

STORMWATER MANAGEMENT
CALCULATIONS

Vertex Rail and Site Improvements
Phase 1 – NCSPA Permit

Wilmington, North Carolina

September 2015



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Engineering
Land Planning
Surveying

DED

9/28/2015

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INFILTRATION BASIN #1 CALCULATIONS

Basin is Interim Design until future build-out of site

Total Area = 125,719 SF
Pervious Area = 96,979 SF > % IMP = 22.86%
Impervious Area = 28,740 SF

Determine the storage volume required to hold the first 3.75 inch of runoff.

Schueler's Method:

$$X = 0.05 + 0.009 (\% \text{ IMP})$$

$$= 0.256$$

Volume Calculations to meet the 2.5 times 1.5" NCDENR Requirement to waive the Offline Bypass and Vegetated Filter Strip.

$$\text{Volume} = (3.75"/12) \times \text{Total Area} \times X$$

$$= 10,047 \text{ CF}$$

Volume Calculations to calculate the ac-in during the first 1.5" of rainfall

$$\text{Volume} = (1.5"/12) \times \text{Total Area} \times X$$

$$= 4,019 \text{ CF}$$

$$\text{Volume} = (\text{ft}^2\text{-ft}) \times (12"/\text{ft}) \times (\text{ac}/43560 \text{ ft}^2) = \text{ac-in}$$

$$= 1.11 \text{ ac-in}$$

Determine the storage volume provided.

Contour Elevation (FMSL)	Area* (SF)	Volume (CF)	
38.00	2750	0	
39.00	4339	3514	
40.00	6141	8728	<<<<<< 1.5" Runoff Storage @ 39.10
40.50	7057	12025	<<<<<< 3.75" Runoff Storage @ 40.40; 6,510 SF Surface Area

* Volume computed using Conic method

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Determine time required for stored runoff to fully infiltrate.

Darcy's Law:

$$Q = kA_{\text{bottom}}(h/L)$$

where: k = (from soils report)= 30.0 in/hr
 A = bottom area of infiltration basin = 2,750 sf
 L = bottom elev. - SHWT elev. = 3.00
 h = water surface elev. (varies)
 SHWT = 35.00

Contour Elevation (FMSL)	Area (SF)	Incremental Storage (CF)	Infiltration Rate, Q (CFS)	Release Time (HRS)
40.50	7057	3297	3.34	0.274
40.00	6141	5214	2.86	0.506
39.00	4339	3514	2.23	0.438
38.00	2750			

* Volume computed using Conic method

Total Drawdown Time = 1.22 Hours = 0.05 Days

Determine time required for stored runoff to fully infiltrate at half the soils infiltration rate.

Darcy's Law:

$$Q = kA_{\text{bottom}}(h/L)$$

where: k = (from soils report)= 15.0 in/hr
 A = bottom area of infiltration basin = 2,750 sf
 L = bottom elev. - SHWT elev. = 3.00
 h = water surface elev. (varies)
 SHWT = 35.00

Contour Elevation (FMSL)	Area (SF)	Incremental Storage (CF)	Infiltration Rate, Q (CFS)	Release Time (HRS)
40.50	7057	3297	1.67	0.548
40.00	6141	5214	1.43	1.011
39.00	4339	3514	1.11	0.876
38.00	2750			

* Volume computed using Conic method

Total Drawdown Time = 2.44 Hours = 0.10 Days

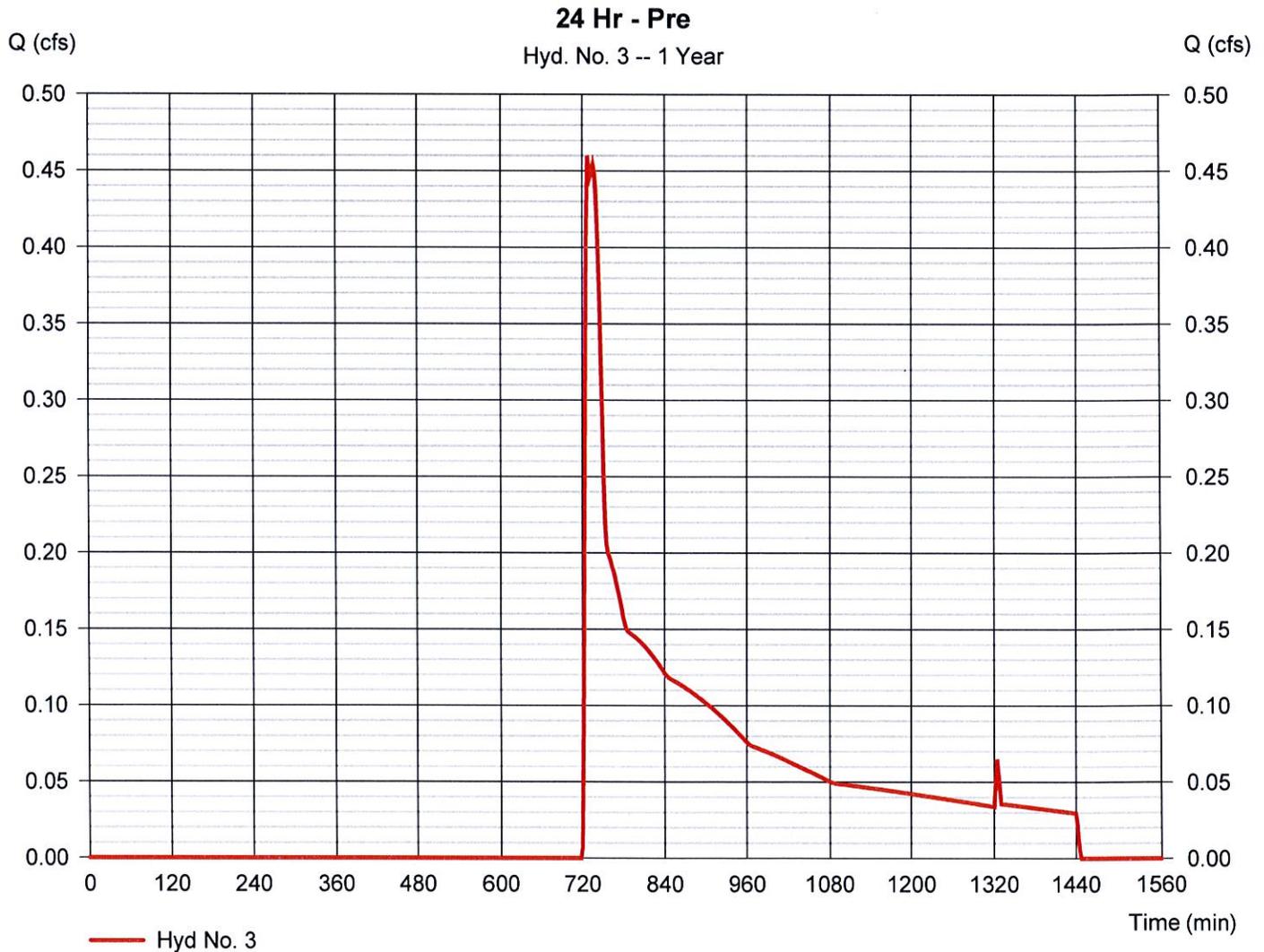
Hydrograph Report

Hyd. No. 3

24 Hr - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 0.460 cfs
Storm frequency	= 1 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 3,544 cuft
Drainage area	= 2.890 ac	Curve number	= 52*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.86 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.190 x 76) + (1.070 x 68) + (1.630 x 39)] / 2.890



