CROCKETT
ENGINEERING CONSULTANTS

STORMWATER REPORT

FOR

STORAGE MART—156

3920 S. STATE ROUTE 291
LEE'S SUMMIT, MO

PROJECT NO. 170504

PREPARDED FOR:
NEW TKG-STORAGEMART PARTNERS PORTFOLIO, LLC
215 N. STADIUM BLVD., SUITE #207
COLUMBIA, MO 65203

ORIGINAL: AUGUST 19, 2019
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1000 W. Nifong Blvd., Bldg. 1 • Columbia, MO 65203
Phone: 573-447-0292
www.crockettengineering.com

CROCKETT
ENGINEERING CONSULTANTS
1000 W. Nifong Blvd., Bldg. 1
Columbia, Missouri 65203
(573) 447-0292

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1. General Information

The site is located at 3920 S. State Route 291 in Lee's Summit, Missouri. The proposed development will be an expansion to the existing StorageMart facility. The proposed development will be constructed on Lots 2A and 3A of the South M-291 Mini Safety Storage Lots 1A, 2A & 3A Plat recorded as Instrument Number 2006E0028581. Lots 2A and 3A of said Plat consist of 1.27 acres. The proposed use will be a 3-story mini-warehouse building consisting of approximately 16,541 square feet on the main level and the 2nd and 3rd floors consisting of approximately 14,961 square feet for a total of approximately 46,463 square feet.

The site is currently open grass area with a drainage ditch along the south property line and the SW Raintree road ditch along the east property line. The stormwater currently sheet flows to the east and southeast corner of the site where it is collected by the SW Raintree road ditch. An existing 36˝ HDPE stormsewer outlet pipe along with several other storm sewer pipes that collect stormwater runoff from the existing facility discharge into a drainage ditch which then crosses the proposed development

site along the south property line. The existing ditch from the 36˝ HDPE discharge location to Lake Winnebago is known as Tributary G1.

The stormwater from the proposed development will be collected and conveyed with the use of onsite storm sewer. The stormsewer will be routed to an extended dry detention facility. The existing 36˝ HDPE and stormsewer discharges from the existing facility will be tied into a new stormsewer network that will collect and bypass the site.

Per the FEMA Flood Map Service Center a portion of the site is located in the 100 year flood plain per FIRM Map 29095C0532G, effective date of January 20, 2017. A portion of the flood plain will be filled for the construction of the proposed detention facility. A flood plain development permit will be required for this development.

USACE has determined that the existing ditch Tributary G1 from the outlet of the existing 36˝ HDPE pipe is classified as a jurisdictional waterway. A nationwide permit has been approved for the development. Please refer to Exhibit C1.

The soil classifications per the USDA Nation Resources Conservation Service (NRCS) Web Soil Survey shows this site to consist of Arisburg-Urban land complex and of Udarnts-Urban land-Sampsel complex. See table below:

Soils Classifications Chart:

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI	Slopes	Hydrologic Soil Group
10082	Arisburg-Urban land complex	0.0	0.9	1% to 5%	C
10180	Udarents-Urban land-Sampsel complex	2.0	99.1	2% to 5%	C/D

*Refer to Exhibit C2

2. Methodology

The following method with the use of Hydraflo Hydrograph Extension for Autodesk Civil 3D 2019 was used to determine the existing and proposed conditions for stormwater runoff for this development:

TR-55 Unit Hydrograph:

- Return Frequencies: 2, 10 & 100 year
- 24-hour SCS Type II Rainfall Distribution
- SCS Runoff Curve Numbers per SCS TR-55
- SCS TR-55 for Time of Concentration
- Rainfall data is taken from the SCS TR-55 ″Urban Hydrology for Small Watersheds″, 2nd Edition, dated June 1986.
    - 2 year – 3.50 inches
    - 10 year – 5.20 inches
    - 100 year – 7.80 inches

3. Existing Conditions Analysis

Existing conditions were modeled using the open space area as pasture in good condition. The stormwater currently sheet flows to the east and southeast corner of the site where it flows into an existing road ditch. An existing 36″ HDPE stormsewer outlet pipe is discharging on the site along with several storm sewer outlets from existing facility. The existing ditch from the 36″ HDPE discharge location is known as Tributary G1 to Lake Winnebago.

The table below summarizes the existing conditions analysis:

Subarea	Drainage Area (acres)	Curve Number	Tc (minutes)	2-year Peak Flow (cfs)	10-year Peak Flow (cfs)	100-year Peak Flow (cfs)
EX. 1A	1.24	74	13.5	1.88	3.94	7.41
EX. 1B	0.03	98	5	0.14	0.21	0.32
OFF 2	0.09	98	5	0.43	0.64	0.96
OFF 3	0.21	74	11.9	0.37	0.76	1.43

The table below shows the Existing conditions peak flow for the existing site:

Event	Peak Flow (cfs) 1.27 ac.	Peak Flow (cfs) 1.27 ac. + Offsite
2-Year	2.03	2.65
10-Year	4.19	5.35
100-Year	7.76	9.80

4. Proposed Conditions Analysis

The stormwater from the proposed development will be collected and conveyed with the use of onsite storm sewer. The stormsewer will be routed to an extended dry detention facility. The existing 36˝ HDPE and stormsewer discharges from the existing facility will be tied into a new stormsewer network that will collect and bypass the site.

The table below summarizes the proposed conditions analysis:

Subarea	Drainage Area (Acres)	Curve Number	Tc (Minutes)	Existing Q2-yr (cfs)	Existing Q10-yr (cfs)	Existing Q100-yr (cfs)
DA 5	0.12	80	13.5	0.25	0.46	0.81
DA 6	0.76	98	5	3.60	5.37	8.08
DA 7	0.10	98	5	0.47	0.71	1.06
DA 8	0.29	80	5	0.80	1.49	2.57
OFF 2	0.09	98	5	0.43	0.64	0.96
OFF 3	0.21	80	13.8	0.43	0.81	1.42

The table below summarizes the Dry Detention Facility:

Frequency	Dev. Pond (cfs)	Max Elev. (ft.)	Max Storage (cu.ft.)
2-year	0.56	984.98	5,968
10-year	1.80	985.33	8,965
100-year	3.49	985.85	13,602

The table below summarizes the Predeveloped with Post Developed runoffs:

Frequency	Pre Dev. (1.27 ac.) (cfs)	Post Dev. Pond (cfs)	Allowable (cfs)	Offsite Runoff Not Detained (cfs)	Combined Post Dev. (cfs)
2-year	2.03	0.56	0.64	1.36	1.40
10-year	4.18	1.80	2.54	2.27	3.67
100-year	7.76	3.49	3.81	3.73	6.09

The table below shows the reduction from the Predeveloped to the Combined Post Developed runoff:

Frequency	Pre Dev. (1.27 ac.) (cfs)	Combined Post Dev. (cfs)	Reduction (cfs)
2-year	2.03	1.40	0.63
10-year	4.18	3.67	0.51
100-year	7.76	6.09	1.67

5. Conclusions and Recommendations

The proposed StorageMart facility development has been evaluated and this report shows that the post development stormwater runoff is lower than the predeveloped condition. The new detention facility will release stormwater at a rate that meets the APWA 5600 stormwater requirements. However, due to site constraints the combined stormwater runoff for the site will exceed the APWA 5600 release rate requirements. The areas not being detained consists mainly grass areas that cannot be routed to the detention facility due to site grades. With the post development condition being less than the predeveloped condition this development will have no impact on downstream properties.

Requested Waivers:

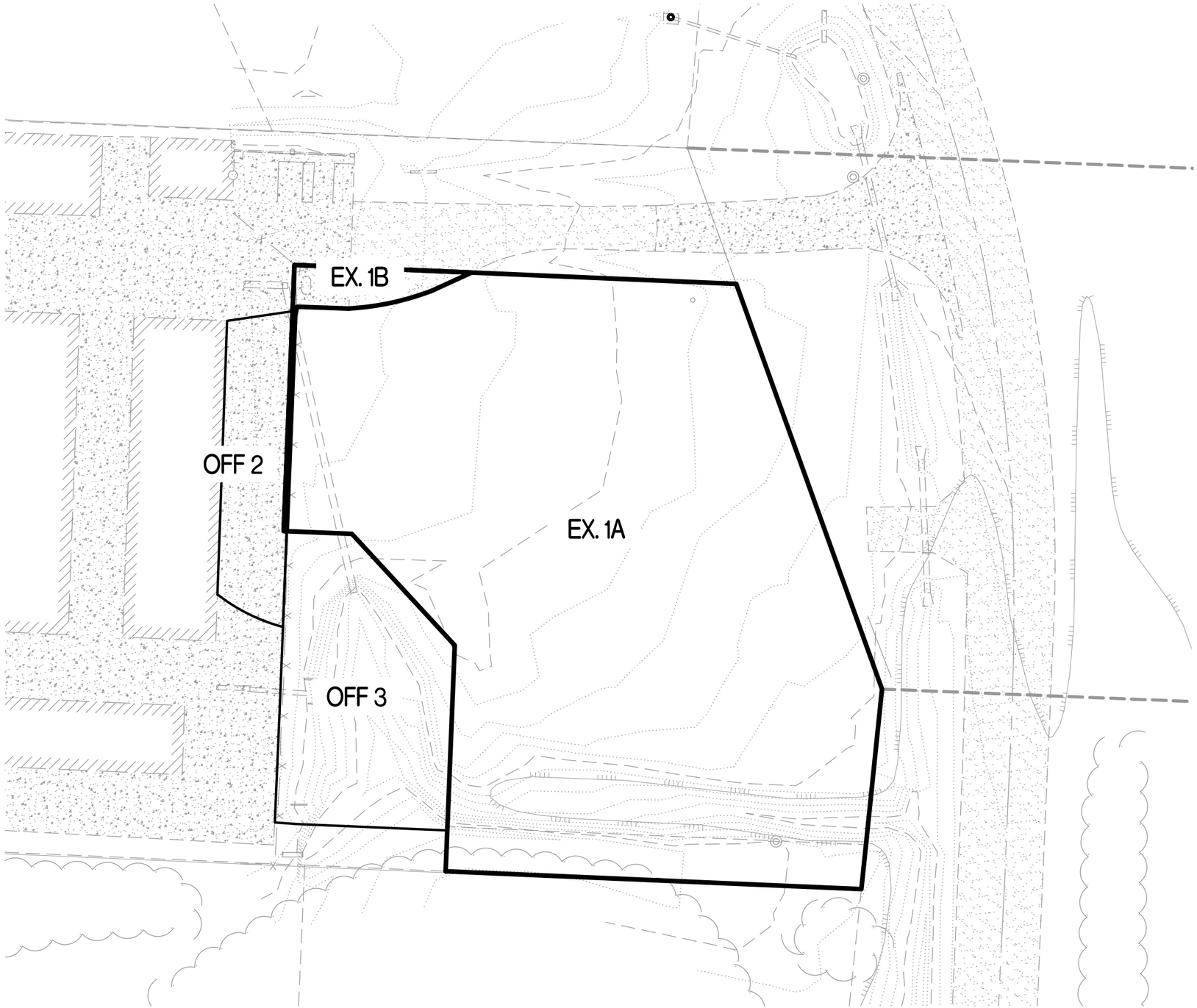
Due to site constraints it is requested that the combined allowable stormwater discharge to exceed the APWA 5600 allowable release rate. The majority of the proposed impervious area will be routed through the detention facility with the exception of 0.10 acres of pavement located north of the building and as depicted on the proposed condition drainage area map (Appendix A2). There will be 0.09 acres of exiting pavement area that will be routed through the detention facility that was previously not being detained. Both these area go to the same watershed therefore by almost treating the equivalent area there will be little to no increase in impervious areas that are not routed through the detention facility. Also, the grass areas located along the east side of the proposed building and south side of the detention facility cannot be detained due to site grades. Due to these areas not being able to be detained by the proposed detention facility the post developed runoff for the entire site exceeds the APWA 5600 release rates. As shown in the tables above the detention facility release rate does meet these requirements and the post developed condition does not exceed the predeveloped condition runoff rates.

For the detention facility the detention outlet structure is required to have a minimum orifice size of 1˝ diameter. For water quality a 40 hour detainment is required. The detention facility cannot meet both of these requirements. A waiver for a slight reduction to the 40 hour detainment is being requested. This will allow for a 1˝ orifice to drain the pond in approximately 37 hours.

