SUMMIT 470 LOGISTICS CENTER PRELIMINARY STORM DRAINAGE STUDY

Prepared for:

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Olsson Project No. 022-03974

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1. GENERAL INFORMATION

Summit 470 Logistics Center is a proposed 41.93-acre industrial development. This study will provide storm analysis and detention calculations of the project. The development will be split into two lots. Lot 1 (35.99 ac.) contains a 465,000 sq ft building, paved parking lots and driveways, two detention tracts, and utility main extensions. Lot 2 (5.94 ac.) will be partially graded to generate earthwork for Lot 1 and tie in a private drive while the rest of the lot will remain undisturbed. The entire site lies within the Little Cedar Creek – Little Blue River watershed with multiple outfalls throughout the site. Approximately 16.43 acres discharges west through an existing culvert and 6.86 discharges north through an existing culvert.

1.1 Project Location

Summit 470 Logistics Center is located partially in the City of Lee's Summit, Missouri and partially in Unity Village, Missouri. The area to be developed is bounded by a railroad and industrial park to the south, Main St. to the west, I-470 to the north, and a medical facility to the east.

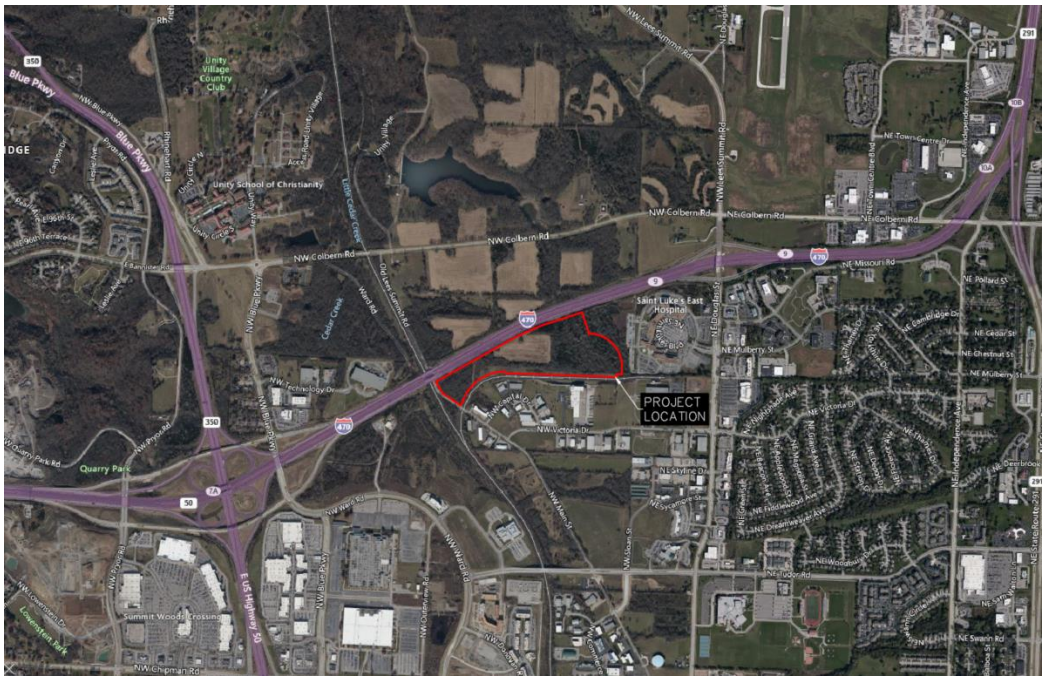

Figure 1. Summit 470 Logistics Center Location Map

1.2 Federal Emergency Management Agency Floodplain Classification

The site lies entirely within areas determined to be outside the 0.2% annual chance floodplain (unshaded Zone X) as depicted on the FEMA Flood Insurance Rate Map (FIRM) Community Panel No 29095C0409G (Village of Unity; City of Kansas City; City of Lee's Summit), revised January 20th, 2017. A copy of the FEMA FIRM panel is included in Appendix E.

1.3 Soil Classifications

A geotechnical investigation has not been completed for this site. Soil Maps published in the NRCS Web Soils Survey for Jackson County, Missouri categorizes soils in the watershed as:

Table 1. Soil Classifications

Symbol	Name	Slopes	Hydrologic Soil Group
10082	Arisburg-Urban land complex	1-5%	C
10120	Sharspburg silt loam	2-5%	C
10129	Sharpsburg-Urban land complex	5-9%	D
30080	Greenton silty clay loam	5-9%	C/D
40107	Snead-Rock outcrop complex, warm	5-14%	D

NRCS Runoff Curve Numbers (CN's) in this study have been assigned to tributary areas onsite based upon these Hydrologic Soil Groups and associated existing and proposed land use. Land uses were determined using zoning maps, aerial photos, and site visits. A copy of the NRCS printout is included in Appendix D.

1.4 Existing Stormwater Studies and Systems

No existing stormwater studies have been discovered.

2. METHODOLOGY

The base data for the models prepared for this report has been obtained from available online maps and aerial imagery. Stormwater management is based upon methods and objectives defined in the Kansas City Metropolitan Chapter of the American Public Works Association's (KC-APWA) 2011 design guidance document called "Section 5600 Storm Drainage Systems & Facilities" (2011).

The Existing Conditions hydrology will be evaluated in Section 3, and Proposed Conditions hydrology will be computed in Section 4. The Proposed Conditions discharge data for each stage of development will be compared to the Existing Conditions results; variations in quantity and rate of stormwater discharge between these models will represent the hydrologic impact generated by the proposed development. The overall stormwater management plan will be designed utilizing this information. Section 3 assumes current land use within the tributary sub-watersheds, and pre-development conditions within the project boundary. Section 4 assumes current land use within the tributary sub-watersheds, and proposed conditions within the project area boundary.

The following methods were used in this study to model existing and proposed conditions for stormwater runoff:

Hydraflow Hydrographs Extension Version 12

- Soil Conservation Survey (SCS) Unit Hydrograph Method
  - 2-year, 10-year, and 100-year Return Frequency Storms
  - Antecedent Moisture Conditions (AMC) II Soil Moisture Conditions
  - 24-Hour SCS Type II Rainfall Distribution
  - SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a – 2-2c)
  - SCS TR-55 methods for determination of time of concentration and travel time. Where specific data pertaining to channel geometry is not available, length and velocity estimates for channel flow travel time is used per Section 5600, KC-APWA Standard Specifications and Design Criteria.

In addition to the hydrologic evaluation, analysis is also required to provide extended detention control of the 90% mean annual event storm event.

Stormwater runoff models were created for the 2-, 10-, and 100-year design storm events. The precipitation depths used in the analyses have been interpolated from the "Technical Paper No.40 Rainfall Frequency Atlas of the United States" (TP-40) isopluvial maps (May 1961). The following Table 2 summarizes the rainfall depths used in this analysis:

Table 2. Precipitation Depths.

Return Period	24-Hour Precipitation Depth (in.)
90% Mean Annual Event	1.37
2-Year (50% Storm)	3.60
10-Year (10% Storm)	5.34
100-Year (1% Storm)	7.90

The following is a summary of the primary points of interest to the watersheds modeled in this report:

- **Outfall A** is the discharge point for the northern area of Summit 470 Logistics Center as well as for small portion of Missouri Department of Transportation (MoDOT) right-of-way (R/W) along Interstate 470. This outfall is an existing culvert conveying flow under I-470 to Unity Village Lake, and then discharging into Little Cedar Creek. Runoff from the proposed project area discharging through Outfall A will be controlled by an extended dry detention basin.
- **Outfall B** is the discharge point for the western & southern area of Summit 470 Logistics Center as well as the existing industrial park and a couple of industrial sites along NW Victoria Drive. This outfall is an existing 6'x6' reinforced concrete box culvert conveying flow under Main St., and then discharging into Little Cedar Creek. Runoff from the proposed project area discharging through Outfall B will be controlled by an extended dry detention basin.

3. EXISTING CONDITIONS

3.1 Existing Site Description

The existing site consists of mostly grassed and wooded vegetation, and straight row crops. It is bounded by Main St., I-470, a railroad, an industrial park, and a medical facility as described in Section 1, above. The total onsite Project Area encompasses 41.93 acres. Overall, the modeled stormwater drainage area encompasses 114.18 acres and is divided into the 3 areas and subareas that are tributary to the outfalls described in Section 2, above.

3.2 Existing Site Hydrology

Site topography and hydrology for project areas that are tributary to each outfall are as follows:

Outfall A

Onsite area that are tributary to Outfall A generally slope from south to north with surface grades up to 16%. Offsite areas north of the site that are tributary to Outfall A slope from north to south, with surface grades up to 33%. Steep slopes (3H:1V) are present in the wooded areas along the MoDOT R/W. Runoff is conveyed via sheet flow and shallow concentrated flow across the project area and offsite areas. No natural channels have been observed throughout the tributary area to Outfall A. This outfall is an existing culvert conveying flow under I-470 to Unity Village Lake, and then discharging into Little Cedar Creek.

Outfall B

There are two onsite areas that are tributary to Outfall B with the difference in the way of conveyance to the discharge point. Approximately half of the onsite tributary area slopes from northeast to southwest, with surface grades up to 33%. Runoff is conveyed via sheet flow and shallow concentrated flow, as well as via channel flow through an existing swale along the north side of the railroad to an existing 6’x6’ reinforced concrete box culvert at Point of Interest B1.

The other half of onsite tributary area slopes from north to south, with surface grades up to 10%, which gets picked up by existing culvert under the railroad. The culvert is a part of an existing complex storm sewer network, which conveys stormwater through the industrial park, then discharges into an existing detention basin at Point of Interest B2.

Offsite areas south of the site that are tributary to Outfall B slope from east to west and are conveyed to the existing detention basin at Point of Interest B2 through an existing storm sewer network.

Runoff Curve Numbers have been developed for each outfall area based upon the current land use obtained from survey data, aerial photography, and site visits. Existing site model input data is summarized in Table 3-1, below. Refer to the Existing Conditions - Drainage Map (EXH-01)

and Existing Conditions - Land Cover (EXH-02) in Appendix A, and model calculations in Appendix B for Runoff Curve Number (CN) and Time of Concentration (Tc) calculations.

Table 3-1. Existing Site Data

Existing Site Data					
Subbasin	On-Site Area (ac.)	Off-site Area (ac.)	Total Drainage Area (ac.)	CN	Tc (min)
A	5.21	1.65	6.86	78.68	11.8
B1	9.32	7.11	16.43	82.00	16.2
B2	12.13	78.76	90.89	86.54	17.0

These routings, drainage area, CN and Tc values for the corresponding areas were used as input to the Existing Conditions model to evaluate the existing stormwater hydrology for the project. The resulting peak flows of the hydrologic routing are provided in Table 3-2, below. Hydrographs and model output data can be found in its entirety in Appendix B.

Table 3-2. Existing Peak Discharge Rates

Existing Peak Discharge Rates			
Outfall	**Q_2 (cfs)**	**Q_{10} (cfs)**	**Q_{100} (cfs)**
Outfall A	16.21	30.63	52.78
Outfall B	151.19	203.36	419.23

Per APWA Section 5608.4 and the City of Lee's Summit criteria, the performance criteria for comprehensive control is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 50 percent storm peak rate less than or equal to 0.5 cubic feet per second (cfs) per site acre
- 10 percent storm peak rate less than or equal to 2.0 cfs per site acre
- 1 percent storm peak rate less than or equal to 3.0 cfs per site acre

Extended detention of the 90 percent mean annual event is also required for comprehensive control per APWA Section 5608.4.

Allowable release rates were calculated for the points of interest, allowing that off-site peak discharges would be permitted to bypass the detention. Off-site bypass peak flow rates were calculated as the site's percentage of the existing conditions, relating to the percentage of off-

site area flowing to each point. The release rates for the proposed development on the development site were calculated based on the detention criteria. The development release rates were added to the bypass peak flow rates to calculate an allowable peak flow rate for each outfall as follows. Tables 3-3 and 3-4 below summarize the amount of area on-site and the allowable discharges for each storm event.

Table 3-3. Outfall On-Site Area

Outfall	Total Area (ac.)	On-Site Area (ac.)	Percent (%) On-Site
Outfall A	6.86	5.21	75.9
Outfall B	107.32	21.45	20.0

Table 3-4. Allowable Peak Flow Rates

Outfall	Allowable 2-Year Q (cfs)	Allowable 10-Year Q (cfs)	Allowable 100-Year Q (cfs)
Outfall A	6.50	17.79	28.32
Outfall B	131.68	205.59	399.73

4. PROPOSED CONDITIONS

4.1 Proposed Site Description

Summit 470 Logistics Center contains a 465,000 sq ft building, paved parking lots and driveways, two detention tracts, and utility main extensions. The sections below will provide updated model calculation results for Proposed Conditions. The updates will account for proposed tributary shifts caused by detention facilities, site grading, and storm sewer infrastructure within the development.

4.2 Proposed Conditions Site Hydrology

The proposed model, as in the existing model, will be divided between Outfalls A and B. Due to the tributary shifts caused by site grading and sewer construction, the limits of existing subareas will be adjusted as shown on the Proposed Conditions - Drainage Map in Appendix A. Table 4-1, below, provides a summary of the proposed subareas. To ensure accurate model results, Point of Interest B3 was introduced to account for drainage to be detained in west basin. Refer to the Proposed Conditions - Drainage Map (EXH-03) and Proposed Conditions – Land Cover (EXH-04) in Appendix A and model calculations in Appendix C for Runoff Curve Number (CN) and Time of Concentration (Tc) calculations.

The analysis provided in Section 3 established existing conditions of the development's drainage areas. The analysis in this section will provide guidance for configuring the detention basin to meet the objectives established in Section 3.

The following tables summarize the results of the proposed conditions analysis. Tables 4-1 and 4-2 assume no detention is provided, to demonstrate the effects of development for each drainage area. Refer to Appendix C for output from and a schematic of the proposed conditions Hydraflow Hydrographs model.

Table 4-1. Proposed Site Data

Proposed Site Data			
Area	Drainage Area (ac.)	CN	Tc (min)
A	16.87	92.36	21.0
B1	12.05	84.50	5.0
B2	77.35	88.64	17.0
B3	15.46	96.03	21.3

Table 4-2. Proposed (No Detention) Conditions Peak Flow Rates

Proposed (No Detention) Peak Discharge Rates			
Outfall	**Q_2 (cfs)**	**Q_{10} (cfs)**	**Q_{100} (cfs)**
Outfall A	48.26	76.19	116.92
Outfall B	169.77	235.75	369.82

Table 4-2 shows post-development peak discharge values points of interest assuming no detention is provided. Table 4-3 compares these to the existing conditions from Section 3 at the points of interest. Negative values indicate a reduction in peak flow rate, while positive values indicate an increase. Without detention, flow rates will increase at both outfalls for almost all storm events.

Table 4-3. Proposed (No Detention) vs Existing Conditions

Proposed (No Detention) Peak Discharge Rates			
Outfall	**Q_2 (cfs)**	**Q_{10} (cfs)**	**Q_{100} (cfs)**
Outfall A	32.05	45.56	64.14
Outfall B	18.58	32.39	-49.41

Two extended dry bottom detention basins, North Basin and West Basin, are going to treat runoff from Areas A and B3 respectively. Details of the detention basins are provided below.

North Basin

- Top of Basin Elevation = 983.90’
- Minimum Basin Elevation = 977.00’
- 100’ Emergency Spillway at 982.80’
  Primary Outfall:
- 5’x5’ Control Structure with: 5” circular orifice at 977.00’ and 12”x48” opening at 981.00’
- 24” Outfall Pipe Elevation = 977.00’

West Basin

- Top of Basin Elevation = 975.70’
- Minimum Basin Elevation = 965.70’
- 100’ Emergency Spillway at 974.40’
  Primary Outfall:
- 5’x5’ Control Structure with: 6” circular orifice at 965.70’ and 12”x36” opening at 970.20’

- 24” Outfall Pipe Elevation = 965.70’

Table 4-4 below includes a hydrologic summary of the proposed detention facilities.

Table 4-4. Proposed Conditions Detention Basin Data

	Peak Q In (cfs)	T_P In (hr.)	Peak Q Out (cfs)	T_P Out (hr.)	Max V_R (ac-ft)	Peak W.S.E. (ft)
North Basin						
2-Year	43.77	12.10	0.63	22.53	2.84	980.72
10-Year	68.40	12.10	3.78	13.77	3.85	981.37
100-Year	104.15	12.10	16.20	12.57	5.33	982.23
West Basin						
2-Year	48.65	12.10	8.75	12.53	2.17	971.01
10-Year	73.71	12.10	18.78	12.47	3.19	972.15
100-Year	110.25	12.10	26.73	12.47	4.85	973.83

4.3 Effects of Proposed Detention

The following tables compare the results of the proposed conditions analysis with the detention described above to the existing conditions from Section 3 at the outfalls. Table 4-5 shows peak discharge values at outfalls in the proposed conditions. Tables 4-6 and 4-7 compare these discharge values to existing and allowable discharge values. In Tables 4-6 and 4-7, negative values indicate a reduction in peak flows, while positive values indicate an increase. With the addition of the detention facility, peak discharges at all outfalls will be below the allowable release rates and below rates in the existing conditions

Table 4-5. Proposed Conditions Updated Outfalls Summary

Outfall	Q_2 (cfs)	T_{P-2} (hr)	Q_{10} (cfs)	T_{P-10} (hr)	Q_{100} (cfs)	T_{P-100} (hr)
A	6.45	12.00	10.85	12.00	17.96	12.50
B	131.03	12.30	180.29	11.97	320.94	12.30

Table 4-6. Proposed Conditions vs Allowable Release Rates

Outfall	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A	-0.05	-6.94	-10.36
B	-0.65	-25.30	-78.79

Table 4-7. Proposed Conditions vs Existing Conditions

Outfall	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A	-9.76	-19.78	-34.82
B	-20.16	-23.07	-98.29

5. RESULTS AND CONCLUSION

This Stormwater Drainage Study has been prepared for the proposed project to establish a comprehensive stormwater management plan for the site. The proposed stormwater management plan has been designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri.

As shown in the discussion and tables in the previous sections, although total runoff volumes generated by the proposed development are increased due to increase in impervious surfaces within the site, the proposed detention basins adequately reduce the peak stormwater rate to meet Allowable Release Rates. Both outfalls A and B also show decreased flowrates compared to those in existing conditions.

This study demonstrated the overall compliance with KCAPWA Section 5600.

APPENDIX A
Exhibits

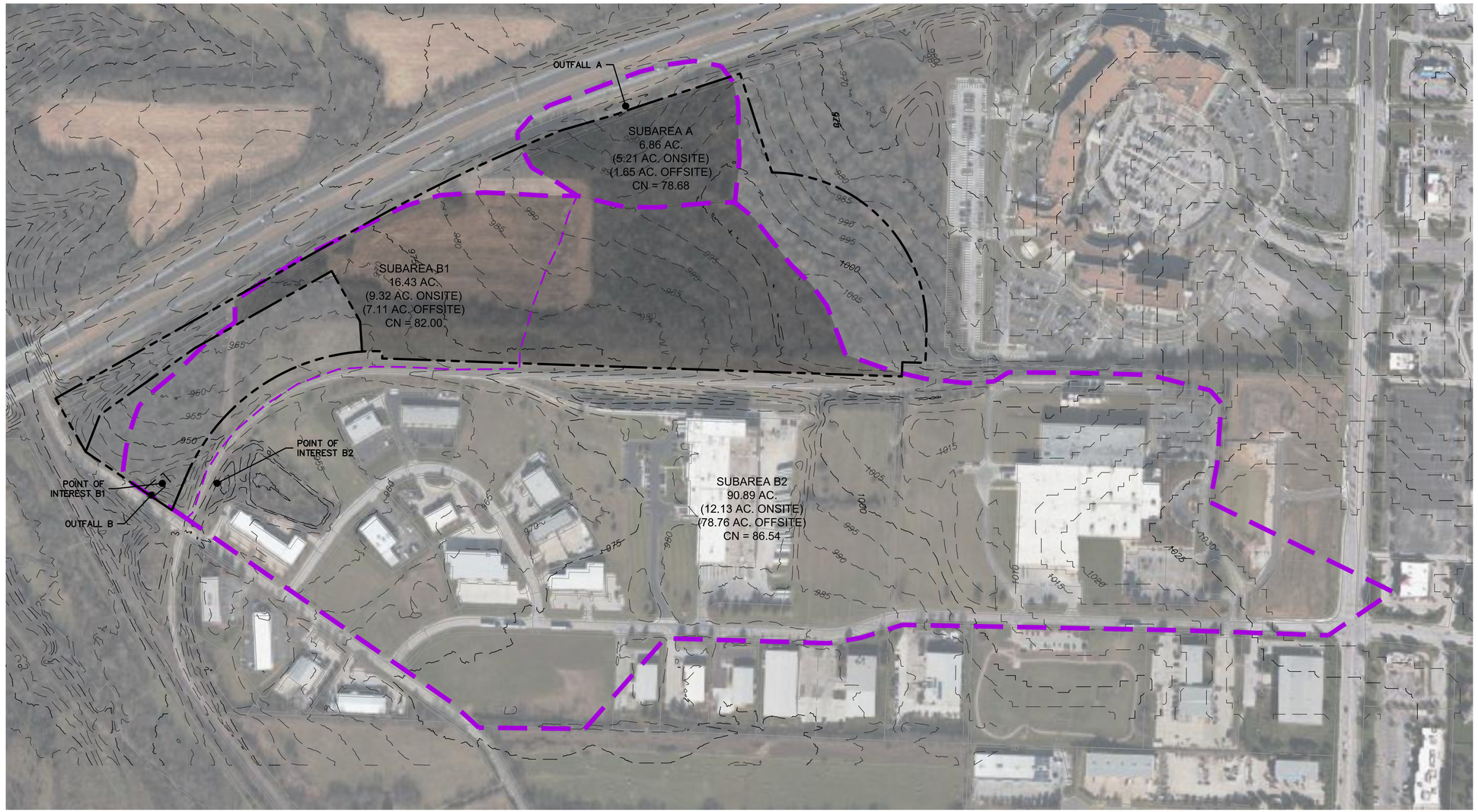

EXHIBIT LEGEND

- PROJECT BOUNDARY
- DRAINAGE AREA BOUNDARIES
- DRAINAGE SUBAREAS BOUNDARIES
- PORTION OF DRAINAGE AREA DIRECTLY FROM THE SITE
- FLOW DIRECTION

N

0' 100' 200' 400'
SCALE IN FEET

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EXISTING CONDITIONS - DRAINAGE MAP

SUMMIT 470 LOGISTICS

LEE'S SUMMIT, MO

2022

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SHEET
EXH-01

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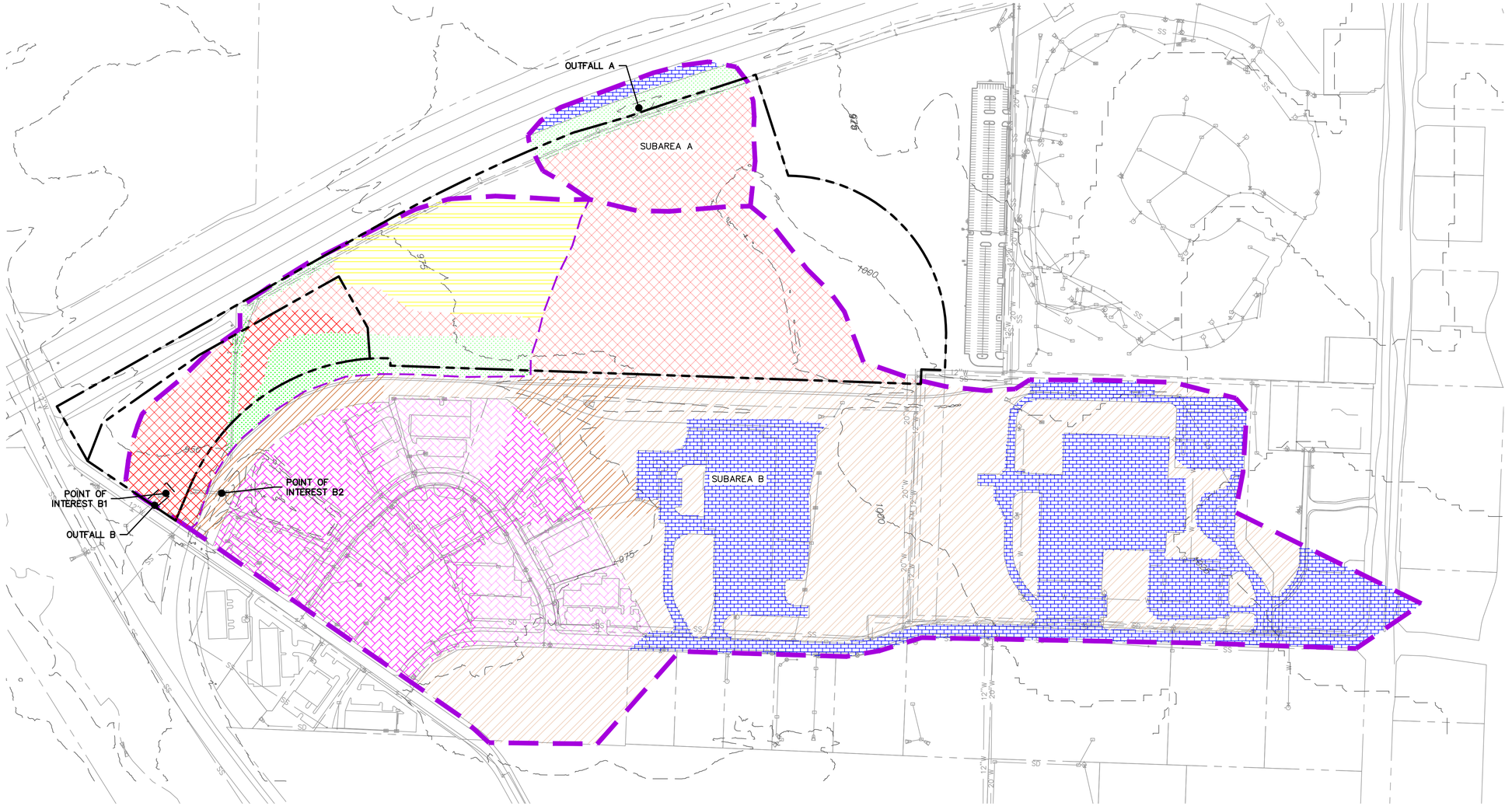

LAND COVER LEGEND						
DRAINAGE AREA	DRAINAGE SUBAREA	HATCH	COVER DESCRIPTION	SOIL GROUP	CN	AREA (AC.)
OUTFALL A			WOODS–GRASS, FAIR	C	76	4.59
			PASTURE, FAIR	C	79	1.66
			PAVEMENT	C	98	0.61
			OUTFALL A TOTAL		79	6.86

LAND COVER LEGEND						
DRAINAGE AREA	DRAINAGE SUBAREA	HATCH	COVER DESCRIPTION	SOIL GROUP	CN	AREA (AC.)
OUTFALL B	SUBAREA B1		WOODS–GRASS, FAIR	C	76	2.38
			WOODS–GRASS, FAIR	C/D	79	0.61
			WOODS–GRASS, FAIR	D	82	3.43
			PASTURE, FAIR	C	79	1.95
			PASTURE, FAIR	D	84	2.08
			STRAIGHT ROW CROPS	C	85	5.98
			SUBAREA B1 TOTAL		82	16.43
	SUBAREA B2		PAVEMENT; BUILDINGS	C	98	21.90
			OPEN SPACE, TURF, FAIR	C	79	30.55
			OPEN SPACE, TURF, FAIR	D	84	4.38
			INDUSTRIAL	C	91	7.47
			INDUSTRIAL	D	93	13.99
			WOODS–GRASS, FAIR	C	76	12.60
			SUBAREA B2 TOTAL		87	90.89

EXHIBIT LEGEND

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EXISTING CONDITIONS - LAND COVER

SUMMIT 470 LOGISTICS

LEE'S SUMMIT, MO

2022

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EXH-02

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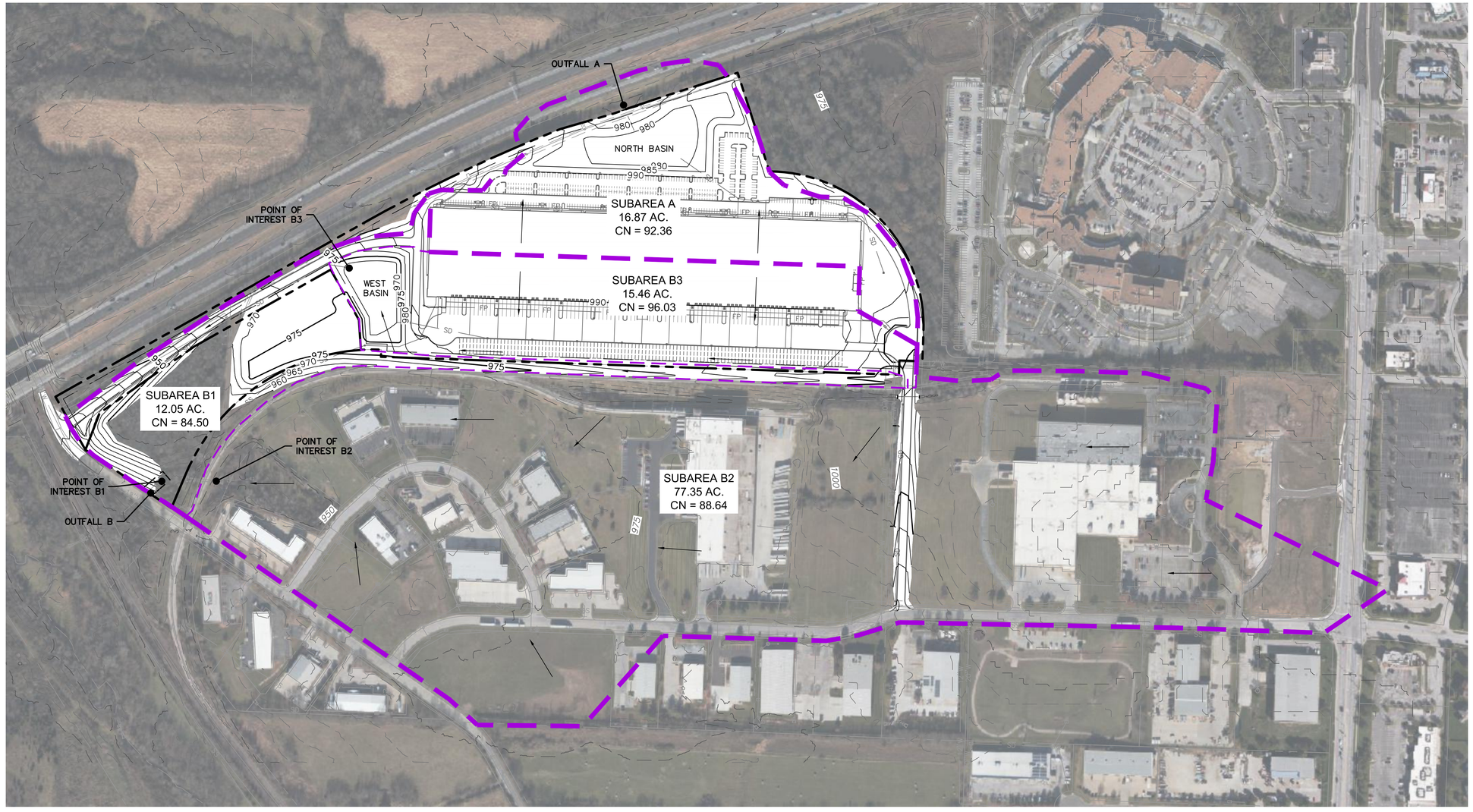

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PROPOSED CONDITIONS - DRAINAGE MAP

SUMMIT 470 LOGISTICS

LEE'S SUMMIT, MO

2022

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project no.: 02203974
date: Nov 07, 2022

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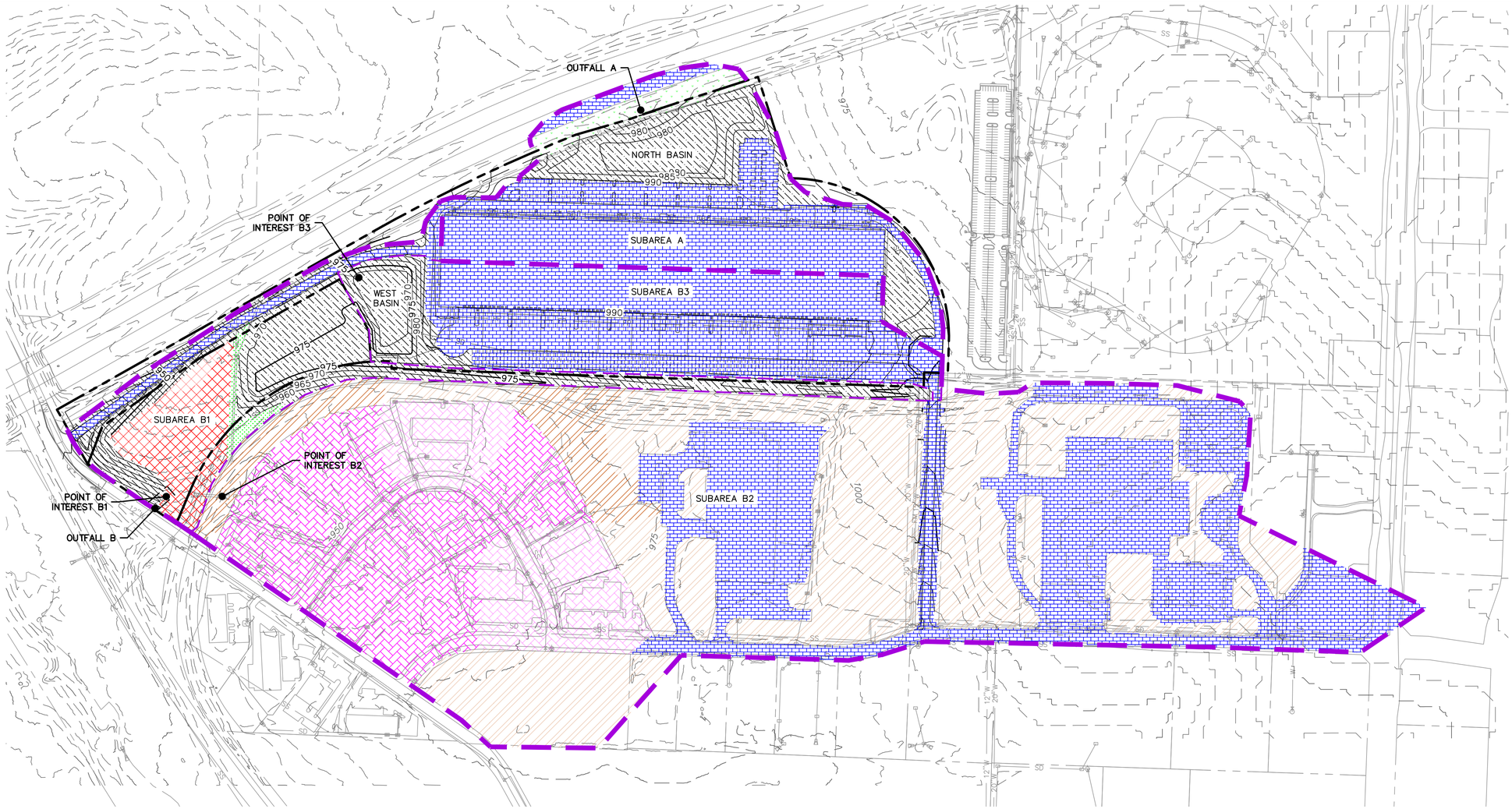

LAND COVER LEGEND						
DRAINAGE AREA	DRAINAGE SUBAREA	HATCH	COVER DESCRIPTION	SOIL GROUP	CN	AREA (AC.)
OUTFALL A			OPEN SPACE, TURF, FAIR	D	84	4.95
			PASTURE, FAIR	C	79	1.36
			PAVEMENT	D	98	10.56
			OUTFALL A TOTAL		92	16.87

LAND COVER LEGEND						
DRAINAGE AREA	DRAINAGE SUBAREA	HATCH	COVER DESCRIPTION	SOIL GROUP	CN	AREA (AC.)
OUTFALL B	SUBAREA B1		WOODS–GRASS, FAIR	C	76	0.23
			WOODS–GRASS, FAIR	C/D	79	0.81
			WOODS–GRASS, FAIR	D	82	2.08
			PASTURE, FAIR	D	84	0.43
			PAVEMENT	D	98	1.15
			OPEN SPACE, TURF, FAIR	D	84	7.35
			SUBAREA B1 TOTAL		85	12.05
	SUBAREA B2		PAVEMENT; BUILDINGS	C	98	23.10
			OPEN SPACE, TURF, FAIR	C	79	28.59
			OPEN SPACE, TURF, FAIR	D	84	4.20
			INDUSTRIAL	C	91	7.47
			INDUSTRIAL	D	93	13.99
			SUBAREA B2 TOTAL		89	77.35
	SUBAREA B3		PAVEMENT; BUILDINGS	D	98	13.29
			OPEN SPACE, TURF, FAIR	D	84	2.17
			SUBAREA B3 TOTAL		96	15.46

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EXISTING CONDITIONS - LAND COVER

SUMMIT 470 LOGISTICS

LEE'S SUMMIT, MO

2022

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project no.:
date:

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EXH-04

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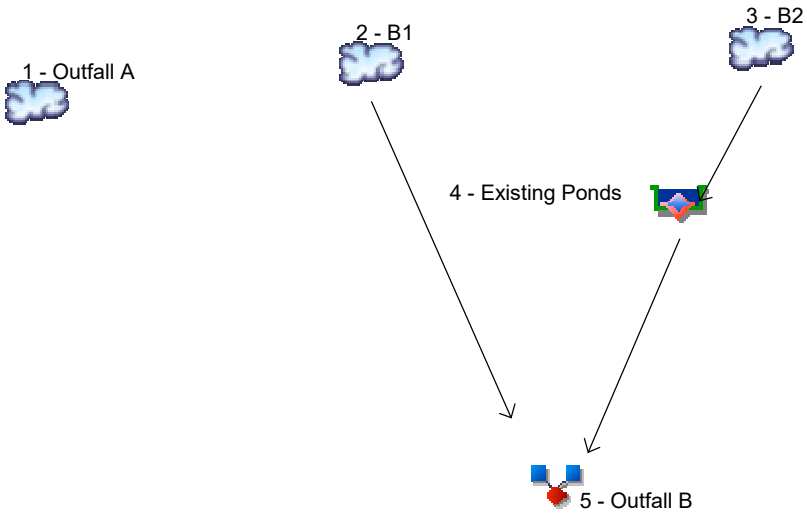
APPENDIX B

Existing Conditions Hydraflow Hydrographs Model Input and Results

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Outfall A
2	SCS Runoff	B1
3	SCS Runoff	B2
4	Reservoir(i)	Existing Ponds
5	Combine	Outfall B

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	------	1.450	16.21	-------	-------	30.63	-------	-------	52.78	Outfall A
2	SCS Runoff	------	4.878	38.69	-------	-------	69.79	-------	-------	116.62	B1
3	SCS Runoff	------	44.89	239.05	-------	-------	402.52	-------	-------	642.57	B2
4	Reservoir(i)	3	38.52	125.93	-------	-------	168.41	-------	-------	382.97	Existing Ponds
5	Combine	2, 4	42.25	151.19	-------	-------	203.36	-------	-------	419.23	Outfall B

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	1.450	2	722	5,159	------	------	------	Outfall A
2	SCS Runoff	4.878	2	724	16,122	------	------	------	B1
3	SCS Runoff	44.89	2	726	147,559	------	------	------	B2
4	Reservoir(i)	38.52	2	730	147,589	3	941.30	12,589	Existing Ponds
5	Combine	42.25	2	730	163,711	2, 4	------	------	Outfall B

