

STORMWATER REPORT

Firestone Complete Auto Care

3501 SW Market Street
Lee's Summit, MO 64082

Jackson County

Gresham Smith Project # 40831.45

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GENERAL INFORMATION

The proposed Firestone Auto Care store is located on approximately 1.237 acres at 3501 SW Market Street in Lee's Summit, Jackson County, Missouri. The site is currently undeveloped. Existing slopes range from 1 to 5 percent, draining to the northeast (see Appendix A). The proposed development is a one story, 6,262 square foot commercial auto maintenance store with associated parking and utilities. Existing drainage patterns will be preserved in the proposed design, with the addition of a detention pond for stormwater discharge management and quality.

Approximately 49.6% of the proposed site will consist of the building footprint and pavement, and the remaining 50.4% will be grass and landscaped areas. See Figure 1 for a further pre and post development breakdown. The soils onsite consist of 16.6% Arisburg-Urban land complex loam, classified as Hydrologic soil group C and 83.4% Udarents-Urban land-Sampsel complex, classified as Hydrologic soil group C according to the NRCS Web Soil Survey. Runoff coefficients for soil group C were used in the following analysis, see table 1 below. None of the project site is located within a Flood Zone according to FEMA map number 29095C0532G, revised January 20, 2017. The proposed area of disturbance is 1.60 acres.

Table 1: Soil Classification Table (based on NRCS Web Soil Survey)

Soil Classification Name	Slope	Hydrologic Soil Group
Arisburg-Urban land complex (16.6% of site)	1 to 5 percent	C
Udarents-urban land-sampsel complex (83.4% of site)	2 to 5 percent	C

METHODOLOGY:

The general design approach for calculating the storm water runoff at the project location came from the APWA (American Public Works Association) hydrology section 5602 and stormwater detention and retention section 5608. The SCS method was used to calculate the peak flow rates of runoff at two points of interest. The SCS method was also used to develop the baseline unit hydrograph. SCS curve numbers are based on APWA Section 5602.3, as the entirety of the site falls under hydrologic soils C (74 for pervious locations and 98 for impervious areas). Design storm rainfall depths are taken from NOAA's Precipitation Data Server for the 24 hour duration on the 2 year, 10 year and 100 year storm events. There is a water quality element for the detention pond that is designed to store the water and drain it out slowly over a 40 hour period.

EXISTING CONDITIONS ANALYSIS:

The 1.237 acre property and the surrounding locations is currently 100% pervious. From the existing drainage patterns, 2 points of interest can be identified. The first is the storm grate to the North of the site along SW Market Street while the second is where the sheet flow from the site and surrounding location becomes concentrated flow to the east. The following land use areas and curve numbers shown below in figure 1 were developed using the TR-55 data:

Figure 1: Existing Conditions Curve Number Summary Table

Curve Numbers - Soil Group C (POI 1)		
Land Use	Curve Number	Predeveloped Acres
Impervious	98	0.286
Semi-Pervious (Gravel)	88	0.000
Pervious (Open Space)	74	0.421
	Total Area	0.708
Composite Curve Number		84

Curve Numbers - Soil Group C (POI 2)		
Land Use	Curve Number	Predeveloped Acres
Impervious	98	0.000
Semi-Pervious (Gravel)	88	0.000
Pervious (Open Space)	74	2.421
	Total Area	2.421
Composite Curve Number		74

The point of interest's locations, flow paths and drainage areas can be found in Appendix A. The flow path for POI 1, using the TR-55 Tc worksheet available in Autocad Civil 3d's Hydraflow software resulted in a time of concentration of 9.6 minutes for existing conditions. The flow path for POI 2, using the TR-55 Tc worksheet available in Autocad Civil 3d's Hydraflow software resulted in a time of concentration of 9.8 minutes for existing conditions. Using the SCS method of calculating storm runoff to each point of interest, the following flow rates were obtained:

FS SITE	24-HOUR RAINFALL	PRE-DEVELOPED RUNOFF FOR POI 1	PRE-DEVELOPED RUNOFF FOR POI 2
RECURRENCE INTERVAL	(IN.)	(C.F.S.)	(C.F.S.)
2-YEAR STORM	3.68	2.343	5.230
10-YEAR STORM	5.61	4.214	10.990
100-YEAR STORM	9.17	7.681	22.65

Detailed calculations for the existing conditions for points of interest 1 and 2 can be found in Appendix B.

PROPOSED CONDITIONS ANALYSIS:

The proposed site grading reduces the storm peak discharge and volume of runoff from the site through the use of a detention pond and outlet control structure. The pond is located to the east of the proposed building. The pond's exact location and outfall may be seen on Drawing C3.1. The detention pond is 5.60 feet from the lowest pond bottom elevation to the top of berm.

The point of interests storm flows were determined using the method presented in Section 5602.6 of the APWA 5600 Manual. Post-developed conditions are not to exceed pre-developed conditions. A waiver will be requested in-lieu of the APWA requirements that post-developed conditions are not to exceed 3 cfs per acre for the 100 year storm event, 2 cfs per acre for the 10 year storm event or 0.5 cfs per acre for the 2 year storm event. The comprehensive control strategy also includes a water quality element which specifies that a 40 hour extended detention be provided for the 1.37 inch 90% mean annual storm event. For this project, a detention basin is incorporated to achieve the water quality and storm water management requirements. Refer to the Hydraflow calculations provided in Appendix B for detailed stage-storage volumes for the pond.

The water surface elevation needed to achieve the required Water Quality Volume was calculated as 1012.76 from the Hydraflow pond stage-storage graph provided in Appendix D. An elevation of 1012.80 was taken as the bottom of the rectangular weir in the Hydraflow model used for detention calculations to ensure that the water quality volume is met.

The outlet of the detention pond will be a precast concrete control structure with a rectangular weir set above the water quality volume storage elevation calculated. See sheet C903 for details of the outlet structure and underdrain connection.

The detention pond's emergency spillway was designed using a 100% clogged scenario against the 1% storm event. When all orifices and pre-cast concrete structure riser are unable to convey water, the emergency spillway must be set where the 1% storm WSE maintains and 1 foot freeboard from the top of the dam. This is achieved by setting the top of the pond berm to an elevation of 1016.35 and the bottom of the emergency spillway to an elevation of 1015.20. This will calculation a 1% WSE of 1015.35 (1 foot below the top of berm). The detailed calculations can be found in Appendix B, while a detail of the detention overflow spillway can be found on sheet C903. A 50' wide emergency overflow spillway was designed to achieve the requirements stated above.

Figure 2 shows the detailed breakdown of land use types used in calculating the curve numbers, using a Hydrologic Soil Group C.

Figure 1: Proposed Condition Curve Number Summary Table

Curve Numbers - Soil Group C (POI 1)		
Land Use	Curve Number	Post Developed Acres
Impervious	98	0.353
Semi-Pervious (Gravel)	88	0.000
Pervious (Open Space)	74	0.176
	Total Area	0.529
Composite Curve Number		90

Curve Numbers - Soil Group C (POI 2)		
Land Use	Curve Number	To Pond Acres
Impervious	98	0.581
Semi-Pervious (Gravel)	88	0.000
Pervious (Open Space)	74	0.439
	Total Area	1.020
Composite Curve Number		88

Curve Numbers - Soil Group C (POI 2)		
Land Use	Curve Number	Remainder of Post Developed Acres
Impervious	98	0.439
Semi-Pervious (Gravel)	88	0.000
Pervious (Open Space)	74	2.221
	Total Area	2.660
Composite Curve Number		78

Figure 3: Stormwater Discharge Summary Table

FS SITE	24-HOUR RAINFALL	POST- DEVELOPED RUNOFF FOR POI 1	POST- DEVELOPED RUNOFF FOR POI 2	POND WATER SURFACE ELEVATION	POND STORAGE VOLUME	FREE BOARD
RECURRENCE INTERVAL	(IN.)	(C.F.S.)	(C.F.S.)	(FT.)	(CU. FT.)	(FT.)
2-YEAR STORM	3.68	2.248	3.750	1013.08	4,150	3.27
10-YEAR STORM	5.61	3.714	10.230	1013.73	6,387	2.62
100-YEAR STORM	9.17	6.376	21.19	1014.55	9,663	1.80
	Top of berm	1016.35				

Stormwater quality is achieved through the use of an extended dry detention pond. The detention pond will provide temporary storage of stormwater runoff allowing settlement of suspended solids over a period of 40 hours. The reduction in flow from the pre-developed to post-developed conditions will correlate to a water quality improvement for the site and allow for TSS removal. Water Quality Volume required by the city of Lee's Summit is found by the equation below, given in Section 5600 of the Comprehensive Control Strategy Design and Construction Manual.

$$WQv = 1.37 * 0.05 + 0.009(\text{Percent site imperviousness})$$

The percent site imperviousness will be 56.4%, yielding a required Water Quality Volume of 2,828 cubic feet. Adding in an additional 20%, a water quality volume of 3,394.15 cubic feet was used for design of this site.

An Extended Dry Detention Basin will be used to achieve the water quality requirement. A 4" perforated PVC riser will connect to the structure. The end of the PVC riser will be capped and a 1" water quality orifice drilled in the end cap and will dewater the pond in approximately 40 hours. The depth of water quality volume was found to be 2.01' (elevation = 1010.75) using the stage-storage table from Hydraflow as shown in Appendix D.

CONCLUSIONS AND RECOMMENDATIONS:

Post development drainage patterns will match the existing conditions drainage pattern. The development of a Firestone Complete Auto Care store is proposed on an existing tract on 100% impervious land. This site will be 56.4% impervious. The majority of the 1.237 acre site will be routed through an extended dry detention pond utilizing a water quality and flow release element, as specified in Lee's Summit Design and Construction Manual (DCM). Two (2) points of interests were used in analysis of comparing pre-construction conditions versus post-construction conditions for the entire site and surround areas. Detailed drainage areas and calculations can be found in Appendix A and B, respectively. The following table summarizes the existing and proposed conditions:

FS SITE	24-HOUR RAINFALL	PRE- DEVELOPE D RUNOFF FOR POI 1	POST- DEVELOPED RUNOFF FOR POI 1	PRE- DEVELOPED RUNOFF FOR POI 2	POST- DEVELOPED RUNOFF FOR POI 2	POND WATER SURFACE ELEVATION	POND STORAGE VOLUME	FREE BOARD
RECURRENCE INTERVAL	(IN.)	(C.F.S.)	(C.F.S.)	(C.F.S.)	(C.F.S.)	(FT.)	(CU. FT.)	(FT.)
2-YEAR STORM	3.68	2.34	2.248	5.23	3.750	1013.08	4,150	3.27
10-YEAR STORM	5.61	4.21	3.714	10.99	10.230	1013.73	6,387	2.62
100-YEAR STORM	9.17	7.68	6.376	22.65	21.19	1014.55	9,663	1.80
	Top of berm		1016.35					

In accordance with the Lee's Summit Design and Construction Manual (DCM) Section 1002.A, the proposed Firestone site will apply for a modification to the following specification:

Perimeter drainage issue which will include specific citations of the Design and Construction Manual related to the peak discharge requirements, as well as supporting documentation, in particular a comparison between pre-development versus post-development peak flow rates for the peripheral areas.

APPENDIX A

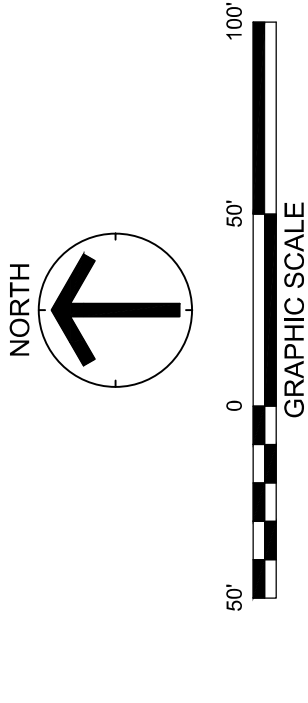
Drainage Area Maps

EXISTING CONDITIONS ANALYSIS (POI 1):

DRAINAGE STUDY AREA = 0.708 ACRES
IMPERVIOUS AREA (CN = 98) = 0.286 ACRES
PERVIOUS AREA, OPEN SPACE (CN = 74) = 0.421 ACRES
COMPOSITE CURVE NUMBER, CN = 84
TIME OF CONCENTRATION = 9.60 MINUTES
PEAK RUNOFF (100 YEAR STORM) = 7.68 CFS

EXISTING CONDITIONS ANALYSIS (POI 2):

DRAINAGE STUDY AREA = 2.421 ACRES
IMPERVIOUS AREA (CN = 98) = 0.000 ACRES
PERVIOUS AREA, OPEN SPACE (CN = 74) = 2.421 ACRES
COMPOSITE CURVE NUMBER, CN = 74
TIME OF CONCENTRATION = 9.8 MINUTES
PEAK RUNOFF (100 YEAR STORM) = 22.65 CFS



POI 1 TIME OF CONCENTRATION FLOW PATH
Tc = 9.60 MINUTES

POI 2 TIME OF CONCENTRATION FLOW PATH
Tc = 9.80 MINUTES

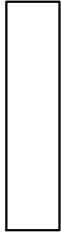
POI 1 PROJECT AREA IN EXISTING CONDITONS

POI 2 PROJECT AREA IN EXISTING CONDITONS

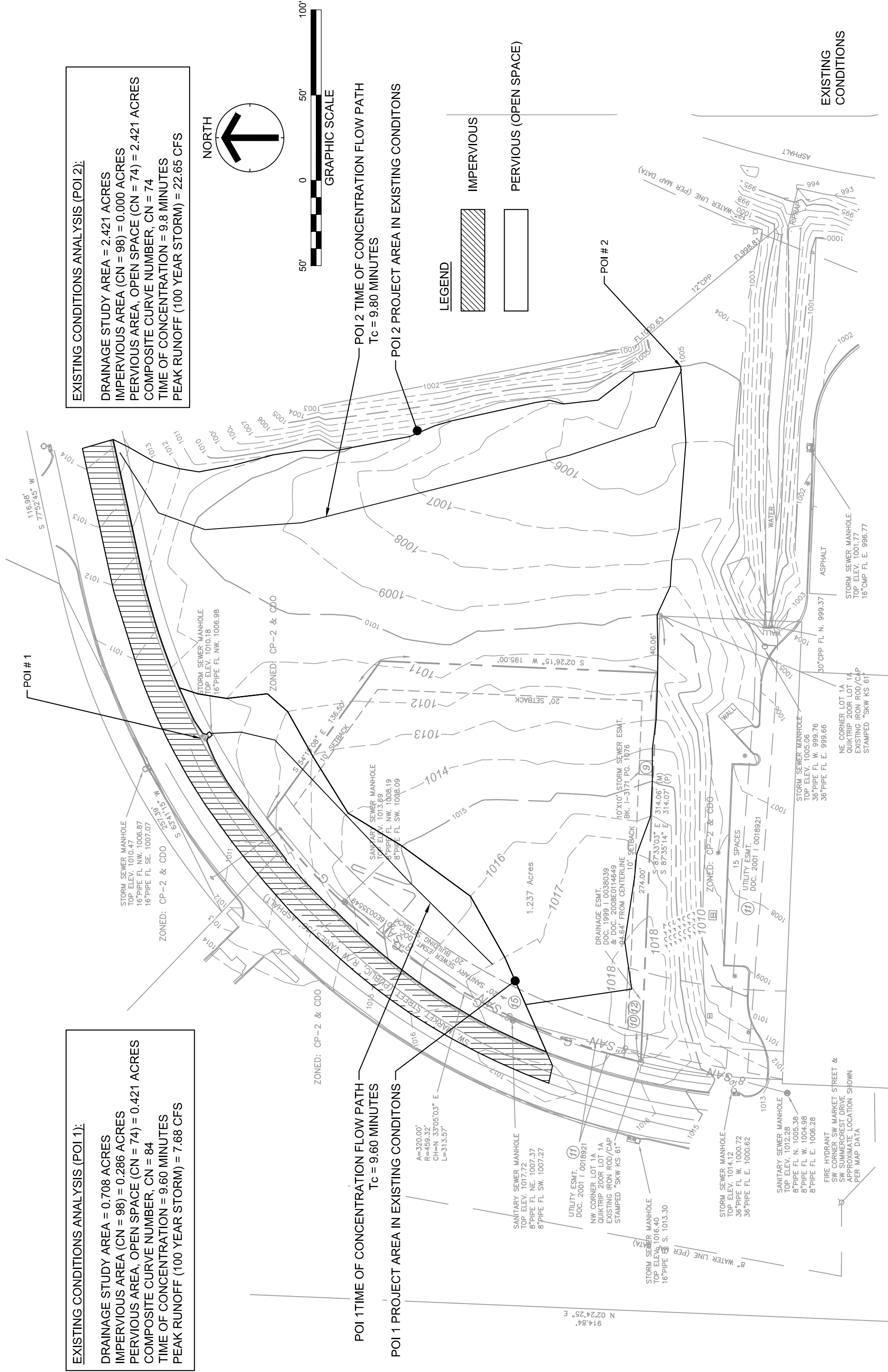
LEGEND



IMPERVIOUS



PERVIOUS (OPEN SPACE)



EXISTING
CONDITIONS

PROPOSED CONDITIONS ANALYSIS (POI 1):

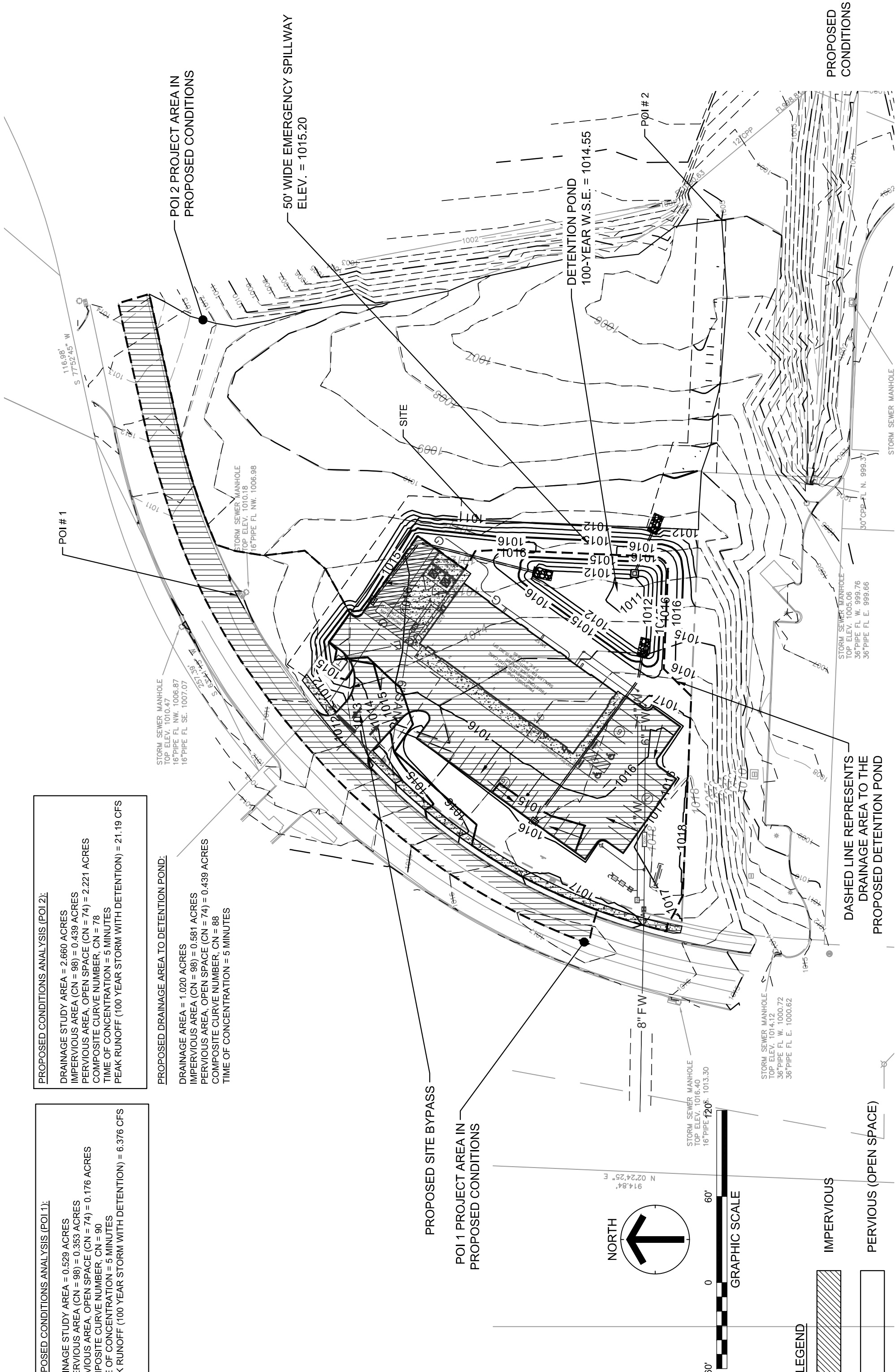
DRAINAGE STUDY AREA = 0.529 ACRES
IMPERVIOUS AREA (CN = 98) = 0.353 ACRES
PERVIOUS AREA, OPEN SPACE (CN = 74) = 0.176 ACRES
COMPOSITE CURVE NUMBER, CN = 90
TIME OF CONCENTRATION = 5 MINUTES
PEAK RUNOFF (100 YEAR STORM WITH DETENTION) = 6.376 CFS

