

KOONTZ RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 21, 2016

Project Name: Koontz Rd

Municipality: Loyalhanna Township

County: Westmoreland

Total Area (acres): 2.10

Major River Basin: Ohio

Watershed: Loyalhanna Creek

Sub Basin: Loyalhanna Creek

Nearest Surface Water to Receive Runoff: Lower Loyalhanna Creek (Serviceberry Run)

Ch. 93 - Designated Water Use: HQ-WWF

Impaired according to Chapter 303(d) list?
List Causes of Impairment:

YES ☐
NO ☒

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES ☐
NO ☒

Existing or Planned drinking water supply?

YES ☐
NO ☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES ☐
NO ☒

Existing River Conservation Plan?

YES ☐
NO ☒

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	2.1	1.34
Other:			
TOTAL EXISTING:	Yes	2.1	1.34

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>1.34</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>1.34</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
2.1	-	1.34	=	0.76
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn _____ ft² x 1/4 in x 1/12 = _____ ft³

Meadow _____ ft² x 1/3 in x 1/12 = _____ ft³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy _____ ft² x 1/2 in x 1/12 = _____ ft³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft² x 1/3 in x 1/12 = _____ ft³

For all other disconnected roof areas

Roof Area _____ ft² x 1/4 in x 1/12 = _____ ft³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas _____ ft² x 1/3 in x 1/12 = _____ ft³

For all other disconnected roof areas

Impervious Areas _____ ft² x 1/4 in x 1/12 = _____ ft³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

ft³

* For use on Worksheet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Koontz Rd
 Drainage Area: 2.10 acres
 2-Year Rainfall: 2.44 in

Total Site Area: 2.10 acres
 Protected Site Area: 1.34 acres
 Managed Site Area: 0.76 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C	9874	0.23	71	4.08	0.82	0.46	380
80% Existing Gravel	C	1177	0.03	89	1.24	0.25	1.40	138
Meadow (20% Gravel)	C	294	0.01	71	4.08	0.82	0.46	11
Woods	C	1168	0.03	70	4.29	0.86	0.43	42
Meadow	C/D	17950	0.41	78	2.82	0.56	0.75	1,121
80% Existing Gravel	C/D	2582	0.06	91	0.99	0.20	1.56	335
Meadow (20% Gravel)	C/D	645	0.01	78	2.82	0.56	0.75	40
TOTAL:		33,690	0.77					2,066

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C	10123	0.23	71	4.08	0.82	0.46	389
Gravel	C	2411	0.06	89	1.24	0.25	1.40	282
Meadow	C/D	13239	0.30	78	2.82	0.56	0.75	827
Gravel	C/D	7938	0.18	91	0.99	0.20	1.56	1,029
TOTAL:		33,711	0.77					2,527

2-Year Volume Increase (ft ³):	461

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Koontz Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 461

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³)
(Required Control Volume minus Non-structural Credit) 461

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	2,400	1,617
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			1,617
			Structural Volume Requirement (ft³): 461
			DIFFERENCE: -1,156

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP

LOCATION: Koontz Road, Westmoreland County, PA

DONE BY: RJM

DATE: 10/21/2016

CHECKED BY: LMD

DATE: 10/23/2016

CHANNEL OR CHANNEL SECTION	DD-1				
TEMPORARY OR PERMANENT? (T OR P)	P				
DESIGN STORM (2, 5, 10, OR 100 YR)	100				
ACRES (AC)	1.07				
MULTIPLIER (1.6, 2.25, or 2.75) ¹	N/A				
Q _r (REQUIRED CAPACITY) (CFS)	4.75				
Q (CALCULATED AT FLOW DEPTH d) (CFS)	4.75				
S (BED SLOPE) ³ (FT/FT)	0.06				
DESIGN METHOD FOR PROTECTIVE LINING ⁵ PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V				
PROTECTIVE LINING ²	NAG P300				
n (MANNING'S COEFFICIENT) ²	0.081				
V _a (ALLOWABLE VELOCITY) (FPS)	5.00				
V (CALCULATED AT FLOW DEPTH) (FPS)	2.56				
t _a (MAX ALLOWABLE SHEAR STRESS) (LB/FT ²)	N/A				
t _d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT ²)	N/A				
CHANNEL BOTTOM WIDTH (FT)	1				
CHANNEL LEFT SIDE SLOPE (_LH:1V)	2				
CHANNEL RIGHT SIDE SLOPE (_RH:1V)	2				
D (TOTAL DEPTH) (FT)	1.50				
CHANNEL TOP WIDTH @ D (FT)	7.00				
d (CALCULATED FLOW DEPTH) (FT)	0.75				
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	4.00				
BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)	1.33				
d ₅₀ STONE SIZE (IN)	N/A				
A (CROSS-SECTIONAL AREA) (SQ. FT.)	1.88				
R (HYDRAULIC RADIUS)	0.43				
S _c (CRITICAL SLOPE) (FT/FT)	0.138				
.7S _c (FT/FT)	0.096				
1.3S _c (FT/FT)	0.179				
STABLE FLOW? (Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW (FT)	N/A				
FREEBOARD BASED ON STABLE FLOW (FT)	0.75				
MINIMUM REQUIRED FREEBOARD ⁴	0.5				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.,
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

**PCSM - DESIGN CALCULATIONS
KOONTZ RD**

TETRA TECH, INC.

By: RJM Date: 10/21/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/23/16 Koontz Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations Koontz Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Koontz Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Koontz Road Block Valve Site is located in Loyalhanna Township, Westmoreland County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.44
10-yr	3.43
50-yr	4.57
100-yr	5.11

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RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.44 in
Total Site Area : 2.1 acres
Protected Site Area: 1.34 acres
Stormwater Management Area 0.76 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.227	71	4.08	0.82	0.46	380
80% Existing Gravel	C	0.027	89	1.24	0.25	1.40	138
Meadow (20% Gravel)	C	0.007	71	4.08	0.82	0.46	11
Woods	C	0.027	70	4.29	0.86	0.43	42
Meadow	C/D	0.412	78	2.82	0.56	0.75	1,121
80% Existing Gravel	C/D	0.059	91	0.99	0.20	1.56	335
Meadow (20% Gravel)	C/D	0.015	78	2.82	0.56	0.75	40
Total		0.77					2,066

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.23	71	4.08	0.82	0.46	389
Gravel	C	0.06	89	1.24	0.25	1.40	282
Meadow	C/D	0.30	78	2.82	0.56	0.75	827
Gravel	C/D	0.18	91	0.99	0.20	1.56	1,029
Total		0.77					2,527

2-Year Volume Increase (cf):	461

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]
P = 2-Year Rainfall (in)
S = $(1000/CN) - 10$
2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
Q = Runoff (in)
Area = Land use area (sq. ft.)

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IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.24	9102.45
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,820
Design Infiltration Area (sf):		2,400
Design Impervious Ratio:	3.8	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.48	21064.70
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		2,633
Design Infiltration Area (sf):		2,400
Design Total Watershed Ratio:	8.8	:1

A diversion channel has been added along the northeast side of the pad to minimize the drainage area to the infiltration berm.

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Koontz Road Block Valve Site will be located along the southern edge of the pad and 100 percent of the disturbed area will be detained by the BMP.

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INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - Infiltration Berm 1	3.5

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

Infiltration Berm 1

Storage Volume

Width (ft)	Length (ft)	Cross Section Area	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
16	150	13.6	2,400	2.00	2040

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
3.5	2,400	2	1400

Volume Abstraction Potential (cf)	3,440.00

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration Berm 1	1617	2040	2040	1617
Total Structural Credit (cf) (Worksheet 5)				1617

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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WATERSHED CHARACTERISTICS

The total watershed area for the project site is 2.10 acres. Based upon the soil survey of Westmoreland County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Cavode silt loam (CaB), Gilpin-Weikert channery silt loam (GwF), and Wharton silt loam (WrC) series which are primarily classified as HSG C/D, C, and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.57
C/D	WrC	Meadow	78	0.70
C/D	WrC	Woods	77	0.04
C/D	WrC	Existing Gravel (80%)	91	0.06
C/D	WrC	Meadow (20% Gravel)	78	0.01
C	GwF	Meadow	71	0.44
C	GwF	Existing Gravel (80%)	89	0.03
C	GwF	Meadow (20% Gravel)	71	0.01
C	GwF	Woods	70	0.25
			Totals	2.11

CN	75

Post-Development Condition

Diversion (Undetained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.57
C/D	WrC	Meadow	78	0.44
C/D	WrC	Woods	77	0.03
C	GwF	Meadow	71	0.03
			Totals	1.07

CN	78

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Infiltration Berm 1 (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	WrC	Meadow	78	0.15
C/D	WrC	Gravel	90	0.18
C/D	WrC	Woods	77	0.01
C	GwF	Meadow	71	0.41
C	GwF	Gravel	89	0.06
C	GwF	Woods	70	0.22
			Totals	1.03

CN	76

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachement C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.80	1,651	34.2	5.8	40.0
10	1.47	2,040	23.1	5.8	28.9
50	2.29	2,040	14.8	5.8	20.6
100	2.69	2,040	12.6	5.8	18.4

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

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DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,617	3,440.00	1,617
10	2,969	3,440.00	2,969
50	4,687	3,440.00	3,440
100	5,539	3,440.00	3,440

STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions Hydraflow documentation is included in Attachment C.

Storm Frequency	Pre-Development	Post-Development			Change (cfs)
	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	
2-yr	1.85	2.3	3,779	1.19	-0.66
10-yr	3.99	4.7	7,599	2.35	-1.64
50-yr	6.78	7.8	13,915	3.84	-2.94
100-yr	8.19	9.3	17,429	5.28	-2.91

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REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Westmoreland County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4381 N 79.457 W 1086.77 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Loyalhanna Twp, Pennsylvania,
USA*

Latitude: 40.4381°, Longitude: -79.457°

Elevation: 1086.77 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.314 (0.283-0.346)	0.374 (0.338-0.413)	0.453 (0.409-0.500)	0.514 (0.463-0.566)	0.592 (0.533-0.651)	0.652 (0.584-0.716)	0.709 (0.634-0.778)	0.770 (0.685-0.844)	0.850 (0.751-0.931)	0.910 (0.800-0.995)
10-min	0.487 (0.440-0.537)	0.584 (0.528-0.645)	0.703 (0.636-0.776)	0.793 (0.715-0.874)	0.905 (0.815-0.996)	0.988 (0.886-1.09)	1.07 (0.954-1.17)	1.15 (1.02-1.26)	1.25 (1.10-1.37)	1.32 (1.17-1.45)
15-min	0.597 (0.540-0.659)	0.714 (0.646-0.789)	0.864 (0.781-0.953)	0.976 (0.880-1.07)	1.12 (1.01-1.23)	1.22 (1.10-1.34)	1.33 (1.19-1.46)	1.43 (1.27-1.57)	1.56 (1.38-1.71)	1.66 (1.46-1.81)
30-min	0.790 (0.714-0.871)	0.955 (0.864-1.06)	1.18 (1.07-1.30)	1.35 (1.22-1.49)	1.58 (1.42-1.74)	1.75 (1.57-1.92)	1.92 (1.71-2.10)	2.09 (1.85-2.29)	2.31 (2.04-2.53)	2.48 (2.18-2.71)
60-min	0.965 (0.872-1.06)	1.17 (1.06-1.30)	1.48 (1.34-1.64)	1.72 (1.55-1.90)	2.05 (1.84-2.25)	2.30 (2.06-2.53)	2.56 (2.29-2.81)	2.83 (2.52-3.10)	3.20 (2.83-3.50)	3.49 (3.07-3.81)
2-hr	1.12 (1.02-1.23)	1.36 (1.24-1.49)	1.71 (1.56-1.88)	2.00 (1.81-2.19)	2.38 (2.16-2.60)	2.69 (2.43-2.94)	3.02 (2.71-3.28)	3.36 (3.00-3.64)	3.83 (3.39-4.14)	4.20 (3.70-4.54)
3-hr	1.20 (1.09-1.31)	1.45 (1.32-1.59)	1.81 (1.65-2.00)	2.11 (1.92-2.32)	2.53 (2.29-2.77)	2.87 (2.58-3.14)	3.22 (2.89-3.51)	3.60 (3.20-3.91)	4.12 (3.64-4.47)	4.54 (3.98-4.92)
6-hr	1.43 (1.30-1.59)	1.72 (1.57-1.91)	2.15 (1.95-2.38)	2.49 (2.26-2.76)	2.99 (2.70-3.29)	3.40 (3.06-3.73)	3.82 (3.42-4.19)	4.28 (3.80-4.68)	4.93 (4.33-5.38)	5.45 (4.75-5.93)
12-hr	1.72 (1.56-1.91)	2.06 (1.87-2.29)	2.54 (2.31-2.82)	2.94 (2.66-3.26)	3.53 (3.18-3.89)	4.01 (3.59-4.41)	4.52 (4.02-4.96)	5.07 (4.48-5.54)	5.87 (5.13-6.39)	6.52 (5.65-7.08)
24-hr	2.04 (1.90-2.21)	2.44 (2.27-2.64)	2.98 (2.77-3.22)	3.43 (3.18-3.70)	4.05 (3.75-4.37)	4.57 (4.21-4.91)	5.11 (4.69-5.48)	5.67 (5.18-6.08)	6.47 (5.87-6.92)	7.11 (6.41-7.59)
2-day	2.38 (2.22-2.57)	2.83 (2.64-3.06)	3.44 (3.20-3.71)	3.92 (3.65-4.22)	4.60 (4.27-4.95)	5.15 (4.76-5.53)	5.72 (5.26-6.13)	6.31 (5.78-6.74)	7.12 (6.49-7.59)	7.76 (7.04-8.27)
3-day	2.56 (2.39-2.75)	3.04 (2.84-3.26)	3.66 (3.42-3.92)	4.16 (3.88-4.45)	4.85 (4.51-5.19)	5.41 (5.01-5.77)	5.98 (5.52-6.38)	6.57 (6.05-7.00)	7.38 (6.76-7.85)	8.02 (7.31-8.52)
4-day	2.74 (2.56-2.93)	3.24 (3.04-3.47)	3.87 (3.63-4.14)	4.39 (4.11-4.68)	5.10 (4.75-5.43)	5.66 (5.27-6.02)	6.24 (5.79-6.63)	6.84 (6.32-7.26)	7.65 (7.03-8.11)	8.28 (7.58-8.78)
7-day	3.28 (3.09-3.49)	3.87 (3.64-4.12)	4.57 (4.30-4.86)	5.12 (4.81-5.45)	5.87 (5.50-6.24)	6.46 (6.05-6.86)	7.06 (6.58-7.48)	7.66 (7.12-8.11)	8.45 (7.83-8.95)	9.05 (8.36-9.58)
10-day	3.79 (3.59-4.00)	4.46 (4.23-4.72)	5.21 (4.94-5.51)	5.81 (5.50-6.13)	6.61 (6.24-6.97)	7.22 (6.81-7.61)	7.84 (7.37-8.26)	8.46 (7.92-8.90)	9.26 (8.64-9.74)	9.87 (9.18-10.4)
20-day	5.32 (5.05-5.60)	6.23 (5.92-6.58)	7.18 (6.83-7.58)	7.93 (7.53-8.37)	8.91 (8.45-9.39)	9.67 (9.15-10.2)	10.4 (9.83-10.9)	11.1 (10.5-11.7)	12.0 (11.3-12.7)	12.7 (11.9-13.4)
30-day	6.70 (6.39-7.03)	7.83 (7.47-8.23)	8.94 (8.53-9.40)	9.81 (9.35-10.3)	11.0 (10.4-11.5)	11.8 (11.2-12.4)	12.6 (12.0-13.2)	13.4 (12.7-14.1)	14.5 (13.7-15.2)	15.2 (14.3-15.9)
45-day	8.59 (8.22-8.99)	10.0 (9.58-10.5)	11.3 (10.8-11.8)	12.3 (11.7-12.9)	13.6 (12.9-14.2)	14.5 (13.8-15.1)	15.4 (14.6-16.1)	16.2 (15.4-16.9)	17.2 (16.3-18.0)	17.9 (17.0-18.7)
60-day	10.4 (9.95-10.8)	12.0 (11.6-12.6)	13.5 (12.9-14.1)	14.6 (14.0-15.2)	16.0 (15.3-16.7)	17.0 (16.2-17.7)	17.9 (17.1-18.7)	18.8 (17.9-19.6)	19.8 (18.9-20.7)	20.5 (19.5-21.4)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



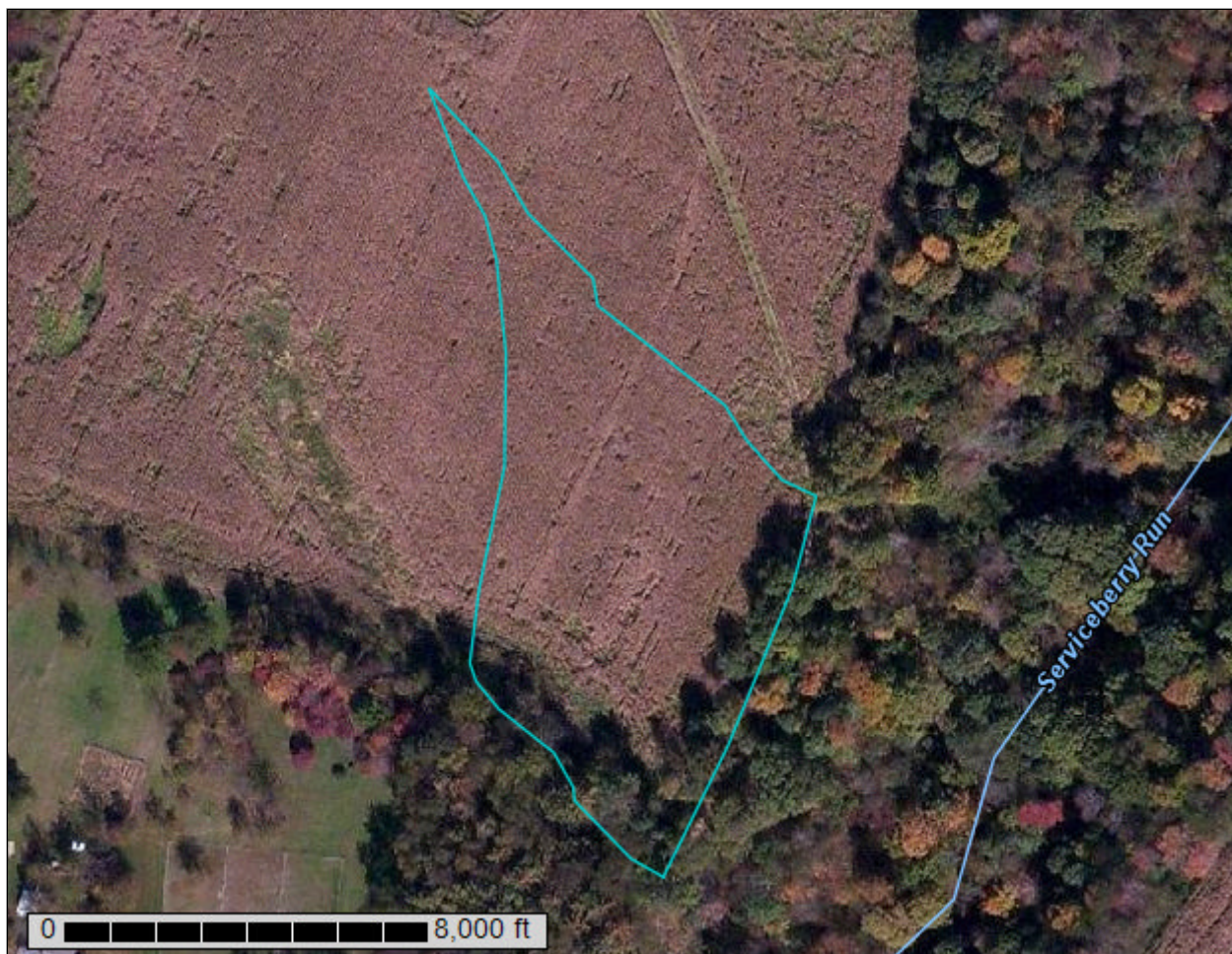
United States
Department of
Agriculture

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

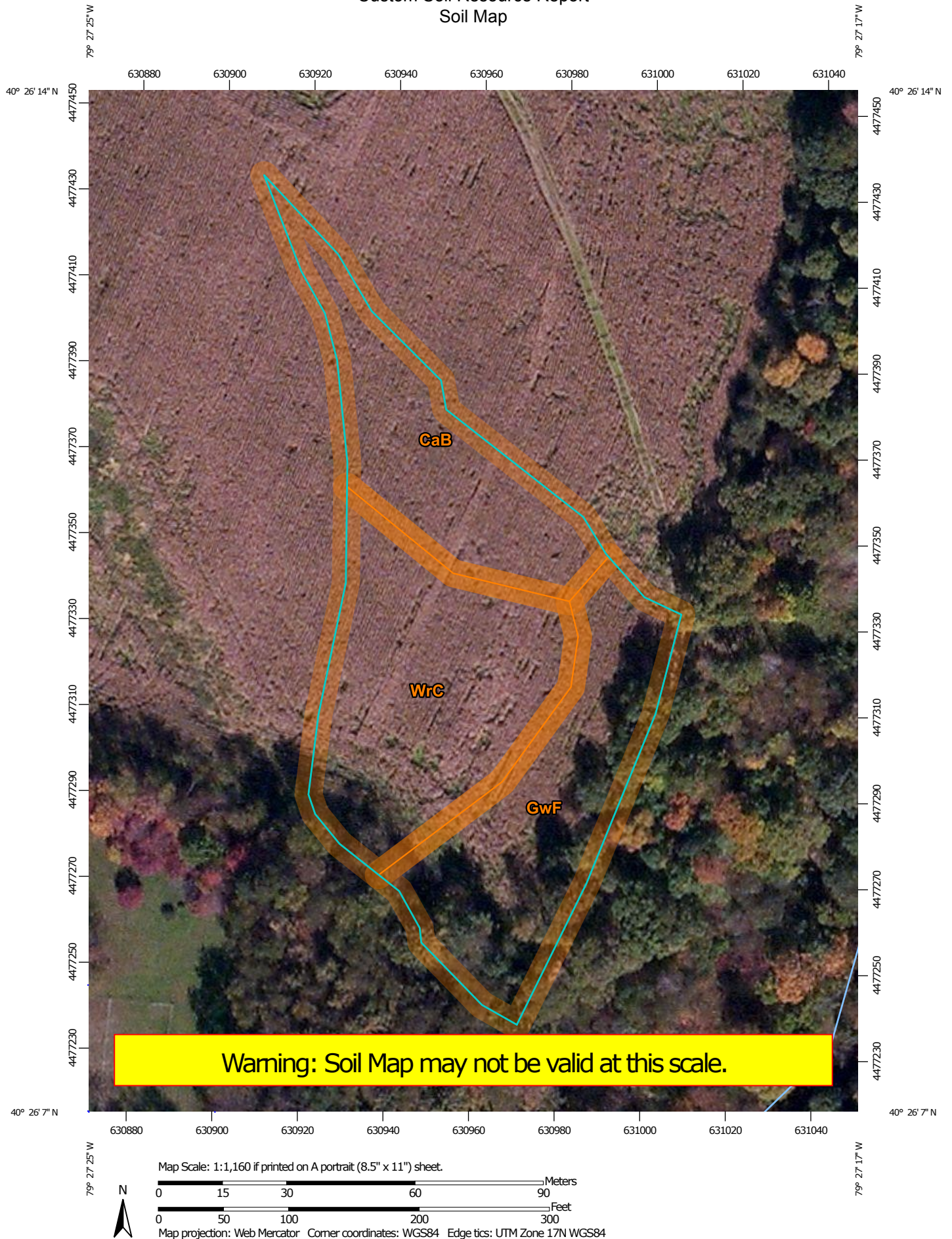
Custom Soil Resource Report for Westmoreland County, Pennsylvania



October 7, 2016

29 of 1484

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Soil Map Unit Polygons

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Special Line Features

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: <http://websoilsurvey.nrcs.usda.gov>
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: Westmoreland County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Westmoreland County, Pennsylvania (PA129)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CaB	Cavode silt loam, 3 to 8 percent slopes	0.6	26.9%
GwF	Gilpin-Weikert channery silt loams, 25 to 60 percent slopes	0.7	34.2%
WrC	Wharton silt loam, 8 to 15 percent slopes	0.8	38.9%
Totals for Area of Interest		2.1	100.0%

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

Westmoreland County, Pennsylvania

CaB—Cavode silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 18s4

Elevation: 1,000 to 1,700 feet

Mean annual precipitation: 36 to 46 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 130 to 160 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Cavode and similar soils: 85 percent

Minor components: 15 percent

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

Description of Cavode

Setting

Landform: Hills

Landform position (two-dimensional): Backslope, summit

Landform position (three-dimensional): Interfluve

Down-slope shape: Linear, concave

Across-slope shape: Concave

Parent material: Acid clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 10 inches: silt loam

Btg - 10 to 47 inches: silty clay loam

BCg - 47 to 57 inches: channery silt loam

R - 57 to 61 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: 40 to 90 inches to lithic bedrock

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 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent

Landform: Hills

Custom Soil Resource Report

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Draws, hills
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

GwF—Gilpin-Weikert channery silt loams, 25 to 60 percent slopes

Map Unit Setting

National map unit symbol: l8q3
Elevation: 800 to 1,700 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 60 percent
Weikert and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 30 inches: very channery loam
R - 30 to 35 inches: bedrock

Properties and qualities

Slope: 25 to 60 percent

Custom Soil Resource Report

Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Weikert

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Acid loamy residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: channery silt loam
Bw - 5 to 15 inches: very channery silt loam
C - 15 to 18 inches: extremely channery silt loam
R - 18 to 28 inches: bedrock

Properties and qualities

Slope: 25 to 65 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Shelocta

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope

Custom Soil Resource Report

Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear, convex
Hydric soil rating: No

Wharton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

WrC—Wharton silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t5mm
Elevation: 620 to 2,160 feet
Mean annual precipitation: 37 to 51 inches
Mean annual air temperature: 47 to 53 degrees F
Frost-free period: 161 to 205 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wharton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wharton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 9 inches: silt loam
Bt1 - 9 to 16 inches: silt loam
Bt2 - 16 to 22 inches: silt loam
Bt3 - 22 to 31 inches: silt loam
BC - 31 to 46 inches: silty clay loam
C - 46 to 69 inches: channery silty clay loam
Cr - 69 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent

Custom Soil Resource Report

Depth to restrictive feature: 40 to 71 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: About 16 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Rarden

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Ernest

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

ATTACHMENT C
KOONTZ RD
HYDRAFLOW RESULTS

ATTACHMENT C-1
KOONTZ RD
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Koontz Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.854	-----	-----	3.989	-----	6.779	8.185	Koontz Rd - PRE
Proj. file: Koontz Rd - Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.854	1	721	4,801	-----	-----	-----	Koontz Rd - PRE
Koontz Rd - Pre.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

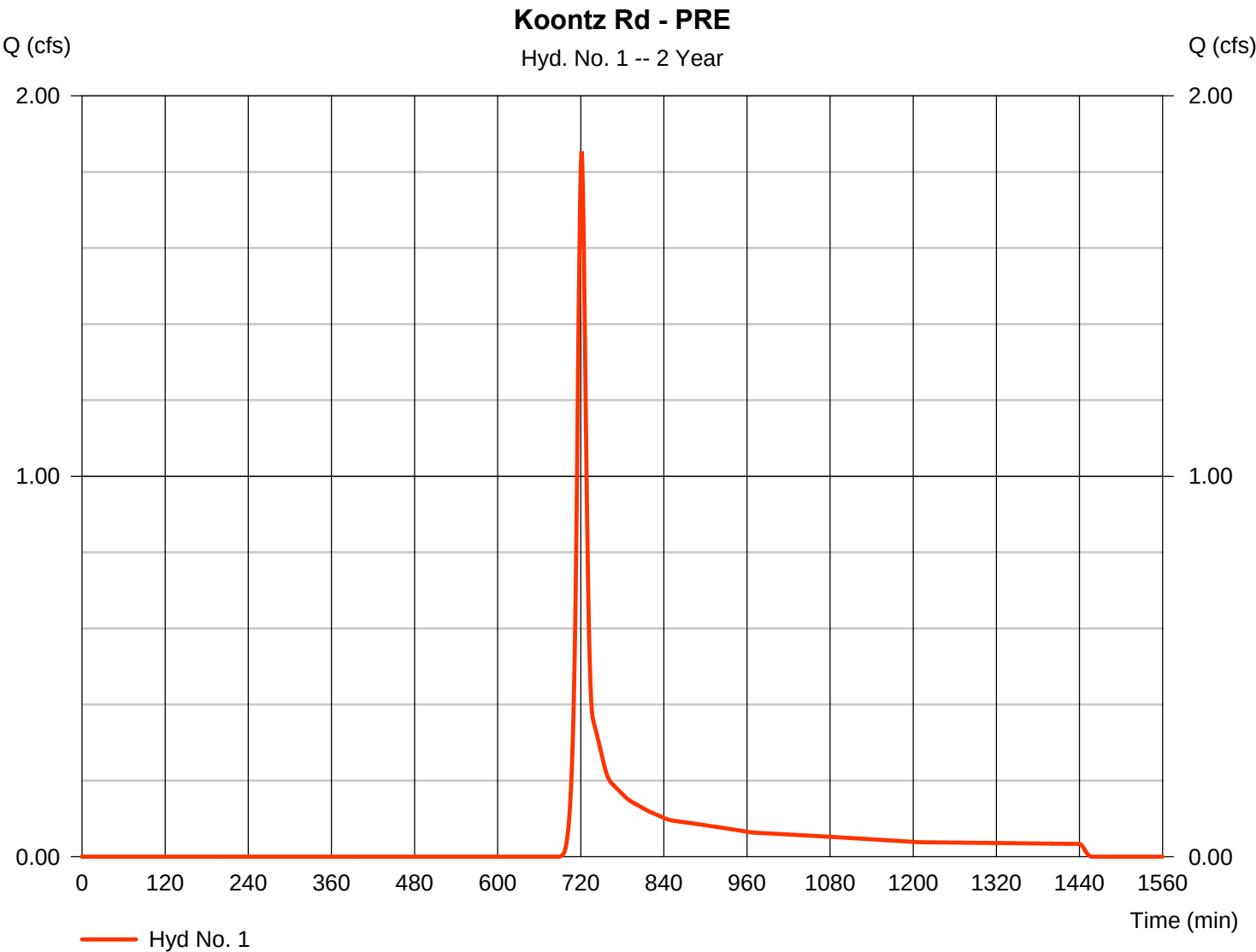
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.854 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	4,801 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

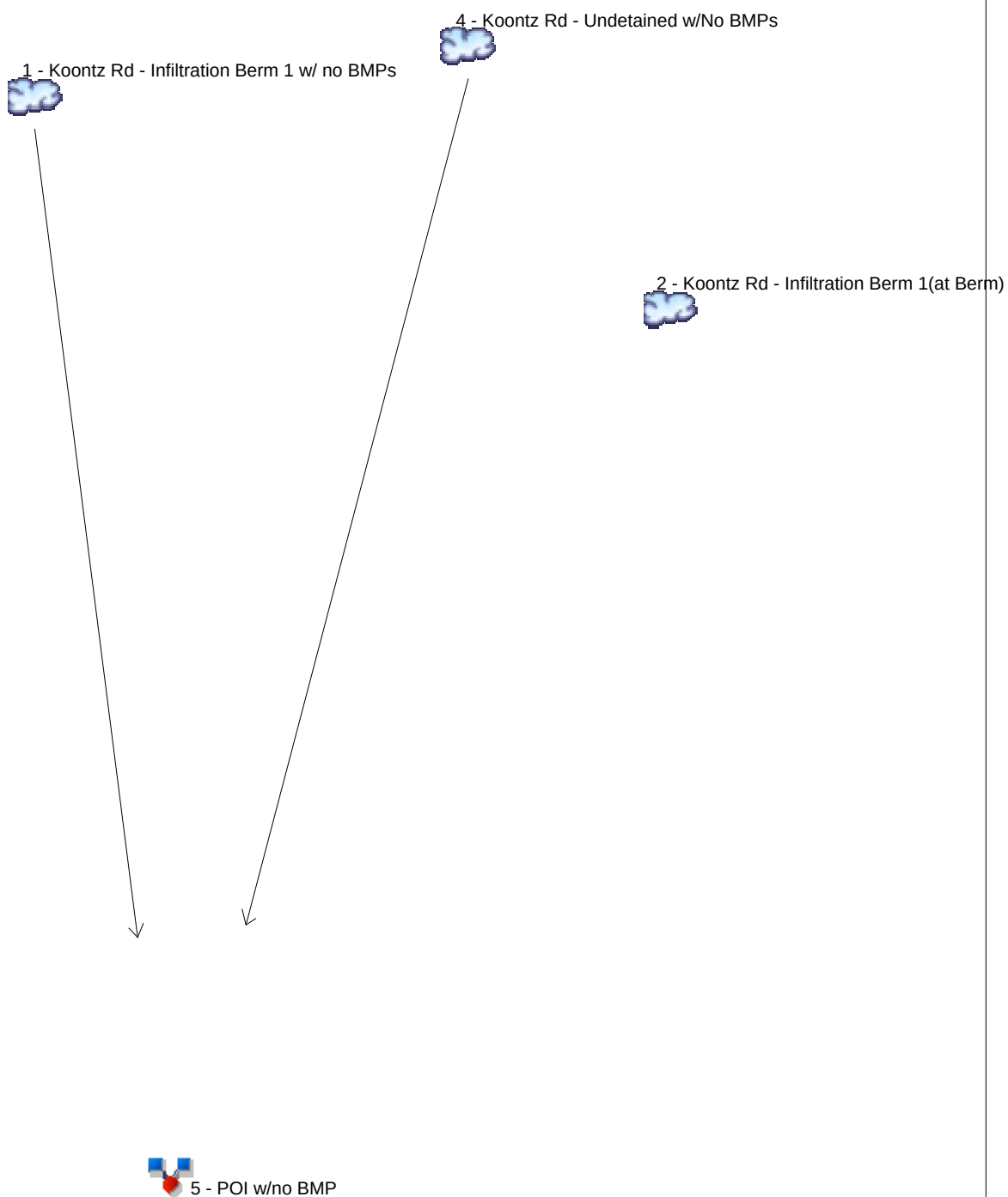
Hyd. No. 1

Koontz Rd - PRE

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 345.00	260.00	0.00				
Watercourse slope (%)	= 6.00	15.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.25	0.00				
Travel Time (min)	= 1.45	+	0.69	+	0.00	=	2.15
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				11.70 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.228	-----	-----	2.523	-----	4.183	5.004	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	-----	-----	0.804	-----	-----	1.473	-----	2.293	2.690	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	-----	-----	1.187	-----	-----	2.351	-----	3.843	4.579	Koontz Rd - Undetained w/No BMPs
5	Combine	1, 4	-----	2.319	-----	-----	4.698	-----	7.760	9.285	POI w/no BMP
Proj. file: Koontz Rd - Post With No BMP.gpw Friday, 11 / 4 / 2016											

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.228	1	718	2,539	-----	-----	-----	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	0.804	1	718	1,617	-----	-----	-----	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	1.187	1	721	2,962	-----	-----	-----	Koontz Rd - Undetained w/No BMPs
5	Combine	2.319	1	719	5,501	1, 4	-----	-----	POI w/no BMP
Koontz Rd - Post With No BMP.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

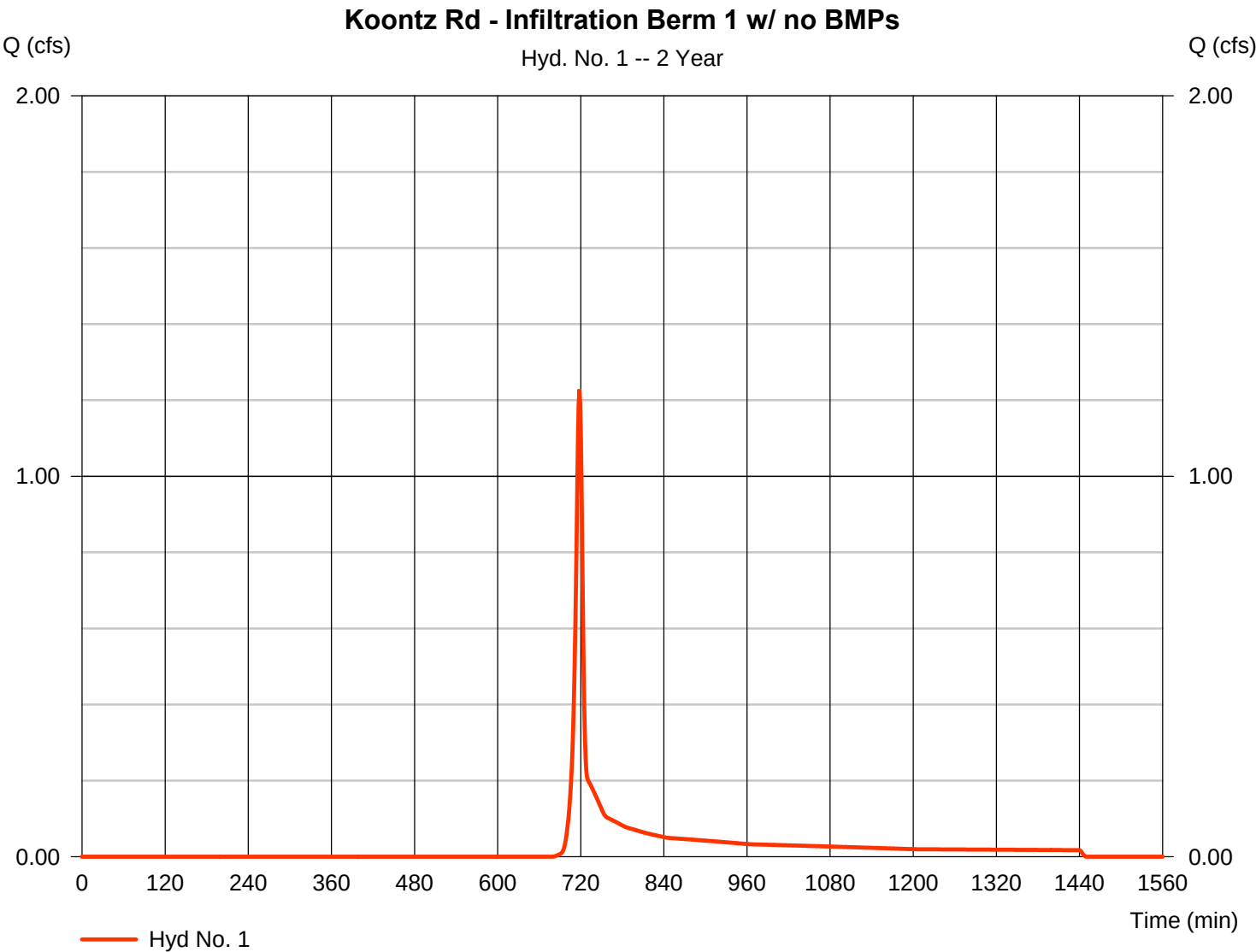
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.228 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	2,539 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	187.00	0.00				
Watercourse slope (%)	= 10.00	17.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	6.65	0.00				
Travel Time (min)	= 0.10	+	0.47	+	0.00	=	0.57
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				5.80 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

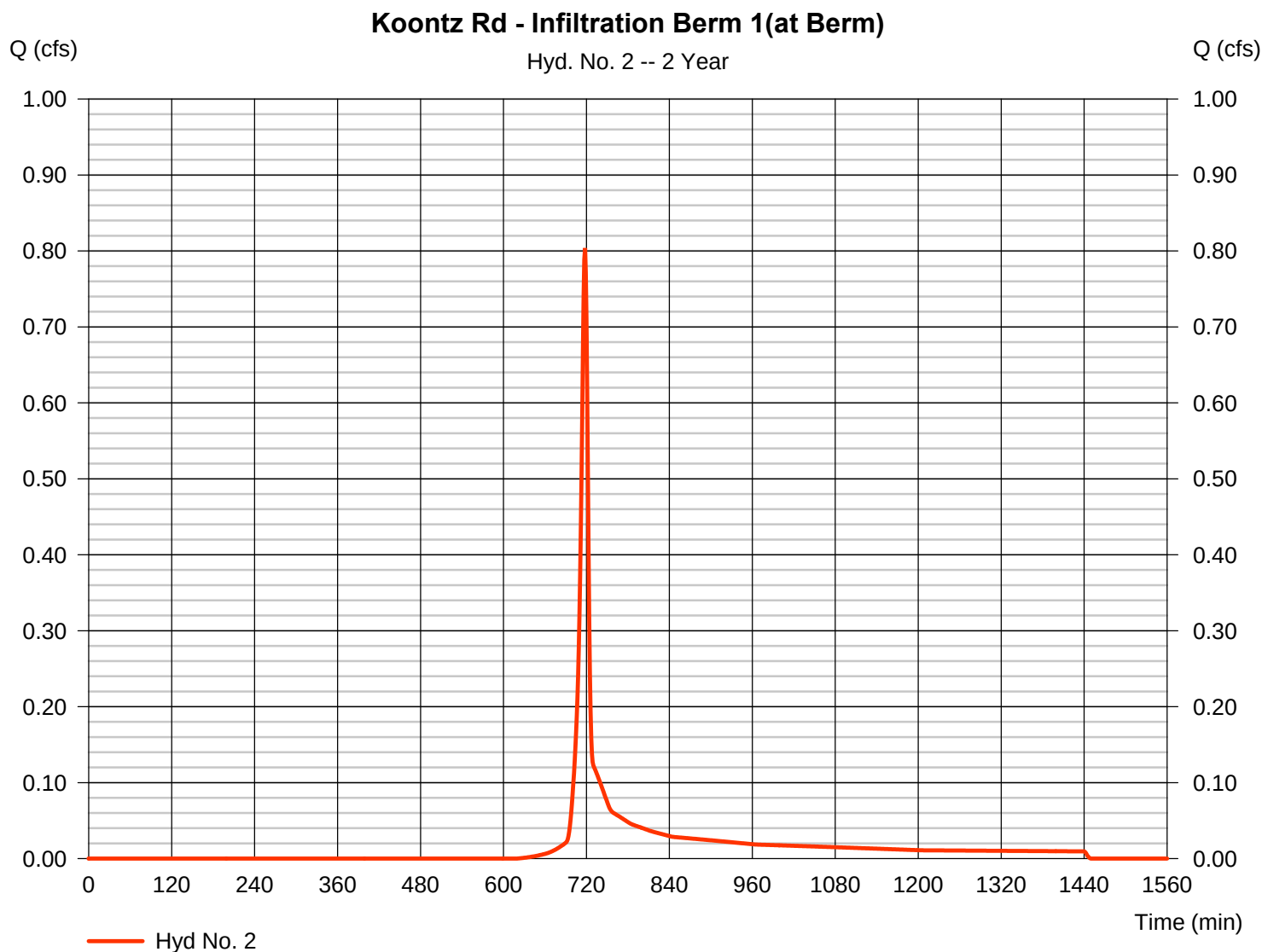
Friday, 11 / 4 / 2016

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type = SCS Runoff
 Storm frequency = 2 yrs
 Time interval = 1 min
 Drainage area = 0.480 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.44 in
 Storm duration = 24 hrs

Peak discharge = 0.804 cfs
 Time to peak = 718 min
 Hyd. volume = 1,617 cuft
 Curve number = 81
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 5.30 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	0.00	0.00				
Watercourse slope (%)	= 10.00	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	0.00	0.00				
Travel Time (min)	= 0.10	+	0.00	+	0.00	=	0.10
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				5.30 min			

Hydrograph Report

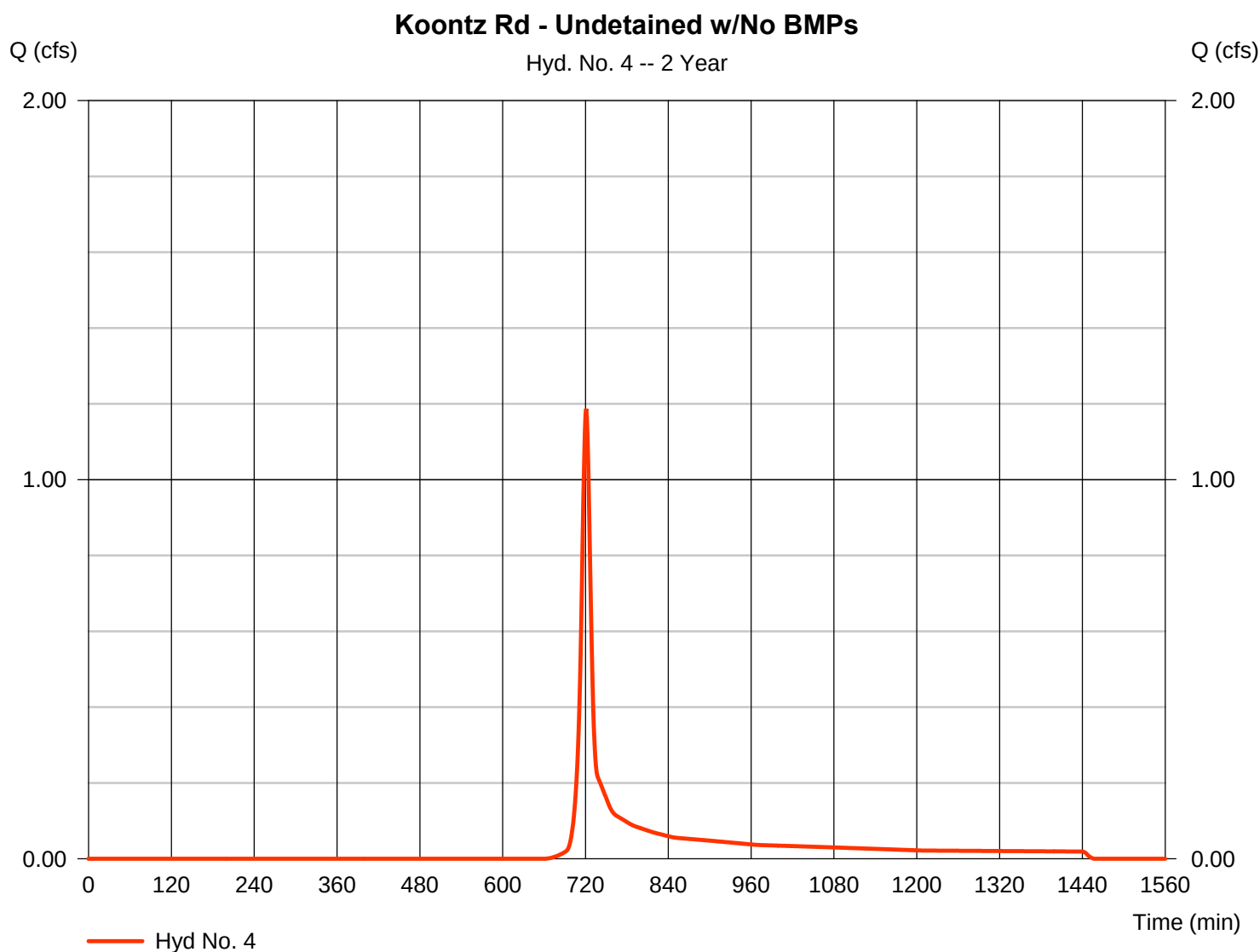
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.187 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	2,962 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	(0)224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

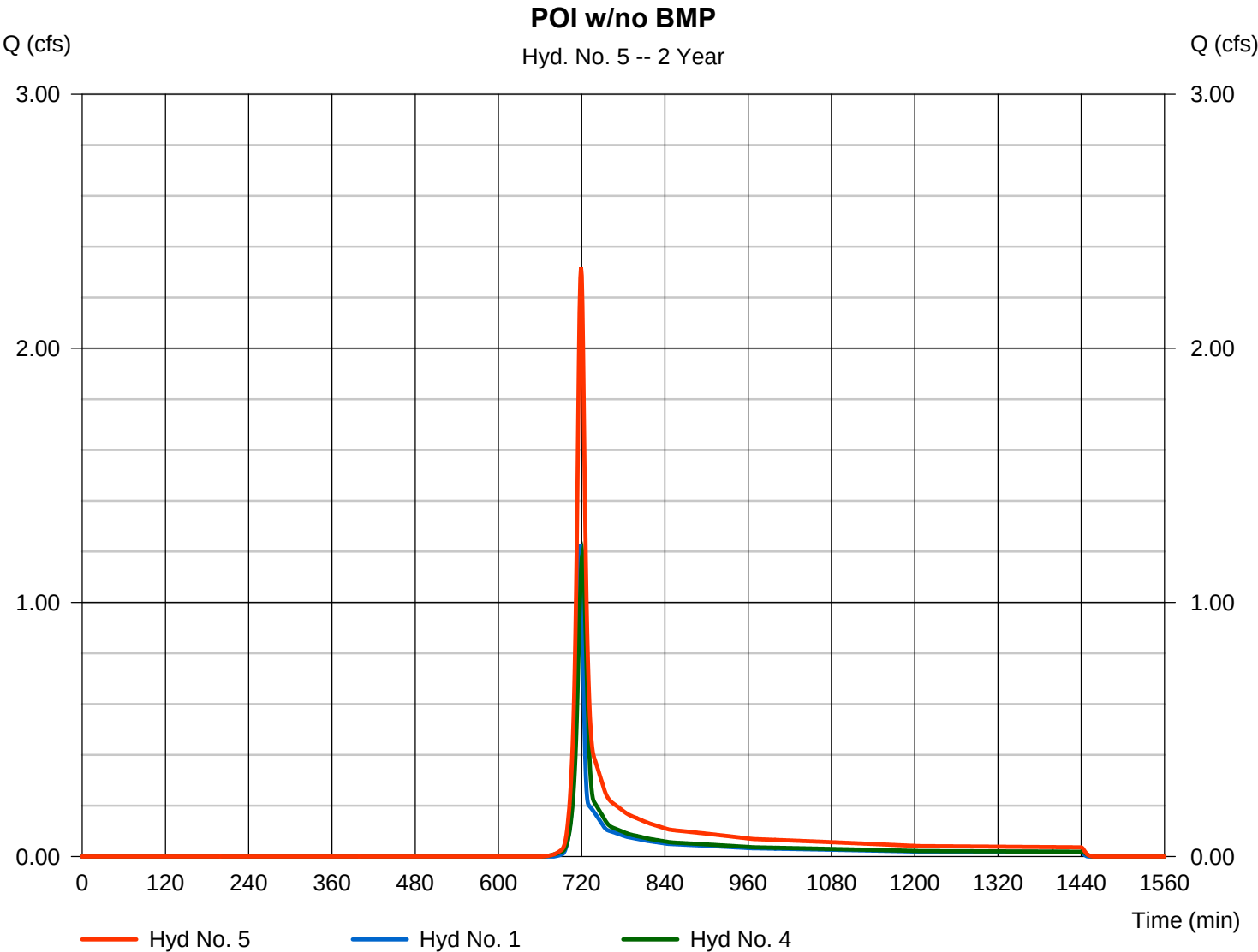
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

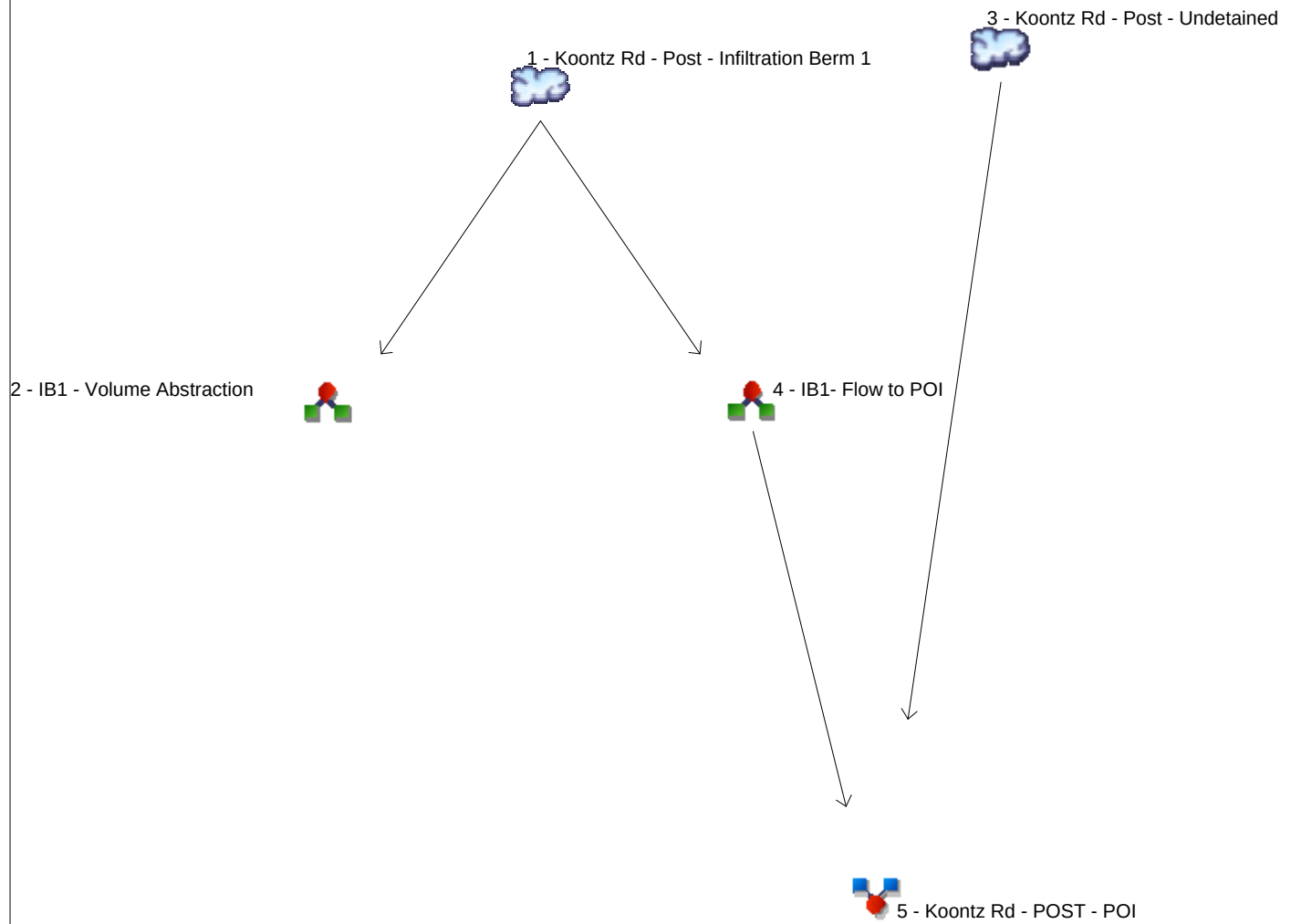
POI w/no BMP

Hydrograph type	= Combine	Peak discharge	= 2.319 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 5,501 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.756	-----	-----	-----	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	1	-----	0.756	-----	-----	-----	-----	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	-----	-----	1.187	-----	-----	-----	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	1	-----	0.044	-----	-----	-----	-----	-----	-----	IB1- Flow to POI
5	Combine	3, 4	-----	1.187	-----	-----	-----	-----	-----	-----	Koontz Rd - POST - POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.756	1	725	2,434	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	0.756	1	725	1,617	1	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	1.187	1	721	2,962	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	0.044	1	885	817	1	-----	-----	IB1- Flow to POI
5	Combine	1.187	1	721	3,779	3, 4	-----	-----	Koontz Rd - POST - POI
Koontz Rd - Post WithBMP -2yr.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

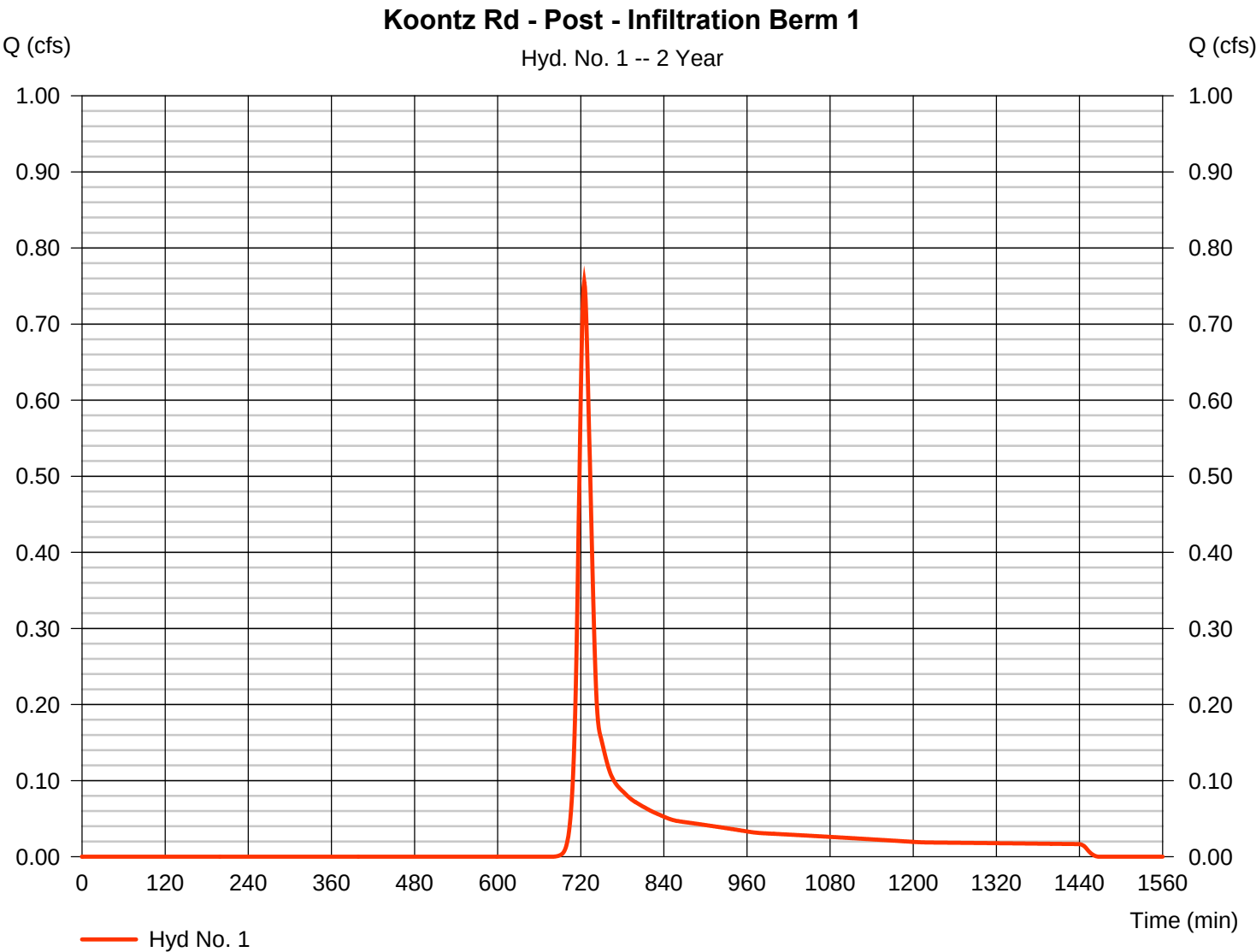
Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.756 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	2,434 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.40 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



Hydrograph Report

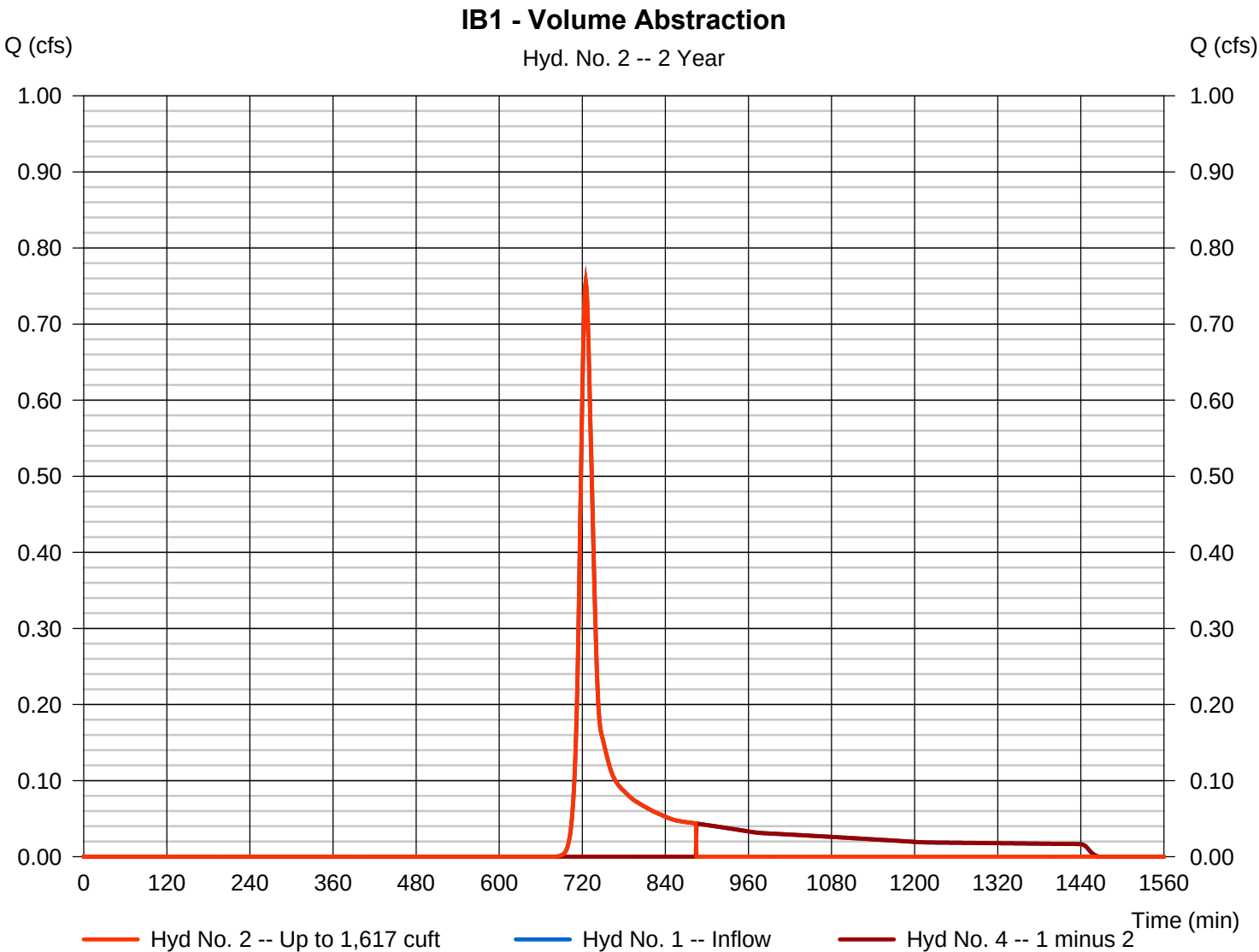
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

IB1 - Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.756 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	1,617 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	1,617 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

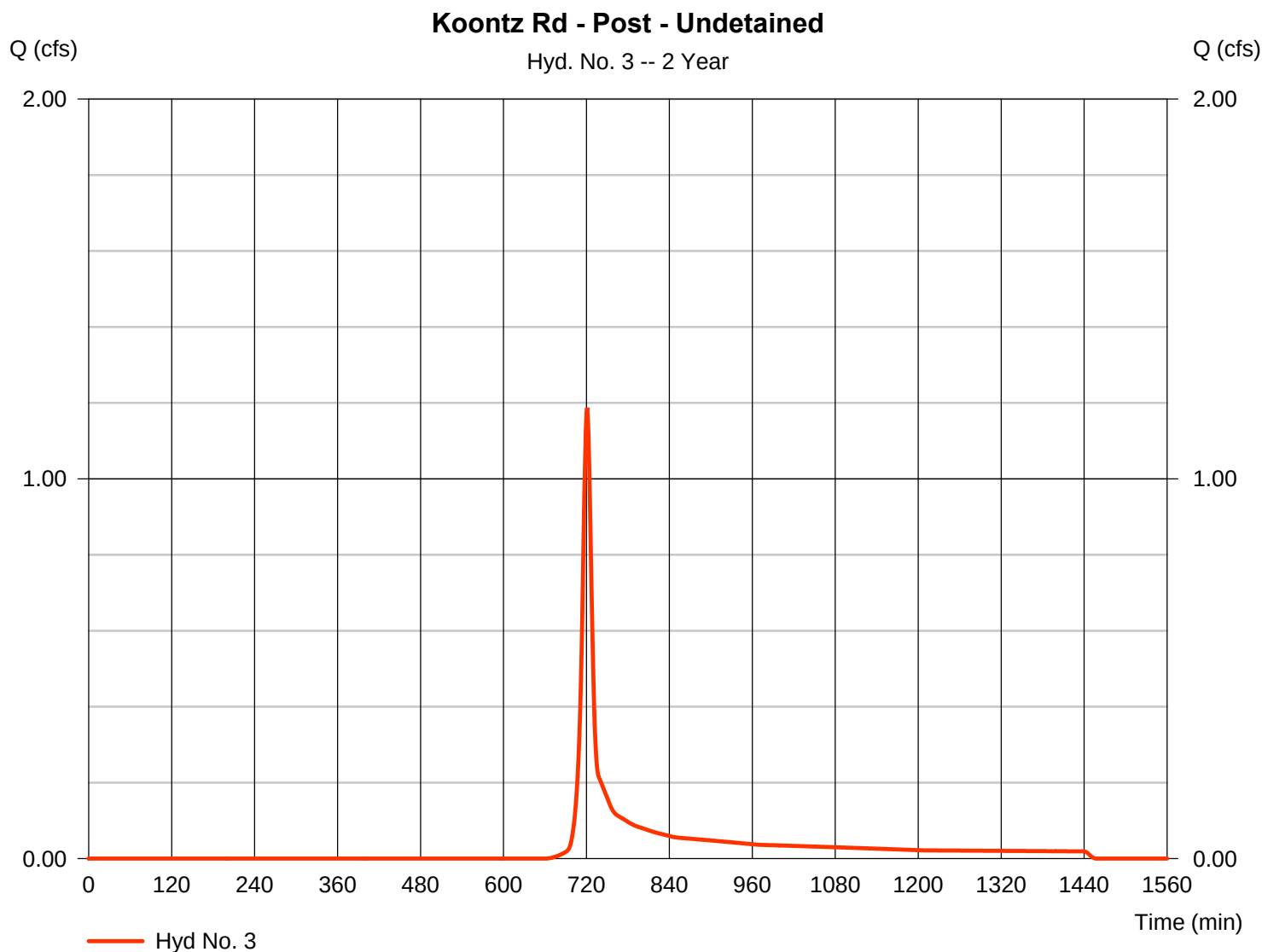
Friday, 11 / 4 / 2016

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type = SCS Runoff
 Storm frequency = 2 yrs
 Time interval = 1 min
 Drainage area = 1.070 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.44 in
 Storm duration = 24 hrs

Peak discharge = 1.187 cfs
 Time to peak = 721 min
 Hyd. volume = 2,962 cuft
 Curve number = 78
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 11.30 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Koontz Rd - Post - Undetained

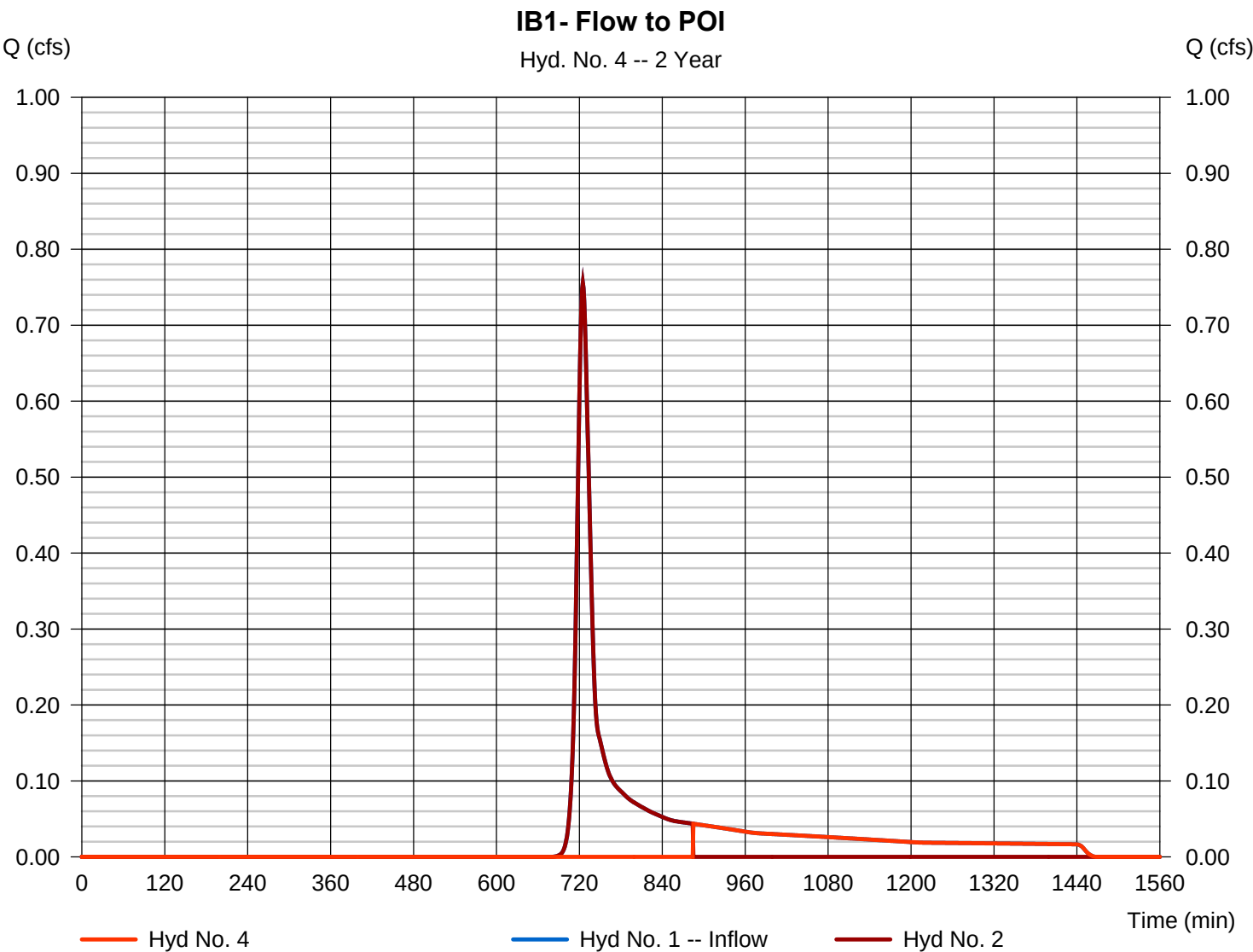
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

Hyd. No. 4

IB1- Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.044 cfs
Storm frequency	=	2 yrs	Time to peak	=	885 min
Time interval	=	1 min	Hyd. volume	=	817 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	2
Diversion method	=	First Flush Volume	Volume Up To	=	1,617 cuft



Hydrograph Report

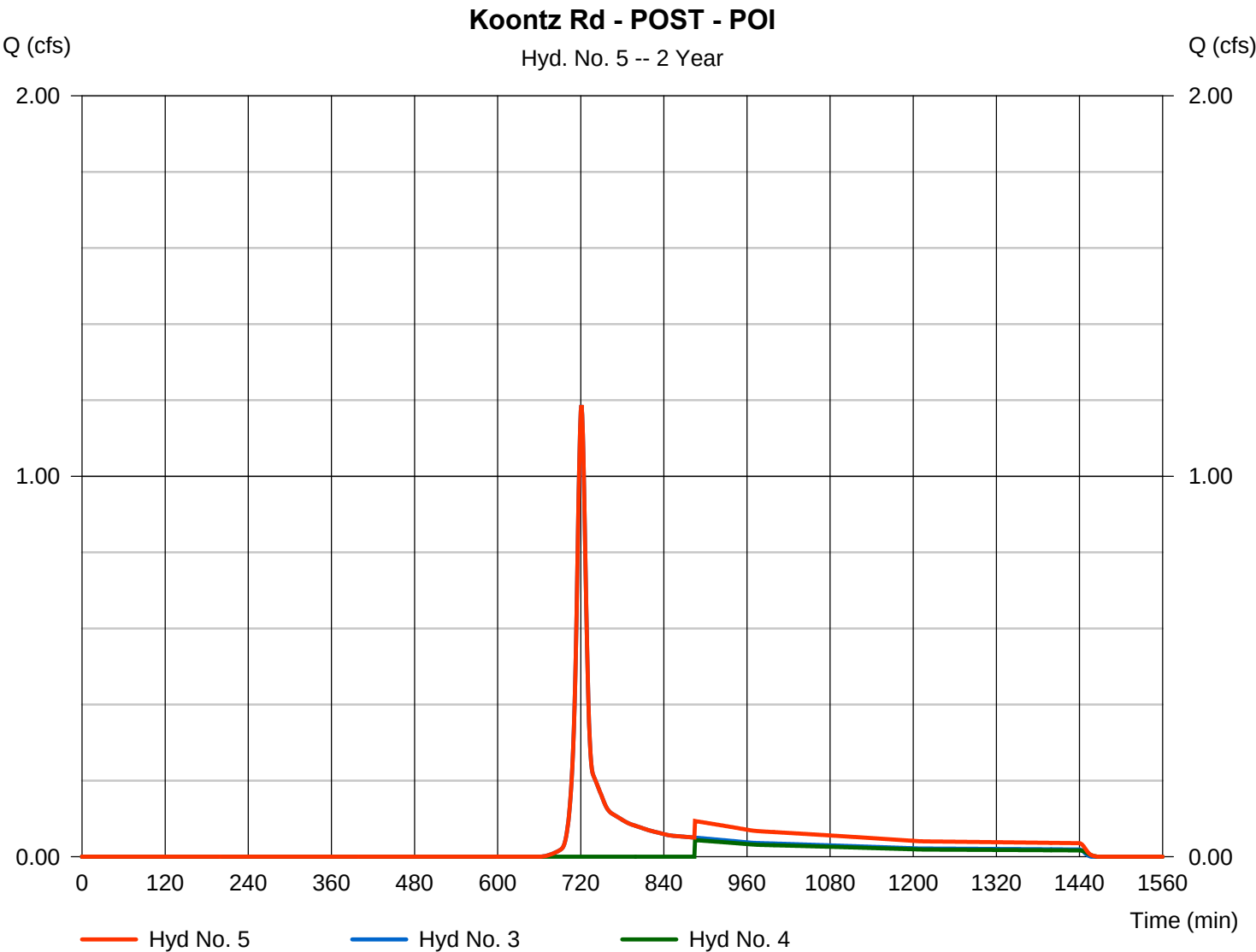
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 1.187 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 3,779 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 1.070 ac



ATTACHMENT C-2
KOONTZ RD
10 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Koontz Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.854	-----	-----	3.989	-----	6.779	8.185	Koontz Rd - PRE
Proj. file: Koontz Rd - Pre.gpw									Friday, 11 / 4 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

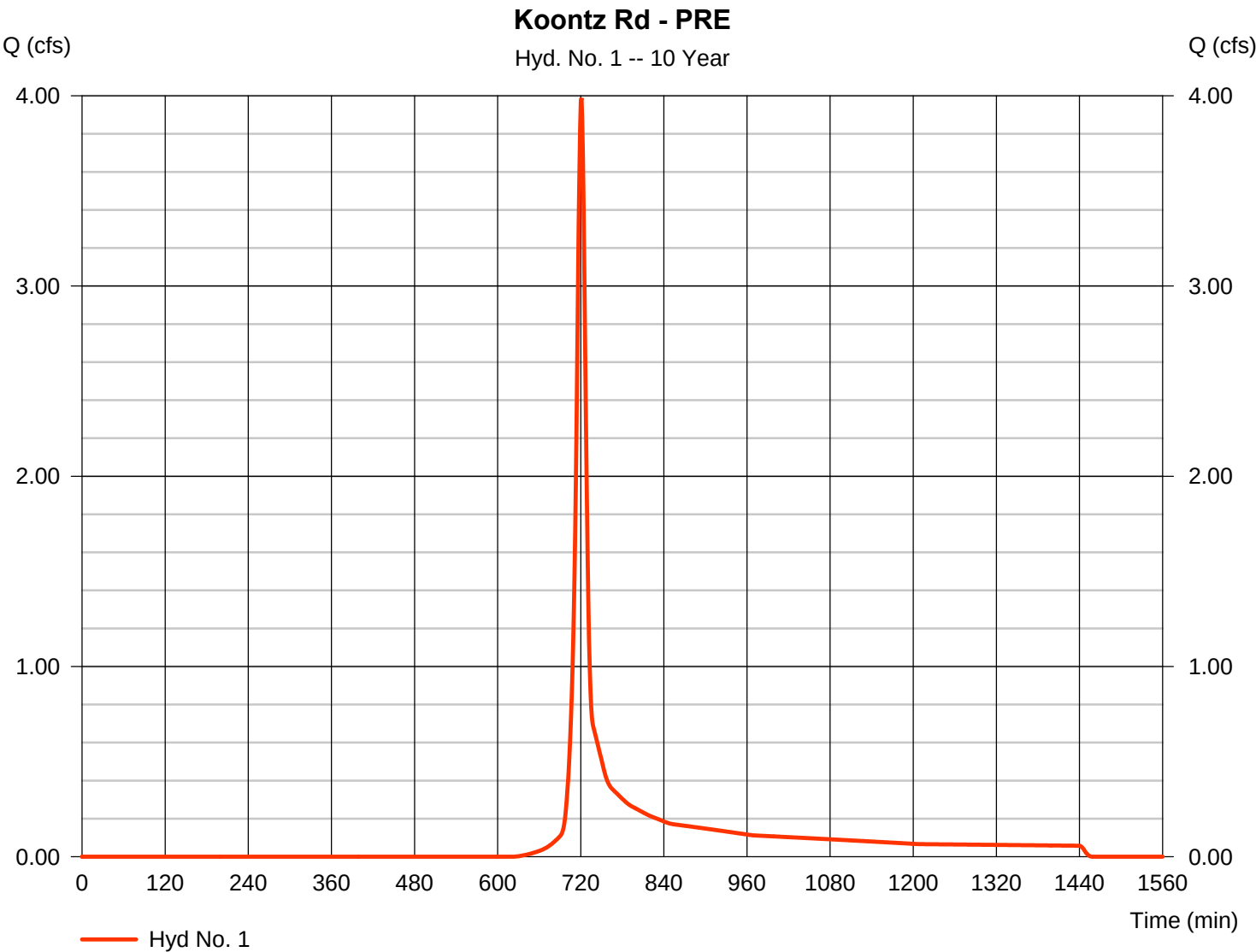
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.989	1	721	9,765	-----	-----	-----	Koontz Rd - PRE
Koontz Rd - Pre.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.989 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	9,765 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

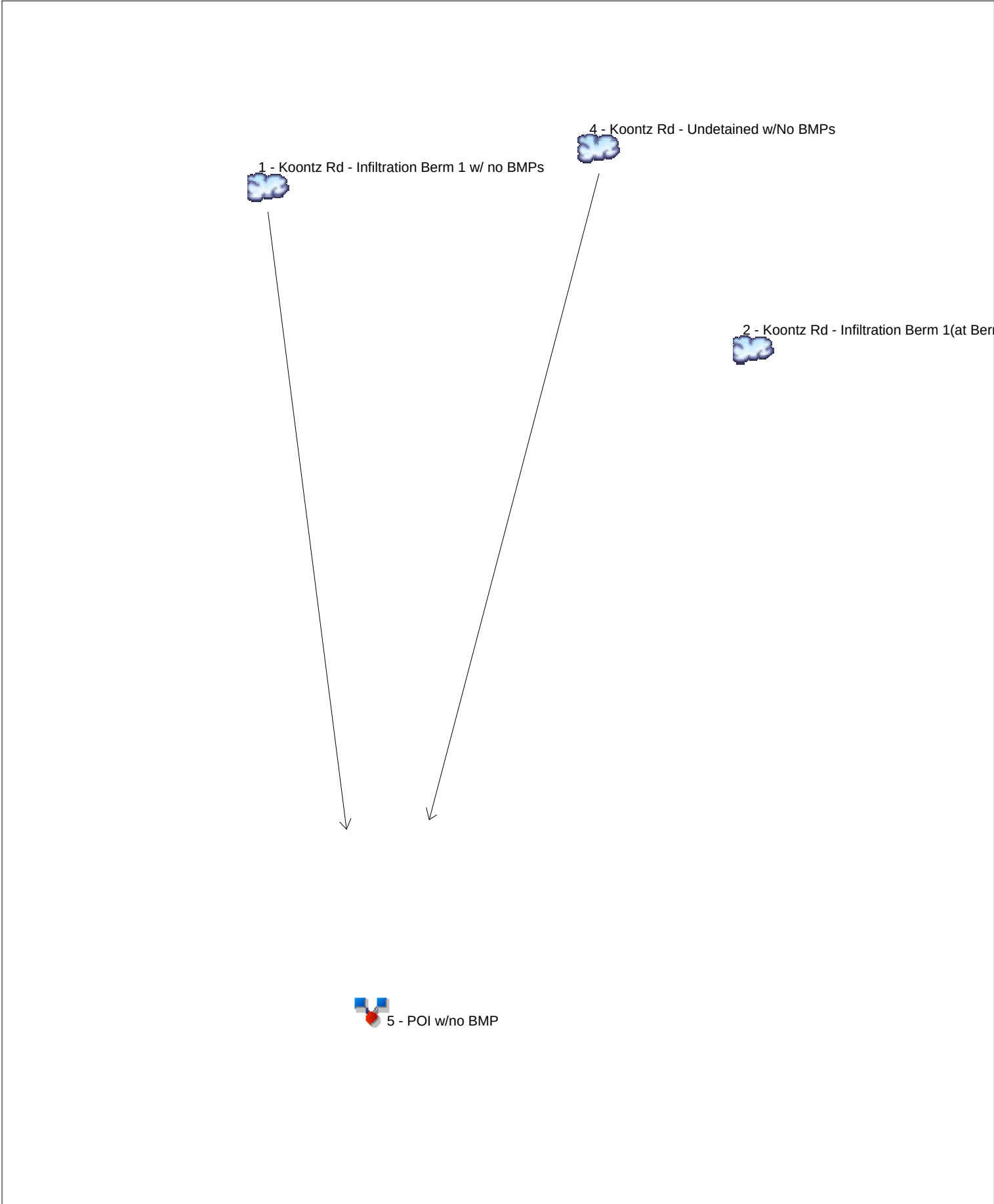
Hyd. No. 1

Koontz Rd - PRE

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 345.00	260.00	0.00				
Watercourse slope (%)	= 6.00	15.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.25	0.00				
Travel Time (min)	= 1.45	+	0.69	+	0.00	=	2.15
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				11.70 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.228	-----	-----	2.523	-----	4.183	5.004	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	-----	-----	0.804	-----	-----	1.473	-----	2.293	2.690	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	-----	-----	1.187	-----	-----	2.351	-----	3.843	4.579	Koontz Rd - Undetained w/No BMPs
5	Combine	1, 4	-----	2.319	-----	-----	4.698	-----	7.760	9.285	POI w/no BMP

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.523	1	718	5,069	-----	-----	-----	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	1.473	1	718	2,969	-----	-----	-----	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	2.351	1	721	5,710	-----	-----	-----	Koontz Rd - Undetained w/No BMPs
5	Combine	4.698	1	719	10,780	1, 4	-----	-----	POI w/no BMP
Koontz Rd - Post With No BMP.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

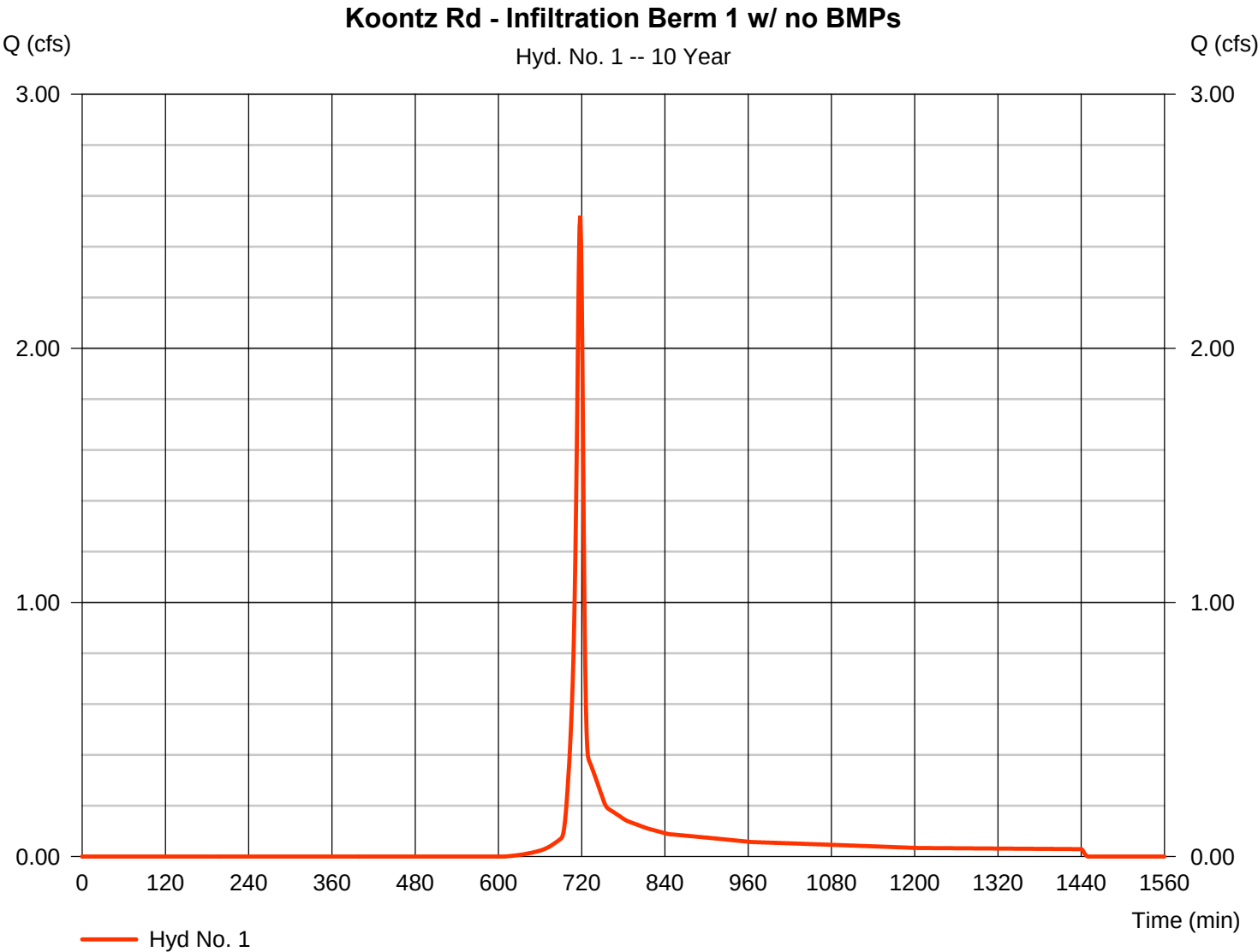
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.523 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	5,069 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.240	0.011	
Flow length (ft)	= 56.0	44.0	0.0	
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00	
Land slope (%)	= 5.40	9.00	0.00	
Travel Time (min)	= 0.59	+	4.64	+
			0.00	= 5.23
Shallow Concentrated Flow				
Flow length (ft)	= 30.00	187.00	0.00	
Watercourse slope (%)	= 10.00	17.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.10	6.65	0.00	
Travel Time (min)	= 0.10	+	0.47	+
			0.00	= 0.57
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				5.80 min

Hydrograph Report

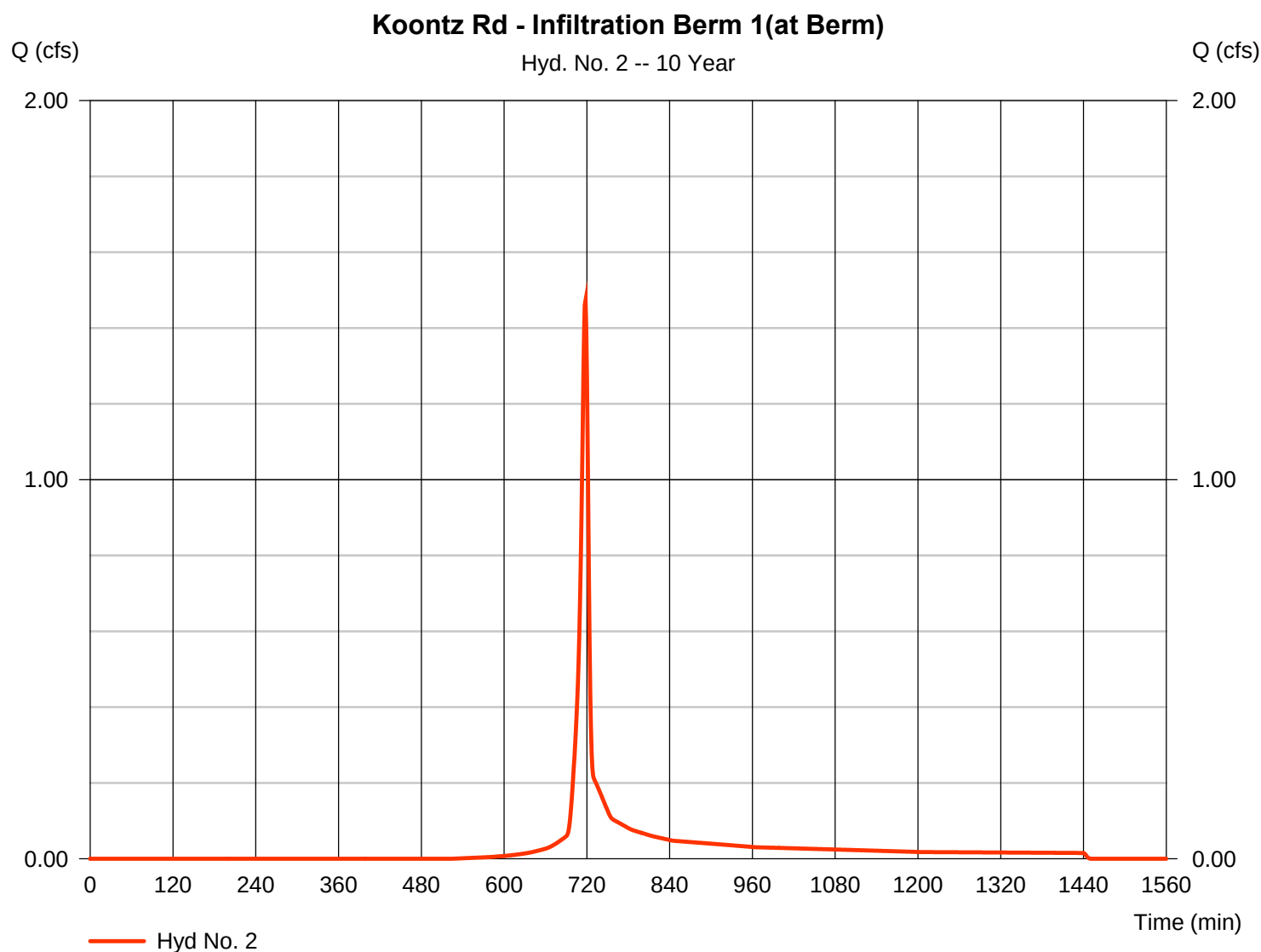
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.473 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 2,969 cuft
Drainage area	= 0.480 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.30 min
Total precip.	= 3.43 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	0.00	0.00				
Watercourse slope (%)	= 10.00	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	0.00	0.00				
Travel Time (min)	= 0.10	+	0.00	+	0.00	=	0.10
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				5.30 min			

Hydrograph Report

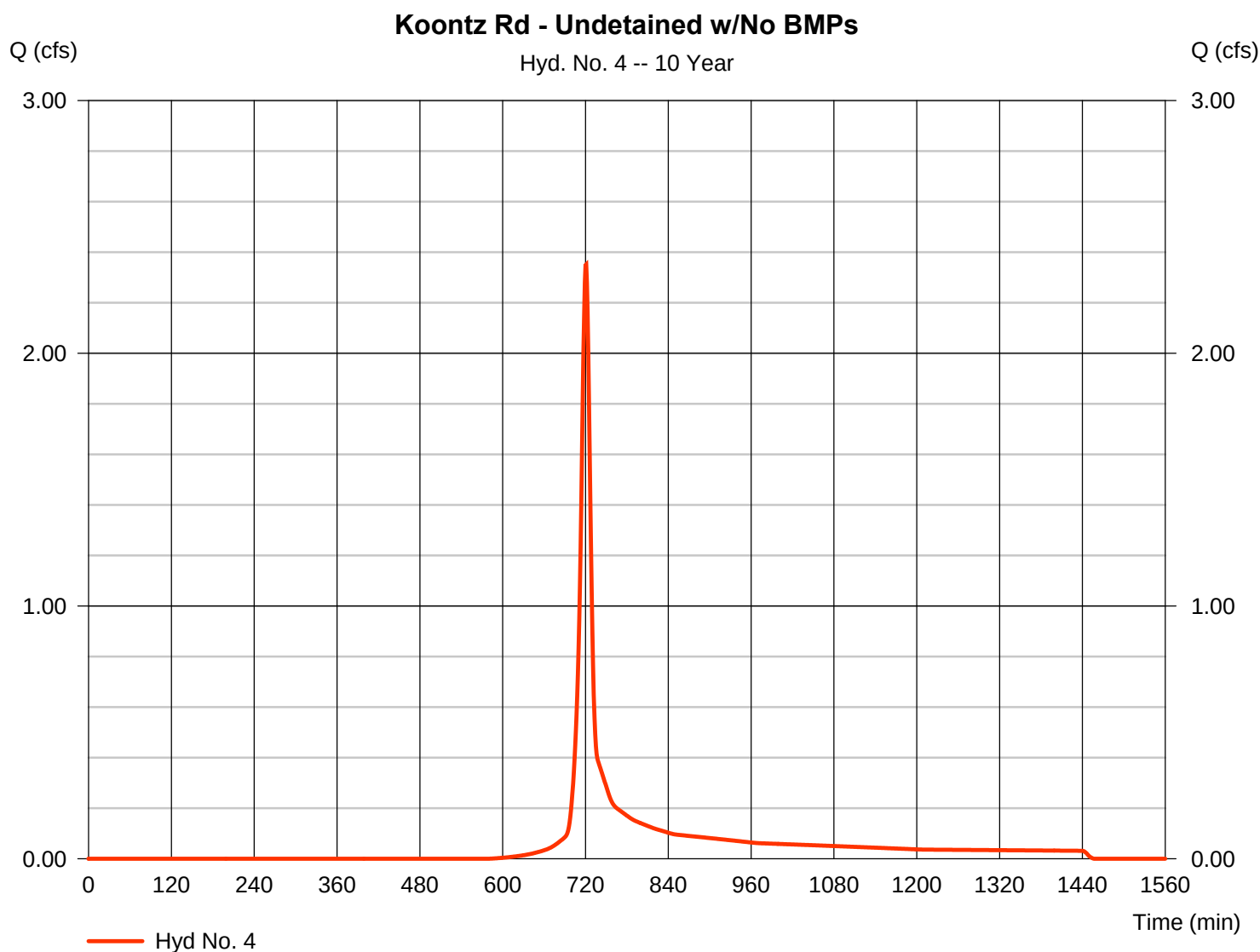
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.351 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	5,710 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

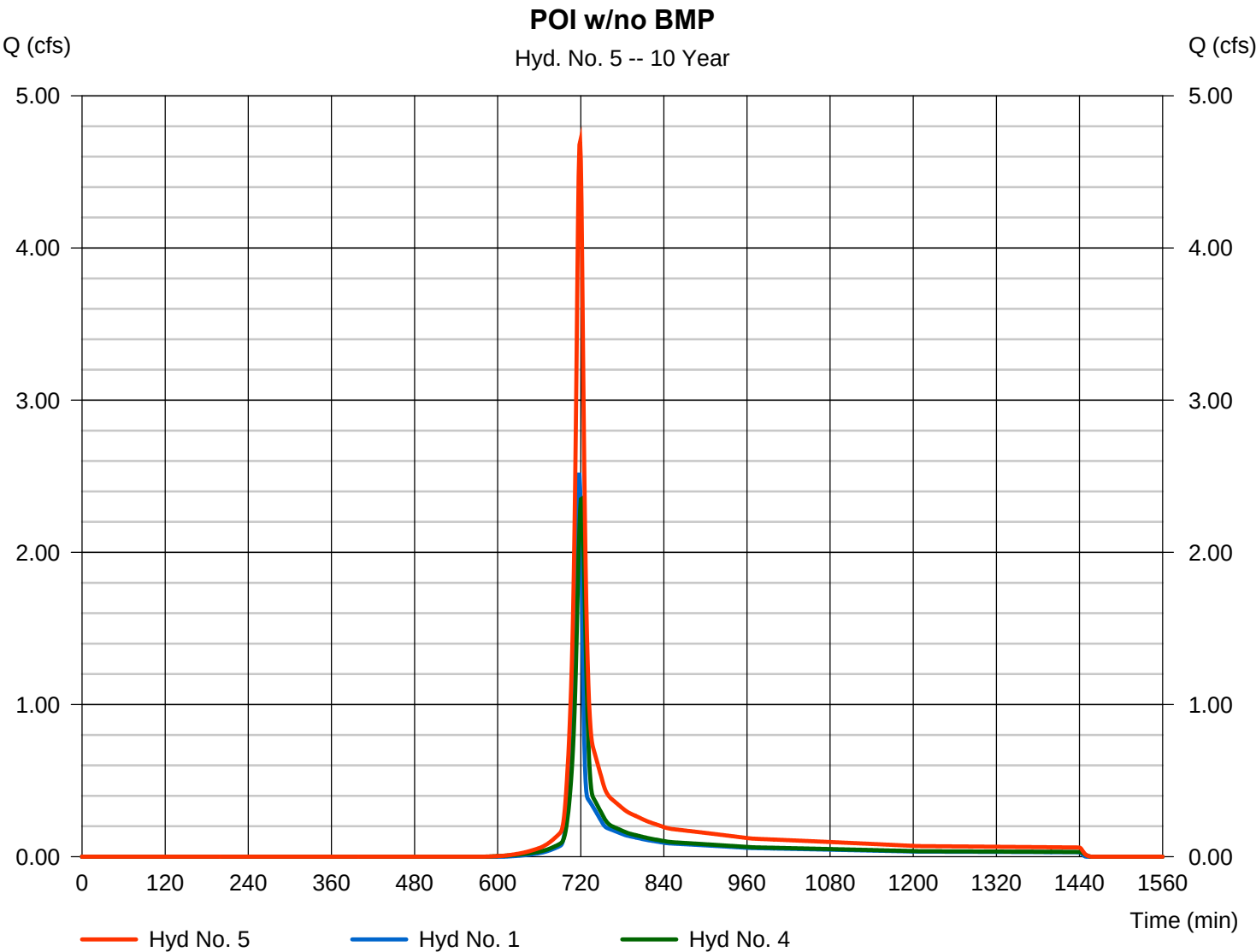
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

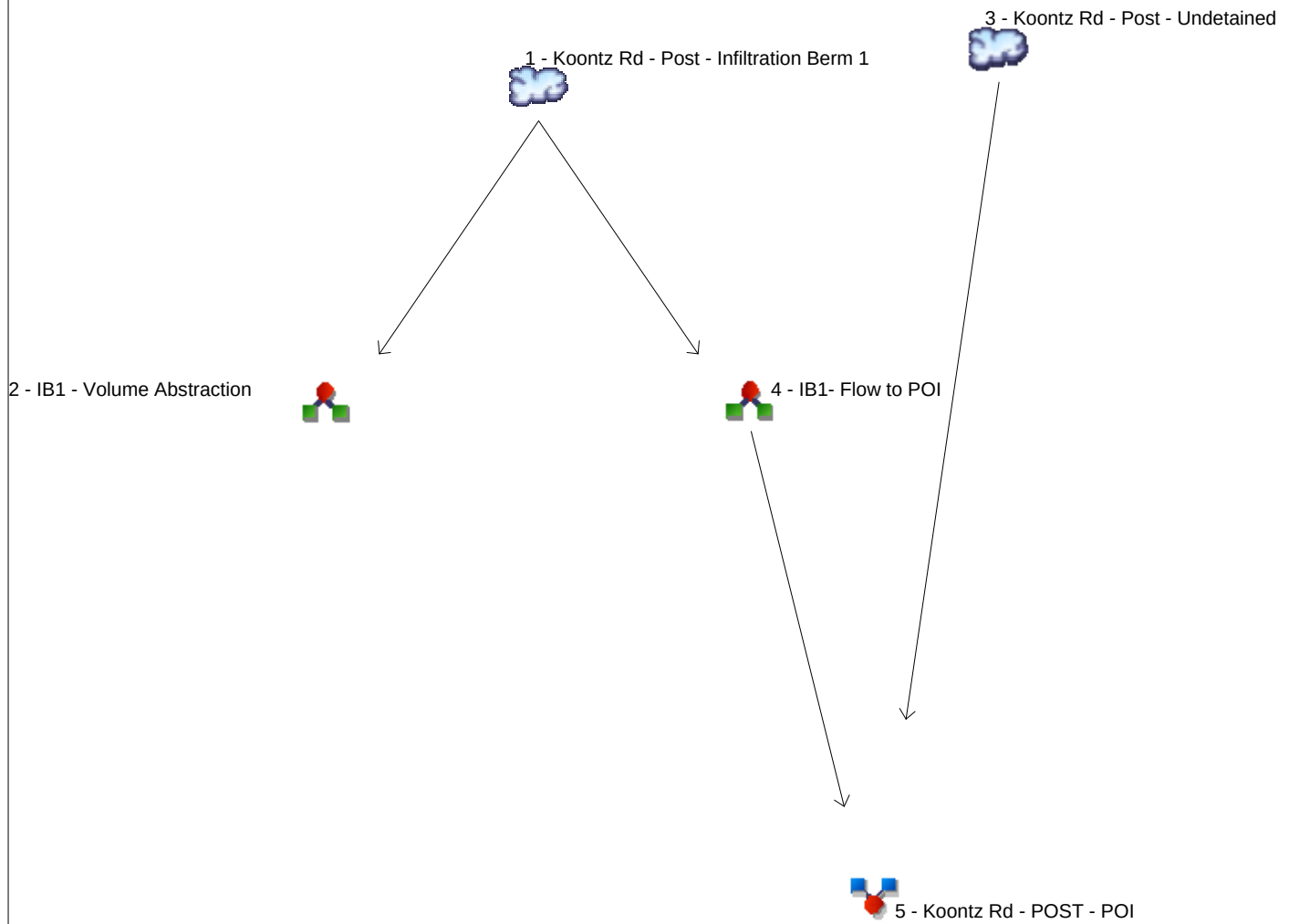
POI w/no BMP

Hydrograph type	= Combine	Peak discharge	= 4.698 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 10,780 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.605	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	1	-----	-----	-----	-----	1.605	-----	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	-----	-----	-----	-----	-----	2.351	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	1	-----	-----	-----	-----	0.126	-----	-----	-----	IB1- Flow to POI
5	Combine	3, 4	-----	-----	-----	-----	2.351	-----	-----	-----	Koontz Rd - POST - POI
Proj. file: Koontz Rd - Post WithBMP -10yr.gpw									Friday, 11 / 4 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.605	1	724	4,860	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	1.605	1	724	2,972	1	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	2.351	1	721	5,710	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	0.126	1	802	1,888	1	-----	-----	IB1- Flow to POI
5	Combine	2.351	1	721	7,599	3, 4	-----	-----	Koontz Rd - POST - POI
Koontz Rd - Post WithBMP -10yr.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

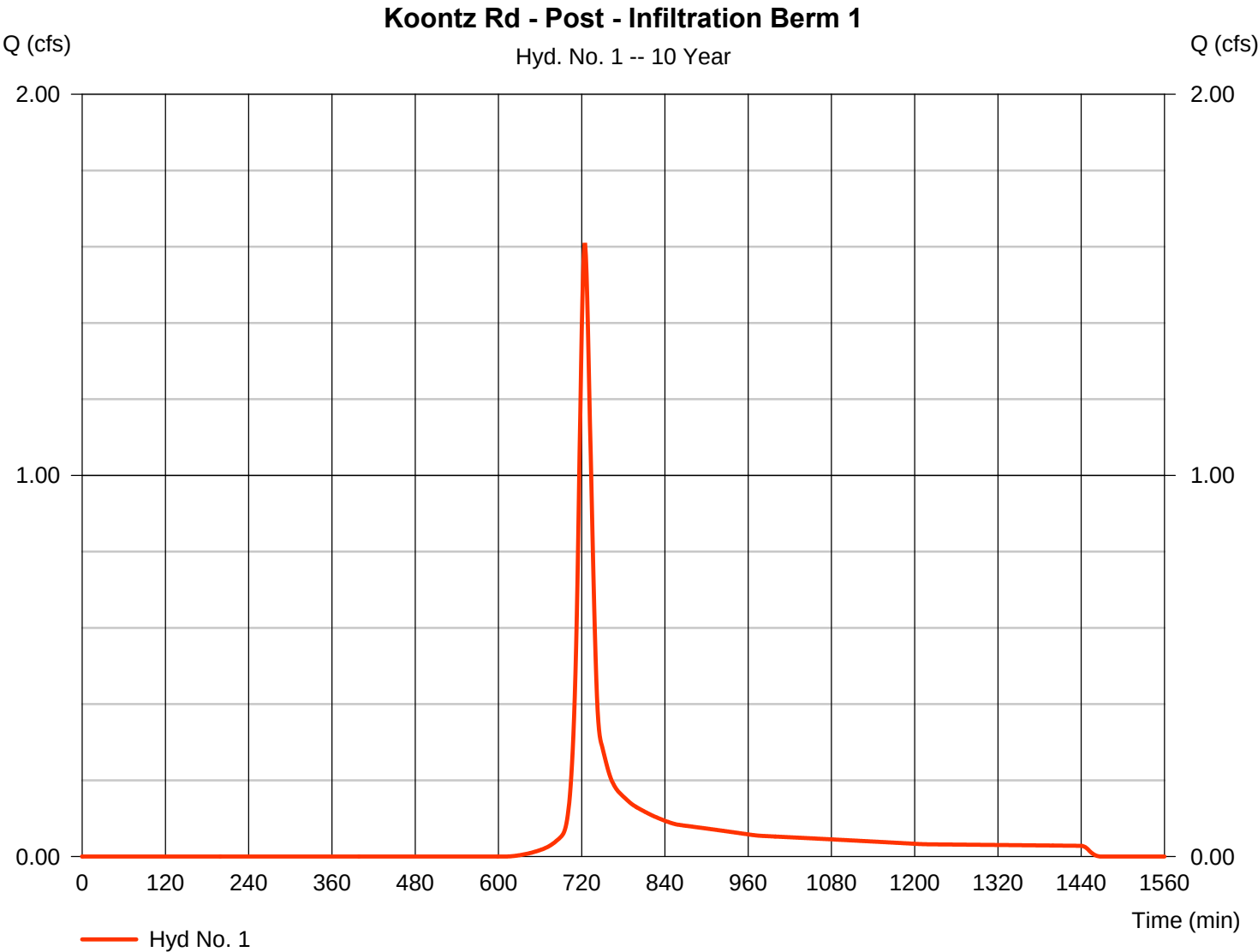
Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.605 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	4,860 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.40 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



Hydrograph Report

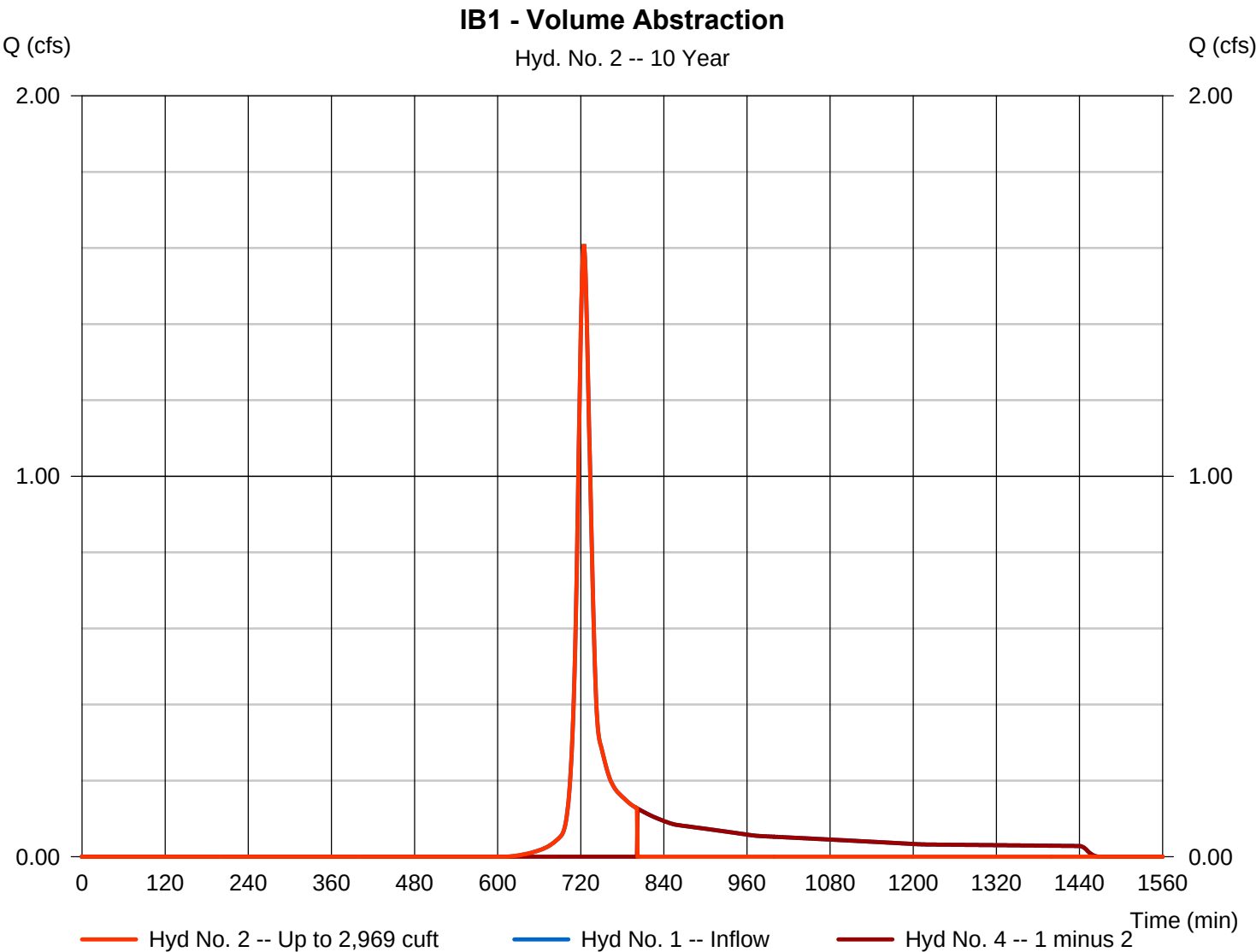
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

IB1 - Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.605 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	2,972 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration2	Diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	2,969 cuft



Hydrograph Report

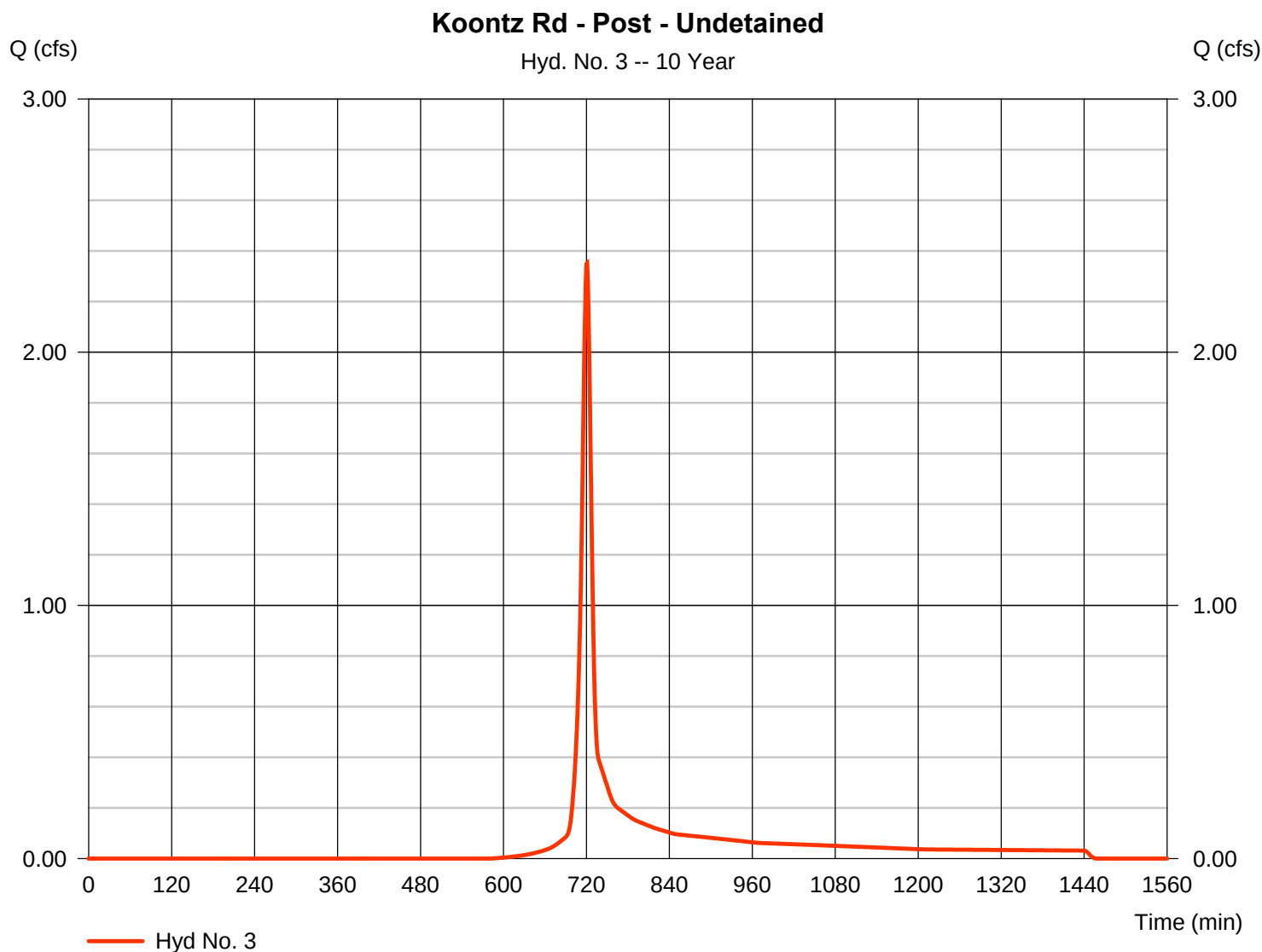
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.351 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	5,710 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Koontz Rd - Post - Undetained

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

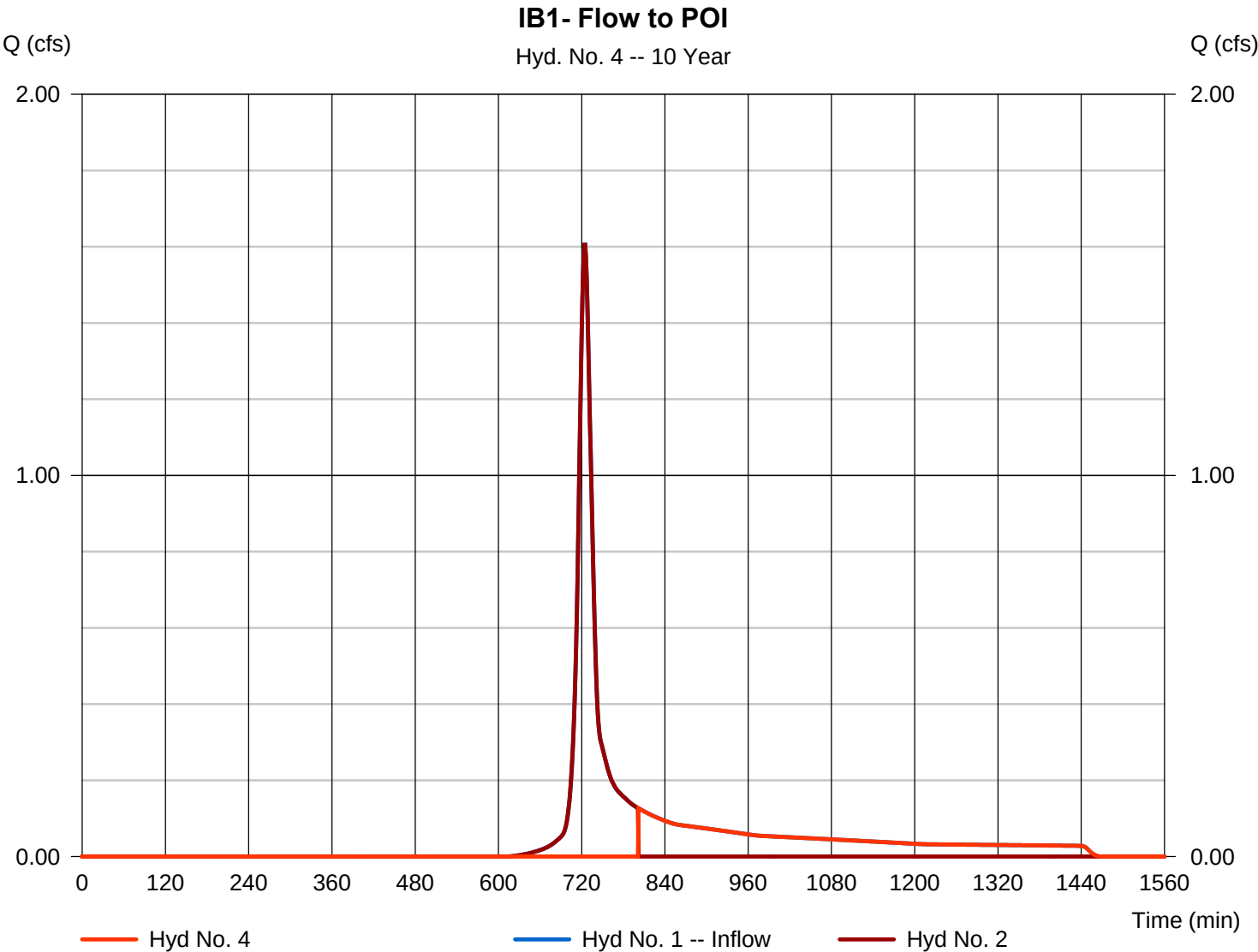
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

IB1- Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.126 cfs
Storm frequency	=	10 yrs	Time to peak	=	802 min
Time interval	=	1 min	Hyd. volume	=	1,888 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	2
Diversion method	=	First Flush Volume	Volume Up To	=	2,969 cuft



Hydrograph Report

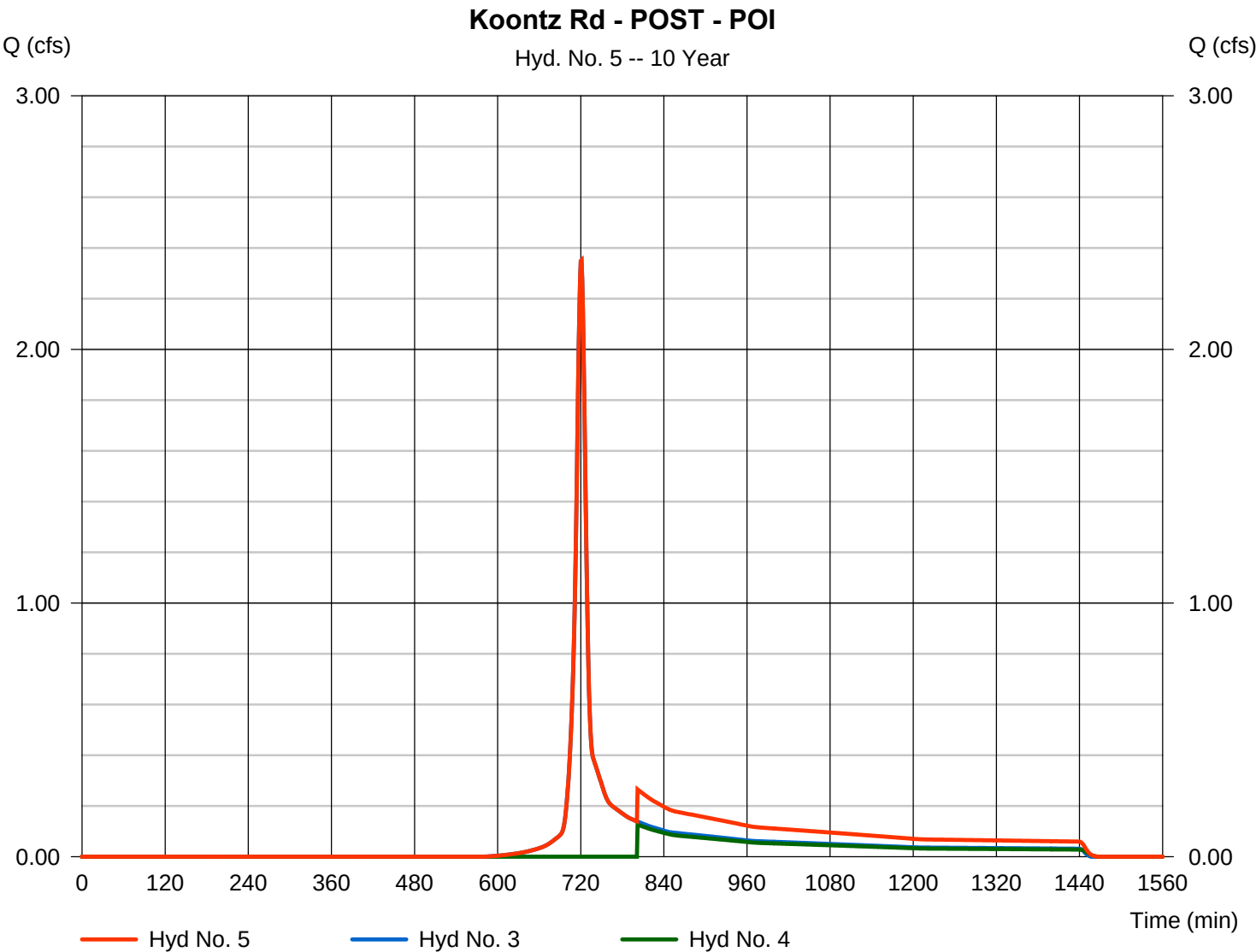
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 2.351 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 7,599 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 1.070 ac



ATTACHMENT C-3
KOONTZ RD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Koontz Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.854	-----	-----	3.989	-----	6.779	8.185	Koontz Rd - PRE
Proj. file: Koontz Rd - Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	6.779	1	720	16,414	-----	-----	-----	Koontz Rd - PRE
Koontz Rd - Pre.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

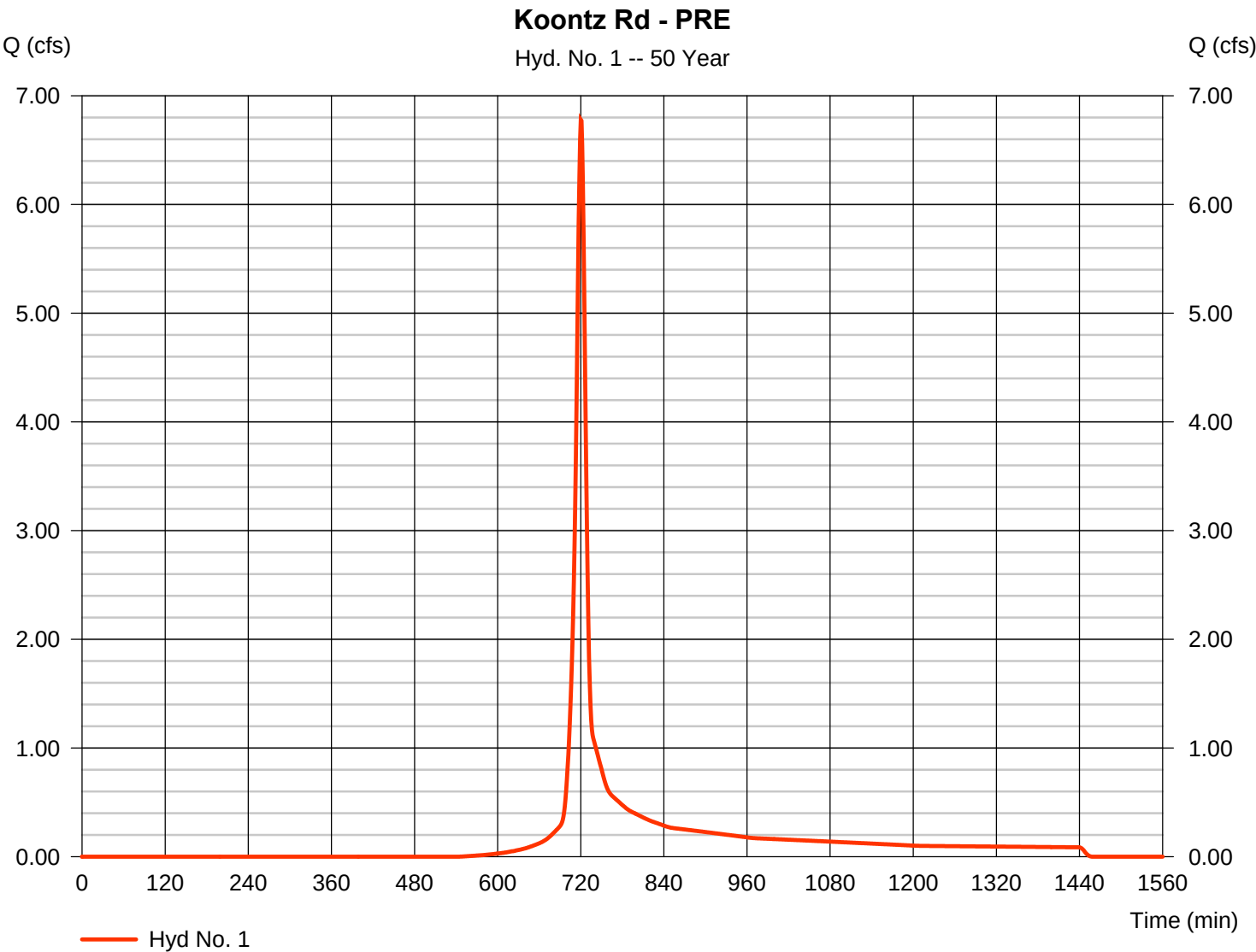
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.779 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	16,414 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

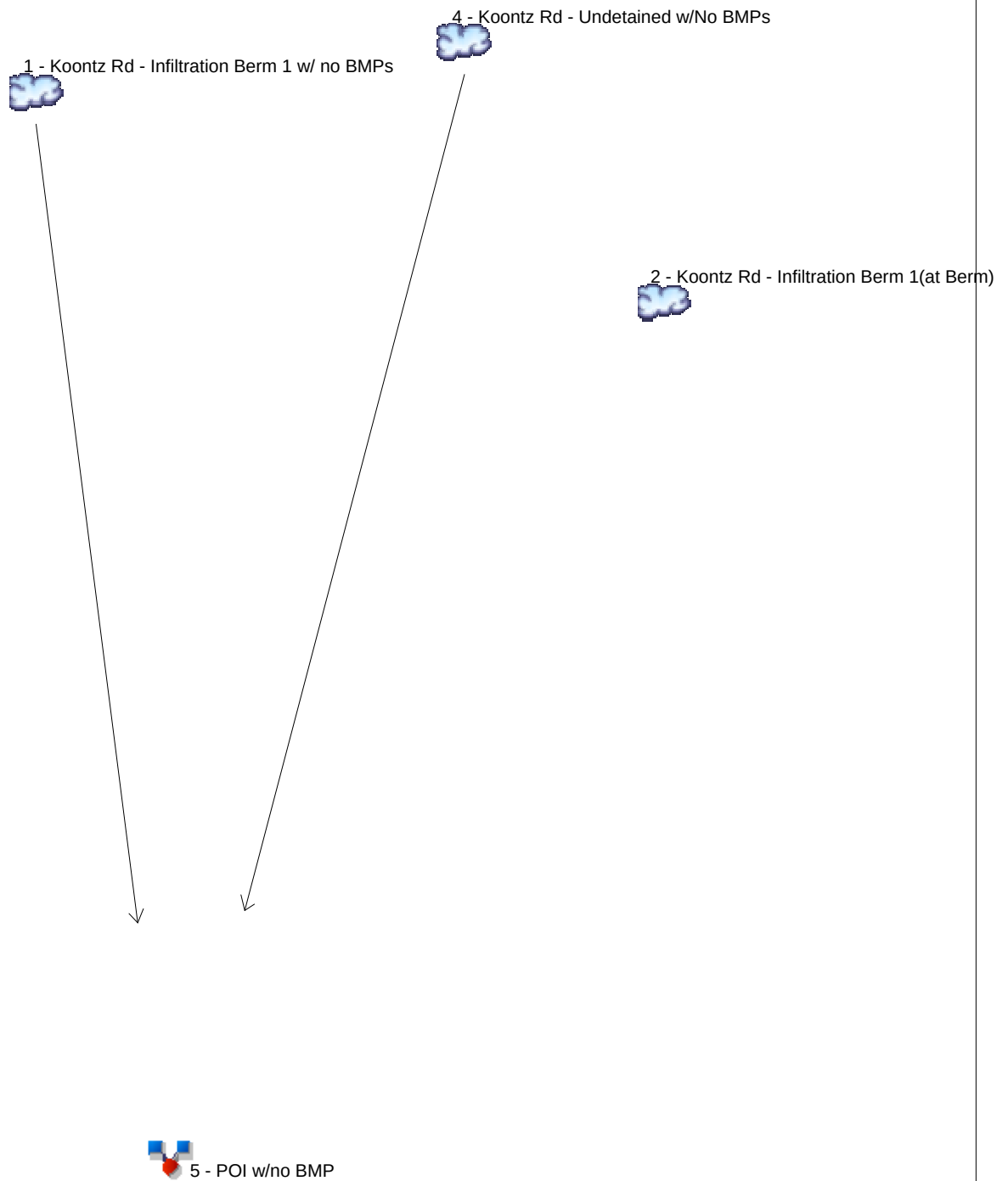
Hyd. No. 1

Koontz Rd - PRE

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 345.00	260.00	0.00				
Watercourse slope (%)	= 6.00	15.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.25	0.00				
Travel Time (min)	= 1.45	+	0.69	+	0.00	=	2.15
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				11.70 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.228	-----	-----	2.523	-----	4.183	5.004	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	-----	-----	0.804	-----	-----	1.473	-----	2.293	2.690	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	-----	-----	1.187	-----	-----	2.351	-----	3.843	4.579	Koontz Rd - Undetained w/No BMPs
5	Combine	1, 4	-----	2.319	-----	-----	4.698	-----	7.760	9.285	POI w/no BMP
Proj. file: Koontz Rd - Post With No BMP.gpw Friday, 11 / 4 / 2016											

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.183	1	718	8,428	-----	-----	-----	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	2.293	1	718	4,687	-----	-----	-----	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	3.843	1	720	9,294	-----	-----	-----	Koontz Rd - Undetained w/No BMPs
5	Combine	7.760	1	718	17,722	1, 4	-----	-----	POI w/no BMP
Koontz Rd - Post With No BMP.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

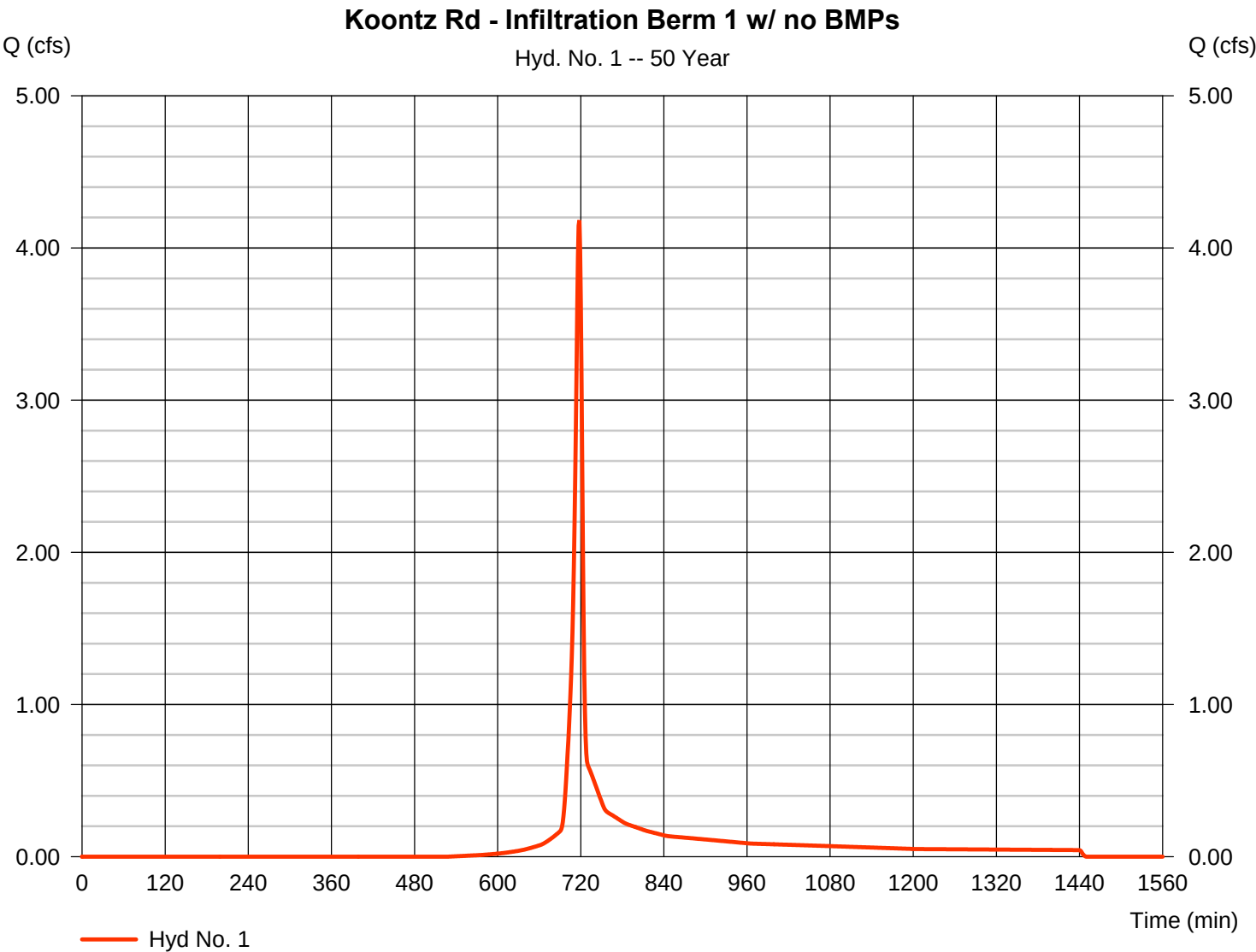
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.183 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	8,428 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.240	0.011	
Flow length (ft)	= 56.0	44.0	0.0	
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00	
Land slope (%)	= 5.40	9.00	0.00	
Travel Time (min)	= 0.59	+	4.64	+
			0.00	= 5.23
Shallow Concentrated Flow				
Flow length (ft)	= 30.00	187.00	0.00	
Watercourse slope (%)	= 10.00	17.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.10	6.65	0.00	
Travel Time (min)	= 0.10	+	0.47	+
			0.00	= 0.57
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				5.80 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

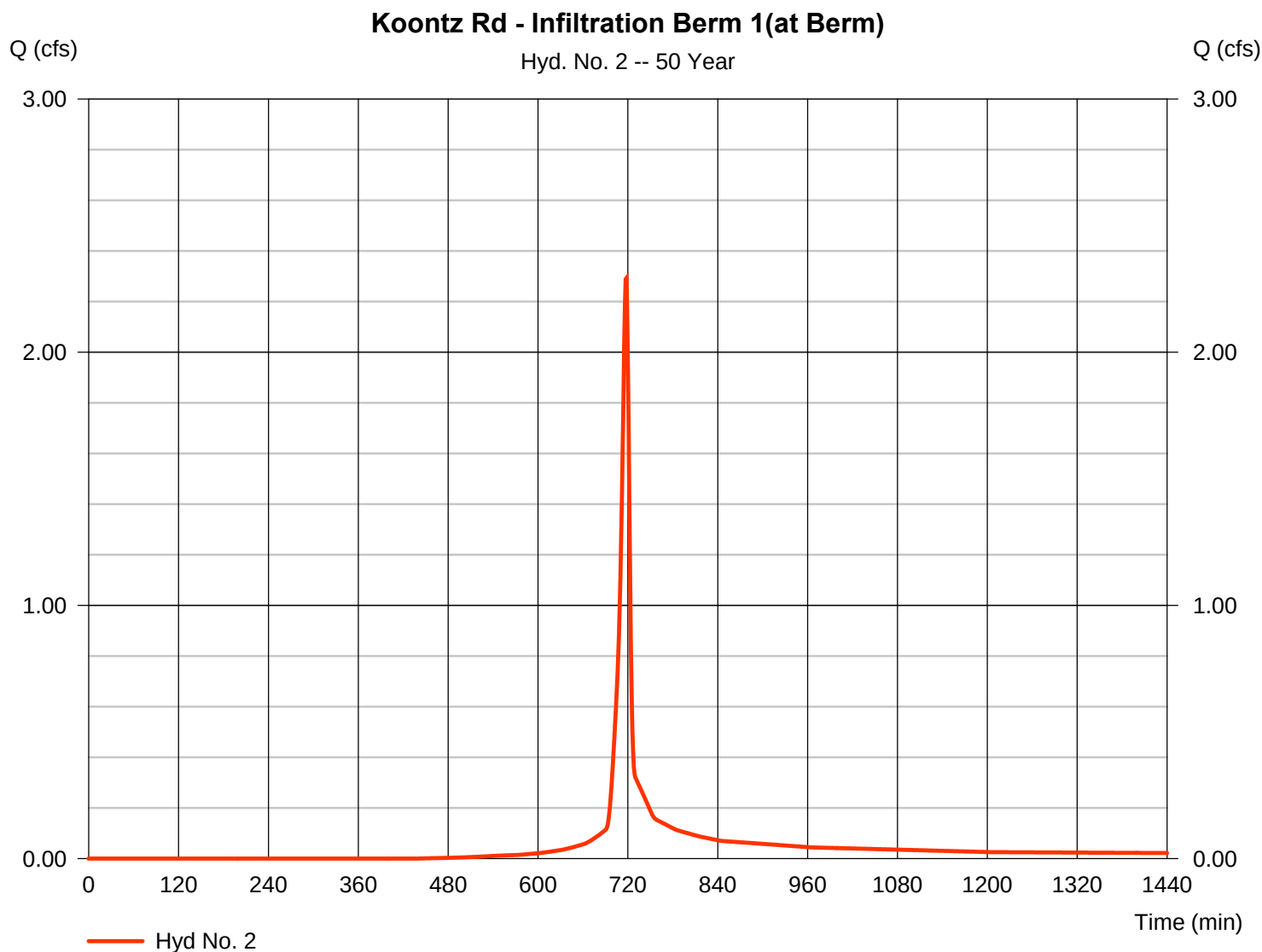
Friday, 11 / 4 / 2016

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type = SCS Runoff
 Storm frequency = 50 yrs
 Time interval = 1 min
 Drainage area = 0.480 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 4.57 in
 Storm duration = 24 hrs

Peak discharge = 2.293 cfs
 Time to peak = 718 min
 Hyd. volume = 4,687 cuft
 Curve number = 81
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 5.30 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	0.00	0.00				
Watercourse slope (%)	= 10.00	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	0.00	0.00				
Travel Time (min)	= 0.10	+	0.00	+	0.00	=	0.10
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				5.30 min			

Hydrograph Report

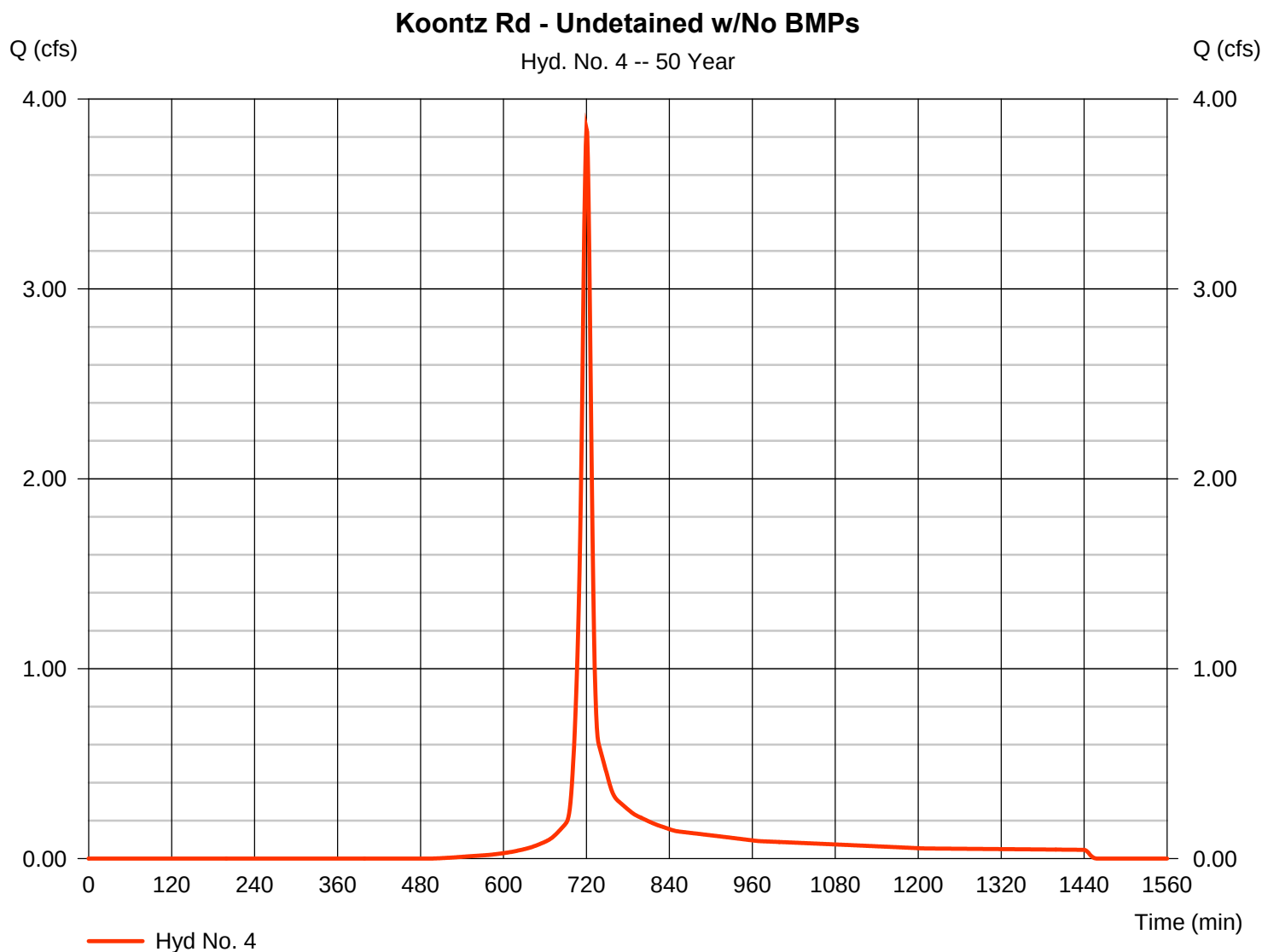
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 3.843 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 9,294 cuft
Drainage area	= 1.070 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.30 min
Total precip.	= 4.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

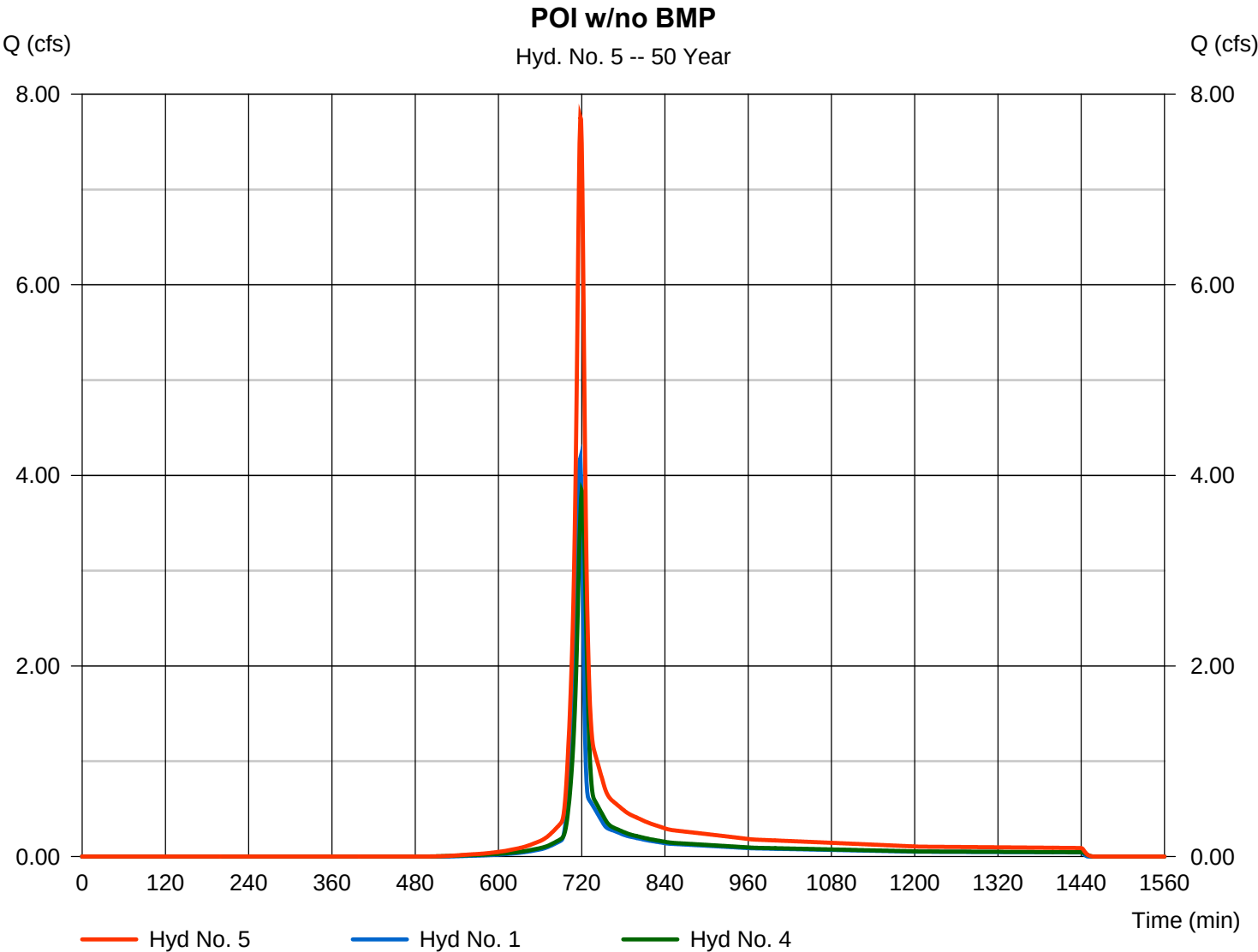
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

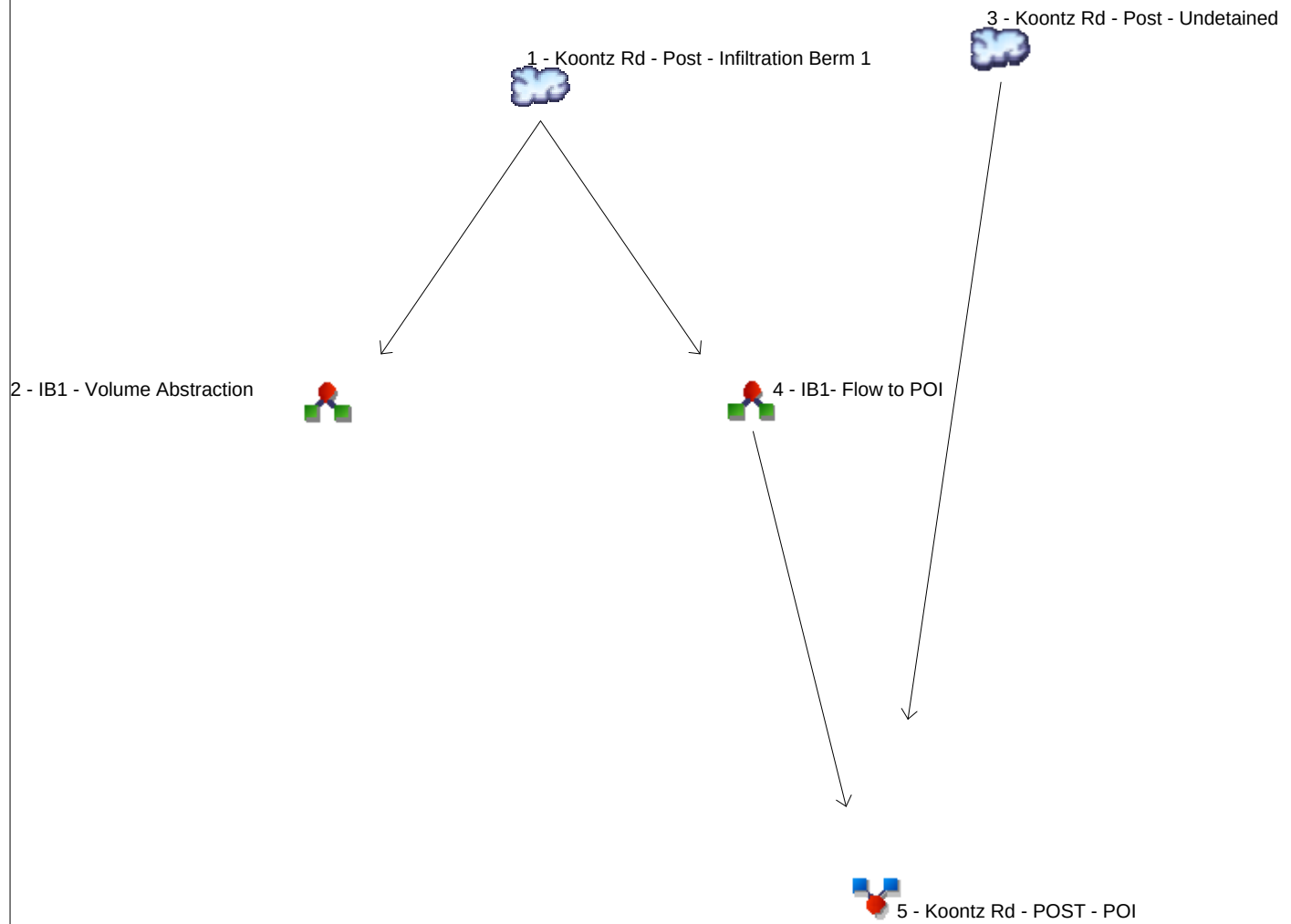
POI w/no BMP

Hydrograph type	= Combine	Peak discharge	= 7.760 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 17,722 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.721	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	1	-----	-----	-----	-----	-----	-----	2.721	-----	IB1 - Volume Abstraction
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	3.843	-----	Koontz Rd - Post - Undetained
4	Diversion2	1	-----	-----	-----	-----	-----	-----	1.721	-----	IB1- Flow to POI
5	Combine	3, 4	-----	-----	-----	-----	-----	-----	3.843	-----	Koontz Rd - POST - POI
Proj. file: Koontz Rd - Post WithBMP -50yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.721	1	724	8,080	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	2.721	1	724	3,458	1	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	3.843	1	720	9,294	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	1.721	1	733	4,621	1	-----	-----	IB1- Flow to POI
5	Combine	3.843	1	720	13,915	3, 4	-----	-----	Koontz Rd - POST - POI
Koontz Rd - Post WithBMP -50yr.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

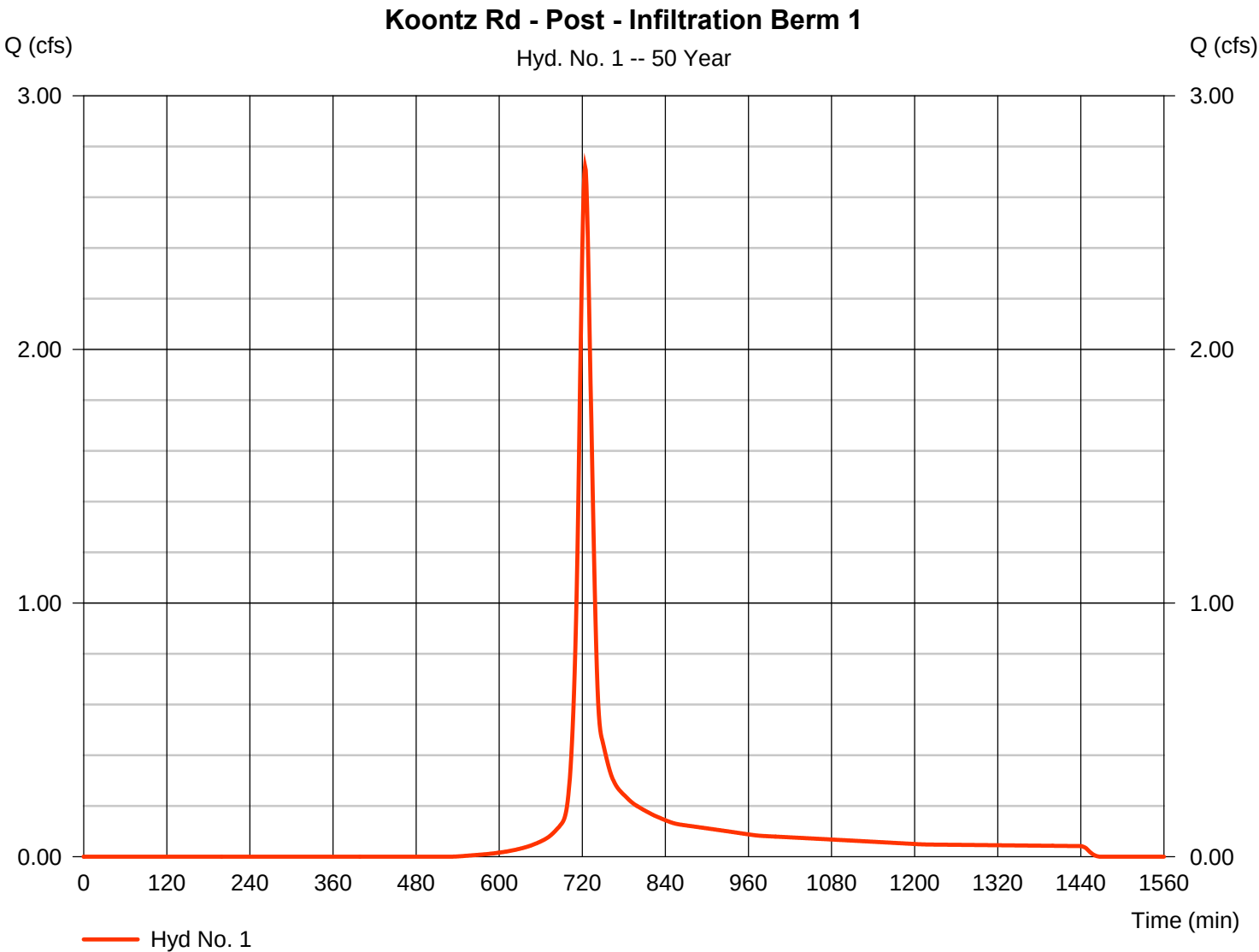
Hydrograph Report

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.721 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	8,080 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.40 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



Hydrograph Report

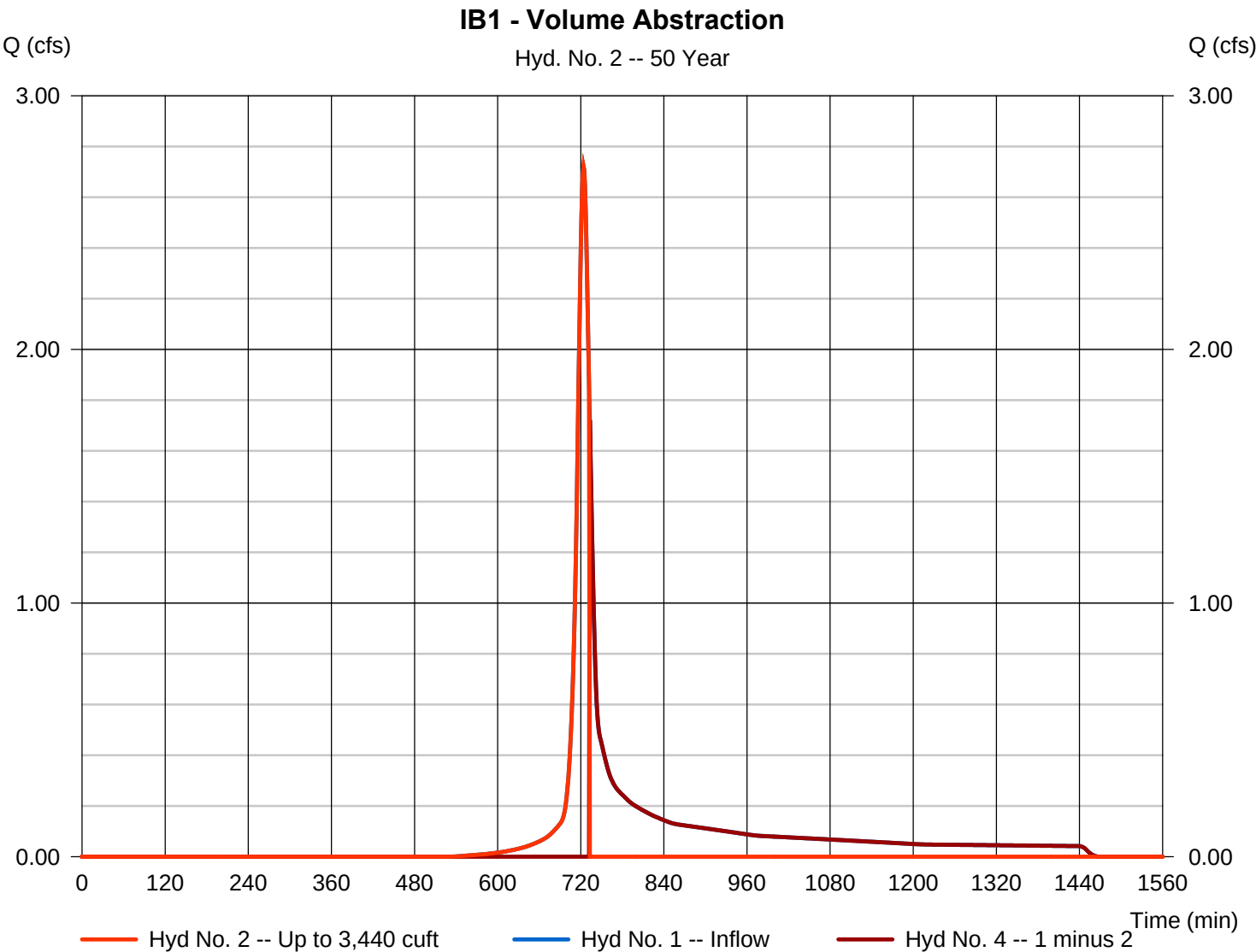
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

IB1 - Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	2.721 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	3,458 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	3,440 cuft



Hydrograph Report

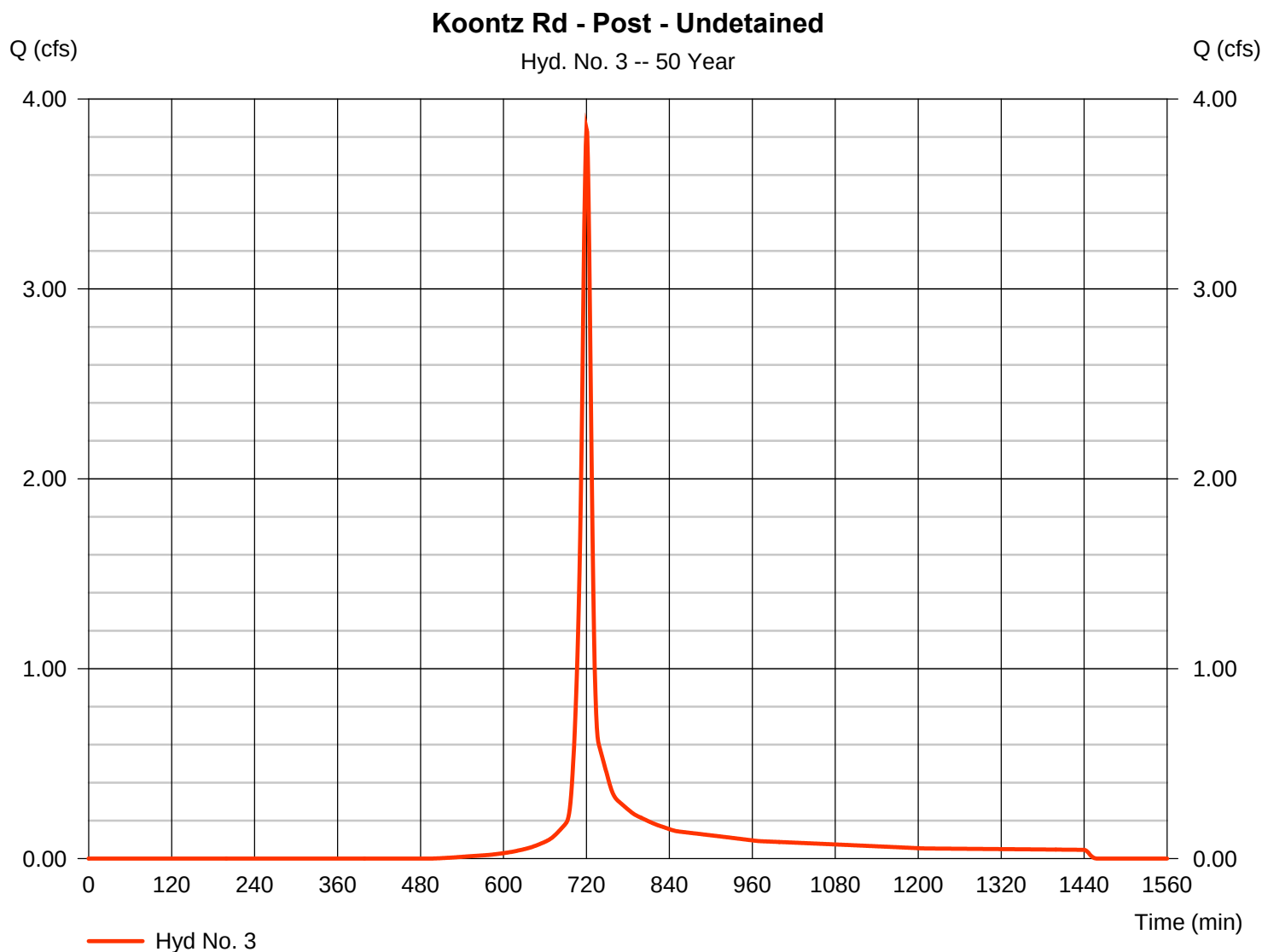
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.843 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	9,294 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Koontz Rd - Post - Undetained

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	(0)224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

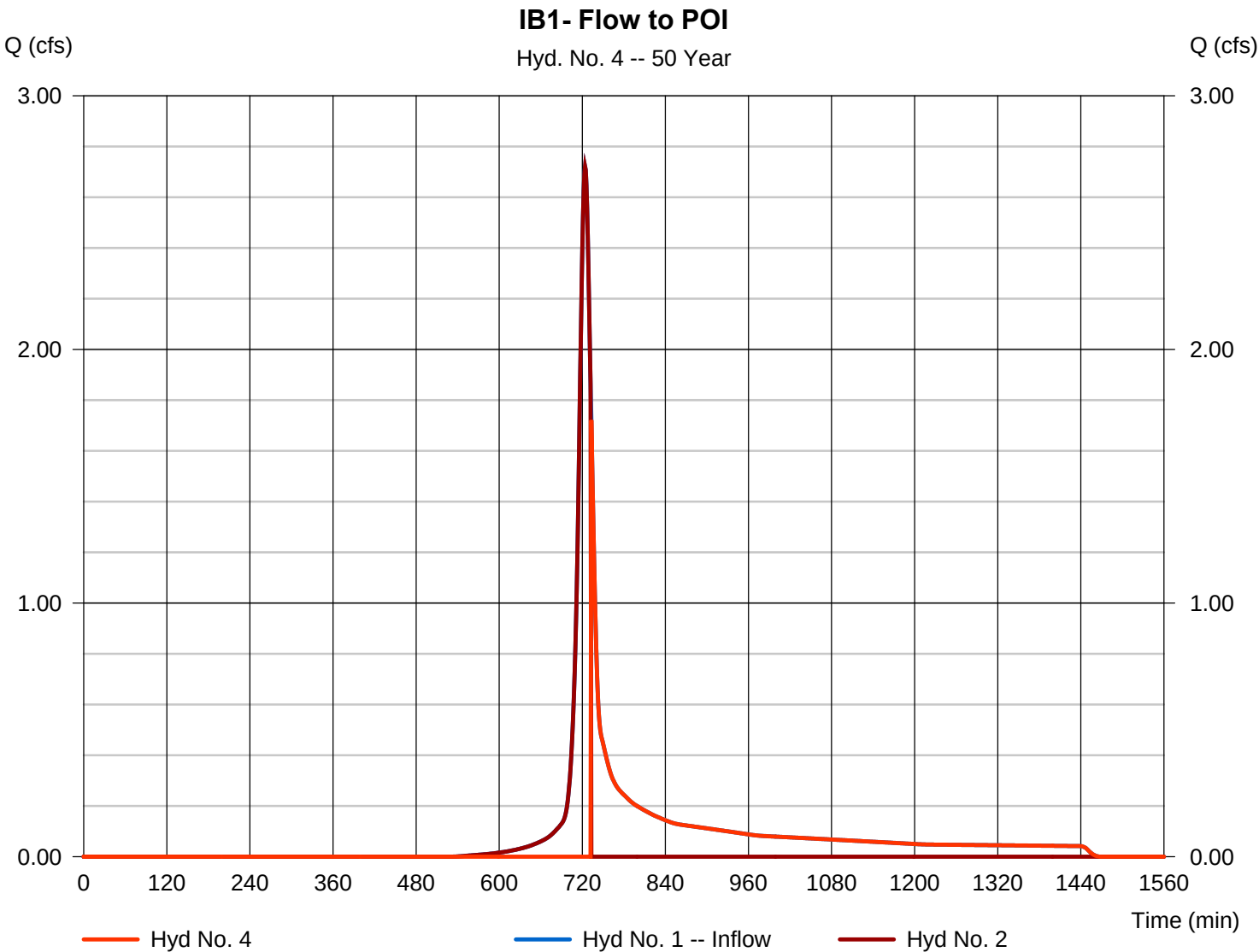
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

IB1- Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	1.721 cfs
Storm frequency	=	50 yrs	Time to peak	=	733 min
Time interval	=	1 min	Hyd. volume	=	4,621 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	2
Diversion method	=	First Flush Volume	Volume Up To	=	3,440 cuft



Hydrograph Report

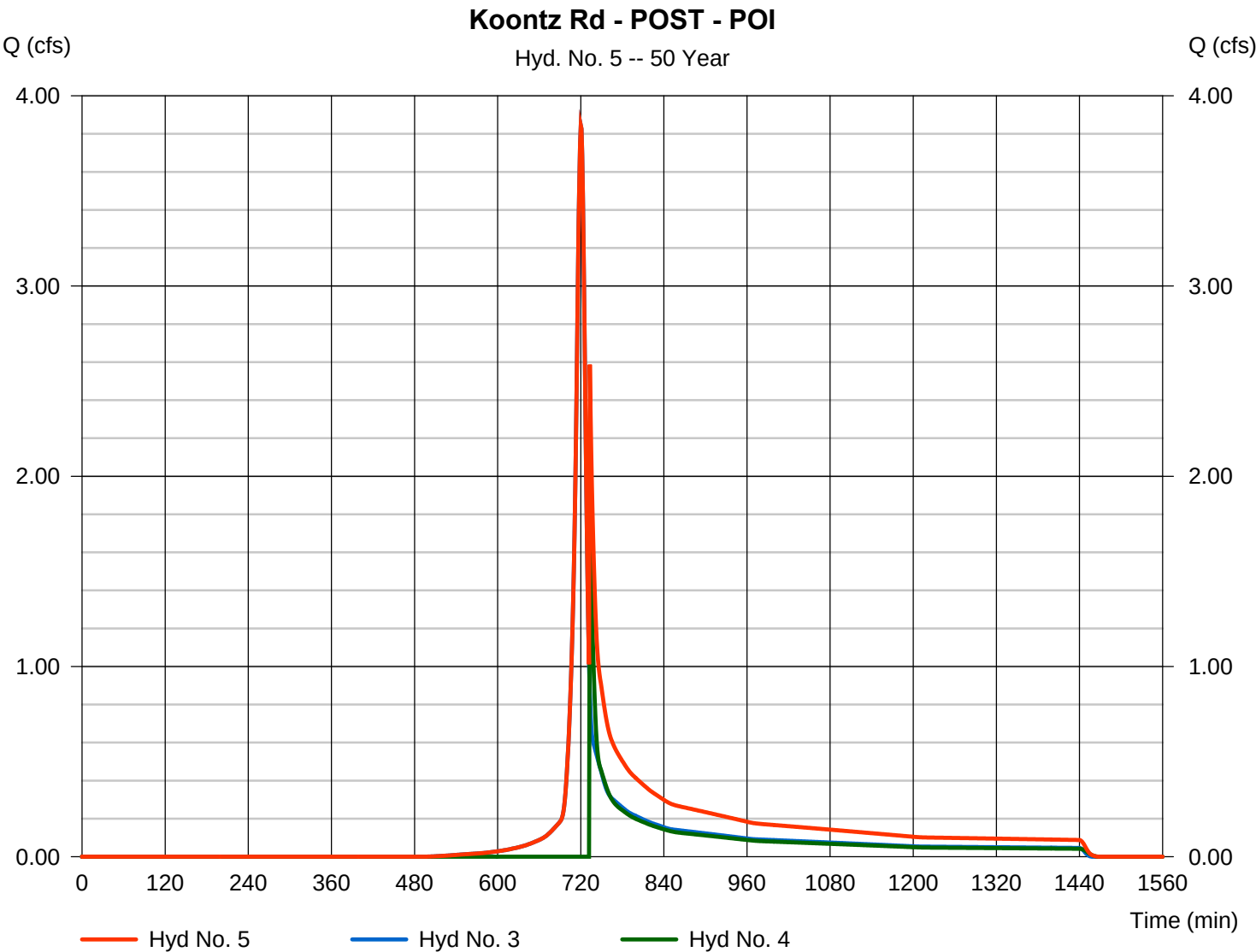
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 3.843 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 13,915 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 1.070 ac



ATTACHMENT C-4
KOONTZ RD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Koontz Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.854	-----	-----	3.989	-----	6.779	8.185	Koontz Rd - PRE
Proj. file: Koontz Rd - Pre.gpw									Friday, 11 / 4 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	8.185	1	720	19,792	-----	-----	-----	Koontz Rd - PRE
Koontz Rd - Pre.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

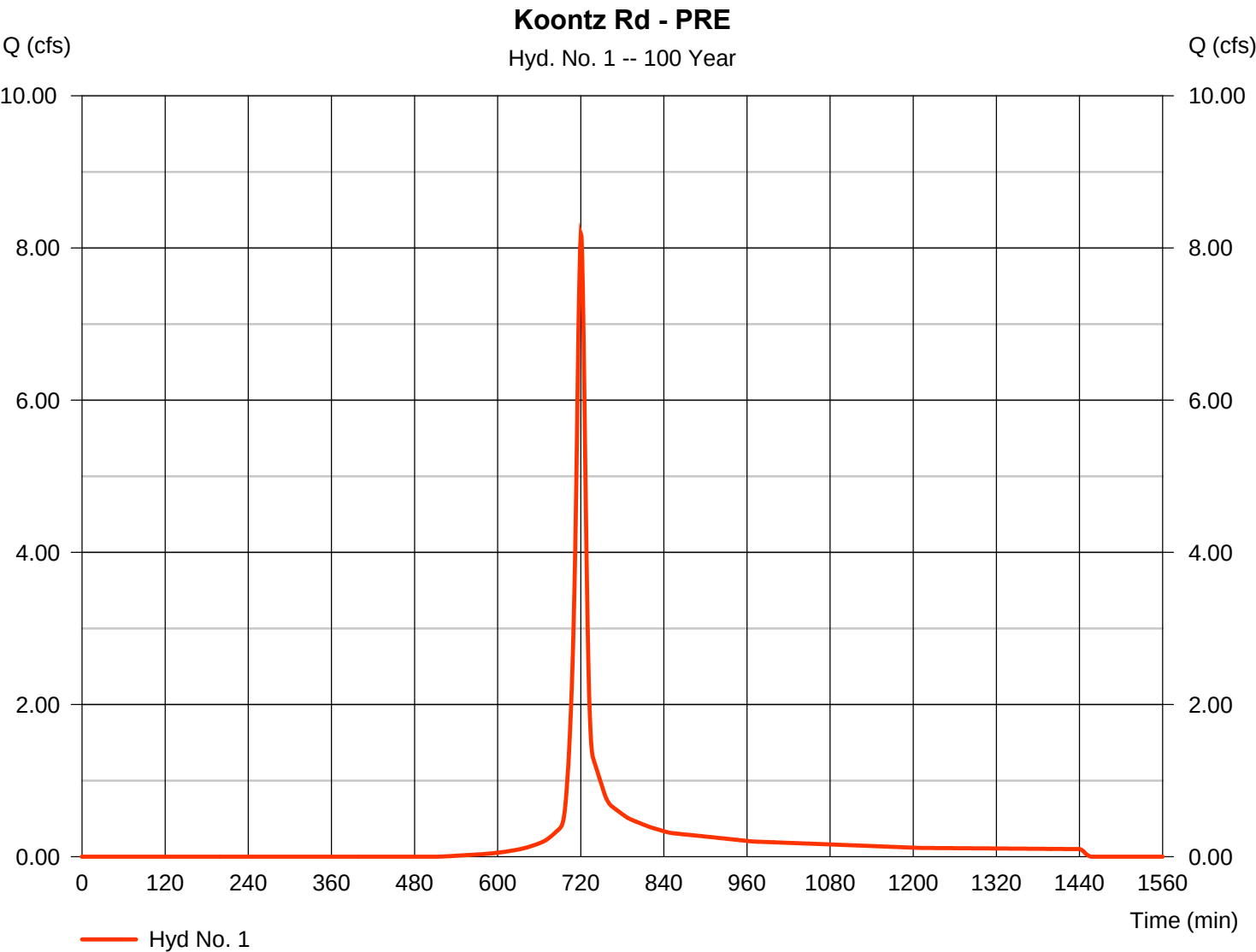
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	8.185 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	19,792 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

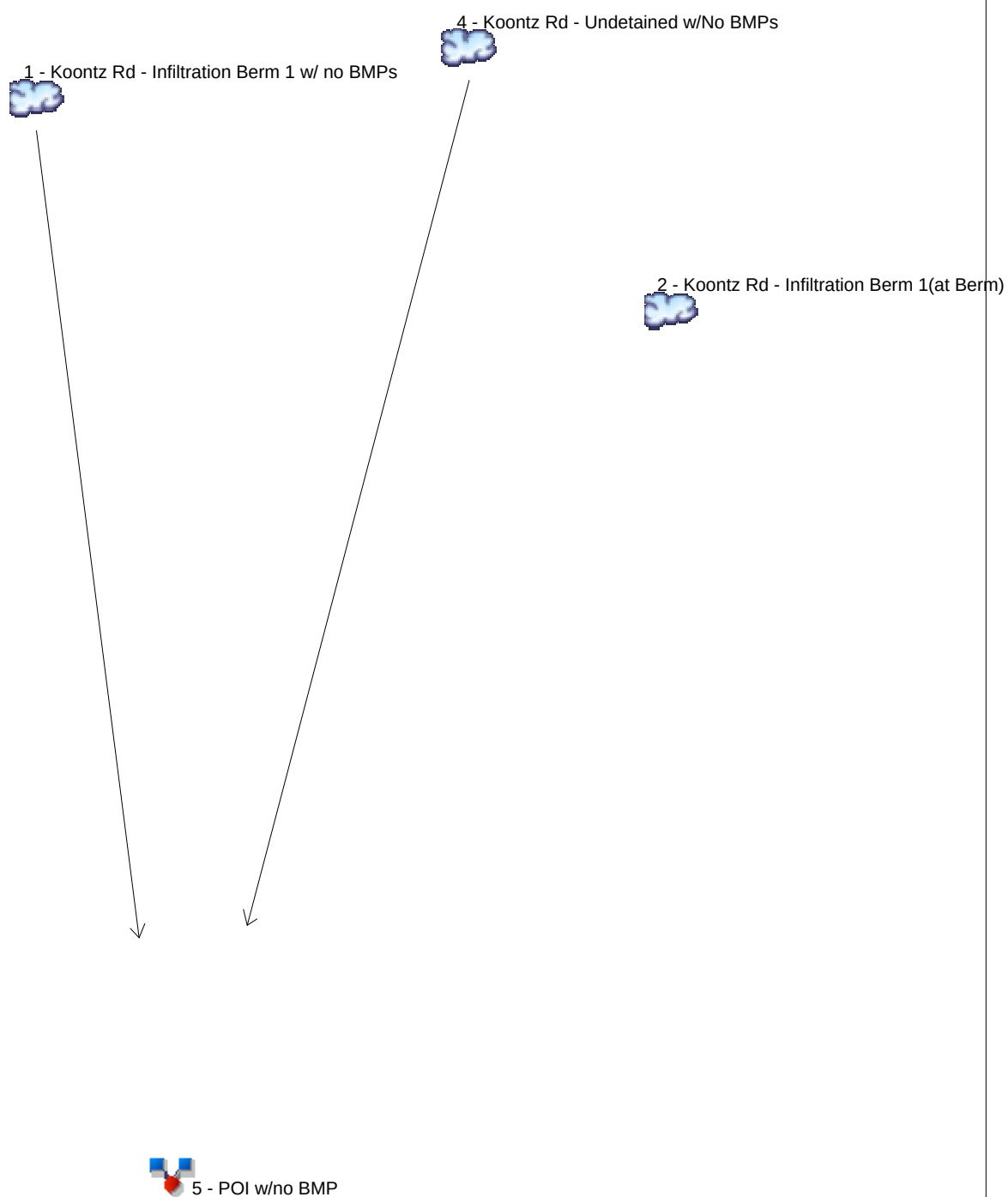
Hyd. No. 1

Koontz Rd - PRE

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 345.00	260.00	0.00				
Watercourse slope (%)	= 6.00	15.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.25	0.00				
Travel Time (min)	= 1.45	+	0.69	+	0.00	=	2.15
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				11.70 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.228	-----	-----	2.523	-----	4.183	5.004	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	-----	-----	0.804	-----	-----	1.473	-----	2.293	2.690	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	-----	-----	1.187	-----	-----	2.351	-----	3.843	4.579	Koontz Rd - Undetained w/No BMPs
5	Combine	1, 4	-----	2.319	-----	-----	4.698	-----	7.760	9.285	POI w/no BMP
Proj. file: Koontz Rd - Post With No BMP.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	5.004	1	718	10,127	-----	-----	-----	Koontz Rd - Infiltration Berm 1 w/ no
2	SCS Runoff	2.690	1	717	5,539	-----	-----	-----	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	4.579	1	720	11,091	-----	-----	-----	Koontz Rd - Undetained w/No BMPs
5	Combine	9.285	1	718	21,218	1, 4	-----	-----	POI w/no BMP
Koontz Rd - Post With No BMP.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

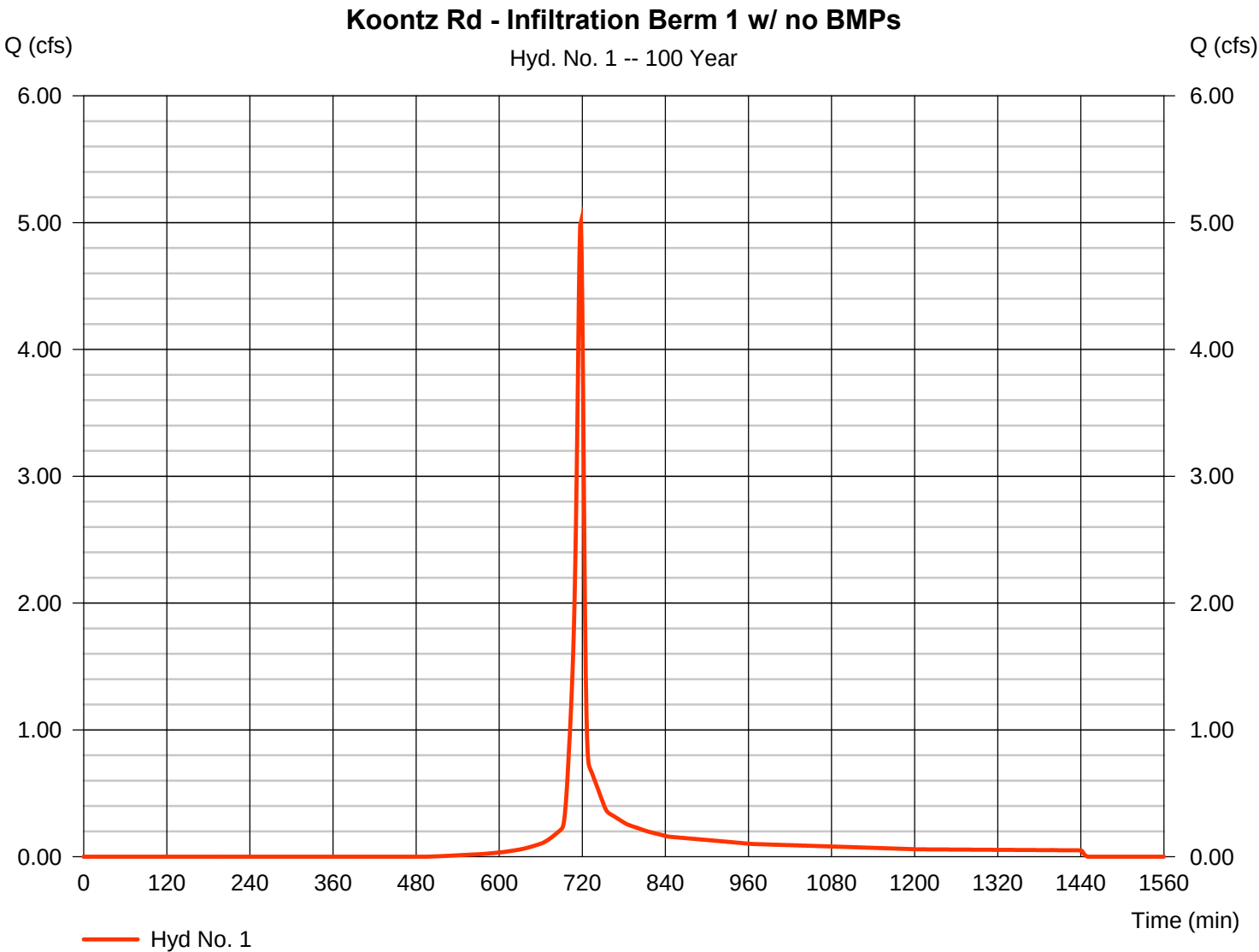
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.004 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	10,127 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/ no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	187.00	0.00				
Watercourse slope (%)	= 10.00	17.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	6.65	0.00				
Travel Time (min)	= 0.10	+	0.47	+	0.00	=	0.57
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				5.80 min			

Hydrograph Report

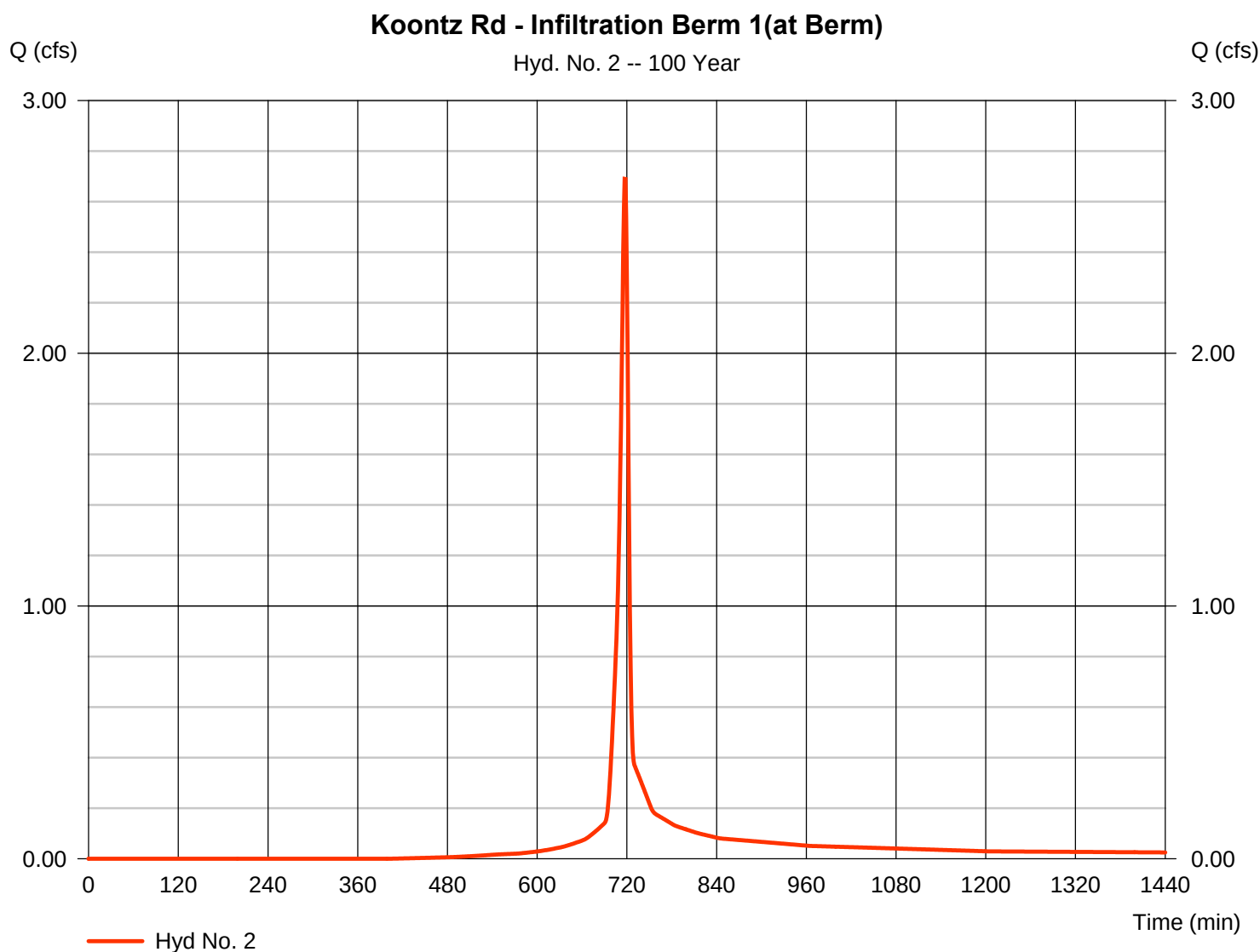
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.690 cfs
Storm frequency	=	100 yrs	Time to peak	=	717 min
Time interval	=	1 min	Hyd. volume	=	5,539 cuft
Drainage area	=	0.480 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.30 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.240	0.011				
Flow length (ft)	= 56.0	44.0	0.0				
Two-year 24-hr precip. (in)	= 2.44	2.44	0.00				
Land slope (%)	= 5.40	9.00	0.00				
Travel Time (min)	= 0.59	+	4.64	+	0.00	=	5.23
Shallow Concentrated Flow							
Flow length (ft)	= 30.00	0.00	0.00				
Watercourse slope (%)	= 10.00	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.10	0.00	0.00				
Travel Time (min)	= 0.10	+	0.00	+	0.00	=	0.10
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				5.30 min			

Hydrograph Report

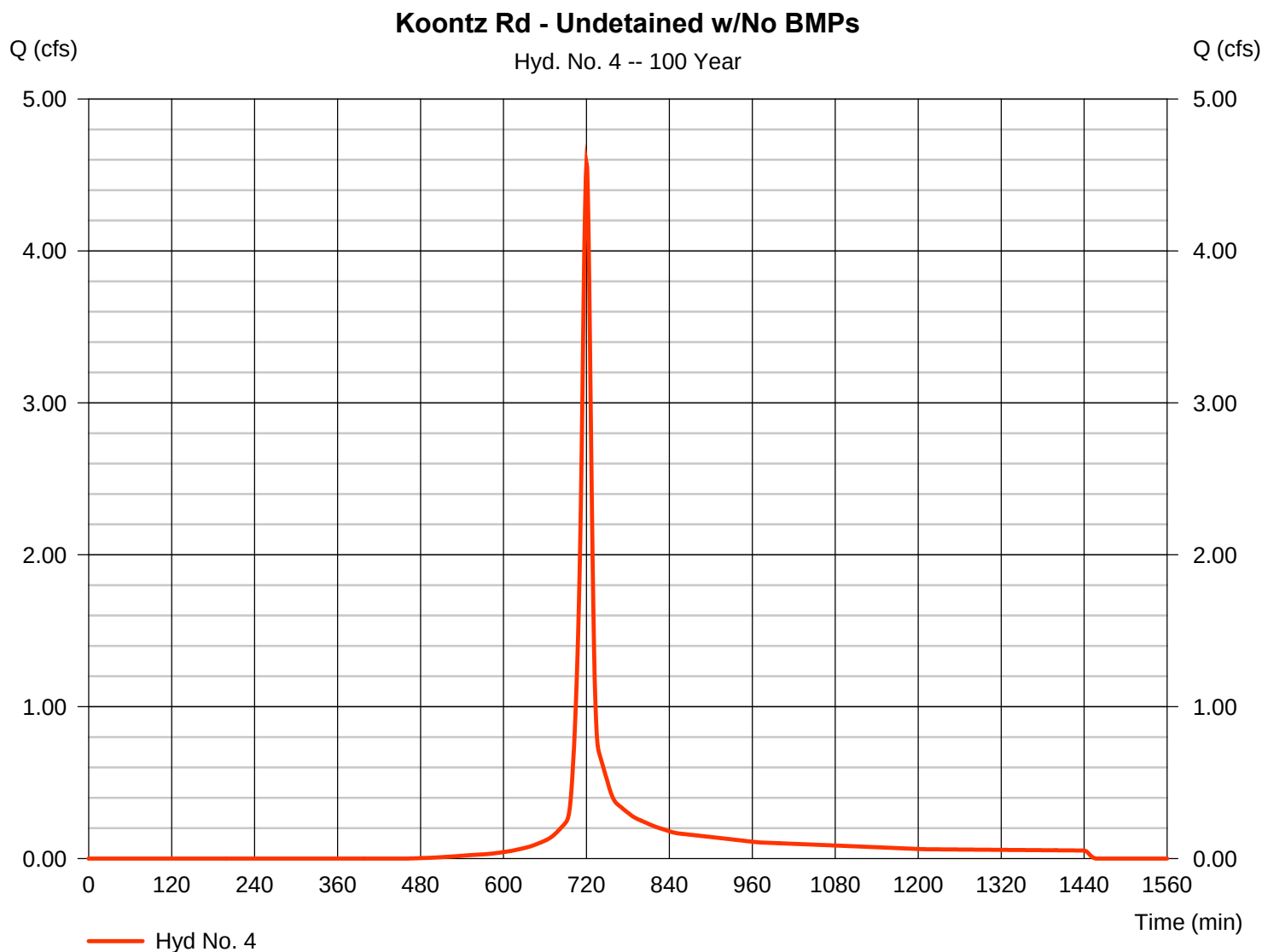
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.579 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	11,091 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Koontz Rd - Undetained w/No BMPs

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

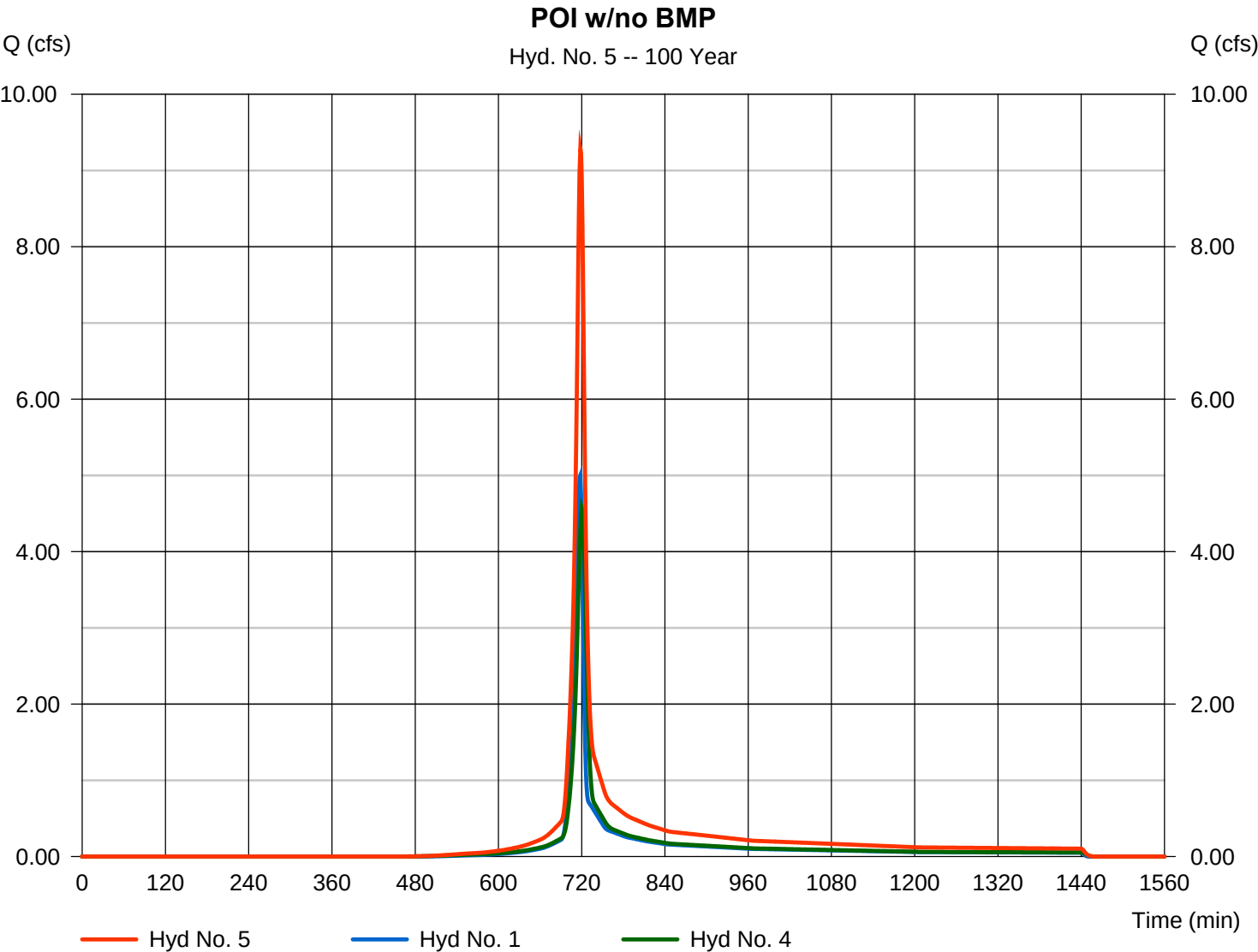
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

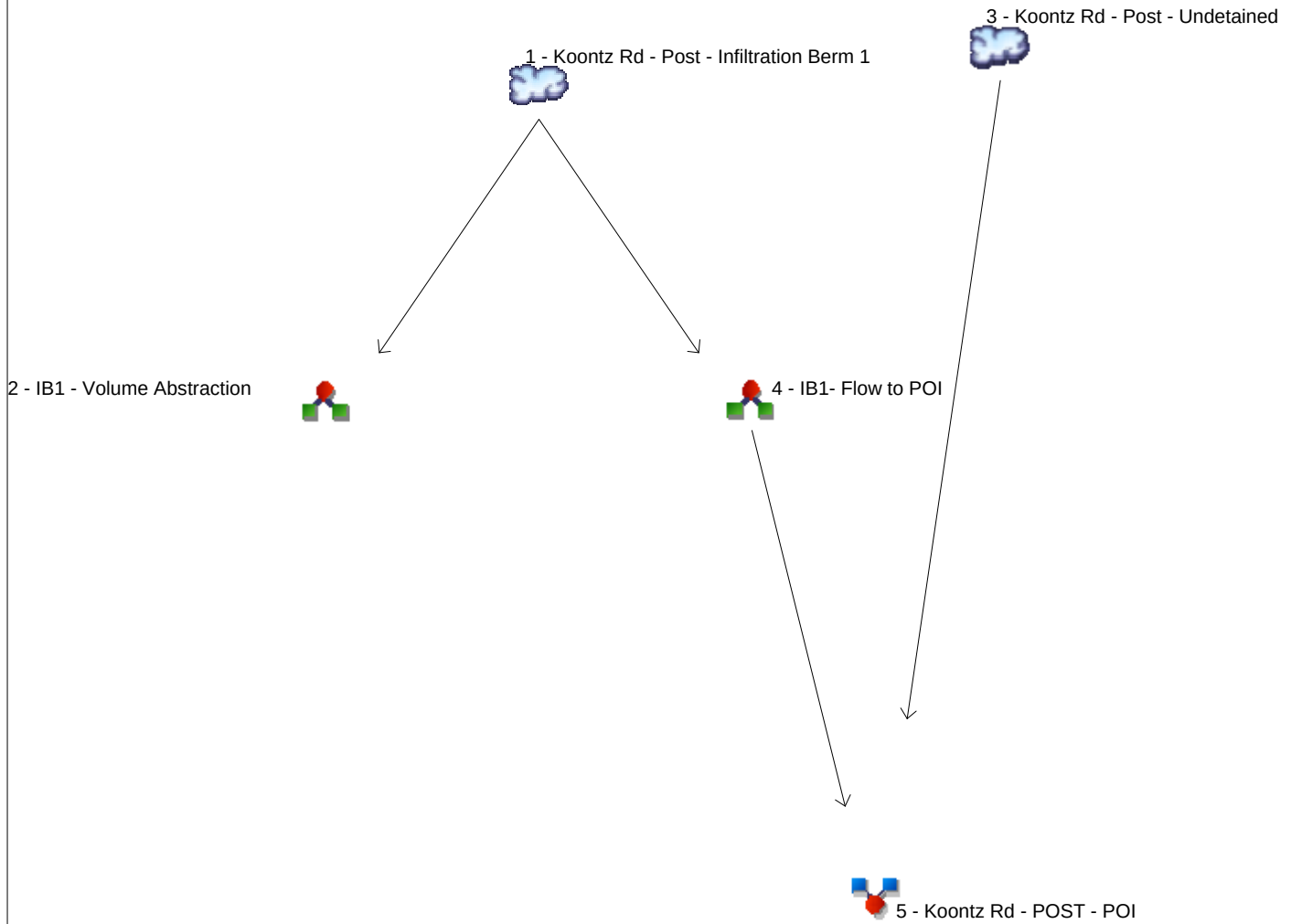
POI w/no BMP

Hydrograph type	= Combine	Peak discharge	= 9.285 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 21,218 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	3.277	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	1	-----	-----	-----	-----	-----	-----	-----	3.277	IB1 - Volume Abstraction
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	4.579	Koontz Rd - Post - Undetained
4	Diversion2	1	-----	-----	-----	-----	-----	-----	-----	2.928	IB1- Flow to POI
5	Combine	3, 4	-----	-----	-----	-----	-----	-----	-----	5.281	Koontz Rd - POST - POI
Proj. file: Koontz Rd - Post WithBMP - 100yr.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.277	1	724	9,708	-----	-----	-----	Koontz Rd - Post - Infiltration Berm 1
2	Diversion1	3.277	1	724	3,534	1	-----	-----	IB1 - Volume Abstraction
3	SCS Runoff	4.579	1	720	11,091	-----	-----	-----	Koontz Rd - Post - Undetained
4	Diversion2	2.928	1	728	6,175	1	-----	-----	IB1- Flow to POI
5	Combine	5.281	1	728	17,429	3, 4	-----	-----	Koontz Rd - POST - POI
Koontz Rd - Post WithBMP - 100yr.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

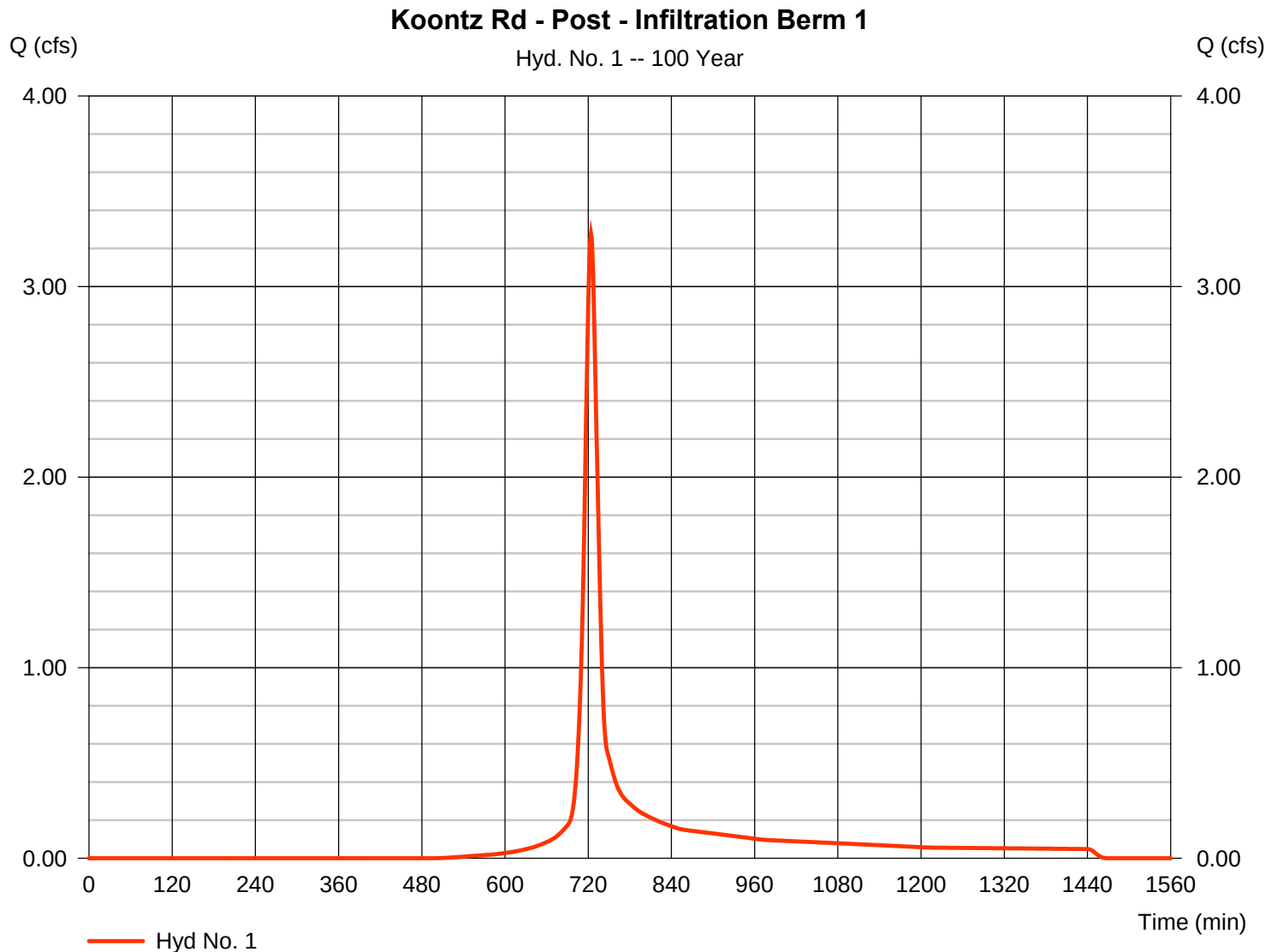
Friday, 11 / 4 / 2016

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.277 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	9,708 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.40 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 75) + (0.400 \times 75) + (0.150 \times 90) + (0.360 \times 71) + (0.090 \times 89) + (0.300 \times 70)] / 1.030$



Hydrograph Report

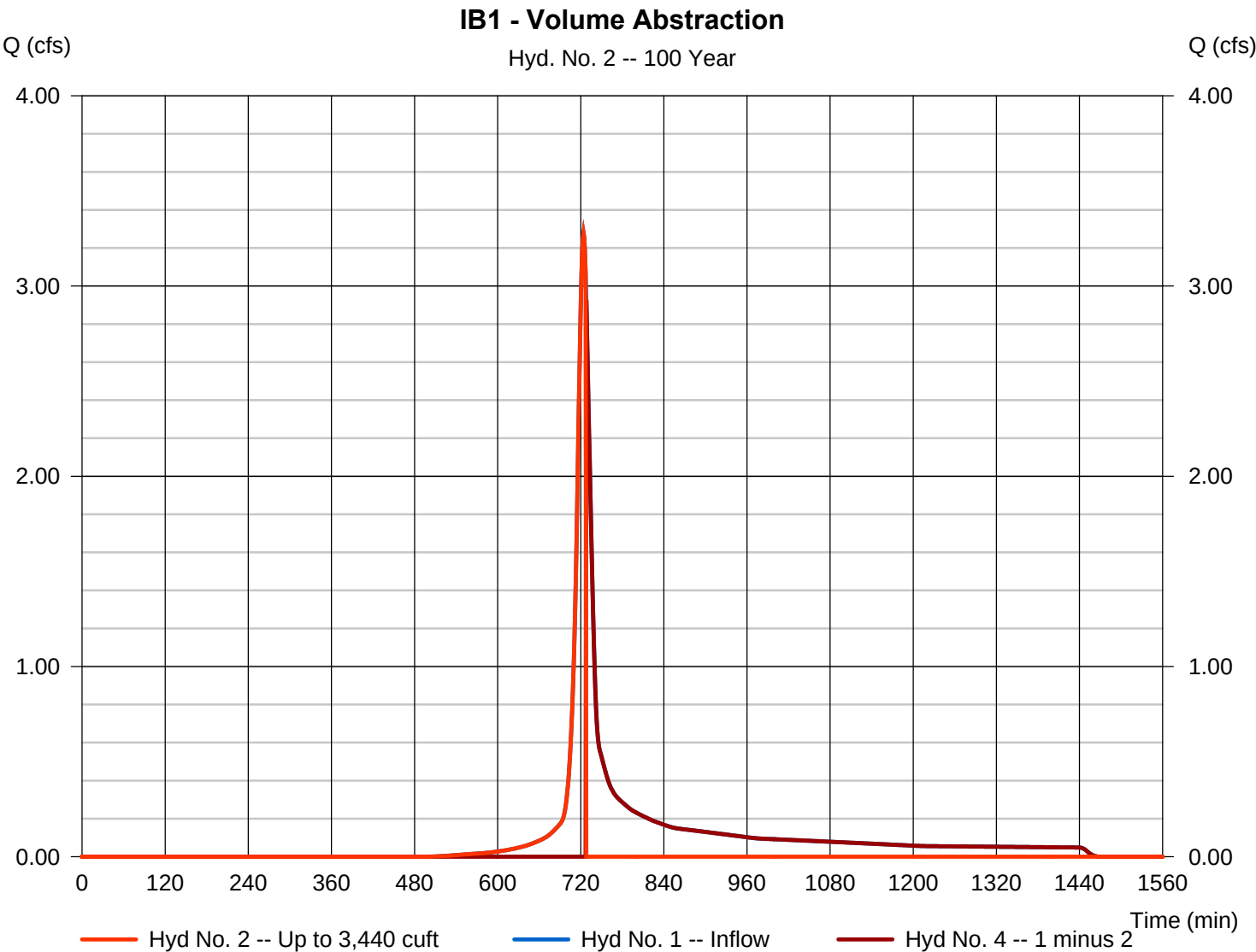
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

IB1 - Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	3.277 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	3,534 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration2	Diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	3,440 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

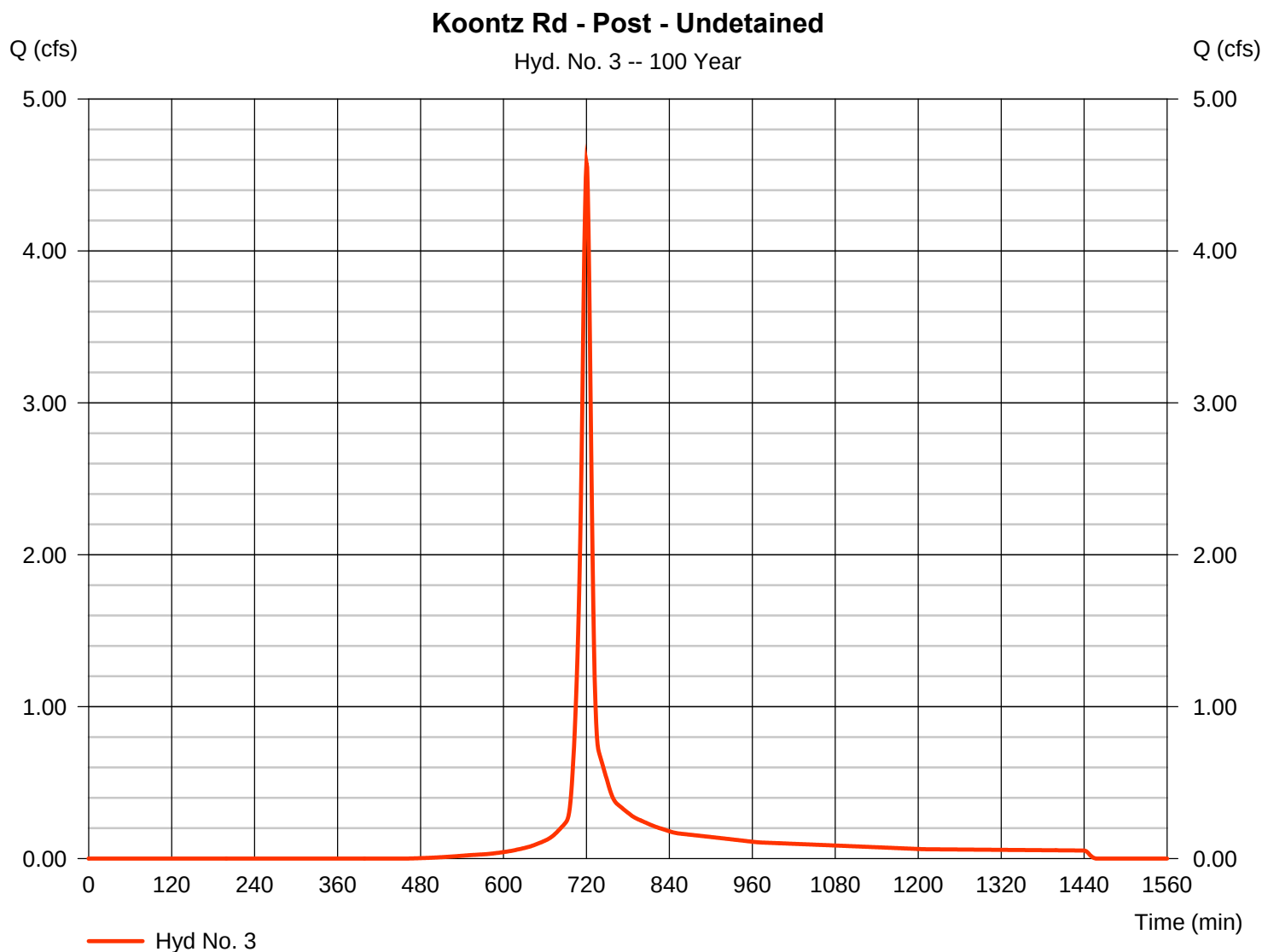
Friday, 11 / 4 / 2016

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 1 min
 Drainage area = 1.070 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 5.11 in
 Storm duration = 24 hrs

Peak discharge = 4.579 cfs
 Time to peak = 720 min
 Hyd. volume = 11,091 cuft
 Curve number = 78
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 11.30 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Koontz Rd - Post - Undetained

<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)	= 2.44	0.00	0.00				
Land slope (%)	= 3.00	0.00	0.00				
Travel Time (min)	= 9.54	+	0.00	+	0.00	=	9.54
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 6.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.95	0.00	0.00				
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22
Channel Flow							
X sectional flow area (sqft)	= 7.50	7.50	0.00				
Wetted perimeter (ft)	= 8.71	8.71	0.00				
Channel slope (%)	= 6.00	12.00	0.00				
Manning's n-value	= 0.026	0.026	0.015				
Velocity (ft/s)	=12.70	17.96	0.00				
Flow length (ft)	((0})224.0	240.0	0.0				
Travel Time (min)	= 0.29	+	0.22	+	0.00	=	0.52
Total Travel Time, Tc				11.30 min			

Hydrograph Report

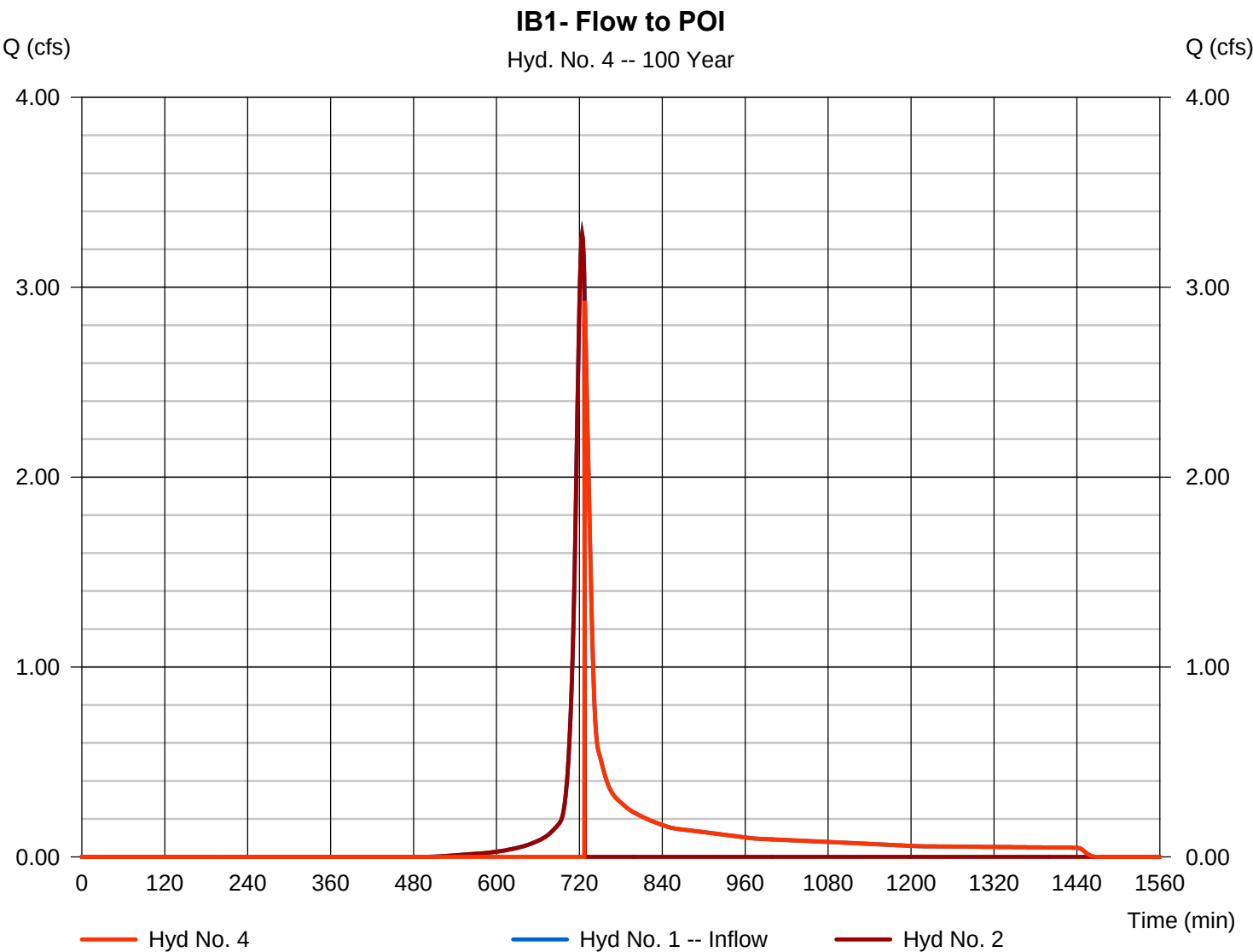
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

IB1- Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	2.928 cfs
Storm frequency	=	100 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	6,175 cuft
Inflow hydrograph	=	1 - Koontz Rd - Post - Infiltration	2 - Diverted hyd.	=	2
Diversion method	=	First Flush Volume	Volume Up To	=	3,440 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

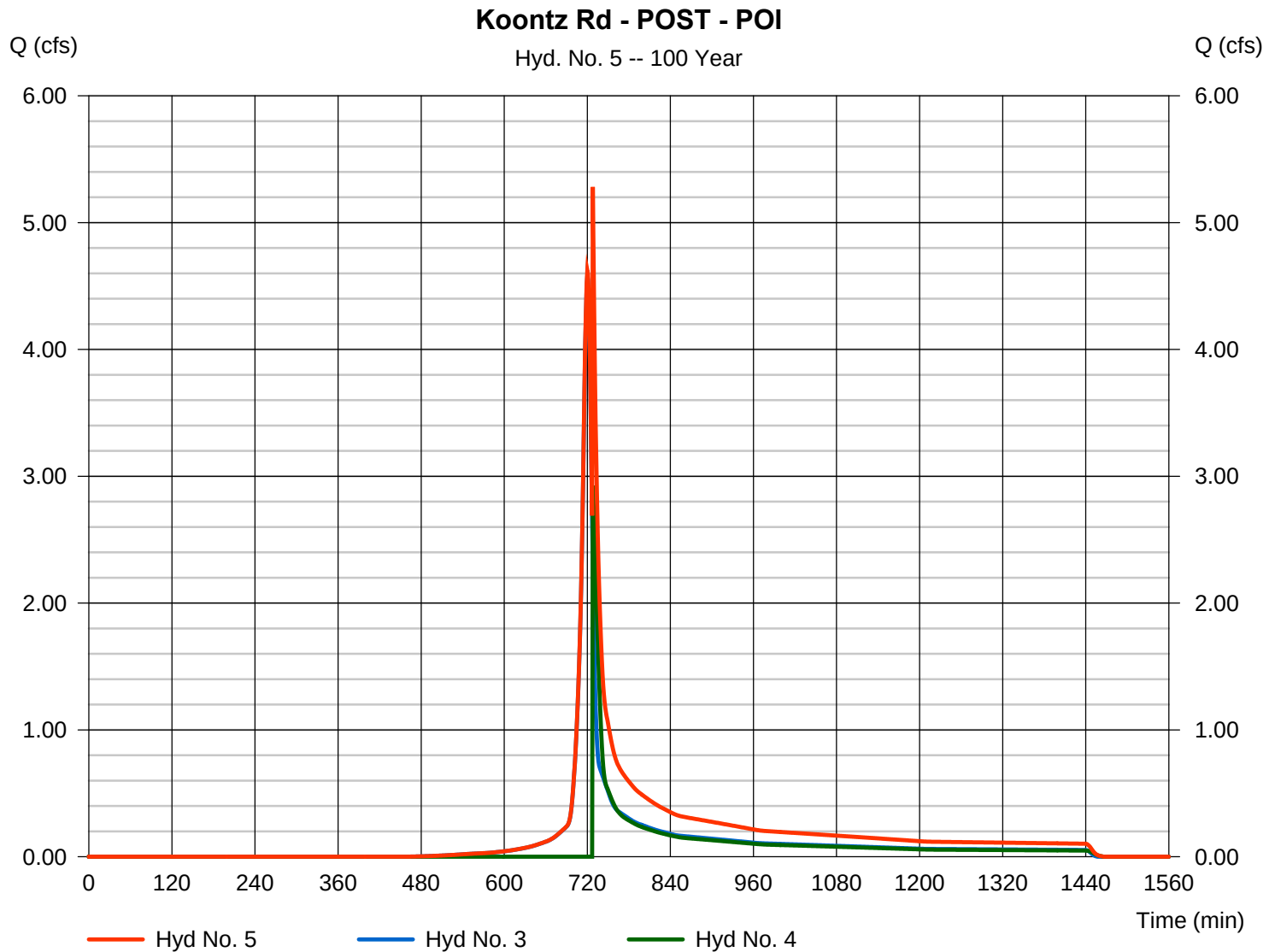
Friday, 11 / 4 / 2016

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 3, 4

Peak discharge = 5.281 cfs
 Time to peak = 728 min
 Hyd. volume = 17,429 cuft
 Contrib. drain. area = 1.070 ac



ATTACHMENT D
KOONTZ RD
DIVERSION CHANNEL DESIGN

TETRA TECH, INC.

By: RJM Date: 10/21/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/23/16 Koontz Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\1 - Koontz Road (formerly Loyalhanna Lake West)\[Koontz Rd BMP Design.xlsx]Channel

DIVERSION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1*	4.75

DD-1 is designated as the watershed labeled as "Koontz Rd - Post - Undetained" from Attachment C. The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	2.56	0.75	0.50	1.25

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes		Channel Lining	Total Depth (ft)
			(_LH:1V)	(_RH:1V)		
DD-1	6%	1	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output .
2. The channel section characteristics resulting in the largest total depth were used.

LEVEL SPREADER DESIGN

CHANNEL DESIGNATION	ENERGY DISSIPATOR TYPE	LENGTH (ft)	Downslope Protection	Q (cfs)
DD-1	Earthen Level Spreader	109	Grass/Rock	7.1

$$Q = C_w \times L \times H^{3/2} \quad (\text{Ref \#5})$$

Q = Flow (cfs)

L = Length of Level Spreader (ft)

C_w = Weir Coefficient 3.27

H = Driving Head (ft) 0.07 Based on V(allowable) = 1.33

$$V = 1.5 \times C_w \times H^{1/2} \quad (\text{Ref \#5})$$

V = Allowable velocity at the Level Spreader (fps)

Grass/Ticket = 1.33

Gravel = 1.5 (Table G.2, Ref #5)

Mulch (trees, Shrubs) = 0.67



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

Project Name: 112IC05958 Sunoco
Project Number: 103213
Channel Name: Koontz Rd - DD1

Discharge	4.75
Peak Flow Period	0.3
Channel Slope	0.06
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	4.75 cfs	4.86 ft/s	0.49 ft	0.034	3 lbs/ft ²	1.85 lbs/ft ²	1.63	STABLE	E
P300 Reinforced Vegetation	Straight	4.75 cfs	2.56 ft/s	0.75 ft	0.081	8 lbs/ft ²	2.79 lbs/ft ²	2.87	STABLE	E
Underlying Substrate	Straight	4.75 cfs	2.56 ft/s	0.75 ft	--	2 lbs/ft ²	0.107 lbs/ft ²	18.63	STABLE	--

BUSH RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 3, 2016

Project Name: Bush Road

Municipality: Loyalhanna Township

County: Westmoreland

Total Area (acres): 5.17

Major River Basin: Ohio River

Watershed: Loyalhanna Creek

Sub Basin: Trib 43288 of Loyalhanna Creek

Nearest Surface Water to Receive Runoff: UNT to Loyalhanna Creek

Ch. 93 - Designated Water Use: WWF

Impaired according to Chapter 303(d) list?

YES

X

List Causes of Impairment:

NO

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES

X

NO

Existing or Planned drinking water supply?

YES

X

NO

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES

X

NO

Existing River Conservation Plan?

YES

X

NO

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	5.17	4.39
Other:			
TOTAL EXISTING:	Yes	5.17	4.39

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	4.39	Ac.
1.2 Area of Riparian Forest Buffer Protection	0	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	0	Ac.
TOTAL	4.39	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
5.17	-	4.39	=	0.78
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn	_____	ft ² x	1/4 in x	1/12 =	_____	ft ³
Meadow	_____	ft ² x	1/3 in x	1/12 =	_____	ft ³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy	_____	ft ² x	1/2 in x	1/12 =	_____	ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	_____	ft ² x	1/3 in x	1/12 =	_____	ft ³

For all other disconnected roof areas

Roof Area	_____	ft ² x	1/4 in x	1/12 =	_____	ft ³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas	_____	ft ² x	1/3 in x	1/12 =	_____	ft ³

For all other disconnected roof areas

Impervious Areas	_____	ft ² x	1/4 in x	1/12 =	_____	ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

_____ ft³

* For use on Workseet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Bush Road
 Drainage Area: 5.17 acres
 2-Year Rainfall: 2.45 in

Total Site Area: 5.17 acres
 Protected Site Area: 4.39 acres
 Managed Site Area: 0.78 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	26136	0.60	78	2.82	0.56	0.76	1,646
Woods	C/D	4356	0.10	77	2.99	0.60	0.71	257
Meadow (20% Gravel)	C/D	697	0.02	78	2.82	0.56	0.76	44
Existing Gravel (80%)	C/D	2788	0.06	90	1.11	0.22	1.49	345
TOTAL:		33,977	0.78					2,293

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	27443	0.63	78	2.82	0.56	0.76	1,728
Gravel - Impervious	C/D	6534	0.15	90	1.11	0.22	1.49	809
TOTAL:		33,977	0.78					2,538

2-Year Volume Increase (ft ³):	245

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI
The use of a weighted CN value for volume calculations is not acceptable

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Bush Road
SUB-BASIN:

Required Control Volume (ft³) - from Worksheet 4: 245

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 245
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	2,894	1,745
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			1,745
Structural Volume Requirement (ft³):			245
DIFFERENCE:			-1,500

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration	X	

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP

LOCATION: Bush Road, Westmoreland County, PA

DONE BY: LMD

DATE: 10/3/2016

CHECKED BY: RJM

DATE: 10/25/2016

CHANNEL OR CHANNEL SECTION	DD 1	DD 2			
TEMPORARY OR PERMANENT? (T OR P)	P	P			
DESIGN STORM (2, 5, 10, OR 100 YR)	100	100			
ACRES (AC)	2.26	0.76			
MULTIPLIER (1.6, 2.25, or 2.75) ¹	N/A	N/A			
Q _r (REQUIRED CAPACITY) (CFS)	11.25	4.00			
Q (CALCULATED AT FLOW DEPTH d) (CFS)	11.25	4.00			
S (BED SLOPE) ³ (FT/FT)	0.02	0.06			
DESIGN METHOD FOR PROTECTIVE LINING ⁵ PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V	V			
PROTECTIVE LINING ²	NAG P300	NAG P300			
n (MANNING'S COEFFICIENT) ²	0.050	0.060			
V _a (ALLOWABLE VELOCITY) (FPS)	5.00	5.00			
V (CALCULATED AT FLOW DEPTH) (FPS)	3.05	3.07			
t _a (MAX ALLOWABLE SHEAR STRESS) (LB/FT ²)	N/A	N/A			
t _d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT ²)	N/A	N/A			
CHANNEL BOTTOM WIDTH (FT)	1	1			
CHANNEL LEFT SIDE SLOPE (_LH:1V)	2	2			
CHANNEL RIGHT SIDE SLOPE (_RH:1V)	2	2			
D (TOTAL DEPTH) (FT)	2.00	1.50			
CHANNEL TOP WIDTH @ D (FT)	9.00	7.00			
d (CALCULATED FLOW DEPTH) (FT)	1.13	0.60			
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	5.52	3.40			
BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)	0.88	1.67			
d ₅₀ STONE SIZE (IN)	N/A	N/A			
A (CROSS-SECTIONAL AREA) (SQ. FT.)	3.68	1.32			
R (HYDRAULIC RADIUS)	0.61	0.36			
S _c (CRITICAL SLOPE) (FT/FT)	0.047	0.080			
.75S _c (FT/FT)	0.033	0.056			
1.35S _c (FT/FT)	0.061	0.104			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW (FT)	N/A	N/A			
FREEBOARD BASED ON STABLE FLOW (FT)	0.87	0.90			
MINIMUM REQUIRED FREEBOARD ⁴	0.5	0.5			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

PCSM - DESIGN CALCULATIONS
BUSH RD

TETRA TECH, INC.

By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations **Bush Road**

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Bush Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Bush Road Block Valve Site is located in Loyalhanna Township, Westmoreland County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This project will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This project will utilize infiltration berms to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.45
10-yr	3.44
50-yr	4.59
100-yr	5.13

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.45 in
Total Site Area : 5.17 acres
Protected Site Area: 4.39 acres
Stormwater Management Area 0.78 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.60	78	2.82	0.56	0.76	1,646
Woods	C/D	0.10	77	2.99	0.60	0.71	257
Meadow (20% Gravel)	C/D	0.02	78	2.82	0.56	0.76	44
Existing Gravel (80%)	C/D	0.06	90	1.11	0.22	1.49	345
Total		0.78					2,293

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.63	78	2.82	0.56	0.76	1,728
Gravel - Impervious	C/D	0.15	90	1.11	0.22	1.49	809
Total		0.78					2,538

2-Year Volume Increase (cf):	245

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]
P = 2-Year Rainfall (in)
S = (1000/CN)-10
2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
Q = Runoff (in)
Area = Land use area (sq. ft.)

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Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.15	6534.0
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1306.8
Design Infiltration Area (sf):		2934.8
Design Impervious Ratio:	2	:1

OK

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.53	23016.5
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		2877.1
Design Infiltration Area (sf):		2934.8
Design Total Watershed Ratio:	7.8	:1

OK

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Bush Road Block Valve Site will be located along the northern edge of the pad and 90 percent of the disturbed area will be detained by the BMP.

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INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr)	3.5

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

INFILTRATION BERM

Storage Volume

Width (ft)	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
49.9	58	50.6	2,894	2.00	2935

Note: The Ponding Area is an irregular shape. The Width and Length are average measurements to obtain plan area.

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
3.5	2,894	2	1688

Volume Abstraction Potential (cf)	4,623.08

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the follow three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration Berm	1745	2935	2934.8	1745
Total Structural Credit (cf) (Worksheet 5)				1745

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
 Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 5.17 acres. Based upon the soil survey of Westmoreland County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Ernest silt loam (ErC), Gilpin channery silt loam (GcD), Gilpin-Rock outcrop complex (GoF), and Wharton silt loam (WrC) series which are primarily classified as HSG C/D, C, C, and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcD	Woods	70	0.82
C/D	WrC	Woods	77	0.07
C/D	WrC	Meadow	78	1.91
C/D	ErC	Woods	77	0.32
C/D	ErC	Existing Gravel (80%)	91	0.06
C/D	ErC	Meadow (20% Gravel)	78	0.02
C/D	ErC	Meadow	78	1.44
C	GoF	Woods	70	0.53
Totals				5.17

CN	76

Post-Development Condition - Undetained 1

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	ErC	Meadow	78	0.08
C/D	ErC	Gravel - Impervious	91	0.02
Totals				0.10

CN	81

Post-Development Condition - Undetained 2

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	ErC	Meadow	78	0.73
C/D	ErC	Woods	77	0.18
C	GoF	Woods	70	0.53
Totals				1.44

CN	75

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
 Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 1121C05958

Post-Development Condition - Diversion Channel 1

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcD	Woods	70	0.67
C/D	WrC	Woods	77	0.05
C/D	WrC	Meadow	78	1.32
C/D	ErC	Meadow	78	0.22
			Totals	2.26

CN	76

Post-Development Condition - Diversion Channel 2

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcD	Woods	70	0.11
C/D	WrC	Woods	77	0.01
C/D	WrC	Meadow	78	0.47
C/D	ErC	Meadow	78	0.17
			Totals	0.76

CN	77

Post-Development Condition - Detained

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcD	Woods	70	0.03
C/D	WrC	Woods	77	0.01
C/D	WrC	Meadow	78	0.13
C/D	ErC	Woods	77	0.04
C/D	ErC	Meadow	78	0.27
C/D	ErC	Gravel	91	0.13
			Totals	0.61

CN	80

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
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PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the Tc as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.79	1,745	36.9	6.9	43.8
10	1.40	2,935	35.0	6.9	41.9
50	2.20	2,935	22.2	6.9	29.1
100	2.59	2,935	18.9	6.9	25.8

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,745	4,623	1,745
10	3,194	4,623	3,194
50	5,052	4,623	4,623
100	5,965	4,623	4,623

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

STORMWATER POND ROUTING

The computer program AutoCAD Civil 3D Hydraflow Hydrographs extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	5.55	5.5	11,008	4.67	-0.89
10-yr	11.44	11.3	21,931	9.74	-1.70
50-yr	19.05	18.9	36,985	16.33	-2.72
100-yr	22.83	22.5	45,233	19.57	-3.26

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By: LMD Date: 10/3/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/2016 Bush Road Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Westmoreland County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4381 N 79.4349 W 998.4 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Loyalhanna Twp, Pennsylvania,
USA*

Latitude: 40.4381°, Longitude: -79.4349°

Elevation: 998.4 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.313 (0.283-0.346)	0.374 (0.338-0.413)	0.452 (0.409-0.499)	0.514 (0.463-0.566)	0.592 (0.533-0.651)	0.652 (0.584-0.716)	0.710 (0.634-0.778)	0.771 (0.685-0.845)	0.851 (0.752-0.932)	0.911 (0.801-0.996)
10-min	0.487 (0.440-0.537)	0.583 (0.527-0.645)	0.703 (0.636-0.776)	0.793 (0.715-0.873)	0.905 (0.815-0.996)	0.988 (0.886-1.09)	1.07 (0.955-1.17)	1.15 (1.02-1.26)	1.25 (1.10-1.37)	1.33 (1.17-1.45)
15-min	0.597 (0.539-0.659)	0.713 (0.645-0.789)	0.863 (0.781-0.953)	0.976 (0.880-1.07)	1.12 (1.01-1.23)	1.22 (1.10-1.34)	1.33 (1.19-1.46)	1.43 (1.27-1.57)	1.56 (1.38-1.71)	1.66 (1.46-1.81)
30-min	0.790 (0.713-0.871)	0.954 (0.863-1.05)	1.18 (1.07-1.30)	1.35 (1.22-1.49)	1.58 (1.42-1.74)	1.75 (1.57-1.92)	1.92 (1.71-2.10)	2.09 (1.86-2.29)	2.31 (2.04-2.53)	2.48 (2.19-2.72)
60-min	0.964 (0.871-1.06)	1.17 (1.06-1.29)	1.48 (1.34-1.64)	1.72 (1.55-1.90)	2.05 (1.84-2.25)	2.30 (2.06-2.53)	2.56 (2.29-2.81)	2.83 (2.52-3.10)	3.20 (2.83-3.50)	3.49 (3.07-3.82)
2-hr	1.12 (1.02-1.23)	1.36 (1.24-1.49)	1.72 (1.56-1.88)	2.00 (1.81-2.19)	2.38 (2.16-2.61)	2.70 (2.43-2.94)	3.02 (2.71-3.29)	3.36 (3.00-3.65)	3.83 (3.40-4.16)	4.21 (3.71-4.56)
3-hr	1.20 (1.09-1.31)	1.45 (1.32-1.59)	1.82 (1.65-2.00)	2.12 (1.92-2.33)	2.53 (2.29-2.77)	2.88 (2.59-3.14)	3.23 (2.89-3.52)	3.60 (3.21-3.92)	4.13 (3.65-4.48)	4.55 (3.99-4.93)
6-hr	1.43 (1.30-1.59)	1.72 (1.57-1.92)	2.15 (1.95-2.38)	2.50 (2.26-2.76)	2.99 (2.70-3.30)	3.40 (3.06-3.74)	3.83 (3.42-4.21)	4.29 (3.80-4.70)	4.94 (4.34-5.40)	5.47 (4.76-5.96)
12-hr	1.72 (1.56-1.91)	2.06 (1.87-2.29)	2.55 (2.31-2.83)	2.95 (2.67-3.27)	3.54 (3.18-3.90)	4.02 (3.60-4.42)	4.54 (4.03-4.98)	5.09 (4.49-5.57)	5.89 (5.14-6.43)	6.55 (5.67-7.13)
24-hr	2.05 (1.91-2.22)	2.45 (2.27-2.65)	2.99 (2.77-3.24)	3.44 (3.18-3.72)	4.07 (3.75-4.39)	4.59 (4.22-4.94)	5.13 (4.70-5.51)	5.70 (5.19-6.11)	6.50 (5.88-6.96)	7.15 (6.43-7.65)
2-day	2.39 (2.22-2.58)	2.84 (2.65-3.07)	3.45 (3.21-3.72)	3.94 (3.65-4.25)	4.62 (4.28-4.97)	5.17 (4.77-5.56)	5.74 (5.27-6.16)	6.33 (5.79-6.78)	7.15 (6.50-7.64)	7.80 (7.05-8.33)
3-day	2.57 (2.40-2.76)	3.05 (2.85-3.28)	3.67 (3.42-3.94)	4.17 (3.88-4.47)	4.86 (4.52-5.21)	5.42 (5.02-5.80)	6.00 (5.54-6.41)	6.59 (6.07-7.03)	7.41 (6.77-7.89)	8.05 (7.32-8.57)
4-day	2.75 (2.57-2.94)	3.25 (3.05-3.48)	3.88 (3.64-4.15)	4.40 (4.12-4.70)	5.11 (4.77-5.44)	5.68 (5.28-6.04)	6.26 (5.80-6.66)	6.86 (6.33-7.29)	7.67 (7.05-8.14)	8.30 (7.60-8.81)
7-day	3.29 (3.10-3.50)	3.88 (3.65-4.13)	4.58 (4.31-4.87)	5.13 (4.82-5.46)	5.89 (5.52-6.25)	6.48 (6.06-6.88)	7.08 (6.60-7.50)	7.68 (7.14-8.13)	8.47 (7.85-8.97)	9.08 (8.38-9.60)
10-day	3.80 (3.60-4.01)	4.47 (4.24-4.73)	5.23 (4.95-5.52)	5.82 (5.51-6.15)	6.62 (6.25-6.99)	7.24 (6.83-7.64)	7.86 (7.39-8.28)	8.48 (7.94-8.92)	9.29 (8.66-9.77)	9.89 (9.20-10.4)
20-day	5.33 (5.06-5.62)	6.25 (5.94-6.59)	7.20 (6.84-7.60)	7.95 (7.55-8.39)	8.94 (8.47-9.41)	9.69 (9.18-10.2)	10.4 (9.85-11.0)	11.1 (10.5-11.7)	12.1 (11.3-12.7)	12.7 (11.9-13.4)
30-day	6.72 (6.41-7.05)	7.85 (7.49-8.25)	8.96 (8.55-9.42)	9.84 (9.37-10.3)	11.0 (10.5-11.5)	11.8 (11.3-12.4)	12.7 (12.0-13.3)	13.5 (12.8-14.1)	14.5 (13.7-15.2)	15.2 (14.4-16.0)
45-day	8.61 (8.24-9.01)	10.0 (9.60-10.5)	11.3 (10.8-11.9)	12.3 (11.8-12.9)	13.6 (13.0-14.2)	14.5 (13.9-15.2)	15.4 (14.7-16.1)	16.2 (15.4-17.0)	17.2 (16.4-18.0)	18.0 (17.0-18.8)
60-day	10.4 (9.97-10.8)	12.1 (11.6-12.6)	13.5 (13.0-14.1)	14.6 (14.0-15.3)	16.0 (15.3-16.7)	17.0 (16.3-17.8)	17.9 (17.2-18.7)	18.8 (18.0-19.6)	19.8 (18.9-20.7)	20.6 (19.6-21.5)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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

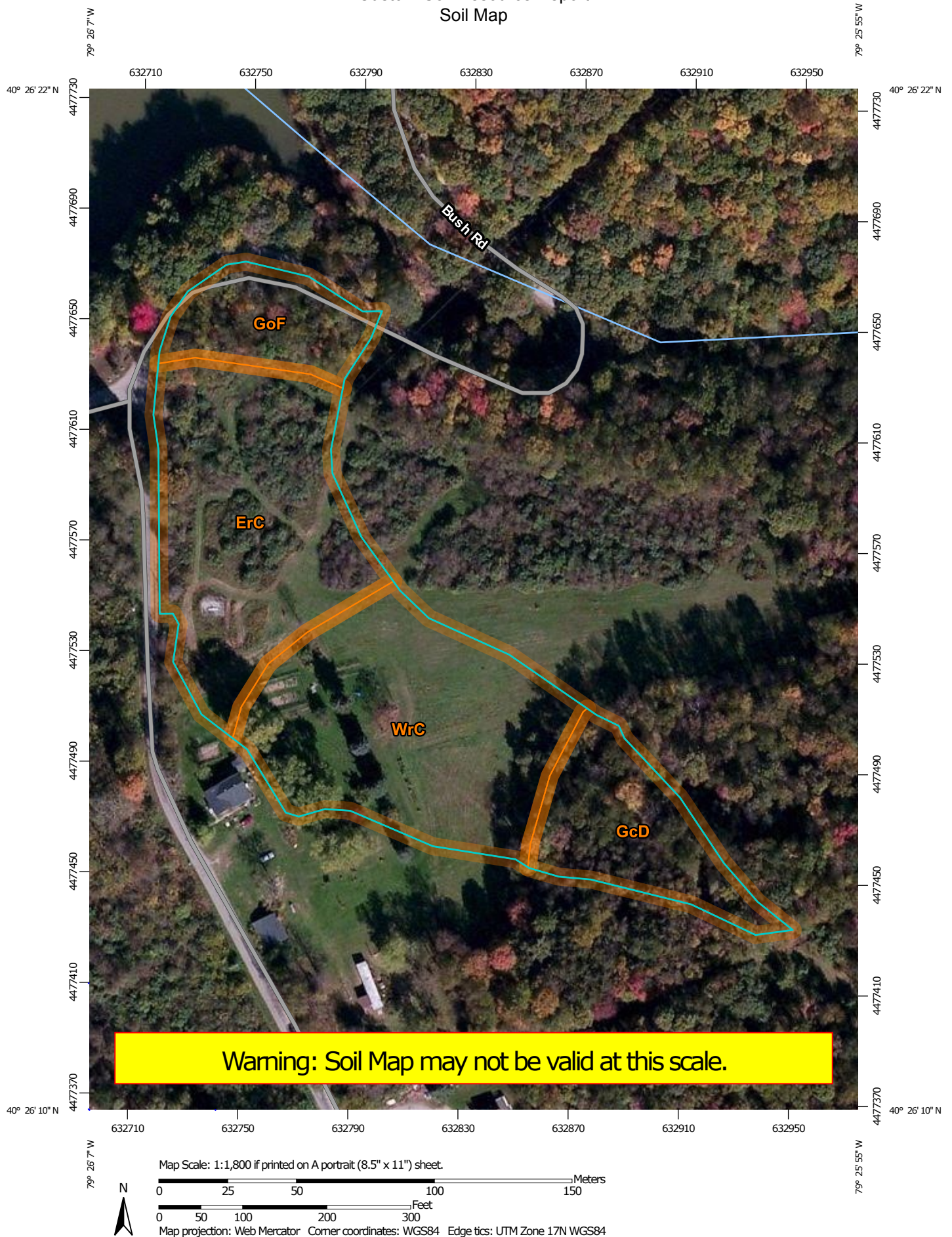
Custom Soil Resource Report for **Westmoreland County, Pennsylvania**



October 20, 2016

177 of 1484

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Soil Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

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: <http://websoilsurvey.nrcs.usda.gov>
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: Westmoreland County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Westmoreland County, Pennsylvania (PA129)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
ErC	Ernest silt loam, 8 to 15 percent slopes	1.9	35.8%
GcD	Gilpin channery silt loam, 15 to 25 percent slopes	0.8	15.6%
GoF	Gilpin-Rock outcrop complex, 45 to 100 percent slopes	0.6	10.9%
WrC	Wharton silt loam, 8 to 15 percent slopes	2.0	37.7%
Totals for Area of Interest		5.2	100.0%

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic

classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Westmoreland County, Pennsylvania

ErC—Ernest silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 18qm

Elevation: 900 to 1,800 feet

Mean annual precipitation: 36 to 46 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 130 to 160 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Ernest and similar soils: 85 percent

Minor components: 15 percent

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

Description of Ernest

Setting

Landform: Hillslopes

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Acid fine-loamy colluvium derived from shale and siltstone

Typical profile

Ap - 0 to 8 inches: silt loam

Bt - 8 to 24 inches: silty clay loam

Btx - 24 to 50 inches: channery silt loam

C - 50 to 74 inches: channery silt loam

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: 20 to 36 inches to fragipan

Natural drainage class: Moderately well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.33 in/hr)

Depth to water table: About 17 to 22 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Brinkerton

Percent of map unit: 5 percent

Landform: Draws, hills

Custom Soil Resource Report

Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

Gilpin

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Lobdell

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

GcD—Gilpin channery silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2t1kv
Elevation: 790 to 3,120 feet
Mean annual precipitation: 39 to 61 inches
Mean annual air temperature: 46 to 53 degrees F
Frost-free period: 161 to 181 days
Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam

Custom Soil Resource Report

C - 24 to 30 inches: extremely channery loam

R - 30 to 40 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent

Depth to restrictive feature: 30 to 36 inches to lithic bedrock

Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: C

Hydric soil rating: No

Minor Components

Weikert

Percent of map unit: 10 percent

Landform: Hills

Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Nose slope

Down-slope shape: Convex

Across-slope shape: Convex

Hydric soil rating: No

Wharton

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Backslope, shoulder

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

GoF—Gilpin-Rock outcrop complex, 45 to 100 percent slopes

Map Unit Setting

National map unit symbol: 18rr

Elevation: 480 to 3,000 feet

Mean annual precipitation: 30 to 65 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 120 to 200 days

Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 45 percent

Rock outcrop: 20 percent

Minor components: 35 percent

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

Description of Gilpin

Setting

Landform: Hillslopes

Landform position (two-dimensional): Backslope, shoulder

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

O_i - 0 to 0 inches: slightly decomposed plant material

O_e - 0 to 1 inches: moderately decomposed plant material

A - 1 to 6 inches: channery silt loam

B_t - 6 to 24 inches: channery silt loam

C - 24 to 30 inches: very channery loam

R - 30 to 35 inches: bedrock

Properties and qualities

Slope: 25 to 70 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock

Natural drainage class: Well drained

Runoff class: High

Capacity of the most limiting layer to transmit water (K_{sat}): Moderately high to high
(0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: C

Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Hillslopes

Landform position (three-dimensional): Free face

Down-slope shape: Linear

Across-slope shape: Linear

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7e

Hydric soil rating: No

Minor Components

Shelocta

Percent of map unit: 15 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Ernest

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Weikert

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

WrC—Wharton silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t5mm
Elevation: 620 to 2,160 feet
Mean annual precipitation: 37 to 51 inches
Mean annual air temperature: 47 to 53 degrees F
Frost-free period: 161 to 205 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wharton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wharton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, shoulder

Custom Soil Resource Report

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Linear

Parent material: Fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 9 inches: silt loam

Bt1 - 9 to 16 inches: silt loam

Bt2 - 16 to 22 inches: silt loam

Bt3 - 22 to 31 inches: silt loam

BC - 31 to 46 inches: silty clay loam

C - 46 to 69 inches: channery silty clay loam

Cr - 69 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: 40 to 71 inches to paralithic bedrock

Natural drainage class: Moderately well drained

Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)

Depth to water table: About 16 to 28 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent

Landform: Hillslopes

Landform position (two-dimensional): Backslope, shoulder

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Rarden

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Interfluvium

Down-slope shape: Convex

Across-slope shape: Linear

Hydric soil rating: No

Ernest

Percent of map unit: 5 percent

Landform: Hillslopes

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave

Custom Soil Resource Report

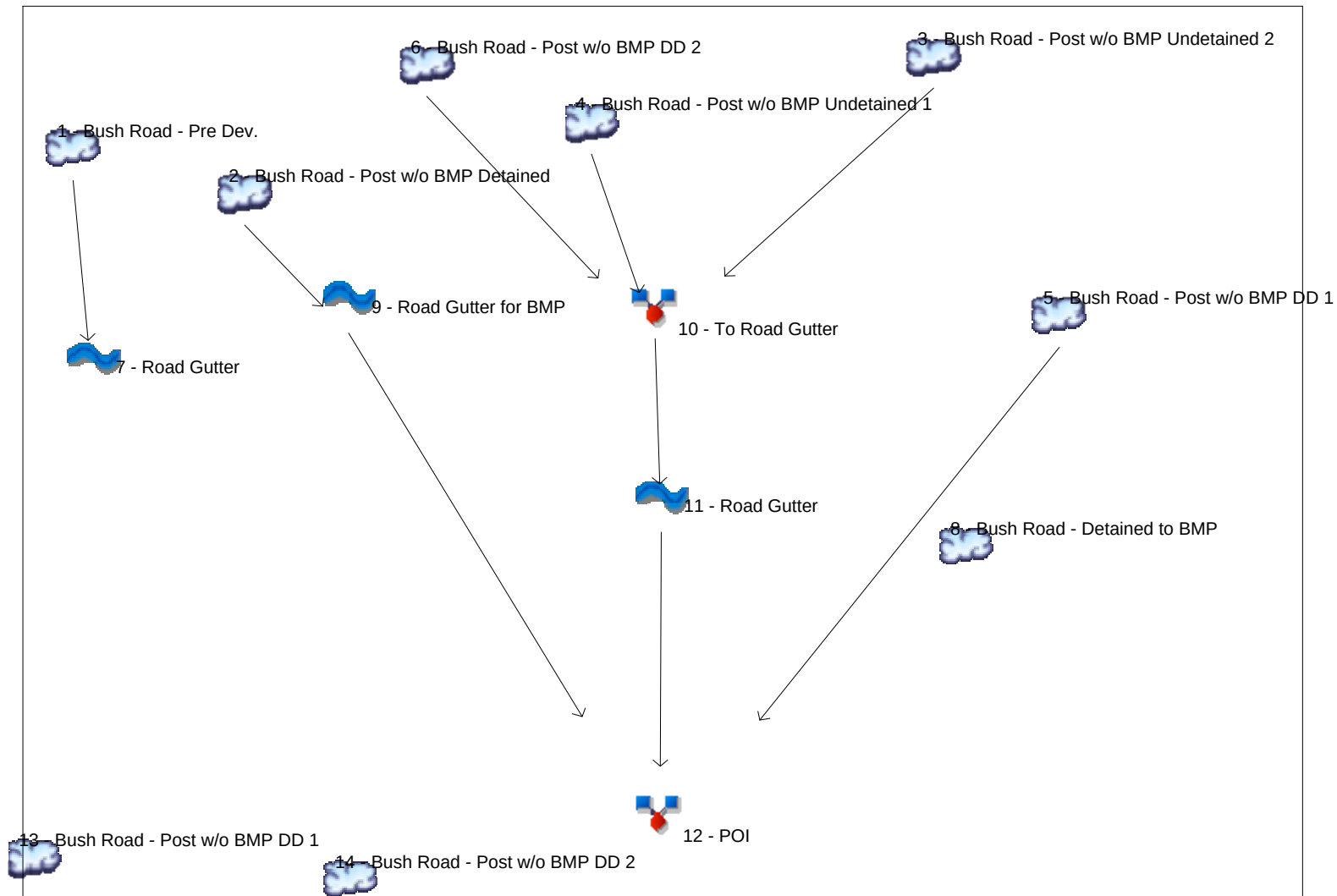
Across-slope shape: Concave
Hydric soil rating: No

ATTACHMENT C
BUSH RD
HYDRAFLOW RESULTS

ATTACHMENT C-1
BUSH RD
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.591	-----	-----	11.46	-----	19.05	22.83	Bush Road - Pre Dev.
2	SCS Runoff	-----	-----	0.870	-----	-----	1.624	-----	2.578	3.039	Bush Road - Post w/o BMP Detained
3	SCS Runoff	-----	-----	1.441	-----	-----	3.036	-----	5.119	6.154	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	-----	-----	0.152	-----	-----	0.278	-----	0.436	0.512	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	-----	-----	2.314	-----	-----	4.778	-----	7.986	9.579	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	-----	-----	0.885	-----	-----	1.768	-----	2.903	3.464	Bush Road - Post w/o BMP DD 2
7	Reach	1	-----	5.552	-----	-----	11.44	-----	19.05	22.83	Road Gutter
8	SCS Runoff	-----	-----	0.760	-----	-----	1.396	-----	2.202	2.590	Bush Road - Detained to BMP
9	Reach	2	-----	0.828	-----	-----	1.576	-----	2.522	2.978	Road Gutter for BMP
10	Combine	3, 4, 6,	-----	2.478	-----	-----	5.081	-----	8.452	10.13	To Road Gutter
11	Reach	10	-----	2.377	-----	-----	4.962	-----	8.354	10.02	Road Gutter
12	Combine	5, 9, 11	-----	5.487	-----	-----	11.32	-----	18.85	22.54	POI
13	SCS Runoff	-----	-----	2.721	-----	-----	5.566	-----	9.243	11.05	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	-----	-----	0.985	-----	-----	1.964	-----	3.218	3.829	Bush Road - Post w/o BMP DD 2
Proj. file: Pre and Post wo BMP 2-100 yrs_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	5.591	1	719	12,159	-----	-----	-----	Bush Road - Pre Dev.
2	SCS Runoff	0.870	1	719	1,845	-----	-----	-----	Bush Road - Post w/o BMP Detained
3	SCS Runoff	1.441	1	719	3,168	-----	-----	-----	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	0.152	1	719	321	-----	-----	-----	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	2.314	1	720	5,451	-----	-----	-----	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	0.885	1	719	1,908	-----	-----	-----	Bush Road - Post w/o BMP DD 2
7	Reach	5.552	1	720	12,158	1	-----	-----	Road Gutter
8	SCS Runoff	0.760	2	720	1,745	-----	-----	-----	Bush Road - Detained to BMP
9	Reach	0.828	1	721	1,842	2	-----	-----	Road Gutter for BMP
10	Combine	2.478	1	719	5,396	3, 4, 6,	-----	-----	To Road Gutter
11	Reach	2.377	1	721	5,395	10	-----	-----	Road Gutter
12	Combine	5.487	1	720	12,688	5, 9, 11	-----	-----	POI
13	SCS Runoff	2.721	1	718	5,622	-----	-----	-----	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	0.985	1	718	2,018	-----	-----	-----	Bush Road - Post w/o BMP DD 2
Pre and Post wo BMP 2-100 yrs_chk.gpw					Return Period: 2 Year			Monday, 11 / 7 / 2016	

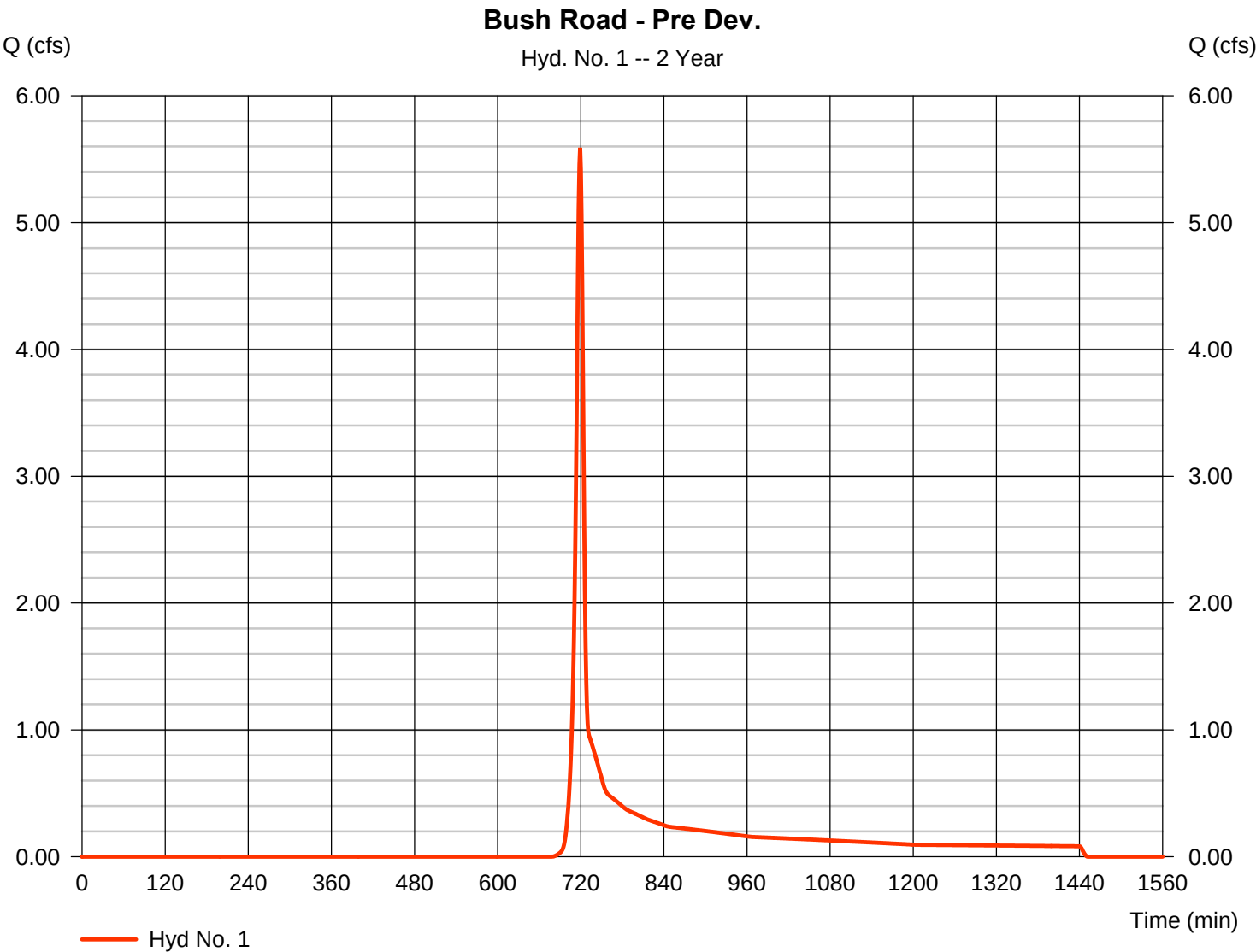
Hydrograph Report

Hyd. No. 1

Bush Road - Pre Dev.

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.591 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	12,159 cuft
Drainage area	=	5.170 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.370 x 78) + (1.350 x 70) + (0.060 x 91) + (0.390 x 77)] / 5.170



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Bush Road - Pre Dev.

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 243.00	800.00	0.00				
Watercourse slope (%)	= 24.00	10.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	5.10	0.00				
Travel Time (min)	= 0.51	+	2.61	+	0.00	=	3.13
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				7.80 min			

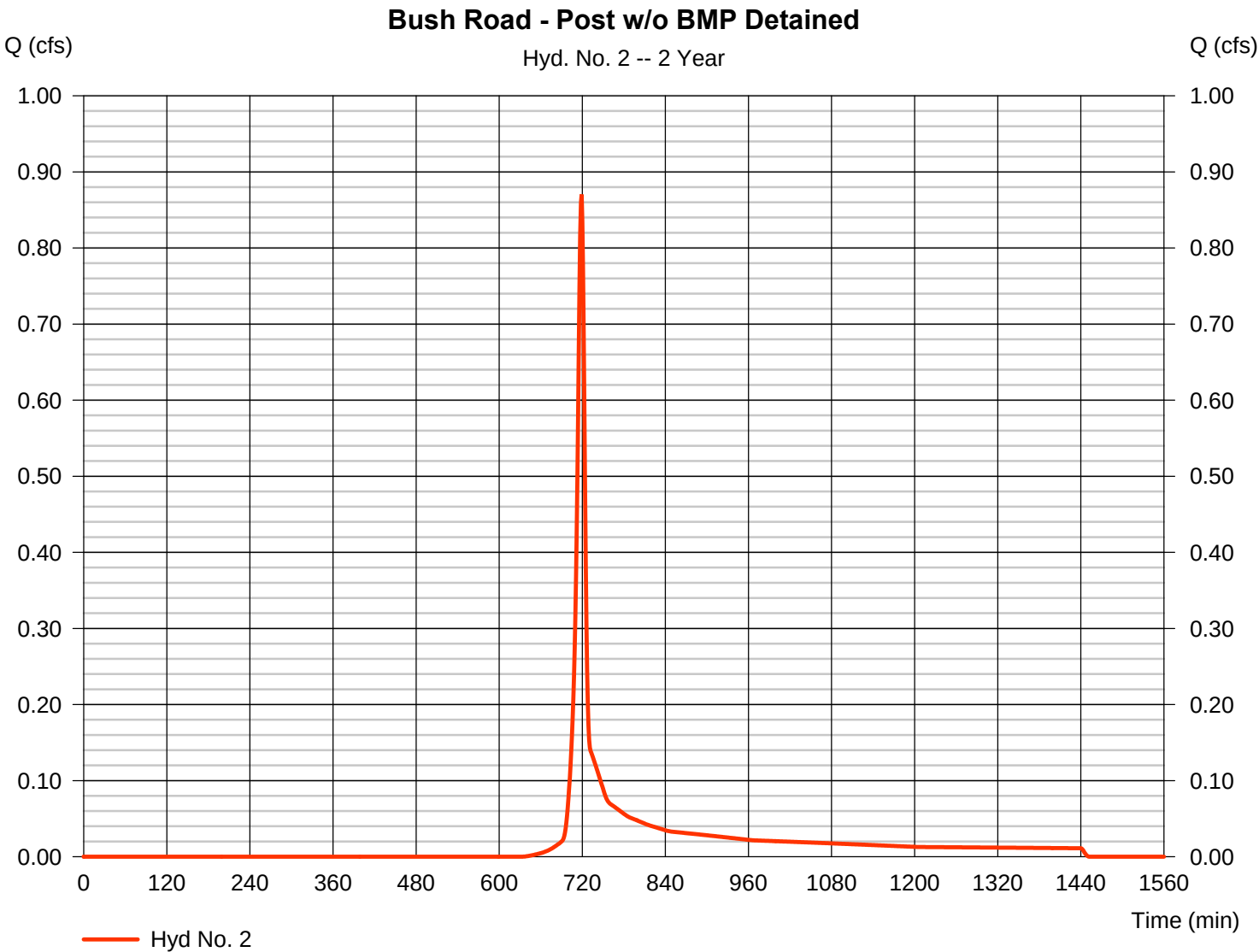
Hydrograph Report

Hyd. No. 2

Bush Road - Post w/o BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.870 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	1,845 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w/o BMP Detained

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	629.00	75.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	2.17	+	0.27	=	2.79
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

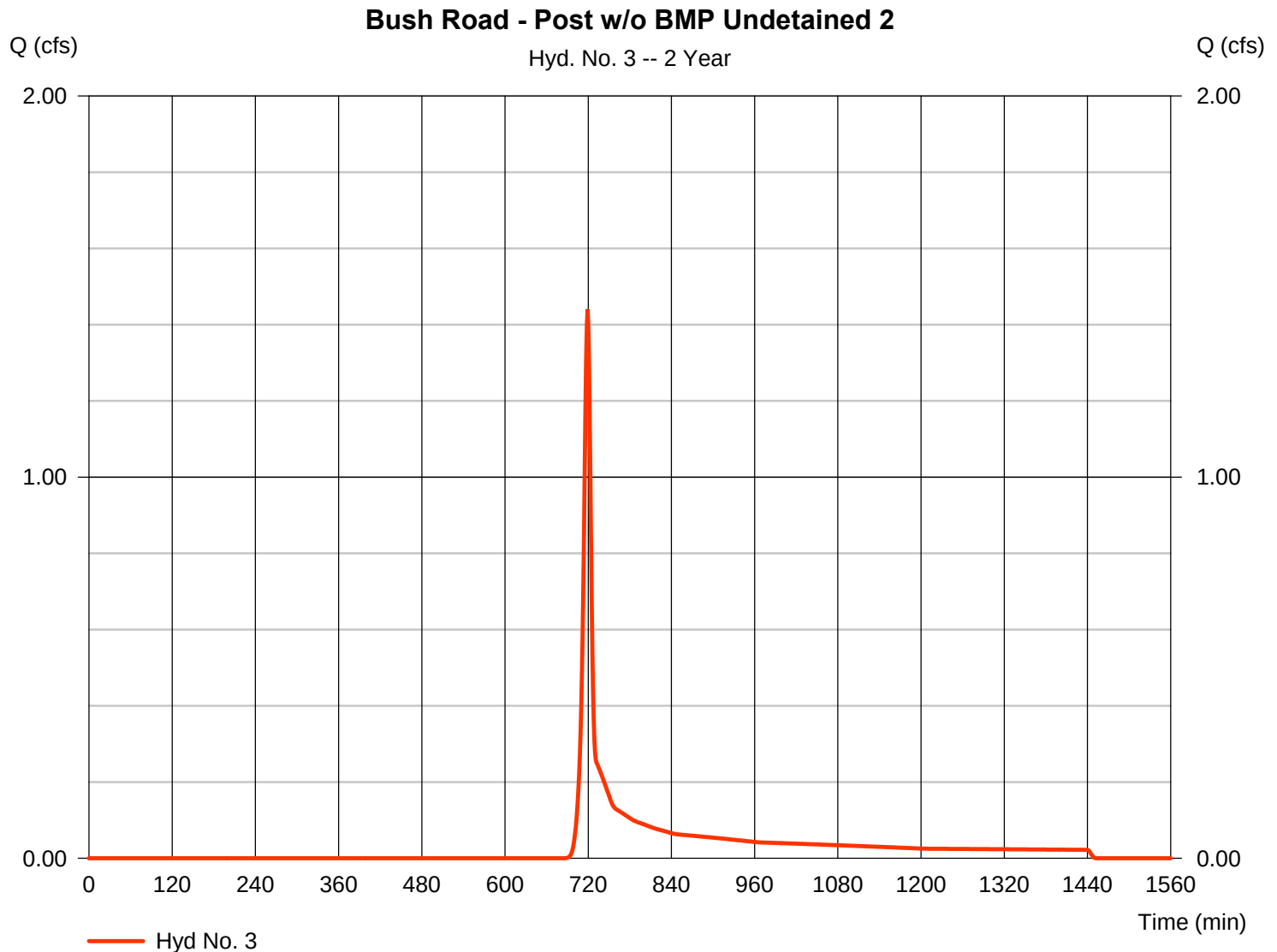
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.441 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	3,168 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

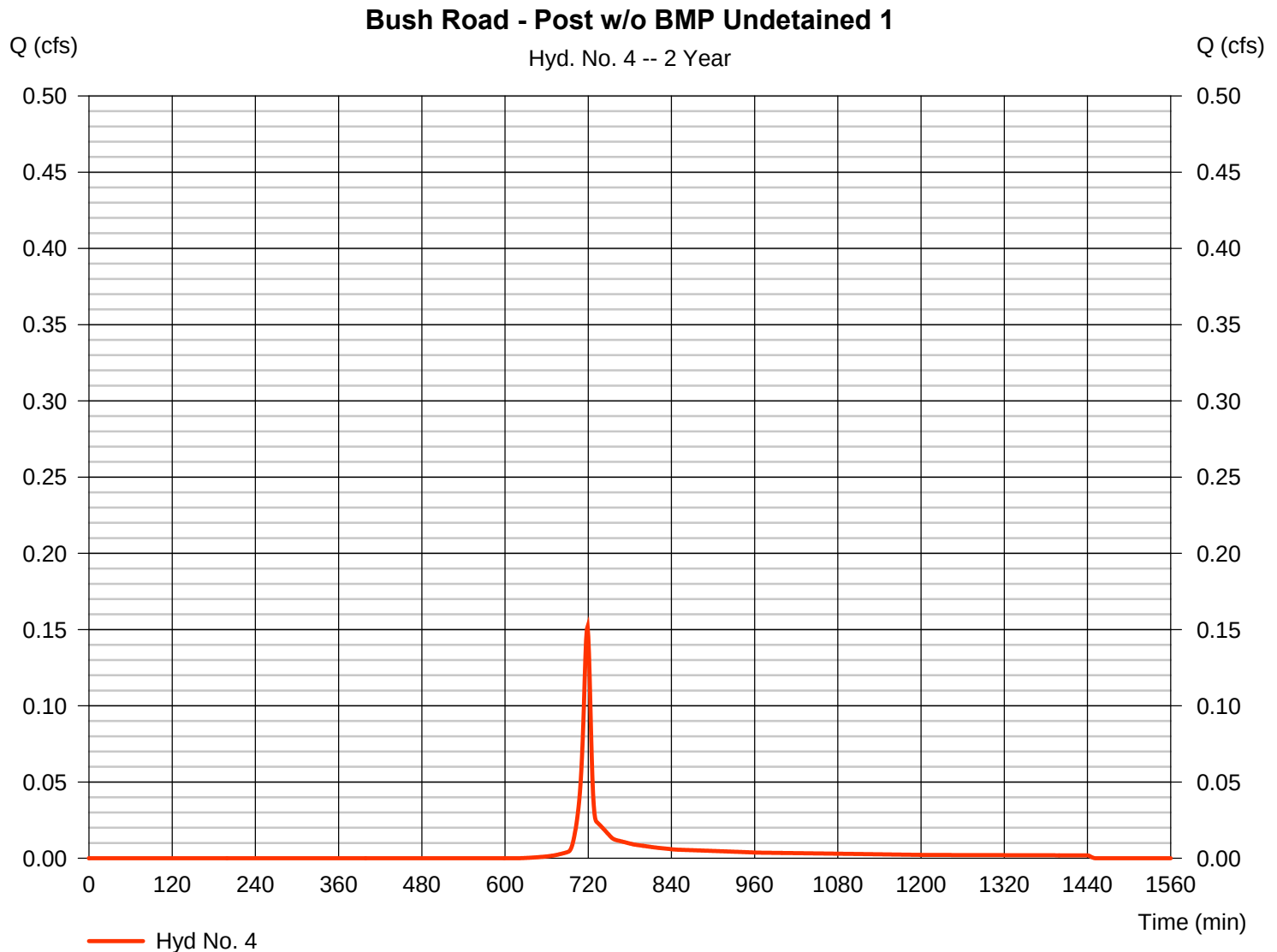
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.152 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	321 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

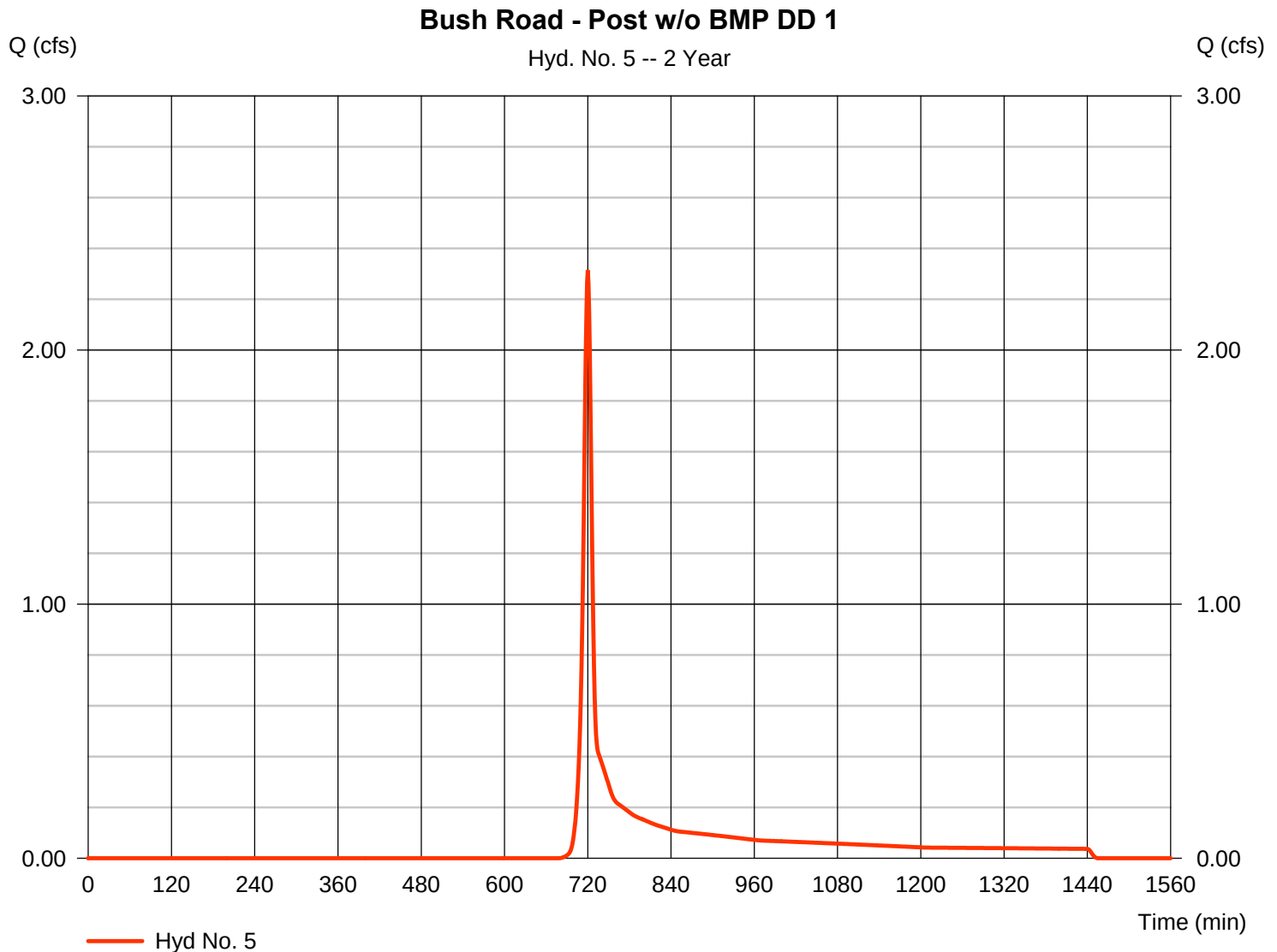
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.314 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	5,451 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

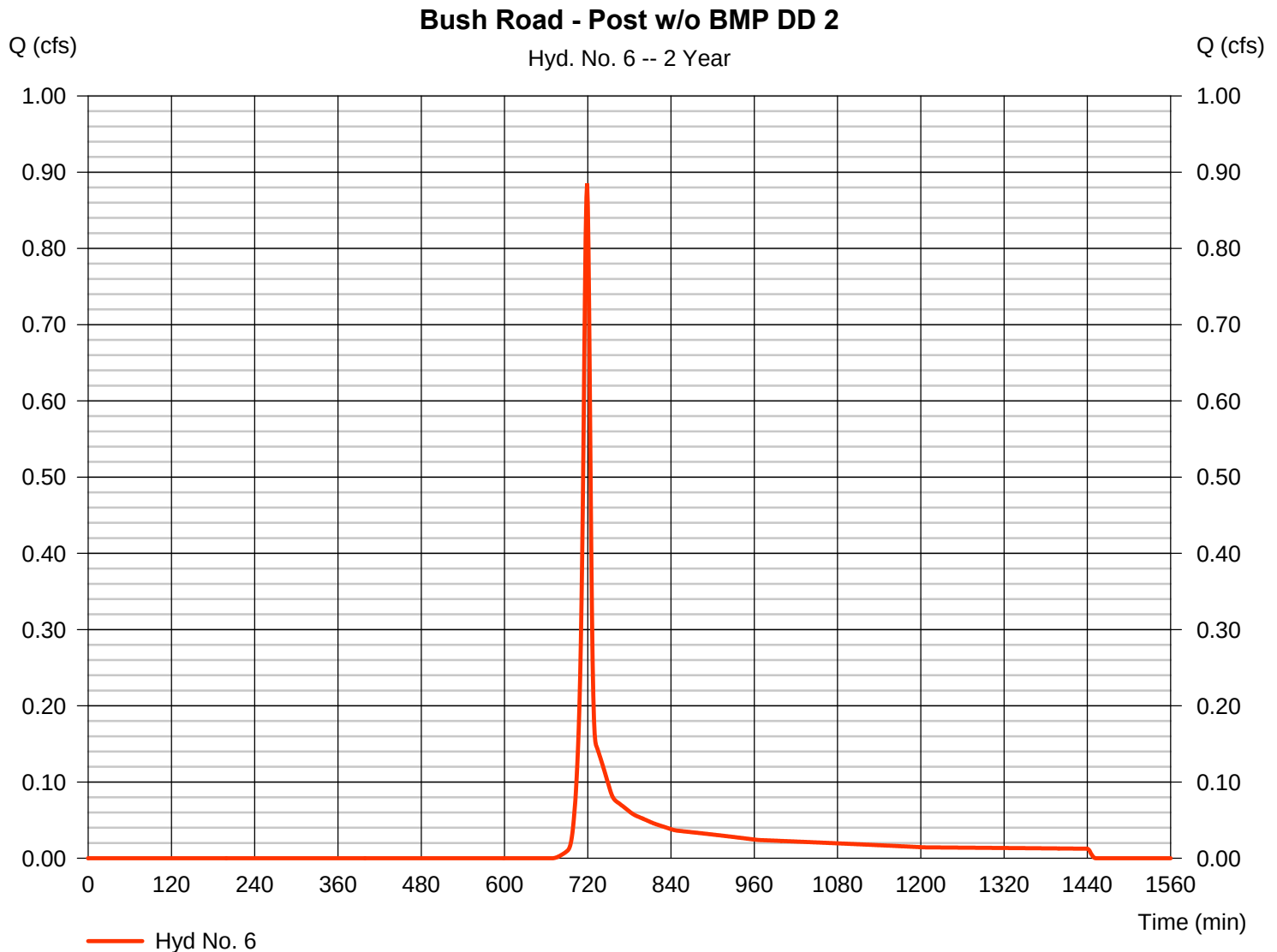
Monday, 11 / 7 / 2016

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.885 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	1,908 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

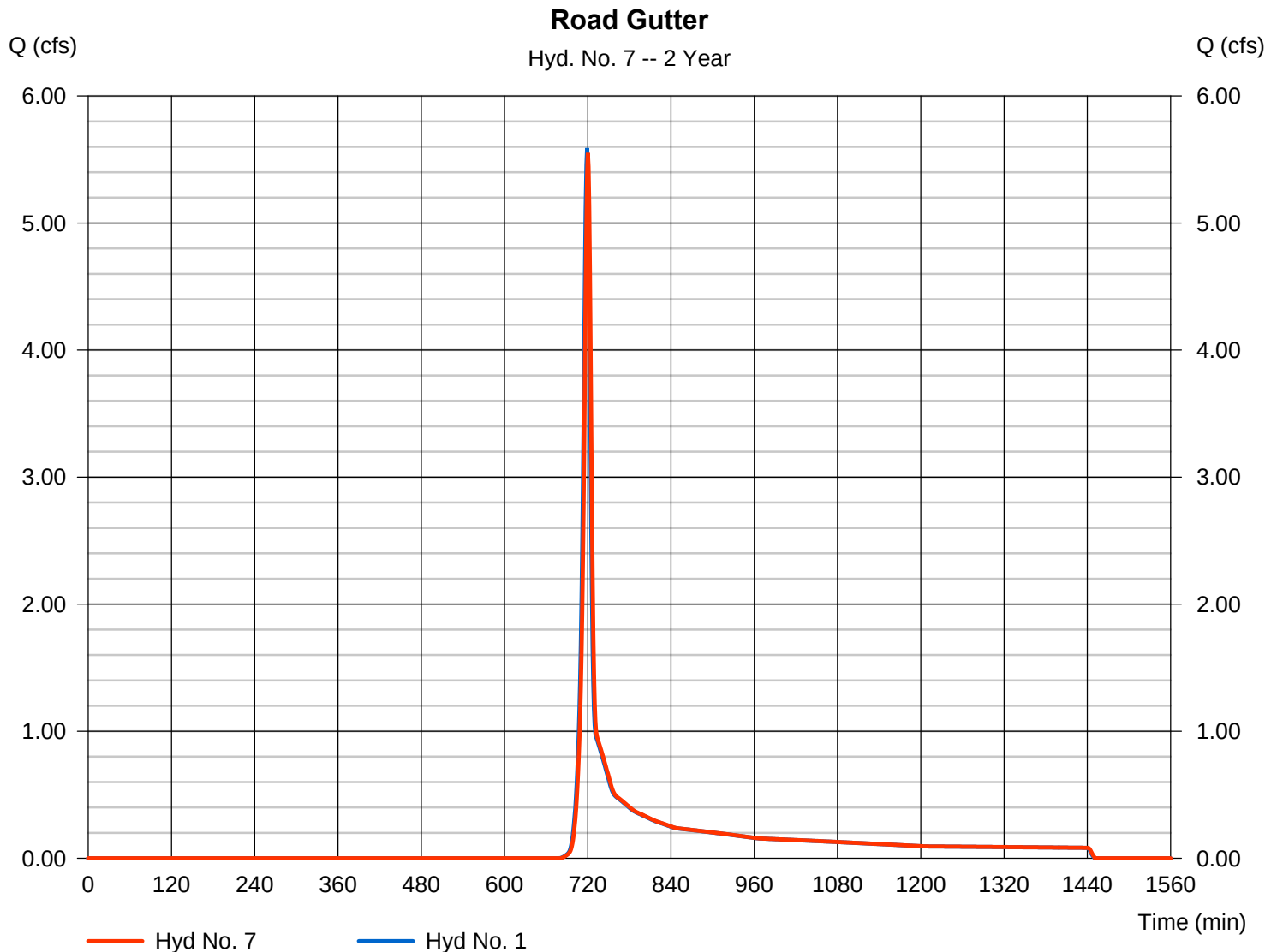
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 5.552 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 12,158 cuft
Inflow hyd. No.	= 1 - Bush Road - Pre Dev.	Section type	= Triangular
Reach length	= 265.0 ft	Channel slope	= 3.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.308	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.8194

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

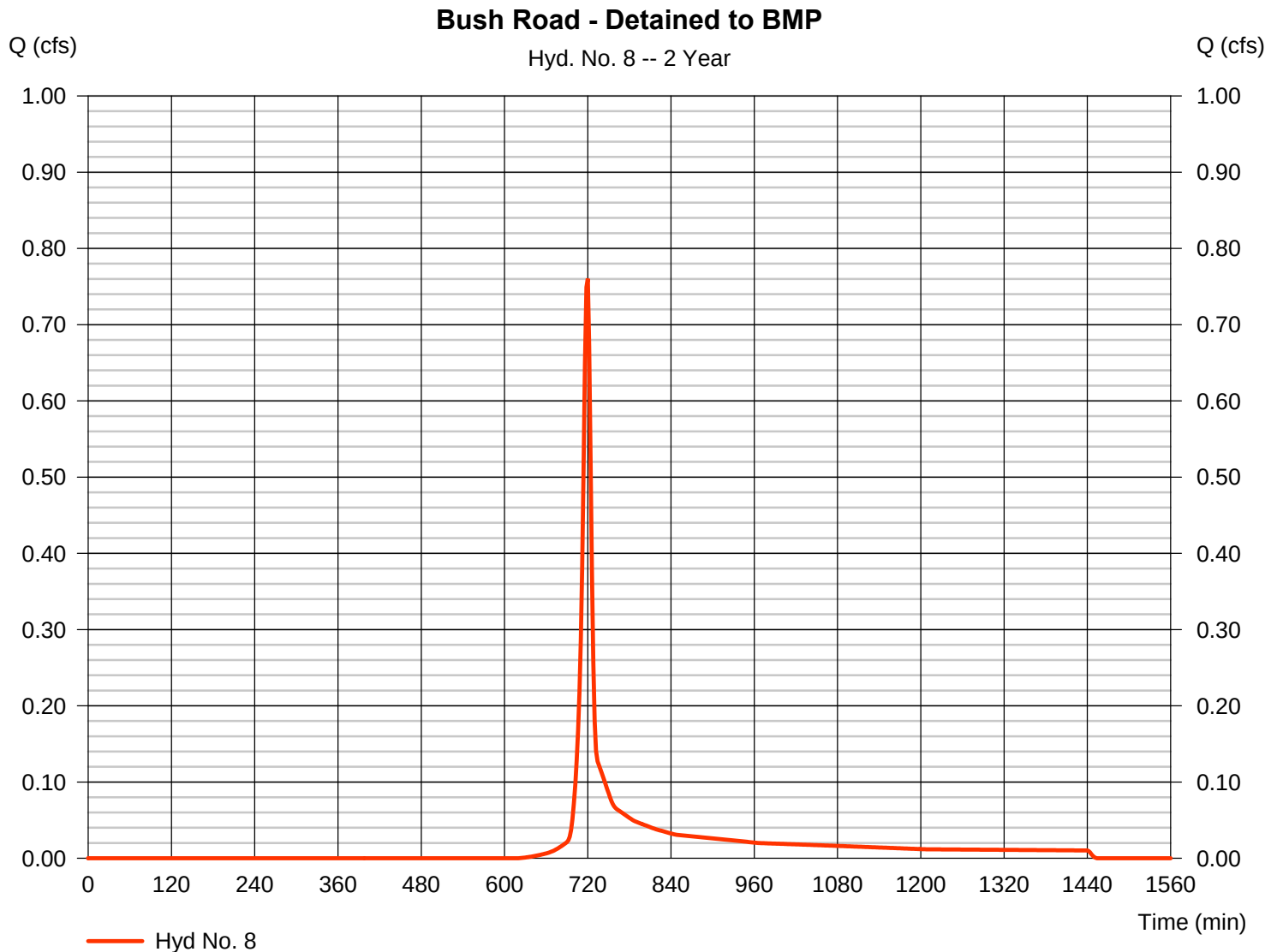
Monday, 11 / 7 / 2016

Hyd. No. 8

Bush Road - Detained to BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.760 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,745 cuft
Drainage area	=	0.530 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.010 \times 77) + (0.360 \times 78) + (0.130 \times 91)] / 0.530$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 8

Bush Road - Detained to BMP

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	535.00	70.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	1.84	+	0.26	=	2.45
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	((0})0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc					6.60 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

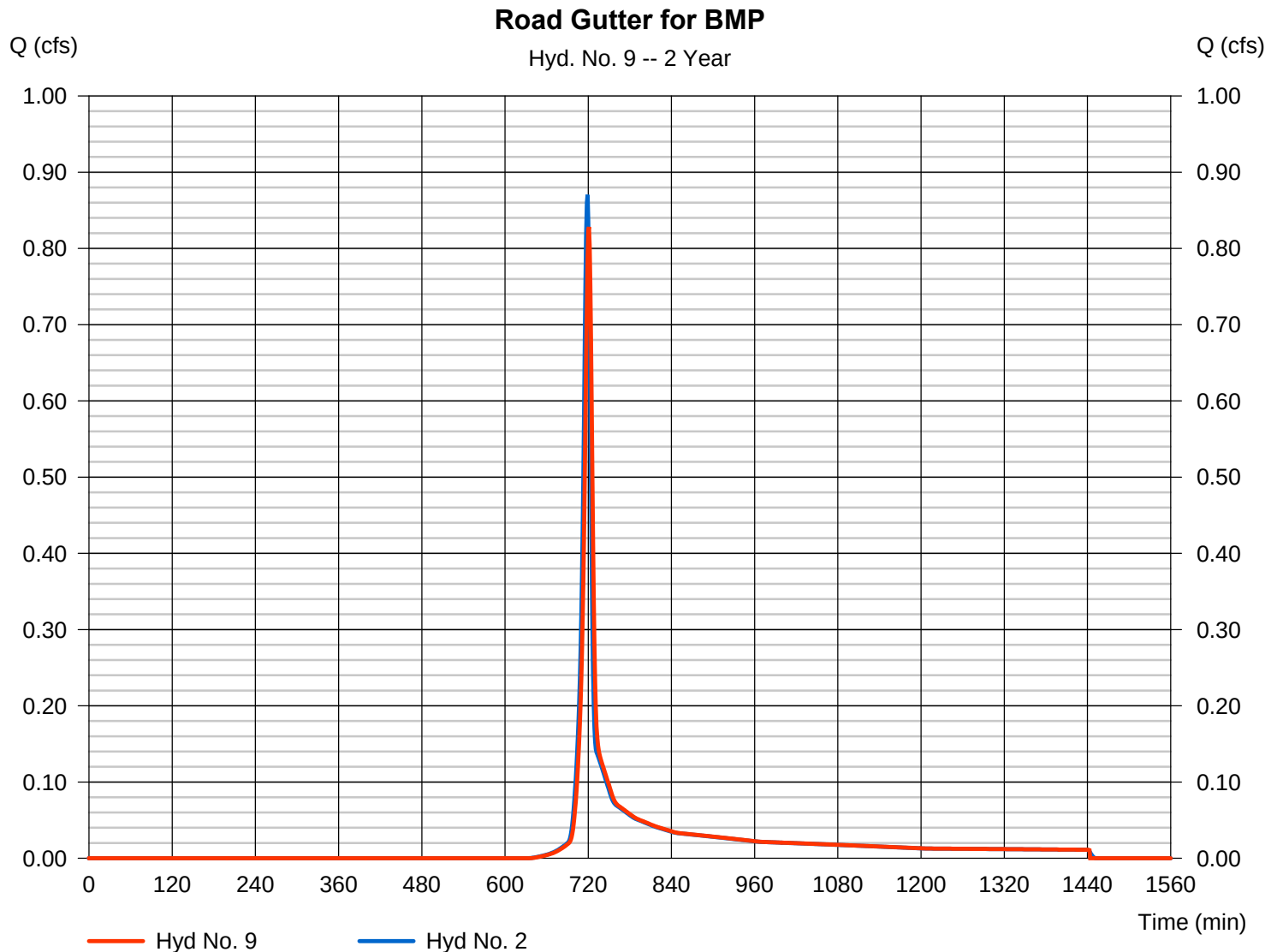
Monday, 11 / 7 / 2016

Hyd. No. 9

Road Gutter for BMP

Hydrograph type	= Reach	Peak discharge	= 0.828 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 1,842 cuft
Inflow hyd. No.	= 2 - Bush Road - Post w/o BMP	Section type	= Triangular
Reach length	= 450.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.4448

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

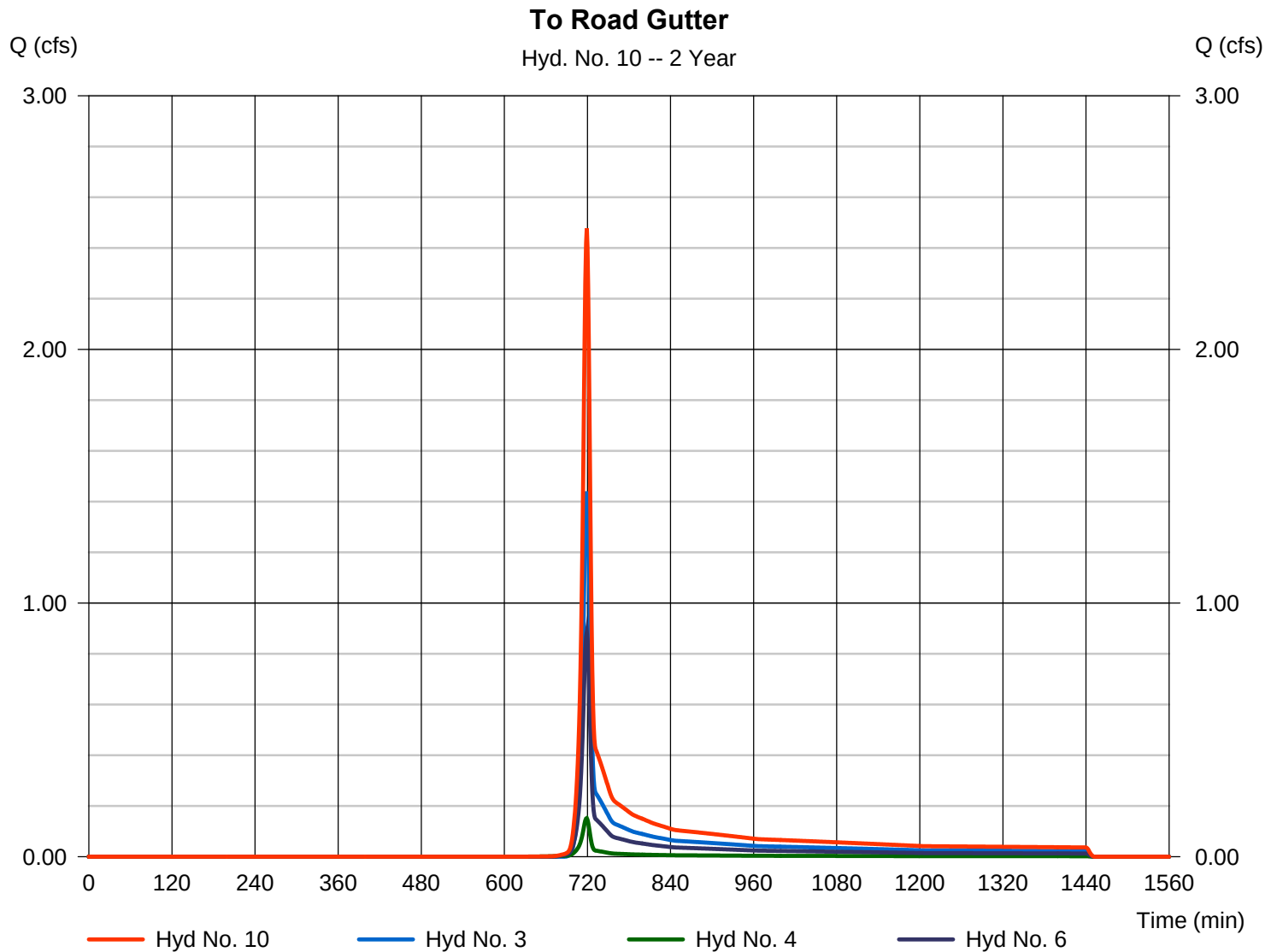
Monday, 11 / 7 / 2016

Hyd. No. 10

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 3, 4, 6

Peak discharge = 2.478 cfs
 Time to peak = 719 min
 Hyd. volume = 5,396 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

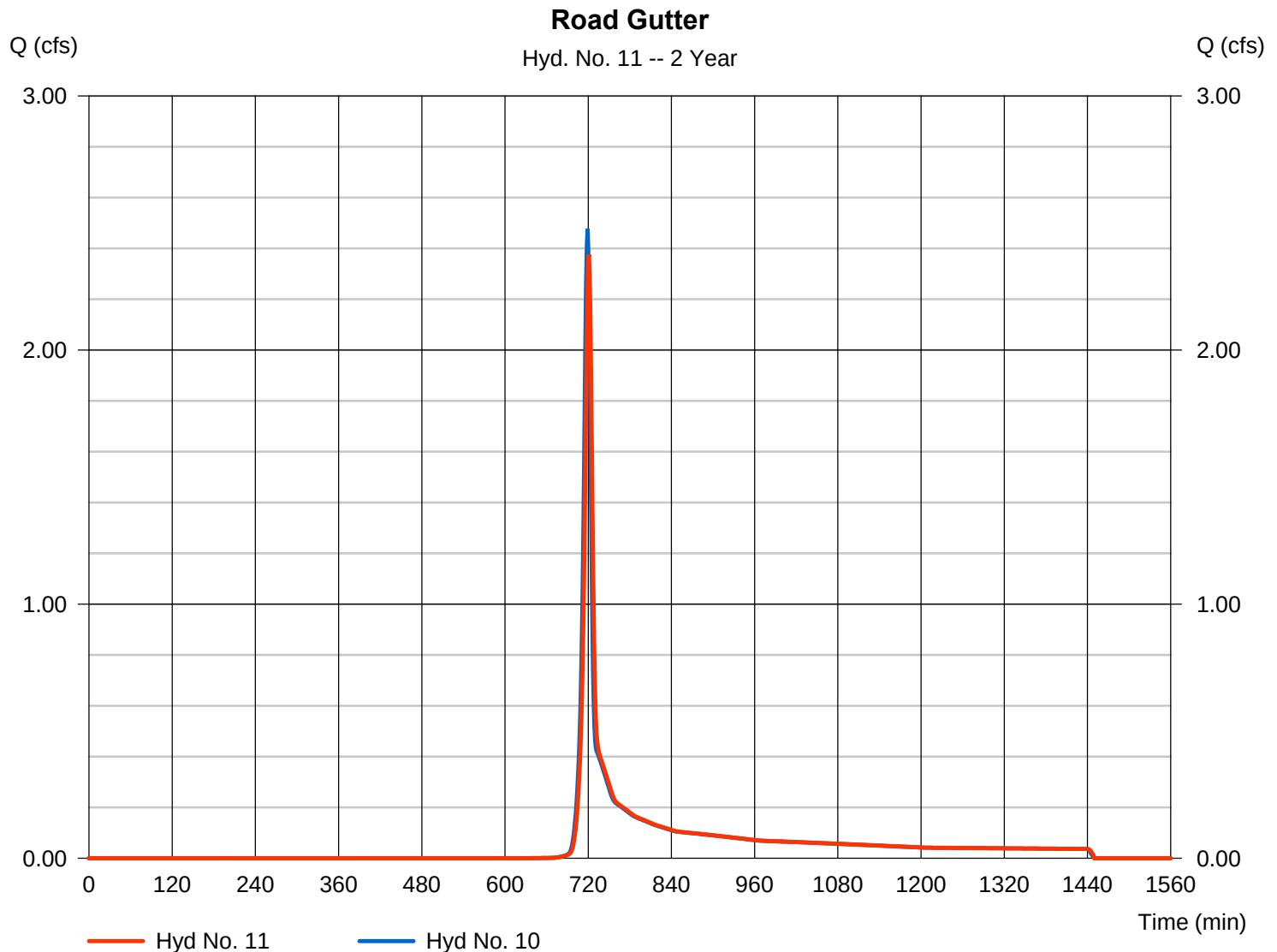
Monday, 11 / 7 / 2016

Hyd. No. 11

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 2.377 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 5,395 cuft
Inflow hyd. No.	= 10 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5011

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

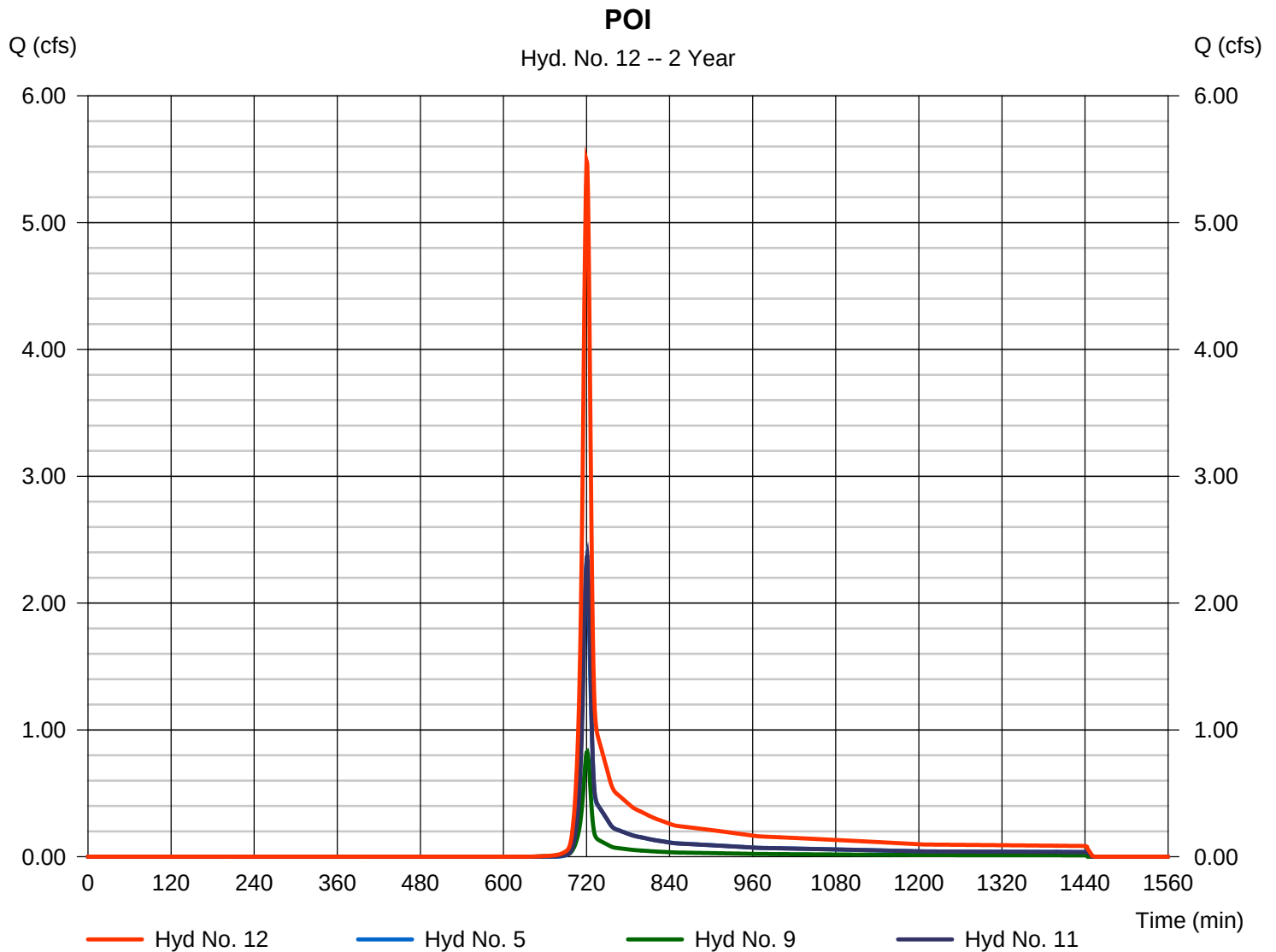
Monday, 11 / 7 / 2016

Hyd. No. 12

POI

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 5, 9, 11

Peak discharge = 5.487 cfs
 Time to peak = 720 min
 Hyd. volume = 12,688 cuft
 Contrib. drain. area = 2.260 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

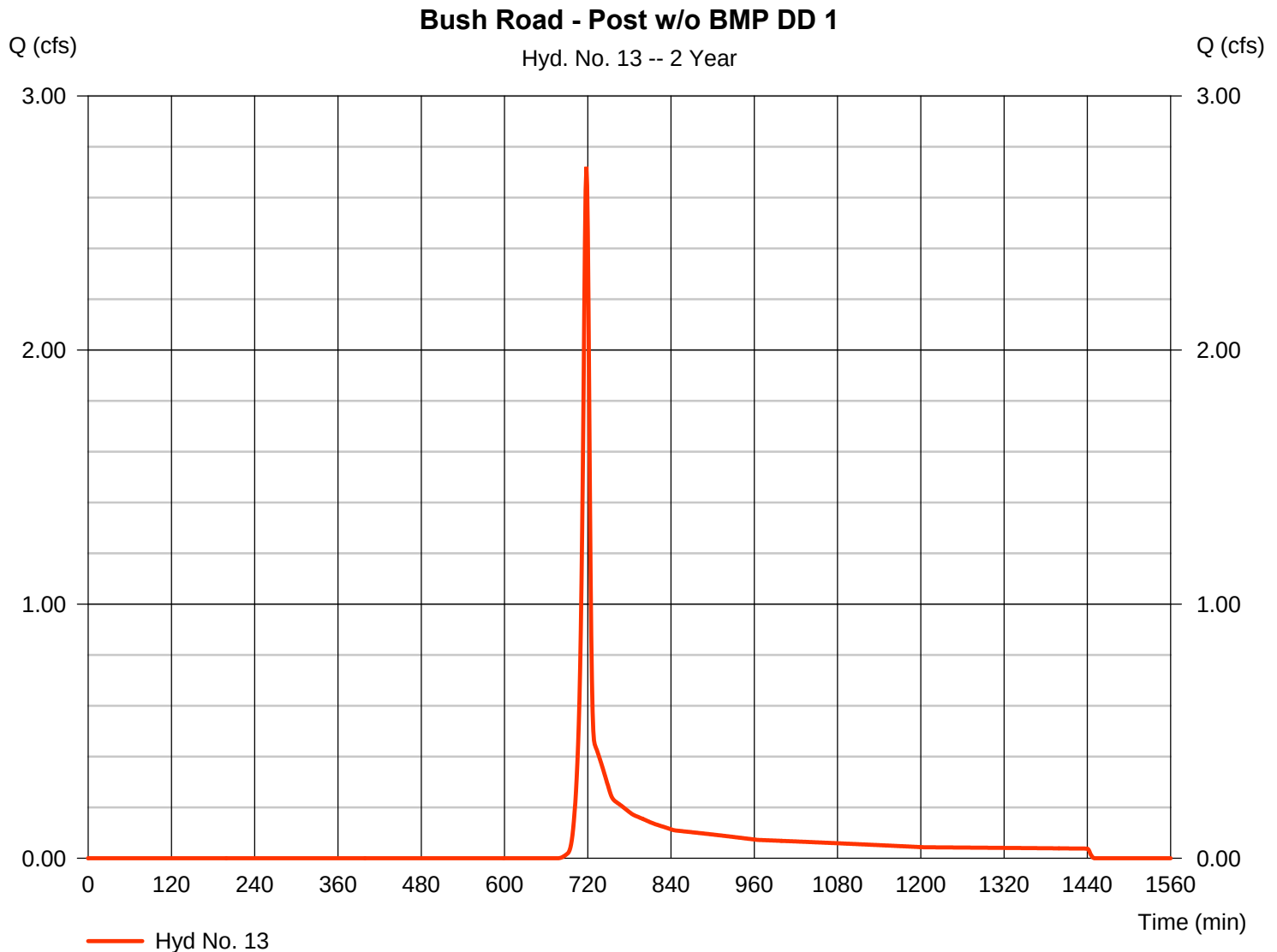
Monday, 11 / 7 / 2016

Hyd. No. 13

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.721 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	5,622 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 13

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	0.00				
Watercourse slope (%)	= 23.00	10.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	0.00				
Travel Time (min)	= 0.60	+	1.26	+	0.00	=	1.86
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	= 0.060	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				6.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

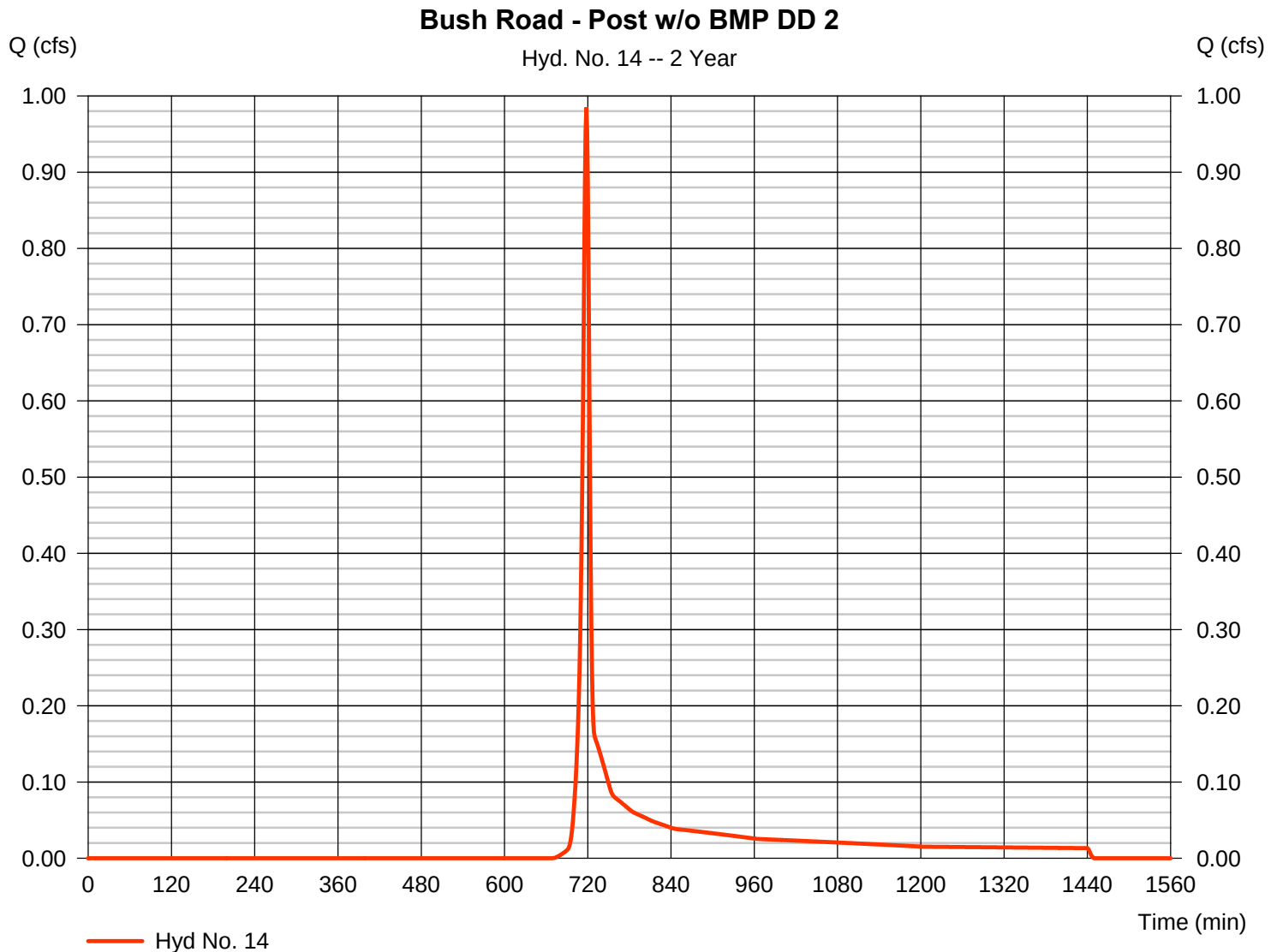
Monday, 11 / 7 / 2016

Hyd. No. 14

Bush Road - Post w/o BMP DD 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.985 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 2,018 cuft
Drainage area	= 0.760 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.50 min
Total precip.	= 2.45 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

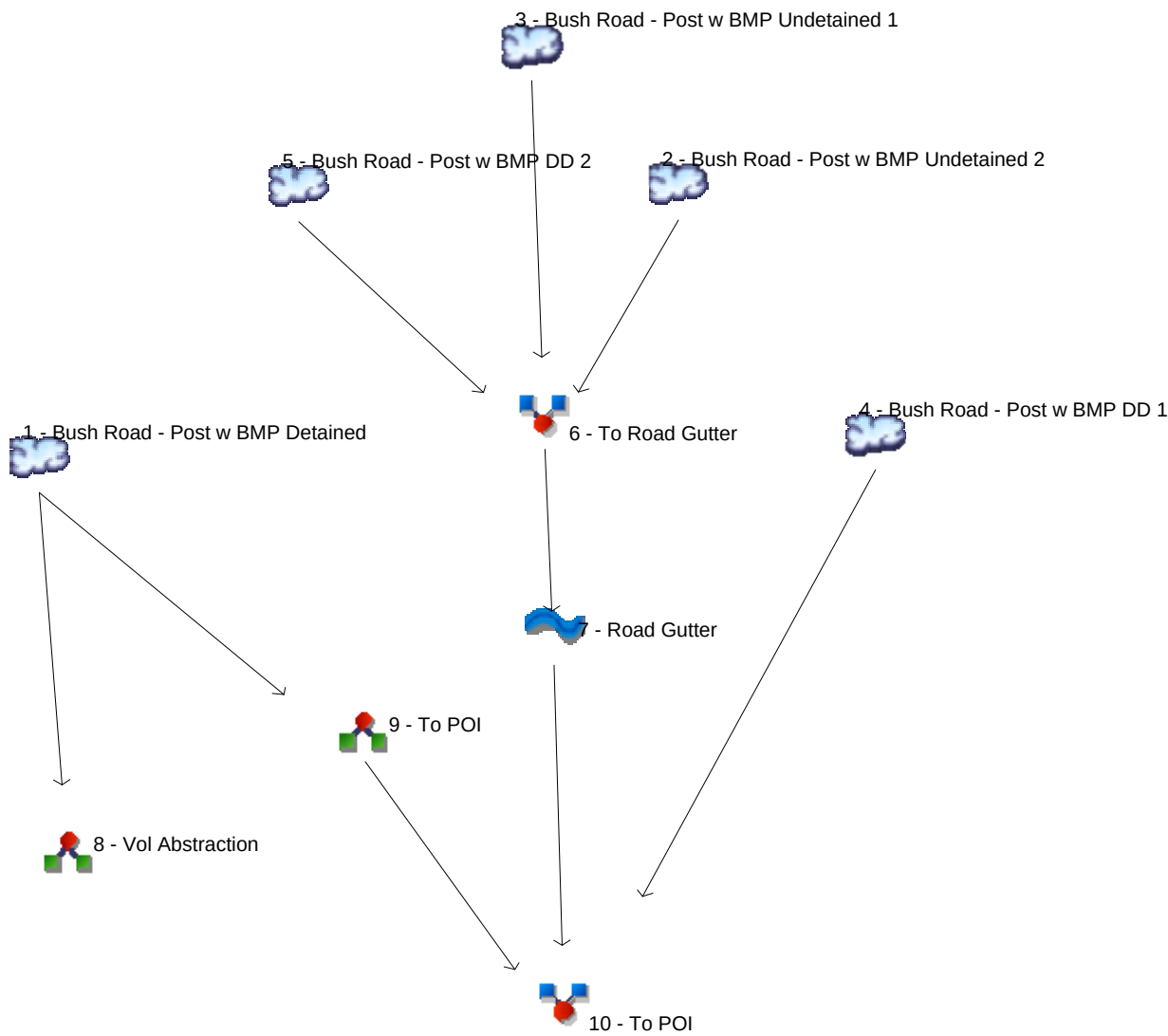
Hyd. No. 14

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
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	= 0.060	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				6.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.488	-----	-----	-----	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	-----	-----	1.441	-----	-----	-----	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	-----	-----	0.152	-----	-----	-----	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	-----	-----	2.314	-----	-----	-----	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	-----	-----	0.885	-----	-----	-----	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	2, 3, 5	-----	2.478	-----	-----	-----	-----	-----	-----	To Road Gutter
7	Reach	6	-----	2.377	-----	-----	-----	-----	-----	-----	Road Gutter
8	Diversion1	1	-----	0.488	-----	-----	-----	-----	-----	-----	Vol Abstraction
9	Diversion2	1	-----	0.013	-----	-----	-----	-----	-----	-----	To POI
10	Combine	4, 7, 9	-----	4.665	-----	-----	-----	-----	-----	-----	To POI
Proj. file: Post w BMP 2 yr_chk .gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.488	1	730	1,907	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	1.441	1	719	3,168	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	0.152	1	719	321	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	2.314	1	720	5,451	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	0.885	1	719	1,908	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	2.478	1	719	5,396	2, 3, 5	-----	-----	To Road Gutter
7	Reach	2.377	1	721	5,395	6	-----	-----	Road Gutter
8	Diversion1	0.488	1	730	1,745	1	-----	-----	Vol Abstraction
9	Diversion2	0.013	1	1240	161	1	-----	-----	To POI
10	Combine	4.665	1	720	11,008	4, 7, 9	-----	-----	To POI
Post w BMP 2 yr_chk .gpw					Return Period: 2 Year			Monday, 11 / 7 / 2016	

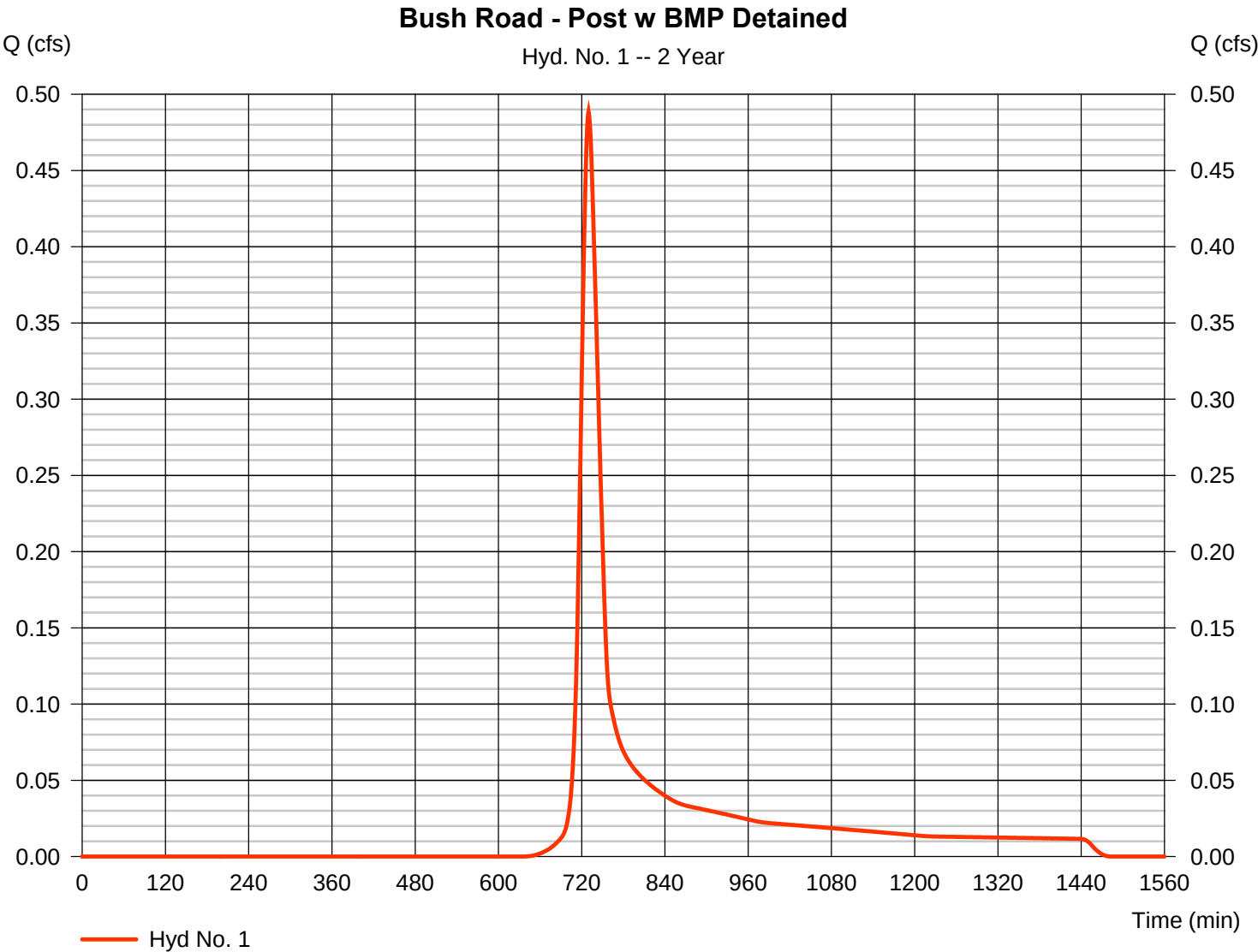
Hydrograph Report

Hyd. No. 1

Bush Road - Post w BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.488 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	1,907 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	25.80 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.441 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	3,168 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

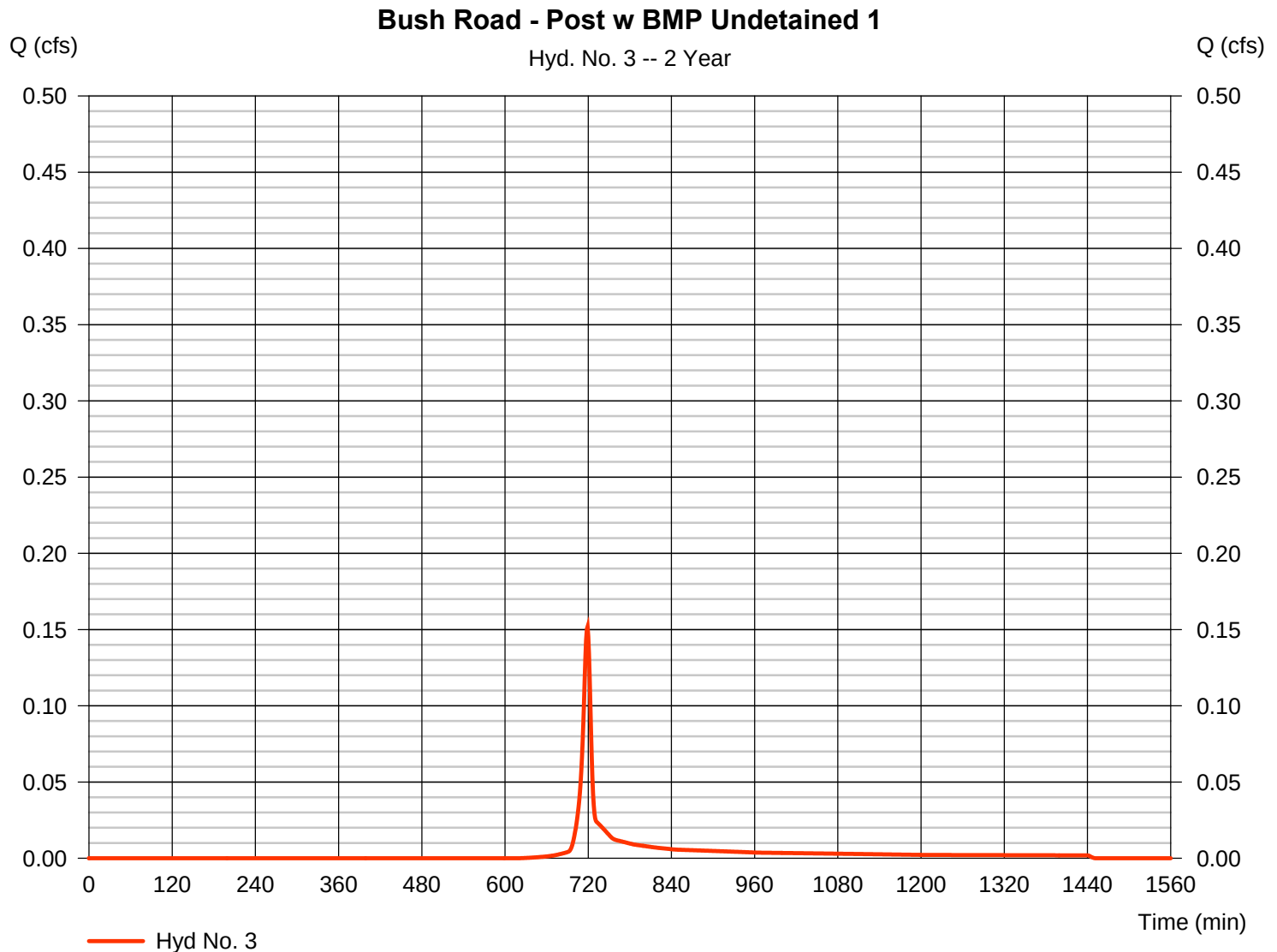
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.152 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	321 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

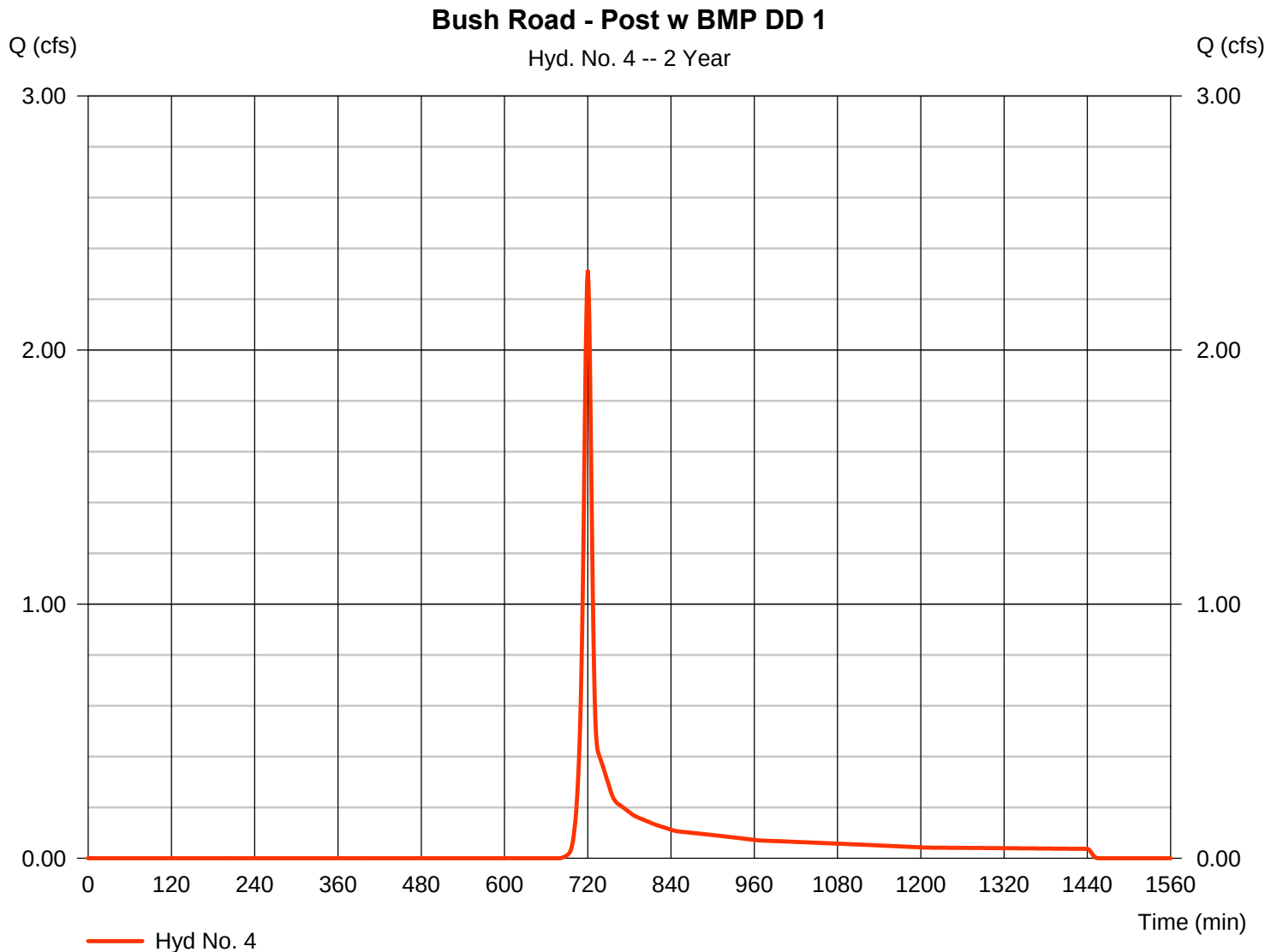
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.314 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	5,451 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	2.45 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

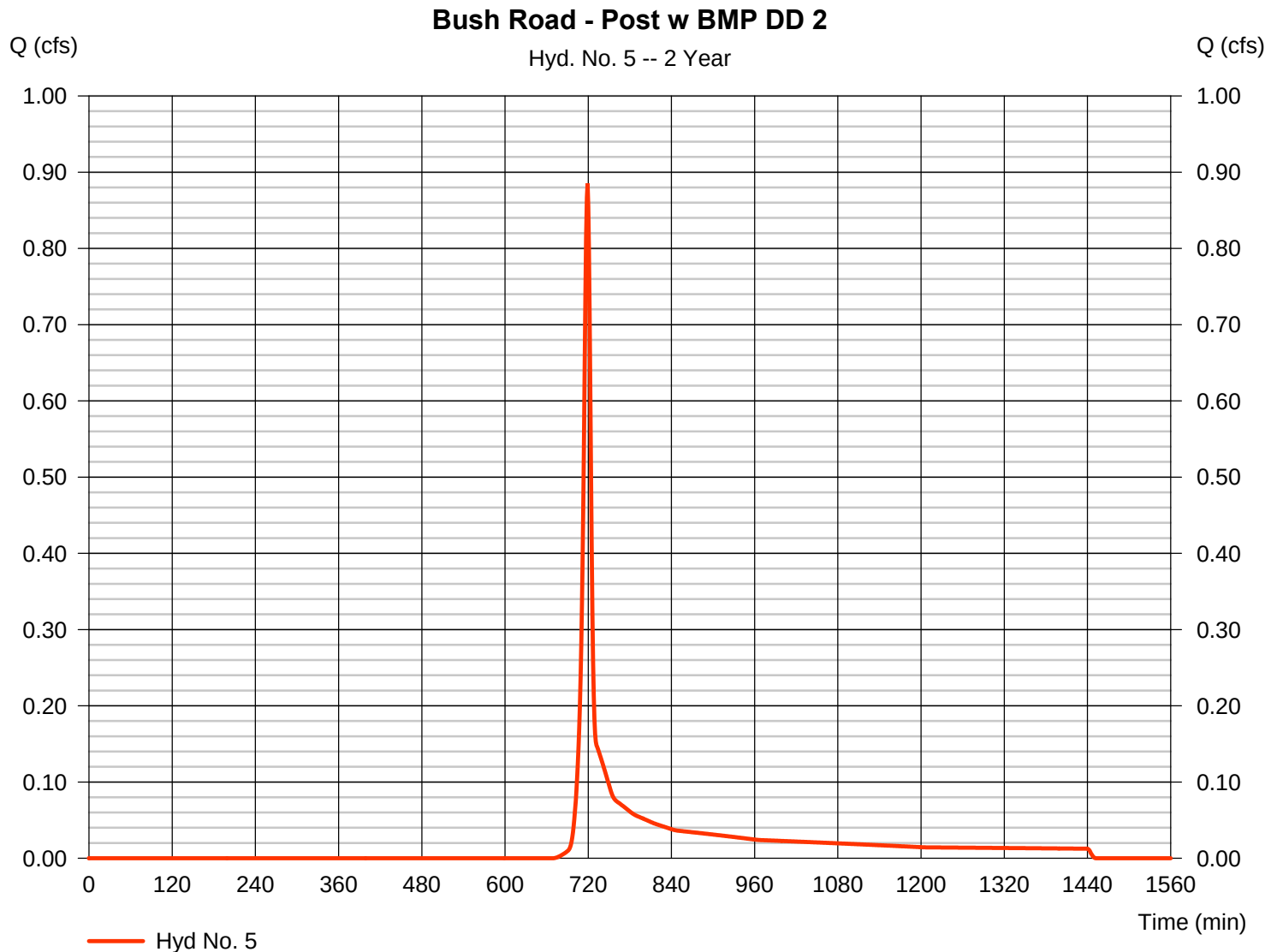
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w BMP DD 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.885 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 1,908 cuft
Drainage area	= 0.760 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.70 min
Total precip.	= 2.45 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc					6.70 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

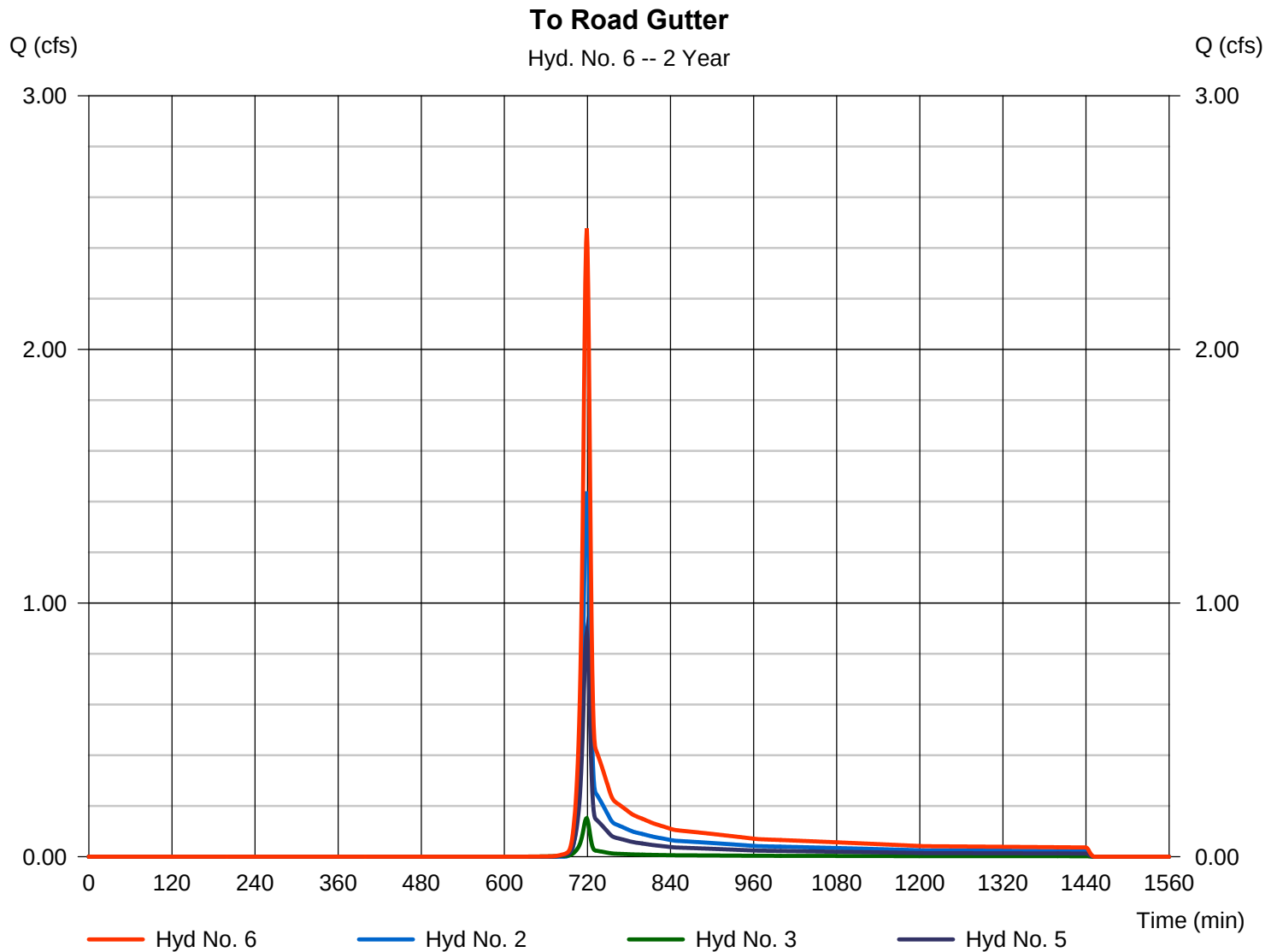
Monday, 11 / 7 / 2016

Hyd. No. 6

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 5

Peak discharge = 2.478 cfs
 Time to peak = 719 min
 Hyd. volume = 5,396 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

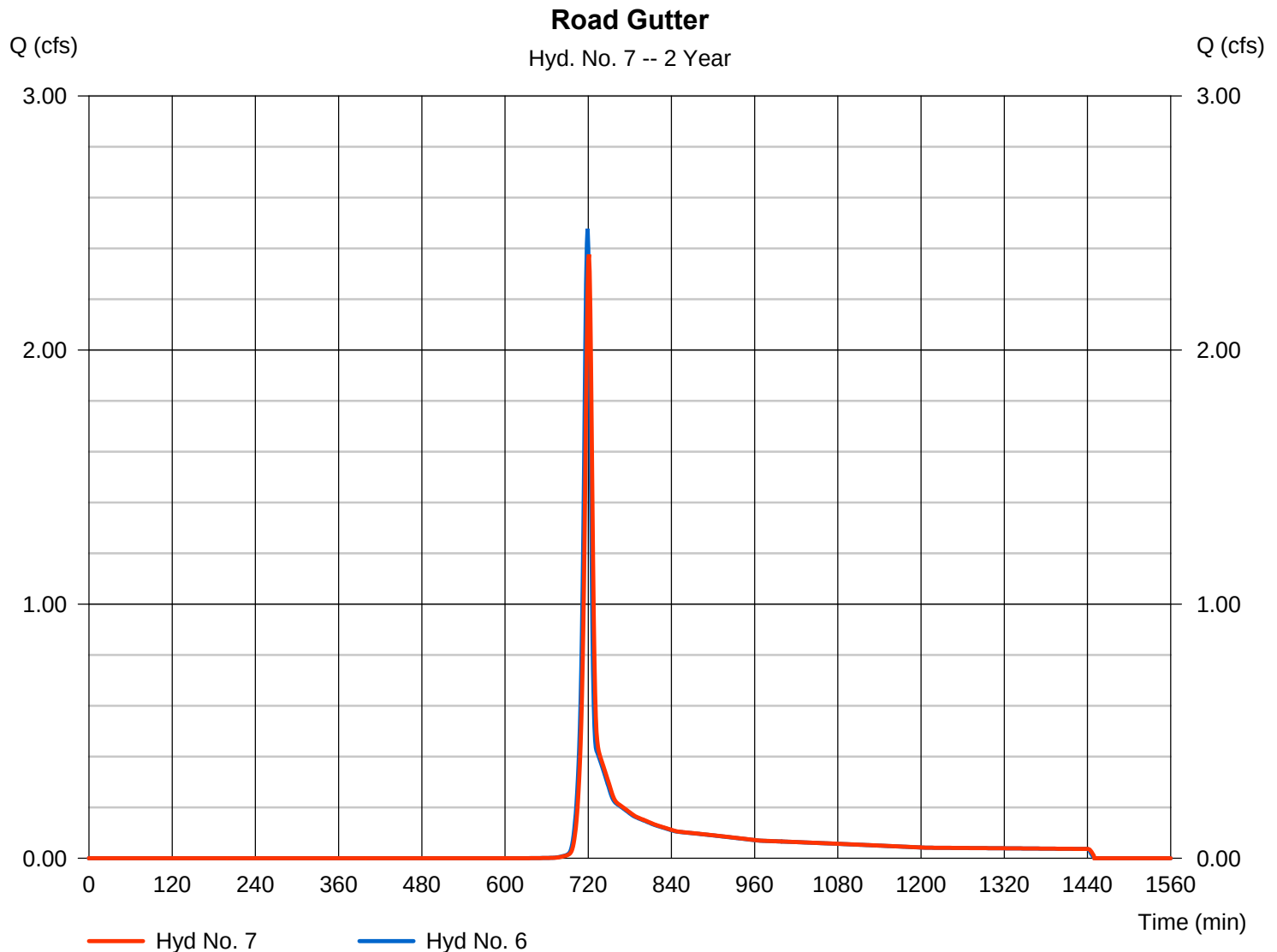
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 2.377 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 5,395 cuft
Inflow hyd. No.	= 6 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5011

Modified Att-Kin routing method used.