Appendix A

A1 Existing Condition Drainage Area Map
A2 Proposed Condition Drainage Area Map

APPENDIX A1
STORAGE MART
HWY 291, LEE'S SUMMIT, MO
EXISTING CONDITION DRAINAGE AREA MAP



SCALE: 1"= 50'

SUMMARY TABLE			
SUBBASIN	DRAINAGE AREA (ACRES)	CURVE NUMBER	TC (MIN.)
EX. 1A	1.24	74	13.5
EX. 1B	0.03	98	5
OFF 2	0.09	98	5
OFF 3	0.21	74	11.9

SITE/CIVIL ENGINEER:

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www.crockettengineering.com

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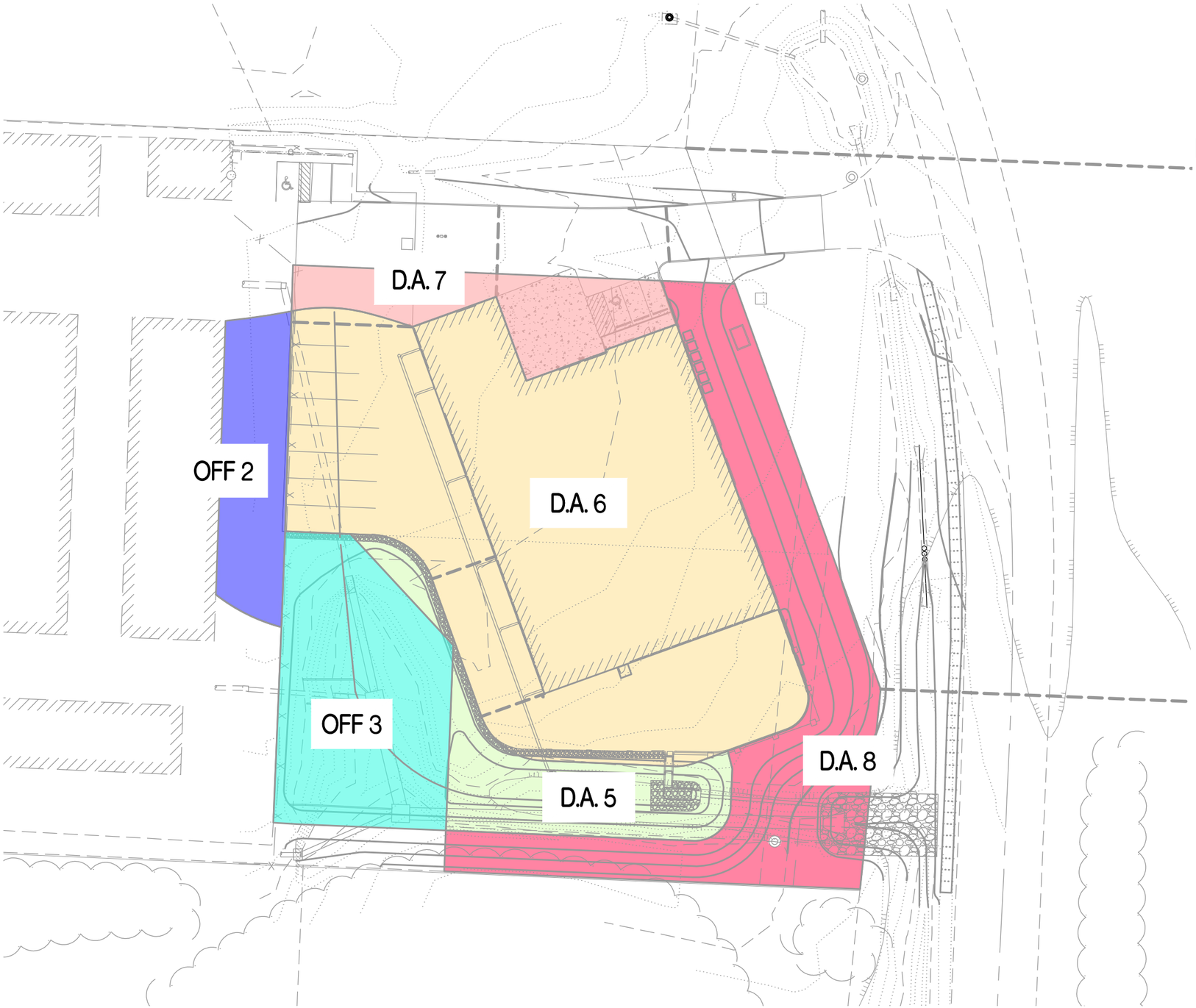
APPENDIX A2
STORAGE MART
HWY 291, LEE'S SUMMIT, MO
PROPOSED CONDITION DRAINAGE AREA MAP



SUMMARY TABLE

LEGEND	SUBBASIN	DRAINAGE AREA (ACRES)	CURVE NUMBER	TC (MIN.)
	DA 5	0.12	80	13.5
	DA 6	0.76	98	5
	DA 7	0.10	98	5
	DA 8	0.29	80	5
	OFF 2	0.09	98	5
	OFF 3	0.21	80	13.8

N

SCALE: 1"= 50'

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Appendix B

B1 Water Quality Calculations
B2 Extended Detention Calculations
B3 Hydrology & Detention Calculations

Water Quality Volume Calculation Worksheet

STORAGE MART - 156
170504

EXTENDED DRY DETENTION

Calculate WQv

(WQv) = P*Rv

P = Rainfall event in inches = 1.37 inches

Rv = Volumetric runoff coefficient

0.05 + 0.009(I)

I = Percent site imperviousness (%)

Size of Area	=	55532 sf
Size of Impervious Area	=	36754 sf

I = 66%

(WQv) = 0.88 watershed inches

(WQv) = 4093.5 ft3

Calculate peak discharge for the Water Quality Storm:

CN = $1000/[10 + 5P + 10Q - 10(Q^2 + 1.25QP)^{1/2}]$

P = Water Quality Storm rainfall (inches)

Q = Runoff volume (inches)—equal to WQv (watershed inches)

= 95.7

Tc = $(L^{0.8}[(1000/CN)-9]^{0.7})/(1140 * Y^{0.5})$

Tc = Time of concentration (hours)

L = Flow length (feet)	=	345 ft
CN = Runoff Curve Number		
Y = Average watershed slope (percent)	=	1.5 %

Tc = 0.08 hours (Note: If less than 0.1 hours, use 0.1 hours)

Ia = 0.089

Ia/P = 0.07 (The limiting value for Ia/P .1)

From Figure 2.3.1 in Appendix F

qu = 1000 cfs/sm/in

1.5625 cfs/ac/in

Qp = 1.76 CFS

OUTLET STRUCTURE DISCHARGE COMPUTATIONS
FOR EXTENDED DETENTION BASINS

****ENTER THE FOLLOWING INFORMATION*****

PROJECT: Storage Mart 156, Lee's Summit, MO
DATE: 11-Nov-19

RISER PIPE DIAMETER: 0 INCHES
OUTLET PIPE DIA.: 0 INCHES

PERFORATION DIA: 1 INCHES
HOLES PER ROW: 1
ORIFICE AREA: 0.79 SQ. IN.
(TOTAL FOR ROW)
ROW SPACING: 0 INCHES
NUMBER OF ROWS: 1

FLOWLINE ELEVATION
AT BOTTOM OF BASIN: 981.75

MAXIMUM PONDING
ELEV. FOR
EXTENDED DETENTION: 984.8

****

IN COLUMN A, ENTER WATER ELEVATIONS AT 3" INCREMENTS BEGINNING WITH THE ELEVATION
ENTERED ABOVE FOR MAXIMUM PONDING ELEVATION FOR EXTENDED DETENTION
AND PROCEEDING DOWNWARD TO THE FLOWLINE ELEVATION AT THE BOTTOM OF THE BASIN

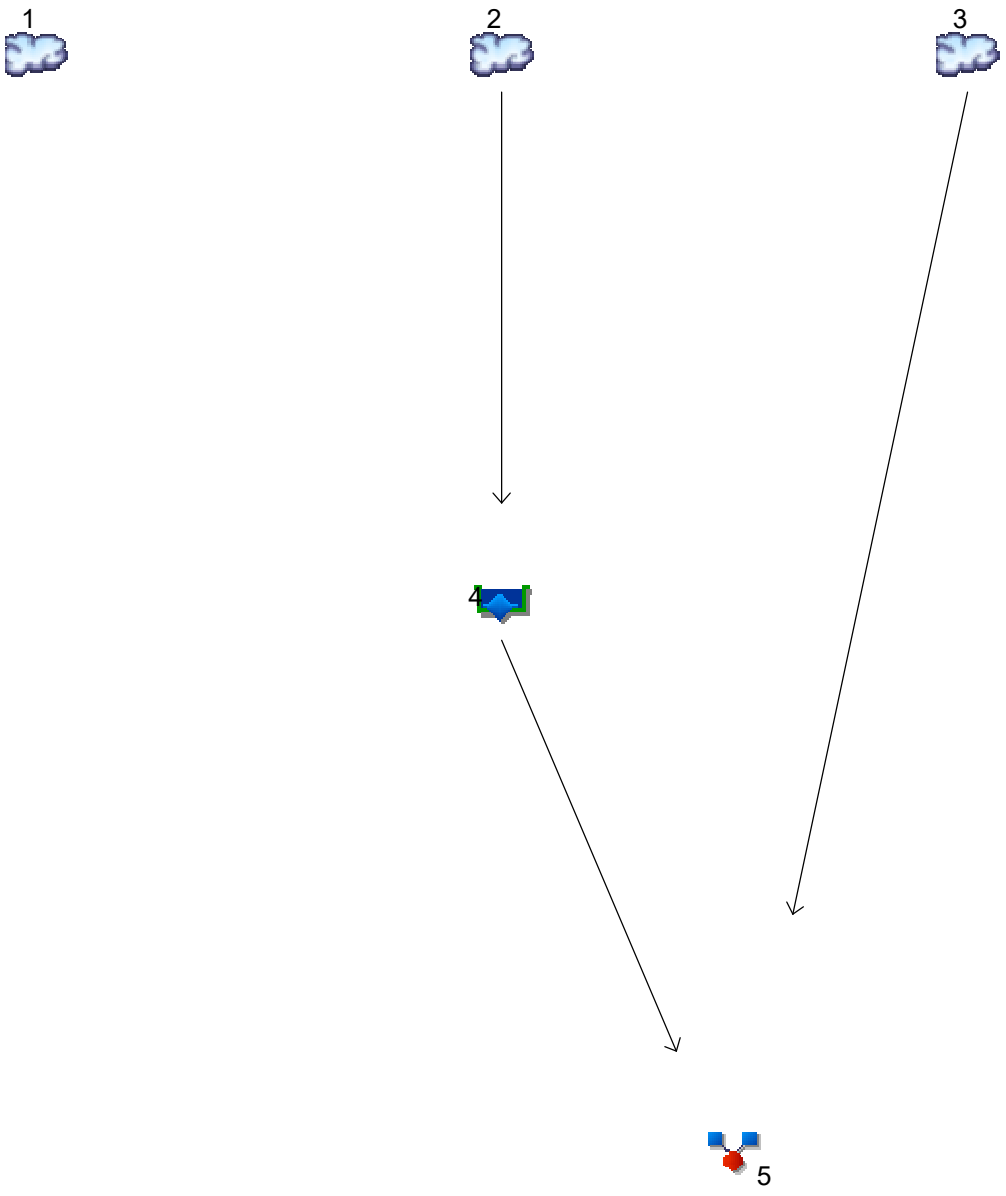
IN COLUMN B ENTER THE AREA CORRESPONDING TO THE ELEVATION IN COLUMN A

ENTER THE ELEVATION OF EACH ROW OF HOLES BELOW THE ROW NUMBER
ENTER ELEVATION 9999.0 FOR ROWS NOT USED

RESULT IS DISPLAYED AT THE BOTTOM OF COLUMN K

WATER ELEVATION	AVERAGE AREA (SF)	AVERAGE VOL (CF)	OUTFLOW RATE (CFS) ROW 1	ROW 2	ROW 3	ROW 4	ROW 5	ROW 6	COMBINED OUTFLOW	DRAIN TIME (HOURS)
			981.75	9999.00	9999.00	9999.00	9999.00	9999.00		
984.80	5492	270	0.046	0.000	0.000	0.000	0.000	0.000	0.046	1.63
984.75	5296	1201	0.045	0.000	0.000	0.000	0.000	0.000	0.045	7.34
984.50	4315	956	0.044	0.000	0.000	0.000	0.000	0.000	0.044	6.10
984.25	3334	711	0.042	0.000	0.000	0.000	0.000	0.000	0.042	4.76
984.00	2353	541	0.039	0.000	0.000	0.000	0.000	0.000	0.039	3.81
983.75	1973	446	0.037	0.000	0.000	0.000	0.000	0.000	0.037	3.33
983.50	1592	351	0.035	0.000	0.000	0.000	0.000	0.000	0.035	2.80
983.25	1212	255	0.032	0.000	0.000	0.000	0.000	0.000	0.032	2.21
983.00	831	184	0.029	0.000	0.000	0.000	0.000	0.000	0.029	1.74
982.75	641	136	0.026	0.000	0.000	0.000	0.000	0.000	0.026	1.44
982.50	450	89	0.023	0.000	0.000	0.000	0.000	0.000	0.023	1.08
982.25	260	41	0.019	0.000	0.000	0.000	0.000	0.000	0.019	0.62
982.00	70	11	0.013	0.000	0.000	0.000	0.000	0.000	0.013	0.24
981.75	20	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
								TOTAL DRAIN TIME		37.1 hours
								MAX. OUTFLOW RATE =		0.43 cfs

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Pre Development
2	SCS Runoff	Post Developed to Detention
3	SCS Runoff	Post Developed Not to Detention
4	Reservoir	Route Thru Pond
5	Combine	Total Post Developed

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	------	-------	2.651	-------	-------	5.353	-------	-------	9.799	Pre Development
2	SCS Runoff	------	-------	5.106	-------	-------	7.956	-------	-------	12.25	Post Developed to Detention
3	SCS Runoff	------	-------	1.316	-------	-------	2.268	-------	-------	3.730	Post Developed Not to Detention
4	Reservoir	2	-------	0.560	-------	-------	1.798	-------	-------	3.491	Route Thru Pond
5	Combine	3, 4	-------	1.398	-------	-------	3.667	-------	-------	6.091	Total Post Developed