PROPOSED CONDITIONS ANALYSIS (POI 2):

DRAINAGE STUDY AREA = 2.660 ACRES
IMPERVIOUS AREA (CN = 98) = 0.439 ACRES
PERVIOUS AREA, OPEN SPACE (CN = 74) = 2.221 ACRES
COMPOSITE CURVE NUMBER, CN = 78
TIME OF CONCENTRATION = 5 MINUTES
PEAK RUNOFF (100 YEAR STORM WITH DETENTION) = 21.19 CFS

PROPOSED DRAINAGE AREA TO DETENTION POND:

DRAINAGE AREA = 1.020 ACRES
IMPERVIOUS AREA (CN = 98) = 0.581 ACRES
PERVIOUS AREA, OPEN SPACE (CN = 74) = 0.439 ACRES
COMPOSITE CURVE NUMBER, CN = 88
TIME OF CONCENTRATION = 5 MINUTES



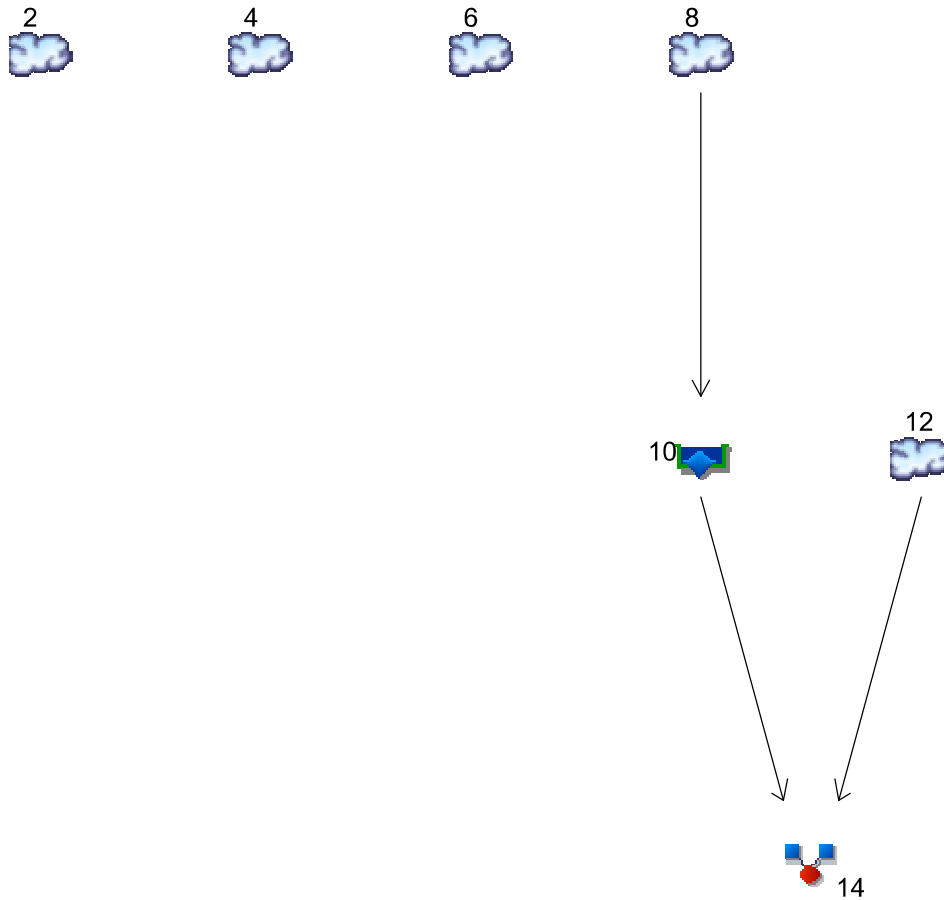
APPENDIX B

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Watershed Model Schematic

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



Legend

Hyd.	Origin	Description
2	SCS Runoff	Existing to POI 1
4	SCS Runoff	Proposed to POI 1
6	SCS Runoff	Existing to POI 2
8	SCS Runoff	Prop to Detention Pond
10	Reservoir	Detention Pond
12	SCS Runoff	Remainder Prop to POI 2
14	Combine	Total to POI 2

Hydrograph Return Period Recap

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

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	
2	SCS Runoff	-----	-----	2.343	-----	-----	4.214	-----	-----	7.681	Existing to POI 1
4	SCS Runoff	-----	-----	2.248	-----	-----	3.714	-----	-----	6.376	Proposed to POI 1
6	SCS Runoff	-----	-----	5.230	-----	-----	10.99	-----	-----	22.65	Existing to POI 2
8	SCS Runoff	-----	-----	4.086	-----	-----	6.926	-----	-----	12.10	Prop to Detention Pond
10	Reservoir	8	-----	0.533	-----	-----	3.052	-----	-----	6.206	Detention Pond
12	SCS Runoff	-----	-----	3.543	-----	-----	7.442	-----	-----	15.34	Remainder Prop to POI 2
14	Combine	10, 12,	-----	3.750	-----	-----	10.23	-----	-----	21.19	Total to POI 2
Proj. file: Lee's Summit - Existing Conditions Analysis.gpw										Friday, 02 / 7 / 2020	

Hydrograph Summary Report

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

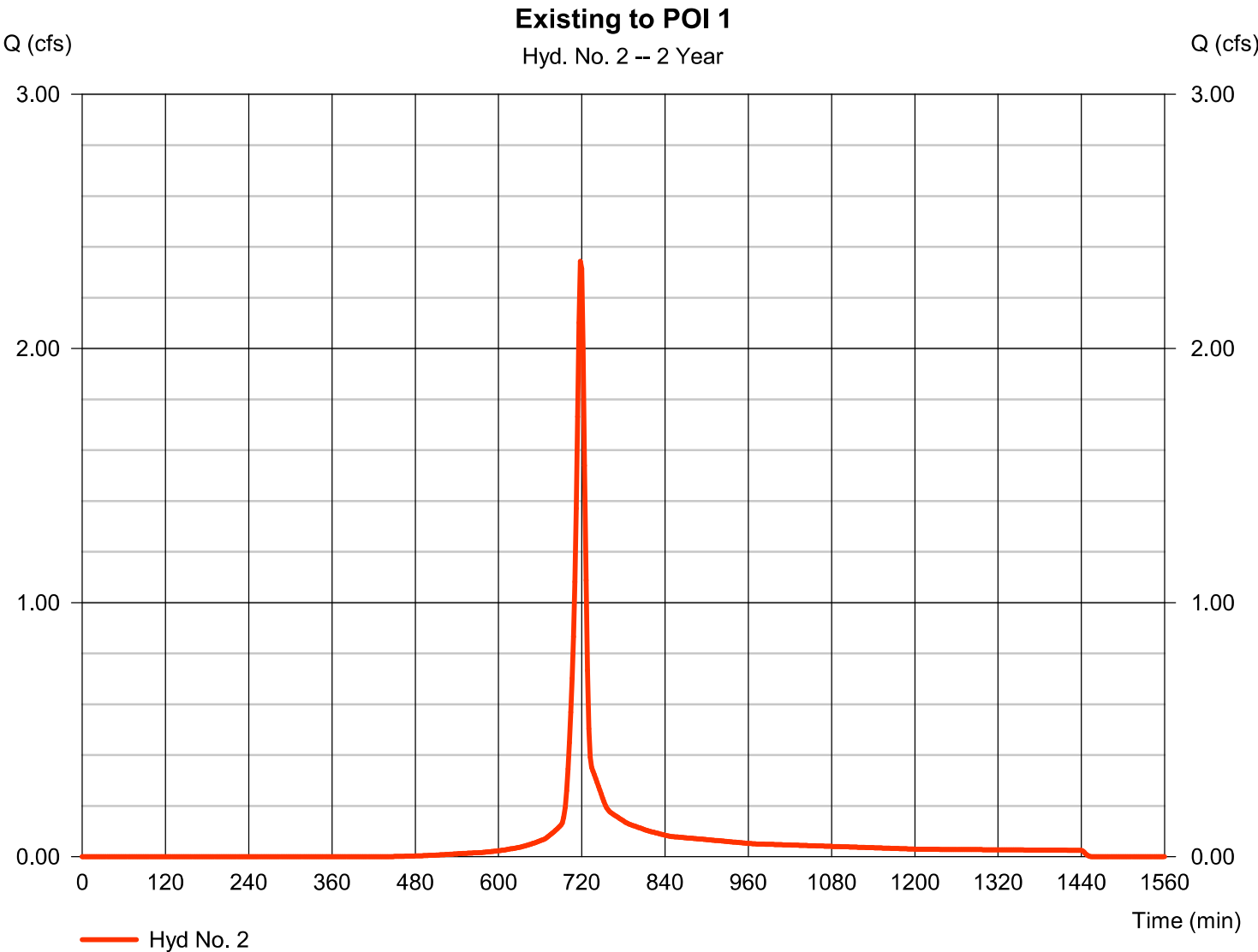
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
2	SCS Runoff	2.343	2	718	5,375	-----	-----	-----	Existing to POI 1
4	SCS Runoff	2.248	2	716	4,711	-----	-----	-----	Proposed to POI 1
6	SCS Runoff	5.230	2	720	12,002	-----	-----	-----	Existing to POI 2
8	SCS Runoff	4.086	2	716	8,447	-----	-----	-----	Prop to Detention Pond
10	Reservoir	0.533	2	728	5,959	8	1013.08	4,150	Detention Pond
12	SCS Runoff	3.543	2	720	8,130	-----	-----	-----	Remainder Prop to POI 2
14	Combine	3.750	2	720	14,089	10, 12,	-----	-----	Total to POI 2
Lee's Summit - Existing Conditions Analysis.gpr					Return Period: 2 Year			Friday, 02 / 7 / 2020	

Hydrograph Report

Hyd. No. 2

Existing to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.343 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 5,375 cuft
Drainage area	= 0.708 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 9.60 min
Total precip.	= 3.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

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

Hyd. No. 2

Existing to POI 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 3.68	0.00	0.00				
Land slope (%)	= 2.24	0.00	0.00				
Travel Time (min)	= 8.73	+	0.00	+	0.00	=	8.73
Shallow Concentrated Flow							
Flow length (ft)	= 100.00	0.00	0.00				
Watercourse slope (%)	= 1.50	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=1.98	0.00	0.00				
Travel Time (min)	= 0.84	+	0.00	+	0.00	=	0.84
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	((0})0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				9.60 min			

Hydrograph Report

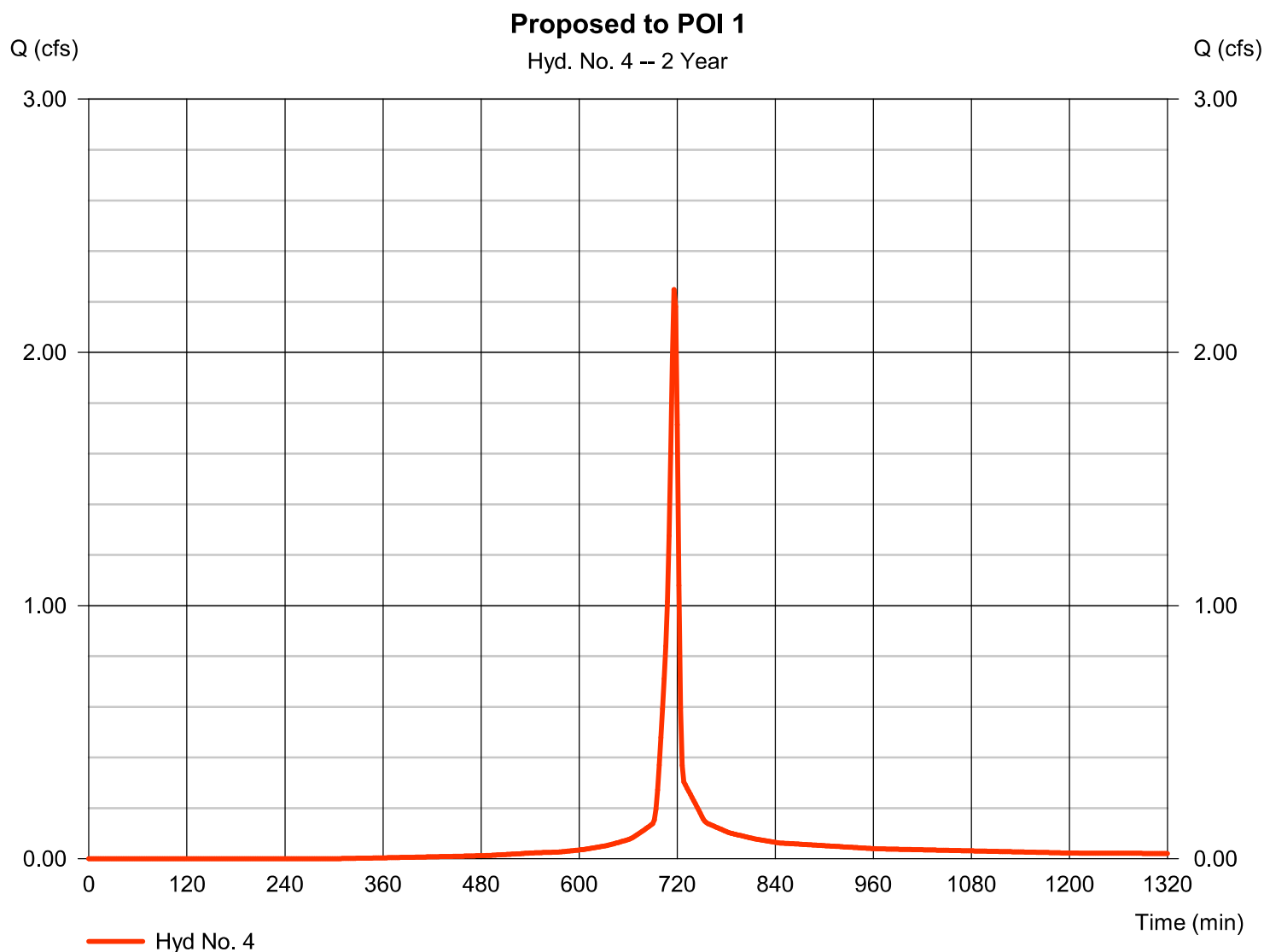
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 4

Proposed to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.248 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,711 cuft
Drainage area	= 0.529 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

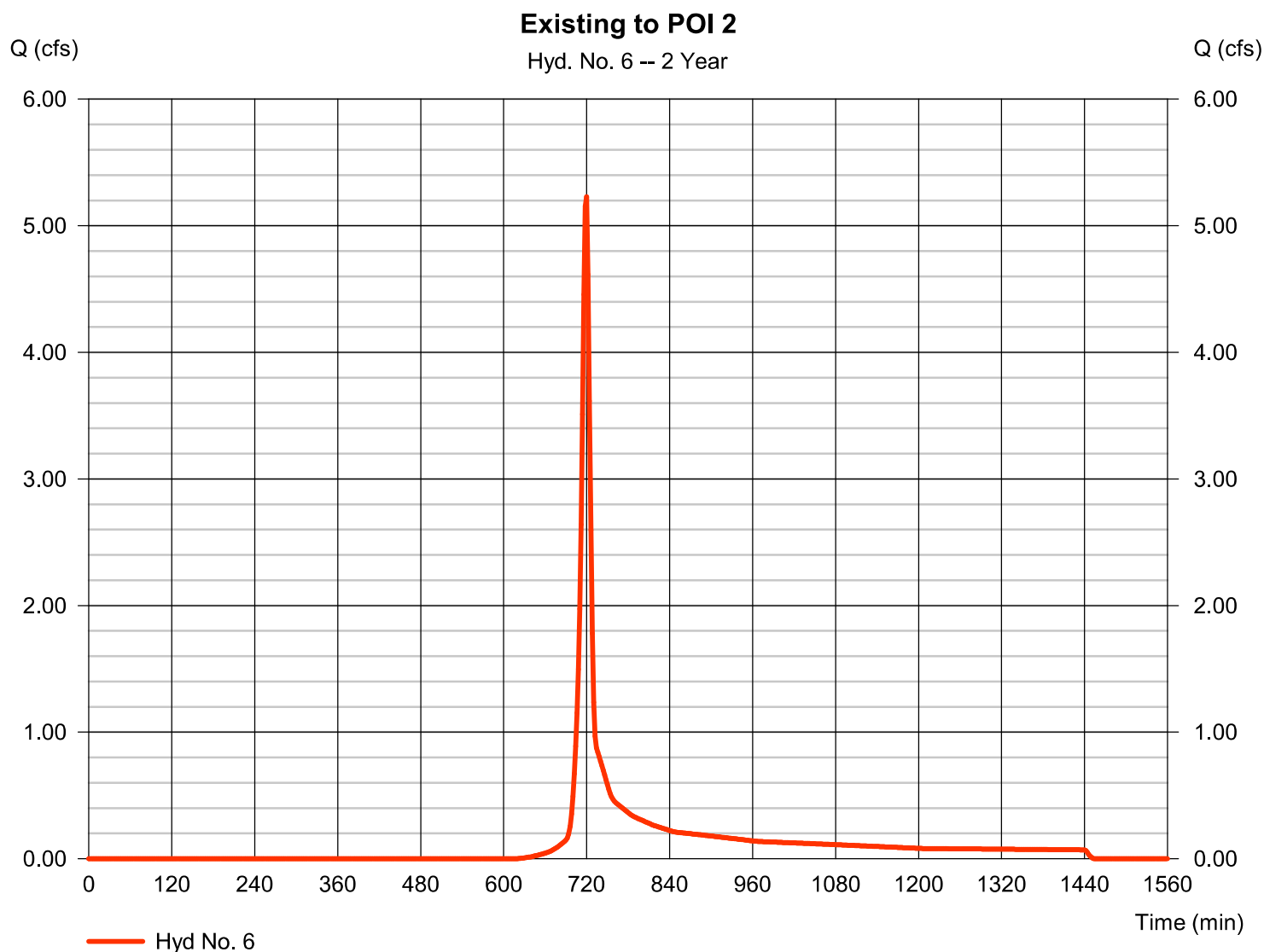
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Friday, 02 / 7 / 2020

Hyd. No. 6

Existing to POI 2

Hydrograph type	= SCS Runoff	Peak discharge	= 5.230 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 12,002 cuft
Drainage area	= 2.421 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.80 min
Total precip.	= 3.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

