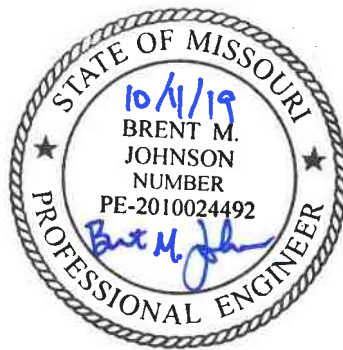


OSAGE DEVELOPMENT PRELIMINARY STORMWATER DRAINAGE STUDY

Prepared for:

Clayton Properties Group, Inc. DBA Summit Homes
120 SE 30th Street
Lee's Summit, MO 64082



**October 2019
Olsson Project No. 019-2339**

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1.0 GENERAL INFORMATION

Osage is a proposed single-family residential development on approximately 36 acres, including a pool, amenity tract reserved for open space, and stormwater detention basin. This project is located in the southwest of the intersection of NW Pryor Road and Highway 150 in Lee's Summit, Missouri



Figure 1. Location Map

1.1 FEMA Floodplain Classification

FEMA Flood Boundary and Floodway Map Community Panel Number 29095C0531G classifies the Osage property as unshaded "Zone X" Area, which FEMA defines as an area of minimal flood hazard, usually above the 500-year flood level. See Exhibit 1—Floodplain Map in Appendix A for location of site in relation to FEMA flood boundaries.

1.2 Soil Classifications

Soil Maps published on the NRCS Web Soil Survey categorize soils on the Osage property as shown in Table 1. See Exhibit 2 in Appendix A for a map of soils on the property.

Table 1. Soil Classifications

Symbol	Name	Slopes	HSG
10082	Arisburg-Urban Land Complex	1-5%	C
10116	Sampsel Silty Clay Loam	2-5%	C/D
10117	Sampsel Silty Clay Loam	5-9%	C/D
10122	Sharpsburg Silt Loam	5-9%	C

2.0 METHODOLOGY

This drainage study has been prepared to evaluate the hydrologic impact generated by development of Osage. 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 “Kansas City Metropolitan Chapter American Public Works Association (KC-APWA) Section 5600 Storm Drainage Systems & Facilities” (2011).

The following methods were used in this study to model Existing and Proposed Conditions for stormwater runoff:

Hydraflow Hydrographs Extension Version 12

- SCS Unit Hydrograph Method
 - 2-year, 10-year and 100-year Return Frequency Storms
 - 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 & Velocity” estimates for channel flow Travel Time is utilized per Section 5600, KC-APWA Standard Specifications and Design Criteria.

Stormwater runoff models were created for the 2-, 10- and 100-year design storm events. The precipitation depths used in the analysis 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 summarizes the rainfall depths used in this analysis:

Table 2. Precipitation Depths

Return Period	24-Hour Precipitation Depth (in.)
2-Year (50% Storm)	3.60
10-year (10% Storm)	5.34
100-Year (1% Storm)	7.90

3.0 EXISTING CONDITIONS

To quantify the effects of development of this project, the following areas and points of interest have been used for existing and proposed conditions analysis. See Exhibit 3—Existing Conditions Drainage Map in Appendix A.

Drainage Area A represents the area in the southwest corner of the site, which bypasses the proposed detention location. In existing conditions, drainage area A has an area of 5.16 acres.

Drainage Area B represents the majority of the site in both the existing and proposed conditions models, which drains to the southeast corner of the site. In existing conditions, drainage area B has an area of 28.57 acres.

Drainage Area C is located in the northwest corner of the site and drains north to Highway 150. In existing conditions, drainage area C has an area of 11.27 acres.

Three points of interest were chosen for comparison between existing and proposed conditions based on the three points of discharge from the site. These points can be found in both Exhibits 3 and 4 in Appendix A.

Point of Interest A1 represents the southwest corner of the site and compares drainage area A for both models.

Point of Interest B1 represents a point near the southeast corner of the site, just upstream of the triple 30-inch CMP culverts crossing NW Pryor Road. Discharge to this point was compared between drainage area B in the existing conditions model and drainage areas B1 and B2 in the proposed conditions model at the outlet of the detention basin. Drainage area B2 bypasses the basin; flows from drainage areas B1 and B2 were combined before comparison with Existing Conditions. See Exhibit—4 Proposed Conditions Drainage Map and Section 4.0 of this report for a more detailed discussion of the Proposed Conditions drainage areas.

Point of Interest C1 represents the northwest corner of the site and compares drainage area C for existing and proposed conditions.

Bypass Area A was included in the model to account for area that does not pass through the site but drains to the culvert under NW Pryor Road near the southeast corner of the development. This area was included in the model to calculate tailwater elevations for the proposed detention basin.

The following tables summarize the results of the Existing Conditions analysis. The proposed conditions data is compared to these results in Sections 4 of this report. Refer to Appendix B for output and a schematic for the existing conditions model and detailed calculations for the time of concentration.

Curve Numbers were determined for existing and proposed conditions as shown in Table 3.

Table 3. Curve Numbers

Land Use	HSG*	CN
Straight Row Crop	C	85
Straight Row Crop	D	89
Multi-Family Residential	C	90
Multi-Family Residential	D	92
Pasture	C	79
Pasture	D	84
Paved Open Ditches with ROW	C	92
Paved Open Ditched with ROW	D	93

*Hydrologic Soil Group

Table 4. Existing Conditions Area Data

Area Name	Onsite Area (ac.)	Offsite Area (ac.)	Total Area (ac.)	T _c (hr.)	Weighted CN
A	2.10	3.06	5.16	0.33	82
B	25.26	3.31	28.57	0.36	84
C	4.02	7.25	11.27	0.33	83
Bypass A	0	2.86	2.86	0.18	87

Table 5. Existing Conditions Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	11.1	20.2	33.9
B1	61.8	109	179
C1	25.4	45.3	75.2

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% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

Extended detention of the 90% 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 offsite peak discharges would be permitted to bypass the detention. Offsite bypass peak flow rates were calculated as a percentage of the existing conditions, relating to the percentage of offsite 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 point of interest as follows.

Table 6. Point of Interest Onsite Area

Point of Interest	Total Area (ac)	Onsite Area (ac)	Percent Onsite
A1	5.16	2.10	40.7%
B1	28.57	25.26	88.4%
C1	11.27	4.02	35.7%

Table 7. Allowable Peak Flow Rates

Point of Interest	Allowable 2-Year Q (cfs)	Allowable 10-Year Q (cfs)	Allowable 100-Year Q (cfs)
A1	7.6	16.0	26.1
B1	19.8	63.2	96.5
C1	18.3	37.1	60.3

4.0 PROPOSED CONDITIONS

4.1 Effects of Development

The proposed conditions analysis assumes completion of the entire Osage development. The modeled subareas and points of interest are similar to the existing conditions model. However, throughout the site, some shifting of ridgelines will occur accommodating proposed detention facilities and anticipated grading activities, which will change the relative areas draining to each point of interest. The following is a summary of the proposed conditions drainage areas, see Exhibit 4—Proposed Conditions Drainage Map in Appendix A.

Drainage Area A in proposed conditions has an area of 0.43 acres. Proposed grading shifts 4.72 acres from drainage area A to drainage area B1.

Drainage Area B1 in proposed conditions has an area is 33.54 acres and will drain to the proposed detention basin. Drainage area from existing conditions is shifted from drainage areas A and C to area B1.

Drainage Area B2 was previously part of drainage area B in existing conditions. This area was separated in the proposed conditions model because it bypasses the detention basin. For

consistency, the sum of drainage areas B1 and B2 were compared at the same point of interest as drainage area B in existing conditions. Drainage Area B2 has an area of 2.73 acres.

Drainage Area C in proposed conditions has a drainage area of 8.30 acres. Proposed grading shifts area from drainage area C to drainage area B1.

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

The following tables summarize the results of the proposed conditions analysis. Tables 9 and 10 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 8. Proposed Conditions Area Data

Area Name	Area (ac.)	T _c (hr.)	Weighted CN
A	0.43	0.10	91
B1	33.54	0.35	88
B2	2.73	0.10	90
C	8.30	0.32	86
Bypass A	2.86	0.18	87

Table 9. Proposed (No Detention) Conditions Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	1.7	2.8	4.3
B1	91.6	152.0	240.0
C1	21.0	35.9	57.9

The following table compares the results of the proposed conditions analysis 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 point B1, but decrease for A1 and C1. The decrease in flow rates at A1 and C1 is due to the proposed changes in grading, which shifts parts of each of these areas to drainage area B1.

Table 10. Proposed (No Detention) vs. Existing Conditions

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-9.4	-17.4	-29.6
B1	29.8	43.0	61.0
C1	-4.4	-9.4	-17.3

4.2 Proposed Detention Facilities

To mitigate the increases in peak flows shown in the previous table and where possible, decrease further to the allowable release rates established in Section 3, detention will be provided for drainage area B1.

The detention facility was placed to capture most of the site runoff and to mitigate increases in peak discharge from the site. The detention facility will be located near the southeast corner of the site and will meet of the requirements outlined in Section 3. It will contain a multistage outlet structure and an independent 160-ft long broad crested weir graded into the east side of the berm. The following points summarize the multistage outlet structure and the emergency spillway:

- The structure itself will be a 5'x5' open-top concrete box with a top elevation of 1017.1, which generally controls the 100-year discharge.
- A 36" opening is present in the box at an elevation of 1012.6, which generally controls the 10-year and 100-year discharge.
- A 4.5" orifice is present in the box at the bottom elevation of the pond- 1010.0. This helps control the 90% mean annual storm event. The 2-year discharge is controlled by a combination of the 4.5" orifice and the 36" opening.
- The entire structure outlets to a 48" RCP, which carries the water to Pryor Road.
- The emergency spillway will consist of a 160-ft long broad crested weir set at an elevation of 1018.4.

A 4.5-inch orifice will be set at the bottom of the multi-stage outlet structure to comply with the KC-APWA requirement for 40-hour release of the 90% mean annual event. The total inflow volume from this event is 2.09 acre-feet for this site. This will be released over 40 hours at a rate of 0.63 cfs.

Table 11 includes a summary of the Proposed Detention Facility

Due to constrictions in lot grading, site size limitations, and the relatively small drainage area detention is not planned for drainage area C. The drainage area to this point is reduced from existing conditions with proposed grading. As a result, the peak discharge rates for the 2-, 10-, and 100-year storms are below the existing values shown in Table 5. Table 10 illustrates these reductions. For point C1, the peak discharge values meet the allowable release rates for the 10-year and 100-year storm but exceed the KC-APWA 5600 allowable release rates of 0.5 cfs per

acre for the 2-year storm. A comparison with allowable release rates can be seen in Table 13. To achieve these release rates at point C-1, a small detention facility would need to be placed in the northwest corner of the site. The benefit of installing this detention facility in order to reduce the 2-year peak discharge value by 3.0 cfs is outweighed by the impact the facility would have on the feasibility of the development, especially considering the substantial reduction in peak discharge values already achieved when compared to existing conditions. As such, a waiver is requested for the 2-year storm for point C-1.

Table 11. Proposed Conditions Detention Flow and Volume Data

	Peak Q In (cfs)	TP In (hr)	Peak Q Out (cfs)	TP Out (hr)	Peak W.S.E. (ft)	Stored Volume (ac-ft)
2-Year	84.4	12.10	5.9	13.53	1014.12	4.2
10-Year	141.0	12.10	39.5	12.47	1015.61	6.0
100-Year	223.0	12.10	92.4	12.37	1017.87	9.0

4.3 Effects of Proposed Detention

The following tables compares the results of the proposed conditions analysis with the detention described above to the existing conditions from Section 3 at the points of interest. In Table 13, negative values indicate a reduction in peak flows, while positive values indicate an increase.

Table 12. Proposed (with Detention) Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	1.7	2.8	4.3
B1	10.3	41.4	95.7
C1	21.3	35.9	57.9

Table 13. Proposed (with Detention) vs. Allowable Release Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-5.9	-13.2	-21.8
B1	-9.5	-21.8	-0.9
C1	3.0	-1.2	-2.4

Table 14. Proposed (with Detention) vs. Existing Conditions

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-9.4	-17.4	-29.6
B1	-51.5	-67.6	-83.3
C1	-4.1	-9.4	-17.3

5.0 SUMMARY

This stormwater drainage study was prepared to evaluate the hydrologic impact generated by the development of Osage and to provide recommendations for a comprehensive stormwater management plan. The project is a single-family residential development on approximately 36 acres, including a pool and amenity tract and open space which will be reserved for detention.

Increases in peak flow rates caused by development will be mitigated for all points of discharge through the site through a combination of dry detention and drainage area changes.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This proposed stormwater management plan was designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri; however, a waiver is requested at point of interest C1 for the 2-year storm. A final macro and first plat micro stormwater drainage study will be required with submittal of the first plat of this development.

The results of the analysis demonstrate that the proposed stormwater management plan for the project achieves compliance with design criteria, including extended detention of the 90% mean annual event, along with the requested waiver for drainage area C. We therefore request approval of this Osage Stormwater Drainage Study. This approval is conditional and should be substantiated with each future plat of Osage.

APPENDIX A

Site Maps

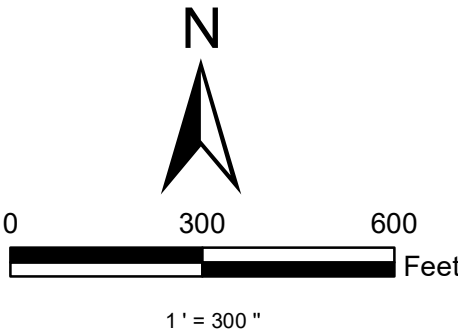
OSAGE
FLOODPLAIN MAP
EXHIBIT 1

LEGEND

-  Site Boundary
-  CURRENT EFFECTIVE ZONE X FLOODPLAIN

Source:
FEMA Flood Boundary & Floodway Map
29095C0531G

Effective Date: 01/20/2017



Drawn: B. Fairchild 9/7/2019

olsson

Location: \\oa.ad.oaconsulting.com\te-rs1\projects\2018\2501-3000\018-2503\40-Design\GIS\MXD\018-2503 Soils Map_ Exhibit.mxd



OSAGE

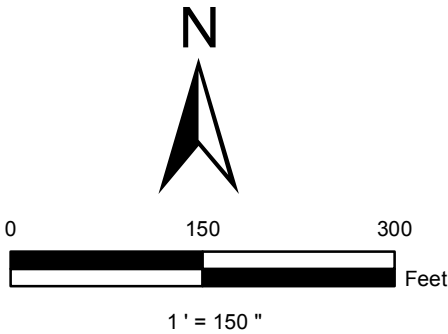
SOIL MAP

EXHIBIT 2

LEGEND

-  PROPERTY BOUNDARY
-  10000
ARISBURG SILT LOAM
1 to 5% SLOPES
-  10082
ARISBURG LAND COMPLEX
1 to 5% SLOPES
-  10016
SAMPSEL SILTY CLAY LOAM
2 to 5% SLOPES
-  10017
SAMPSEL SILTY CLAY LOAM
5 to 9% SLOPES
-  10120
SHARPSBURG SILT LOAM
2 to 5% SLOPES
-  10122
SHARPSBURG SILT LOAM
5 to 9% SLOPES

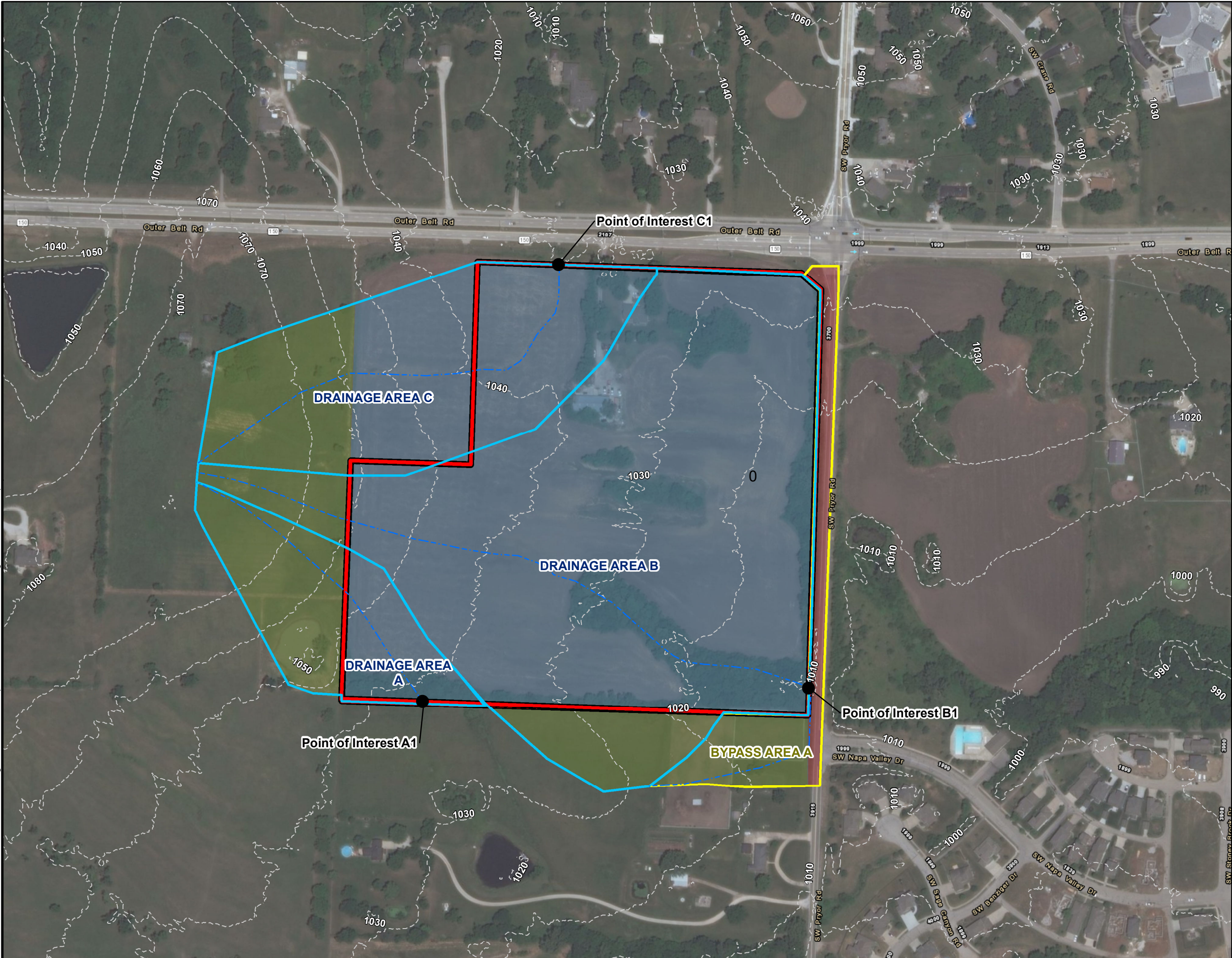
Source:
Soil Survey of Jackson County, Missouri



Drawn: B. Fairchild 9/12/2018

olsson

Location: F:\2018\2501-3000\018-2503\40-Design\GIS\MXD\2019 Updated MXDs\018-2503 Existing Conditions DA Map.mxd



OSAGE

EXISTING CONDITIONS

DRAINAGE MAP

EXHIBIT 3

LEGEND

- SITE BOUNDARY
- EXISTING DRAINAGE AREA BOUNDARIES
- BYPASS AREA BOUNDARIES
- EXISTING 10-FT CONTOURS
- EXISTING FLOW PATH

LAND USE

- Multifamily Residential
- Pasture
- Paved Open Ditches w/ ROW
- Straight Row Crop

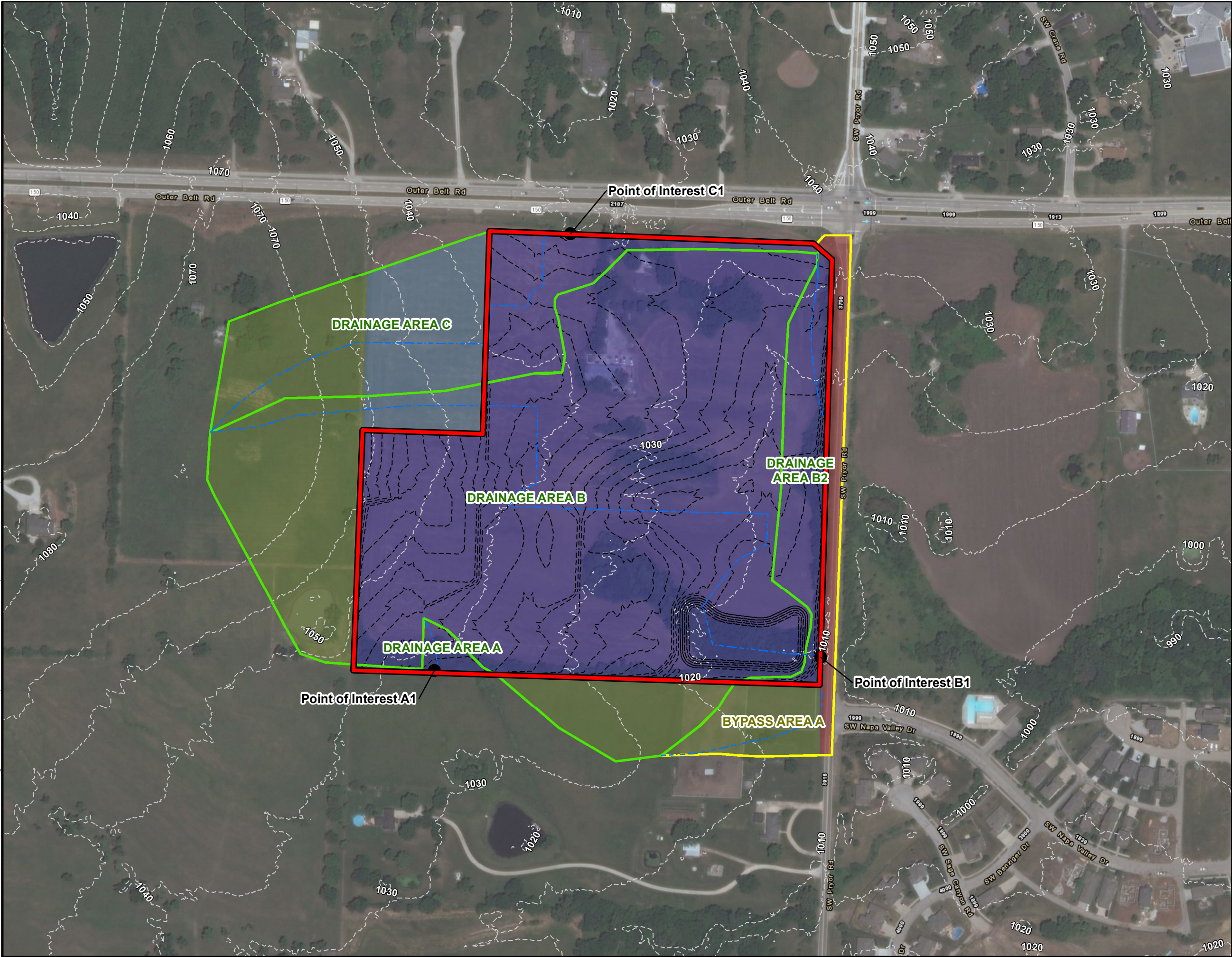
North Arrow

0 250 500 Feet

1" = 250'

Drawn: B. Fairchild 9/7/2019

Location: F:\2018\2501-3000\018-2503\40-Design\GIS\MXD\2019 Updated MXDs\018-2503 Proposed Conditions DA Map 2.mxd



OSAGE

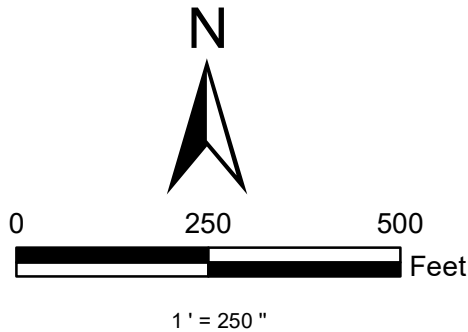
PROPOSED CONDITIONS

DRAINAGE MAP

EXHIBIT 4

LEGEND

- SITE BOUNDARY
- BYPASS AREA BOUNDARIES
- PROPOSED DRAINAGE AREA BOUNDARIES
- PROPOSED 2-FT CONTOURS
- EXISTING 10-FT CONTOURS
- PROPOSED FLOW PATHS
- LAND USE**
 - Multifamily Residential
 - Pasture
 - Paved Open Ditches w/ ROW
 - Straight Row Crop



