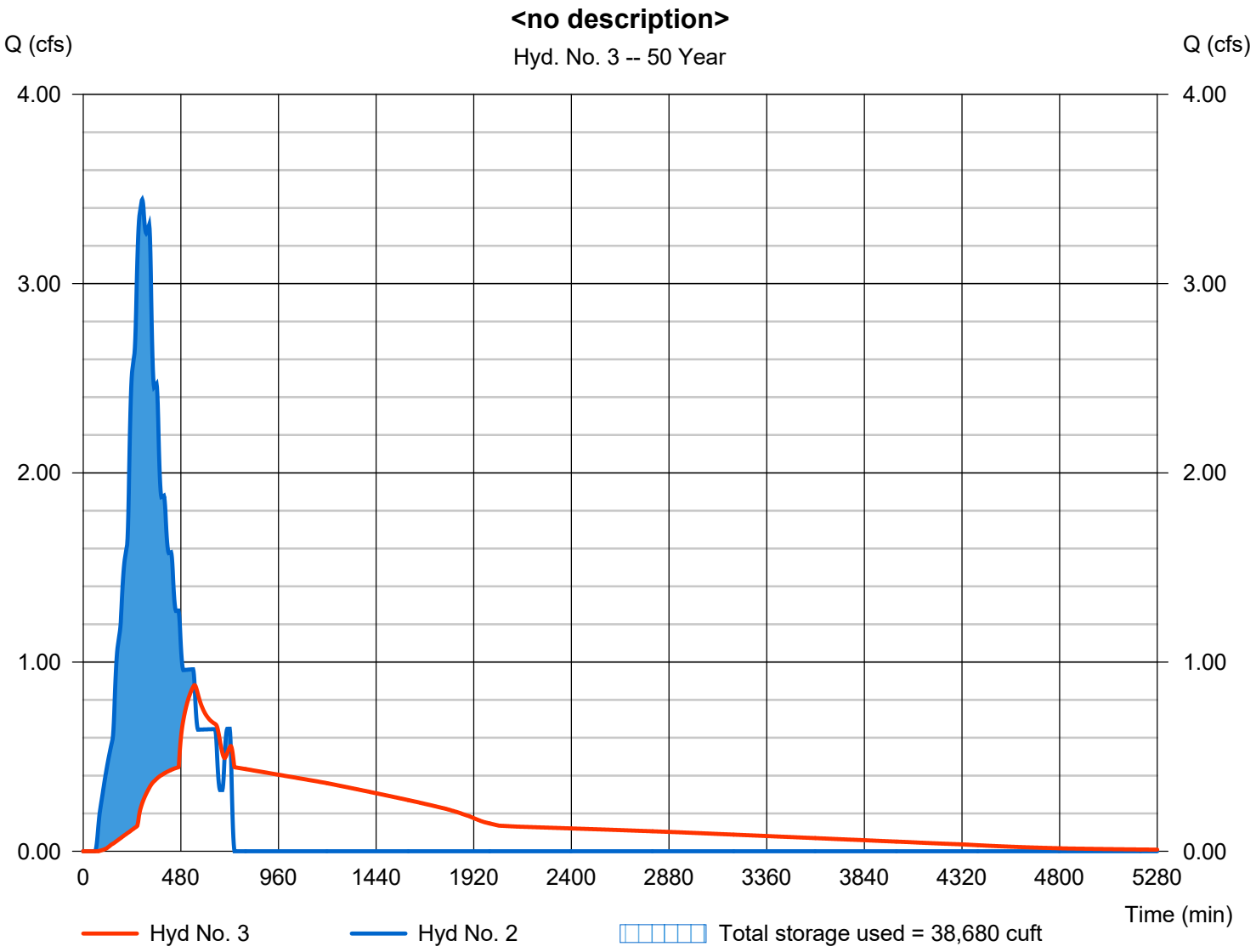
Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	0.878 cfs
Storm frequency	=	50 yrs	Time to peak	=	548 min
Time interval	=	2 min	Hyd. volume	=	53,548 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	865.00 ft
Reservoir name	=	Basin 1	Max. Storage	=	38,680 cuft

Storage Indication method used.