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2019.2

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	2.651	2	722	7,587	------	------	------	Pre Development
2	SCS Runoff	5.106	2	716	10,982	------	------	------	Post Developed to Detention
3	SCS Runoff	1.316	2	716	2,676	------	------	------	Post Developed Not to Detention
4	Reservoir	0.560	2	736	10,976	2	984.98	5,986	Route Thru Pond
5	Combine	1.398	2	716	13,652	3, 4	------	------	Total Post Developed

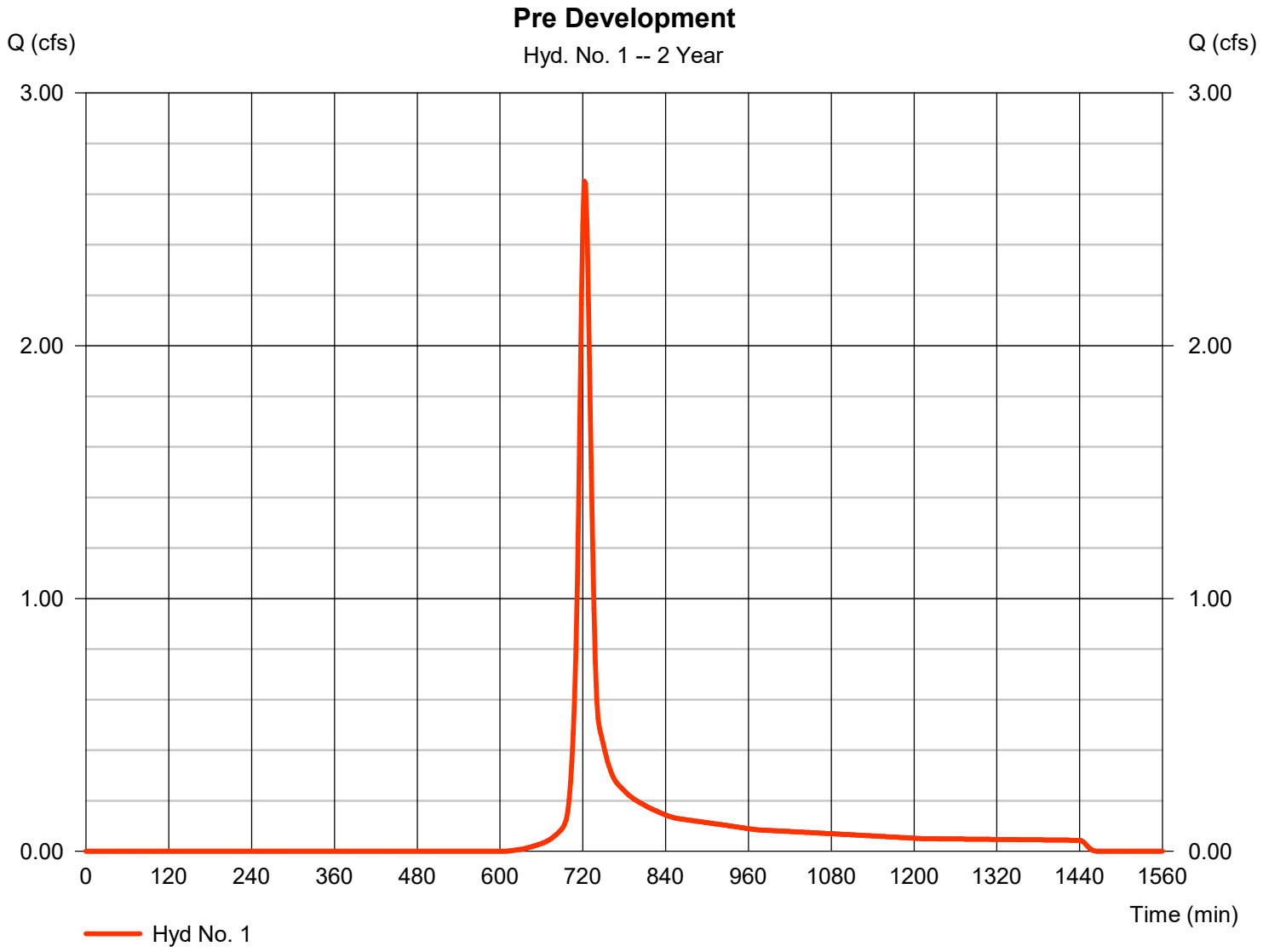
Hydrograph Report

Hyd. No. 1

Pre Development

Hydrograph type	= SCS Runoff	Peak discharge	= 2.651 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 7,587 cuft
Drainage area	= 1.570 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.240 x 74) + (0.030 x 98) + (0.090 x 98) + (0.210 x 74)] / 1.570



TR55 Tc Worksheet

Hyd. No. 1

Pre Development

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)	= 3.50		0.00		0.00		
Land slope (%)	= 2.70		0.00		0.00		
Travel Time (min)	**= 12.10**	**+**	**0.00**	**+**	**0.00**	**=**	**12.10**
Shallow Concentrated Flow							
Flow length (ft)	= 230.00		0.00		0.00		
Watercourse slope (%)	= 2.70		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=2.65		0.00		0.00		
Travel Time (min)	**= 1.45**	**+**	**0.00**	**+**	**0.00**	**=**	**1.45**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 13.50 min

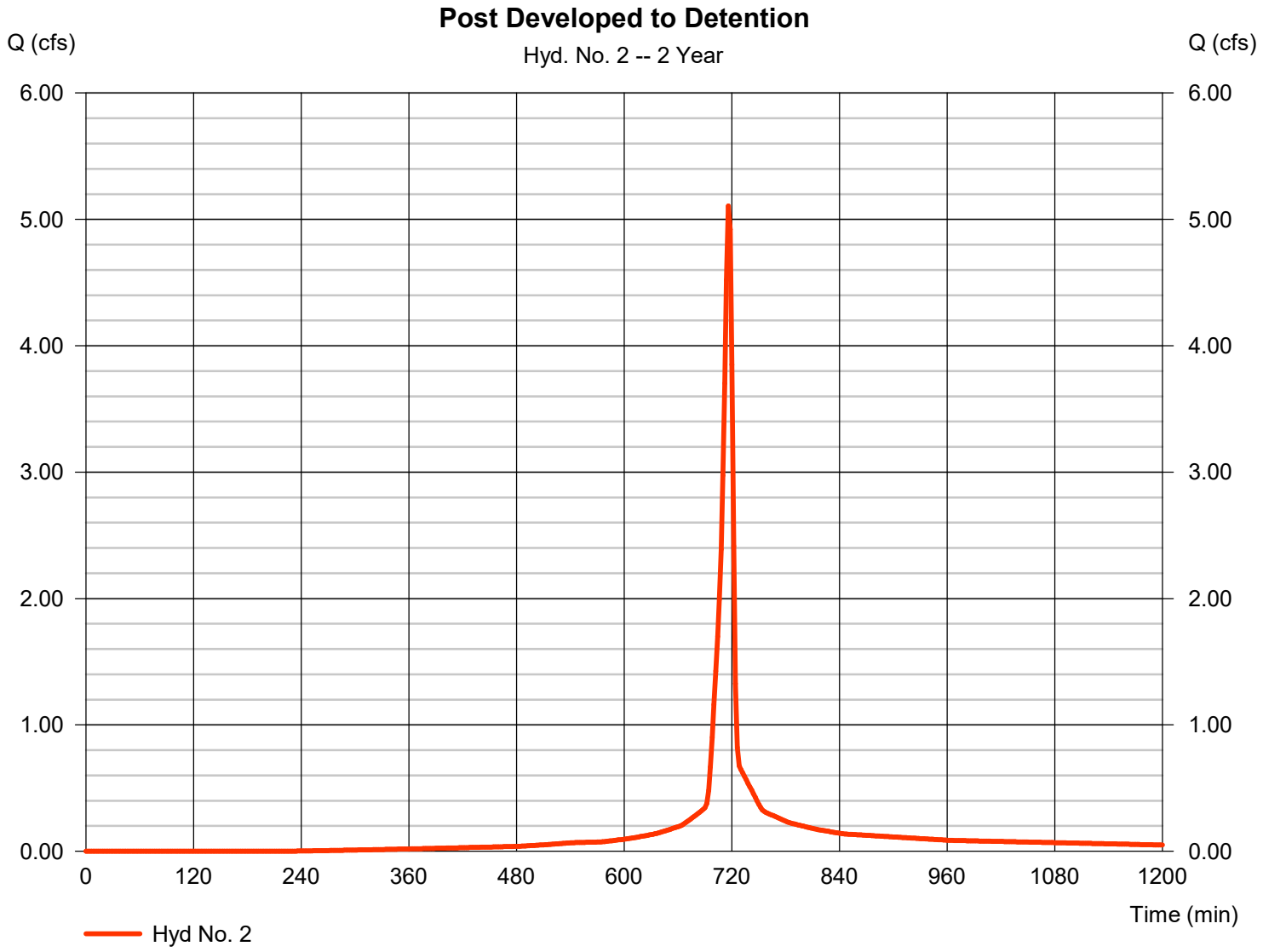
Hydrograph Report

Hyd. No. 2

Post Developed to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 5.106 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 10,982 cuft
Drainage area	= 1.180 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.760 x 98) + (0.120 x 80) + (0.090 x 98) + (0.210 x 80)] / 1.180



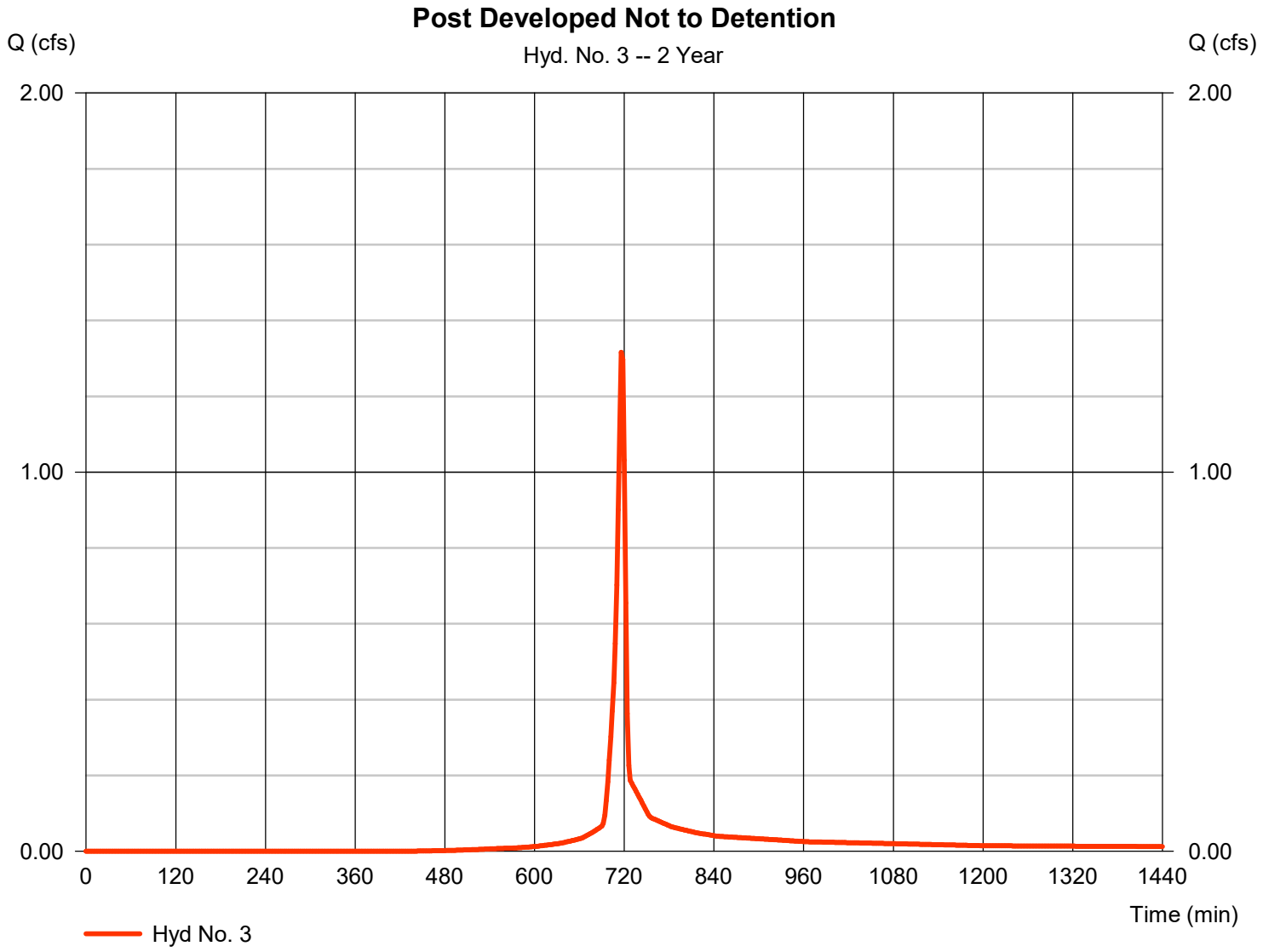
Hydrograph Report

Hyd. No. 3

Post Developed Not to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 1.316 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,676 cuft
Drainage area	= 0.390 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.290 x 80)] / 0.390