Drawn: B. Fairchild 9/7/2019

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APPENDIX B

Existing Conditions Hydroflow Hydrographs Model Input and Results

Subarea A

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.005	Grass-Range, Short (0.15)		0.272
Shallow Concentrated	778	0.052	Unpaved		0.059
Channel					
Total	878				0.331

Subarea B

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.005	Grass-Range, Short (0.15)		0.272
Shallow Concentrated	646	0.052	Unpaved		0.049
Channel	1065			7	0.042
Total	1811				0.363

Subarea C

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.005	Grass-Range, Short (0.15)		0.272
Shallow Concentrated	451	0.057	Unpaved		0.033
Channel	709			7	0.028
Total	1260				0.333

Bypass Area A

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.030	Grass-Range, Short (0.15)		0.133
Shallow Concentrated	472	0.035	Unpaved		0.044
Channel					
Total	572				0.177

Hydrograph Summary Report

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

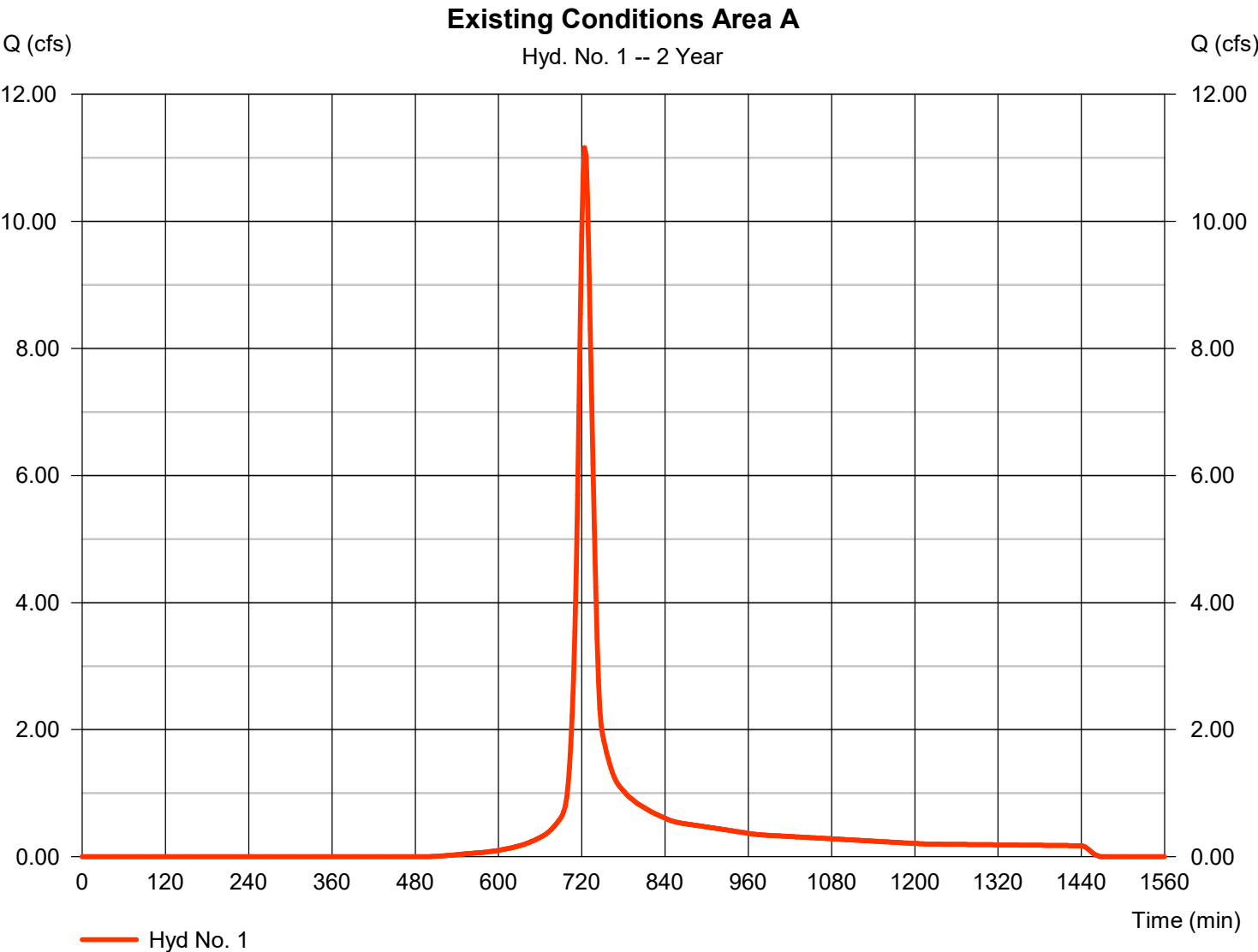
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	11.16	2	724	34,942	-----	-----	-----	Existing Conditions Area A
2	SCS Runoff	61.82	2	726	213,484	-----	-----	-----	Existing Conditions Area B
3	SCS Runoff	25.41	2	724	79,488	-----	-----	-----	Existing Conditions Area C
4	SCS Runoff	9.322	2	720	24,330	-----	-----	-----	Bypass Area A
5	Combine	68.77	2	726	237,814	2, 4	-----	-----	Pryor Culvert
Allera_Existing_Conditions.gpw					Return Period: 2 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

Hyd. No. 1

Existing Conditions Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 11.16 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 34,942 cuft
Drainage area	= 5.160 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

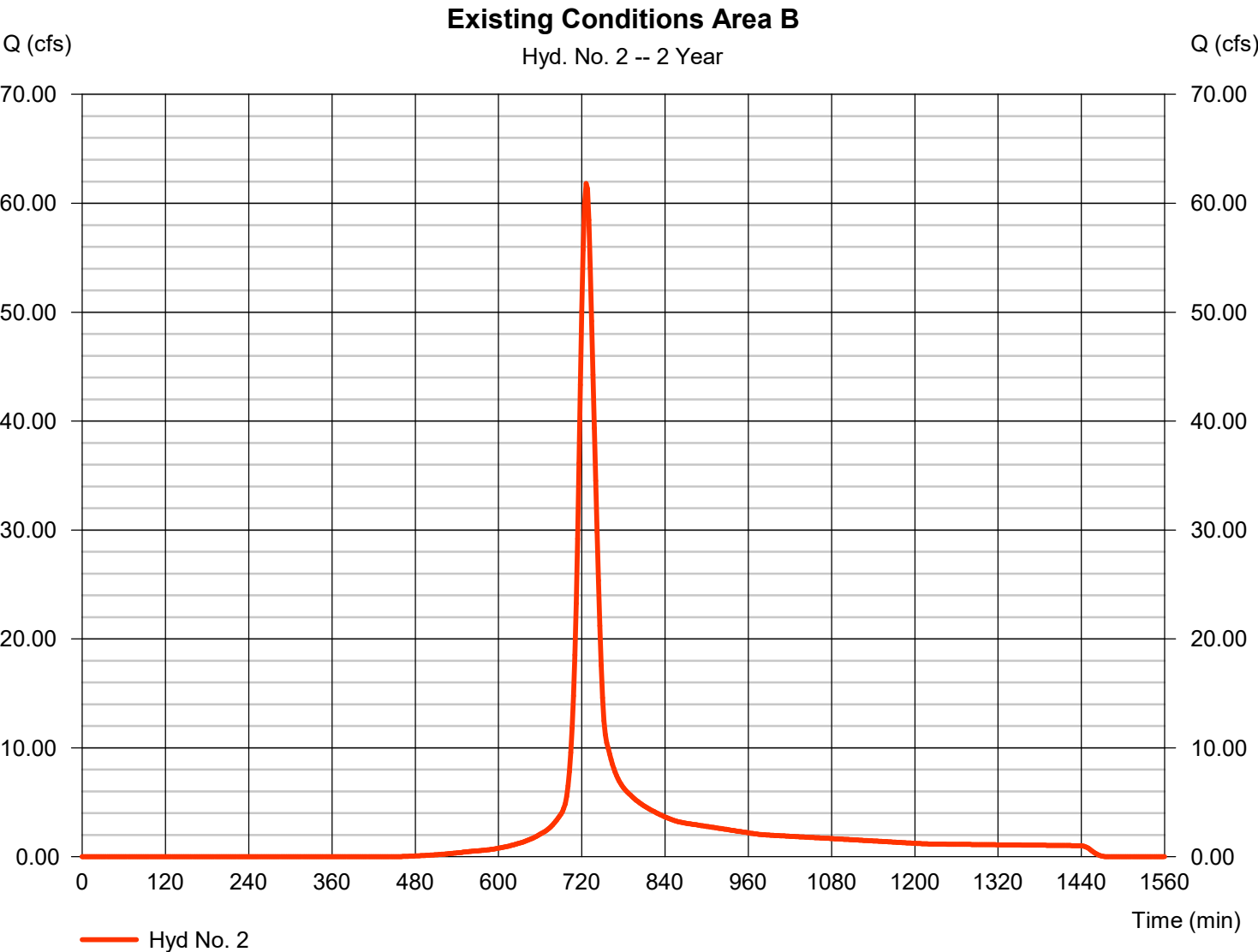


Hydrograph Report

Hyd. No. 2

Existing Conditions Area B

Hydrograph type	= SCS Runoff	Peak discharge	= 61.82 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 213,484 cuft
Drainage area	= 28.570 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

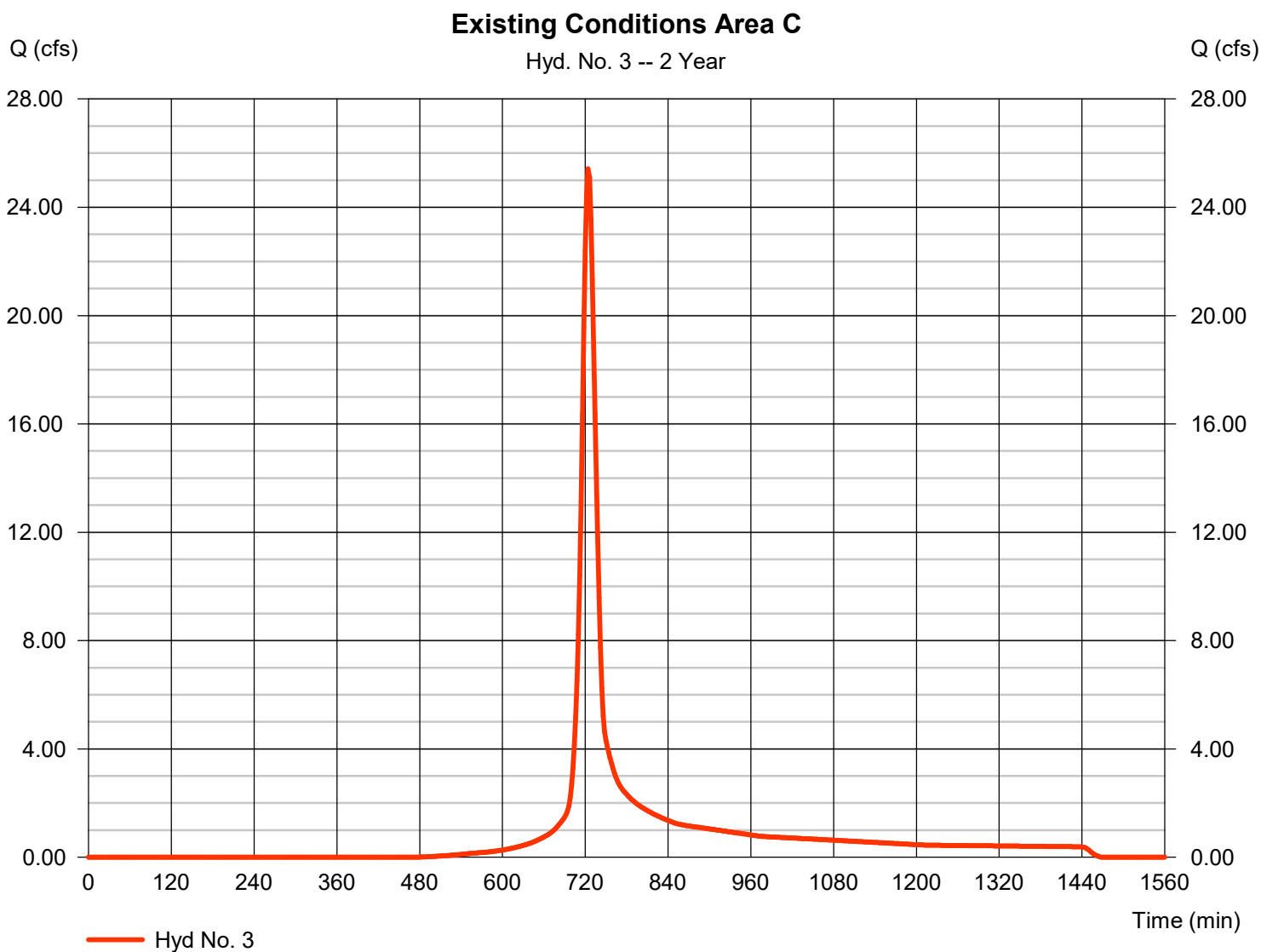
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 3

Existing Conditions Area C

Hydrograph type	= SCS Runoff	Peak discharge	= 25.41 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 79,488 cuft
Drainage area	= 11.270 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

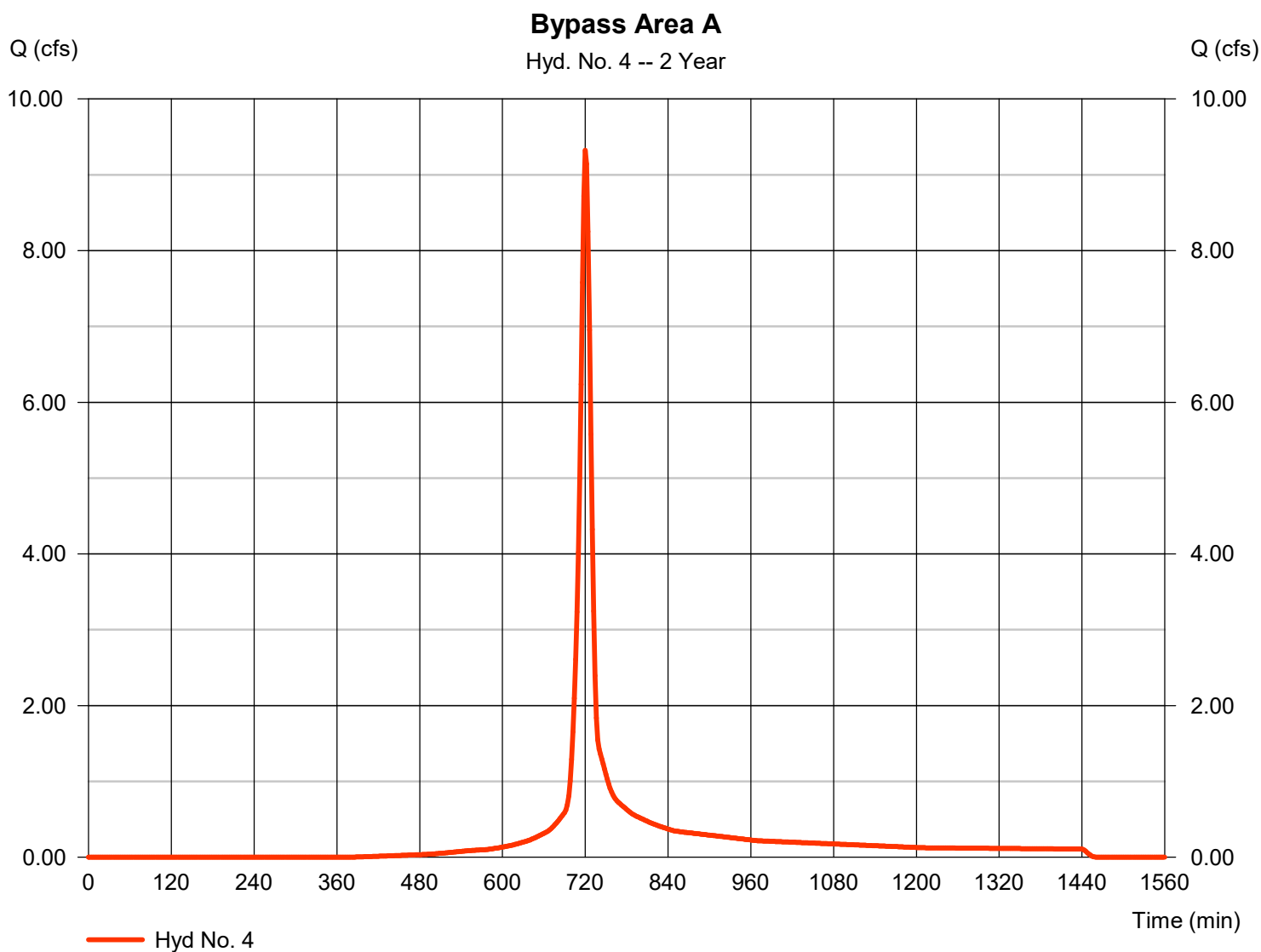
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 9.322 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 24,330 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

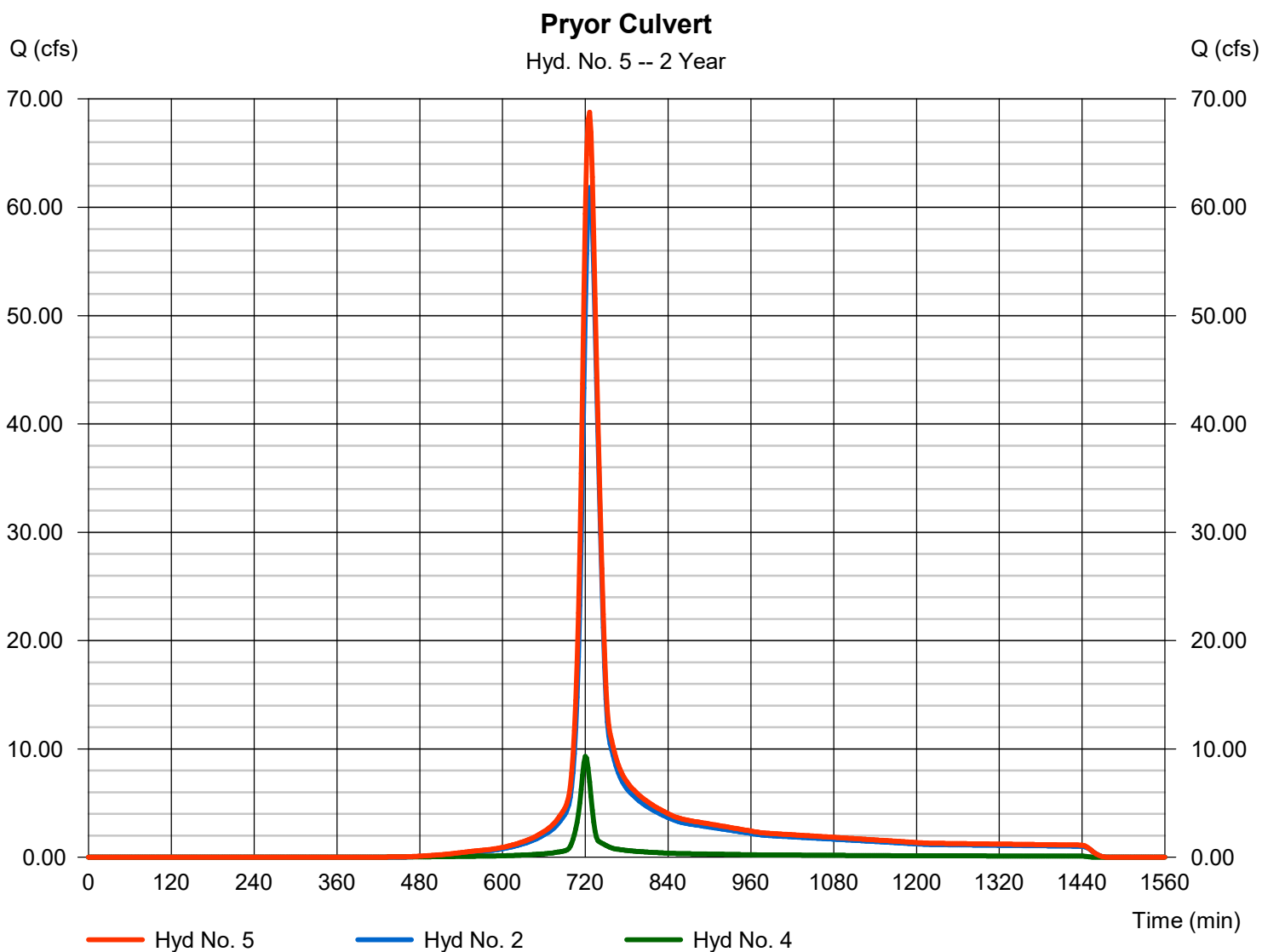
Thursday, 09 / 12 / 2019

Hyd. No. 5

Pryor Culvert

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 2, 4

Peak discharge = 68.77 cfs
Time to peak = 726 min
Hyd. volume = 237,814 cuft
Contrib. drain. area = 31.430 ac



Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	20.21	2	724	63,402	-----	-----	-----	Existing Conditions Area A
2	SCS Runoff	108.92	2	726	378,212	-----	-----	-----	Existing Conditions Area B
3	SCS Runoff	45.33	2	724	142,503	-----	-----	-----	Existing Conditions Area C
4	SCS Runoff	15.64	2	720	41,632	-----	-----	-----	Bypass Area A
5	Combine	120.39	2	726	419,844	2, 4	-----	-----	Pryor Culvert
Allera_Existing_Conditions.gpw					Return Period: 10 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

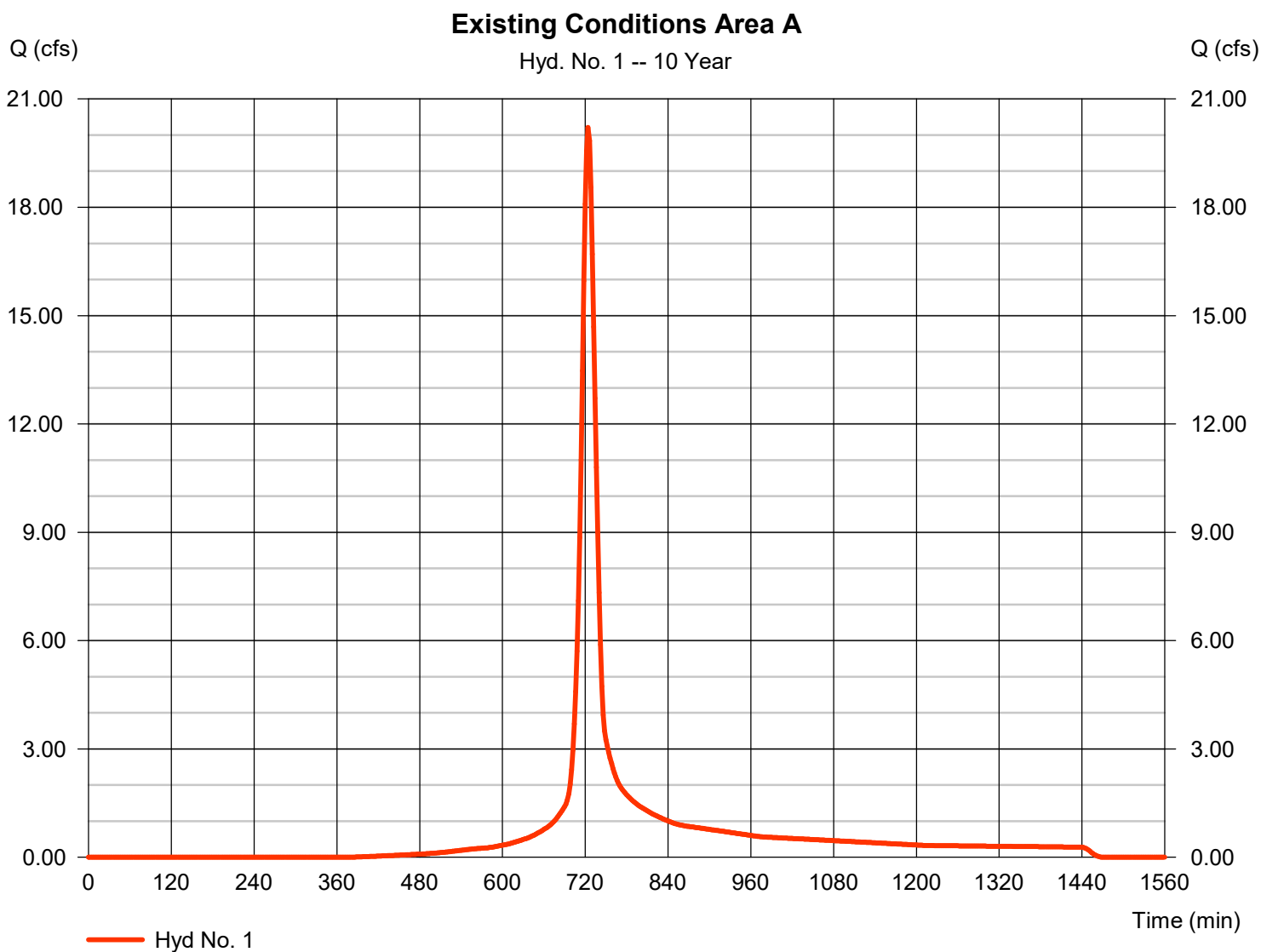
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 1