Hydrograph Report

Hyd. No. 1

Predevelopment

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.905 cfs
Storm frequency	=	100 yrs	Time to peak	=	328 min
Time interval	=	2 min	Hyd. volume	=	44,941 cuft
Drainage area	=	4.720 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	39.90 min
Total precip.	=	5.00 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

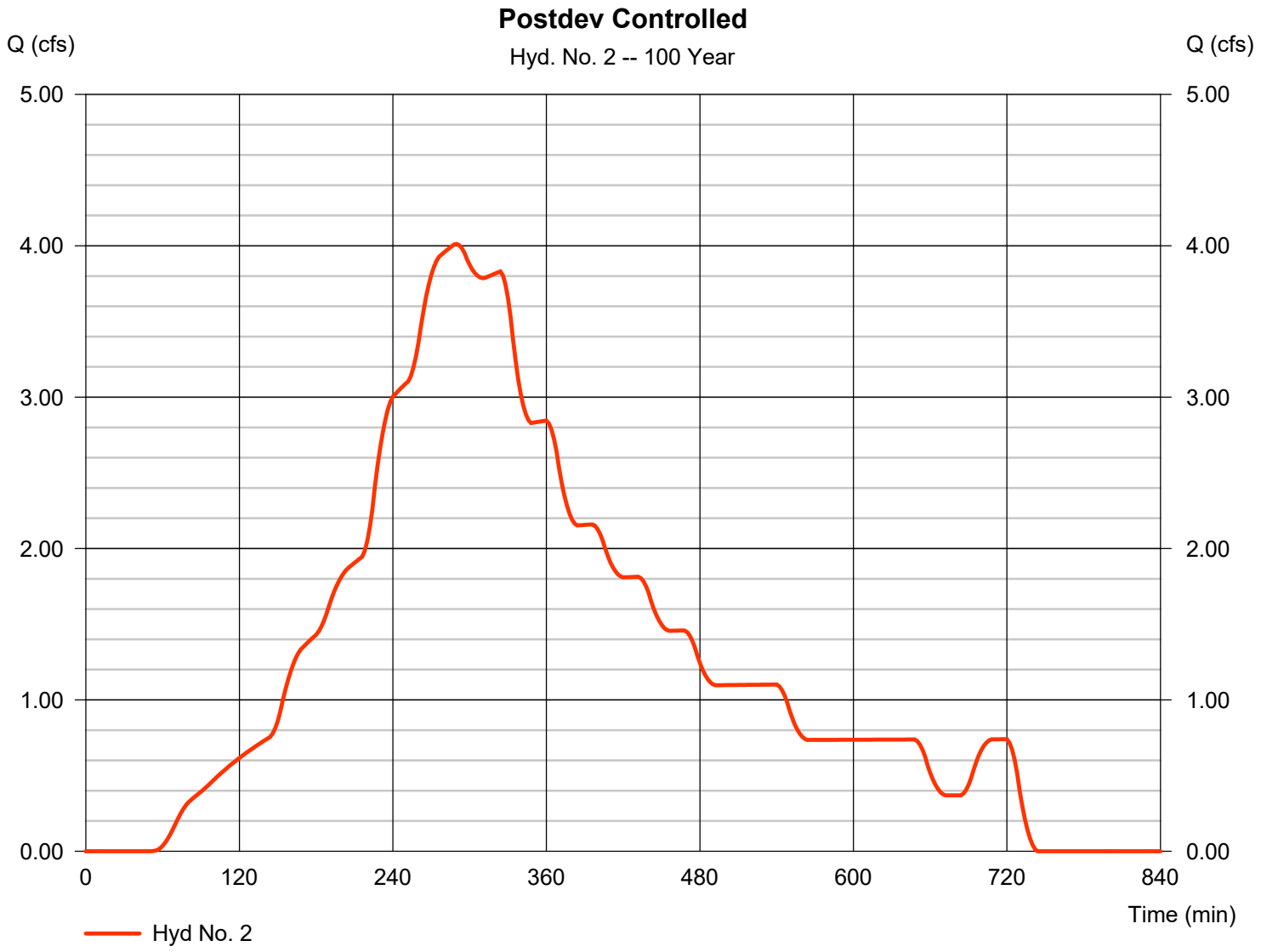
Hydrograph Report

Hyd. No. 2

Postdev Controlled

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.011 cfs
Storm frequency	=	100 yrs	Time to peak	=	290 min
Time interval	=	2 min	Hyd. volume	=	63,011 cuft
Drainage area	=	4.720 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	5.00 in	Distribution	=	Huff-2nd
Storm duration	=	12.00 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.350 x 98) + (2.370 x 80)] / 4.720



Hydrograph Report

Hyd. No. 3

<no description>

Hydrograph type	=	Reservoir	Peak discharge	=	1.789 cfs
Storm frequency	=	100 yrs	Time to peak	=	436 min
Time interval	=	2 min	Hyd. volume	=	62,779 cuft
Inflow hyd. No.	=	2 - Postdev Controlled	Max. Elevation	=	865.05 ft
Reservoir name	=	Basin 1	Max. Storage	=	39,445 cuft

Storage Indication method used.