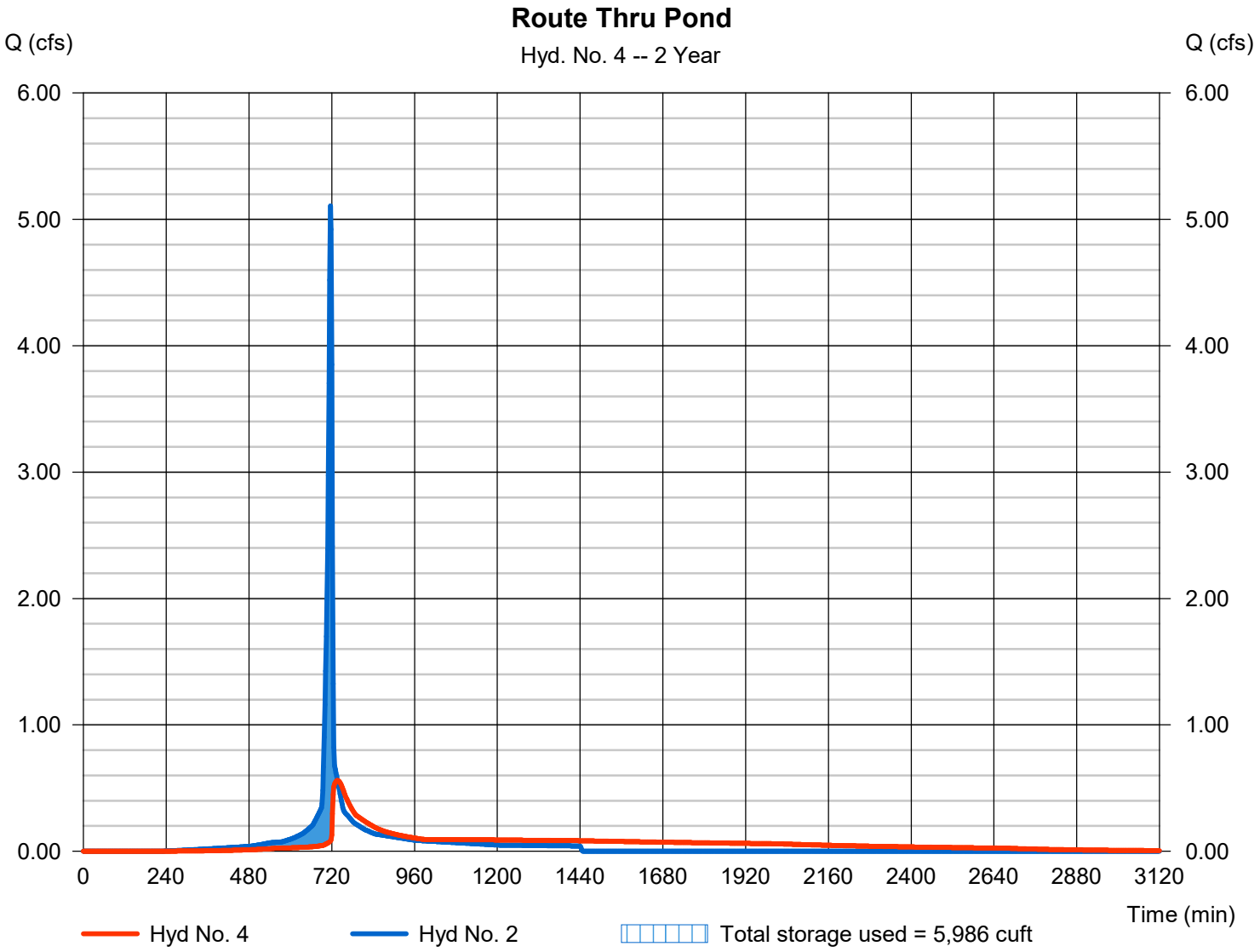
Hydrograph Report

Hyd. No. 4

Route Thru Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.560 cfs
Storm frequency	=	2 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	10,976 cuft
Inflow hyd. No.	=	2 - Post Developed to Detention	Max. Elevation	=	984.98 ft
Reservoir name	=	DETENTION POND	Max. Storage	=	5,986 cuft

Storage Indication method used.



Pond No. 1 - DETENTION POND

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 981.75 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	981.75	20	0	0
0.25	982.00	70	11	11
1.25	983.00	831	381	391
2.25	984.00	2,353	1,527	1,919
3.25	985.00	6,277	4,157	6,076
4.25	986.00	11,744	8,868	14,944
5.25	987.00	16,300	13,959	28,902

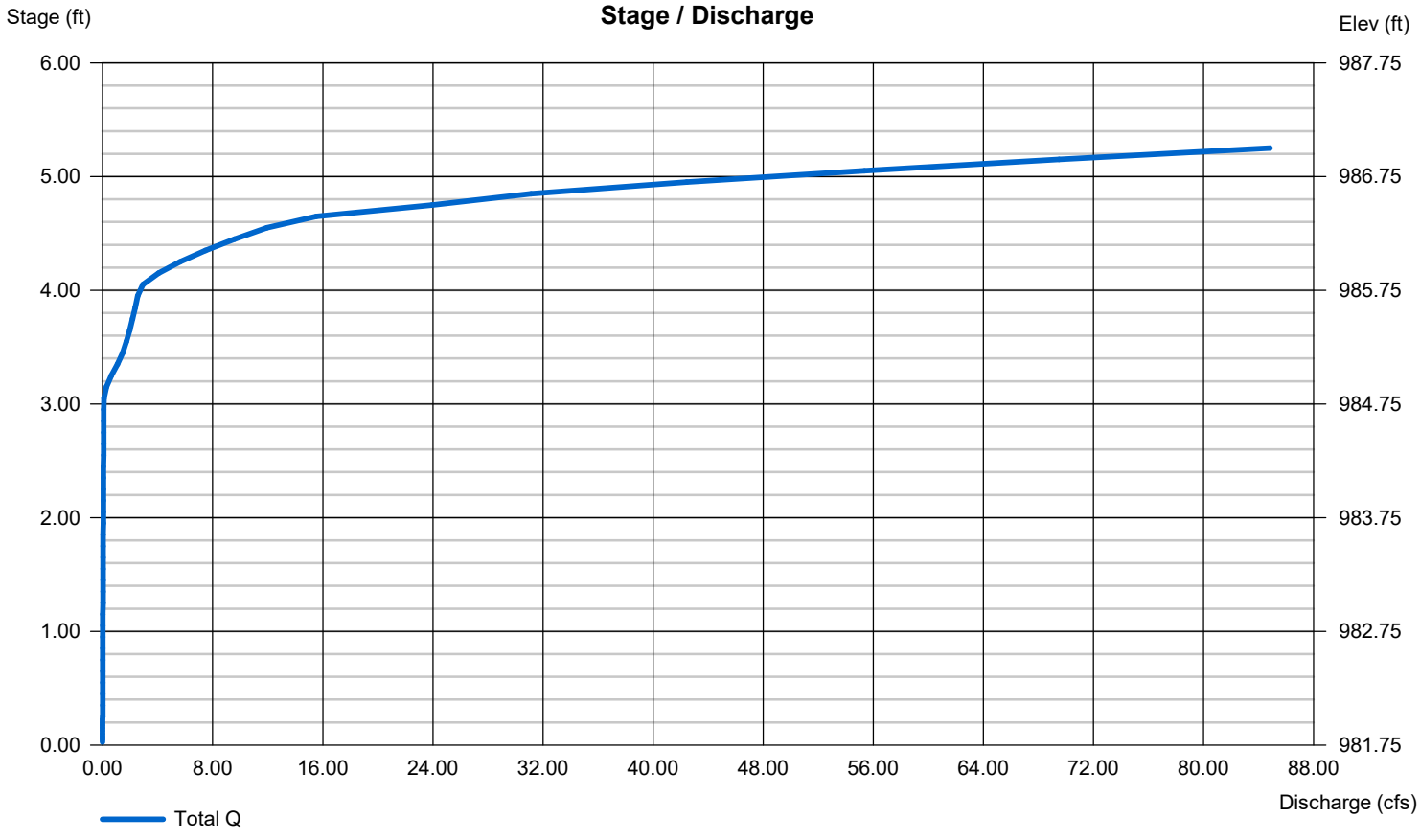
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	4.00	0.00	1.00
Span (in)	= 15.00	21.00	0.00	1.00
No. Barrels	= 1	1	0	1
Invert El. (ft)	= 975.32	984.80	0.00	981.75
Length (ft)	= 60.85	0.00	0.00	1.00
Slope (%)	= 2.00	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	No	Yes

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 6.28	50.00	0.00	0.00
Crest El. (ft)	= 985.75	986.36	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 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).

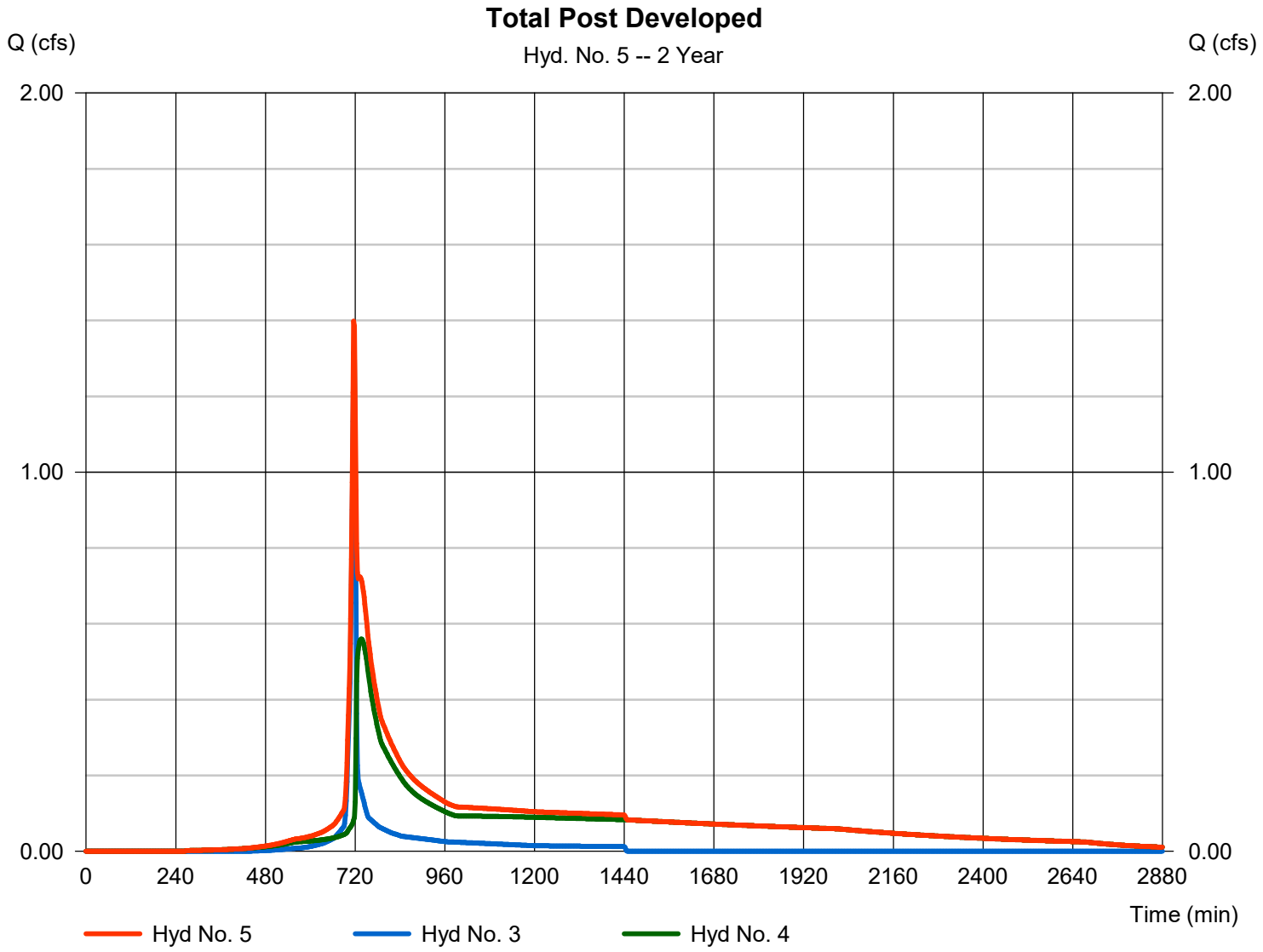


Hydrograph Report

Hyd. No. 5

Total Post Developed

Hydrograph type	= Combine	Peak discharge	= 1.398 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 13,652 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 0.390 ac



Hydrograph Summary Report

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	5.353	2	722	15,010	------	------	------	Pre Development
2	SCS Runoff	7.956	2	716	17,647	------	------	------	Post Developed to Detention
3	SCS Runoff	2.268	2	716	4,716	------	------	------	Post Developed Not to Detention
4	Reservoir	1.798	2	724	17,640	2	985.33	8,965	Route Thru Pond
5	Combine	3.667	2	718	22,356	3, 4	------	------	Total Post Developed