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

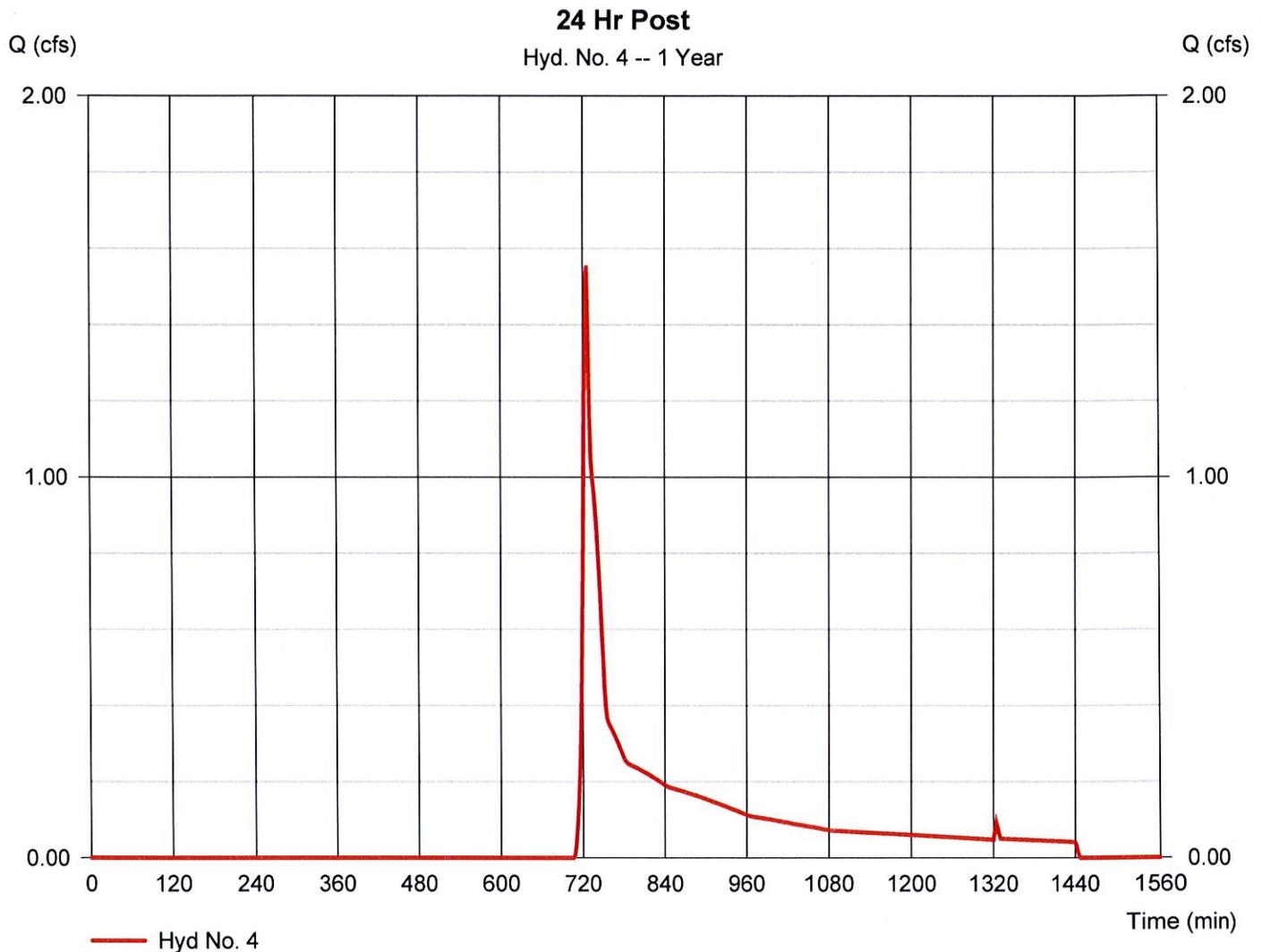
Monday, 09 / 28 / 2015

Hyd. No. 4

24 Hr Post

Hydrograph type	= SCS Runoff	Peak discharge	= 1.556 cfs
Storm frequency	= 1 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 6,371 cuft
Drainage area	= 2.890 ac	Curve number	= 59*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.86 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.080 x 39) + (0.660 x 76) + (1.150 x 68)] / 2.890



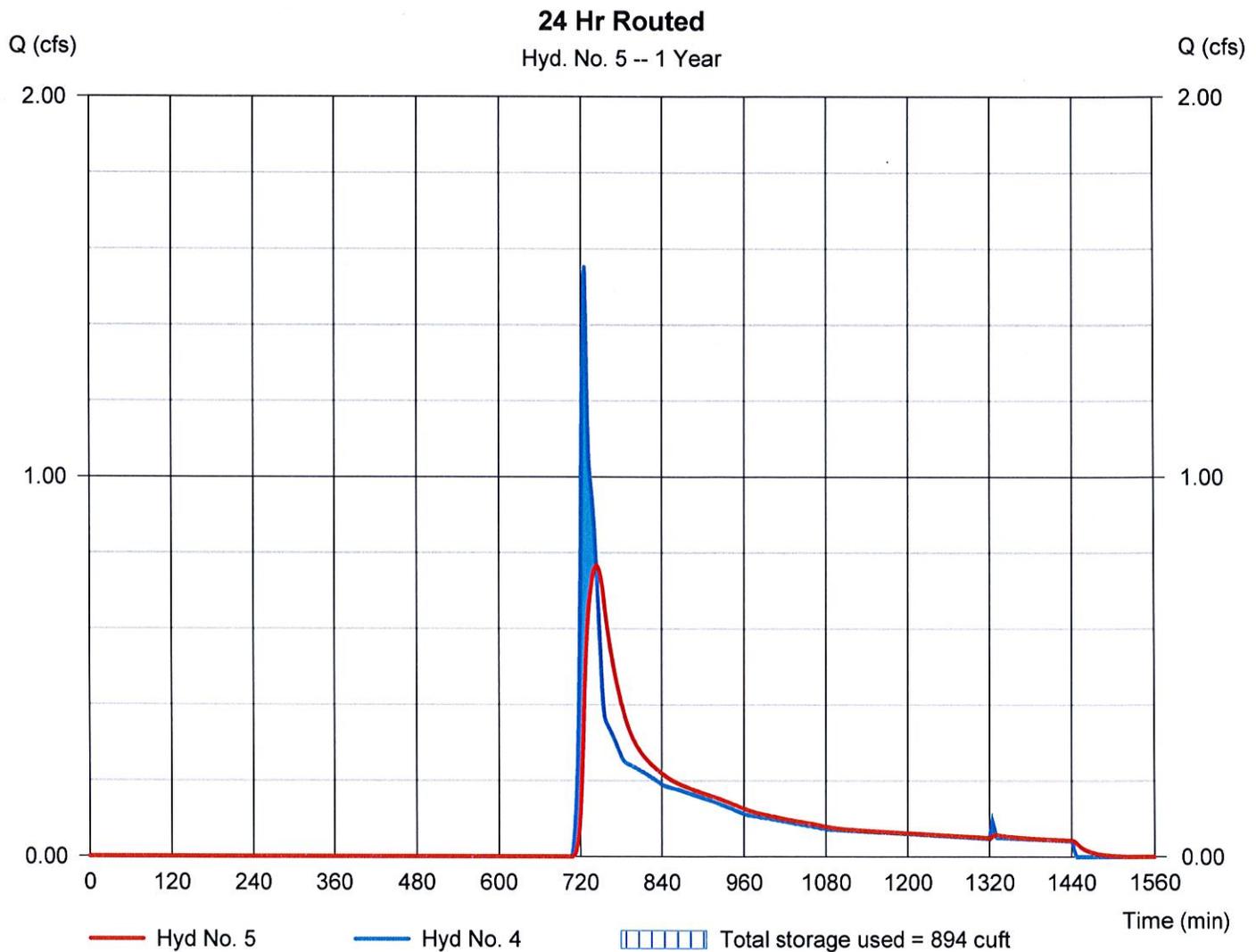
Hydrograph Report

Hyd. No. 5

24 Hr Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.766 cfs
Storm frequency	= 1 yrs	Time to peak	= 744 min
Time interval	= 2 min	Hyd. volume	= 6,370 cuft
Inflow hyd. No.	= 4 - 24 Hr Post	Max. Elevation	= 38.25 ft
Reservoir name	= Infiltration Basin #1 - 30 in/hr	Max. Storage	= 894 cuft

Storage Indication method used. Outflow includes exfiltration.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