Existing Conditions Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 20.21 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 63,402 cuft
Drainage area	= 5.160 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.00 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

Thursday, 09 / 12 / 2019

Hyd. No. 2

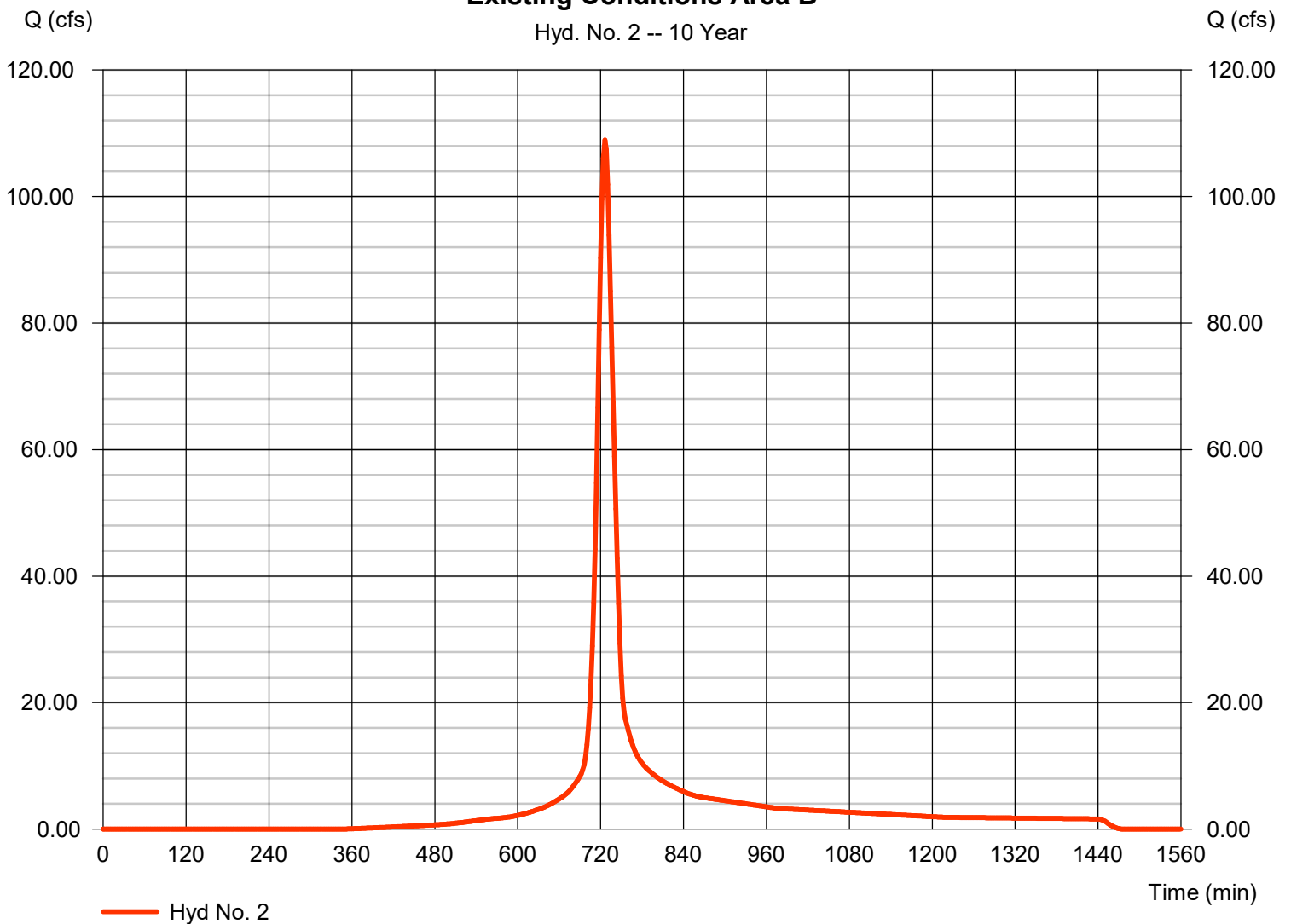
Existing Conditions Area B

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 2 min
 Drainage area = 28.570 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 5.34 in
 Storm duration = 24 hrs

Peak discharge = 108.92 cfs
 Time to peak = 726 min
 Hyd. volume = 378,212 cuft
 Curve number = 84
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 22.00 min
 Distribution = Type II
 Shape factor = 484

Existing Conditions Area B

Hyd. No. 2 -- 10 Year



Hydrograph Report

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

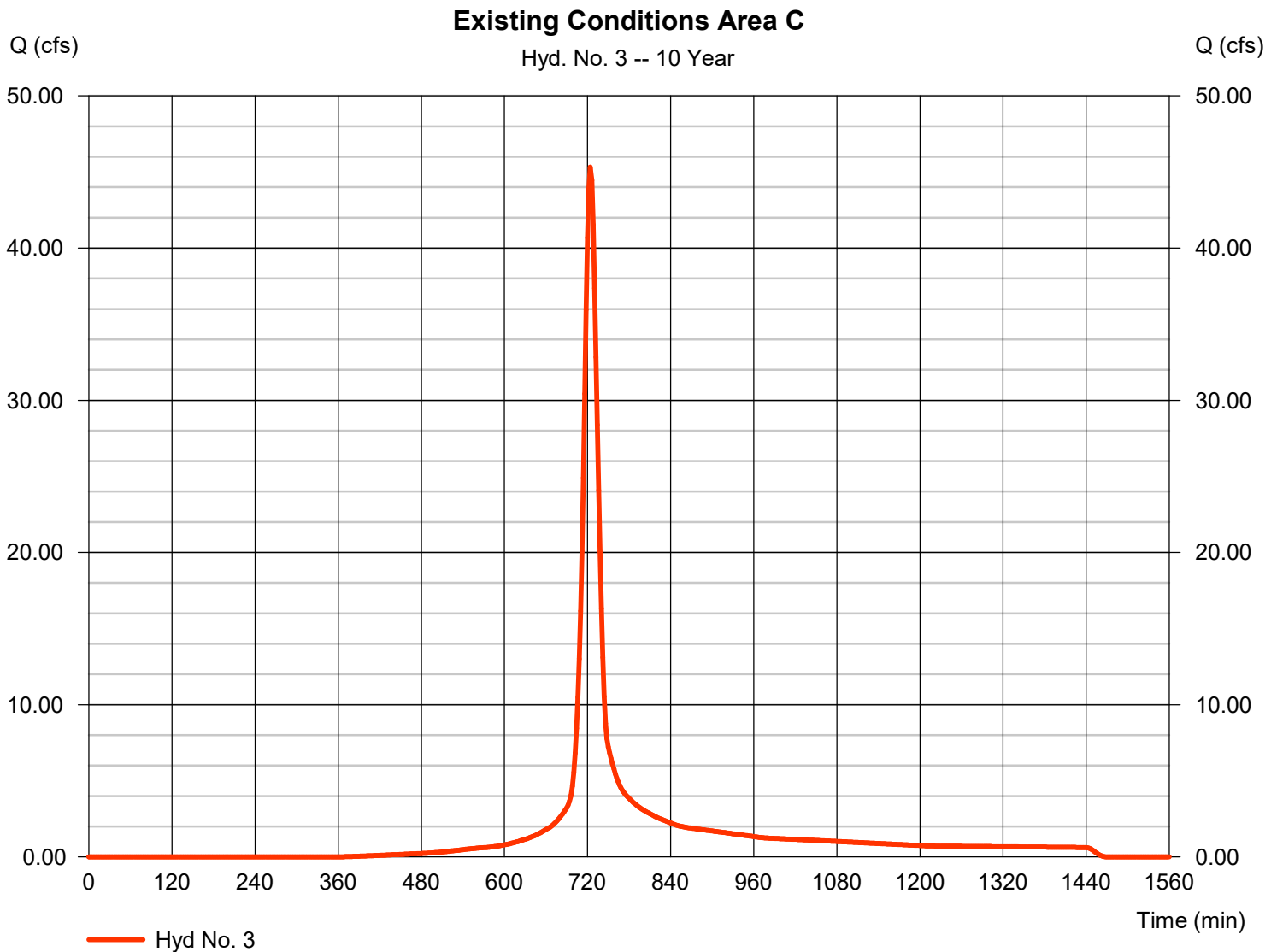
Thursday, 09 / 12 / 2019

Hyd. No. 3

Existing Conditions Area C

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 2 min
 Drainage area = 11.270 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 5.34 in
 Storm duration = 24 hrs

Peak discharge = 45.33 cfs
 Time to peak = 724 min
 Hyd. volume = 142,503 cuft
 Curve number = 83
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 20.00 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

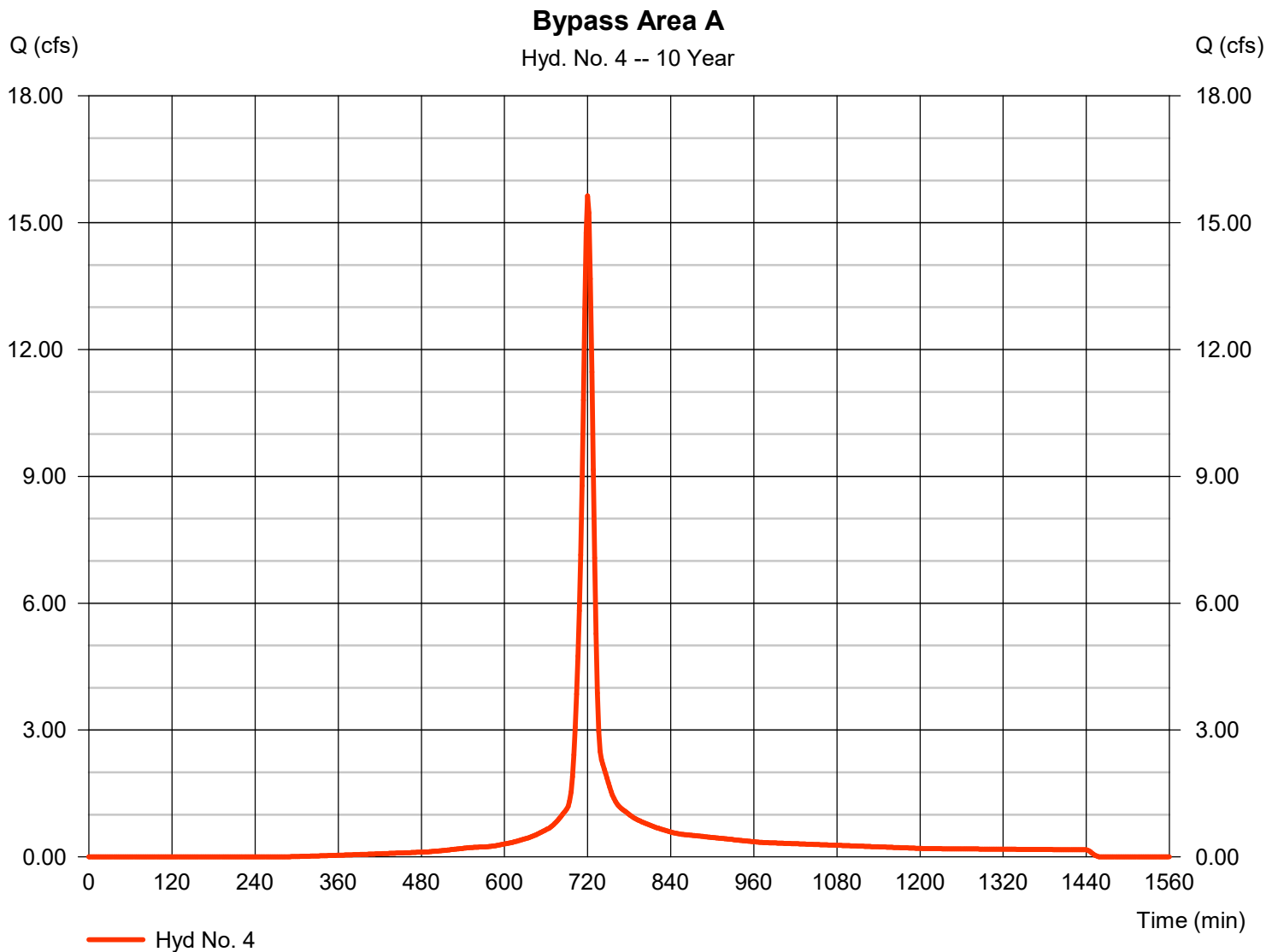
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 15.64 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 41,632 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

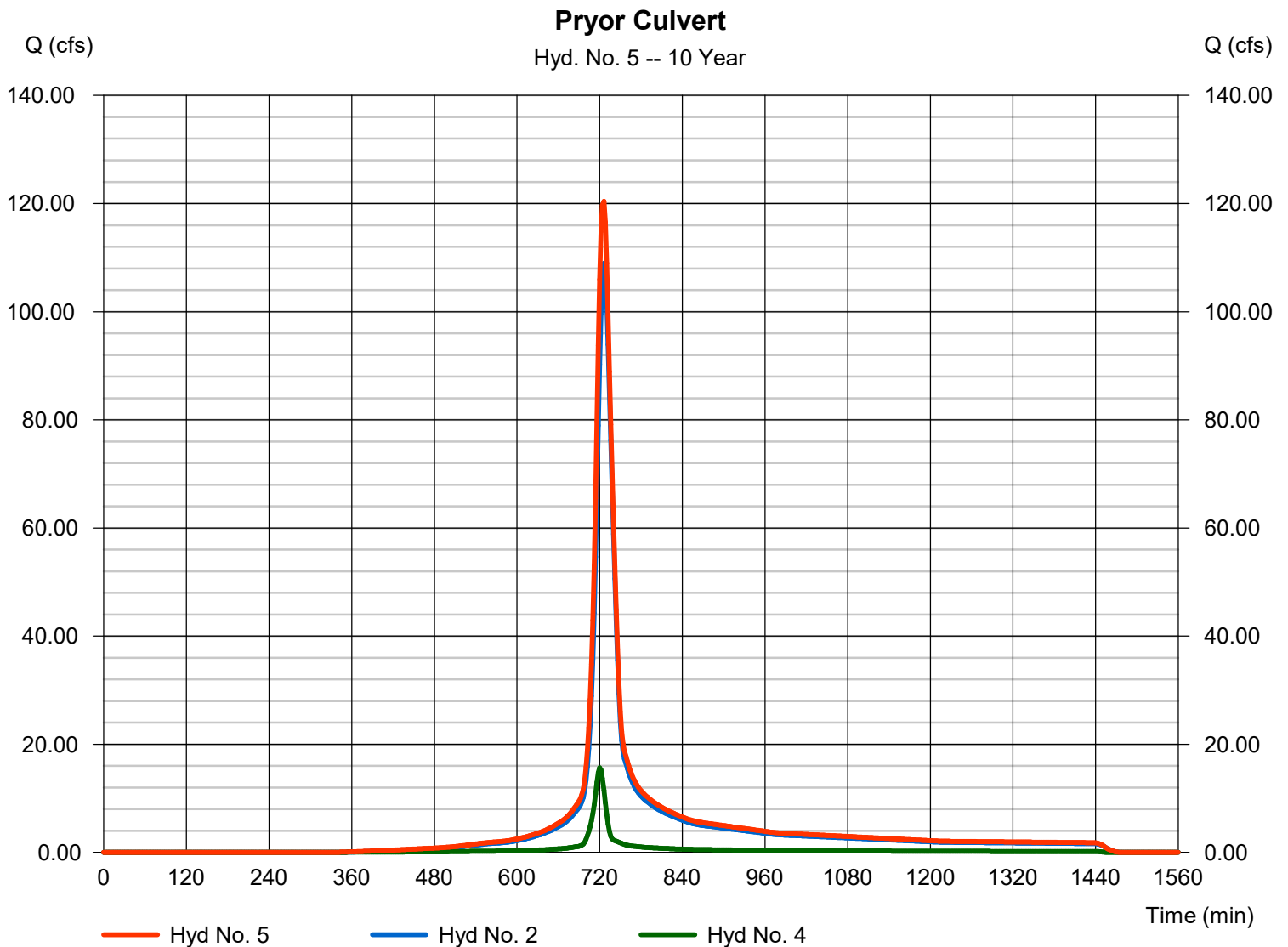
Thursday, 09 / 12 / 2019

Hyd. No. 5

Pryor Culvert

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 2 min
 Inflow hyds. = 2, 4

Peak discharge = 120.39 cfs
 Time to peak = 726 min
 Hyd. volume = 419,844 cuft
 Contrib. drain. area = 31.430 ac



Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	33.87	2	724	107,981	-----	-----	-----	Existing Conditions Area A
2	SCS Runoff	179.23	2	726	633,290	-----	-----	-----	Existing Conditions Area B
3	SCS Runoff	75.19	2	724	240,632	-----	-----	-----	Existing Conditions Area C
4	SCS Runoff	24.90	2	720	68,010	-----	-----	-----	Bypass Area A
5	Combine	197.29	2	726	701,300	2, 4	-----	-----	Pryor Culvert
Allera_Existing_Conditions.gpw					Return Period: 100 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

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

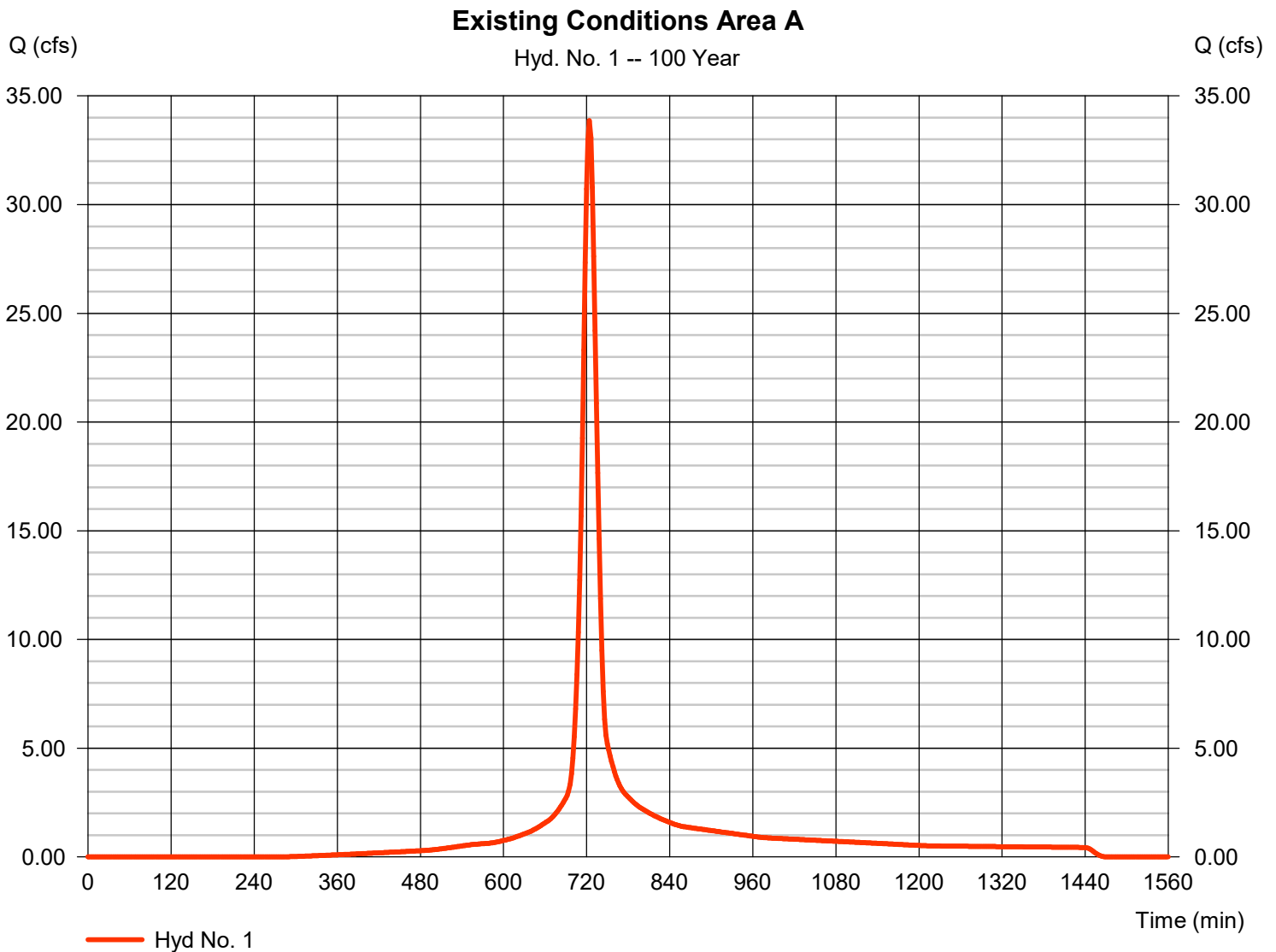
Thursday, 09 / 12 / 2019

Hyd. No. 1

Existing Conditions Area A

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 5.160 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 7.90 in
 Storm duration = 24 hrs

Peak discharge = 33.87 cfs
 Time to peak = 724 min
 Hyd. volume = 107,981 cuft
 Curve number = 82
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 20.00 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

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

Thursday, 09 / 12 / 2019

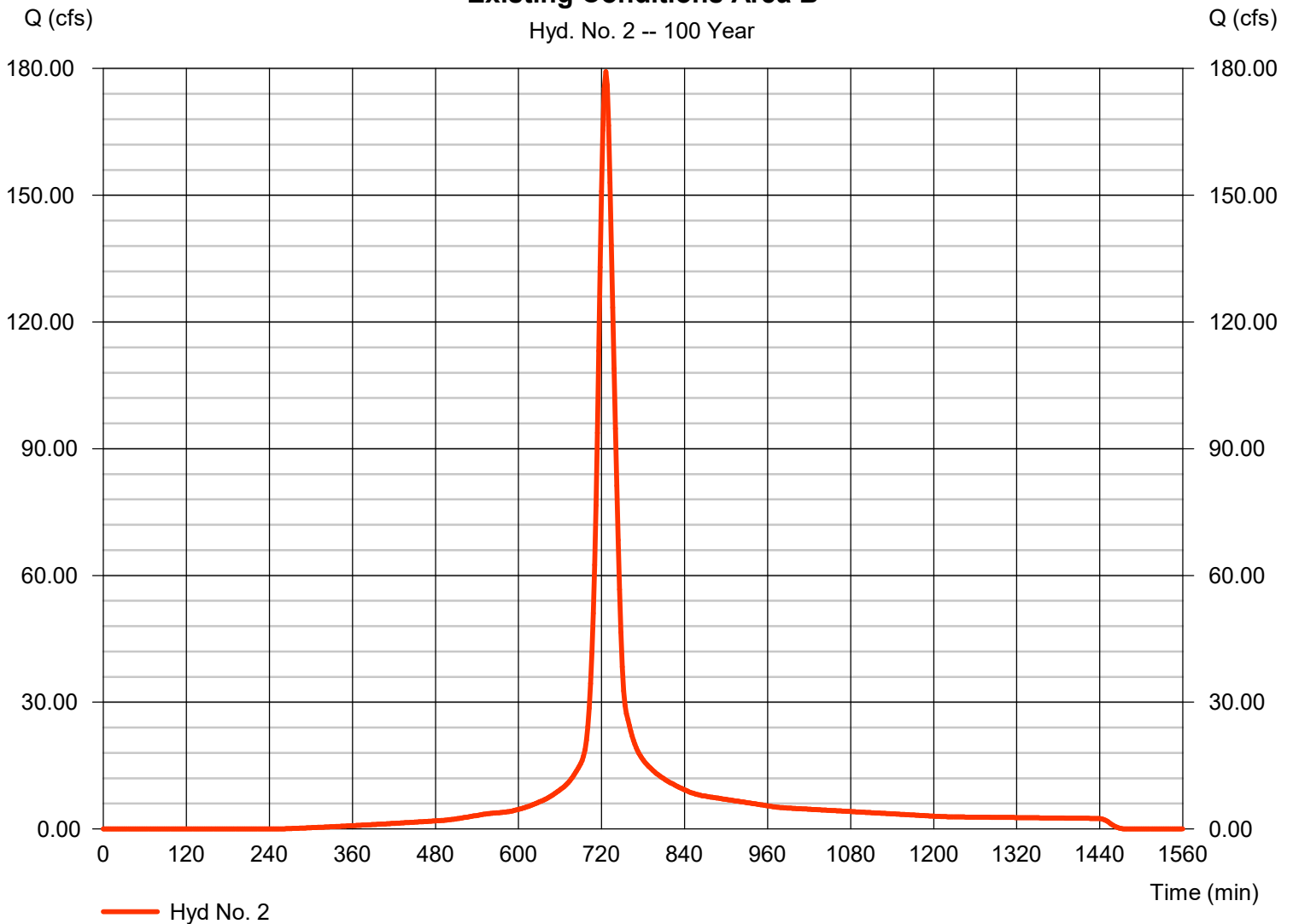
Hyd. No. 2

Existing Conditions Area B

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 28.570 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 7.90 in
 Storm duration = 24 hrs

Peak discharge = 179.23 cfs
 Time to peak = 726 min
 Hyd. volume = 633,290 cuft
 Curve number = 84
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 22.00 min
 Distribution = Type II
 Shape factor = 484

Existing Conditions Area B



Hydrograph Report

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

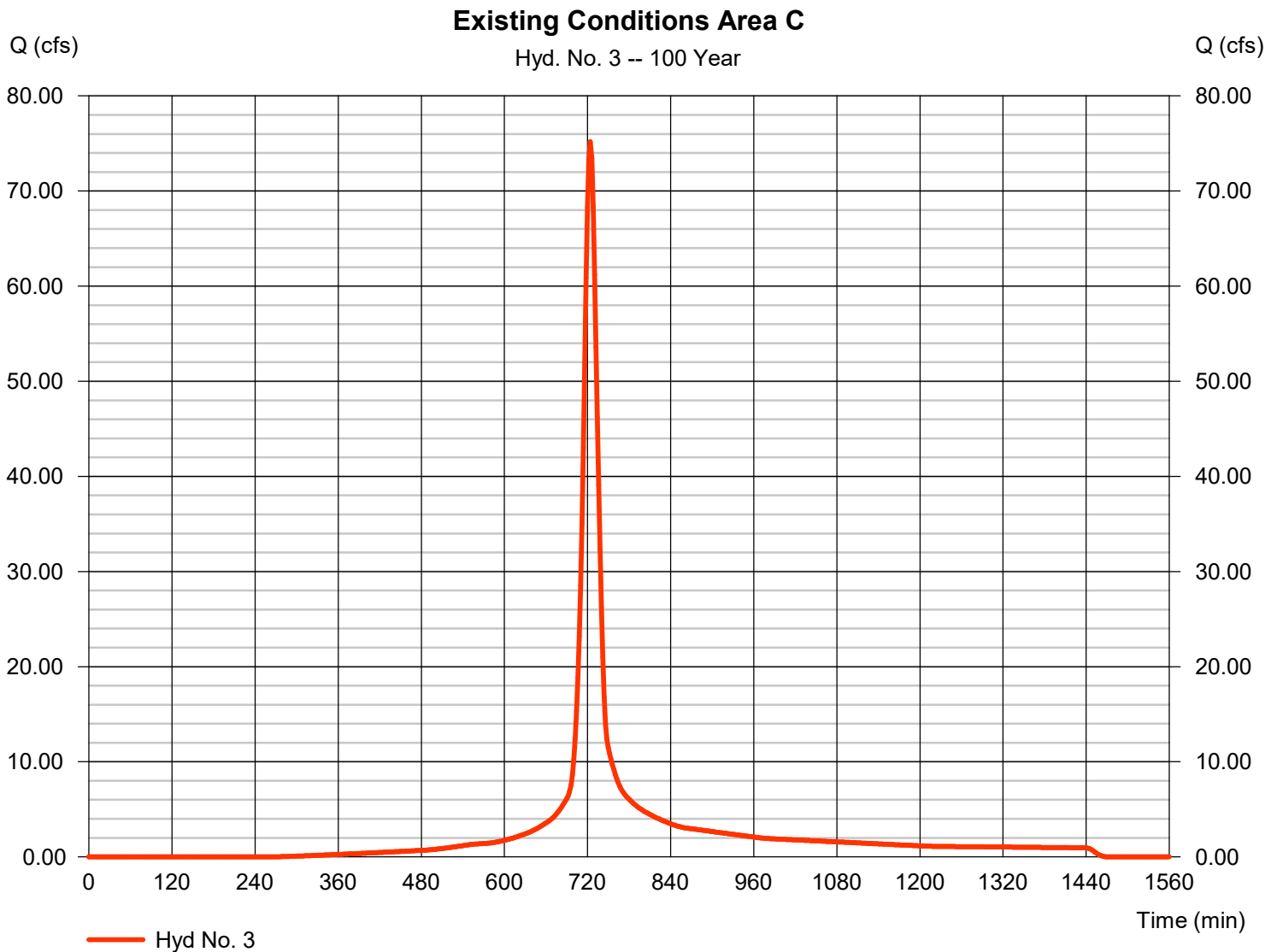
Thursday, 09 / 12 / 2019

Hyd. No. 3

Existing Conditions Area C

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 11.270 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 7.90 in
 Storm duration = 24 hrs

Peak discharge = 75.19 cfs
 Time to peak = 724 min
 Hyd. volume = 240,632 cuft
 Curve number = 83
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 20.00 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

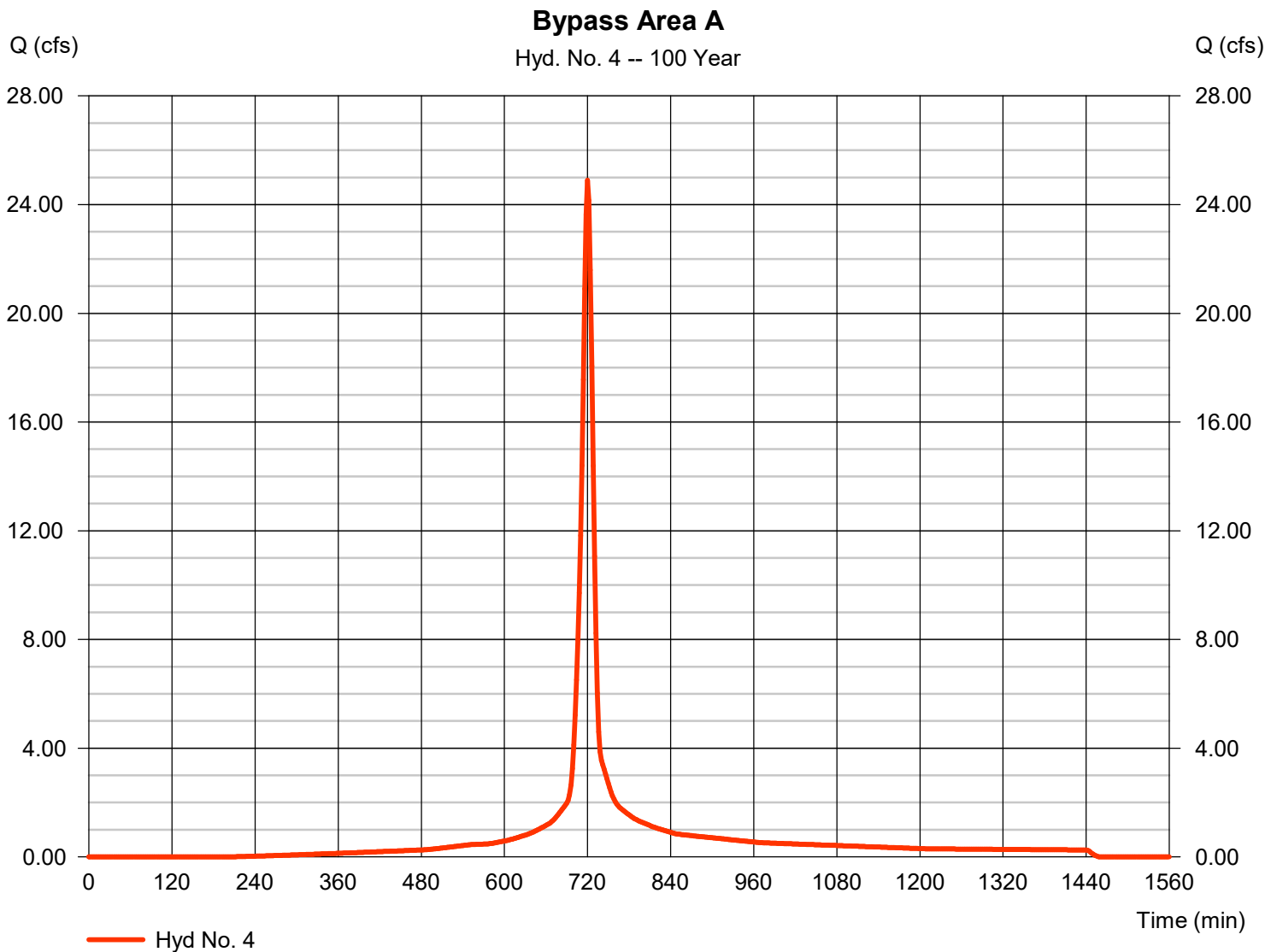
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 24.90 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 68,010 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

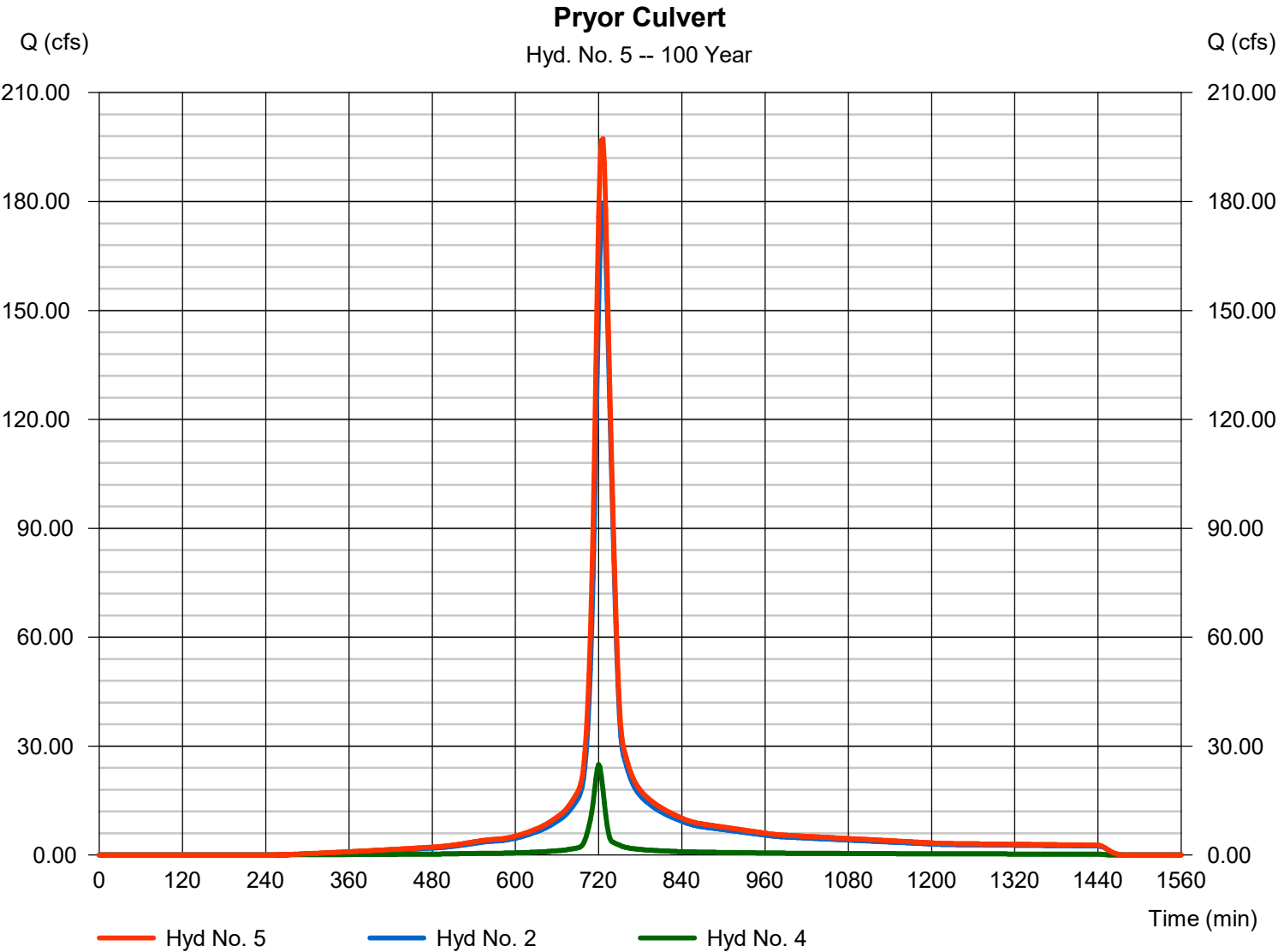


Hydrograph Report

Hyd. No. 5

Pryor Culvert

Hydrograph type	= Combine	Peak discharge	= 197.29 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 701,300 cuft
Inflow hyds.	= 2, 4	Contrib. drain. area	= 31.430 ac



APPENDIX C

Proposed Conditions Hydroflow Hydrographs Model Input and Results

Subarea A

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.0362	Grass-Range, Short (0.15)		0.093
Shallow Concentrated	58	0.0524	Unpaved		0.004
Channel					
Total	158				0.127

Subarea B1

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.005	Grass-Range, Short (0.15)		0.272
Shallow Concentrated	646	0.0503	Unpaved		0.05
Channel	1771			15	0.033
Total	2517				0.355

Subarea B2

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.0420	Grass-Range, Short (0.15)		0.116
Shallow Concentrated	469	.0336	Unpaved		0.044
Channel	539			7	.021
Total	1108				0.181

Subarea C

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.005	Grass-Range, Short (0.15)		0.272
Shallow Concentrated	451	0.057	Unpaved		0.033
Channel	746			10	0.021
Total	1297				0.326

Bypass Area A

	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	Velocity (ft/s)	Time (hr)
Sheet	100	0.030	Grass-Range, Short (0.15)		0.133
Shallow Concentrated	472	0.035	Unpaved		0.044
Channel					
Total	572				0.177

Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.653	3	717	3,857	-----	-----	-----	Proposed Area A
2	SCS Runoff	84.38	2	726	292,466	-----	-----	-----	Proposed Area B1
3	SCS Runoff	20.92	2	724	65,498	-----	-----	-----	Proposed Area C
4	SCS Runoff	9.813	2	720	25,975	-----	-----	-----	Proposed Area B2
5	SCS Runoff	9.322	2	720	24,330	-----	-----	-----	Bypass Area A
6	Reservoir	5.853	2	812	276,519	2	1014.12	181,704	Detention Pond
7	Combine	10.32	2	720	302,493	4, 6	-----	-----	Point of Interest
8	Combine	19.64	2	720	326,824	5, 7	-----	-----	Point of Interest w/ Bypass Area
Allera_Proposed_Detention.gpw					Return Period: 2 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

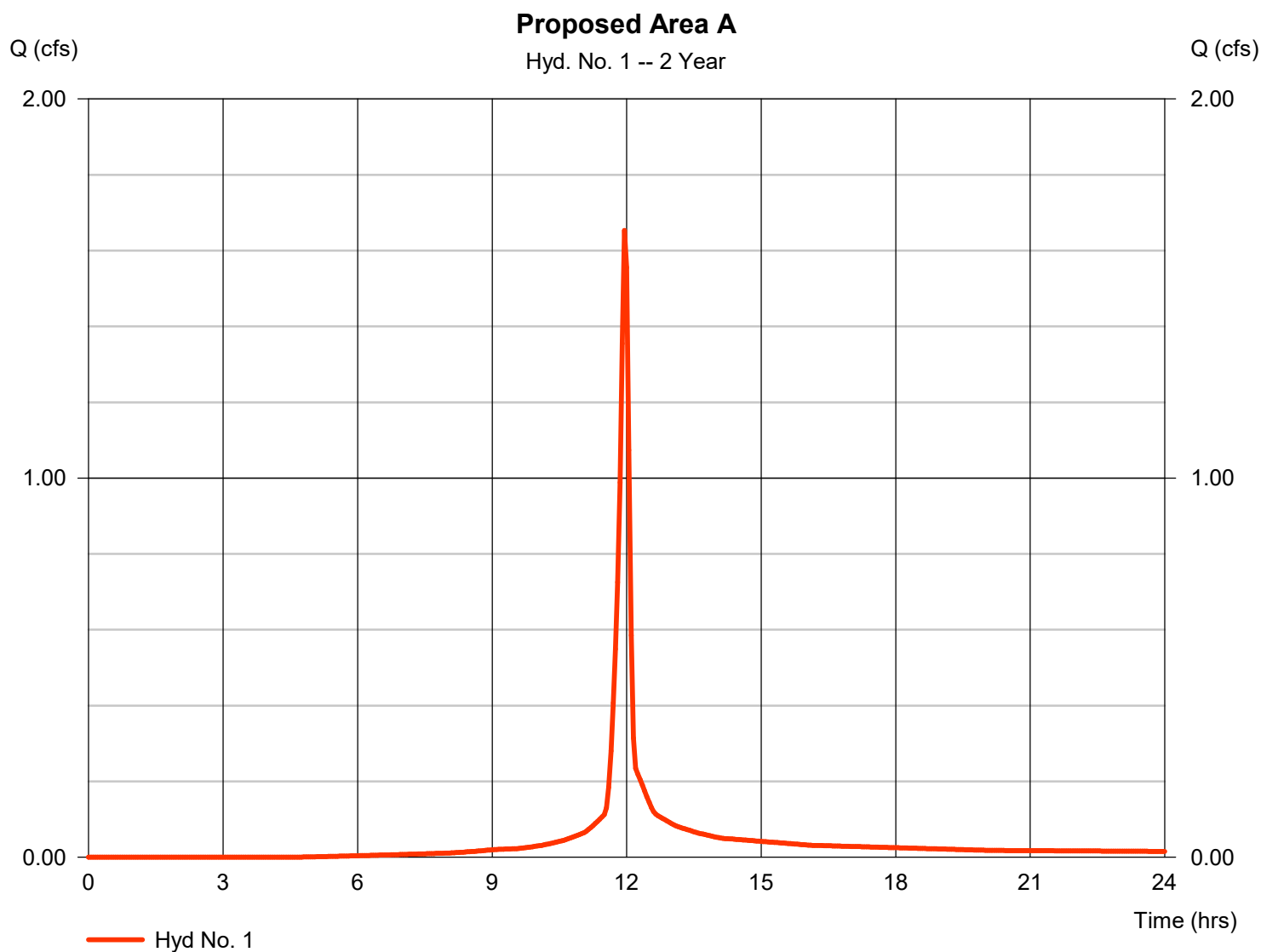
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 1

Proposed Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 1.653 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.95 hrs
Time interval	= 3 min	Hyd. volume	= 3,857 cuft
Drainage area	= 0.430 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 7.60 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

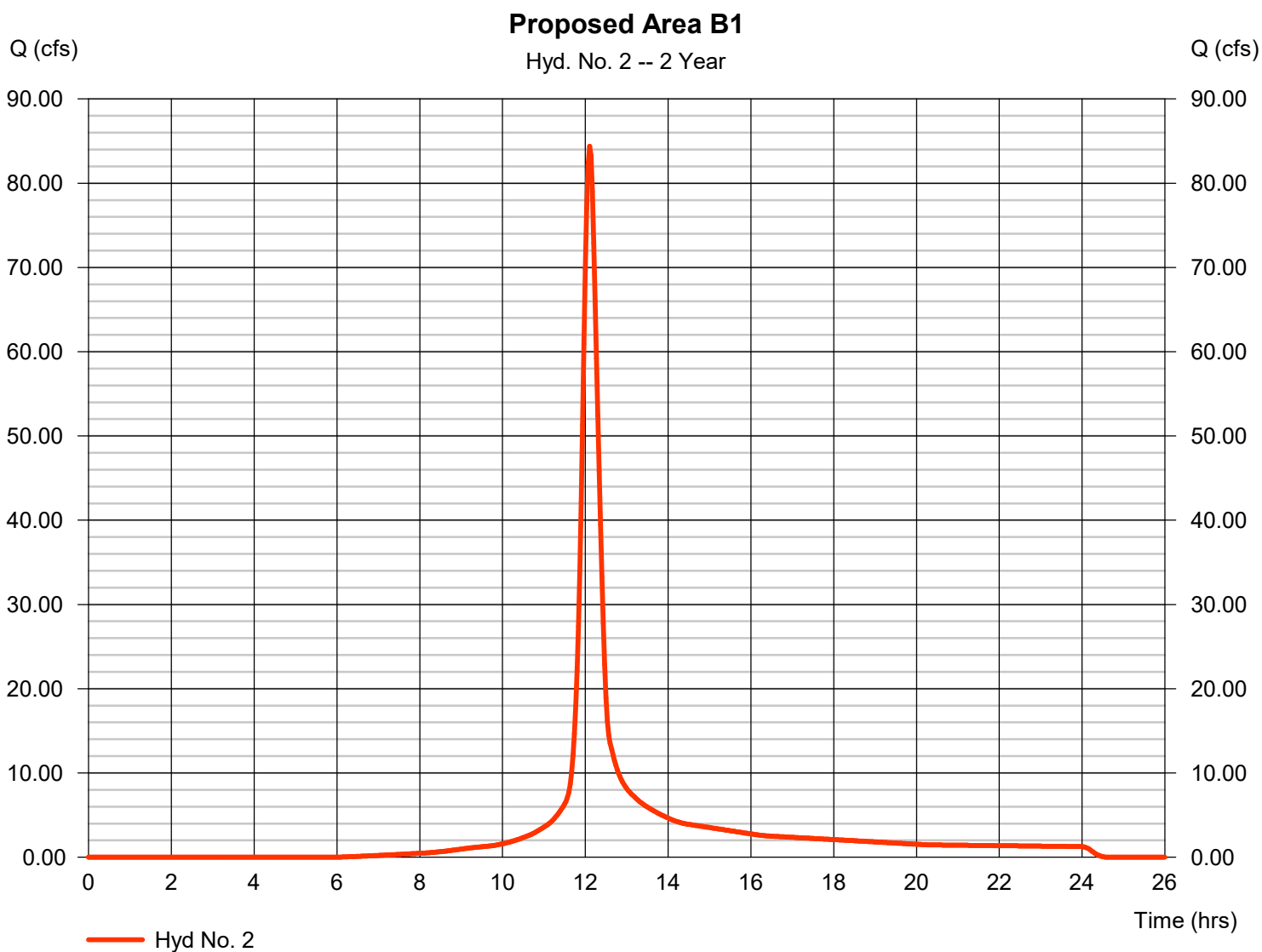
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 2

Proposed Area B1

Hydrograph type	= SCS Runoff	Peak discharge	= 84.38 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 292,466 cuft
Drainage area	= 33.540 ac	Curve number	= 88
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

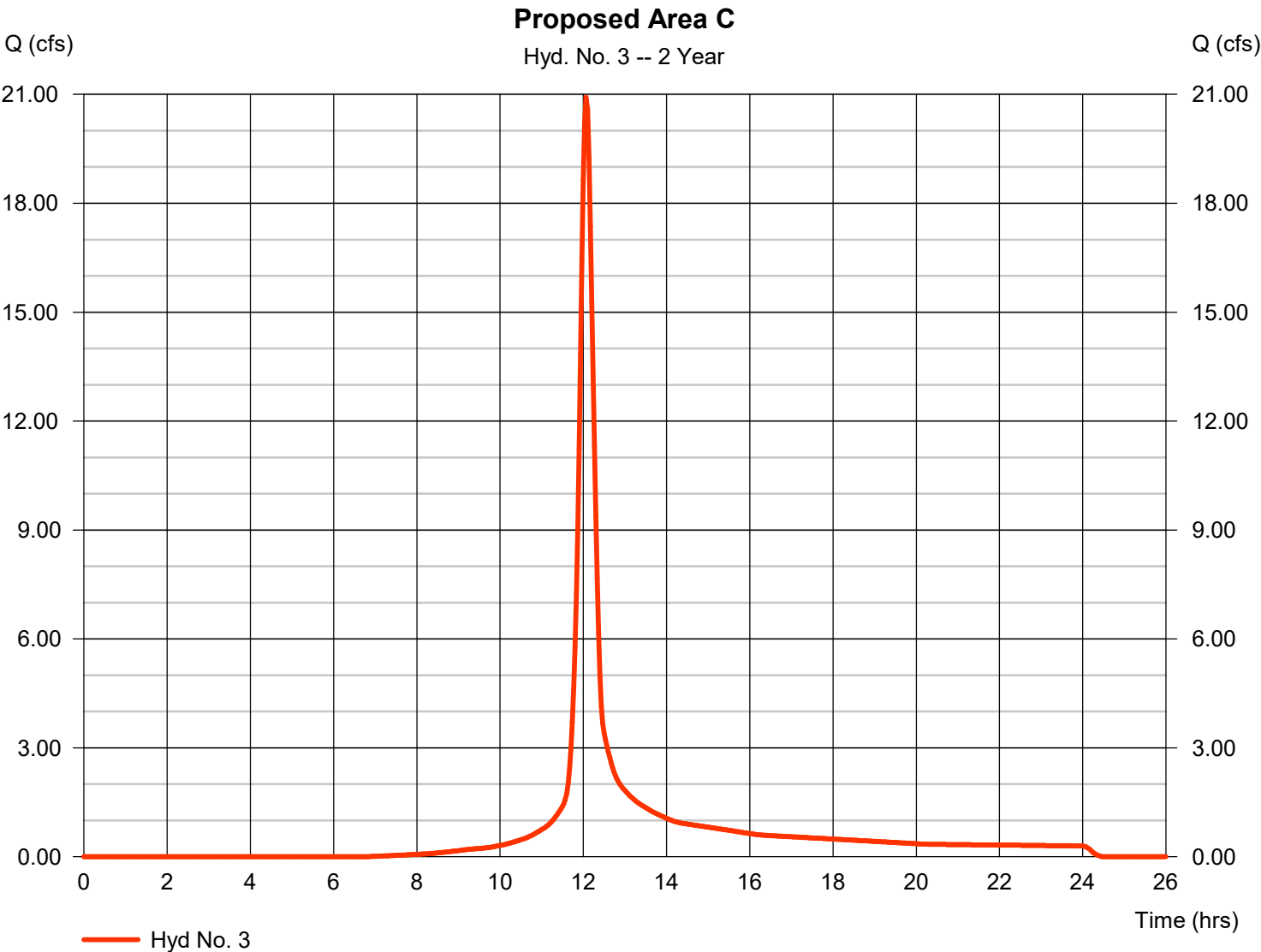


Hydrograph Report

Hyd. No. 3

Proposed Area C

Hydrograph type	= SCS Runoff	Peak discharge	= 20.92 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 65,498 cuft
Drainage area	= 8.250 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.60 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

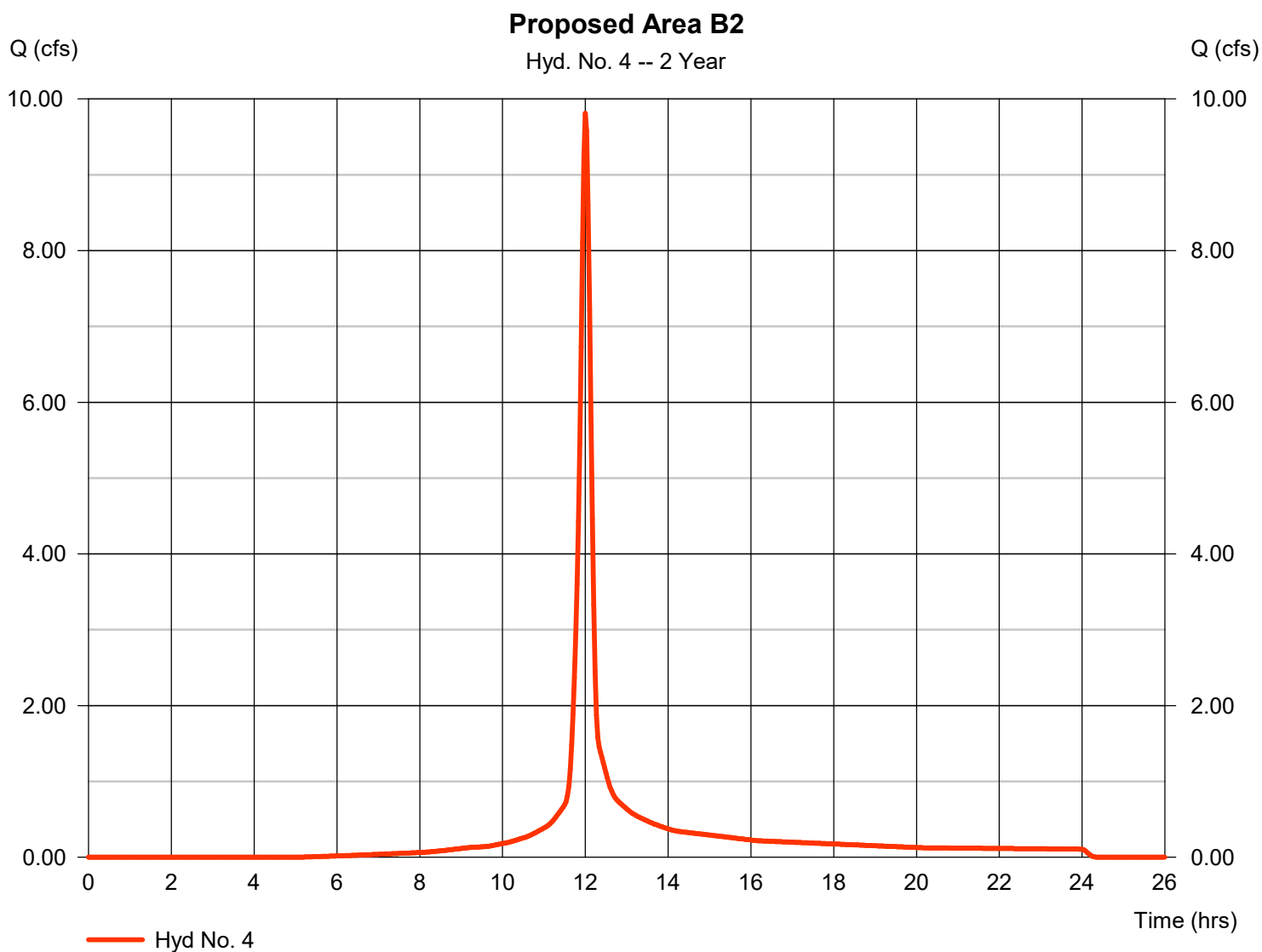
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Proposed Area B2

Hydrograph type	= SCS Runoff	Peak discharge	= 9.813 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 25,975 cuft
Drainage area	= 2.730 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.90 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

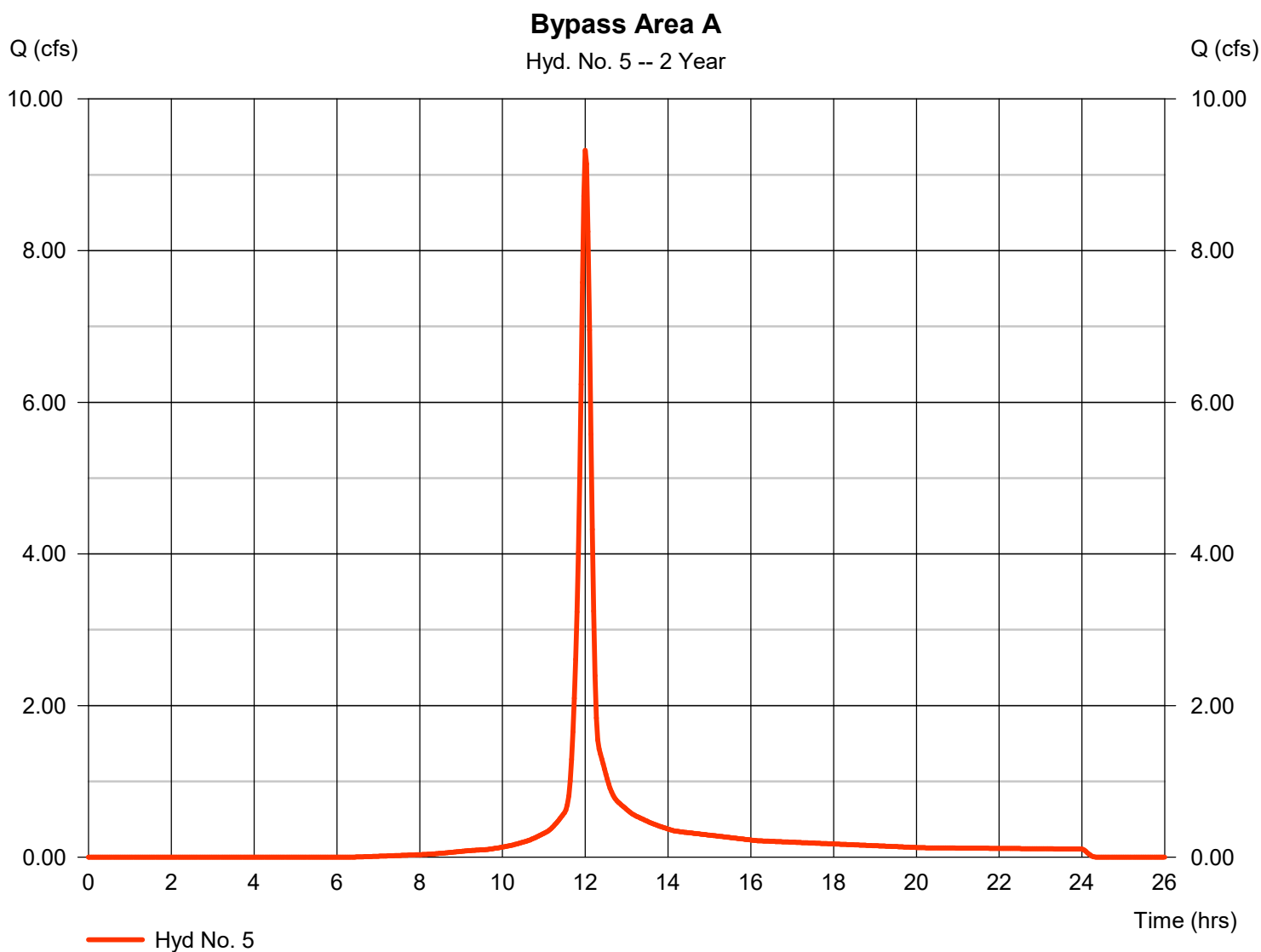
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 5

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 9.322 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 24,330 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

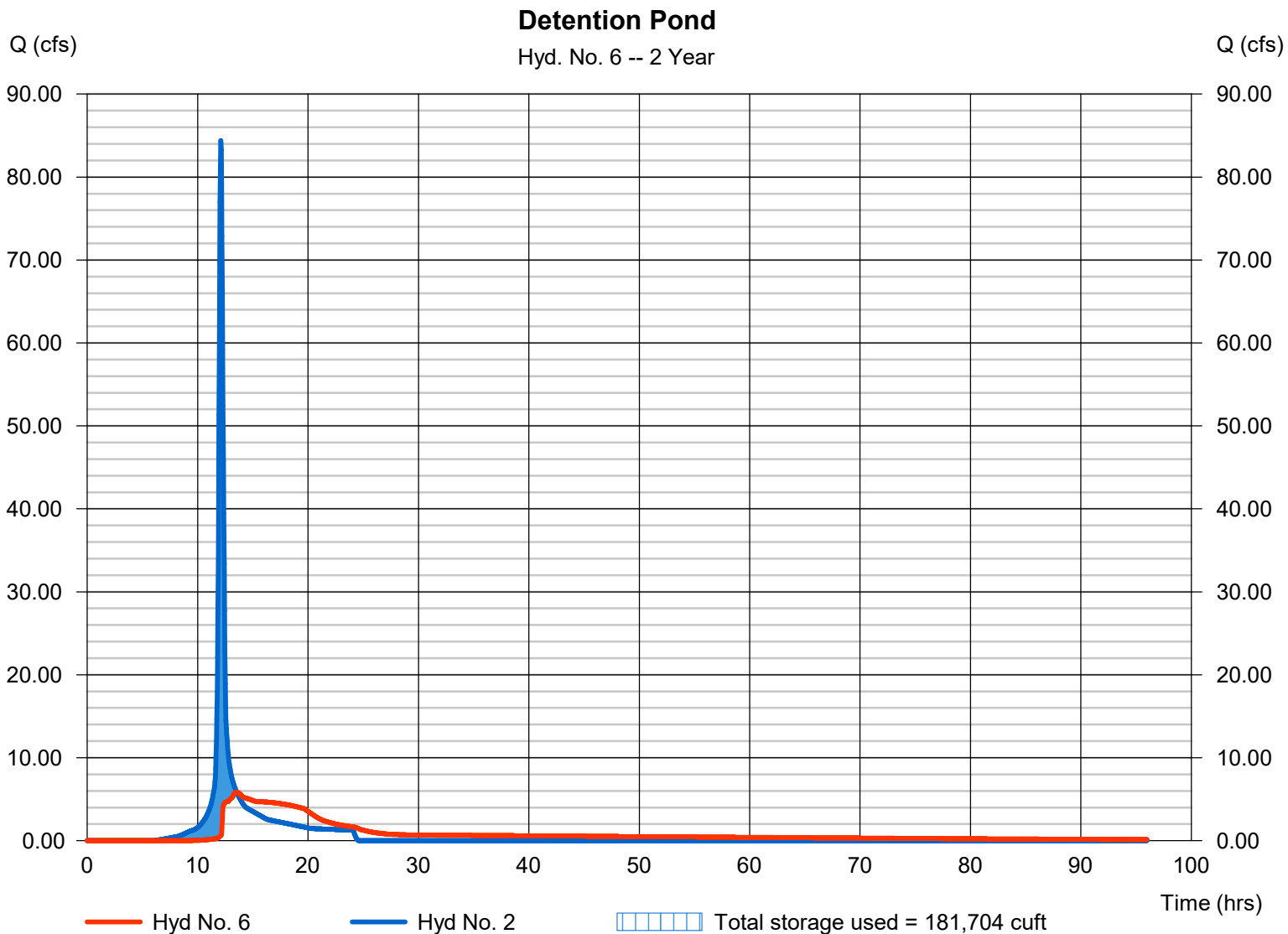
Thursday, 09 / 12 / 2019

Hyd. No. 6

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 5.853 cfs
Storm frequency	= 2 yrs	Time to peak	= 13.53 hrs
Time interval	= 2 min	Hyd. volume	= 276,519 cuft
Inflow hyd. No.	= 2 - Proposed Area B1	Max. Elevation	= 1014.12 ft
Reservoir name	= Detention	Max. Storage	= 181,704 cuft

Storage Indication method used.

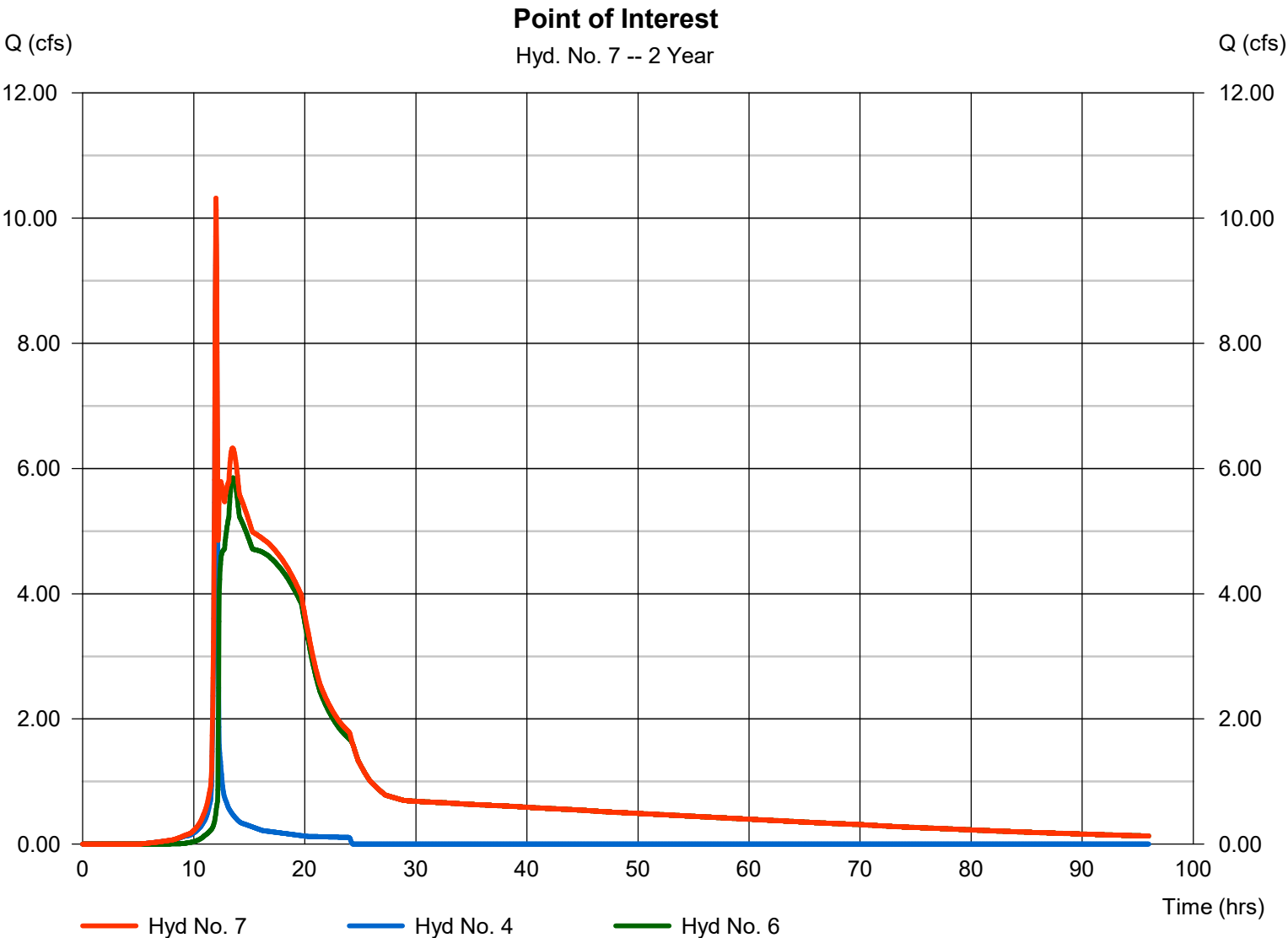


Hydrograph Report

Hyd. No. 7

Point of Interest

Hydrograph type	= Combine	Peak discharge	= 10.32 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 302,493 cuft
Inflow hyds.	= 4, 6	Contrib. drain. area	= 2.730 ac



Hydrograph Report

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

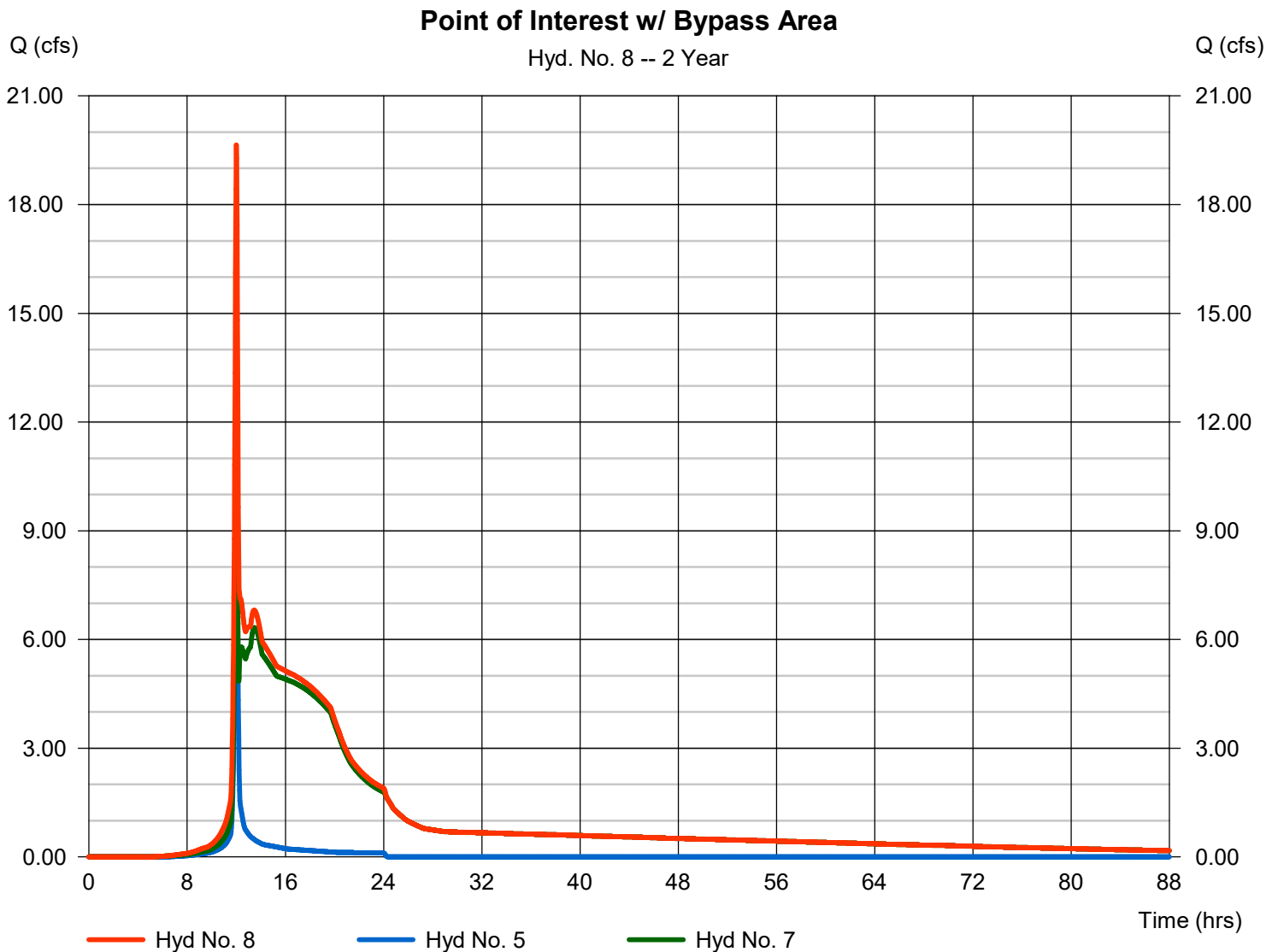
Thursday, 09 / 12 / 2019

Hyd. No. 8

Point of Interest w/ Bypass Area

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 5, 7

Peak discharge = 19.64 cfs
Time to peak = 12.00 hrs
Hyd. volume = 326,824 cuft
Contrib. drain. area = 2.860 ac



Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.631	3	717	6,311	-----	-----	-----	Proposed Area A
2	SCS Runoff	140.46	2	726	494,803	-----	-----	-----	Proposed Area B1
3	SCS Runoff	35.72	2	724	113,366	-----	-----	-----	Proposed Area C
4	SCS Runoff	15.83	2	720	42,972	-----	-----	-----	Proposed Area B2
5	SCS Runoff	15.64	2	720	41,632	-----	-----	-----	Bypass Area A
6	Reservoir	39.50	2	748	478,332	2	1015.61	259,345	Detention Pond
7	Combine	41.42	2	746	521,304	4, 6	-----	-----	Point of Interest
8	Combine	43.39	2	746	562,937	5, 7	-----	-----	Point of Interest w/ Bypass Area
Allera_Proposed_Detention.gpw					Return Period: 10 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

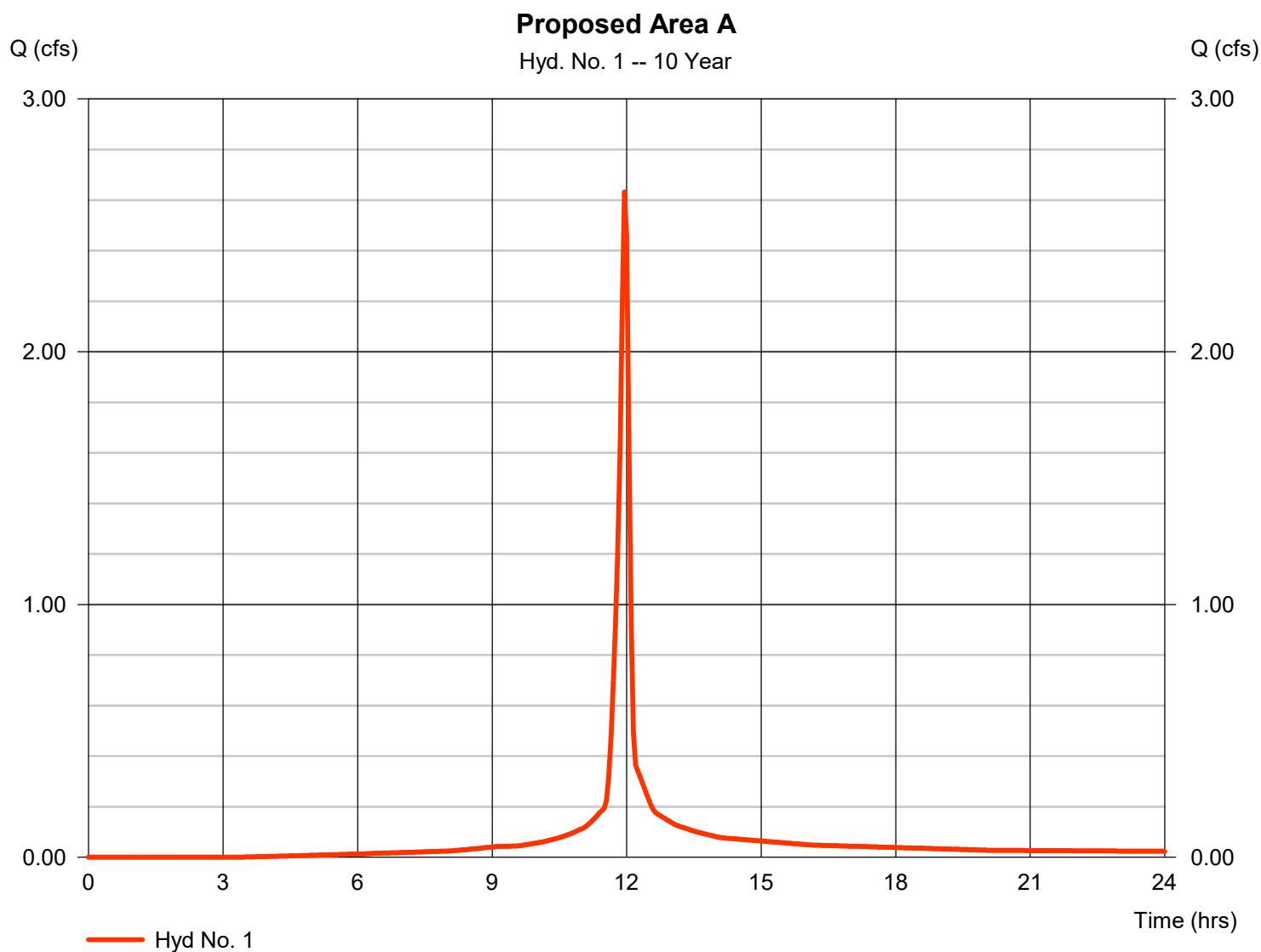
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 1

Proposed Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 2.631 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 3 min	Hyd. volume	= 6,311 cuft
Drainage area	= 0.430 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

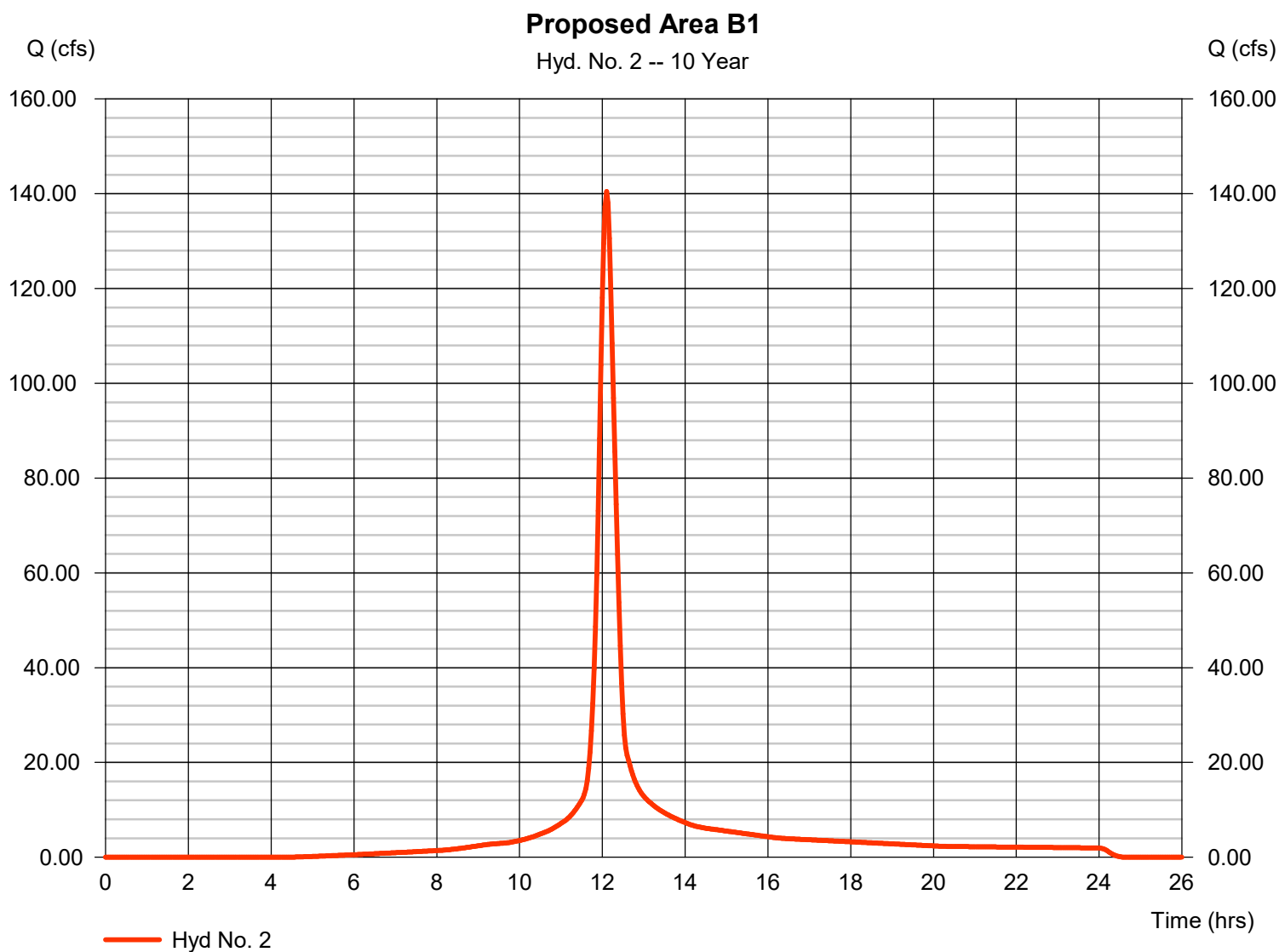
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 2

Proposed Area B1

Hydrograph type	= SCS Runoff	Peak discharge	= 140.46 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 494,803 cuft
Drainage area	= 33.540 ac	Curve number	= 88
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

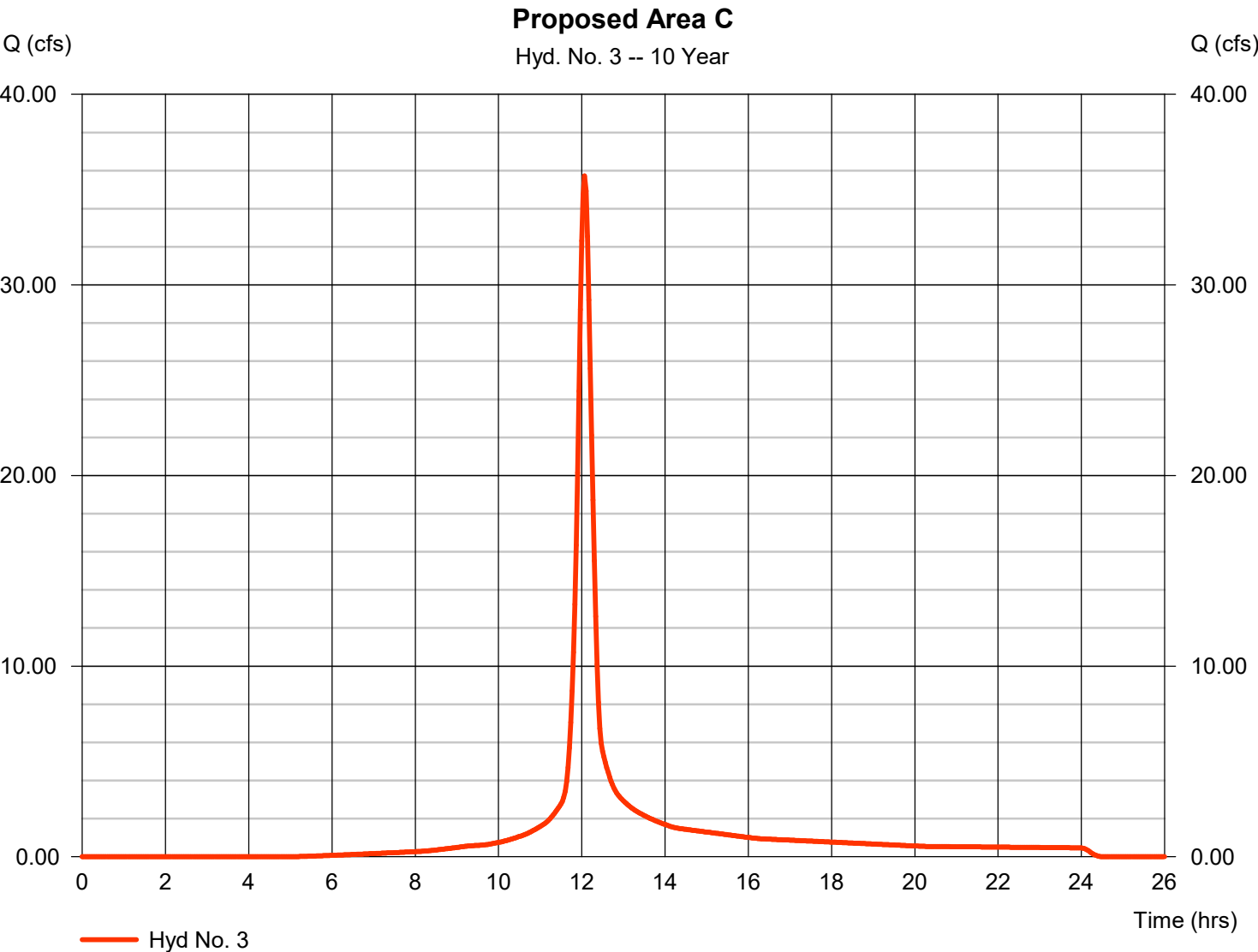


Hydrograph Report

Hyd. No. 3

Proposed Area C

Hydrograph type	= SCS Runoff	Peak discharge	= 35.72 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 113,366 cuft
Drainage area	= 8.250 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.60 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

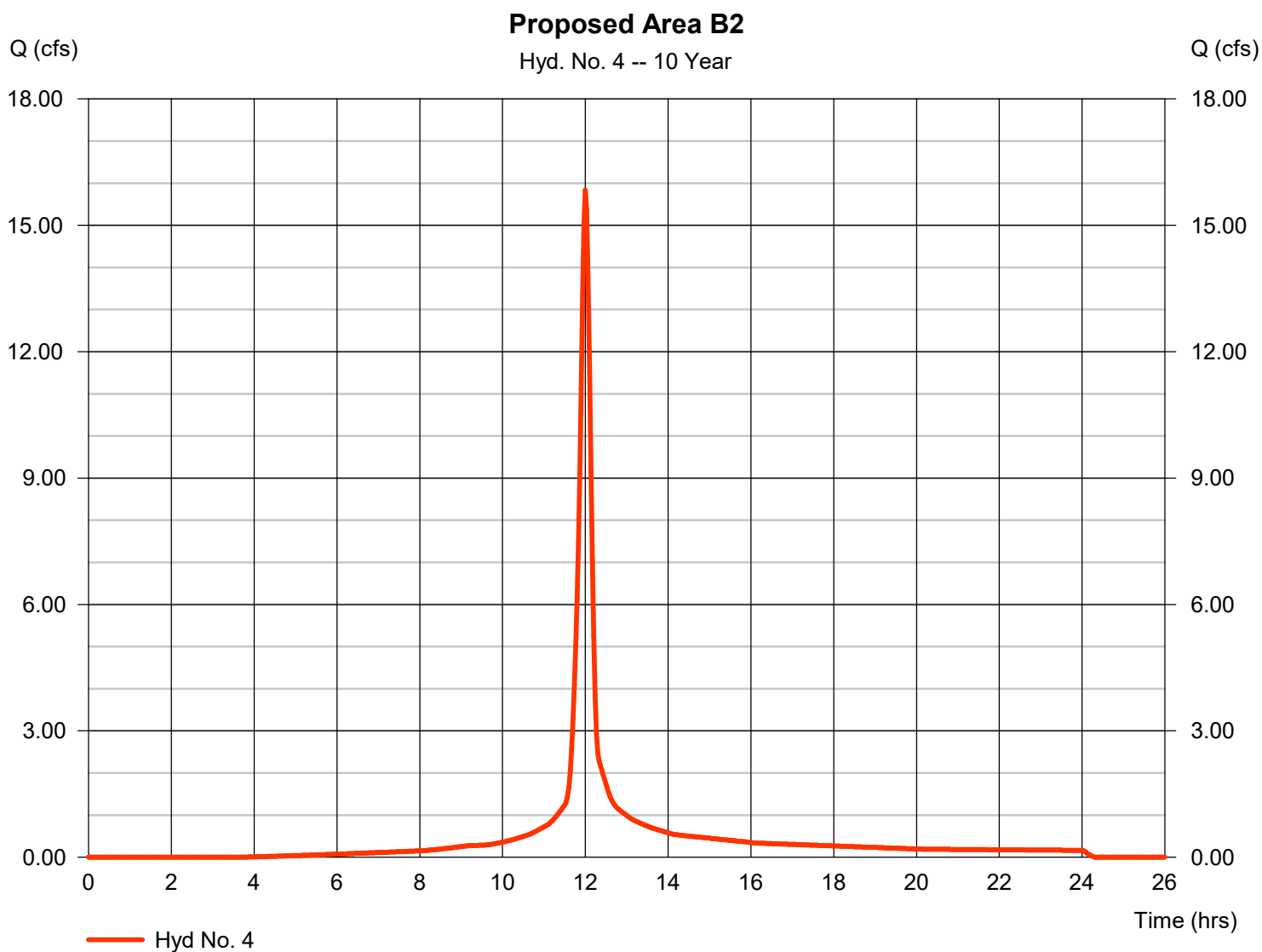
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Proposed Area B2

Hydrograph type	= SCS Runoff	Peak discharge	= 15.83 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 42,972 cuft
Drainage area	= 2.730 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.90 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

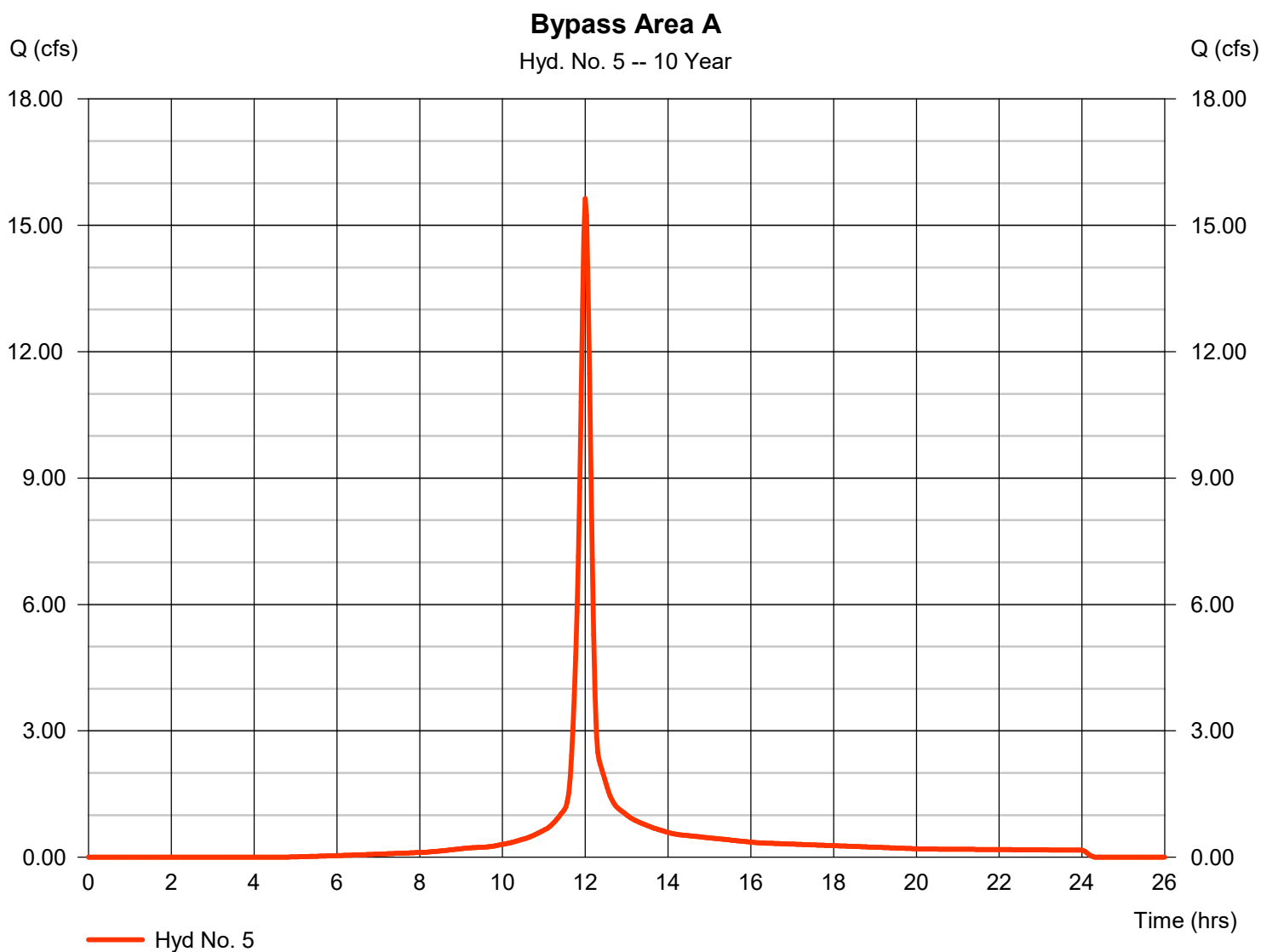
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 5

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 15.64 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 41,632 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 5.34 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

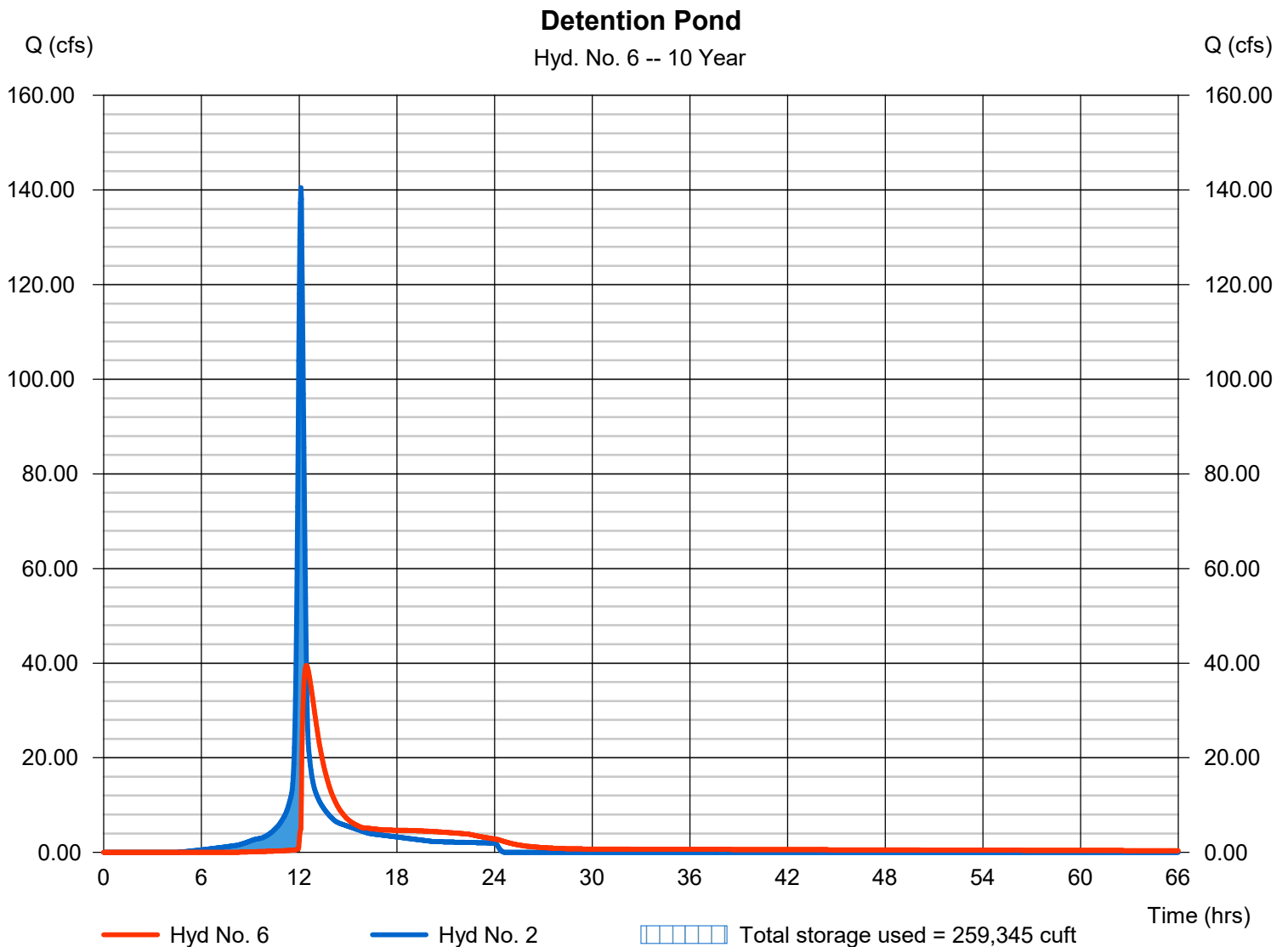
Thursday, 09 / 12 / 2019

Hyd. No. 6

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 39.50 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 478,332 cuft
Inflow hyd. No.	= 2 - Proposed Area B1	Max. Elevation	= 1015.61 ft
Reservoir name	= Detention	Max. Storage	= 259,345 cuft

Storage Indication method used.

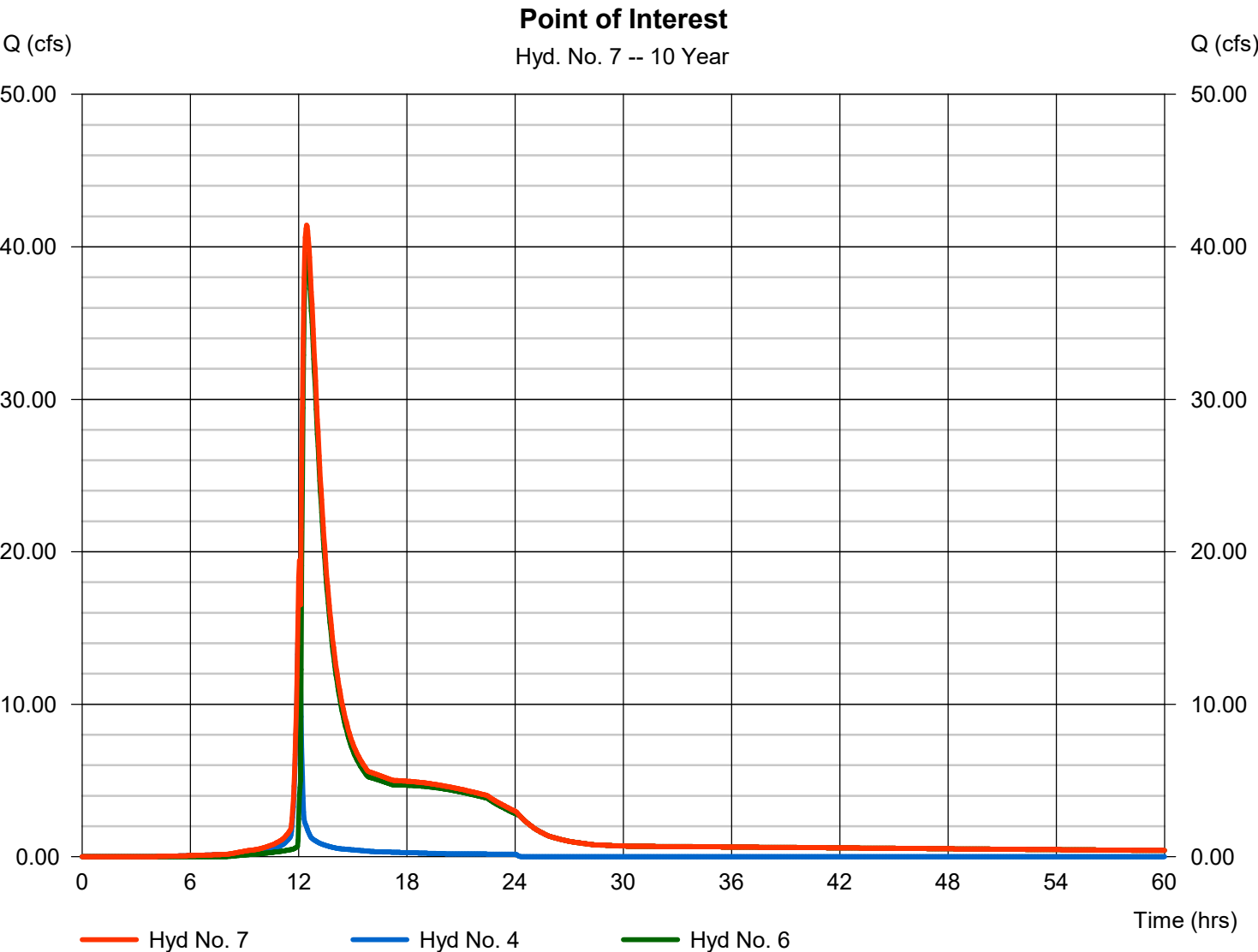


Hydrograph Report

Hyd. No. 7

Point of Interest

Hydrograph type	= Combine	Peak discharge	= 41.42 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 521,304 cuft
Inflow hyds.	= 4, 6	Contrib. drain. area	= 2.730 ac



Hydrograph Report

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

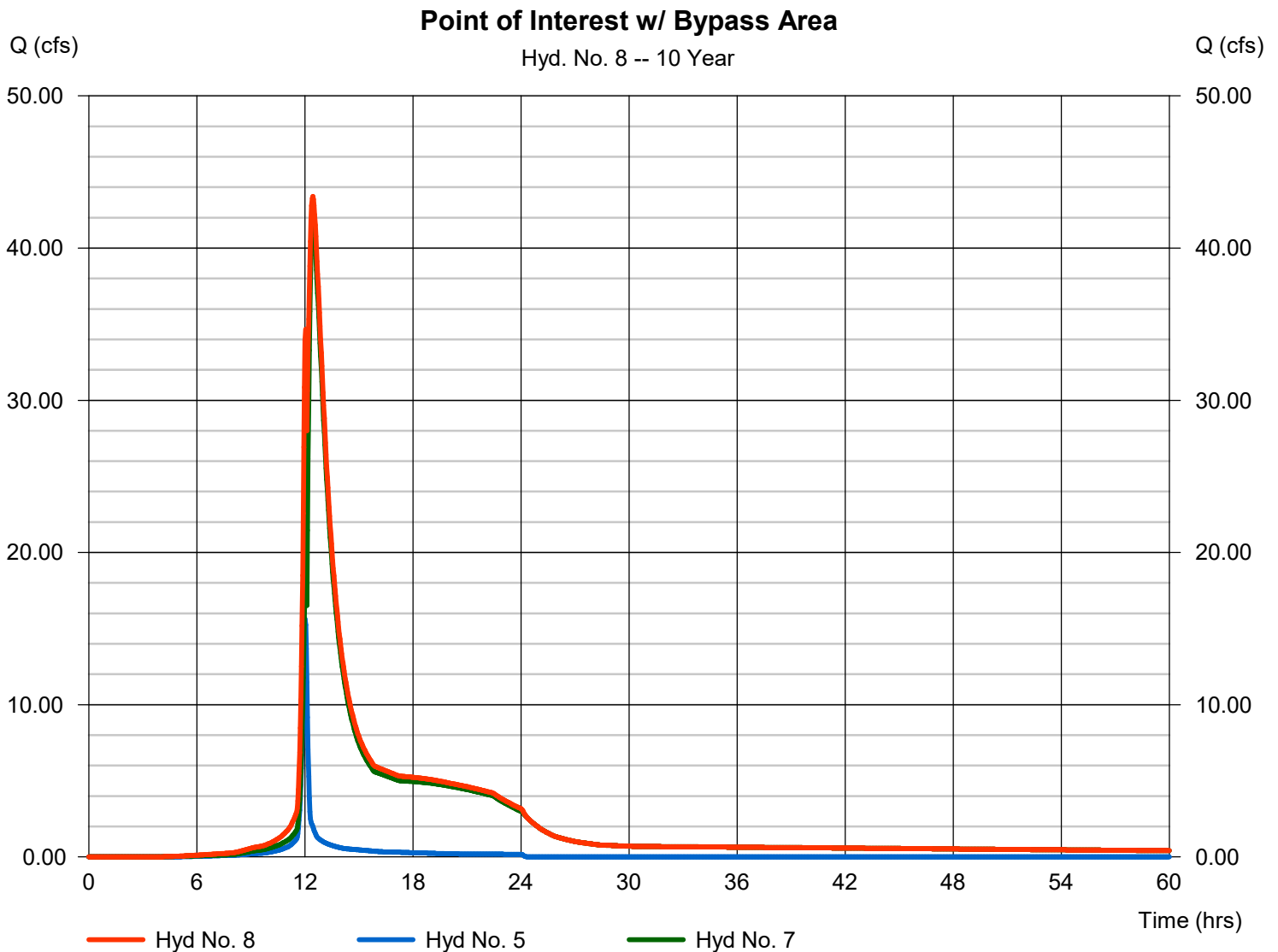
Thursday, 09 / 12 / 2019

Hyd. No. 8

Point of Interest w/ Bypass Area

Hydrograph type = Combine
Storm frequency = 10 yrs
Time interval = 2 min
Inflow hyds. = 5, 7

Peak discharge = 43.39 cfs
Time to peak = 12.43 hrs
Hyd. volume = 562,937 cuft
Contrib. drain. area = 2.860 ac



Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.050	3	717	9,988	-----	-----	-----	Proposed Area A
2	SCS Runoff	222.56	2	726	801,846	-----	-----	-----	Proposed Area B1
3	SCS Runoff	57.55	2	724	186,708	-----	-----	-----	Proposed Area C
4	SCS Runoff	24.59	2	720	68,544	-----	-----	-----	Proposed Area B2
5	SCS Runoff	24.90	2	720	68,010	-----	-----	-----	Bypass Area A
6	Reservoir	92.38	2	742	715,056	2	1017.87	390,342	Detention Pond
7	Combine	95.68	2	742	783,600	4, 6	-----	-----	Point of Interest
8	Combine	99.07	2	742	851,611	5, 7	-----	-----	Point of Interest w/ Bypass Area
Allera_Proposed_Detention.gpw					Return Period: 100 Year			Thursday, 09 / 12 / 2019	

Hydrograph Report

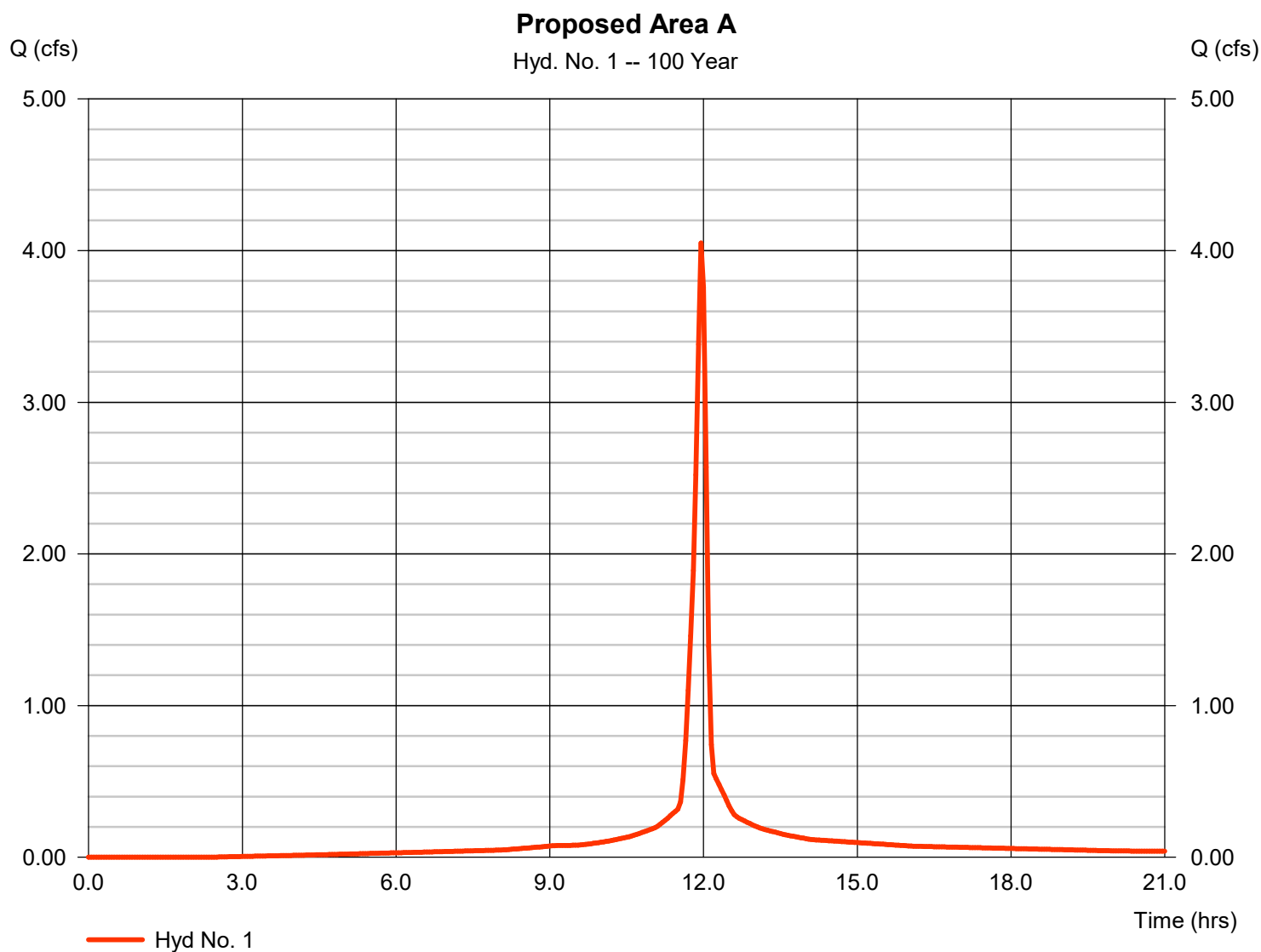
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 1

Proposed Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 4.050 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.95 hrs
Time interval	= 3 min	Hyd. volume	= 9,988 cuft
Drainage area	= 0.430 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 7.60 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

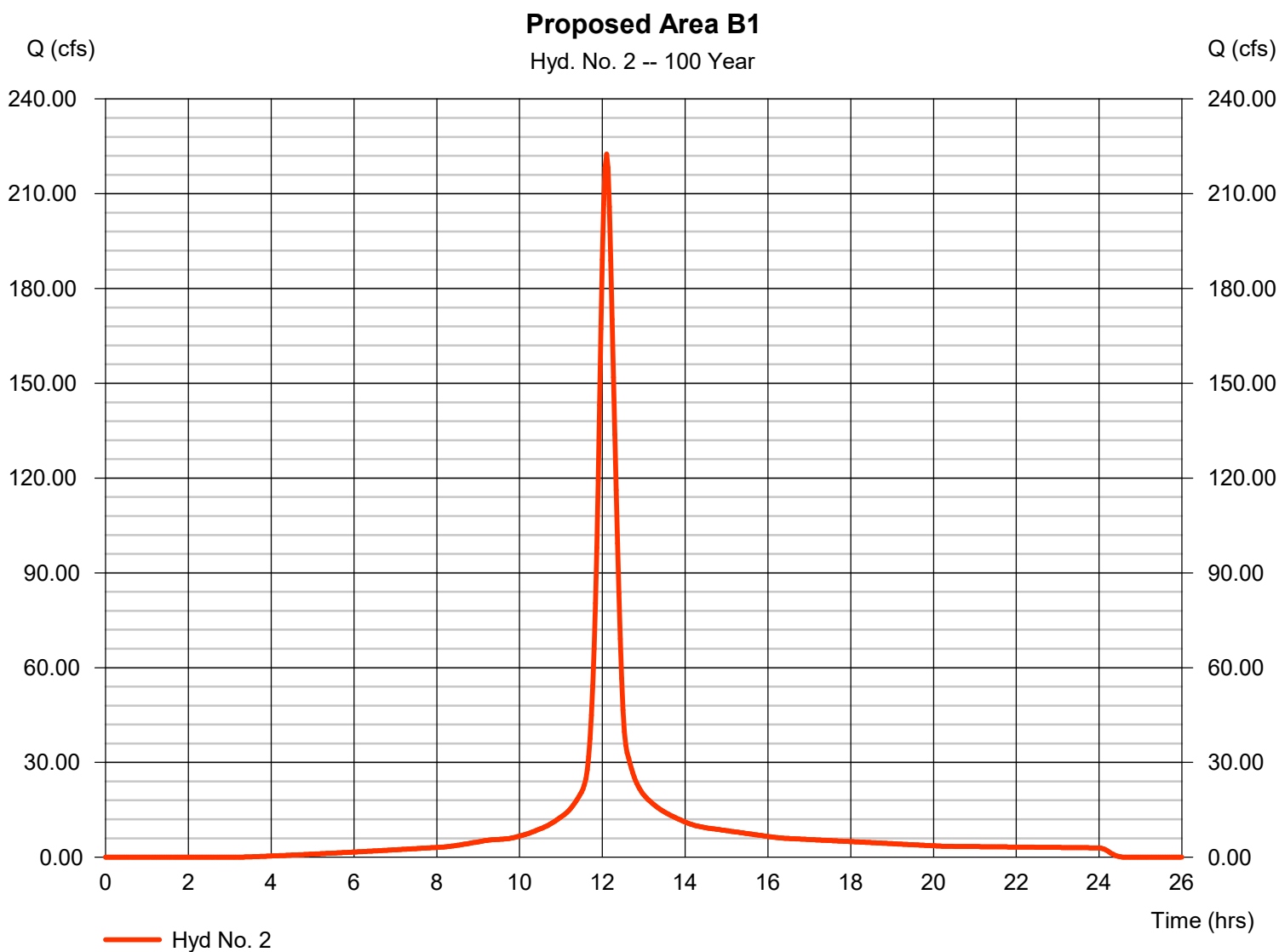
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 2

Proposed Area B1

Hydrograph type	= SCS Runoff	Peak discharge	= 222.56 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 801,846 cuft
Drainage area	= 33.540 ac	Curve number	= 88
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

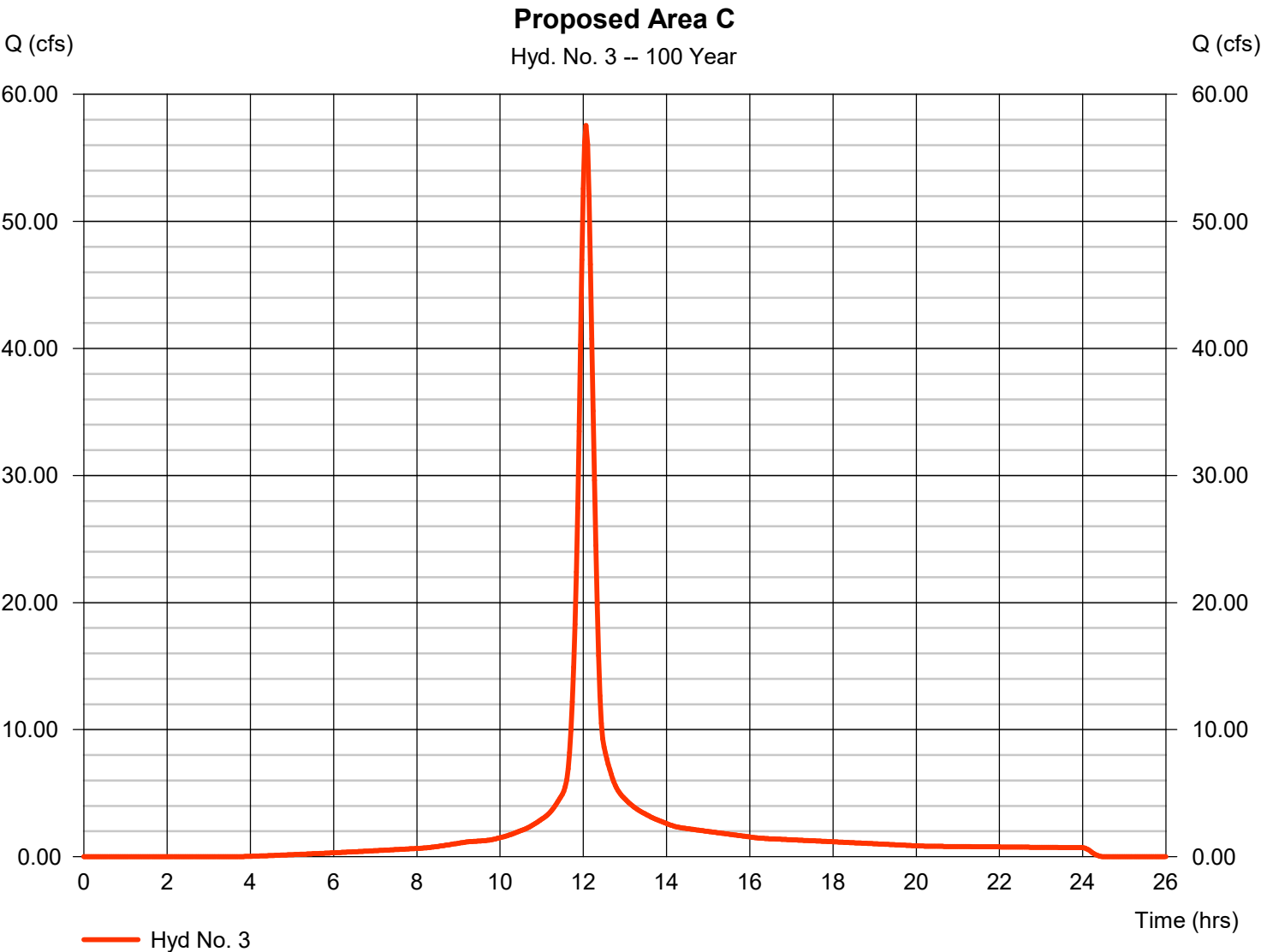


Hydrograph Report

Hyd. No. 3

Proposed Area C

Hydrograph type	= SCS Runoff	Peak discharge	= 57.55 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 186,708 cuft
Drainage area	= 8.250 ac	Curve number	= 86
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.60 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

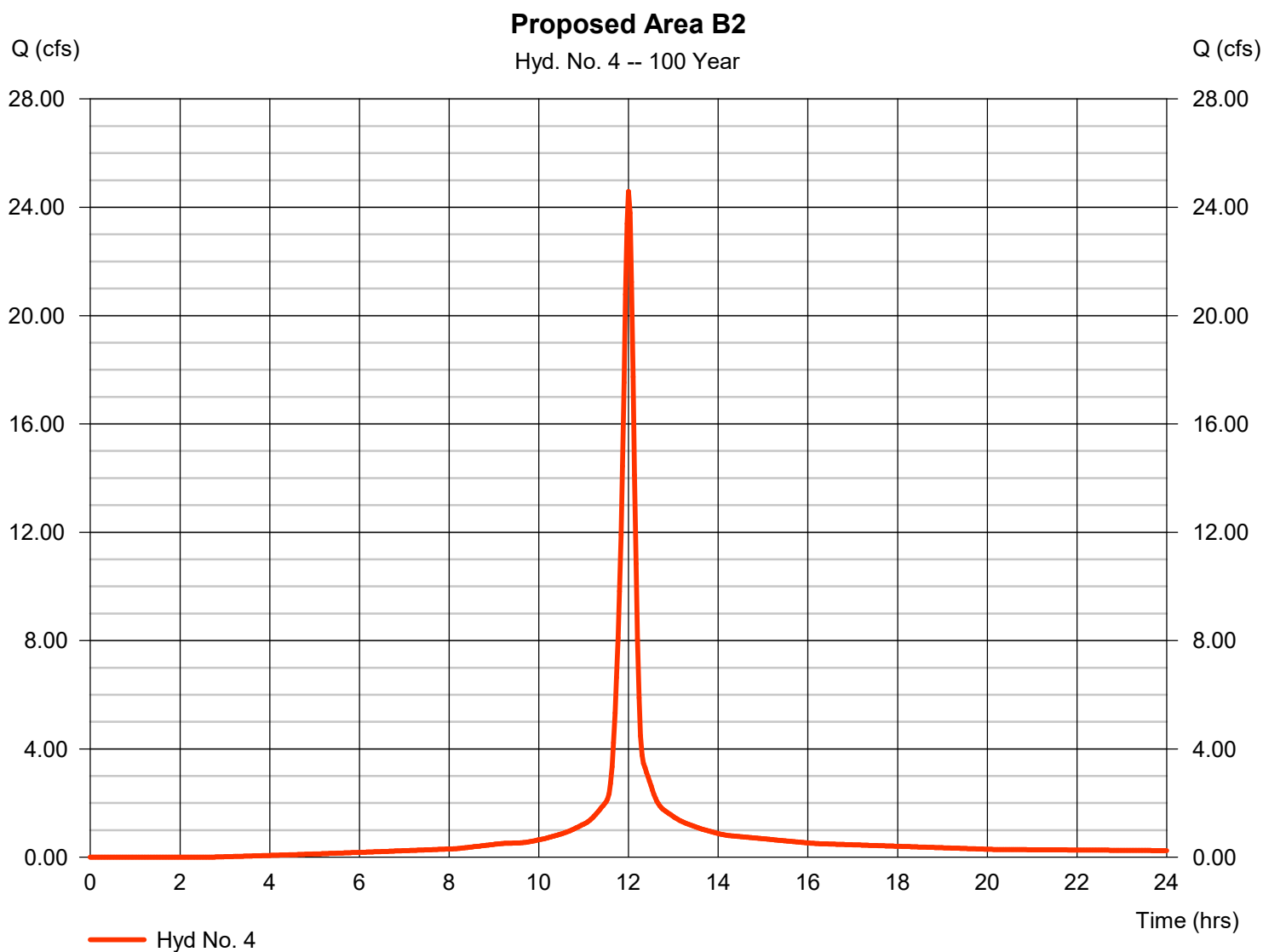
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 4

Proposed Area B2

Hydrograph type	= SCS Runoff	Peak discharge	= 24.59 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 68,544 cuft
Drainage area	= 2.730 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.90 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

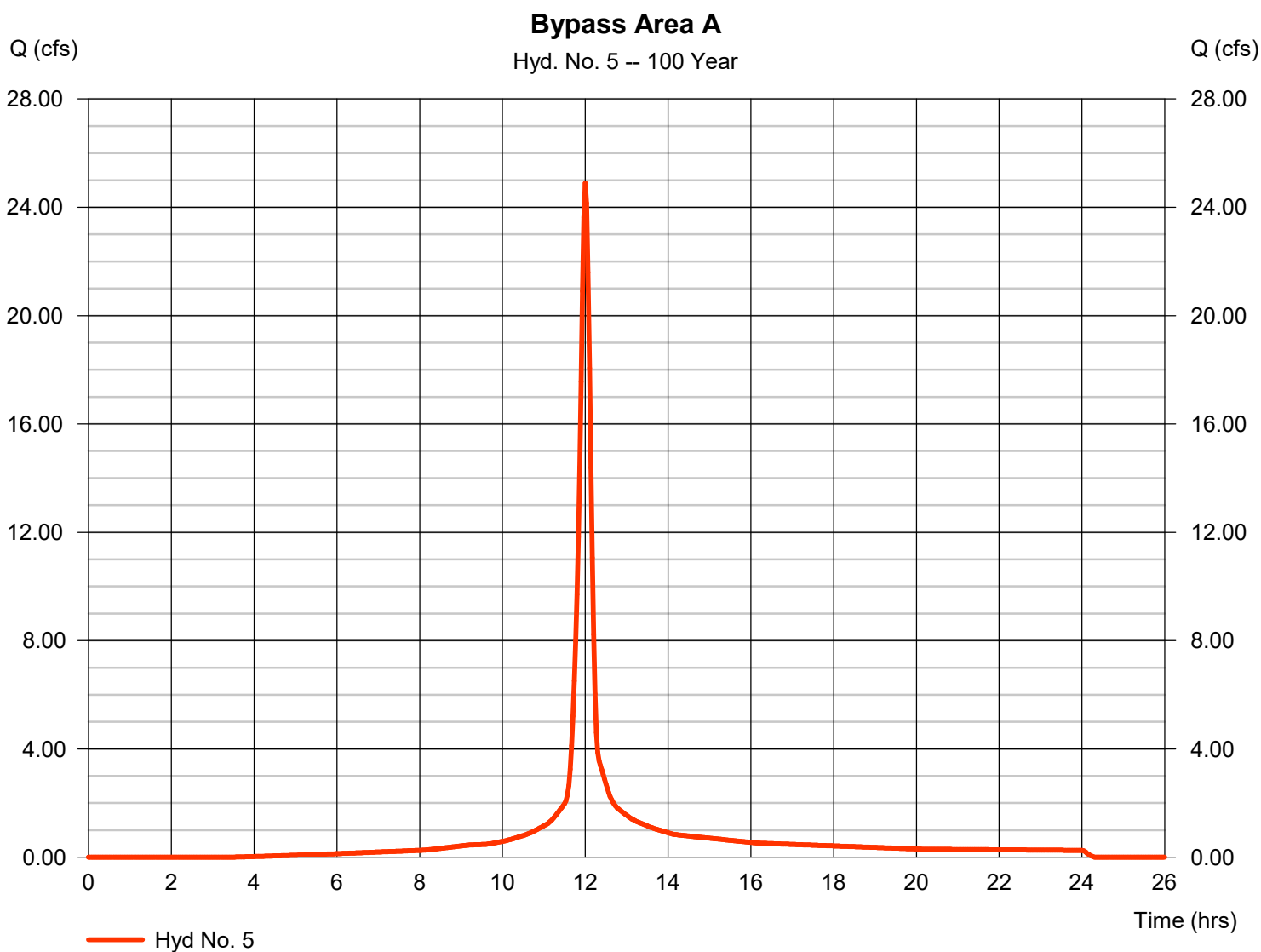
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Thursday, 09 / 12 / 2019

Hyd. No. 5

Bypass Area A

Hydrograph type	= SCS Runoff	Peak discharge	= 24.90 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 68,010 cuft
Drainage area	= 2.860 ac	Curve number	= 87
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.60 min
Total precip.	= 7.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

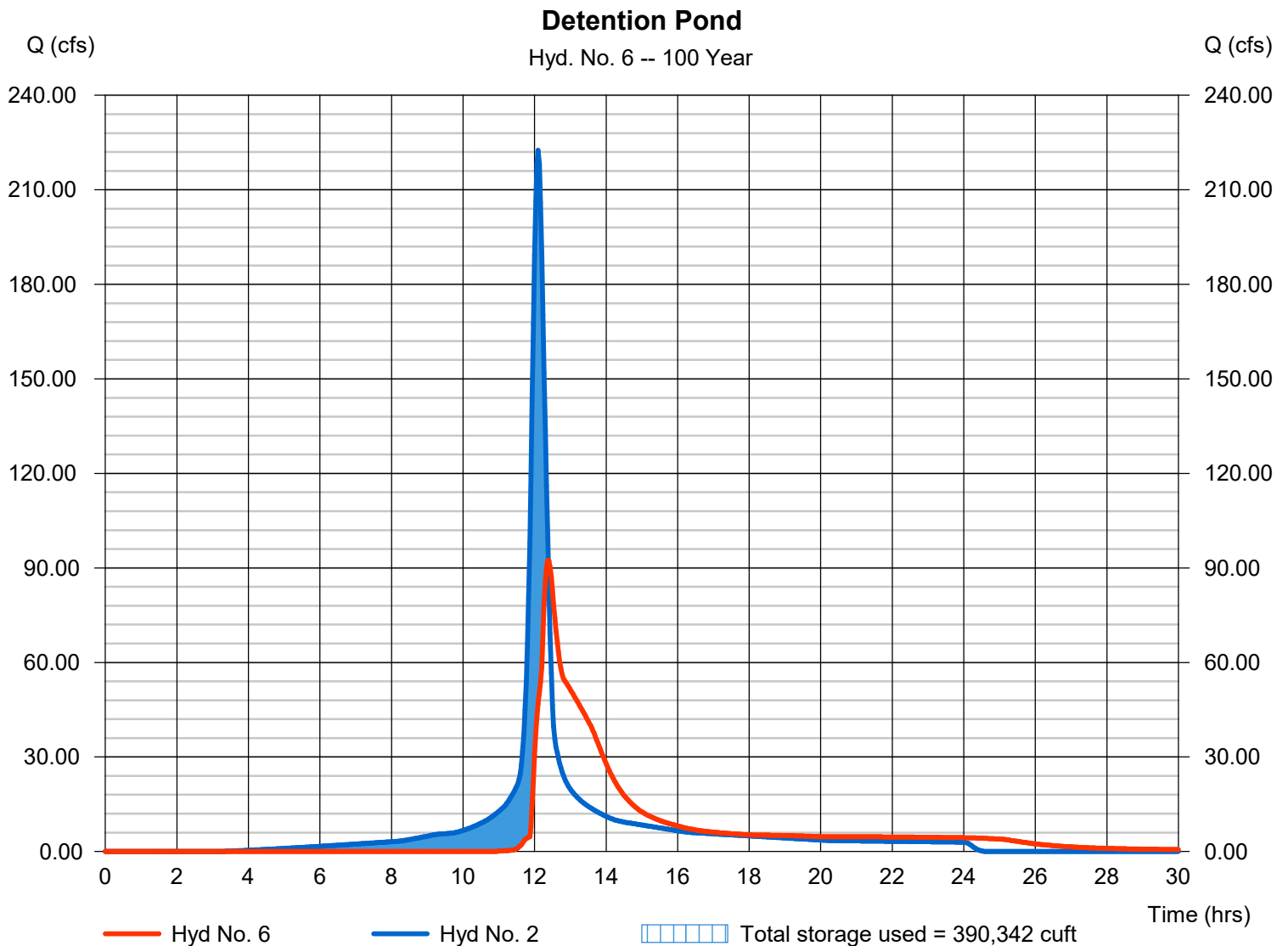
Thursday, 09 / 12 / 2019

Hyd. No. 6

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 92.38 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 715,056 cuft
Inflow hyd. No.	= 2 - Proposed Area B1	Max. Elevation	= 1017.87 ft
Reservoir name	= Detention	Max. Storage	= 390,342 cuft

Storage Indication method used.



Hydrograph Report

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

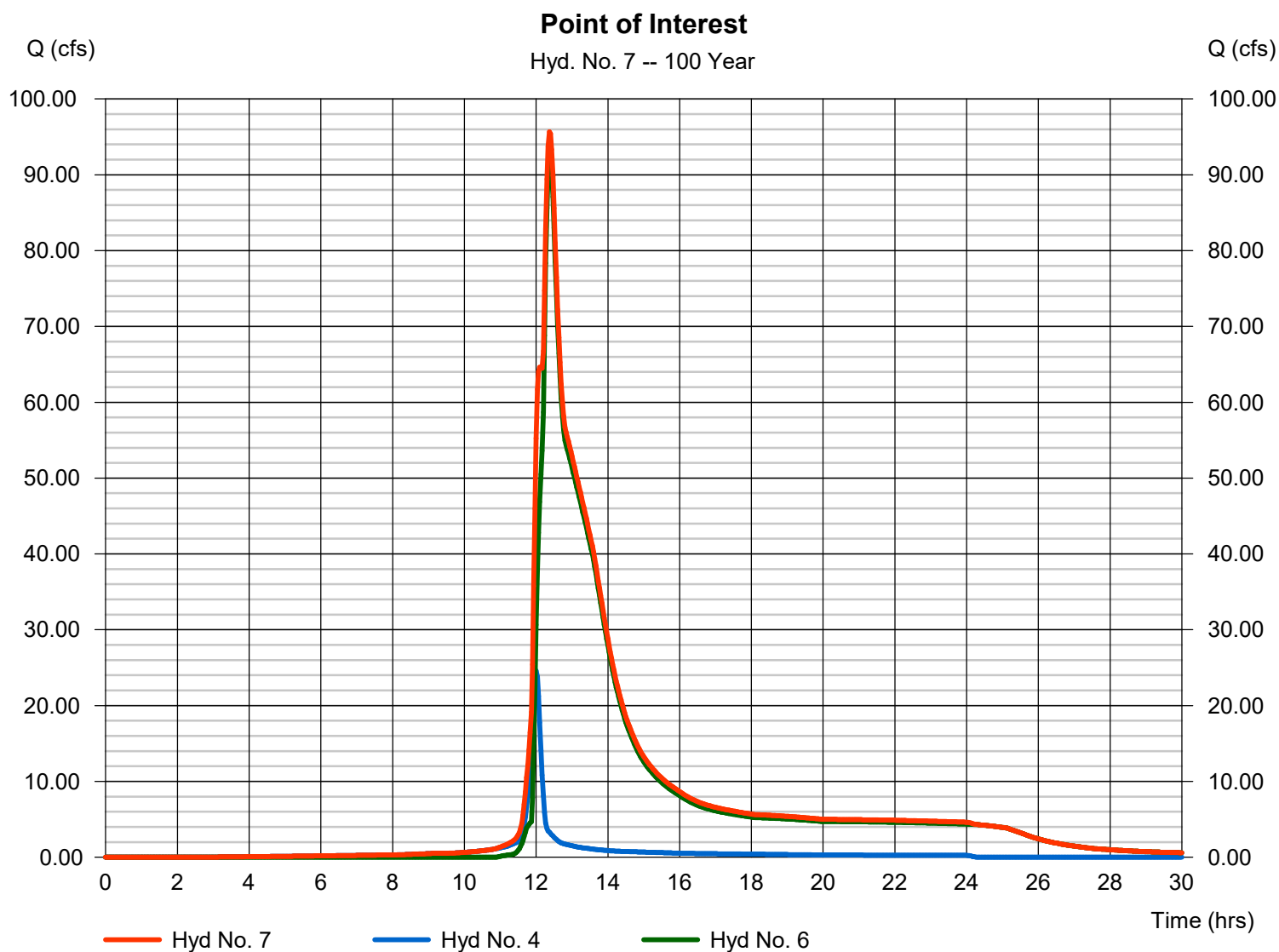
Thursday, 09 / 12 / 2019

Hyd. No. 7

Point of Interest

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 2 min
 Inflow hyds. = 4, 6

Peak discharge = 95.68 cfs
 Time to peak = 12.37 hrs
 Hyd. volume = 783,600 cuft
 Contrib. drain. area = 2.730 ac

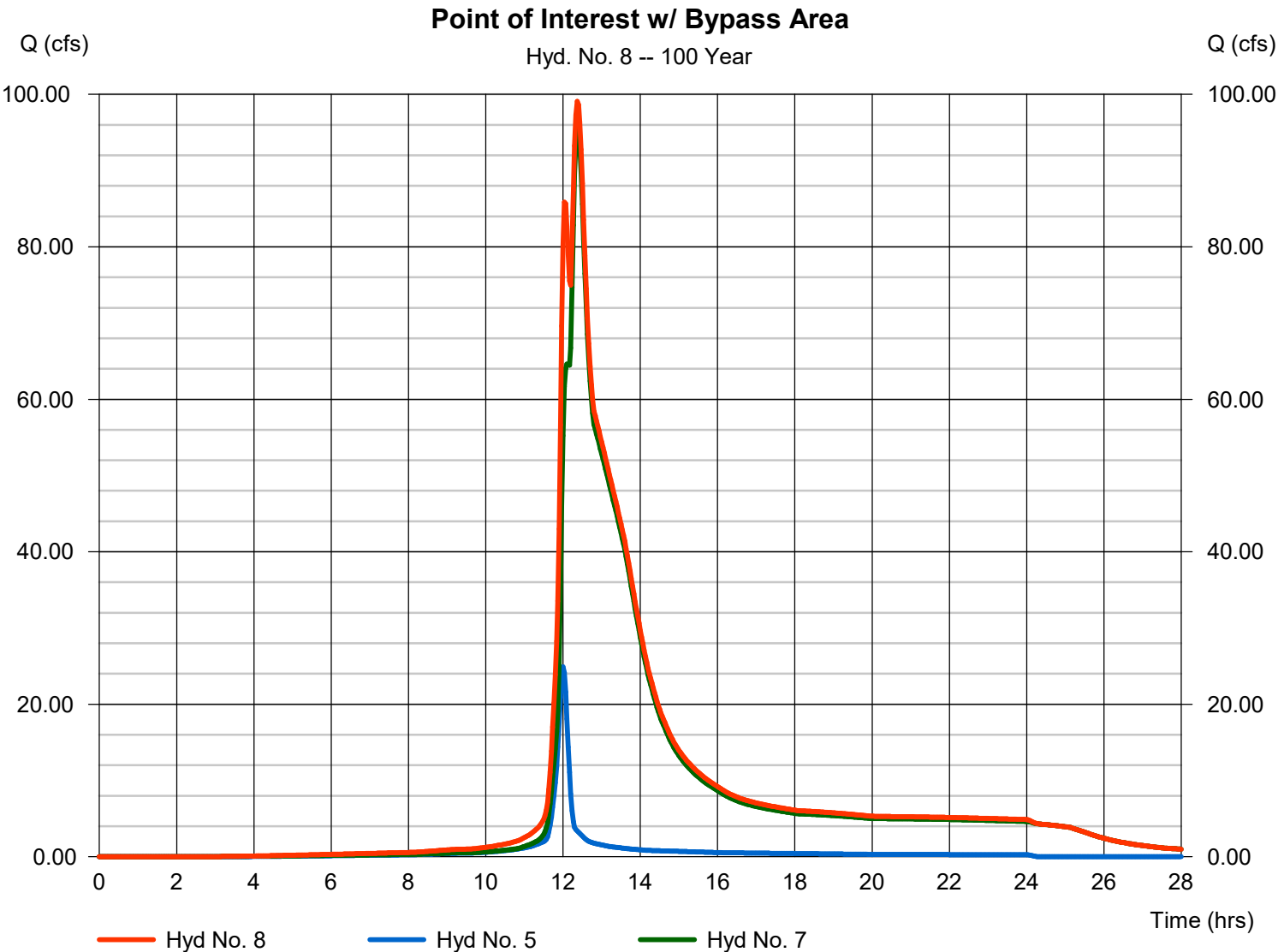


Hydrograph Report

Hyd. No. 8

Point of Interest w/ Bypass Area

Hydrograph type	= Combine	Peak discharge	= 99.07 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 851,611 cuft
Inflow hyds.	= 5, 7	Contrib. drain. area	= 2.860 ac



APPENDIX D

Hy-8 Input and Results

Table 1 - Summary of Culvert Flows at Crossing: Pryor Road

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Pryor Road Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1009.66	2 year Proposed	20.00	20.00	0.00	1
1010.25	10 year Proposed	40.00	40.00	0.00	1
1011.07	2 year Existing	69.00	69.00	0.00	1
1012.16	100 year Proposed	97.00	97.00	0.00	1
1012.47	10 year Existing	120.00	103.50	16.35	9
1012.76	100 year Existing	197.00	109.31	87.43	4
1012.32	Overtopping	100.49	100.49	0.00	Overtopping

Table 2 - Culvert Summary Table: Pryor Road

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year Proposed	20.00	20.00	1009.66	1.253	0.0*	1-S2n	0.778	0.850	0.778	0.565	4.937
10 year Proposed	40.00	40.00	1010.25	1.844	0.851	1-S2n	1.134	1.228	1.134	0.836	5.957
2 year Existing	69.00	69.00	1011.07	2.656	1.911	5-S2n	1.593	1.629	1.593	1.127	6.764
100 year Proposed	97.00	97.00	1012.16	3.747	3.519	7-M2c	2.500	1.934	1.934	1.353	7.936
10 year Existing	120.00	103.50	1012.47	4.055	3.725	7-M2c	2.500	1.994	1.994	1.514	8.220
100 year Existing	197.00	109.31	1012.76	4.348	3.995	7-M2c	2.500	2.044	2.044	1.955	8.481

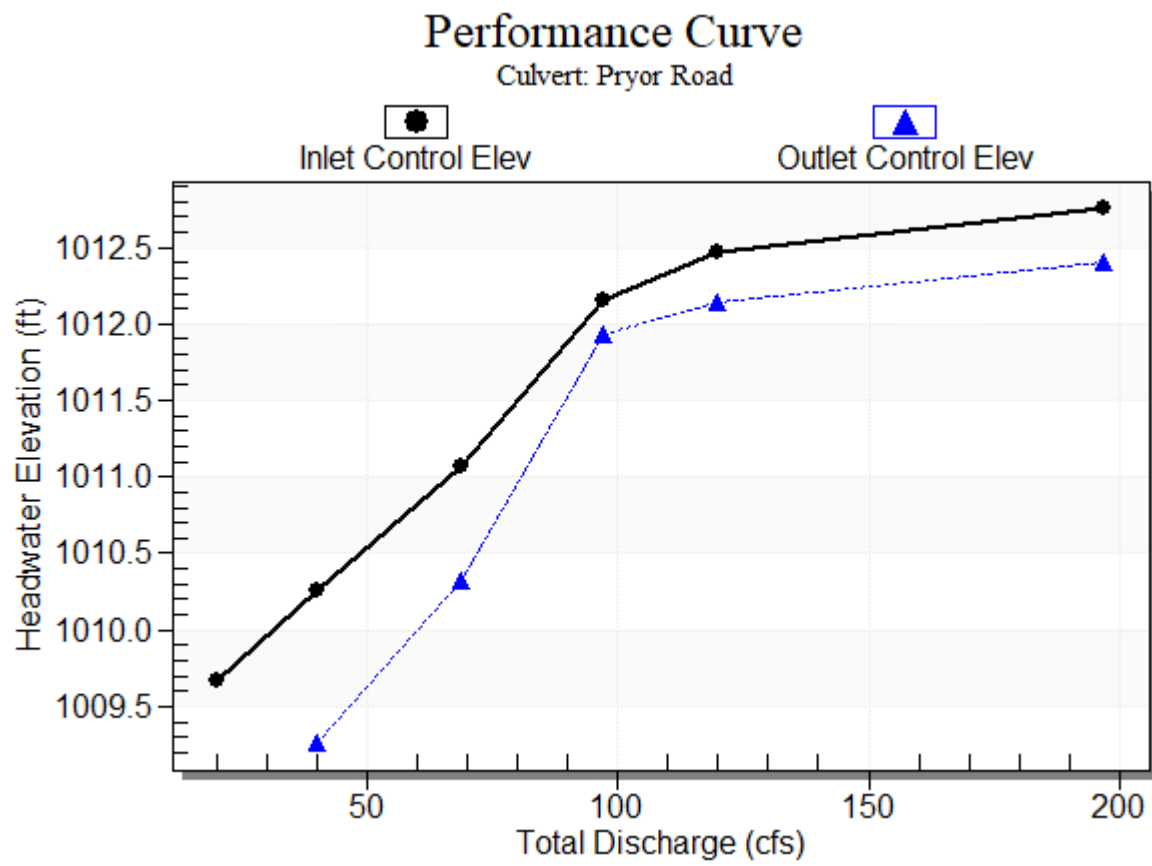
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 1008.41 ft, Outlet Elevation (invert): 1007.70 ft

Culvert Length: 38.71 ft, Culvert Slope: 0.0183

Culvert Performance Curve Plot: Pryor Road



Water Surface Profile Plot for Culvert: Pryor Road

Crossing - Pryor Road, Design Discharge - 197.0 cfs

Culvert - Pryor Road, Culvert Discharge - 109.3 cfs

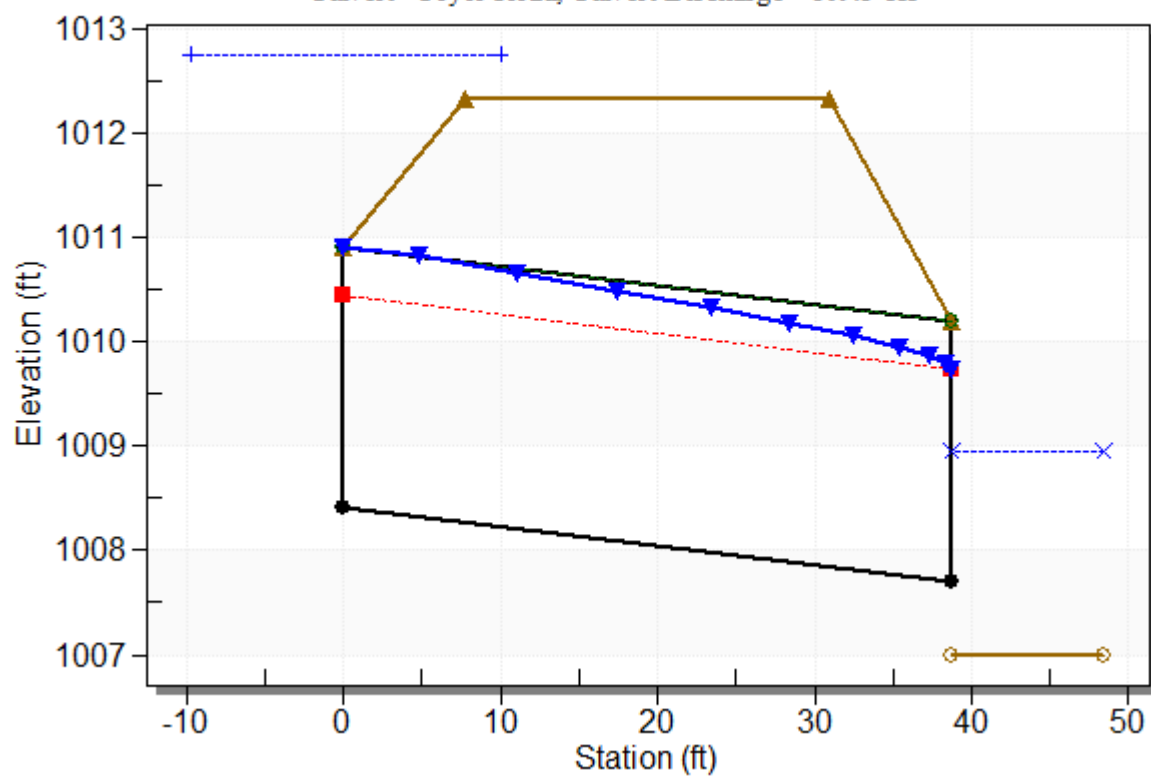


Table 3 - Downstream Channel Rating Curve (Crossing: Pryor Road)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
20.00	1007.57	0.57	3.65	0.71	0.93
40.00	1007.84	0.84	4.56	1.04	0.98
69.00	1008.13	1.13	5.38	1.41	1.02
97.00	1008.35	1.35	5.95	1.69	1.04
120.00	1008.51	1.51	6.32	1.89	1.06
197.00	1008.96	1.96	7.27	2.44	1.09