Hydrograph Report

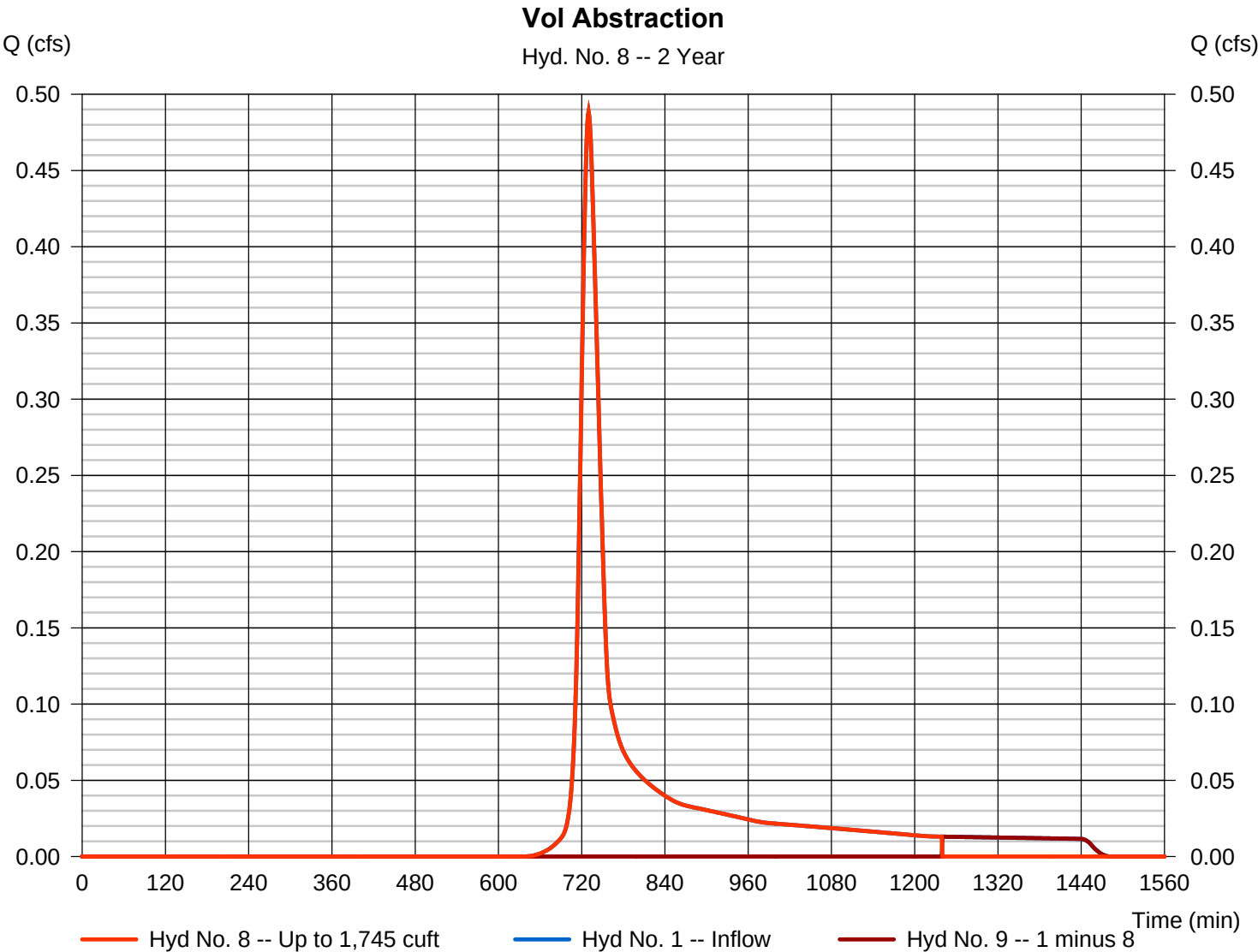
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 8

Vol Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.488 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	1,745 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Divided hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	1,745 cuft



Hydrograph Report

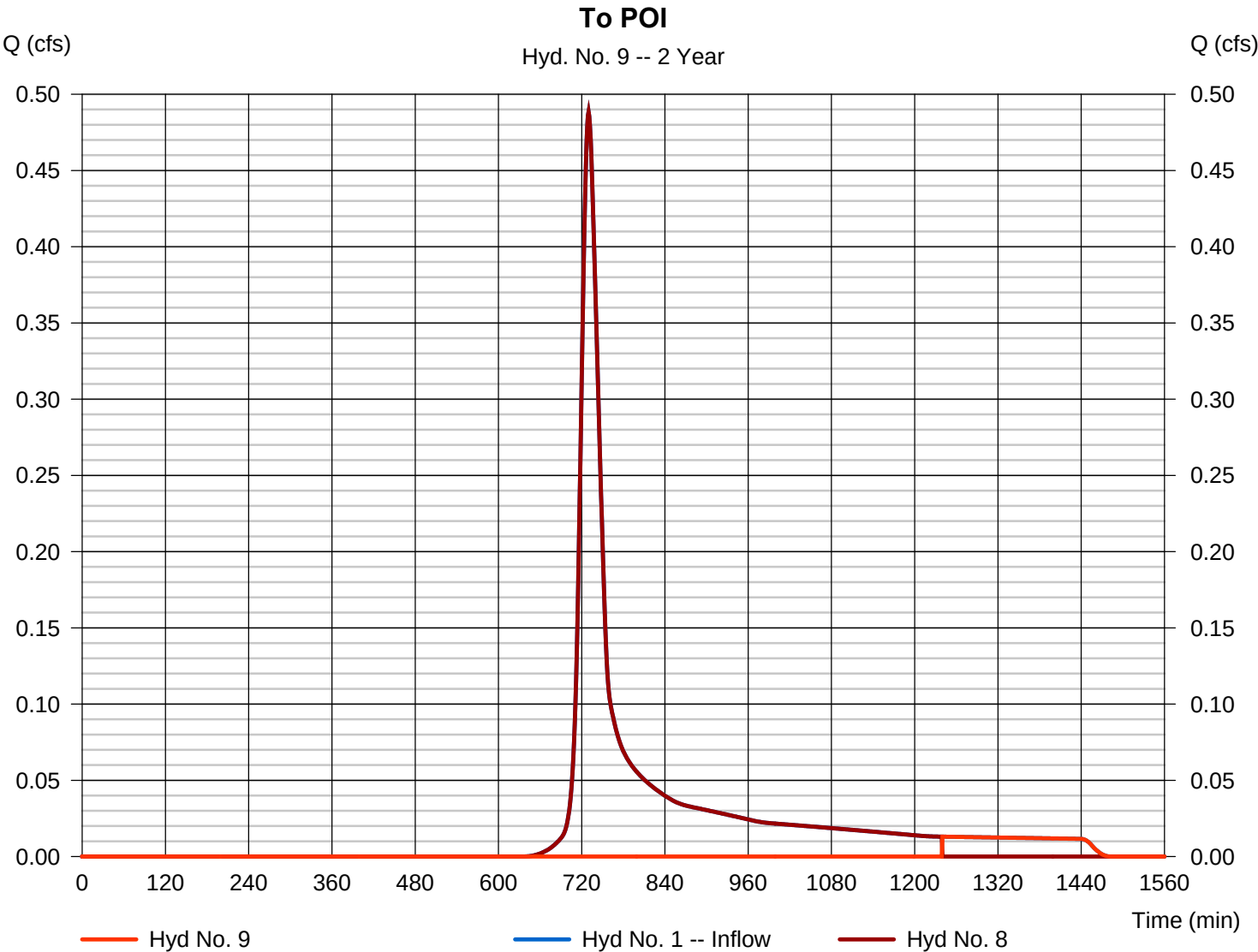
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 9

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.013 cfs
Storm frequency	=	2 yrs	Time to peak	=	1240 min
Time interval	=	1 min	Hyd. volume	=	161 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Diverted hyd.	=	8
Diversion method	=	First Flush Volume	Volume Up To	=	1,745 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

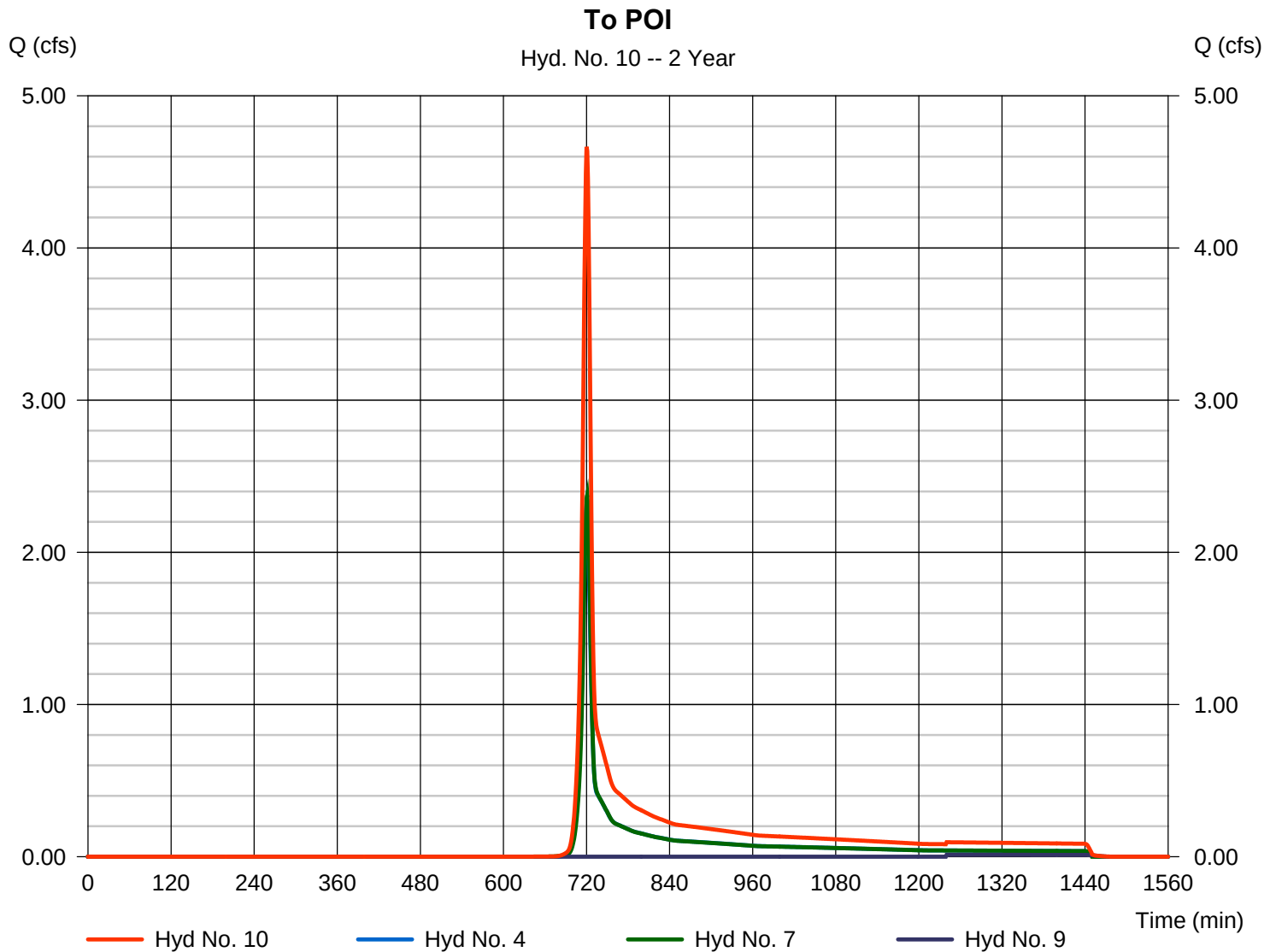
Monday, 11 / 7 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 4, 7, 9

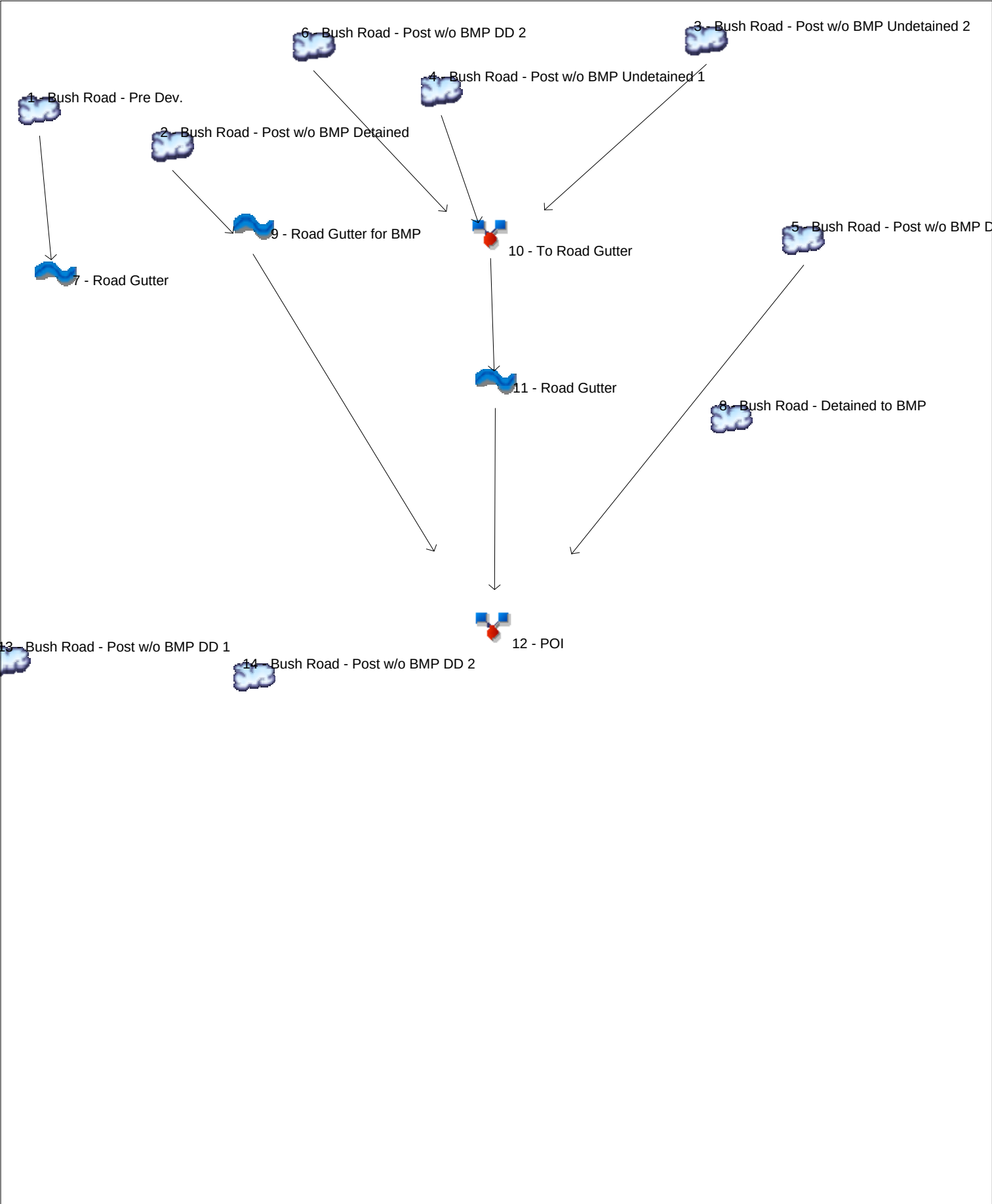
Peak discharge = 4.665 cfs
 Time to peak = 720 min
 Hyd. volume = 11,008 cuft
 Contrib. drain. area = 2.260 ac



ATTACHMENT C-2
BUSH RD
10 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.591	-----	-----	11.46	-----	19.05	22.83	Bush Road - Pre Dev.
2	SCS Runoff	-----	-----	0.870	-----	-----	1.624	-----	2.578	3.039	Bush Road - Post w/o BMP Detained
3	SCS Runoff	-----	-----	1.441	-----	-----	3.036	-----	5.119	6.154	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	-----	-----	0.152	-----	-----	0.278	-----	0.436	0.512	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	-----	-----	2.314	-----	-----	4.778	-----	7.986	9.579	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	-----	-----	0.885	-----	-----	1.768	-----	2.903	3.464	Bush Road - Post w/o BMP DD 2
7	Reach	1	-----	5.552	-----	-----	11.44	-----	19.05	22.83	Road Gutter
8	SCS Runoff	-----	-----	0.760	-----	-----	1.396	-----	2.202	2.590	Bush Road - Detained to BMP
9	Reach	2	-----	0.828	-----	-----	1.576	-----	2.522	2.978	Road Gutter for BMP
10	Combine	3, 4, 6,	-----	2.478	-----	-----	5.081	-----	8.452	10.13	To Road Gutter
11	Reach	10	-----	2.377	-----	-----	4.962	-----	8.354	10.02	Road Gutter
12	Combine	5, 9, 11	-----	5.487	-----	-----	11.32	-----	18.85	22.54	POI
13	SCS Runoff	-----	-----	2.721	-----	-----	5.566	-----	9.243	11.05	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	-----	-----	0.985	-----	-----	1.964	-----	3.218	3.829	Bush Road - Post w/o BMP DD 2
Proj. file: Pre and Post wo BMP 2-100 yrs_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	11.46	1	719	24,189	-----	-----	-----	Bush Road - Pre Dev.
2	SCS Runoff	1.624	1	719	3,430	-----	-----	-----	Bush Road - Post w/o BMP Detained
3	SCS Runoff	3.036	1	719	6,419	-----	-----	-----	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	0.278	1	718	588	-----	-----	-----	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	4.778	1	720	10,845	-----	-----	-----	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	1.768	1	719	3,728	-----	-----	-----	Bush Road - Post w/o BMP DD 2
7	Reach	11.44	1	720	24,188	1	-----	-----	Road Gutter
8	SCS Runoff	1.396	2	718	3,194	-----	-----	-----	Bush Road - Detained to BMP
9	Reach	1.576	1	720	3,428	2	-----	-----	Road Gutter for BMP
10	Combine	5.081	1	719	10,735	3, 4, 6,	-----	-----	To Road Gutter
11	Reach	4.962	1	720	10,734	10	-----	-----	Road Gutter
12	Combine	11.32	1	720	25,008	5, 9, 11	-----	-----	POI
13	SCS Runoff	5.566	1	718	11,184	-----	-----	-----	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	1.964	1	718	3,943	-----	-----	-----	Bush Road - Post w/o BMP DD 2
Pre and Post wo BMP 2-100 yrs_chk.gpw					Return Period: 10 Year			Monday, 11 / 7 / 2016	

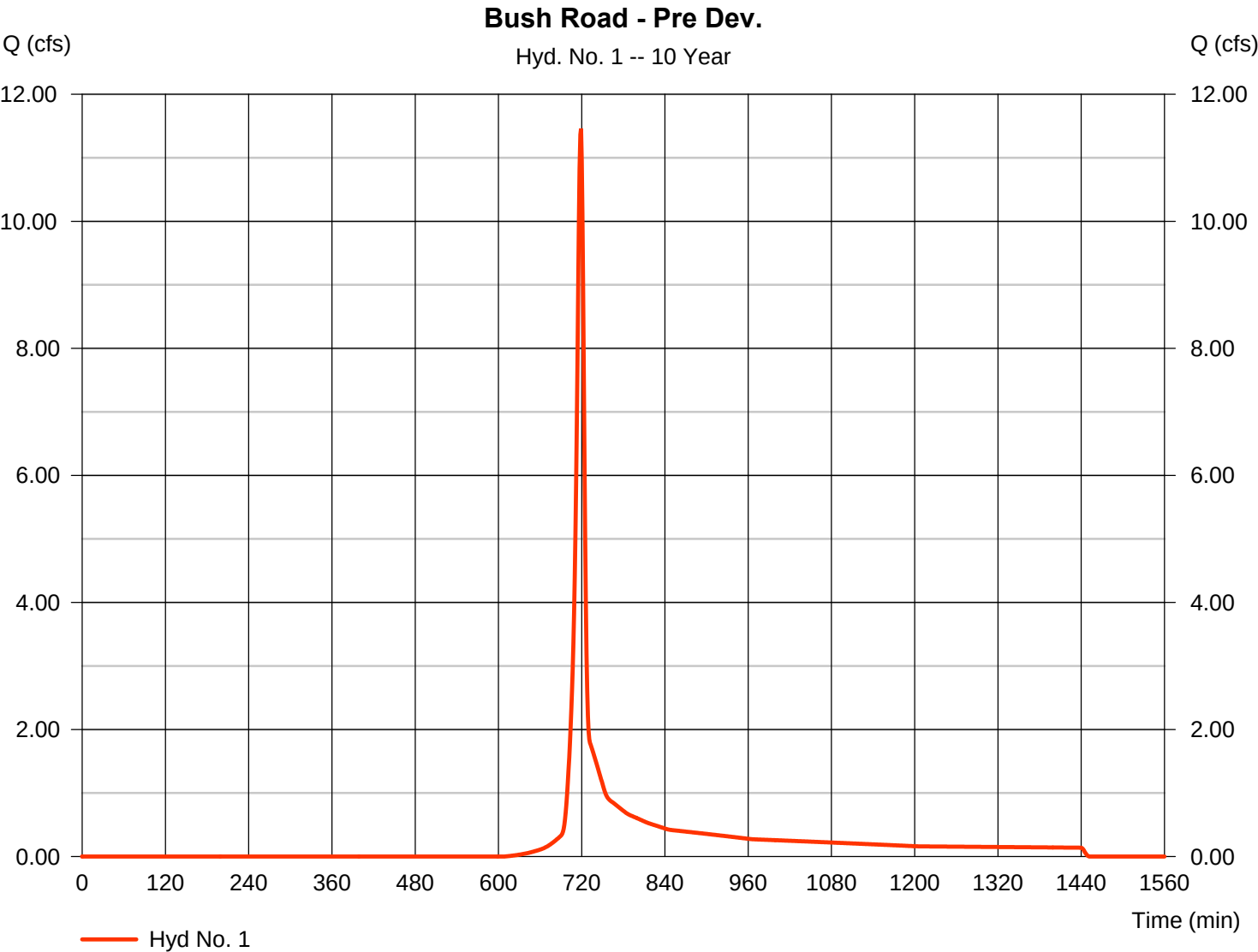
Hydrograph Report

Hyd. No. 1

Bush Road - Pre Dev.

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.46 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	24,189 cuft
Drainage area	=	5.170 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.370 x 78) + (1.350 x 70) + (0.060 x 91) + (0.390 x 77)] / 5.170



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Bush Road - Pre Dev.

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 243.00	800.00	0.00				
Watercourse slope (%)	= 24.00	10.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	5.10	0.00				
Travel Time (min)	= 0.51	+	2.61	+	0.00	=	3.13
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				7.80 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

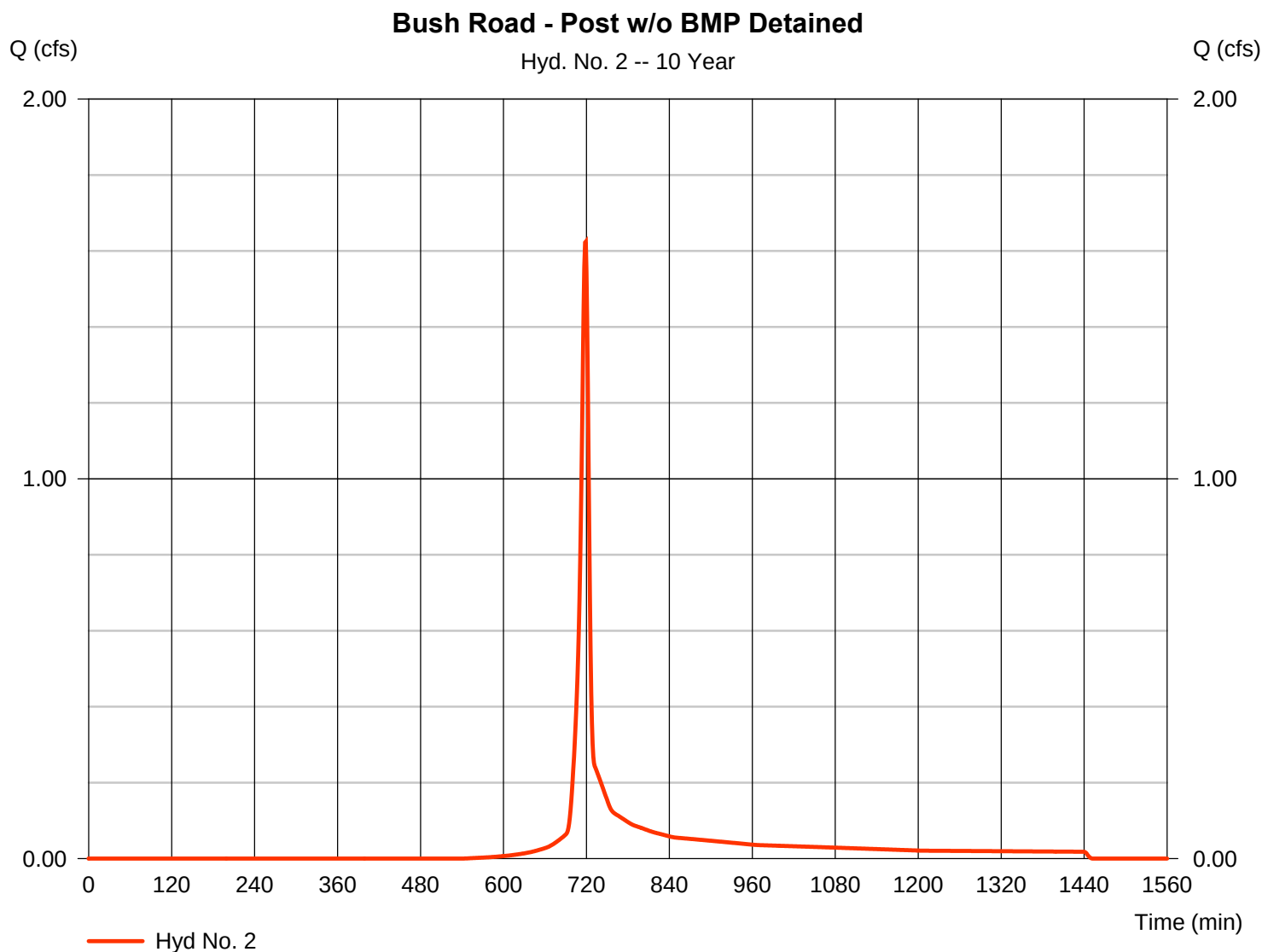
Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w/o BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.624 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	3,430 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.050 \times 77) + (0.400 \times 78) + (0.130 \times 91)] / 0.610$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w/o BMP Detained

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	629.00	75.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	2.17	+	0.27	=	2.79
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

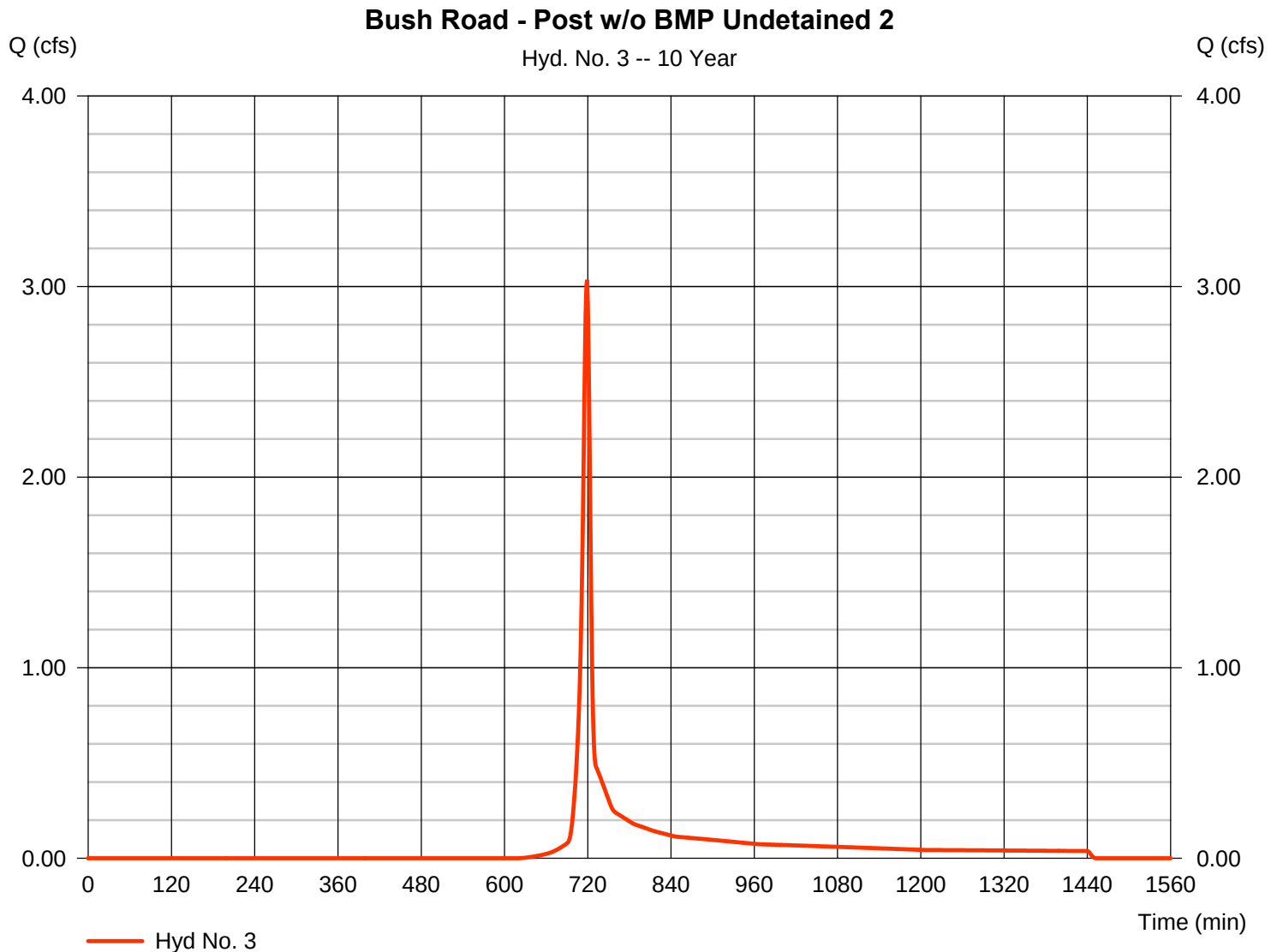
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.036 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	6,419 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

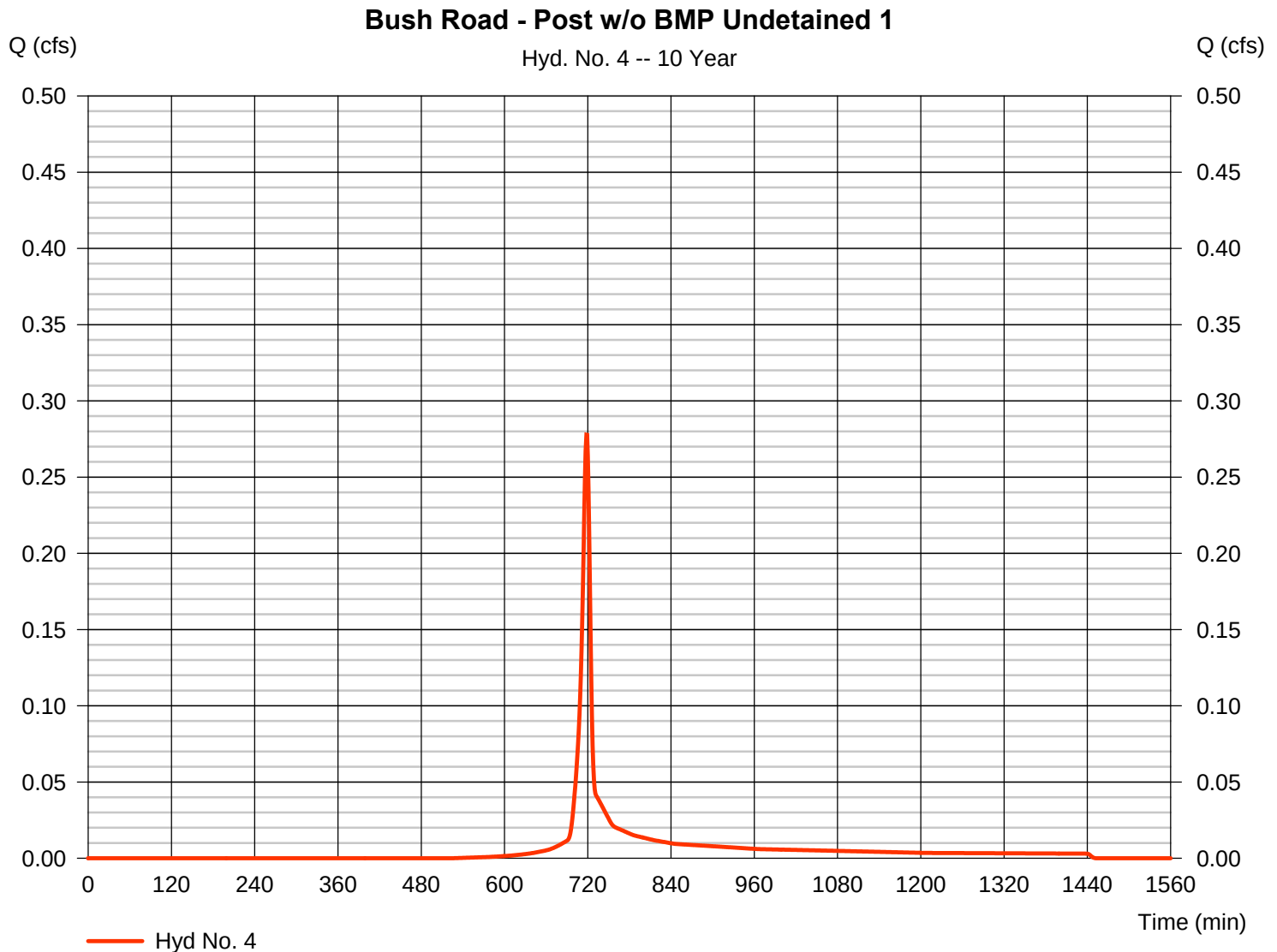
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.278 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	588 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

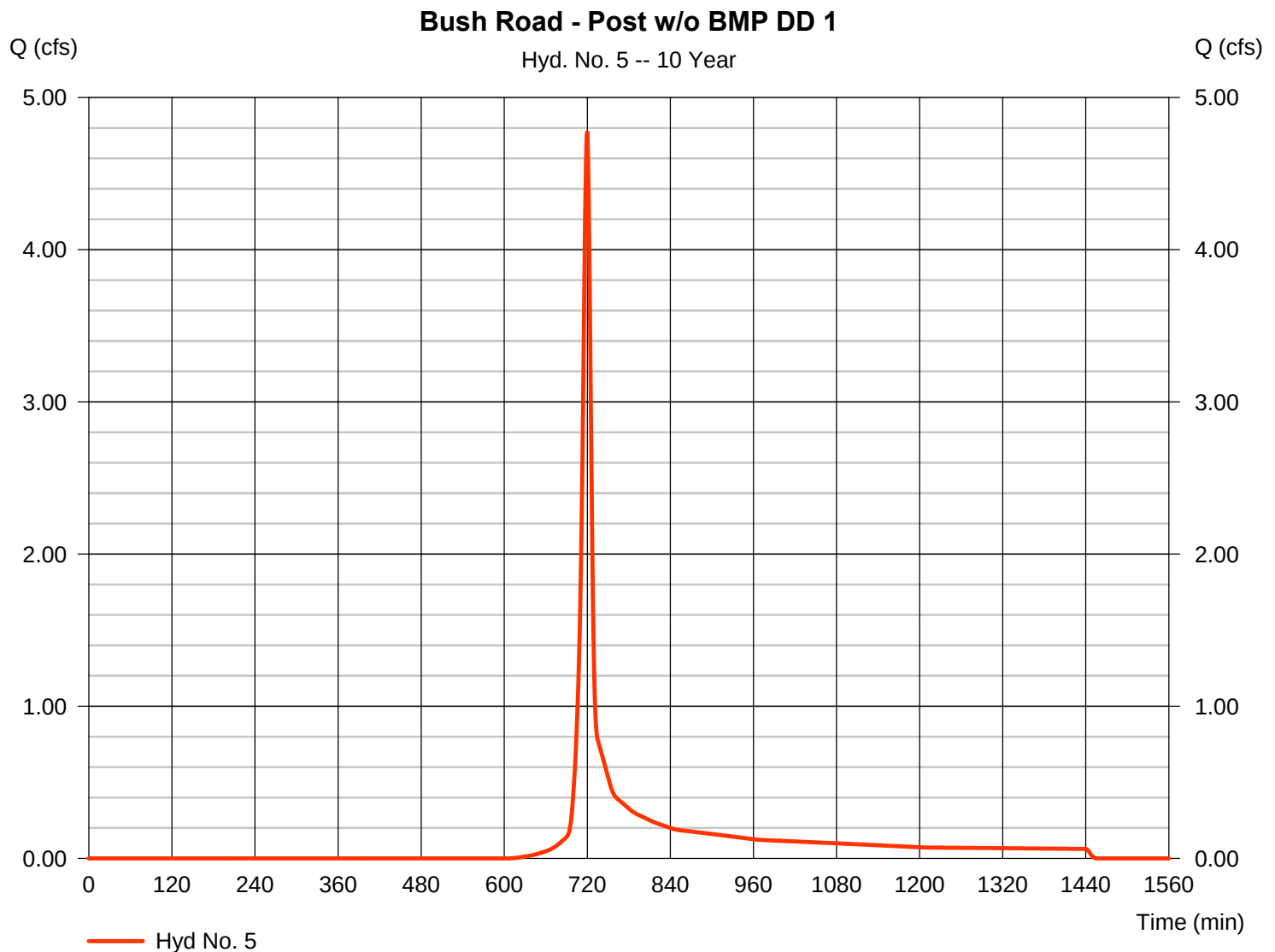
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.778 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	10,845 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 280.00	385.00	270.00	
Watercourse slope (%)	= 23.00	10.00	15.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=7.74	5.10	6.25	
Travel Time (min)	= 0.60	+	1.26	+
			0.72	= 2.58
Channel Flow				
X sectional flow area (sqft)	= 2.52	0.00	0.00	
Wetted perimeter (ft)	= 5.02	0.00	0.00	
Channel slope (%)	= 2.00	0.00	0.00	
Manning's n-value	= 0.060	0.015	0.015	
Velocity (ft/s)	=2.21	0.00	0.00	
Flow length (ft)	({})175.0	0.0	0.0	
Travel Time (min)	= 1.32	+	0.00	+
			0.00	= 1.32
Total Travel Time, Tc				8.50 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

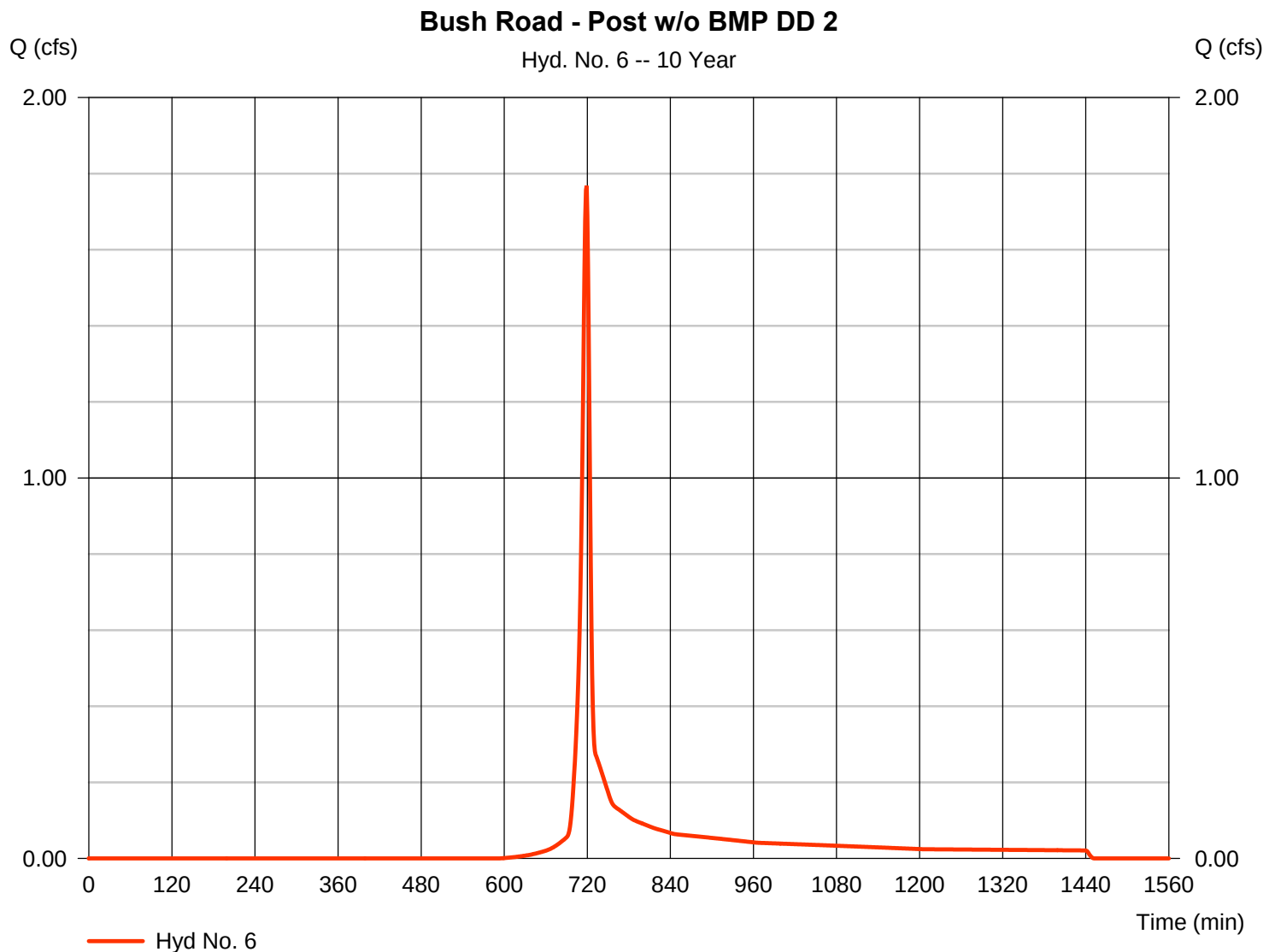
Monday, 11 / 7 / 2016

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.768 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	3,728 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00	
Land slope (%)	= 22.00	0.00	0.00	
Travel Time (min)	= 4.29	+	0.00	+
			0.00	= 4.29
Shallow Concentrated Flow				
Flow length (ft)	= 210.00	510.00	0.00	
Watercourse slope (%)	= 25.00	9.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=8.07	4.84	0.00	
Travel Time (min)	= 0.43	+	1.76	+
			0.00	= 2.19
Channel Flow				
X sectional flow area (sqft)	= 1.03	0.00	0.00	
Wetted perimeter (ft)	= 3.28	0.00	0.00	
Channel slope (%)	= 9.00	0.00	0.00	
Manning's n-value	= 0.060	0.015	0.015	
Velocity (ft/s)	=3.43	0.00	0.00	
Flow length (ft)	(0)45.0	0.0	0.0	
Travel Time (min)	= 0.22	+	0.00	+
			0.00	= 0.22
Total Travel Time, Tc				6.70 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

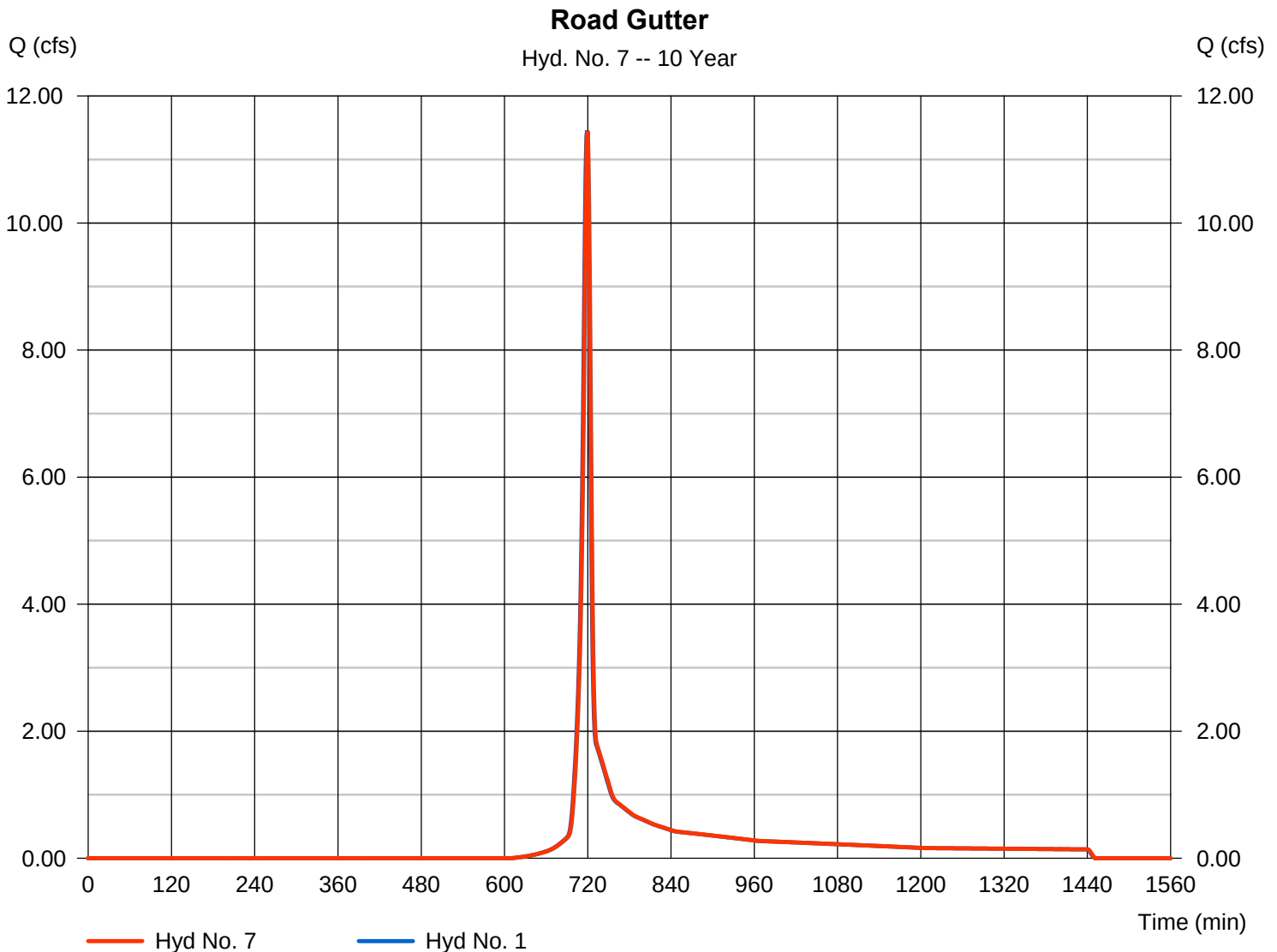
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 11.44 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 24,188 cuft
Inflow hyd. No.	= 1 - Bush Road - Pre Dev.	Section type	= Triangular
Reach length	= 265.0 ft	Channel slope	= 3.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.308	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.9074

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

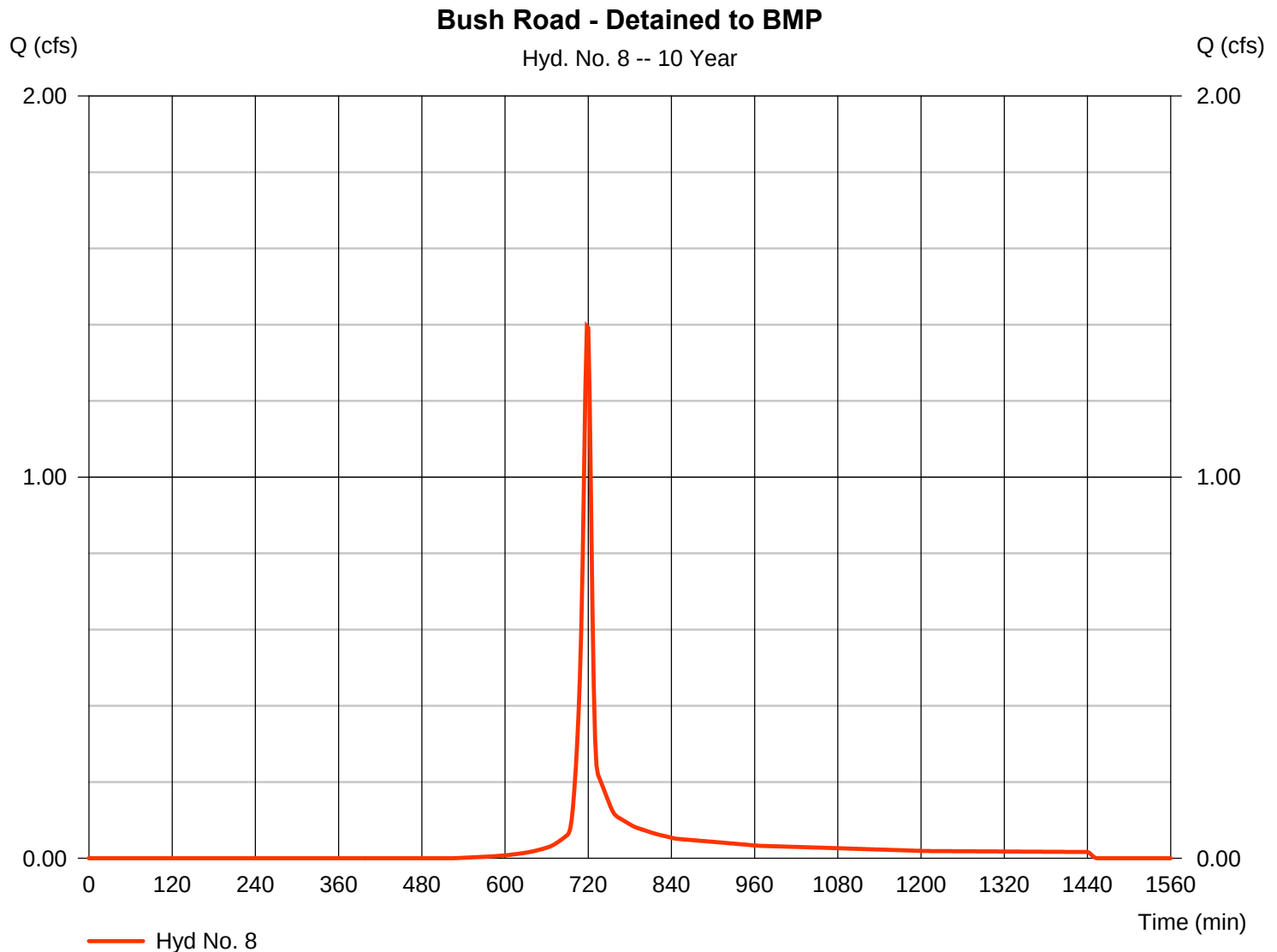
Monday, 11 / 7 / 2016

Hyd. No. 8

Bush Road - Detained to BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.396 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	3,194 cuft
Drainage area	=	0.530 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.010 \times 77) + (0.360 \times 78) + (0.130 \times 91)] / 0.530$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 8

Bush Road - Detained to BMP

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	535.00	70.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	1.84	+	0.26	=	2.45
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	((0})0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				6.60 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

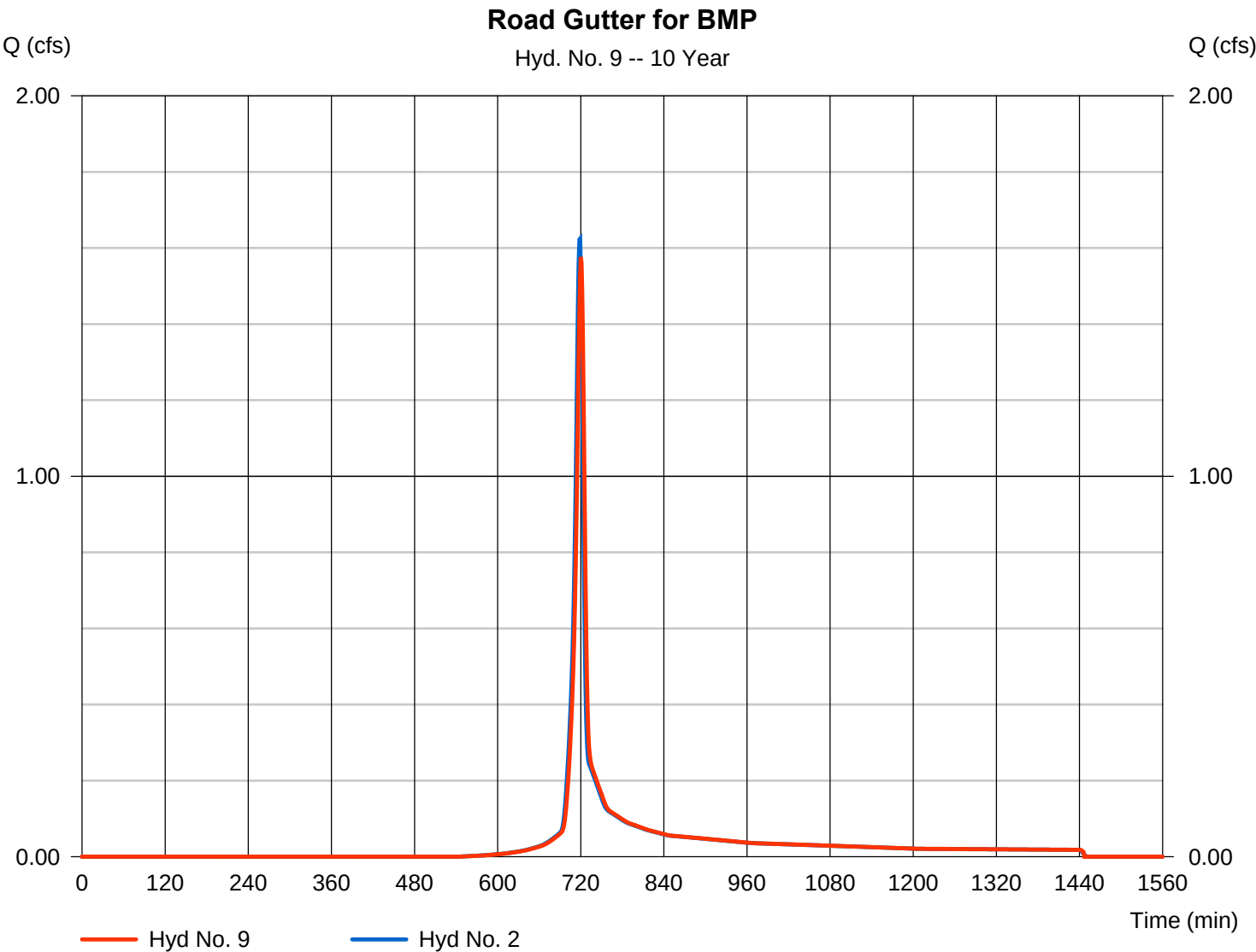
Monday, 11 / 7 / 2016

Hyd. No. 9

Road Gutter for BMP

Hydrograph type	= Reach	Peak discharge	= 1.576 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 3,428 cuft
Inflow hyd. No.	= 2 - Bush Road - Post w/o BMP	Section type	= Triangular
Reach length	= 450.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5011

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

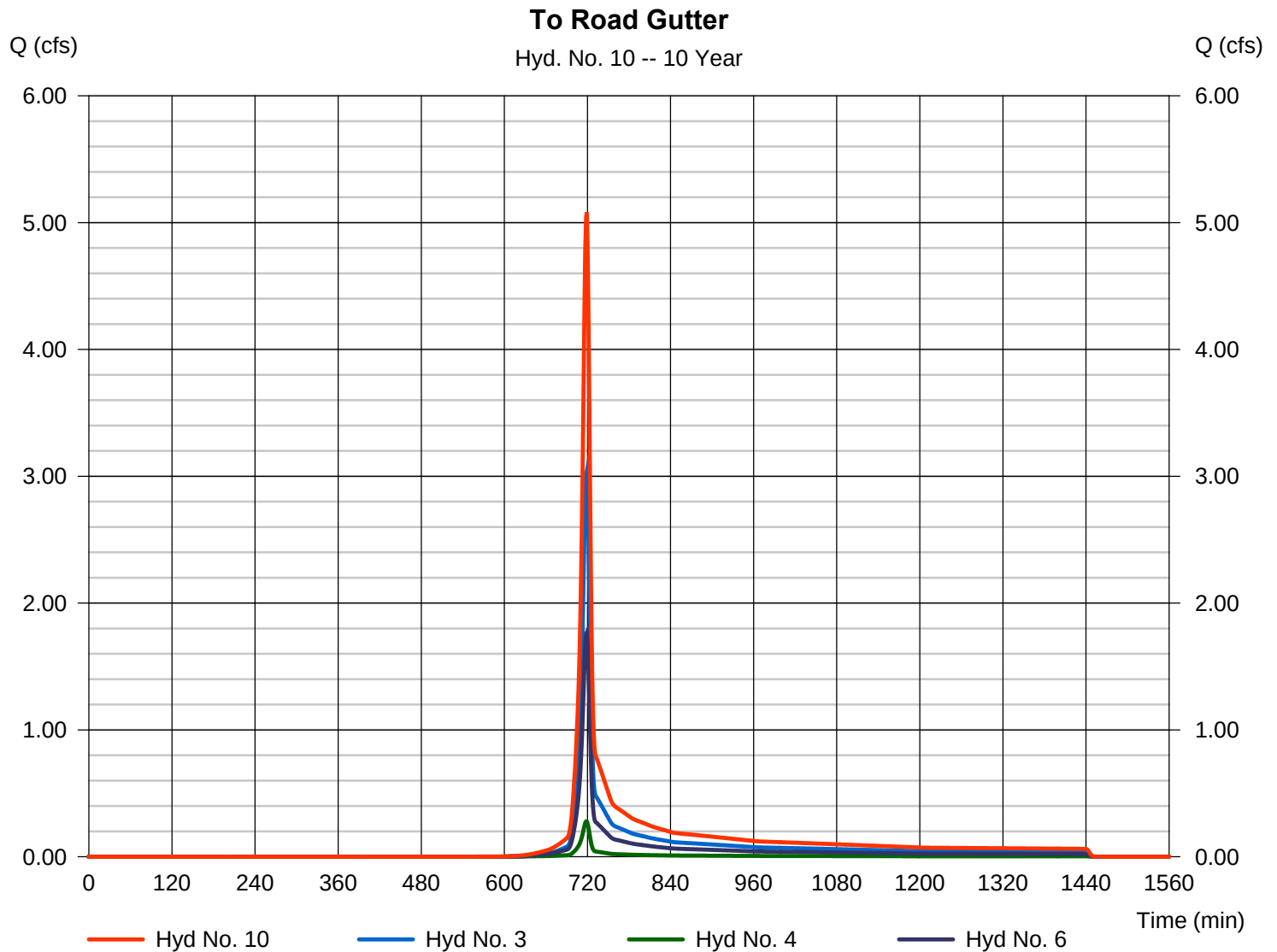
Monday, 11 / 7 / 2016

Hyd. No. 10

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 3, 4, 6

Peak discharge = 5.081 cfs
 Time to peak = 719 min
 Hyd. volume = 10,735 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

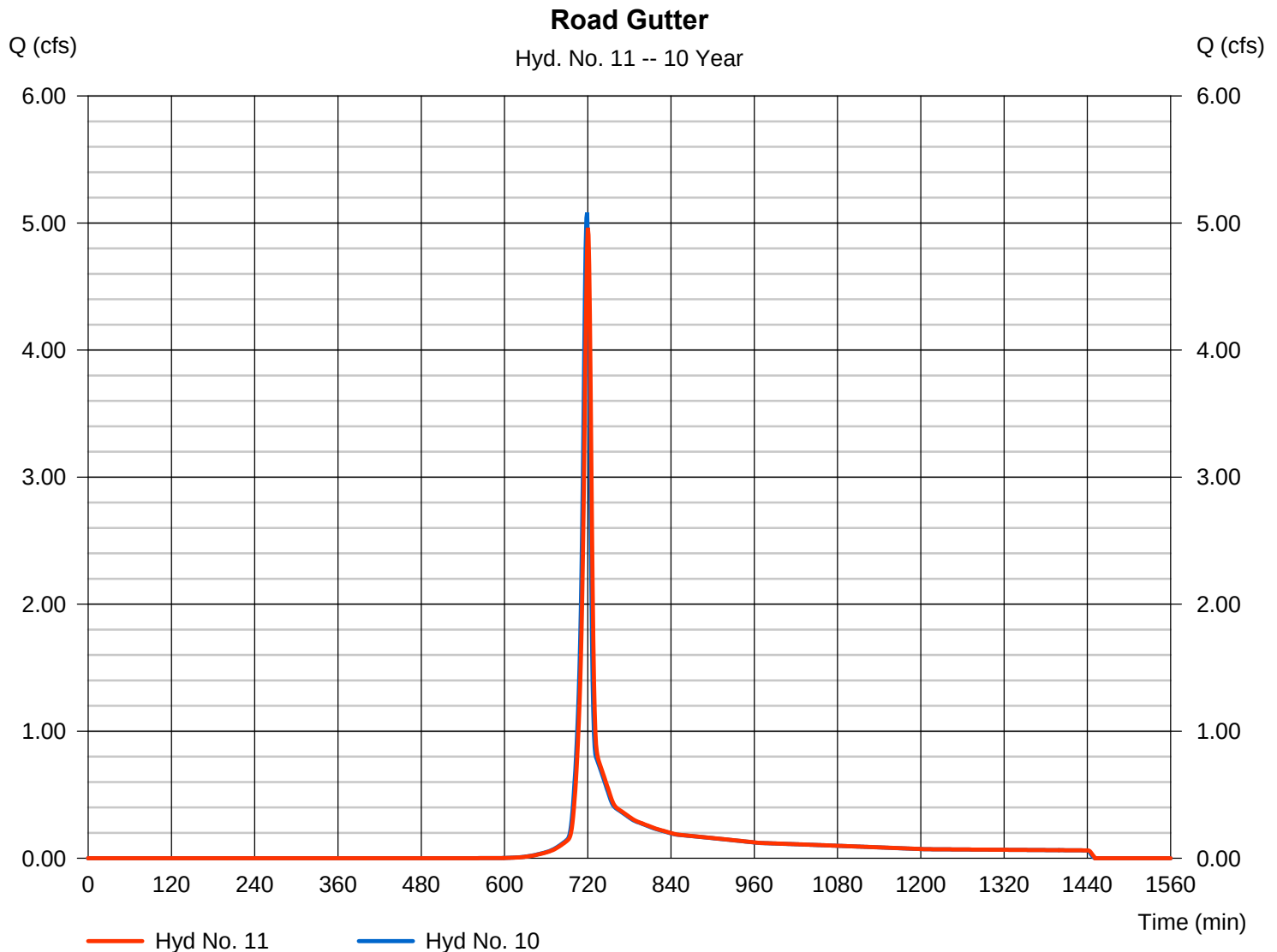
Monday, 11 / 7 / 2016

Hyd. No. 11

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 4.962 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 10,734 cuft
Inflow hyd. No.	= 10 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5715

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

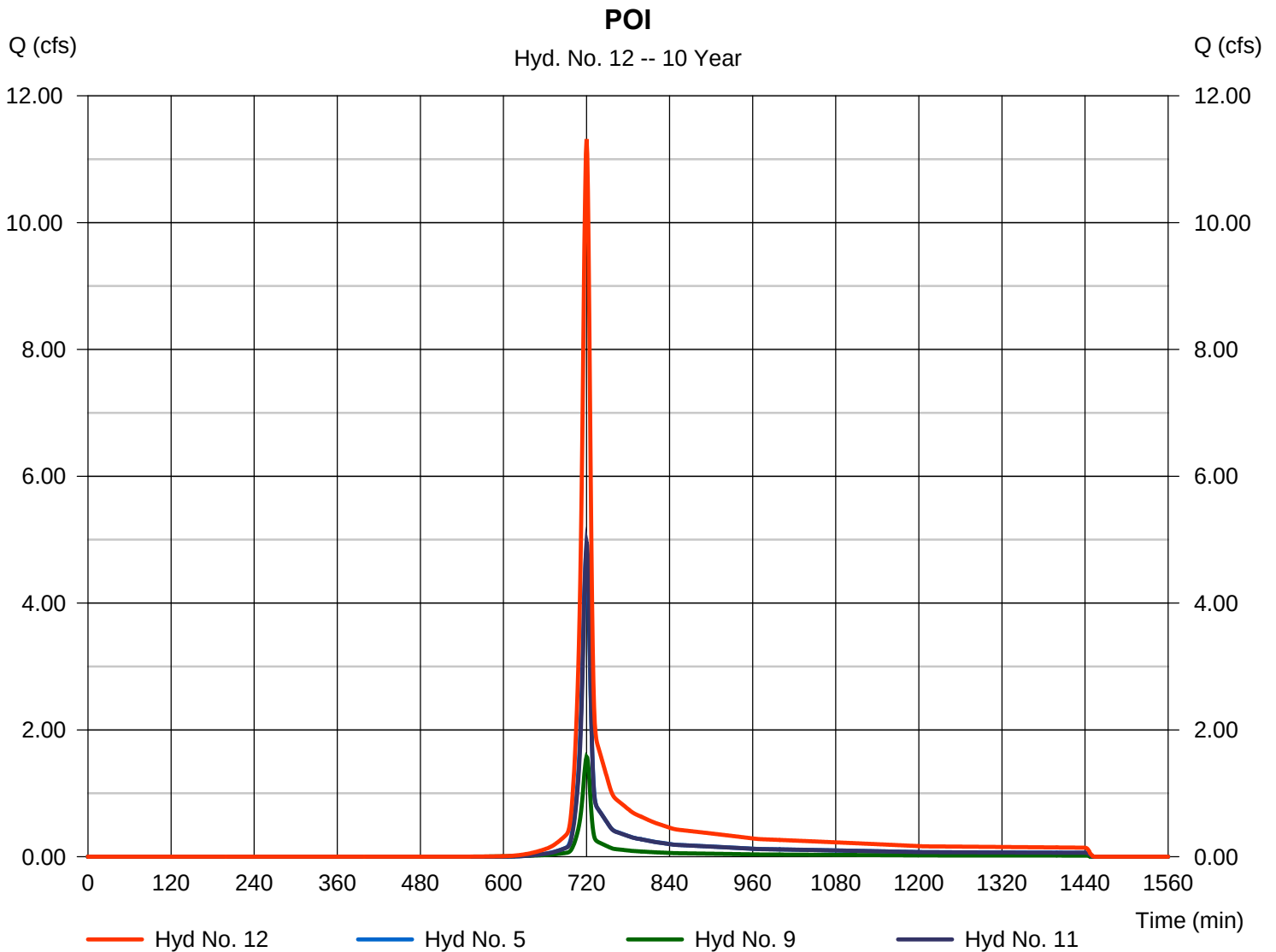
Monday, 11 / 7 / 2016

Hyd. No. 12

POI

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 5, 9, 11

Peak discharge = 11.32 cfs
 Time to peak = 720 min
 Hyd. volume = 25,008 cuft
 Contrib. drain. area = 2.260 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

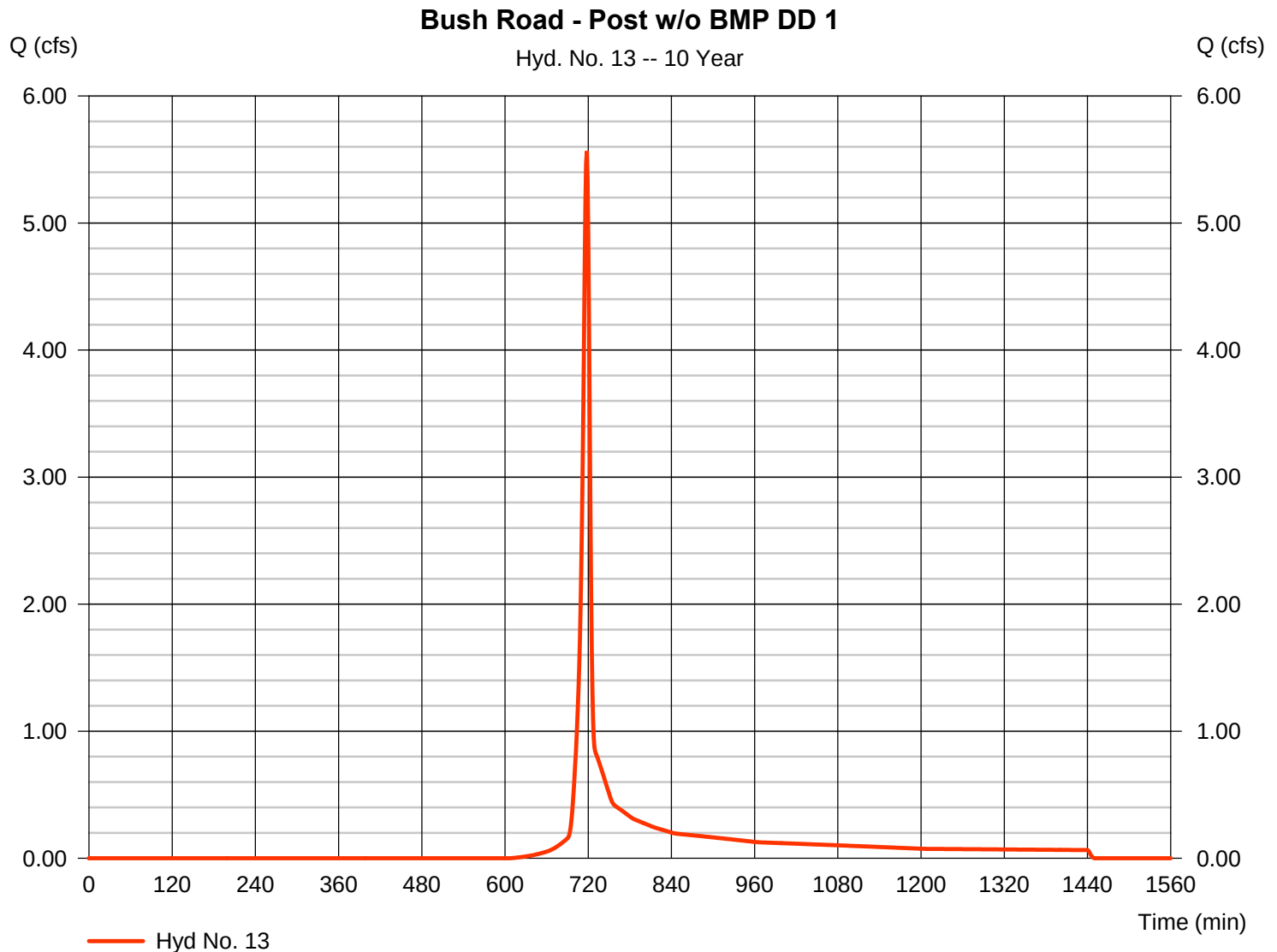
Monday, 11 / 7 / 2016

Hyd. No. 13

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.566 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	11,184 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 13

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 280.00	385.00	0.00	
Watercourse slope (%)	= 23.00	10.00	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=7.74	5.10	0.00	
Travel Time (min)	= 0.60	+	1.26	+
			0.00	= 1.86
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	= 0.060	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				6.50 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

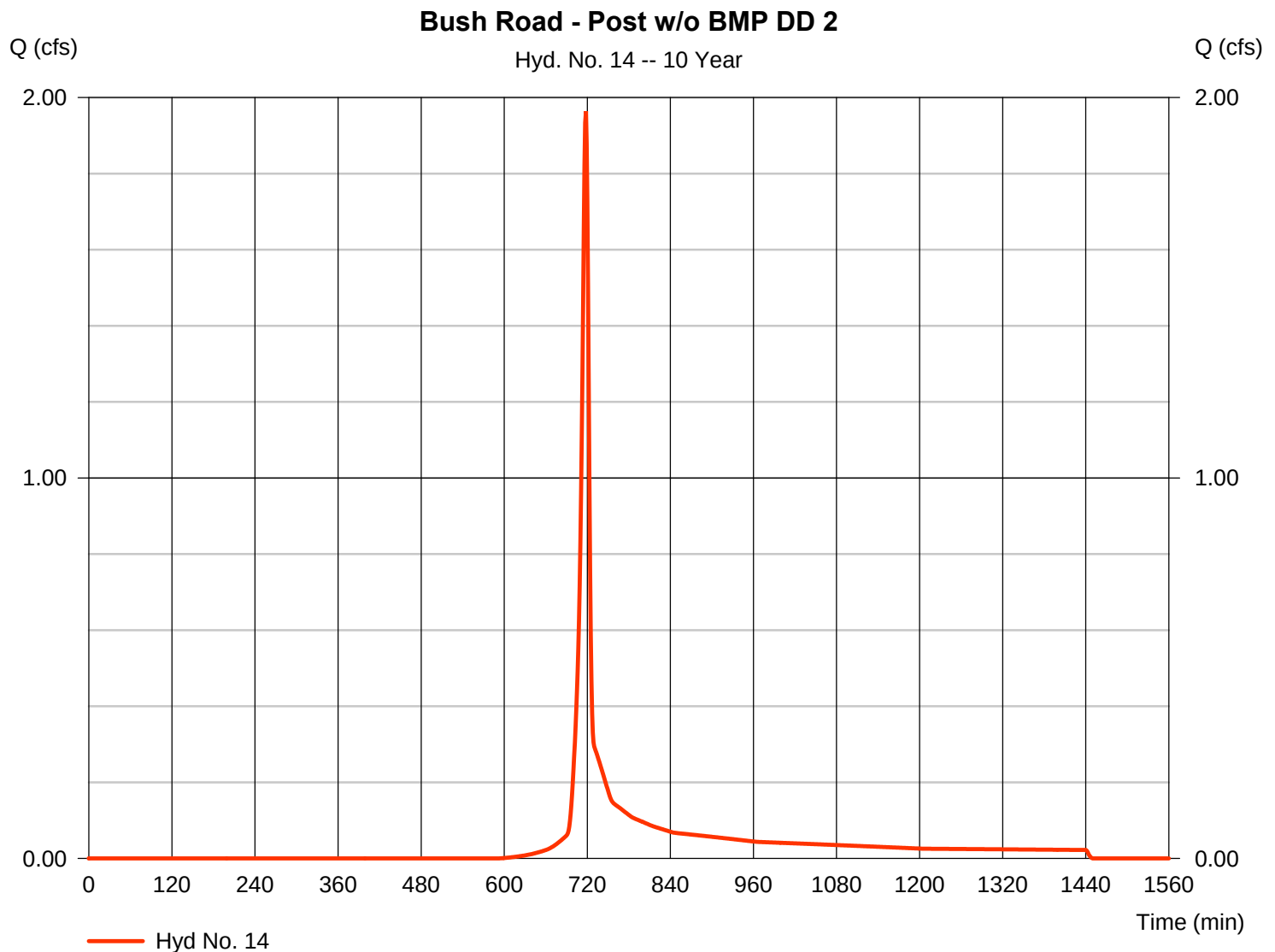
Monday, 11 / 7 / 2016

Hyd. No. 14

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.964 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	3,943 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

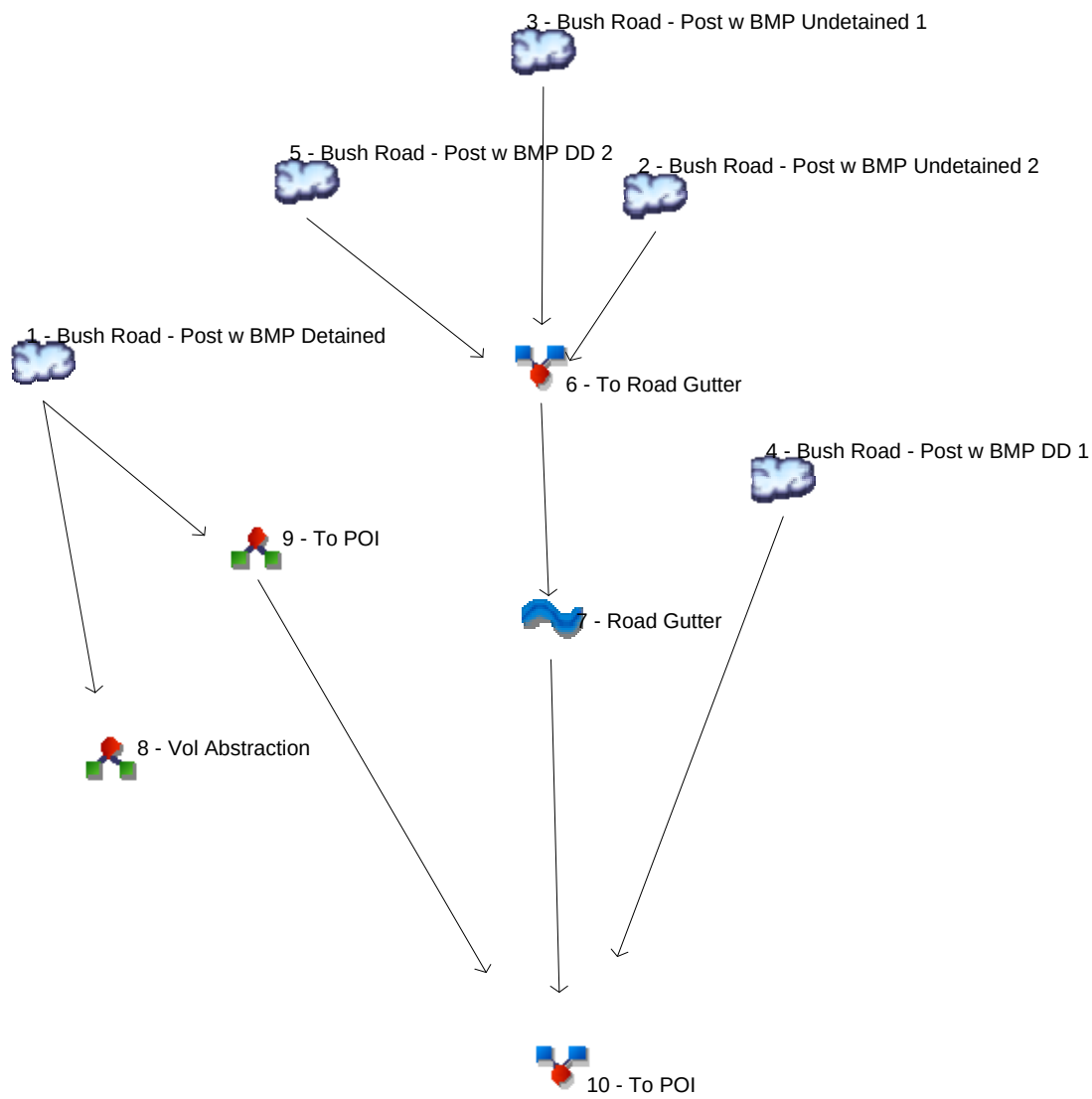
Hyd. No. 14

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
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	= 0.060	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				6.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	0.943	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	-----	-----	-----	-----	-----	3.036	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	-----	-----	-----	-----	-----	0.278	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	-----	-----	-----	-----	-----	4.778	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	-----	-----	-----	-----	-----	1.768	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	2, 3, 5	-----	-----	-----	-----	5.081	-----	-----	-----	To Road Gutter
7	Reach	6	-----	-----	-----	-----	4.962	-----	-----	-----	Road Gutter
8	Diversion1	1	-----	-----	-----	-----	0.943	-----	-----	-----	Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	0.025	-----	-----	-----	To POI
10	Combine	4, 7, 9	-----	-----	-----	-----	9.741	-----	-----	-----	To POI
Proj. file: Post w BMP 10 yr_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.943	1	730	3,546	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	3.036	1	719	6,419	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	0.278	1	718	588	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	4.778	1	720	10,845	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	1.768	1	719	3,728	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	5.081	1	719	10,735	2, 3, 5	-----	-----	To Road Gutter
7	Reach	4.962	1	720	10,734	6	-----	-----	Road Gutter
8	Diversion1	0.943	1	730	3,194	1	-----	-----	Vol Abstraction
9	Diversion2	0.025	1	1174	351	1	-----	-----	To POI
10	Combine	9.741	1	720	21,931	4, 7, 9	-----	-----	To POI
Post w BMP 10 yr_chk.gpw					Return Period: 10 Year			Monday, 11 / 7 / 2016	

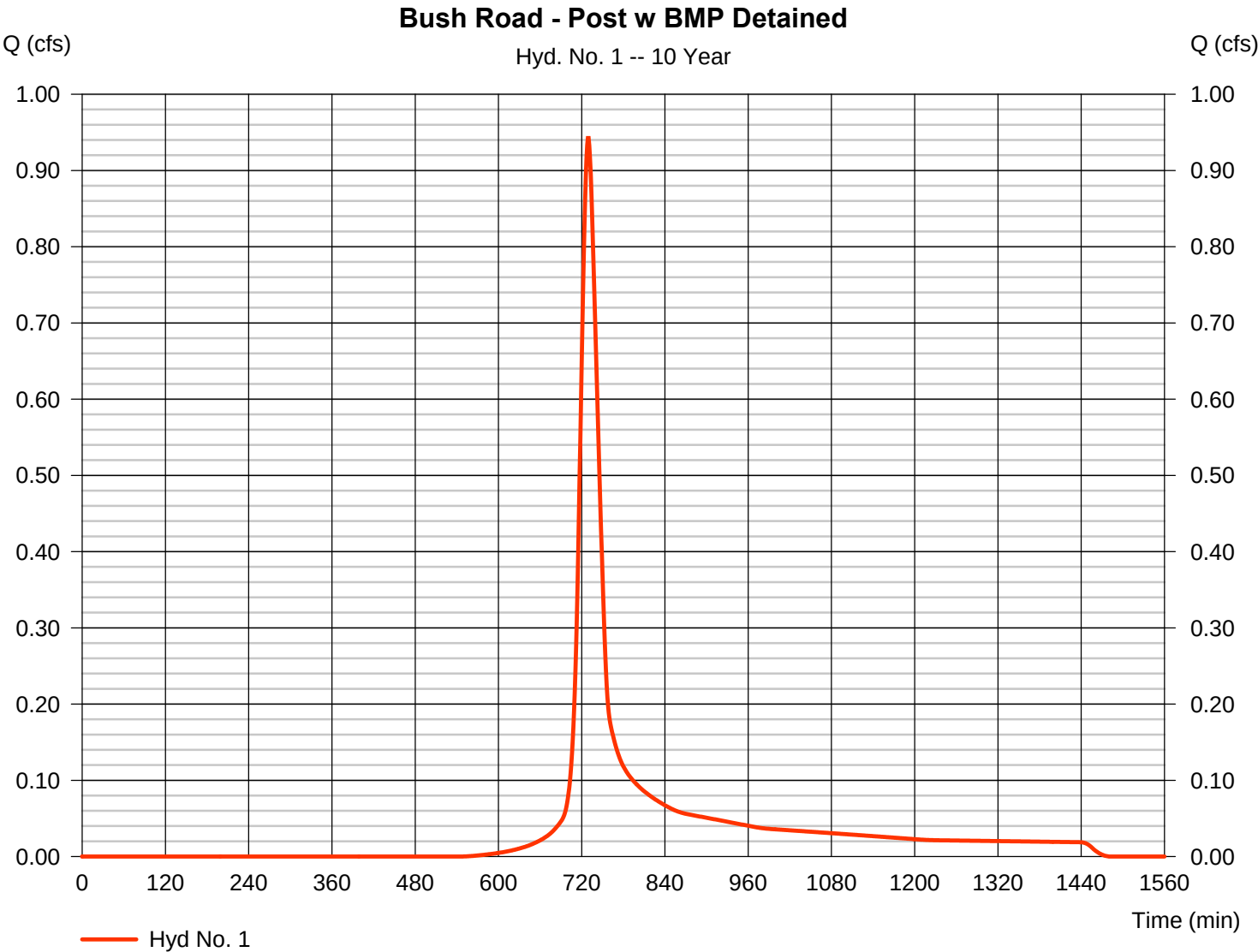
Hydrograph Report

Hyd. No. 1

Bush Road - Post w BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.943 cfs
Storm frequency	=	10 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	3,546 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	25.80 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.036 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	6,419 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.730 x 78) + (0.180 x 77) + (0.530 x 70)] / 1.440



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

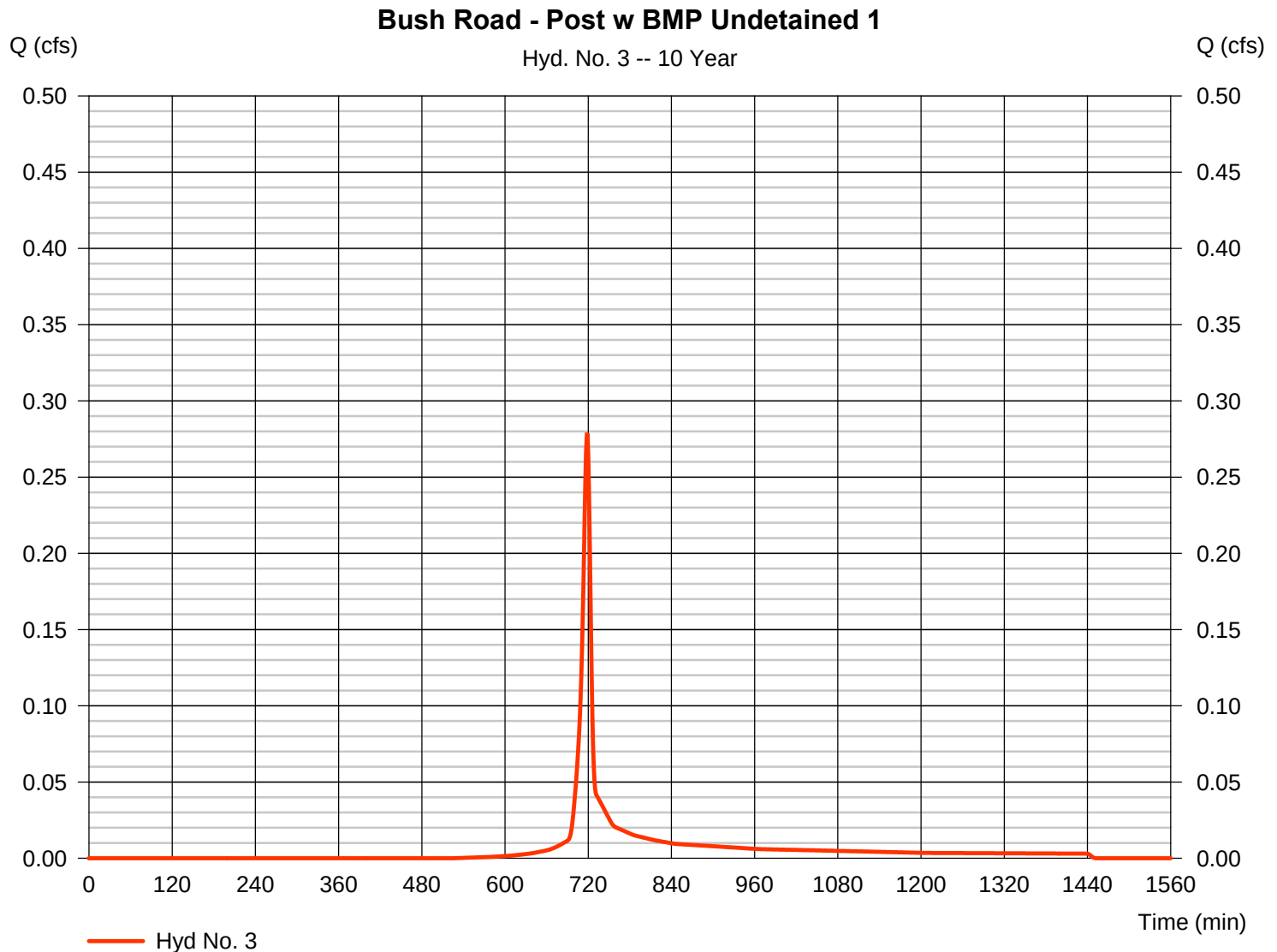
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.278 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	588 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

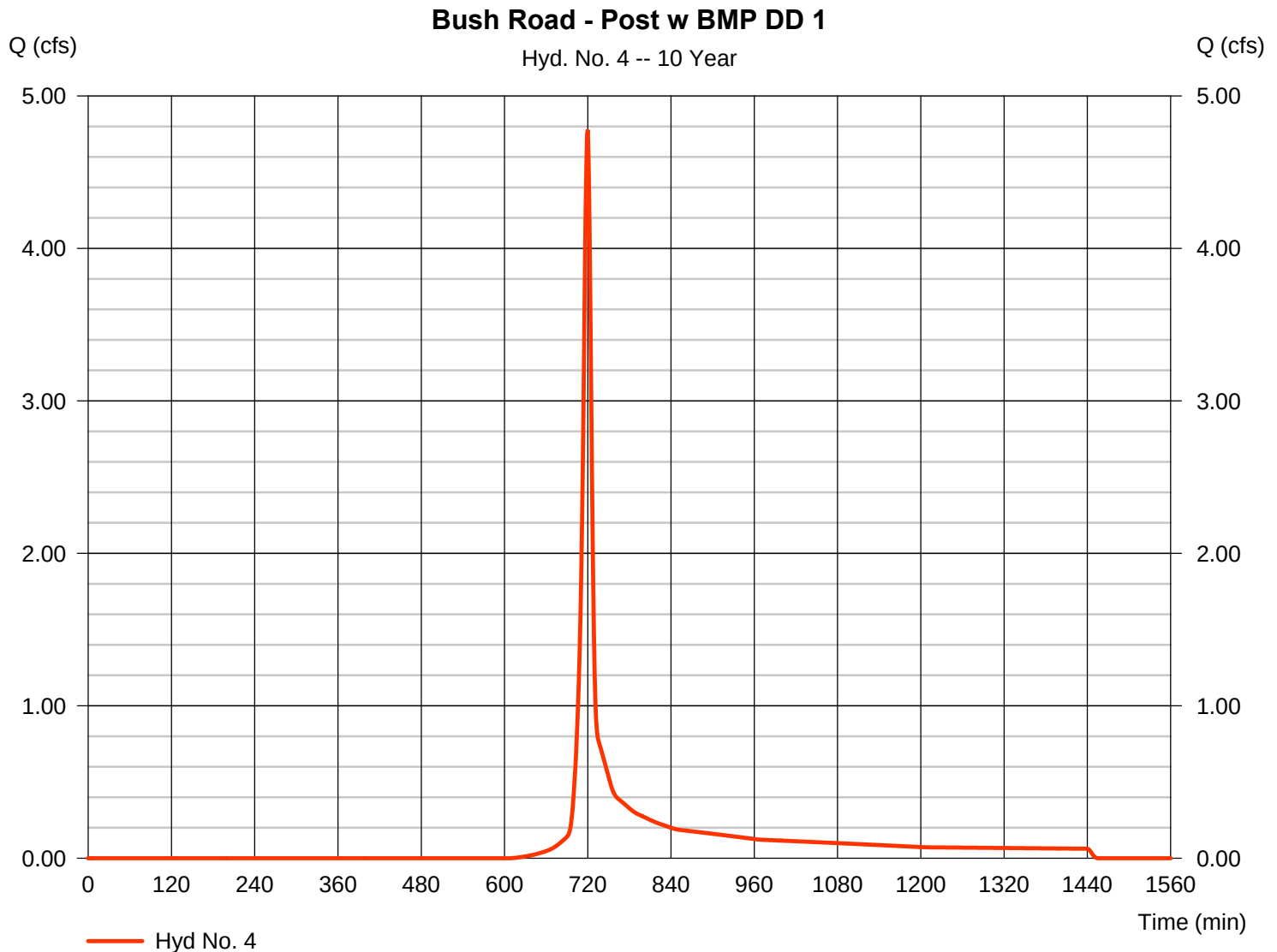
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w BMP DD 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.778 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 10,845 cuft
Drainage area	= 2.260 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 8.50 min
Total precip.	= 3.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w BMP DD 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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 280.00	385.00	270.00	
Watercourse slope (%)	= 23.00	10.00	15.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=7.74	5.10	6.25	
Travel Time (min)	= 0.60	+	1.26	+
			0.72	= 2.58
Channel Flow				
X sectional flow area (sqft)	= 2.52	0.00	0.00	
Wetted perimeter (ft)	= 5.02	0.00	0.00	
Channel slope (%)	= 2.00	0.00	0.00	
Manning's n-value	= 0.060	0.015	0.015	
Velocity (ft/s)	=2.21	0.00	0.00	
Flow length (ft)	({})175.0	0.0	0.0	
Travel Time (min)	= 1.32	+	0.00	+
			0.00	= 1.32
Total Travel Time, Tc				8.50 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

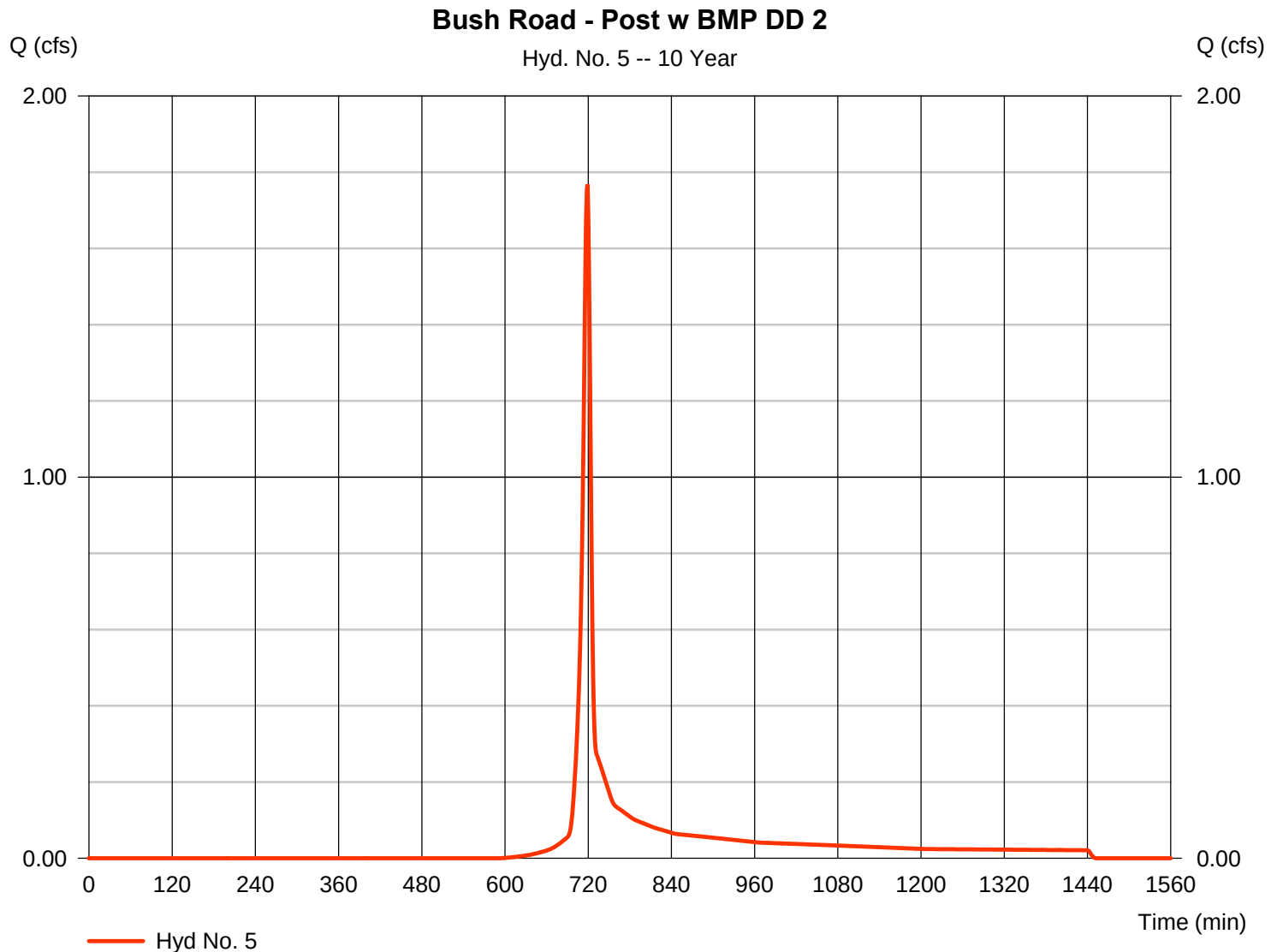
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.768 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	3,728 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	3.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

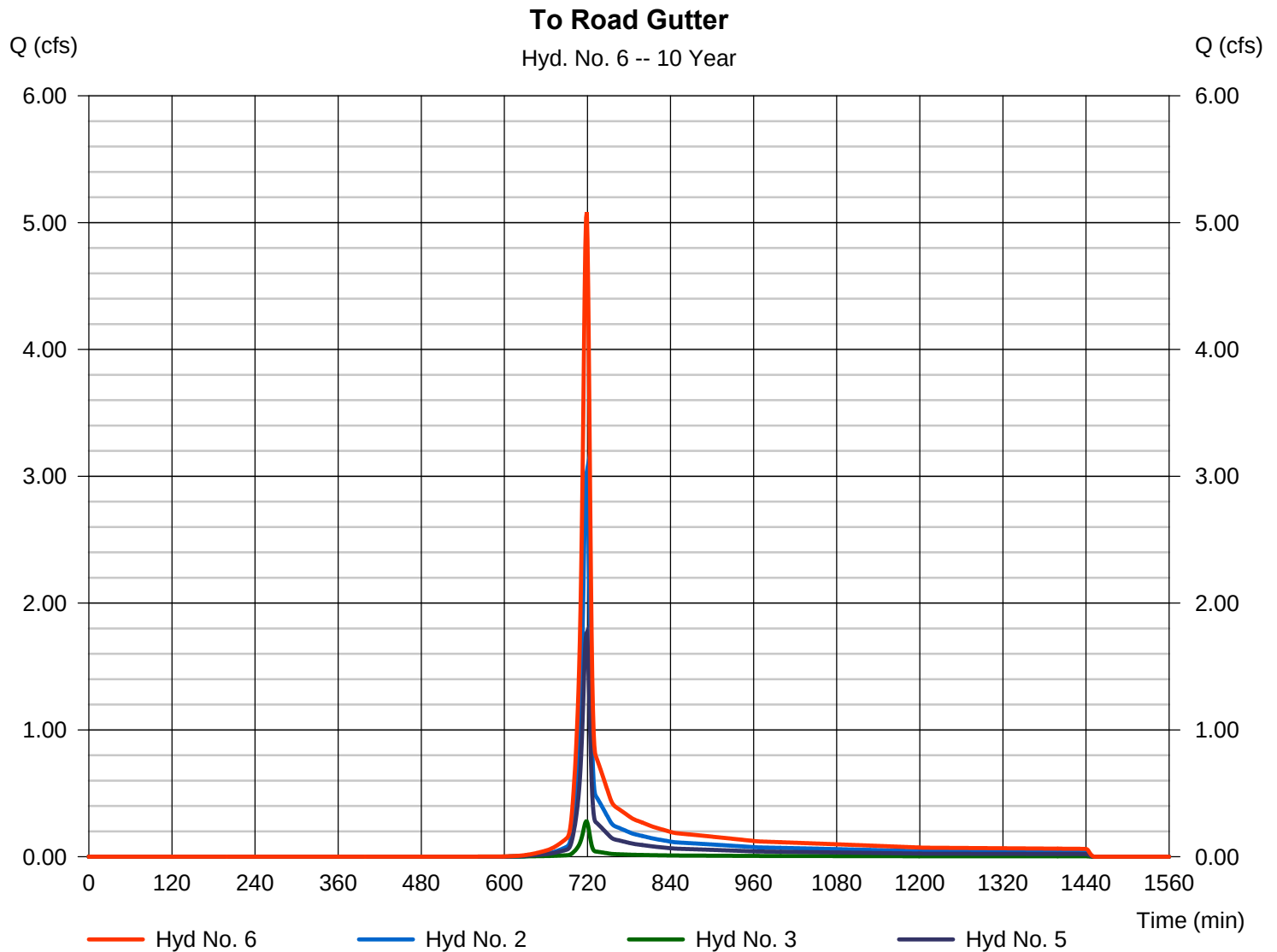
Monday, 11 / 7 / 2016

Hyd. No. 6

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 5

Peak discharge = 5.081 cfs
 Time to peak = 719 min
 Hyd. volume = 10,735 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

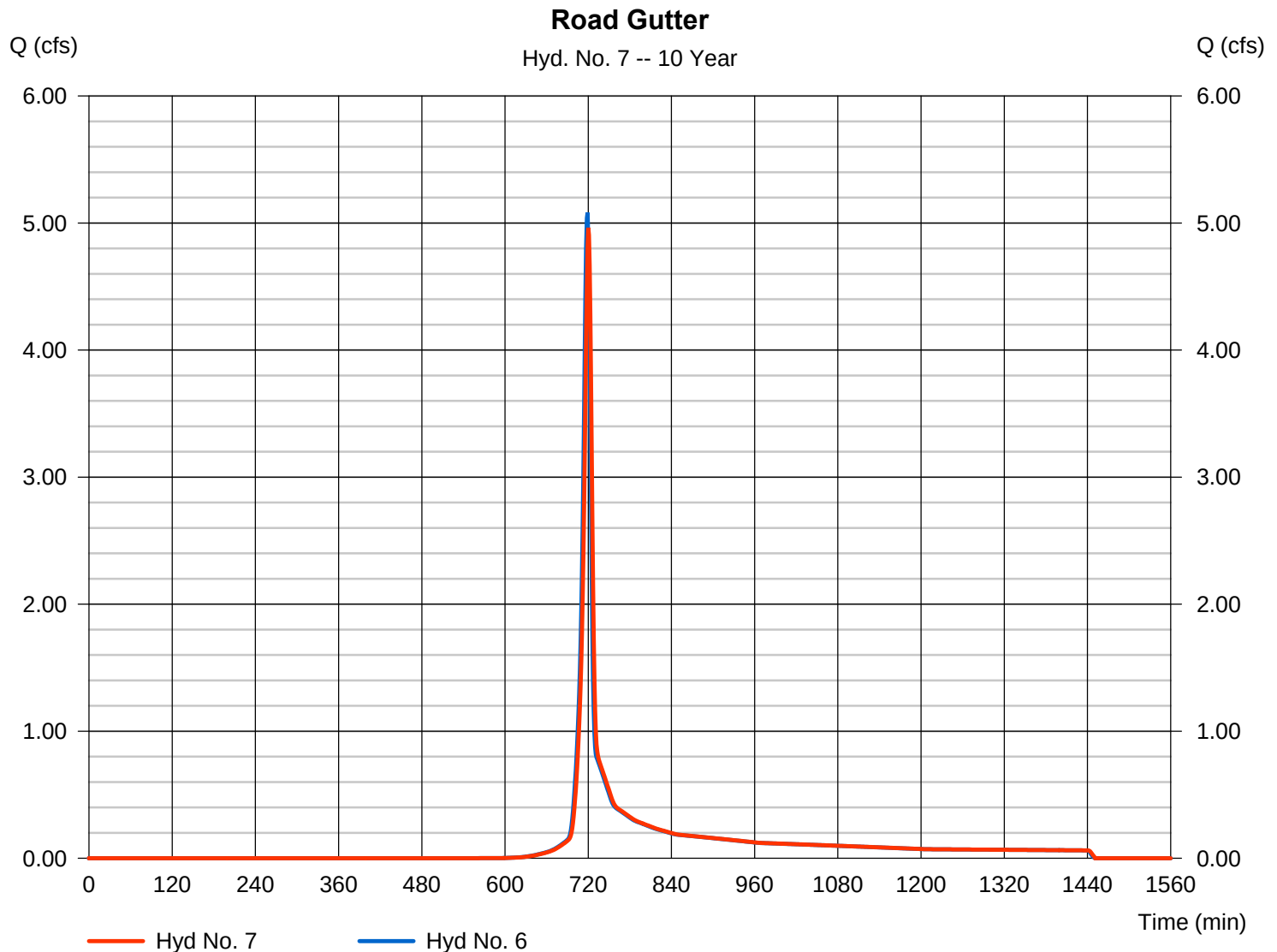
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 4.962 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 10,734 cuft
Inflow hyd. No.	= 6 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5715

Modified Att-Kin routing method used.



Hydrograph Report

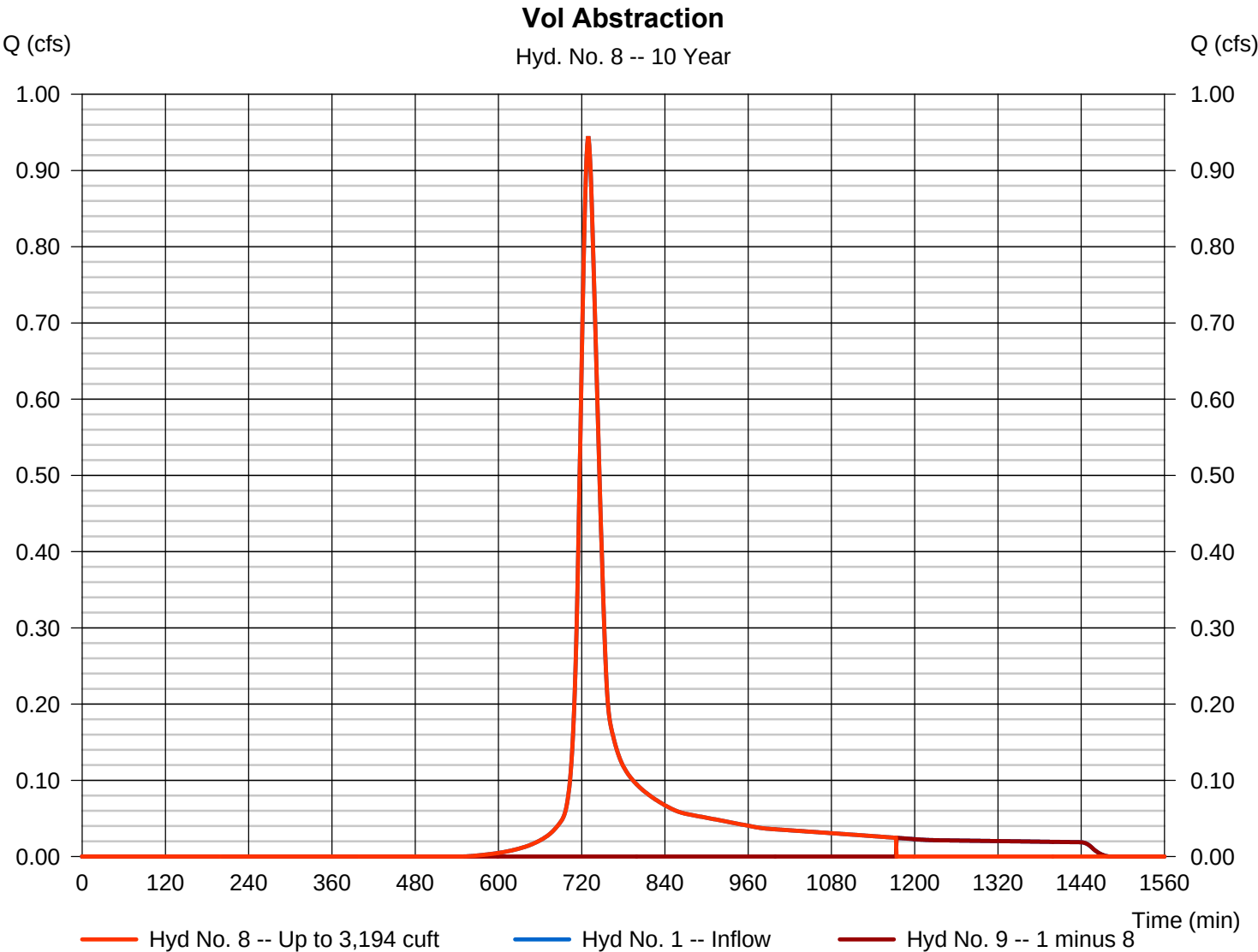
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 8

Vol Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.943 cfs
Storm frequency	=	10 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	3,194 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Divided hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	3,194 cuft



Hydrograph Report

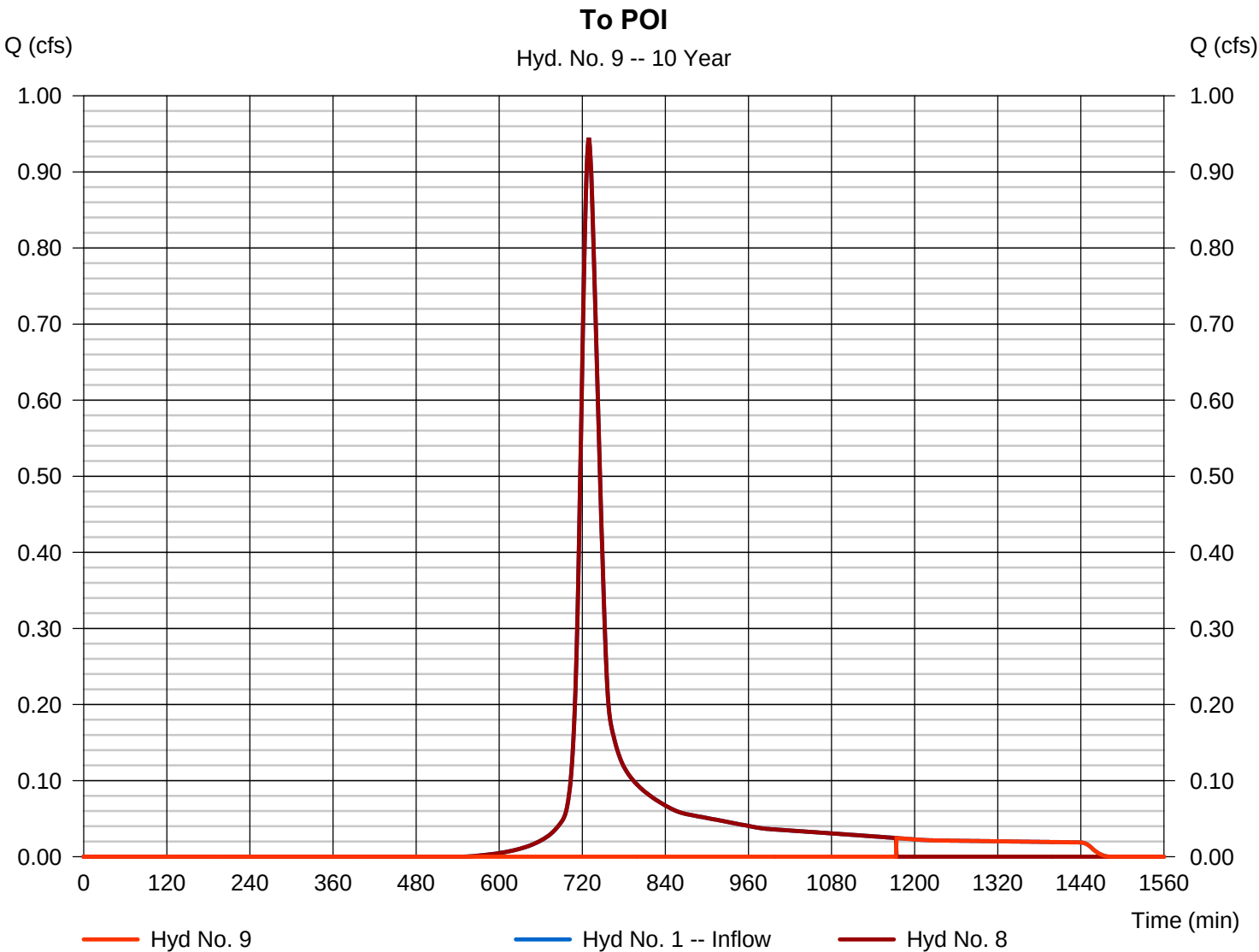
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 9

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.025 cfs
Storm frequency	=	10 yrs	Time to peak	=	1174 min
Time interval	=	1 min	Hyd. volume	=	351 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Diverted hyd.	=	8
Diversion method	=	First Flush Volume	Volume Up To	=	3,194 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

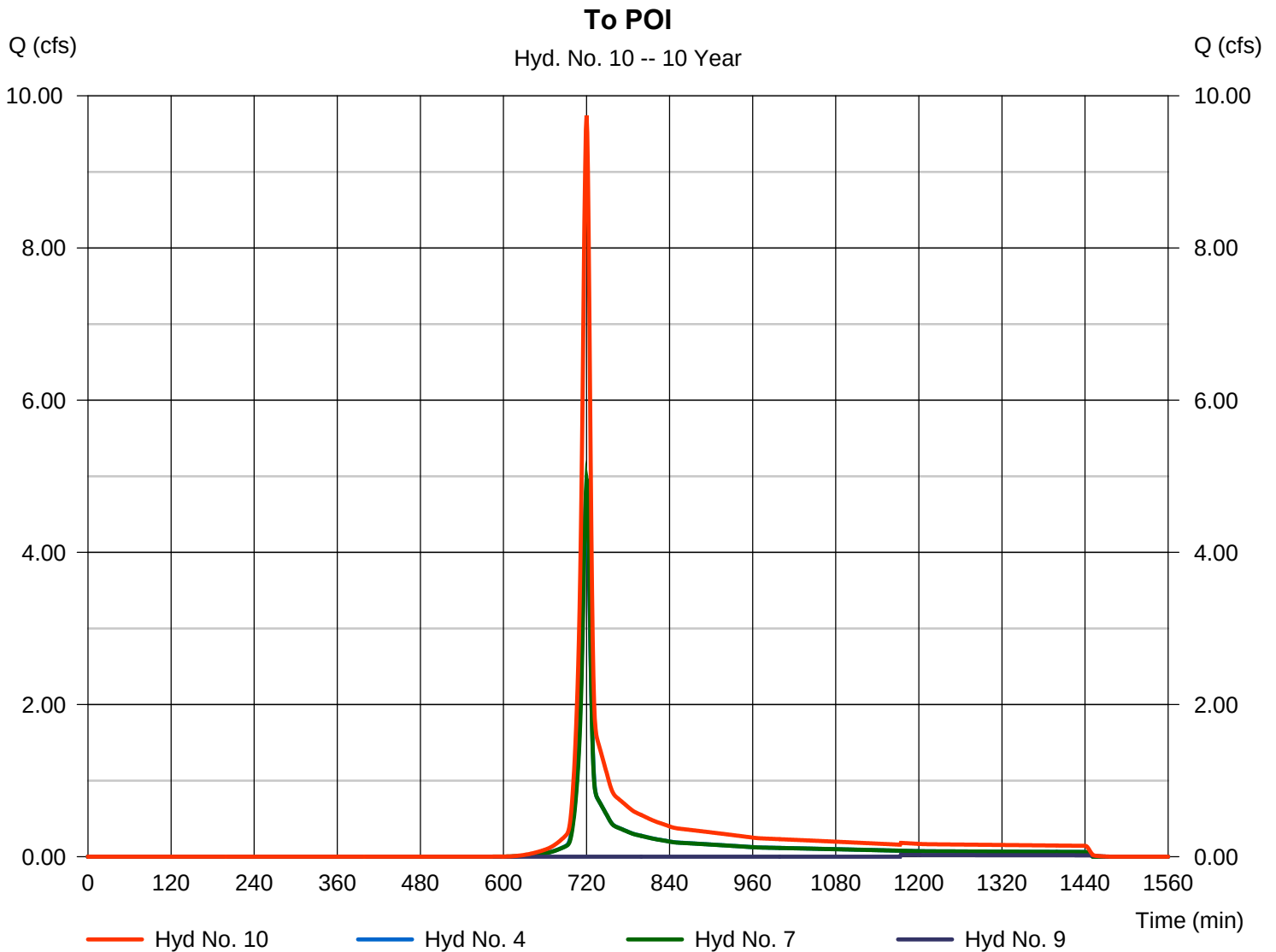
Monday, 11 / 7 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 4, 7, 9

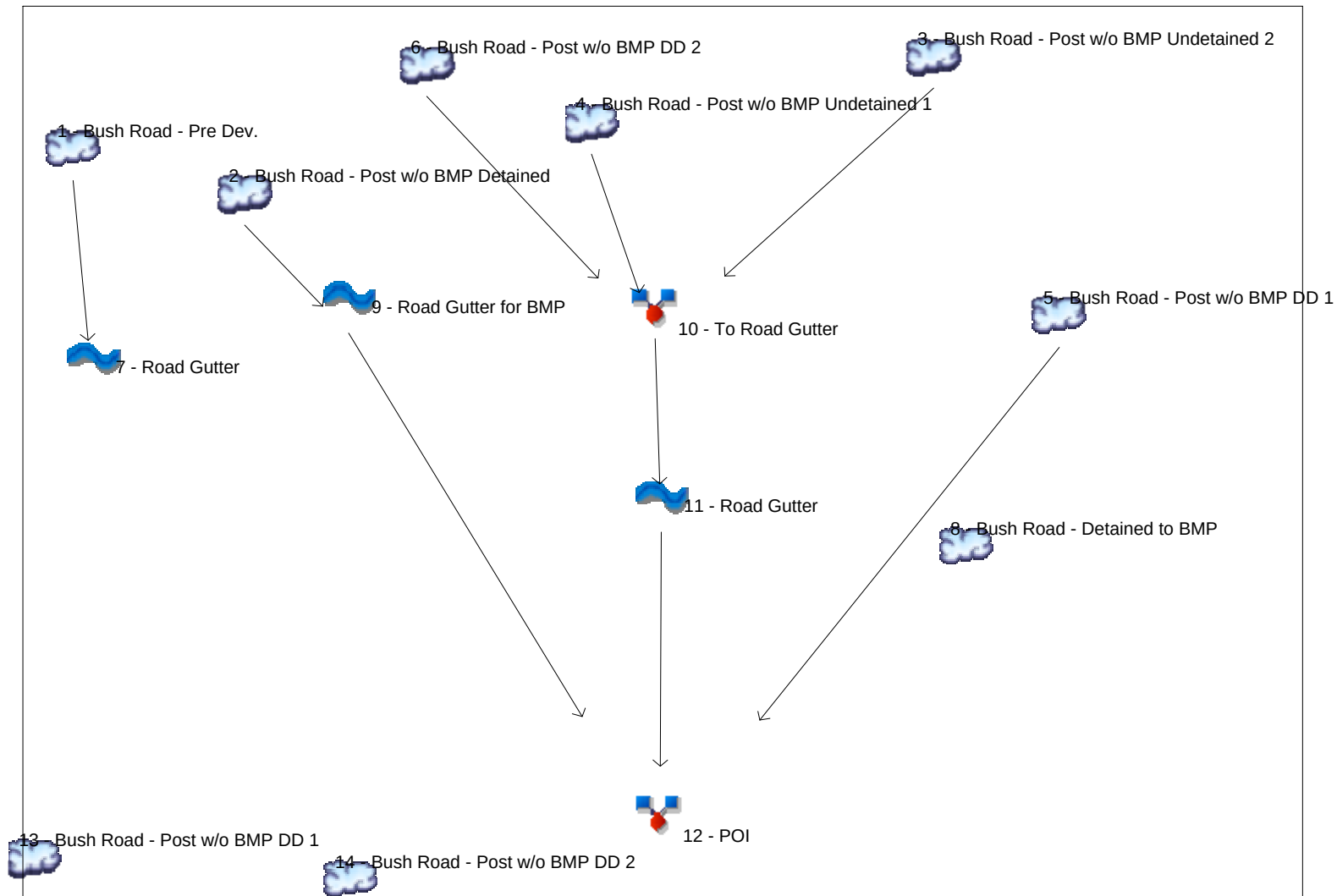
Peak discharge = 9.741 cfs
 Time to peak = 720 min
 Hyd. volume = 21,931 cuft
 Contrib. drain. area = 2.260 ac



ATTACHMENT C-3
BUSH RD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.591	-----	-----	11.46	-----	19.05	22.83	Bush Road - Pre Dev.
2	SCS Runoff	-----	-----	0.870	-----	-----	1.624	-----	2.578	3.039	Bush Road - Post w/o BMP Detained
3	SCS Runoff	-----	-----	1.441	-----	-----	3.036	-----	5.119	6.154	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	-----	-----	0.152	-----	-----	0.278	-----	0.436	0.512	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	-----	-----	2.314	-----	-----	4.778	-----	7.986	9.579	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	-----	-----	0.885	-----	-----	1.768	-----	2.903	3.464	Bush Road - Post w/o BMP DD 2
7	Reach	1	-----	5.552	-----	-----	11.44	-----	19.05	22.83	Road Gutter
8	SCS Runoff	-----	-----	0.760	-----	-----	1.396	-----	2.202	2.590	Bush Road - Detained to BMP
9	Reach	2	-----	0.828	-----	-----	1.576	-----	2.522	2.978	Road Gutter for BMP
10	Combine	3, 4, 6,	-----	2.478	-----	-----	5.081	-----	8.452	10.13	To Road Gutter
11	Reach	10	-----	2.377	-----	-----	4.962	-----	8.354	10.02	Road Gutter
12	Combine	5, 9, 11	-----	5.487	-----	-----	11.32	-----	18.85	22.54	POI
13	SCS Runoff	-----	-----	2.721	-----	-----	5.566	-----	9.243	11.05	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	-----	-----	0.985	-----	-----	1.964	-----	3.218	3.829	Bush Road - Post w/o BMP DD 2
Proj. file: Pre and Post wo BMP 2-100 yrs_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	19.05	1	719	40,289	-----	-----	-----	Bush Road - Pre Dev.
2	SCS Runoff	2.578	1	718	5,480	-----	-----	-----	Bush Road - Post w/o BMP Detained
3	SCS Runoff	5.119	1	719	10,811	-----	-----	-----	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	0.436	1	718	929	-----	-----	-----	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	7.986	1	719	18,064	-----	-----	-----	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	2.903	1	718	6,143	-----	-----	-----	Bush Road - Post w/o BMP DD 2
7	Reach	19.05	1	720	40,289	1	-----	-----	Road Gutter
8	SCS Runoff	2.202	2	718	5,052	-----	-----	-----	Bush Road - Detained to BMP
9	Reach	2.522	1	720	5,479	2	-----	-----	Road Gutter for BMP
10	Combine	8.452	1	719	17,883	3, 4, 6,	-----	-----	To Road Gutter
11	Reach	8.354	1	720	17,882	10	-----	-----	Road Gutter
12	Combine	18.85	1	720	41,425	5, 9, 11	-----	-----	POI
13	SCS Runoff	9.243	1	718	18,628	-----	-----	-----	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	3.218	1	718	6,498	-----	-----	-----	Bush Road - Post w/o BMP DD 2
Pre and Post wo BMP 2-100 yrs_chk.gpw					Return Period: 50 Year			Monday, 11 / 7 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

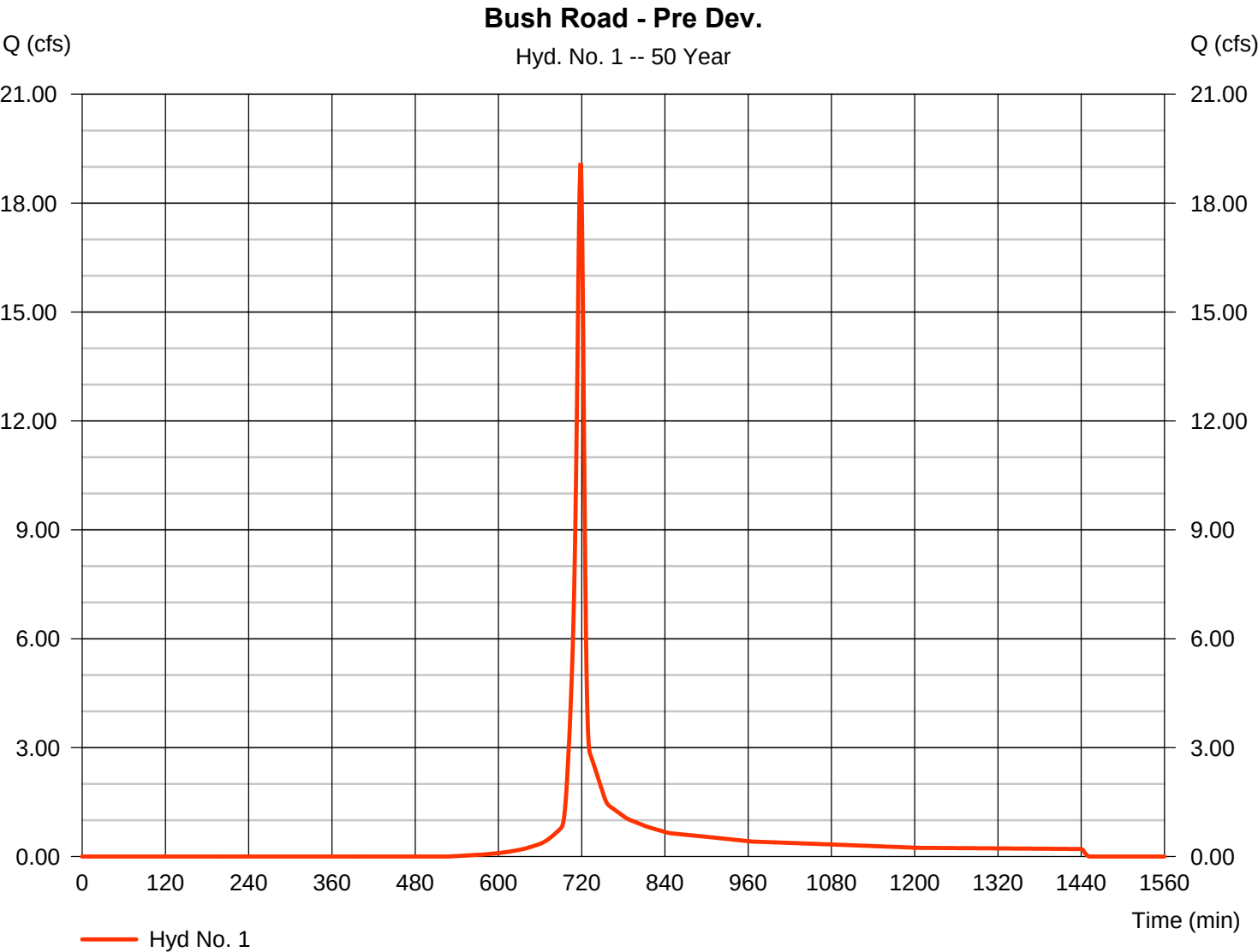
Monday, 11 / 7 / 2016

Hyd. No. 1

Bush Road - Pre Dev.

Hydrograph type	=	SCS Runoff	Peak discharge	=	19.05 cfs
Storm frequency	=	50 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	40,289 cuft
Drainage area	=	5.170 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.370 x 78) + (1.350 x 70) + (0.060 x 91) + (0.390 x 77)] / 5.170



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Bush Road - Pre Dev.

<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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 243.00	800.00	0.00	
Watercourse slope (%)	= 24.00	10.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=7.90	5.10	0.00	
Travel Time (min)	= 0.51	+	2.61	+
			0.00	= 3.13
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				7.80 min

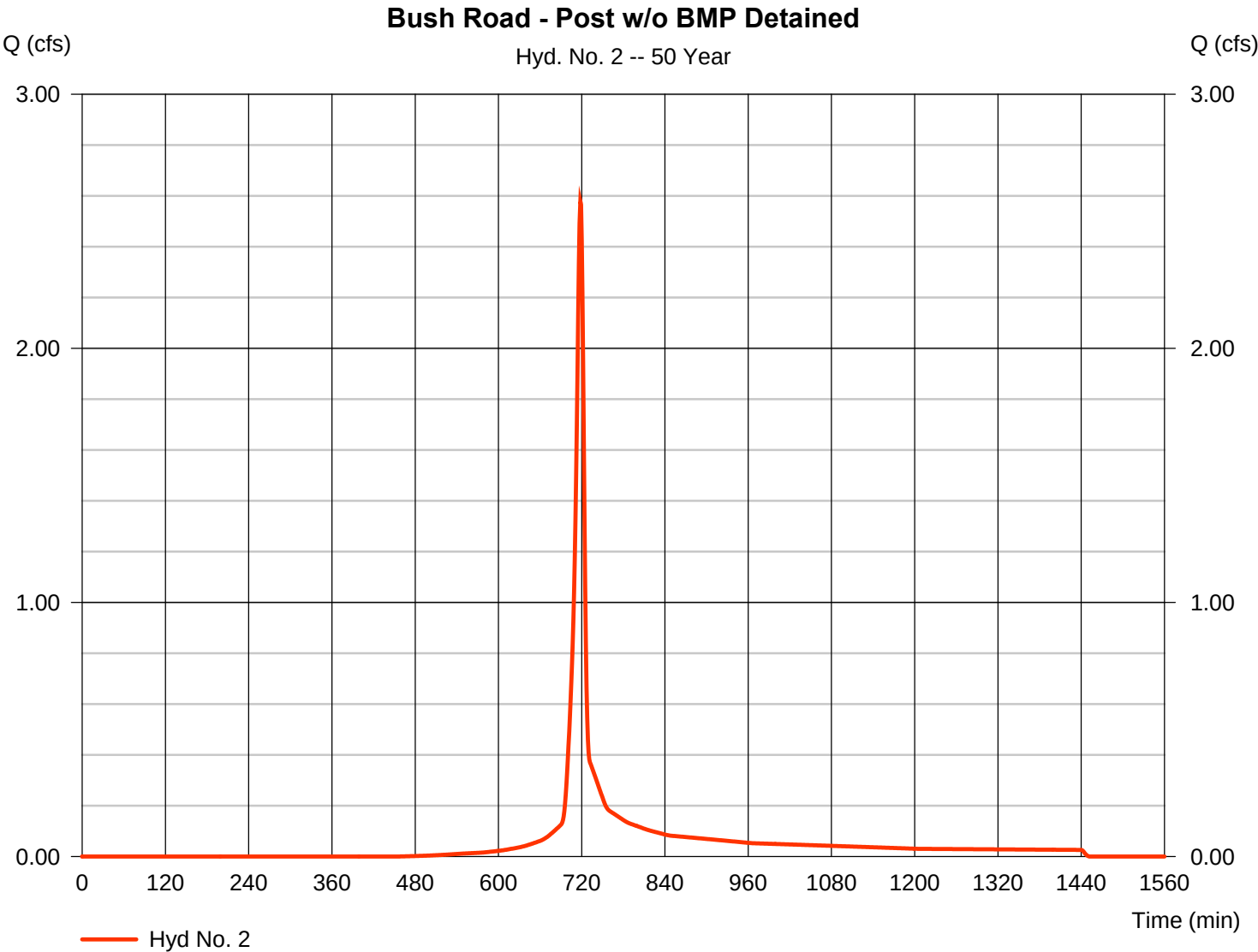
Hydrograph Report

Hyd. No. 2

Bush Road - Post w/o BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.578 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	5,480 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w/o BMP Detained

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	629.00	75.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	2.17	+	0.27	=	2.79
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

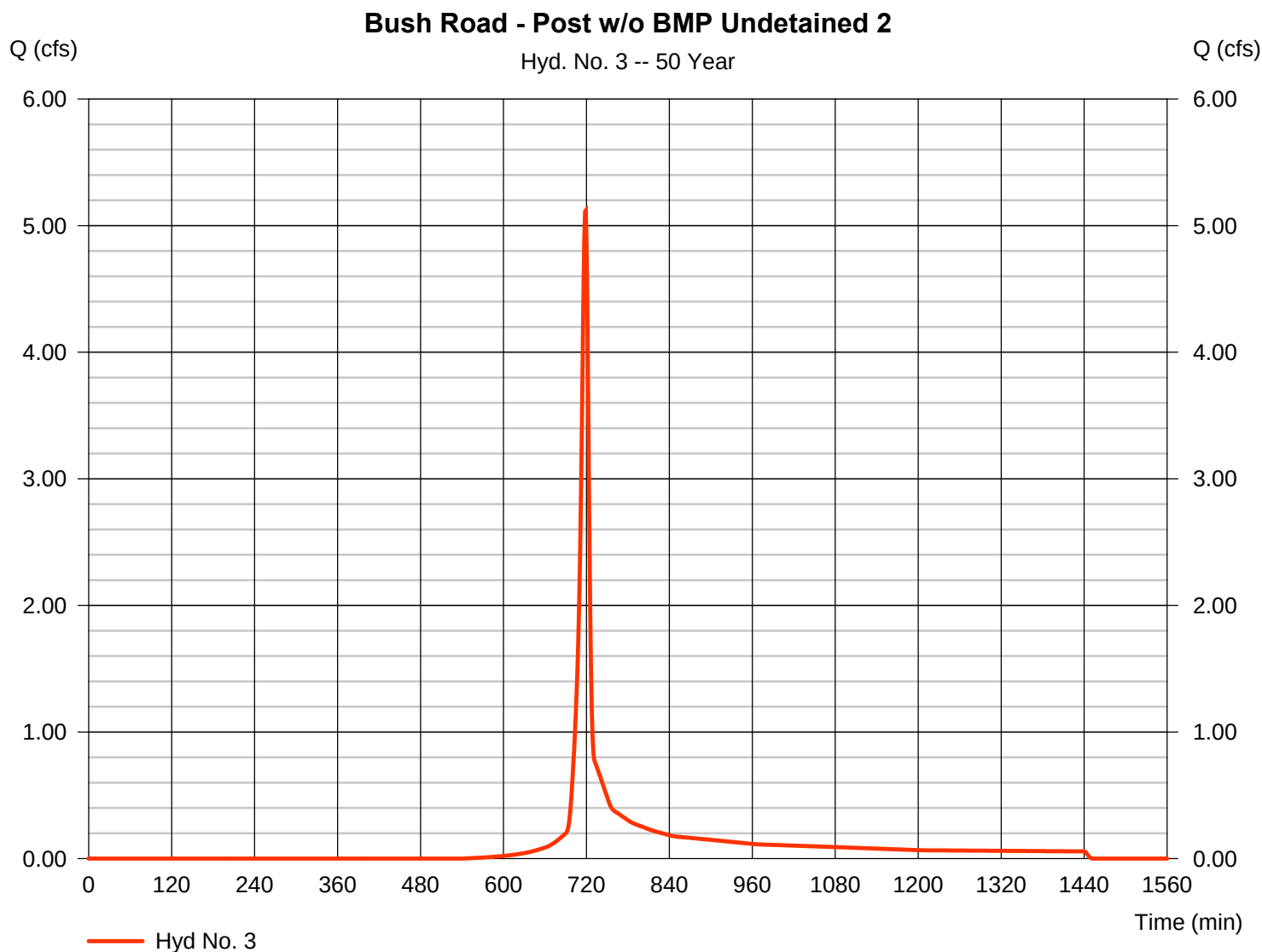
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.119 cfs
Storm frequency	=	50 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	10,811 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

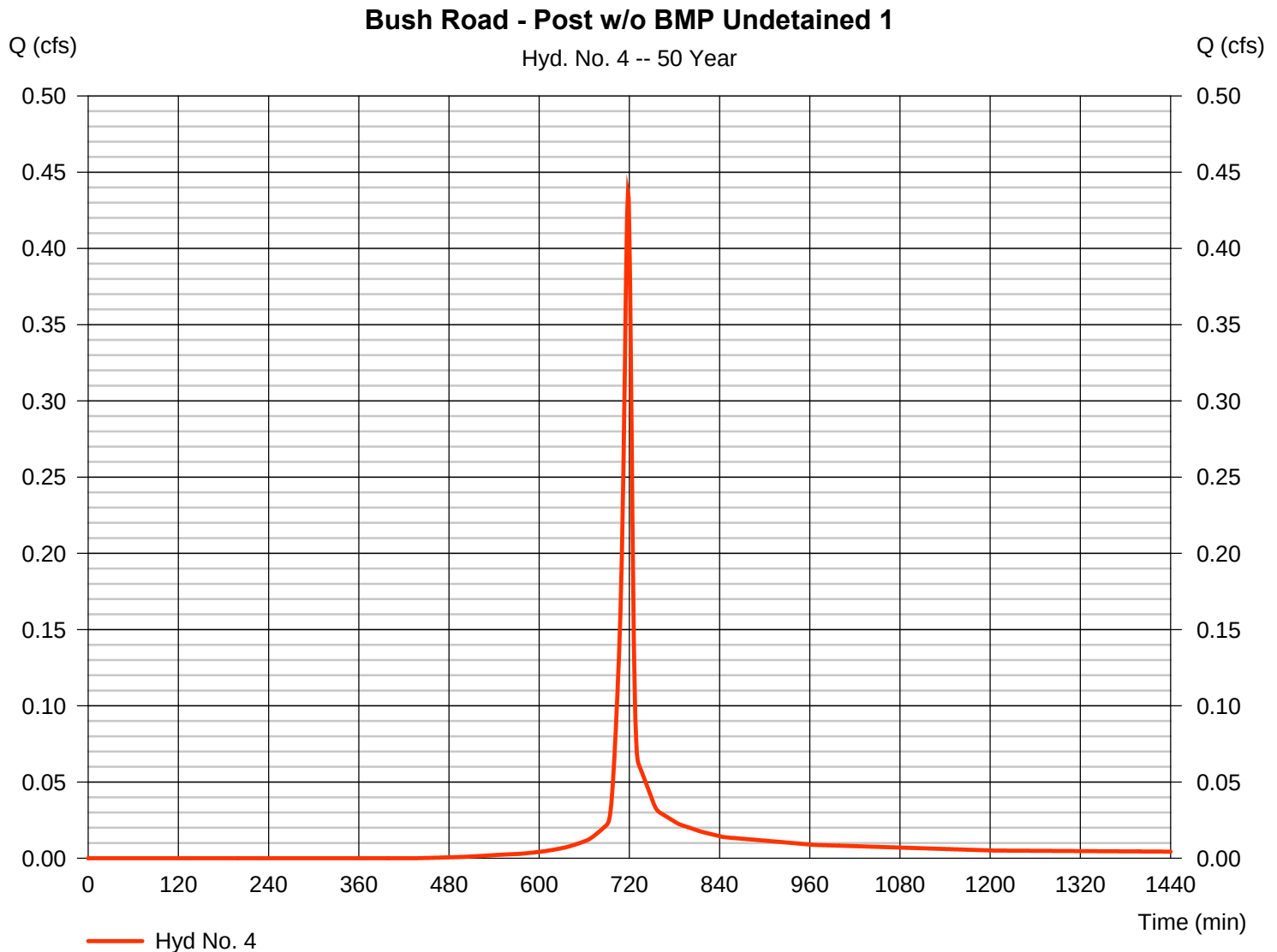
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.436 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	929 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

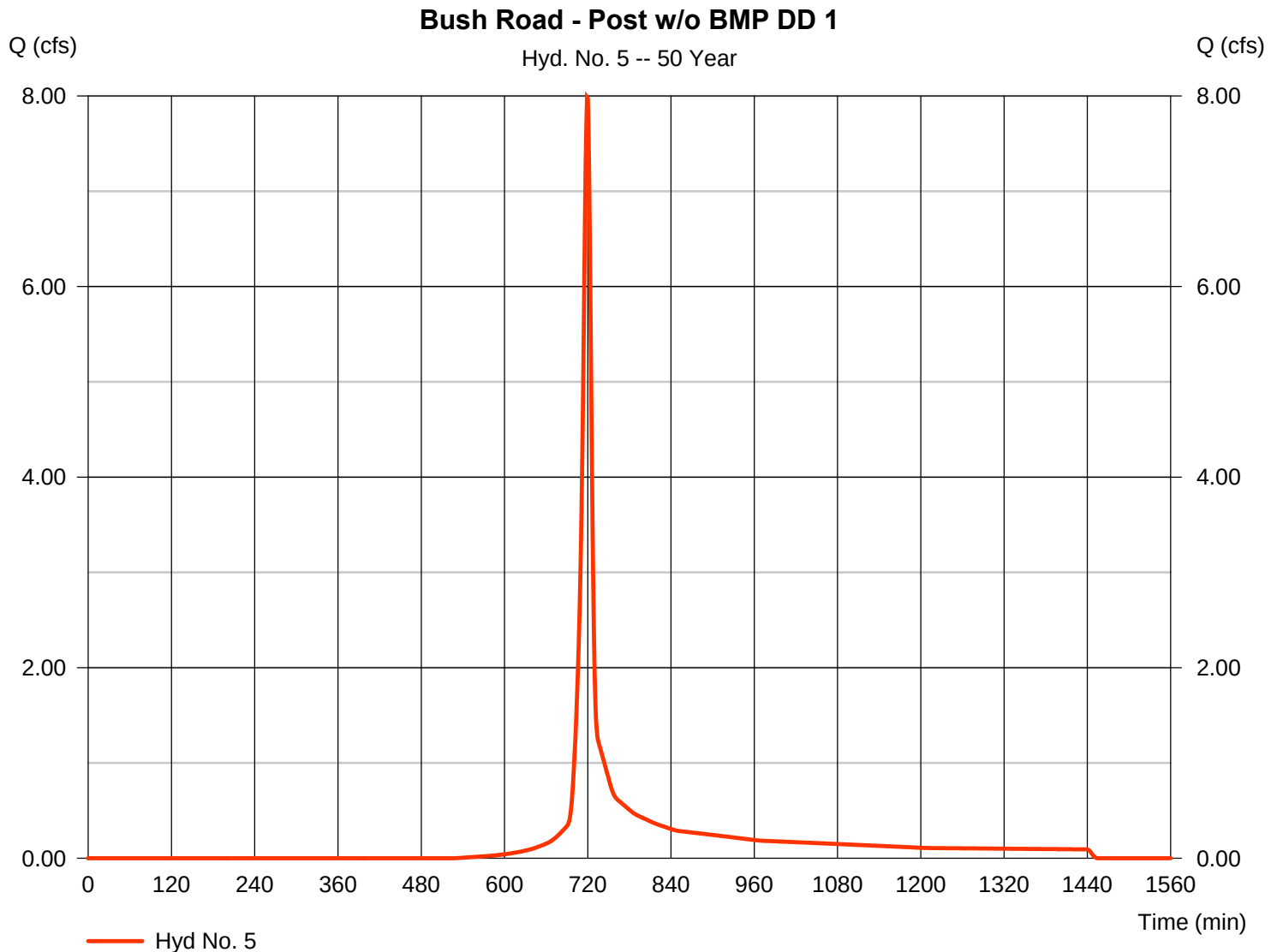
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.986 cfs
Storm frequency	=	50 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	18,064 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

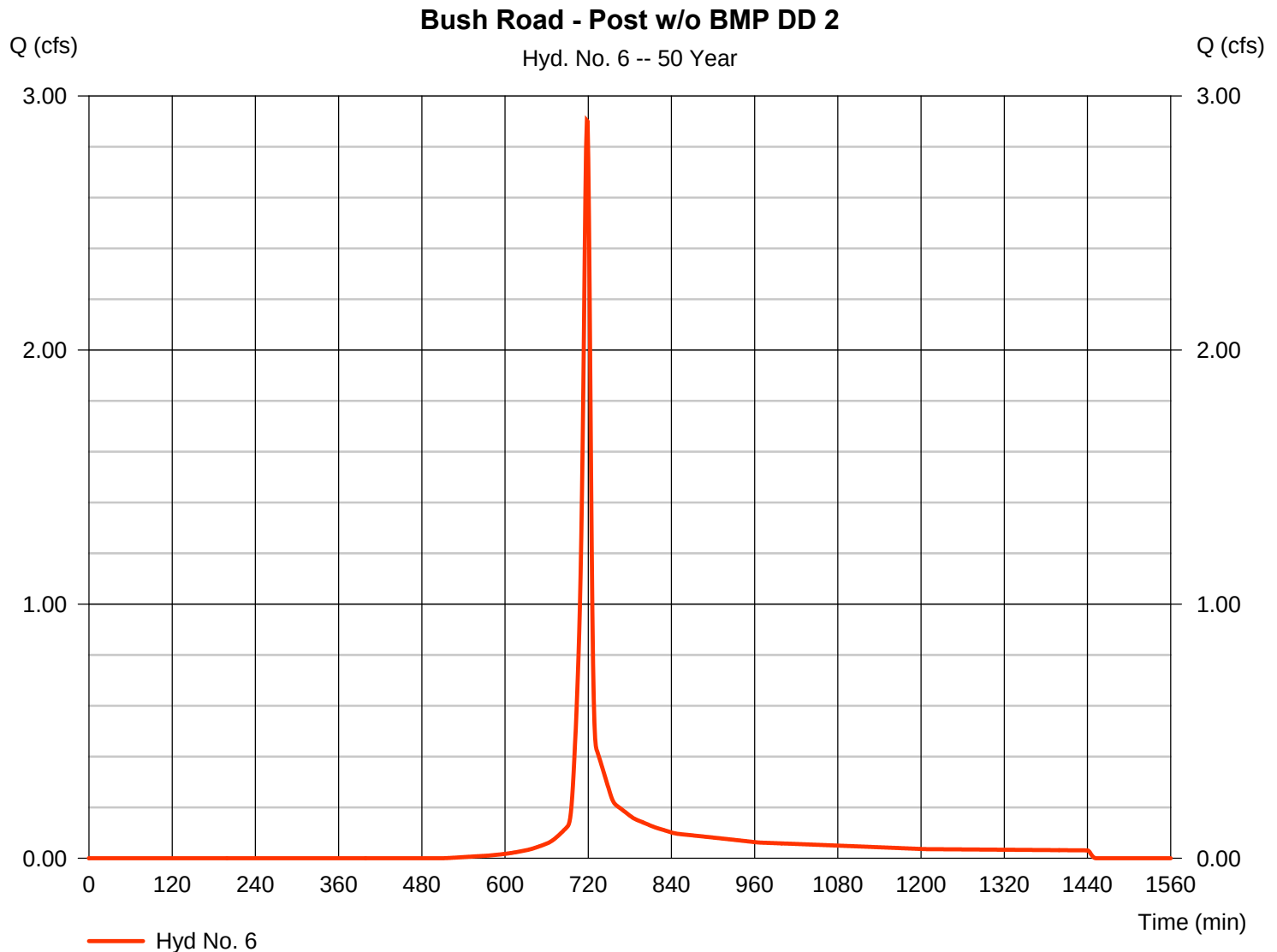
Monday, 11 / 7 / 2016

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.903 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	6,143 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc					6.70 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

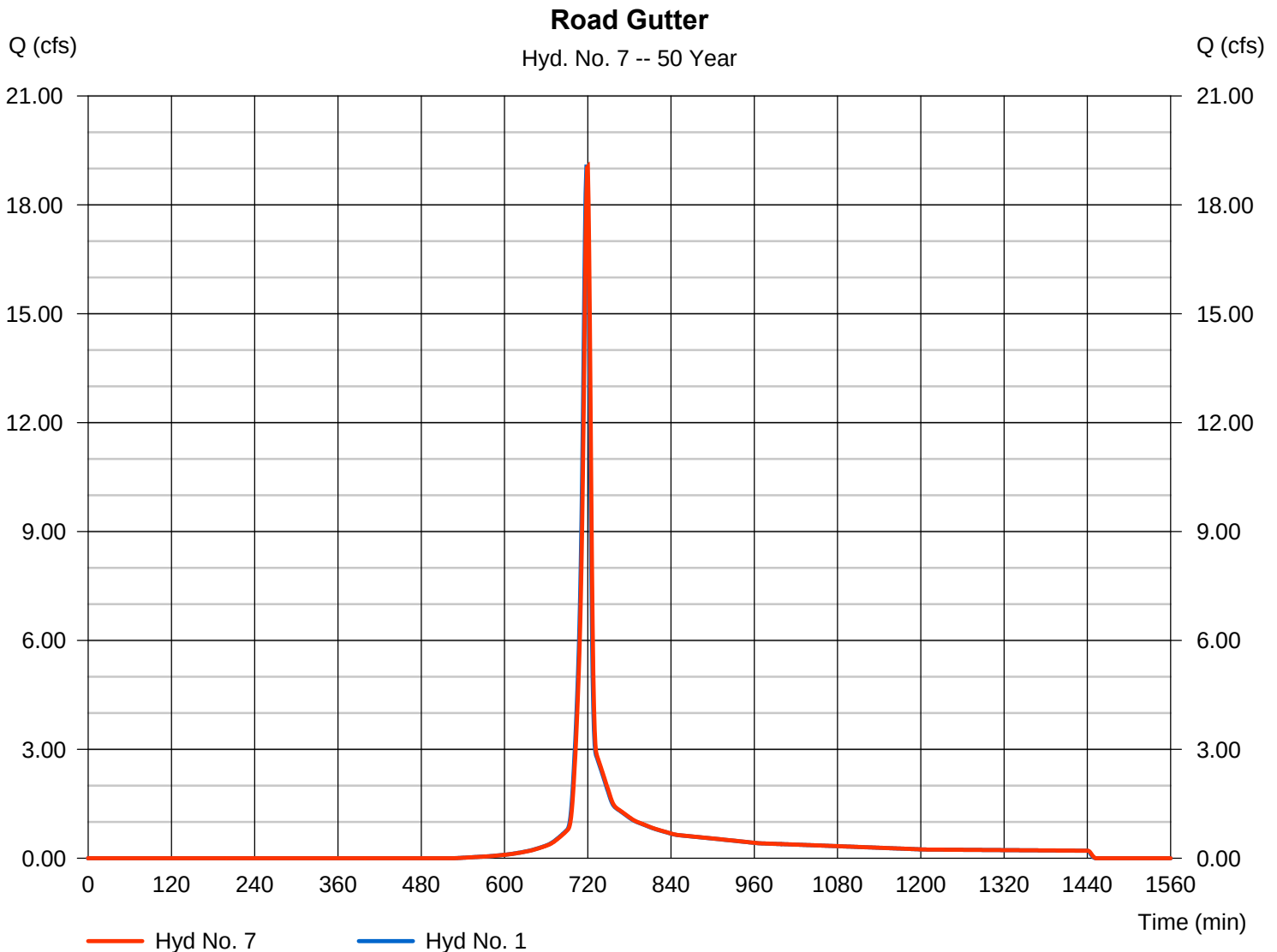
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 19.05 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 40,289 cuft
Inflow hyd. No.	= 1 - Bush Road - Pre Dev.	Section type	= Triangular
Reach length	= 265.0 ft	Channel slope	= 3.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.308	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.9707

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

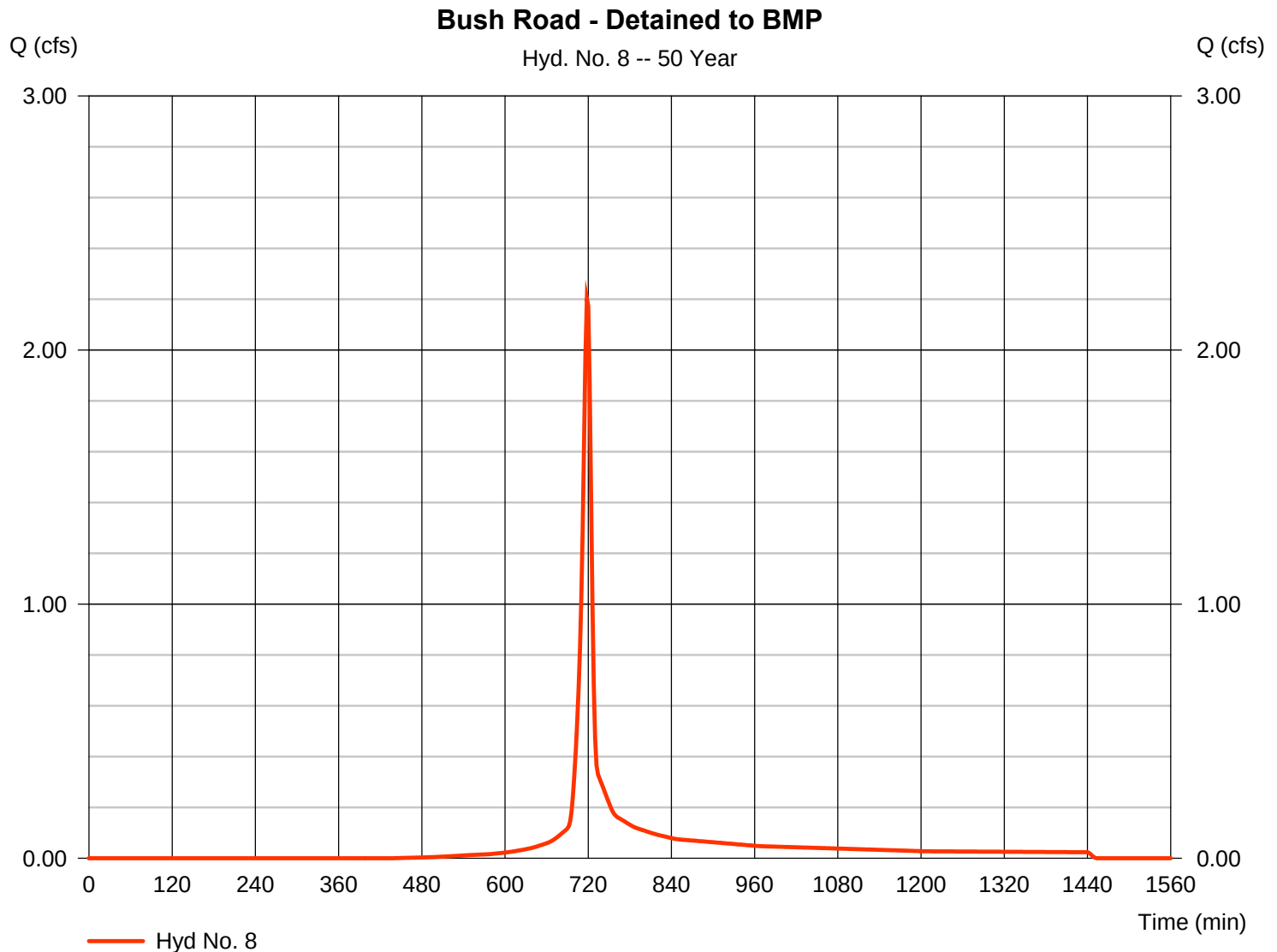
Monday, 11 / 7 / 2016

Hyd. No. 8

Bush Road - Detained to BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.202 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	5,052 cuft
Drainage area	=	0.530 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.010 \times 77) + (0.360 \times 78) + (0.130 \times 91)] / 0.530$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 8

Bush Road - Detained to BMP

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	535.00	70.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	1.84	+	0.26	=	2.45
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc					6.60 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

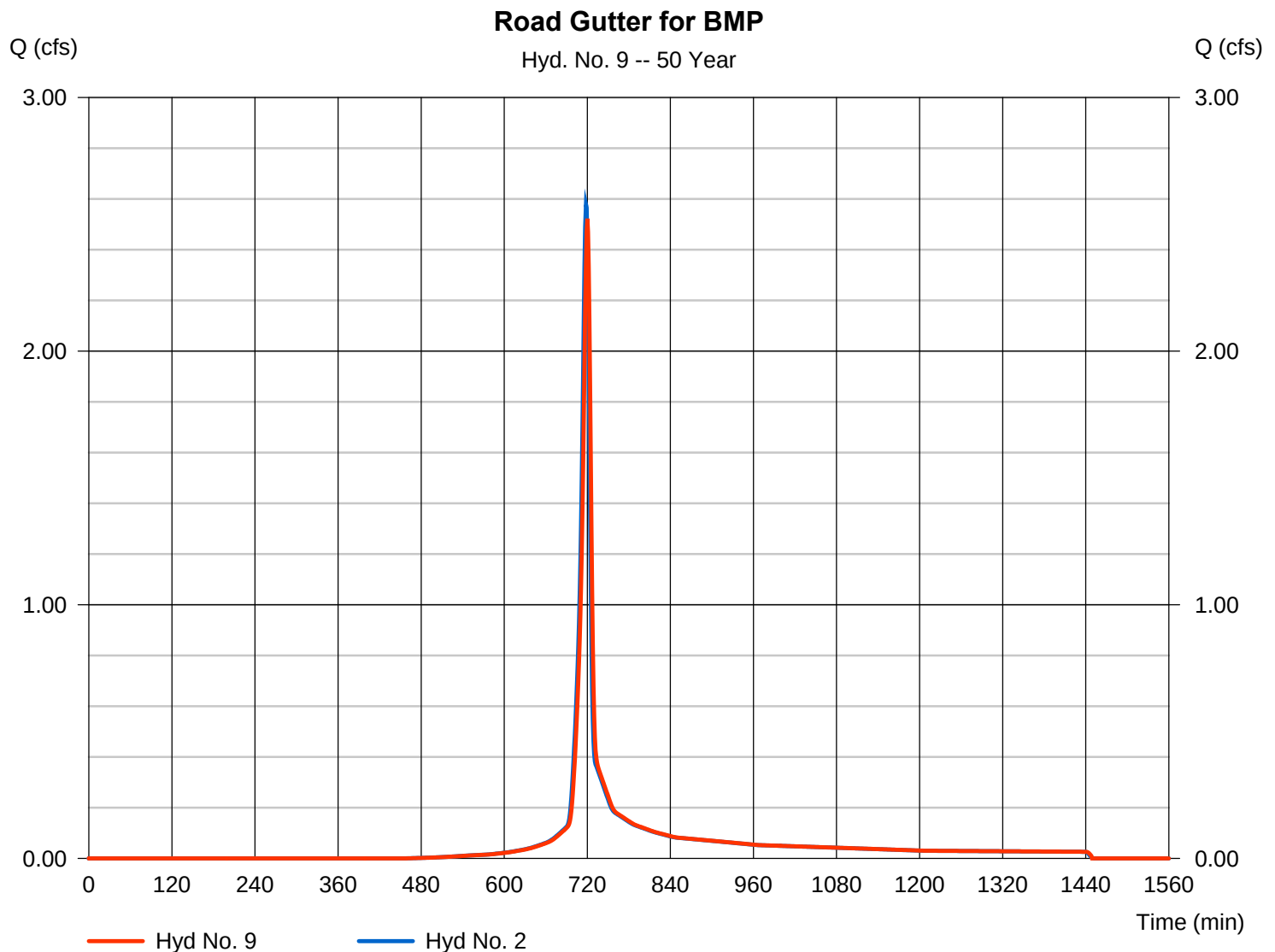
Monday, 11 / 7 / 2016

Hyd. No. 9

Road Gutter for BMP

Hydrograph type	= Reach	Peak discharge	= 2.522 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 5,479 cuft
Inflow hyd. No.	= 2 - Bush Road - Post w/o BMP	Section type	= Triangular
Reach length	= 450.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5457

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

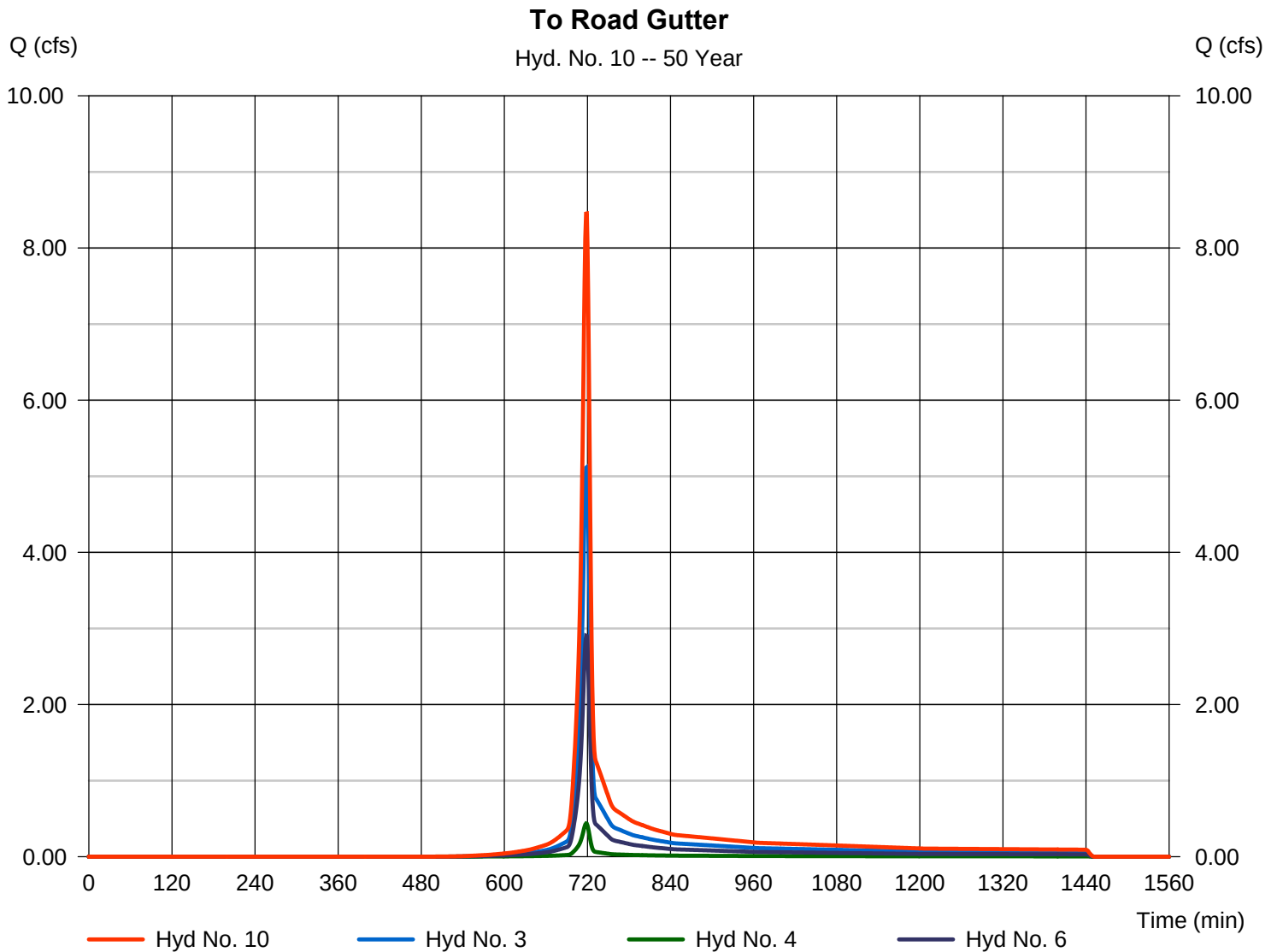
Monday, 11 / 7 / 2016

Hyd. No. 10

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 3, 4, 6

Peak discharge = 8.452 cfs
 Time to peak = 719 min
 Hyd. volume = 17,883 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

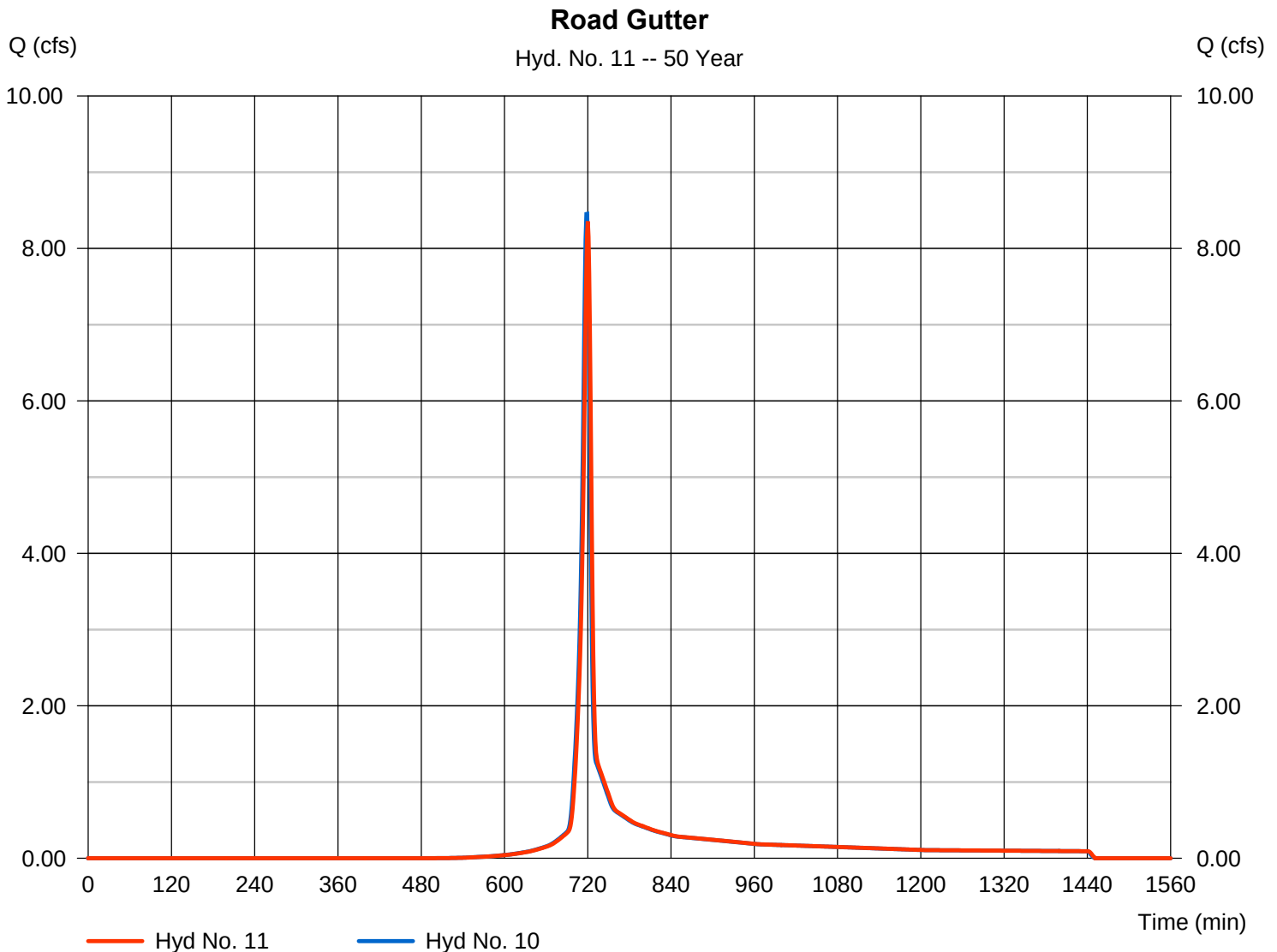
Monday, 11 / 7 / 2016

Hyd. No. 11

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 8.354 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 17,882 cuft
Inflow hyd. No.	= 10 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.6249

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

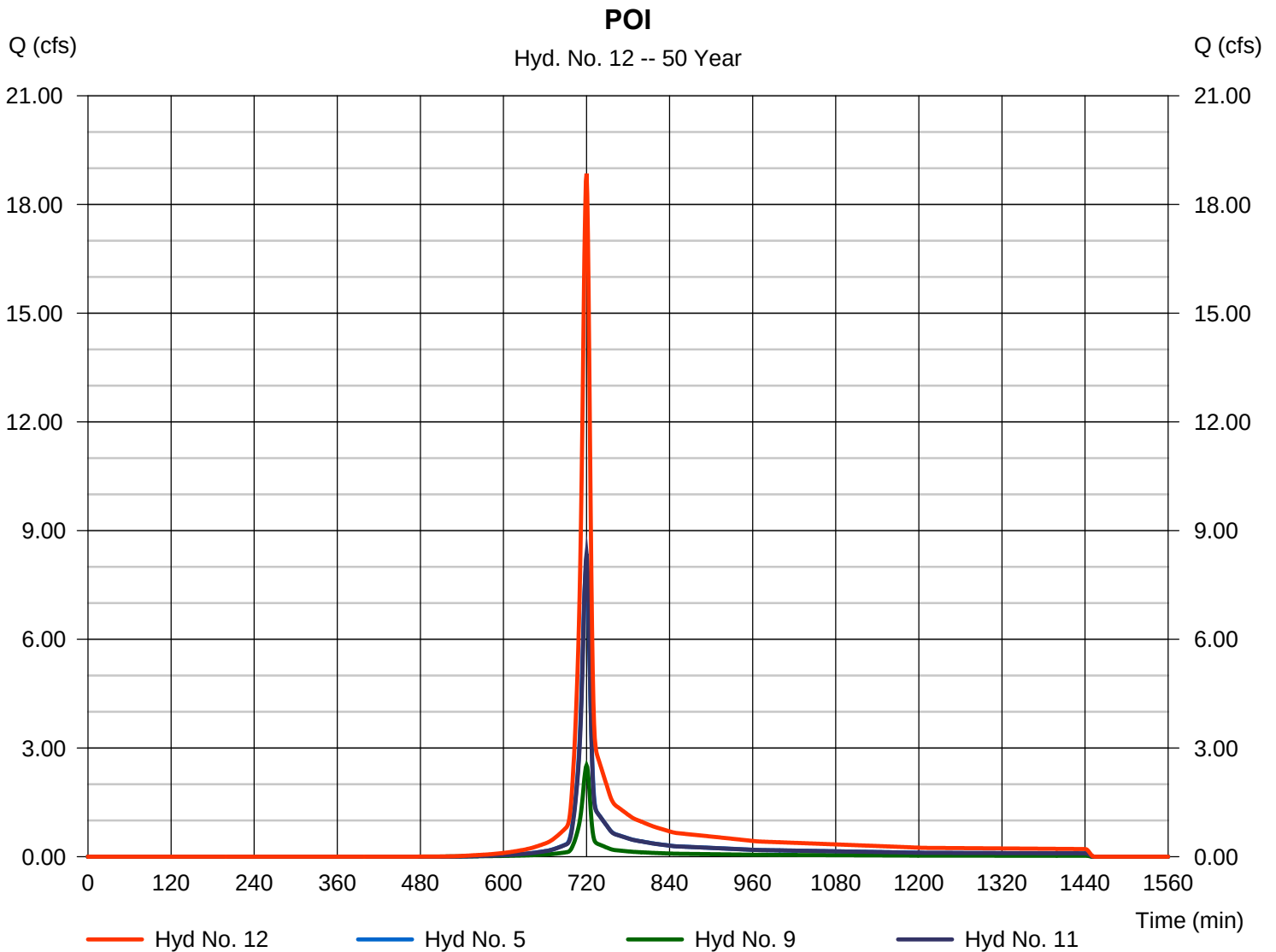
Monday, 11 / 7 / 2016

Hyd. No. 12

POI

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 5, 9, 11

Peak discharge = 18.85 cfs
 Time to peak = 720 min
 Hyd. volume = 41,425 cuft
 Contrib. drain. area = 2.260 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

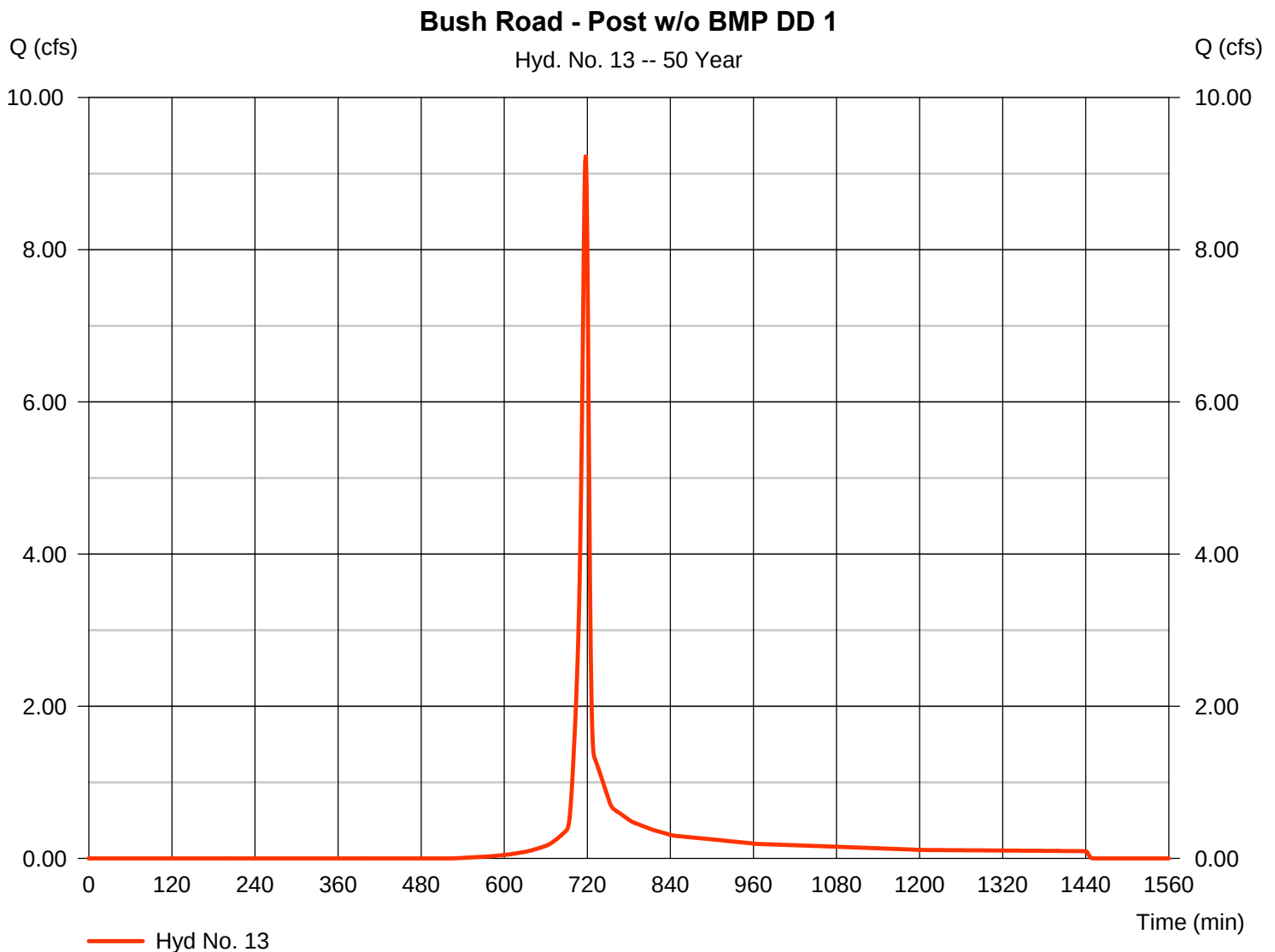
Monday, 11 / 7 / 2016

Hyd. No. 13

Bush Road - Post w/o BMP DD 1

Hydrograph type	= SCS Runoff	Peak discharge	= 9.243 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 18,628 cuft
Drainage area	= 2.260 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.50 min
Total precip.	= 4.59 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 13

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 280.00	385.00	0.00	
Watercourse slope (%)	= 23.00	10.00	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=7.74	5.10	0.00	
Travel Time (min)	= 0.60	+	1.26	+
			0.00	= 1.86
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	= 0.060	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				6.50 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

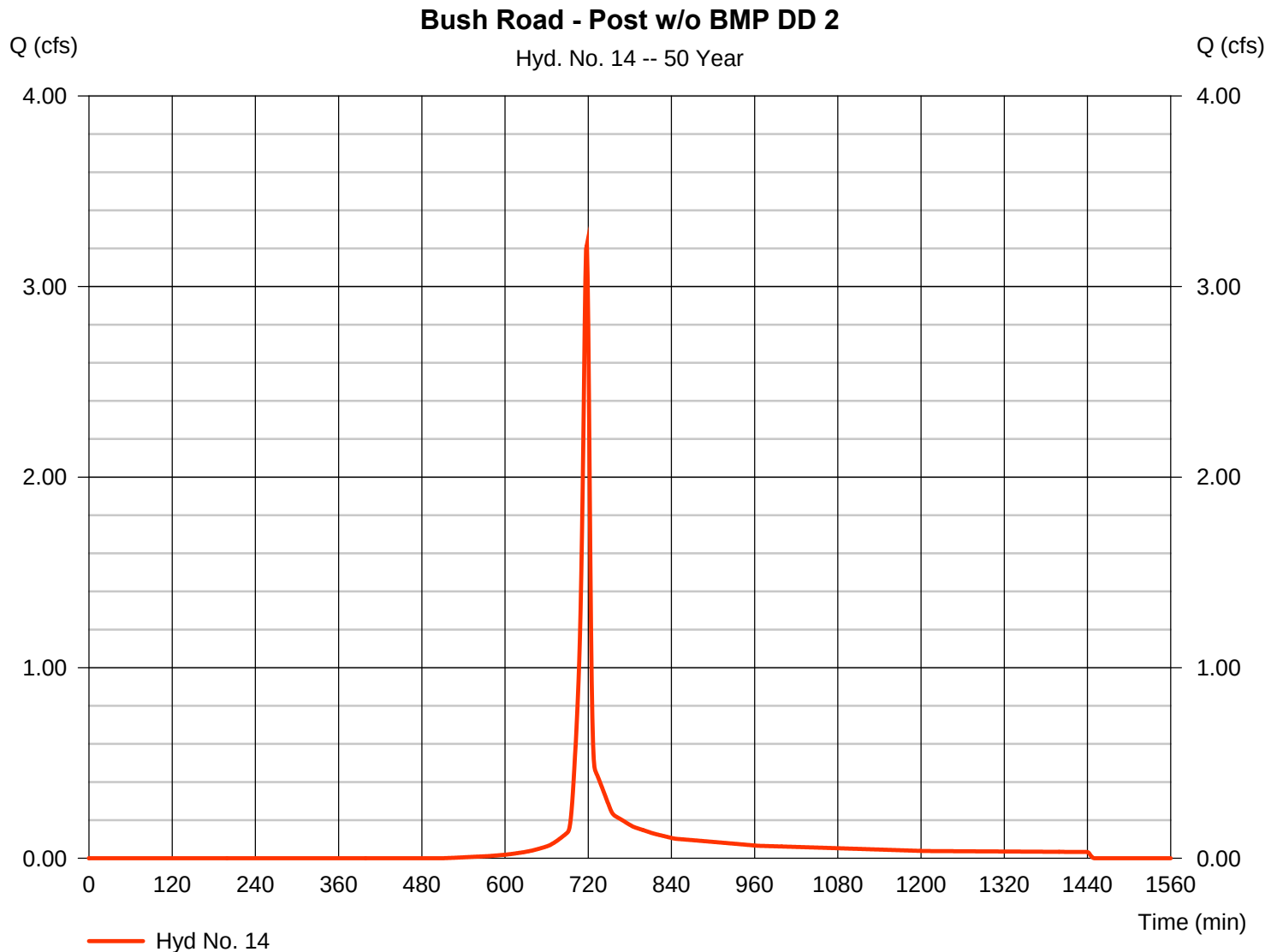
Monday, 11 / 7 / 2016

Hyd. No. 14

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.218 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	6,498 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

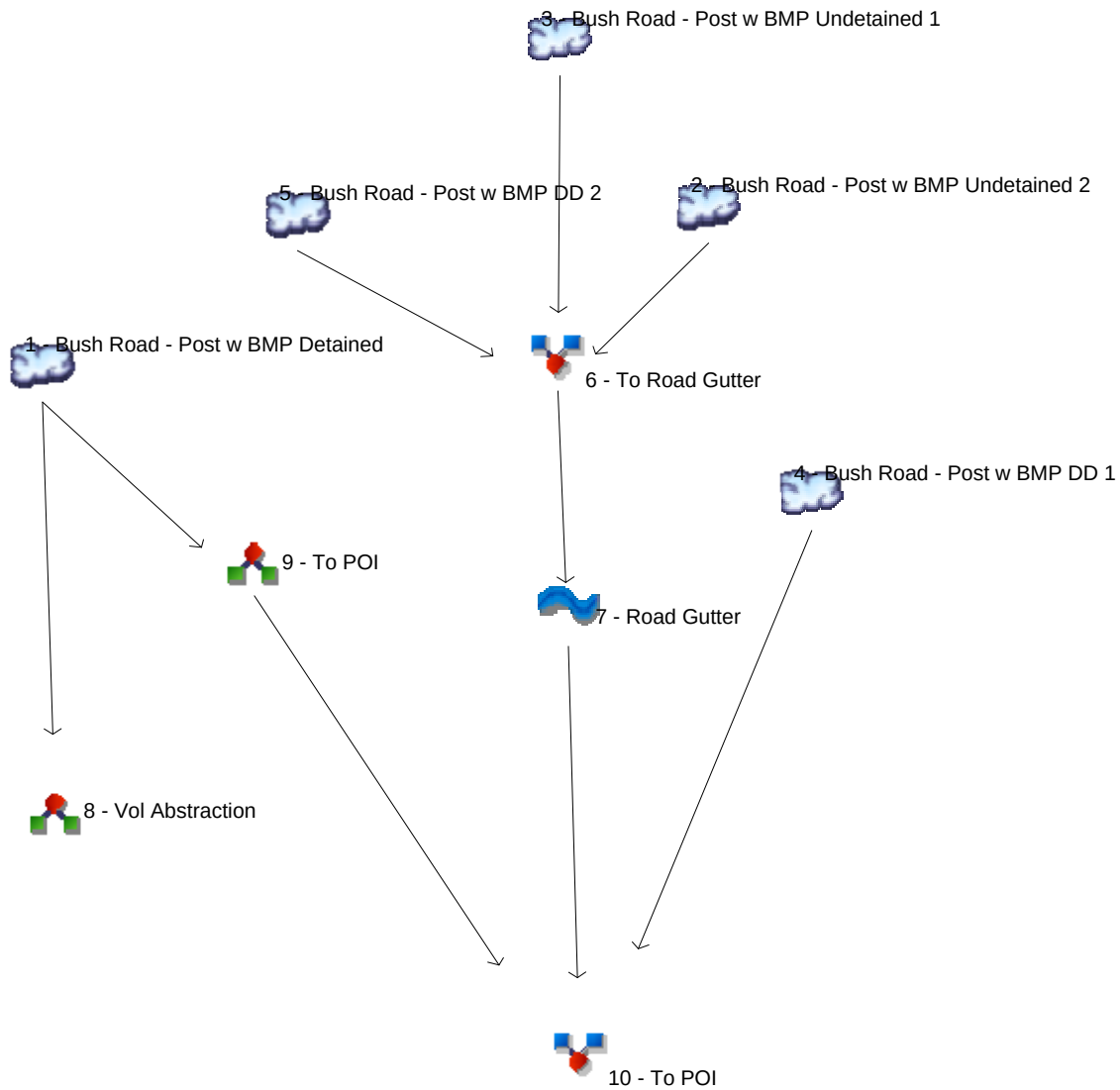
Hyd. No. 14

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
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	= 0.060	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				6.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.522	1.804	Bush Road - Post w BMP Detained
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	5.119	6.154	Bush Road - Post w BMP Undetained
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.436	0.512	Bush Road - Post w BMP Undetained
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	7.986	9.579	Bush Road - Post w BMP DD 1
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.903	3.464	Bush Road - Post w BMP DD 2
6	Combine	2, 3, 5	-----	-----	-----	-----	-----	-----	8.452	10.13	To Road Gutter
7	Reach	6	-----	-----	-----	-----	-----	-----	8.354	10.02	Road Gutter
8	Diversion1	1	-----	-----	-----	-----	-----	-----	1.522	1.804	Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	-----	-----	0.055	0.140	To POI
10	Combine	4, 7, 9	-----	-----	-----	-----	-----	-----	16.33	19.57	To POI
Proj. file: Post w BMP 50-100 yr_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.522	1	729	5,665	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	5.119	1	719	10,811	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	0.436	1	718	929	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	7.986	1	719	18,064	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	2.903	1	718	6,143	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	8.452	1	719	17,883	2, 3, 5	-----	-----	To Road Gutter
7	Reach	8.354	1	720	17,882	6	-----	-----	Road Gutter
8	Diversion1	1.522	1	729	4,626	1	-----	-----	Vol Abstraction
9	Diversion2	0.055	1	979	1,039	1	-----	-----	To POI
10	Combine	16.33	1	720	36,985	4, 7, 9	-----	-----	To POI
Post w BMP 50-100 yr_chk.gpw					Return Period: 50 Year			Monday, 11 / 7 / 2016	

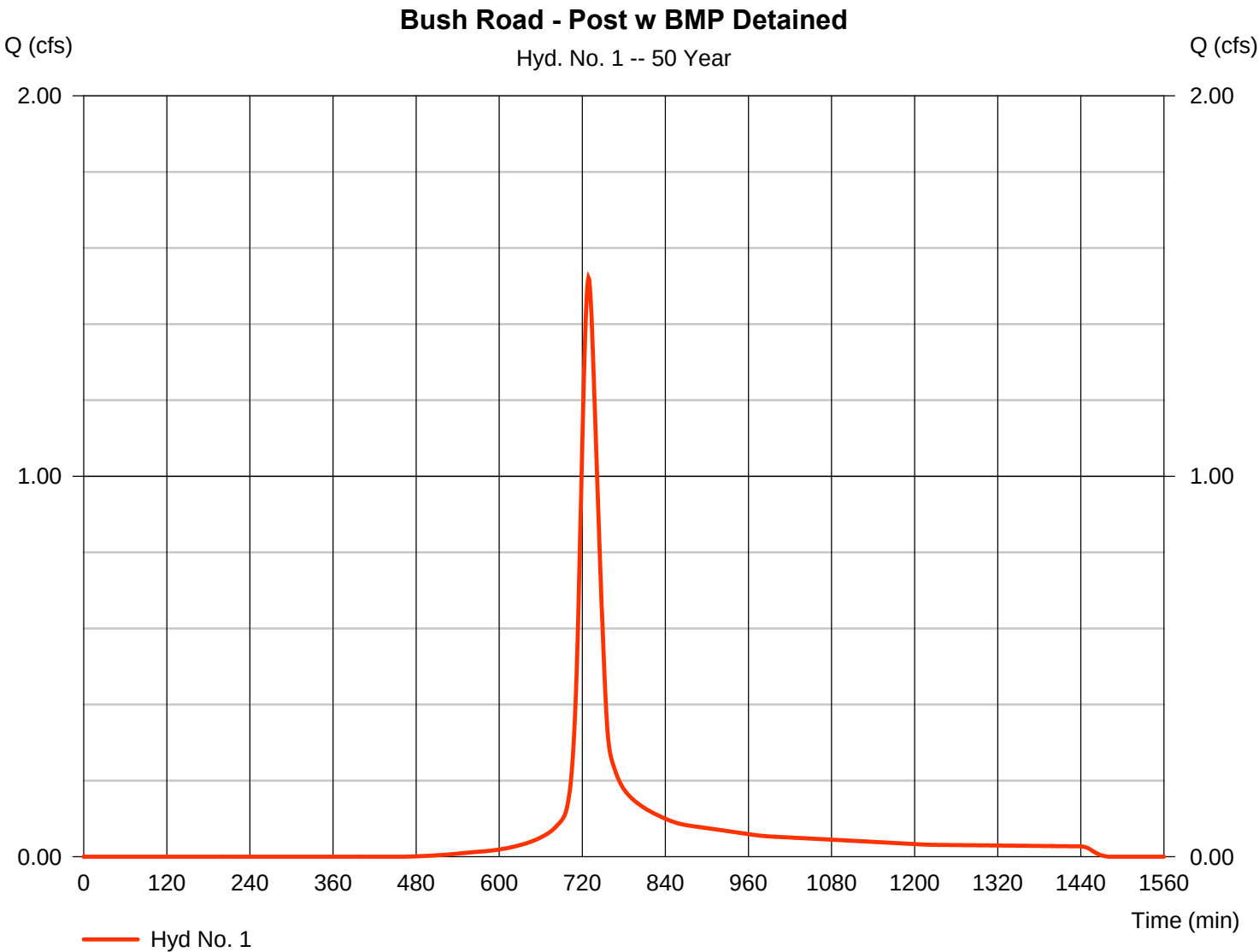
Hydrograph Report

Hyd. No. 1

Bush Road - Post w BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.522 cfs
Storm frequency	=	50 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	5,665 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	25.80 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

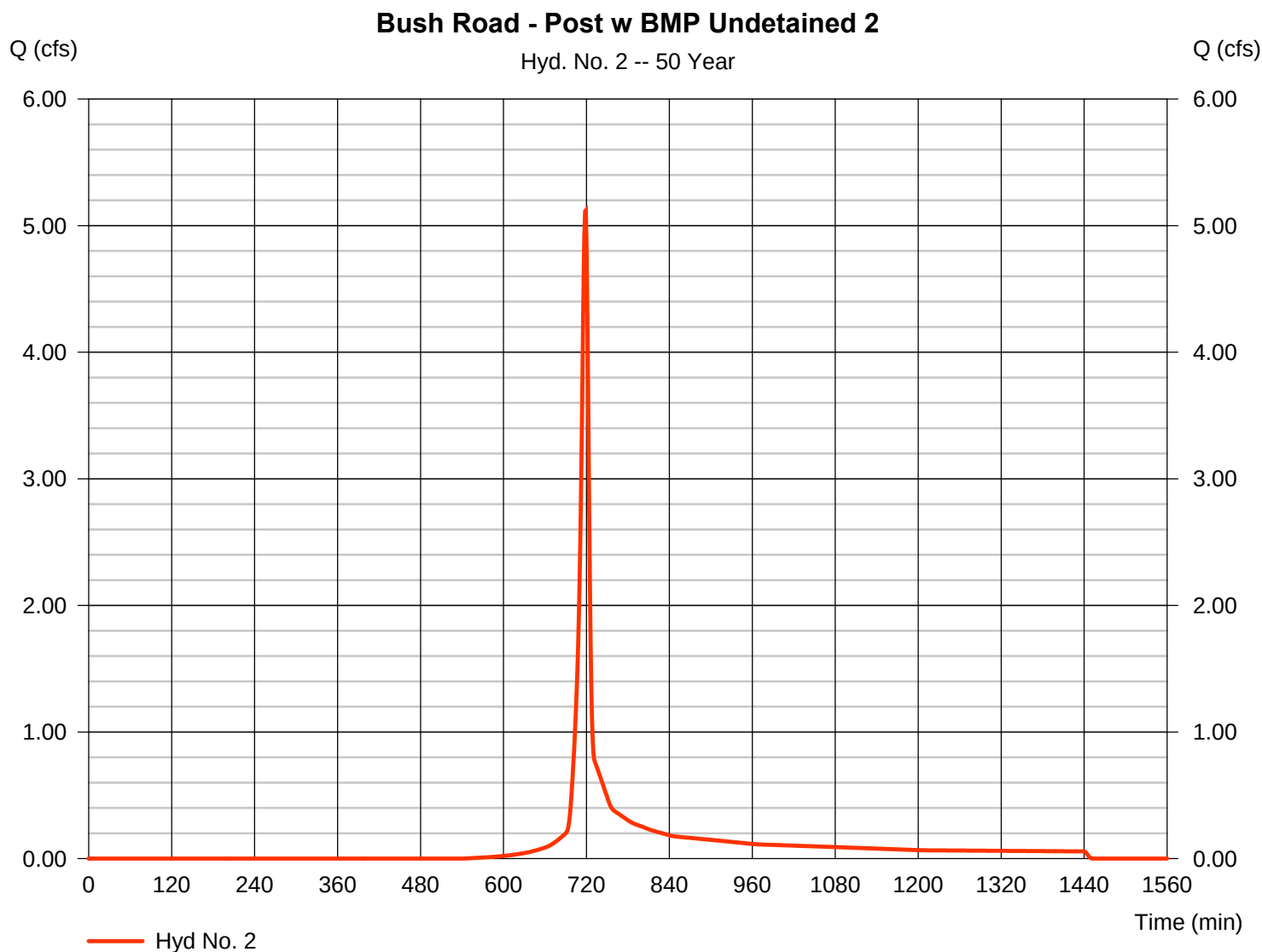
Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.119 cfs
Storm frequency	=	50 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	10,811 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

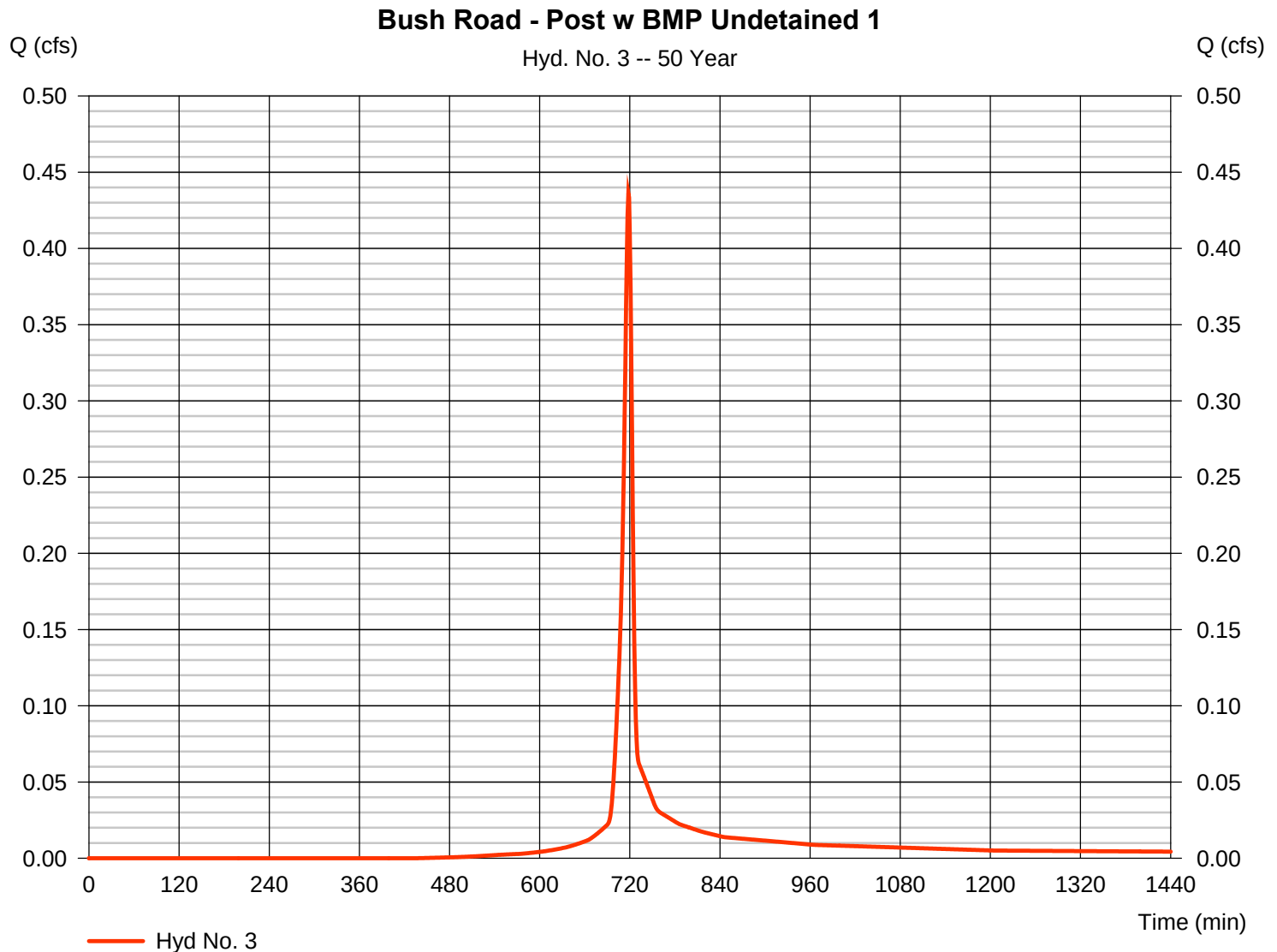
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.436 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	929 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

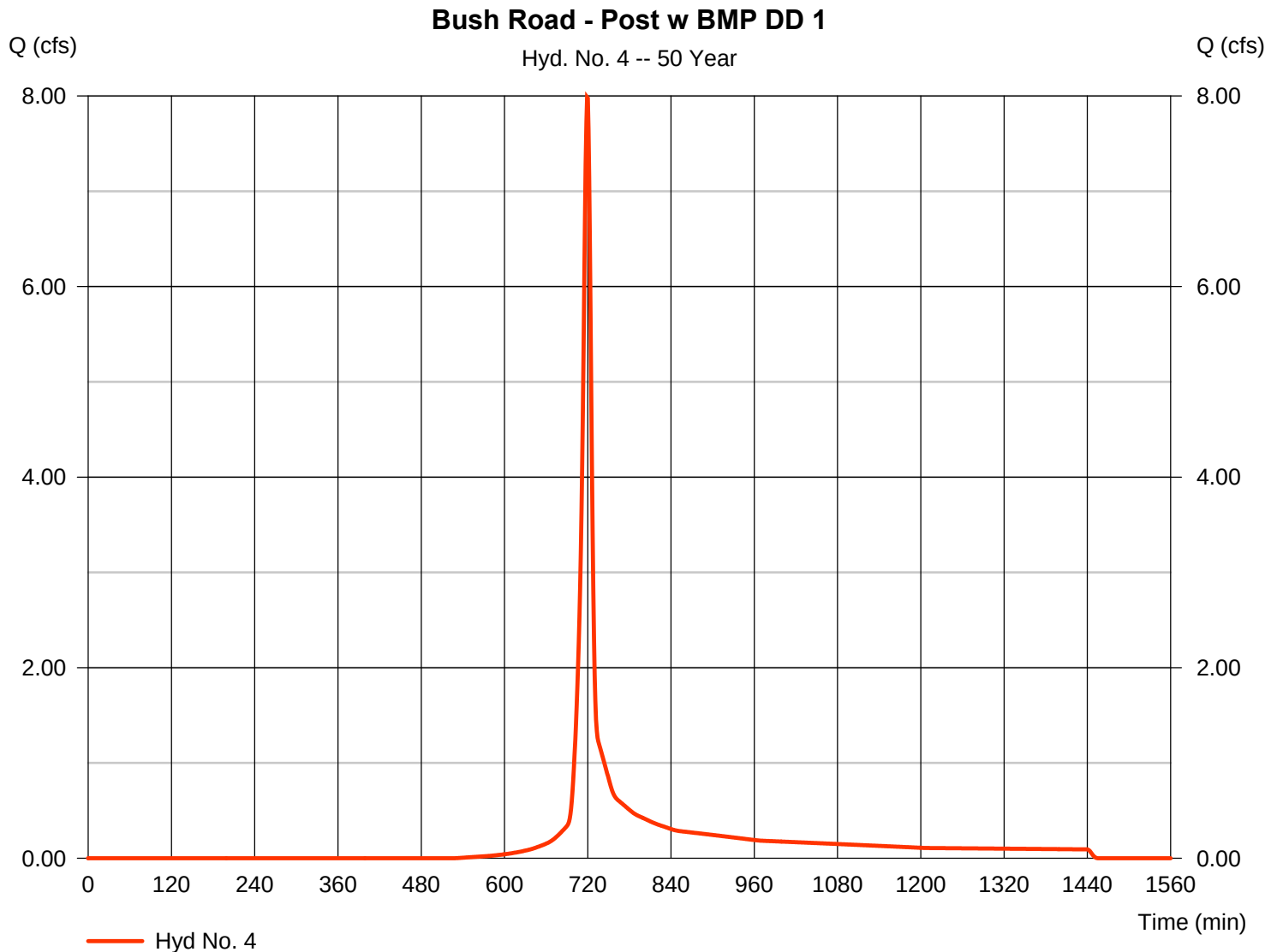
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.986 cfs
Storm frequency	=	50 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	18,064 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

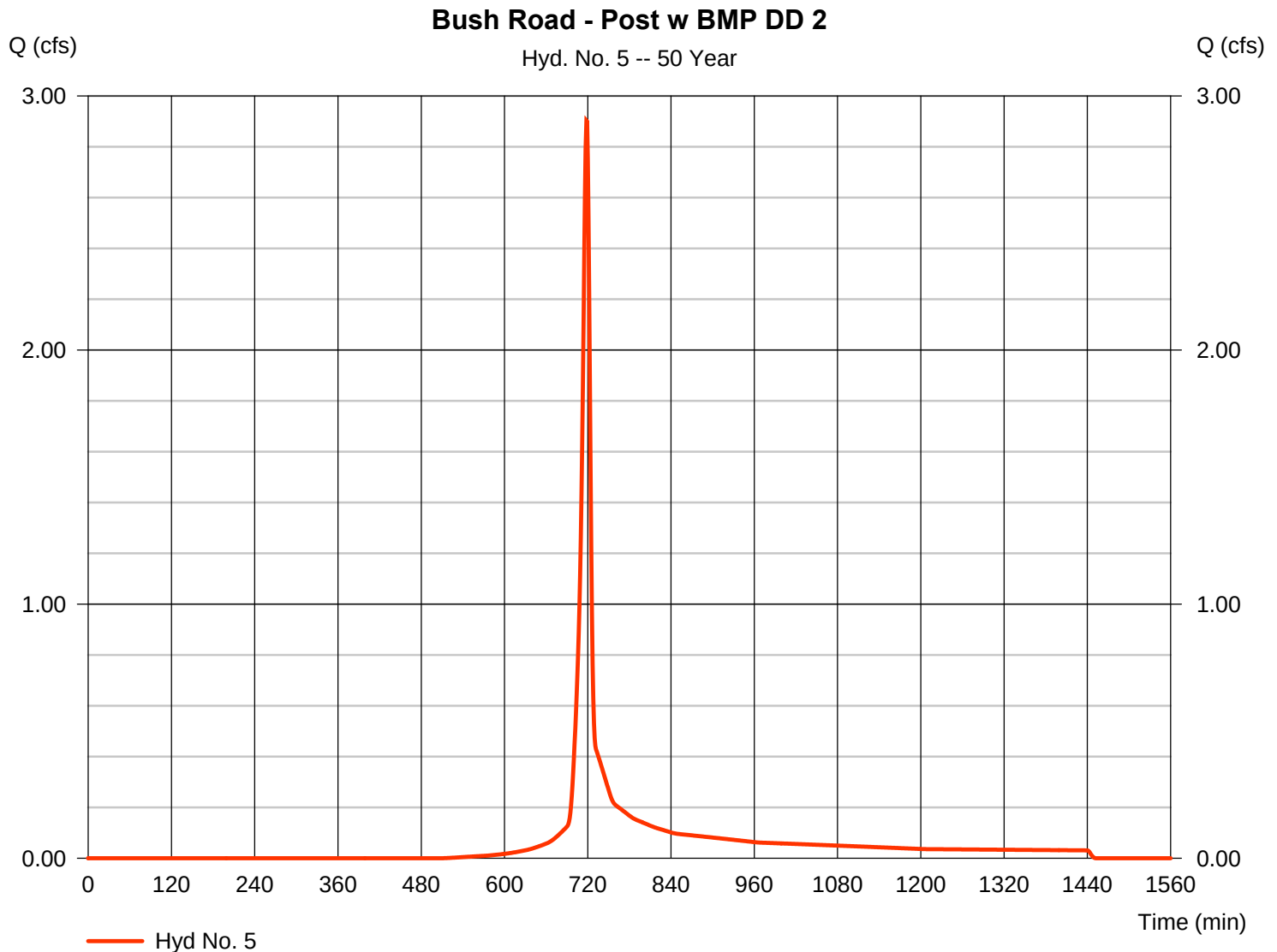
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.903 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	6,143 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	4.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc					6.70 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

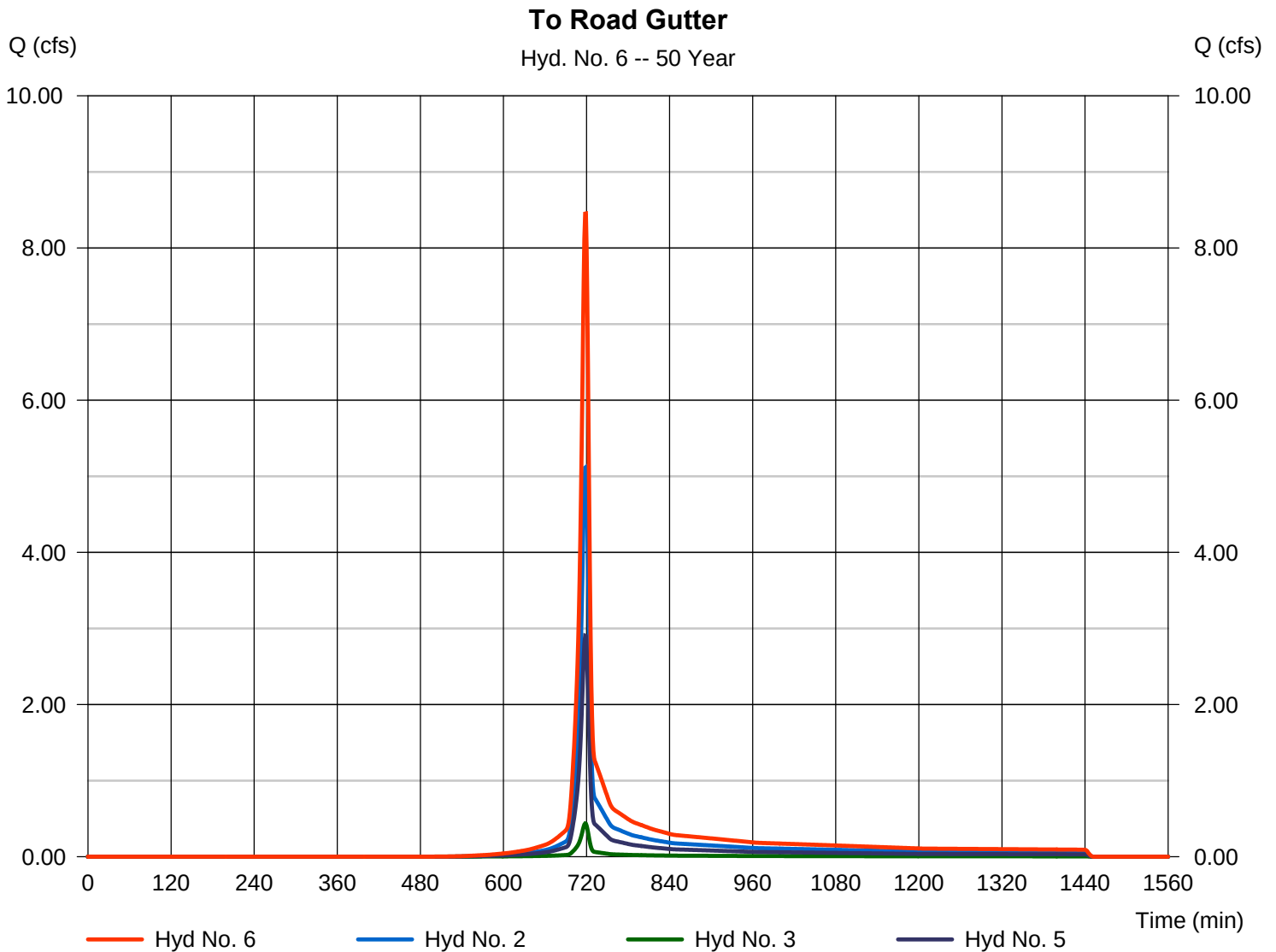
Monday, 11 / 7 / 2016

Hyd. No. 6

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 5

Peak discharge = 8.452 cfs
 Time to peak = 719 min
 Hyd. volume = 17,883 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

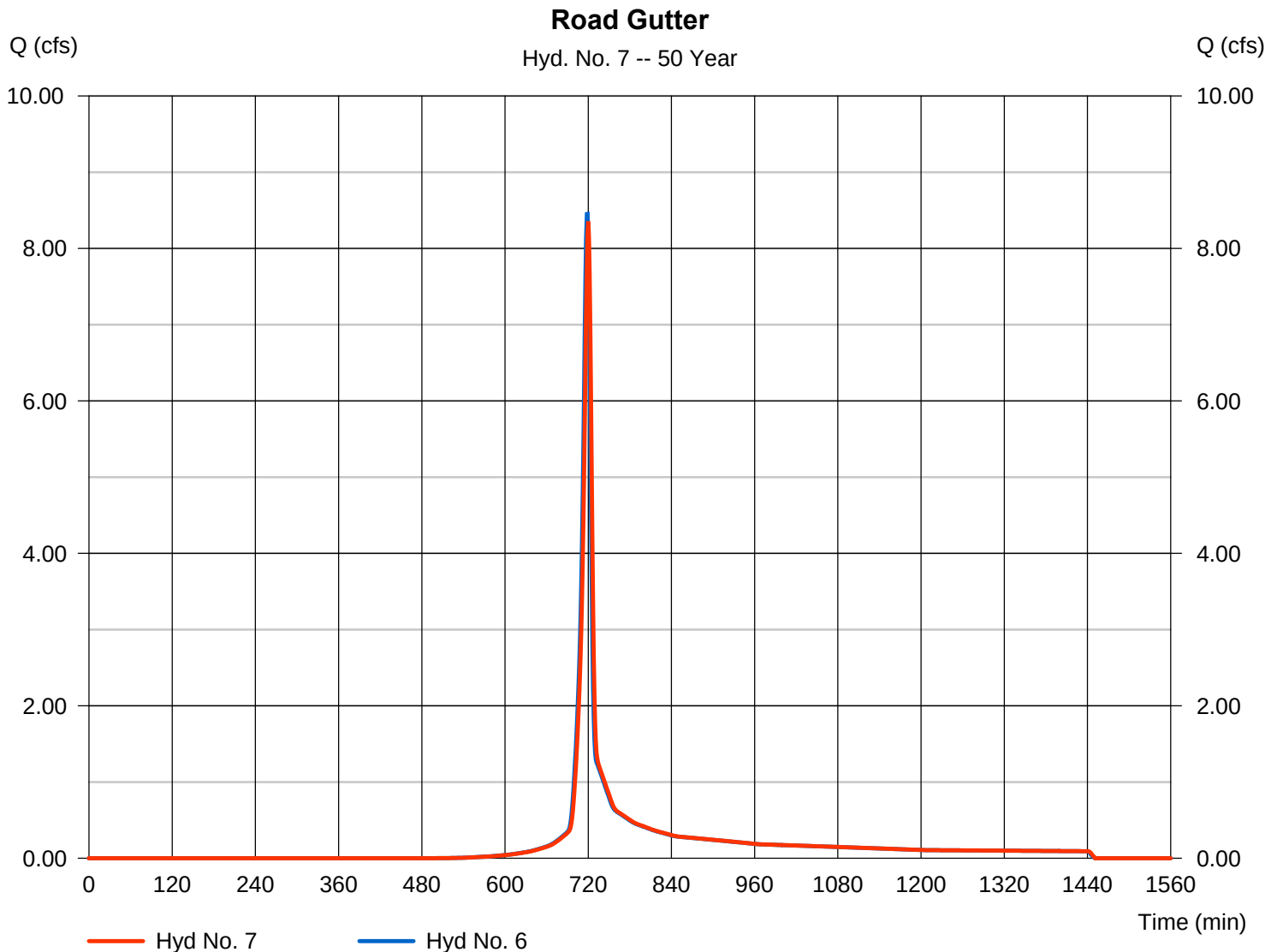
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 8.354 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 17,882 cuft
Inflow hyd. No.	= 6 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.6249

Modified Att-Kin routing method used.



Hydrograph Report

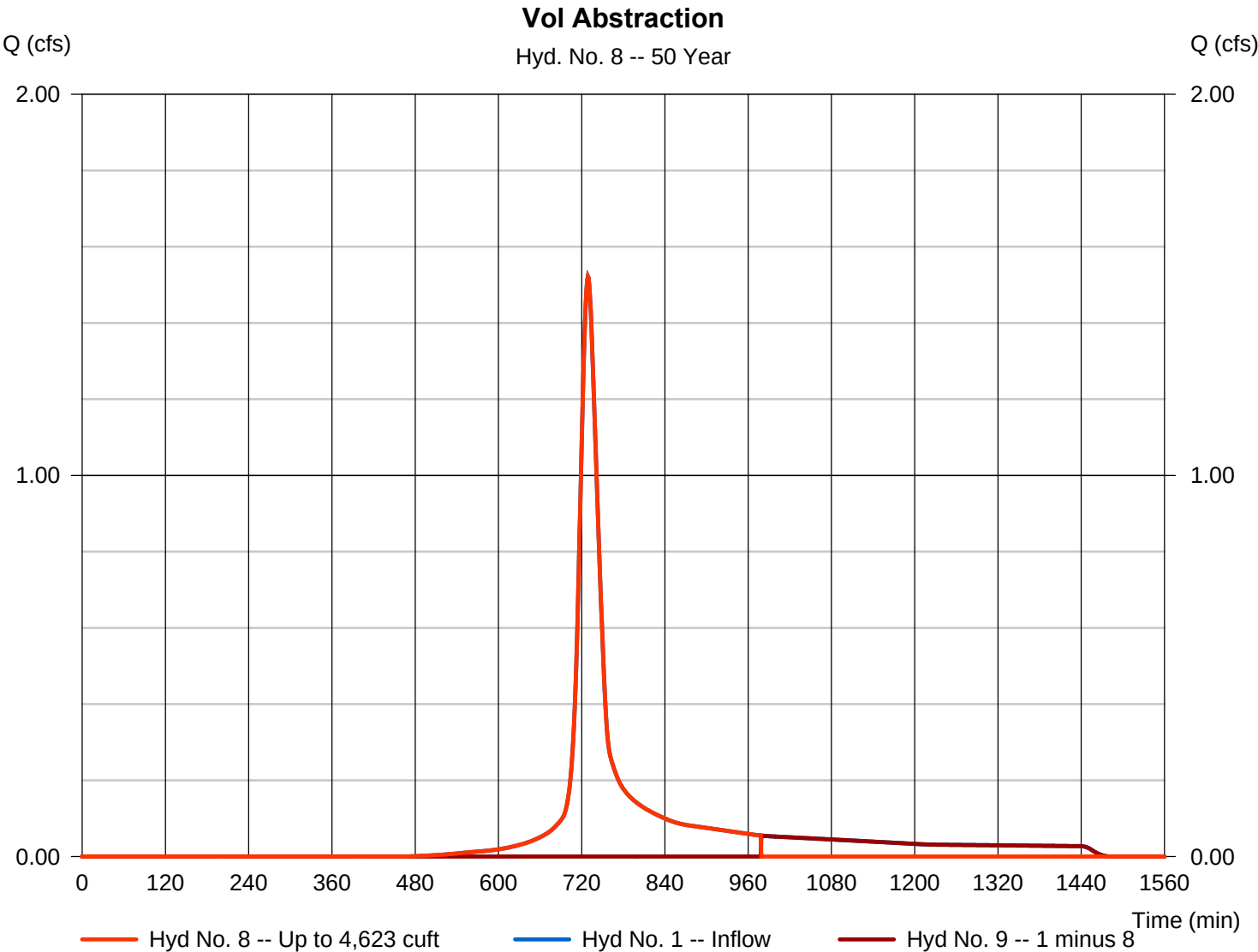
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 8

Vol Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.522 cfs
Storm frequency	=	50 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	4,626 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Divided hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	4,623 cuft



Hydrograph Report

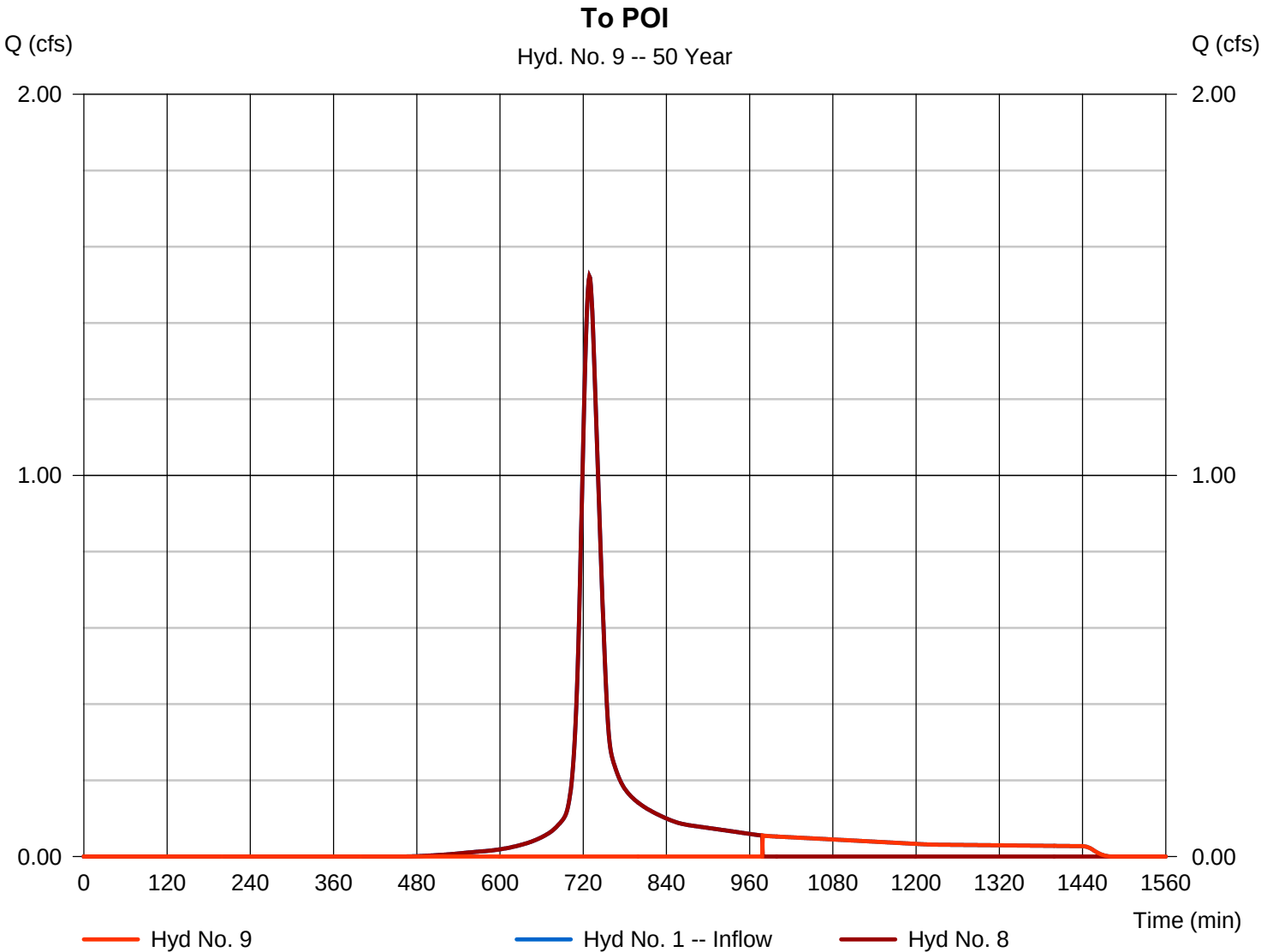
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 9

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.055 cfs
Storm frequency	=	50 yrs	Time to peak	=	979 min
Time interval	=	1 min	Hyd. volume	=	1,039 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Diverted hyd.	=	8
Diversion method	=	First Flush Volume	Volume Up To	=	4,623 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

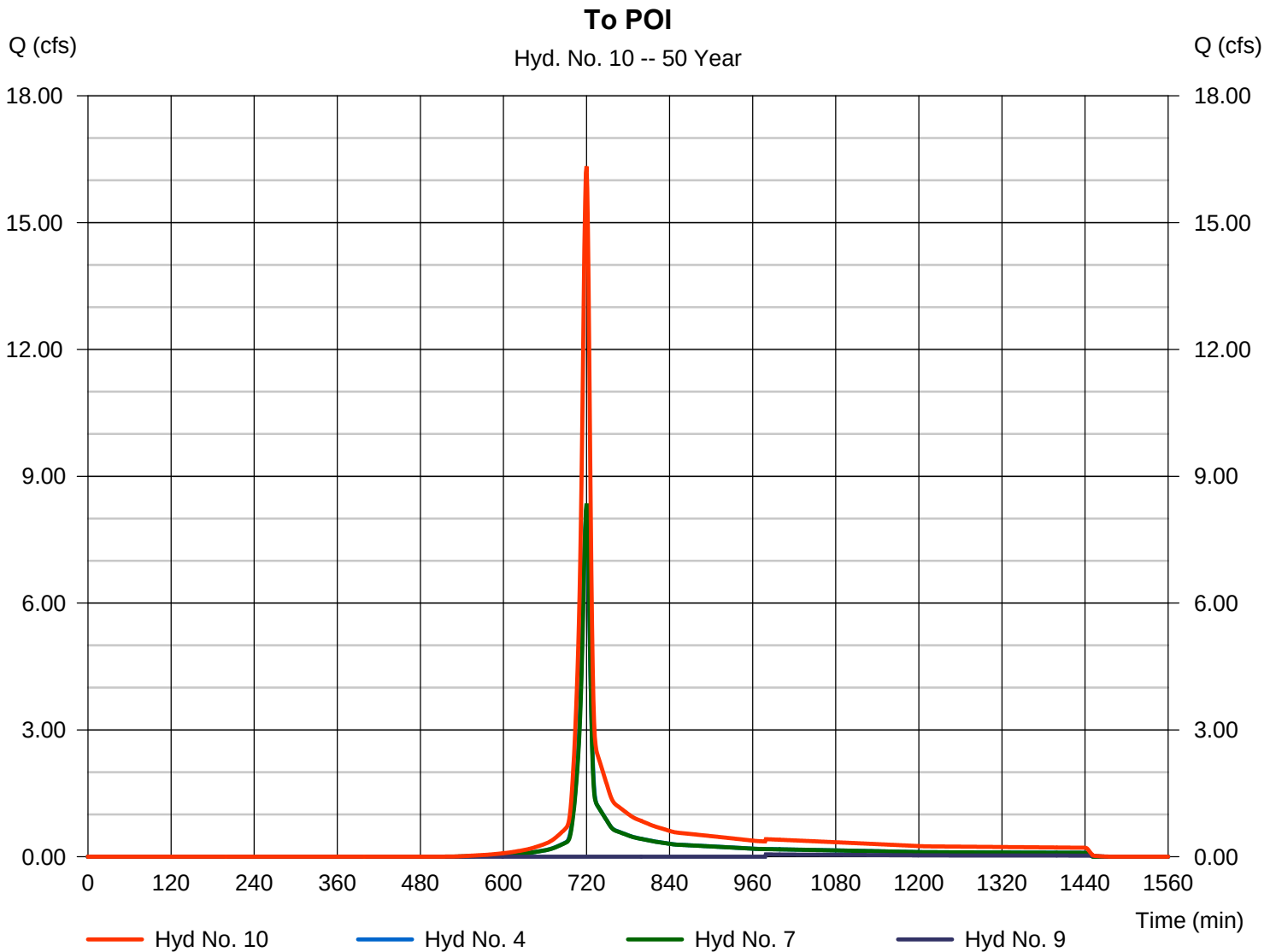
Monday, 11 / 7 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 4, 7, 9

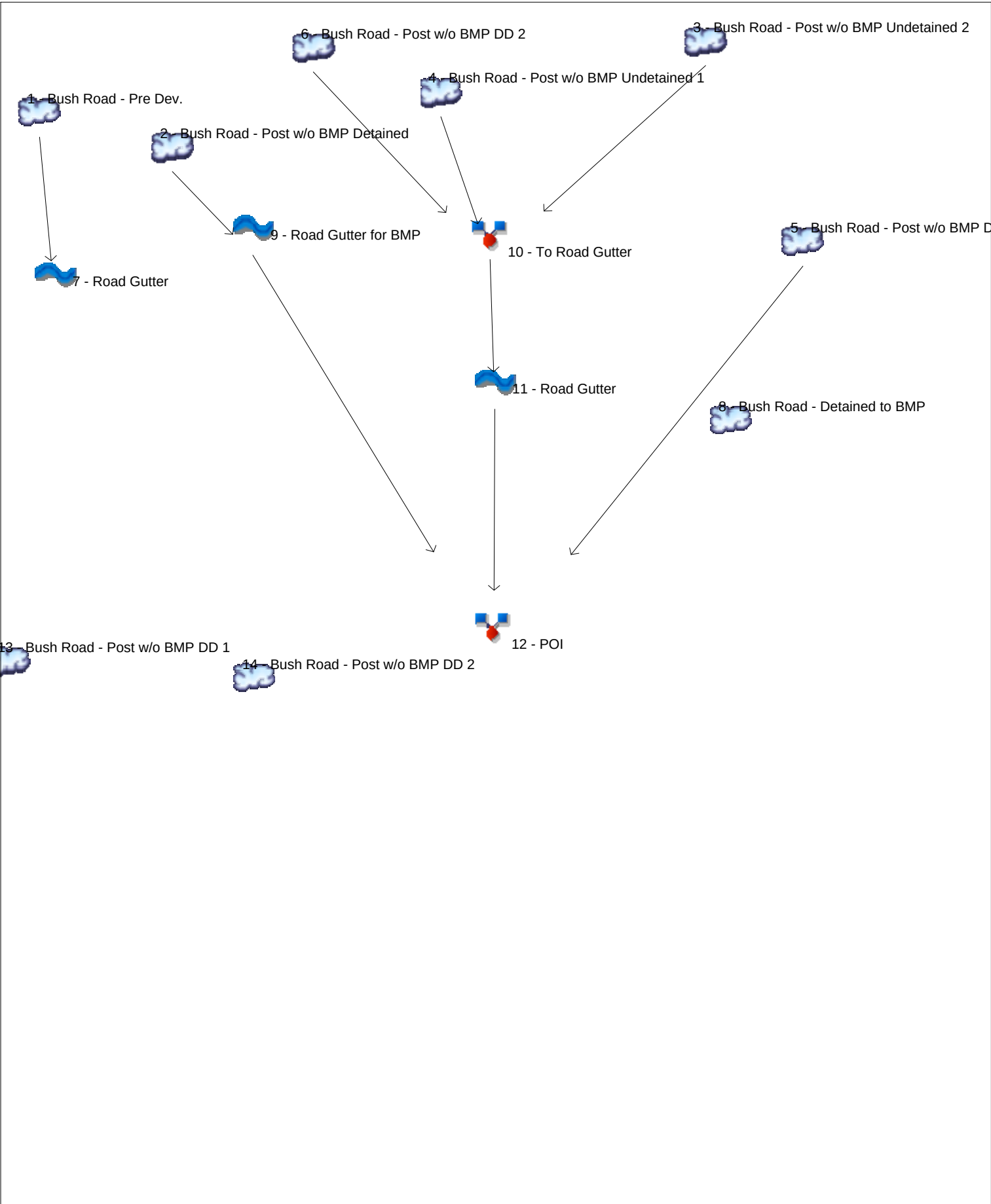
Peak discharge = 16.33 cfs
 Time to peak = 720 min
 Hyd. volume = 36,985 cuft
 Contrib. drain. area = 2.260 ac



ATTACHMENT C-4
BUSH RD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.591	-----	-----	11.46	-----	19.05	22.83	Bush Road - Pre Dev.
2	SCS Runoff	-----	-----	0.870	-----	-----	1.624	-----	2.578	3.039	Bush Road - Post w/o BMP Detained
3	SCS Runoff	-----	-----	1.441	-----	-----	3.036	-----	5.119	6.154	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	-----	-----	0.152	-----	-----	0.278	-----	0.436	0.512	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	-----	-----	2.314	-----	-----	4.778	-----	7.986	9.579	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	-----	-----	0.885	-----	-----	1.768	-----	2.903	3.464	Bush Road - Post w/o BMP DD 2
7	Reach	1	-----	5.552	-----	-----	11.44	-----	19.05	22.83	Road Gutter
8	SCS Runoff	-----	-----	0.760	-----	-----	1.396	-----	2.202	2.590	Bush Road - Detained to BMP
9	Reach	2	-----	0.828	-----	-----	1.576	-----	2.522	2.978	Road Gutter for BMP
10	Combine	3, 4, 6,	-----	2.478	-----	-----	5.081	-----	8.452	10.13	To Road Gutter
11	Reach	10	-----	2.377	-----	-----	4.962	-----	8.354	10.02	Road Gutter
12	Combine	5, 9, 11	-----	5.487	-----	-----	11.32	-----	18.85	22.54	POI
13	SCS Runoff	-----	-----	2.721	-----	-----	5.566	-----	9.243	11.05	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	-----	-----	0.985	-----	-----	1.964	-----	3.218	3.829	Bush Road - Post w/o BMP DD 2
Proj. file: Pre and Post wo BMP 2-100 yrs_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	22.83	1	718	48,362	-----	-----	-----	Bush Road - Pre Dev.
2	SCS Runoff	3.039	1	718	6,491	-----	-----	-----	Bush Road - Post w/o BMP Detained
3	SCS Runoff	6.154	1	718	13,022	-----	-----	-----	Bush Road - Post w/o BMP Undetain
4	SCS Runoff	0.512	1	718	1,097	-----	-----	-----	Bush Road - Post w/o BMP Undetain
5	SCS Runoff	9.579	1	719	21,683	-----	-----	-----	Bush Road - Post w/o BMP DD 1
6	SCS Runoff	3.464	1	718	7,349	-----	-----	-----	Bush Road - Post w/o BMP DD 2
7	Reach	22.83	1	719	48,362	1	-----	-----	Road Gutter
8	SCS Runoff	2.590	2	718	5,965	-----	-----	-----	Bush Road - Detained to BMP
9	Reach	2.978	1	720	6,490	2	-----	-----	Road Gutter for BMP
10	Combine	10.13	1	718	21,468	3, 4, 6,	-----	-----	To Road Gutter
11	Reach	10.02	1	720	21,468	10	-----	-----	Road Gutter
12	Combine	22.54	1	720	49,641	5, 9, 11	-----	-----	POI
13	SCS Runoff	11.05	1	718	22,360	-----	-----	-----	Bush Road - Post w/o BMP DD 1
14	SCS Runoff	3.829	1	718	7,773	-----	-----	-----	Bush Road - Post w/o BMP DD 2
Pre and Post wo BMP 2-100 yrs_chk.gpw					Return Period: 100 Year			Monday, 11 / 7 / 2016	

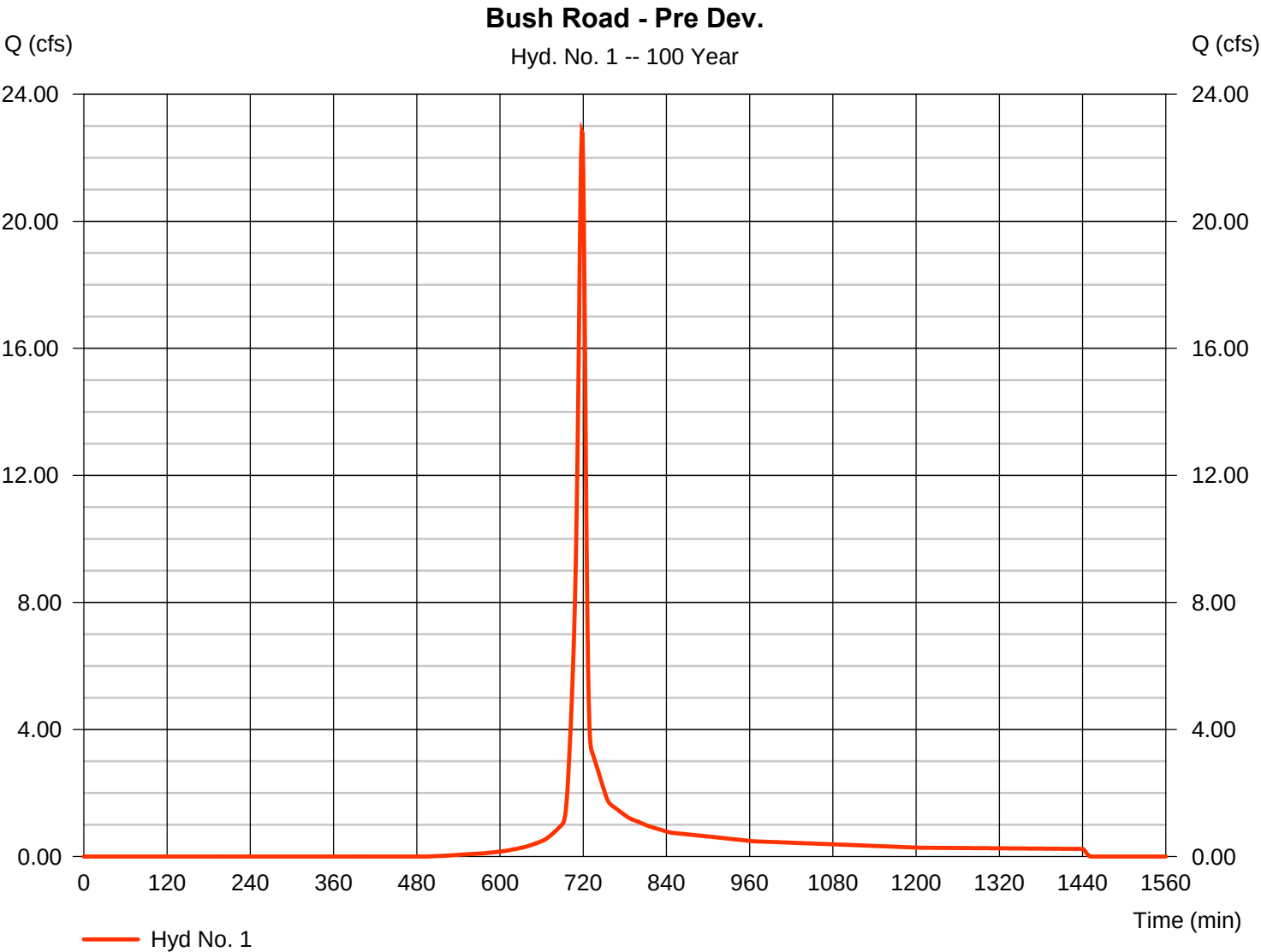
Hydrograph Report

Hyd. No. 1

Bush Road - Pre Dev.

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.83 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	48,362 cuft
Drainage area	=	5.170 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(3.370 x 78) + (1.350 x 70) + (0.060 x 91) + (0.390 x 77)] / 5.170



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Bush Road - Pre Dev.

<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)	= 2.45	0.00	0.00	
Land slope (%)	= 18.00	0.00	0.00	
Travel Time (min)	= 4.65	+	0.00	+
			0.00	= 4.65
Shallow Concentrated Flow				
Flow length (ft)	= 243.00	800.00	0.00	
Watercourse slope (%)	= 24.00	10.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=7.90	5.10	0.00	
Travel Time (min)	= 0.51	+	2.61	+
			0.00	= 3.13
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				7.80 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

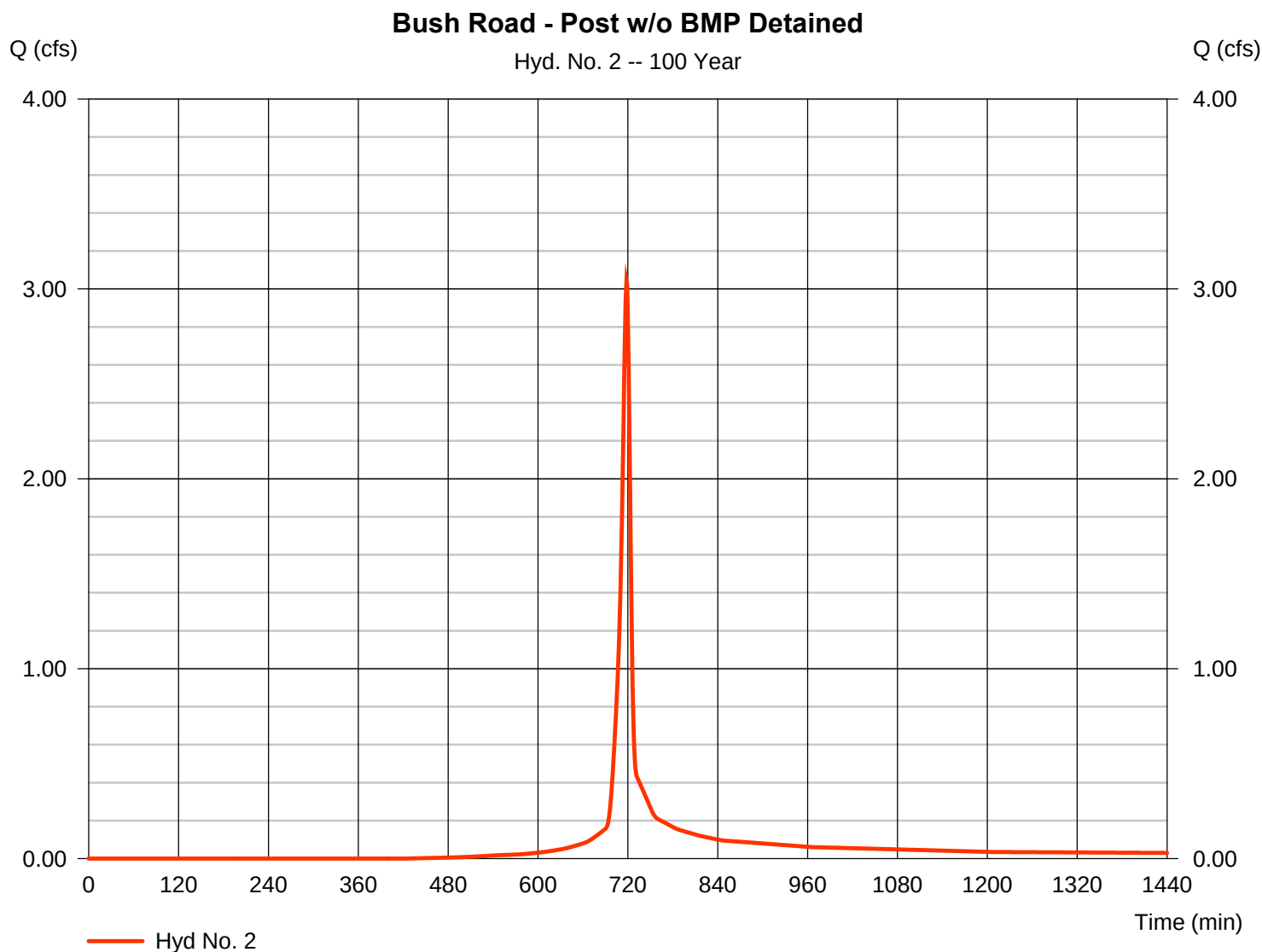
Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w/o BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.039 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	6,491 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.050 \times 77) + (0.400 \times 78) + (0.130 \times 91)] / 0.610$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w/o BMP Detained

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	629.00	75.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	2.17	+	0.27	=	2.79
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

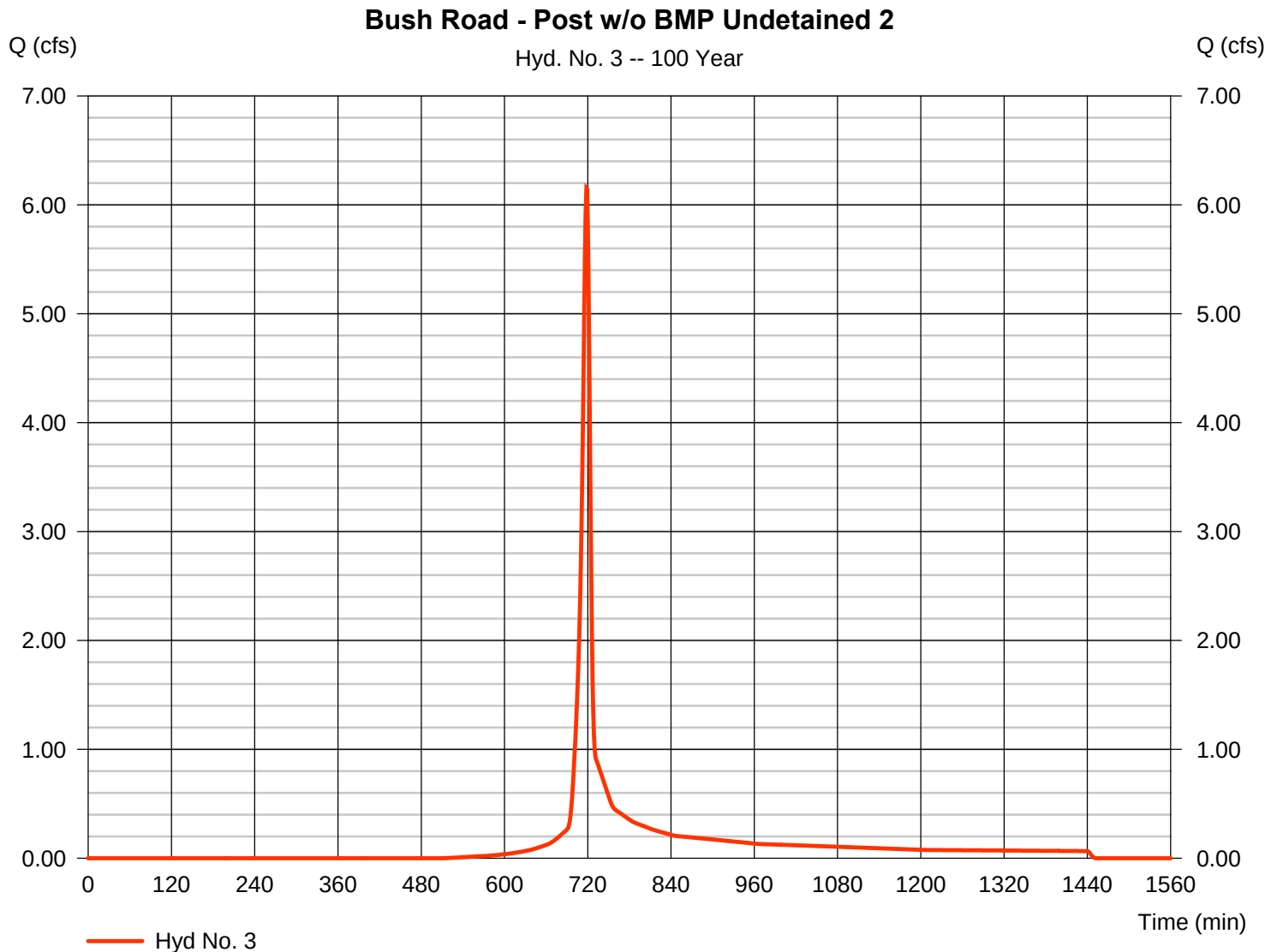
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.154 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	13,022 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w/o BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

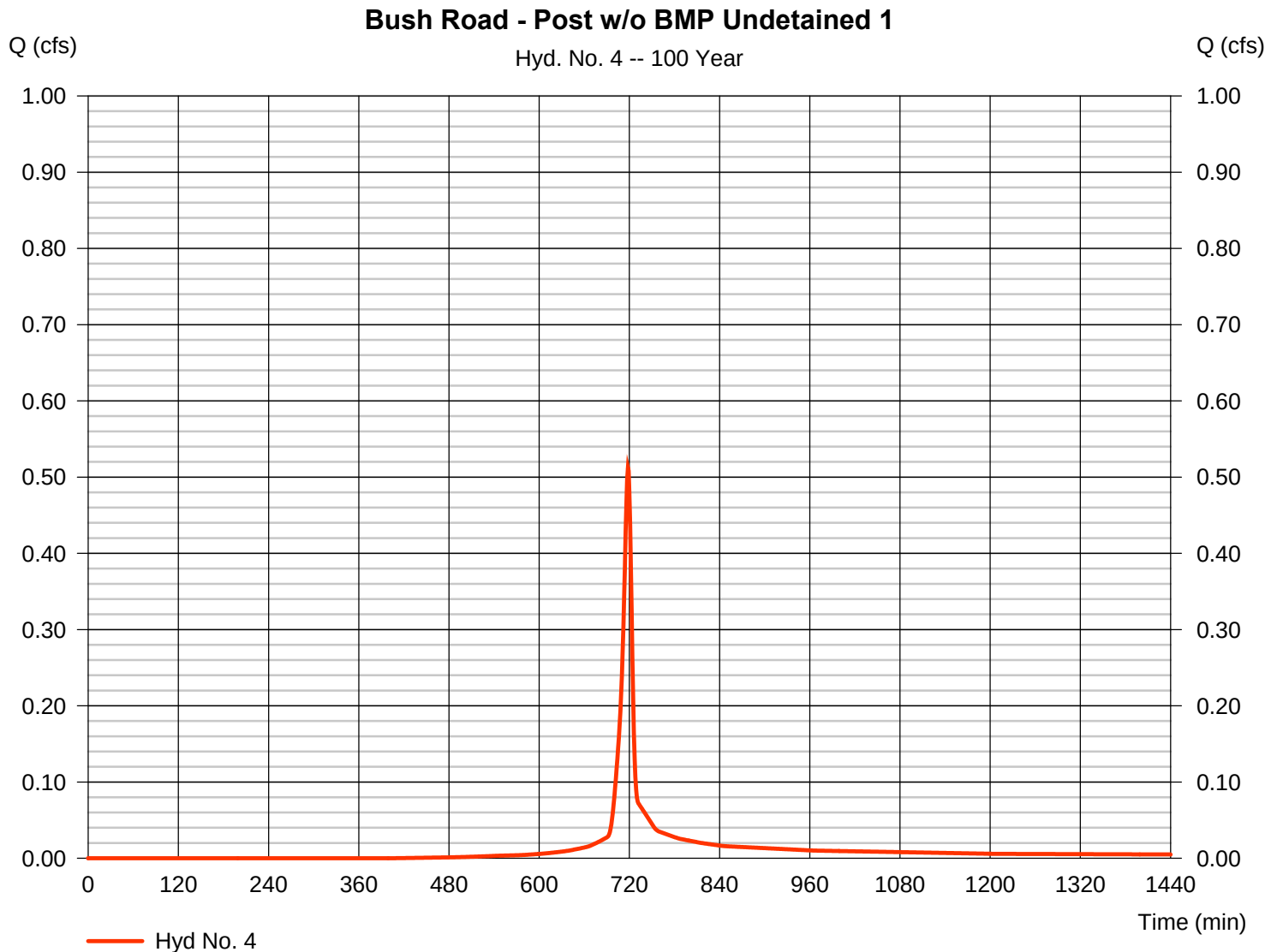
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.512 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	1,097 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w/o BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

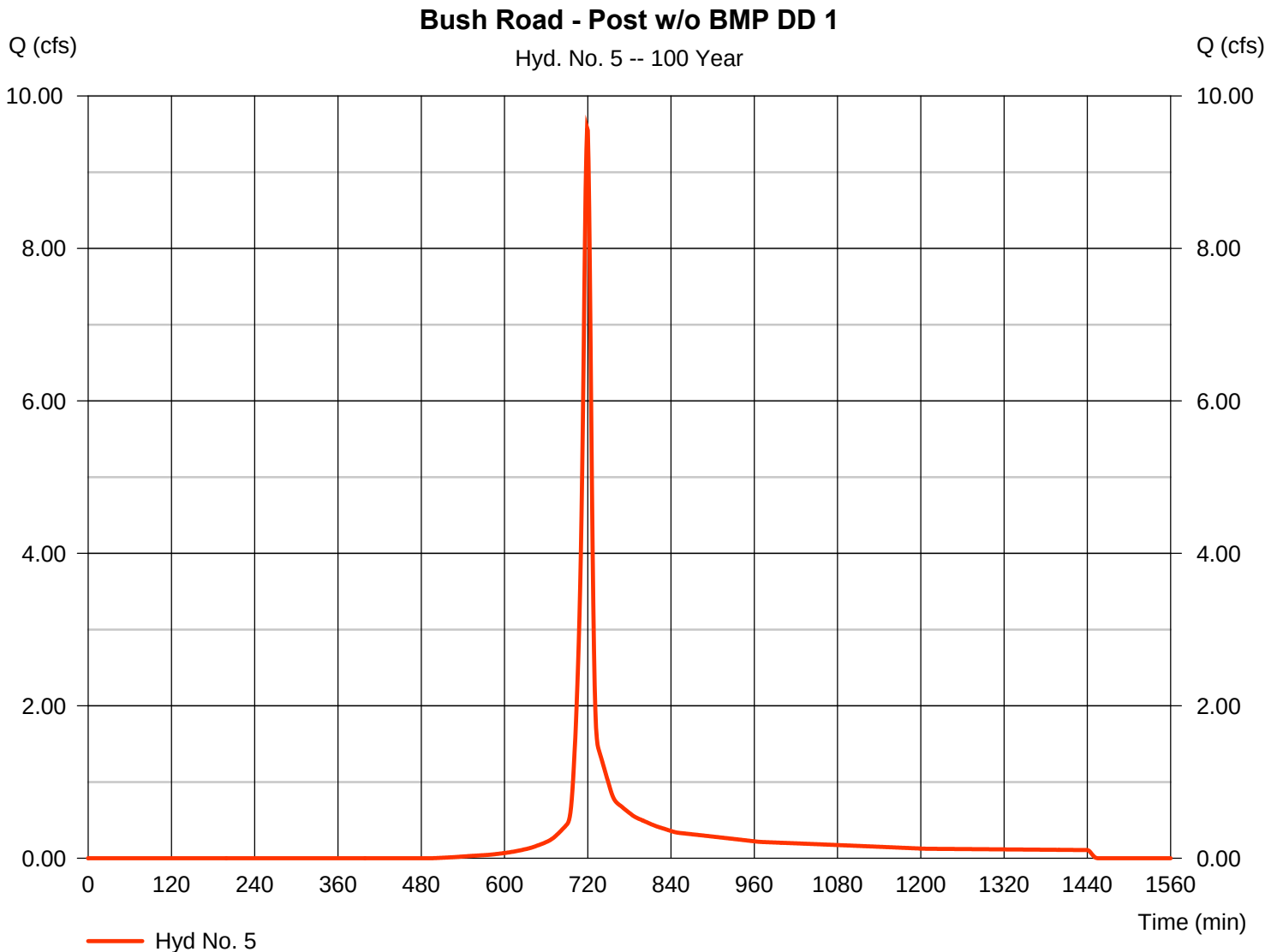
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.579 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	21,683 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

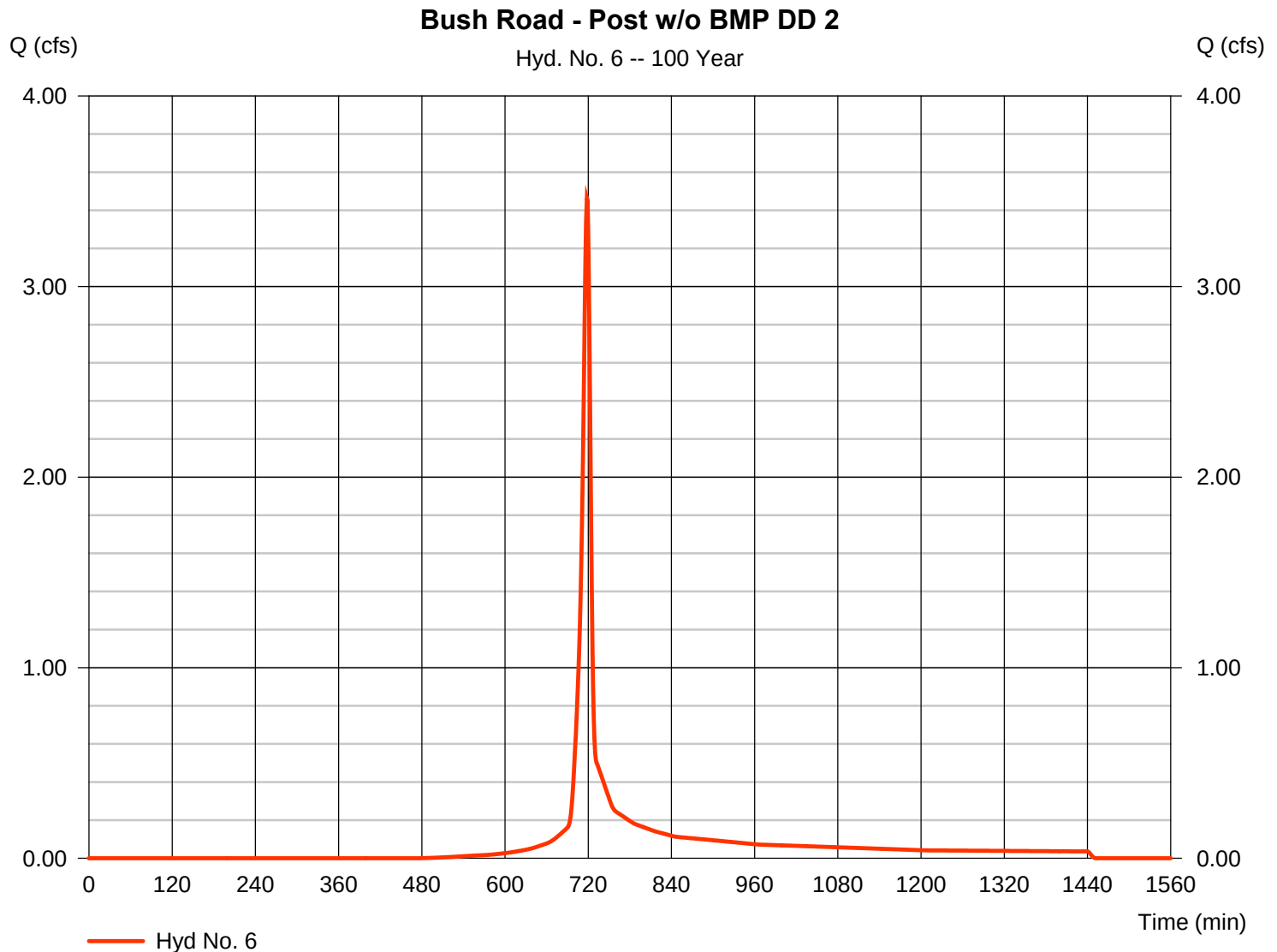
Monday, 11 / 7 / 2016

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.464 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	7,349 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 6

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

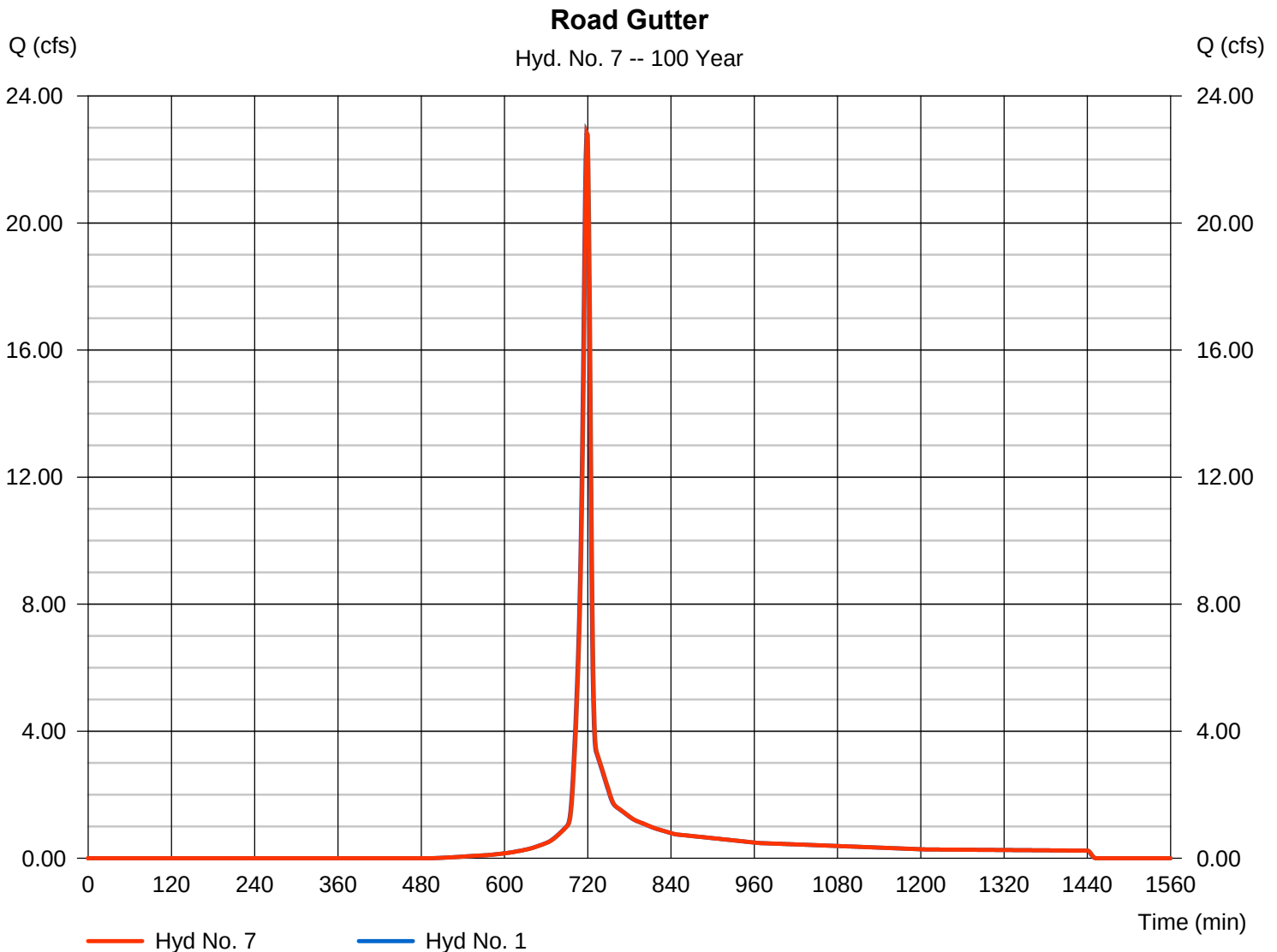
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 22.83 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 48,362 cuft
Inflow hyd. No.	= 1 - Bush Road - Pre Dev.	Section type	= Triangular
Reach length	= 265.0 ft	Channel slope	= 3.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.308	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.9933

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

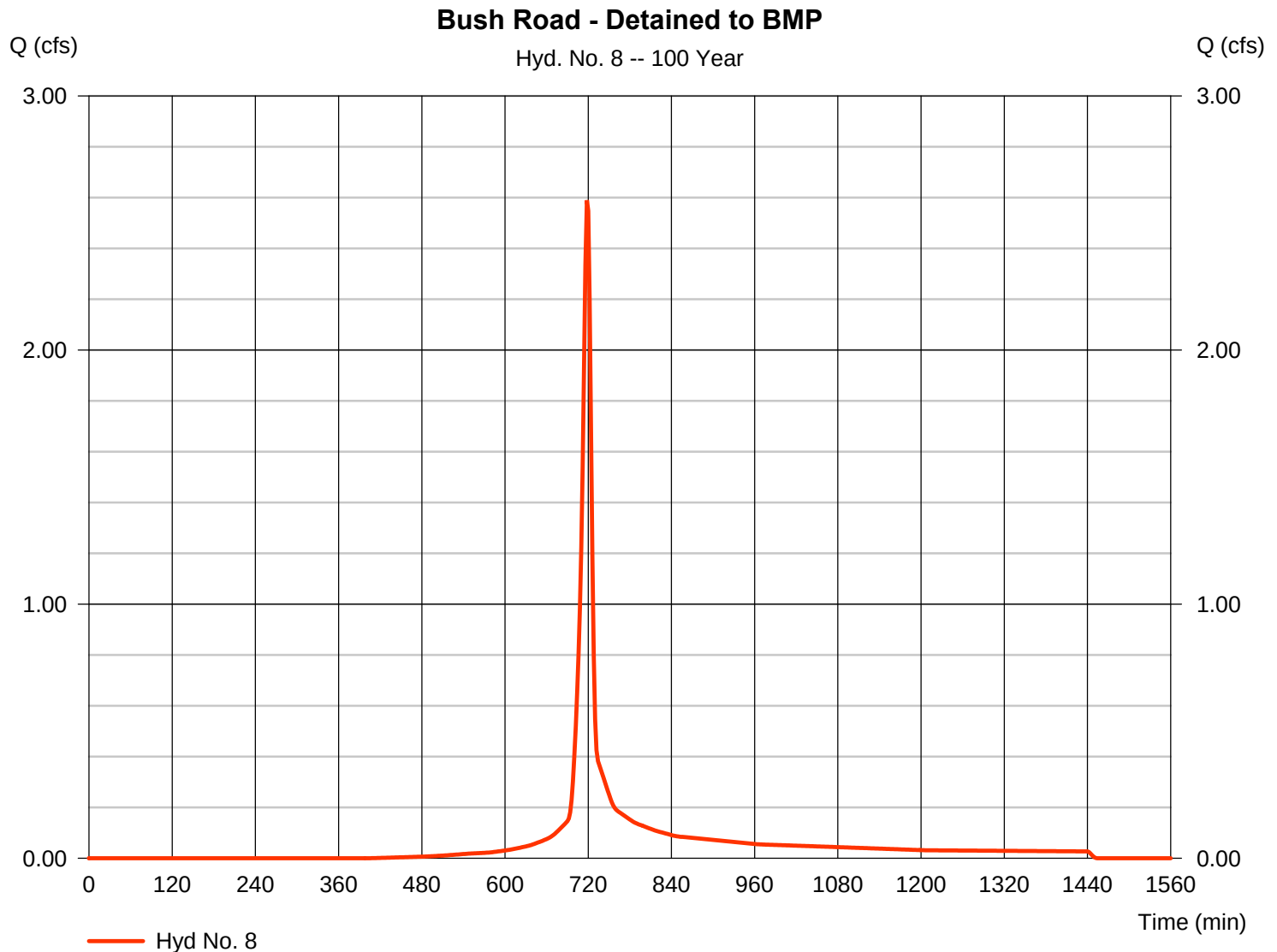
Monday, 11 / 7 / 2016

Hyd. No. 8

Bush Road - Detained to BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.590 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	5,965 cuft
Drainage area	=	0.530 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 70) + (0.010 \times 77) + (0.360 \times 78) + (0.130 \times 91)] / 0.530$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 8

Bush Road - Detained to BMP

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 24.00	0.00	0.00				
Travel Time (min)	= 4.14	+	0.00	+	0.00	=	4.14
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	535.00	70.00				
Watercourse slope (%)	= 24.00	9.00	5.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=7.90	4.84	4.55				
Travel Time (min)	= 0.35	+	1.84	+	0.26	=	2.45
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc					6.60 min		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

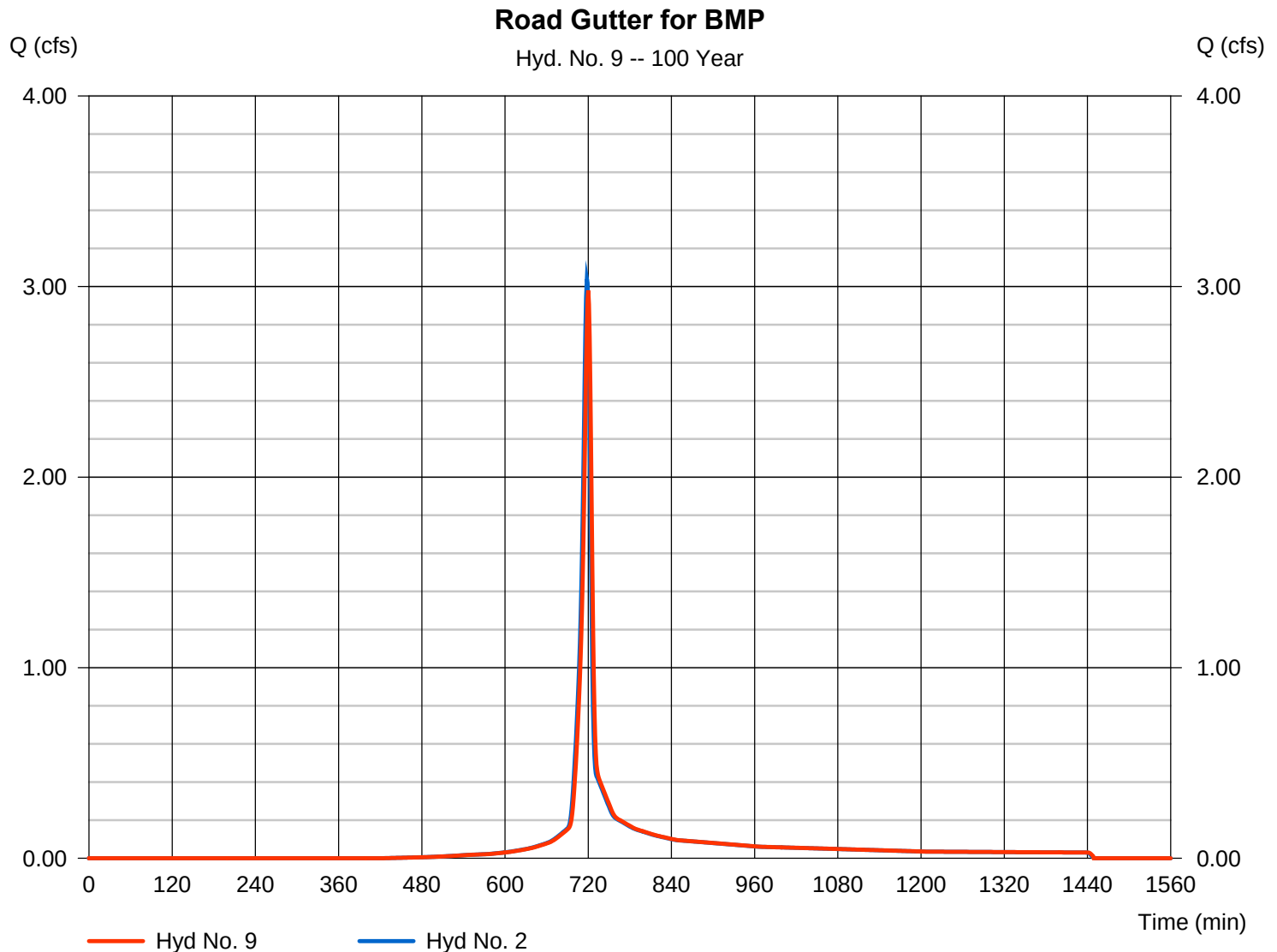
Monday, 11 / 7 / 2016

Hyd. No. 9

Road Gutter for BMP

Hydrograph type	= Reach	Peak discharge	= 2.978 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 6,490 cuft
Inflow hyd. No.	= 2 - Bush Road - Post w/o BMP	Section type	= Triangular
Reach length	= 450.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.5621

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

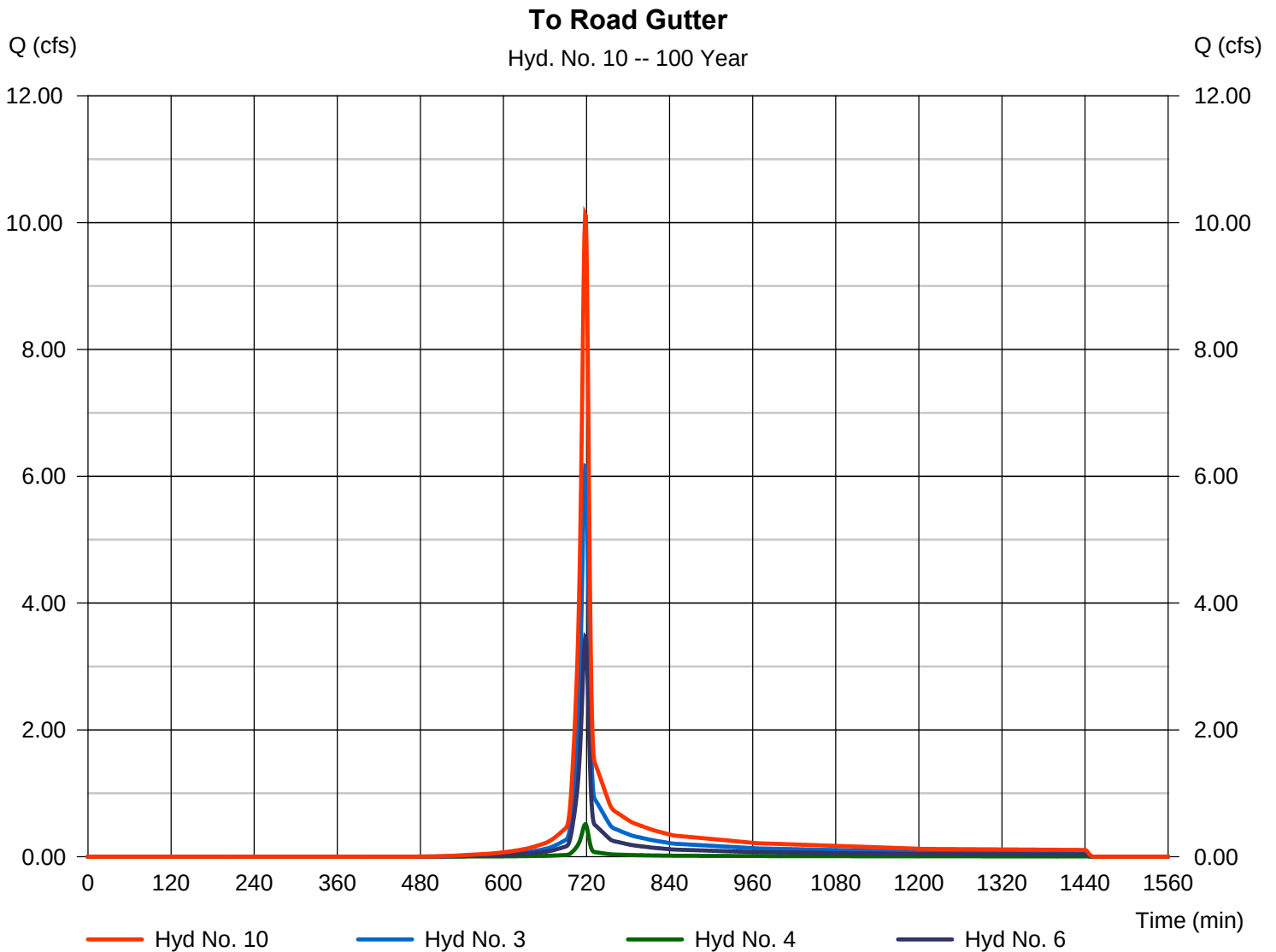
Monday, 11 / 7 / 2016

Hyd. No. 10

To Road Gutter

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 3, 4, 6

Peak discharge = 10.13 cfs
 Time to peak = 718 min
 Hyd. volume = 21,468 cuft
 Contrib. drain. area = 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

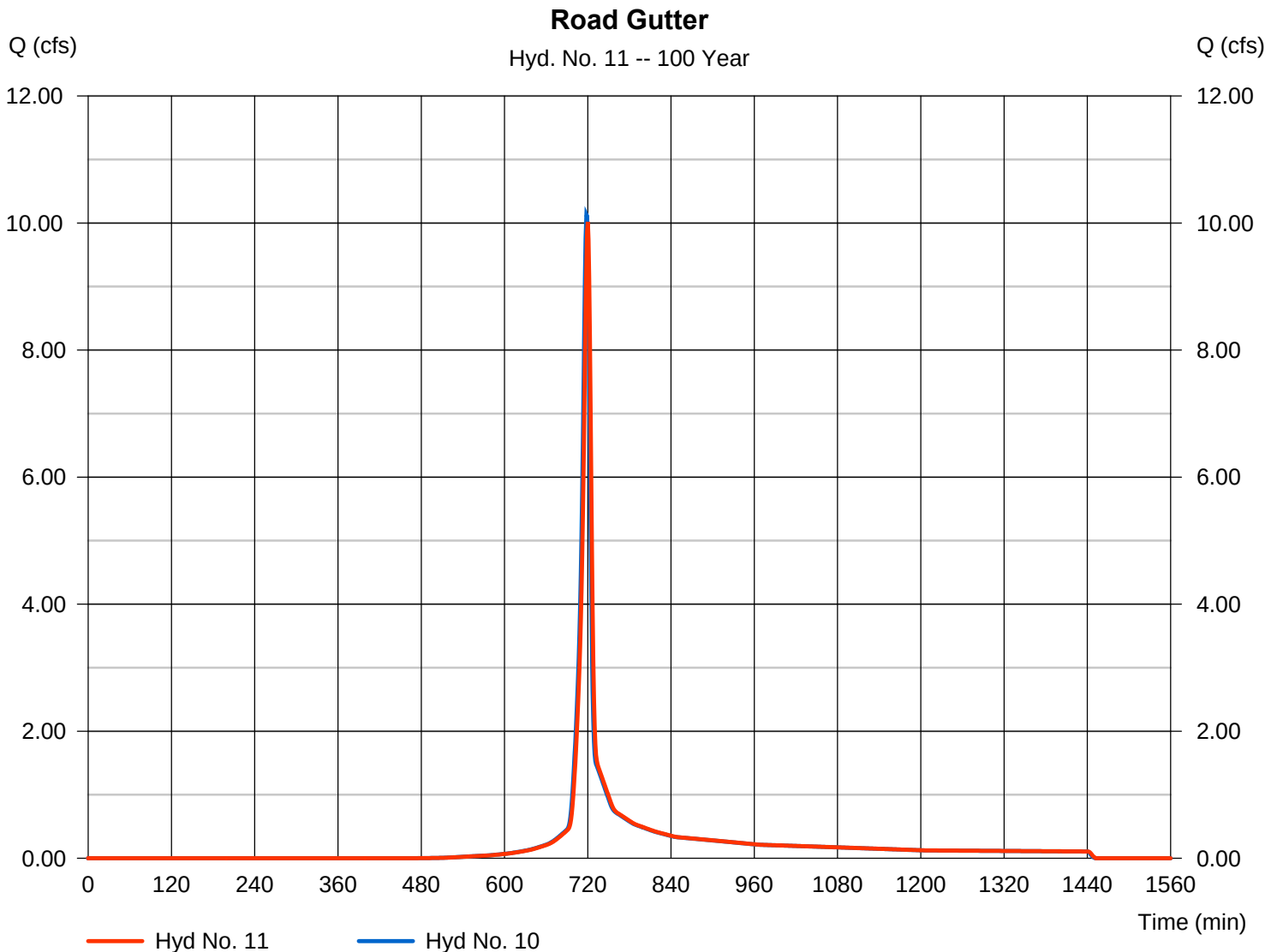
Monday, 11 / 7 / 2016

Hyd. No. 11

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 10.02 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 21,468 cuft
Inflow hyd. No.	= 10 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.6445

Modified Att-Kin routing method used.



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

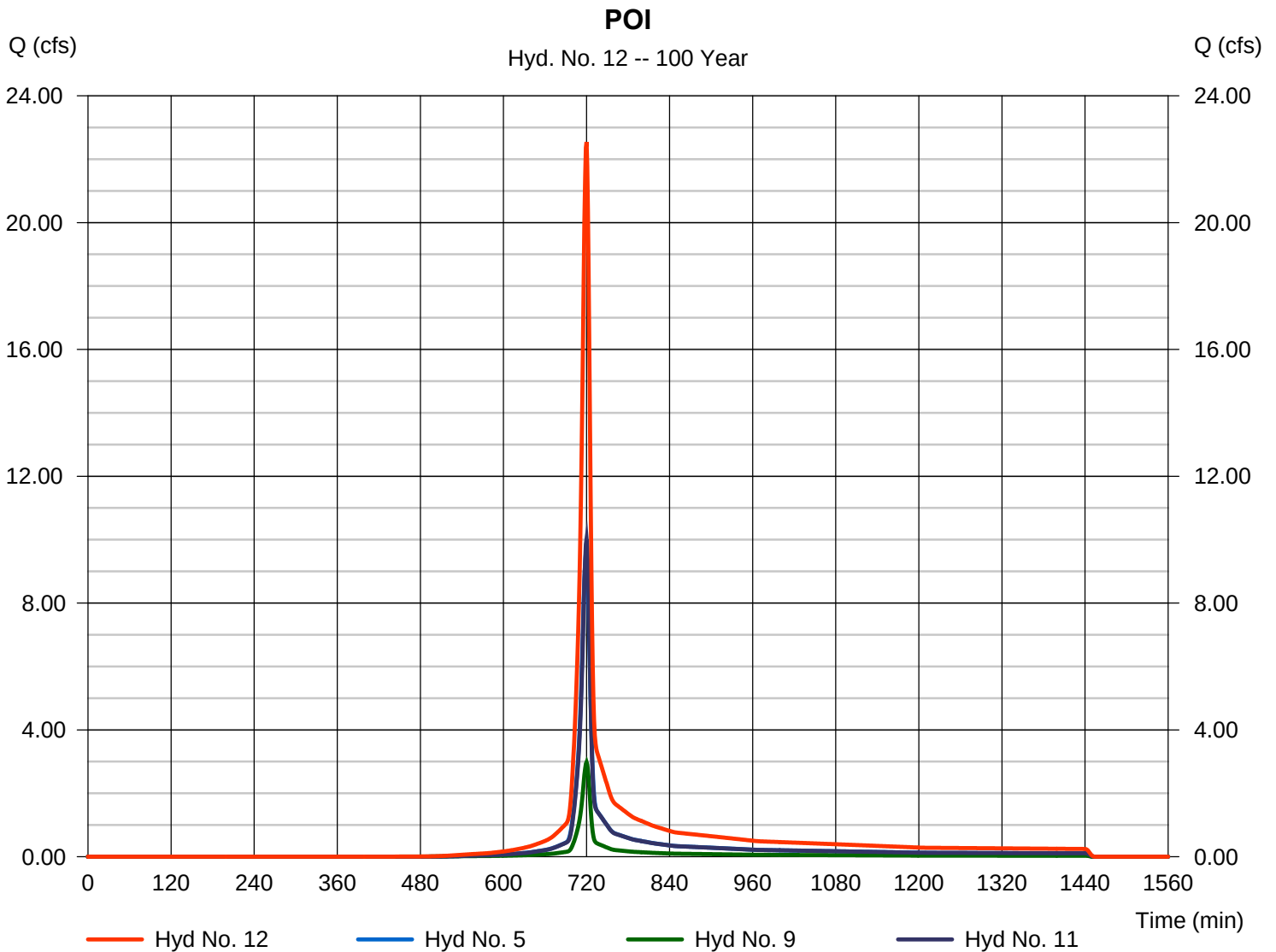
Monday, 11 / 7 / 2016

Hyd. No. 12

POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 5, 9, 11

Peak discharge = 22.54 cfs
 Time to peak = 720 min
 Hyd. volume = 49,641 cuft
 Contrib. drain. area = 2.260 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

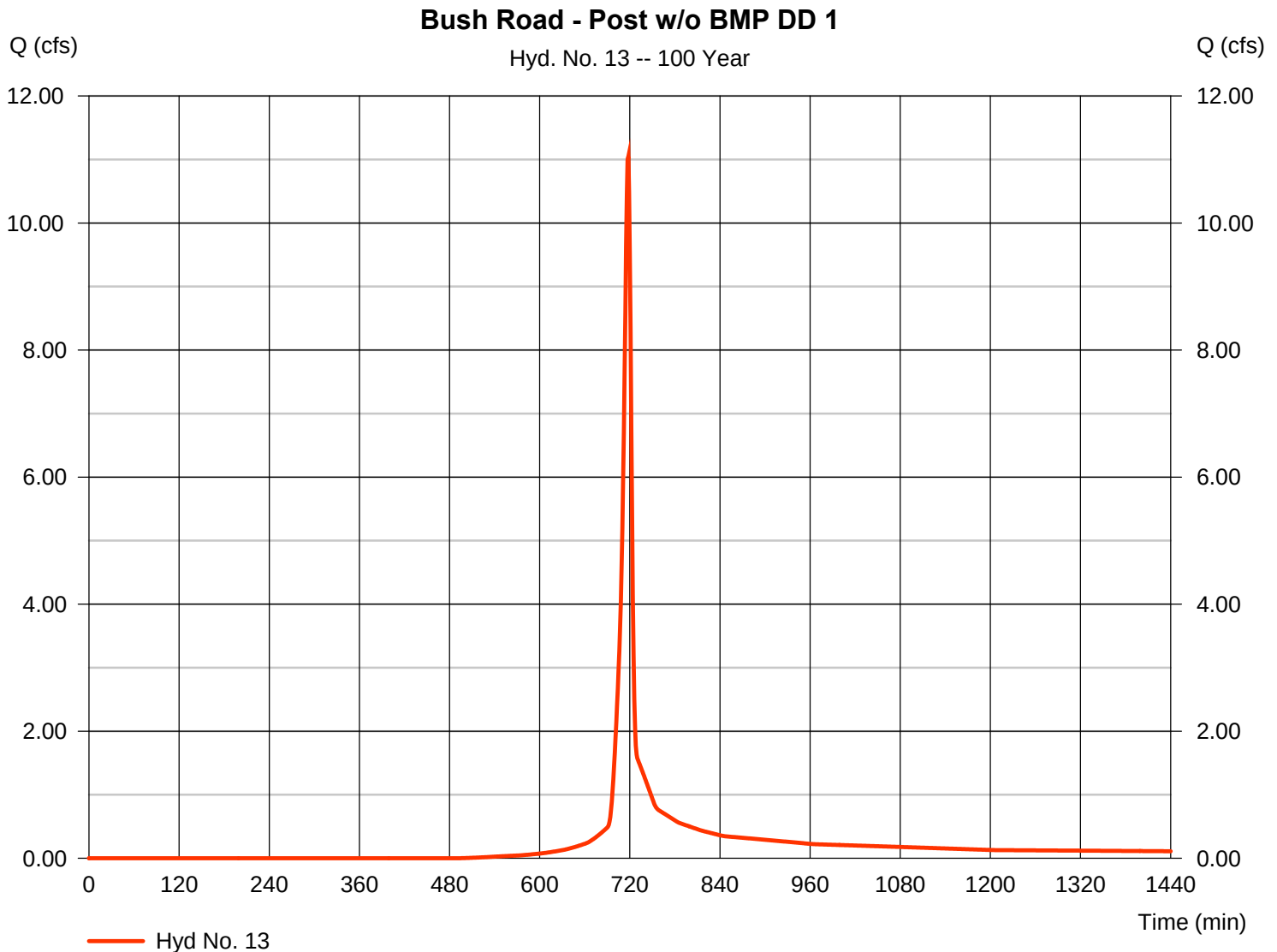
Monday, 11 / 7 / 2016

Hyd. No. 13

Bush Road - Post w/o BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.05 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	22,360 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 13

Bush Road - Post w/o BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	0.00				
Watercourse slope (%)	= 23.00	10.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	0.00				
Travel Time (min)	= 0.60	+	1.26	+	0.00	=	1.86
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	= 0.060	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				6.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

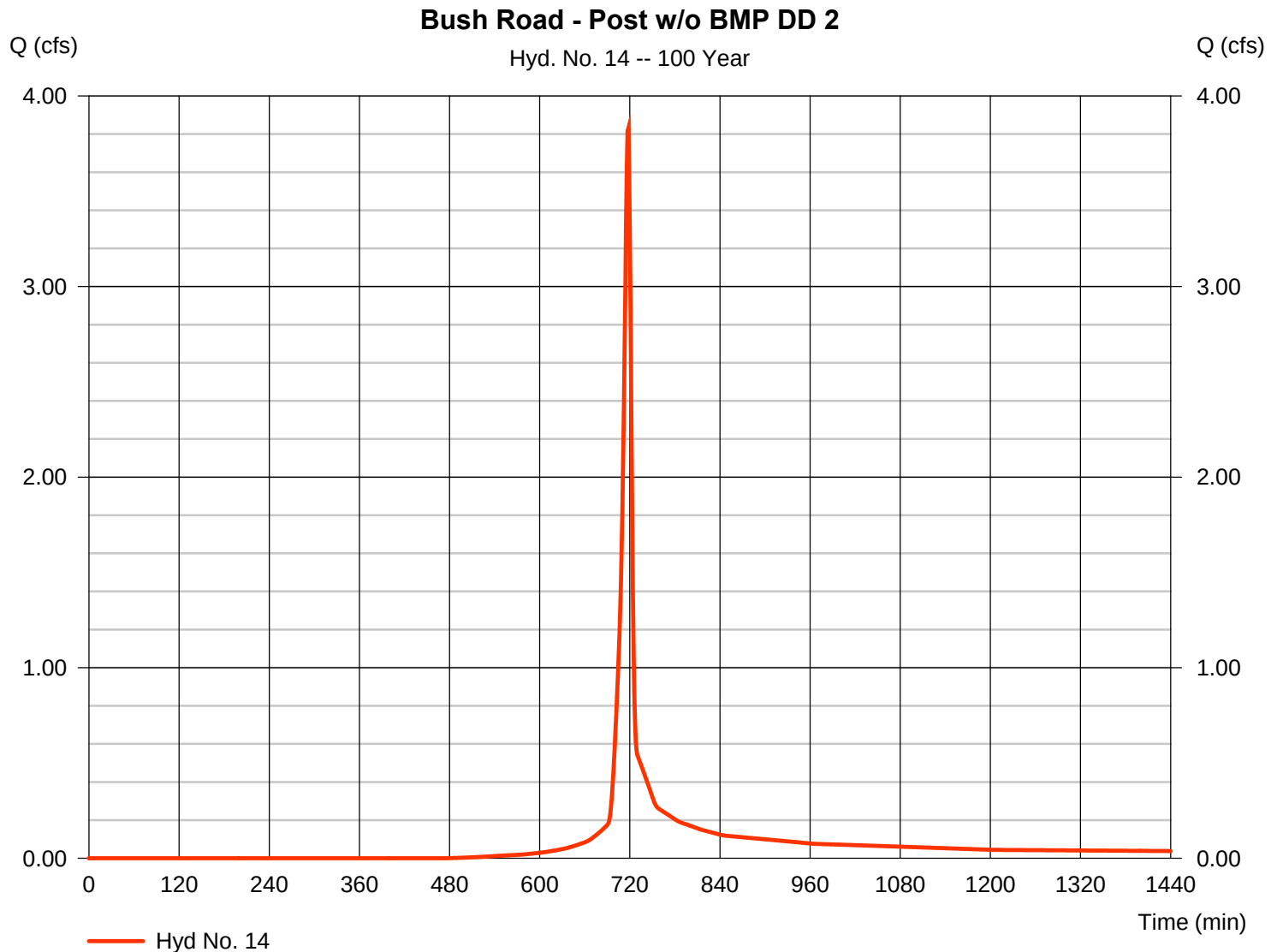
Monday, 11 / 7 / 2016

Hyd. No. 14

Bush Road - Post w/o BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.829 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	7,773 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

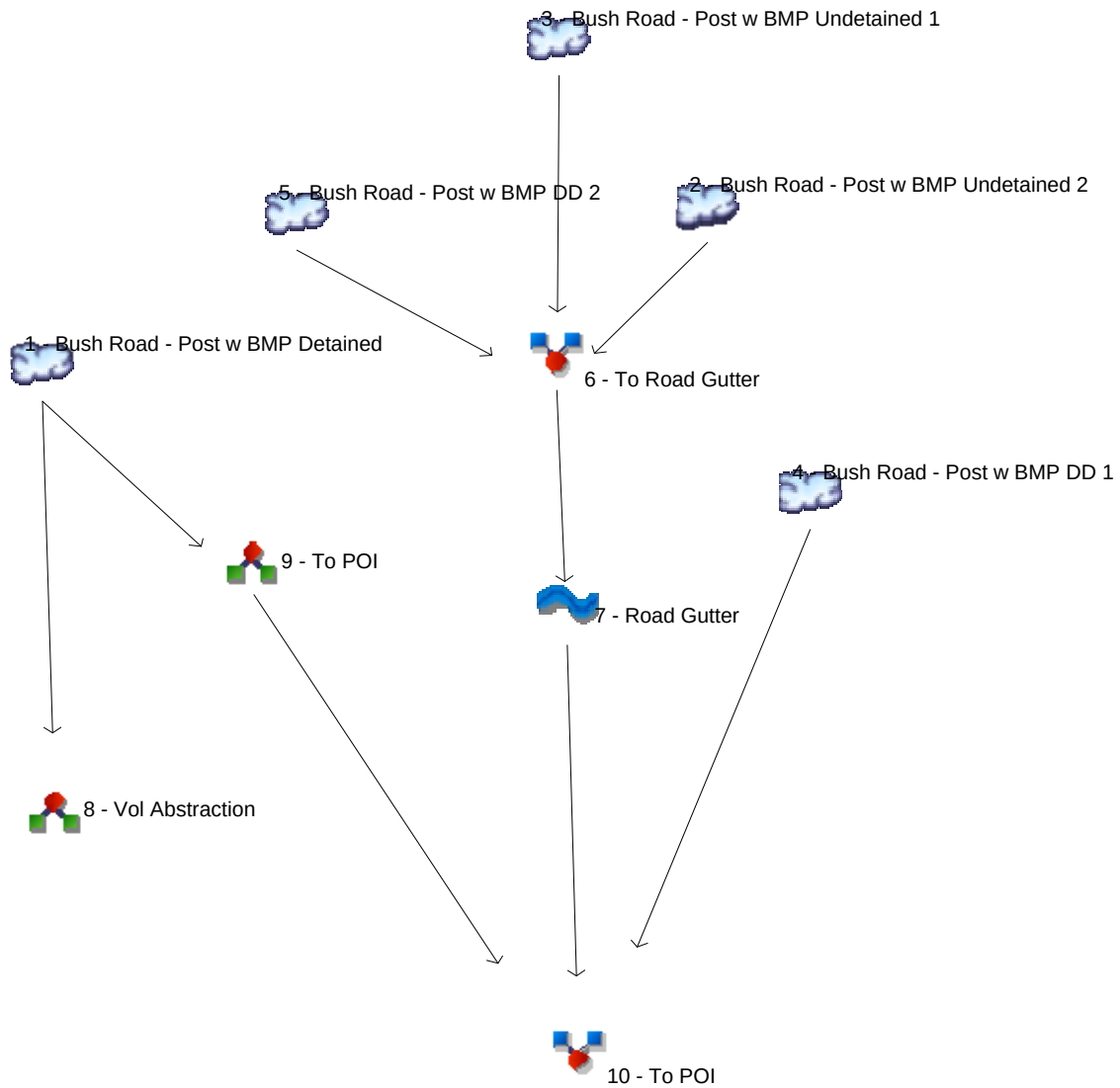
Hyd. No. 14

Bush Road - Post w/o BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
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	= 0.060	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				6.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.522	1.804	Bush Road - Post w BMP Detained
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	5.119	6.154	Bush Road - Post w BMP Undetained
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.436	0.512	Bush Road - Post w BMP Undetained
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	7.986	9.579	Bush Road - Post w BMP DD 1
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.903	3.464	Bush Road - Post w BMP DD 2
6	Combine	2, 3, 5	-----	-----	-----	-----	-----	-----	8.452	10.13	To Road Gutter
7	Reach	6	-----	-----	-----	-----	-----	-----	8.354	10.02	Road Gutter
8	Diversion1	1	-----	-----	-----	-----	-----	-----	1.522	1.804	Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	-----	-----	0.055	0.140	To POI
10	Combine	4, 7, 9	-----	-----	-----	-----	-----	-----	16.33	19.57	To POI
Proj. file: Post w BMP 50-100 yr_chk.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.804	1	729	6,709	-----	-----	-----	Bush Road - Post w BMP Detained
2	SCS Runoff	6.154	1	718	13,022	-----	-----	-----	Bush Road - Post w BMP Undetained
3	SCS Runoff	0.512	1	718	1,097	-----	-----	-----	Bush Road - Post w BMP Undetained
4	SCS Runoff	9.579	1	719	21,683	-----	-----	-----	Bush Road - Post w BMP DD 1
5	SCS Runoff	3.464	1	718	7,349	-----	-----	-----	Bush Road - Post w BMP DD 2
6	Combine	10.13	1	718	21,468	2, 3, 5	-----	-----	To Road Gutter
7	Reach	10.02	1	720	21,468	6	-----	-----	Road Gutter
8	Diversion1	1.804	1	729	4,628	1	-----	-----	Vol Abstraction
9	Diversion2	0.140	1	816	2,082	1	-----	-----	To POI
10	Combine	19.57	1	720	45,233	4, 7, 9	-----	-----	To POI
Post w BMP 50-100 yr_chk.gpw					Return Period: 100 Year			Monday, 11 / 7 / 2016	

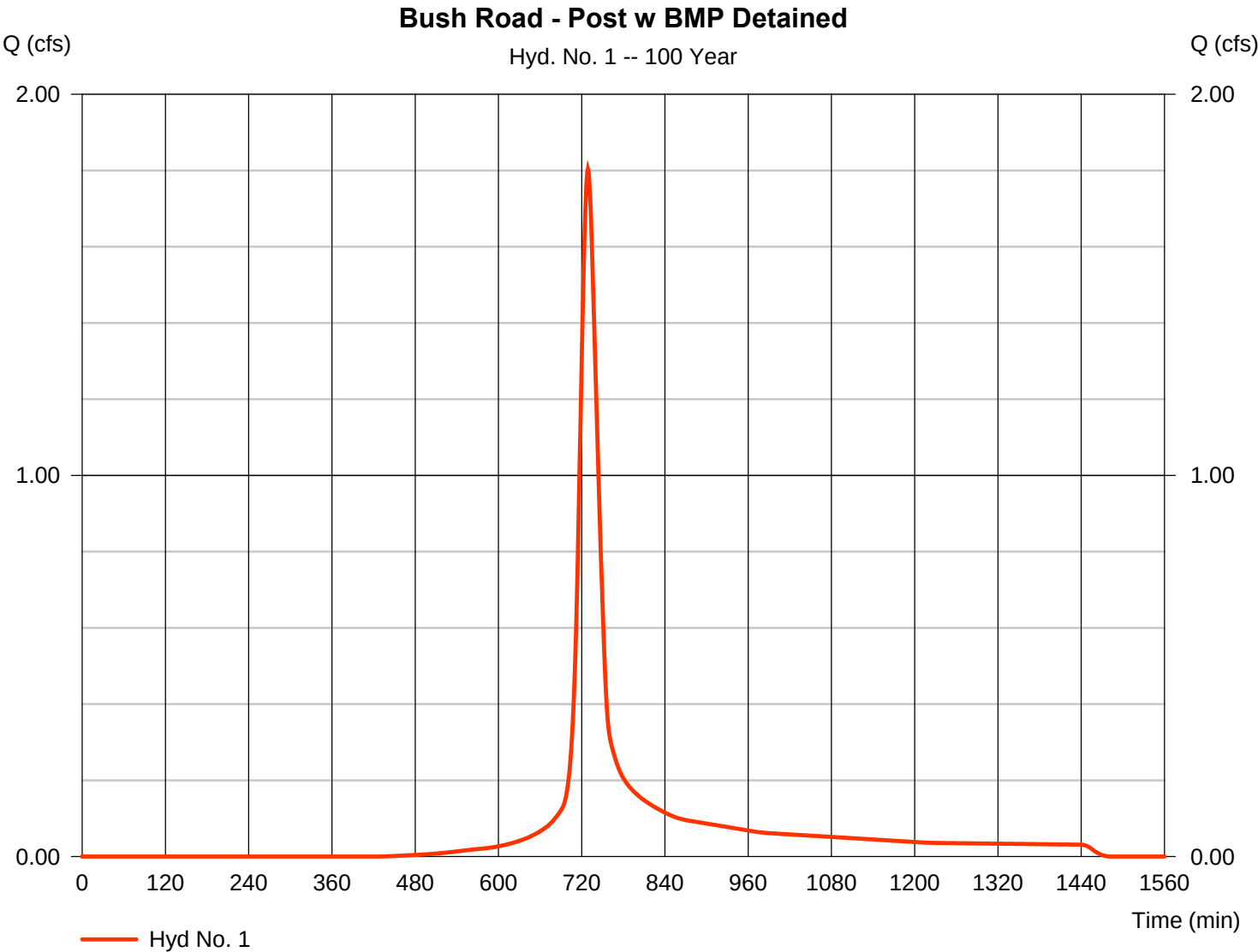
Hydrograph Report

Hyd. No. 1

Bush Road - Post w BMP Detained

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.804 cfs
Storm frequency	=	100 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	6,709 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	25.80 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 70) + (0.050 x 77) + (0.400 x 78) + (0.130 x 91)] / 0.610



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

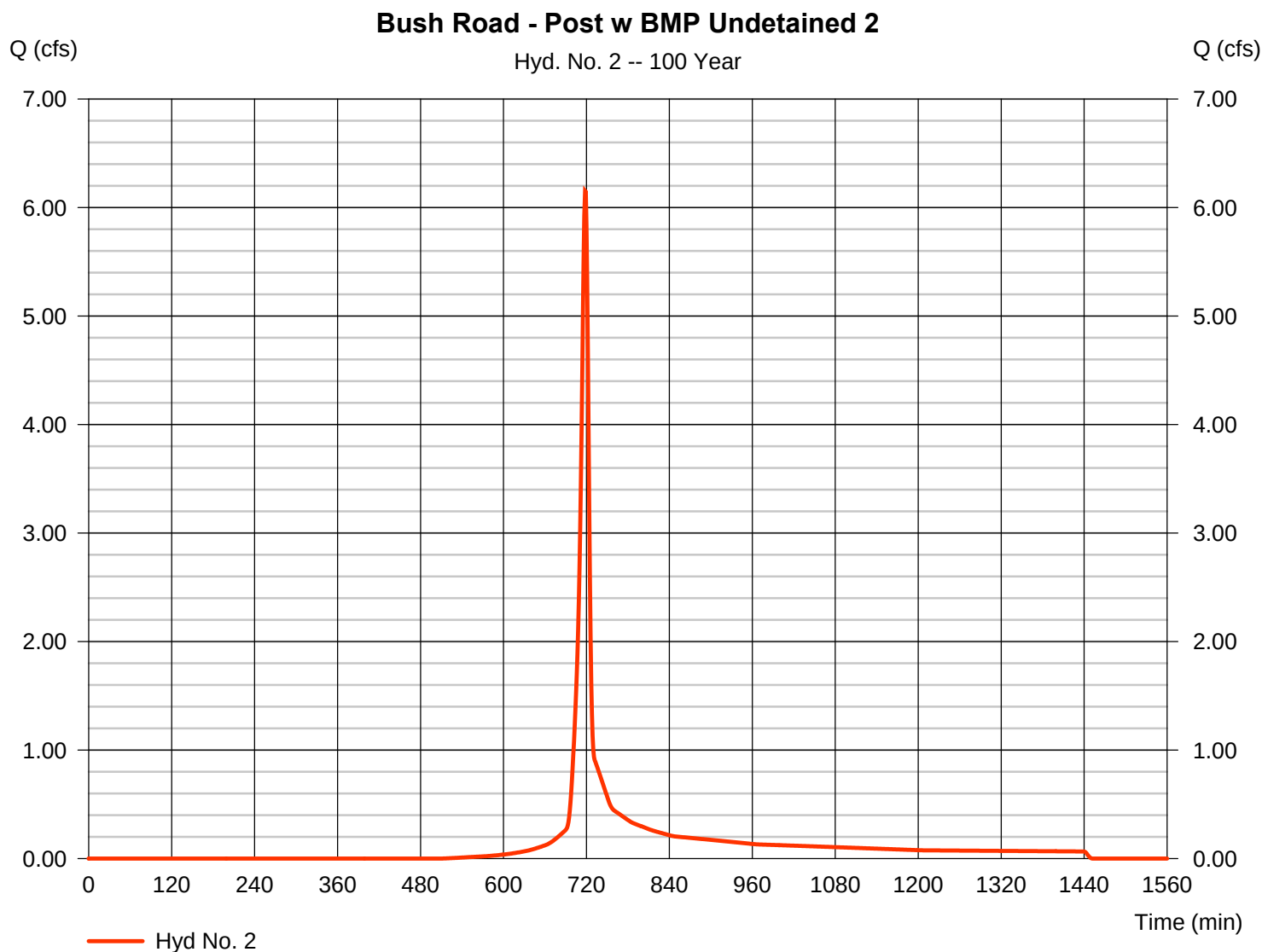
Monday, 11 / 7 / 2016

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.154 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	13,022 cuft
Drainage area	=	1.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.730 \times 78) + (0.180 \times 77) + (0.530 \times 70)] / 1.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Bush Road - Post w BMP Undetained 2

<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)	= 65.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.45	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 6.01	+	0.00	+	0.00	=	6.01
Shallow Concentrated Flow							
Flow length (ft)	= 20.00	140.00	0.00				
Watercourse slope (%)	= 2.00	7.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=2.87	4.27	0.00				
Travel Time (min)	= 0.12	+	0.55	+	0.00	=	0.66
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				6.70 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

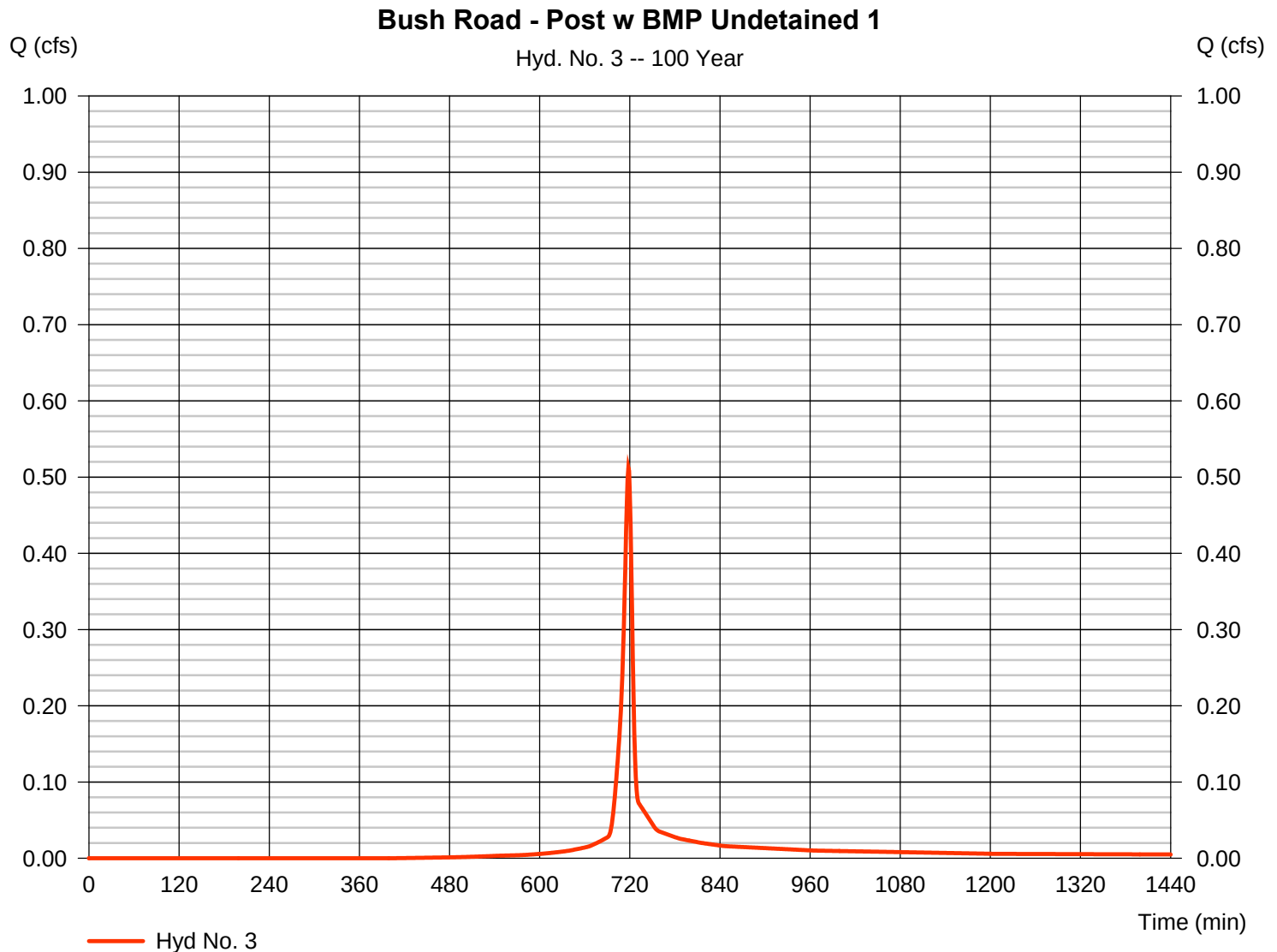
Monday, 11 / 7 / 2016

Hyd. No. 3

Bush Road - Post w BMP Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.512 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	1,097 cuft
Drainage area	=	0.100 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.080 \times 78) + (0.020 \times 91)] / 0.100$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Bush Road - Post w BMP Undetained 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)	= 2.45	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.22	+	0.00	+	0.00	=	7.22
Shallow Concentrated Flow							
Flow length (ft)	= 172.00	111.00	0.00				
Watercourse slope (%)	= 6.00	18.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	6.85	0.00				
Travel Time (min)	= 0.73	+	0.27	+	0.00	=	1.00
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

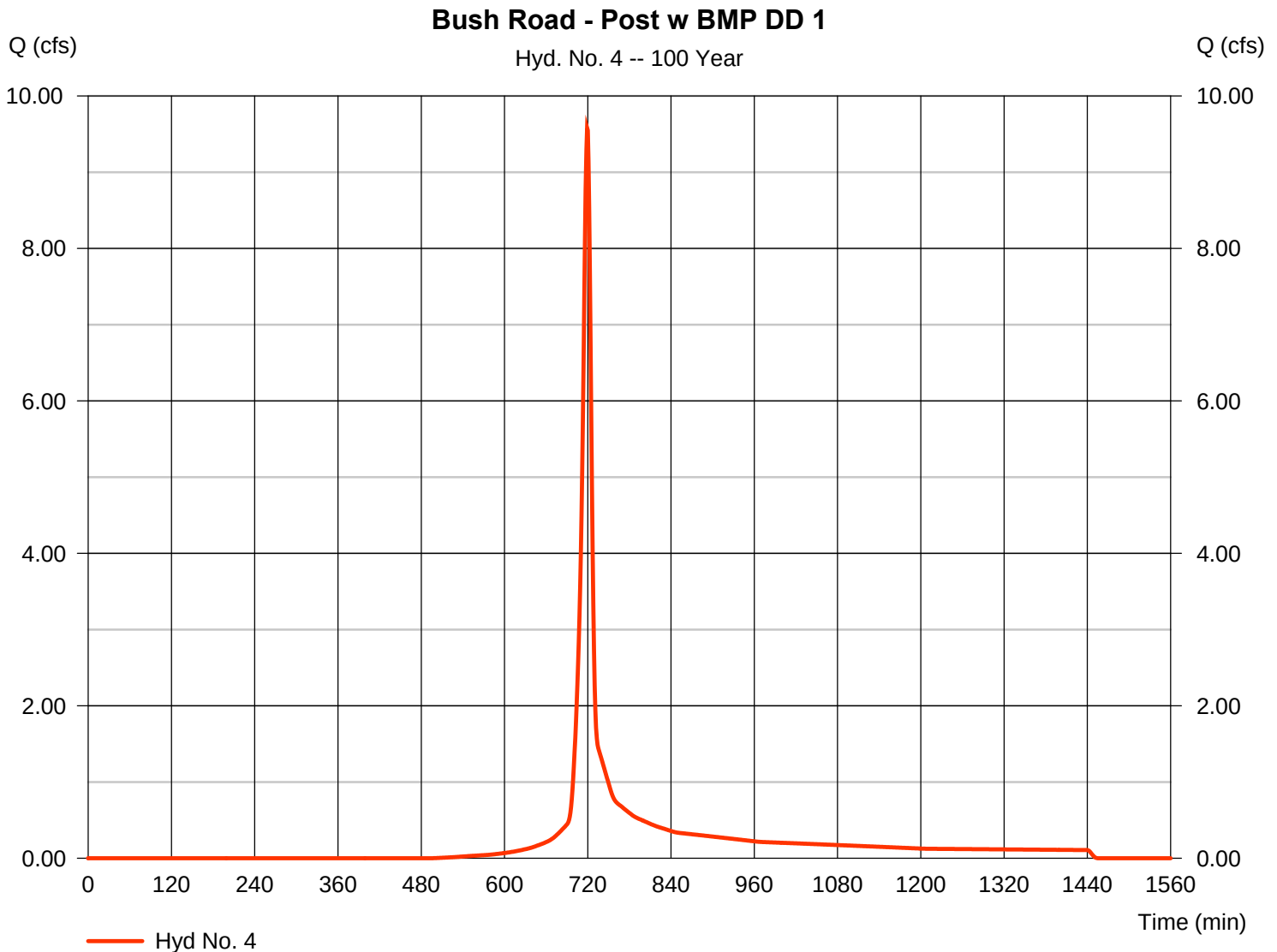
Monday, 11 / 7 / 2016

Hyd. No. 4

Bush Road - Post w BMP DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.579 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	21,683 cuft
Drainage area	=	2.260 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.50 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.670 \times 70) + (0.050 \times 77) + (1.540 \times 78)] / 2.260$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Bush Road - Post w BMP DD 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)	= 2.45	0.00	0.00				
Land slope (%)	= 18.00	0.00	0.00				
Travel Time (min)	= 4.65	+	0.00	+	0.00	=	4.65
Shallow Concentrated Flow							
Flow length (ft)	= 280.00	385.00	270.00				
Watercourse slope (%)	= 23.00	10.00	15.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=7.74	5.10	6.25				
Travel Time (min)	= 0.60	+	1.26	+	0.72	=	2.58
Channel Flow							
X sectional flow area (sqft)	= 2.52	0.00	0.00				
Wetted perimeter (ft)	= 5.02	0.00	0.00				
Channel slope (%)	= 2.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=2.21	0.00	0.00				
Flow length (ft)	({})175.0	0.0	0.0				
Travel Time (min)	= 1.32	+	0.00	+	0.00	=	1.32
Total Travel Time, Tc				8.50 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

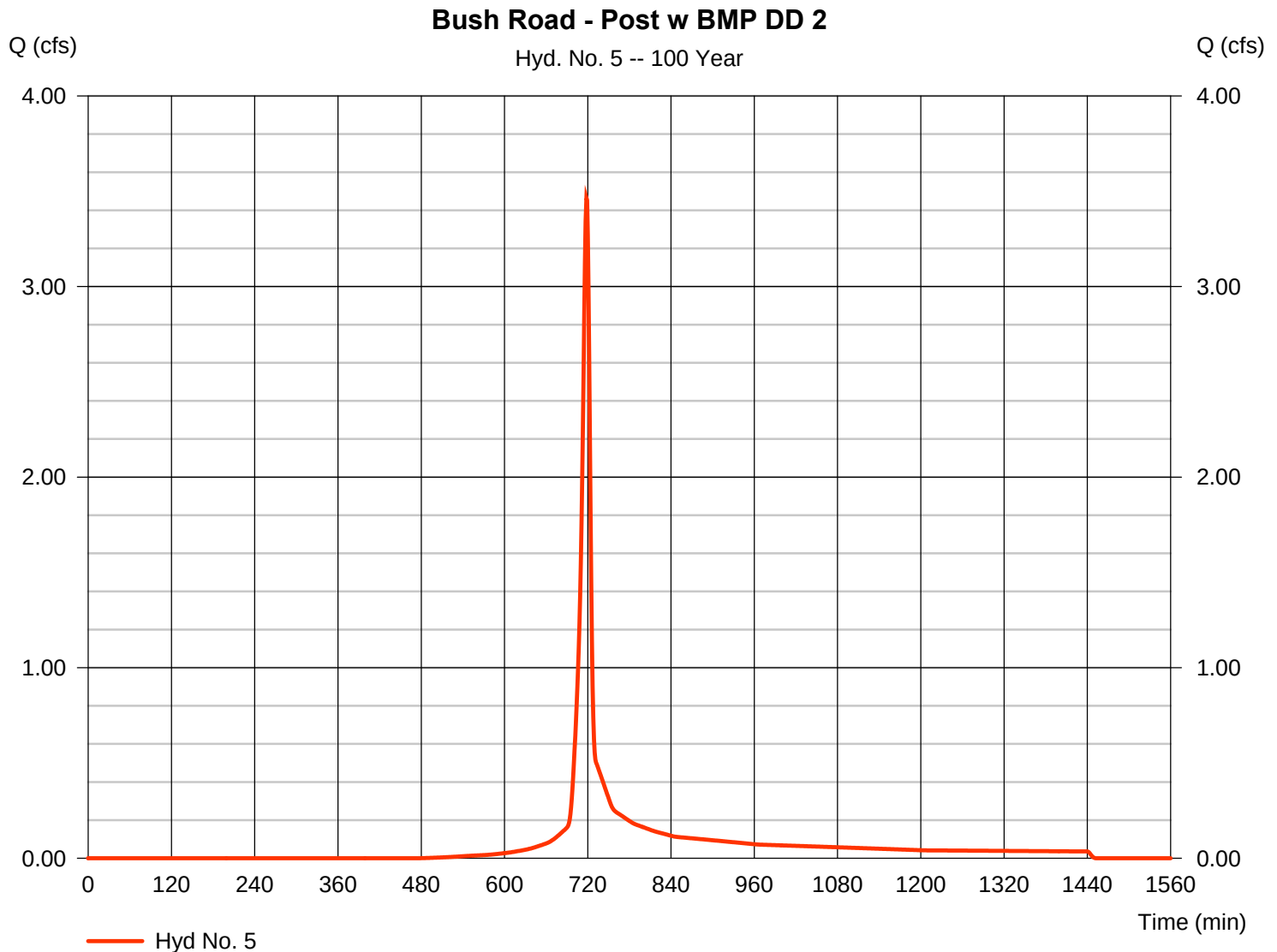
Monday, 11 / 7 / 2016

Hyd. No. 5

Bush Road - Post w BMP DD 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.464 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	7,349 cuft
Drainage area	=	0.760 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 70) + (0.010 \times 77) + (0.640 \times 78)] / 0.760$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Bush Road - Post w BMP DD 2

<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)	= 2.45	0.00	0.00				
Land slope (%)	= 22.00	0.00	0.00				
Travel Time (min)	= 4.29	+	0.00	+	0.00	=	4.29
Shallow Concentrated Flow							
Flow length (ft)	= 210.00	510.00	0.00				
Watercourse slope (%)	= 25.00	9.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.07	4.84	0.00				
Travel Time (min)	= 0.43	+	1.76	+	0.00	=	2.19
Channel Flow							
X sectional flow area (sqft)	= 1.03	0.00	0.00				
Wetted perimeter (ft)	= 3.28	0.00	0.00				
Channel slope (%)	= 9.00	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.43	0.00	0.00				
Flow length (ft)	(0)}45.0	0.0	0.0				
Travel Time (min)	= 0.22	+	0.00	+	0.00	=	0.22
Total Travel Time, Tc					6.70 min		

Hydrograph Report

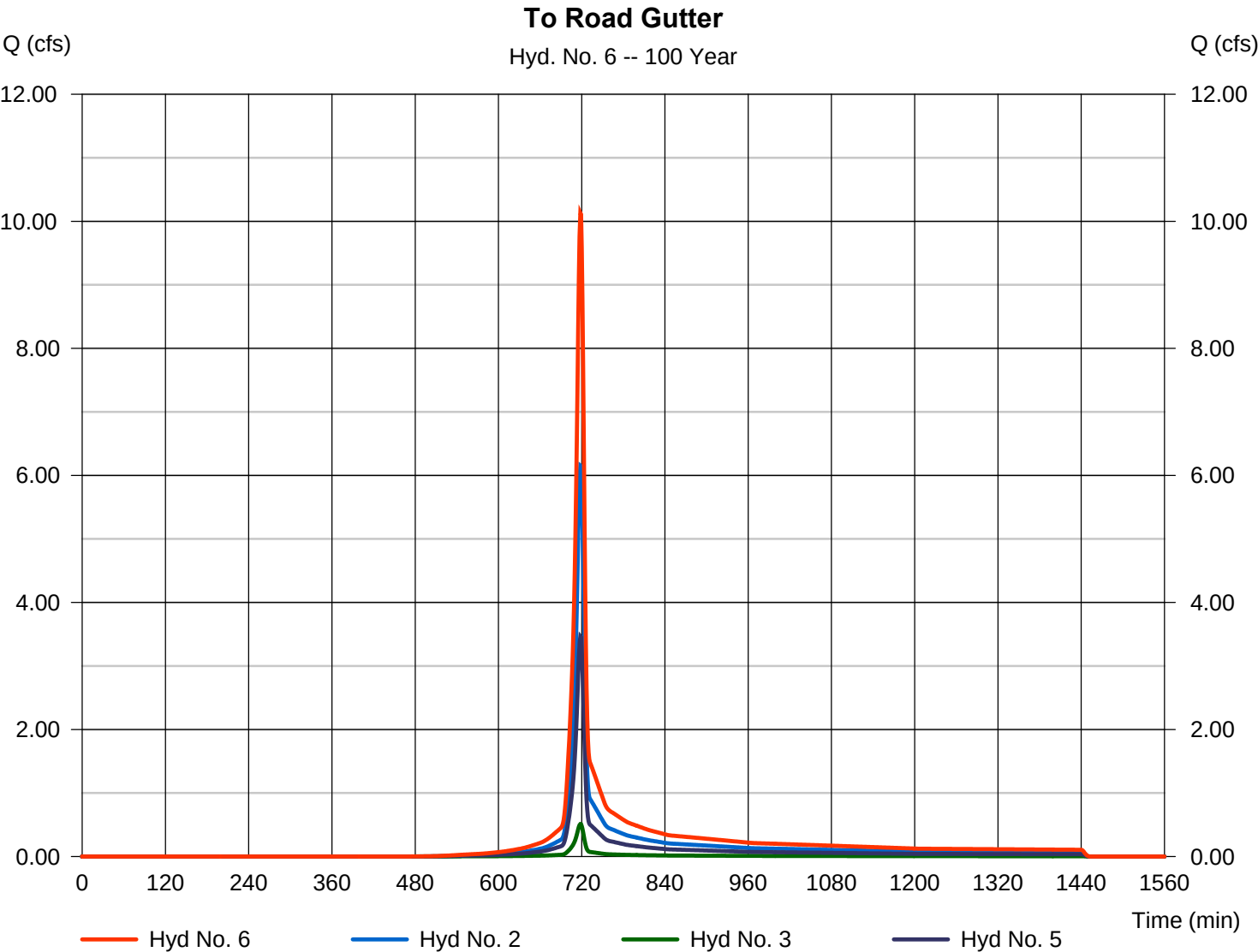
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 6

To Road Gutter

Hydrograph type	= Combine	Peak discharge	= 10.13 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 21,468 cuft
Inflow hyds.	= 2, 3, 5	Contrib. drain. area	= 2.300 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

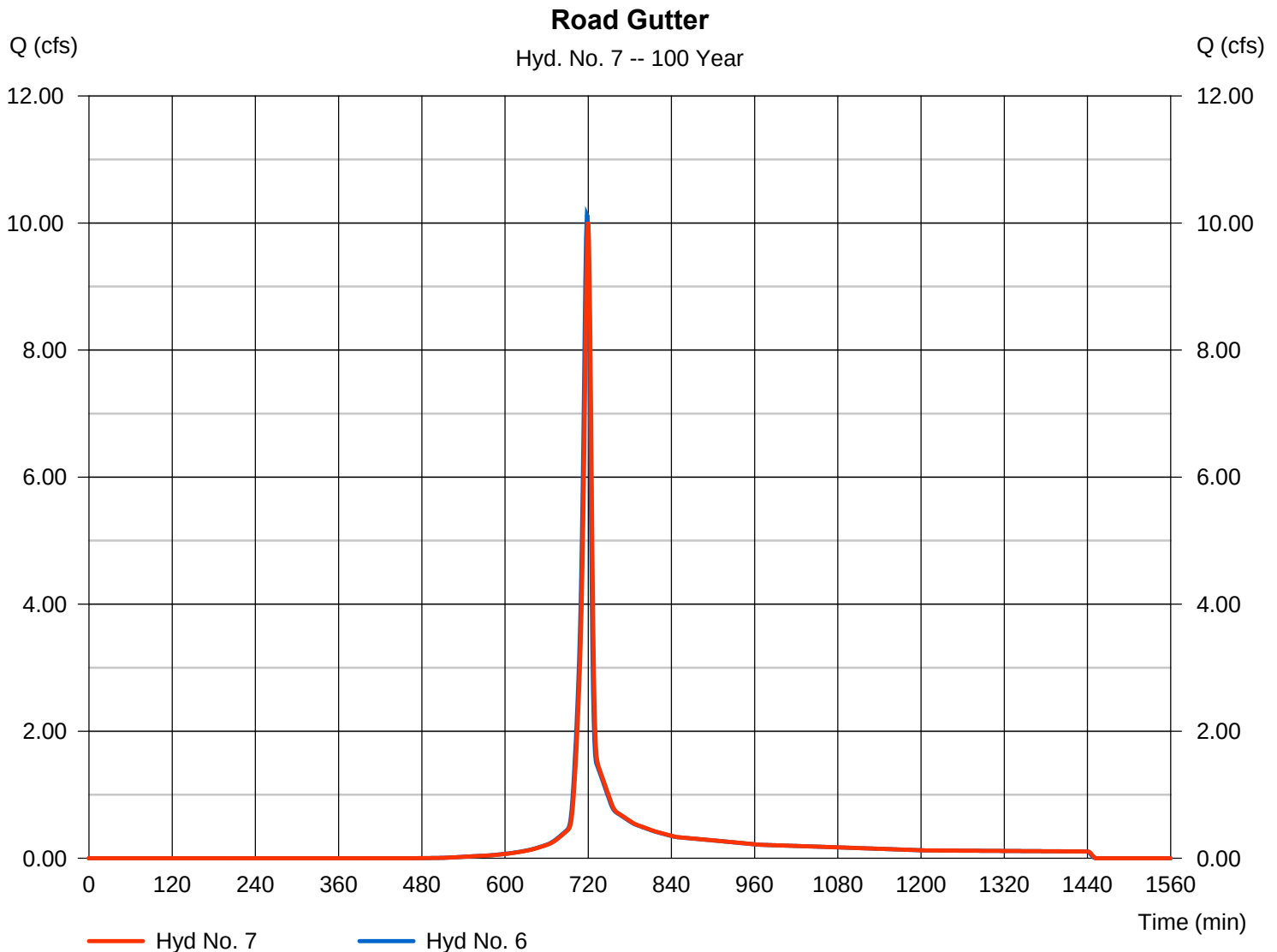
Monday, 11 / 7 / 2016

Hyd. No. 7

Road Gutter

Hydrograph type	= Reach	Peak discharge	= 10.02 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 21,468 cuft
Inflow hyd. No.	= 6 - To Road Gutter	Section type	= Triangular
Reach length	= 500.0 ft	Channel slope	= 4.0 %
Manning's n	= 0.030	Bottom width	= 0.0 ft
Side slope	= 2.0:1	Max. depth	= 0.0 ft
Rating curve x	= 4.975	Rating curve m	= 1.333
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.6445

Modified Att-Kin routing method used.