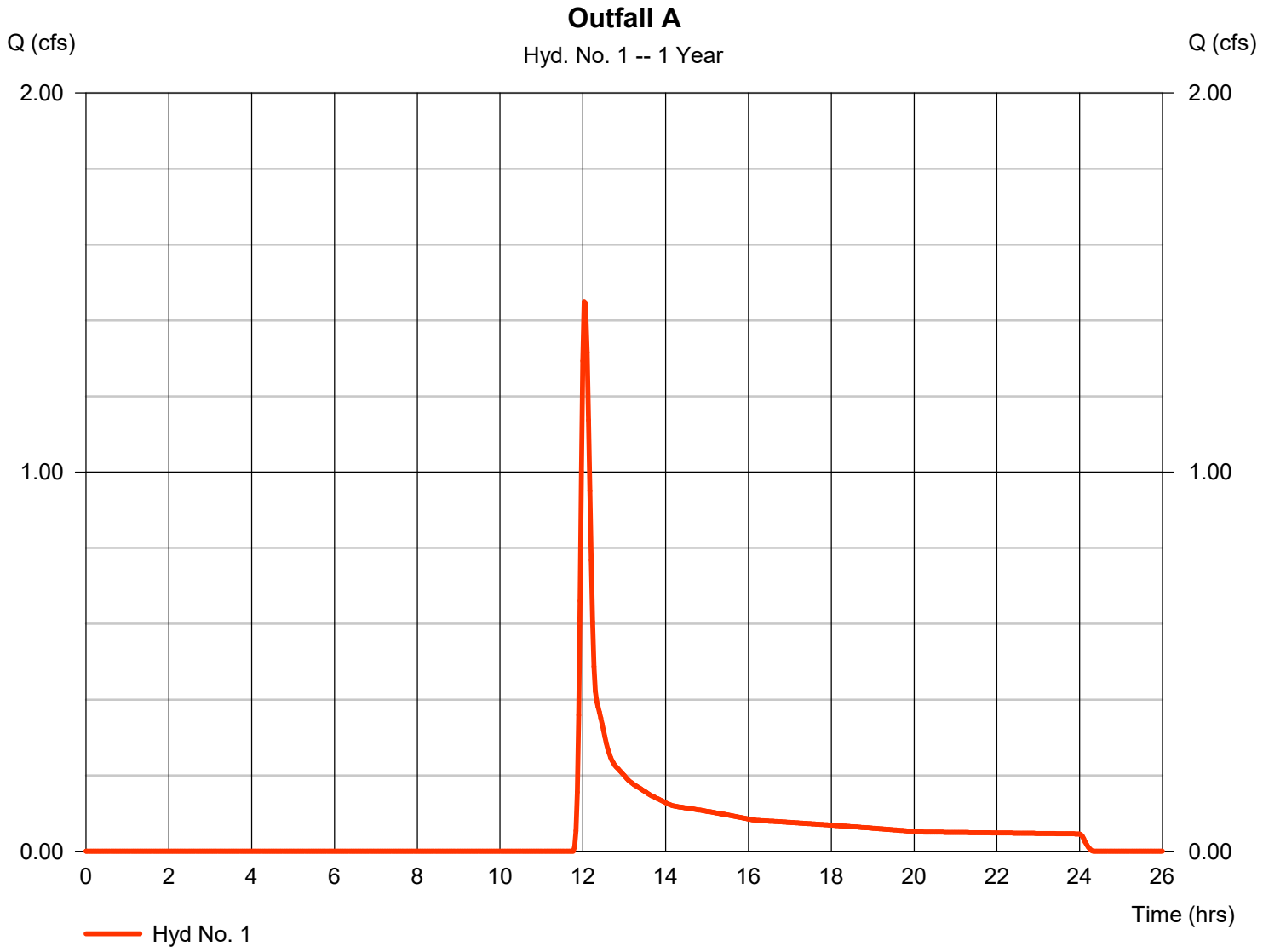
Hydrograph Report

Hyd. No. 1

Outfall A

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.450 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	5,159 cuft
Drainage area	=	6.860 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.590 x 76) + (1.660 x 79) + (0.610 x 98)] / 6.860



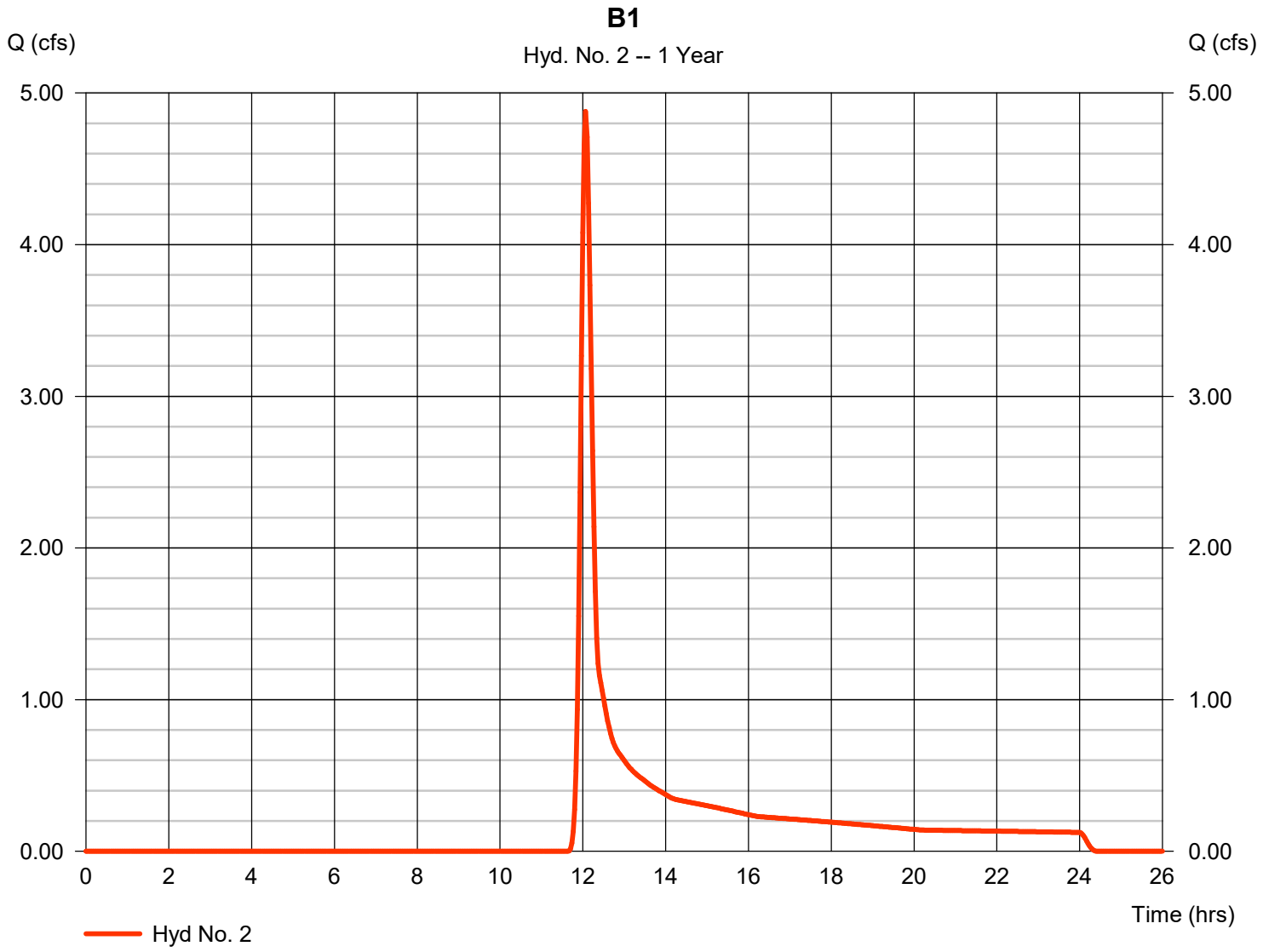
Hydrograph Report

Hyd. No. 2

B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.878 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	16,122 cuft
Drainage area	=	16.430 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	16.20 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.430 x 82) + (0.610 x 79) + (2.380 x 76) + (2.080 x 84) + (1.950 x 79) + (5.980 x 85)] / 16.430



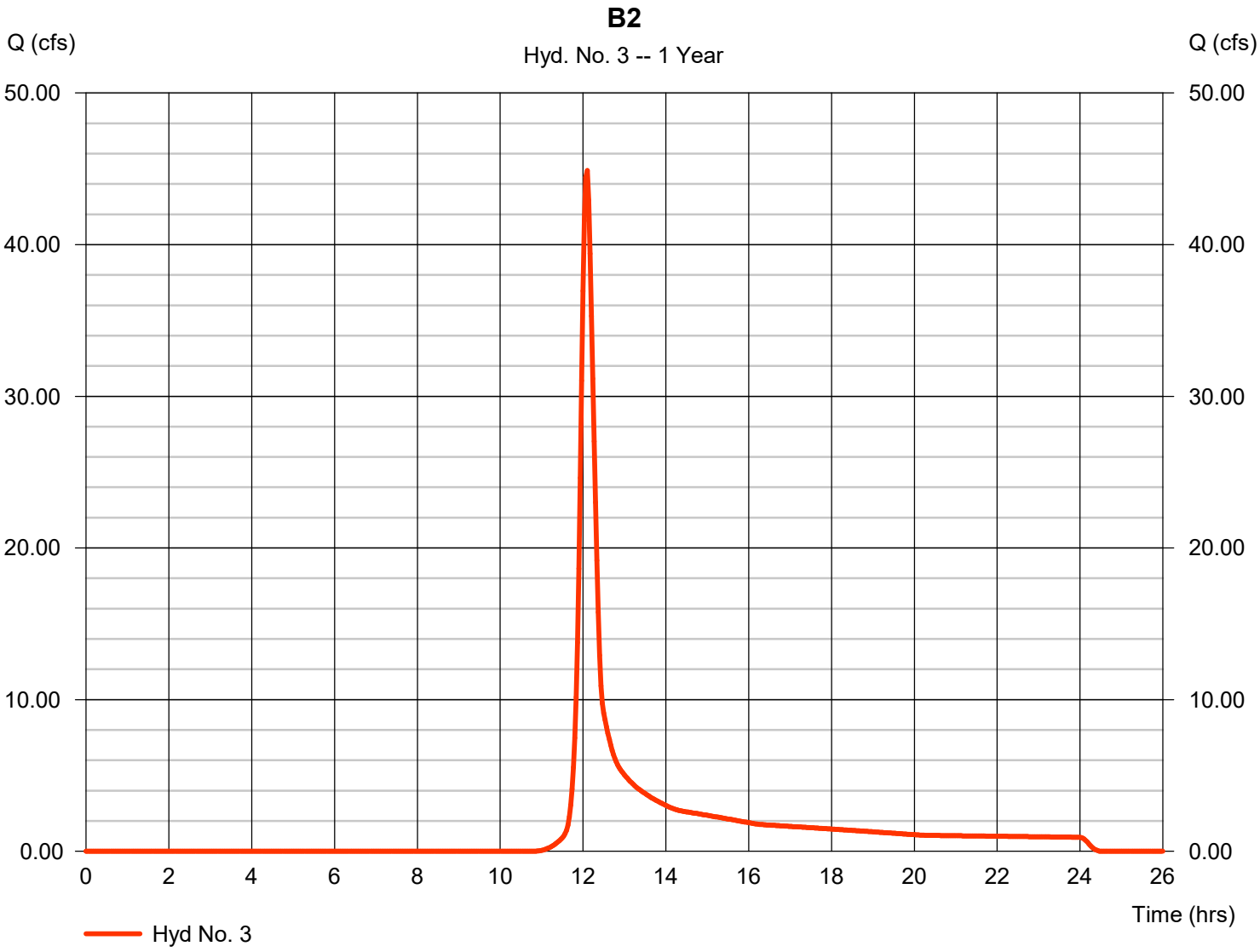
Hydrograph Report

Hyd. No. 3

B2

Hydrograph type	= SCS Runoff	Peak discharge	= 44.89 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 147,559 cuft
Drainage area	= 90.890 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.00 min
Total precip.	= 1.37 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(21.900 x 98) + (30.550 x 79) + (4.380 x 84) + (7.470 x 91) + (13.990 x 93) + (12.600 x 76)] / 90.890



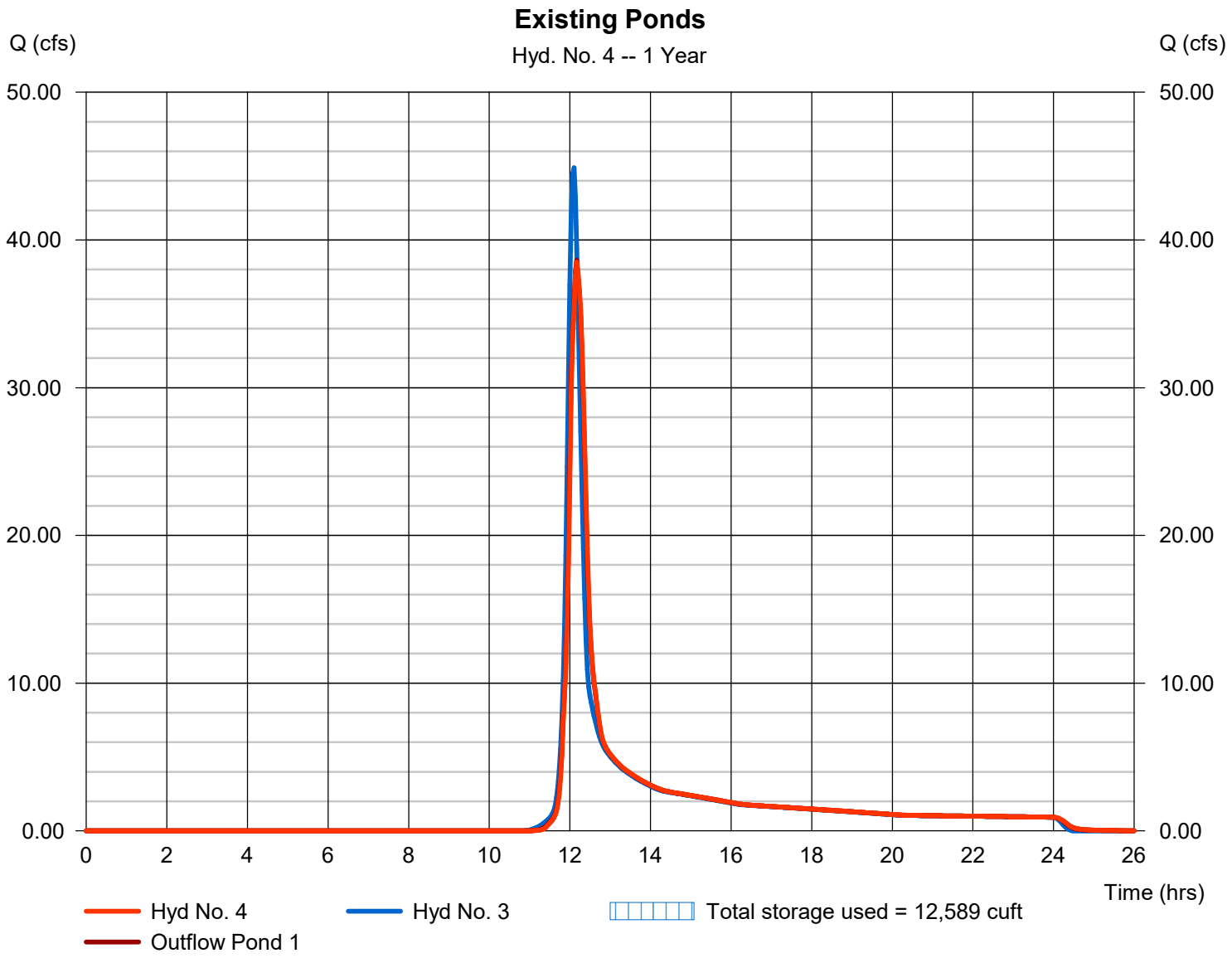
Hydrograph Report

Hyd. No. 4

Existing Ponds

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	38.52 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	147,589 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - B2	Other Inflow hyd.	=	None
Max. Elevation	=	941.30 ft	Max. Elevation	=	939.64 ft
Max. Storage	=	11,443 cuft	Max. Storage	=	1,146 cuft

Interconnected Pond Routing. Storage Indication method used.

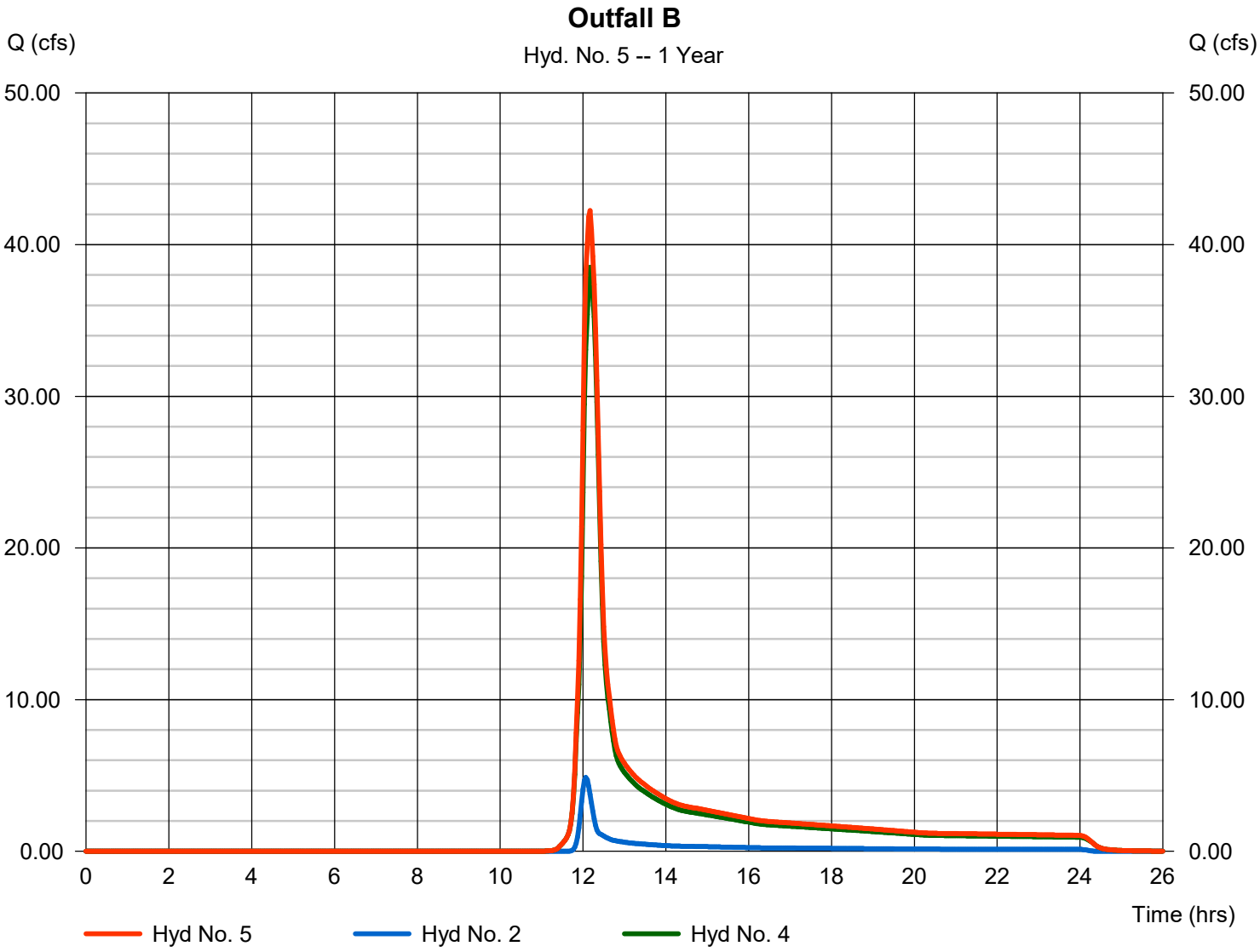


Hydrograph Report

Hyd. No. 5

Outfall B

Hydrograph type	= Combine	Peak discharge	= 42.25 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 163,711 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 16.430 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	16.21	2	720	42,219	------	------	------	Outfall A
2	SCS Runoff	38.69	2	722	108,478	------	------	------	B1
3	SCS Runoff	239.05	2	724	749,770	------	------	------	B2
4	Reservoir(i)	125.93	2	736	749,770	3	945.36	148,177	Existing Ponds
5	Combine	151.19	2	726	858,247	2, 4	------	------	Outfall B

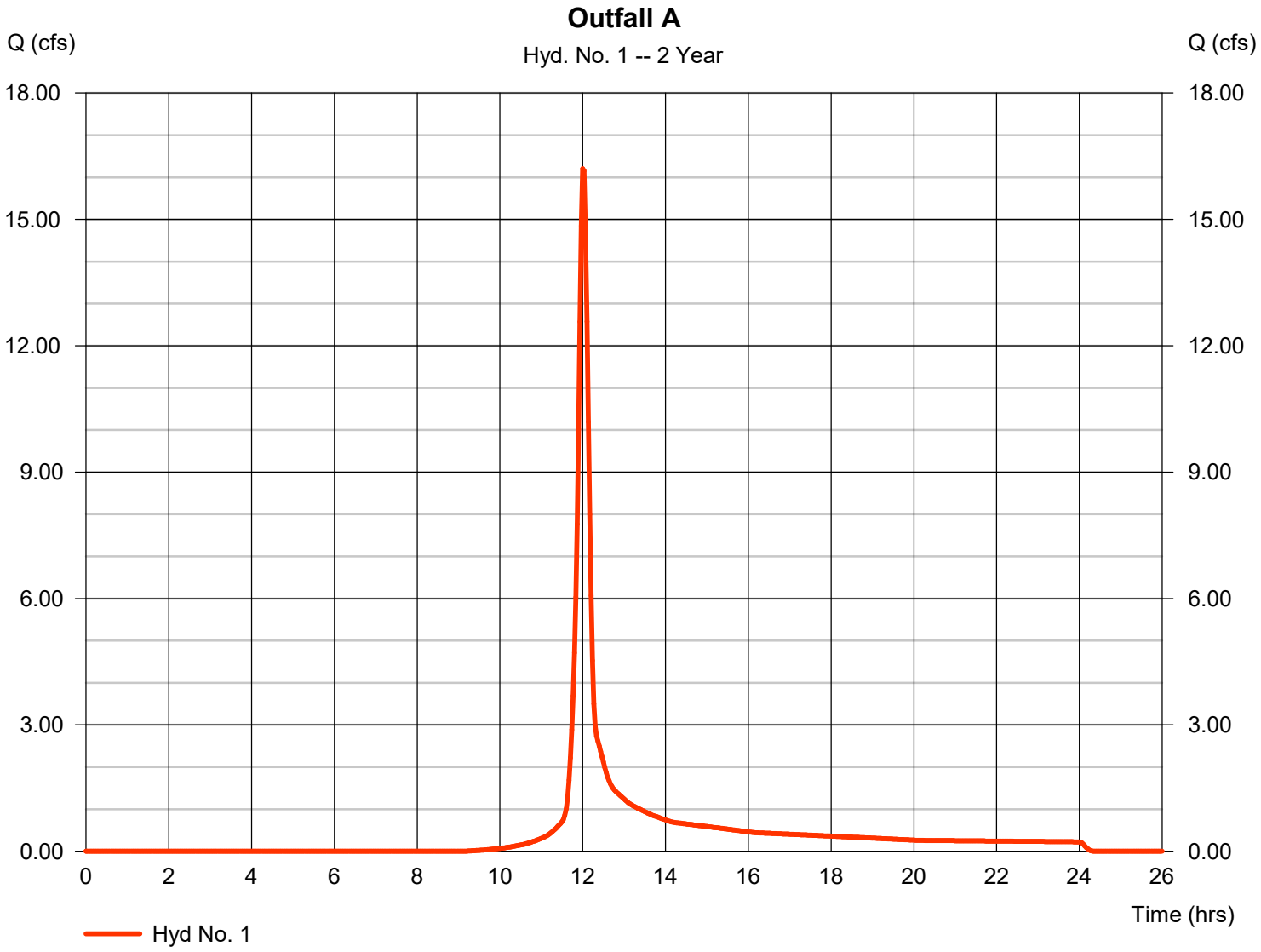
Hydrograph Report

Hyd. No. 1

Outfall A

Hydrograph type	=	SCS Runoff	Peak discharge	=	16.21 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	42,219 cuft
Drainage area	=	6.860 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.590 x 76) + (1.660 x 79) + (0.610 x 98)] / 6.860



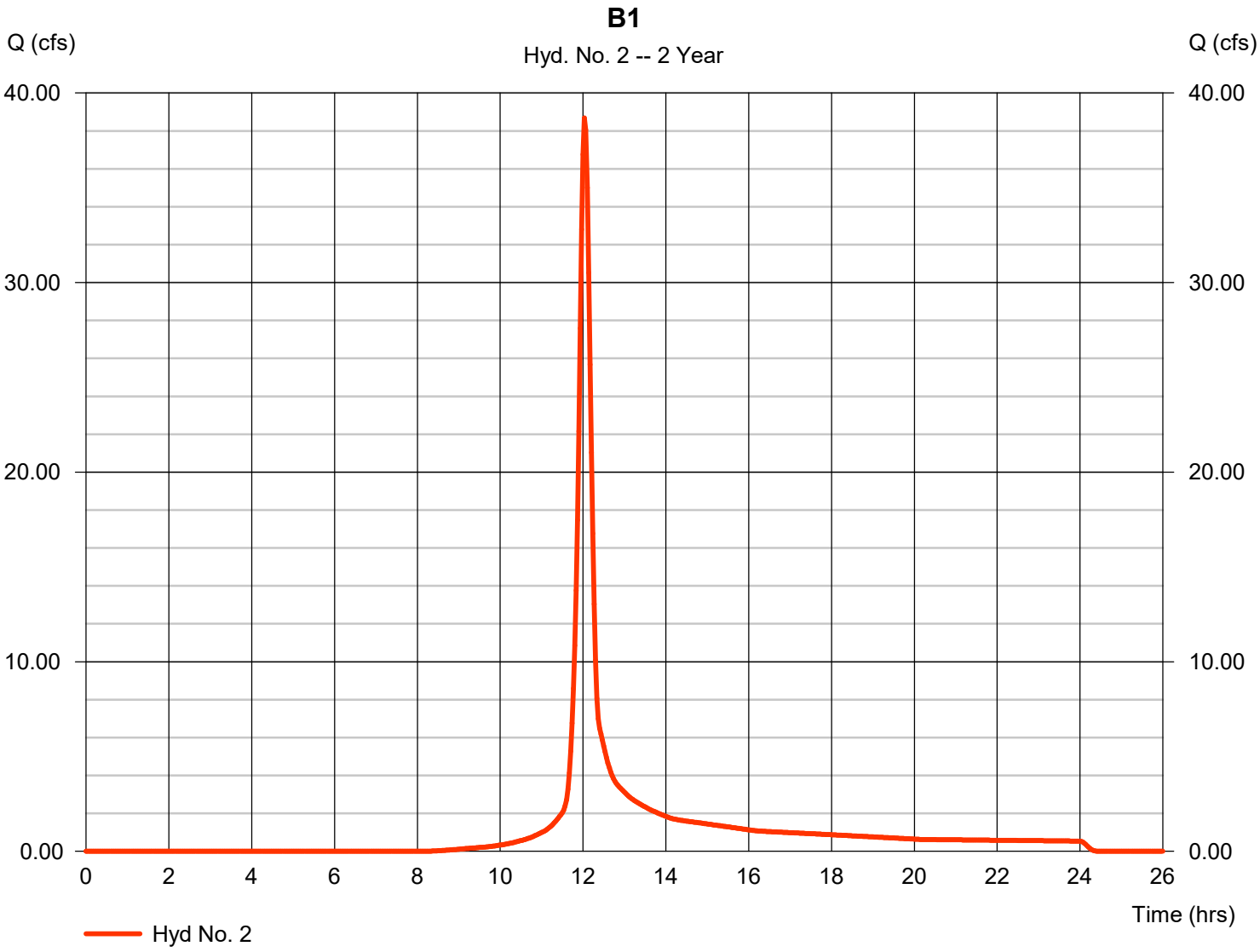
Hydrograph Report

Hyd. No. 2

B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	38.69 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	108,478 cuft
Drainage area	=	16.430 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	16.20 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.430 x 82) + (0.610 x 79) + (2.380 x 76) + (2.080 x 84) + (1.950 x 79) + (5.980 x 85)] / 16.430



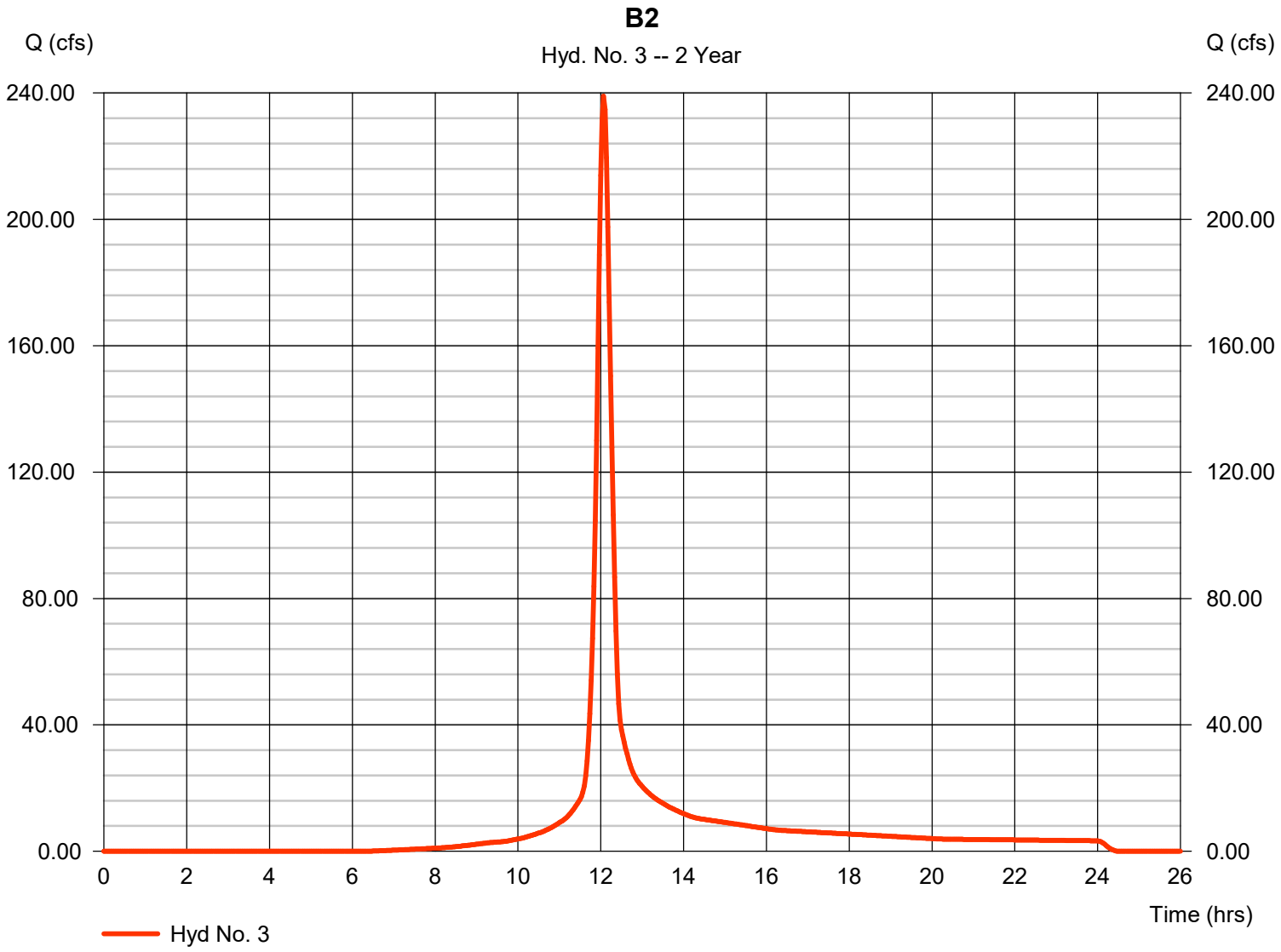
Hydrograph Report

Hyd. No. 3

B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	239.05 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	749,770 cuft
Drainage area	=	90.890 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(21.900 x 98) + (30.550 x 79) + (4.380 x 84) + (7.470 x 91) + (13.990 x 93) + (12.600 x 76)] / 90.890



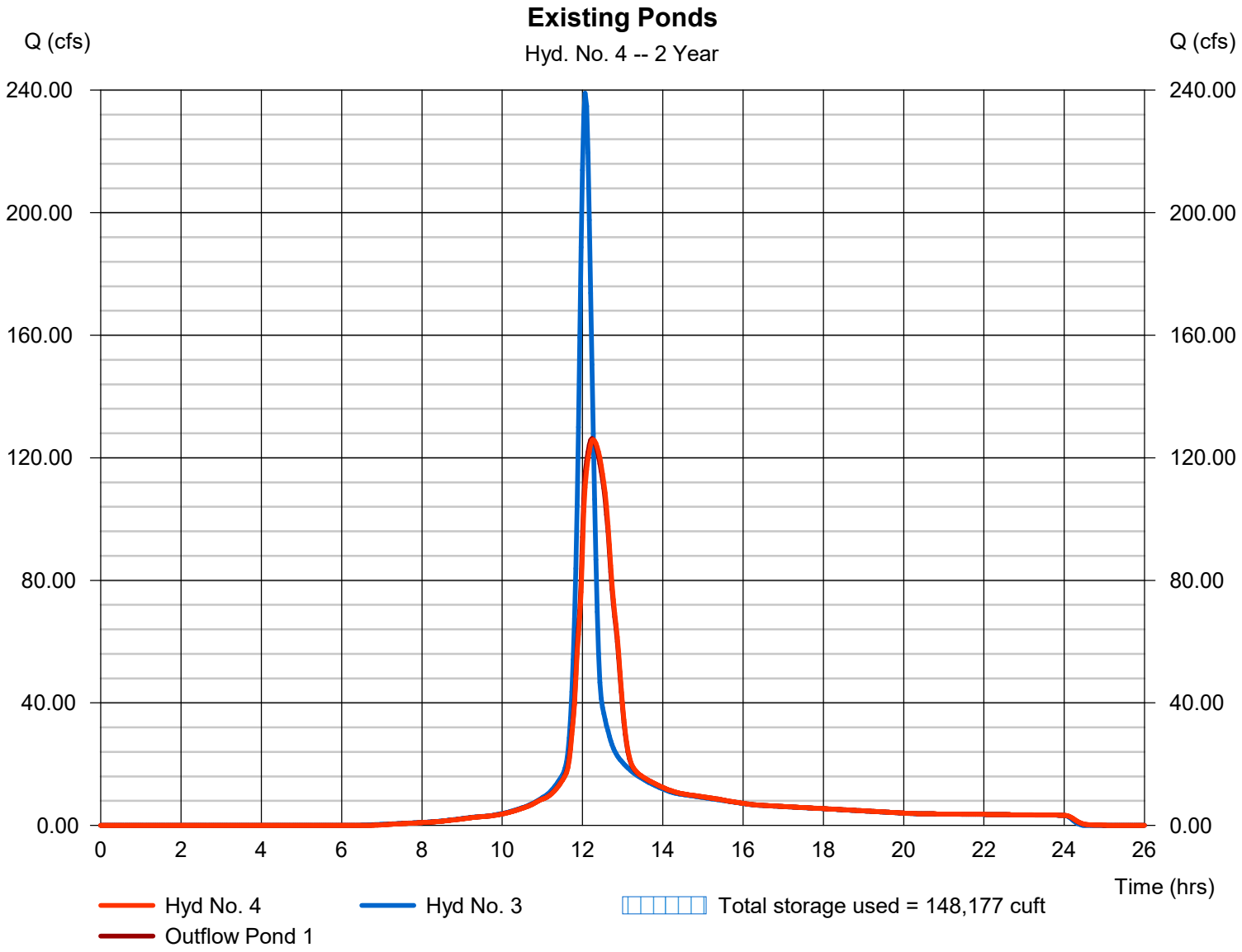
Hydrograph Report

Hyd. No. 4

Existing Ponds

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	125.93 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.27 hrs
Time interval	=	2 min	Hyd. volume	=	749,770 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - B2	Other Inflow hyd.	=	None
Max. Elevation	=	945.36 ft	Max. Elevation	=	941.60 ft
Max. Storage	=	142,882 cuft	Max. Storage	=	5,295 cuft

Interconnected Pond Routing. Storage Indication method used.