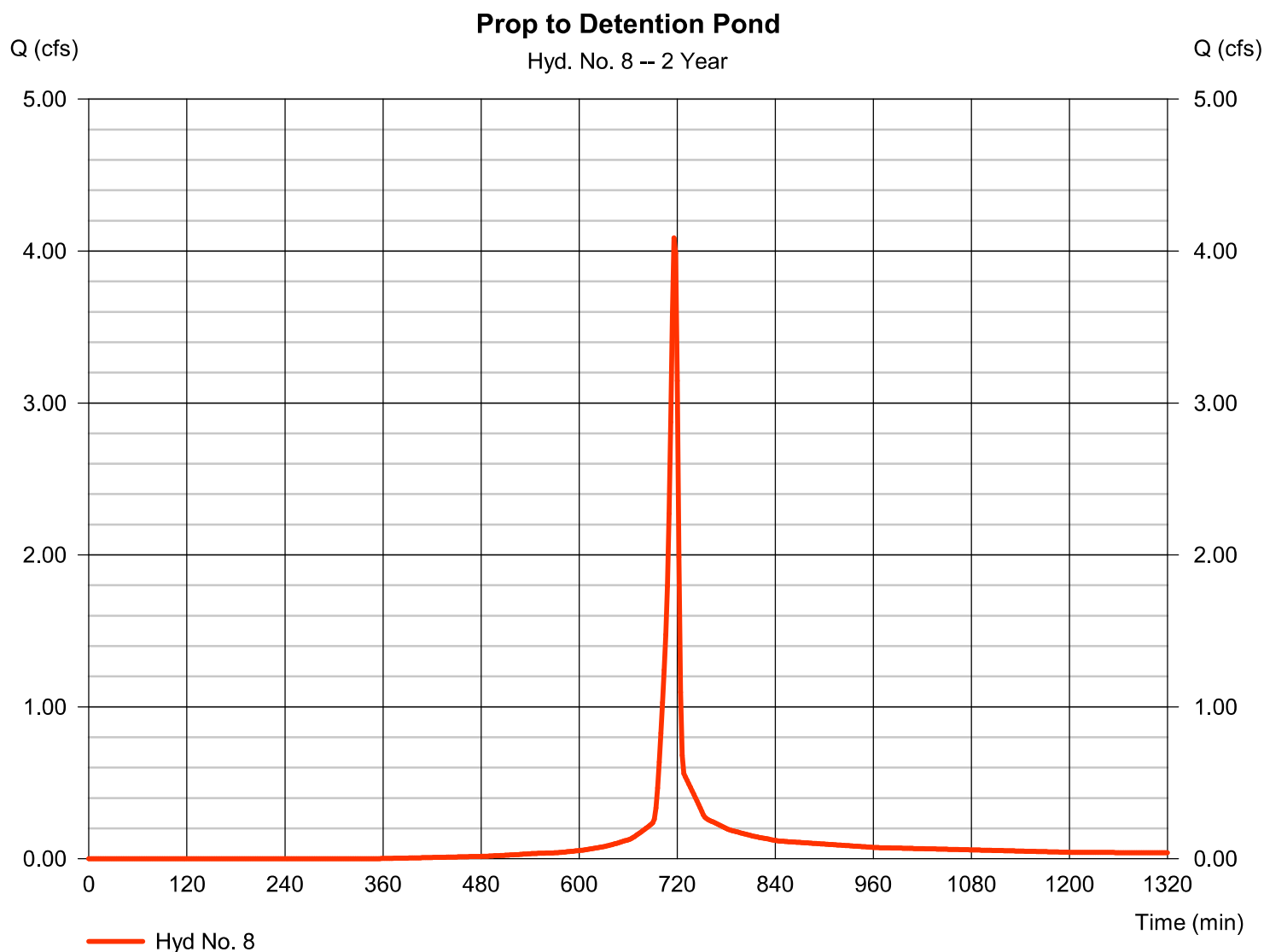
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 8

Prop to Detention Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 4.086 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 8,447 cuft
Drainage area	= 1.020 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

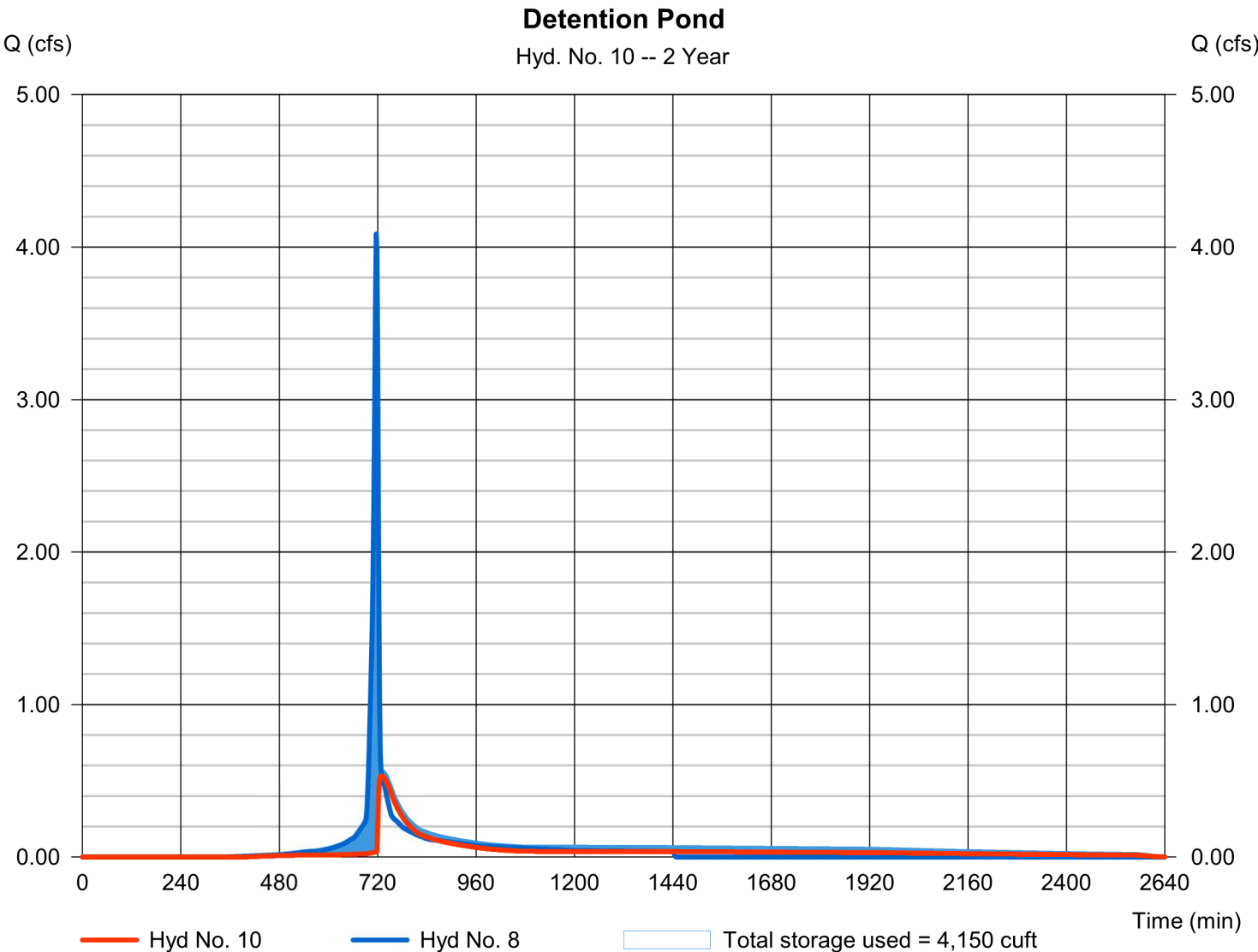
Friday, 02 / 7 / 2020

Hyd. No. 10

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.533 cfs
Storm frequency	= 2 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 5,959 cuft
Inflow hyd. No.	= 8 - Prop to Detention Pond	Max. Elevation	= 1013.08 ft
Reservoir name	= Detention Pond	Max. Storage	= 4,150 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond No. 1 - Detention Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 1010.75 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1010.75	05	0	0
0.25	1011.00	406	38	38
1.25	1012.00	2,272	1,213	1,251
2.25	1013.00	3,009	2,632	3,882
3.25	1014.00	3,837	3,414	7,297
4.25	1015.00	4,760	4,290	11,586
5.25	1016.00	5,775	5,259	16,845
5.60	1016.35	6,159	2,088	18,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	1.00	Inactive	Inactive
Span (in)	= 12.00	1.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 1010.65	1010.75	0.00	0.00
Length (ft)	= 30.00	0.50	0.00	0.00
Slope (%)	= 0.50	0.50	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 11.00	50.00	1.00	Inactive
Crest El. (ft)	= 1014.70	1015.20	1012.80	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Ciplti	Rect	---
Multi-Stage	= Yes	No	Yes	No
Exfil.(in/hr)	= 0.420 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

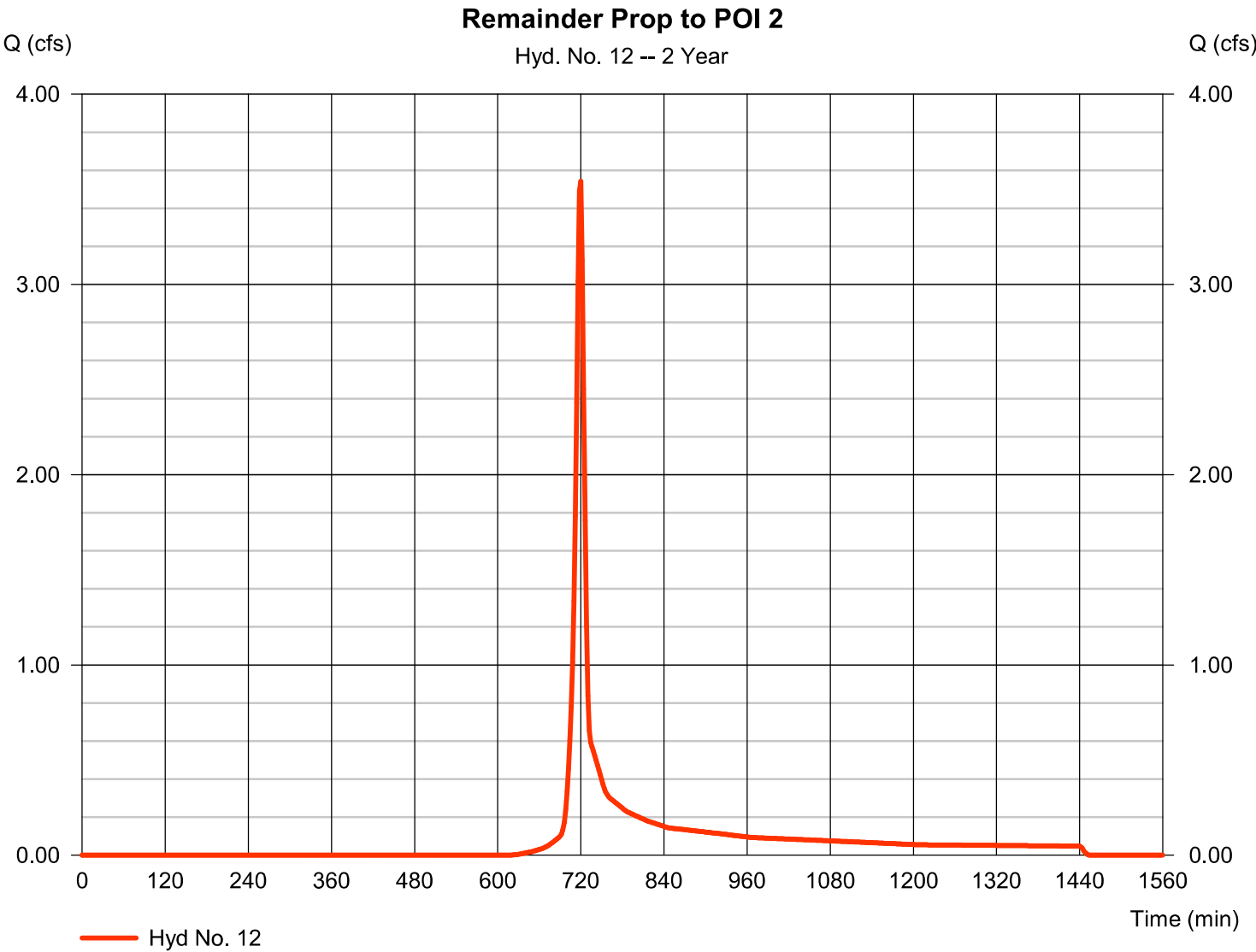
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1010.75	0.00	0.00	---	---	0.00	0.00	0.00	---	0.000	---	0.000
0.25	38	1011.00	0.04 ic	0.01 ic	---	---	0.00	0.00	0.00	---	0.004	---	0.016
1.25	1,251	1012.00	0.04 ic	0.03 ic	---	---	0.00	0.00	0.00	---	0.022	---	0.051
2.25	3,882	1013.00	0.30 oc	0.04 ic	---	---	0.00	0.00	0.30	---	0.029	---	0.366
3.25	7,297	1014.00	4.38 oc	0.05 ic	---	---	0.00	0.00	4.38	---	0.037	---	4.462
4.25	11,586	1015.00	7.35 ic	0.05 ic	---	---	3.96 s	0.00	3.39 s	---	0.046	---	7.449
5.25	16,845	1016.00	8.32 ic	0.06 ic	---	---	6.62 s	119.14	1.64 s	---	0.056	---	127.52
5.60	18,933	1016.35	8.62 ic	0.06 ic	---	---	7.01 s	205.32	1.50 s	---	0.060	---	213.95

Hydrograph Report

Hyd. No. 12

Remainder Prop to POI 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.543 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	8,130 cuft
Drainage area	=	1.640 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.80 min
Total precip.	=	3.68 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

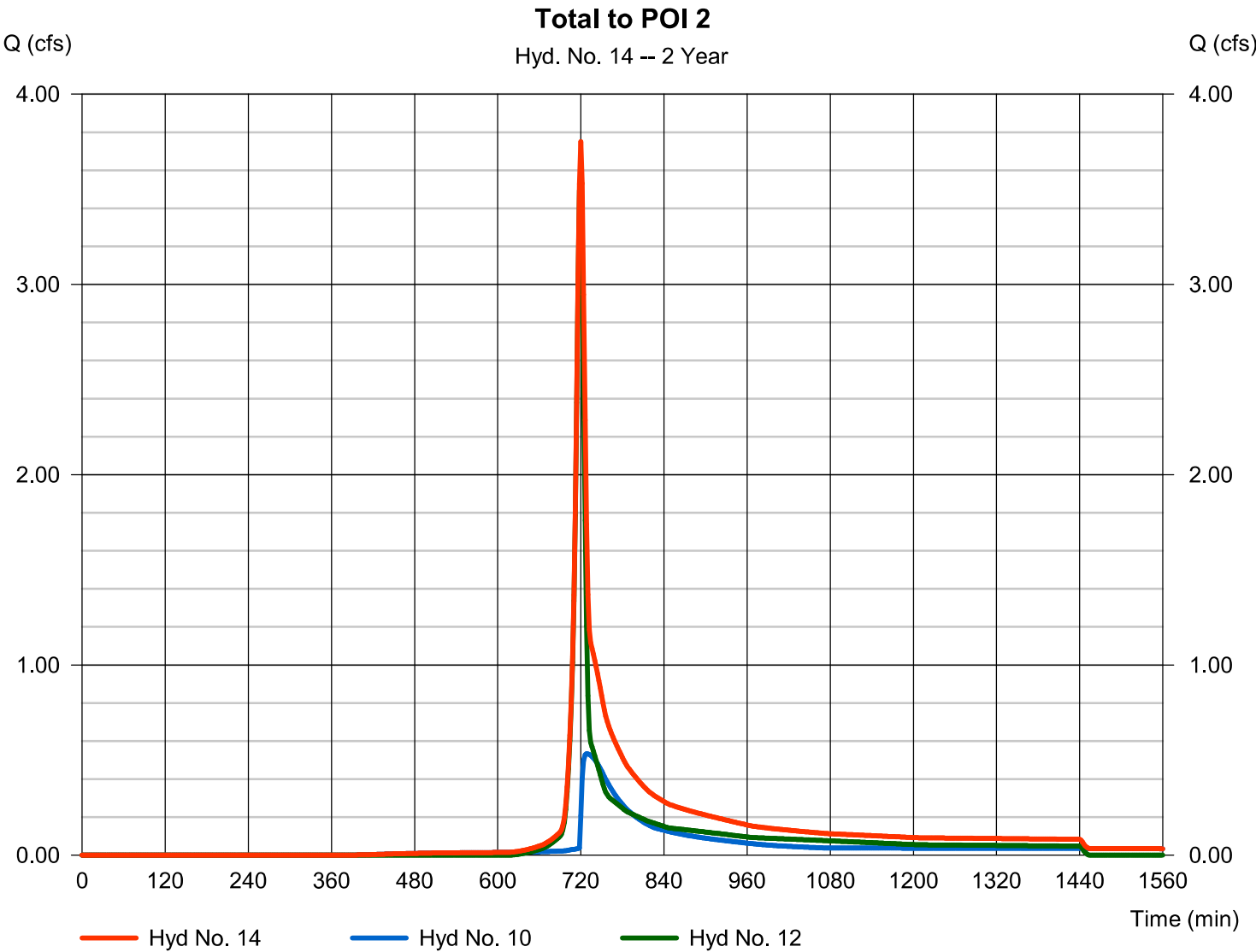


Hydrograph Report

Hyd. No. 14

Total to POI 2

Hydrograph type	= Combine	Peak discharge	= 3.750 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 14,089 cuft
Inflow hyds.	= 10, 12	Contrib. drain. area	= 1.640 ac



Hydrograph Summary Report

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

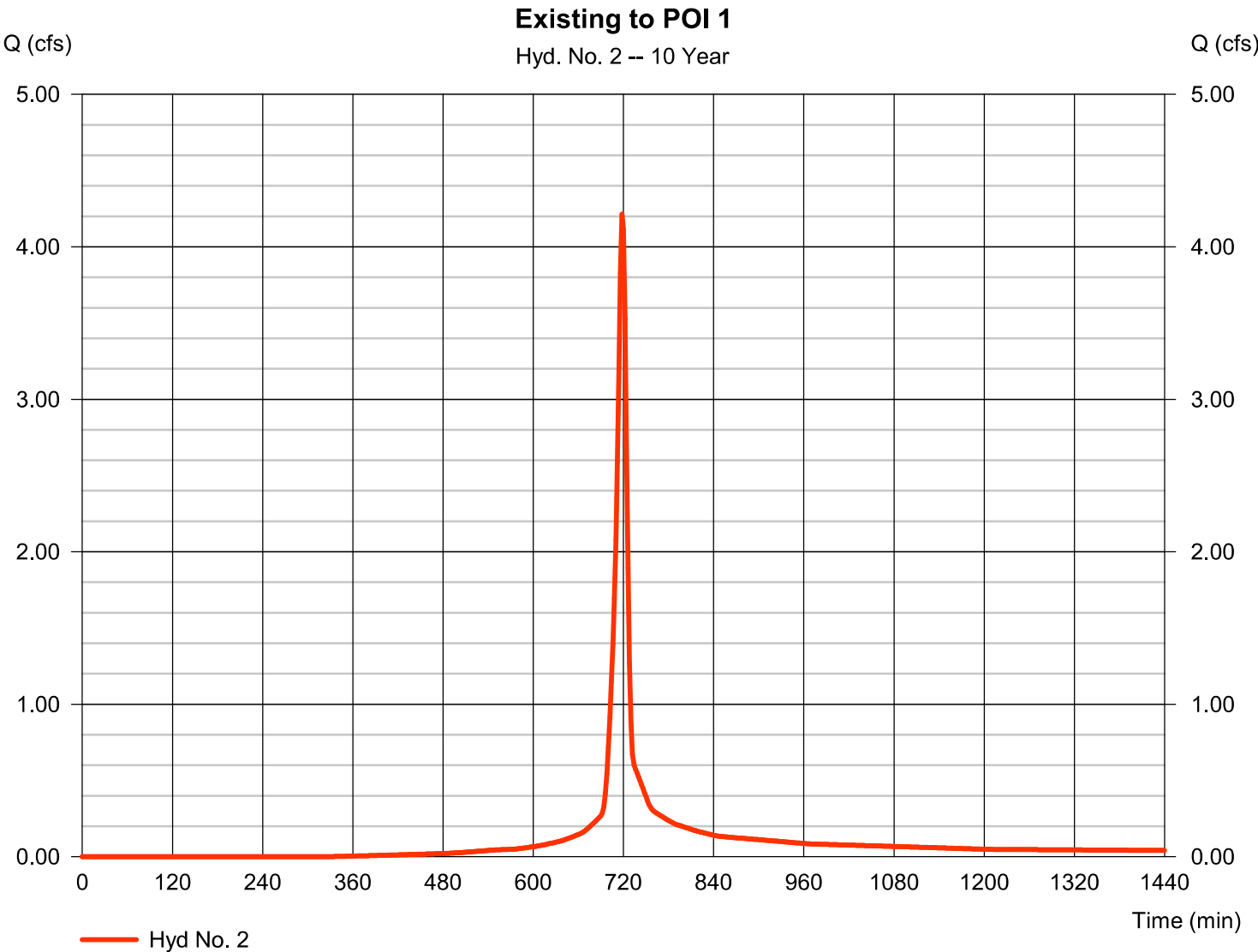
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
2	SCS Runoff	4.214	2	718	9,851	-----	-----	-----	Existing to POI 1
4	SCS Runoff	3.714	2	716	8,041	-----	-----	-----	Proposed to POI 1
6	SCS Runoff	10.99	2	718	25,132	-----	-----	-----	Existing to POI 2
8	SCS Runoff	6.926	2	716	14,757	-----	-----	-----	Prop to Detention Pond
10	Reservoir	3.052	2	722	11,942	8	1013.73	6,387	Detention Pond
12	SCS Runoff	7.442	2	718	17,025	-----	-----	-----	Remainder Prop to POI 2
14	Combine	10.23	2	720	28,967	10, 12,	-----	-----	Total to POI 2
Lee's Summit - Existing Conditions Analysis.gpr					Return Period: 10 Year			Friday, 02 / 7 / 2020	

Hydrograph Report

Hyd. No. 2

Existing to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.214 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 9,851 cuft
Drainage area	= 0.708 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 9.60 min
Total precip.	= 5.61 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