Hydrograph Report

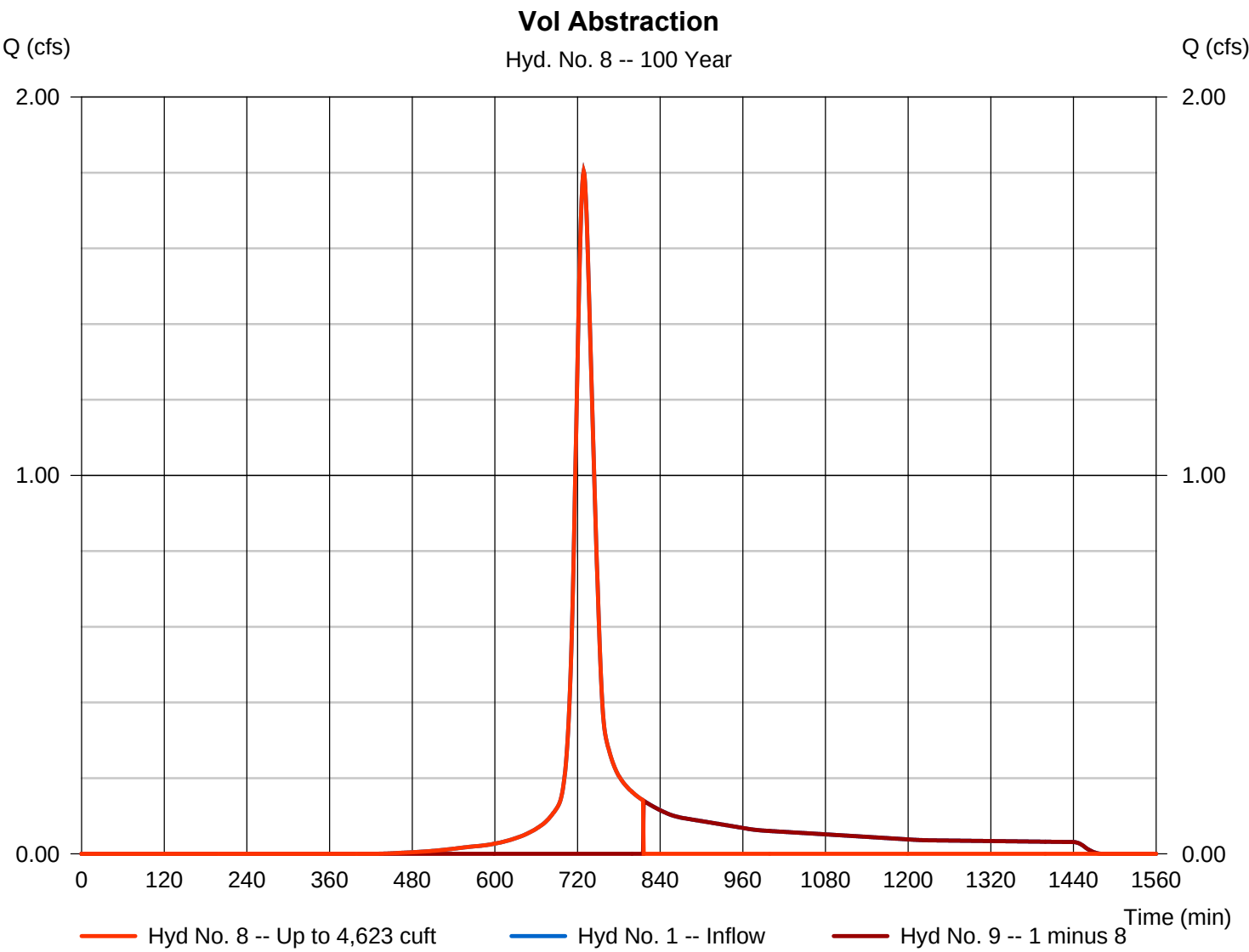
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 8

Vol Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.804 cfs
Storm frequency	=	100 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	4,628 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Divided hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	4,623 cuft



Hydrograph Report

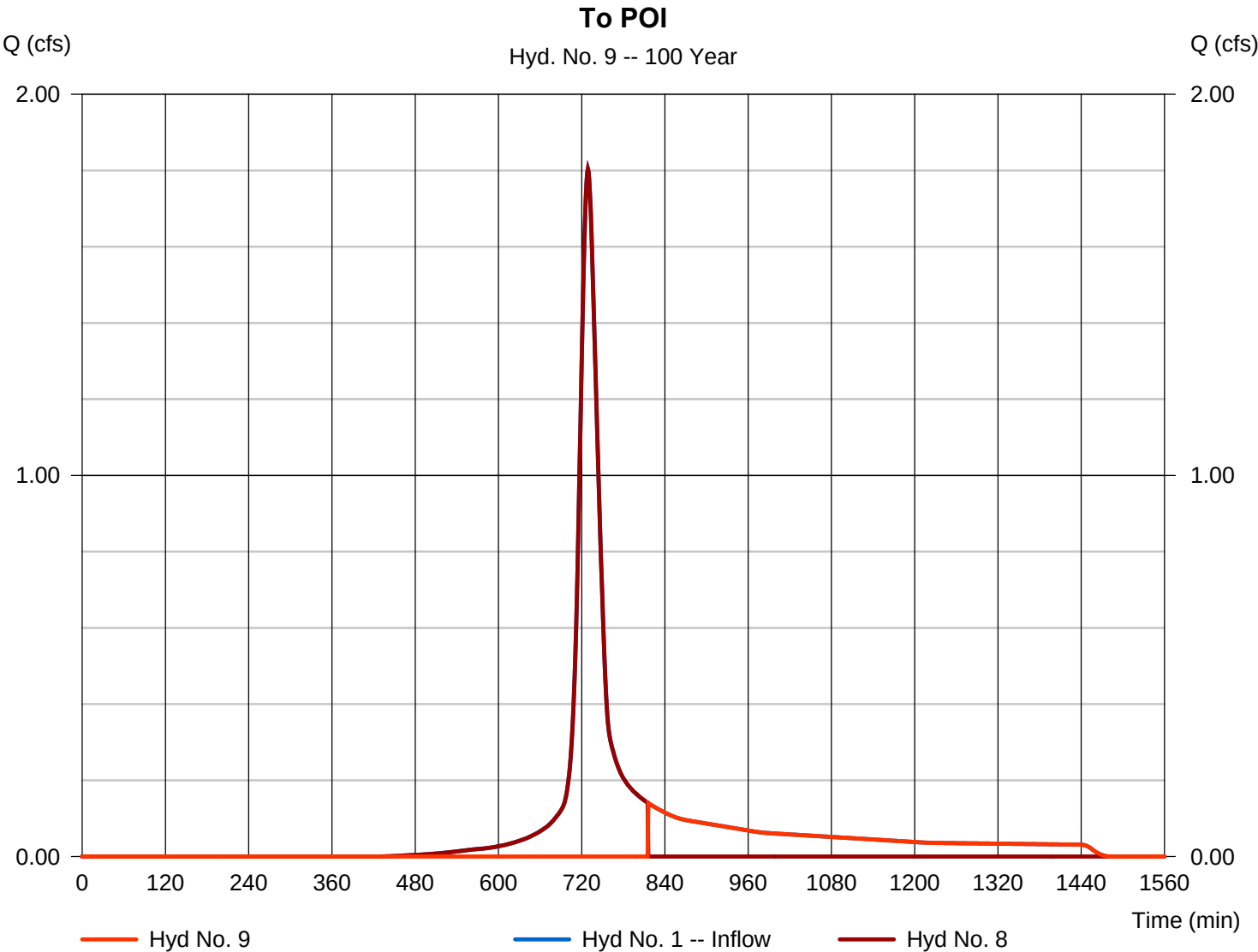
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 9

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.140 cfs
Storm frequency	=	100 yrs	Time to peak	=	816 min
Time interval	=	1 min	Hyd. volume	=	2,082 cuft
Inflow hydrograph	=	1 - Bush Road - Post w BMP Divided	Diverted hyd.	=	8
Diversion method	=	First Flush Volume	Volume Up To	=	4,623 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

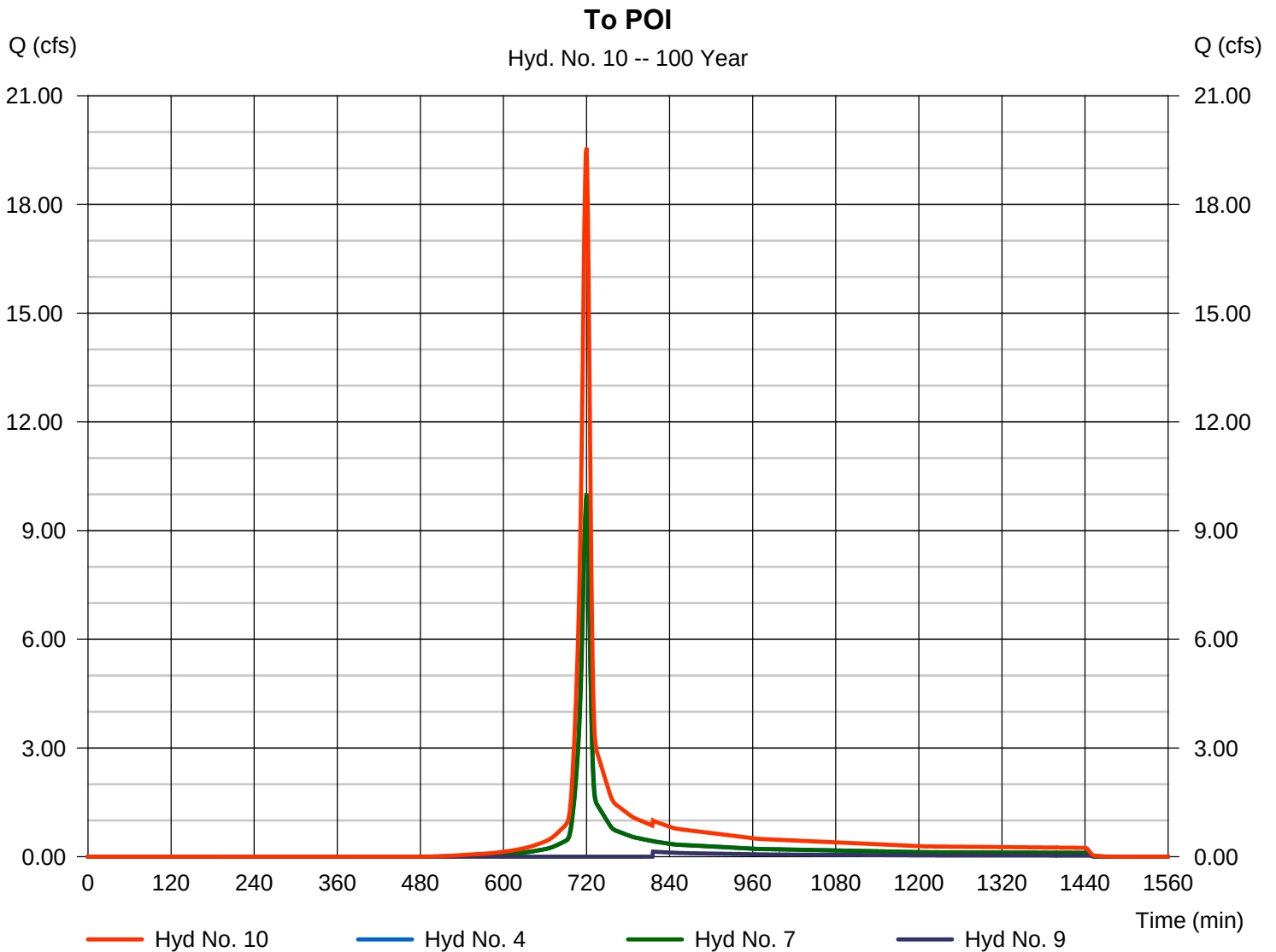
Monday, 11 / 7 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 4, 7, 9

Peak discharge = 19.57 cfs
 Time to peak = 720 min
 Hyd. volume = 45,233 cuft
 Contrib. drain. area = 2.260 ac



ATTACHMENT D
BUSH RD
DIVERSION CHANNEL DESIGN

TETRA TECH, INC.

By: LMD Date: 10/03/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/16 Bush Road Proj. No.: 112IC05958

DIVERSION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1	11.25
DD-2	4.00

The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	3.05	1.13	0.50	1.63
DD-2	3.07	0.60	0.50	1.10

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes		Channel Lining	Total Depth (ft)
			(_LH:1V)	(_RH:1V)		
DD-1	2%	1	2	2	NAG P300	2.00
DD-2	6%	1	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output.
2. The channel section characteristics resulting in the largest total depth were used.

TETRA TECH, INC.

By: LMD Date: 10/03/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: EAD Date: 10/25/16 Bush Road Proj. No.: 112IC05958

LEVEL SPREADER DESIGN

CHANNEL DESIGNATION	ENERGY DISSIPATOR TYPE	LENGTH (ft)	Downslope Protection	Q (cfs)
DD-1	Earthen Level Spreader	173	Grass/Rock	11.25

$$Q = C_w \times L \times H^{3/2} \quad (\text{Ref \#5})$$

Q = Flow (cfs)

L = Length of Level Spreader (ft)

C_w = Weir Coefficient 3.27

H = Driving Head (ft) 0.07 Based on V(allowable) = 1.33

$$V = 1.5 \times C_w \times H^{1/2} \quad (\text{Ref \#5})$$

V = Allowable velocity at the Level Spreader (fps)

Grass/Ticket = 1.33

Gravel = 1.5 (Table G.2, Ref #5)

Mulch (trees, Shrubs) = 0.67



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: 112IC05958 Sunoco
 Project Number: 103213
 Channel Name: DD1**

Discharge	11.25
Peak Flow Period	0.3
Channel Slope	0.02
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	D
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

P300 - Class D - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	11.25 cfs	4.41 ft/s	0.91 ft	0.03	3 lbs/ft ²	1.13 lbs/ft ²	2.65	STABLE	E
P300 Reinforced Vegetation	Straight	11.25 cfs	3.05 ft/s	1.13 ft	0.05	8 lbs/ft ²	1.41 lbs/ft ²	5.66	STABLE	E
Underlying Substrate	Straight	11.25 cfs	3.05 ft/s	1.13 ft	--	2 lbs/ft ²	0.113 lbs/ft ²	17.65	STABLE	--



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**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: 112IC05958 Sunoco
 Project Number: 103213
 Channel Name: DD2**

Discharge	4
Peak Flow Period	0.3
Channel Slope	0.06
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	D
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

P300 - Class D - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	4 cfs	4.64 ft/s	0.45 ft	0.034	3 lbs/ft ²	1.69 lbs/ft ²	1.77	STABLE	E
P300 Reinforced Vegetation	Straight	4 cfs	3.07 ft/s	0.6 ft	0.06	8 lbs/ft ²	2.23 lbs/ft ²	3.59	STABLE	E
Underlying Substrate	Straight	4 cfs	3.07 ft/s	0.6 ft	--	2 lbs/ft ²	0.172 lbs/ft ²	11.63	STABLE	--

WESTINGHOUSE RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 4, 2016

Project Name: Westinghouse Rd

Municipality: Derry Township

County: Westmoreland

Total Area (acres): 0.91

Major River Basin: Ohio

Watershed: Conemaugh River

Sub Basin: Conemaugh River

Nearest Surface Water to Receive Runoff: Conemaugh River

Ch. 93 - Designated Water Use: WWF

Impaired according to Chapter 303(d) list?

YES ☒

NO ☐

List Causes of Impairment:

Acid Mine Drainage - Metals
Acid Mine Drainage - pH
Acid Mine Drainage - Suspended Solids

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES ☐

NO ☒

Existing or Planned drinking water supply?

YES ☐

NO ☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES ☐

NO ☒

Existing River Conservation Plan?

YES ☐

NO ☒

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	0.91	0.1
Other:			
TOTAL EXISTING:	Yes	0.91	0.1

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>0.1</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>0.1</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
<u>0.91</u>	-	<u>0.1</u>	=	<u>0.81</u>
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn	<u> </u> ft ² x	1/4 in x	1/12 =	<u> </u> ft ³
Meadow	<u> </u> ft ² x	1/3 in x	1/12 =	<u> </u> ft ³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy	<u> </u> ft ² x	1/2 in x	1/12 =	<u> </u> ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	<u> </u> ft ² x	1/3 in x	1/12 =	<u> </u> ft ³

For all other disconnected roof areas

Roof Area	<u> </u> ft ² x	1/4 in x	1/12 =	<u> </u> ft ³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas	<u> </u> ft ² x	1/3 in x	1/12 =	<u> </u> ft ³

For all other disconnected roof areas

Impervious Areas	<u> </u> ft ² x	1/4 in x	1/12 =	<u> </u> ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

 ft³

** For use on Worksheet 5*

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Westinghouse Rd
 Drainage Area: 0.91 acres
 2-Year Rainfall: 2.50 in

Total Site Area: 0.91 acres
 Protected Site Area: 0.10 acres
 Managed Site Area: 0.81 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	5663	0.13	78	2.82	0.56	0.79	372
Woods	C/D	21344	0.49	77	2.99	0.60	0.74	1,317
Gravel	C/D	436	0.01	91	0.99	0.20	1.61	58
Meadow	C	4792	0.11	71	4.08	0.82	0.49	196
Woods	C	3049	0.07	70	4.29	0.86	0.46	116
TOTAL:		35,284	0.81					2,059

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	21780	0.50	78	2.82	0.56	0.79	1,430
Gravel	C/D	5537	0.13	91	0.99	0.20	1.61	743
Meadow	C	7405	0.17	71	4.08	0.82	0.49	303
Gravel	C	479	0.01	89	1.24	0.25	1.45	58
TOTAL:		35,201	0.81					2,534

2-Year Volume Increase (ft ³):	475

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Westinghouse Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 475

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 475
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	3,113	1,222
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			1,222
Structural Volume Requirement (ft³):			475
DIFFERENCE:			-747

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenion		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

**PCSM - DESIGN CALCULATIONS
WESTINGHOUSE RD**

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations **Westinghouse Road**

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Westinghouse Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Westinghouse Road Block Valve Site is located in Derry Township, Westmoreland County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This project will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This project will utilize infiltration berms to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.50
10-yr	3.52
50-yr	4.70
100-yr	5.26

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.50 in

Total Site Area : 0.91 acres

Protected Site Area: 0.10 acres

Stormwater Management Area 0.81 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.13	78	2.82	0.56	0.79	372
Woods	C/D	0.49	77	2.99	0.60	0.74	1,317
Gravel	C/D	0.01	91	0.99	0.20	1.61	58
Meadow	C	0.11	71	4.08	0.82	0.49	196
Woods	C	0.07	70	4.29	0.86	0.46	116
Total		0.81					2,059

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.50	78	2.82	0.56	0.79	1,430
Gravel	C/D	0.13	91	0.99	0.20	1.61	743
Meadow	C	0.17	71	4.08	0.82	0.49	303
Gravel	C	0.01	89	1.24	0.25	1.45	58
Total		0.81					2,534

2-Year Volume Increase (cf):	475

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

P = 2-Year Rainfall (in)

S = $(1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$

Q = Runoff (in)

Area = Land use area (sq. ft.)

TETRA TECH, INC.

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Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.20	8,712
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,742
Design Infiltration Area (sf):		3,113
Designed Impervious Ratio:	2.8	:1

OK

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.34	14,810
Maximum Total Watershed Ratio:	8	:1
Minimum Infiltration Area (sf):		1,851
Design Infiltration Area (sf):		3,113
Designed Total Watershed Ratio:	4.8	:1

OK

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Westinghouse Road Block Valve Site will be located along the eastern side of the pad and 100% of the disturbed area will be detained by the BMP.

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - Infiltration Berm 1	0.8

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

Infiltration Berm

Storage Volume

Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
38	83	3,113	2.00	3154

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.8	3,113	2	415

Volume Abstraction Potential (cf)	3,569

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration Berm 1	1222	3154	3154	1222
Total Structural Credit (cf) (Worksheet 5)				1222

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 0.91 acres. Based upon the soil survey of Westmoreland County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Gilpin channery silt loam (GcB), and Weinbach silt loam (WeA) series which are primarily classified as HSG C and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	WeA	Meadow	78	0.13
C/D	WeA	Woods	77	0.55
C/D	WeA	Impervious - Gravel	91	0.01
C	GcB	Meadow	71	0.11
C	GcB	Woods	70	0.11
Totals				0.91
CN				76

Post-Development Condition

Undetained Area

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	WeA	Meadow	78	0.03
C	GcB	Meadow	71	0.07
C	GcB	Woods	70	0.04
Totals				0.14
CN				72

BMP (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	WeA	Meadow	78	0.46
C/D	WeA	Woods	77	0.06
C/D	WeA	Gravel	91	0.13
C	GcB	Meadow	71	0.11
C	GcB	Gravel	89	0.01
Totals				0.77
CN				79

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.7	1,222	29.1	3.1	32.2
10	1.2	2,170	29.6	3.1	32.7
50	1.9	3,154	28.3	3.1	31.4
100	2.2	3,154	24.3	3.1	27.4

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow } w/o \text{ BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,222	3,569	1,222
10	2,170	3,569	2,170
50	3,360	3,569	3,360
100	3,946	3,569	3,569

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	0.7	1.3	1,378	0.1	-0.6
10-yr	1.6	2.4	2,795	0.5	-1.1
50-yr	2.6	3.8	4,744	1.1	-1.5
100-yr	3.2	4.5	5,912	1.6	-1.6

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/12/2016 Westinghouse Rd Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Westmoreland County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4447 N 79.3043 W 965.89 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Derry Twp, Pennsylvania, USA*
Latitude: 40.4447°, Longitude: -79.3043°
Elevation: 965.89 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.315 (0.285-0.347)	0.375 (0.340-0.415)	0.454 (0.411-0.501)	0.516 (0.466-0.568)	0.595 (0.536-0.655)	0.657 (0.589-0.722)	0.717 (0.640-0.786)	0.780 (0.693-0.854)	0.864 (0.763-0.946)	0.928 (0.815-1.01)
10-min	0.489 (0.442-0.539)	0.586 (0.531-0.648)	0.706 (0.639-0.779)	0.797 (0.719-0.877)	0.911 (0.819-1.00)	0.995 (0.893-1.09)	1.08 (0.963-1.18)	1.16 (1.03-1.27)	1.27 (1.12-1.39)	1.35 (1.19-1.48)
15-min	0.599 (0.542-0.661)	0.717 (0.649-0.793)	0.867 (0.785-0.957)	0.980 (0.885-1.08)	1.13 (1.01-1.24)	1.23 (1.10-1.35)	1.34 (1.20-1.47)	1.45 (1.29-1.59)	1.58 (1.40-1.74)	1.69 (1.48-1.85)
30-min	0.793 (0.717-0.875)	0.959 (0.869-1.06)	1.19 (1.07-1.31)	1.36 (1.23-1.50)	1.59 (1.43-1.75)	1.76 (1.58-1.94)	1.94 (1.73-2.12)	2.11 (1.88-2.31)	2.35 (2.07-2.57)	2.53 (2.22-2.77)
60-min	0.968 (0.876-1.07)	1.18 (1.07-1.30)	1.49 (1.35-1.64)	1.73 (1.56-1.91)	2.06 (1.85-2.27)	2.32 (2.08-2.55)	2.59 (2.31-2.84)	2.87 (2.55-3.14)	3.25 (2.87-3.56)	3.56 (3.12-3.89)
2-hr	1.13 (1.03-1.24)	1.37 (1.24-1.50)	1.73 (1.57-1.90)	2.01 (1.83-2.21)	2.41 (2.18-2.64)	2.73 (2.46-2.98)	3.07 (2.75-3.35)	3.43 (3.05-3.72)	3.92 (3.46-4.26)	4.33 (3.80-4.69)
3-hr	1.21 (1.10-1.33)	1.46 (1.33-1.61)	1.84 (1.67-2.02)	2.14 (1.94-2.36)	2.57 (2.32-2.82)	2.92 (2.62-3.19)	3.29 (2.93-3.59)	3.68 (3.27-4.01)	4.23 (3.73-4.60)	4.69 (4.09-5.09)
6-hr	1.46 (1.32-1.62)	1.75 (1.59-1.95)	2.19 (1.98-2.43)	2.54 (2.30-2.82)	3.05 (2.75-3.37)	3.47 (3.11-3.83)	3.92 (3.49-4.31)	4.40 (3.89-4.83)	5.09 (4.45-5.57)	5.65 (4.90-6.17)
12-hr	1.76 (1.60-1.96)	2.11 (1.92-2.35)	2.61 (2.37-2.90)	3.02 (2.74-3.35)	3.63 (3.27-4.01)	4.14 (3.70-4.55)	4.68 (4.15-5.13)	5.26 (4.64-5.76)	6.12 (5.33-6.68)	6.83 (5.90-7.44)
24-hr	2.10 (1.94-2.28)	2.50 (2.32-2.72)	3.06 (2.83-3.33)	3.52 (3.25-3.82)	4.17 (3.83-4.51)	4.70 (4.31-5.08)	5.26 (4.80-5.68)	5.85 (5.31-6.30)	6.68 (6.02-7.18)	7.35 (6.58-7.89)
2-day	2.44 (2.26-2.64)	2.90 (2.69-3.15)	3.52 (3.27-3.82)	4.02 (3.72-4.36)	4.72 (4.36-5.11)	5.29 (4.87-5.71)	5.88 (5.38-6.34)	6.49 (5.92-6.98)	7.33 (6.65-7.88)	8.00 (7.22-8.59)
3-day	2.62 (2.44-2.82)	3.11 (2.90-3.35)	3.74 (3.48-4.04)	4.26 (3.96-4.58)	4.97 (4.61-5.34)	5.55 (5.12-5.96)	6.14 (5.65-6.59)	6.76 (6.20-7.24)	7.60 (6.93-8.14)	8.27 (7.49-8.84)
4-day	2.80 (2.61-3.00)	3.31 (3.10-3.56)	3.96 (3.71-4.25)	4.49 (4.19-4.81)	5.22 (4.86-5.58)	5.81 (5.38-6.20)	6.41 (5.92-6.84)	7.03 (6.47-7.50)	7.87 (7.20-8.39)	8.53 (7.77-9.09)
7-day	3.36 (3.16-3.58)	3.96 (3.73-4.23)	4.68 (4.40-4.99)	5.25 (4.93-5.60)	6.03 (5.64-6.41)	6.64 (6.20-7.06)	7.25 (6.75-7.70)	7.87 (7.30-8.35)	8.70 (8.04-9.23)	9.33 (8.58-9.89)
10-day	3.89 (3.68-4.12)	4.58 (4.33-4.85)	5.36 (5.06-5.67)	5.97 (5.64-6.31)	6.79 (6.40-7.17)	7.43 (6.99-7.84)	8.07 (7.57-8.51)	8.70 (8.14-9.18)	9.54 (8.88-10.1)	10.2 (9.43-10.7)
20-day	5.47 (5.20-5.76)	6.41 (6.09-6.76)	7.39 (7.02-7.79)	8.16 (7.74-8.61)	9.17 (8.69-9.66)	9.95 (9.41-10.5)	10.7 (10.1-11.3)	11.4 (10.8-12.0)	12.4 (11.6-13.0)	13.1 (12.3-13.8)
30-day	6.90 (6.59-7.24)	8.06 (7.69-8.47)	9.20 (8.79-9.67)	10.1 (9.64-10.6)	11.3 (10.7-11.8)	12.2 (11.6-12.7)	13.0 (12.4-13.6)	13.8 (13.1-14.5)	14.9 (14.1-15.6)	15.6 (14.8-16.4)
45-day	8.85 (8.47-9.27)	10.3 (9.87-10.8)	11.6 (11.1-12.2)	12.7 (12.1-13.3)	14.0 (13.3-14.6)	14.9 (14.2-15.6)	15.8 (15.1-16.6)	16.7 (15.9-17.5)	17.7 (16.8-18.6)	18.5 (17.5-19.3)
60-day	10.7 (10.3-11.2)	12.4 (11.9-13.0)	13.9 (13.3-14.5)	15.1 (14.4-15.7)	16.5 (15.8-17.2)	17.5 (16.8-18.3)	18.5 (17.7-19.3)	19.3 (18.5-20.2)	20.4 (19.5-21.3)	21.2 (20.2-22.1)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

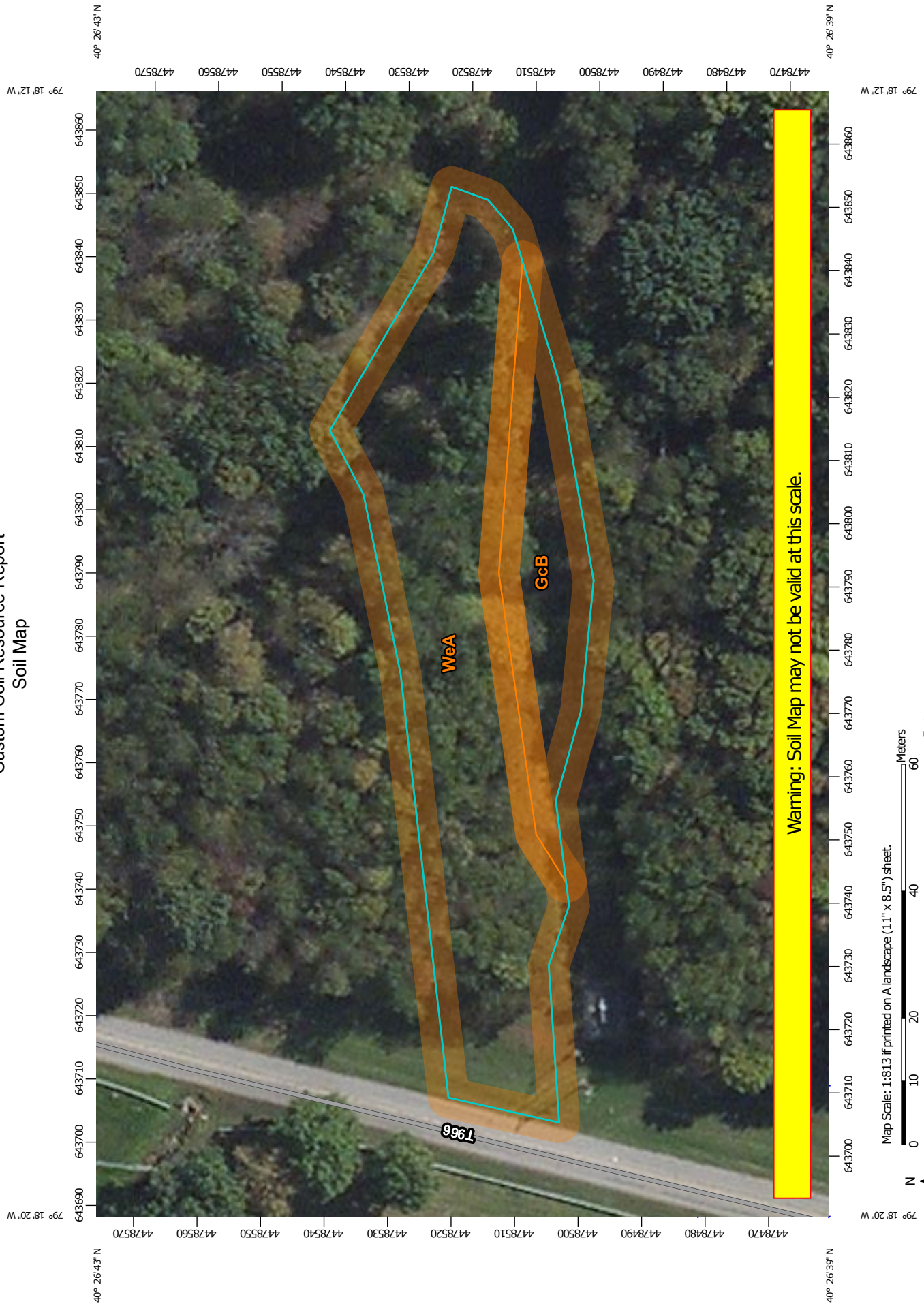
A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for Westmoreland County, Pennsylvania



September 30, 2016

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

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: <http://websoilsurvey.nrcs.usda.gov>
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: Westmoreland County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Westmoreland County, Pennsylvania (PA129)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GcB	Gilpin channery silt loam, 3 to 8 percent slopes	0.2	22.4%
WeA	Weinbach silt loam, 0 to 2 percent slopes	0.7	77.6%
Totals for Area of Interest		0.9	100.0%

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

Westmoreland County, Pennsylvania

GcB—Gilpin channery silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t1kt
Elevation: 870 to 2,720 feet
Mean annual precipitation: 40 to 53 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 167 to 179 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Gilpin and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 30 inches: extremely channery loam
R - 30 to 40 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 30 to 36 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Wharton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder

Custom Soil Resource Report

Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Weikert

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

WeA—Weinbach silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 18s0
Elevation: 700 to 1,300 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Weinbach and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Weinbach

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old silty alluvium

Typical profile

Ap - 0 to 10 inches: silt loam
Btg - 10 to 30 inches: silt loam
Btx - 30 to 65 inches: silty clay loam
BC - 65 to 80 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 20 to 30 inches to fragipan
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)

Custom Soil Resource Report

Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Monongahela

Percent of map unit: 10 percent
Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ginat

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Interfluve, tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

ATTACHMENT C
WESTINGHOUSE ROAD
HYDRAFLOW RESULTS

**ATTACHMENT C-1
WESTINGHOUSE ROAD
2 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Westinghouse Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.744	-----	-----	1.554	-----	2.626	3.161	Westinghouse Rd - PRE
Proj. file: Westinghouse Rd-PRE.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.744	2	724	2,237	-----	-----	-----	Westinghouse Rd - PRE
Westinghouse Rd-PRE.gpw					Return Period: 2 Year			Monday, 11 / 7 / 2016	

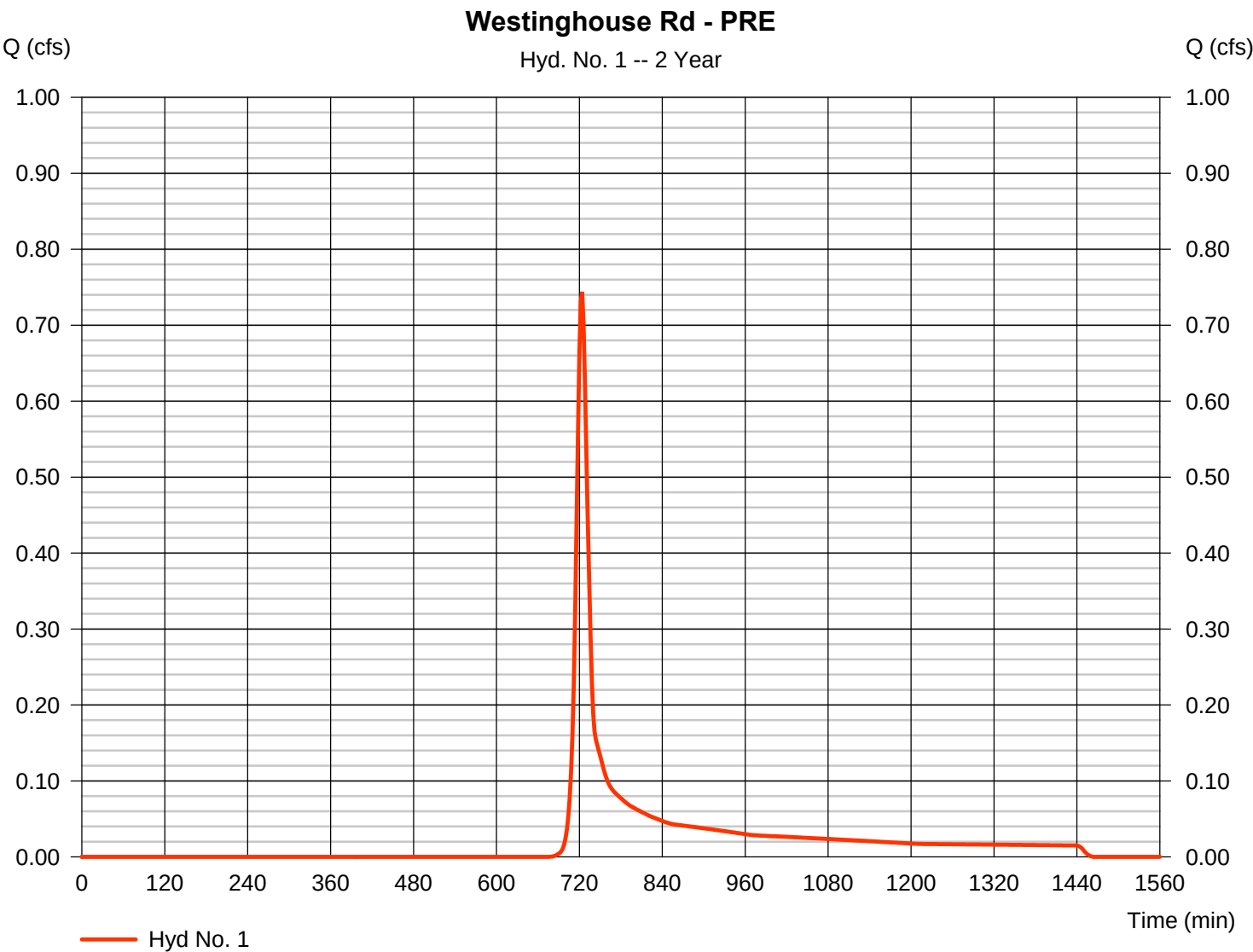
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.744 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	2,237 cuft
Drainage area	=	0.910 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.30 min
Total precip.	=	2.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.550 x 77) + (0.010 x 91) + (0.110 x 71) + (0.110 x 70)] / 0.910



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

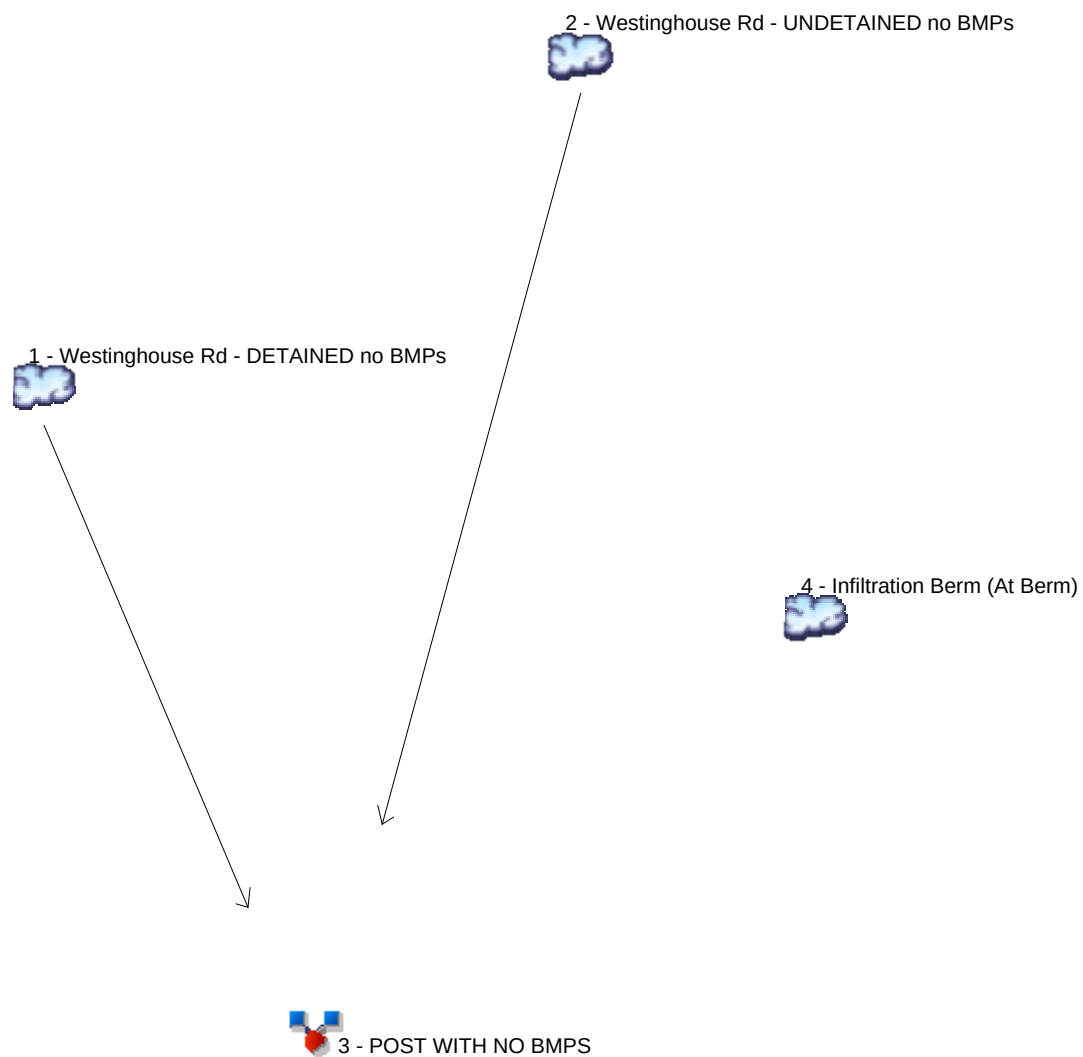
Hyd. No. 1

Westinghouse Rd - PRE

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 14.63	+	0.00	+	0.00	=	14.63
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	248.00	0.00				
Watercourse slope (%)	= 4.00	11.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.23	5.35	0.00				
Travel Time (min)	= 0.85	+	0.77	+	0.00	=	1.62
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				16.30 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.096	-----	-----	2.060	-----	3.293	3.901	Westinghouse Rd - DETAINED no B
2	SCS Runoff	-----	-----	0.108	-----	-----	0.249	-----	0.437	0.532	Westinghouse Rd - UNDETAINED no
3	Combine	1, 2	-----	1.265	-----	-----	2.389	-----	3.791	4.480	POST WITH NO BMPS
4	SCS Runoff	-----	-----	0.700	-----	-----	1.220	-----	1.855	2.160	Infiltration Berm (At Berm)
Proj. file: Westinghouse Rd-Post No BMPs.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.096	2	718	2,194	-----	-----	-----	Westinghouse Rd - DETAINED no B
2	SCS Runoff	0.108	2	720	269	-----	-----	-----	Westinghouse Rd - UNDETAINED no
3	Combine	1.265	2	718	2,598	1, 2	-----	-----	POST WITH NO BMPS
4	SCS Runoff	0.700	1	716	1,222	-----	-----	-----	Infiltration Berm (At Berm)
Westinghouse Rd-Post No BMPs.gpw					Return Period: 2 Year			Monday, 11 / 7 / 2016	

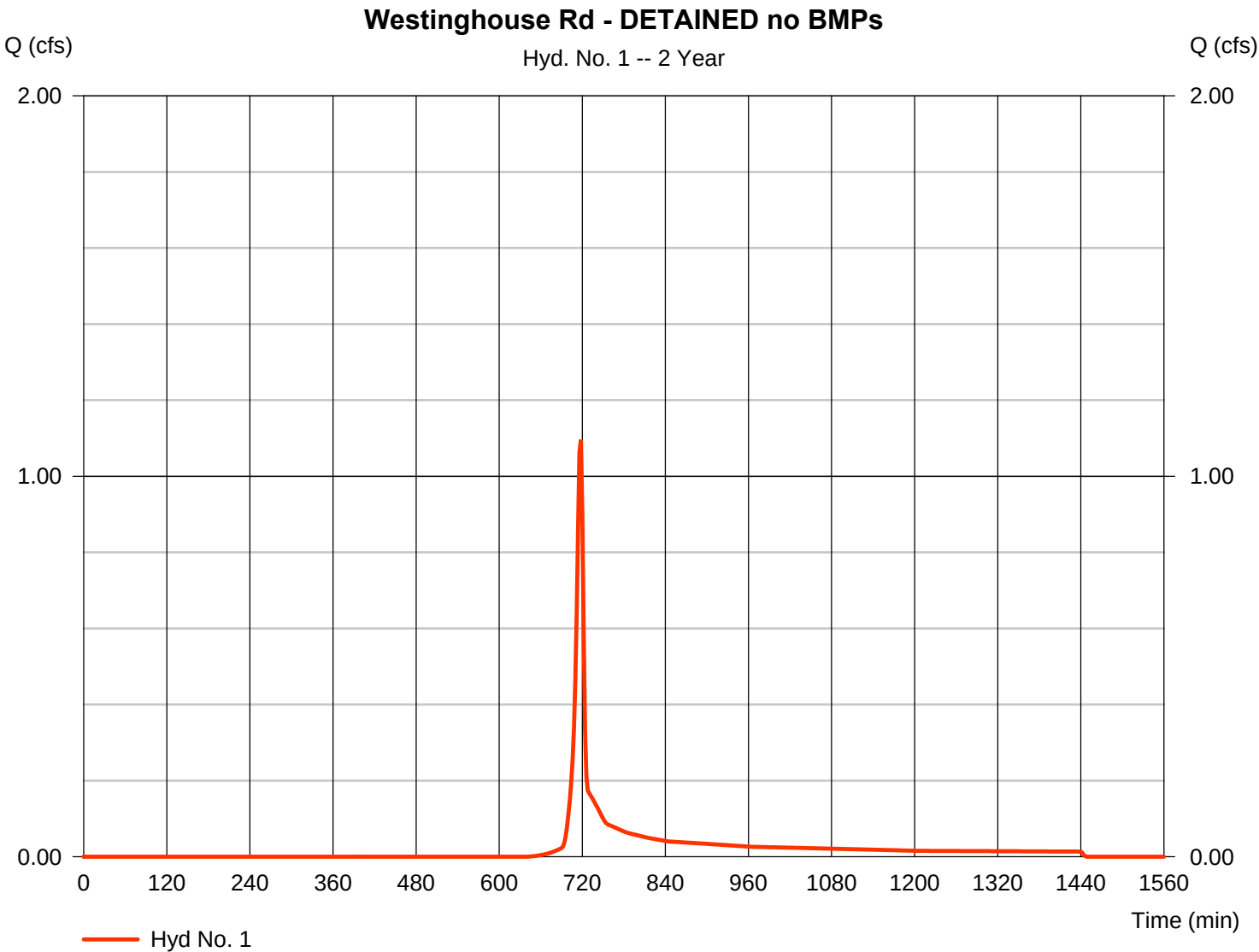
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.096 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	2,194 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	2.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	96.00	208.00				
Watercourse slope (%)	= 5.00	6.00	13.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.55	3.95	5.82				
Travel Time (min)	= 0.27	+	0.40	+	0.60	=	1.27
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 2.78	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=8.99	0.00	0.00				
Flow length (ft)	(0)36.0	0.0	0.0				
Travel Time (min)	= 0.07	+	0.00	+	0.00	=	0.07
Total Travel Time, Tc				3.10 min			

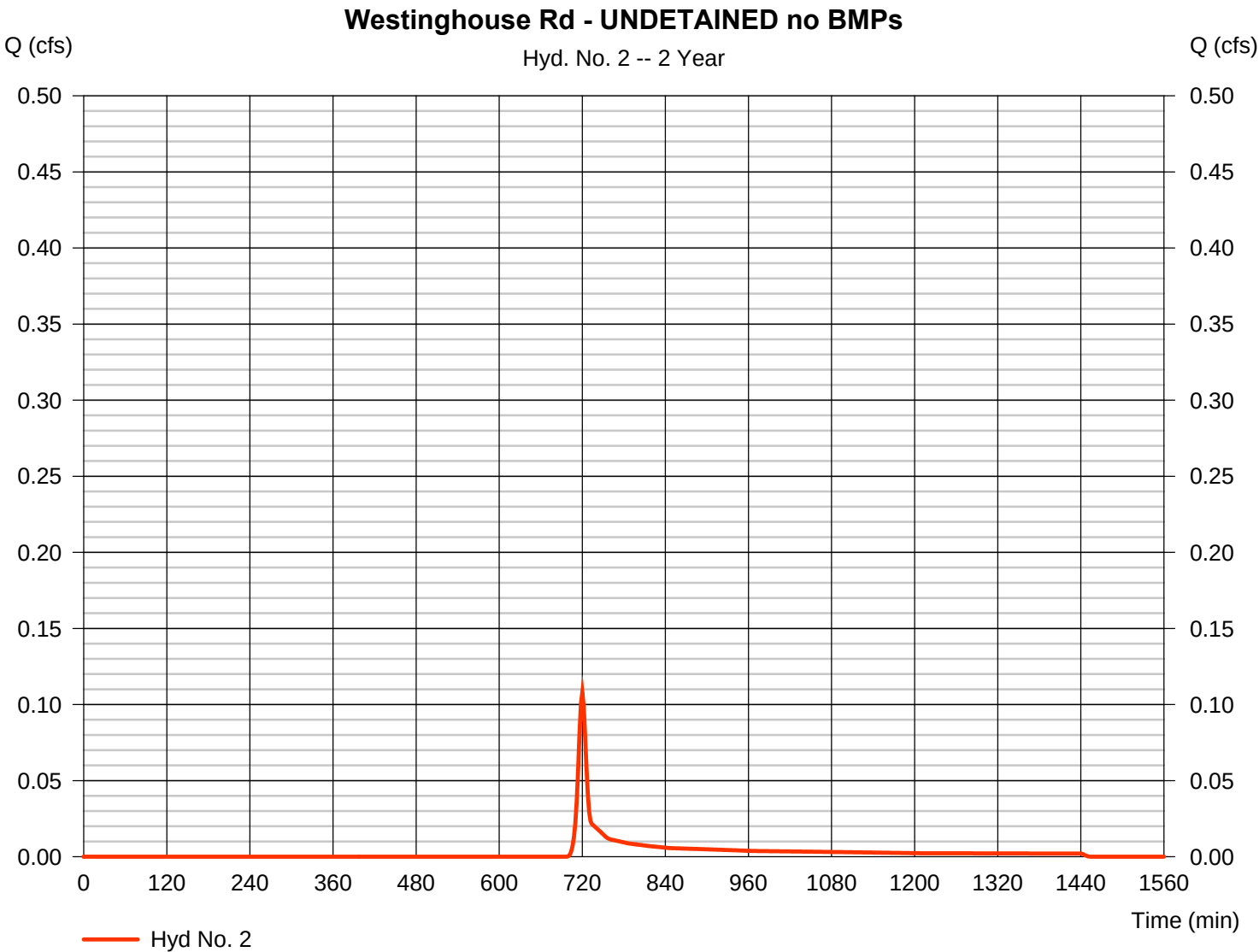
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.108 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	269 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	2.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 78) + (0.070 x 71) + (0.040 x 70)] / 0.140



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

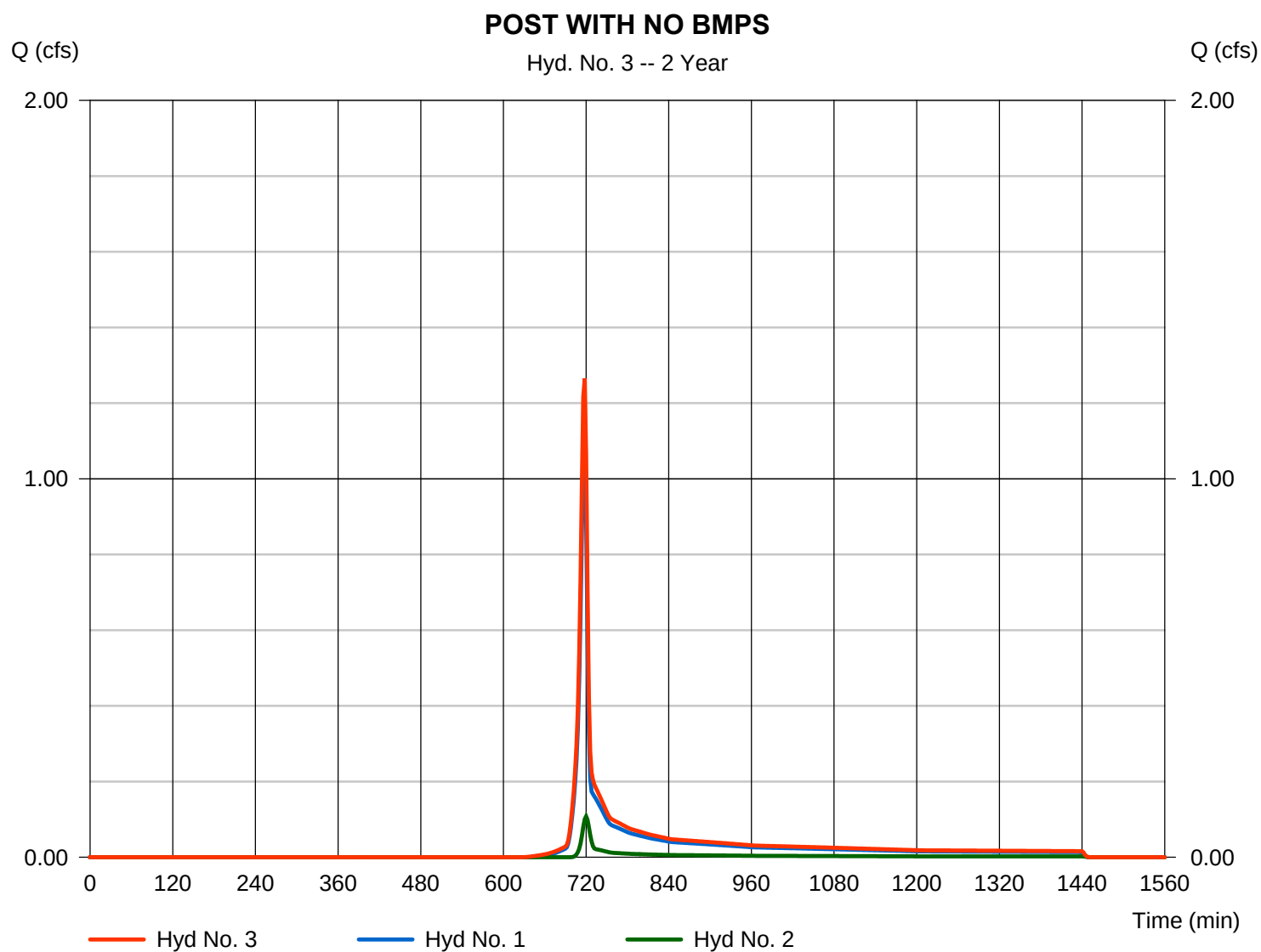
Monday, 11 / 7 / 2016

Hyd. No. 3

POST WITH NO BMPS

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 1.265 cfs
 Time to peak = 718 min
 Hyd. volume = 2,598 cuft
 Contrib. drain. area = 0.910 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

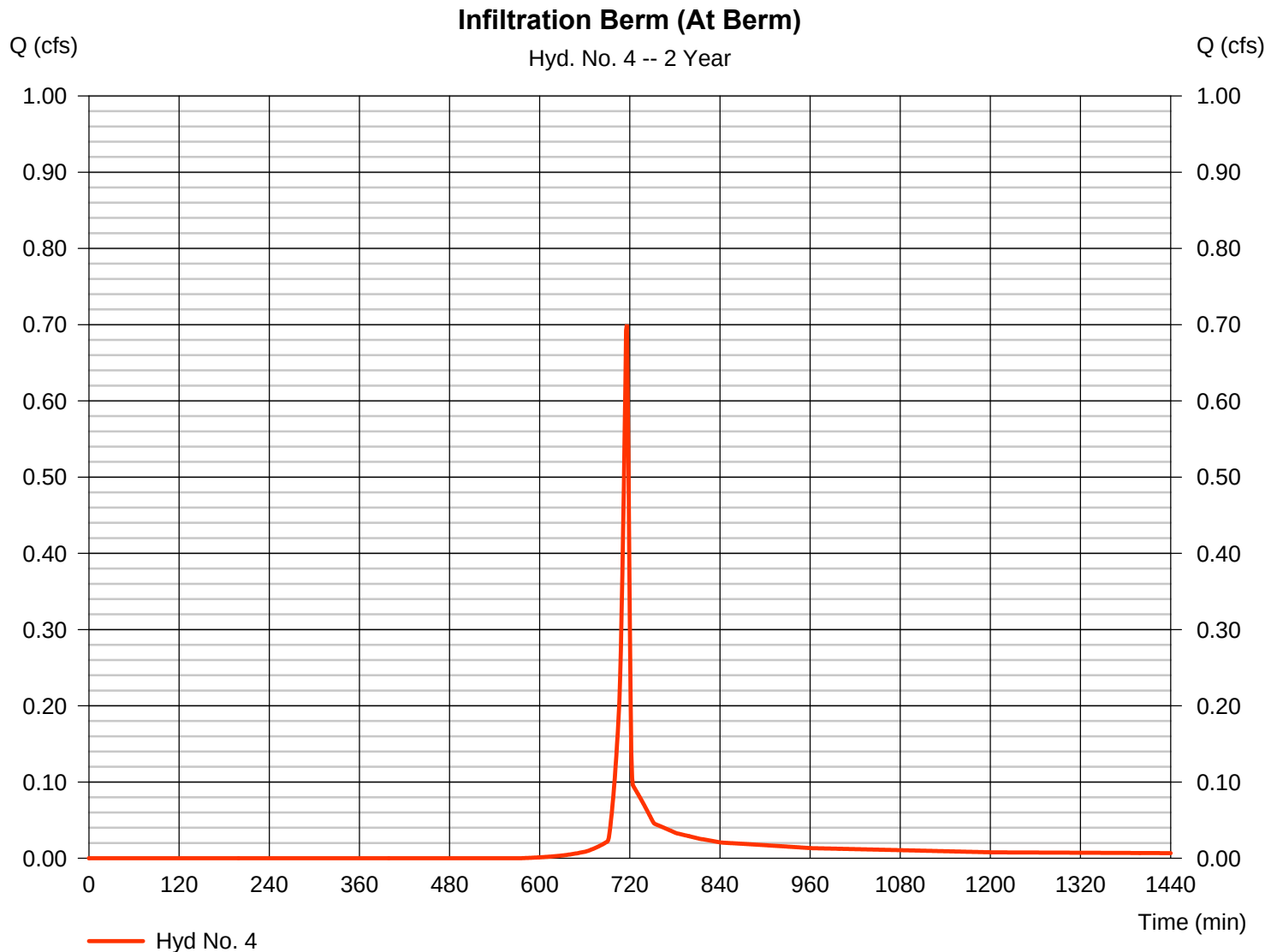
Monday, 11 / 7 / 2016

Hyd. No. 4

Infiltration Berm (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.700 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 1,222 cuft
Drainage area	= 0.340 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.50 min
Total precip.	= 2.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.160 \times 78) + (0.170 \times 91) + (0.010 \times 89)] / 0.340$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

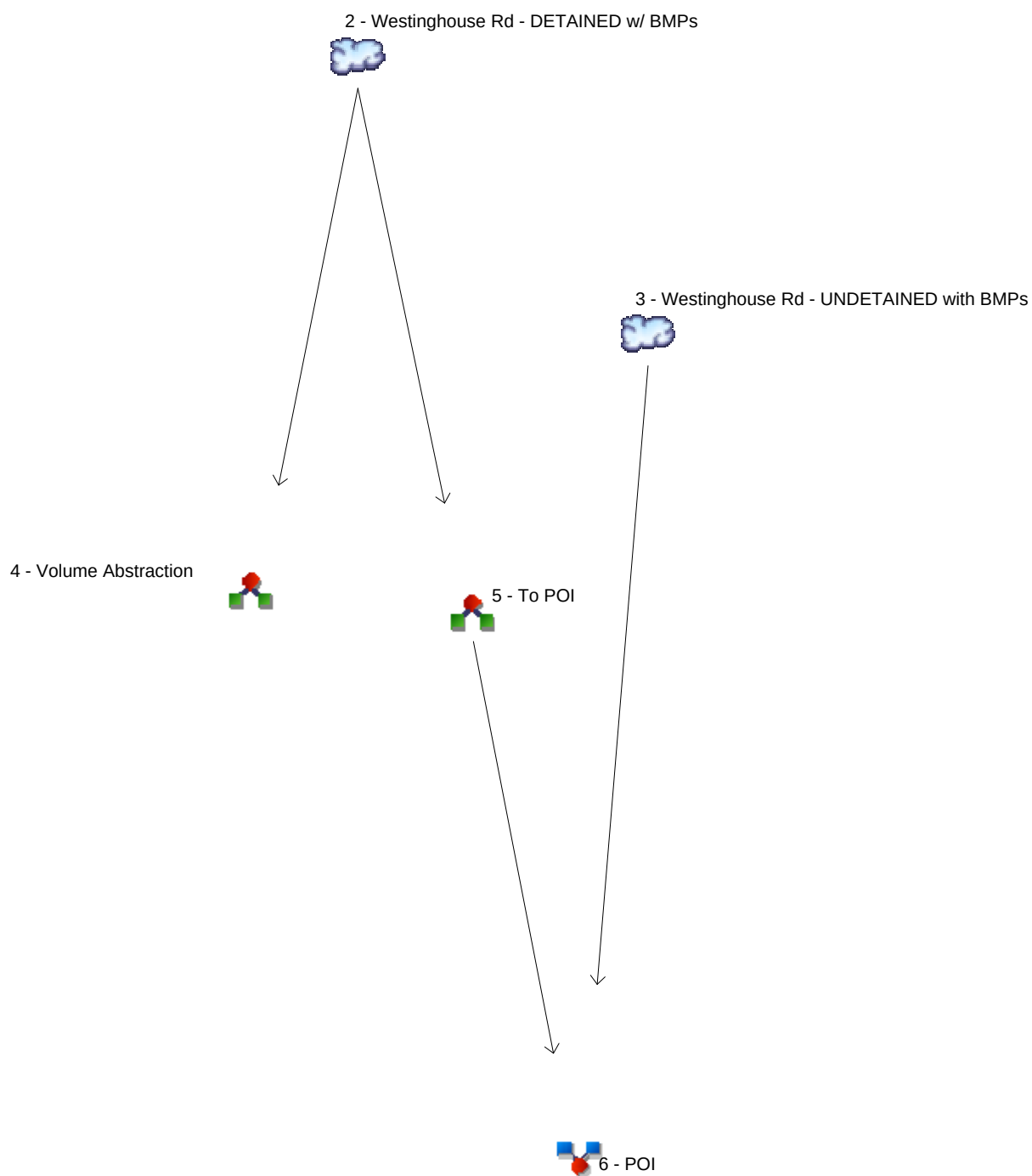
Hyd. No. 4

Infiltration Berm (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	71.00	0.00				
Watercourse slope (%)	= 5.00	3.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.55	2.79	0.00				
Travel Time (min)	= 0.27	+	0.42	+	0.00	=	0.69
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				2.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	-----	-----	0.552	-----	-----	-----	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	-----	-----	0.108	-----	-----	-----	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	2	-----	0.552	-----	-----	-----	-----	-----	-----	Volume Abstraction
5	Diversion2	2	-----	0.092	-----	-----	-----	-----	-----	-----	To POI
6	Combine	3, 5	-----	0.108	-----	-----	-----	-----	-----	-----	POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	0.552	2	732	2,341	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	0.108	2	720	269	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	0.552	2	732	1,231	2	-----	-----	Volume Abstraction
5	Diversion2	0.092	2	778	1,110	2	-----	-----	To POI
6	Combine	0.108	2	720	1,378	3, 5	-----	-----	POI
Westinghouse Rd-Post wBMP - 2yr.gpw					Return Period: 2 Year			Monday, 11 / 7 / 2016	

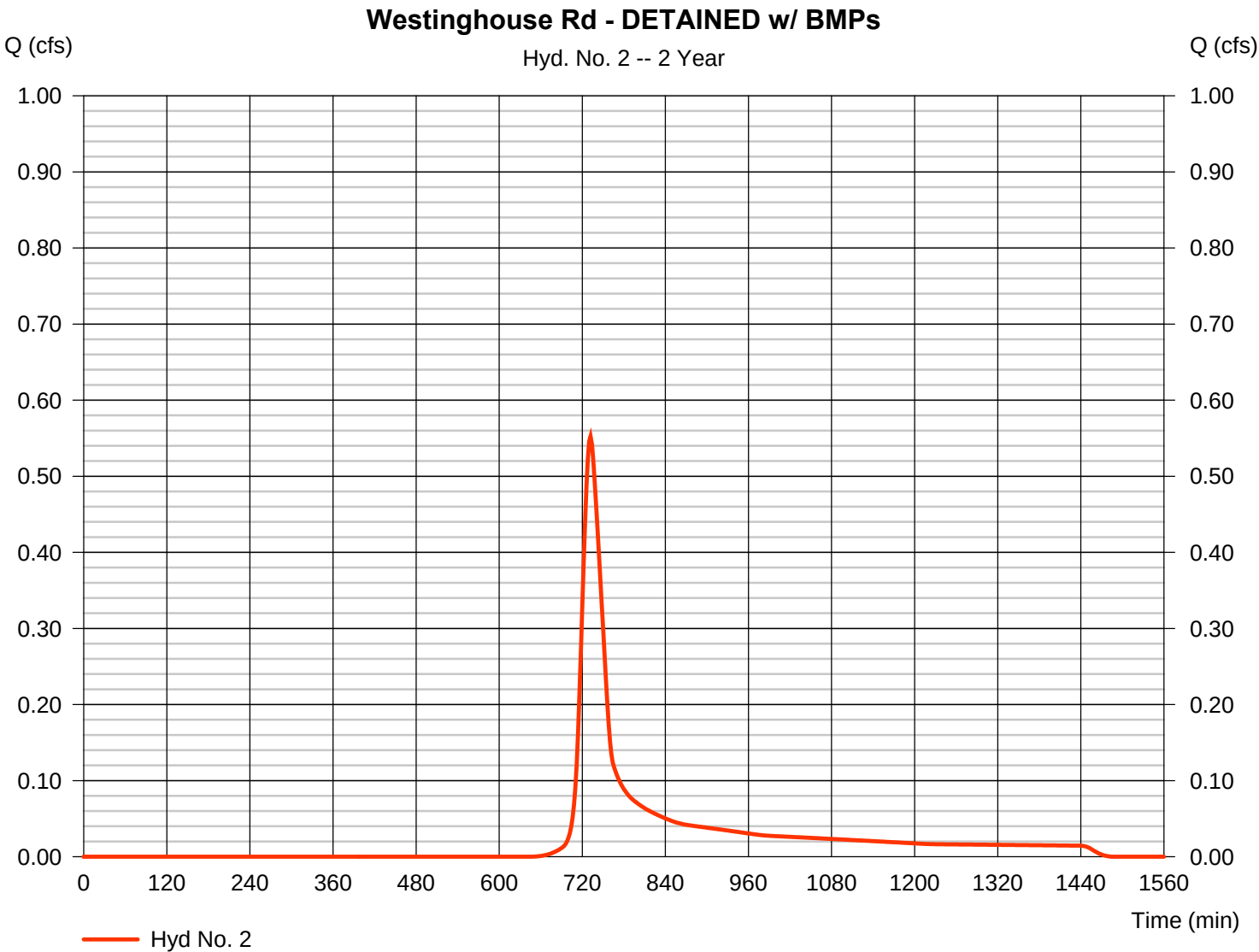
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.552 cfs
Storm frequency	=	2 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	2,341 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	27.40 min
Total precip.	=	2.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

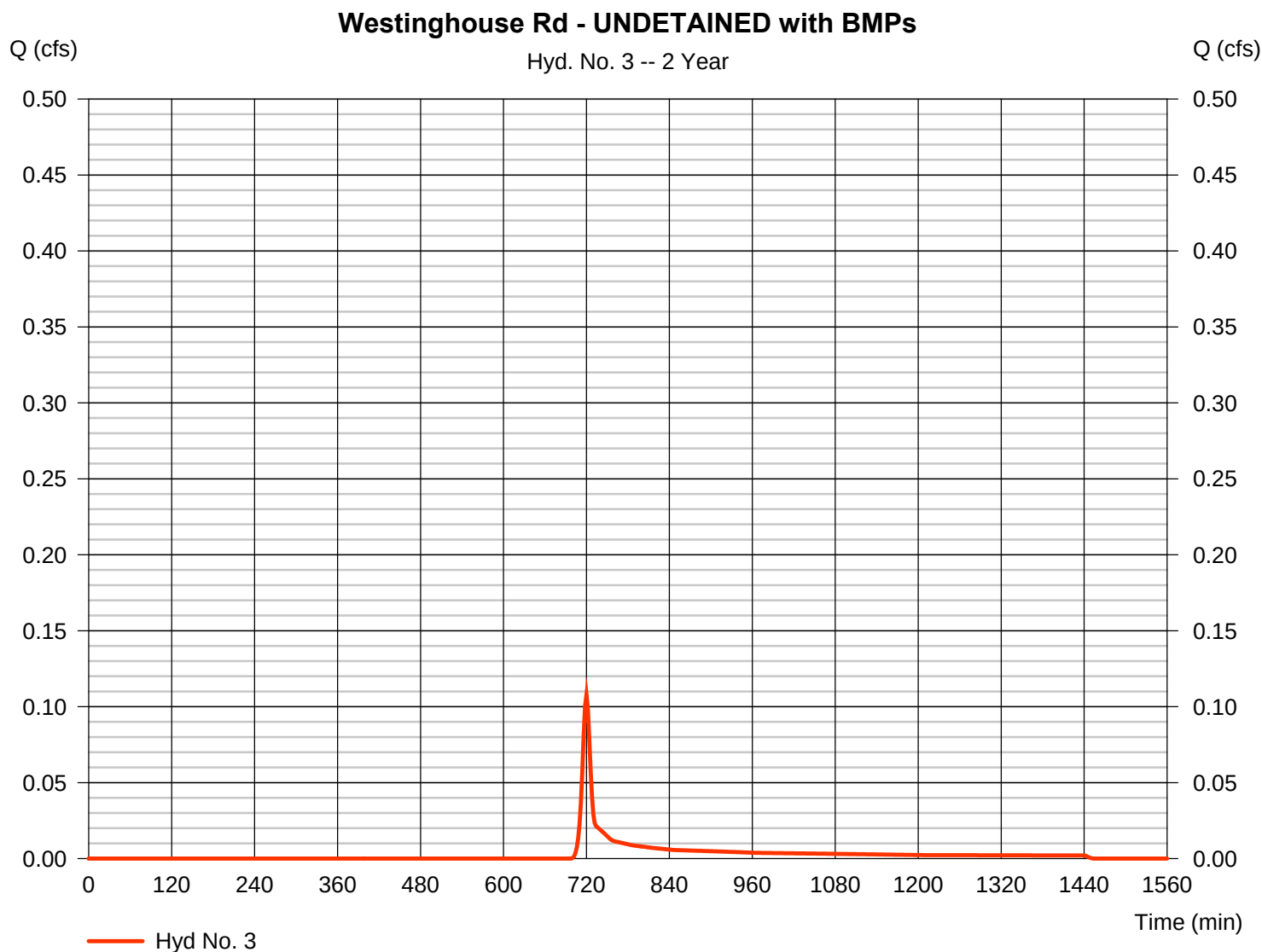
Monday, 11 / 7 / 2016

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.108 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	269 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	2.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 78) + (0.070 \times 71) + (0.040 \times 70)] / 0.140$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

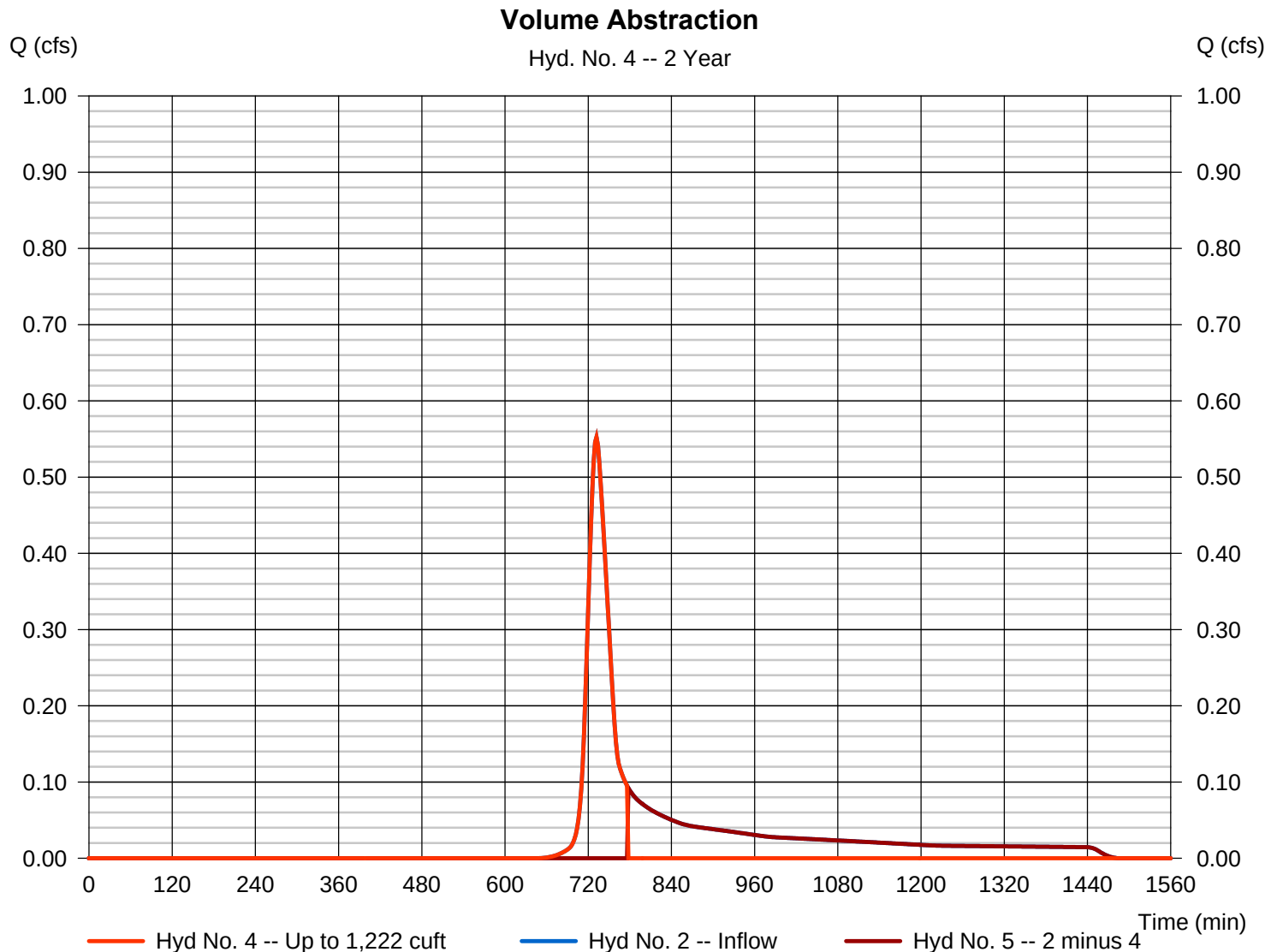
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.552 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 1,231 cuft
Inflow hydrograph	= 2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	= 5
Diversion method	= First Flush Volume		= 1,222 cuft



Hydrograph Report

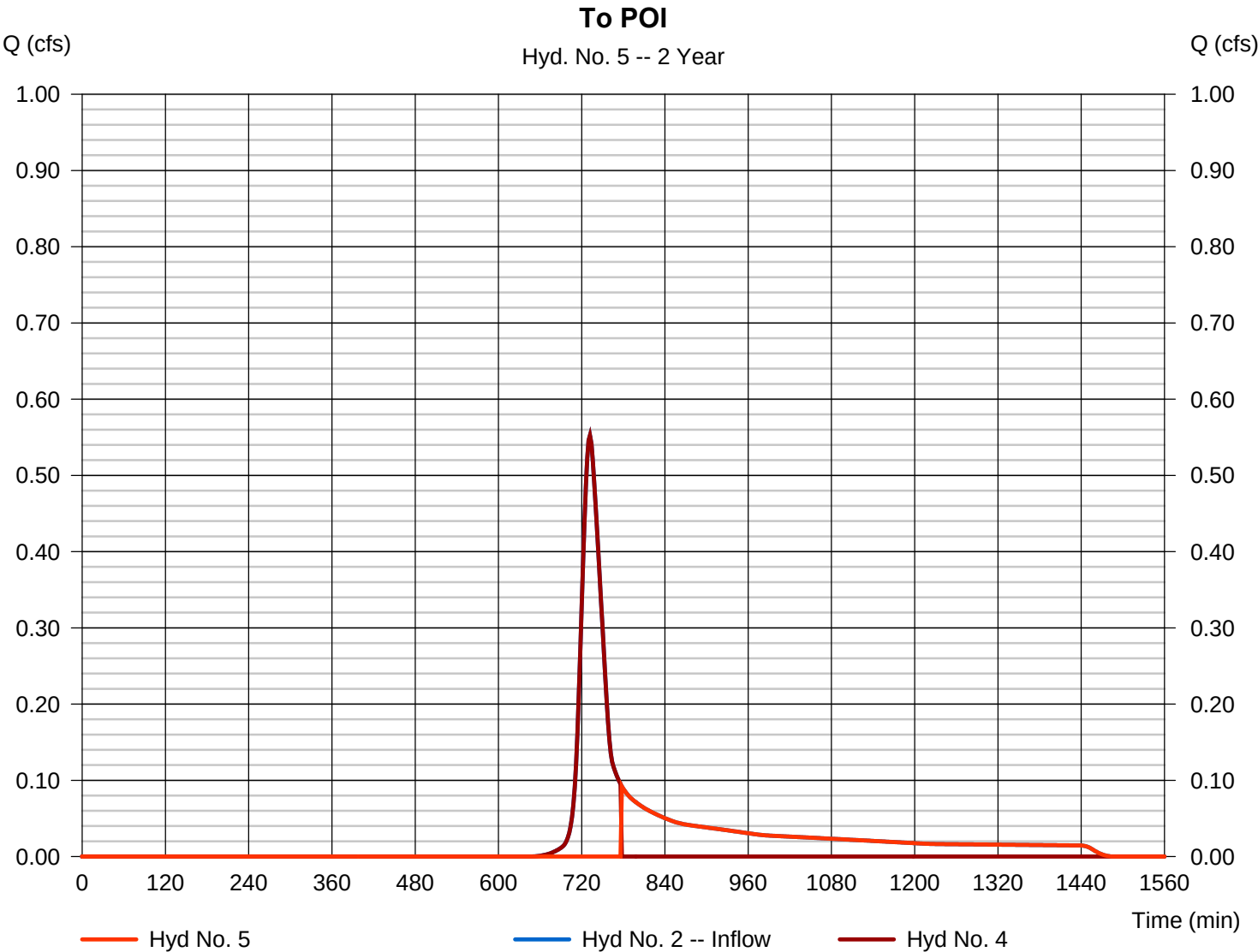
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.092 cfs
Storm frequency	=	2 yrs	Time to peak	=	778 min
Time interval	=	2 min	Hyd. volume	=	1,110 cuft
Inflow hydrograph	=	2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	=	4
Diversion method	=	First Flush Volume			= 1,222 cuft



Hydrograph Report

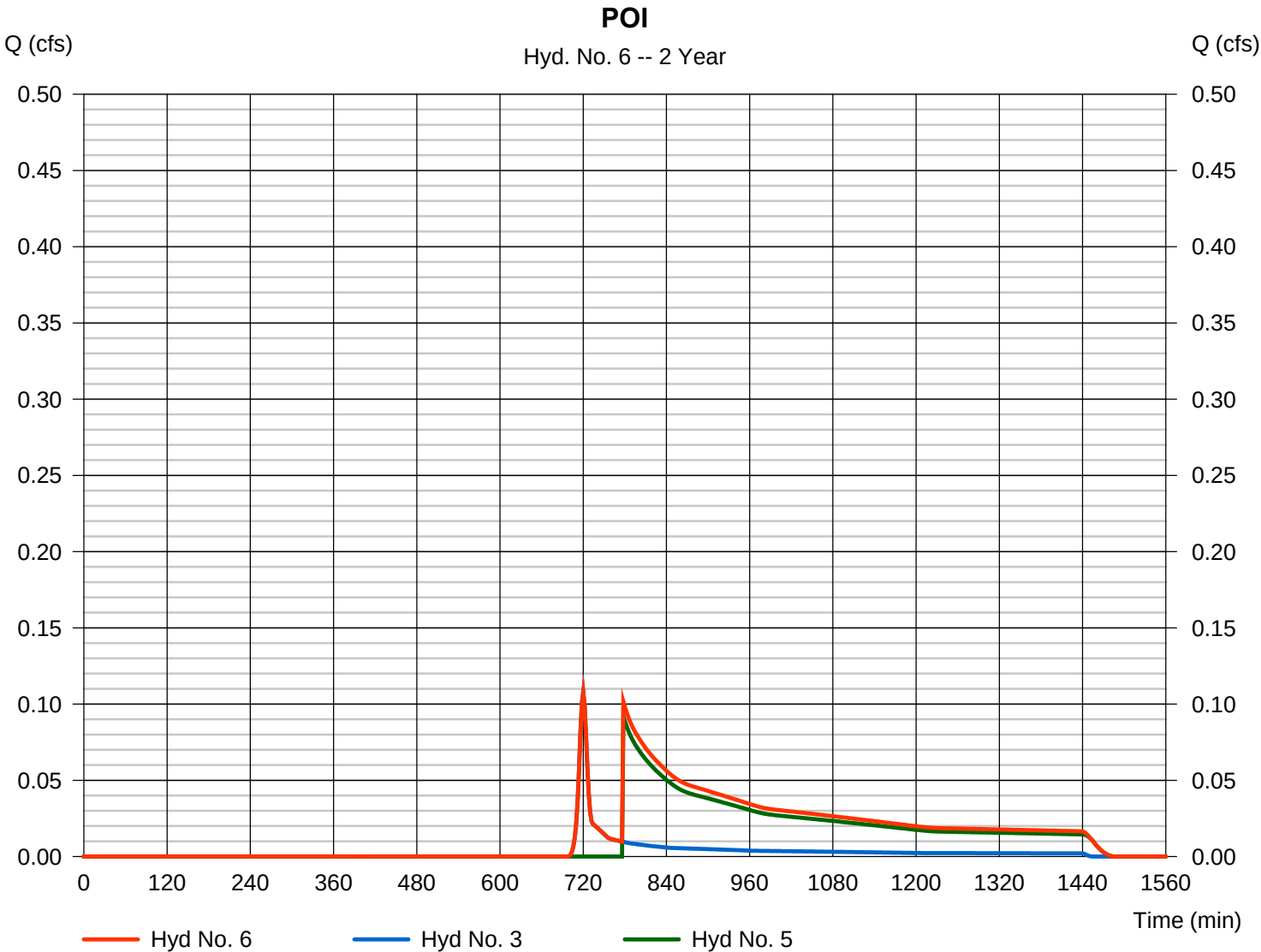
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 0.108 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 1,378 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.140 ac



ATTACHMENT C-2
WESTINGHOUSE ROAD
10 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Westinghouse Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.744	-----	-----	1.554	-----	2.626	3.161	Westinghouse Rd - PRE
Proj. file: Westinghouse Rd-PRE.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.554	2	722	4,444	-----	-----	-----	Westinghouse Rd - PRE
Westinghouse Rd-PRE.gpw					Return Period: 10 Year			Monday, 11 / 7 / 2016	

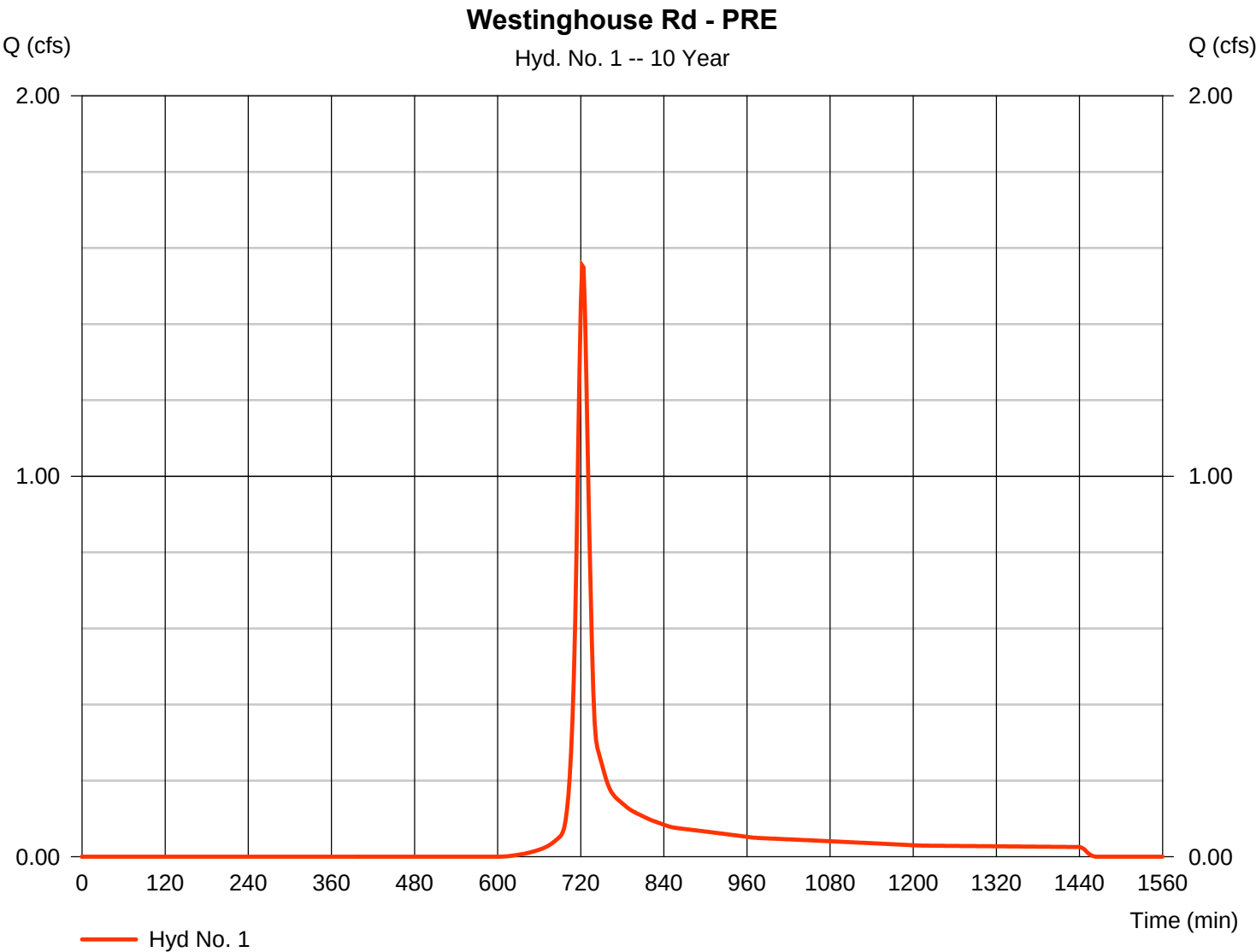
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.554 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	4,444 cuft
Drainage area	=	0.910 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.30 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.550 x 77) + (0.010 x 91) + (0.110 x 71) + (0.110 x 70)] / 0.910



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

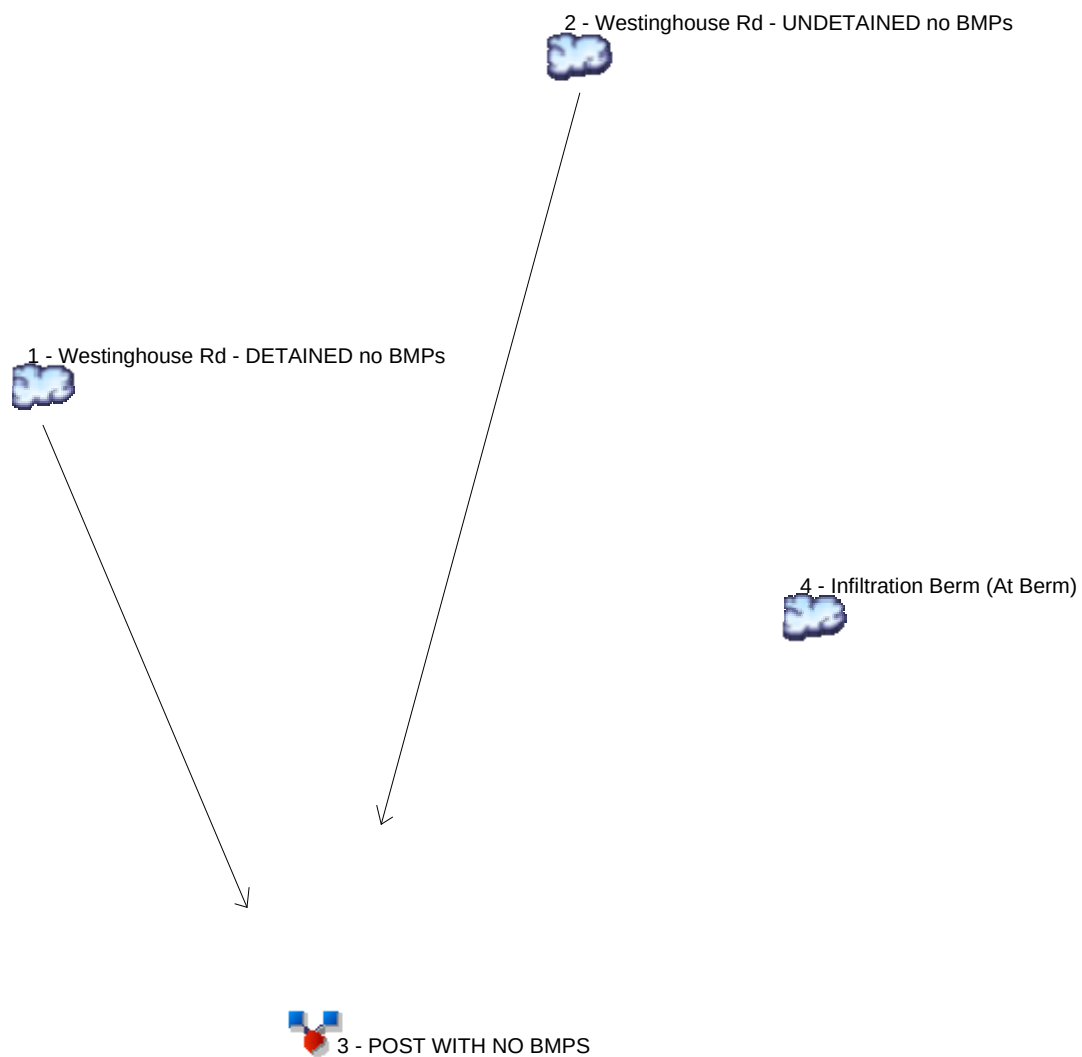
Hyd. No. 1

Westinghouse Rd - PRE

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 14.63	+	0.00	+	0.00	=	14.63
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	248.00	0.00				
Watercourse slope (%)	= 4.00	11.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.23	5.35	0.00				
Travel Time (min)	= 0.85	+	0.77	+	0.00	=	1.62
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				16.30 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.096	-----	-----	2.060	-----	3.293	3.901	Westinghouse Rd - DETAINED no B
2	SCS Runoff	-----	-----	0.108	-----	-----	0.249	-----	0.437	0.532	Westinghouse Rd - UNDETAINED no
3	Combine	1, 2	-----	1.265	-----	-----	2.389	-----	3.791	4.480	POST WITH NO BMPS
4	SCS Runoff	-----	-----	0.700	-----	-----	1.220	-----	1.855	2.160	Infiltration Berm (At Berm)
Proj. file: Westinghouse Rd-Post No BMPs.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.060	2	718	4,144	-----	-----	-----	Westinghouse Rd - DETAINED no B
2	SCS Runoff	0.249	2	720	576	-----	-----	-----	Westinghouse Rd - UNDETAINED no
3	Combine	2.389	2	718	4,906	1, 2	-----	-----	POST WITH NO BMPS
4	SCS Runoff	1.220	1	716	2,170	-----	-----	-----	Infiltration Berm (At Berm)
Westinghouse Rd-Post No BMPs.gpw					Return Period: 10 Year			Monday, 11 / 7 / 2016	

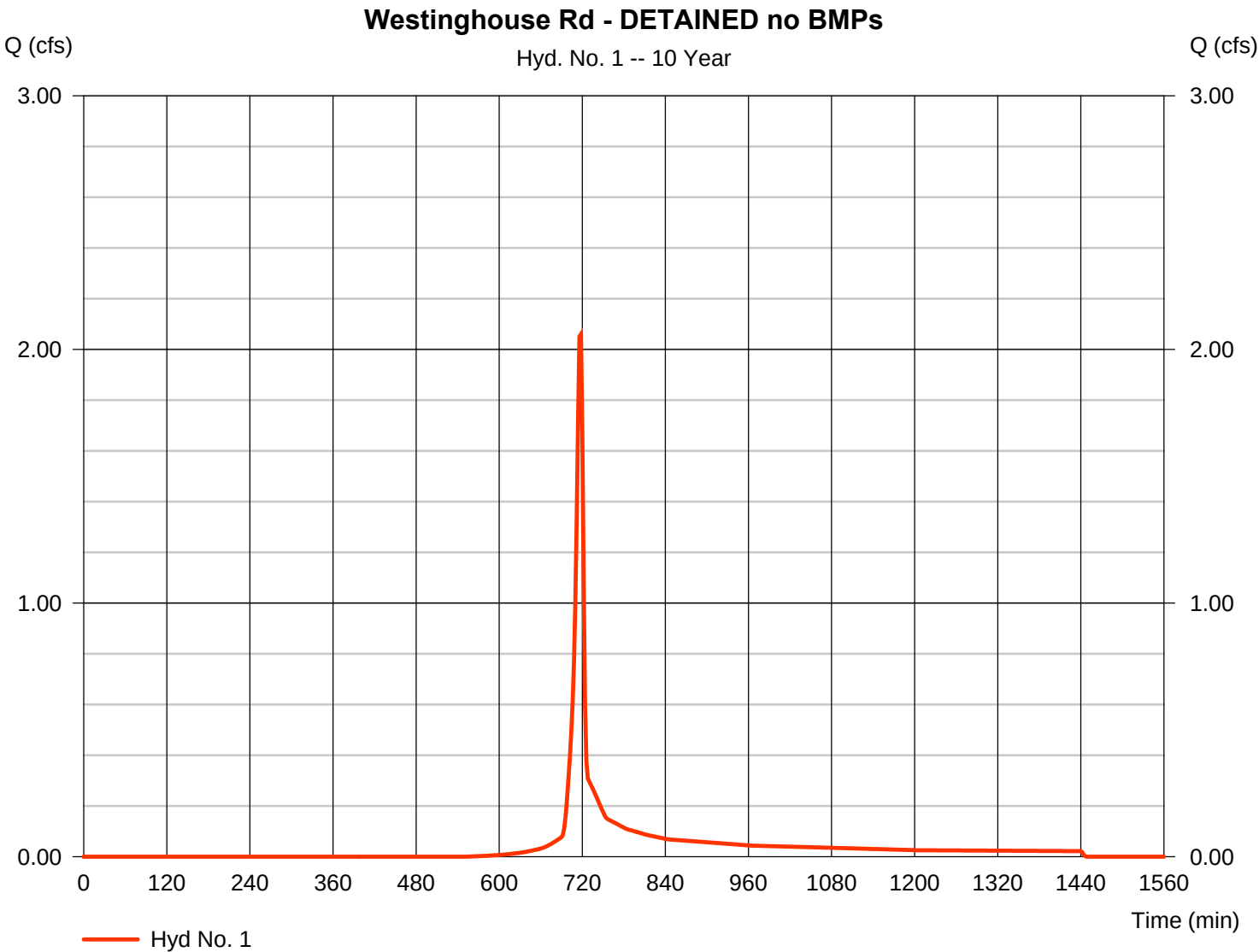
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.060 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	4,144 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	96.00	208.00				
Watercourse slope (%)	= 5.00	6.00	13.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.55	3.95	5.82				
Travel Time (min)	= 0.27	+	0.40	+	0.60	=	1.27
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 2.78	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=8.99	0.00	0.00				
Flow length (ft)	{0}36.0	0.0	0.0				
Travel Time (min)	= 0.07	+	0.00	+	0.00	=	0.07
Total Travel Time, Tc				3.10 min			

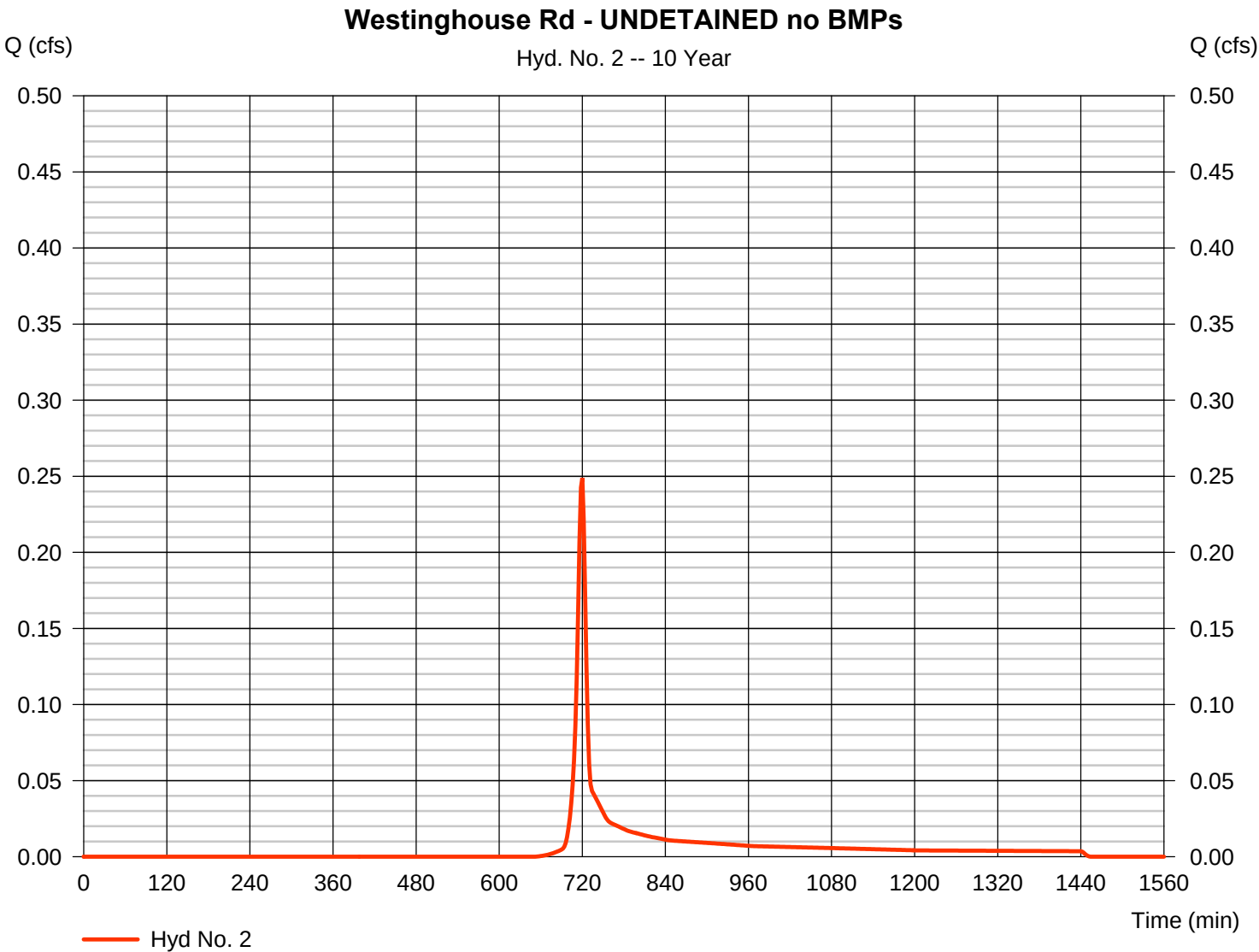
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.249 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	576 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 78) + (0.070 x 71) + (0.040 x 70)] / 0.140



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

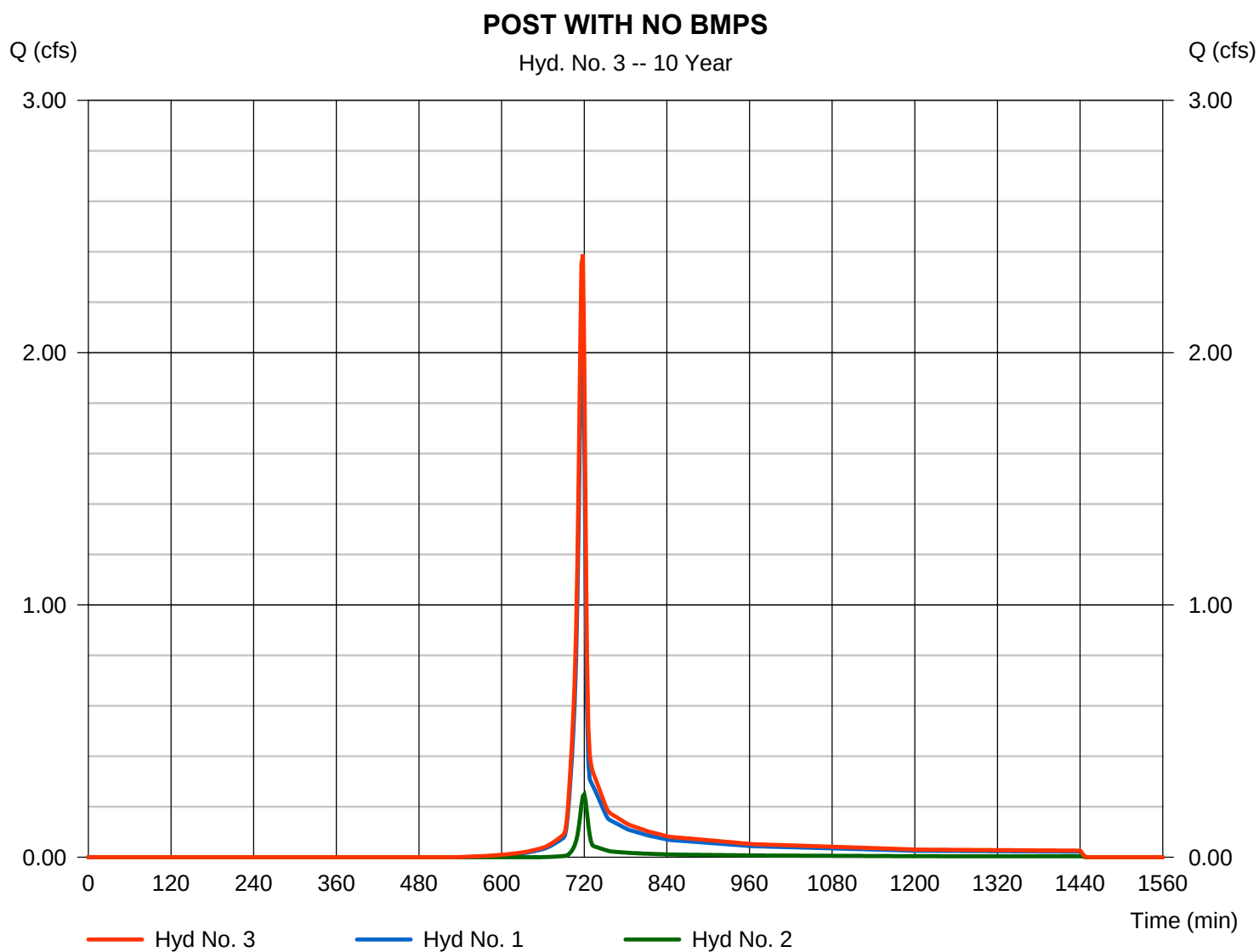
Monday, 11 / 7 / 2016

Hyd. No. 3

POST WITH NO BMPS

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 2.389 cfs
 Time to peak = 718 min
 Hyd. volume = 4,906 cuft
 Contrib. drain. area = 0.910 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

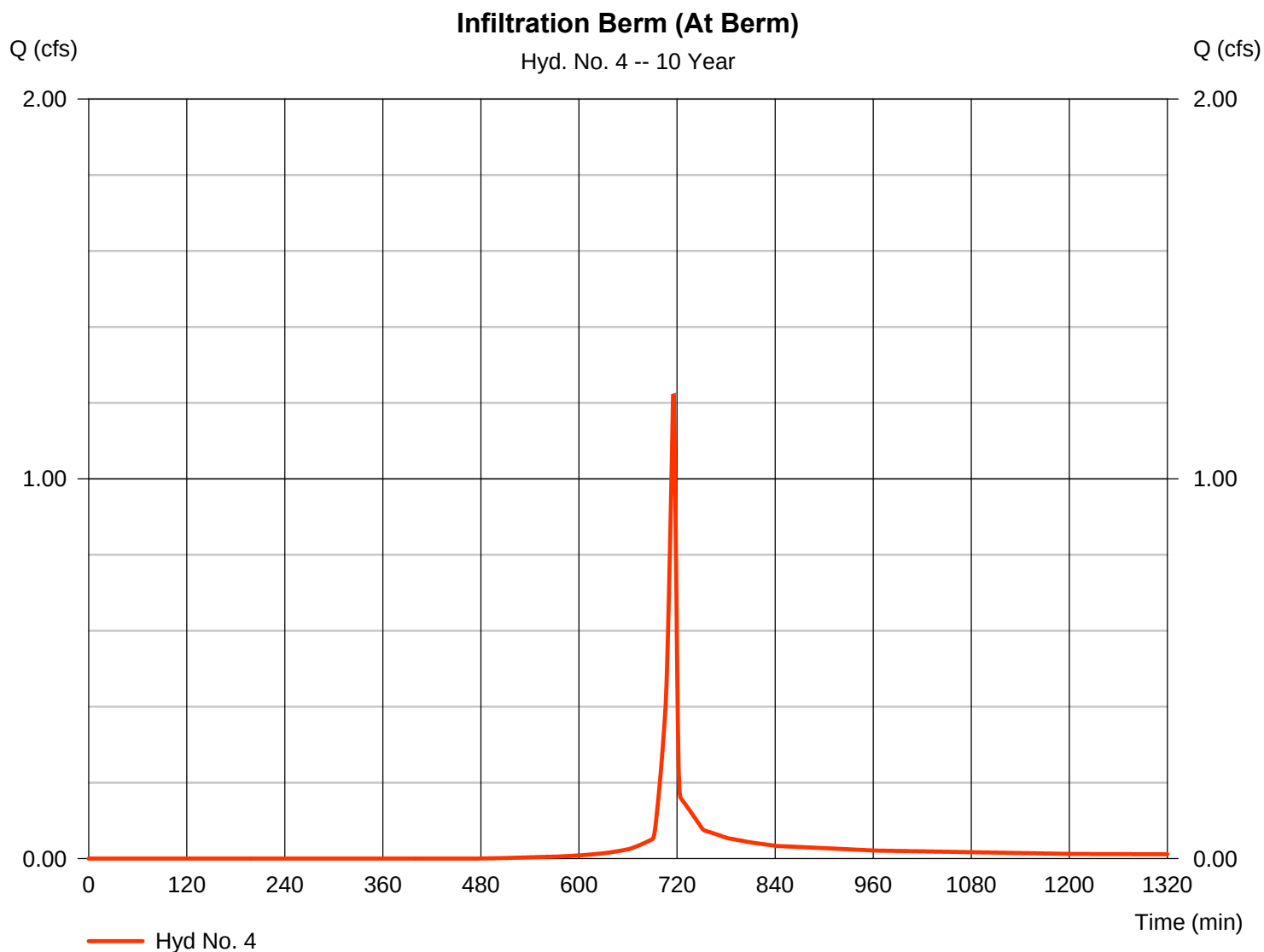
Monday, 11 / 7 / 2016

Hyd. No. 4

Infiltration Berm (At Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.220 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	1 min	Hyd. volume	=	2,170 cuft
Drainage area	=	0.340 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	2.50 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.160 \times 78) + (0.170 \times 91) + (0.010 \times 89)] / 0.340$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

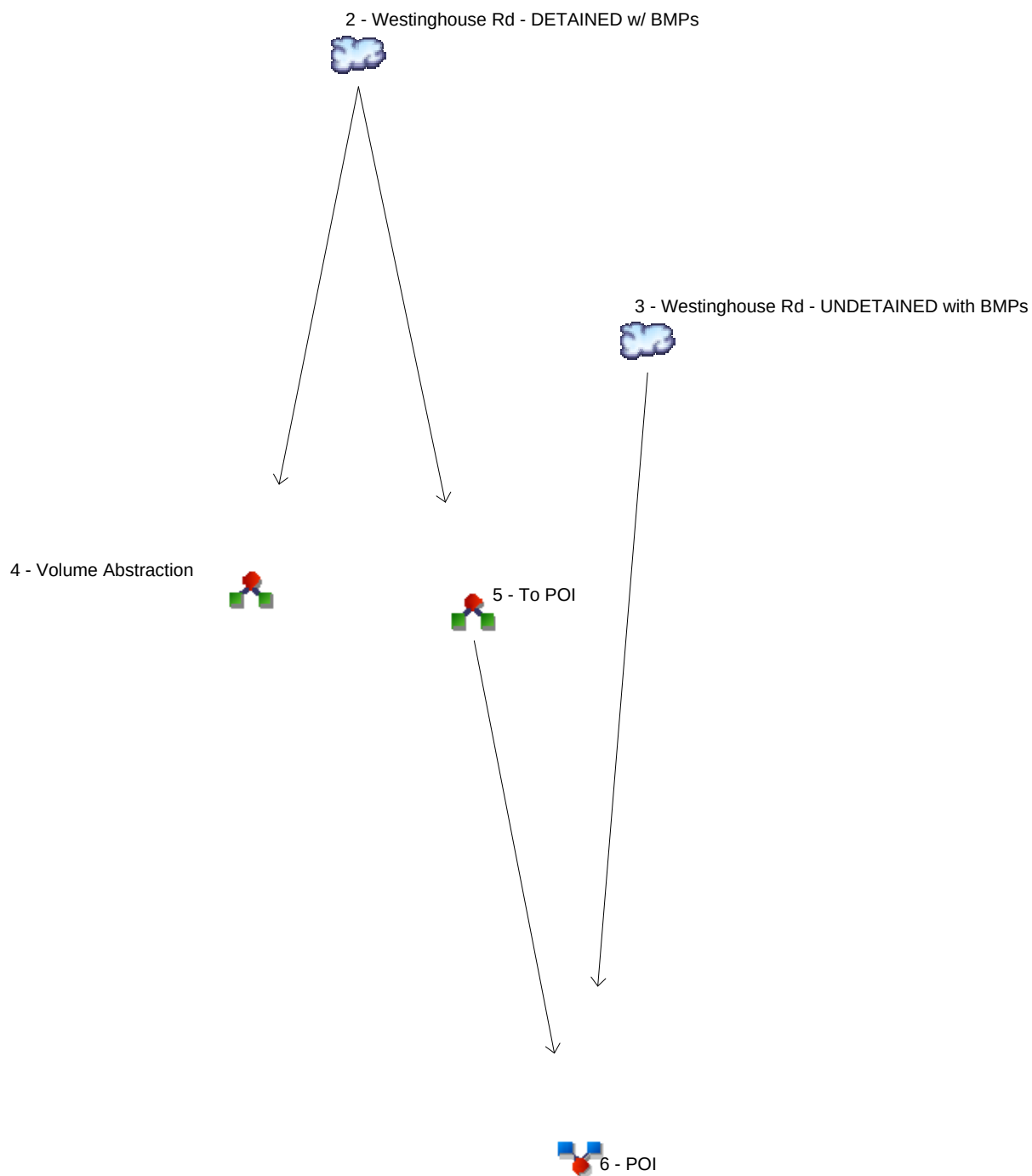
Hyd. No. 4

Infiltration Berm (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	71.00	0.00				
Watercourse slope (%)	= 5.00	3.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.55	2.79	0.00				
Travel Time (min)	= 0.27	+	0.42	+	0.00	=	0.69
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				2.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	-----	-----	-----	-----	-----	1.089	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	-----	-----	-----	-----	-----	0.249	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	2	-----	-----	-----	-----	1.089	-----	-----	-----	Volume Abstraction
5	Diversion2	2	-----	-----	-----	-----	0.426	-----	-----	-----	To POI
6	Combine	3, 5	-----	-----	-----	-----	0.451	-----	-----	-----	POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.089	2	732	4,421	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	0.249	2	720	576	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	1.089	2	732	2,202	2	-----	-----	Volume Abstraction
5	Diversion2	0.426	2	754	2,218	2	-----	-----	To POI
6	Combine	0.451	2	754	2,795	3, 5	-----	-----	POI
Westinghouse Rd-Post wBMP - 10yr.gpw					Return Period: 10 Year			Monday, 11 / 7 / 2016	

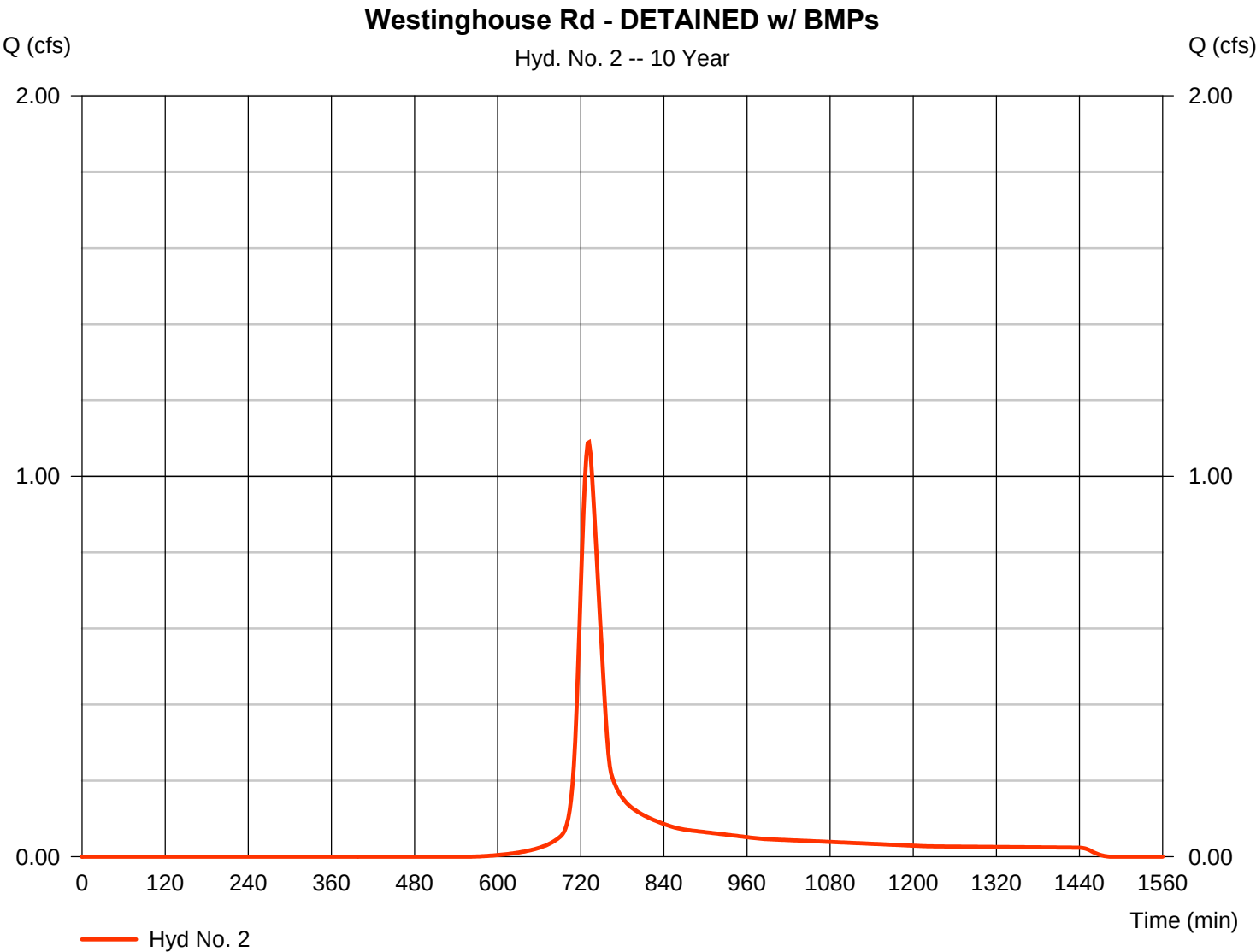
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.089 cfs
Storm frequency	=	10 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	4,421 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	27.40 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



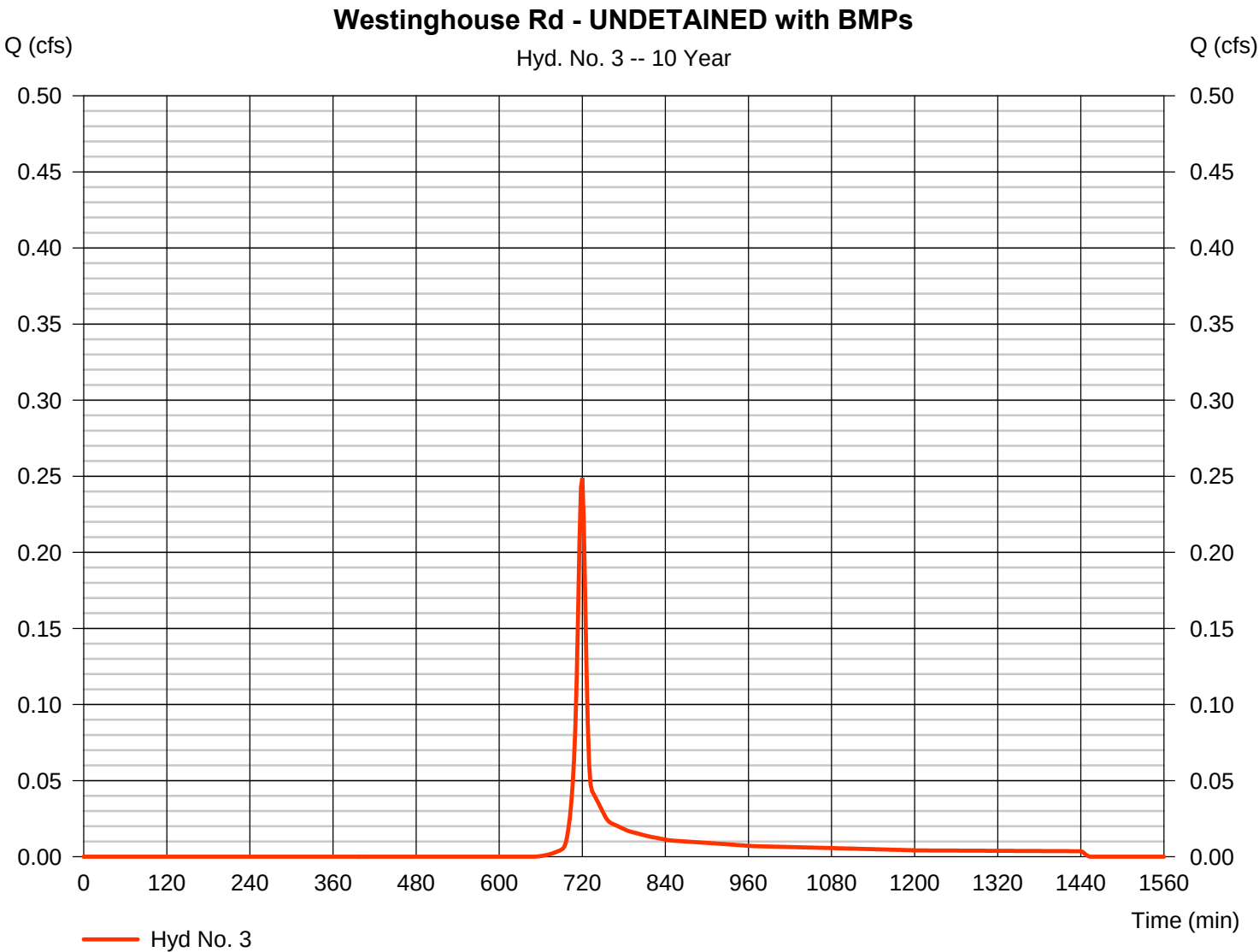
Hydrograph Report

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.249 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	576 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	3.52 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 78) + (0.070 x 71) + (0.040 x 70)] / 0.140



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

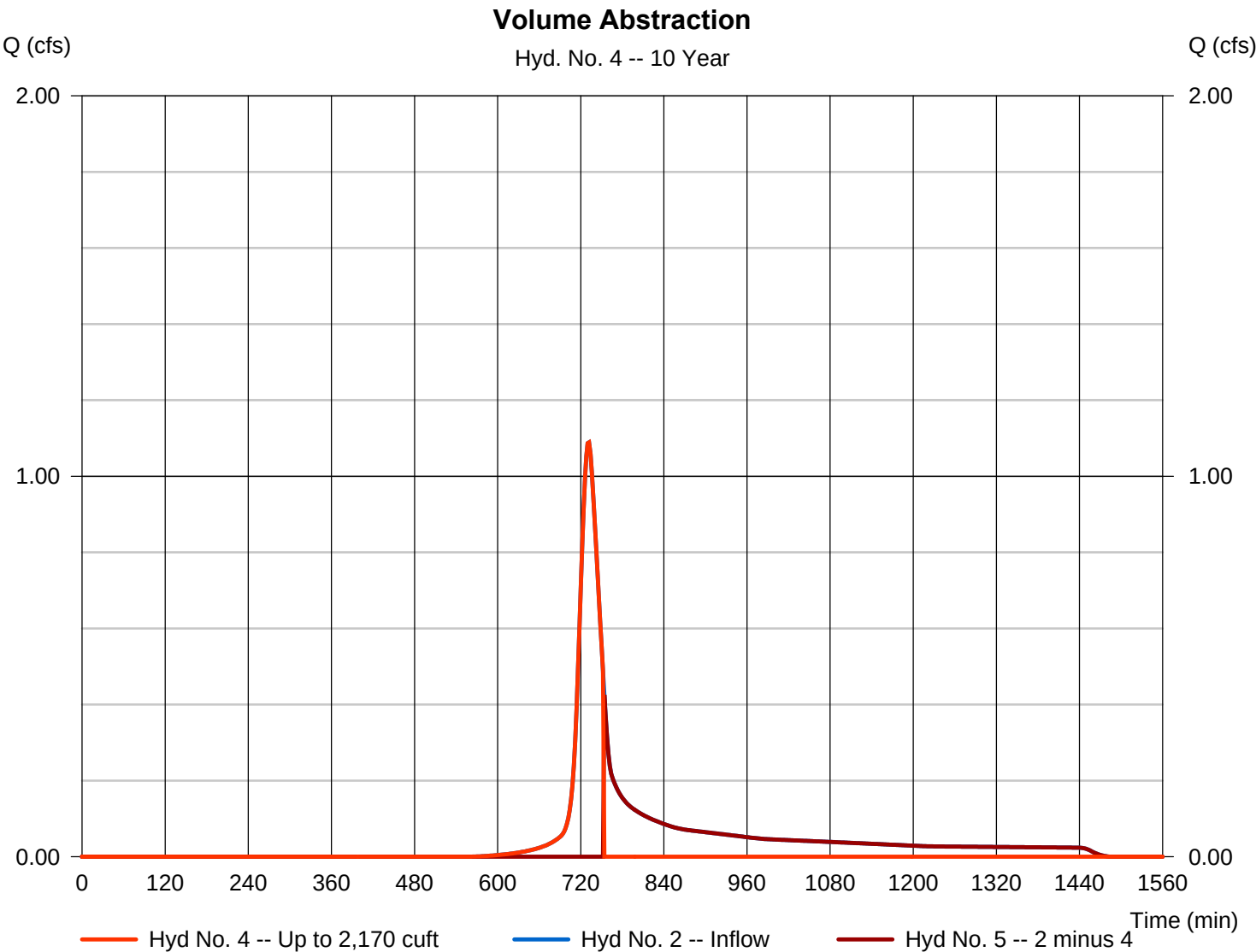
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.089 cfs
Storm frequency	=	10 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	2,202 cuft
Inflow hydrograph	=	2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	=	2,170 cuft
Diversion method	=	First Flush Volume			



Hydrograph Report

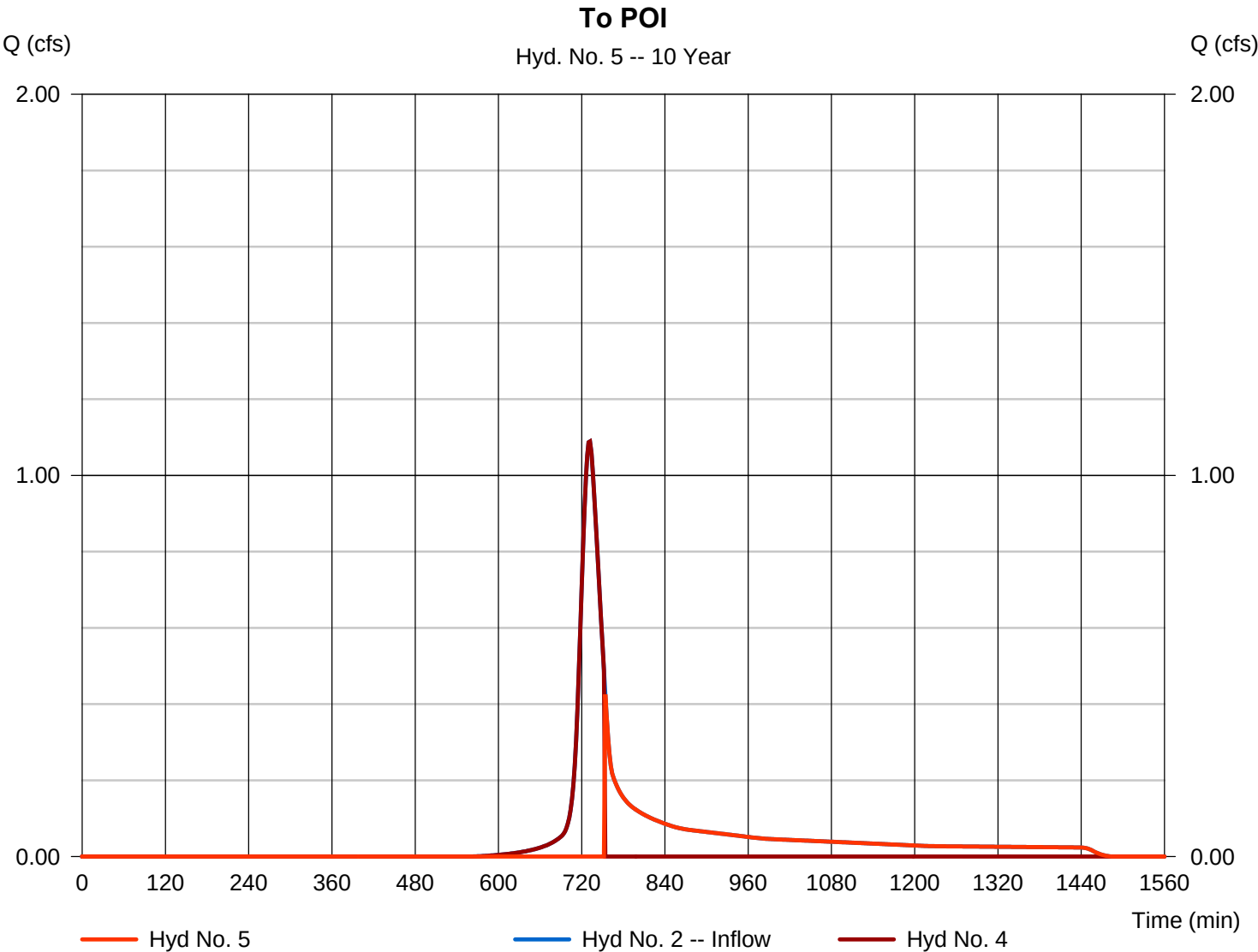
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.426 cfs
Storm frequency	=	10 yrs	Time to peak	=	754 min
Time interval	=	2 min	Hyd. volume	=	2,218 cuft
Inflow hydrograph	=	2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	=	2,170 cuft
Diversion method	=	First Flush Volume			



Hydrograph Report

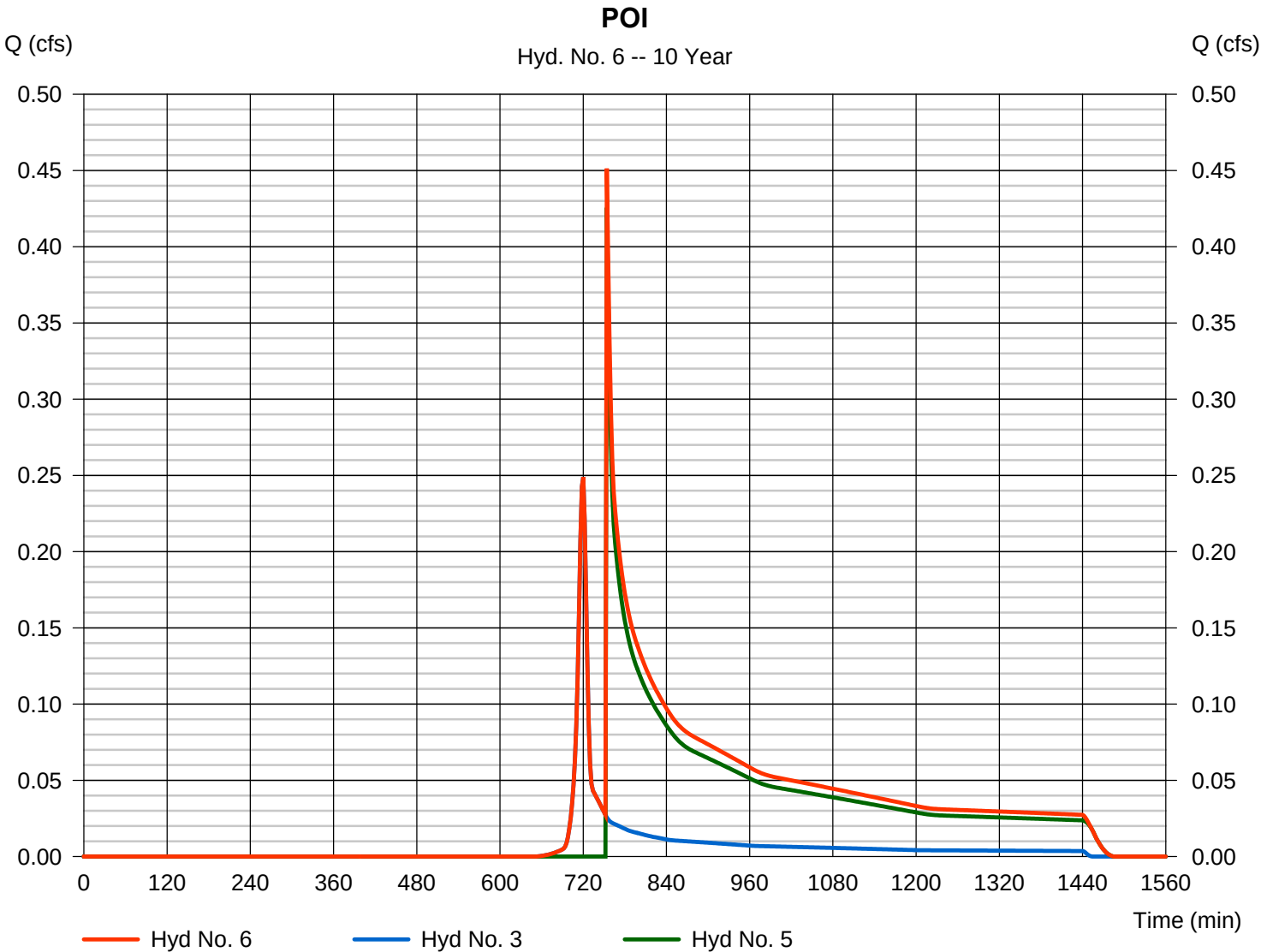
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 0.451 cfs
Storm frequency	= 10 yrs	Time to peak	= 754 min
Time interval	= 2 min	Hyd. volume	= 2,795 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.140 ac



ATTACHMENT C-3
WESTINGHOUSE ROAD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Westinghouse Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.744	-----	-----	1.554	-----	2.626	3.161	Westinghouse Rd - PRE
Proj. file: Westinghouse Rd-PRE.gpw									Monday, 11 / 7 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.626	2	722	7,377	-----	-----	-----	Westinghouse Rd - PRE
Westinghouse Rd-PRE.gpw					Return Period: 50 Year			Monday, 11 / 7 / 2016	

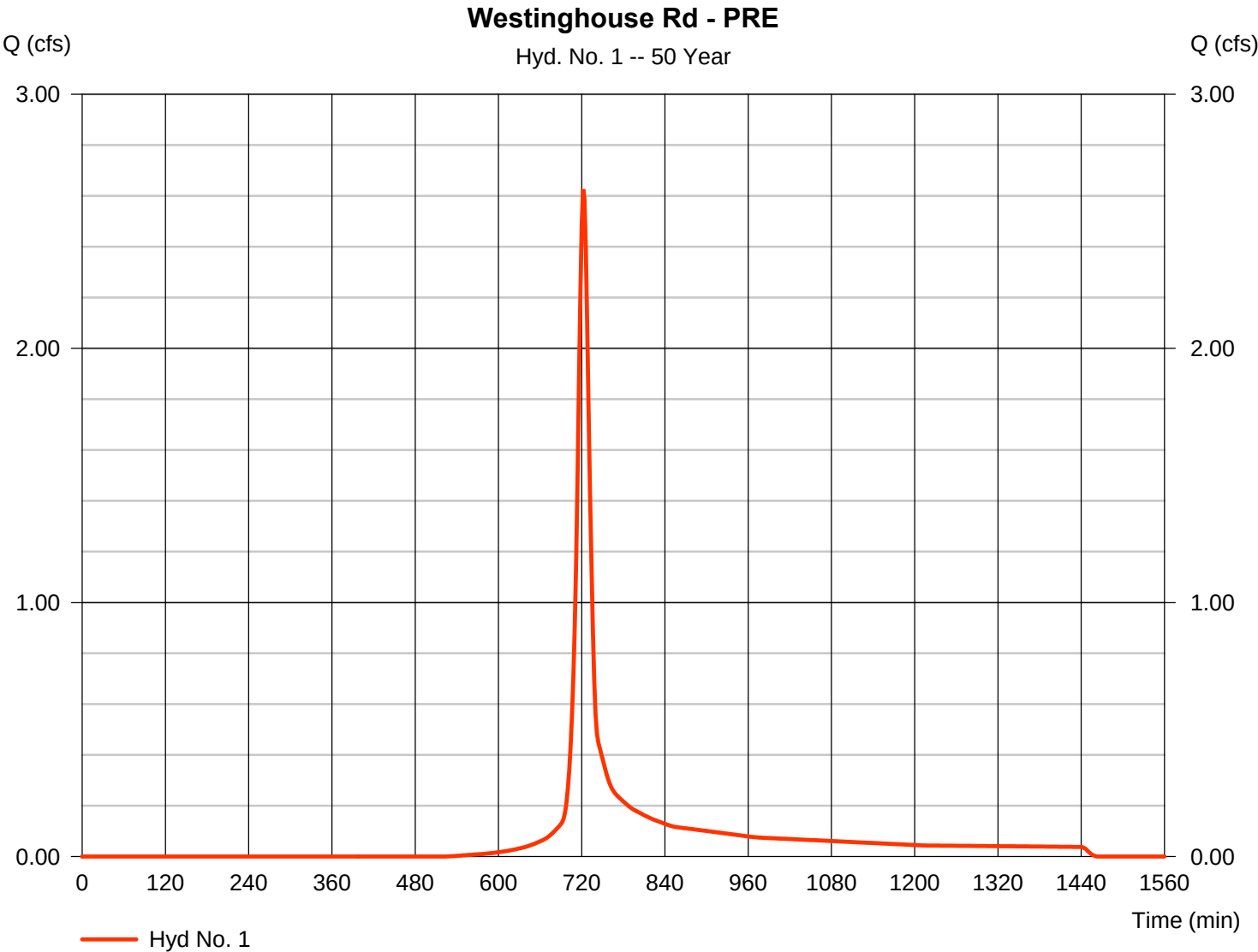
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.626 cfs
Storm frequency	=	50 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	7,377 cuft
Drainage area	=	0.910 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.30 min
Total precip.	=	4.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.550 x 77) + (0.010 x 91) + (0.110 x 71) + (0.110 x 70)] / 0.910



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

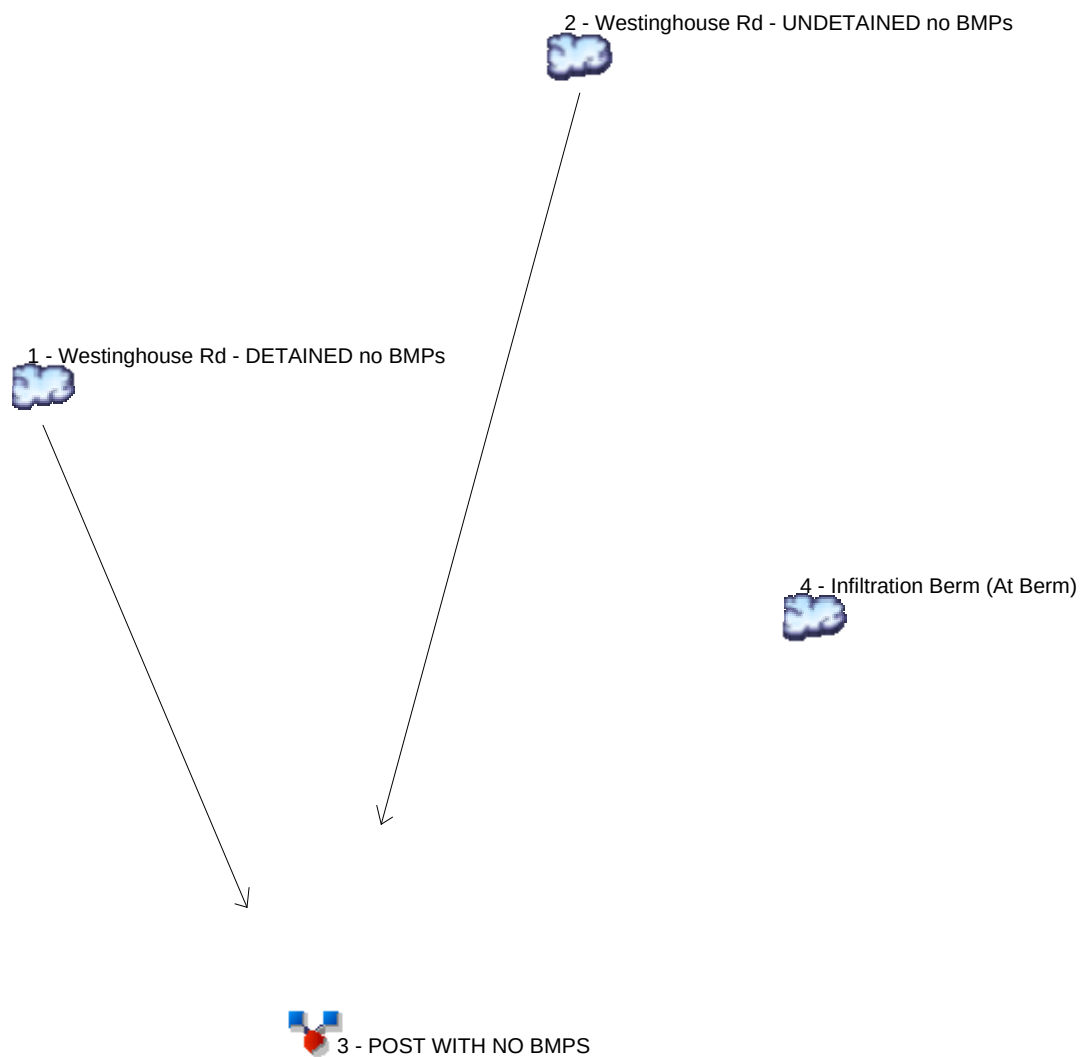
Hyd. No. 1

Westinghouse Rd - PRE

<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)	= 2.50	0.00	0.00	
Land slope (%)	= 1.00	0.00	0.00	
Travel Time (min)	= 14.63	+	0.00	+
			0.00	= 14.63
Shallow Concentrated Flow				
Flow length (ft)	= 165.00	248.00	0.00	
Watercourse slope (%)	= 4.00	11.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.23	5.35	0.00	
Travel Time (min)	= 0.85	+	0.77	+
			0.00	= 1.62
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				16.30 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.096	-----	-----	2.060	-----	3.293	3.901	Westinghouse Rd - DETAINED no B
2	SCS Runoff	-----	-----	0.108	-----	-----	0.249	-----	0.437	0.532	Westinghouse Rd - UNDETAINED no
3	Combine	1, 2	-----	1.265	-----	-----	2.389	-----	3.791	4.480	POST WITH NO BMPS
4	SCS Runoff	-----	-----	0.700	-----	-----	1.220	-----	1.855	2.160	Infiltration Berm (At Berm)
Proj. file: Westinghouse Rd-Post No BMPs.gpw											Monday, 11 / 7 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.293	2	716	6,670	-----	-----	-----	Westinghouse Rd - DETAINED no B
2	SCS Runoff	0.437	2	720	1,001	-----	-----	-----	Westinghouse Rd - UNDETAINED no
3	Combine	3.791	2	718	7,900	1, 2	-----	-----	POST WITH NO BMPS
4	SCS Runoff	1.855	1	715	3,360	-----	-----	-----	Infiltration Berm (At Berm)
Westinghouse Rd-Post No BMPs.gpw					Return Period: 50 Year			Monday, 11 / 7 / 2016	

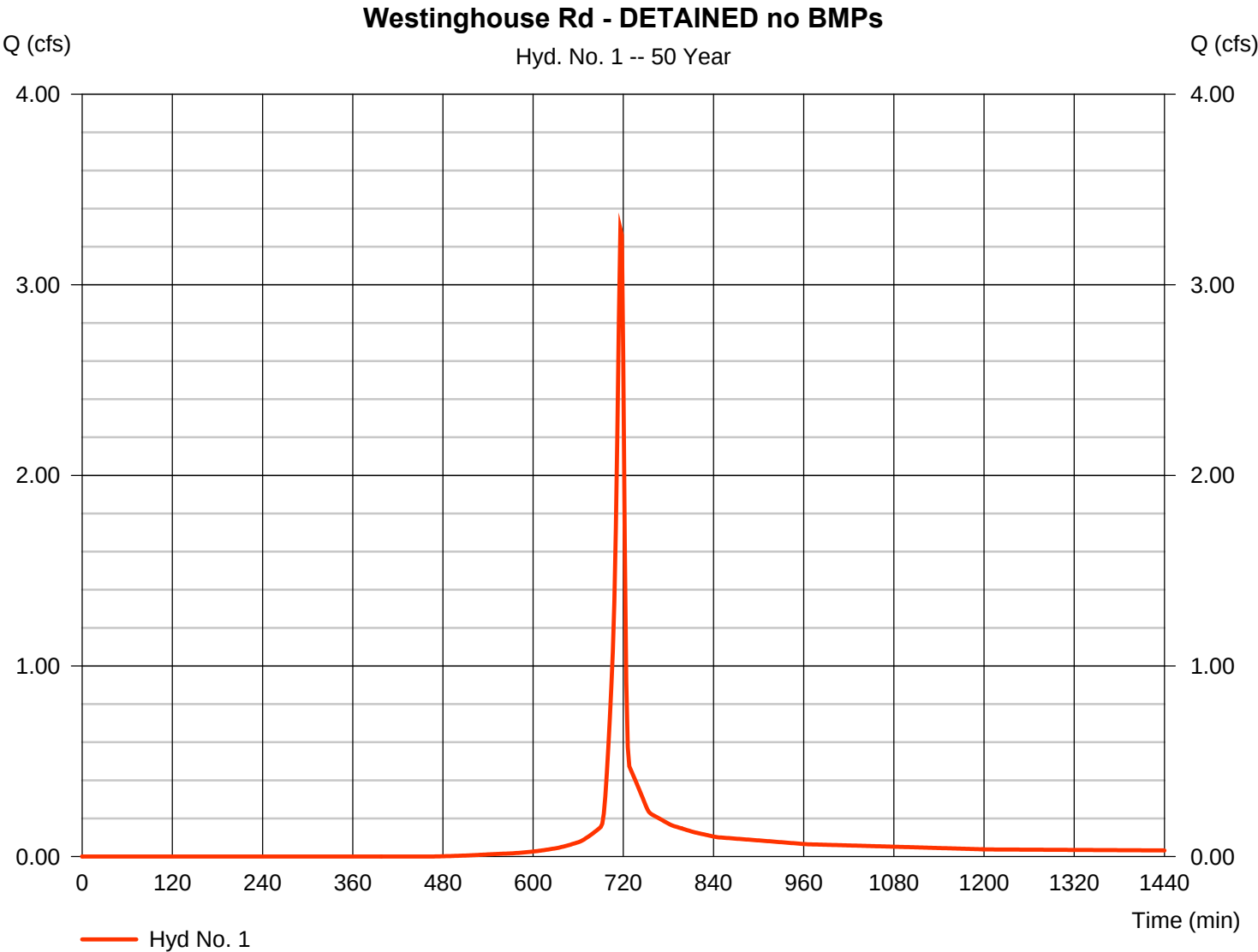
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.293 cfs
Storm frequency	=	50 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	6,670 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	4.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	96.00	208.00				
Watercourse slope (%)	= 5.00	6.00	13.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.55	3.95	5.82				
Travel Time (min)	= 0.27	+	0.40	+	0.60	=	1.27
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 2.78	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=8.99	0.00	0.00				
Flow length (ft)	{0}36.0	0.0	0.0				
Travel Time (min)	= 0.07	+	0.00	+	0.00	=	0.07
Total Travel Time, Tc				3.10 min			

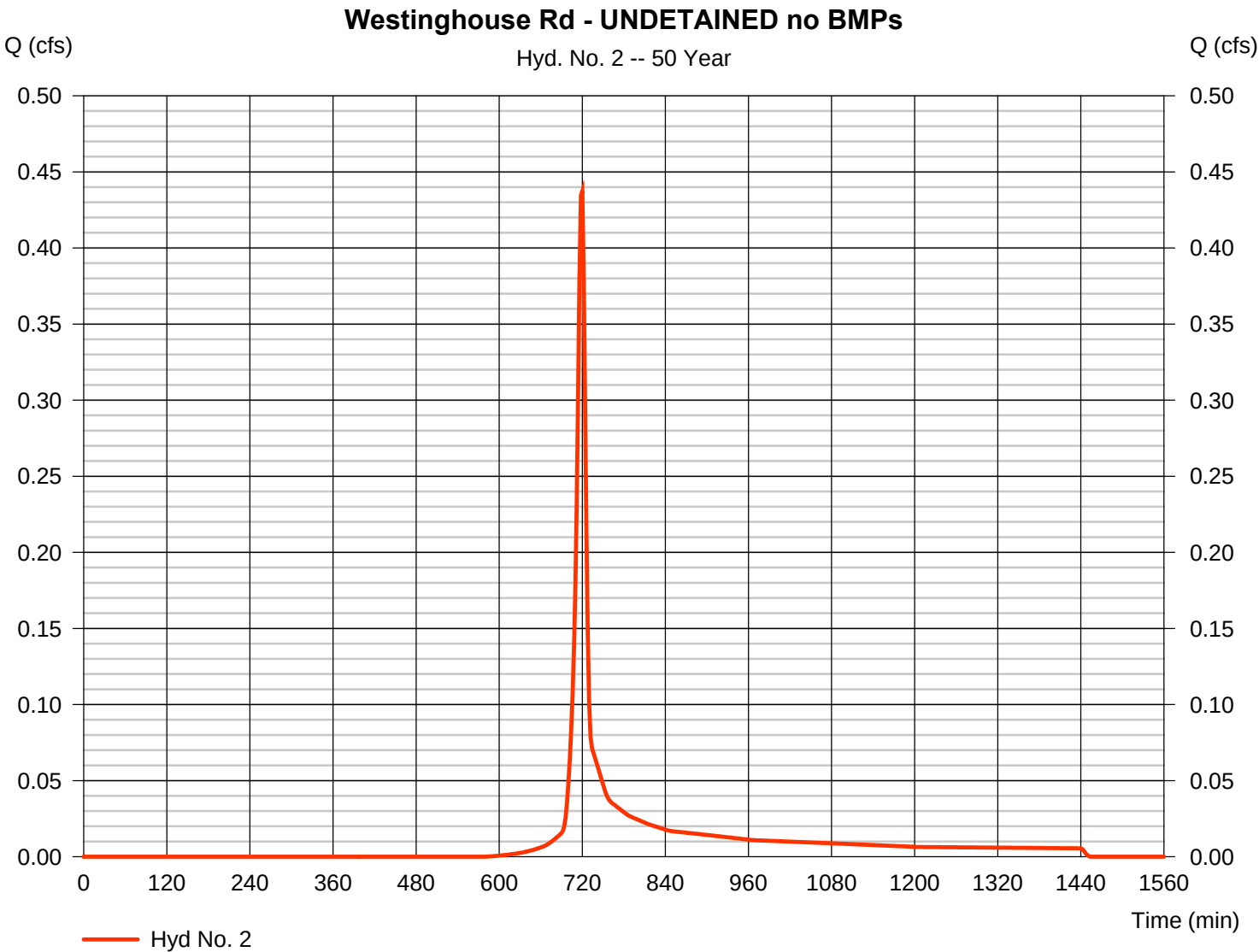
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.437 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,001 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	4.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 78) + (0.070 x 71) + (0.040 x 70)] / 0.140



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

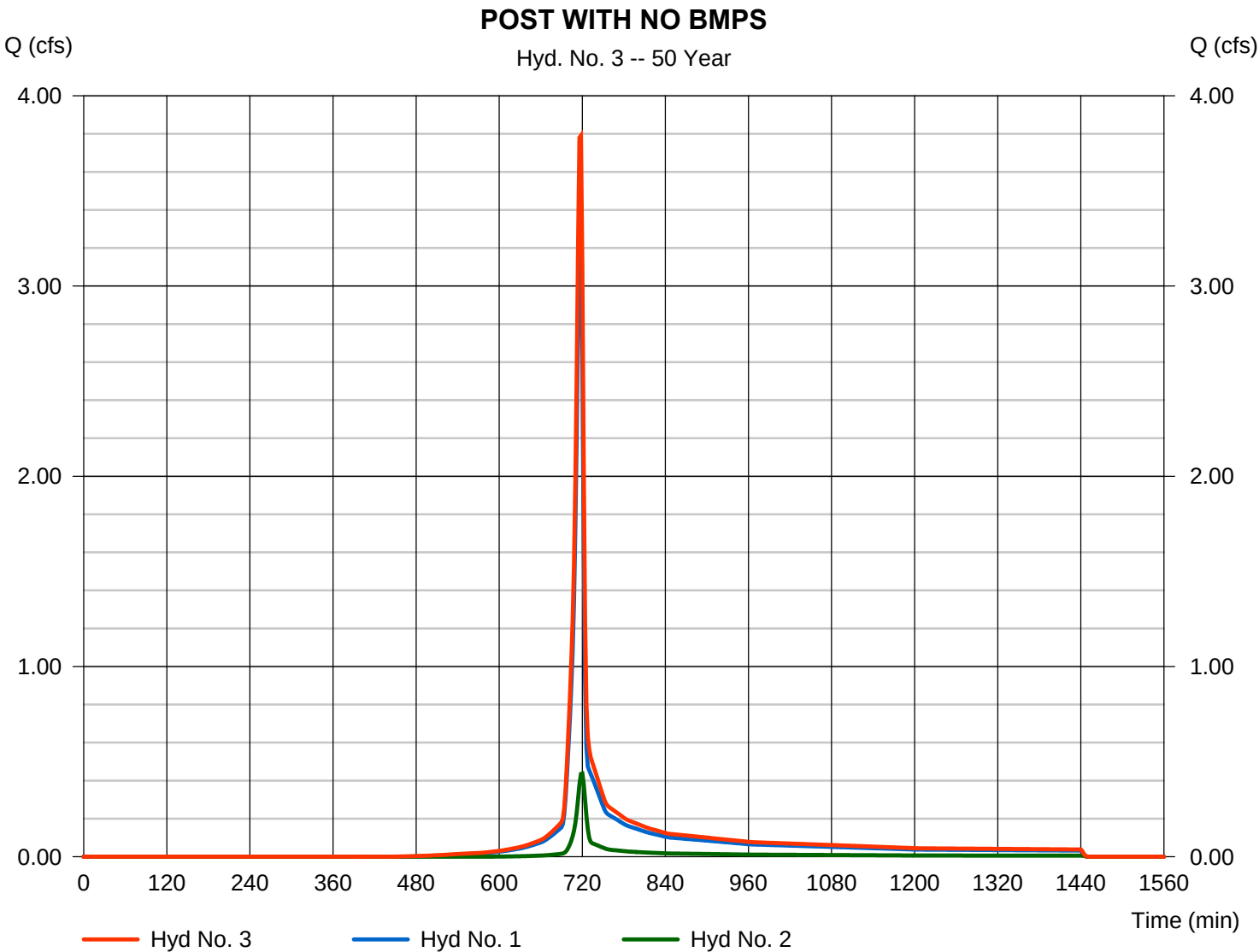
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

Hyd. No. 3

POST WITH NO BMPS

Hydrograph type	= Combine	Peak discharge	= 3.791 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 7,900 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.910 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

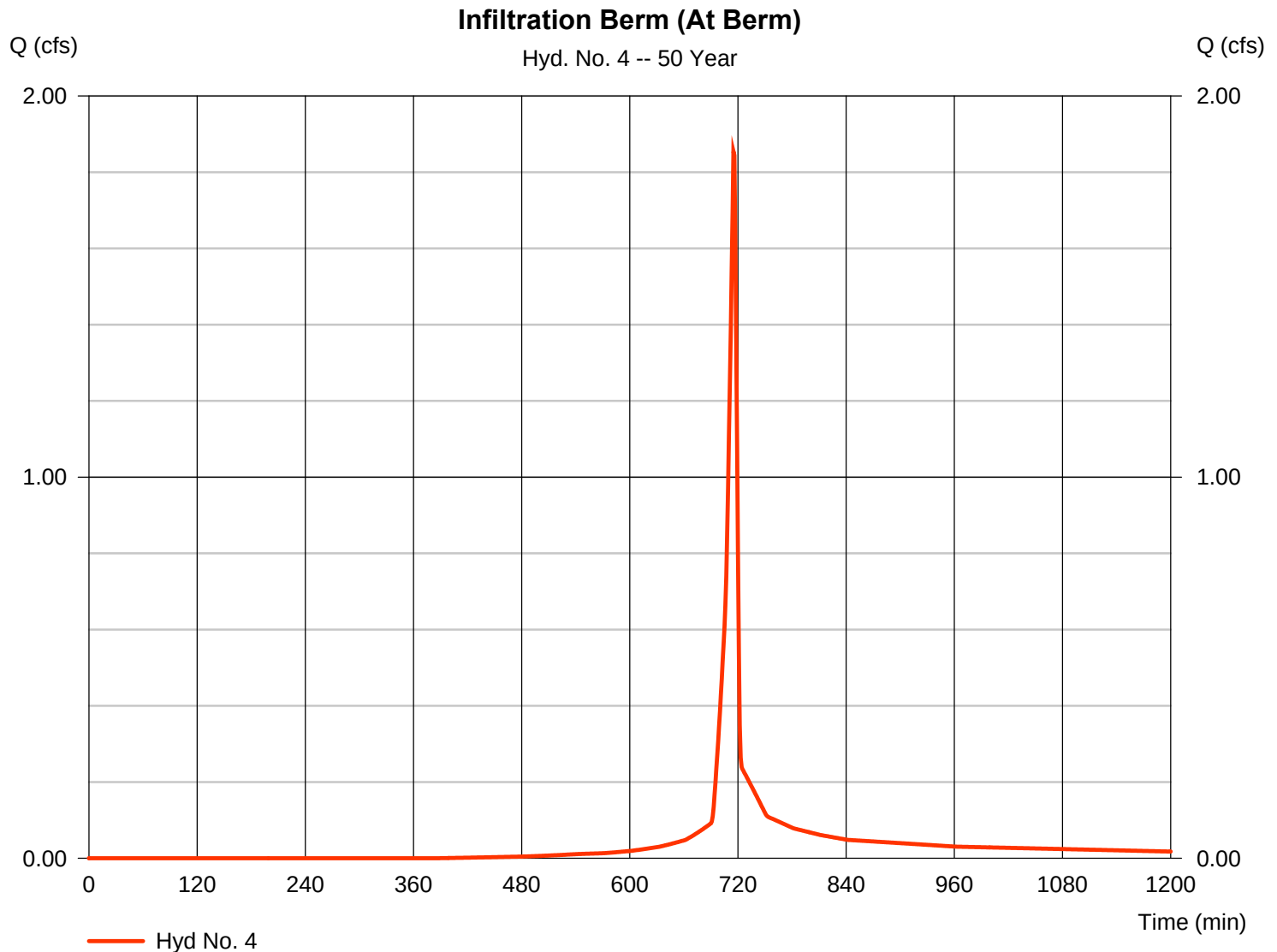
Monday, 11 / 7 / 2016

Hyd. No. 4

Infiltration Berm (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.855 cfs
Storm frequency	= 50 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 3,360 cuft
Drainage area	= 0.340 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.50 min
Total precip.	= 4.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.160 \times 78) + (0.170 \times 91) + (0.010 \times 89)] / 0.340$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

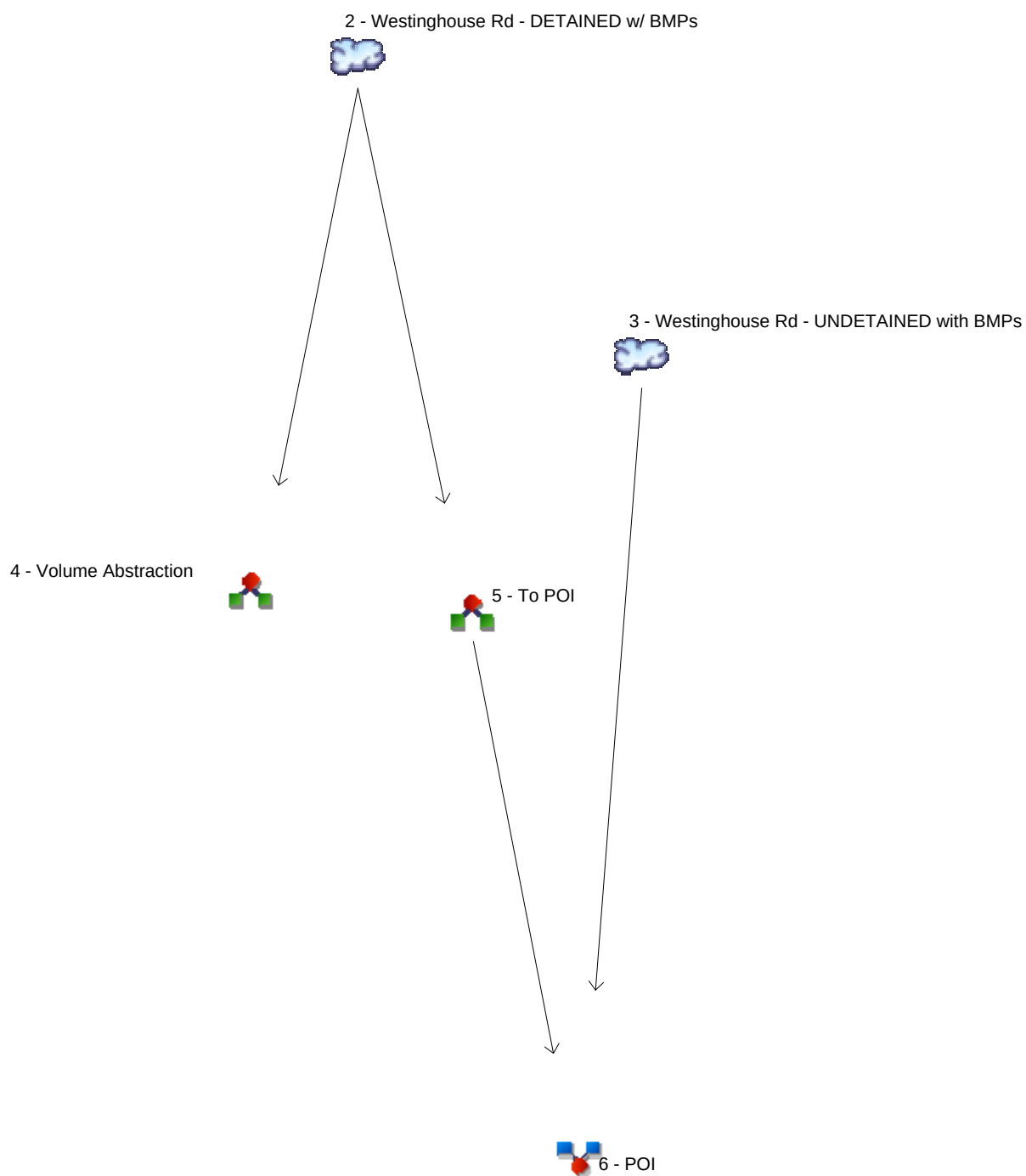
Hyd. No. 4

Infiltration Berm (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	71.00	0.00				
Watercourse slope (%)	= 5.00	3.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.55	2.79	0.00				
Travel Time (min)	= 0.27	+	0.42	+	0.00	=	0.69
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				2.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	-----	-----	-----	-----	-----	-----	-----	1.777	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.437	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	2	-----	-----	-----	-----	-----	-----	1.777	-----	Volume Abstraction
5	Diversion2	2	-----	-----	-----	-----	-----	-----	1.087	-----	To POI
6	Combine	3, 5	-----	-----	-----	-----	-----	-----	1.141	-----	POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.777	2	730	7,114	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	0.437	2	720	1,001	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	1.777	2	730	3,371	2	-----	-----	Volume Abstraction
5	Diversion2	1.087	2	746	3,743	2	-----	-----	To POI
6	Combine	1.141	2	746	4,744	3, 5	-----	-----	POI
Westinghouse Rd-Post wBMP - 50yr.gpw					Return Period: 50 Year			Monday, 11 / 7 / 2016	

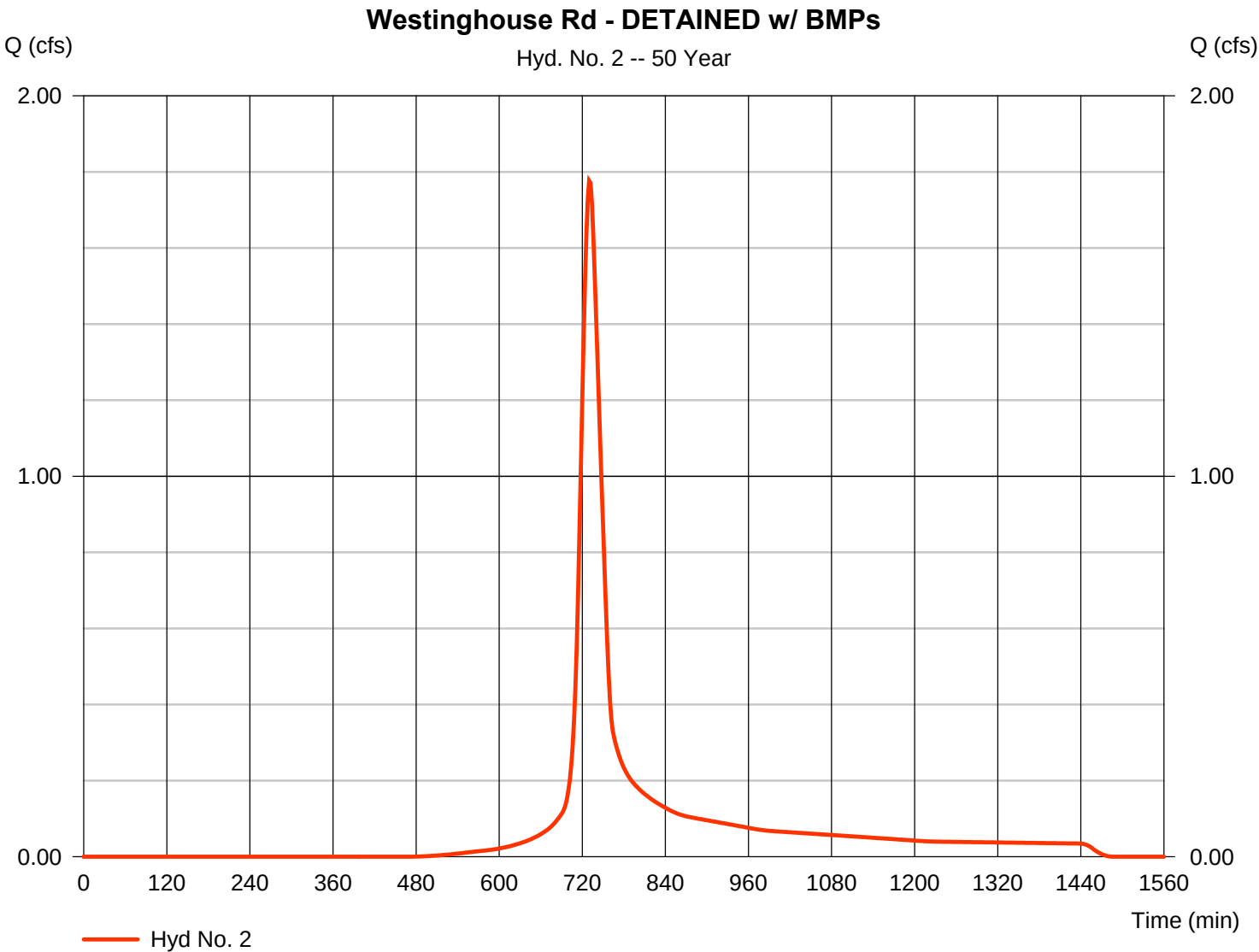
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.777 cfs
Storm frequency	=	50 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	7,114 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	27.40 min
Total precip.	=	4.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

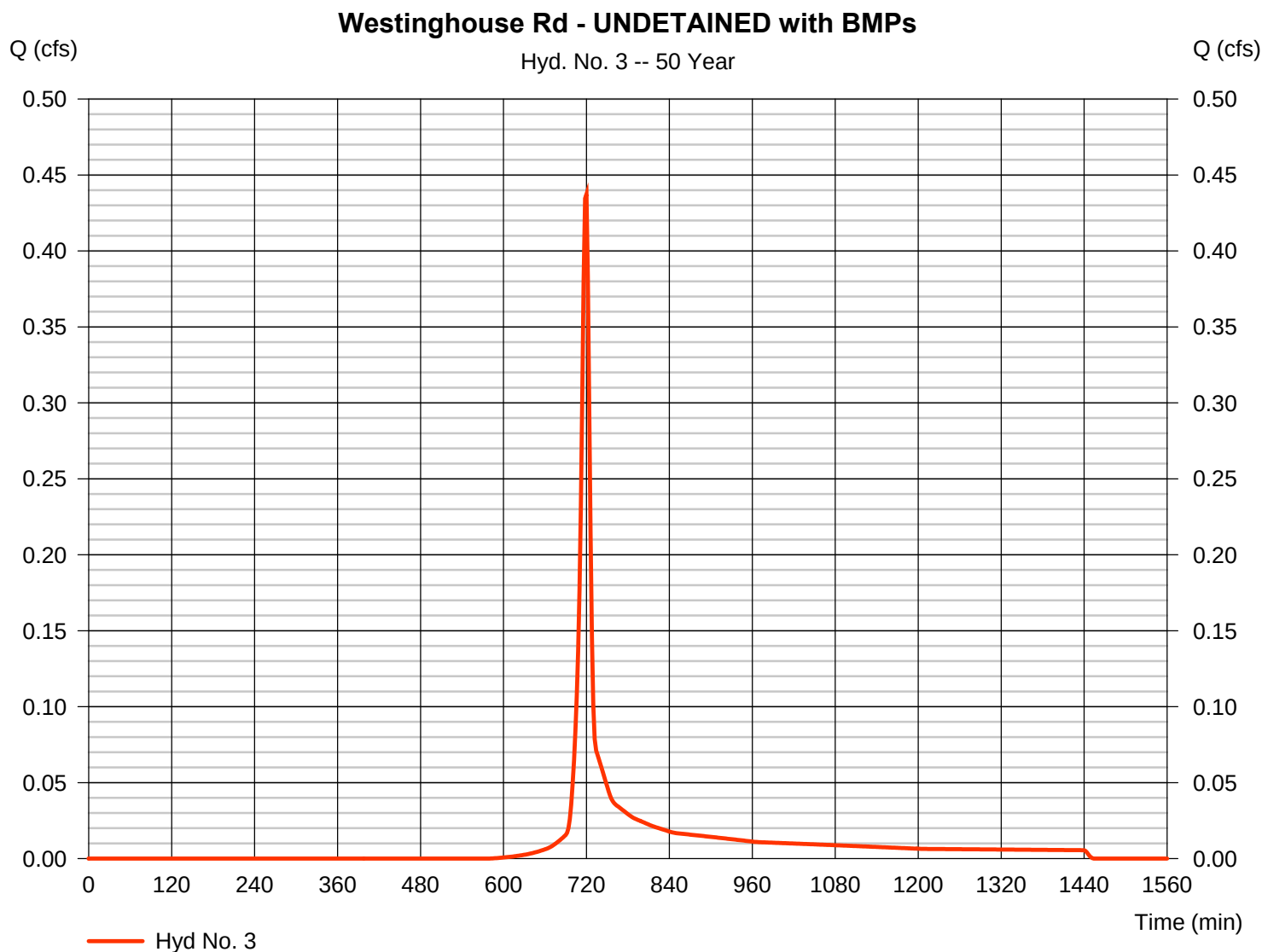
Monday, 11 / 7 / 2016

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.437 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,001 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	4.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 78) + (0.070 \times 71) + (0.040 \times 70)] / 0.140$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

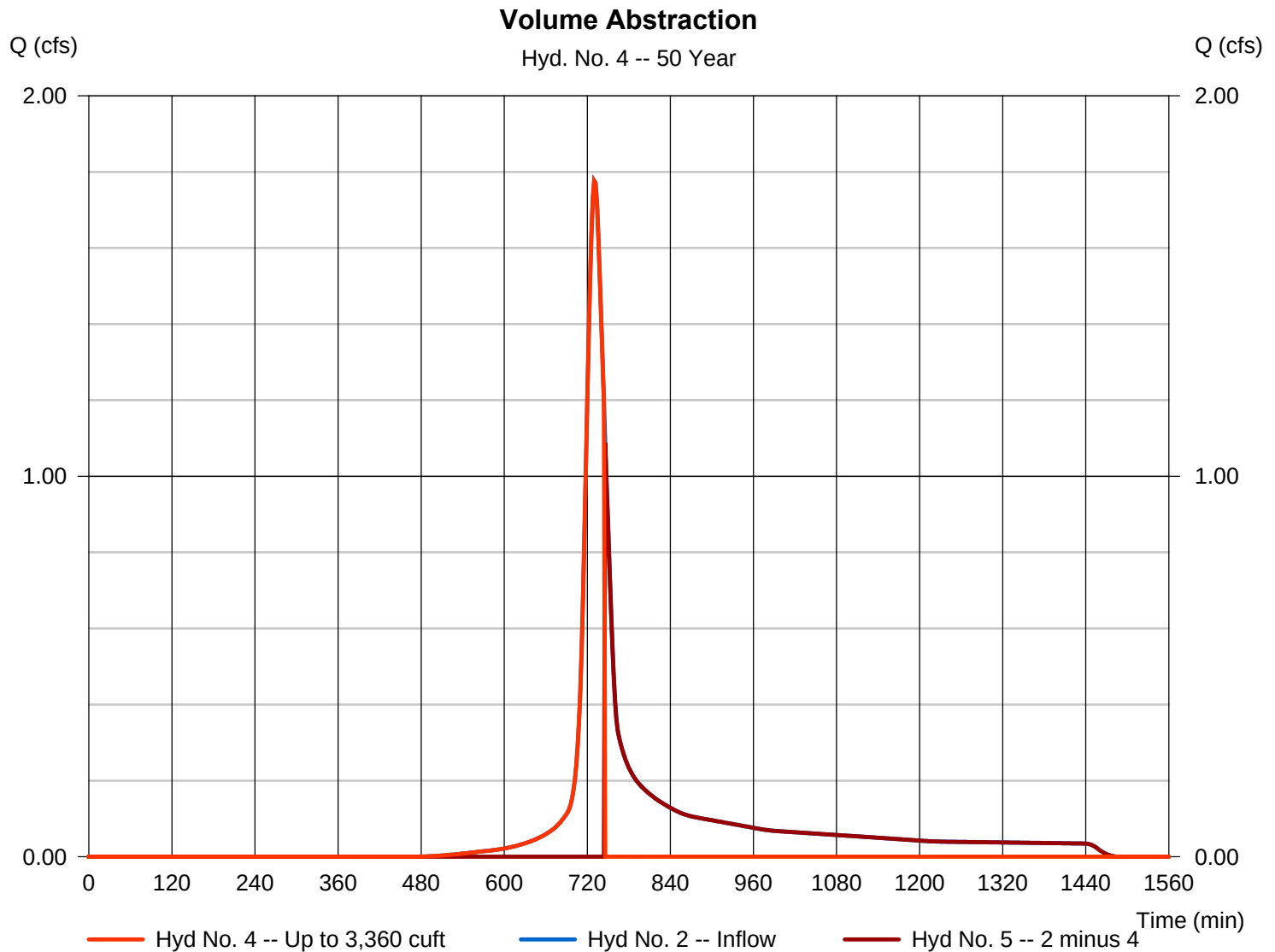
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.777 cfs
Storm frequency	= 50 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 3,371 cuft
Inflow hydrograph	= 2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	= 3,360 cuft
Diversion method	= First Flush Volume		



Hydrograph Report

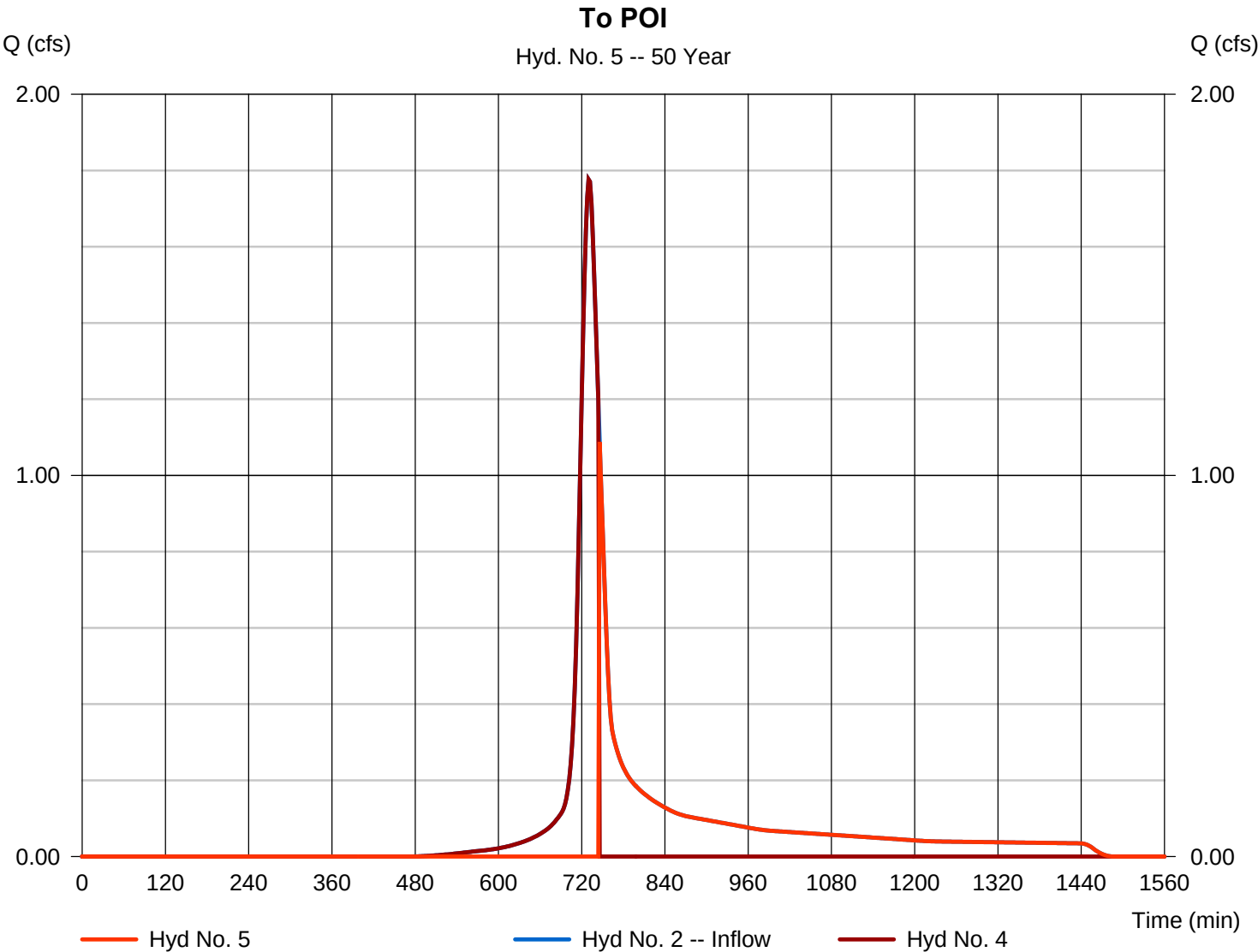
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	1.087 cfs
Storm frequency	=	50 yrs	Time to peak	=	746 min
Time interval	=	2 min	Hyd. volume	=	3,743 cuft
Inflow hydrograph	=	2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	=	3,360 cuft
Diversion method	=	First Flush Volume			



Hydrograph Report

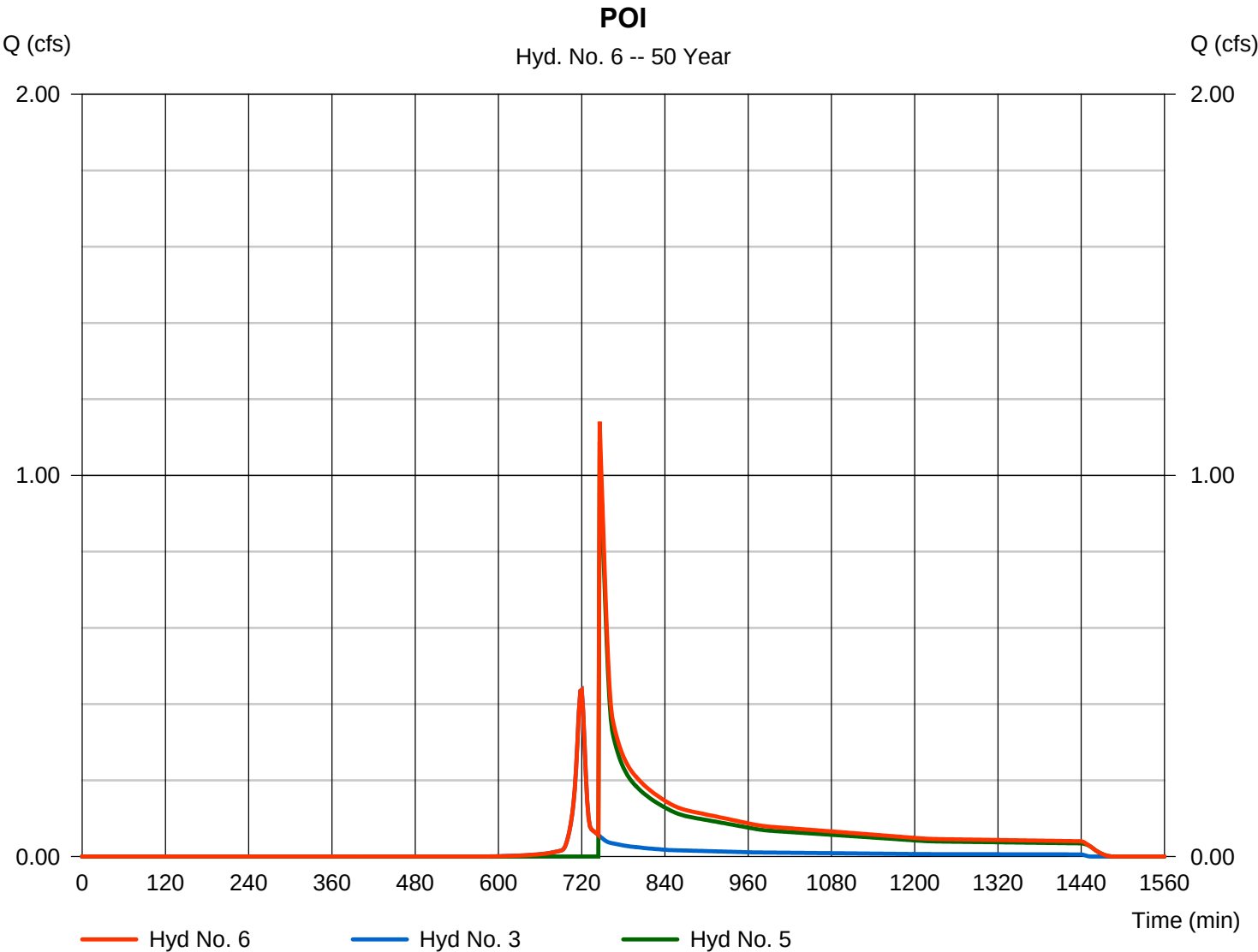
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 1.141 cfs
Storm frequency	= 50 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 4,744 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.140 ac



ATTACHMENT C-4
WESTINGHOUSE ROAD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Westinghouse Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.744	-----	-----	1.554	-----	2.626	3.161	Westinghouse Rd - PRE
Proj. file: Westinghouse Rd-PRE.gpw										Monday, 11 / 7 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.161	2	722	8,861	-----	-----	-----	Westinghouse Rd - PRE
Westinghouse Rd-PRE.gpw					Return Period: 100 Year			Monday, 11 / 7 / 2016	

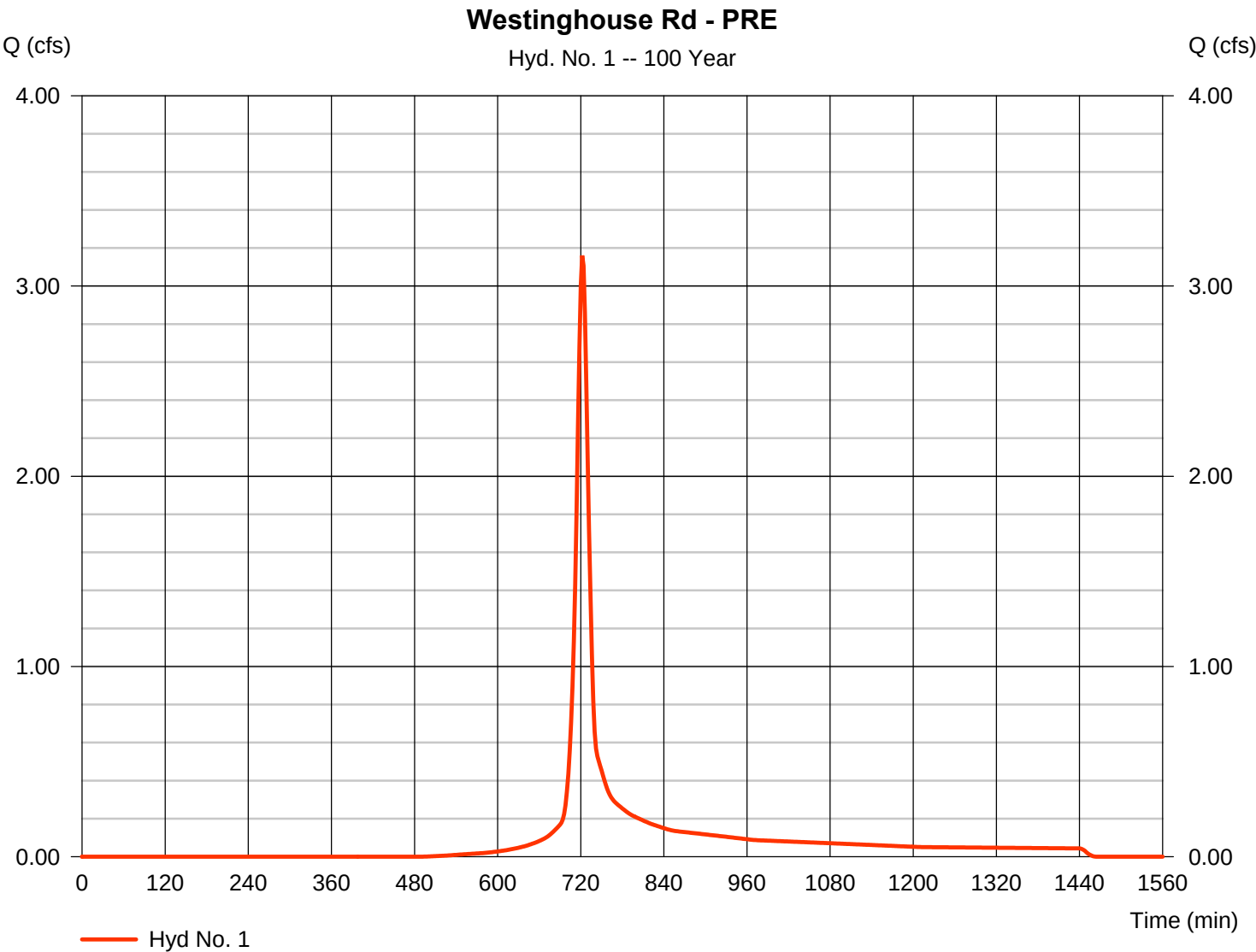
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.161 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	8,861 cuft
Drainage area	=	0.910 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	16.30 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.550 x 77) + (0.010 x 91) + (0.110 x 71) + (0.110 x 70)] / 0.910



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

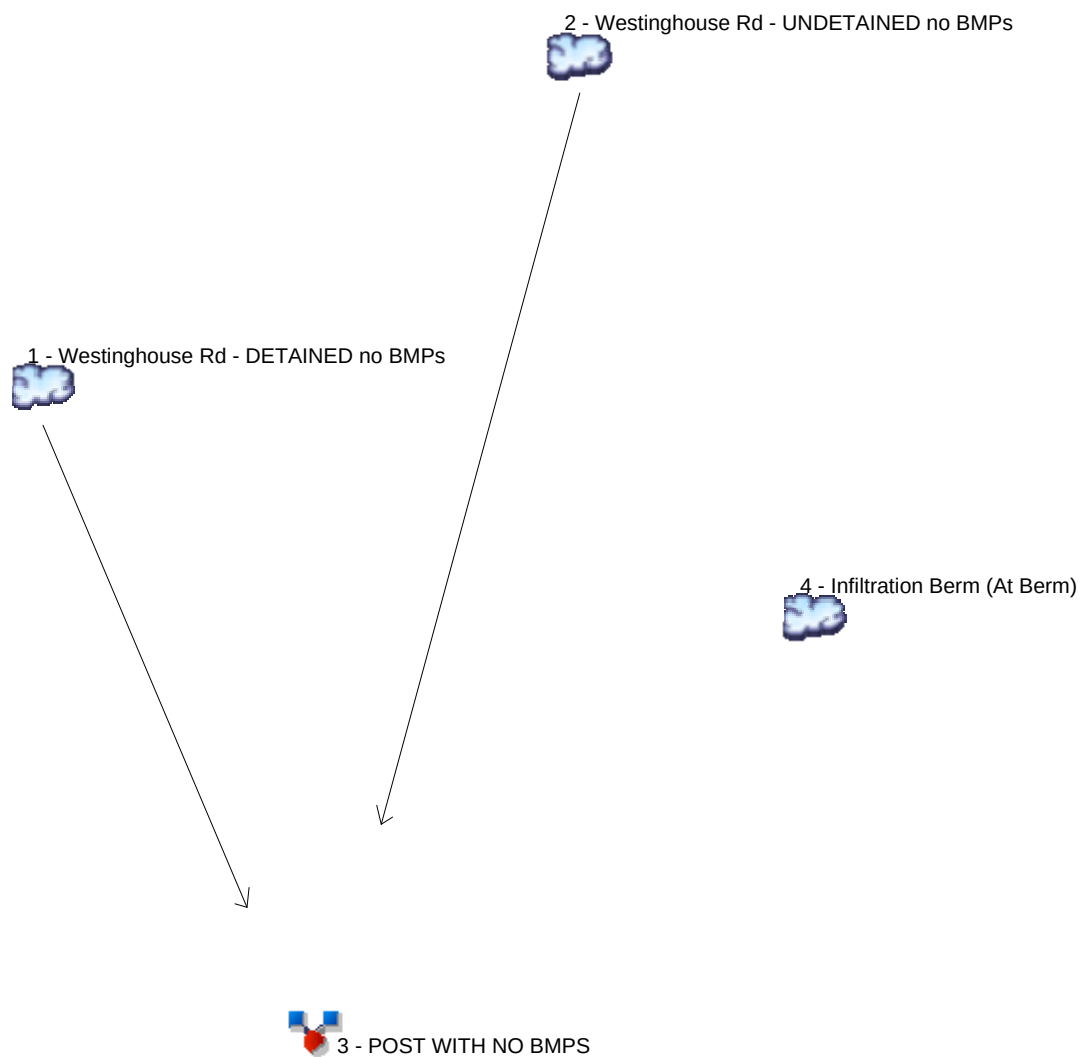
Hyd. No. 1

Westinghouse Rd - PRE

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 14.63	+	0.00	+	0.00	=	14.63
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	248.00	0.00				
Watercourse slope (%)	= 4.00	11.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.23	5.35	0.00				
Travel Time (min)	= 0.85	+	0.77	+	0.00	=	1.62
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				16.30 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.096	-----	-----	2.060	-----	3.293	3.901	Westinghouse Rd - DETAINED no B
2	SCS Runoff	-----	-----	0.108	-----	-----	0.249	-----	0.437	0.532	Westinghouse Rd - UNDETAINED no
3	Combine	1, 2	-----	1.265	-----	-----	2.389	-----	3.791	4.480	POST WITH NO BMPS
4	SCS Runoff	-----	-----	0.700	-----	-----	1.220	-----	1.855	2.160	Infiltration Berm (At Berm)
Proj. file: Westinghouse Rd-Post No BMPs.gpw											Monday, 11 / 7 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.901	2	716	7,931	-----	-----	-----	Westinghouse Rd - DETAINED no B
2	SCS Runoff	0.532	2	720	1,220	-----	-----	-----	Westinghouse Rd - UNDETAINED no
3	Combine	4.480	2	716	9,398	1, 2	-----	-----	POST WITH NO BMPS
4	SCS Runoff	2.160	1	715	3,946	-----	-----	-----	Infiltration Berm (At Berm)
Westinghouse Rd-Post No BMPs.gpw					Return Period: 100 Year			Monday, 11 / 7 / 2016	

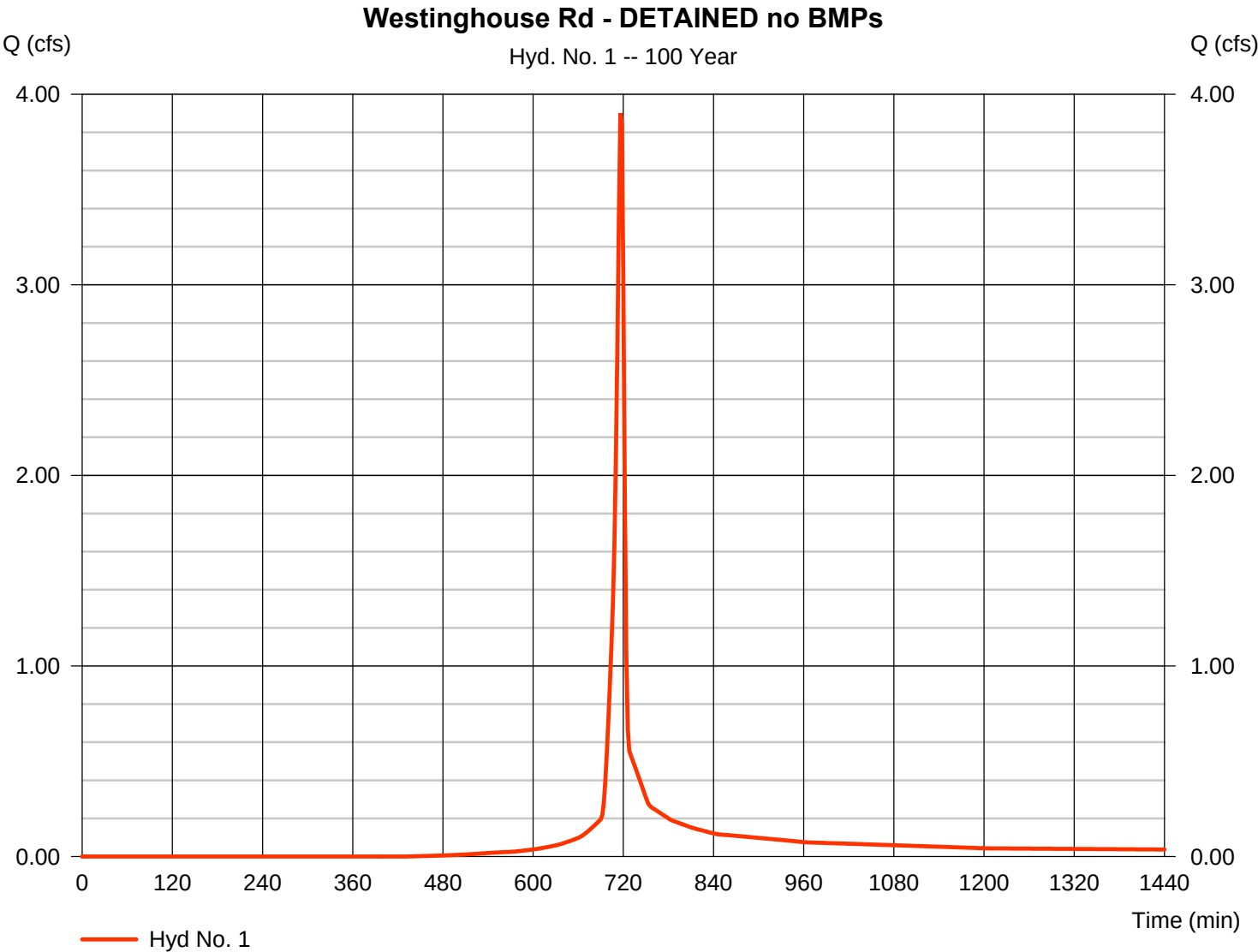
Hydrograph Report

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.901 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	7,931 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Westinghouse Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	96.00	208.00				
Watercourse slope (%)	= 5.00	6.00	13.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.55	3.95	5.82				
Travel Time (min)	= 0.27	+	0.40	+	0.60	=	1.27
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 2.78	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=8.99	0.00	0.00				
Flow length (ft)	{0}36.0	0.0	0.0				
Travel Time (min)	= 0.07	+	0.00	+	0.00	=	0.07
Total Travel Time, Tc				3.10 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

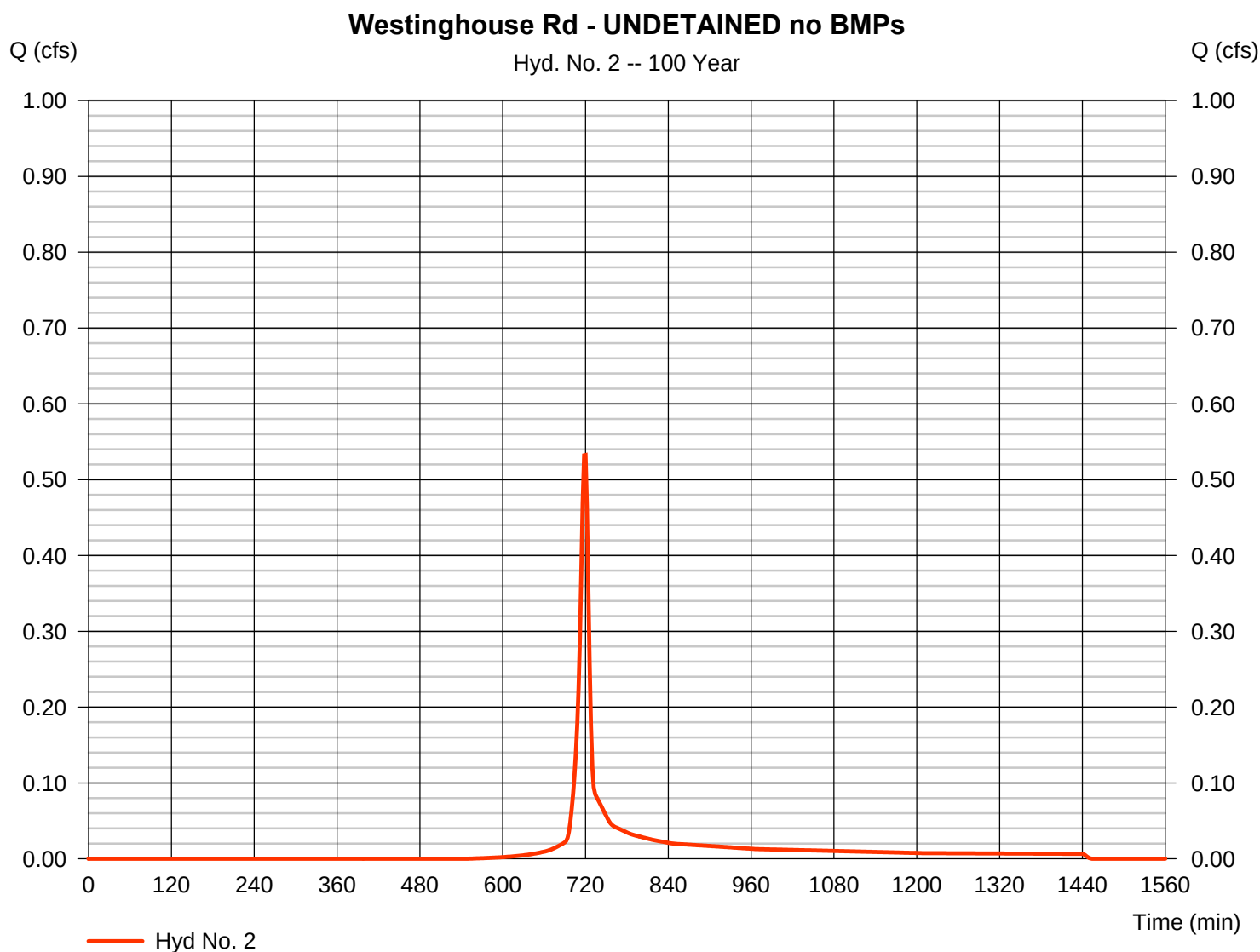
Monday, 11 / 7 / 2016

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.532 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,220 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 78) + (0.070 \times 71) + (0.040 \times 70)] / 0.140$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Westinghouse Rd - UNDETAINED no BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

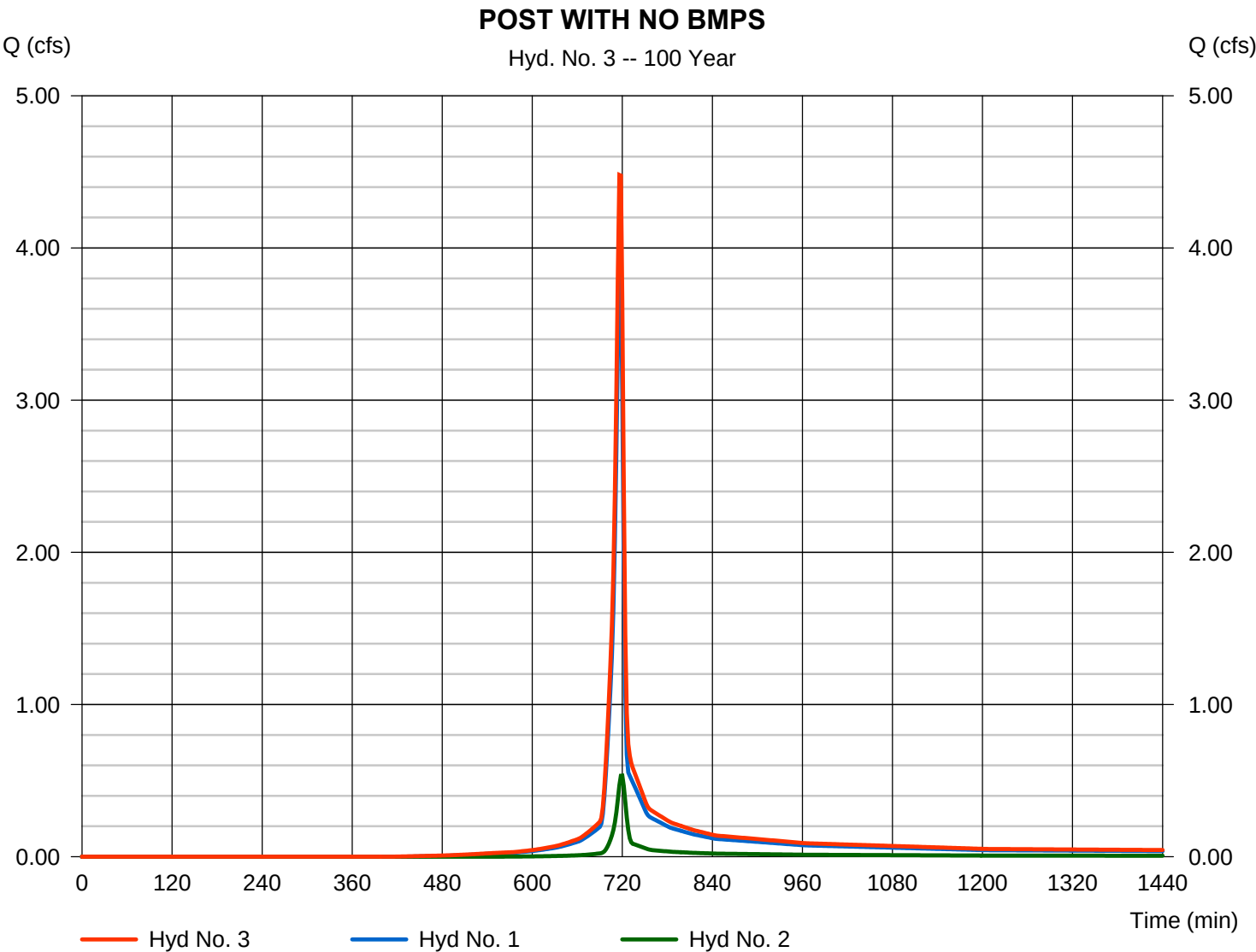
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 3

POST WITH NO BMPS

Hydrograph type	= Combine	Peak discharge	= 4.480 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 9,398 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.910 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

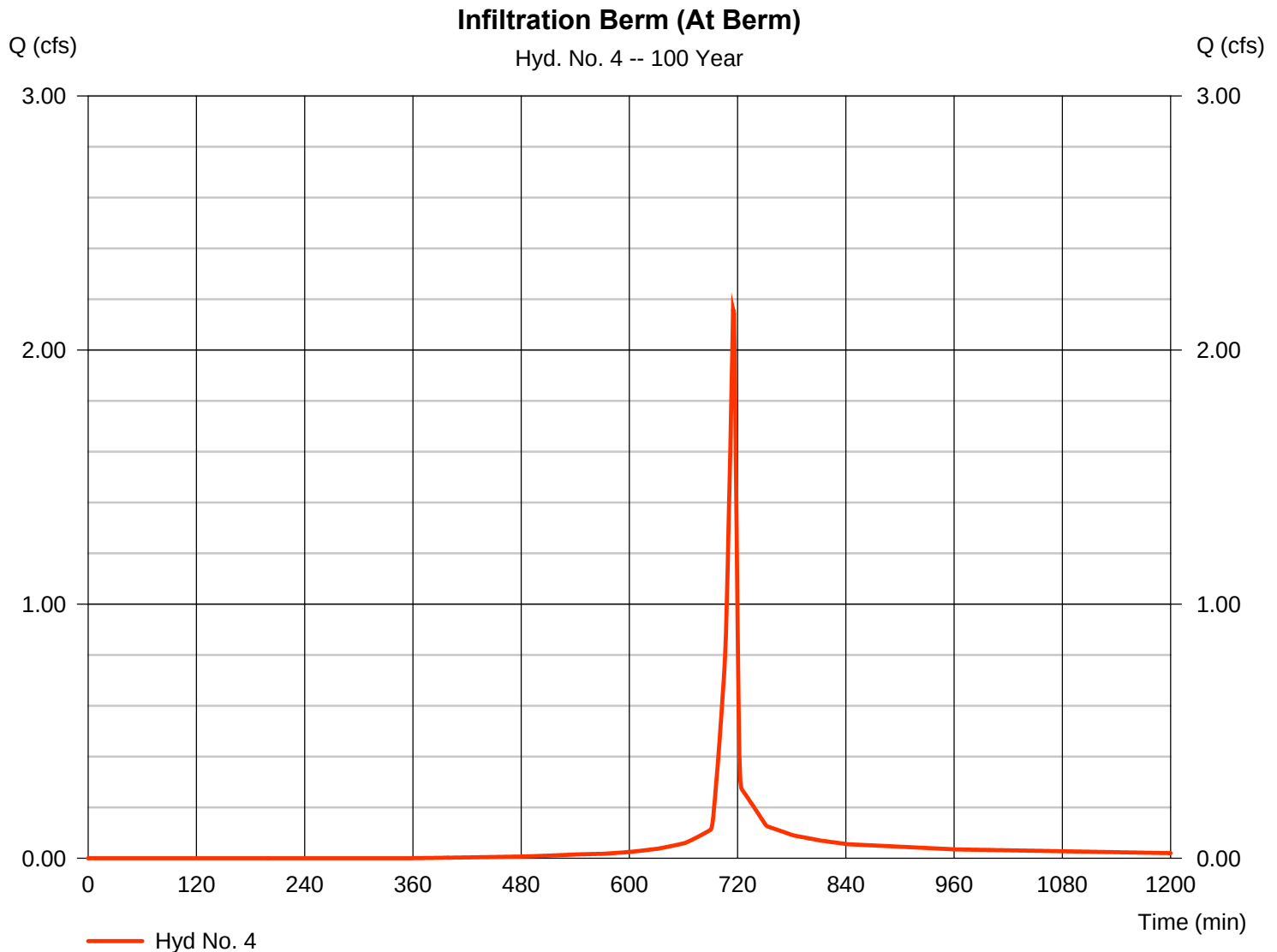
Monday, 11 / 7 / 2016

Hyd. No. 4

Infiltration Berm (At Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.160 cfs
Storm frequency	=	100 yrs	Time to peak	=	715 min
Time interval	=	1 min	Hyd. volume	=	3,946 cuft
Drainage area	=	0.340 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	2.50 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.160 \times 78) + (0.170 \times 91) + (0.010 \times 89)] / 0.340$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

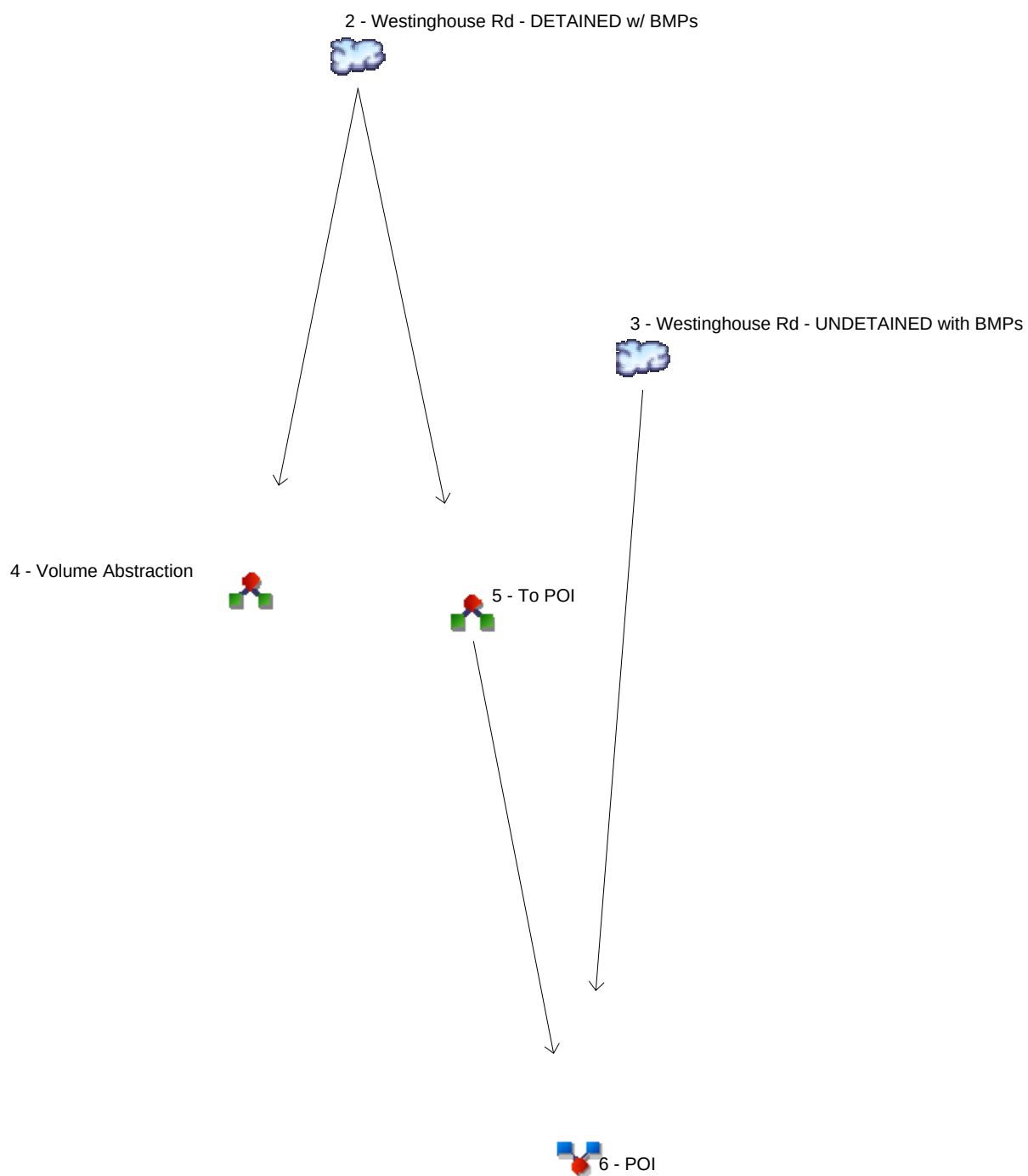
Hyd. No. 4

Infiltration Berm (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.50	0.00	0.00				
Land slope (%)	= 1.00	0.00	0.00				
Travel Time (min)	= 1.81	+	0.00	+	0.00	=	1.81
Shallow Concentrated Flow							
Flow length (ft)	= 73.00	71.00	0.00				
Watercourse slope (%)	= 5.00	3.00	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.55	2.79	0.00				
Travel Time (min)	= 0.27	+	0.42	+	0.00	=	0.69
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				2.50 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	-----	-----	-----	-----	-----	-----	-----	-----	2.117	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	0.532	Westinghouse Rd - UNDETAINED wit
4	Diversion1	2	-----	-----	-----	-----	-----	-----	-----	2.117	Volume Abstraction
5	Diversion2	2	-----	-----	-----	-----	-----	-----	-----	1.546	To POI
6	Combine	3, 5	-----	-----	-----	-----	-----	-----	-----	1.617	POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.117	2	730	8,460	-----	-----	-----	Westinghouse Rd - DETAINED w/ B
3	SCS Runoff	0.532	2	720	1,220	-----	-----	-----	Westinghouse Rd - UNDETAINED wit
4	Diversion1	2.117	2	730	3,768	2	-----	-----	Volume Abstraction
5	Diversion2	1.546	2	742	4,693	2	-----	-----	To POI
6	Combine	1.617	2	742	5,912	3, 5	-----	-----	POI
Westinghouse Rd-Post wBMP - 100yr.gpw					Return Period: 100 Year			Monday, 11 / 7 / 2016	

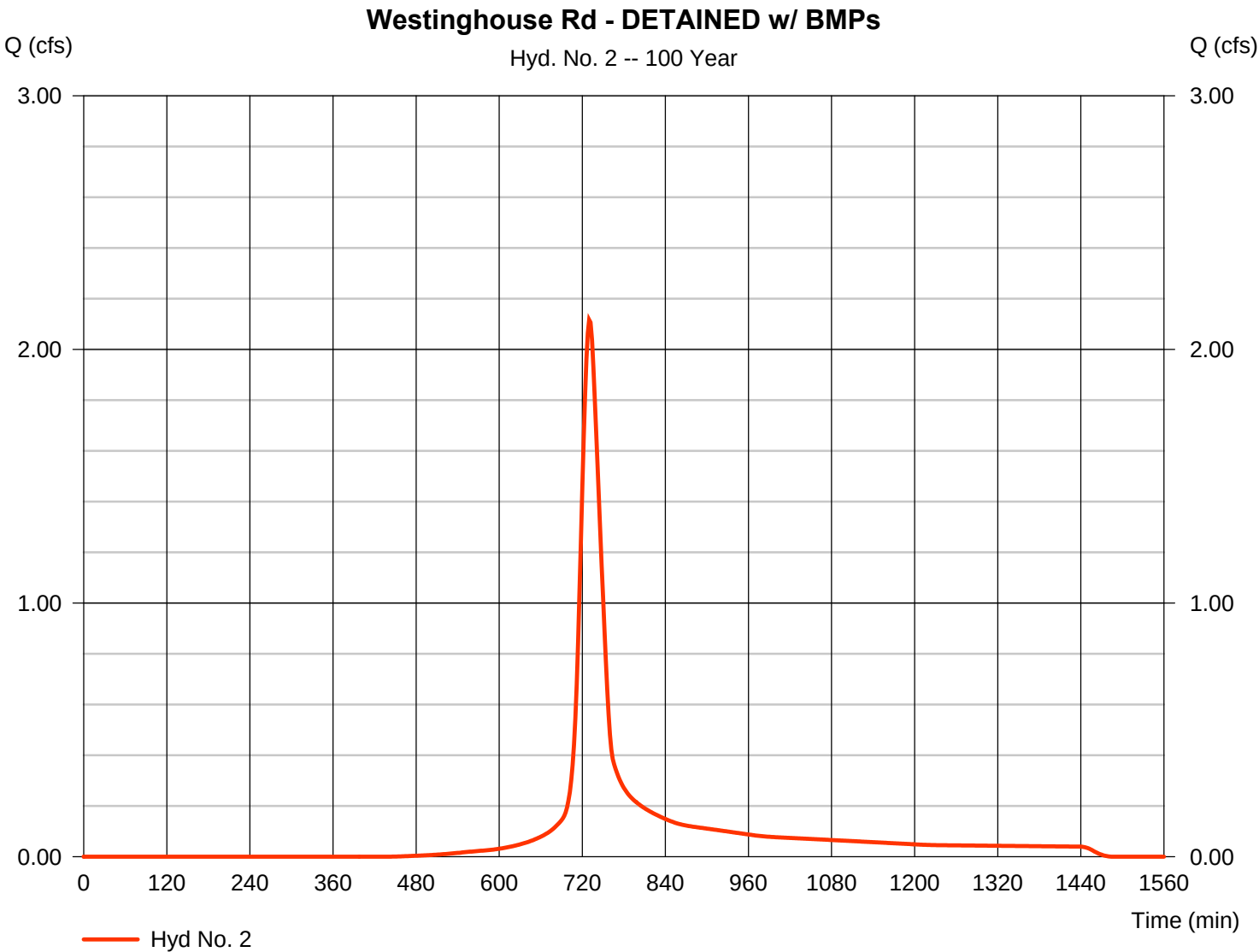
Hydrograph Report

Hyd. No. 2

Westinghouse Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.117 cfs
Storm frequency	=	100 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	8,460 cuft
Drainage area	=	0.770 ac	Curve number	=	79*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	27.40 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.420 x 78) + (0.060 x 77) + (0.170 x 91) + (0.110 x 71) + (0.010 x 89)] / 0.770



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

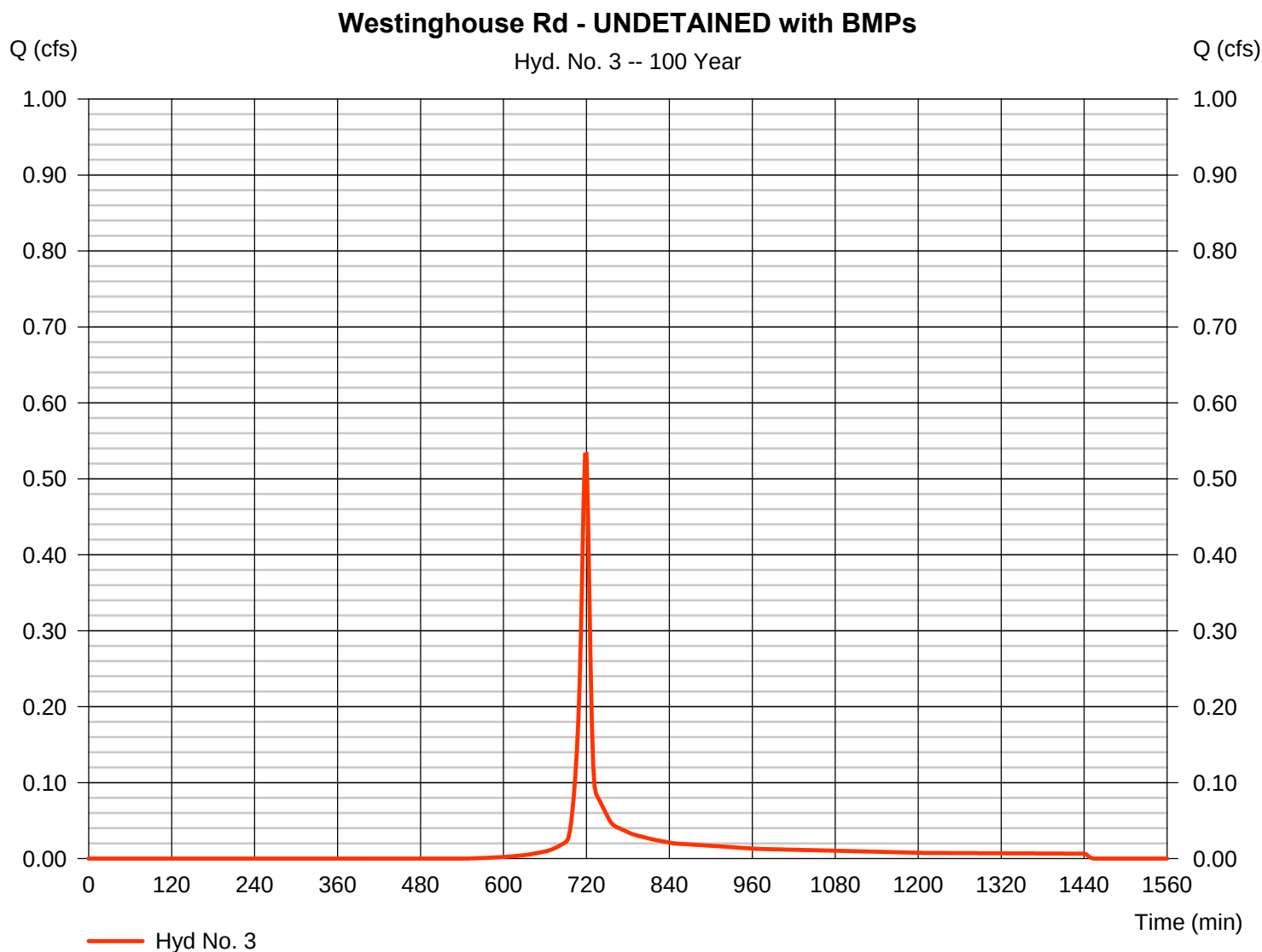
Monday, 11 / 7 / 2016

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.532 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,220 cuft
Drainage area	=	0.140 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.30 min
Total precip.	=	5.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.030 \times 78) + (0.070 \times 71) + (0.040 \times 70)] / 0.140$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Westinghouse Rd - UNDETAINED with BMPs

<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)	= 2.50	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.40	+	0.00	+	0.00	=	8.40
Shallow Concentrated Flow							
Flow length (ft)	= 290.00	0.00	0.00				
Watercourse slope (%)	= 10.20	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=5.15	0.00	0.00				
Travel Time (min)	= 0.94	+	0.00	+	0.00	=	0.94
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				9.30 min			

Hydrograph Report

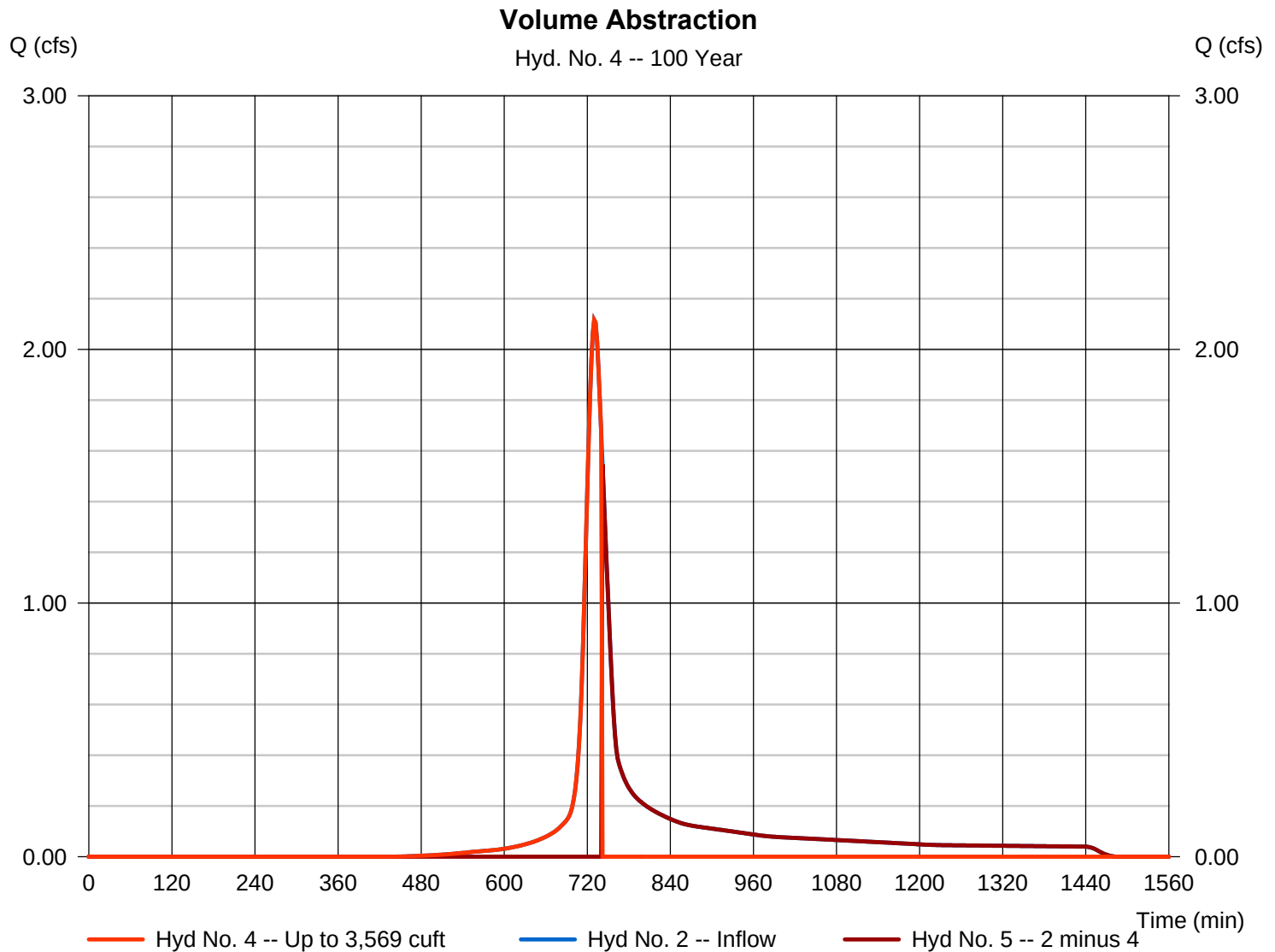
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.117 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 3,768 cuft
Inflow hydrograph	= 2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	= 5
Diversion method	= First Flush Volume		= 3,569 cuft



Hydrograph Report

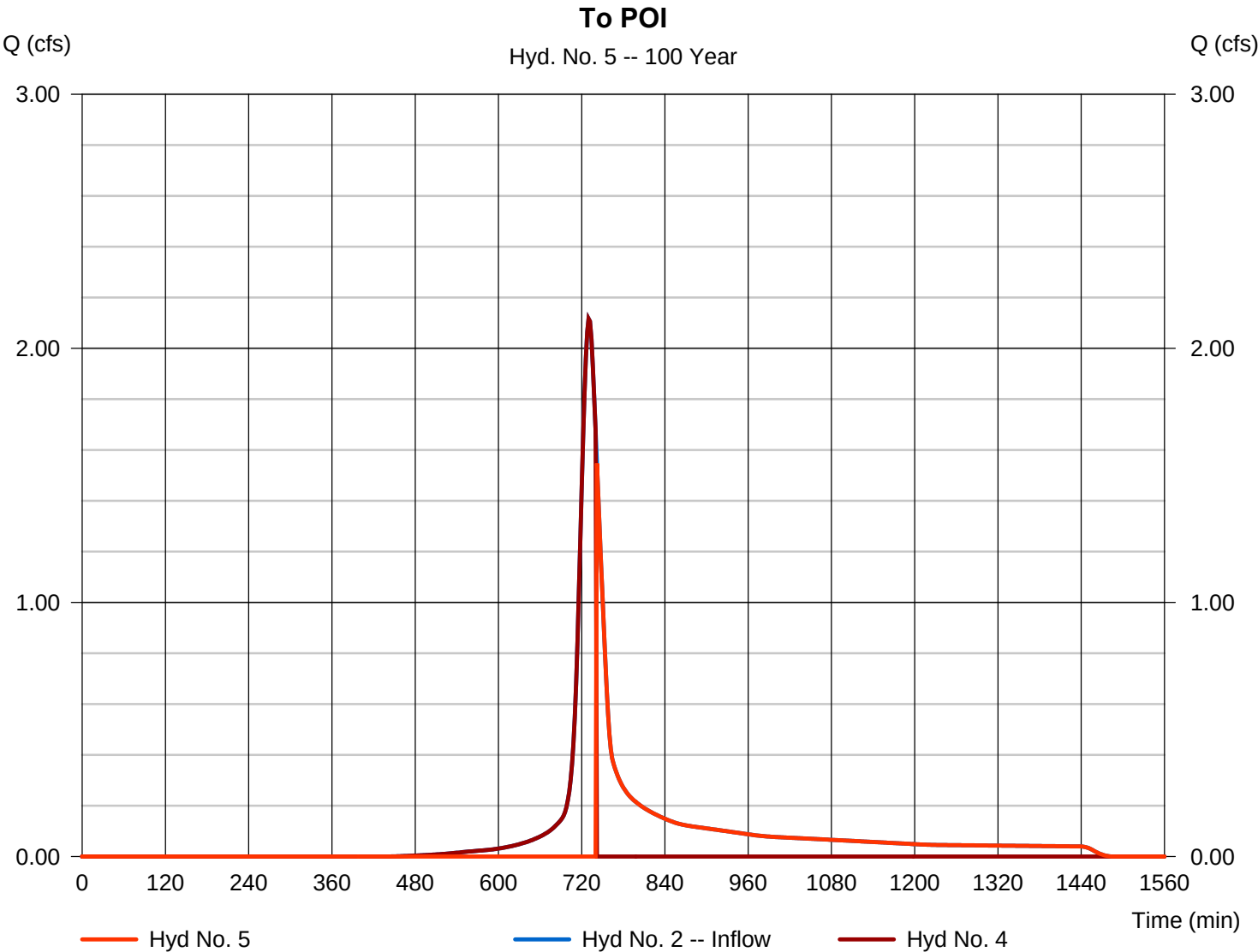
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	1.546 cfs
Storm frequency	=	100 yrs	Time to peak	=	742 min
Time interval	=	2 min	Hyd. volume	=	4,693 cuft
Inflow hydrograph	=	2 - Westinghouse Rd - DETAINED on Diversion hyd.	Volume Up To	=	3,569 cuft
Diversion method	=	First Flush Volume			



Hydrograph Report

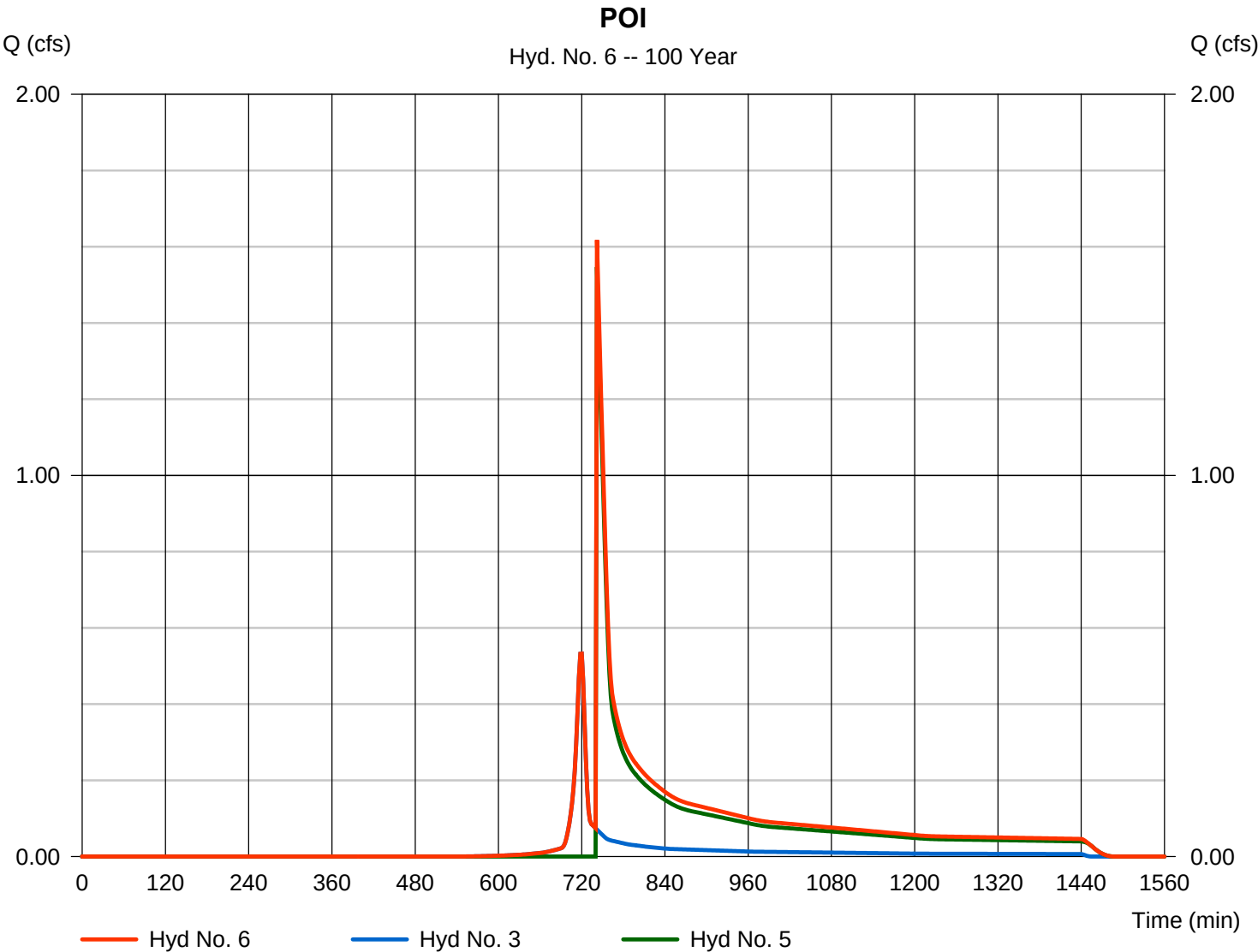
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Monday, 11 / 7 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 1.617 cfs
Storm frequency	= 100 yrs	Time to peak	= 742 min
Time interval	= 2 min	Hyd. volume	= 5,912 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 0.140 ac



NEWPORT RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 4, 2016

Project Name: Newport Rd

Municipality: Burrell Township

County: Indiana

Total Area (acres): 5.44

Major River Basin: Ohio

Watershed: Blacklick Creek

Sub Basin: Blacklick Creek - Conemaugh River

Nearest Surface Water to Receive Runoff: UNT Blacklick Creek

Ch. 93 - Designated Water Use: TSF

Impaired according to Chapter 303(d) list?

YES

☒

List Causes of Impairment:

NO

☐

AMD - Metals

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES

☐

NO

☒

Existing or Planned drinking water supply?

YES

☐

NO

☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES

☐

NO

☒

Existing River Conservation Plan?

YES

☐

NO

☒

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	5.44	3.73
Other:			
TOTAL EXISTING:	Yes	5.44	3.73

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECTED AREA			
1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	3.73	Ac.	
1.2 Area of Riparian Forest Buffer Protection	0	Ac.	
3.1 Area of Minimum Disturbance/Reduced Grading	0	Ac.	
TOTAL	<u>3.73</u>	Ac.	

Site Area	minus	Protected Area	=	Stormwater Management Area
5.44	-	3.73	=	1.71
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS			
3.1 Minimum Soil Compaction			
Lawn	_____ ft ²	x 1/4 in x 1/12	= _____ ft ³
Meadow	_____ ft ²	x 1/3 in x 1/12	= _____ ft ³
3.3 Protected Existing Trees			
<i>For trees within 100 feet of impervious area:</i>			
Tree canopy	_____ ft ²	x 1/2 in x 1/12	= _____ ft ³
5.1 Disconnect Roof Leaders to Vegetated Areas			
<i>For runoff directed to areas protected under 5.8.1 and 5.8.2</i>			
Roof Area	_____ ft ²	x 1/3 in x 1/12	= _____ ft ³
<i>For all other disconnected roof areas</i>			
Roof Area	_____ ft ²	x 1/4 in x 1/12	= _____ ft ³
5.2 Disconnect Non-Roof impervious to Vegetated Areas			
<i>For runoff directed to areas protected under 5.8.1 and 5.8.2</i>			
Impervious Areas	_____ ft ²	x 1/3 in x 1/12	= _____ ft ³
<i>For all other disconnected roof areas</i>			
Impervious Areas	_____ ft ²	x 1/4 in x 1/12	= _____ ft ³
TOTAL NON-STRUCTURAL VOLUME CREDIT*			ft³

* For use on Worksheet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT:	Newport Rd
Drainage Area:	5.44 acres
2-Year Rainfall:	2.51 in
Total Site Area:	5.44 acres
Protected Site Area:	3.73 acres
Managed Site Area:	1.71 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C	46174	1.06	71	4.08	0.82	0.50	1,909
Meadow	C/D	28314	0.65	78	2.82	0.56	0.79	1,874
TOTAL:		74,488	1.71					3,784

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C	21344	0.49	71	4.08	0.82	0.50	883
Impervious Gravel	C	6970	0.16	89	1.24	0.25	1.46	850
Meadow	C/D	39640	0.91	78	2.82	0.56	0.79	2,624
Impervious Gravel	C/D	6534	0.15	91	0.99	0.20	1.62	882
TOTAL:		74,488	1.71					5,238

2-Year Volume Increase (ft ³):	1,455

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 $S = (1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Newport Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 1,455

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 1,455
(Required Control Volume minus Non-structural Credit)

Proposed BMP	Area (ft ²)	Storage Volume (ft ³)
6.4.1 Porous Pavement		
6.4.2 Infiltration Basin		
6.4.3 Infiltration Bed		
6.4.4 Infiltration Trench		
6.4.5 Rain Garden/Bioretenention		
6.4.6 Dry Well/Seepage Pit		
6.4.7 Constructed Filter		
6.4.8 Vegetated Swale		
6.4.9 Vegetated Filter Strip		
6.4.10 Berm	7,280	2,906
6.5.1 Vegetated Roof		
6.5.2 Capture and Re-Use		
6.6.1 Constructed Wetlands		
6.6.2 Wet Pond/Retention Basin		
6.7.1 Riparian Buffer Restoration		
6.7.2 Landscape Restoration/Reforestation		
6.7.3 Soil Amendment		
6.8.1 Level Spreader		
6.8.2 Special Storage Areas		
Other:		
Total Structural Volume Provided (ft³):		2,906
Structural Volume Requirement (ft³):		1,455
DIFFERENCE:		-1,451

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenion		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP

LOCATION: Newport Road, Indiana County, PA

DONE BY: EAD

DATE: 10/4/2016

CHECKED BY: LMD

DATE: 10/19/2016

CHANNEL OR CHANNEL SECTION	DD-1	CD-1			
TEMPORARY OR PERMANENT? (T OR P)	P	P			
DESIGN STORM (2, 5, 10, OR 100 YR)	100	100			
ACRES (AC)	2.15	0.21			
MULTIPLIER (1.6, 2.25, or 2.75) ¹	N/A	N/A			
Q _r (REQUIRED CAPACITY) (CFS)	8.30	1.50			
Q (CALCULATED AT FLOW DEPTH d) (CFS)	8.30	1.50			
S (BED SLOPE) ³ (FT/FT)	0.038	0.045			
DESIGN METHOD FOR PROTECTIVE LINING ⁵ PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V	V			
PROTECTIVE LINING ²	NAG P300	NAG P300			
n (MANNING'S COEFFICIENT) ²	0.070	0.126			
V _a (ALLOWABLE VELOCITY) (FPS)	5.00	5.00			
V (CALCULATED AT FLOW DEPTH) (FPS)	2.76	1.24			
t _a (MAX ALLOWABLE SHEAR STRESS) (LB/FT ²)	N/A	N/A			
t _d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT ²)	N/A	N/A			
CHANNEL BOTTOM WIDTH (FT)	1	0			
CHANNEL LEFT SIDE SLOPE (_LH:1V)	2	2			
CHANNEL RIGHT SIDE SLOPE (_RH:1V)	2	2			
D (TOTAL DEPTH) (FT)	1.50	1.50			
CHANNEL TOP WIDTH @ D (FT)	7.00	6.00			
d (CALCULATED FLOW DEPTH) (FT)	1.00	0.78			
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	5.00	3.12			
BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)	1.00	0.00			
d ₅₀ STONE SIZE (IN)	N/A	N/A			
A (CROSS-SECTIONAL AREA) (SQ. FT.)	3.00	1.22			
R (HYDRAULIC RADIUS)	0.55	0.35			
S _c (CRITICAL SLOPE) (FT/FT)	0.095	0.367			
.75S _c (FT/FT)	0.067	0.257			
1.35S _c (FT/FT)	0.124	0.477			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW (FT)	N/A	N/A			
FREEBOARD BASED ON STABLE FLOW (FT)	0.50	0.72			
MINIMUM REQUIRED FREEBOARD ⁴	0.5	0.5			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

**PCSM - DESIGN CALCULATIONS
NEWPORT RD**

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations **Newport Road**

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Newport Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Newport Road Block Valve Site is located in Burrell Township, Indiana County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This project will utilize infiltration berms to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.51
10-yr	3.53
50-yr	4.72
100-yr	5.28

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.51 in

Total Site Area : 5.44 acres

Protected Site Area: 3.73 acres

Stormwater Management Area 1.71 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	1.06	71	4.08	0.82	0.50	1,909
Meadow	C/D	0.65	78	2.82	0.56	0.79	1,874
Total		1.71					3,784

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.49	71	4.08	0.82	0.50	883
Impervious Gravel	C	0.16	89	1.24	0.25	1.46	850
Meadow	C/D	0.91	78	2.82	0.56	0.79	2,624
Impervious Gravel	C/D	0.15	91	0.99	0.20	1.62	882
Total		1.71					5,238

2-Year Volume Increase (cf):	1,455

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

P = 2-Year Rainfall (in)

S = $(1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$

Q = Runoff (in)

Area = Land use area (sq. ft.)

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LOADING RATES

INFILTRATION BERM 1

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.12	5,227
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,045
Design Infiltration Area (sf):		2,260
Designed Impervious Ratio:	2.3	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.64	27,878
Maximum Total Watershed Ratio:	8	:1
Minimum Infiltration Area (sf):		3,485
Design Infiltration Area (sf):		2,260
Designed Total Watershed Ratio:	12.3	:1

A Diversion Channel could not be constructed on the northern side of the pad due to the presence of a protected wetland area.

INFILTRATION BERM 2

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.07	3,049
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		610
Design Infiltration Area (sf):		2,852
Designed Impervious Ratio:	1.1	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	1.15	50,094
Maximum Total Watershed Ratio:	8	:1
Minimum Infiltration Area (sf):		6,262
Design Infiltration Area (sf):		2,852
Designed Total Watershed Ratio:	17.6	:1

A Diversion Channel could not be constructed on the northern side of the pad due to the presence of a protected wetland area.

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INFILTRATION BERM 3

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.10	4,356
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		871
Design Infiltration Area (sf):		1,813
Designed Impervious Ratio:	2.4	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.19	8,276
Maximum Total Watershed Ratio:	8	:1
Minimum Infiltration Area (sf):		1,035
Design Infiltration Area (sf):		1,813
Designed Total Watershed Ratio:	4.6	:1

INFILTRATION BERM 4

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.02	871
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		174
Design Infiltration Area (sf):		355
Designed Impervious Ratio:	2.5	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.06	2,614
Maximum Total Watershed Ratio:	8	:1
Minimum Infiltration Area (sf):		327
Design Infiltration Area (sf):		355
Designed Total Watershed Ratio:	7.4	:1

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berms for the Newport Block Valve Site will be located along the southern side of the pad and 90% of the disturbed area will be detained by the BMP.

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - <i>Infiltration Berm 1</i>	1.1
Design Infiltration Rate (in/hr) - <i>Infiltration Berm 2</i>	1.5
Design Infiltration Rate (in/hr) - <i>Infiltration Berm 3</i>	0.8
Design Infiltration Rate (in/hr) - <i>Infiltration Berm 4</i>	0.8

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

INFILTRATION BERM 1

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	89	13.1	2,260	1.00	1166

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
1.1	2,260	2	414

Volume Abstraction Potential (cf)	1,580

INFILTRATION BERM 2

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	64	12.7	2,852	1.20	813

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
1.5	2,852	2	713

Volume Abstraction Potential (cf)	1,526

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

INFILTRATION BERM 3

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	60	29.1	1,813	1.70	1746

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.8	1,813	2	242

Volume Abstraction Potential (cf)	1,988

INFILTRATION BERM 4

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	26	9.2	355	1.30	239

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.8	355	2	47

Volume Abstraction Potential (cf)	287

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Vol. 72- hrs (cf)	Structural Vol. Credit (cf)
Infiltration Berm 1	1679	1166	1166	1166
Infiltration Berm 2	2298	813	813	813
Infiltration Berm 3	688	1746	1746	688
Infiltration Berm 4	239	239	239	239
Total Structral Credit (cf) [Worksheet 5]				2905.7

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 5.44 acres. Based upon the soil survey of Indiana County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Gilpin channery silt loam (GcA), Gilpin channery silt loam (GcC), Gilpin-Weikert channery silt (GwD), Monogahela silt loam (MoA), Monogahela silt loam (MoB), and Monogahela silt loam (MoC). These primarily classify as either HCG Class C or C/D. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcA	Meadow	71	1.32
C	GcC	Meadow	71	0.84
C	GwD	Meadow	71	0.37
C/D	MoA	Meadow	78	0.19
C/D	MoB	Meadow	78	2.22
C/D	MoB	Woods	77	0.21
C/D	MoC	Meadow	78	0.27
C/D	MoC	Woods	77	0.02
			Totals	5.44
			CN	75

Post-Development Condition

Undetained 1

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcA	Meadow	71	0.34
C	GcC	Meadow	71	0.18
C	GwD	Meadow	71	0.17
C/D	MoB	Meadow	78	0.09
C/D	MoB	Woods	77	0.04
			Totals	0.82
			CN	72

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

Diversion Ditch 1

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcA	Meadow	71	0.08
C	GcC	Meadow	71	0.13
C	GwD	Meadow	71	0.02
C/D	MoA	Meadow	78	0.08
C/D	MoB	Meadow	78	0.86
C/D	MoC	Meadow	78	0.003
			Totals	1.17

CN	77

Undetained 2 - Below Access Road

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	MoA	Meadow	78	0.01
C/D	MoB	Meadow	78	0.45
C/D	MoB	Woods	77	0.14
C/D	MoC	Meadow	78	0.16
C/D	MoC	Woods	77	0.02
C/D	MoC	Impervious - Gravel	91	0.02
			Totals	0.80

CN	78

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 Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

BMP (Detained) [Infiltration Berm 1]

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcA	Meadow	71	0.19
C	GcA	Impervious - Gravel	89	0.10
C	GcC	Meadow	71	0.19
C	GwD	Meadow	71	0.01
C/D	MoB	Meadow	78	0.46
C/D	MoB	Impervious - Gravel	91	0.03
			Totals	0.98
			CN	77

BMP (Detained) [Infiltration Berm 2]

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	GcA	Meadow	71	0.57
C	GcA	Impervious - Gravel	89	0.05
C	GcC	Meadow	71	0.34
C	GwD	Meadow	71	0.16
C	GwD	Impervious - Gravel	89	0.02
C/D	MoB	Meadow	78	0.23
C/D	MoB	Woods	77	0.03
C/D	MoB	Impervious - Gravel	91	0.001
			Totals	1.40
			CN	73

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Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

BMP (Detained) [Infiltration Berm 3]

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	MoA	Meadow	78	0.080
C/D	MoA	Impervious - Gravel	91	0.003
C/D	MoB	Meadow	78	0.010
C/D	MoB	Impervious - Gravel	91	0.080
C/D	MoC	Meadow	78	0.040
			Totals	0.21

CN	83

BMP (Detained) [Infiltration Berm 4]

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	MoA	Meadow	78	0.005
C/D	MoA	Impervious - Gravel	91	0.010
C/D	MoB	Meadow	78	0.002
C/D	MoB	Impervious - Gravel	91	0.004
C/D	MoC	Meadow	78	0.040
C/D	MoC	Impervious - Gravel	91	0.005
			Totals	0.07

CN	82

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
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PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the Tc as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.61	1,166	31.9	13.4	45.3
10	1.27	1,166	15.3	13.4	28.7
50	2.13	1,166	9.1	13.4	22.5
100	2.56	1,166	7.6	13.4	21.0

Infiltration Berm 2

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.78	813	17.4	14.4	31.8
10	1.84	813	7.4	14.4	21.8
50	3.26	813	4.2	14.4	18.6
100	3.99	813	3.4	14.4	17.8

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Infiltration Berm 3

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.34	688	33.4	3.6	37.0
10	0.60	1,218	33.7	3.6	37.3
50	0.92	1,746	31.5	3.6	35.1
100	1.08	1,746	27.0	3.6	30.6

Infiltration Berm 4

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.14	239	28.9	2.3	31.2
10	0.24	239	16.4	2.3	18.7
50	0.37	239	10.7	2.3	13.0
100	0.44	239	9.1	2.3	11.4

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

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By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,679	1,580	1,580
10	3,323	1,580	1,580
50	5,526	1,580	1,580
100	6,632	1,580	1,580

Infiltration Berm 2

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	2,298	1,526	1,526
10	4,910	1,526	1,526
50	8,543	1,526	1,526
100	10,399	1,526	1,526

Infiltration Berm 3

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	688	1,988	688
10	1,218	1,988	1,218
50	1,889	1,988	1,889
100	2,217	1,988	1,988

Infiltration Berm 4

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	239	287	239
10	431	287	287
50	674	287	287
100	793	287	287

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

STORMWATER ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	5.5	4.4	9,631	2.5	-2.9
10-yr	11.5	9.3	22,366	5.4	-6.2
50-yr	19.4	15.7	39,658	14.1	-5.4
100-yr	23.4	18.9	48,540	17.4	-6.0

TETRA TECH, INC.

By: EAD Date: 10/4/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/19/2016 Newport Rd Proj. No.: 112IC05958

REFERENCES

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- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Indiana County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.448 N 79.2853 W 1044.09 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Burrell Twp, Pennsylvania, USA*
Latitude: 40.448°, Longitude: -79.2853°
Elevation: 1044.09 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.315 (0.285-0.348)	0.376 (0.341-0.416)	0.455 (0.412-0.502)	0.517 (0.467-0.569)	0.596 (0.537-0.656)	0.658 (0.590-0.723)	0.718 (0.641-0.787)	0.781 (0.694-0.856)	0.866 (0.765-0.949)	0.930 (0.817-1.02)
10-min	0.490 (0.443-0.540)	0.587 (0.532-0.649)	0.707 (0.640-0.781)	0.798 (0.720-0.879)	0.912 (0.821-1.00)	0.997 (0.894-1.10)	1.08 (0.965-1.19)	1.17 (1.04-1.28)	1.27 (1.12-1.39)	1.36 (1.19-1.48)
15-min	0.600 (0.543-0.662)	0.718 (0.650-0.794)	0.868 (0.786-0.959)	0.981 (0.886-1.08)	1.13 (1.01-1.24)	1.23 (1.11-1.36)	1.34 (1.20-1.47)	1.45 (1.29-1.59)	1.59 (1.40-1.74)	1.69 (1.49-1.85)
30-min	0.794 (0.719-0.876)	0.961 (0.870-1.06)	1.19 (1.08-1.31)	1.36 (1.23-1.50)	1.59 (1.43-1.75)	1.76 (1.58-1.94)	1.94 (1.73-2.13)	2.12 (1.88-2.32)	2.36 (2.08-2.58)	2.54 (2.23-2.78)
60-min	0.970 (0.878-1.07)	1.18 (1.07-1.30)	1.49 (1.35-1.65)	1.73 (1.57-1.91)	2.06 (1.86-2.27)	2.32 (2.08-2.55)	2.59 (2.31-2.84)	2.87 (2.55-3.15)	3.26 (2.88-3.57)	3.57 (3.13-3.90)
2-hr	1.13 (1.03-1.24)	1.37 (1.25-1.51)	1.73 (1.57-1.90)	2.02 (1.83-2.21)	2.42 (2.18-2.64)	2.74 (2.46-2.99)	3.08 (2.75-3.35)	3.44 (3.06-3.74)	3.94 (3.47-4.28)	4.34 (3.81-4.71)
3-hr	1.21 (1.10-1.33)	1.46 (1.33-1.61)	1.84 (1.67-2.03)	2.15 (1.95-2.36)	2.58 (2.32-2.82)	2.93 (2.63-3.20)	3.30 (2.94-3.60)	3.69 (3.27-4.02)	4.25 (3.74-4.62)	4.71 (4.10-5.11)
6-hr	1.46 (1.33-1.63)	1.76 (1.60-1.95)	2.19 (1.99-2.43)	2.55 (2.31-2.82)	3.06 (2.76-3.38)	3.48 (3.12-3.84)	3.93 (3.50-4.32)	4.41 (3.90-4.84)	5.11 (4.47-5.59)	5.68 (4.92-6.20)
12-hr	1.77 (1.61-1.97)	2.12 (1.93-2.36)	2.62 (2.38-2.91)	3.04 (2.75-3.36)	3.65 (3.28-4.02)	4.15 (3.72-4.57)	4.70 (4.17-5.15)	5.29 (4.66-5.78)	6.15 (5.36-6.71)	6.86 (5.94-7.48)
24-hr	2.10 (1.95-2.29)	2.51 (2.33-2.73)	3.07 (2.84-3.34)	3.53 (3.26-3.83)	4.18 (3.85-4.53)	4.72 (4.33-5.10)	5.28 (4.82-5.70)	5.87 (5.34-6.32)	6.71 (6.05-7.21)	7.39 (6.61-7.93)
2-day	2.45 (2.27-2.65)	2.91 (2.70-3.16)	3.53 (3.28-3.83)	4.03 (3.74-4.37)	4.74 (4.38-5.12)	5.31 (4.88-5.73)	5.90 (5.41-6.36)	6.51 (5.95-7.01)	7.36 (6.68-7.91)	8.04 (7.25-8.63)
3-day	2.63 (2.44-2.83)	3.12 (2.91-3.37)	3.75 (3.50-4.05)	4.27 (3.97-4.60)	4.99 (4.62-5.37)	5.57 (5.14-5.98)	6.17 (5.67-6.62)	6.79 (6.22-7.27)	7.64 (6.96-8.18)	8.31 (7.53-8.89)
4-day	2.81 (2.62-3.01)	3.32 (3.11-3.57)	3.98 (3.72-4.27)	4.51 (4.20-4.83)	5.24 (4.87-5.61)	5.83 (5.40-6.23)	6.44 (5.94-6.88)	7.06 (6.49-7.54)	7.91 (7.23-8.45)	8.58 (7.81-9.16)
7-day	3.37 (3.17-3.60)	3.98 (3.74-4.25)	4.70 (4.41-5.01)	5.27 (4.95-5.62)	6.05 (5.67-6.44)	6.67 (6.23-7.09)	7.29 (6.78-7.74)	7.91 (7.34-8.40)	8.75 (8.08-9.29)	9.39 (8.63-9.96)
10-day	3.91 (3.70-4.13)	4.60 (4.35-4.87)	5.38 (5.08-5.69)	6.00 (5.66-6.34)	6.83 (6.43-7.21)	7.47 (7.02-7.88)	8.11 (7.60-8.55)	8.75 (8.18-9.23)	9.59 (8.92-10.1)	10.2 (9.48-10.8)
20-day	5.50 (5.22-5.79)	6.44 (6.12-6.79)	7.42 (7.05-7.83)	8.20 (7.78-8.65)	9.21 (8.73-9.71)	9.99 (9.45-10.5)	10.7 (10.2-11.3)	11.5 (10.8-12.1)	12.4 (11.7-13.1)	13.2 (12.3-13.9)
30-day	6.93 (6.62-7.28)	8.10 (7.73-8.51)	9.25 (8.83-9.72)	10.2 (9.68-10.7)	11.3 (10.8-11.9)	12.2 (11.6-12.8)	13.1 (12.4-13.7)	13.9 (13.2-14.6)	15.0 (14.1-15.7)	15.7 (14.8-16.5)
45-day	8.90 (8.51-9.32)	10.4 (9.92-10.9)	11.7 (11.2-12.3)	12.7 (12.2-13.3)	14.0 (13.4-14.7)	15.0 (14.3-15.7)	15.9 (15.2-16.7)	16.8 (15.9-17.6)	17.8 (16.9-18.7)	18.6 (17.6-19.5)
60-day	10.7 (10.3-11.2)	12.5 (12.0-13.1)	14.0 (13.4-14.6)	15.1 (14.5-15.8)	16.6 (15.9-17.3)	17.6 (16.9-18.4)	18.6 (17.8-19.4)	19.5 (18.6-20.3)	20.5 (19.6-21.4)	21.3 (20.3-22.2)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
 Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
 Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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 Indiana County, Pennsylvania

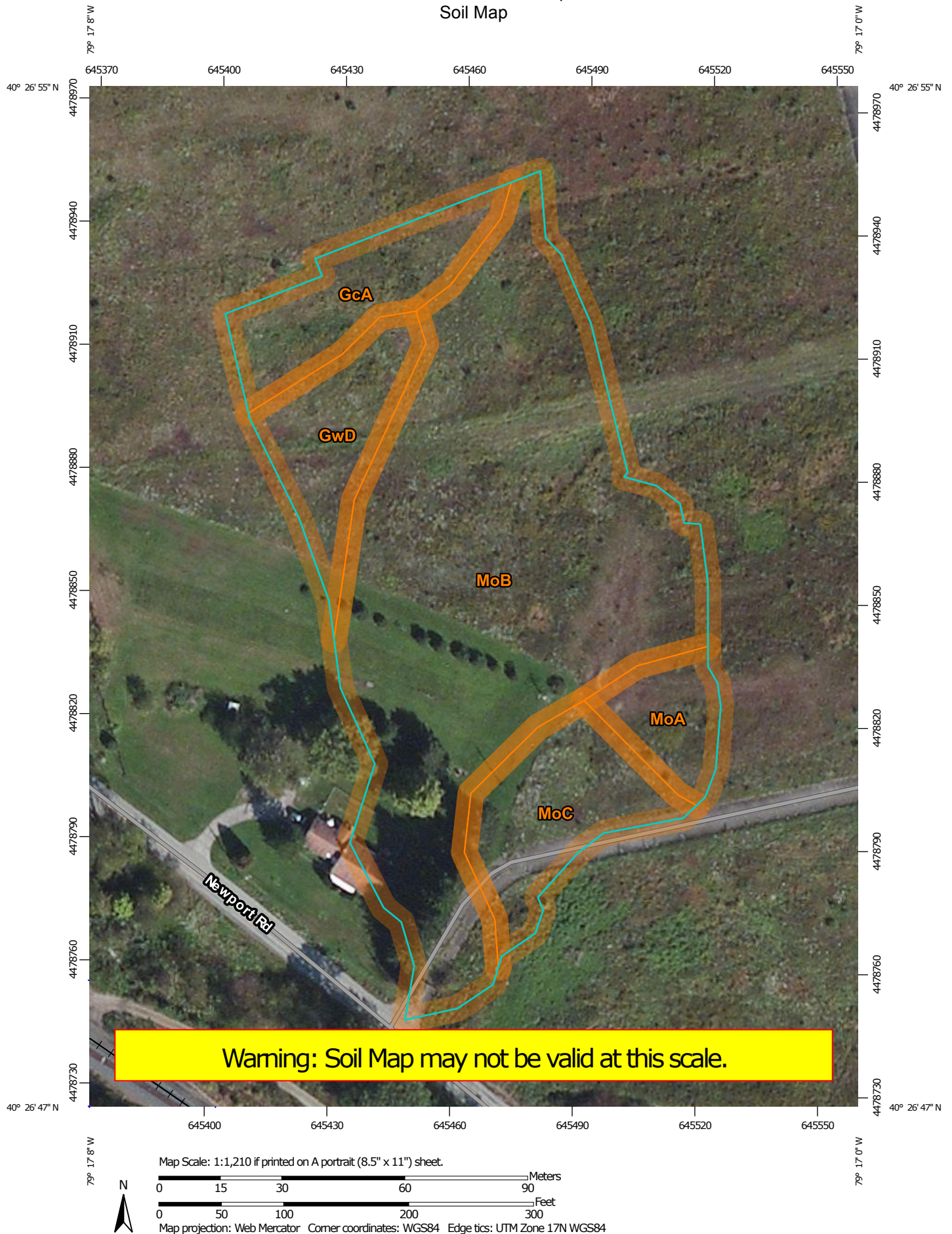
Newport Road



October 12, 2016

555 of 1484

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Soil Map Unit Polygons

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Special Line Features

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: <http://websoilsurvey.nrcs.usda.gov>
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: Indiana County, Pennsylvania
Survey Area Data: Version 11, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Indiana County, Pennsylvania (PA063)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
GcA	Gilpin channery silt loam, 0 to 3 percent slopes	0.3	9.7%
GwD	Gilpin-Weikert channery silt loams, 15 to 25 percent slopes	0.3	9.1%
MoA	Monongahela silt loam, 0 to 2 percent slopes	0.2	5.2%
MoB	Monongahela silt loam, 2 to 6 percent slopes	2.3	64.8%
MoC	Monongahela silt loam, 6 to 12 percent slopes	0.4	11.1%
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 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.

Indiana County, Pennsylvania

GcA—Gilpin channery silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2lcr0
Elevation: 800 to 1,700 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 120 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Gilpin and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 30 inches: very channery loam
R - 30 to 35 inches: bedrock

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Wharton

Percent of map unit: 10 percent
Landform: Hills

Custom Soil Resource Report

Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Weikert

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

GwD—Gilpin-Weikert channery silt loams, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 1vrrv
Elevation: 800 to 1,800 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 45 percent
Weikert and similar soils: 45 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 30 inches: very channery loam
R - 30 to 35 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained

Custom Soil Resource Report

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: C

Hydric soil rating: No

Description of Weikert

Setting

Landform: Hillslopes

Landform position (two-dimensional): Backslope, shoulder

Landform position (three-dimensional): Nose slope

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Acid loamy residuum weathered from shale and siltstone

Typical profile

A - 0 to 5 inches: channery silt loam

Bw - 5 to 15 inches: very channery silt loam

C - 15 to 18 inches: extremely channery silt loam

R - 18 to 28 inches: bedrock

Properties and qualities

Slope: 15 to 25 percent

Depth to restrictive feature: 10 to 20 inches to lithic bedrock

Natural drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: D

Hydric soil rating: No

Minor Components

Ernest

Percent of map unit: 5 percent

Landform: Hillslopes

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Head slope

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: No

Wharton

Percent of map unit: 5 percent

Landform: Hillslopes

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

MoA—Monongahela silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 1vrqt

Elevation: 700 to 1,300 feet

Mean annual precipitation: 36 to 46 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 130 to 160 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Monongahela and similar soils: 85 percent

Minor components: 15 percent

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

Description of Monongahela

Setting

Landform: Terraces

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Old fine-loamy alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 9 inches: silt loam

Bt - 9 to 29 inches: loam

Btx - 29 to 63 inches: loam

C - 63 to 80 inches: cobbly sandy loam

Properties and qualities

Slope: 0 to 2 percent

Depth to restrictive feature: 25 to 35 inches to fragipan

Natural drainage class: Moderately well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)

Depth to water table: About 17 to 28 inches

Frequency of flooding: None

Frequency of ponding: None

Custom Soil Resource Report

Available water storage in profile: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Weinbach

Percent of map unit: 10 percent

Landform: Terraces

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Culleoka

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Backslope, shoulder, summit

Landform position (three-dimensional): Interfluve

Down-slope shape: Convex

Across-slope shape: Convex

Hydric soil rating: No

MoB—Monongahela silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 1vrqv

Elevation: 700 to 1,300 feet

Mean annual precipitation: 36 to 46 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 130 to 160 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Monongahela and similar soils: 80 percent

Minor components: 20 percent

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

Description of Monongahela

Setting

Landform: Terraces

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Old fine-loamy alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 9 inches: silt loam
Bt - 9 to 29 inches: loam
Btx - 29 to 63 inches: loam
C - 63 to 80 inches: cobbly sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 25 to 35 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 17 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Culleoka

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Weinbach

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

MoC—Monongahela silt loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 1vrqw
Elevation: 700 to 1,300 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F

Custom Soil Resource Report

Frost-free period: 130 to 160 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Monongahela and similar soils: 80 percent

Minor components: 20 percent

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

Description of Monongahela

Setting

Landform: Terraces

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Old fine-loamy alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 9 inches: silt loam

Bt - 9 to 29 inches: loam

Btx - 29 to 63 inches: loam

C - 63 to 80 inches: cobbly sandy loam

Properties and qualities

Slope: 6 to 12 percent

Depth to restrictive feature: 25 to 35 inches to fragipan

Natural drainage class: Moderately well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)

Depth to water table: About 17 to 28 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Weinbach

Percent of map unit: 10 percent

Landform: Terraces

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Culleoka

Percent of map unit: 10 percent

Landform: Hillslopes

Landform position (two-dimensional): Backslope, shoulder, summit

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex

Custom Soil Resource Report

Hydric soil rating: No

**ATTACHMENT C
NEWPORT RD
HYDRAFLOW RESULTS**

ATTACHMENT C-1
NEWPORT RD
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Newport Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.466	-----	-----	11.50	-----	19.42	23.37	Newport Rd - PRE
Proj. file: Newport Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	5.466	1	720	12,962	-----	-----	-----	Newport Rd - PRE
Newport Rd-PRE.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

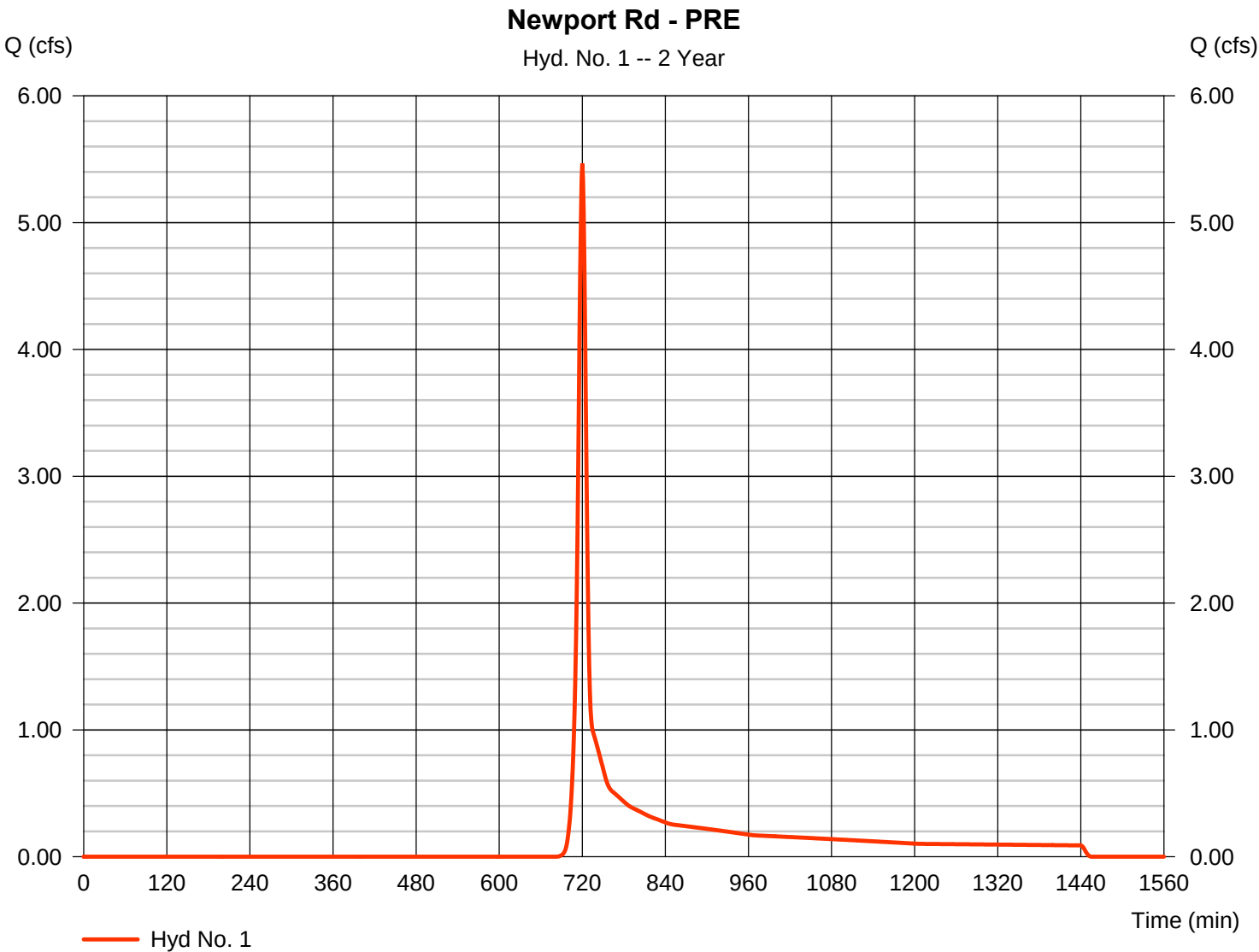
Hydrograph Report

Hyd. No. 1

Newport Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.466 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	12,962 cuft
Drainage area	=	5.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.00 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.530 x 71) + (2.680 x 78) + (0.230 x 77)] / 5.440



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

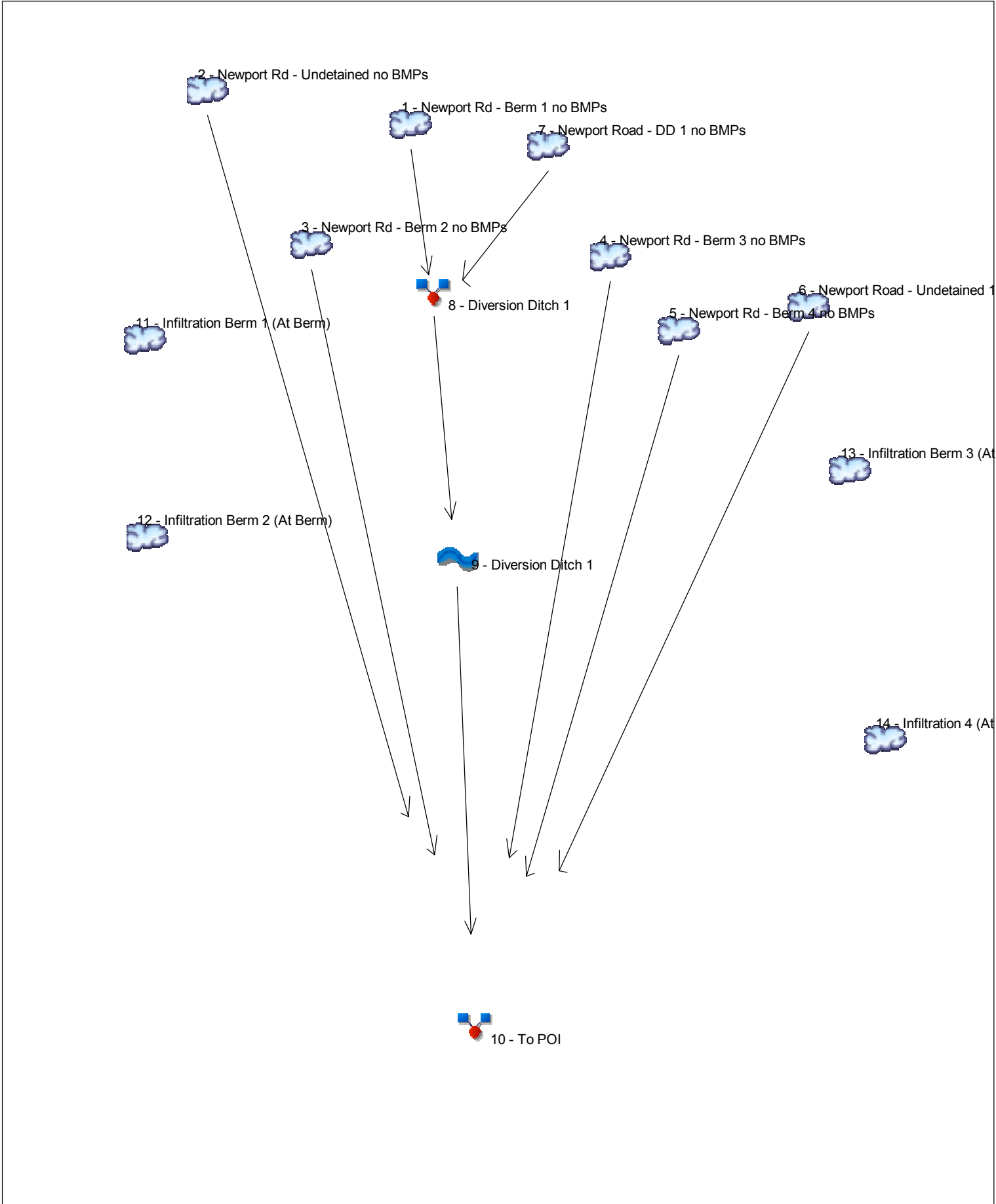
Hyd. No. 1

Newport Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 6.35	+	0.00	+	0.00	=	6.35
Shallow Concentrated Flow							
Flow length (ft)	= 620.00	141.00	124.00				
Watercourse slope (%)	= 6.50	12.80	4.70				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.11	5.77	3.50				
Travel Time (min)	= 2.51	+	0.41	+	0.59	=	3.51
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)63.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					10.00 min		

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.758	-----	-----	1.432	-----	2.282	2.694	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	-----	-----	1.053	-----	-----	2.041	-----	3.307	3.927	Newport Rd - Undetained no BMPs
3	SCS Runoff	-----	-----	0.964	-----	-----	2.202	-----	3.878	4.722	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	-----	-----	0.432	-----	-----	0.754	-----	1.148	1.337	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	-----	-----	0.595	-----	-----	1.394	-----	2.476	3.022	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	1.121	-----	-----	2.272	-----	3.777	4.516	Newport Road - DD 1 no BMPs
8	Combine	1, 7	-----	1.870	-----	-----	3.695	-----	6.035	7.178	Diversion Ditch 1
9	Reach	8	-----	1.859	-----	-----	3.677	-----	6.014	7.156	Diversion Ditch 1
10	Combine	2, 3, 4, 5, 6, 9	-----	4.448	-----	-----	9.297	-----	15.70	18.87	To POI
11	SCS Runoff	-----	-----	0.613	-----	-----	1.265	-----	2.128	2.558	Infiltration Berm 1 (At Berm)
12	SCS Runoff	-----	-----	0.782	-----	-----	1.836	-----	3.263	3.993	Infiltration Berm 2 (At Berm)
13	SCS Runoff	-----	-----	0.343	-----	-----	0.602	-----	0.923	1.076	Infiltration Berm 3 (At Berm)
14	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Infiltration 4 (At Berm)
Proj. file: Newport Rd No BMP.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.758	1	722	1,953	-----	-----	-----	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	1.053	1	719	2,249	-----	-----	-----	Newport Rd - Undetained no BMPs
3	SCS Runoff	0.964	1	723	2,912	-----	-----	-----	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	0.432	1	717	811	-----	-----	-----	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	0.138	1	716	239	-----	-----	-----	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	0.595	1	721	1,617	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	1.121	1	723	3,171	-----	-----	-----	Newport Road - DD 1 no BMPs
8	Combine	1.870	1	722	5,123	1, 7	-----	-----	Diversion Ditch 1
9	Reach	1.859	1	724	5,121	8	-----	-----	Diversion Ditch 1
10	Combine	4.448	1	721	12,950	2, 3, 4, 5, 6, 9	-----	-----	To POI
11	SCS Runoff	0.613	2	722	1,679	-----	-----	-----	Infiltration Berm 1 (At Berm)
12	SCS Runoff	0.782	2	722	2,298	-----	-----	-----	Infiltration Berm 2 (At Berm)
13	SCS Runoff	0.343	2	718	688	-----	-----	-----	Infiltration Berm 3 (At Berm)
14	SCS Runoff	0.138	1	716	239	-----	-----	-----	Infiltration 4 (At Berm)
Newport Rd No BMP.gpw					Return Period: 2 Year			Tuesday, 11 / 15 / 2016	

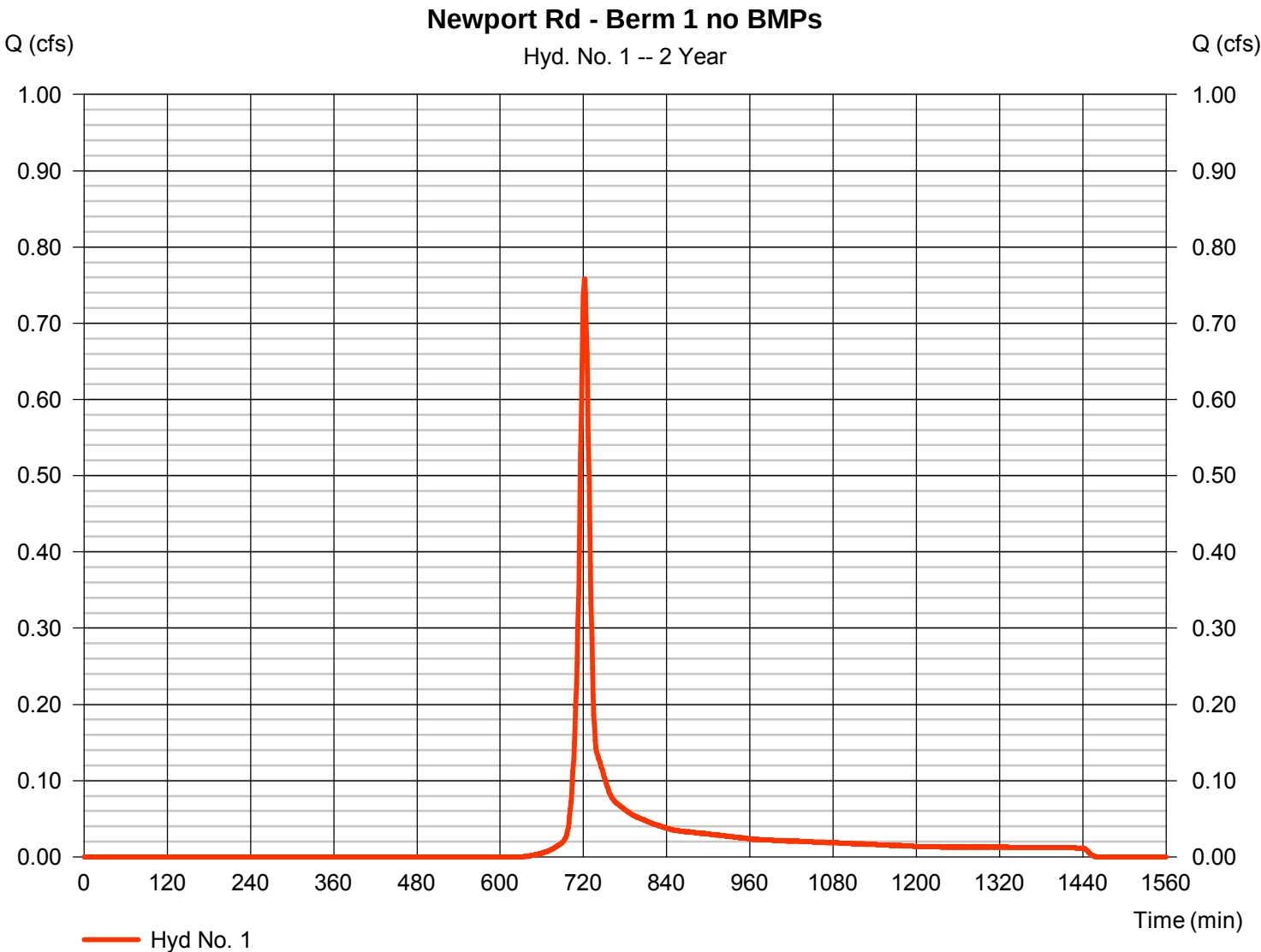
Hydrograph Report

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.758 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	1,953 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.42 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.390 x 71) + (0.460 x 78) + (0.100 x 89) + (0.030 x 91)] / 0.610



TR55 Tc Worksheet

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

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 100.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00	
Land slope (%)	= 2.00	0.00	0.00	
Travel Time (min)	= 11.06	+	0.00	+
			0.00	= 11.06
Shallow Concentrated Flow				
Flow length (ft)	= 251.00	62.00	297.00	
Watercourse slope (%)	= 8.00	4.80	6.40	
Surface description	= Unpaved	Paved	Unpaved	
Average velocity (ft/s)	=4.56	4.45	4.08	
Travel Time (min)	= 0.92	+	0.23	+
			1.21	= 2.36
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	= 0.025	0.025	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.42 min

Hydrograph Report

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

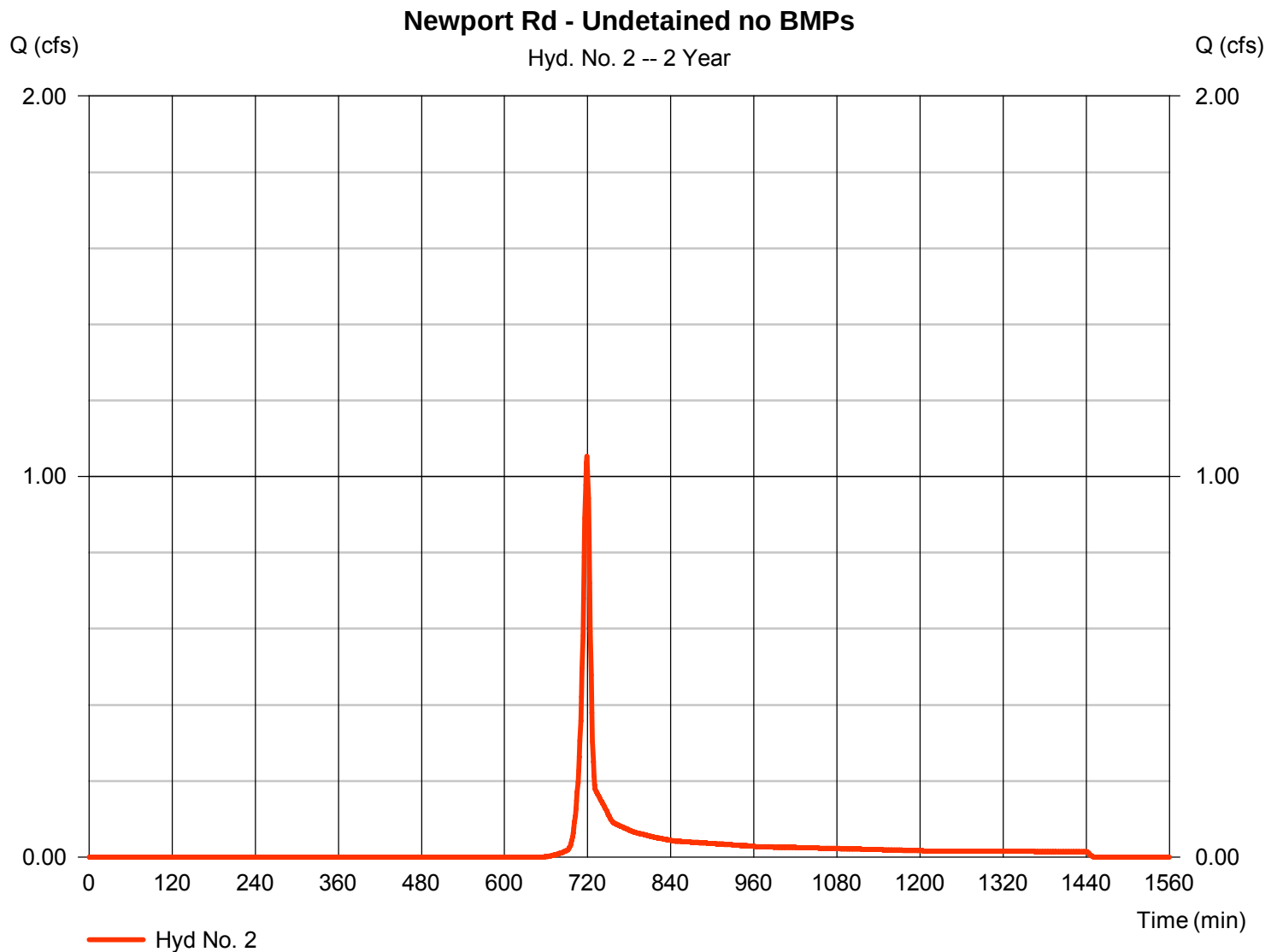
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.053 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	2,249 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					6.70 min		

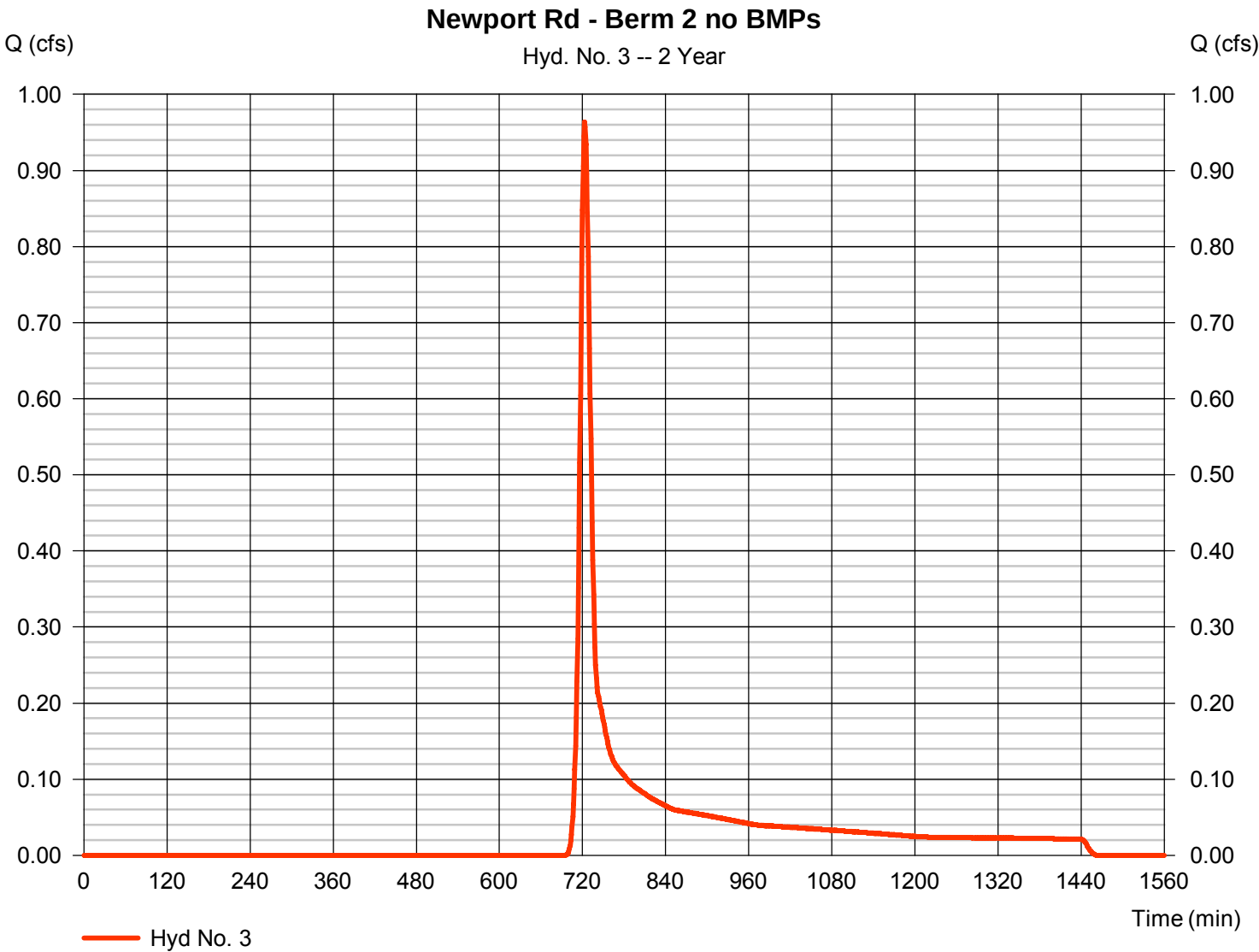
Hydrograph Report

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.964 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	2,912 cuft
Drainage area	=	1.400 ac	Curve number	=	73*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.070 x 71) + (0.030 x 77) + (0.230 x 78) + (0.060 x 89) + (0.010 x 91)] / 1.400



TR55 Tc Worksheet

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

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	239.00	175.00				
Watercourse slope (%)	= 6.40	11.00	6.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.08	5.35	3.95				
Travel Time (min)	= 1.85	+	0.74	+	0.74	=	3.33
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	= 0.025	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				14.40 min			

Hydrograph Report

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

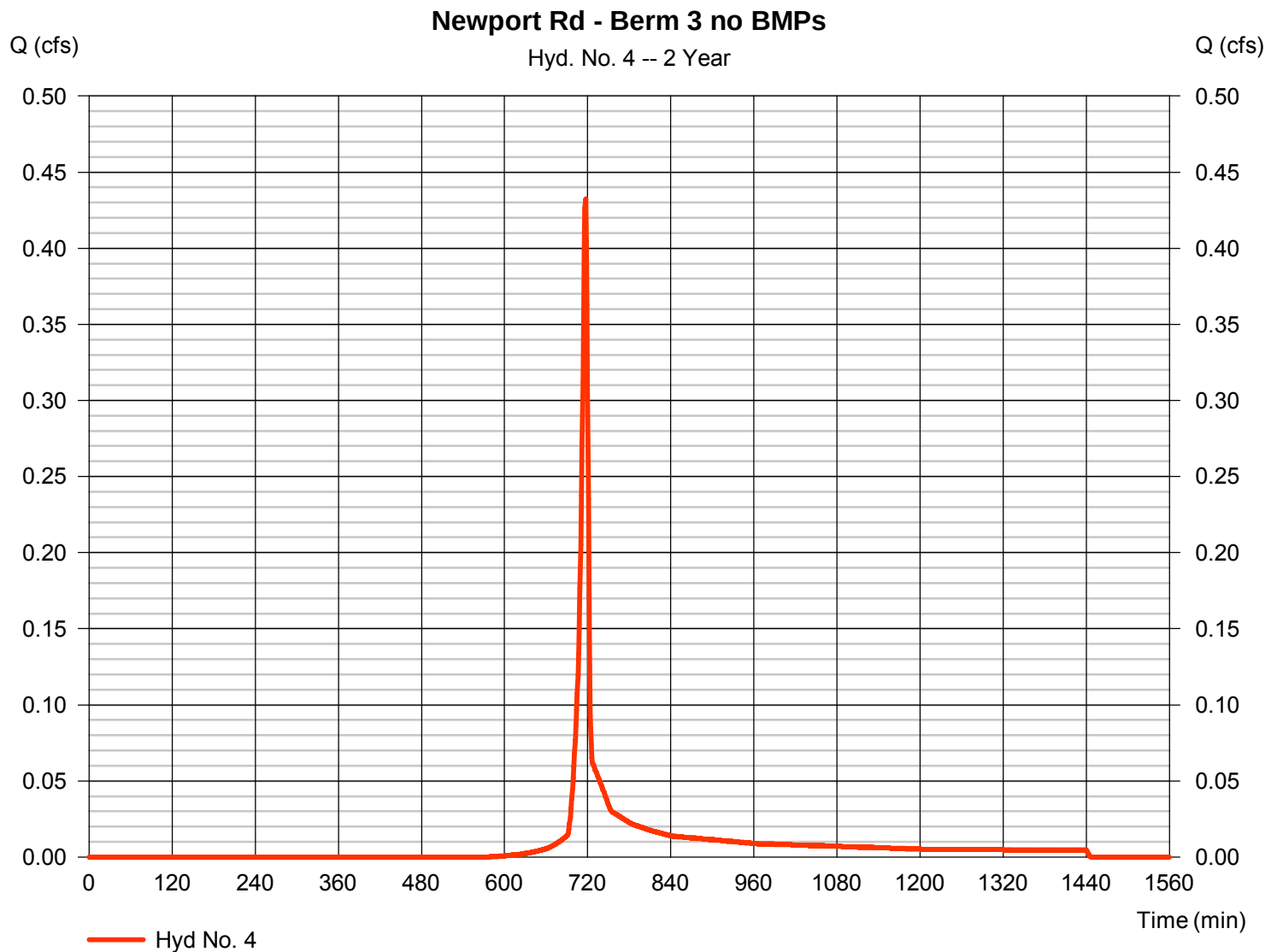
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 0.432 cfs
Storm frequency	= 2 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 811 cuft
Drainage area	= 0.210 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.130 \times 78) + (0.080 \times 91)] / 0.210$



TR55 Tc Worksheet

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

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	94.00	0.00				
Watercourse slope (%)	= 5.50	8.50	0.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.77	4.70	0.00				
Travel Time (min)	= 0.57	+	0.33	+	0.00	=	0.90
Channel Flow							
X sectional flow area (sqft)	= 2.00	2.00	0.00				
Wetted perimeter (ft)	= 4.47	4.47	0.00				
Channel slope (%)	= 4.49	7.51	0.00				
Manning's n-value	= 0.060	0.025	0.015				
Velocity (ft/s)	=3.07	9.53	0.00				
Flow length (ft)	(0)}89.0	230.0	0.0				
Travel Time (min)	= 0.48	+	0.40	+	0.00	=	0.89
Total Travel Time, Tc				3.60 min			

Hydrograph Report

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

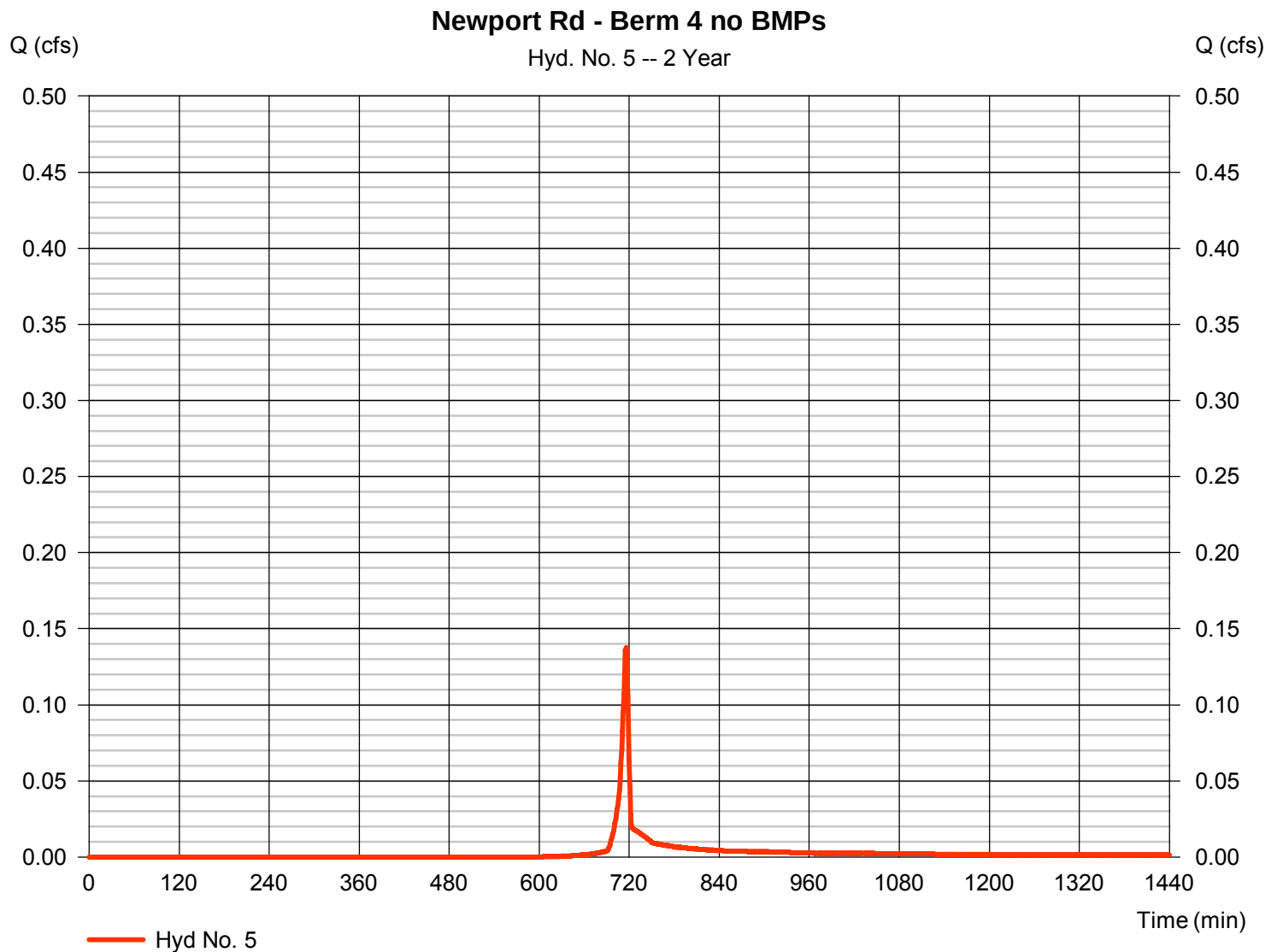
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.138 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	1 min	Hyd. volume	=	239 cuft
Drainage area	=	0.070 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	2.30 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 69.00	0.00	0.00				
Watercourse slope (%)	= 5.90	0.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=3.92	0.00	0.00				
Travel Time (min)	= 0.29	+	0.00	+	0.00	=	0.29
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)200.0	0.0	0.0				
Travel Time (min)	= 0.36	+	0.00	+	0.00	=	0.36
Total Travel Time, Tc				2.30 min			

Hydrograph Report

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

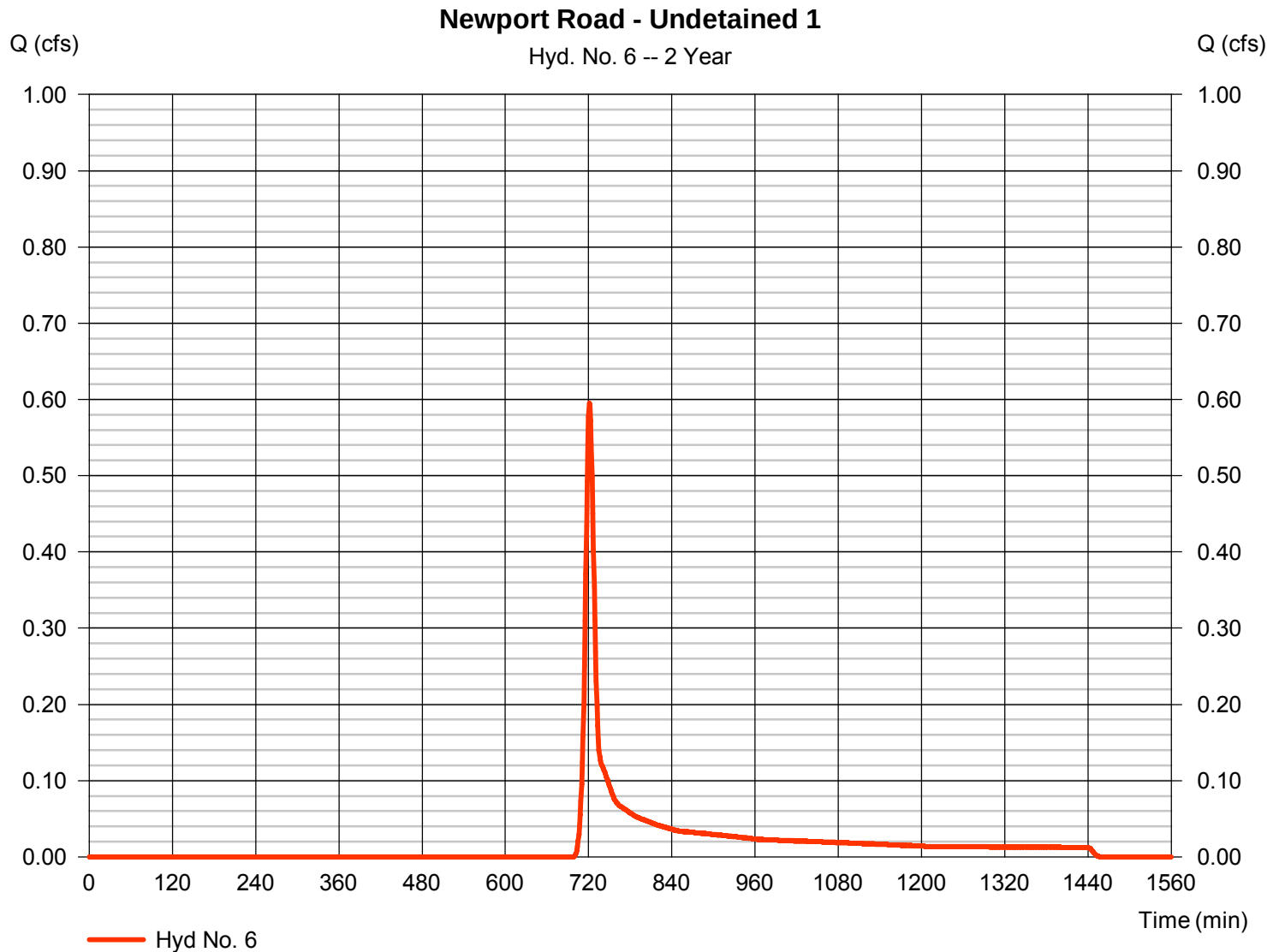
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.595 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	1,617 cuft
Drainage area	=	0.820 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.80 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

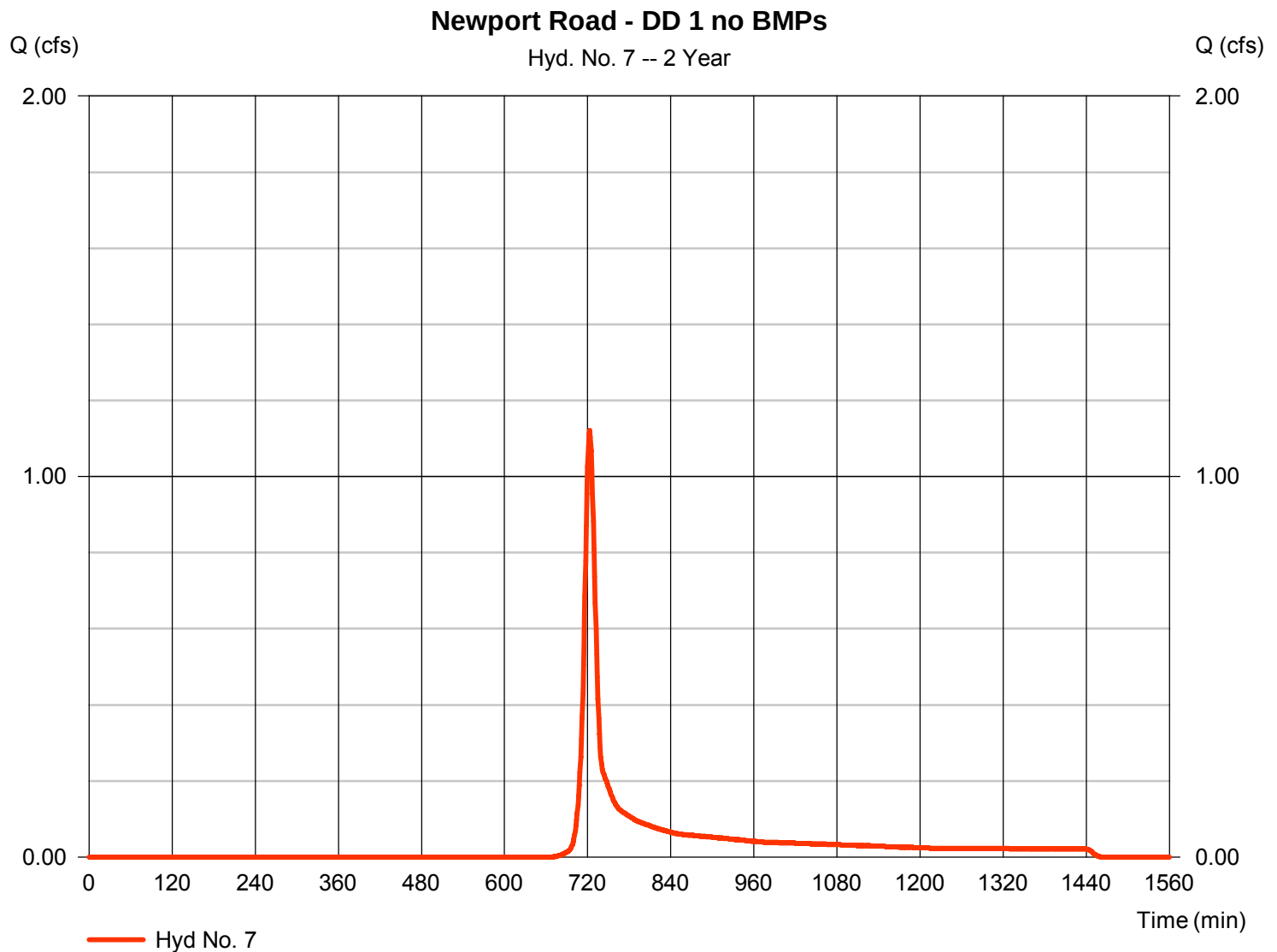
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.121 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	3,171 cuft
Drainage area	=	1.170 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.50 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 1 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

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

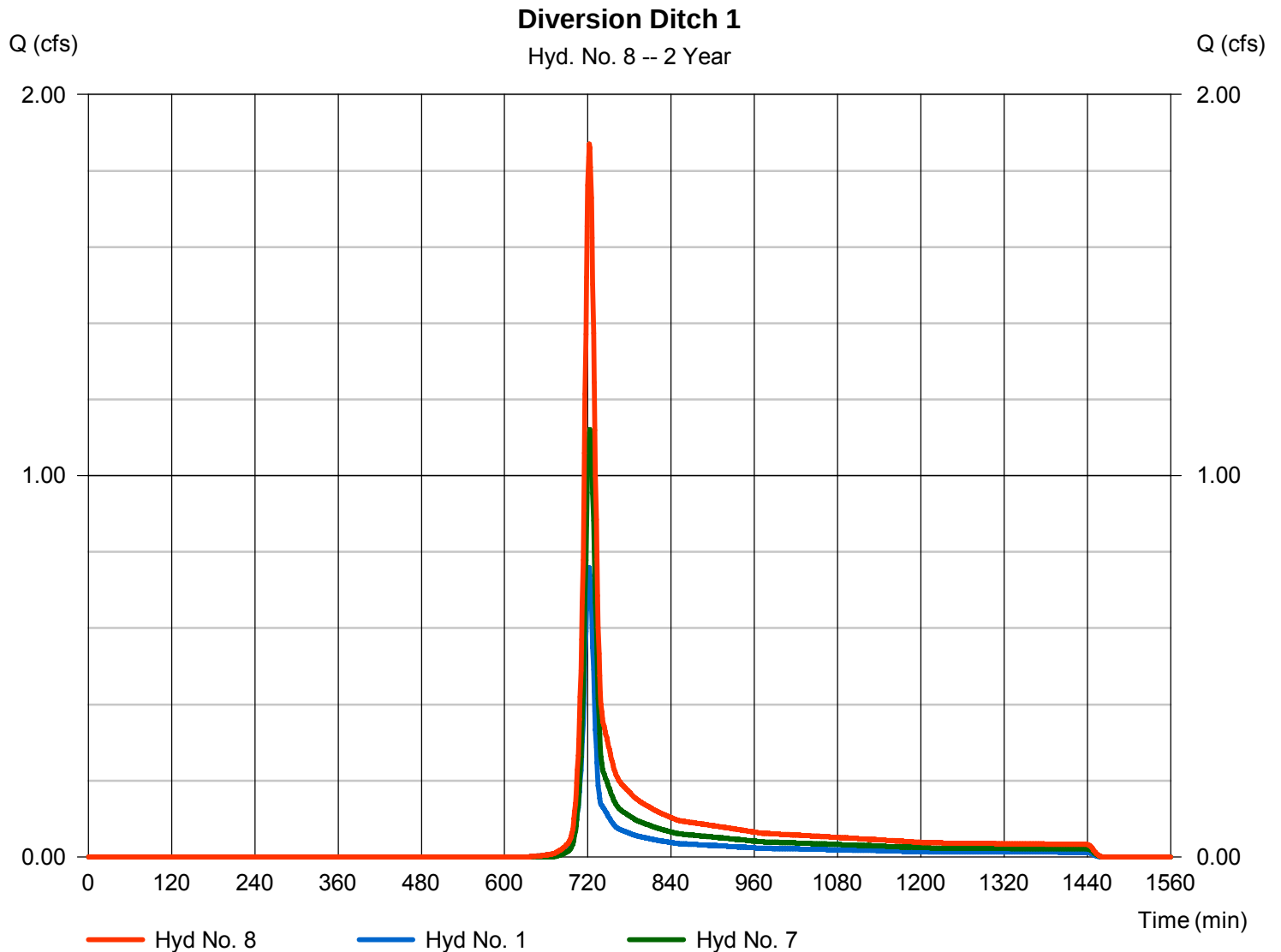
Tuesday, 11 / 15 / 2016

Hyd. No. 8

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 7

Peak discharge = 1.870 cfs
 Time to peak = 722 min
 Hyd. volume = 5,123 cuft
 Contrib. drain. area = 1.780 ac



Hydrograph Report

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

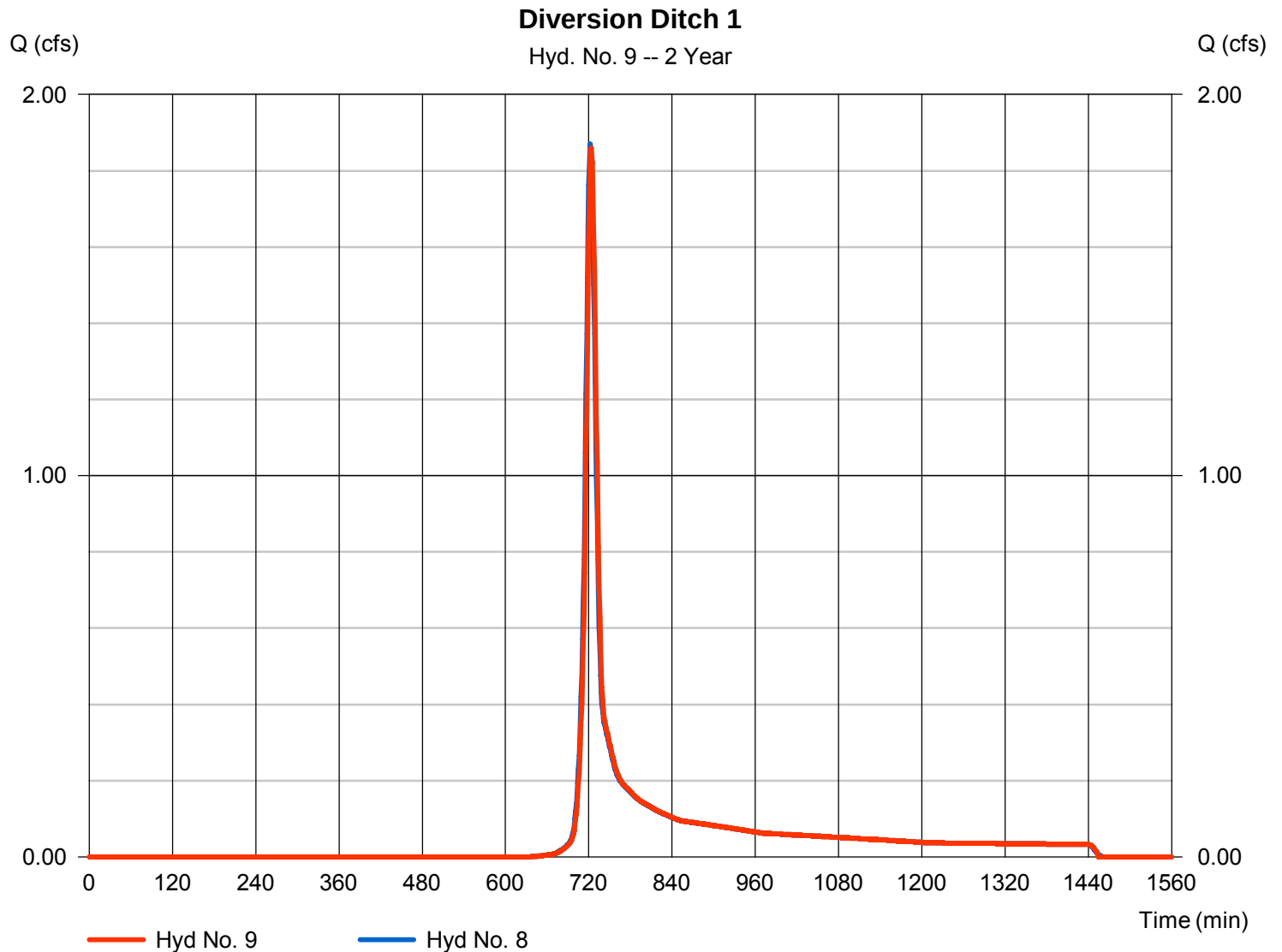
Tuesday, 11 / 15 / 2016

Hyd. No. 9

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 1.859 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 5,121 cuft
Inflow hyd. No.	= 8 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7701

Modified Att-Kin routing method used.