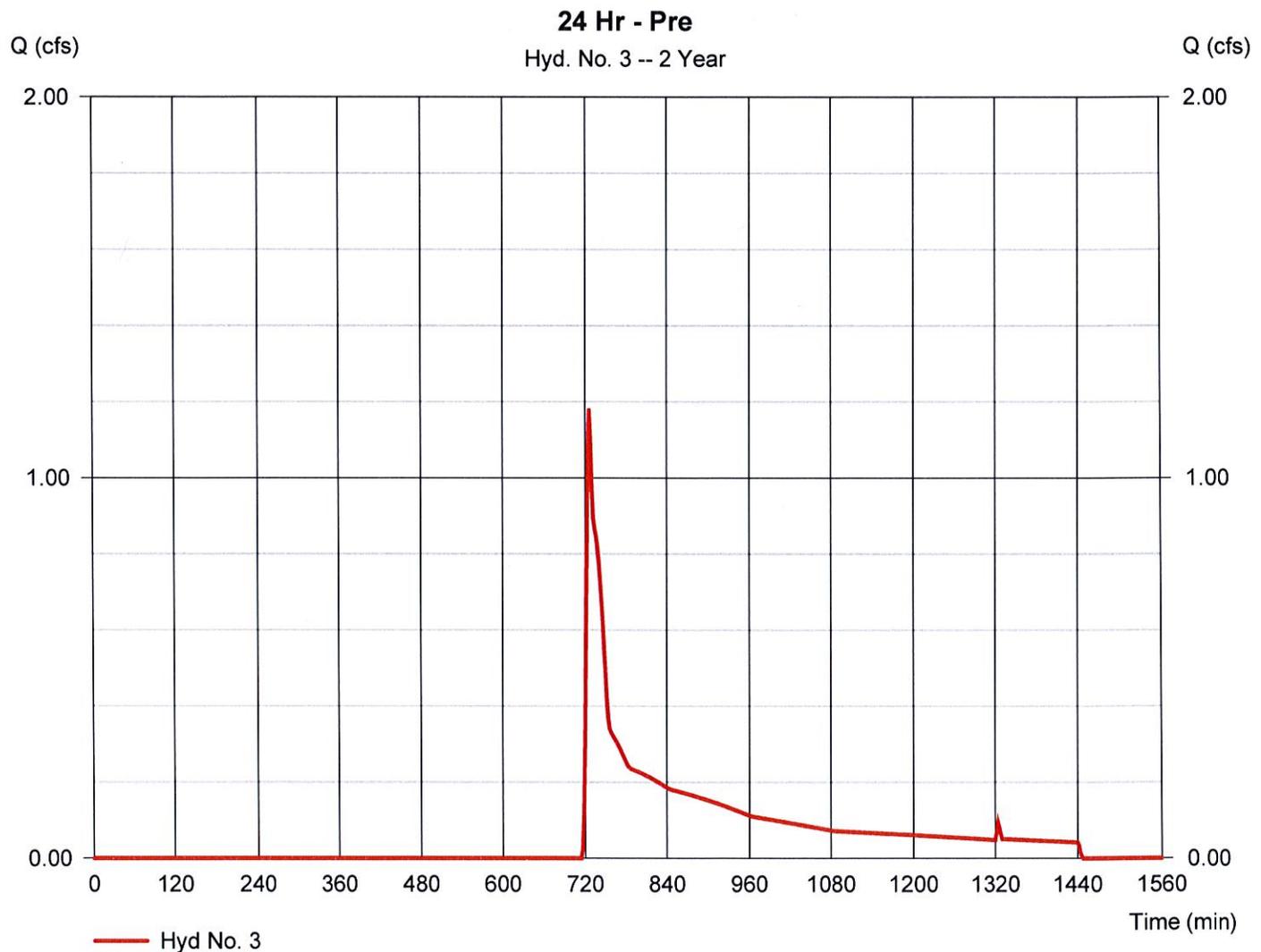
Monday, 09 / 28 / 2015

Hyd. No. 3

24 Hr - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 1.183 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 5,828 cuft
Drainage area	= 2.890 ac	Curve number	= 52*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.190 x 76) + (1.070 x 68) + (1.630 x 39)] / 2.890



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

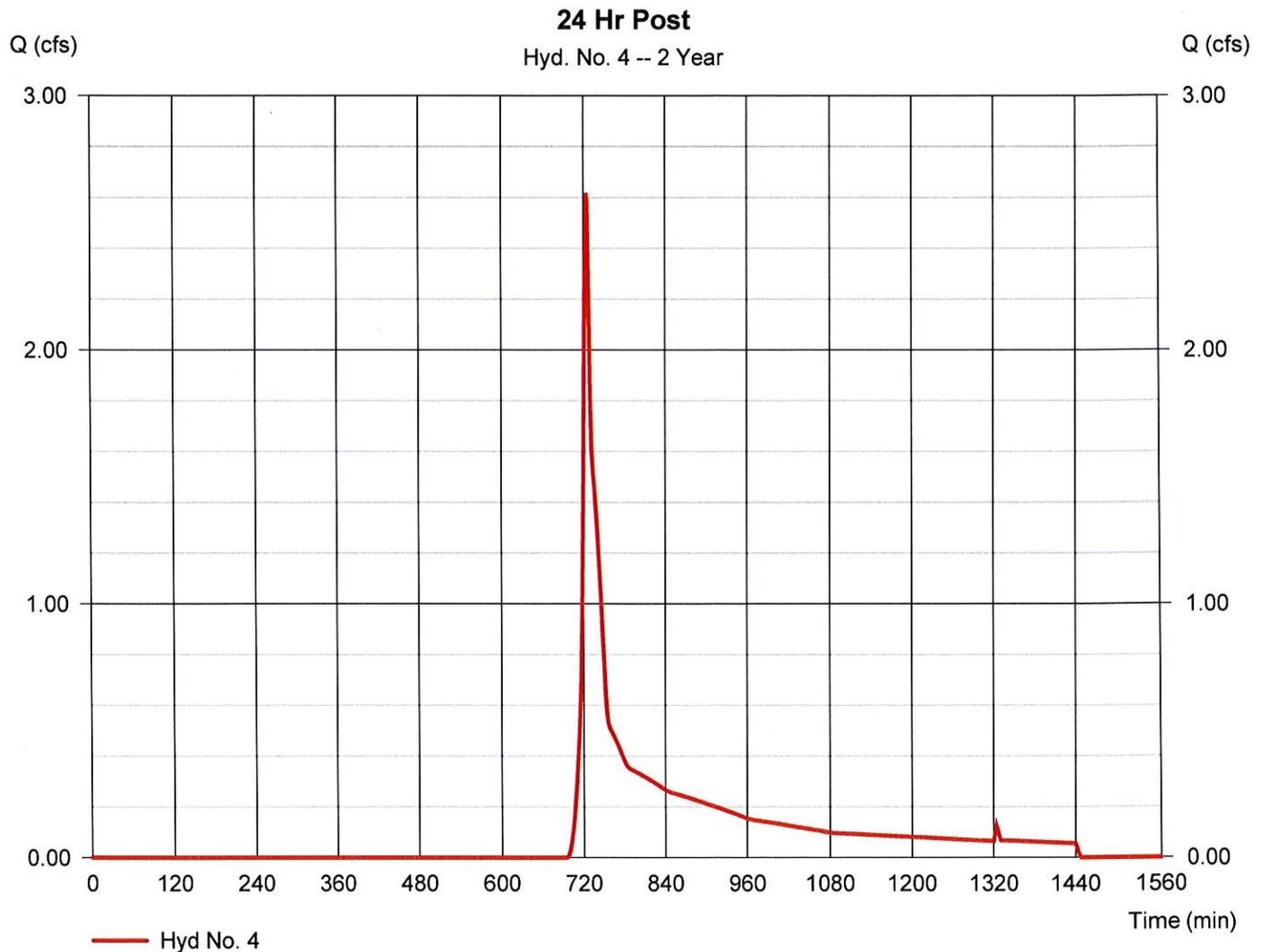
Monday, 09 / 28 / 2015

Hyd. No. 4

24 Hr Post

Hydrograph type	= SCS Runoff	Peak discharge	= 2.618 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 9,457 cuft
Drainage area	= 2.890 ac	Curve number	= 59*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.080 \times 39) + (0.660 \times 76) + (1.150 \times 68)] / 2.890$