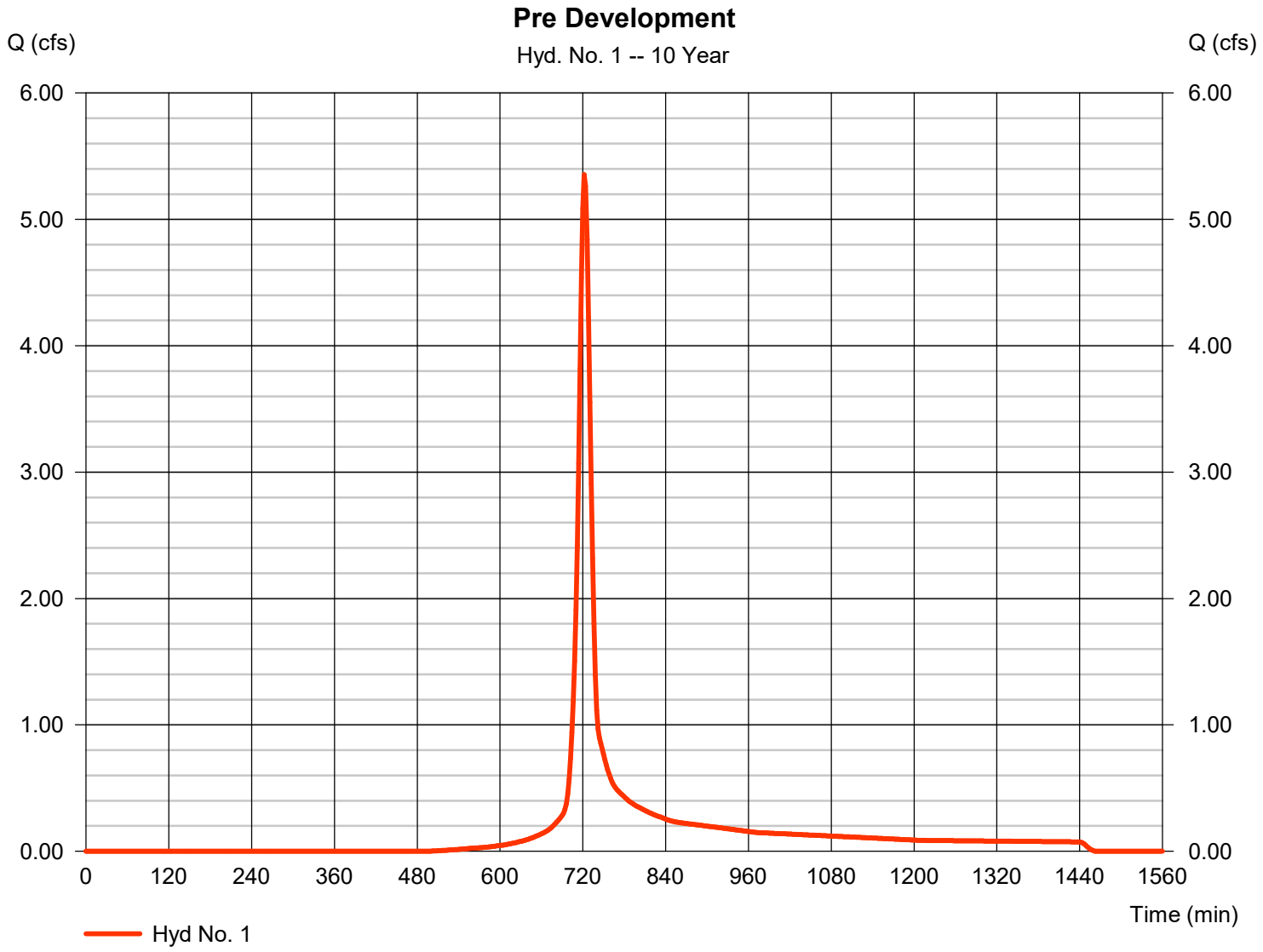
Hydrograph Report

Hyd. No. 1

Pre Development

Hydrograph type	= SCS Runoff	Peak discharge	= 5.353 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 15,010 cuft
Drainage area	= 1.570 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.240 x 74) + (0.030 x 98) + (0.090 x 98) + (0.210 x 74)] / 1.570



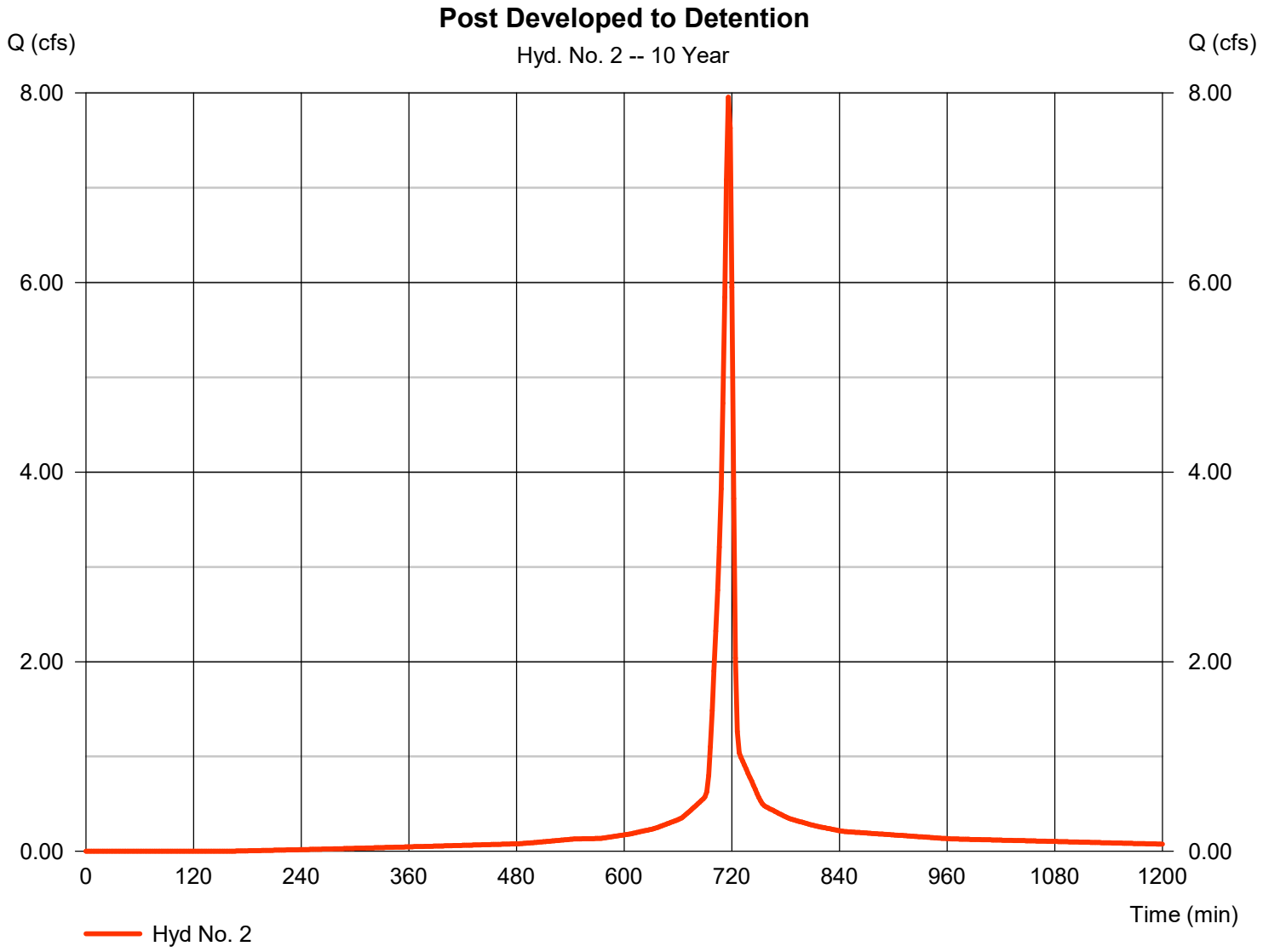
Hydrograph Report

Hyd. No. 2

Post Developed to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 7.956 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 17,647 cuft
Drainage area	= 1.180 ac	Curve number	= 93*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.760 x 98) + (0.120 x 80) + (0.090 x 98) + (0.210 x 80)] / 1.180



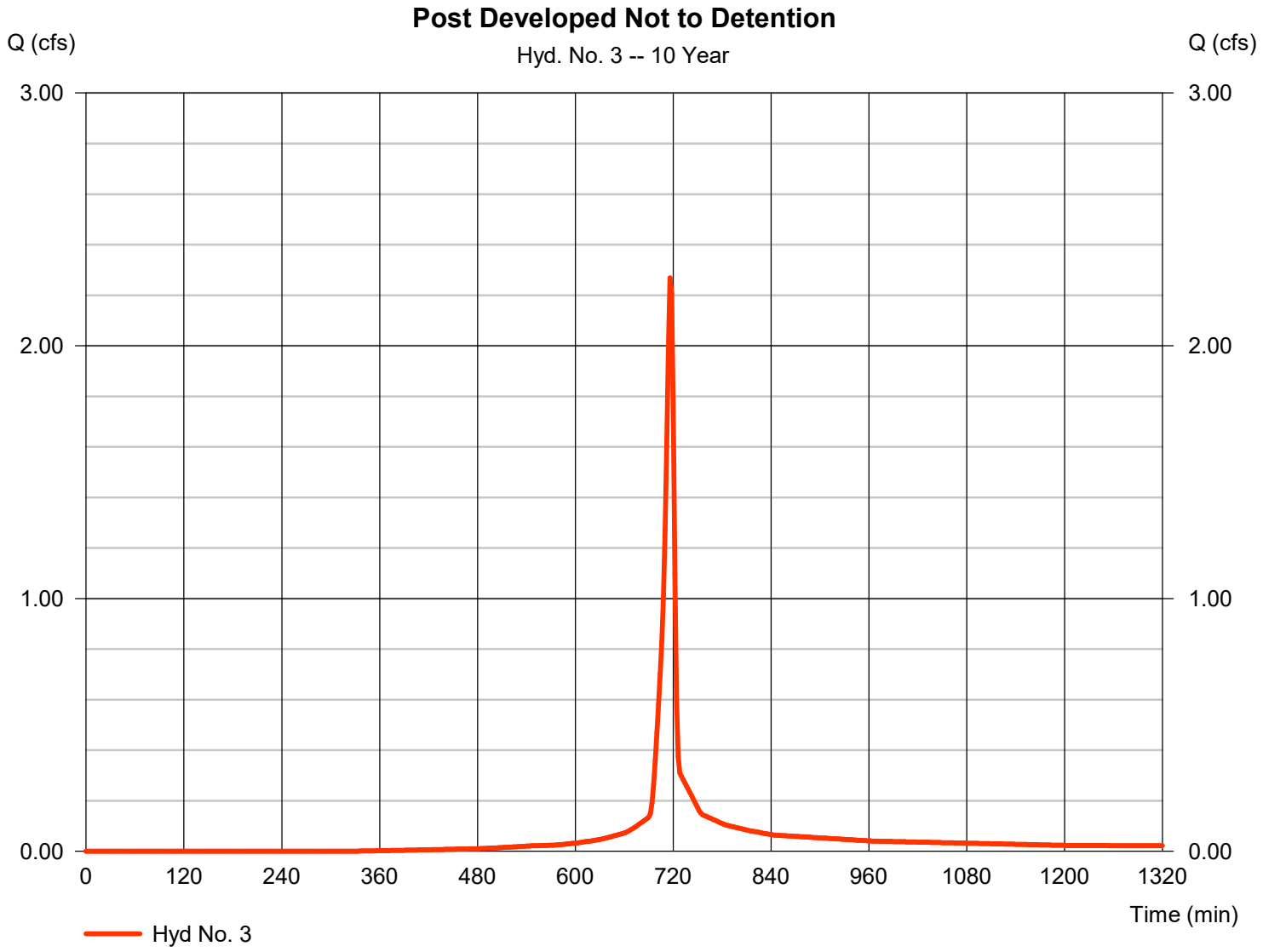
Hydrograph Report

Hyd. No. 3

Post Developed Not to Detention

Hydrograph type	= SCS Runoff	Peak discharge	= 2.268 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,716 cuft
Drainage area	= 0.390 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.290 x 80)] / 0.390