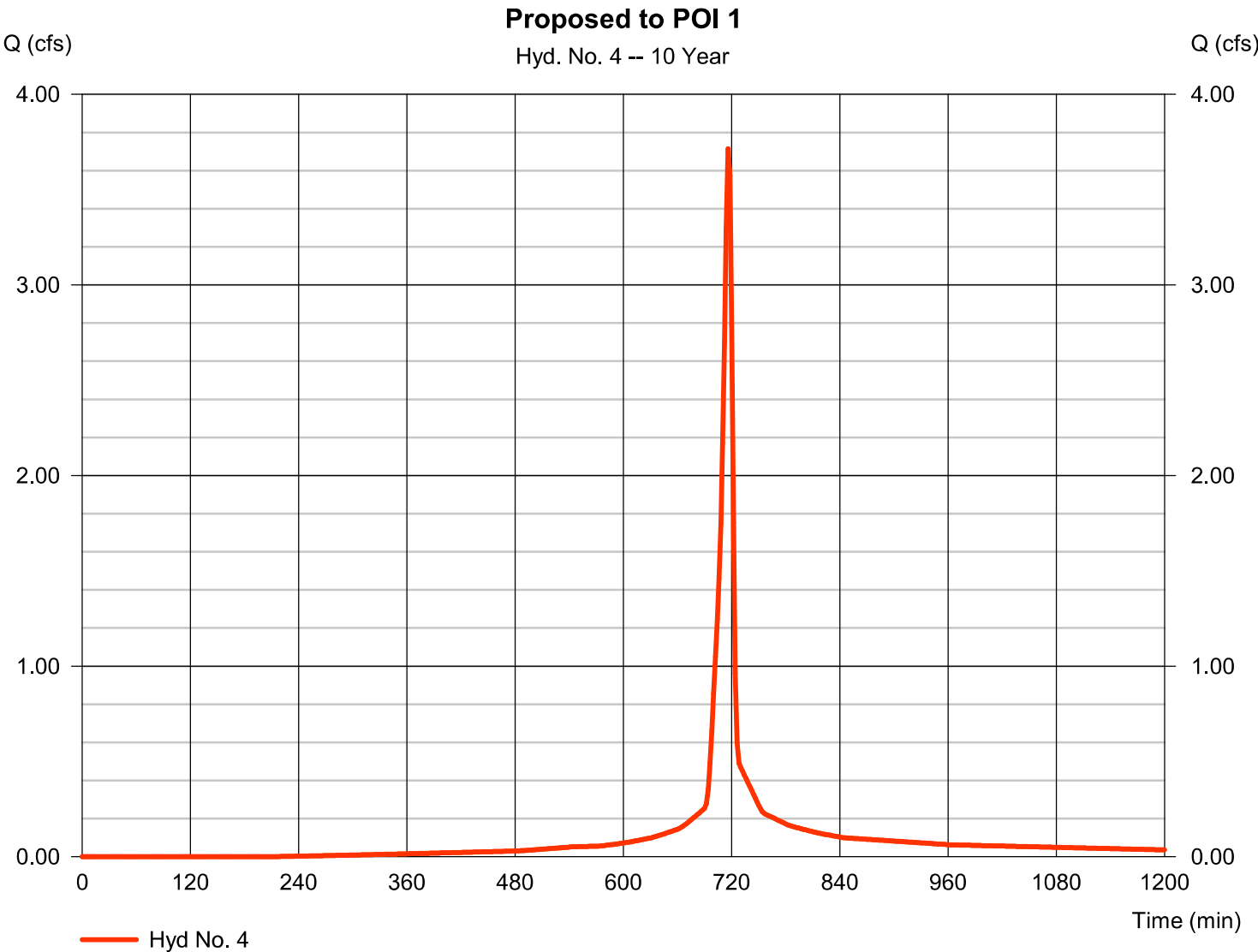


Hydrograph Report

Hyd. No. 4

Proposed to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.714 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 8,041 cuft
Drainage area	= 0.529 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.61 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

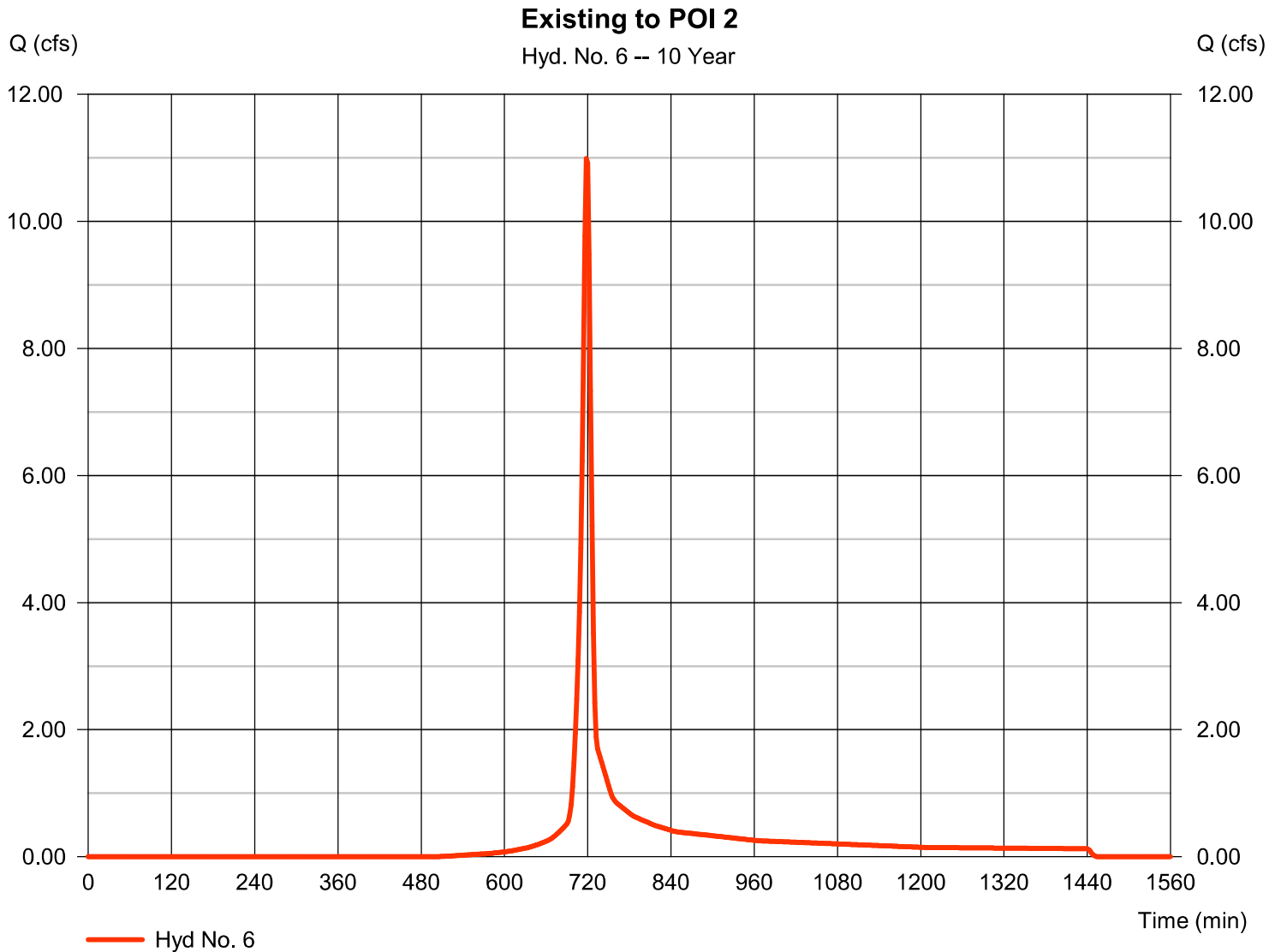
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Friday, 02 / 7 / 2020

Hyd. No. 6

Existing to POI 2

Hydrograph type	= SCS Runoff	Peak discharge	= 10.99 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 25,132 cuft
Drainage area	= 2.421 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.80 min
Total precip.	= 5.61 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

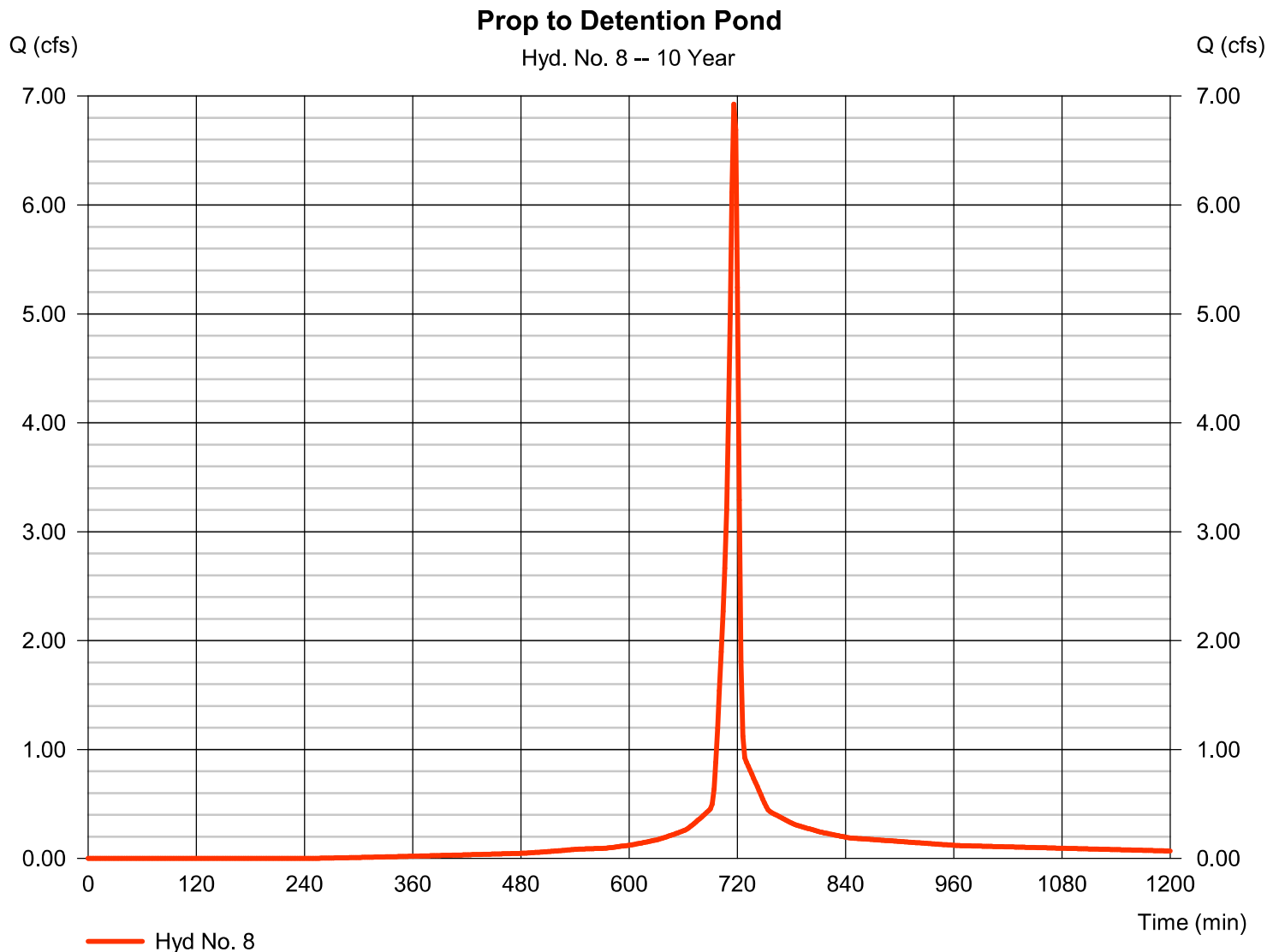
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Friday, 02 / 7 / 2020

Hyd. No. 8

Prop to Detention Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 6.926 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 14,757 cuft
Drainage area	= 1.020 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.61 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

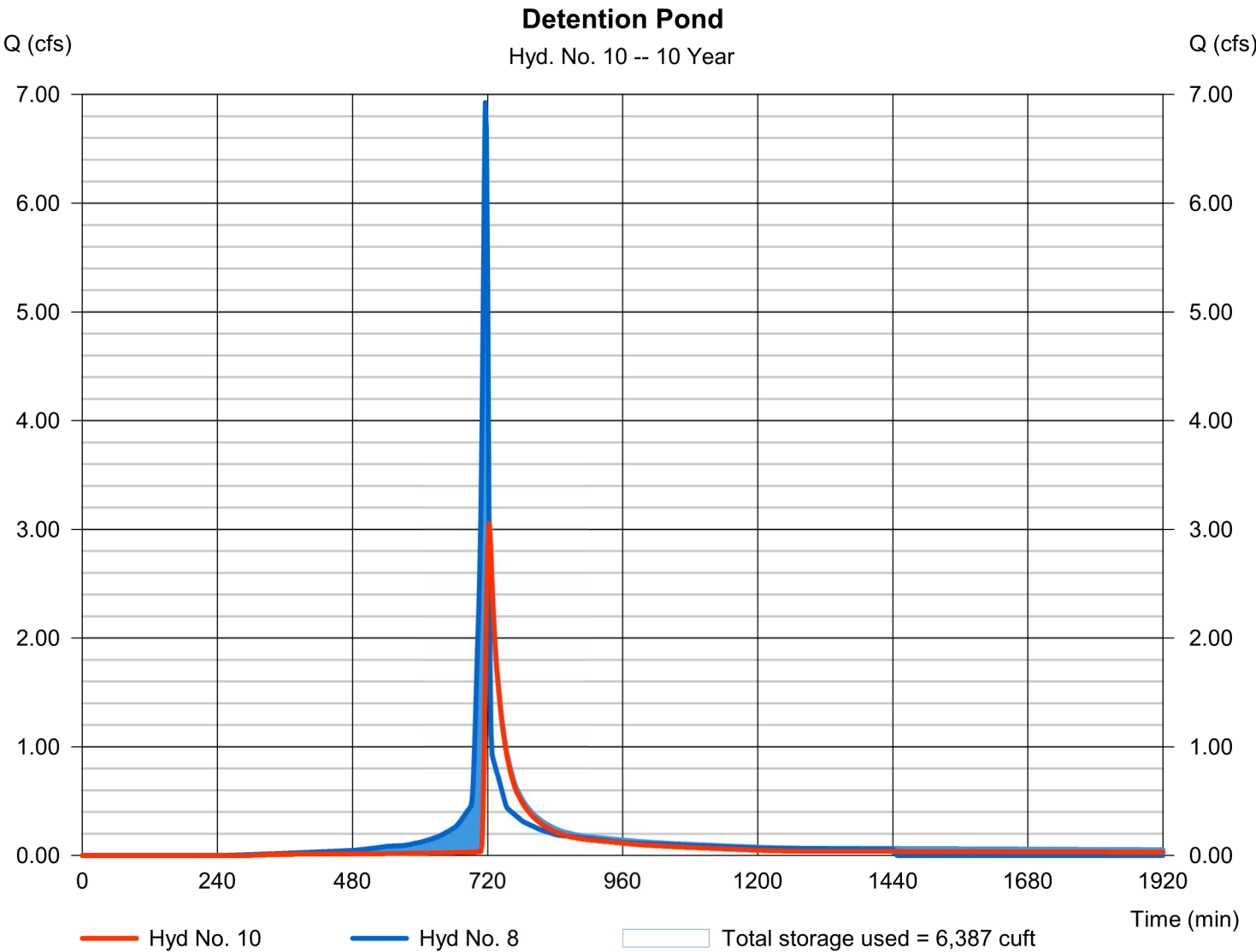
Friday, 02 / 7 / 2020

Hyd. No. 10

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 3.052 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 11,942 cuft
Inflow hyd. No.	= 8 - Prop to Detention Pond	Max. Elevation	= 1013.73 ft
Reservoir name	= Detention Pond	Max. Storage	= 6,387 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

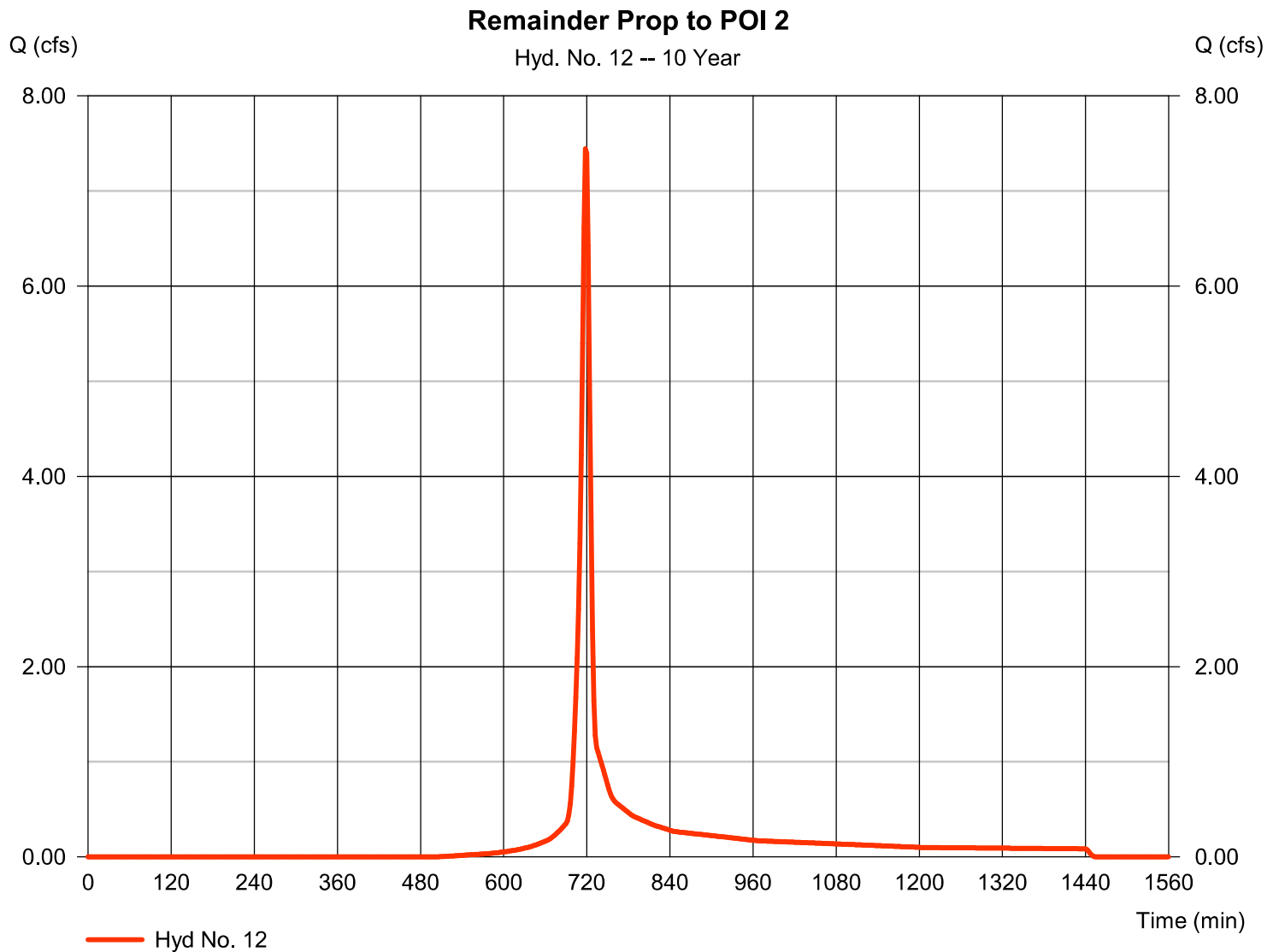
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Friday, 02 / 7 / 2020

Hyd. No. 12

Remainder Prop to POI 2

Hydrograph type	= SCS Runoff	Peak discharge	= 7.442 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 17,025 cuft
Drainage area	= 1.640 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.80 min
Total precip.	= 5.61 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