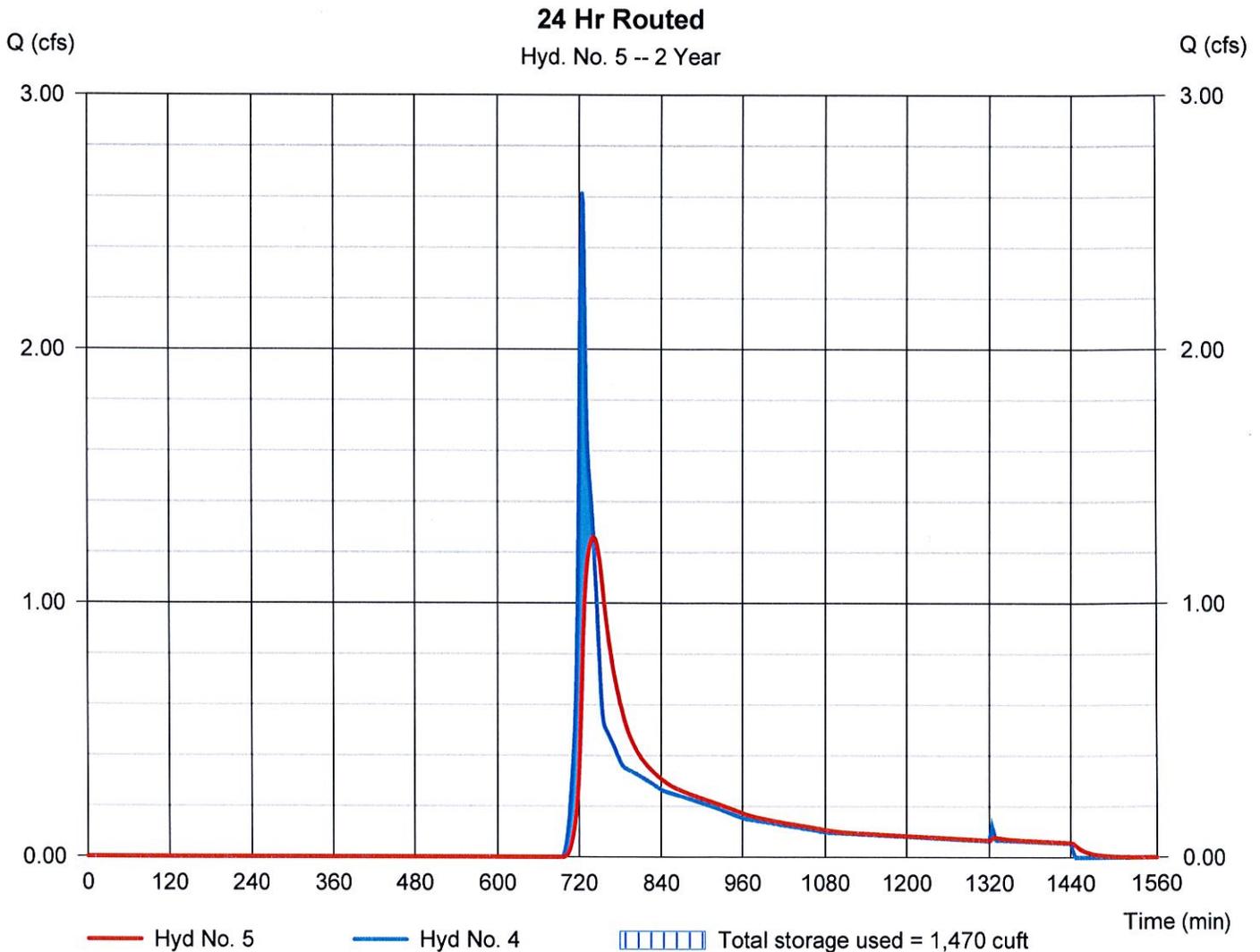
Hydrograph Report

Hyd. No. 5

24 Hr Routed

Hydrograph type	= Reservoir	Peak discharge	= 1.260 cfs
Storm frequency	= 2 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 9,456 cuft
Inflow hyd. No.	= 4 - 24 Hr Post	Max. Elevation	= 38.42 ft
Reservoir name	= Infiltration Basin #1 - 30 in/hr	Max. Storage	= 1,470 cuft

Storage Indication method used. Outflow includes exfiltration.



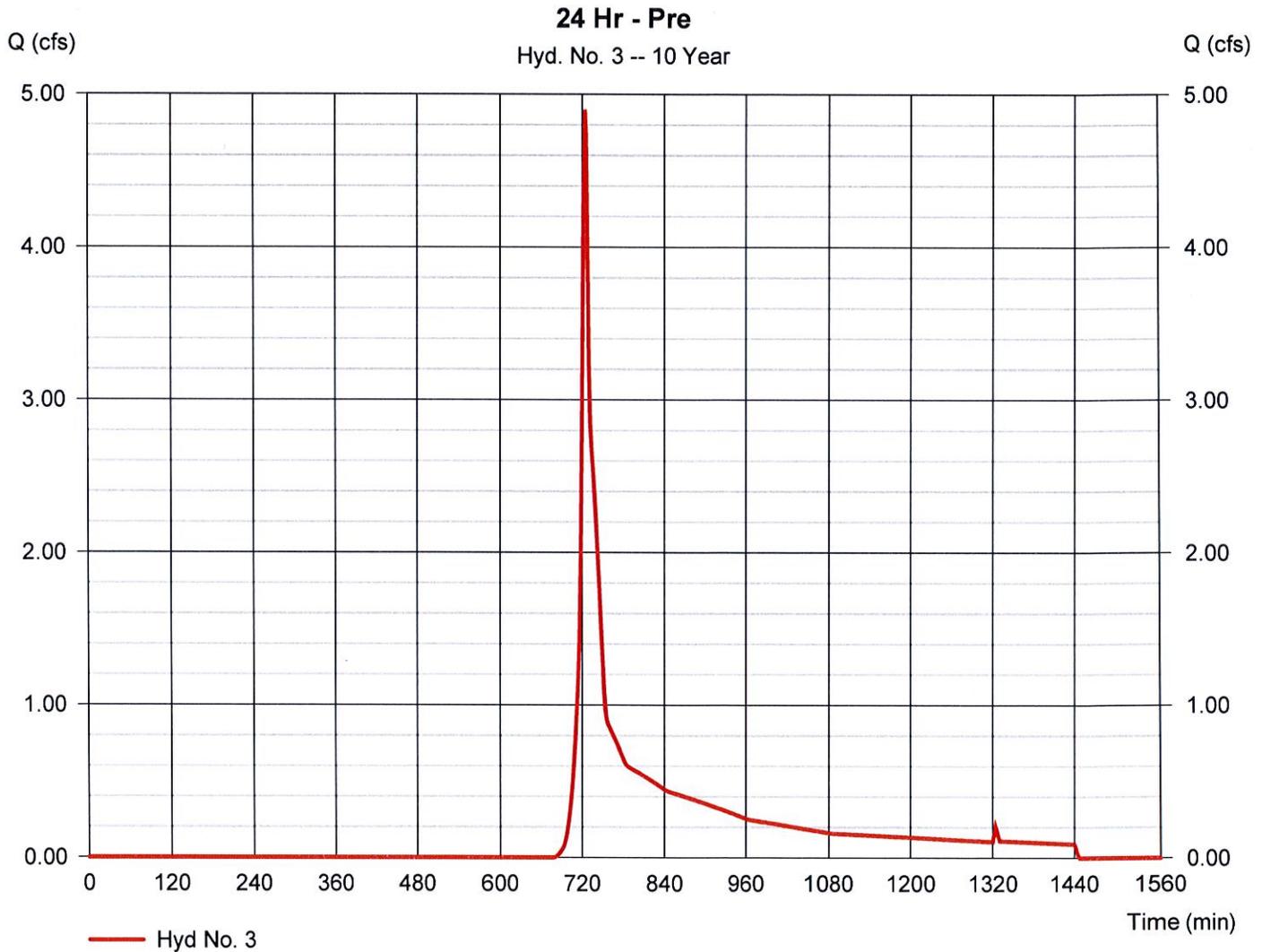
Hydrograph Report

Hyd. No. 3

24 Hr - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 4.900 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 16,564 cuft
Drainage area	= 2.890 ac	Curve number	= 52*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.72 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.190 x 76) + (1.070 x 68) + (1.630 x 39)] / 2.890