Hydrograph Report

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

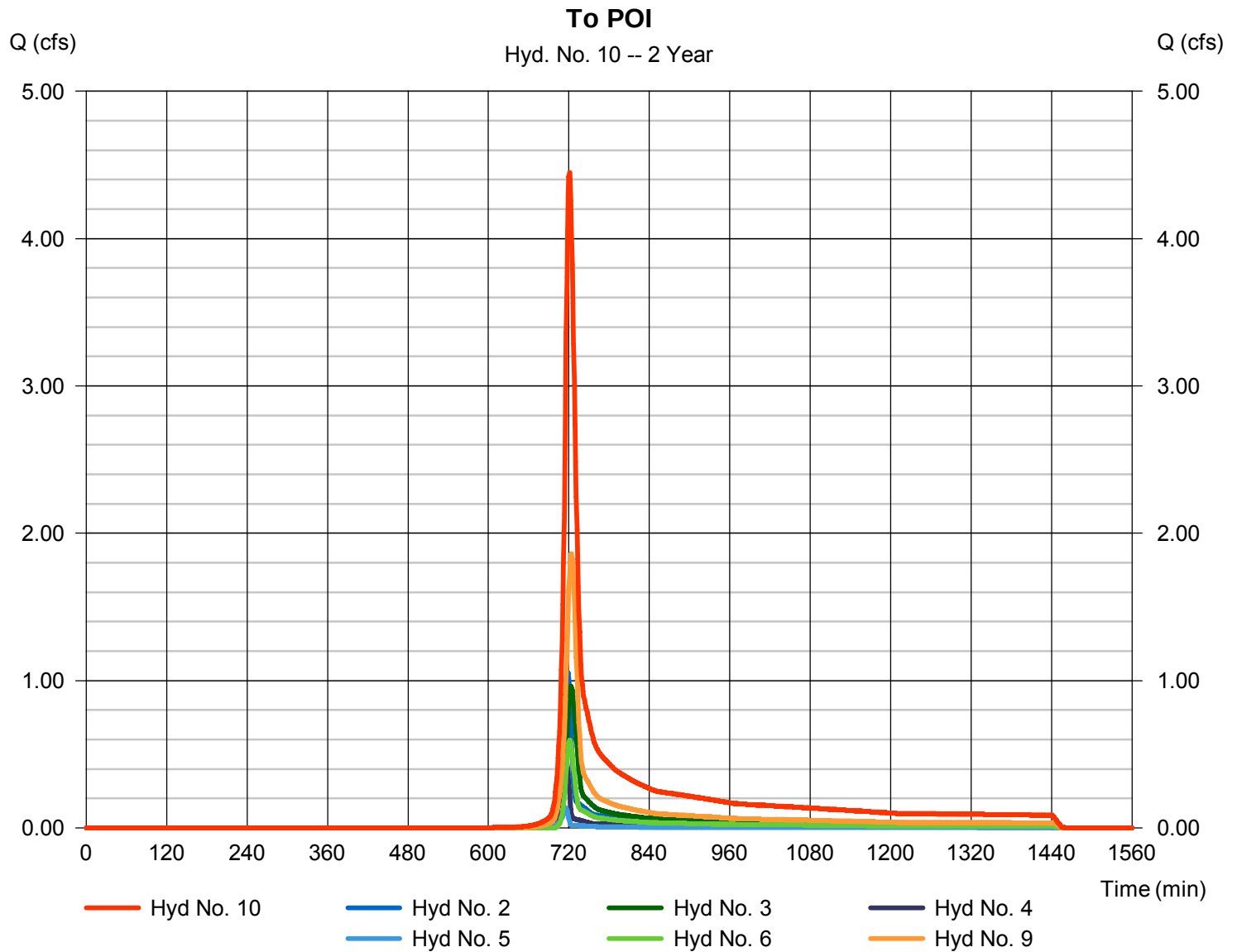
Tuesday, 11 / 15 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 4, 5, 6, 9

Peak discharge = 4.448 cfs
 Time to peak = 721 min
 Hyd. volume = 12,950 cuft
 Contrib. drain. area = 3.300 ac



Hydrograph Report

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

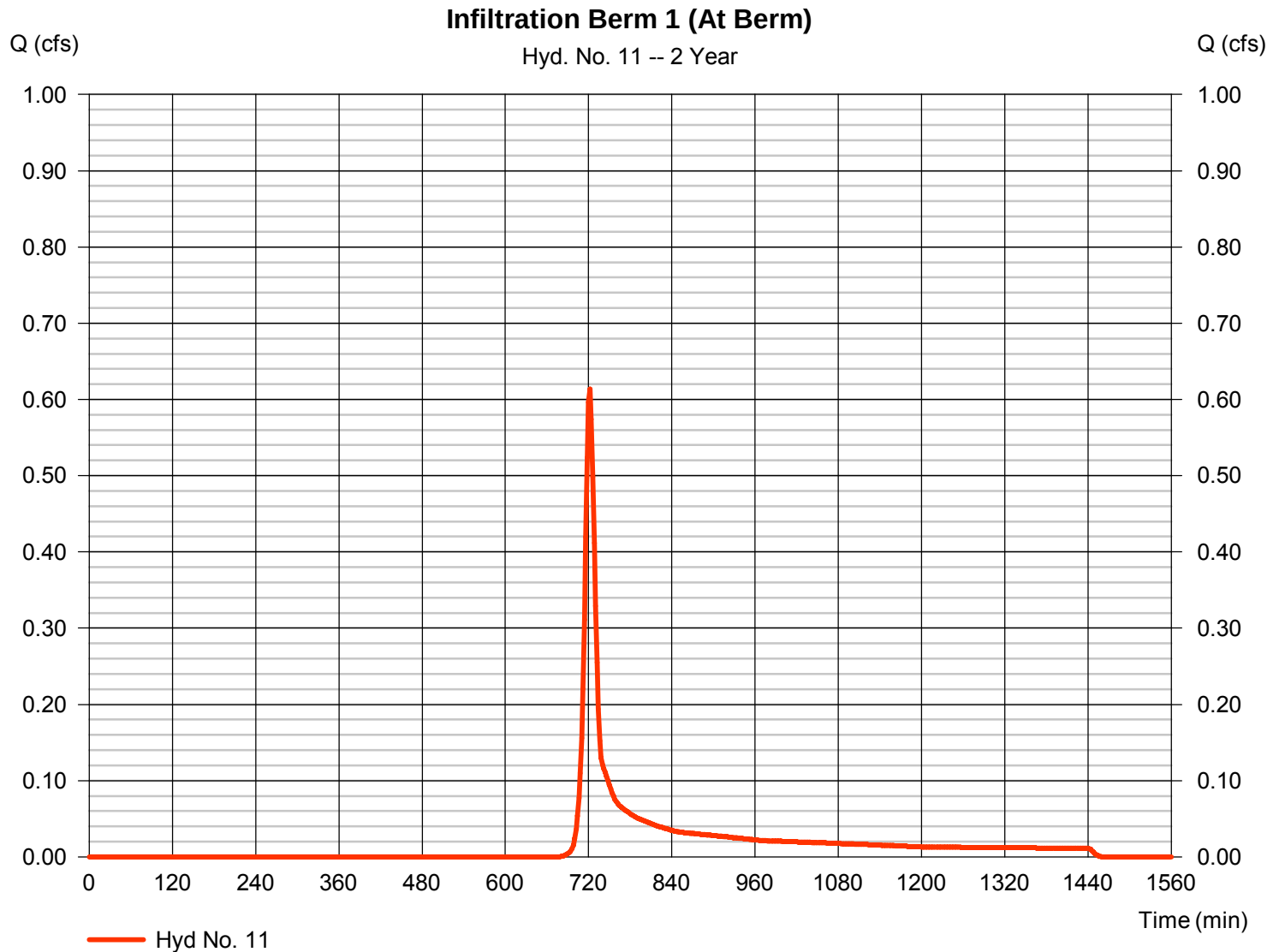
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Infiltration Berm 1 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.613 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 1,679 cuft
Drainage area	= 0.640 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.60 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.130 \times 78) + (0.100 \times 89) + (0.020 \times 91)] / 0.640$



TR55 Tc Worksheet

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

Hyd. No. 11

Infiltration Berm 1 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	69.00				
Watercourse slope (%)	= 8.00	4.80	4.30				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	3.35				
Travel Time (min)	= 0.92	+	0.23	+	0.34	=	1.49
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				12.60 min			

Hydrograph Report

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

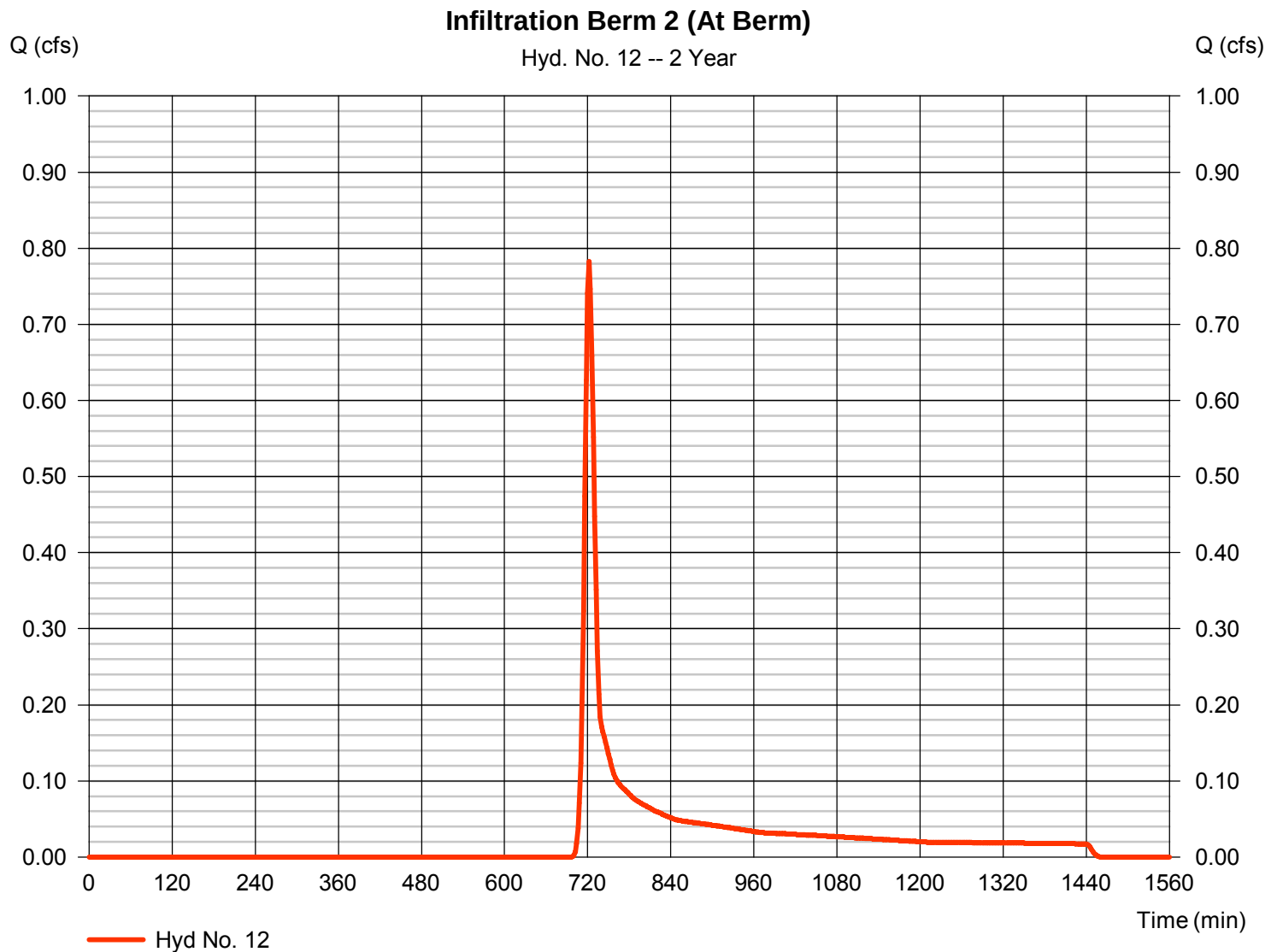
Tuesday, 11 / 15 / 2016

Hyd. No. 12

Infiltration Berm 2 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.782 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 2,298 cuft
Drainage area	= 1.150 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.90 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.030 \times 71) + (0.070 \times 78) + (0.050 \times 89)] / 1.150$



TR55 Tc Worksheet

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

Hyd. No. 12

Infiltration Berm 2 (At Berm)

<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)	= 2.51	2.51	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
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				12.90 min			

Hydrograph Report

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

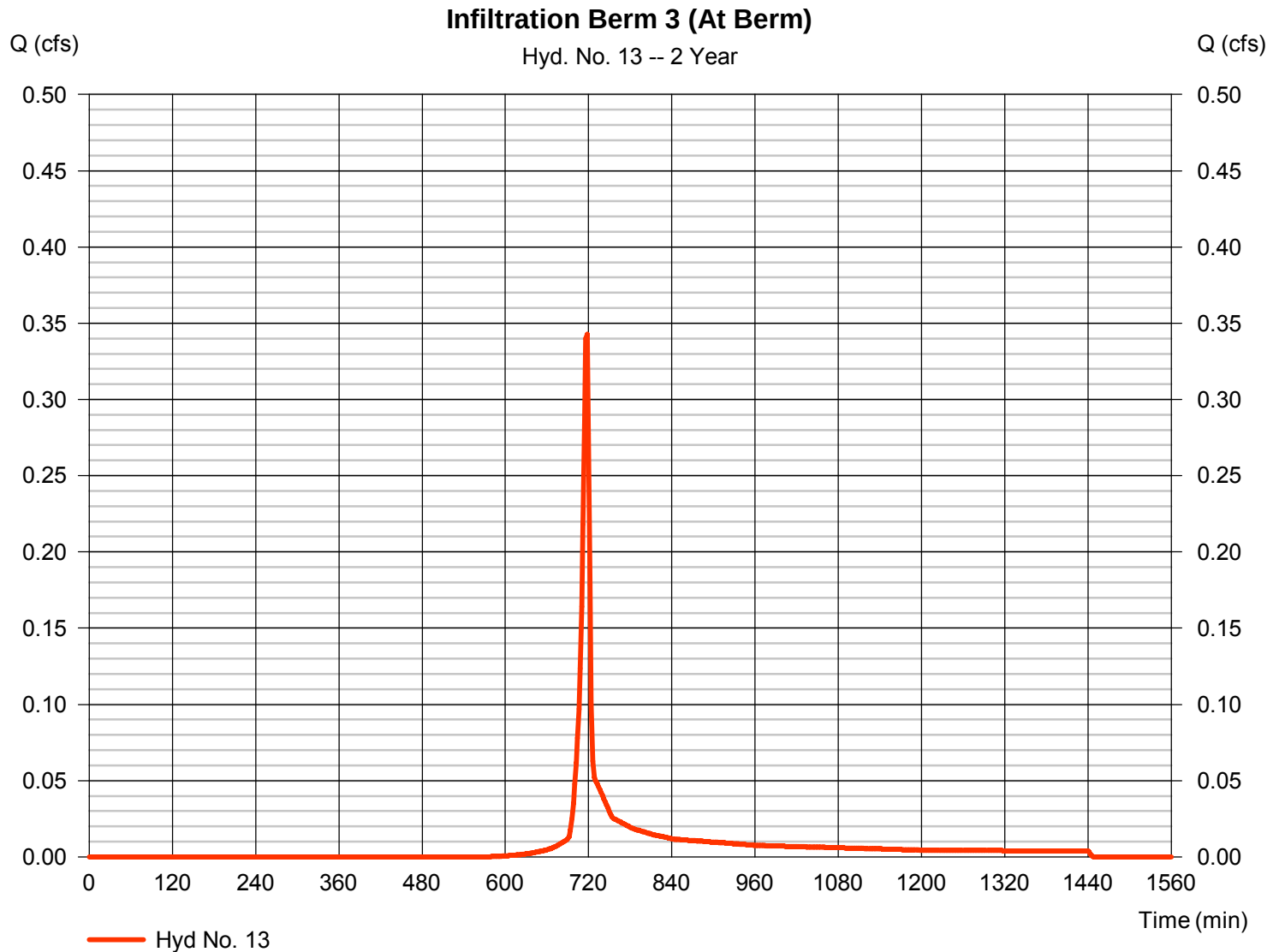
Tuesday, 11 / 15 / 2016

Hyd. No. 13

Infiltration Berm 3 (At Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.343 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	688 cuft
Drainage area	=	0.190 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 78) + (0.080 \times 91)] / 0.190$



TR55 Tc Worksheet

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

Hyd. No. 13

Infiltration Berm 3 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	46.00	0.00				
Watercourse slope (%)	= 5.50	6.50	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.77	4.11	0.00				
Travel Time (min)	= 0.57	+	0.19	+	0.00	=	0.76
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 4.49	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.07	0.00	0.00				
Flow length (ft)	({0})89.0	0.0	0.0				
Travel Time (min)	= 0.48	+	0.00	+	0.00	=	0.48
Total Travel Time, Tc				3.10 min			

Hydrograph Report

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

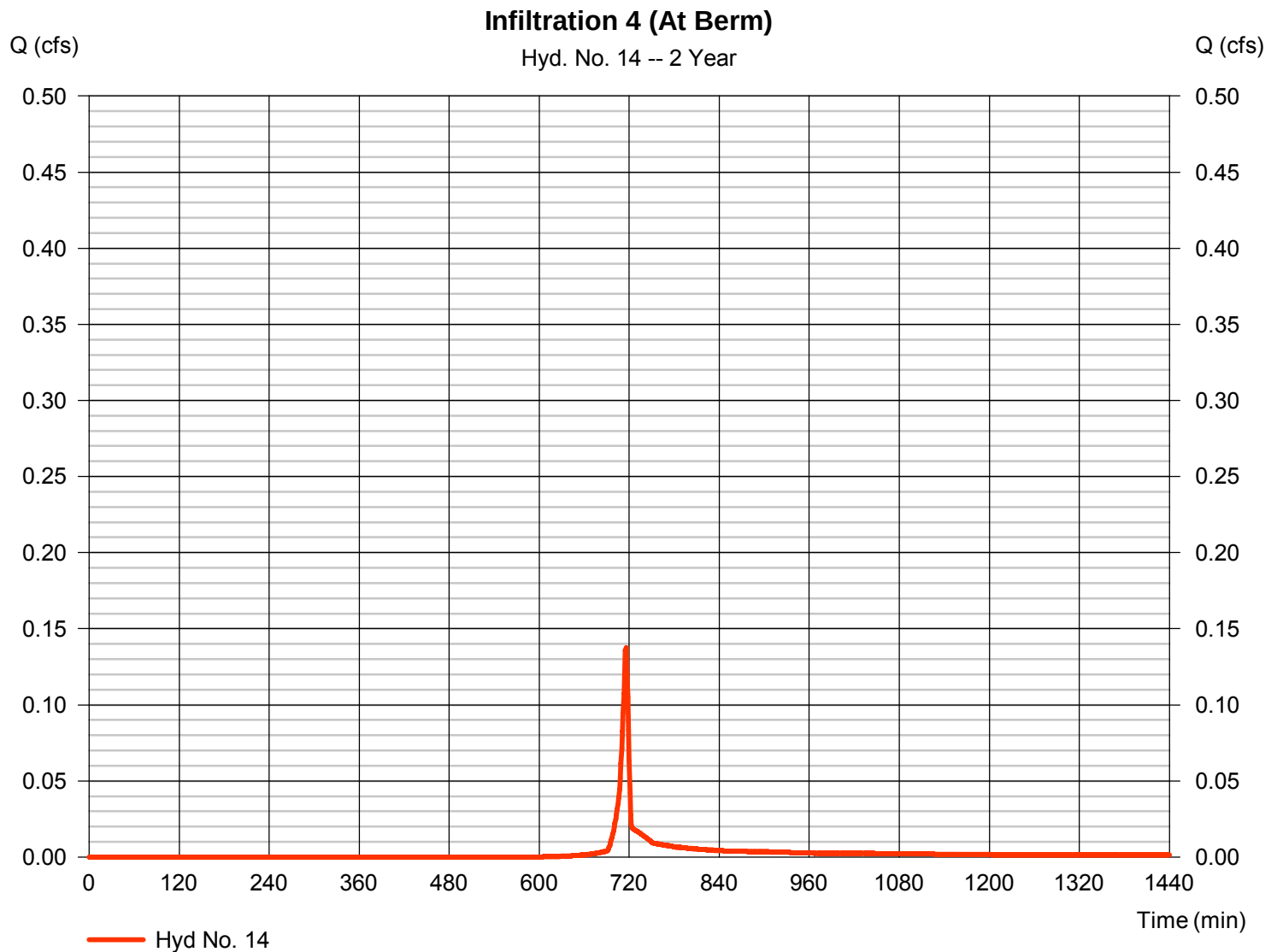
Tuesday, 11 / 15 / 2016

Hyd. No. 14

Infiltration 4 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.138 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 239 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.90 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

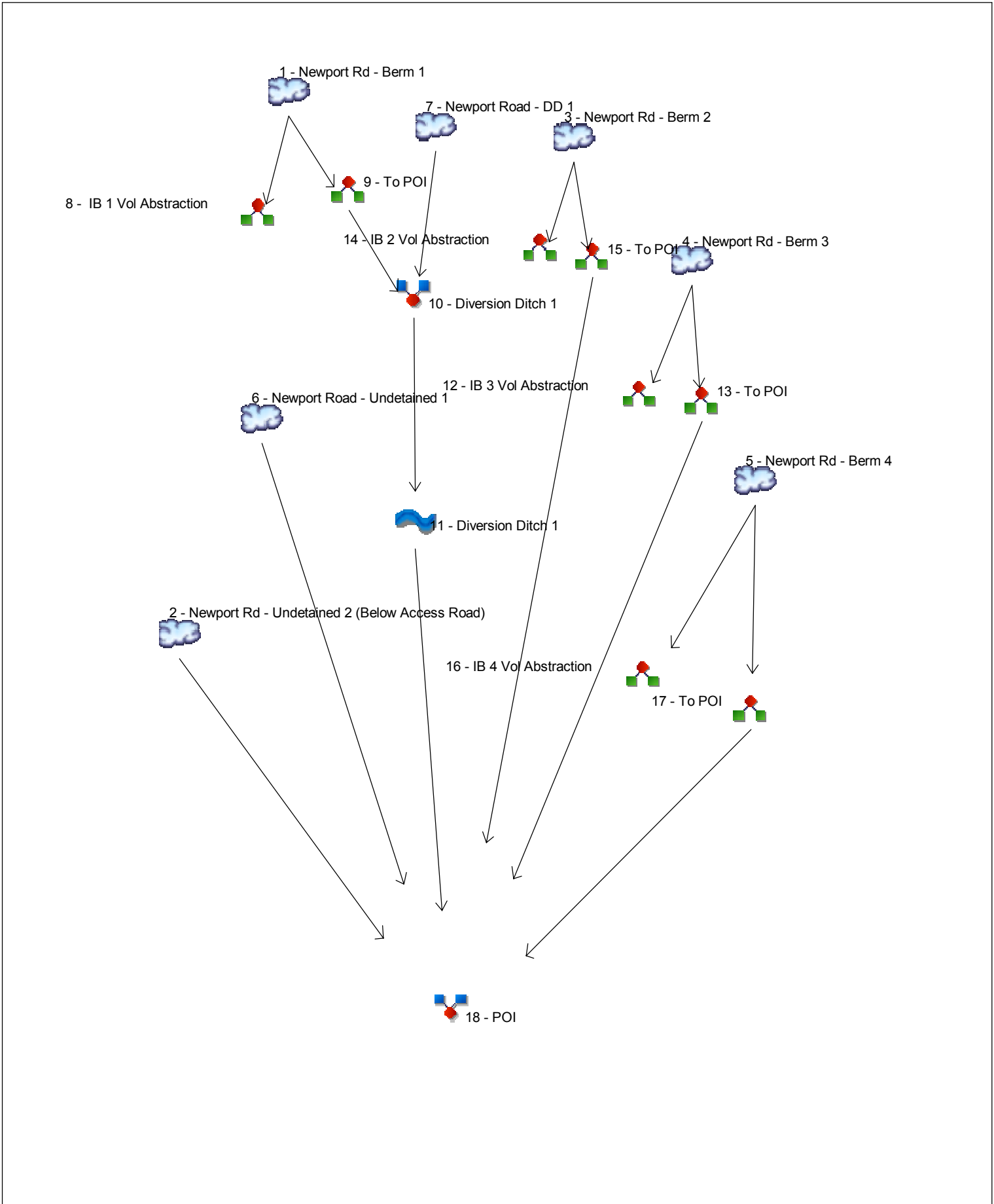
Hyd. No. 14

Infiltration 4 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 54.00	0.00	0.00				
Watercourse slope (%)	= 7.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.39	0.00	0.00				
Travel Time (min)	= 0.21	+	0.00	+	0.00	=	0.21
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				1.90 min			

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.759	-----	-----	-----	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	-----	-----	1.053	-----	-----	-----	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	-----	-----	0.849	-----	-----	-----	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	-----	-----	0.192	-----	-----	-----	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	-----	-----	0.107	-----	-----	-----	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	-----	-----	0.595	-----	-----	-----	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	1.121	-----	-----	-----	-----	-----	-----	Newport Road - DD 1
8	Diversion1	1	-----	0.759	-----	-----	-----	-----	-----	-----	IB 1 Vol Abstraction
9	Diversion2	1	-----	0.068	-----	-----	-----	-----	-----	-----	To POI
10	Combine	7, 9	-----	1.121	-----	-----	-----	-----	-----	-----	Diversion Ditch 1
11	Reach	10	-----	1.117	-----	-----	-----	-----	-----	-----	Diversion Ditch 1
12	Diversion1	4	-----	0.192	-----	-----	-----	-----	-----	-----	IB 3 Vol Abstraction
13	Diversion2	4	-----	0.008	-----	-----	-----	-----	-----	-----	To POI
14	Diversion1	3	-----	0.849	-----	-----	-----	-----	-----	-----	IB 2 Vol Abstraction
15	Diversion2	3	-----	0.085	-----	-----	-----	-----	-----	-----	To POI
16	Diversion1	5	-----	0.107	-----	-----	-----	-----	-----	-----	IB 4 Vol Abstraction
17	Diversion2	5	-----	0.002	-----	-----	-----	-----	-----	-----	To POI
18	Combine	2, 6, 11, 13, 15, 17	-----	2.542	-----	-----	-----	-----	-----	-----	POI
Proj. file: Newport Rd wBMP-2yr.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.759	1	727	2,681	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	1.053	1	719	2,249	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	0.849	1	725	2,879	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	0.192	1	733	816	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	0.107	1	721	260	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	0.595	1	721	1,617	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	1.121	1	723	3,171	-----	-----	-----	Newport Road - DD 1
8	Diversion1	0.759	1	727	1,584	1	-----	-----	IB 1 Vol Abstraction
9	Diversion2	0.068	1	817	1,098	1	-----	-----	To POI
10	Combine	1.121	1	723	4,269	7, 9	-----	-----	Diversion Ditch 1
11	Reach	1.117	1	724	4,265	10	-----	-----	Diversion Ditch 1
12	Diversion1	0.192	1	733	688	4	-----	-----	IB 3 Vol Abstraction
13	Diversion2	0.008	1	1070	128	4	-----	-----	To POI
14	Diversion1	0.849	1	725	1,529	3	-----	-----	IB 2 Vol Abstraction
15	Diversion2	0.085	1	804	1,350	3	-----	-----	To POI
16	Diversion1	0.107	1	721	239	5	-----	-----	IB 4 Vol Abstraction
17	Diversion2	0.002	1	1226	21	5	-----	-----	To POI
18	Combine	2.542	1	721	9,631	2, 6, 11, 13, 15, 17	-----	-----	POI
Newport Rd wBMP-2yr.gpw					Return Period: 2 Year			Tuesday, 11 / 15 / 2016	

Hydrograph Report

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

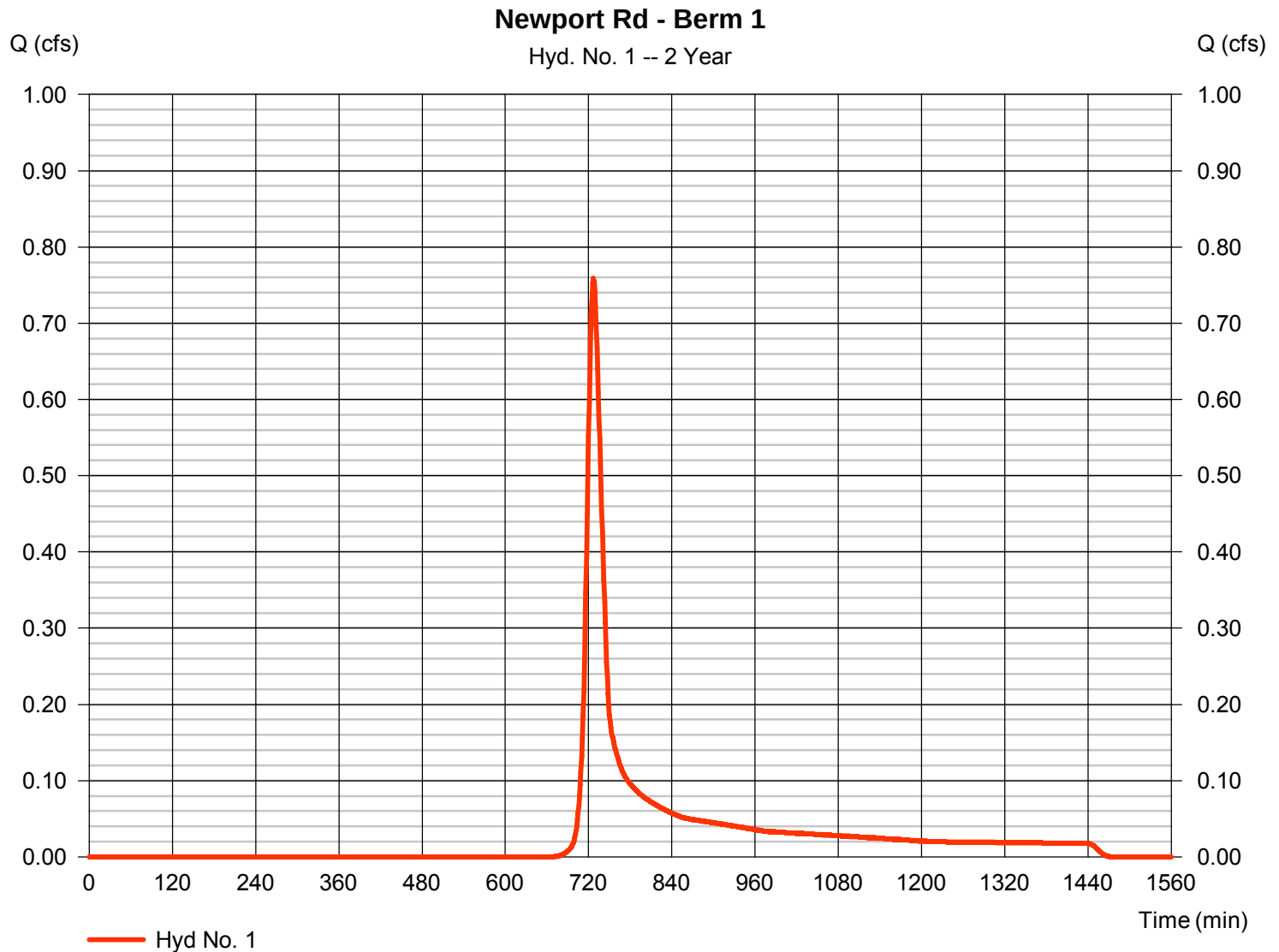
Tuesday, 11 / 15 / 2016

Hyd. No. 1

Newport Rd - Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.759 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 2,681 cuft
Drainage area	= 0.980 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 21.00 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.460 \times 78) + (0.100 \times 89) + (0.030 \times 91)] / 0.980$



Hydrograph Report

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

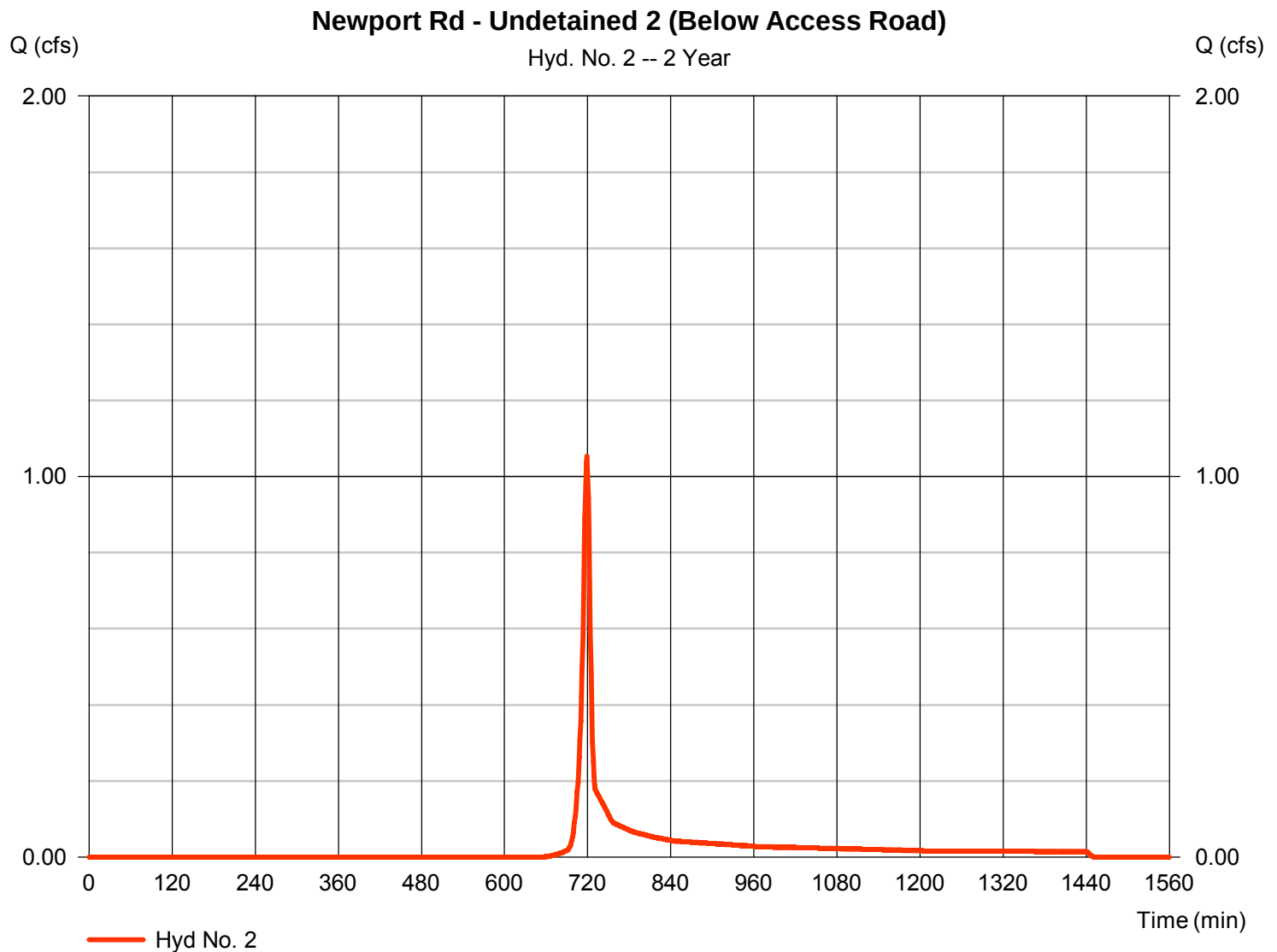
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.053 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 2,249 cuft
Drainage area	= 0.800 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.70 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc				6.70 min			

Hydrograph Report

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

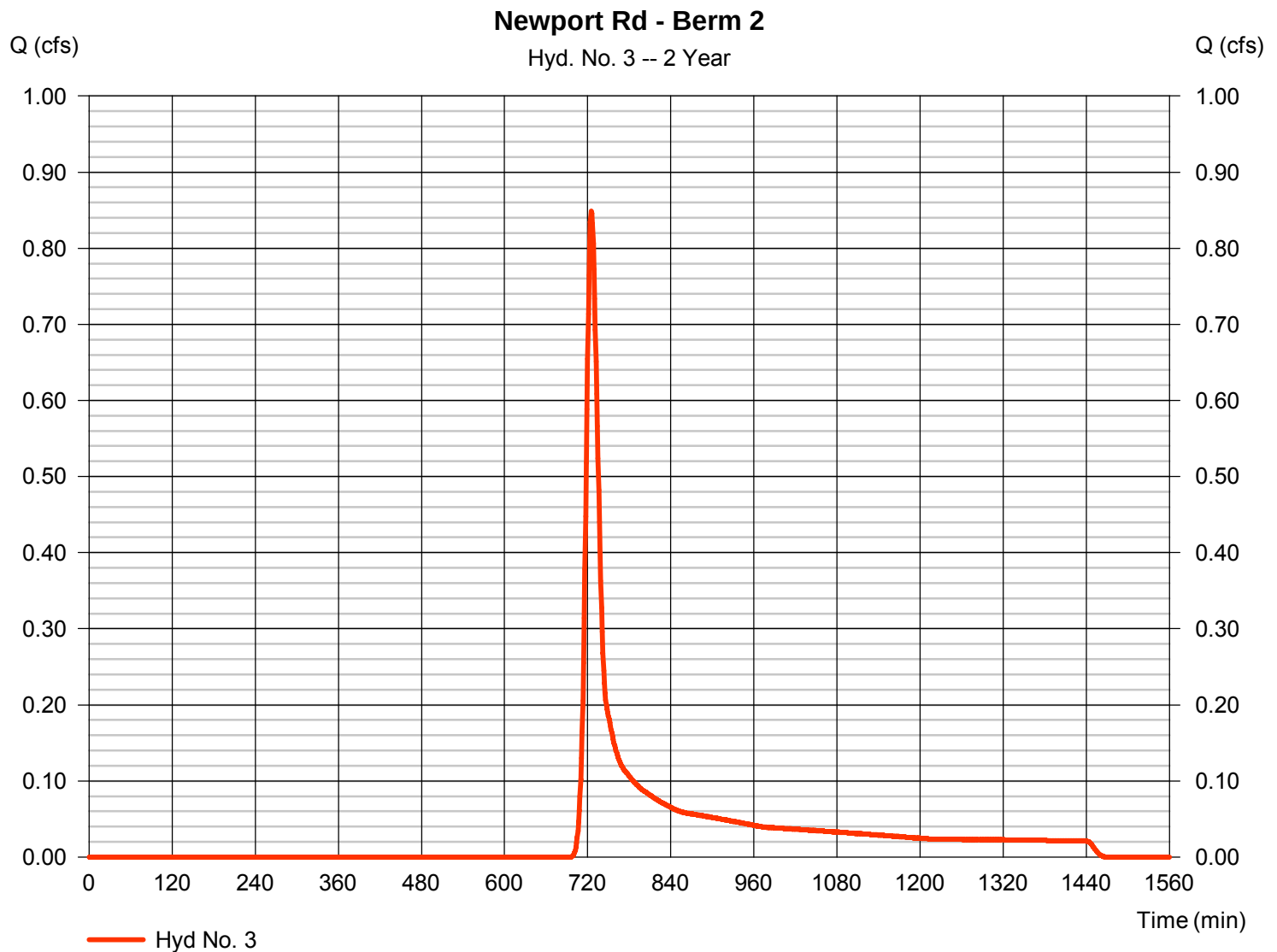
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.849 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 2,879 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.80 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



Hydrograph Report

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

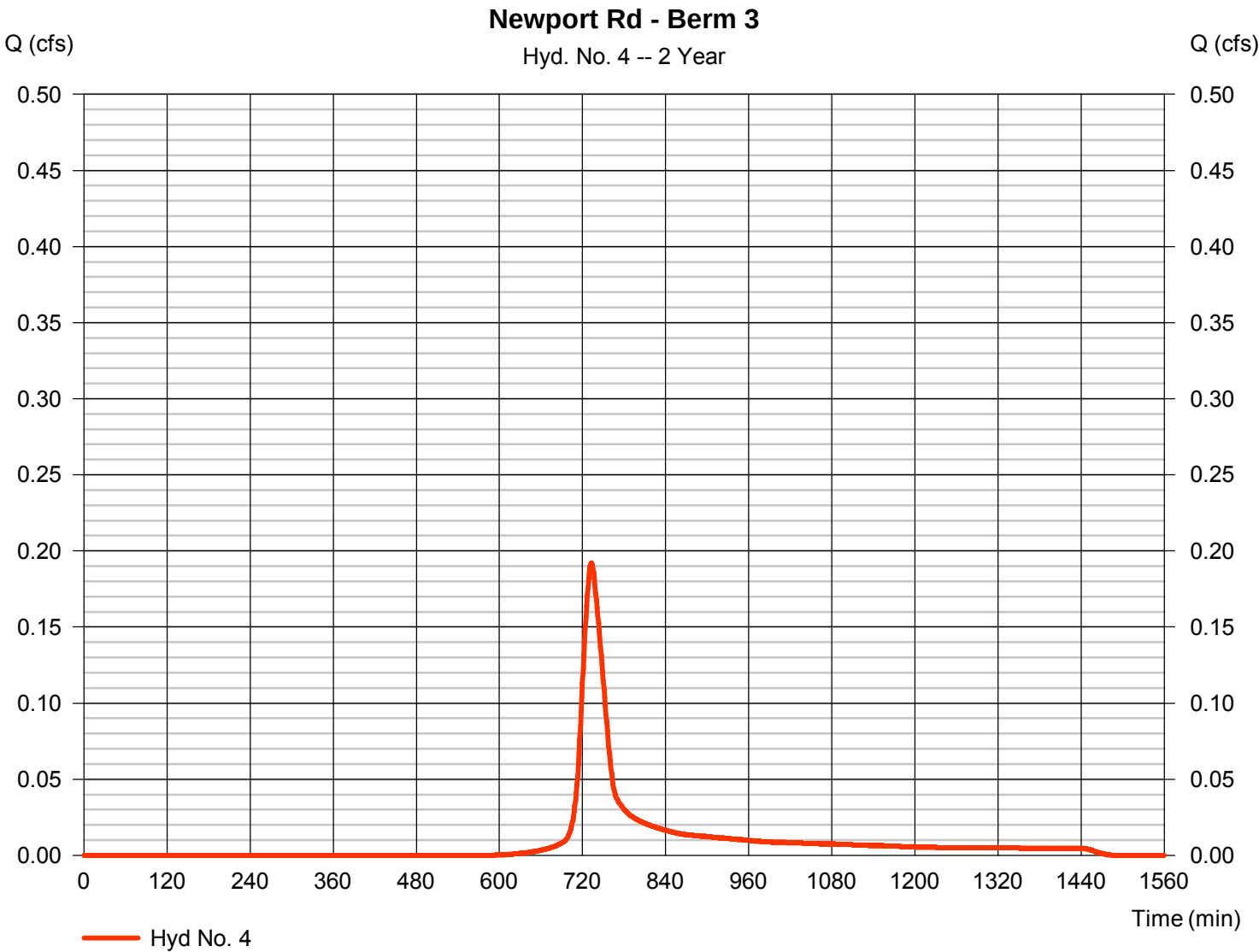
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.192 cfs
Storm frequency	=	2 yrs	Time to peak	=	733 min
Time interval	=	1 min	Hyd. volume	=	816 cuft
Drainage area	=	0.210 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	30.60 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.080 x 91)] / 0.210



Hydrograph Report

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

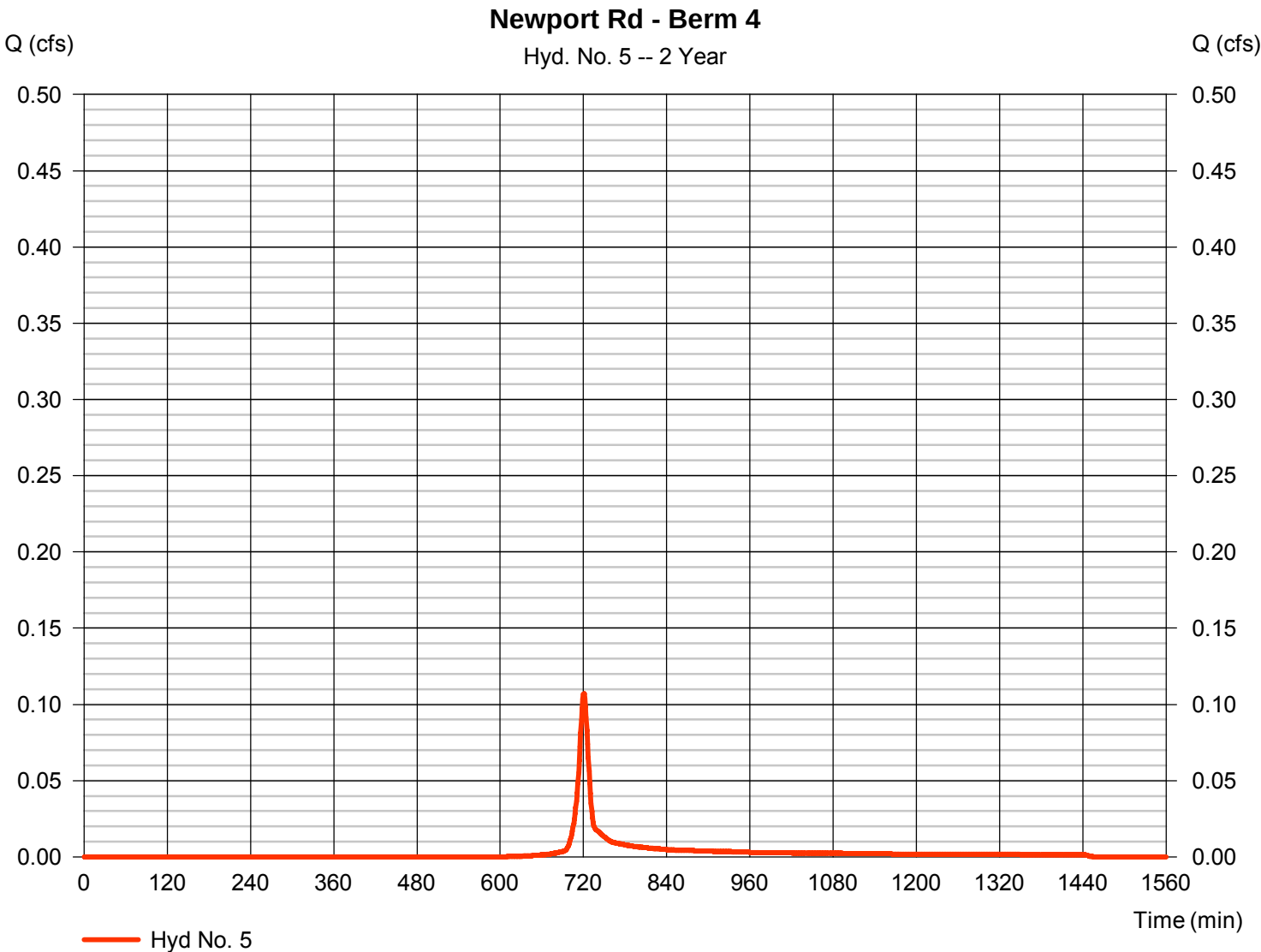
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.107 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	260 cuft
Drainage area	=	0.070 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.40 min
Total precip.	=	2.51 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.050 x 78) + (0.020 x 91)] / 0.070



Hydrograph Report

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

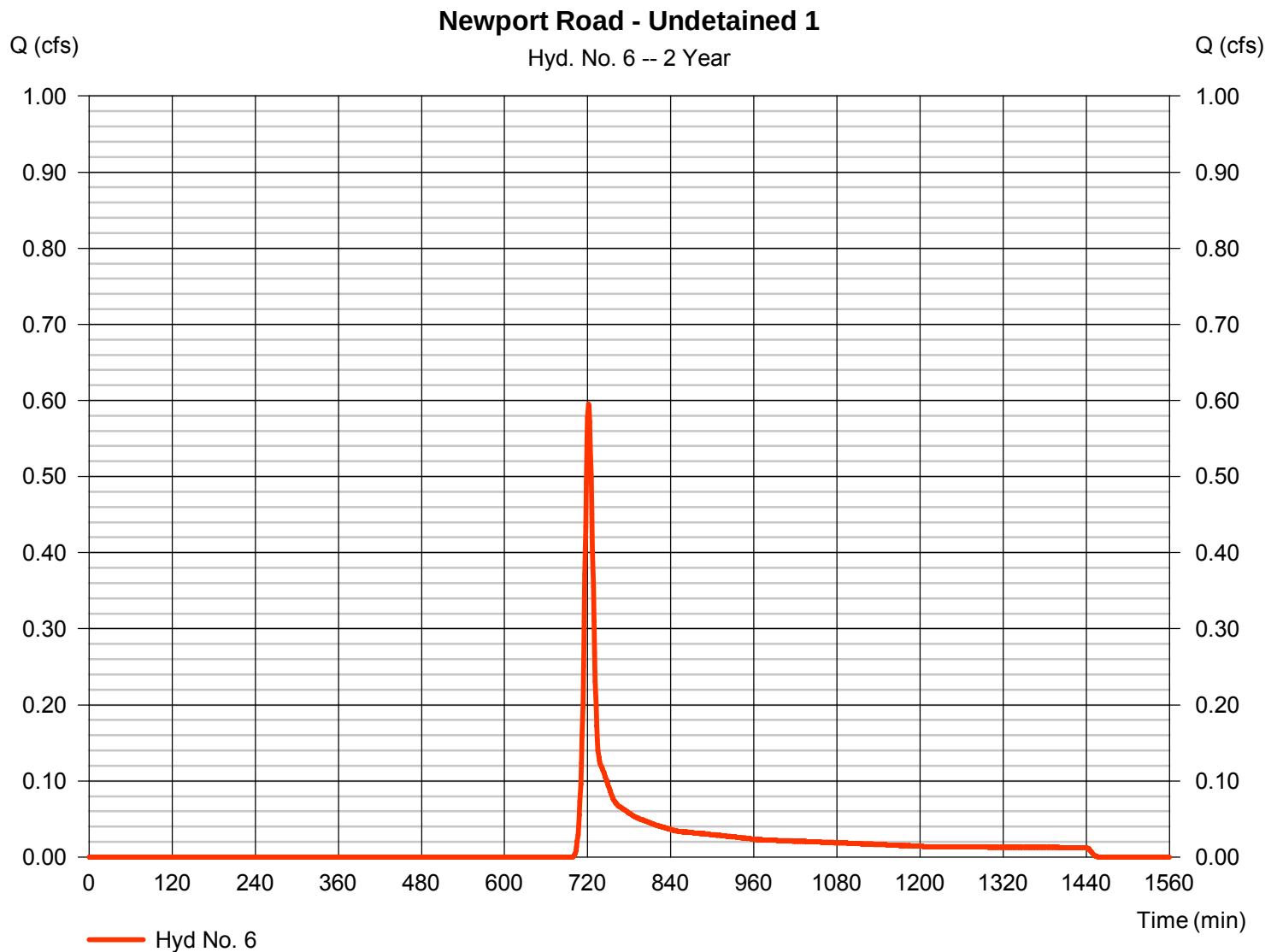
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.595 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 1,617 cuft
Drainage area	= 0.820 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.80 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

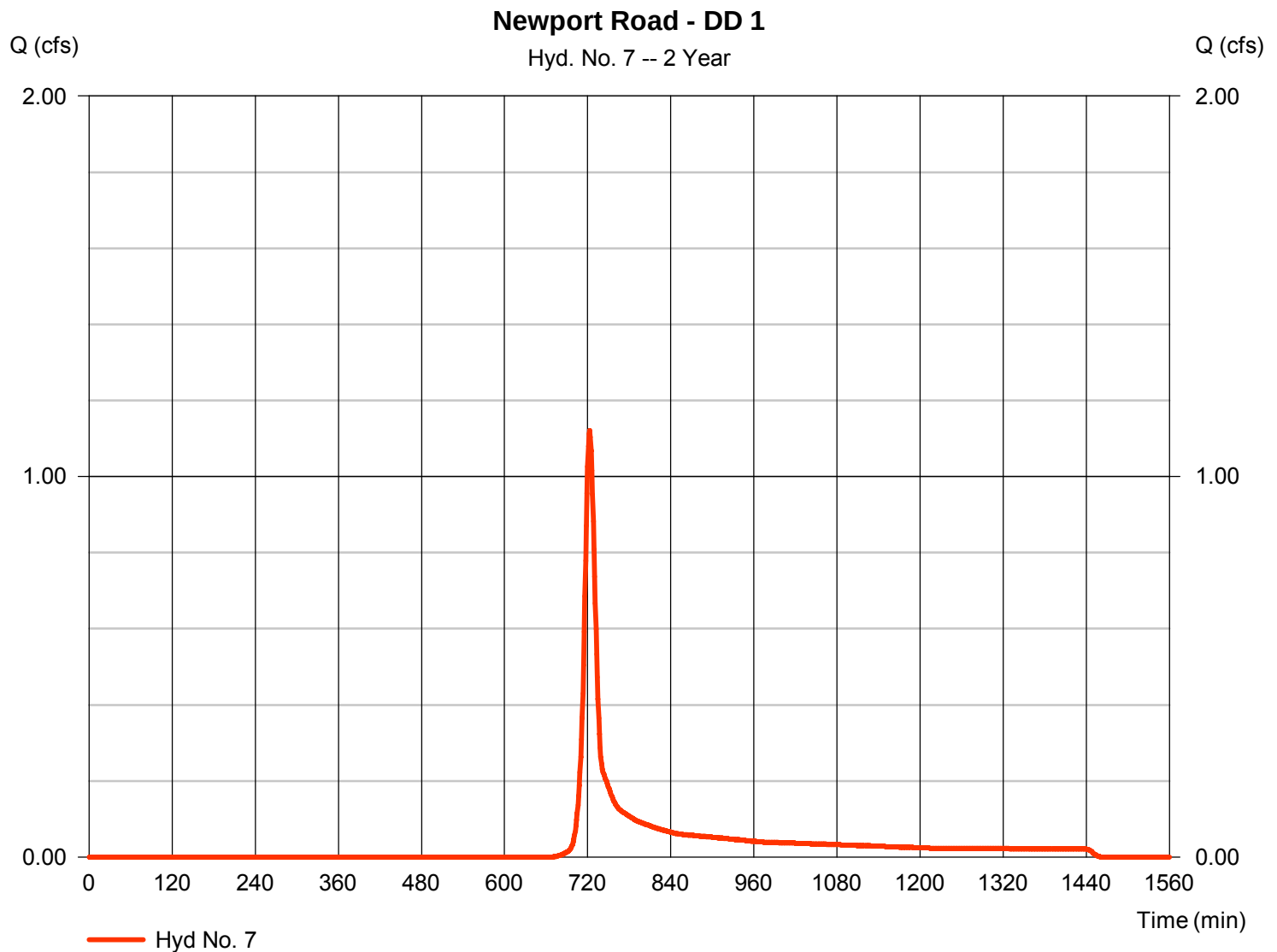
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.121 cfs
Storm frequency	= 2 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 3,171 cuft
Drainage area	= 1.170 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 2.51 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

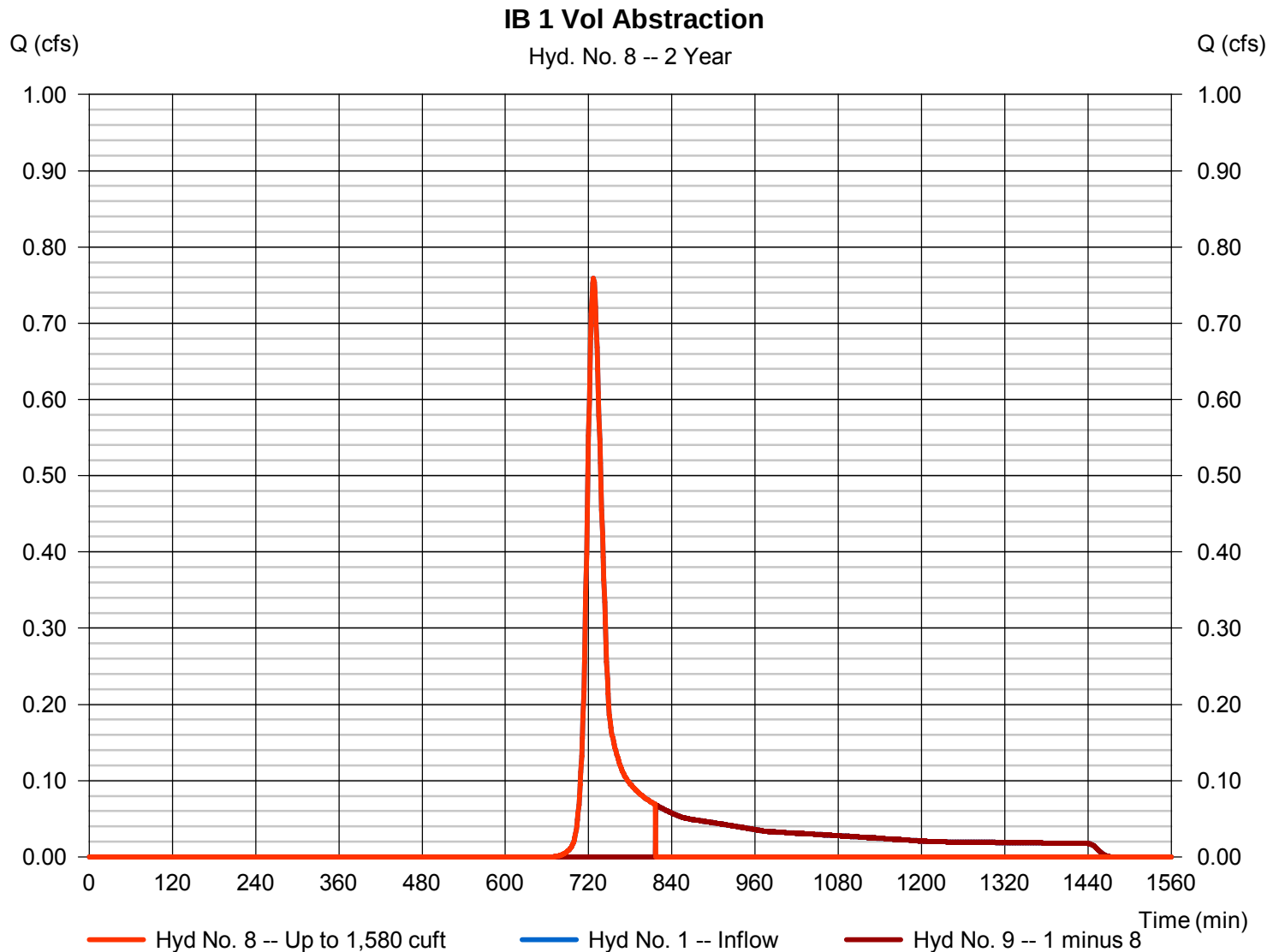
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 8

IB 1 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.759 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 1,584 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 9
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

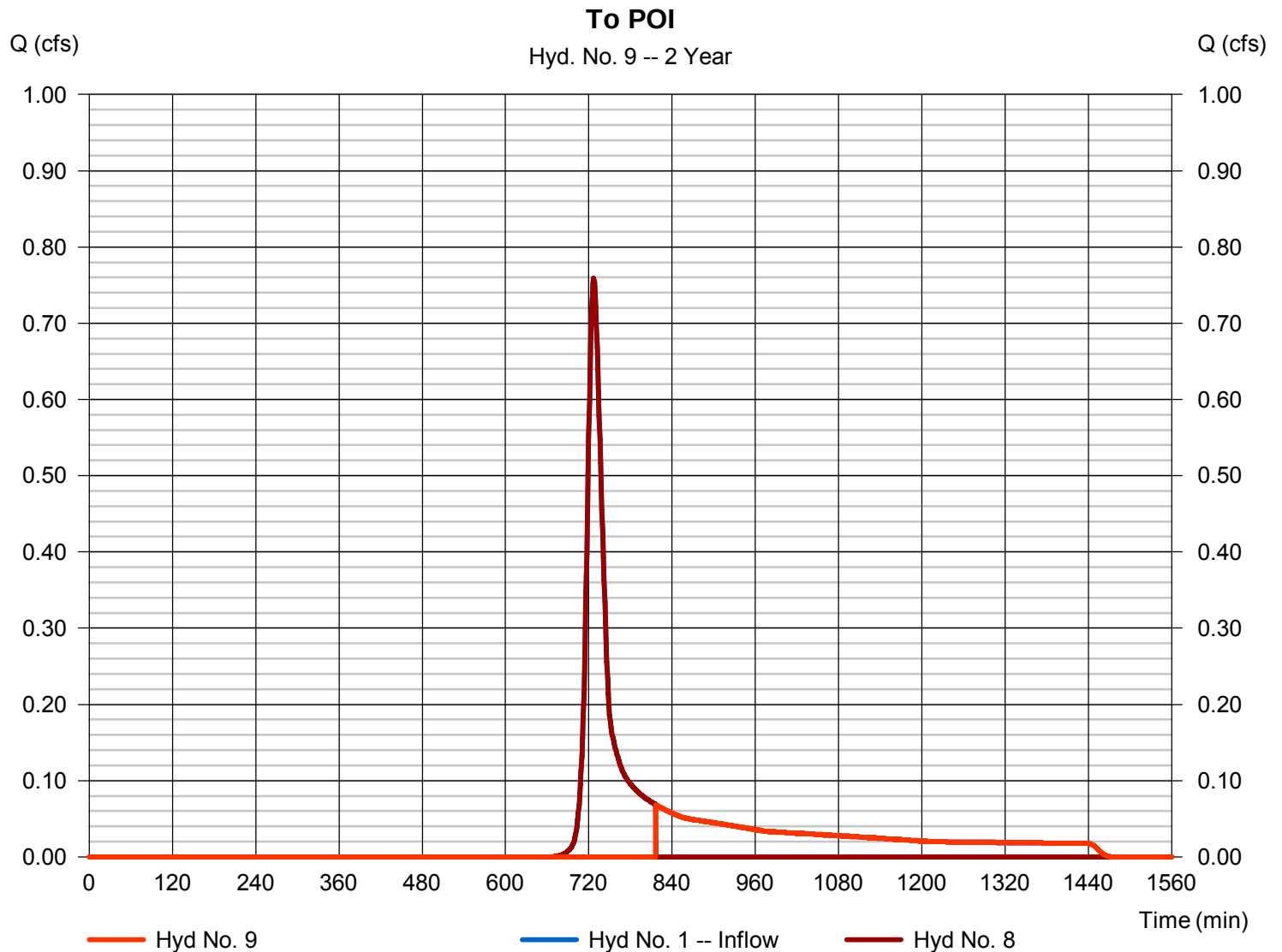
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 9

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.068 cfs
Storm frequency	= 2 yrs	Time to peak	= 817 min
Time interval	= 1 min	Hyd. volume	= 1,098 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 8
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

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

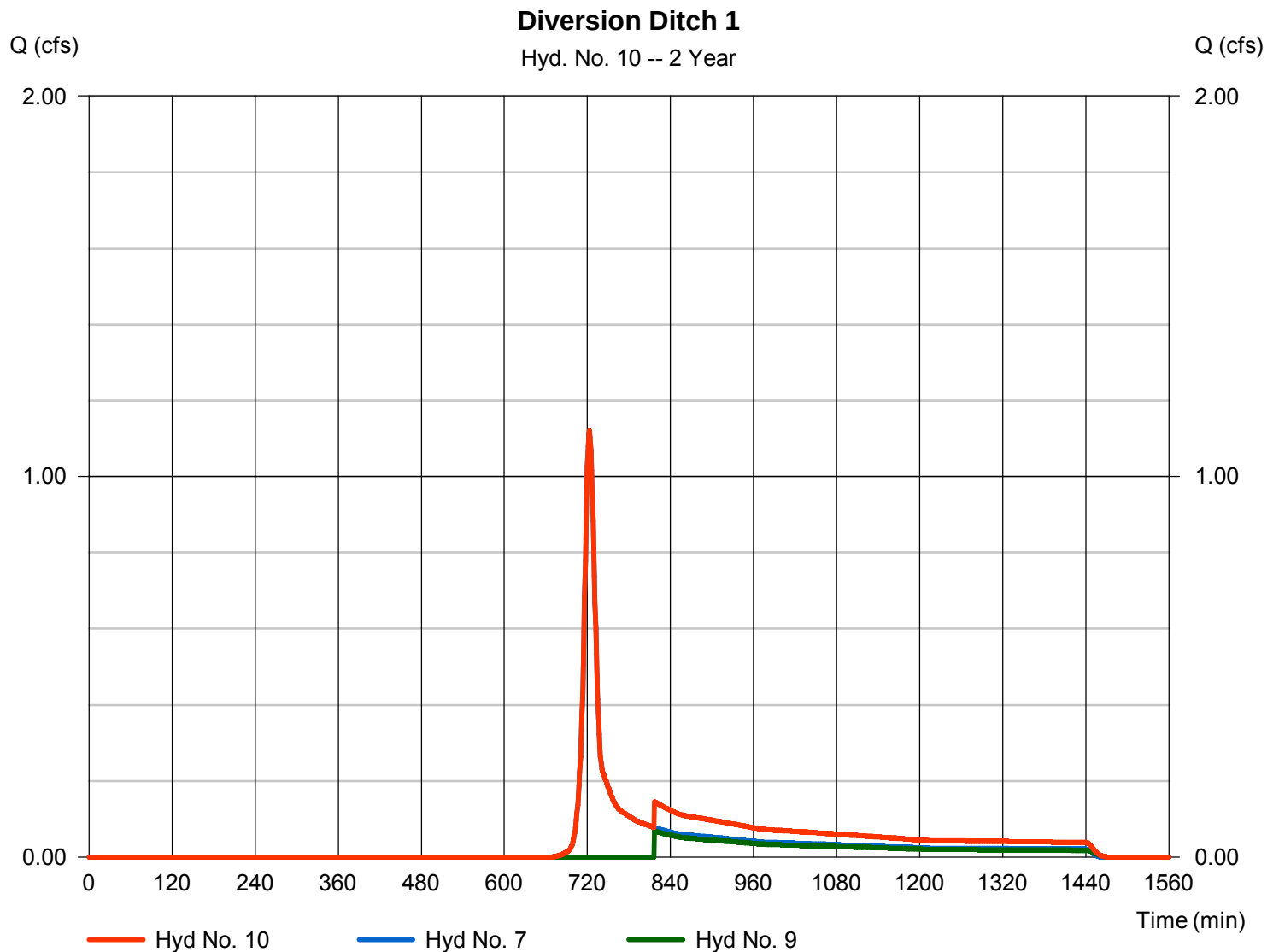
Tuesday, 11 / 15 / 2016

Hyd. No. 10

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 7, 9

Peak discharge = 1.121 cfs
 Time to peak = 723 min
 Hyd. volume = 4,269 cuft
 Contrib. drain. area = 1.170 ac



Hydrograph Report

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

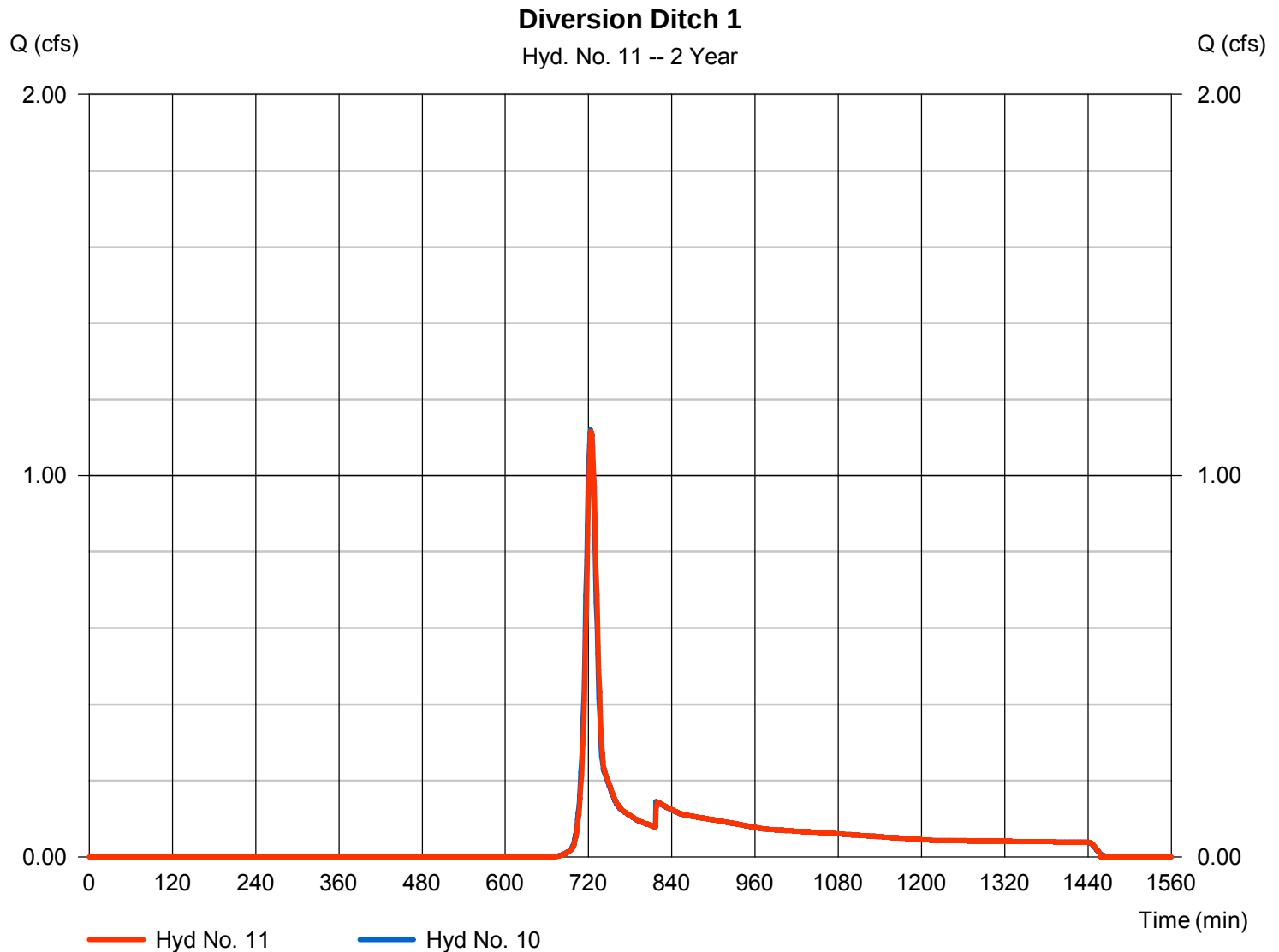
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 1.117 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 4,265 cuft
Inflow hyd. No.	= 10 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7782

Modified Att-Kin routing method used.



Hydrograph Report

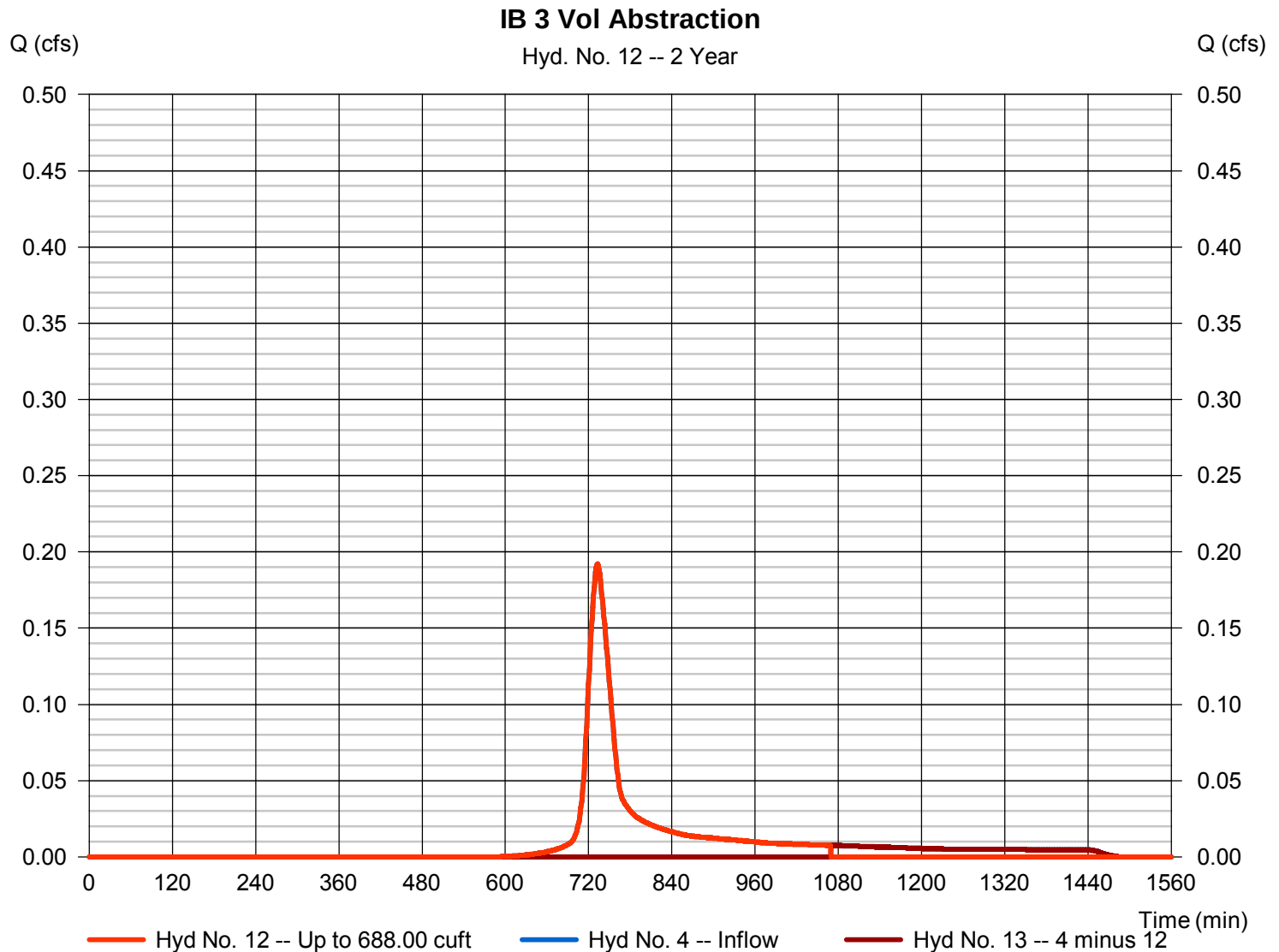
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 12

IB 3 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.192 cfs
Storm frequency	= 2 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 688 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 13
Diversion method	= First Flush Volume	Volume Up To	= 688.00 cuft



Hydrograph Report

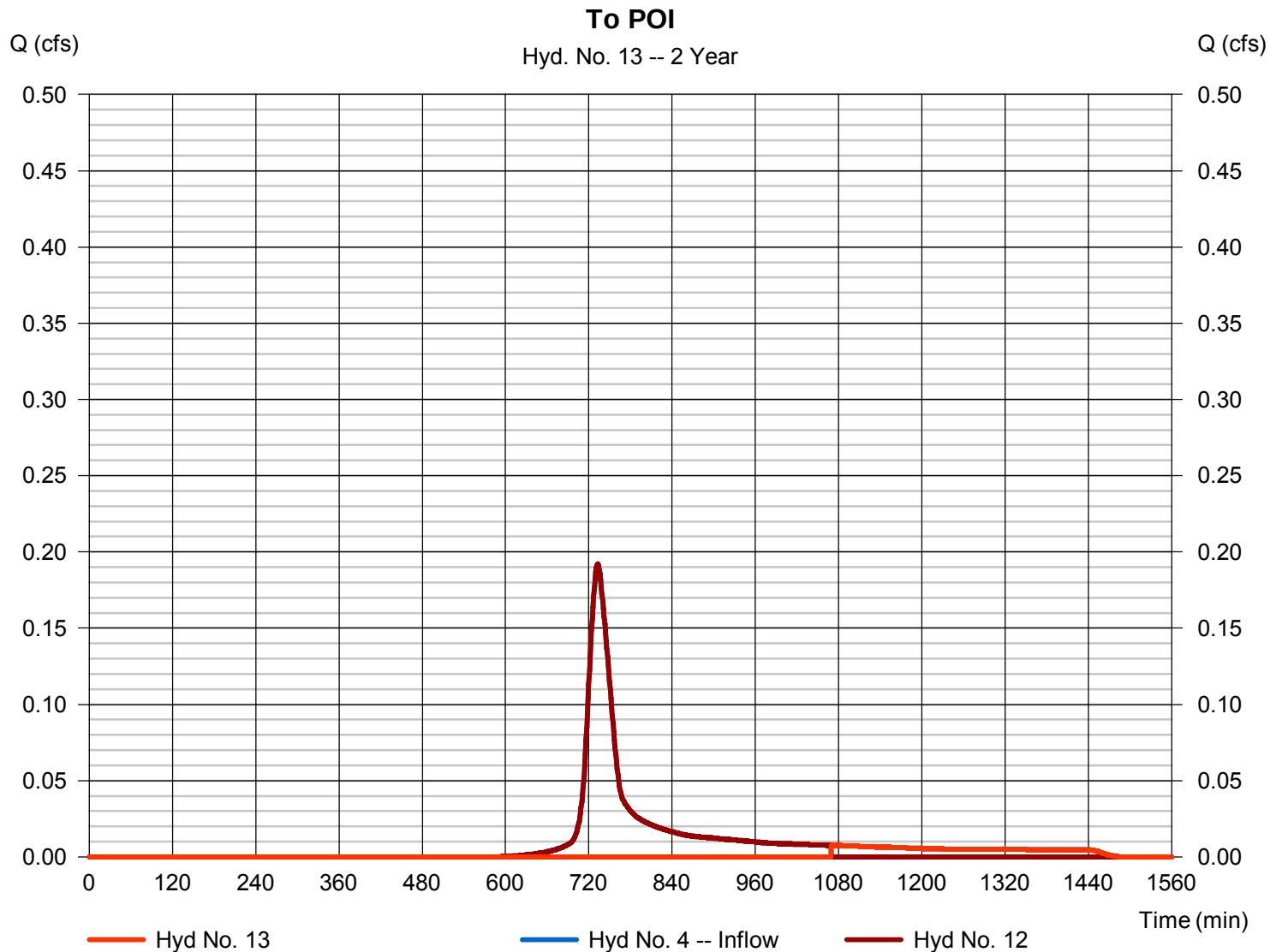
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 13

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.008 cfs
Storm frequency	= 2 yrs	Time to peak	= 1070 min
Time interval	= 1 min	Hyd. volume	= 128 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 12
Diversion method	= First Flush Volume	Volume Up To	= 688.00 cuft



Hydrograph Report

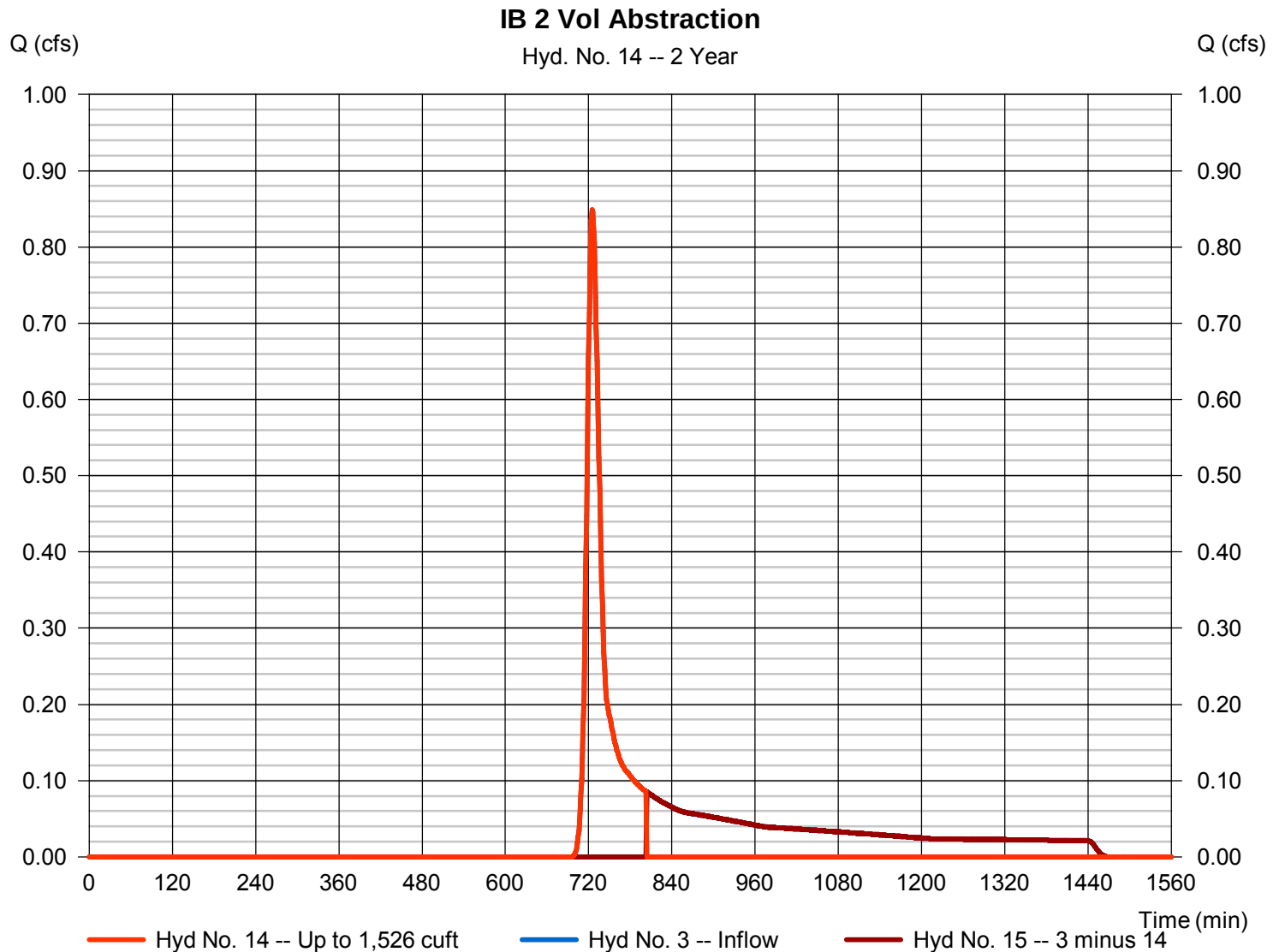
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 14

IB 2 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.849 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 1,529 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 15
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

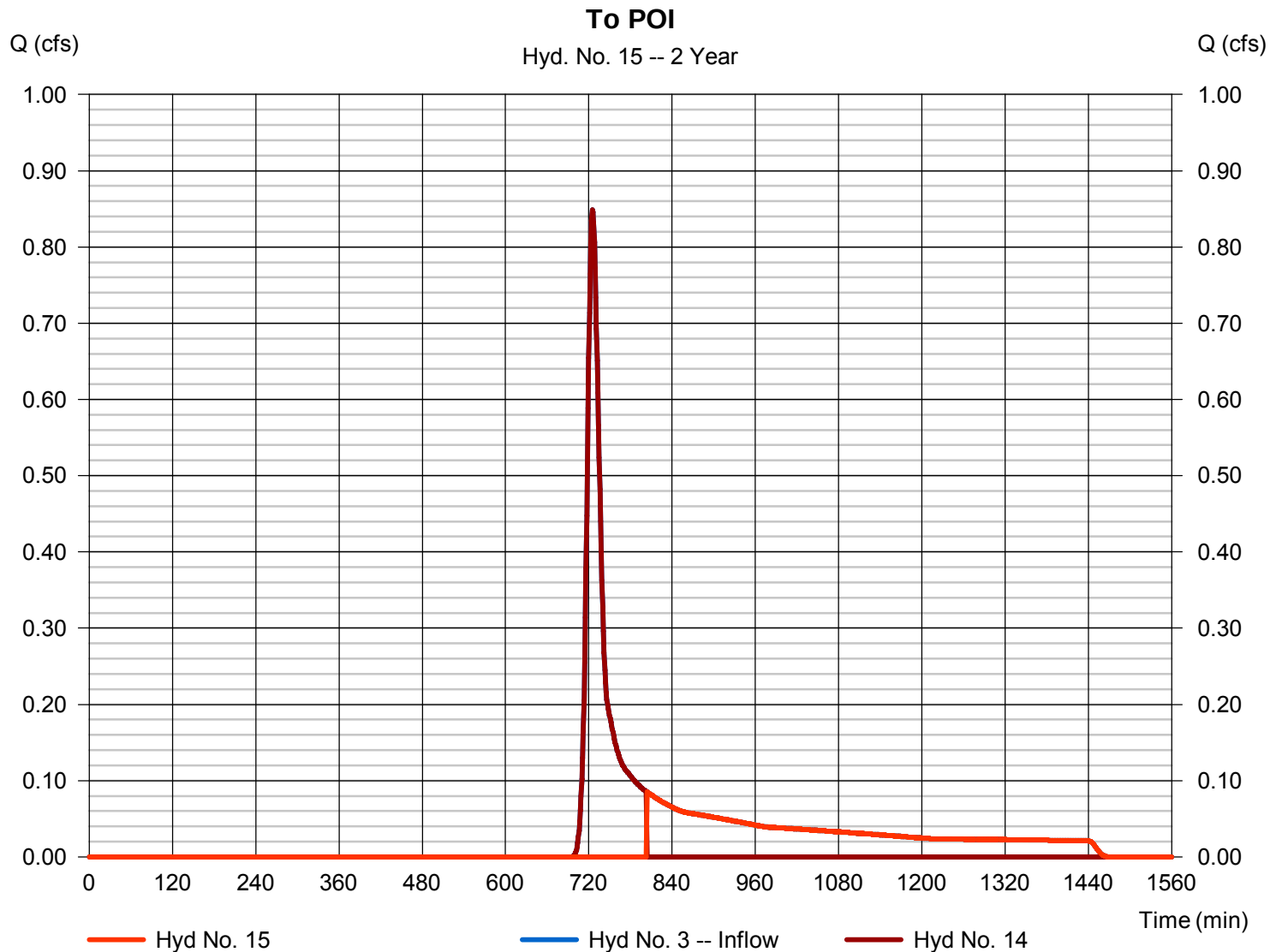
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 15

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.085 cfs
Storm frequency	= 2 yrs	Time to peak	= 804 min
Time interval	= 1 min	Hyd. volume	= 1,350 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 14
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

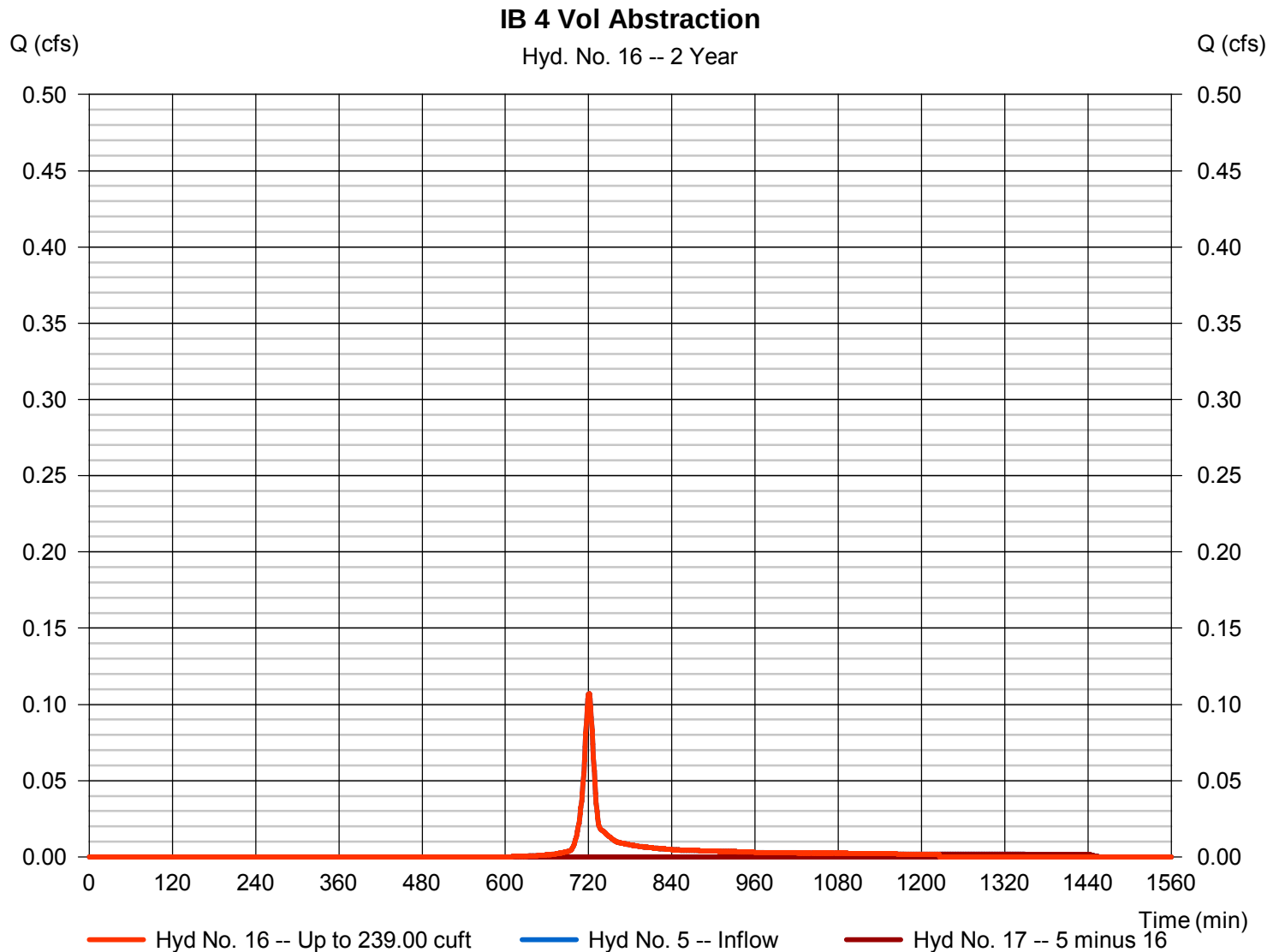
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 16

IB 4 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.107 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 239 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 17
Diversion method	= First Flush Volume	Volume Up To	= 239.00 cuft



Hydrograph Report

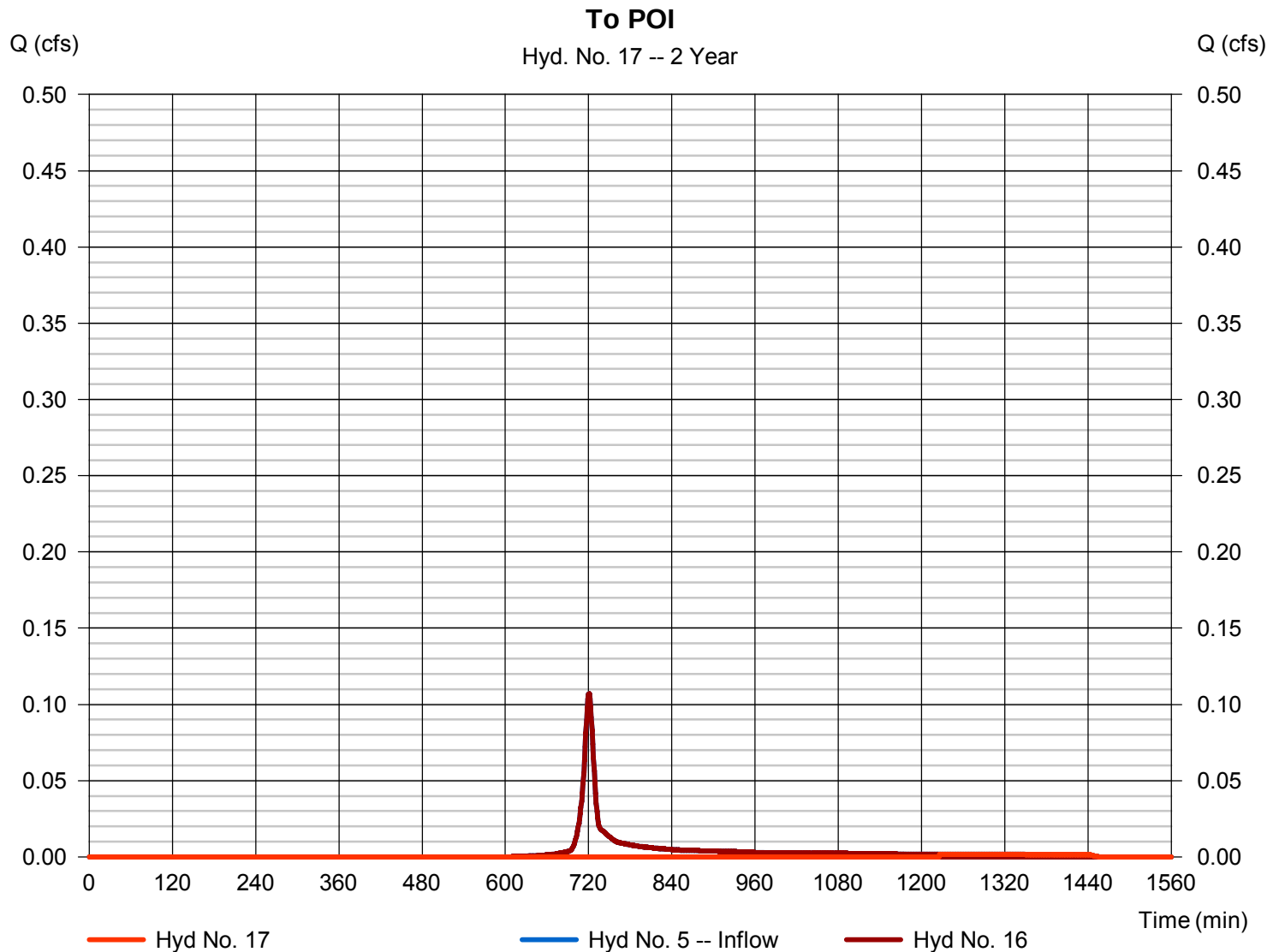
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 17

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.002 cfs
Storm frequency	= 2 yrs	Time to peak	= 1226 min
Time interval	= 1 min	Hyd. volume	= 21 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 16
Diversion method	= First Flush Volume	Volume Up To	= 239.00 cuft



Hydrograph Report

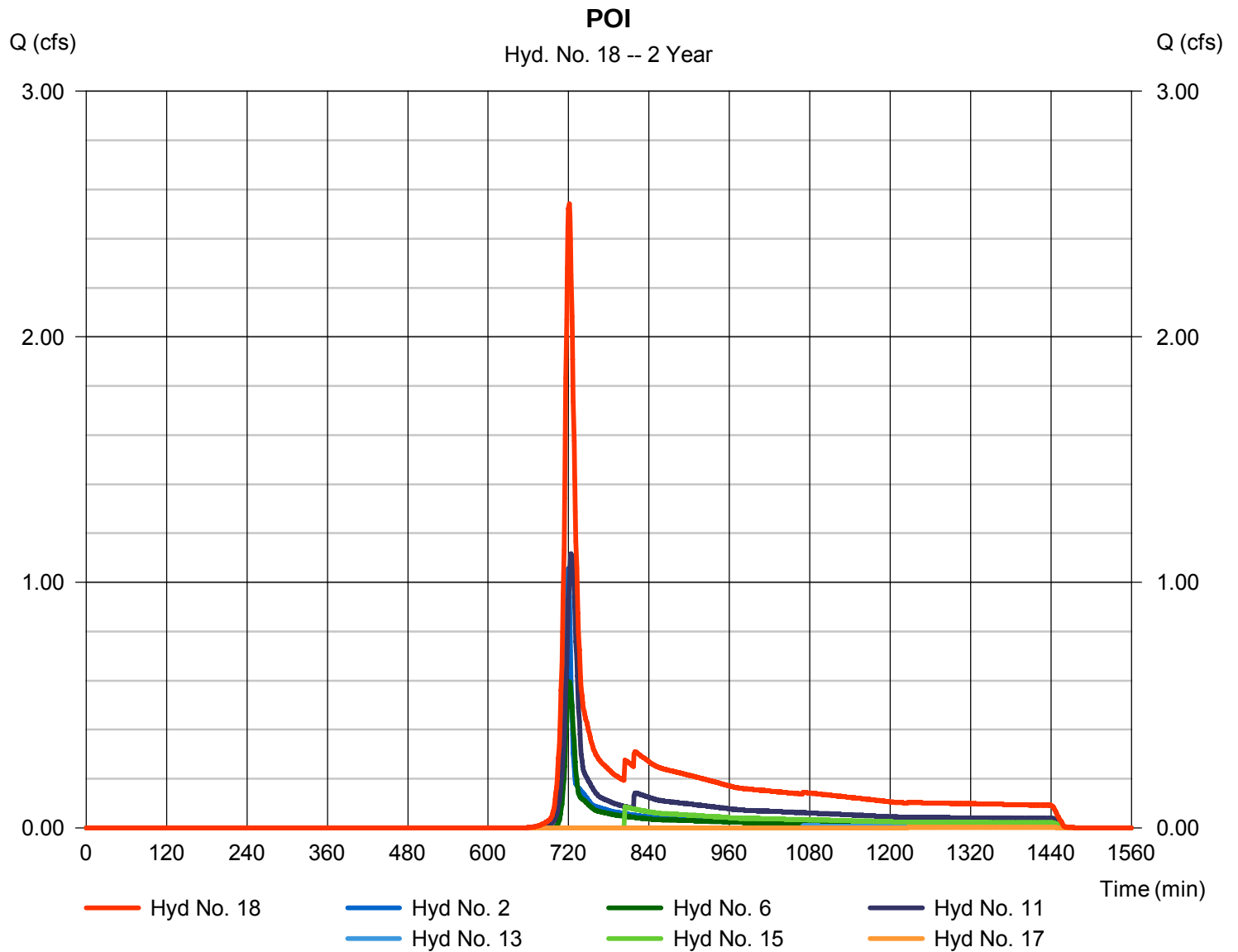
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 18

POI

Hydrograph type	= Combine	Peak discharge	= 2.542 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 9,631 cuft
Inflow hyds.	= 2, 6, 11, 13, 15, 17	Contrib. drain. area	= 1.620 ac



ATTACHMENT C-2
NEWPORT RD
10 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Newport Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.466	-----	-----	11.50	-----	19.42	23.37	Newport Rd - PRE
Proj. file: Newport Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	11.50	1	720	26,127	-----	-----	-----	Newport Rd - PRE
Newport Rd-PRE.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

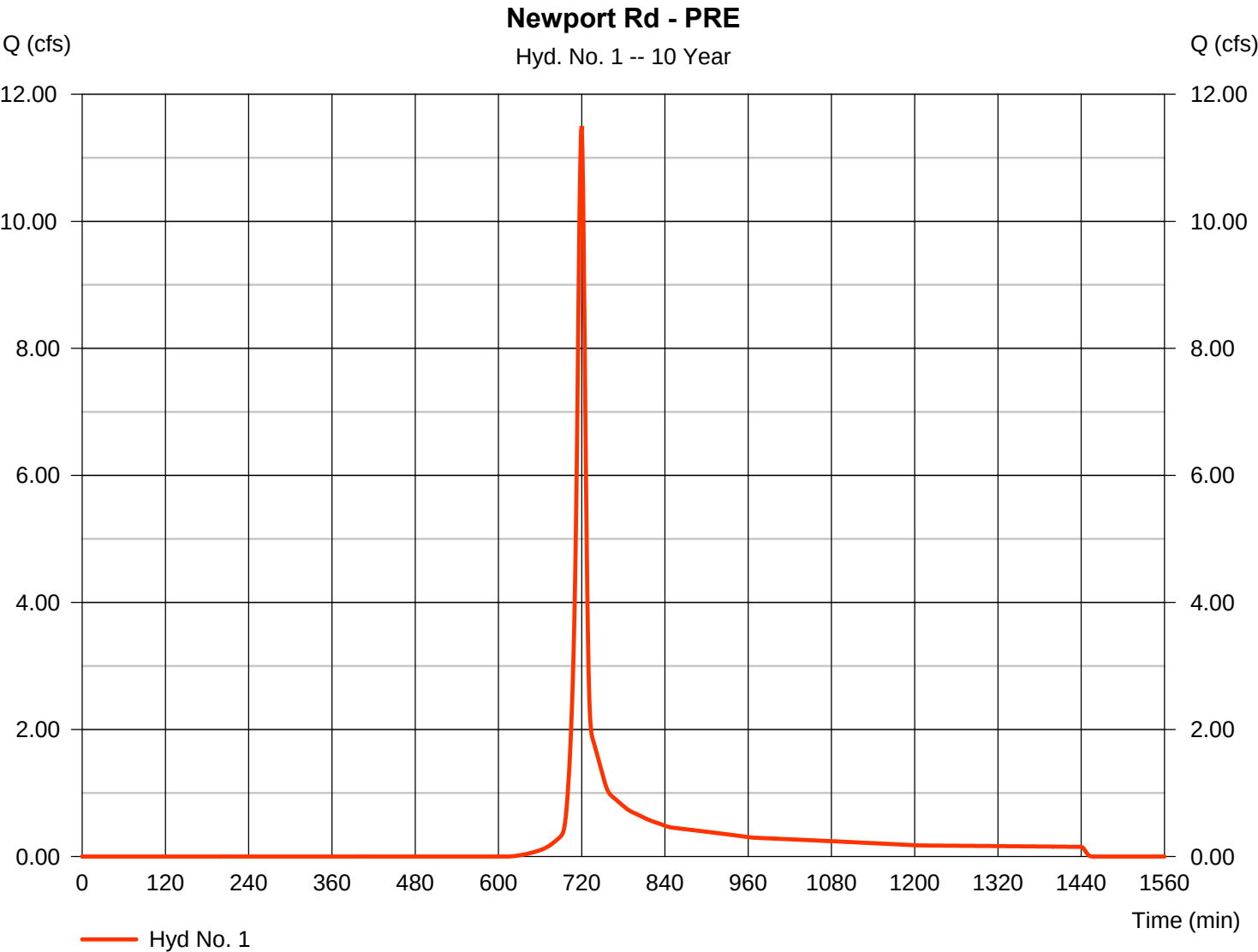
Hydrograph Report

Hyd. No. 1

Newport Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.50 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	26,127 cuft
Drainage area	=	5.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.530 x 71) + (2.680 x 78) + (0.230 x 77)] / 5.440



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

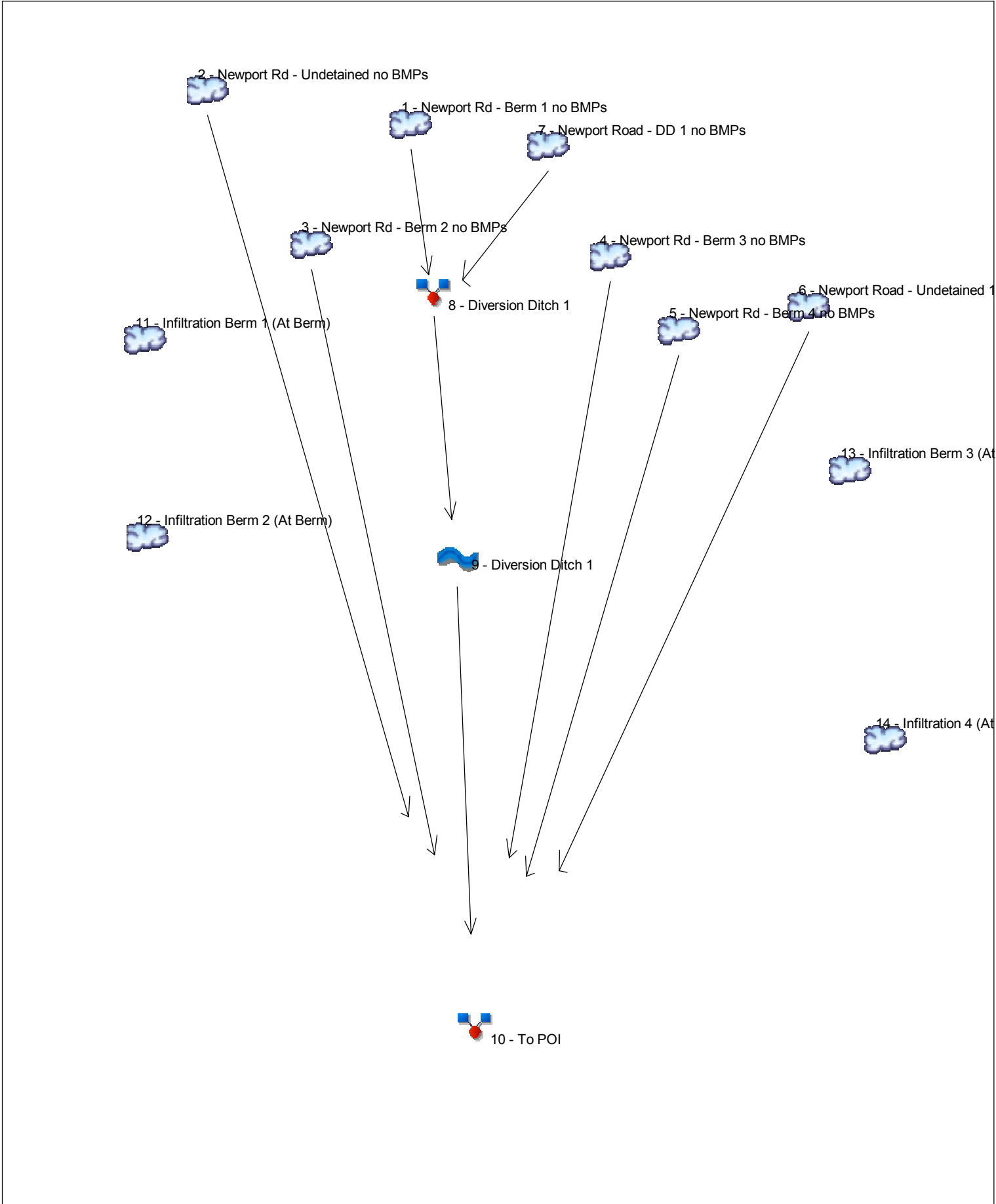
Hyd. No. 1

Newport Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 6.35	+	0.00	+	0.00	=	6.35
Shallow Concentrated Flow							
Flow length (ft)	= 620.00	141.00	124.00				
Watercourse slope (%)	= 6.50	12.80	4.70				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.11	5.77	3.50				
Travel Time (min)	= 2.51	+	0.41	+	0.59	=	3.51
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)63.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					10.00 min		

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.758	-----	-----	1.432	-----	2.282	2.694	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	-----	-----	1.053	-----	-----	2.041	-----	3.307	3.927	Newport Rd - Undetained no BMPs
3	SCS Runoff	-----	-----	0.964	-----	-----	2.202	-----	3.878	4.722	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	-----	-----	0.432	-----	-----	0.754	-----	1.148	1.337	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	-----	-----	0.595	-----	-----	1.394	-----	2.476	3.022	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	1.121	-----	-----	2.272	-----	3.777	4.516	Newport Road - DD 1 no BMPs
8	Combine	1, 7	-----	1.870	-----	-----	3.695	-----	6.035	7.178	Diversion Ditch 1
9	Reach	8	-----	1.859	-----	-----	3.677	-----	6.014	7.156	Diversion Ditch 1
10	Combine	2, 3, 4, 5, 6, 9	-----	4.448	-----	-----	9.297	-----	15.70	18.87	To POI
11	SCS Runoff	-----	-----	0.613	-----	-----	1.265	-----	2.128	2.558	Infiltration Berm 1 (At Berm)
12	SCS Runoff	-----	-----	0.782	-----	-----	1.836	-----	3.263	3.993	Infiltration Berm 2 (At Berm)
13	SCS Runoff	-----	-----	0.343	-----	-----	0.602	-----	0.923	1.076	Infiltration Berm 3 (At Berm)
14	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Infiltration 4 (At Berm)
Proj. file: Newport Rd No BMP.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	1.432	1	721	3,619	-----	-----	-----	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	2.041	1	719	4,304	-----	-----	-----	Newport Rd - Undetained no BMPs
3	SCS Runoff	2.202	1	723	6,098	-----	-----	-----	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	0.754	1	717	1,436	-----	-----	-----	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	0.243	1	716	431	-----	-----	-----	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	1.394	1	721	3,456	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	2.272	1	722	6,170	-----	-----	-----	Newport Road - DD 1 no BMPs
8	Combine	3.695	1	722	9,789	1, 7	-----	-----	Diversion Ditch 1
9	Reach	3.677	1	723	9,787	8	-----	-----	Diversion Ditch 1
10	Combine	9.297	1	720	25,511	2, 3, 4, 5, 6, 9	-----	-----	To POI
11	SCS Runoff	1.265	2	722	3,323	-----	-----	-----	Infiltration Berm 1 (At Berm)
12	SCS Runoff	1.836	2	722	4,910	-----	-----	-----	Infiltration Berm 2 (At Berm)
13	SCS Runoff	0.602	2	716	1,218	-----	-----	-----	Infiltration Berm 3 (At Berm)
14	SCS Runoff	0.243	1	716	431	-----	-----	-----	Infiltration 4 (At Berm)
Newport Rd No BMP.gpw					Return Period: 10 Year			Tuesday, 11 / 15 / 2016	

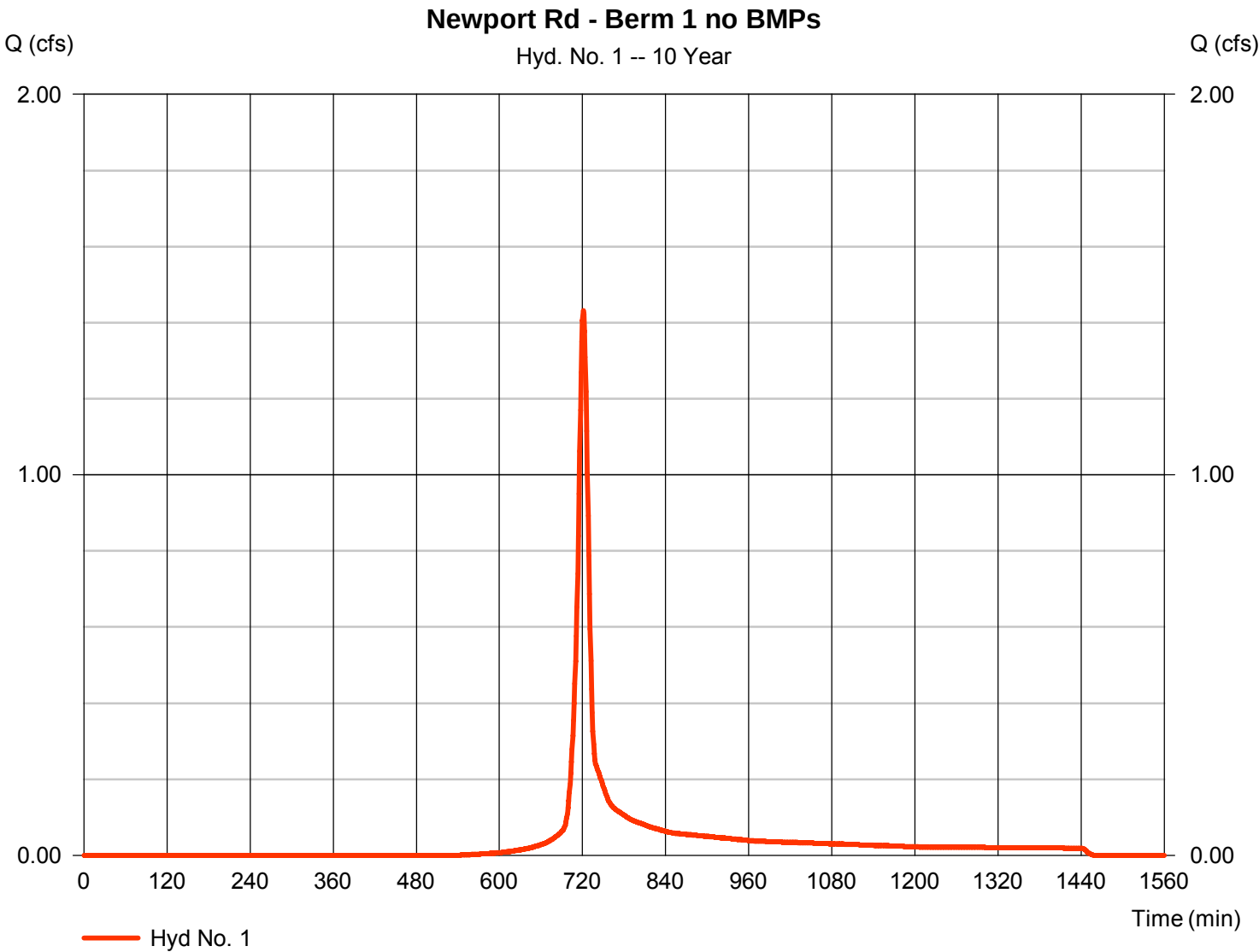
Hydrograph Report

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.432 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	3,619 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.42 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.390 x 71) + (0.460 x 78) + (0.100 x 89) + (0.030 x 91)] / 0.610



TR55 Tc Worksheet

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

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	297.00				
Watercourse slope (%)	= 8.00	4.80	6.40				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	4.08				
Travel Time (min)	= 0.92	+	0.23	+	1.21	=	2.36
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	= 0.025	0.025	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.42 min			

Hydrograph Report

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

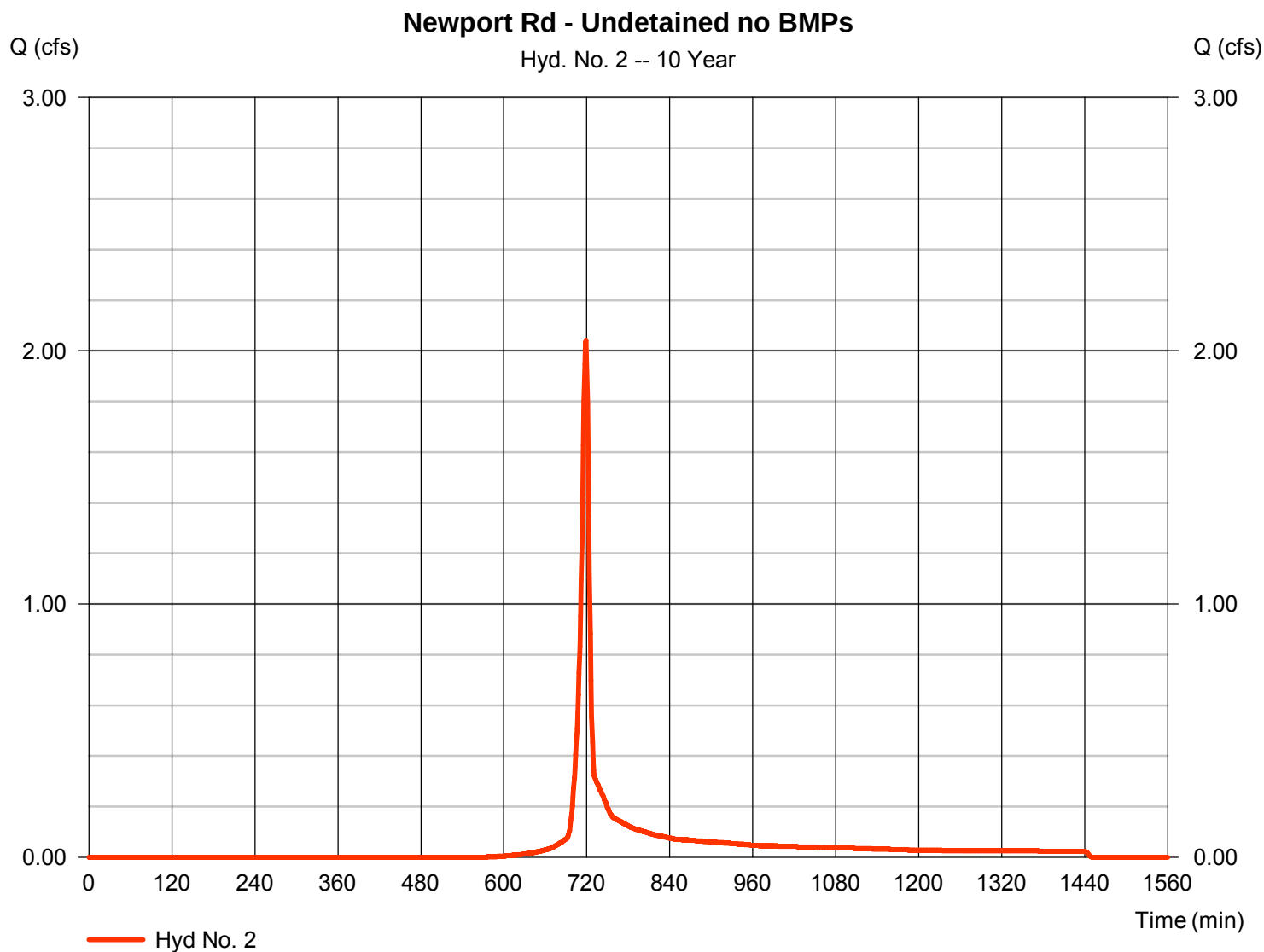
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.041 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	4,304 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					6.70 min		

Hydrograph Report

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

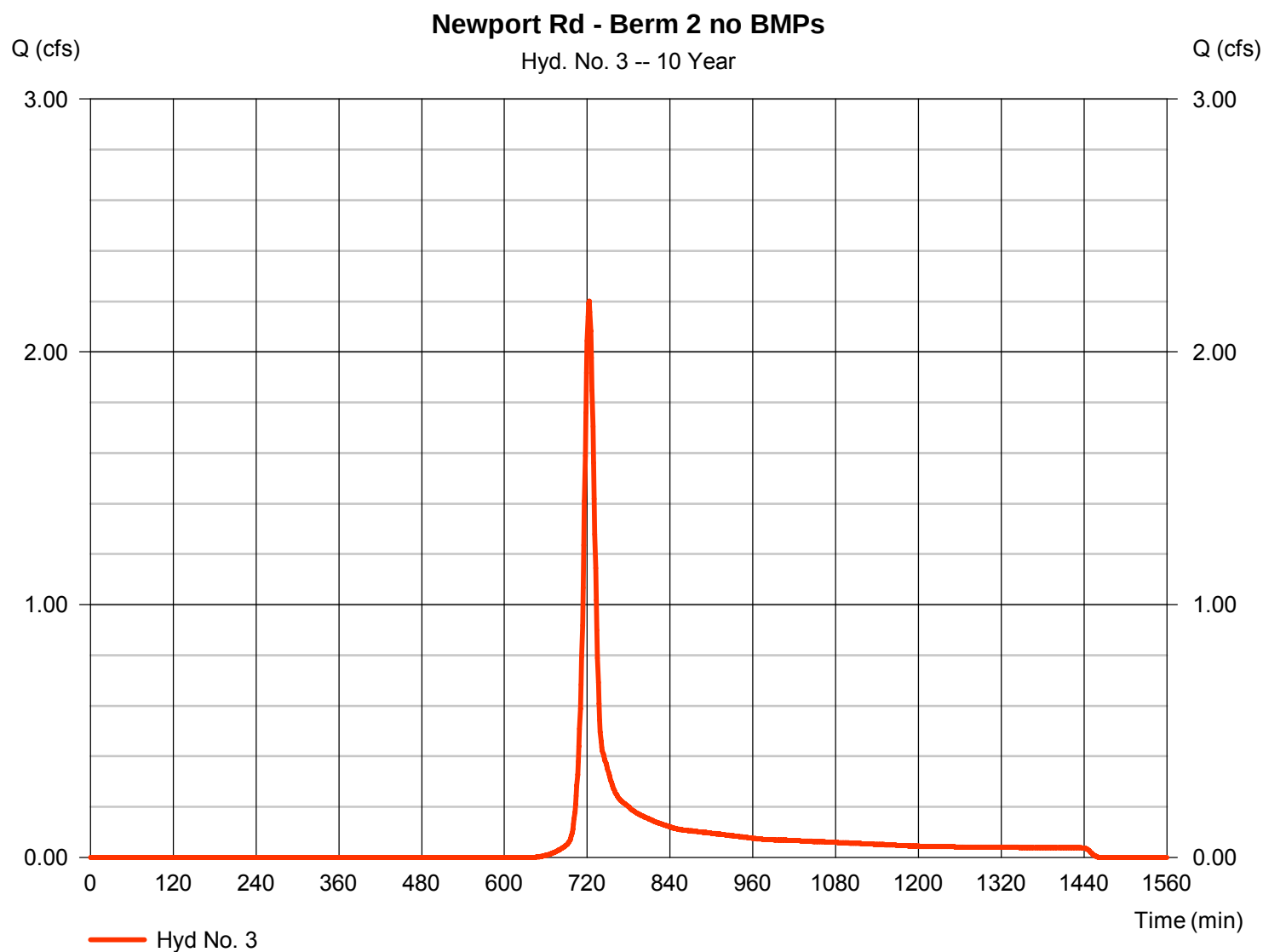
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.202 cfs
Storm frequency	=	10 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	6,098 cuft
Drainage area	=	1.400 ac	Curve number	=	73*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.40 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



TR55 Tc Worksheet

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

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	239.00	175.00				
Watercourse slope (%)	= 6.40	11.00	6.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.08	5.35	3.95				
Travel Time (min)	= 1.85	+	0.74	+	0.74	=	3.33
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	= 0.025	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				14.40 min			

Hydrograph Report

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

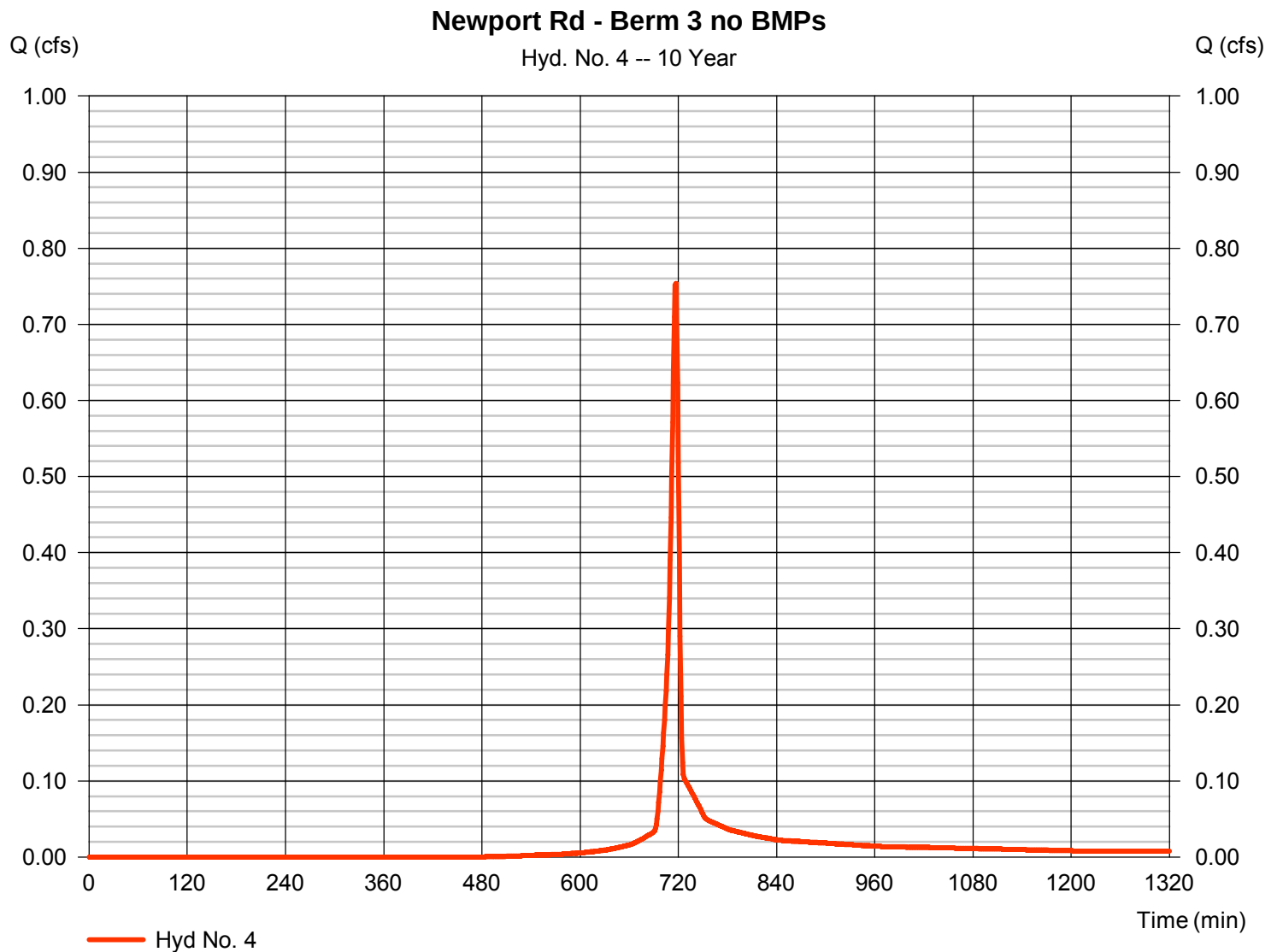
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.754 cfs
Storm frequency	=	10 yrs	Time to peak	=	717 min
Time interval	=	1 min	Hyd. volume	=	1,436 cuft
Drainage area	=	0.210 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.60 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.130 \times 78) + (0.080 \times 91)] / 0.210$



TR55 Tc Worksheet

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

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	94.00	0.00				
Watercourse slope (%)	= 5.50	8.50	0.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.77	4.70	0.00				
Travel Time (min)	= 0.57	+	0.33	+	0.00	=	0.90
Channel Flow							
X sectional flow area (sqft)	= 2.00	2.00	0.00				
Wetted perimeter (ft)	= 4.47	4.47	0.00				
Channel slope (%)	= 4.49	7.51	0.00				
Manning's n-value	= 0.060	0.025	0.015				
Velocity (ft/s)	=3.07	9.53	0.00				
Flow length (ft)	(0)}89.0	230.0	0.0				
Travel Time (min)	= 0.48	+	0.40	+	0.00	=	0.89
Total Travel Time, Tc				3.60 min			

Hydrograph Report

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

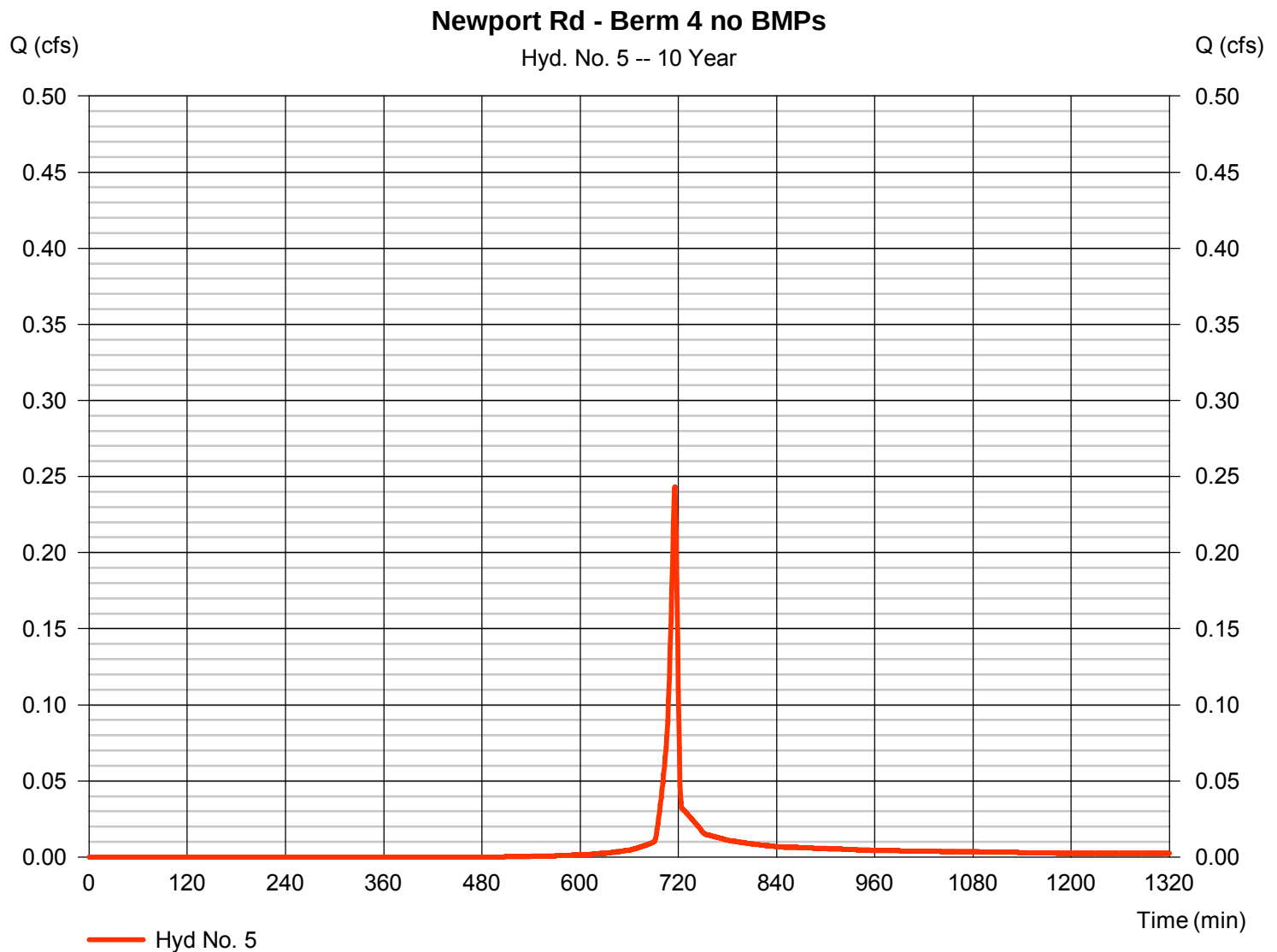
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 0.243 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 431 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.30 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 69.00	0.00	0.00				
Watercourse slope (%)	= 5.90	0.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=3.92	0.00	0.00				
Travel Time (min)	= 0.29	+	0.00	+	0.00	=	0.29
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)200.0	0.0	0.0				
Travel Time (min)	= 0.36	+	0.00	+	0.00	=	0.36
Total Travel Time, Tc				2.30 min			

Hydrograph Report

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

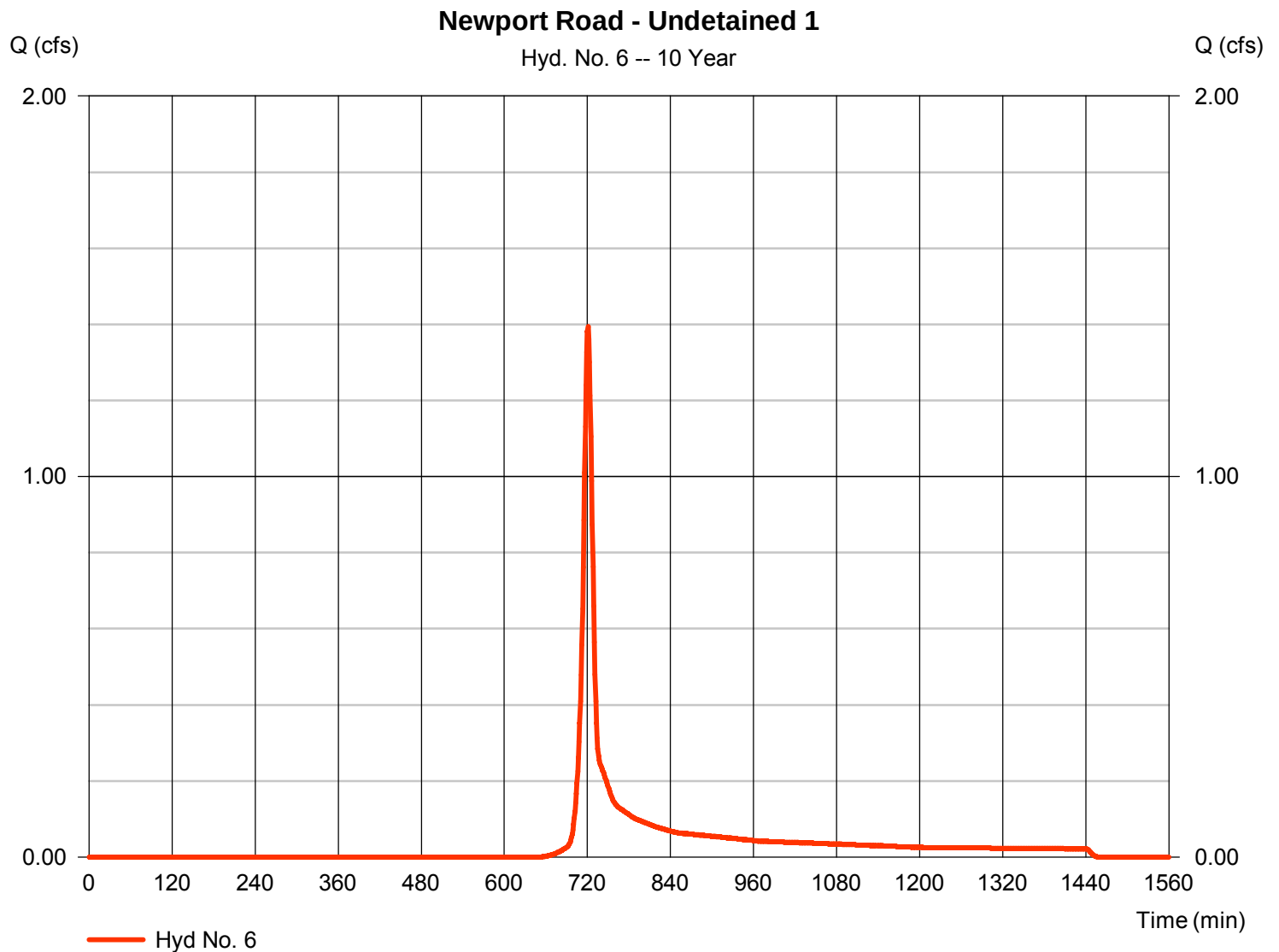
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.394 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 3,456 cuft
Drainage area	= 0.820 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.80 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

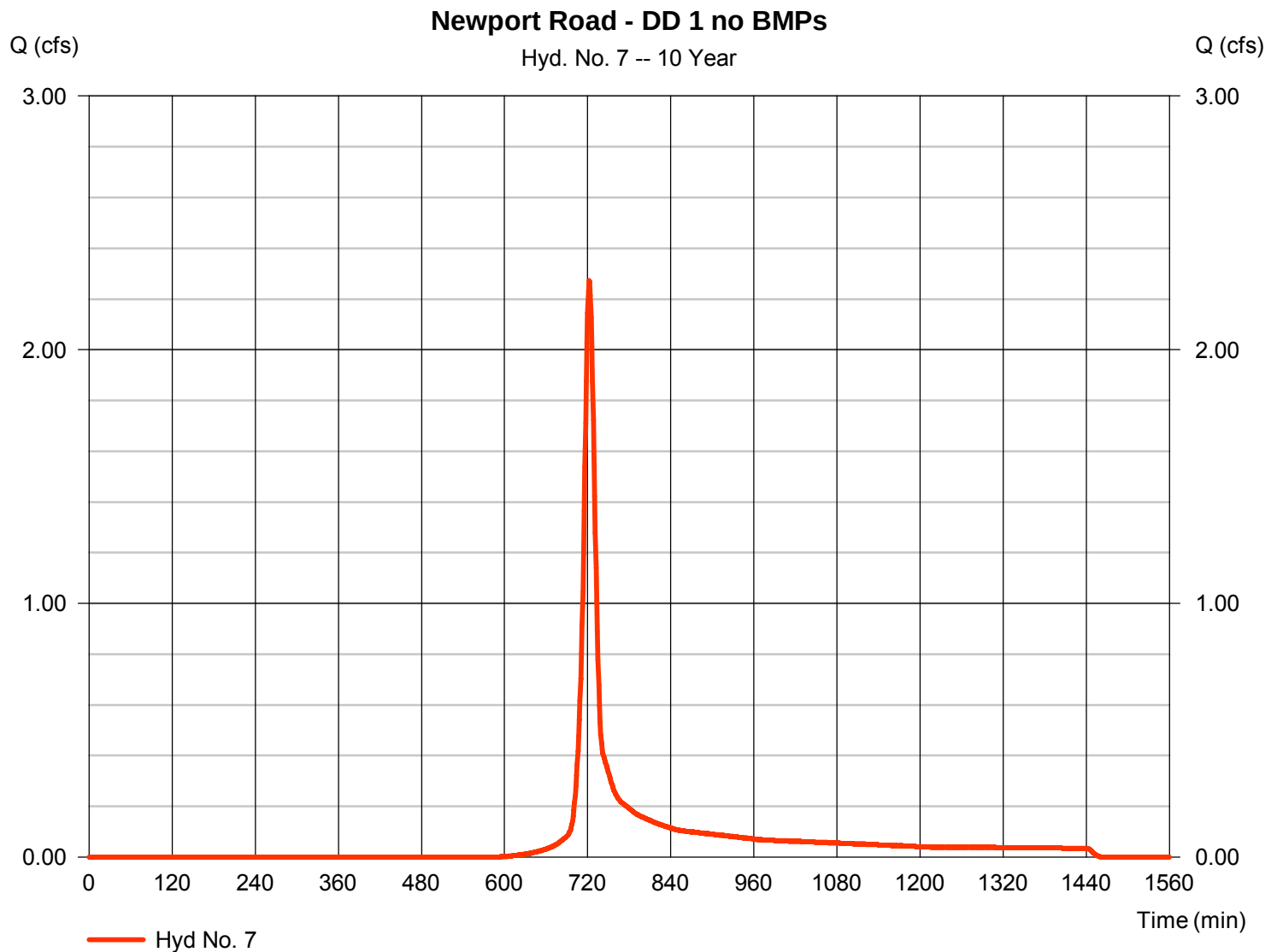
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.272 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	6,170 cuft
Drainage area	=	1.170 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.50 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 1 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

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

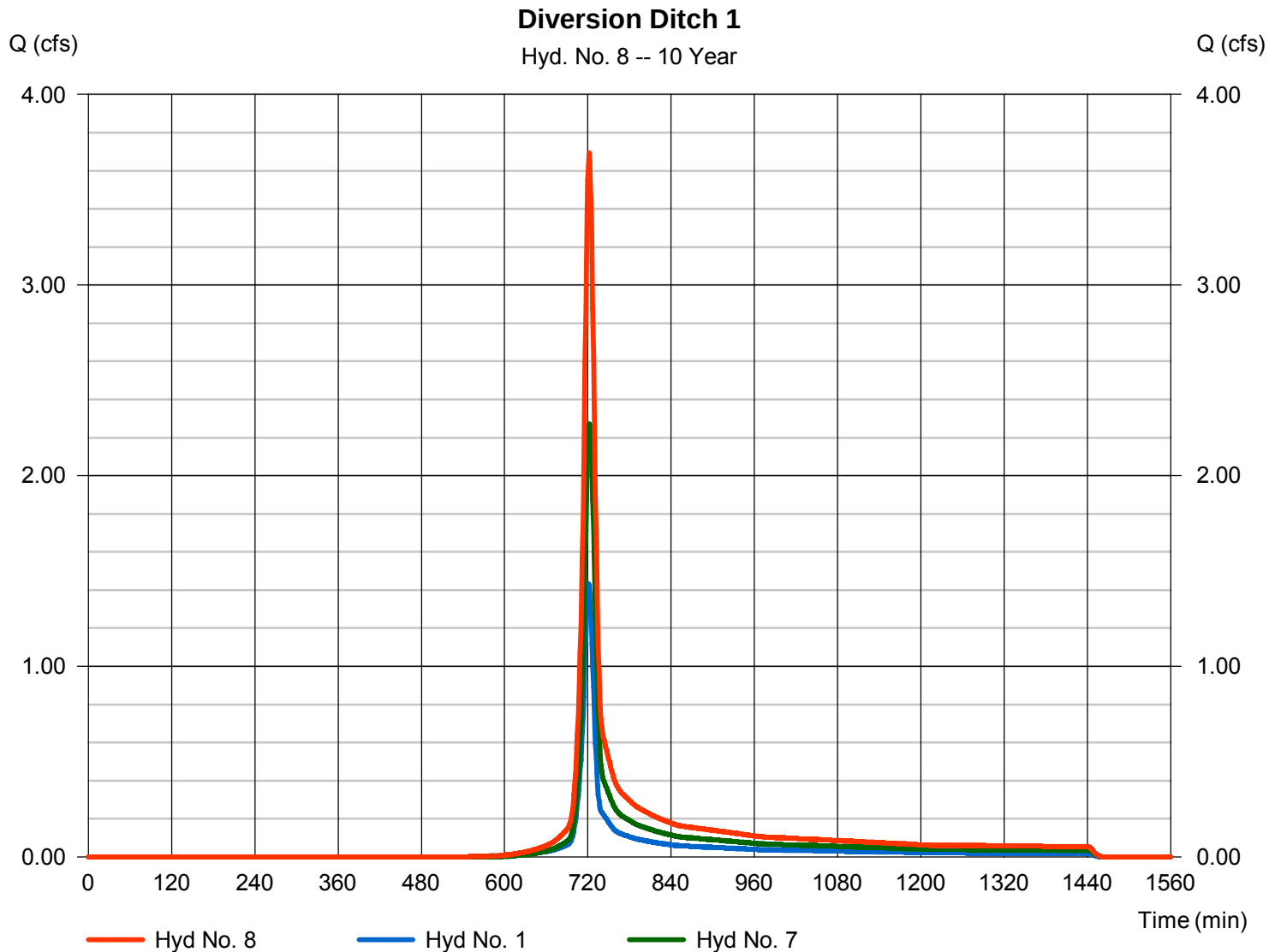
Tuesday, 11 / 15 / 2016

Hyd. No. 8

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 7

Peak discharge = 3.695 cfs
 Time to peak = 722 min
 Hyd. volume = 9,789 cuft
 Contrib. drain. area = 1.780 ac



Hydrograph Report

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

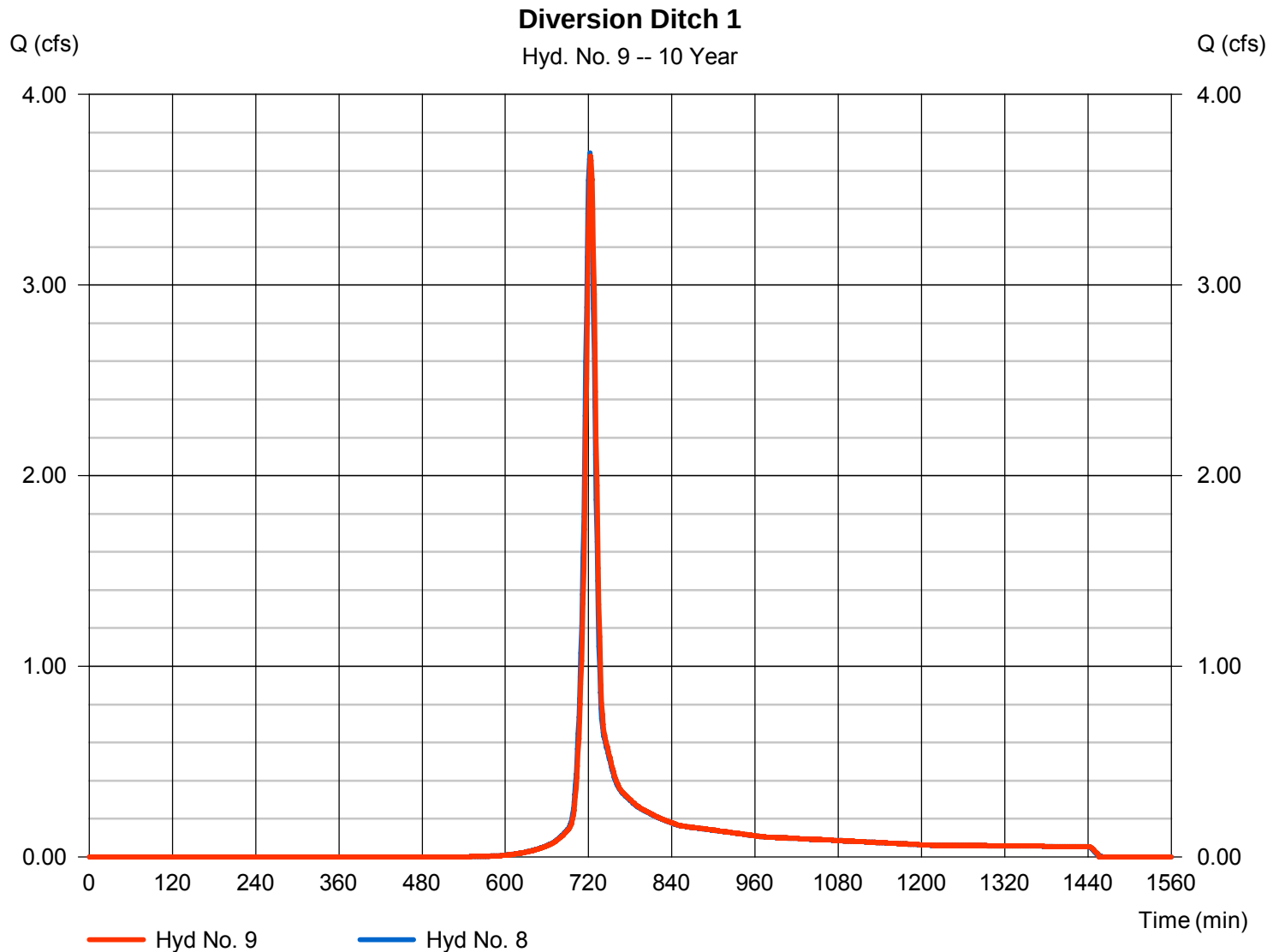
Tuesday, 11 / 15 / 2016

Hyd. No. 9

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 3.677 cfs
Storm frequency	= 10 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 9,787 cuft
Inflow hyd. No.	= 8 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7594

Modified Att-Kin routing method used.



Hydrograph Report

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

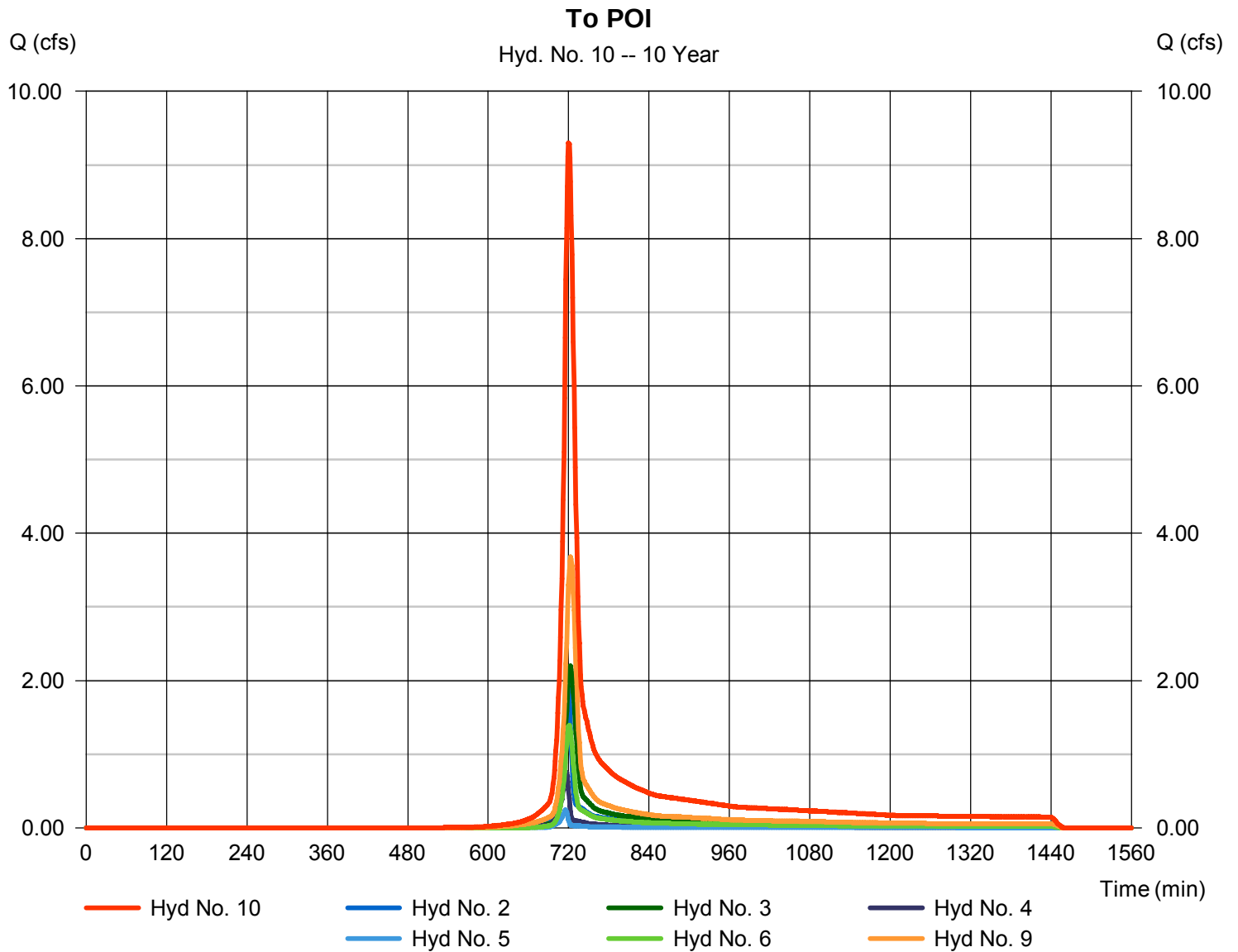
Tuesday, 11 / 15 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 4, 5, 6, 9

Peak discharge = 9.297 cfs
 Time to peak = 720 min
 Hyd. volume = 25,511 cuft
 Contrib. drain. area = 3.300 ac



Hydrograph Report

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

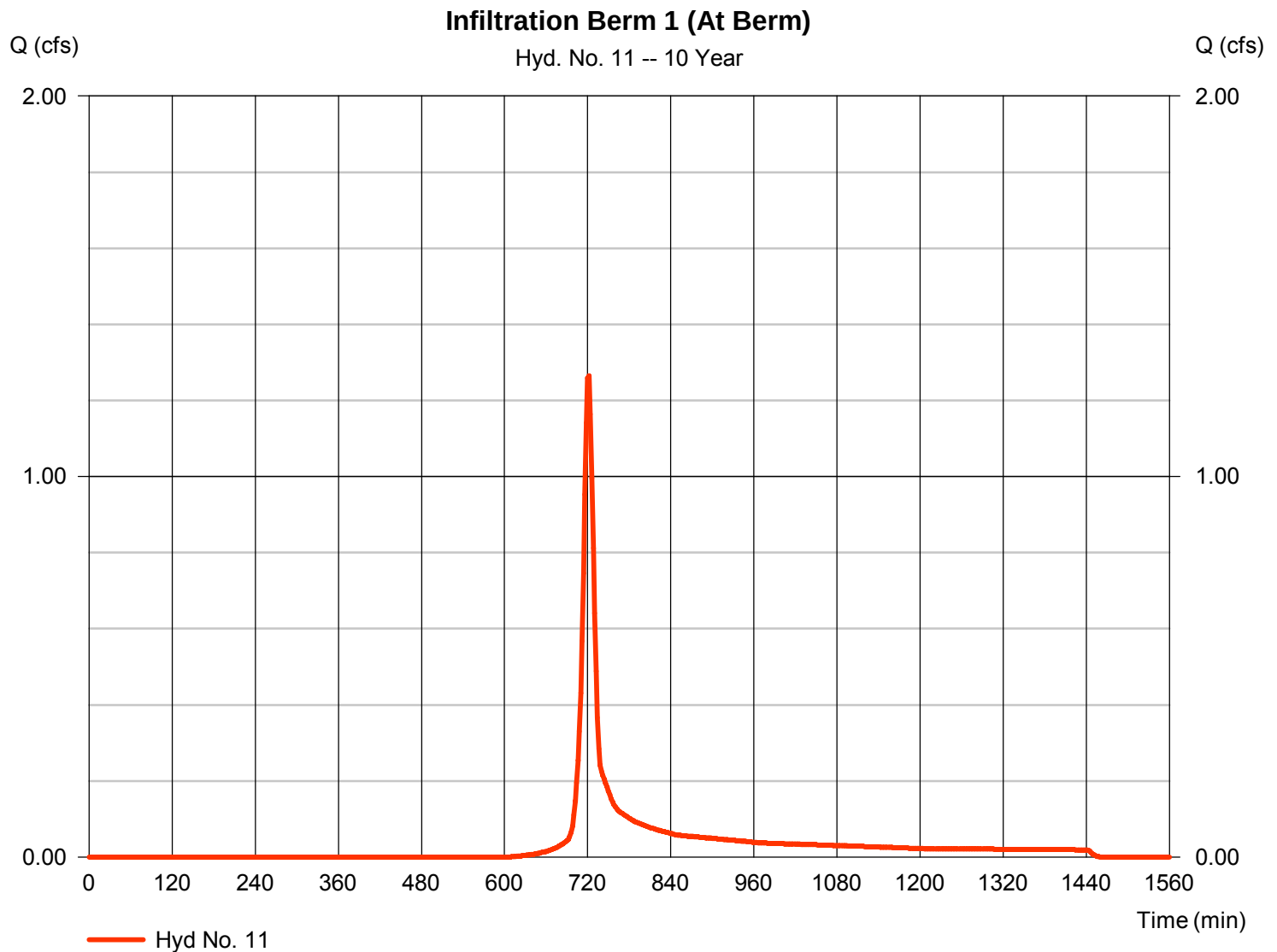
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Infiltration Berm 1 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.265 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 3,323 cuft
Drainage area	= 0.640 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.60 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.130 \times 78) + (0.100 \times 89) + (0.020 \times 91)] / 0.640$



TR55 Tc Worksheet

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

Hyd. No. 11

Infiltration Berm 1 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	69.00				
Watercourse slope (%)	= 8.00	4.80	4.30				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	3.35				
Travel Time (min)	= 0.92	+	0.23	+	0.34	=	1.49
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				12.60 min			

Hydrograph Report

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

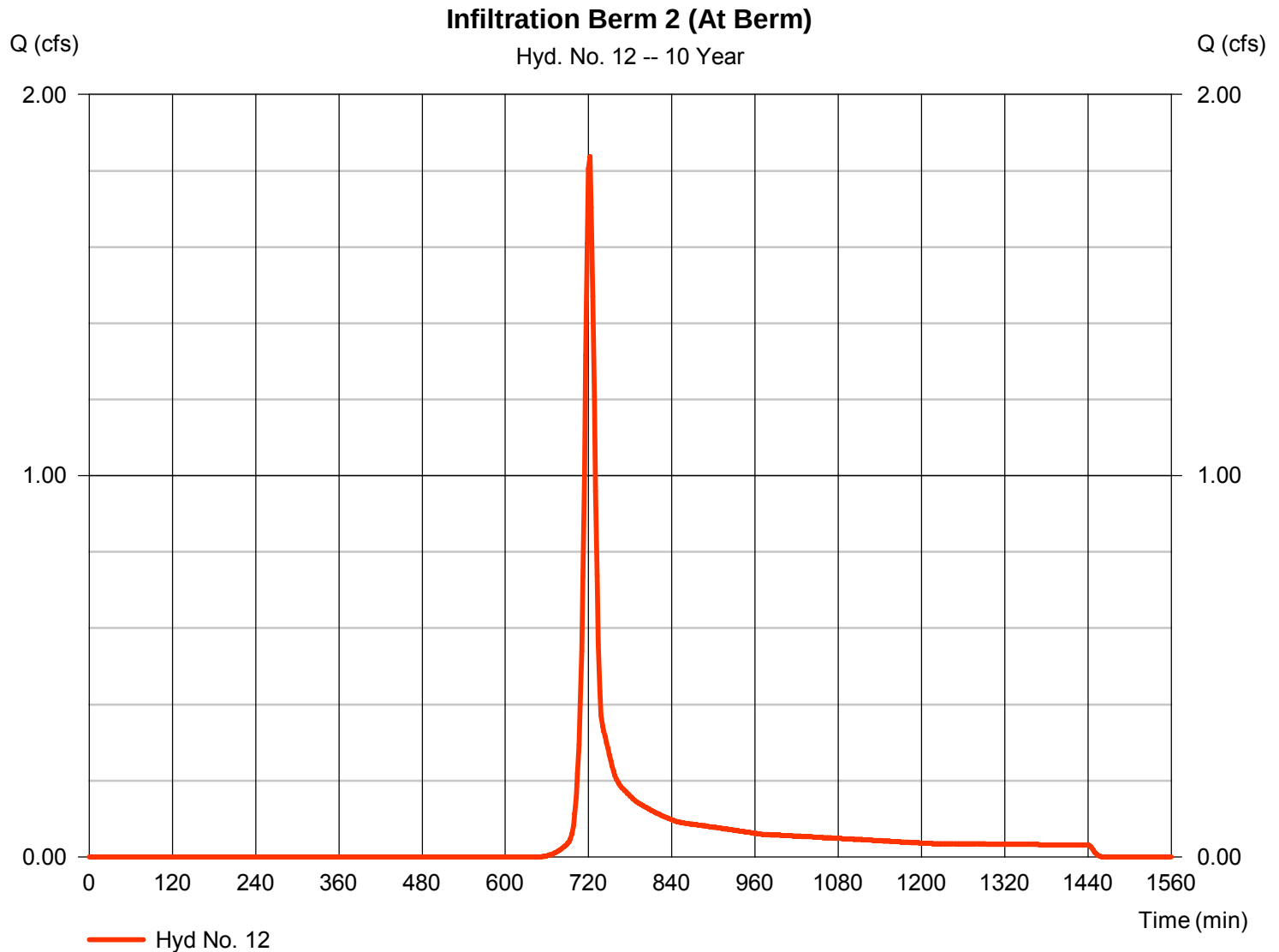
Tuesday, 11 / 15 / 2016

Hyd. No. 12

Infiltration Berm 2 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.836 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 4,910 cuft
Drainage area	= 1.150 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.90 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.030 \times 71) + (0.070 \times 78) + (0.050 \times 89)] / 1.150$



TR55 Tc Worksheet

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

Hyd. No. 12

Infiltration Berm 2 (At Berm)

<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)	= 2.51	2.51	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
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				12.90 min			

Hydrograph Report

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

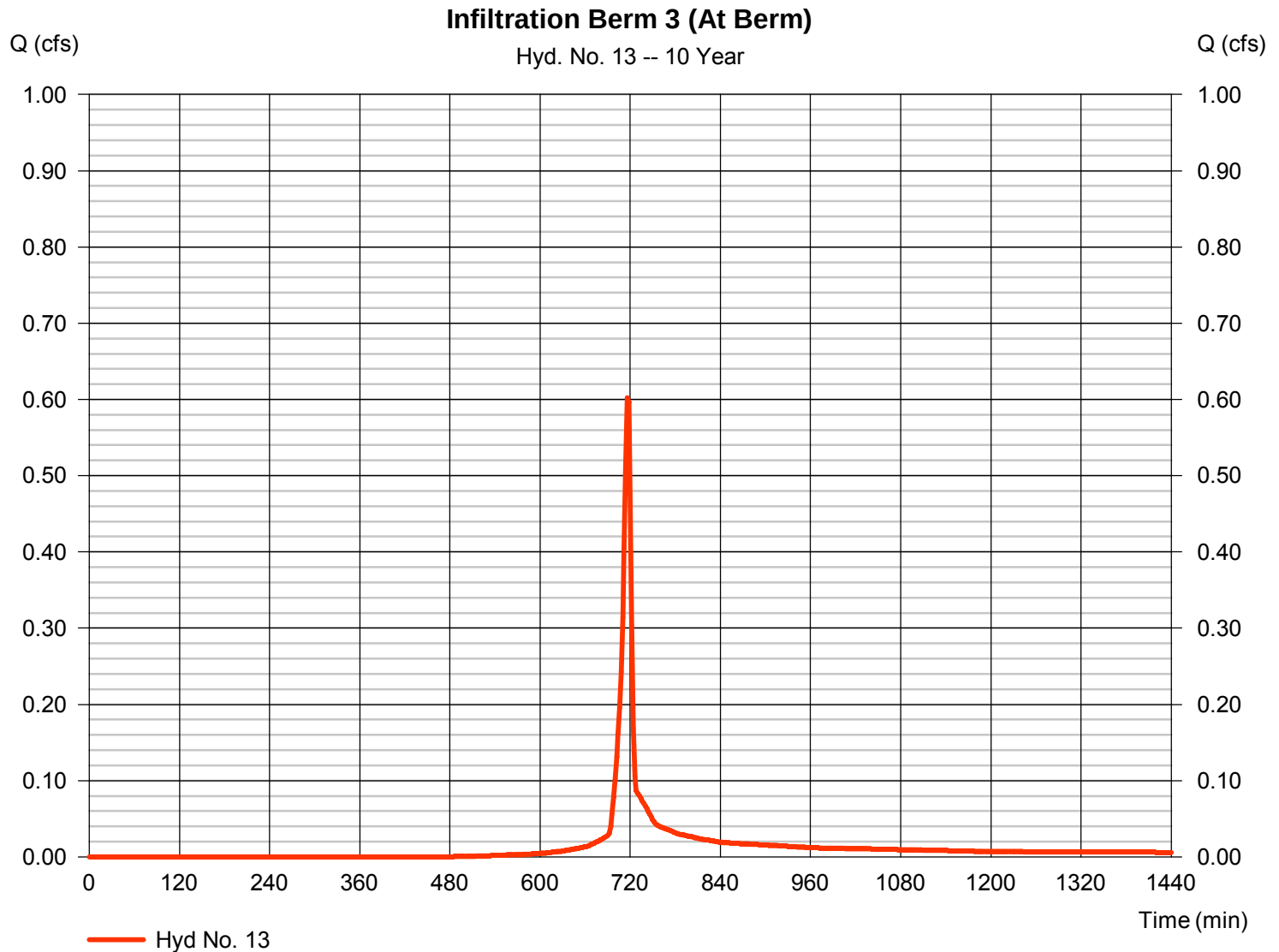
Tuesday, 11 / 15 / 2016

Hyd. No. 13

Infiltration Berm 3 (At Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.602 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	1,218 cuft
Drainage area	=	0.190 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.10 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.110 \times 78) + (0.080 \times 91)] / 0.190$



TR55 Tc Worksheet

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

Hyd. No. 13

Infiltration Berm 3 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	46.00	0.00				
Watercourse slope (%)	= 5.50	6.50	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.77	4.11	0.00				
Travel Time (min)	= 0.57	+	0.19	+	0.00	=	0.76
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 4.49	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.07	0.00	0.00				
Flow length (ft)	({0})89.0	0.0	0.0				
Travel Time (min)	= 0.48	+	0.00	+	0.00	=	0.48
Total Travel Time, Tc				3.10 min			

Hydrograph Report

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

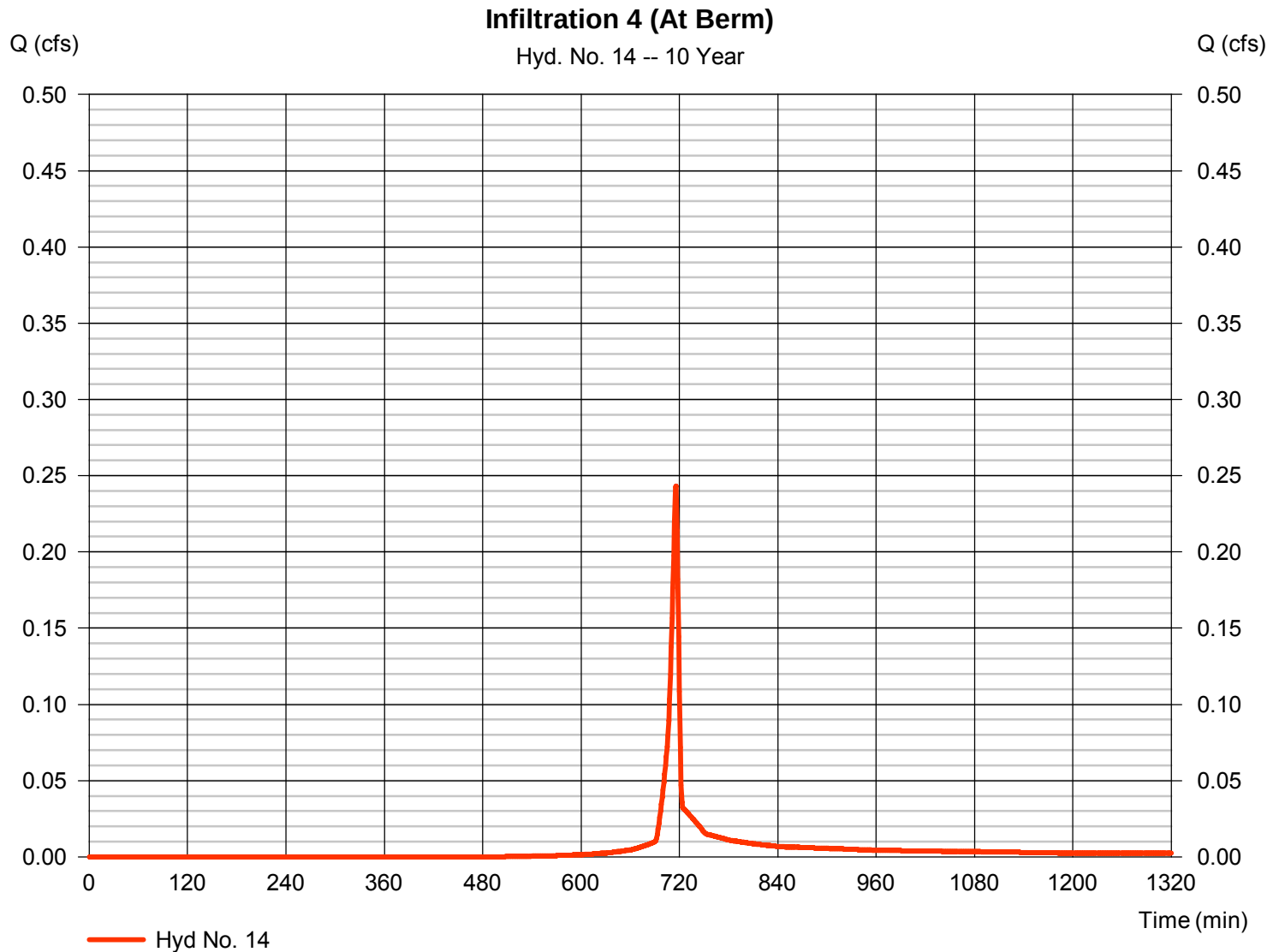
Tuesday, 11 / 15 / 2016

Hyd. No. 14

Infiltration 4 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.243 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 431 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.90 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

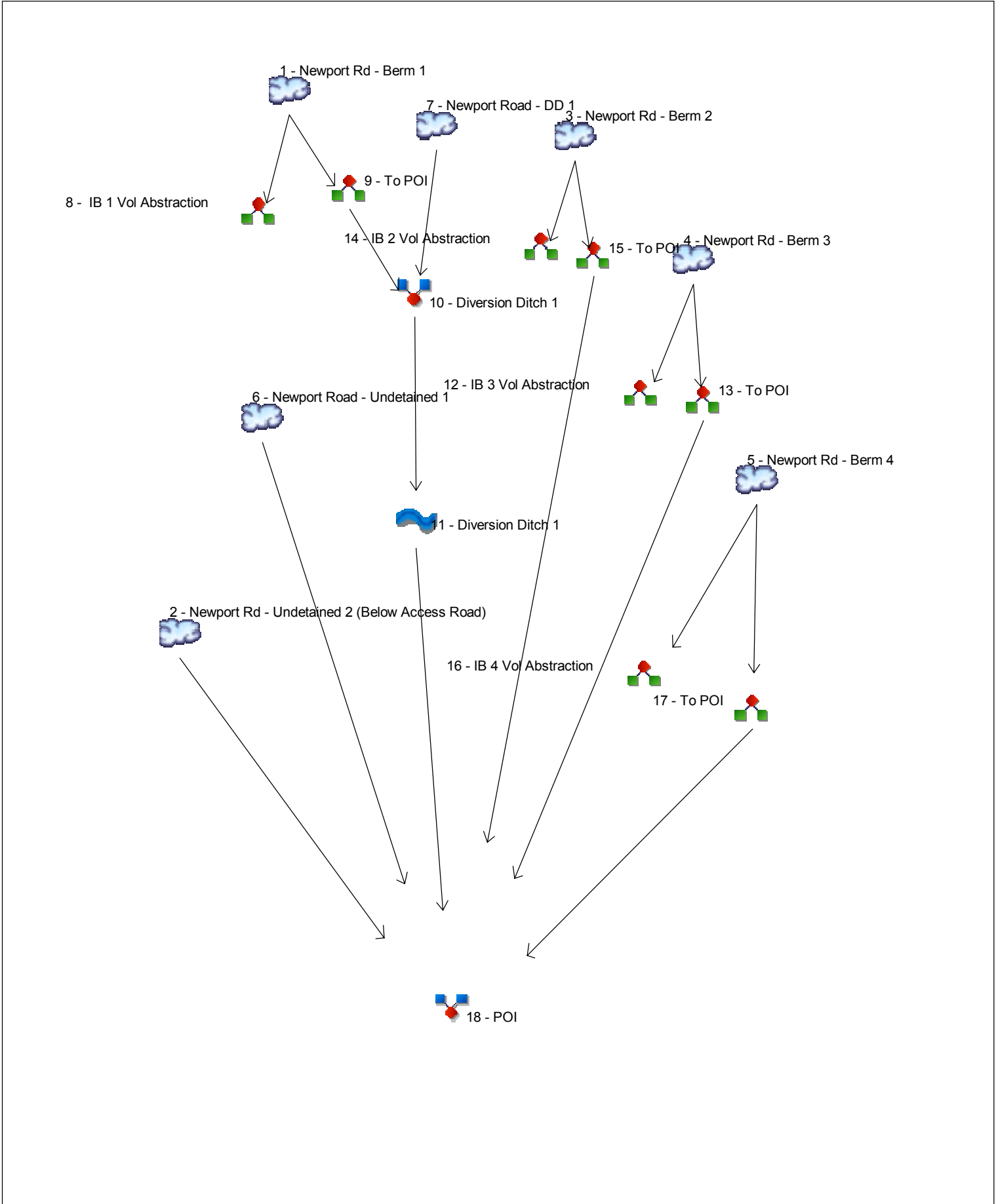
Hyd. No. 14

Infiltration 4 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 54.00	0.00	0.00				
Watercourse slope (%)	= 7.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.39	0.00	0.00				
Travel Time (min)	= 0.21	+	0.00	+	0.00	=	0.21
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				1.90 min			

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.558	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	-----	-----	-----	-----	-----	2.041	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	-----	-----	-----	-----	-----	1.961	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	-----	-----	-----	-----	-----	0.347	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	-----	-----	-----	-----	-----	0.193	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	-----	-----	-----	-----	-----	1.394	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	-----	-----	-----	2.272	-----	-----	-----	Newport Road - DD 1
8	Diversion1	1	-----	-----	-----	-----	1.558	-----	-----	-----	IB 1 Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	1.398	-----	-----	-----	To POI
10	Combine	7, 9	-----	-----	-----	-----	2.677	-----	-----	-----	Diversion Ditch 1
11	Reach	10	-----	-----	-----	-----	2.456	-----	-----	-----	Diversion Ditch 1
12	Diversion1	4	-----	-----	-----	-----	0.347	-----	-----	-----	IB 3 Vol Abstraction
13	Diversion2	4	-----	-----	-----	-----	0.013	-----	-----	-----	To POI
14	Diversion1	3	-----	-----	-----	-----	1.961	-----	-----	-----	IB 2 Vol Abstraction
15	Diversion2	3	-----	-----	-----	-----	1.878	-----	-----	-----	To POI
16	Diversion1	5	-----	-----	-----	-----	0.193	-----	-----	-----	IB 4 Vol Abstraction
17	Diversion2	5	-----	-----	-----	-----	0.014	-----	-----	-----	To POI
18	Combine	2, 6, 11, 13, 15, 17	-----	-----	-----	-----	5.348	-----	-----	-----	POI
Proj. file: Newport Rd wBMP-10yr.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	1.558	1	727	5,218	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	2.041	1	719	4,304	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	1.961	1	725	6,028	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	0.347	1	732	1,445	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	0.193	1	720	467	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	1.394	1	721	3,456	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	2.272	1	722	6,170	-----	-----	-----	Newport Road - DD 1
8	Diversion1	1.558	1	727	1,657	1	-----	-----	IB 1 Vol Abstraction
9	Diversion2	1.398	1	731	3,561	1	-----	-----	To POI
10	Combine	2.677	1	731	9,731	7, 9	-----	-----	Diversion Ditch 1
11	Reach	2.456	1	733	9,728	10	-----	-----	Diversion Ditch 1
12	Diversion1	0.347	1	732	1,218	4	-----	-----	IB 3 Vol Abstraction
13	Diversion2	0.013	1	1036	227	4	-----	-----	To POI
14	Diversion1	1.961	1	725	1,557	3	-----	-----	IB 2 Vol Abstraction
15	Diversion2	1.878	1	727	4,472	3	-----	-----	To POI
16	Diversion1	0.193	1	720	288	5	-----	-----	IB 4 Vol Abstraction
17	Diversion2	0.014	1	771	180	5	-----	-----	To POI
18	Combine	5.348	1	727	22,366	2, 6, 11, 13, 15, 17	-----	-----	POI
Newport Rd wBMP-10yr.gpw					Return Period: 10 Year			Tuesday, 11 / 15 / 2016	

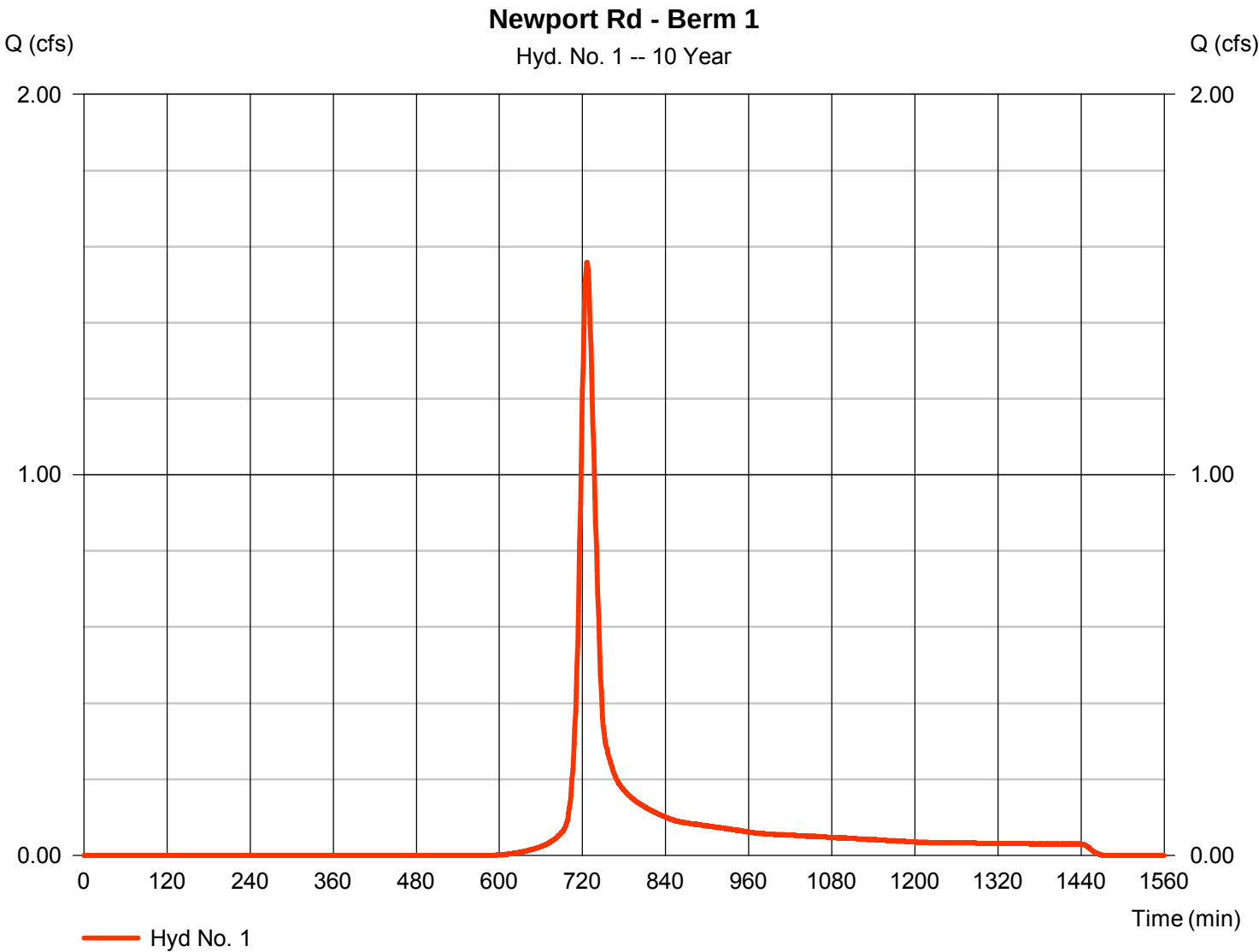
Hydrograph Report

Hyd. No. 1

Newport Rd - Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.558 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 5,218 cuft
Drainage area	= 0.980 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 21.00 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.390 x 71) + (0.460 x 78) + (0.100 x 89) + (0.030 x 91)] / 0.980



Hydrograph Report

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

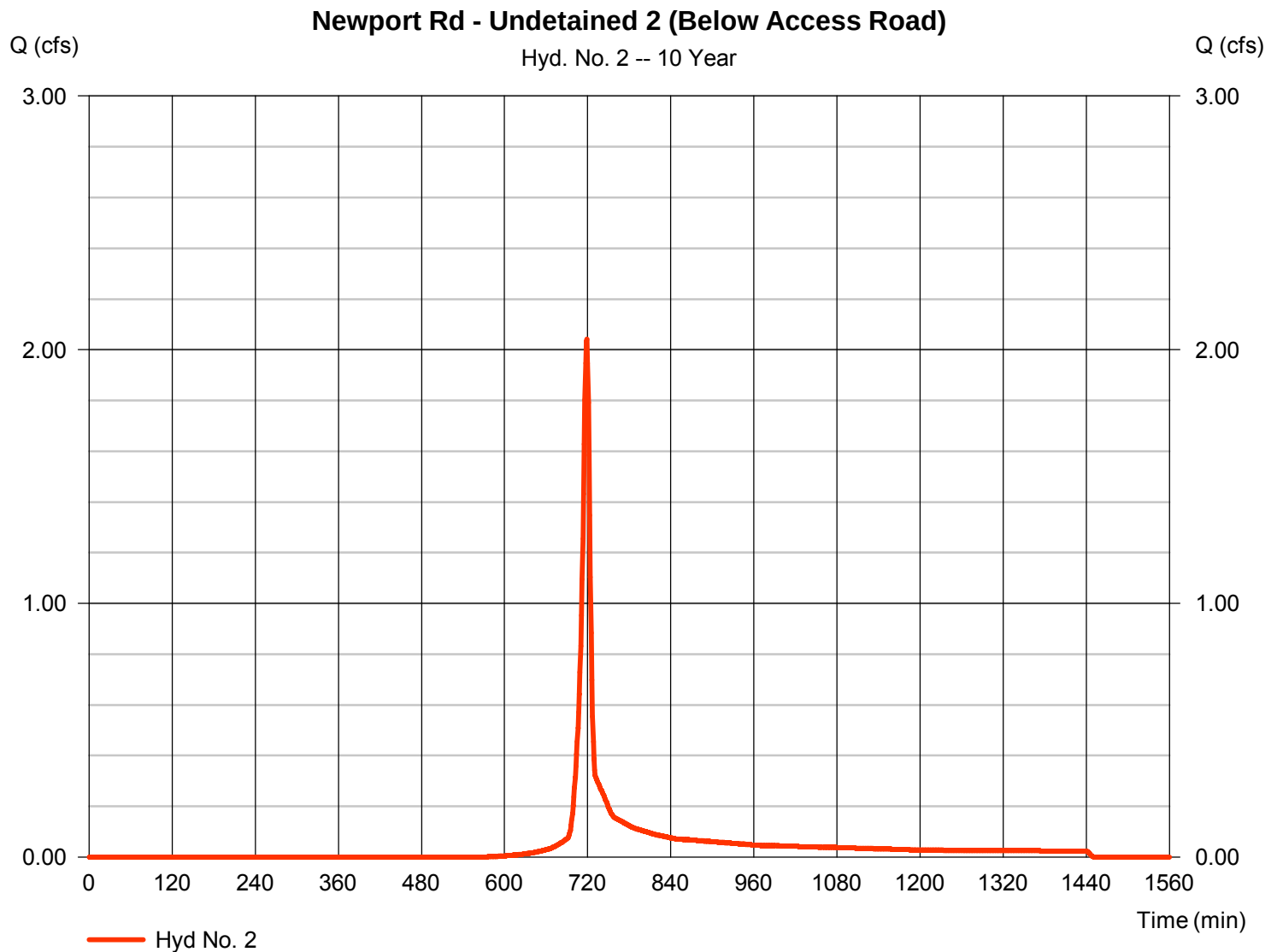
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.041 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 4,304 cuft
Drainage area	= 0.800 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.70 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc				6.70 min			

Hydrograph Report

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

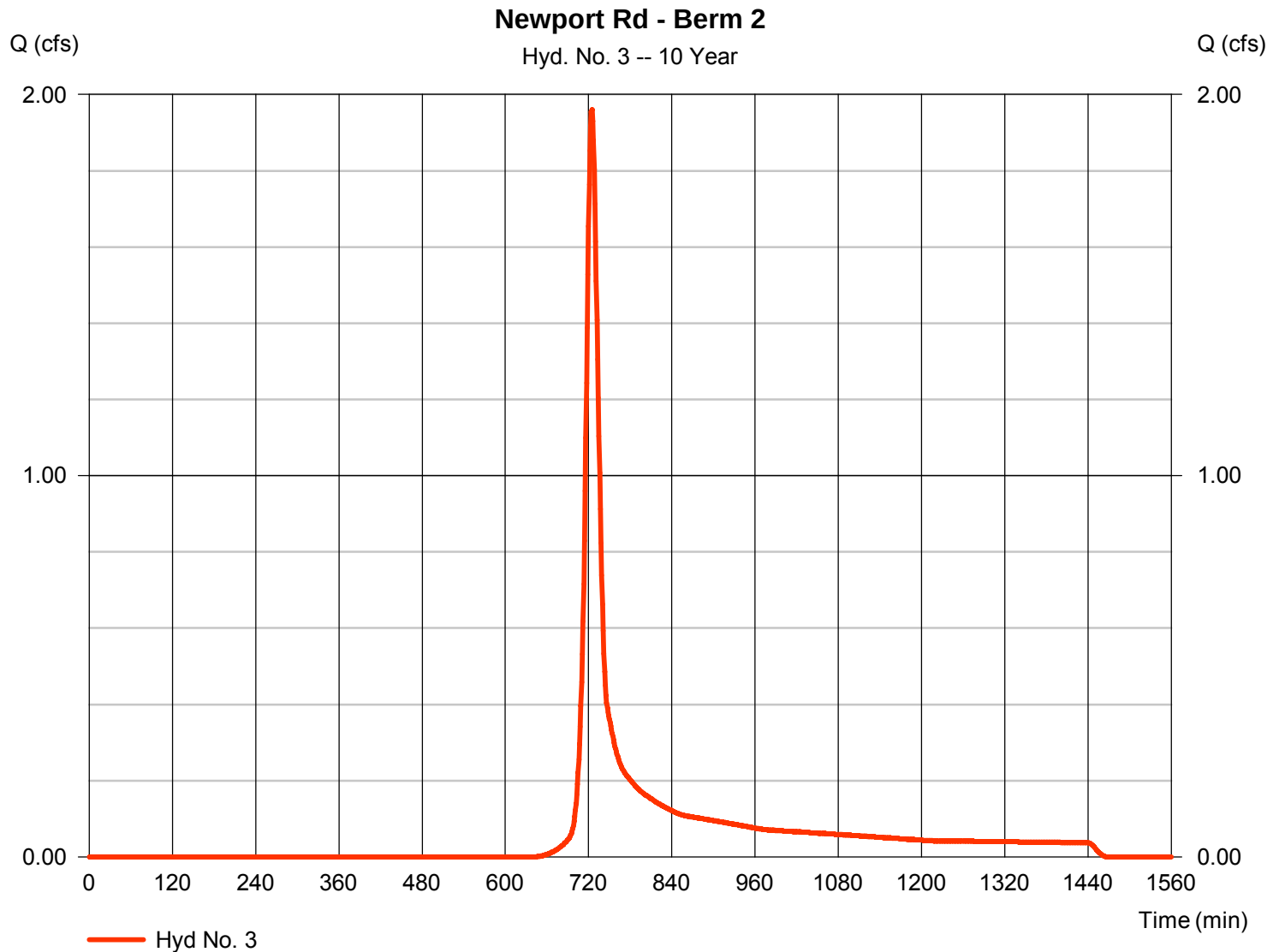
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 1.961 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 6,028 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.80 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



Hydrograph Report

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

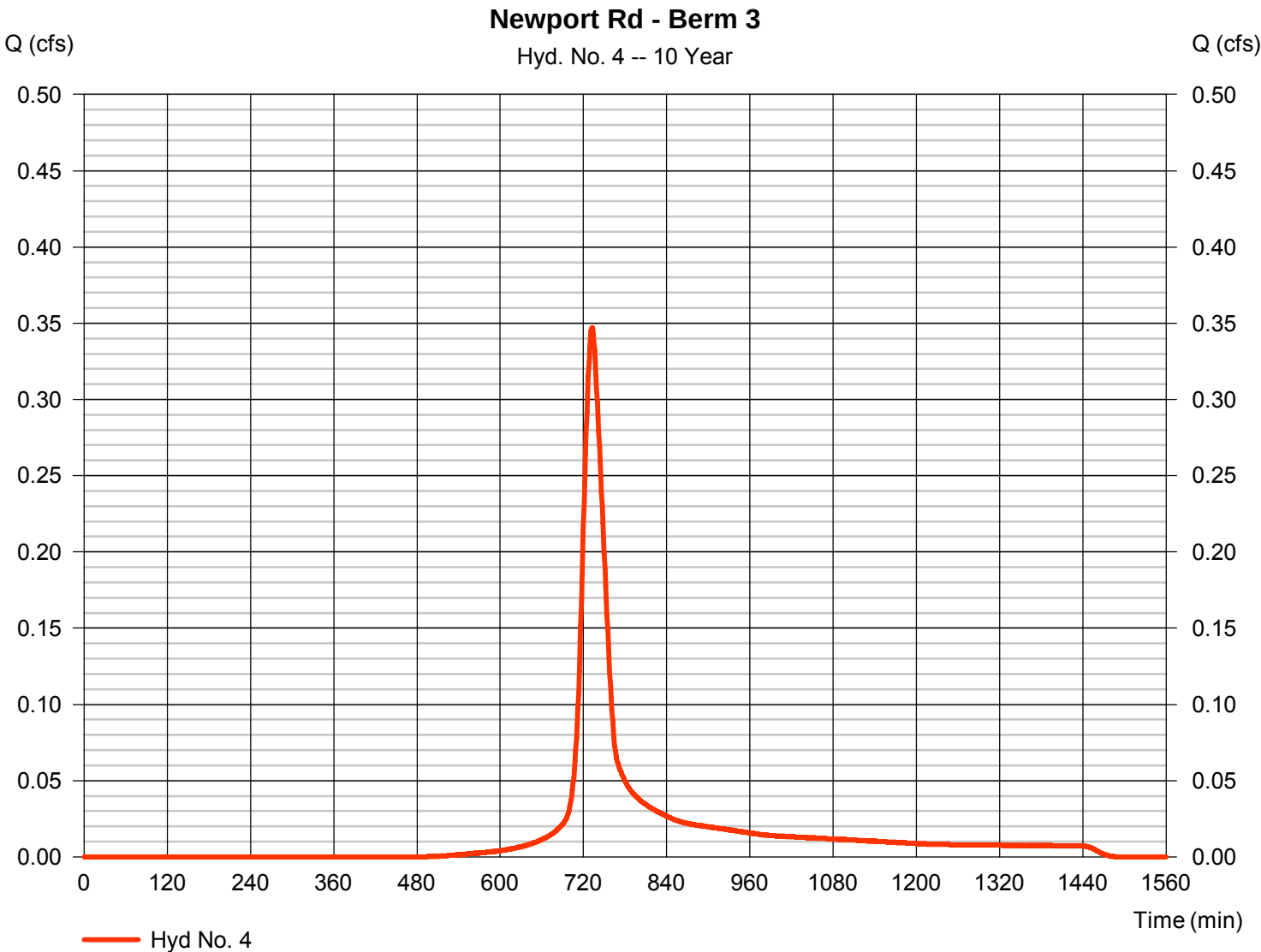
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3

Hydrograph type	= SCS Runoff	Peak discharge	= 0.347 cfs
Storm frequency	= 10 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 1,445 cuft
Drainage area	= 0.210 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 30.60 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 78) + (0.080 x 91)] / 0.210



Hydrograph Report

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

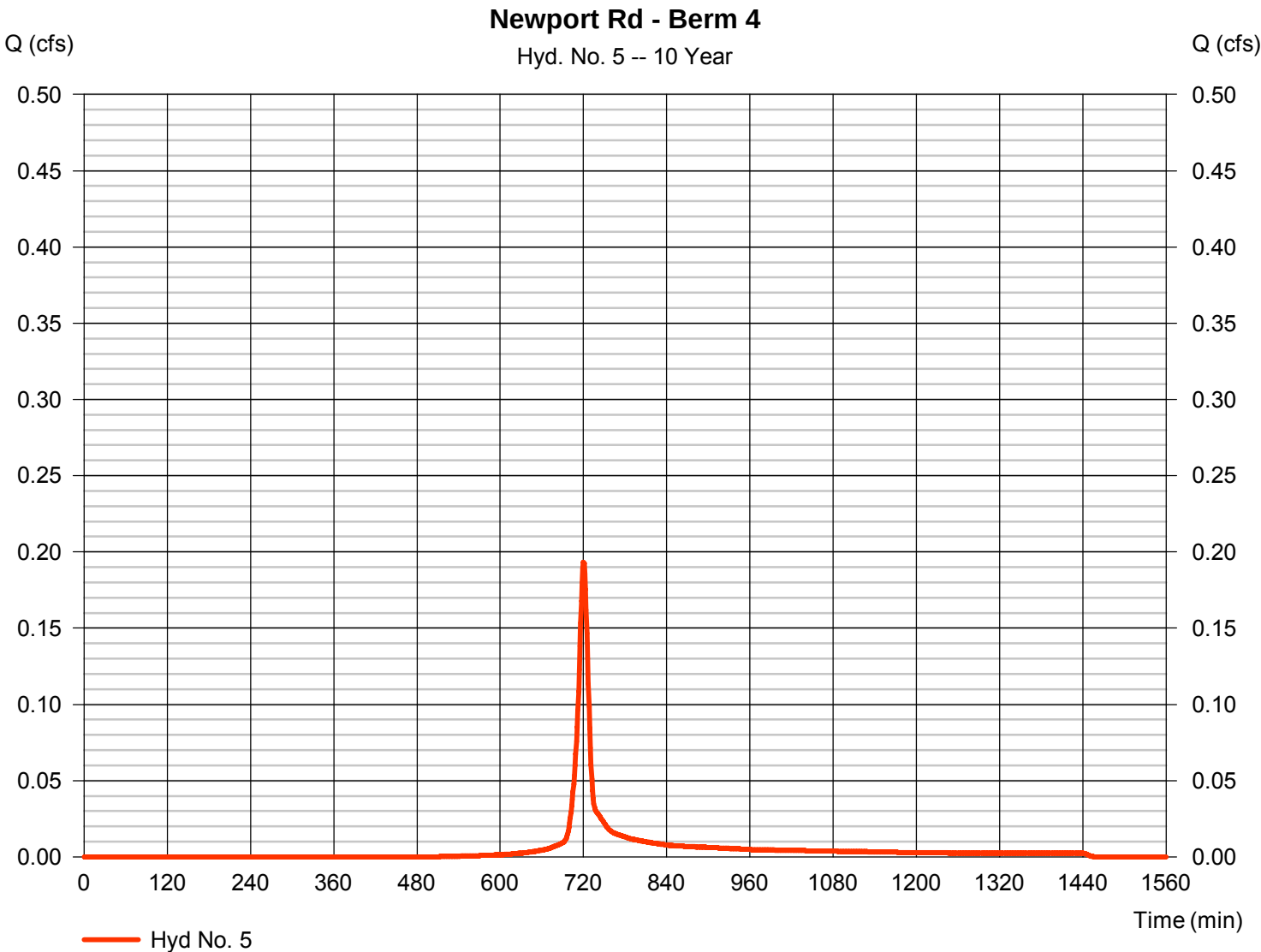
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.193 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	467 cuft
Drainage area	=	0.070 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.40 min
Total precip.	=	3.53 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.050 x 78) + (0.020 x 91)] / 0.070



Hydrograph Report

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

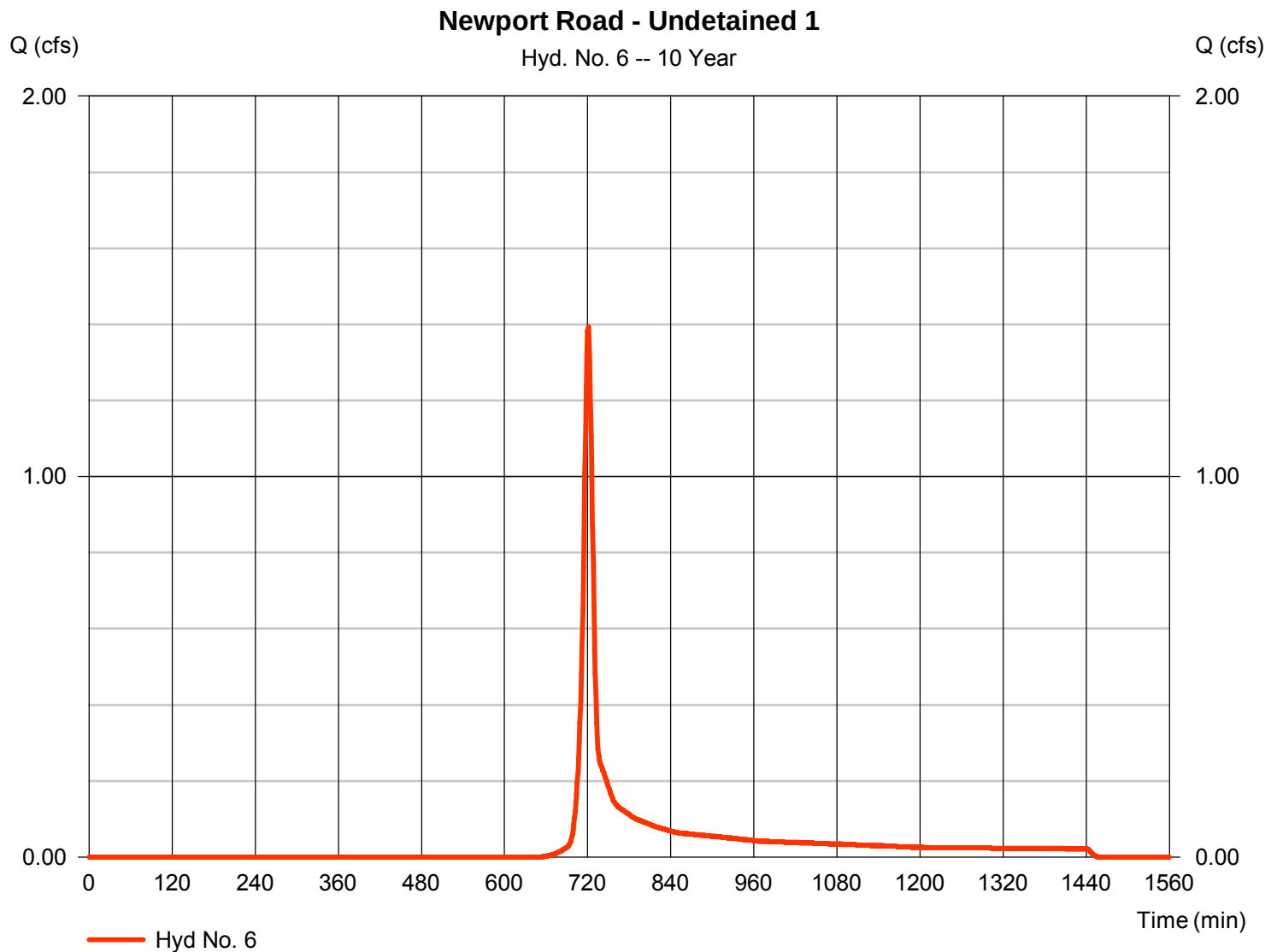
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.394 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 3,456 cuft
Drainage area	= 0.820 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.80 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

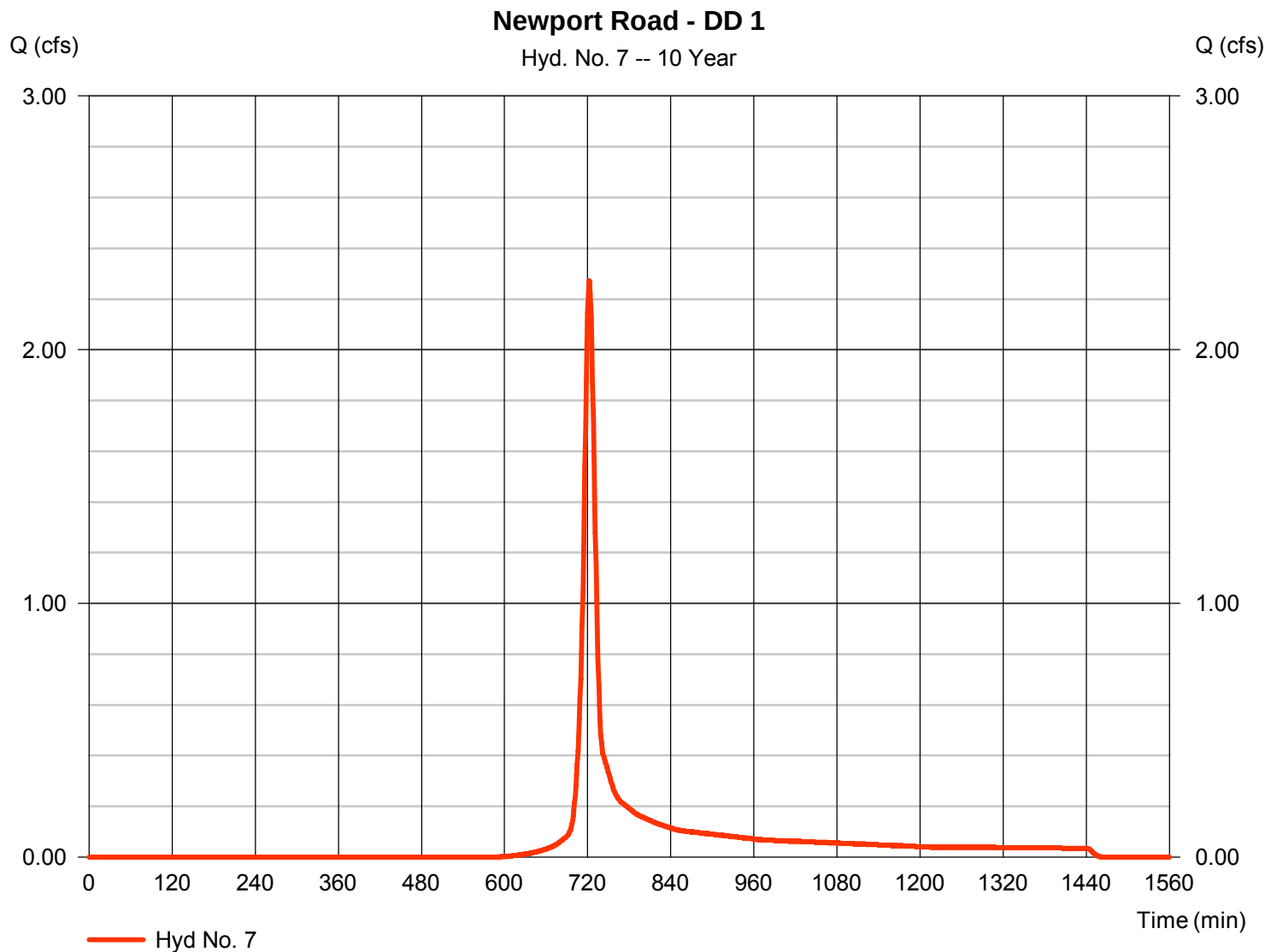
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.272 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 6,170 cuft
Drainage area	= 1.170 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 3.53 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

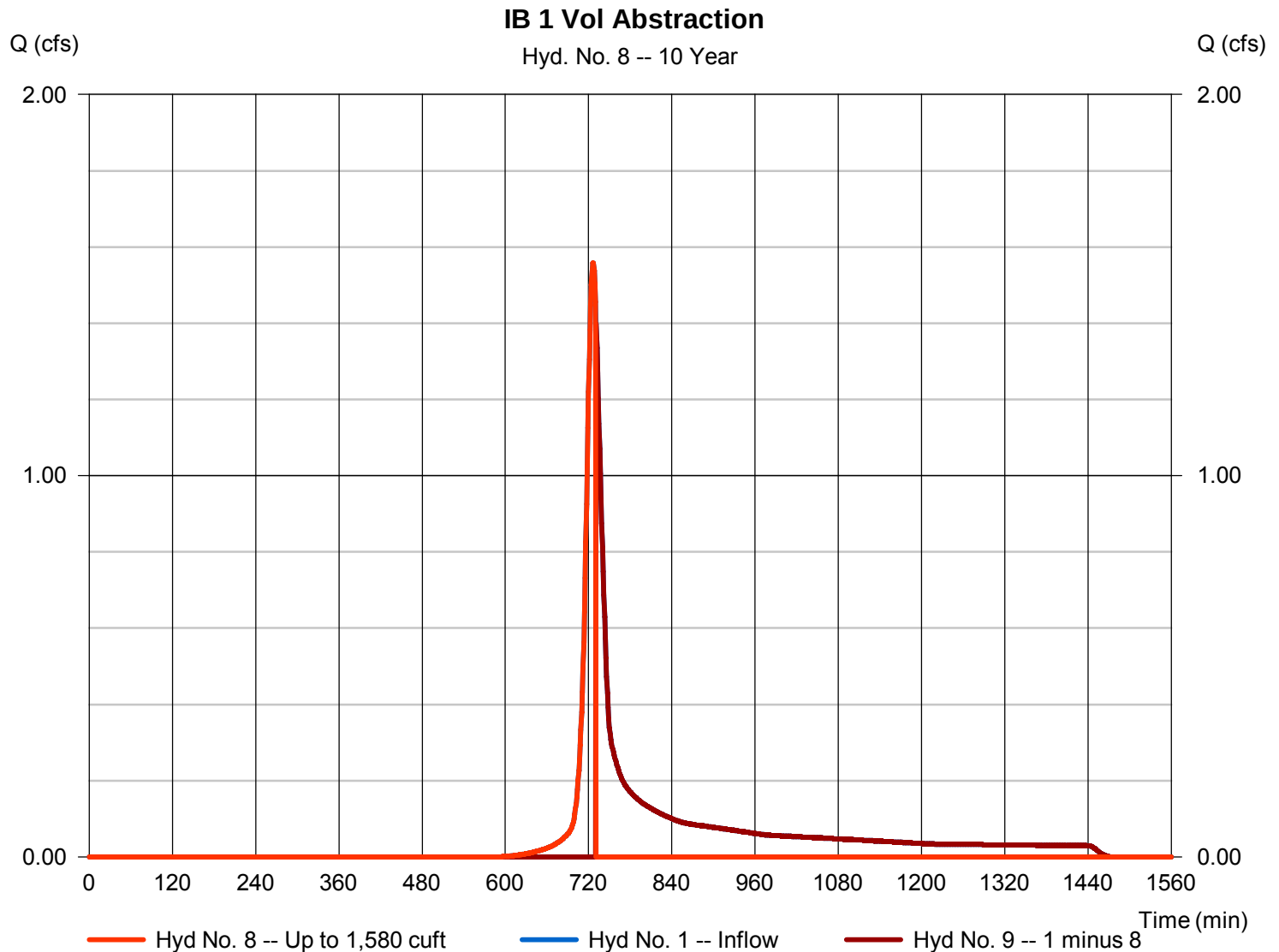
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 8

IB 1 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.558 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 1,657 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 9
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

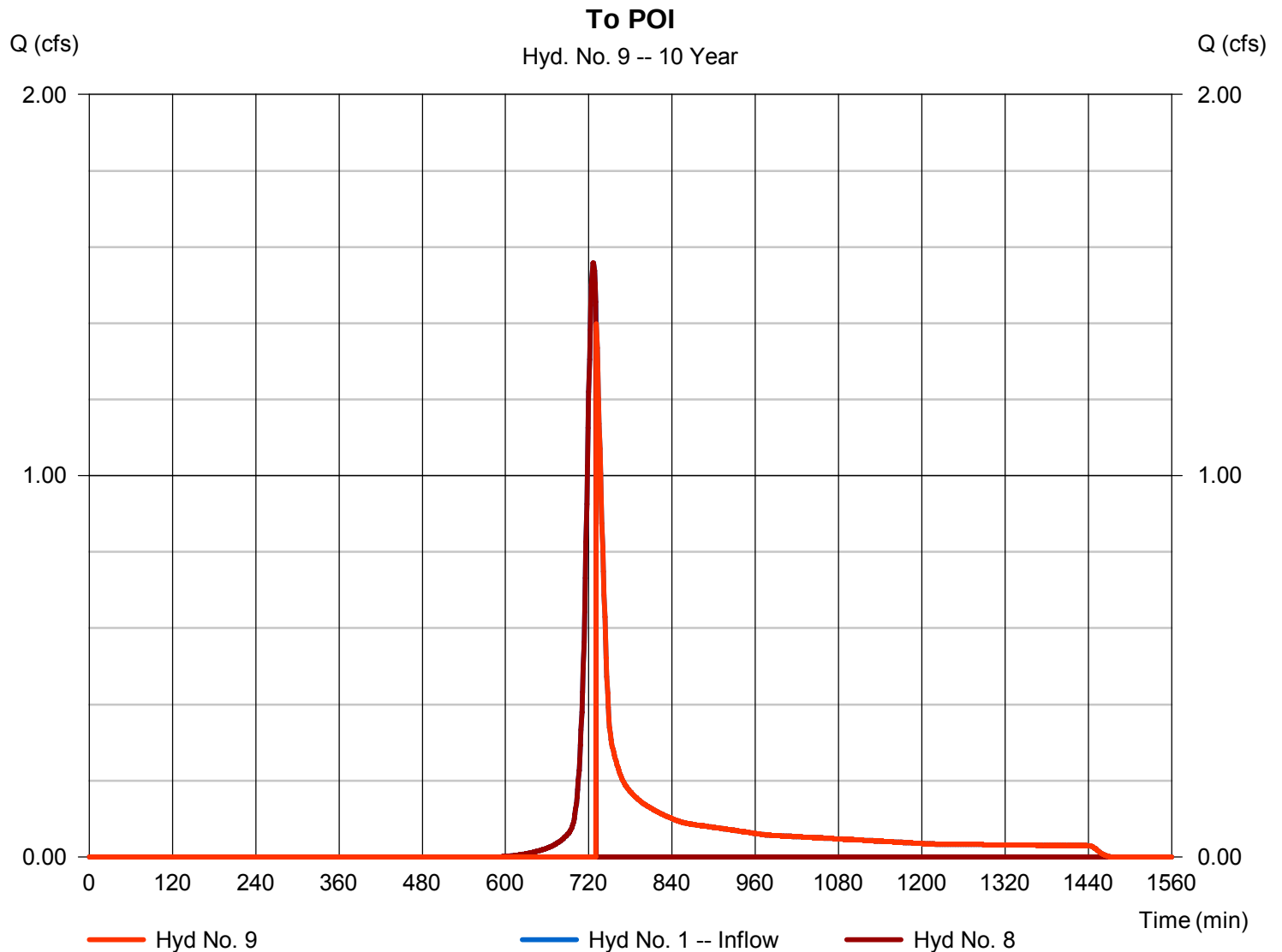
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 9

To POI

Hydrograph type	= Diversion2	Peak discharge	= 1.398 cfs
Storm frequency	= 10 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 3,561 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 8
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

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

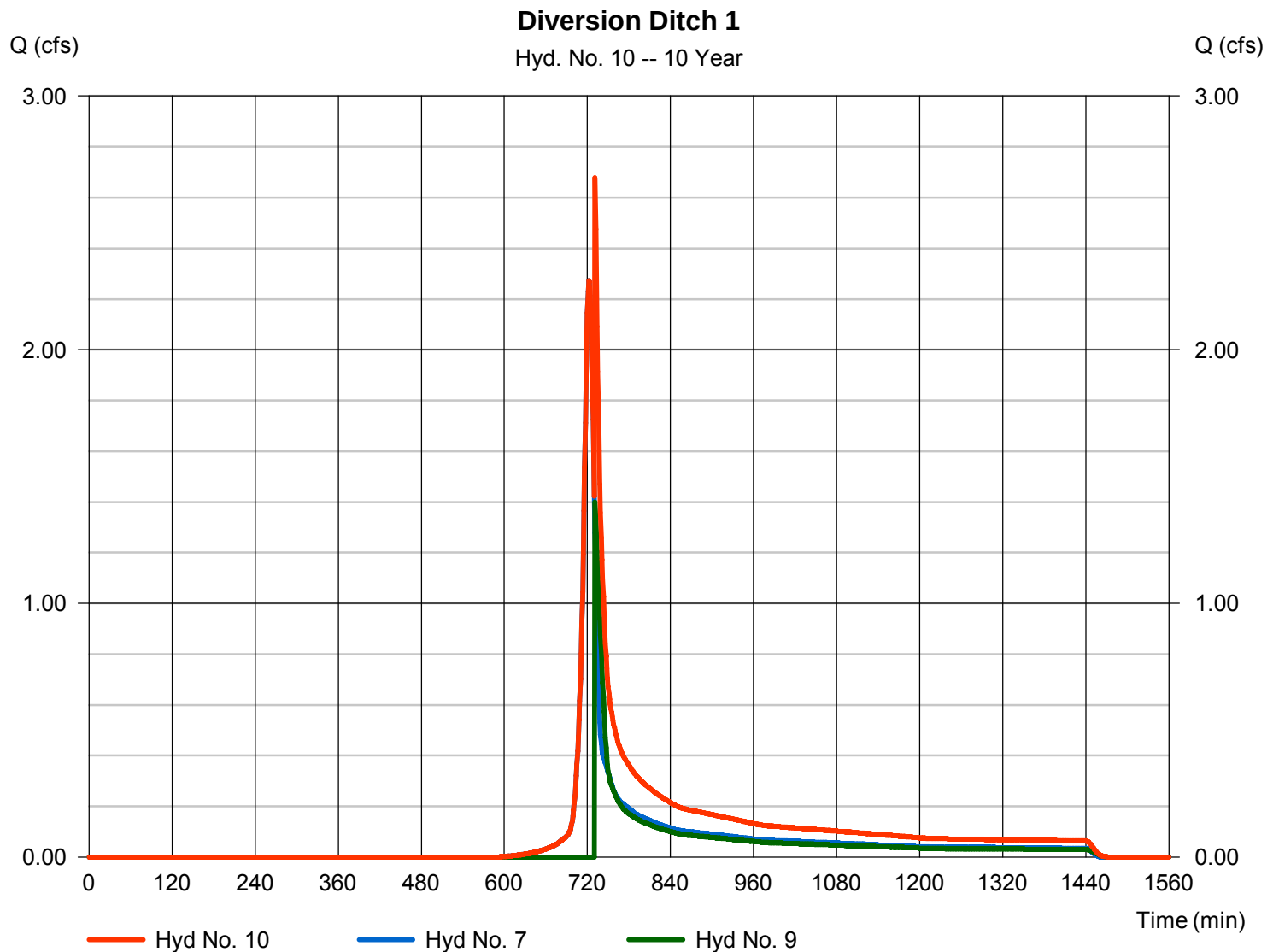
Tuesday, 11 / 15 / 2016

Hyd. No. 10

Diversion Ditch 1

Hydrograph type = Combine
Storm frequency = 10 yrs
Time interval = 1 min
Inflow hyds. = 7, 9

Peak discharge = 2.677 cfs
Time to peak = 731 min
Hyd. volume = 9,731 cuft
Contrib. drain. area = 1.170 ac



Hydrograph Report

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

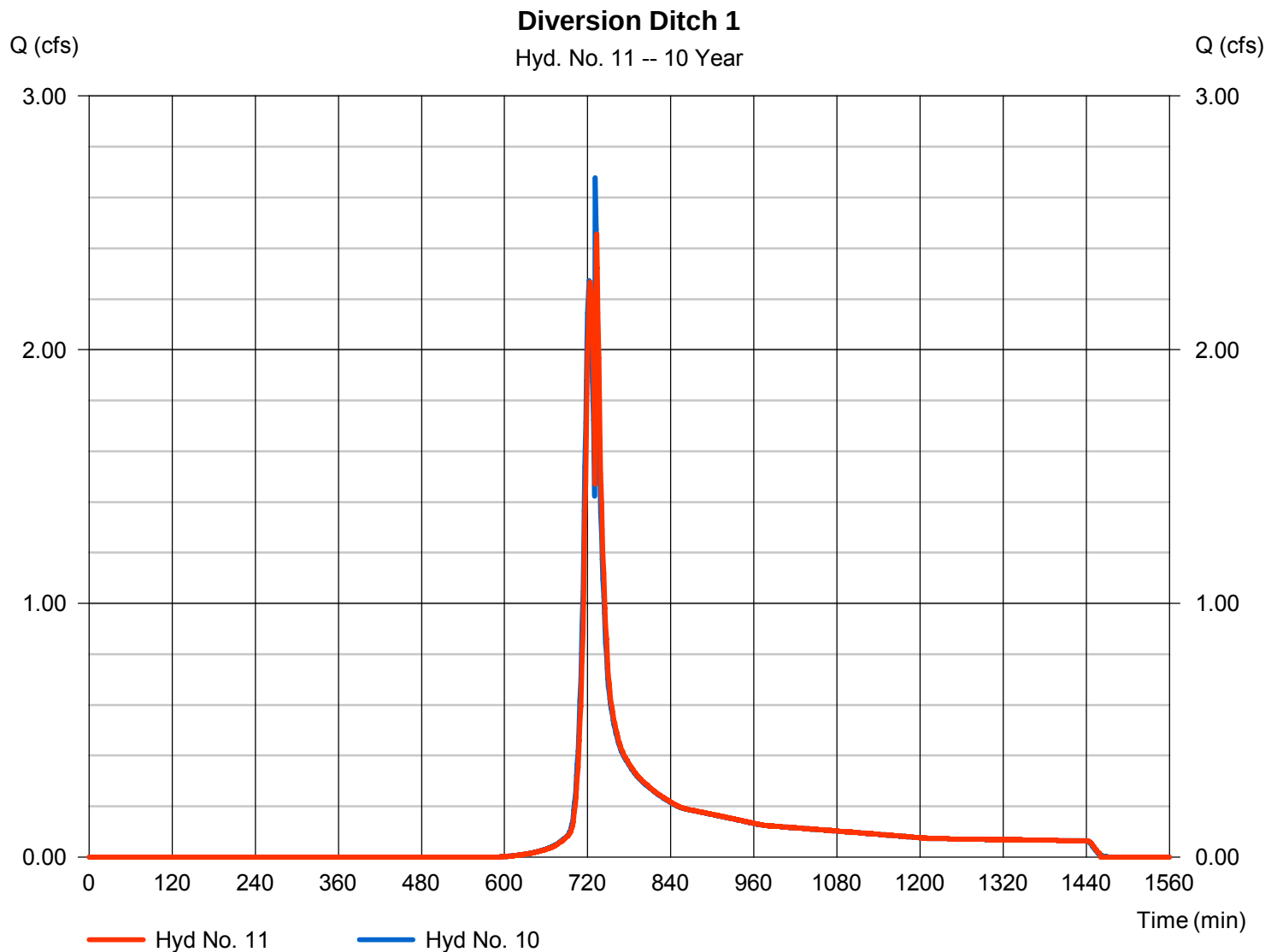
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 2.456 cfs
Storm frequency	= 10 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 9,728 cuft
Inflow hyd. No.	= 10 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7644

Modified Att-Kin routing method used.



Hydrograph Report

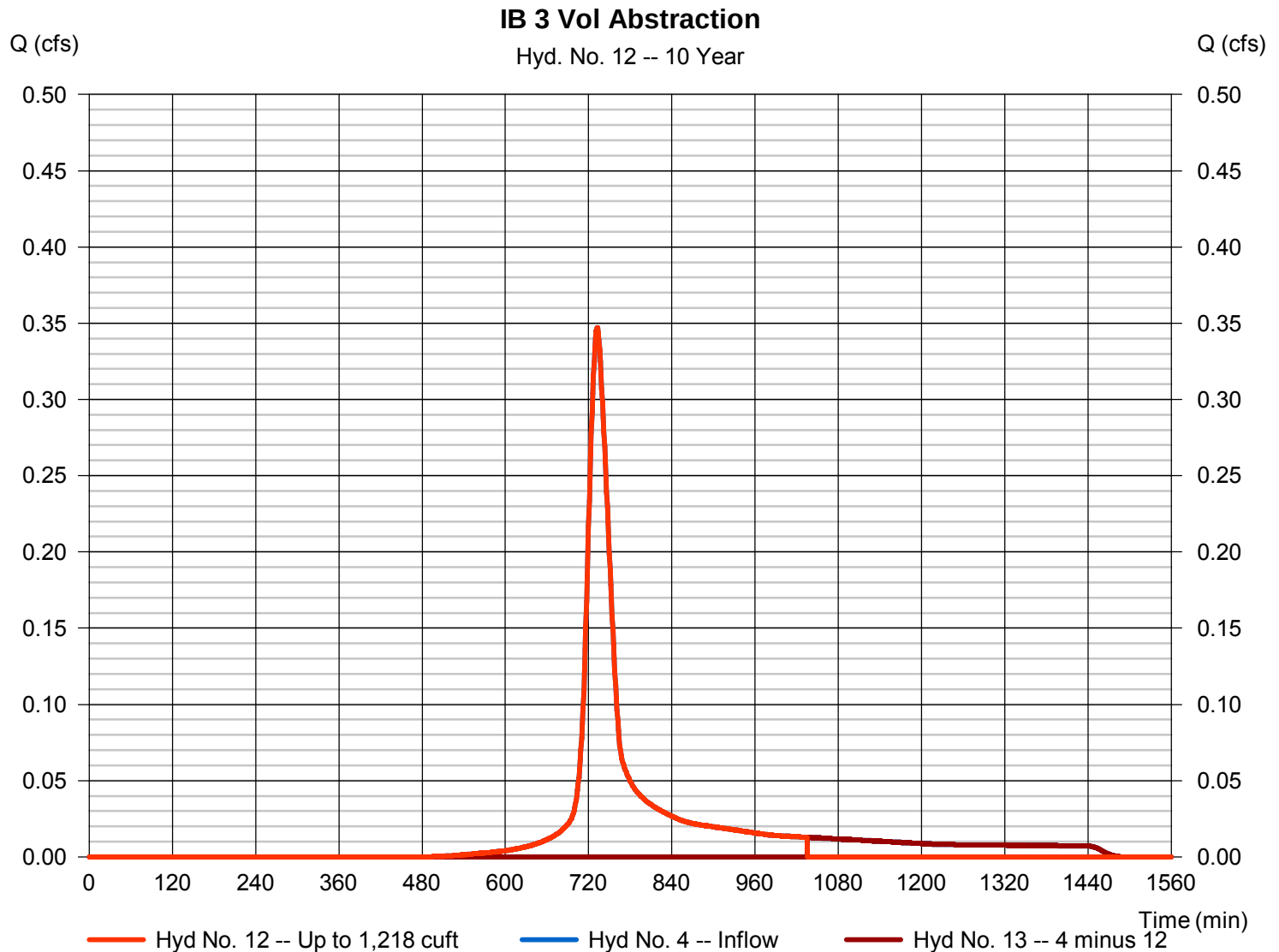
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 12

IB 3 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.347 cfs
Storm frequency	= 10 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 1,218 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 13
Diversion method	= First Flush Volume	Volume Up To	= 1,218 cuft



Hydrograph Report

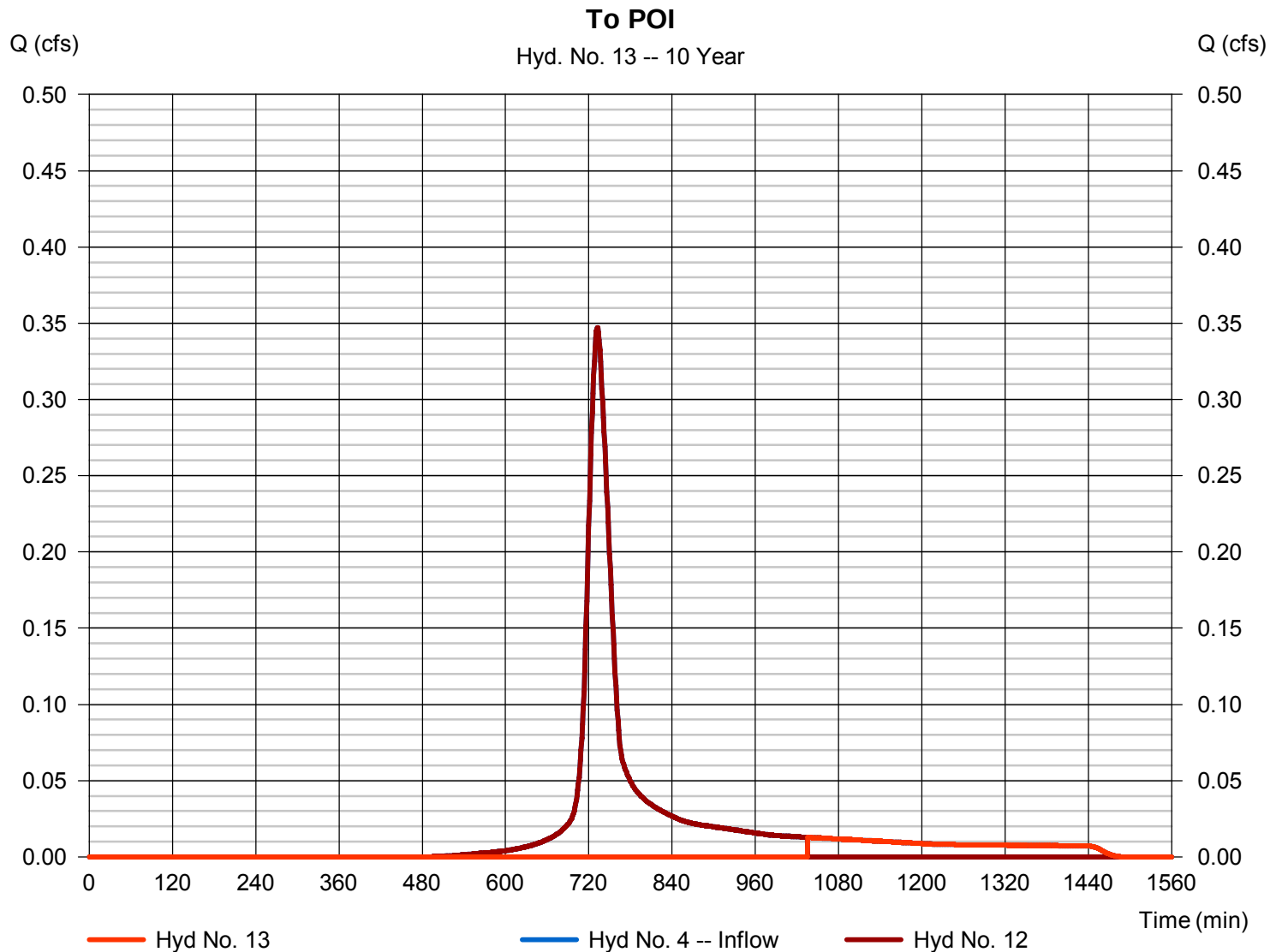
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 13

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.013 cfs
Storm frequency	= 10 yrs	Time to peak	= 1036 min
Time interval	= 1 min	Hyd. volume	= 227 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 12
Diversion method	= First Flush Volume	Volume Up To	= 1,218 cuft



Hydrograph Report

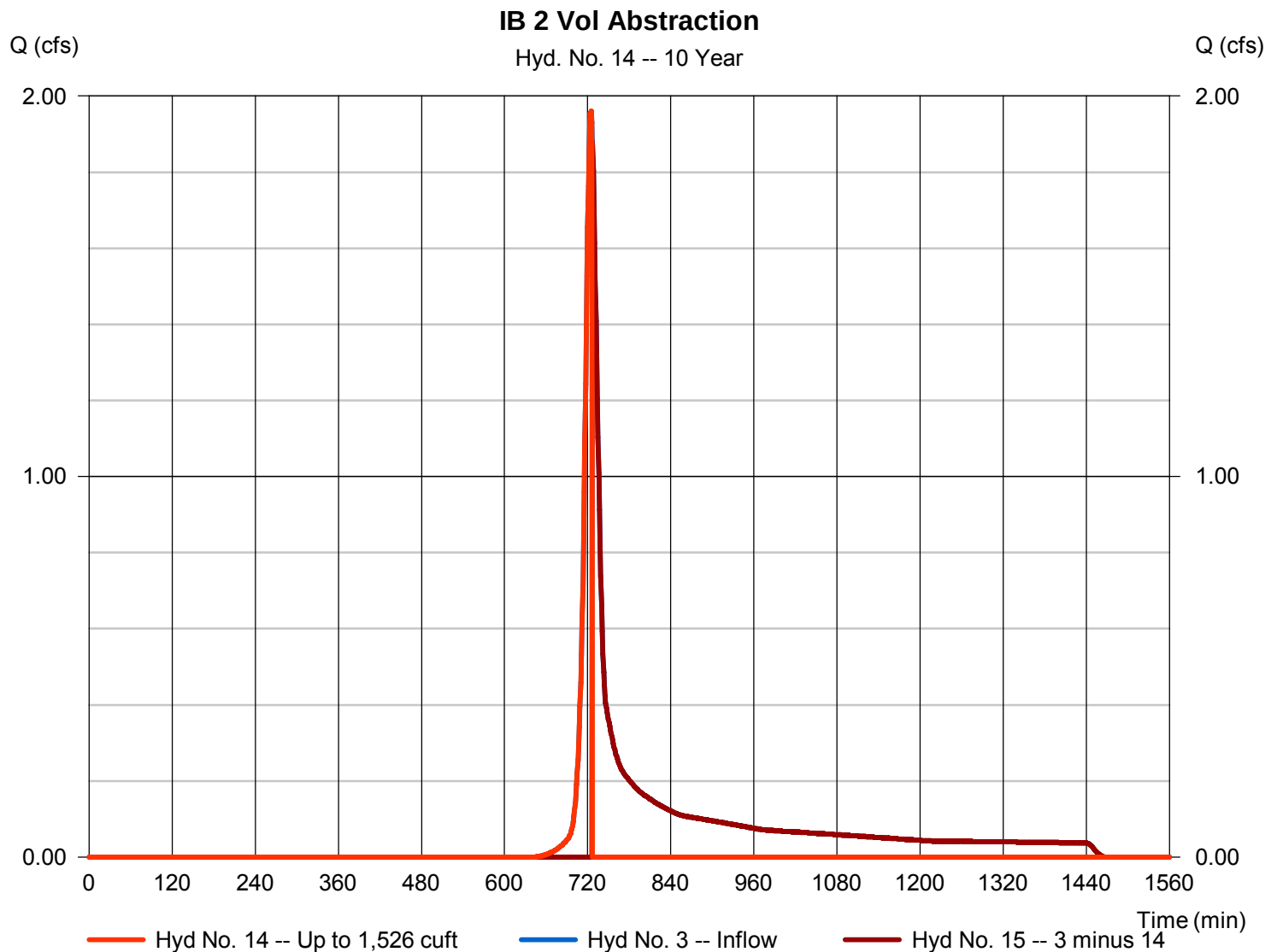
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 14

IB 2 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.961 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 1,557 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 15
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

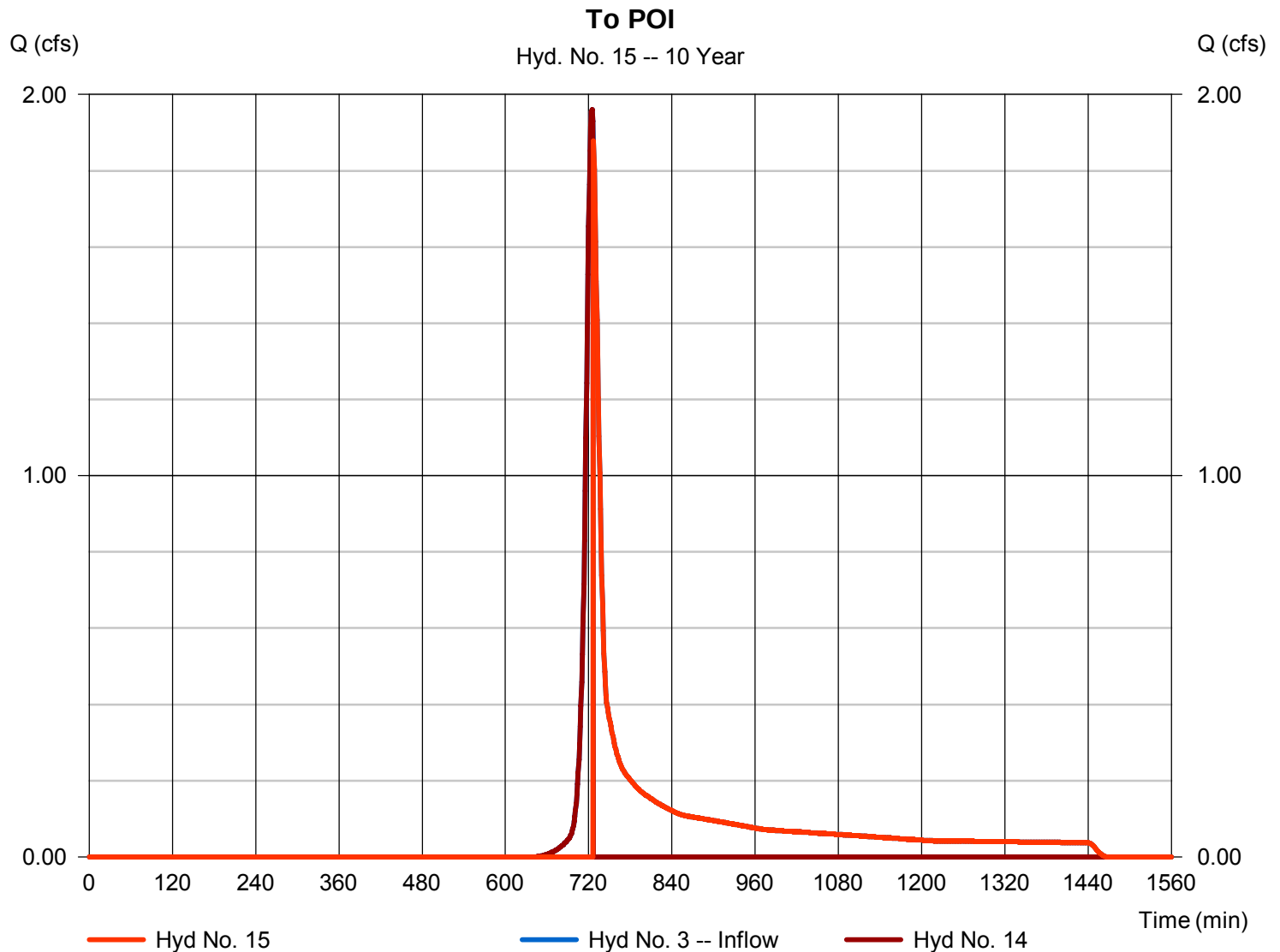
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 15

To POI

Hydrograph type	= Diversion2	Peak discharge	= 1.878 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 4,472 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 14
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

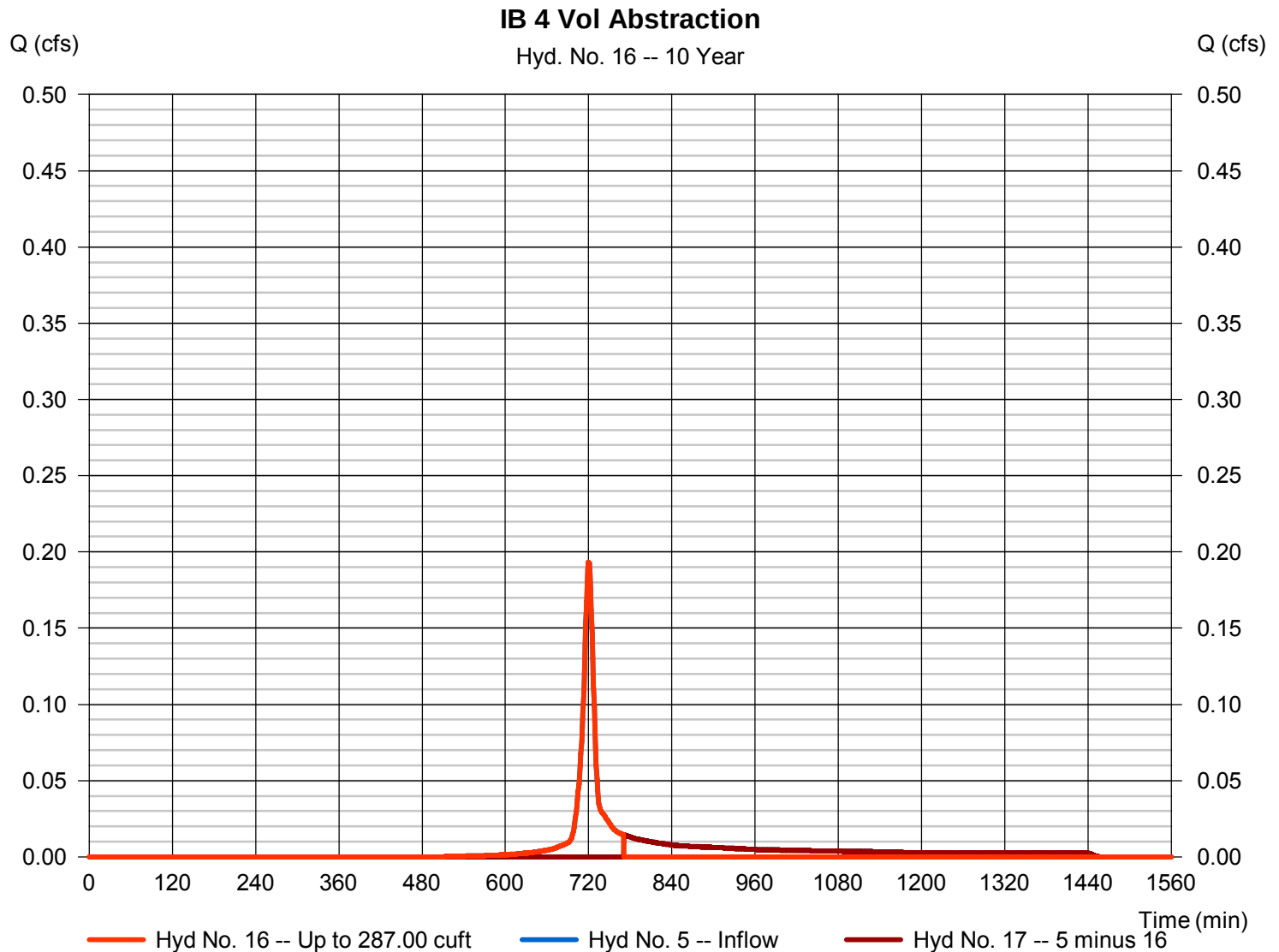
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 16

IB 4 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.193 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 288 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 17
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

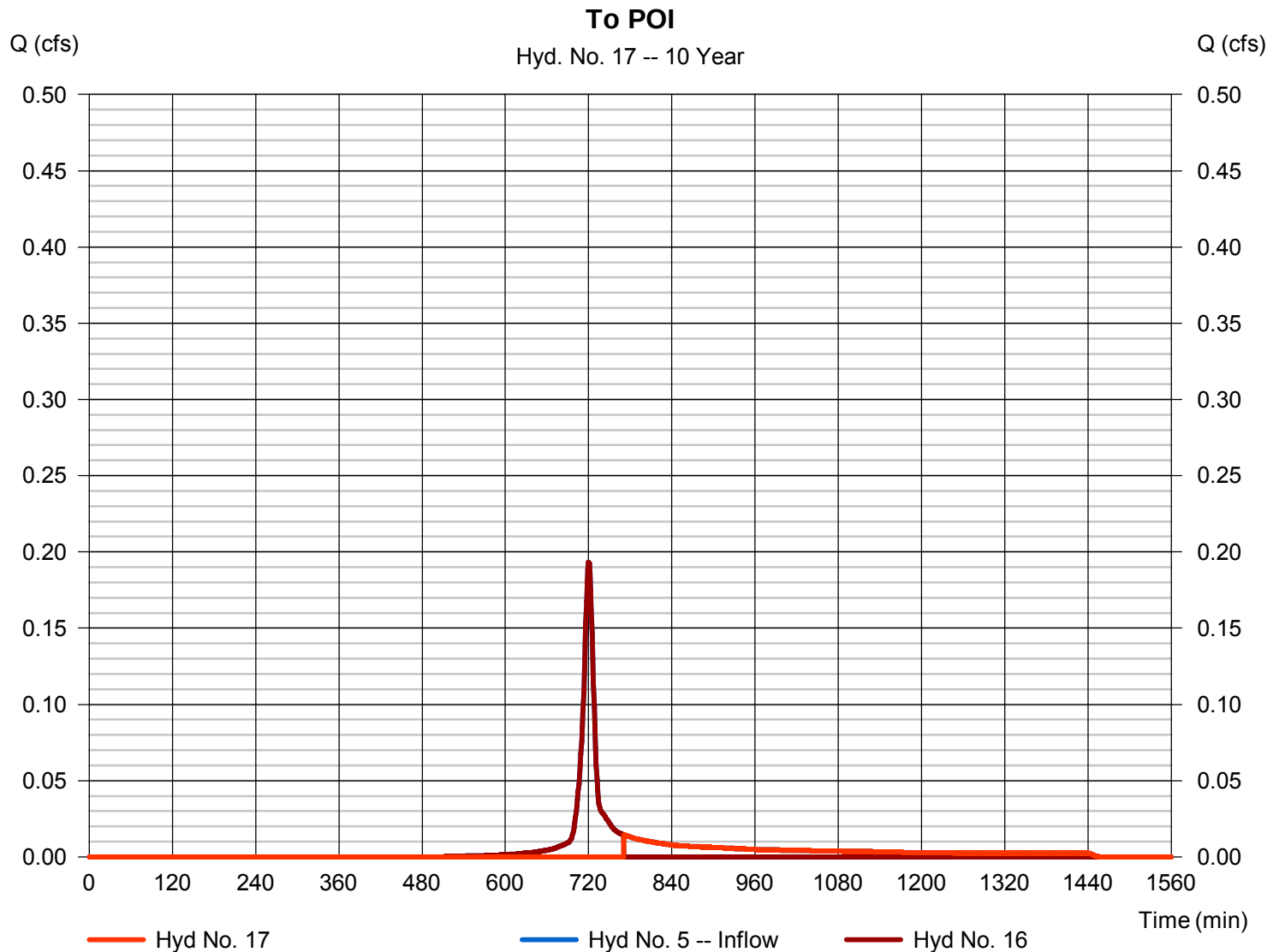
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 17

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.014 cfs
Storm frequency	= 10 yrs	Time to peak	= 771 min
Time interval	= 1 min	Hyd. volume	= 180 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 16
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

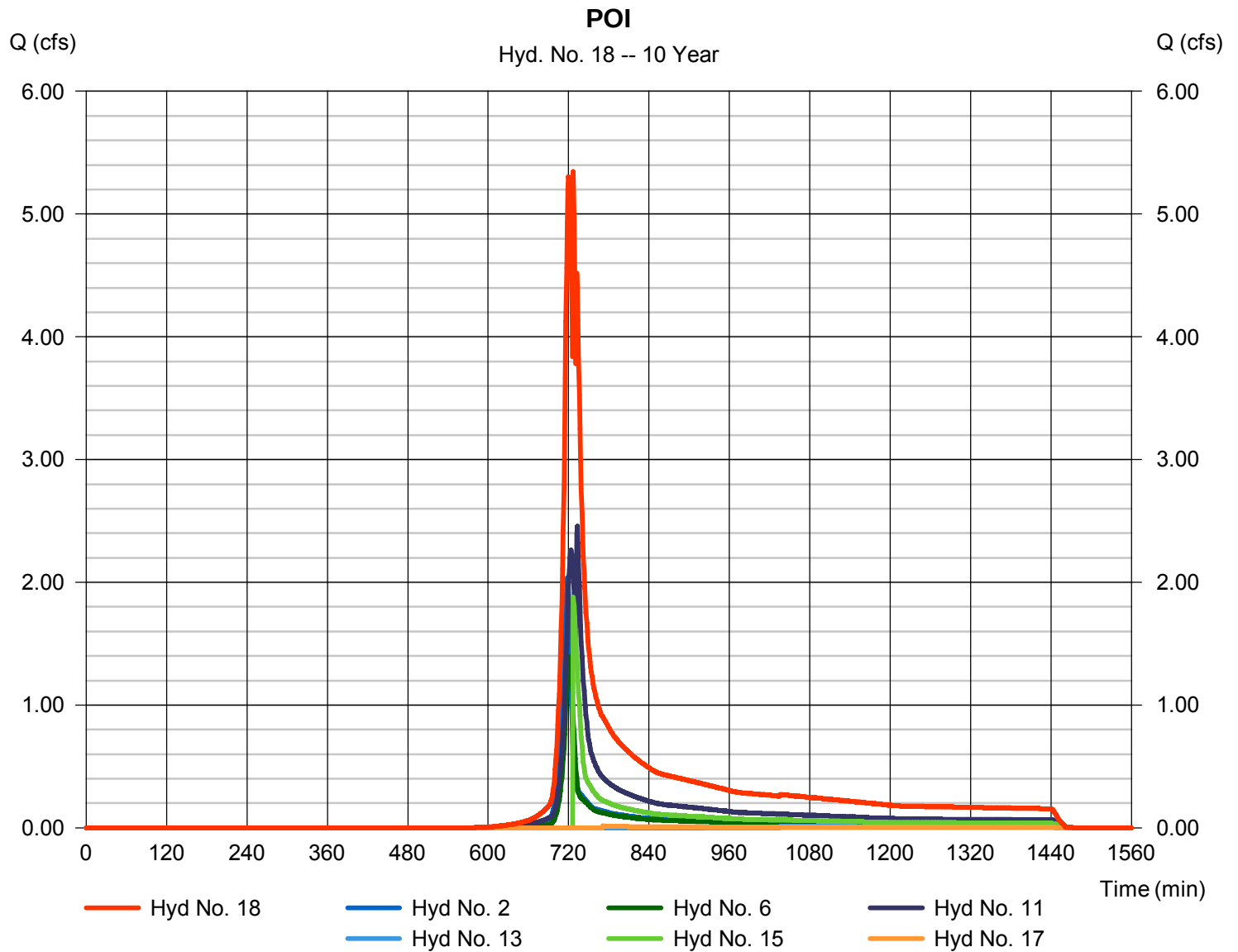
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 18

POI

Hydrograph type	= Combine	Peak discharge	= 5.348 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 22,366 cuft
Inflow hyds.	= 2, 6, 11, 13, 15, 17	Contrib. drain. area	= 1.620 ac



ATTACHMENT C-3
NEWPORT RD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Newport Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.466	-----	-----	11.50	-----	19.42	23.37	Newport Rd - PRE
Proj. file: Newport Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	19.42	1	719	43,922	-----	-----	-----	Newport Rd - PRE
Newport Rd-PRE.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

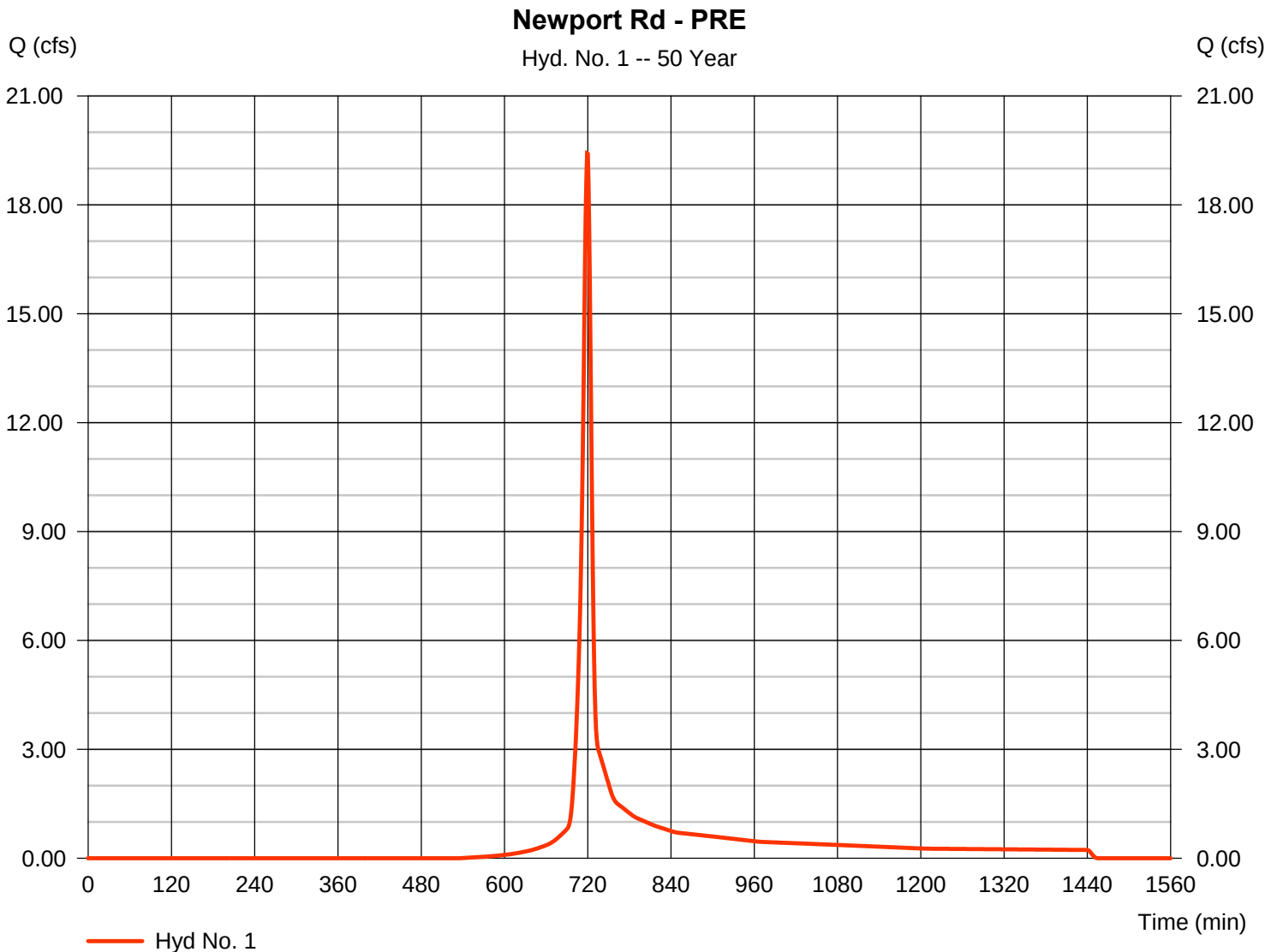
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Newport Rd - PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 19.42 cfs
Storm frequency	= 50 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 43,922 cuft
Drainage area	= 5.440 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.00 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(2.530 \times 71) + (2.680 \times 78) + (0.230 \times 77)] / 5.440$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

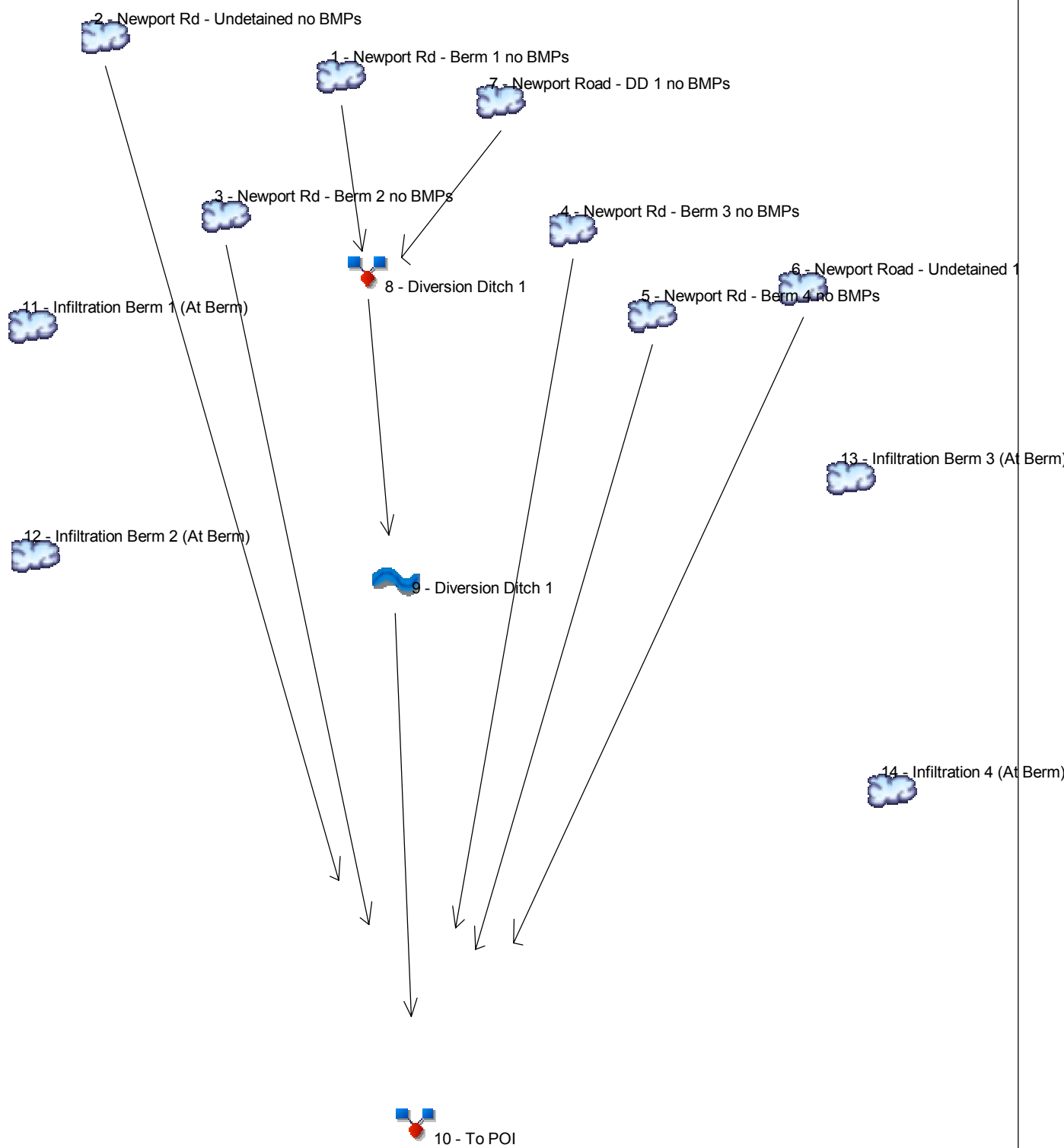
Hyd. No. 1

Newport Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 6.35	+	0.00	+	0.00	=	6.35
Shallow Concentrated Flow							
Flow length (ft)	= 620.00	141.00	124.00				
Watercourse slope (%)	= 6.50	12.80	4.70				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.11	5.77	3.50				
Travel Time (min)	= 2.51	+	0.41	+	0.59	=	3.51
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)63.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					10.00 min		

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.758	-----	-----	1.432	-----	2.282	2.694	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	-----	-----	1.053	-----	-----	2.041	-----	3.307	3.927	Newport Rd - Undetained no BMPs
3	SCS Runoff	-----	-----	0.964	-----	-----	2.202	-----	3.878	4.722	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	-----	-----	0.432	-----	-----	0.754	-----	1.148	1.337	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	-----	-----	0.595	-----	-----	1.394	-----	2.476	3.022	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	1.121	-----	-----	2.272	-----	3.777	4.516	Newport Road - DD 1 no BMPs
8	Combine	1, 7	-----	1.870	-----	-----	3.695	-----	6.035	7.178	Diversion Ditch 1
9	Reach	8	-----	1.859	-----	-----	3.677	-----	6.014	7.156	Diversion Ditch 1
10	Combine	2, 3, 4, 5, 6, 9	-----	4.448	-----	-----	9.297	-----	15.70	18.87	To POI
11	SCS Runoff	-----	-----	0.613	-----	-----	1.265	-----	2.128	2.558	Infiltration Berm 1 (At Berm)
12	SCS Runoff	-----	-----	0.782	-----	-----	1.836	-----	3.263	3.993	Infiltration Berm 2 (At Berm)
13	SCS Runoff	-----	-----	0.343	-----	-----	0.602	-----	0.923	1.076	Infiltration Berm 3 (At Berm)
14	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Infiltration 4 (At Berm)
Proj. file: Newport Rd No BMP.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	2.282	1	721	5,776	-----	-----	-----	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	3.307	1	718	7,010	-----	-----	-----	Newport Rd - Undetained no BMPs
3	SCS Runoff	3.878	1	722	10,485	-----	-----	-----	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	1.148	1	716	2,227	-----	-----	-----	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	0.374	1	715	674	-----	-----	-----	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	2.476	1	721	6,013	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	3.777	1	722	10,153	-----	-----	-----	Newport Road - DD 1 no BMPs
8	Combine	6.035	1	722	15,929	1, 7	-----	-----	Diversion Ditch 1
9	Reach	6.014	1	723	15,928	8	-----	-----	Diversion Ditch 1
10	Combine	15.70	1	720	42,337	2, 3, 4, 5, 6, 9	-----	-----	To POI
11	SCS Runoff	2.128	2	720	5,526	-----	-----	-----	Infiltration Berm 1 (At Berm)
12	SCS Runoff	3.263	2	722	8,543	-----	-----	-----	Infiltration Berm 2 (At Berm)
13	SCS Runoff	0.923	2	716	1,889	-----	-----	-----	Infiltration Berm 3 (At Berm)
14	SCS Runoff	0.374	1	715	674	-----	-----	-----	Infiltration 4 (At Berm)
Newport Rd No BMP.gpw					Return Period: 50 Year			Tuesday, 11 / 15 / 2016	

Hydrograph Report

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

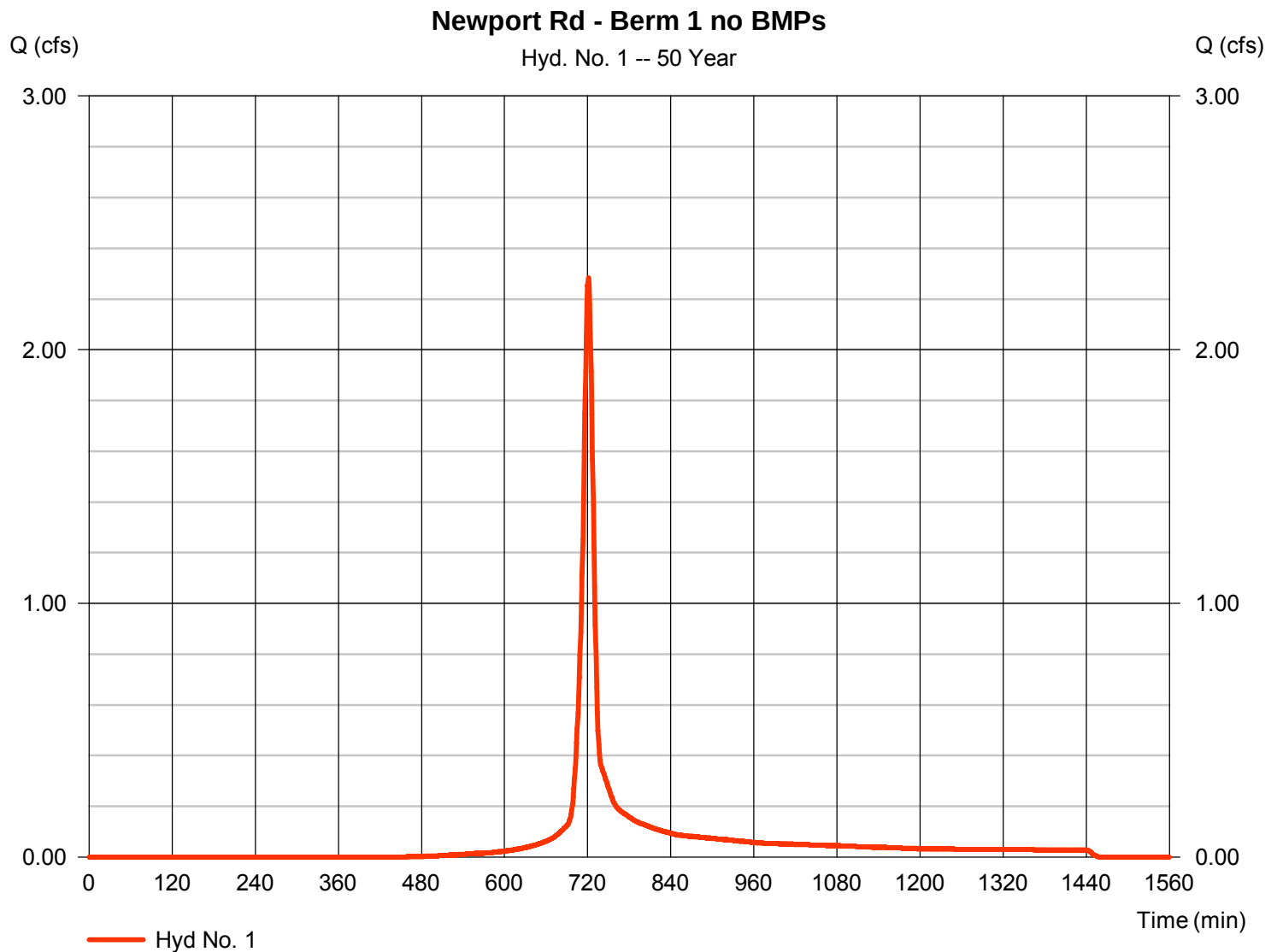
Tuesday, 11 / 15 / 2016

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 2.282 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 5,776 cuft
Drainage area	= 0.610 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.42 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.460 \times 78) + (0.100 \times 89) + (0.030 \times 91)] / 0.610$



TR55 Tc Worksheet

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

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	297.00				
Watercourse slope (%)	= 8.00	4.80	6.40				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	4.08				
Travel Time (min)	= 0.92	+	0.23	+	1.21	=	2.36
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	= 0.025	0.025	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.42 min			

Hydrograph Report

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

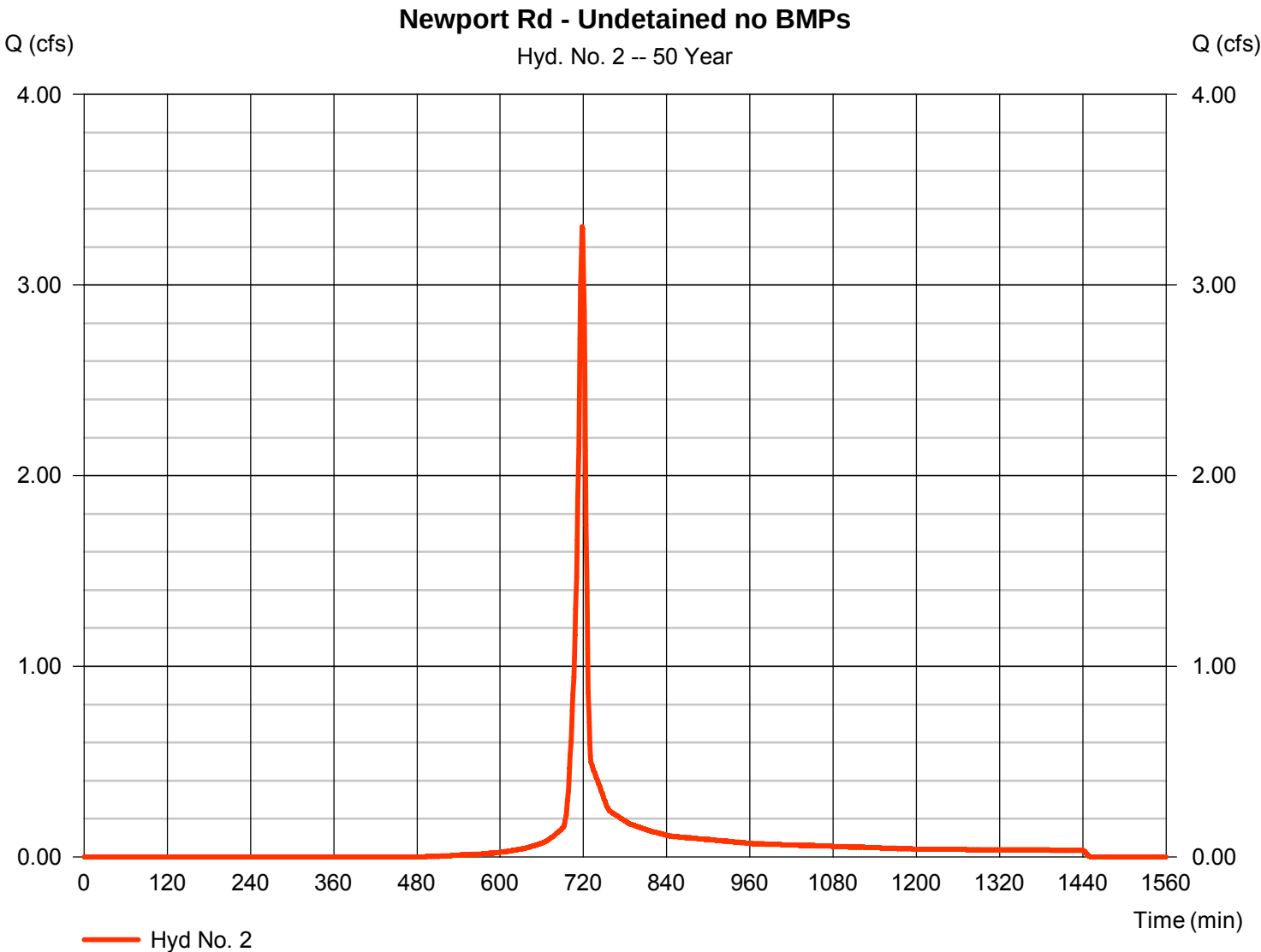
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.307 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	7,010 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	4.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.620 x 78) + (0.160 x 77) + (0.020 x 91)] / 0.800



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained no BMPs

<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)	= 2.51	0.00	0.00	
Land slope (%)	= 10.00	0.00	0.00	
Travel Time (min)	= 5.81	+	0.00	+
			0.00	= 5.81
Shallow Concentrated Flow				
Flow length (ft)	= 55.00	142.00	0.00	
Watercourse slope (%)	= 15.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=6.25	3.95	0.00	
Travel Time (min)	= 0.15	+	0.60	+
			0.00	= 0.75
Channel Flow				
X sectional flow area (sqft)	= 2.00	0.00	0.00	
Wetted perimeter (ft)	= 4.47	0.00	0.00	
Channel slope (%)	= 6.70	0.00	0.00	
Manning's n-value	= 0.025	0.025	0.015	
Velocity (ft/s)	=9.00	0.00	0.00	
Flow length (ft)	({})58.0	0.0	0.0	
Travel Time (min)	= 0.11	+	0.00	+
			0.00	= 0.11
Total Travel Time, Tc				6.70 min

Hydrograph Report

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

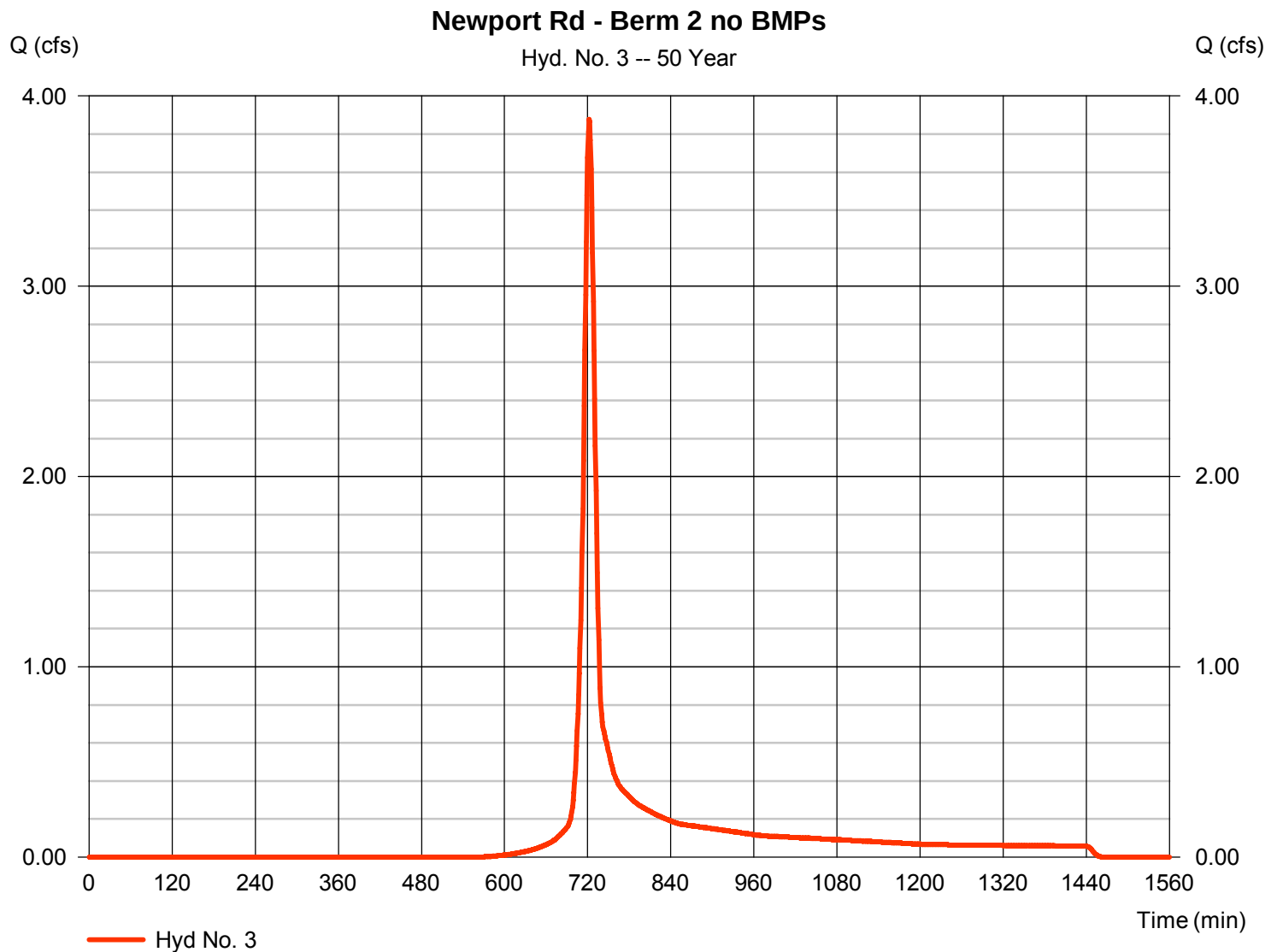
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 3.878 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 10,485 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.40 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



TR55 Tc Worksheet

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

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	239.00	175.00				
Watercourse slope (%)	= 6.40	11.00	6.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.08	5.35	3.95				
Travel Time (min)	= 1.85	+	0.74	+	0.74	=	3.33
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	= 0.025	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				14.40 min			

Hydrograph Report

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

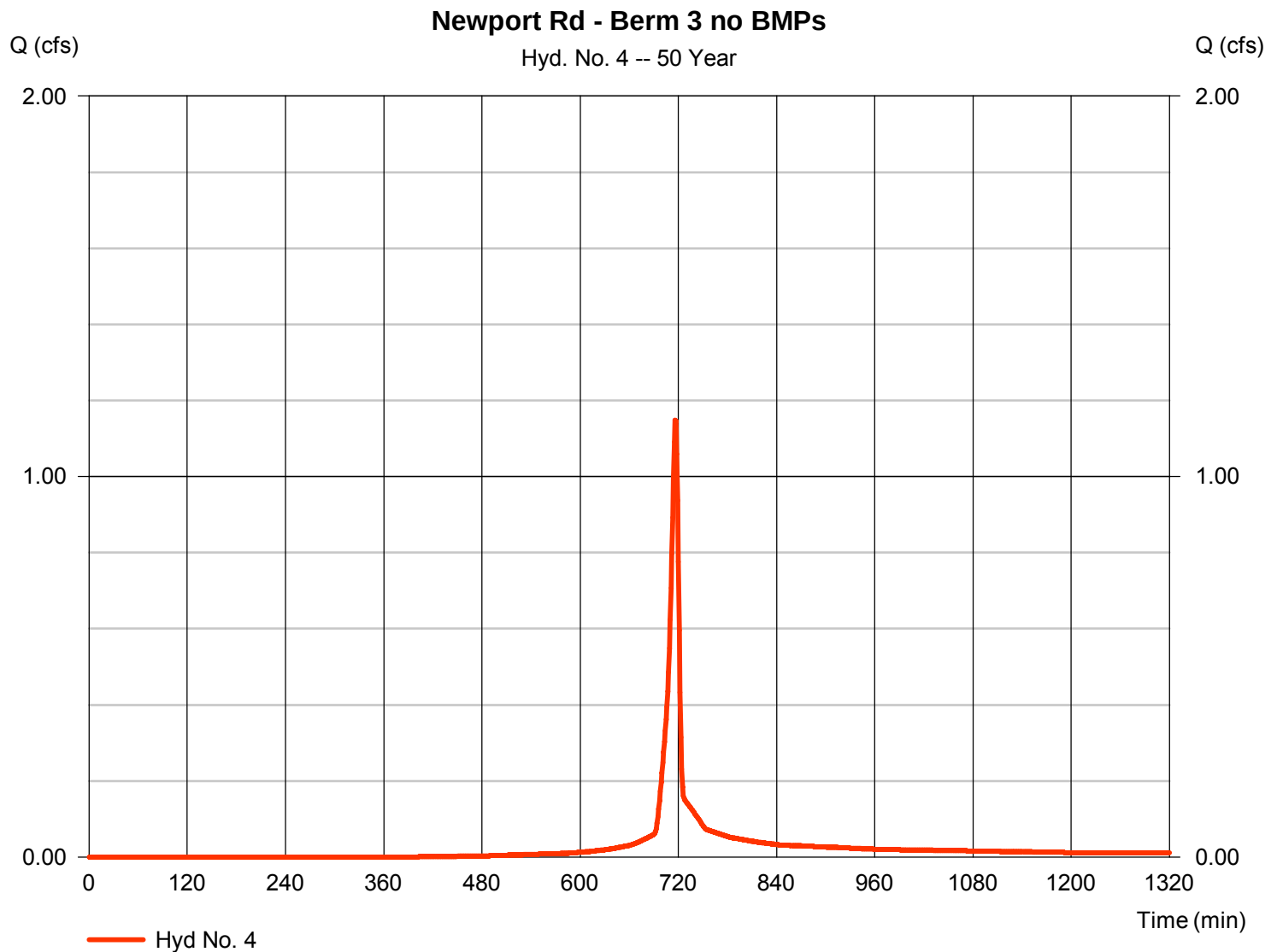
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 1.148 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 2,227 cuft
Drainage area	= 0.210 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.130 \times 78) + (0.080 \times 91)] / 0.210$



TR55 Tc Worksheet

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

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	94.00	0.00				
Watercourse slope (%)	= 5.50	8.50	0.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.77	4.70	0.00				
Travel Time (min)	= 0.57	+	0.33	+	0.00	=	0.90
Channel Flow							
X sectional flow area (sqft)	= 2.00	2.00	0.00				
Wetted perimeter (ft)	= 4.47	4.47	0.00				
Channel slope (%)	= 4.49	7.51	0.00				
Manning's n-value	= 0.060	0.025	0.015				
Velocity (ft/s)	=3.07	9.53	0.00				
Flow length (ft)	(0)}89.0	230.0	0.0				
Travel Time (min)	= 0.48	+	0.40	+	0.00	=	0.89
Total Travel Time, Tc				3.60 min			

Hydrograph Report

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

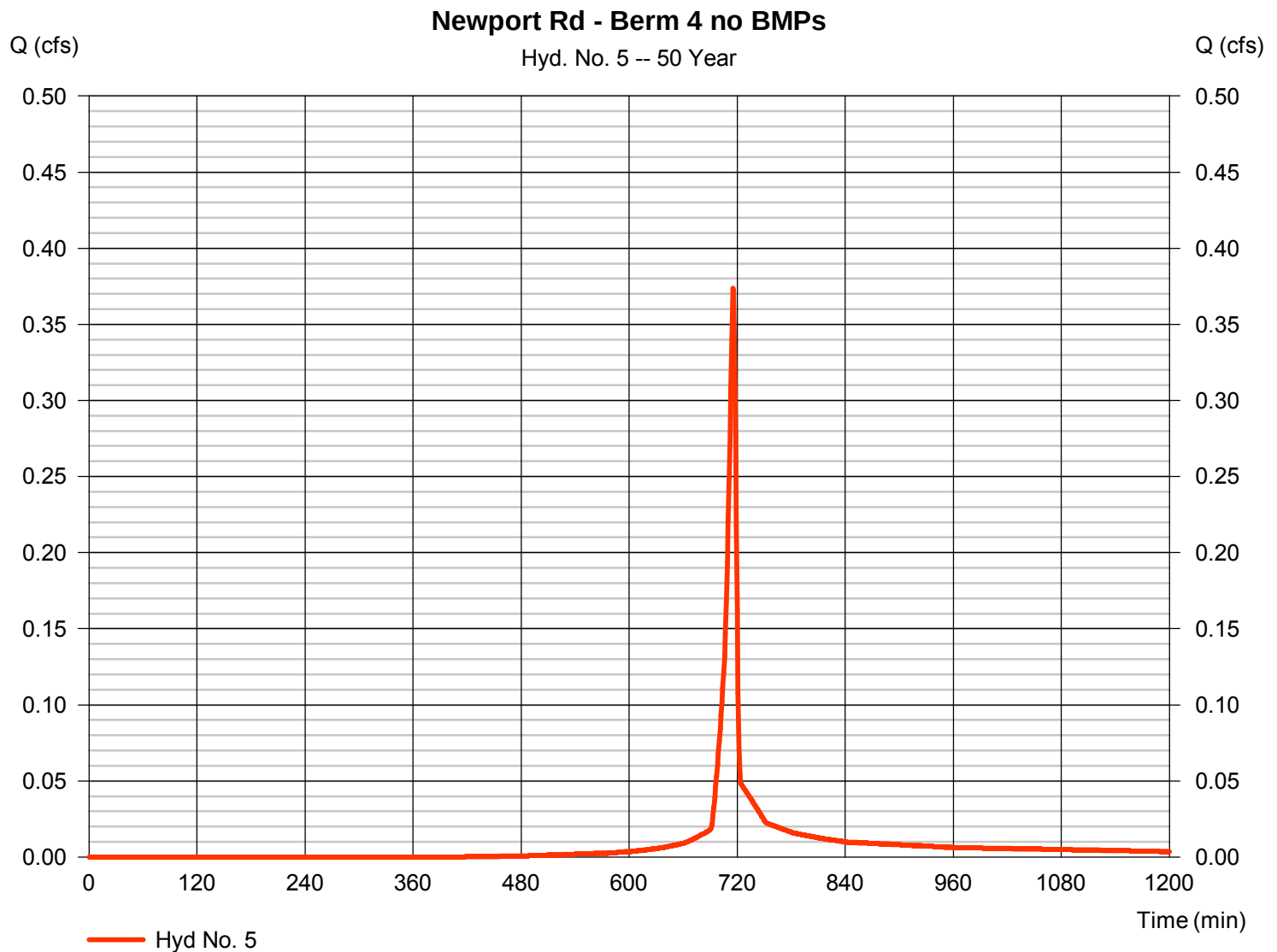
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 0.374 cfs
Storm frequency	= 50 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 674 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.30 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 69.00	0.00	0.00				
Watercourse slope (%)	= 5.90	0.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=3.92	0.00	0.00				
Travel Time (min)	= 0.29	+	0.00	+	0.00	=	0.29
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)200.0	0.0	0.0				
Travel Time (min)	= 0.36	+	0.00	+	0.00	=	0.36
Total Travel Time, Tc				2.30 min			

Hydrograph Report

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

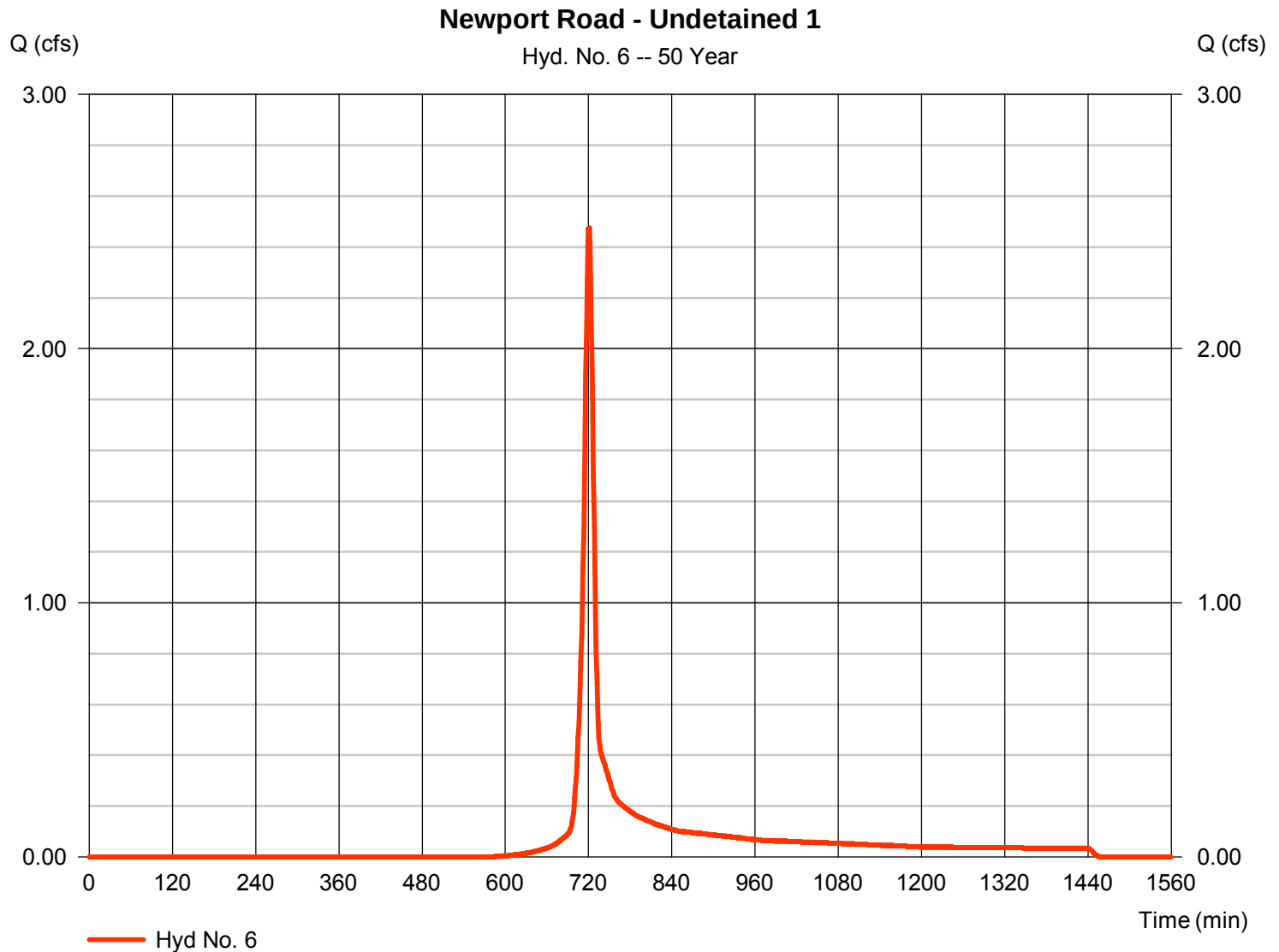
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.476 cfs
Storm frequency	=	50 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	6,013 cuft
Drainage area	=	0.820 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.80 min
Total precip.	=	4.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

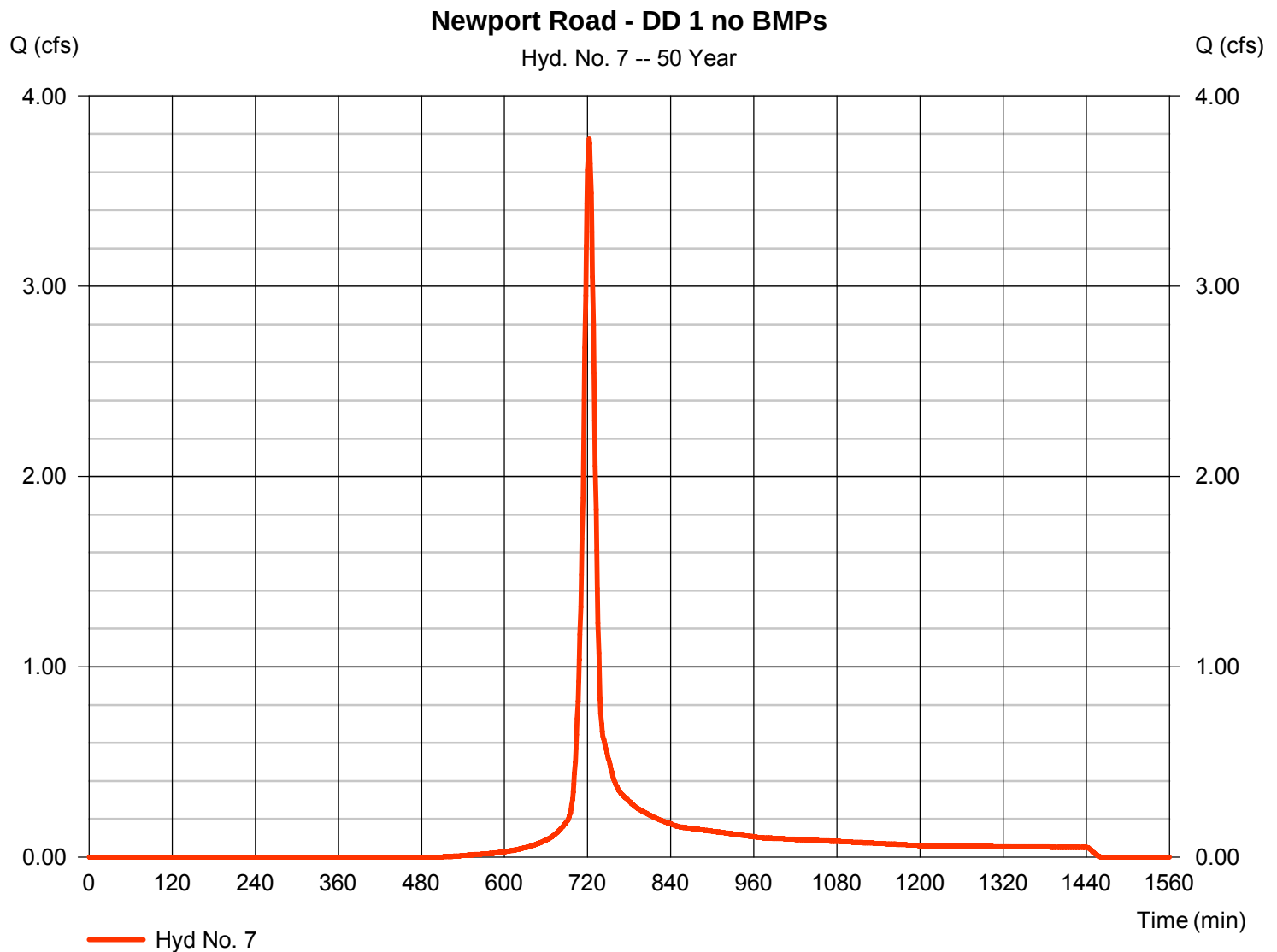
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 3.777 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 10,153 cuft
Drainage area	= 1.170 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 1 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

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

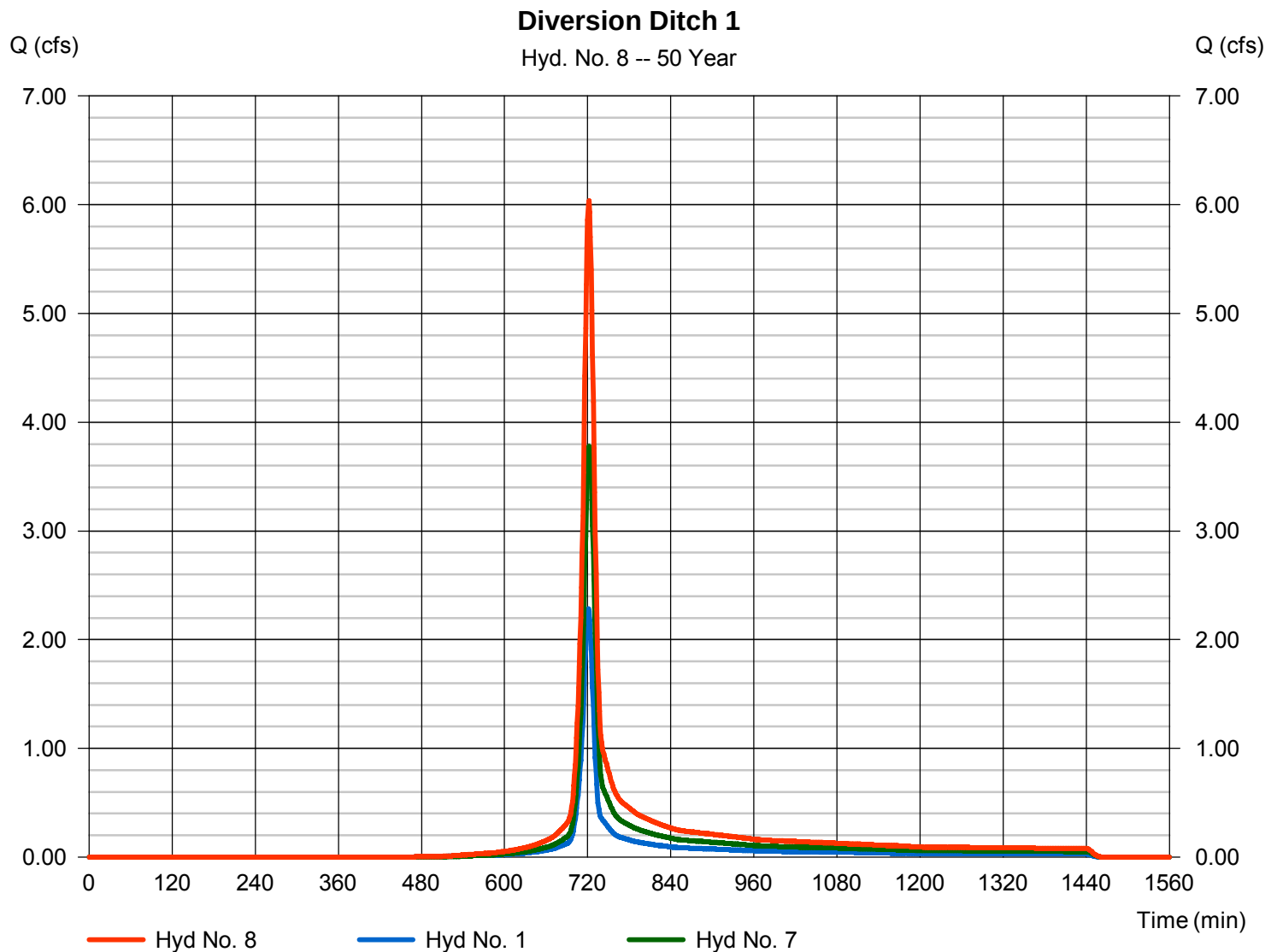
Tuesday, 11 / 15 / 2016

Hyd. No. 8

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 7

Peak discharge = 6.035 cfs
 Time to peak = 722 min
 Hyd. volume = 15,929 cuft
 Contrib. drain. area = 1.780 ac



Hydrograph Report

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

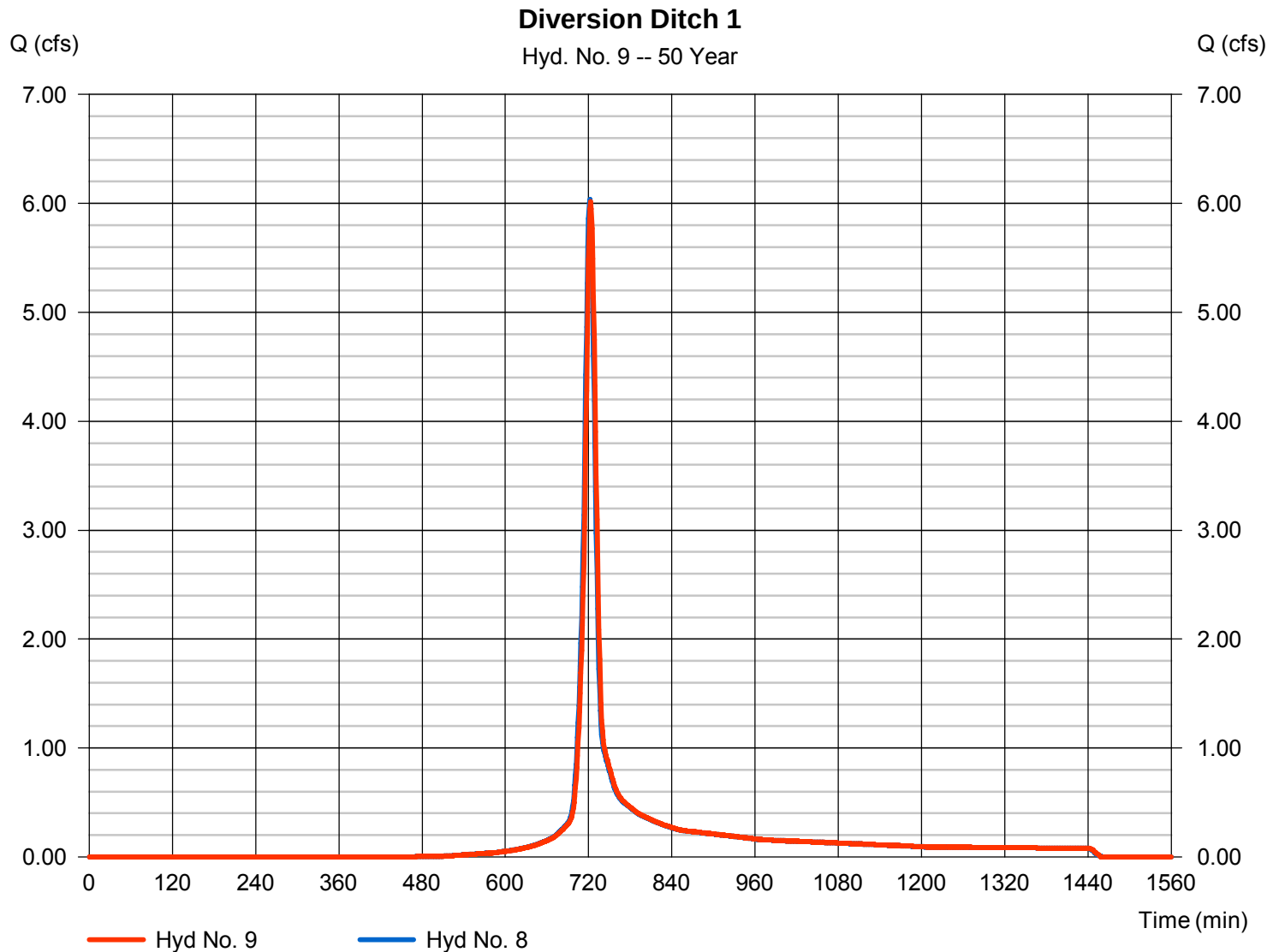
Tuesday, 11 / 15 / 2016

Hyd. No. 9

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 6.014 cfs
Storm frequency	= 50 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 15,928 cuft
Inflow hyd. No.	= 8 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7517

Modified Att-Kin routing method used.



Hydrograph Report

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

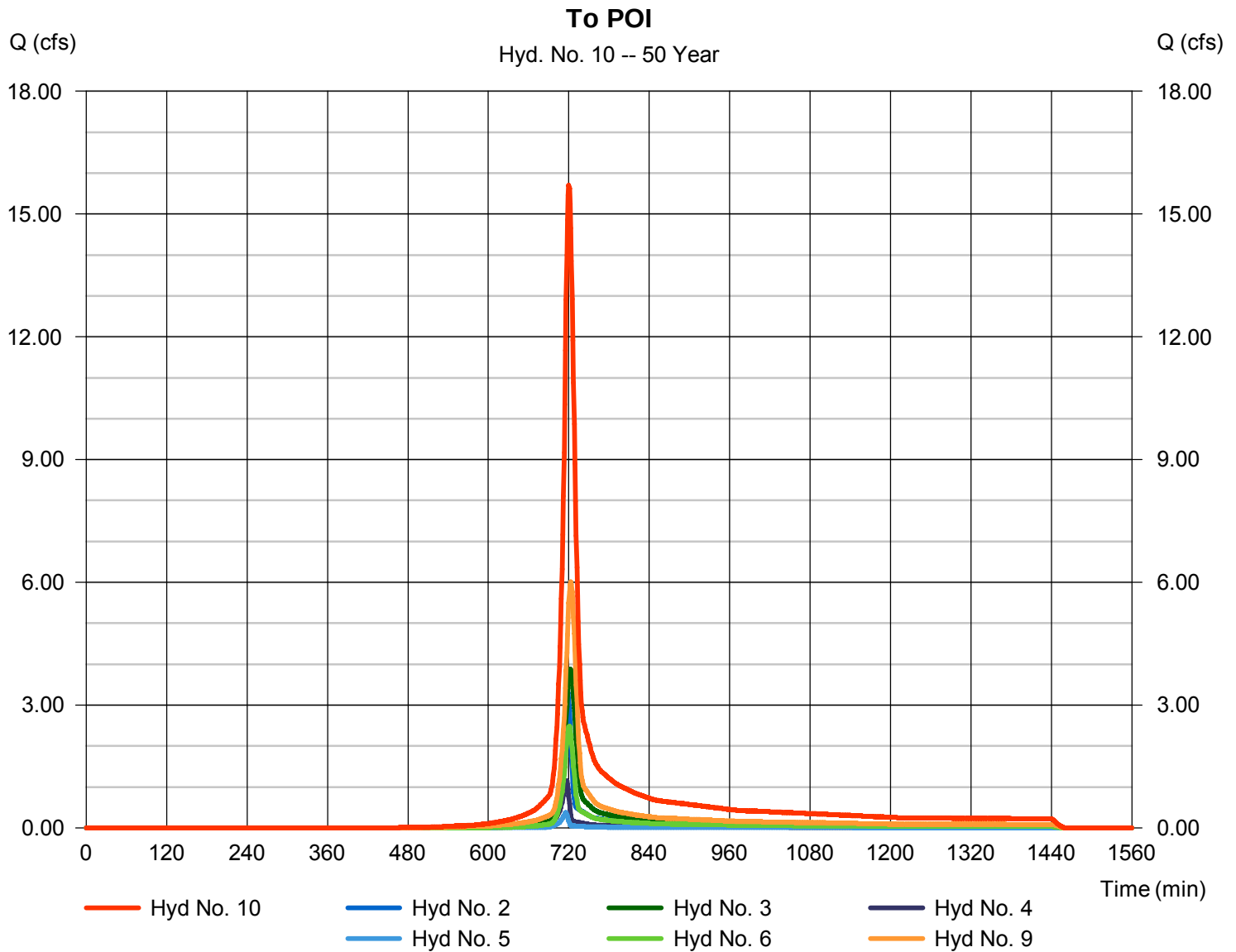
Tuesday, 11 / 15 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 4, 5, 6, 9

Peak discharge = 15.70 cfs
 Time to peak = 720 min
 Hyd. volume = 42,337 cuft
 Contrib. drain. area = 3.300 ac



Hydrograph Report

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

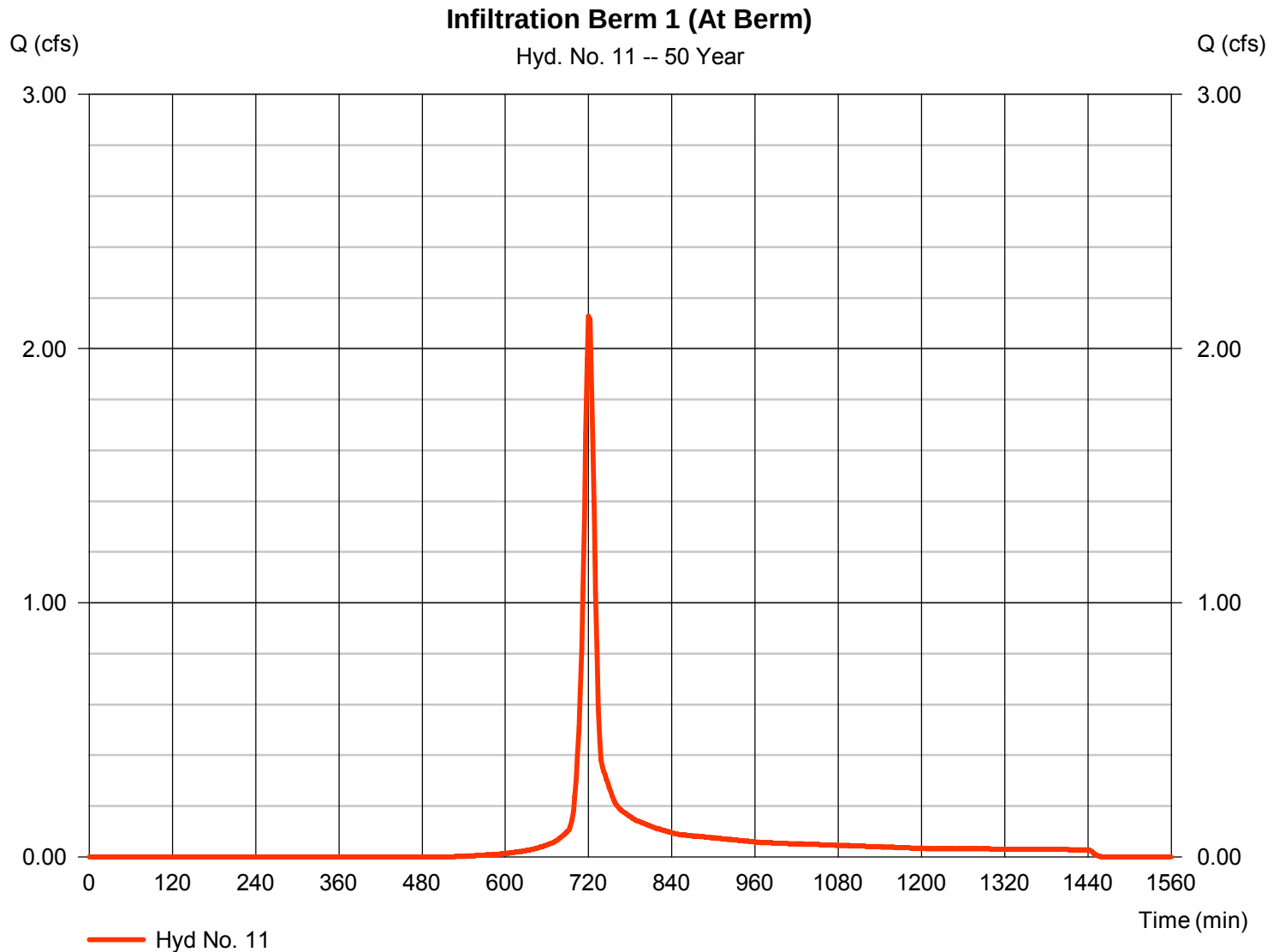
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Infiltration Berm 1 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.128 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 5,526 cuft
Drainage area	= 0.640 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.60 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.130 \times 78) + (0.100 \times 89) + (0.020 \times 91)] / 0.640$



TR55 Tc Worksheet

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

Hyd. No. 11

Infiltration Berm 1 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	69.00				
Watercourse slope (%)	= 8.00	4.80	4.30				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	3.35				
Travel Time (min)	= 0.92	+	0.23	+	0.34	=	1.49
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				12.60 min			

Hydrograph Report

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

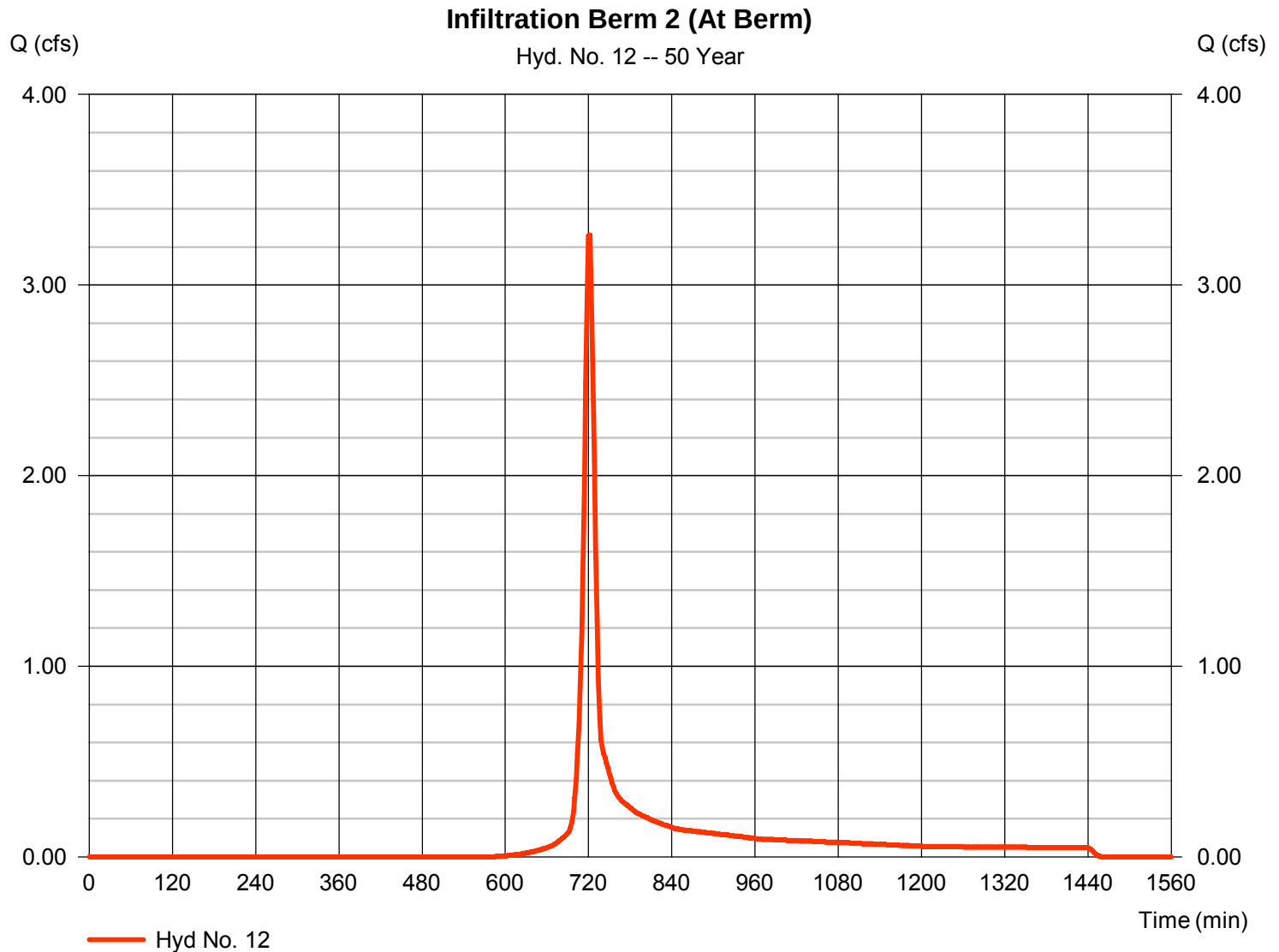
Tuesday, 11 / 15 / 2016

Hyd. No. 12

Infiltration Berm 2 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.263 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 8,543 cuft
Drainage area	= 1.150 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.90 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.030 \times 71) + (0.070 \times 78) + (0.050 \times 89)] / 1.150$



TR55 Tc Worksheet

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

Hyd. No. 12

Infiltration Berm 2 (At Berm)

<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)	= 2.51	2.51	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
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				12.90 min			

Hydrograph Report

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

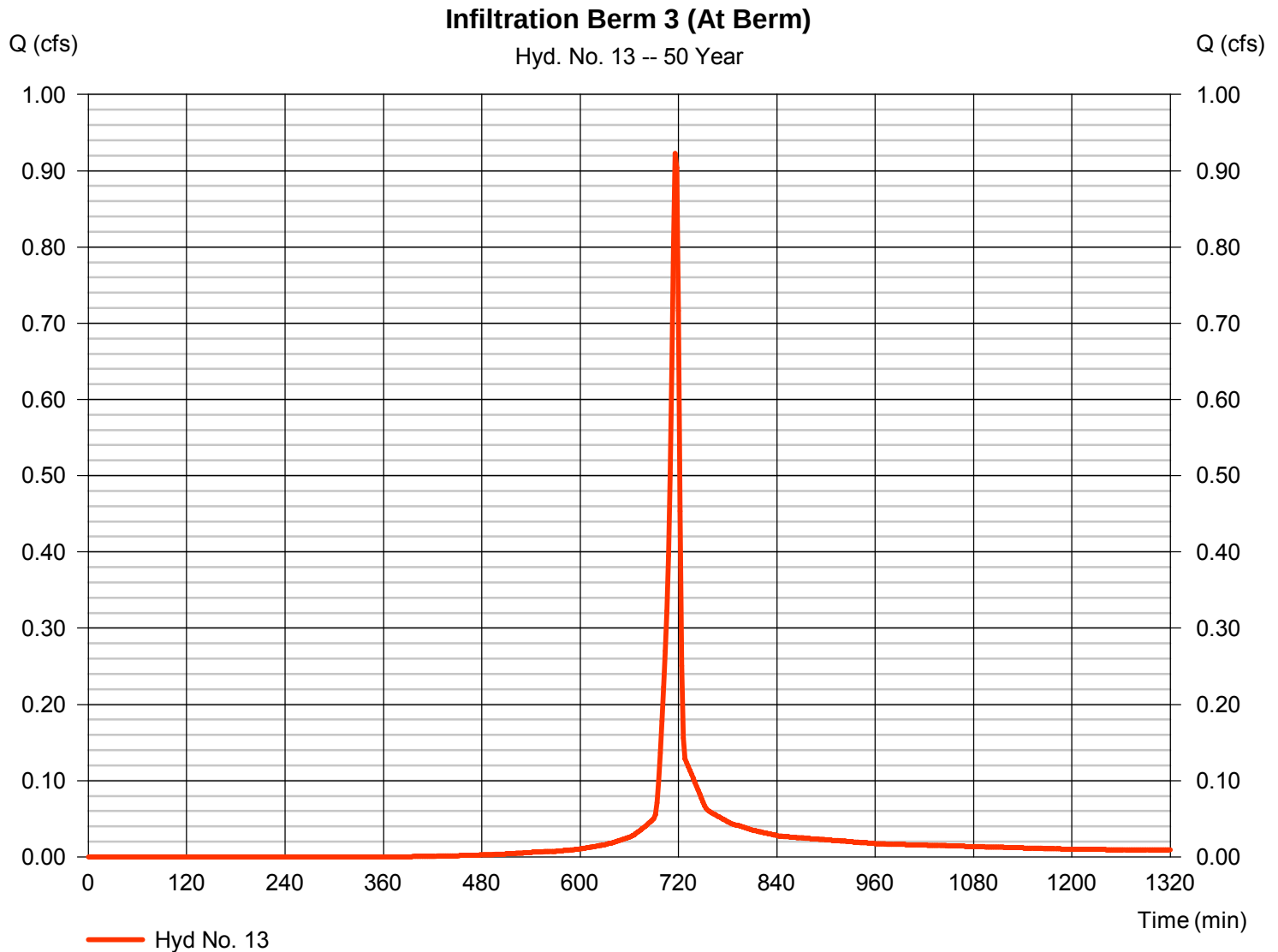
Tuesday, 11 / 15 / 2016

Hyd. No. 13

Infiltration Berm 3 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.923 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,889 cuft
Drainage area	= 0.190 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.10 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.110 \times 78) + (0.080 \times 91)] / 0.190$



TR55 Tc Worksheet

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

Hyd. No. 13

Infiltration Berm 3 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	46.00	0.00				
Watercourse slope (%)	= 5.50	6.50	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.77	4.11	0.00				
Travel Time (min)	= 0.57	+	0.19	+	0.00	=	0.76
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 4.49	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.07	0.00	0.00				
Flow length (ft)	(0)}89.0	0.0	0.0				
Travel Time (min)	= 0.48	+	0.00	+	0.00	=	0.48
Total Travel Time, Tc				3.10 min			

Hydrograph Report

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

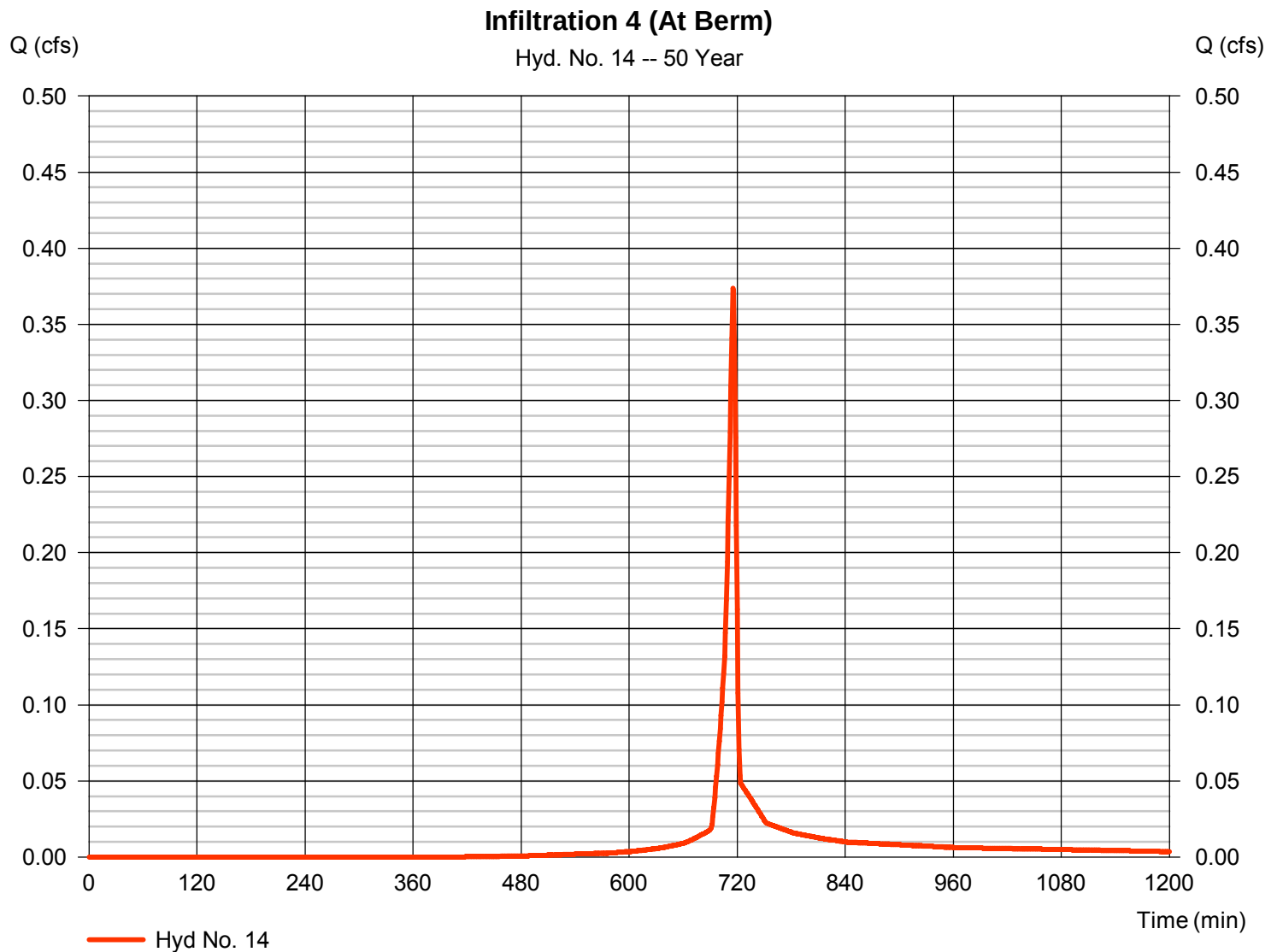
Tuesday, 11 / 15 / 2016

Hyd. No. 14

Infiltration 4 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.374 cfs
Storm frequency	= 50 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 674 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.90 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

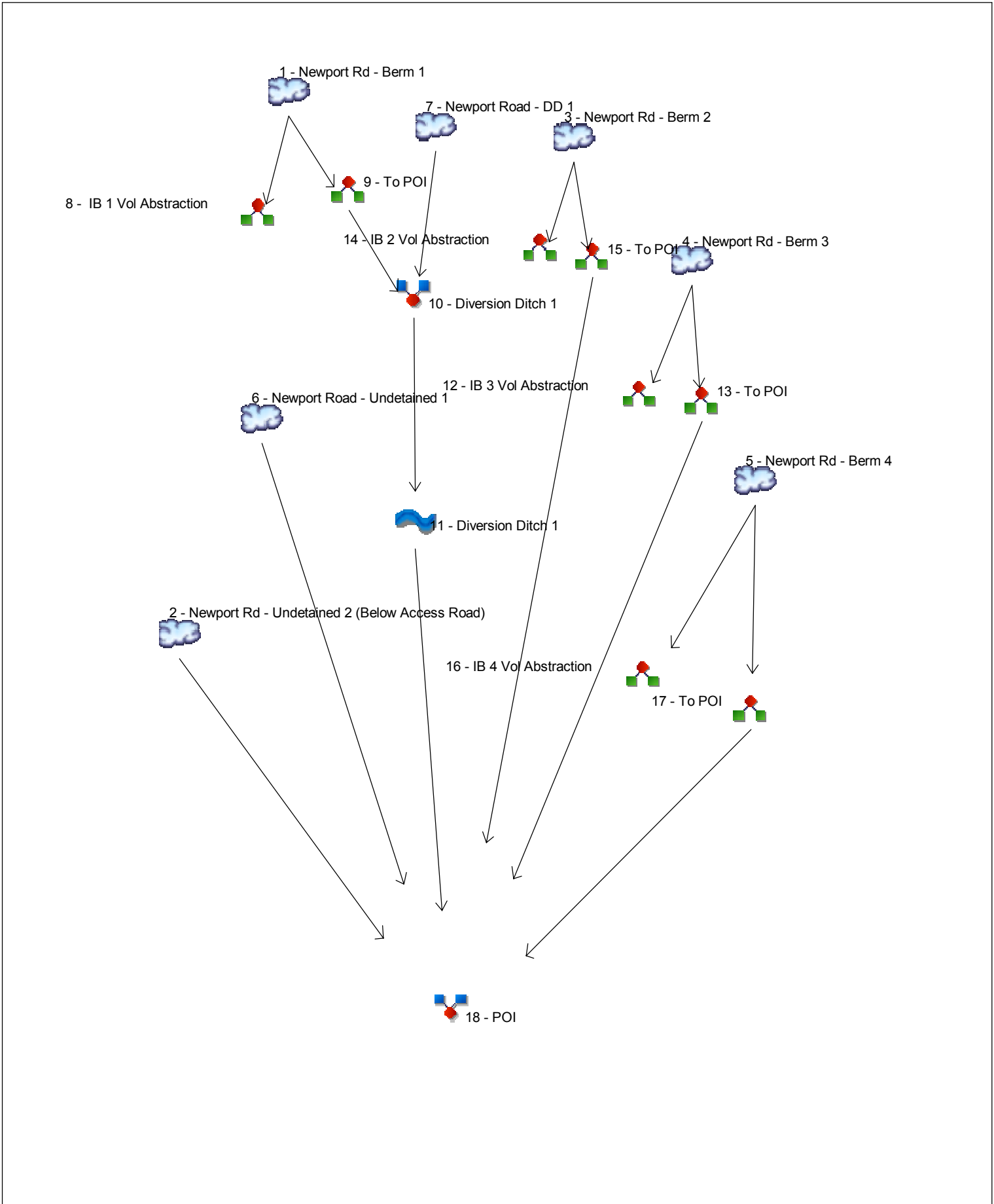
Hyd. No. 14

Infiltration 4 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 54.00	0.00	0.00				
Watercourse slope (%)	= 7.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.39	0.00	0.00				
Travel Time (min)	= 0.21	+	0.00	+	0.00	=	0.21
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				1.90 min			

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.608	-----	Newport Rd - Berm 1
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	3.307	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	3.471	-----	Newport Rd - Berm 2
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.540	-----	Newport Rd - Berm 3
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.301	-----	Newport Rd - Berm 4
6	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.476	-----	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	3.777	-----	Newport Road - DD 1
8	Diversion1	1	-----	-----	-----	-----	-----	-----	2.108	-----	IB 1 Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	-----	-----	2.608	-----	To POI
10	Combine	7, 9	-----	-----	-----	-----	-----	-----	6.210	-----	Diversion Ditch 1
11	Reach	10	-----	-----	-----	-----	-----	-----	6.171	-----	Diversion Ditch 1
12	Diversion1	4	-----	-----	-----	-----	-----	-----	0.540	-----	IB 3 Vol Abstraction
13	Diversion2	4	-----	-----	-----	-----	-----	-----	0.019	-----	To POI
14	Diversion1	3	-----	-----	-----	-----	-----	-----	2.602	-----	IB 2 Vol Abstraction
15	Diversion2	3	-----	-----	-----	-----	-----	-----	3.471	-----	To POI
16	Diversion1	5	-----	-----	-----	-----	-----	-----	0.301	-----	IB 4 Vol Abstraction
17	Diversion2	5	-----	-----	-----	-----	-----	-----	0.270	-----	To POI
18	Combine	2, 6, 11, 13, 15, 17	-----	-----	-----	-----	-----	-----	14.05	-----	POI
Proj. file: Newport Rd wBMP-50yr.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	2.608	1	726	8,586	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	3.307	1	718	7,010	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	3.471	1	724	10,366	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	0.540	1	732	2,242	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	0.301	1	720	732	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	2.476	1	721	6,013	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	3.777	1	722	10,153	-----	-----	-----	Newport Road - DD 1
8	Diversion1	2.108	1	720	1,618	1	-----	-----	IB 1 Vol Abstraction
9	Diversion2	2.608	1	726	6,968	1	-----	-----	To POI
10	Combine	6.210	1	723	17,121	7, 9	-----	-----	Diversion Ditch 1
11	Reach	6.171	1	725	17,118	10	-----	-----	Diversion Ditch 1
12	Diversion1	0.540	1	732	1,890	4	-----	-----	IB 3 Vol Abstraction
13	Diversion2	0.019	1	1011	352	4	-----	-----	To POI
14	Diversion1	2.602	1	718	1,638	3	-----	-----	IB 2 Vol Abstraction
15	Diversion2	3.471	1	724	8,728	3	-----	-----	To POI
16	Diversion1	0.301	1	720	295	5	-----	-----	IB 4 Vol Abstraction
17	Diversion2	0.270	1	723	437	5	-----	-----	To POI
18	Combine	14.05	1	723	39,658	2, 6, 11, 13, 15, 17	-----	-----	POI
Newport Rd wBMP-50yr.gpw					Return Period: 50 Year			Tuesday, 11 / 15 / 2016	

Hydrograph Report

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

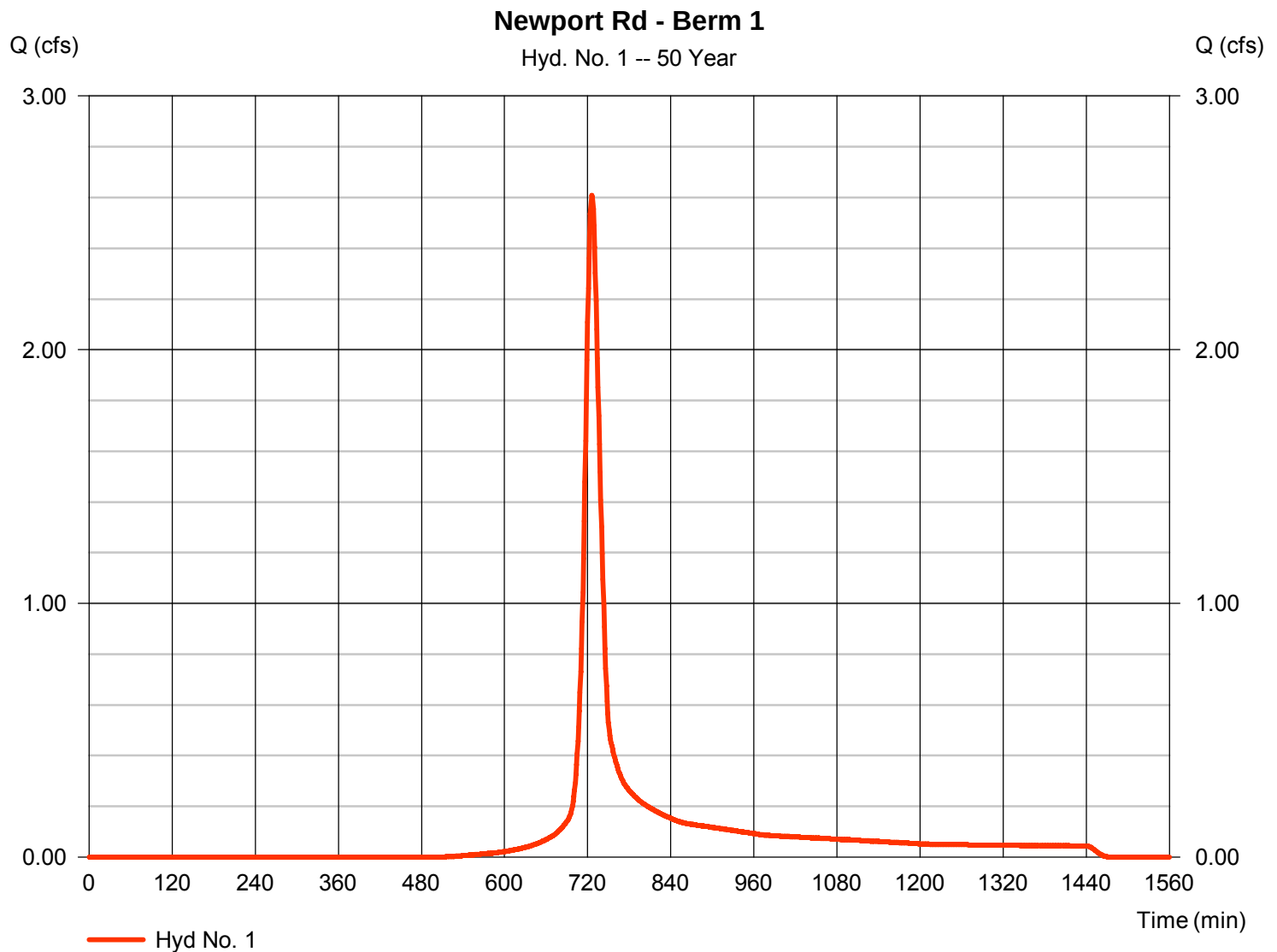
Tuesday, 11 / 15 / 2016

Hyd. No. 1

Newport Rd - Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.608 cfs
Storm frequency	= 50 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 8,586 cuft
Drainage area	= 0.980 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 21.00 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.460 \times 78) + (0.100 \times 89) + (0.030 \times 91)] / 0.980$



Hydrograph Report

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

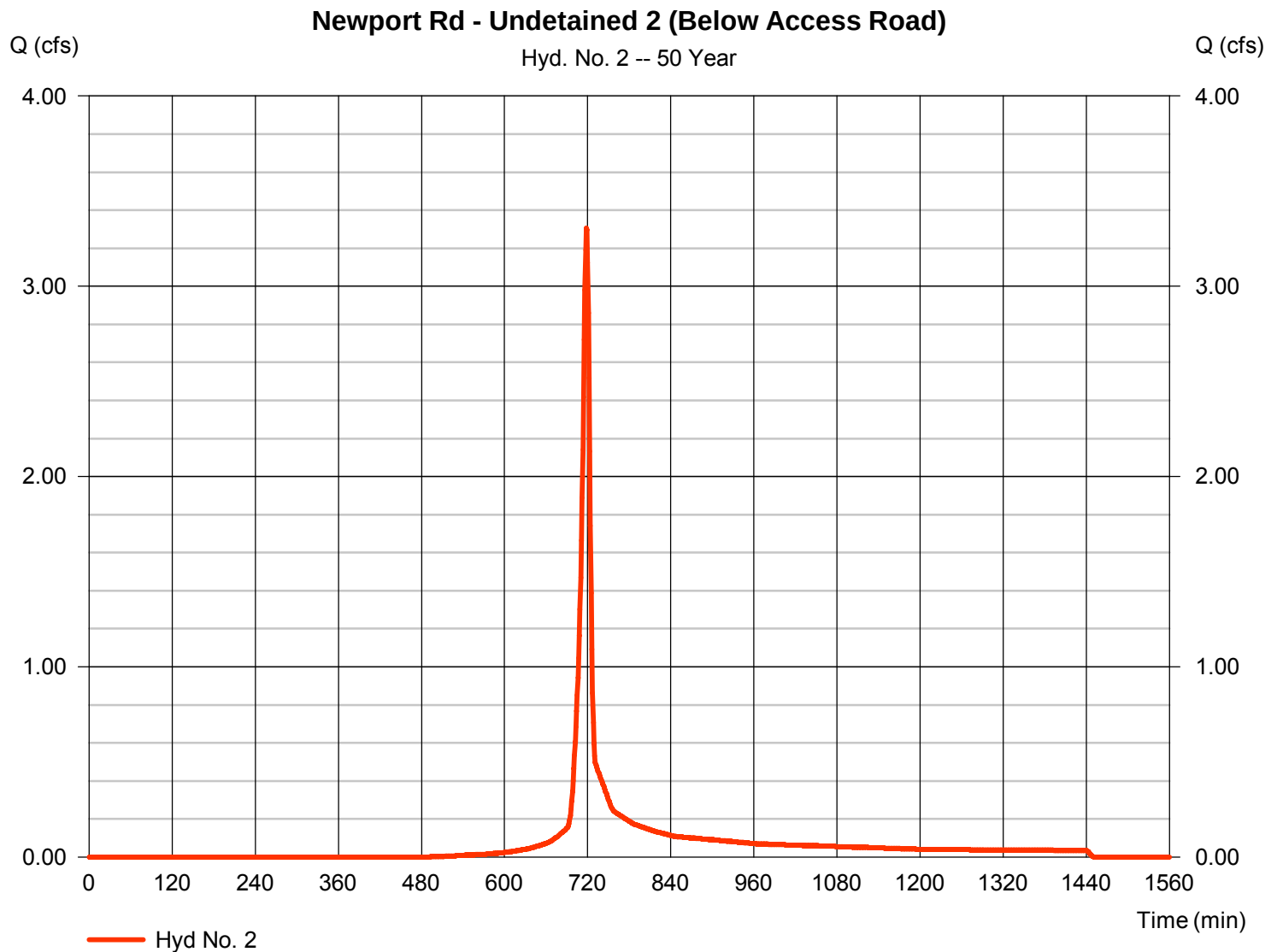
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.307 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 7,010 cuft
Drainage area	= 0.800 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.70 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)}58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc				6.70 min			

Hydrograph Report

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

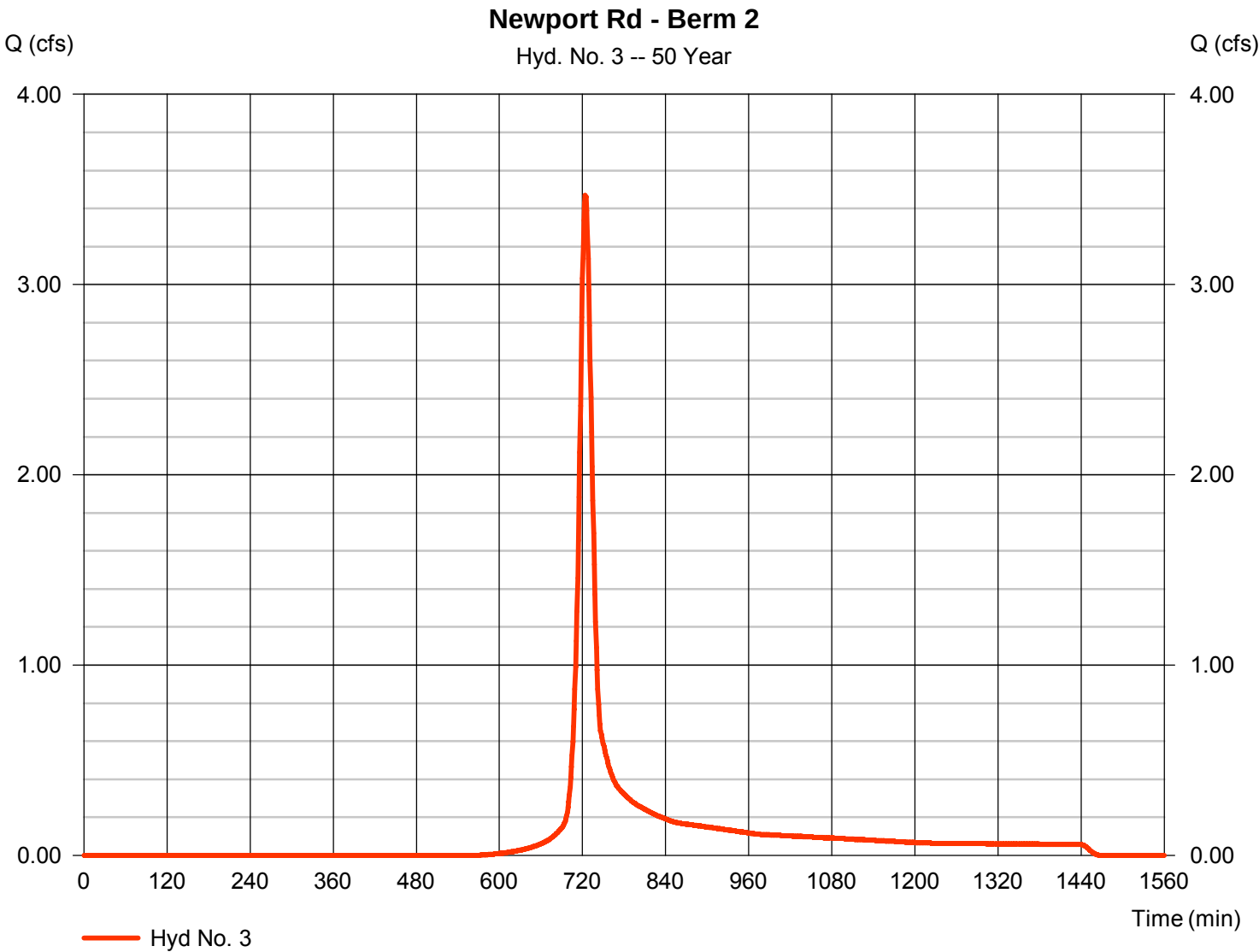
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 3.471 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 10,366 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.80 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.070 x 71) + (0.030 x 77) + (0.230 x 78) + (0.060 x 89) + (0.010 x 91)] / 1.400



Hydrograph Report

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

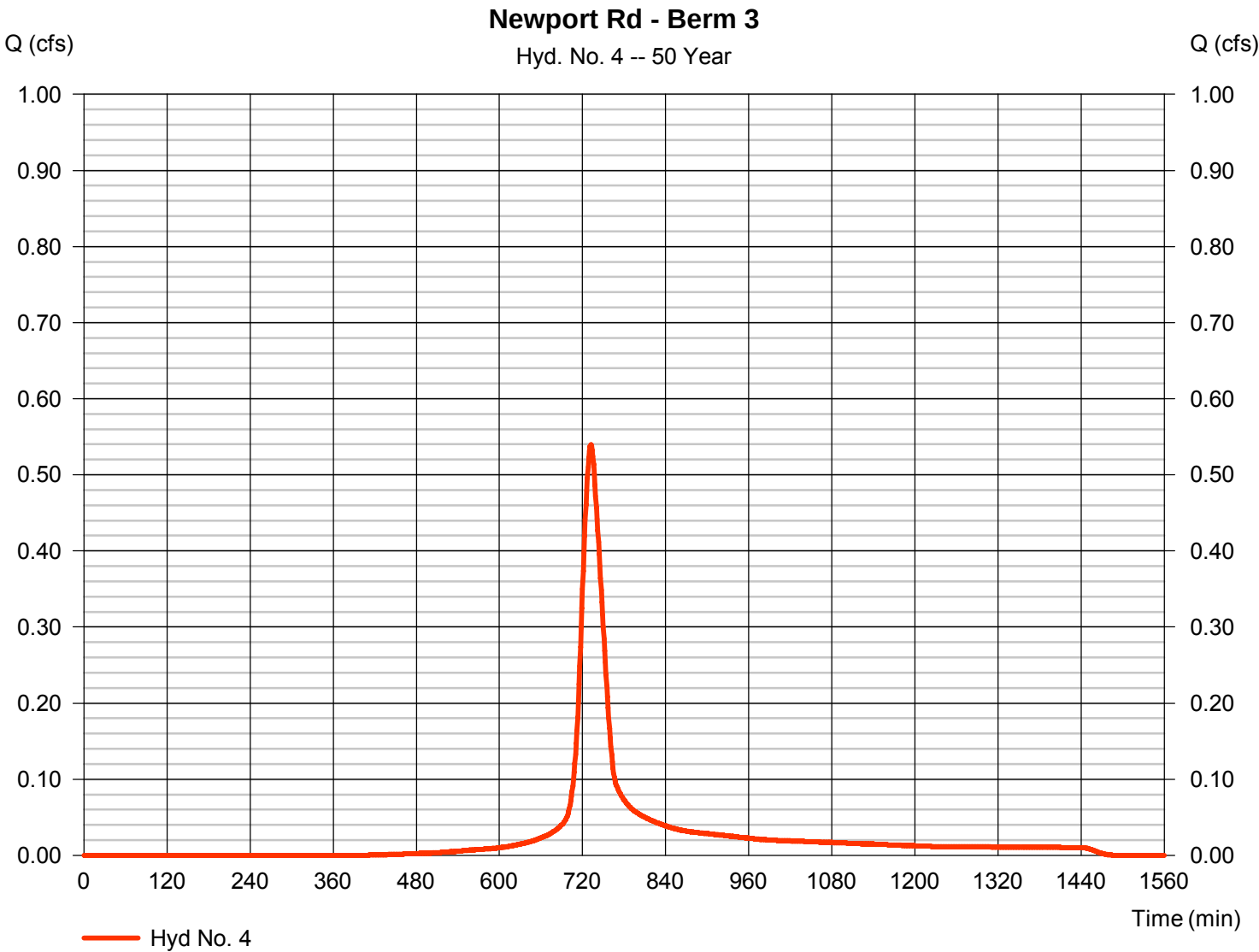
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.540 cfs
Storm frequency	=	50 yrs	Time to peak	=	732 min
Time interval	=	1 min	Hyd. volume	=	2,242 cuft
Drainage area	=	0.210 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	30.60 min
Total precip.	=	4.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.130 x 78) + (0.080 x 91)] / 0.210



Hydrograph Report

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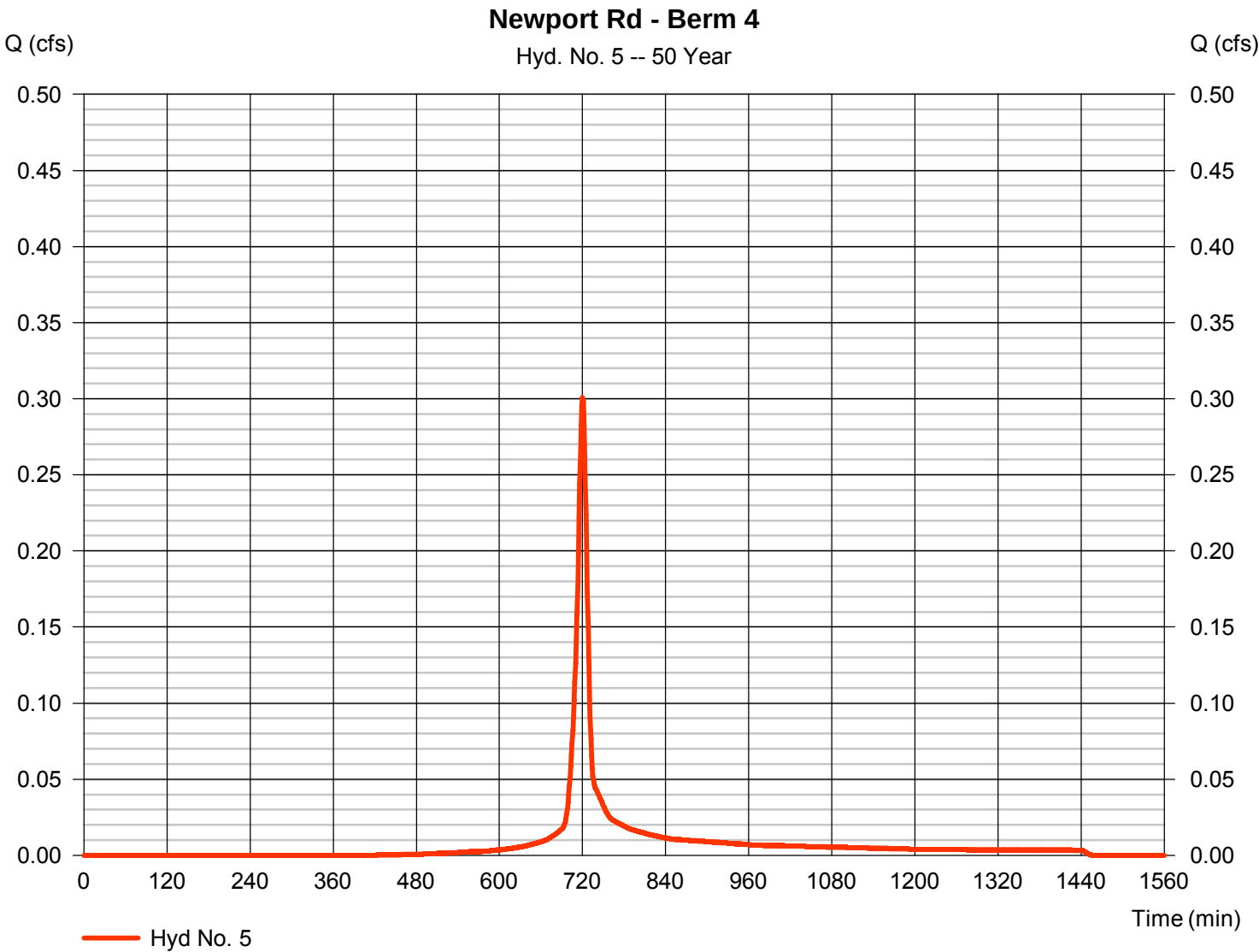
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.301 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	732 cuft
Drainage area	=	0.070 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.40 min
Total precip.	=	4.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.050 x 78) + (0.020 x 91)] / 0.070



Hydrograph Report

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

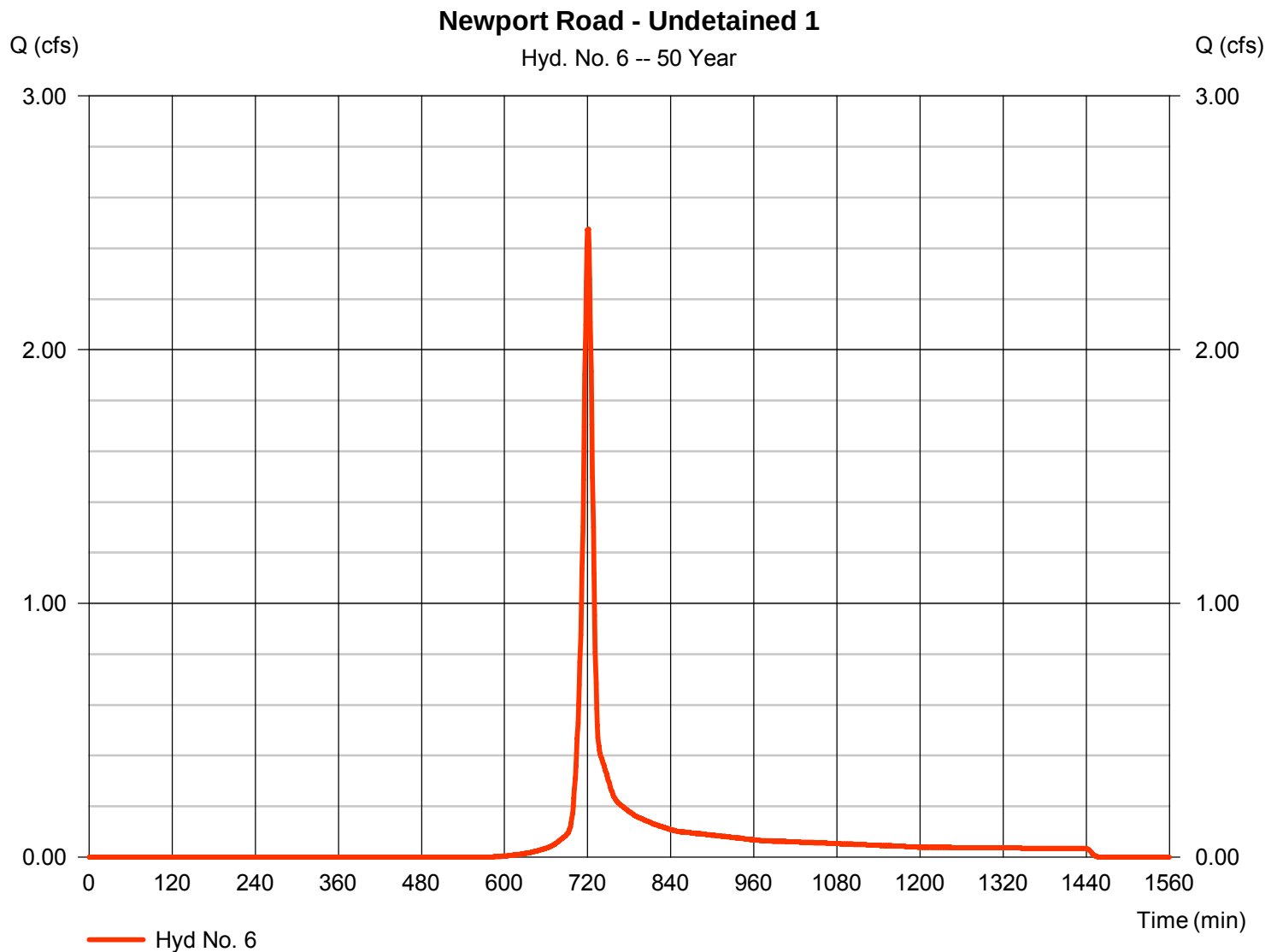
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.476 cfs
Storm frequency	=	50 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	6,013 cuft
Drainage area	=	0.820 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.80 min
Total precip.	=	4.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

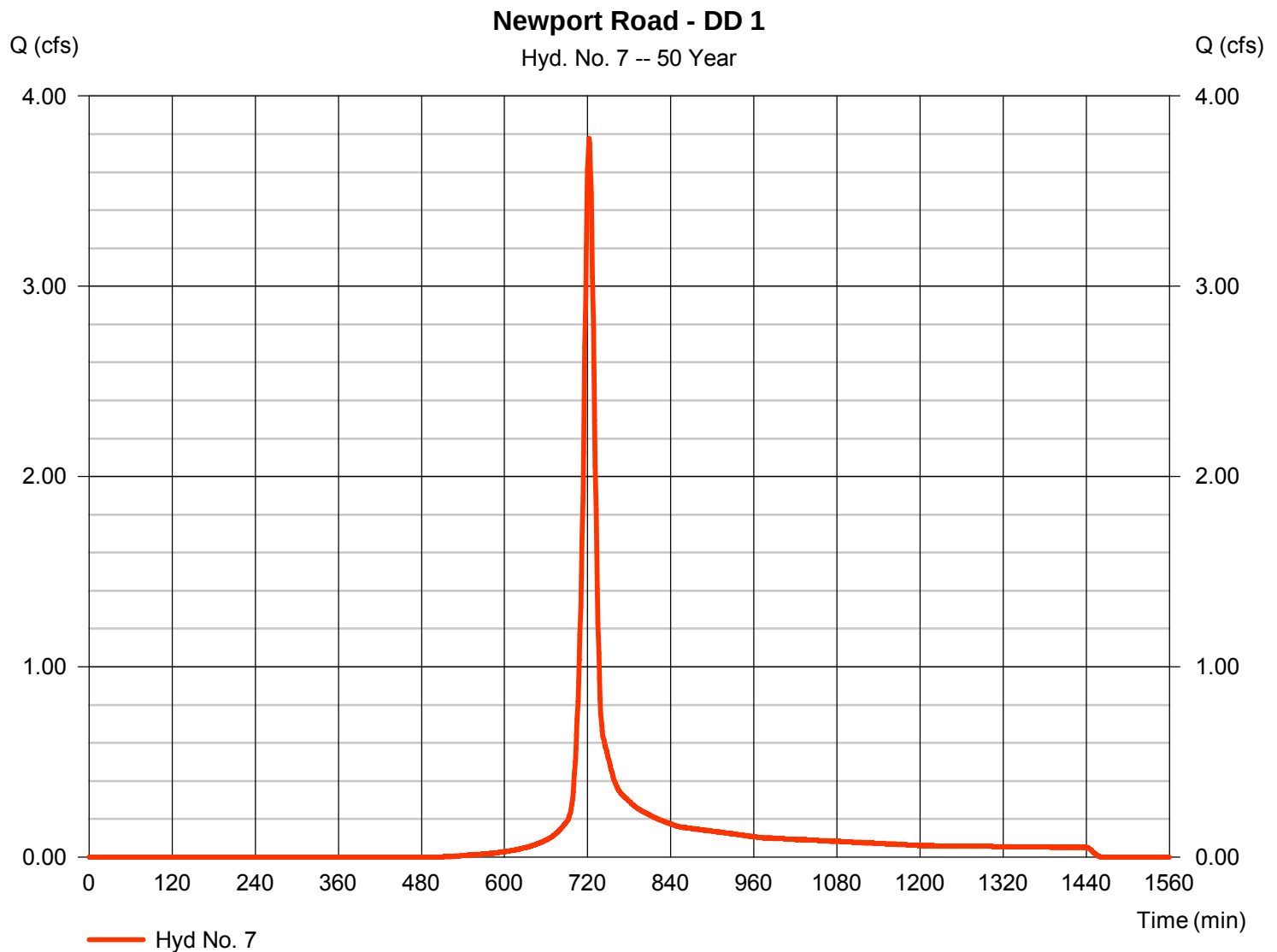
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.777 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 10,153 cuft
Drainage area	= 1.170 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.50 min
Total precip.	= 4.72 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

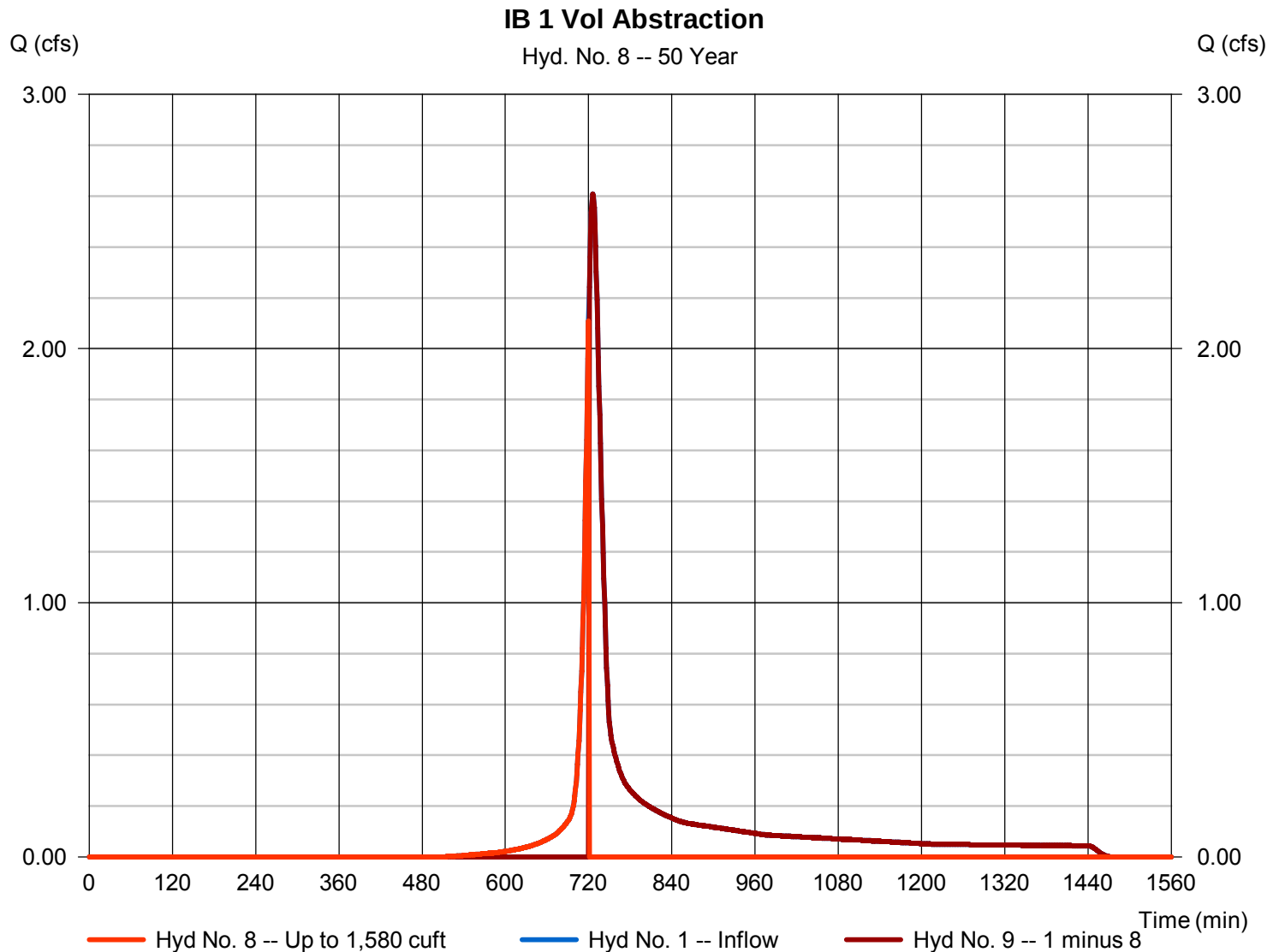
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Tuesday, 11 / 15 / 2016

Hyd. No. 8

IB 1 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.108 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 1,618 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 9
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

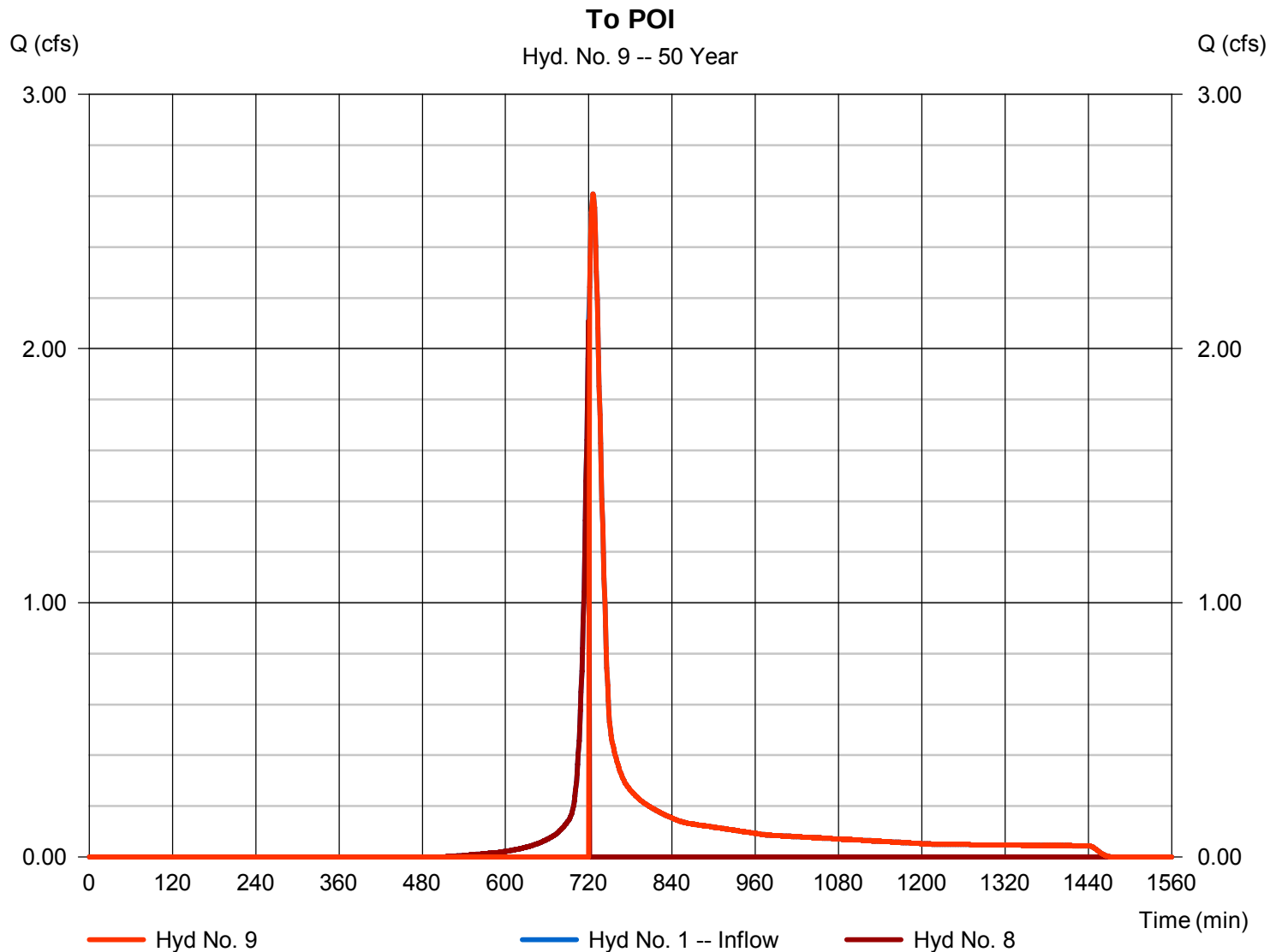
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Tuesday, 11 / 15 / 2016

Hyd. No. 9

To POI

Hydrograph type	= Diversion2	Peak discharge	= 2.608 cfs
Storm frequency	= 50 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 6,968 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 8
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

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

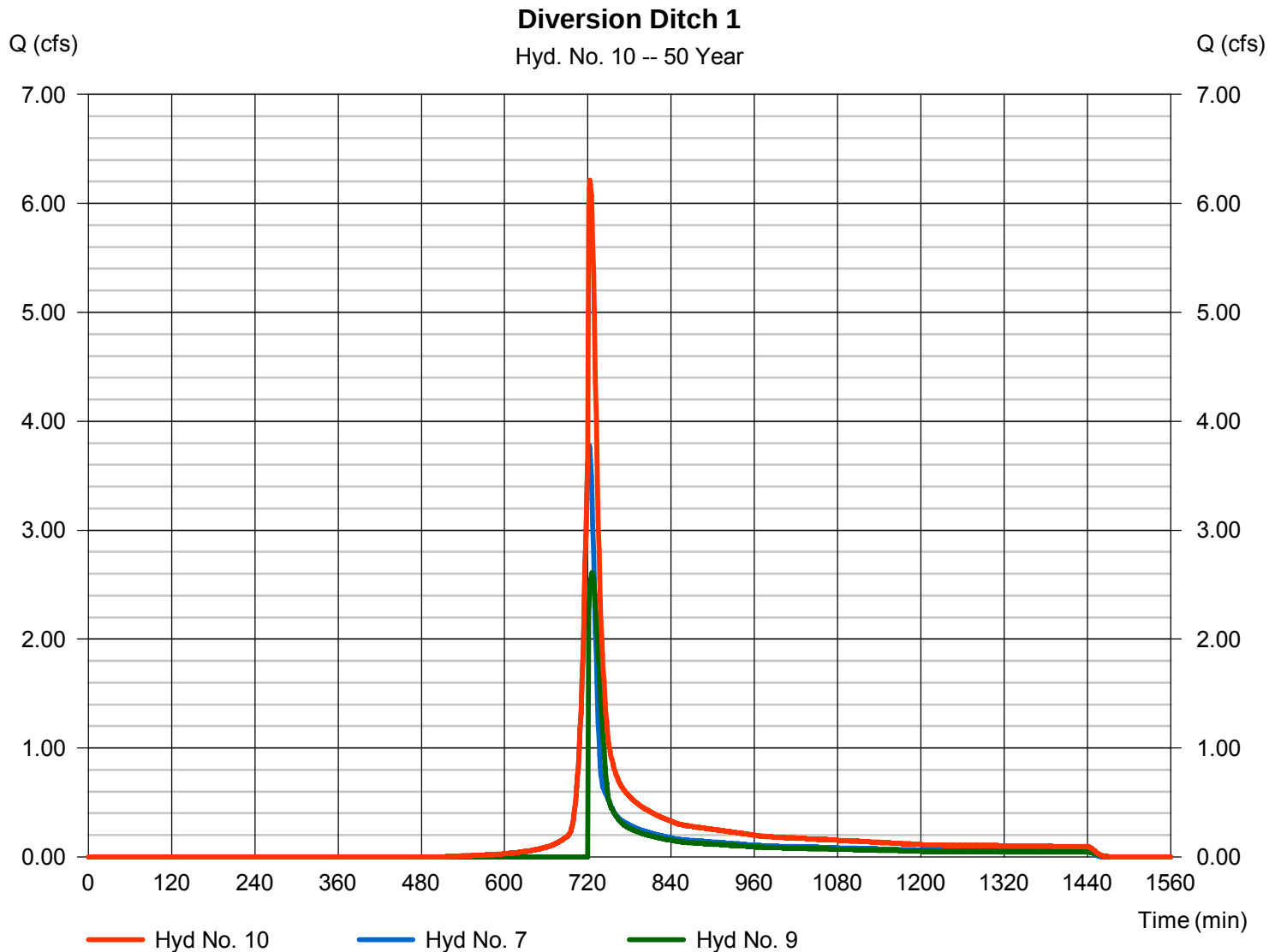
Tuesday, 11 / 15 / 2016

Hyd. No. 10

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 7, 9

Peak discharge = 6.210 cfs
 Time to peak = 723 min
 Hyd. volume = 17,121 cuft
 Contrib. drain. area = 1.170 ac



Hydrograph Report

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

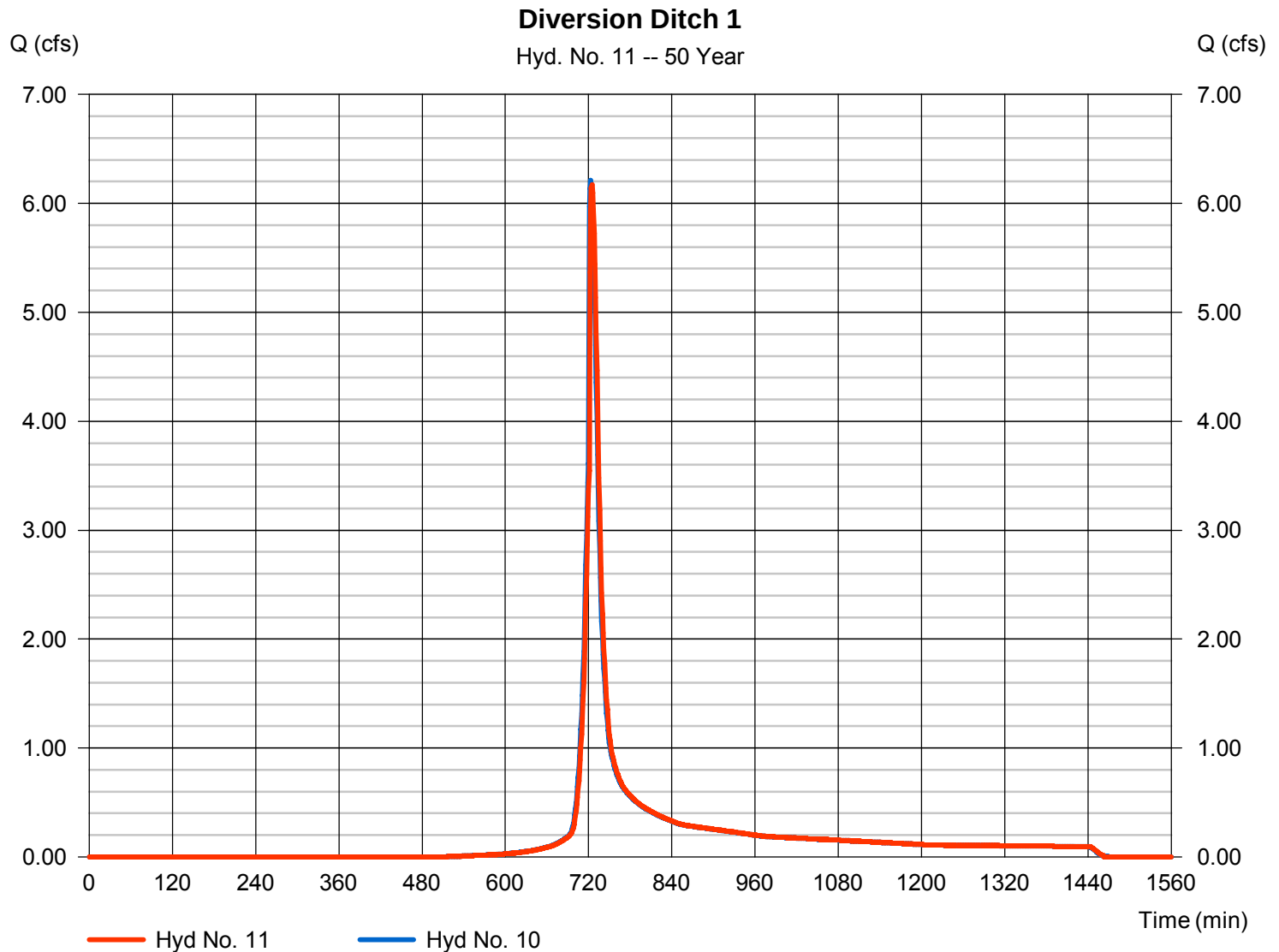
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 6.171 cfs
Storm frequency	= 50 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 17,118 cuft
Inflow hyd. No.	= 10 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7512

Modified Att-Kin routing method used.