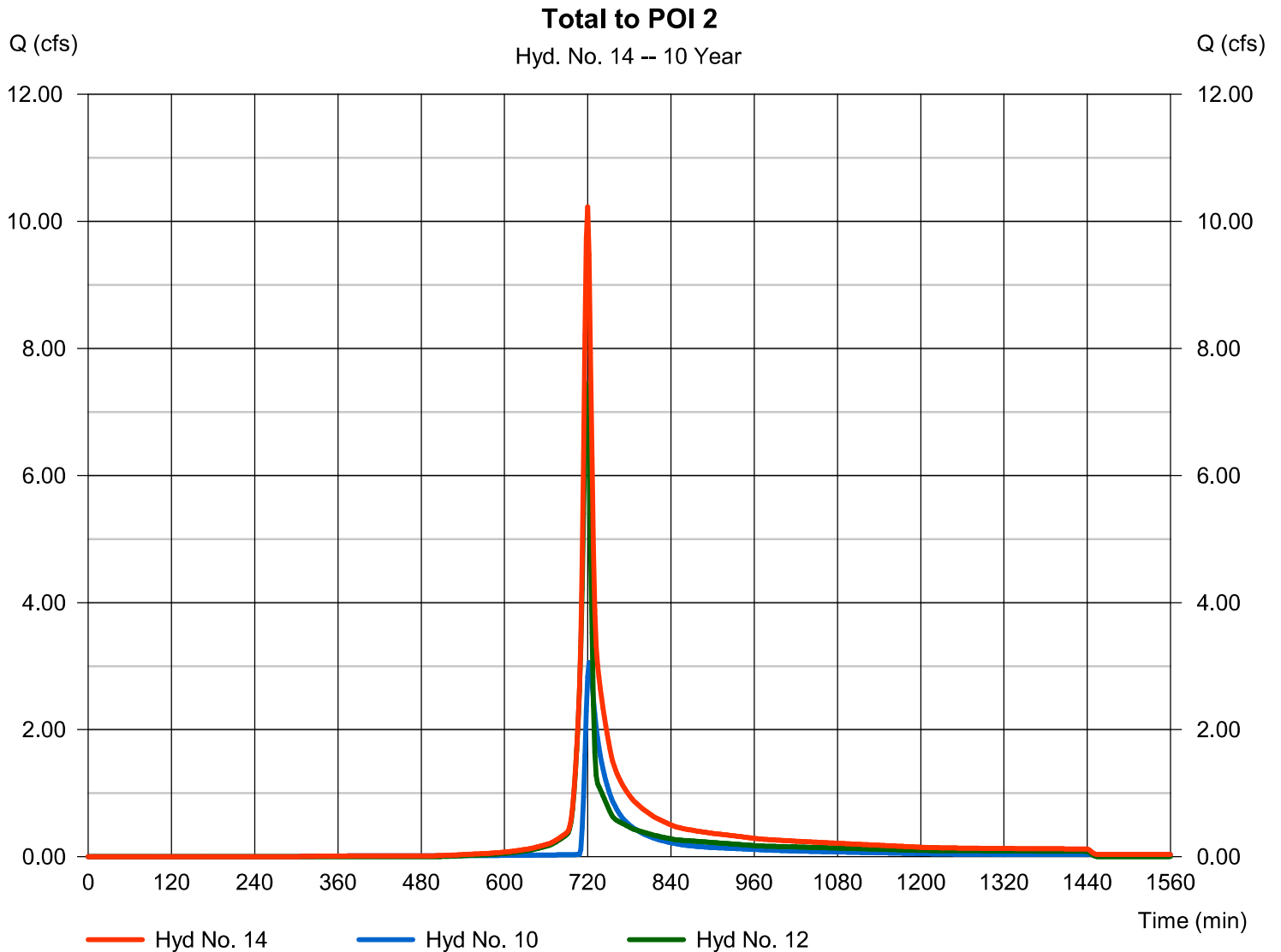
Friday, 02 / 7 / 2020

Hyd. No. 14

Total to POI 2

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 2 min
 Inflow hyds. = 10, 12

Peak discharge = 10.23 cfs
 Time to peak = 720 min
 Hyd. volume = 28,967 cuft
 Contrib. drain. area = 1.640 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 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
2	SCS Runoff	7.681	2	718	18,565	-----	-----	-----	Existing to POI 1
4	SCS Runoff	6.376	2	716	14,329	-----	-----	-----	Proposed to POI 1
6	SCS Runoff	22.65	2	718	52,590	-----	-----	-----	Existing to POI 2
8	SCS Runoff	12.10	2	716	26,780	-----	-----	-----	Prop to Detention Pond
10	Reservoir	6.206	2	722	23,682	8	1014.55	9,663	Detention Pond
12	SCS Runoff	15.34	2	718	35,625	-----	-----	-----	Remainder Prop to POI 2
14	Combine	21.19	2	718	59,307	10, 12,	-----	-----	Total to POI 2
Lee's Summit - Existing Conditions Analysis.gpr					Return Period: 100 Year			Friday, 02 / 7 / 2020	

Hydrograph Report

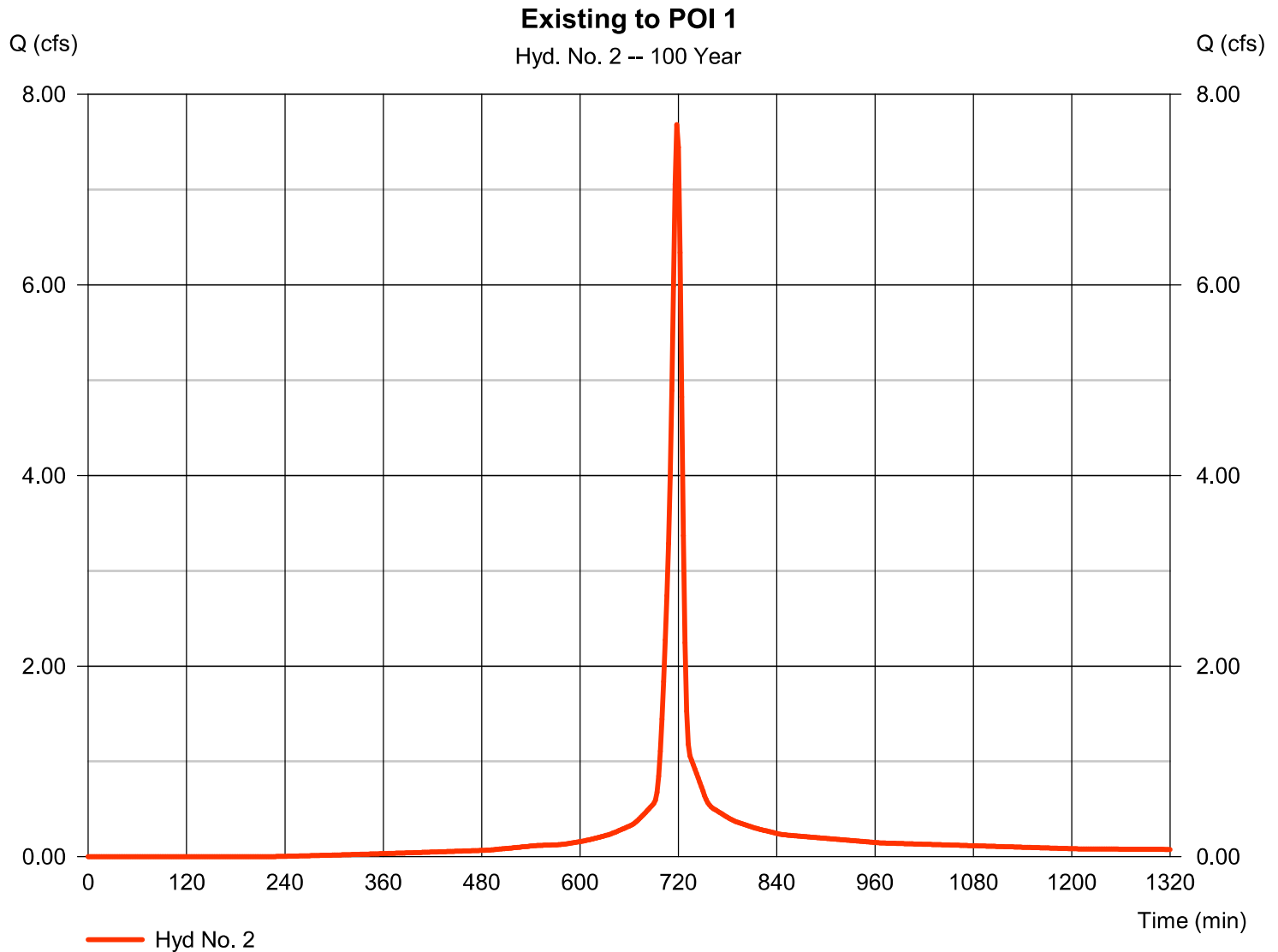
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Friday, 02 / 7 / 2020

Hyd. No. 2

Existing to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 7.681 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 18,565 cuft
Drainage area	= 0.708 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 9.60 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

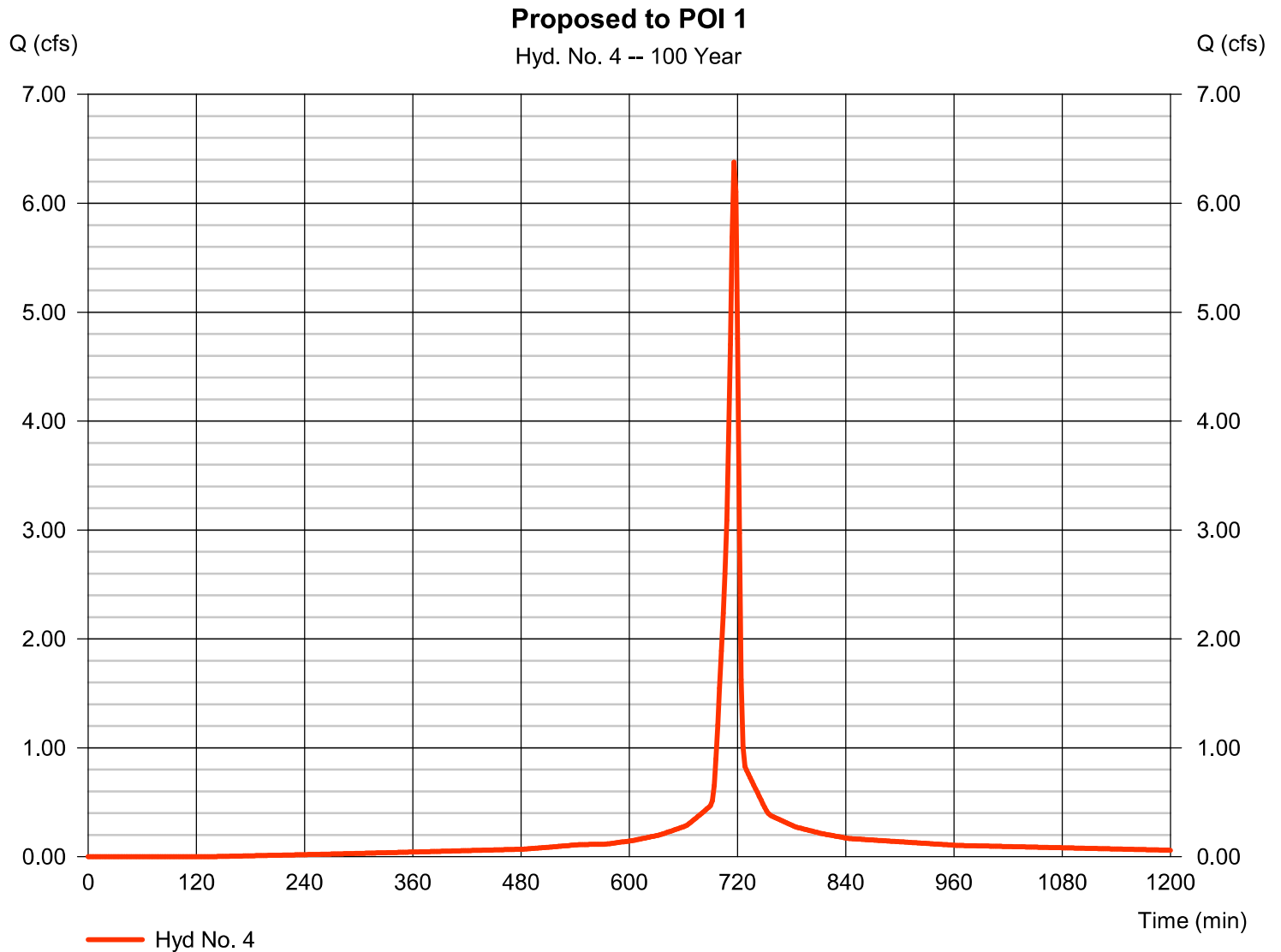
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 4

Proposed to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.376 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 14,329 cuft
Drainage area	= 0.529 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

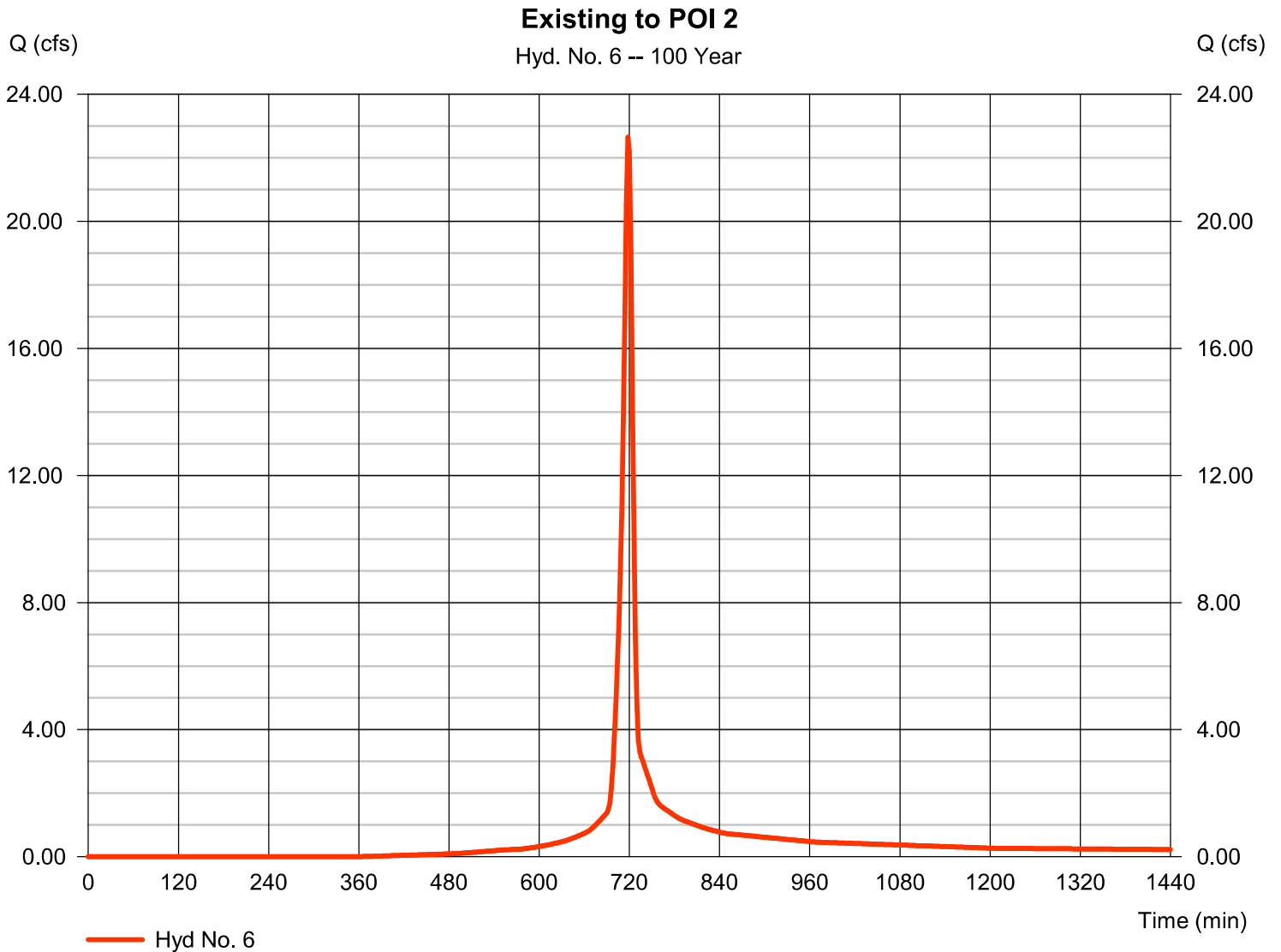
Friday, 02 / 7 / 2020

Hyd. No. 6

Existing to POI 2

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 2.421 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 9.17 in
 Storm duration = 24 hrs

Peak discharge = 22.65 cfs
 Time to peak = 718 min
 Hyd. volume = 52,590 cuft
 Curve number = 74
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 9.80 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

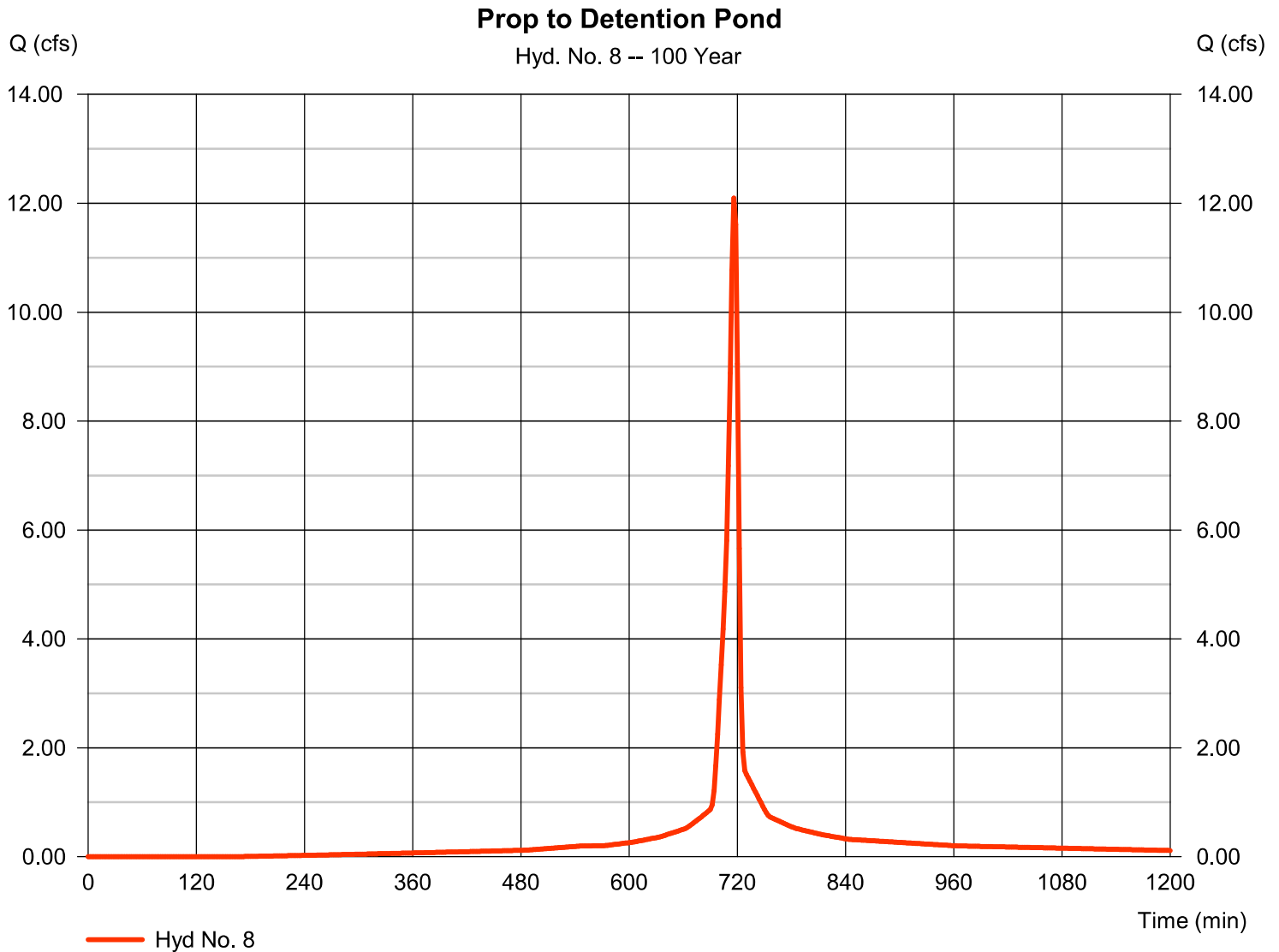
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Friday, 02 / 7 / 2020

Hyd. No. 8

Prop to Detention Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 12.10 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 26,780 cuft
Drainage area	= 1.020 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