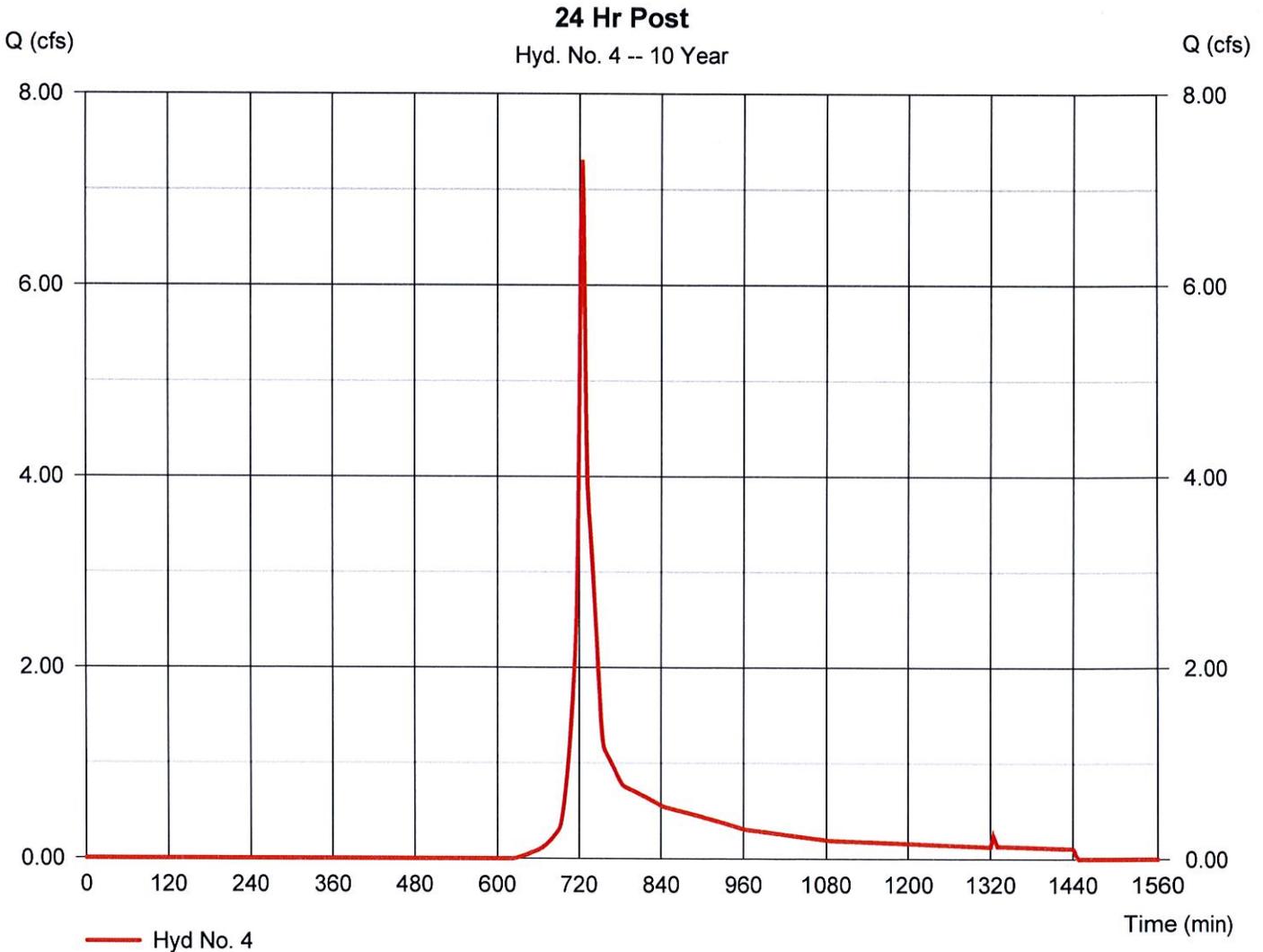
Hydrograph Report

Hyd. No. 4

24 Hr Post

Hydrograph type	= SCS Runoff	Peak discharge	= 7.310 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 22,755 cuft
Drainage area	= 2.890 ac	Curve number	= 59*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.72 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.080 x 39) + (0.660 x 76) + (1.150 x 68)] / 2.890



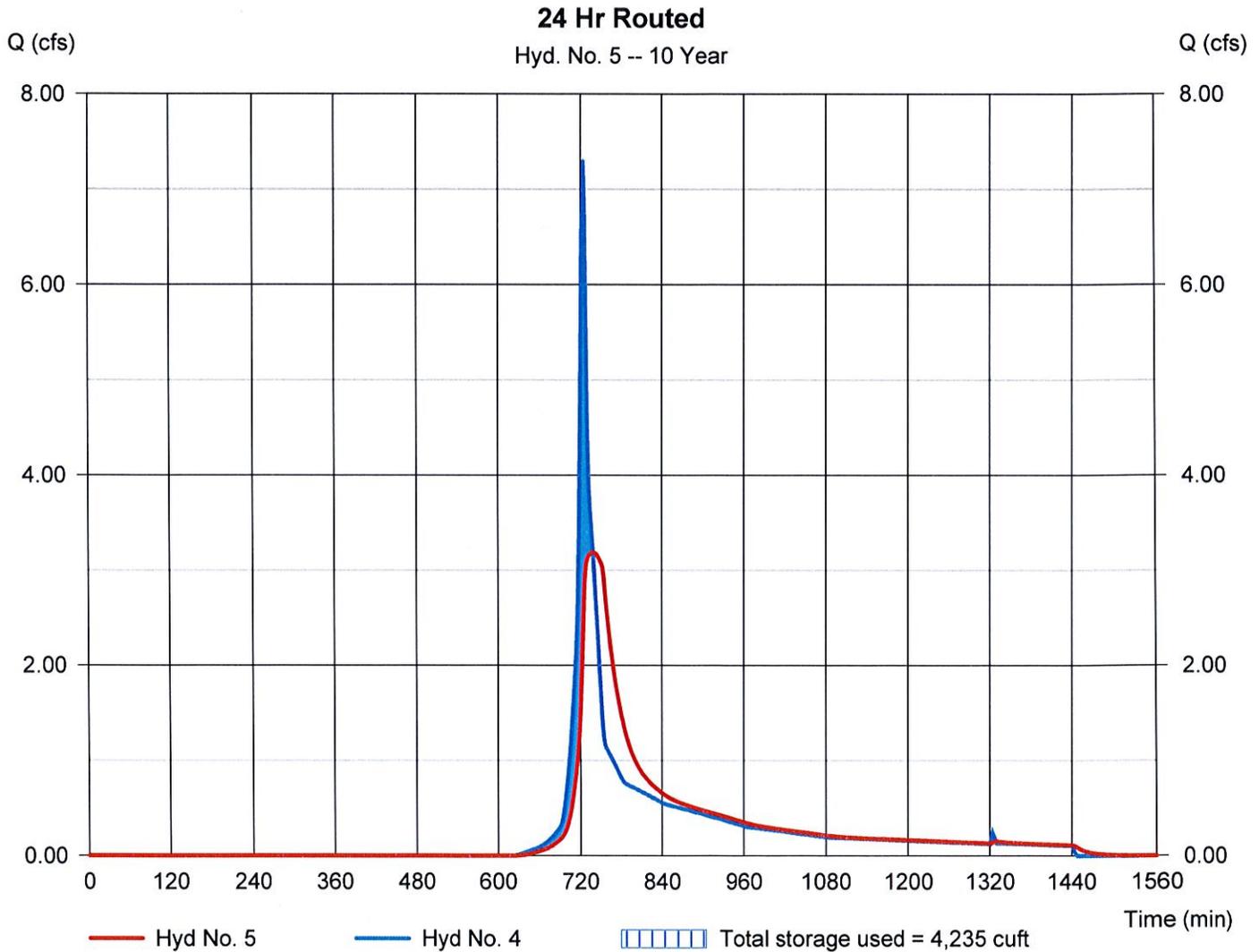
Hydrograph Report

Hyd. No. 5

24 Hr Routed

Hydrograph type	= Reservoir	Peak discharge	= 3.186 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 22,754 cuft
Inflow hyd. No.	= 4 - 24 Hr Post	Max. Elevation	= 39.14 ft
Reservoir name	= Infiltration Basin #1 - 30 in/hr	Max. Storage	= 4,235 cuft

Storage Indication method used. Outflow includes exfiltration.