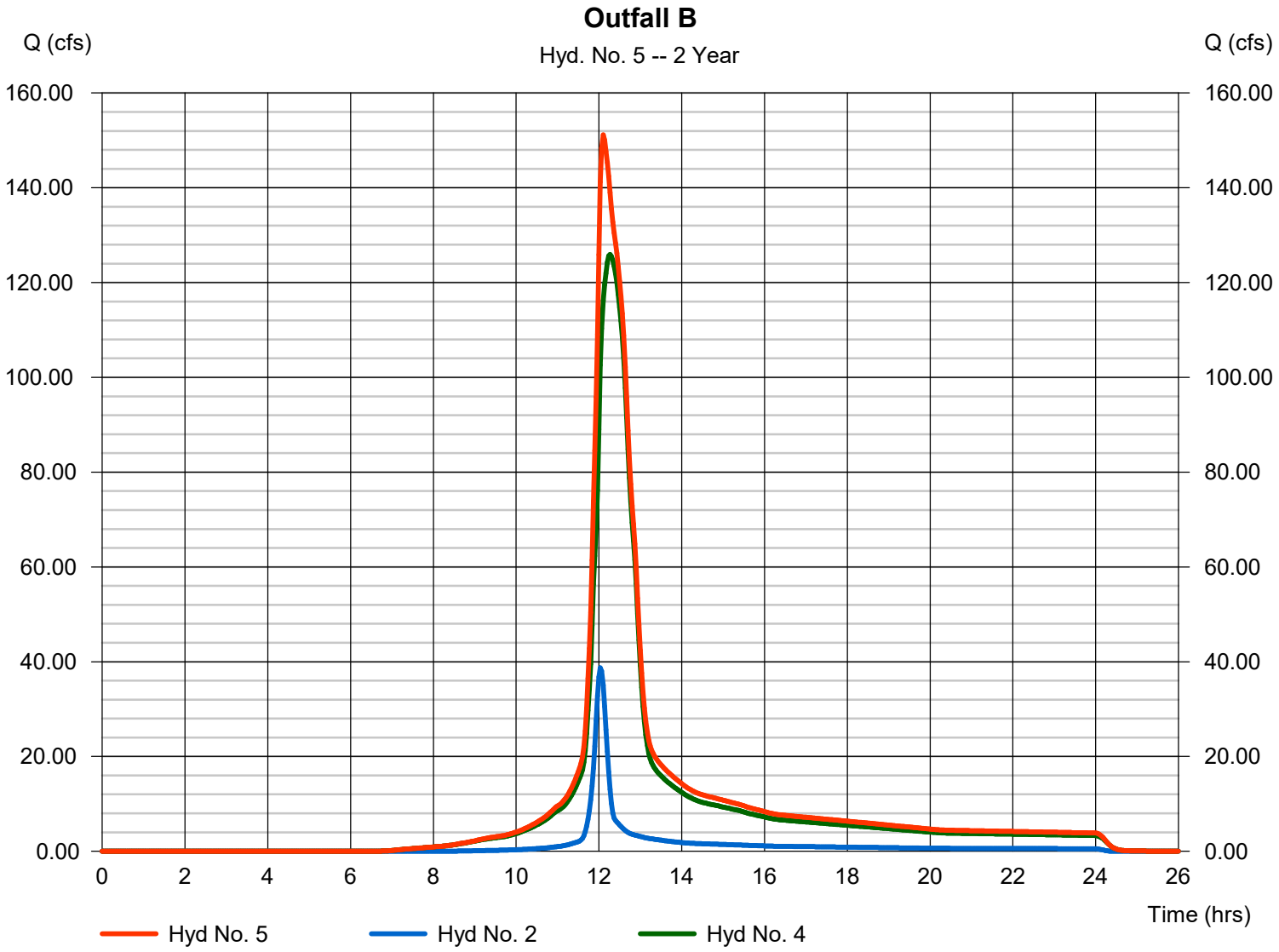


Hydrograph Report

Hyd. No. 5

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	151.19 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	858,247 cuft
Inflow hyds.	=	2, 4	Contrib. drain. area	=	16.430 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	30.63	2	720	79,518	------	------	------	Outfall A
2	SCS Runoff	69.79	2	722	196,831	------	------	------	B1
3	SCS Runoff	402.52	2	724	1,282,949	------	------	------	B2
4	Reservoir(i)	168.41	2	740	1,283,383	3	949.14	322,845	Existing Ponds
5	Combine	203.36	2	726	1,480,215	2, 4	------	------	Outfall B

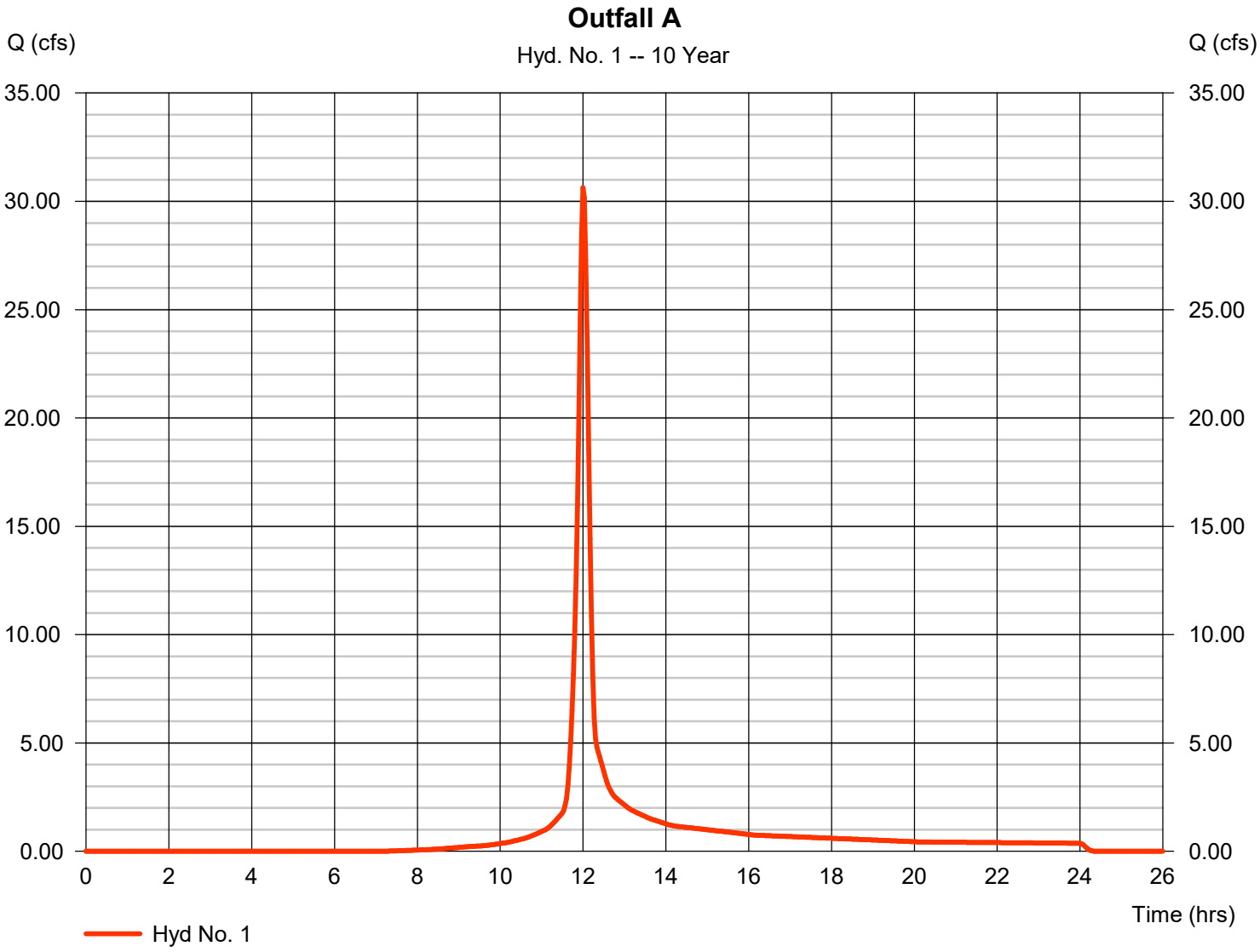
Hydrograph Report

Hyd. No. 1

Outfall A

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.63 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	79,518 cuft
Drainage area	=	6.860 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.590 x 76) + (1.660 x 79) + (0.610 x 98)] / 6.860



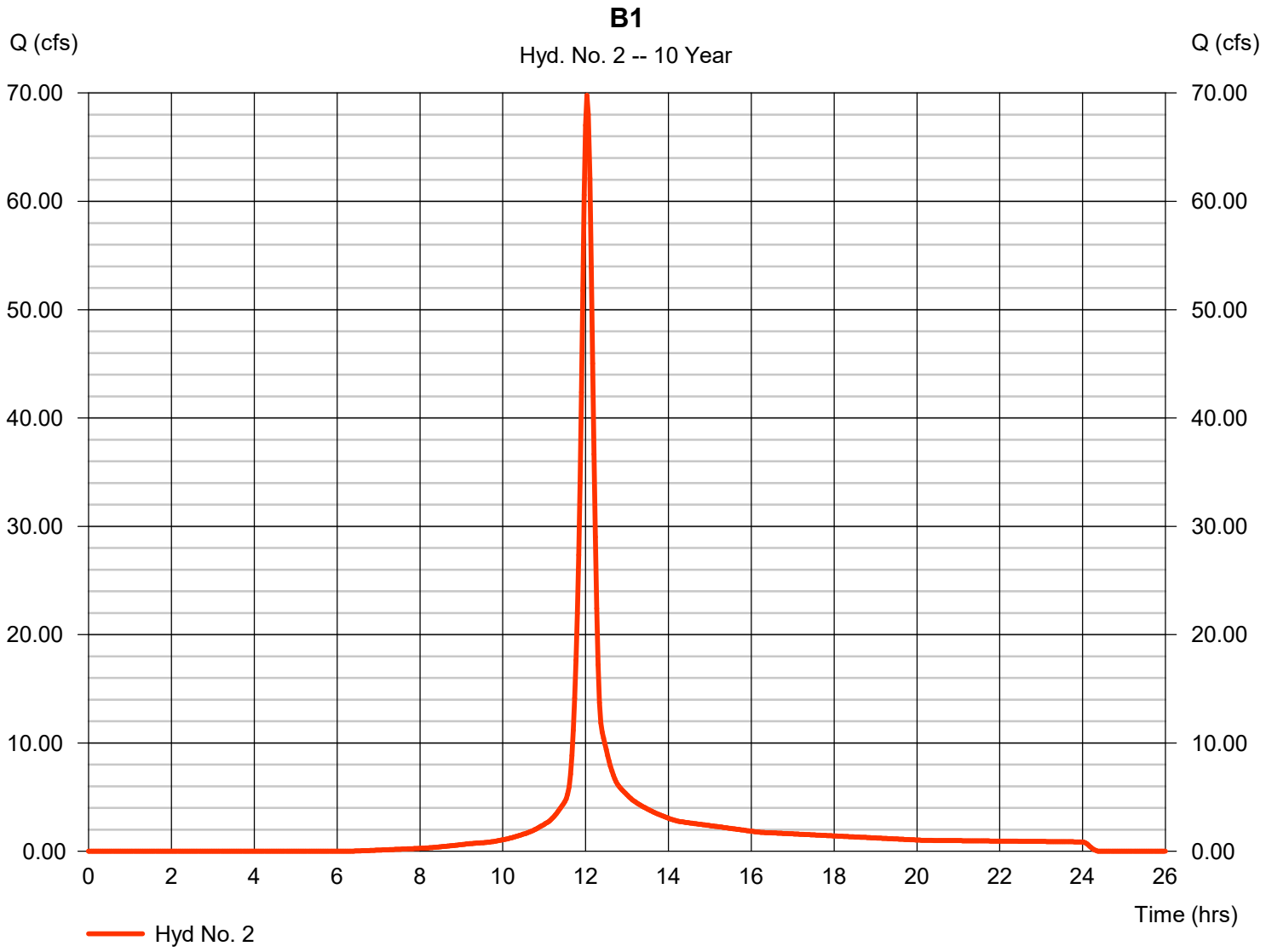
Hydrograph Report

Hyd. No. 2

B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	69.79 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	196,831 cuft
Drainage area	=	16.430 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	16.20 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.430 x 82) + (0.610 x 79) + (2.380 x 76) + (2.080 x 84) + (1.950 x 79) + (5.980 x 85)] / 16.430



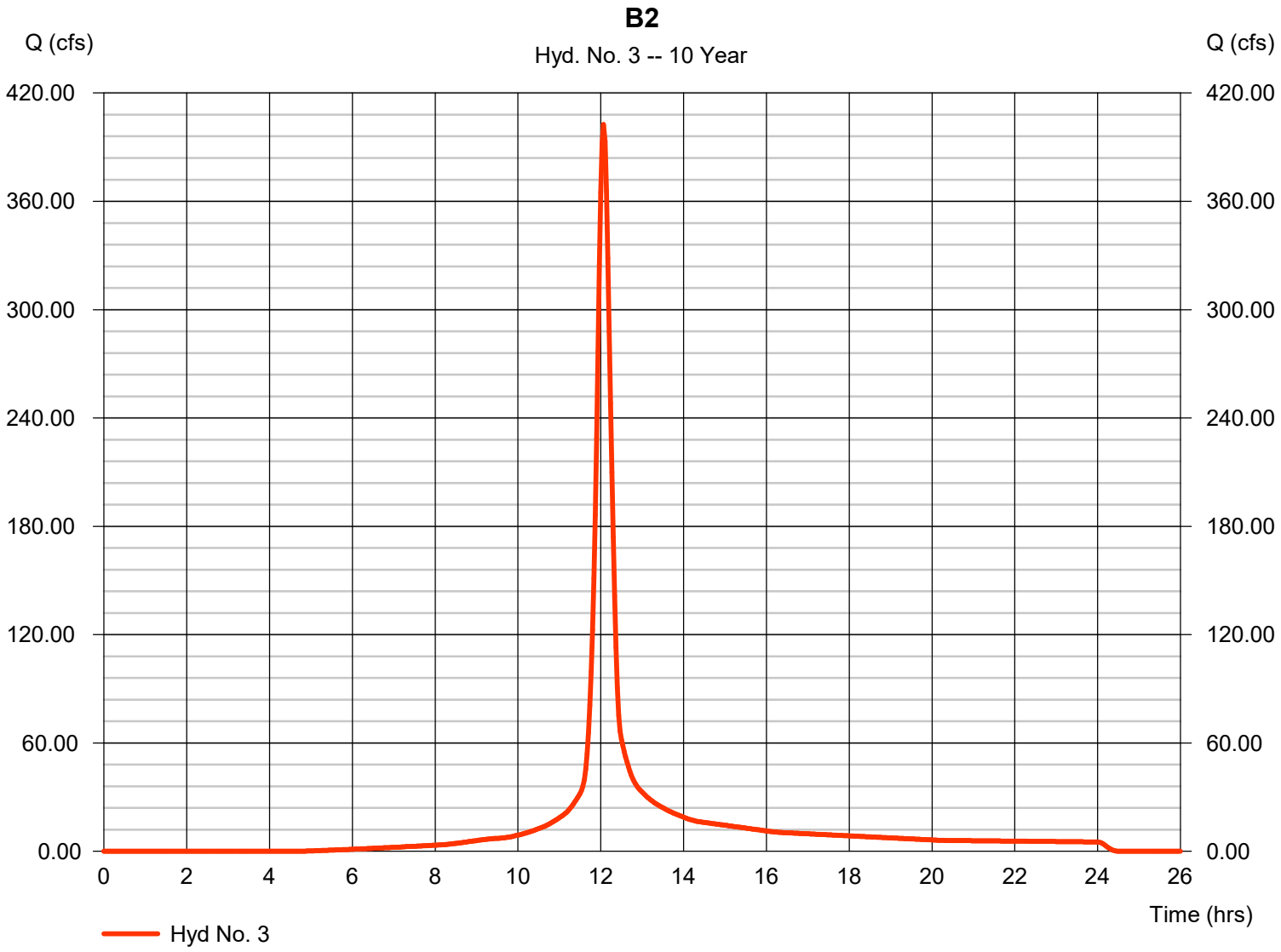
Hydrograph Report

Hyd. No. 3

B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	402.52 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	1,282,949 cuft
Drainage area	=	90.890 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(21.900 x 98) + (30.550 x 79) + (4.380 x 84) + (7.470 x 91) + (13.990 x 93) + (12.600 x 76)] / 90.890



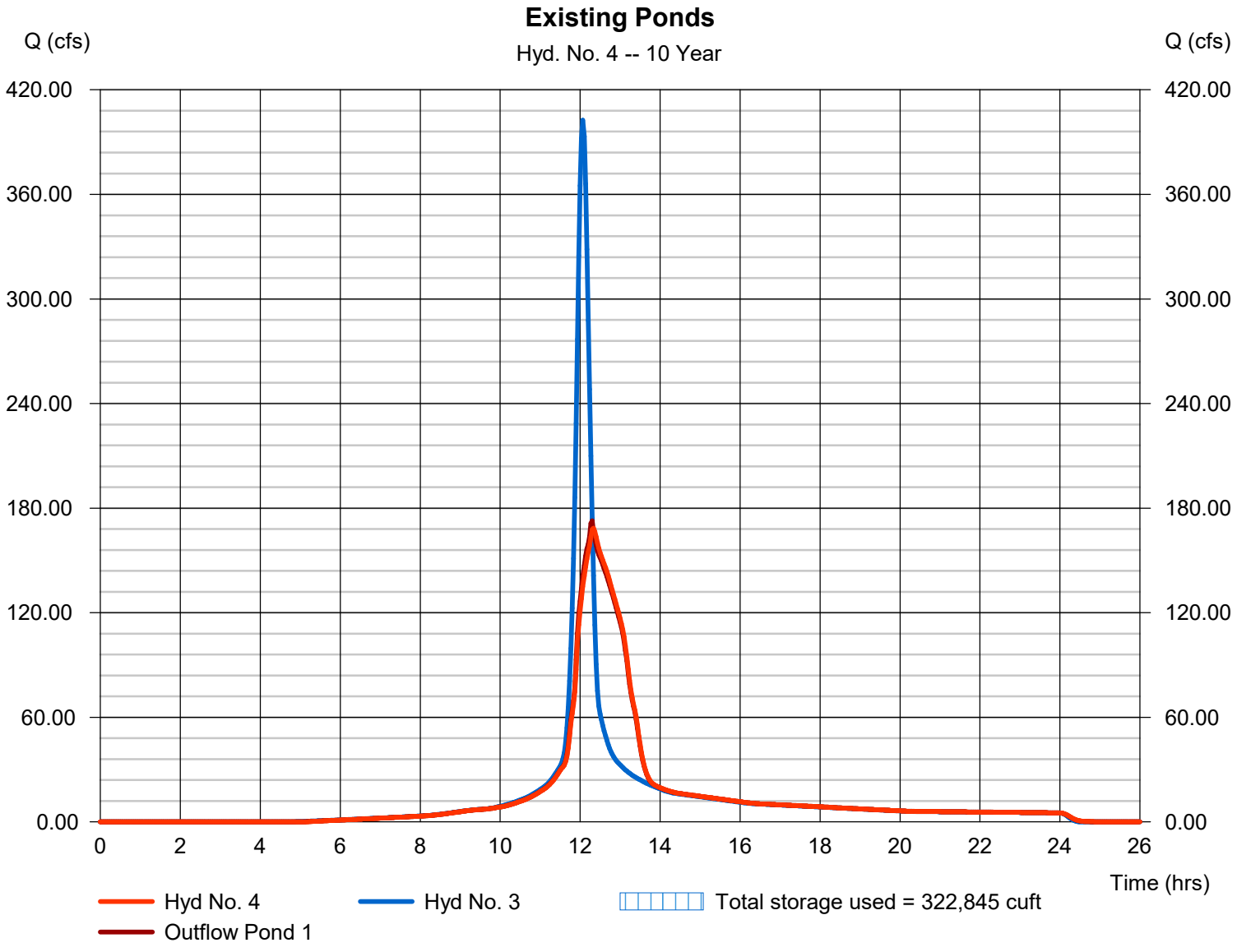
Hydrograph Report

Hyd. No. 4

Existing Ponds

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	168.41 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.33 hrs
Time interval	=	2 min	Hyd. volume	=	1,283,383 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - B2	Other Inflow hyd.	=	None
Max. Elevation	=	949.14 ft	Max. Elevation	=	943.06 ft
Max. Storage	=	311,686 cuft	Max. Storage	=	11,159 cuft

Interconnected Pond Routing. Storage Indication method used.

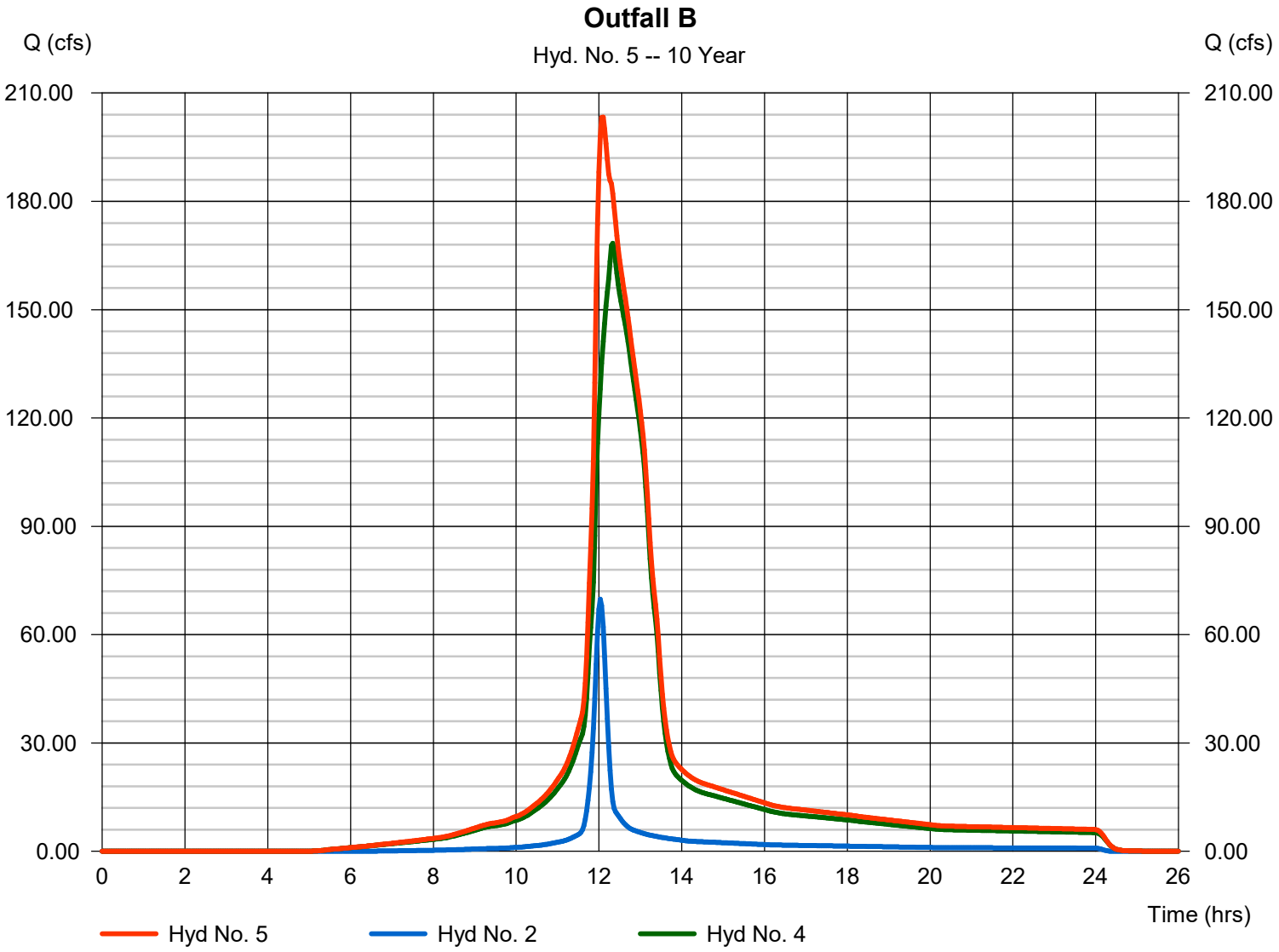


Hydrograph Report

Hyd. No. 5

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	203.36 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	1,480,215 cuft
Inflow hyds.	=	2, 4	Contrib. drain. area	=	16.430 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	52.78	2	720	139,054	------	------	------	Outfall A
2	SCS Runoff	116.62	2	722	335,227	------	------	------	B1
3	SCS Runoff	642.57	2	724	2,095,847	------	------	------	B2
4	Reservoir(i)	382.97	2	736	2,096,551	3	951.93	529,785	Existing Ponds
5	Combine	419.23	2	736	2,431,777	2, 4	------	------	Outfall B

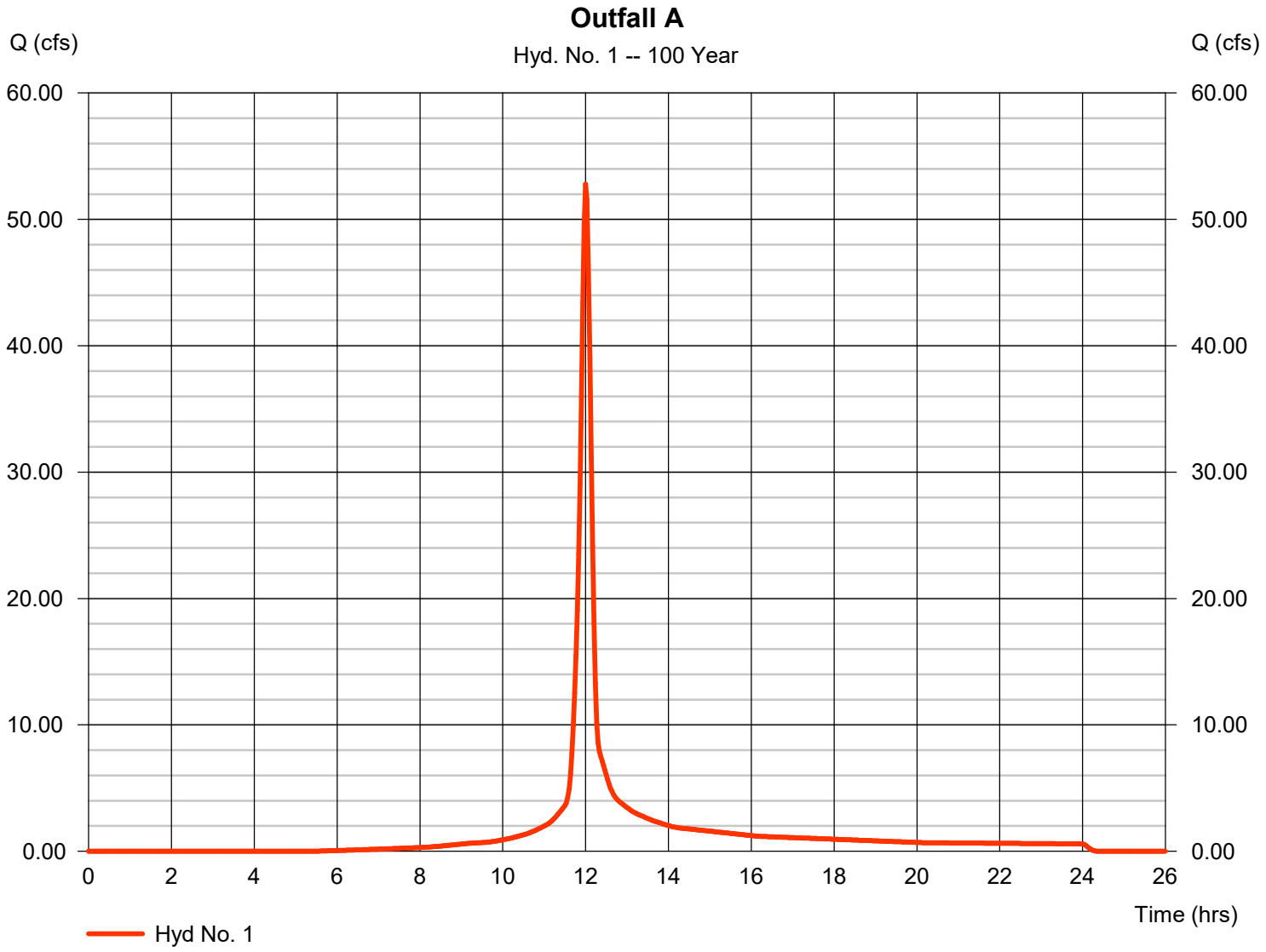
Hydrograph Report

Hyd. No. 1

Outfall A

Hydrograph type	=	SCS Runoff	Peak discharge	=	52.78 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	139,054 cuft
Drainage area	=	6.860 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.590 x 76) + (1.660 x 79) + (0.610 x 98)] / 6.860



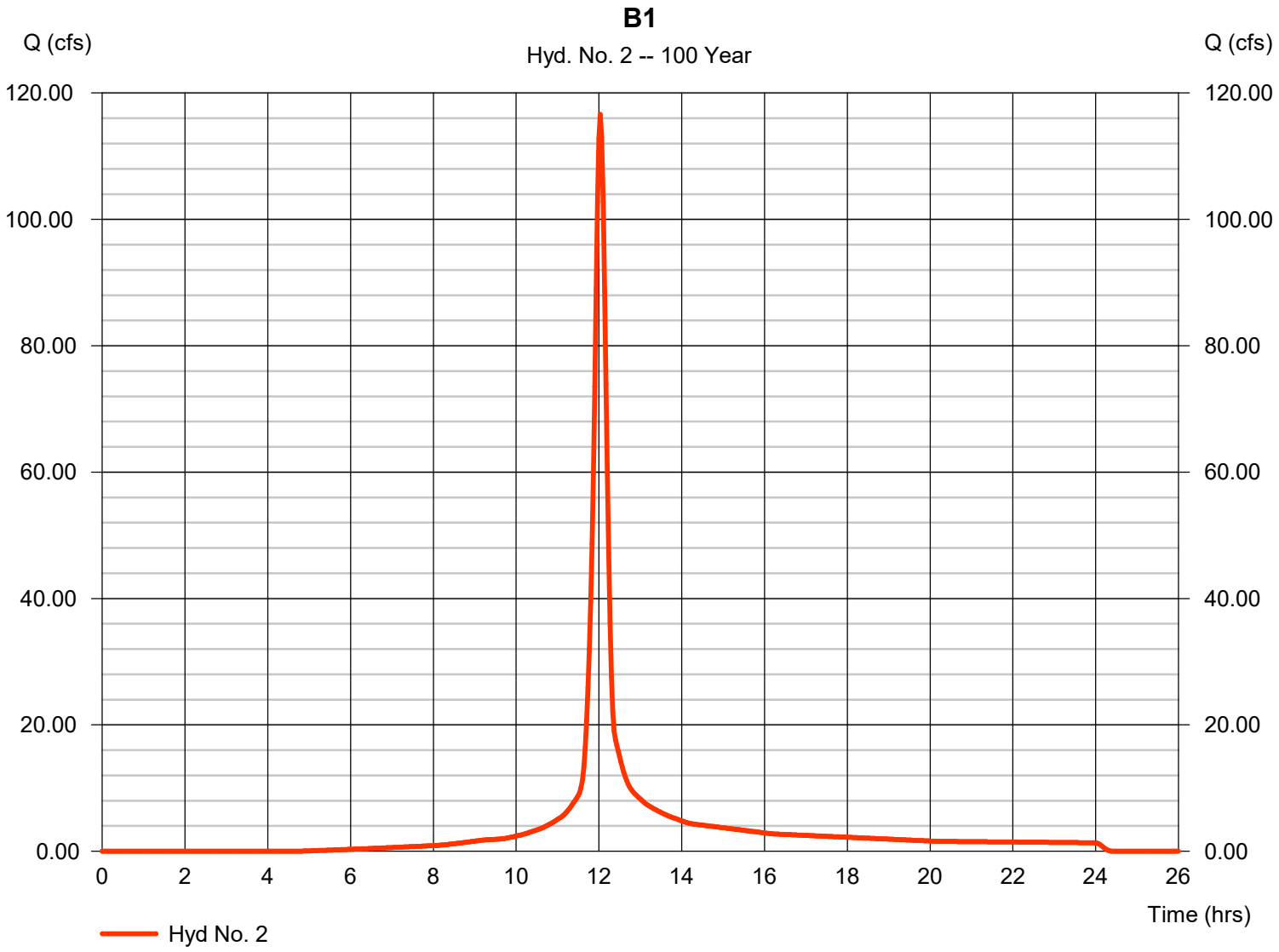
Hydrograph Report

Hyd. No. 2

B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	116.62 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	335,227 cuft
Drainage area	=	16.430 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	16.20 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.430 x 82) + (0.610 x 79) + (2.380 x 76) + (2.080 x 84) + (1.950 x 79) + (5.980 x 85)] / 16.430



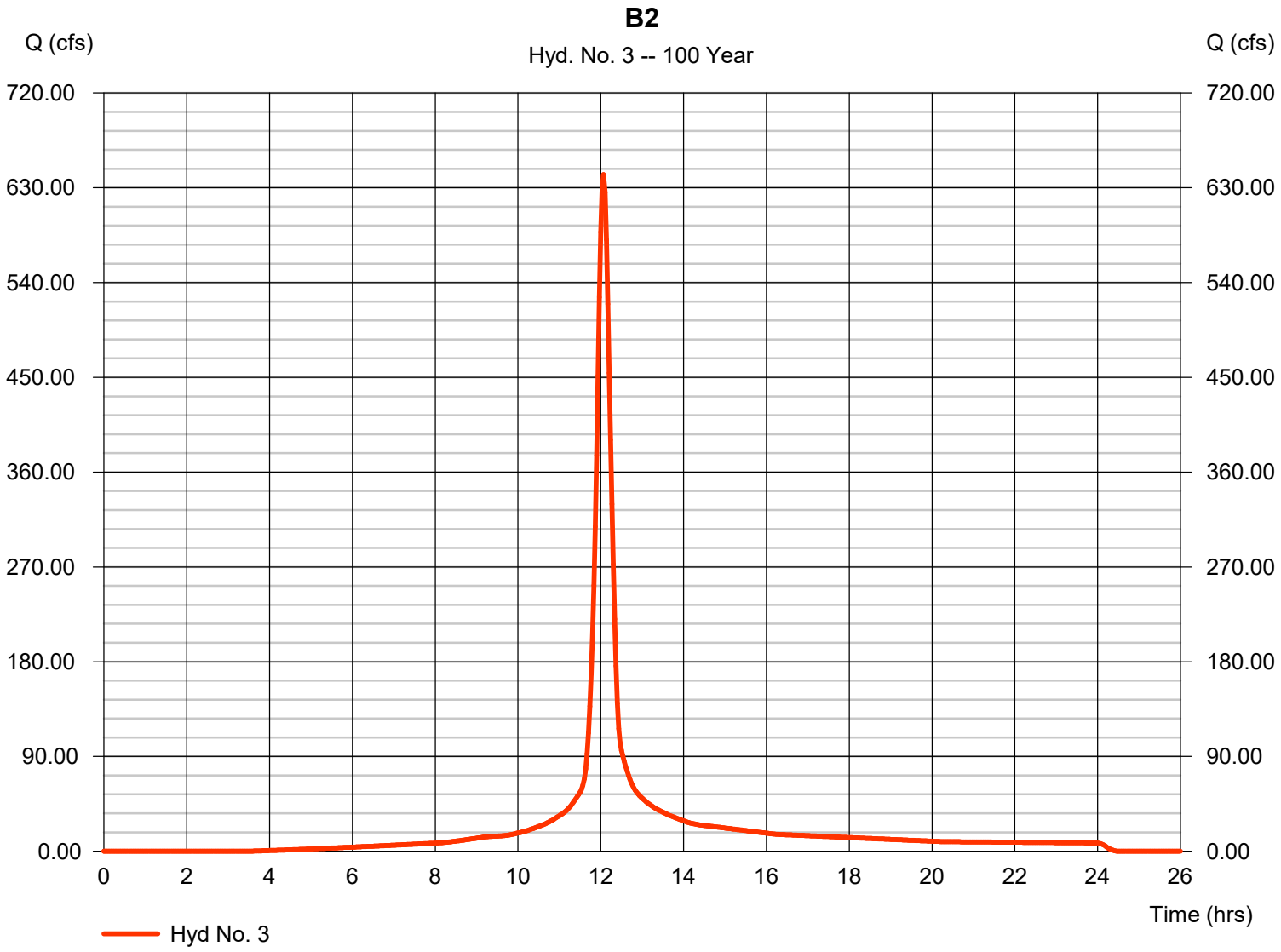
Hydrograph Report

Hyd. No. 3

B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	642.57 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	2,095,847 cuft
Drainage area	=	90.890 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(21.900 x 98) + (30.550 x 79) + (4.380 x 84) + (7.470 x 91) + (13.990 x 93) + (12.600 x 76)] / 90.890



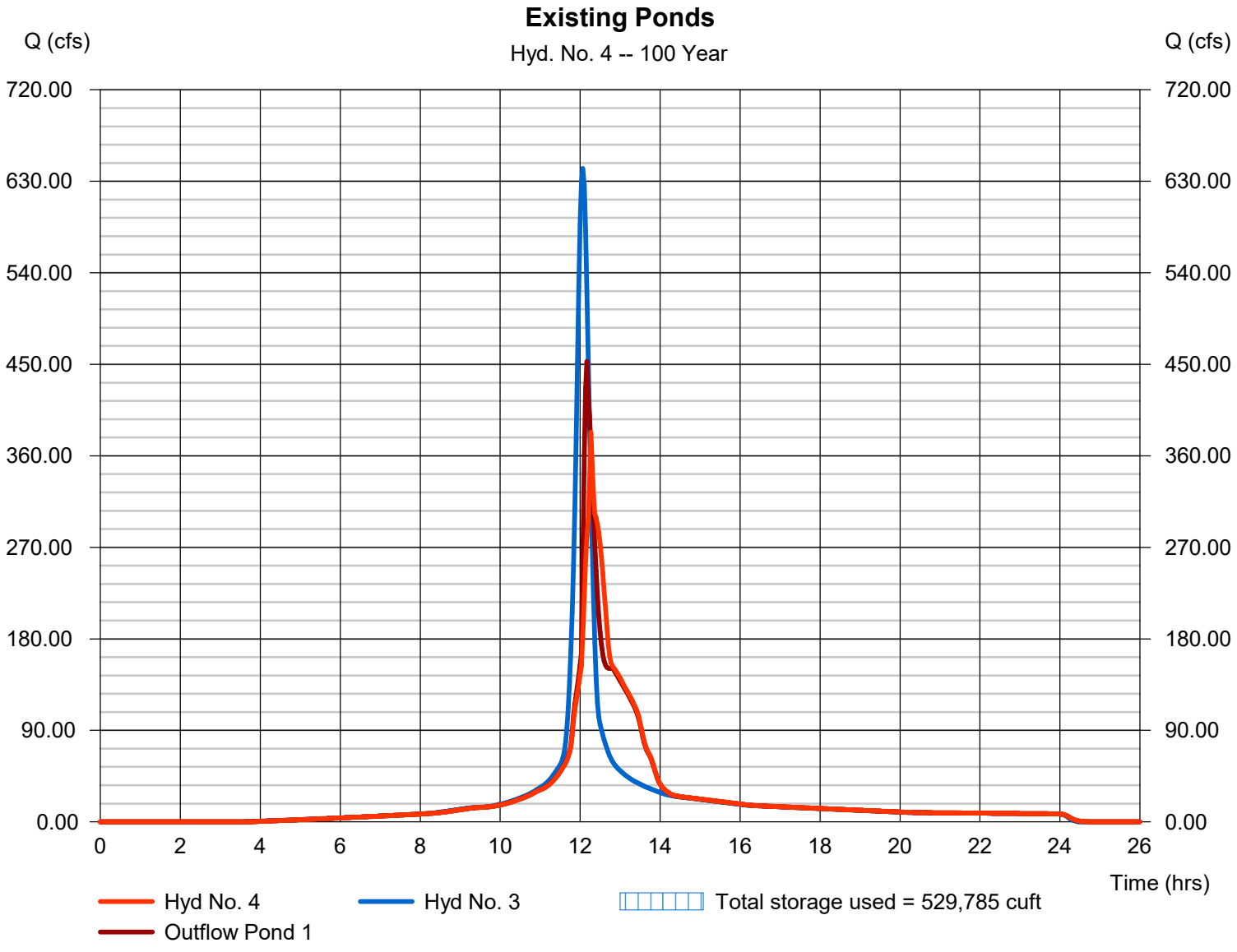
Hydrograph Report

Hyd. No. 4

Existing Ponds

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	382.97 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.27 hrs
Time interval	=	2 min	Hyd. volume	=	2,096,551 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - B2	Other Inflow hyd.	=	None
Max. Elevation	=	951.93 ft	Max. Elevation	=	950.87 ft
Max. Storage	=	432,177 cuft	Max. Storage	=	97,607 cuft

Interconnected Pond Routing. Storage Indication method used.