Hydrograph Report

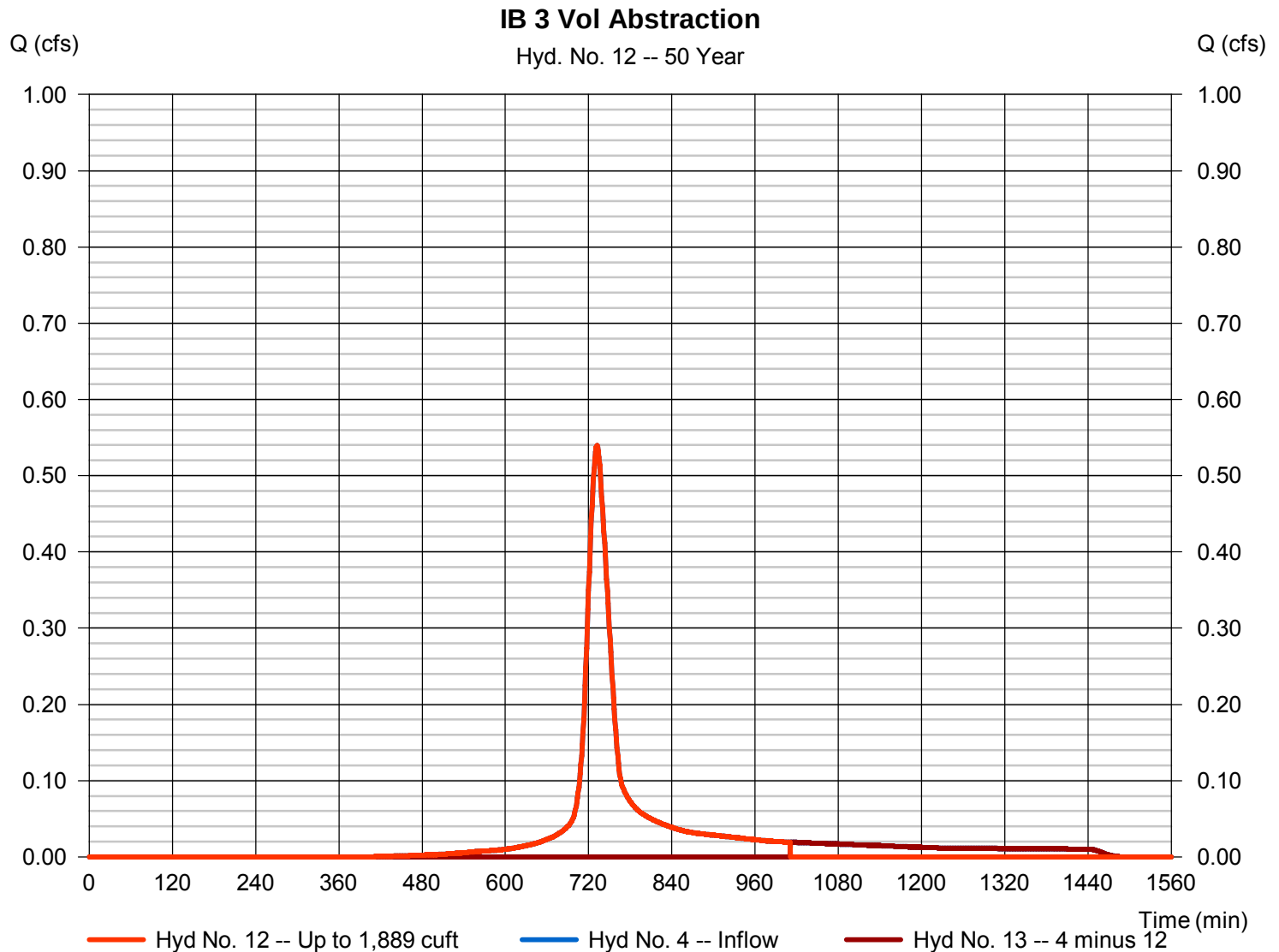
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Tuesday, 11 / 15 / 2016

Hyd. No. 12

IB 3 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.540 cfs
Storm frequency	= 50 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 1,890 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 13
Diversion method	= First Flush Volume	Volume Up To	= 1,889 cuft



Hydrograph Report

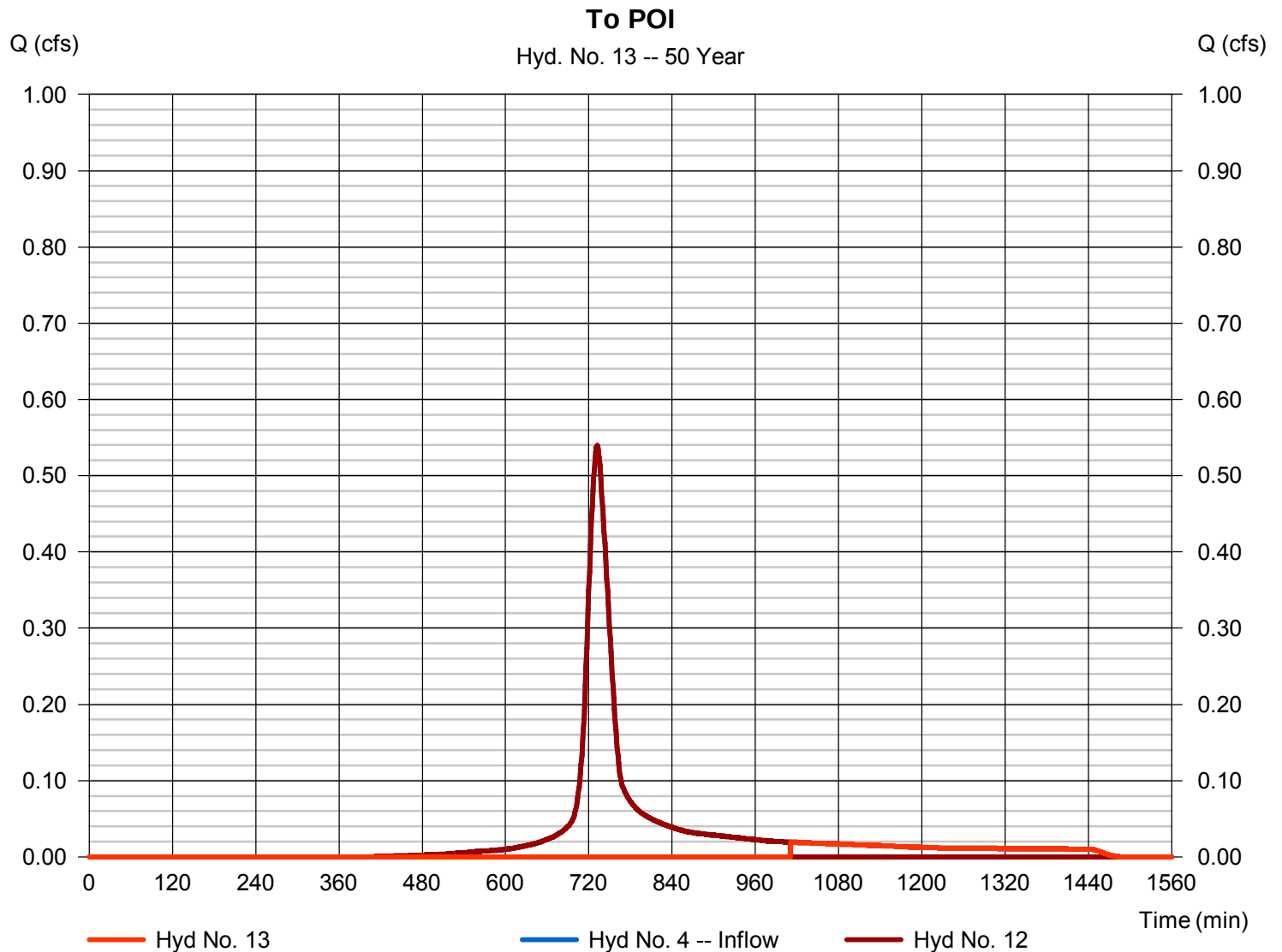
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Tuesday, 11 / 15 / 2016

Hyd. No. 13

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.019 cfs
Storm frequency	= 50 yrs	Time to peak	= 1011 min
Time interval	= 1 min	Hyd. volume	= 352 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 12
Diversion method	= First Flush Volume	Volume Up To	= 1,889 cuft



Hydrograph Report

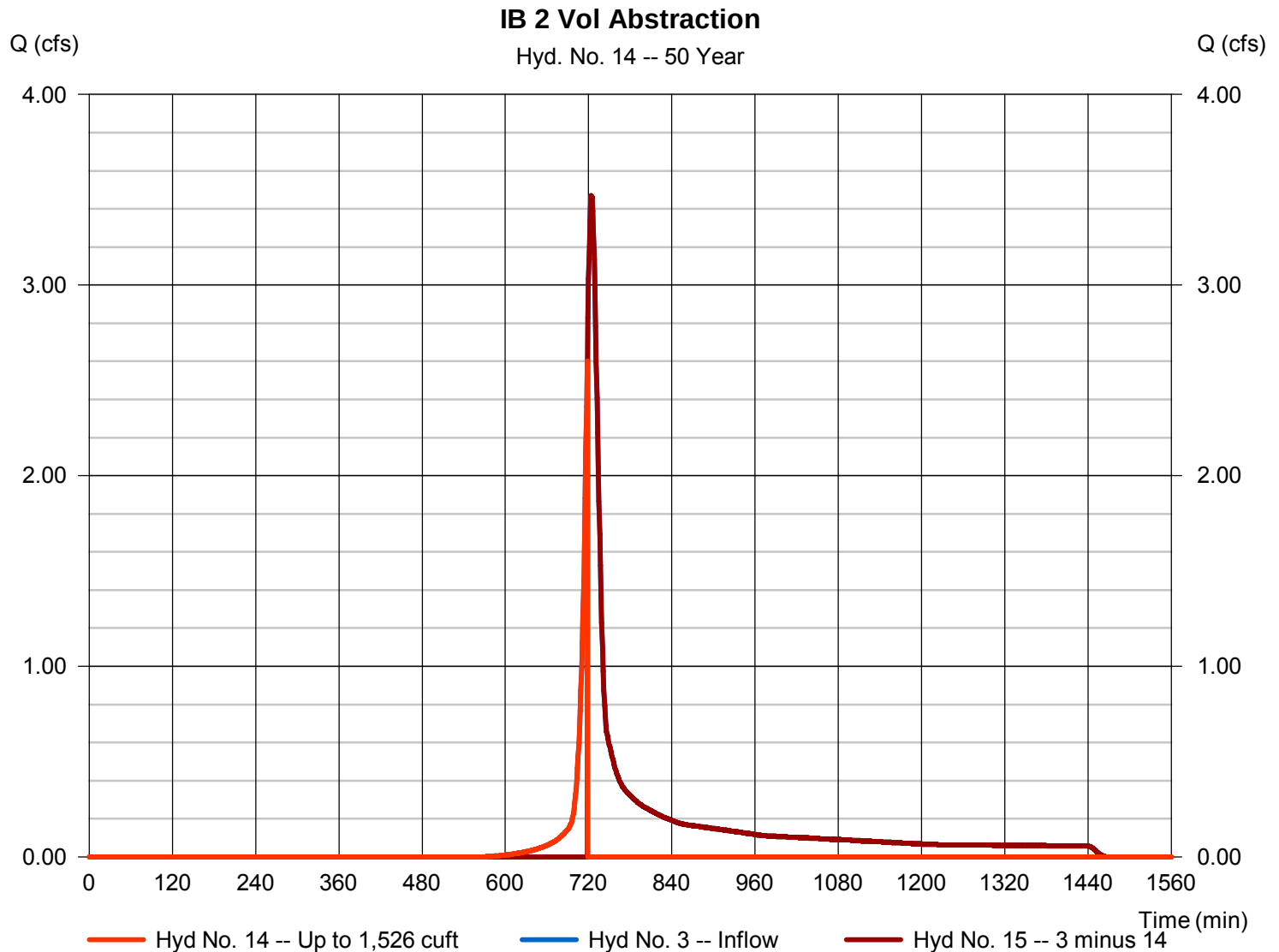
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 14

IB 2 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.602 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 1,638 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 15
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

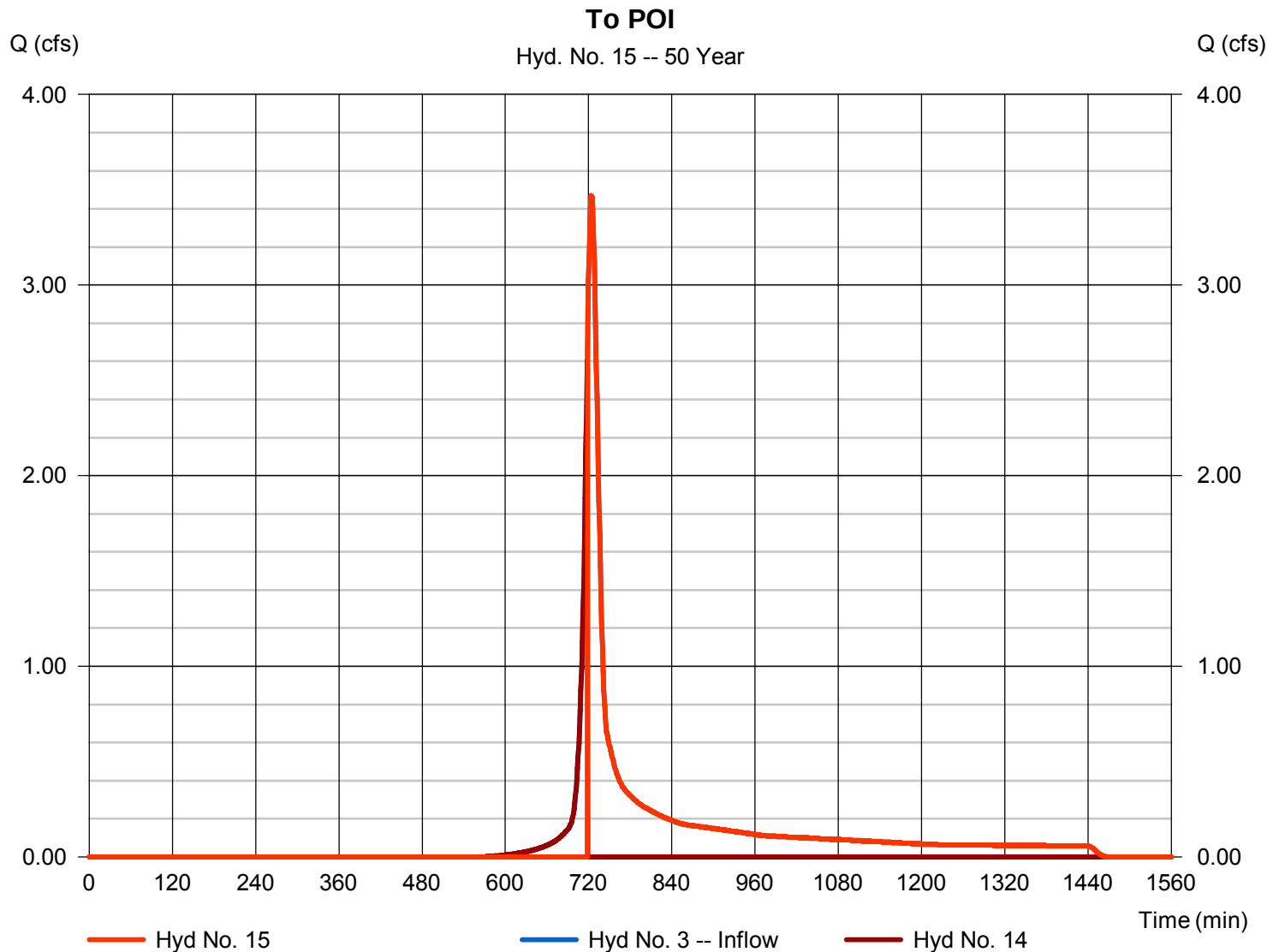
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 15

To POI

Hydrograph type	= Diversion2	Peak discharge	= 3.471 cfs
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 8,728 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 14
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

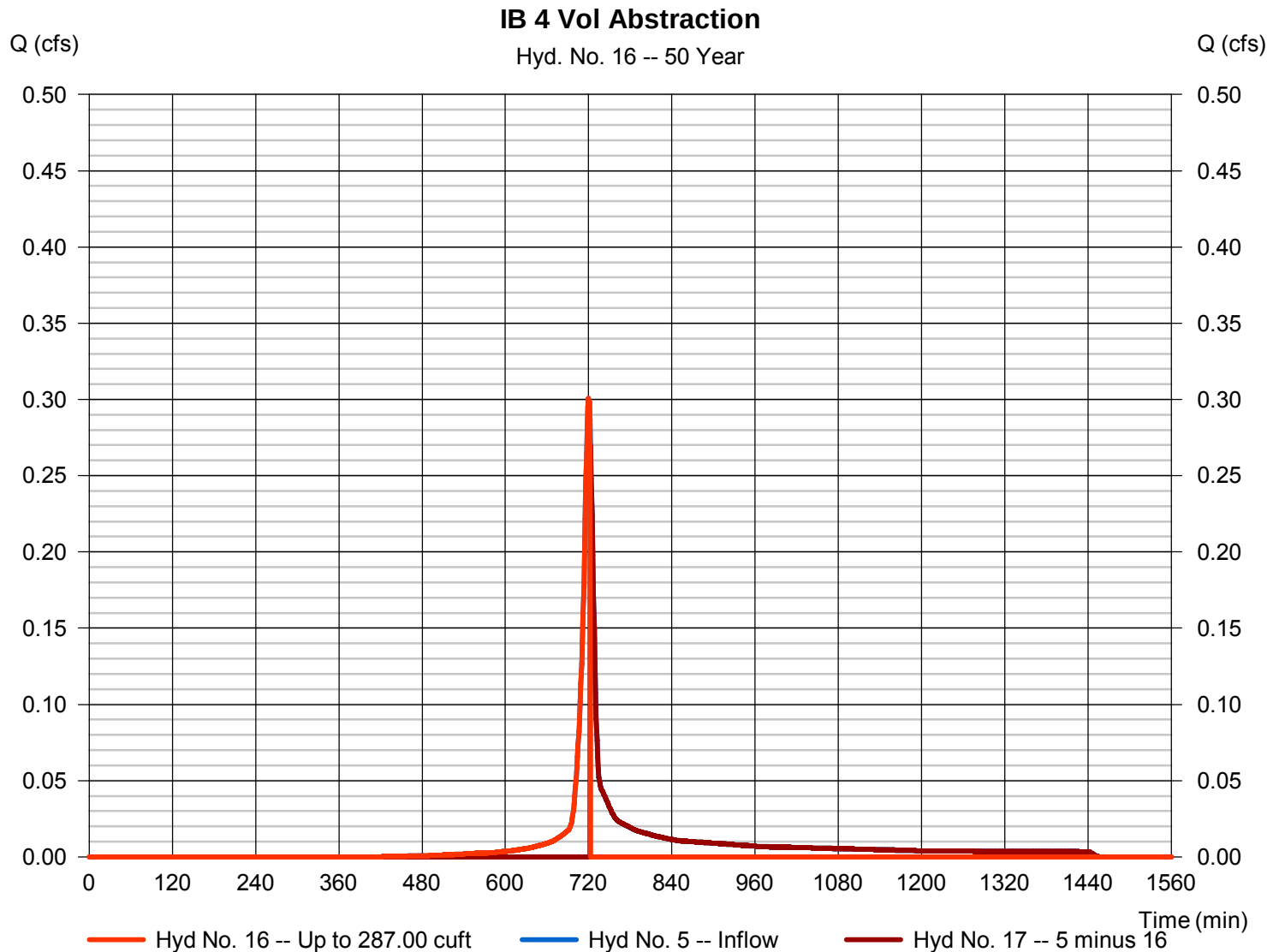
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 16

IB 4 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.301 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 295 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 17
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

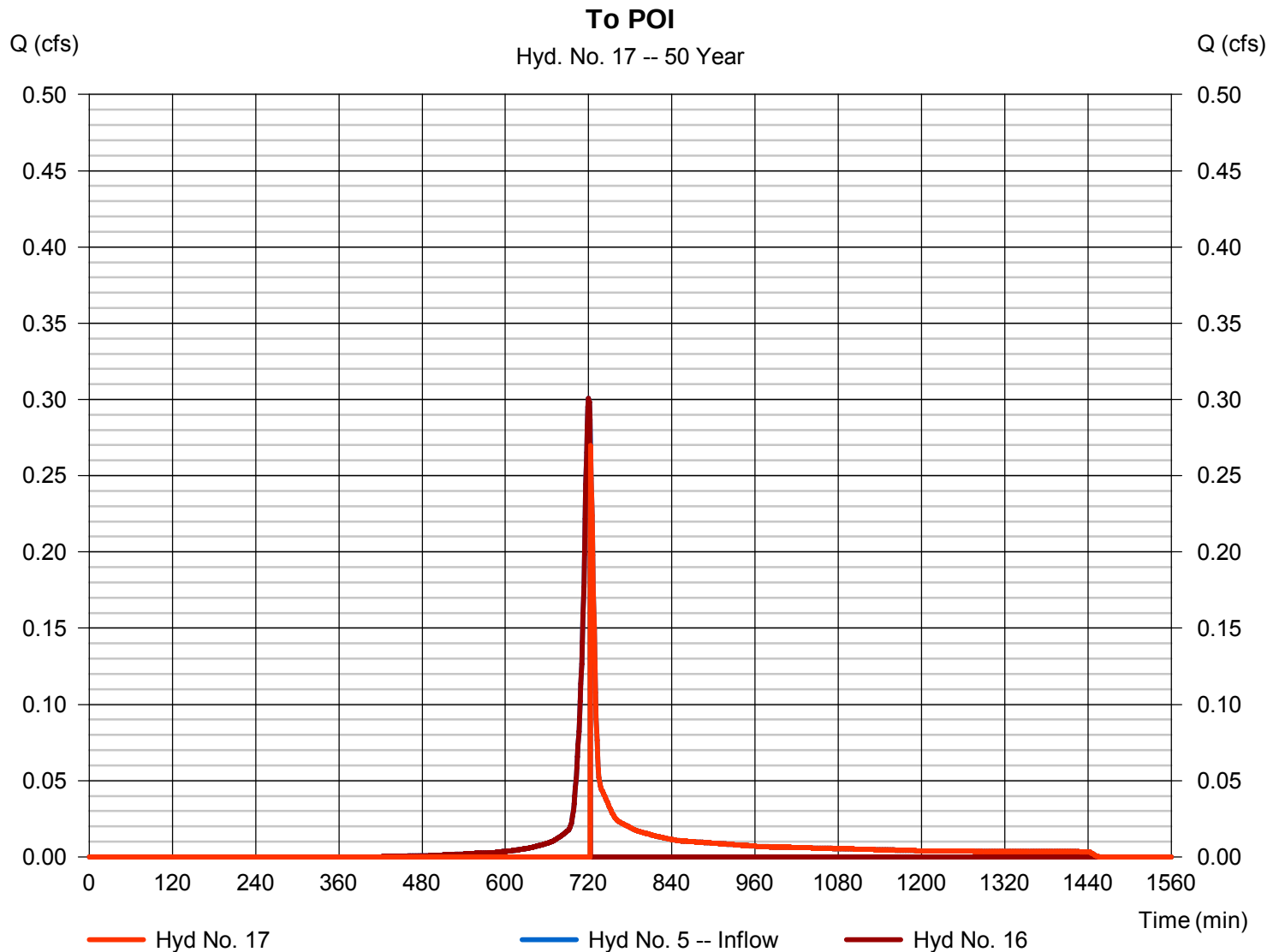
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 17

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.270 cfs
Storm frequency	= 50 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 437 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 16
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

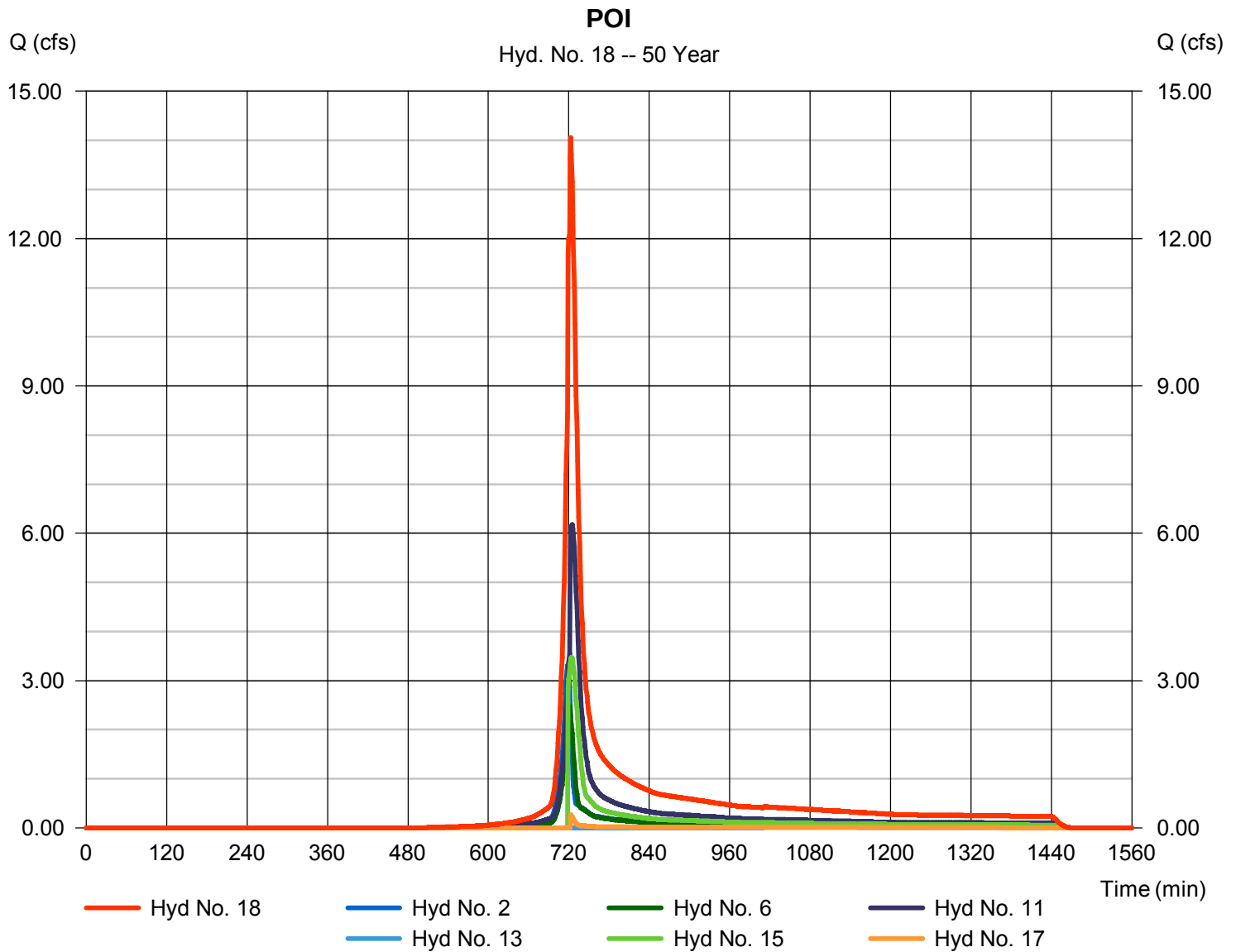
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 18

POI

Hydrograph type	= Combine	Peak discharge	= 14.05 cfs
Storm frequency	= 50 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 39,658 cuft
Inflow hyds.	= 2, 6, 11, 13, 15, 17	Contrib. drain. area	= 1.620 ac



ATTACHMENT C-4
NEWPORT RD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Newport Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	5.466	-----	-----	11.50	-----	19.42	23.37	Newport Rd - PRE
Proj. file: Newport Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	23.37	1	719	52,887	-----	-----	-----	Newport Rd - PRE
Newport Rd-PRE.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

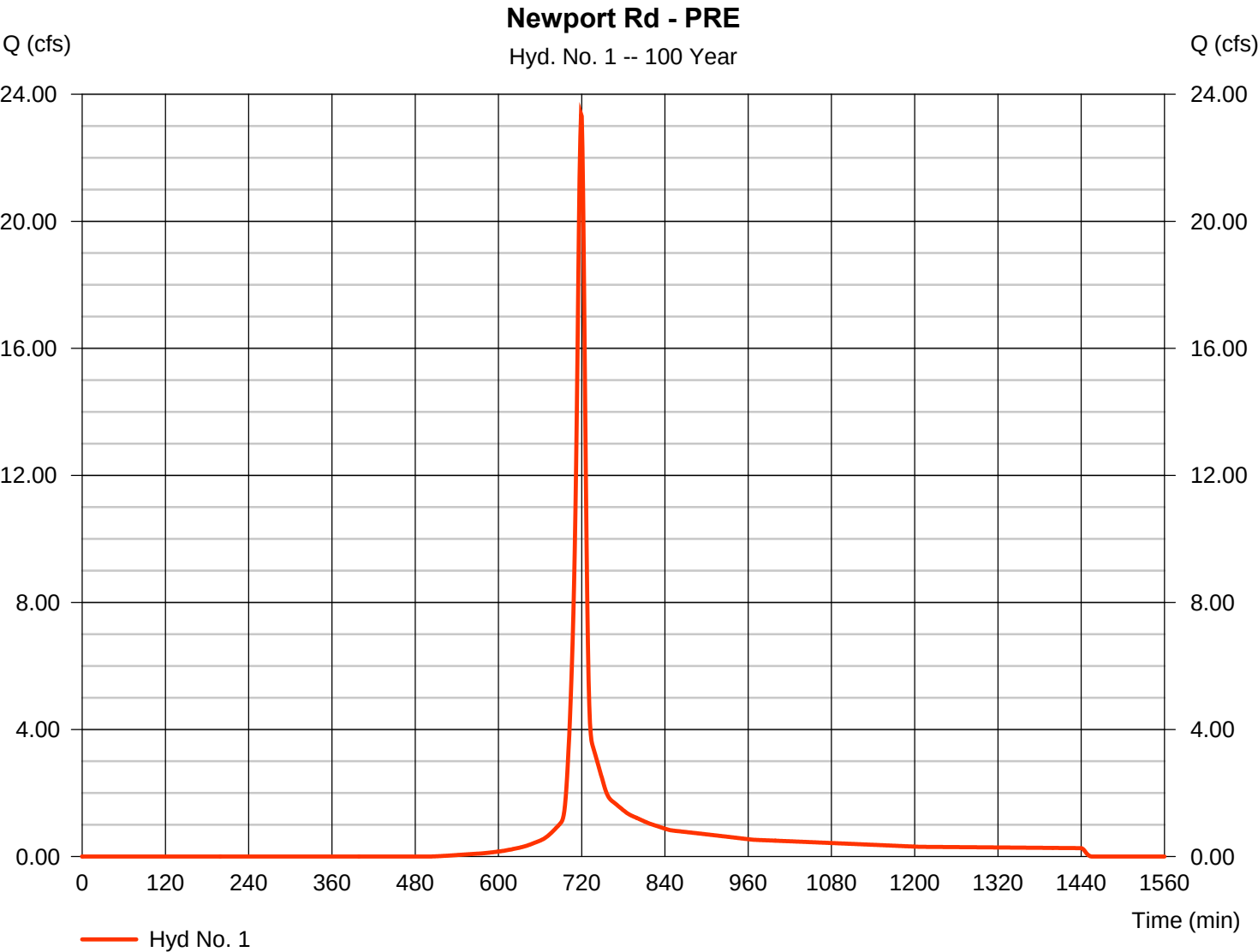
Hydrograph Report

Hyd. No. 1

Newport Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.37 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	52,887 cuft
Drainage area	=	5.440 ac	Curve number	=	75*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.00 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(2.530 x 71) + (2.680 x 78) + (0.230 x 77)] / 5.440



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

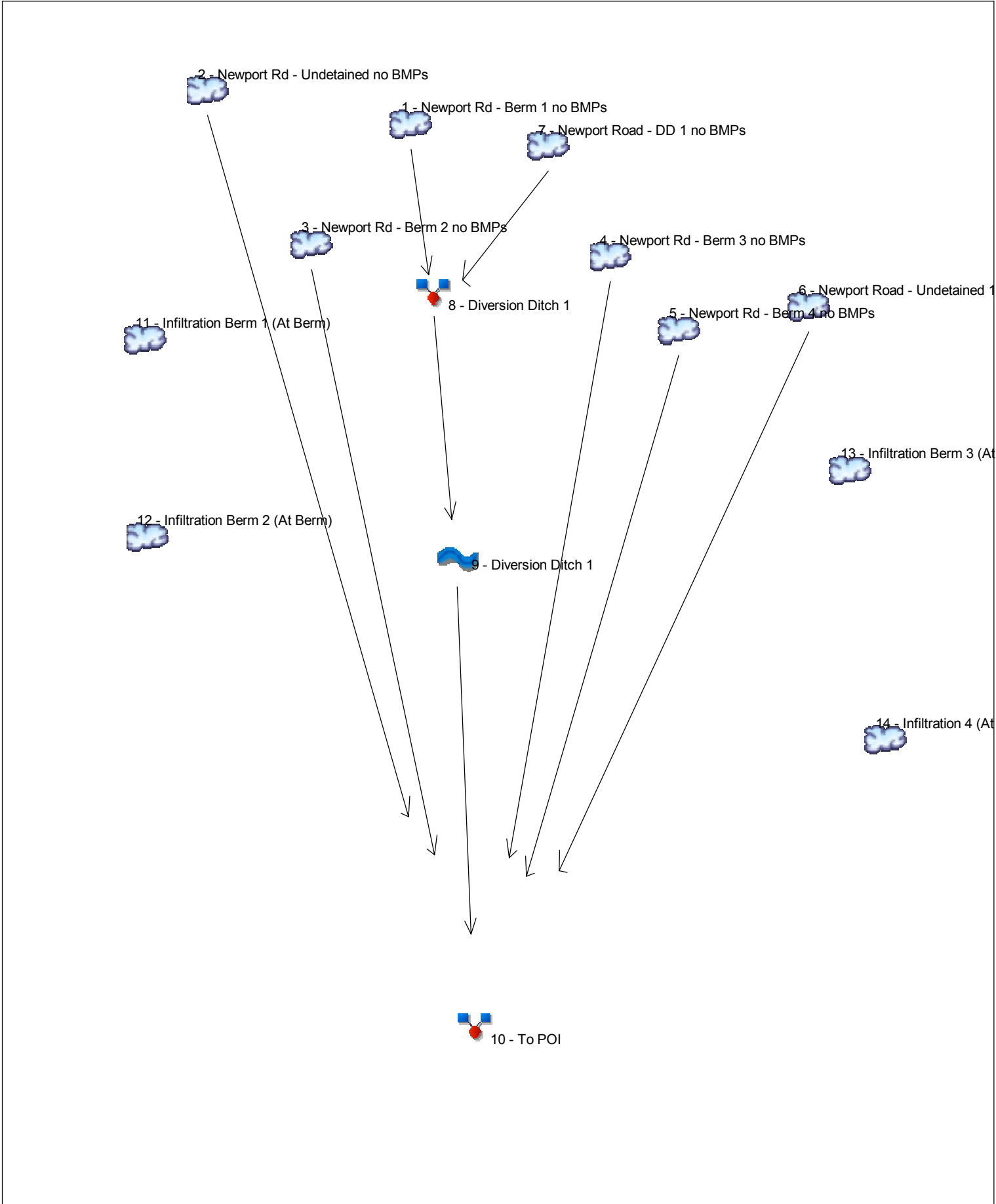
Hyd. No. 1

Newport Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 6.35	+	0.00	+	0.00	=	6.35
Shallow Concentrated Flow							
Flow length (ft)	= 620.00	141.00	124.00				
Watercourse slope (%)	= 6.50	12.80	4.70				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.11	5.77	3.50				
Travel Time (min)	= 2.51	+	0.41	+	0.59	=	3.51
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)63.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc					10.00 min		

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.758	-----	-----	1.432	-----	2.282	2.694	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	-----	-----	1.053	-----	-----	2.041	-----	3.307	3.927	Newport Rd - Undetained no BMPs
3	SCS Runoff	-----	-----	0.964	-----	-----	2.202	-----	3.878	4.722	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	-----	-----	0.432	-----	-----	0.754	-----	1.148	1.337	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	-----	-----	0.595	-----	-----	1.394	-----	2.476	3.022	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	1.121	-----	-----	2.272	-----	3.777	4.516	Newport Road - DD 1 no BMPs
8	Combine	1, 7	-----	1.870	-----	-----	3.695	-----	6.035	7.178	Diversion Ditch 1
9	Reach	8	-----	1.859	-----	-----	3.677	-----	6.014	7.156	Diversion Ditch 1
10	Combine	2, 3, 4, 5, 6, 9	-----	4.448	-----	-----	9.297	-----	15.70	18.87	To POI
11	SCS Runoff	-----	-----	0.613	-----	-----	1.265	-----	2.128	2.558	Infiltration Berm 1 (At Berm)
12	SCS Runoff	-----	-----	0.782	-----	-----	1.836	-----	3.263	3.993	Infiltration Berm 2 (At Berm)
13	SCS Runoff	-----	-----	0.343	-----	-----	0.602	-----	0.923	1.076	Infiltration Berm 3 (At Berm)
14	SCS Runoff	-----	-----	0.138	-----	-----	0.243	-----	0.374	0.436	Infiltration 4 (At Berm)
Proj. file: Newport Rd No BMP.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	2.694	1	721	6,841	-----	-----	-----	Newport Rd - Berm 1 no BMPs
2	SCS Runoff	3.927	1	718	8,355	-----	-----	-----	Newport Rd - Undetained no BMPs
3	SCS Runoff	4.722	1	722	12,715	-----	-----	-----	Newport Rd - Berm 2 no BMPs
4	SCS Runoff	1.337	1	716	2,614	-----	-----	-----	Newport Rd - Berm 3 no BMPs
5	SCS Runoff	0.436	1	715	793	-----	-----	-----	Newport Rd - Berm 4 no BMPs
6	SCS Runoff	3.022	1	720	7,319	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	4.516	1	722	12,142	-----	-----	-----	Newport Road - DD 1 no BMPs
8	Combine	7.178	1	722	18,983	1, 7	-----	-----	Diversion Ditch 1
9	Reach	7.156	1	723	18,982	8	-----	-----	Diversion Ditch 1
10	Combine	18.87	1	720	50,778	2, 3, 4, 5, 6, 9	-----	-----	To POI
11	SCS Runoff	2.558	2	720	6,632	-----	-----	-----	Infiltration Berm 1 (At Berm)
12	SCS Runoff	3.993	2	720	10,399	-----	-----	-----	Infiltration Berm 2 (At Berm)
13	SCS Runoff	1.076	2	716	2,217	-----	-----	-----	Infiltration Berm 3 (At Berm)
14	SCS Runoff	0.436	1	715	793	-----	-----	-----	Infiltration 4 (At Berm)
Newport Rd No BMP.gpw					Return Period: 100 Year			Tuesday, 11 / 15 / 2016	

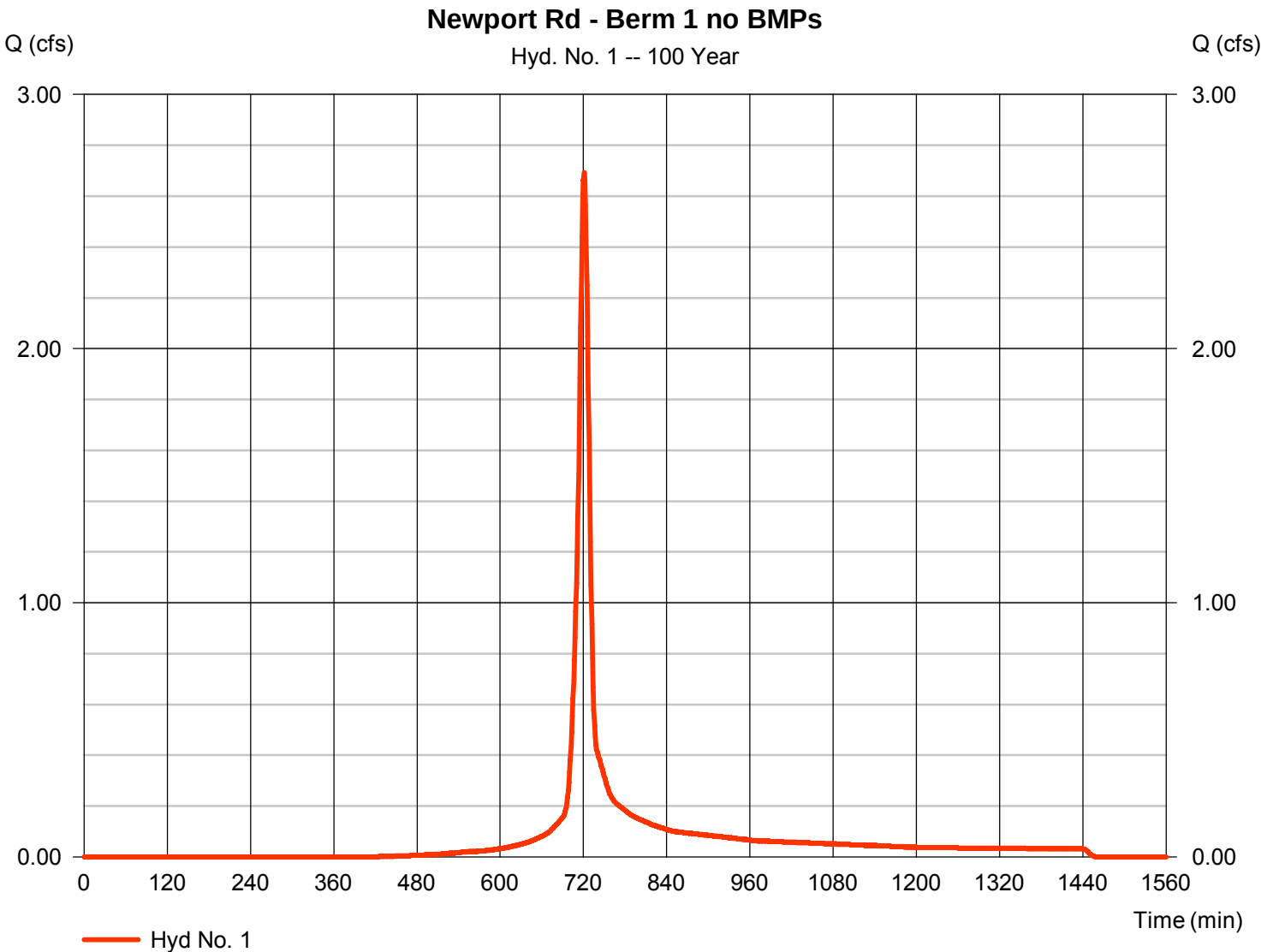
Hydrograph Report

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.694 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	6,841 cuft
Drainage area	=	0.610 ac	Curve number	=	80*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.42 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.390 x 71) + (0.460 x 78) + (0.100 x 89) + (0.030 x 91)] / 0.610



TR55 Tc Worksheet

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

Hyd. No. 1

Newport Rd - Berm 1 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	297.00				
Watercourse slope (%)	= 8.00	4.80	6.40				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	4.08				
Travel Time (min)	= 0.92	+	0.23	+	1.21	=	2.36
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	= 0.025	0.025	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.42 min			

Hydrograph Report

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

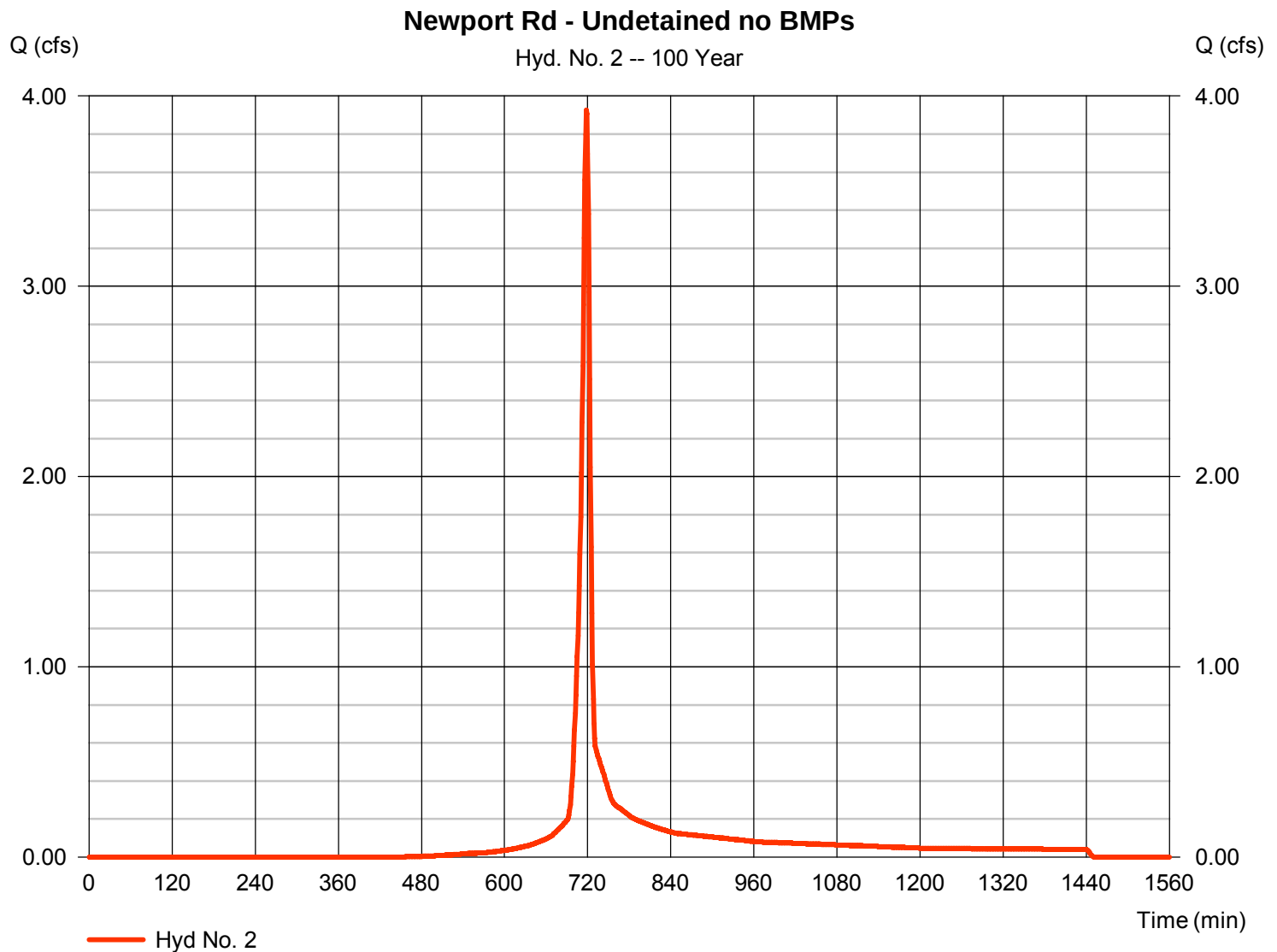
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.927 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	8,355 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.70 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained no BMPs

<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)	= 2.51	0.00	0.00	
Land slope (%)	= 10.00	0.00	0.00	
Travel Time (min)	= 5.81	+	0.00	+
			0.00	= 5.81
Shallow Concentrated Flow				
Flow length (ft)	= 55.00	142.00	0.00	
Watercourse slope (%)	= 15.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=6.25	3.95	0.00	
Travel Time (min)	= 0.15	+	0.60	+
			0.00	= 0.75
Channel Flow				
X sectional flow area (sqft)	= 2.00	0.00	0.00	
Wetted perimeter (ft)	= 4.47	0.00	0.00	
Channel slope (%)	= 6.70	0.00	0.00	
Manning's n-value	= 0.025	0.025	0.015	
Velocity (ft/s)	=9.00	0.00	0.00	
Flow length (ft)	({})58.0	0.0	0.0	
Travel Time (min)	= 0.11	+	0.00	+
			0.00	= 0.11
Total Travel Time, Tc				6.70 min

Hydrograph Report

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

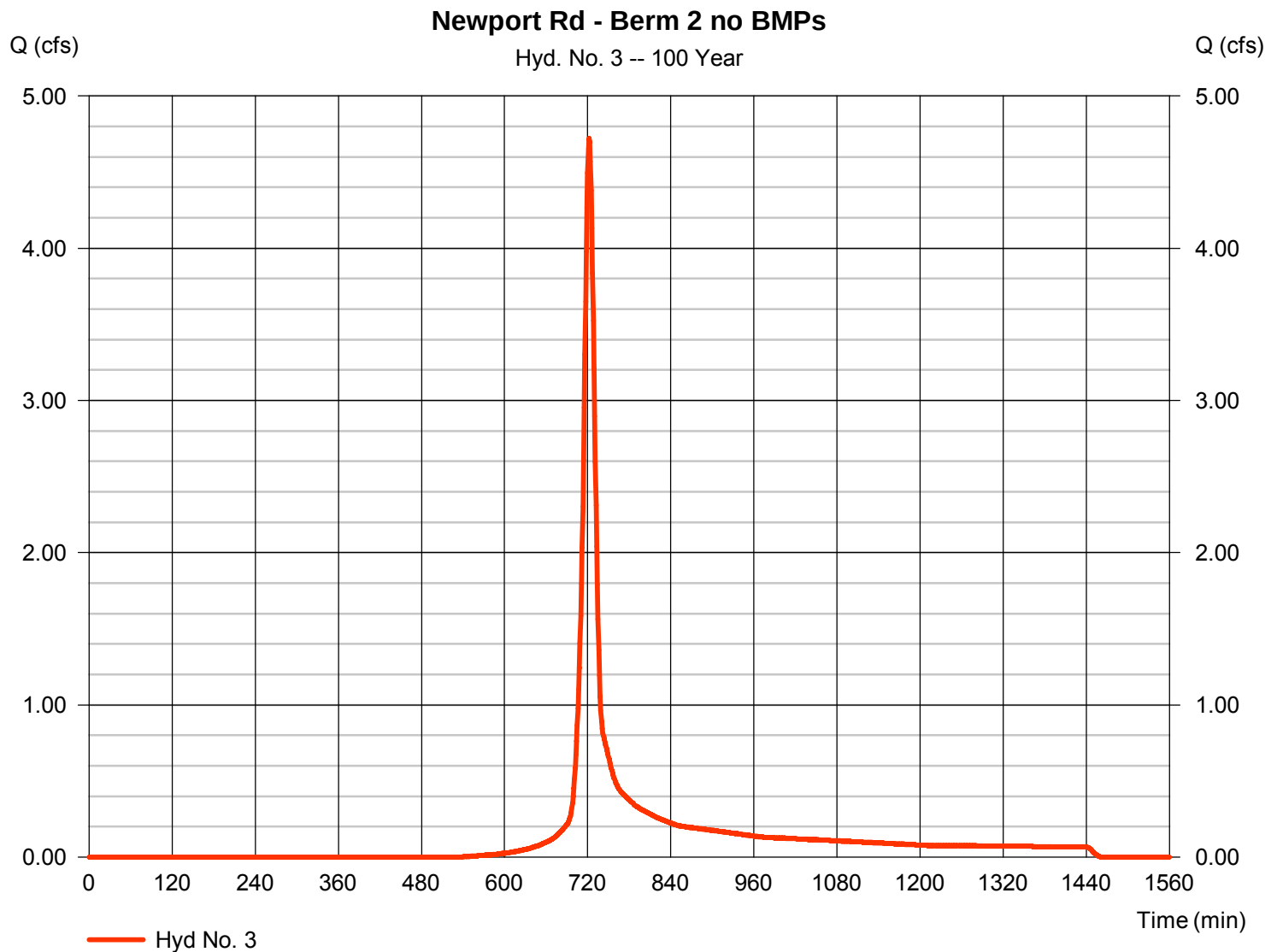
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 4.722 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 12,715 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.40 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



TR55 Tc Worksheet

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

Hyd. No. 3

Newport Rd - Berm 2 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	239.00	175.00				
Watercourse slope (%)	= 6.40	11.00	6.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.08	5.35	3.95				
Travel Time (min)	= 1.85	+	0.74	+	0.74	=	3.33
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	= 0.025	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				14.40 min			

Hydrograph Report

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

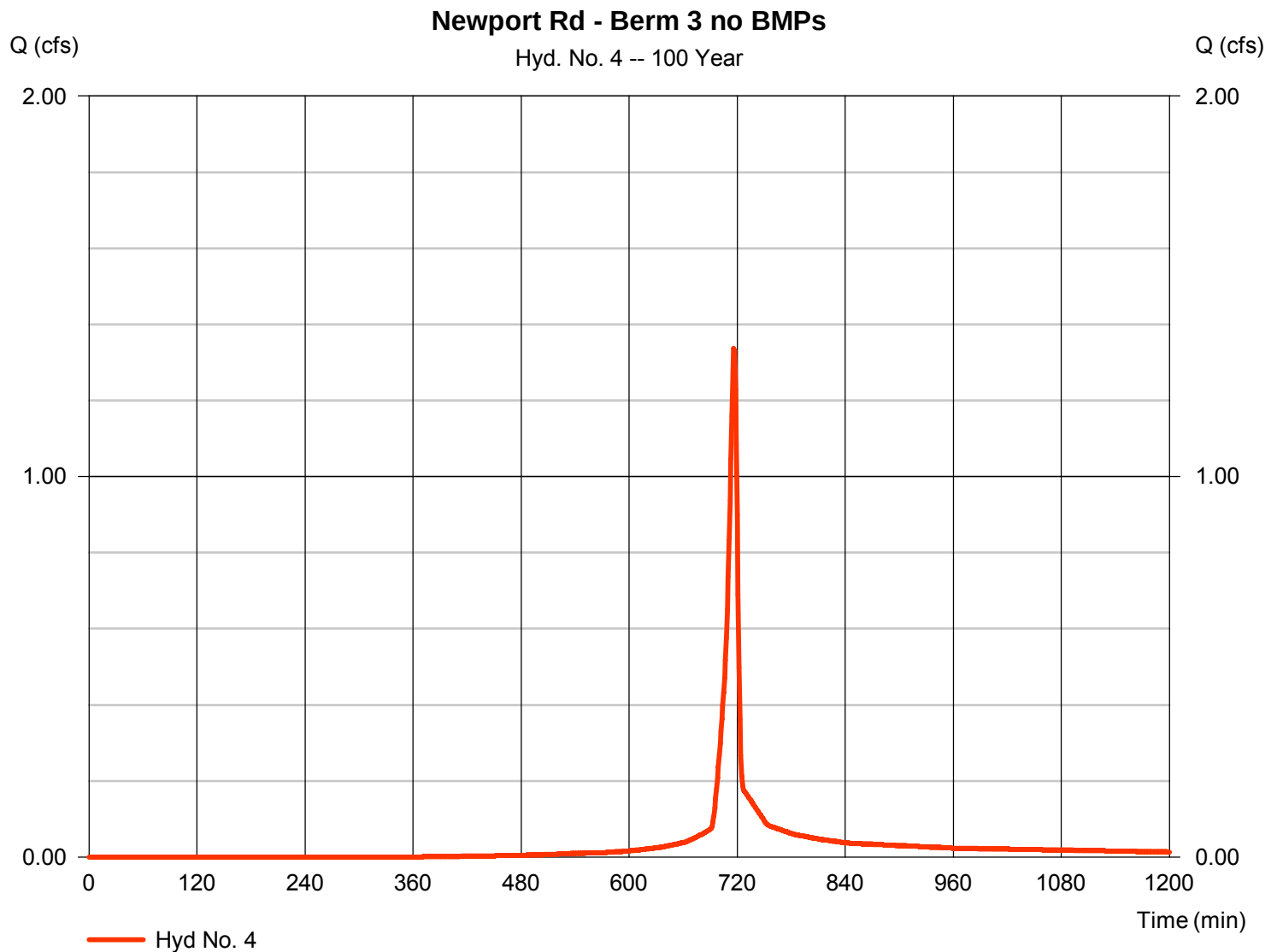
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.337 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	1 min	Hyd. volume	=	2,614 cuft
Drainage area	=	0.210 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.60 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.130 \times 78) + (0.080 \times 91)] / 0.210$



TR55 Tc Worksheet

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

Hyd. No. 4

Newport Rd - Berm 3 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	94.00	0.00				
Watercourse slope (%)	= 5.50	8.50	0.00				
Surface description	= Paved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.77	4.70	0.00				
Travel Time (min)	= 0.57	+	0.33	+	0.00	=	0.90
Channel Flow							
X sectional flow area (sqft)	= 2.00	2.00	0.00				
Wetted perimeter (ft)	= 4.47	4.47	0.00				
Channel slope (%)	= 4.49	7.51	0.00				
Manning's n-value	= 0.060	0.025	0.015				
Velocity (ft/s)	=3.07	9.53	0.00				
Flow length (ft)	(0)}89.0	230.0	0.0				
Travel Time (min)	= 0.48	+	0.40	+	0.00	=	0.89
Total Travel Time, Tc				3.60 min			

Hydrograph Report

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

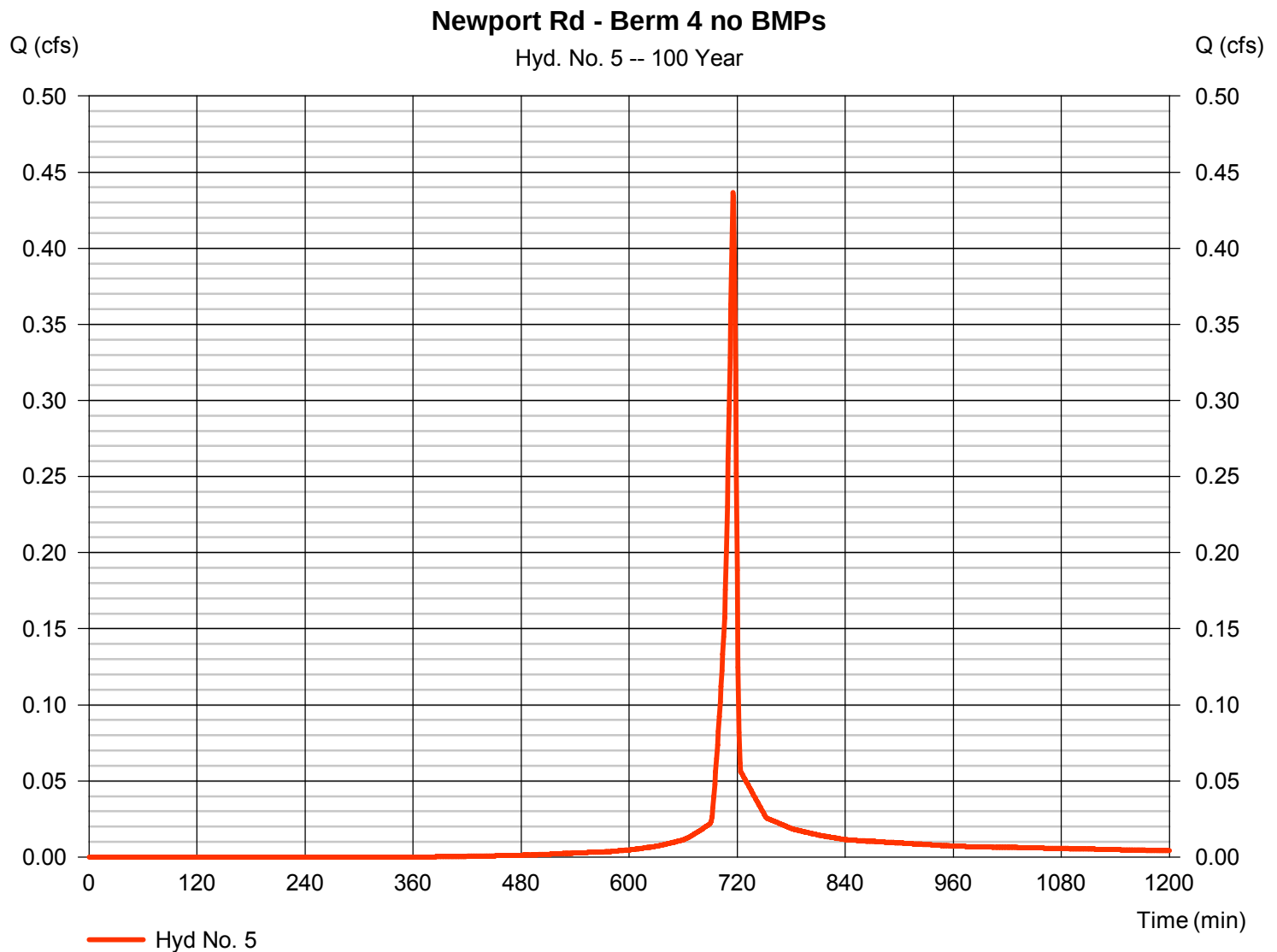
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 0.436 cfs
Storm frequency	= 100 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 793 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 2.30 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

Hyd. No. 5

Newport Rd - Berm 4 no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 69.00	0.00	0.00				
Watercourse slope (%)	= 5.90	0.00	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=3.92	0.00	0.00				
Travel Time (min)	= 0.29	+	0.00	+	0.00	=	0.29
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 7.00	0.00	0.00				
Manning's n-value	= 0.025	0.015	0.015				
Velocity (ft/s)	=9.20	0.00	0.00				
Flow length (ft)	(0)200.0	0.0	0.0				
Travel Time (min)	= 0.36	+	0.00	+	0.00	=	0.36
Total Travel Time, Tc				2.30 min			

Hydrograph Report

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

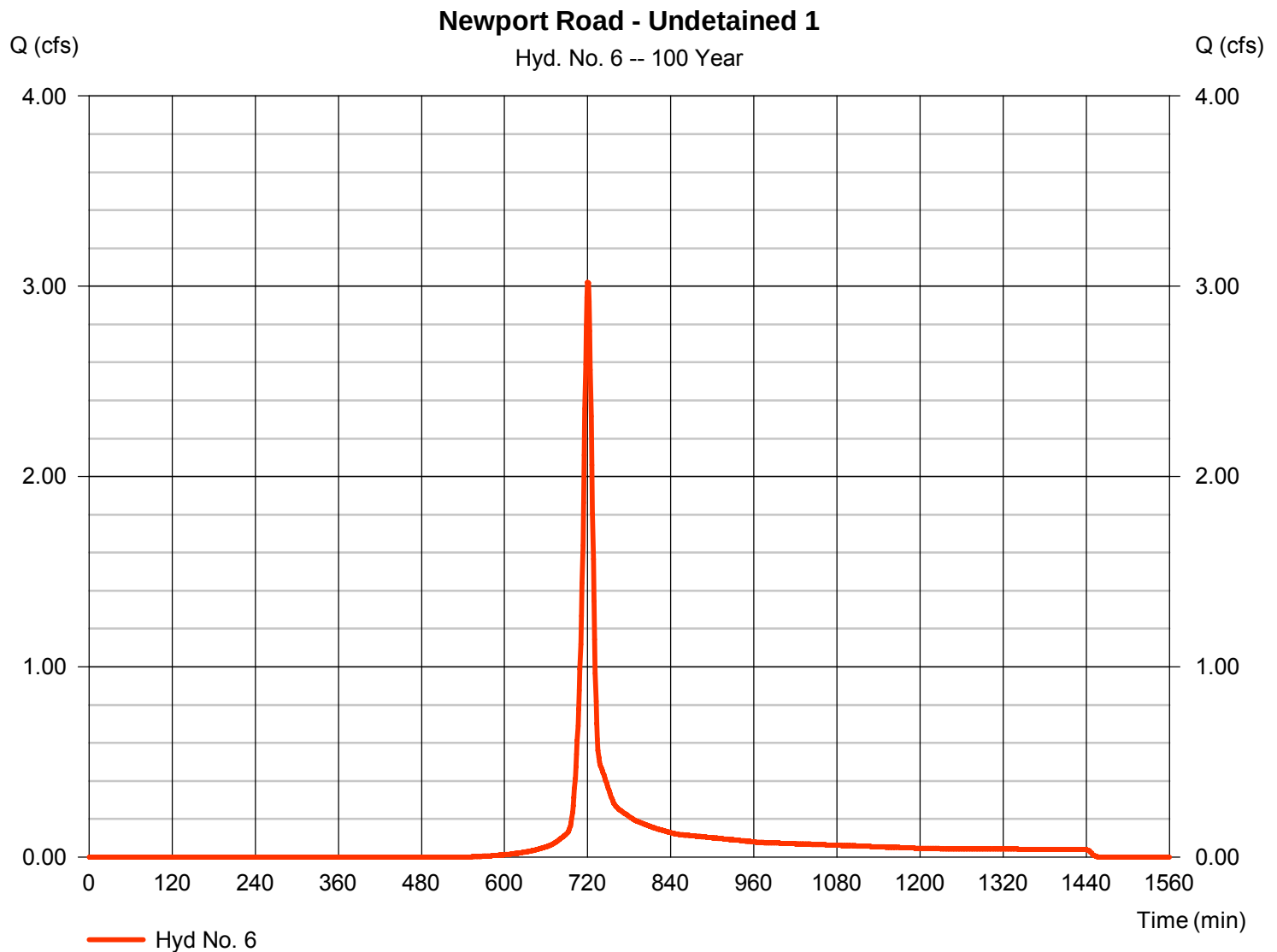
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.022 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	7,319 cuft
Drainage area	=	0.820 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.80 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

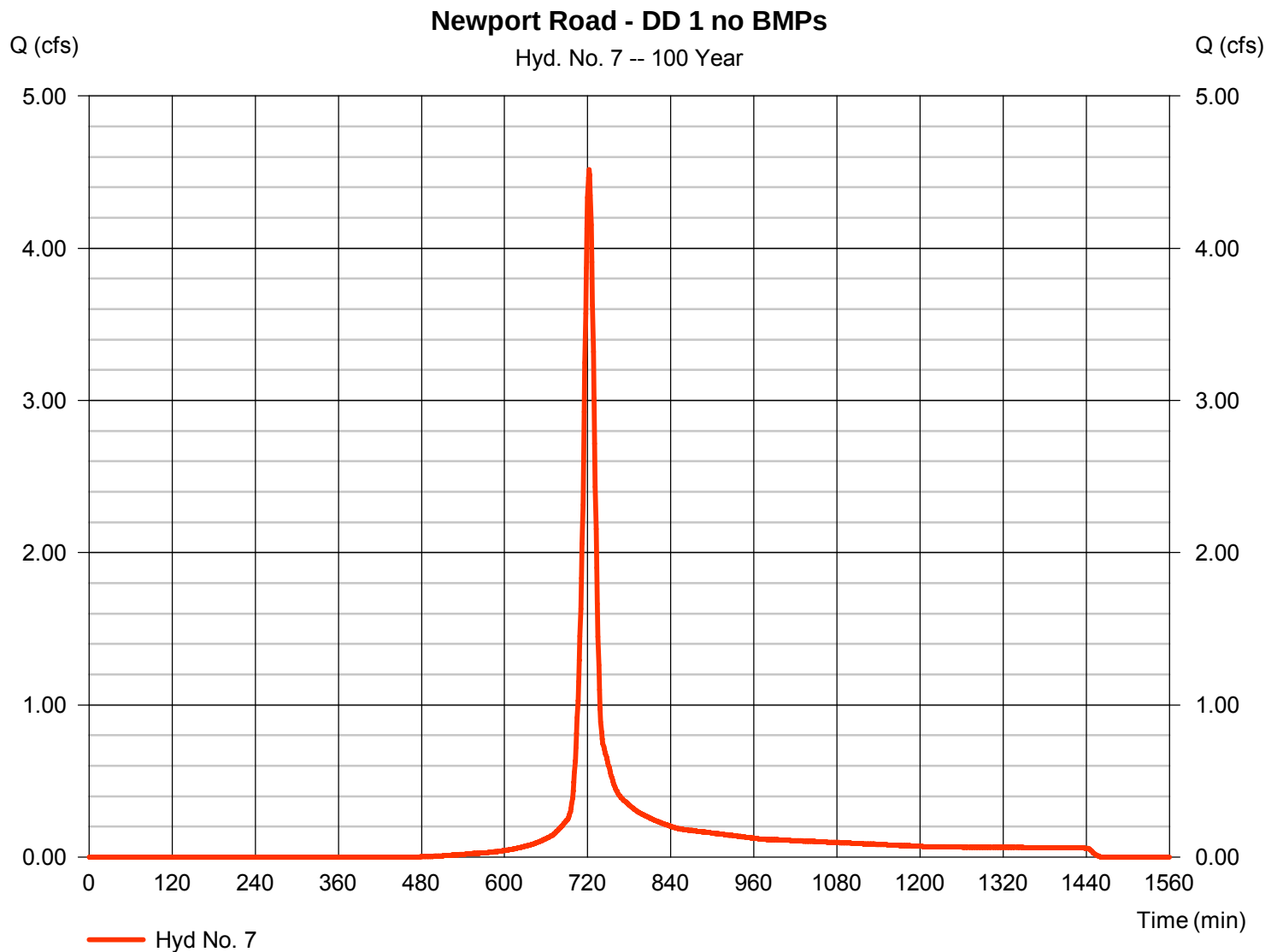
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.516 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	12,142 cuft
Drainage area	=	1.170 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.50 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 1 no BMPs

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

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

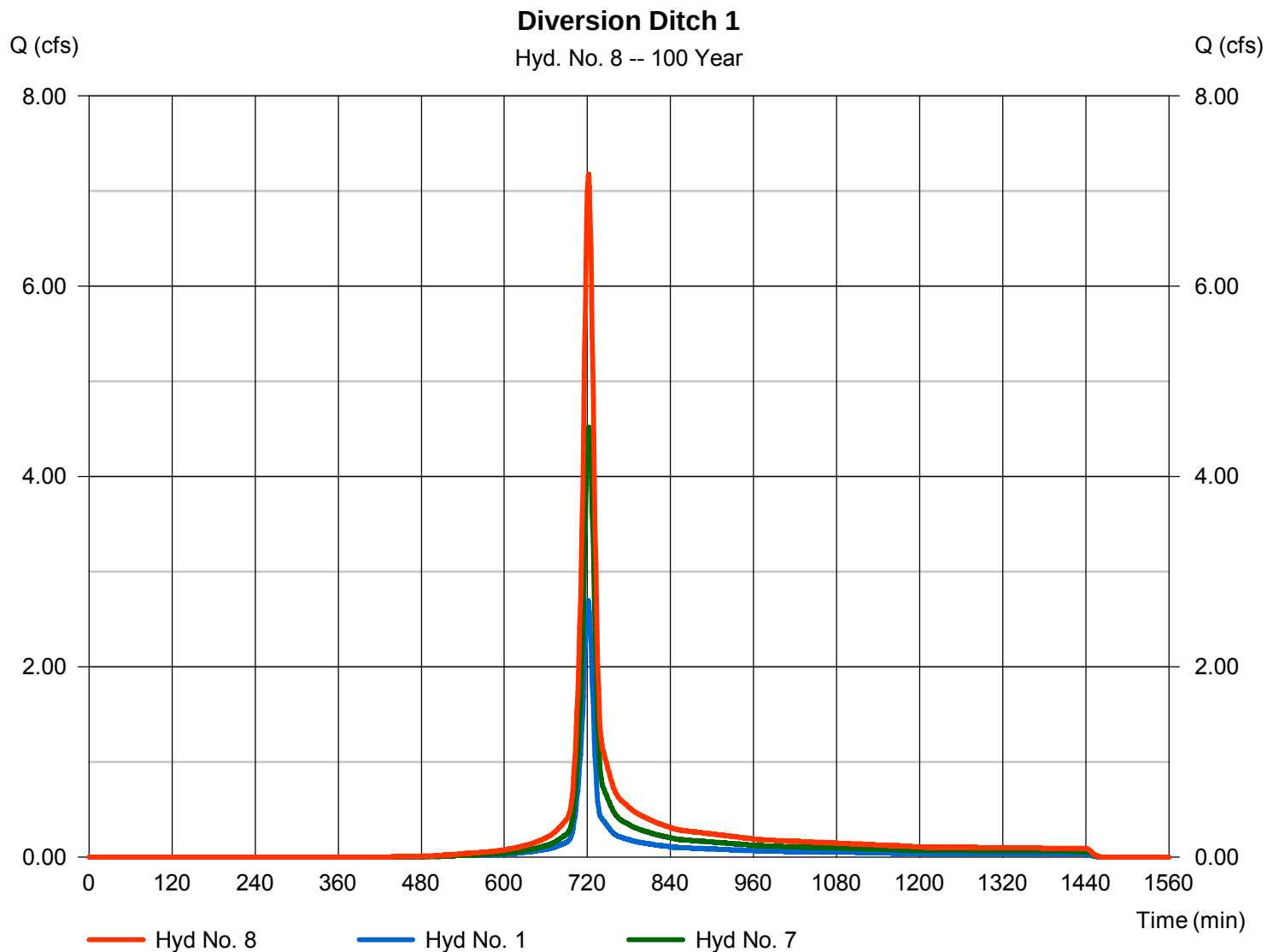
Tuesday, 11 / 15 / 2016

Hyd. No. 8

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 7

Peak discharge = 7.178 cfs
 Time to peak = 722 min
 Hyd. volume = 18,983 cuft
 Contrib. drain. area = 1.780 ac



Hydrograph Report

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

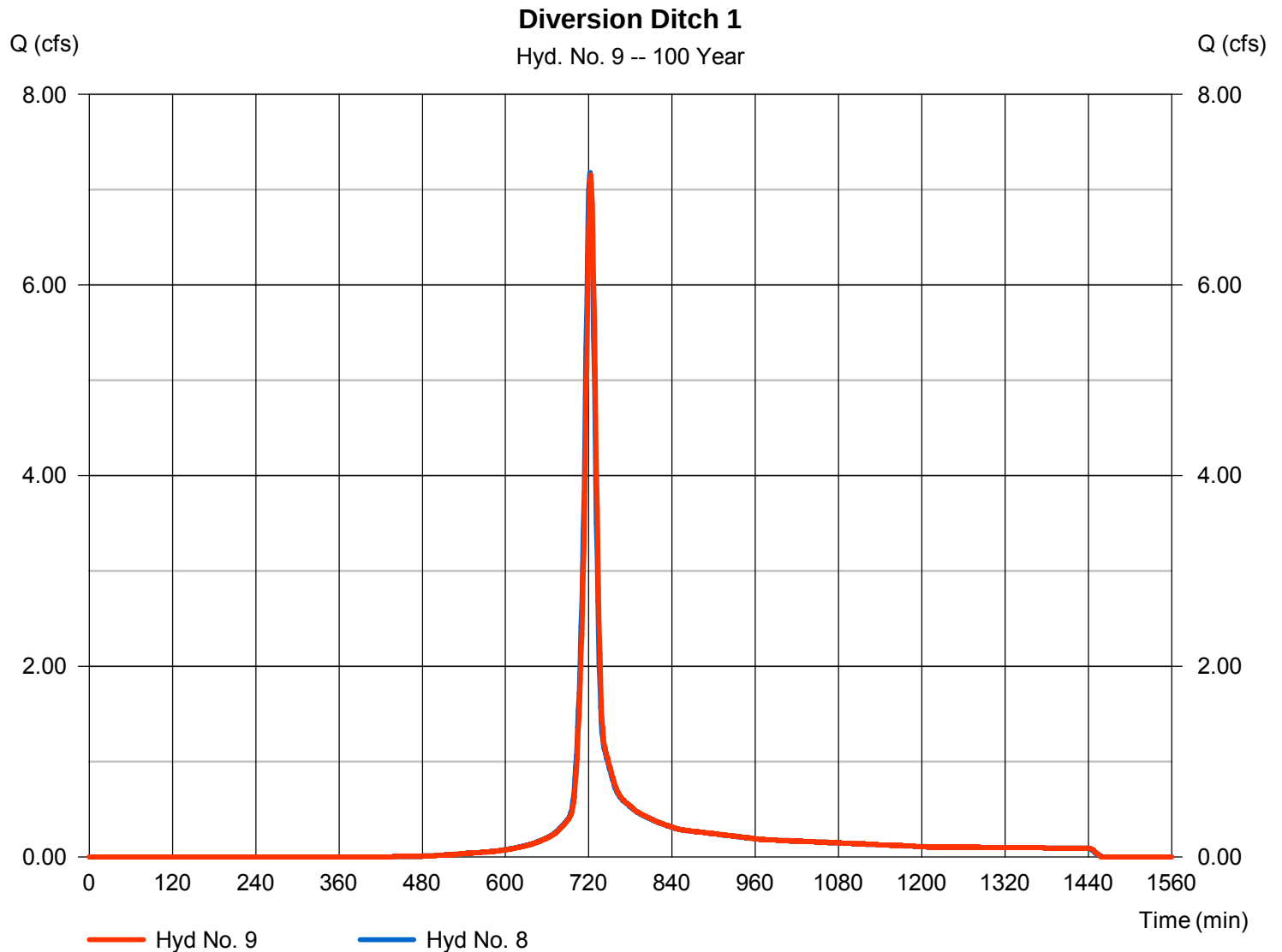
Tuesday, 11 / 15 / 2016

Hyd. No. 9

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 7.156 cfs
Storm frequency	= 100 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 18,982 cuft
Inflow hyd. No.	= 8 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7489

Modified Att-Kin routing method used.



Hydrograph Report

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

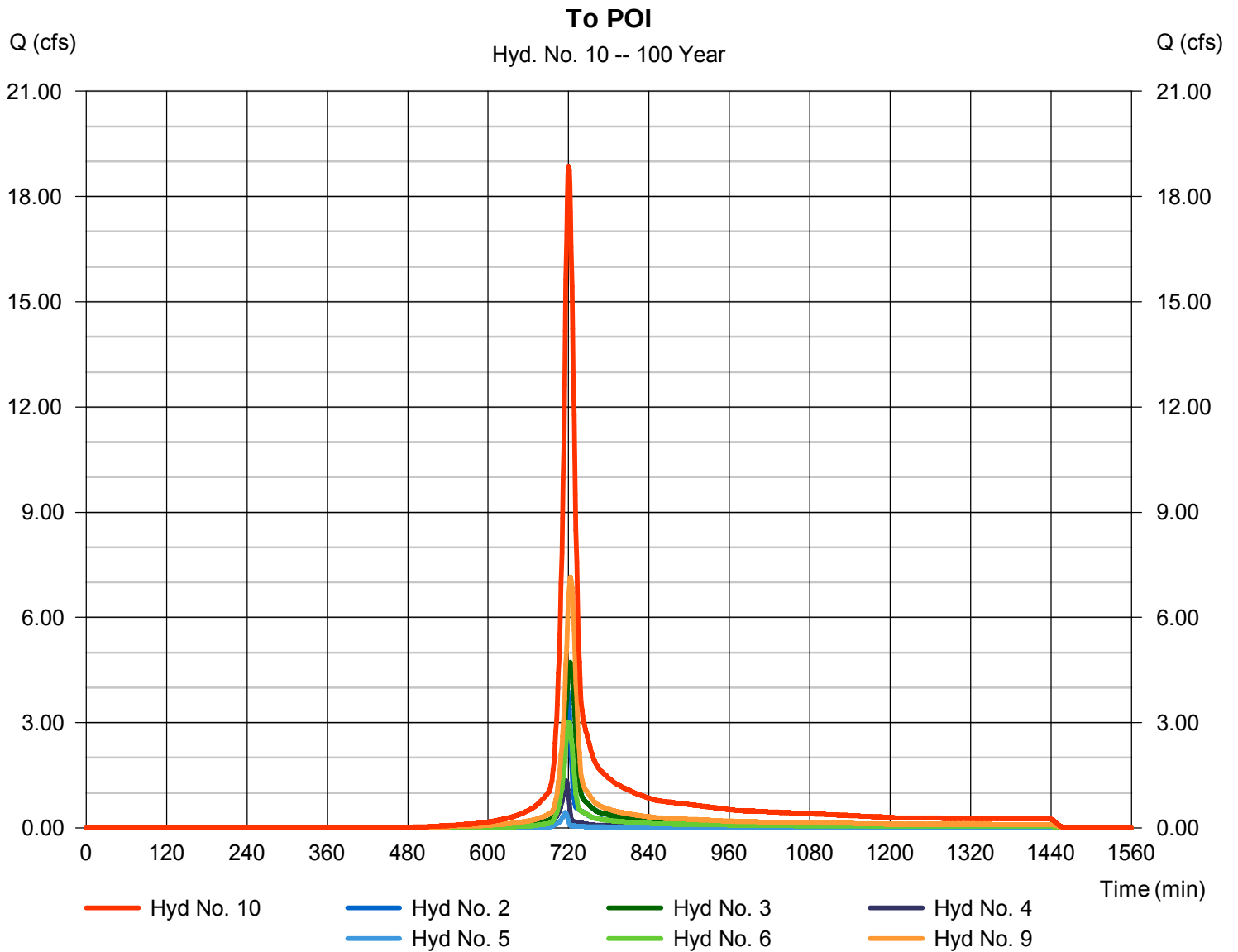
Tuesday, 11 / 15 / 2016

Hyd. No. 10

To POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 3, 4, 5, 6, 9

Peak discharge = 18.87 cfs
 Time to peak = 720 min
 Hyd. volume = 50,778 cuft
 Contrib. drain. area = 3.300 ac



Hydrograph Report

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

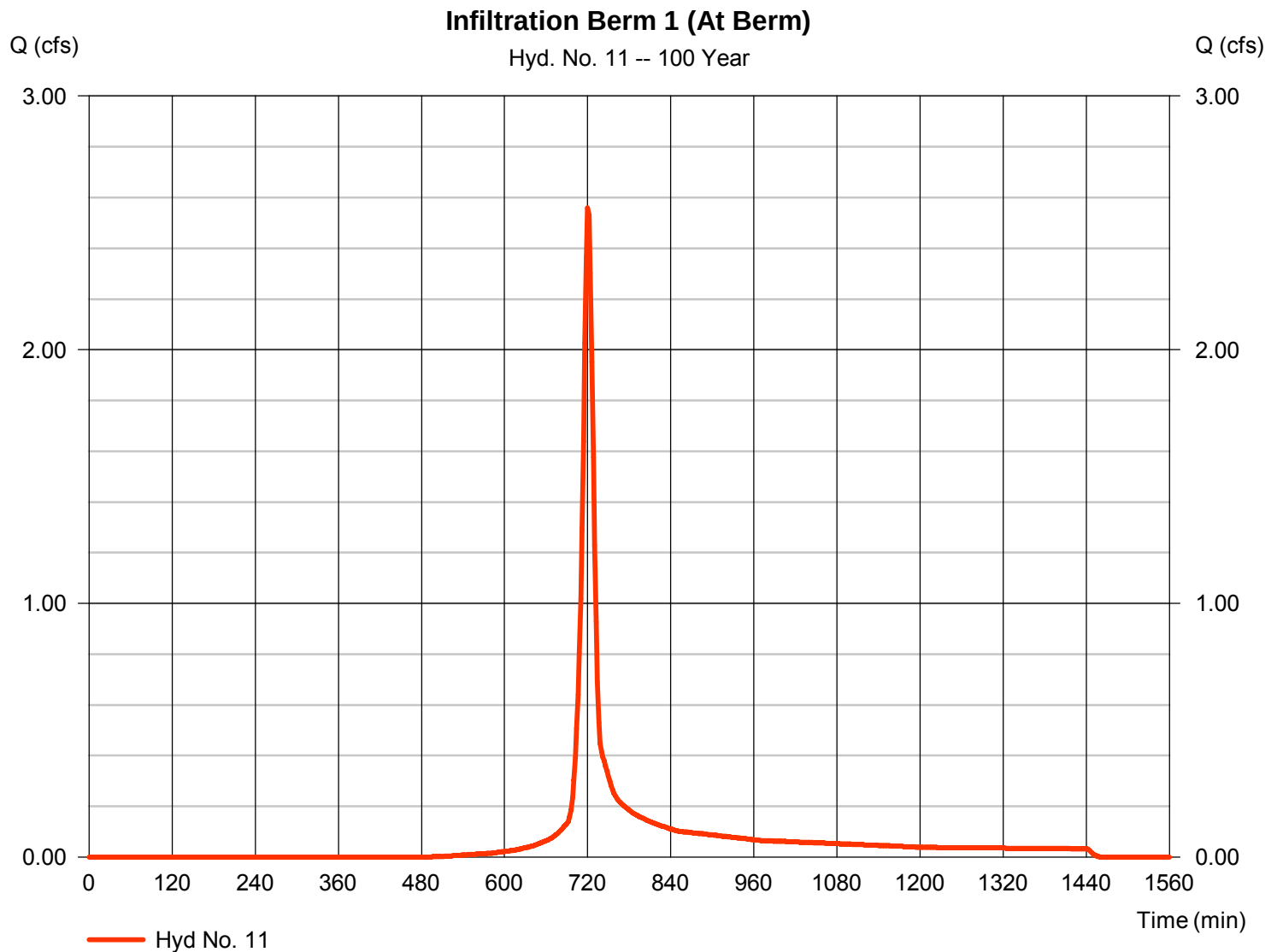
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Infiltration Berm 1 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.558 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 6,632 cuft
Drainage area	= 0.640 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.60 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.130 \times 78) + (0.100 \times 89) + (0.020 \times 91)] / 0.640$



TR55 Tc Worksheet

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

Hyd. No. 11

Infiltration Berm 1 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 251.00	62.00	69.00				
Watercourse slope (%)	= 8.00	4.80	4.30				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=4.56	4.45	3.35				
Travel Time (min)	= 0.92	+	0.23	+	0.34	=	1.49
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				12.60 min			

Hydrograph Report

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

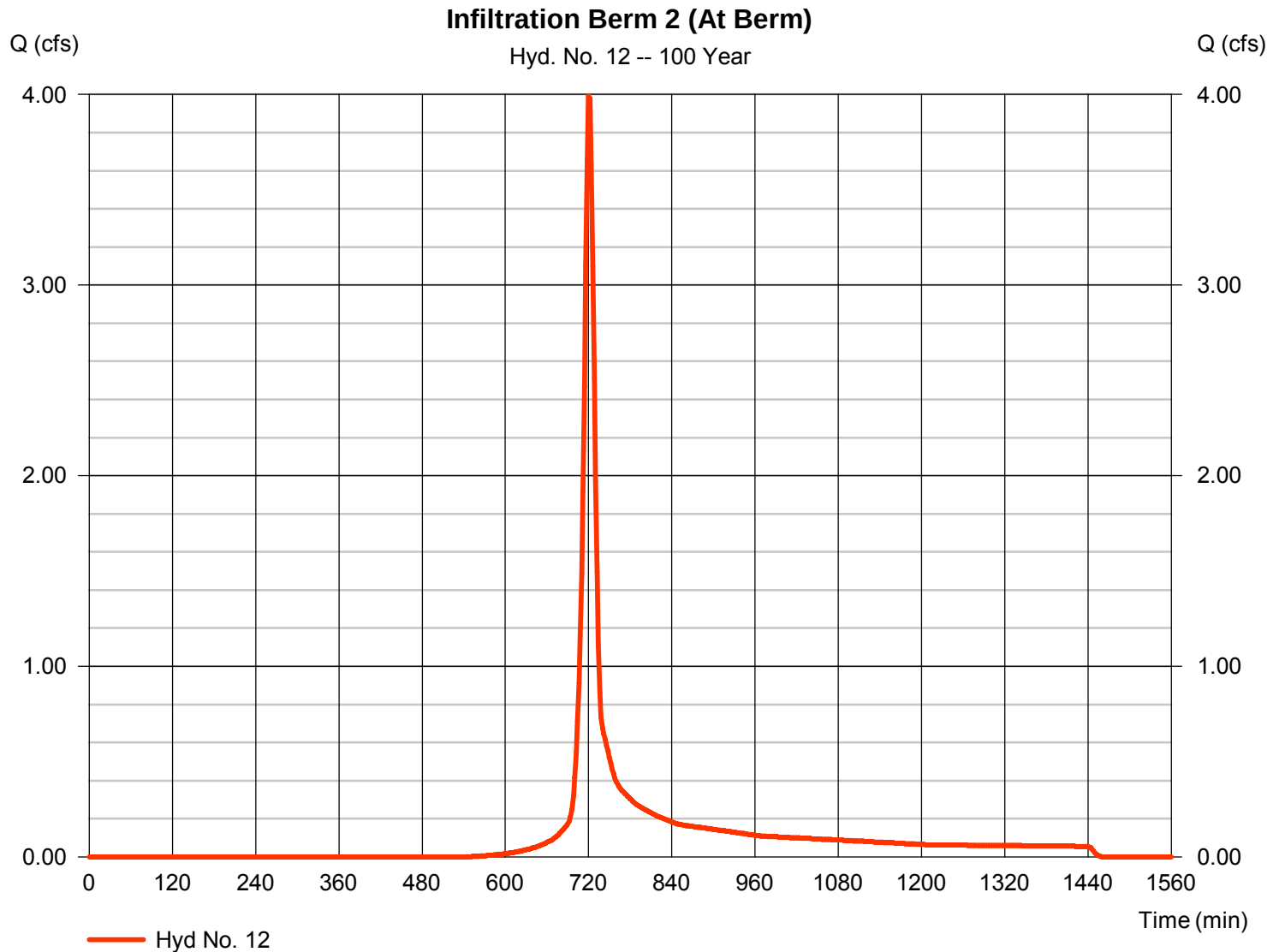
Tuesday, 11 / 15 / 2016

Hyd. No. 12

Infiltration Berm 2 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.993 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 10,399 cuft
Drainage area	= 1.150 ac	Curve number	= 72*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 12.90 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.030 \times 71) + (0.070 \times 78) + (0.050 \times 89)] / 1.150$



TR55 Tc Worksheet

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

Hyd. No. 12

Infiltration Berm 2 (At Berm)

<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)	= 2.51	2.51	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 453.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
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				12.90 min			

Hydrograph Report

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

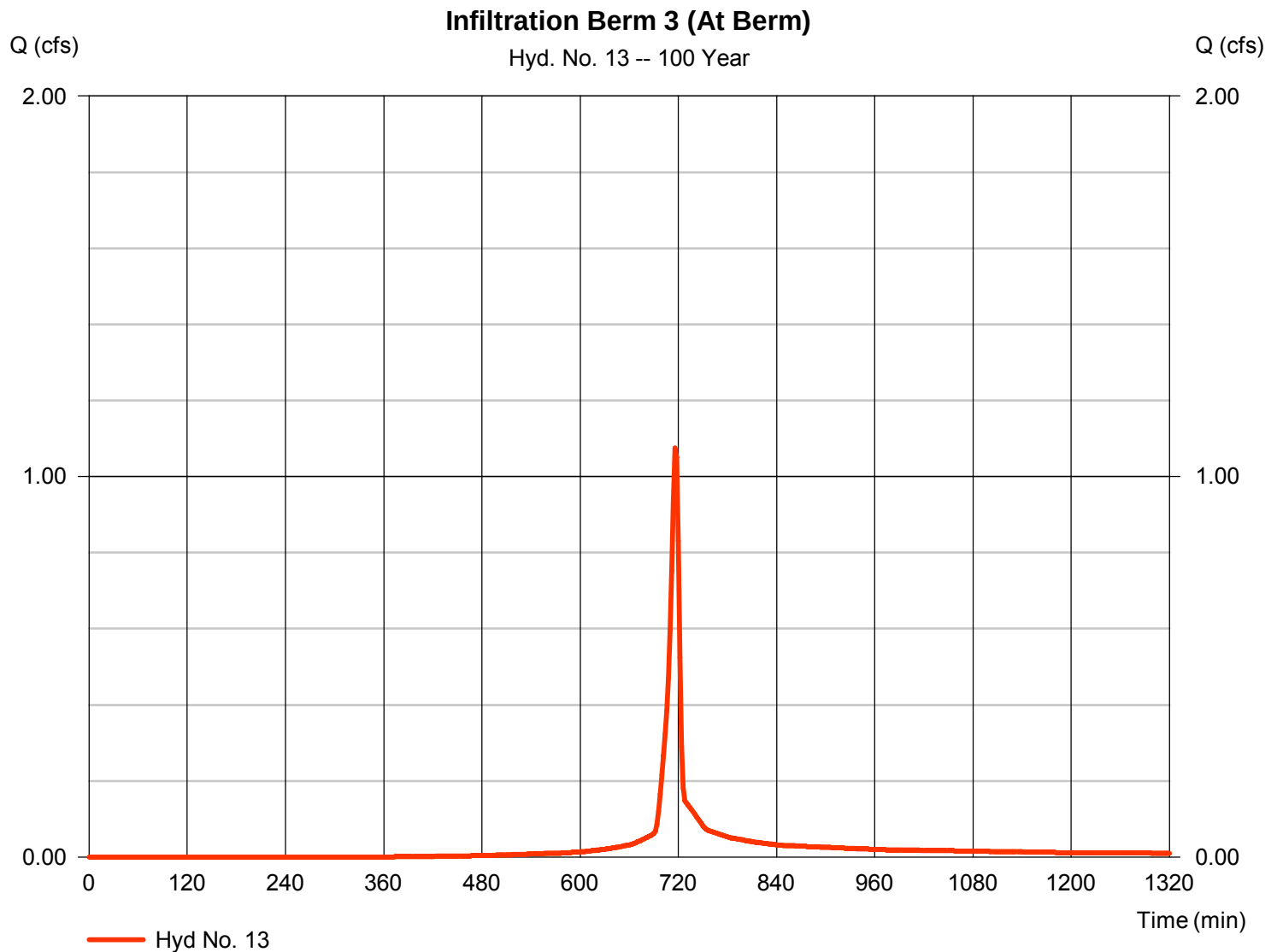
Tuesday, 11 / 15 / 2016

Hyd. No. 13

Infiltration Berm 3 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.076 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,217 cuft
Drainage area	= 0.190 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.10 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.110 \times 78) + (0.080 \times 91)] / 0.190$



TR55 Tc Worksheet

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

Hyd. No. 13

Infiltration Berm 3 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 7.00	0.00	0.00				
Travel Time (min)	= 1.85	+	0.00	+	0.00	=	1.85
Shallow Concentrated Flow							
Flow length (ft)	= 163.00	46.00	0.00				
Watercourse slope (%)	= 5.50	6.50	0.00				
Surface description	= Paved	Unpaved	Paved				
Average velocity (ft/s)	=4.77	4.11	0.00				
Travel Time (min)	= 0.57	+	0.19	+	0.00	=	0.76
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 4.49	0.00	0.00				
Manning's n-value	= 0.060	0.015	0.015				
Velocity (ft/s)	=3.07	0.00	0.00				
Flow length (ft)	(0)}89.0	0.0	0.0				
Travel Time (min)	= 0.48	+	0.00	+	0.00	=	0.48
Total Travel Time, Tc				3.10 min			

Hydrograph Report

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

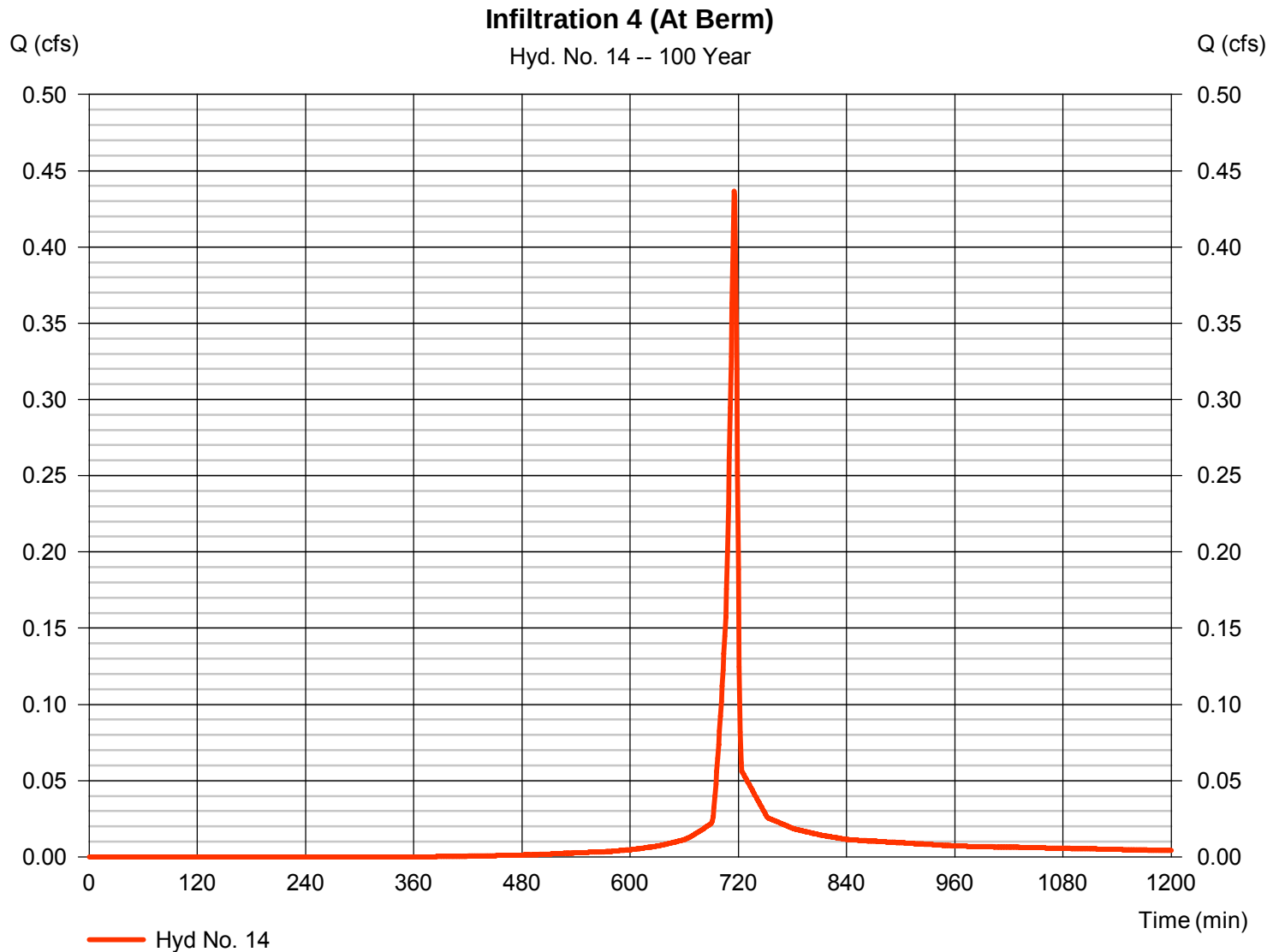
Tuesday, 11 / 15 / 2016

Hyd. No. 14

Infiltration 4 (At Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.436 cfs
Storm frequency	= 100 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 793 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.90 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



TR55 Tc Worksheet

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

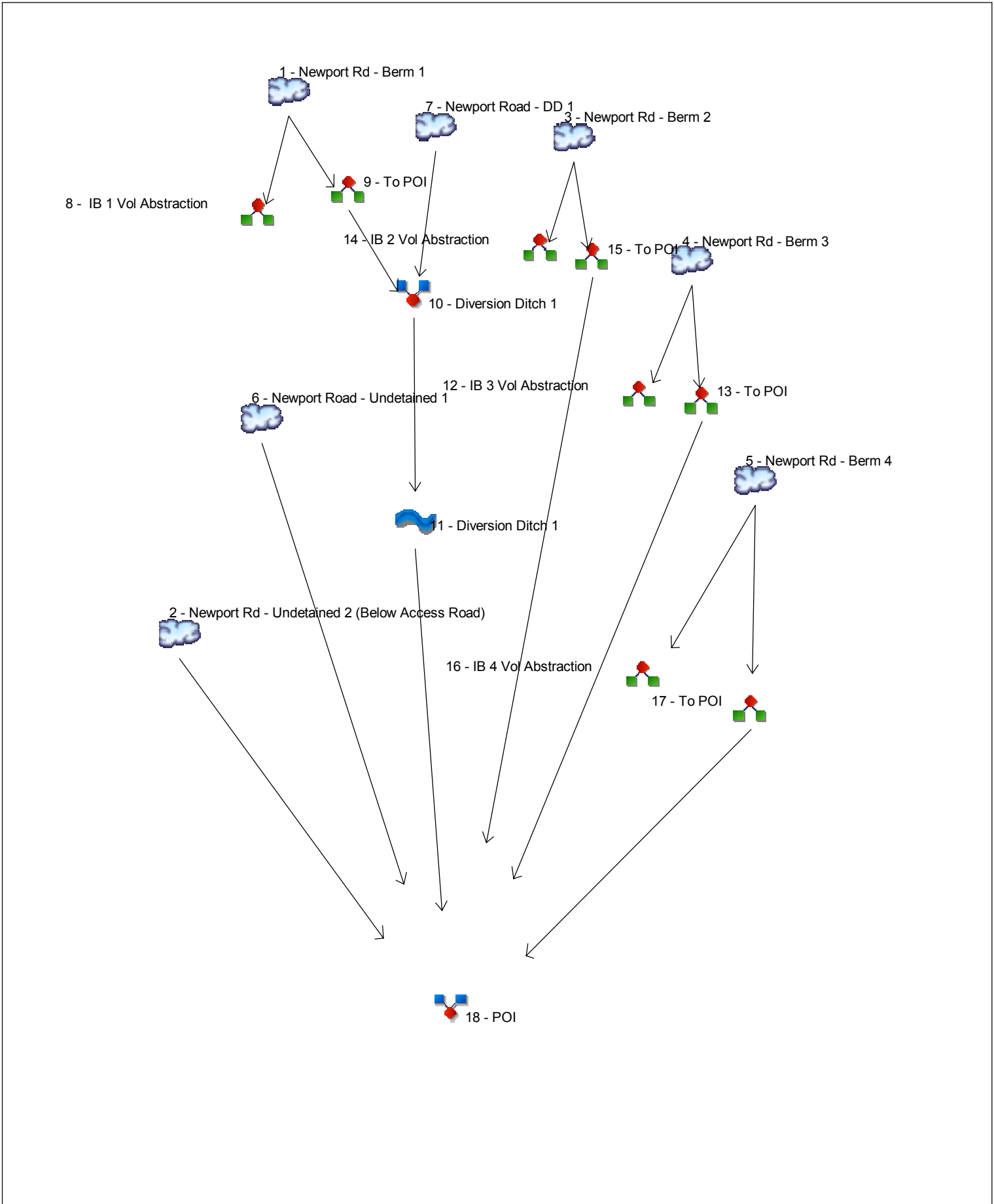
Hyd. No. 14

Infiltration 4 (At Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.030	0.011	0.011				
Flow length (ft)	= 96.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.51	0.00	0.00				
Land slope (%)	= 8.30	0.00	0.00				
Travel Time (min)	= 1.67	+	0.00	+	0.00	=	1.67
Shallow Concentrated Flow							
Flow length (ft)	= 54.00	0.00	0.00				
Watercourse slope (%)	= 7.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.39	0.00	0.00				
Travel Time (min)	= 0.21	+	0.00	+	0.00	=	0.21
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				1.90 min			

Watershed Model Schematic

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



Hydrograph Return Period Recap

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

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	3.125	Newport Rd - Berm 1
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	3.927	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	4.232	Newport Rd - Berm 2
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	0.632	Newport Rd - Berm 3
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	0.352	Newport Rd - Berm 4
6	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	3.022	Newport Road - Undetained 1
7	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	4.516	Newport Road - DD 1
8	Diversion1	1	-----	-----	-----	-----	-----	-----	-----	1.999	IB 1 Vol Abstraction
9	Diversion2	1	-----	-----	-----	-----	-----	-----	-----	3.125	To POI
10	Combine	7, 9	-----	-----	-----	-----	-----	-----	-----	7.438	Diversion Ditch 1
11	Reach	10	-----	-----	-----	-----	-----	-----	-----	7.400	Diversion Ditch 1
12	Diversion1	4	-----	-----	-----	-----	-----	-----	-----	0.632	IB 3 Vol Abstraction
13	Diversion2	4	-----	-----	-----	-----	-----	-----	-----	0.036	To POI
14	Diversion1	3	-----	-----	-----	-----	-----	-----	-----	2.357	IB 2 Vol Abstraction
15	Diversion2	3	-----	-----	-----	-----	-----	-----	-----	4.232	To POI
16	Diversion1	5	-----	-----	-----	-----	-----	-----	-----	0.346	IB 4 Vol Abstraction
17	Diversion2	5	-----	-----	-----	-----	-----	-----	-----	0.352	To POI
18	Combine	2, 6, 11, 13, 15, 17	-----	-----	-----	-----	-----	-----	-----	17.39	POI
Proj. file: Newport Rd wBMP-100yr.gpw										Tuesday, 11 / 15 / 2016	

Hydrograph Summary Report

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

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	3.125	1	726	10,268	-----	-----	-----	Newport Rd - Berm 1
2	SCS Runoff	3.927	1	718	8,355	-----	-----	-----	Newport Rd - Undetained 2 (Below A
3	SCS Runoff	4.232	1	724	12,571	-----	-----	-----	Newport Rd - Berm 2
4	SCS Runoff	0.632	1	732	2,631	-----	-----	-----	Newport Rd - Berm 3
5	SCS Runoff	0.352	1	720	861	-----	-----	-----	Newport Rd - Berm 4
6	SCS Runoff	3.022	1	720	7,319	-----	-----	-----	Newport Road - Undetained 1
7	SCS Runoff	4.516	1	722	12,142	-----	-----	-----	Newport Road - DD 1
8	Diversion1	1.999	1	717	1,658	1	-----	-----	IB 1 Vol Abstraction
9	Diversion2	3.125	1	726	8,610	1	-----	-----	To POI
10	Combine	7.438	1	723	20,752	7, 9	-----	-----	Diversion Ditch 1
11	Reach	7.400	1	724	20,750	10	-----	-----	Diversion Ditch 1
12	Diversion1	0.632	1	732	1,990	4	-----	-----	IB 3 Vol Abstraction
13	Diversion2	0.036	1	870	641	4	-----	-----	To POI
14	Diversion1	2.357	1	715	1,662	3	-----	-----	IB 2 Vol Abstraction
15	Diversion2	4.232	1	724	10,909	3	-----	-----	To POI
16	Diversion1	0.346	1	719	296	5	-----	-----	IB 4 Vol Abstraction
17	Diversion2	0.352	1	720	565	5	-----	-----	To POI
18	Combine	17.39	1	721	48,540	2, 6, 11, 13, 15, 17	-----	-----	POI
Newport Rd wBMP-100yr.gpw					Return Period: 100 Year			Tuesday, 11 / 15 / 2016	

Hydrograph Report

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

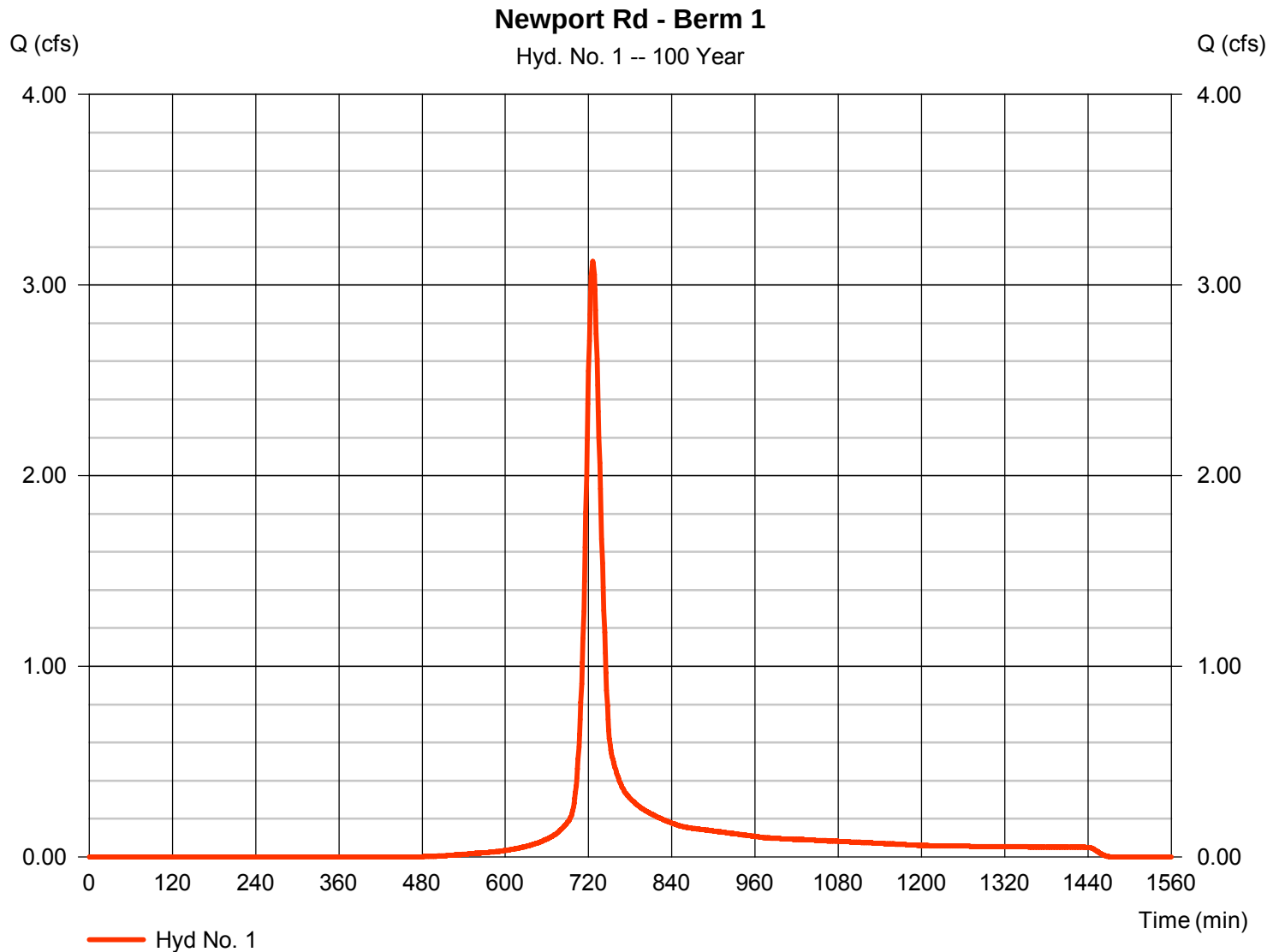
Tuesday, 11 / 15 / 2016

Hyd. No. 1

Newport Rd - Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.125 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 10,268 cuft
Drainage area	= 0.980 ac	Curve number	= 77*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 21.00 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.390 \times 71) + (0.460 \times 78) + (0.100 \times 89) + (0.030 \times 91)] / 0.980$



Hydrograph Report

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

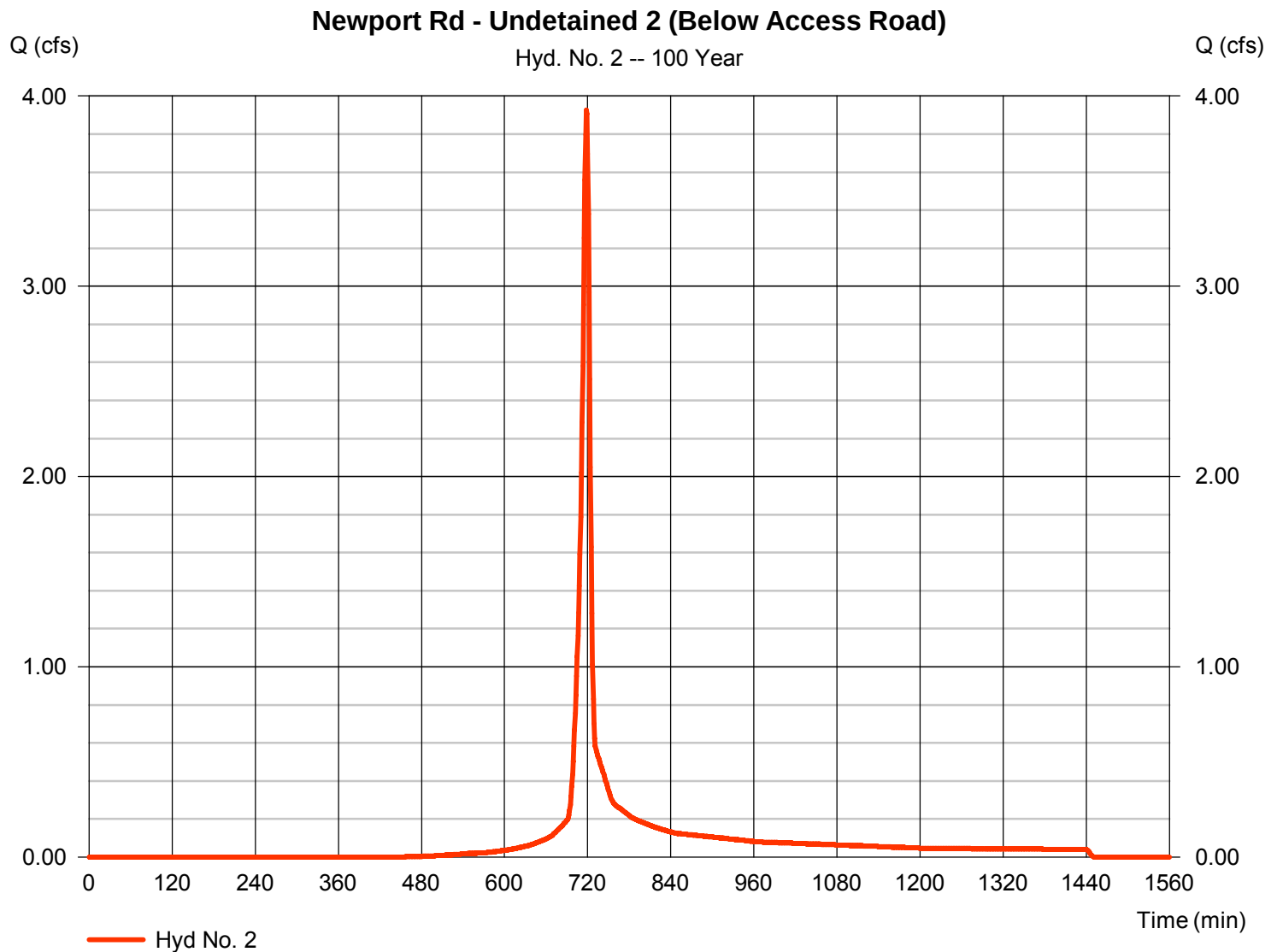
Tuesday, 11 / 15 / 2016

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.927 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 8,355 cuft
Drainage area	= 0.800 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.70 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.620 \times 78) + (0.160 \times 77) + (0.020 \times 91)] / 0.800$



TR55 Tc Worksheet

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

Hyd. No. 2

Newport Rd - Undetained 2 (Below Access Road)

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 10.00	0.00	0.00				
Travel Time (min)	= 5.81	+	0.00	+	0.00	=	5.81
Shallow Concentrated Flow							
Flow length (ft)	= 55.00	142.00	0.00				
Watercourse slope (%)	= 15.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=6.25	3.95	0.00				
Travel Time (min)	= 0.15	+	0.60	+	0.00	=	0.75
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.47	0.00	0.00				
Channel slope (%)	= 6.70	0.00	0.00				
Manning's n-value	= 0.025	0.025	0.015				
Velocity (ft/s)	=9.00	0.00	0.00				
Flow length (ft)	(0)58.0	0.0	0.0				
Travel Time (min)	= 0.11	+	0.00	+	0.00	=	0.11
Total Travel Time, Tc				6.70 min			

Hydrograph Report

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

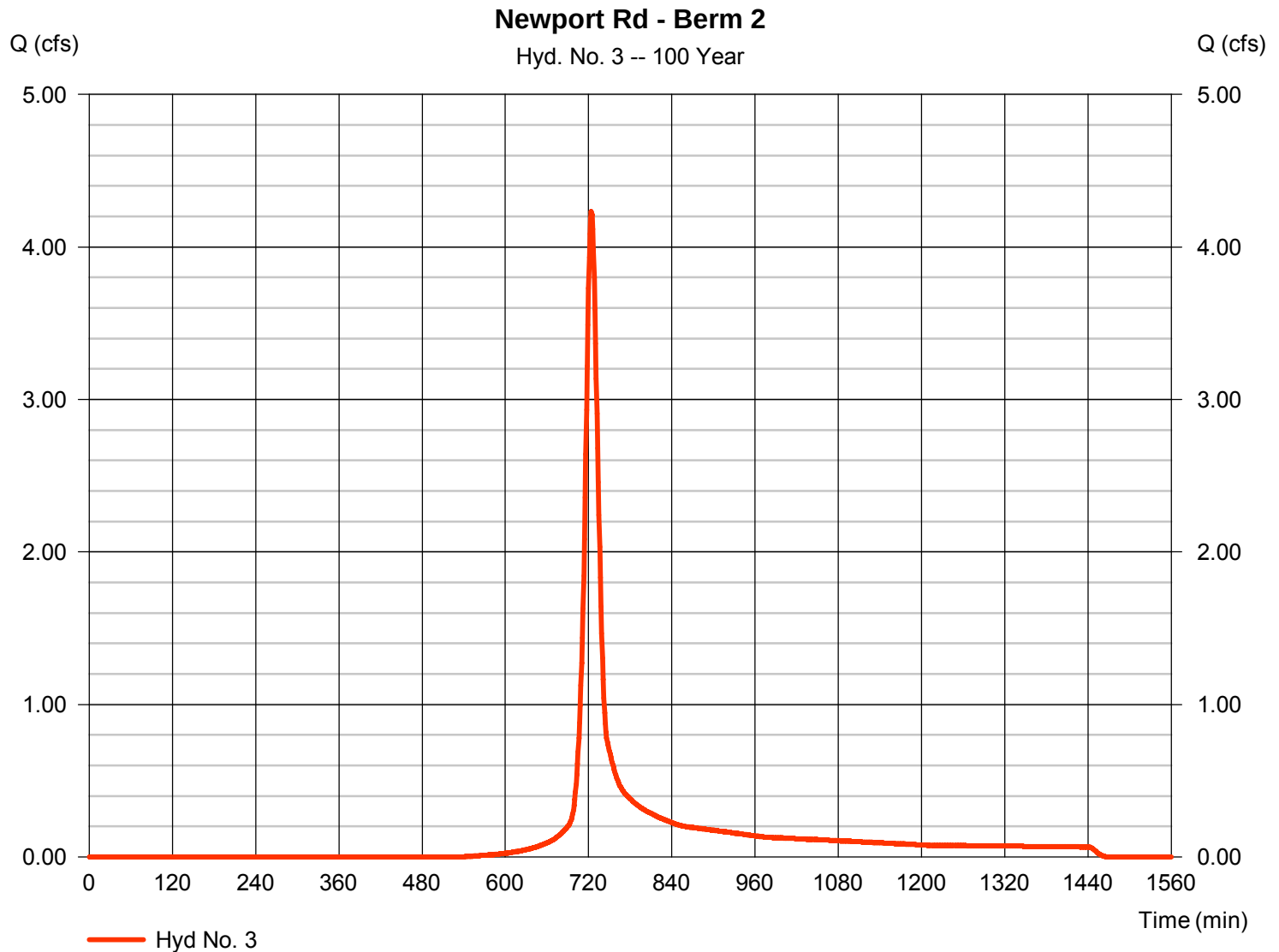
Tuesday, 11 / 15 / 2016

Hyd. No. 3

Newport Rd - Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 4.232 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 12,571 cuft
Drainage area	= 1.400 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.80 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(1.070 \times 71) + (0.030 \times 77) + (0.230 \times 78) + (0.060 \times 89) + (0.010 \times 91)] / 1.400$



Hydrograph Report

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

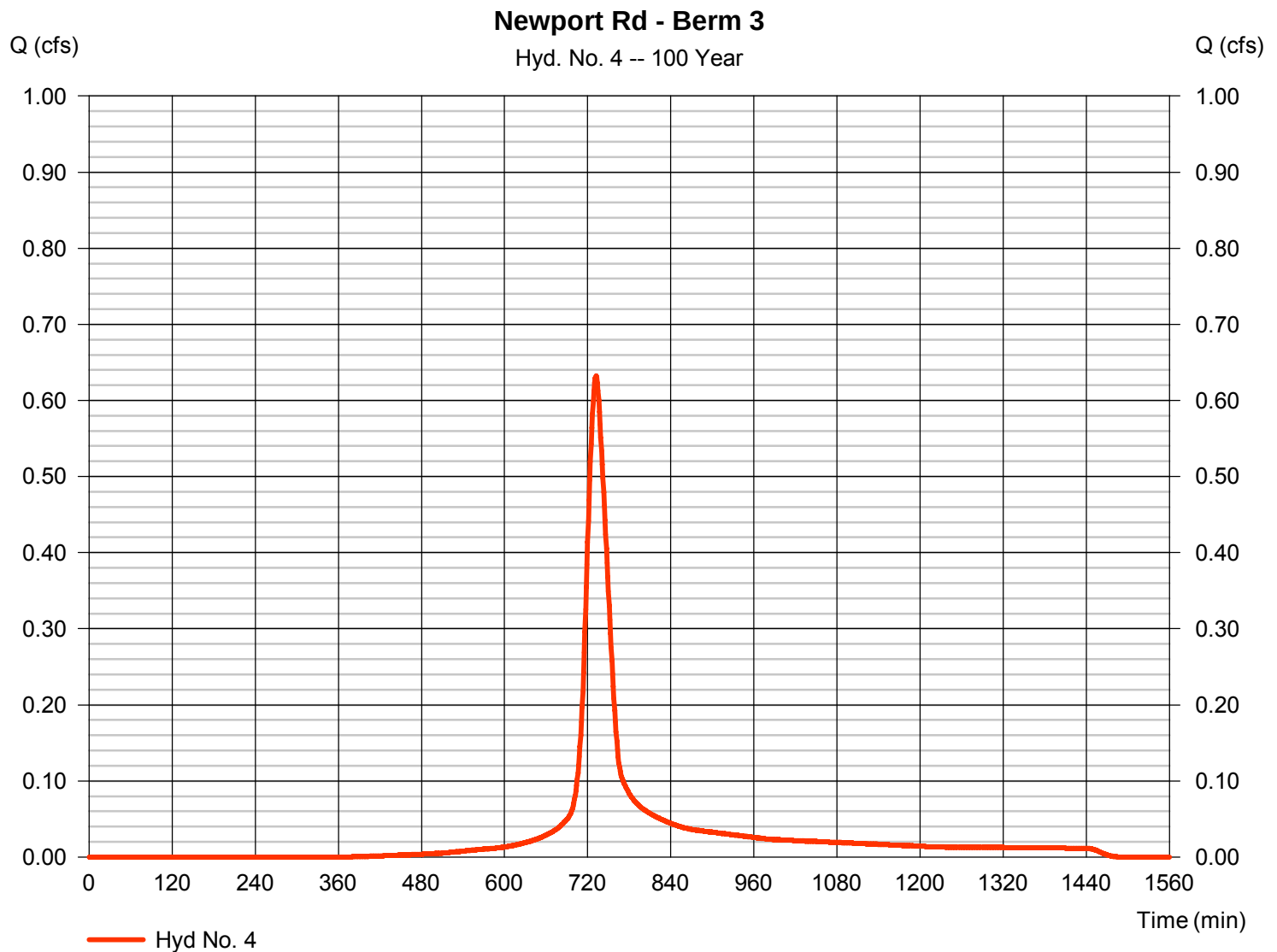
Tuesday, 11 / 15 / 2016

Hyd. No. 4

Newport Rd - Berm 3

Hydrograph type	= SCS Runoff	Peak discharge	= 0.632 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 2,631 cuft
Drainage area	= 0.210 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 30.60 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.130 \times 78) + (0.080 \times 91)] / 0.210$



Hydrograph Report

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

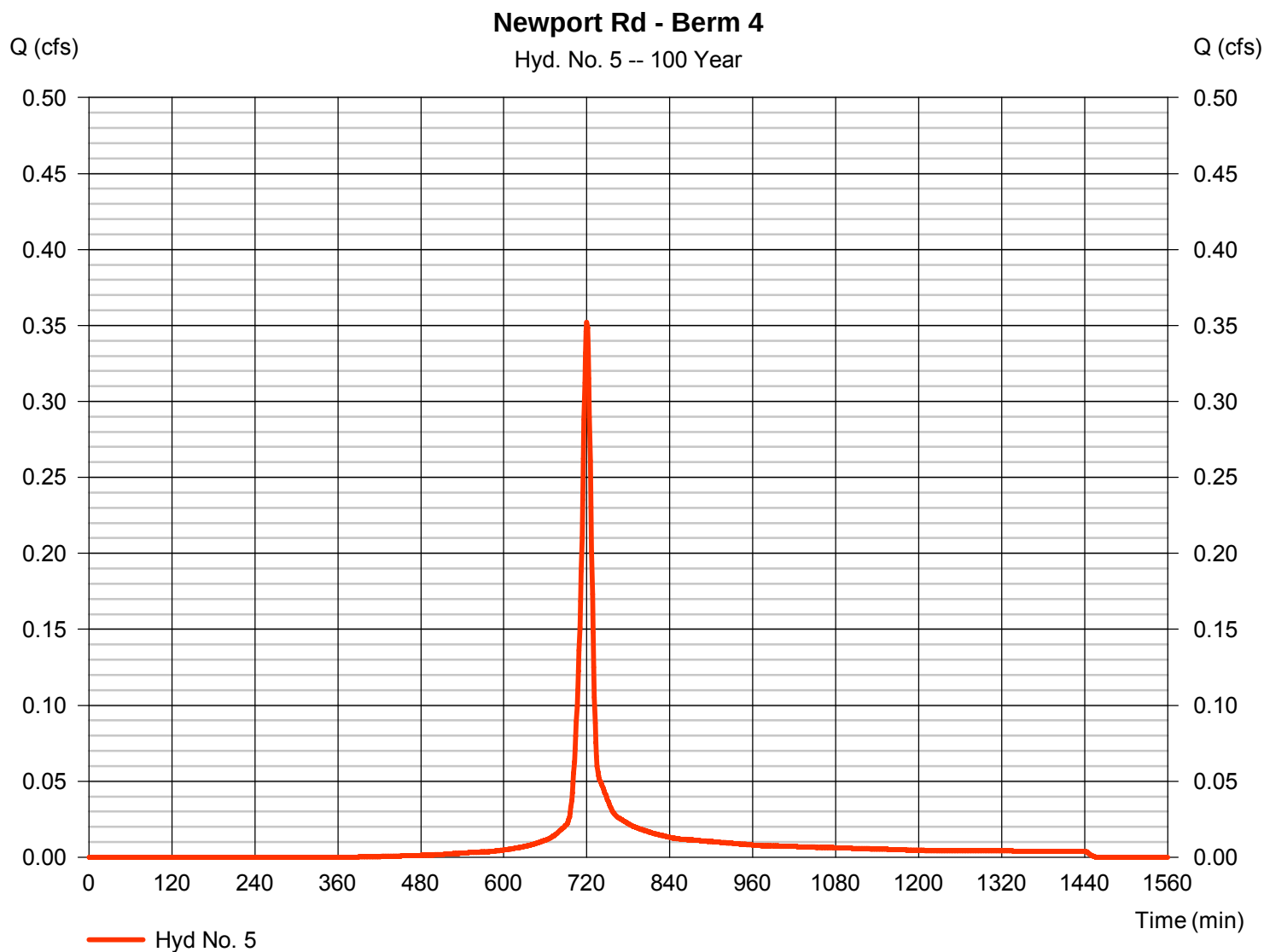
Tuesday, 11 / 15 / 2016

Hyd. No. 5

Newport Rd - Berm 4

Hydrograph type	= SCS Runoff	Peak discharge	= 0.352 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 861 cuft
Drainage area	= 0.070 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.40 min
Total precip.	= 5.28 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.050 \times 78) + (0.020 \times 91)] / 0.070$



Hydrograph Report

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

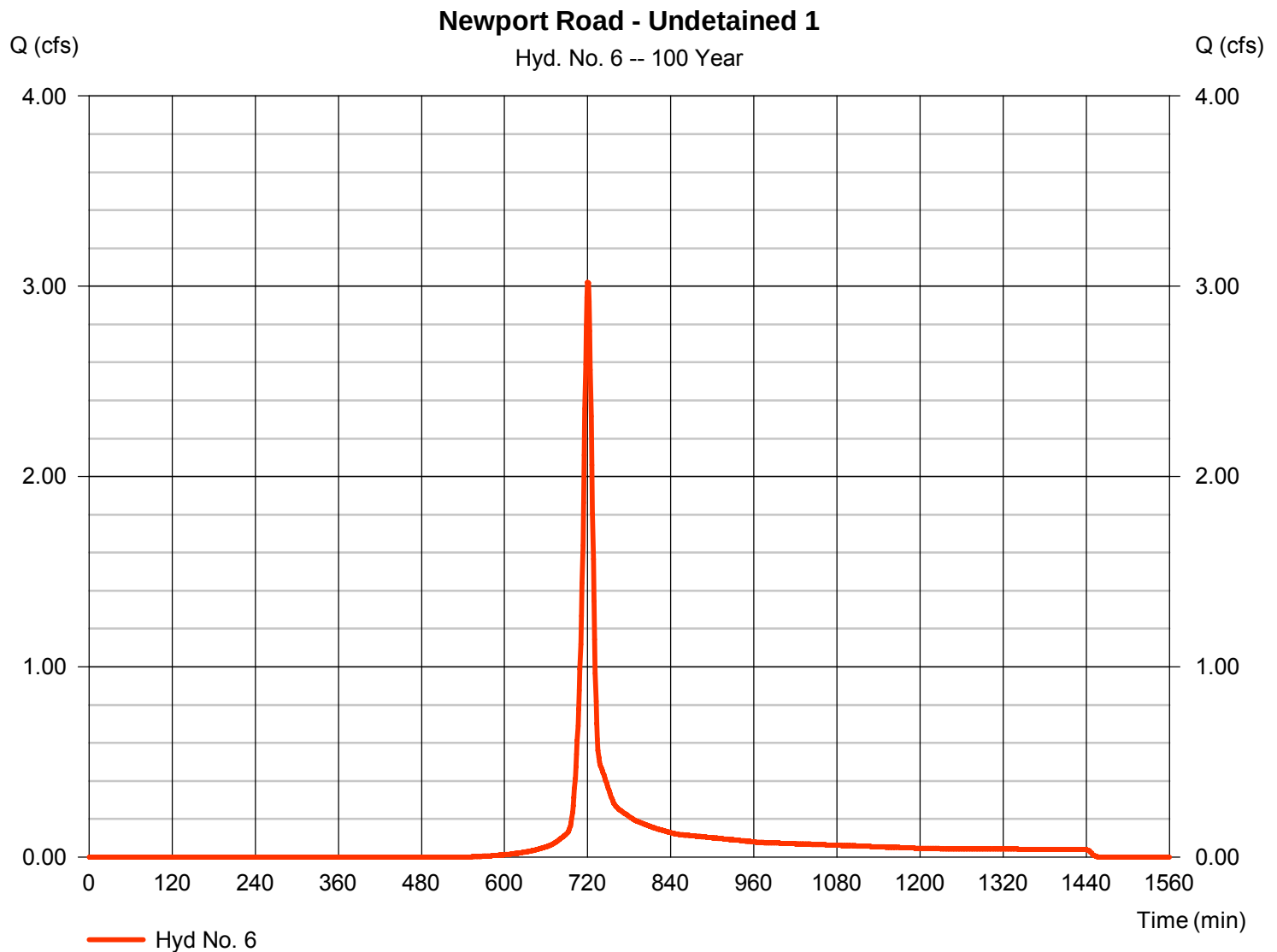
Tuesday, 11 / 15 / 2016

Hyd. No. 6

Newport Road - Undetained 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.022 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	7,319 cuft
Drainage area	=	0.820 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.80 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.690 \times 71) + (0.090 \times 78) + (0.040 \times 77)] / 0.820$



TR55 Tc Worksheet

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

Hyd. No. 6

Newport Road - Undetained 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)	= 2.51	0.00	0.00				
Land slope (%)	= 5.00	0.00	0.00				
Travel Time (min)	= 7.67	+	0.00	+	0.00	=	7.67
Shallow Concentrated Flow							
Flow length (ft)	= 165.00	298.00	384.00				
Watercourse slope (%)	= 10.00	5.00	10.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.10	3.61	5.10				
Travel Time (min)	= 0.54	+	1.38	+	1.25	=	3.17
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	= 0.060	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				10.80 min			

Hydrograph Report

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

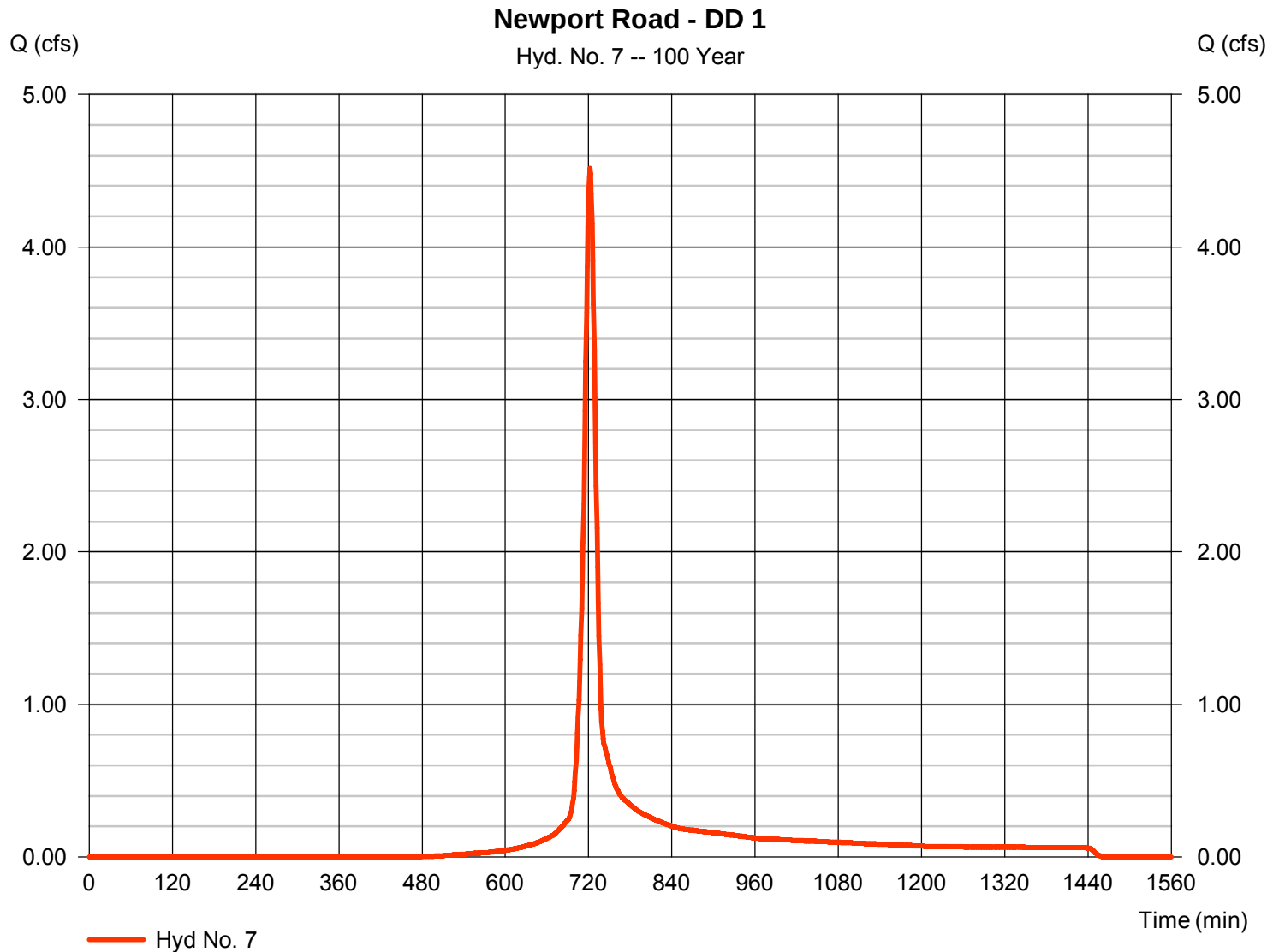
Tuesday, 11 / 15 / 2016

Hyd. No. 7

Newport Road - DD 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.516 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	12,142 cuft
Drainage area	=	1.170 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.50 min
Total precip.	=	5.28 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.230 \times 71) + (0.940 \times 78)] / 1.170$



TR55 Tc Worksheet

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

Hyd. No. 7

Newport Road - DD 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)	= 2.51	0.00	0.00				
Land slope (%)	= 2.00	0.00	0.00				
Travel Time (min)	= 11.06	+	0.00	+	0.00	=	11.06
Shallow Concentrated Flow							
Flow length (ft)	= 213.00	410.00	0.00				
Watercourse slope (%)	= 8.00	6.30	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.56	4.05	0.00				
Travel Time (min)	= 0.78	+	1.69	+	0.00	=	2.47
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				13.50 min			

Hydrograph Report

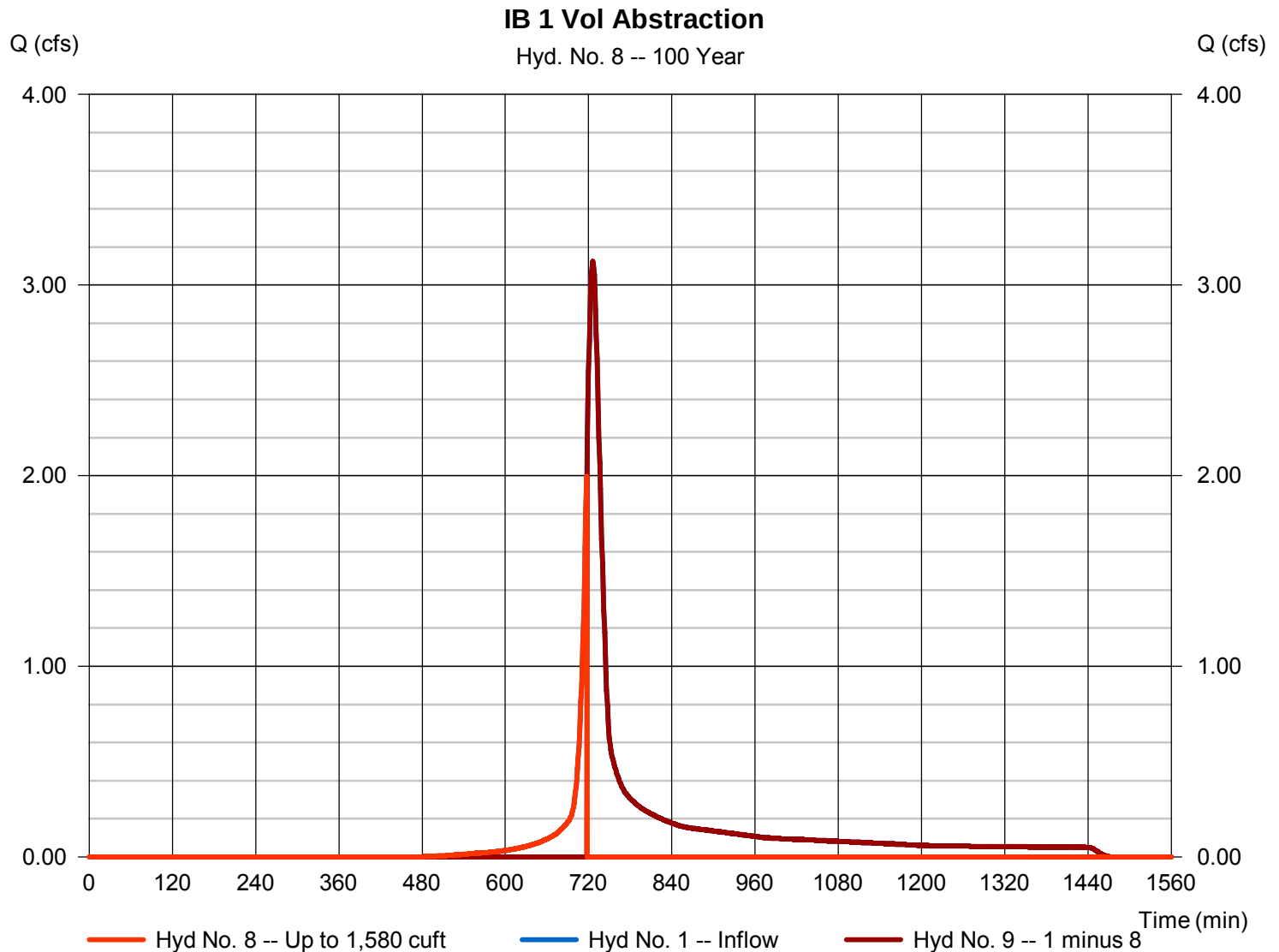
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 8

IB 1 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.999 cfs
Storm frequency	= 100 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 1,658 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 9
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

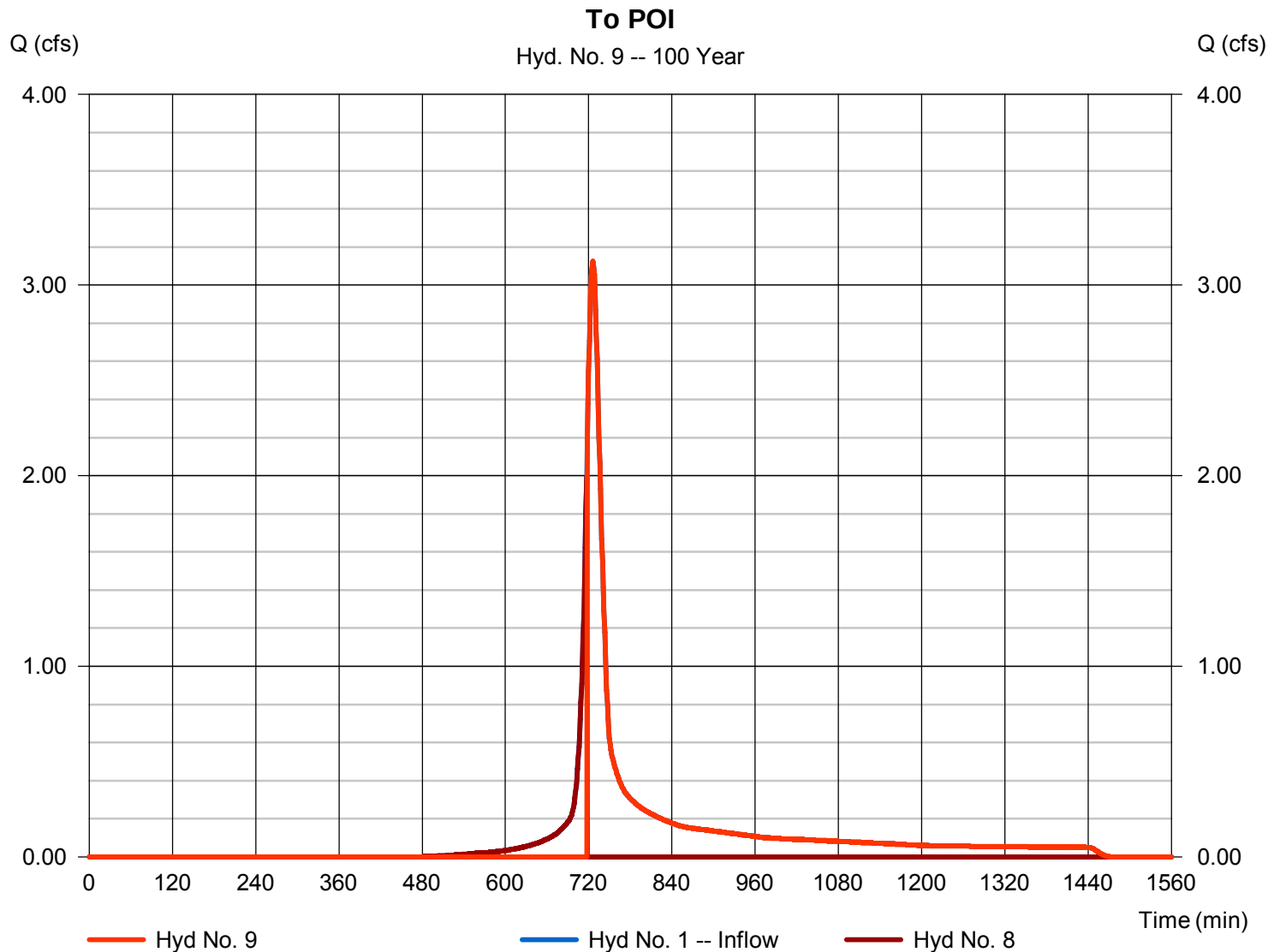
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Tuesday, 11 / 15 / 2016

Hyd. No. 9

To POI

Hydrograph type	= Diversion2	Peak discharge	= 3.125 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 8,610 cuft
Inflow hydrograph	= 1 - Newport Rd - Berm 1	2nd diverted hyd.	= 8
Diversion method	= First Flush Volume	Volume Up To	= 1,580 cuft



Hydrograph Report

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

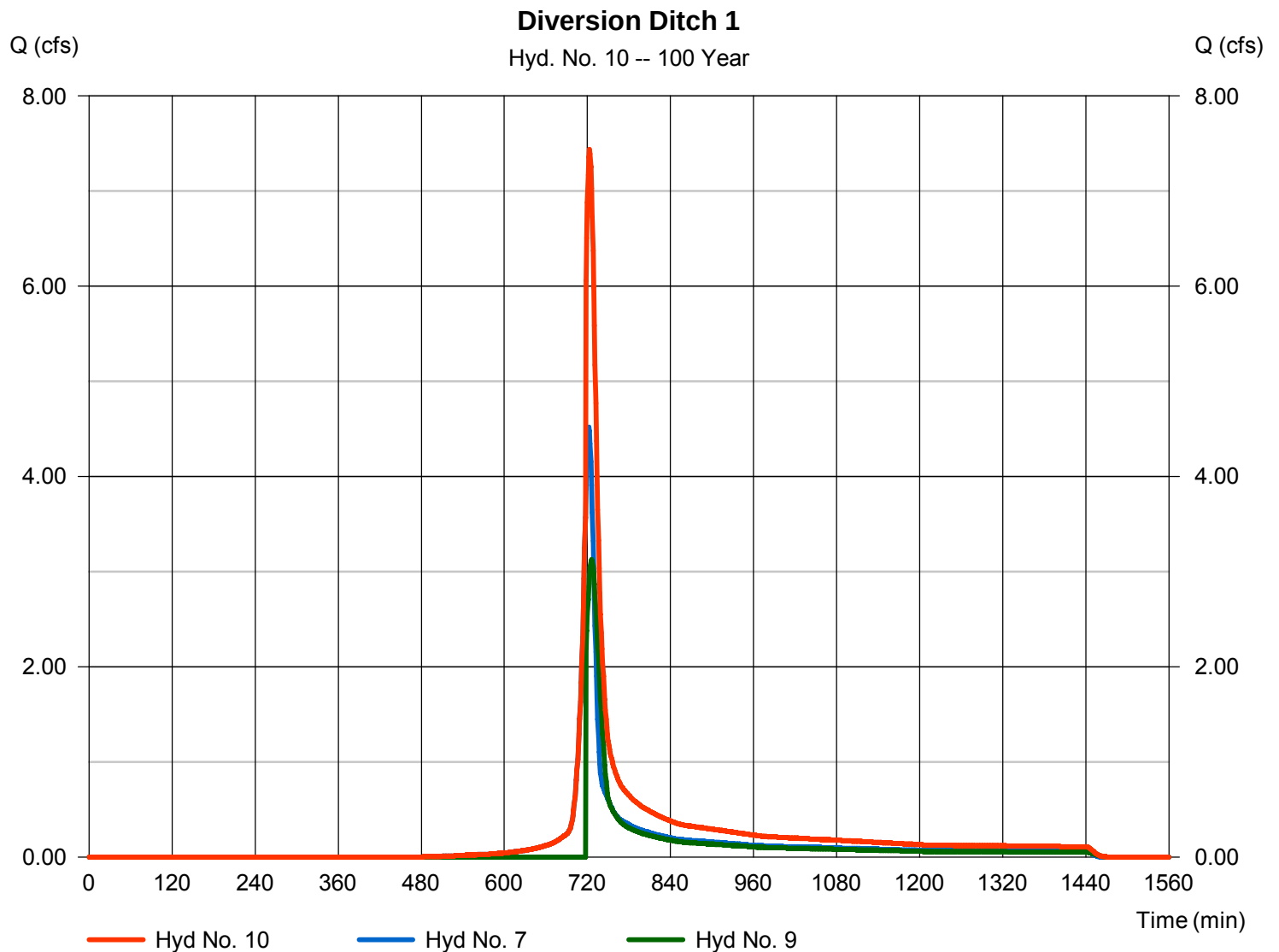
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Hyd. No. 10

Diversion Ditch 1

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 7, 9

Peak discharge = 7.438 cfs
 Time to peak = 723 min
 Hyd. volume = 20,752 cuft
 Contrib. drain. area = 1.170 ac



Hydrograph Report

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

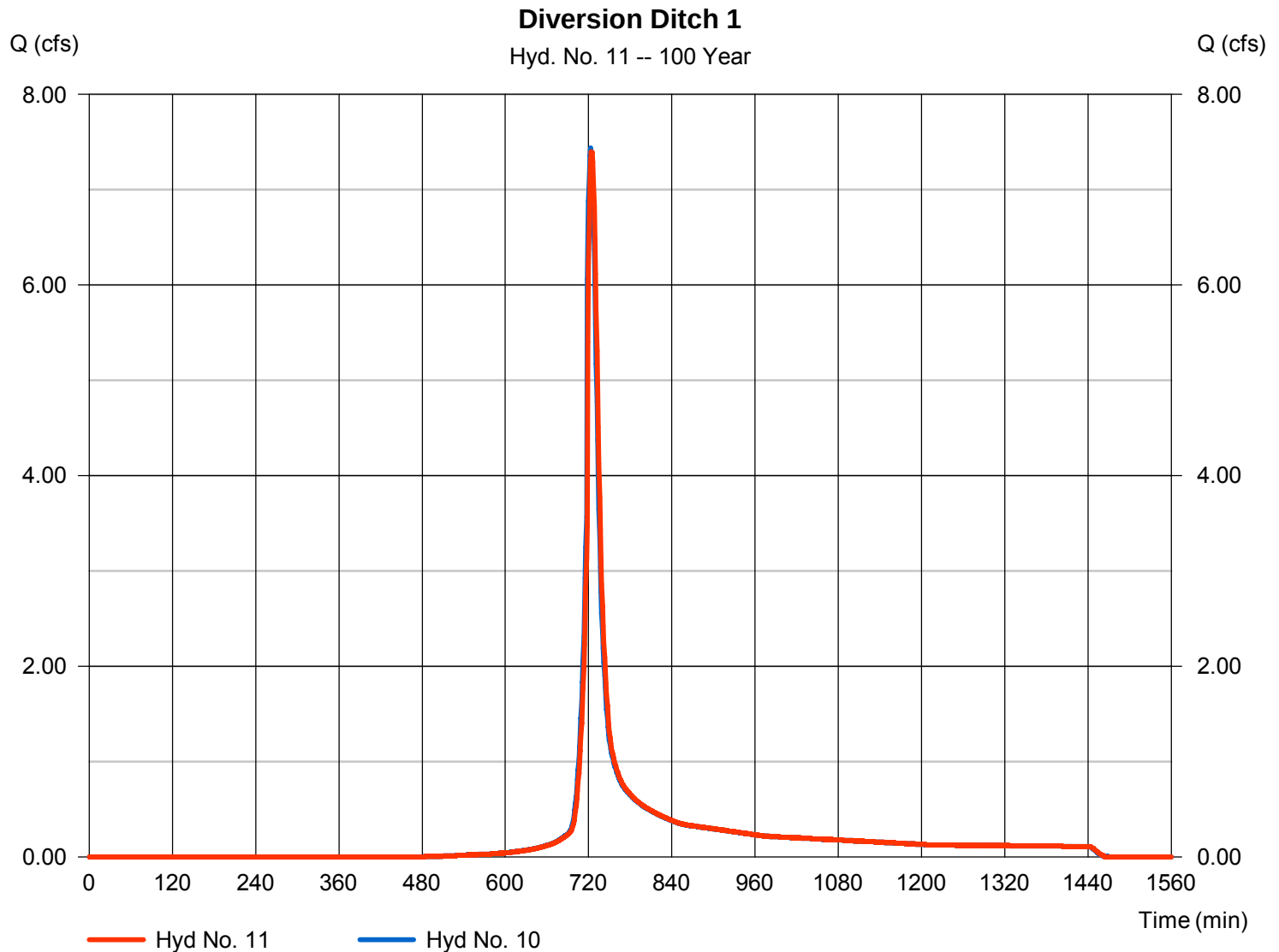
Tuesday, 11 / 15 / 2016

Hyd. No. 11

Diversion Ditch 1

Hydrograph type	= Reach	Peak discharge	= 7.400 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 20,750 cuft
Inflow hyd. No.	= 10 - Diversion Ditch 1	Section type	= Trapezoidal
Reach length	= 232.0 ft	Channel slope	= 3.8 %
Manning's n	= 0.060	Bottom width	= 1.0 ft
Side slope	= 2.0:1	Max. depth	= 2.0 ft
Rating curve x	= 4.847	Rating curve m	= 0.968
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.7484

Modified Att-Kin routing method used.



Hydrograph Report

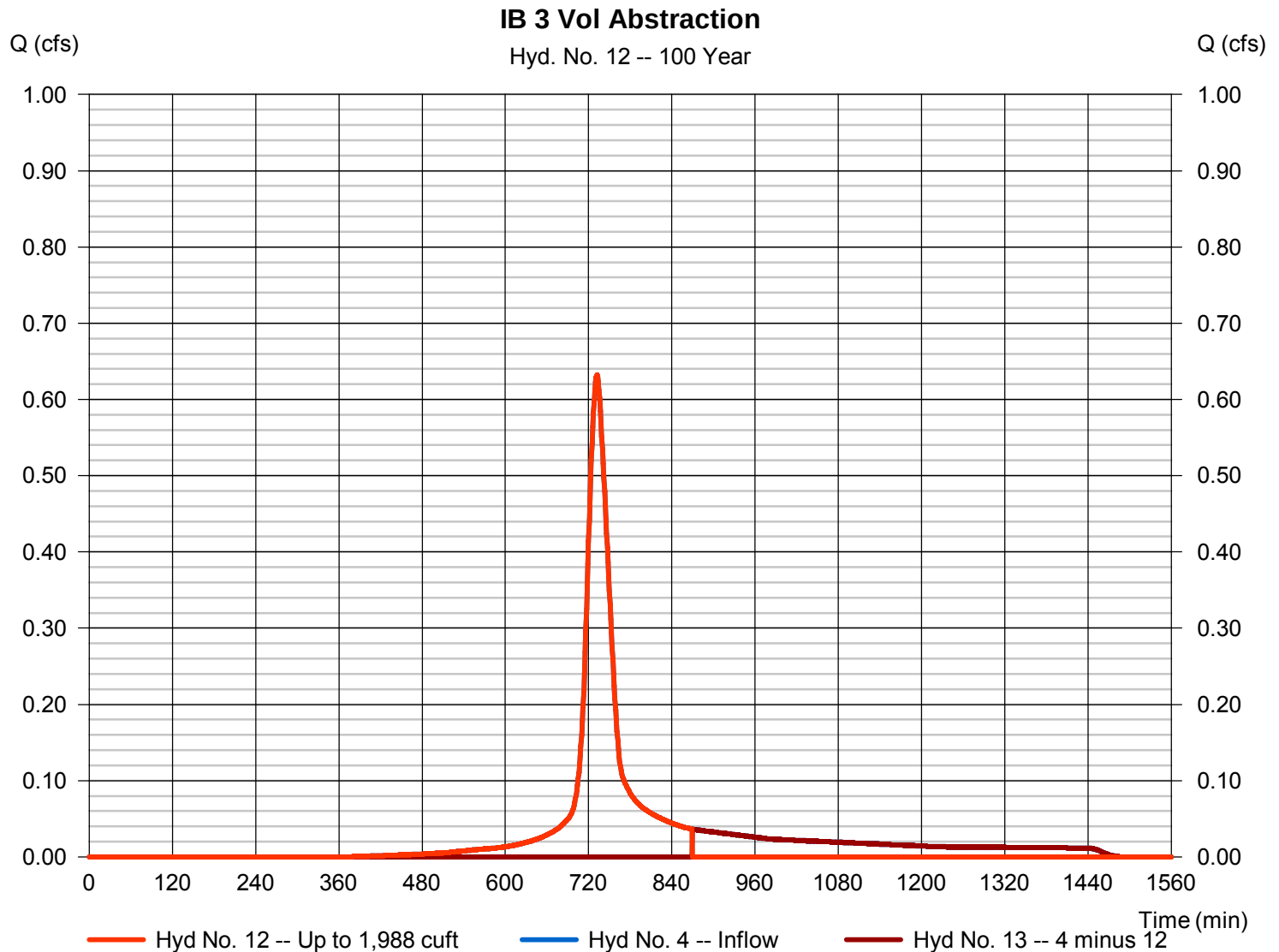
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Tuesday, 11 / 15 / 2016

Hyd. No. 12

IB 3 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.632 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 1,990 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 13
Diversion method	= First Flush Volume	Volume Up To	= 1,988 cuft



Hydrograph Report

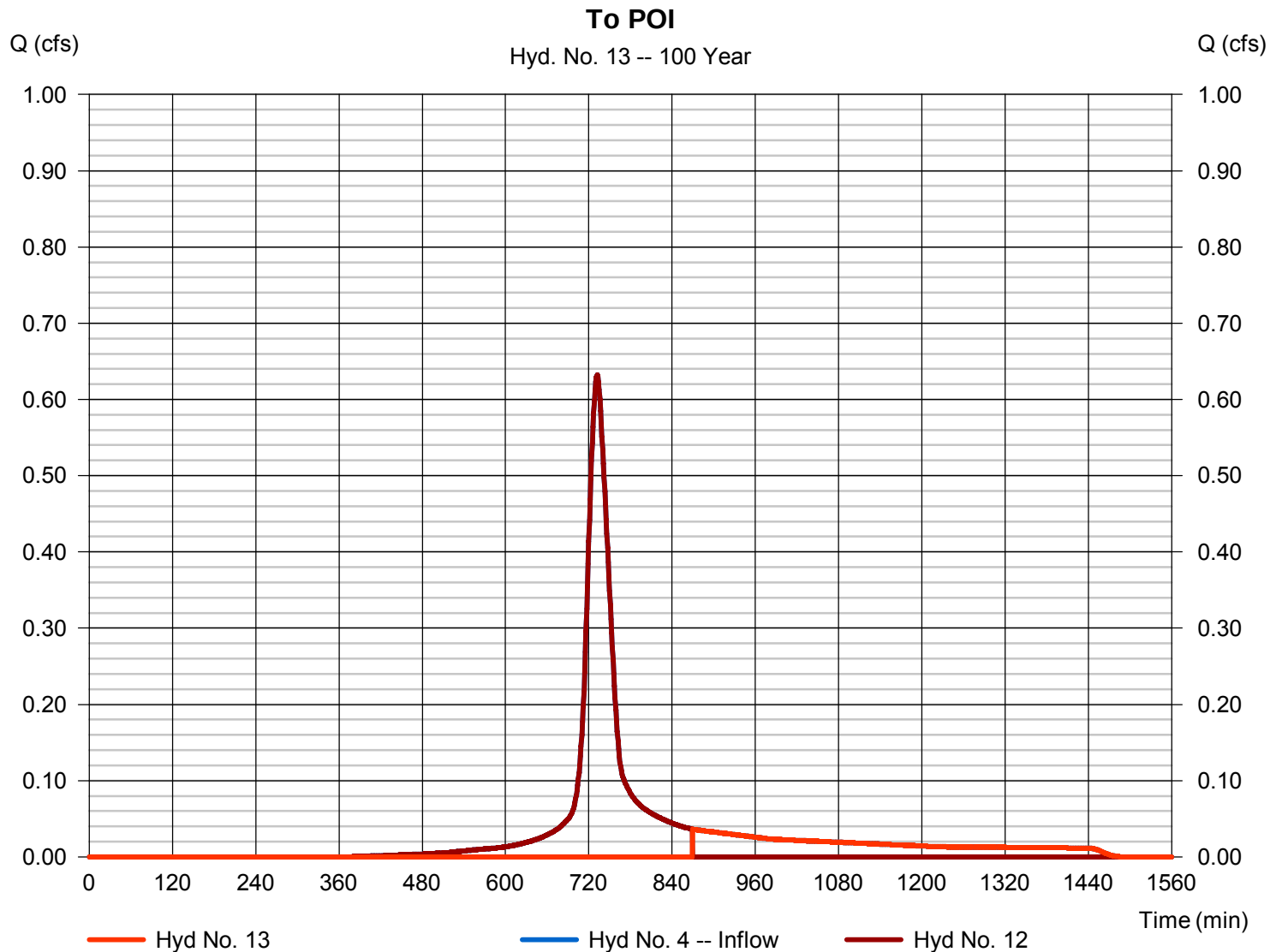
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Tuesday, 11 / 15 / 2016

Hyd. No. 13

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.036 cfs
Storm frequency	= 100 yrs	Time to peak	= 870 min
Time interval	= 1 min	Hyd. volume	= 641 cuft
Inflow hydrograph	= 4 - Newport Rd - Berm 3	2nd diverted hyd.	= 12
Diversion method	= First Flush Volume	Volume Up To	= 1,988 cuft



Hydrograph Report

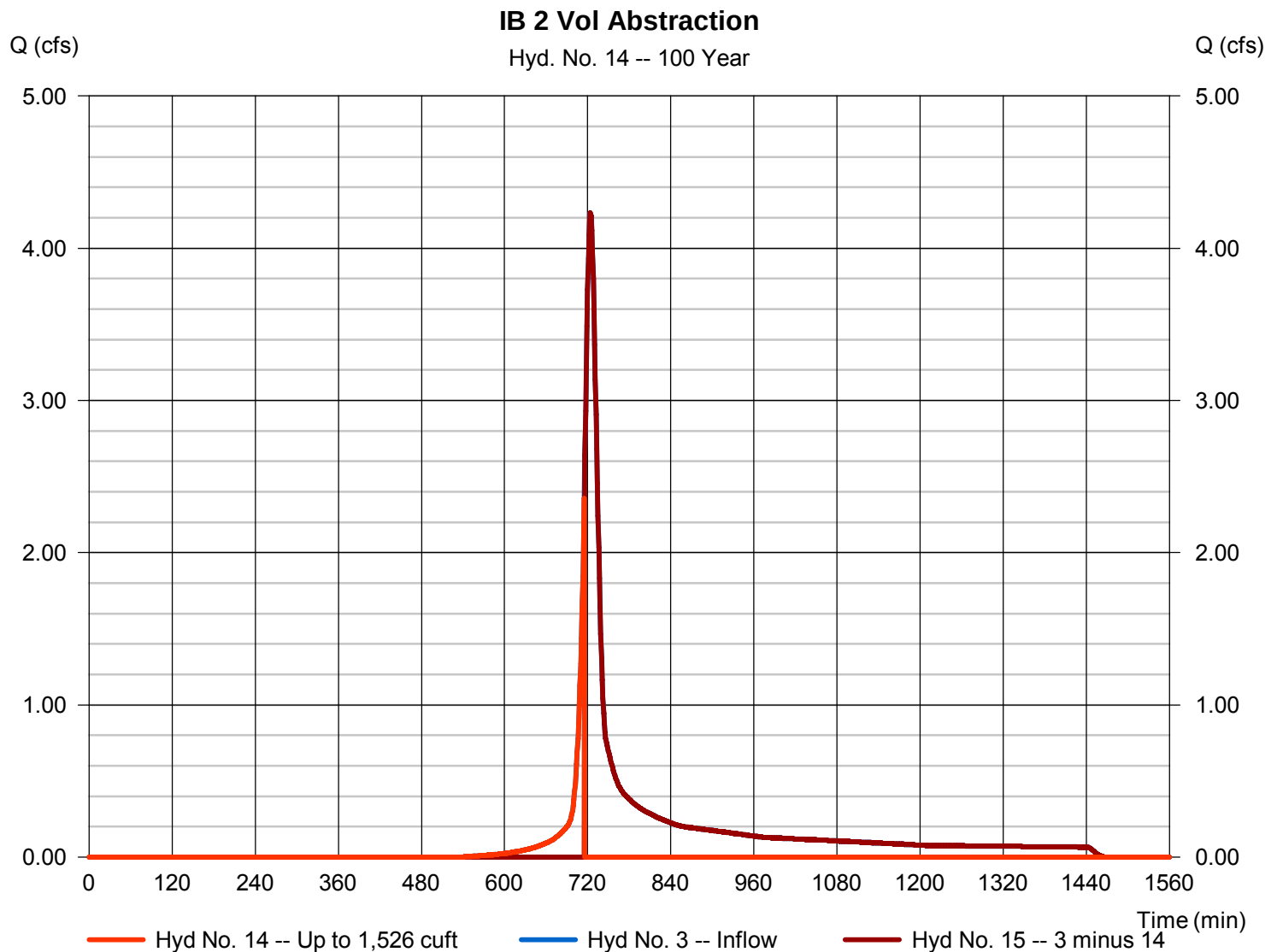
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Tuesday, 11 / 15 / 2016

Hyd. No. 14

IB 2 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.357 cfs
Storm frequency	= 100 yrs	Time to peak	= 715 min
Time interval	= 1 min	Hyd. volume	= 1,662 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 15
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

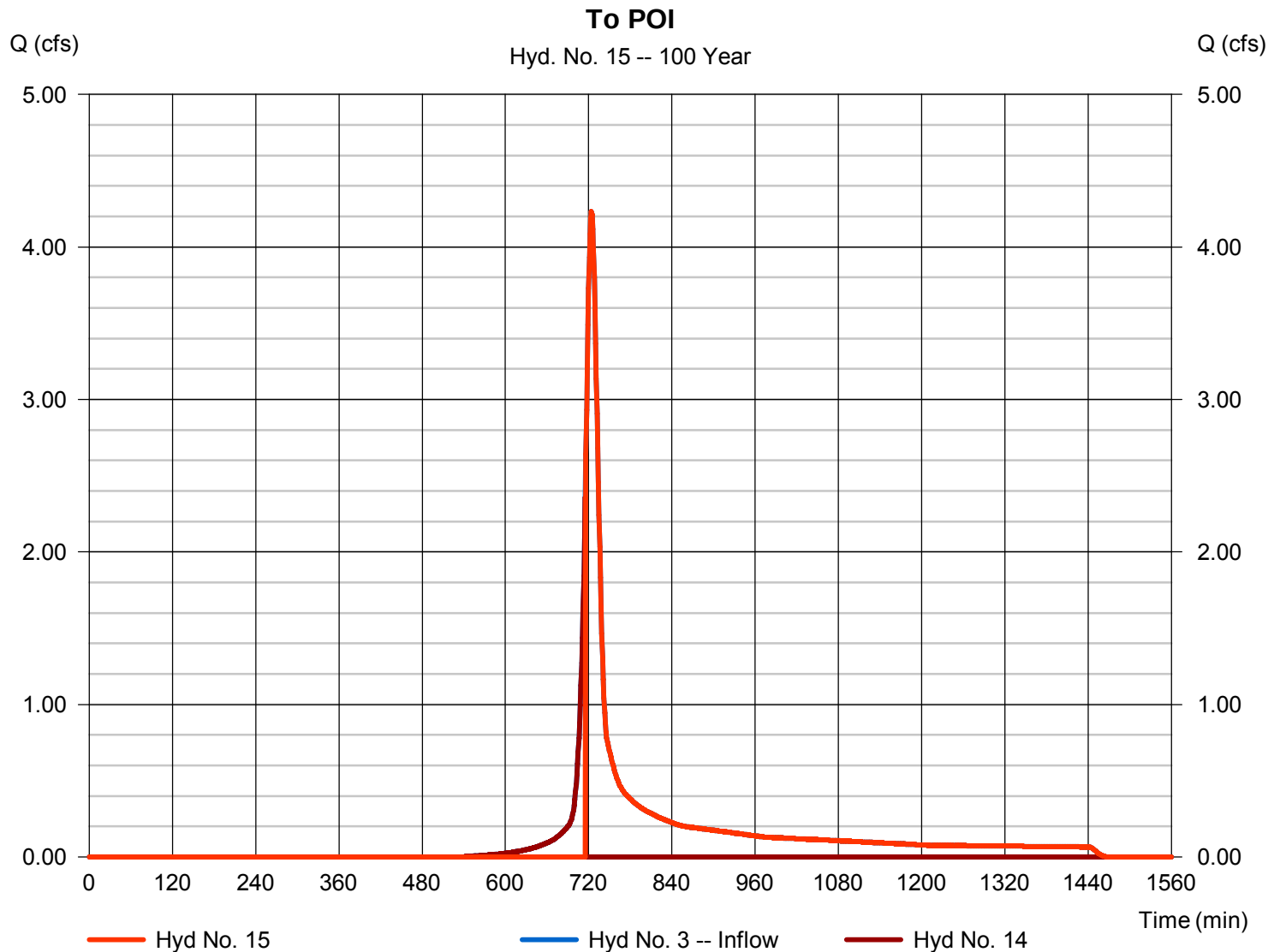
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 11 / 15 / 2016

Hyd. No. 15

To POI

Hydrograph type	= Diversion2	Peak discharge	= 4.232 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 10,909 cuft
Inflow hydrograph	= 3 - Newport Rd - Berm 2	2nd diverted hyd.	= 14
Diversion method	= First Flush Volume	Volume Up To	= 1,526 cuft



Hydrograph Report

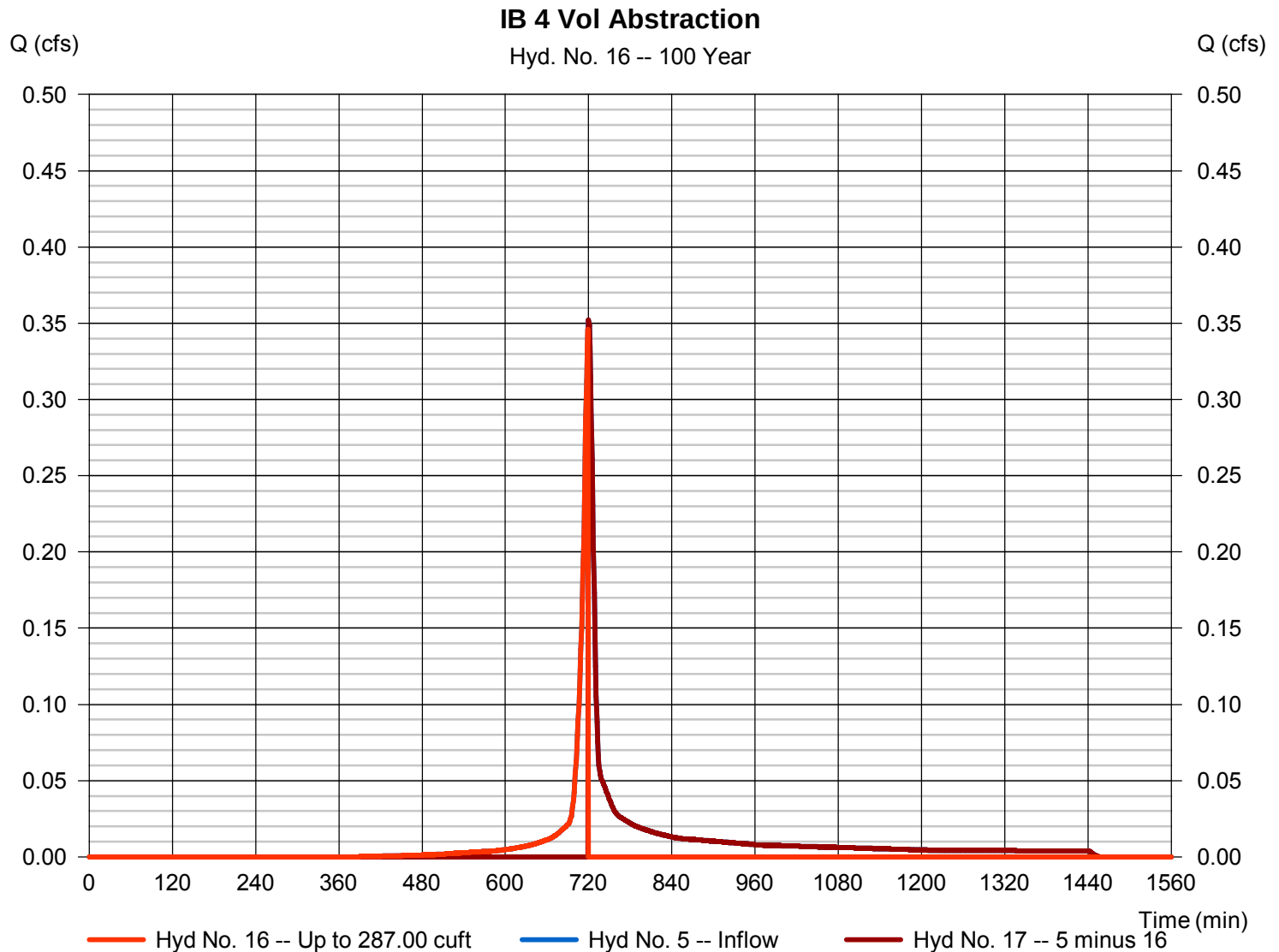
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Tuesday, 11 / 15 / 2016

Hyd. No. 16

IB 4 Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.346 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 296 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 17
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

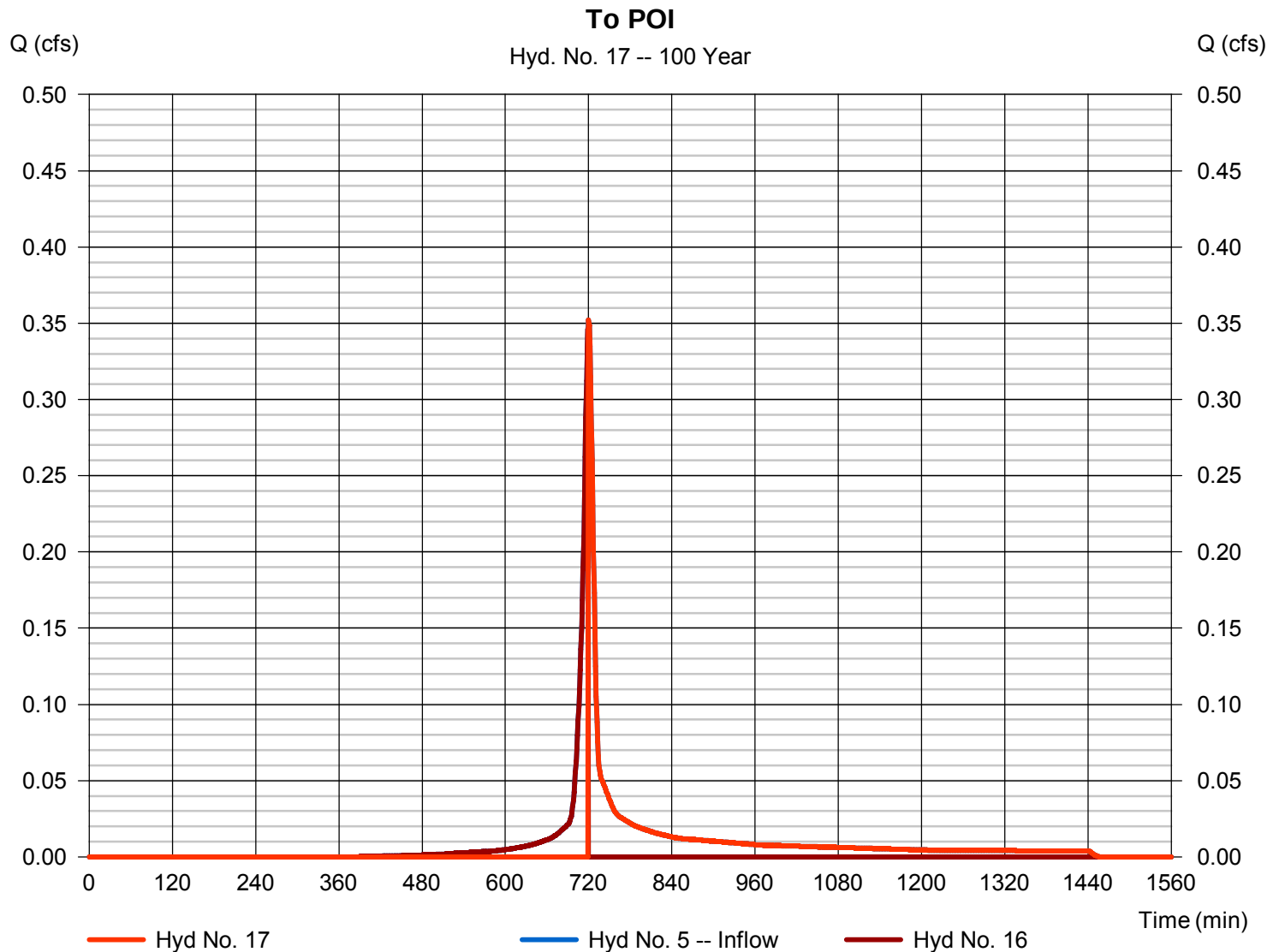
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Tuesday, 11 / 15 / 2016

Hyd. No. 17

To POI

Hydrograph type	= Diversion2	Peak discharge	= 0.352 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 565 cuft
Inflow hydrograph	= 5 - Newport Rd - Berm 4	2nd diverted hyd.	= 16
Diversion method	= First Flush Volume	Volume Up To	= 287.00 cuft



Hydrograph Report

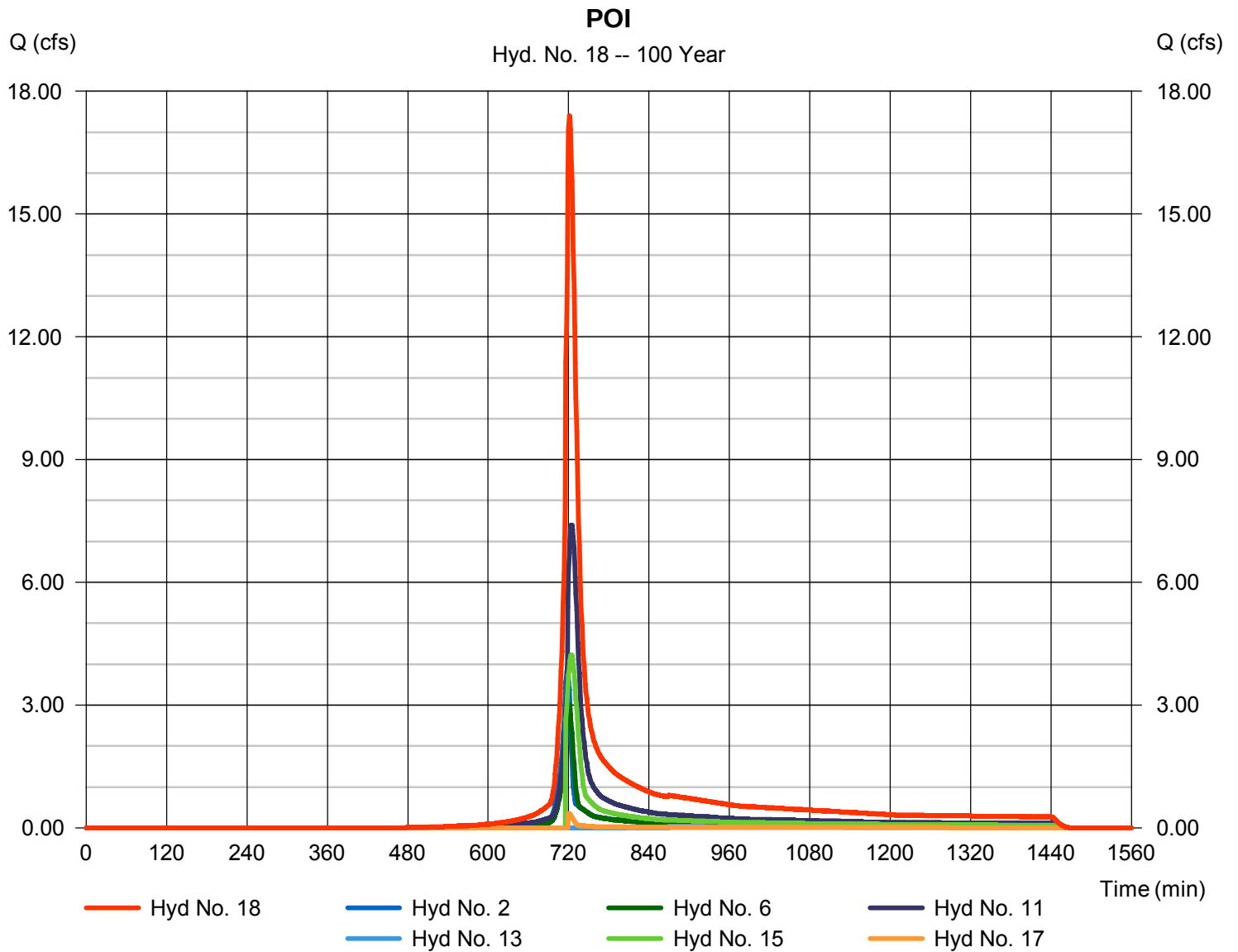
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Tuesday, 11 / 15 / 2016

Hyd. No. 18

POI

Hydrograph type	= Combine	Peak discharge	= 17.39 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 48,540 cuft
Inflow hyds.	= 2, 6, 11, 13, 15, 17	Contrib. drain. area	= 1.620 ac



ATTACHMENT D
NEWPORT RD
DIVERSION CHANNEL DESIGN

TETRA TECH, INC.

By: EAD
Chkd. By: LMD

Date: 10/4/2016
Date: 10/19/2016

Subject: Sunoco PA Pipeline Project
Newport Rd

Sheet No.: of
Proj. No.: 112IC05958

DIVERSION/COLLECTION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1	8.30
CD-1	1.50

Diversion and collection ditches are designated as the watershed labeled as "Newport Rd No BMP" from Attachment C. The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The diversion and collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	2.76	1.00	0.50	1.50
CD-1	1.24	0.78	0.50	1.28

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes		Channel Lining	Total Depth (ft)
			(_LH:1V)	(_RH:1V)		
DD-1	3.8%	1	2	2	NAG P300	1.50
CD-1	4.5%	0	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output .
2. The channel section characteristics resulting in the largest total depth were used.



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Newport Road
 Project Number: 104079
 Channel Name: DD-1**

Discharge	8.3
Peak Flow Period	0.3
Channel Slope	0.038
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	8.3 cfs	4.95 ft/s	0.7 ft	0.032	3 lbs/ft ²	1.66 lbs/ft ²	1.81	STABLE	E
P300 Reinforced Vegetation	Straight	8.3 cfs	2.76 ft/s	1 ft	0.07	8 lbs/ft ²	2.37 lbs/ft ²	3.37	STABLE	E
Underlying Substrate	Straight	8.3 cfs	2.76 ft/s	1 ft	--	2 lbs/ft ²	0.103 lbs/ft ²	19.38	STABLE	--



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: 112IC05958 Sunoco
 Project Number: 103213
 Channel Name: CD-1**

Discharge	1.5
Peak Flow Period	0.3
Channel Slope	0.045
Channel Bottom Width	0
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	1.5 cfs	3.31 ft/s	0.48 ft	0.034	3 lbs/ft ²	1.34 lbs/ft ²	2.24	STABLE	E
P300 Reinforced Vegetation	Straight	1.5 cfs	1.24 ft/s	0.78 ft	0.126	8 lbs/ft ²	2.19 lbs/ft ²	3.66	STABLE	E
Underlying Substrate	Straight	1.5 cfs	1.24 ft/s	0.78 ft	--	2 lbs/ft ²	0.034 lbs/ft ²	59.2	STABLE	--

CHESTNUT RIDGE RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 10, 2016

Project Name: Chestnut Ridge Rd

Municipality: Burrell Township/West Wheatfield Township

County: Indiana

Total Area (acres): 5.89

Major River Basin: Ohio

Watershed: Conemaugh River

Sub Basin: Richards Run-Conemaugh River

Nearest Surface Water to Receive Runoff: Tributary 44795 of Roaring Run

Ch. 93 - Designated Water Use: CWF

Impaired according to Chapter 303(d) list?

YES

X

List Causes of Impairment:

NO

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES

X

NO

Existing or Planned drinking water supply?

YES

X

NO

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES

X

NO

Existing River Conservation Plan?

YES

X

NO

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	5.89	4.61
Other:			
TOTAL EXISTING:	Yes	5.89	4.61

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>4.61</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>4.61</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
<u>5.89</u>	-	<u>4.61</u>	=	<u>1.28</u>
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn _____ ft² x 1/4 in x 1/12 = _____ ft³

Meadow _____ ft² x 1/3 in x 1/12 = _____ ft³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy _____ ft² x 1/2 in x 1/12 = _____ ft³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft² x 1/3 in x 1/12 = _____ ft³

For all other disconnected roof areas

Roof Area _____ ft² x 1/4 in x 1/12 = _____ ft³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas _____ ft² x 1/3 in x 1/12 = _____ ft³

For all other disconnected roof areas

Impervious Areas _____ ft² x 1/4 in x 1/12 = _____ ft³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

 ft³

* For use on Worksheet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Chestnut Ridge Rd
 Drainage Area: 5.89 acres
 2-Year Rainfall: 2.57 in

Total Site Area: 5.89 acres
 Protected Site Area: 4.61 acres
 Managed Site Area: 1.28 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Woods	B	31061	0.71	55	8.18	1.64	0.10	248
80% Existing Gravel	B	5414	0.12	85	1.76	0.35	1.23	557
Meadow (20% Gravel)	B	1354	0.03	58	7.24	1.45	0.15	17
Meadow	B	17860	0.41	58	7.24	1.45	0.15	224
TOTAL:		55,688	1.28					1,045

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	B	42689	0.98	58	7.24	1.45	0.15	535
Gravel	B	13180	0.30	85	1.76	0.35	1.23	1,356
TOTAL:		55,869	1.28					1,891

2-Year Volume Increase (ft ³):	846

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Chestnut Ridge Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 846

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 846
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	3,264	1,155
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			1,155
			Structural Volume Requirement (ft³): 846
			DIFFERENCE: -309

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP

LOCATION: Chestnut Ridge Road, Westmoreland County, PA

DONE BY: RJM

DATE: 10/10/2016

CHECKED BY: LMD

DATE: 10/11/2016

CHANNEL OR CHANNEL SECTION	DD-1				
TEMPORARY OR PERMANENT? (T OR P)	P				
DESIGN STORM (2, 5, 10, OR 100 YR)	100				
ACRES (AC)	3.40				
MULTIPLIER (1.6, 2.25, or 2.75) ¹	N/A				
Q _r (REQUIRED CAPACITY) (CFS)	7.00				
Q (CALCULATED AT FLOW DEPTH d) (CFS)	7.00				
S (BED SLOPE) ³ (FT/FT)	0.065				
DESIGN METHOD FOR PROTECTIVE LINING ⁵	V				
PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)					
PROTECTIVE LINING ²	NAG P300				
n (MANNING'S COEFFICIENT) ²	0.060				
V _a (ALLOWABLE VELOCITY) (FPS)	5.00				
V (CALCULATED AT FLOW DEPTH) (FPS)	3.23				
τ _a (MAX ALLOWABLE SHEAR STRESS) (LB/FT ²)	N/A				
τ _d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT ²)	N/A				
CHANNEL BOTTOM WIDTH (FT)	1				
CHANNEL LEFT SIDE SLOPE (LH:1V)	2				
CHANNEL RIGHT SIDE SLOPE (RH:1V)	2				
D (TOTAL DEPTH) (FT)	1.50				
CHANNEL TOP WIDTH @ D (FT)	7.00				
d (CALCULATED FLOW DEPTH) (FT)	0.82				
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	4.28				
BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)	1.22				
d ₅₀ STONE SIZE (IN)	N/A				
A (CROSS-SECTIONAL AREA) (SQ. FT.)	2.16				
R (HYDRAULIC RADIUS)	0.46				
S _c (CRITICAL SLOPE) (FT/FT)	0.074				
.7S _c (FT/FT)	0.052				
1.3S _c (FT/FT)	0.096				
STABLE FLOW? (Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW (FT)	N/A				
FREEBOARD BASED ON STABLE FLOW (FT)	0.68				
MINIMUM REQUIRED FREEBOARD ⁴	0.5				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

**PCSM - DESIGN CALCULATIONS
CHESTNUT RIDGE RD**

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations Chestnut Ridge Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Chestnut Ridge Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Chestnut Ridge Road Block Valve Site is located in Burrell Township and West Wheatfield Township, Indiana County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.57
10-yr	3.64
50-yr	4.92
100-yr	5.54

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.57 in

Total Site Area : 5.89 acres

Protected Site Area: 4.61 acres

Stormwater Management Area 1.28 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Woods	B	0.71	55	8.18	1.64	0.10	248
80% Existing Gravel	B	0.12	85	1.76	0.35	1.23	557
Meadow (20% Gravel)	B	0.03	58	7.24	1.45	0.15	17
Meadow	B	0.41	58	7.24	1.45	0.15	224
Total		1.28					1,045

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	B	0.98	58	7.24	1.45	0.15	535
Gravel	B	0.30	85	1.76	0.35	1.23	1,356
Total		1.28					1,891

2-Year Volume Increase (cf):	846

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

P = 2-Year Rainfall (in)

S = $(1000/CN) - 10$

2. Runoff Volume (CF) = Q x Area x 1/12

Q = Runoff (in)

Area = Land use area (sq. ft.)

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
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IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.30	13180.08
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		2,636
Design Infiltration Area (sf):		3,264
Design Impervious Ratio:	4.0	:1

OK

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.72	31446.30
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		3,931
Design Infiltration Area (sf):		3,264
Design Total Watershed Ratio:	9.6	:1

The Infiltration Berm is placed in a location to maximize catchment of the disturbed area. A diversion channel has been instructed along the southern edge of the valve site and access road to minimize the total loading of the infiltration berm as much as possible.

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Chestnut Ridge Road Block Valve Site will be located at the northeast edge of the pad and 100 percent of the disturbed area will be detained by the BMP.

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INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - Infiltration Berm	1.9

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

Infiltration Berm

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	94	39	3,264	2.00	3704

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
1.9	3,264	2	1034

Volume Abstraction Potential (cf)	4,737.20

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration BMP				
Infiltration Berm	1155	3704	3703.6	1155
Total Structural Credit (cf) (Worksheet 5)				1155

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 5.89 acres. Based upon the soil survey of Westmoreland County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Clymer channery loam (CIC) and Buchanan loam (BuB) series which are primarily classified as HSG B and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	BuB	Meadow	78	0.04
C/D	BuB	Woods	77	0.29
B	CIC	Existing Impervious (80%)	98	0.02
B	CIC	Meadow (20% Impervious)	58	0.01
B	CIC	Meadow	58	1.08
B	CIC	Existing Gravel (80%)	85	0.12
B	CIC	Meadow (20% Gravel)	58	0.03
B	CIC	Woods	55	4.30
			Totals	5.89

CN	58

Post-Development Condition

Undetained Area 2 (UD2)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
B	CIC	Meadow	58	0.07
B	CIC	Woods	55	0.87
C/D	BuB	Woods	77	0.12
			Totals	1.06

CN	58

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

Diversion Channel DD-1 (Undetained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
B	CLC	Meadow	58	1.09
B	CLC	Woods	55	2.18
B	CLC	Impervious	98	0.03
C/D	BuB	Woods	77	0.10
C/D	BuB	Meadow	78	0.02
			Totals	3.42

CN	57

Infiltration Berm 1 (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
B	CLC	Meadow	58	0.50
B	CLC	Gravel	85	0.30
B	CLC	Woods	55	0.53
C/D	BuB	Meadow	78	0.01
C/D	BuB	Woods	77	0.06
			Totals	1.40

CN	64

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Rd Proj. No.: 112IC05958

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydroflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. Without BMPs (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.5	1,155	40.6	10.2	50.8
10	1.2	2,647	36.0	10.2	46.2
50	2.3	3,704	26.9	10.2	37.1
100	2.9	3,704	21.7	10.2	31.9

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,155	4,737.20	1,155
10	2,647	4,737.20	2,647
50	4,840	4,737.20	4,737
100	6,010	4,737.20	4,737

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By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
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STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	0.4	0.6	2,586	0.2	-0.2
10-yr	3.6	3.8	9,219	2.3	-1.3
50-yr	9.8	9.9	20,825	6.7	-3.1
100-yr	13.4	13.3	28,612	9.2	-4.2

A diversion channel was designed along the southern edge of the LOD to divert runoff away from the proposed pad. The runoff from the channel was then redistributed at the downstream end of the channel via a level spreader. The rerouting of the watershed "Diversion (Undetained)" and extended time of concentration for that area, resulted in a lower peak flow at the Point of Interest for the total watershed when the BMP was not considered.

TETRA TECH, INC.

By: RJM Date: 10/10/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/2016 Chestnut Ridge Rd Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Indiana County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4391 N 79.1552 W 1926.68 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: West Wheatfield Twp,
Pennsylvania, USA*
Latitude: 40.4391°, Longitude: -79.1552°
Elevation: 1926.68 ft**

* source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.318 (0.288-0.351)	0.379 (0.344-0.419)	0.458 (0.415-0.507)	0.521 (0.471-0.575)	0.603 (0.542-0.664)	0.666 (0.597-0.732)	0.729 (0.650-0.800)	0.796 (0.706-0.873)	0.887 (0.781-0.972)	0.957 (0.837-1.05)
10-min	0.494 (0.447-0.545)	0.592 (0.537-0.655)	0.712 (0.645-0.788)	0.805 (0.726-0.887)	0.922 (0.828-1.01)	1.01 (0.904-1.11)	1.10 (0.978-1.21)	1.19 (1.05-1.30)	1.30 (1.15-1.43)	1.39 (1.22-1.52)
15-min	0.605 (0.548-0.668)	0.724 (0.657-0.801)	0.875 (0.792-0.967)	0.990 (0.894-1.09)	1.14 (1.02-1.25)	1.25 (1.12-1.37)	1.36 (1.22-1.50)	1.48 (1.31-1.62)	1.63 (1.43-1.78)	1.74 (1.52-1.90)
30-min	0.801 (0.726-0.884)	0.969 (0.879-1.07)	1.20 (1.08-1.32)	1.38 (1.24-1.52)	1.61 (1.45-1.77)	1.79 (1.60-1.96)	1.97 (1.75-2.16)	2.16 (1.91-2.37)	2.41 (2.12-2.64)	2.61 (2.28-2.85)
60-min	0.978 (0.886-1.08)	1.19 (1.08-1.31)	1.50 (1.36-1.66)	1.75 (1.58-1.93)	2.08 (1.87-2.30)	2.35 (2.11-2.59)	2.63 (2.35-2.89)	2.93 (2.60-3.21)	3.33 (2.94-3.65)	3.67 (3.21-4.01)
2-hr	1.15 (1.04-1.26)	1.39 (1.26-1.53)	1.76 (1.60-1.94)	2.05 (1.86-2.26)	2.47 (2.22-2.70)	2.80 (2.52-3.07)	3.16 (2.82-3.45)	3.55 (3.14-3.86)	4.09 (3.60-4.46)	4.54 (3.96-4.94)
3-hr	1.23 (1.12-1.36)	1.50 (1.36-1.65)	1.88 (1.71-2.07)	2.19 (1.99-2.42)	2.64 (2.37-2.90)	3.01 (2.69-3.29)	3.40 (3.02-3.71)	3.83 (3.38-4.17)	4.44 (3.88-4.83)	4.94 (4.29-5.37)
6-hr	1.50 (1.36-1.66)	1.80 (1.64-2.00)	2.25 (2.04-2.49)	2.61 (2.37-2.89)	3.14 (2.83-3.47)	3.58 (3.21-3.94)	4.06 (3.61-4.46)	4.57 (4.04-5.01)	5.32 (4.64-5.82)	5.95 (5.14-6.49)
12-hr	1.81 (1.66-2.02)	2.18 (1.99-2.42)	2.69 (2.46-2.99)	3.13 (2.84-3.46)	3.76 (3.40-4.15)	4.30 (3.85-4.72)	4.88 (4.34-5.35)	5.51 (4.86-6.03)	6.44 (5.62-7.04)	7.23 (6.24-7.88)
24-hr	2.15 (1.99-2.34)	2.57 (2.38-2.80)	3.15 (2.91-3.43)	3.64 (3.36-3.95)	4.34 (3.98-4.70)	4.92 (4.49-5.32)	5.54 (5.03-5.98)	6.20 (5.59-6.68)	7.16 (6.39-7.70)	7.95 (7.02-8.55)
2-day	2.49 (2.31-2.71)	2.97 (2.75-3.23)	3.62 (3.35-3.93)	4.14 (3.83-4.50)	4.90 (4.50-5.30)	5.51 (5.05-5.97)	6.16 (5.62-6.66)	6.85 (6.21-7.40)	7.82 (7.02-8.44)	8.60 (7.66-9.29)
3-day	2.68 (2.48-2.90)	3.18 (2.95-3.45)	3.84 (3.56-4.16)	4.38 (4.06-4.74)	5.15 (4.75-5.56)	5.77 (5.30-6.23)	6.42 (5.87-6.93)	7.10 (6.45-7.66)	8.06 (7.25-8.70)	8.82 (7.88-9.53)
4-day	2.86 (2.66-3.09)	3.39 (3.15-3.66)	4.07 (3.78-4.39)	4.63 (4.29-4.98)	5.40 (4.99-5.82)	6.03 (5.54-6.49)	6.68 (6.12-7.19)	7.36 (6.70-7.93)	8.30 (7.49-8.95)	9.05 (8.11-9.77)
7-day	3.45 (3.23-3.69)	4.08 (3.82-4.37)	4.83 (4.52-5.17)	5.43 (5.08-5.82)	6.26 (5.84-6.70)	6.92 (6.43-7.40)	7.59 (7.02-8.11)	8.27 (7.62-8.84)	9.19 (8.40-9.84)	9.89 (9.00-10.6)
10-day	4.02 (3.79-4.27)	4.74 (4.47-5.03)	5.55 (5.24-5.89)	6.21 (5.84-6.57)	7.08 (6.64-7.49)	7.76 (7.27-8.21)	8.44 (7.88-8.93)	9.13 (8.48-9.66)	10.0 (9.27-10.6)	10.7 (9.87-11.4)
20-day	5.69 (5.39-5.99)	6.66 (6.32-7.03)	7.69 (7.29-8.11)	8.49 (8.04-8.95)	9.55 (9.03-10.1)	10.4 (9.78-10.9)	11.2 (10.5-11.8)	11.9 (11.2-12.6)	12.9 (12.1-13.6)	13.7 (12.7-14.4)
30-day	7.20 (6.88-7.57)	8.41 (8.03-8.86)	9.61 (9.17-10.1)	10.6 (10.1-11.1)	11.8 (11.2-12.4)	12.7 (12.1-13.4)	13.6 (12.9-14.3)	14.5 (13.7-15.2)	15.6 (14.7-16.4)	16.4 (15.4-17.3)
45-day	9.28 (8.86-9.73)	10.8 (10.3-11.3)	12.2 (11.7-12.8)	13.3 (12.7-13.9)	14.7 (14.0-15.4)	15.7 (14.9-16.4)	16.6 (15.8-17.5)	17.5 (16.6-18.4)	18.7 (17.6-19.6)	19.5 (18.3-20.5)
60-day	11.2 (10.8-11.7)	13.0 (12.5-13.6)	14.6 (14.0-15.3)	15.8 (15.2-16.5)	17.3 (16.6-18.1)	18.4 (17.6-19.2)	19.4 (18.6-20.3)	20.4 (19.5-21.3)	21.5 (20.5-22.5)	22.3 (21.3-23.4)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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

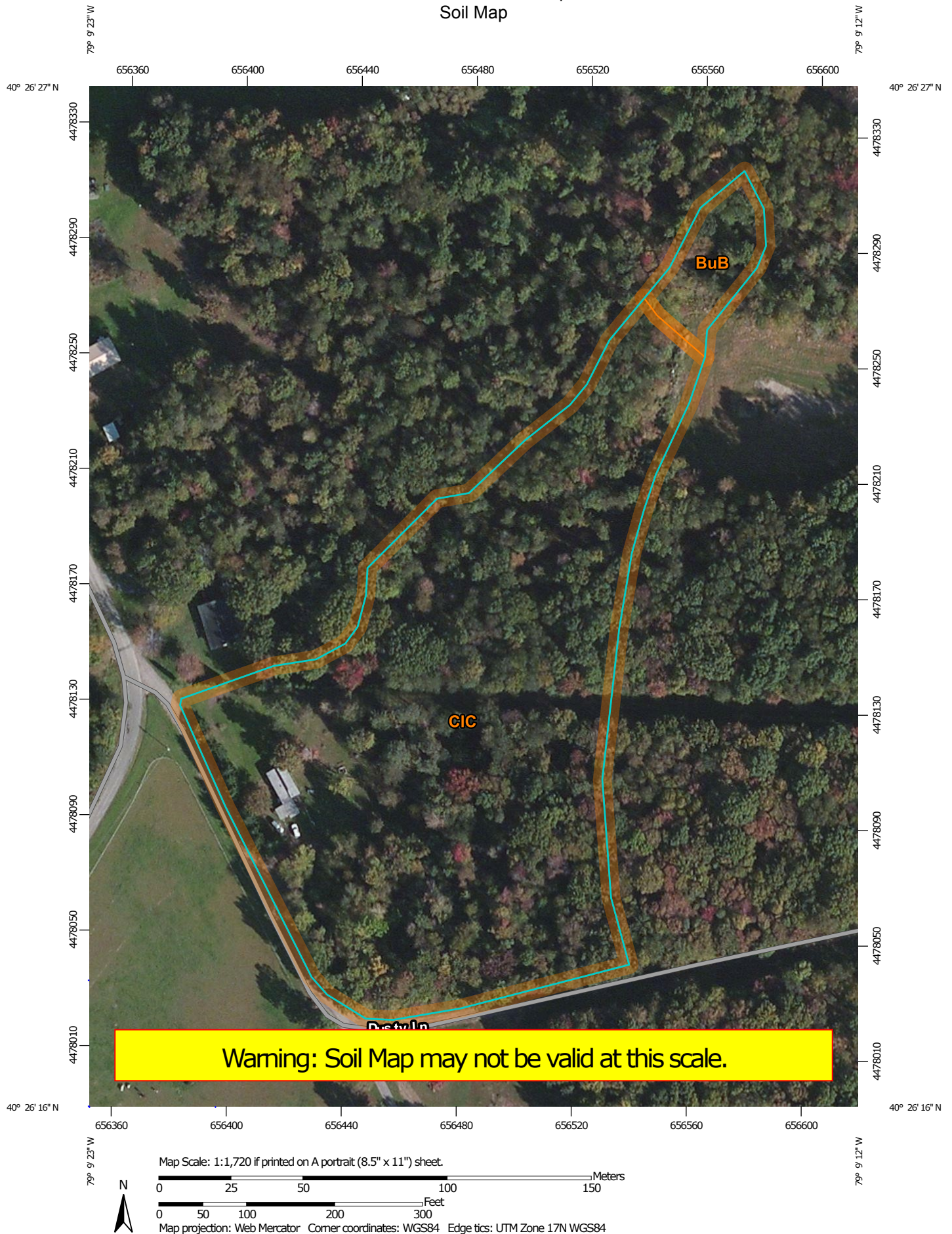
Custom Soil Resource Report for Indiana County, Pennsylvania



October 9, 2016

845 of 1484

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Soil Map Unit Polygons

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Special Line Features

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: <http://websoilsurvey.nrcs.usda.gov>
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: Indiana County, Pennsylvania
Survey Area Data: Version 11, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Indiana County, Pennsylvania (PA063)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BuB	Buchanan loam, 3 to 8 percent slopes	0.3	5.5%
CIC	Clymer channery loam, 8 to 15 percent slopes	5.6	94.5%
Totals for Area of Interest		5.9	100.0%

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

Indiana County, Pennsylvania

BuB—Buchanan loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1vrt4
Elevation: 700 to 1,800 feet
Mean annual precipitation: 38 to 54 inches
Mean annual air temperature: 37 to 59 degrees F
Frost-free period: 130 to 170 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Buchanan and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Buchanan

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Linear, concave
Across-slope shape: Concave, linear
Parent material: Acid fine-loamy colluvium derived from sandstone and siltstone

Typical profile

Ap - 0 to 6 inches: loam
Bt - 6 to 27 inches: channery loam
Btx - 27 to 60 inches: channery loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 36 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 14 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Andover

Percent of map unit: 5 percent
Landform: Mountain slopes
Landform position (two-dimensional): Toeslope

Custom Soil Resource Report

Landform position (three-dimensional): Mountainbase
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

CIC—Clymer channery loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1vrpf
Elevation: 980 to 2,800 feet
Mean annual precipitation: 35 to 65 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 110 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Clymer and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Clymer

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountaintop, interfluvium
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Acid coarse-loamy residuum weathered from sandstone and siltstone

Typical profile

Ap - 0 to 8 inches: channery loam
Bt - 8 to 36 inches: channery loam
C - 36 to 50 inches: extremely channery sandy loam
R - 50 to 62 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Custom Soil Resource Report

Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Cookport

Percent of map unit: 15 percent
Landform: Mountains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Hazleton

Percent of map unit: 10 percent
Landform: Hillsides or mountainsides
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Mountaintop, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

**ATTACHMENT C
CHESTNUT RIDGE
HYDRAFLOW RESULTS**

ATTACHMENT C-1
CHESTNUT RIDGE
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.361	-----	-----	3.620	-----	9.841	13.37	Chestnut - Pre
Proj. file: Chestnut Ridge Hydro - pre.gpw									Wednesday, 11 / 9 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

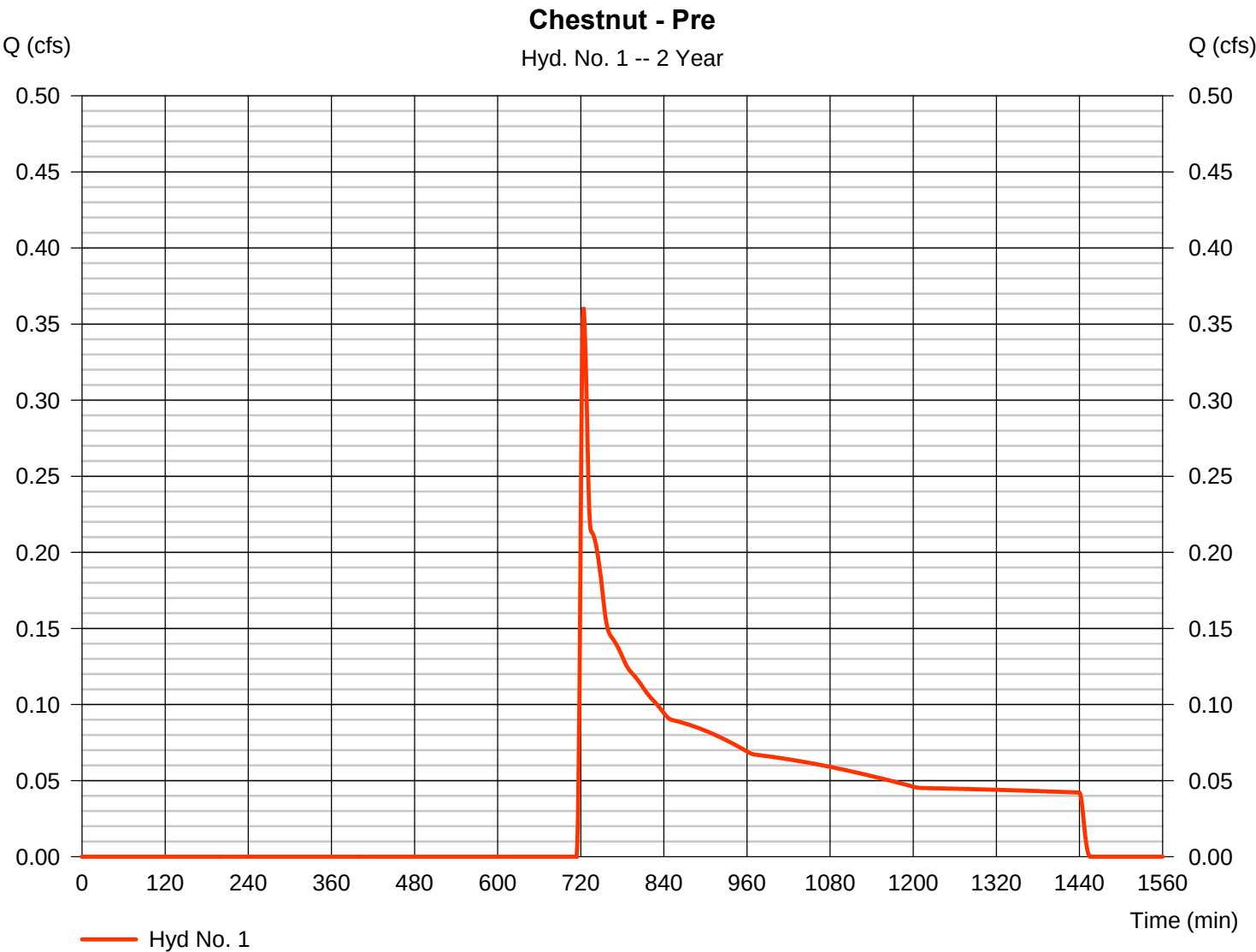
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.361	1	724	3,216	-----	-----	-----	Chestnut - Pre
Chestnut Ridge Hydro - pre.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.361 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	3,216 cuft
Drainage area	=	5.890 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.00 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

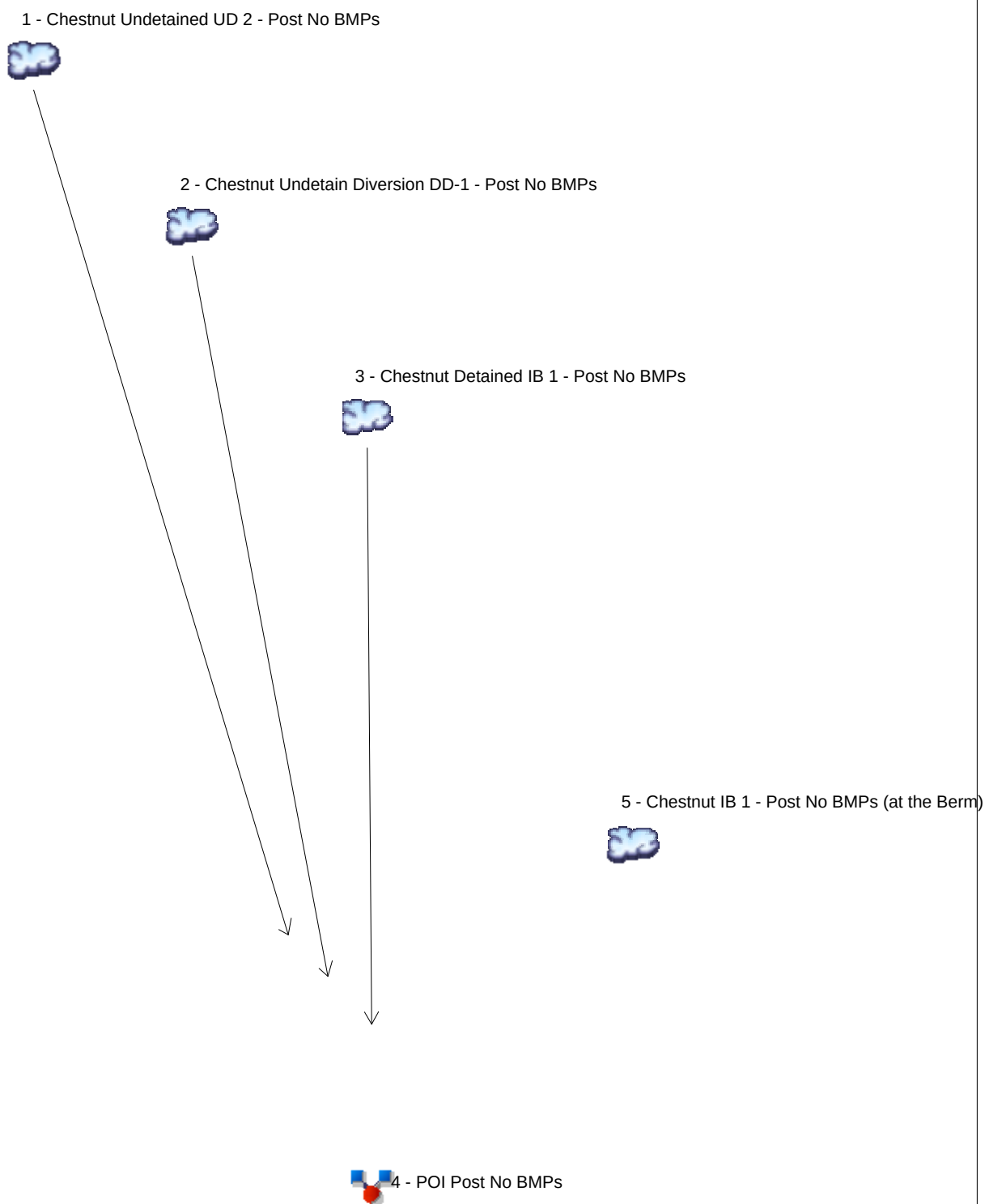
Hyd. No. 1

Chestnut - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 12.0	88.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 16.70	8.00	0.00				
Travel Time (min)	= 0.86	+	5.67	+	0.00	=	6.53
Shallow Concentrated Flow							
Flow length (ft)	= 260.00	650.00	0.00				
Watercourse slope (%)	= 7.30	7.10	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.36	4.30	0.00				
Travel Time (min)	= 0.99	+	2.52	+	0.00	=	3.51
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				10.00 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.065	-----	-----	0.651	-----	1.771	2.406	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	-----	-----	0.121	-----	-----	1.679	-----	4.962	6.859	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	-----	-----	0.395	-----	-----	1.481	-----	3.174	4.088	Chestnut Detained IB 1 - Post No BM
4	Combine	1, 2, 3	-----	0.561	-----	-----	3.788	-----	9.879	13.30	POI Post No BMPs
5	SCS Runoff	-----	-----	0.474	-----	-----	1.226	-----	2.293	2.850	Chestnut IB 1 - Post No BMPs (at the

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

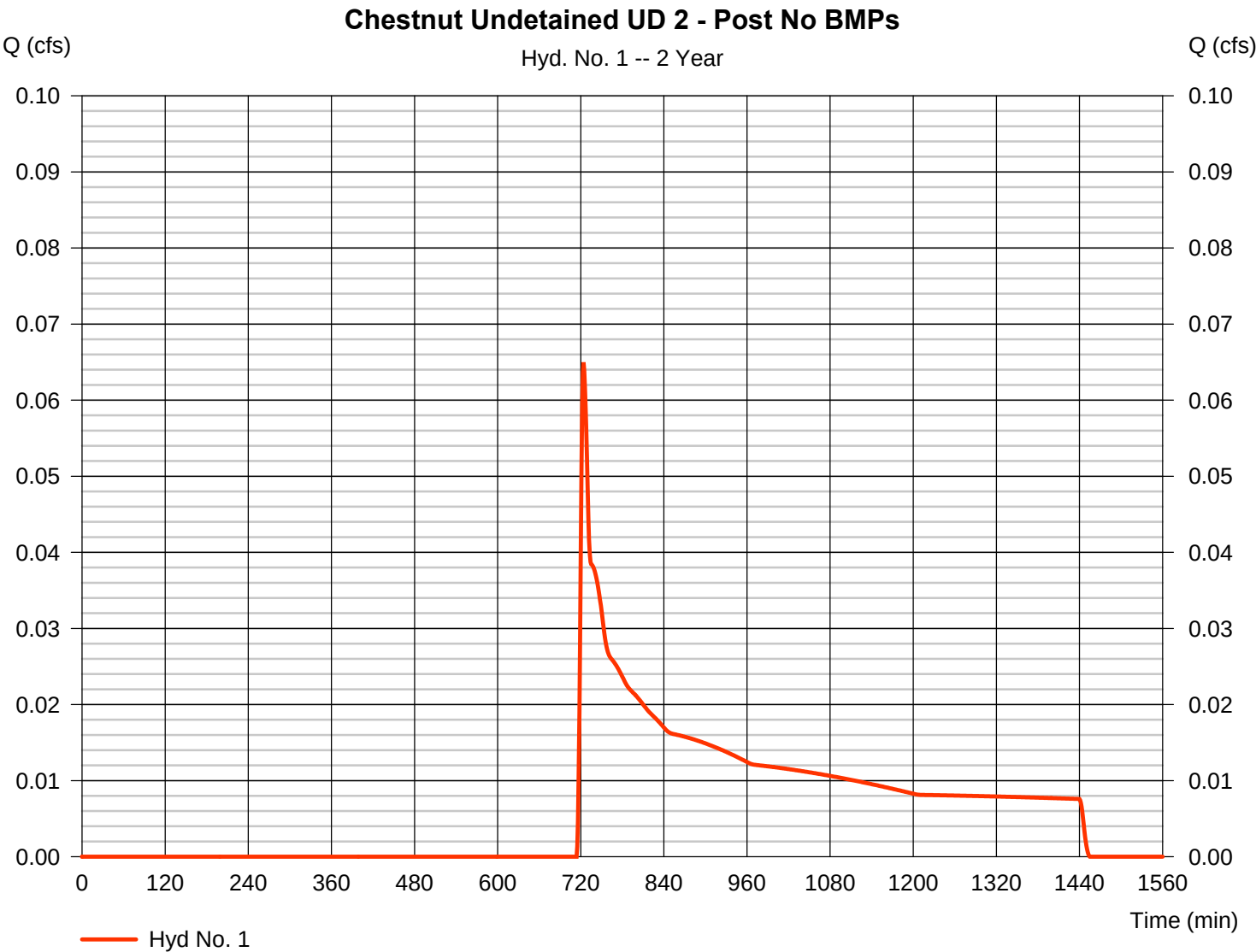
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.065	1	724	579	-----	-----	-----	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	0.121	1	728	1,653	-----	-----	-----	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	0.395	1	723	1,527	-----	-----	-----	Chestnut Detained IB 1 - Post No BM
4	Combine	0.561	1	724	3,759	1, 2, 3	-----	-----	POI Post No BMPs
5	SCS Runoff	0.474	1	719	1,155	-----	-----	-----	Chestnut IB 1 - Post No BMPs (at the
Chestnut Ridge Hydro - post no BMP.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.065 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	579 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 14.0	86.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 43.00	9.30	0.00				
Travel Time (min)	= 0.66	+	5.24	+	0.00	=	5.91
Shallow Concentrated Flow							
Flow length (ft)	= 765.00	0.00	0.00				
Watercourse slope (%)	= 7.30	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.36	0.00	0.00				
Travel Time (min)	= 2.92	+	0.00	+	0.00	=	2.92
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				8.80 min			

Hydrograph Report

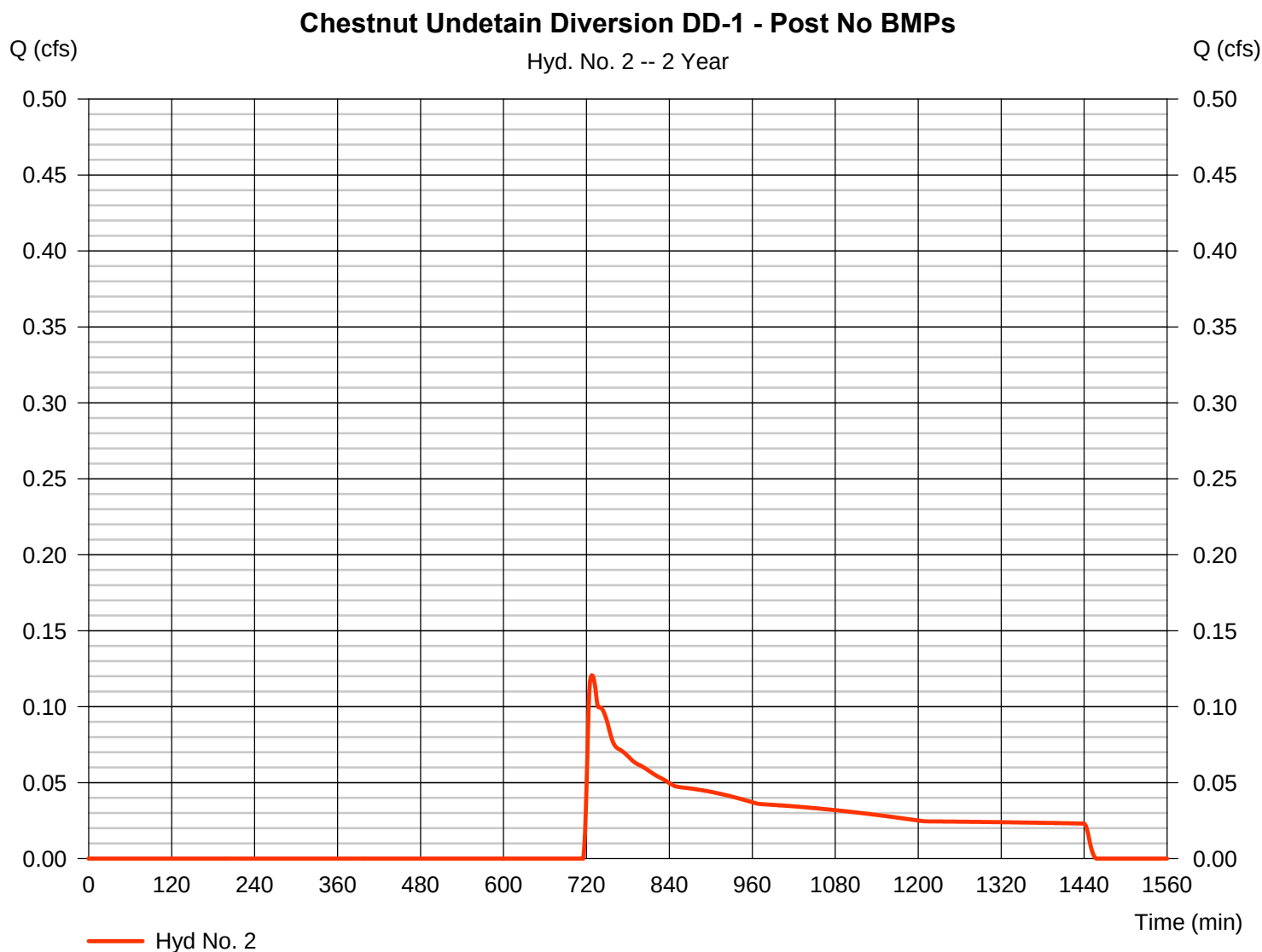
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.121 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	1,653 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

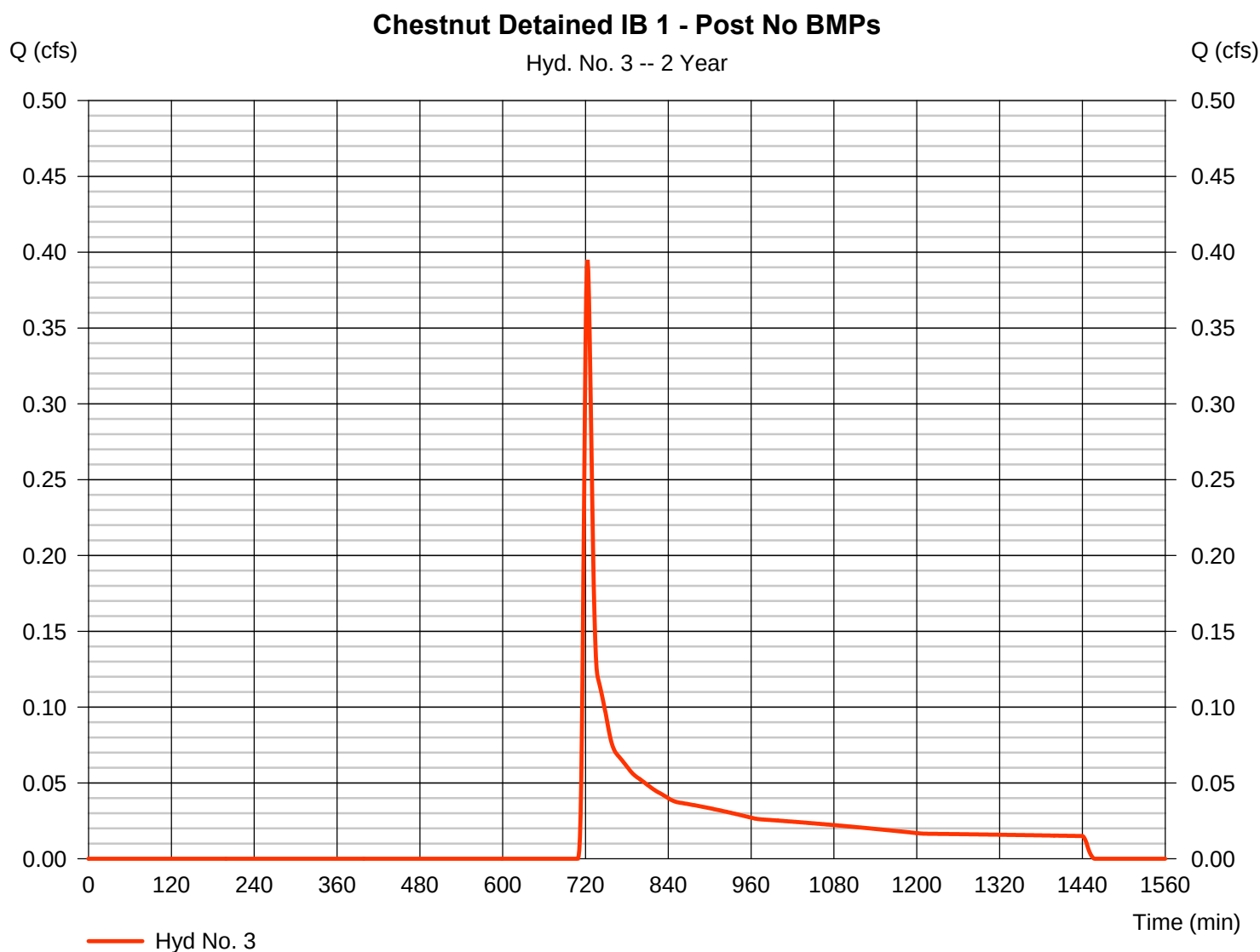
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.395 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	1,527 cuft
Drainage area	=	1.400 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.20 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

<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)	= 2.57	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.05	+	0.00	+	0.00	=	7.05
Shallow Concentrated Flow							
Flow length (ft)	= 796.00	0.00	0.00				
Watercourse slope (%)	= 6.70	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.18	0.00	0.00				
Travel Time (min)	= 3.18	+	0.00	+	0.00	=	3.18
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				10.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

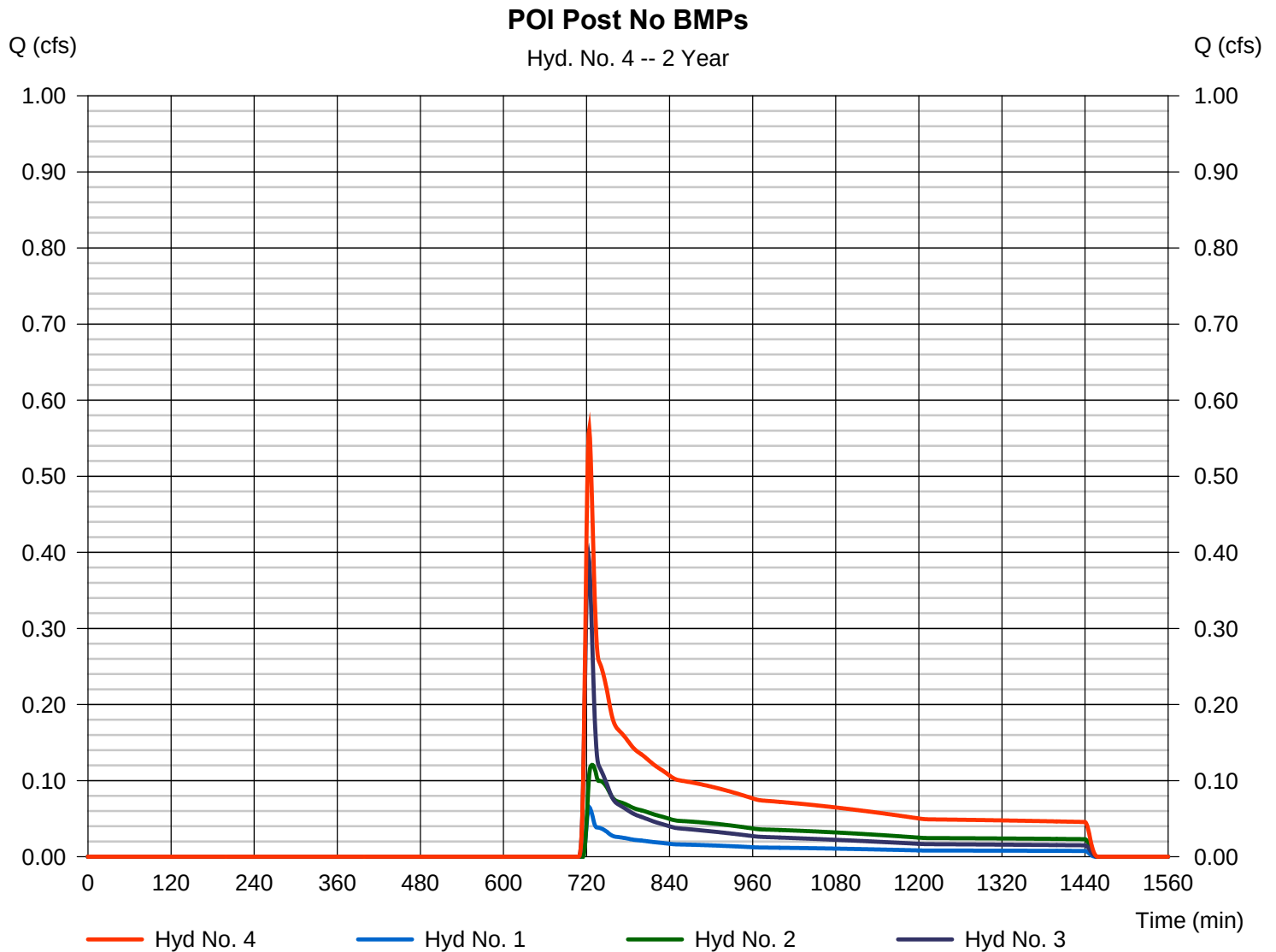
Wednesday, 11 / 9 / 2016

Hyd. No. 4

POI Post No BMPs

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 3

Peak discharge = 0.561 cfs
 Time to peak = 724 min
 Hyd. volume = 3,759 cuft
 Contrib. drain. area = 5.880 ac



Hydrograph Report

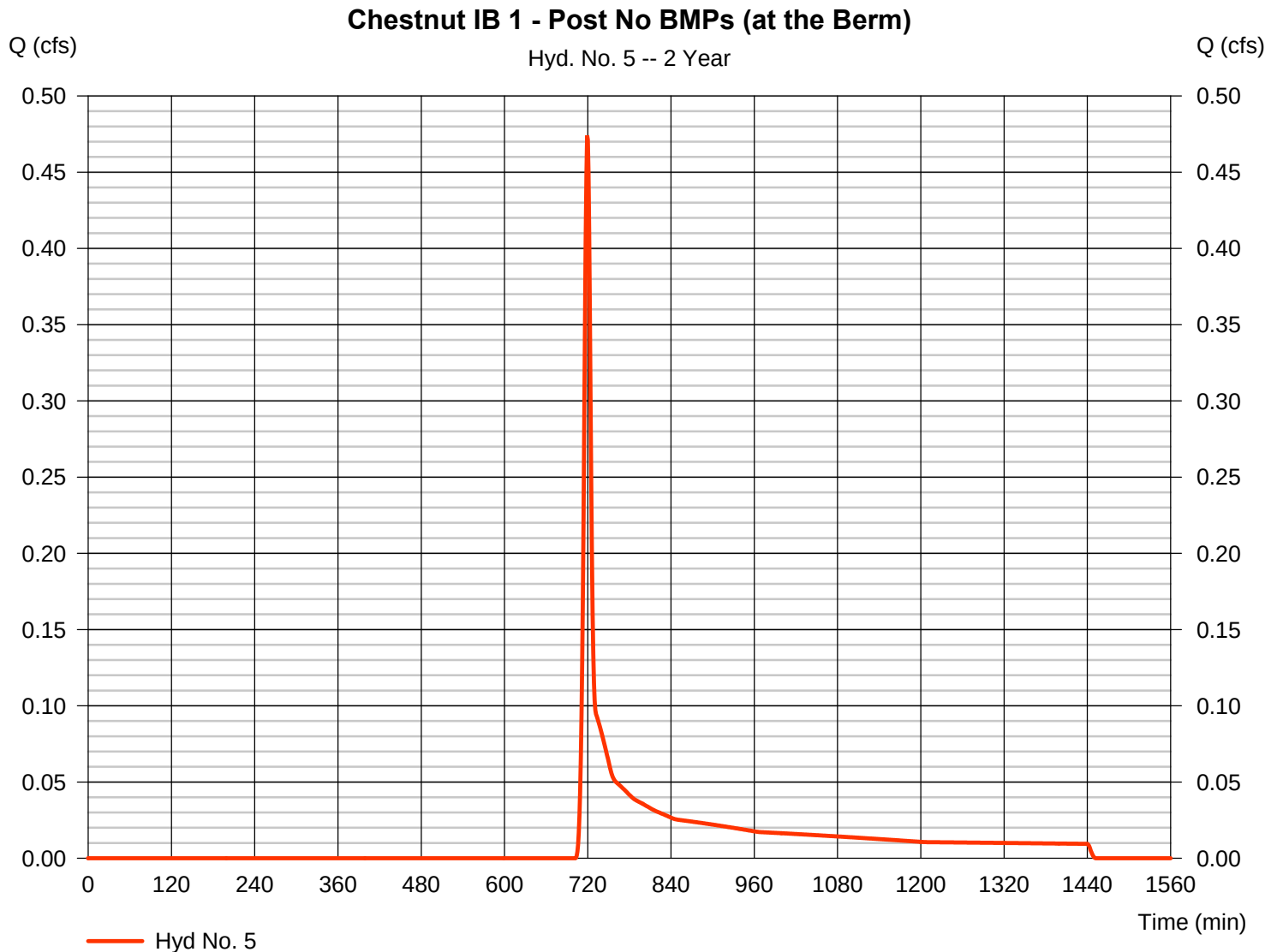
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.474 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 1,155 cuft
Drainage area	= 0.720 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 2.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

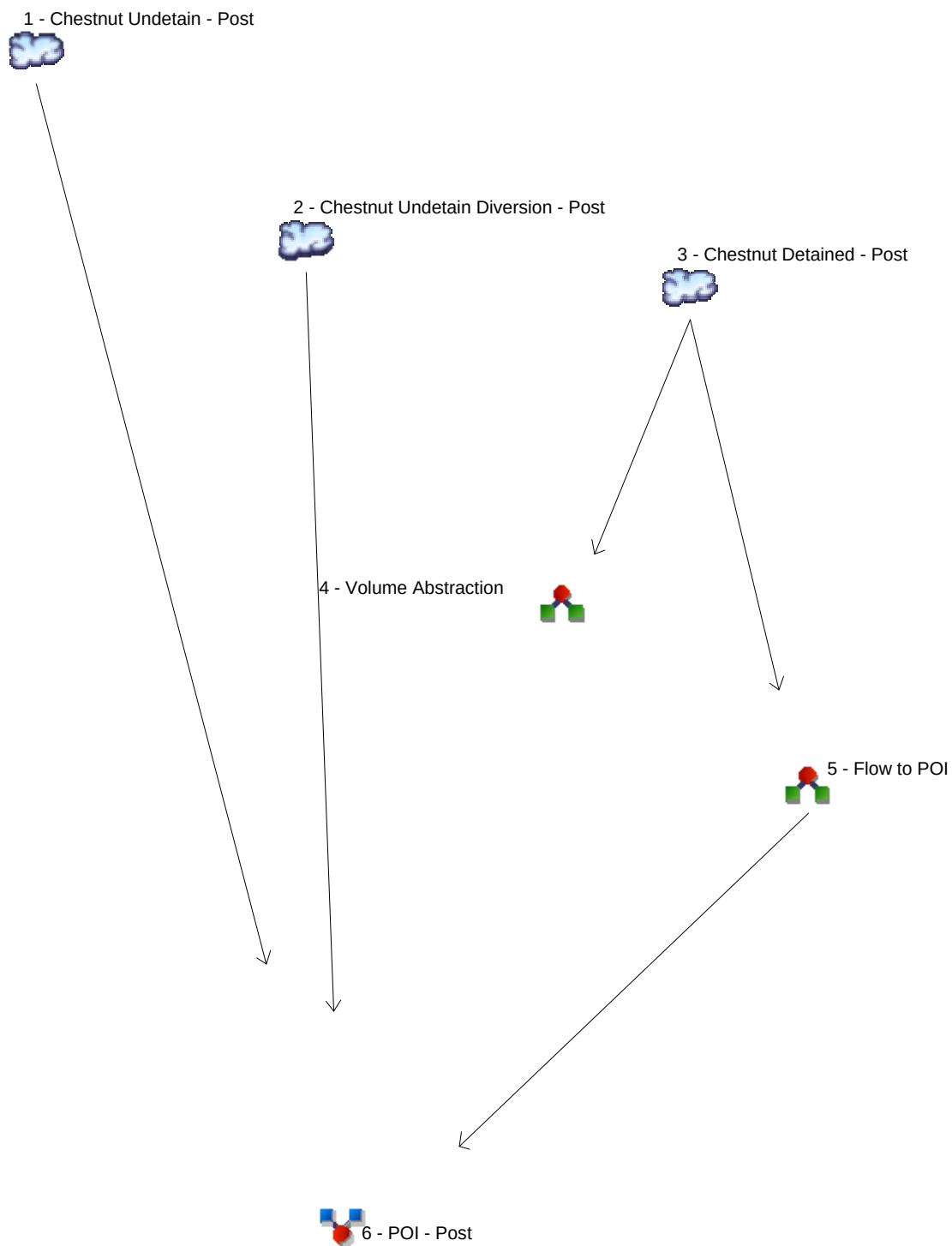
Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

<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)	= 2.57	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.05	+	0.00	+	0.00	=	7.05
Shallow Concentrated Flow							
Flow length (ft)	= 137.00	0.00	0.00				
Watercourse slope (%)	= 6.70	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.18	0.00	0.00				
Travel Time (min)	= 0.55	+	0.00	+	0.00	=	0.55
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				7.60 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.065	-----	-----	-----	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	-----	-----	0.121	-----	-----	-----	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	-----	-----	0.199	-----	-----	-----	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	3	-----	0.199	-----	-----	-----	-----	-----	-----	Volume Abstraction
5	Diversion2	3	-----	0.021	-----	-----	-----	-----	-----	-----	Flow to POI
6	Combine	1, 2, 5	-----	0.181	-----	-----	-----	-----	-----	-----	POI - Post

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.065	1	724	579	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	0.121	1	728	1,653	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	0.199	1	737	1,510	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	0.199	1	737	1,156	3	-----	-----	Volume Abstraction
5	Diversion2	0.021	1	1109	355	3	-----	-----	Flow to POI
6	Combine	0.181	1	726	2,586	1, 2, 5	-----	-----	POI - Post
Chestnut Ridge Hydro - post - 2 yr.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

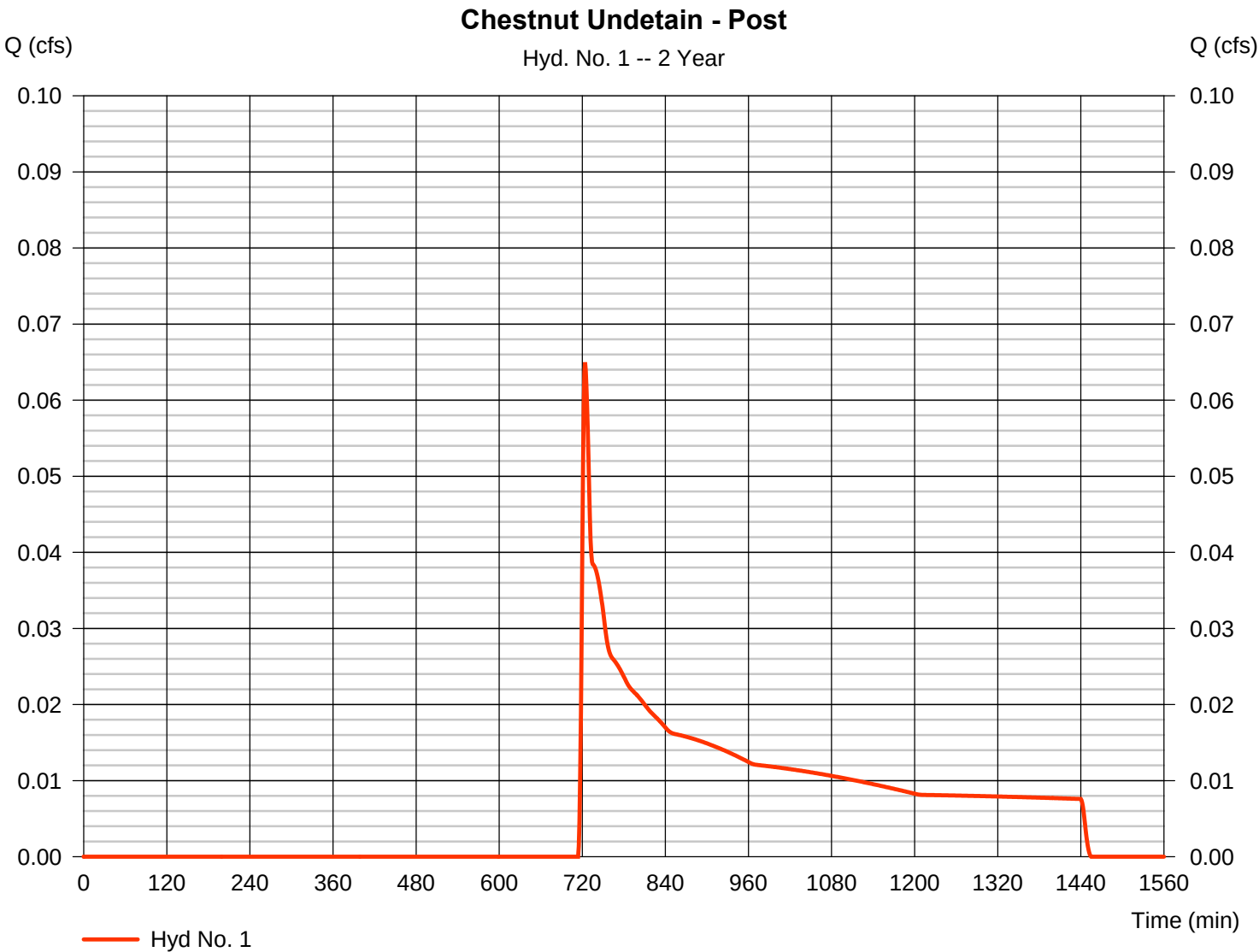
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 1

Chestnut Undetain - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.065 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	579 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetain - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 14.0	86.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 43.00	9.30	0.00				
Travel Time (min)	= 0.66	+	5.24	+	0.00	=	5.91
Shallow Concentrated Flow							
Flow length (ft)	= 765.00	0.00	0.00				
Watercourse slope (%)	= 7.30	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.36	0.00	0.00				
Travel Time (min)	= 2.92	+	0.00	+	0.00	=	2.92
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				8.80 min			

Hydrograph Report

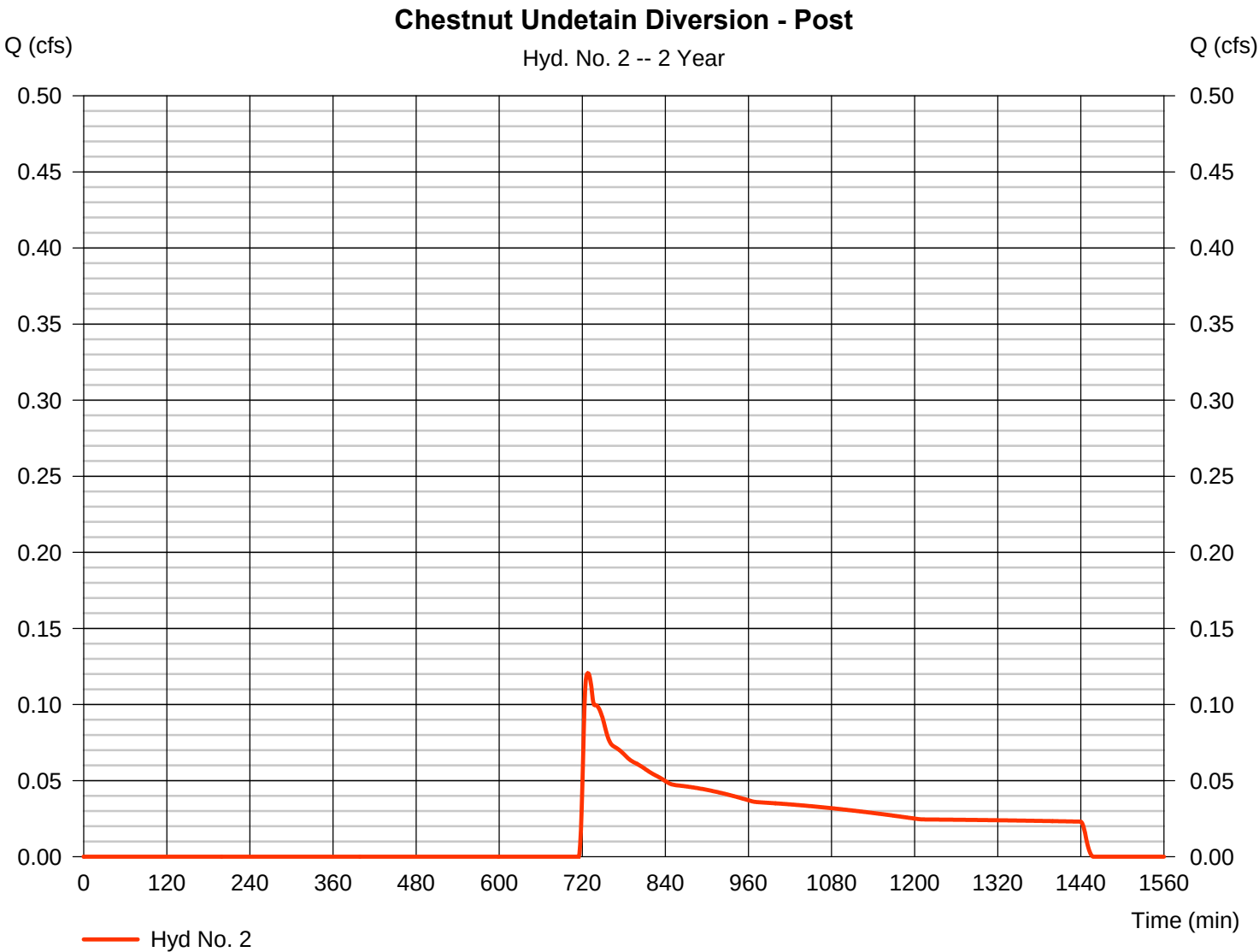
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.121 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	1,653 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	2.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 12.0	88.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 16.70	8.00	0.00				
Travel Time (min)	= 0.86	+	5.67	+	0.00	=	6.53
Shallow Concentrated Flow							
Flow length (ft)	= 65.00	690.00	0.00				
Watercourse slope (%)	= 6.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	3.95	0.00				
Travel Time (min)	= 0.27	+	2.91	+	0.00	=	3.18
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 6.30	0.00	0.00				
Manning's n-value	= 0.026	0.015	0.015				
Velocity (ft/s)	=13.01	0.00	0.00				
Flow length (ft)	(0)285.0	0.0	0.0				
Travel Time (min)	= 0.37	+	0.00	+	0.00	=	0.37
Total Travel Time, Tc				10.10 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

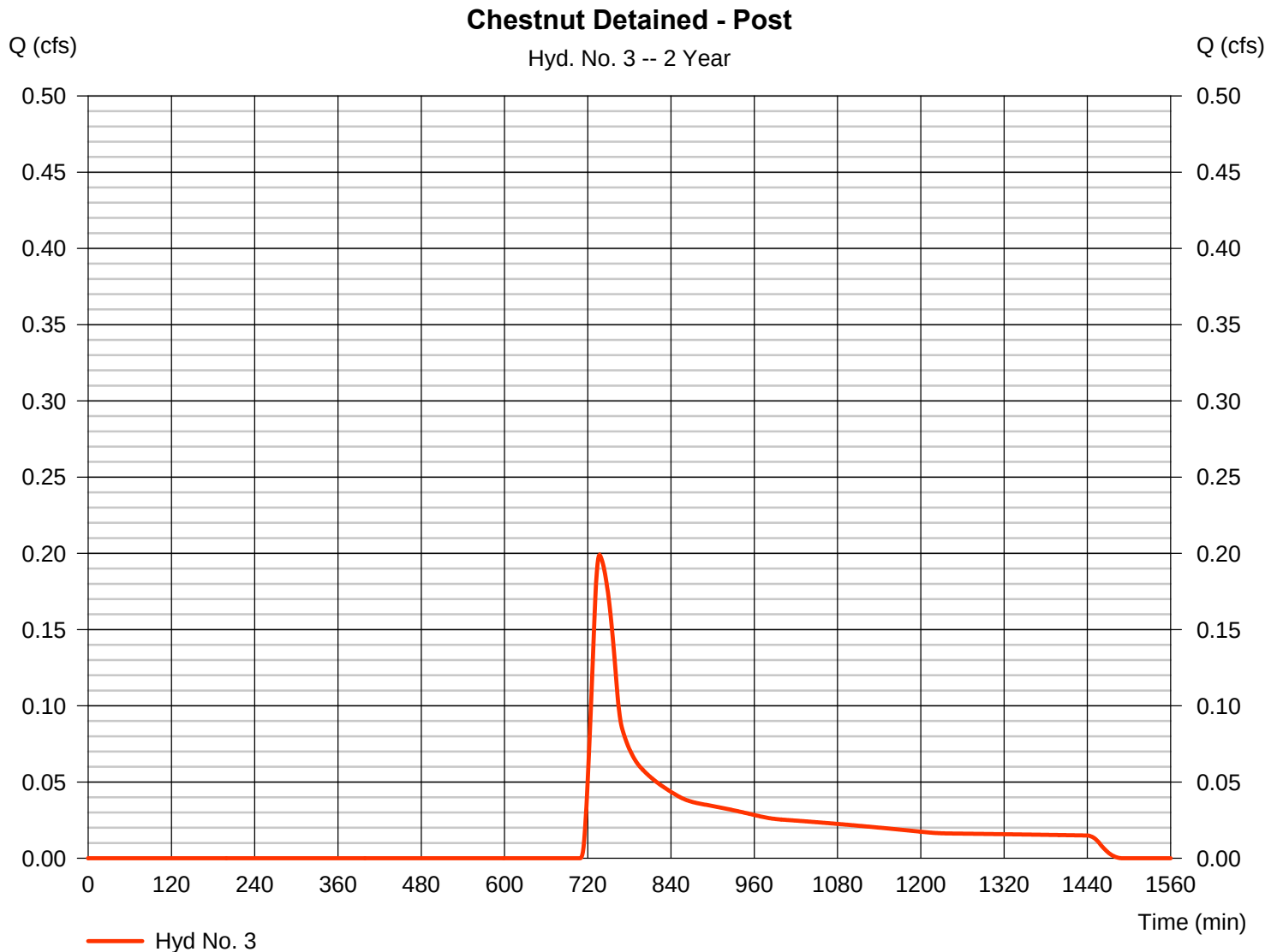
Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained - Post

Hydrograph type = SCS Runoff
 Storm frequency = 2 yrs
 Time interval = 1 min
 Drainage area = 1.400 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 2.57 in
 Storm duration = 24 hrs

Peak discharge = 0.199 cfs
 Time to peak = 737 min
 Hyd. volume = 1,510 cuft
 Curve number = 64
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 31.90 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

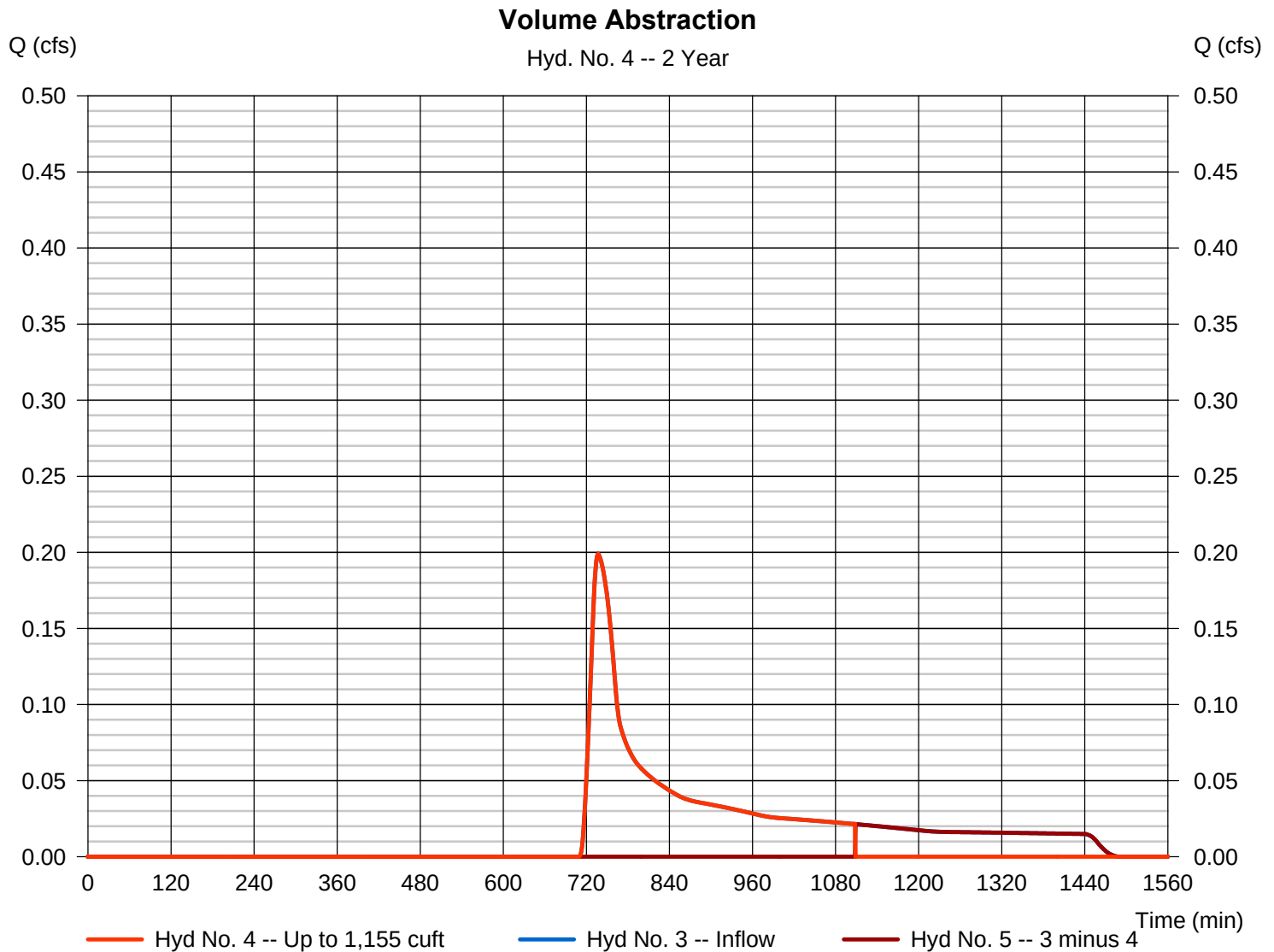
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.199 cfs
Storm frequency	= 2 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 1,156 cuft
Inflow hydrograph	= 3 - Chestnut Detained - Post	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,155 cuft



Hydrograph Report

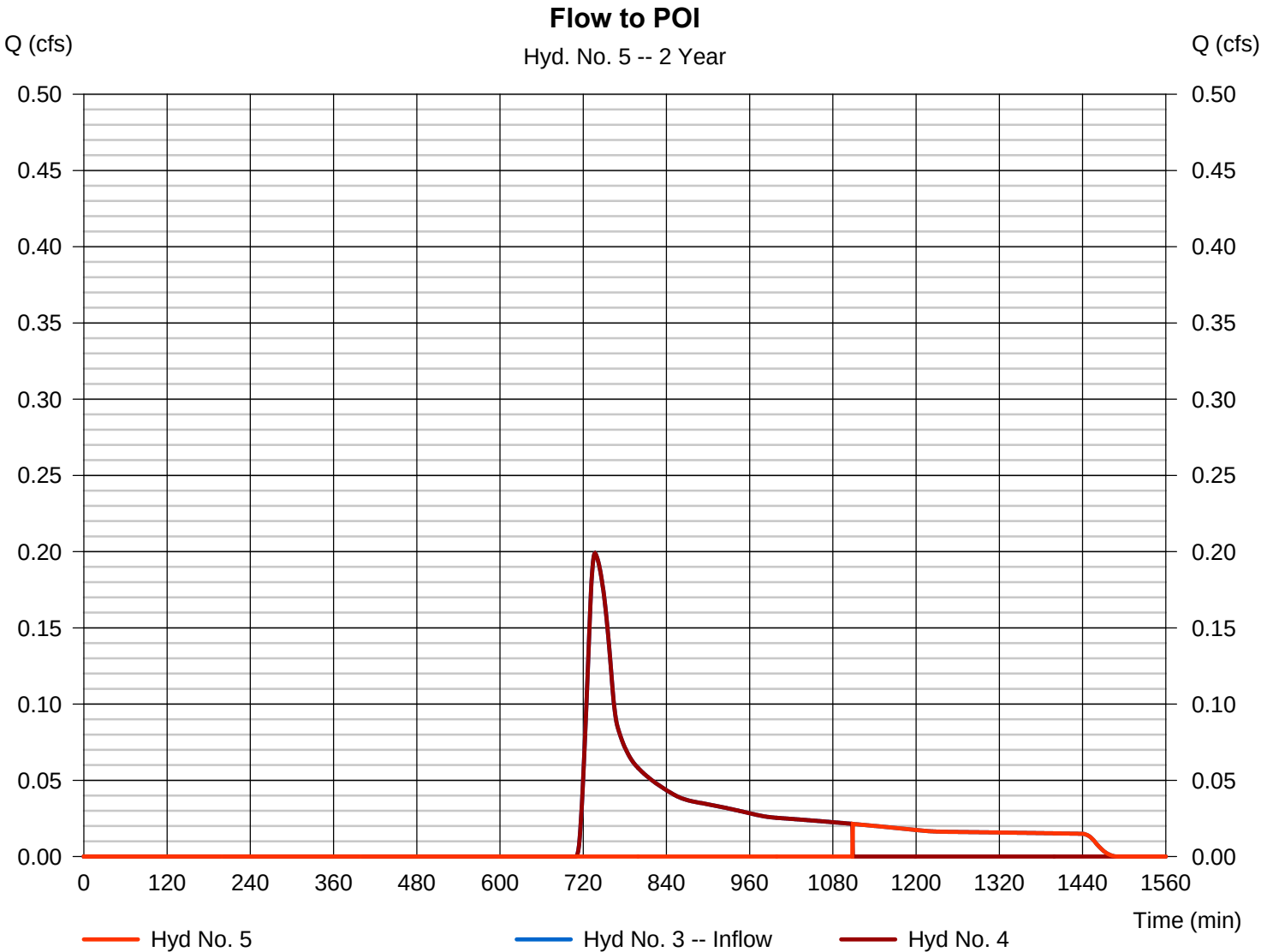
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Flow to POI

Hydrograph type	= Diversion2	Peak discharge	= 0.021 cfs
Storm frequency	= 2 yrs	Time to peak	= 1109 min
Time interval	= 1 min	Hyd. volume	= 355 cuft
Inflow hydrograph	= 3 - Chestnut Detained - Post	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,155 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

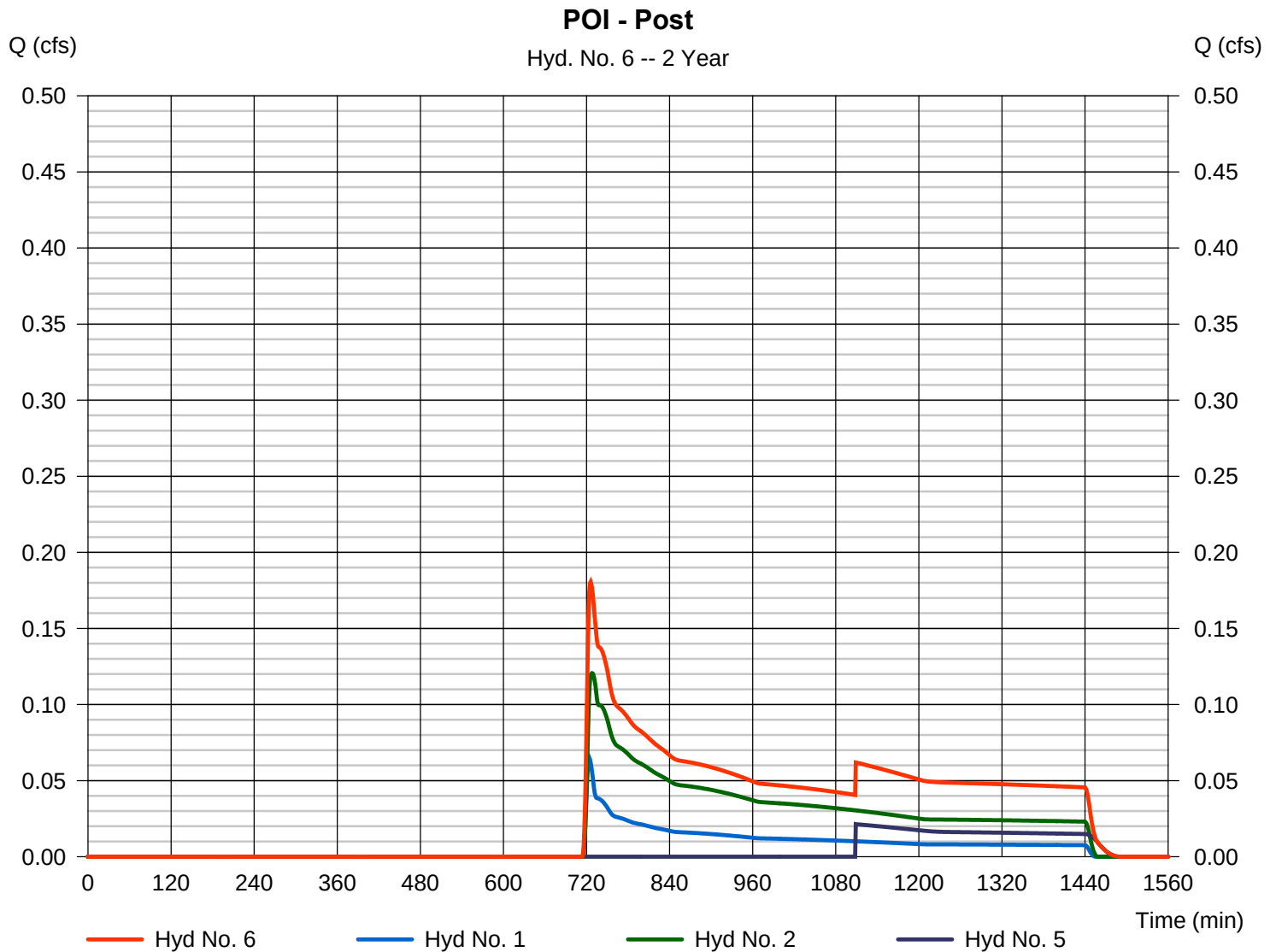
Wednesday, 11 / 9 / 2016

Hyd. No. 6

POI - Post

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 5

Peak discharge = 0.181 cfs
 Time to peak = 726 min
 Hyd. volume = 2,586 cuft
 Contrib. drain. area = 4.480 ac



**ATTACHMENT C-2
CHESTNUT RIDGE
10 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut - Pre



Hydrograph Return Period Recap

Hydranow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.361	-----	-----	3.620	-----	9.841	13.37	Chestnut - Pre
Proj. file: Chestnut Ridge Hydro - pre.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

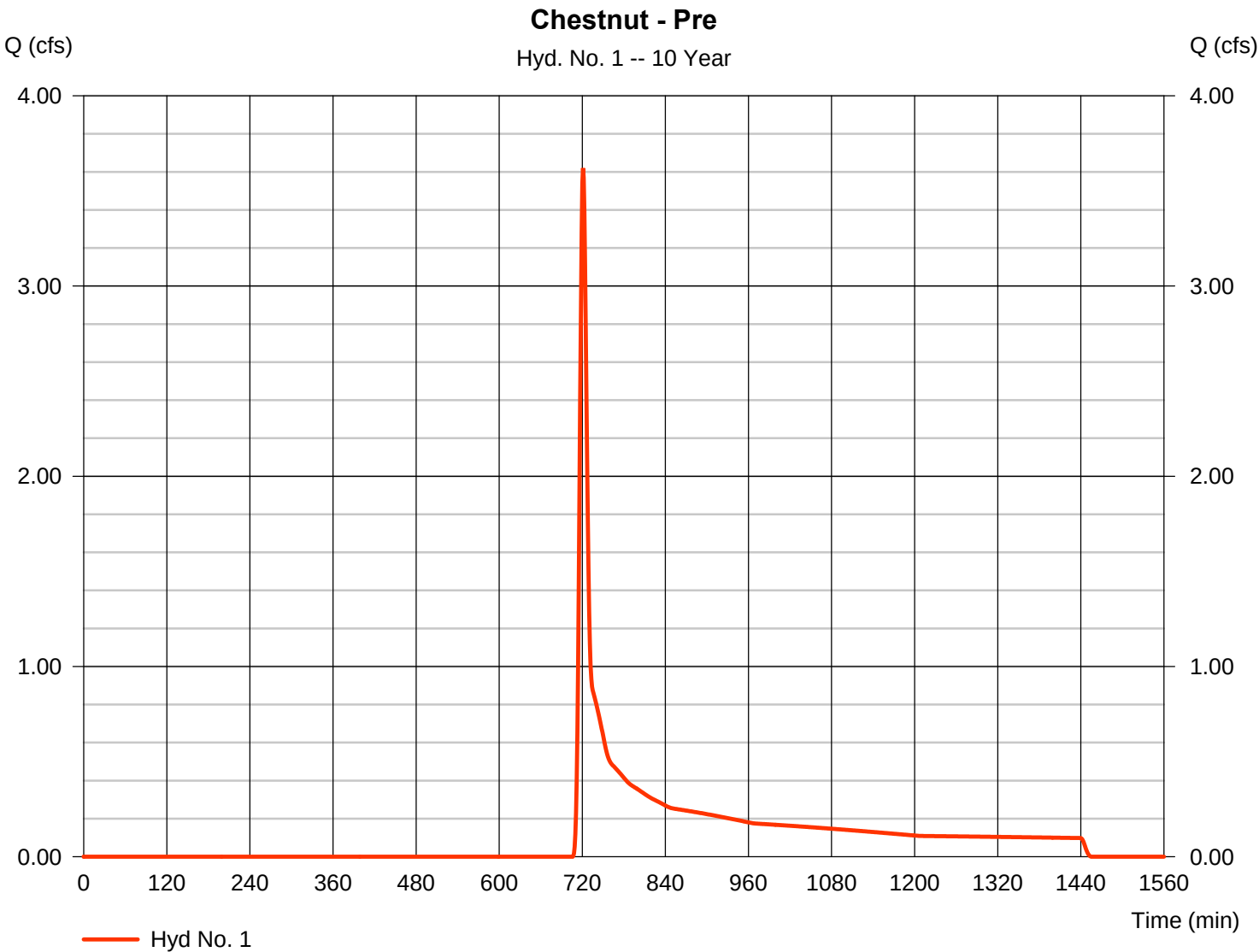
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.620	1	721	10,888	-----	-----	-----	Chestnut - Pre
Chestnut Ridge Hydro - pre.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.620 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	10,888 cuft
Drainage area	=	5.890 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.00 min
Total precip.	=	3.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 12.0	88.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 16.70	8.00	0.00				
Travel Time (min)	= 0.86	+	5.67	+	0.00	=	6.53
Shallow Concentrated Flow							
Flow length (ft)	= 260.00	650.00	0.00				
Watercourse slope (%)	= 7.30	7.10	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.36	4.30	0.00				
Travel Time (min)	= 0.99	+	2.52	+	0.00	=	3.51
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					10.00 min		

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut Undetained UD 2 - Post No BMPs



2 - Chestnut Undetain Diversion DD-1 - Post No BMPs



3 - Chestnut Detained IB 1 - Post No BMPs



5 - Chestnut IB 1 - Post No BMPs (at the Berm)



4 - POI Post No BMPs

Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.065	-----	-----	0.651	-----	1.771	2.406	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	-----	-----	0.121	-----	-----	1.679	-----	4.962	6.859	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	-----	-----	0.395	-----	-----	1.481	-----	3.174	4.088	Chestnut Detained IB 1 - Post No BM
4	Combine	1, 2, 3	-----	0.561	-----	-----	3.788	-----	9.879	13.30	POI Post No BMPs
5	SCS Runoff	-----	-----	0.474	-----	-----	1.226	-----	2.293	2.850	Chestnut IB 1 - Post No BMPs (at the

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

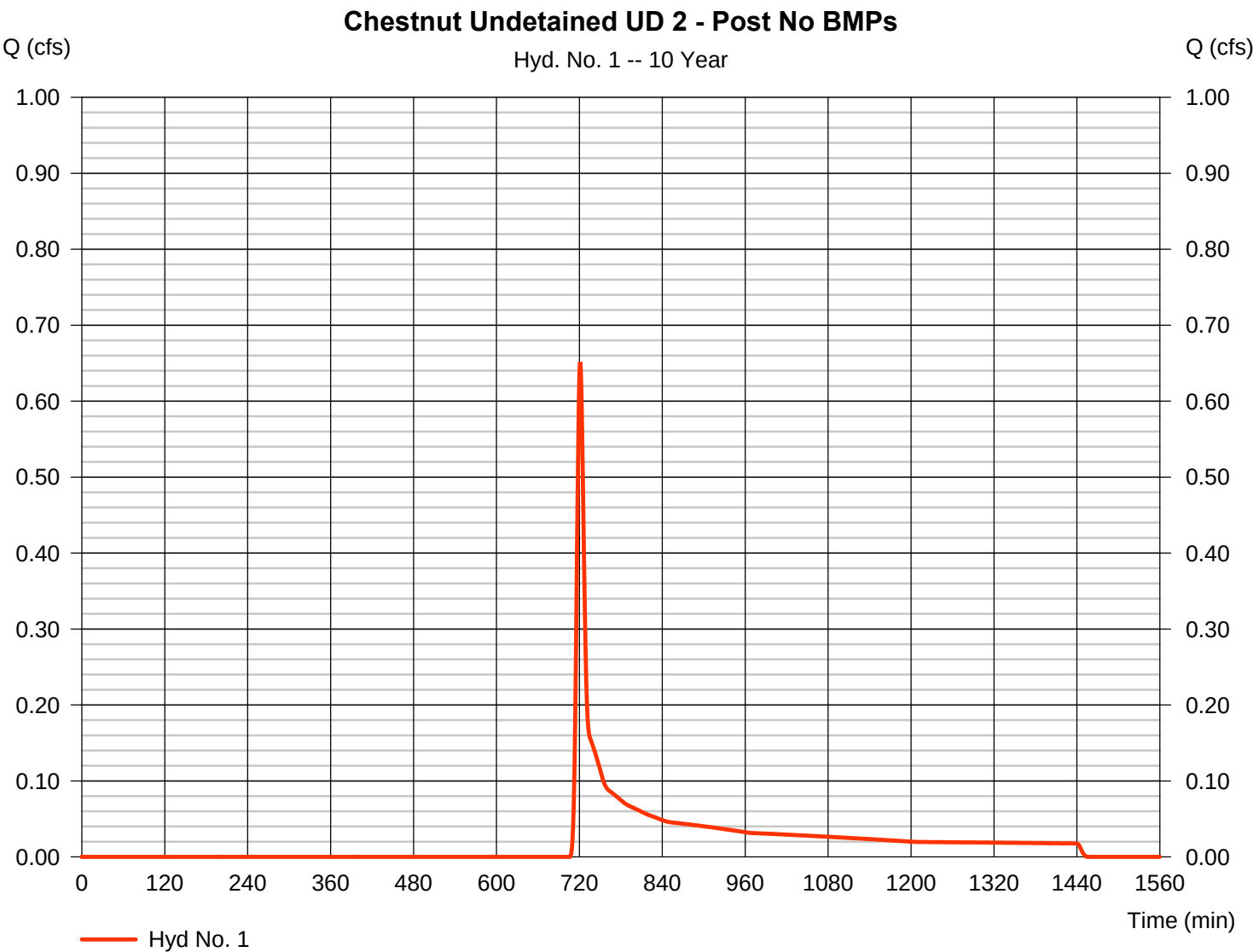
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.651	1	721	1,959	-----	-----	-----	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	1.679	1	723	5,932	-----	-----	-----	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	1.481	1	721	4,019	-----	-----	-----	Chestnut Detained IB 1 - Post No BM
4	Combine	3.788	1	722	11,911	1, 2, 3	-----	-----	POI Post No BMPs
5	SCS Runoff	1.226	1	719	2,647	-----	-----	-----	Chestnut IB 1 - Post No BMPs (at the
Chestnut Ridge Hydro - post no BMP.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.651 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	1,959 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	3.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 14.0	86.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 43.00	9.30	0.00	
Travel Time (min)	= 0.66	+	5.24	+
			0.00	= 5.91
Shallow Concentrated Flow				
Flow length (ft)	= 765.00	0.00	0.00	
Watercourse slope (%)	= 7.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.36	0.00	0.00	
Travel Time (min)	= 2.92	+	0.00	+
			0.00	= 2.92
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				8.80 min

Hydrograph Report

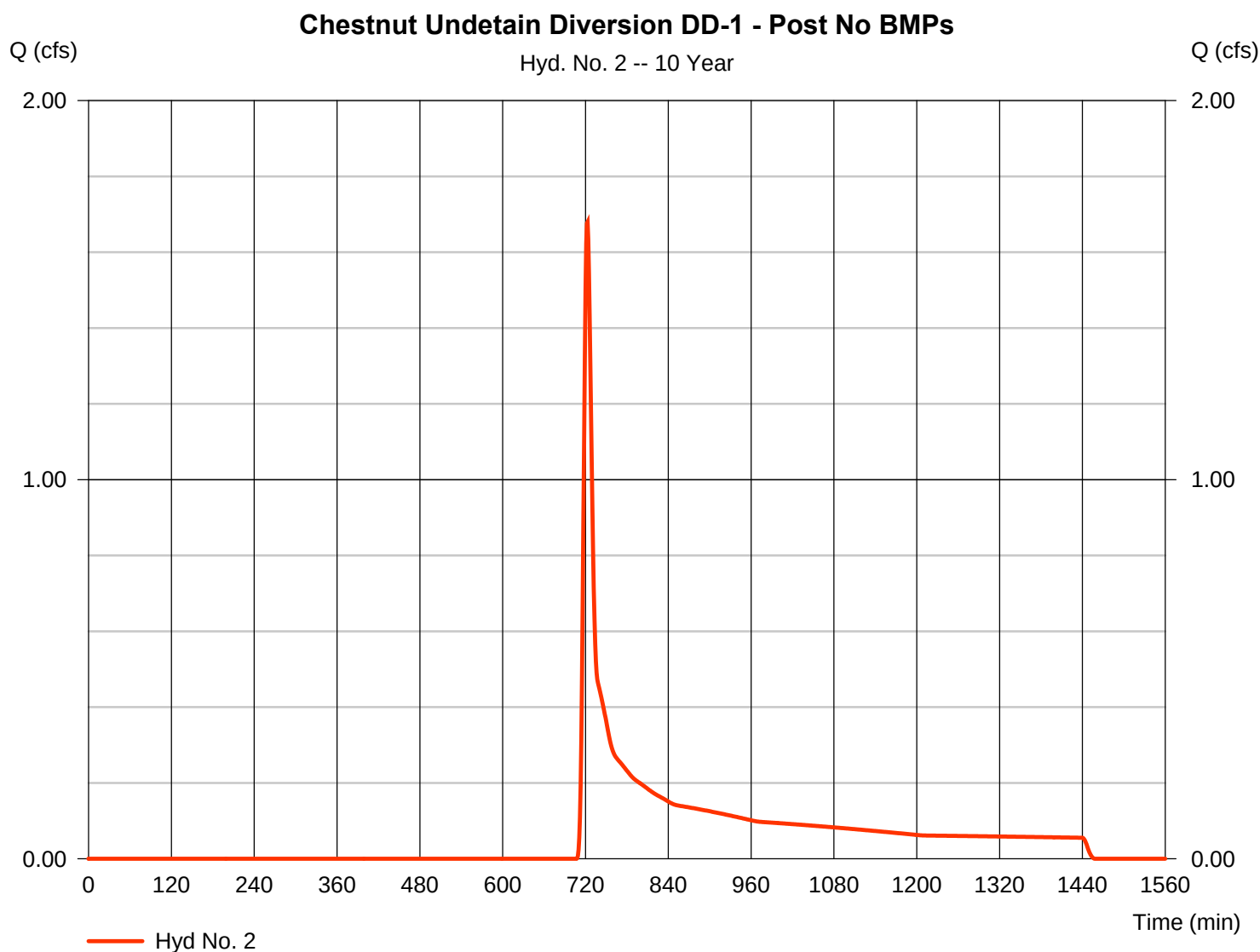
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 1.679 cfs
Storm frequency	= 10 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 5,932 cuft
Drainage area	= 3.420 ac	Curve number	= 57
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.10 min
Total precip.	= 3.64 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

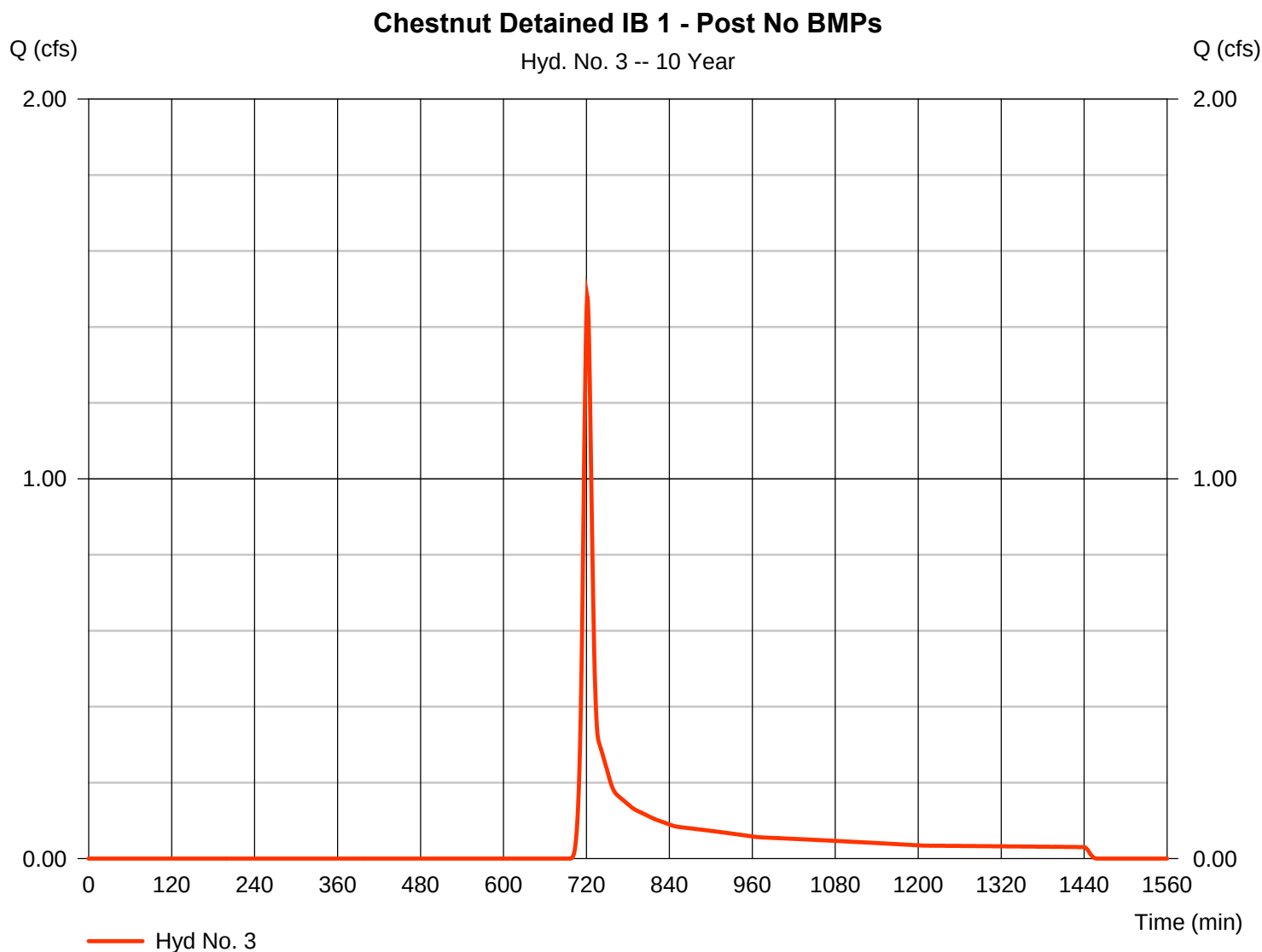
Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 1 min
 Drainage area = 1.400 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 3.64 in
 Storm duration = 24 hrs

Peak discharge = 1.481 cfs
 Time to peak = 721 min
 Hyd. volume = 4,019 cuft
 Curve number = 64
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 10.20 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

<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)	= 2.57	0.00	0.00	
Land slope (%)	= 6.00	0.00	0.00	
Travel Time (min)	= 7.05	+	0.00	+
			0.00	= 7.05
Shallow Concentrated Flow				
Flow length (ft)	= 796.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 3.18	+	0.00	+
			0.00	= 3.18
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				10.20 min

Hydrograph Report

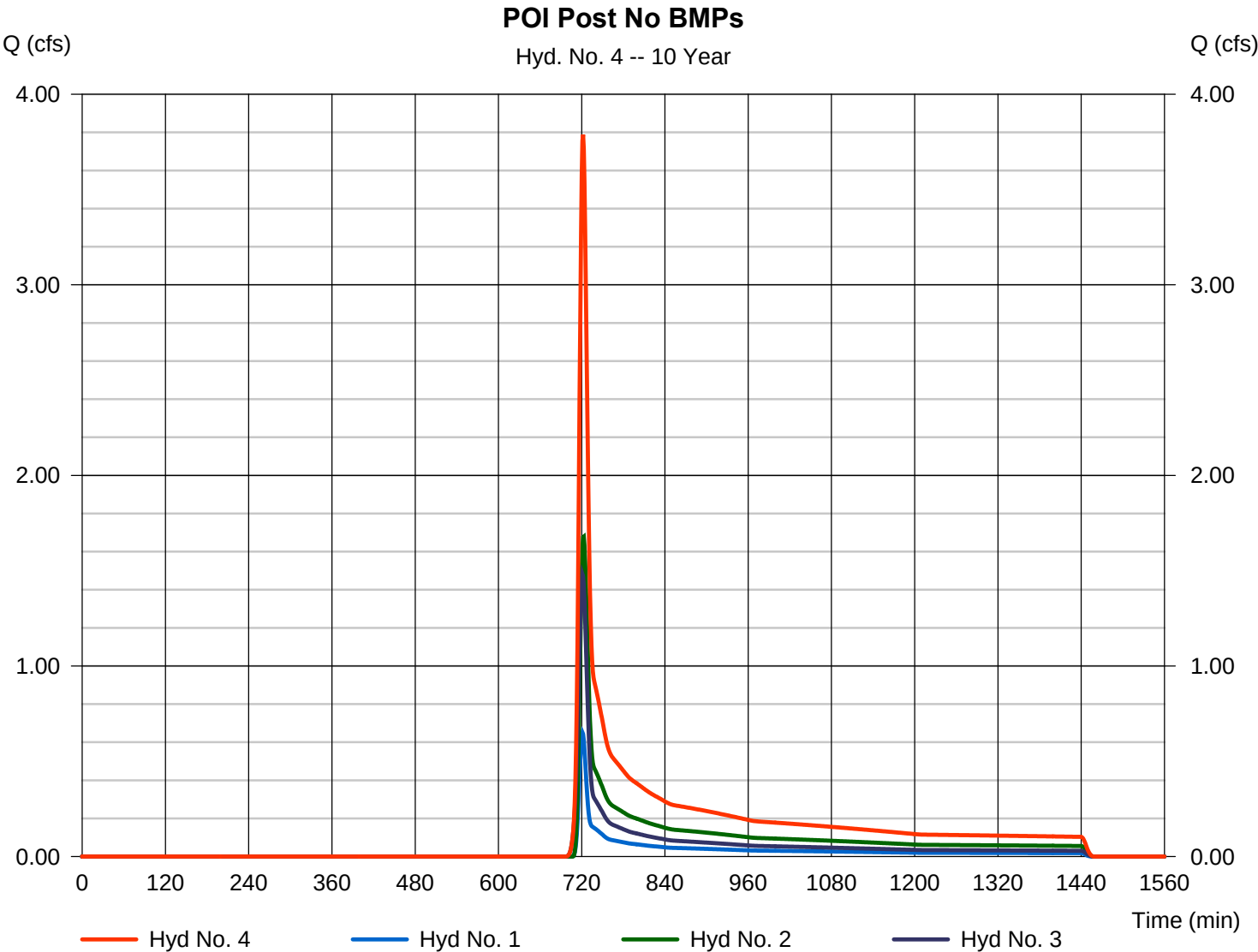
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

POI Post No BMPs

Hydrograph type	= Combine	Peak discharge	= 3.788 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 11,911 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 5.880 ac



Hydrograph Report

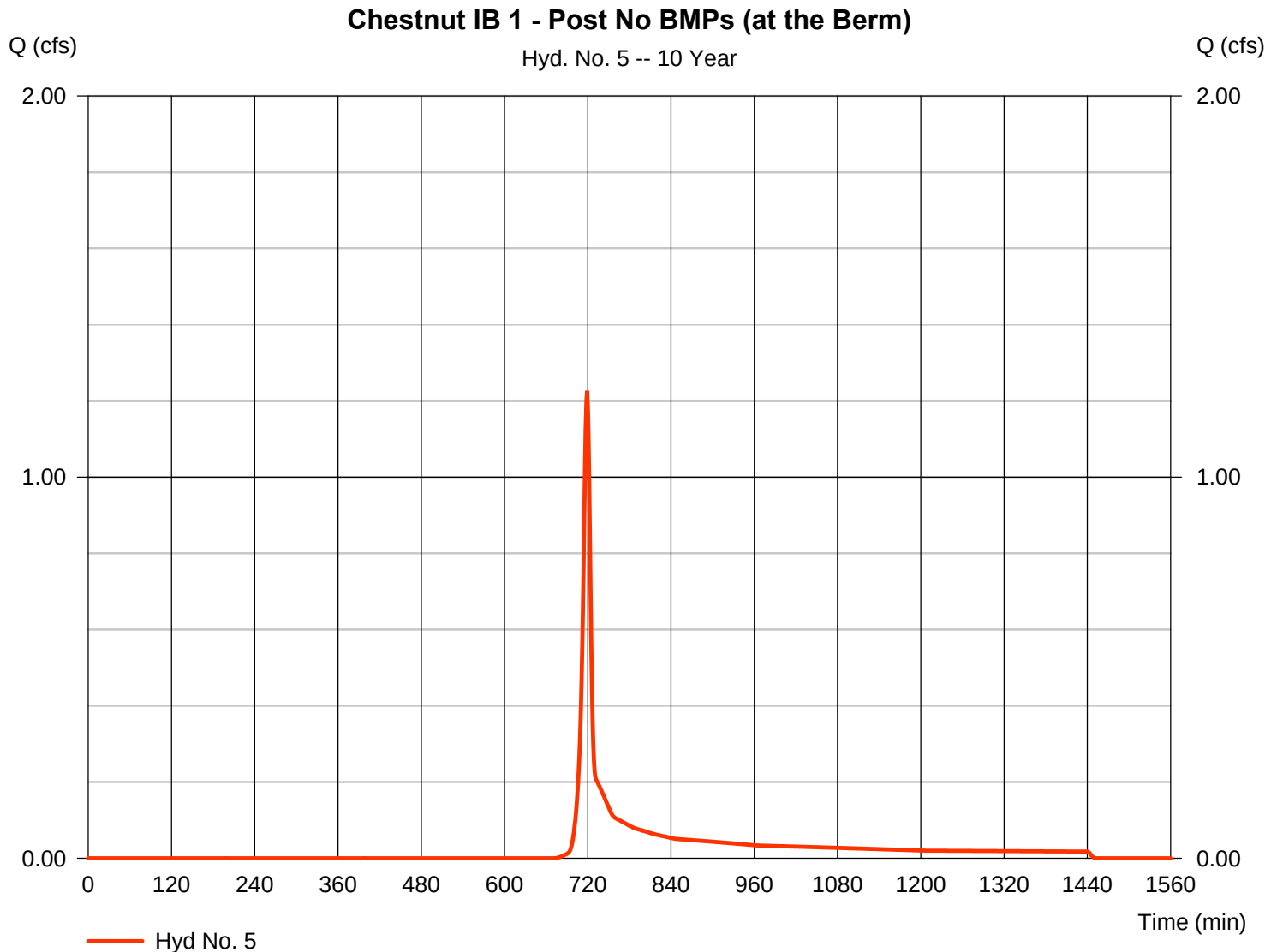
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.226 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 2,647 cuft
Drainage area	= 0.720 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 3.64 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

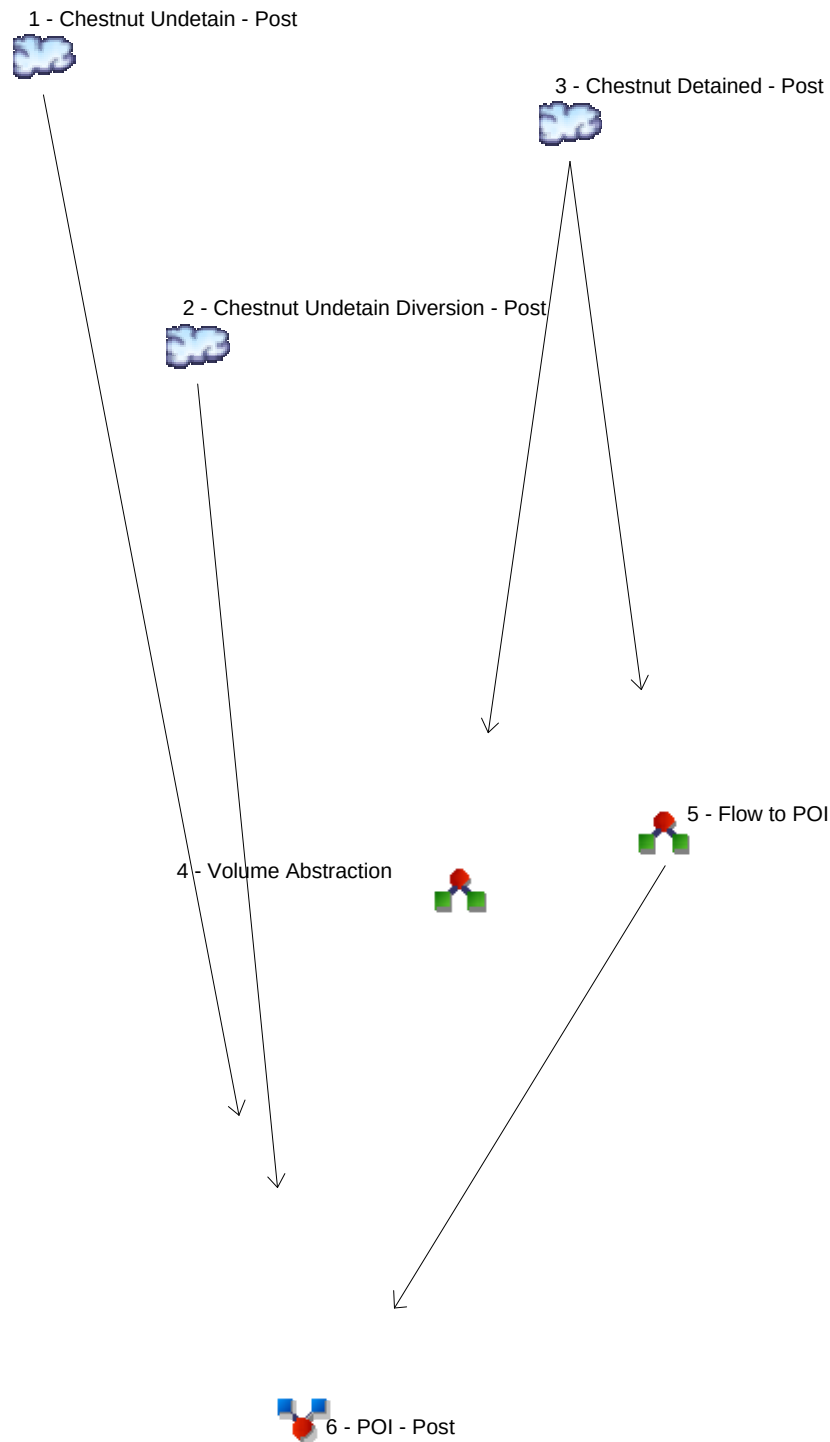
Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

<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)	= 2.57	0.00	0.00	
Land slope (%)	= 6.00	0.00	0.00	
Travel Time (min)	= 7.05	+	0.00	+
			0.00	= 7.05
Shallow Concentrated Flow				
Flow length (ft)	= 137.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.55	+	0.00	+
			0.00	= 0.55
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				7.60 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	0.651	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	-----	-----	-----	-----	-----	1.679	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	-----	-----	-----	-----	-----	0.772	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	3	-----	-----	-----	-----	0.772	-----	-----	-----	Volume Abstraction
5	Diversion2	3	-----	-----	-----	-----	0.070	-----	-----	-----	Flow to POI
6	Combine	1, 2, 5	-----	-----	-----	-----	2.318	-----	-----	-----	POI - Post
Proj. file: Chestnut Ridge Hydro - post - 10 yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