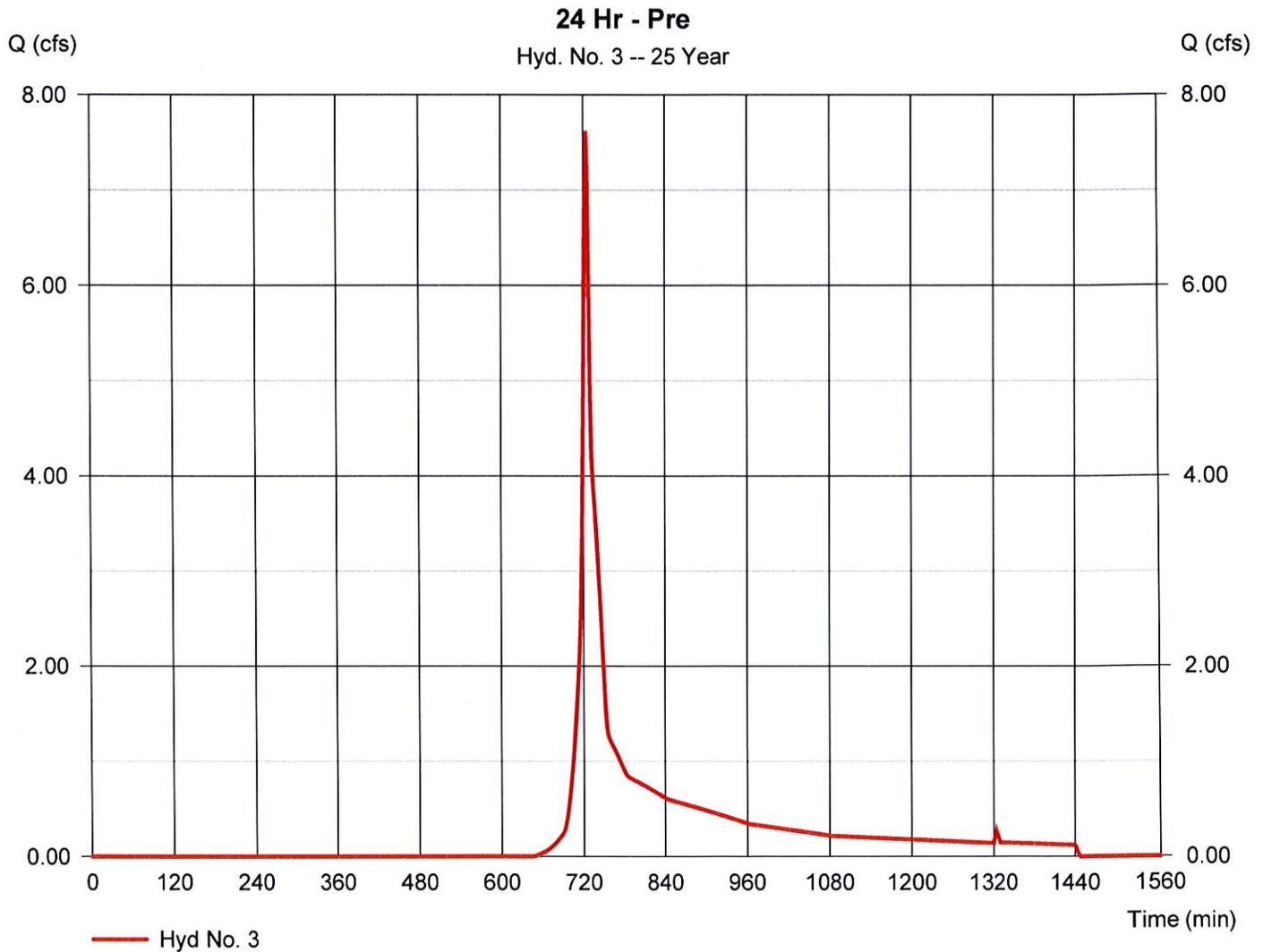
Hydrograph Report

Hyd. No. 3

24 Hr - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 7.622 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 24,272 cuft
Drainage area	= 2.890 ac	Curve number	= 52*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.01 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.190 x 76) + (1.070 x 68) + (1.630 x 39)] / 2.890



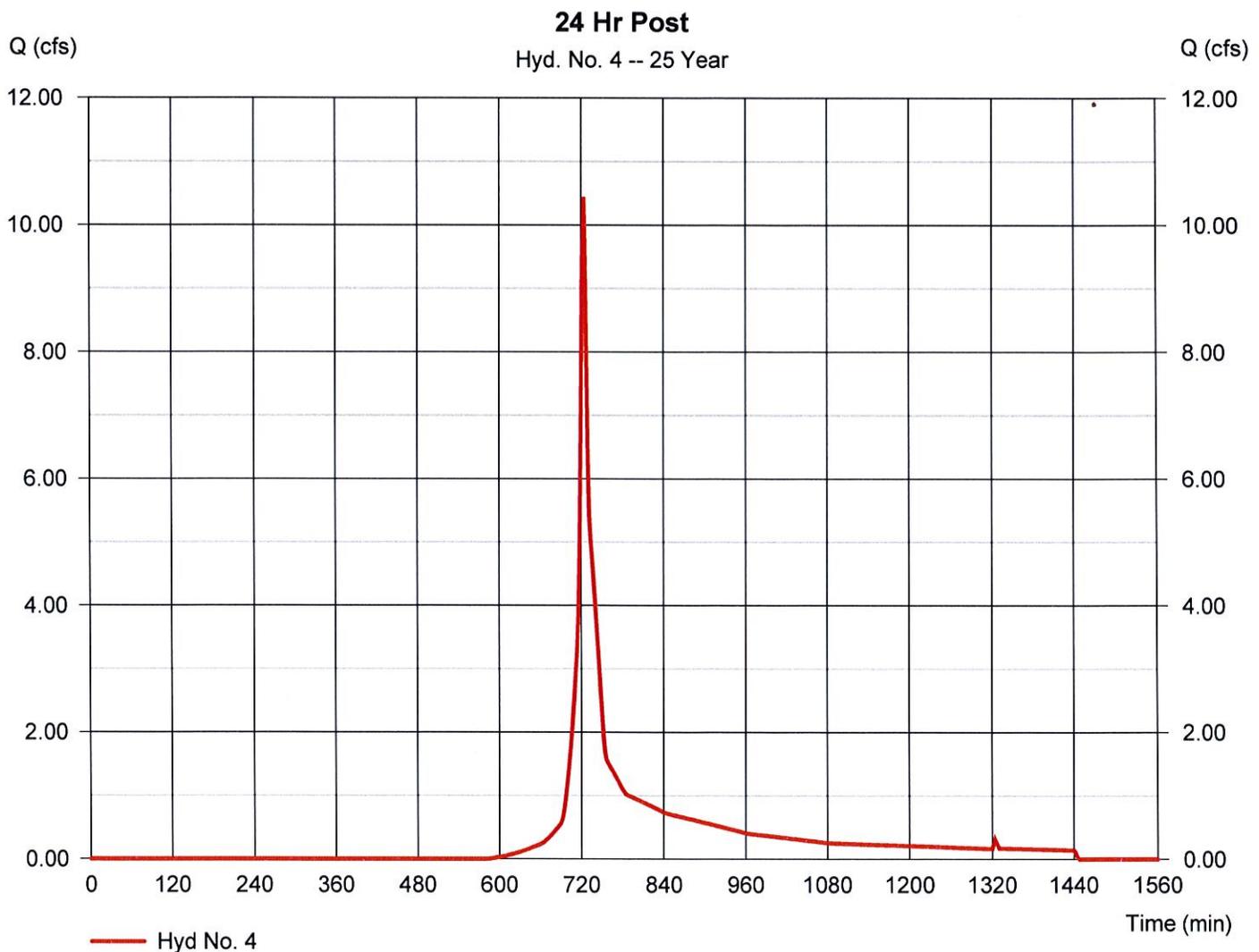
Hydrograph Report

Hyd. No. 4

24 Hr Post

Hydrograph type	= SCS Runoff	Peak discharge	= 10.44 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 31,766 cuft
Drainage area	= 2.890 ac	Curve number	= 59*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.01 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.080 \times 39) + (0.660 \times 76) + (1.150 \times 68)] / 2.890$