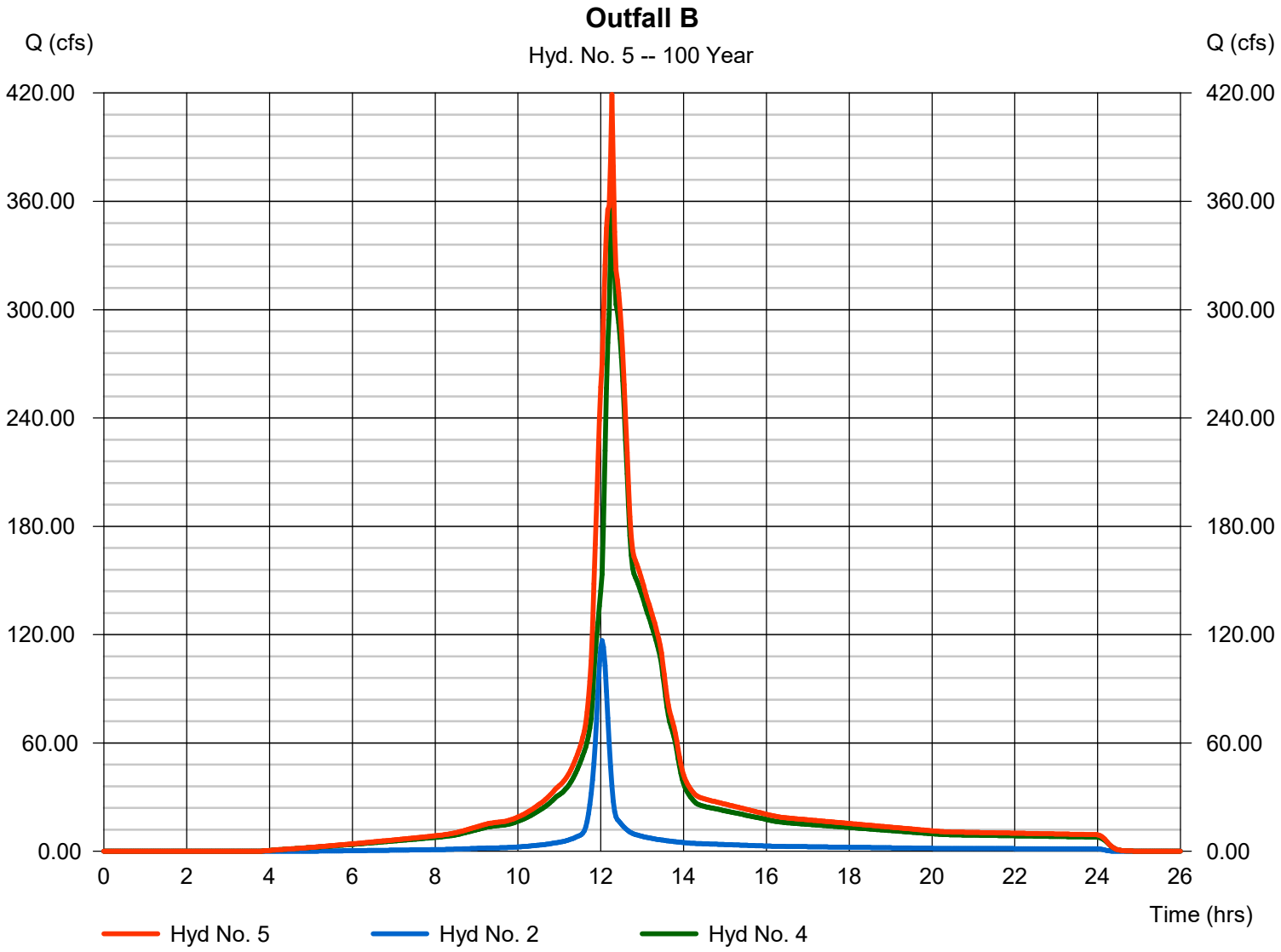


Hydrograph Report

Hyd. No. 5

Outfall B

Hydrograph type	= Combine	Peak discharge	= 419.23 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 2,431,777 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 16.430 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	47.7559	11.1000	0.8294	--------
2	71.8477	13.3000	0.8718	--------
3	0.0000	0.0000	0.0000	--------
5	75.7517	14.2000	0.8271	--------
10	86.7192	15.3000	0.8244	--------
25	103.3028	16.6000	0.8227	--------
50	116.5747	17.3000	0.8234	--------
100	124.5734	17.6000	0.8144	--------

File name: Liberty MO.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	4.76	3.81	3.19	2.76	2.44	2.19	1.99	1.83	1.69	1.58	1.48	1.39
2	5.70	4.62	3.90	3.38	2.99	2.69	2.45	2.24	2.08	1.93	1.81	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	6.58	5.43	4.65	4.08	3.64	3.30	3.02	2.79	2.59	2.42	2.28	2.15
10	7.25	6.05	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.81	4.38	4.03	3.73	3.48	3.26	3.08	2.91
50	9.05	7.66	6.67	5.92	5.34	4.87	4.48	4.16	3.88	3.64	3.43	3.25
100	9.83	8.35	7.30	6.49	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

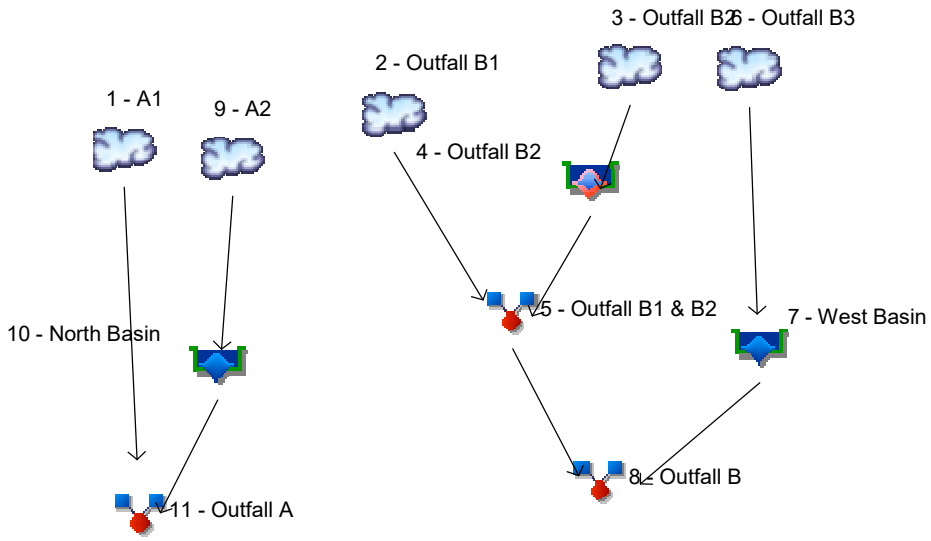
Precip. file name: Y:\KCS\Teams\LDVP\Reference - Other\IDF Information\KC Metro.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.60	0.00	4.66	5.34	6.80	7.83	7.90
SCS 6-Hr	2.22	2.65	0.00	3.40	4.05	5.00	5.78	6.58
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX C

Proposed Conditions Hydraflow Hydrographs Model Input and Results

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	A1
2	SCS Runoff	Outfall B1
3	SCS Runoff	Outfall B2
4	Reservoir(i)	Outfall B2
5	Combine	Outfall B1 & B2
6	SCS Runoff	Outfall B3
7	Reservoir	West Basin
8	Combine	Outfall B
9	SCS Runoff	A2
10	Reservoir	North Basin
11	Combine	Outfall A

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	------	0.997	5.973	-------	-------	10.30	-------	-------	16.70	A1
2	SCS Runoff	------	7.519	42.37	-------	-------	72.53	-------	-------	116.96	Outfall B1
3	SCS Runoff	------	46.75	217.90	-------	-------	357.20	-------	-------	560.35	Outfall B2
4	Reservoir(i)	3	40.31	121.08	-------	-------	152.22	-------	-------	282.77	Outfall B2
5	Combine	2, 4	41.51	126.26	-------	-------	179.05	-------	-------	295.11	Outfall B1 & B2
6	SCS Runoff	------	15.89	48.65	-------	-------	73.71	-------	-------	110.25	Outfall B3
7	Reservoir	6	0.964	8.754	-------	-------	18.78	-------	-------	26.73	West Basin
8	Combine	5, 7	42.38	131.03	-------	-------	180.29	-------	-------	320.94	Outfall B
9	SCS Runoff	------	12.02	43.77	-------	-------	68.40	-------	-------	104.15	A2
10	Reservoir	9	0.421	0.631	-------	-------	3.775	-------	-------	17.19	North Basin
11	Combine	1, 10	1.298	6.449	-------	-------	10.85	-------	-------	18.92	Outfall A

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	0.997	2	722	2,742	------	------	------	A1
2	SCS Runoff	7.519	2	718	15,249	------	------	------	Outfall B1
3	SCS Runoff	46.75	2	726	150,070	------	------	------	Outfall B2
4	Reservoir(i)	40.31	2	730	150,122	3	941.36	13,405	Outfall B2
5	Combine	41.51	2	730	165,371	2, 4	------	------	Outfall B1 & B2
6	SCS Runoff	15.89	2	726	55,518	------	------	------	Outfall B3
7	Reservoir	0.964	2	824	55,508	6	968.68	29,818	West Basin
8	Combine	42.38	2	730	220,879	5, 7	------	------	Outfall B
9	SCS Runoff	12.02	2	726	41,512	------	------	------	A2
10	Reservoir	0.421	2	964	41,472	9	978.61	27,093	North Basin
11	Combine	1.298	2	722	44,214	1, 10	------	------	Outfall A

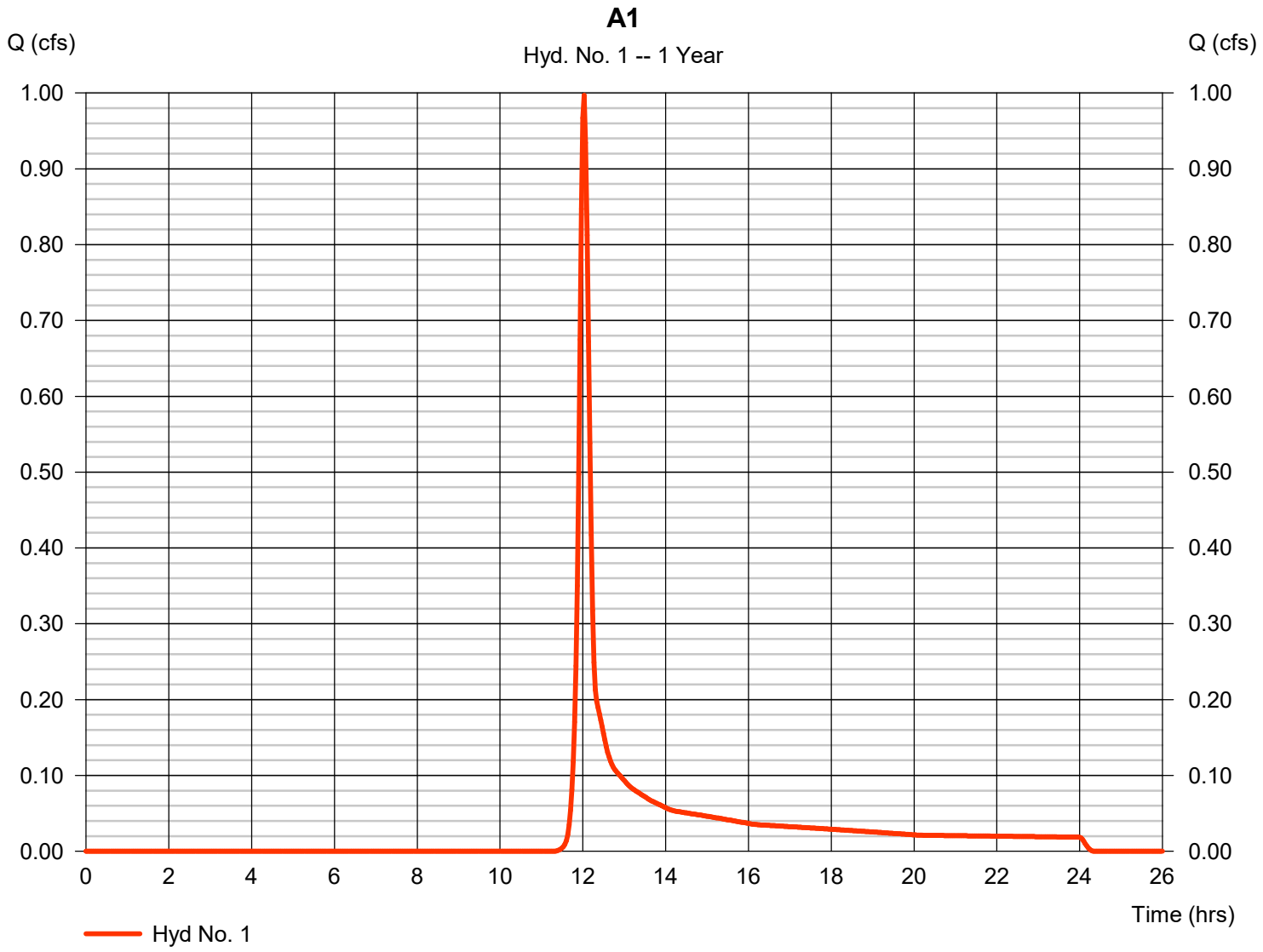
Hydrograph Report

Hyd. No. 1

A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.997 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	2,742 cuft
Drainage area	=	1.970 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.360 x 79) + (0.610 x 98)] / 1.970



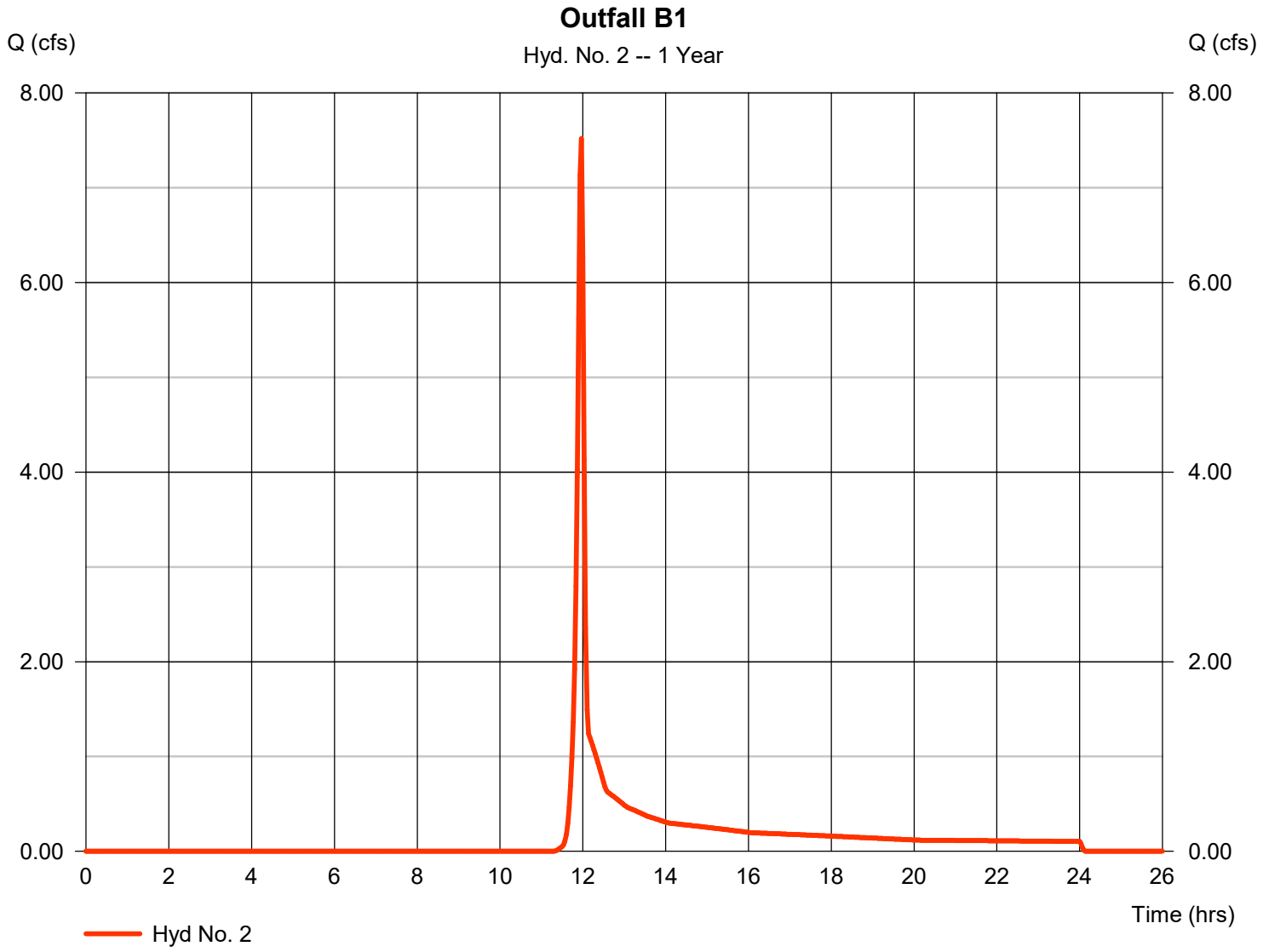
Hydrograph Report

Hyd. No. 2

Outfall B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.519 cfs
Storm frequency	=	1 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	15,249 cuft
Drainage area	=	12.050 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.150 x 98) + (7.350 x 84) + (2.080 x 82) + (0.810 x 79) + (0.230 x 76) + (0.430 x 84)] / 12.050



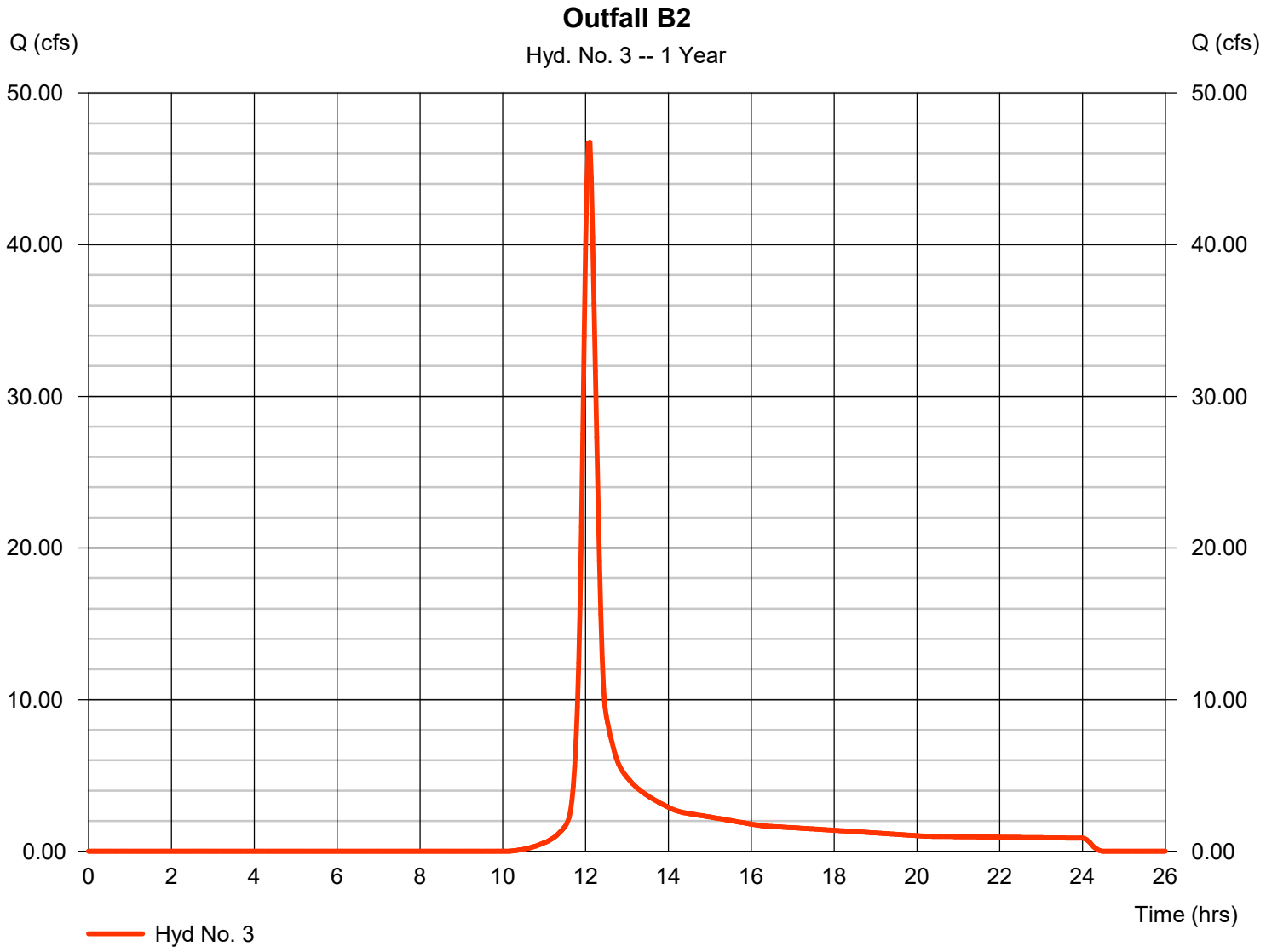
Hydrograph Report

Hyd. No. 3

Outfall B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	46.75 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	150,070 cuft
Drainage area	=	77.350 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(23.100 x 98) + (28.590 x 79) + (4.200 x 84) + (7.470 x 91) + (13.990 x 93)] / 77.350



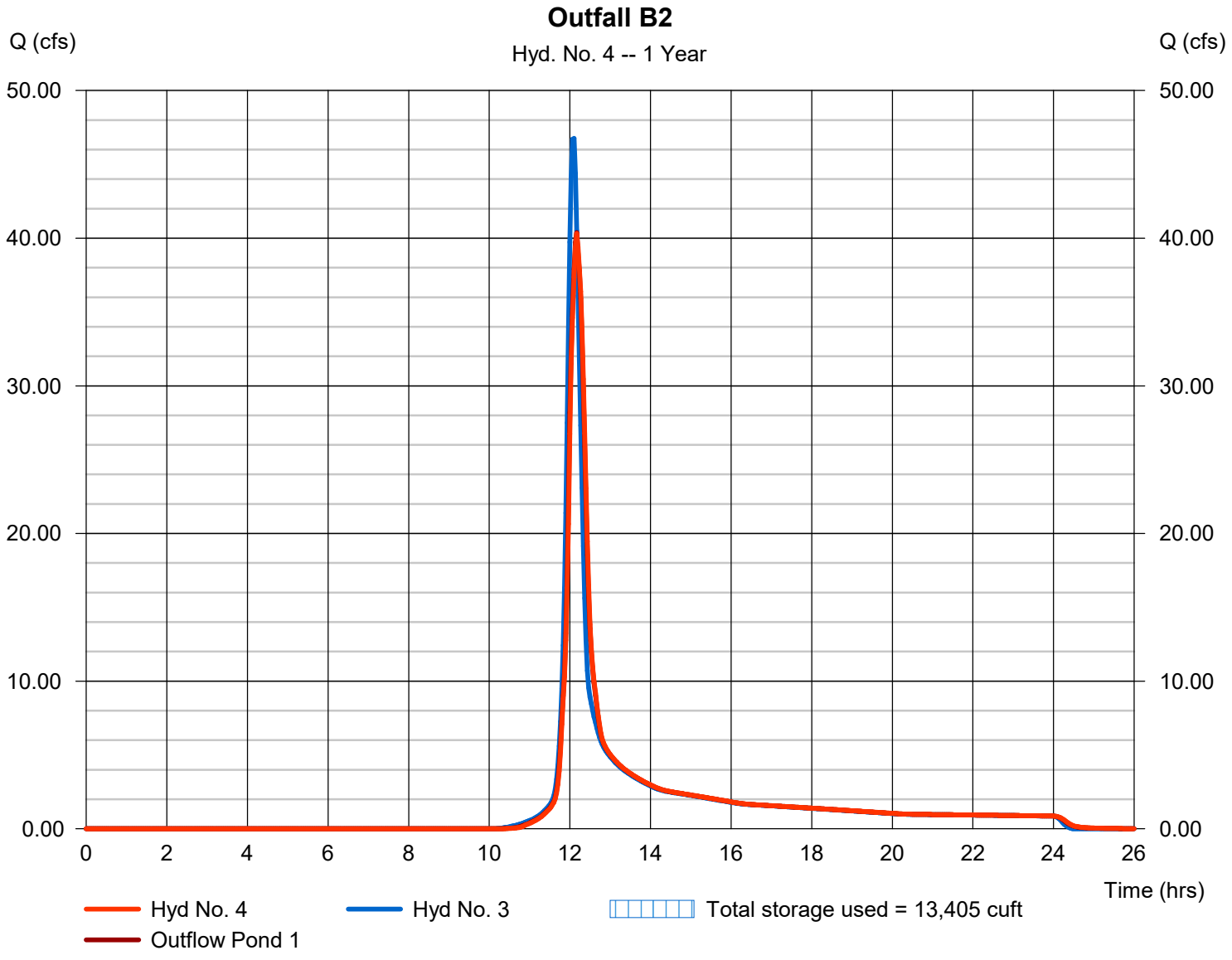
Hydrograph Report

Hyd. No. 4

Outfall B2

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	40.31 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	150,122 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - Outfall B2	Other Inflow hyd.	=	None
Max. Elevation	=	941.36 ft	Max. Elevation	=	939.68 ft
Max. Storage	=	12,214 cuft	Max. Storage	=	1,190 cuft

Interconnected Pond Routing. Storage Indication method used.

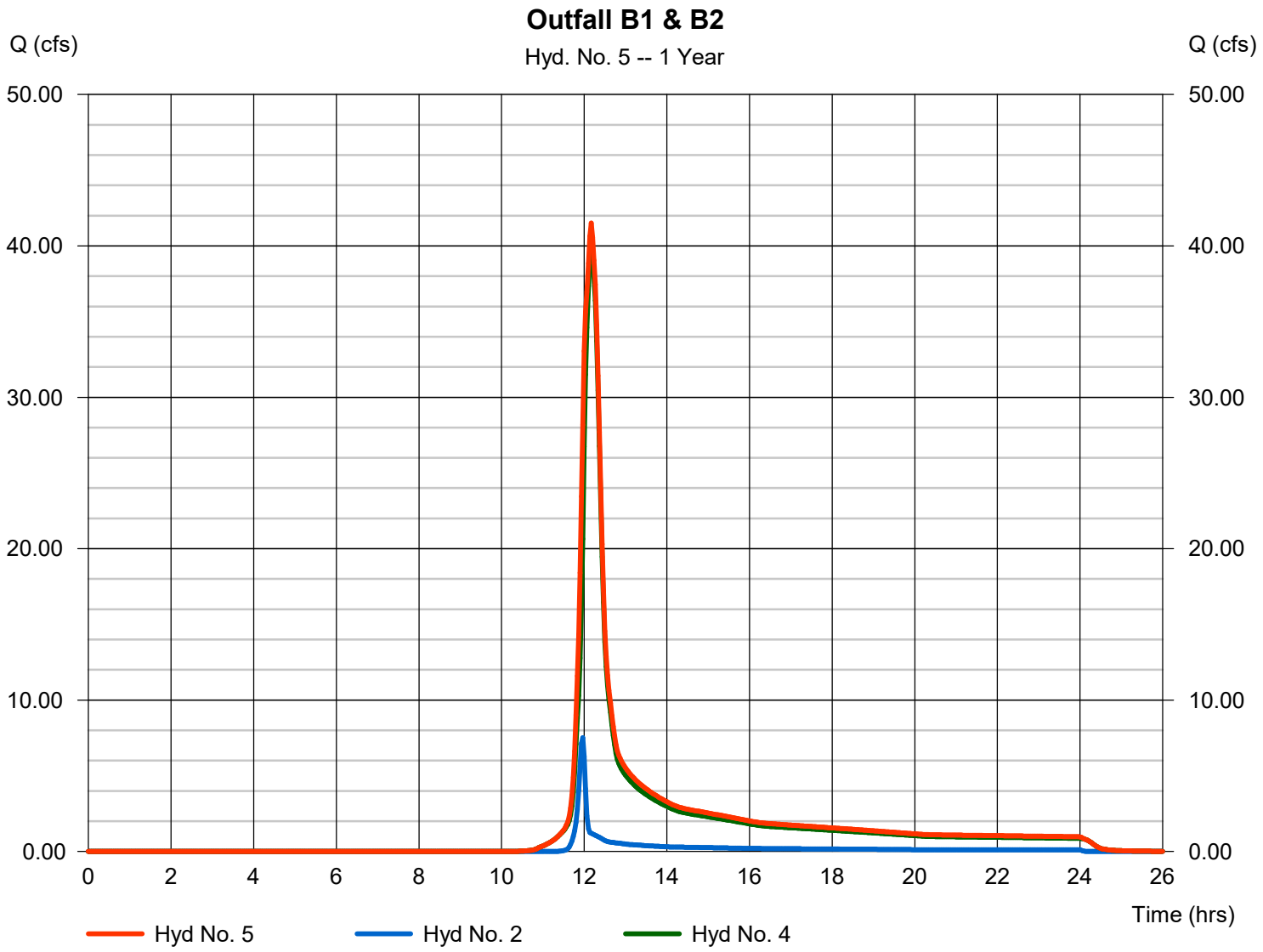


Hydrograph Report

Hyd. No. 5

Outfall B1 & B2

Hydrograph type	= Combine	Peak discharge	= 41.51 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 165,371 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 12.050 ac



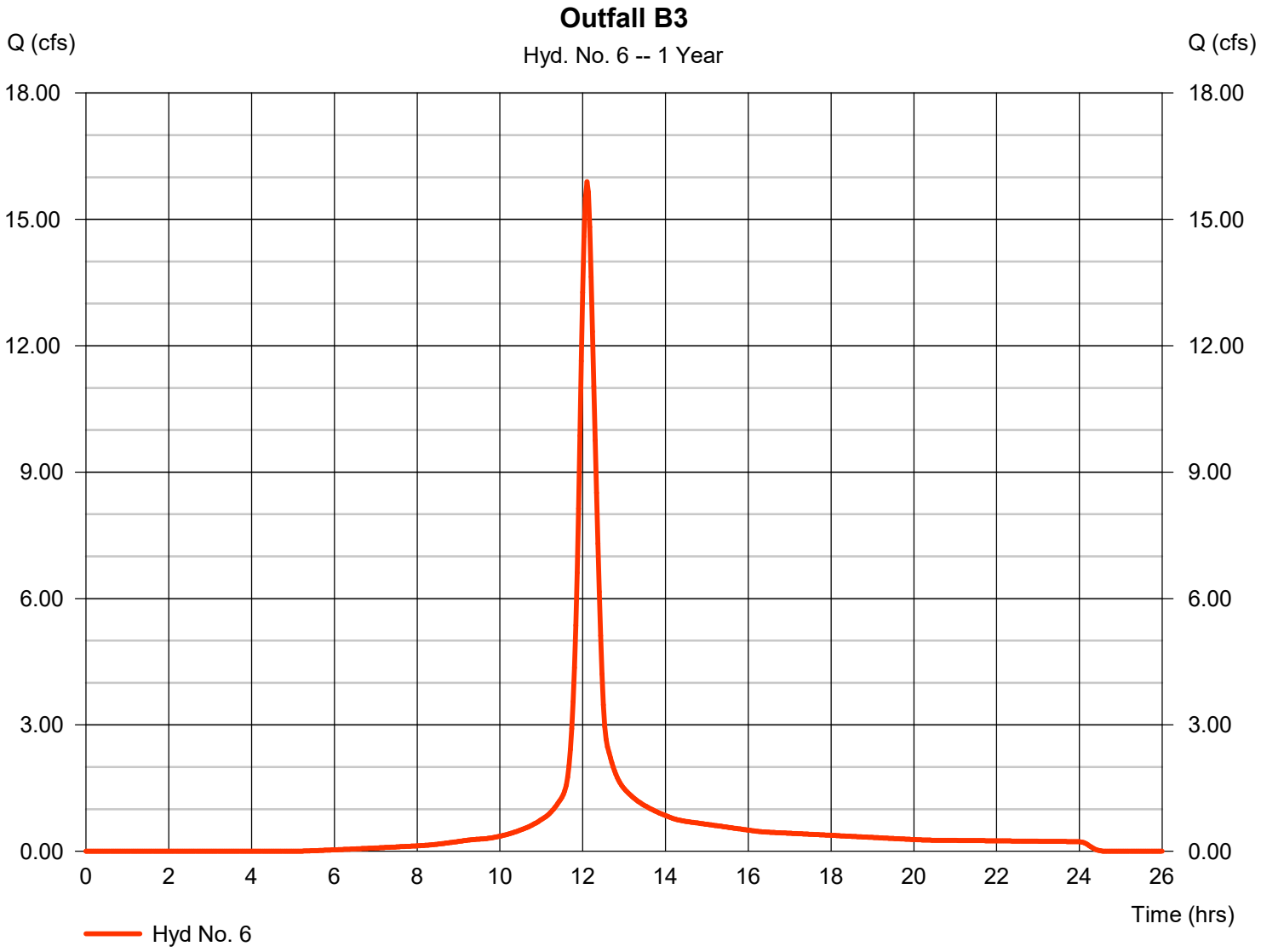
Hydrograph Report

Hyd. No. 6

Outfall B3

Hydrograph type	=	SCS Runoff	Peak discharge	=	15.89 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	55,518 cuft
Drainage area	=	15.460 ac	Curve number	=	96*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.30 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(13.290 x 98) + (2.170 x 84)] / 15.460



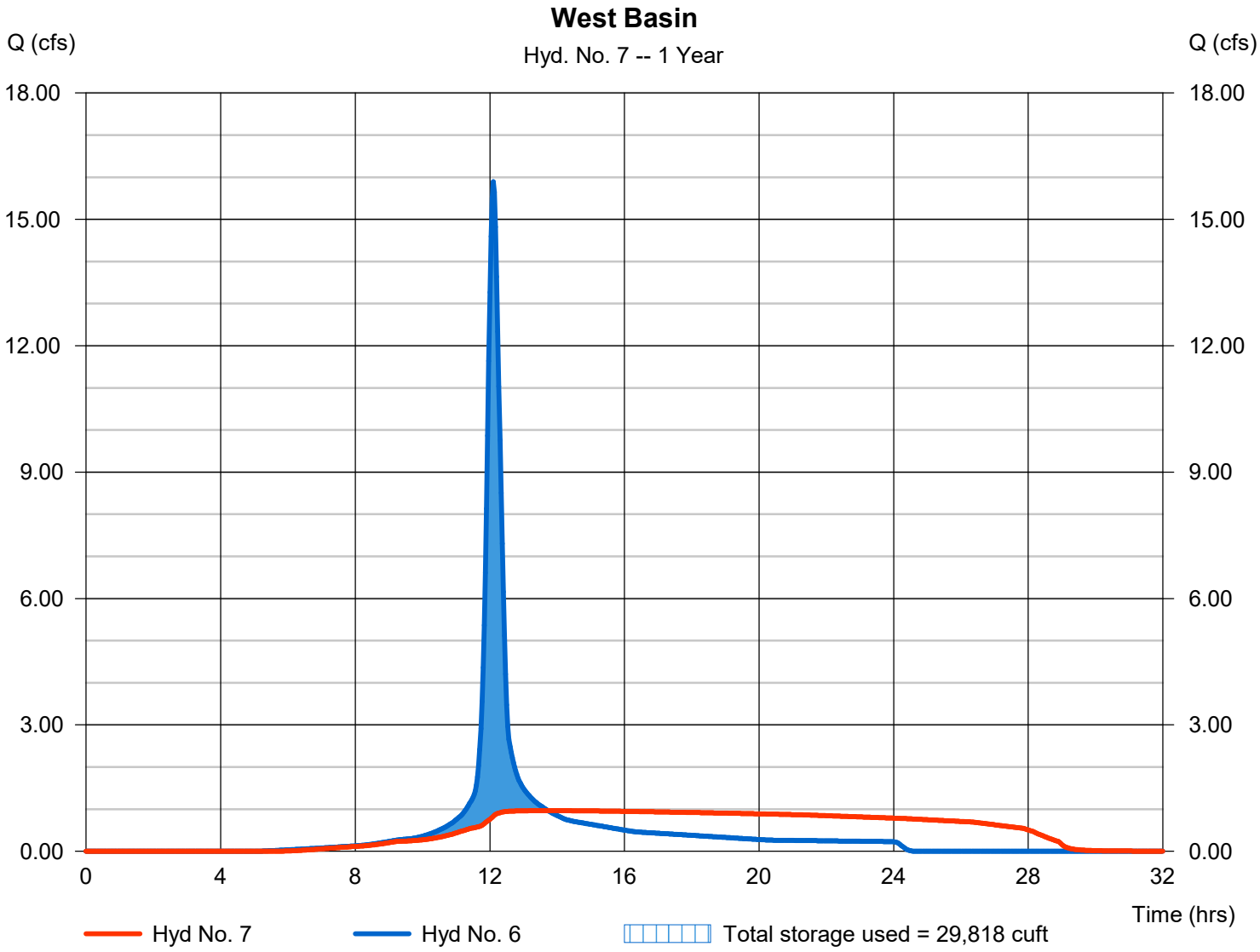
Hydrograph Report

Hyd. No. 7

West Basin

Hydrograph type	=	Reservoir	Peak discharge	=	0.964 cfs
Storm frequency	=	1 yrs	Time to peak	=	13.73 hrs
Time interval	=	2 min	Hyd. volume	=	55,508 cuft
Inflow hyd. No.	=	6 - Outfall B3	Max. Elevation	=	968.68 ft
Reservoir name	=	West Pond	Max. Storage	=	29,818 cuft

Storage Indication method used.