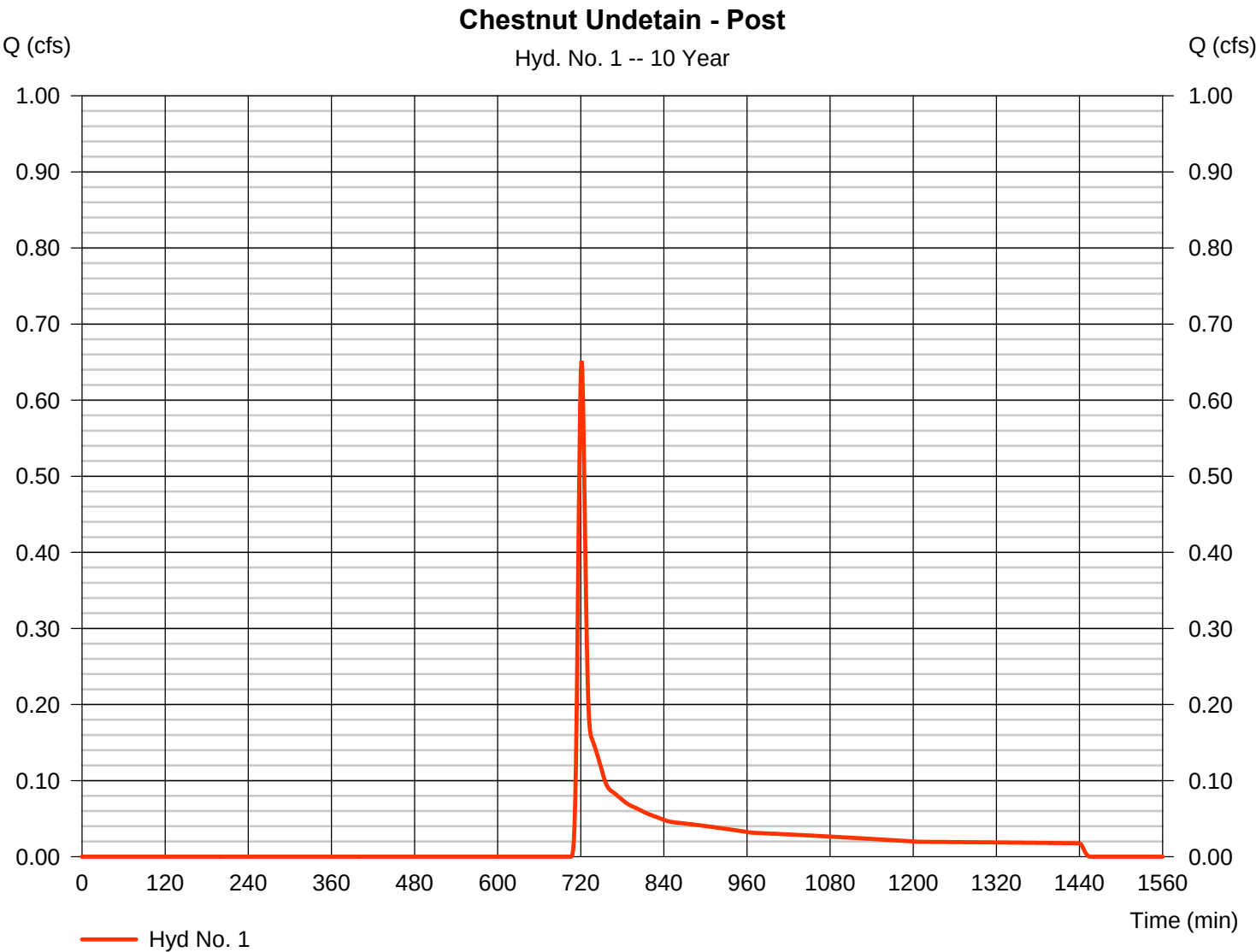
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.651	1	721	1,959	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	1.679	1	723	5,932	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	0.772	1	735	3,975	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	0.772	1	735	2,647	3	-----	-----	Volume Abstraction
5	Diversion2	0.070	1	925	1,328	3	-----	-----	Flow to POI
6	Combine	2.318	1	722	9,219	1, 2, 5	-----	-----	POI - Post
Chestnut Ridge Hydro - post - 10 yr.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut Undetain - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.651 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	1,959 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	3.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetain - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 14.0	86.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 43.00	9.30	0.00	
Travel Time (min)	= 0.66	+	5.24	+
			0.00	= 5.91
Shallow Concentrated Flow				
Flow length (ft)	= 765.00	0.00	0.00	
Watercourse slope (%)	= 7.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.36	0.00	0.00	
Travel Time (min)	= 2.92	+	0.00	+
			0.00	= 2.92
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				8.80 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

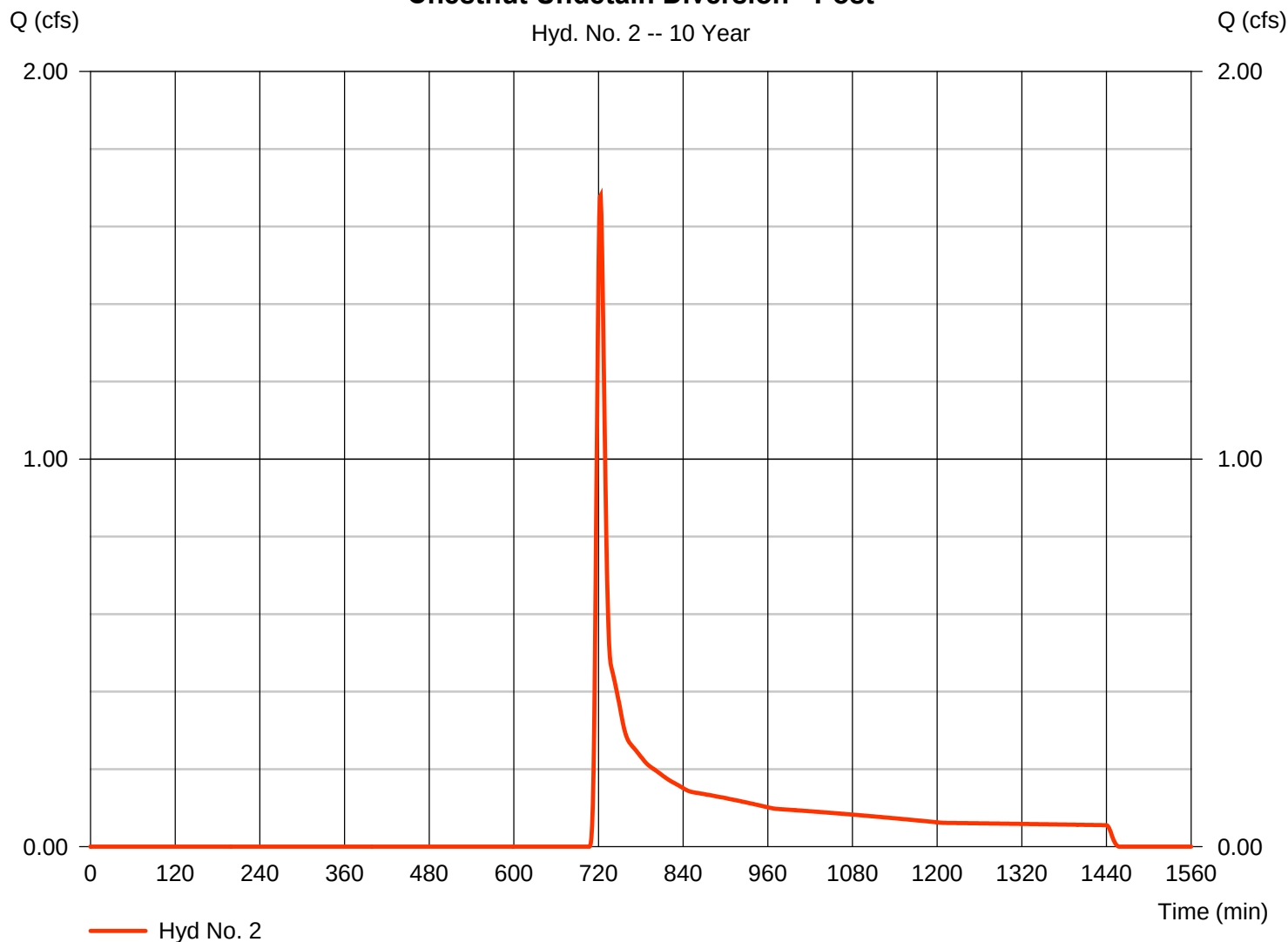
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.679 cfs
Storm frequency	=	10 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	5,932 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	3.64 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

Chestnut Undetain Diversion - Post



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

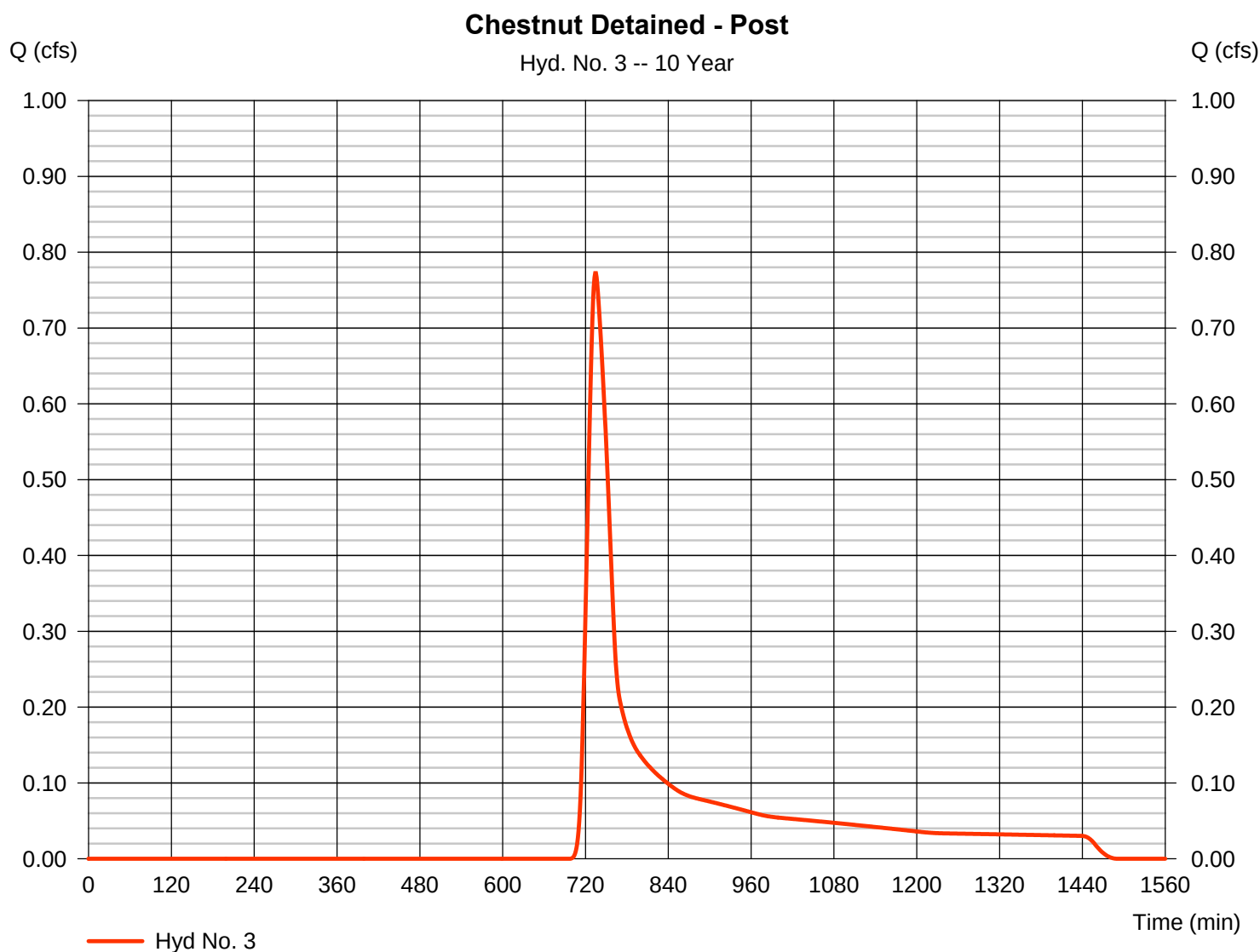
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained - Post

Hydrograph type	= SCS Runoff	Peak discharge	= 0.772 cfs
Storm frequency	= 10 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 3,975 cuft
Drainage area	= 1.400 ac	Curve number	= 64
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.90 min
Total precip.	= 3.64 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

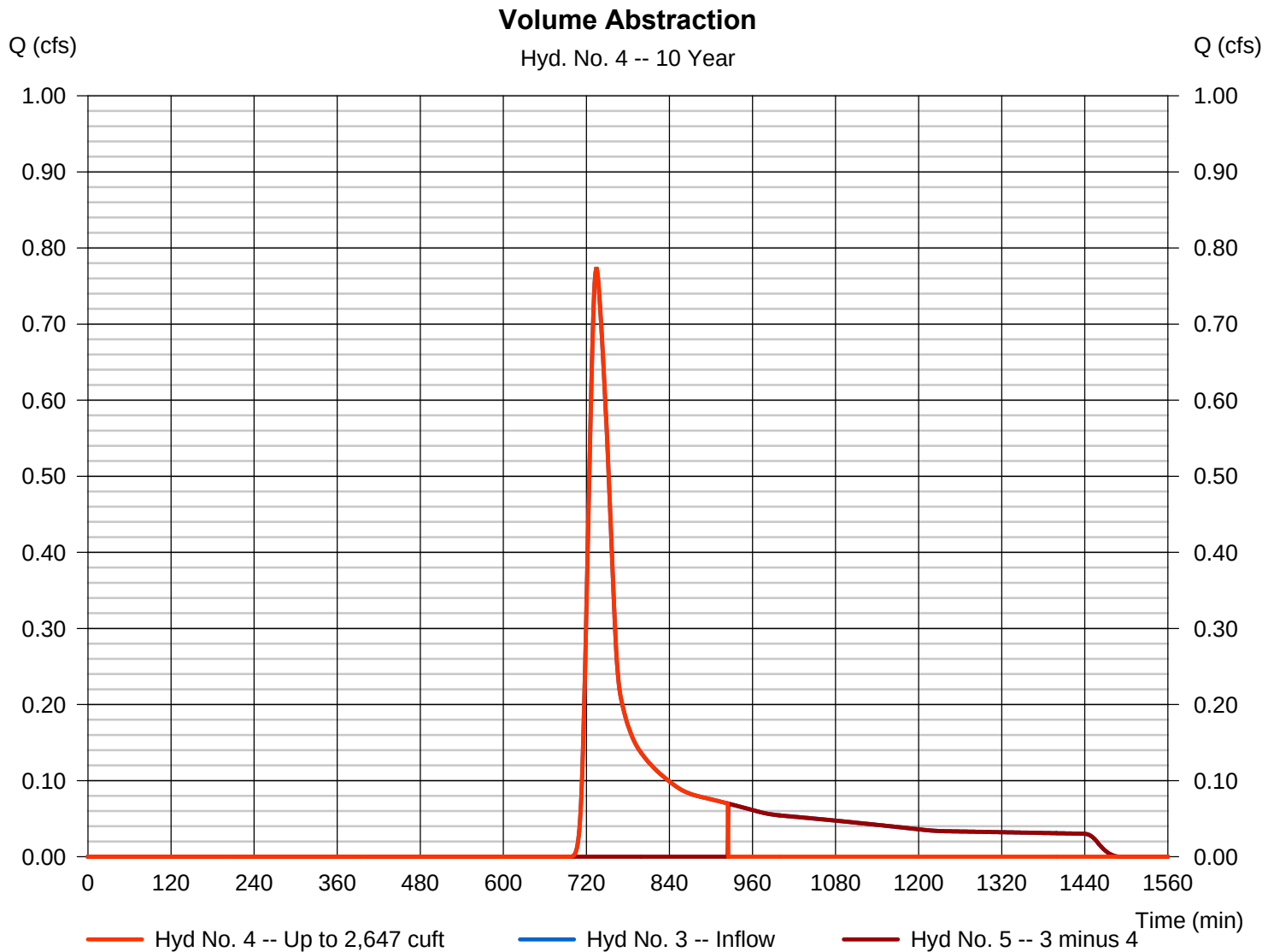
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.772 cfs
Storm frequency	= 10 yrs	Time to peak	= 735 min
Time interval	= 1 min	Hyd. volume	= 2,647 cuft
Inflow hydrograph	= 3 - Chestnut Detained - Post	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 2,647 cuft



Hydrograph Report

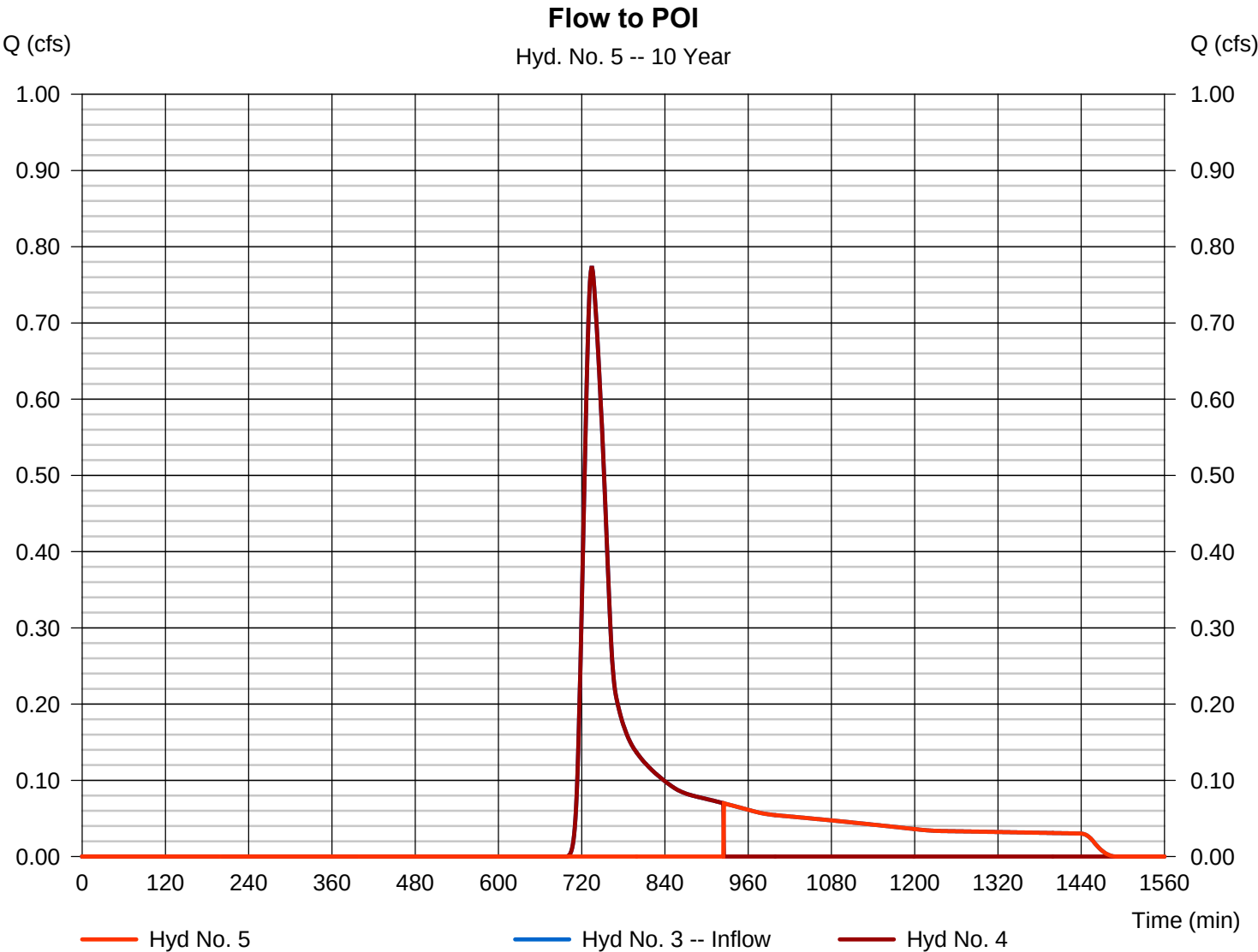
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.070 cfs
Storm frequency	=	10 yrs	Time to peak	=	925 min
Time interval	=	1 min	Hyd. volume	=	1,328 cuft
Inflow hydrograph	=	3 - Chestnut Detained - Post	2nd diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	2,647 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

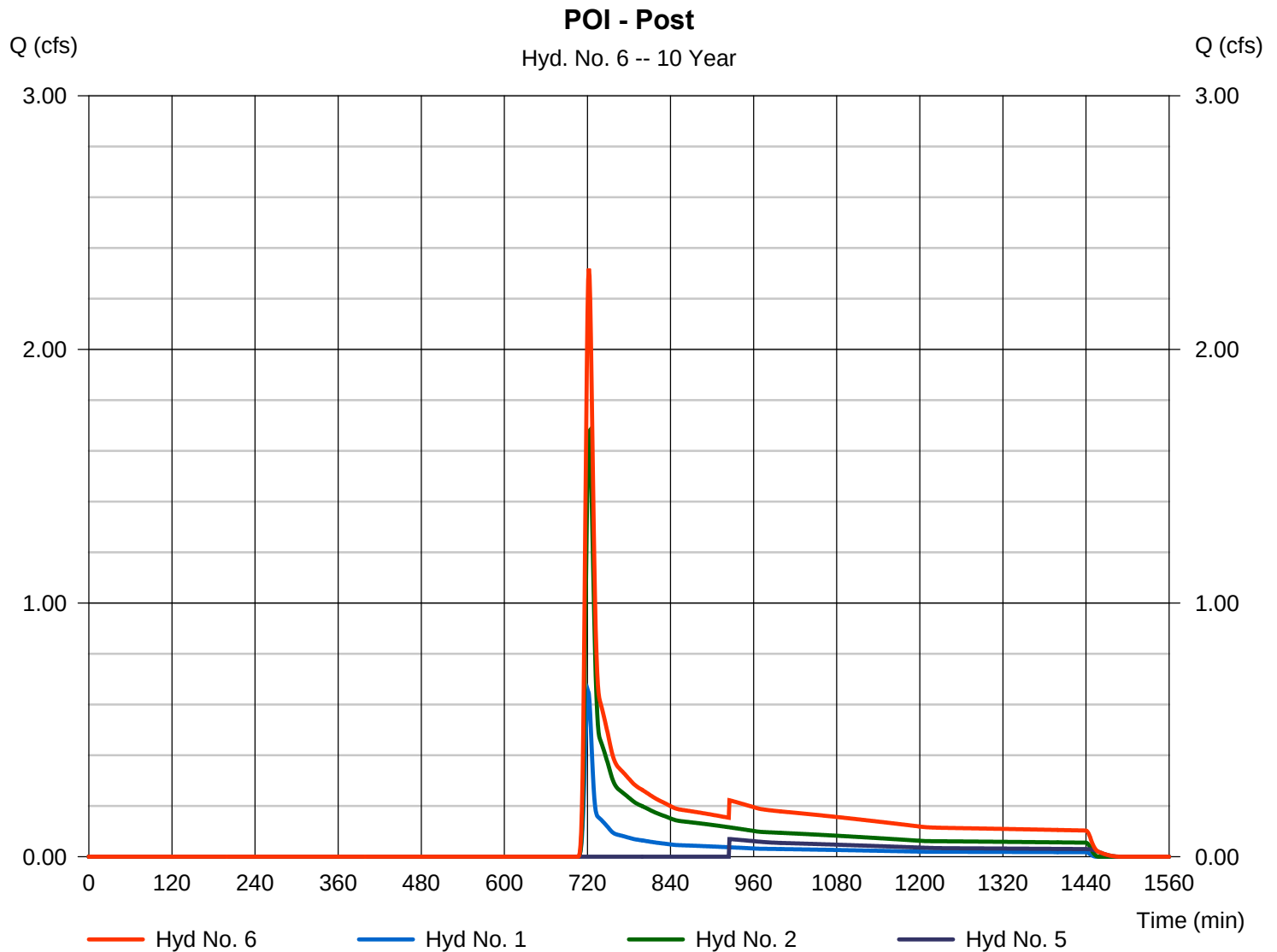
Wednesday, 11 / 9 / 2016

Hyd. No. 6

POI - Post

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 5

Peak discharge = 2.318 cfs
 Time to peak = 722 min
 Hyd. volume = 9,219 cuft
 Contrib. drain. area = 4.480 ac



**ATTACHMENT C-3
CHESTNUT RIDGE
50 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut - Pre



Hydrograph Return Period Recap

Hydranow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.361	-----	-----	3.620	-----	9.841	13.37	Chestnut - Pre
Proj. file: Chestnut Ridge Hydro - pre.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.841	1	720	24,054	-----	-----	-----	Chestnut - Pre
Chestnut Ridge Hydro - pre.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

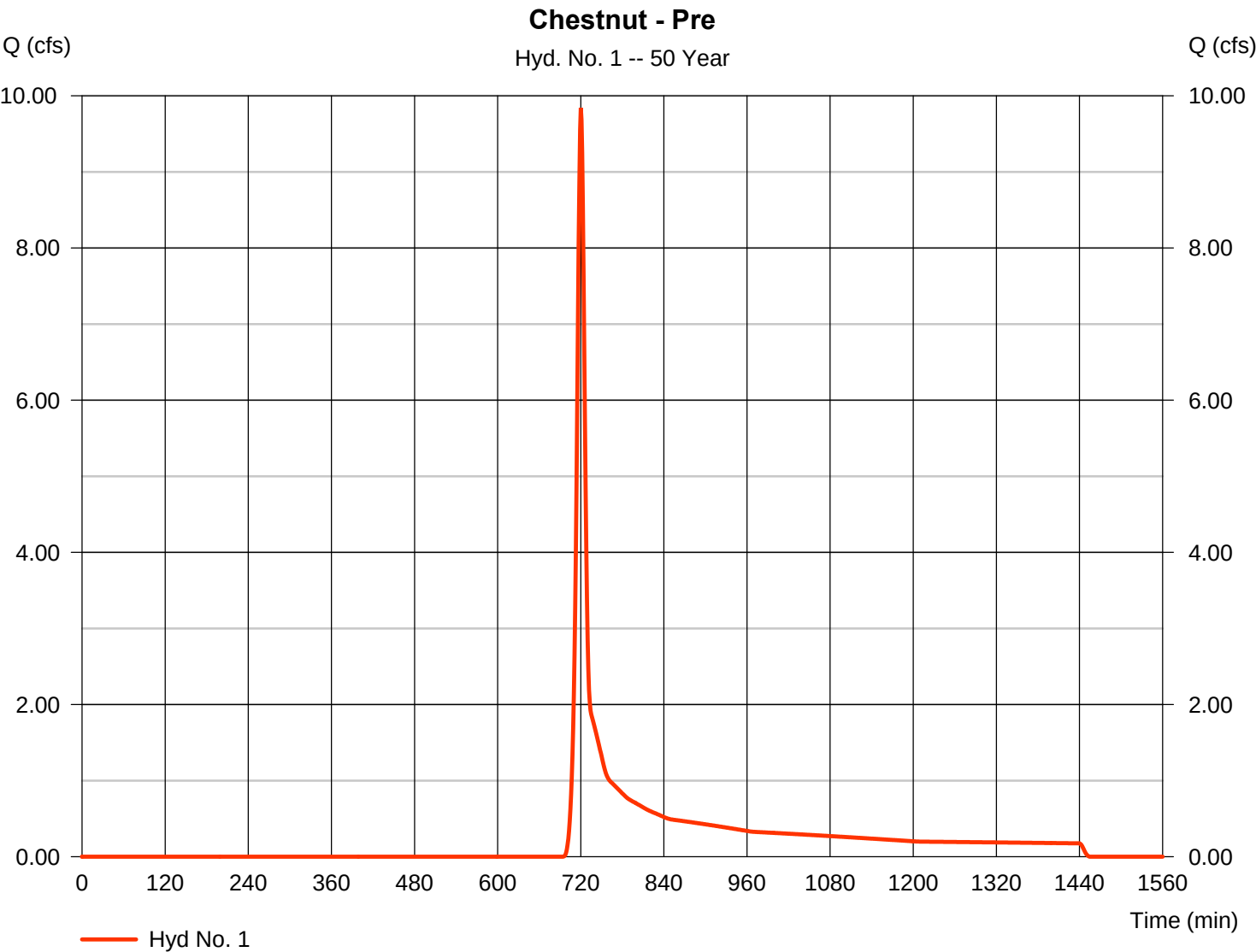
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 1

Chestnut - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 9.841 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 24,054 cuft
Drainage area	= 5.890 ac	Curve number	= 58
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.00 min
Total precip.	= 4.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

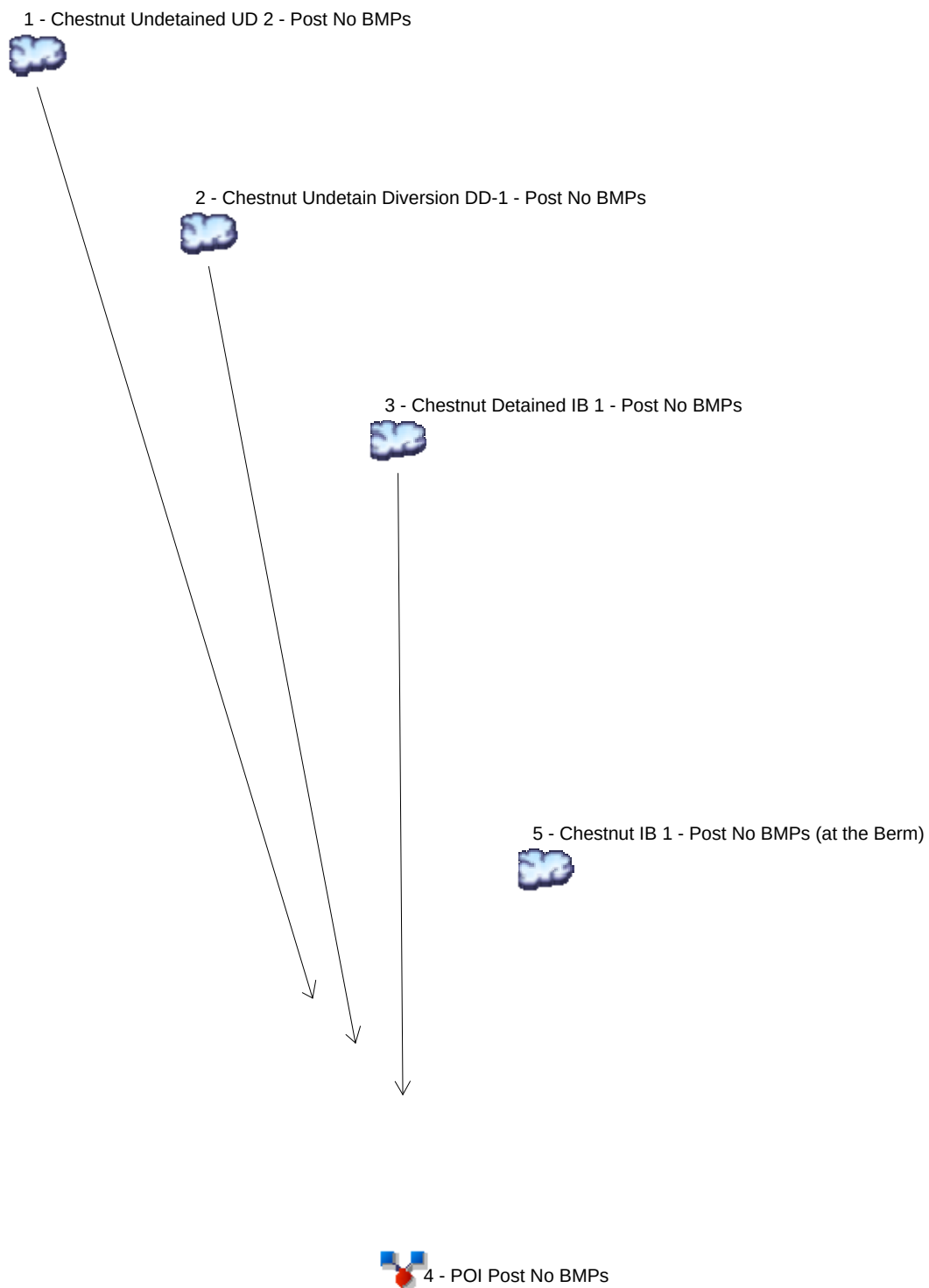
Hyd. No. 1

Chestnut - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 12.0	88.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 16.70	8.00	0.00				
Travel Time (min)	= 0.86	+	5.67	+	0.00	=	6.53
Shallow Concentrated Flow							
Flow length (ft)	= 260.00	650.00	0.00				
Watercourse slope (%)	= 7.30	7.10	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.36	4.30	0.00				
Travel Time (min)	= 0.99	+	2.52	+	0.00	=	3.51
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				10.00 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.065	-----	-----	0.651	-----	1.771	2.406	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	-----	-----	0.121	-----	-----	1.679	-----	4.962	6.859	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	-----	-----	0.395	-----	-----	1.481	-----	3.174	4.088	Chestnut Detained IB 1 - Post No BM
4	Combine	1, 2, 3	-----	0.561	-----	-----	3.788	-----	9.879	13.30	POI Post No BMPs
5	SCS Runoff	-----	-----	0.474	-----	-----	1.226	-----	2.293	2.850	Chestnut IB 1 - Post No BMPs (at the

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.771	1	720	4,329	-----	-----	-----	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	4.962	1	721	13,422	-----	-----	-----	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	3.174	1	721	7,908	-----	-----	-----	Chestnut Detained IB 1 - Post No BM
4	Combine	9.879	1	721	25,660	1, 2, 3	-----	-----	POI Post No BMPs
5	SCS Runoff	2.293	1	719	4,840	-----	-----	-----	Chestnut IB 1 - Post No BMPs (at the
Chestnut Ridge Hydro - post no BMP.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

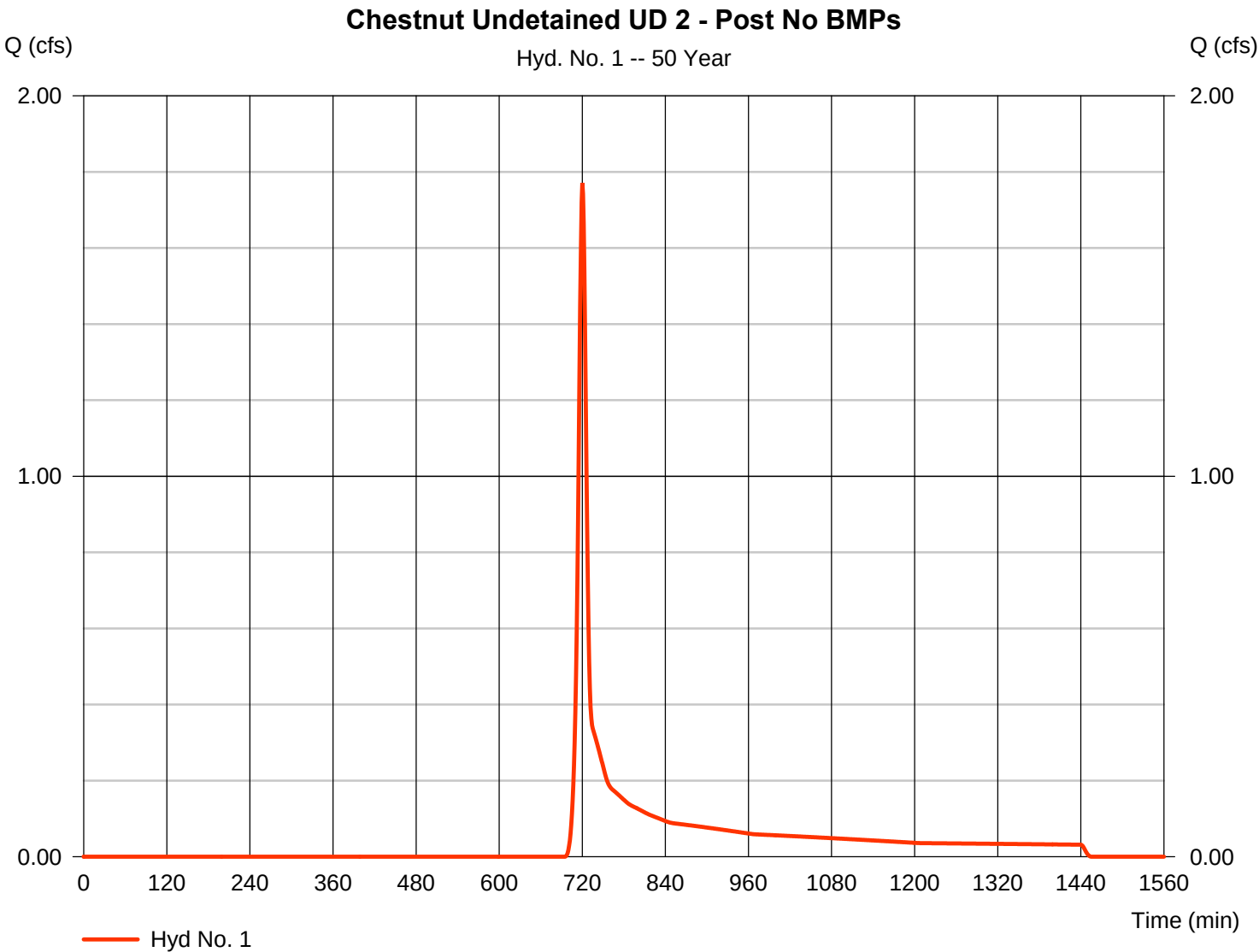
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.771 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	4,329 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	4.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

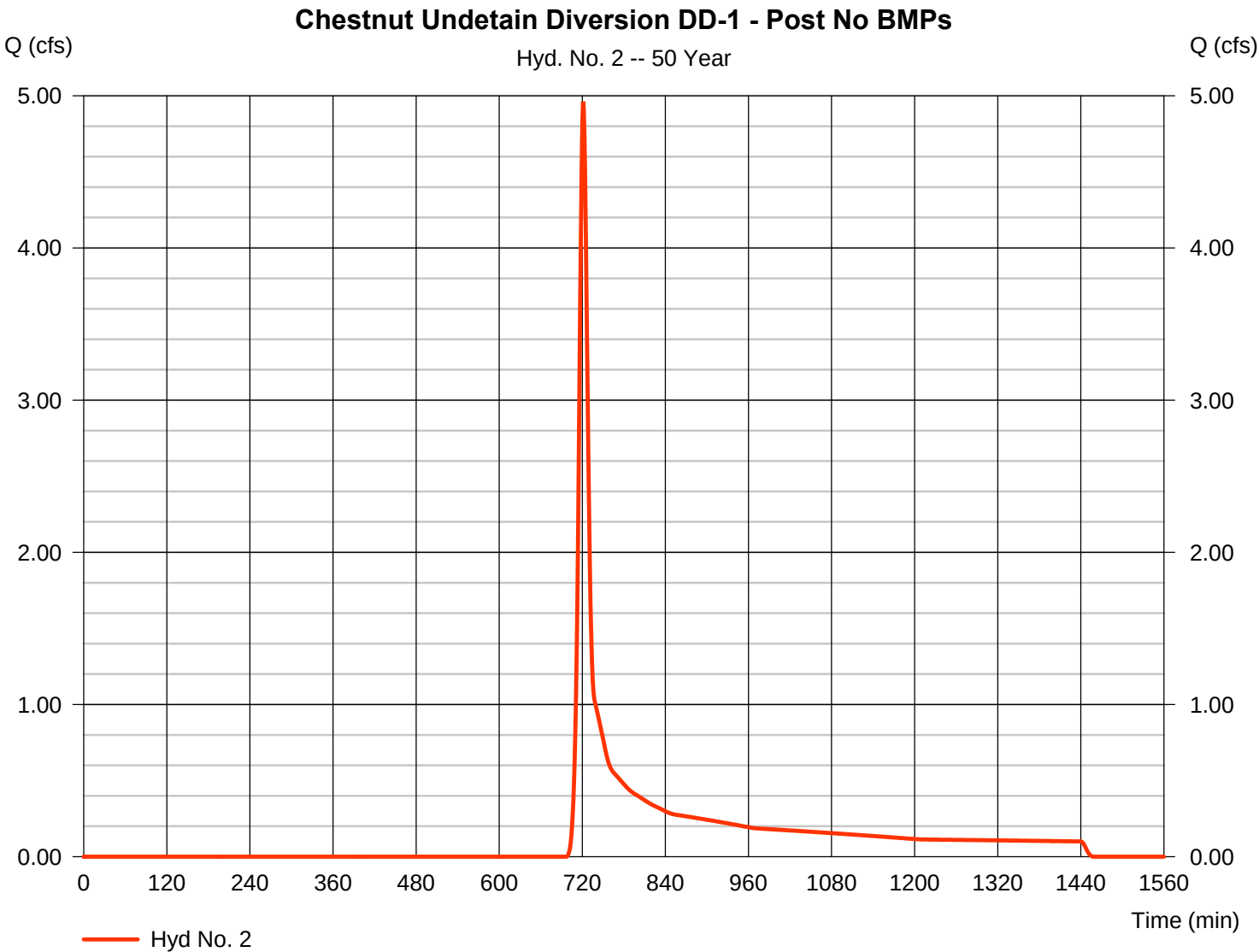
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 14.0	86.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 43.00	9.30	0.00				
Travel Time (min)	= 0.66	+	5.24	+	0.00	=	5.91
Shallow Concentrated Flow							
Flow length (ft)	= 765.00	0.00	0.00				
Watercourse slope (%)	= 7.30	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.36	0.00	0.00				
Travel Time (min)	= 2.92	+	0.00	+	0.00	=	2.92
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				8.80 min			

Hydrograph Report

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.962 cfs
Storm frequency	=	50 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	13,422 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	4.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

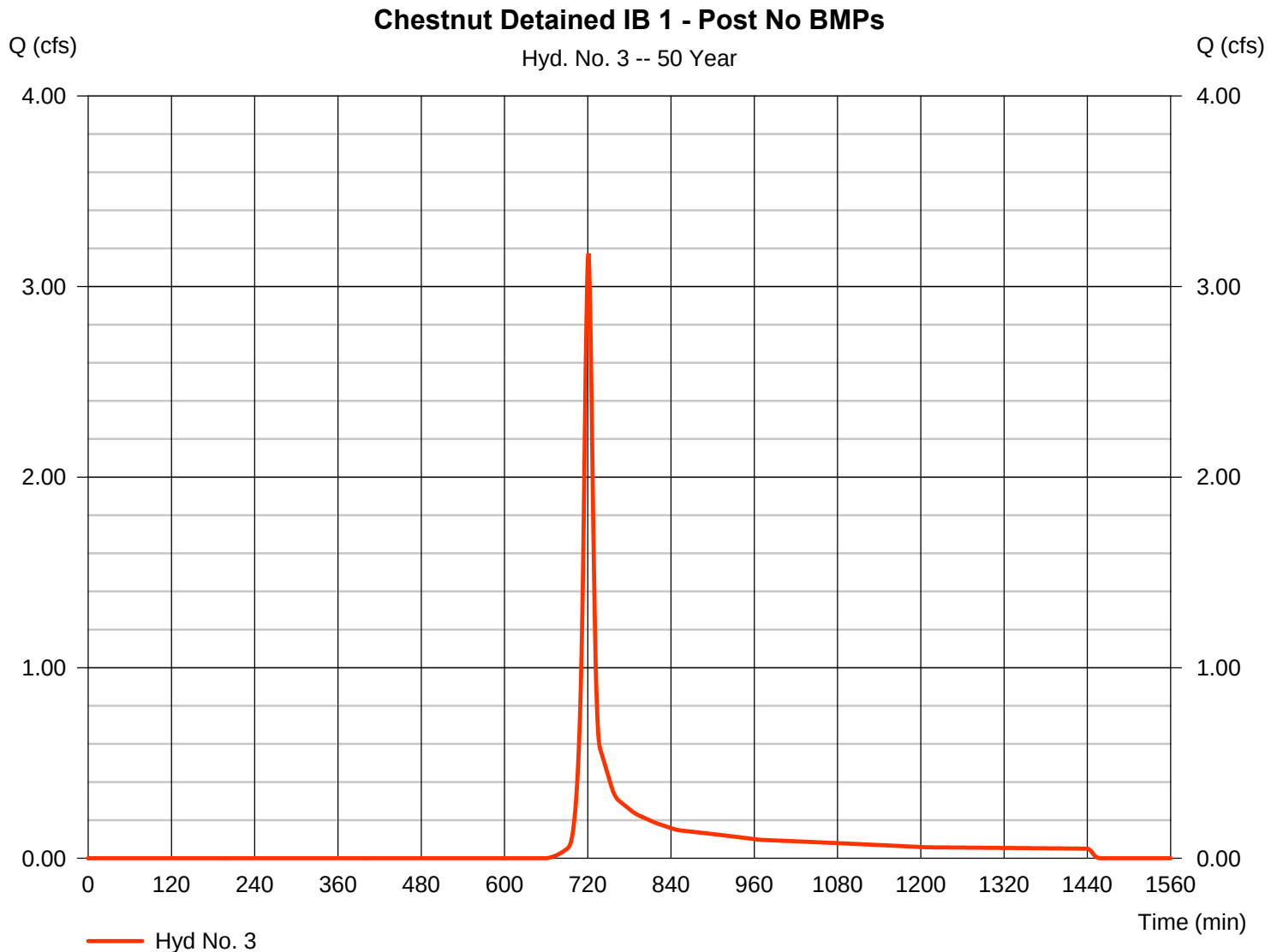
Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

Hydrograph type = SCS Runoff
 Storm frequency = 50 yrs
 Time interval = 1 min
 Drainage area = 1.400 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 4.92 in
 Storm duration = 24 hrs

Peak discharge = 3.174 cfs
 Time to peak = 721 min
 Hyd. volume = 7,908 cuft
 Curve number = 64
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 10.20 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

<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)	= 2.57	0.00	0.00	
Land slope (%)	= 6.00	0.00	0.00	
Travel Time (min)	= 7.05	+	0.00	+
			0.00	= 7.05
Shallow Concentrated Flow				
Flow length (ft)	= 796.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 3.18	+	0.00	+
			0.00	= 3.18
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				10.20 min

Hydrograph Report

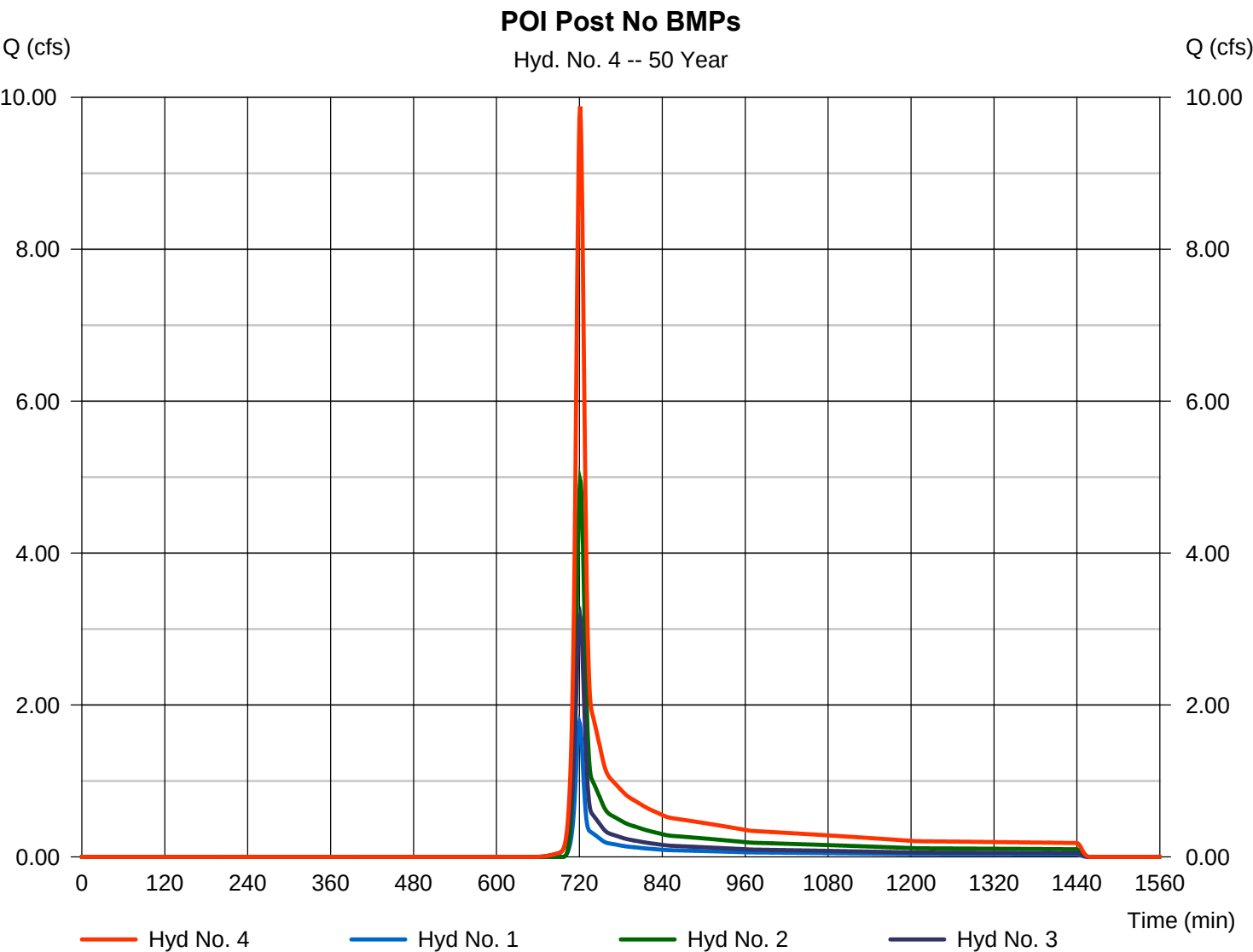
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

POI Post No BMPs

Hydrograph type	= Combine	Peak discharge	= 9.879 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 25,660 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 5.880 ac



Hydrograph Report

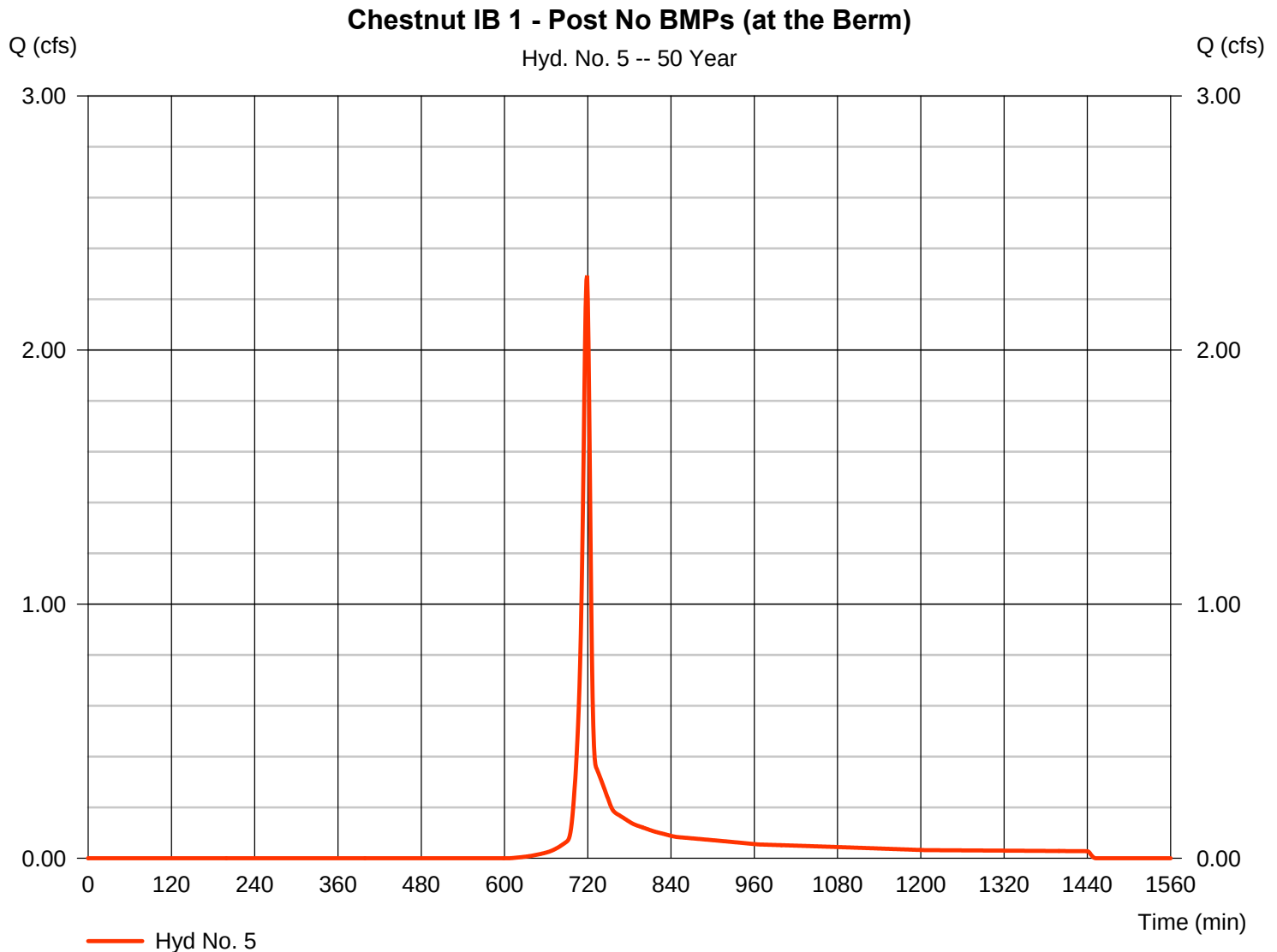
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.293 cfs
Storm frequency	= 50 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 4,840 cuft
Drainage area	= 0.720 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 4.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

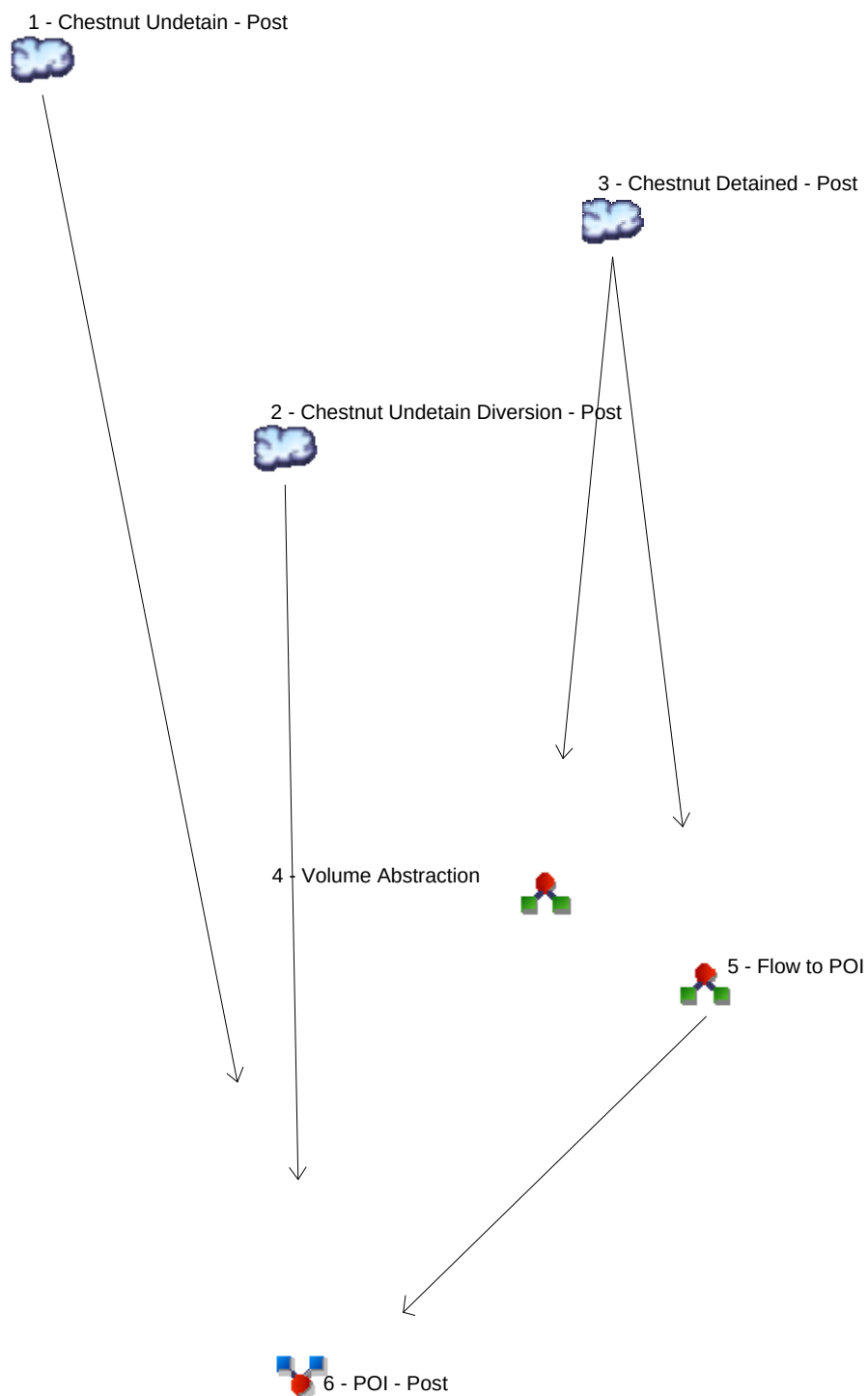
Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

<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)	= 2.57	0.00	0.00	
Land slope (%)	= 6.00	0.00	0.00	
Travel Time (min)	= 7.05	+	0.00	+
			0.00	= 7.05
Shallow Concentrated Flow				
Flow length (ft)	= 137.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.55	+	0.00	+
			0.00	= 0.55
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				7.60 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.771	-----	Chestnut Undetain - Post
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	4.962	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.738	-----	Chestnut Detained - Post
4	Diversion1	3	-----	-----	-----	-----	-----	-----	1.738	-----	Volume Abstraction
5	Diversion2	3	-----	-----	-----	-----	-----	-----	0.187	-----	Flow to POI
6	Combine	1, 2, 5	-----	-----	-----	-----	-----	-----	6.705	-----	POI - Post
Proj. file: Chestnut Ridge Hydro - post - 50 yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.771	1	720	4,329	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	4.962	1	721	13,422	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	1.738	1	733	7,821	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	1.738	1	733	4,747	3	-----	-----	Volume Abstraction
5	Diversion2	0.187	1	831	3,074	3	-----	-----	Flow to POI
6	Combine	6.705	1	721	20,825	1, 2, 5	-----	-----	POI - Post
Chestnut Ridge Hydro - post - 50 yr.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

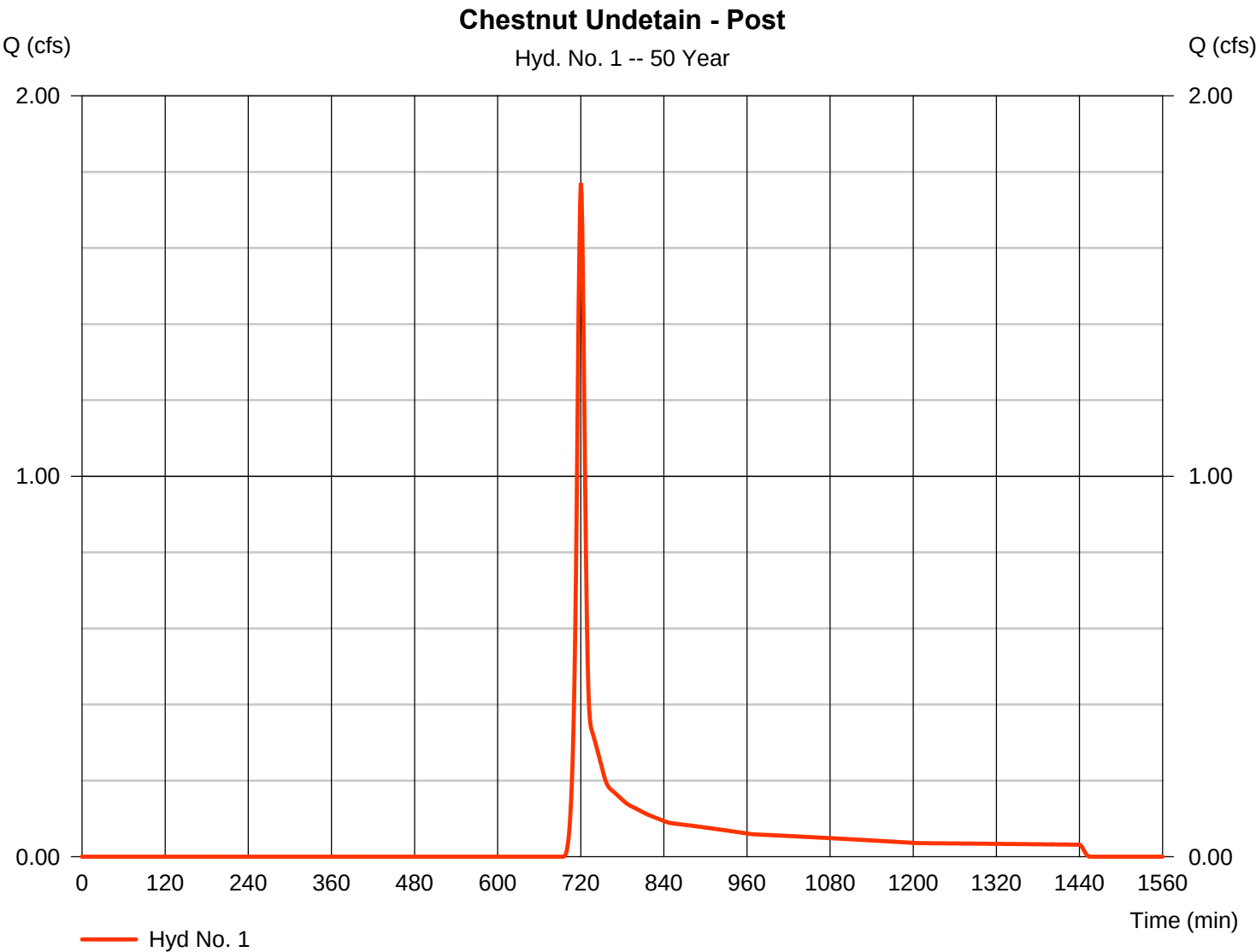
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 1

Chestnut Undetain - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.771 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	4,329 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	4.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetain - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 14.0	86.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 43.00	9.30	0.00	
Travel Time (min)	= 0.66	+	5.24	+
			0.00	= 5.91
Shallow Concentrated Flow				
Flow length (ft)	= 765.00	0.00	0.00	
Watercourse slope (%)	= 7.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.36	0.00	0.00	
Travel Time (min)	= 2.92	+	0.00	+
			0.00	= 2.92
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				8.80 min

Hydrograph Report

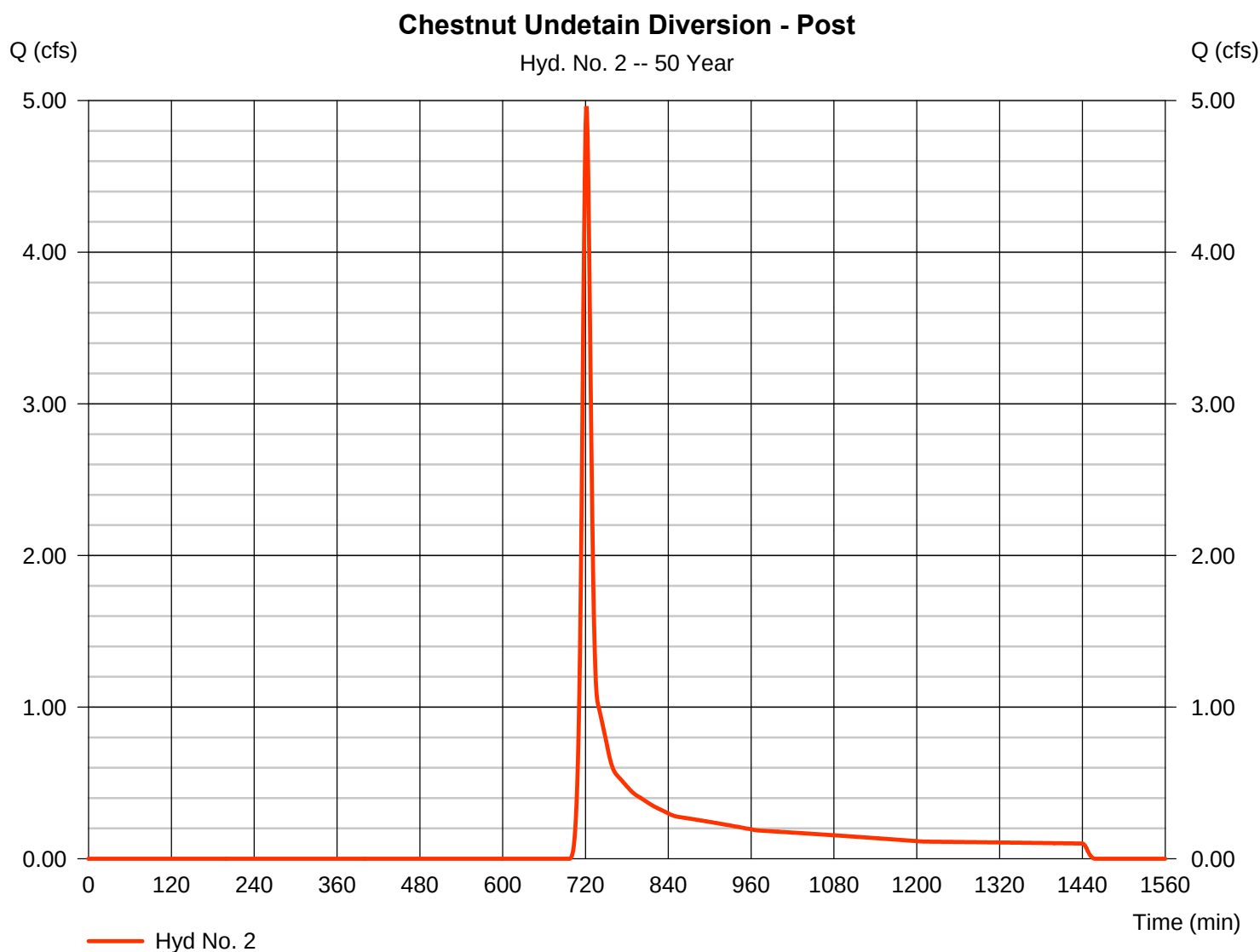
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion - Post

Hydrograph type	= SCS Runoff	Peak discharge	= 4.962 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 13,422 cuft
Drainage area	= 3.420 ac	Curve number	= 57
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.10 min
Total precip.	= 4.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

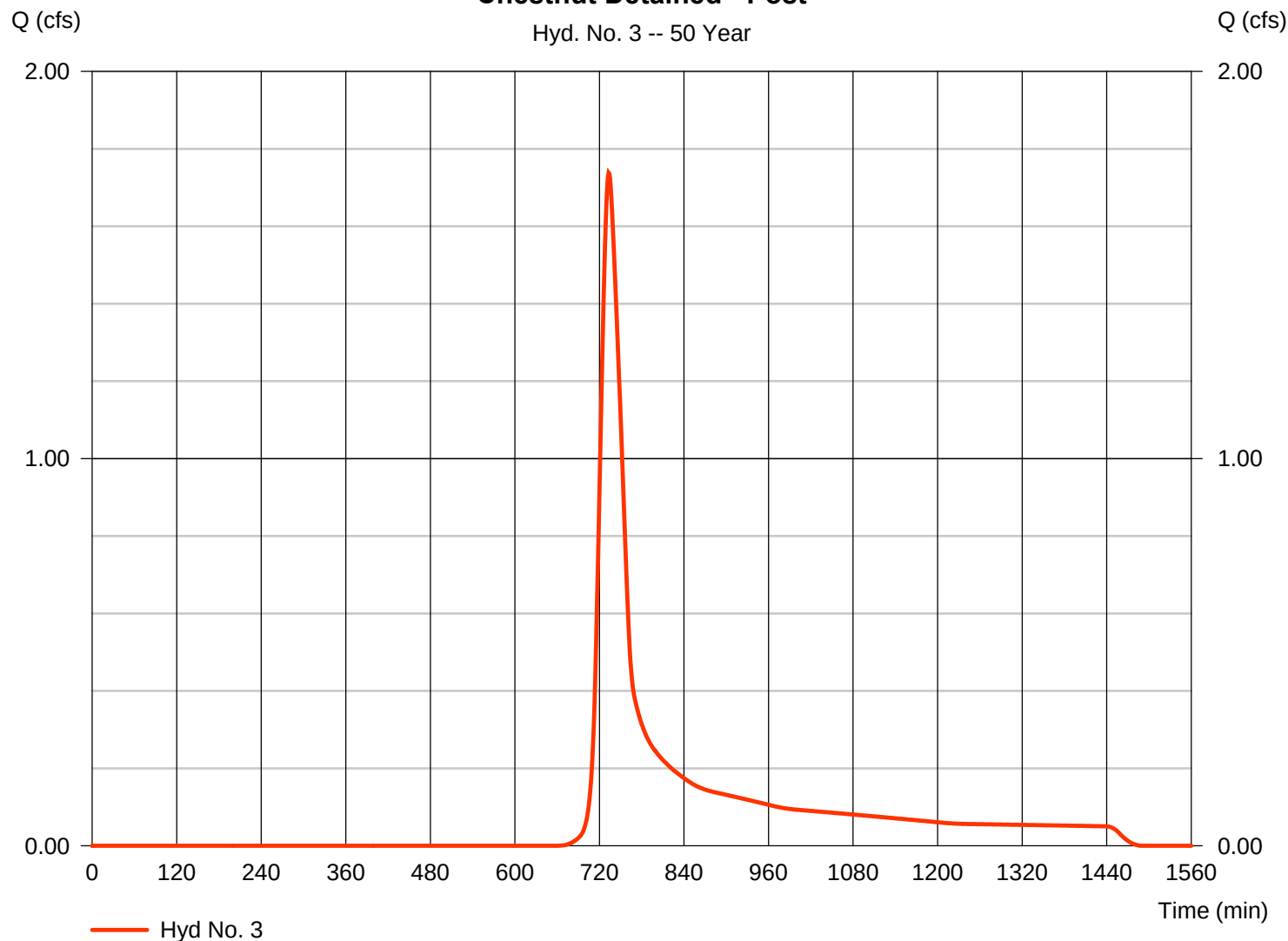
Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained - Post

Hydrograph type	= SCS Runoff	Peak discharge	= 1.738 cfs
Storm frequency	= 50 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 7,821 cuft
Drainage area	= 1.400 ac	Curve number	= 64
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.90 min
Total precip.	= 4.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Chestnut Detained - Post



Hydrograph Report

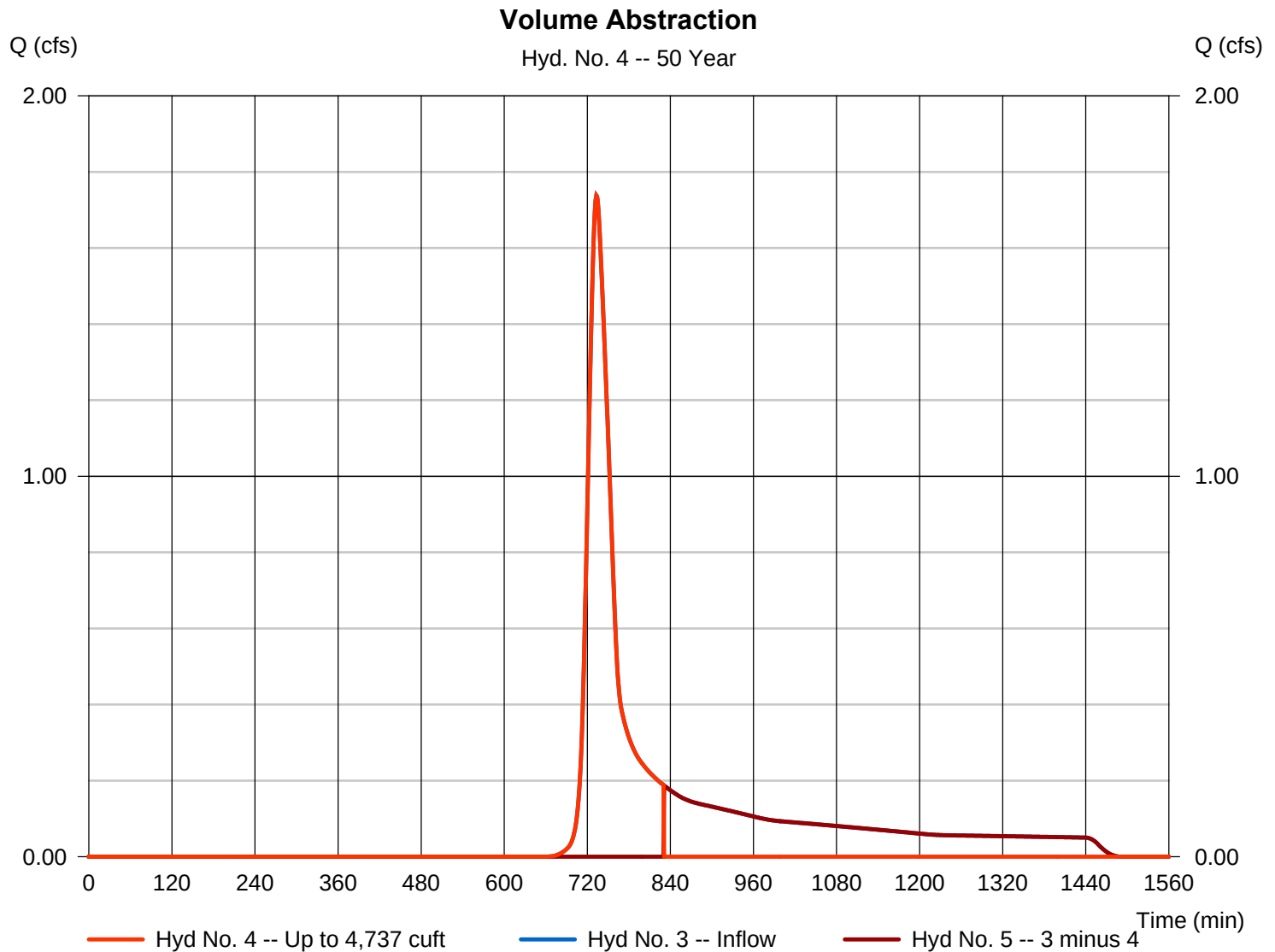
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.738 cfs
Storm frequency	= 50 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 4,747 cuft
Inflow hydrograph	= 3 - Chestnut Detained - Post	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 4,737 cuft



Hydrograph Report

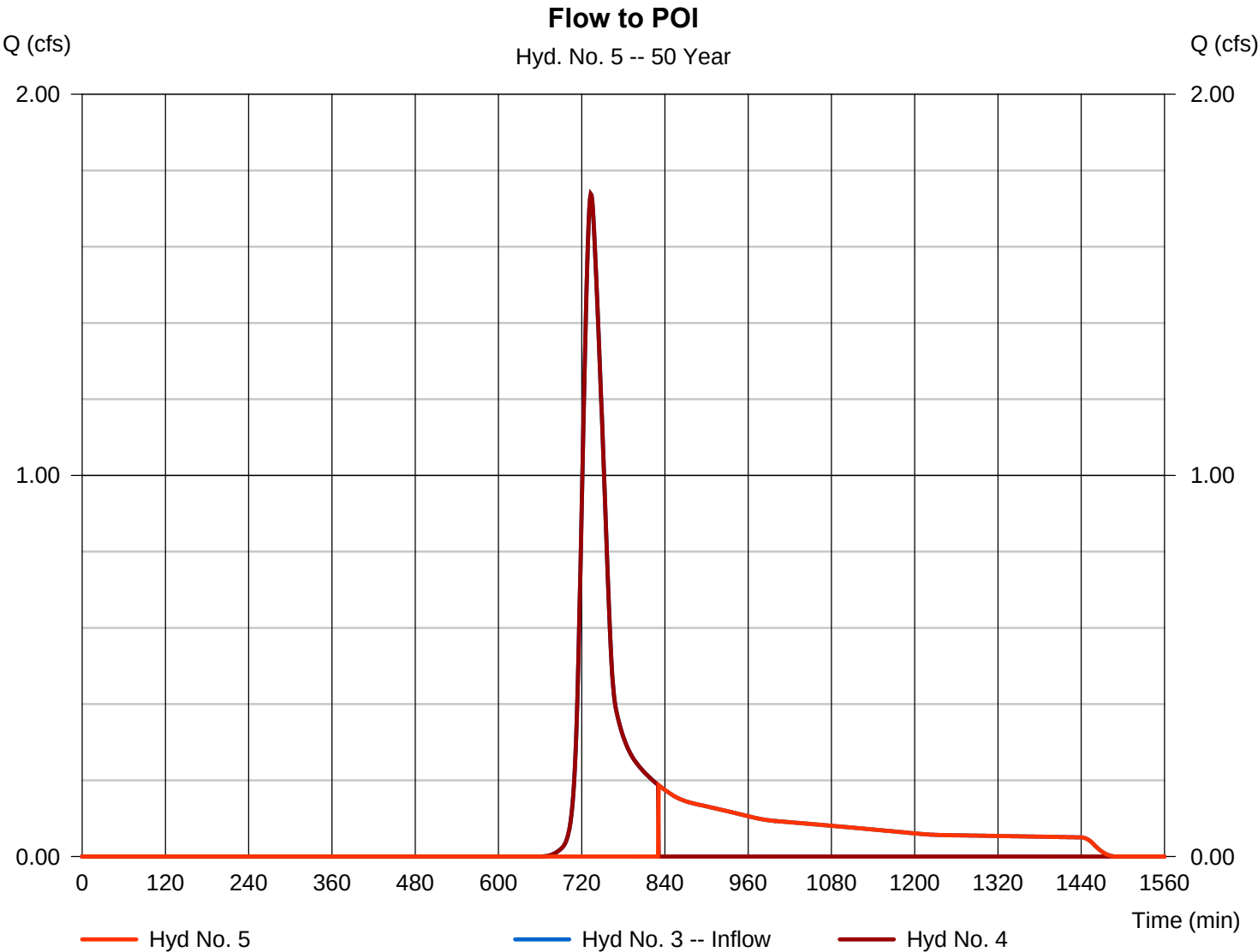
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.187 cfs
Storm frequency	=	50 yrs	Time to peak	=	831 min
Time interval	=	1 min	Hyd. volume	=	3,074 cuft
Inflow hydrograph	=	3 - Chestnut Detained - Post	2nd diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	4,737 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

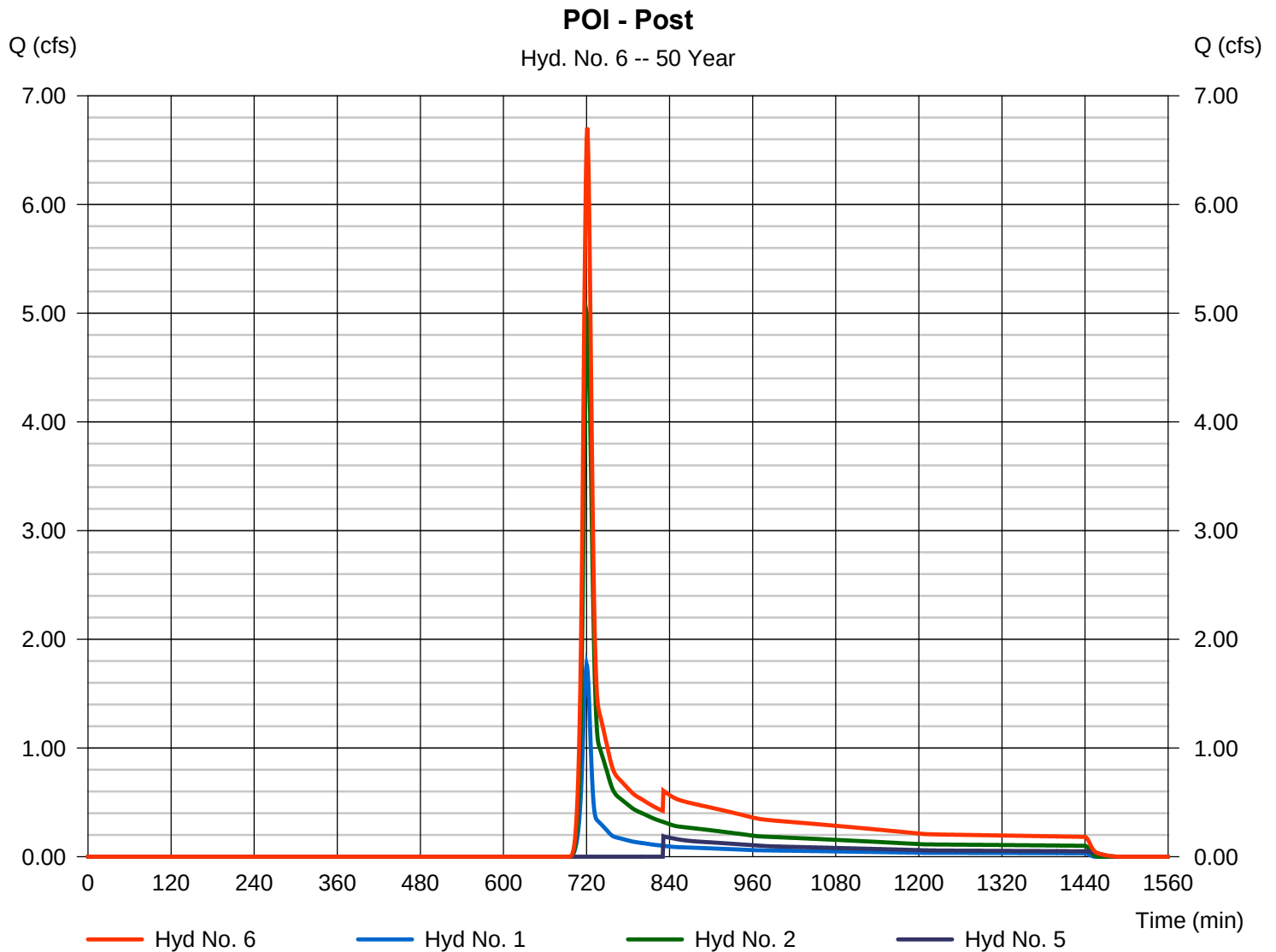
Wednesday, 11 / 9 / 2016

Hyd. No. 6

POI - Post

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 5

Peak discharge = 6.705 cfs
 Time to peak = 721 min
 Hyd. volume = 20,825 cuft
 Contrib. drain. area = 4.480 ac



ATTACHMENT C-4
CHESTNUT RIDGE
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.361	-----	-----	3.620	-----	9.841	13.37	Chestnut - Pre
Proj. file: Chestnut Ridge Hydro - pre.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

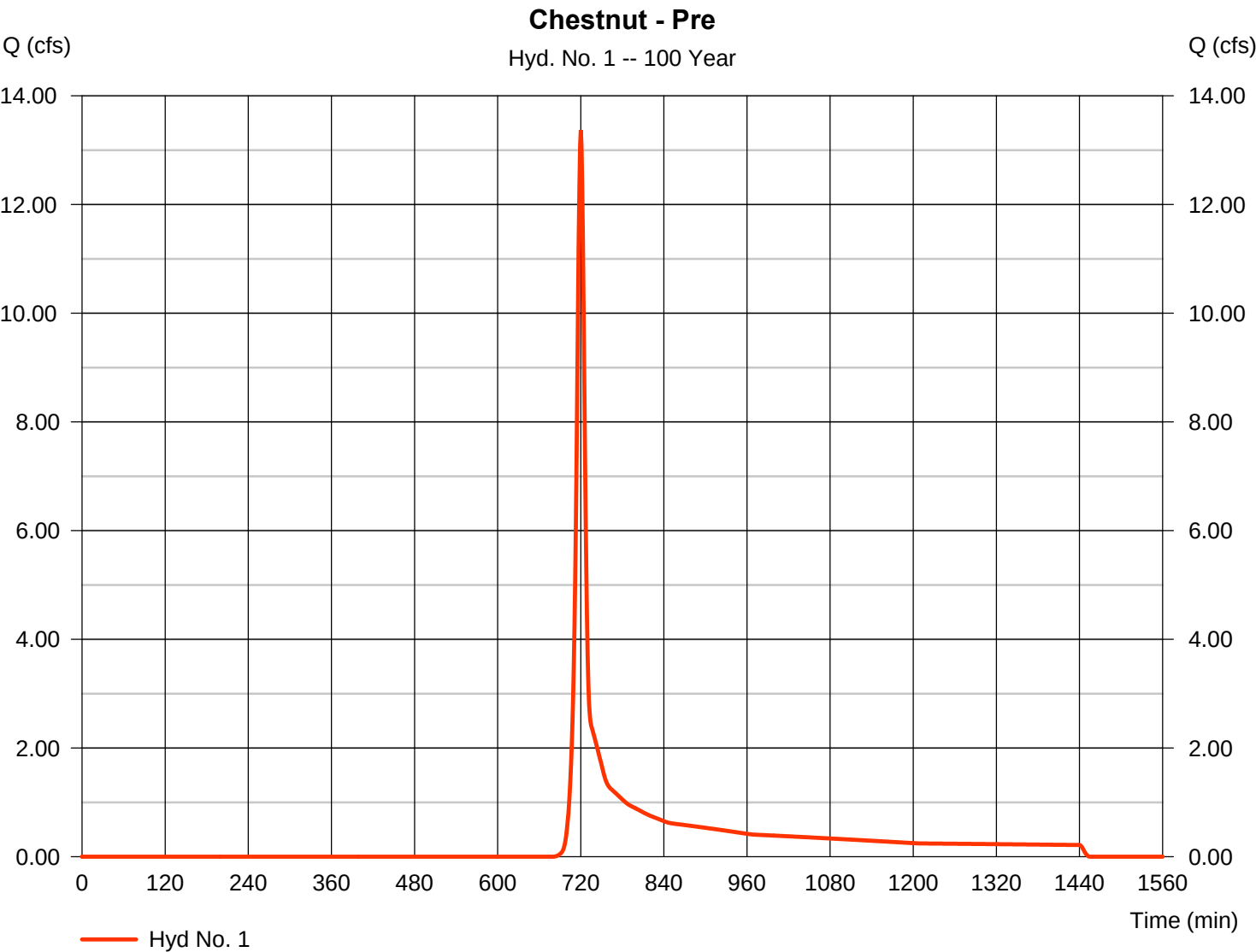
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	13.37	1	720	31,585	-----	-----	-----	Chestnut - Pre
Chestnut Ridge Hydro - pre.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 13.37 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 31,585 cuft
Drainage area	= 5.890 ac	Curve number	= 58
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.54 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 260.00	650.00	0.00	
Watercourse slope (%)	= 7.30	7.10	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.36	4.30	0.00	
Travel Time (min)	= 0.99	+	2.52	+
			0.00	= 3.51
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				10.00 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Chestnut Undetained UD 2 - Post No BMPs



2 - Chestnut Undetain Diversion DD-1 - Post No BMPs



3 - Chestnut Detained IB 1 - Post No BMPs



5 - Chestnut IB 1 - Post No BMPs (at the Berm)



4 - POI Post No BMPs

Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.065	-----	-----	0.651	-----	1.771	2.406	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	-----	-----	0.121	-----	-----	1.679	-----	4.962	6.859	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	-----	-----	0.395	-----	-----	1.481	-----	3.174	4.088	Chestnut Detained IB 1 - Post No BM
4	Combine	1, 2, 3	-----	0.561	-----	-----	3.788	-----	9.879	13.30	POI Post No BMPs
5	SCS Runoff	-----	-----	0.474	-----	-----	1.226	-----	2.293	2.850	Chestnut IB 1 - Post No BMPs (at the

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

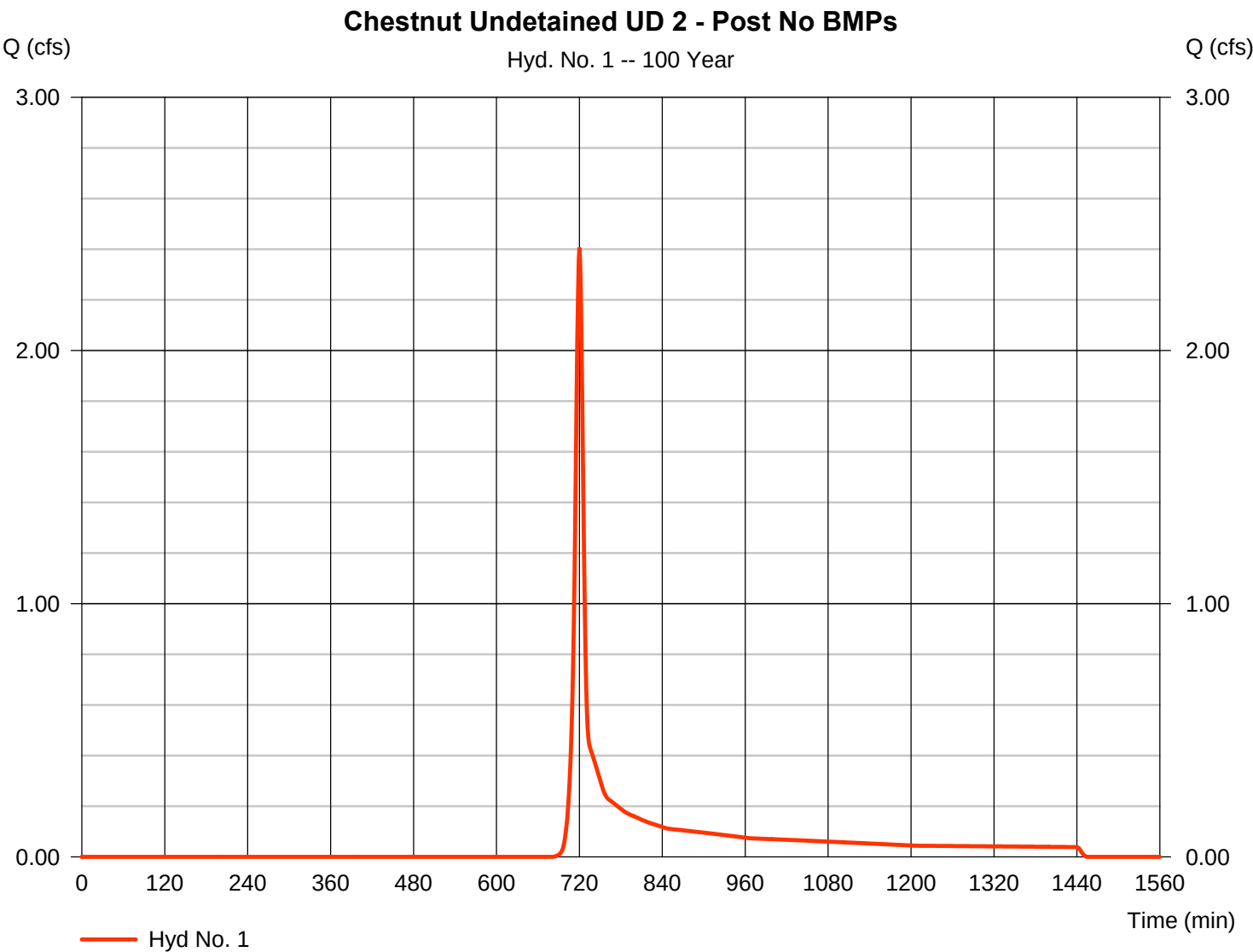
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.406	1	720	5,684	-----	-----	-----	Chestnut Undetained UD 2 - Post No
2	SCS Runoff	6.859	1	721	17,741	-----	-----	-----	Chestnut Undetain Diversion DD-1 -
3	SCS Runoff	4.088	1	721	10,043	-----	-----	-----	Chestnut Detained IB 1 - Post No BM
4	Combine	13.30	1	721	33,468	1, 2, 3	-----	-----	POI Post No BMPs
5	SCS Runoff	2.850	1	719	6,010	-----	-----	-----	Chestnut IB 1 - Post No BMPs (at the
Chestnut Ridge Hydro - post no BMP.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.406 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	5,684 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetained UD 2 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 14.0	86.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 43.00	9.30	0.00	
Travel Time (min)	= 0.66	+	5.24	+
			0.00	= 5.91
Shallow Concentrated Flow				
Flow length (ft)	= 765.00	0.00	0.00	
Watercourse slope (%)	= 7.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.36	0.00	0.00	
Travel Time (min)	= 2.92	+	0.00	+
			0.00	= 2.92
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				8.80 min

Hydrograph Report

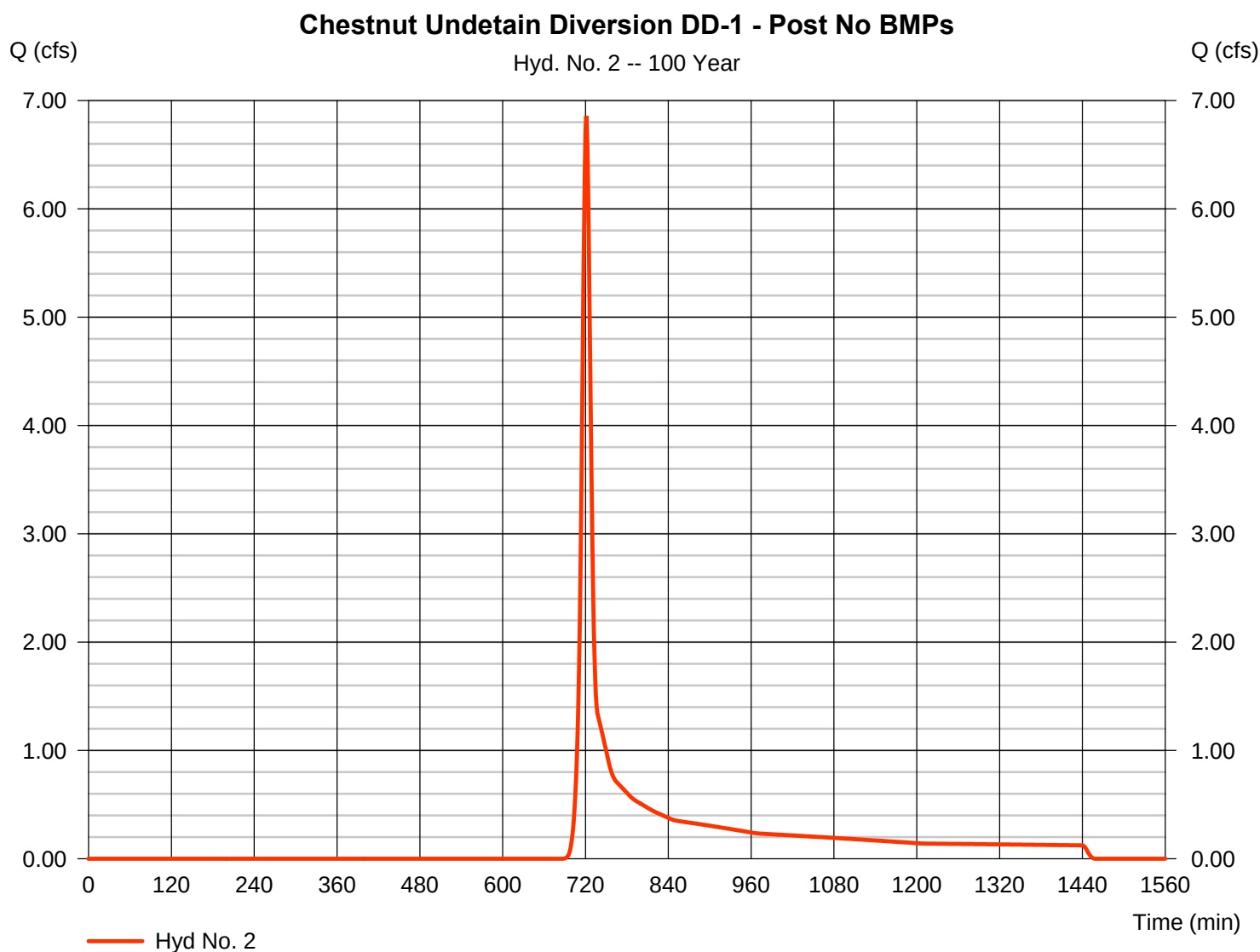
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.859 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	17,741 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion DD-1 - Post No BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 12.0	88.0	0.0	
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00	
Land slope (%)	= 16.70	8.00	0.00	
Travel Time (min)	= 0.86	+	5.67	+
			0.00	= 6.53
Shallow Concentrated Flow				
Flow length (ft)	= 65.00	690.00	0.00	
Watercourse slope (%)	= 6.00	6.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.95	3.95	0.00	
Travel Time (min)	= 0.27	+	2.91	+
			0.00	= 3.18
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.30	0.00	0.00	
Manning's n-value	= 0.026	0.015	0.015	
Velocity (ft/s)	=13.01	0.00	0.00	
Flow length (ft)	(0)285.0	0.0	0.0	
Travel Time (min)	= 0.37	+	0.00	+
			0.00	= 0.37
Total Travel Time, Tc				10.10 min

Hydrograph Report

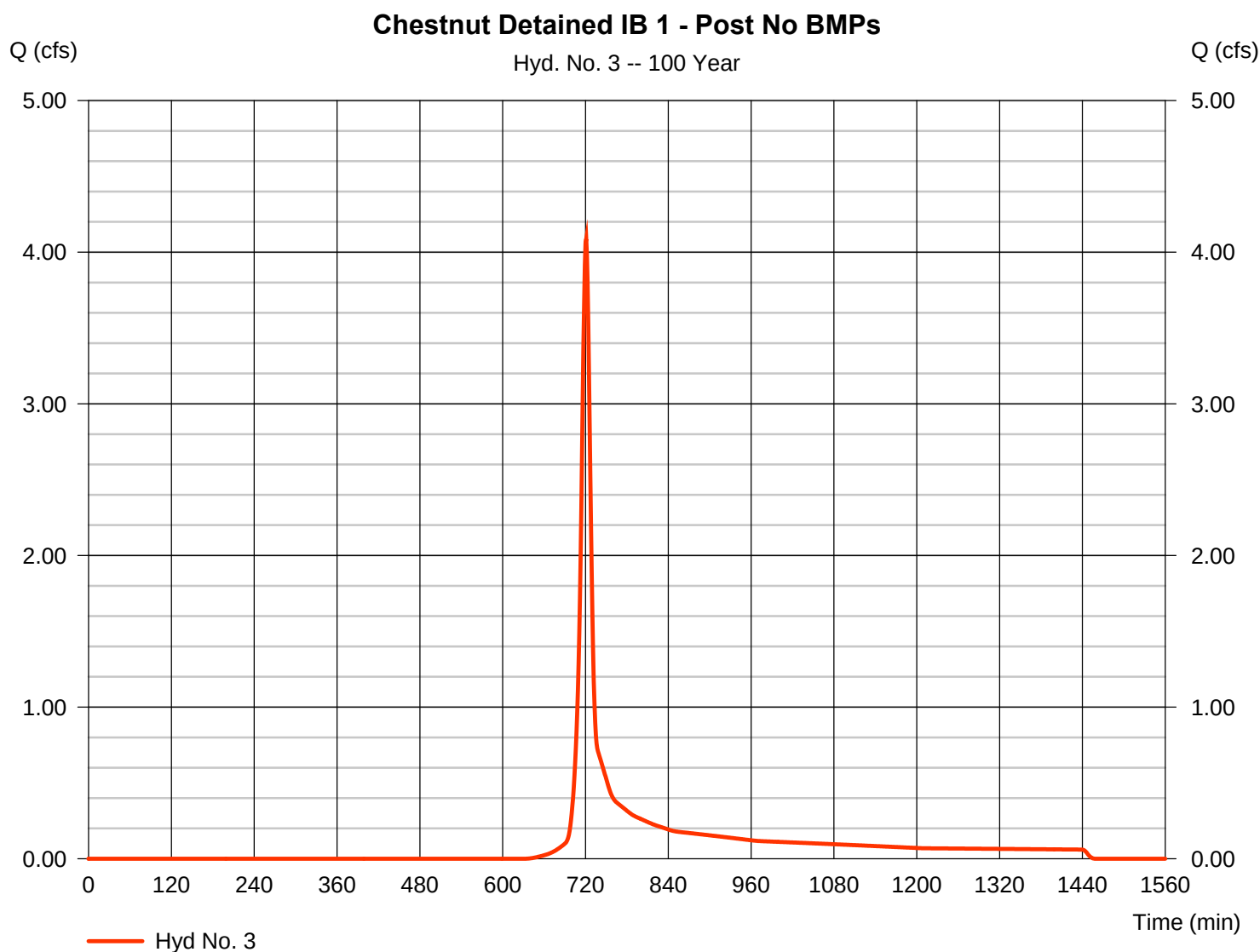
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.088 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	10,043 cuft
Drainage area	=	1.400 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.20 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Chestnut Detained IB 1 - Post No BMPs

<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)	= 2.57	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.05	+	0.00	+	0.00	=	7.05
Shallow Concentrated Flow							
Flow length (ft)	= 796.00	0.00	0.00				
Watercourse slope (%)	= 6.70	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.18	0.00	0.00				
Travel Time (min)	= 3.18	+	0.00	+	0.00	=	3.18
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				10.20 min			

Hydrograph Report

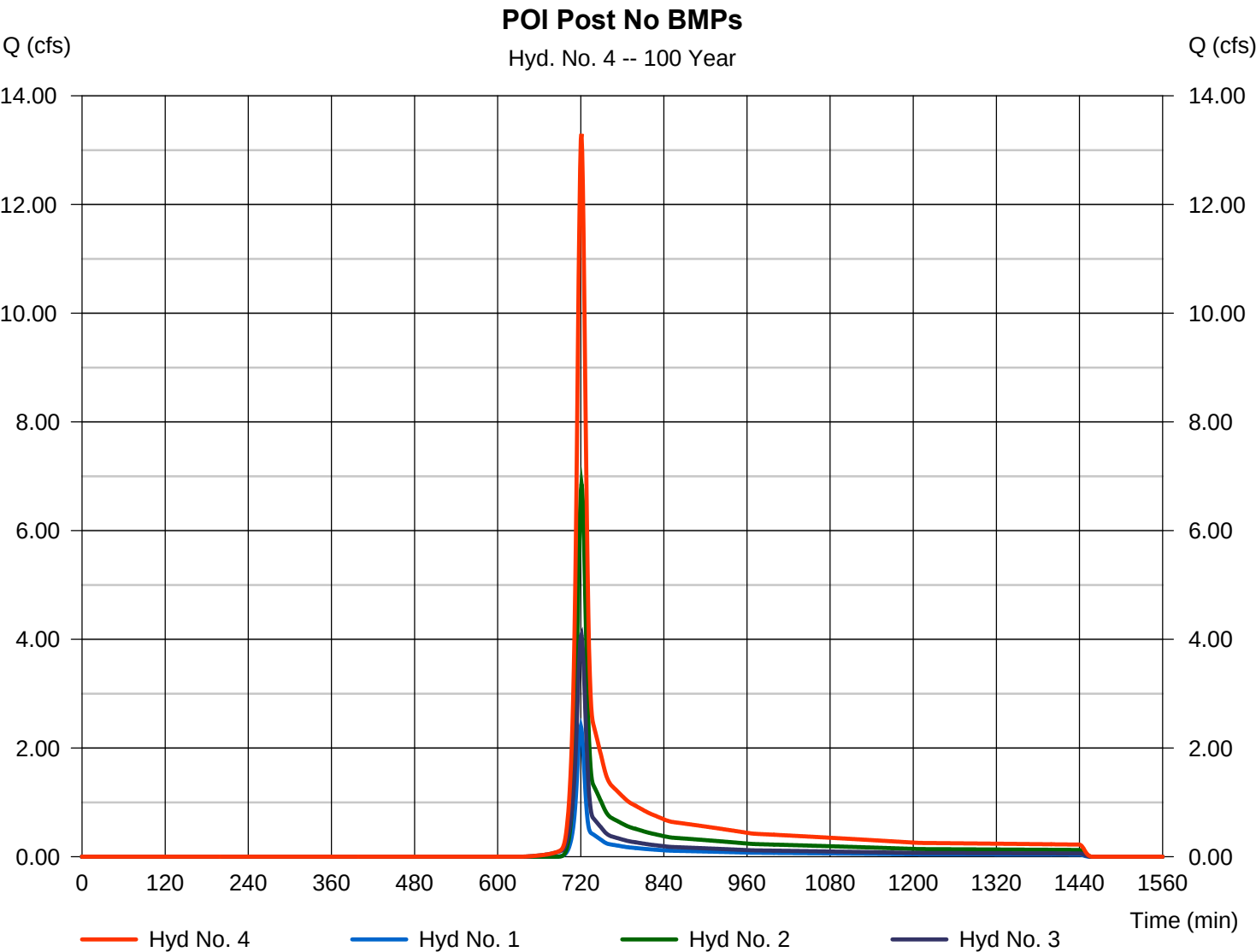
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

POI Post No BMPs

Hydrograph type	= Combine	Peak discharge	= 13.30 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 33,468 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 5.880 ac



Hydrograph Report

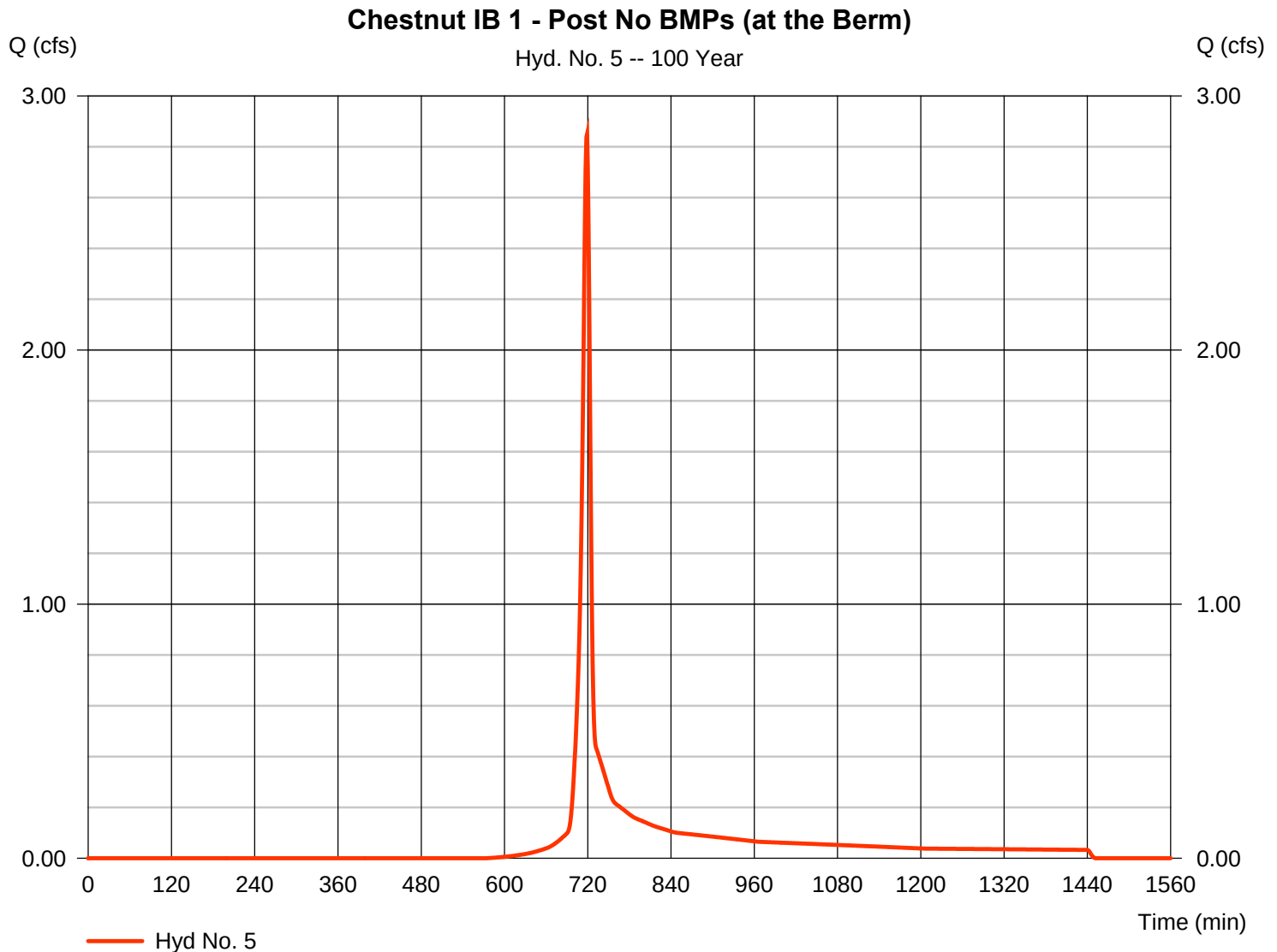
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.850 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 6,010 cuft
Drainage area	= 0.720 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.54 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

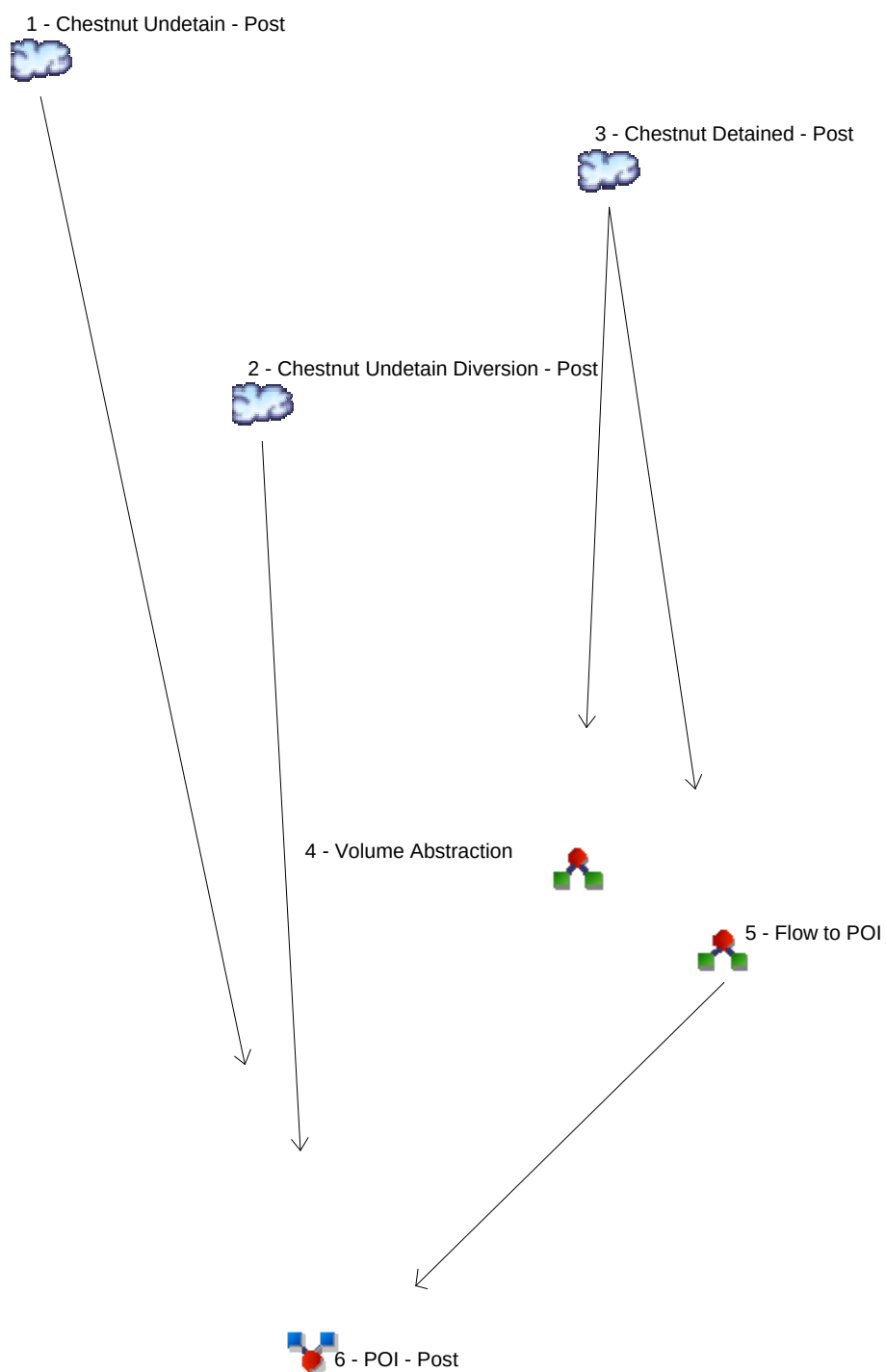
Hyd. No. 5

Chestnut IB 1 - Post No BMPs (at the Berm)

<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)	= 2.57	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.05	+	0.00	+	0.00	=	7.05
Shallow Concentrated Flow							
Flow length (ft)	= 137.00	0.00	0.00				
Watercourse slope (%)	= 6.70	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=4.18	0.00	0.00				
Travel Time (min)	= 0.55	+	0.00	+	0.00	=	0.55
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				7.60 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	2.406	Chestnut Undetain - Post
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	6.859	Chestnut Undetain Diversion - Post
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	2.269	Chestnut Detained - Post
4	Diversion1	3	-----	-----	-----	-----	-----	-----	-----	2.269	Volume Abstraction
5	Diversion2	3	-----	-----	-----	-----	-----	-----	-----	0.727	Flow to POI
6	Combine	1, 2, 5	-----	-----	-----	-----	-----	-----	-----	9.210	POI - Post

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.406	1	720	5,684	-----	-----	-----	Chestnut Undetain - Post
2	SCS Runoff	6.859	1	721	17,741	-----	-----	-----	Chestnut Undetain Diversion - Post
3	SCS Runoff	2.269	1	733	9,931	-----	-----	-----	Chestnut Detained - Post
4	Diversion1	2.269	1	733	4,744	3	-----	-----	Volume Abstraction
5	Diversion2	0.727	1	761	5,187	3	-----	-----	Flow to POI
6	Combine	9.210	1	721	28,612	1, 2, 5	-----	-----	POI - Post
Chestnut Ridge Hydro - post - 100 yr.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

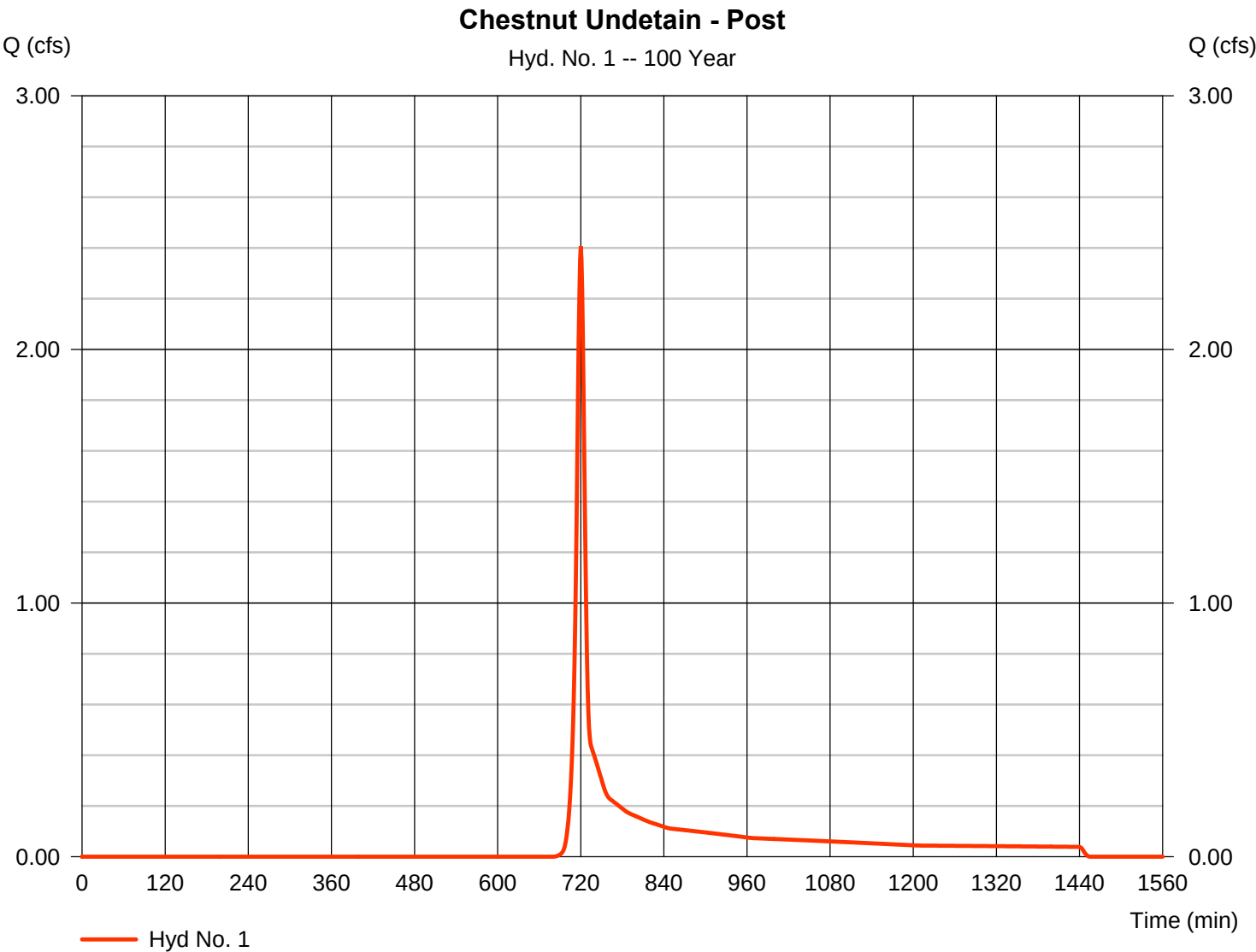
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 1

Chestnut Undetain - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.406 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	5,684 cuft
Drainage area	=	1.060 ac	Curve number	=	58
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.80 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Chestnut Undetain - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 14.0	86.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 43.00	9.30	0.00				
Travel Time (min)	= 0.66	+	5.24	+	0.00	=	5.91
Shallow Concentrated Flow							
Flow length (ft)	= 765.00	0.00	0.00				
Watercourse slope (%)	= 7.30	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.36	0.00	0.00				
Travel Time (min)	= 2.92	+	0.00	+	0.00	=	2.92
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				8.80 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

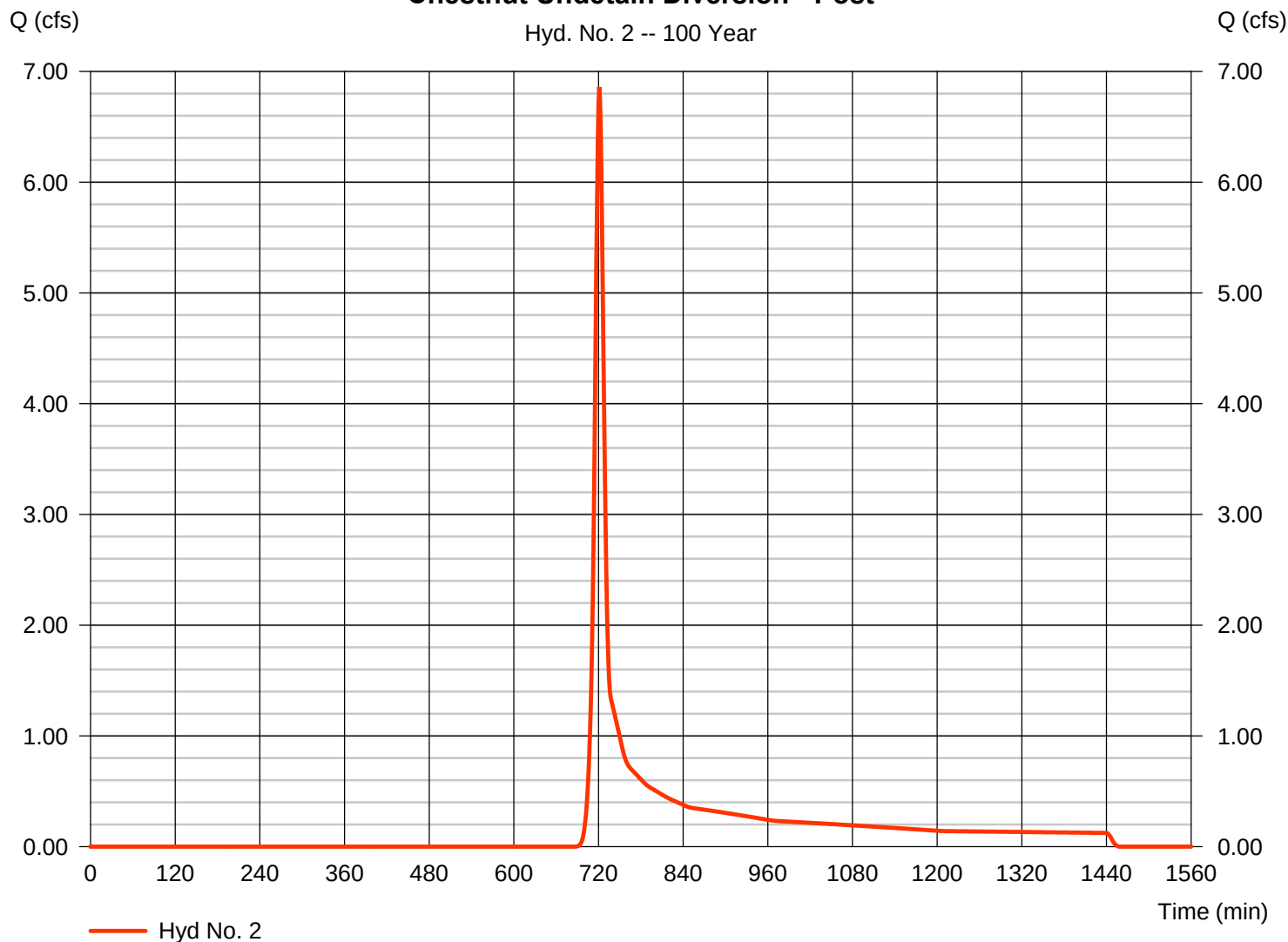
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Chestnut Undetain Diversion - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.859 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	17,741 cuft
Drainage area	=	3.420 ac	Curve number	=	57
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

Chestnut Undetain Diversion - Post



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Chestnut Undetain Diversion - Post

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 12.0	88.0	0.0				
Two-year 24-hr precip. (in)	= 2.57	2.57	0.00				
Land slope (%)	= 16.70	8.00	0.00				
Travel Time (min)	= 0.86	+	5.67	+	0.00	=	6.53
Shallow Concentrated Flow							
Flow length (ft)	= 65.00	690.00	0.00				
Watercourse slope (%)	= 6.00	6.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.95	3.95	0.00				
Travel Time (min)	= 0.27	+	2.91	+	0.00	=	3.18
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 6.30	0.00	0.00				
Manning's n-value	= 0.026	0.015	0.015				
Velocity (ft/s)	=13.01	0.00	0.00				
Flow length (ft)	(0)285.0	0.0	0.0				
Travel Time (min)	= 0.37	+	0.00	+	0.00	=	0.37
Total Travel Time, Tc				10.10 min			

Hydrograph Report

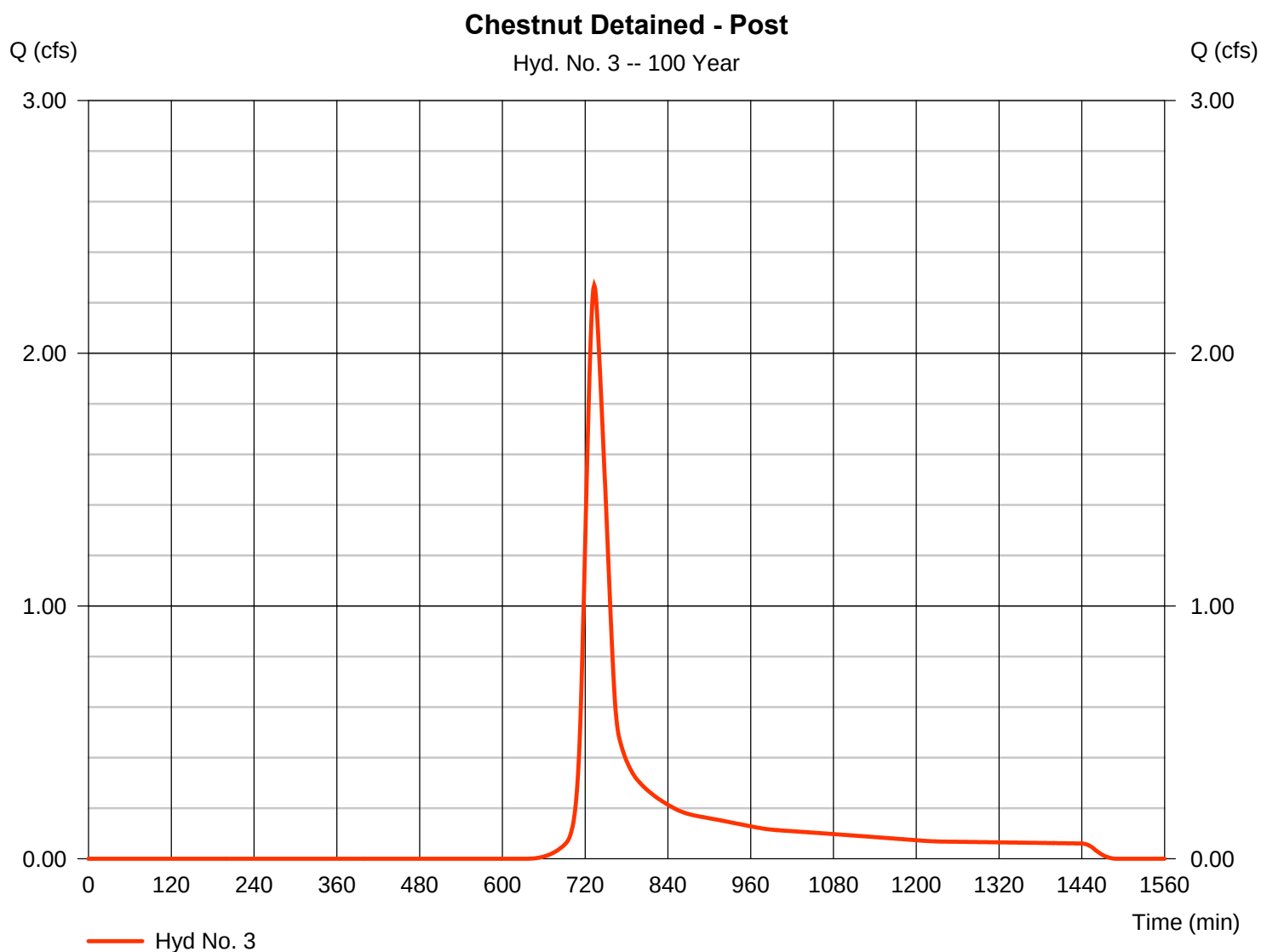
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Chestnut Detained - Post

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.269 cfs
Storm frequency	=	100 yrs	Time to peak	=	733 min
Time interval	=	1 min	Hyd. volume	=	9,931 cuft
Drainage area	=	1.400 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	31.90 min
Total precip.	=	5.54 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

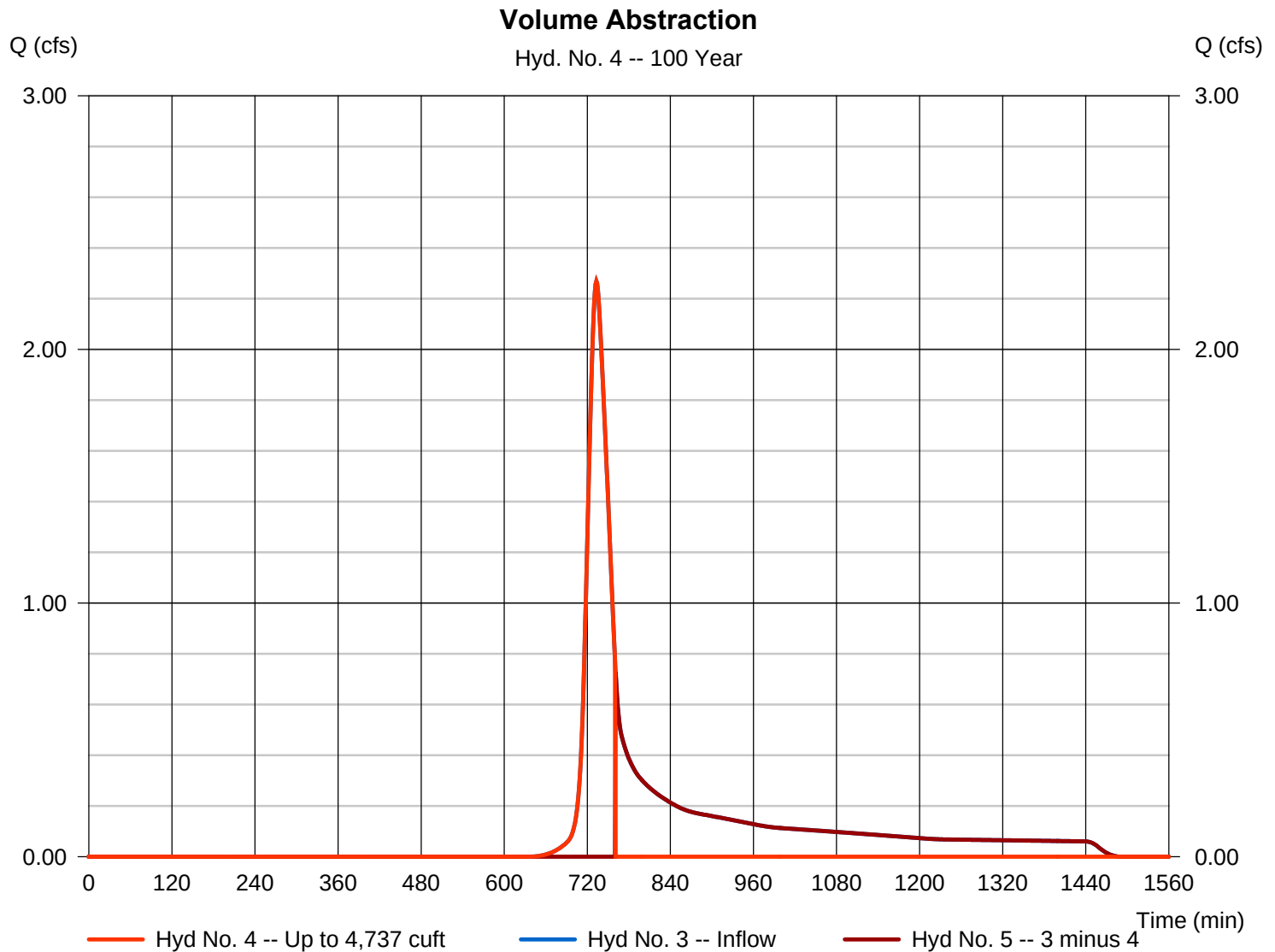
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Volume Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.269 cfs
Storm frequency	= 100 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 4,744 cuft
Inflow hydrograph	= 3 - Chestnut Detained - Post	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 4,737 cuft



Hydrograph Report

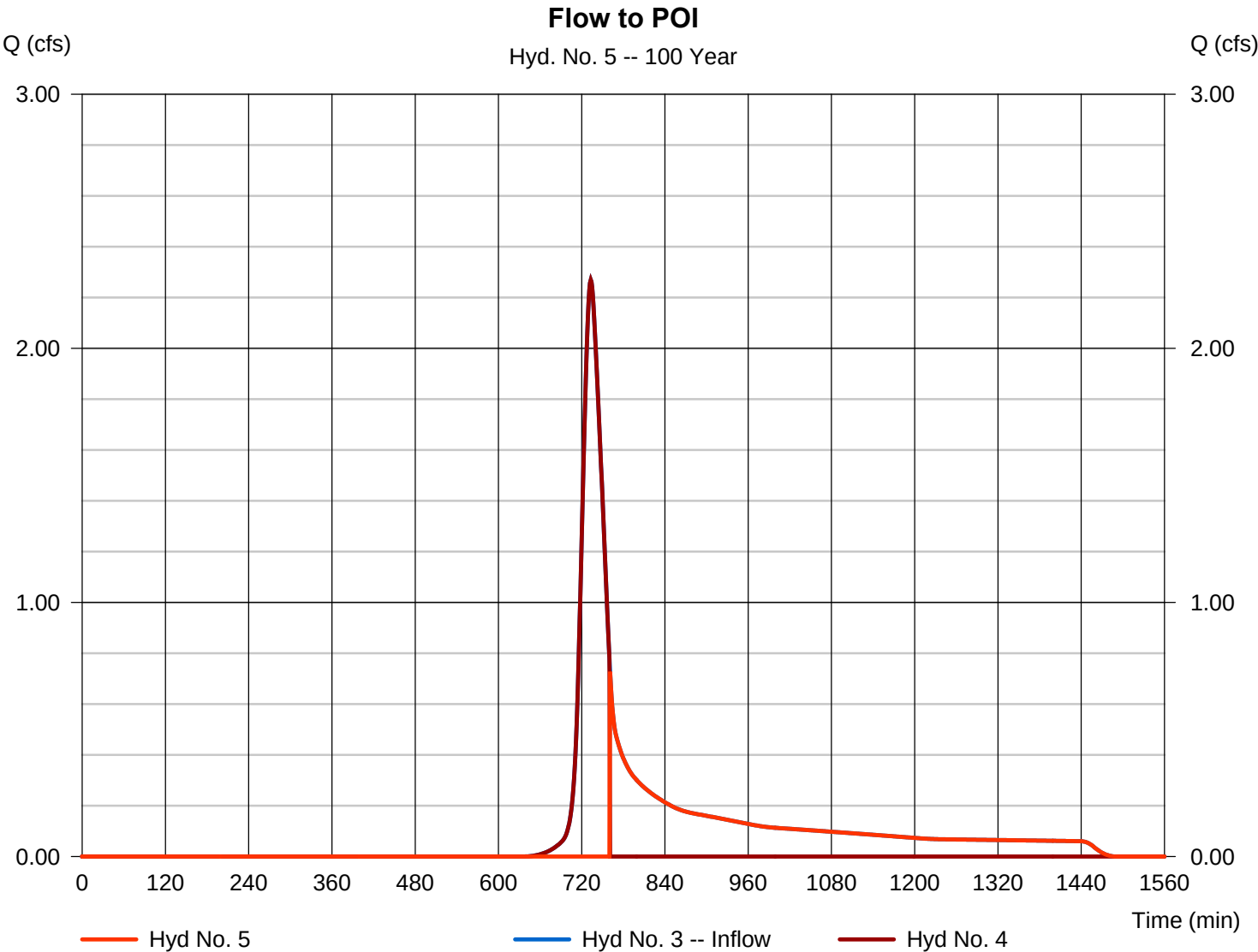
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

Flow to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.727 cfs
Storm frequency	=	100 yrs	Time to peak	=	761 min
Time interval	=	1 min	Hyd. volume	=	5,187 cuft
Inflow hydrograph	=	3 - Chestnut Detained - Post	2nd diverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	4,737 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

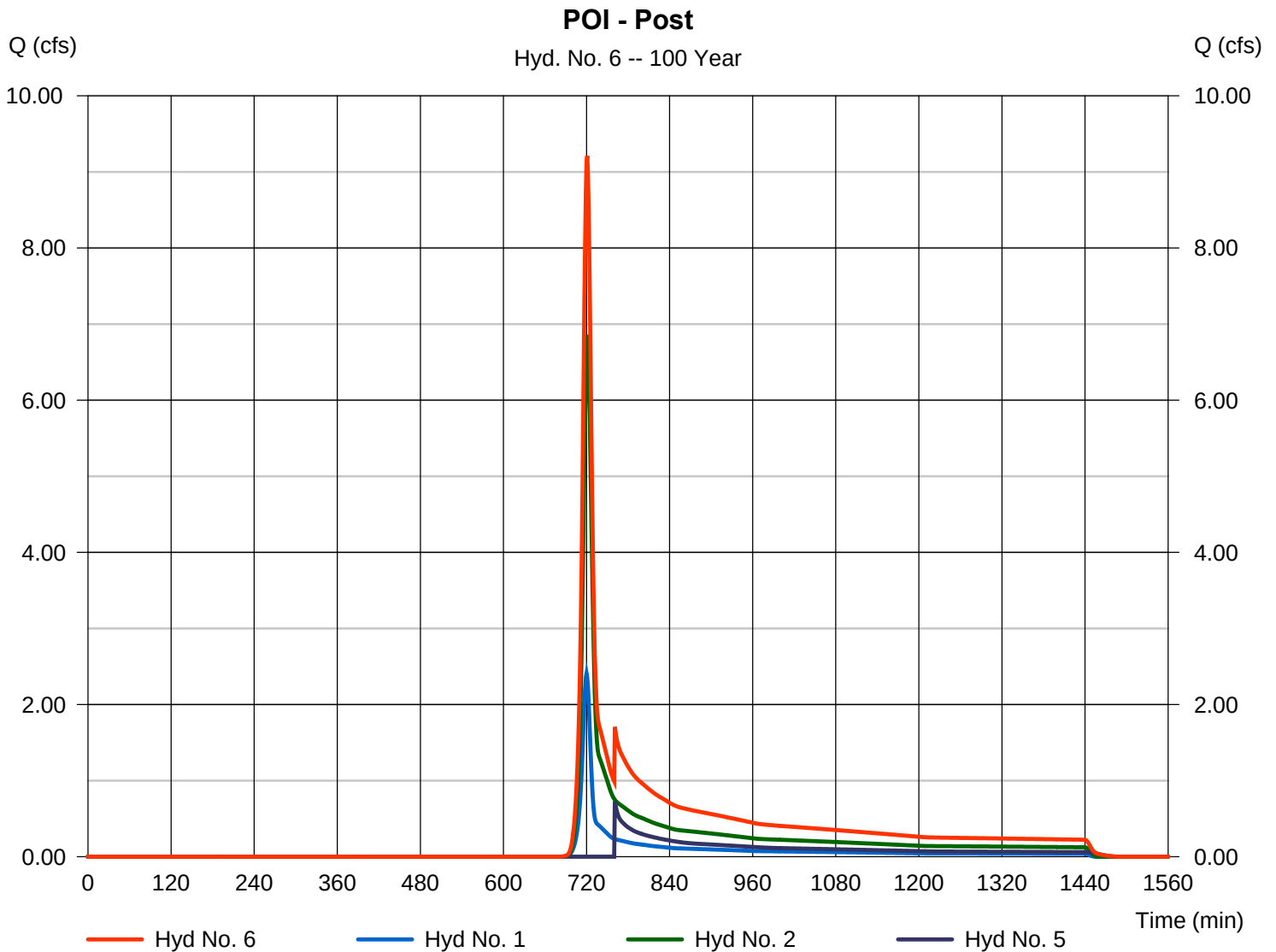
Wednesday, 11 / 9 / 2016

Hyd. No. 6

POI - Post

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 5

Peak discharge = 9.210 cfs
 Time to peak = 721 min
 Hyd. volume = 28,612 cuft
 Contrib. drain. area = 4.480 ac



**ATTACHMENT D
CHESTNUT RIDGE
DIVERSION CHANNEL DESIGN**

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Road Proj. No.: 112IC05958

DIVERSION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1*	7.00

DD-1 is designated as the watershed labeled as "Chestnut Undetained Diversion-Post" from Attachment C. The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	3.23	0.82	0.50	1.32

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes		Channel Lining	Total Depth (ft)
			(_LH:1V)	(_RH:1V)		
DD-1	6.5%	1	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output .
2. The channel section characteristics resulting in the largest total depth were used.

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Chestnut Ridge Road Proj. No.: 112IC05958

LEVEL SPREADER DESIGN

CHANNEL DESIGNATION	ENERGY DISSIPATOR TYPE	LENGTH (ft)	Downslope Protection	Q (cfs)
DD-1	Earthen Level Spreader	107	Grass/Rock	7

$$Q = C_w \times L \times H^{3/2} \text{ (Ref \#5)}$$

Q = Flow (cfs)

L = Length of Level Spreader (ft)

C_w = Weir Coefficient 3.27

H = Driving Head (ft) 0.07 Based on V(allowable) = 1.33

$$V = 1.5 \times C_w \times H^{1/2} \text{ (Ref \#5)}$$

V = Allowable velocity at the Level Spreader (fps)

Grass/Ticket = 1.33

Gravel = 1.5 (Table G.2, Ref #5)

Mulch (trees, Shrubs) = 0.67



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

Project Name: 112IC05958 Sunoco
Project Number: 103213
Channel Name: Chestnut Ridge DD1

Discharge	7
Peak Flow Period	0.3
Channel Slope	0.065
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	7 cfs	5.63 ft/s	0.58 ft	0.033	3 lbs/ft ²	2.34 lbs/ft ²	1.28	STABLE	E
P300 Reinforced Vegetation	Straight	7 cfs	3.23 ft/s	0.82 ft	0.07	8 lbs/ft ²	3.33 lbs/ft ²	2.4	STABLE	E
Underlying Substrate	Straight	7 cfs	3.23 ft/s	0.82 ft	--	2 lbs/ft ²	0.162 lbs/ft ²	12.34	STABLE	--

GRANGE HALL RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 10, 2016

Project Name: Grange Hall Rd

Municipality: East Wheatfield

County: Indiana

Total Area (acres): 0.80

Major River Basin: Ohio

Watershed: Conemaugh River

Sub Basin: Baldwin Creek - Conemaugh River

Nearest Surface Water to Receive Runoff: Tributary 45008 of Findley Run

Ch. 93 - Designated Water Use: HQ-CWF

Impaired according to Chapter 303(d) list?

YES

☐

List Causes of Impairment:

NO

☒

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES

☐

NO

☒

Existing or Planned drinking water supply?

YES

☐

NO

☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES

☐

NO

☒

Existing River Conservation Plan?

YES

☐

NO

☒

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	0.80	0.42
Other:			
TOTAL EXISTING:	Yes	0.80	0.42

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>0.42</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>0.42</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
<u>0.80</u>	-	<u>0.42</u>	=	<u>0.38</u>
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn	<u> </u>	ft ² x	1/4 in x	1/12	=	<u> </u>	ft ³
Meadow	<u> </u>	ft ² x	1/3 in x	1/12	=	<u> </u>	ft ³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy	<u> </u>	ft ² x	1/2 in x	1/12	=	<u> </u>	ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	<u> </u>	ft ² x	1/3 in x	1/12	=	<u> </u>	ft ³

For all other disconnected roof areas

Roof Area	<u> </u>	ft ² x	1/4 in x	1/12	=	<u> </u>	ft ³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas	<u> </u>	ft ² x	1/3 in x	1/12	=	<u> </u>	ft ³

For all other disconnected roof areas

Impervious Areas	<u> </u>	ft ² x	1/4 in x	1/12	=	<u> </u>	ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

 ft³

** For use on Worksheet 5*

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT:	Grange Hall Rd
Drainage Area:	0.80 acres
2-Year Rainfall:	2.59 in
Total Site Area:	0.80 acres
Protected Site Area:	0.42 acres
Managed Site Area:	0.38 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	16553	0.38	78	2.82	0.56	0.85	1,168
TOTAL:		16,553	0.38					1,168

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	9319	0.21	78	2.82	0.56	0.85	658
Gravel - Impervious	C/D	7234	0.17	91	0.99	0.20	1.69	1,020
TOTAL:		16,553	0.38					1,678

2-Year Volume Increase (ft ³):	510

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 $S = (1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI. The use of a weighted CN value for volume calculations is not acceptable.

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Grange Hall Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 510

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 510
(Required Control Volume minus Non-structural Credit)

Proposed BMP	Area (ft ²)	Storage Volume (ft ³)
6.4.1 Porous Pavement		
6.4.2 Infiltration Basin		
6.4.3 Infiltration Bed		
6.4.4 Infiltration Trench		
6.4.5 Rain Garden/Bioretenion		
6.4.6 Dry Well/Seepage Pit		
6.4.7 Constructed Filter		
6.4.8 Vegetated Swale		
6.4.9 Vegetated Filter Strip		
6.4.10 Berm	1,879	1,755
6.5.1 Vegetated Roof		
6.5.2 Capture and Re-Use		
6.6.1 Constructed Wetlands		
6.6.2 Wet Pond/Retention Basin		
6.7.1 Riparian Buffer Restoration		
6.7.2 Landscape Restoration/Reforestation		
6.7.3 Soil Amendment		
6.8.1 Level Spreader		
6.8.2 Special Storage Areas		
Other:		
Total Structural Volume Provided (ft³):		1,755
Structural Volume Requirement (ft³):		510
DIFFERENCE:		-1,245

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenion		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

**PCSM - DESIGN CALCULATIONS
GRANGE HALL RD**

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations Grange Hall Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Grange Hall Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Grange Hall Road Block Valve Site is located in East Wheatfield Township, Indiana County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.59
10-yr	3.72
50-yr	5.11
100-yr	5.81

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.59 in

Total Site Area : 0.80 acres

Protected Site Area: 0.42 acres

Stormwater Management Area 0.38 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.38	78	2.82	0.56	0.85	1,168
Total		0.38					1,168

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.21	78	2.82	0.56	0.85	658
Gravel - Impervious	C/D	0.17	91	0.99	0.20	1.69	1,020
Total		0.38					1,678

2-Year Volume Increase (cf):	510

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

P = 2-Year Rainfall (in)

S = $(1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$

Q = Runoff (in)

Area = Land use area (sq. ft.)

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.17	7234.00
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,447
Design Infiltration Area (sf):		1,879
Design Impervious Ratio:	3.8	:1

OK

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.43	18853.45
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		2,357
Design Infiltration Area (sf):		1,879
Design Total Watershed Ratio:	10.0	:1

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Grange Hall Road Block Valve Site will be located northeast edge of the pad and 100 percent of the disturbed area will be detained by the BMP.

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr)	0.2

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

Infiltration Berm

Storage Volume

	Length (ft)	Cross Section Area	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	53	33.2	1,879	1.20	1760

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.2	1,879	2	63

Volume Abstraction Potential (cf)	1,822.23

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration BMP				
Infiltration Berm	1755	1760	1759.6	1755
Total Structural Credit (cf) (Worksheet 5)				1755

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\6 - Grange Hall\Native\[Grange Hall Rd BMP Design.xlsx]Design Volume

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 0.80 acres. Based upon the soil survey of Indiana County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Atkins-Philo complex (AtA) and Ernest silt loam (ErB) series which are both primarily classified as HSG C/D. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	AtA	Meadow	78	0.23
C/D	ErB	Meadow	78	0.57
			Totals	0.80

CN	78

Post-Development Condition

Undetained Area

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	AtA	Meadow	78	0.07
C/D	ErB	Meadow	78	0.11
			Totals	0.18

CN	78

Infiltration Berm Area (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	AtA	Meadow	78	0.17
C/D	ErB	Meadow	78	0.28
C/D	ErB	Gravel - Impervious	91	0.17
			Totals	0.62

CN	82

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\6 - Grange Hall\Native\[Grange Hall Rd BMP Design.xlsx]Design Volume

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.8	1755	38.1	8.2	46.3
10	1.4	1760	21.0	8.2	29.2
50	2.2	1760	13.3	8.2	21.5
100	2.6	1760	11.2	8.2	19.4

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow } w/o \text{ BMP (cfs)}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,755	1,822	1,755
10	3,192	1,822	1,822
50	5,110	1,822	1,822
100	6,112	1,822	1,822

TETRA TECH, INC.

By: RJM Date: 10/10/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/16 Grange Hall Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\6 - Grange Hall\Native\[Grange Hall Rd BMP Design.xlsx]Peak Discharge

STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

Storm Frequency	Pre-Development	Post-Development			
	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	1.06	1.3	1,191	0.24	-0.82
10-yr	2.11	2.4	3,691	1.14	-0.97
50-yr	3.56	3.9	7,049	2.89	-0.67
100-yr	4.31	4.7	8,917	3.47	-0.84

TETRA TECH, INC.

By: RJM Date: 10/10/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/11/2016 Grange Hall Rd Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Indiana County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4298 N 78.9955 W 1350.73 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: East Wheatfield Twp,
Pennsylvania, USA*
Latitude: 40.4298°, Longitude: -78.9955°
Elevation: 1350.73 ft**

* source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.324 (0.294-0.358)	0.388 (0.352-0.429)	0.468 (0.424-0.518)	0.532 (0.480-0.587)	0.617 (0.554-0.679)	0.683 (0.611-0.752)	0.751 (0.668-0.824)	0.823 (0.728-0.903)	0.923 (0.810-1.01)	1.00 (0.872-1.10)
10-min	0.503 (0.457-0.556)	0.605 (0.549-0.669)	0.728 (0.659-0.805)	0.822 (0.742-0.906)	0.943 (0.847-1.04)	1.04 (0.927-1.14)	1.13 (1.00-1.24)	1.23 (1.09-1.35)	1.36 (1.19-1.49)	1.46 (1.27-1.60)
15-min	0.617 (0.560-0.682)	0.740 (0.672-0.818)	0.893 (0.810-0.988)	1.01 (0.912-1.11)	1.17 (1.05-1.28)	1.28 (1.15-1.41)	1.40 (1.25-1.54)	1.53 (1.35-1.68)	1.69 (1.49-1.86)	1.82 (1.59-2.00)
30-min	0.816 (0.740-0.902)	0.990 (0.899-1.09)	1.22 (1.11-1.35)	1.40 (1.27-1.55)	1.65 (1.48-1.81)	1.83 (1.64-2.02)	2.03 (1.80-2.23)	2.23 (1.97-2.45)	2.51 (2.20-2.75)	2.73 (2.38-2.99)
60-min	0.996 (0.904-1.10)	1.22 (1.10-1.34)	1.53 (1.39-1.70)	1.79 (1.61-1.97)	2.13 (1.92-2.35)	2.42 (2.16-2.66)	2.71 (2.41-2.98)	3.03 (2.67-3.32)	3.47 (3.04-3.80)	3.84 (3.34-4.20)
2-hr	1.17 (1.06-1.29)	1.42 (1.29-1.57)	1.80 (1.63-1.99)	2.10 (1.90-2.32)	2.54 (2.28-2.79)	2.90 (2.60-3.18)	3.29 (2.92-3.61)	3.71 (3.28-4.06)	4.33 (3.79-4.73)	4.85 (4.20-5.30)
3-hr	1.26 (1.14-1.39)	1.53 (1.39-1.69)	1.92 (1.74-2.12)	2.25 (2.03-2.48)	2.72 (2.44-2.99)	3.11 (2.78-3.42)	3.54 (3.14-3.87)	4.00 (3.52-4.38)	4.69 (4.08-5.12)	5.27 (4.54-5.74)
6-hr	1.51 (1.38-1.69)	1.83 (1.66-2.03)	2.28 (2.07-2.54)	2.66 (2.40-2.95)	3.21 (2.88-3.55)	3.68 (3.28-4.05)	4.18 (3.70-4.60)	4.73 (4.16-5.20)	5.54 (4.81-6.08)	6.24 (5.37-6.83)
12-hr	1.84 (1.68-2.05)	2.21 (2.01-2.46)	2.74 (2.49-3.04)	3.19 (2.89-3.53)	3.85 (3.46-4.25)	4.41 (3.94-4.86)	5.03 (4.46-5.53)	5.71 (5.02-6.26)	6.73 (5.83-7.37)	7.61 (6.51-8.31)
24-hr	2.17 (2.00-2.37)	2.59 (2.40-2.83)	3.20 (2.96-3.49)	3.72 (3.42-4.04)	4.47 (4.08-4.85)	5.11 (4.64-5.53)	5.81 (5.23-6.28)	6.58 (5.87-7.11)	7.71 (6.78-8.35)	8.67 (7.53-9.40)
2-day	2.50 (2.32-2.72)	2.99 (2.77-3.25)	3.66 (3.39-3.98)	4.23 (3.90-4.59)	5.04 (4.63-5.46)	5.73 (5.22-6.20)	6.47 (5.85-7.00)	7.27 (6.52-7.88)	8.45 (7.47-9.16)	9.43 (8.23-10.2)
3-day	2.69 (2.50-2.92)	3.20 (2.98-3.47)	3.90 (3.62-4.22)	4.47 (4.14-4.84)	5.30 (4.88-5.73)	5.99 (5.48-6.47)	6.72 (6.10-7.26)	7.50 (6.75-8.11)	8.63 (7.67-9.36)	9.55 (8.40-10.4)
4-day	2.88 (2.68-3.11)	3.42 (3.19-3.69)	4.13 (3.85-4.46)	4.72 (4.38-5.09)	5.56 (5.13-6.00)	6.24 (5.74-6.73)	6.96 (6.36-7.52)	7.72 (6.99-8.35)	8.80 (7.87-9.55)	9.68 (8.57-10.5)
7-day	3.48 (3.27-3.72)	4.12 (3.87-4.41)	4.91 (4.61-5.26)	5.56 (5.21-5.95)	6.45 (6.02-6.90)	7.17 (6.66-7.67)	7.90 (7.30-8.46)	8.65 (7.95-9.28)	9.70 (8.81-10.4)	10.5 (9.47-11.3)
10-day	4.08 (3.85-4.34)	4.81 (4.54-5.11)	5.67 (5.35-6.03)	6.35 (5.98-6.74)	7.28 (6.83-7.72)	8.01 (7.49-8.50)	8.74 (8.14-9.28)	9.48 (8.78-10.1)	10.5 (9.62-11.2)	11.2 (10.3-12.0)
20-day	5.85 (5.57-6.16)	6.86 (6.53-7.23)	7.92 (7.53-8.35)	8.76 (8.32-9.24)	9.87 (9.34-10.4)	10.7 (10.1-11.3)	11.5 (10.9-12.2)	12.4 (11.6-13.1)	13.4 (12.5-14.2)	14.2 (13.2-15.1)
30-day	7.39 (7.07-7.74)	8.63 (8.26-9.06)	9.86 (9.43-10.3)	10.8 (10.4-11.4)	12.1 (11.5-12.7)	13.1 (12.4-13.7)	14.0 (13.3-14.7)	14.9 (14.1-15.7)	16.0 (15.1-16.9)	16.9 (15.8-17.8)
45-day	9.55 (9.15-9.98)	11.1 (10.7-11.7)	12.6 (12.0-13.2)	13.7 (13.1-14.3)	15.1 (14.4-15.8)	16.2 (15.4-16.9)	17.2 (16.3-18.0)	18.1 (17.2-19.0)	19.3 (18.2-20.3)	20.2 (19.0-21.3)
60-day	11.6 (11.1-12.0)	13.4 (12.9-14.0)	15.1 (14.5-15.7)	16.3 (15.7-17.0)	17.9 (17.1-18.6)	19.0 (18.2-19.8)	20.1 (19.2-21.0)	21.1 (20.1-22.0)	22.3 (21.2-23.3)	23.1 (21.9-24.3)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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

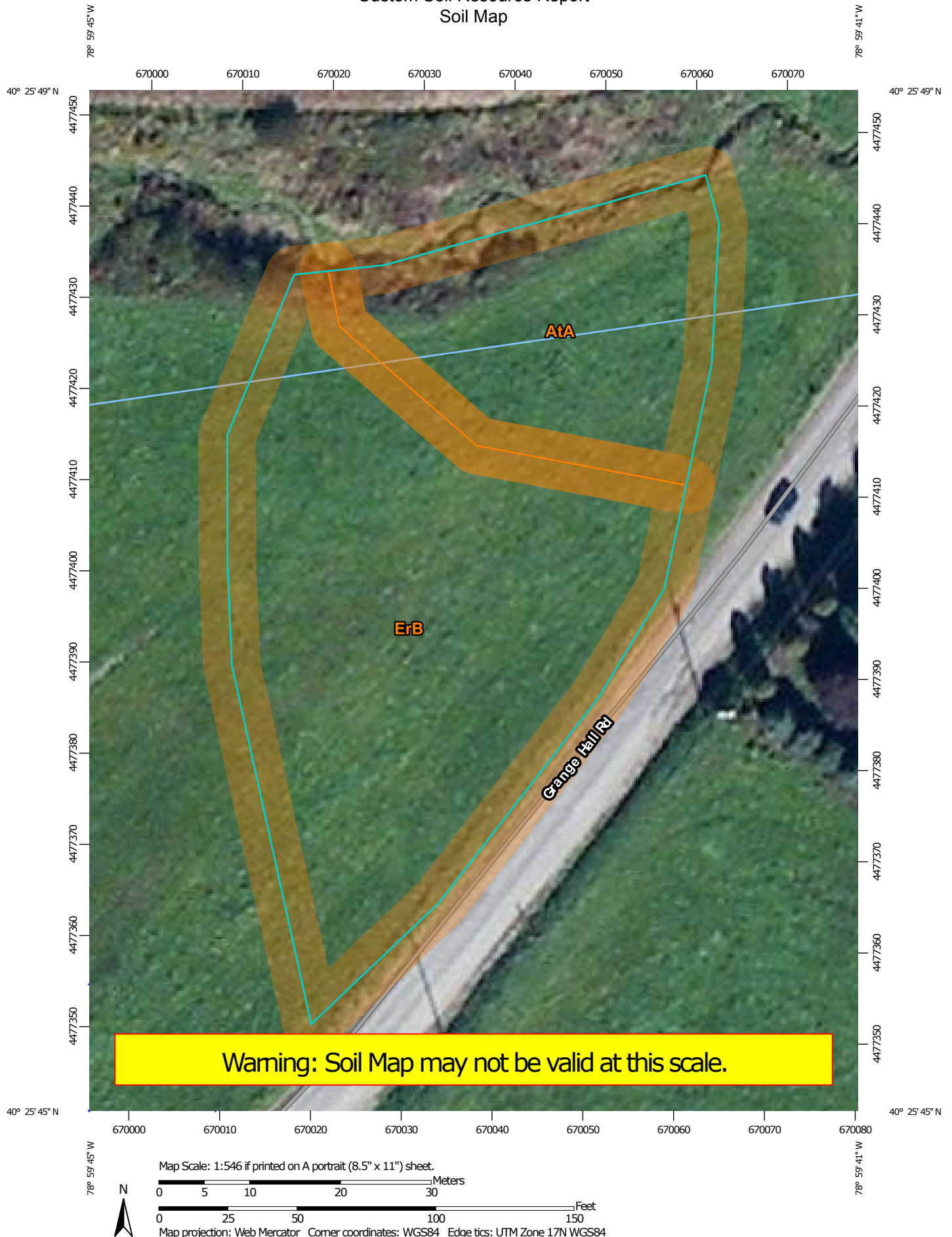
Custom Soil Resource Report for Indiana County, Pennsylvania



October 11, 2016

1005 of 1484

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: <http://websoilsurvey.nrcs.usda.gov>
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: Indiana County, Pennsylvania
Survey Area Data: Version 11, Nov 16, 2015

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

Date(s) aerial images were photographed: Oct 6, 2011—Oct 17, 2011

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

Indiana County, Pennsylvania (PA063)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AtA	Atkins-Philo complex, 0 to 3 percent slopes, frequently flooded	0.2	29.4%
ErB	Ernest silt loam, 3 to 8 percent slopes	0.6	70.6%
Totals for Area of Interest		0.8	100.0%

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

Indiana County, Pennsylvania

AtA—Atkins-Philo complex, 0 to 3 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2vxh1

Elevation: 1,000 to 1,880 feet

Mean annual precipitation: 38 to 50 inches

Mean annual air temperature: 45 to 49 degrees F

Frost-free period: 126 to 165 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Philo and similar soils: 40 percent

Atkins and similar soils: 40 percent

Minor components: 20 percent

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

Description of Philo

Setting

Landform: Flood plains

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Coarse-loamy alluvium derived from sandstone and shale

Typical profile

Oi - 0 to 0 inches: slightly decomposed plant material

Oe - 0 to 2 inches: moderately decomposed plant material

A - 2 to 4 inches: silt loam

BA - 4 to 13 inches: loam

Bw1 - 13 to 18 inches: loam

Bw2 - 18 to 25 inches: loam

C1 - 25 to 37 inches: sandy loam

2C2 - 37 to 80 inches: stratified gravelly sand

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Moderately well drained

Runoff class: Negligible

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high
(0.06 to 2.00 in/hr)

Depth to water table: About 14 to 31 inches

Frequency of flooding: Occasional

Frequency of ponding: None

Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: B/D

Hydric soil rating: No

Description of Atkins

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Acid fine-loamy alluvium derived from sandstone and shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 8 inches: silt loam
Bg - 8 to 26 inches: loam
BCg - 26 to 38 inches: silt loam
Cg - 38 to 80 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high
(0.06 to 1.98 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Frequent
Frequency of ponding: Occasional
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Brinkerton, wooded

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

Portville

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Pope

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

ErB—Ernest silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1vrq0
Elevation: 900 to 1,800 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Ernest and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ernest

Setting

Landform: Hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Acid fine-loamy colluvium derived from shale and siltstone

Typical profile

Ap - 0 to 8 inches: silt loam
Bt - 8 to 24 inches: silty clay loam
Btx - 24 to 50 inches: channery silt loam
C - 50 to 74 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 36 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.33 in/hr)
Depth to water table: About 17 to 22 inches
Frequency of flooding: None

Custom Soil Resource Report

Frequency of ponding: None

Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2e

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Brinkerton

Percent of map unit: 5 percent

Landform: Draws, hills

Landform position (two-dimensional): Toeslope, footslope

Landform position (three-dimensional): Head slope, base slope

Down-slope shape: Linear, concave

Across-slope shape: Linear, concave

Hydric soil rating: Yes

Lobdell

Percent of map unit: 5 percent

Landform: Flood plains

Landform position (three-dimensional): Talf

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Gilpin

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Summit, shoulder

Landform position (three-dimensional): Interfluve

Down-slope shape: Convex

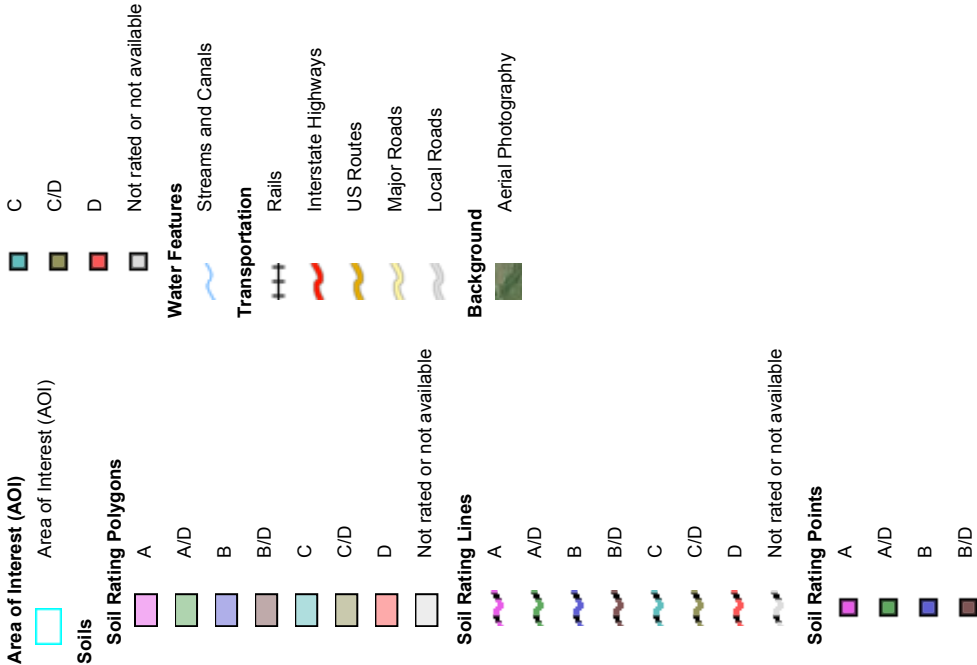
Across-slope shape: Convex, linear

Hydric soil rating: No

Custom Soil Resource Report
Map—Hydrologic Soil Group



MAP LEGEND



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: <http://websoilsurvey.nrcs.usda.gov>
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: Indiana County, Pennsylvania
Survey Area Data: Version 11, Nov 16, 2015

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

Date(s) aerial images were photographed: Oct 6, 2011—Oct 17, 2011

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

Hydrologic Soil Group— Summary by Map Unit — Indiana County, Pennsylvania (PA063)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AtA	Atkins-Philo complex, 0 to 3 percent slopes, frequently flooded	C/D	0.2	29.4%
ErB	Ernest silt loam, 3 to 8 percent slopes	C/D	0.6	70.6%
Totals for Area of Interest			0.8	100.0%

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

**ATTACHMENT C
GRANGE HALL RD
HYDRAFLOW RESULTS**

**ATTACHMENT C-1
GRANGE HALL RD
2 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Grange Hall - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.063	-----	-----	2.113	-----	3.557	4.311	Grange Hall - Pre
Proj. file: Grange Hall - PRE.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.063	2	720	2,459	-----	-----	-----	Grange Hall - Pre
Grange Hall - PRE.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

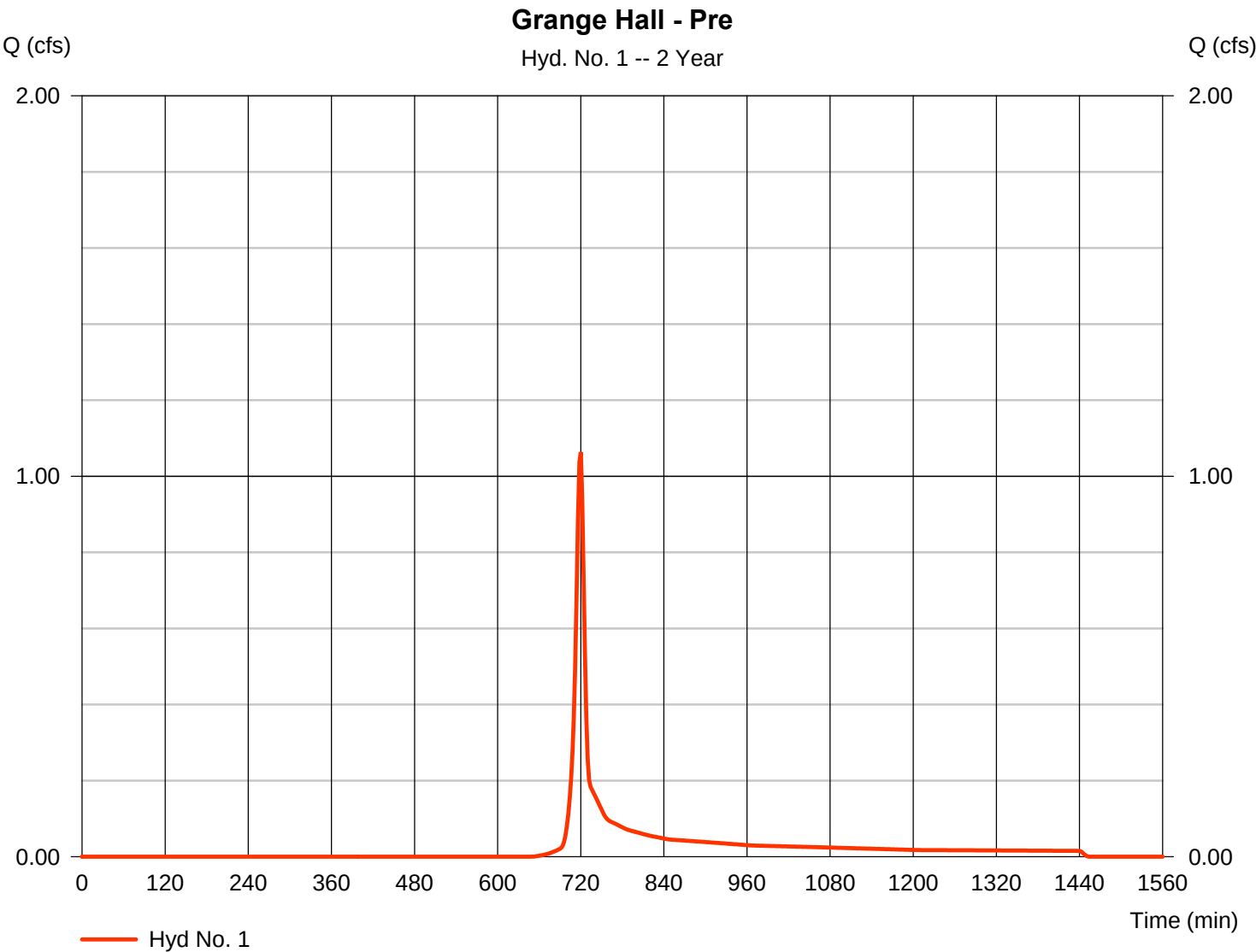
Friday, 11 / 4 / 2016

Hyd. No. 1

Grange Hall - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.063 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	2,459 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.10 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.230 x 78) + (0.570 x 78)] / 0.800



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

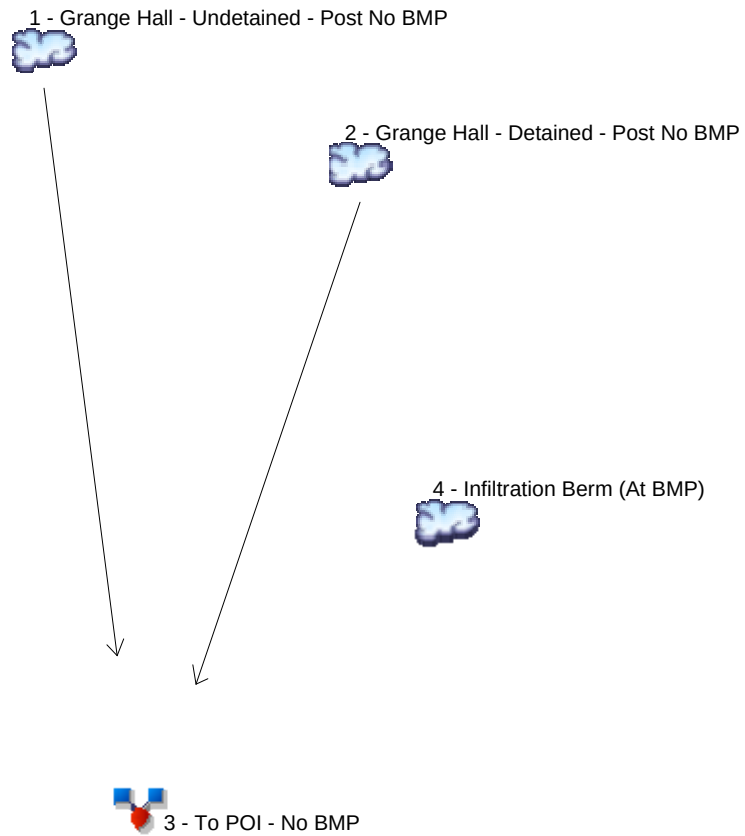
Hyd. No. 1

Grange Hall - Pre

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 267.00	0.00	0.00				
Watercourse slope (%)	= 7.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.27	0.00	0.00				
Travel Time (min)	= 1.04	+	0.00	+	0.00	=	1.04
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				8.10 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.239	-----	-----	0.476	-----	0.800	0.970	Grange Hall - Undetained - Post No B
2	SCS Runoff	-----	-----	1.047	-----	-----	1.933	-----	3.097	3.693	Grange Hall - Detained - Post No BM
3	Combine	1, 2	-----	1.286	-----	-----	2.408	-----	3.897	4.663	To POI - No BMP
4	SCS Runoff	-----	-----	0.767	-----	-----	1.394	-----	2.206	2.620	Infiltration Berm (At BMP)
Proj. file: Grange Hall - Post no BMPs.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.239	2	720	553	-----	-----	-----	Grange Hall - Undetained - Post No B
2	SCS Runoff	1.047	2	720	2,396	-----	-----	-----	Grange Hall - Detained - Post No BM
3	Combine	1.286	2	720	2,949	1, 2	-----	-----	To POI - No BMP
4	SCS Runoff	0.767	2	720	1,755	-----	-----	-----	Infiltration Berm (At BMP)
Grange Hall - Post no BMPs.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

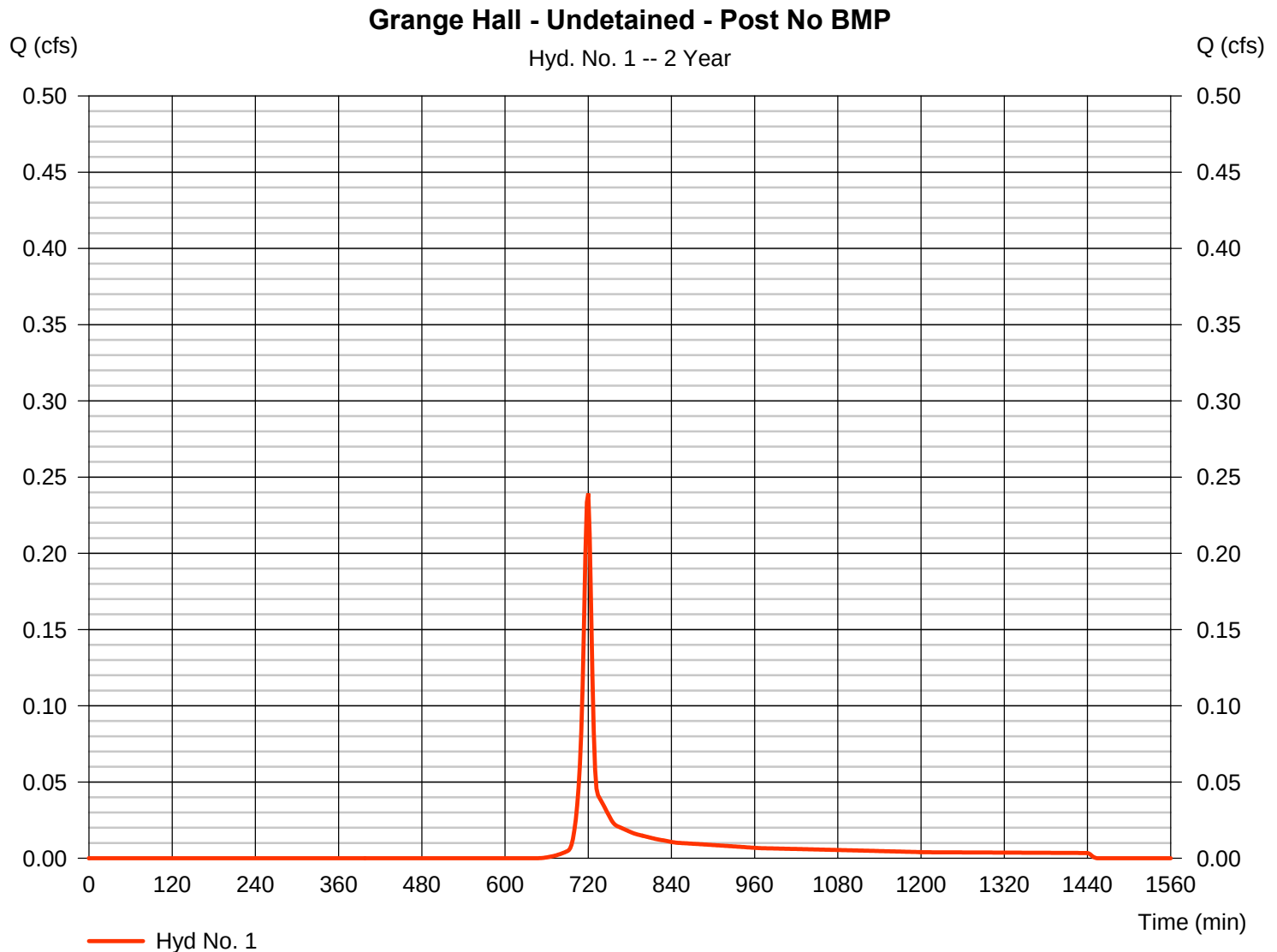
Friday, 11 / 4 / 2016

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.239 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	553 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.070 \times 78) + (0.110 \times 78)] / 0.180$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

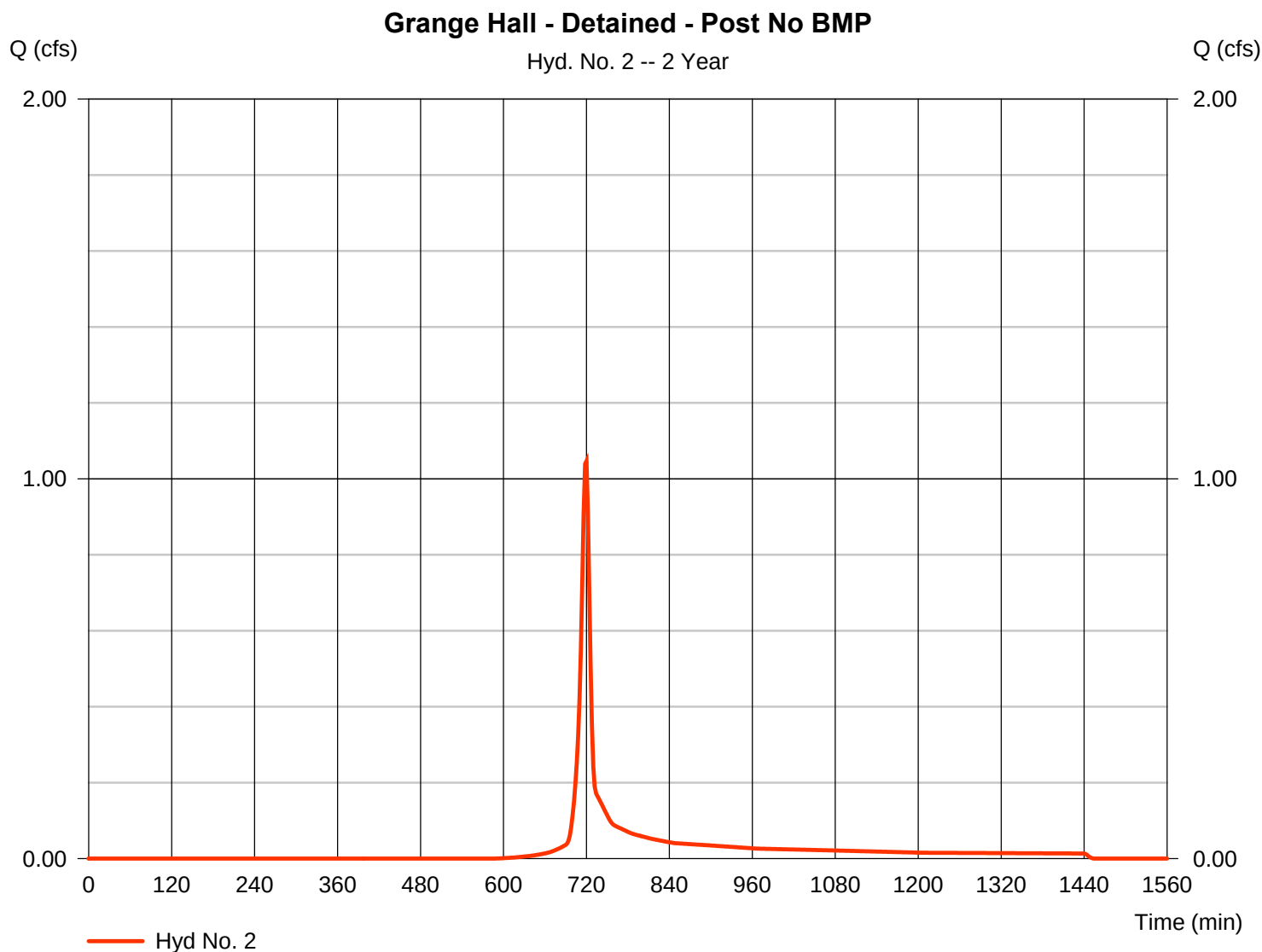
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.047 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	2,396 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Grange Hall - Detained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	236.00				
Watercourse slope (%)	= 5.00	6.00	10.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	5.10				
Travel Time (min)	= 0.20	+	0.22	+	0.77	=	1.19
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

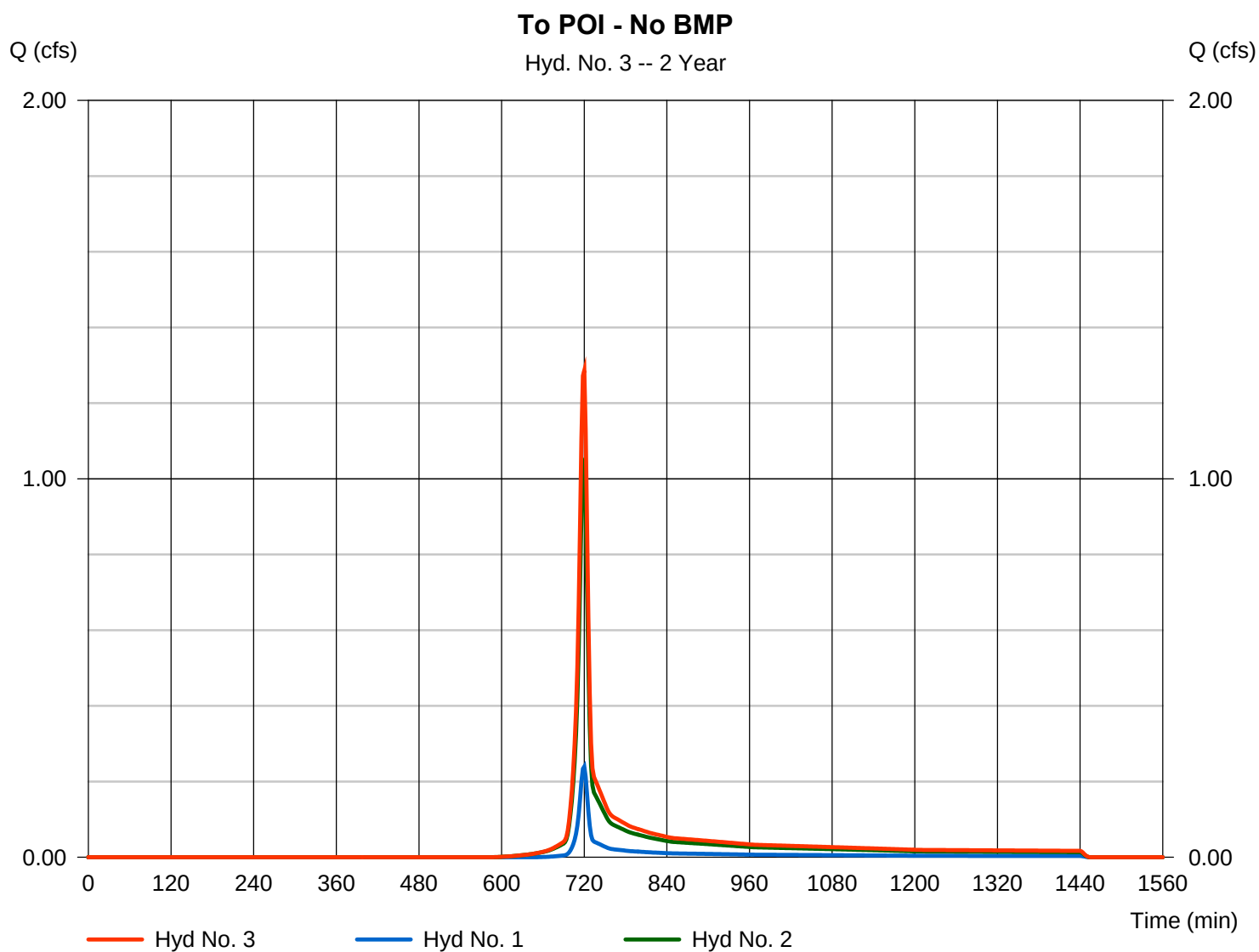
Friday, 11 / 4 / 2016

Hyd. No. 3

To POI - No BMP

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 1.286 cfs
 Time to peak = 720 min
 Hyd. volume = 2,949 cuft
 Contrib. drain. area = 0.800 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

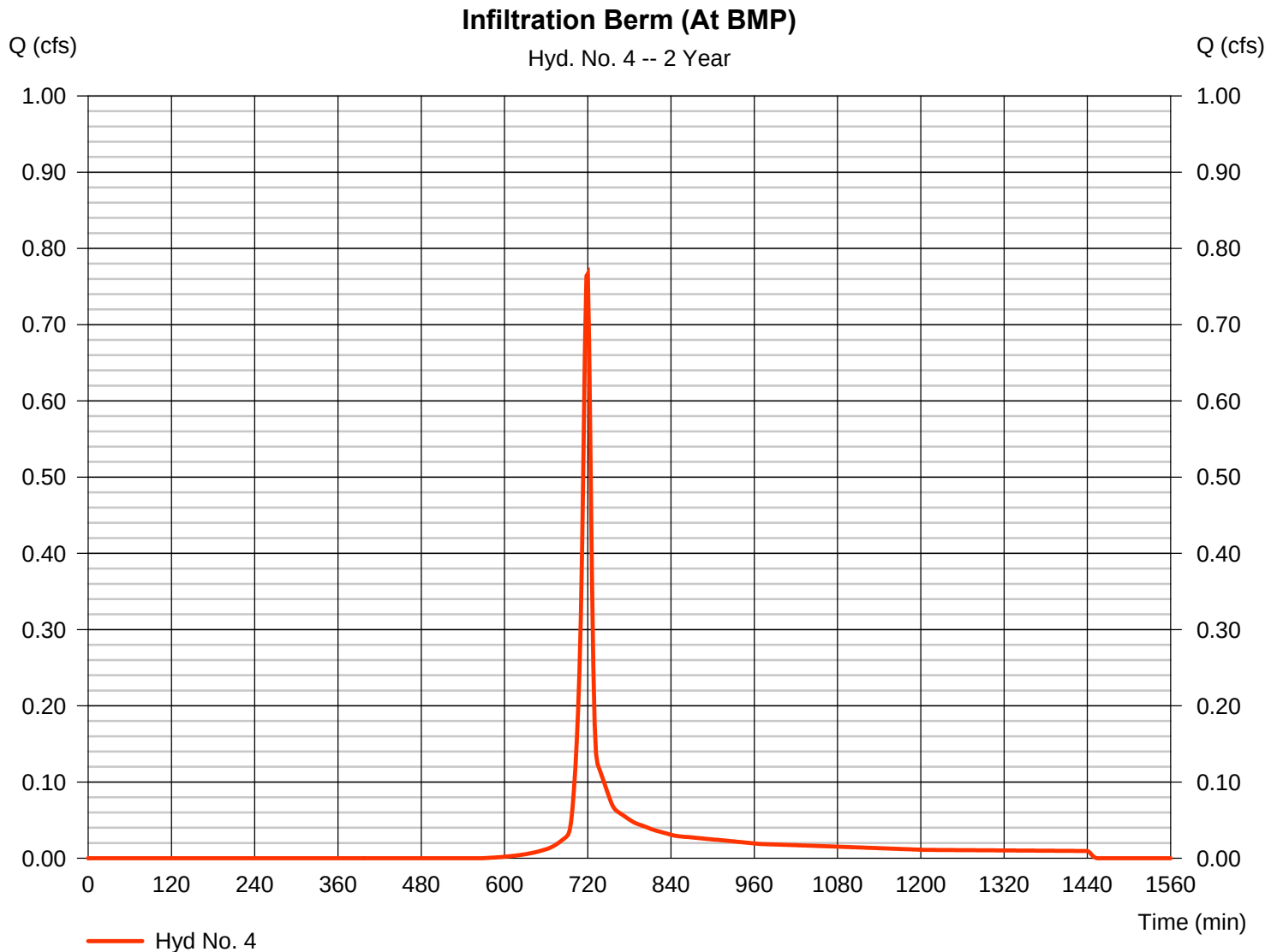
Friday, 11 / 4 / 2016

Hyd. No. 4

Infiltration Berm (At BMP)

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.767 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,755 cuft
Drainage area	=	0.430 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.90 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.260 \times 78) + (0.170 \times 91)] / 0.430$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

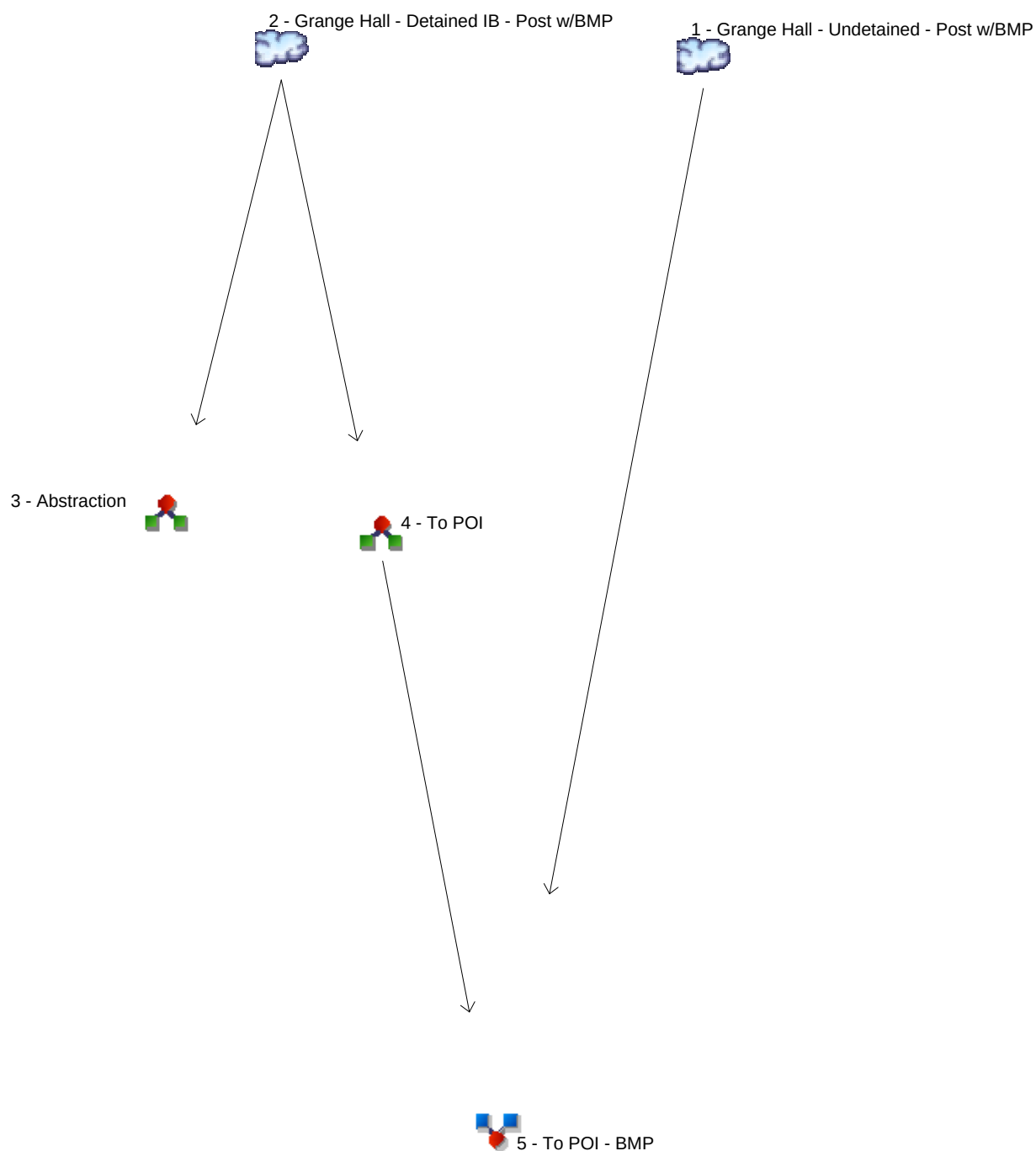
Hyd. No. 4

Infiltration Berm (At BMP)

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	88.00				
Watercourse slope (%)	= 5.00	6.00	4.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	3.23				
Travel Time (min)	= 0.20	+	0.22	+	0.45	=	0.87
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				7.90 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.239	-----	-----	-----	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	-----	-----	0.751	-----	-----	-----	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	2	-----	0.751	-----	-----	-----	-----	-----	-----	Abstraction
4	Diversion2	2	-----	0.035	-----	-----	-----	-----	-----	-----	To POI
5	Combine	1, 4	-----	0.239	-----	-----	-----	-----	-----	-----	To POI - BMP
Proj. file: Grange Hall - Post wBMP - 2yr.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.239	2	720	553	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	0.751	2	724	2,396	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	0.751	2	724	1,759	2	-----	-----	Abstraction
4	Diversion2	0.035	2	904	637	2	-----	-----	To POI
5	Combine	0.239	2	720	1,191	1, 4	-----	-----	To POI - BMP
Grange Hall - Post wBMP - 2yr.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

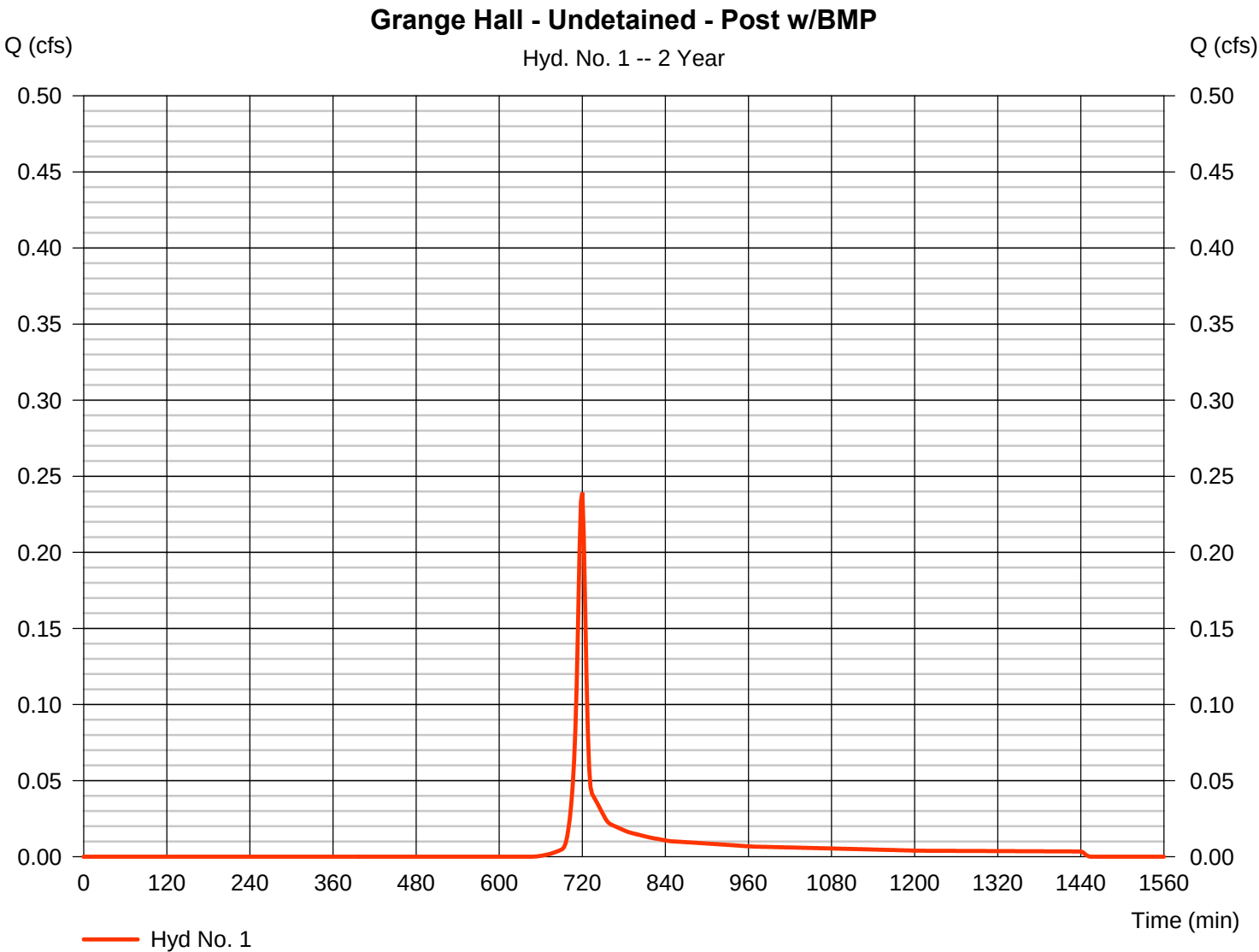
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.239 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	553 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

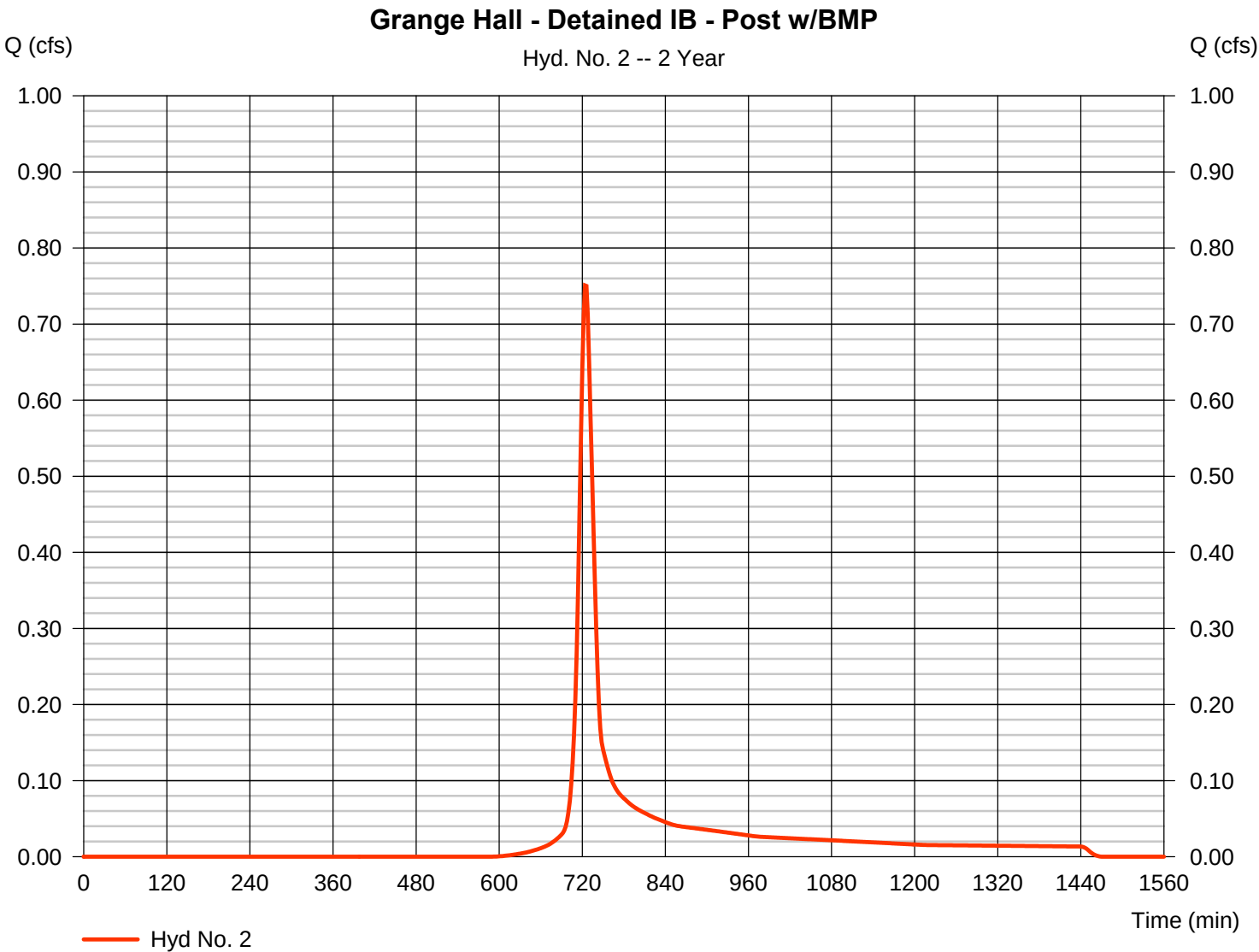
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained IB - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.751 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	2,396 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	19.40 min
Total precip.	=	2.59 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.170 x 78) + (0.280 x 78) + (0.170 x 91)] / 0.620



Hydrograph Report

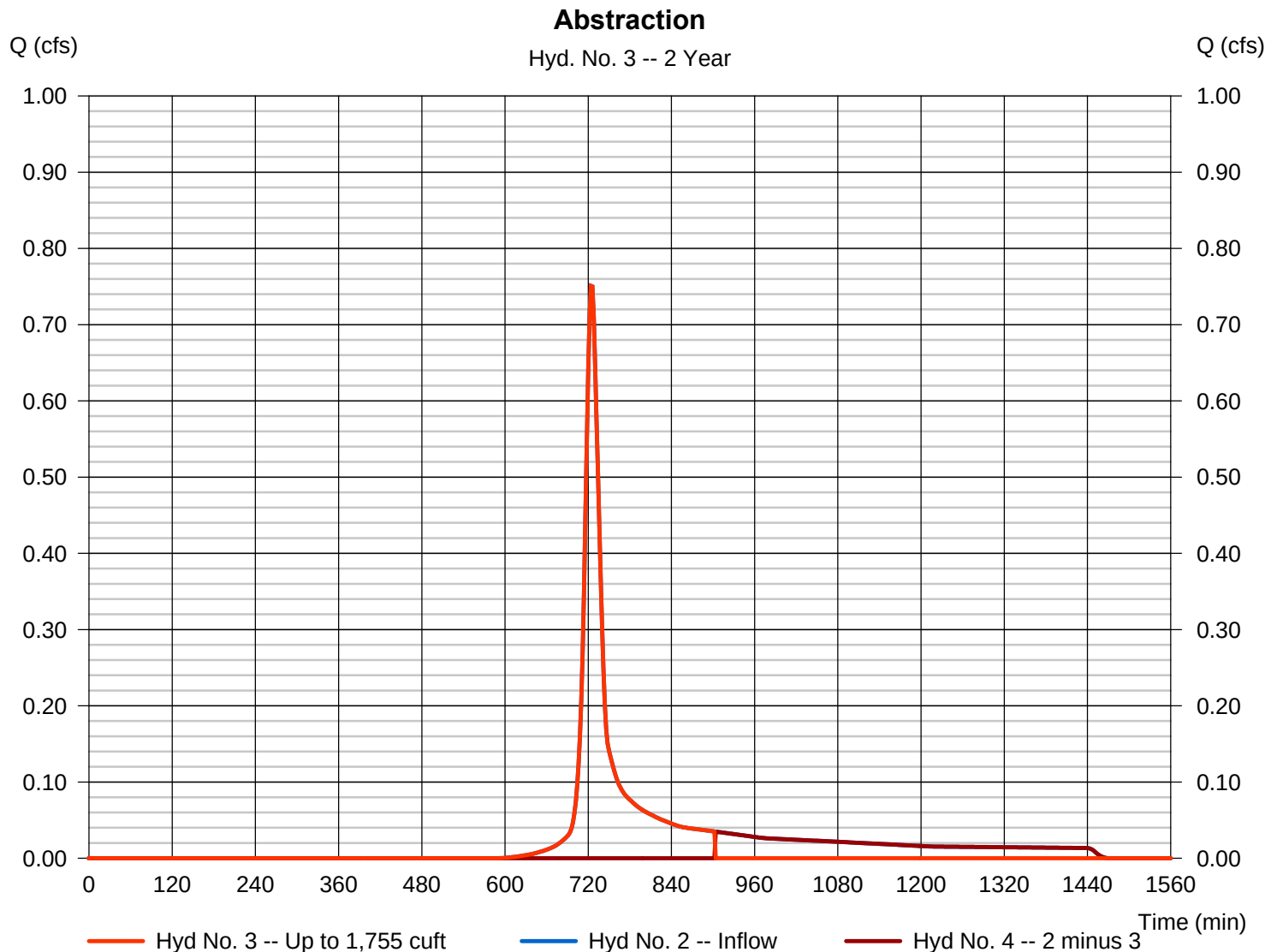
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.751 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 1,759 cuft
Inflow hydrograph	= 2 - Grange Hall - Detained IB - Positive BIP hyd.	Volume Up To	= 4
Diversion method	= First Flush Volume		= 1,755 cuft



Hydrograph Report

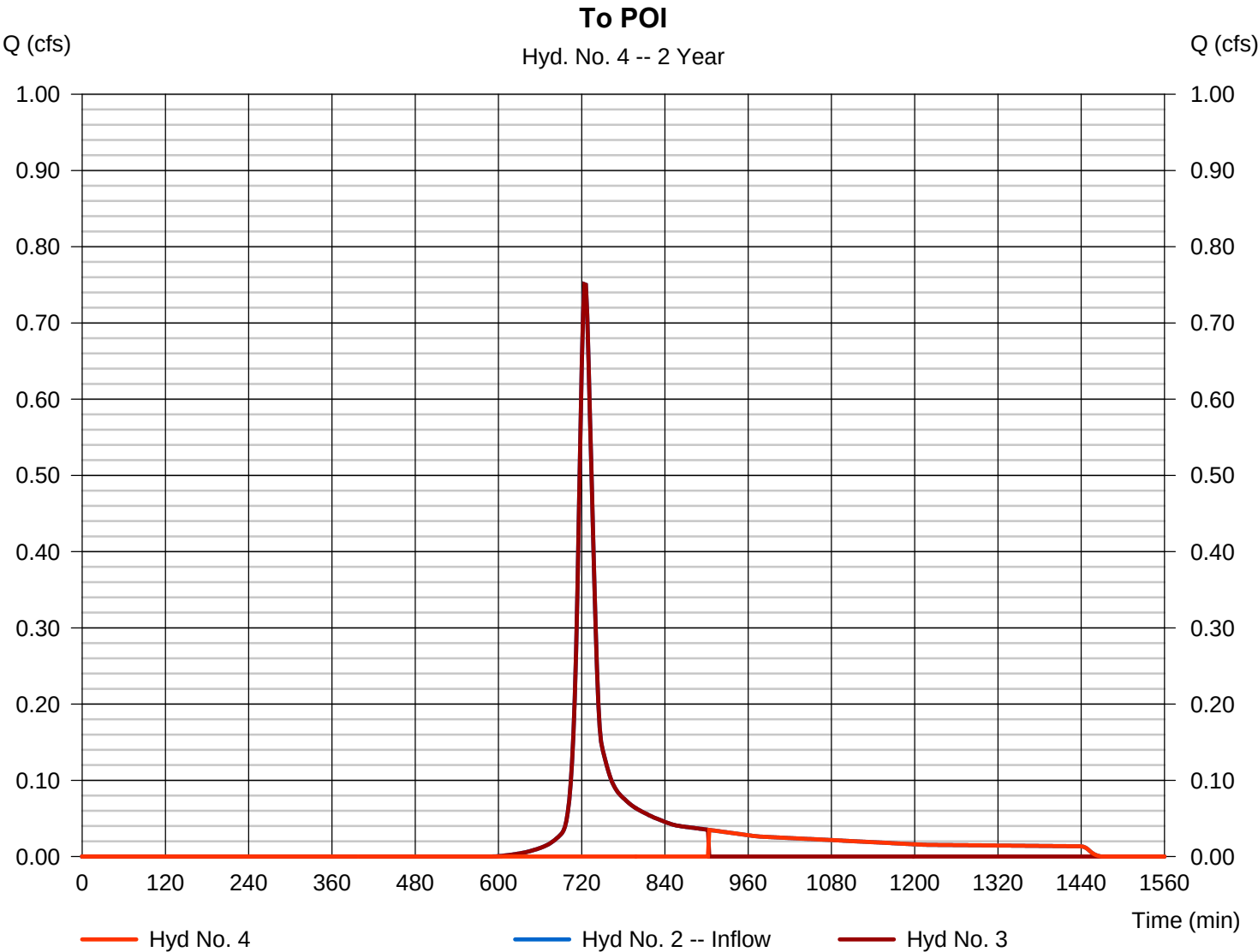
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.035 cfs
Storm frequency	=	2 yrs	Time to peak	=	904 min
Time interval	=	2 min	Hyd. volume	=	637 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BP hyd.	Positive BP hyd.	=	3
Diversion method	=	First Flush Volume	Volume Up To	=	1,755 cuft



Hydrograph Report

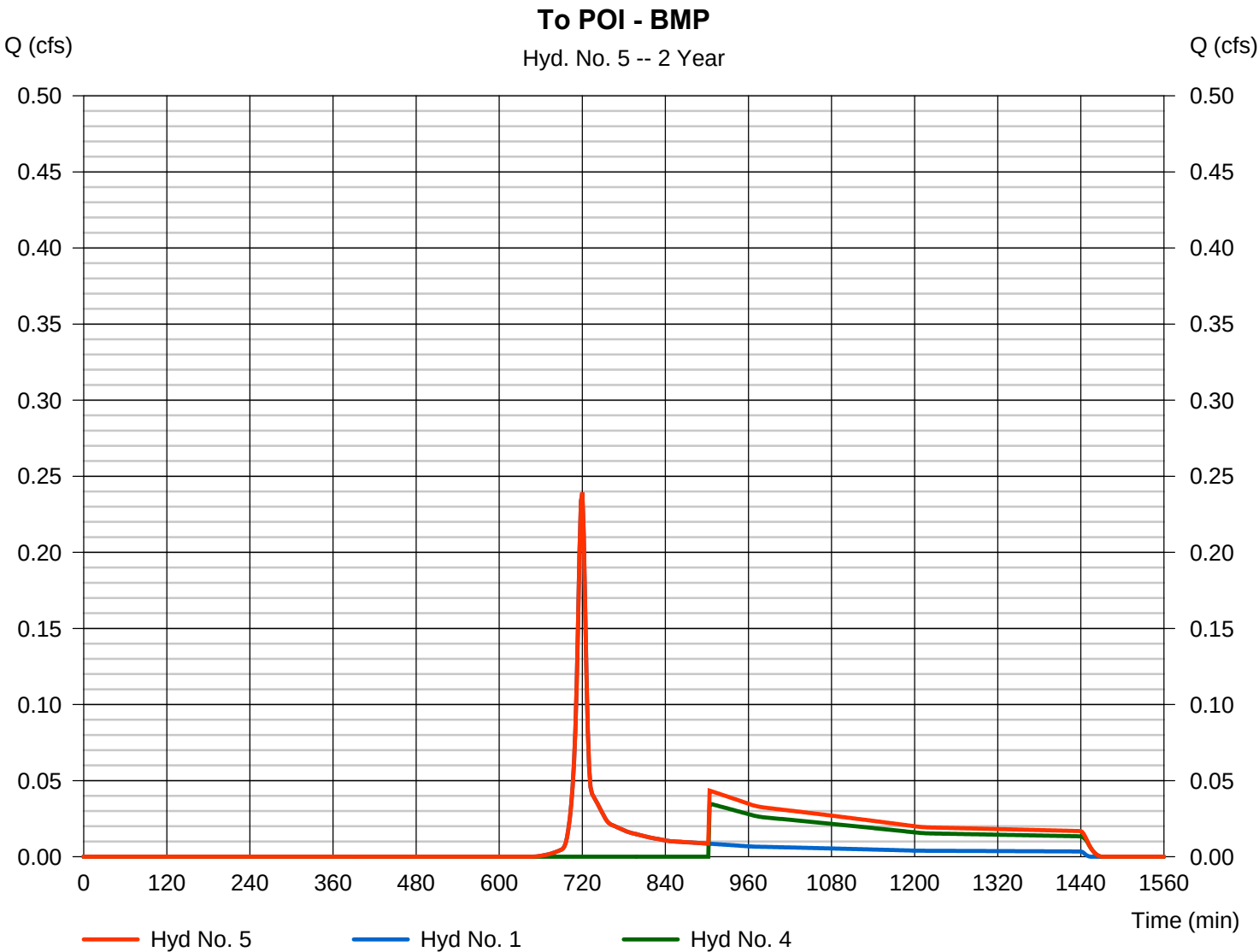
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

To POI - BMP

Hydrograph type	= Combine	Peak discharge	= 0.239 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 1,191 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 0.180 ac



**ATTACHMENT C-2
GRANGE HALL RD
10 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Grange Hall - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.063	-----	-----	2.113	-----	3.557	4.311	Grange Hall - Pre
Proj. file: Grange Hall - PRE.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.113	2	720	4,840	-----	-----	-----	Grange Hall - Pre
Grange Hall - PRE.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

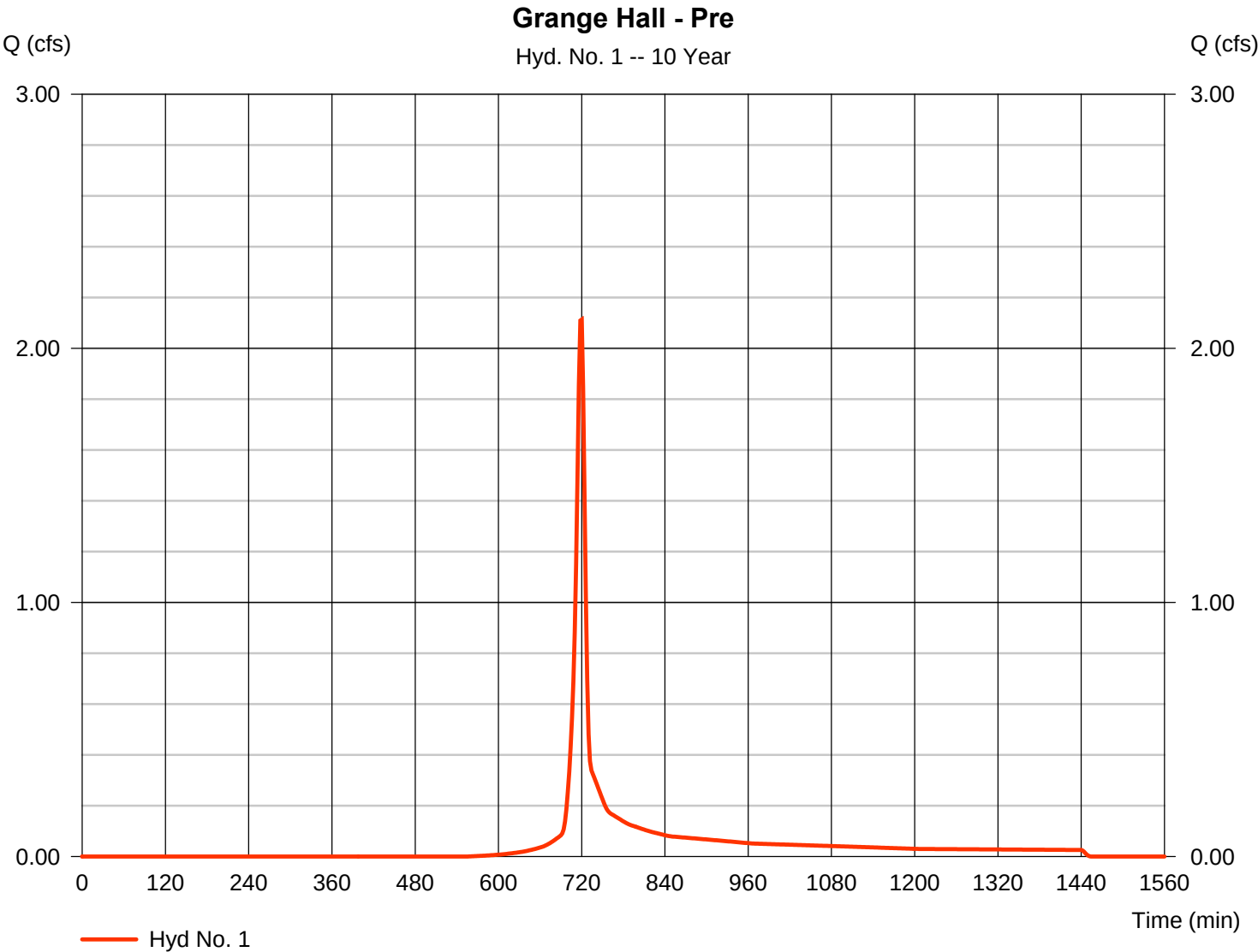
Friday, 11 / 4 / 2016

Hyd. No. 1

Grange Hall - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.113 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	4,840 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.10 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.230 x 78) + (0.570 x 78)] / 0.800



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

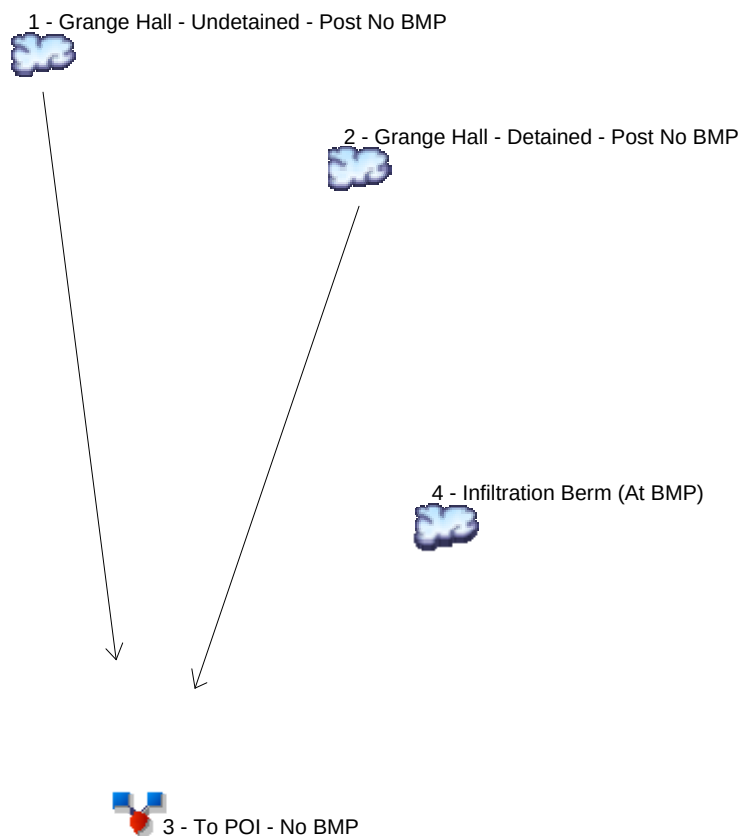
Hyd. No. 1

Grange Hall - Pre

<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)	= 2.59	0.00	0.00	
Land slope (%)	= 6.00	0.00	0.00	
Travel Time (min)	= 7.02	+	0.00	+
			0.00	= 7.02
Shallow Concentrated Flow				
Flow length (ft)	= 267.00	0.00	0.00	
Watercourse slope (%)	= 7.00	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.27	0.00	0.00	
Travel Time (min)	= 1.04	+	0.00	+
			0.00	= 1.04
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				8.10 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.239	-----	-----	0.476	-----	0.800	0.970	Grange Hall - Undetained - Post No B
2	SCS Runoff	-----	-----	1.047	-----	-----	1.933	-----	3.097	3.693	Grange Hall - Detained - Post No BM
3	Combine	1, 2	-----	1.286	-----	-----	2.408	-----	3.897	4.663	To POI - No BMP
4	SCS Runoff	-----	-----	0.767	-----	-----	1.394	-----	2.206	2.620	Infiltration Berm (At BMP)
Proj. file: Grange Hall - Post no BMPs.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.476	2	720	1,089	-----	-----	-----	Grange Hall - Undetained - Post No B
2	SCS Runoff	1.933	2	718	4,424	-----	-----	-----	Grange Hall - Detained - Post No BM
3	Combine	2.408	2	718	5,513	1, 2	-----	-----	To POI - No BMP
4	SCS Runoff	1.394	2	718	3,192	-----	-----	-----	Infiltration Berm (At BMP)
Grange Hall - Post no BMPs.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

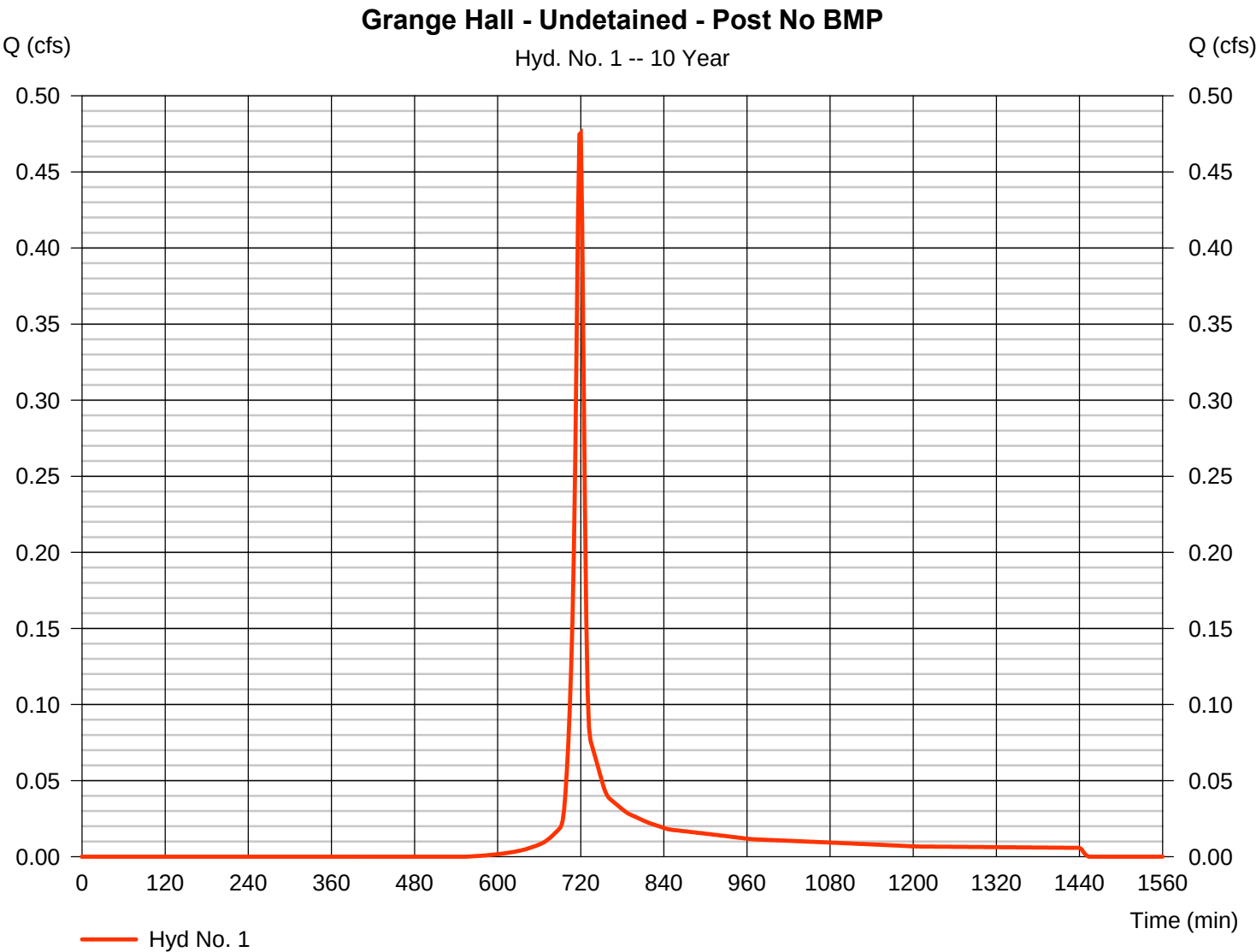
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.476 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,089 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

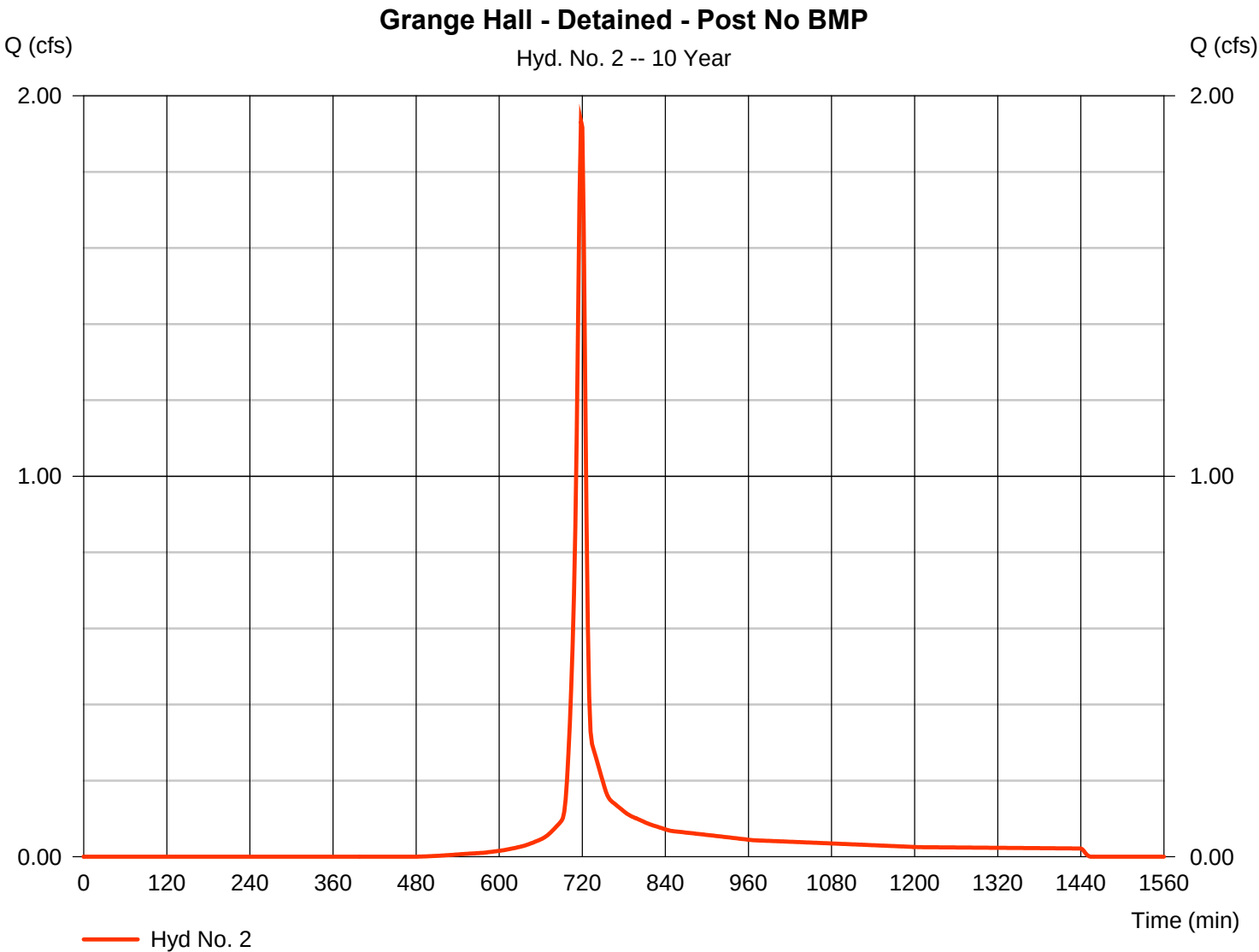
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.933 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	4,424 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.170 x 78) + (0.280 x 78) + (0.170 x 91)] / 0.620



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Grange Hall - Detained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	236.00				
Watercourse slope (%)	= 5.00	6.00	10.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	5.10				
Travel Time (min)	= 0.20	+	0.22	+	0.77	=	1.19
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				8.20 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

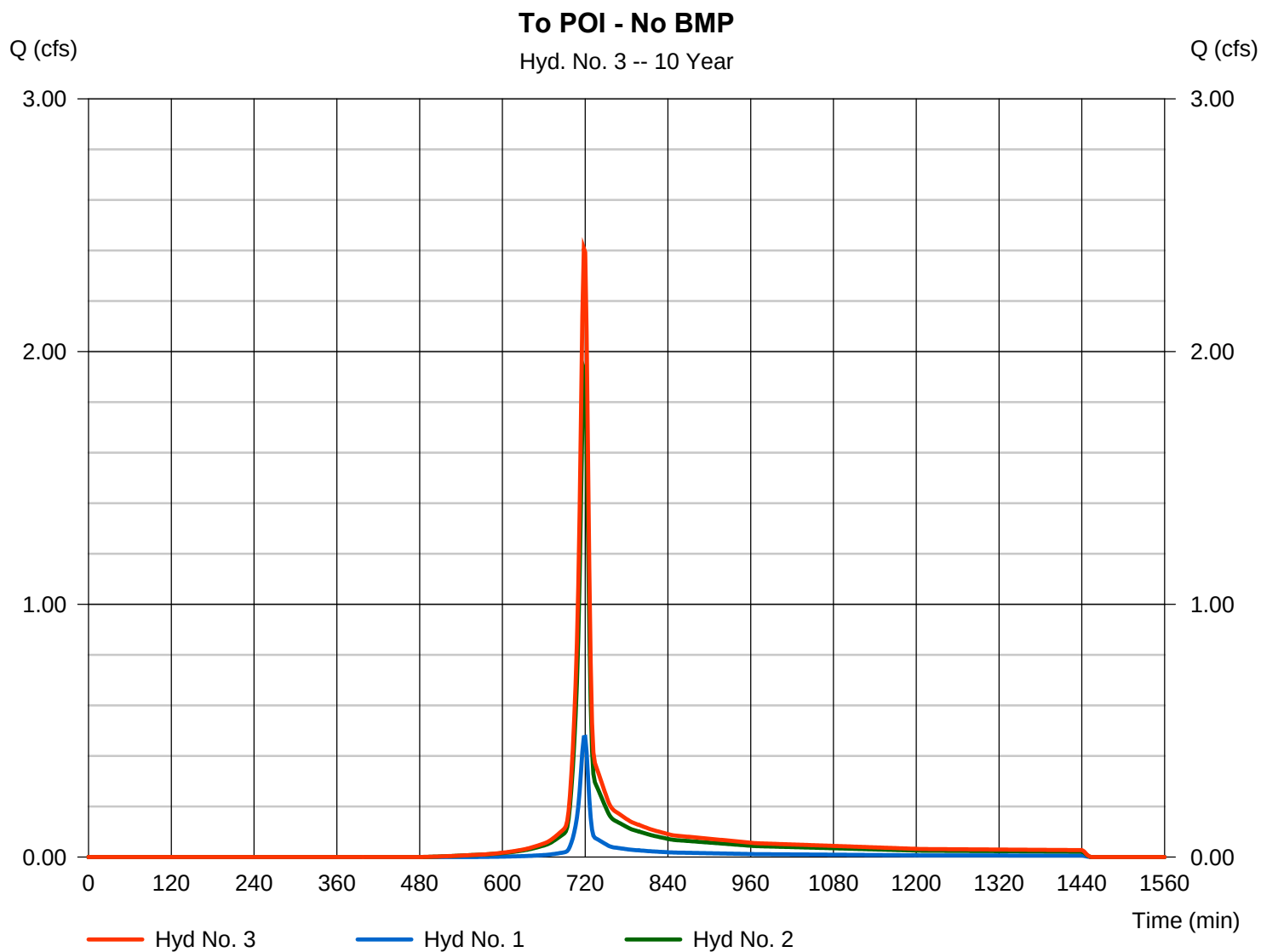
Friday, 11 / 4 / 2016

Hyd. No. 3

To POI - No BMP

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 2.408 cfs
 Time to peak = 718 min
 Hyd. volume = 5,513 cuft
 Contrib. drain. area = 0.800 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

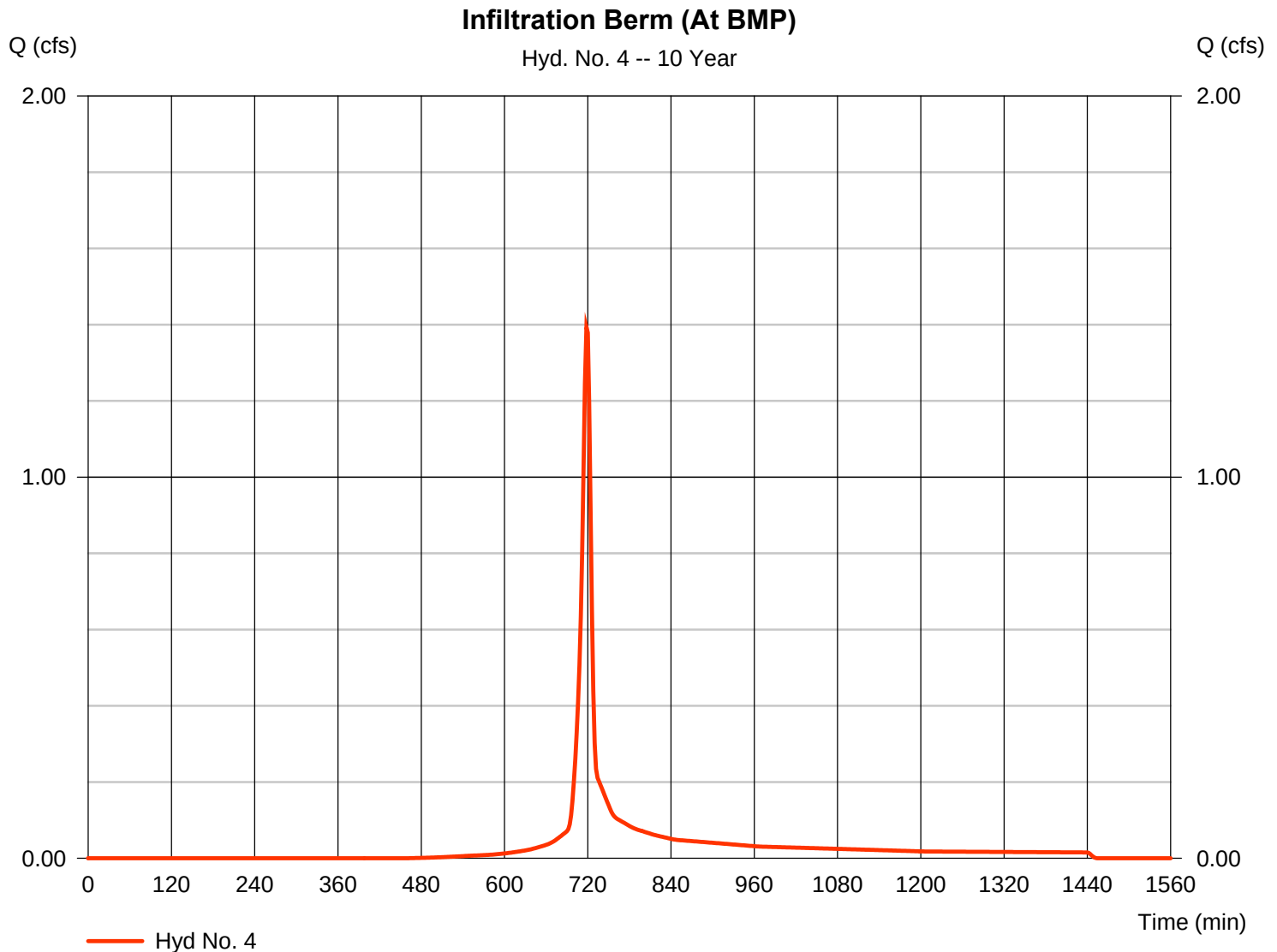
Friday, 11 / 4 / 2016

Hyd. No. 4

Infiltration Berm (At BMP)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.394 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	3,192 cuft
Drainage area	=	0.430 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.90 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.260 \times 78) + (0.170 \times 91)] / 0.430$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

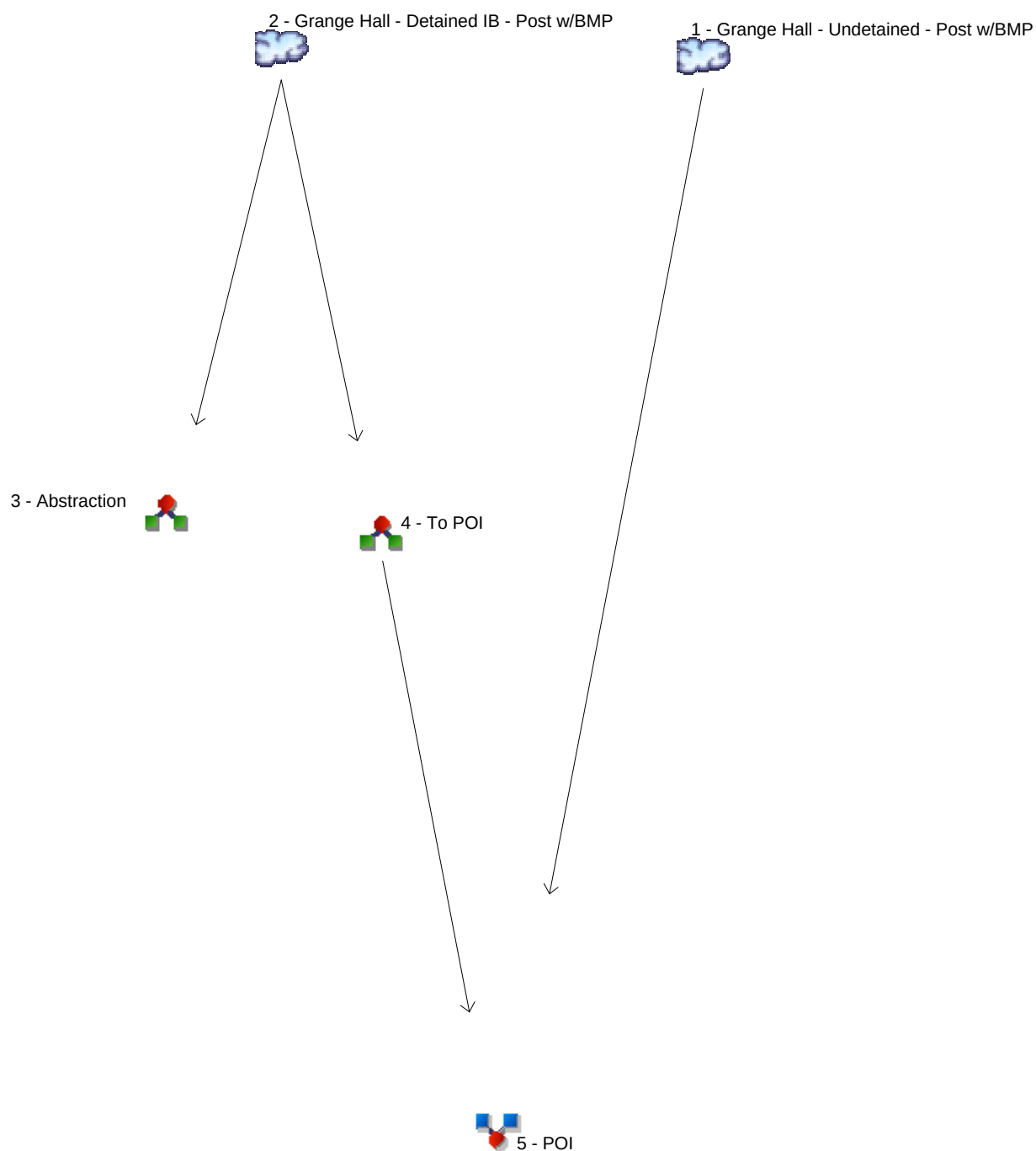
Hyd. No. 4

Infiltration Berm (At BMP)

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	88.00				
Watercourse slope (%)	= 5.00	6.00	4.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	3.23				
Travel Time (min)	= 0.20	+	0.22	+	0.45	=	0.87
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				7.90 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	0.476	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	-----	-----	-----	-----	-----	1.414	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	2	-----	-----	-----	-----	1.414	-----	-----	-----	Abstraction
4	Diversion2	2	-----	-----	-----	-----	1.050	-----	-----	-----	To POI
5	Combine	1, 4	-----	-----	-----	-----	1.135	-----	-----	-----	POI
Proj. file: Grange Hall - Post wBMP - 10yr.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.476	2	720	1,089	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	1.414	2	724	4,424	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	1.414	2	724	1,822	2	-----	-----	Abstraction
4	Diversion2	1.050	2	732	2,602	2	-----	-----	To POI
5	Combine	1.135	2	732	3,691	1, 4	-----	-----	POI
Grange Hall - Post wBMP - 10yr.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

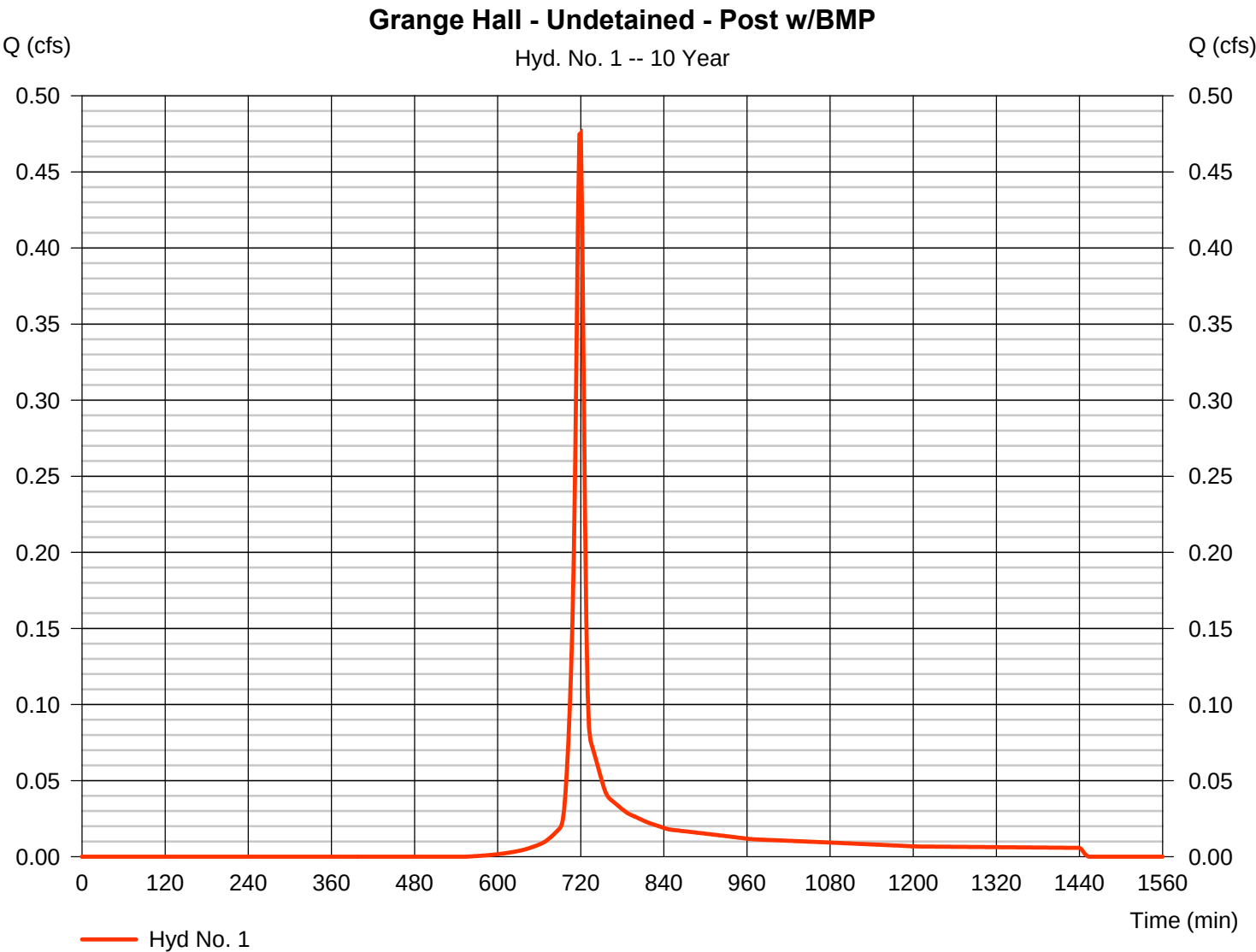
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.476 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,089 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

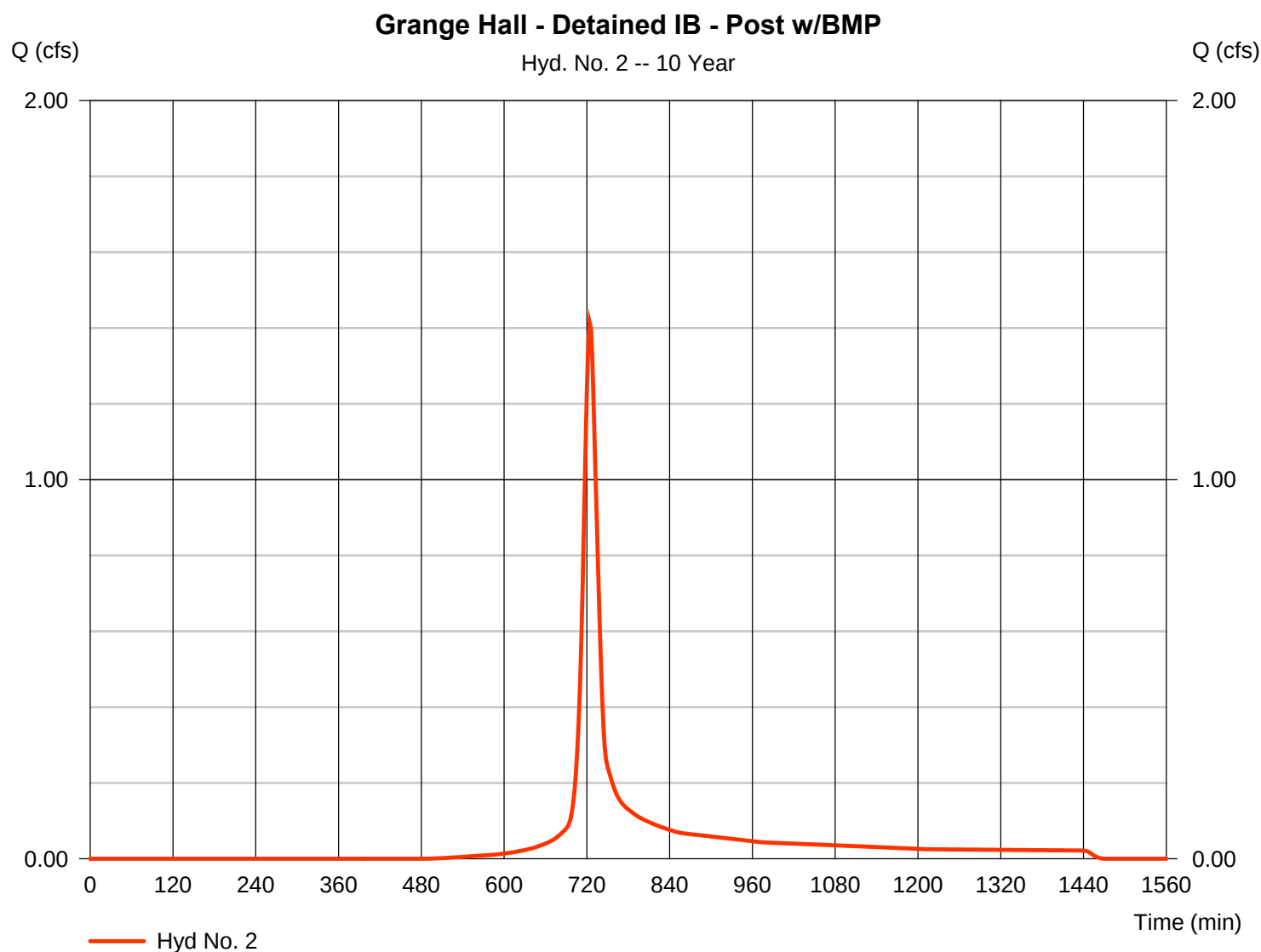
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained IB - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.414 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	4,424 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	19.40 min
Total precip.	=	3.72 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



Hydrograph Report

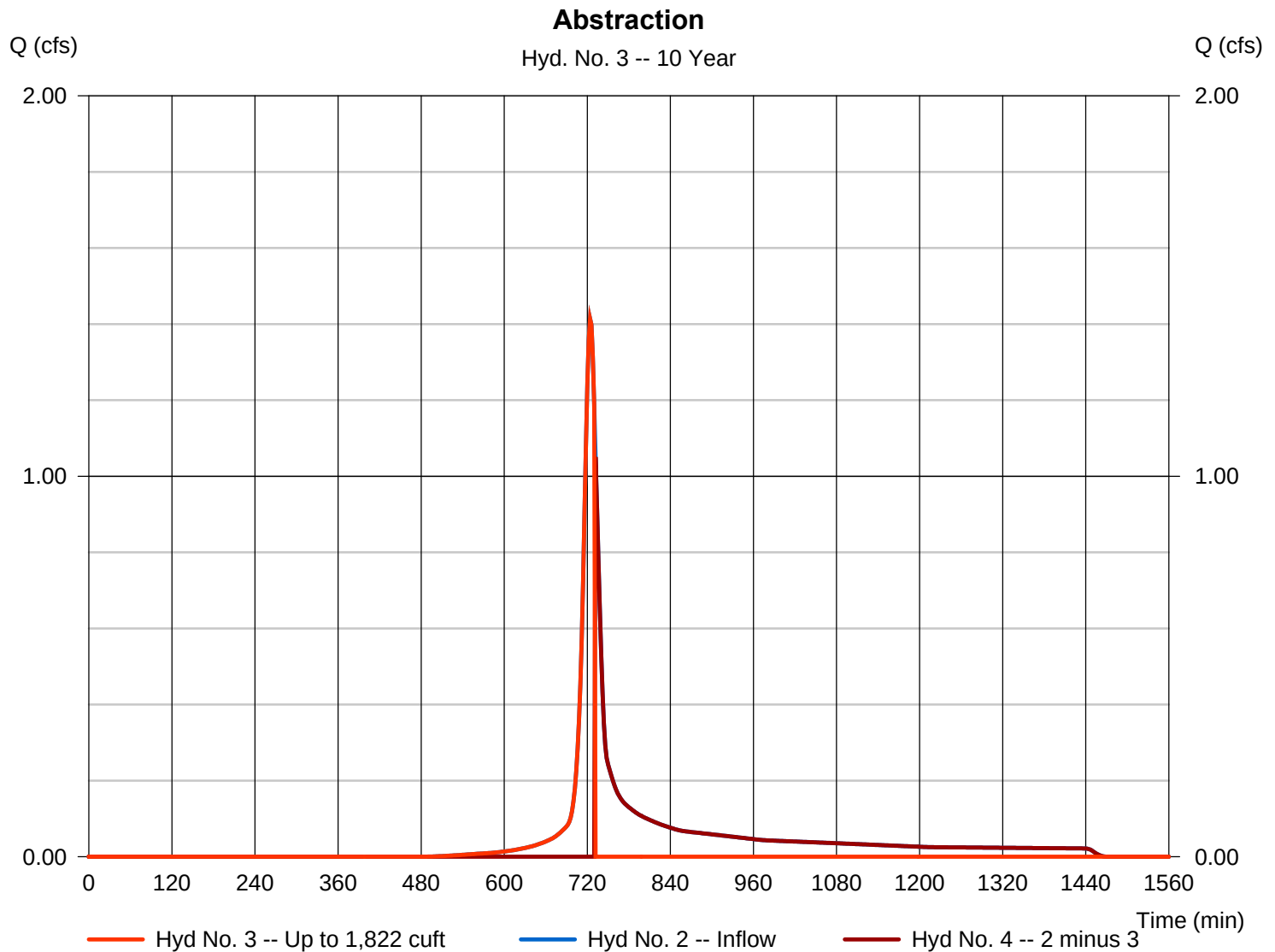
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.414 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 1,822 cuft
Inflow hydrograph	= 2 - Grange Hall - Detained IB - Positive BIP hyd.	Volume Up To	= 1,822 cuft
Diversion method	= First Flush Volume		



Hydrograph Report

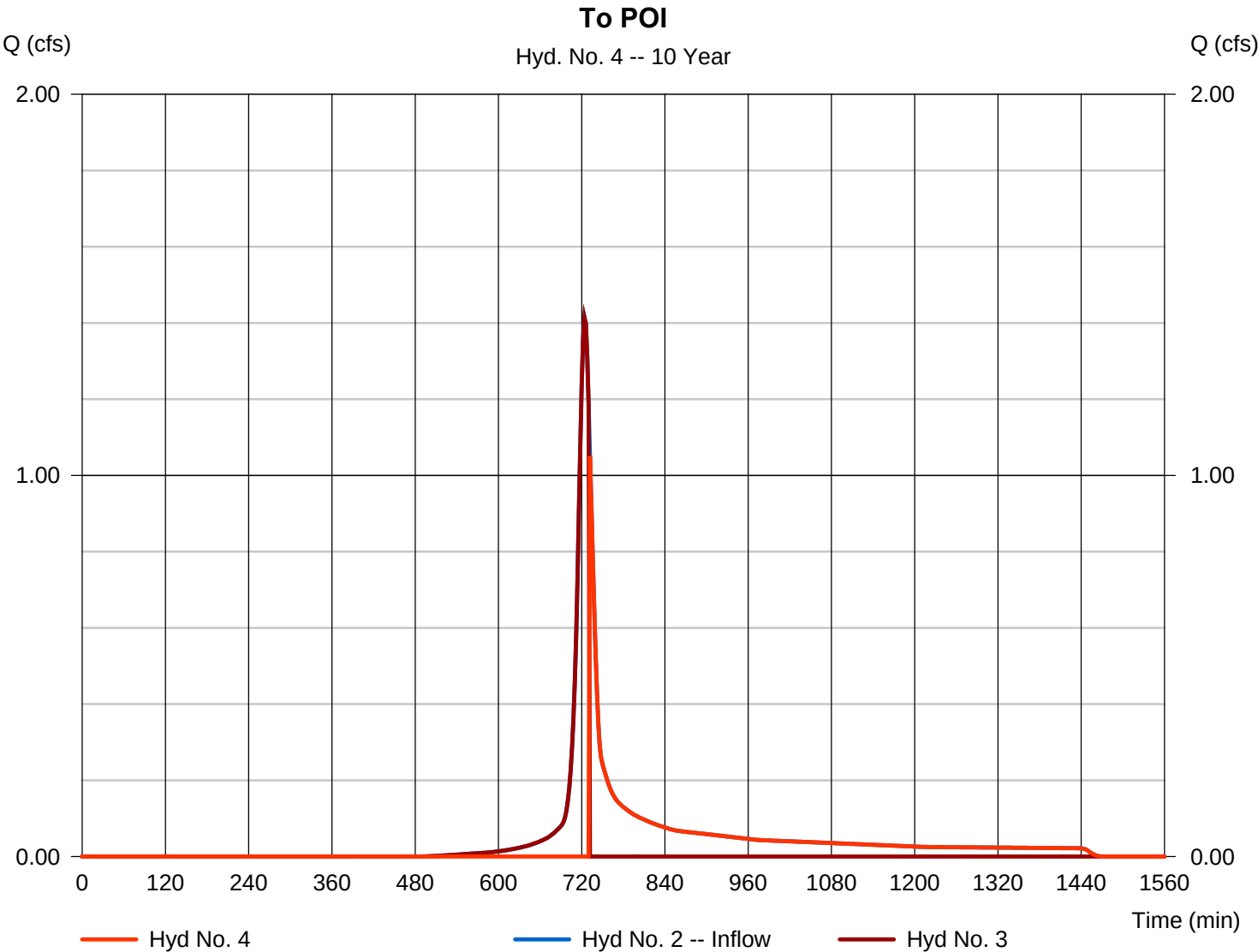
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	1.050 cfs
Storm frequency	=	10 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	2,602 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BIP	Positive BIP hyd.	=	3
Diversion method	=	First Flush Volume	Volume Up To	=	1,822 cuft



Hydrograph Report

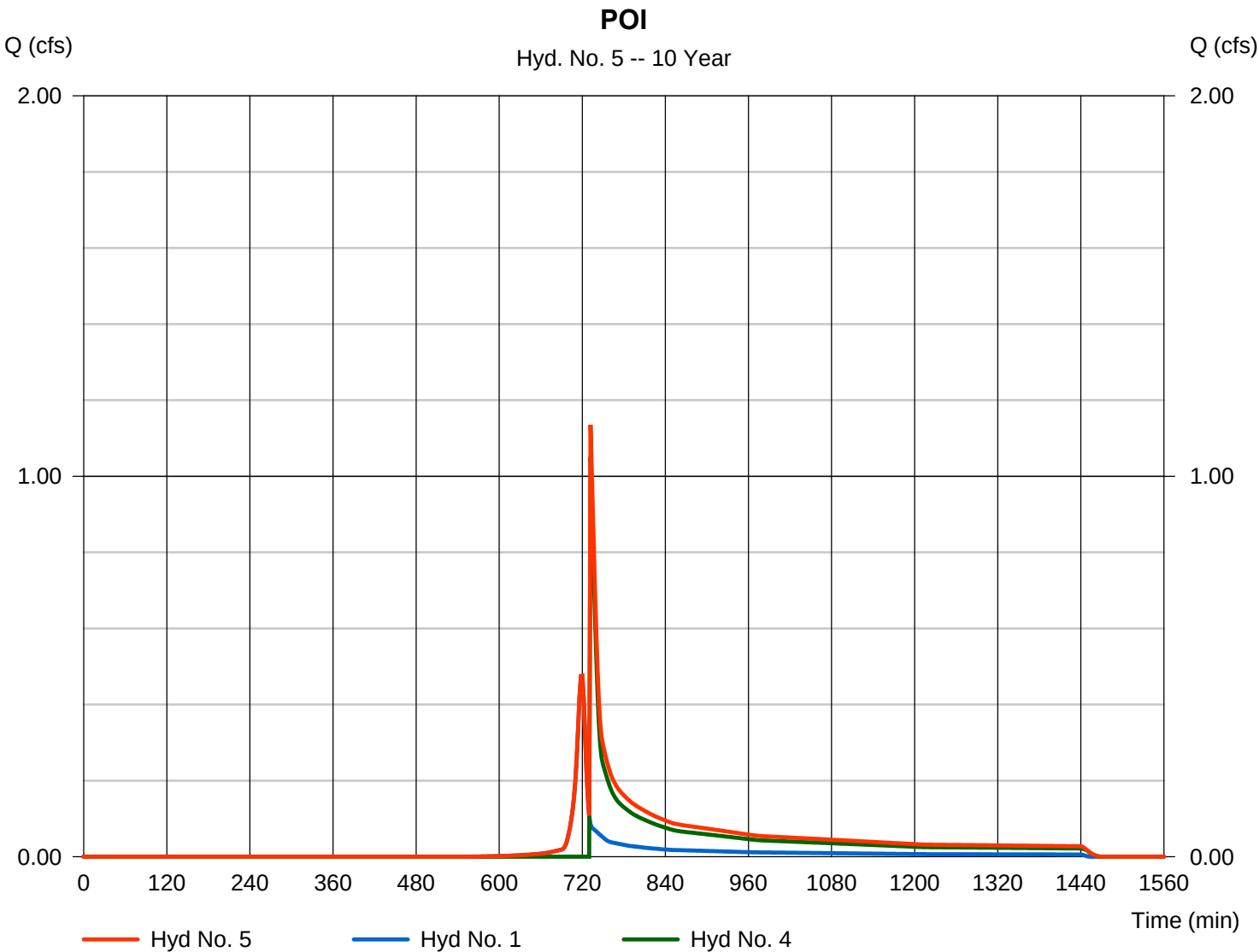
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

POI

Hydrograph type	= Combine	Peak discharge	= 1.135 cfs
Storm frequency	= 10 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 3,691 cuft
Inflow hyds.	= 1, 4	Contrib. drain. area	= 0.180 ac



**ATTACHMENT C-3
GRANGE HALL RD
50 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Grange Hall - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.063	-----	-----	2.113	-----	3.557	4.311	Grange Hall - Pre
Proj. file: Grange Hall - PRE.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.557	2	718	8,147	-----	-----	-----	Grange Hall - Pre
Grange Hall - PRE.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

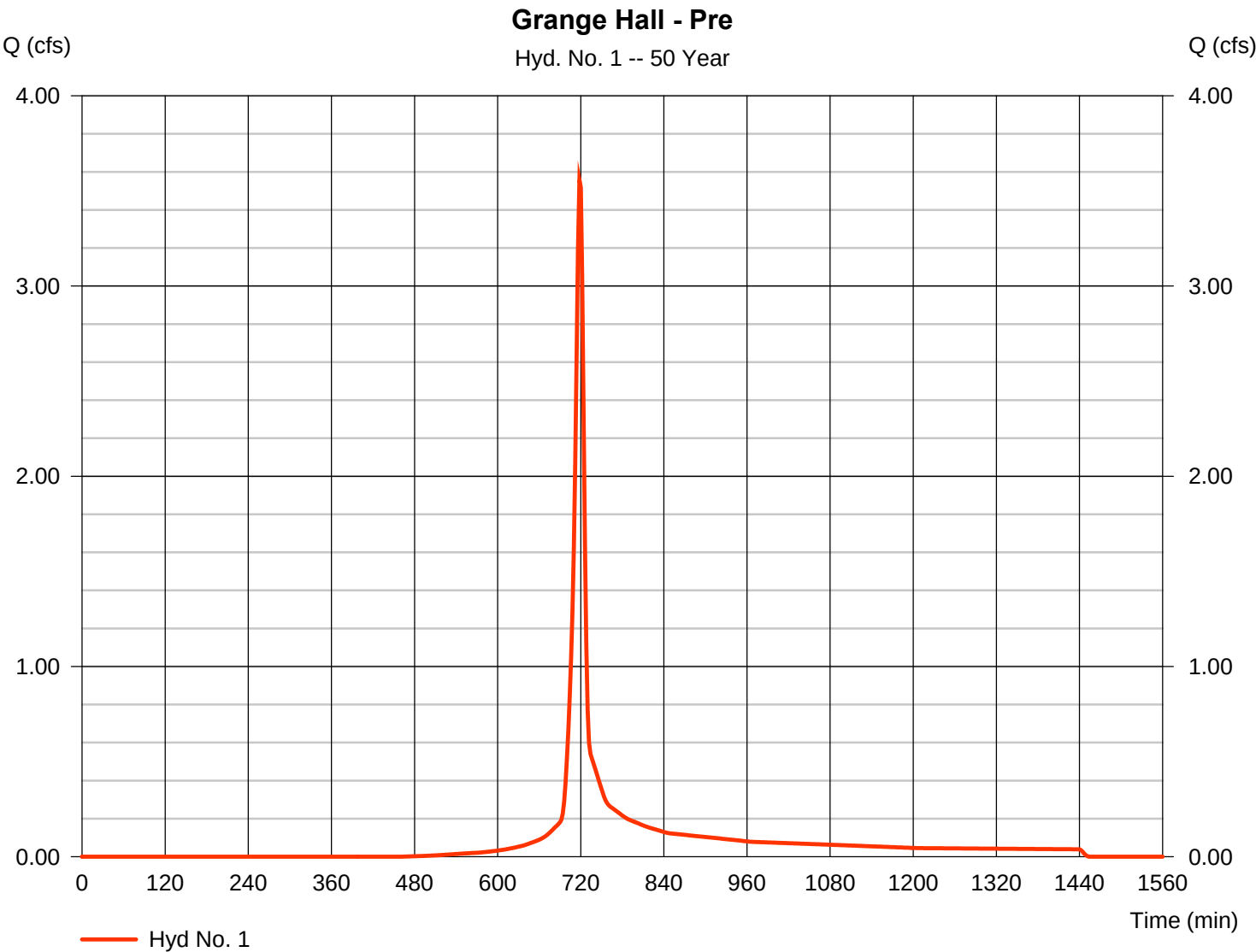
Hydrograph Report

Hyd. No. 1

Grange Hall - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.557 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	8,147 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.10 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.230 x 78) + (0.570 x 78)] / 0.800



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

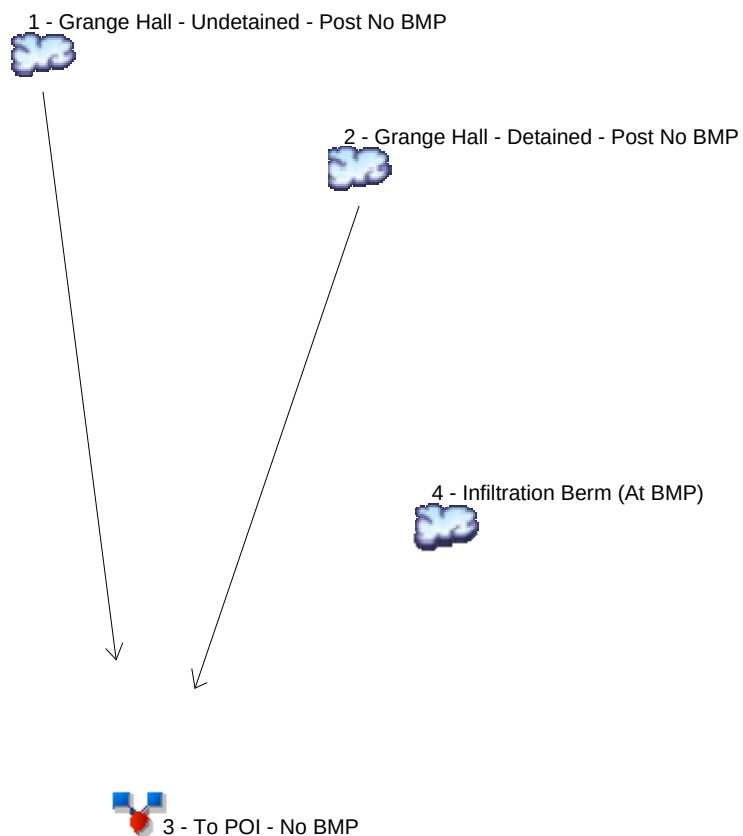
Hyd. No. 1

Grange Hall - Pre

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 267.00	0.00	0.00				
Watercourse slope (%)	= 7.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.27	0.00	0.00				
Travel Time (min)	= 1.04	+	0.00	+	0.00	=	1.04
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				8.10 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.239	-----	-----	0.476	-----	0.800	0.970	Grange Hall - Undetained - Post No B
2	SCS Runoff	-----	-----	1.047	-----	-----	1.933	-----	3.097	3.693	Grange Hall - Detained - Post No BM
3	Combine	1, 2	-----	1.286	-----	-----	2.408	-----	3.897	4.663	To POI - No BMP
4	SCS Runoff	-----	-----	0.767	-----	-----	1.394	-----	2.206	2.620	Infiltration Berm (At BMP)
Proj. file: Grange Hall - Post no BMPs.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.800	2	718	1,833	-----	-----	-----	Grange Hall - Undetained - Post No B
2	SCS Runoff	3.097	2	718	7,152	-----	-----	-----	Grange Hall - Detained - Post No BM
3	Combine	3.897	2	718	8,985	1, 2	-----	-----	To POI - No BMP
4	SCS Runoff	2.206	2	718	5,110	-----	-----	-----	Infiltration Berm (At BMP)
Grange Hall - Post no BMPs.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

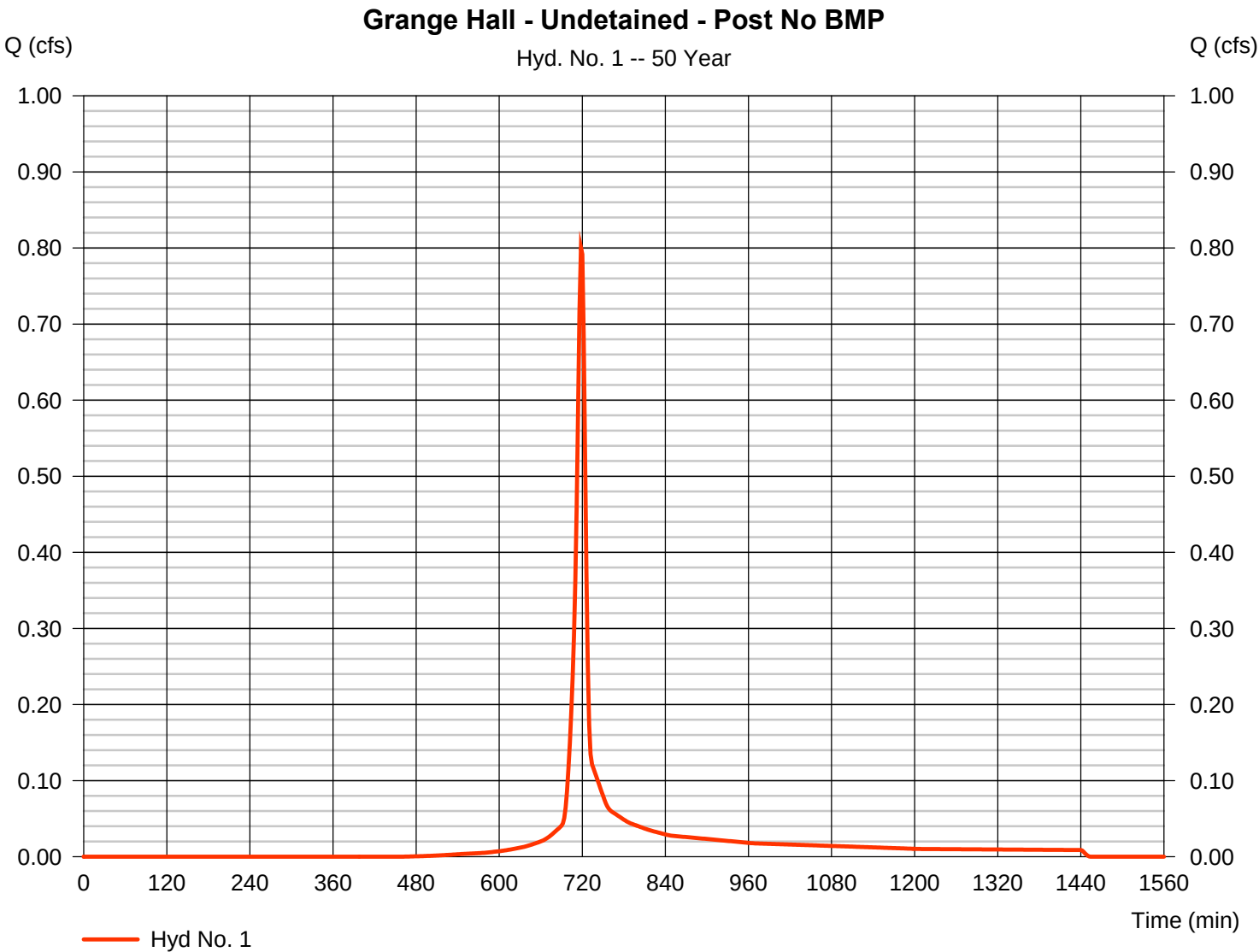
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.800 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	1,833 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

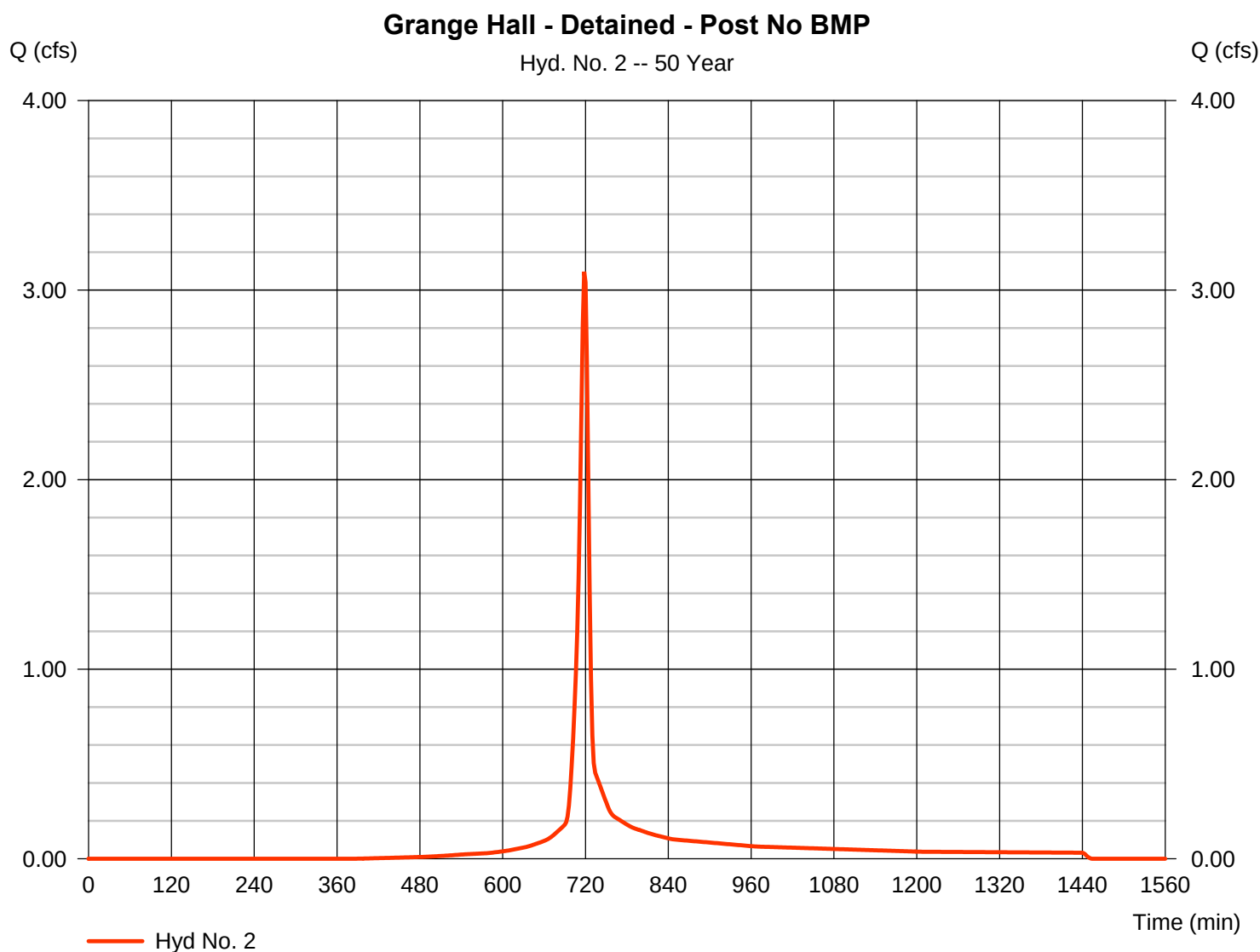
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.097 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	7,152 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Grange Hall - Detained - Post No BMP

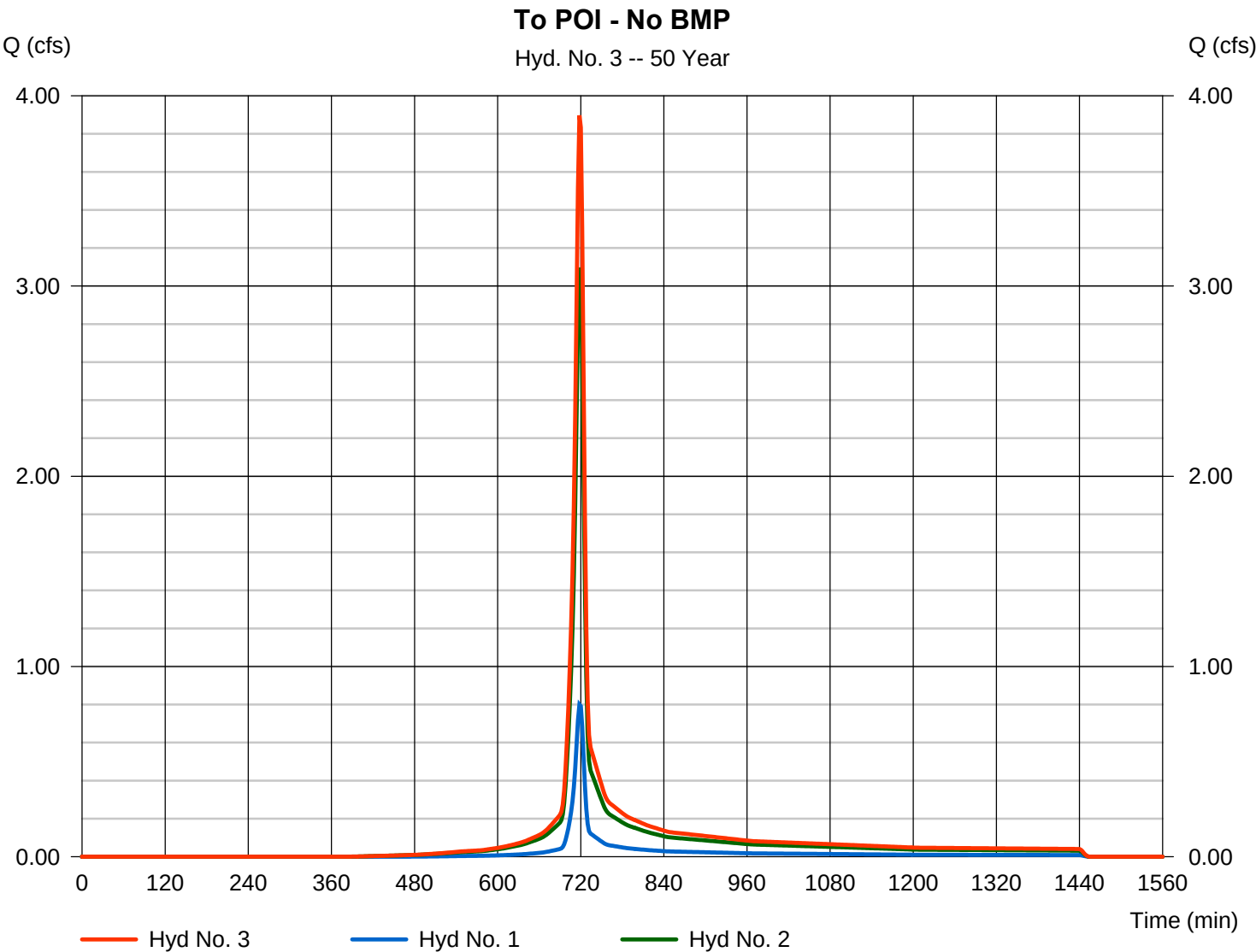
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	236.00				
Watercourse slope (%)	= 5.00	6.00	10.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	5.10				
Travel Time (min)	= 0.20	+	0.22	+	0.77	=	1.19
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				8.20 min			

Hydrograph Report

Hyd. No. 3

To POI - No BMP

Hydrograph type	= Combine	Peak discharge	= 3.897 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 8,985 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.800 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

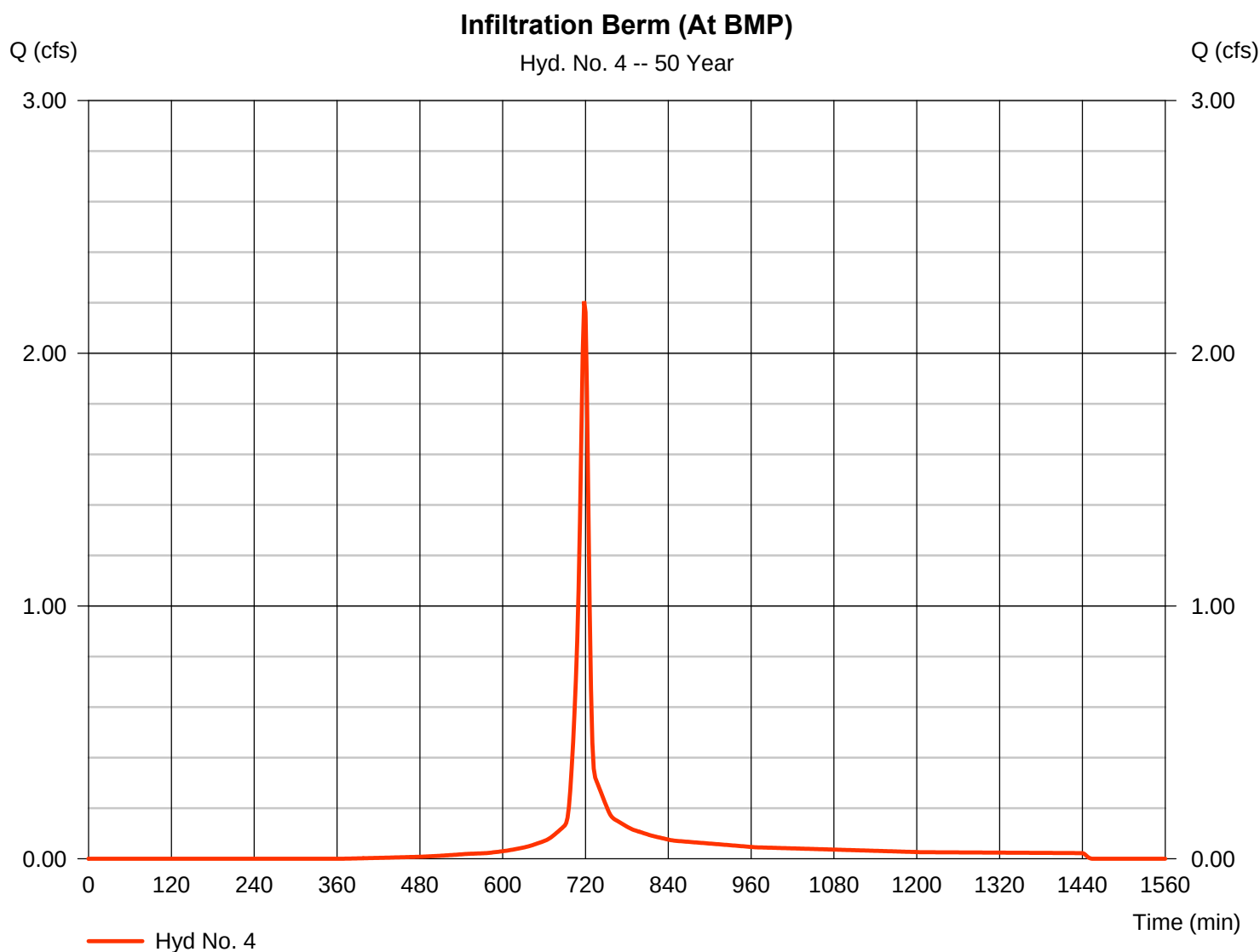
Friday, 11 / 4 / 2016

Hyd. No. 4

Infiltration Berm (At BMP)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.206 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	5,110 cuft
Drainage area	=	0.430 ac	Curve number	=	83*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.90 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.260 \times 78) + (0.170 \times 91)] / 0.430$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

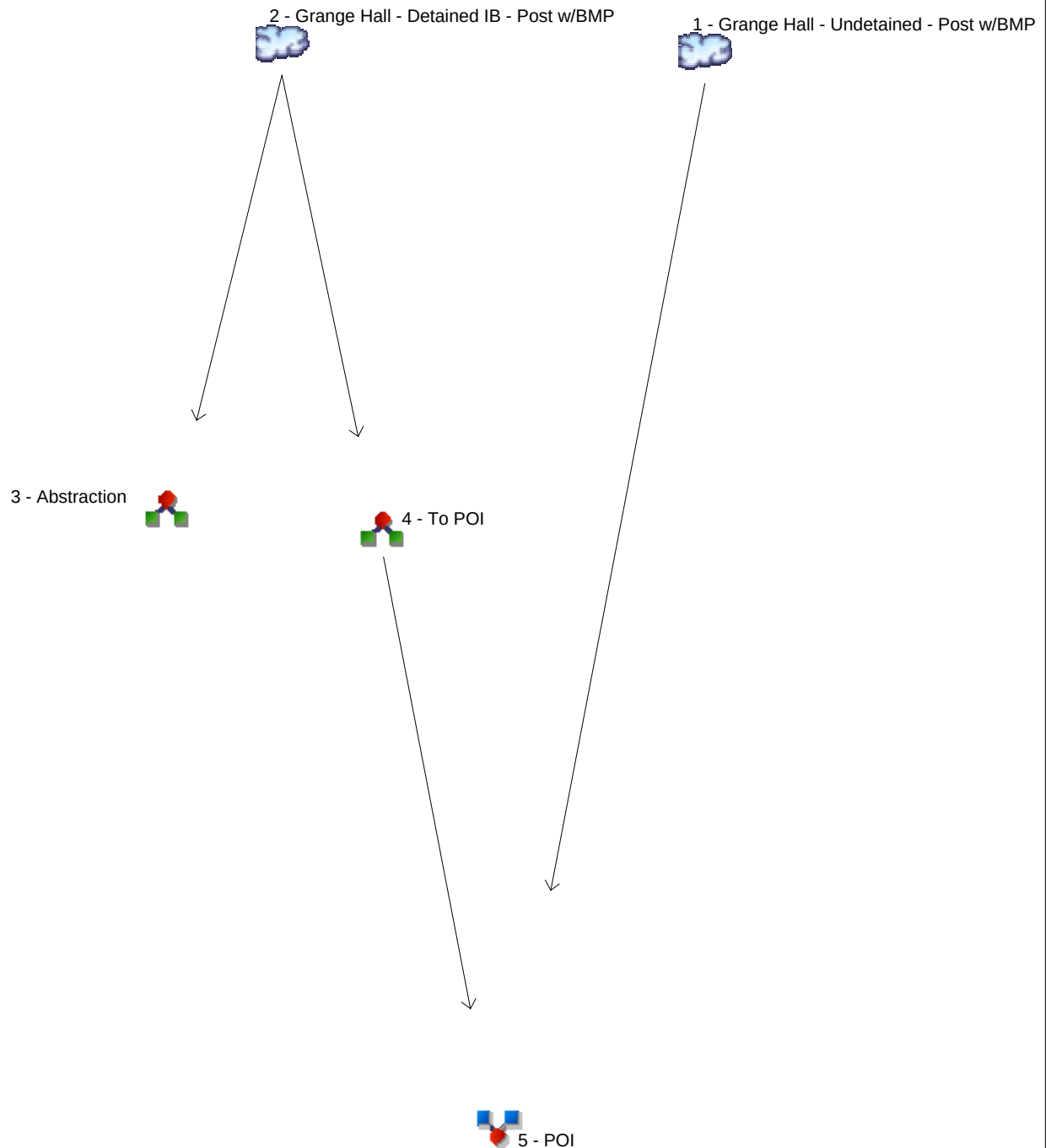
Hyd. No. 4

Infiltration Berm (At BMP)

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	88.00				
Watercourse slope (%)	= 5.00	6.00	4.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	3.23				
Travel Time (min)	= 0.20	+	0.22	+	0.45	=	0.87
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				7.90 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.800	0.970	Grange Hall - Undetained - Post w/B
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.282	2.728	Grange Hall - Detained IB - Post w/B
3	Diversion1	2	-----	-----	-----	-----	-----	-----	2.039	1.833	Abstraction
4	Diversion2	2	-----	-----	-----	-----	-----	-----	2.282	2.728	To POI
5	Combine	1, 4	-----	-----	-----	-----	-----	-----	2.892	3.470	POI
Proj. file: Grange Hall - Post wBMP - 50,100yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.800	2	718	1,833	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	2.282	2	724	7,152	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	2.039	2	720	1,936	2	-----	-----	Abstraction
4	Diversion2	2.282	2	724	5,216	2	-----	-----	To POI
5	Combine	2.892	2	722	7,049	1, 4	-----	-----	POI
Grange Hall - Post wBMP - 50,100yr.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

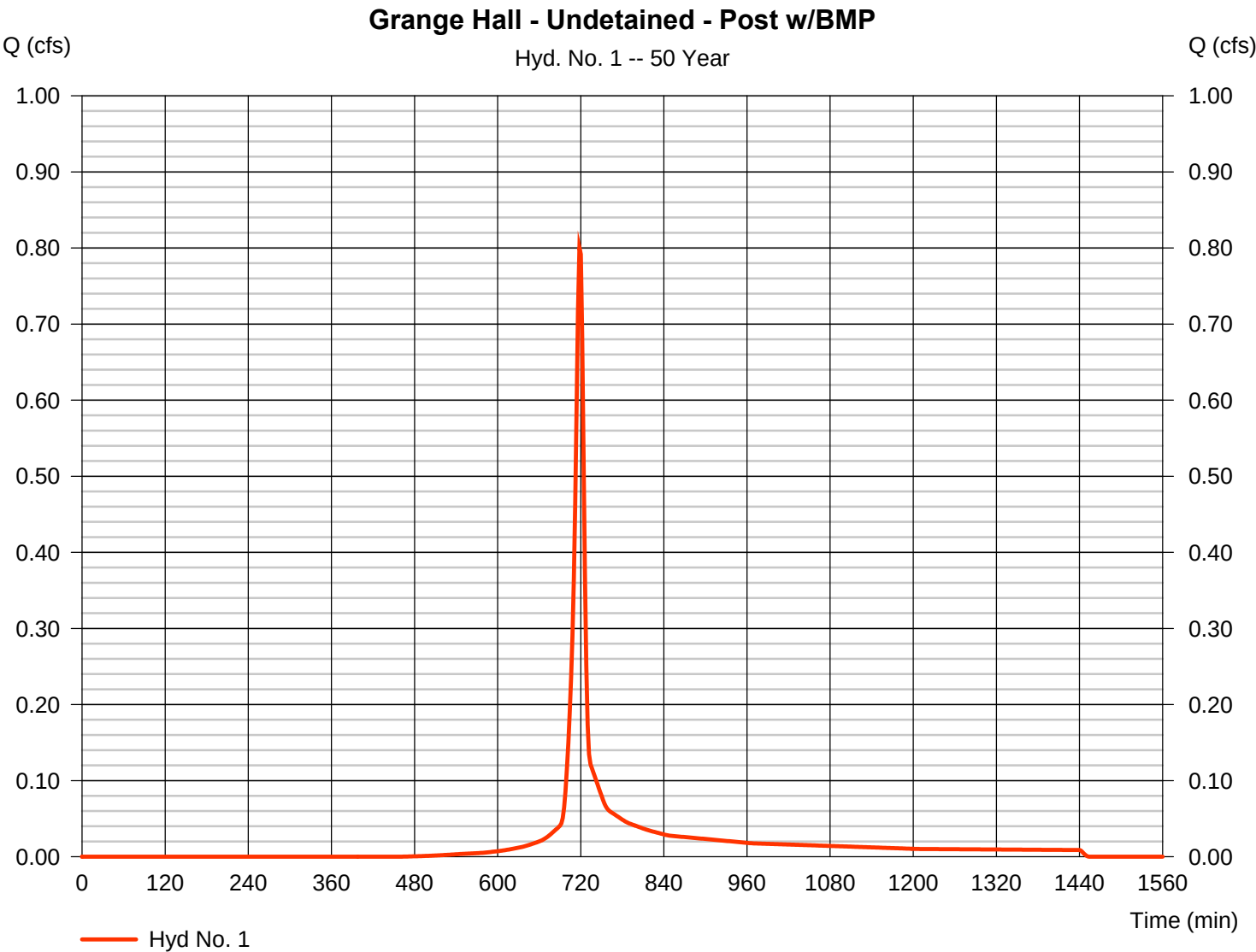
Friday, 11 / 4 / 2016

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.800 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	1,833 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

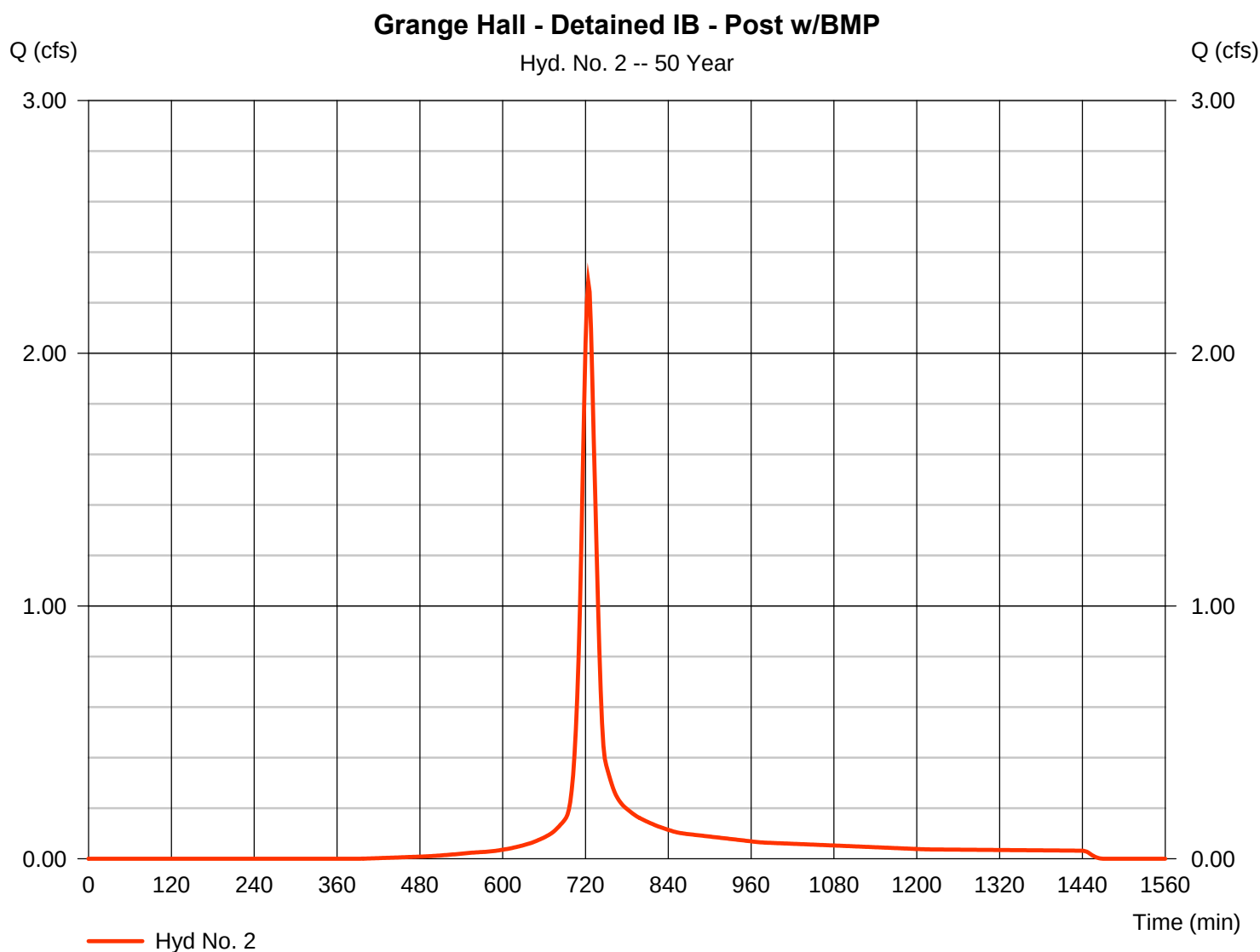
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained IB - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.282 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	7,152 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	19.40 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



Hydrograph Report

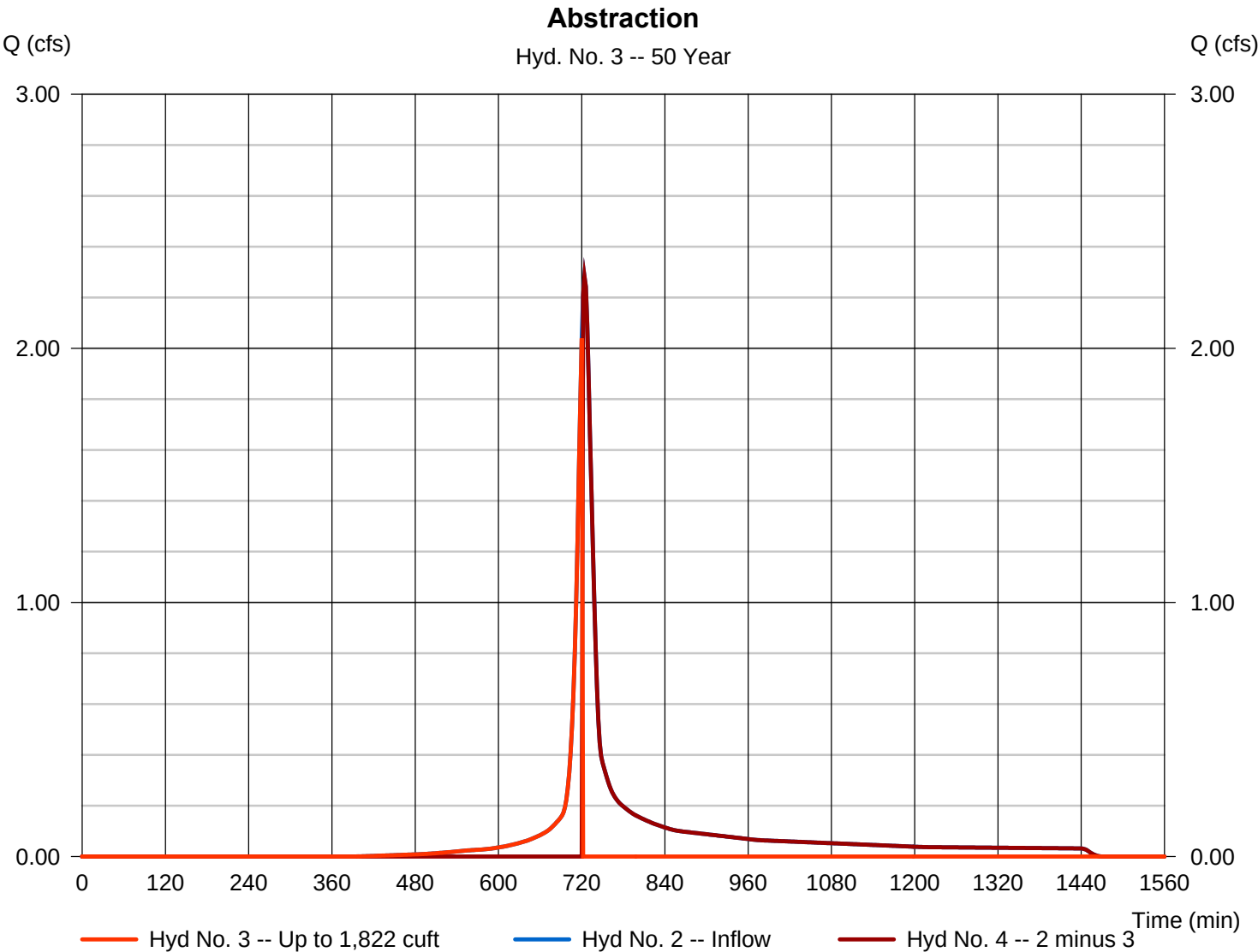
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	2.039 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	1,936 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BIP	Positive BIP hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	1,822 cuft



Hydrograph Report

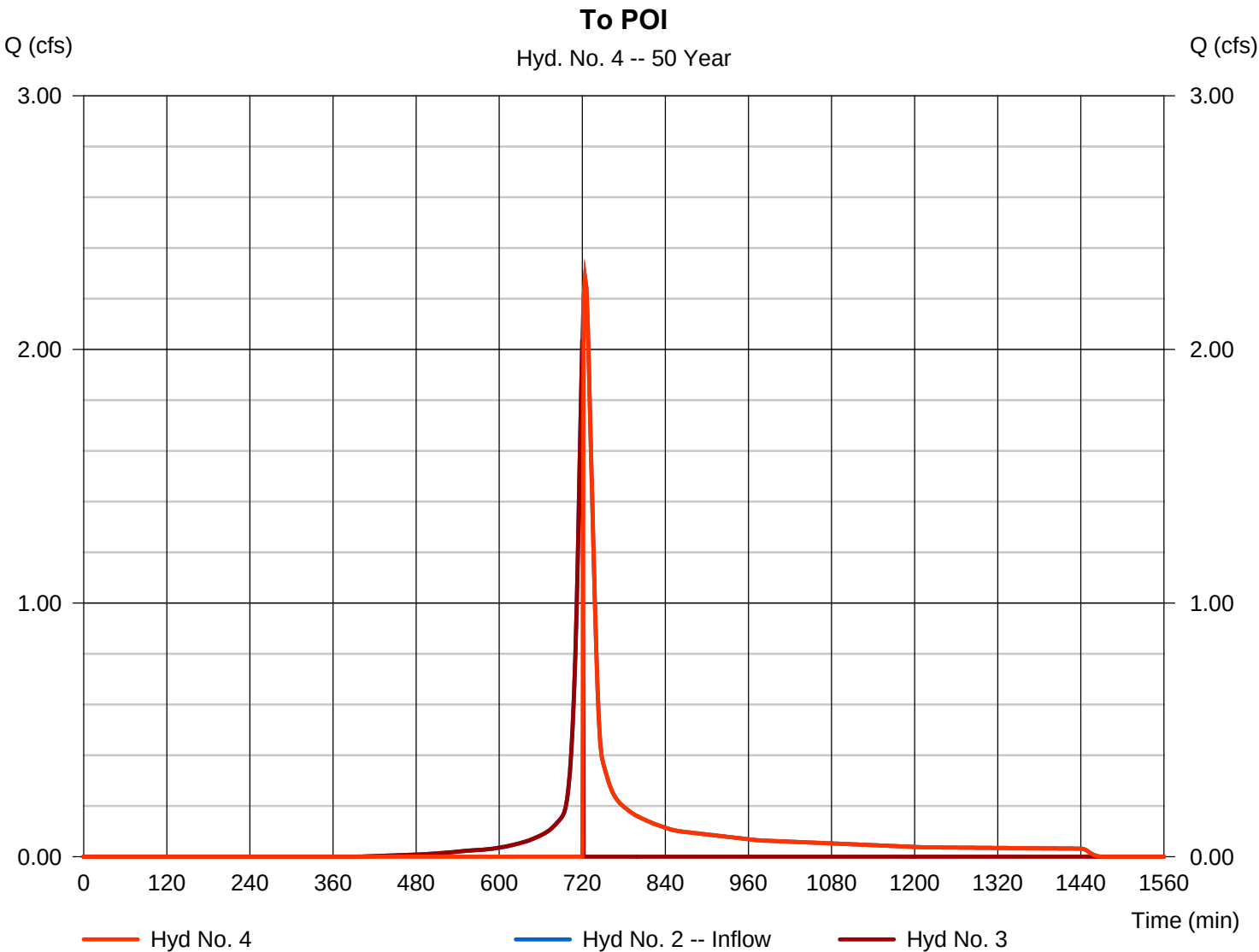
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	2.282 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	5,216 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BIP hyd.	Positive BIP hyd.	=	3
Diversion method	=	First Flush Volume	Volume Up To	=	1,822 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

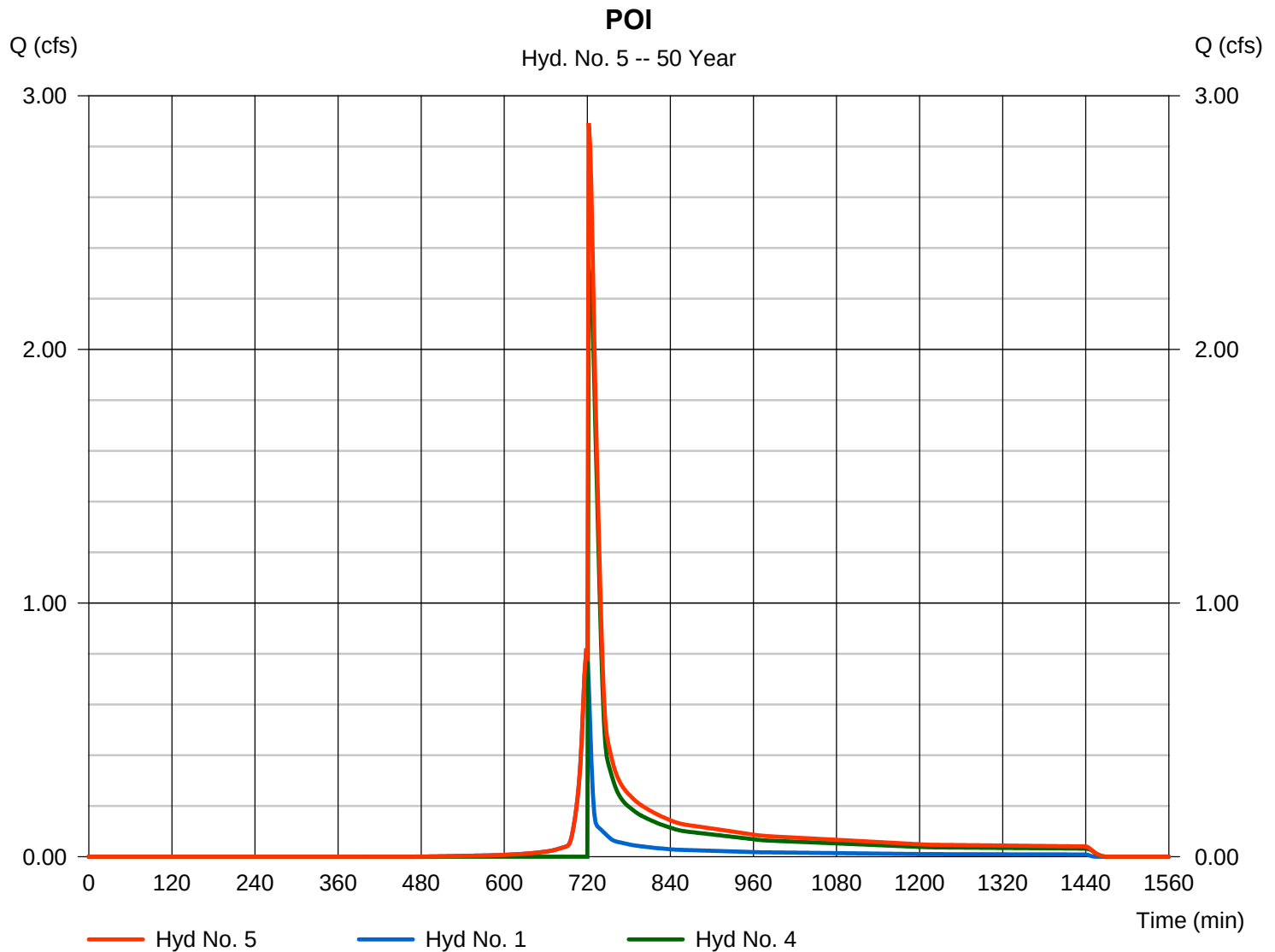
Friday, 11 / 4 / 2016

Hyd. No. 5

POI

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 4

Peak discharge = 2.892 cfs
 Time to peak = 722 min
 Hyd. volume = 7,049 cuft
 Contrib. drain. area = 0.180 ac



**ATTACHMENT C-4
GRANGE HALL RD
100 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Grange Hall - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.063	-----	-----	2.113	-----	3.557	4.311	Grange Hall - Pre
Proj. file: Grange Hall - PRE.gpw									Friday, 11 / 4 / 2016		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.311	2	718	9,907	-----	-----	-----	Grange Hall - Pre
Grange Hall - PRE.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

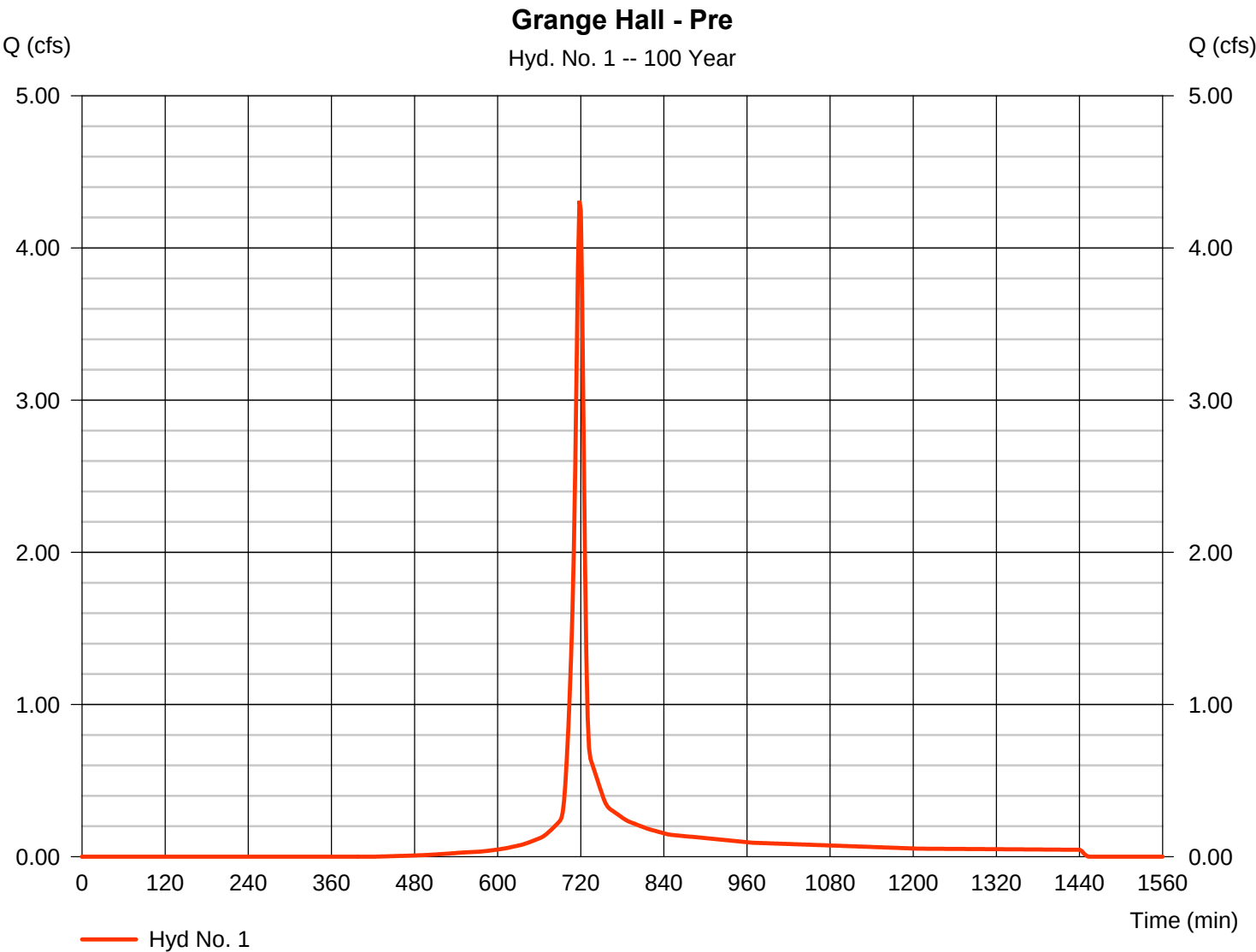
Friday, 11 / 4 / 2016

Hyd. No. 1

Grange Hall - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.311 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	9,907 cuft
Drainage area	=	0.800 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.10 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.230 x 78) + (0.570 x 78)] / 0.800



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

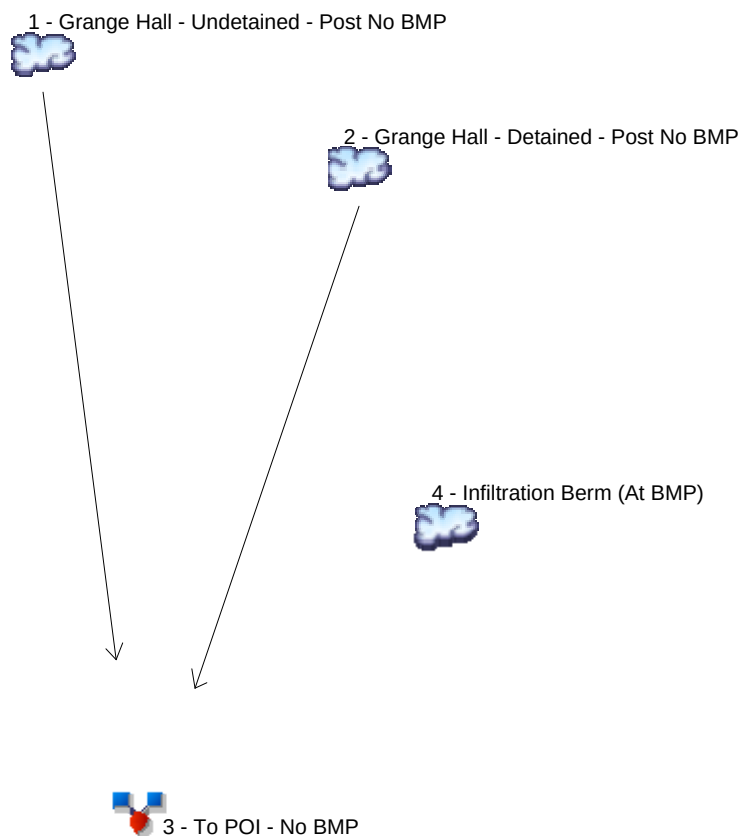
Hyd. No. 1

Grange Hall - Pre

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 267.00	0.00	0.00				
Watercourse slope (%)	= 7.00	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.27	0.00	0.00				
Travel Time (min)	= 1.04	+	0.00	+	0.00	=	1.04
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				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				8.10 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.239	-----	-----	0.476	-----	0.800	0.970	Grange Hall - Undetained - Post No B
2	SCS Runoff	-----	-----	1.047	-----	-----	1.933	-----	3.097	3.693	Grange Hall - Detained - Post No BM
3	Combine	1, 2	-----	1.286	-----	-----	2.408	-----	3.897	4.663	To POI - No BMP
4	SCS Runoff	-----	-----	0.767	-----	-----	1.394	-----	2.206	2.620	Infiltration Berm (At BMP)
Proj. file: Grange Hall - Post no BMPs.gpw											Friday, 11 / 4 / 2016

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.970	2	718	2,229	-----	-----	-----	Grange Hall - Undetained - Post No B
2	SCS Runoff	3.693	2	718	8,581	-----	-----	-----	Grange Hall - Detained - Post No BM
3	Combine	4.663	2	718	10,810	1, 2	-----	-----	To POI - No BMP
4	SCS Runoff	2.620	2	718	6,112	-----	-----	-----	Infiltration Berm (At BMP)
Grange Hall - Post no BMPs.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

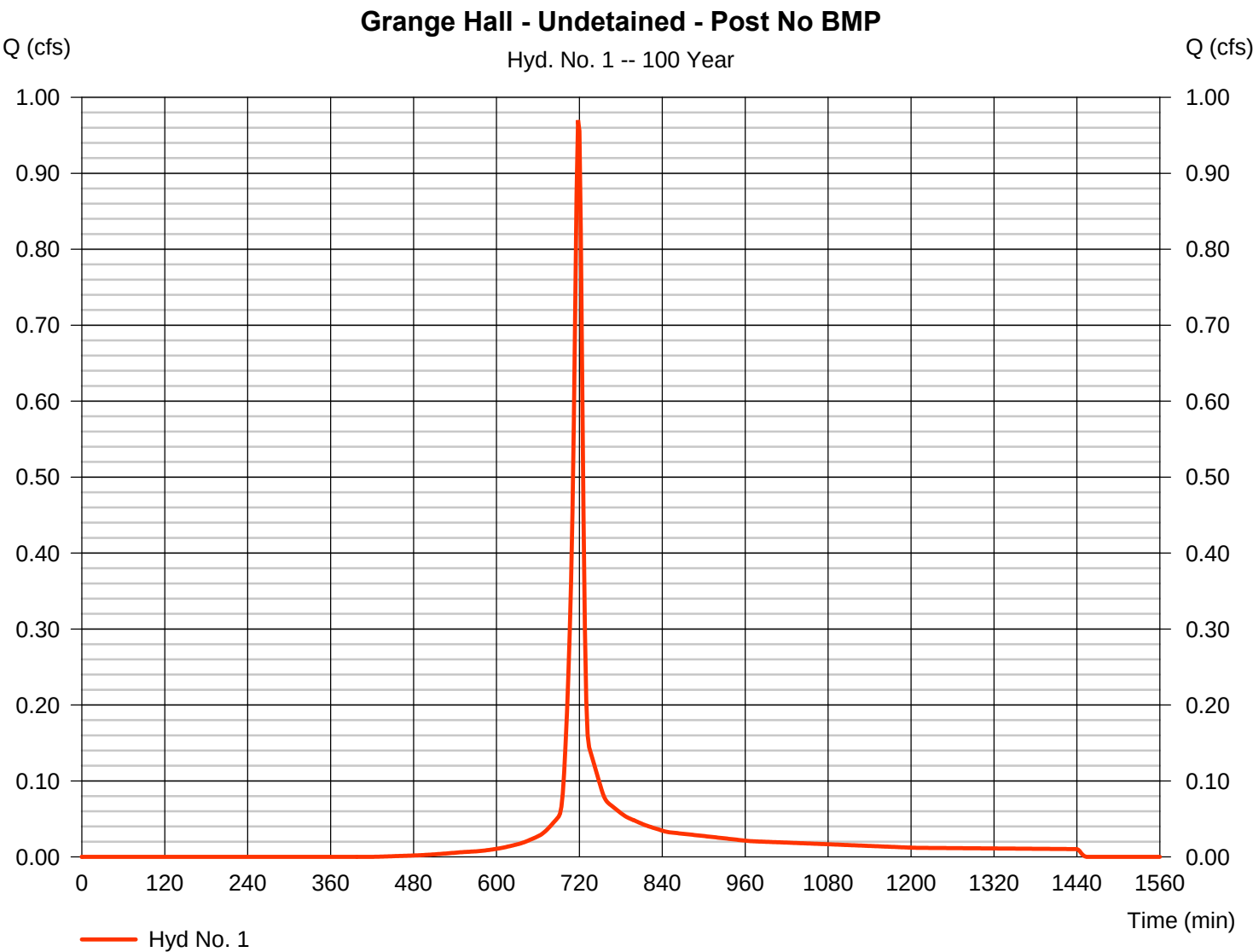
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.970 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	2,229 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

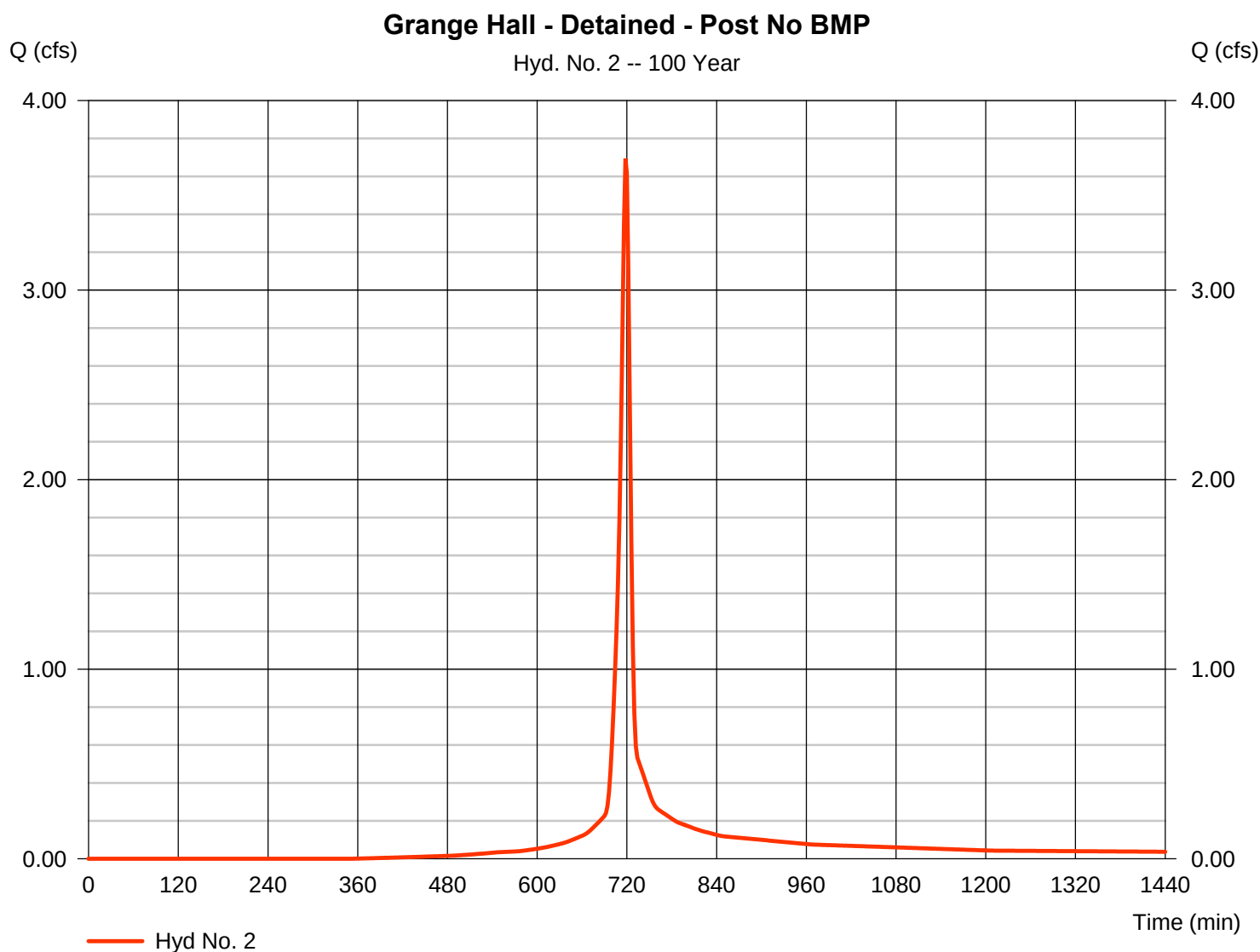
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained - Post No BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.693 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	8,581 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.20 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Grange Hall - Detained - Post No BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	236.00				
Watercourse slope (%)	= 5.00	6.00	10.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	5.10				
Travel Time (min)	= 0.20	+	0.22	+	0.77	=	1.19
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				8.20 min			

Hydrograph Report

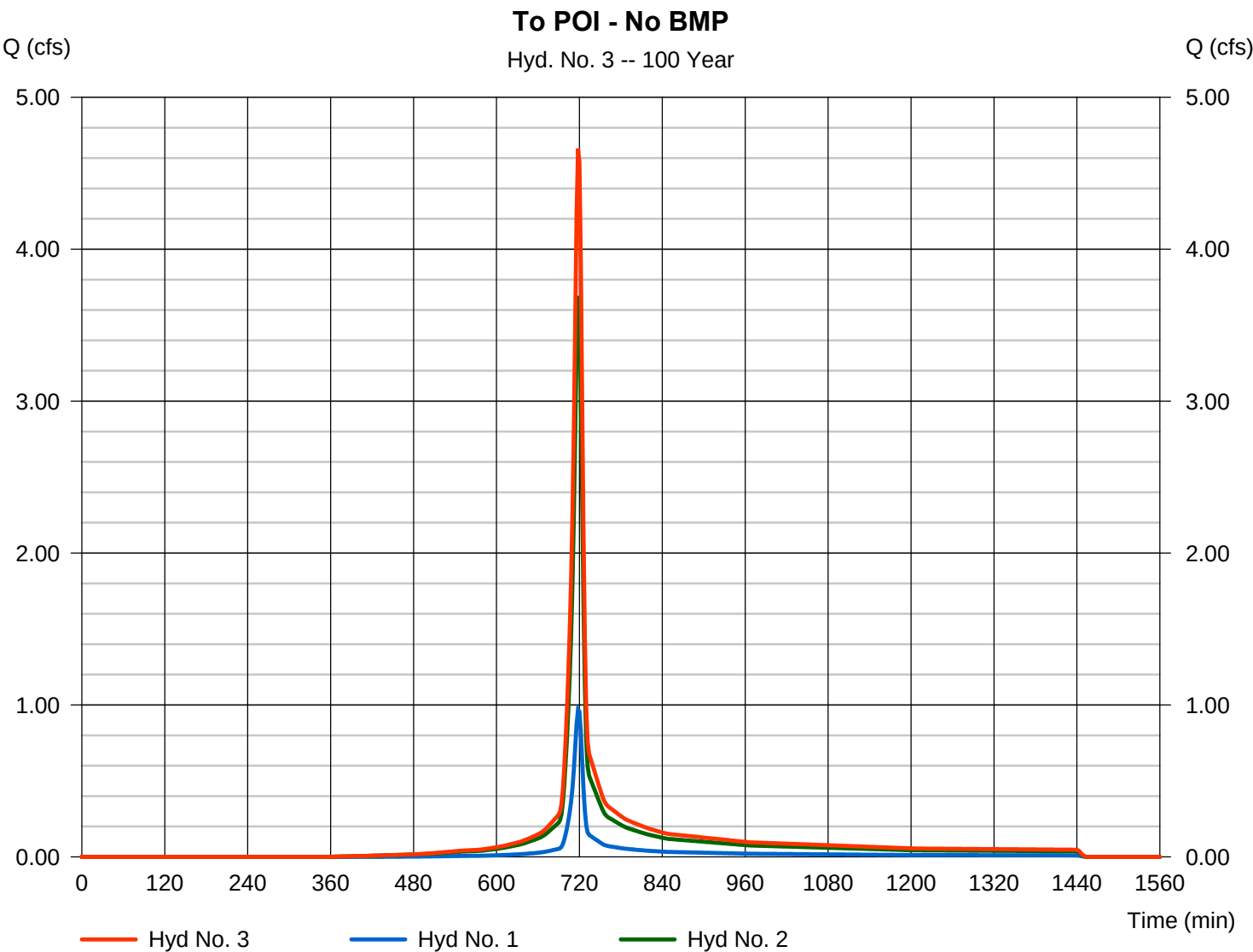
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

To POI - No BMP

Hydrograph type	= Combine	Peak discharge	= 4.663 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 10,810 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.800 ac



Hydrograph Report

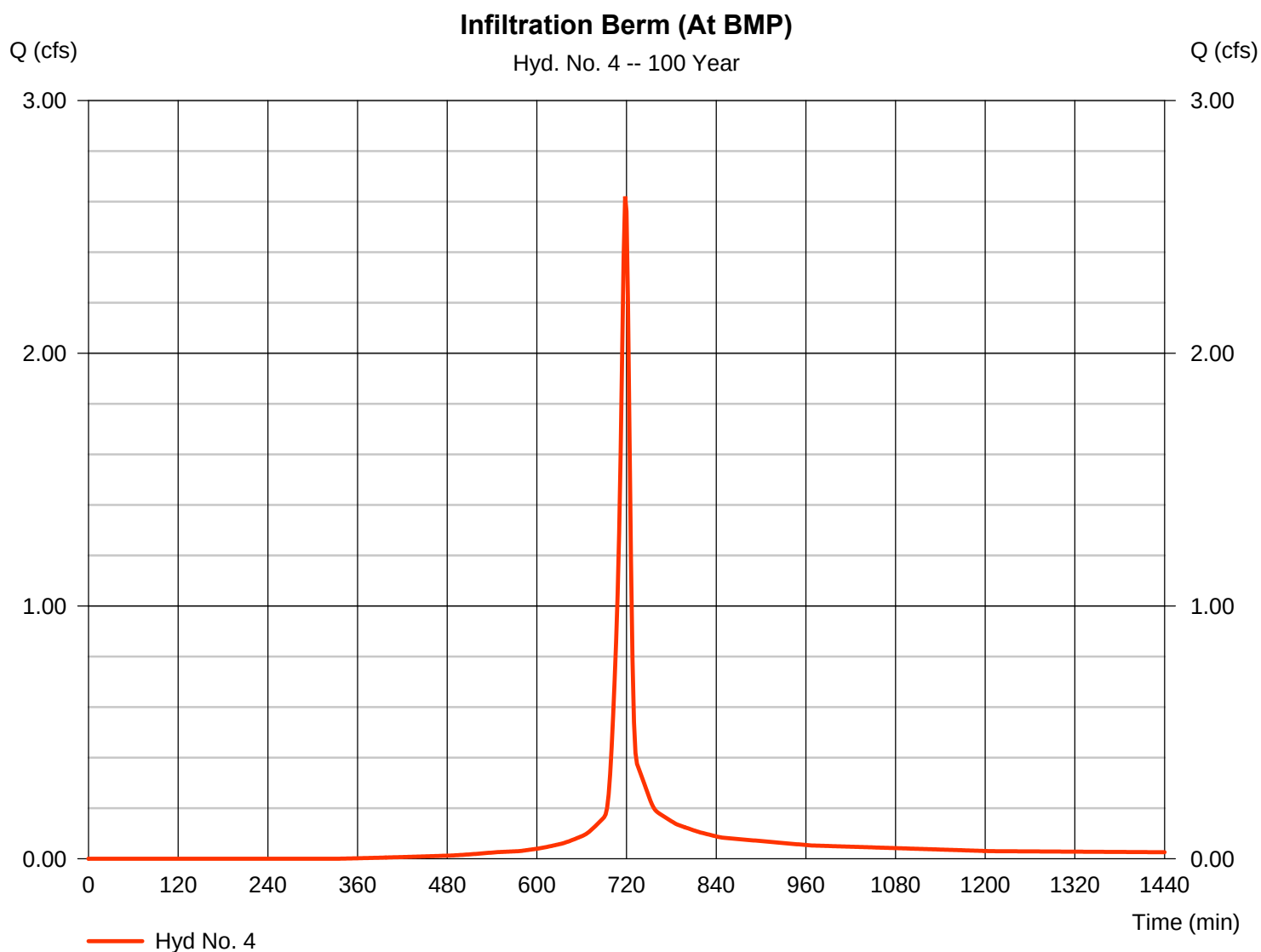
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Infiltration Berm (At BMP)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.620 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 6,112 cuft
Drainage area	= 0.430 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.90 min
Total precip.	= 5.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.260 \times 78) + (0.170 \times 91)] / 0.430$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

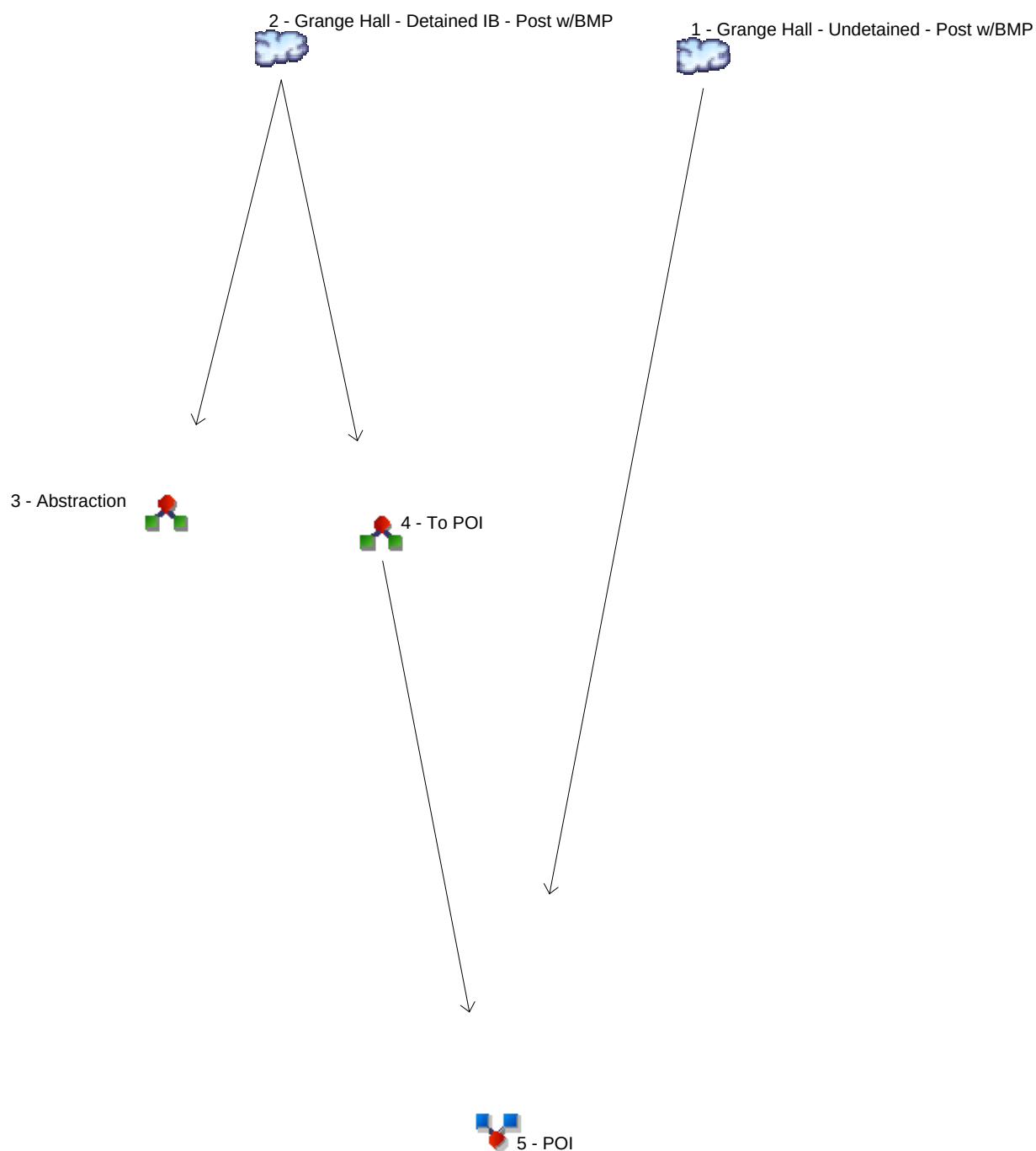
Hyd. No. 4

Infiltration Berm (At BMP)

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 6.00	0.00	0.00				
Travel Time (min)	= 7.02	+	0.00	+	0.00	=	7.02
Shallow Concentrated Flow							
Flow length (ft)	= 43.00	65.00	88.00				
Watercourse slope (%)	= 5.00	6.00	4.00				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=3.61	4.98	3.23				
Travel Time (min)	= 0.20	+	0.22	+	0.45	=	0.87
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				7.90 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.800	0.970	Grange Hall - Undetained - Post w/B
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.282	2.728	Grange Hall - Detained IB - Post w/B
3	Diversion1	2	-----	-----	-----	-----	-----	-----	2.039	1.833	Abstraction
4	Diversion2	2	-----	-----	-----	-----	-----	-----	2.282	2.728	To POI
5	Combine	1, 4	-----	-----	-----	-----	-----	-----	2.892	3.470	POI
Proj. file: Grange Hall - Post wBMP - 50,100yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.970	2	718	2,229	-----	-----	-----	Grange Hall - Undetained - Post w/B
2	SCS Runoff	2.728	2	724	8,581	-----	-----	-----	Grange Hall - Detained IB - Post w/B
3	Diversion1	1.833	2	716	1,893	2	-----	-----	Abstraction
4	Diversion2	2.728	2	724	6,688	2	-----	-----	To POI
5	Combine	3.470	2	722	8,917	1, 4	-----	-----	POI
Grange Hall - Post wBMP - 50,100yr.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

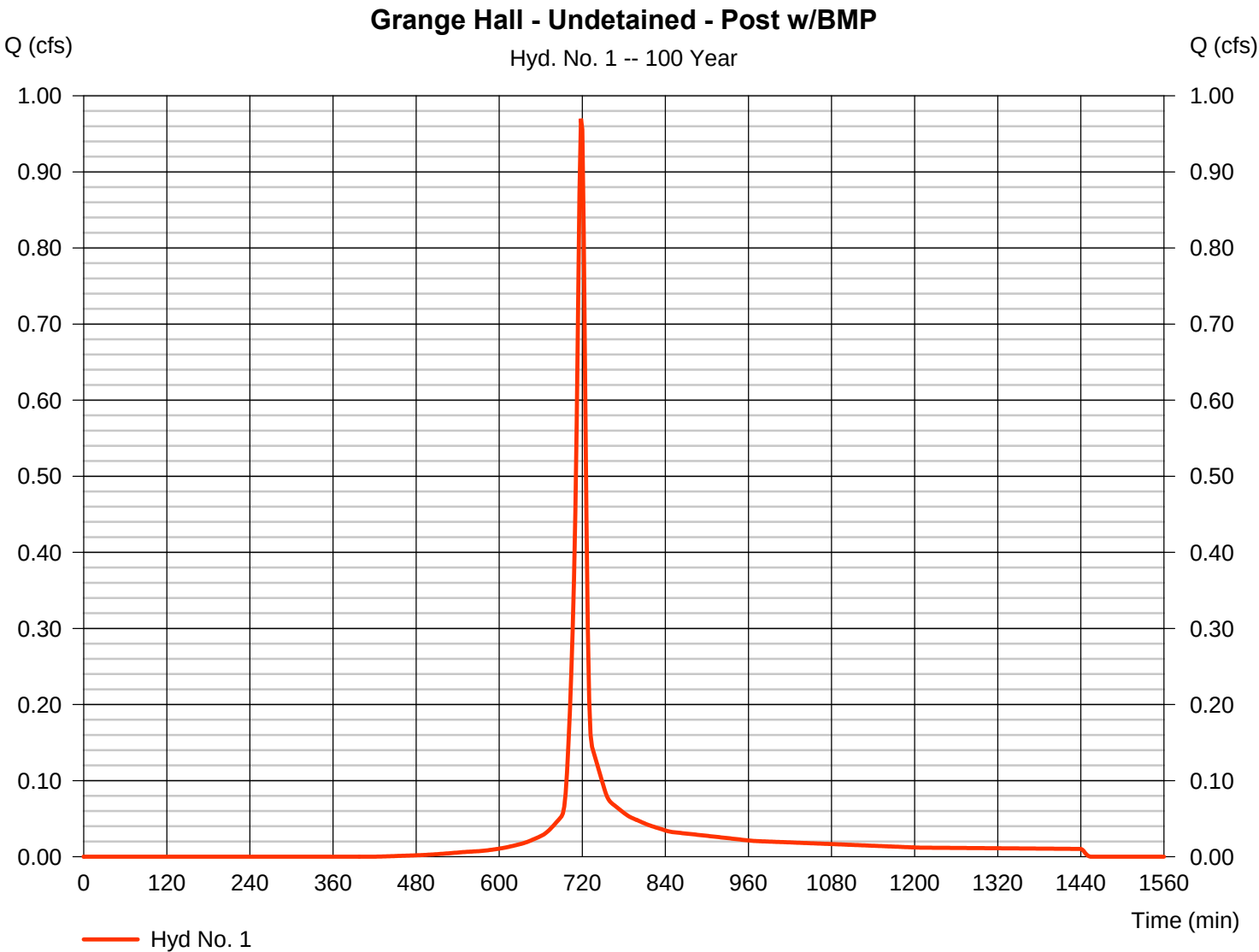
Hydrograph Report

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.970 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	2,229 cuft
Drainage area	=	0.180 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.90 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.070 x 78) + (0.110 x 78)] / 0.180



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Grange Hall - Undetained - Post w/BMP

<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)	= 2.59	0.00	0.00				
Land slope (%)	= 9.50	0.00	0.00				
Travel Time (min)	= 5.84	+	0.00	+	0.00	=	5.84
Shallow Concentrated Flow							
Flow length (ft)	= 17.00	143.00	0.00				
Watercourse slope (%)	= 30.00	2.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=8.84	2.28	0.00				
Travel Time (min)	= 0.03	+	1.04	+	0.00	=	1.08
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				6.90 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

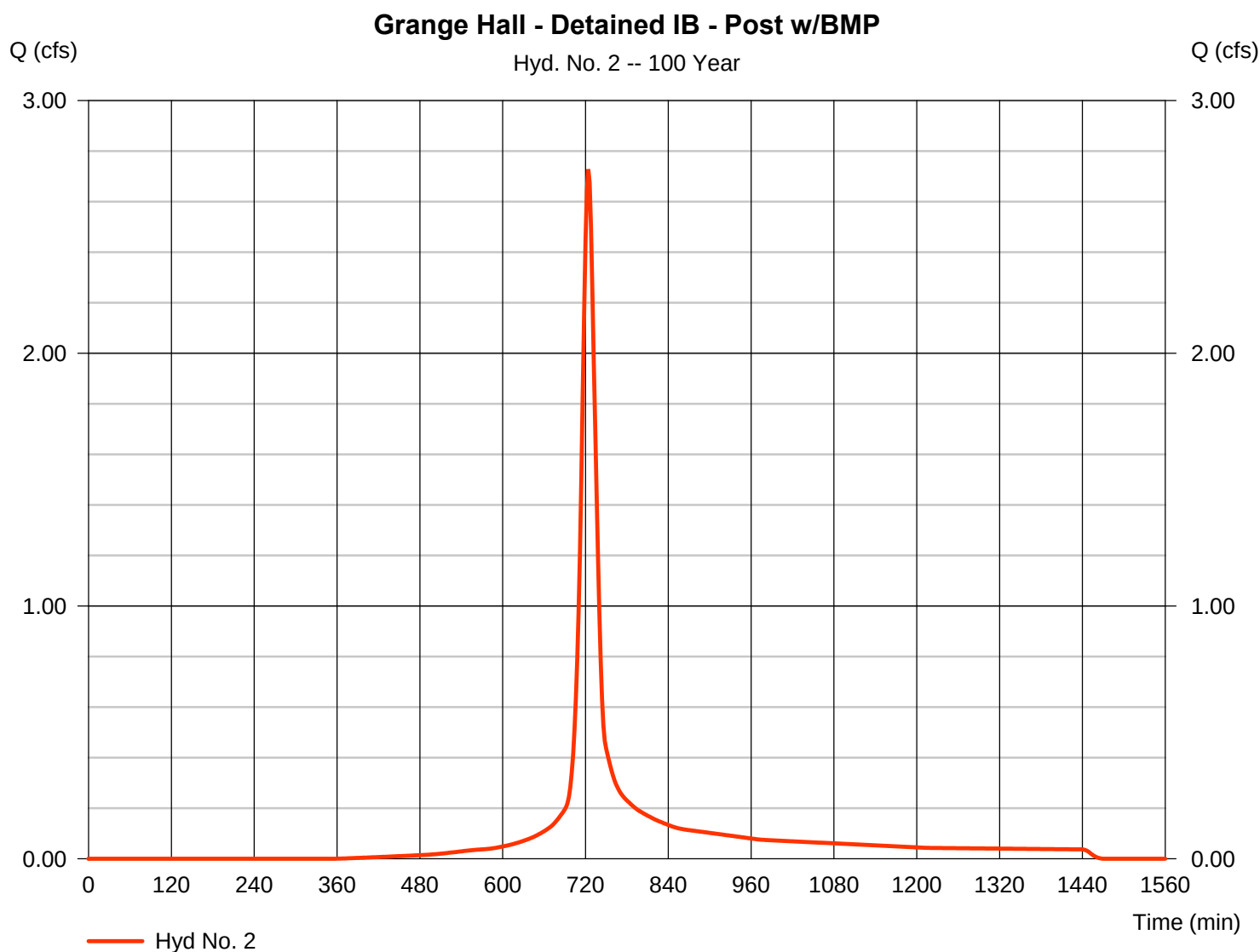
Friday, 11 / 4 / 2016

Hyd. No. 2

Grange Hall - Detained IB - Post w/BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.728 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	8,581 cuft
Drainage area	=	0.620 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	19.40 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.170 \times 78) + (0.280 \times 78) + (0.170 \times 91)] / 0.620$



Hydrograph Report

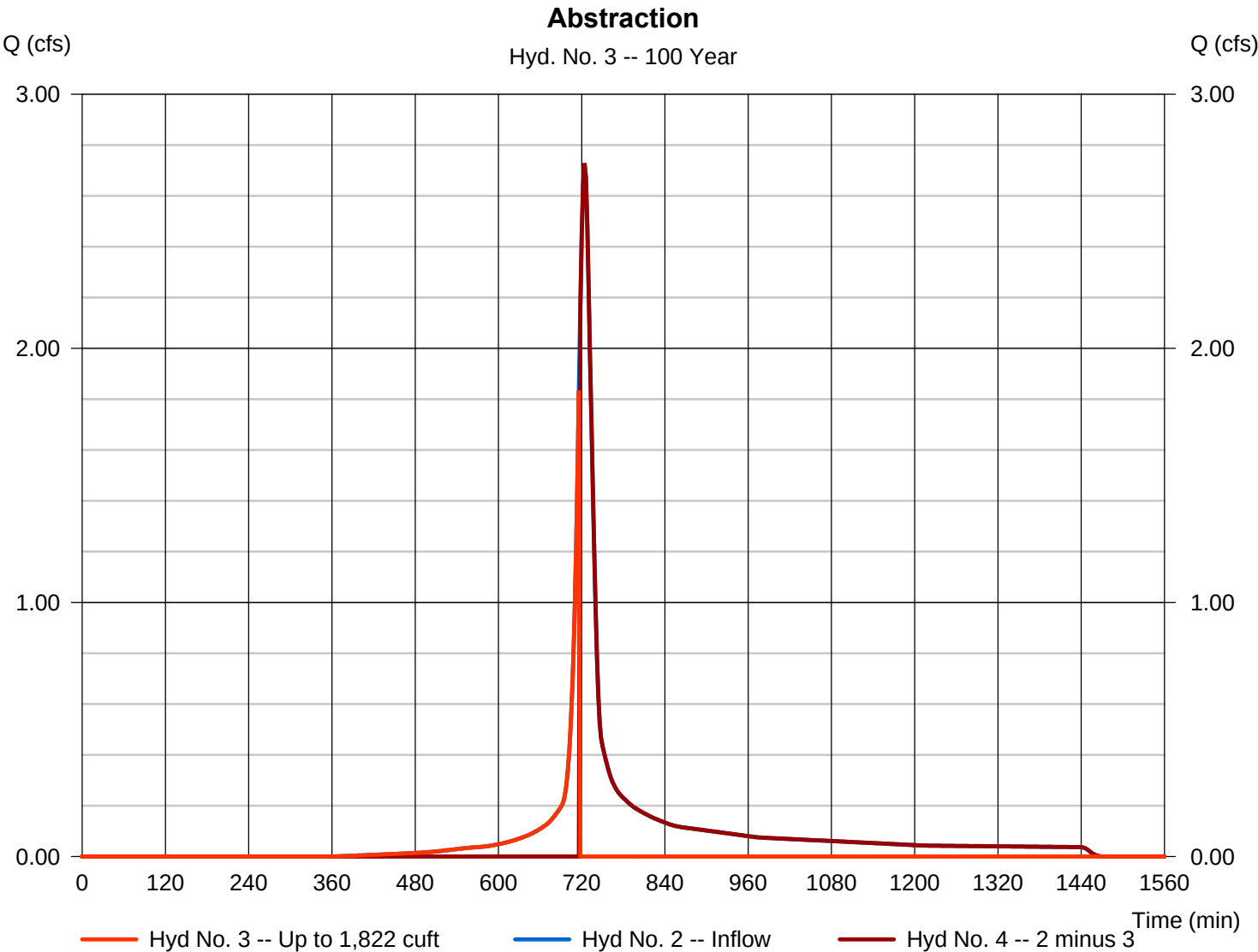
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.833 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	1,893 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BIP	Positive BIP hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	1,822 cuft



Hydrograph Report

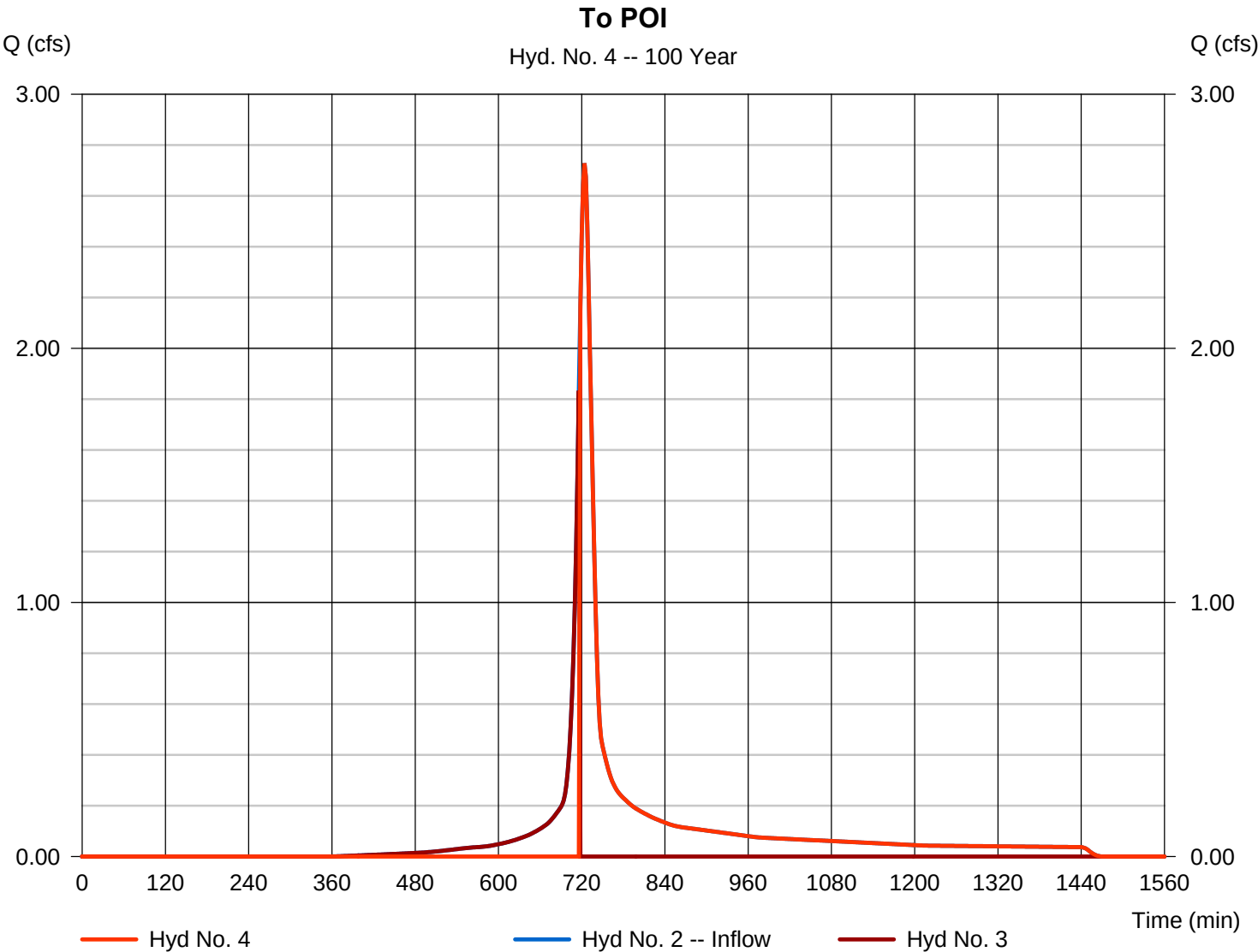
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	2.728 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	6,688 cuft
Inflow hydrograph	=	2 - Grange Hall - Detained IB - Positive BIP hyd.	Positive BIP hyd.	=	3
Diversion method	=	First Flush Volume	Volume Up To	=	1,822 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

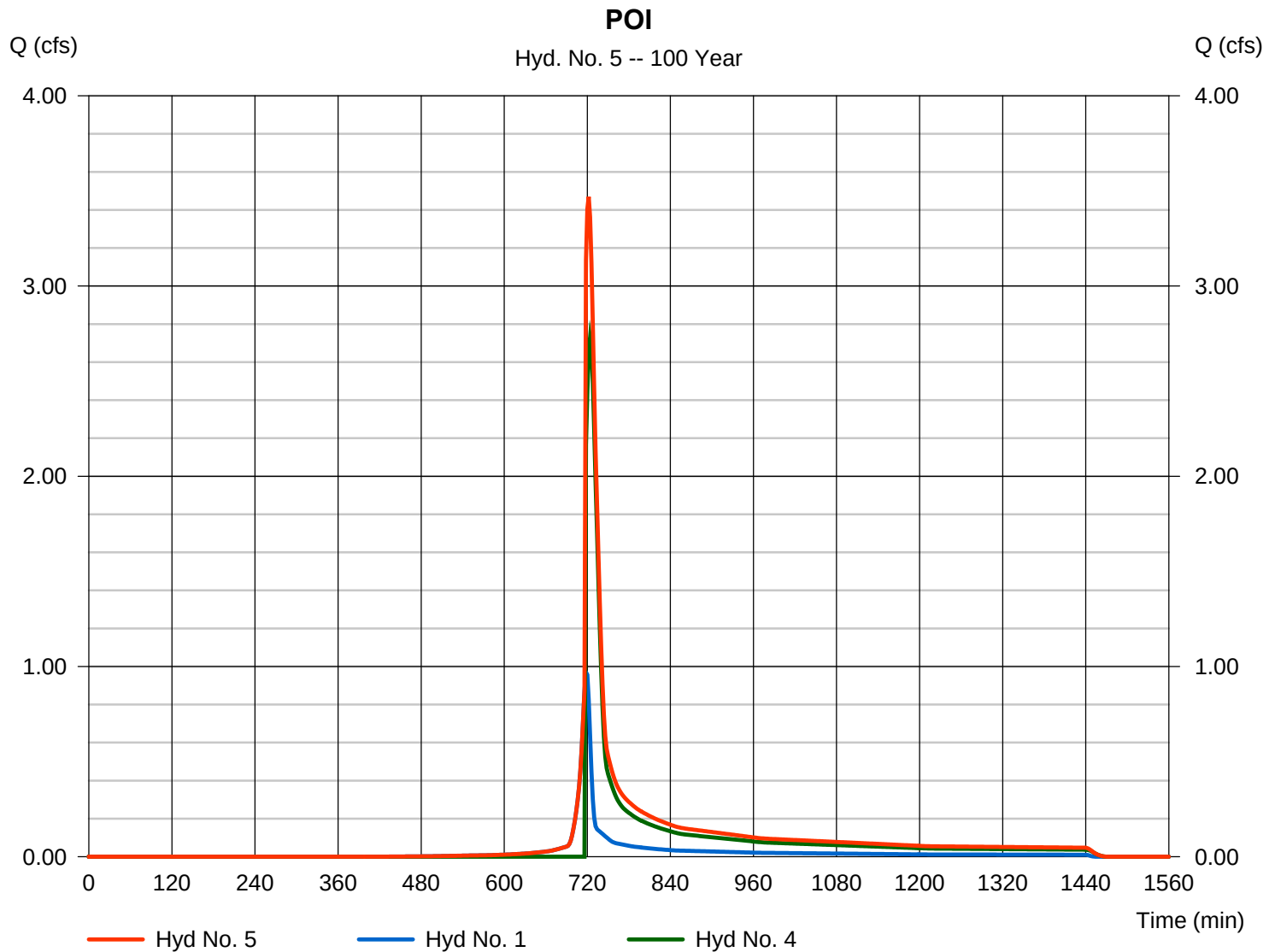
Friday, 11 / 4 / 2016

Hyd. No. 5

POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 4

Peak discharge = 3.470 cfs
 Time to peak = 722 min
 Hyd. volume = 8,917 cuft
 Contrib. drain. area = 0.180 ac



COONEY RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 19, 2016

Project Name: Cooney Rd

Municipality: Munster Township/Cresson Township

County: Cambria

Total Area (acres): 1.77

Major River Basin: Ohio

Watershed: Little Conemaugh River

Sub Basin: Tributary to Bens Creek-Little Conemaugh River

Nearest Surface Water to Receive Runoff: Tributary 46127 to Little Conemaugh River

Ch. 93 - Designated Water Use: CWF

Impaired according to Chapter 303(d) list?
List Causes of Impairment:

YES
NO

X

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES
NO

X

Existing or Planned drinking water supply?