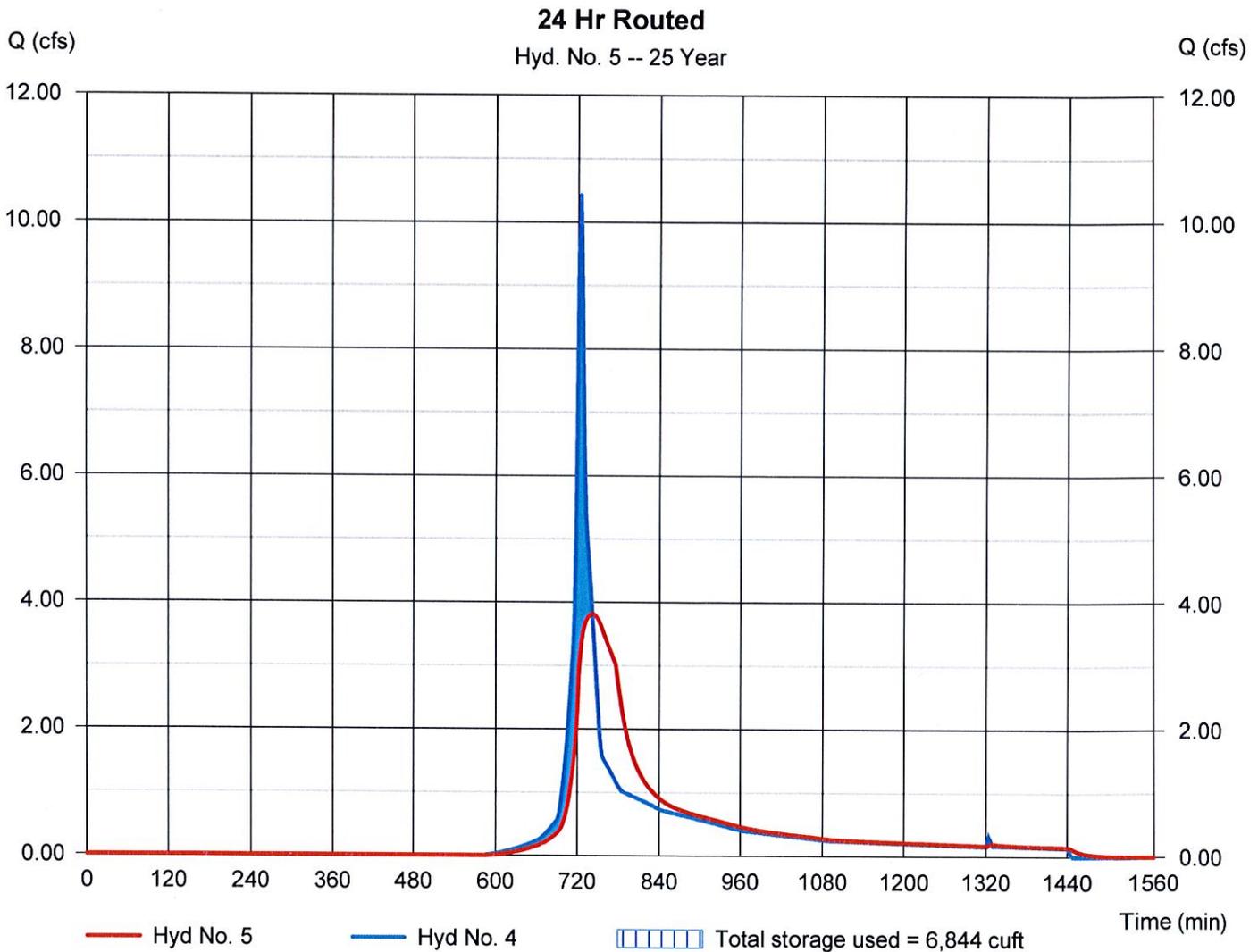
Hydrograph Report

Hyd. No. 5

24 Hr Routed

Hydrograph type	= Reservoir	Peak discharge	= 3.813 cfs
Storm frequency	= 25 yrs	Time to peak	= 742 min
Time interval	= 2 min	Hyd. volume	= 31,764 cuft
Inflow hyd. No.	= 4 - 24 Hr Post	Max. Elevation	= 39.64 ft
Reservoir name	= Infiltration Basin #1 - 30 in/hr	Max. Storage	= 6,844 cuft

Storage Indication method used. Outflow includes exfiltration.



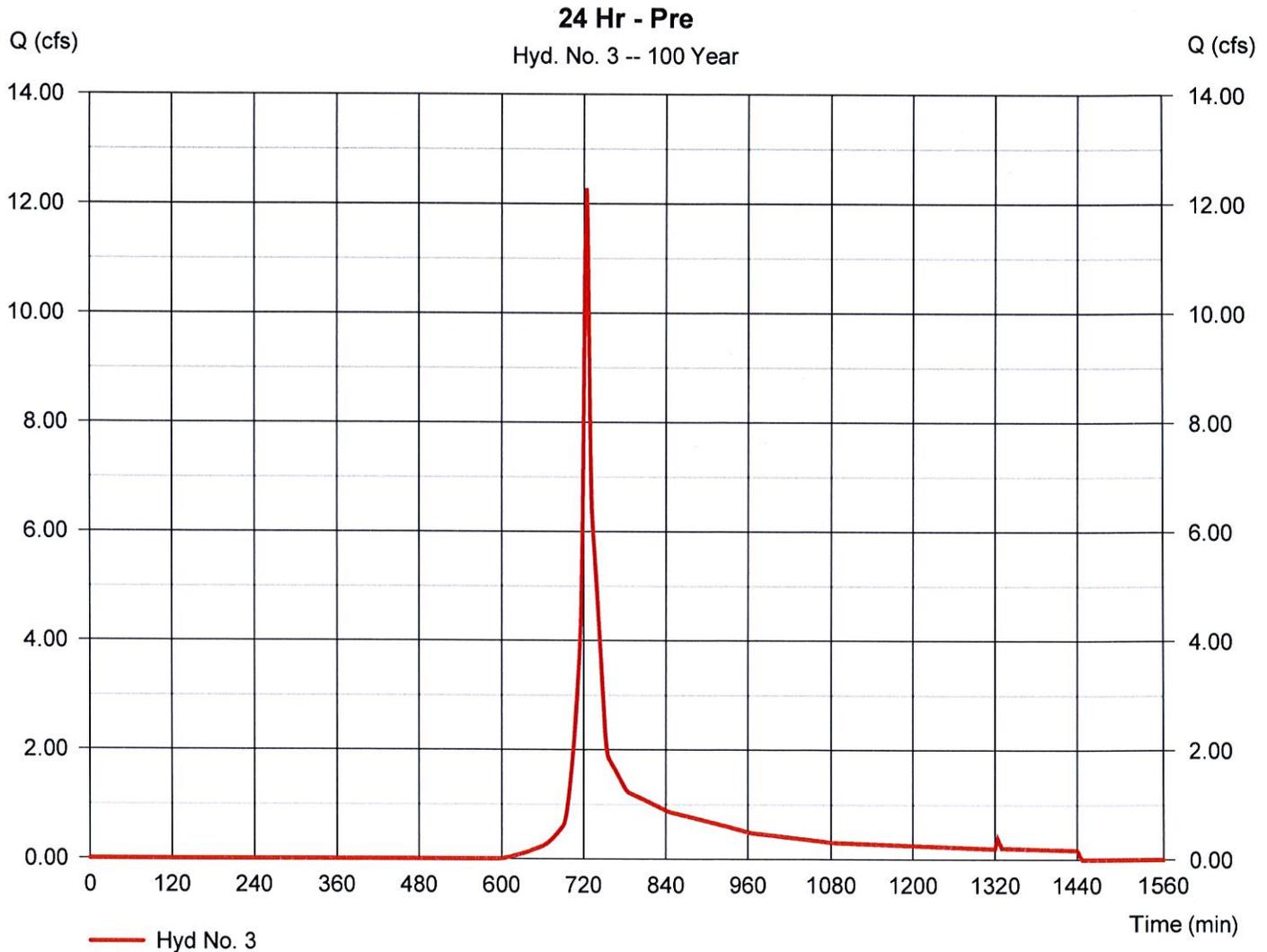
Hydrograph Report

Hyd. No. 3

24 Hr - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 12.28 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 37,613 cuft
Drainage area	= 2.890 ac	Curve number	= 52*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.190 x 76) + (1.070 x 68) + (1.630 x 39)] / 2.890