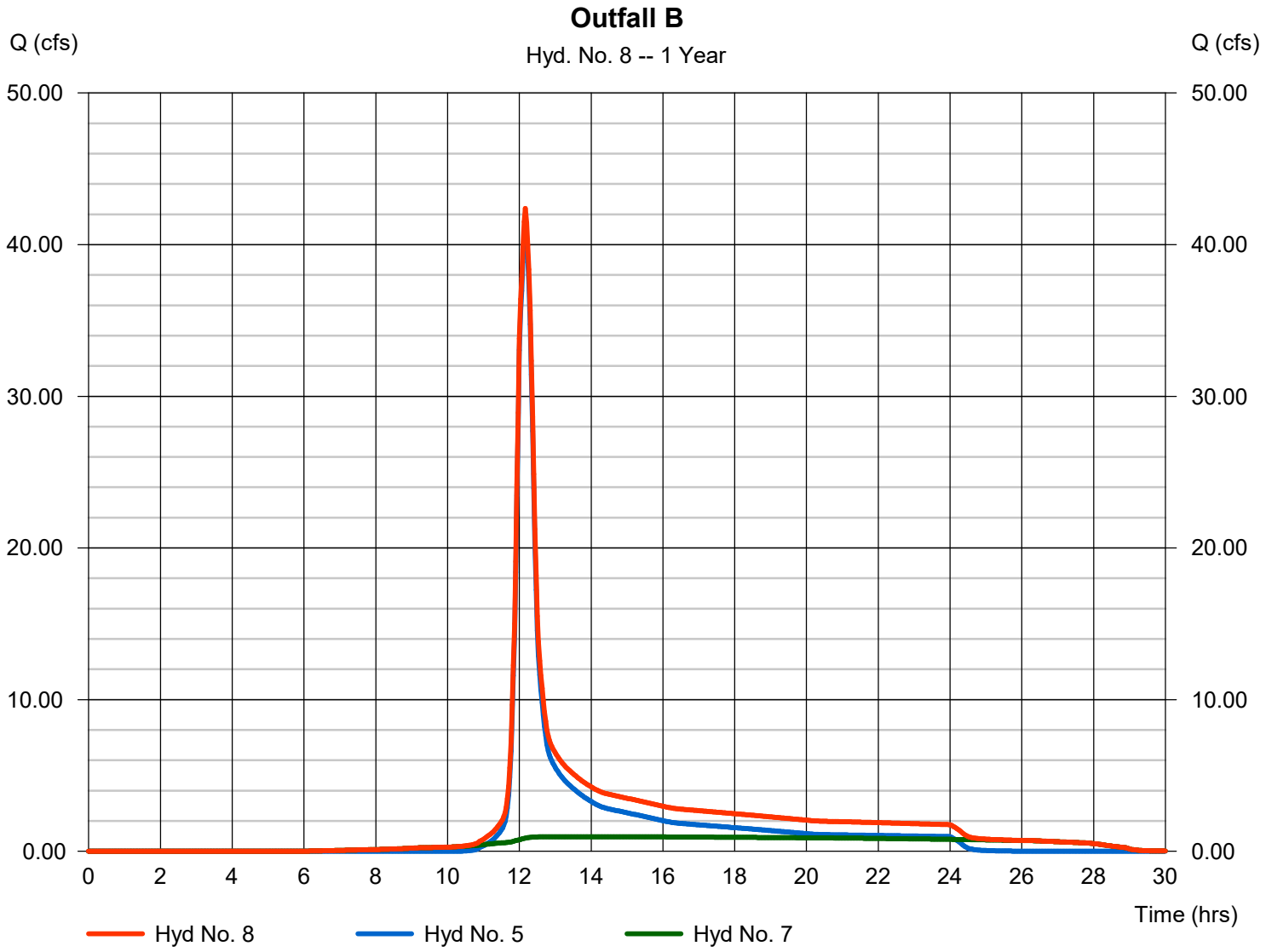


Hydrograph Report

Hyd. No. 8

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	42.38 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.17 hrs
Time interval	=	2 min	Hyd. volume	=	220,879 cuft
Inflow hyds.	=	5, 7	Contrib. drain. area	=	0.000 ac



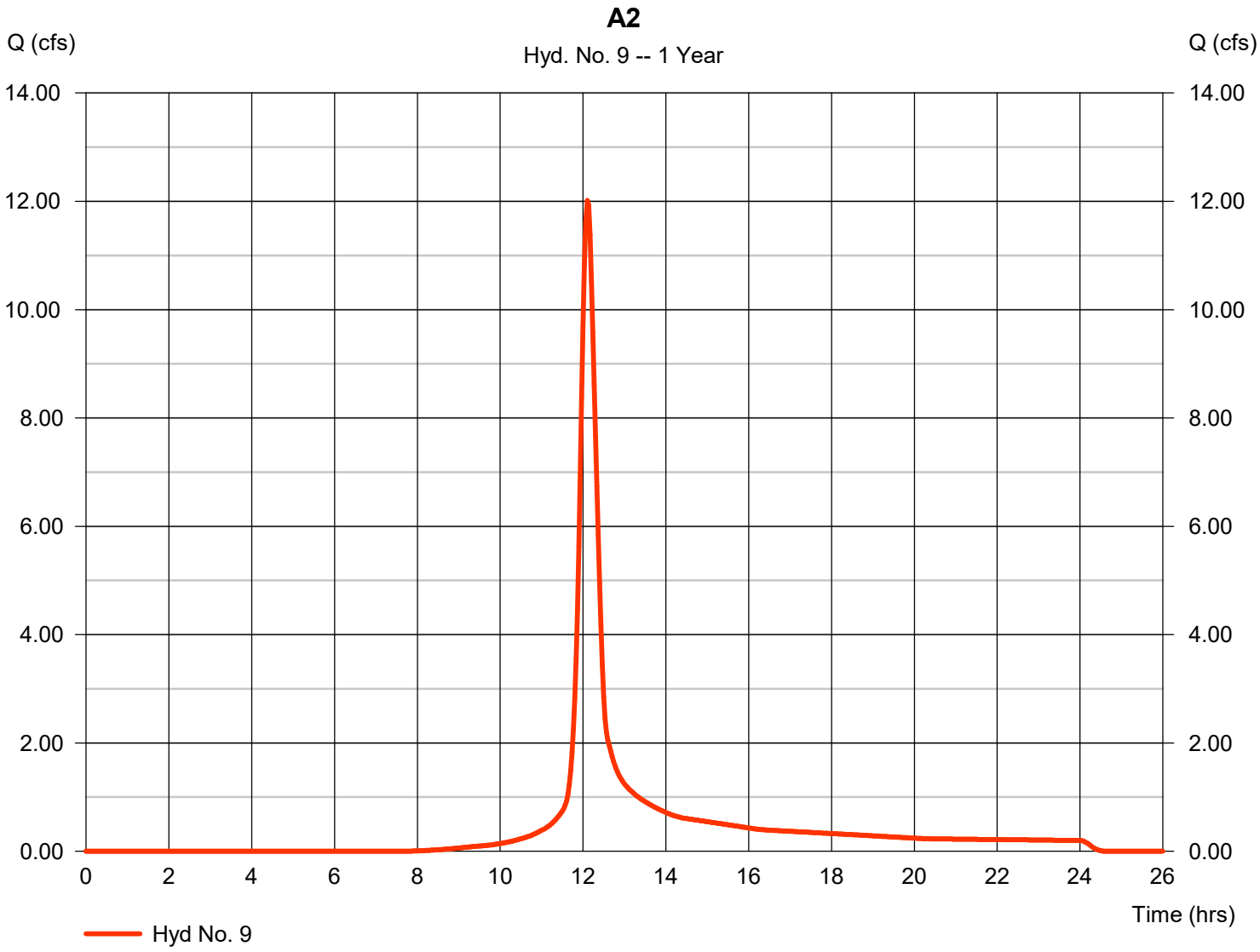
Hydrograph Report

Hyd. No. 9

A2

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.02 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	41,512 cuft
Drainage area	=	14.900 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.00 min
Total precip.	=	1.37 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.950 x 98) + (4.950 x 84)] / 14.900



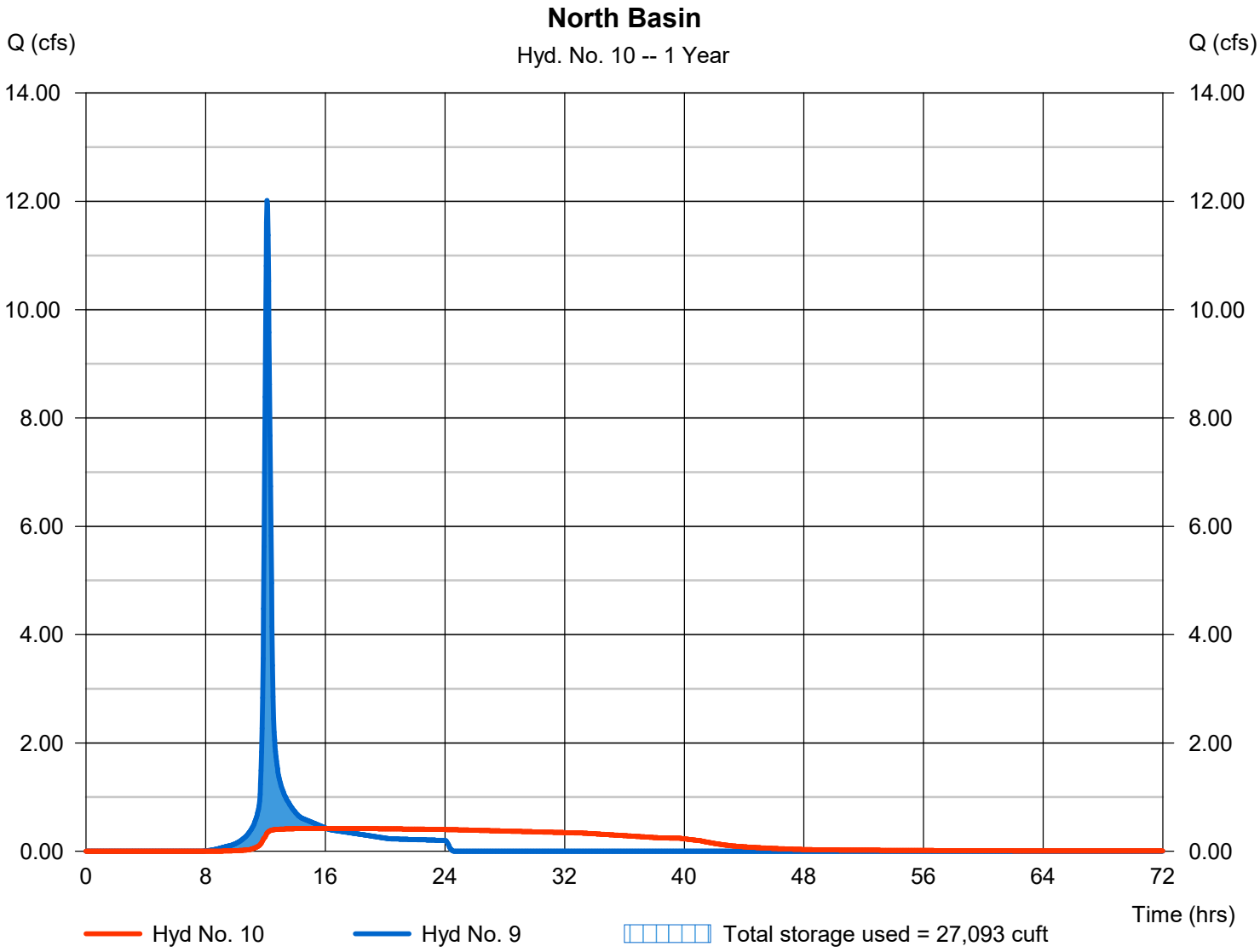
Hydrograph Report

Hyd. No. 10

North Basin

Hydrograph type	=	Reservoir	Peak discharge	=	0.421 cfs
Storm frequency	=	1 yrs	Time to peak	=	16.07 hrs
Time interval	=	2 min	Hyd. volume	=	41,472 cuft
Inflow hyd. No.	=	9 - A2	Max. Elevation	=	978.61 ft
Reservoir name	=	North Pond	Max. Storage	=	27,093 cuft

Storage Indication method used.

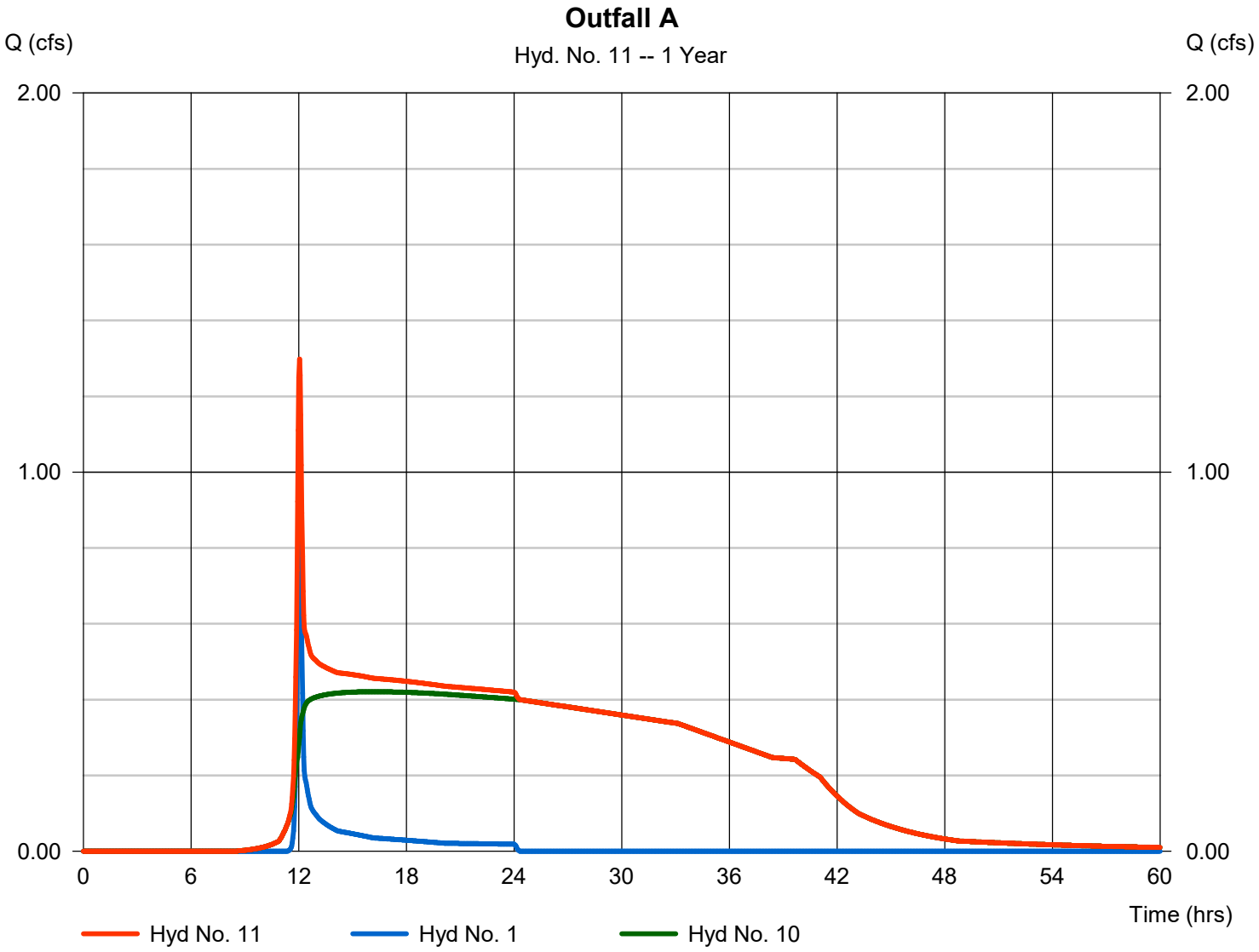


Hydrograph Report

Hyd. No. 11

Outfall A

Hydrograph type	= Combine	Peak discharge	= 1.298 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 44,214 cuft
Inflow hyds.	= 1, 10	Contrib. drain. area	= 1.970 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	5.973	2	720	15,514	------	------	------	A1
2	SCS Runoff	42.37	2	716	86,269	------	------	------	Outfall B1
3	SCS Runoff	217.90	2	724	687,842	------	------	------	Outfall B2
4	Reservoir(i)	121.08	2	736	687,873	3	945.04	128,661	Outfall B2
5	Combine	126.26	2	734	774,142	2, 4	------	------	Outfall B1 & B2
6	SCS Runoff	48.65	2	726	179,599	------	------	------	Outfall B3
7	Reservoir	8.754	2	752	179,589	6	971.01	94,563	West Basin
8	Combine	131.03	2	738	953,731	5, 7	------	------	Outfall B
9	SCS Runoff	43.77	2	726	155,887	------	------	------	A2
10	Reservoir	0.631	2	1354	153,777	9	980.72	123,748	North Basin
11	Combine	6.449	2	720	169,291	1, 10	------	------	Outfall A

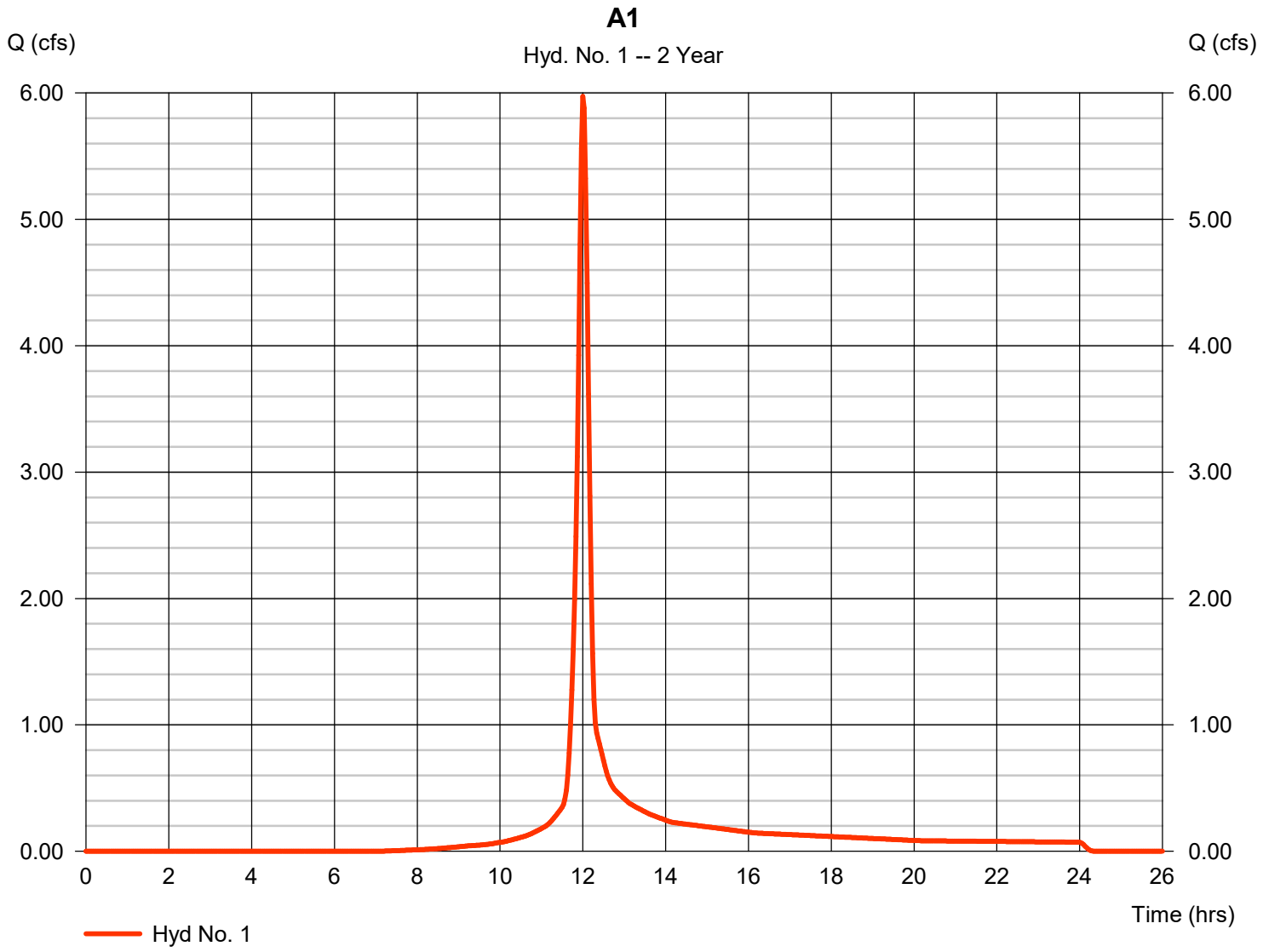
Hydrograph Report

Hyd. No. 1

A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.973 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	15,514 cuft
Drainage area	=	1.970 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.360 x 79) + (0.610 x 98)] / 1.970



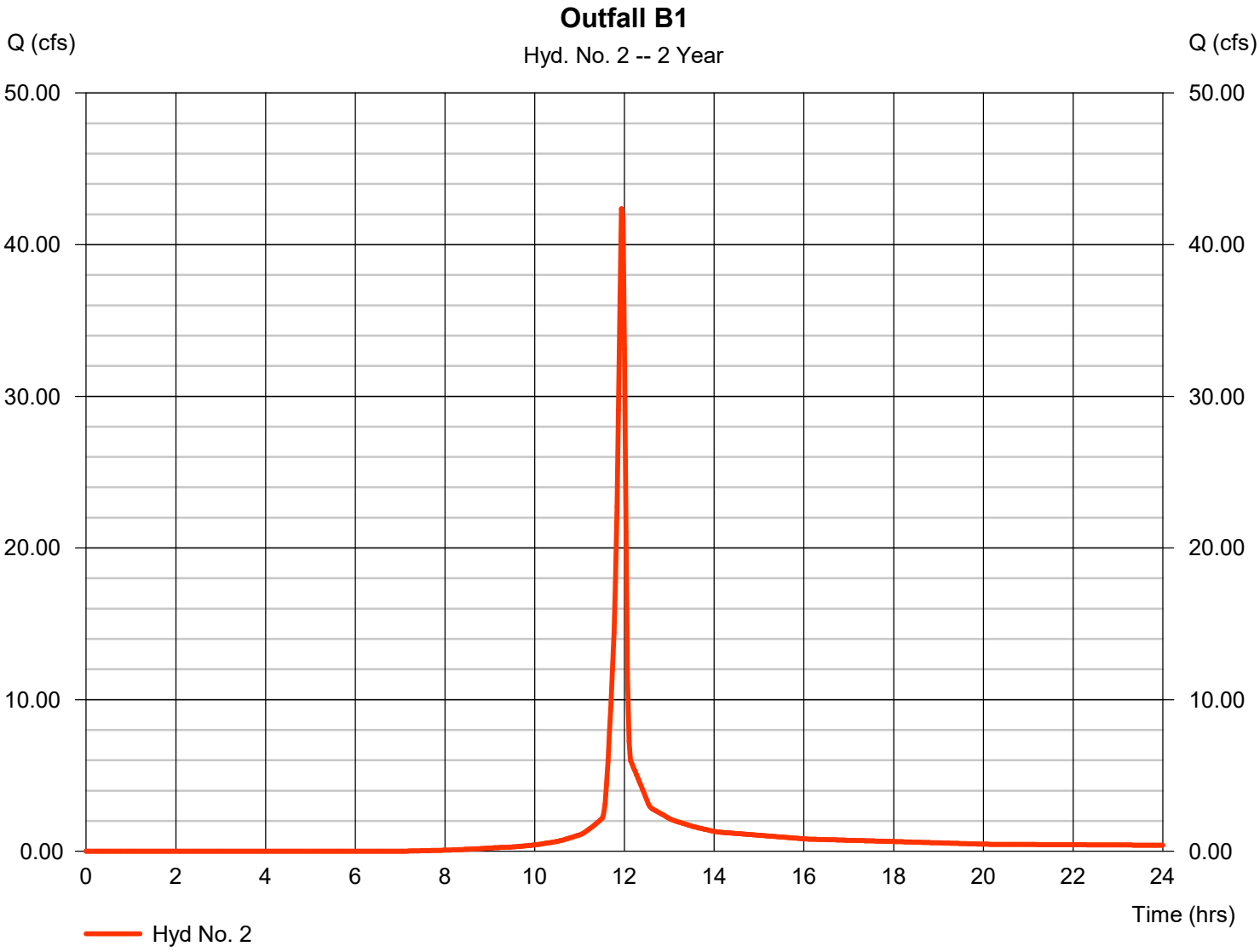
Hydrograph Report

Hyd. No. 2

Outfall B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	42.37 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	86,269 cuft
Drainage area	=	12.050 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.150 x 98) + (7.350 x 84) + (2.080 x 82) + (0.810 x 79) + (0.230 x 76) + (0.430 x 84)] / 12.050



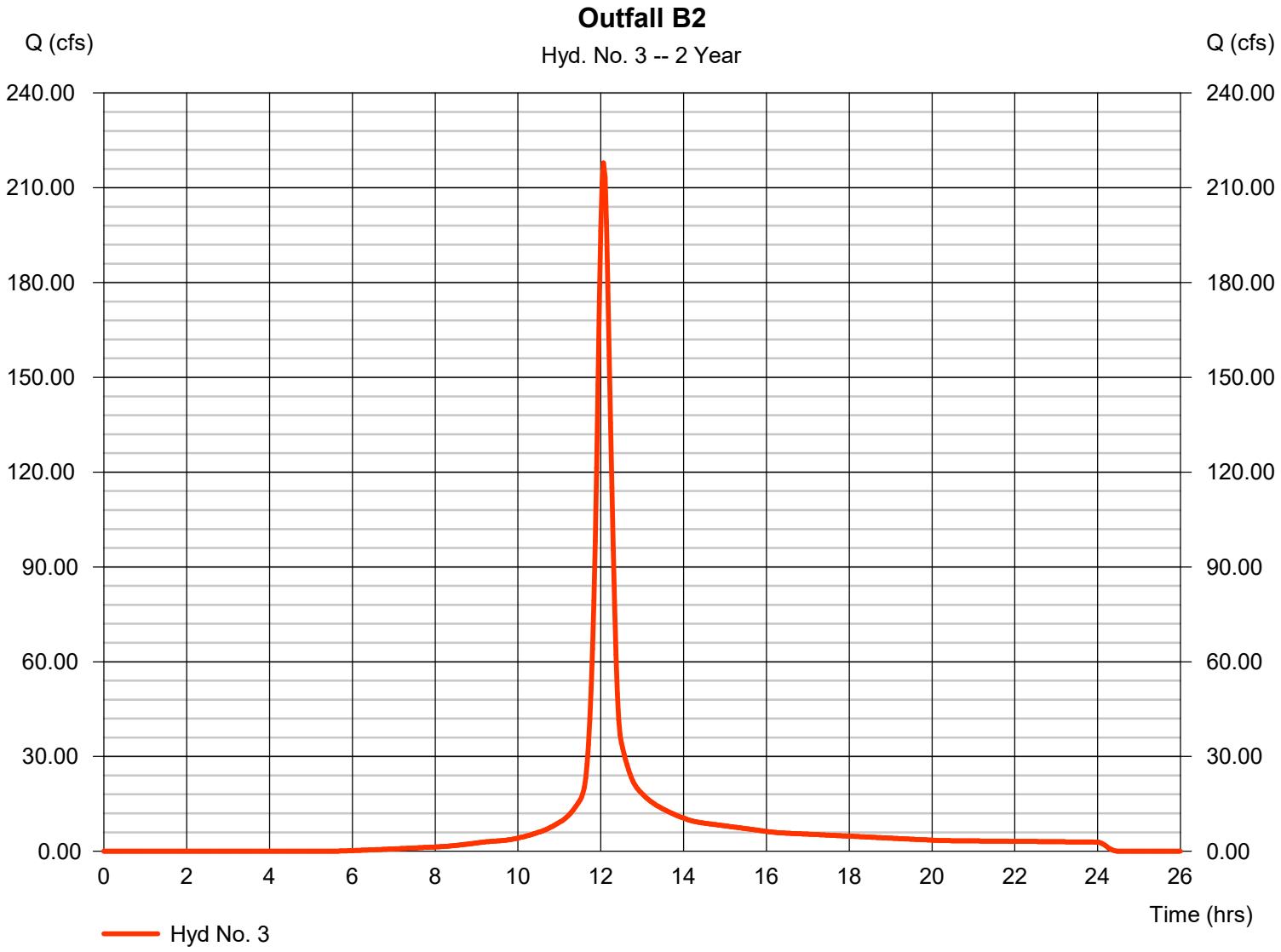
Hydrograph Report

Hyd. No. 3

Outfall B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	217.90 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	687,842 cuft
Drainage area	=	77.350 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(23.100 x 98) + (28.590 x 79) + (4.200 x 84) + (7.470 x 91) + (13.990 x 93)] / 77.350



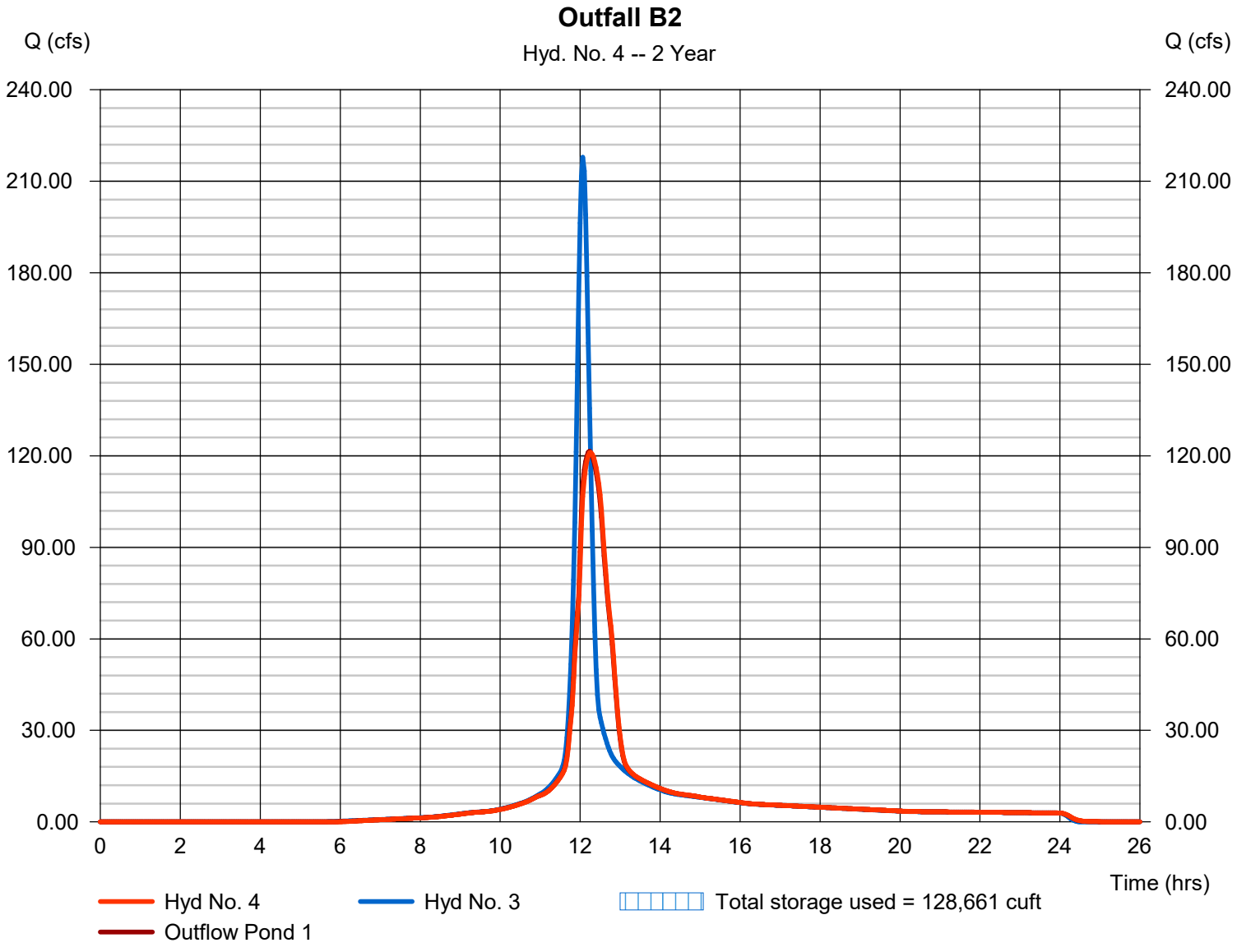
Hydrograph Report

Hyd. No. 4

Outfall B2

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	121.08 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.27 hrs
Time interval	=	2 min	Hyd. volume	=	687,873 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - Outfall B2	Other Inflow hyd.	=	None
Max. Elevation	=	945.04 ft	Max. Elevation	=	941.45 ft
Max. Storage	=	123,838 cuft	Max. Storage	=	4,823 cuft

Interconnected Pond Routing. Storage Indication method used.

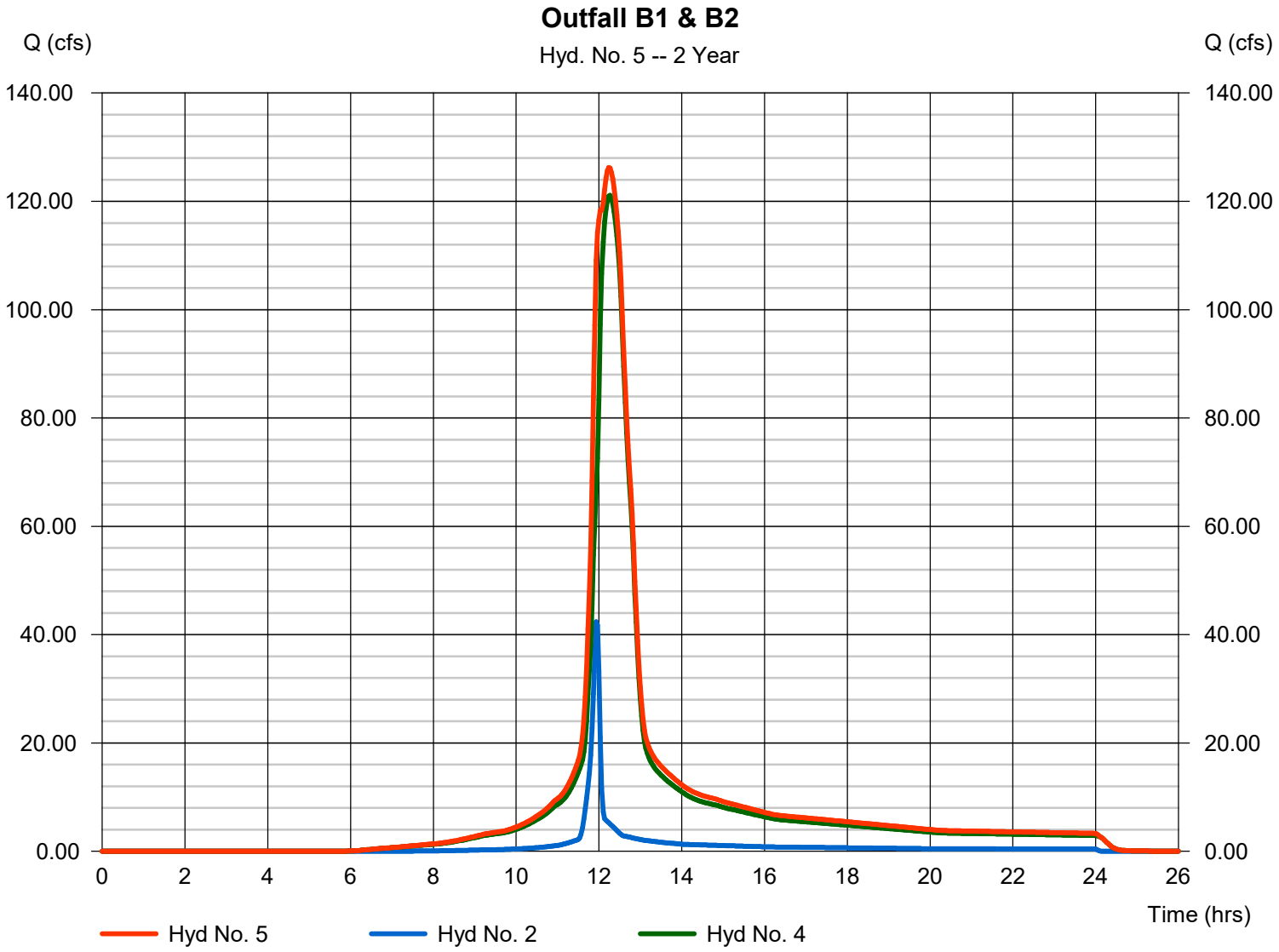


Hydrograph Report

Hyd. No. 5

Outfall B1 & B2

Hydrograph type	= Combine	Peak discharge	= 126.26 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 774,142 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 12.050 ac



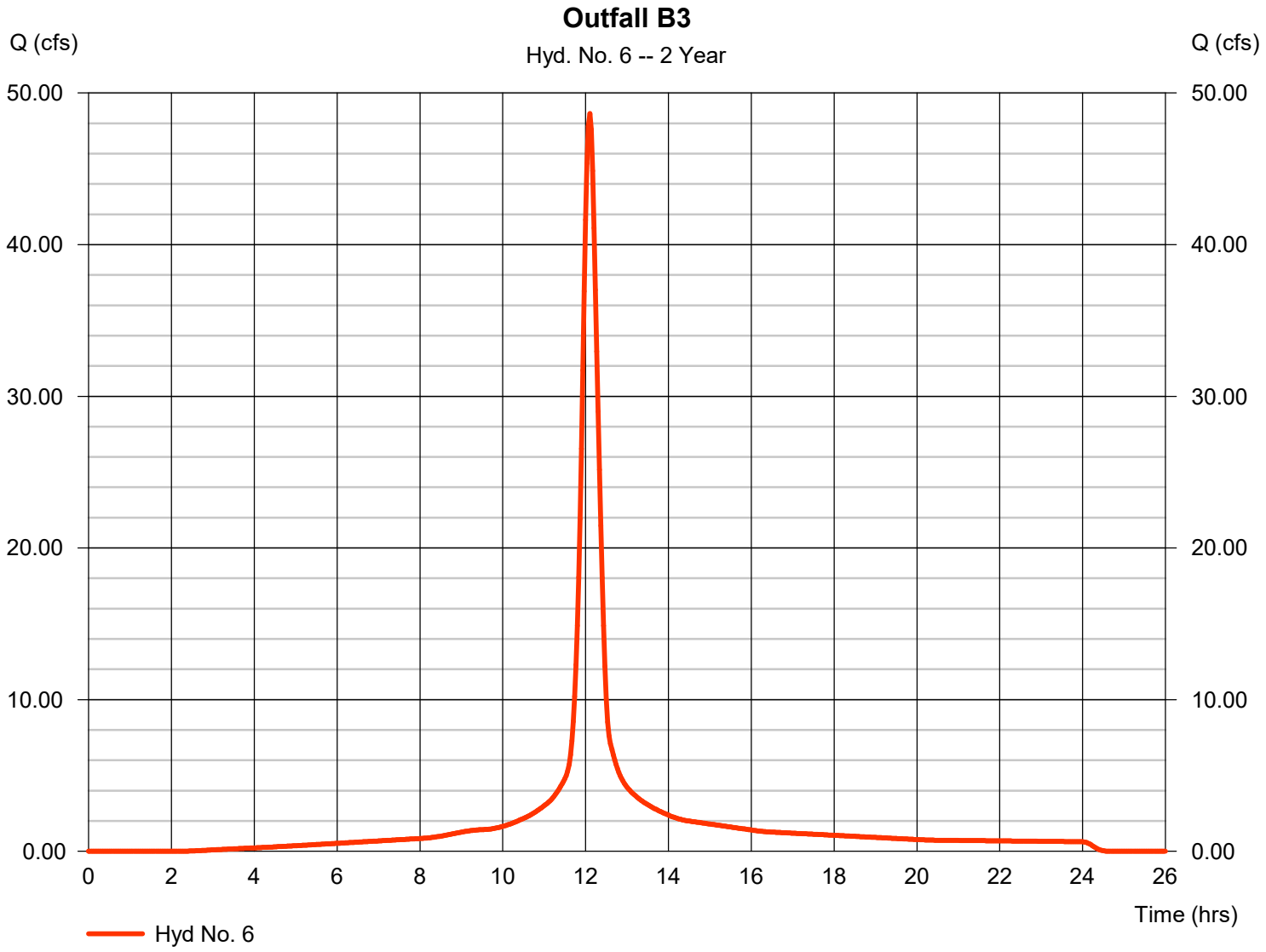
Hydrograph Report

Hyd. No. 6

Outfall B3

Hydrograph type	=	SCS Runoff	Peak discharge	=	48.65 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	179,599 cuft
Drainage area	=	15.460 ac	Curve number	=	96*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.30 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(13.290 x 98) + (2.170 x 84)] / 15.460



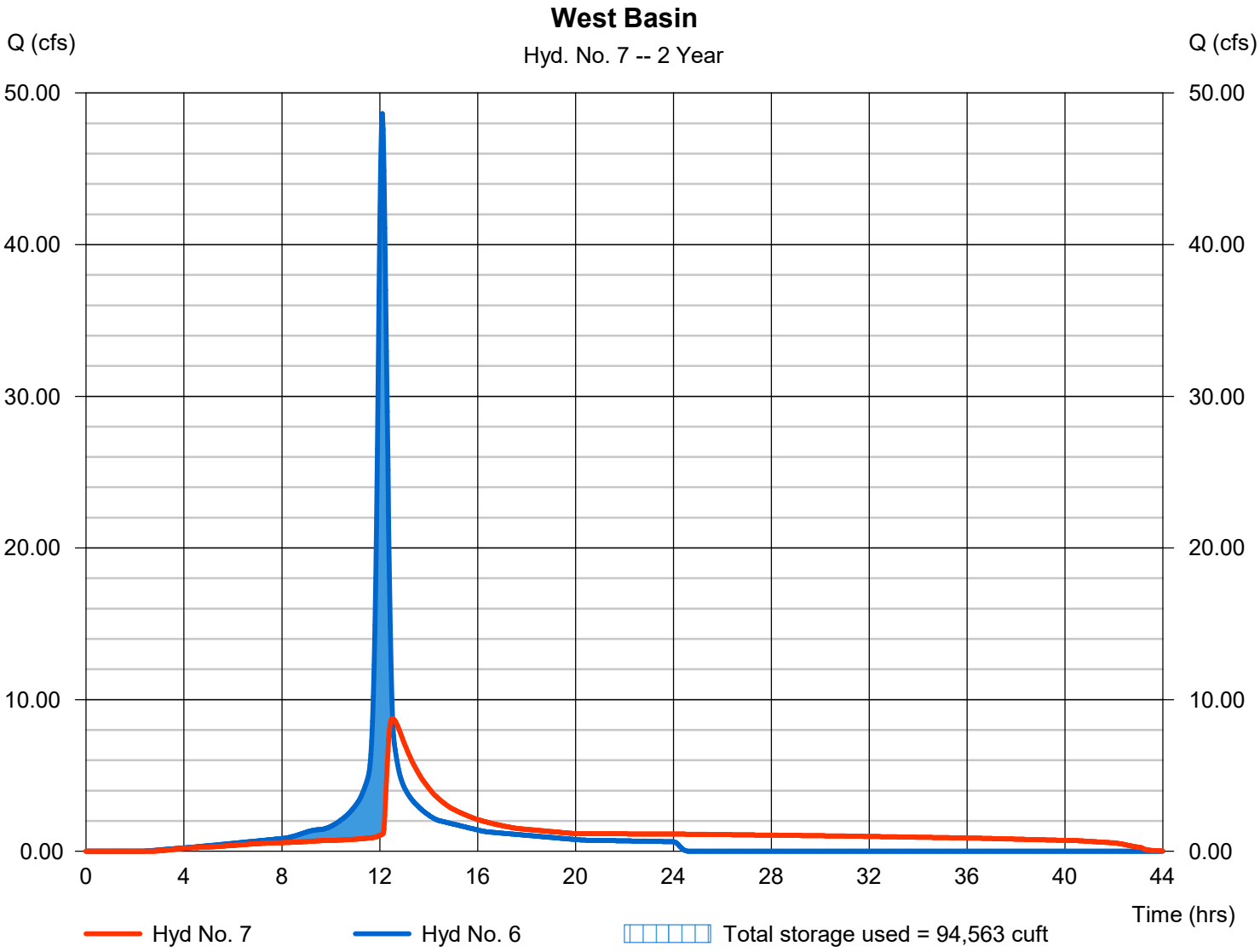
Hydrograph Report

Hyd. No. 7

West Basin

Hydrograph type	=	Reservoir	Peak discharge	=	8.754 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.53 hrs
Time interval	=	2 min	Hyd. volume	=	179,589 cuft
Inflow hyd. No.	=	6 - Outfall B3	Max. Elevation	=	971.01 ft
Reservoir name	=	West Pond	Max. Storage	=	94,563 cuft

Storage Indication method used.