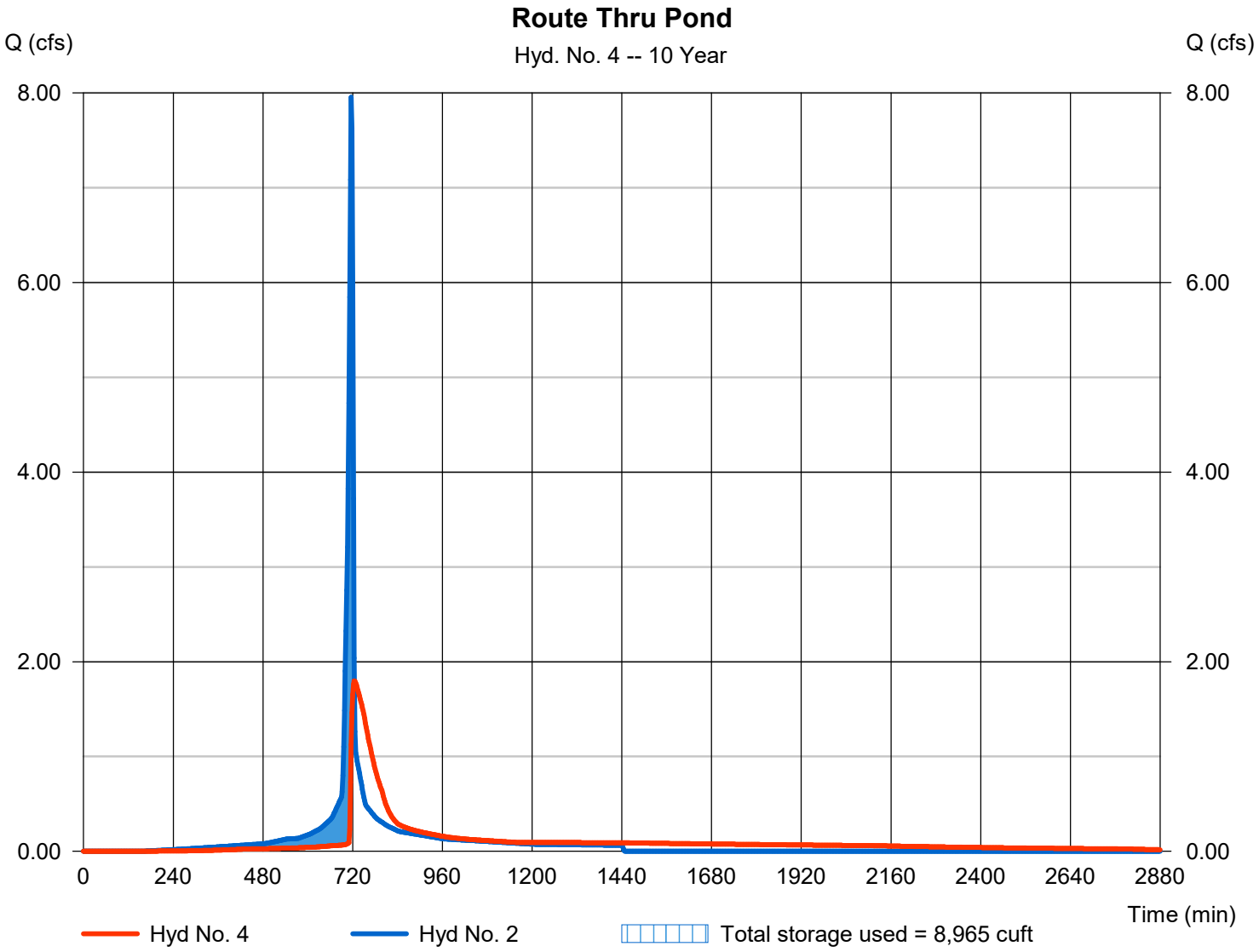
Hydrograph Report

Hyd. No. 4

Route Thru Pond

Hydrograph type	=	Reservoir	Peak discharge	=	1.798 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	17,640 cuft
Inflow hyd. No.	=	2 - Post Developed to Detention	Max. Elevation	=	985.33 ft
Reservoir name	=	DETENTION POND	Max. Storage	=	8,965 cuft

Storage Indication method used.

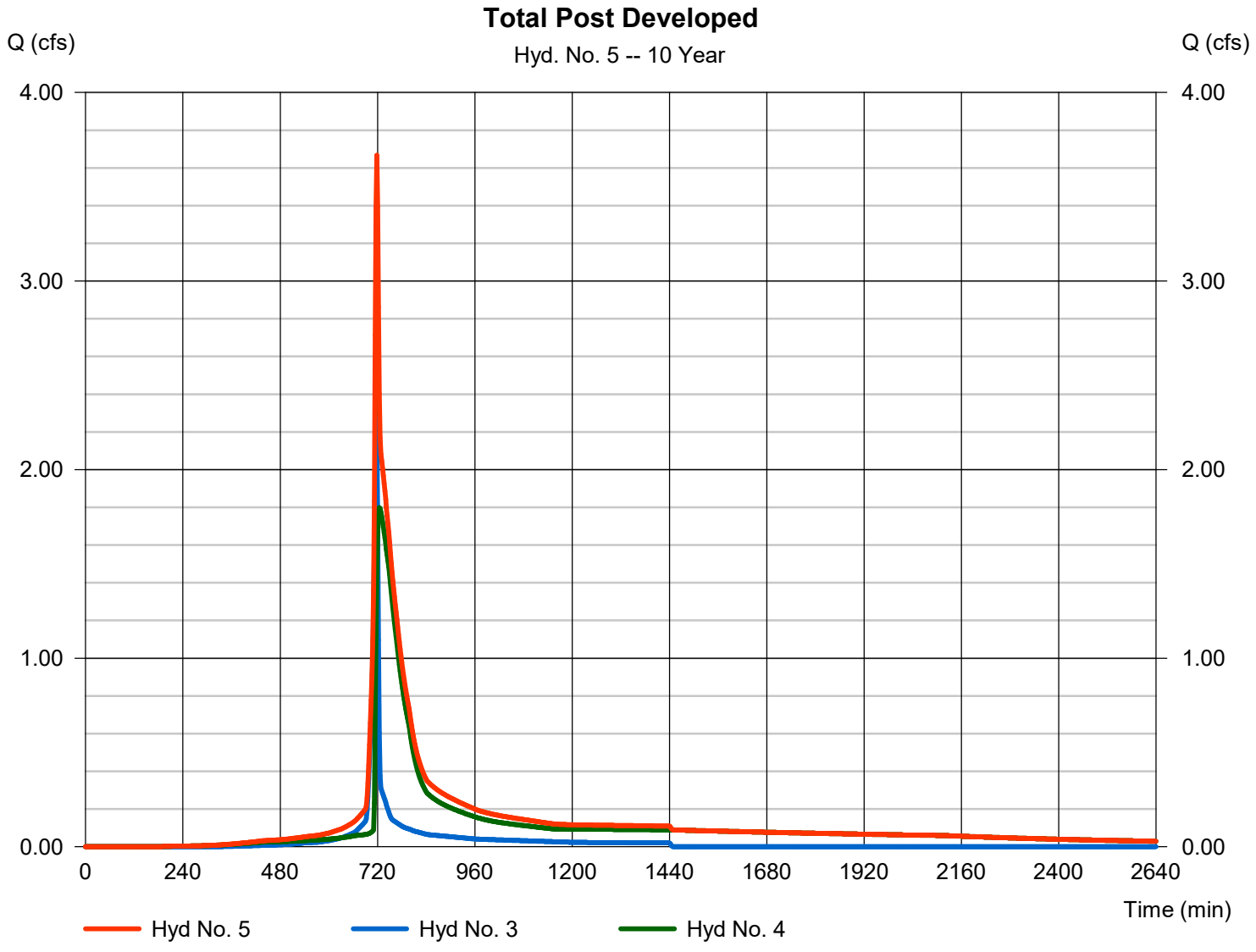


Hydrograph Report

Hyd. No. 5

Total Post Developed

Hydrograph type	= Combine	Peak discharge	= 3.667 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 22,356 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 0.390 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2019.2

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	9.799	2	722	27,651	------	------	------	Pre Development
2	SCS Runoff	12.25	2	716	27,966	------	------	------	Post Developed to Detention
3	SCS Runoff	3.730	2	716	7,990	------	------	------	Post Developed Not to Detention
4	Reservoir	3.491	2	724	27,960	2	985.85	13,602	Route Thru Pond
5	Combine	6.091	2	718	35,950	3, 4	------	------	Total Post Developed

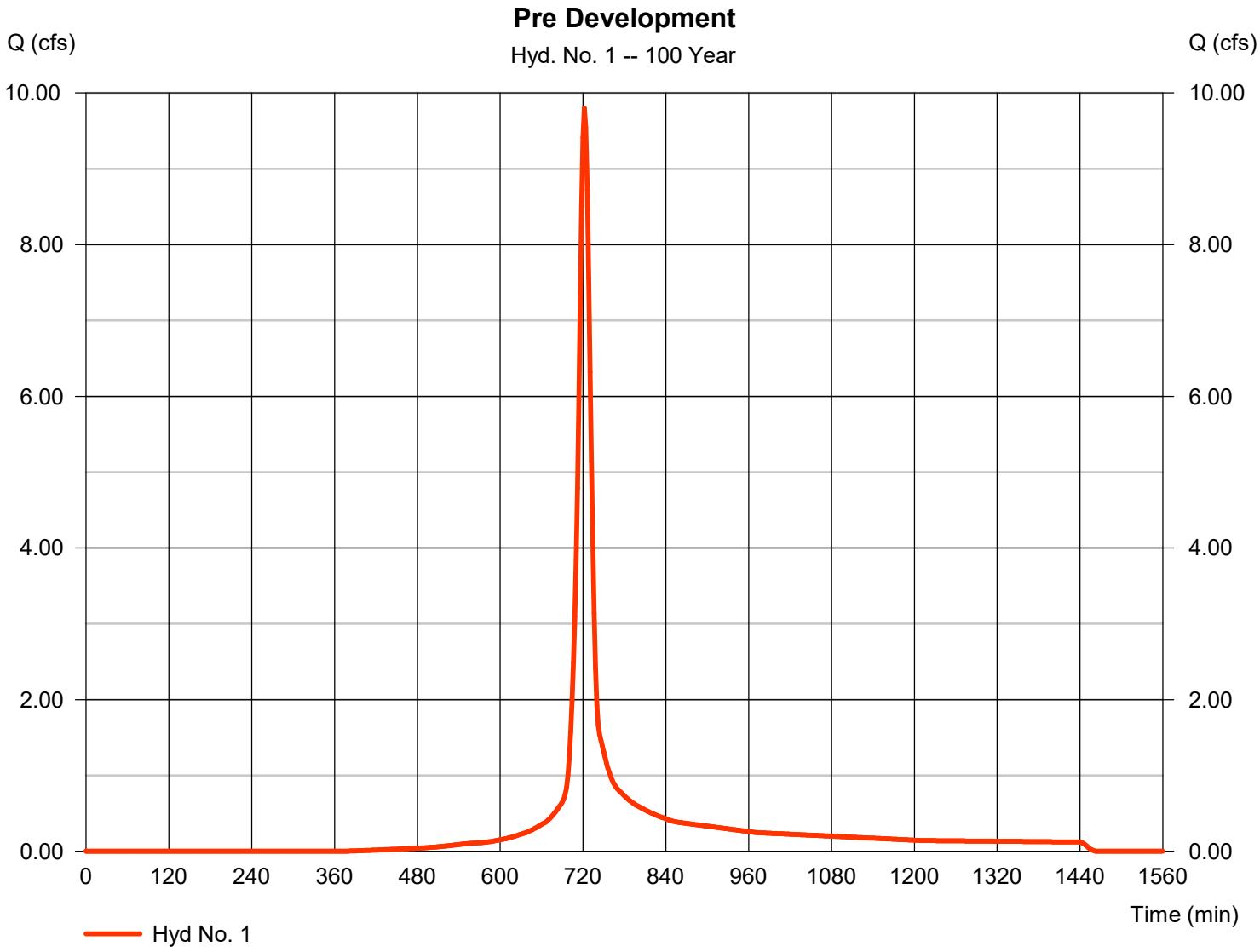
Hydrograph Report

Hyd. No. 1

Pre Development

Hydrograph type	= SCS Runoff	Peak discharge	= 9.799 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 27,651 cuft
Drainage area	= 1.570 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.240 x 74) + (0.030 x 98) + (0.090 x 98) + (0.210 x 74)] / 1.570



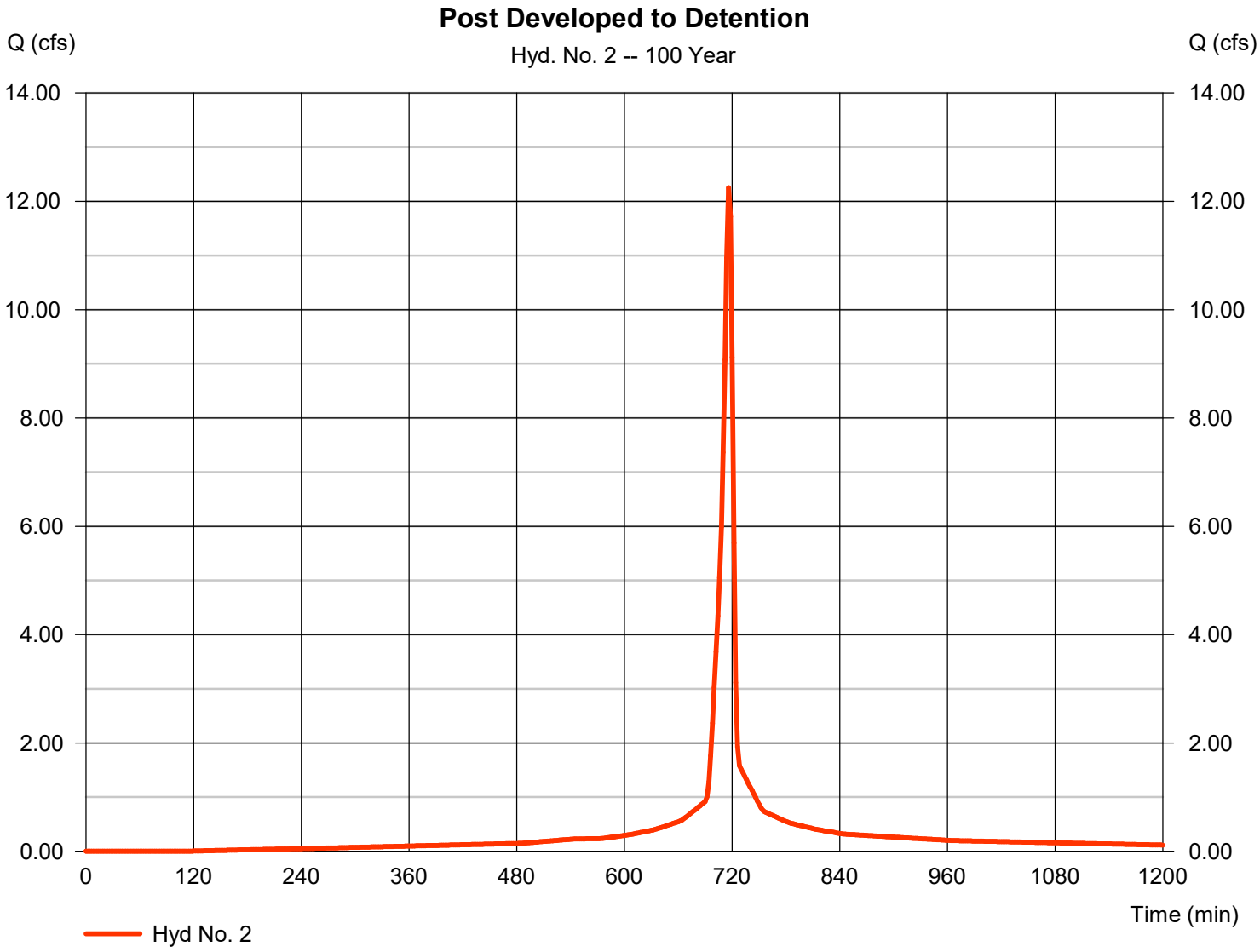
Hydrograph Report

Hyd. No. 2

Post Developed to Detention

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.25 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	27,966 cuft
Drainage area	=	1.180 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.760 x 98) + (0.120 x 80) + (0.090 x 98) + (0.210 x 80)] / 1.180