YES
NO

X

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES
NO

X

Existing River Conservation Plan?

YES
NO

X

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	1.77	0.77
Other:			
TOTAL EXISTING:	Yes	1.77	0.77

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>0.77</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>0.77</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
1.77	-	0.77	=	1.00
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³
Meadow	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy	<u> </u>	ft ² x	1/2 in x	1/12 =	<u> </u>	ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

For all other disconnected roof areas

Roof Area	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

For all other disconnected roof areas

Impervious Areas	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

ft³

* For use on Worksheet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Cooney Rd
 Drainage Area: 1.77 acres
 2-Year Rainfall: 2.62 in

Total Site Area: 1.77 acres
 Protected Site Area: 0.77 acres
 Managed Site Area: 1.00 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	34848	0.80	78	2.82	0.56	0.87	2,517
Woods	C/D	3920	0.09	77	2.99	0.60	0.82	267
80% Existing Gravel	C/D	3920	0.09	91	0.99	0.20	1.72	562
Meadow (20% Gravel)	C/D	871	0.02	78	2.82	0.56	0.87	63
TOTAL:		43,560	1.00					3,409

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C/D	35719	0.82	78	2.82	0.56	0.87	2,580
Impervious Gravel	C/D	7841	0.18	91	0.99	0.20	1.72	1,124
TOTAL:		43,560	1.00					3,704

2-Year Volume Increase (ft ³):	295

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Cooney Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 295

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 295
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	2,074	2,486
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			2,486
			Structural Volume Requirement (ft³): 295
			DIFFERENCE: -2,191

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

**PCSM - DESIGN CALCULATIONS
COONEY RD**

TETRA TECH, INC.

By: EAD Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations Cooney Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Cooney Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Cooney Road Block Valve Site is located in Munster/Cresson Townships, Cambria County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.62
10-yr	3.76
50-yr	5.13
100-yr	5.80

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.62 in

Total Site Area : 1.77 acres

Protected Site Area: 0.77 acres

Stormwater Management Area 1.00 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.80	78	2.82	0.56	0.87	2,517
Woods	C/D	0.09	77	2.99	0.60	0.82	267
80% Existing Gravel	C/D	0.09	91	0.99	0.20	1.72	562
Meadow (20% Gravel)	C/D	0.02	78	2.82	0.56	0.87	63
Total		1.00					3,409

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C/D	0.82	78	2.82	0.56	0.87	2,580
Impervious Gravel	C/D	0.18	91	0.99	0.20	1.72	1,124
Total		1.00					3,704

2-Year Volume Increase (cf):	295

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

P = 2-Year Rainfall (in)

S = $(1000/CN) - 10$

2. Runoff Volume (CF) = Q x Area x 1/12

Q = Runoff (in)

Area = Land use area (sq. ft.)

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.18	7841
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,568
Design Infiltration Area (sf):		2,074
Design Impervious Ratio:	3.8	:1

OK

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.65	28226
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		3,528
Design Infiltration Area (sf):		2,074
Design Total Watershed Ratio:	13.6	:1

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Cooney Road Block Valve Site will be located on the eastern edge of the pad and 95 percent of the disturbed area will be detained by the BMP.

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr)	0.5

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

Infiltration Berm

Storage Volume

	Length (ft)	Cross Section Area (sf)	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
	39	77	2,074	2.00	2,999

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.5	2,074	2	173

Volume Abstraction Potential (cf)	3,171.93

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration BMP				
Infiltration Berm	2486	2999	2999.1	2486
Total Structural Credit (cf) (Worksheet 5)				2486

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 1.77 acres. Based upon the soil survey of Cambria County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Cavode siltloam (CaB) and Cavode silt loam (CaC) series which are primarily classified as HSG C/D. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.57
C/D	CaB	Woods	77	0.19
C/D	CaC	Meadow	78	0.77
C/D	CaC	Woods	77	0.14
C/D	CaC	Existing Gravel (80%)	91	0.08
C/D	CaC	Meadow (20% Gravel)	78	0.02
			Totals	1.77
			CN	78

Post-Development Condition

Undetained Area 1

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.39
C/D	CaB	Woods	77	0.17
C/D	CaC	Meadow	78	0.21
C/D	CaC	Woods	77	0.07
C/D	CaC	Impervious - Gravel	91	0.01
			Totals	0.85
			CN	78

Undetained Area 2

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.03
C/D	CaC	Meadow	78	0.02
			Totals	0.05
			CN	78

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By: EAD Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

BMP (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.20
C/D	CaC	Meadow	78	0.50
C/D	CaC	Impervious - Gravel	91	0.18
			Totals	0.88

CN	81

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	1.1	2,999	46.0	10.3	56.3
10	2.0	2,999	25.0	10.3	35.3
50	3.2	2,999	15.8	10.3	26.1
100	3.7	2,999	13.4	10.3	23.7

Note: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

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Chkd. By: LMD Date: 10/21/16 Cooney Rd Proj. No.: 112IC05958

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	2,486	3,172	2,486
10	4,572	3,172	3,172
50	7,308	3,172	3,172
100	8,698	3,172	3,172

STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

Storm Frequency	Pre-Development	Post-Development			
	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	2.2	2.5	3,580	1.2	-0.9
10-yr	4.3	4.9	8,365	2.4	-1.9
50-yr	7.2	7.9	15,757	4.0	-3.2
100-yr	8.7	9.4	19,510	5.3	-3.4

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By: EAD Date: 10/19/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/21/2016 Cooney Rd Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Cambria County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4539 N 78.6205 W 2054.23 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Munster Twp, Pennsylvania,
USA*

Latitude: 40.4539°, Longitude: -78.6205°

Elevation: 2054.23 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.323 (0.292–0.358)	0.387 (0.350–0.430)	0.469 (0.423–0.521)	0.533 (0.479–0.591)	0.619 (0.553–0.684)	0.687 (0.611–0.759)	0.756 (0.669–0.833)	0.829 (0.728–0.914)	0.932 (0.811–1.03)	1.01 (0.872–1.11)
10-min	0.501 (0.453–0.557)	0.604 (0.547–0.671)	0.729 (0.658–0.809)	0.823 (0.740–0.913)	0.946 (0.846–1.05)	1.04 (0.927–1.15)	1.14 (1.01–1.26)	1.24 (1.09–1.36)	1.37 (1.19–1.51)	1.47 (1.27–1.62)
15-min	0.615 (0.556–0.683)	0.738 (0.669–0.821)	0.895 (0.808–0.993)	1.01 (0.911–1.12)	1.17 (1.05–1.29)	1.29 (1.15–1.42)	1.41 (1.25–1.56)	1.54 (1.35–1.70)	1.71 (1.49–1.88)	1.84 (1.59–2.02)
30-min	0.813 (0.735–0.903)	0.988 (0.895–1.10)	1.23 (1.11–1.36)	1.41 (1.27–1.56)	1.65 (1.48–1.83)	1.84 (1.64–2.04)	2.04 (1.81–2.25)	2.25 (1.97–2.48)	2.53 (2.20–2.79)	2.76 (2.38–3.03)
60-min	0.993 (0.898–1.10)	1.21 (1.10–1.35)	1.54 (1.39–1.71)	1.79 (1.61–1.98)	2.14 (1.91–2.37)	2.43 (2.16–2.68)	2.73 (2.41–3.01)	3.05 (2.68–3.36)	3.50 (3.05–3.86)	3.87 (3.34–4.26)
2-hr	1.16 (1.05–1.30)	1.41 (1.27–1.57)	1.80 (1.61–2.00)	2.10 (1.88–2.34)	2.54 (2.25–2.81)	2.90 (2.56–3.21)	3.29 (2.88–3.63)	3.71 (3.23–4.09)	4.33 (3.72–4.77)	4.84 (4.13–5.35)
3-hr	1.25 (1.13–1.39)	1.52 (1.37–1.69)	1.92 (1.72–2.13)	2.24 (2.01–2.48)	2.71 (2.41–2.99)	3.10 (2.74–3.41)	3.52 (3.09–3.88)	3.98 (3.47–4.37)	4.66 (4.01–5.11)	5.23 (4.46–5.73)
6-hr	1.52 (1.37–1.70)	1.84 (1.66–2.05)	2.29 (2.06–2.55)	2.67 (2.39–2.97)	3.21 (2.85–3.56)	3.66 (3.24–4.06)	4.16 (3.64–4.59)	4.69 (4.08–5.18)	5.48 (4.70–6.03)	6.14 (5.22–6.75)
12-hr	1.91 (1.73–2.14)	2.30 (2.08–2.58)	2.85 (2.58–3.19)	3.32 (2.98–3.70)	4.00 (3.57–4.45)	4.58 (4.06–5.09)	5.22 (4.59–5.78)	5.93 (5.15–6.55)	6.97 (5.98–7.70)	7.87 (6.66–8.67)
24-hr	2.19 (2.02–2.40)	2.62 (2.42–2.87)	3.25 (2.99–3.54)	3.76 (3.45–4.10)	4.51 (4.11–4.89)	5.13 (4.66–5.56)	5.80 (5.23–6.27)	6.51 (5.84–7.04)	7.55 (6.69–8.14)	8.39 (7.38–9.06)
2-day	2.55 (2.36–2.77)	3.05 (2.82–3.32)	3.76 (3.47–4.08)	4.35 (4.00–4.71)	5.19 (4.75–5.62)	5.89 (5.36–6.37)	6.64 (6.00–7.17)	7.44 (6.68–8.05)	8.59 (7.63–9.30)	9.54 (8.38–10.3)
3-day	2.73 (2.53–2.97)	3.26 (3.03–3.54)	4.00 (3.71–4.34)	4.61 (4.26–4.99)	5.49 (5.04–5.93)	6.21 (5.68–6.70)	6.98 (6.33–7.53)	7.79 (7.02–8.42)	8.96 (7.99–9.69)	9.91 (8.75–10.7)
4-day	2.92 (2.71–3.16)	3.48 (3.23–3.77)	4.25 (3.95–4.60)	4.88 (4.52–5.27)	5.79 (5.33–6.24)	6.53 (5.99–7.04)	7.31 (6.67–7.89)	8.14 (7.37–8.80)	9.32 (8.34–10.1)	10.3 (9.11–11.1)
7-day	3.52 (3.30–3.78)	4.19 (3.92–4.50)	5.06 (4.73–5.42)	5.75 (5.37–6.17)	6.72 (6.25–7.20)	7.49 (6.94–8.02)	8.28 (7.64–8.87)	9.10 (8.35–9.76)	10.2 (9.30–11.0)	11.1 (10.0–12.0)
10-day	4.29 (4.03–4.58)	5.08 (4.77–5.43)	6.05 (5.68–6.46)	6.83 (6.40–7.29)	7.89 (7.37–8.42)	8.74 (8.13–9.33)	9.60 (8.90–10.3)	10.5 (9.66–11.2)	11.7 (10.7–12.5)	12.6 (11.5–13.6)
20-day	6.09 (5.79–6.43)	7.16 (6.81–7.58)	8.34 (7.92–8.82)	9.24 (8.77–9.78)	10.4 (9.87–11.0)	11.3 (10.7–12.0)	12.2 (11.5–12.9)	13.1 (12.3–13.9)	14.2 (13.3–15.1)	15.1 (14.0–16.1)
30-day	7.75 (7.38–8.15)	9.08 (8.65–9.56)	10.4 (9.91–11.0)	11.5 (10.9–12.1)	12.8 (12.1–13.5)	13.8 (13.1–14.5)	14.7 (13.9–15.5)	15.7 (14.8–16.6)	16.9 (15.8–17.8)	17.8 (16.6–18.8)
45-day	9.46 (9.04–9.91)	11.1 (10.6–11.6)	12.5 (12.0–13.1)	13.6 (13.0–14.3)	15.0 (14.3–15.7)	16.0 (15.2–16.8)	16.9 (16.1–17.7)	17.8 (16.9–18.7)	18.8 (17.8–19.8)	19.6 (18.5–20.6)
60-day	12.2 (11.7–12.7)	14.2 (13.6–14.8)	15.9 (15.3–16.6)	17.2 (16.5–18.0)	18.8 (18.0–19.6)	19.9 (19.0–20.8)	21.0 (20.0–21.9)	21.9 (20.9–22.9)	23.1 (21.9–24.2)	23.9 (22.6–25.1)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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 **Cambria County, Pennsylvania**

Cooney Road



October 19, 2016

1149 of 1484

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

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

Soil Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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: <http://websoilsurvey.nrcs.usda.gov>
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: Cambria County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Oct 6, 2011—Oct 17, 2011

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

Cambria County, Pennsylvania (PA021)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CaB	Cavode silt loam, 3 to 8 percent slopes	0.8	39.4%
CaC	Cavode silt loam, 8 to 15 percent slopes	1.2	60.6%
Totals for Area of Interest		2.0	100.0%

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

Cambria County, Pennsylvania

CaB—Cavode silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 15wm

Elevation: 1,000 to 1,700 feet

Mean annual precipitation: 36 to 46 inches

Mean annual air temperature: 41 to 62 degrees F

Frost-free period: 130 to 160 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Cavode and similar soils: 85 percent

Minor components: 15 percent

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

Description of Cavode

Setting

Landform: Hills

Landform position (two-dimensional): Backslope, summit

Landform position (three-dimensional): Interfluve

Down-slope shape: Linear, concave

Across-slope shape: Concave

Parent material: Acid clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 10 inches: silt loam

Btg - 10 to 47 inches: silty clay loam

BCg - 47 to 57 inches: channery silt loam

R - 57 to 61 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: 40 to 90 inches to lithic bedrock

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 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent

Landform: Hills

Custom Soil Resource Report

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Hills, draws
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: Yes

CaC—Cavode silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: l5wn
Elevation: 1,000 to 1,700 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cavode and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cavode

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave
Parent material: Acid clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 10 inches: silt loam
Btg - 10 to 47 inches: silty clay loam
BCg - 47 to 57 inches: channery silt loam
R - 57 to 61 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 40 to 90 inches to lithic bedrock
Natural drainage class: Somewhat poorly drained
Runoff class: Very high

Custom Soil Resource Report

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 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent

Landform: Hillslopes

Landform position (two-dimensional): Summit, backslope, shoulder

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Linear, convex

Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent

Landform: Hills, draws

Landform position (two-dimensional): Toeslope, footslope

Landform position (three-dimensional): Base slope, head slope

Down-slope shape: Concave, linear

Across-slope shape: Concave, linear

Hydric soil rating: Yes

ATTACHMENT C
COONEY RD
HYDRAFLOW RESULTS

ATTACHMENT C-1
COONEY RD
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Cooney Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	2.154	-----	-----	4.315	-----	7.212	8.680	Cooney Rd - PRE
Proj. file: Cooney Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.154	2	722	5,743	-----	-----	-----	Cooney Rd - PRE
Cooney Rd-PRE.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

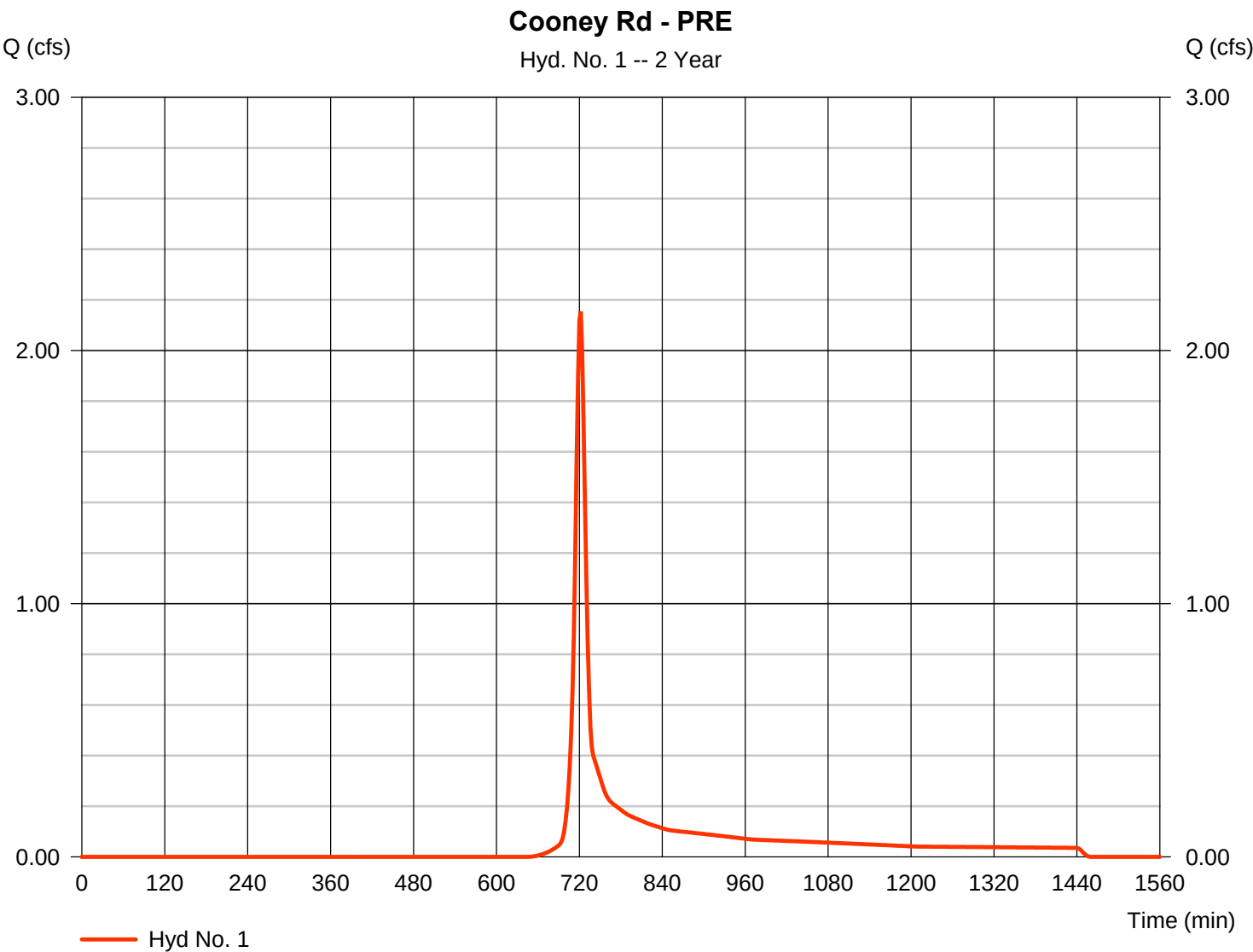
Hydrograph Report

Hyd. No. 1

Cooney Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.154 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	5,743 cuft
Drainage area	=	1.770 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.40 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.360 x 78) + (0.330 x 77) + (0.080 x 91)] / 1.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

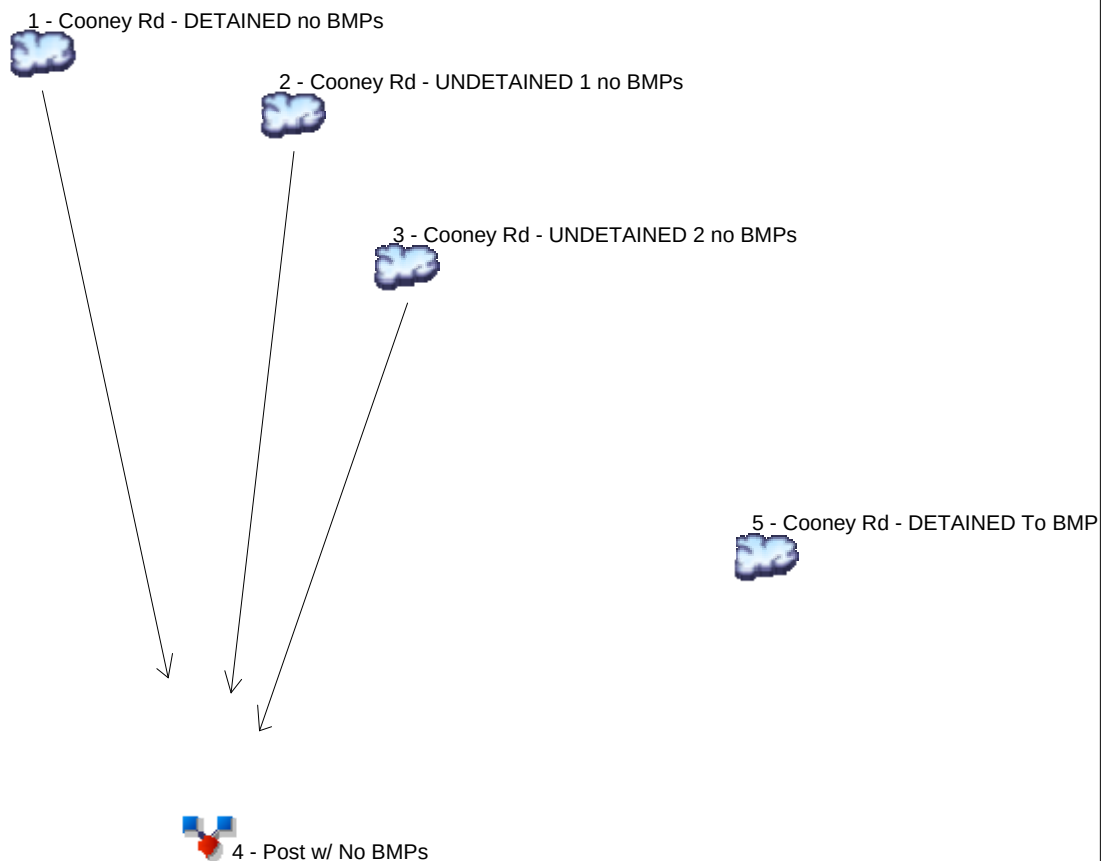
Hyd. No. 1

Cooney Rd - PRE

<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)	= 2.51	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.38	+	0.00	+
			0.00	= 8.38
Shallow Concentrated Flow				
Flow length (ft)	= 91.00	351.00	0.00	
Watercourse slope (%)	= 10.90	4.60	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=5.33	3.46	0.00	
Travel Time (min)	= 0.28	+	1.69	+
			0.00	= 1.98
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	= 0.025	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				10.40 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.290	-----	-----	2.441	-----	3.926	4.668	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	-----	-----	1.157	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	-----	-----	0.068	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2 no BM
4	Combine	1, 2, 3	-----	2.509	-----	-----	4.862	-----	7.907	9.435	Post w/ No BMPs
5	SCS Runoff	-----	-----	1.086	-----	-----	1.998	-----	3.164	3.744	Cooney Rd - DETAINED To BMP

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.290	2	722	3,389	-----	-----	-----	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	1.157	2	720	2,674	-----	-----	-----	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	0.068	2	720	157	-----	-----	-----	Cooney Rd - UNDETAINED 2 no BM
4	Combine	2.509	2	720	6,221	1, 2, 3	-----	-----	Post w/ No BMPs
5	SCS Runoff	1.086	2	720	2,486	-----	-----	-----	Cooney Rd - DETAINED To BMP
Cooney Rd-no BMP.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

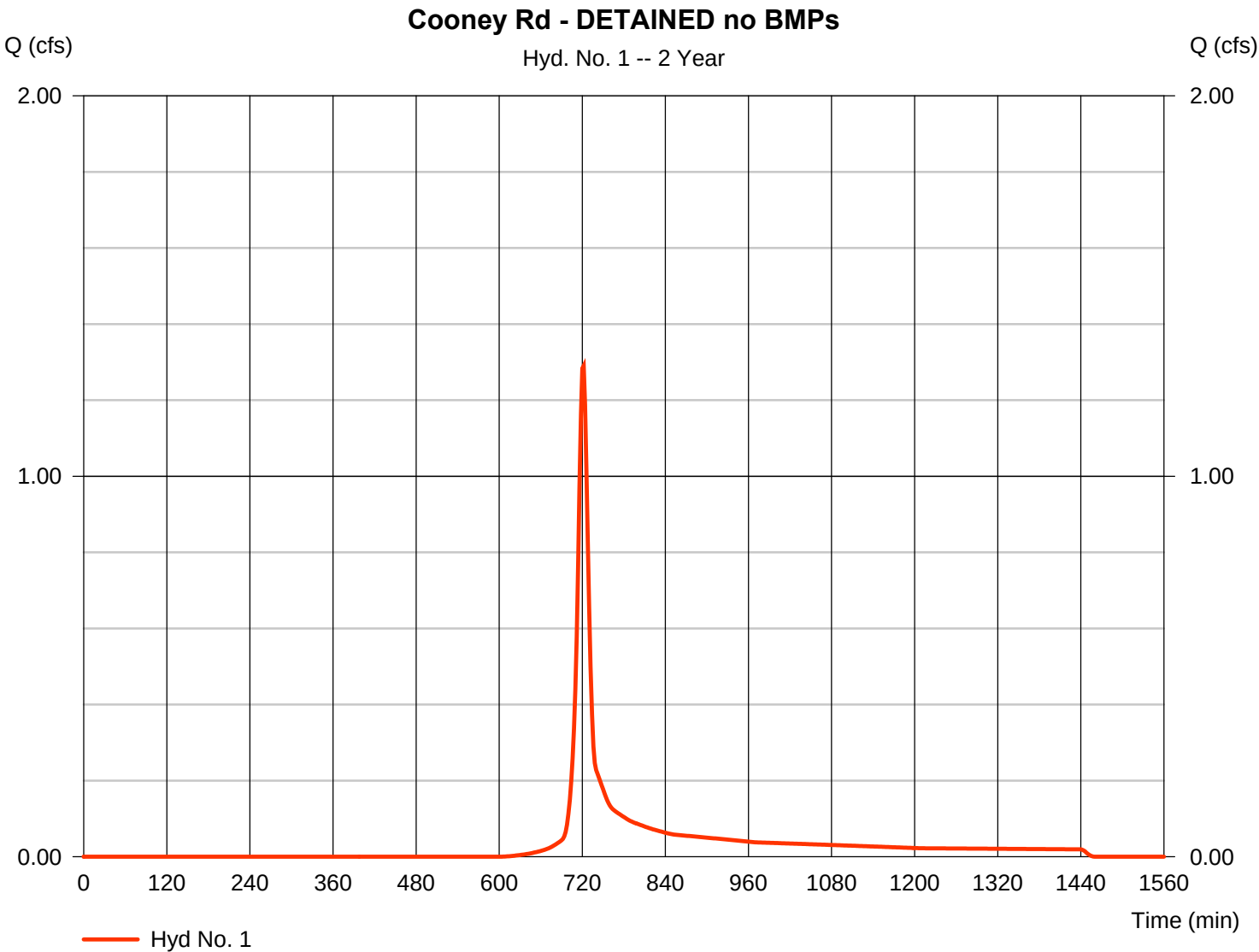
Hydrograph Report

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.290 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	3,389 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.30 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	282.00				
Watercourse slope (%)	= 13.20	4.50	4.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.46				
Travel Time (min)	= 0.11	+	0.59	+	1.36	=	2.06
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	= 0.025	0.025	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				10.30 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

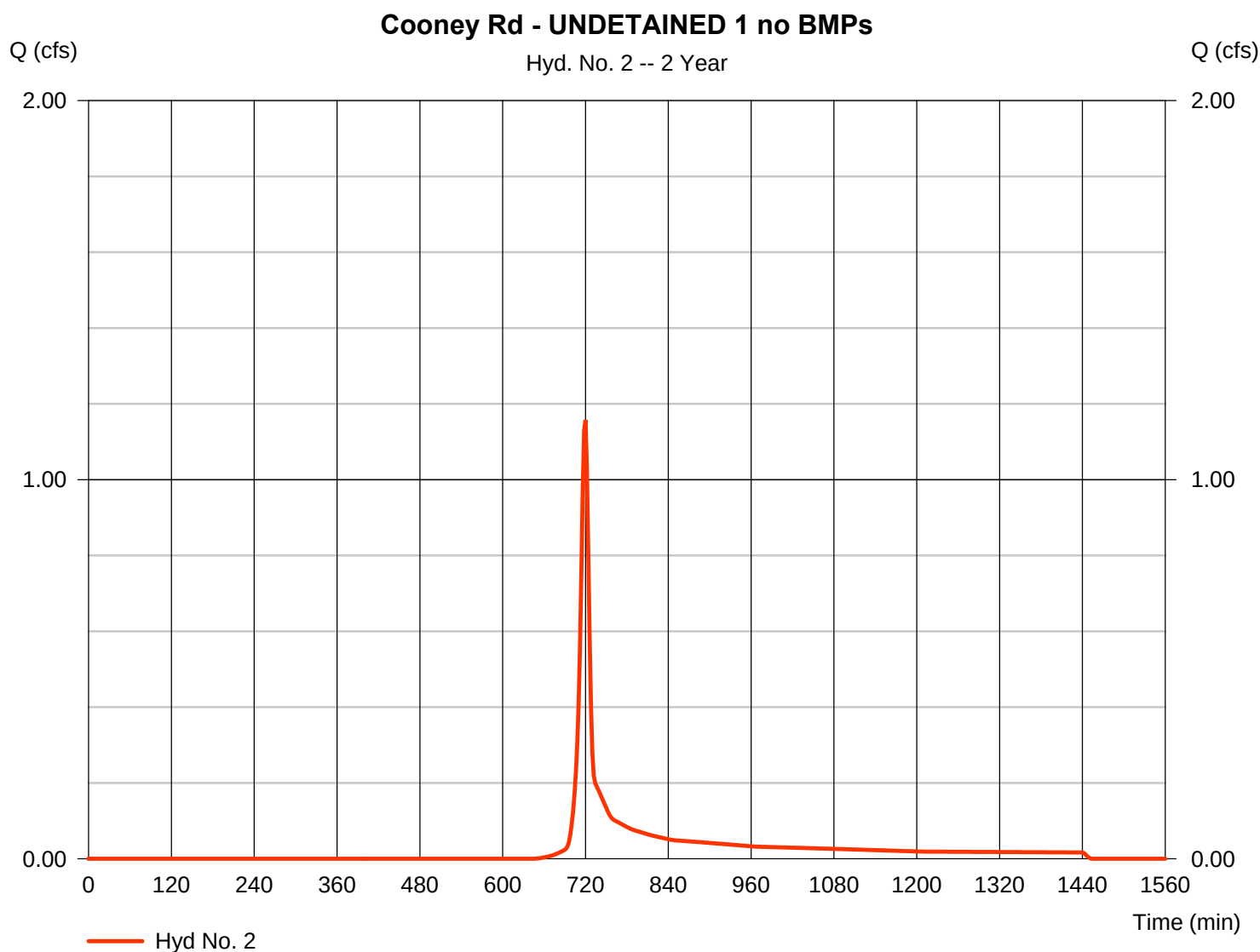
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.157 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	2,674 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

<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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

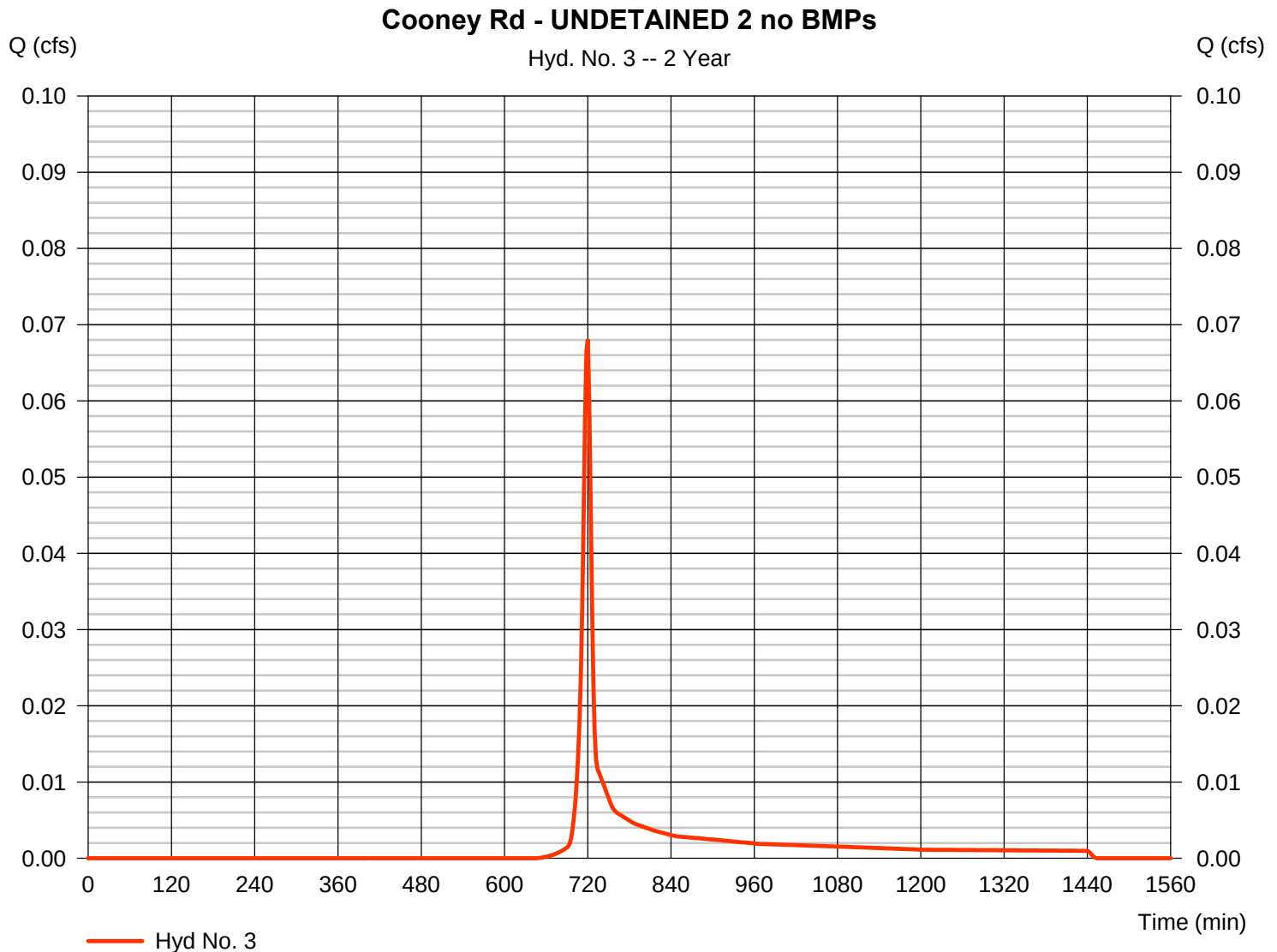
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Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.068 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	157 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

<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)	= 2.62	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.21	+	0.00	+
			0.00	= 8.21
Shallow Concentrated Flow				
Flow length (ft)	= 178.00	0.00	0.00	
Watercourse slope (%)	= 5.10	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.64	0.00	0.00	
Travel Time (min)	= 0.81	+	0.00	+
			0.00	= 0.81
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	= 0.025	0.025	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				9.00 min

Hydrograph Report

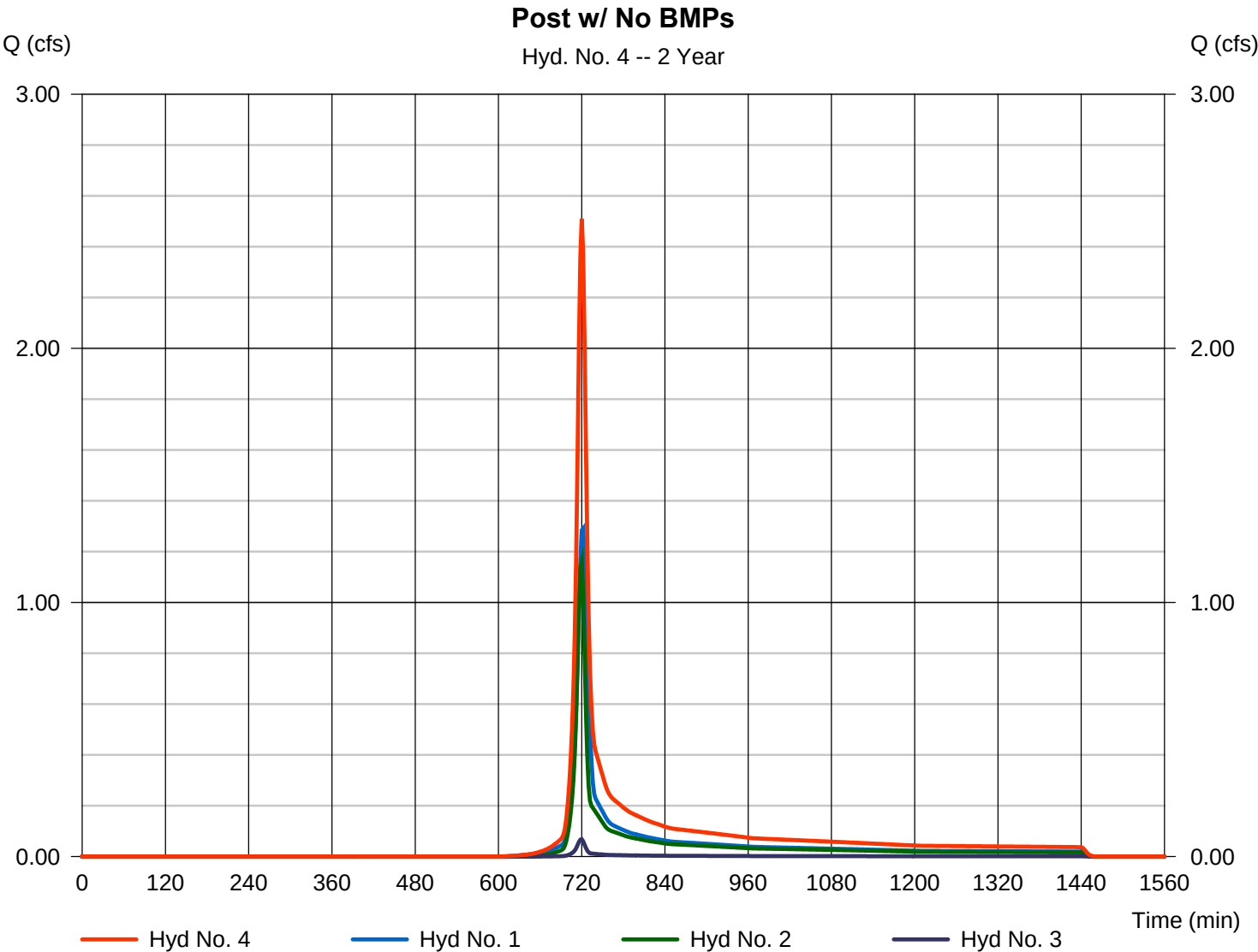
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Wednesday, 11 / 9 / 2016

Hyd. No. 4

Post w/ No BMPs

Hydrograph type	= Combine	Peak discharge	= 2.509 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 6,221 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 1.780 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

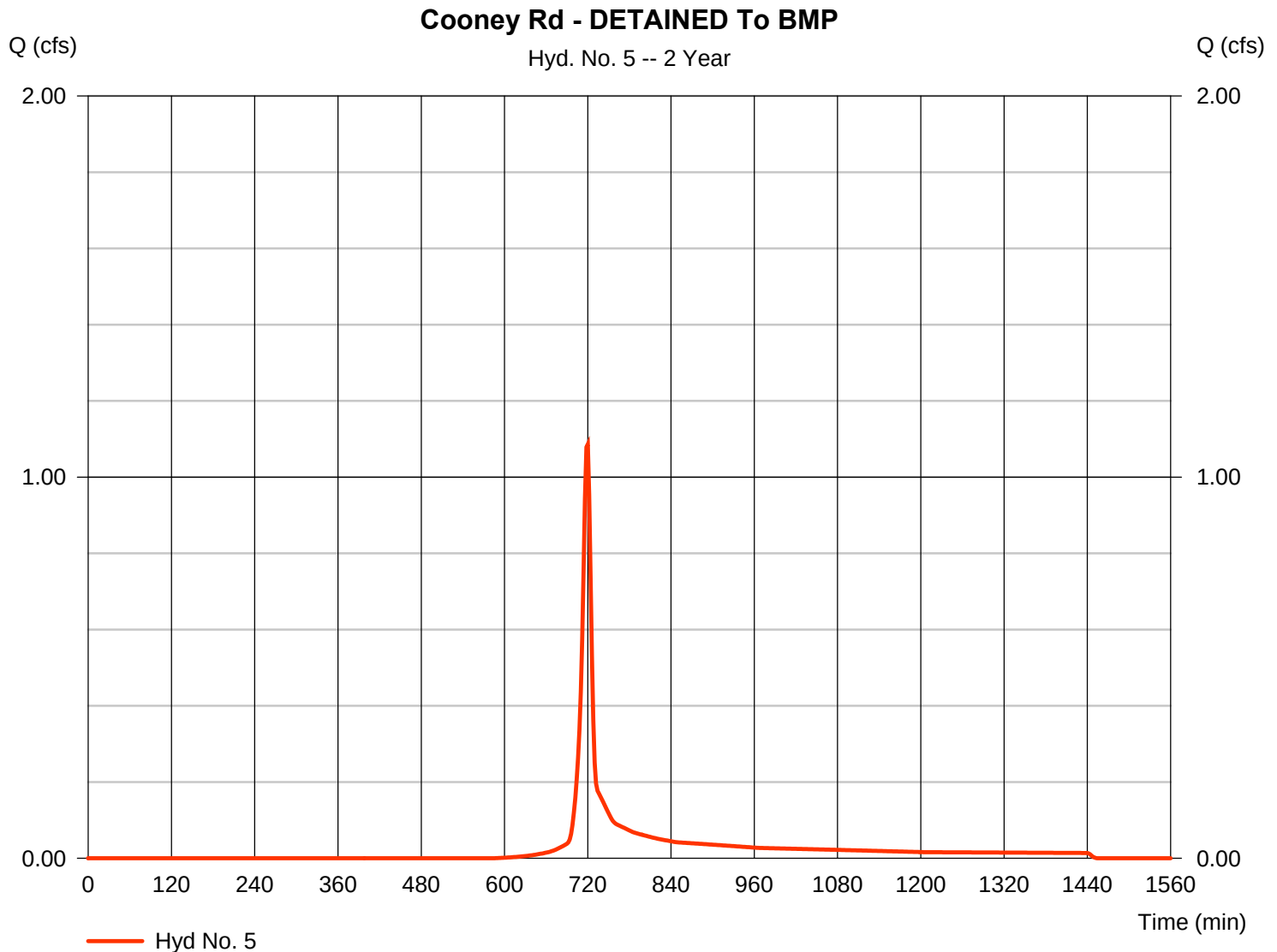
Wednesday, 11 / 9 / 2016

Hyd. No. 5

Cooney Rd - DETAINED To BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.086 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	2,486 cuft
Drainage area	=	0.630 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.20 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.450 \times 78) + (0.180 \times 91)] / 0.630$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

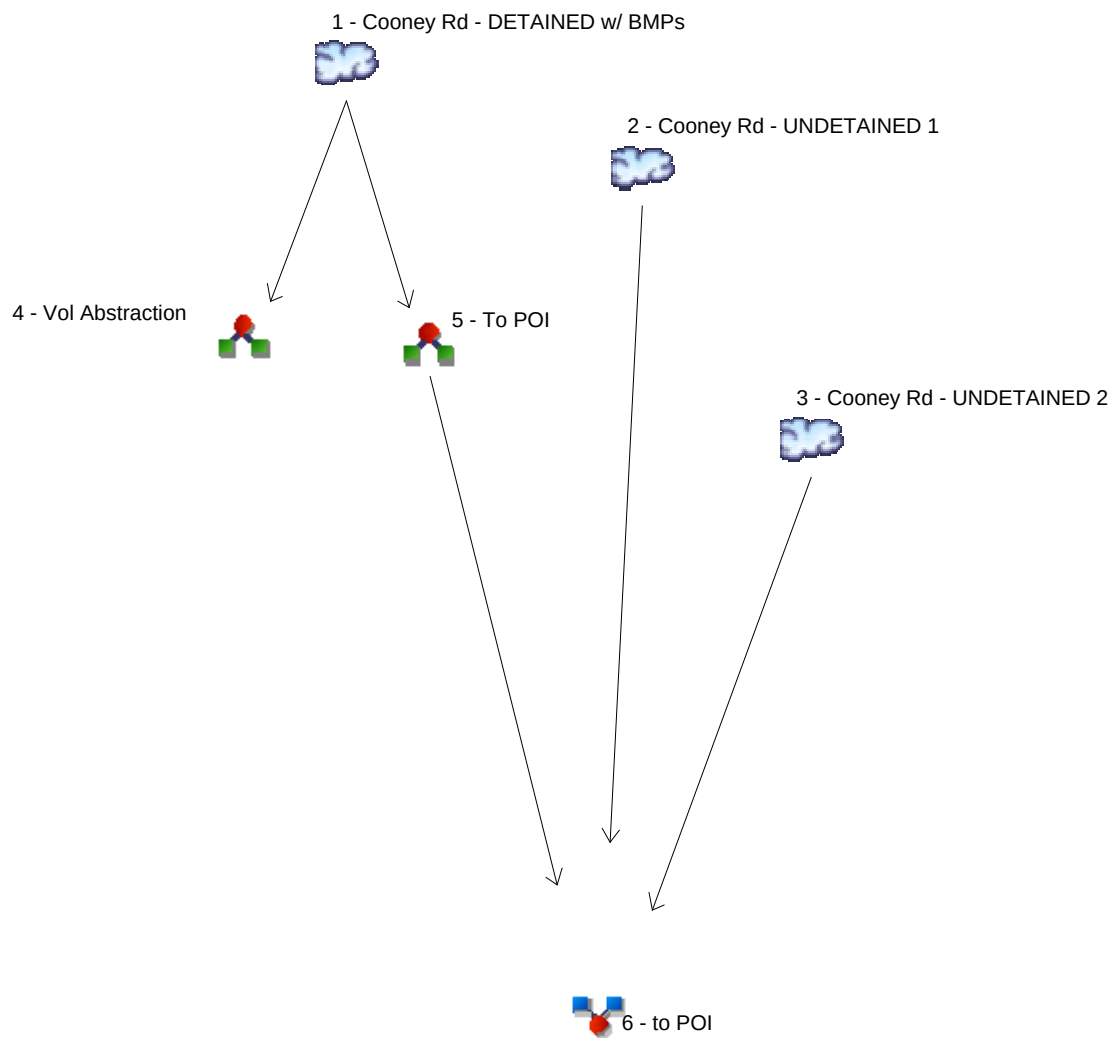
Hyd. No. 5

Cooney Rd - DETAINED To BMP

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 100.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.21	+	0.00	+
			0.00	= 8.21
Shallow Concentrated Flow				
Flow length (ft)	= 39.00	152.00	55.00	
Watercourse slope (%)	= 13.20	4.50	3.60	
Surface description	= Unpaved	Paved	Unpaved	
Average velocity (ft/s)	=5.86	4.31	3.06	
Travel Time (min)	= 0.11	+	0.59	+
			0.30	= 1.00
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	= 0.025	0.025	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				9.20 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.856	-----	-----	-----	-----	-----	-----	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	-----	-----	1.157	-----	-----	-----	-----	-----	-----	Cooney Rd - UNDETAINED 1
3	SCS Runoff	-----	-----	0.068	-----	-----	-----	-----	-----	-----	Cooney Rd - UNDETAINED 2
4	Diversion1	1	-----	0.856	-----	-----	-----	-----	-----	-----	Vol Abstraction
5	Diversion2	1	-----	0.040	-----	-----	-----	-----	-----	-----	To POI
6	Combine	2, 3, 5	-----	1.226	-----	-----	-----	-----	-----	-----	to POI
Proj. file: Cooney Rd- wBMP-2yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.856	2	730	3,235	-----	-----	-----	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	1.157	2	720	2,674	-----	-----	-----	Cooney Rd - UNDETAINED 1
3	SCS Runoff	0.068	2	720	157	-----	-----	-----	Cooney Rd - UNDETAINED 2
4	Diversion1	0.856	2	730	2,487	1	-----	-----	Vol Abstraction
5	Diversion2	0.040	2	958	748	1	-----	-----	To POI
6	Combine	1.226	2	720	3,580	2, 3, 5	-----	-----	to POI
Cooney Rd- wBMP-2yr.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2016	

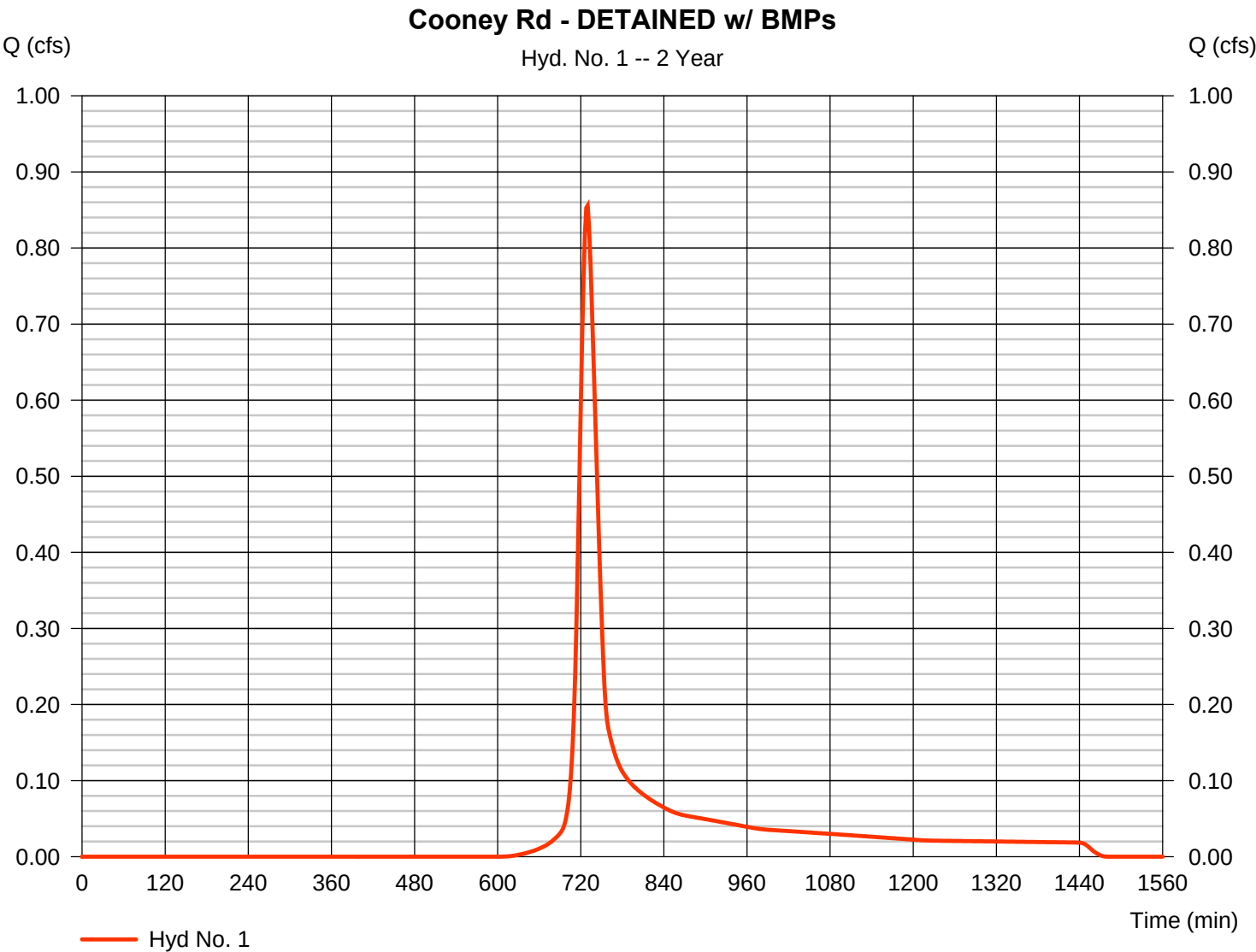
Hydrograph Report

Hyd. No. 1

Cooney Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.856 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	3,235 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	23.70 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

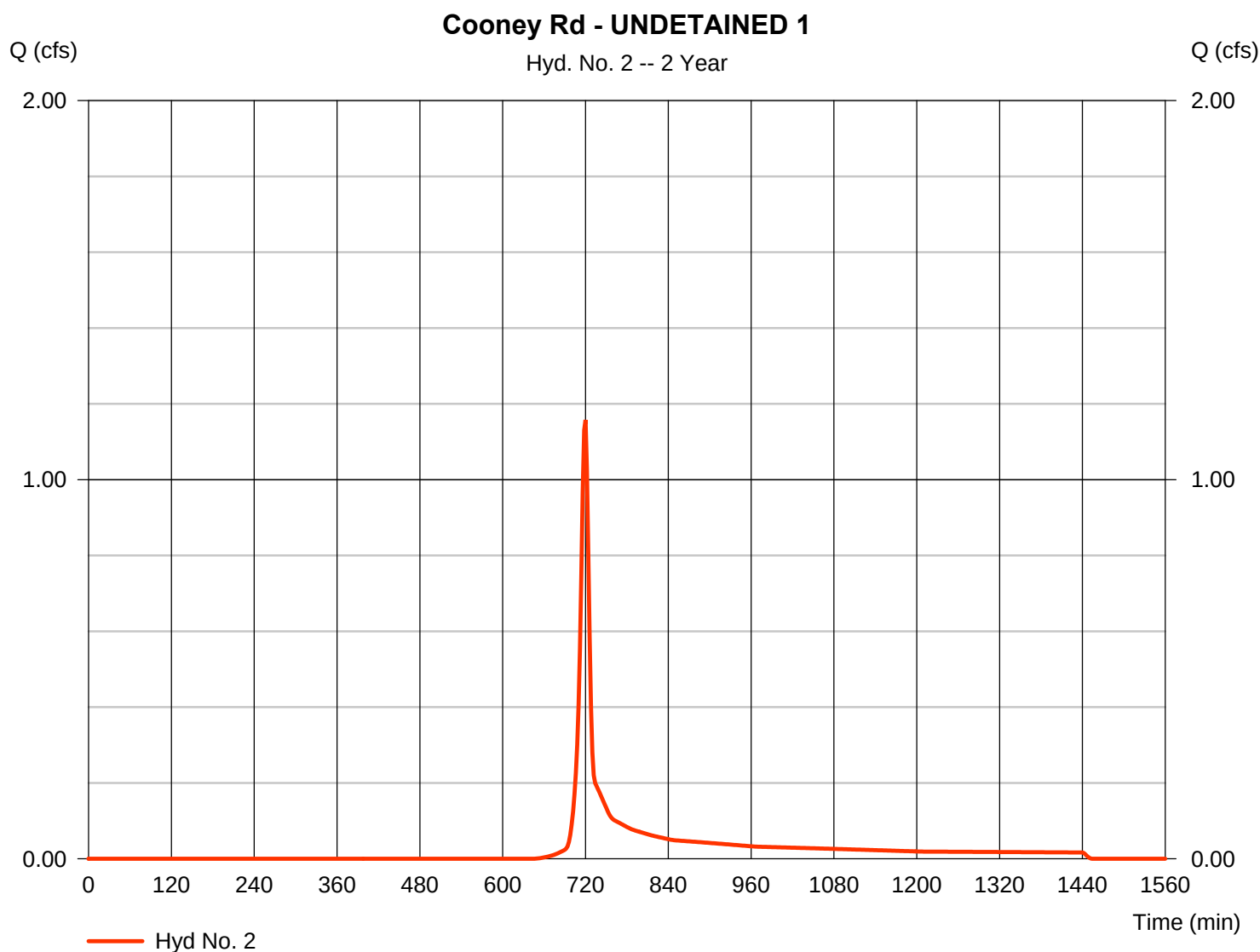
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.157 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	2,674 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

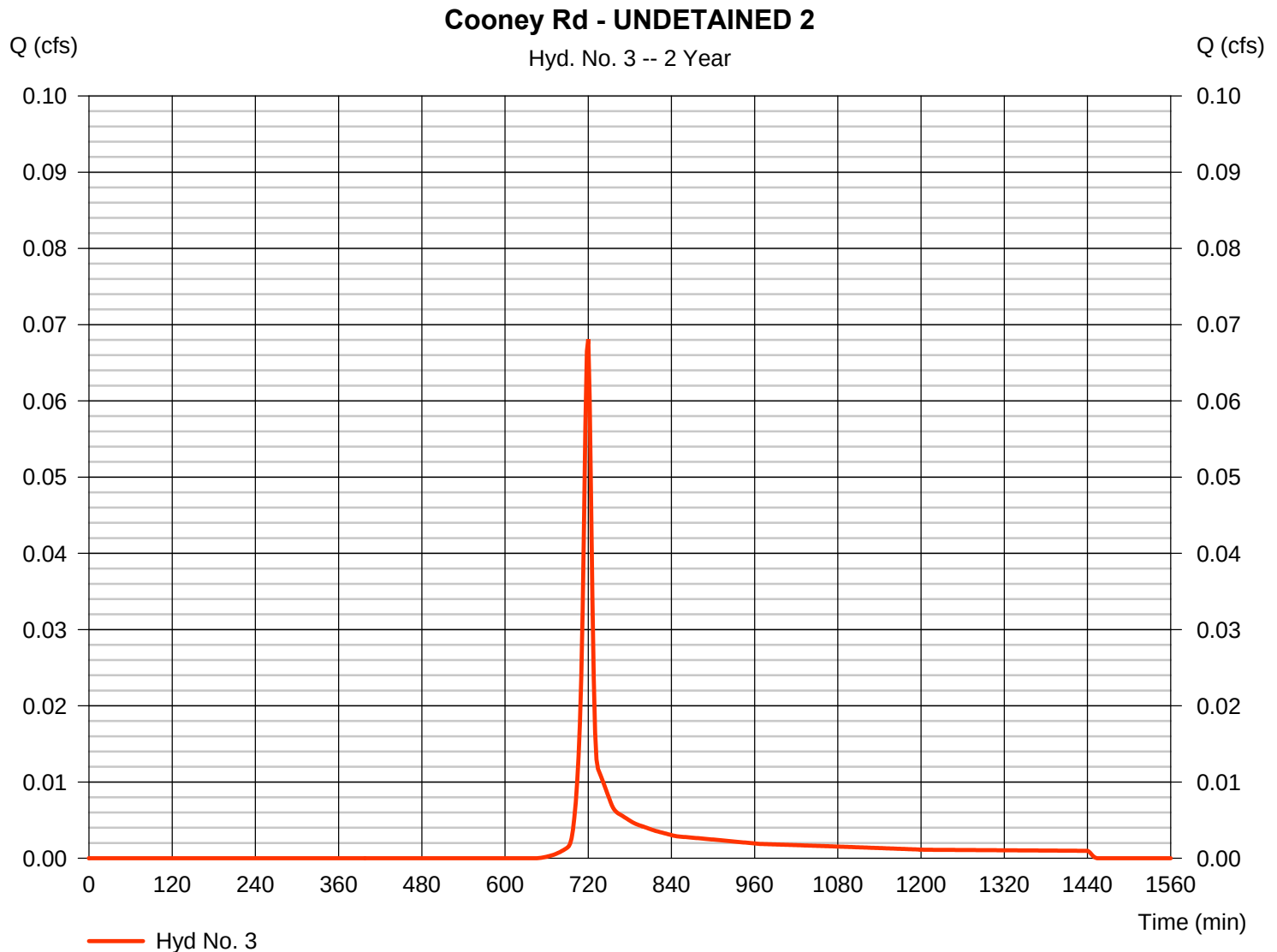
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.068 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	157 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	2.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2

<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)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 178.00	0.00	0.00				
Watercourse slope (%)	= 5.10	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.64	0.00	0.00				
Travel Time (min)	= 0.81	+	0.00	+	0.00	=	0.81
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	= 0.025	0.025	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				9.00 min			

Hydrograph Report

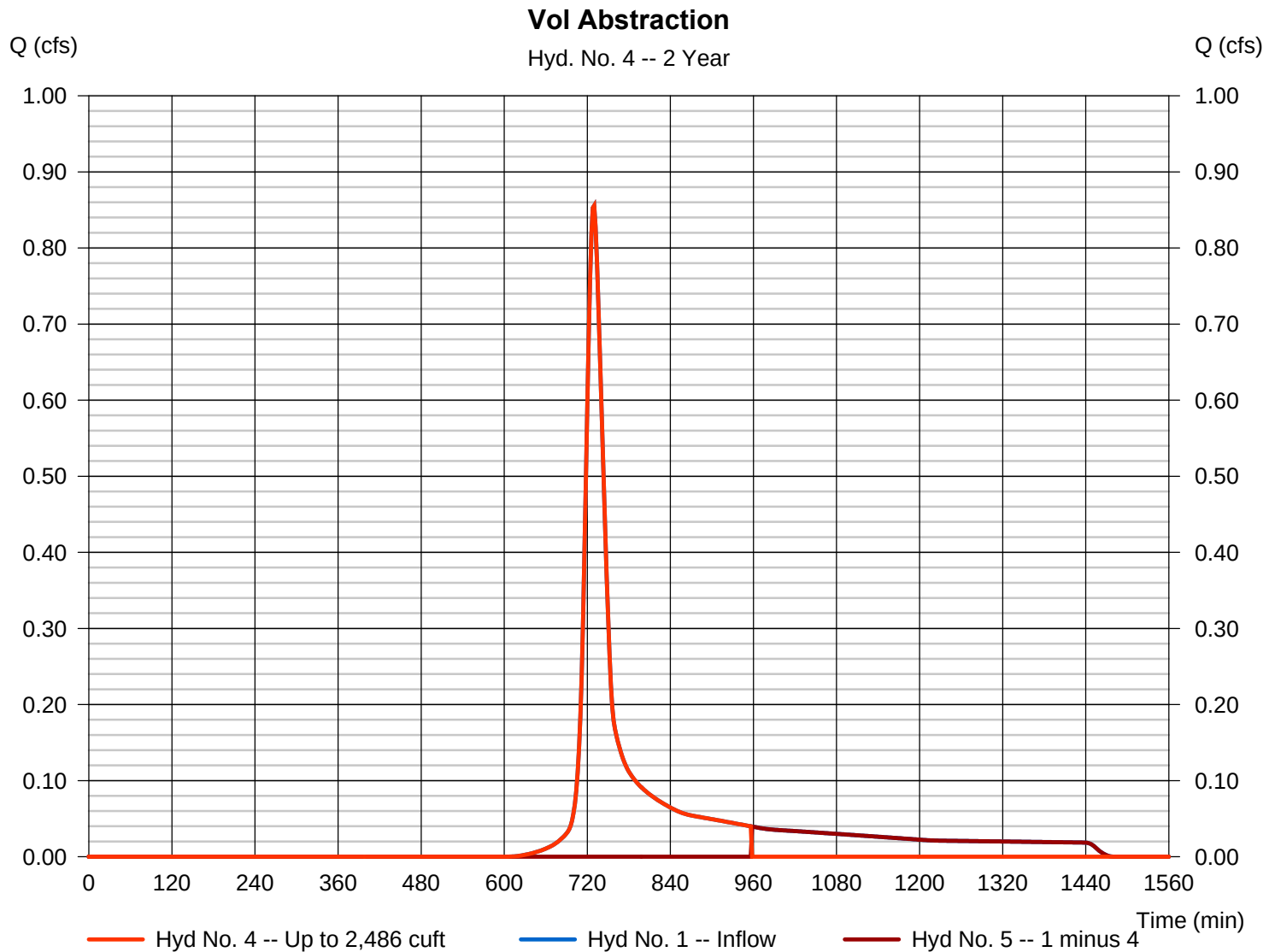
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 0.856 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 2,487 cuft
Inflow hydrograph	= 1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 2,486 cuft



Hydrograph Report

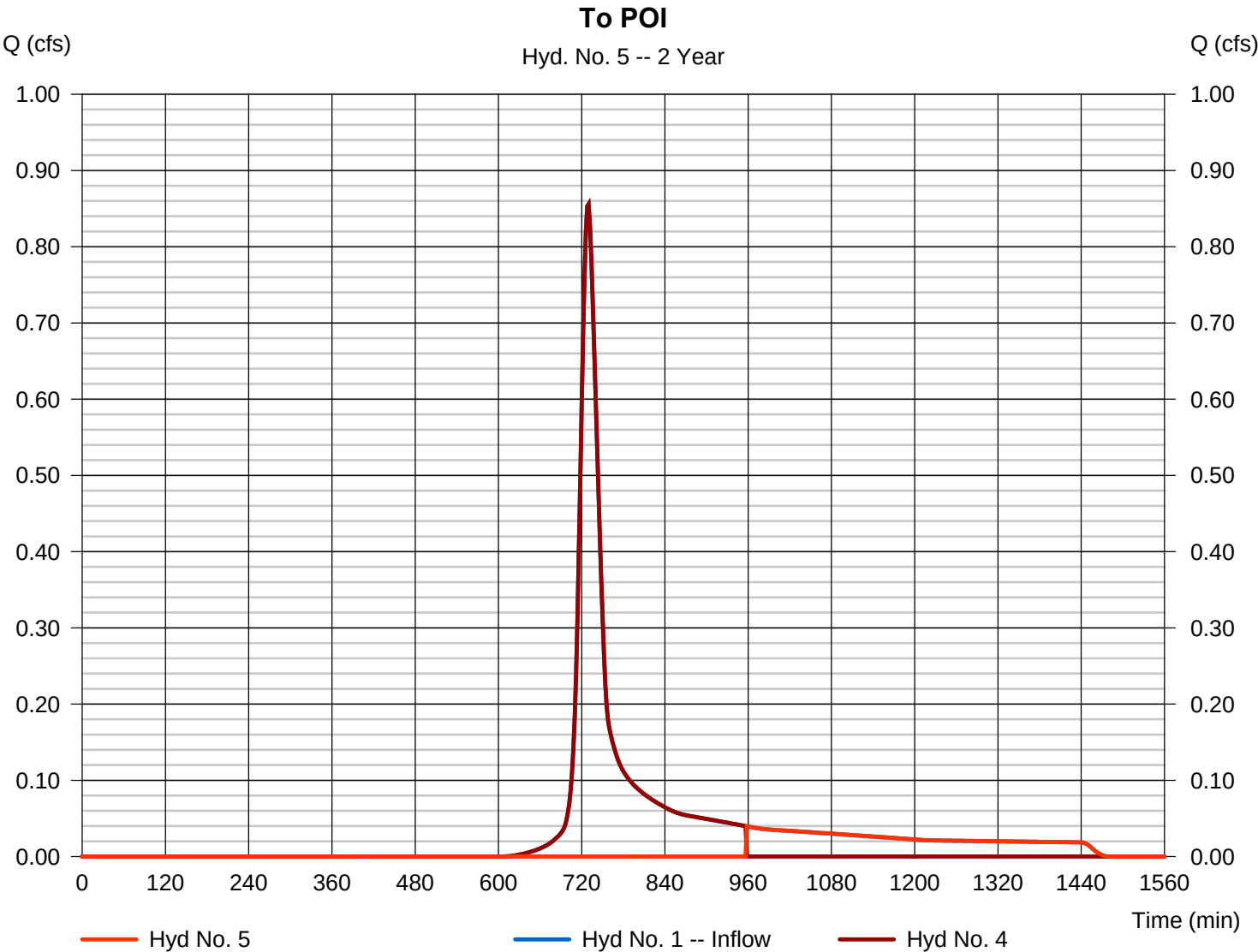
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.040 cfs
Storm frequency	=	2 yrs	Time to peak	=	958 min
Time interval	=	2 min	Hyd. volume	=	748 cuft
Inflow hydrograph	=	1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	2,486 cuft



Hydrograph Report

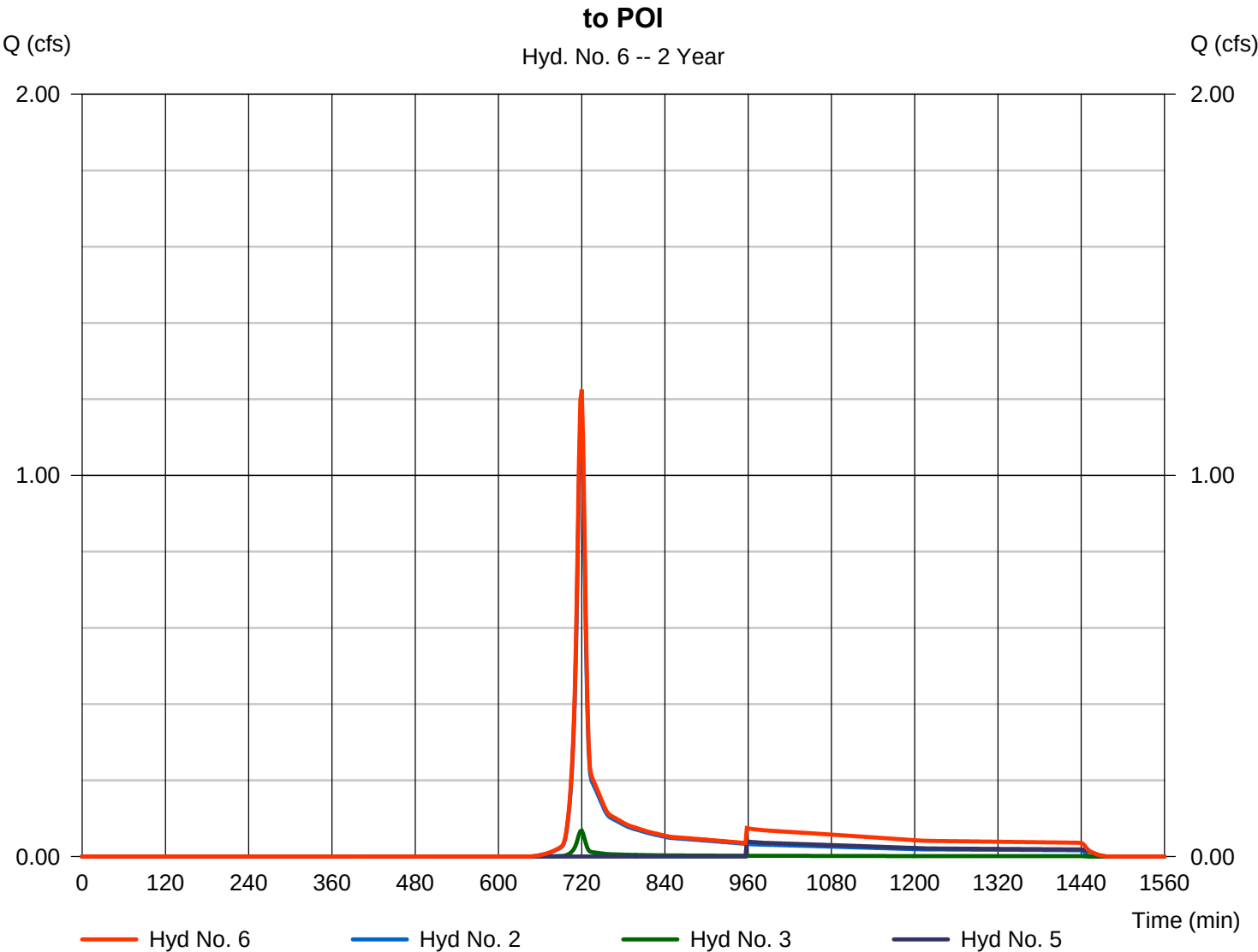
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 6

to POI

Hydrograph type	= Combine	Peak discharge	= 1.226 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 3,580 cuft
Inflow hyds.	= 2, 3, 5	Contrib. drain. area	= 0.900 ac



**ATTACHMENT C-2
COONEY RD
10 Year-24 Hour Storm**

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Cooney Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	2.154	-----	-----	4.315	-----	7.212	8.680	Cooney Rd - PRE
Proj. file: Cooney Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.315	2	720	11,248	-----	-----	-----	Cooney Rd - PRE
Cooney Rd-PRE.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

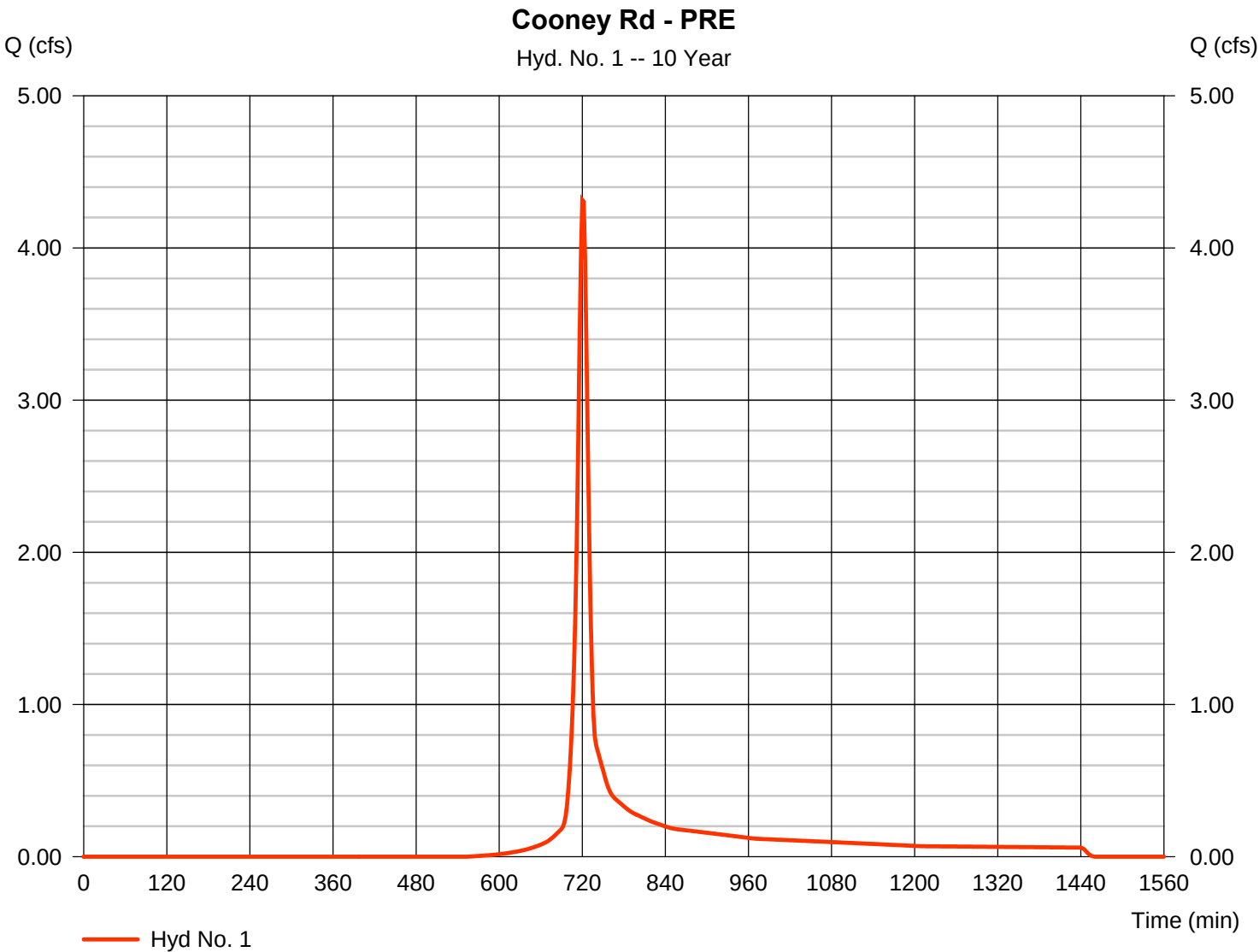
Hydrograph Report

Hyd. No. 1

Cooney Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.315 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	11,248 cuft
Drainage area	=	1.770 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.40 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.360 x 78) + (0.330 x 77) + (0.080 x 91)] / 1.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

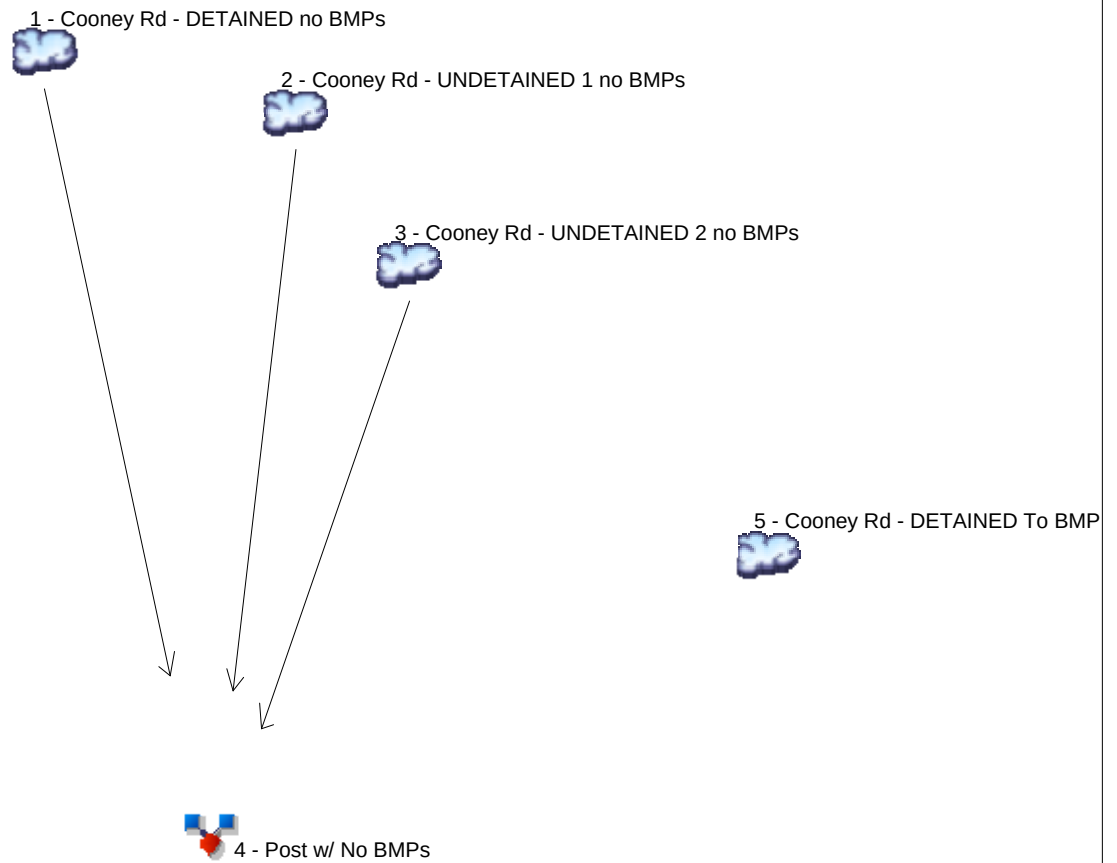
Hyd. No. 1

Cooney Rd - PRE

<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)	= 2.51	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.38	+	0.00	+
			0.00	= 8.38
Shallow Concentrated Flow				
Flow length (ft)	= 91.00	351.00	0.00	
Watercourse slope (%)	= 10.90	4.60	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=5.33	3.46	0.00	
Travel Time (min)	= 0.28	+	1.69	+
			0.00	= 1.98
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	= 0.025	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				10.40 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.290	-----	-----	2.441	-----	3.926	4.668	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	-----	-----	1.157	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	-----	-----	0.068	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2 no BM
4	Combine	1, 2, 3	-----	2.509	-----	-----	4.862	-----	7.907	9.435	Post w/ No BMPs
5	SCS Runoff	-----	-----	1.086	-----	-----	1.998	-----	3.164	3.744	Cooney Rd - DETAINED To BMP
</											

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.441	2	720	6,329	-----	-----	-----	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	2.287	2	720	5,238	-----	-----	-----	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	0.135	2	720	308	-----	-----	-----	Cooney Rd - UNDETAINED 2 no BM
4	Combine	4.862	2	720	11,876	1, 2, 3	-----	-----	Post w/ No BMPs
5	SCS Runoff	1.998	2	718	4,572	-----	-----	-----	Cooney Rd - DETAINED To BMP
Cooney Rd-no BMP.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

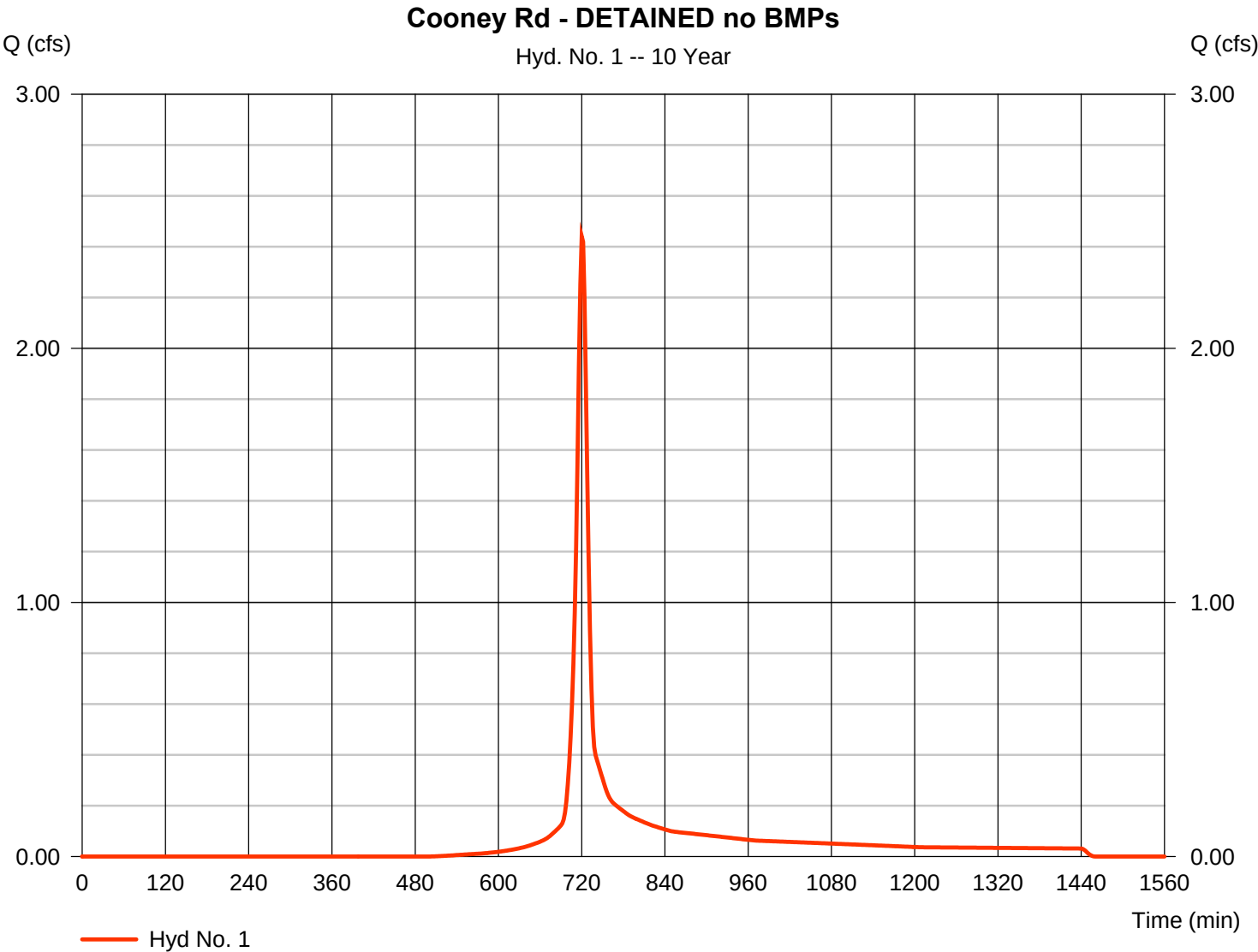
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.441 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	6,329 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.30 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	282.00				
Watercourse slope (%)	= 13.20	4.50	4.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.46				
Travel Time (min)	= 0.11	+	0.59	+	1.36	=	2.06
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	= 0.025	0.025	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				10.30 min			

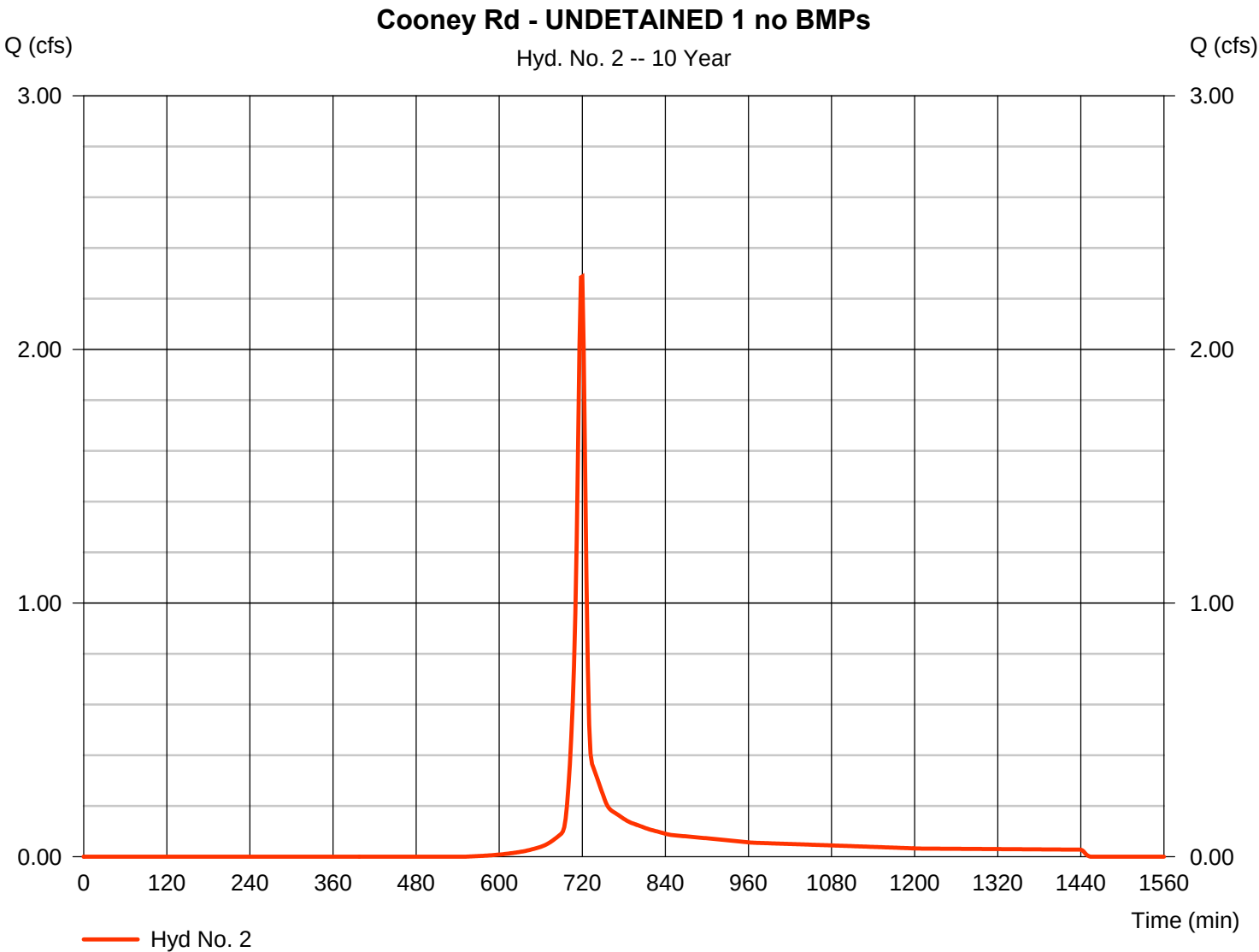
Hydrograph Report

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.287 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	5,238 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 78) + (0.240 x 77) + (0.010 x 91)] / 0.850



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

<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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

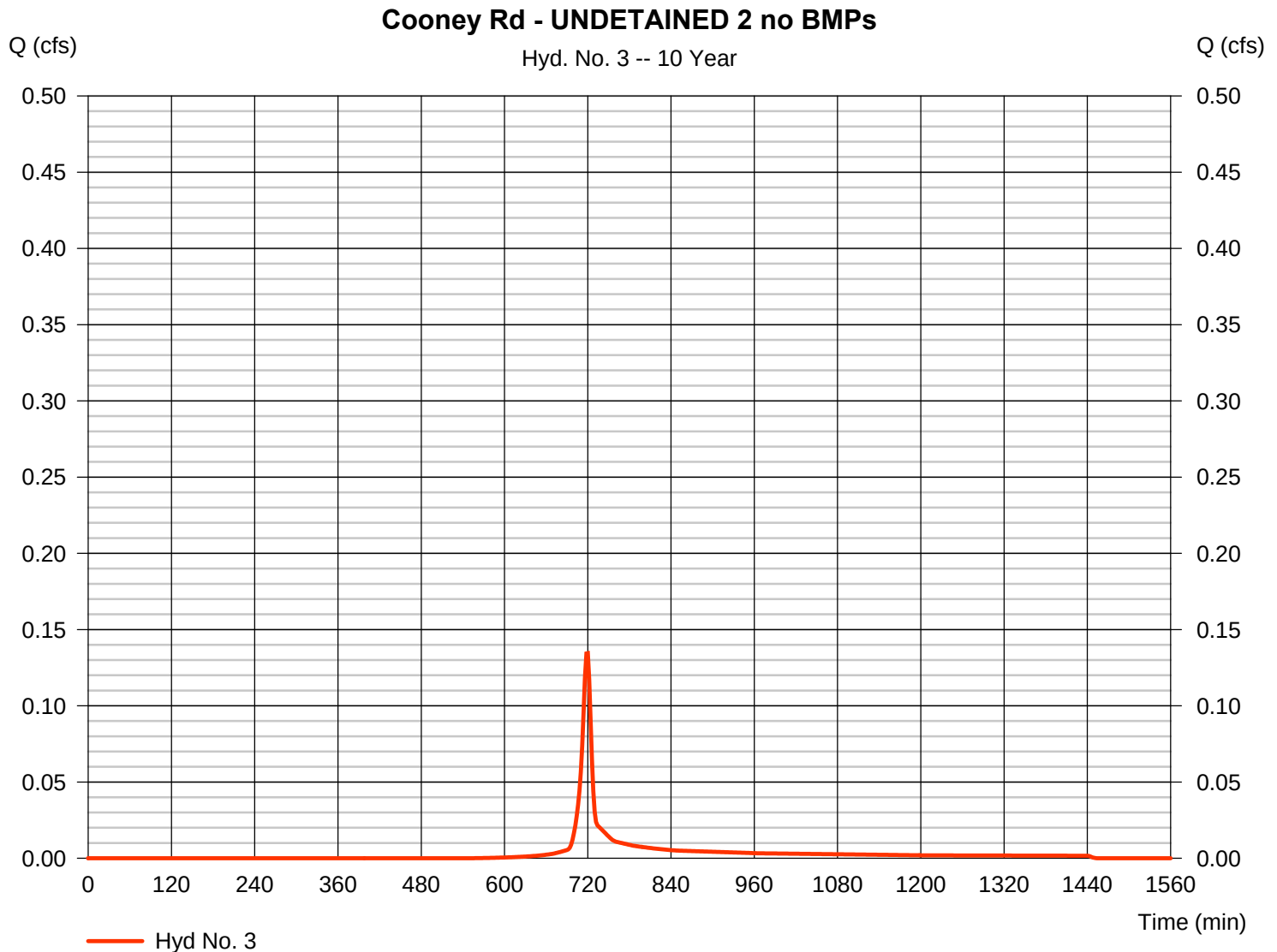
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.135 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	308 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

<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)	= 2.62	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.21	+	0.00	+
			0.00	= 8.21
Shallow Concentrated Flow				
Flow length (ft)	= 178.00	0.00	0.00	
Watercourse slope (%)	= 5.10	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.64	0.00	0.00	
Travel Time (min)	= 0.81	+	0.00	+
			0.00	= 0.81
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	= 0.025	0.025	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				9.00 min

Hydrograph Report

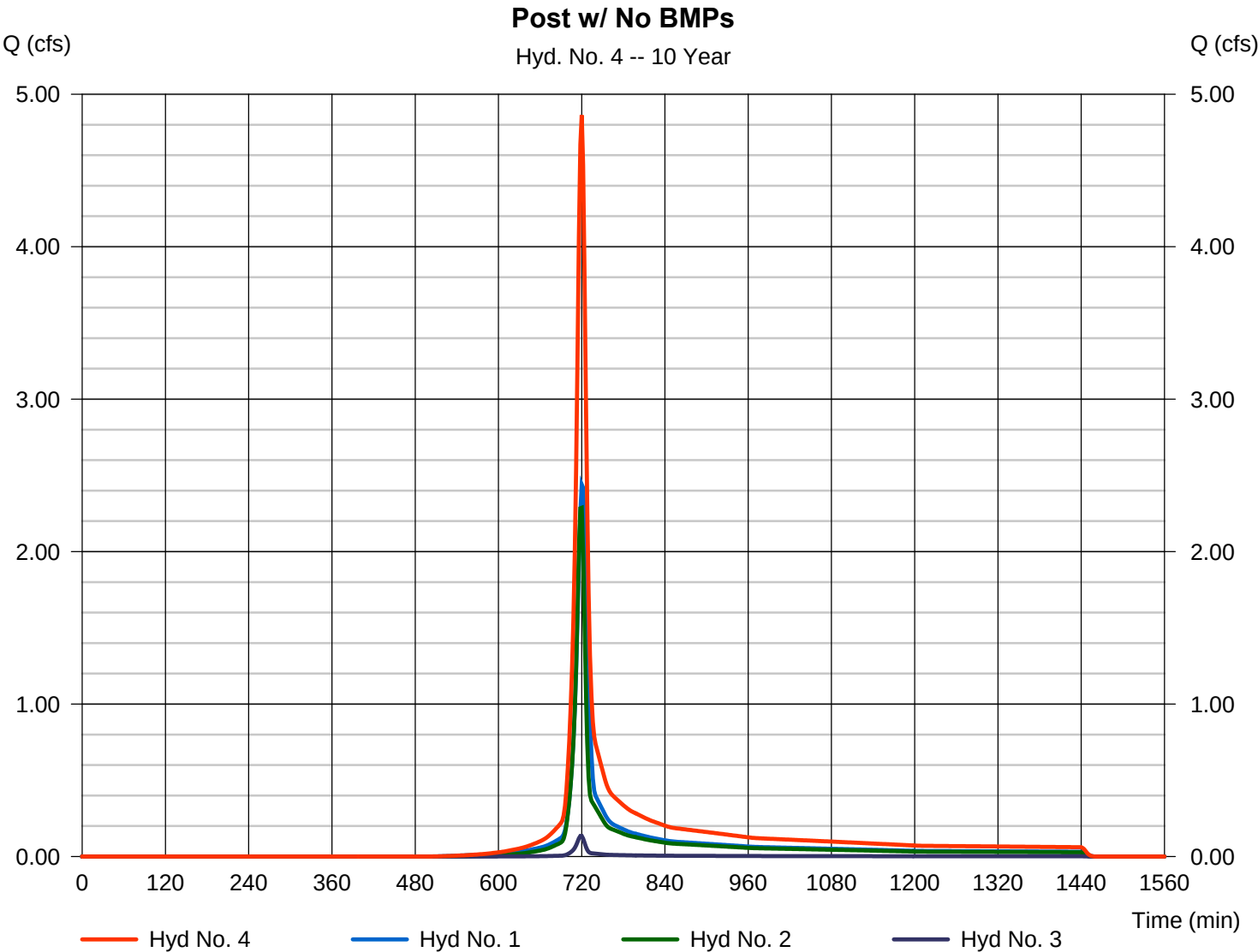
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Post w/ No BMPs

Hydrograph type	= Combine	Peak discharge	= 4.862 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 11,876 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 1.780 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

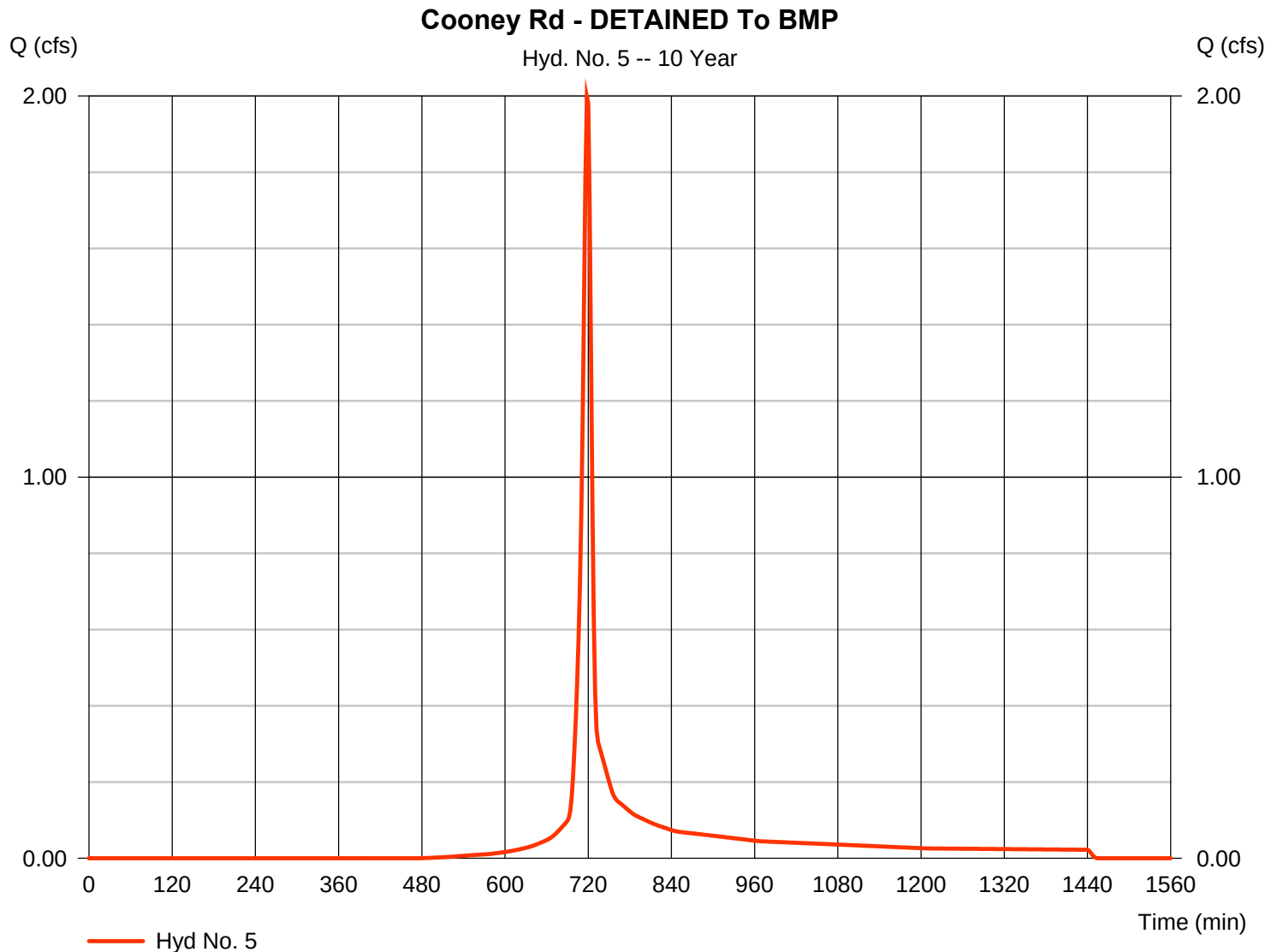
Wednesday, 11 / 9 / 2016

Hyd. No. 5

Cooney Rd - DETAINED To BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.998 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	4,572 cuft
Drainage area	=	0.630 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.20 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.450 \times 78) + (0.180 \times 91)] / 0.630$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

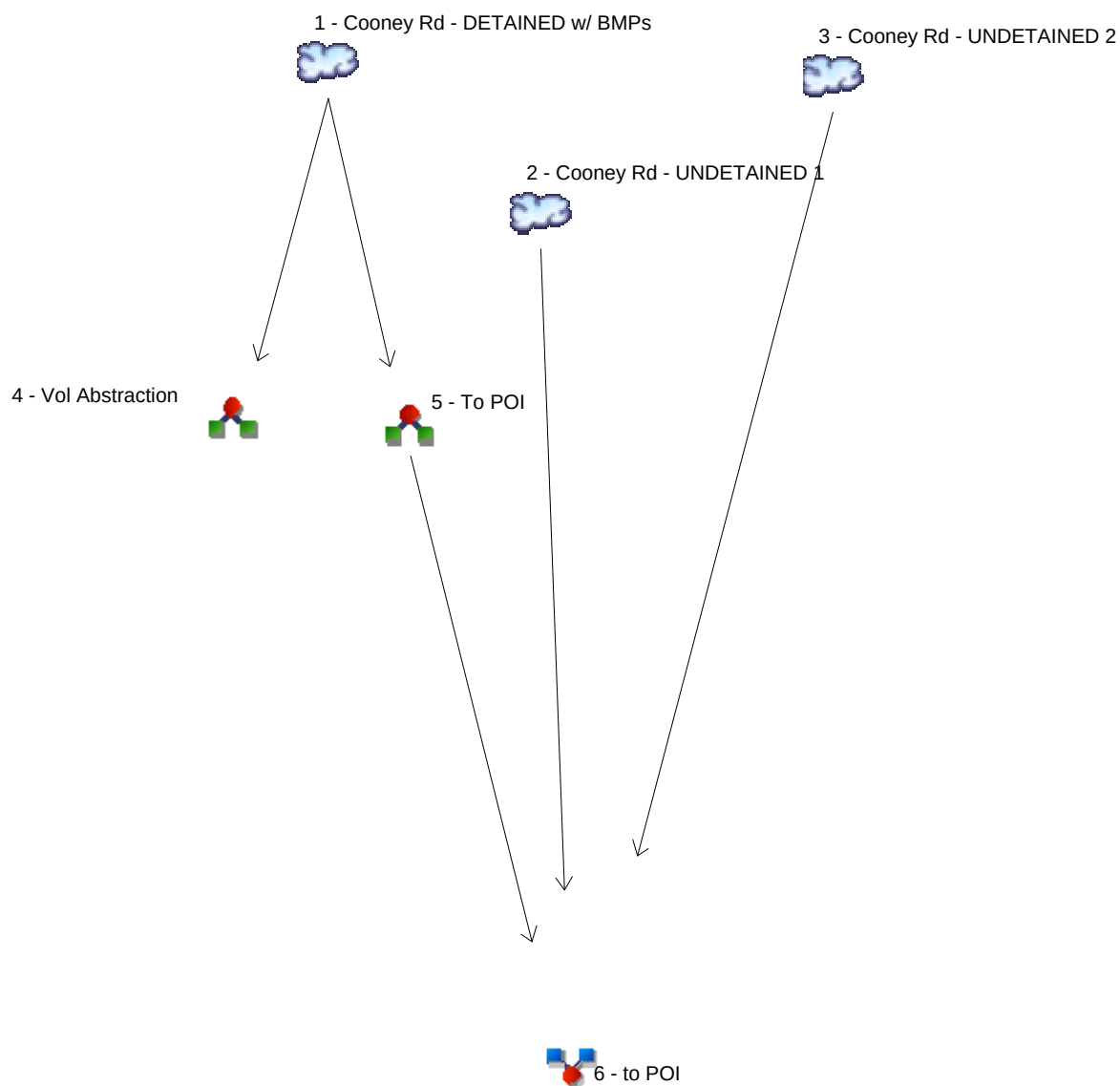
Hyd. No. 5

Cooney Rd - DETAINED To BMP

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	55.00				
Watercourse slope (%)	= 13.20	4.50	3.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.06				
Travel Time (min)	= 0.11	+	0.59	+	0.30	=	1.00
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	= 0.025	0.025	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				9.20 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.640	-----	2.657	3.166	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	-----	-----	-----	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1
3	SCS Runoff	-----	-----	-----	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2
4	Diversion1	1	-----	-----	-----	-----	1.640	-----	2.657	2.931	Vol Abstraction
5	Diversion2	1	-----	-----	-----	-----	0.470	-----	2.629	3.166	To POI
6	Combine	2, 3, 5	-----	-----	-----	-----	2.422	-----	4.025	5.327	to POI
Proj. file: Cooney Rd- wBMP-10,50,100yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.640	2	728	6,042	-----	-----	-----	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	2.287	2	720	5,238	-----	-----	-----	Cooney Rd - UNDETAINED 1
3	SCS Runoff	0.135	2	720	308	-----	-----	-----	Cooney Rd - UNDETAINED 2
4	Diversion1	1.640	2	728	3,223	1	-----	-----	Vol Abstraction
5	Diversion2	0.470	2	752	2,818	1	-----	-----	To POI
6	Combine	2.422	2	720	8,365	2, 3, 5	-----	-----	to POI
Cooney Rd- wBMP-10,50,100yr.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2016	

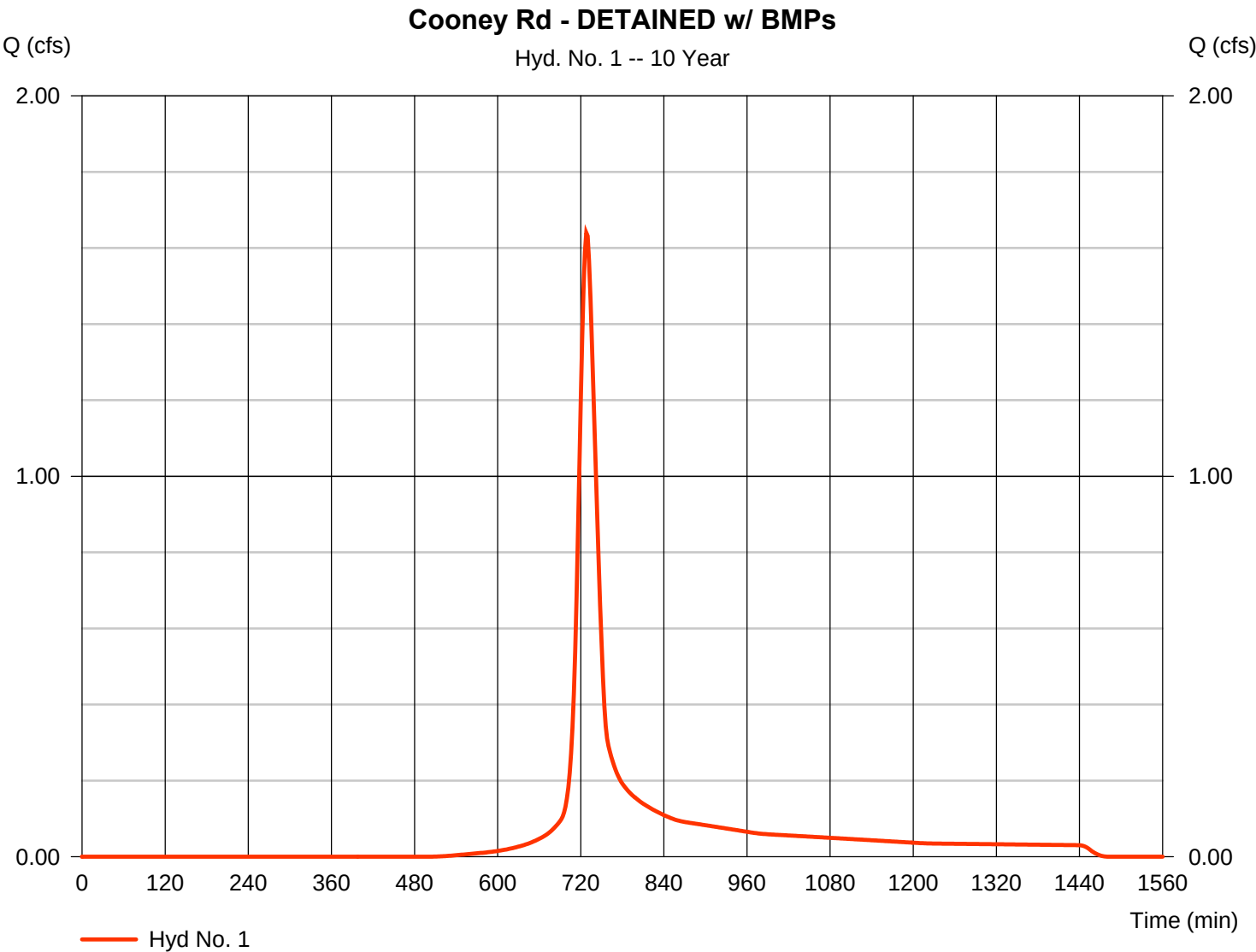
Hydrograph Report

Hyd. No. 1

Cooney Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.640 cfs
Storm frequency	=	10 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	6,042 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	23.70 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

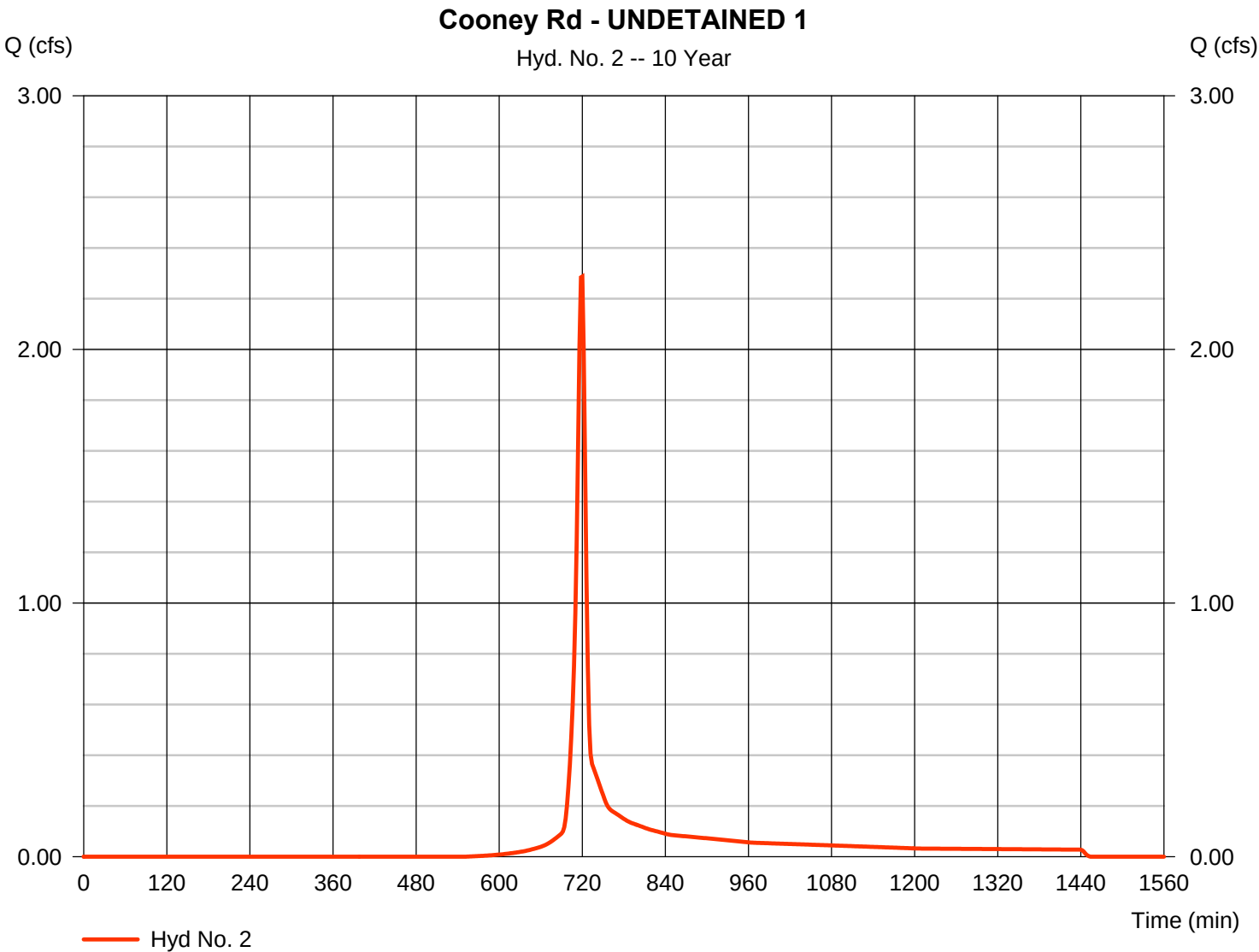
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.287 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	5,238 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 78) + (0.240 x 77) + (0.010 x 91)] / 0.850



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

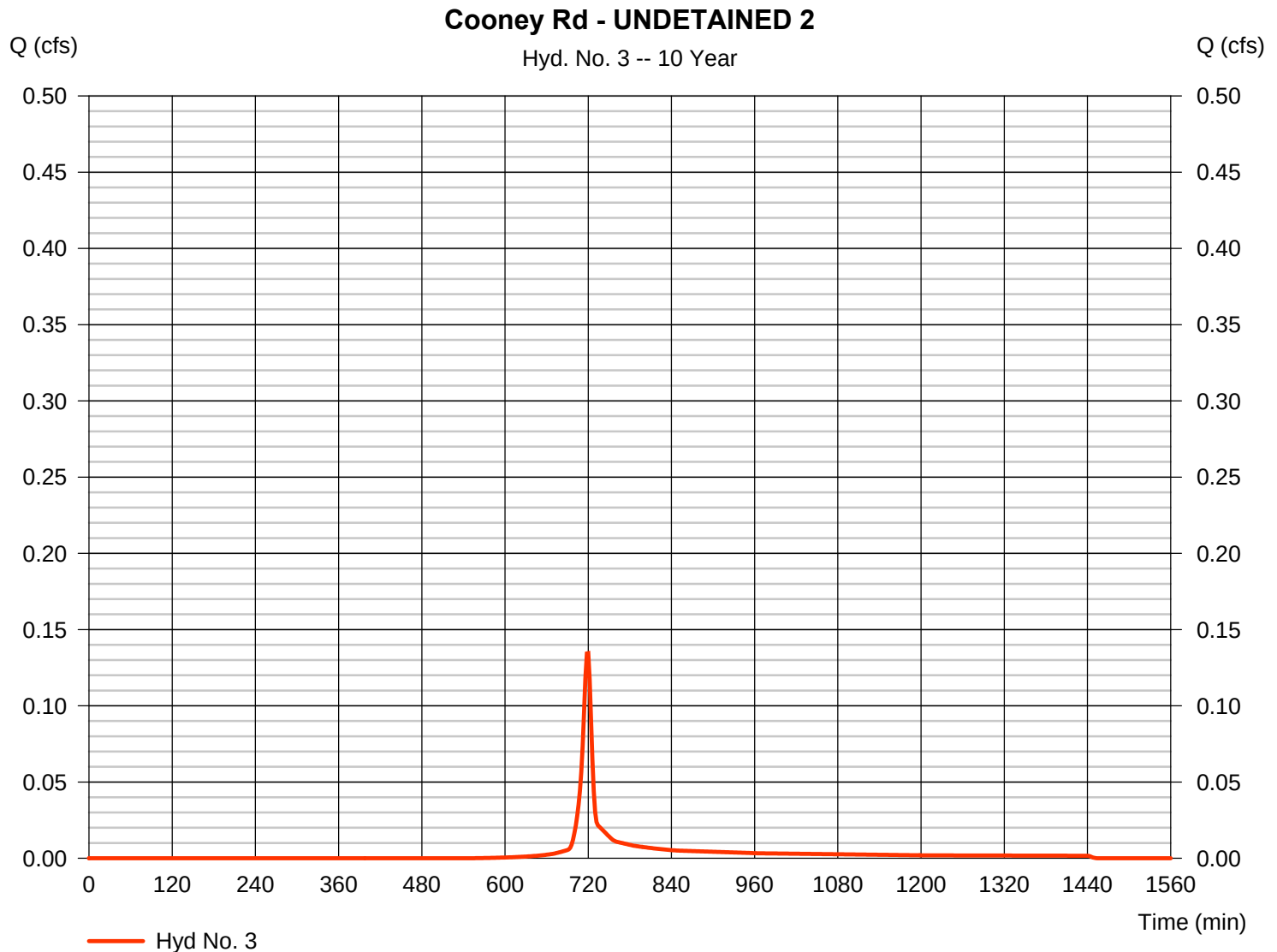
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.135 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	308 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	3.76 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2

<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)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 178.00	0.00	0.00				
Watercourse slope (%)	= 5.10	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.64	0.00	0.00				
Travel Time (min)	= 0.81	+	0.00	+	0.00	=	0.81
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	= 0.025	0.025	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				9.00 min			

Hydrograph Report

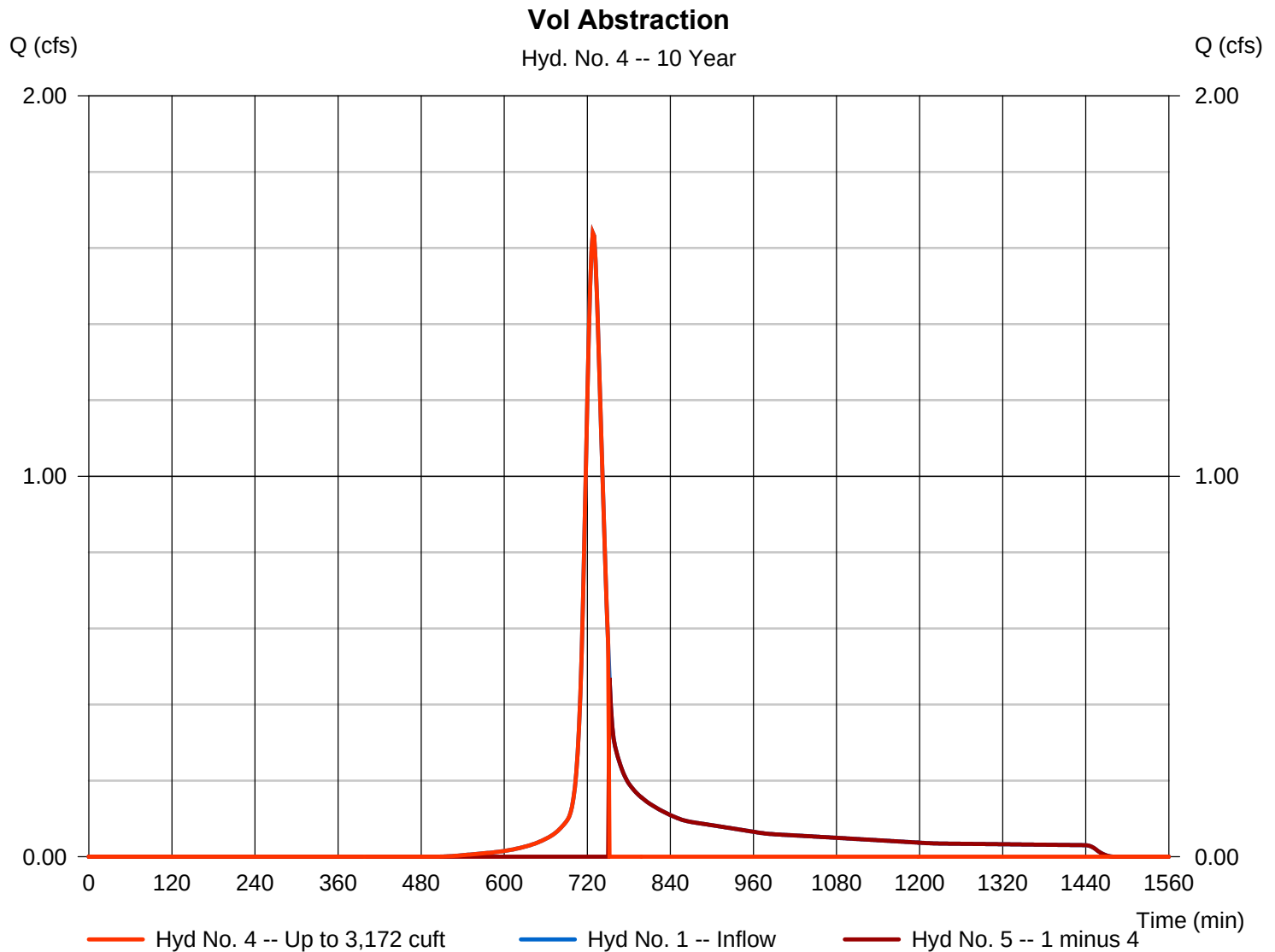
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 1.640 cfs
Storm frequency	= 10 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 3,223 cuft
Inflow hydrograph	= 1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 3,172 cuft



Hydrograph Report

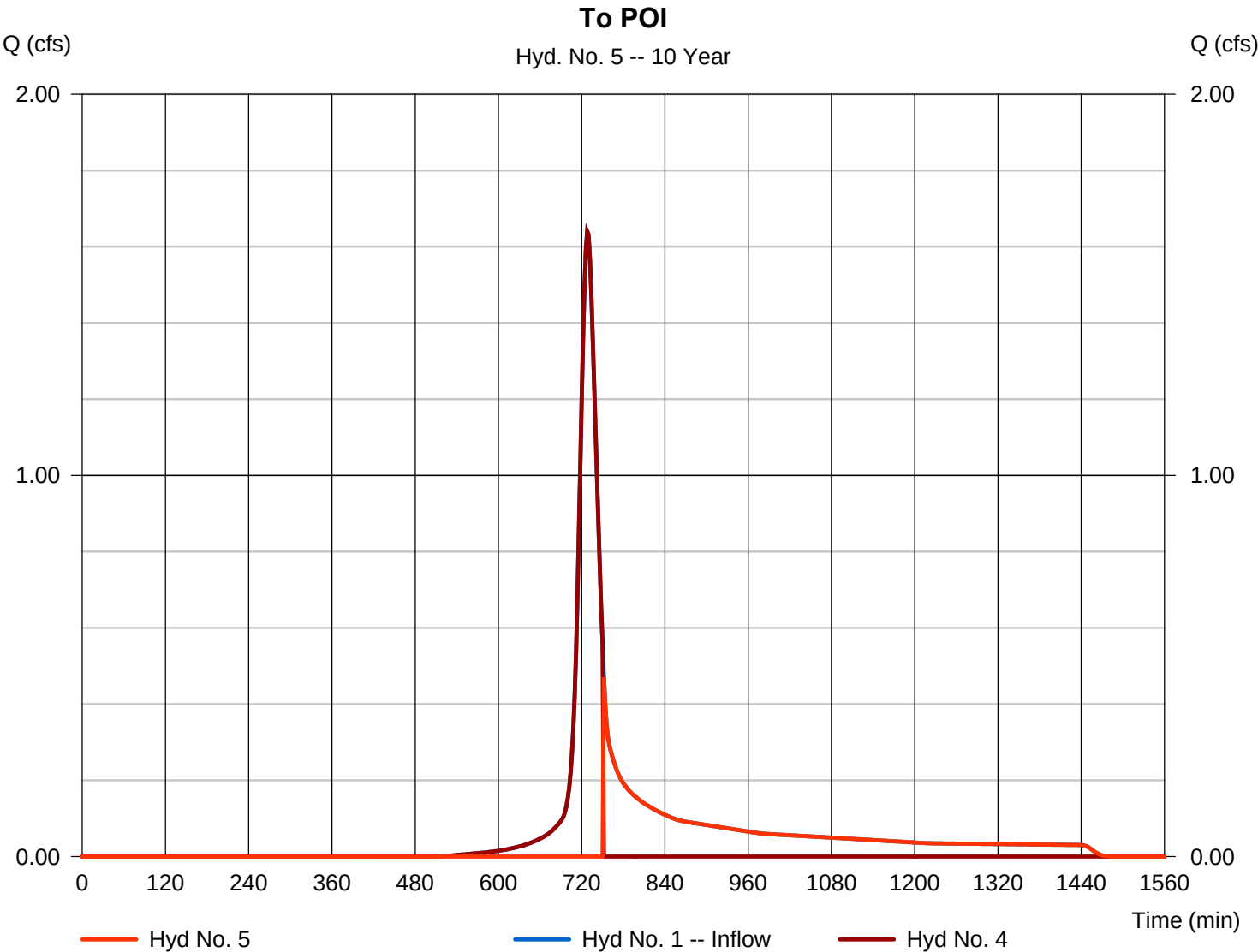
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.470 cfs
Storm frequency	=	10 yrs	Time to peak	=	752 min
Time interval	=	2 min	Hyd. volume	=	2,818 cuft
Inflow hydrograph	=	1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	3,172 cuft



Hydrograph Report

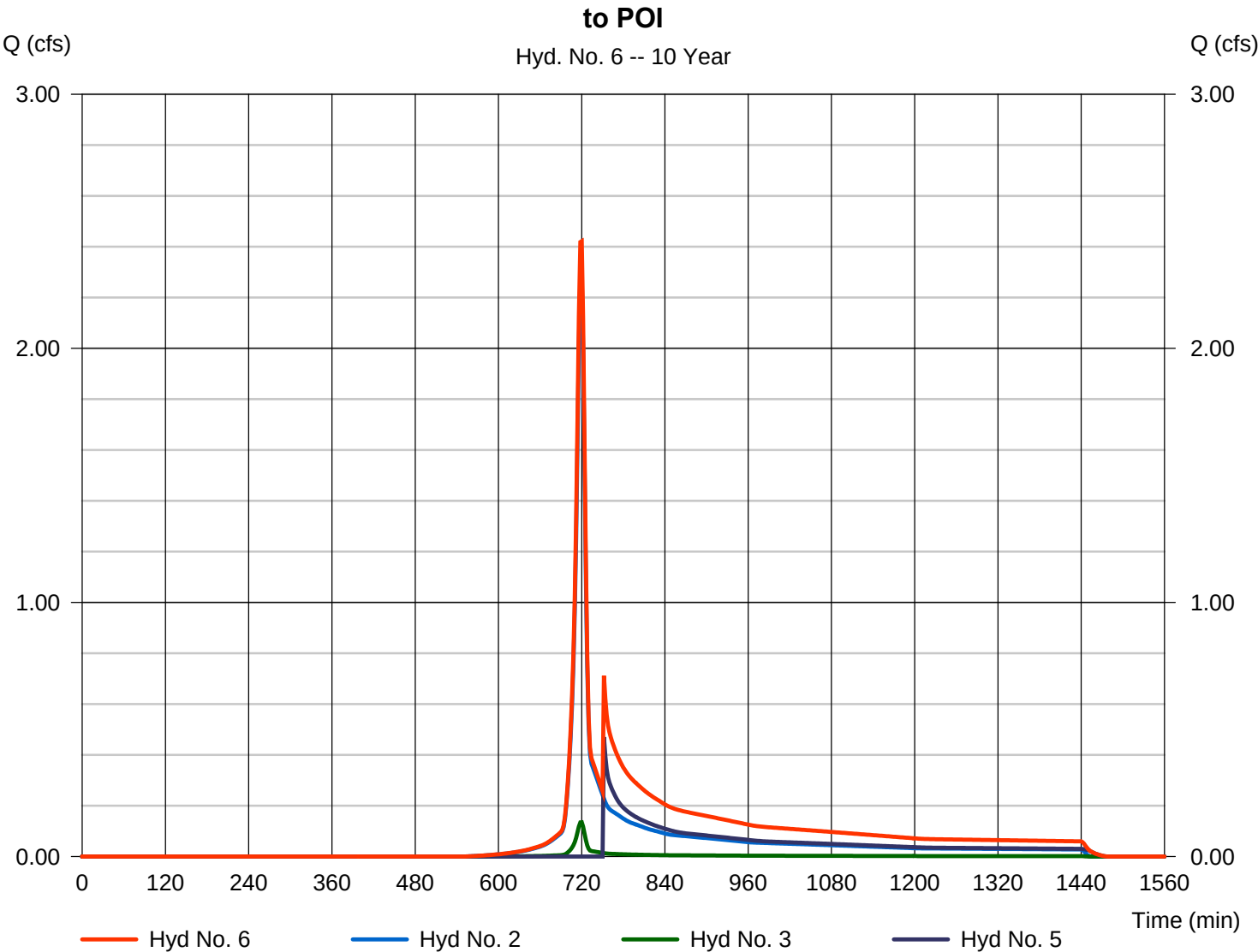
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 6

to POI

Hydrograph type	= Combine	Peak discharge	= 2.422 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 8,365 cuft
Inflow hyds.	= 2, 3, 5	Contrib. drain. area	= 0.900 ac



ATTACHMENT C-3
COONEY RD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Cooney Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	2.154	-----	-----	4.315	-----	7.212	8.680	Cooney Rd - PRE
Proj. file: Cooney Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	7.212	2	720	18,701	-----	-----	-----	Cooney Rd - PRE
Cooney Rd-PRE.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

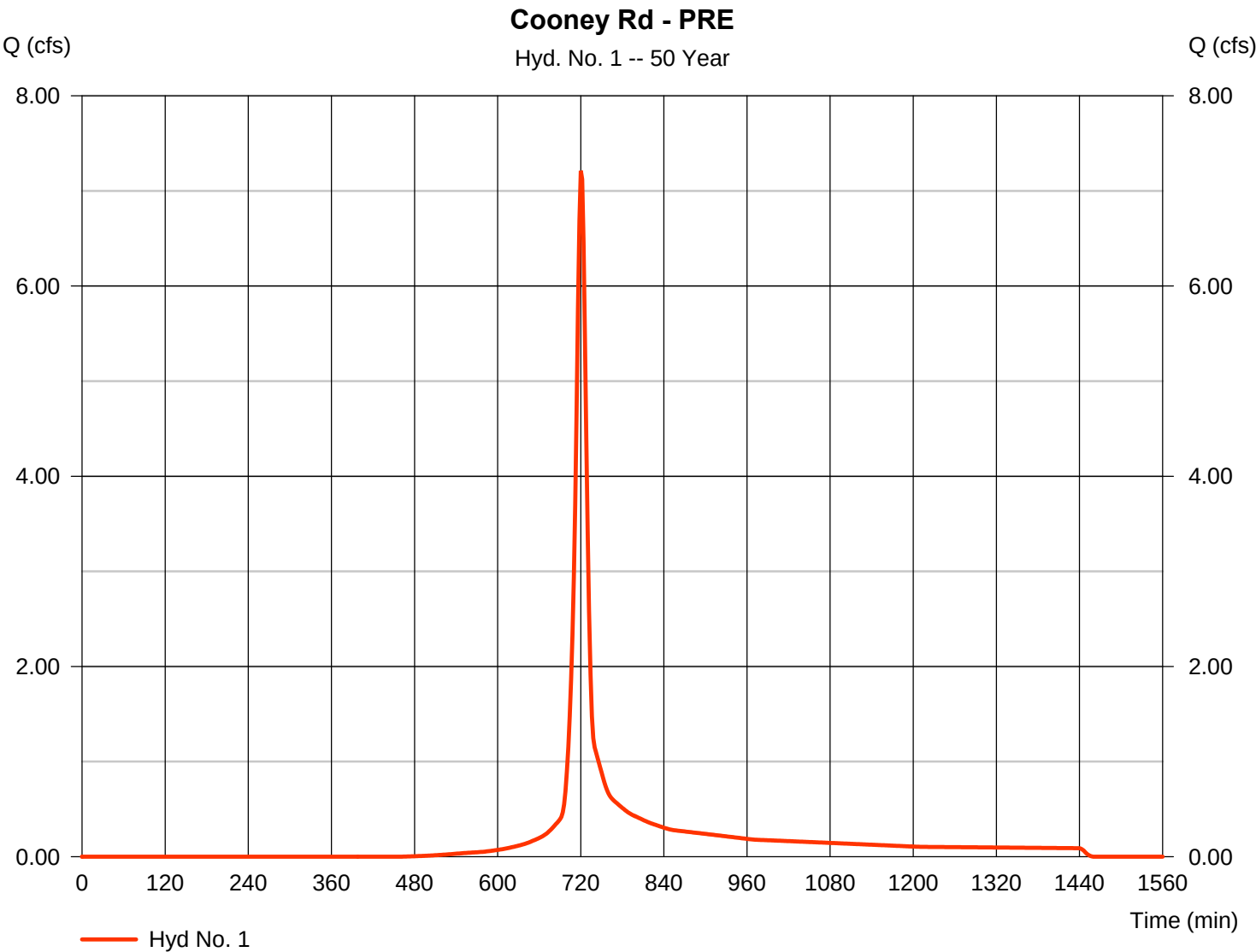
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Cooney Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.212 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	18,701 cuft
Drainage area	=	1.770 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.40 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.360 x 78) + (0.330 x 77) + (0.080 x 91)] / 1.770



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

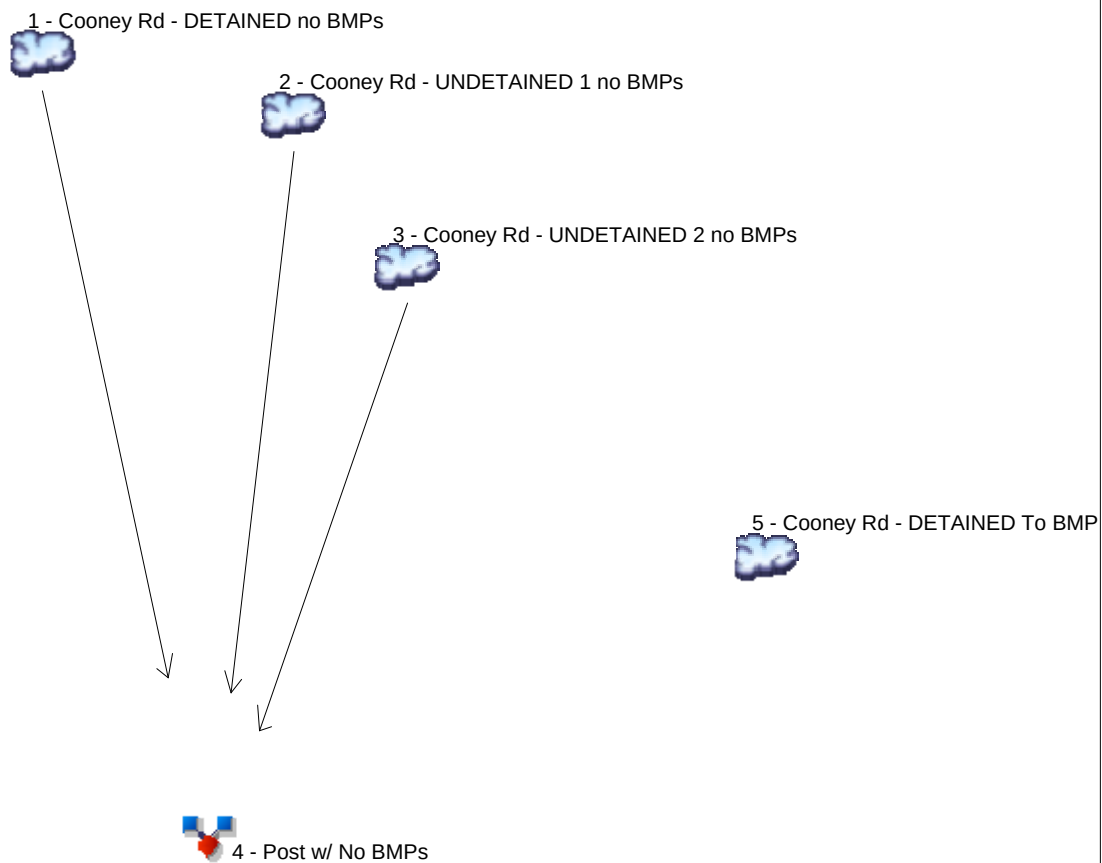
Hyd. No. 1

Cooney Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.38	+	0.00	+	0.00	=	8.38
Shallow Concentrated Flow							
Flow length (ft)	= 91.00	351.00	0.00				
Watercourse slope (%)	= 10.90	4.60	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.33	3.46	0.00				
Travel Time (min)	= 0.28	+	1.69	+	0.00	=	1.98
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	= 0.025	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				10.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.290	-----	-----	2.441	-----	3.926	4.668	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	-----	-----	1.157	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	-----	-----	0.068	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2 no BM
4	Combine	1, 2, 3	-----	2.509	-----	-----	4.862	-----	7.907	9.435	Post w/ No BMPs
5	SCS Runoff	-----	-----	1.086	-----	-----	1.998	-----	3.164	3.744	Cooney Rd - DETAINED To BMP
Proj. file: Cooney Rd-no BMP.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.926	2	720	10,214	-----	-----	-----	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	3.802	2	718	8,709	-----	-----	-----	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	0.224	2	718	512	-----	-----	-----	Cooney Rd - UNDETAINED 2 no BM
4	Combine	7.907	2	720	19,434	1, 2, 3	-----	-----	Post w/ No BMPs
5	SCS Runoff	3.164	2	718	7,308	-----	-----	-----	Cooney Rd - DETAINED To BMP
Cooney Rd-no BMP.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

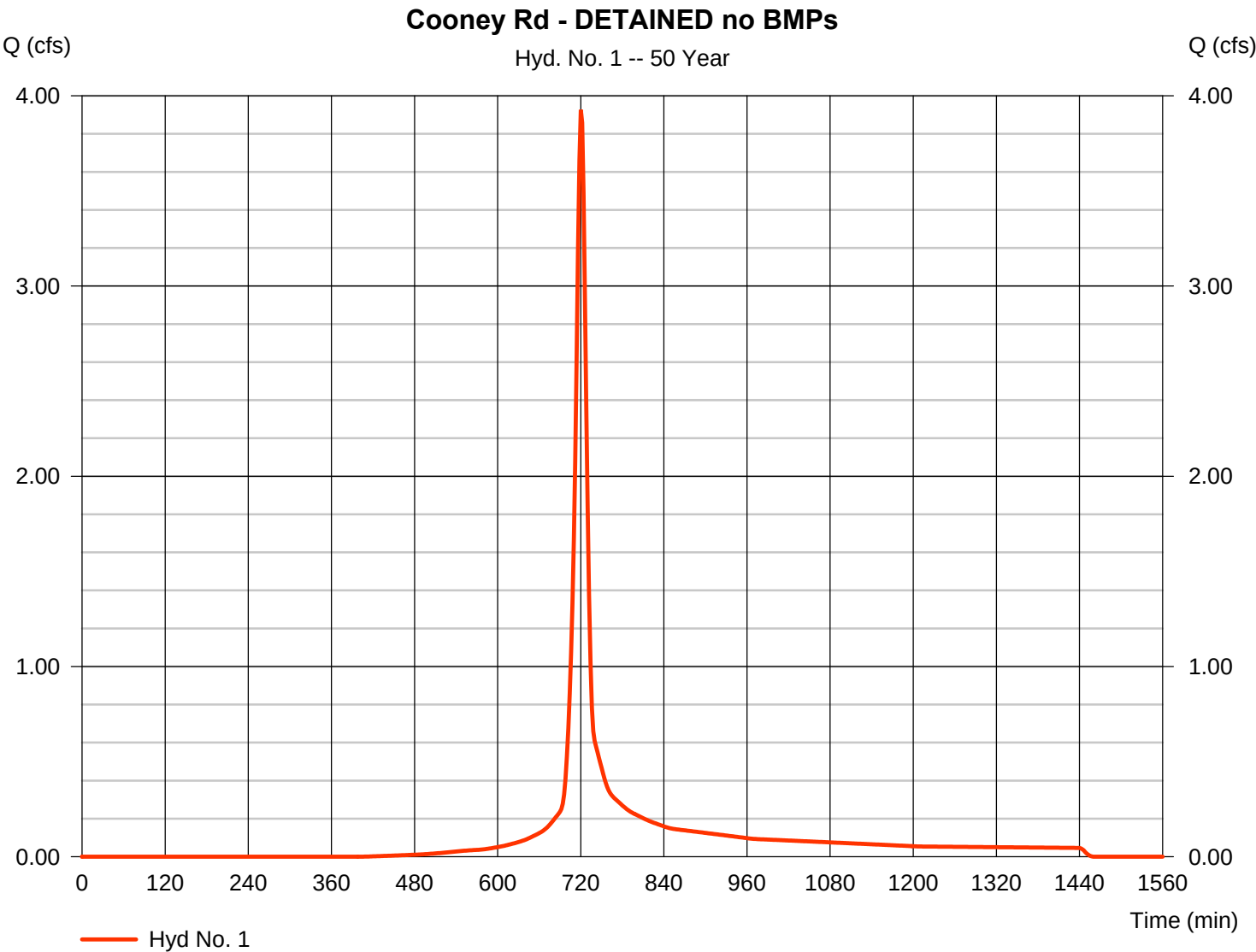
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.926 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	10,214 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.30 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	282.00				
Watercourse slope (%)	= 13.20	4.50	4.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.46				
Travel Time (min)	= 0.11	+	0.59	+	1.36	=	2.06
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	= 0.025	0.025	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				10.30 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

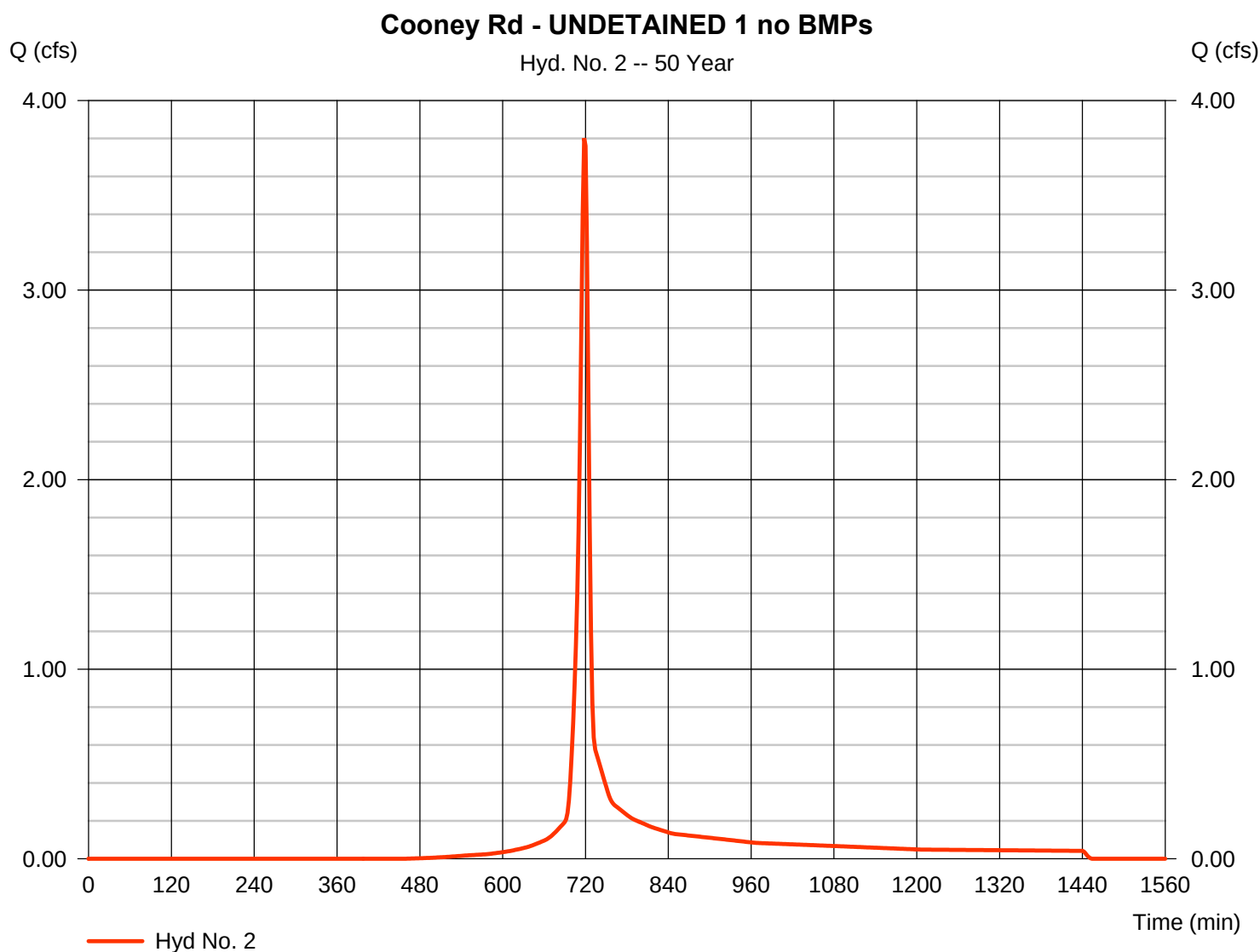
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.802 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	8,709 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

<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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

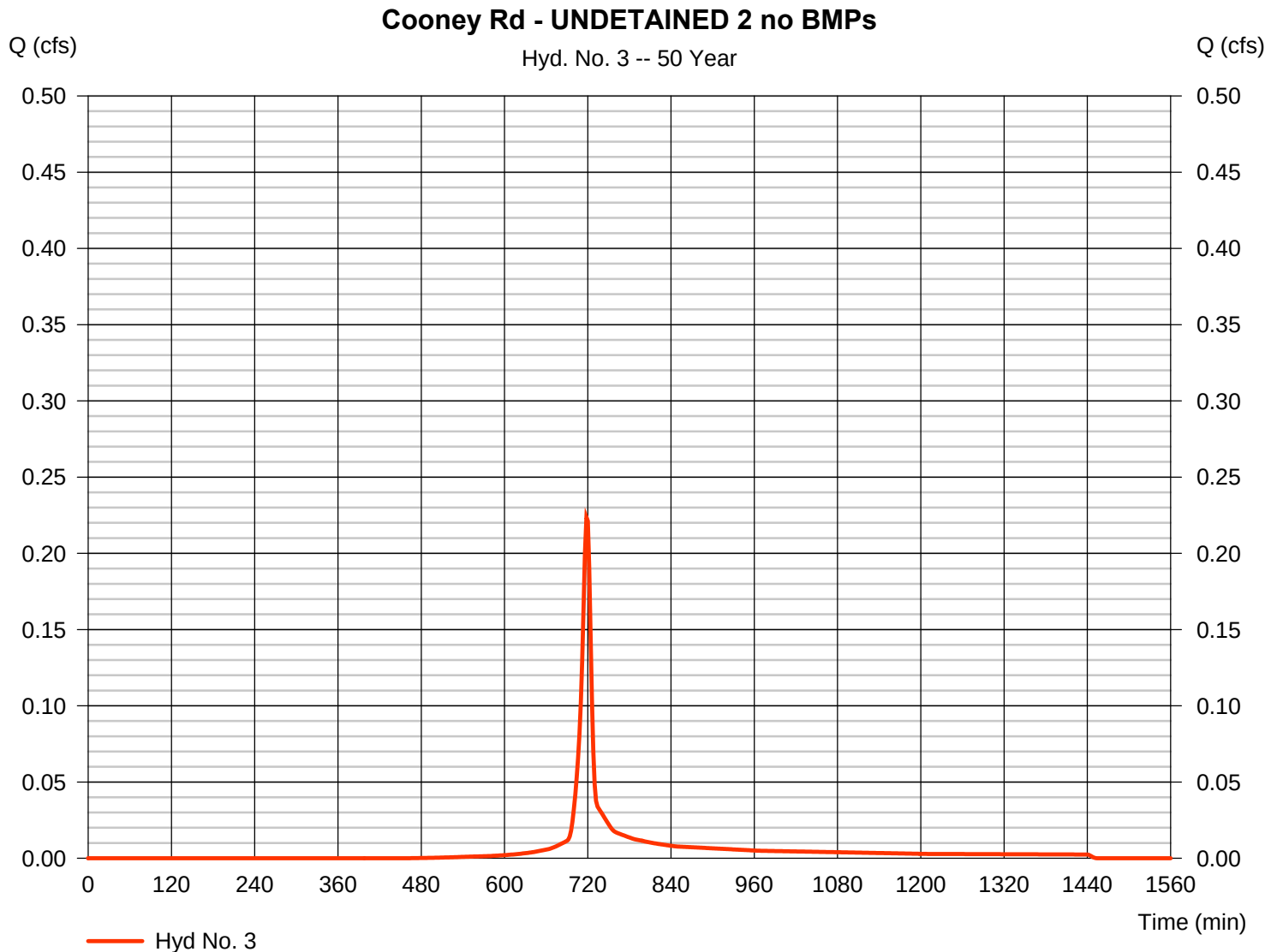
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.224 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	512 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

<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)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 178.00	0.00	0.00				
Watercourse slope (%)	= 5.10	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.64	0.00	0.00				
Travel Time (min)	= 0.81	+	0.00	+	0.00	=	0.81
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	= 0.025	0.025	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				9.00 min			

Hydrograph Report

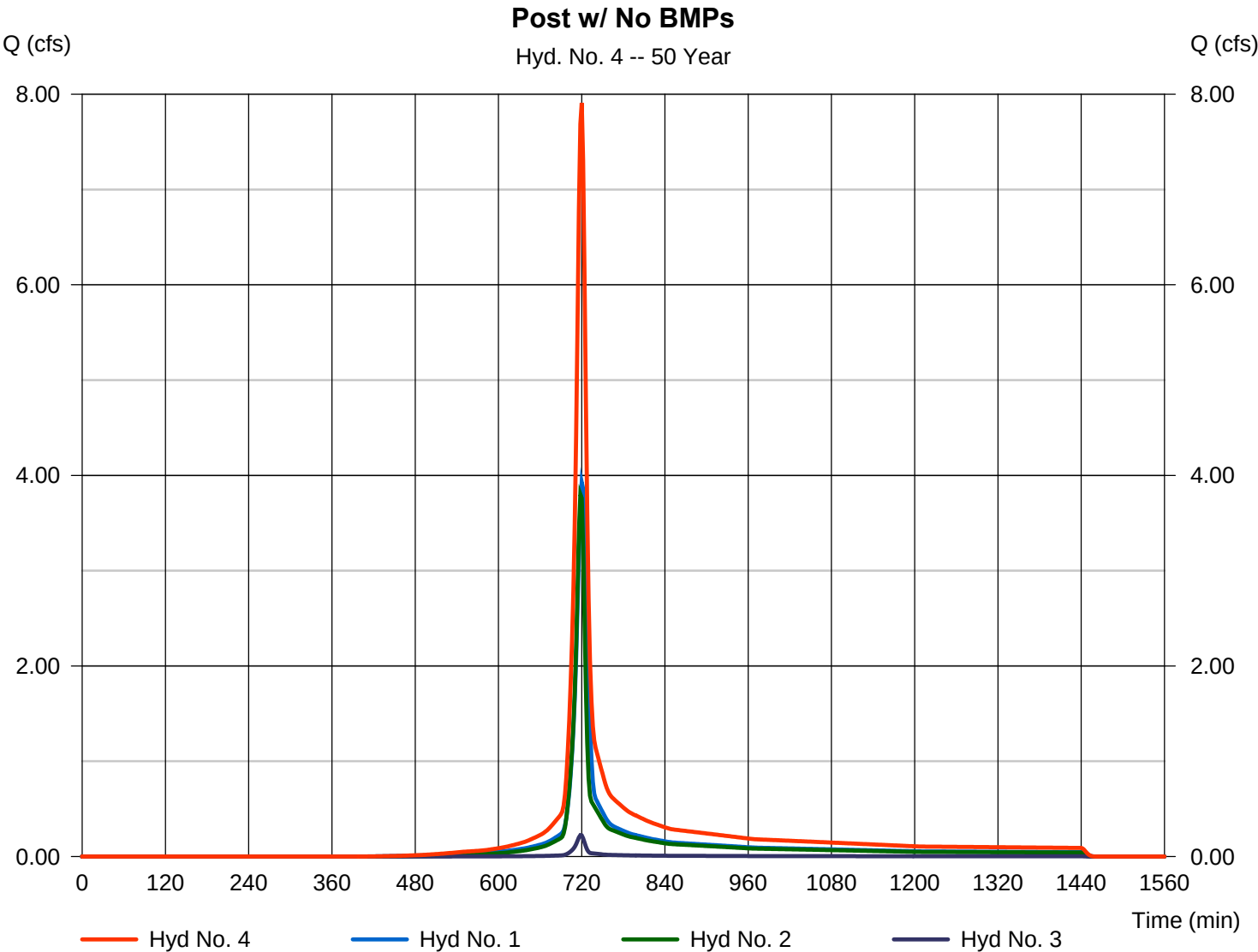
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Post w/ No BMPs

Hydrograph type	= Combine	Peak discharge	= 7.907 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 19,434 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 1.780 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

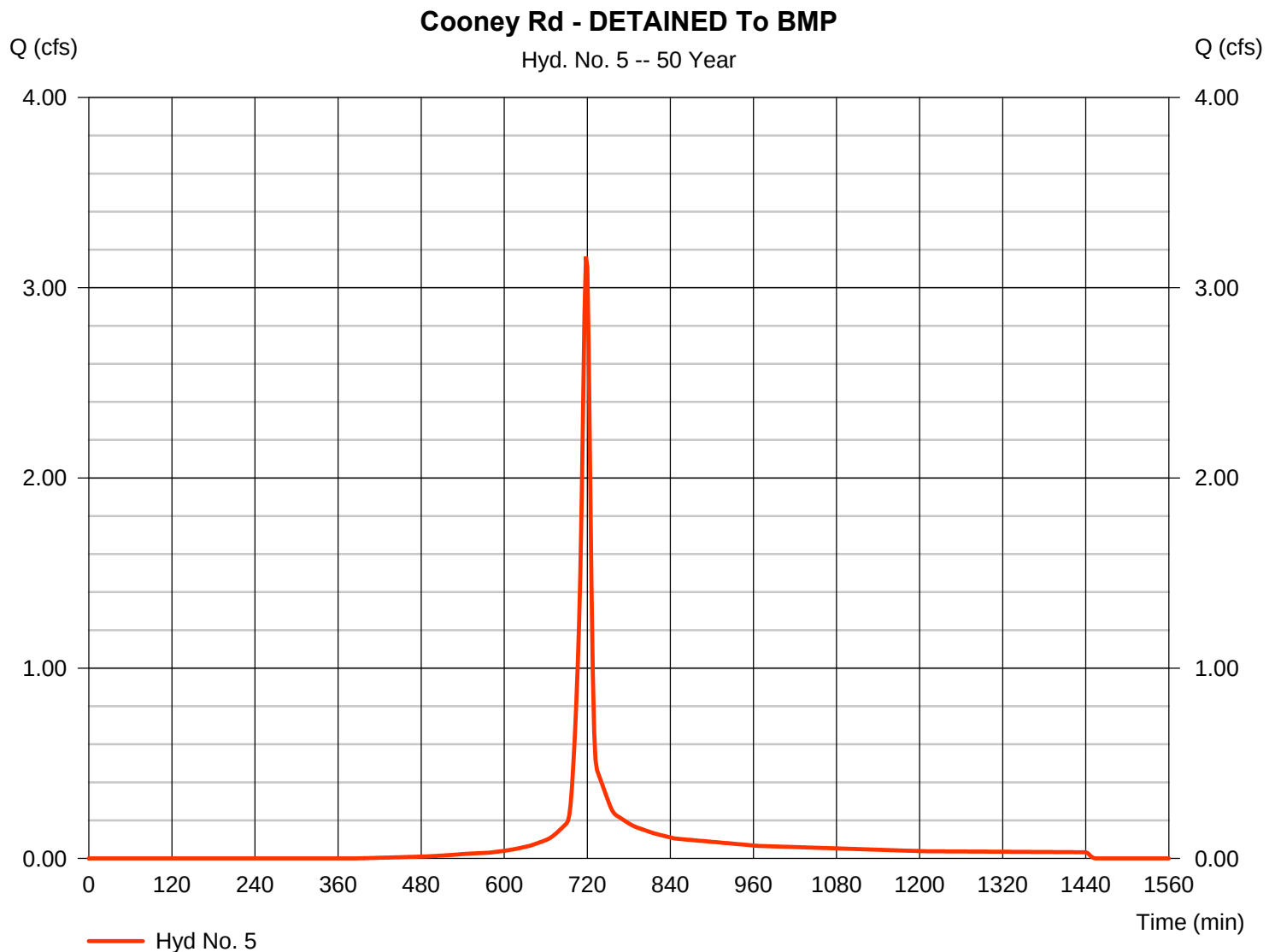
Wednesday, 11 / 9 / 2016

Hyd. No. 5

Cooney Rd - DETAINED To BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.164 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	7,308 cuft
Drainage area	=	0.630 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.20 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.450 \times 78) + (0.180 \times 91)] / 0.630$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

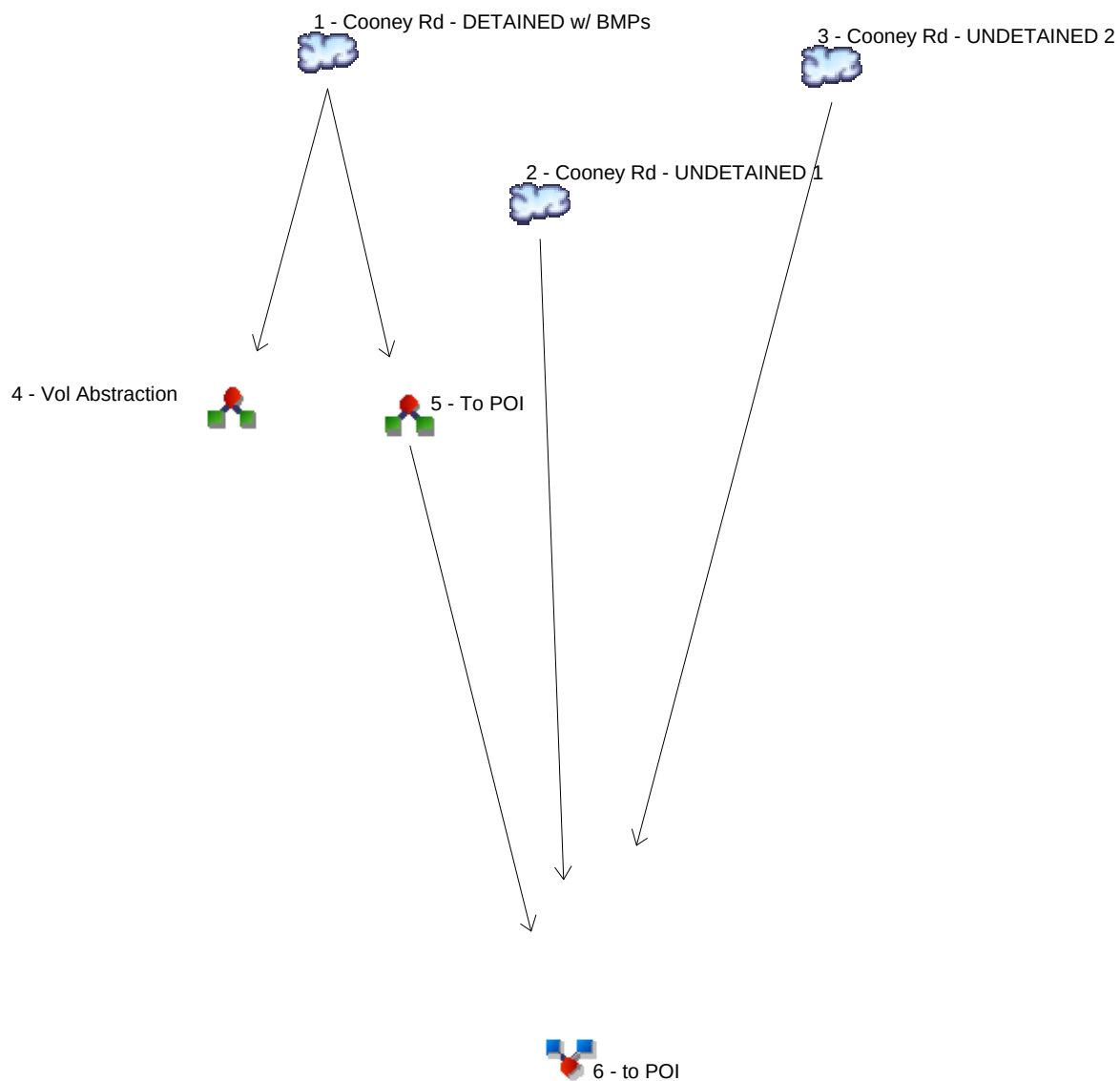
Hyd. No. 5

Cooney Rd - DETAINED To BMP

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	55.00				
Watercourse slope (%)	= 13.20	4.50	3.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.06				
Travel Time (min)	= 0.11	+	0.59	+	0.30	=	1.00
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	= 0.025	0.025	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				9.20 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.640	-----	2.657	3.166	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	-----	-----	-----	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1
3	SCS Runoff	-----	-----	-----	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2
4	Diversion1	1	-----	-----	-----	-----	1.640	-----	2.657	2.931	Vol Abstraction
5	Diversion2	1	-----	-----	-----	-----	0.470	-----	2.629	3.166	To POI
6	Combine	2, 3, 5	-----	-----	-----	-----	2.422	-----	4.025	5.327	to POI
Proj. file: Cooney Rd- wBMP-10,50,100yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.657	2	728	9,749	-----	-----	-----	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	3.802	2	718	8,709	-----	-----	-----	Cooney Rd - UNDETAINED 1
3	SCS Runoff	0.224	2	718	512	-----	-----	-----	Cooney Rd - UNDETAINED 2
4	Diversion1	2.657	2	728	3,214	1	-----	-----	Vol Abstraction
5	Diversion2	2.629	2	730	6,536	1	-----	-----	To POI
6	Combine	4.025	2	718	15,757	2, 3, 5	-----	-----	to POI
Cooney Rd- wBMP-10,50,100yr.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

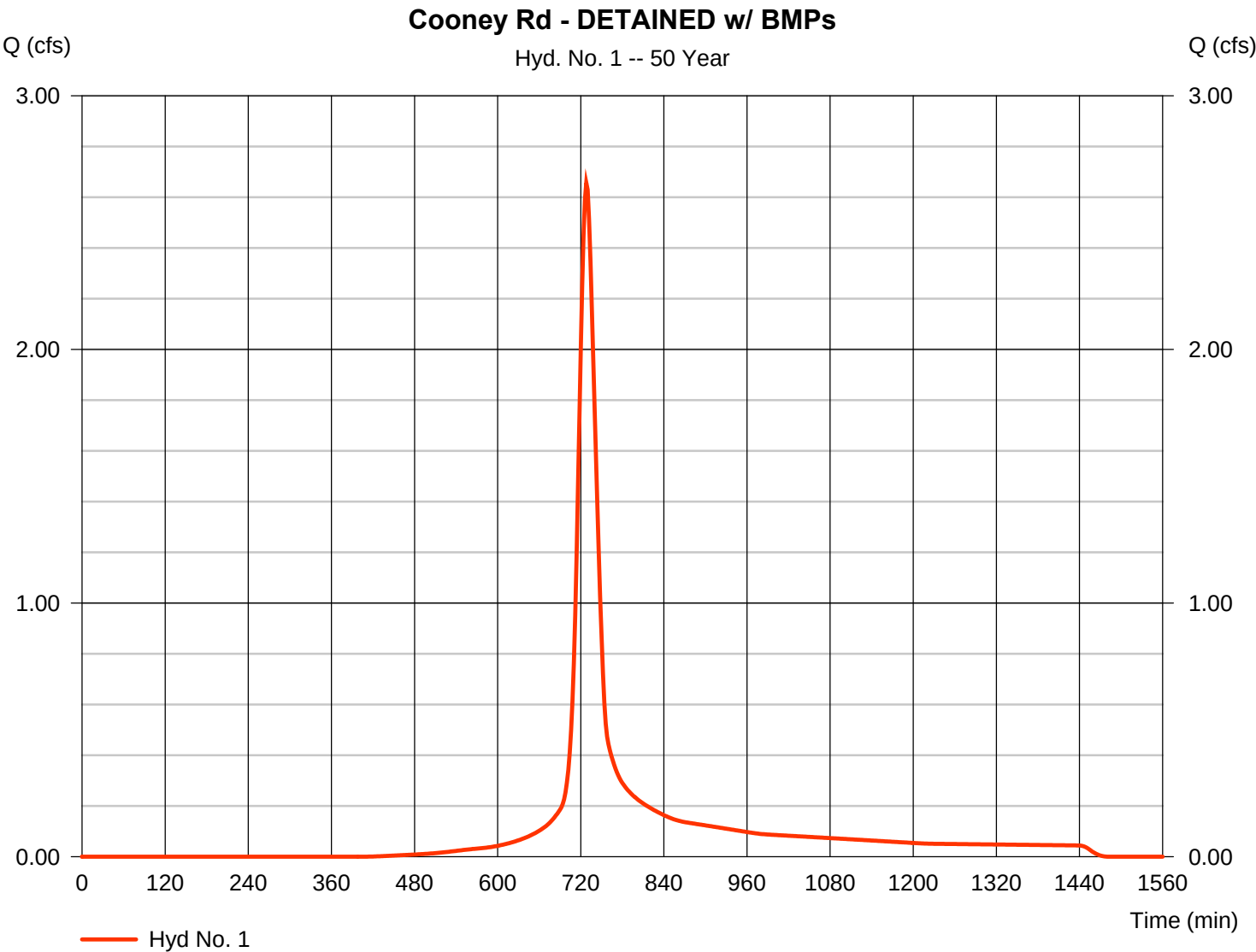
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Cooney Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.657 cfs
Storm frequency	=	50 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	9,749 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	23.70 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

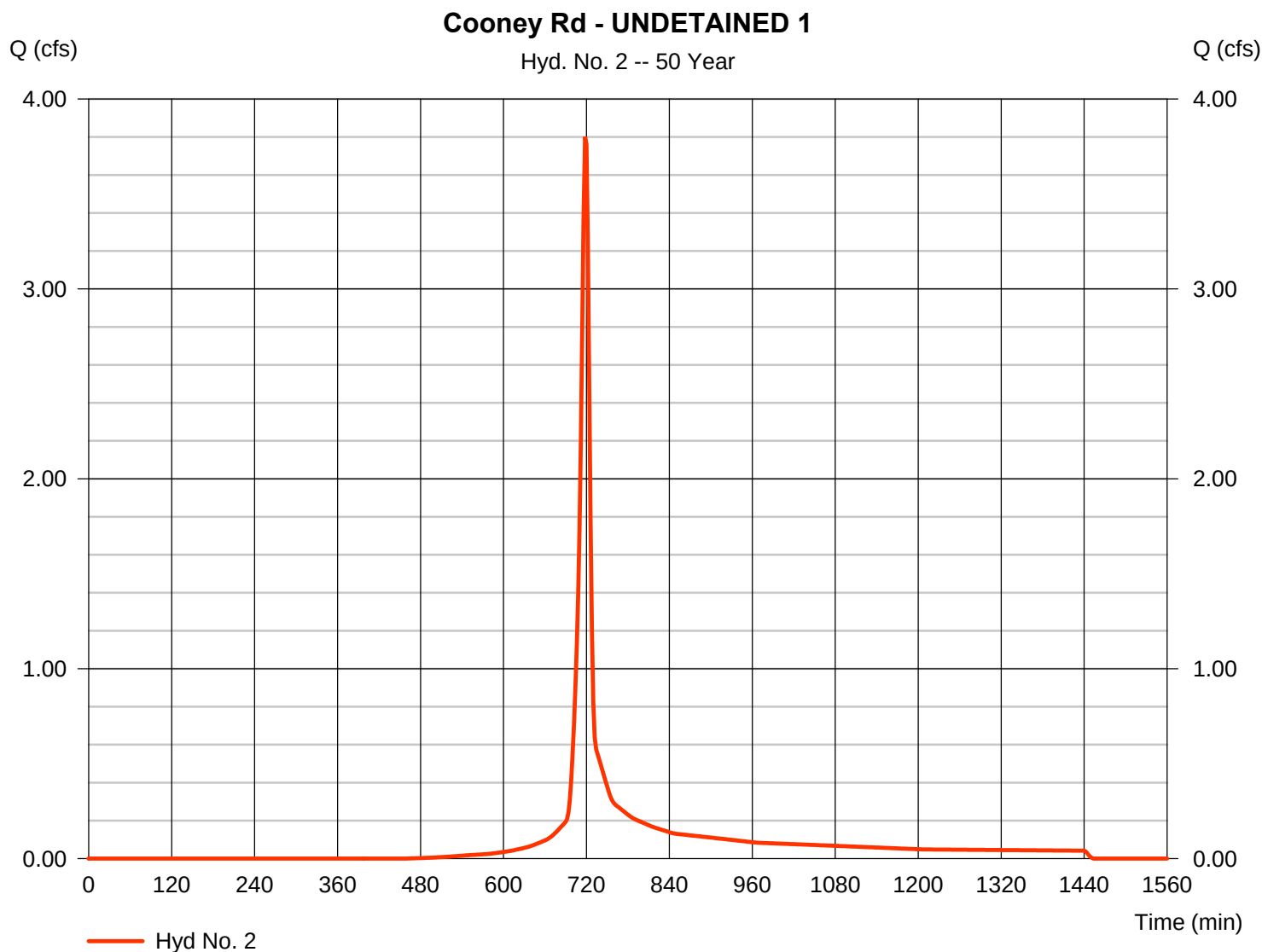
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.802 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	8,709 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

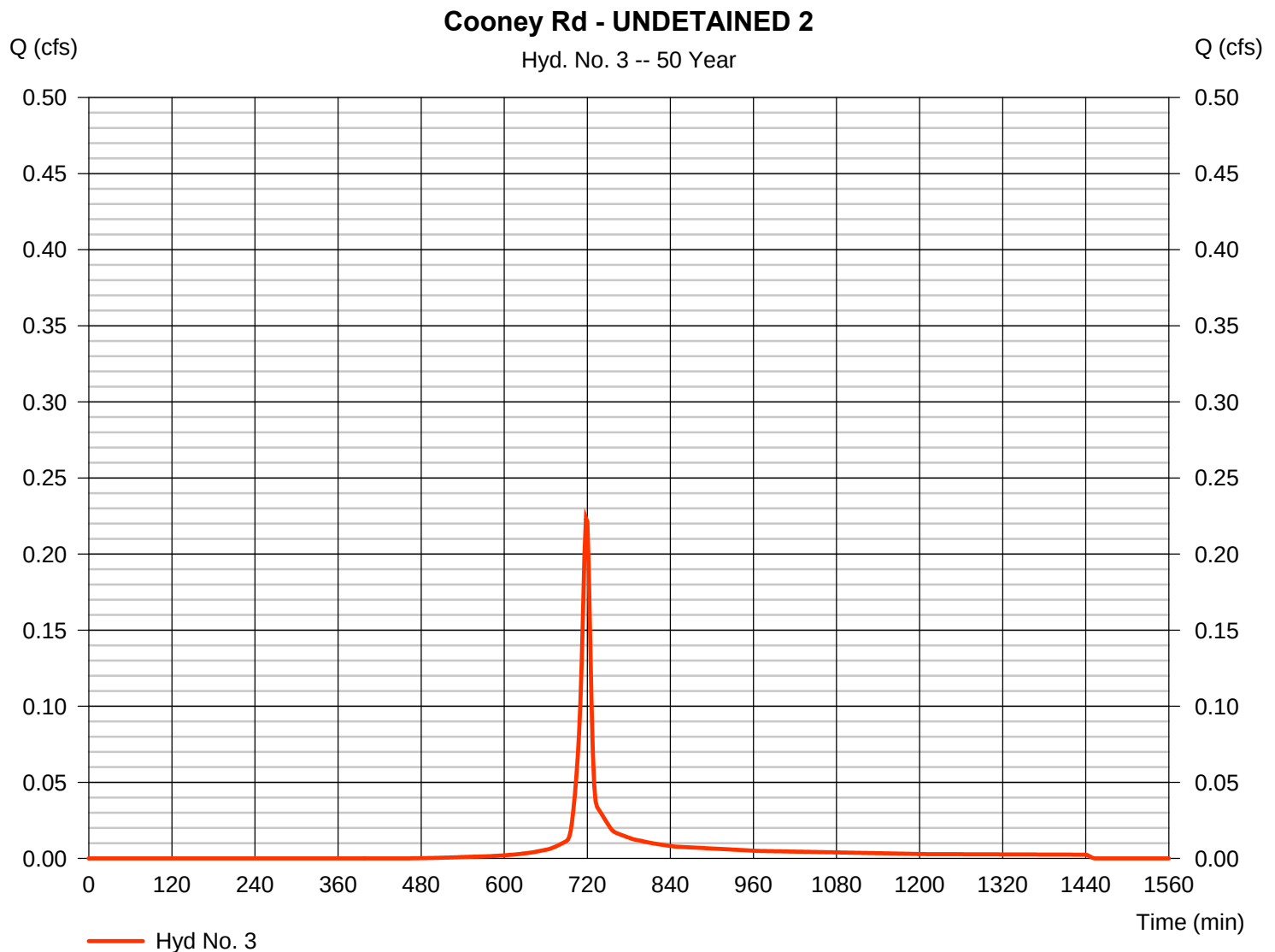
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.224 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	512 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	5.13 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2

<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)	= 2.62	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.21	+	0.00	+
			0.00	= 8.21
Shallow Concentrated Flow				
Flow length (ft)	= 178.00	0.00	0.00	
Watercourse slope (%)	= 5.10	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.64	0.00	0.00	
Travel Time (min)	= 0.81	+	0.00	+
			0.00	= 0.81
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	= 0.025	0.025	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				9.00 min

Hydrograph Report

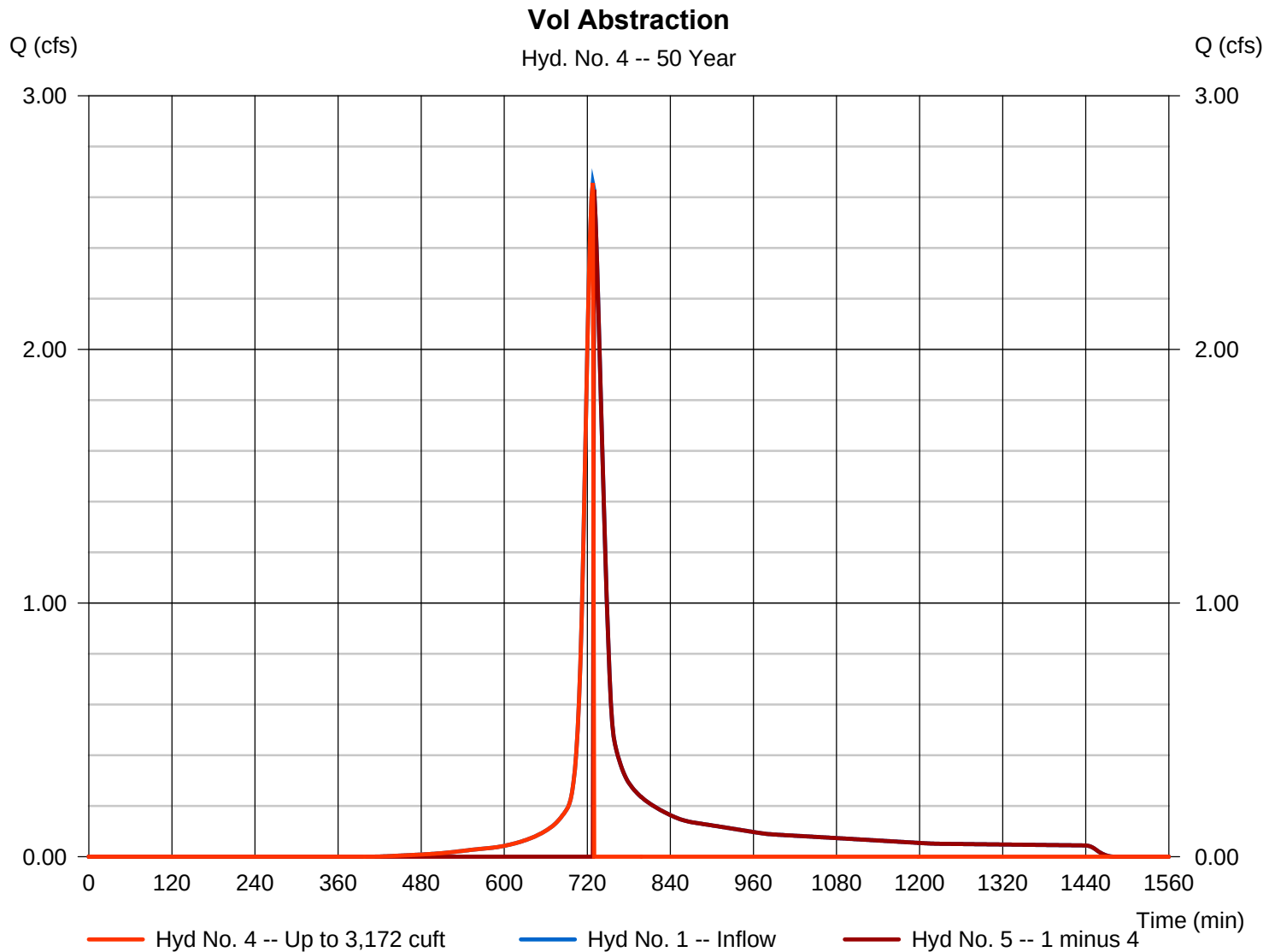
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.657 cfs
Storm frequency	= 50 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 3,214 cuft
Inflow hydrograph	= 1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 3,172 cuft



Hydrograph Report

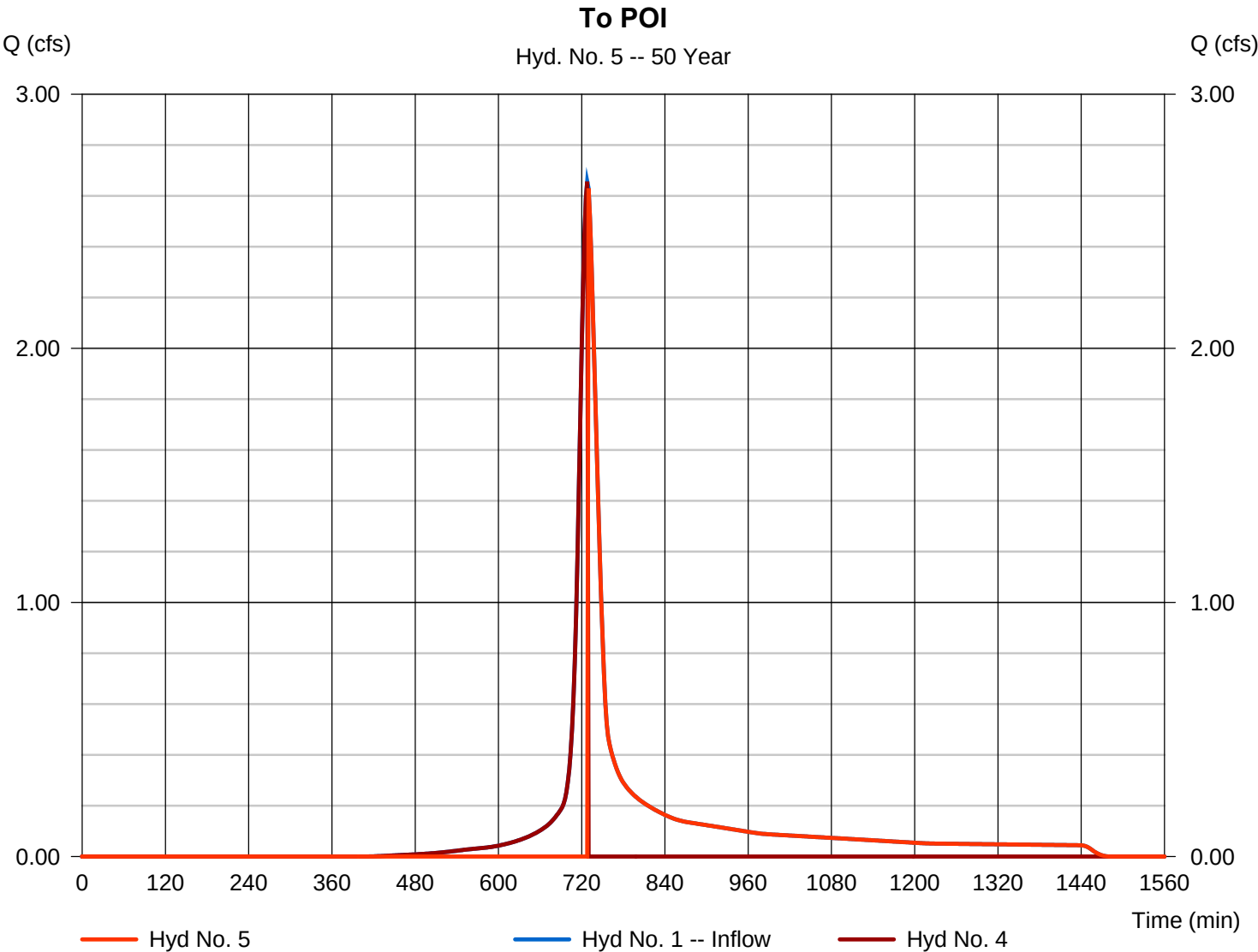
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	2.629 cfs
Storm frequency	=	50 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	6,536 cuft
Inflow hydrograph	=	1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	3,172 cuft



Hydrograph Report

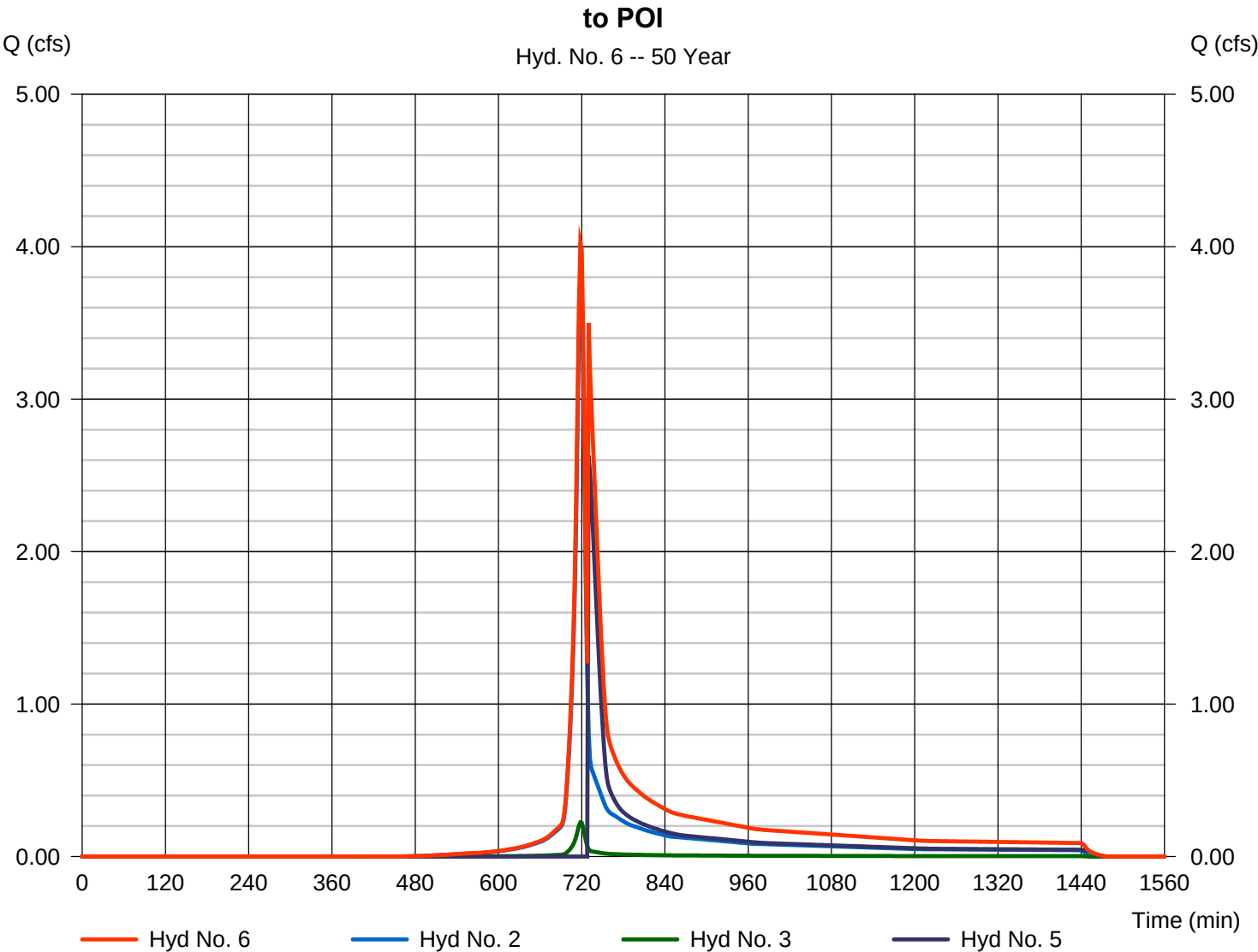
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 6

to POI

Hydrograph type	= Combine	Peak discharge	= 4.025 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 15,757 cuft
Inflow hyds.	= 2, 3, 5	Contrib. drain. area	= 0.900 ac



ATTACHMENT C-4
COONEY RD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Cooney Rd - PRE



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	2.154	-----	-----	4.315	-----	7.212	8.680	Cooney Rd - PRE
Proj. file: Cooney Rd-PRE.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	8.680	2	720	22,547	-----	-----	-----	Cooney Rd - PRE
Cooney Rd-PRE.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

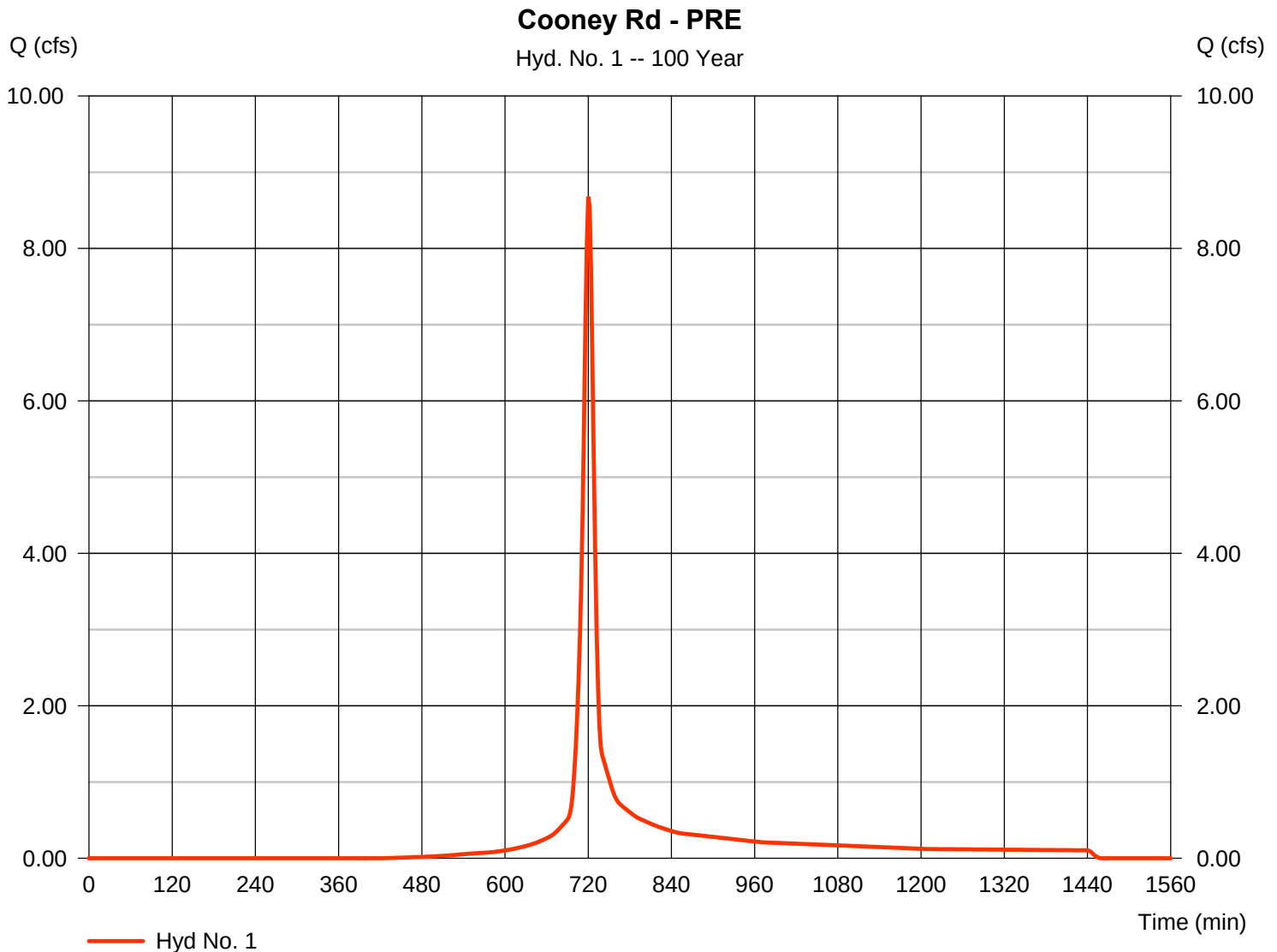
Wednesday, 11 / 9 / 2016

Hyd. No. 1

Cooney Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	8.680 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	22,547 cuft
Drainage area	=	1.770 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.40 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(1.360 \times 78) + (0.330 \times 77) + (0.080 \times 91)] / 1.770$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

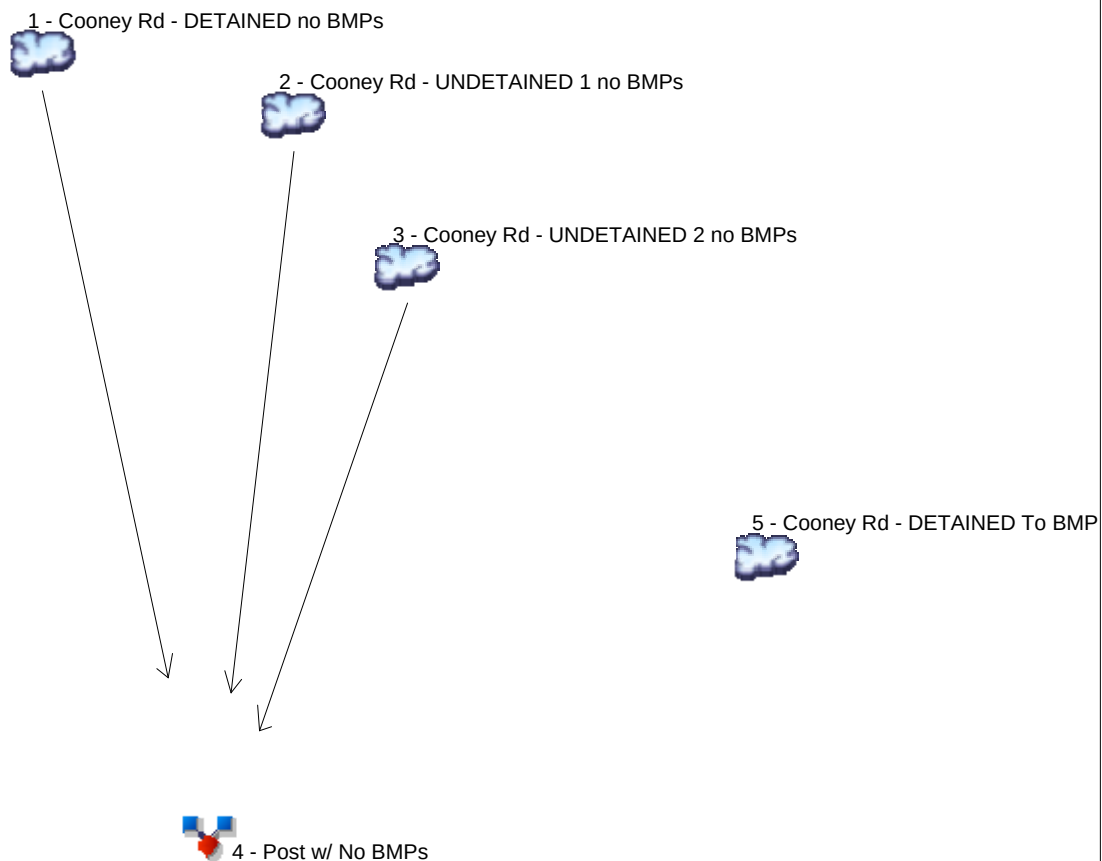
Hyd. No. 1

Cooney Rd - PRE

<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)	= 2.51	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.38	+	0.00	+	0.00	=	8.38
Shallow Concentrated Flow							
Flow length (ft)	= 91.00	351.00	0.00				
Watercourse slope (%)	= 10.90	4.60	0.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=5.33	3.46	0.00				
Travel Time (min)	= 0.28	+	1.69	+	0.00	=	1.98
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	= 0.025	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				10.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.290	-----	-----	2.441	-----	3.926	4.668	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	-----	-----	1.157	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	-----	-----	0.068	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2 no BM
4	Combine	1, 2, 3	-----	2.509	-----	-----	4.862	-----	7.907	9.435	Post w/ No BMPs
5	SCS Runoff	-----	-----	1.086	-----	-----	1.998	-----	3.164	3.744	Cooney Rd - DETAINED To BMP
Proj. file: Cooney Rd-no BMP.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.668	2	720	12,195	-----	-----	-----	Cooney Rd - DETAINED no BMPs
2	SCS Runoff	4.569	2	718	10,499	-----	-----	-----	Cooney Rd - UNDETAINED 1 no BM
3	SCS Runoff	0.269	2	718	618	-----	-----	-----	Cooney Rd - UNDETAINED 2 no BM
4	Combine	9.435	2	720	23,312	1, 2, 3	-----	-----	Post w/ No BMPs
5	SCS Runoff	3.744	2	718	8,698	-----	-----	-----	Cooney Rd - DETAINED To BMP
Cooney Rd-no BMP.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

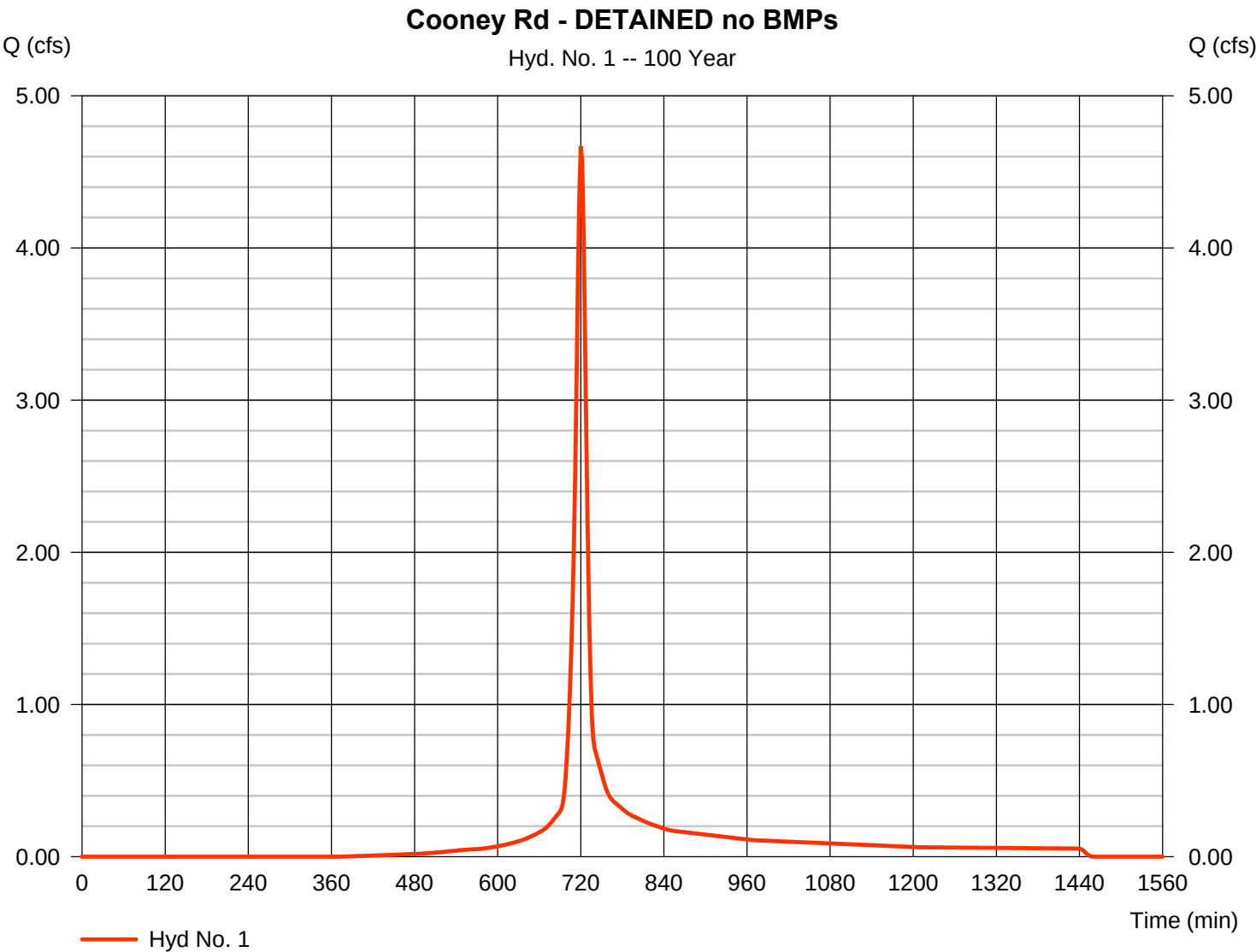
Hydrograph Report

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.668 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	12,195 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.30 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Cooney Rd - DETAINED no BMPs

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	282.00				
Watercourse slope (%)	= 13.20	4.50	4.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.46				
Travel Time (min)	= 0.11	+	0.59	+	1.36	=	2.06
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	= 0.025	0.025	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				10.30 min			

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

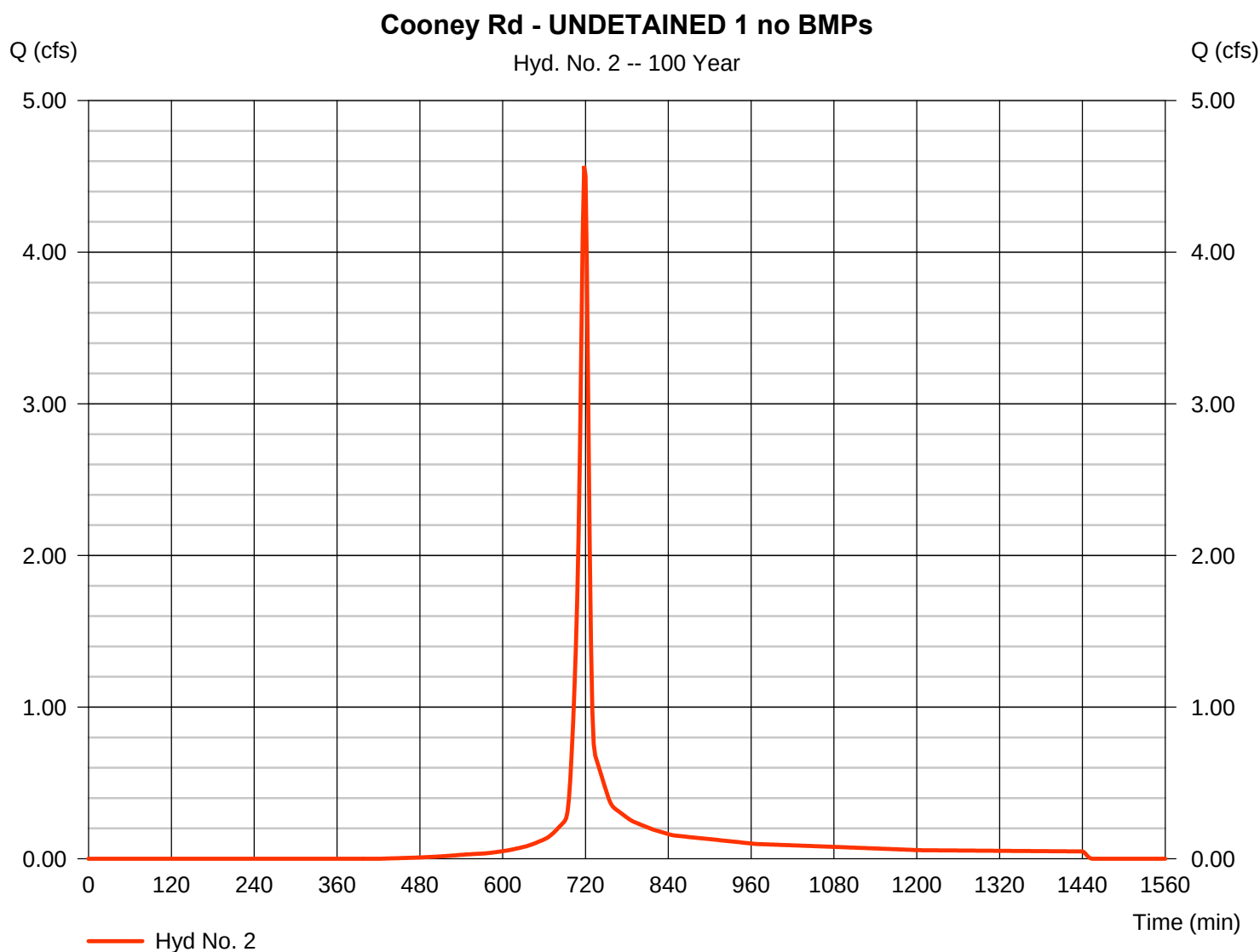
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.569 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	10,499 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 1 no BMPs

<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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

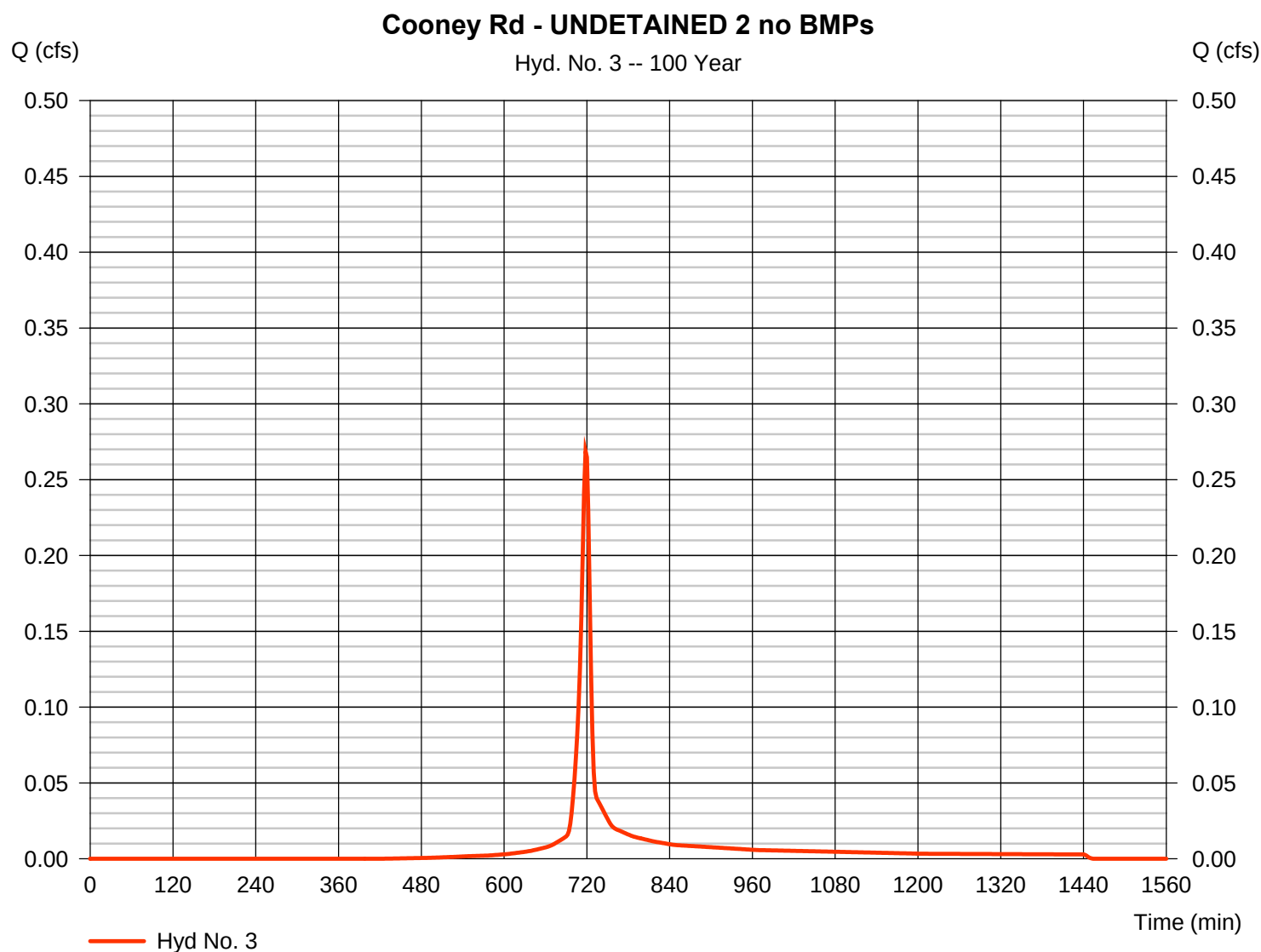
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.269 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	618 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2 no BMPs

<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)	= 2.62	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 8.21	+	0.00	+
			0.00	= 8.21
Shallow Concentrated Flow				
Flow length (ft)	= 178.00	0.00	0.00	
Watercourse slope (%)	= 5.10	0.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.64	0.00	0.00	
Travel Time (min)	= 0.81	+	0.00	+
			0.00	= 0.81
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	= 0.025	0.025	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				9.00 min

Hydrograph Report

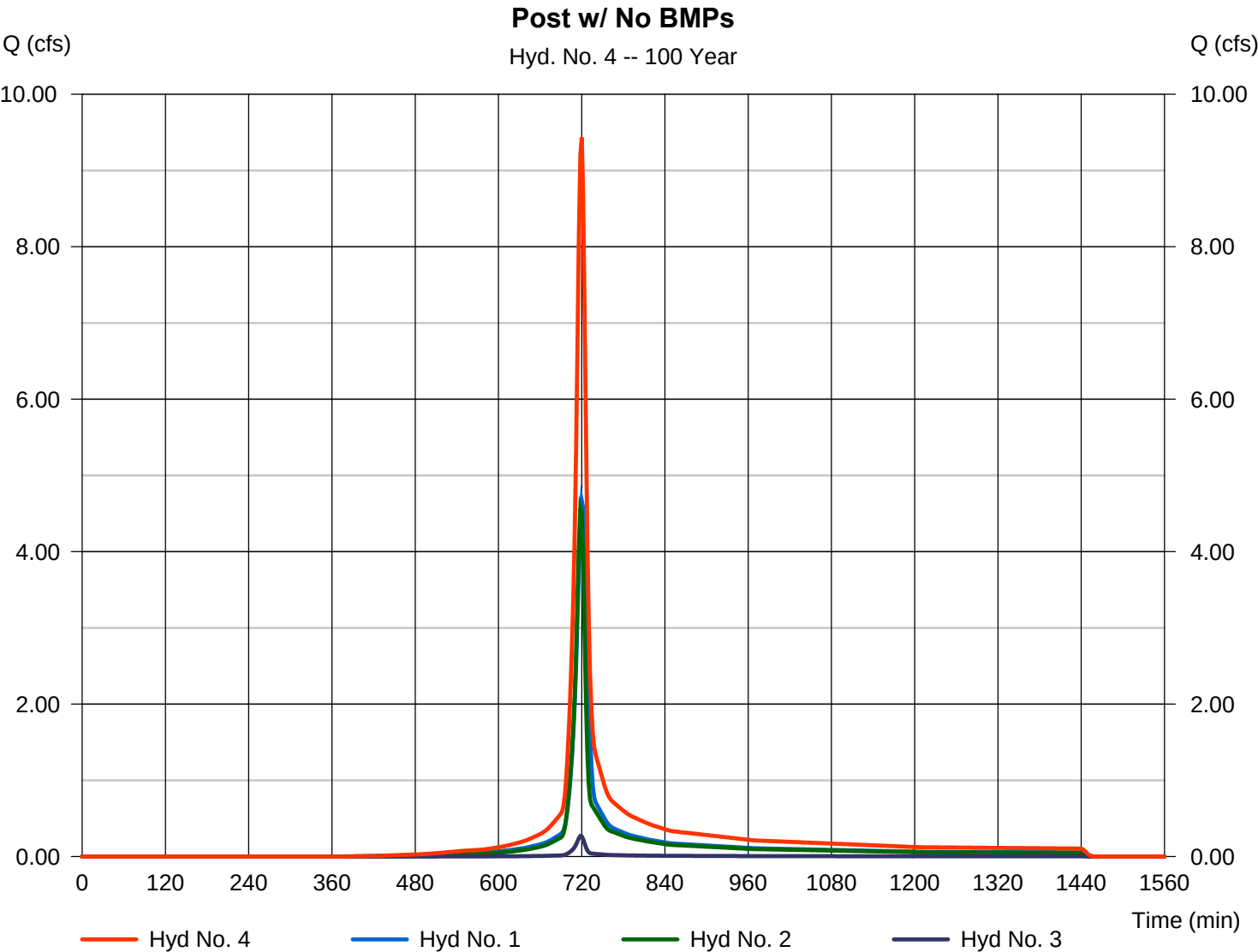
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Post w/ No BMPs

Hydrograph type	= Combine	Peak discharge	= 9.435 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 23,312 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 1.780 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

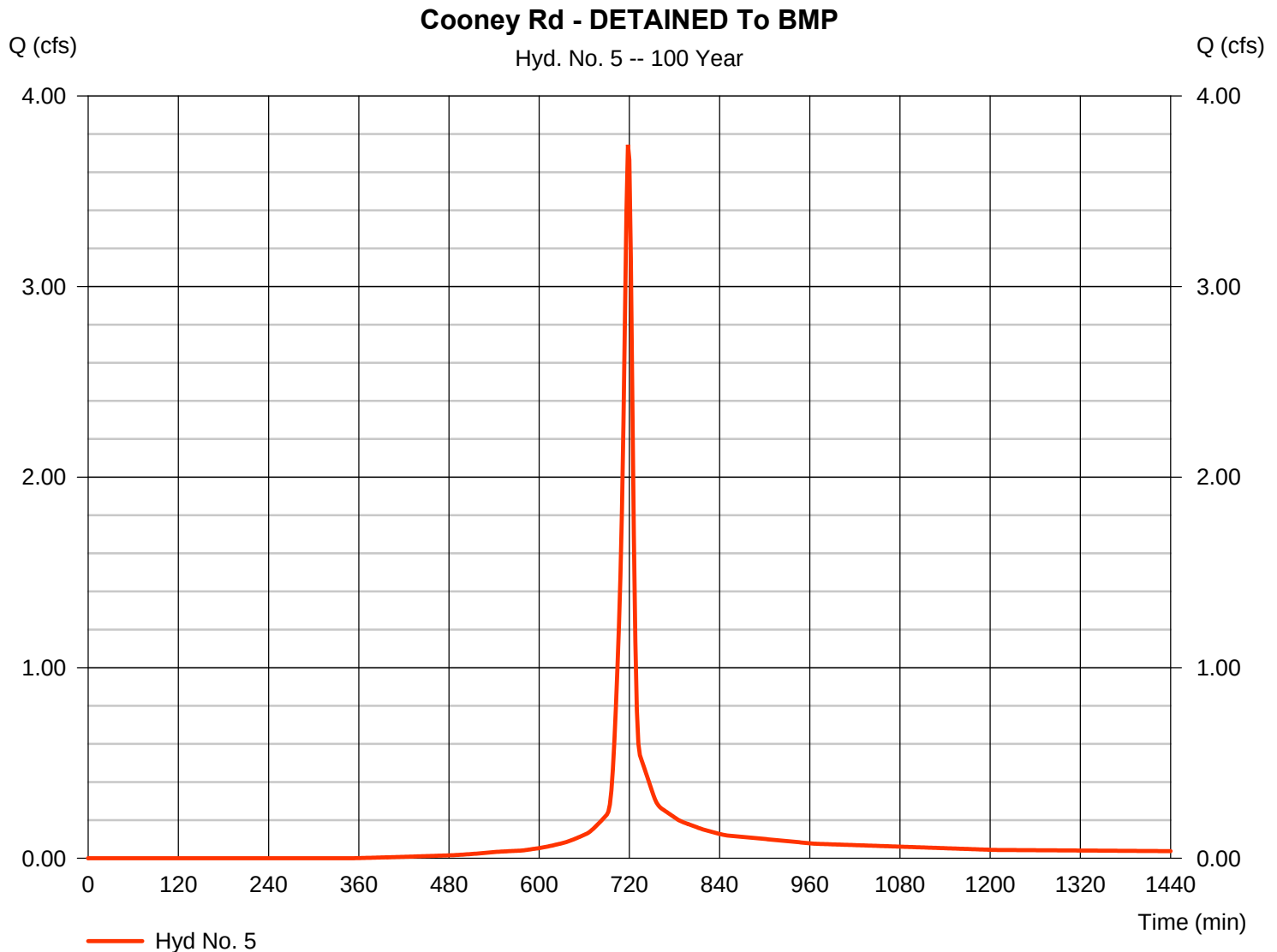
Wednesday, 11 / 9 / 2016

Hyd. No. 5

Cooney Rd - DETAINED To BMP

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.744 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	8,698 cuft
Drainage area	=	0.630 ac	Curve number	=	82*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.20 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.450 \times 78) + (0.180 \times 91)] / 0.630$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

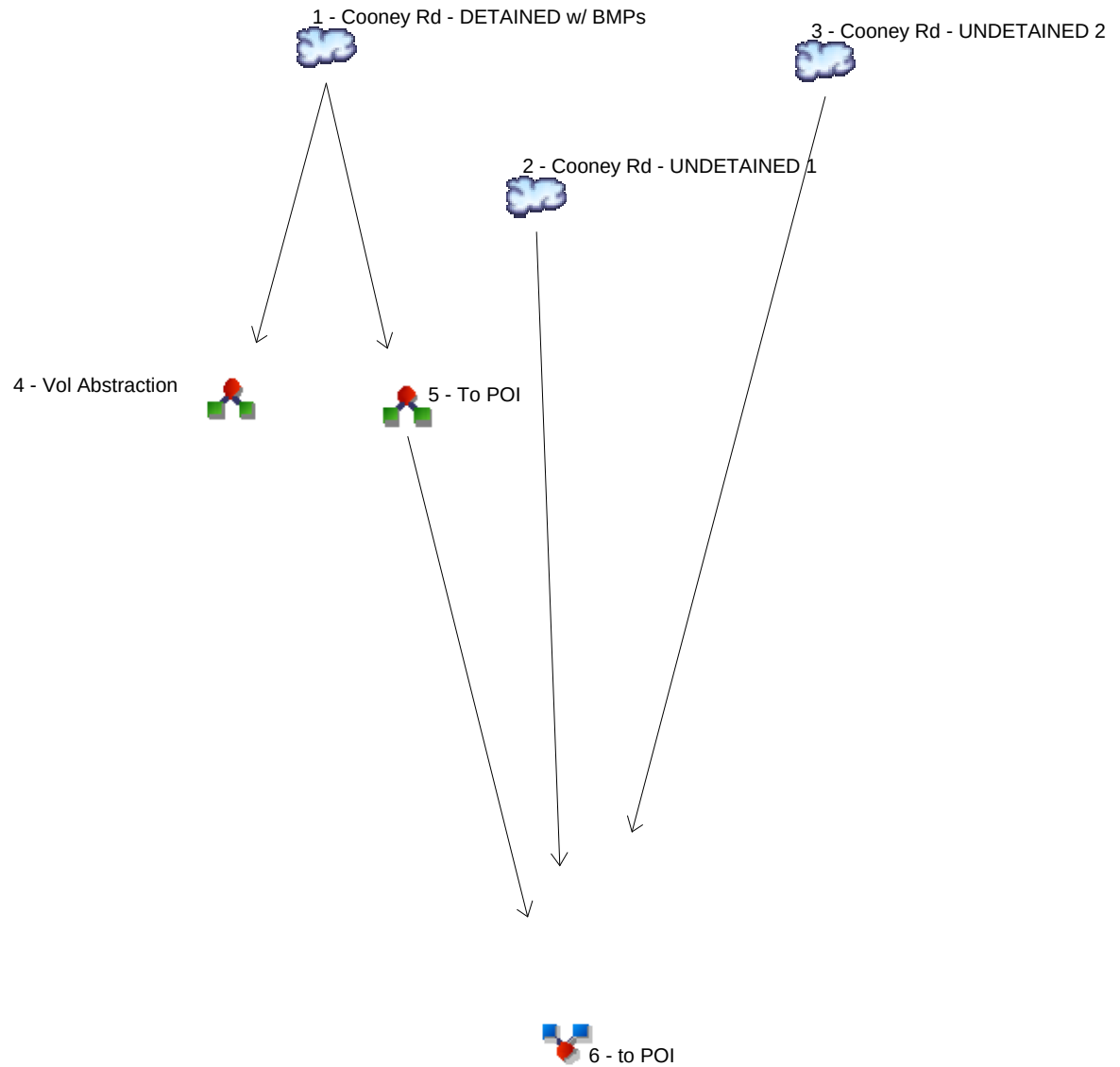
Hyd. No. 5

Cooney Rd - DETAINED To BMP

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.150	0.150	0.011				
Flow length (ft)	= 100.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 39.00	152.00	55.00				
Watercourse slope (%)	= 13.20	4.50	3.60				
Surface description	= Unpaved	Paved	Unpaved				
Average velocity (ft/s)	=5.86	4.31	3.06				
Travel Time (min)	= 0.11	+	0.59	+	0.30	=	1.00
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	= 0.025	0.025	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				9.20 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.640	-----	2.657	3.166	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	-----	-----	-----	-----	-----	2.287	-----	3.802	4.569	Cooney Rd - UNDETAINED 1
3	SCS Runoff	-----	-----	-----	-----	-----	0.135	-----	0.224	0.269	Cooney Rd - UNDETAINED 2
4	Diversion1	1	-----	-----	-----	-----	1.640	-----	2.657	2.931	Vol Abstraction
5	Diversion2	1	-----	-----	-----	-----	0.470	-----	2.629	3.166	To POI
6	Combine	2, 3, 5	-----	-----	-----	-----	2.422	-----	4.025	5.327	to POI
Proj. file: Cooney Rd- wBMP-10,50,100yr.gpw										Wednesday, 11 / 9 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.166	2	728	11,641	-----	-----	-----	Cooney Rd - DETAINED w/ BMPs
2	SCS Runoff	4.569	2	718	10,499	-----	-----	-----	Cooney Rd - UNDETAINED 1
3	SCS Runoff	0.269	2	718	618	-----	-----	-----	Cooney Rd - UNDETAINED 2
4	Diversion1	2.931	2	724	3,248	1	-----	-----	Vol Abstraction
5	Diversion2	3.166	2	728	8,393	1	-----	-----	To POI
6	Combine	5.327	2	726	19,510	2, 3, 5	-----	-----	to POI
Cooney Rd- wBMP-10,50,100yr.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2016	

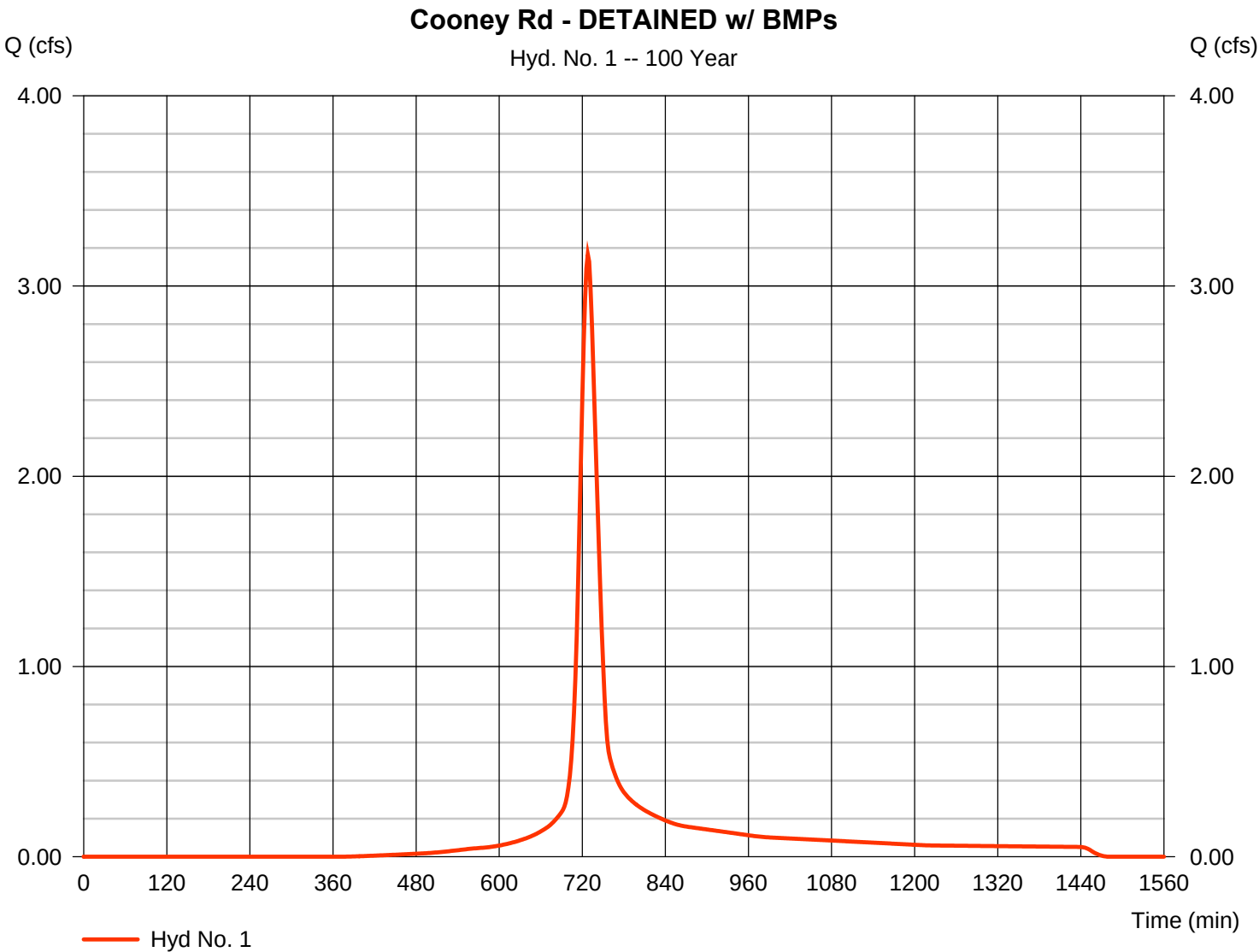
Hydrograph Report

Hyd. No. 1

Cooney Rd - DETAINED w/ BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.166 cfs
Storm frequency	=	100 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	11,641 cuft
Drainage area	=	0.880 ac	Curve number	=	81*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	23.70 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.700 x 78) + (0.180 x 91)] / 0.880



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

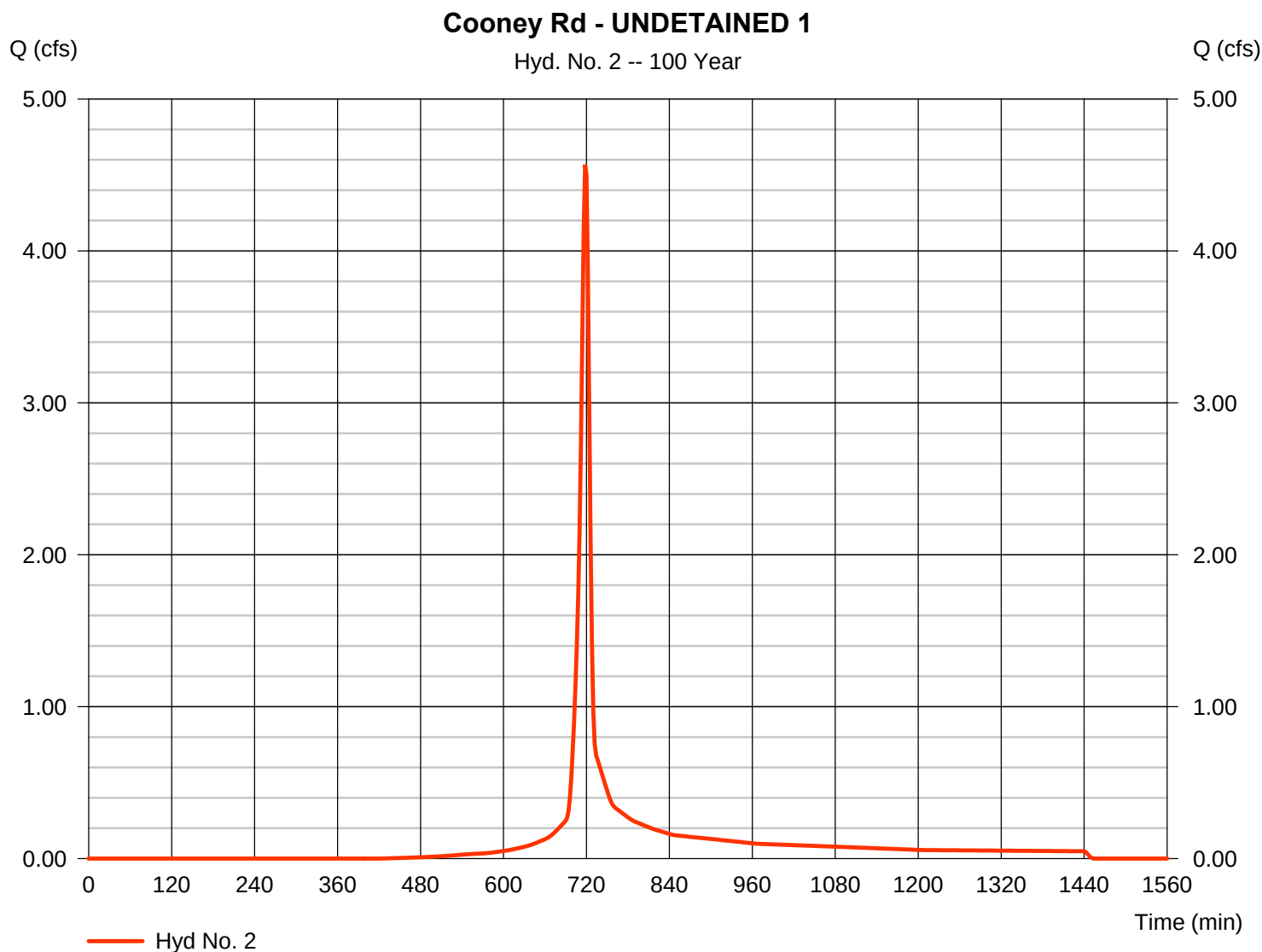
Wednesday, 11 / 9 / 2016

Hyd. No. 2

Cooney Rd - UNDETAINED 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.569 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	10,499 cuft
Drainage area	=	0.850 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.80 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.600 \times 78) + (0.240 \times 77) + (0.010 \times 91)] / 0.850$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Cooney Rd - UNDETAINED 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)	= 80.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.62	0.00	0.00				
Land slope (%)	= 8.00	0.00	0.00				
Travel Time (min)	= 5.20	+	0.00	+	0.00	=	5.20
Shallow Concentrated Flow							
Flow length (ft)	= 183.00	272.00	0.00				
Watercourse slope (%)	= 2.20	4.40	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=2.39	3.38	0.00				
Travel Time (min)	= 1.27	+	1.34	+	0.00	=	2.61
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	= 0.025	0.025	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				7.80 min			

Hydrograph Report

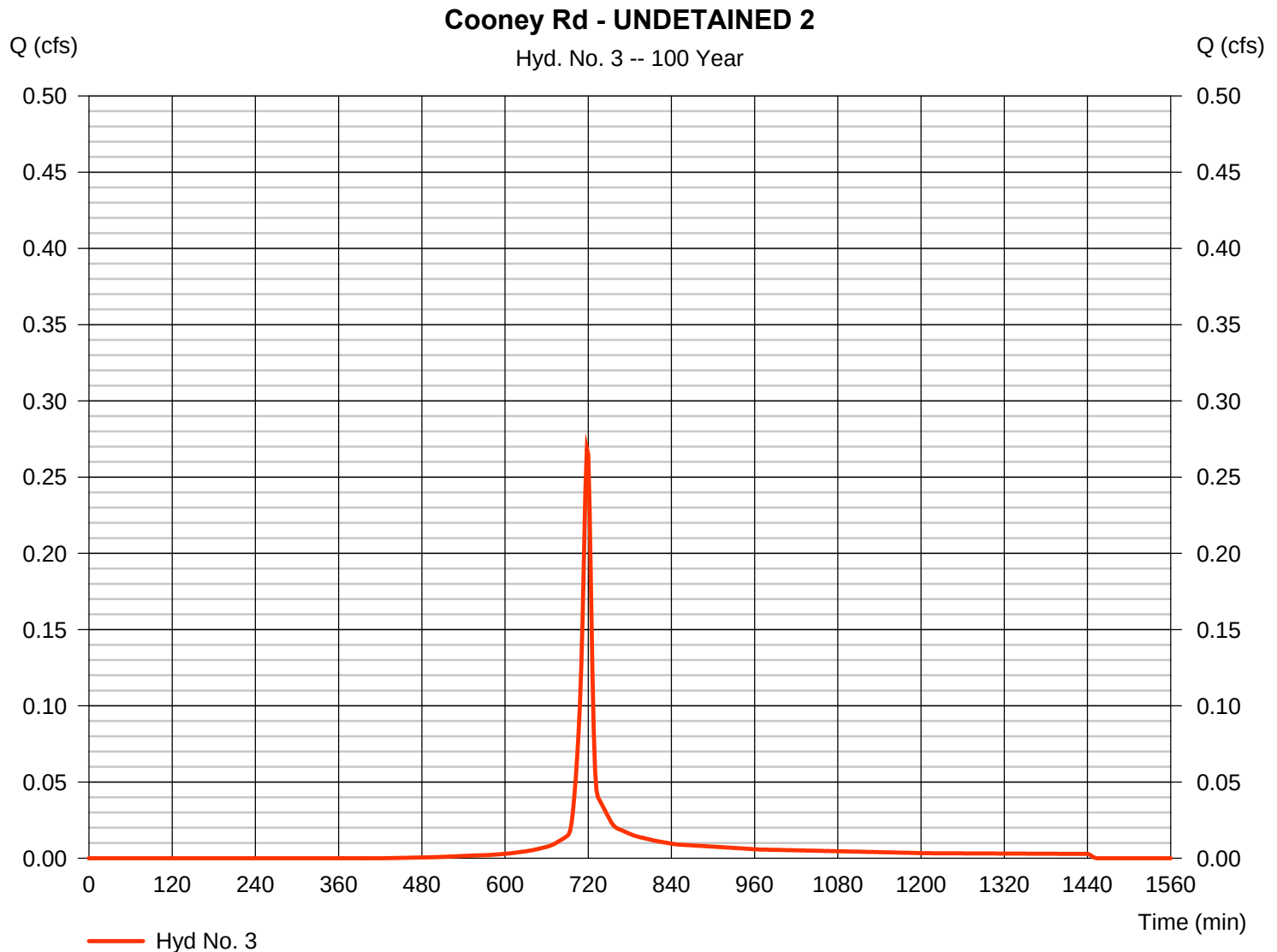
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 3

Cooney Rd - UNDETAINED 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.269 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	618 cuft
Drainage area	=	0.050 ac	Curve number	=	78*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	9.00 min
Total precip.	=	5.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = $[(0.050 \times 78)] / 0.050$ 

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Cooney Rd - UNDETAINED 2

<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)	= 2.62	0.00	0.00				
Land slope (%)	= 4.00	0.00	0.00				
Travel Time (min)	= 8.21	+	0.00	+	0.00	=	8.21
Shallow Concentrated Flow							
Flow length (ft)	= 178.00	0.00	0.00				
Watercourse slope (%)	= 5.10	0.00	0.00				
Surface description	= Unpaved	Unpaved	Paved				
Average velocity (ft/s)	=3.64	0.00	0.00				
Travel Time (min)	= 0.81	+	0.00	+	0.00	=	0.81
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	= 0.025	0.025	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				9.00 min			

Hydrograph Report

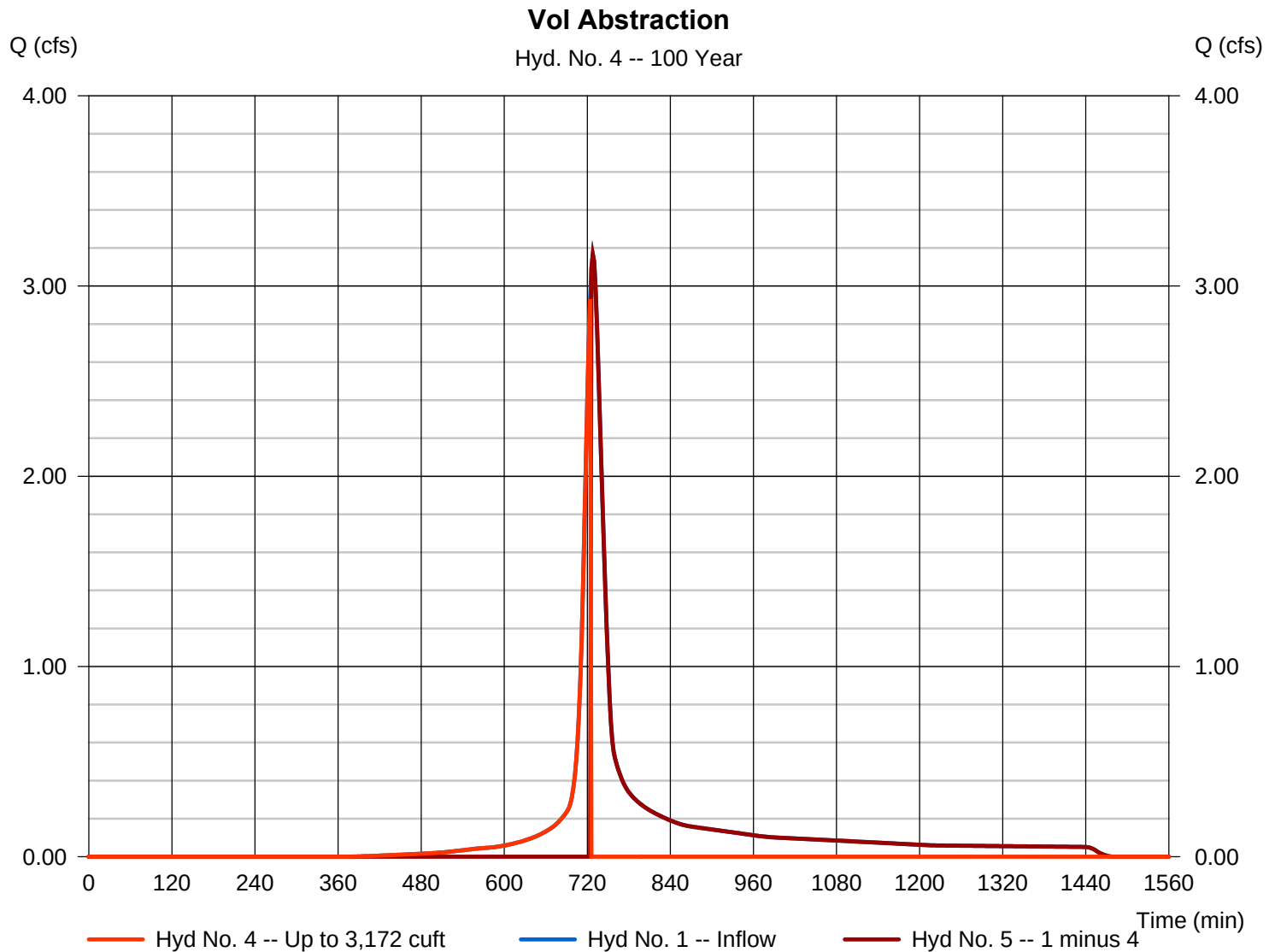
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 4

Vol Abstraction

Hydrograph type	= Diversion1	Peak discharge	= 2.931 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 3,248 cuft
Inflow hydrograph	= 1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 3,172 cuft



Hydrograph Report

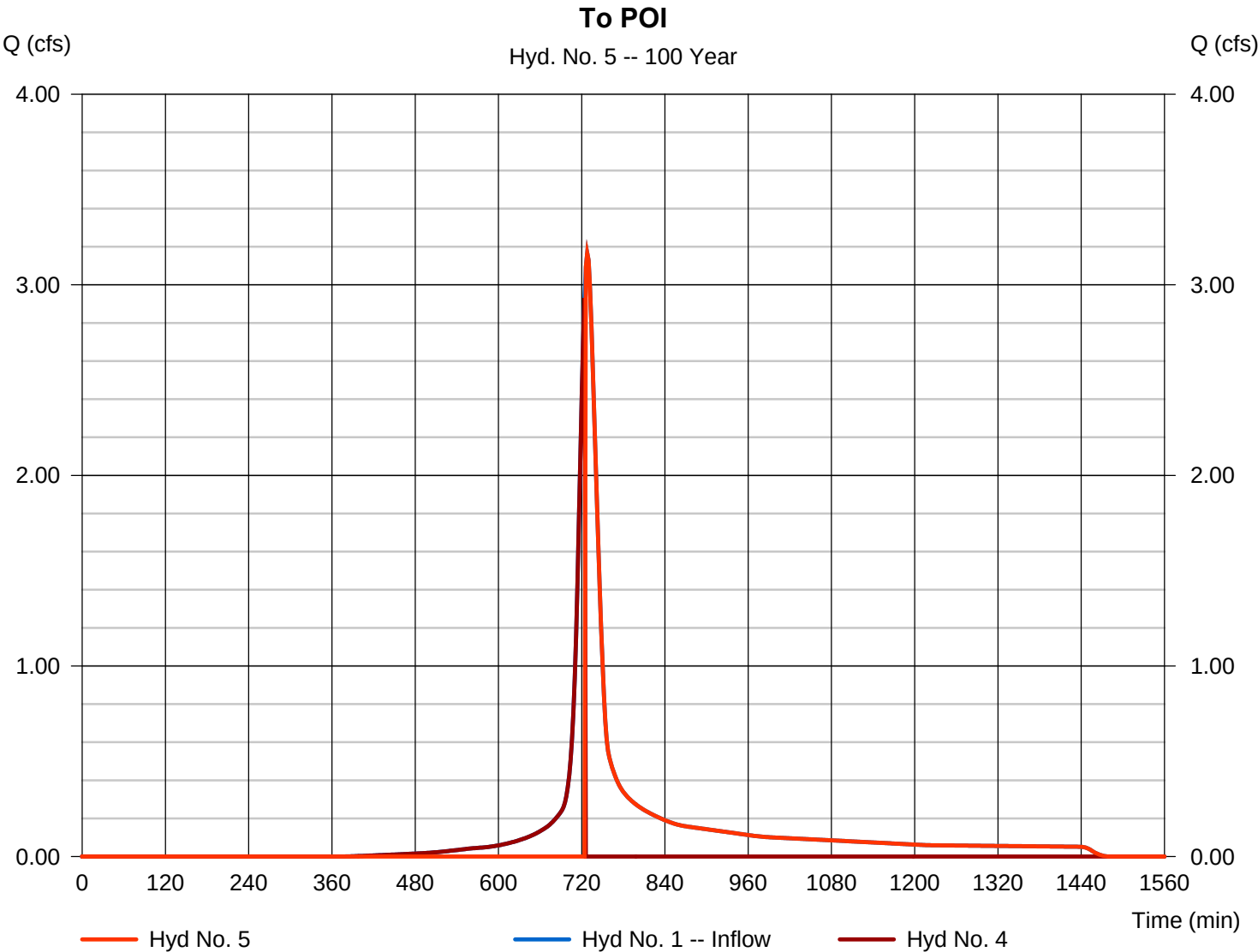
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 5

To POI

Hydrograph type	=	Diversion2	Peak discharge	=	3.166 cfs
Storm frequency	=	100 yrs	Time to peak	=	728 min
Time interval	=	2 min	Hyd. volume	=	8,393 cuft
Inflow hydrograph	=	1 - Cooney Rd - DETAINED w/2 BMPs	Inverted hyd.	=	4
Diversion method	=	First Flush Volume	Volume Up To	=	3,172 cuft



Hydrograph Report

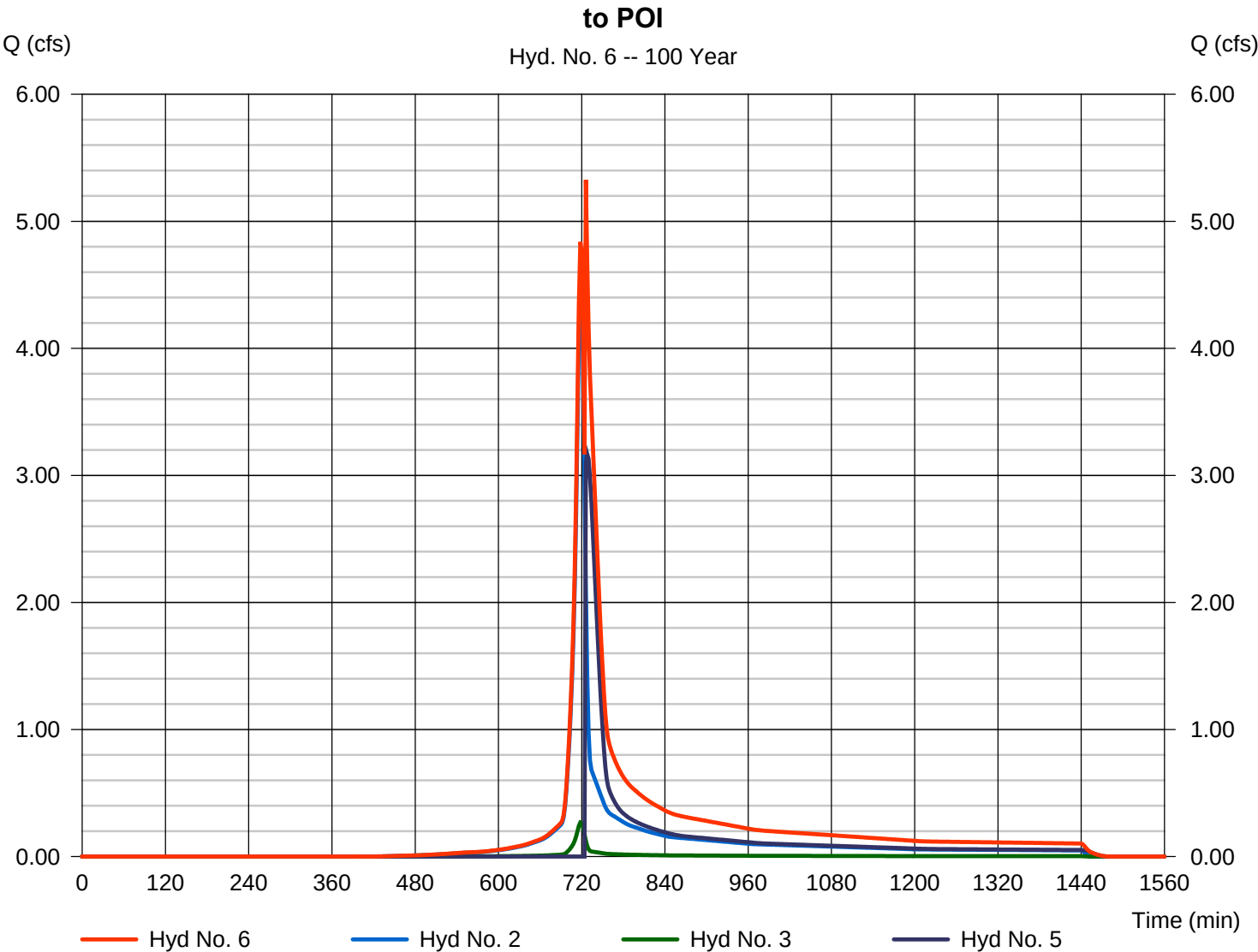
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

Hyd. No. 6

to POI

Hydrograph type	= Combine	Peak discharge	= 5.327 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 19,510 cuft
Inflow hyds.	= 2, 3, 5	Contrib. drain. area	= 0.900 ac



KOZAK RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 19, 2016

Project Name: Kozak Rd

Municipality: Cresson Township

County: Cambria

Total Area (acres): 4.63

Major River Basin: Ohio

Watershed: Little Conemaugh River

Sub Basin: Bens Creek- Little Conemaugh River

Nearest Surface Water to Receive Runoff: Tributary 46125 to Little Conemaugh River

Ch. 93 - Designated Water Use: CWF

Impaired according to Chapter 303(d) list?

YES

☒

List Causes of Impairment:

NO

☐

AMD - Metals

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements

YES

☐

NO

☒

Existing or Planned drinking water supply?

YES

☐

NO

☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan?

YES

☐

NO

☒

Existing River Conservation Plan?

YES

☐

NO

☒

WORKSHEET 2. SENSITIVE NATURAL RESOURCES

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	4.63	4.03
Other:			
TOTAL EXISTING:	Yes	4.63	4.03

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	<u>4.03</u>	Ac.
1.2 Area of Riparian Forest Buffer Protection	<u>0</u>	Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	<u>0</u>	Ac.
TOTAL	<u>4.03</u>	Ac.

Site Area	minus	Protected Area	=	Stormwater Management Area
4.63	-	4.03	=	0.59
<i>This is the area that requires stormwater management</i>				

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³
Meadow	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy	<u> </u>	ft ² x	1/2 in x	1/12 =	<u> </u>	ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

For all other disconnected roof areas

Roof Area	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas	<u> </u>	ft ² x	1/3 in x	1/12 =	<u> </u>	ft ³

For all other disconnected roof areas

Impervious Areas	<u> </u>	ft ² x	1/4 in x	1/12 =	<u> </u>	ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT*

ft³

* For use on Worksheet 5

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Kozak Rd
 Drainage Area: 4.63 acres
 2-Year Rainfall: 2.66 in

Total Site Area: 4.63 acres
 Protected Site Area: 4.03 acres
 Managed Site Area: 0.59 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Woods	C	23793	0.55	70	4.29	0.86	0.53	1,058
Meadow	C	2070	0.05	71	4.08	0.82	0.57	99
TOTAL:		25,863	0.59					1,157

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Meadow	C	16412	0.38	71	4.08	0.82	0.57	784
Gravel	C	9281	0.21	89	1.24	0.25	1.60	1,234
TOTAL:		25,693	0.59					2,018

2-Year Volume Increase (ft ³):	860

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

**Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
 The use of a weighted CN value for volume calculations is not acceptable.**

WORKSHEET 5. STRUCTURAL BMP VOLUME CREDITS

PROJECT: Kozak Rd
SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 860

Non-structural Volume Credit (ft³) - from Worksheet 3: - N/A

Structural Volume Reqmt (ft³) 860
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft ²)	Storage Volume (ft ³)
6.4.1	Porous Pavement		
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretenention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm	3,180	1,372
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			
Total Structural Volume Provided (ft³):			1,372
			Structural Volume Requirement (ft³): 860
			DIFFERENCE: -512

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary “yes” rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) “provided across the site” is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretenention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP

LOCATION: Kozak Road, Cambria County, PA

DONE BY: RJM

DATE: 10/19/2016

CHECKED BY: LMD

DATE: 10/20/2016

CHANNEL OR CHANNEL SECTION	DD-1				
TEMPORARY OR PERMANENT? (T OR P)	P				
DESIGN STORM (2, 5, 10, OR 100 YR)	100				
ACRES (AC)	1.60				
MULTIPLIER (1.6, 2.25, or 2.75) ¹	N/A				
Q _r (REQUIRED CAPACITY) (CFS)	6.00				
Q (CALCULATED AT FLOW DEPTH d) (CFS)	6.00				
S (BED SLOPE) ³ (FT/FT)	0.06				
DESIGN METHOD FOR PROTECTIVE LINING ⁵ PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V				
PROTECTIVE LINING ²	NAG P300				
n (MANNING'S COEFFICIENT) ²	0.075				
V _a (ALLOWABLE VELOCITY) (FPS)	5.00				
V (CALCULATED AT FLOW DEPTH) (FPS)	2.89				
t _a (MAX ALLOWABLE SHEAR STRESS) (LB/FT ²)	N/A				
t _d (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT ²)	N/A				
CHANNEL BOTTOM WIDTH (FT)	1				
CHANNEL LEFT SIDE SLOPE (LH:1V)	2				
CHANNEL RIGHT SIDE SLOPE (RH:1V)	2				
D (TOTAL DEPTH) (FT)	1.50				
CHANNEL TOP WIDTH @ D (FT)	7.00				
d (CALCULATED FLOW DEPTH) (FT)	0.80				
CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)	4.20				
BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)	1.25				
d ₅₀ STONE SIZE (IN)	N/A				
A (CROSS-SECTIONAL AREA) (SQ. FT.)	2.08				
R (HYDRAULIC RADIUS)	0.45				
S _c (CRITICAL SLOPE) (FT/FT)	0.116				
.7S _c (FT/FT)	0.081				
1.3S _c (FT/FT)	0.151				
STABLE FLOW? (Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW (FT)	N/A				
FREEBOARD BASED ON STABLE FLOW (FT)	0.70				
MINIMUM REQUIRED FREEBOARD ⁴	0.5				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

PCSM - DESIGN CALCULATIONS
KOZAK RD

TETRA TECH, INC.

By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

Post Construction Stormwater Management Plan - Design Calculations Kozak Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Kozak Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Kozak Road Block Valve Site is located in Cresson Township, Cambria County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

PCSM Design Requirements

The PCSM design for this project follows the PA Department of Environmental Protection's (PaDEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

TETRA TECH, INC.

By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.66
10-yr	3.83
50-yr	5.22
100-yr	5.91

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.66 in
Total Site Area : 4.63 acres
Protected Site Area: 4.03 acres
Stormwater Management Area 0.59 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Woods	C	0.55	70	4.29	0.86	0.53	1,058
Meadow	C	0.05	71	4.08	0.82	0.57	99
Total		0.59					1,157

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.38	71	4.08	0.82	0.57	784
Gravel	C	0.21	89	1.24	0.25	1.60	1,234
Total		0.59					2,018

2-Year Volume Increase (cf):	860

1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]
P = 2-Year Rainfall (in)
S = $(1000/CN) - 10$
2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
Q = Runoff (in)
Area = Land use area (sq. ft.)

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By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

LOADING RATES

INFILTRATION BERM 1

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.17	7219.00
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,444
Design Infiltration Area (sf):		1,855
Design Impervious Ratio:	3.9	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.27	11716.00
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		1,465
Design Infiltration Area (sf):		1,855
Design Total Watershed Ratio:	6.3	:1

INFILTRATION BERM 2

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.04	1931.00
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		386
Design Infiltration Area (sf):		1,325
Design Impervious Ratio:	1.5	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.09	4082.00
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		510
Design Infiltration Area (sf):		1,325
Design Total Watershed Ratio:	3.1	:1

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Koontz Road Block Valve Site will be located northeast edge of the pad and 98 percent of the disturbed area will be detained by the BMP.

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Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - Infiltration Berm 1	0.1
Design Infiltration Rate (in/hr) - Infiltration Berm 2	0.1

MAXIMUM VOLUME ABSTRACTION FOR STRUCTURAL BMPs

INFILTRATION BERM 1

Storage Volume

Width (ft)	Length (ft)	Cross-Section Area	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
26.5	70	15	1,855	0.60	1050

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	Infiltration Volume (cf)
0.1	1,855	2	31

Volume Abstraction Potential (cf)	1,080.92

INFILTRATION BERM 2

Storage Volume

Width (ft)	Length (ft)	Cross Section Area	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
25.0	53	14.5	1,325	0.60	769

Infiltration Volume for "Volume Abstraction" in Routing Process:

Infiltration Rate (in/hr)	Surface Area (sf)	Infiltration Period (hrs)	(cf)
0.1	1,325	2	22

Volume Abstraction Potential (cf)	790.58

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration Berm 1	1135	1050	1050	1050
Infiltration Berm 2	322	769	768.5	322
Total Structural Credit (cf) (Worksheet 5)				1372

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

TETRA TECH, INC.

By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\8 - Kozak Road (formerly Cresson RR East)\[Kozak Rd BMP Design.xlsx]Reference

WATERSHED CHARACTERISTICS

The total watershed area for the project site is 4.63 acres. Based upon the soil survey of Cambria County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Cookport and Ernest Soils (CeC), Brinkerton Soils (BtB) Atkins Silt Loam (At) series which are primarily classified as HSG C, D and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Meadow	71	0.25
C	CeC	Woods	70	2.04
D	BtB	Meadow	78	0.40
D	BtB	Woods	77	1.05
C/D	At	Woods	77	0.89
Totals				4.63

CN	74

Post-Development Condition

Undetained Area 1 (Diversion Channel)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Meadow	71	0.34
C	CeC	Woods	70	1.22
Totals				1.56

CN	70

Undetained Area 2

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Gravel	89	0.003
C	CeC	Meadow	71	0.02
C	CeC	Woods	70	0.11
D	BtB	Meadow	78	0.13
D	BtB	Woods	77	0.38
C/D	At	Woods	77	0.49
Totals				1.12

CN	76

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By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
 Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

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Undetained Area 3

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Meadow	71	0.03
C	CeC	Woods	70	0.05
D	BtB	Meadow	78	0.11
D	BtB	Woods	77	0.26
C/D	At	Woods	77	0.20
			Totals	0.65

CN	76

Infiltration Berm 1 (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Gravel	89	0.17
C	CeC	Meadow	71	0.11
C	CeC	Woods	70	0.10
D	BtB	Meadow	78	0.11
D	BtB	Woods	77	0.36
C/D	At	Woods	77	0.20
			Totals	1.04

CN	78

Infiltration Berm 2 (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C	CeC	Gravel	89	0.04
C	CeC	Meadow	71	0.08
C	CeC	Woods	70	0.02
D	BtB	Meadow	78	0.07
D	BtB	Woods	77	0.03
			Totals	0.25

CN	77

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By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\8 - Kozak Road (formerly Cresson RR East)\[Kozak Rd BMP Design.xlsx]Reference

PEAK FLOW CALCULATIONS

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachment C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.6	1,050	29.2	6.2	35.4
10	1.1	1,050	15.9	6.2	22.1
50	1.71	1,050	10.2	6.2	16.4
100	2.02	1,050	8.7	6.2	14.9

Notes: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

Infiltration Berm 2

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.19	322	29.0	1.6	30.6
10	0.35	622	29.6	1.6	31.2
50	0.57	769	22.5	1.6	24.1
100	0.68	769	18.8	1.6	20.4

Notes: The Adjusted Time of Concentration for the 100 year-24 hour storm event was conservatively used for all events.

$$\text{Additional Residence Time (min.)} = \frac{\text{Storage Volume (cf)}}{\text{Peak Flow w/o BMP}} * \frac{1 \text{ min}}{60 \text{ sec}}$$

TETRA TECH, INC.

By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
 Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\8 - Kozak Road (formerly Cresson RR East)\[Kozak Rd BMP Design.xlsx]Reference

DESIGN VOLUME ABSTRACTION

The Design Volume Abstraction for each infiltration structure will be the minimum value of the runoff volume to the infiltration structure or the volume abstraction potential of the infiltration structure.

Infiltration Berm 1

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	1,135	1,081	1,081
10	2,092	1,081	1,081
50	3,330	1,081	1,081
100	3,968	1,081	1,081

Infiltration Berm 2

Storm Event (Yr.)	Volume Runoff to BMP (cf)	Volume Abstraction Potential (cf)	Design Volume Abstraction (cf)
2	322	791	322
10	622	791	622
50	1,018	791	791
100	1,225	791	791

STORMWATER ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions. Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	Peak Runoff (cfs)	Peak Outflow (No BMP) (cfs)	Watershed Runoff Vol. (with BMPs) (cf)	Peak Outflow (with BMP) (cfs)	Change (cfs)
2-yr	4.06	4.5	10,871	3.03	-1.03
10-yr	9.06	9.8	23,626	9.05	-0.01
50-yr	15.87	16.9	41,321	15.60	-0.27
100-yr	19.44	20.6	50,890	19.05	-0.39

TETRA TECH, INC.

By: RJM Date: 10/19/2016 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/2016 Kozak Rd Proj. No.: 112IC05958

REFERENCES

- 1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.
- 2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.
- 3) Soil Survey of Cambria County, PA, United States Department of Agriculture, Soil Conservation Service, October 2016.
- 4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.
- 5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.
- 6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4446 N 78.5946 W 2082.1 ft.
- 7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.
- 8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES



NOAA Atlas 14, Volume 2, Version 3
Location name: Cresson Twp, Pennsylvania, USA*
Latitude: 40.4446°, Longitude: -78.5946°
Elevation: 2082.1 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.323 (0.292-0.359)	0.387 (0.351-0.431)	0.469 (0.424-0.522)	0.534 (0.480-0.592)	0.620 (0.554-0.686)	0.689 (0.612-0.760)	0.758 (0.670-0.836)	0.831 (0.729-0.916)	0.934 (0.812-1.03)	1.01 (0.873-1.12)
10-min	0.501 (0.453-0.558)	0.605 (0.548-0.672)	0.729 (0.658-0.811)	0.824 (0.741-0.914)	0.948 (0.847-1.05)	1.04 (0.928-1.15)	1.14 (1.01-1.26)	1.24 (1.09-1.37)	1.37 (1.19-1.51)	1.48 (1.27-1.62)
15-min	0.615 (0.556-0.683)	0.739 (0.670-0.822)	0.895 (0.808-0.995)	1.01 (0.912-1.13)	1.17 (1.05-1.30)	1.29 (1.15-1.43)	1.42 (1.25-1.56)	1.54 (1.35-1.70)	1.71 (1.49-1.89)	1.84 (1.59-2.03)
30-min	0.813 (0.735-0.904)	0.989 (0.897-1.10)	1.23 (1.11-1.36)	1.41 (1.27-1.56)	1.65 (1.48-1.83)	1.85 (1.64-2.04)	2.05 (1.81-2.26)	2.25 (1.98-2.48)	2.54 (2.21-2.79)	2.77 (2.38-3.04)
60-min	0.993 (0.898-1.10)	1.21 (1.10-1.35)	1.54 (1.39-1.71)	1.79 (1.61-1.99)	2.15 (1.92-2.37)	2.43 (2.16-2.69)	2.73 (2.42-3.02)	3.06 (2.68-3.37)	3.51 (3.05-3.87)	3.88 (3.35-4.27)
2-hr	1.17 (1.05-1.30)	1.42 (1.27-1.58)	1.80 (1.61-2.00)	2.10 (1.88-2.34)	2.54 (2.25-2.82)	2.91 (2.56-3.22)	3.30 (2.89-3.65)	3.72 (3.23-4.11)	4.34 (3.73-4.79)	4.86 (4.14-5.37)
3-hr	1.25 (1.13-1.40)	1.52 (1.37-1.70)	1.92 (1.73-2.13)	2.24 (2.01-2.49)	2.71 (2.41-3.00)	3.10 (2.74-3.42)	3.53 (3.10-3.89)	3.99 (3.48-4.39)	4.67 (4.02-5.13)	5.25 (4.47-5.76)
6-hr	1.53 (1.38-1.71)	1.84 (1.66-2.06)	2.30 (2.07-2.56)	2.68 (2.39-2.98)	3.22 (2.86-3.58)	3.68 (3.25-4.08)	4.17 (3.65-4.61)	4.71 (4.09-5.20)	5.50 (4.71-6.06)	6.16 (5.23-6.78)
12-hr	1.93 (1.75-2.17)	2.33 (2.11-2.61)	2.89 (2.61-3.24)	3.36 (3.02-3.75)	4.06 (3.61-4.51)	4.65 (4.11-5.16)	5.30 (4.64-5.87)	6.01 (5.22-6.65)	7.08 (6.05-7.82)	8.00 (6.75-8.83)
24-hr	2.22 (2.04-2.43)	2.66 (2.45-2.91)	3.30 (3.03-3.60)	3.83 (3.51-4.16)	4.59 (4.18-4.98)	5.22 (4.74-5.66)	5.91 (5.33-6.39)	6.64 (5.95-7.18)	7.71 (6.83-8.32)	8.59 (7.54-9.28)
2-day	2.60 (2.40-2.83)	3.11 (2.88-3.39)	3.84 (3.54-4.18)	4.45 (4.09-4.83)	5.32 (4.87-5.77)	6.05 (5.50-6.55)	6.83 (6.16-7.39)	7.67 (6.87-8.31)	8.89 (7.86-9.64)	9.90 (8.66-10.8)
3-day	2.79 (2.58-3.02)	3.33 (3.08-3.62)	4.09 (3.79-4.44)	4.73 (4.36-5.12)	5.63 (5.17-6.09)	6.38 (5.82-6.90)	7.19 (6.51-7.77)	8.05 (7.23-8.71)	9.28 (8.24-10.1)	10.3 (9.05-11.2)
4-day	2.97 (2.76-3.22)	3.55 (3.29-3.85)	4.35 (4.03-4.71)	5.00 (4.63-5.41)	5.94 (5.46-6.42)	6.72 (6.15-7.25)	7.54 (6.86-8.14)	8.42 (7.59-9.11)	9.68 (8.63-10.5)	10.7 (9.45-11.6)
7-day	3.58 (3.35-3.84)	4.26 (3.99-4.58)	5.16 (4.82-5.53)	5.88 (5.48-6.30)	6.88 (6.39-7.37)	7.68 (7.11-8.22)	8.51 (7.83-9.12)	9.36 (8.57-10.1)	10.6 (9.57-11.4)	11.5 (10.3-12.4)
10-day	4.34 (4.07-4.64)	5.14 (4.83-5.50)	6.14 (5.76-6.57)	6.95 (6.51-7.42)	8.04 (7.50-8.59)	8.92 (8.29-9.53)	9.81 (9.08-10.5)	10.7 (9.88-11.5)	12.0 (10.9-12.9)	13.0 (11.8-14.0)
20-day	6.09 (5.79-6.43)	7.17 (6.82-7.58)	8.36 (7.93-8.84)	9.27 (8.79-9.80)	10.5 (9.89-11.1)	11.4 (10.7-12.0)	12.3 (11.5-13.0)	13.1 (12.3-13.9)	14.3 (13.3-15.2)	15.1 (14.0-16.1)
30-day	7.73 (7.36-8.12)	9.06 (8.62-9.53)	10.4 (9.89-10.9)	11.4 (10.9-12.0)	12.7 (12.1-13.4)	13.7 (13.0-14.5)	14.7 (13.9-15.5)	15.6 (14.7-16.5)	16.8 (15.8-17.8)	17.7 (16.5-18.8)
45-day	9.47 (9.05-9.92)	11.1 (10.6-11.6)	12.6 (12.0-13.2)	13.7 (13.0-14.3)	15.0 (14.3-15.7)	16.0 (15.3-16.8)	16.9 (16.1-17.8)	17.8 (16.9-18.7)	18.9 (17.8-19.8)	19.6 (18.5-20.6)
60-day	12.1 (11.7-12.7)	14.2 (13.6-14.8)	15.9 (15.3-16.6)	17.2 (16.5-17.9)	18.7 (17.9-19.6)	19.9 (19.0-20.7)	20.9 (19.9-21.8)	21.8 (20.8-22.8)	22.9 (21.8-24.0)	23.7 (22.5-24.9)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

ATTACHMENT B

USDA SOILS MAP & PROPERTIES



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

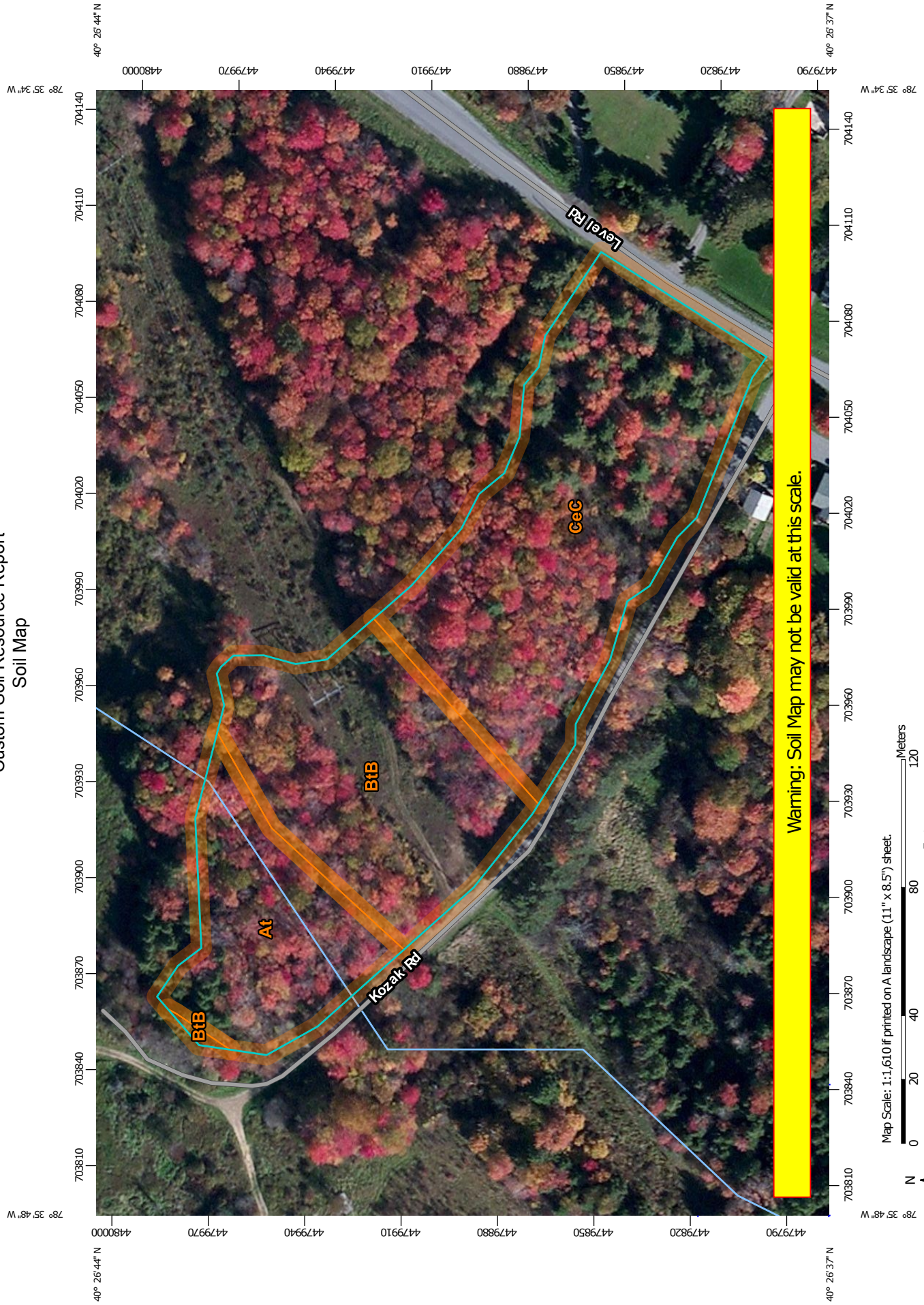
Custom Soil Resource Report for **Cambria County, Pennsylvania**



October 18, 2016

1307 of 1484

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 1:20,000.

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: <http://websoilsurvey.nrcs.usda.gov>
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: Cambria County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Oct 6, 2011—Oct 17, 2011

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

Cambria County, Pennsylvania (PA021)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
At	Atkins silt loam, 0 to 3 percent slopes, frequently flooded	0.9	19.4%
BtB	Brinkerton soils, 3 to 8 percent slopes	1.4	31.2%
CeC	Cookport and Ernest soils, 8 to 15 percent slopes	2.3	49.4%
Totals for Area of Interest		4.6	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 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.