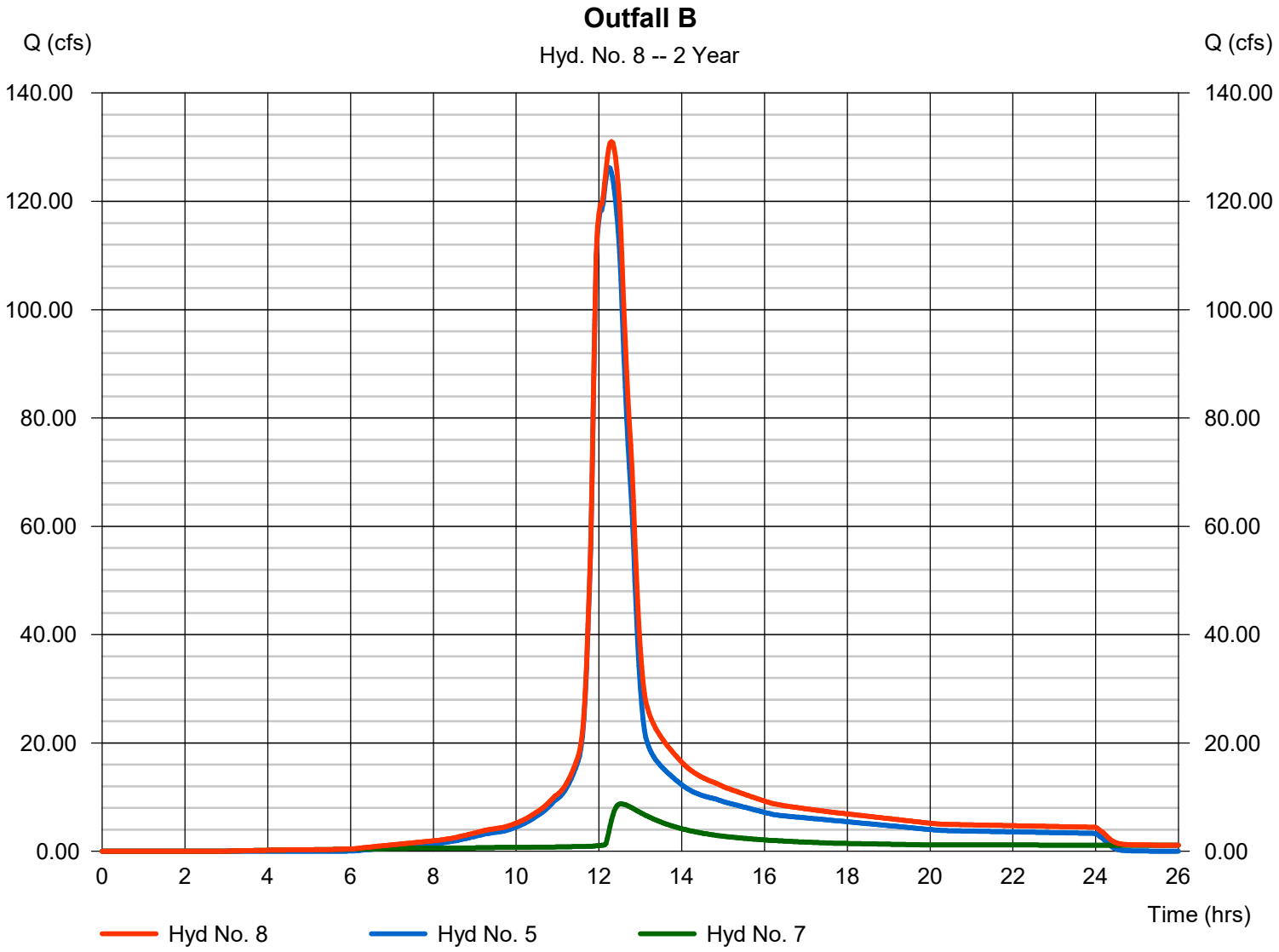


Hydrograph Report

Hyd. No. 8

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	131.03 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.30 hrs
Time interval	=	2 min	Hyd. volume	=	953,731 cuft
Inflow hyds.	=	5, 7	Contrib. drain. area	=	0.000 ac



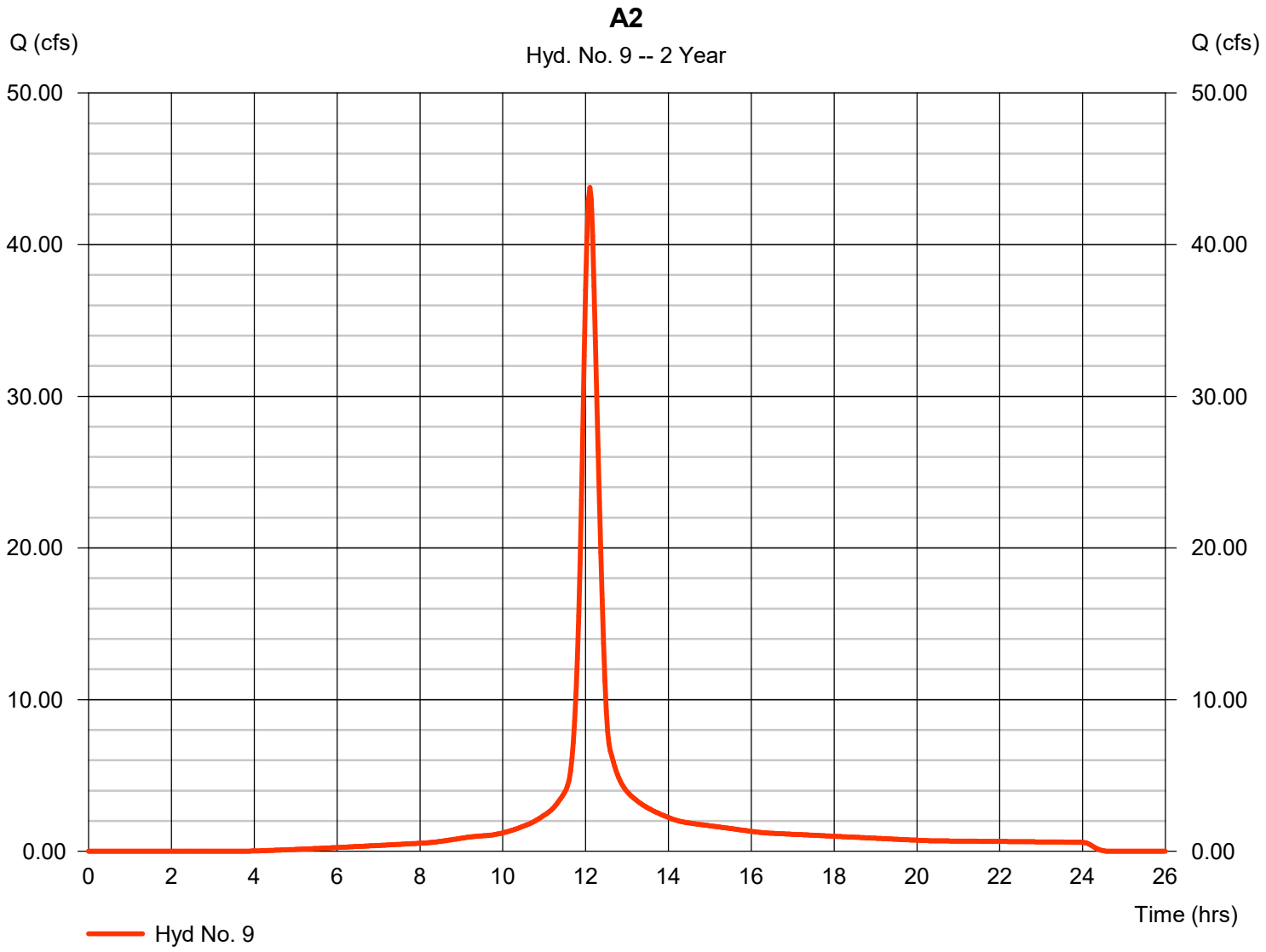
Hydrograph Report

Hyd. No. 9

A2

Hydrograph type	=	SCS Runoff	Peak discharge	=	43.77 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	155,887 cuft
Drainage area	=	14.900 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.00 min
Total precip.	=	3.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.950 x 98) + (4.950 x 84)] / 14.900



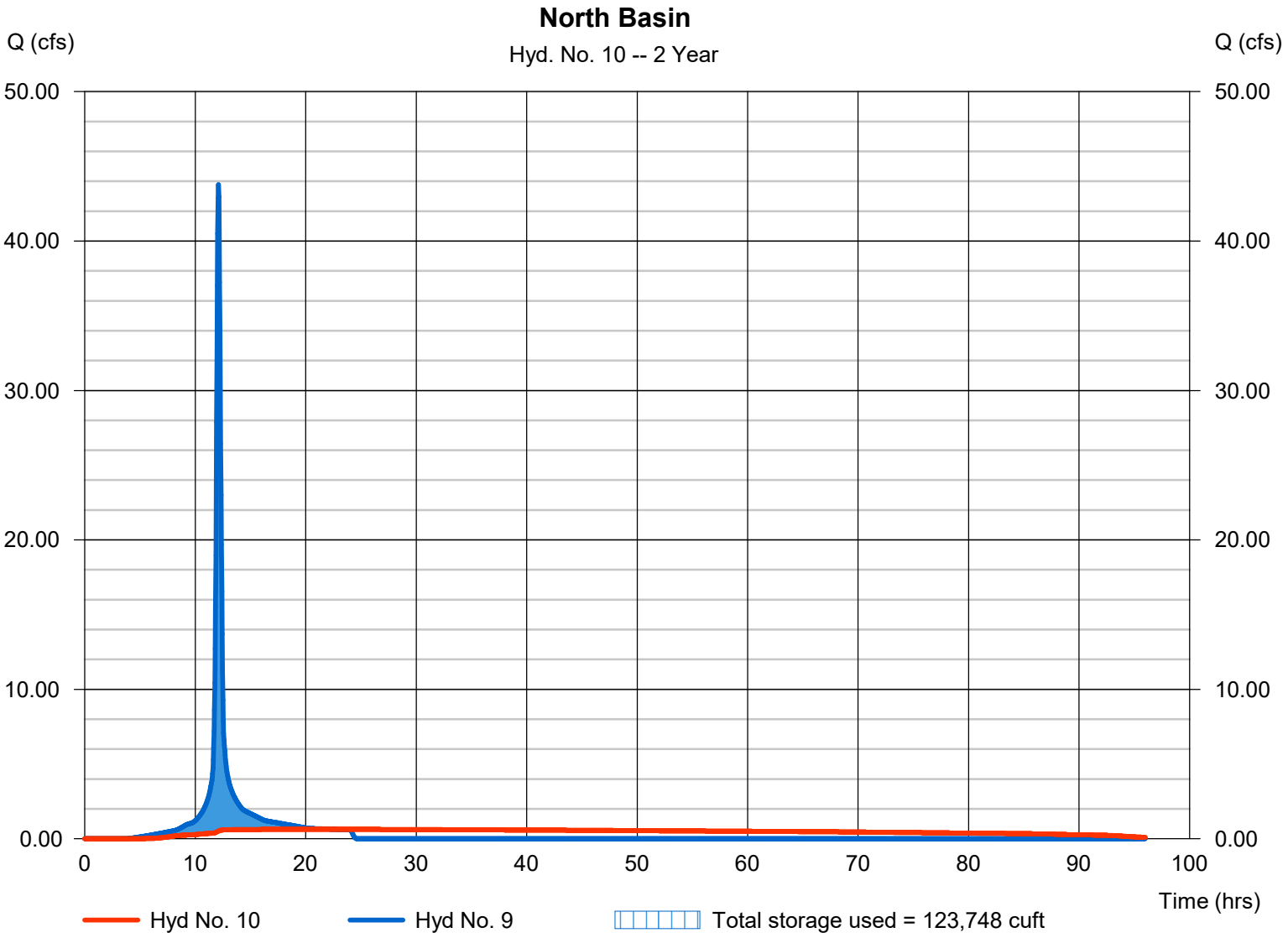
Hydrograph Report

Hyd. No. 10

North Basin

Hydrograph type	=	Reservoir	Peak discharge	=	0.631 cfs
Storm frequency	=	2 yrs	Time to peak	=	22.57 hrs
Time interval	=	2 min	Hyd. volume	=	153,777 cuft
Inflow hyd. No.	=	9 - A2	Max. Elevation	=	980.72 ft
Reservoir name	=	North Pond	Max. Storage	=	123,748 cuft

Storage Indication method used.

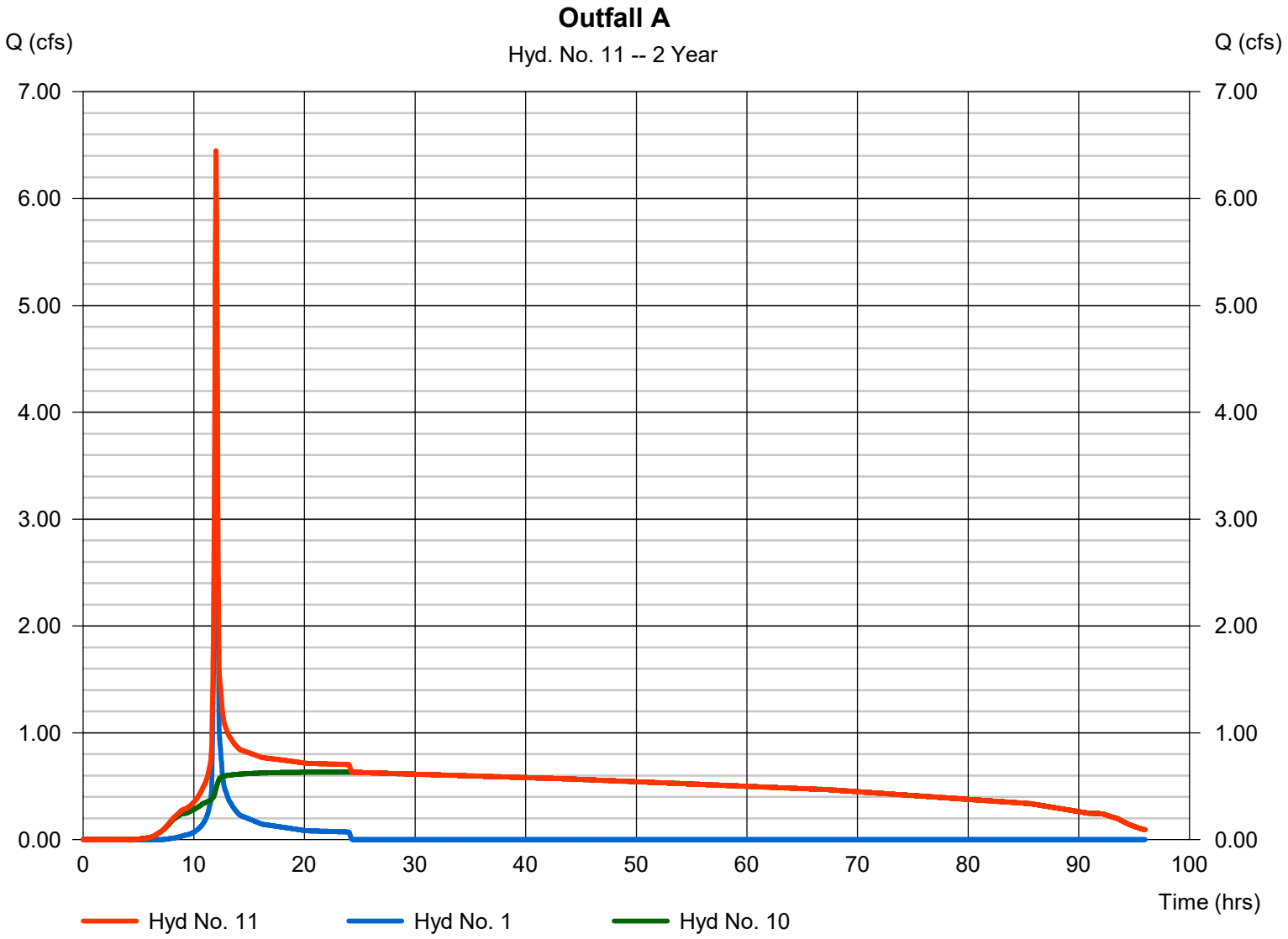


Hydrograph Report

Hyd. No. 11

Outfall A

Hydrograph type	= Combine	Peak discharge	= 6.449 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 169,291 cuft
Inflow hyds.	= 1, 10	Contrib. drain. area	= 1.970 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	10.30	2	720	27,165	------	------	------	A1
2	SCS Runoff	72.53	2	716	151,056	------	------	------	Outfall B1
3	SCS Runoff	357.20	2	724	1,150,701	------	------	------	Outfall B2
4	Reservoir(i)	152.22	2	738	1,150,718	3	947.40	274,027	Outfall B2
5	Combine	179.05	2	718	1,301,774	2, 4	------	------	Outfall B1 & B2
6	SCS Runoff	73.71	2	726	278,218	------	------	------	Outfall B3
7	Reservoir	18.78	2	748	278,208	6	972.15	138,930	West Basin
8	Combine	180.29	2	718	1,579,980	5, 7	------	------	Outfall B
9	SCS Runoff	68.40	2	726	249,506	------	------	------	A2
10	Reservoir	3.775	2	826	239,460	9	981.37	167,524	North Basin
11	Combine	10.85	2	720	266,625	1, 10	------	------	Outfall A

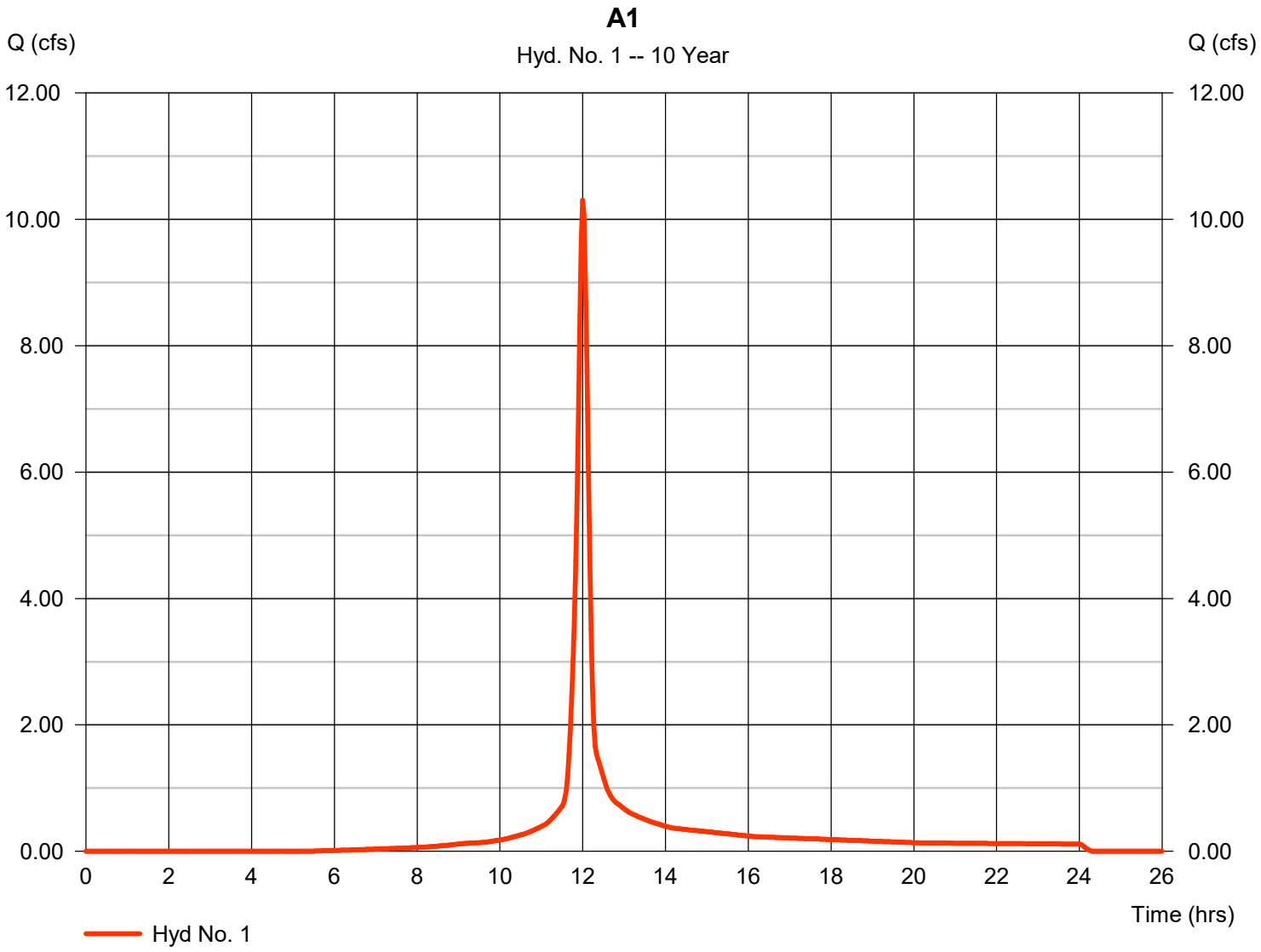
Hydrograph Report

Hyd. No. 1

A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.30 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	27,165 cuft
Drainage area	=	1.970 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.360 x 79) + (0.610 x 98)] / 1.970



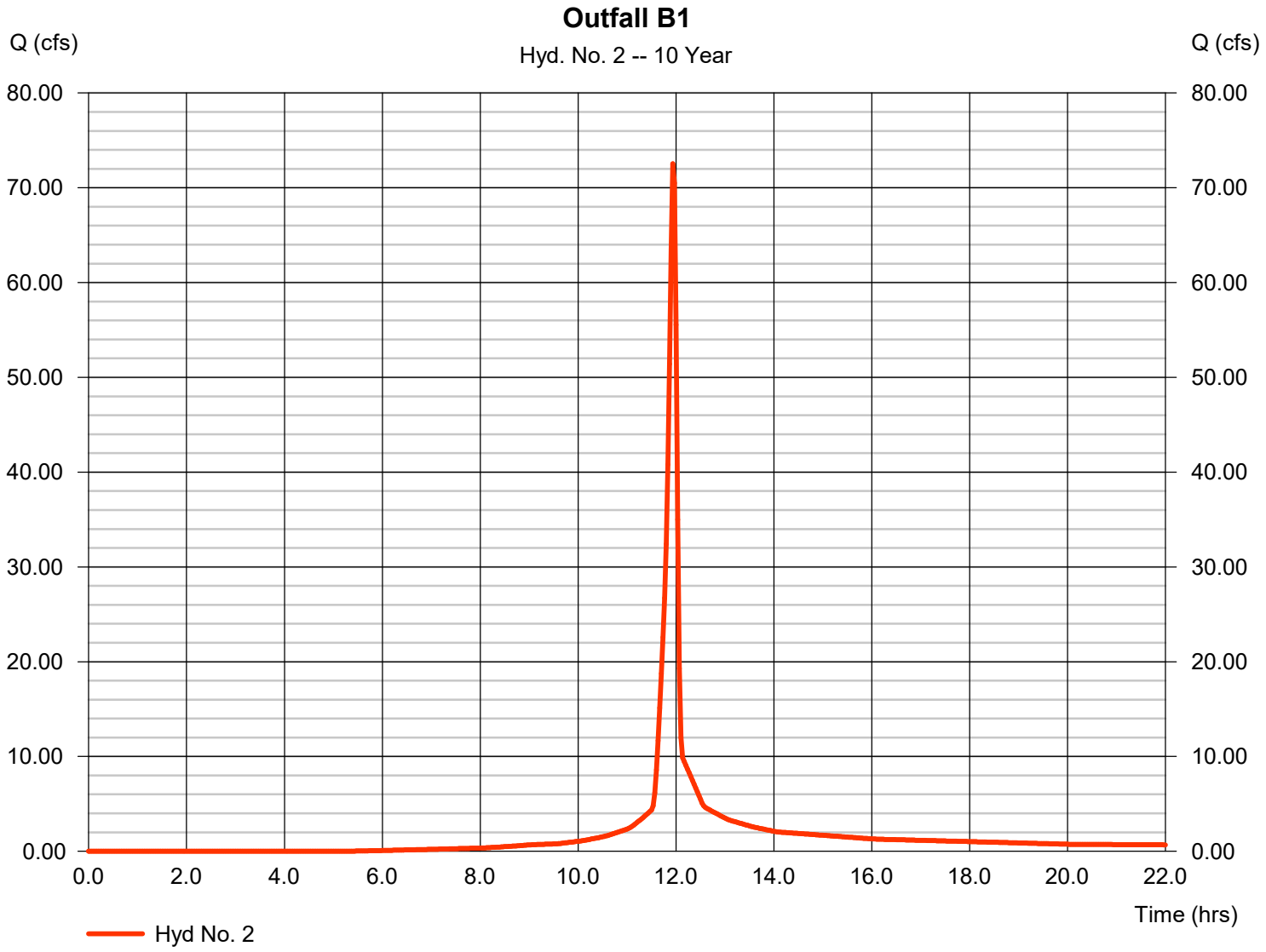
Hydrograph Report

Hyd. No. 2

Outfall B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	72.53 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	151,056 cuft
Drainage area	=	12.050 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.150 x 98) + (7.350 x 84) + (2.080 x 82) + (0.810 x 79) + (0.230 x 76) + (0.430 x 84)] / 12.050



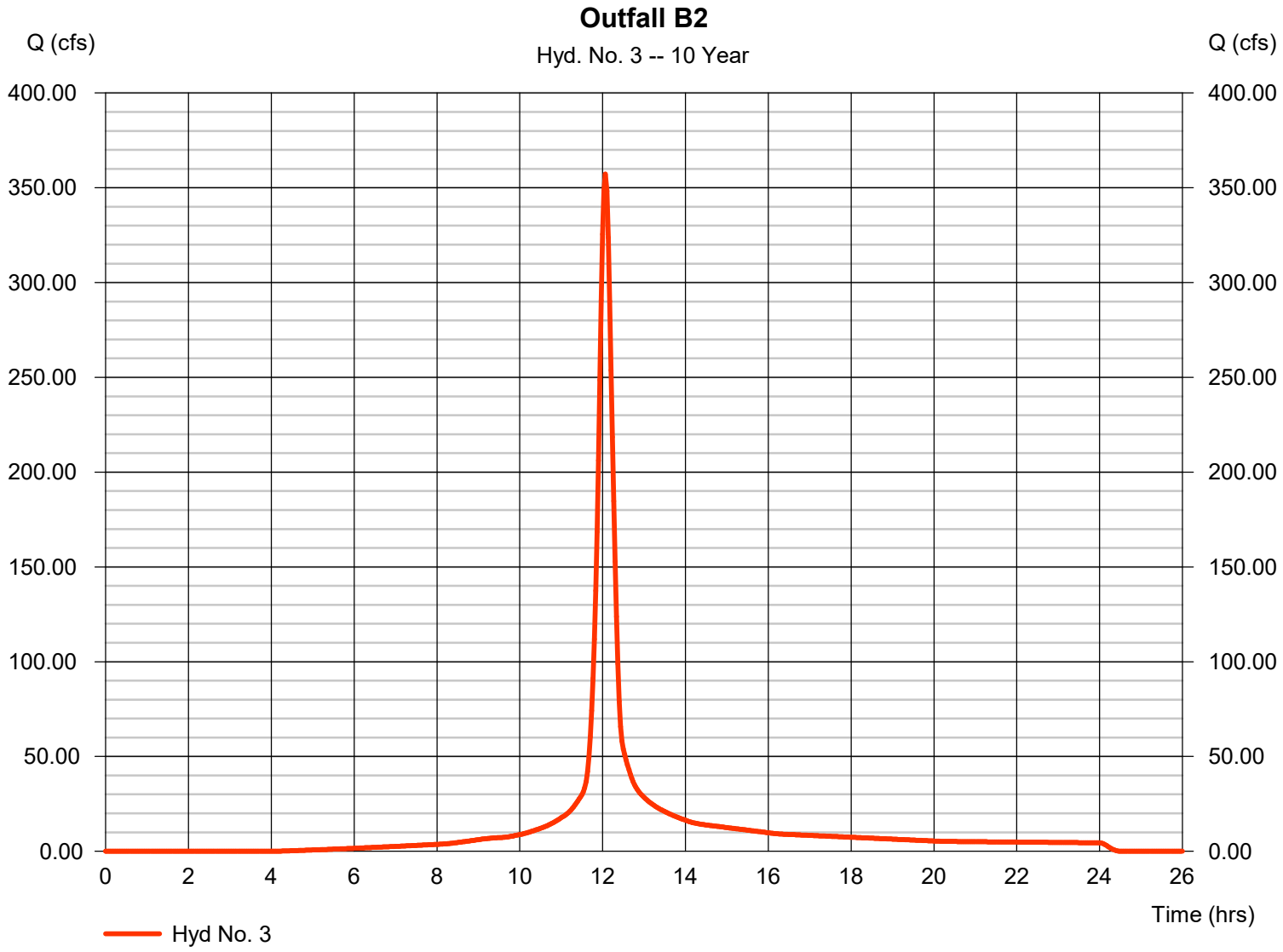
Hydrograph Report

Hyd. No. 3

Outfall B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	357.20 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	1,150,701 cuft
Drainage area	=	77.350 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(23.100 x 98) + (28.590 x 79) + (4.200 x 84) + (7.470 x 91) + (13.990 x 93)] / 77.350



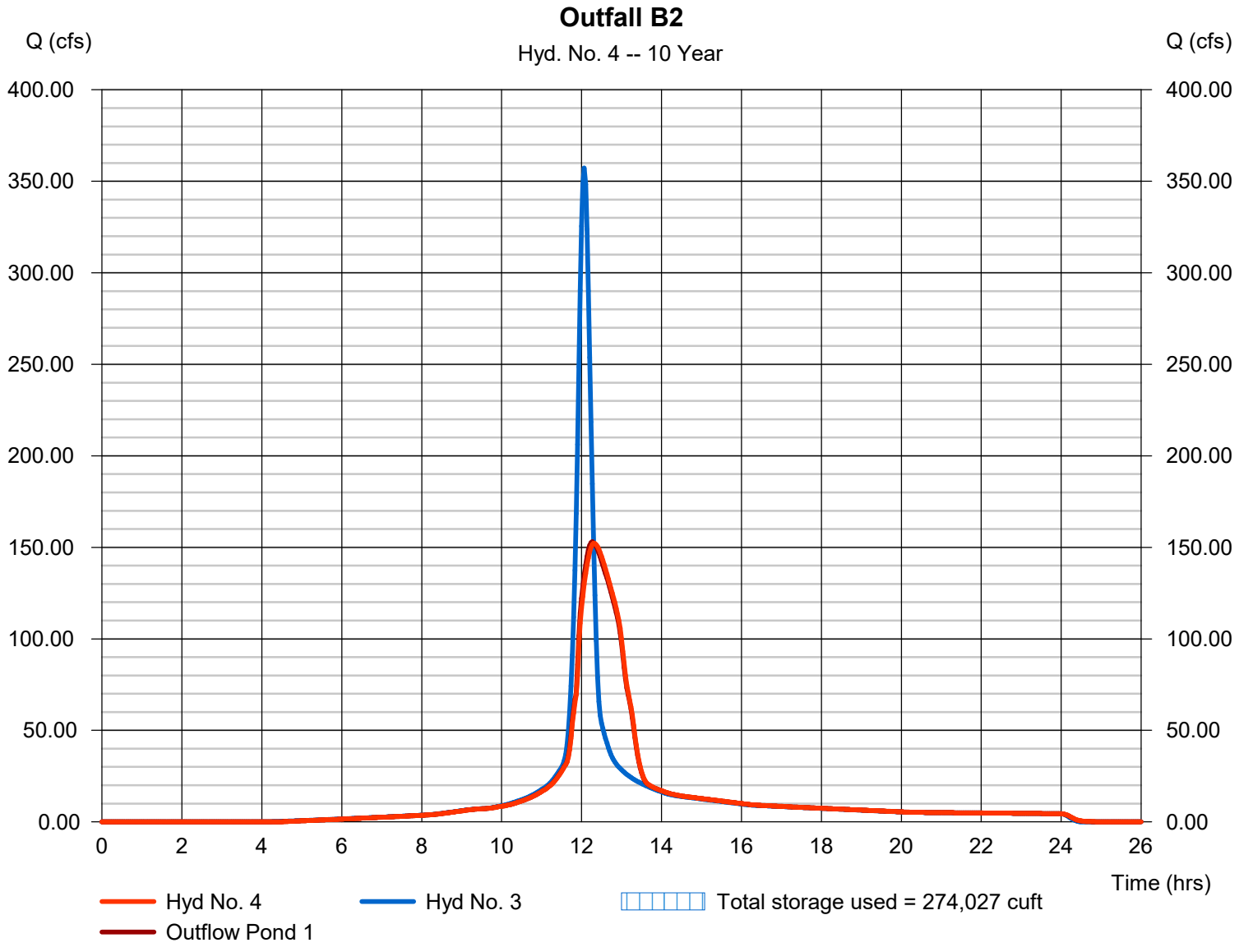
Hydrograph Report

Hyd. No. 4

Outfall B2

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	152.22 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.30 hrs
Time interval	=	2 min	Hyd. volume	=	1,150,718 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - Outfall B2	Other Inflow hyd.	=	None
Max. Elevation	=	947.40 ft	Max. Elevation	=	942.45 ft
Max. Storage	=	265,538 cuft	Max. Storage	=	8,488 cuft

Interconnected Pond Routing. Storage Indication method used.

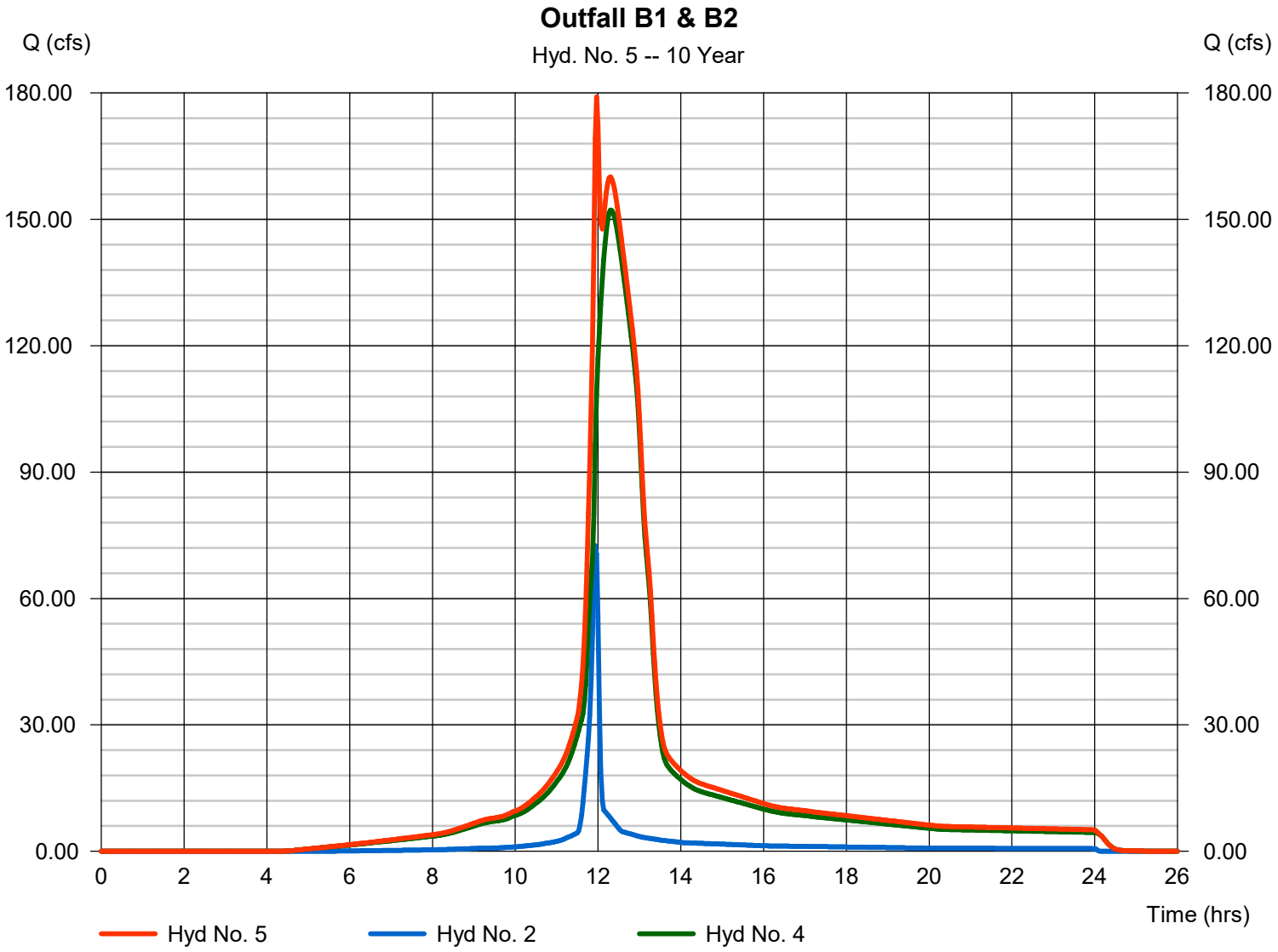


Hydrograph Report

Hyd. No. 5

Outfall B1 & B2

Hydrograph type	= Combine	Peak discharge	= 179.05 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 1,301,774 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 12.050 ac



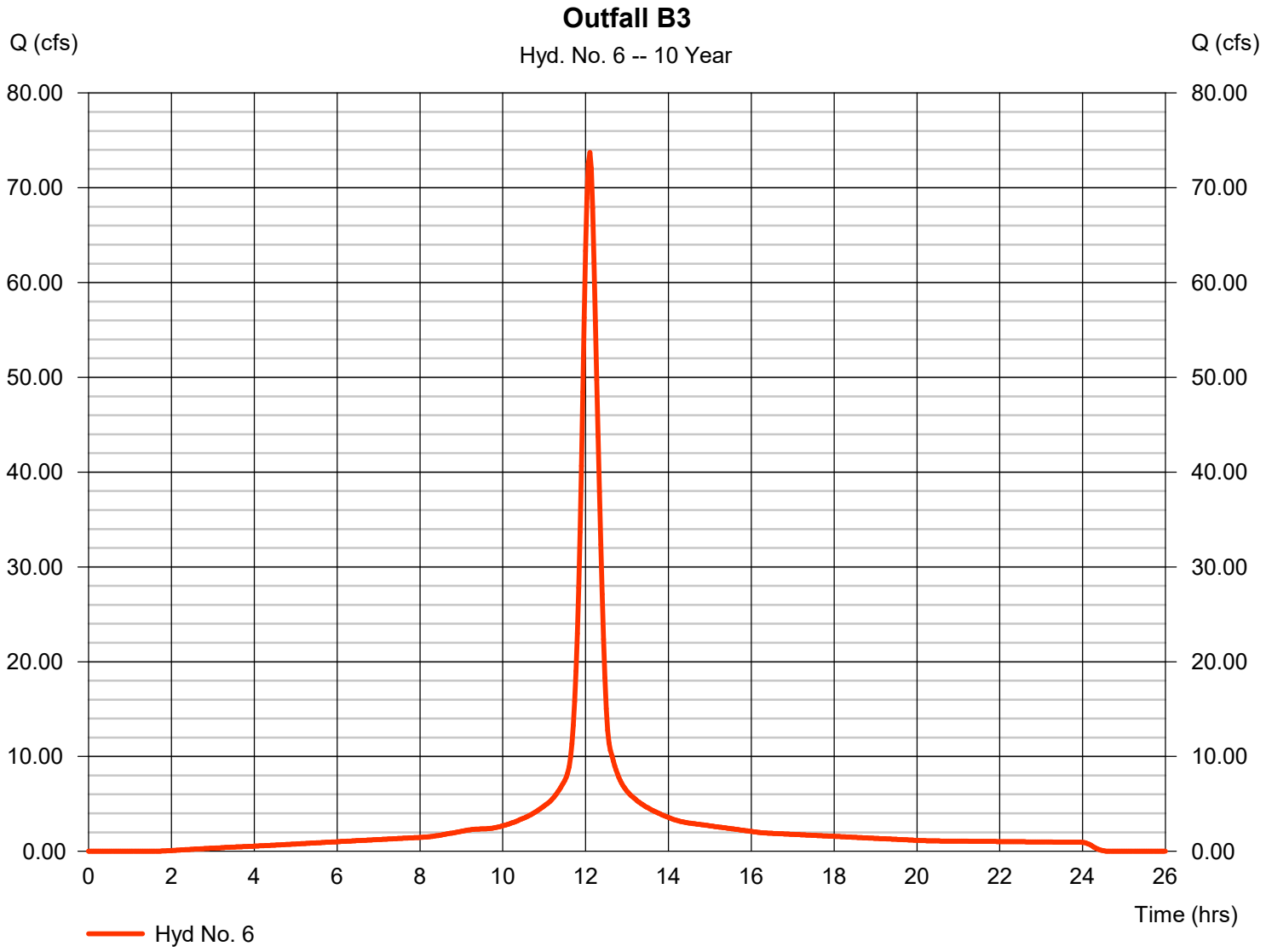
Hydrograph Report

Hyd. No. 6

Outfall B3

Hydrograph type	=	SCS Runoff	Peak discharge	=	73.71 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	278,218 cuft
Drainage area	=	15.460 ac	Curve number	=	96*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.30 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(13.290 x 98) + (2.170 x 84)] / 15.460