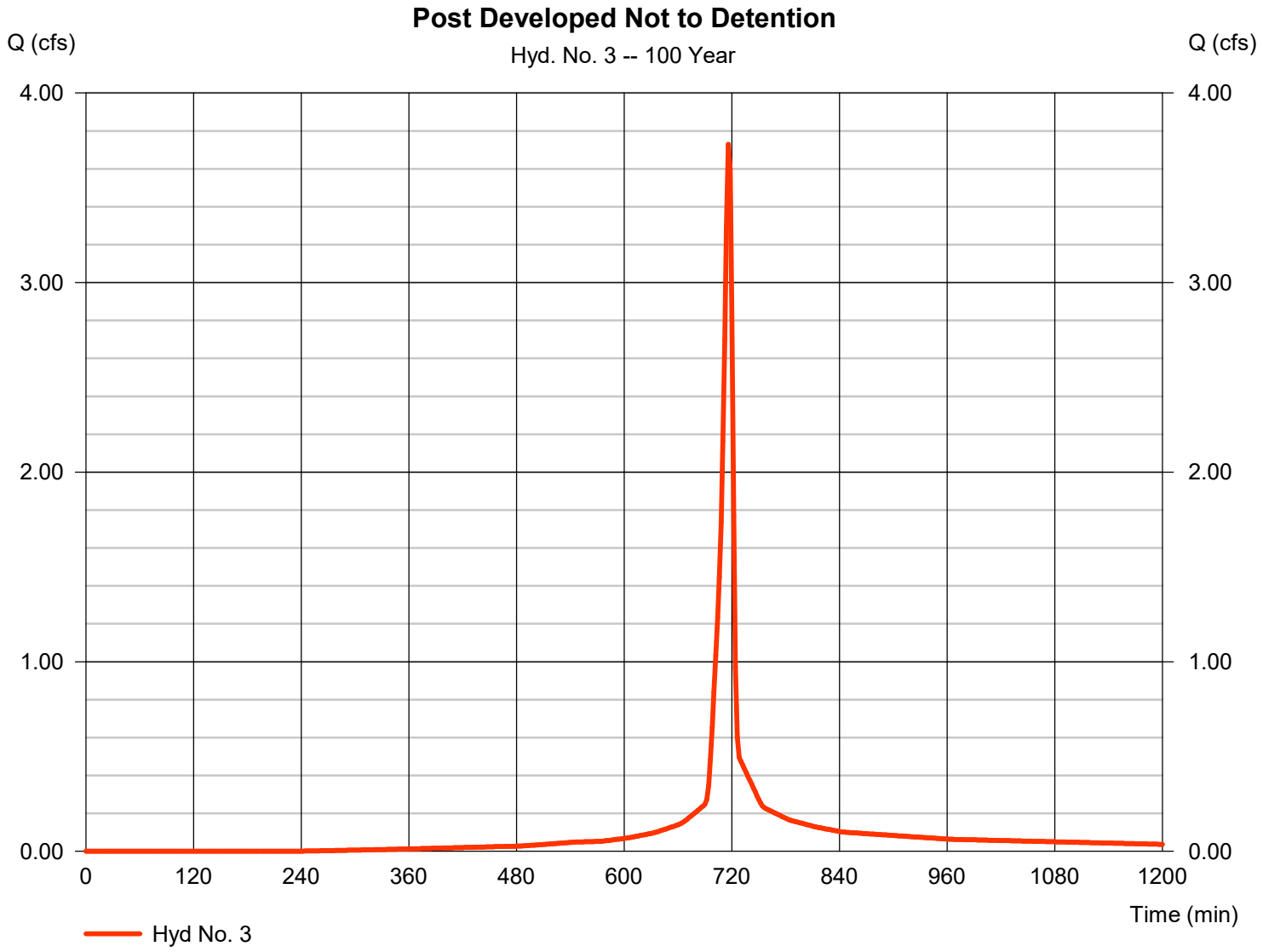
Hydrograph Report

Hyd. No. 3

Post Developed Not to Detention

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.730 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	7,990 cuft
Drainage area	=	0.390 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.100 x 98) + (0.290 x 80)] / 0.390



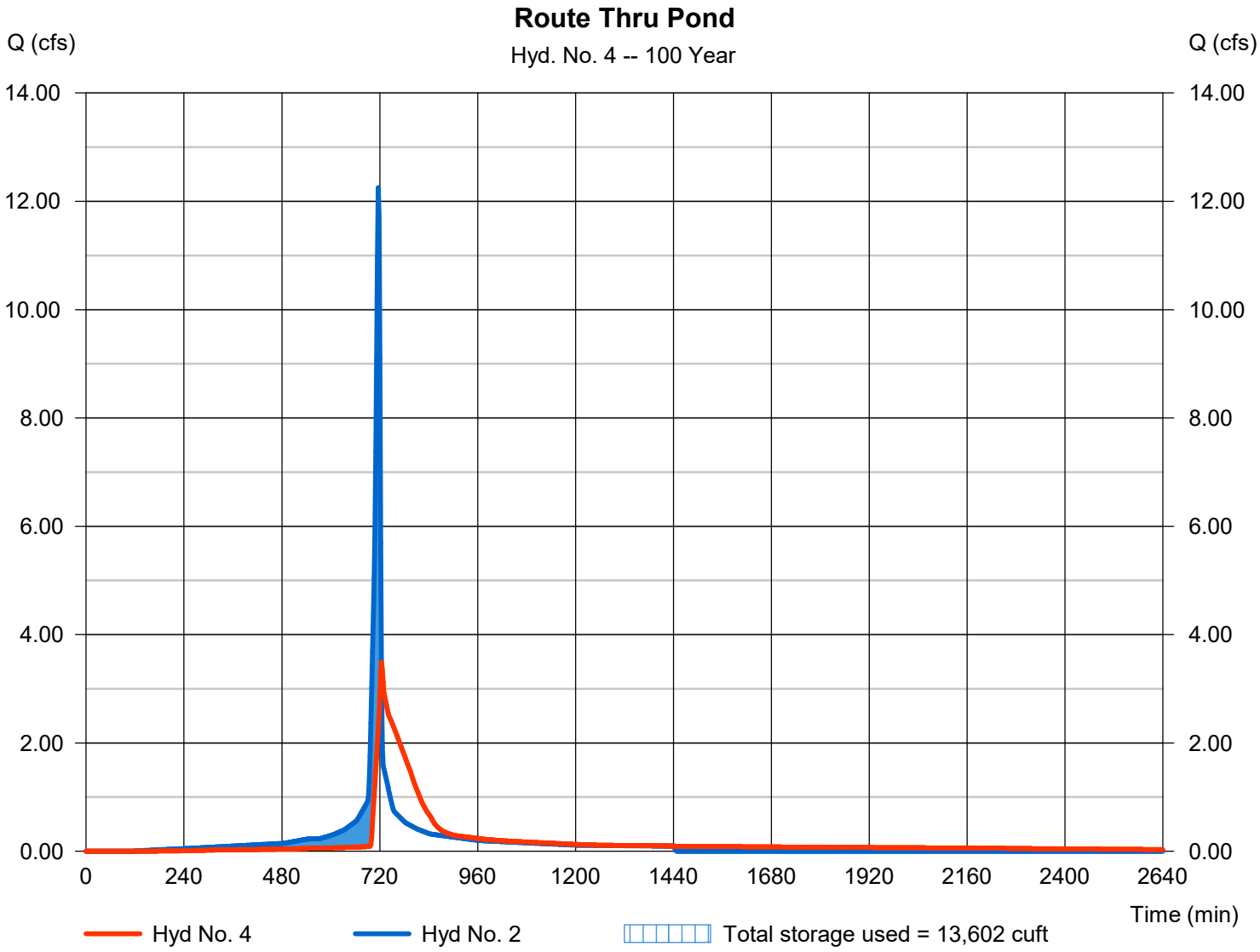
Hydrograph Report

Hyd. No. 4

Route Thru Pond

Hydrograph type	=	Reservoir	Peak discharge	=	3.491 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	27,960 cuft
Inflow hyd. No.	=	2 - Post Developed to Detention	Max. Elevation	=	985.85 ft
Reservoir name	=	DETENTION POND	Max. Storage	=	13,602 cuft

Storage Indication method used.

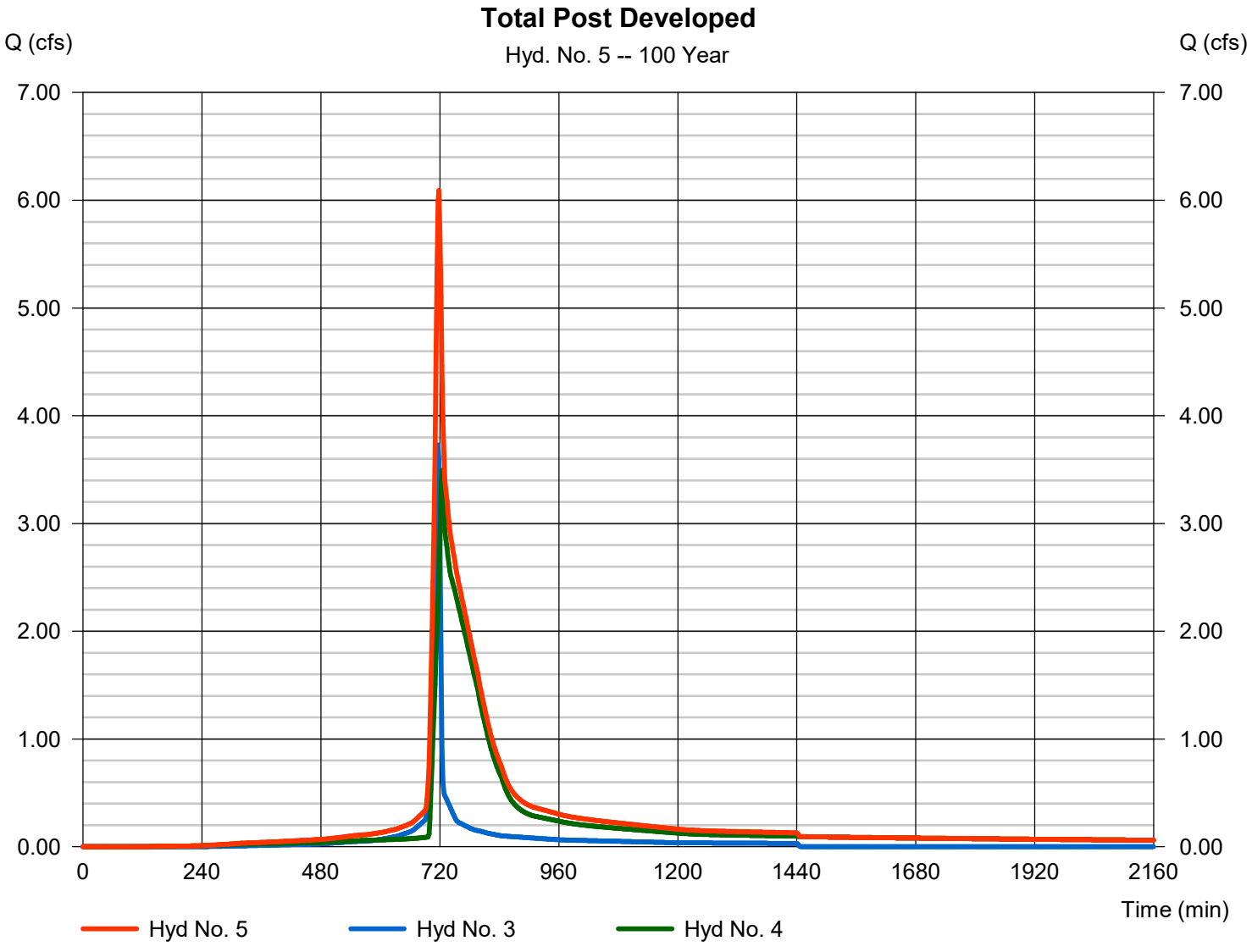


Hydrograph Report

Hyd. No. 5

Total Post Developed

Hydrograph type	= Combine	Peak discharge	= 6.091 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 35,950 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 0.390 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	97.4891	21.4000	0.9996	--------
2	45.6810	10.9000	0.7723	--------
3	0.0000	0.0000	0.0000	--------
5	41.0993	9.2000	0.7134	--------
10	104.6537	15.4000	0.8832	--------
25	130.7578	16.9000	0.8935	--------
50	97.9050	14.1000	0.8019	--------
100	140.8789	15.4000	0.8548	--------