Cambria County, Pennsylvania

At—Atkins silt loam, 0 to 3 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2sfsp

Elevation: 550 to 2,790 feet

Mean annual precipitation: 38 to 50 inches

Mean annual air temperature: 45 to 49 degrees F

Frost-free period: 126 to 165 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Atkins and similar soils: 85 percent

Minor components: 15 percent

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

Description of Atkins

Setting

Landform: Flood plains

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope

Down-slope shape: Linear

Across-slope shape: Concave

Parent material: Acid fine-loamy alluvium derived from sandstone and shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material

Oe - 1 to 2 inches: moderately decomposed plant material

A - 2 to 8 inches: silt loam

Bg - 8 to 26 inches: loam

BCg - 26 to 38 inches: silt loam

Cg - 38 to 80 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Poorly drained

Runoff class: Negligible

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high
(0.06 to 1.98 in/hr)

Depth to water table: About 0 to 6 inches

Frequency of flooding: Frequent

Frequency of ponding: Frequent

Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: C/D

Hydric soil rating: Yes

Minor Components

Philo

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Basher

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Linden

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

BtB—Brinkerton soils, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2sgqs
Elevation: 790 to 2,830 feet
Mean annual precipitation: 38 to 50 inches
Mean annual air temperature: 45 to 49 degrees F
Frost-free period: 126 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Brinkerton, wooded, and similar soils: 66 percent
Brinkerton, nonwooded, and similar soils: 19 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brinkerton, Wooded

Setting

Landform: Hillslopes
Landform position (two-dimensional): Toeslope

Custom Soil Resource Report

Landform position (three-dimensional): Base slope

Down-slope shape: Concave, linear

Across-slope shape: Concave

Parent material: Acid fine-silty colluvium derived from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material

A - 1 to 3 inches: mucky silt loam

Eg - 3 to 8 inches: silt loam

Btg - 8 to 21 inches: silty clay loam

Btxg - 21 to 42 inches: silt loam

BC - 42 to 65 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: 17 to 30 inches to fragipan

Natural drainage class: 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 2 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: D

Hydric soil rating: Yes

Description of Brinkerton, Nonwooded

Setting

Landform: Hillslopes

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave, linear

Across-slope shape: Concave

Parent material: Acid fine-silty colluvium derived from shale and siltstone

Typical profile

Ap - 0 to 8 inches: silt loam

Btg - 8 to 21 inches: silty clay loam

Btxg - 21 to 42 inches: silt loam

BC - 42 to 65 inches: channery silt loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: 17 to 30 inches to fragipan

Natural drainage class: 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 6 to 12 inches

Frequency of flooding: None

Frequency of ponding: None

Custom Soil Resource Report

Available water storage in profile: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: D

Hydric soil rating: Yes

Minor Components

Ernest

Percent of map unit: 5 percent

Landform: Hillslopes

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope, head slope

Down-slope shape: Concave

Across-slope shape: Concave, linear

Hydric soil rating: No

Philo

Percent of map unit: 5 percent

Landform: Flood plains

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread

Down-slope shape: Linear, convex

Across-slope shape: Linear

Other vegetative classification: Acid Loams (AL3)

Hydric soil rating: No

Portville

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave

Across-slope shape: Linear

Hydric soil rating: No

CeC—Cookport and Ernest soils, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 15ws

Elevation: 300 to 3,000 feet

Mean annual precipitation: 30 to 65 inches

Mean annual air temperature: 45 to 59 degrees F

Frost-free period: 110 to 214 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Cookport and similar soils: 70 percent

Custom Soil Resource Report

Ernest and similar soils: 25 percent

Minor components: 5 percent

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

Description of Cookport

Setting

Landform: Mountains

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Mountaintop

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Residuum weathered from acid sandstone

Typical profile

H1 - 0 to 14 inches: channery loam

H2 - 14 to 26 inches: channery loam

H3 - 26 to 40 inches: channery loam

H4 - 40 to 60 inches: channery sandy loam

H5 - 60 to 62 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: About 26 inches to fragipan; 40 to 72 inches to lithic bedrock

Natural drainage class: Moderately well drained

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: About 18 to 30 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: C

Hydric soil rating: No

Description of Ernest

Setting

Landform: Hills

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Colluvium derived from shale and siltstone

Typical profile

H1 - 0 to 8 inches: silt loam

H2 - 8 to 26 inches: silty clay loam

H3 - 26 to 41 inches: channery silt loam

H4 - 41 to 61 inches: channery silt loam

Properties and qualities

Slope: 8 to 15 percent

Custom Soil Resource Report

Depth to restrictive feature: 17 to 36 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 4 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Brinkerton

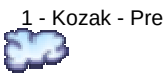
Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

ATTACHMENT C
KOZAK RD
HYDRAFLOW RESULTS

ATTACHMENT C-1
KOZAK RD
2 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	4.055	-----	-----	9.055	-----	15.87	19.44	Kozak - Pre
Proj. file: Kozak Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.055	1	723	11,769	-----	-----	-----	Kozak - Pre
Kozak Pre.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

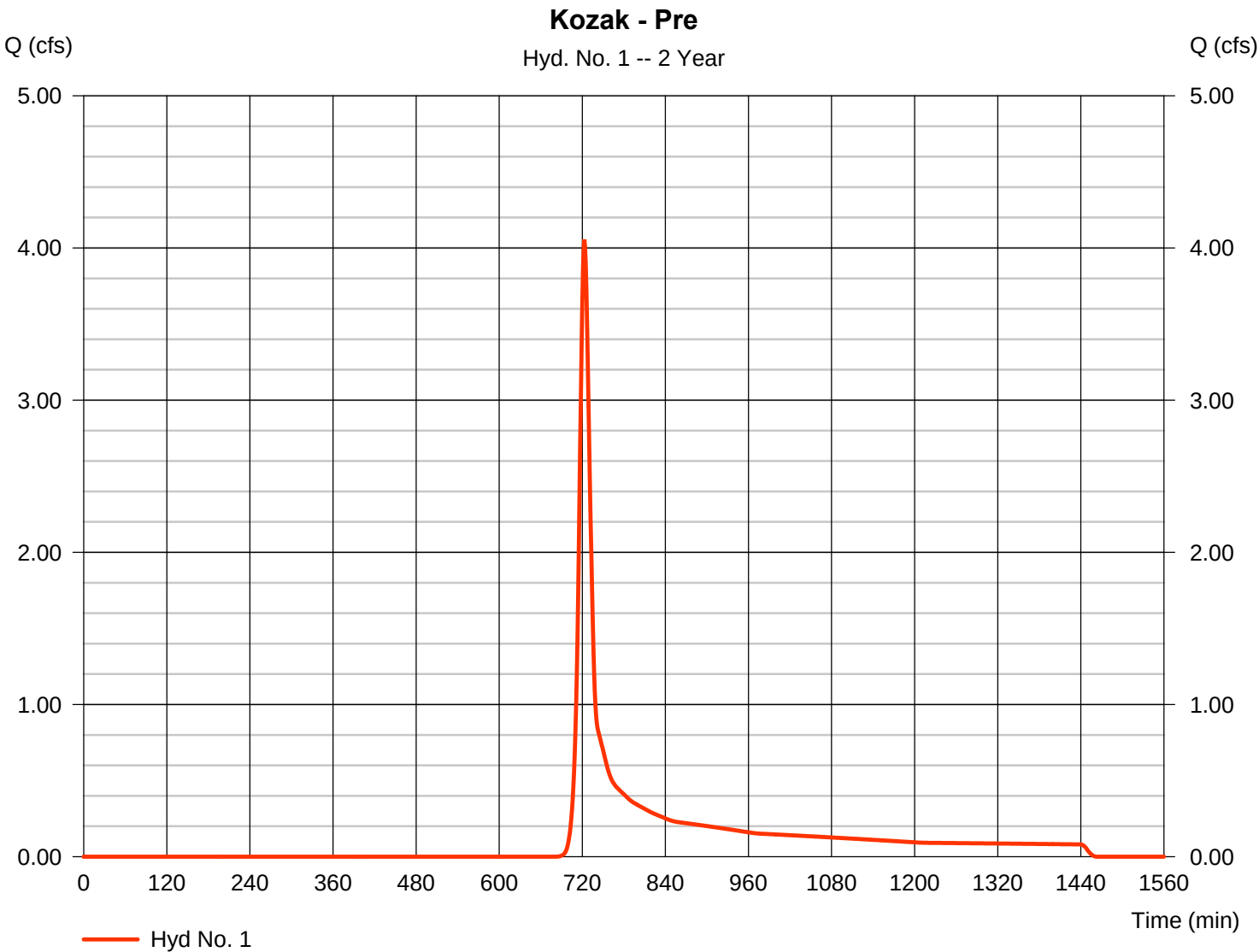
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.055 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	11,769 cuft
Drainage area	=	4.630 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.64 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

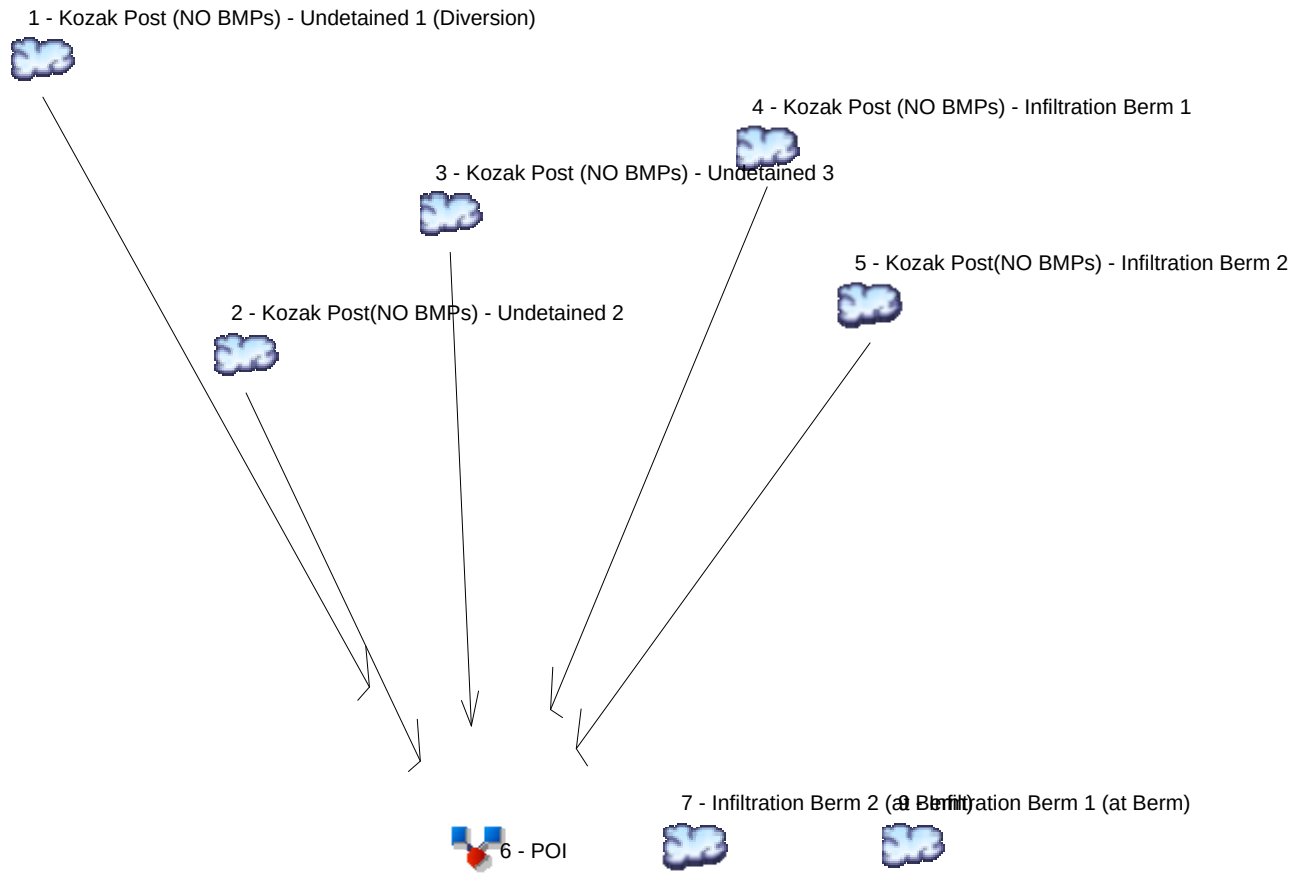
Hyd. No. 1

Kozak - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 10.0	90.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 10.00	13.30	0.00	
Travel Time (min)	= 1.30	+	10.15	+
			0.00	= 11.45
Shallow Concentrated Flow				
Flow length (ft)	= 805.00	0.00	0.00	
Watercourse slope (%)	= 6.80	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.21	0.00	0.00	
Travel Time (min)	= 3.19	+	0.00	+
			0.00	= 3.19
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				14.64 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.016	-----	-----	2.600	-----	4.829	6.026	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	-----	-----	1.205	-----	-----	2.535	-----	4.306	5.223	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	-----	-----	0.711	-----	-----	1.467	-----	2.464	2.979	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	-----	-----	1.721	-----	-----	3.392	-----	5.538	6.632	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	-----	-----	0.411	-----	-----	0.818	-----	1.341	1.613	Kozak Post(NO BMPs) - Infiltration B
6	Combine	1, 2, 3, 4, 5	-----	4.472	-----	-----	9.782	-----	16.89	20.60	POI
7	SCS Runoff	-----	-----	0.185	-----	-----	0.353	-----	0.568	0.678	Infiltration Berm 2 (at Berm)
9	SCS Runoff	-----	-----	0.605	-----	-----	1.098	-----	1.713	2.024	Infiltration Berm 1 (at Berm)
Proj. file: Kozak Post.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

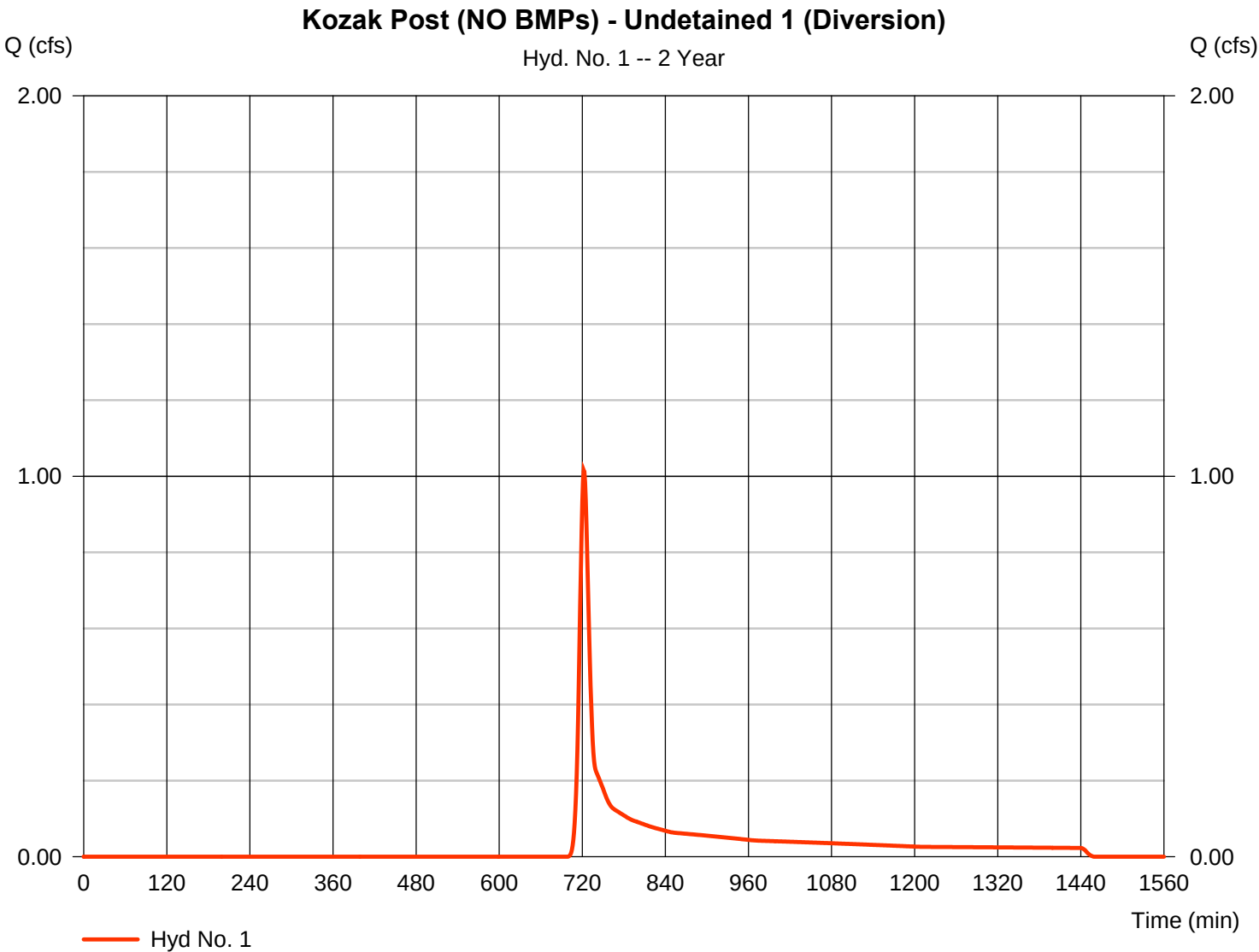
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.016	1	722	2,976	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	1.205	1	722	3,175	-----	-----	-----	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	0.711	1	723	1,988	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	1.721	1	718	3,479	-----	-----	-----	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	0.411	1	716	717	-----	-----	-----	Kozak Post(NO BMPs) - Infiltration B
6	Combine	4.472	1	719	12,334	1, 2, 3, 4, 5	-----	-----	POI
7	SCS Runoff	0.185	1	716	322	-----	-----	-----	Infiltration Berm 2 (at Berm)
9	SCS Runoff	0.605	1	717	1,135	-----	-----	-----	Infiltration Berm 1 (at Berm)
Kozak Post.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.016 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	2,976 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

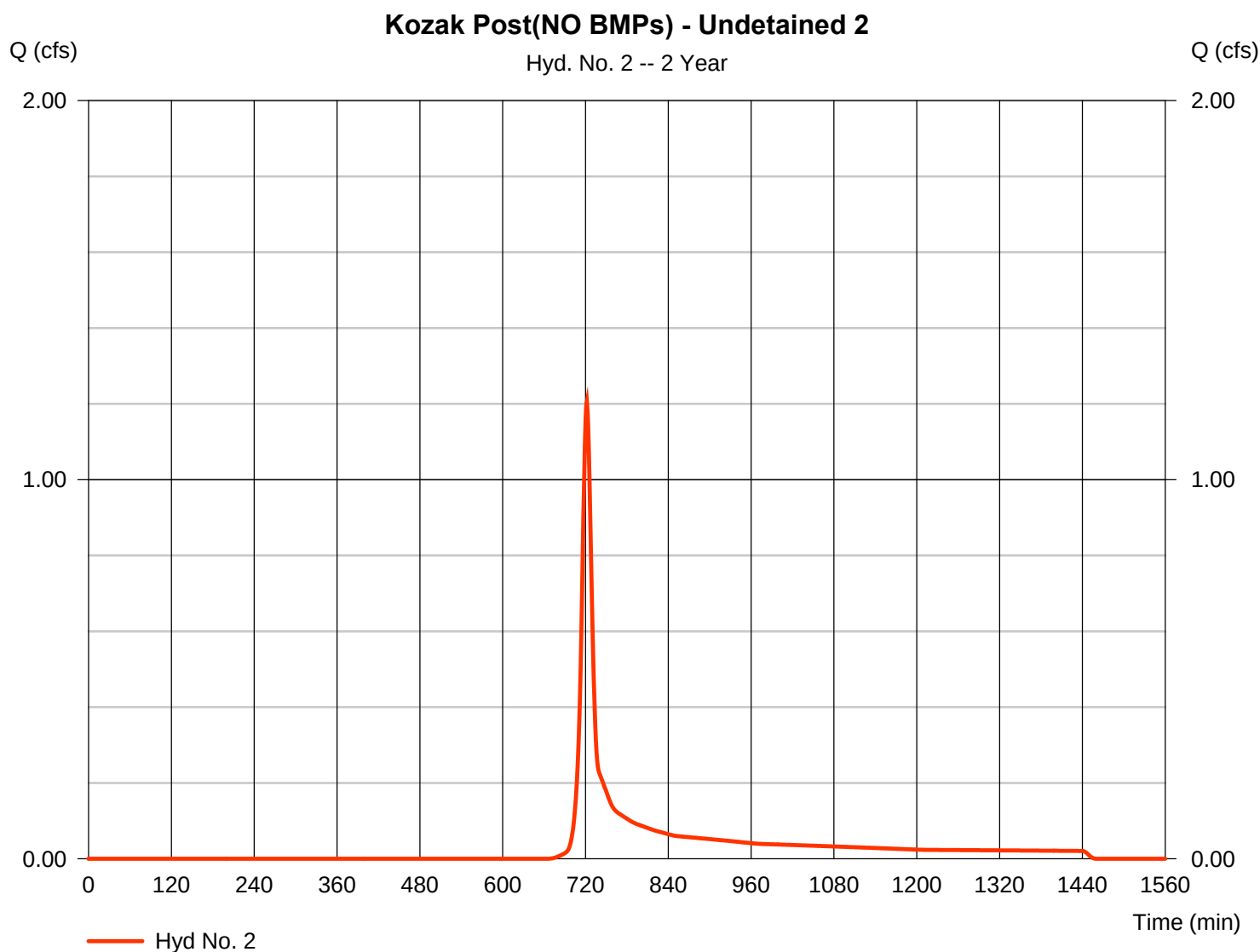
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Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.205 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	3,175 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

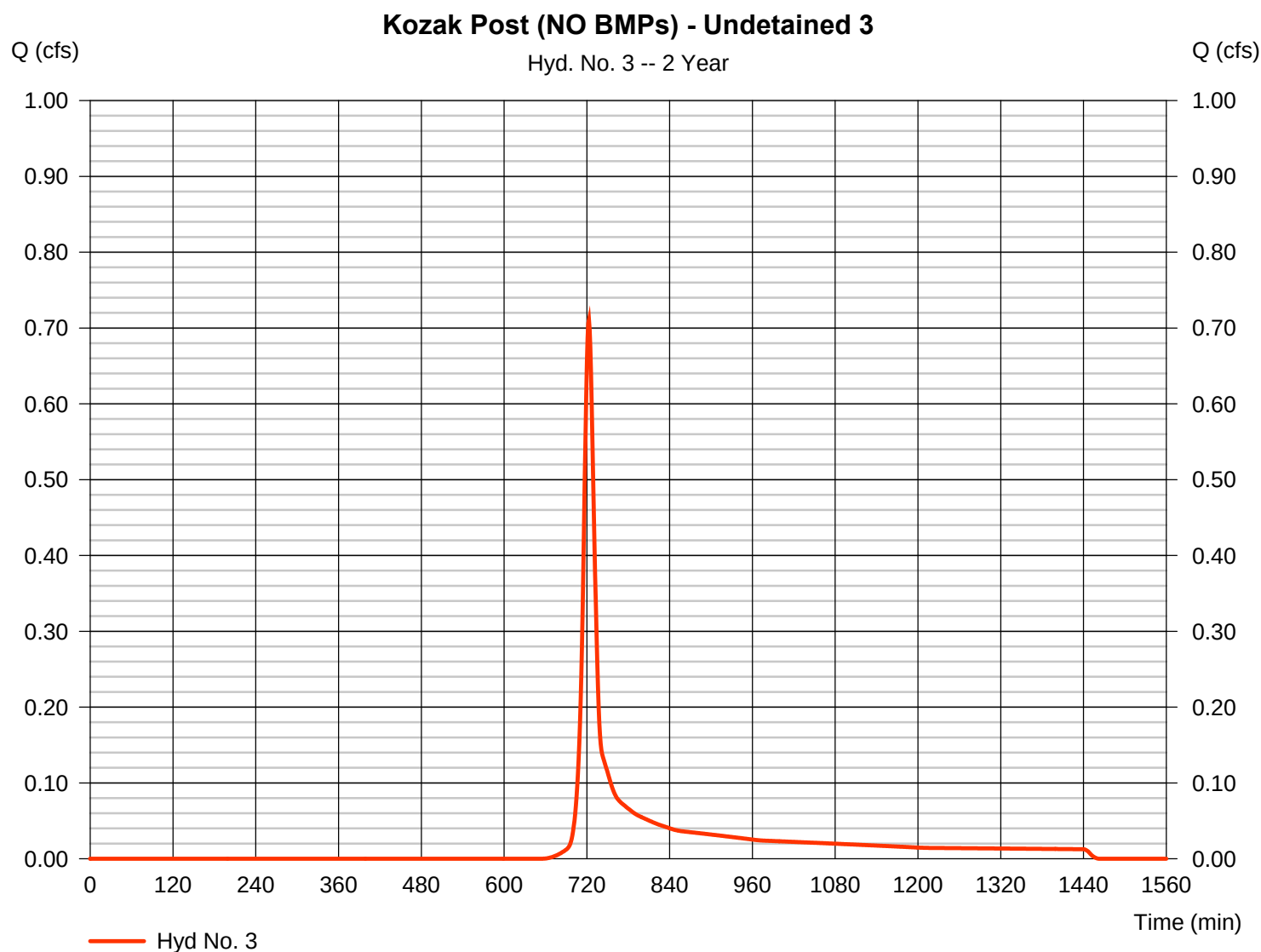
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Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.711 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	1,988 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

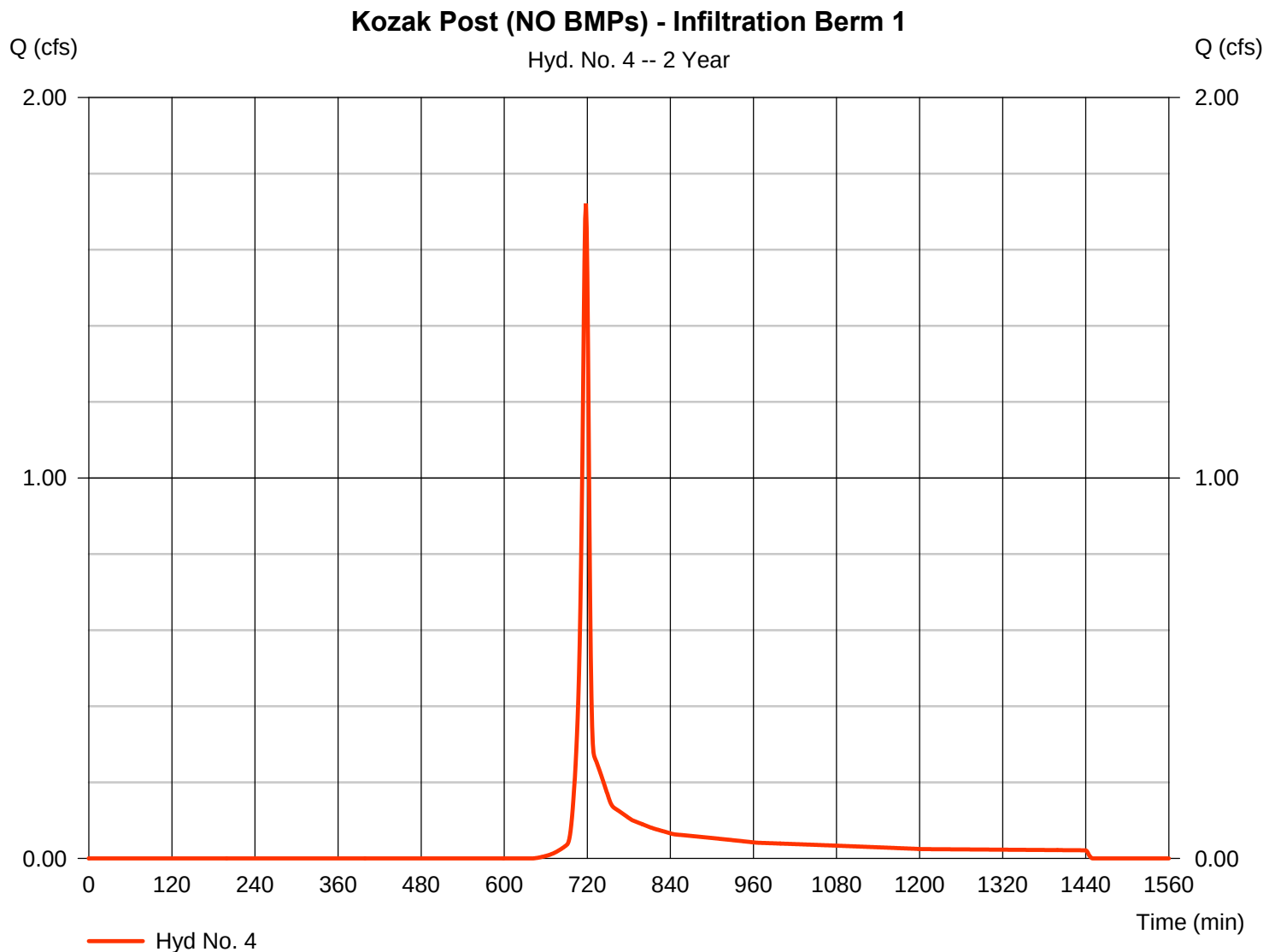
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.721 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	3,479 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.20 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.240	
Flow length (ft)	= 8.0	65.0	37.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 25.00	6.20	23.00	
Travel Time (min)	= 0.76	+	0.60	+
			2.66	= 4.01
Shallow Concentrated Flow				
Flow length (ft)	= 522.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 2.18	+	0.00	+
			0.00	= 2.18
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				6.20 min

Hydrograph Report

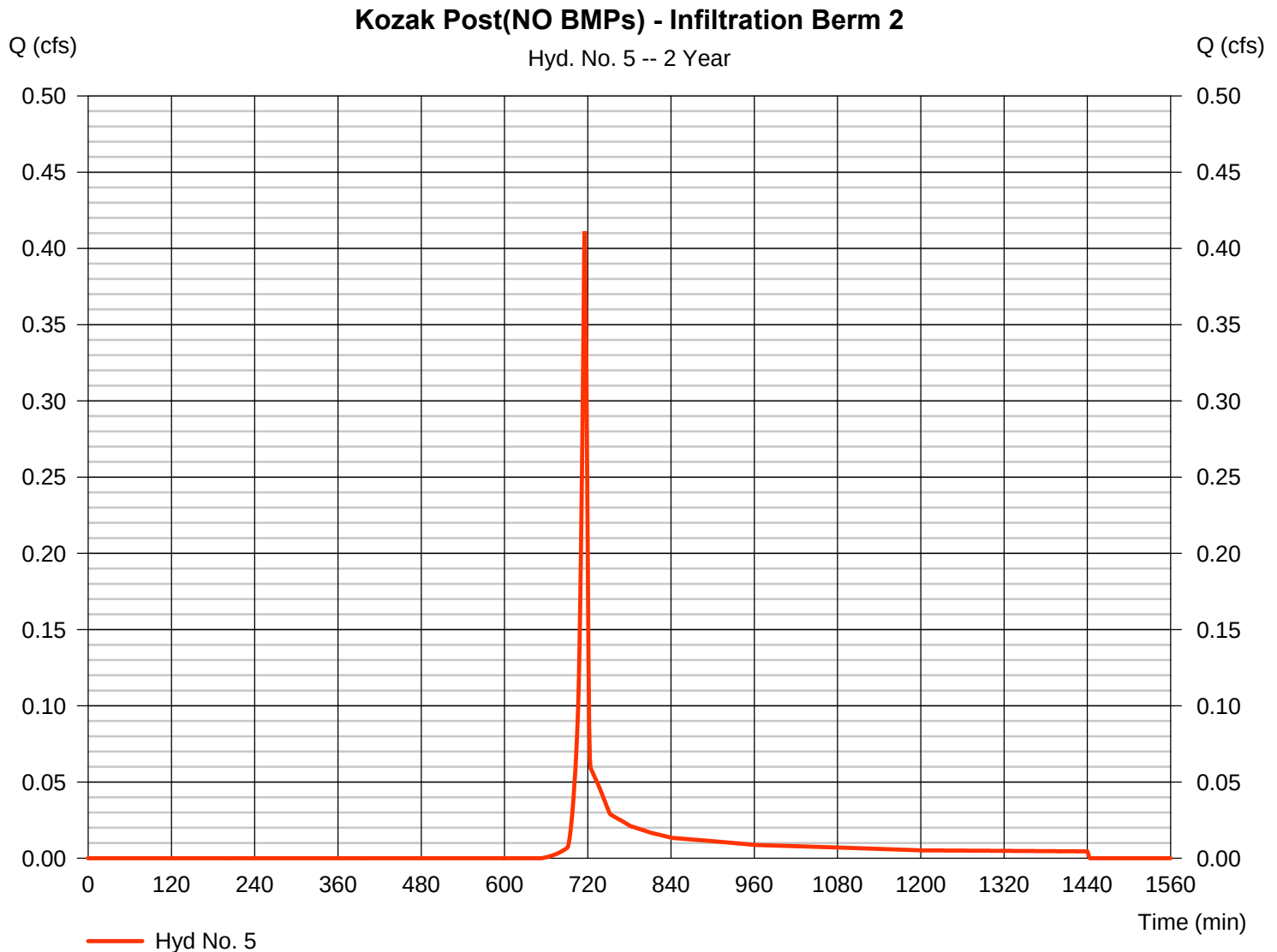
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.411 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	1 min	Hyd. volume	=	717 cuft
Drainage area	=	0.250 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	1.62 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.011	0.011	
Flow length (ft)	= 45.0	54.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 3.30	8.30	0.00	
Travel Time (min)	= 0.57	+	0.46	+
			0.00	= 1.03
Shallow Concentrated Flow				
Flow length (ft)	= 40.00	35.00	63.00	
Watercourse slope (%)	= 7.50	11.40	8.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=4.42	5.45	4.56	
Travel Time (min)	= 0.15	+	0.11	+
			0.23	= 0.49
Channel Flow				
X sectional flow area (sqft)	= 2.00	0.00	0.00	
Wetted perimeter (ft)	= 4.68	0.00	0.00	
Channel slope (%)	= 11.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=18.64	0.00	0.00	
Flow length (ft)	(0)107.0	0.0	0.0	
Travel Time (min)	= 0.10	+	0.00	+
			0.00	= 0.10
Total Travel Time, Tc				1.62 min

Hydrograph Report

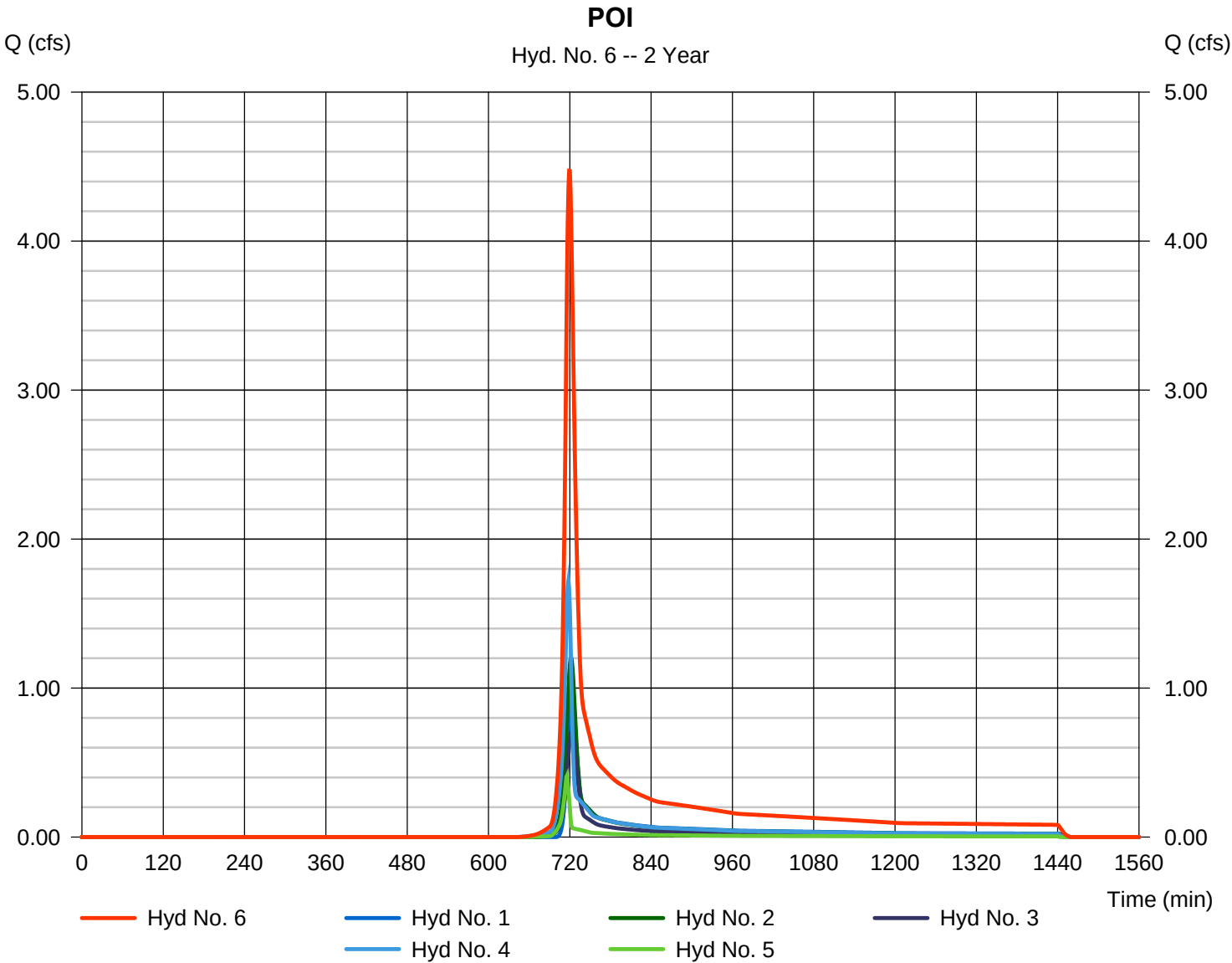
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Friday, 11 / 4 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 4.472 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 12,334 cuft
Inflow hyds.	= 1, 2, 3, 4, 5	Contrib. drain. area	= 4.620 ac



Hydrograph Report

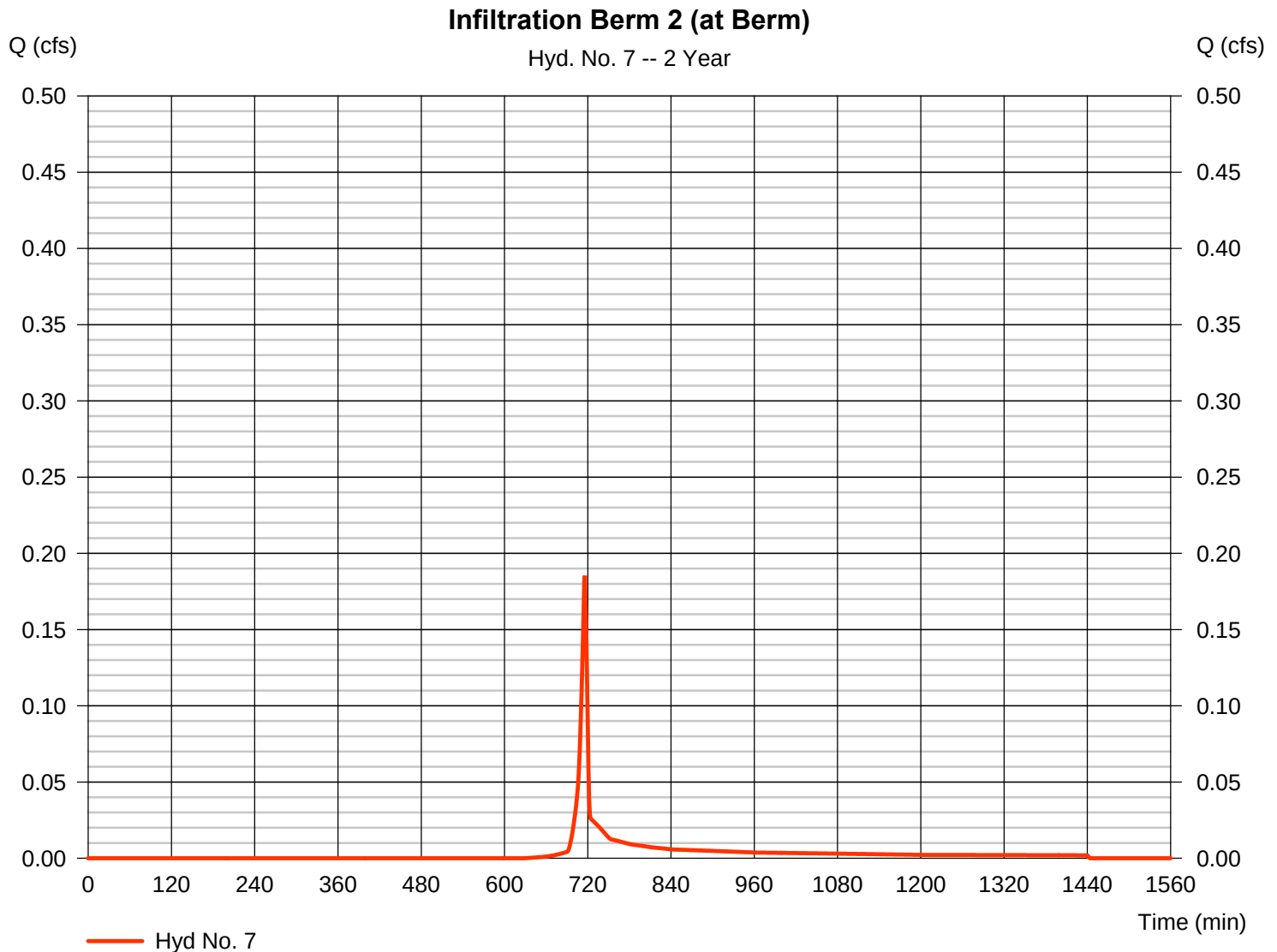
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 7

Infiltration Berm 2 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.185 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 322 cuft
Drainage area	= 0.100 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 1.60 min
Total precip.	= 2.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

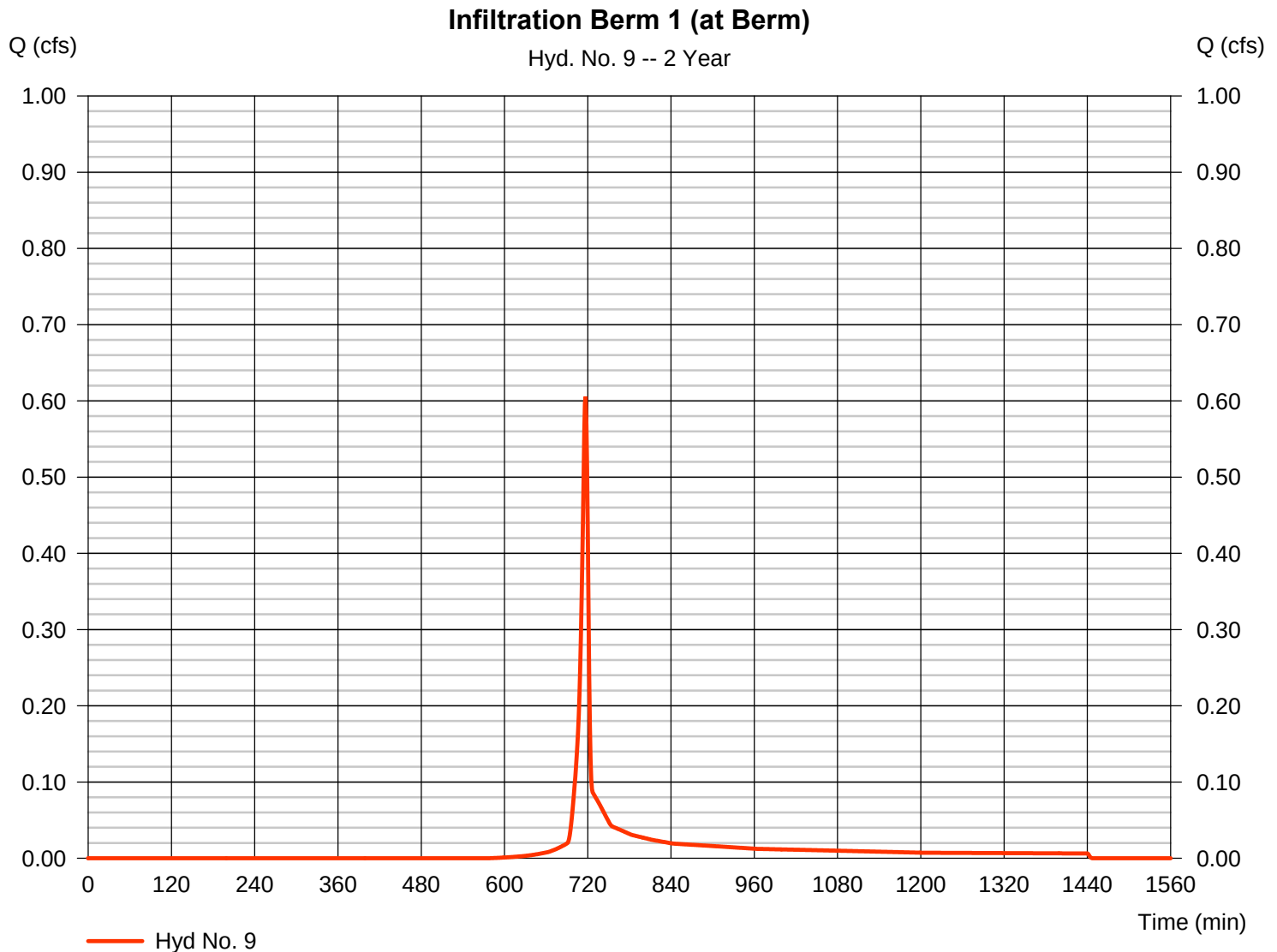
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Friday, 11 / 4 / 2016

Hyd. No. 9

Infiltration Berm 1 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.605 cfs
Storm frequency	= 2 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 1,135 cuft
Drainage area	= 0.280 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.40 min
Total precip.	= 2.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

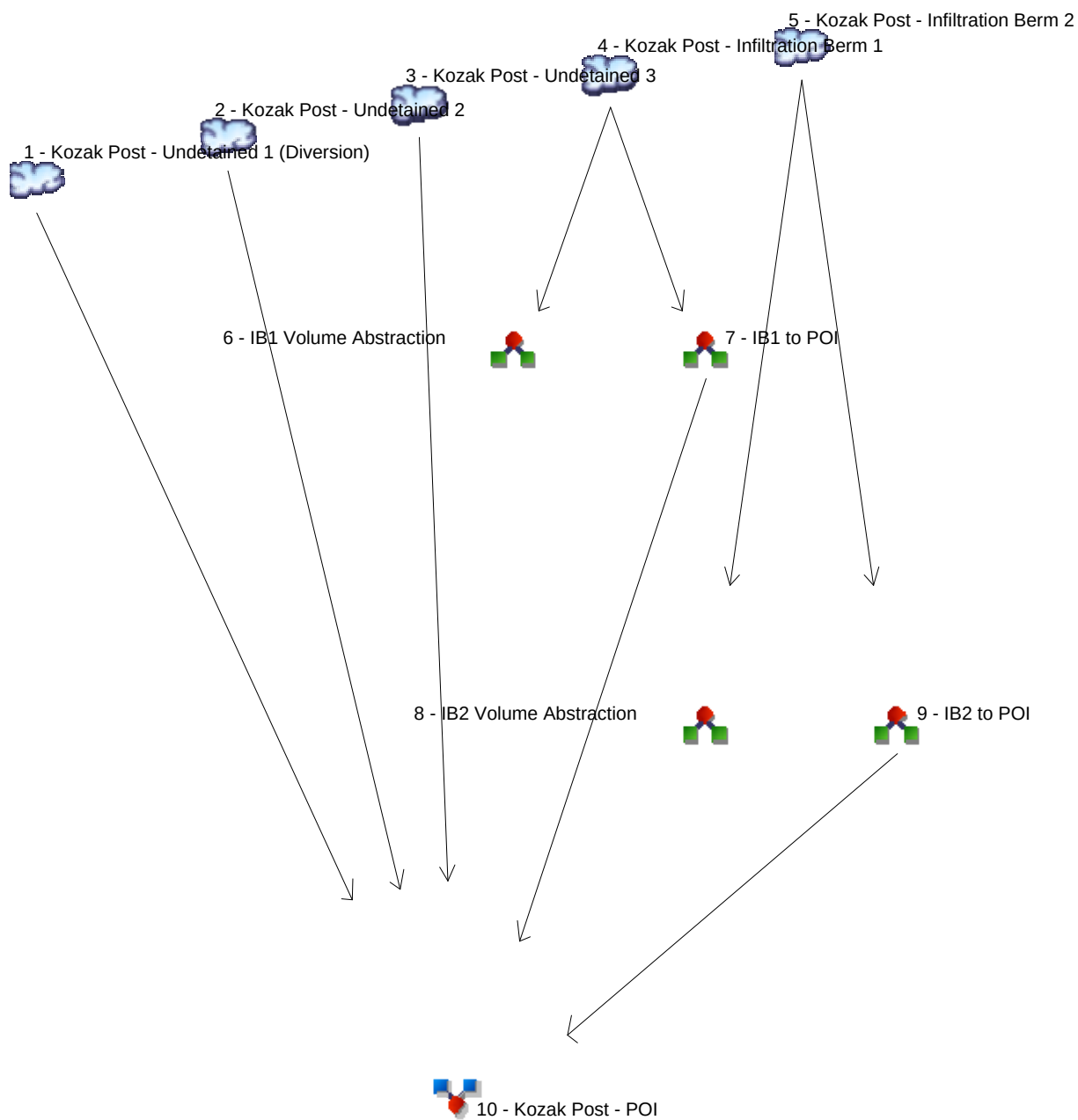
Hyd. No. 9

Infiltration Berm 1 (at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.011	0.240				
Flow length (ft)	= 8.0	65.0	27.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 25.00	6.20	23.00				
Travel Time (min)	= 0.76	+	0.60	+	2.07	=	3.42
Shallow Concentrated Flow							
Flow length (ft)	= 0.00	0.00	0.00				
Watercourse slope (%)	= 0.00	0.00	0.00				
Surface description	= Paved	Paved	Paved				
Average velocity (ft/s)	=0.00	0.00	0.00				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
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				3.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.016	-----	-----	-----	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	-----	-----	1.205	-----	-----	-----	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	-----	-----	0.711	-----	-----	-----	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	-----	-----	1.216	-----	-----	-----	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	-----	-----	0.221	-----	-----	-----	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	4	-----	1.216	-----	-----	-----	-----	-----	-----	IB1 Volume Abstraction
7	Diversion2	4	-----	0.943	-----	-----	-----	-----	-----	-----	IB1 to POI
8	Diversion1	5	-----	0.221	-----	-----	-----	-----	-----	-----	IB2 Volume Abstraction
9	Diversion2	5	-----	0.080	-----	-----	-----	-----	-----	-----	IB2 to POI
10	Combine	1, 2, 3, 7, 9	-----	3.027	-----	-----	-----	-----	-----	-----	Kozak Post - POI
Proj. file: Kozak Post wBMPs 2yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.016	1	722	2,976	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	1.205	1	722	3,175	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	0.711	1	723	1,988	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	1.216	1	723	3,373	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	0.221	1	727	772	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	1.216	1	723	1,086	4	-----	-----	IB1 Volume Abstraction
7	Diversion2	0.943	1	728	2,287	4	-----	-----	IB1 to POI
8	Diversion1	0.221	1	727	327	5	-----	-----	IB2 Volume Abstraction
9	Diversion2	0.080	1	745	445	5	-----	-----	IB2 to POI
10	Combine	3.027	1	728	10,871	1, 2, 3, 7, 9	-----	-----	Kozak Post - POI
Kozak Post wBMPs 2yr.gpw					Return Period: 2 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

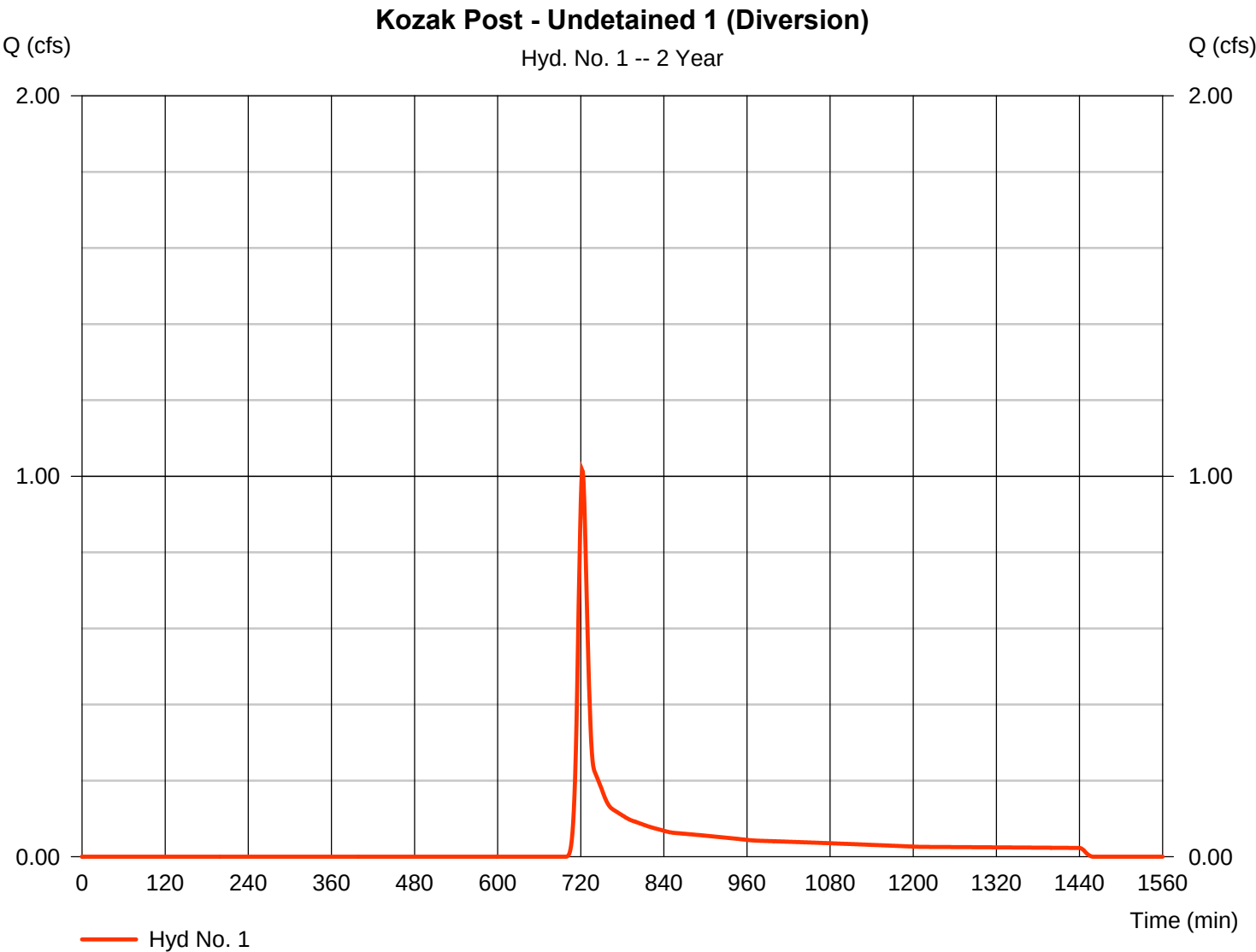
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.016 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	2,976 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

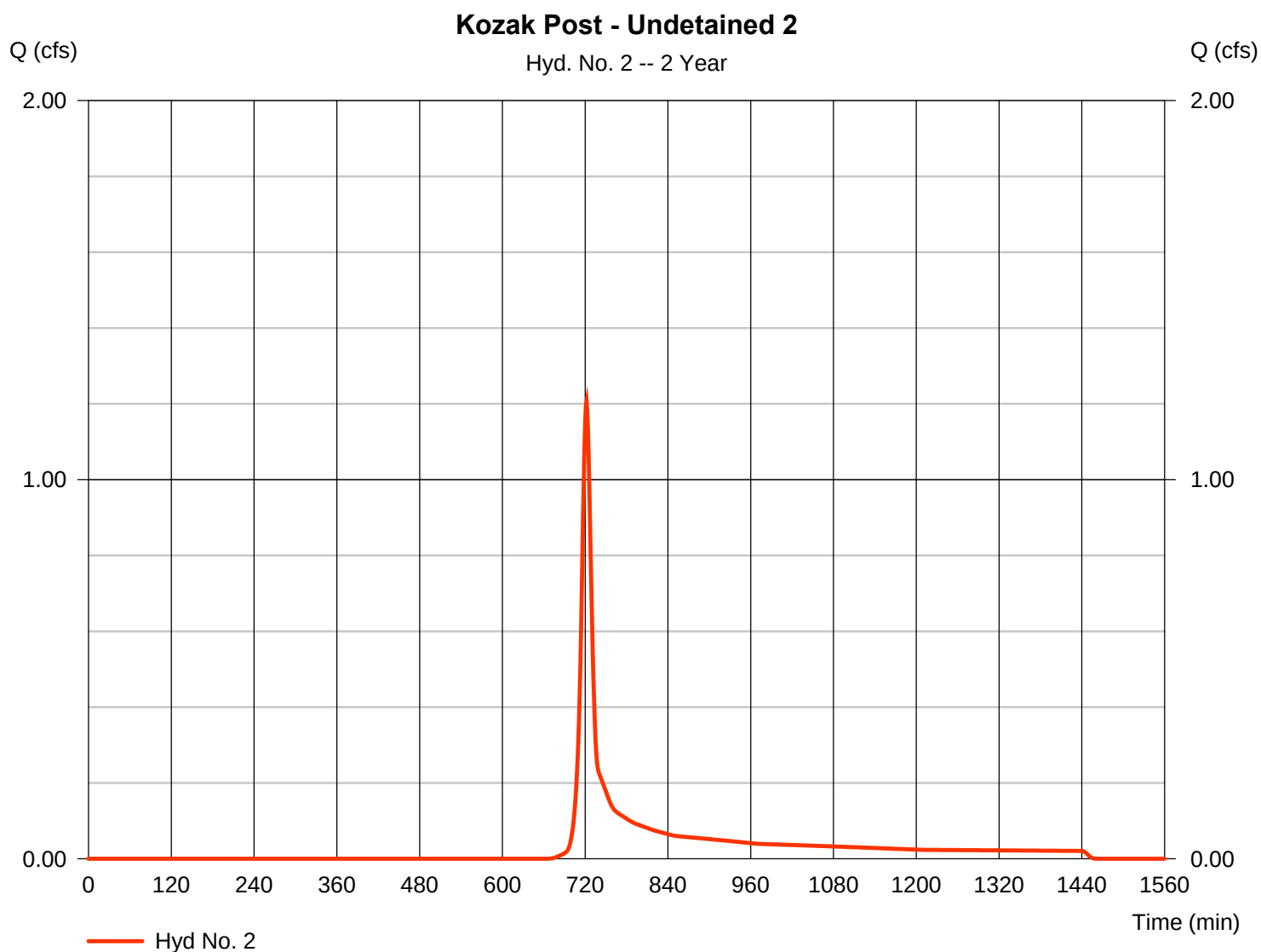
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.205 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	3,175 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

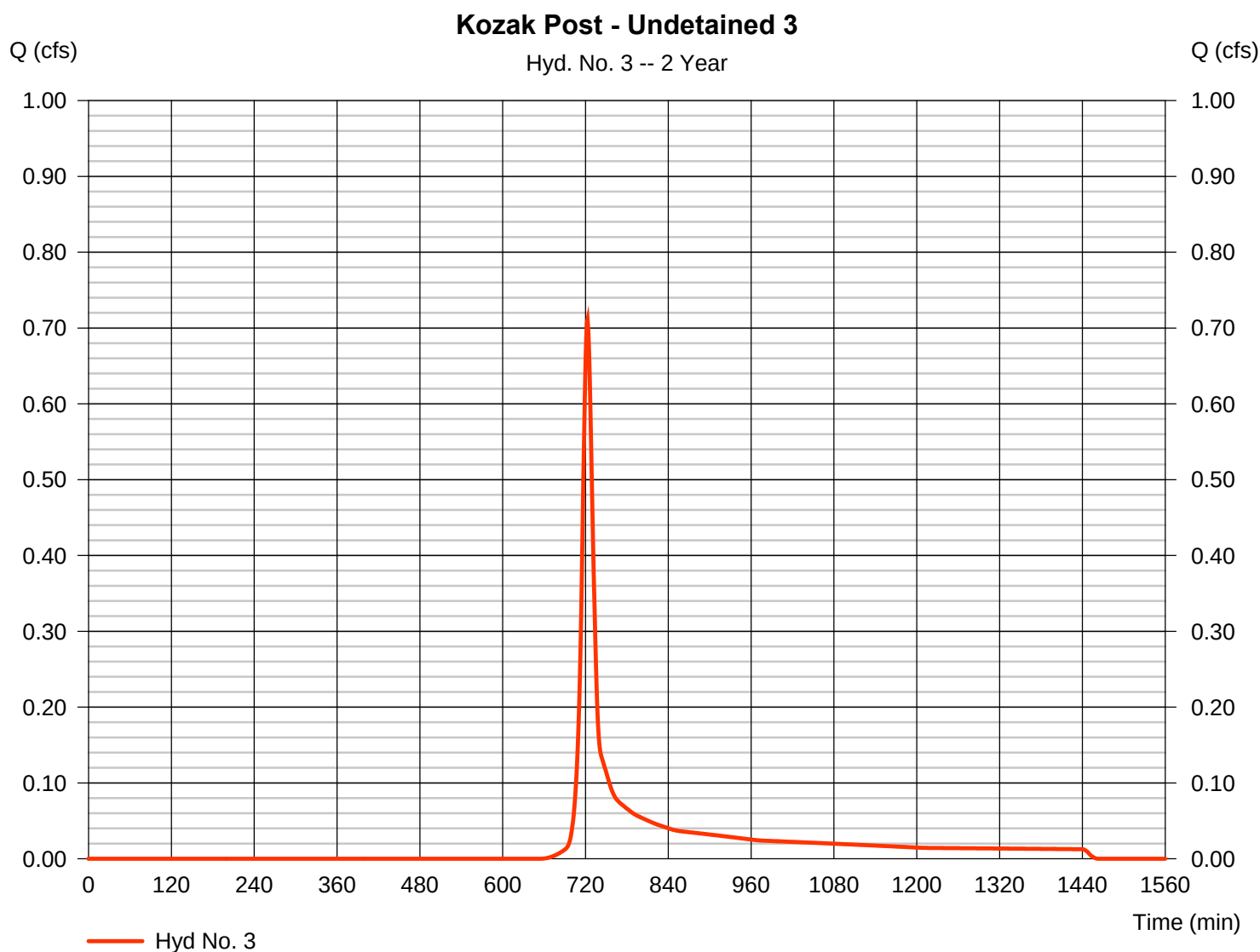
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post - Undetained 3

Hydrograph type	= SCS Runoff	Peak discharge	= 0.711 cfs
Storm frequency	= 2 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 1,988 cuft
Drainage area	= 0.650 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.80 min
Total precip.	= 2.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

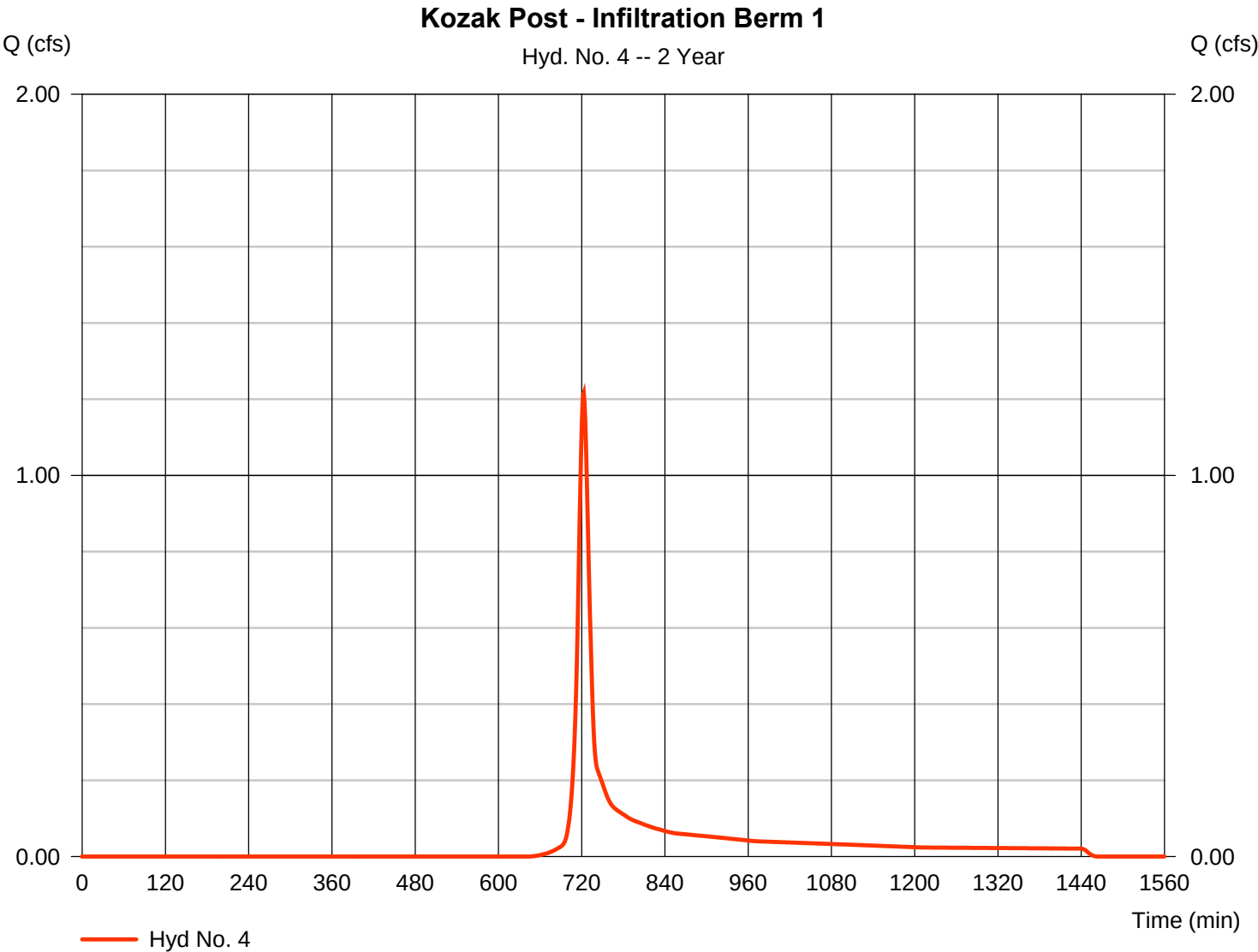
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.216 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	3,373 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	14.90 min
Total precip.	=	2.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

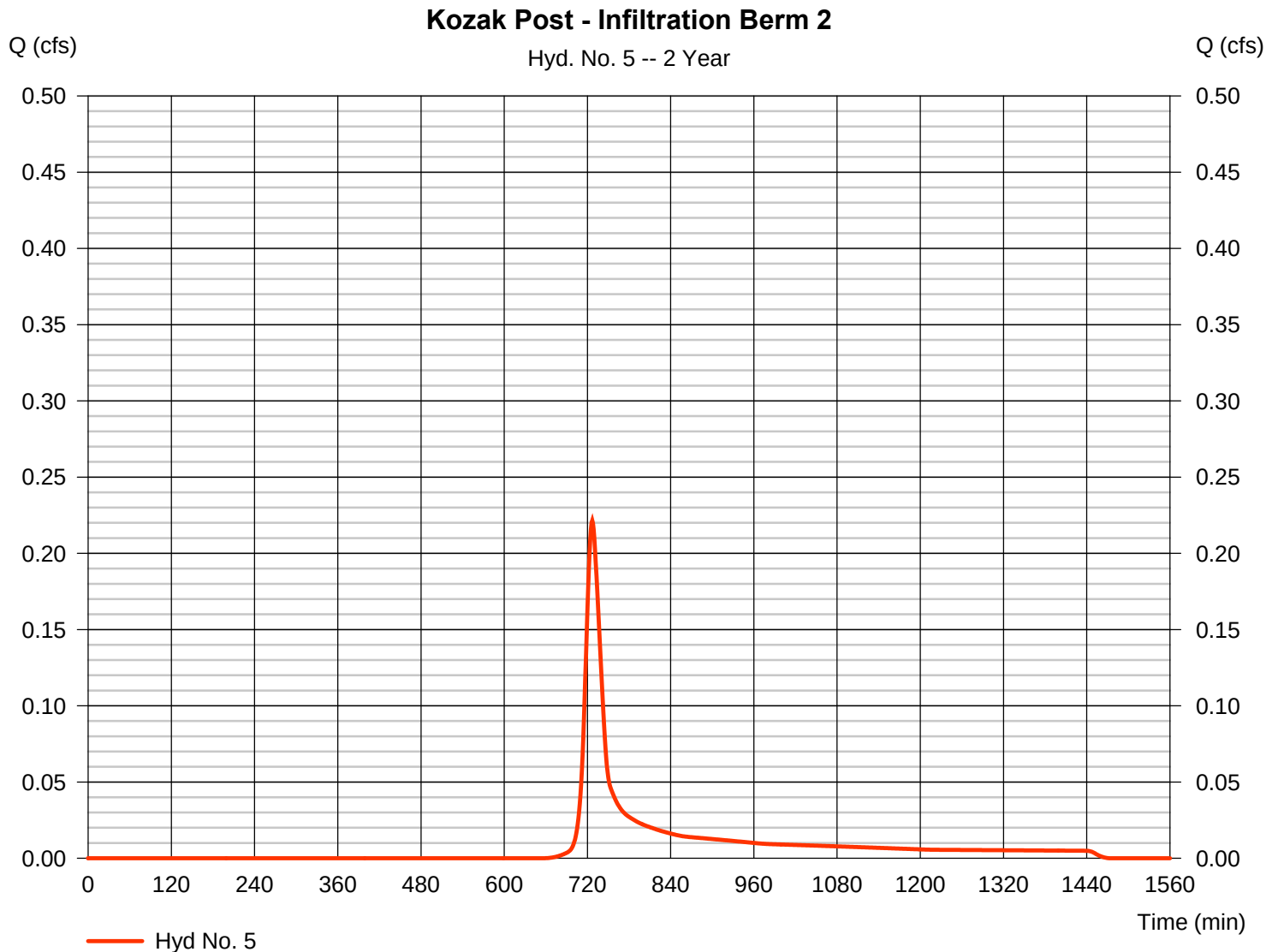
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.221 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 772 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.40 min
Total precip.	= 2.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

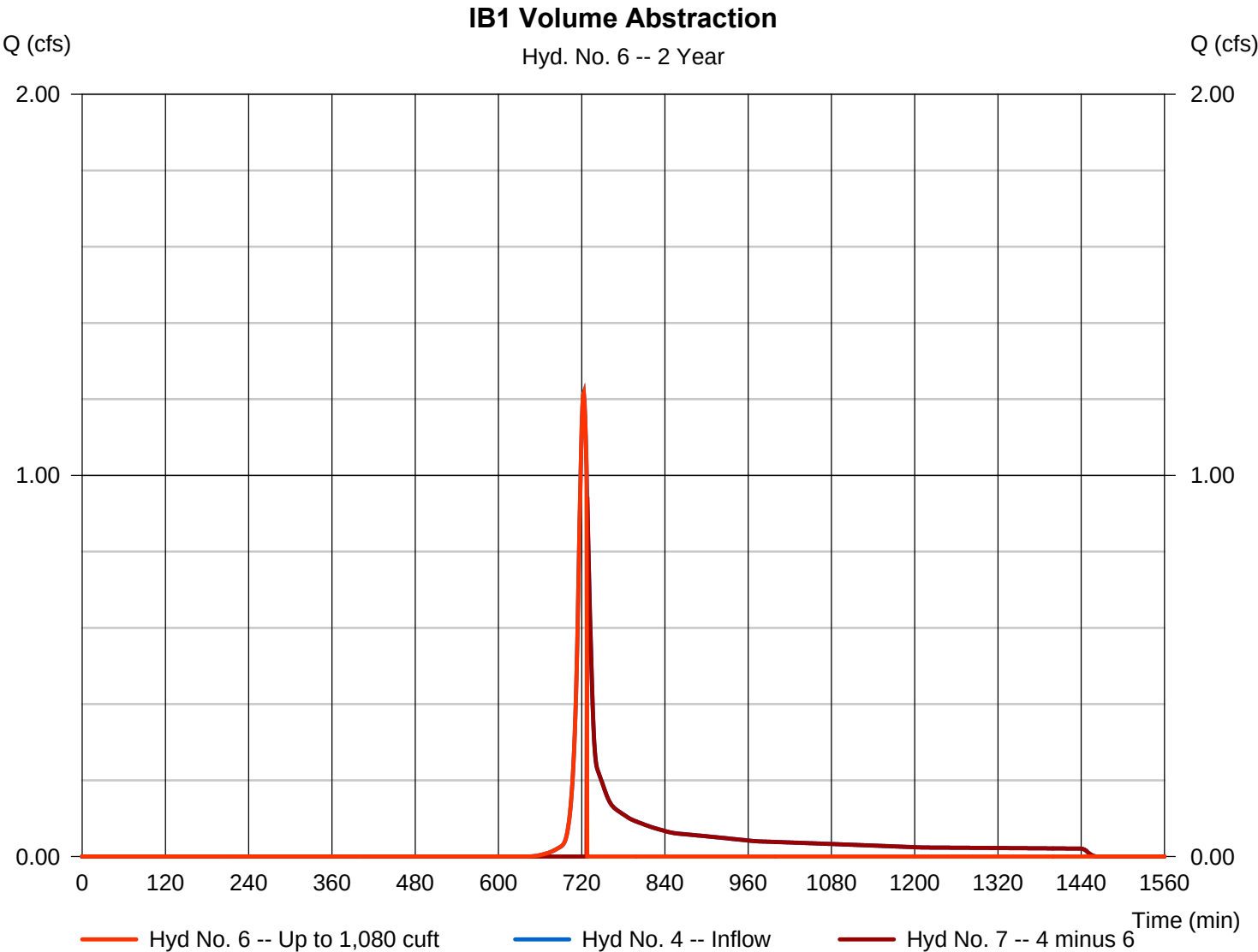
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 6

IB1 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.216 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	1,086 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	7
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

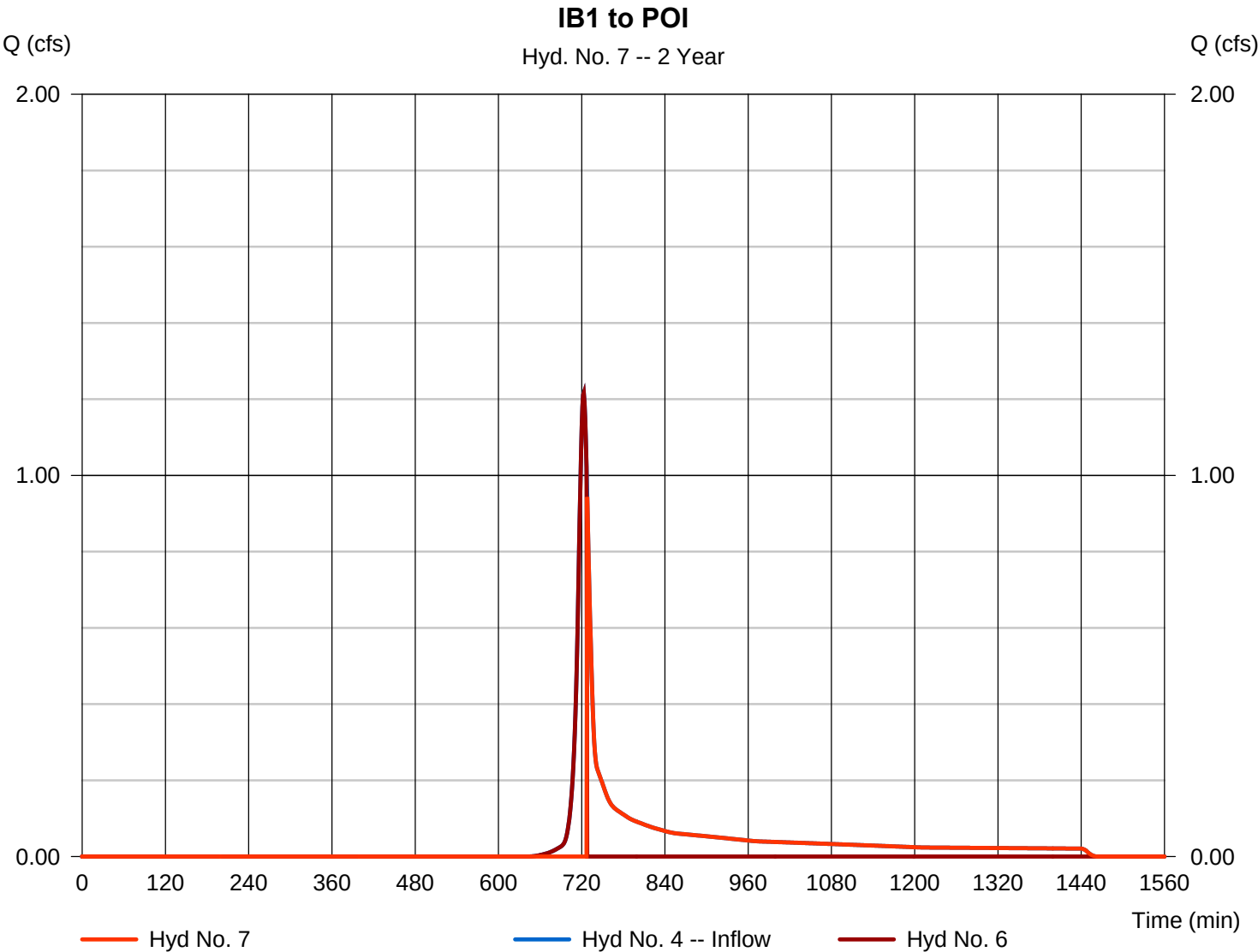
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 7

IB1 to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.943 cfs
Storm frequency	=	2 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	2,287 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	6
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

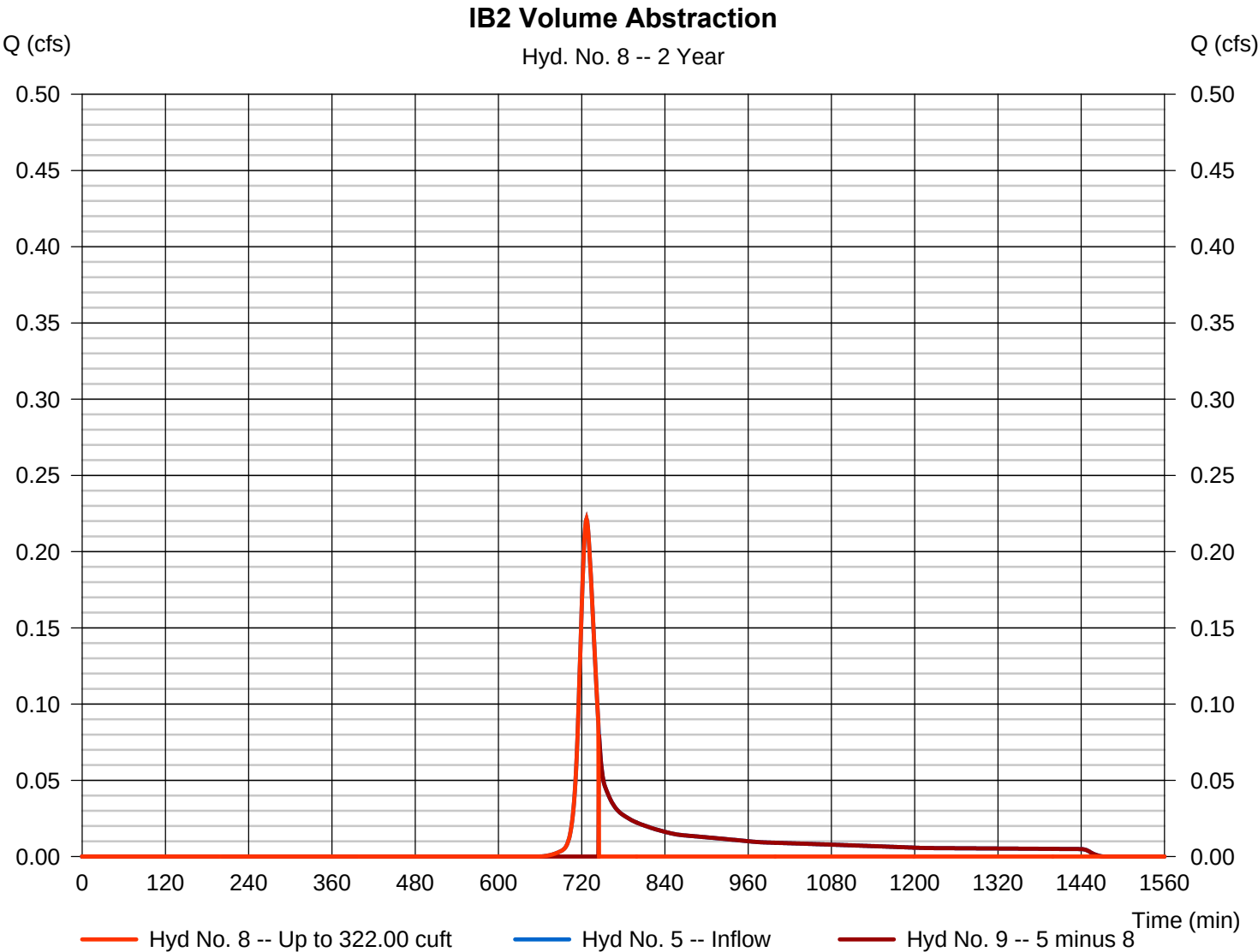
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 8

IB2 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.221 cfs
Storm frequency	=	2 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	327 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms and diverted hyd.		=	9
Diversion method	=	First Flush Volume	Volume Up To	=	322.00 cuft



Hydrograph Report

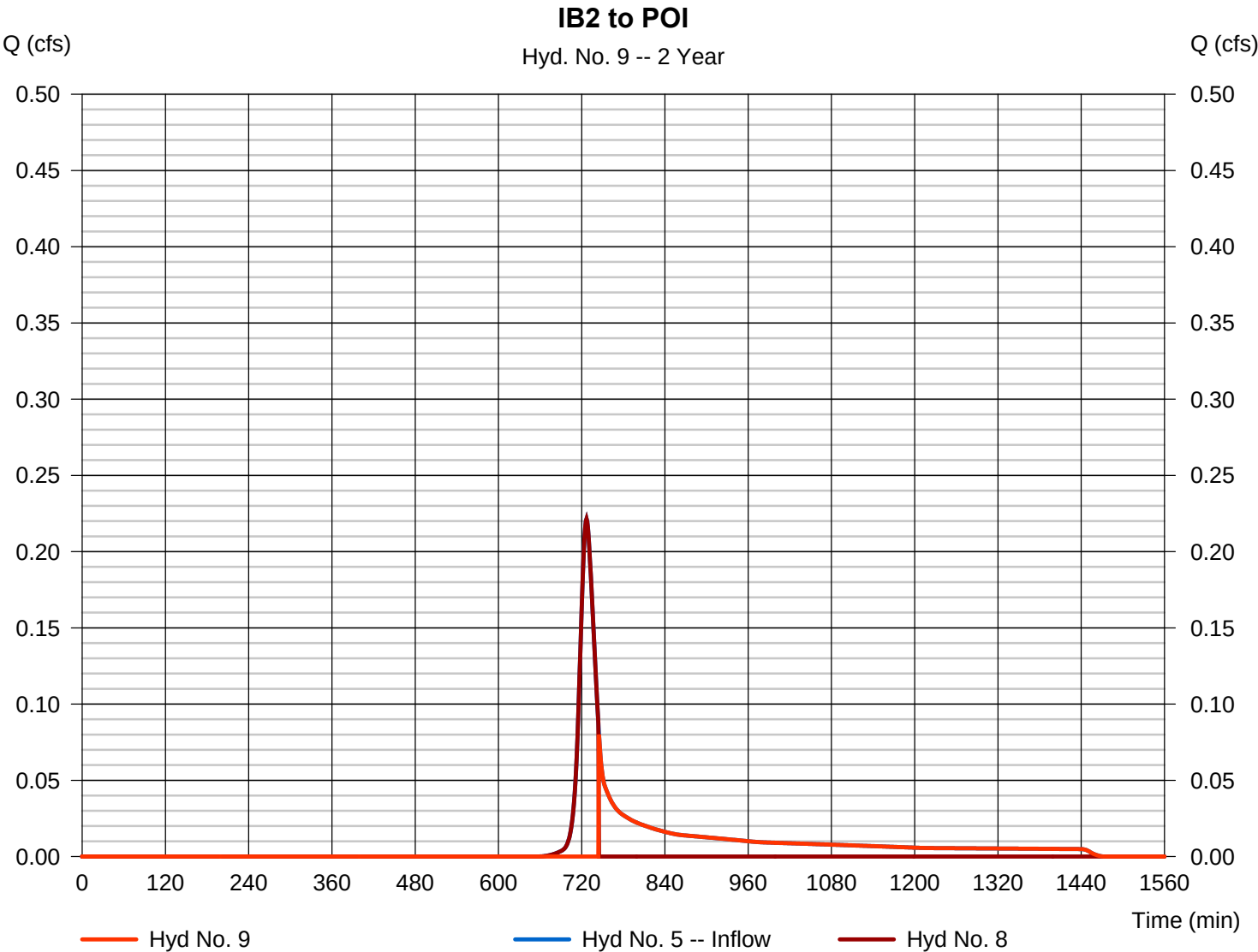
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 9

IB2 to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.080 cfs
Storm frequency	=	2 yrs	Time to peak	=	745 min
Time interval	=	1 min	Hyd. volume	=	445 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms and diverted hyd.		=	8
Diversion method	=	First Flush Volume	Volume Up To	=	322.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

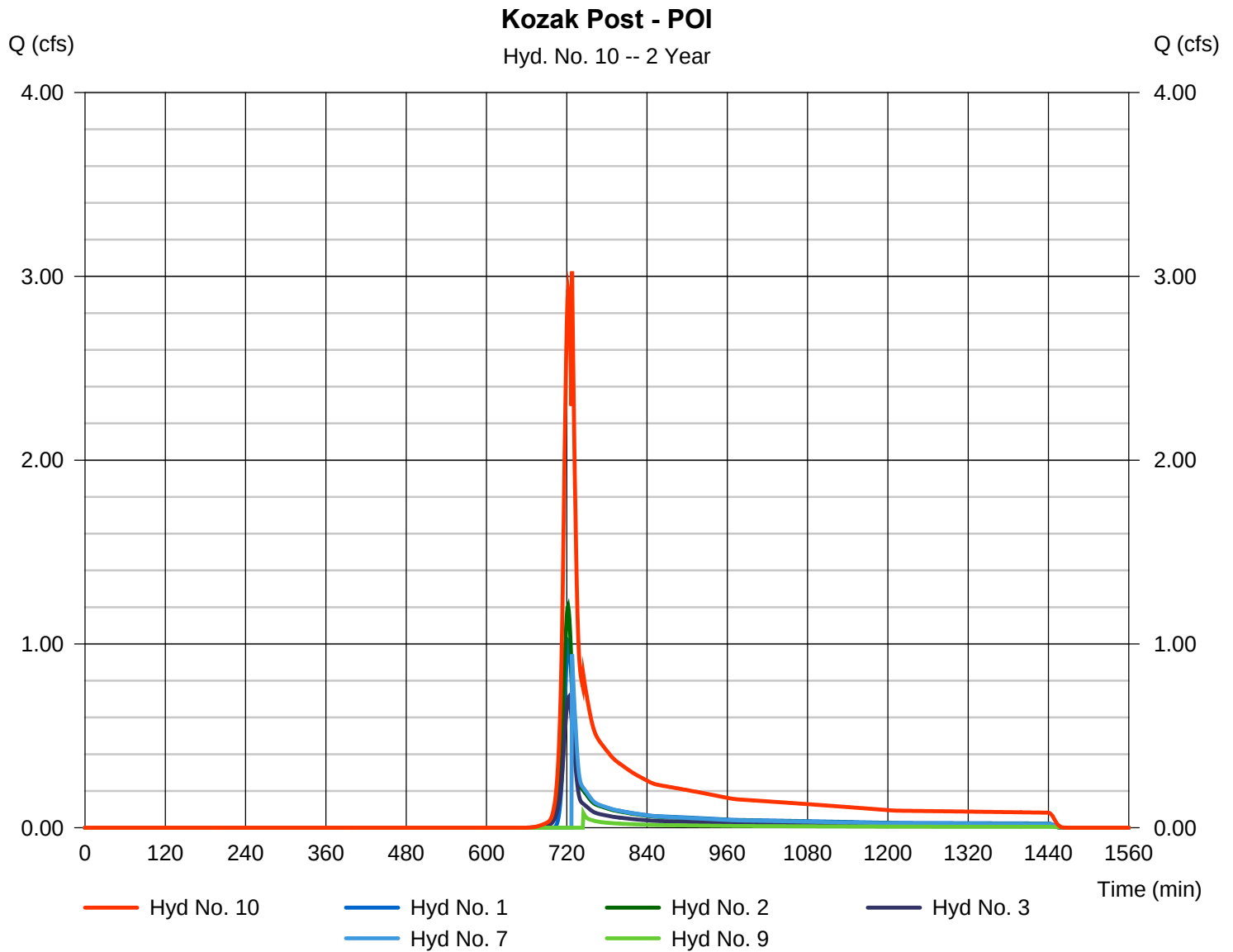
Friday, 11 / 4 / 2016

Hyd. No. 10

Kozak Post - POI

Hydrograph type = Combine
 Storm frequency = 2 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 3, 7, 9

Peak discharge = 3.027 cfs
 Time to peak = 728 min
 Hyd. volume = 10,871 cuft
 Contrib. drain. area = 3.330 ac



ATTACHMENT C-2
CHESTNUT RIDGE
10 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Kozak - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	4.055	-----	-----	9.055	-----	15.87	19.44	Kozak - Pre
Proj. file: Kozak Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

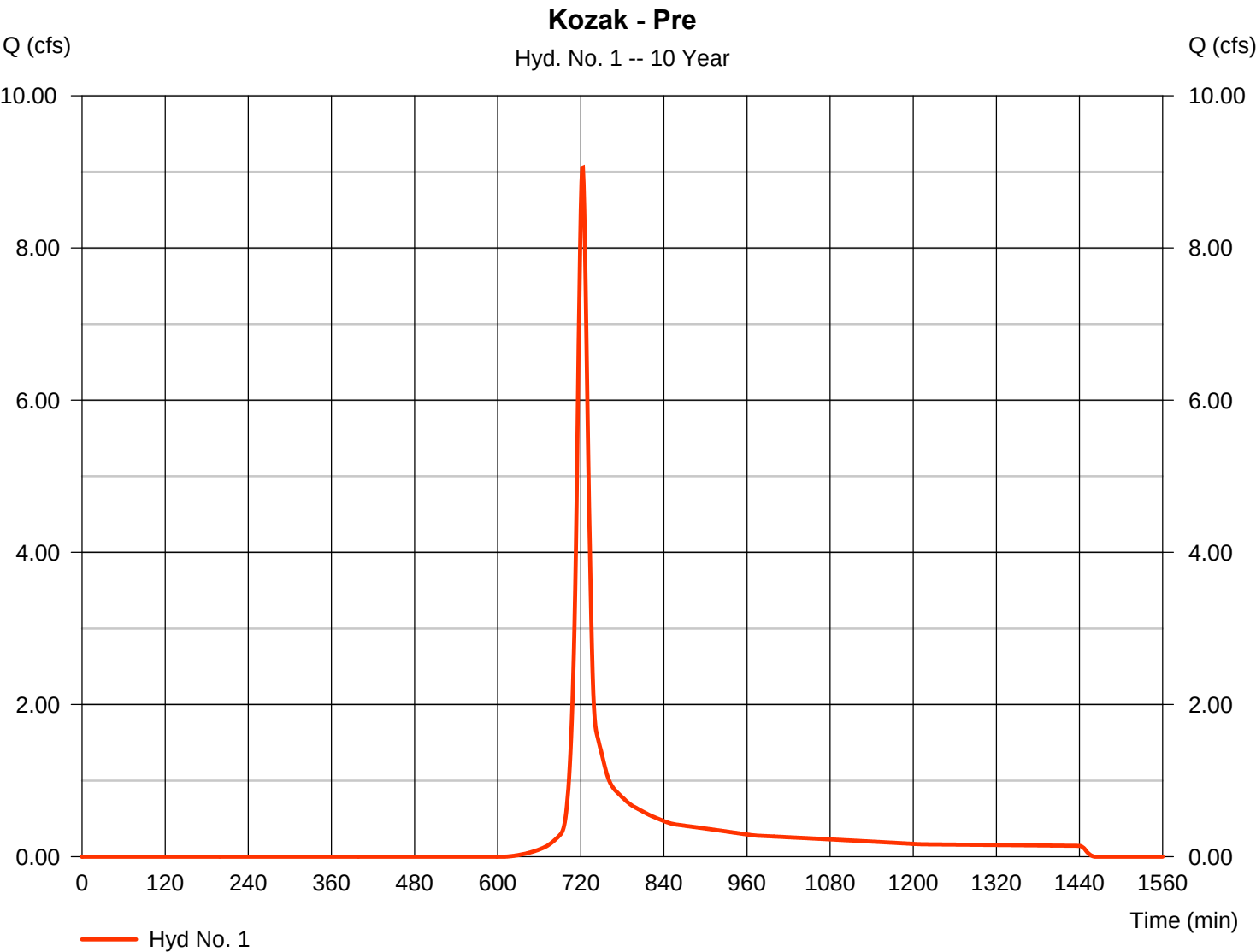
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.055	1	723	24,752	-----	-----	-----	Kozak - Pre
Kozak Pre.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.055 cfs
Storm frequency	=	10 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	24,752 cuft
Drainage area	=	4.630 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.64 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

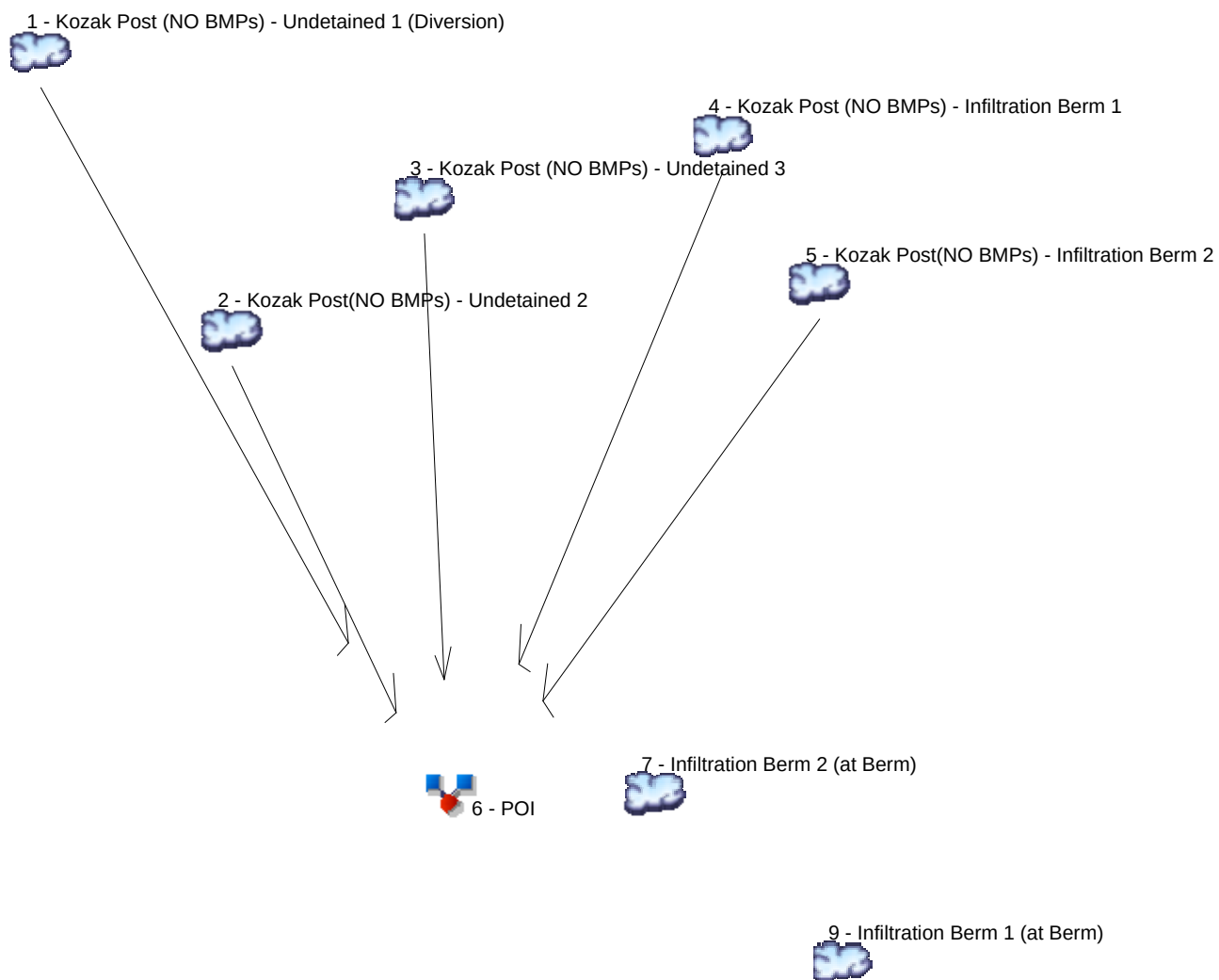
Hyd. No. 1

Kozak - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.400	0.011				
Flow length (ft)	= 10.0	90.0	0.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00				
Land slope (%)	= 10.00	13.30	0.00				
Travel Time (min)	= 1.30	+	10.15	+	0.00	=	11.45
Shallow Concentrated Flow							
Flow length (ft)	= 805.00	0.00	0.00				
Watercourse slope (%)	= 6.80	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.21	0.00	0.00				
Travel Time (min)	= 3.19	+	0.00	+	0.00	=	3.19
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					14.64 min		

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.016	-----	-----	2.600	-----	4.829	6.026	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	-----	-----	1.205	-----	-----	2.535	-----	4.306	5.223	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	-----	-----	0.711	-----	-----	1.467	-----	2.464	2.979	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	-----	-----	1.721	-----	-----	3.392	-----	5.538	6.632	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	-----	-----	0.411	-----	-----	0.818	-----	1.341	1.613	Kozak Post(NO BMPs) - Infiltration B
6	Combine	1, 2, 3, 4, 5	-----	4.472	-----	-----	9.782	-----	16.89	20.60	POI
7	SCS Runoff	-----	-----	0.185	-----	-----	0.353	-----	0.568	0.678	Infiltration Berm 2 (at Berm)
9	SCS Runoff	-----	-----	0.605	-----	-----	1.098	-----	1.713	2.024	Infiltration Berm 1 (at Berm)
Proj. file: Kozak Post.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

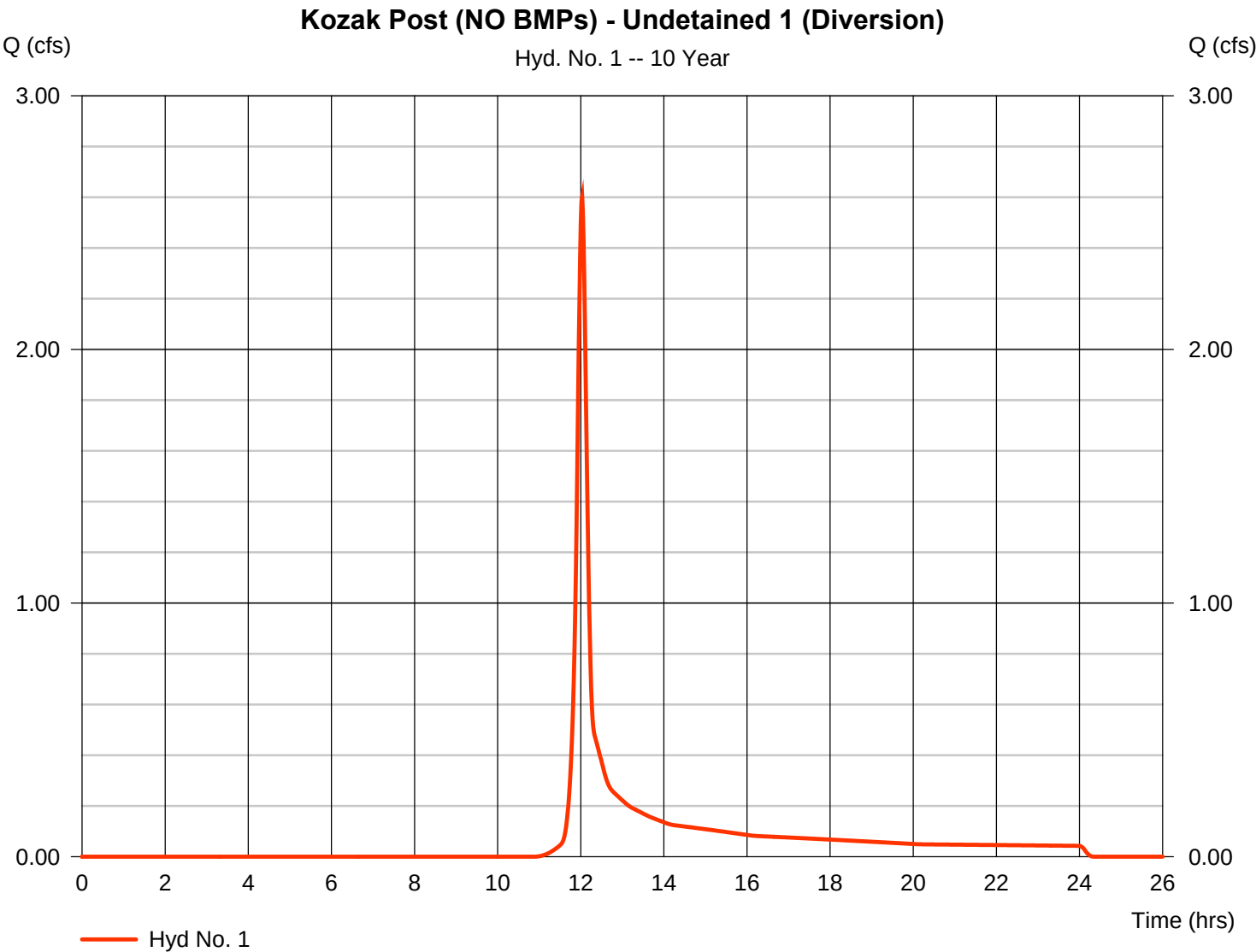
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.600	1	722	6,787	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	2.535	1	721	6,441	-----	-----	-----	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	1.467	1	722	3,964	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	3.392	1	718	6,823	-----	-----	-----	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	0.818	1	716	1,429	-----	-----	-----	Kozak Post(NO BMPs) - Infiltration B
6	Combine	9.782	1	719	25,444	1, 2, 3, 4, 5	-----	-----	POI
7	SCS Runoff	0.353	1	716	622	-----	-----	-----	Infiltration Berm 2 (at Berm)
9	SCS Runoff	1.098	1	717	2,092	-----	-----	-----	Infiltration Berm 1 (at Berm)
Kozak Post.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.600 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.03 hrs
Time interval	=	1 min	Hyd. volume	=	6,787 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

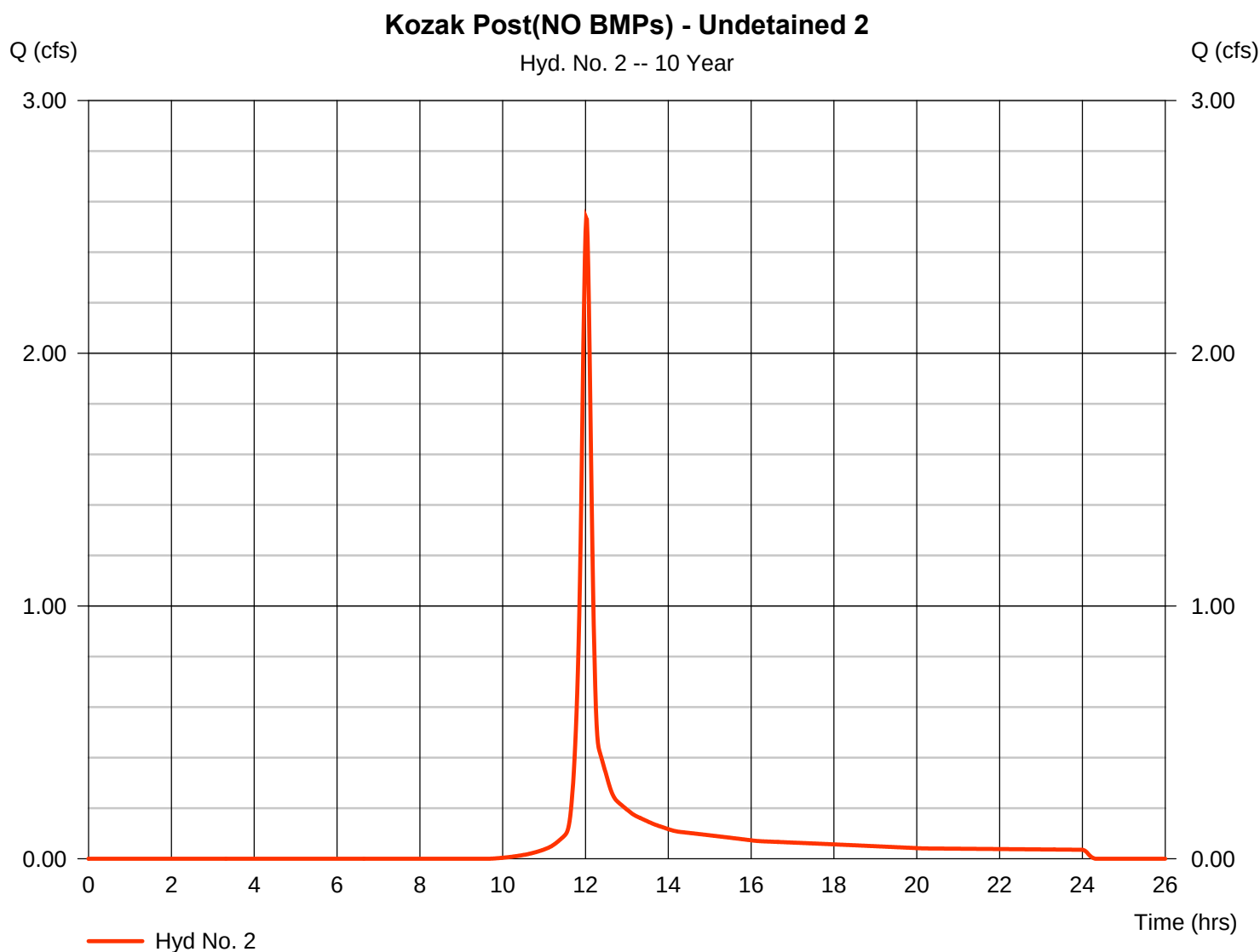
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.535 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	6,441 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.150	0.400	
Flow length (ft)	= 14.0	8.0	78.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 7.10	50.00	11.50	
Travel Time (min)	= 0.17	+	0.39	+
			9.59	= 10.15
Shallow Concentrated Flow				
Flow length (ft)	= 565.00	0.00	0.00	
Watercourse slope (%)	= 6.40	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.08	0.00	0.00	
Travel Time (min)	= 2.31	+	0.00	+
			0.00	= 2.31
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				12.50 min

Hydrograph Report

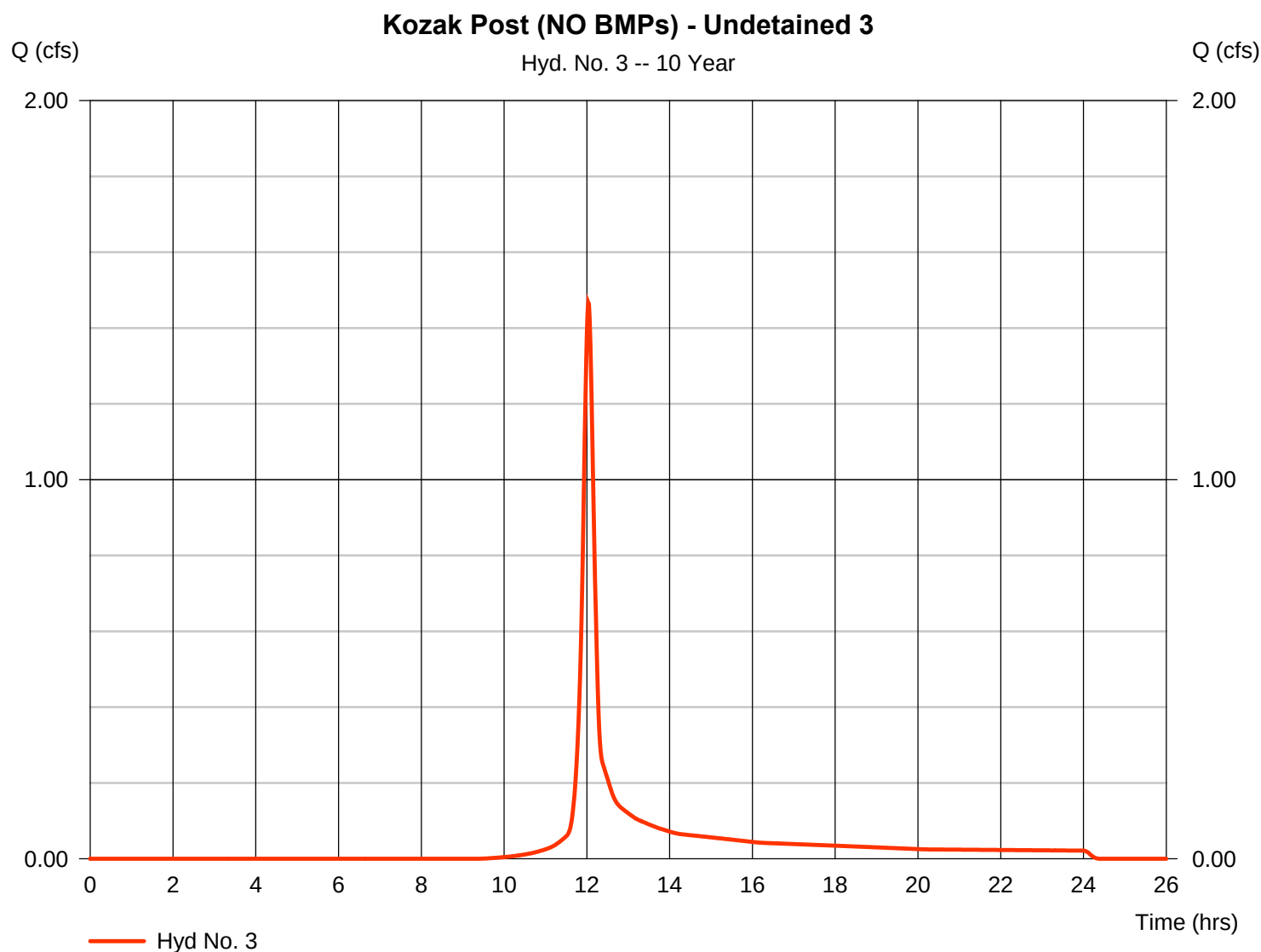
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Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.467 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.03 hrs
Time interval	=	1 min	Hyd. volume	=	3,964 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

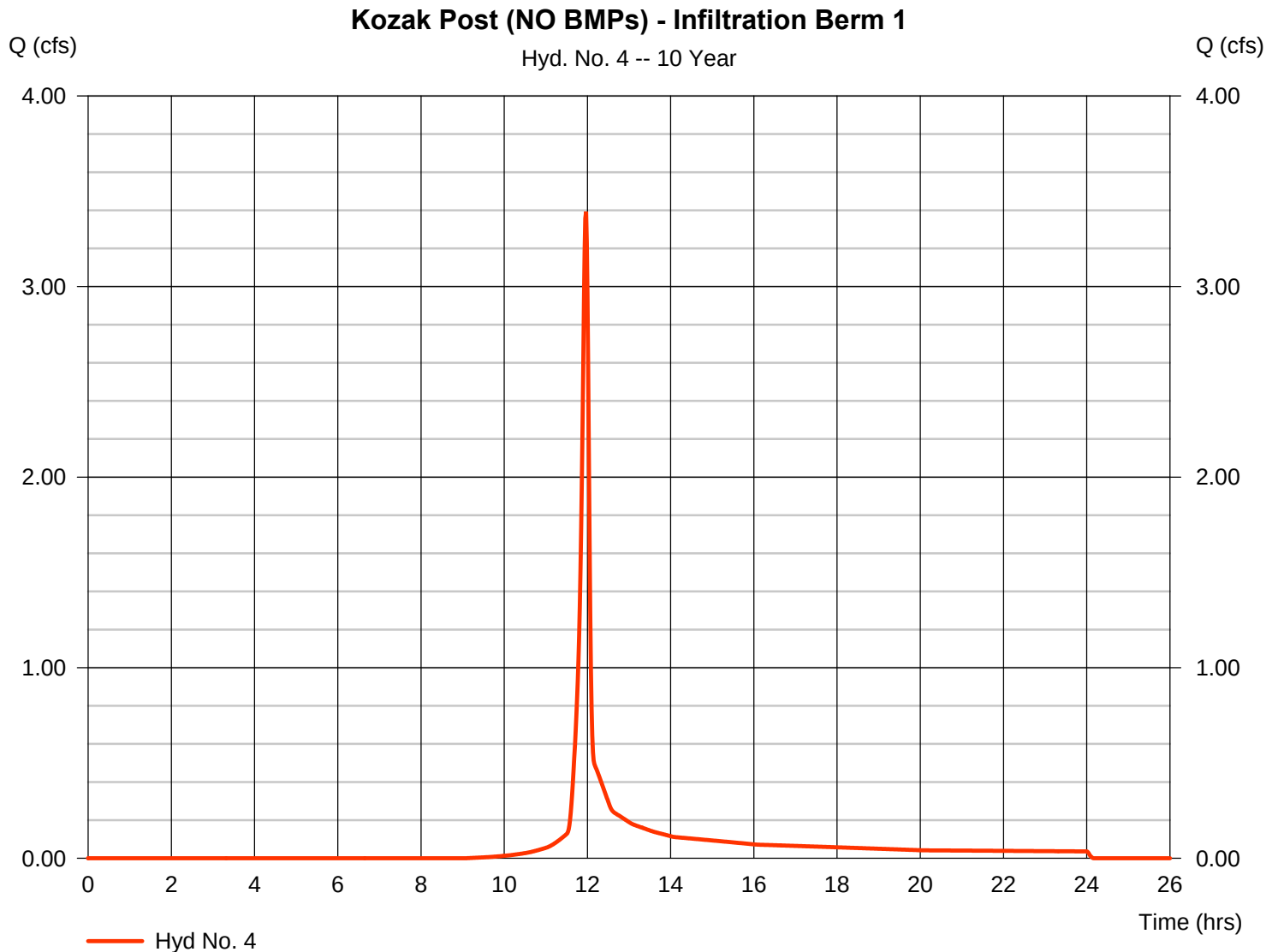
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Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.392 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	6,823 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.20 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.011	0.240				
Flow length (ft)	= 8.0	65.0	37.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 25.00	6.20	23.00				
Travel Time (min)	= 0.76	+	0.60	+	2.66	=	4.01
Shallow Concentrated Flow							
Flow length (ft)	= 522.00	0.00	0.00				
Watercourse slope (%)	= 6.10	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=3.98	0.00	0.00				
Travel Time (min)	= 2.18	+	0.00	+	0.00	=	2.18
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				6.20 min			

Hydrograph Report

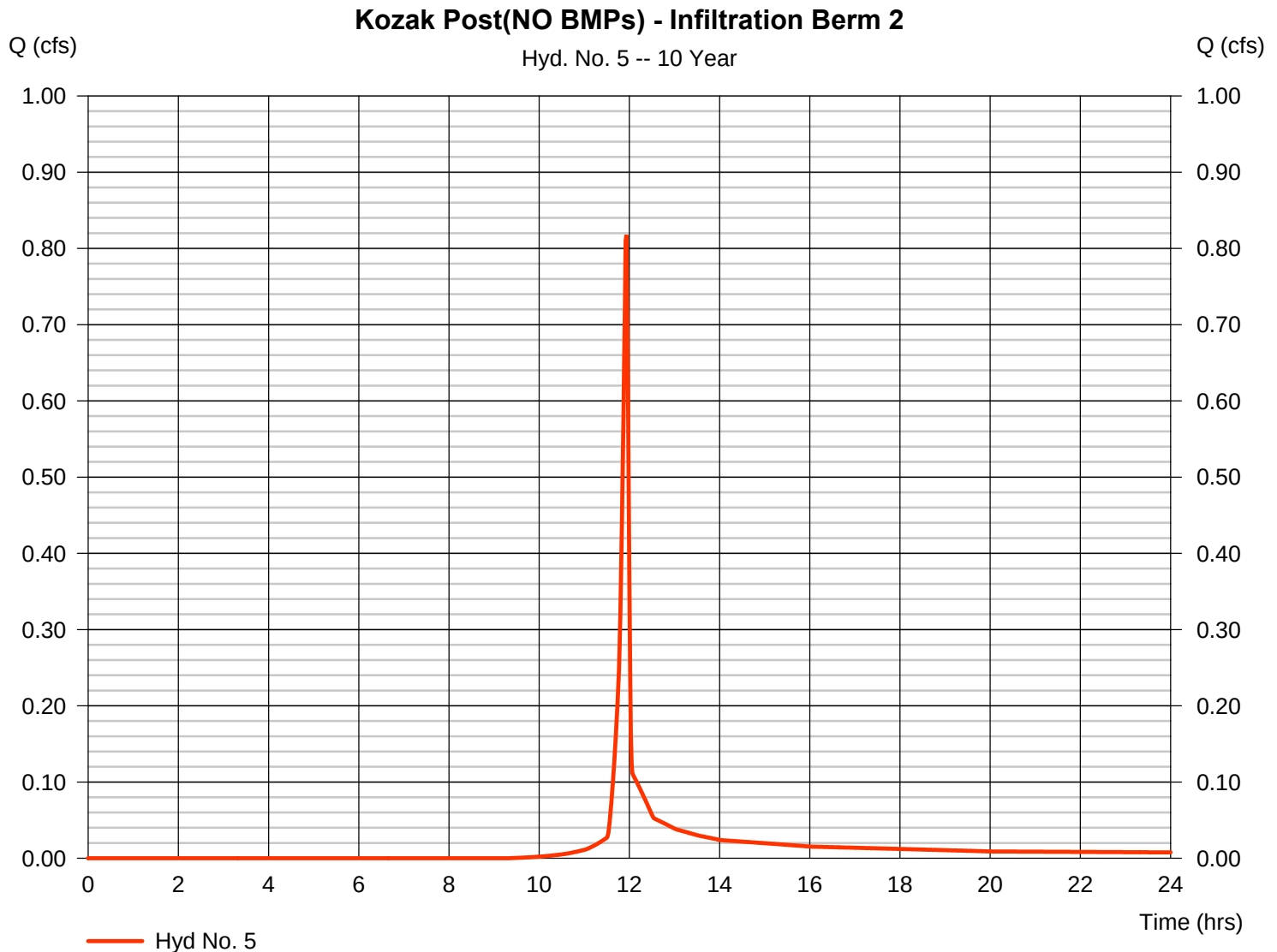
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Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.818 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 1 min	Hyd. volume	= 1,429 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.62 min
Total precip.	= 3.83 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.011	0.011	
Flow length (ft)	= 45.0	54.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 3.30	8.30	0.00	
Travel Time (min)	= 0.57	+	0.46	+
			0.00	= 1.03
Shallow Concentrated Flow				
Flow length (ft)	= 40.00	35.00	63.00	
Watercourse slope (%)	= 7.50	11.40	8.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=4.42	5.45	4.56	
Travel Time (min)	= 0.15	+	0.11	+
			0.23	= 0.49
Channel Flow				
X sectional flow area (sqft)	= 2.00	0.00	0.00	
Wetted perimeter (ft)	= 4.68	0.00	0.00	
Channel slope (%)	= 11.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=18.64	0.00	0.00	
Flow length (ft)	107.0	0.0	0.0	
Travel Time (min)	= 0.10	+	0.00	+
			0.00	= 0.10
Total Travel Time, Tc				1.62 min

Hydrograph Report

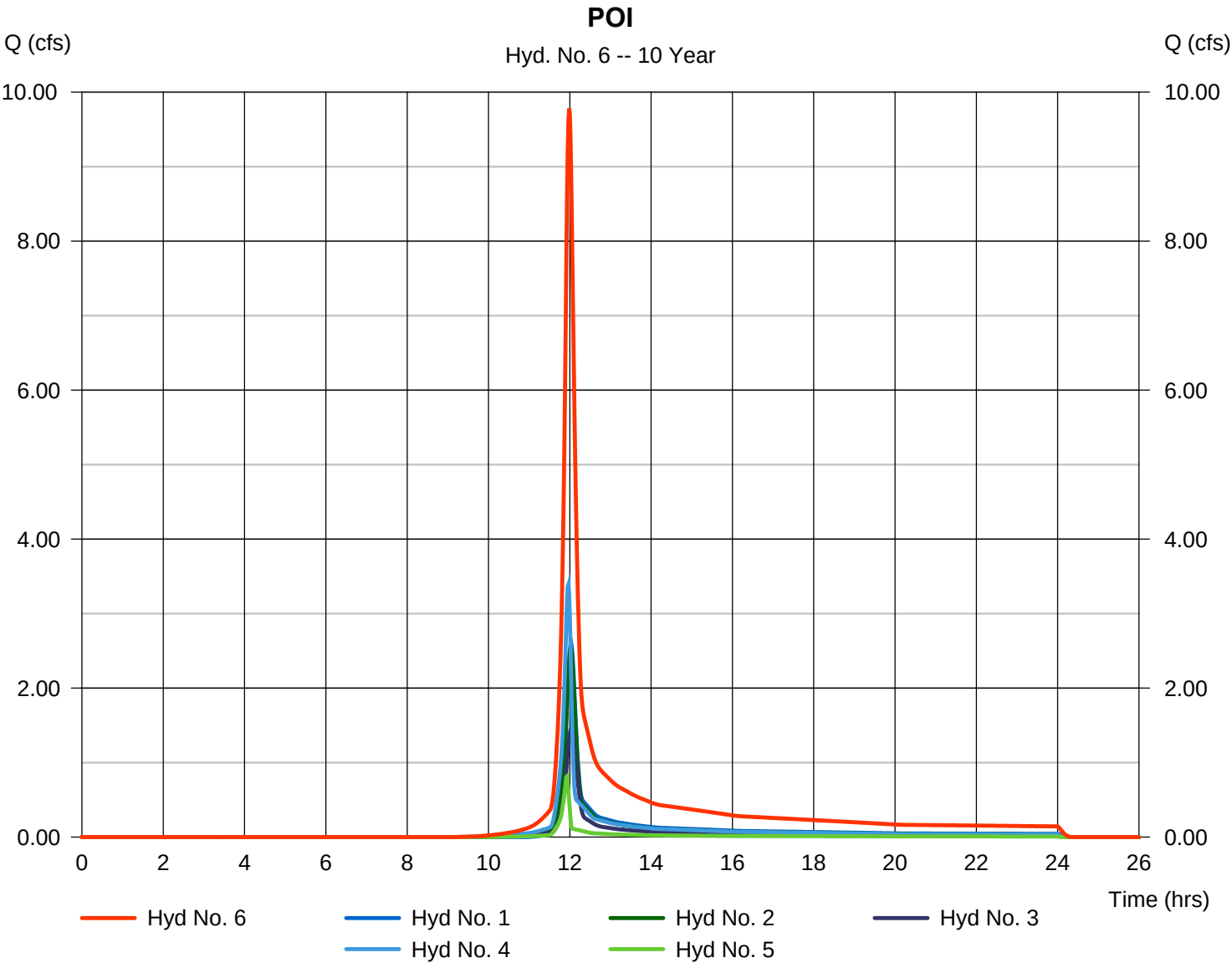
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Friday, 11 / 4 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 9.782 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 25,444 cuft
Inflow hyds.	= 1, 2, 3, 4, 5	Contrib. drain. area	= 4.620 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

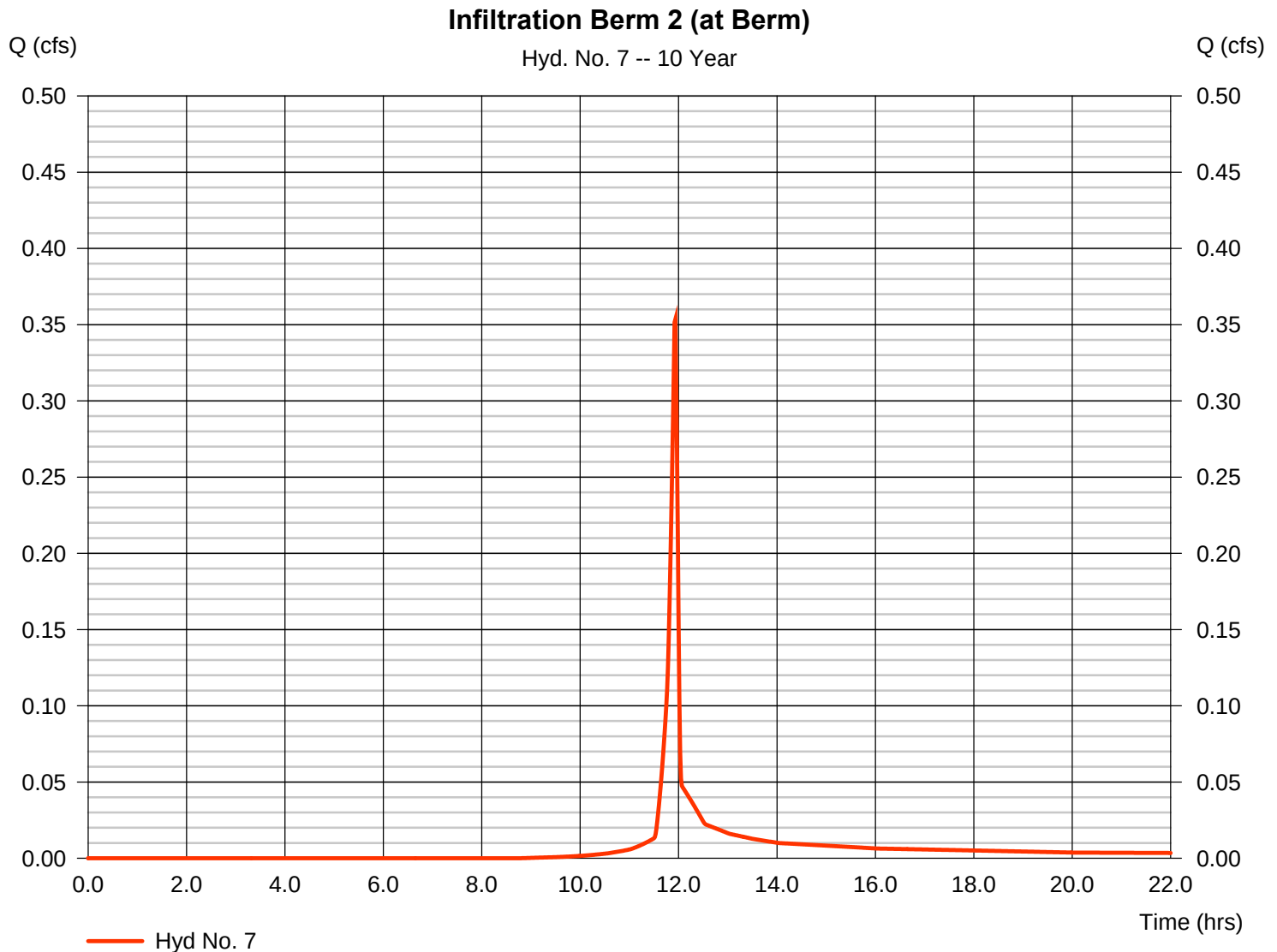
Friday, 11 / 4 / 2016

Hyd. No. 7

Infiltration Berm 2 (at Berm)

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 1 min
 Drainage area = 0.100 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 3.83 in
 Storm duration = 24 hrs

Peak discharge = 0.353 cfs
 Time to peak = 11.93 hrs
 Hyd. volume = 622 cuft
 Curve number = 79
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.60 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

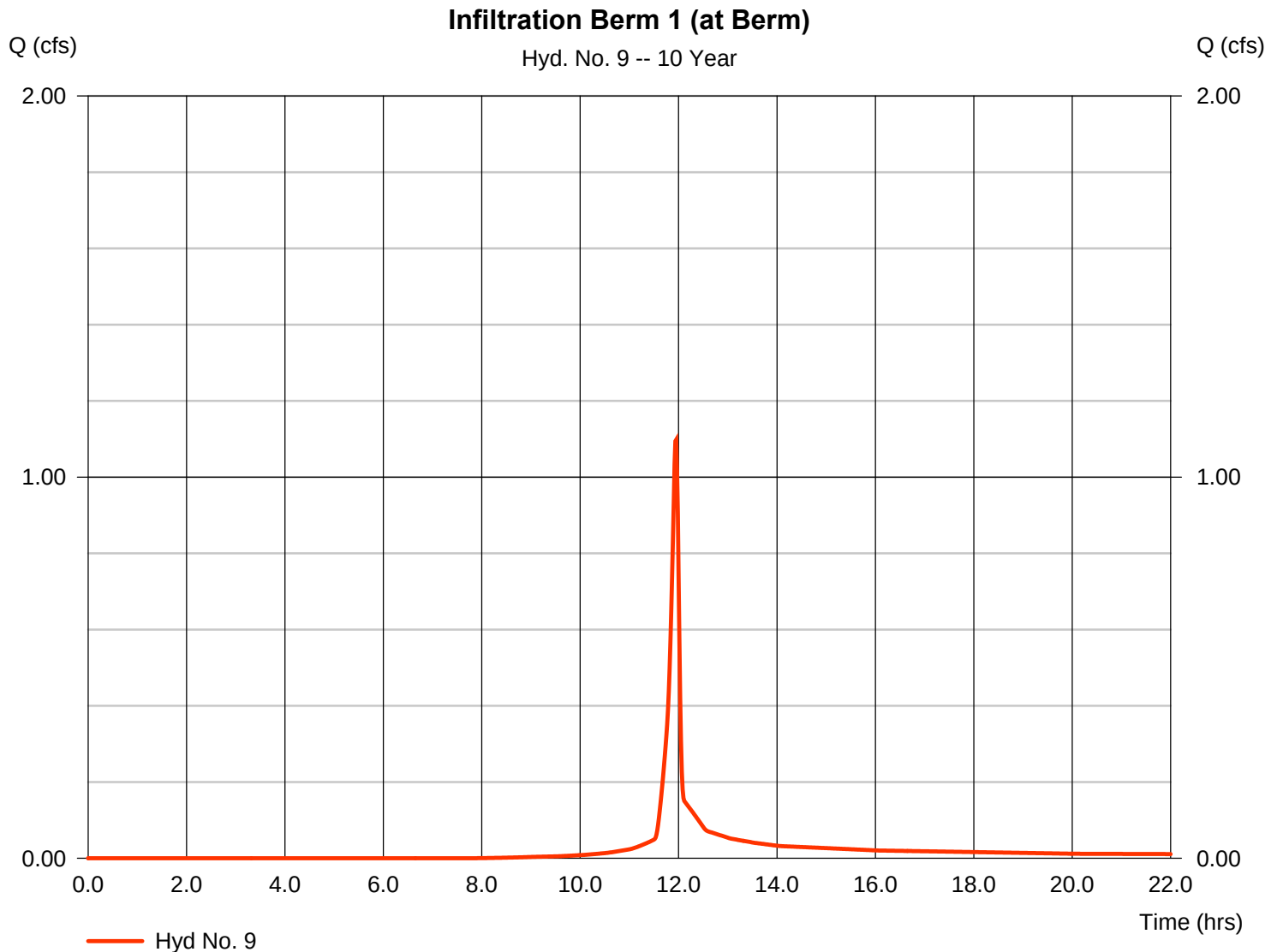
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 9

Infiltration Berm 1 (at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.098 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.95 hrs
Time interval	=	1 min	Hyd. volume	=	2,092 cuft
Drainage area	=	0.280 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	3.40 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

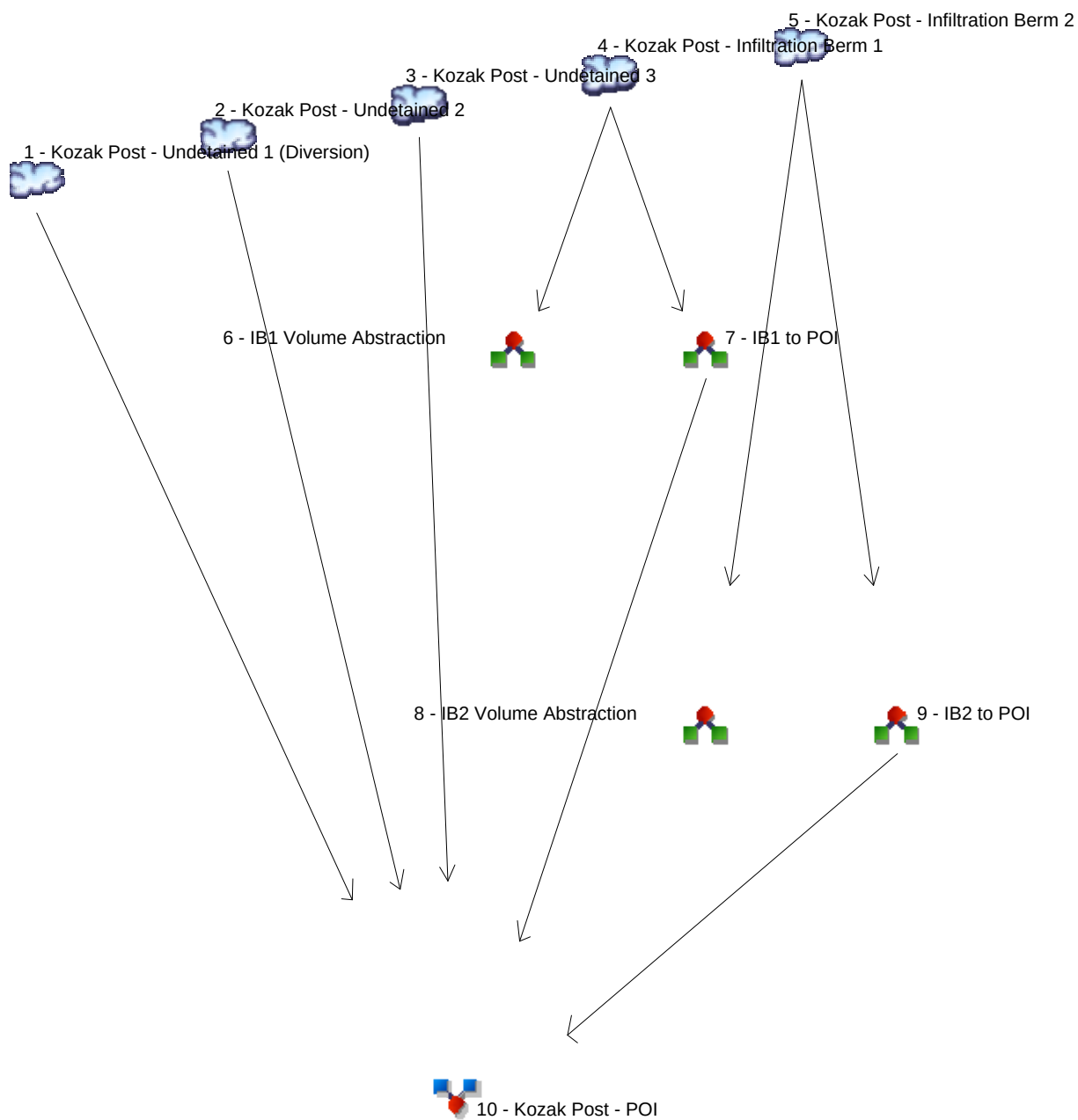
Hyd. No. 9

Infiltration Berm 1 (at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.011	0.240				
Flow length (ft)	= 8.0	65.0	27.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 25.00	6.20	23.00				
Travel Time (min)	= 0.76	+	0.60	+	2.07	=	3.42
Shallow Concentrated Flow							
Flow length (ft)	= 0.00	0.00	0.00				
Watercourse slope (%)	= 0.00	0.00	0.00				
Surface description	= Paved	Paved	Paved				
Average velocity (ft/s)	=0.00	0.00	0.00				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
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				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				3.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	2.600	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	-----	-----	-----	-----	-----	2.535	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	-----	-----	-----	-----	-----	1.467	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	-----	-----	-----	-----	-----	2.453	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	-----	-----	-----	-----	-----	0.463	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	4	-----	-----	-----	-----	1.703	-----	-----	-----	IB1 Volume Abstraction
7	Diversion2	4	-----	-----	-----	-----	2.453	-----	-----	-----	IB1 to POI
8	Diversion1	5	-----	-----	-----	-----	0.463	-----	-----	-----	IB2 Volume Abstraction
9	Diversion2	5	-----	-----	-----	-----	0.296	-----	-----	-----	IB2 to POI
10	Combine	1, 2, 3, 7, 9	-----	-----	-----	-----	9.048	-----	-----	-----	Kozak Post - POI
Proj. file: Kozak Post wBMPs 10yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

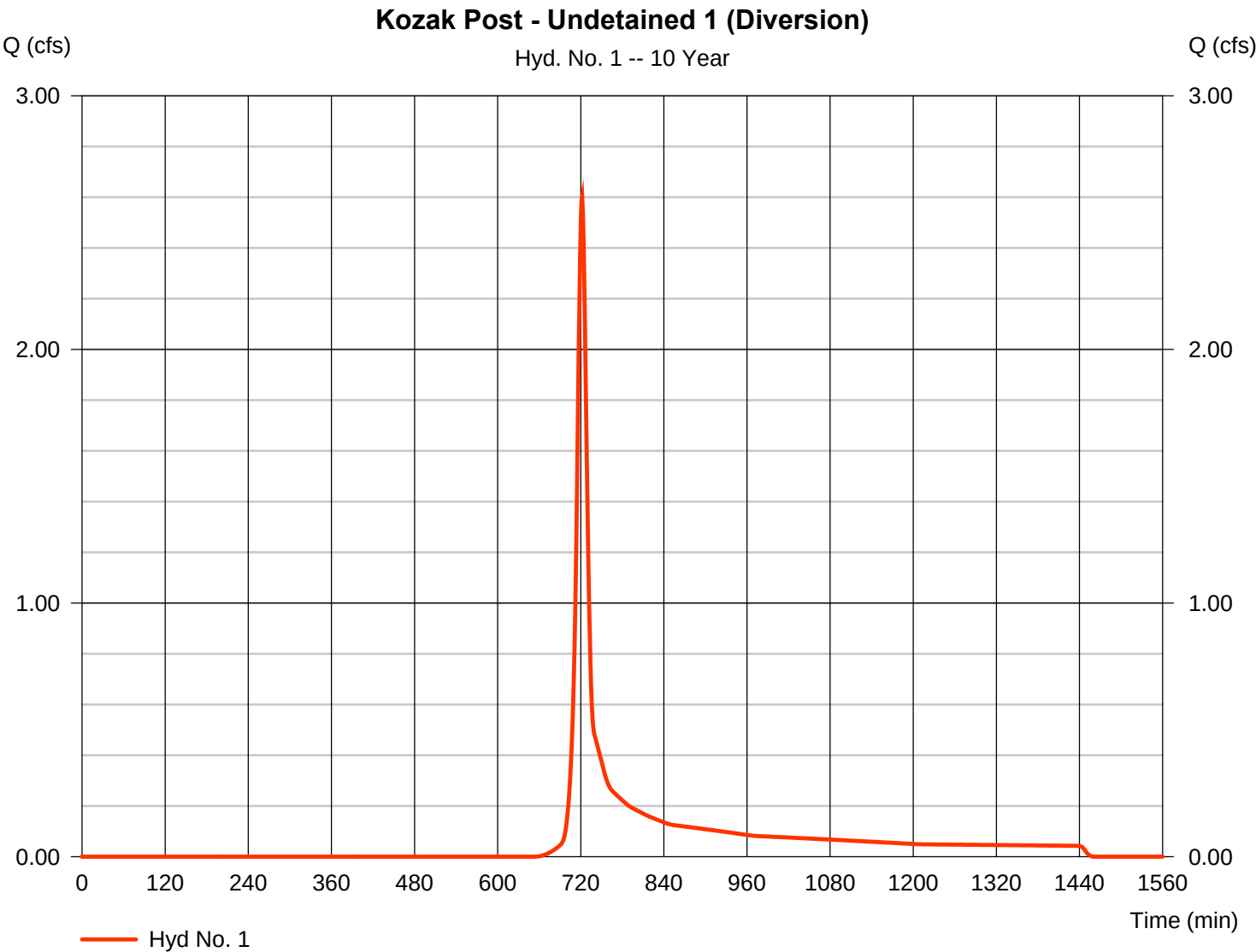
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.600	1	722	6,787	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	2.535	1	721	6,441	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	1.467	1	722	3,964	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	2.453	1	722	6,616	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	0.463	1	726	1,539	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	1.703	1	716	1,081	4	-----	-----	IB1 Volume Abstraction
7	Diversion2	2.453	1	722	5,535	4	-----	-----	IB1 to POI
8	Diversion1	0.463	1	726	641	5	-----	-----	IB2 Volume Abstraction
9	Diversion2	0.296	1	737	899	5	-----	-----	IB2 to POI
10	Combine	9.048	1	722	23,626	1, 2, 3, 7, 9	-----	-----	Kozak Post - POI
Kozak Post wBMPs 10yr.gpw					Return Period: 10 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.600 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	6,787 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

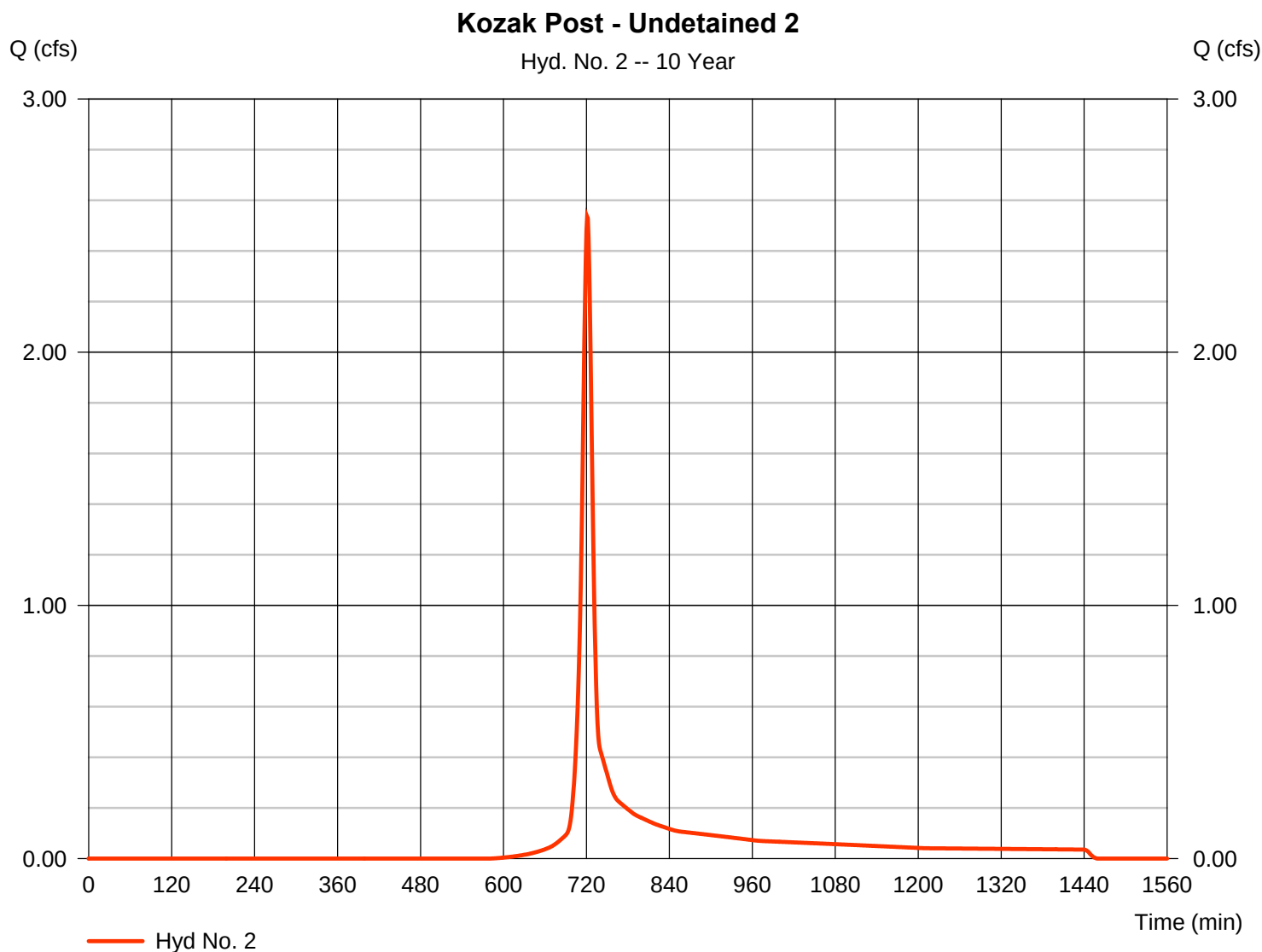
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Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.535 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	6,441 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

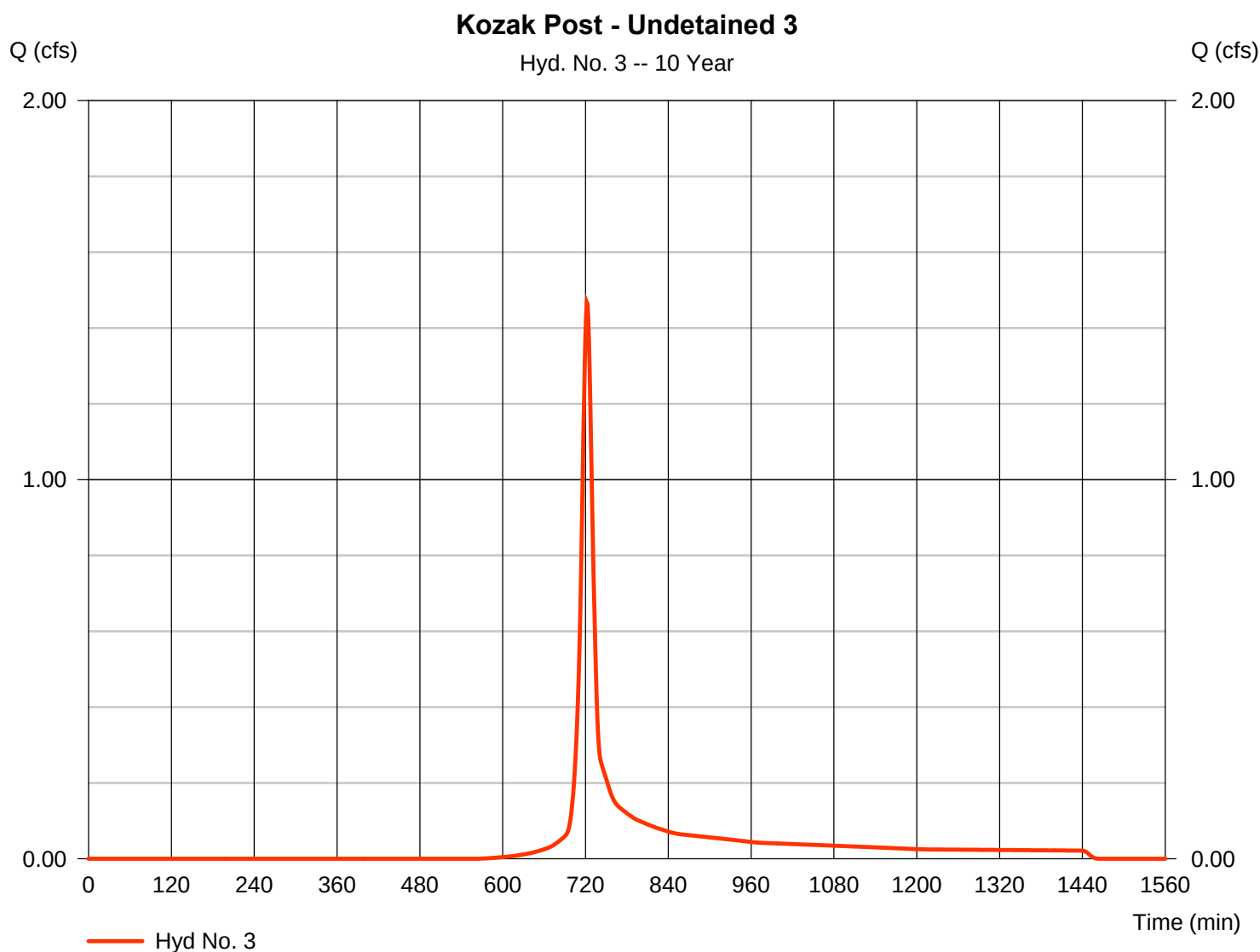
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.467 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	3,964 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

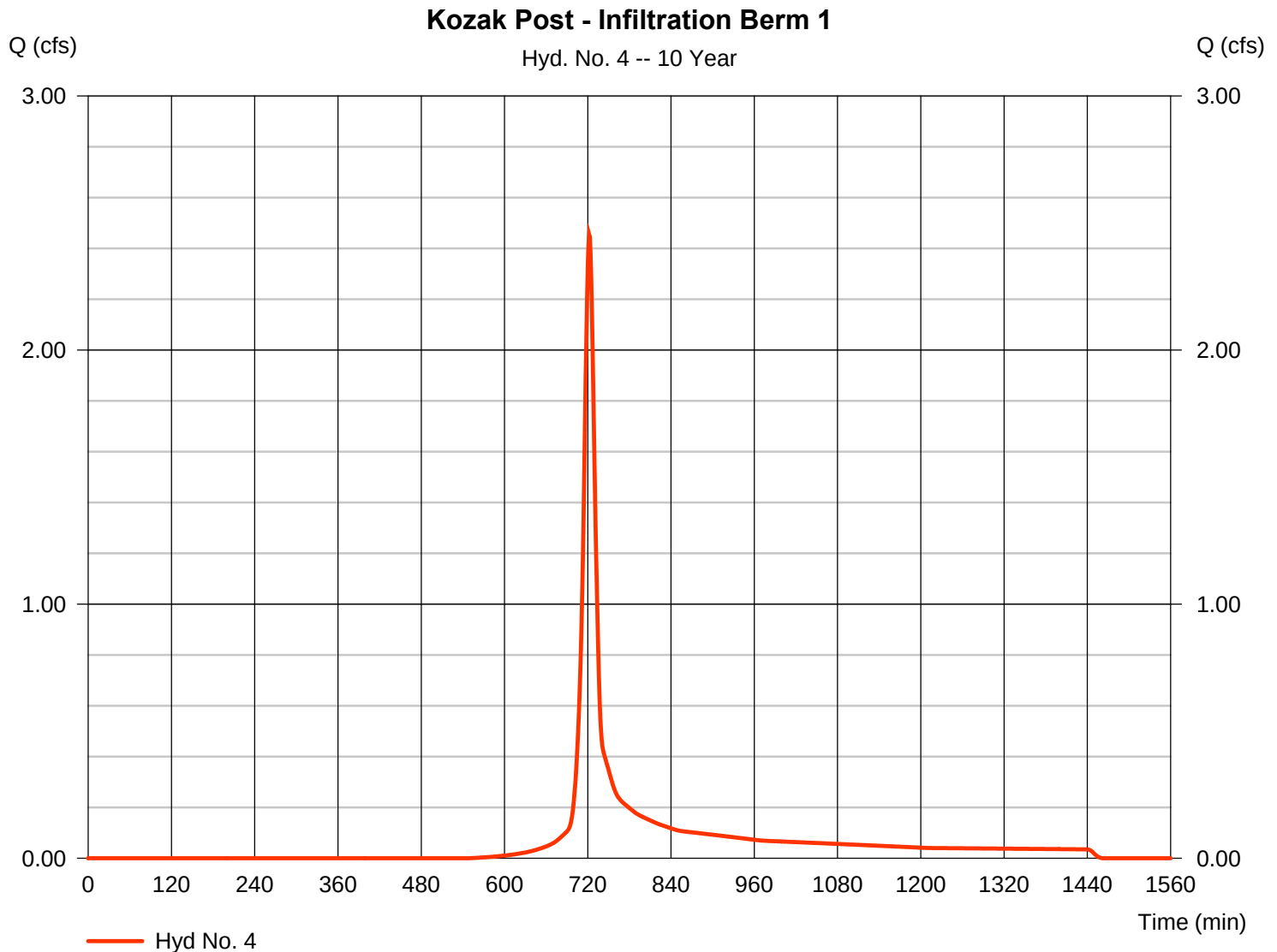
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.453 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	6,616 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	14.90 min
Total precip.	=	3.83 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

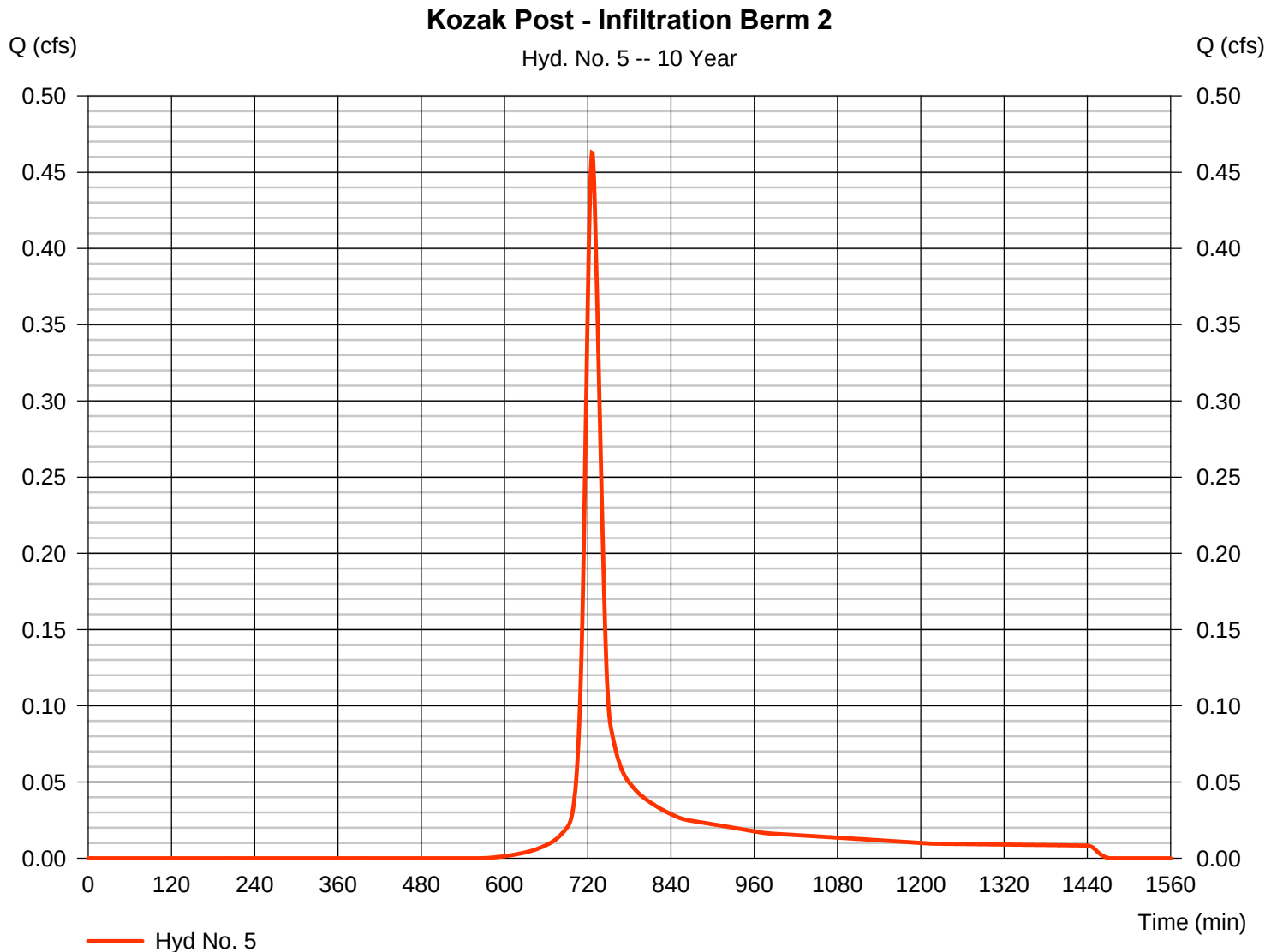
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.463 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 1,539 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.40 min
Total precip.	= 3.83 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

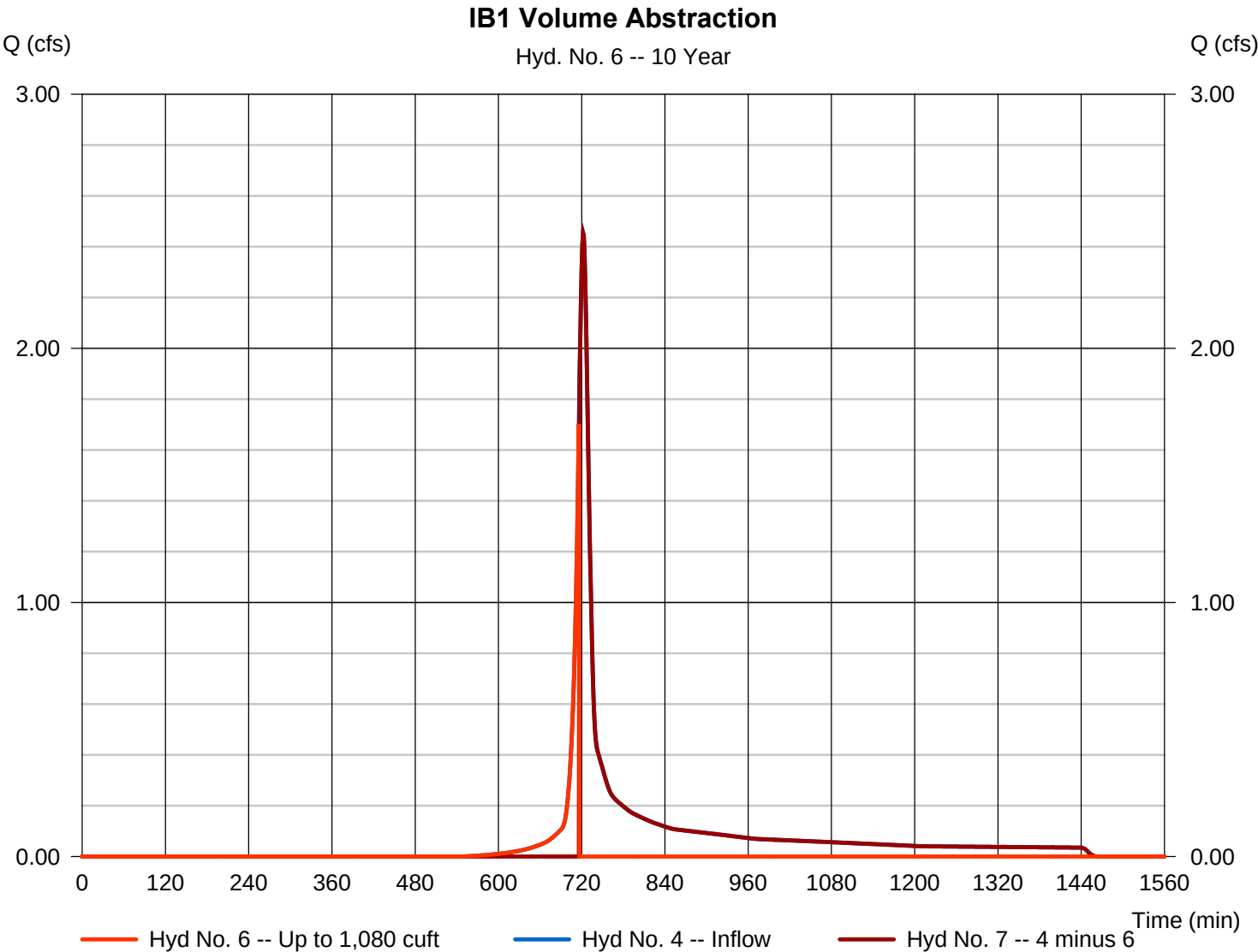
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 6

IB1 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	1.703 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	1 min	Hyd. volume	=	1,081 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	7
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

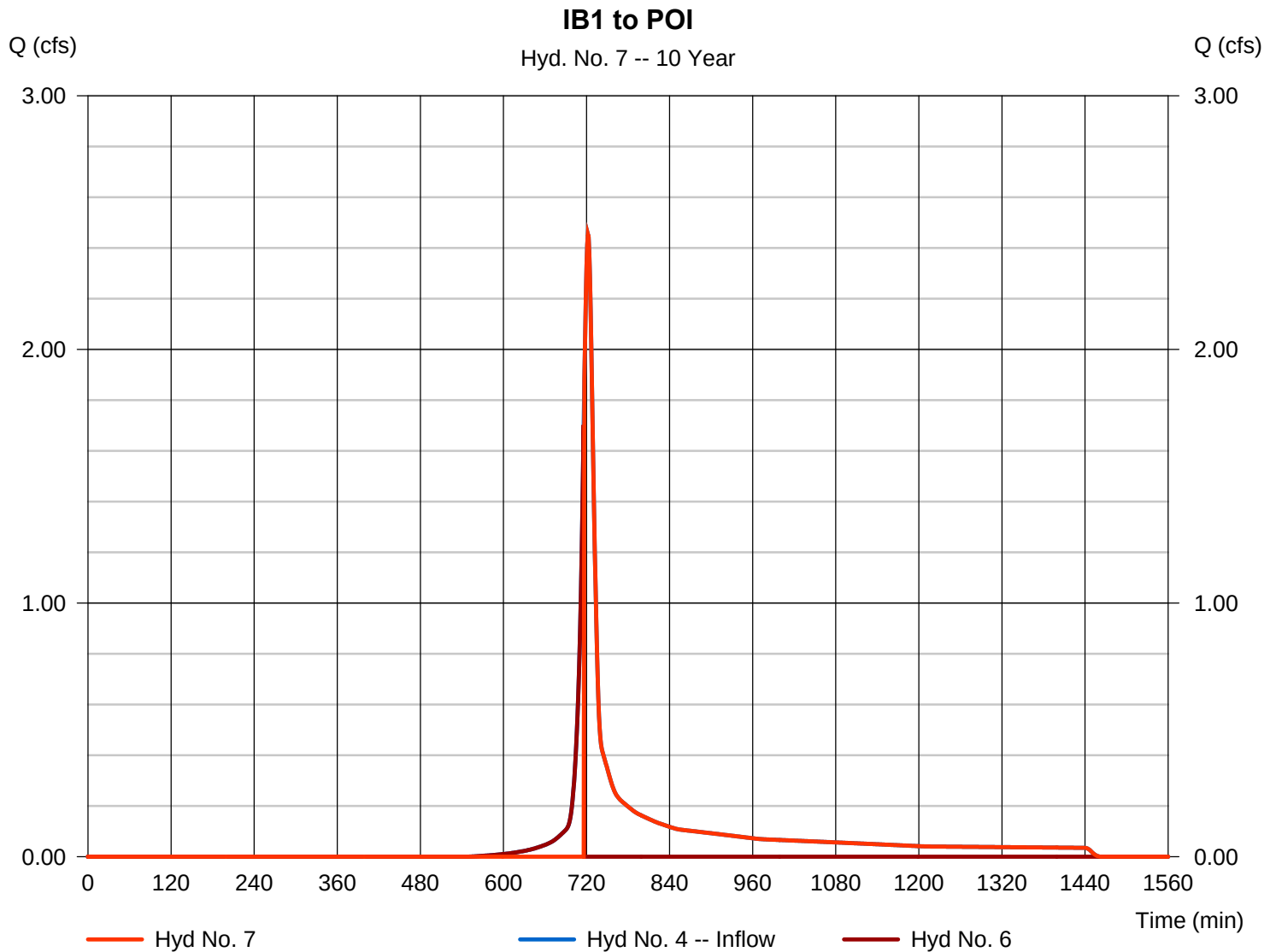
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 7

IB1 to POI

Hydrograph type	= Diversion2	Peak discharge	= 2.453 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 5,535 cuft
Inflow hydrograph	= 4 - Kozak Post - Infiltration Berms and diverted hyd.		= 6
Diversion method	= First Flush Volume	Volume Up To	= 1,080 cuft



Hydrograph Report

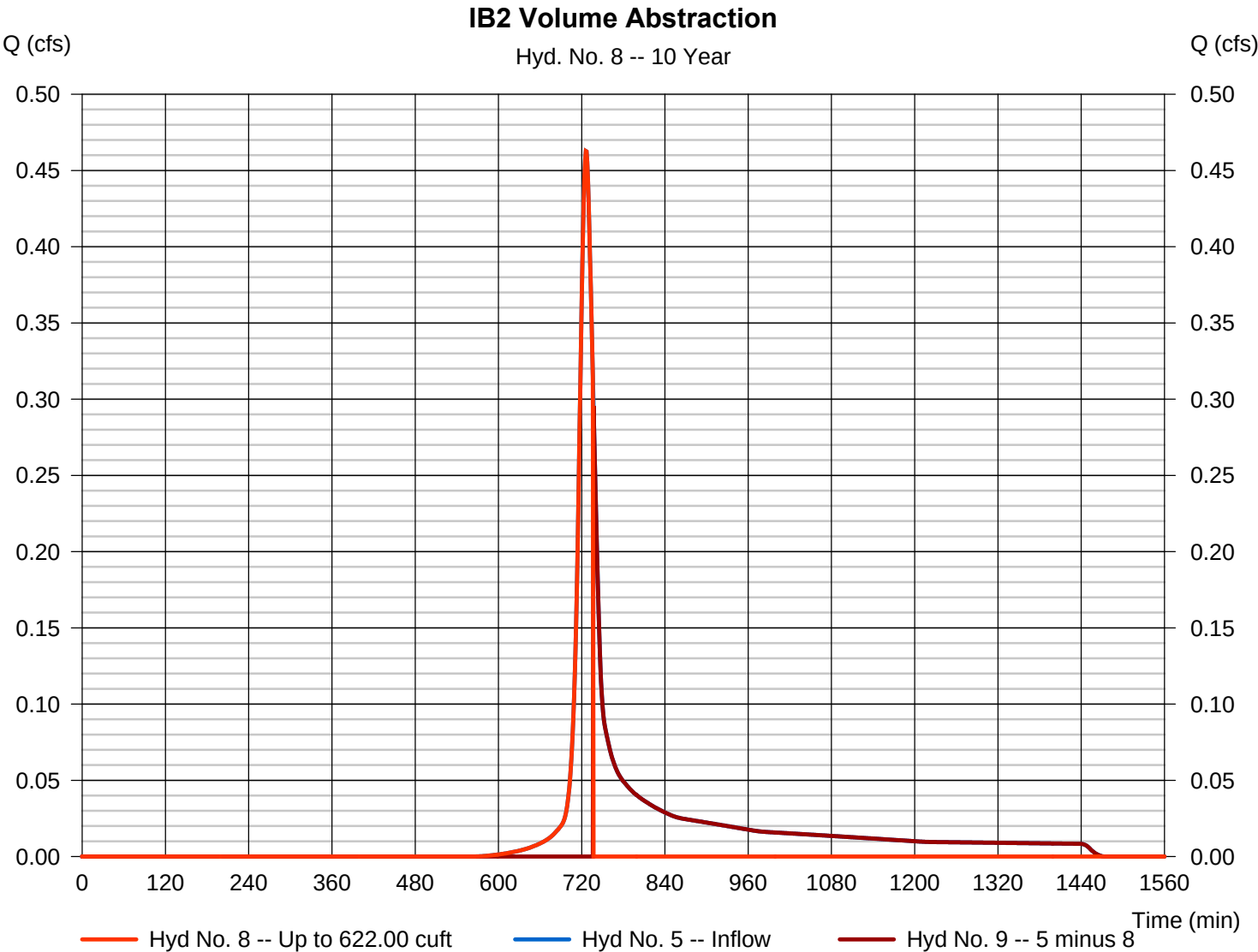
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 8

IB2 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.463 cfs
Storm frequency	=	10 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	641 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms	and diverted hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	622.00 cuft



Hydrograph Report

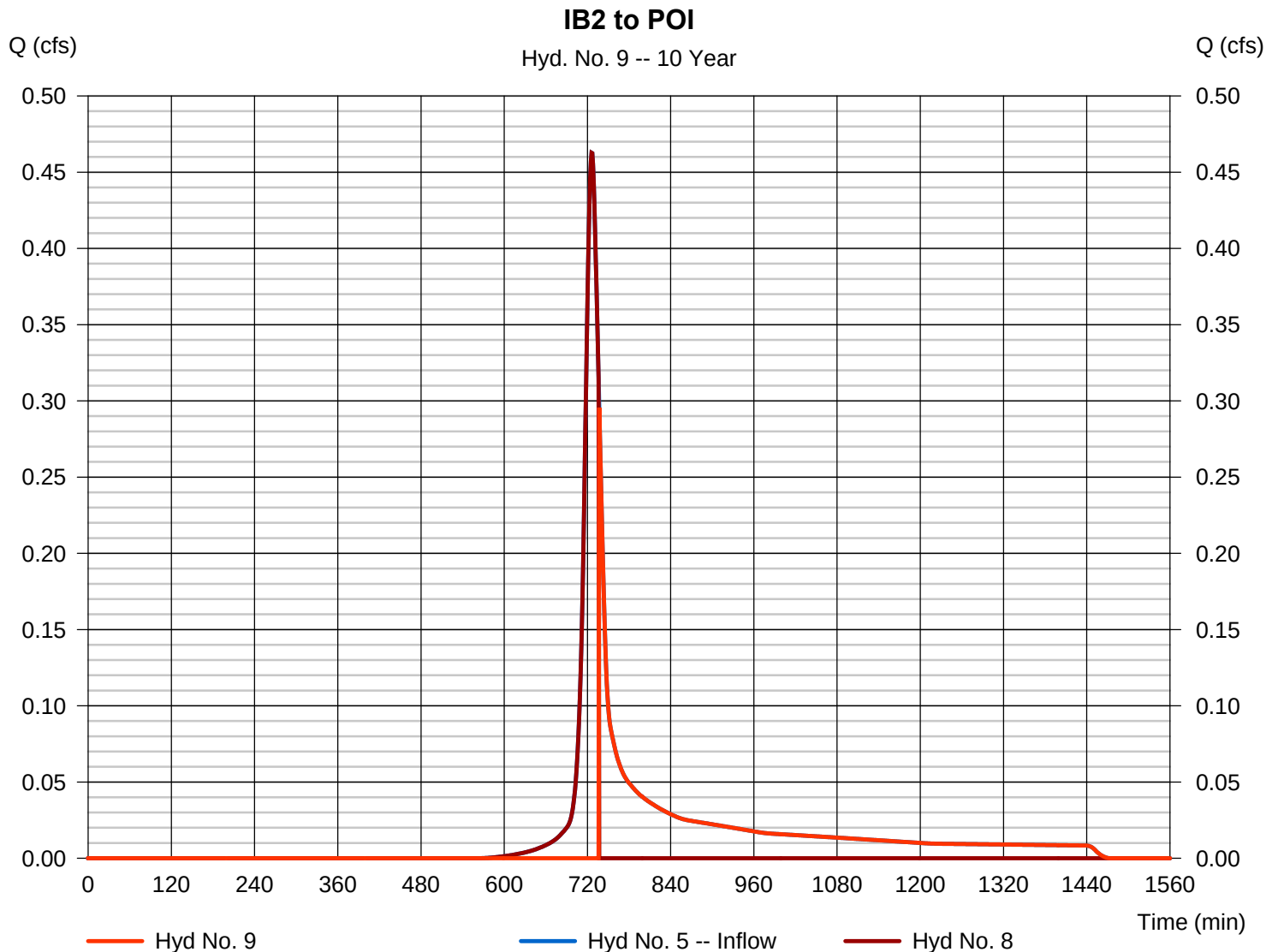
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 9

IB2 to POI

Hydrograph type	= Diversion2	Peak discharge	= 0.296 cfs
Storm frequency	= 10 yrs	Time to peak	= 737 min
Time interval	= 1 min	Hyd. volume	= 899 cuft
Inflow hydrograph	= 5 - Kozak Post - Infiltration Berms and diverted hyd.		= 8
Diversion method	= First Flush Volume	Volume Up To	= 622.00 cuft



Hydrograph Report

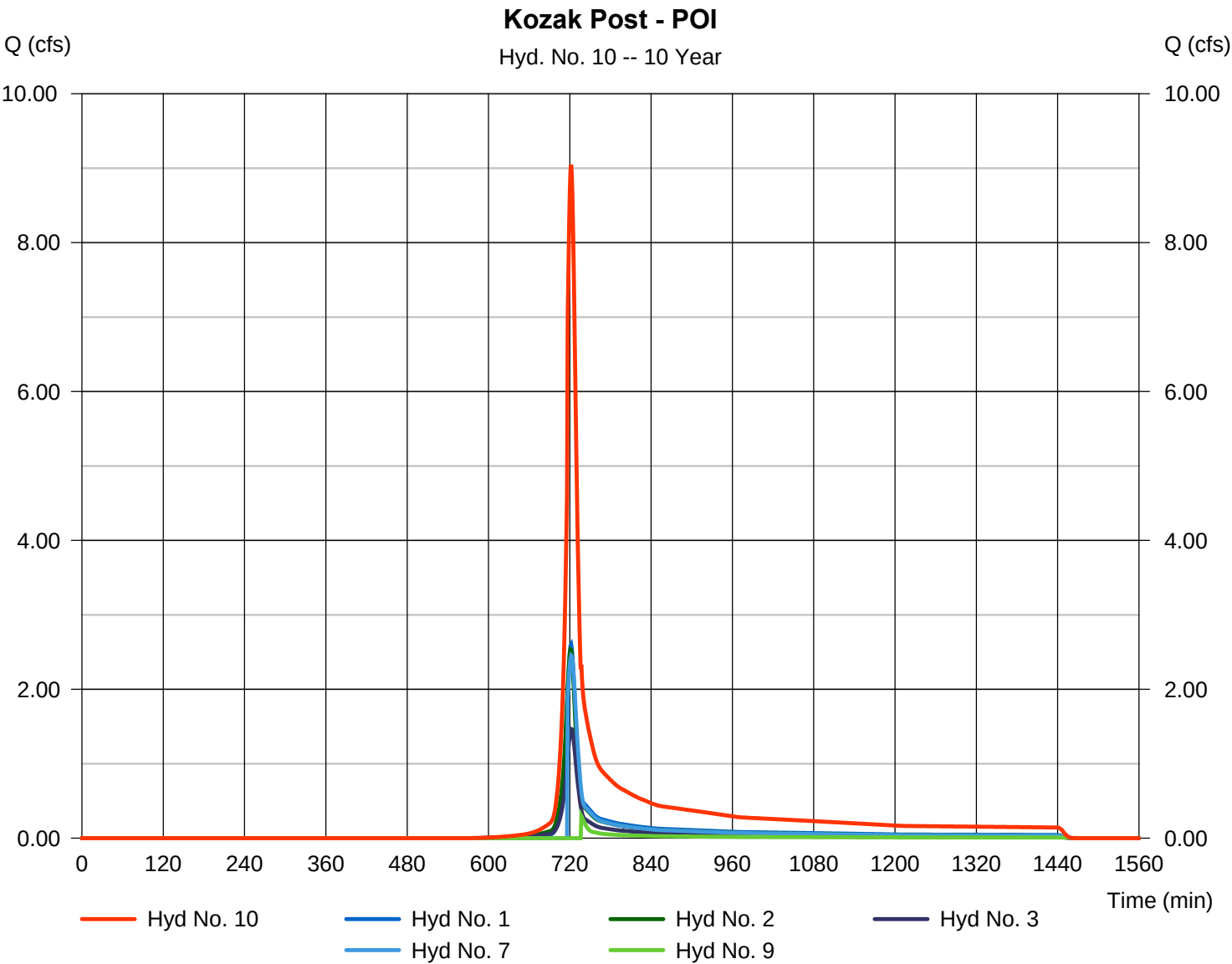
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 10

Kozak Post - POI

Hydrograph type	= Combine	Peak discharge	= 9.048 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 23,626 cuft
Inflow hyds.	= 1, 2, 3, 7, 9	Contrib. drain. area	= 3.330 ac



ATTACHMENT C-3
KOZAK RD
50 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Kozak - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	4.055	-----	-----	9.055	-----	15.87	19.44	Kozak - Pre
Proj. file: Kozak Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

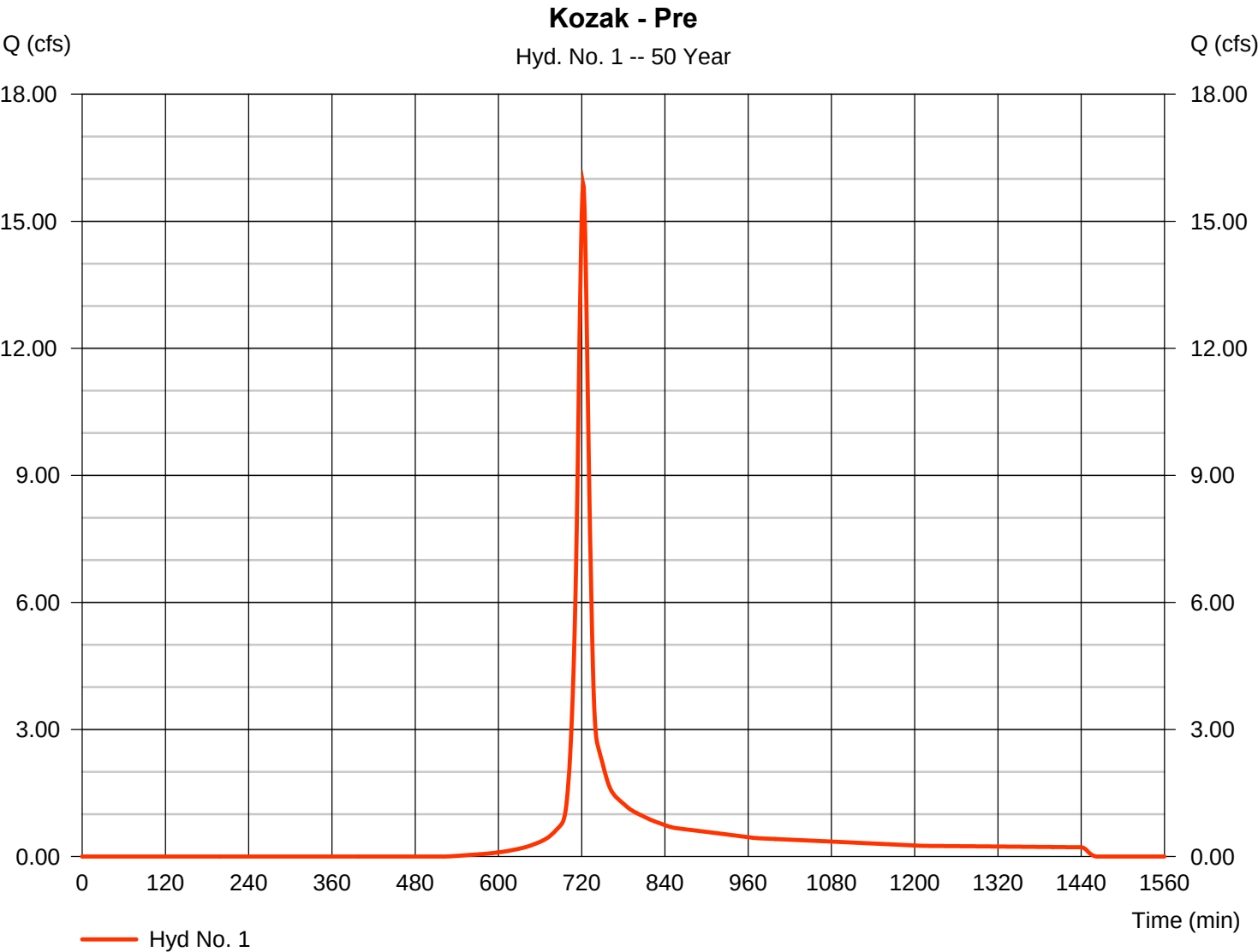
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	15.87	1	722	42,706	-----	-----	-----	Kozak - Pre
Kozak Pre.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak - Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 15.87 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 42,706 cuft
Drainage area	= 4.630 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.64 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

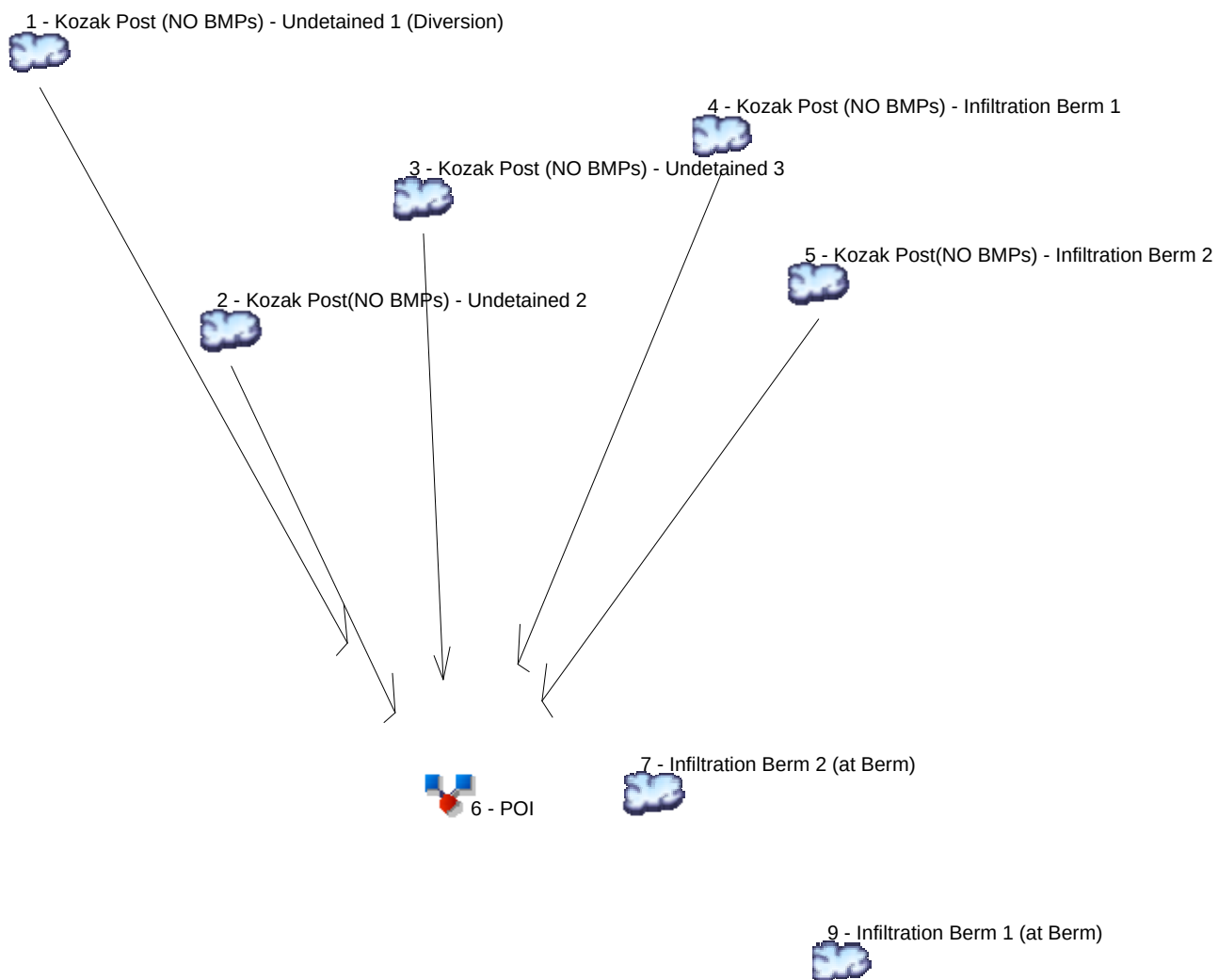
Hyd. No. 1

Kozak - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 10.0	90.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 10.00	13.30	0.00	
Travel Time (min)	= 1.30	+	10.15	+
			0.00	= 11.45
Shallow Concentrated Flow				
Flow length (ft)	= 805.00	0.00	0.00	
Watercourse slope (%)	= 6.80	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.21	0.00	0.00	
Travel Time (min)	= 3.19	+	0.00	+
			0.00	= 3.19
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				14.64 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.016	-----	-----	2.600	-----	4.829	6.026	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	-----	-----	1.205	-----	-----	2.535	-----	4.306	5.223	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	-----	-----	0.711	-----	-----	1.467	-----	2.464	2.979	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	-----	-----	1.721	-----	-----	3.392	-----	5.538	6.632	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	-----	-----	0.411	-----	-----	0.818	-----	1.341	1.613	Kozak Post(NO BMPs) - Infiltration B
6	Combine	1, 2, 3, 4, 5	-----	4.472	-----	-----	9.782	-----	16.89	20.60	POI
7	SCS Runoff	-----	-----	0.185	-----	-----	0.353	-----	0.568	0.678	Infiltration Berm 2 (at Berm)
9	SCS Runoff	-----	-----	0.605	-----	-----	1.098	-----	1.713	2.024	Infiltration Berm 1 (at Berm)
Proj. file: Kozak Post.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.829	1	721	12,268	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	4.306	1	721	10,877	-----	-----	-----	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	2.464	1	722	6,626	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	5.538	1	718	11,288	-----	-----	-----	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	1.341	1	716	2,389	-----	-----	-----	Kozak Post(NO BMPs) - Infiltration B
6	Combine	16.89	1	719	43,448	1, 2, 3, 4, 5	-----	-----	POI
7	SCS Runoff	0.568	1	715	1,018	-----	-----	-----	Infiltration Berm 2 (at Berm)
9	SCS Runoff	1.713	1	716	3,330	-----	-----	-----	Infiltration Berm 1 (at Berm)
Kozak Post.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

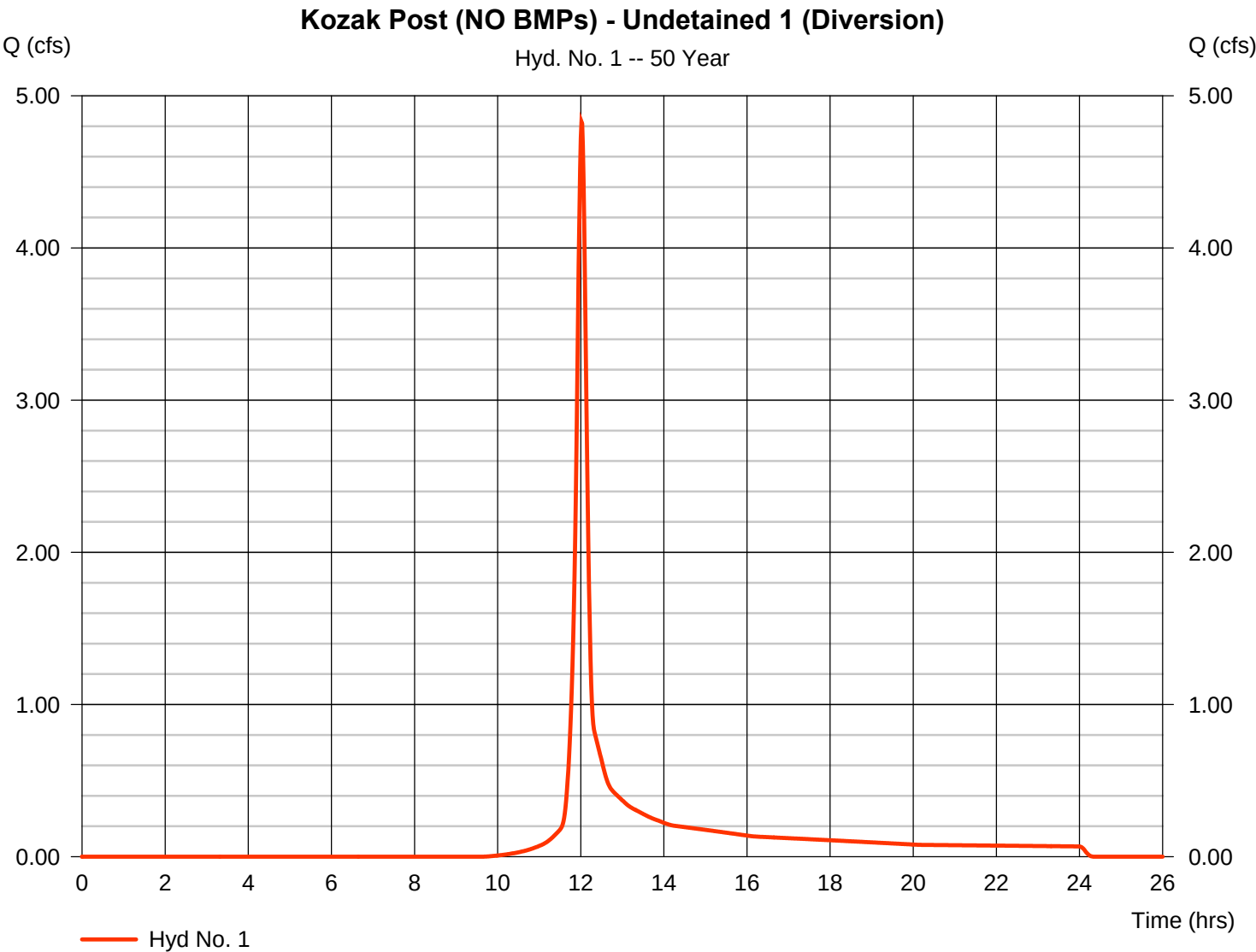
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.829 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	12,268 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

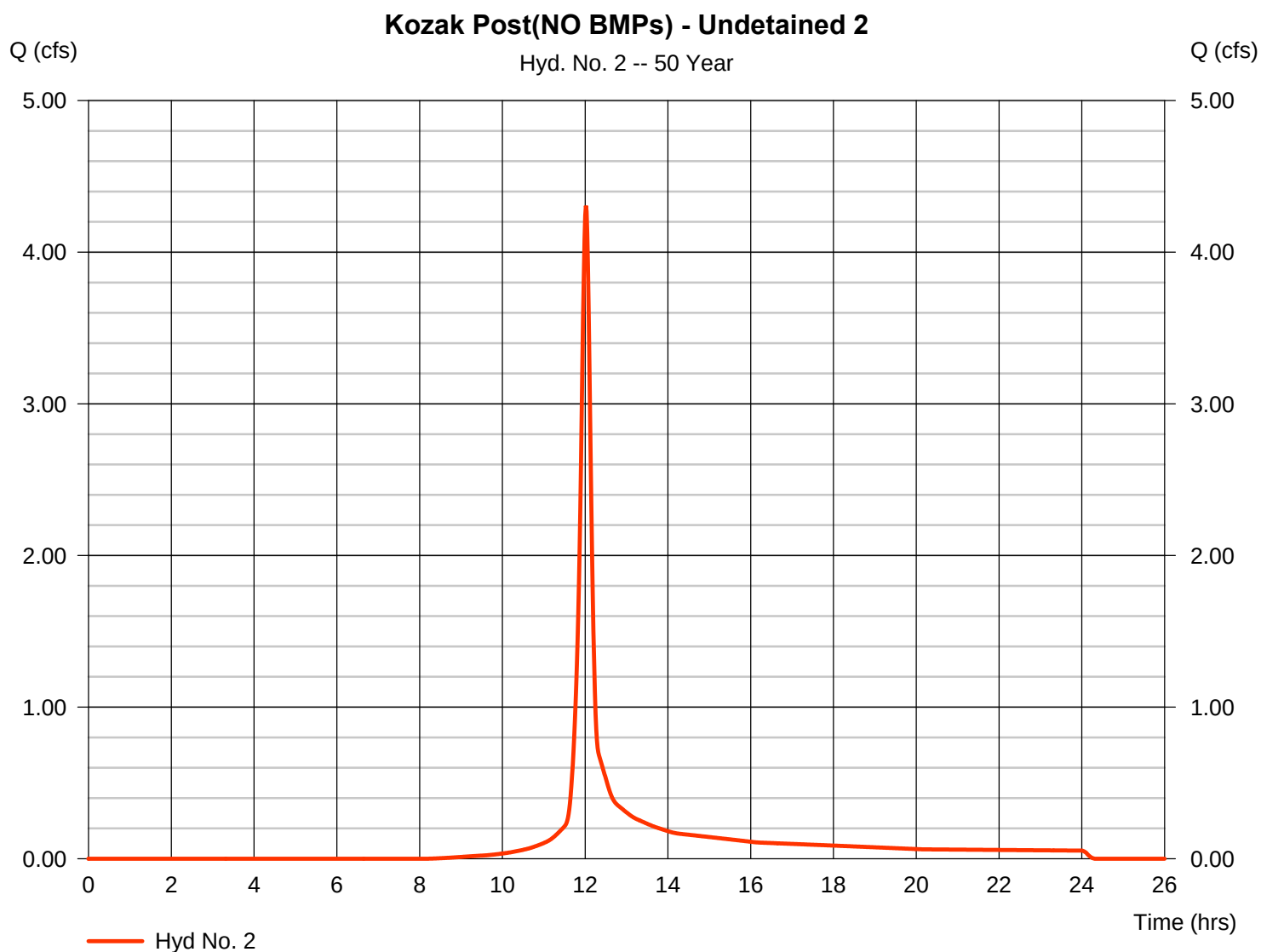
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.306 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	10,877 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

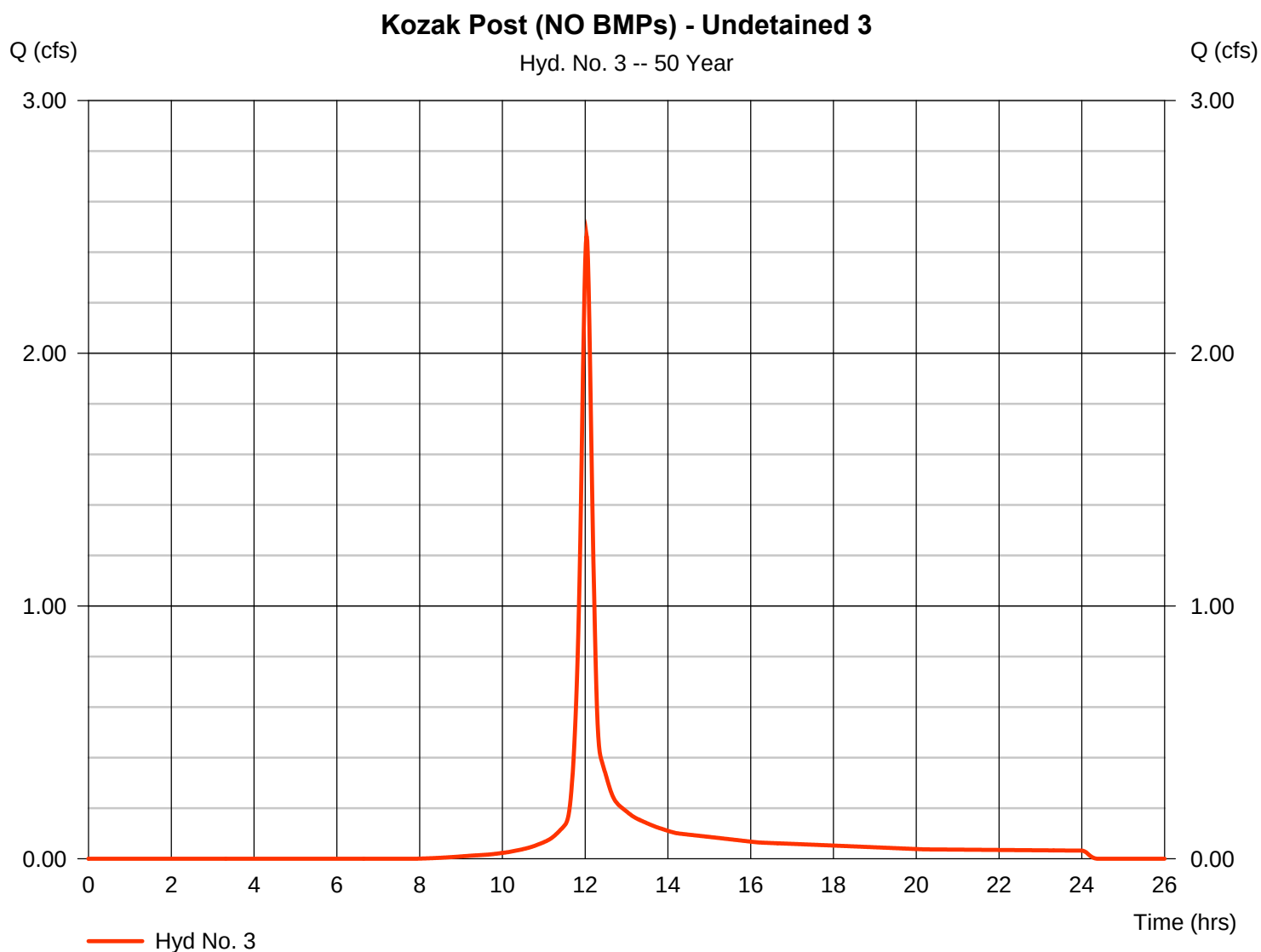
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.464 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.03 hrs
Time interval	=	1 min	Hyd. volume	=	6,626 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

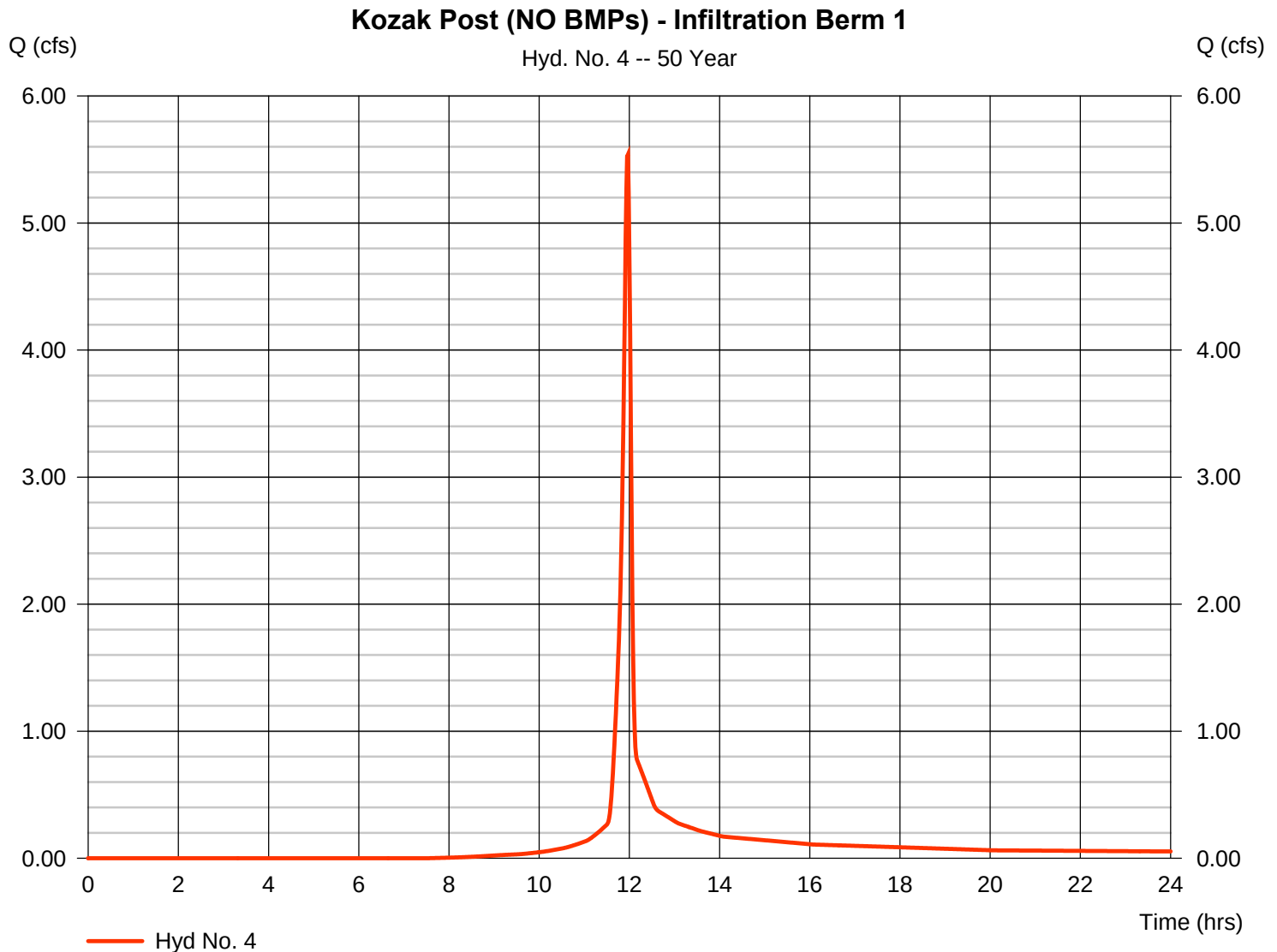
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.538 cfs
Storm frequency	=	50 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	11,288 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.20 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.240	
Flow length (ft)	= 8.0	65.0	37.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 25.00	6.20	23.00	
Travel Time (min)	= 0.76	+	0.60	+
			2.66	= 4.01
Shallow Concentrated Flow				
Flow length (ft)	= 522.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 2.18	+	0.00	+
			0.00	= 2.18
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				6.20 min

Hydrograph Report

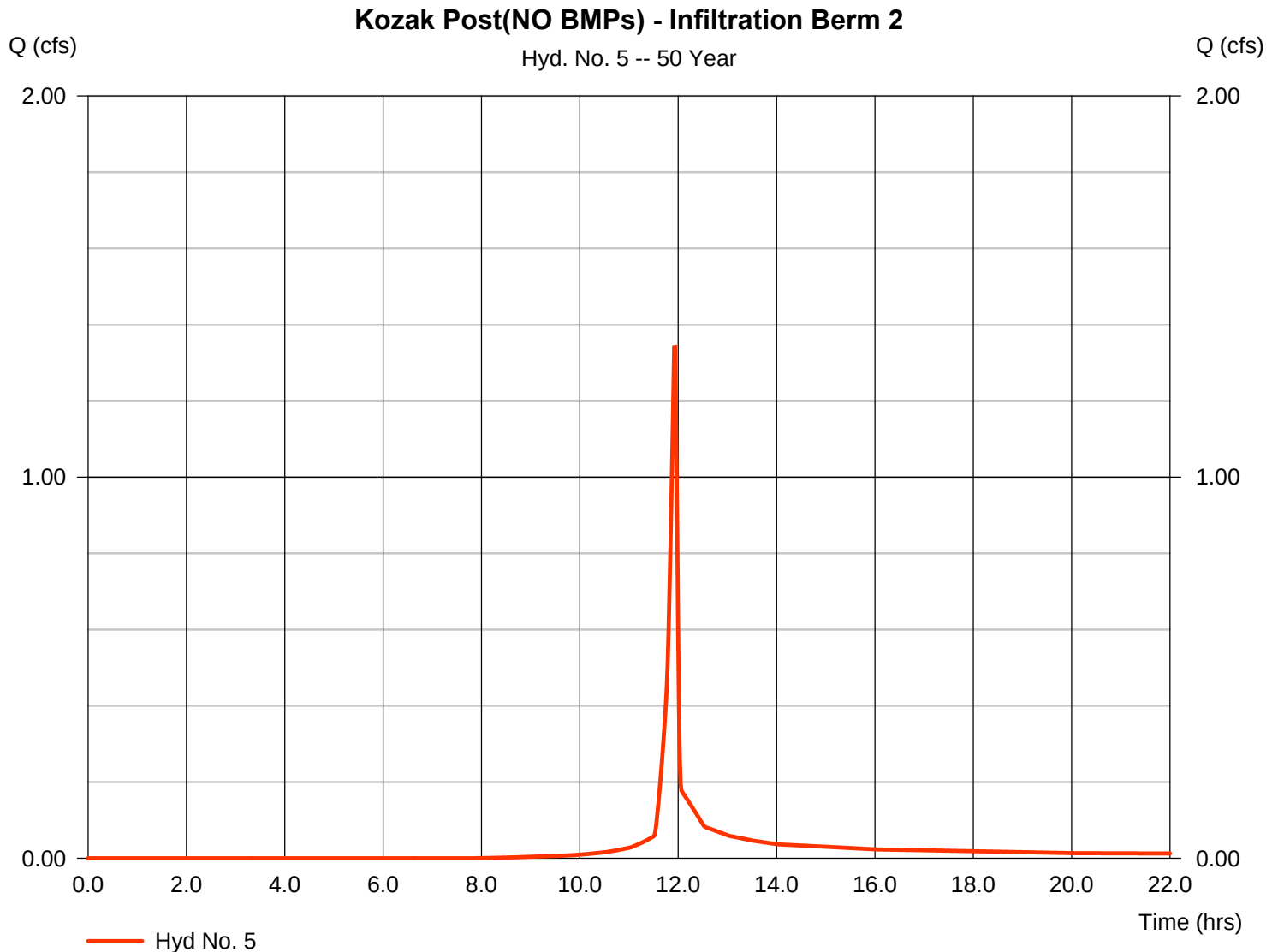
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 1.341 cfs
Storm frequency	= 50 yrs	Time to peak	= 11.93 hrs
Time interval	= 1 min	Hyd. volume	= 2,389 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.62 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.011	0.011				
Flow length (ft)	= 45.0	54.0	0.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00				
Land slope (%)	= 3.30	8.30	0.00				
Travel Time (min)	= 0.57	+	0.46	+	0.00	=	1.03
Shallow Concentrated Flow							
Flow length (ft)	= 40.00	35.00	63.00				
Watercourse slope (%)	= 7.50	11.40	8.00				
Surface description	= Unpaved	Unpaved	Unpaved				
Average velocity (ft/s)	=4.42	5.45	4.56				
Travel Time (min)	= 0.15	+	0.11	+	0.23	=	0.49
Channel Flow							
X sectional flow area (sqft)	= 2.00	0.00	0.00				
Wetted perimeter (ft)	= 4.68	0.00	0.00				
Channel slope (%)	= 11.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=18.64	0.00	0.00				
Flow length (ft)	({0})107.0	0.0	0.0				
Travel Time (min)	= 0.10	+	0.00	+	0.00	=	0.10
Total Travel Time, Tc					1.62 min		

Hydrograph Report

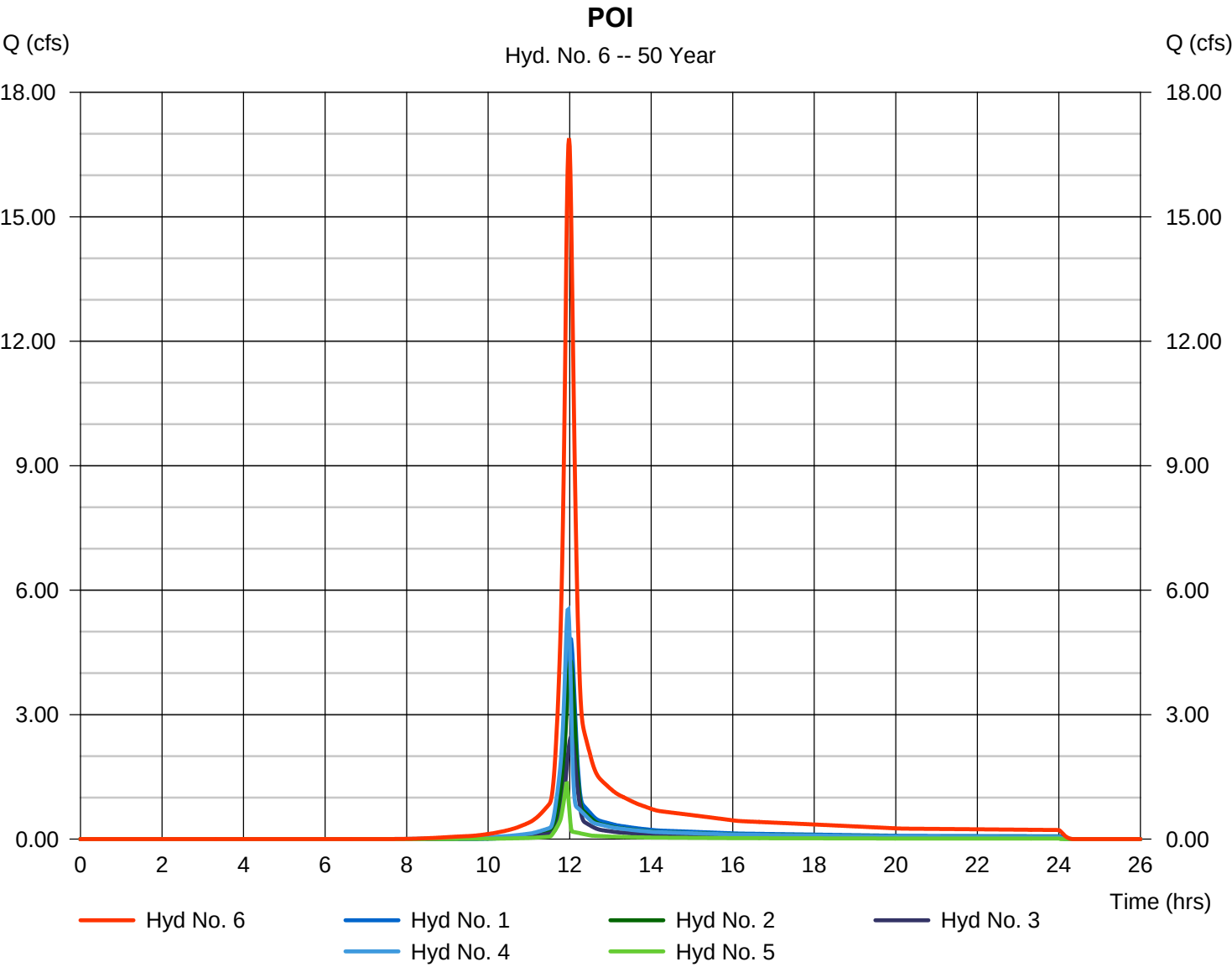
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Friday, 11 / 4 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 16.89 cfs
Storm frequency	= 50 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 43,448 cuft
Inflow hyds.	= 1, 2, 3, 4, 5	Contrib. drain. area	= 4.620 ac



Hydrograph Report

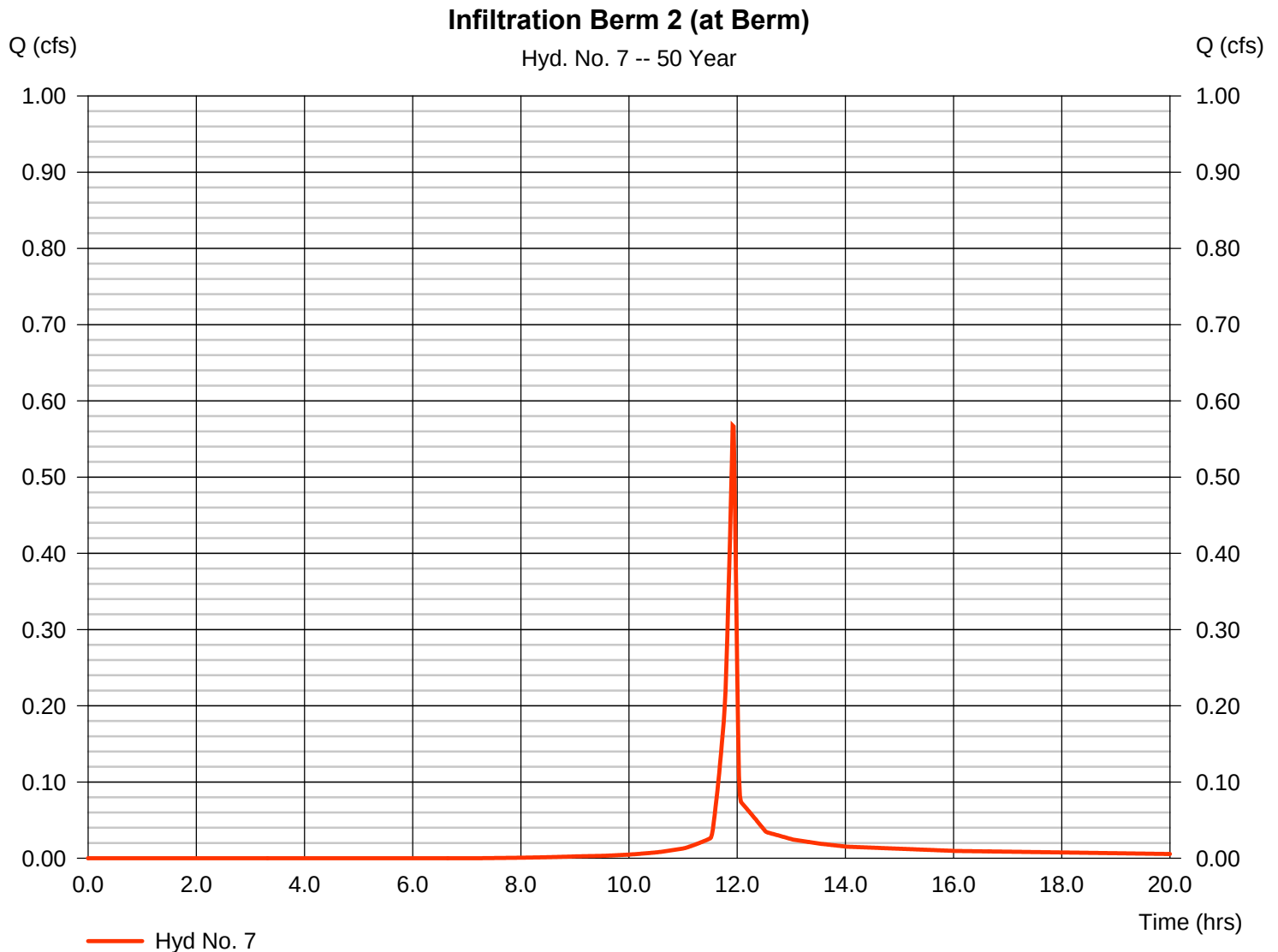
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Friday, 11 / 4 / 2016

Hyd. No. 7

Infiltration Berm 2 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.568 cfs
Storm frequency	= 50 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 1,018 cuft
Drainage area	= 0.100 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 1.60 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

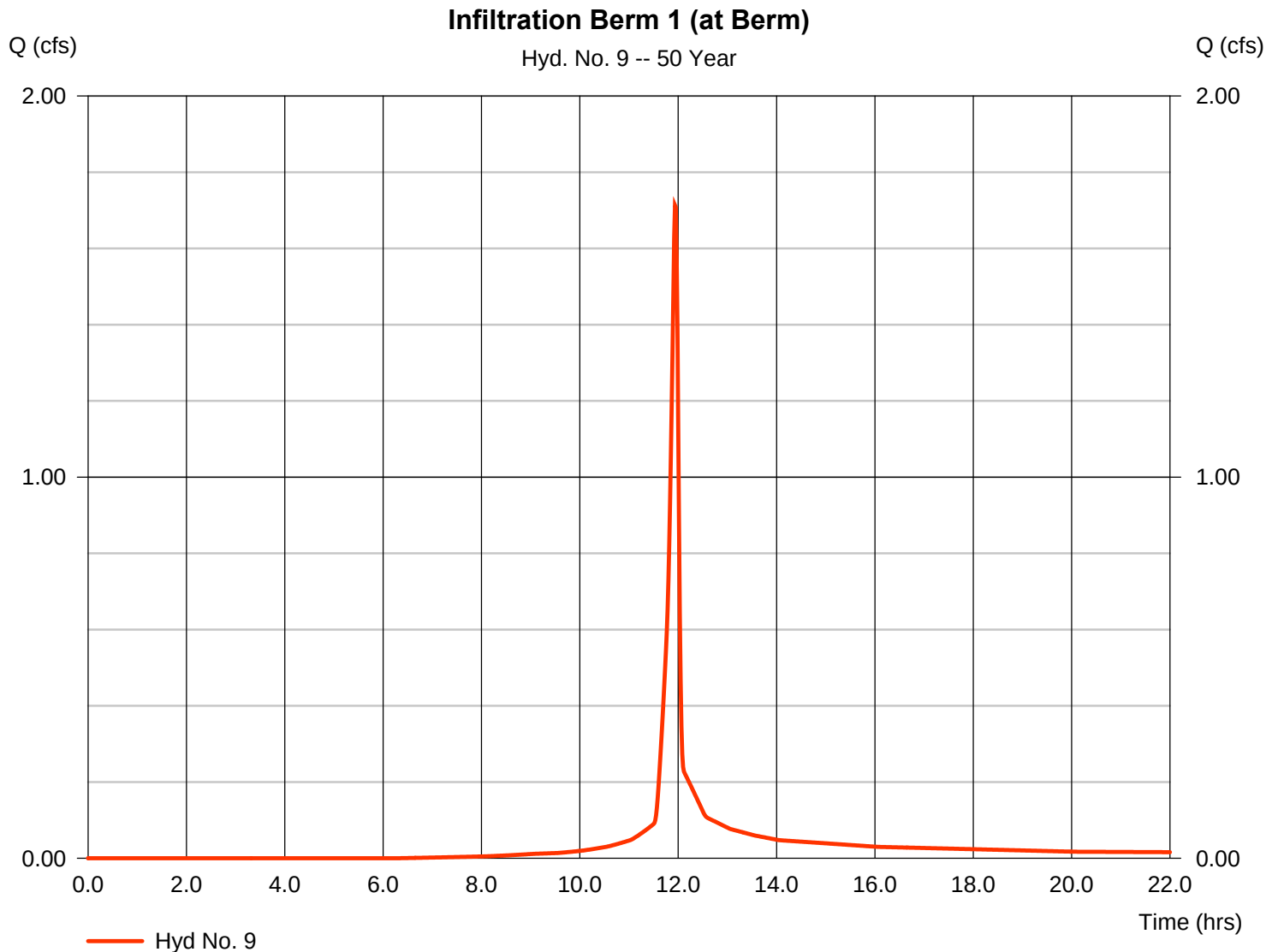
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Friday, 11 / 4 / 2016

Hyd. No. 9

Infiltration Berm 1 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.713 cfs
Storm frequency	= 50 yrs	Time to peak	= 11.93 hrs
Time interval	= 1 min	Hyd. volume	= 3,330 cuft
Drainage area	= 0.280 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.40 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

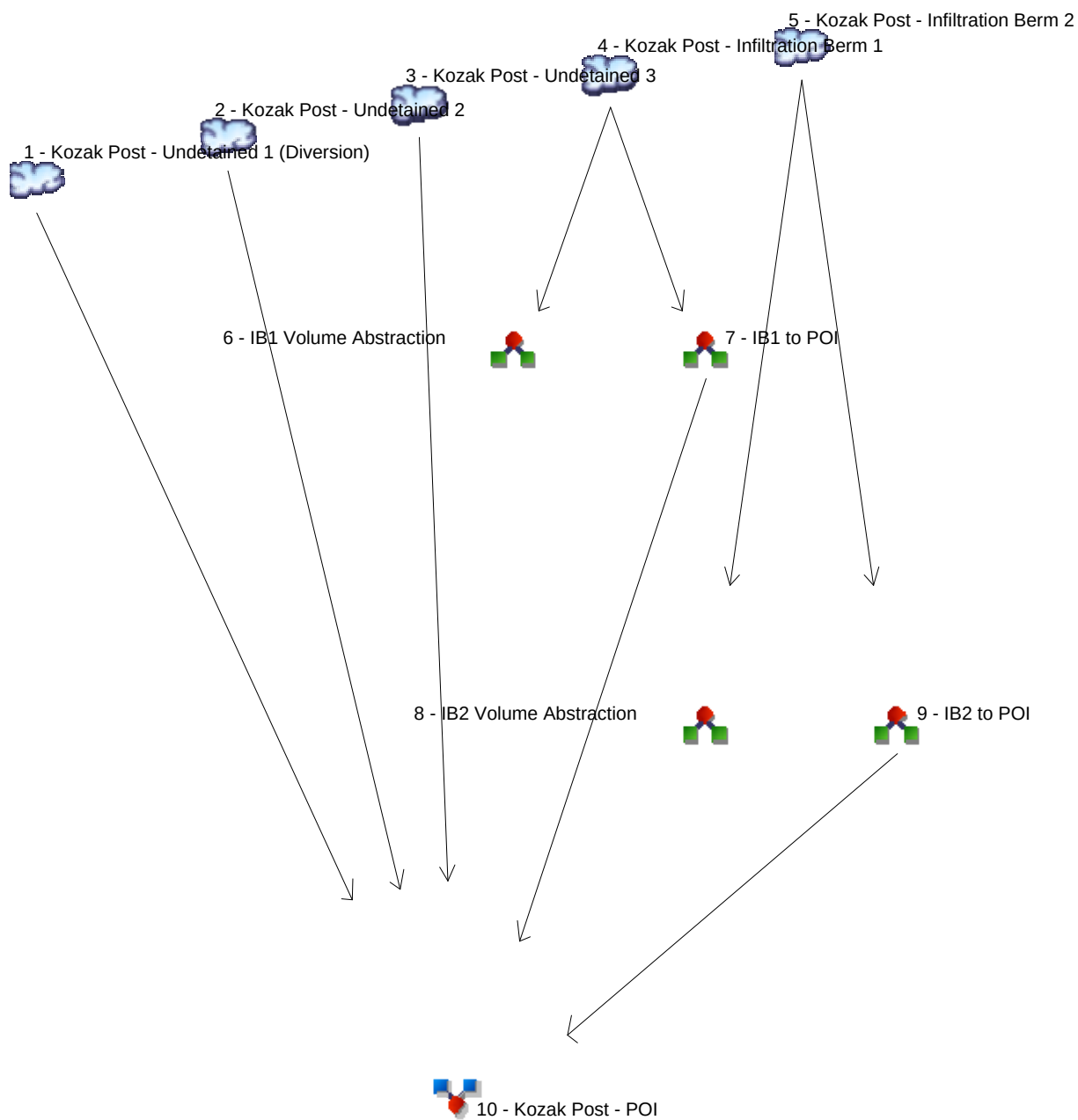
Hyd. No. 9

Infiltration Berm 1 (at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.011	0.240				
Flow length (ft)	= 8.0	65.0	27.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 25.00	6.20	23.00				
Travel Time (min)	= 0.76	+	0.60	+	2.07	=	3.42
Shallow Concentrated Flow							
Flow length (ft)	= 0.00	0.00	0.00				
Watercourse slope (%)	= 0.00	0.00	0.00				
Surface description	= Paved	Paved	Paved				
Average velocity (ft/s)	=0.00	0.00	0.00				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
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				3.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	4.829	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	4.306	-----	Kozak Post - Undetained 2
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.464	-----	Kozak Post - Undetained 3
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	4.069	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.783	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	4	-----	-----	-----	-----	-----	-----	0.942	-----	IB1 Volume Abstraction
7	Diversion2	4	-----	-----	-----	-----	-----	-----	4.069	-----	IB1 to POI
8	Diversion1	5	-----	-----	-----	-----	-----	-----	0.783	-----	IB2 Volume Abstraction
9	Diversion2	5	-----	-----	-----	-----	-----	-----	0.766	-----	IB2 to POI
10	Combine	1, 2, 3, 7, 9	-----	-----	-----	-----	-----	-----	15.62	-----	Kozak Post - POI
Proj. file: Kozak Post wBMPs 50yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.829	1	721	12,268	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	4.306	1	721	10,877	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	2.464	1	722	6,626	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	4.069	1	722	10,946	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	0.783	1	726	2,573	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	0.942	1	706	1,136	4	-----	-----	IB1 Volume Abstraction
7	Diversion2	4.069	1	722	9,810	4	-----	-----	IB1 to POI
8	Diversion1	0.783	1	726	833	5	-----	-----	IB2 Volume Abstraction
9	Diversion2	0.766	1	728	1,740	5	-----	-----	IB2 to POI
10	Combine	15.62	1	722	41,321	1, 2, 3, 7, 9	-----	-----	Kozak Post - POI
Kozak Post wBMPs 50yr.gpw					Return Period: 50 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

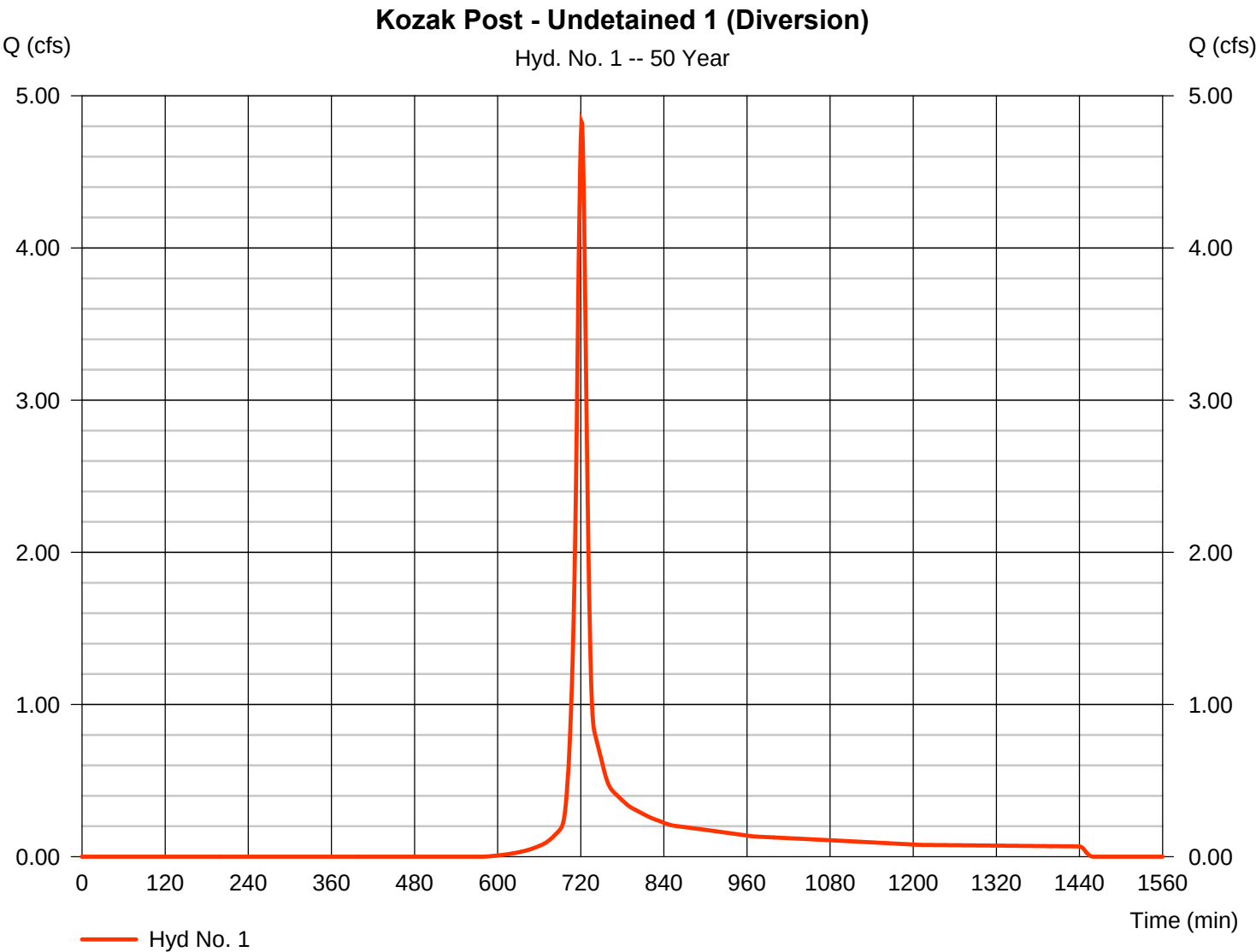
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Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.829 cfs
Storm frequency	=	50 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	12,268 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

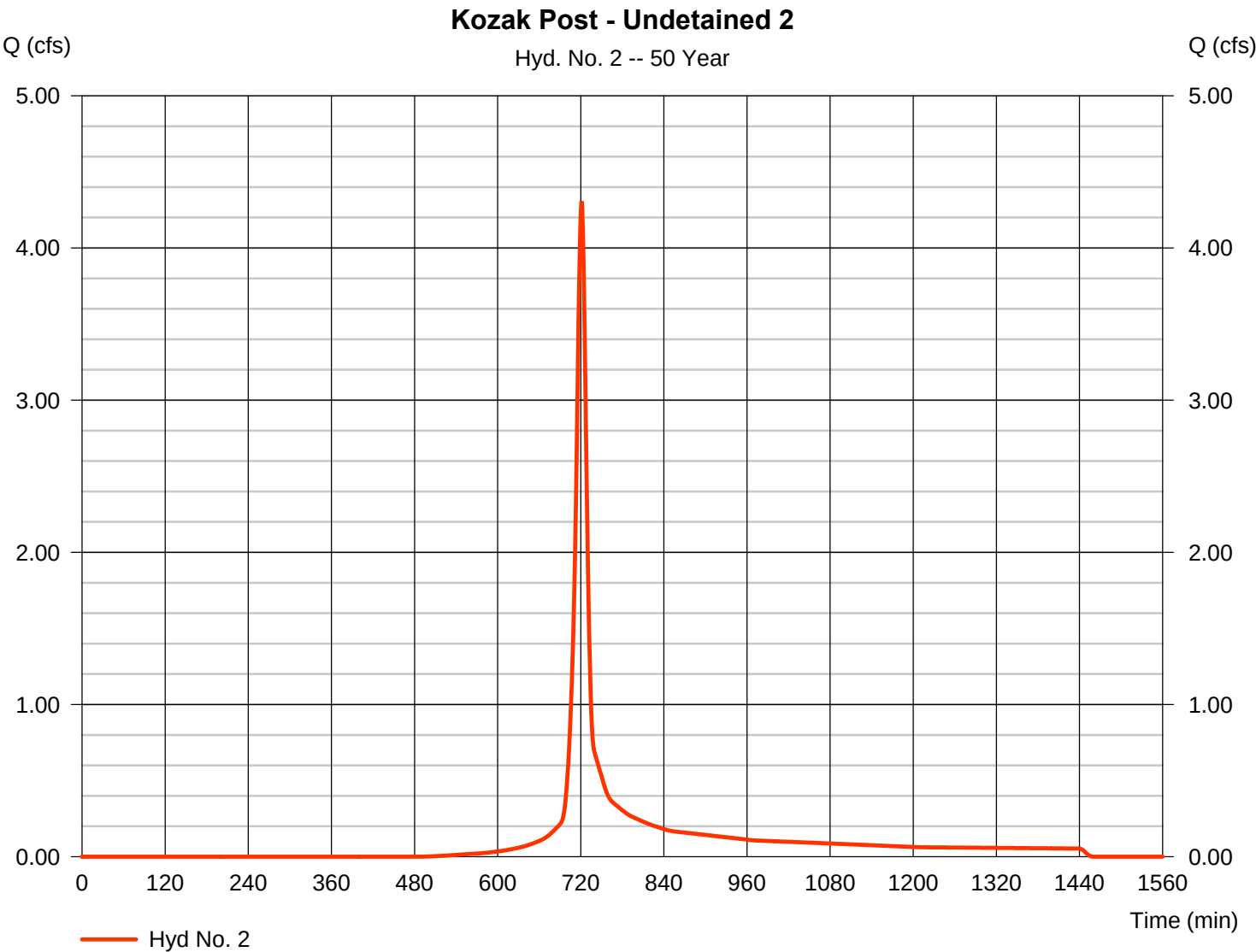
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Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.306 cfs
Storm frequency	=	50 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	10,877 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

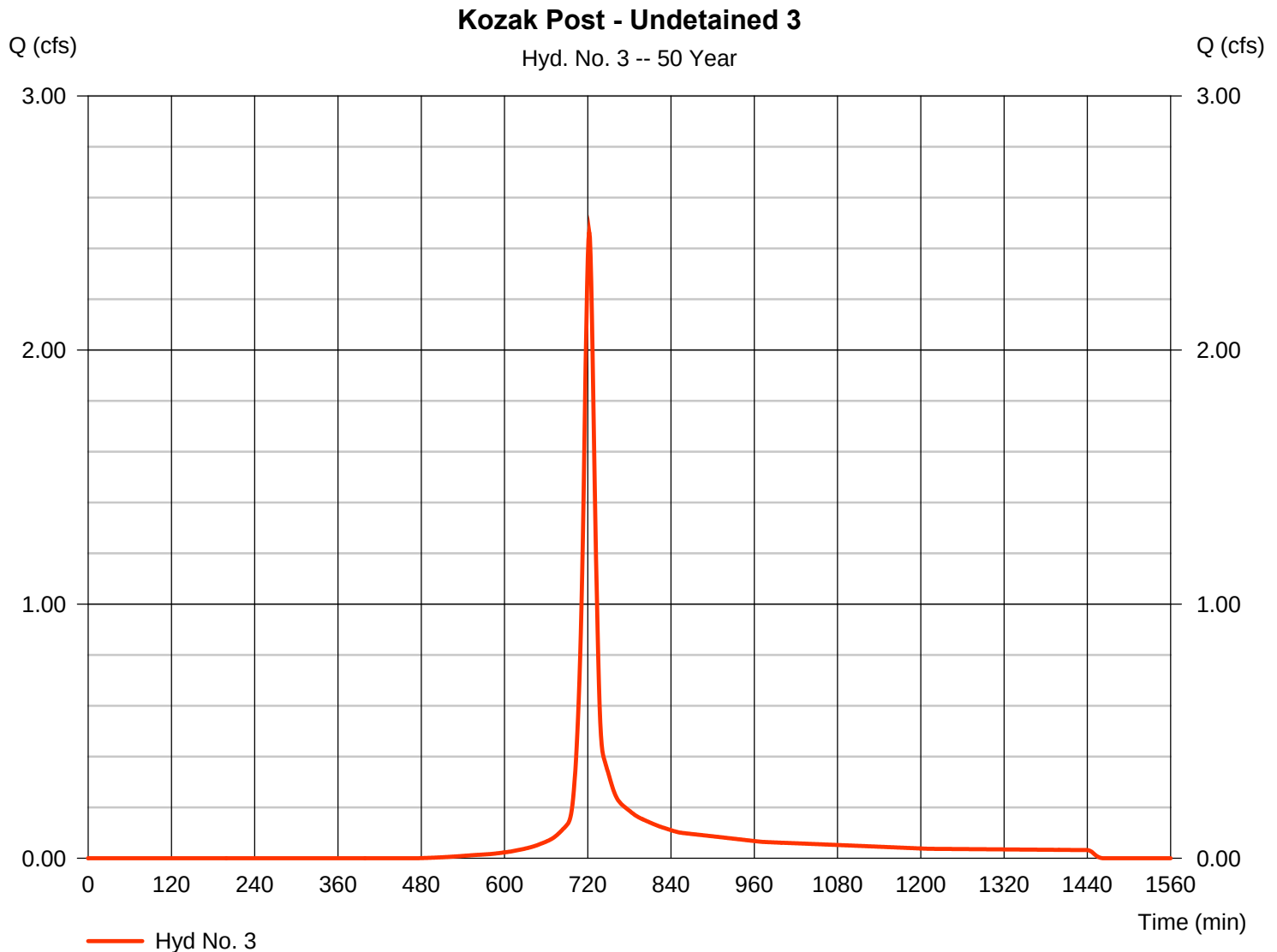
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Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.464 cfs
Storm frequency	=	50 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	6,626 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	5.22 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

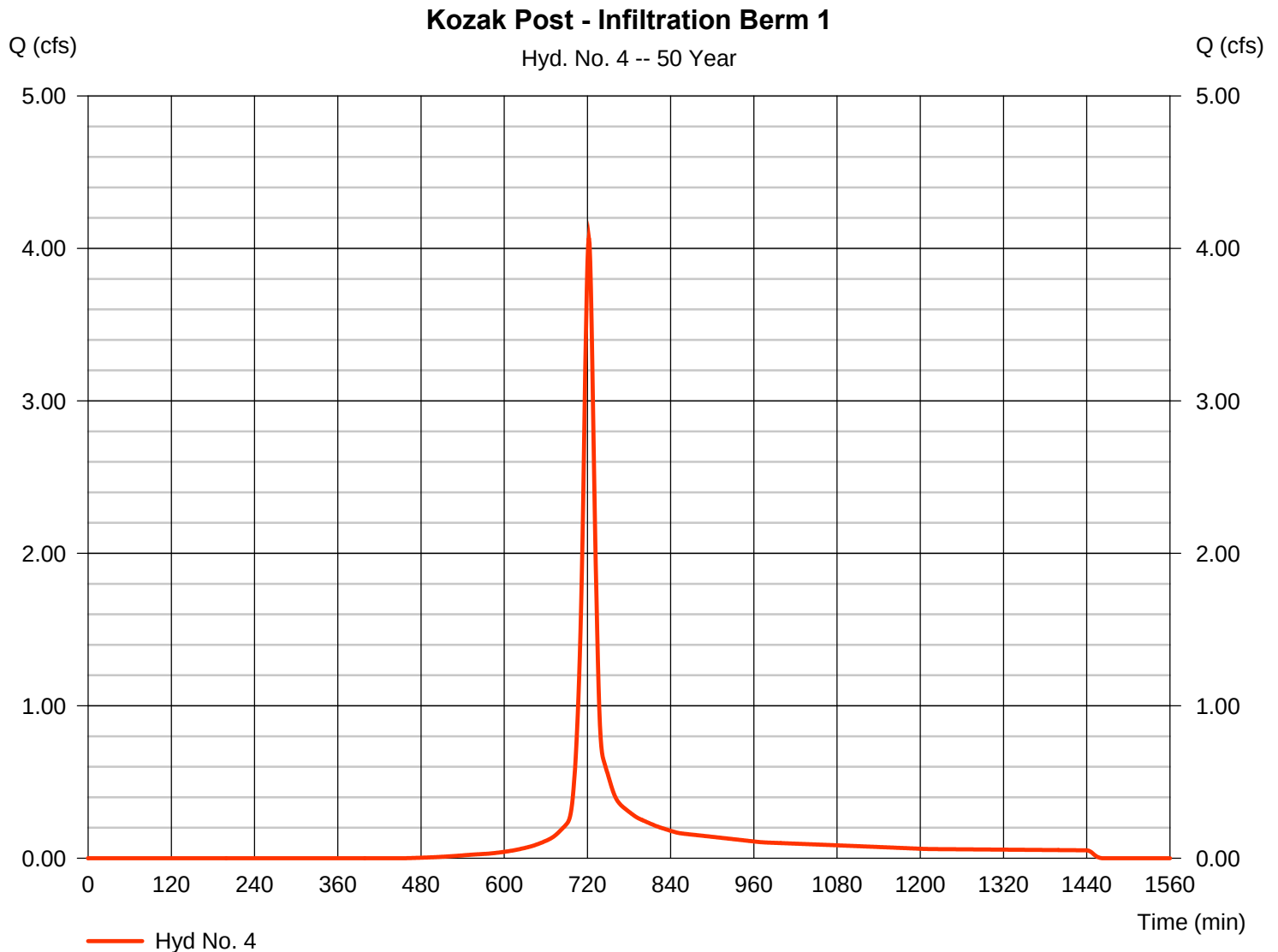
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Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post - Infiltration Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.069 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 10,946 cuft
Drainage area	= 1.040 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 14.90 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

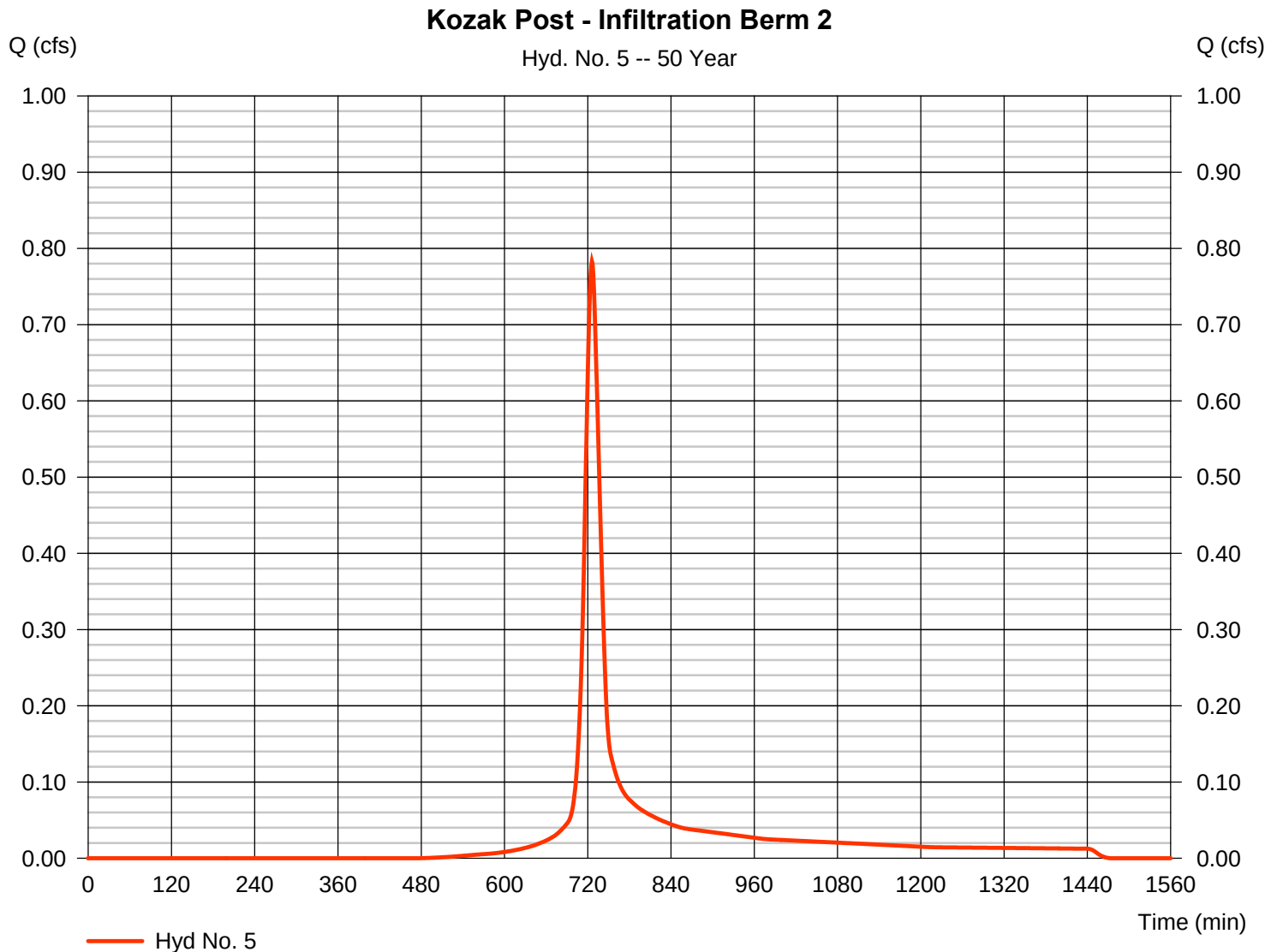
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Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.783 cfs
Storm frequency	= 50 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 2,573 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.40 min
Total precip.	= 5.22 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

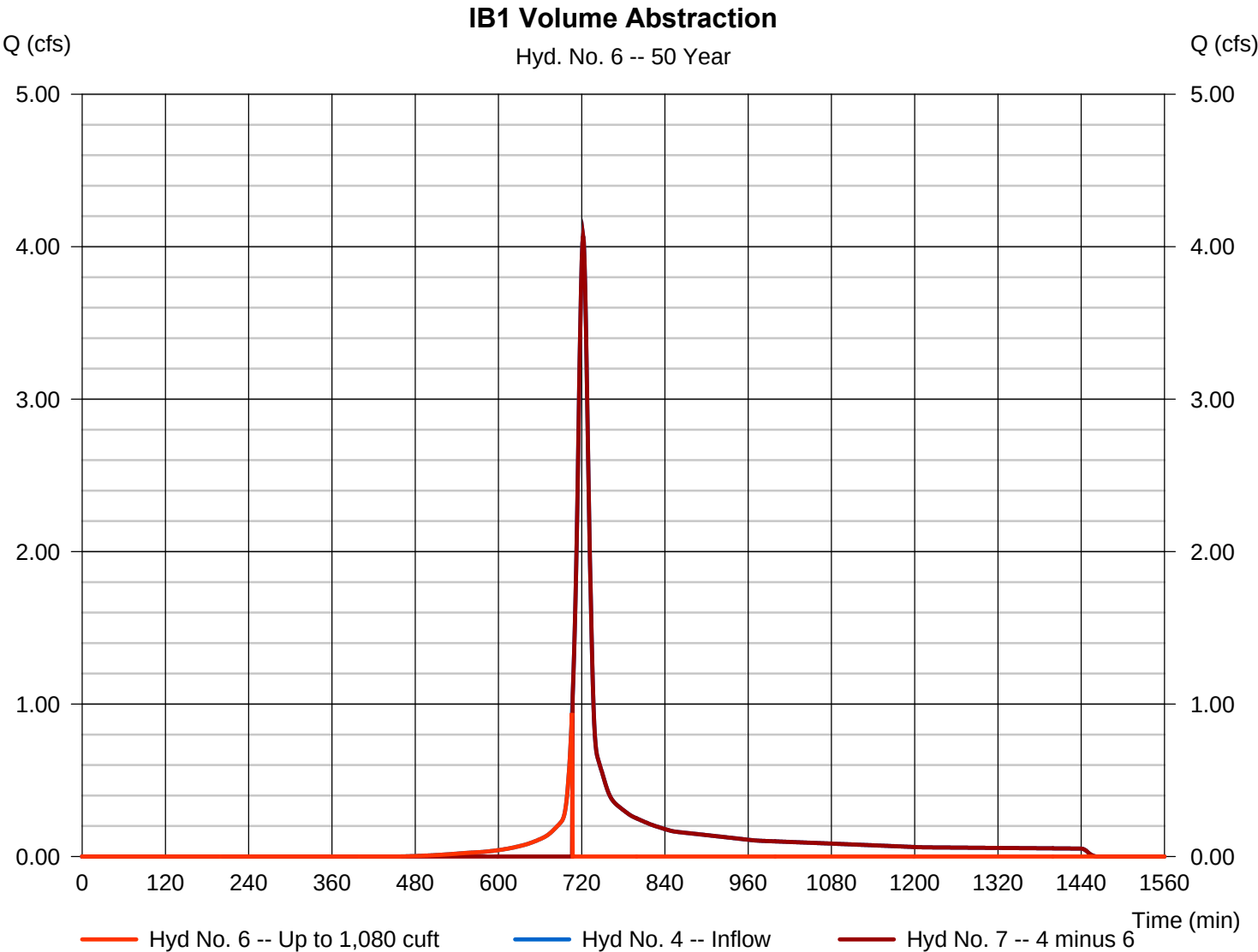
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Friday, 11 / 4 / 2016

Hyd. No. 6

IB1 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.942 cfs
Storm frequency	=	50 yrs	Time to peak	=	706 min
Time interval	=	1 min	Hyd. volume	=	1,136 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	7
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

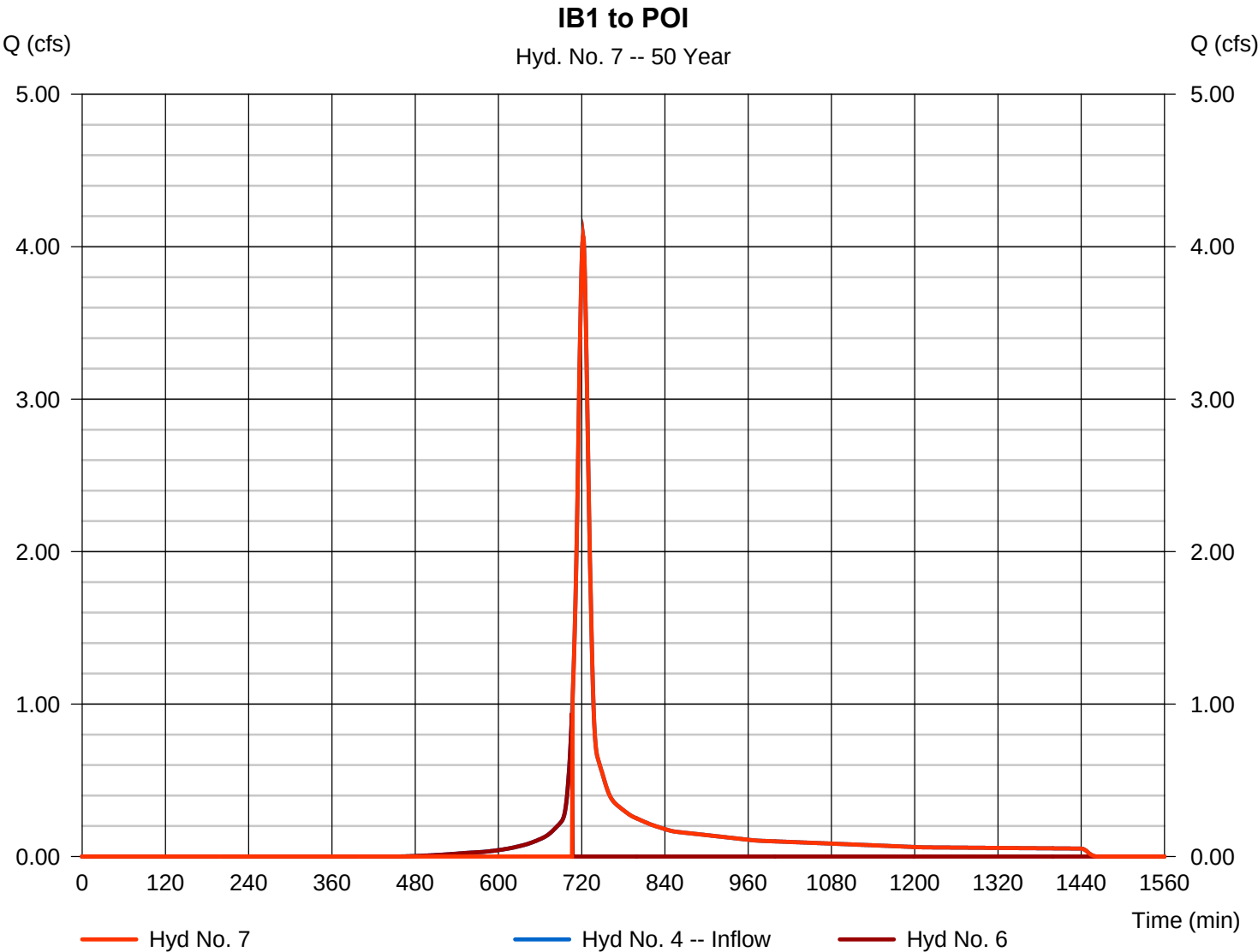
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Friday, 11 / 4 / 2016

Hyd. No. 7

IB1 to POI

Hydrograph type	= Diversion2	Peak discharge	= 4.069 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 9,810 cuft
Inflow hydrograph	= 4 - Kozak Post - Infiltration Berms and diverted hyd.		= 6
Diversion method	= First Flush Volume	Volume Up To	= 1,080 cuft



Hydrograph Report

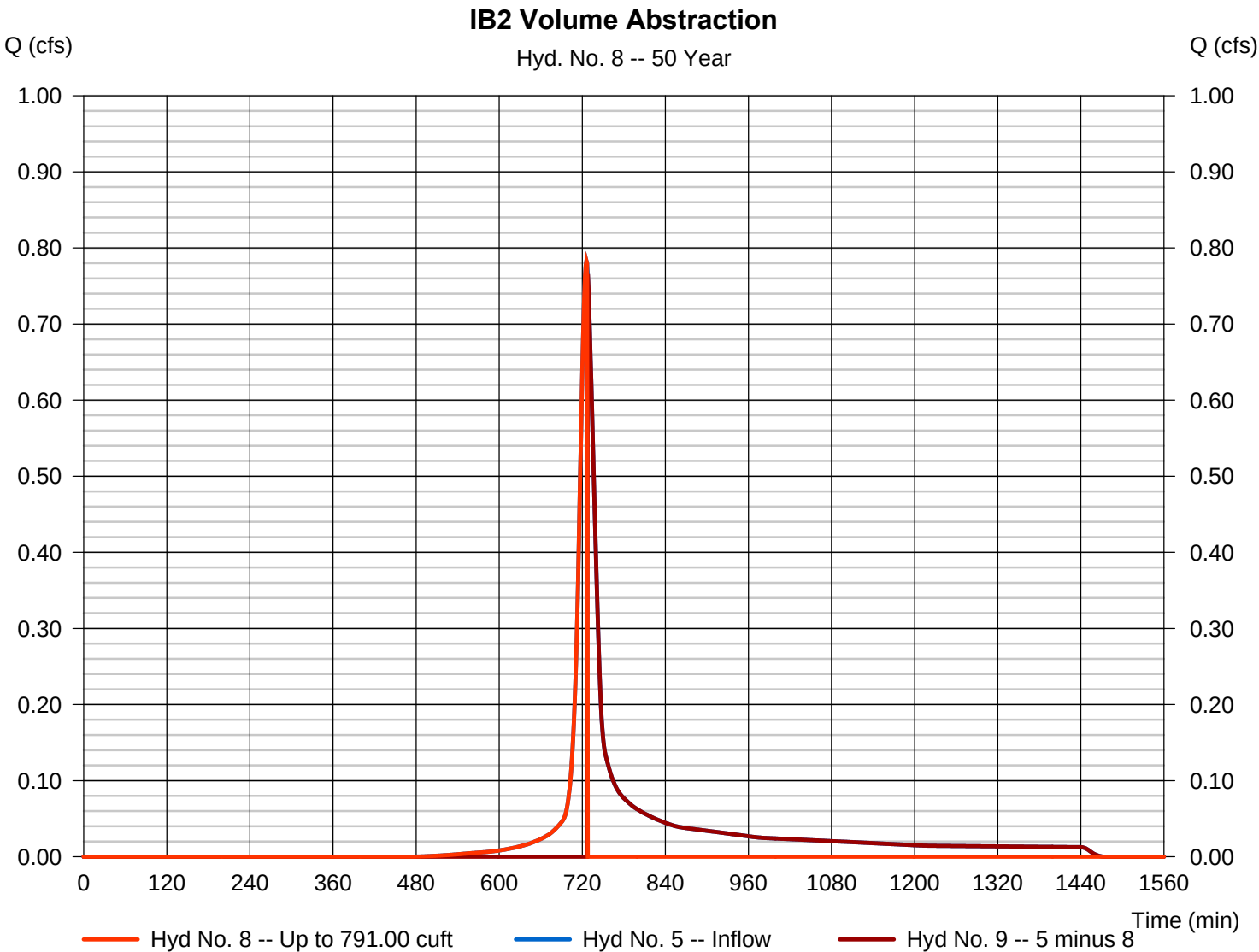
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 8

IB2 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.783 cfs
Storm frequency	=	50 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	833 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms	and diverted hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	791.00 cuft



Hydrograph Report

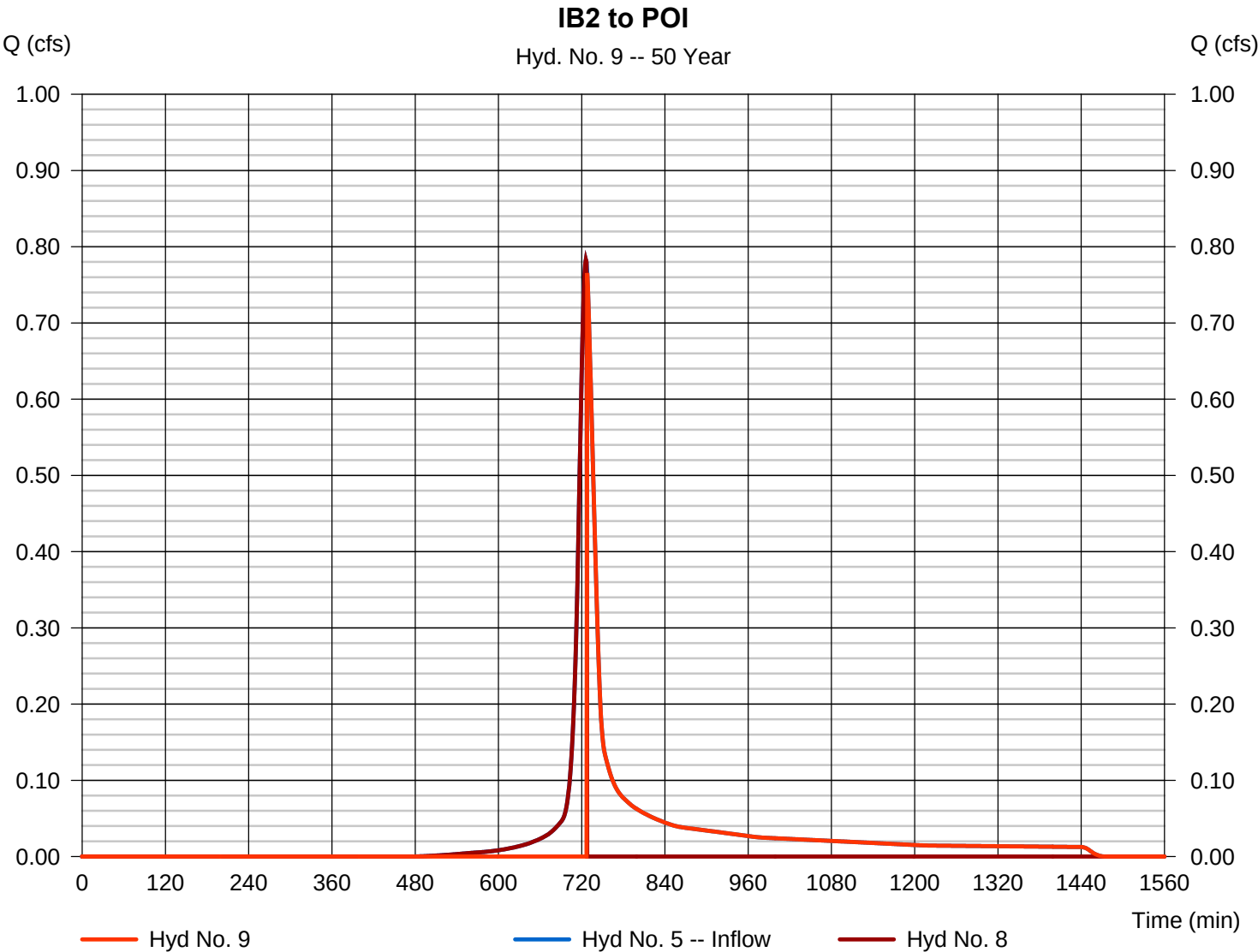
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 9

IB2 to POI

Hydrograph type	= Diversion2	Peak discharge	= 0.766 cfs
Storm frequency	= 50 yrs	Time to peak	= 728 min
Time interval	= 1 min	Hyd. volume	= 1,740 cuft
Inflow hydrograph	= 5 - Kozak Post - Infiltration Berms and diverted hyd.		= 8
Diversion method	= First Flush Volume	Volume Up To	= 791.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

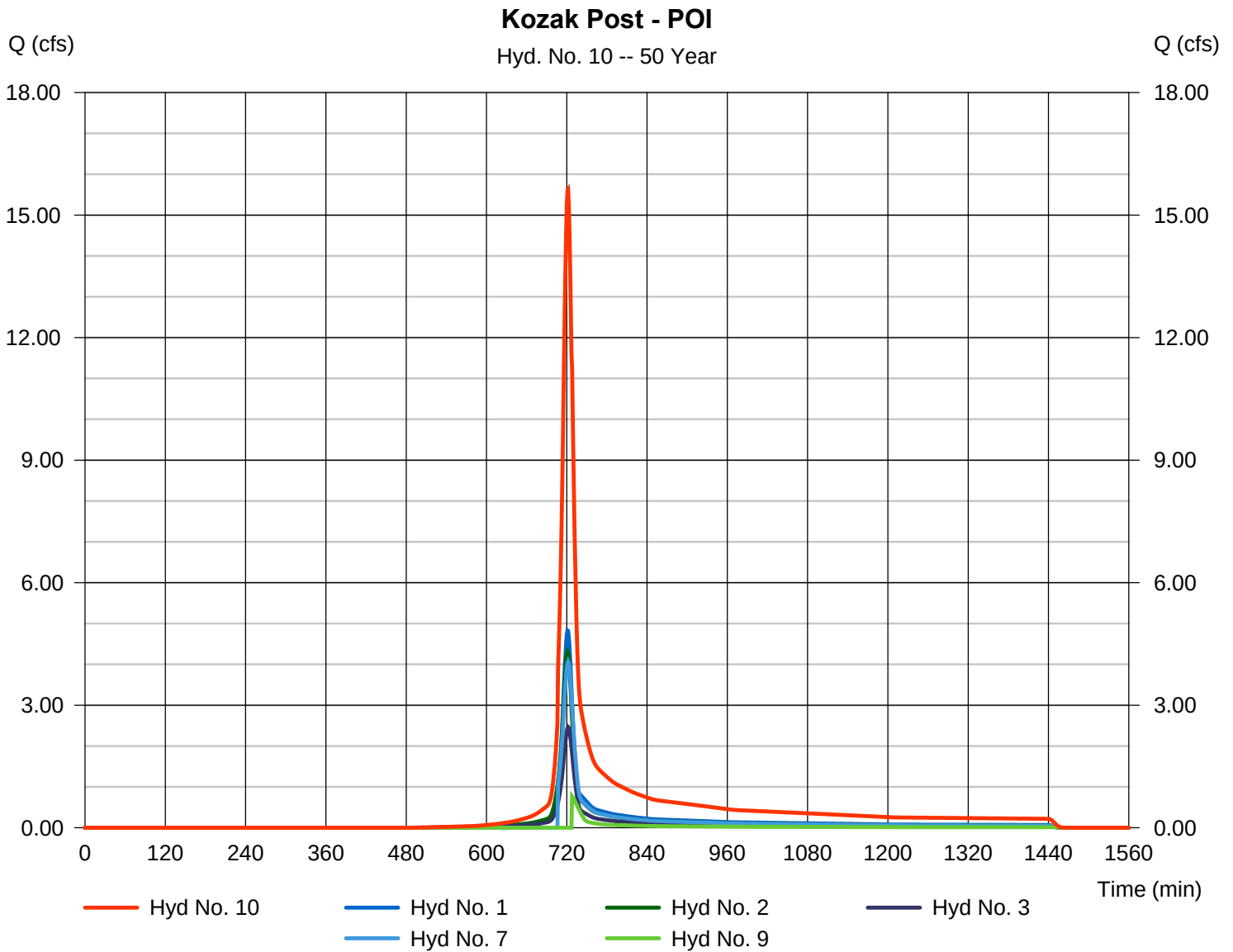
Friday, 11 / 4 / 2016

Hyd. No. 10

Kozak Post - POI

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 3, 7, 9

Peak discharge = 15.62 cfs
 Time to peak = 722 min
 Hyd. volume = 41,321 cuft
 Contrib. drain. area = 3.330 ac



ATTACHMENT C-4
KOZAK RD
100 Year-24 Hour Storm

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

1 - Kozak - Pre



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	4.055	-----	-----	9.055	-----	15.87	19.44	Kozak - Pre
Proj. file: Kozak Pre.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	19.44	1	722	52,258	-----	-----	-----	Kozak - Pre
Kozak Pre.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

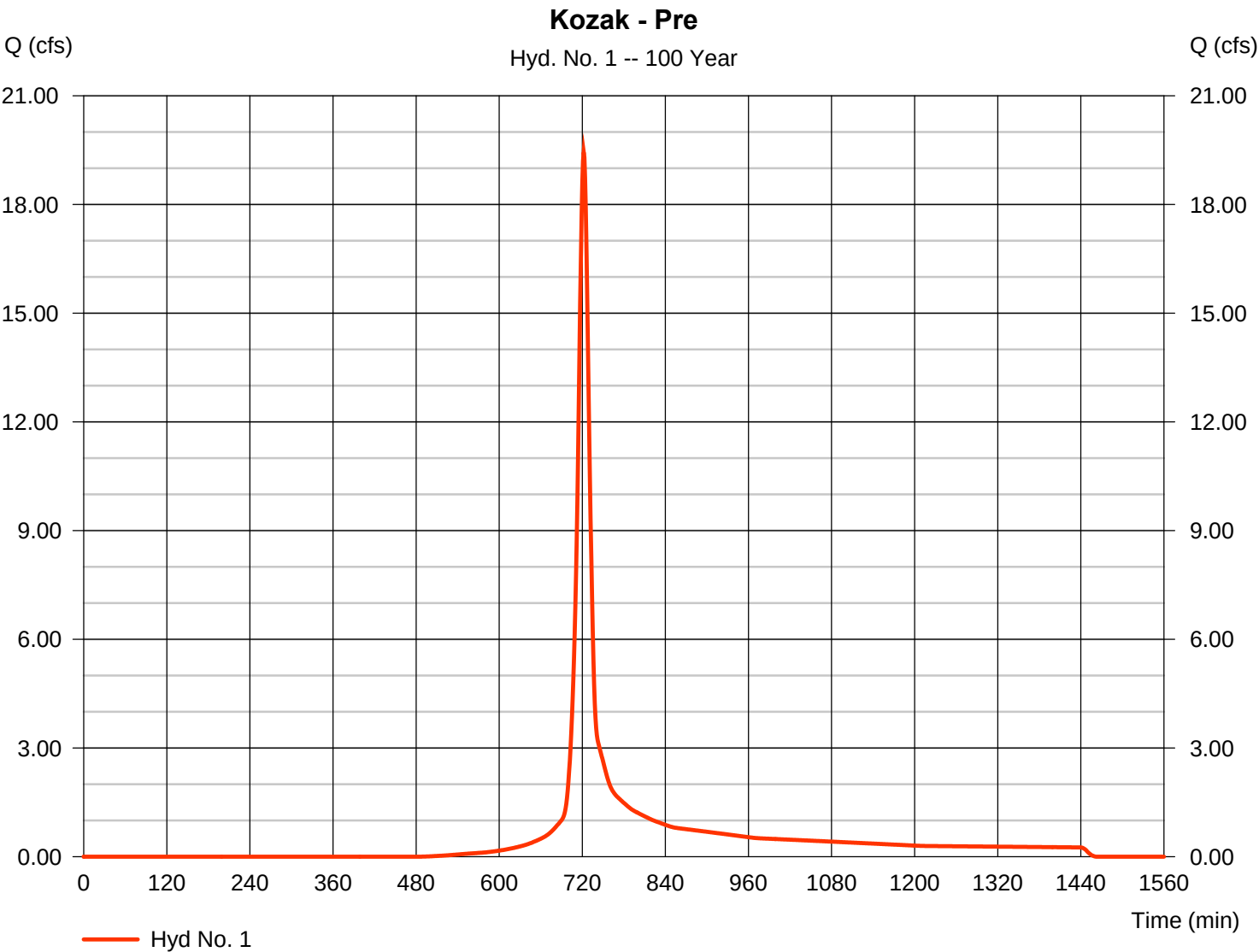
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak - Pre

Hydrograph type	=	SCS Runoff	Peak discharge	=	19.44 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	52,258 cuft
Drainage area	=	4.630 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	14.64 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

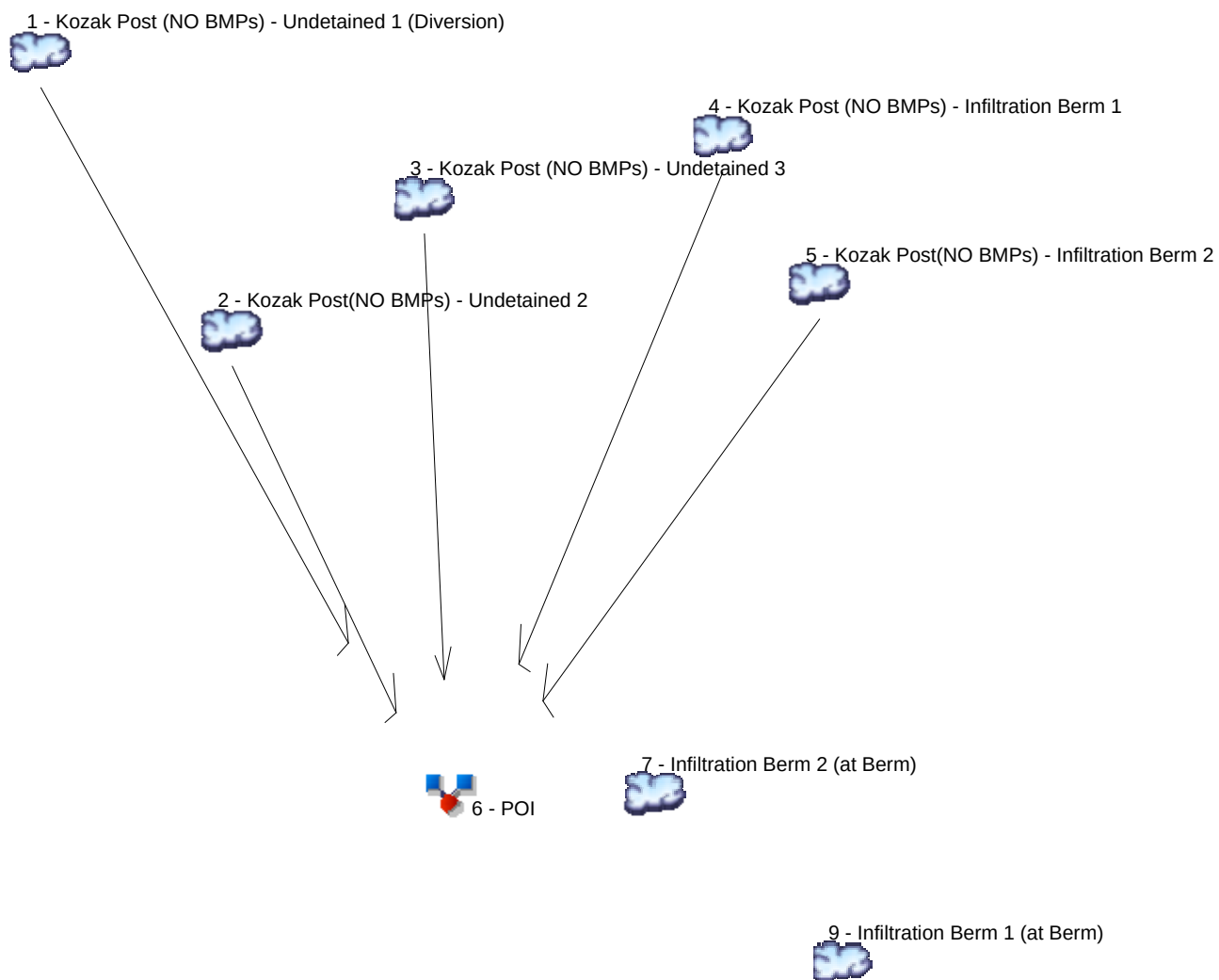
Hyd. No. 1

Kozak - Pre

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 10.0	90.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 10.00	13.30	0.00	
Travel Time (min)	= 1.30	+	10.15	+
			0.00	= 11.45
Shallow Concentrated Flow				
Flow length (ft)	= 805.00	0.00	0.00	
Watercourse slope (%)	= 6.80	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.21	0.00	0.00	
Travel Time (min)	= 3.19	+	0.00	+
			0.00	= 3.19
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				14.64 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	1.016	-----	-----	2.600	-----	4.829	6.026	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	-----	-----	1.205	-----	-----	2.535	-----	4.306	5.223	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	-----	-----	0.711	-----	-----	1.467	-----	2.464	2.979	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	-----	-----	1.721	-----	-----	3.392	-----	5.538	6.632	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	-----	-----	0.411	-----	-----	0.818	-----	1.341	1.613	Kozak Post(NO BMPs) - Infiltration B
6	Combine	1, 2, 3, 4, 5	-----	4.472	-----	-----	9.782	-----	16.89	20.60	POI
7	SCS Runoff	-----	-----	0.185	-----	-----	0.353	-----	0.568	0.678	Infiltration Berm 2 (at Berm)
9	SCS Runoff	-----	-----	0.605	-----	-----	1.098	-----	1.713	2.024	Infiltration Berm 1 (at Berm)
Proj. file: Kozak Post.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	6.026	1	721	15,240	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
2	SCS Runoff	5.223	1	721	13,217	-----	-----	-----	Kozak Post(NO BMPs) - Undetained
3	SCS Runoff	2.979	1	722	8,024	-----	-----	-----	Kozak Post (NO BMPs) - Undetained
4	SCS Runoff	6.632	1	718	13,624	-----	-----	-----	Kozak Post (NO BMPs) - Infiltration B
5	SCS Runoff	1.613	1	715	2,893	-----	-----	-----	Kozak Post(NO BMPs) - Infiltration B
6	Combine	20.60	1	719	52,998	1, 2, 3, 4, 5	-----	-----	POI
7	SCS Runoff	0.678	1	715	1,225	-----	-----	-----	Infiltration Berm 2 (at Berm)
9	SCS Runoff	2.024	1	716	3,968	-----	-----	-----	Infiltration Berm 1 (at Berm)
Kozak Post.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

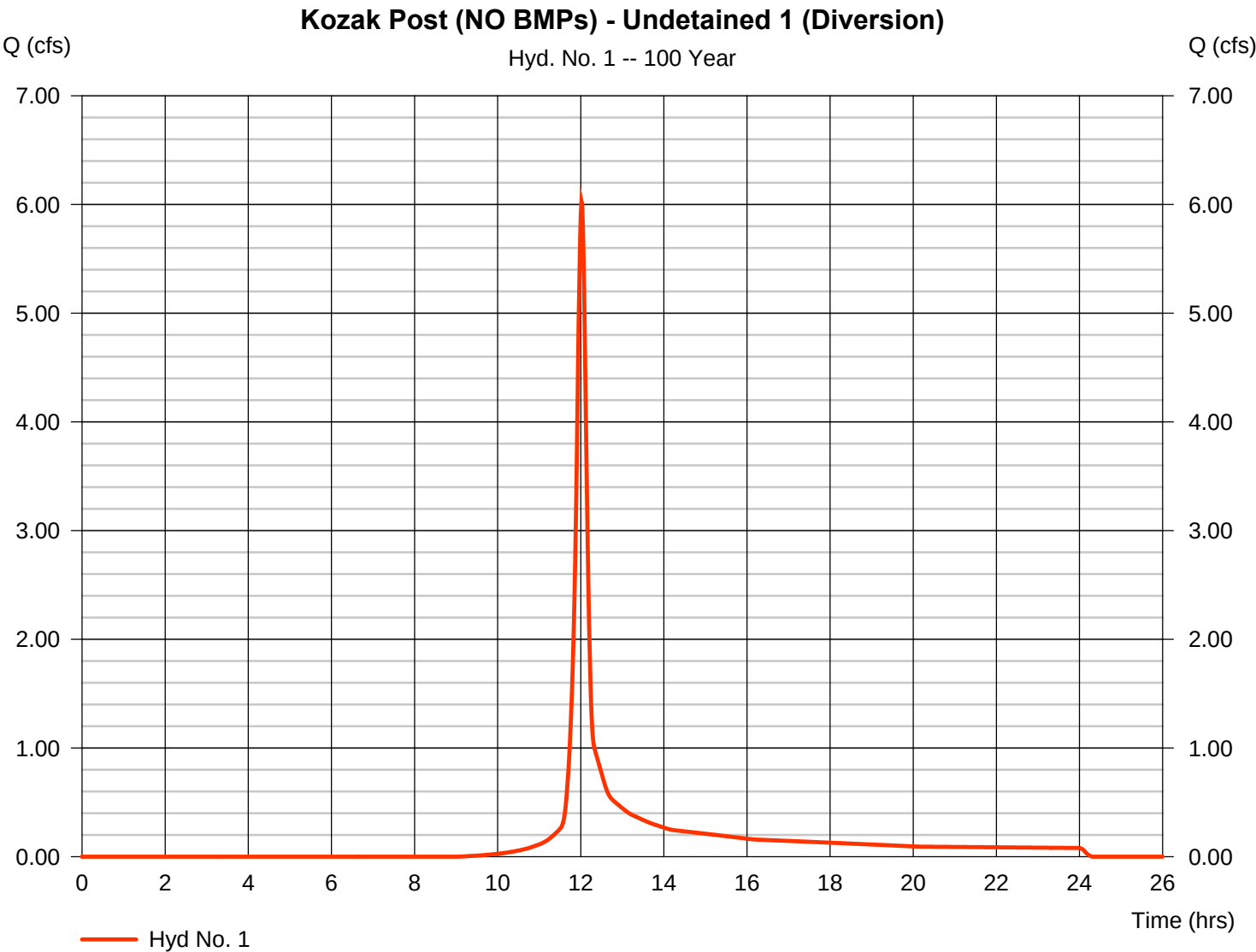
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.026 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	15,240 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 1

Kozak Post (NO BMPs) - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.011	
Flow length (ft)	= 16.0	84.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 12.50	12.00	0.00	
Travel Time (min)	= 1.74	+	10.00	+
			0.00	= 11.74
Shallow Concentrated Flow				
Flow length (ft)	= 194.00	0.00	0.00	
Watercourse slope (%)	= 6.70	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=4.18	0.00	0.00	
Travel Time (min)	= 0.77	+	0.00	+
			0.00	= 0.77
Channel Flow				
X sectional flow area (sqft)	= 7.50	0.00	0.00	
Wetted perimeter (ft)	= 8.71	0.00	0.00	
Channel slope (%)	= 6.00	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=11.01	0.00	0.00	
Flow length (ft)	(0)274.0	0.0	0.0	
Travel Time (min)	= 0.41	+	0.00	+
			0.00	= 0.41
Total Travel Time, Tc				12.90 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

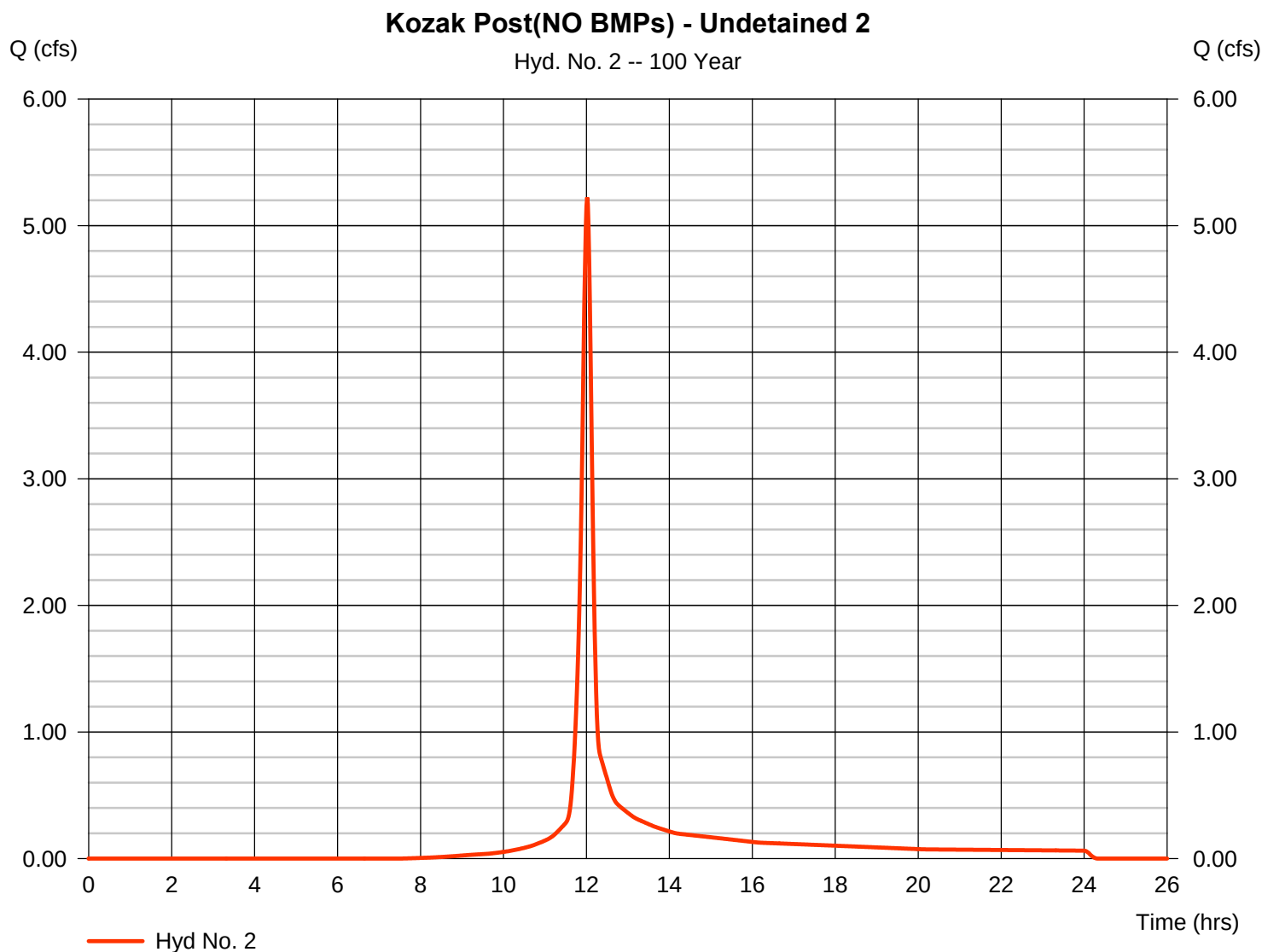
Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 1 min
 Drainage area = 1.120 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 5.91 in
 Storm duration = 24 hrs

Peak discharge = 5.223 cfs
 Time to peak = 12.02 hrs
 Hyd. volume = 13,217 cuft
 Curve number = 76
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 12.50 min
 Distribution = Type II
 Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post(NO BMPs) - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

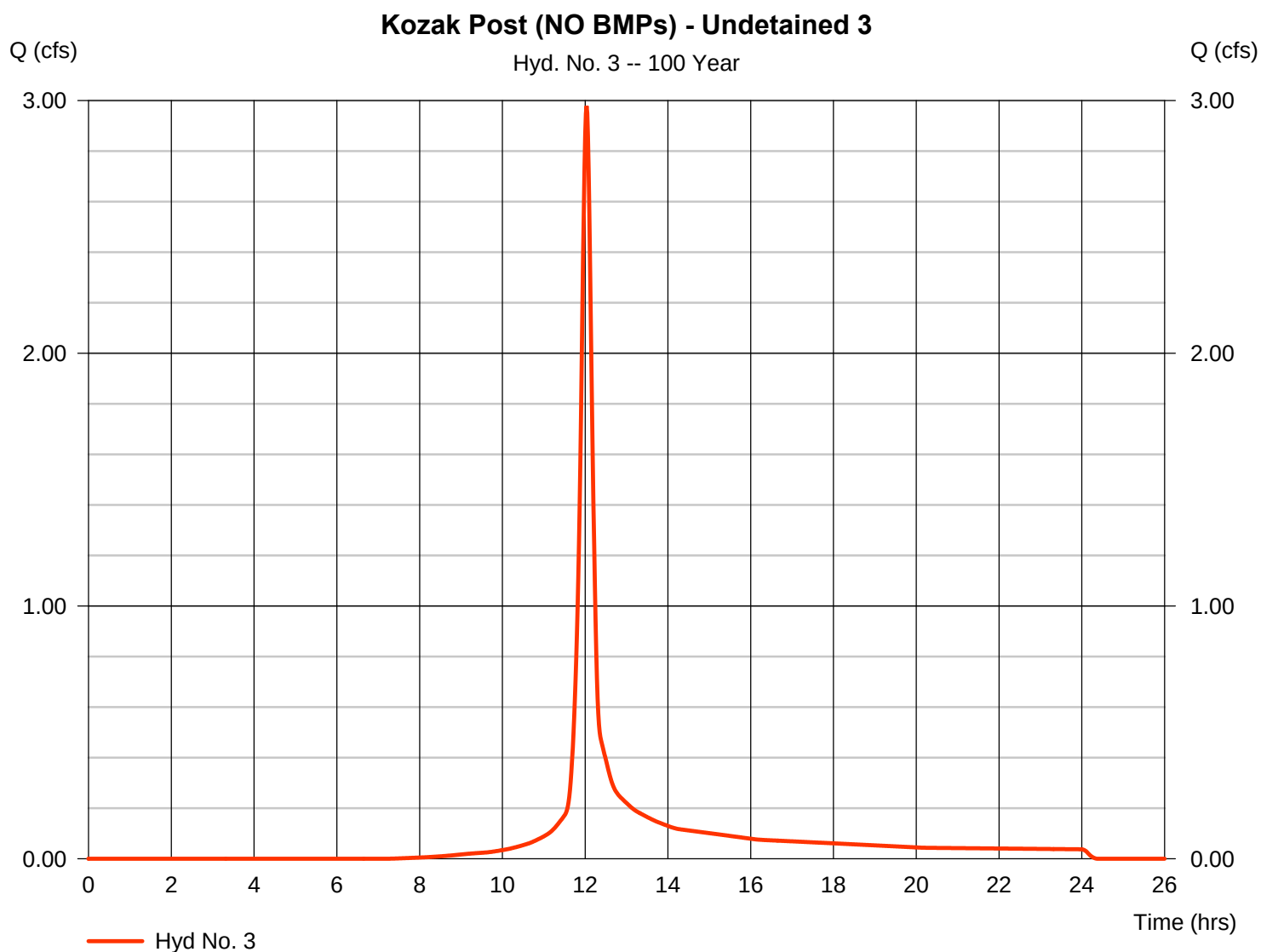
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.979 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.03 hrs
Time interval	=	1 min	Hyd. volume	=	8,024 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post (NO BMPs) - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

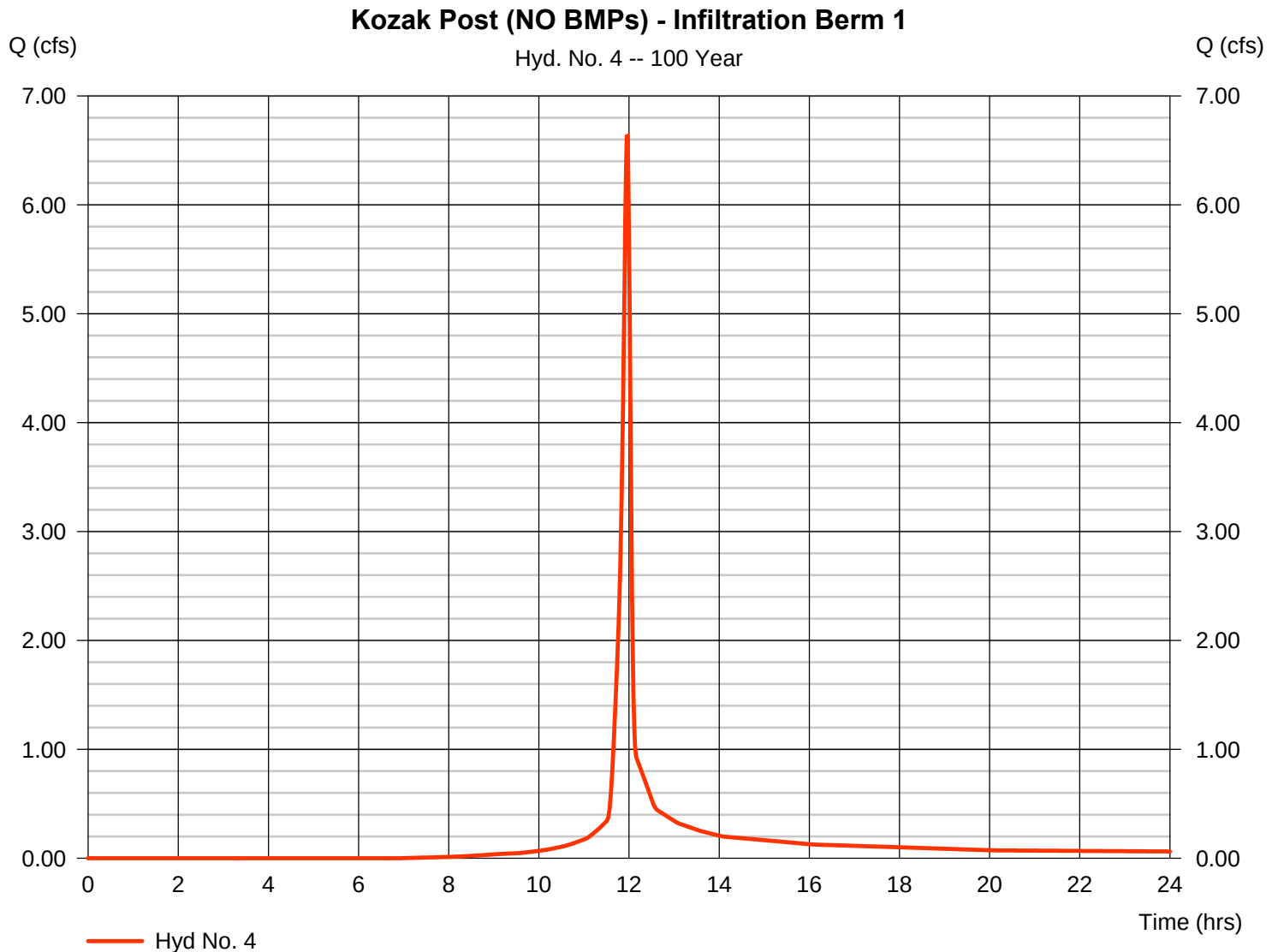
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Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.632 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	13,624 cuft
Drainage area	=	1.040 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.20 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 4

Kozak Post (NO BMPs) - Infiltration Berm 1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.240	
Flow length (ft)	= 8.0	65.0	37.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 25.00	6.20	23.00	
Travel Time (min)	= 0.76	+	0.60	+
			2.66	= 4.01
Shallow Concentrated Flow				
Flow length (ft)	= 522.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 2.18	+	0.00	+
			0.00	= 2.18
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				6.20 min

Hydrograph Report

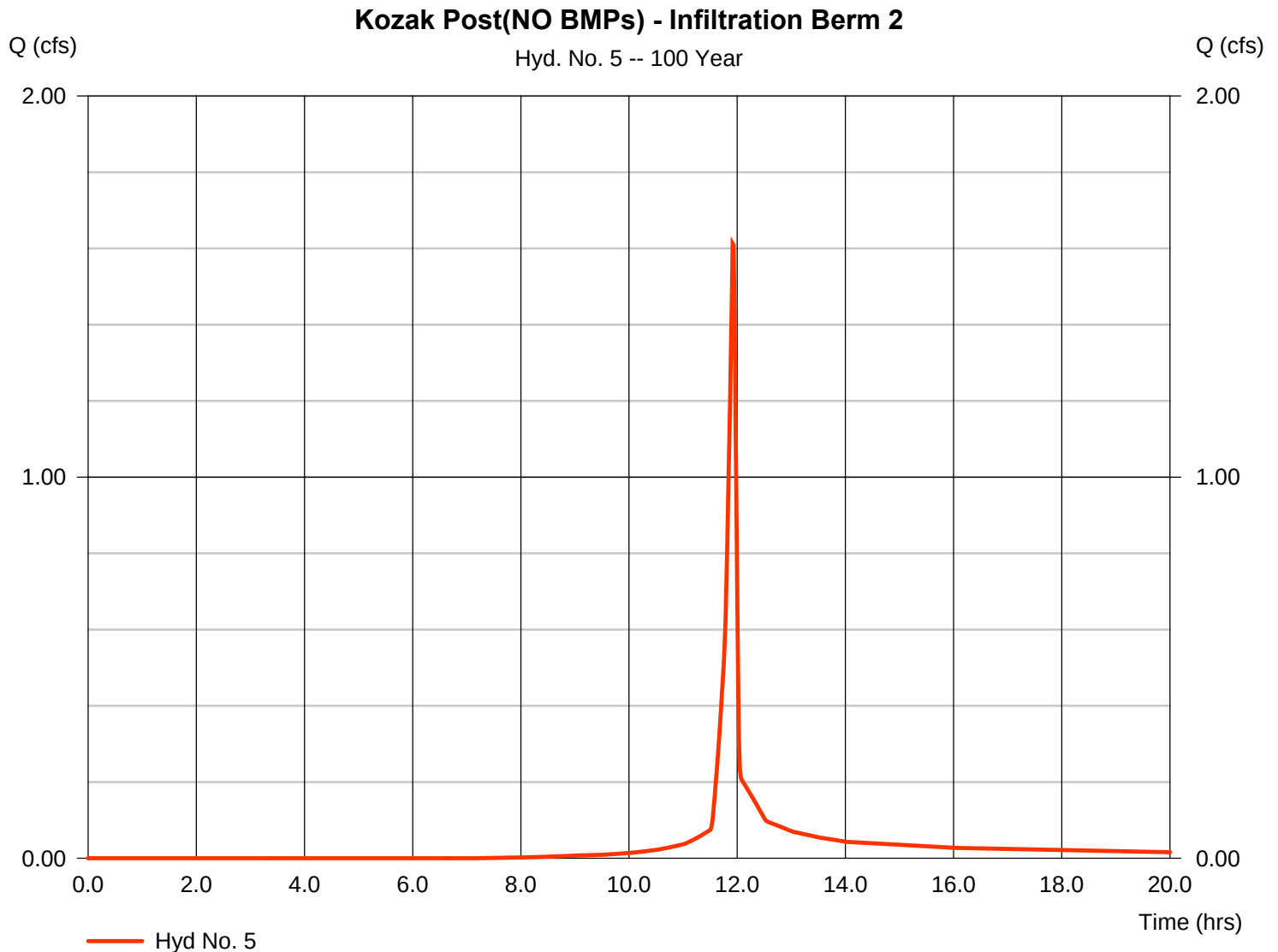
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.613 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.92 hrs
Time interval	=	1 min	Hyd. volume	=	2,893 cuft
Drainage area	=	0.250 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	1.62 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 5

Kozak Post(NO BMPs) - Infiltration Berm 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.011	0.011	0.011	
Flow length (ft)	= 45.0	54.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00	
Land slope (%)	= 3.30	8.30	0.00	
Travel Time (min)	= 0.57	+	0.46	+
			0.00	= 1.03
Shallow Concentrated Flow				
Flow length (ft)	= 40.00	35.00	63.00	
Watercourse slope (%)	= 7.50	11.40	8.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=4.42	5.45	4.56	
Travel Time (min)	= 0.15	+	0.11	+
			0.23	= 0.49
Channel Flow				
X sectional flow area (sqft)	= 2.00	0.00	0.00	
Wetted perimeter (ft)	= 4.68	0.00	0.00	
Channel slope (%)	= 11.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=18.64	0.00	0.00	
Flow length (ft)	107.0	0.0	0.0	
Travel Time (min)	= 0.10	+	0.00	+
			0.00	= 0.10
Total Travel Time, Tc				1.62 min

Hydrograph Report

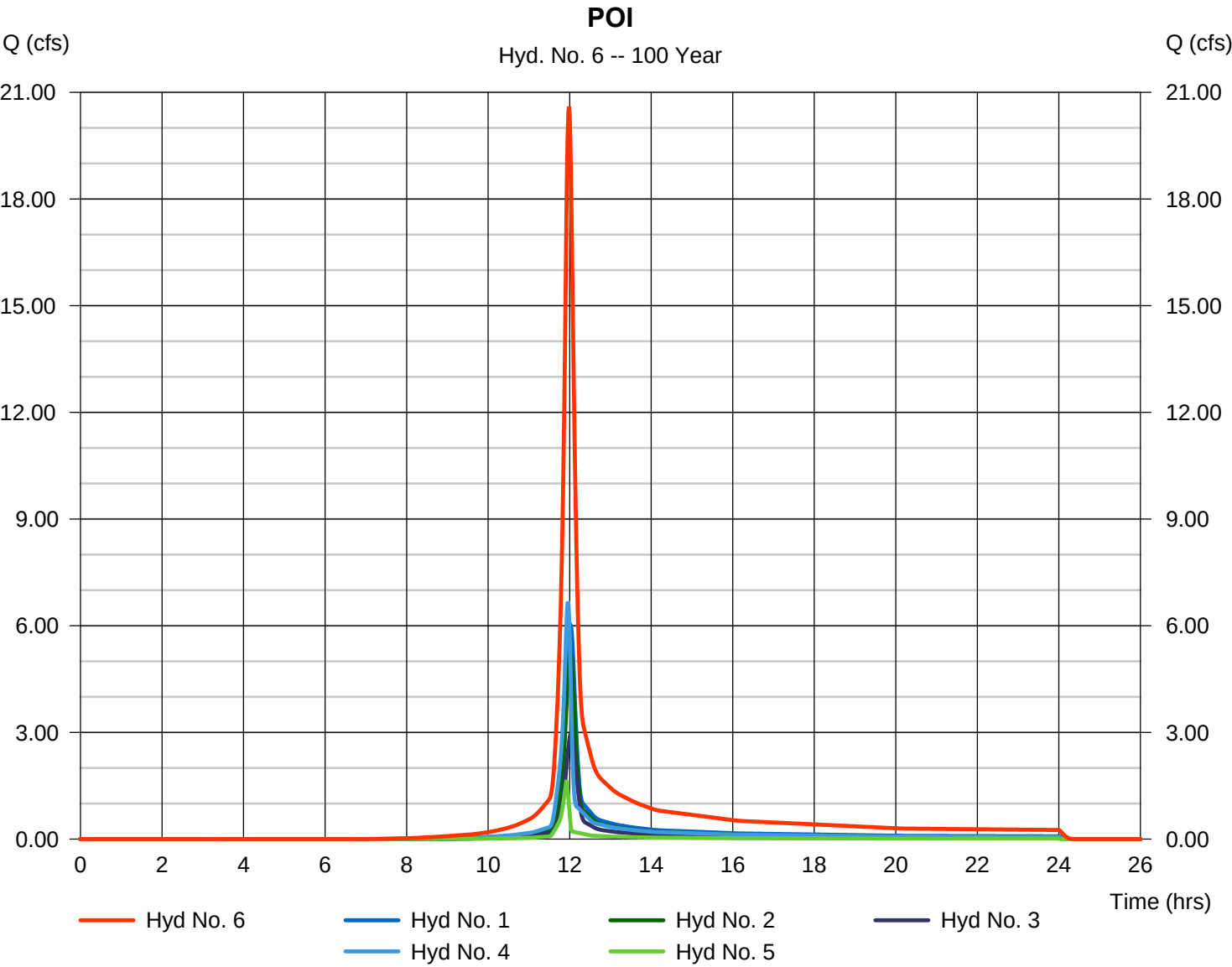
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 6

POI

Hydrograph type	= Combine	Peak discharge	= 20.60 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 52,998 cuft
Inflow hyds.	= 1, 2, 3, 4, 5	Contrib. drain. area	= 4.620 ac



Hydrograph Report

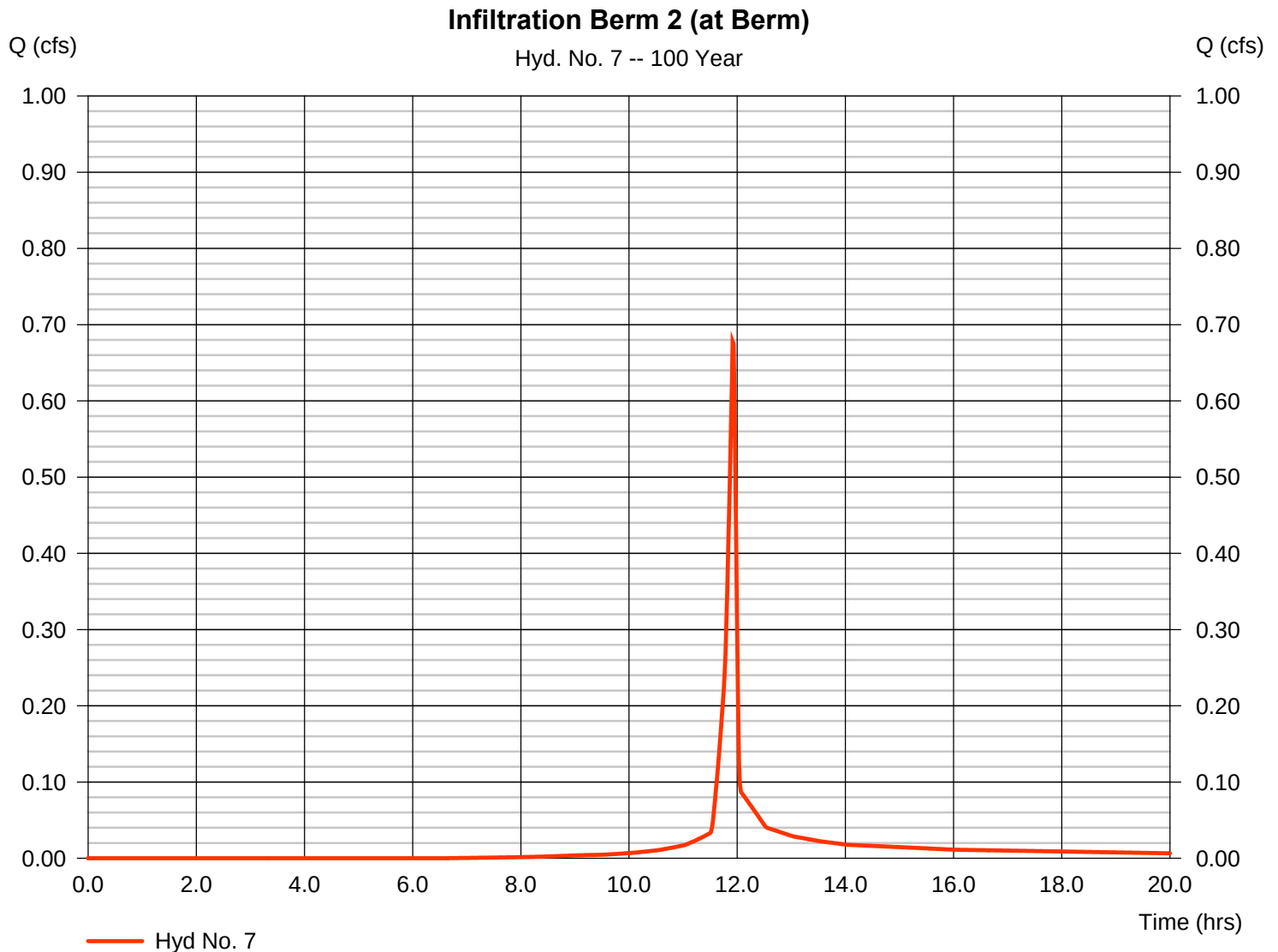
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 7

Infiltration Berm 2 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.678 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.92 hrs
Time interval	= 1 min	Hyd. volume	= 1,225 cuft
Drainage area	= 0.100 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 1.60 min
Total precip.	= 5.91 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

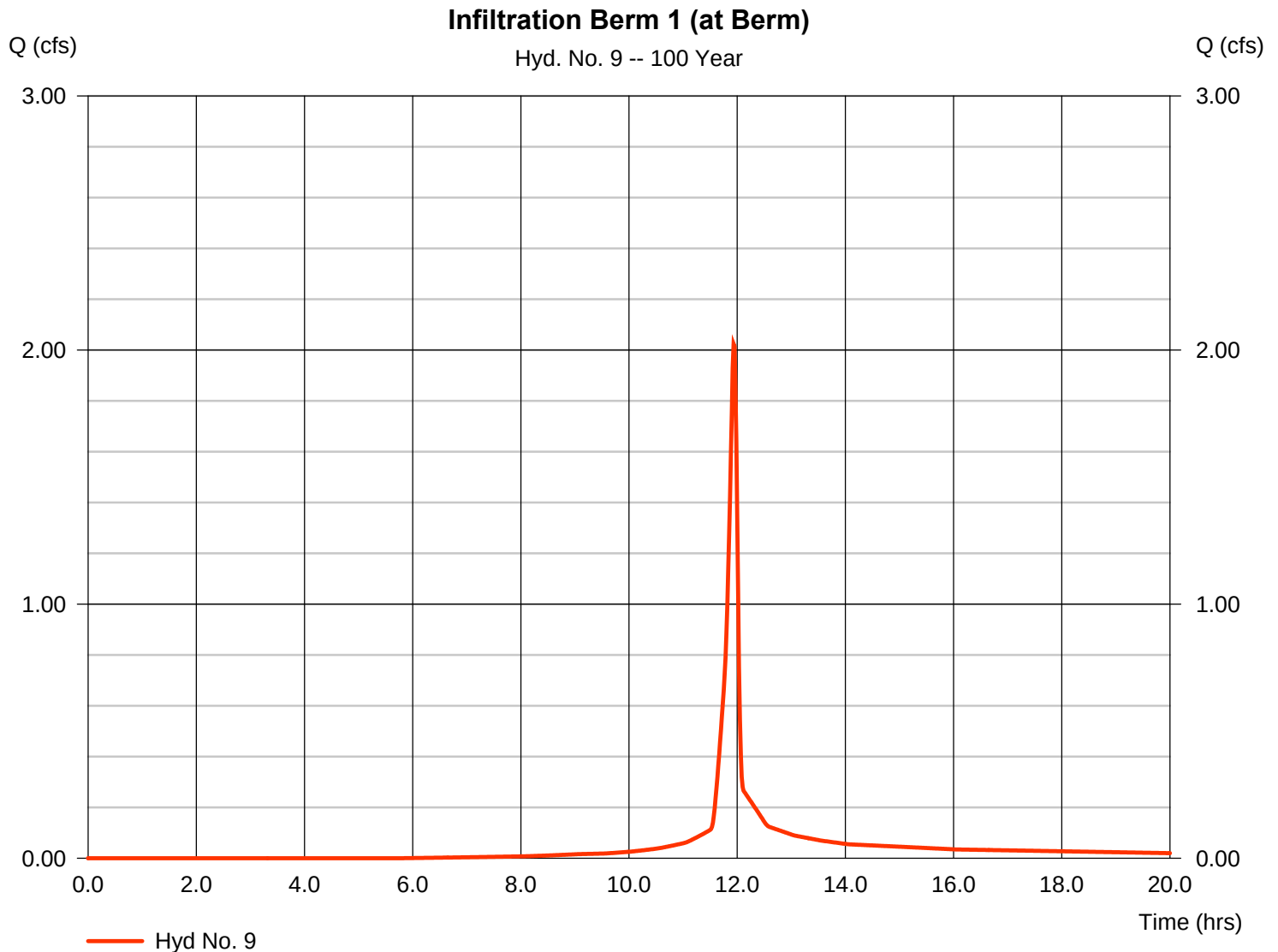
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Friday, 11 / 4 / 2016

Hyd. No. 9

Infiltration Berm 1 (at Berm)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.024 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.93 hrs
Time interval	= 1 min	Hyd. volume	= 3,968 cuft
Drainage area	= 0.280 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.40 min
Total precip.	= 5.91 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

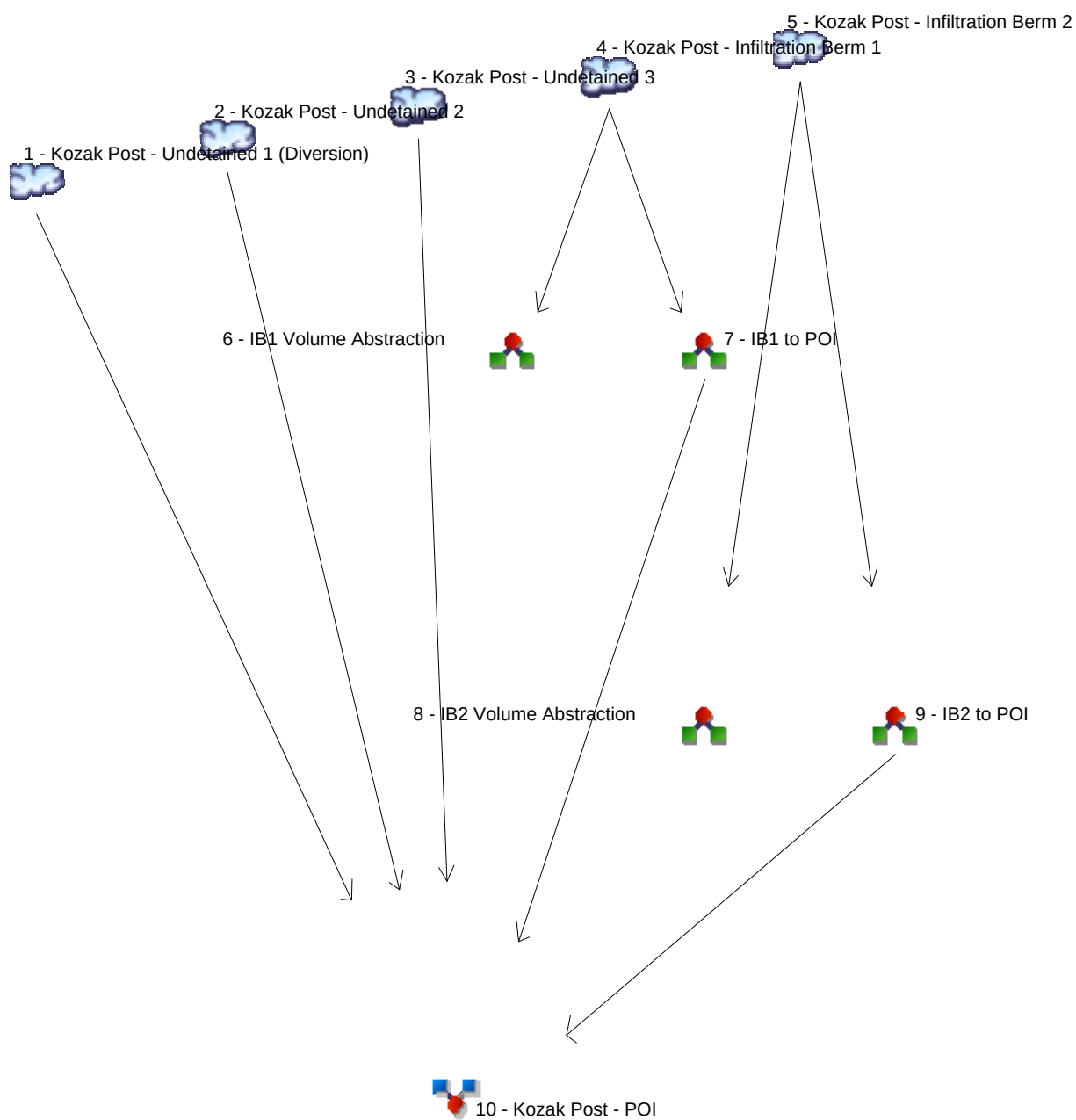
Hyd. No. 9

Infiltration Berm 1 (at Berm)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.011	0.240				
Flow length (ft)	= 8.0	65.0	27.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 25.00	6.20	23.00				
Travel Time (min)	= 0.76	+	0.60	+	2.07	=	3.42
Shallow Concentrated Flow							
Flow length (ft)	= 0.00	0.00	0.00				
Watercourse slope (%)	= 0.00	0.00	0.00				
Surface description	= Paved	Paved	Paved				
Average velocity (ft/s)	=0.00	0.00	0.00				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
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				3.40 min			

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	6.026	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	5.223	Kozak Post - Undetained 2
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	2.979	Kozak Post - Undetained 3
4	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	4.897	Kozak Post - Infiltration Berm 1
5	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	0.948	Kozak Post - Infiltration Berm 2
6	Diversion1	4	-----	-----	-----	-----	-----	-----	-----	0.353	IB1 Volume Abstraction
7	Diversion2	4	-----	-----	-----	-----	-----	-----	-----	4.897	IB1 to POI
8	Diversion1	5	-----	-----	-----	-----	-----	-----	-----	0.901	IB2 Volume Abstraction
9	Diversion2	5	-----	-----	-----	-----	-----	-----	-----	0.948	IB2 to POI
10	Combine	1, 2, 3, 7, 9	-----	-----	-----	-----	-----	-----	-----	19.05	Kozak Post - POI
Proj. file: Kozak Post wBMPs 100yr.gpw										Friday, 11 / 4 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

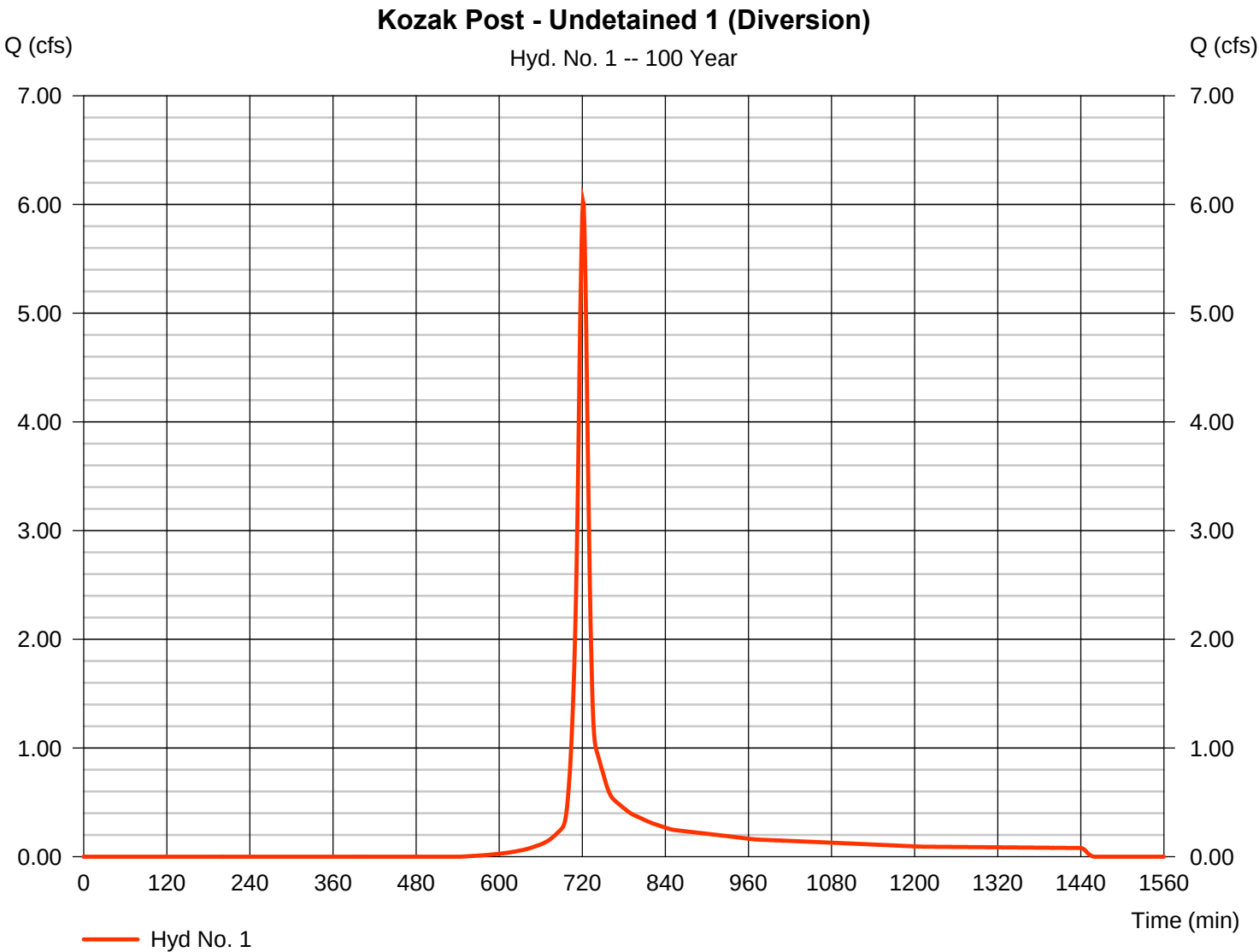
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	6.026	1	721	15,240	-----	-----	-----	Kozak Post - Undetained 1 (Diversion
2	SCS Runoff	5.223	1	721	13,217	-----	-----	-----	Kozak Post - Undetained 2
3	SCS Runoff	2.979	1	722	8,024	-----	-----	-----	Kozak Post - Undetained 3
4	SCS Runoff	4.897	1	722	13,211	-----	-----	-----	Kozak Post - Infiltration Berm 1
5	SCS Runoff	0.948	1	726	3,116	-----	-----	-----	Kozak Post - Infiltration Berm 2
6	Diversion1	0.353	1	695	1,086	4	-----	-----	IB1 Volume Abstraction
7	Diversion2	4.897	1	722	12,125	4	-----	-----	IB1 to POI
8	Diversion1	0.901	1	723	833	5	-----	-----	IB2 Volume Abstraction
9	Diversion2	0.948	1	726	2,283	5	-----	-----	IB2 to POI
10	Combine	19.05	1	721	50,890	1, 2, 3, 7, 9	-----	-----	Kozak Post - POI
Kozak Post wBMPs 100yr.gpw					Return Period: 100 Year			Friday, 11 / 4 / 2016	

Hydrograph Report

Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.026 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	15,240 cuft
Drainage area	=	1.560 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.90 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

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Hyd. No. 1

Kozak Post - Undetained 1 (Diversion)

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.240	0.400	0.011				
Flow length (ft)	= 16.0	84.0	0.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	0.00				
Land slope (%)	= 12.50	12.00	0.00				
Travel Time (min)	= 1.74	+	10.00	+	0.00	=	11.74
Shallow Concentrated Flow							
Flow length (ft)	= 194.00	0.00	0.00				
Watercourse slope (%)	= 6.70	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.18	0.00	0.00				
Travel Time (min)	= 0.77	+	0.00	+	0.00	=	0.77
Channel Flow							
X sectional flow area (sqft)	= 7.50	0.00	0.00				
Wetted perimeter (ft)	= 8.71	0.00	0.00				
Channel slope (%)	= 6.00	0.00	0.00				
Manning's n-value	= 0.030	0.015	0.015				
Velocity (ft/s)	=11.01	0.00	0.00				
Flow length (ft)	(0)274.0	0.0	0.0				
Travel Time (min)	= 0.41	+	0.00	+	0.00	=	0.41
Total Travel Time, Tc				12.90 min			

Hydrograph Report

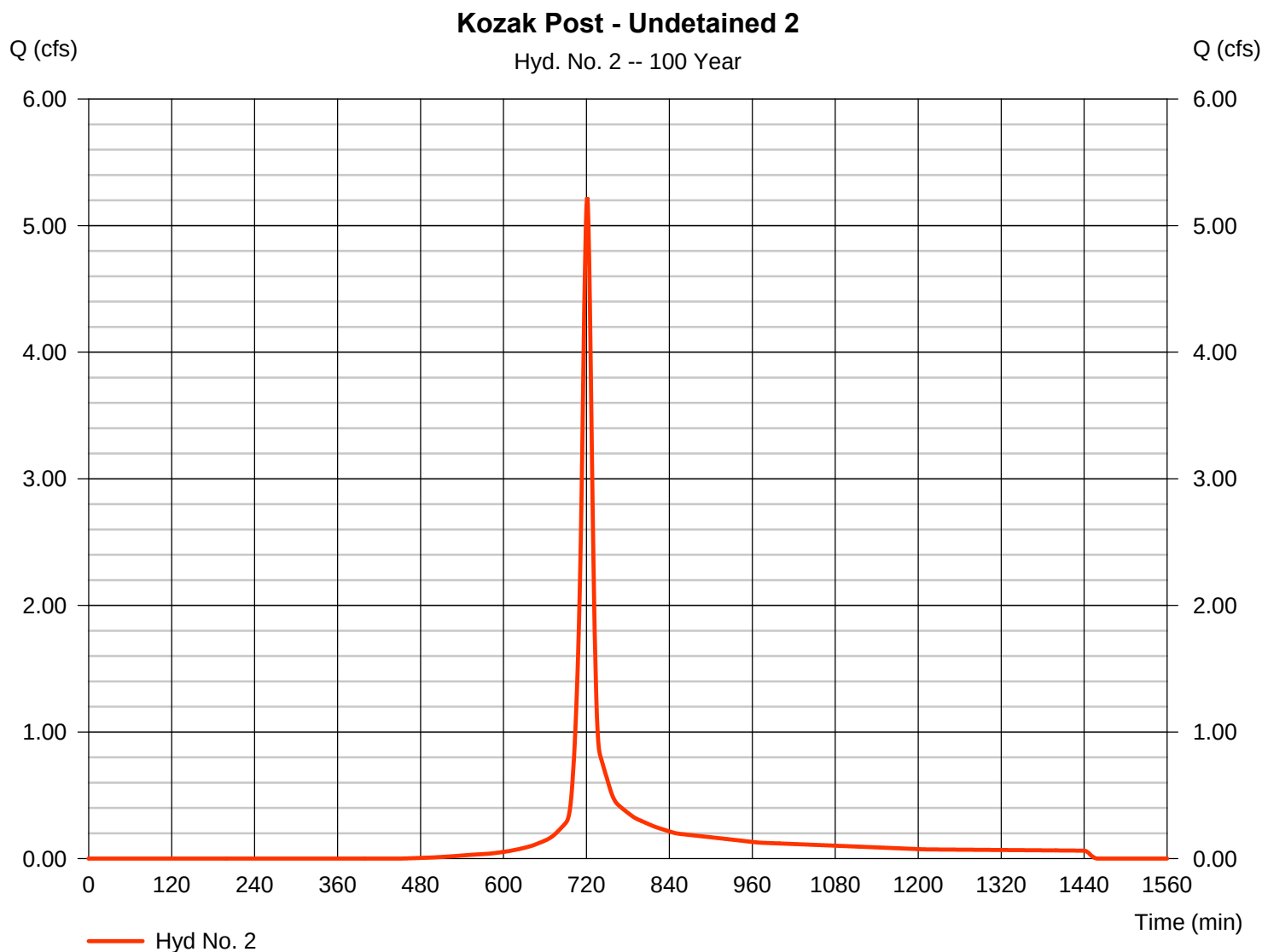
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Friday, 11 / 4 / 2016

Hyd. No. 2

Kozak Post - Undetained 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.223 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	13,217 cuft
Drainage area	=	1.120 ac	Curve number	=	76
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	12.50 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 2

Kozak Post - Undetained 2

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.011	0.150	0.400				
Flow length (ft)	= 14.0	8.0	78.0				
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66				
Land slope (%)	= 7.10	50.00	11.50				
Travel Time (min)	= 0.17	+	0.39	+	9.59	=	10.15
Shallow Concentrated Flow							
Flow length (ft)	= 565.00	0.00	0.00				
Watercourse slope (%)	= 6.40	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=4.08	0.00	0.00				
Travel Time (min)	= 2.31	+	0.00	+	0.00	=	2.31
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				12.50 min			

Hydrograph Report

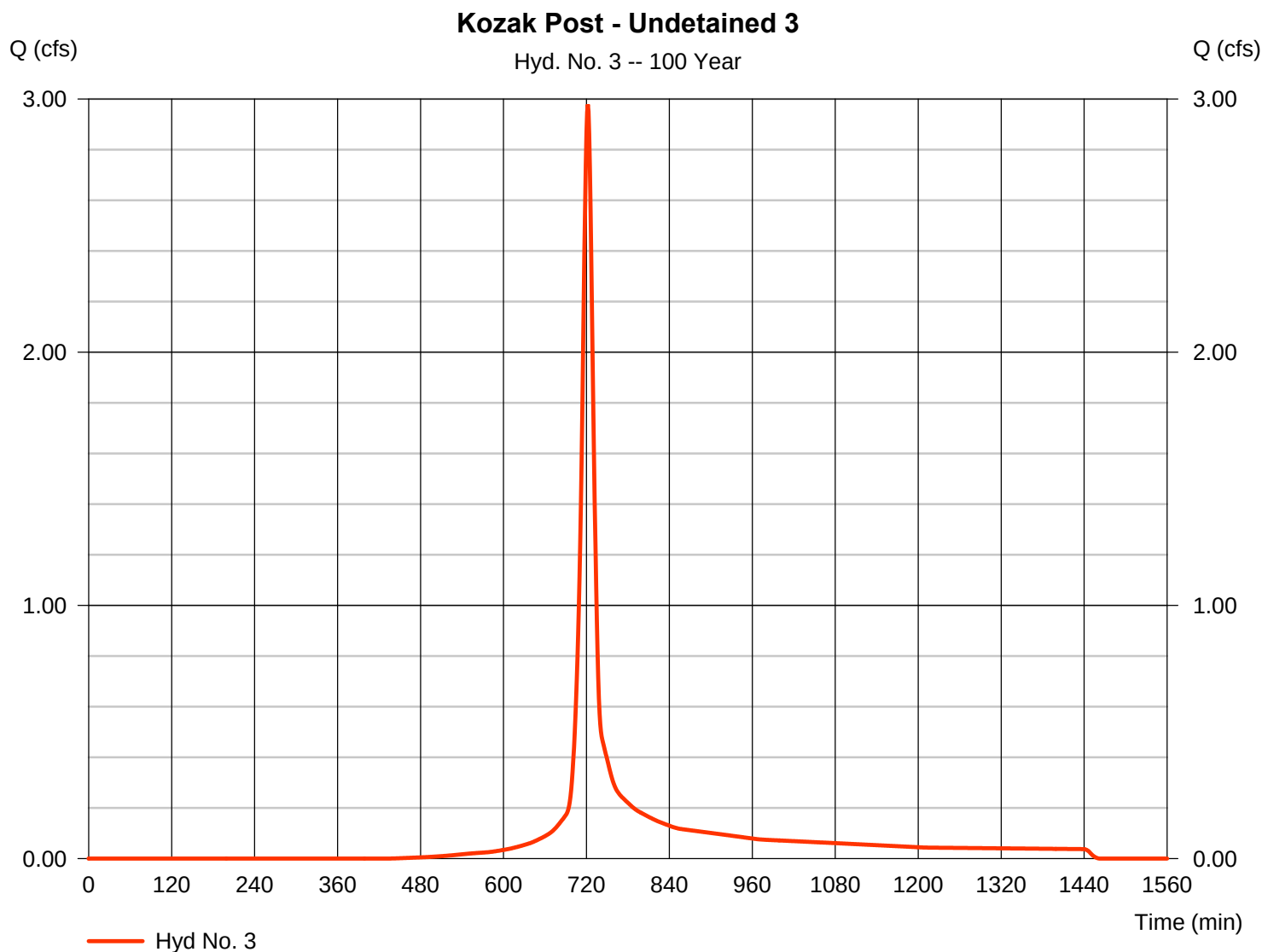
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Friday, 11 / 4 / 2016

Hyd. No. 3

Kozak Post - Undetained 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.979 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	8,024 cuft
Drainage area	=	0.650 ac	Curve number	=	77
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.80 min
Total precip.	=	5.91 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No. 3

Kozak Post - Undetained 3

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.400	0.400	
Flow length (ft)	= 43.0	57.0	0.0	
Two-year 24-hr precip. (in)	= 2.66	2.66	2.66	
Land slope (%)	= 11.60	9.00	0.00	
Travel Time (min)	= 3.94	+	8.23	+
			0.00	= 12.18
Shallow Concentrated Flow				
Flow length (ft)	= 378.00	0.00	0.00	
Watercourse slope (%)	= 6.10	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=3.98	0.00	0.00	
Travel Time (min)	= 1.58	+	0.00	+
			0.00	= 1.58
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				13.80 min

Hydrograph Report

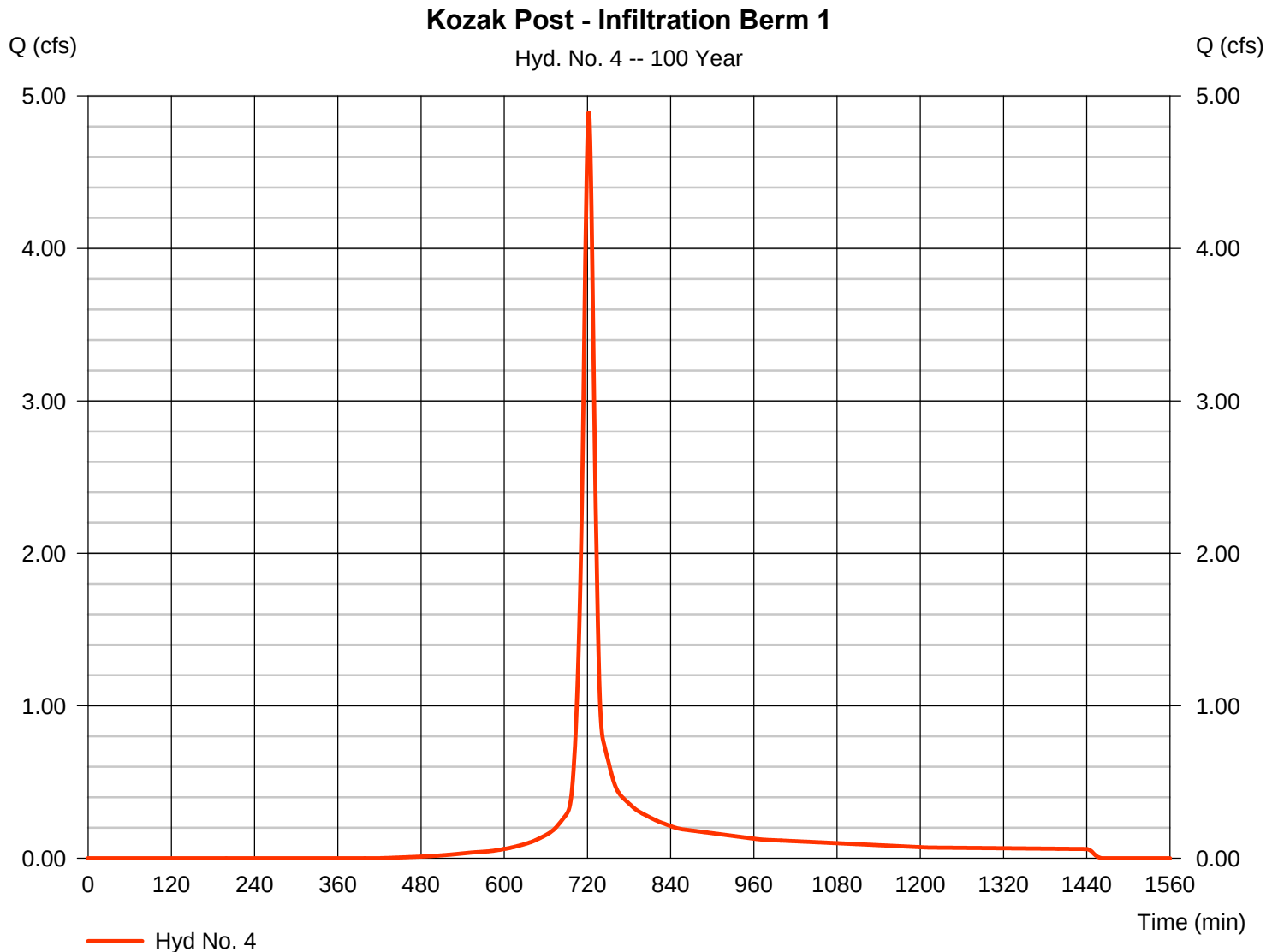
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Friday, 11 / 4 / 2016

Hyd. No. 4

Kozak Post - Infiltration Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.897 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 13,211 cuft
Drainage area	= 1.040 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 14.90 min
Total precip.	= 5.91 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

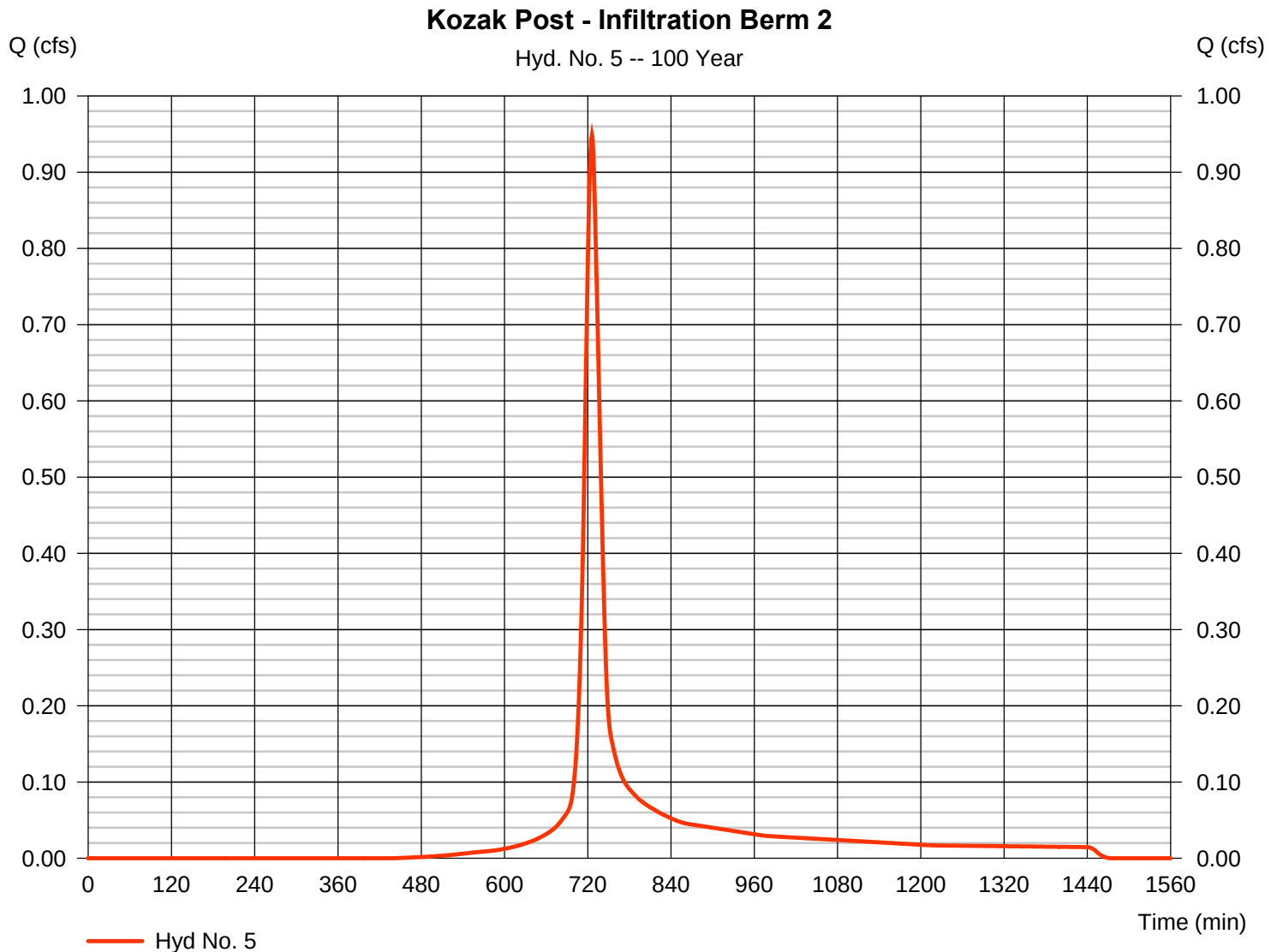
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Friday, 11 / 4 / 2016

Hyd. No. 5

Kozak Post - Infiltration Berm 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.948 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 3,116 cuft
Drainage area	= 0.250 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.40 min
Total precip.	= 5.91 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

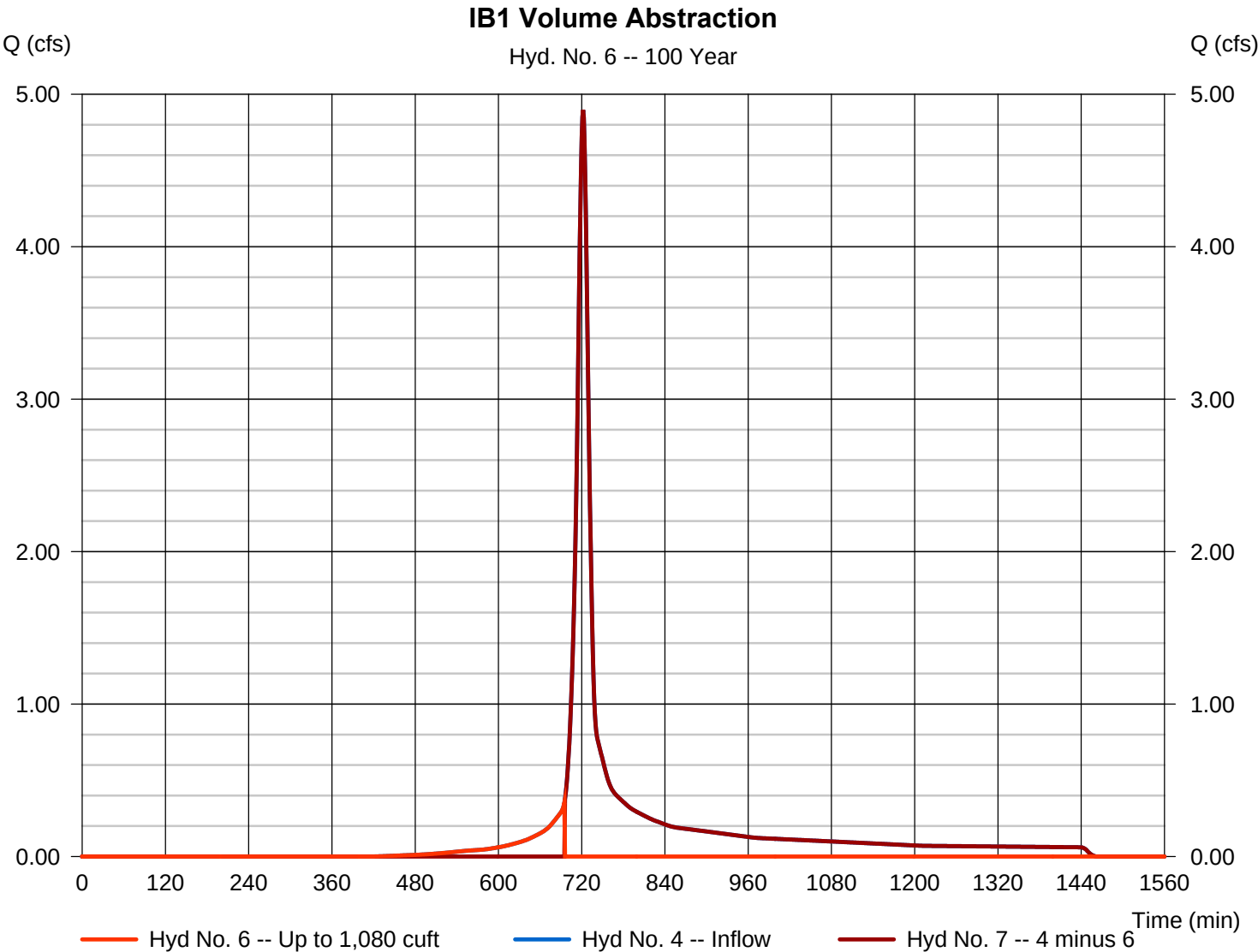
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Hyd. No. 6

IB1 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.353 cfs
Storm frequency	=	100 yrs	Time to peak	=	695 min
Time interval	=	1 min	Hyd. volume	=	1,086 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	7
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

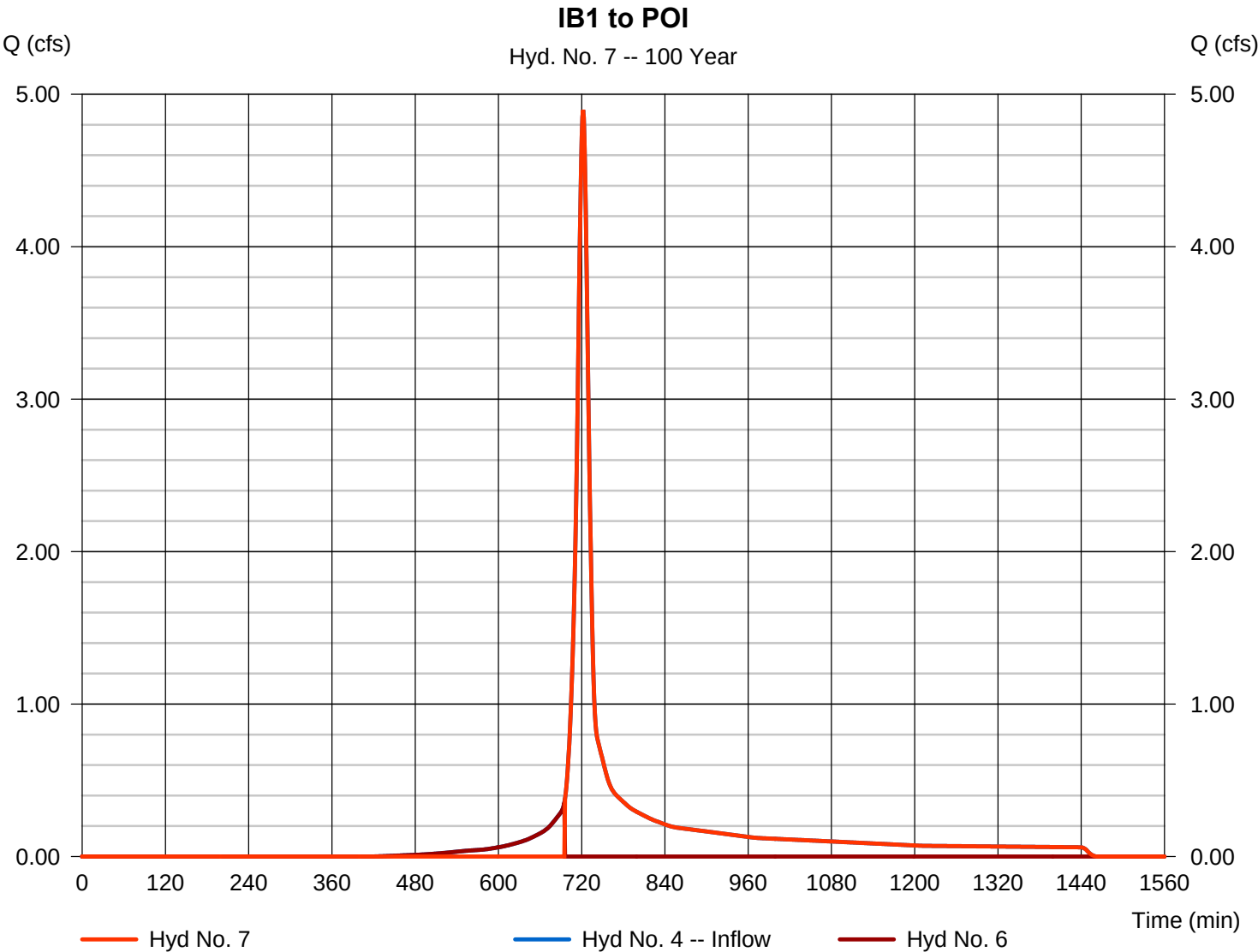
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Friday, 11 / 4 / 2016

Hyd. No. 7

IB1 to POI

Hydrograph type	=	Diversion2	Peak discharge	=	4.897 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	12,125 cuft
Inflow hydrograph	=	4 - Kozak Post - Infiltration Berms and diverted hyd.		=	6
Diversion method	=	First Flush Volume	Volume Up To	=	1,080 cuft



Hydrograph Report

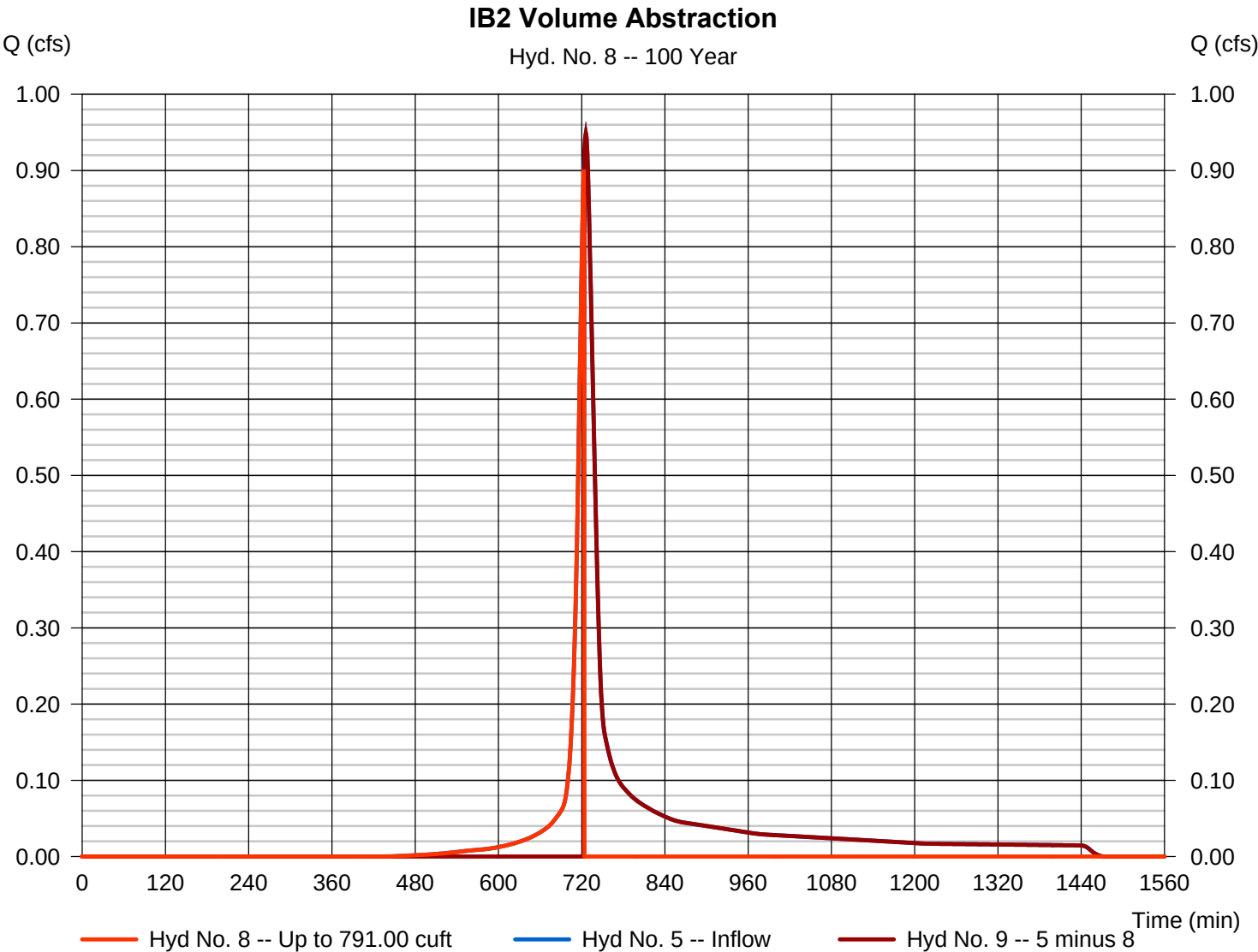
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Friday, 11 / 4 / 2016

Hyd. No. 8

IB2 Volume Abstraction

Hydrograph type	=	Diversion1	Peak discharge	=	0.901 cfs
Storm frequency	=	100 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	833 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms	and diverted hyd.	=	9
Diversion method	=	First Flush Volume	Volume Up To	=	791.00 cuft



Hydrograph Report

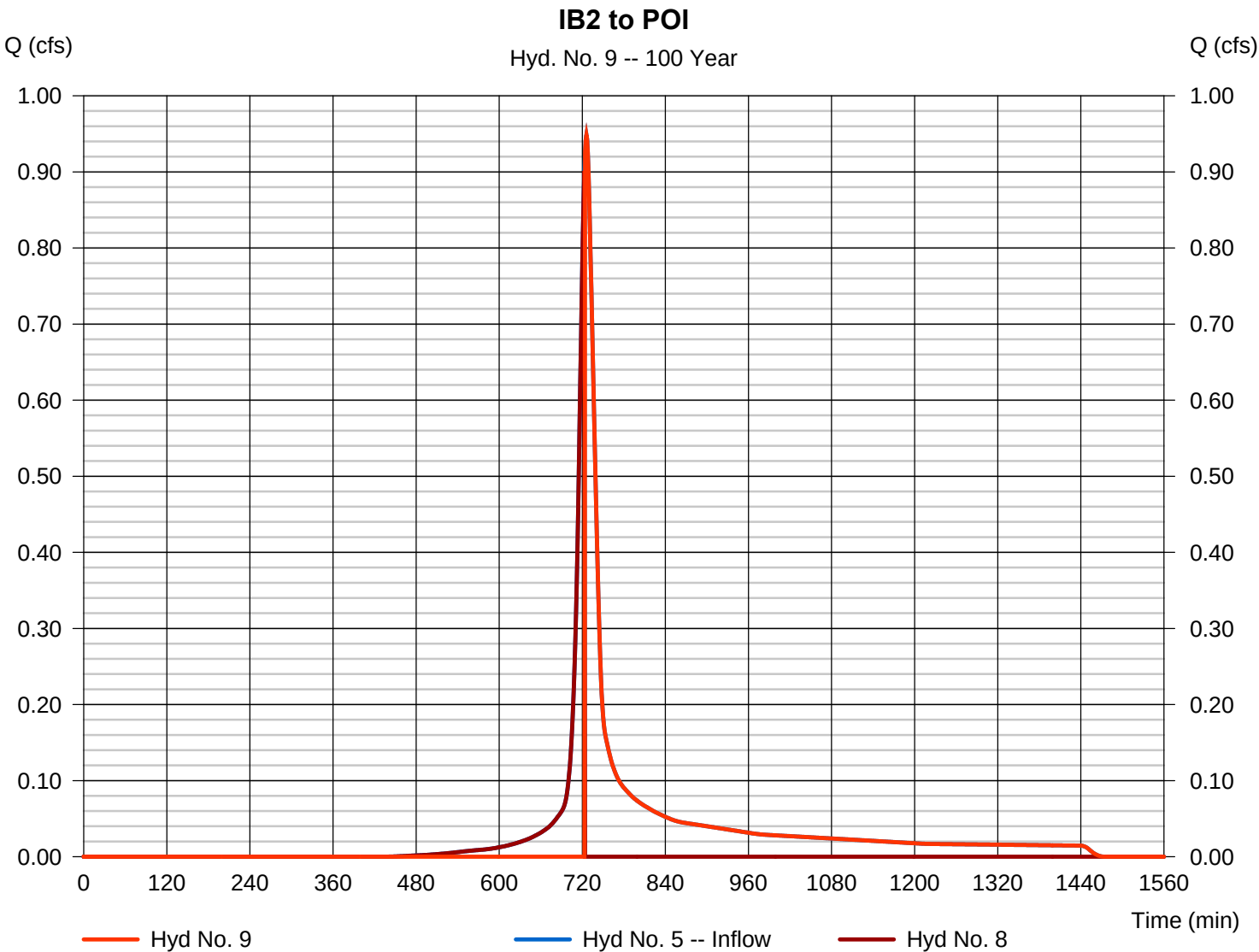
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Friday, 11 / 4 / 2016

Hyd. No. 9

IB2 to POI

Hydrograph type	=	Diversion2	Peak discharge	=	0.948 cfs
Storm frequency	=	100 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	2,283 cuft
Inflow hydrograph	=	5 - Kozak Post - Infiltration Berms and diverted hyd.		=	8
Diversion method	=	First Flush Volume	Volume Up To	=	791.00 cuft



Hydrograph Report

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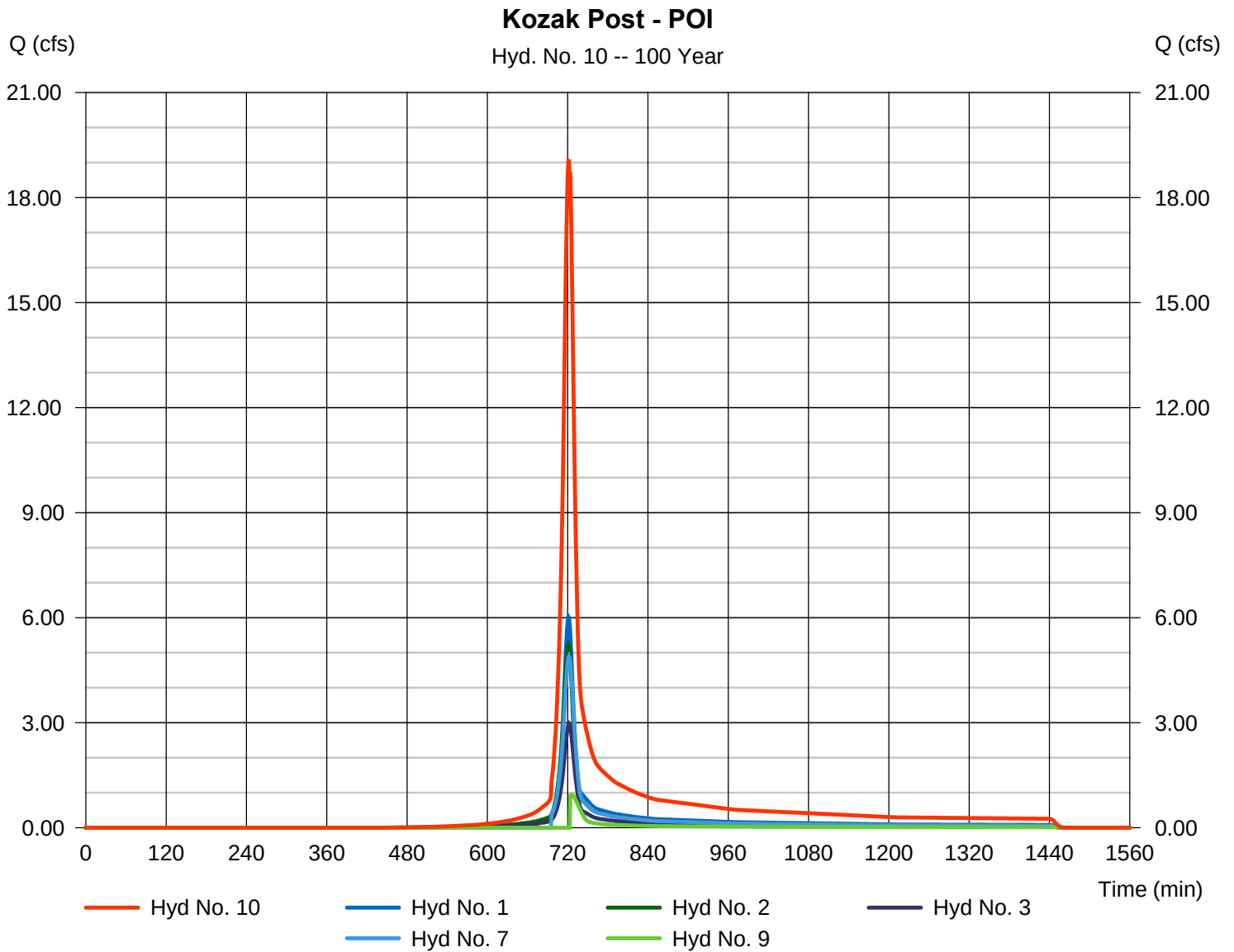
Friday, 11 / 4 / 2016

Hyd. No. 10

Kozak Post - POI

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 1 min
 Inflow hyds. = 1, 2, 3, 7, 9

Peak discharge = 19.05 cfs
 Time to peak = 721 min
 Hyd. volume = 50,890 cuft
 Contrib. drain. area = 3.330 ac



ATTACHMENT D
KOZAK RD
DIVERSION CHANNEL DESIGN

TETRA TECH, INC.

By: RJM Date: 10/19/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 10/20/16 Kozak Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\8 - Kozak Road (formerly Cresson RR East)\[Kozak Rd BMP Design.xlsx]WS #11

DIVERSION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1*	6.00

DD-1 is designated as the watershed labeled as "Undetained Area 1" from Attachment C. The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	2.89	0.80	0.50	1.30

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes		Channel Lining	Total Depth (ft)
			(LH:1V)	(RH:1V)		
DD-1	6%	1	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output .
2. The channel section characteristics resulting in the largest total depth were used.



Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Chestnut Ridge
 Project Number: 103515
 Channel Name: Kozak DD1**

Discharge	6
Peak Flow Period	0.3
Channel Slope	0.06
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	6 cfs	5.22 ft/s	0.55 ft	0.034	3 lbs/ft ²	2.05 lbs/ft ²	1.46	STABLE	E
P300 Reinforced Vegetation	Straight	6 cfs	2.89 ft/s	0.8 ft	0.075	8 lbs/ft ²	3 lbs/ft ²	2.67	STABLE	E
Underlying Substrate	Straight	6 cfs	2.89 ft/s	0.8 ft	--	2 lbs/ft ²	0.131 lbs/ft ²	15.25	STABLE	--