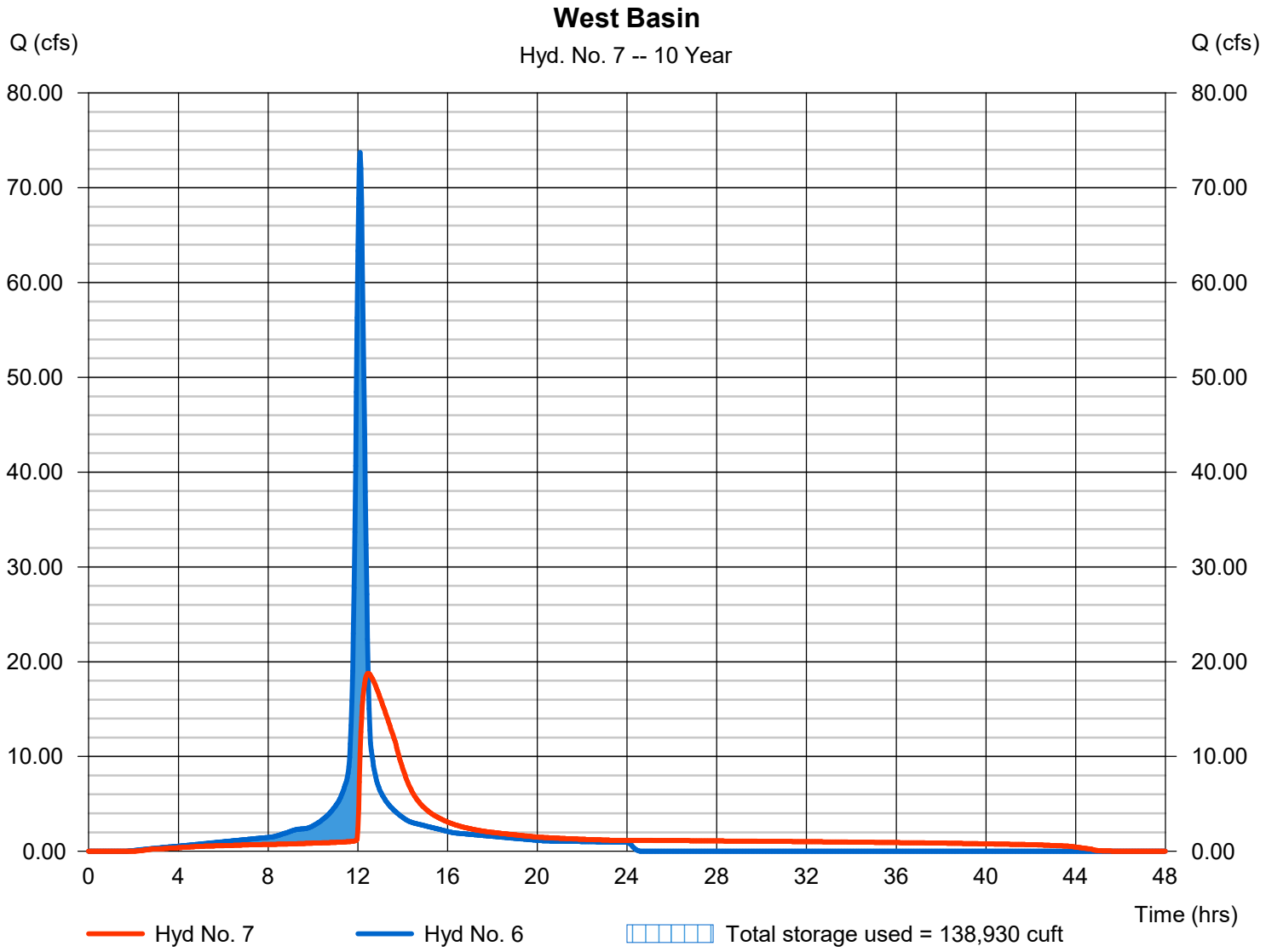
Hydrograph Report

Hyd. No. 7

West Basin

Hydrograph type	=	Reservoir	Peak discharge	=	18.78 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.47 hrs
Time interval	=	2 min	Hyd. volume	=	278,208 cuft
Inflow hyd. No.	=	6 - Outfall B3	Max. Elevation	=	972.15 ft
Reservoir name	=	West Pond	Max. Storage	=	138,930 cuft

Storage Indication method used.

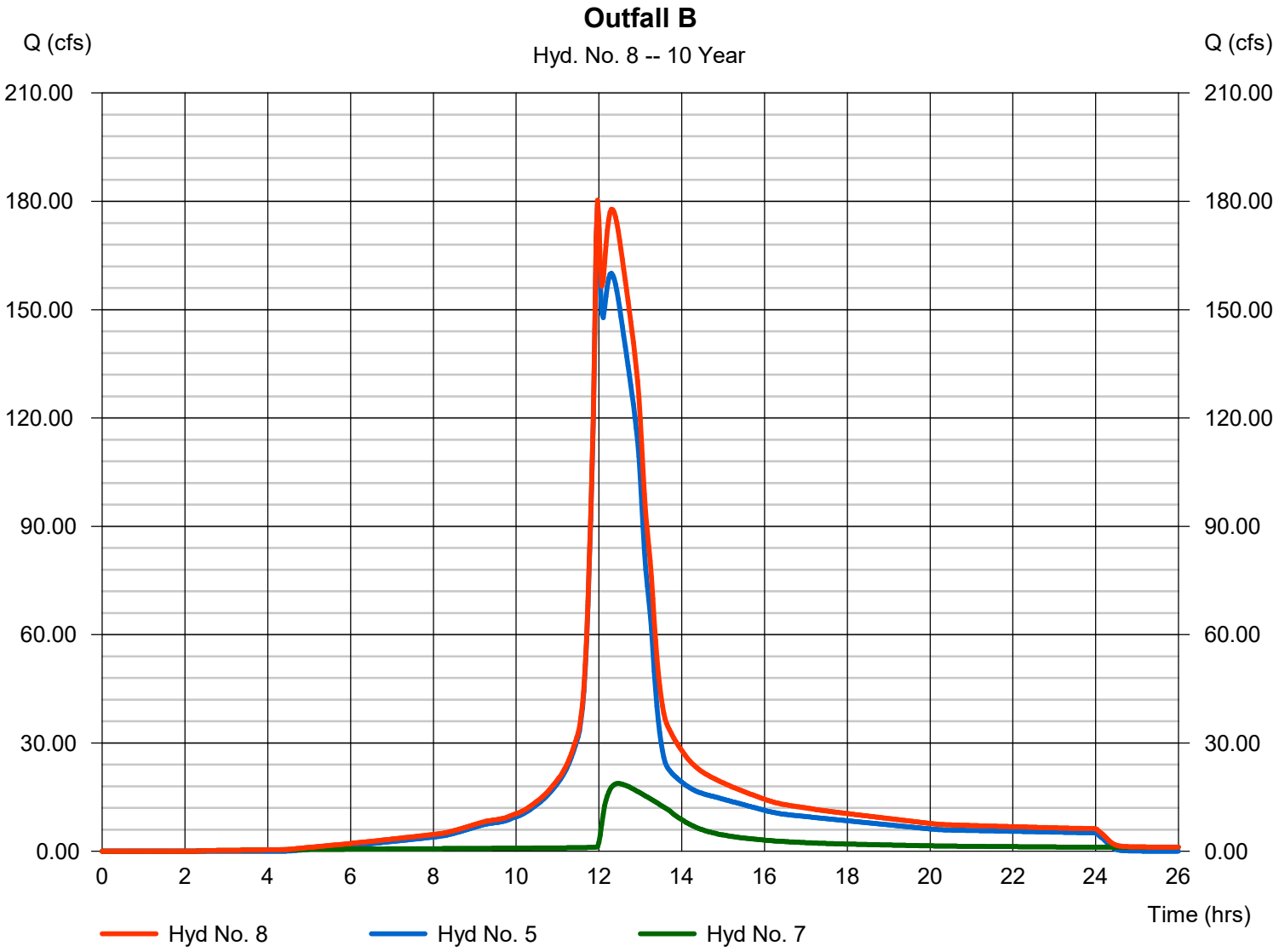


Hydrograph Report

Hyd. No. 8

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	180.29 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	1,579,980 cuft
Inflow hyds.	=	5, 7	Contrib. drain. area	=	0.000 ac



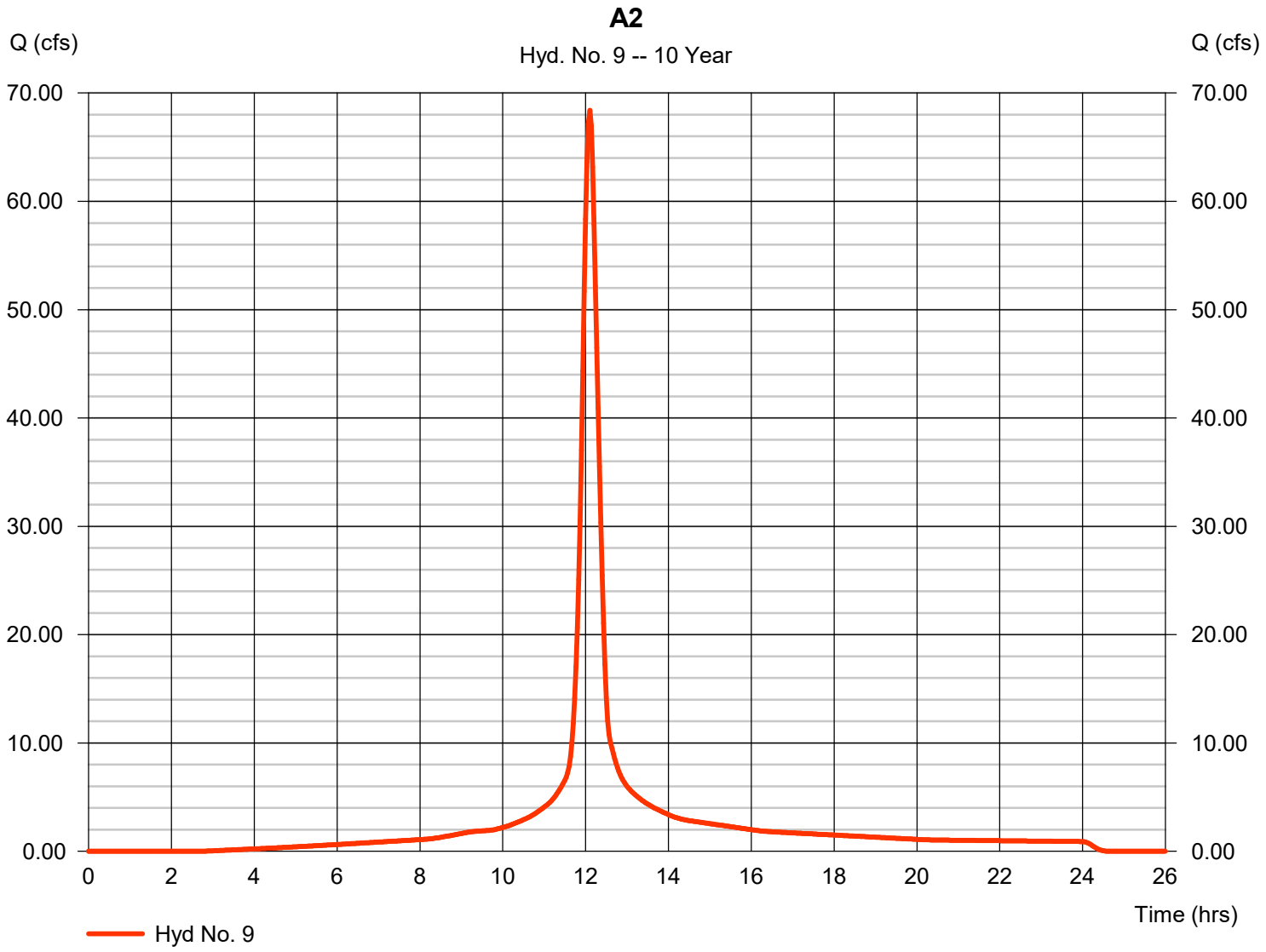
Hydrograph Report

Hyd. No. 9

A2

Hydrograph type	=	SCS Runoff	Peak discharge	=	68.40 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	249,506 cuft
Drainage area	=	14.900 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.00 min
Total precip.	=	5.34 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.950 x 98) + (4.950 x 84)] / 14.900



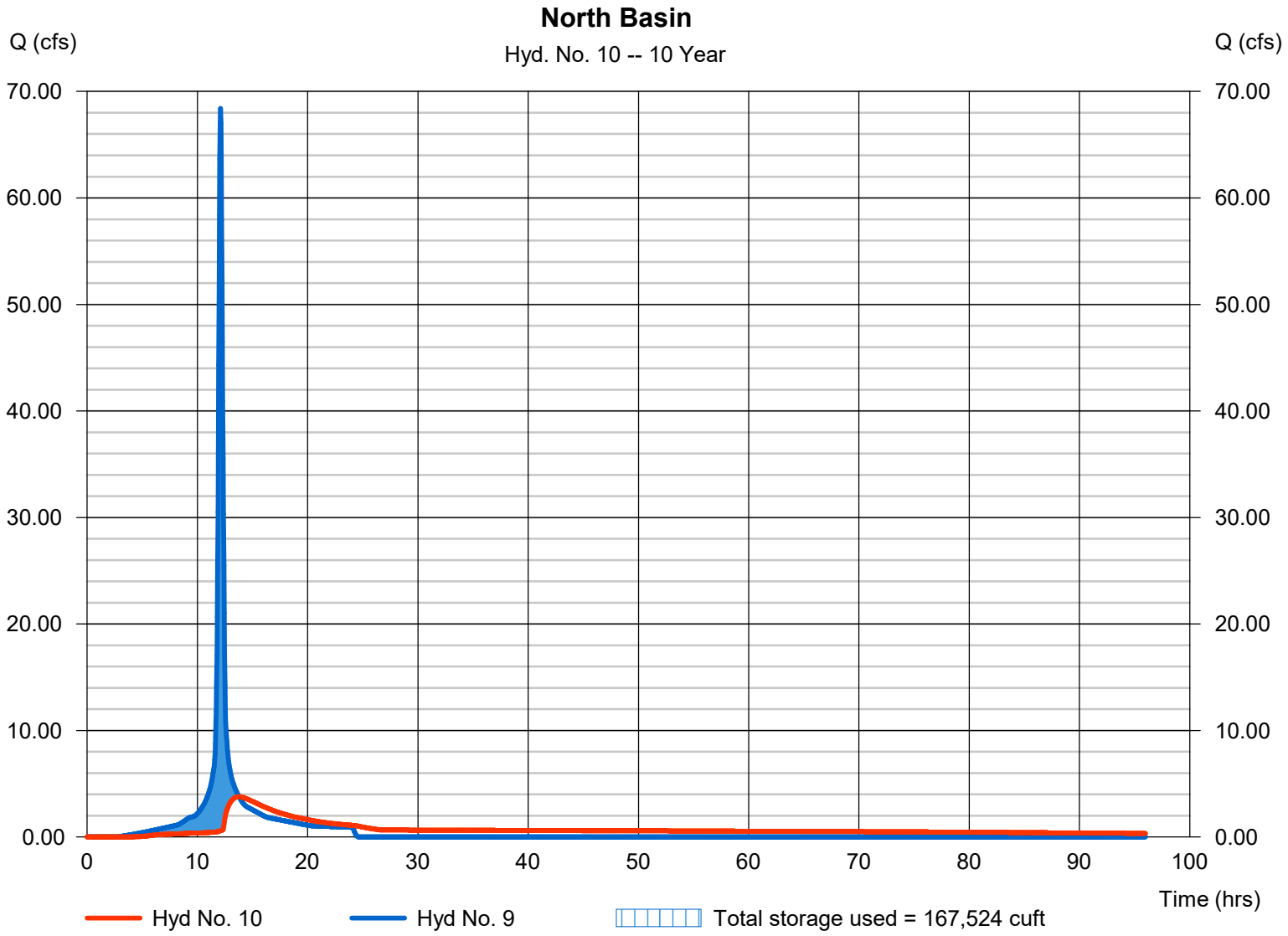
Hydrograph Report

Hyd. No. 10

North Basin

Hydrograph type	=	Reservoir	Peak discharge	=	3.775 cfs
Storm frequency	=	10 yrs	Time to peak	=	13.77 hrs
Time interval	=	2 min	Hyd. volume	=	239,460 cuft
Inflow hyd. No.	=	9 - A2	Max. Elevation	=	981.37 ft
Reservoir name	=	North Pond	Max. Storage	=	167,524 cuft

Storage Indication method used.

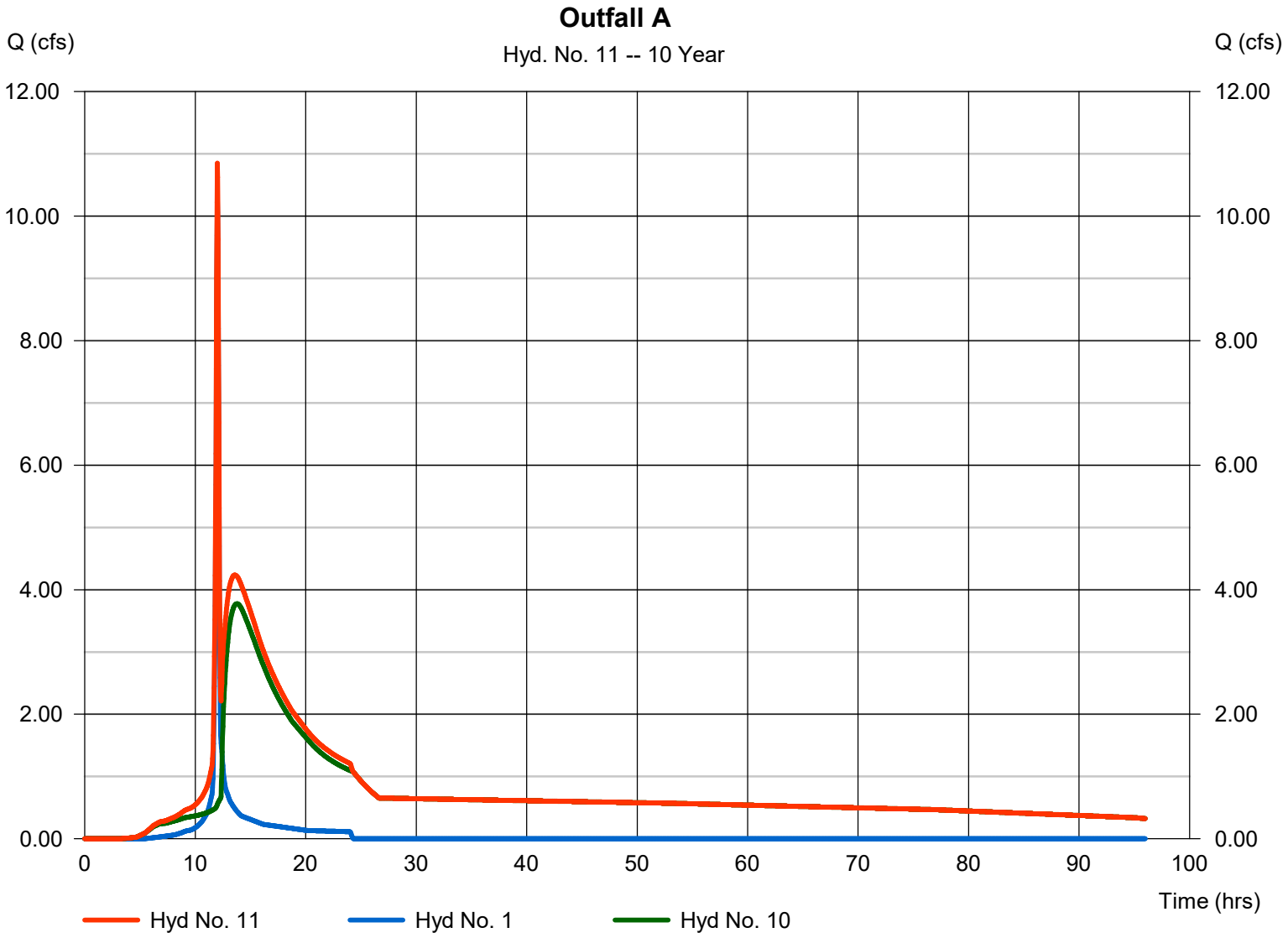


Hydrograph Report

Hyd. No. 11

Outfall A

Hydrograph type	=	Combine	Peak discharge	=	10.85 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	266,625 cuft
Inflow hyds.	=	1, 10	Contrib. drain. area	=	1.970 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

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	16.70	2	720	45,109	------	------	------	A1
2	SCS Runoff	116.96	2	716	250,835	------	------	------	Outfall B1
3	SCS Runoff	560.35	2	724	1,849,981	------	------	------	Outfall B2
4	Reservoir(i)	282.77	2	738	1,851,127	3	951.34	467,672	Outfall B2
5	Combine	295.11	2	738	2,101,965	2, 4	------	------	Outfall B1 & B2
6	SCS Runoff	110.25	2	726	423,907	------	------	------	Outfall B3
7	Reservoir	26.73	2	748	423,896	6	973.83	211,246	West Basin
8	Combine	320.94	2	738	2,525,864	5, 7	------	------	Outfall B
9	SCS Runoff	104.15	2	726	388,861	------	------	------	A2
10	Reservoir	17.19	2	752	377,665	9	982.23	231,926	North Basin
11	Combine	18.92	2	752	422,773	1, 10	------	------	Outfall A

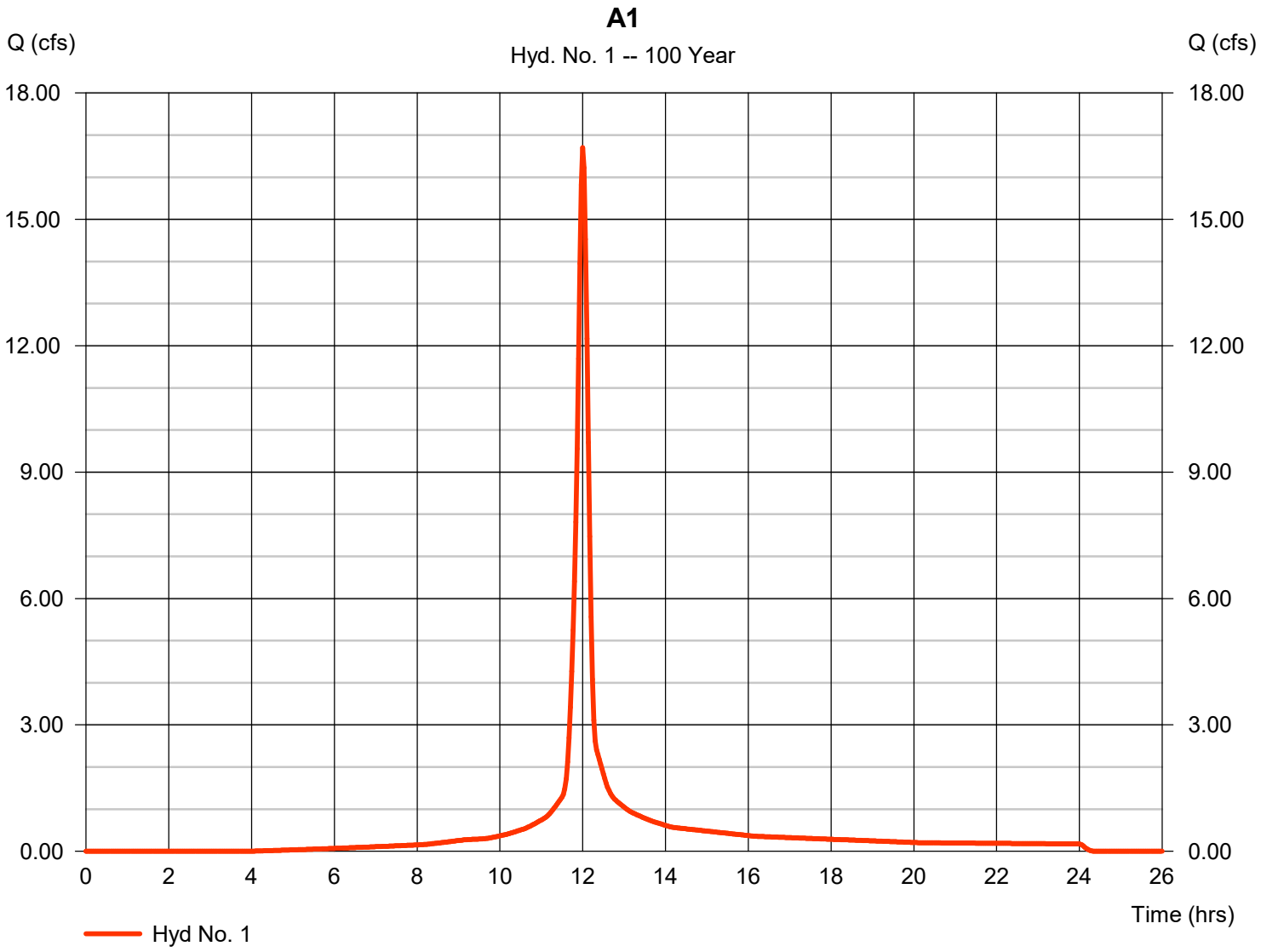
Hydrograph Report

Hyd. No. 1

A1

Hydrograph type	= SCS Runoff	Peak discharge	= 16.70 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 45,109 cuft
Drainage area	= 1.970 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.80 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (1.360 x 79) + (0.610 x 98)] / 1.970



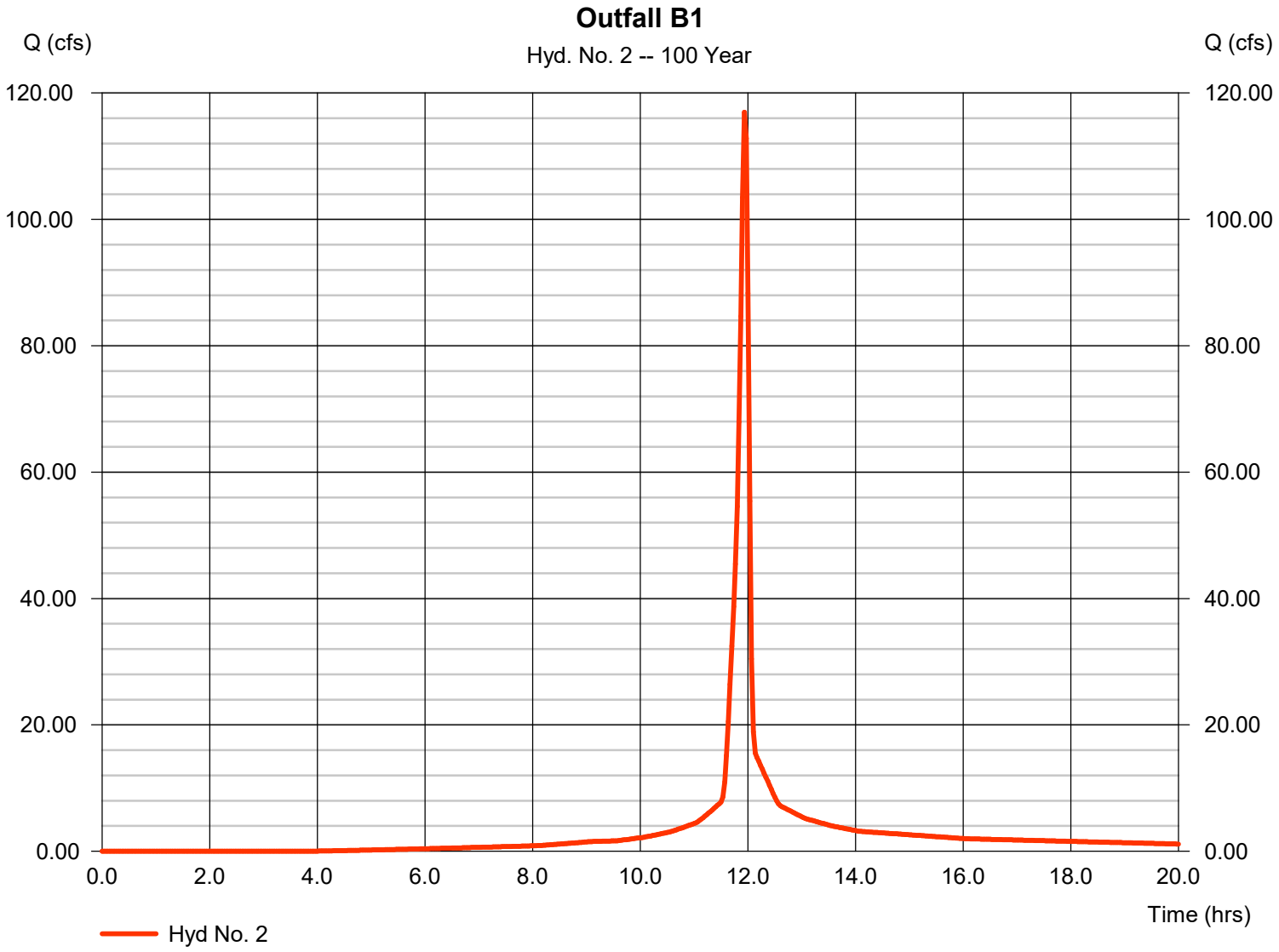
Hydrograph Report

Hyd. No. 2

Outfall B1

Hydrograph type	=	SCS Runoff	Peak discharge	=	116.96 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	250,835 cuft
Drainage area	=	12.050 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.150 x 98) + (7.350 x 84) + (2.080 x 82) + (0.810 x 79) + (0.230 x 76) + (0.430 x 84)] / 12.050



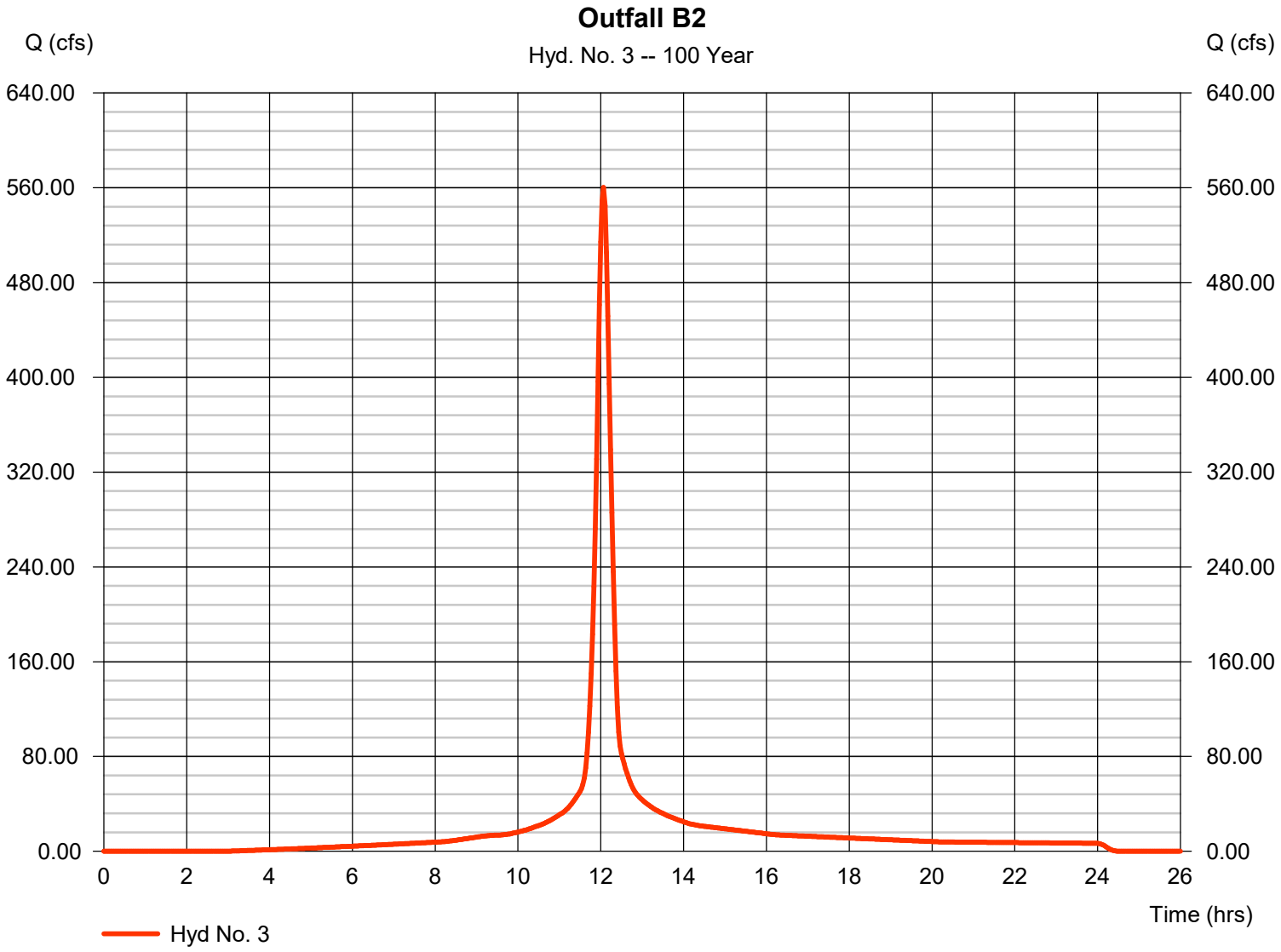
Hydrograph Report

Hyd. No. 3

Outfall B2

Hydrograph type	=	SCS Runoff	Peak discharge	=	560.35 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	1,849,981 cuft
Drainage area	=	77.350 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	17.00 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(23.100 x 98) + (28.590 x 79) + (4.200 x 84) + (7.470 x 91) + (13.990 x 93)] / 77.350



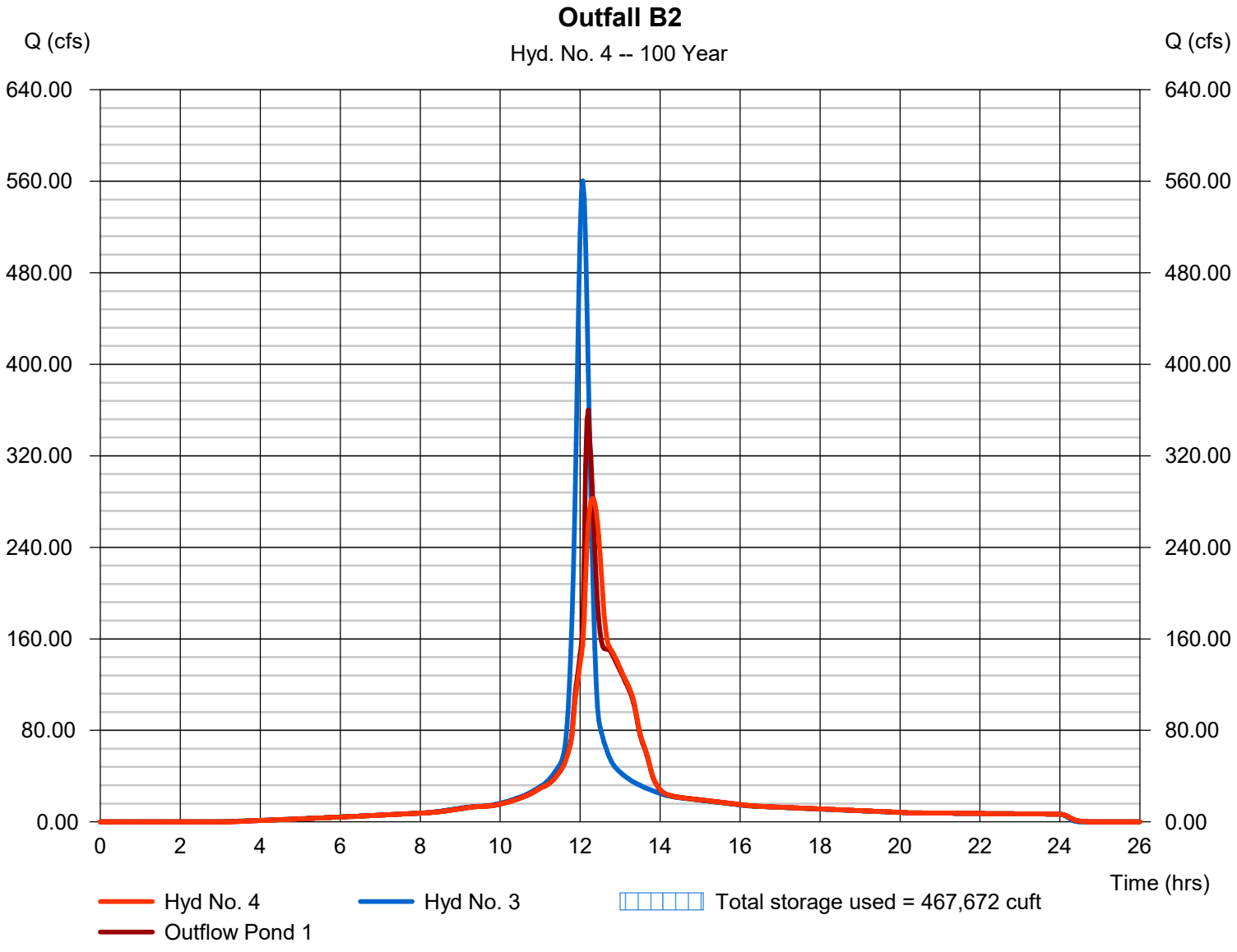
Hydrograph Report

Hyd. No. 4

Outfall B2

Hydrograph type	=	Reservoir (Interconnected)	Peak discharge	=	282.77 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.30 hrs
Time interval	=	2 min	Hyd. volume	=	1,851,127 cuft
Upper Pond	=	Existing Pond 1	Lower Pond	=	Existing Pond 2
Inflow hyd.	=	3 - Outfall B2	Other Inflow hyd.	=	None
Max. Elevation	=	951.34 ft	Max. Elevation	=	949.07 ft
Max. Storage	=	400,472 cuft	Max. Storage	=	67,199 cuft

Interconnected Pond Routing. Storage Indication method used.