File name: Kansas City IDF.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	3.70	3.11	2.68	2.36	2.10	1.90	1.73	1.59	1.47	1.37	1.28	1.20
2	5.39	4.37	3.70	3.23	2.88	2.60	2.38	2.20	2.04	1.91	1.80	1.70
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	6.19	4.99	4.23	3.70	3.31	3.00	2.75	2.55	2.38	2.24	2.11	2.00
10	7.30	6.01	5.13	4.48	3.99	3.60	3.28	3.02	2.80	2.61	2.44	2.30
25	8.29	6.90	5.93	5.20	4.65	4.20	3.84	3.53	3.28	3.06	2.87	2.70
50	9.19	7.63	6.56	5.78	5.18	4.70	4.31	3.99	3.72	3.48	3.28	3.10
100	10.70	8.87	7.61	6.68	5.97	5.40	4.94	4.56	4.23	3.95	3.71	3.50

Tc = time in minutes. Values may exceed 60.

ame: Y:\2017\170504- Storage Mart- Hwy 291, Lee's Summit, MO\Civil\Engineering Calcs\Kansas City Storm Data.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	3.00	3.50	0.00	4.50	5.20	5.90	6.60	7.80
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

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Weir Report

SPILLWAY

Rectangular Weir

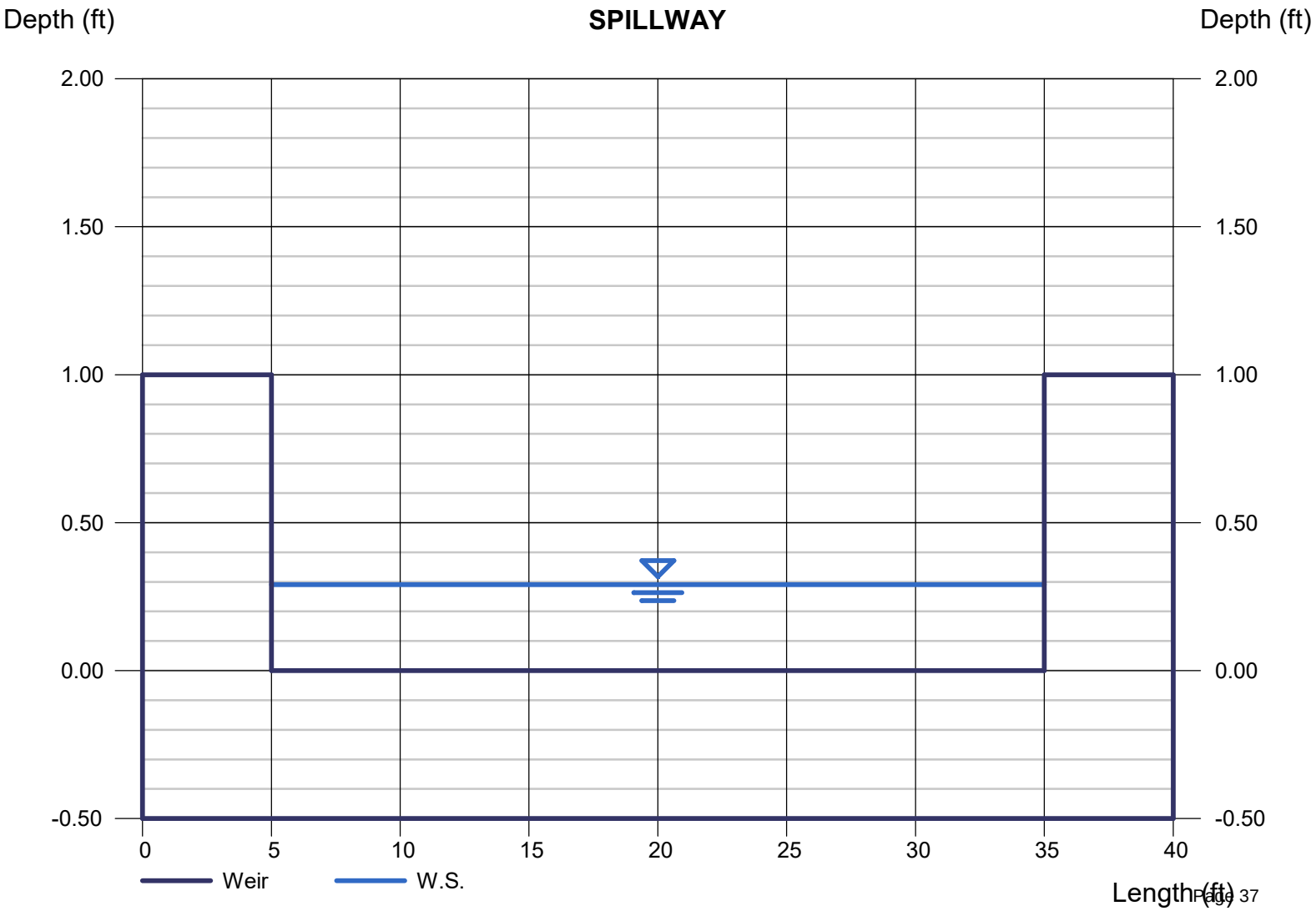
Crest	= Broad
Bottom Length (ft)	= 30.00
Total Depth (ft)	= 1.00

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 12.25

Highlighted

Depth (ft)	= 0.29
Q (cfs)	= 12.25
Area (sqft)	= 8.73
Velocity (ft/s)	= 1.40
Top Width (ft)	= 30.00



Appendix C

C1 USACE Letter
C2 NRCS Soils Report

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

September 26, 2019

Regulatory Branch
(NWK-2019-00702)
(Jackson, MO, NWP 39)

Mr. Tim D. Crockett
Crockett Engineering Consultants
1000 West Nifong Boulevard, Building #1
Columbia, Missouri 65203

Dear Mr. Crockett

This letter pertains to an application you submitted, on behalf New TKG-StorageMart Partners Portfolio, LLC, for a Department of the Army (DA) permit. It was received on August 16, 2019. The proposed work concerns the construction of a new StorageMart building and associated paved areas. This project will result in the piping of approximately 280 linear foot (LF) of intermittent stream with 60-inch stormsewer pipe along with approximately 42 LF of riprap at the outlet. This will result in the placement of fill material within an unnamed tributary to Middle Big Creek. The project is located in Section 32, Township 47 North, Range 31 West, city of Lee's Summit, Jackson County, Missouri (Lat. 38.84812, Long. -94.37718).

The placement of dredged or fill material below the ordinary high water elevation as proposed by your project requires permit authorization from this office. The Corps of Engineers has jurisdiction over all waters of the United States. Discharges of dredged or fill material in waters of the United States, including wetlands, require prior authorization from the Corps under Section 404 of the Clean Water Act (33 USC 1344). The implementing regulation for this Act is found at 33 CFR 320-332.

We have reviewed the information furnished and have determined that your project is authorized by nationwide permit **(NWP) 39,** provided you ensure that the conditions listed in the enclosed copy of excerpts from the January 6, 2017 Federal Register, Issuance of Nationwide Permits, are met. You must also comply with the Kansas City District Regional NWP Conditions posted at:
http://www.nwk.usace.army.mil/Missions/RegulatoryBranch/NationWidePermits.aspx

The Missouri Department of Natural Resources has certified that this NWP will not violate existing state water quality standards provided you comply with the conditions included in their attached certification document. All conditions included in the water quality certification become conditions of the NWP authorization. Please review all conditions associated with this NWP. If you have any questions concerning state water quality standards or compliance issues with the associated certification conditions, please contact the Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, Missouri 65102-0176. You may also contact the office at 573-526-3589 or by email at wpsc401cert@dnr.mo.gov.

General condition 30 requires you to sign and submit the enclosed "Compliance Certification" within 30 days of completing the authorized activity or the completion of the implementation of any required compensatory mitigation.

This NWP verification is valid until March 18, 2022. Should your project plans change or if your activity is not complete within the specified verification term, you must contact this office for another permit

determination. Although the Corps has verified your project would meet the terms and conditions of a nationwide permit, other Federal, state and/or local permits may be required. You should verify this yourself.

We are interested in your thoughts and opinions concerning your experience with the Kansas City District, Corps of Engineers Regulatory Program. Please feel free to complete our Customer Service Survey form on our website at: http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey. You may also call and request a paper copy of the survey which you may complete and return to us by mail.

Mr. Anthony Koch, Regulatory Specialist, reviewed the information furnished and made this determination. If you have any questions concerning this matter, please feel free to contact Mr. Koch at 816-389-3828 or by email at anthony.j.koch@usace.army.mil. Please reference Permit No. NWK-2019-00702 in all comments and/or inquiries relating to this project.

Enclosures

cc (electronically w/o enclosures):

Environmental Protection Agency,
Watershed Planning and Implementation Branch
U.S. Fish and Wildlife Service, Columbia, Missouri
Missouri Department of Natural Resources,
Water Protection Program
State Historic Preservation Office
Missouri Department of Conservation

US Army Corps
of Engineers
Kansas City District

Nationwide Permit No. 39
Commercial and Institutional Developments.

Discharges of dredged or fill material into non-tidal waters of the United States for the construction or expansion of commercial and institutional building foundations and building pads and attendant features that are necessary for the use and maintenance of the structures. Attendant features may include, but are not limited to, roads, parking lots, garages, yards, utility lines, storm water management facilities, wastewater treatment facilities, and recreation facilities such as playgrounds and playing fields. Examples of commercial developments include retail stores, industrial facilities, restaurants, business parks, and shopping centers. Examples of institutional developments include schools, fire stations, government office buildings, judicial buildings, public works buildings, libraries, hospitals, and places of worship. The construction of new golf courses and new ski areas is not authorized by this NWP.

The discharge must not cause the loss of greater than 1/2-acre of non-tidal waters of the United States. The discharge must not cause the loss of more than 300 linear feet of stream bed, unless for intermittent and ephemeral stream beds the district engineer waives the 300 linear foot limit by making a written determination concluding that the discharge will result in no more than minimal adverse environmental effects. The loss of stream bed plus any other losses of jurisdictional wetlands and waters caused by the NWP activity cannot exceed 1/2-acre. This NWP does not authorize discharges into non-tidal wetlands adjacent to tidal waters.

Notification: The permittee must submit a pre-construction notification to the district engineer prior to commencing the activity. (See general condition 32.) (Authorities: Sections 10 and 404)

Note: For any activity that involves the construction of a wind energy generating structure, solar tower, or overhead transmission line, a copy of the PCN and NWP verification will be provided to the Department of Defense Siting Clearinghouse, which will evaluate potential effects on military activities.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Jackson County, Missouri

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:675 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 30 60 120 180

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

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

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

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

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 18, Sep 16, 2017

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

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

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	0.0	0.9%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	2.0	99.1%
Totals for Area of Interest		**2.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the

development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jackson County, Missouri

10082—Arisburg-Urban land complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w7ld
Elevation: 750 to 1,130 feet
Mean annual precipitation: 39 to 45 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arisburg and similar soils: 61 percent
Urban land: 30 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arisburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 13 inches: silt loam
Bt - 13 to 19 inches: silty clay loam
Btg - 19 to 56 inches: silty clay loam
BCg - 56 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: Loess Upland Prairie (R107BY007MO)
Hydric soil rating: No

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Sharpsburg

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loess Upland Prairie (R109XY002MO)
Hydric soil rating: No

Sampsel

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: Interbedded Sedimentary Upland Savanna (R109XY010MO)
Hydric soil rating: Yes

Greenton

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Loess Upland Prairie (R109XY002MO)
Hydric soil rating: No

10180—Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1n85h
Elevation: 600 to 900 feet
Mean annual precipitation: 33 to 43 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Udarents and similar soils: 41 percent
Urban land: 39 percent
Sampsel and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Deep Loess Upland Prairie (R107BY002MO)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Sampsel

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Residuum weathered from shale

Typical profile

Ap - 0 to 13 inches: silty clay loam
Bt - 13 to 80 inches: silty clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: Wet Footslope Prairie (R112XY041MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Hydrologic Soil Group and Surface Runoff

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or

soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–Jackson County, Missouri			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
10082—Arisburg-Urban land complex, 1 to 5 percent slopes			
Arisburg	61	—	C
Urban land	30	—	—
10180—Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes			
Udarents	41	Very high	C
Urban land	39	—	—
Sampsel	15	Very high	C/D

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