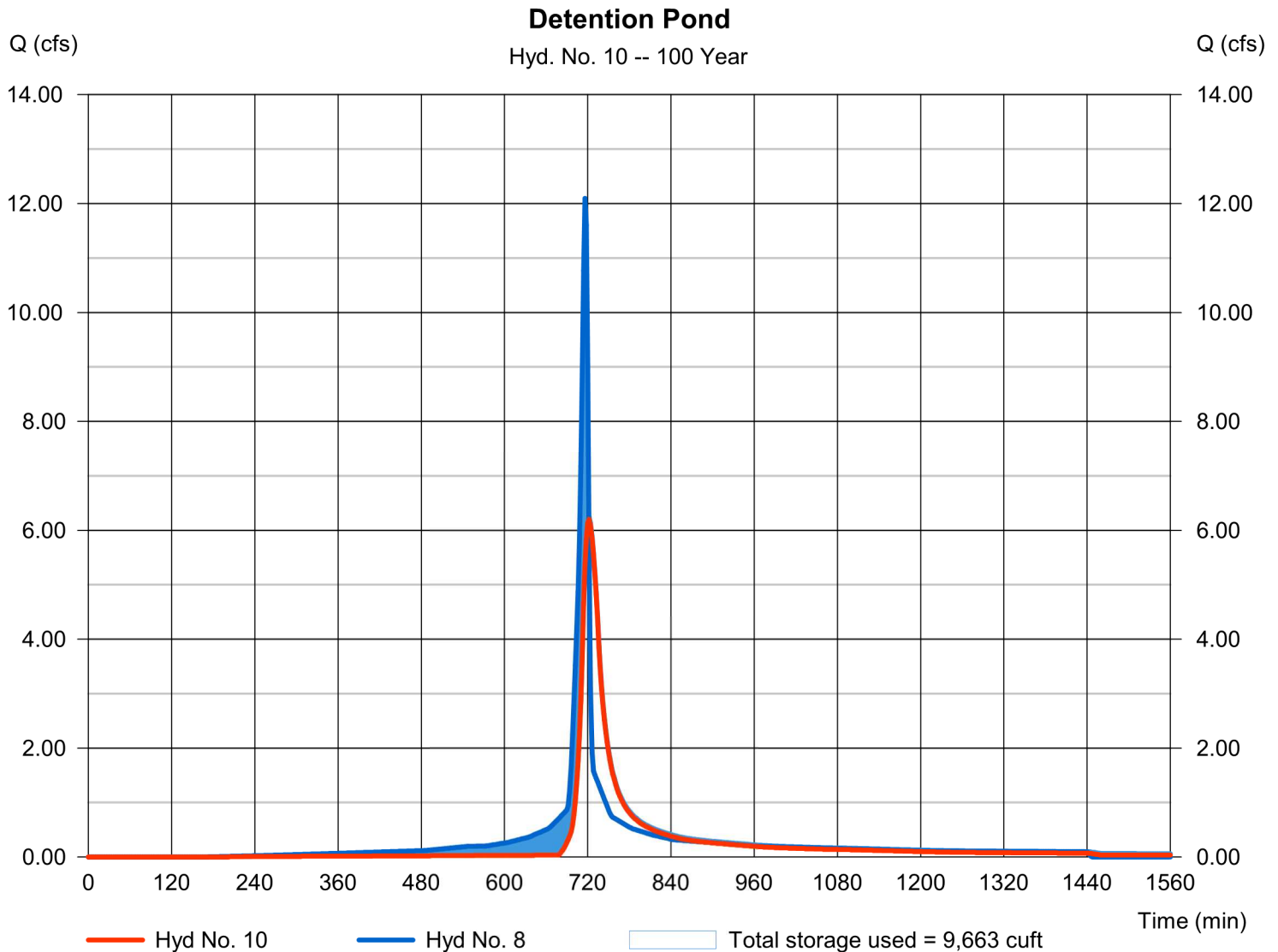
Friday, 02 / 7 / 2020

Hyd. No. 10

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 6.206 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 23,682 cuft
Inflow hyd. No.	= 8 - Prop to Detention Pond	Max. Elevation	= 1014.55 ft
Reservoir name	= Detention Pond	Max. Storage	= 9,663 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

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

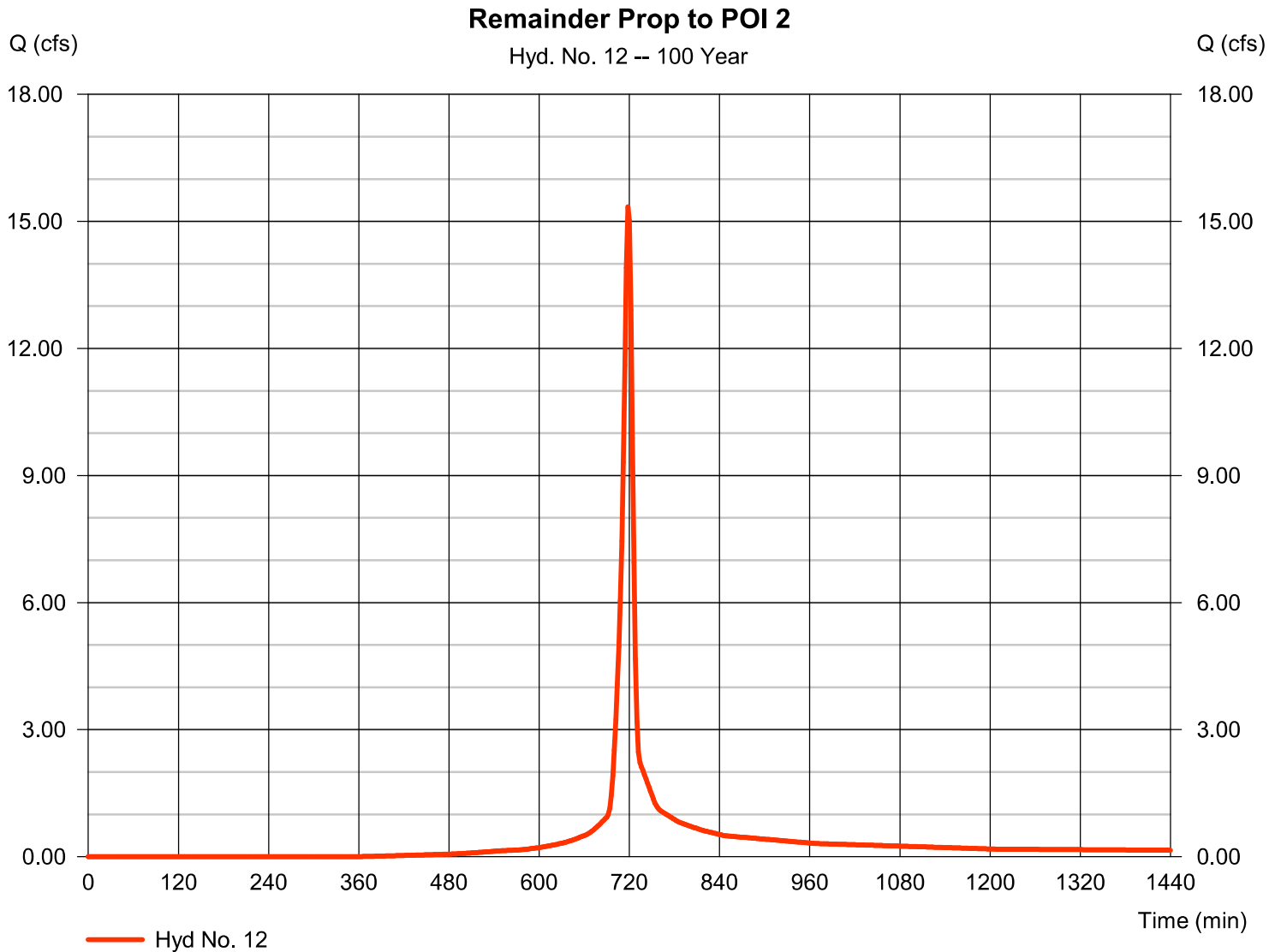
Friday, 02 / 7 / 2020

Hyd. No. 12

Remainder Prop to POI 2

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 1.640 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 9.17 in
 Storm duration = 24 hrs

Peak discharge = 15.34 cfs
 Time to peak = 718 min
 Hyd. volume = 35,625 cuft
 Curve number = 74
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 9.80 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

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

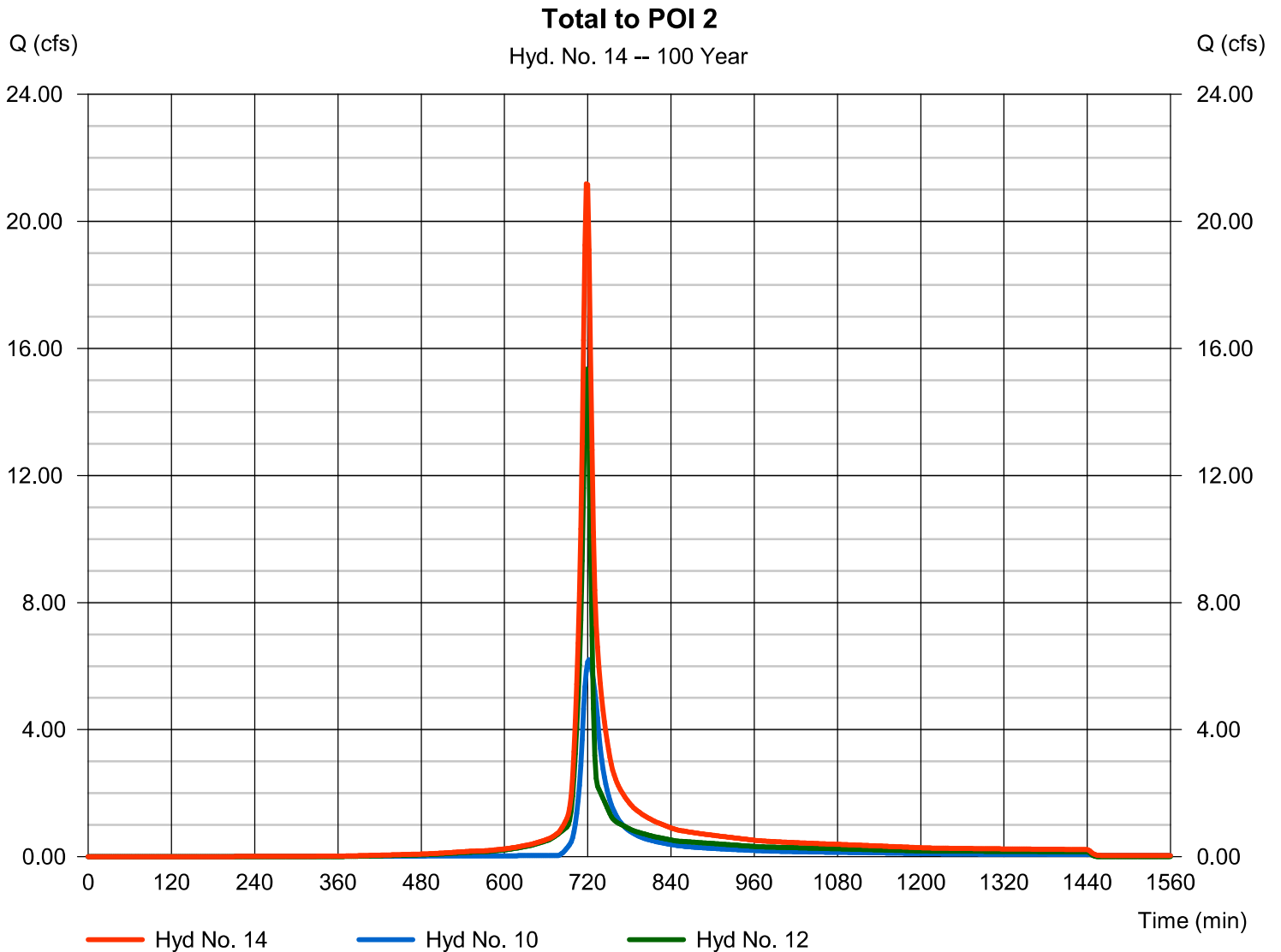
Friday, 02 / 7 / 2020

Hyd. No. 14

Total to POI 2

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 10, 12

Peak discharge = 21.19 cfs
Time to peak = 718 min
Hyd. volume = 59,307 cuft
Contrib. drain. area = 1.640 ac



CLOGGED OUTFLOW ANALYSIS

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100 - Year

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Hydrograph Reports..... 3

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 TR-55 Tc Worksheet..... 4

 Hydrograph No. 4, SCS Runoff, Proposed to POI 1..... 5

 Hydrograph No. 6, SCS Runoff, Existing to POI 2..... 6

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 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
2	SCS Runoff	7.681	2	718	18,565	-----	-----	-----	Existing to POI 1
4	SCS Runoff	6.376	2	716	14,329	-----	-----	-----	Proposed to POI 1
6	SCS Runoff	22.65	2	718	52,590	-----	-----	-----	Existing to POI 2
8	SCS Runoff	12.10	2	716	26,780	-----	-----	-----	Prop to Detention Pond
10	Reservoir	9.654	2	720	11,531	8	1015.35	13,404	Detention Pond
12	SCS Runoff	15.34	2	718	35,625	-----	-----	-----	Remainder Prop to POI 2
14	Combine	24.68	2	720	47,155	10, 12,	-----	-----	Total to POI 2
Lee's Summit - Existing Conditions Analysis.gpr					Return Period: 100 Year			Friday, 02 / 7 / 2020	

Hydrograph Report

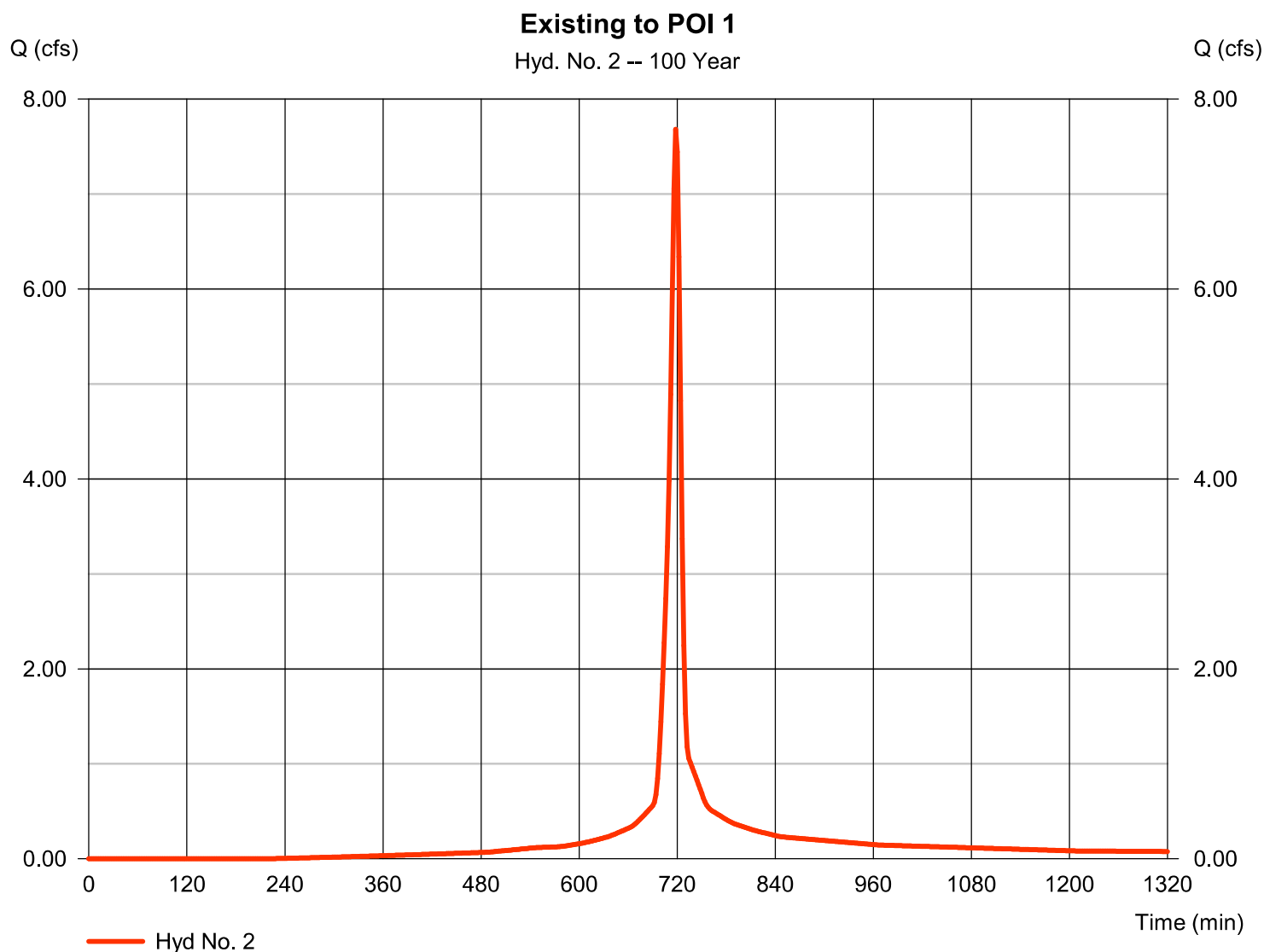
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Friday, 02 / 7 / 2020

Hyd. No. 2

Existing to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 7.681 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 18,565 cuft
Drainage area	= 0.708 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 9.60 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

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

Hyd. No. 2

Existing to POI 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 3.68	0.00	0.00				
Land slope (%)	= 2.24	0.00	0.00				
Travel Time (min)	= 8.73	+	0.00	+	0.00	=	8.73
Shallow Concentrated Flow							
Flow length (ft)	= 100.00	0.00	0.00				
Watercourse slope (%)	= 1.50	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=1.98	0.00	0.00				
Travel Time (min)	= 0.84	+	0.00	+	0.00	=	0.84
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	((0))0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				9.60 min			

Hydrograph Report

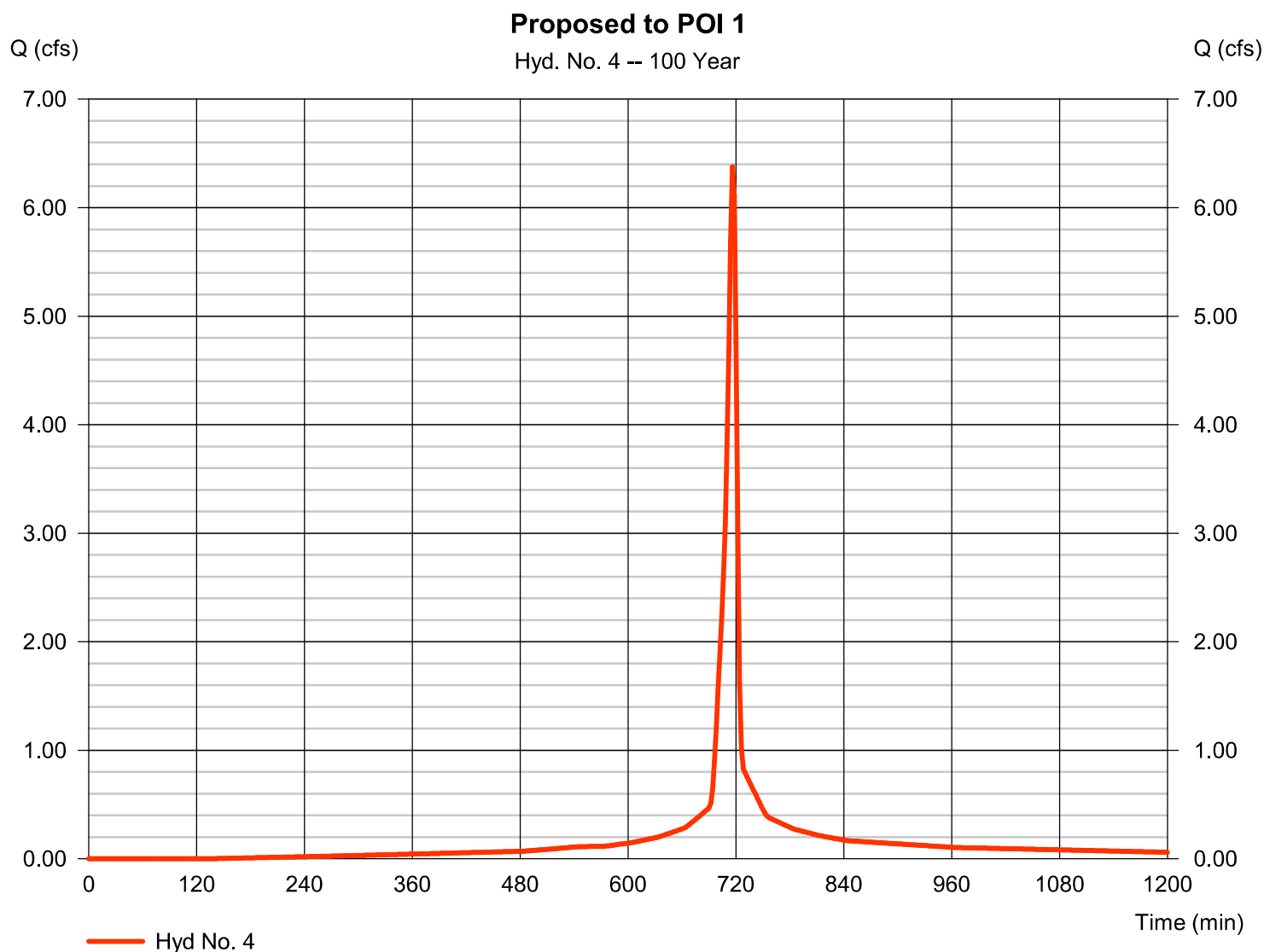
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 4