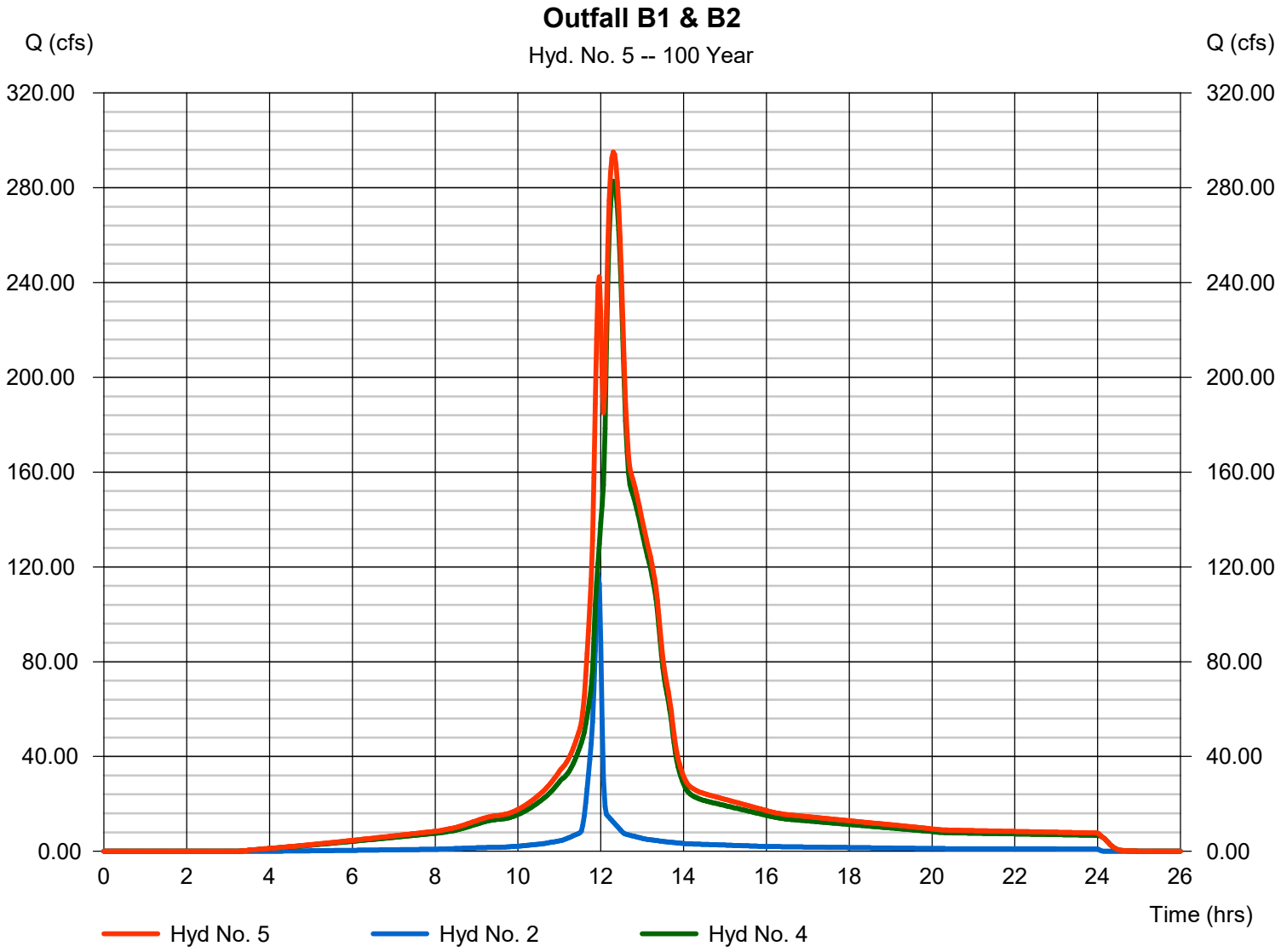


Hydrograph Report

Hyd. No. 5

Outfall B1 & B2

Hydrograph type	= Combine	Peak discharge	= 295.11 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.30 hrs
Time interval	= 2 min	Hyd. volume	= 2,101,965 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 12.050 ac



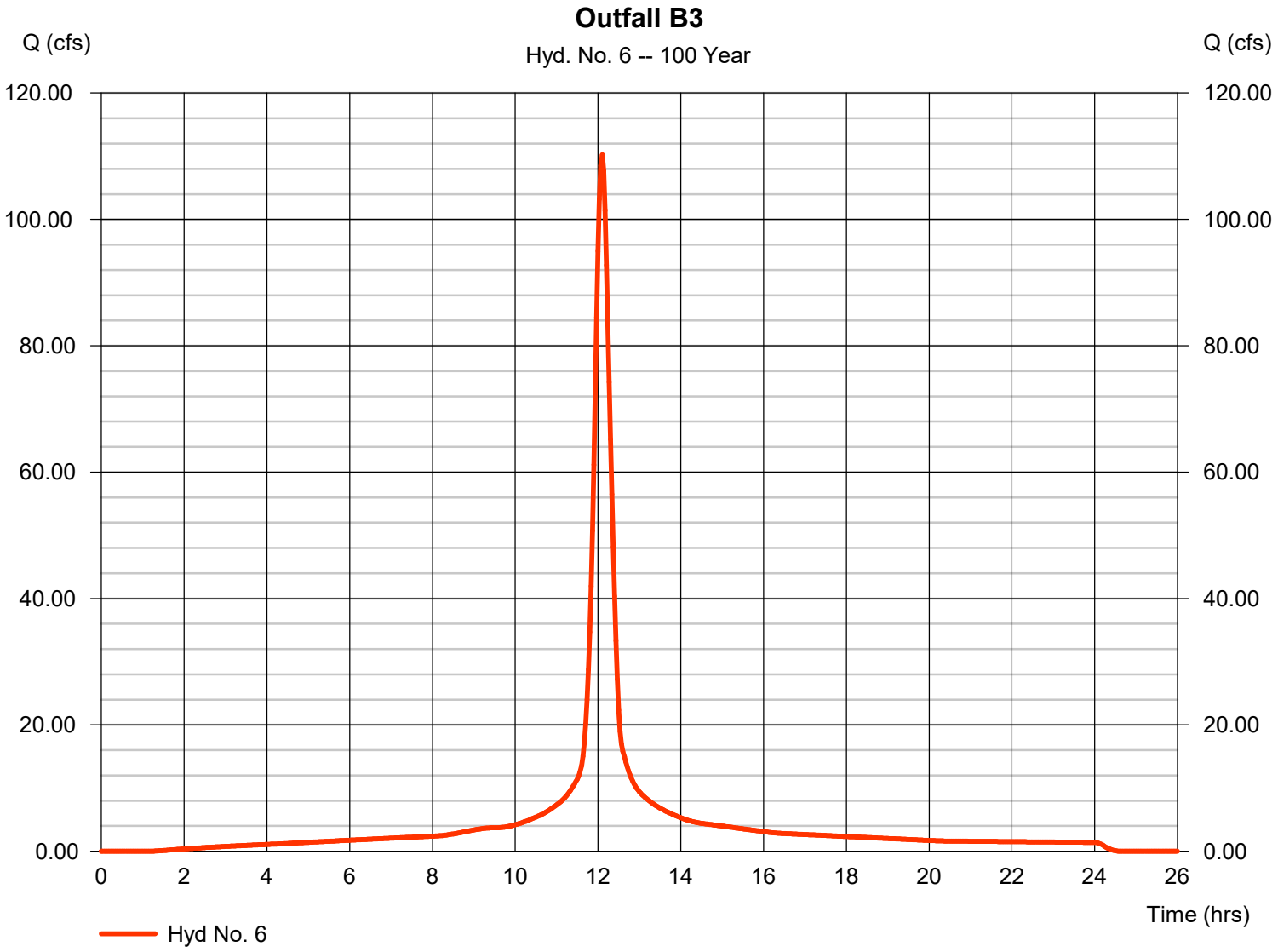
Hydrograph Report

Hyd. No. 6

Outfall B3

Hydrograph type	=	SCS Runoff	Peak discharge	=	110.25 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	423,907 cuft
Drainage area	=	15.460 ac	Curve number	=	96*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.30 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(13.290 x 98) + (2.170 x 84)] / 15.460



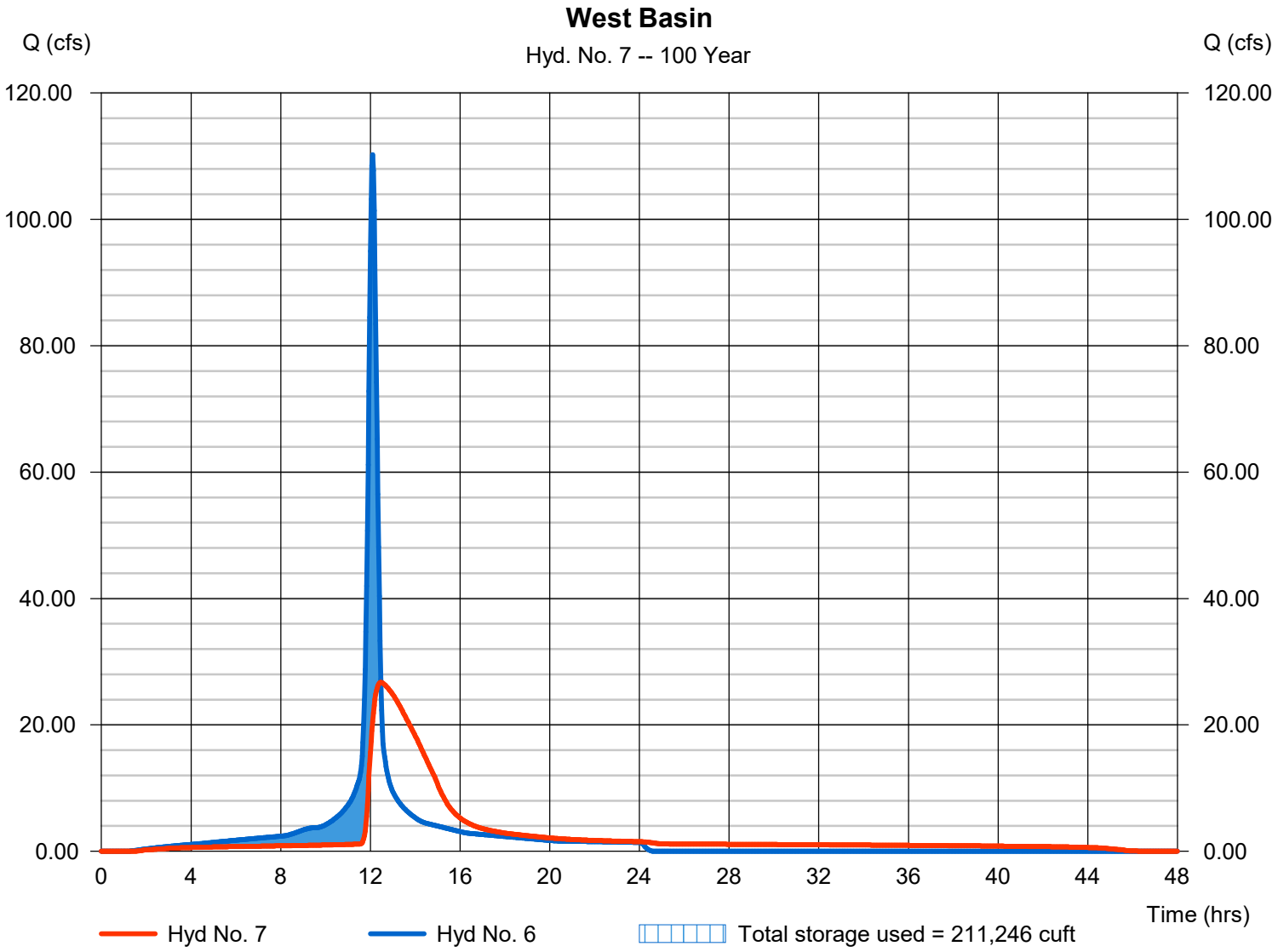
Hydrograph Report

Hyd. No. 7

West Basin

Hydrograph type	=	Reservoir	Peak discharge	=	26.73 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.47 hrs
Time interval	=	2 min	Hyd. volume	=	423,896 cuft
Inflow hyd. No.	=	6 - Outfall B3	Max. Elevation	=	973.83 ft
Reservoir name	=	West Pond	Max. Storage	=	211,246 cuft

Storage Indication method used.

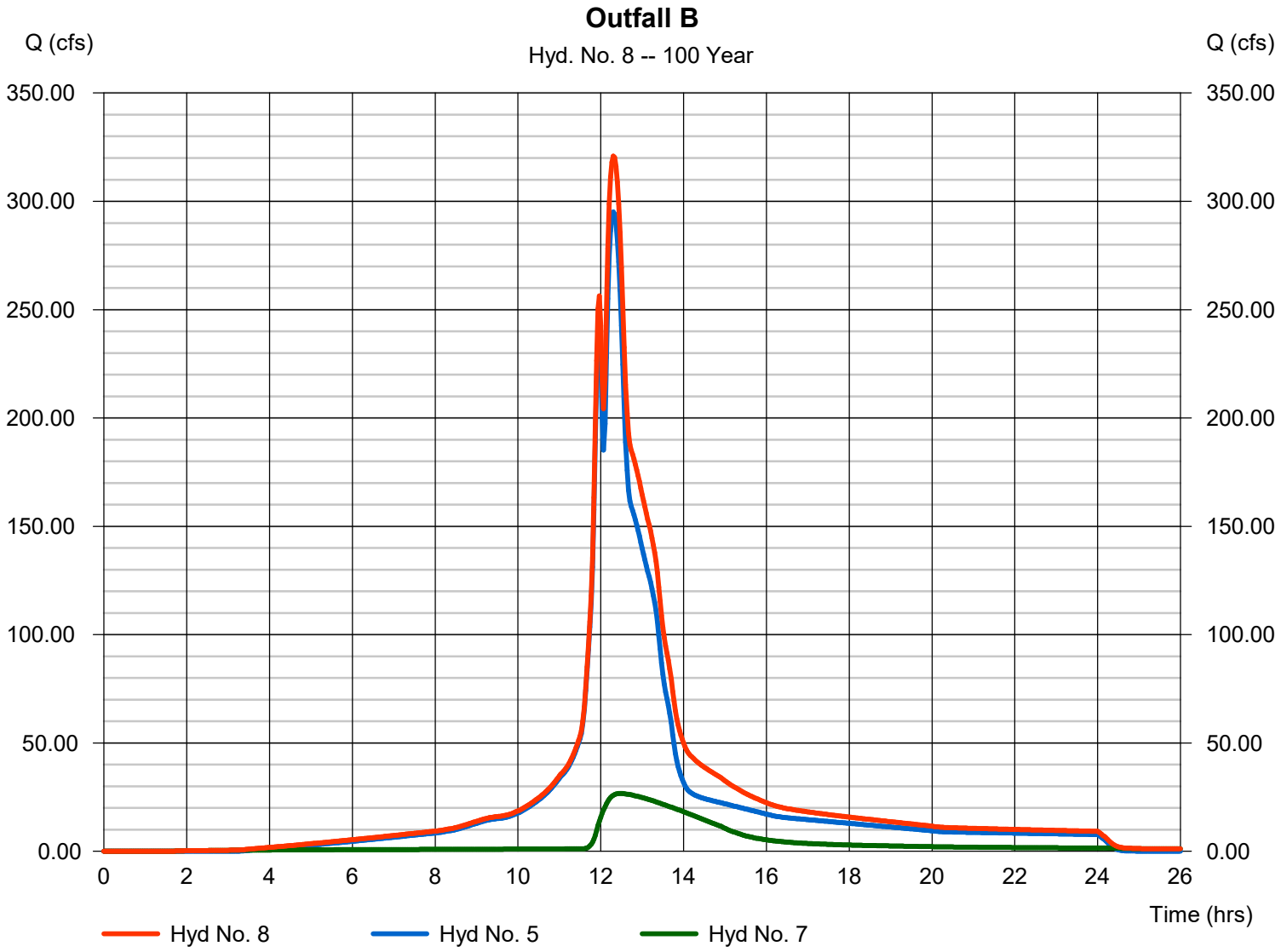


Hydrograph Report

Hyd. No. 8

Outfall B

Hydrograph type	=	Combine	Peak discharge	=	320.94 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.30 hrs
Time interval	=	2 min	Hyd. volume	=	2,525,864 cuft
Inflow hyds.	=	5, 7	Contrib. drain. area	=	0.000 ac



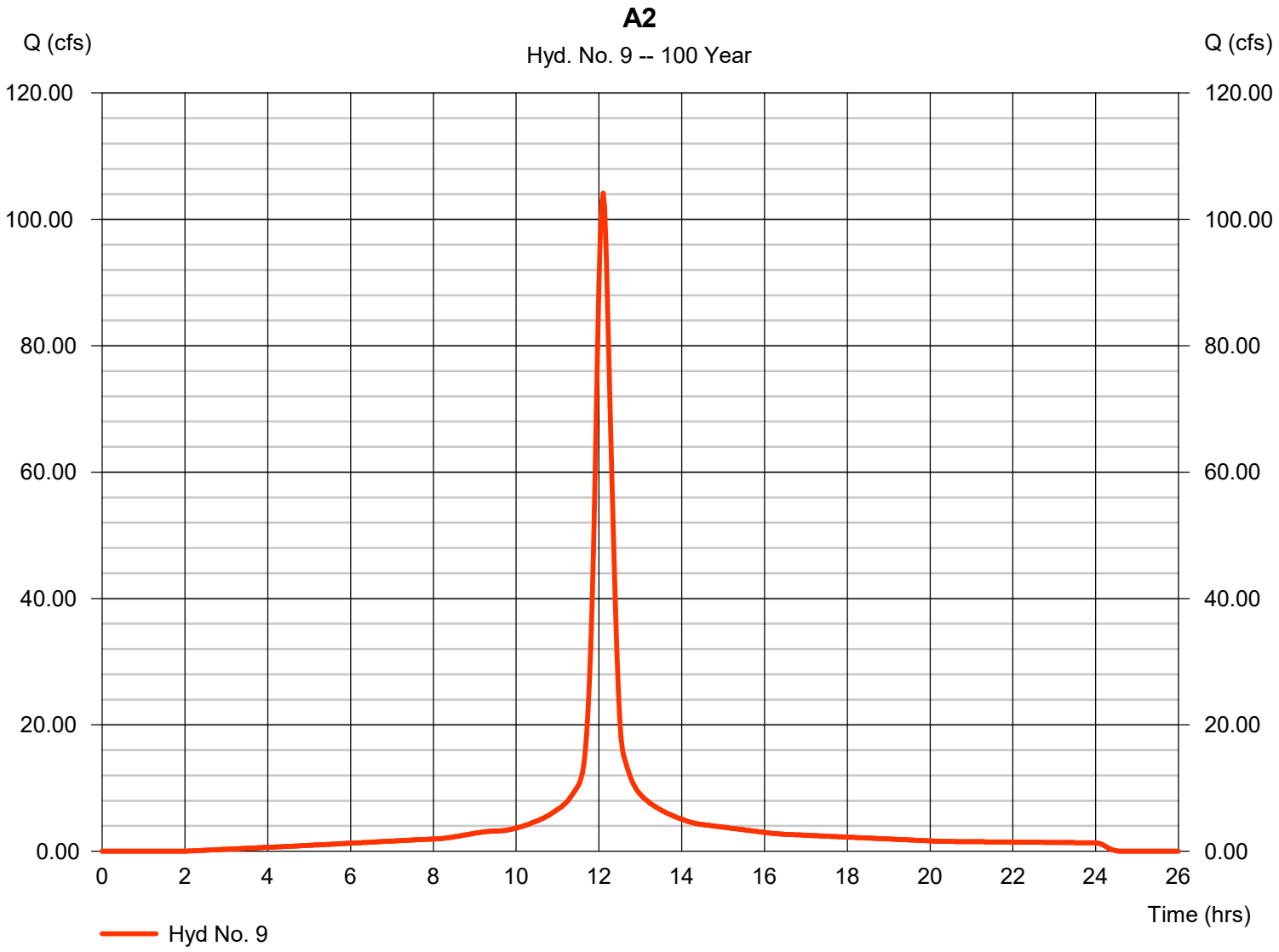
Hydrograph Report

Hyd. No. 9

A2

Hydrograph type	=	SCS Runoff	Peak discharge	=	104.15 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	388,861 cuft
Drainage area	=	14.900 ac	Curve number	=	93*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.00 min
Total precip.	=	7.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(9.950 x 98) + (4.950 x 84)] / 14.900



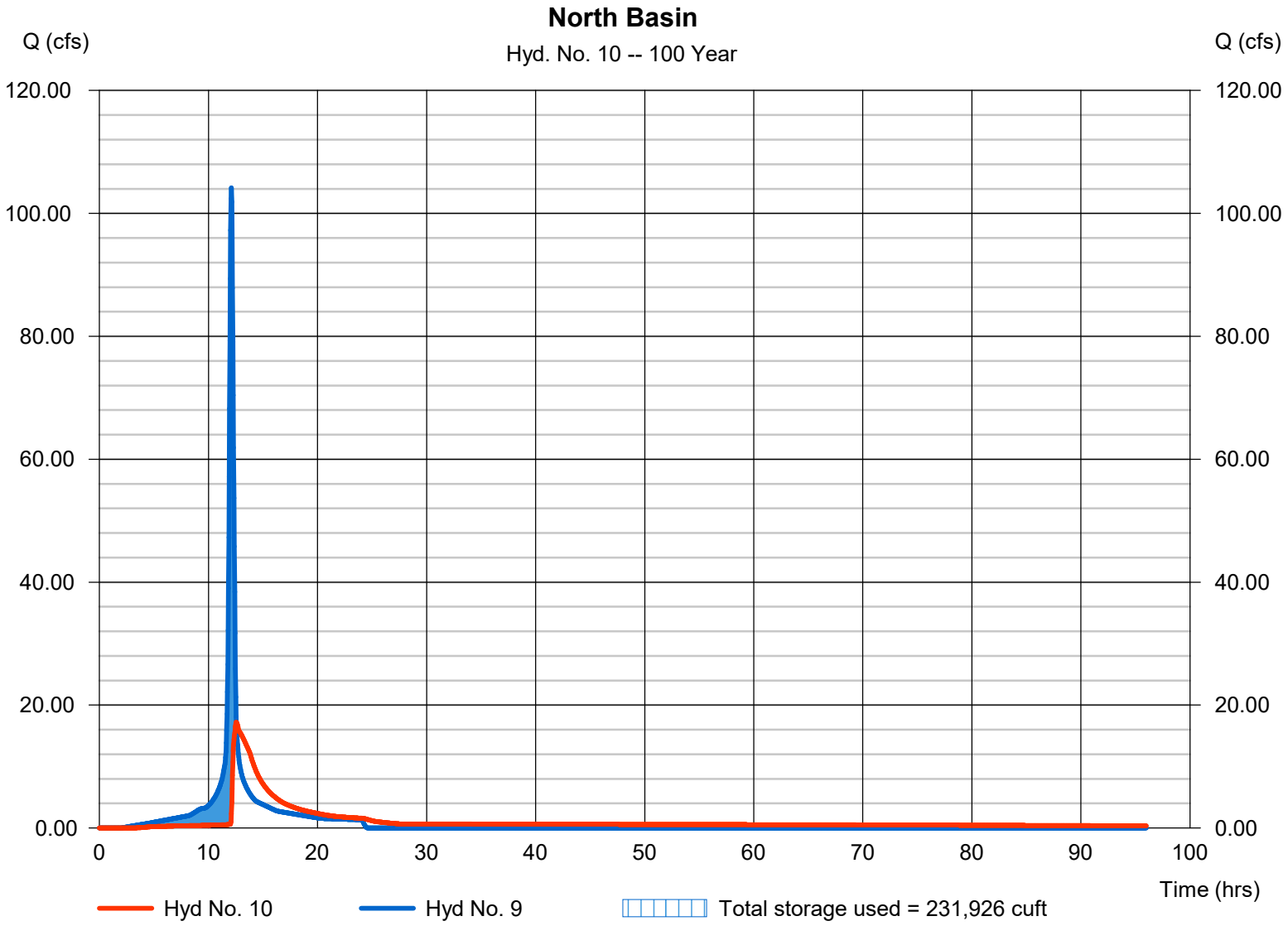
Hydrograph Report

Hyd. No. 10

North Basin

Hydrograph type	=	Reservoir	Peak discharge	=	17.19 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.53 hrs
Time interval	=	2 min	Hyd. volume	=	377,665 cuft
Inflow hyd. No.	=	9 - A2	Max. Elevation	=	982.23 ft
Reservoir name	=	North Pond	Max. Storage	=	231,926 cuft

Storage Indication method used.

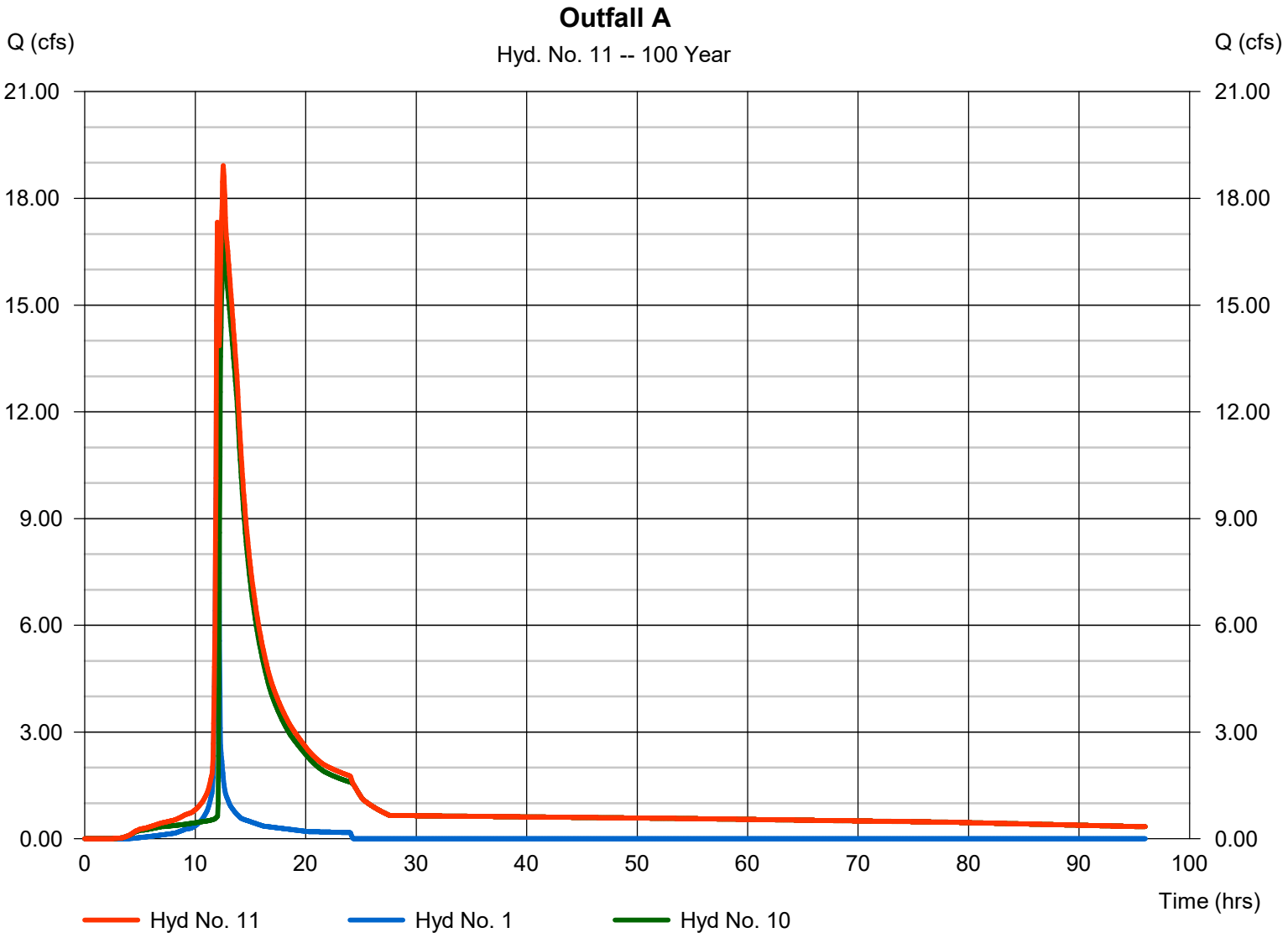


Hydrograph Report

Hyd. No. 11

Outfall A

Hydrograph type	= Combine	Peak discharge	= 18.92 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.53 hrs
Time interval	= 2 min	Hyd. volume	= 422,773 cuft
Inflow hyds.	= 1, 10	Contrib. drain. area	= 1.970 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	47.7559	11.1000	0.8294	--------
2	71.8477	13.3000	0.8718	--------
3	0.0000	0.0000	0.0000	--------
5	75.7517	14.2000	0.8271	--------
10	86.7192	15.3000	0.8244	--------
25	103.3028	16.6000	0.8227	--------
50	116.5747	17.3000	0.8234	--------
100	124.5734	17.6000	0.8144	--------

File name: Liberty MO.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	4.76	3.81	3.19	2.76	2.44	2.19	1.99	1.83	1.69	1.58	1.48	1.39
2	5.70	4.62	3.90	3.38	2.99	2.69	2.45	2.24	2.08	1.93	1.81	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	6.58	5.43	4.65	4.08	3.64	3.30	3.02	2.79	2.59	2.42	2.28	2.15
10	7.25	6.05	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.81	4.38	4.03	3.73	3.48	3.26	3.08	2.91
50	9.05	7.66	6.67	5.92	5.34	4.87	4.48	4.16	3.88	3.64	3.43	3.25
100	9.83	8.35	7.30	6.49	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: Y:\KCS\Teams\LDVP\Reference - Other\IDF Information\KC Metro.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.60	0.00	4.66	5.34	6.80	7.83	7.90
SCS 6-Hr	2.22	2.65	0.00	3.40	4.05	5.00	5.78	6.58
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX D
Soils

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

October 13, 2022

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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Contents

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.

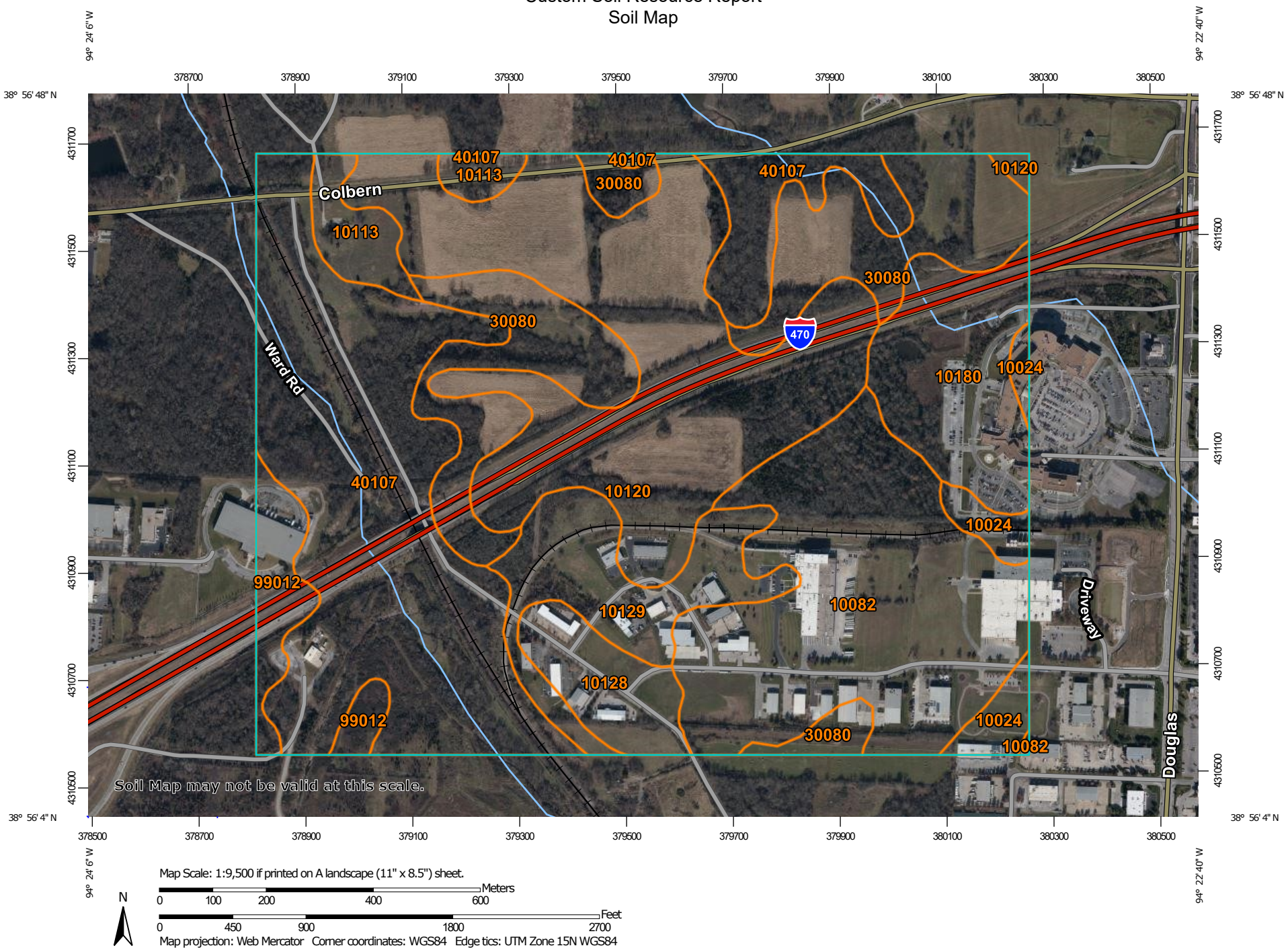
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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 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 24, Aug 31, 2022

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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
10024	Greenton-Urban land complex, 5 to 9 percent slopes	8.2	2.0%
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	70.4	17.5%
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	10.0	2.5%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	87.0	21.6%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	12.8	3.2%
10129	Sharpsburg-Urban land complex, 5 to 9 percent slopes	24.6	6.1%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	26.6	6.6%
30080	Greenton silty clay loam, 5 to 9 percent slopes	53.1	13.2%
40107	Snead-Rock outcrop complex, warm, 5 to 14 percent slopes	98.7	24.5%
99012	Urban land, upland, 5 to 9 percent slopes	11.0	2.7%
Totals for Area of Interest		**402.3**	**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

10024—Greenton-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qky4
Elevation: 800 to 1,100 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 60 percent
Urban land: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave, convex
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

A - 0 to 16 inches: silty clay loam
Bt1 - 16 to 26 inches: silty clay loam
2Bt2 - 26 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
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 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Across-slope shape: Concave, convex

Interpretive groups

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

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
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107XB007MO - Loess Upland Prairie
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

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: R109XY010MO - Interbedded Sedimentary Upland Savanna
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: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

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: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

10113—Oska silty clay loam, 5 to 9 percent slopes, eroded

Map Unit Setting

National map unit symbol: yrm7
Elevation: 600 to 1,200 feet
Mean annual precipitation: 33 to 43 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Oska and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Oska

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum

Typical profile

A - 0 to 7 inches: silty clay loam
Bt - 7 to 34 inches: silty clay loam
R - 34 to 80 inches: bedrock

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R106XY015KS - Loamy Upland (PE 30-37)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)

Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Snead, eroded, warm

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: No

10120—Sharpsburg silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2yy7v
Elevation: 1,000 to 1,300 feet
Mean annual precipitation: 33 to 41 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

Sharpsburg and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 16 inches: silty clay loam
Bt1 - 16 to 22 inches: silty clay loam
Bt2 - 22 to 46 inches: silty clay loam
BC - 46 to 58 inches: silty clay loam
C - 58 to 79 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 45 to 50 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Minor Components

Sibley

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Higginsville, eroded

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

10128—Sharpsburg-Urban land complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2ql09
Elevation: 1,000 to 1,320 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

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

A - 0 to 17 inches: silt loam
Bt - 17 to 55 inches: silty clay loam
C - 55 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: 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 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)

Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve

Interpretive groups

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

Minor Components

Macksburg

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

10129—Sharpsburg-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2ql0b
Elevation: 990 to 1,320 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex

Parent material: Loess

Typical profile

A - 0 to 7 inches: silt loam
Bt - 7 to 48 inches: silty clay loam
C - 48 to 60 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well 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 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest

Interpretive groups

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

Minor Components

Macksburg

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: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

Lagonda, eroded

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear

Across-slope shape: Convex
Ecological site: R108XD860IA - Loess Upland Prairie
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: 46 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
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C

Ecological site: R107XB002MO - Deep Loess Upland Prairie
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
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: 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: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

30080—Greenton silty clay loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2xjd9
Elevation: 640 to 1,120 feet
Mean annual precipitation: 35 to 41 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 177 to 209 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

Ap - 0 to 12 inches: silty clay loam
Bt - 12 to 28 inches: silty clay
2Bt - 28 to 30 inches: silty clay
2C - 30 to 79 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
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 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D

Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: Yes

40107—Snead-Rock outcrop complex, warm, 5 to 14 percent slopes

Map Unit Setting

National map unit symbol: 2zccr
Elevation: 660 to 1,130 feet
Mean annual precipitation: 39 to 43 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 185 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Snead, warm, and similar soils: 70 percent
Rock outcrop: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Snead, Warm

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone and shale

Typical profile

A - 0 to 10 inches: silty clay loam
Bw - 10 to 20 inches: silty clay
BC - 20 to 24 inches: silty clay
C - 24 to 35 inches: silty clay
Cr - 35 to 45 inches: bedrock

Properties and qualities

Slope: 5 to 14 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock

Drainage class: Moderately well drained
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 24 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: No

Description of Rock Outcrop

Typical profile
R - 0 to 79 inches: bedrock

Properties and qualities
Slope: 5 to 14 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

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

Minor Components

Oska
Percent of map unit: 4 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R106XY015KS - Loamy Upland (PE 30-37)
Hydric soil rating: No

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

Kennebec, occasionally flooded
Percent of map unit: 3 percent
Landform: Drainageways

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R109XY028MO - Loamy Upland Drainageway Savanna
Hydric soil rating: No

99012—Urban land, upland, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2q0qh
Mean annual precipitation: 36 to 43 inches
Frost-free period: 170 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Unranked

Minor Components

Udorthents

Percent of map unit: 5 percent
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R107XB002MO - Deep Loess Upland Prairie
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Harvester

Percent of map unit: 5 percent
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F115XB061MO - Anthropic Deep Loess Upland
Other vegetative classification: Trees/Timber (Woody Vegetation)

Hydric soil rating: No

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APPENDIX E
FEMA

94°24'22.95"W 38°58'14.11"N

94°22'29.6"W 38°56'8.44"N

FLOOD HAZARD INFORMATION

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **10/31/2022 9:16 AM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards. This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

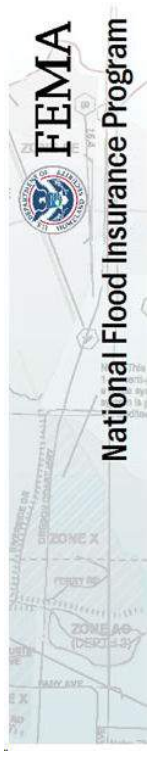
Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map, please see the Flood Insurance Study (FIS) Report for your community at https://msc.fema.gov

N

1 inch = 500 feet 1:6,000

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

0 50 100 200 300 400 Meters



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

PANEL 409 OF 605

Panel Contains:

COMMUNITY	NUMBER	PANEL
VILLAGE OF UNITY	290513	0409
CITY OF KANSAS CITY	290173	0409
CITY OF LEE'S SUMMIT	290174	0409

MAP NUMBER
29095C0409G
EFFECTIVE DATE
January 20, 2017

SUMMIT 470 LOGISTICS CENTER PRELIMINARY STORM DRAINAGE STUDY

Lee’s Summit, MO - 2022

November 2022

Olsson Project No. 022-03974