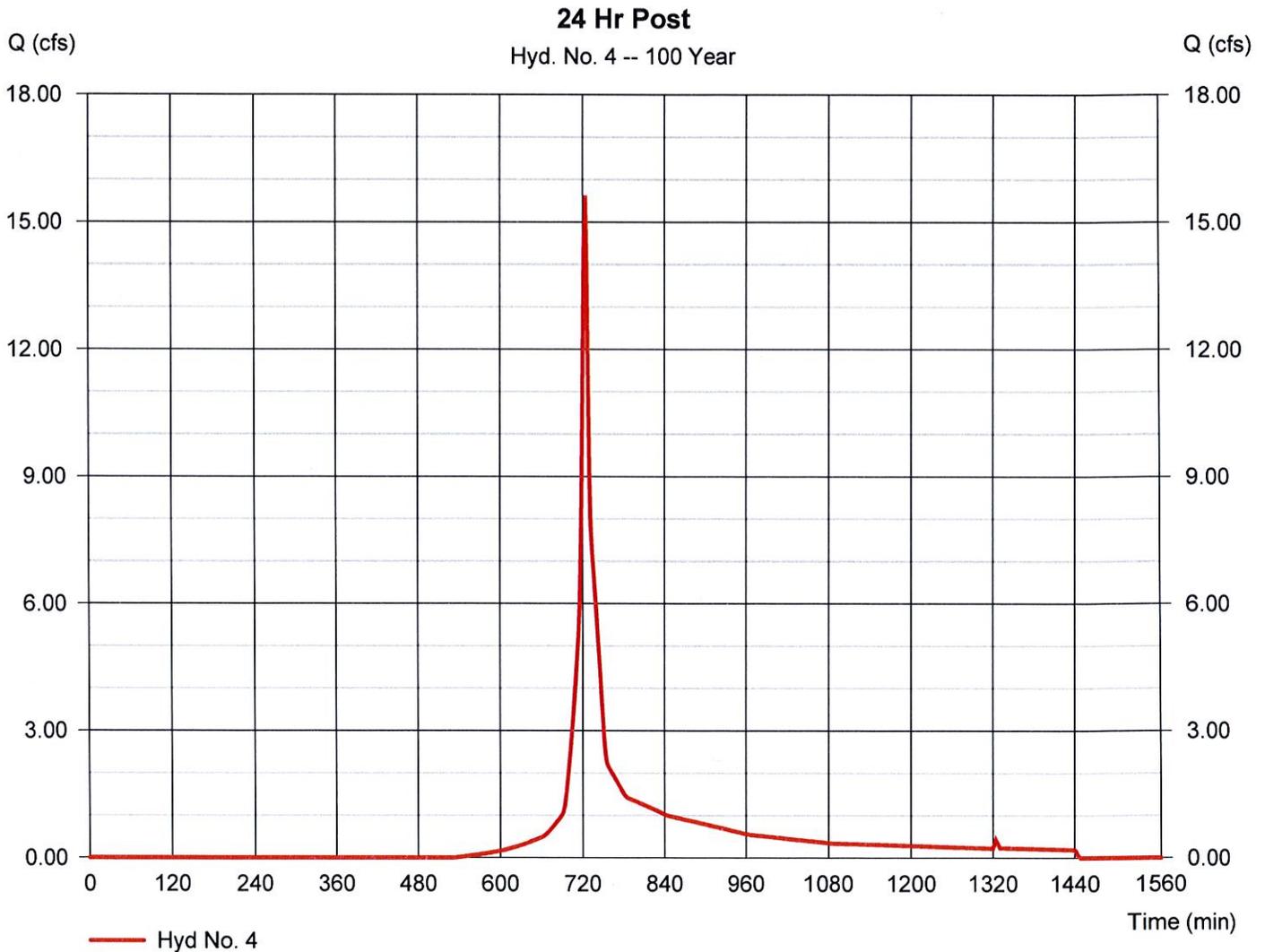
Hydrograph Report

Hyd. No. 4

24 Hr Post

Hydrograph type	= SCS Runoff	Peak discharge	= 15.63 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 46,861 cuft
Drainage area	= 2.890 ac	Curve number	= 59*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.080 x 39) + (0.660 x 76) + (1.150 x 68)] / 2.890



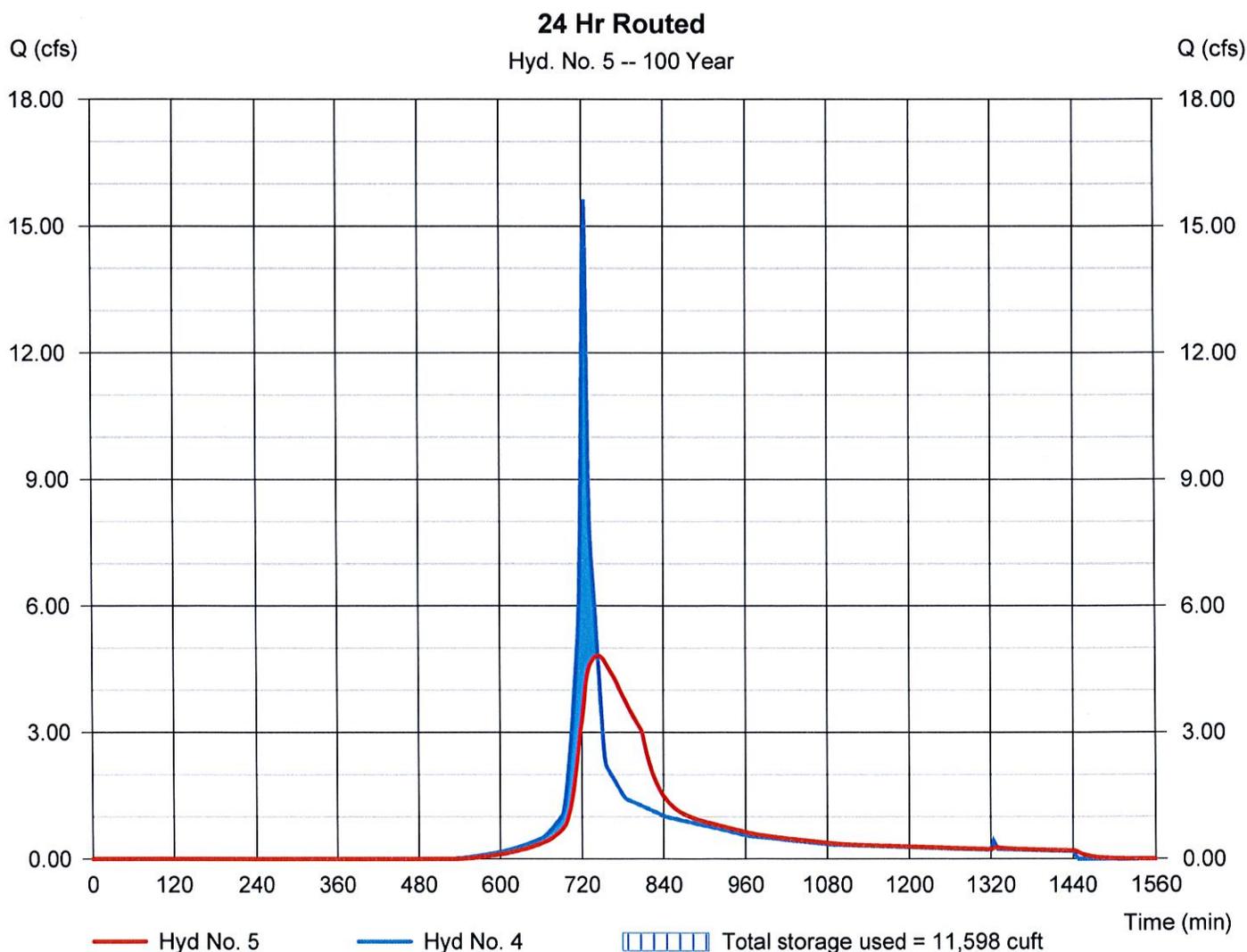
Hydrograph Report

Hyd. No. 5

24 Hr Routed

Hydrograph type	= Reservoir	Peak discharge	= 4.818 cfs
Storm frequency	= 100 yrs	Time to peak	= 744 min
Time interval	= 2 min	Hyd. volume	= 46,860 cuft
Inflow hyd. No.	= 4 - 24 Hr Post	Max. Elevation	= 40.44 ft
Reservoir name	= Infiltration Basin #1 - 30 in/hr	Max. Storage	= 11,598 cuft

Storage Indication method used. Outflow includes exfiltration.



Pond No. 1 - Infiltration Basin #1 - 30 in/hr

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 38.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	38.00	2,750	0	0
1.00	39.00	4,339	3,514	3,514
2.00	40.00	6,141	5,213	8,728
2.50	40.50	7,057	3,297	12,024

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	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	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 76.00	0.00	0.00	0.00
Crest El. (ft)	= 40.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 30.000 (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).