Proposed to POI 1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.376 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 14,329 cuft
Drainage area	= 0.529 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

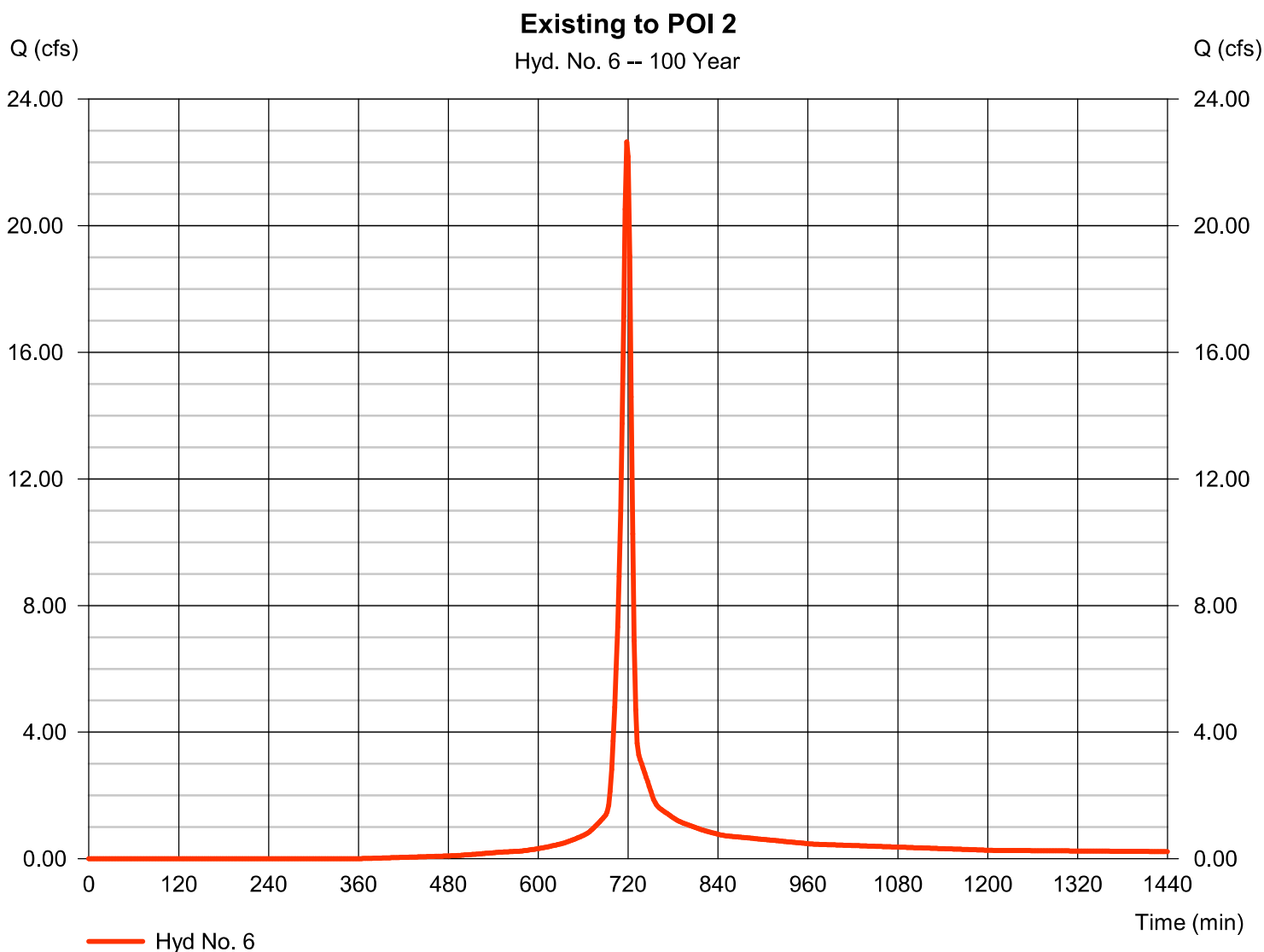
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Friday, 02 / 7 / 2020

Hyd. No. 6

Existing to POI 2

Hydrograph type	= SCS Runoff	Peak discharge	= 22.65 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 52,590 cuft
Drainage area	= 2.421 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.80 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

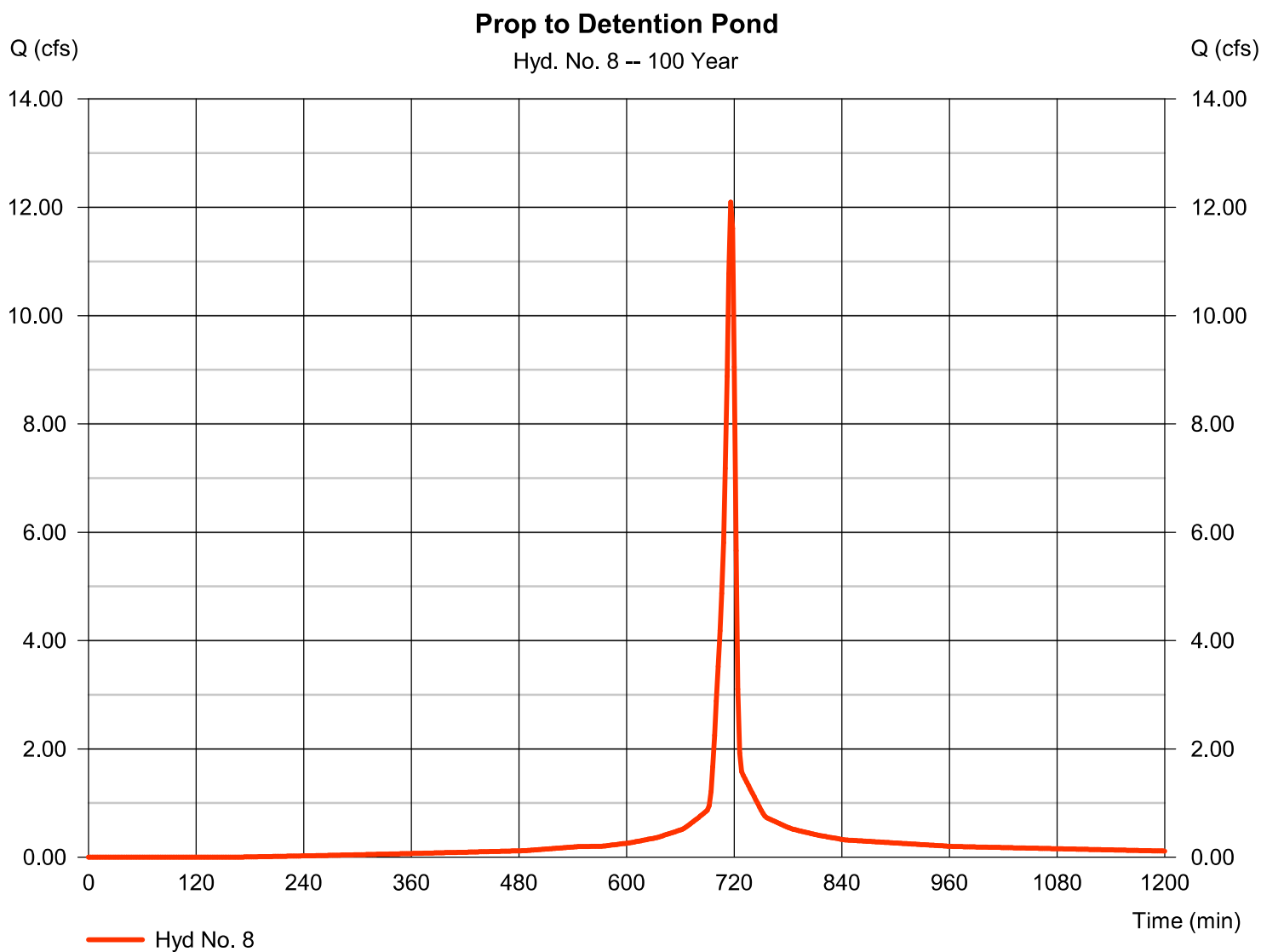
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 8

Prop to Detention Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 12.10 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 26,780 cuft
Drainage area	= 1.020 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 9.17 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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

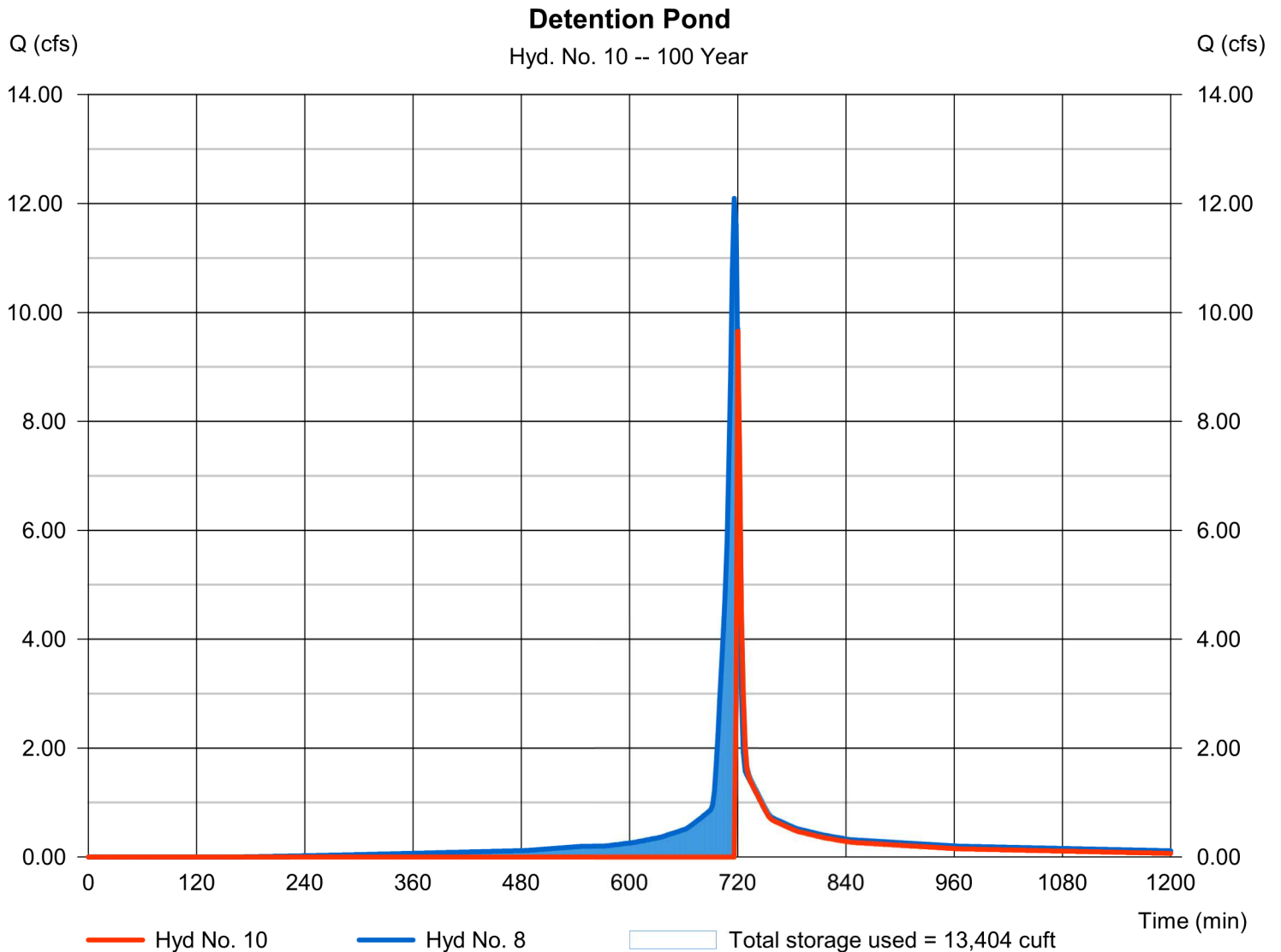
Friday, 02 / 7 / 2020

Hyd. No. 10

Detention Pond

Hydrograph type	= Reservoir	Peak discharge	= 9.654 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 11,531 cuft
Inflow hyd. No.	= 8 - Prop to Detention Pond	Max. Elevation	= 1015.35 ft
Reservoir name	= Detention Pond	Max. Storage	= 13,404 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

9

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

Friday, 02 / 7 / 2020

Pond No. 1 - Detention Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 1010.75 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1010.75	05	0	0
0.25	1011.00	406	38	38
1.25	1012.00	2,272	1,213	1,251
2.25	1013.00	3,009	2,632	3,882
3.25	1014.00	3,837	3,414	7,297
4.25	1015.00	4,760	4,290	11,586
5.25	1016.00	5,775	5,259	16,845
5.60	1016.35	6,159	2,088	18,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 12.00	1.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 1010.65	1010.75	0.00	0.00
Length (ft)	= 30.00	0.50	0.00	0.00
Slope (%)	= 0.50	0.50	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	50.00	Inactive	Inactive
Crest El. (ft)	= 1014.70	1015.20	1012.80	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Ciplti	Rect	---
Multi-Stage	= Yes	No	Yes	No
Exfil.(in/hr)	= 0.420 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

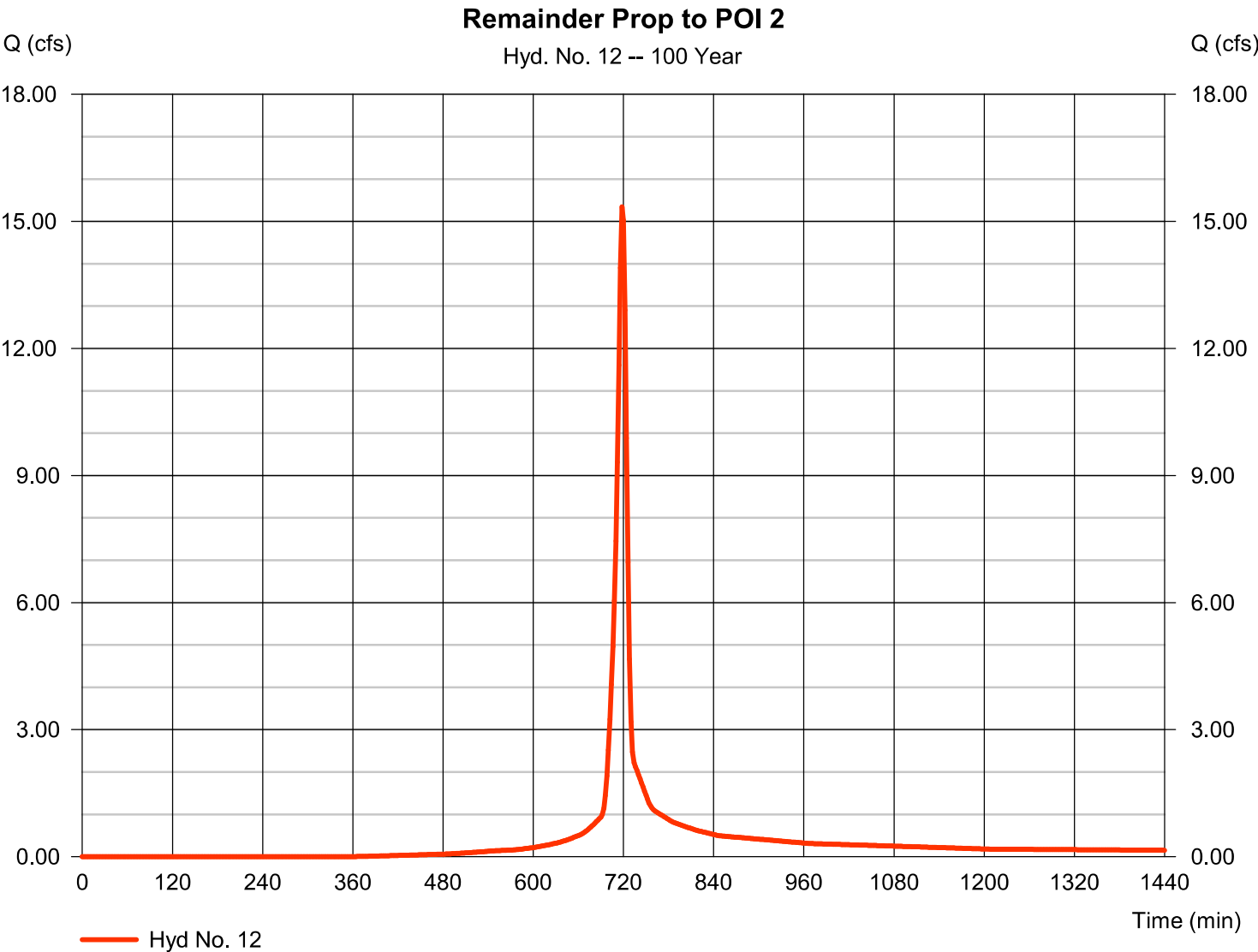
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1010.75	0.00	0.00	---	---	0.00	0.00	0.00	---	0.000	---	0.000
0.25	38	1011.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.004	---	0.004
1.25	1,251	1012.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.022	---	0.022
2.25	3,882	1013.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.029	---	0.029
3.25	7,297	1014.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.037	---	0.037
4.25	11,586	1015.00	0.00	0.00	---	---	0.00	0.00	0.00	---	0.046	---	0.046
5.25	16,845	1016.00	0.00	0.00	---	---	0.00	119.13	0.00	---	0.056	---	119.19
5.60	18,933	1016.35	0.00	0.00	---	---	0.00	205.32	0.00	---	0.060	---	205.38

Hydrograph Report

Hyd. No. 12

Remainder Prop to POI 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	15.34 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	35,625 cuft
Drainage area	=	1.640 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.80 min
Total precip.	=	9.17 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

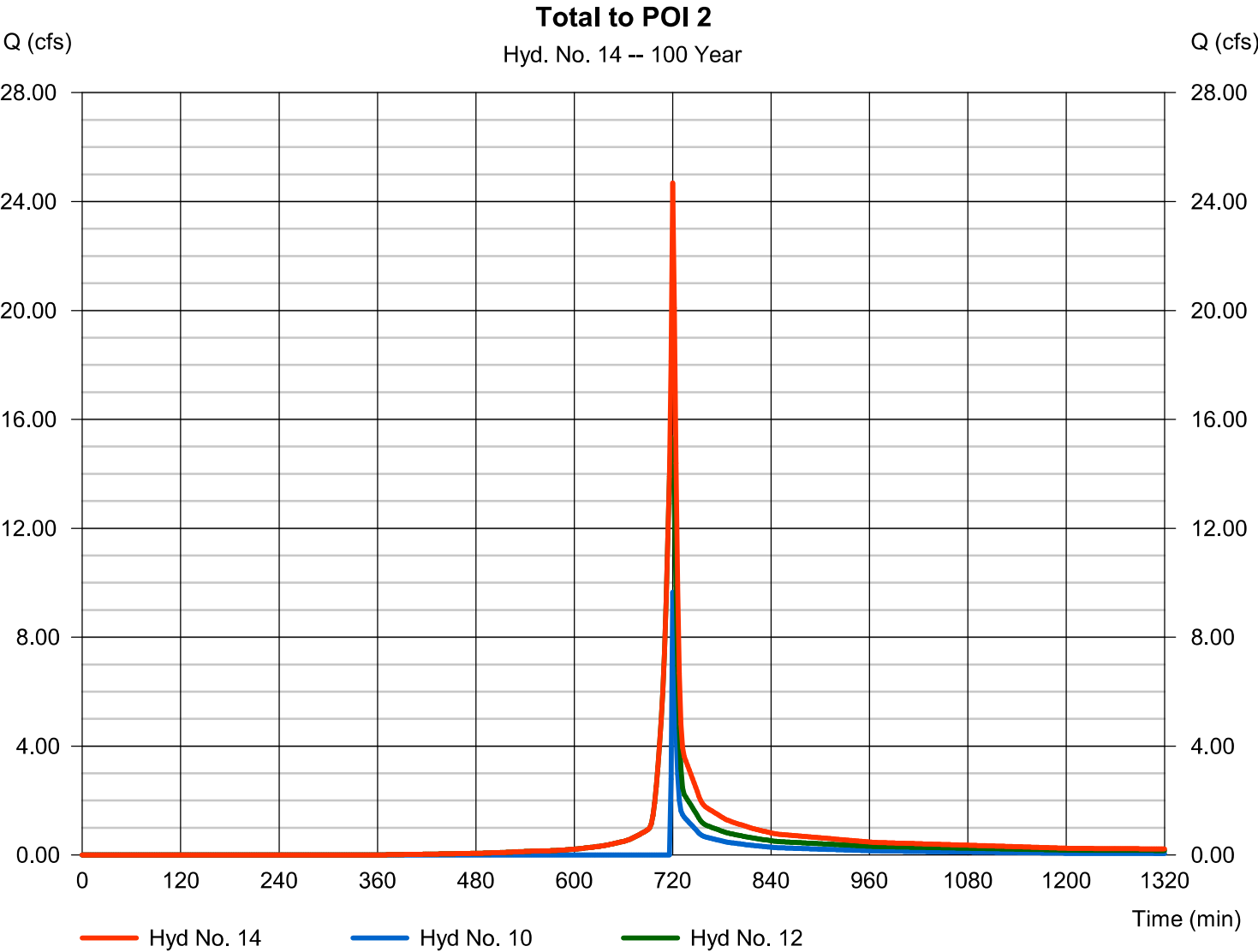
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Friday, 02 / 7 / 2020

Hyd. No. 14

Total to POI 2

Hydrograph type	= Combine	Peak discharge	= 24.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 47,155 cuft
Inflow hyds.	= 10, 12	Contrib. drain. area	= 1.640 ac



APPENDIX C

Water Quality Calculations

WATER QUALITY POND CALCULATIONS-PERFORATED PIPE

Project: Firestone Complete Auto Care, Lee's Summit, MO
GSP# 40831.45

Date: 11/18/19
Revised Date: 2/7/20

Calculate Water Quality Volume

P (in.), rainfall for 90% storm event	1.37
I, impervious cover by %	56.4
R_v , runoff coefficient = $0.05 + 0.009 \times I$	0.56
A (ac), drainage area	1.02
WQ_v (ac-ft), water quality volume = $P \times R_v \times A/12$	0.06
WQ_v (ft ³), water quality volume converted units	2828
Add 20% WQ_v (ft ³), water quality volume converted units	3394.15

Pond Areas

Elevation (ft)	Area (ft ²)	Elev. Difference (ft)	Increment Volume (ft ³)	Total Volume (ft ³)
1010.75	4.75			0
1011	407.55	0.25	52	52
1012	2272.4	1	1340	1392
1013	3008.65	1	2641	4032
1014	3837.05	1	3423	7455
1015	4759.5	1	4298	11753
1016	5775.05	1	5267	17020
1016.35	6158.85	0.35	2088	19109
		Required WQ_v elevation (ft)		1012.76
		Weir elevation (ft)		1012.80

Size Low Flow Orifice

C, orifice coefficient	0.66
T (hrs), drawdown time (should be between 24 and 48 hrs)	40
g (ft/s ²), gravity	32.20
$Q_{wq, avg}$ (cfs), average release rate of WQ_v	0.024
$H_{wq, avg}$ (ft), average head on the water quality outlet	1.00
A_{wq} (ft ²), the orifice area	0.004
D_{wq} (ft), the orifice area	0.08
D_{wq} (in), the orifice area	0.90
Use D=	1.00

APPENDIX D

NRCS Soil Map



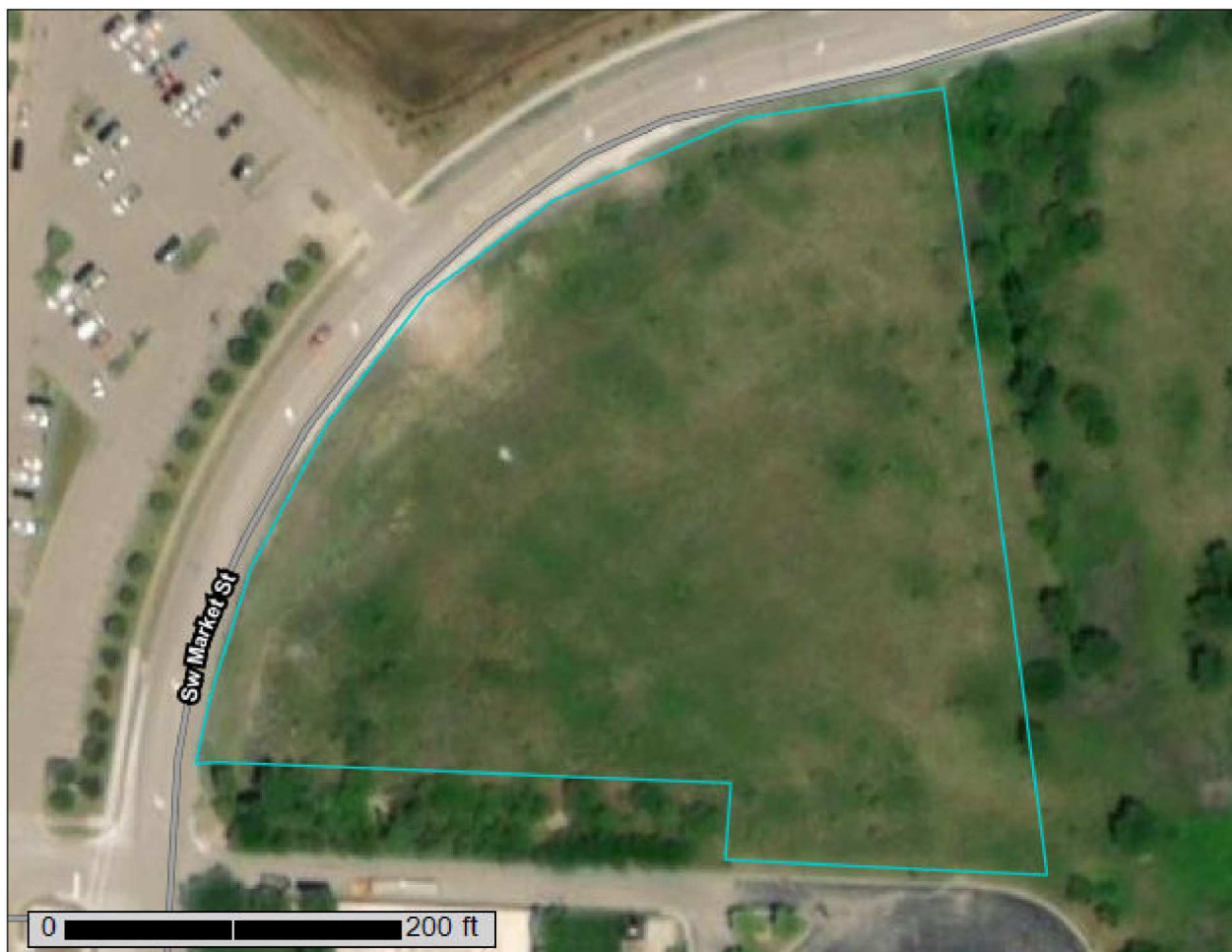
United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

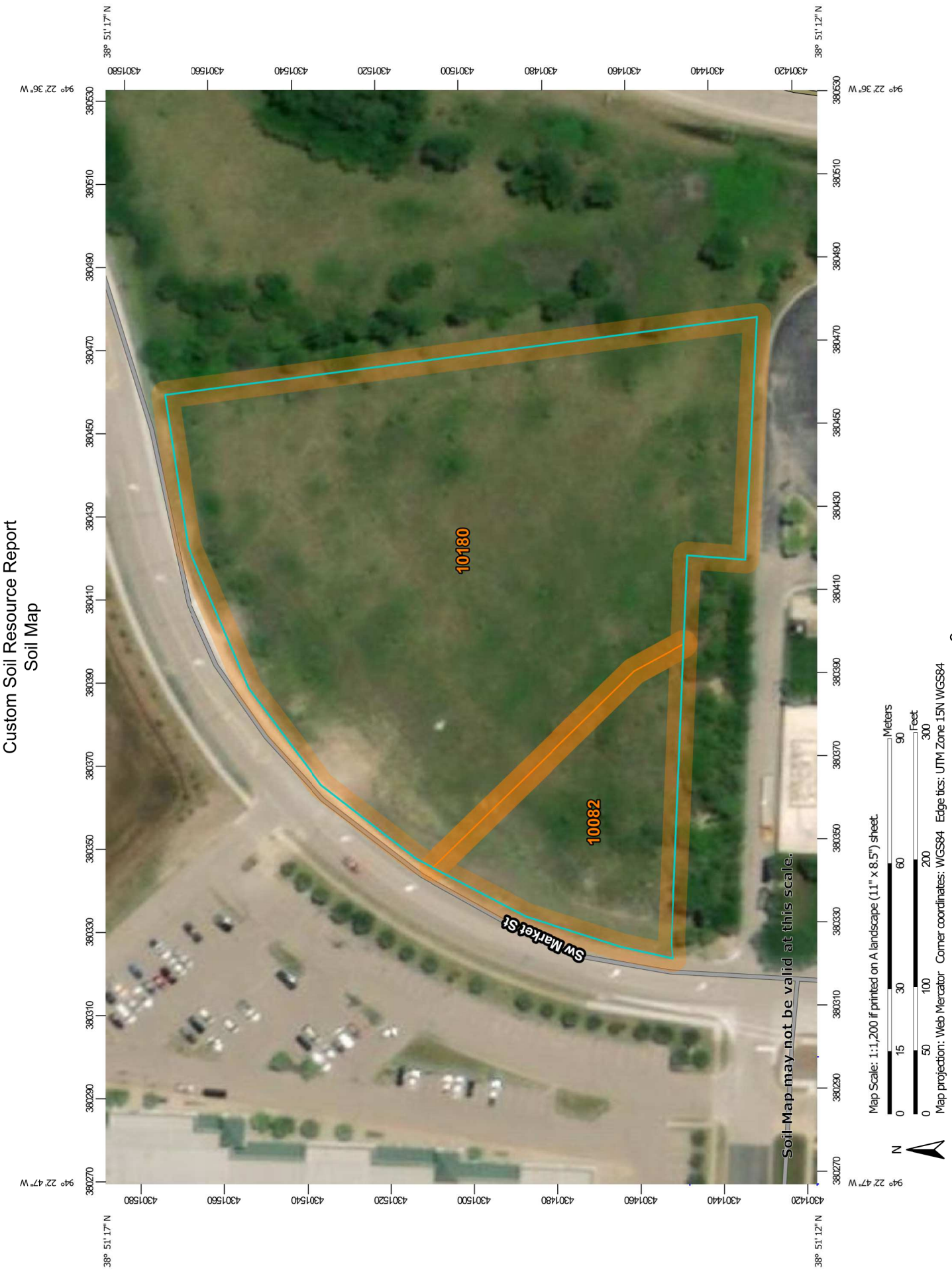
A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for **Jackson County, Missouri**



October 22, 2019

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 20, Sep 16, 2019

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	0.6	16.6%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	3.0	83.4%
Totals for Area of Interest		3.6	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

Custom Soil Resource Report

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

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

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

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

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

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

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

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

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

Jackson County, Missouri

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

Map Unit Setting

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

Map Unit Composition

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

Description of Arisburg

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 3 percent

Landform: Hills

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Concave

Ecological site: Interbedded Sedimentary Upland Savanna (R109XY010MO)

Hydric soil rating: Yes

Greenton

Percent of map unit: 3 percent

Landform: Hillslopes

Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex

Ecological site: Loess Upland Prairie (R109XY002MO)

Hydric soil rating: No

Sharpsburg

Percent of map unit: 3 percent

Landform: Ridges

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Interfluve

Down-slope shape: Linear

Across-slope shape: Linear

Ecological site: Loess Upland Prairie (R109XY002MO)

Hydric soil rating: No

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

Map Unit Setting

National map unit symbol: 1n85h

Elevation: 600 to 900 feet

Mean annual precipitation: 33 to 43 inches

Mean annual air temperature: 50 to 57 degrees F

Frost-free period: 175 to 220 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Udarents and similar soils: 41 percent

Urban land: 39 percent

Sampsel and similar soils: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Crest

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam

C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Somewhat poorly drained

Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: C

Ecological site: Deep Loess Upland Prairie (R107BY002MO)

Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)

Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Interfluve

Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Hydric soil rating: No

Description of Sampsel

Setting

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

Typical profile

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

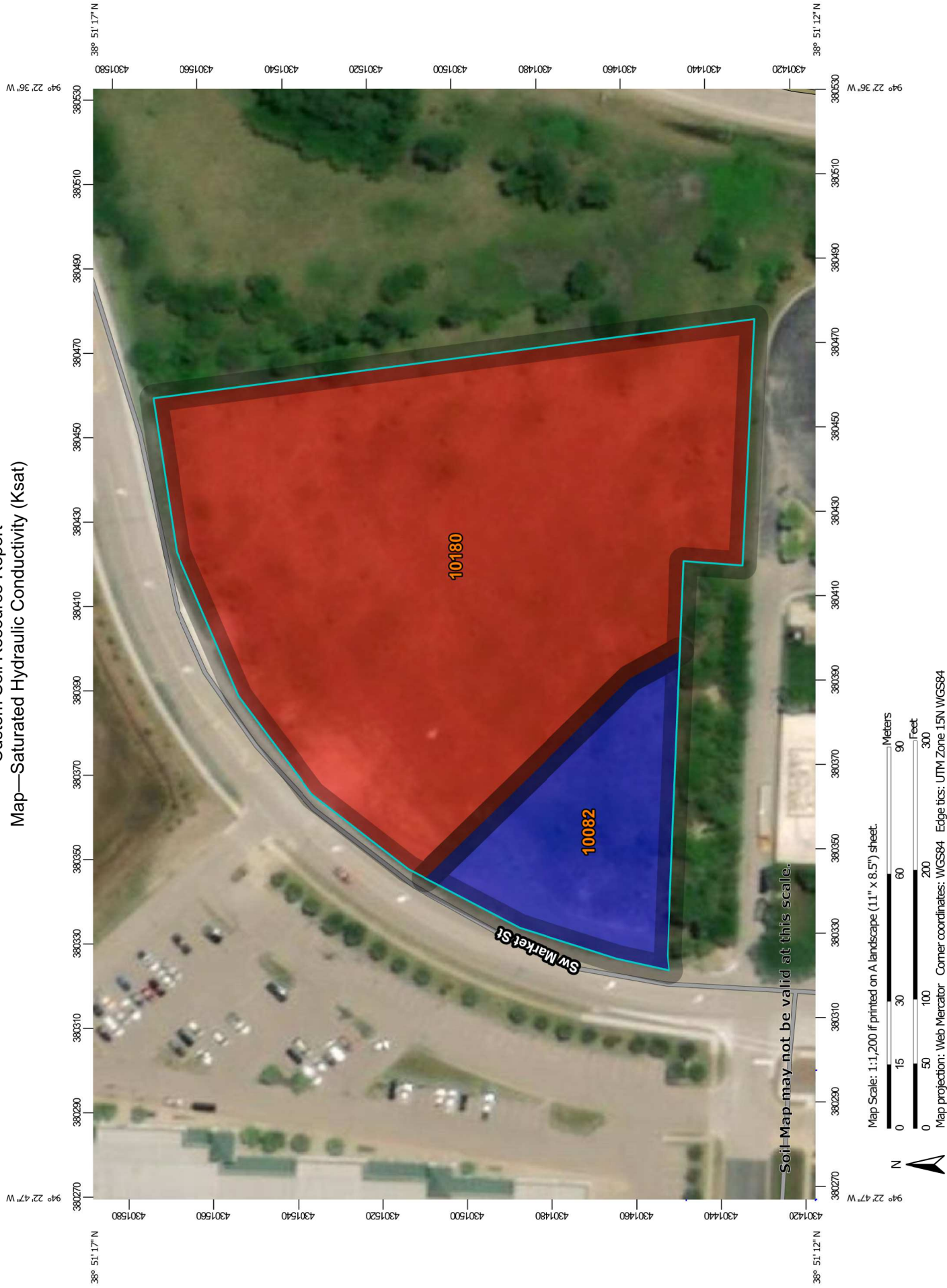
Properties and qualities

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

Interpretive groups


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

Custom Soil Resource Report
Map—Saturated Hydraulic Conductivity (Ksat)




MAP LEGEND


Area of Interest (AOI)


 Area of Interest (AOI)

Soils


Soil Rating Polygons



≤ 2.9163



> 2.9163 and ≤ 3.8300


Not rated or not available


Soil Rating Lines



≤ 2.9163



> 2.9163 and ≤ 3.8300


Not rated or not available


Soil Rating Points


≤ 2.9163



> 2.9163 and ≤ 3.8300



Not rated or not available


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 20, Sep 16, 2019

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

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

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

Table—Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	3.8300	0.6	16.6%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	2.9163	3.0	83.4%
Totals for Area of Interest			3.6	100.0%

Rating Options—Saturated Hydraulic Conductivity (Ksat)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): All Layers (Weighted Average)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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

Custom Soil Resource Report

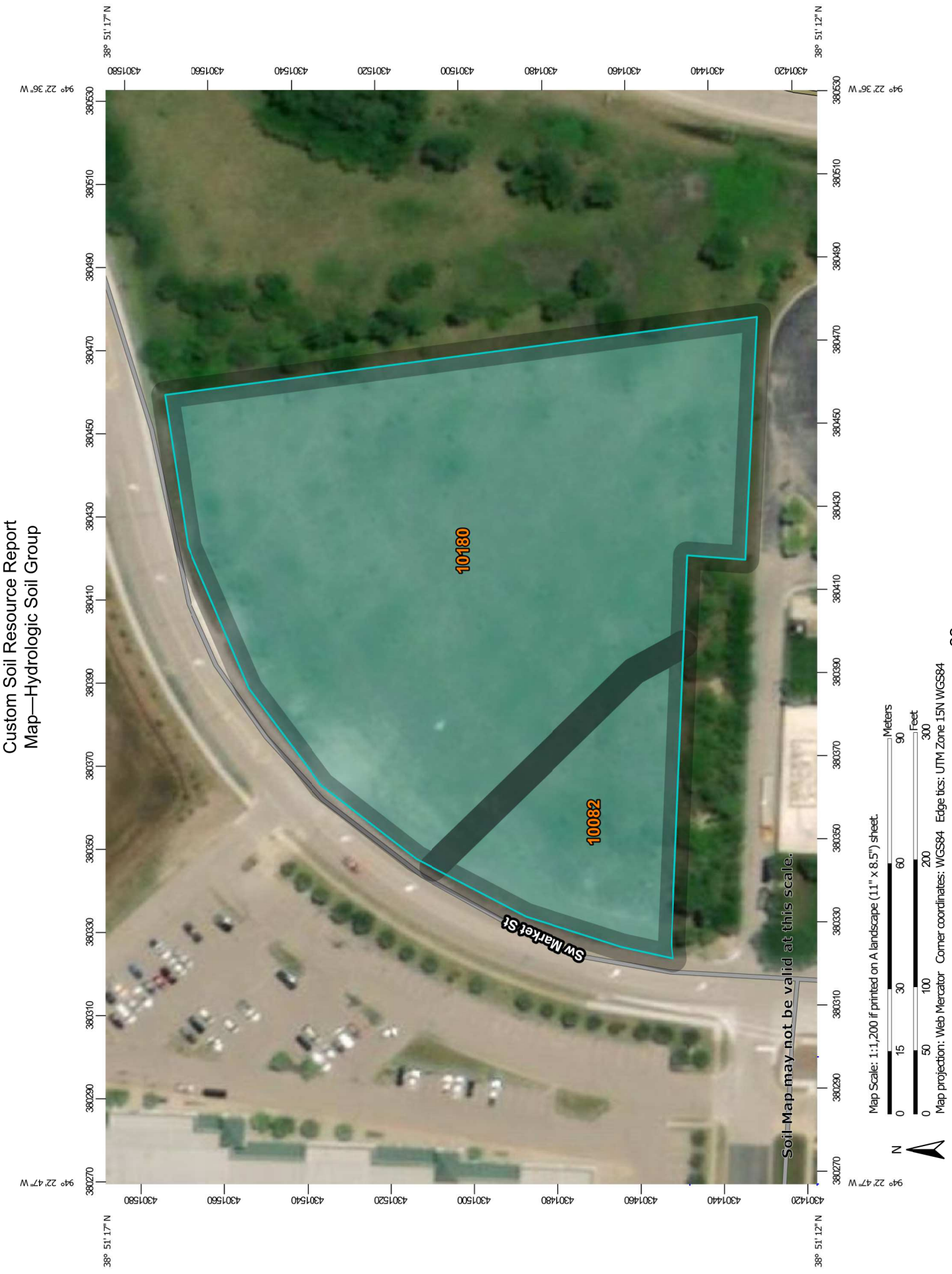
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

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

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Custom Soil Resource Report
Map—Hydrologic Soil Group



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D

C
C/D
D
Not rated or not available

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 20, Sep 16, 2019

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

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

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	C	0.6	16.6%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	C	3.0	83.4%
Totals for Area of Interest			3.6	100.0%

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher