

## **ATTACHMENT 4 – Stormwater Calculations**



# Fairview Road



## TETRA TECH, INC.

By: RH    Date: 11/11/2016    Subject: Fairview Road  
Checked By: JB    Date: 11/15/2016    PCSM Design and Evaluation

### **PURPOSE:**

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Fairview Road block valve site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The site is located within Wallace Township, Chester County, Pennsylvania. Permanent stormwater controls will be developed to satisfy PADEP and Chester County's approved Act 167 Plan.

### **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). The design criteria evaluated for the site are summarized below.

#### **Act 167 Consistency**

The Fairview Road block valve site is located in Chester County, which has enacted an Act 167 Plan. This plan requires that NRCS curve numbers be used for the runoff calculations. In addition, certain watersheds within Chester County have release rate requirements. Fairview Road is not in an area with release rate requirements. The PCSM design at the Fairview Road block valve site has been designed for consistency with Chester County's approved Act 167 Plan.

#### **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 two infiltration berms 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 2-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plan.
- The curve numbers that were utilized in the PCSM design for the Fairview Road block valve site mirror the requirements of Chester County. Additionally, since there are no release rate

requirements within this watershed, all requirements of Chester County's Act 167 Plan have been met.

This site will utilize two infiltration berms to manage the two-year through 100-year peak rate increases. These BMPs will also help to increase the time of concentration for the detained drainage area encompassing the block valve.

### **Recommended Water Quality Control Guideline**

Control Guideline 1 will provide water quality control and stream channel protection as well as flood control protection.

### **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 Site Restoration/Post Construction Stormwater Management Plan. Infiltration test locations and recommended design rates are also labeled on the PCSM Plan Drawings in Attachment 6.

During the onsite infiltration tests, the depth to seasonal high groundwater and shallow bedrock or another confining layer were evaluated. The post-construction stormwater management facility for the site has been designed to maintain 2 feet of separation between the ponding elevation of the facility and the seasonal high water table and bedrock.

The proposed infiltration berm is located such that drainage from the block valve site reaches the berm while avoiding additional site impacts. This has forced the infiltration berm ponding area to be located over an existing Sunoco pipeline. However, infiltration tests were performed after construction of this pipeline. Because the tests yielded favorable results despite any compaction that potentially occurred during construction of the existing line, an infiltration berm is feasible in this location.

The post-construction stormwater management design will utilize onsite infiltration to meet Volume Control Guideline 1.

### **Loading Ratio**

Loading ratios have been considered for the design of infiltration BMPs. In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.
- Maximum Drainage Area Loading Ratio of 8:1 relating total drainage area to infiltration area.

The maximum impervious loading ratio of 5:1 has been met. The impervious loading ratio for the site is 3.8:1.

The maximum drainage area loading ratio of 8:1 has not been met. The drainage area loading ratio for the site is 25.8:1. However, runoff from the site and upslope drainage area will be dispersed to two infiltration berms. The infiltration berms have been placed to maximize the loading ratio to the maximum extent practicable, and other infiltration design parameters from the PA Stormwater BMP Manual have been met.

## **Disturbed Area**

To meet Standard Worksheet 10 guidelines, 90% of the disturbed area is contained by the proposed PCSM BMPs.

## **Karst Topography**

The Fairview Road block valve site is not located in an area with known karst topography.

## **Special Protection Watershed**

Fairview Road block valve is located within a special protection watershed. The project site was designed to minimize the total amount of impervious area. The impervious area for the Fairview Road block valve was limited to the amount that is required to safely construct and operate the block valve. In addition, the previously proposed gravel turn-around was eliminated, and replaced with a grass area.

Non-discharge alternatives were analyzed for this block valve site. The location of the Fairview Road block valve site was evaluated by ASME B31.4 Valve Spacing 434.15.2(e) which states that mainline valves should not be more than 7.5 miles apart. The valve sites were located in such a way that they avoided environmentally sensitive areas (such as wetlands and floodplains), were close to an existing road, and close to power. Land owner preference was also accounted for while locating the block valve sites. Once all of these factors were taken into account, several block valve sites, including Fairview Road, were located in special protection watersheds.

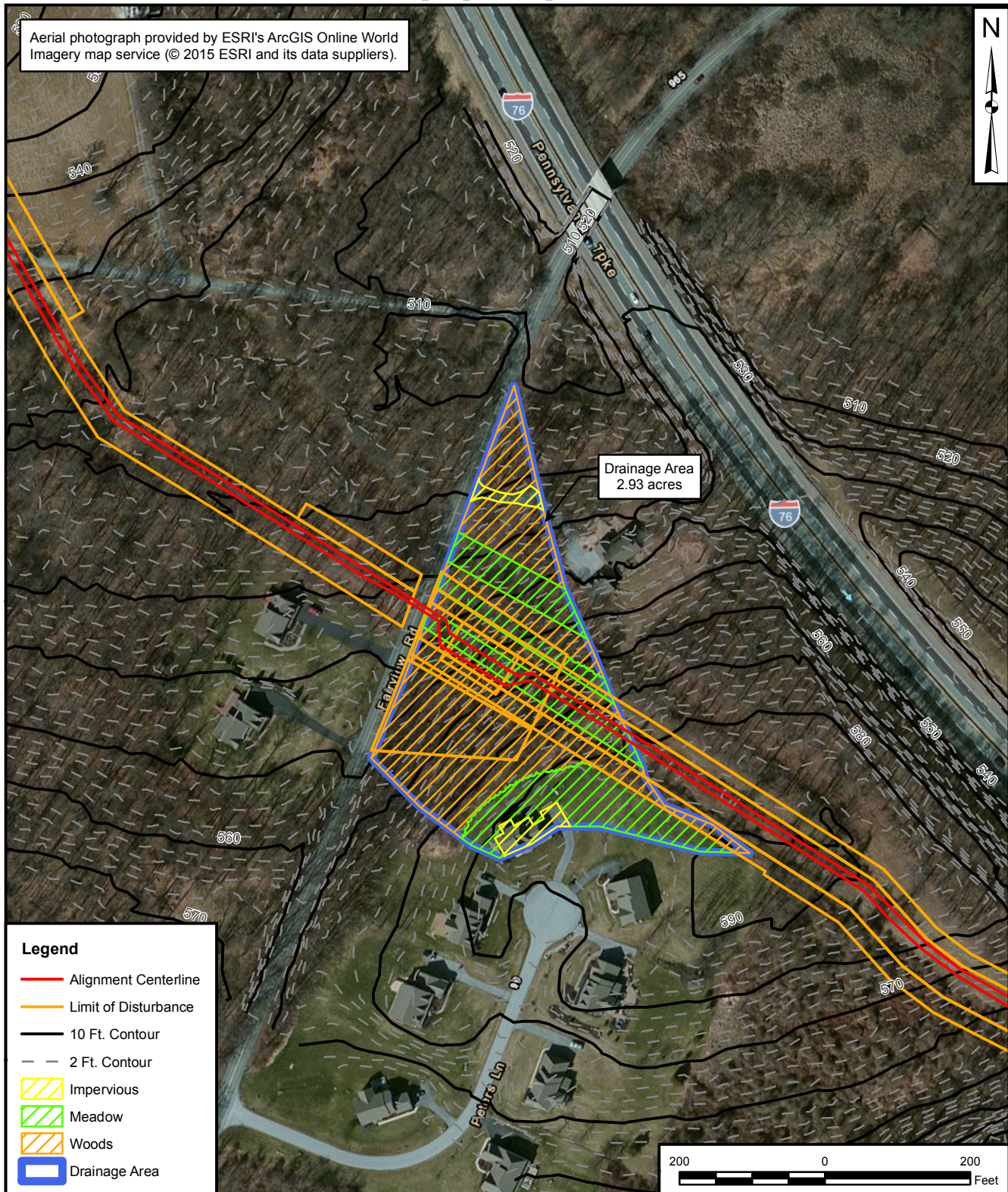
Non-discharge alternatives were also considered when determining the type of BMP proposed. Fairview Road block valve site utilizes infiltration berms to manage stormwater. Stormwater runoff is infiltrated to the maximum extent possible. Stormwater runoff is spread out to flow through areas that have been restored to meadow conditions, to infiltration berms, or to undisturbed area. There will not be an increase in stormwater runoff rate or volume to prevent the physical degradation of the receiving water, such as scour, and stream bank destabilization. Stormwater runoff volume is not increasing throughout post-construction, and any post-construction stormwater discharge is managed so that it will not degrade the physical, chemical or biological characteristics of the receiving stream.

Runoff from the site will be managed by two downslope infiltration berms. Poned runoff will be temporarily stored upslope of the berm until it infiltrates and filters through the soil media. Due to the design of the berms, which maintain a constant elevation through the entire berm length, the stormwater runoff will be released in sheet flow down a stabilized slope, without causing erosion, rather than concentrating the flow. Filtration through the existing vegetation and soil is an efficient way to remove suspended stormwater pollutants such as sediment, as the suspended particles are physically filtered from the stormwater as it flows through the vegetation and percolates into the soil.

The extent of the disturbed area will be minimized, and the duration of disturbance will be minimized by stabilizing disturbed areas as soon as practicable. Cut and fill for the project site has been minimized. Where possible based on the criteria listed above, sites were located in areas with shallow slopes to minimize the amount of cut and fill required. At Fairview Road block valve site, the grading was done to tie into existing contours, which did lead to some cut and fill requirements. This was done so that the block valve site was graded towards the natural slope. No direct discharge to surface water occurs at the site. The site will be restored promptly with proper vegetative cover techniques.

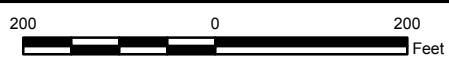
Antidegradation requirements for the special protection watershed are met because the post-construction stormwater infiltration volume equals or exceeds the pre-construction stormwater infiltration volume, and post-construction stormwater discharge is pretreated via infiltration berms. The runoff is managed so that it will not degrade the physical, chemical, or biological characteristics of the receiving stream.

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).



**Legend**

- Alignment Centerline
- Limit of Disturbance
- 10 Ft. Contour
- 2 Ft. Contour
- Impervious
- Meadow
- Woods
- Drainage Area

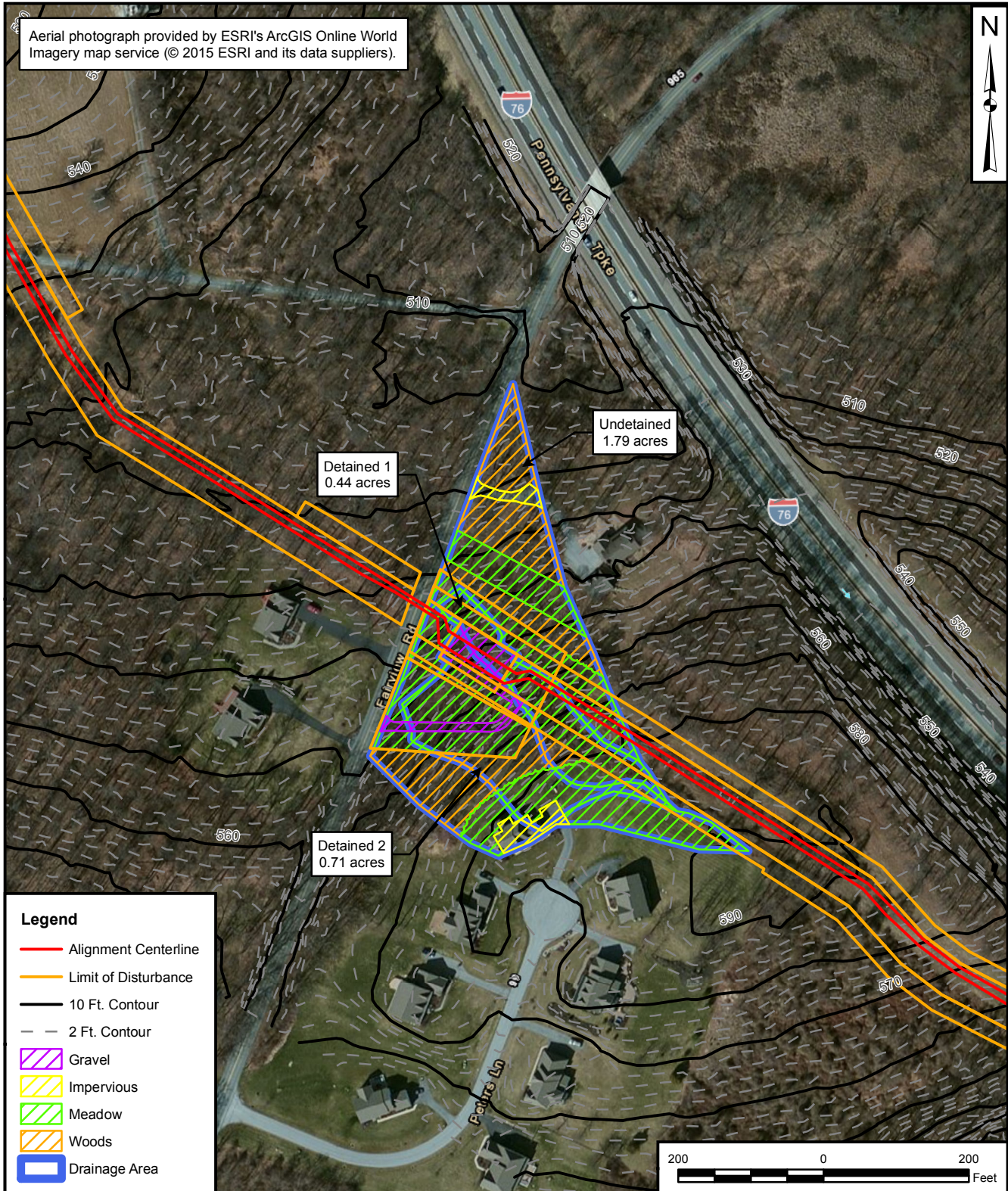


**PRE-DEVELOPMENT DRAINAGE AREA MAP**  
**FAIRVIEW ROAD**  
**PENNSYLVANIA PIPELINE PROJECT**  
**SUNOCO LOGISTICS, L.P.**  
**CHESTER COUNTY, PENNSYLVANIA**

|                               |     |
|-------------------------------|-----|
| DRAWN BY: J. HERNING 05/11/15 |     |
| CHECKED BY: J. BRODY 11/09/16 |     |
| APPROVED BY:                  |     |
| CONTRACT NUMBER: 112IC05958   |     |
| FIGURE NUMBER                 | REV |
| 1                             | 0   |



Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).



**Legend**

- Alignment Centerline
- Limit of Disturbance
- 10 Ft. Contour
- 2 Ft. Contour
- Gravel
- Impervious
- Meadow
- Woods
- Drainage Area



**POST-DEVELOPMENT DRAINAGE AREA MAP**  
**FAIRVIEW ROAD**  
**PENNSYLVANIA PIPELINE PROJECT**  
**SUNOCO LOGISTICS, L.P.**  
**CHESTER COUNTY, PENNSYLVANIA**

|                               |     |
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| CONTRACT NUMBER: 112IC05958   |     |
| FIGURE NUMBER                 | REV |
| 2                             | 0   |





**NOAA Atlas 14, Volume 2, Version 3**  
**Location name: Wallace Twp, Pennsylvania, USA\***  
**Latitude: 40.1019°, Longitude: -75.7559°**  
**Elevation: 548.24 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**

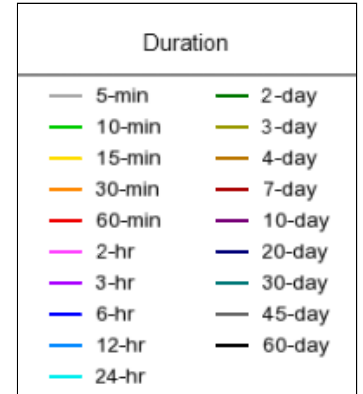
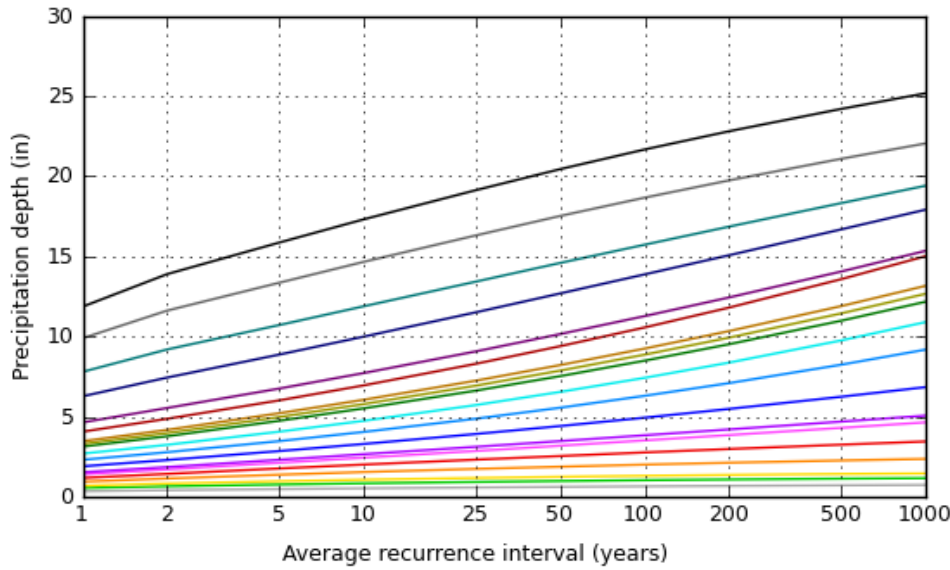
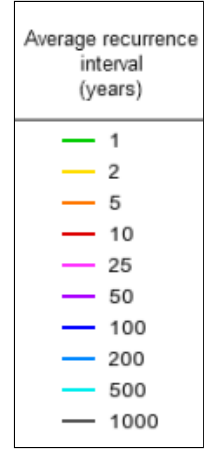
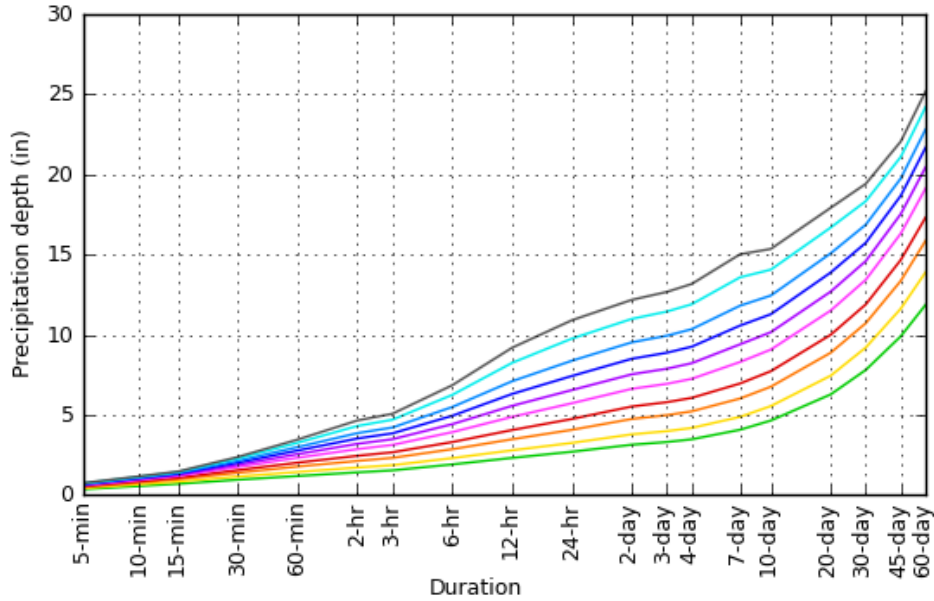
| <b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b> |                                     |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|--|-------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Duration   | Average recurrence interval (years) |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|  | 1                                   | 2                      | 5                      | 10                     | 25                     | 50                     | 100                    | 200                    | 500                    | 1000                   |
| 5-min  | 0.345<br>(0.314-0.380)              | 0.411<br>(0.374-0.452) | 0.479<br>(0.436-0.527) | 0.527<br>(0.479-0.580) | 0.582<br>(0.526-0.639) | 0.618<br>(0.555-0.678) | 0.653<br>(0.584-0.717) | 0.683<br>(0.609-0.751) | 0.716<br>(0.633-0.787) | 0.739<br>(0.650-0.814) |
| 10-min   | 0.551<br>(0.502-0.607)              | 0.657<br>(0.599-0.723) | 0.767<br>(0.698-0.844) | 0.843<br>(0.766-0.927) | 0.927<br>(0.838-1.02)  | 0.985<br>(0.885-1.08)  | 1.04<br>(0.929-1.14)   | 1.08<br>(0.965-1.19)   | 1.13<br>(1.00-1.24)    | 1.16<br>(1.02-1.28)    |
| 15-min   | 0.689<br>(0.627-0.759)              | 0.826<br>(0.752-0.909) | 0.971<br>(0.883-1.07)  | 1.07<br>(0.969-1.17)   | 1.18<br>(1.06-1.29)    | 1.25<br>(1.12-1.37)    | 1.31<br>(1.17-1.44)    | 1.37<br>(1.22-1.50)    | 1.43<br>(1.26-1.57)    | 1.46<br>(1.28-1.61)    |
| 30-min   | 0.945<br>(0.860-1.04)               | 1.14<br>(1.04-1.26)    | 1.38<br>(1.25-1.52)    | 1.54<br>(1.40-1.70)    | 1.74<br>(1.57-1.91)    | 1.88<br>(1.69-2.06)    | 2.01<br>(1.80-2.21)    | 2.13<br>(1.90-2.34)    | 2.27<br>(2.01-2.49)    | 2.37<br>(2.08-2.61)    |
| 60-min   | 1.18<br>(1.07-1.30)                 | 1.43<br>(1.30-1.58)    | 1.77<br>(1.61-1.95)    | 2.01<br>(1.83-2.21)    | 2.32<br>(2.09-2.55)    | 2.54<br>(2.29-2.79)    | 2.77<br>(2.48-3.04)    | 2.98<br>(2.66-3.28)    | 3.25<br>(2.88-3.58)    | 3.45<br>(3.04-3.81)    |
| 2-hr   | 1.41<br>(1.26-1.56)                 | 1.71<br>(1.54-1.90)    | 2.12<br>(1.91-2.36)    | 2.44<br>(2.18-2.71)    | 2.86<br>(2.54-3.17)    | 3.19<br>(2.82-3.54)    | 3.52<br>(3.10-3.90)    | 3.85<br>(3.37-4.27)    | 4.30<br>(3.72-4.77)    | 4.65<br>(3.98-5.16)    |
| 3-hr   | 1.53<br>(1.38-1.71)                 | 1.85<br>(1.67-2.07)    | 2.31<br>(2.08-2.58)    | 2.66<br>(2.38-2.96)    | 3.12<br>(2.78-3.46)    | 3.48<br>(3.08-3.85)    | 3.84<br>(3.38-4.25)    | 4.21<br>(3.67-4.66)    | 4.69<br>(4.06-5.21)    | 5.06<br>(4.34-5.64)    |
| 6-hr   | 1.90<br>(1.71-2.12)                 | 2.29<br>(2.07-2.56)    | 2.85<br>(2.57-3.18)    | 3.30<br>(2.96-3.67)    | 3.92<br>(3.49-4.35)    | 4.42<br>(3.90-4.89)    | 4.94<br>(4.33-5.47)    | 5.49<br>(4.77-6.07)    | 6.24<br>(5.36-6.91)    | 6.84<br>(5.79-7.58)    |
| 12-hr  | 2.31<br>(2.08-2.60)                 | 2.78<br>(2.50-3.13)    | 3.47<br>(3.12-3.90)    | 4.05<br>(3.62-4.53)    | 4.87<br>(4.31-5.43)    | 5.56<br>(4.88-6.17)    | 6.30<br>(5.47-7.00)    | 7.09<br>(6.09-7.87)    | 8.24<br>(6.95-9.15)    | 9.19<br>(7.62-10.2)    |
| 24-hr  | 2.69<br>(2.47-2.96)                 | 3.24<br>(2.97-3.56)    | 4.06<br>(3.71-4.46)    | 4.74<br>(4.32-5.20)    | 5.72<br>(5.19-6.26)    | 6.54<br>(5.91-7.15)    | 7.42<br>(6.67-8.11)    | 8.38<br>(7.48-9.14)    | 9.76<br>(8.62-10.6)    | 10.9<br>(9.54-11.9)    |
| 2-day  | 3.13<br>(2.85-3.46)                 | 3.78<br>(3.44-4.18)    | 4.74<br>(4.31-5.23)    | 5.52<br>(5.00-6.09)    | 6.62<br>(5.97-7.29)    | 7.53<br>(6.76-8.28)    | 8.49<br>(7.59-9.34)    | 9.52<br>(8.45-10.5)    | 11.0<br>(9.67-12.1)    | 12.2<br>(10.6-13.4)    |
| 3-day  | 3.30<br>(3.00-3.65)                 | 3.98<br>(3.62-4.40)    | 4.98<br>(4.53-5.50)    | 5.79<br>(5.25-6.39)    | 6.93<br>(6.26-7.64)    | 7.87<br>(7.08-8.68)    | 8.87<br>(7.93-9.77)    | 9.93<br>(8.83-10.9)    | 11.4<br>(10.1-12.6)    | 12.7<br>(11.1-14.0)    |
| 4-day  | 3.47<br>(3.16-3.84)                 | 4.18<br>(3.80-4.63)    | 5.21<br>(4.74-5.78)    | 6.05<br>(5.49-6.70)    | 7.24<br>(6.54-8.00)    | 8.22<br>(7.39-9.07)    | 9.25<br>(8.28-10.2)    | 10.3<br>(9.20-11.4)    | 11.9<br>(10.5-13.1)    | 13.2<br>(11.5-14.5)    |
| 7-day  | 4.07<br>(3.73-4.46)                 | 4.87<br>(4.46-5.34)    | 6.01<br>(5.50-6.60)    | 6.95<br>(6.35-7.62)    | 8.29<br>(7.55-9.07)    | 9.40<br>(8.51-10.3)    | 10.6<br>(9.52-11.5)    | 11.8<br>(10.6-12.9)    | 13.6<br>(12.1-14.8)    | 15.0<br>(13.2-16.4)    |
| 10-day   | 4.64<br>(4.28-5.05)                 | 5.54<br>(5.11-6.04)    | 6.75<br>(6.21-7.35)    | 7.72<br>(7.09-8.40)    | 9.07<br>(8.30-9.85)    | 10.2<br>(9.26-11.0)    | 11.3<br>(10.3-12.2)    | 12.4<br>(11.3-13.5)    | 14.1<br>(12.6-15.3)    | 15.4<br>(13.7-16.7)    |
| 20-day   | 6.27<br>(5.83-6.76)                 | 7.44<br>(6.92-8.02)    | 8.87<br>(8.25-9.55)    | 9.99<br>(9.28-10.8)    | 11.5<br>(10.7-12.4)    | 12.7<br>(11.7-13.6)    | 13.9<br>(12.8-14.9)    | 15.1<br>(13.8-16.2)    | 16.7<br>(15.2-18.0)    | 17.9<br>(16.3-19.3)    |
| 30-day   | 7.80<br>(7.33-8.32)                 | 9.20<br>(8.64-9.80)    | 10.7<br>(10.1-11.4)    | 11.9<br>(11.1-12.7)    | 13.4<br>(12.6-14.3)    | 14.6<br>(13.6-15.6)    | 15.7<br>(14.7-16.8)    | 16.9<br>(15.7-18.0)    | 18.3<br>(16.9-19.6)    | 19.4<br>(17.9-20.8)    |
| 45-day   | 9.90<br>(9.36-10.5)                 | 11.6<br>(11.0-12.3)    | 13.4<br>(12.6-14.1)    | 14.7<br>(13.9-15.5)    | 16.3<br>(15.4-17.3)    | 17.5<br>(16.5-18.6)    | 18.7<br>(17.6-19.8)    | 19.7<br>(18.5-20.9)    | 21.1<br>(19.7-22.3)    | 22.1<br>(20.6-23.4)    |
| 60-day   | 11.9<br>(11.2-12.5)                 | 13.9<br>(13.2-14.7)    | 15.9<br>(15.0-16.8)    | 17.3<br>(16.4-18.3)    | 19.1<br>(18.1-20.2)    | 20.4<br>(19.3-21.6)    | 21.7<br>(20.5-22.9)    | 22.8<br>(21.5-24.1)    | 24.2<br>(22.8-25.6)    | 25.2<br>(23.7-26.7)    |

<sup>1</sup> 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.

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# PF graphical

PDS-based depth-duration-frequency (DDF) curves  
Latitude: 40.1019°, Longitude: -75.7559°

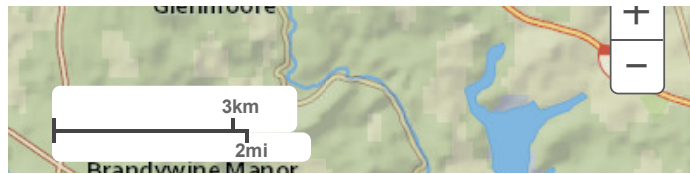


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## Maps & aerials

### Small scale terrain





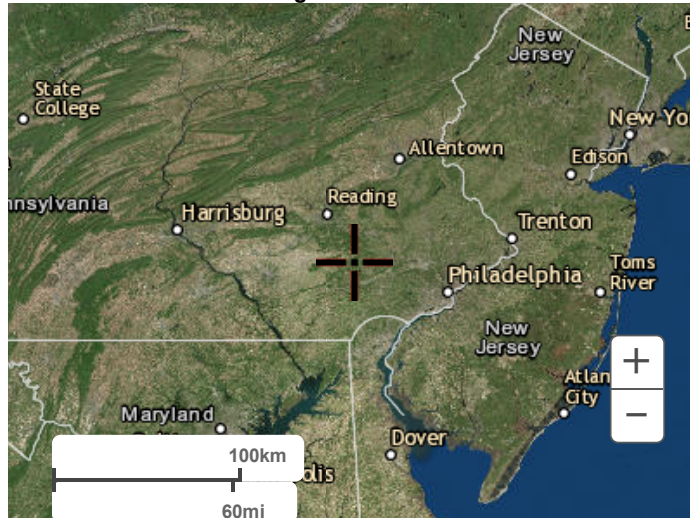
Large scale terrain



Large scale map



Large scale aerial



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**WORKSHEET 1. GENERAL SITE INFORMATION**

**Date:** November 11, 2016

**Project Name:** Fairview Road Valve Site

**Municipality:** Wallace

**County:** Chester

**Total Area (acres):** 2.93

**Major River Basin:** Delaware River

**Watershed:** Brandywine Creek

**Sub Basin:** East Branch Brandywine Creek

**Nearest Surface Water to Receive Runoff:** Marsh Creek

**Chapter 93 - Designated Water Use:** High Quality (HQ) / Trout Stocking Fish (TSF)

**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.

See pre-development drainage area map

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

Woodlands - 0.94 acres

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

0.00 acres

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?<br>Yes/no/n/a | TOTAL AREA<br>(Ac.) | PROTECTED AREA (Ac.) |
|-------------------------------------|-----------------------|---------------------|----------------------|
| Waterbodies                         | N/A                   |                     |                      |
| Floodplains                         | N/A                   |                     |                      |
| Riparian Areas                      | N/A                   |                     |                      |
| Wetlands                            | N/A                   |                     |                      |
| Woodlands                           | Yes                   | 0.94                |                      |
| Natural Drainage Ways               | N/A                   |                     |                      |
| Steep Slopes, 15% - 25%             | N/A                   |                     |                      |
| Steep Slopes, over 25%              | N/A                   |                     |                      |
| Other:                              |                       |                     |                      |
| Other:                              |                       |                     |                      |
| <b>TOTAL EXISTING:</b>              |                       | <b>0.94</b>         | <b>0.00</b>          |

## Worksheet 3. Nonstructural BMP Credits

### PROTECTED AREA

|   |                |
|---|----------------|
| 1.1 Area of Protected Sensitive/Special Value Features (see WS 2) | 0.00 Ac.       |
| 1.2 Area of Riparian Forest Buffer Protection                     | 0.00 Ac.       |
| 3.1 Area of Minimum Disturbance/Reduced Grading                   | 0.00 Ac        |
| <b>TOTAL</b>  | <b>0.00 Ac</b> |

|  |       |                |   |                            |
|--|-------|----------------|---|----------------------------|
| Site Area  | Minus | Protected Area | = | Stormwater Management Area |
| 1.27   | -     | 0              | = | 1.27                       |
| This is the area that requires stormwater management |       |                |   |                            |

### VOLUME CREDITS

#### 3.1 Minimum Soil Compaction (See Chapter 8, page 22 – SW BMP Manual)

|        |                       |               |   |                       |
|--------|-----------------------|---------------|---|-----------------------|
| Lawn   | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|        | _____                 |               |   |                       |
| Meadow | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |

#### 3.3 Protect Existing Trees (See Chapter 8, page 23 – SW BMP Manual)

*For Trees within 100 feet of impervious area:*

|             |                       |               |   |                       |
|-------------|-----------------------|---------------|---|-----------------------|
| Tree Canopy | _____ ft <sup>2</sup> | x 1/2" x 1/12 | = | _____ ft <sup>3</sup> |
|             | _____                 |               |   |                       |

#### 5.1 Disconnect Roof Leaders to Vegetated Areas (See Chapter 8 page 25 – SW BMP Manual)

*For runoff directed to areas protected under 5.8.1 and 5.8.2*

|           |                       |               |   |                       |
|-----------|-----------------------|---------------|---|-----------------------|
| Roof Area | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------|-----------------------|---------------|---|-----------------------|

*For all other disconnected roof areas*

|           |                       |               |   |                       |
|-----------|-----------------------|---------------|---|-----------------------|
| Roof Area | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------|-----------------------|---------------|---|-----------------------|

#### 5.2 Disconnect Non-Roof impervious to Vegetated Areas (See Chapter 8, page 26 – SW BMP Manual)

*For Runoff directed to areas protected under 5.8.1 and 5.8.2*

|                 |                       |               |   |                       |
|-----------------|-----------------------|---------------|---|-----------------------|
| Impervious Area | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------------|-----------------------|---------------|---|-----------------------|

*For all other disconnected roof areas*

|                 |                       |               |   |                       |
|-----------------|-----------------------|---------------|---|-----------------------|
| Impervious Area | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------------|-----------------------|---------------|---|-----------------------|

**TOTAL NON-STRUCTURAL VOLUME CREDIT\*** \_\_\_\_\_ ft<sup>3</sup>

\*For use on Worksheet 5

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

**PROJECT:**

Drainage Area:  
2-Year Rainfall:

Fairview Road Valve Site  
2.93 acres  
3.24 in

Total Site Area:  
Protected Site Area:  
Managed Site Area:

1.27 acres  
N/A acres  
1.27 acres

**Existing Conditions**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S     | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|-------|------------|----------------------------|---|
| Impervious           | -         | 0             | 0.00        | 98 | 0.20  | 0.04       | 3.01                       | 0   |
| Woods                | A         | 40,946        | 0.94        | 30 | 23.33 | 4.67       | 0.09                       | 317   |
| Meadow               | A         | 14,375        | 0.33        | 30 | 23.33 | 4.67       | 0.09                       | 111   |
| <b>TOTAL:</b>        |           | <b>55,321</b> | <b>1.27</b> |    |       |            |                            | <b>428</b>                                    |

**Developed Conditions**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S     | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|-------|------------|----------------------------|---|
| Impervious           | -         | 0             | 0.00        | 98 | 0.20  | 0.04       | 3.01                       | 0   |
| Woods                | A         | 0             | 0.00        | 30 | 23.33 | 4.67       | 0.09                       | 0   |
| Meadow               | A         | 47,045        | 1.08        | 30 | 23.33 | 4.67       | 0.09                       | 364   |
| Impervious - Gravel  | A         | 8,276         | 0.19        | 76 | 3.16  | 0.63       | 1.18                       | 814   |
| <b>TOTAL:</b>        |           | <b>55,321</b> | <b>1.27</b> |    |       |            |                            | <b>1,178</b>                                  |

|  |            |
|--|------------|
| 2-Year Volume Increase (ft <sup>3</sup> ): | <b>750</b> |
|--|------------|

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

1. Runoff (in) =  $Q = (P - 0.2S) / (P + 0.8S)$  where  
 $P = 2\text{-Year Rainfall (in)}$   
 $S = (1000/CN) - 10$

2. Runoff Volume (CF) =  $Q \times \text{Area} \times 1/12$

$Q = \text{Runoff (in)}$   
 $\text{Area} = \text{Land use area (sq. ft.)}$

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

PROJECT: Fairview Road Valve Site  
 2-Year Rainfall: 3.24 in

**RUNOFF TO BERM A (DETAINED 1)**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S     | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|-------|------------|----------------------------|---|
| Impervious - Gravel  | A         | 2,614         | 0.06        | 98 | 0.20  | 0.04       | 3.01                       | 655   |
| Woods                | A         | 1,742         | 0.04        | 30 | 23.33 | 4.67       | 0.09                       | 13  |
| Meadow               | A         | 14,810        | 0.34        | 30 | 23.33 | 4.67       | 0.09                       | 115   |
| <b>TOTAL:</b>        |           | <b>19,166</b> | <b>0.44</b> |    |       |            |                            | <b>783</b>                                    |

**RUNOFF TO BERM B (DETAINED 2)**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S     | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|-------|------------|----------------------------|---|
| Impervious           | -         | 871           | 0.02        | 98 | 0.20  | 0.04       | 3.01                       | 218   |
| Woods                | A         | 0             | 0.00        | 30 | 23.33 | 4.67       | 0.09                       | 0   |
| Meadow               | A         | 25,265        | 0.58        | 30 | 23.33 | 4.67       | 0.09                       | 196   |
| Impervious - Gravel  | A         | 4,792         | 0.11        | 76 | 3.16  | 0.63       | 1.18                       | 471   |
| <b>TOTAL:</b>        |           | <b>30,928</b> | <b>0.71</b> |    |       |            |                            | <b>885</b>                                    |

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: Fairview Road Valve Site  
 SUB-BASIN: \_\_\_\_\_

|   |     |
|---|-----|
| <b>Required Control Volume (ft<sup>3</sup>) - from Worksheet 4:</b>   | 750 |
| <b>Non-structural Volume Credit (ft<sup>3</sup>) - from Worksheet 3:</b><br>(maximum is 25% of required volume) | N/A |
| <b>Structural Volume Reqmt (ft<sup>3</sup>)</b><br><i>(Required Control Volume minus Non-structural Credit)</i> | 750 |

| Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 6 | Area (ft <sup>2</sup> ) | Volume Reduction Permanently Removed (ft <sup>3</sup> ) |
|---|-------------------------|---|
| 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   | 1,628                   | 1,455   |
| 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/Riparian Forest 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:  |                         |   |
| <b>Total Structural Volume (ft<sup>3</sup>):</b>                            |                         | <b>1,455</b>  |
| <b>Structural Volume Requirement (ft<sup>3</sup>):</b>                      |                         | <b>750</b>  |
| <b>DIFFERENCE:</b>  |                         | <b>-705</b>   |

**VOLUME CREDIT DETERMINATION DETAINED 1**

- 1 Detained area runoff volume to BMP = 783 cf
- 2 Storage volume of the BMP = 570 cf
- 3 Infiltrated volume within 72 hours after the 2-yr/24-hr event  
(Infiltration Rate/12) x Infiltration Area x 72 hrs = 1,316 cf

**VOLUME CREDIT DETERMINATION DETAINED 2**

- 1 Detained area runoff volume to BMP = 885 cf
- 2 Storage volume of the BMP = 1,260 cf
- 3 Infiltrated volume within 72 hours after the 2-yr/24-hr event  
(Infiltration Rate/12) x Infiltration Area x 72 hrs = 885 cf

## 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*

**PRIMARY BMPs FOR NITRATE:**

|   | YES                                 | NO                       |
|---|-------------------------------------|--------------------------|
| NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers            | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.5.4 - Cluster Uses at Each Site                                | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.6.1 - Minimize Total Disturbed Area                            | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| NS BMP 5.9.1 - Street Sweeping / Vacuuming                              | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.1 - Riparian Buffer Restoration                      | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.2 - Landscape Restoration                            | <input type="checkbox"/>            | <input type="checkbox"/> |

**SECONDARY BMPs FOR NITRATE:**

|  |                                     |                          |
|--|-------------------------------------|--------------------------|
| NS BMP 5.4.1 - Protect Sensitive / Special Value Features  | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.6.2 - Minimize Soil Compaction                    | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Structural BMP 6.4.5 - Rain Garden / Bioretention          | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.4.8 - Vegetated Swale                     | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.4.9 - Vegetated Filter Strip              | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.6.1 - Constructed Wetland                 | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.1 - Riparian Buffer Restoration         | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.2 - Landscape Restoration               | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.3 - Soils Amendment/Restoration         | <input checked="" type="checkbox"/> | <input type="checkbox"/> |

**TIME OF CONCENTRATION ADJUSTMENT DETAINED 1**

POST CONSTRUCTION TC TO BMP (DETAINED TC) BEFORE ADJUSTMENT 6.3 MIN

STRUCTURAL VOLUME PROVIDED BY BMP 570 CF

RATES OF RUNOFF TO THE BMP (FROM HYDRAFLOW REPORT)

| Storm Event  | Q (CFS) |
|--------------|---------|
| 2 YR/24 HR   | -       |
| 10 YR/24 HR  | 0.003   |
| 50 YR/24 HR  | 0.125   |
| 100 YR/24 HR | 0.329   |

ADDITIONAL RESIDENCE TIME (MIN) = (STRUCTURAL VOLUME PROVIDED BY BMP / RATE OF RUNOFF TO BMP) / 60

| Storm Event  | Q (CFS) | Additional Residence Time (min.) |
|--------------|---------|----------------------------------|
| 2 YR/24 HR   | -       | n/a - detained                   |
| 10 YR/24 HR  | 0.003   | 3166.667                         |
| 50 YR/24 HR  | 0.125   | 76.000                           |
| 100 YR/24 HR | 0.329   | 28.875                           |

ADJUSTED TC = POST CONSTRUCTION TC TO BMP BEFORE ADJUSTMENT + ADDITIONAL RESIDENCE TIME

| Storm Event  | Q (CFS) | Additional Residence Time (min.) | Adjusted Time of Concentration (min.) |
|--------------|---------|----------------------------------|---------------------------------------|
| 2 YR/24 HR   | -       | n/a - detained                   | 6.300                                 |
| 10 YR/24 HR  | 0.003   | 3166.667                         | 3172.967                              |
| 50 YR/24 HR  | 0.125   | 76.000                           | 82.300                                |
| 100 YR/24 HR | 0.329   | 28.875                           | 35.175                                |

**TIME OF CONCENTRATION ADJUSTMENT DETAINED 2**

POST CONSTRUCTION TC TO BMP (DETAINED TC) BEFORE ADJUSTMENT 8.3 MIN

STRUCTURAL VOLUME PROVIDED BY BMP 885 CF

RATES OF RUNOFF TO THE BMP (FROM HYDRAFLOW REPORT)

| Storm Event  | Q (CFS) |
|--------------|---------|
| 2 YR/24 HR   | -       |
| 10 YR/24 HR  | 0.014   |
| 50 YR/24 HR  | 0.409   |
| 100 YR/24 HR | 0.797   |

ADDITIONAL RESIDENCE TIME (MIN) = (STRUCTURAL VOLUME PROVIDED BY BMP / RATE OF RUNOFF TO BMP) / 60

| Storm Event  | Q (CFS) | Additional Residence Time (min.) |
|--------------|---------|----------------------------------|
| 2 YR/24 HR   | -       | n/a - detained                   |
| 10 YR/24 HR  | 0.014   | 1053.571                         |
| 50 YR/24 HR  | 0.409   | 36.064                           |
| 100 YR/24 HR | 0.797   | 18.507                           |

ADJUSTED TC = POST CONSTRUCTION TC TO BMP BEFORE ADJUSTMENT + ADDITIONAL RESIDENCE TIME

| Storm Event  | Q (CFS) | Additional Residence Time (min.) | Adjusted Time of Concentration (min.) |
|--------------|---------|----------------------------------|---------------------------------------|
| 2 YR/24 HR   | -       | n/a - detained                   | 8.300                                 |
| 10 YR/24 HR  | 0.014   | 1053.571                         | 1061.871                              |
| 50 YR/24 HR  | 0.409   | 36.064                           | 44.364                                |
| 100 YR/24 HR | 0.797   | 18.507                           | 26.807                                |

INFILTRATION BERM DEWATERING CALCULATION

SITE NAME: Fairview Road Berm A

STORAGE VOLUME                      570 CF  
DESIGN INFILTRATION RATE        0.3 IN/HR      BASED ON IT-02  
INFILTRATION AREA                 687 SF

DEWATERING TIME = STORAGE VOLUME / ((DESIGN INFILTRATION RATE /12) \* INFILTRATION AREA)

**DEWATERING TIME =                      33.2 HOURS**

INFILTRATION BERM DEWATERING CALCULATION

SITE NAME: Fairview Road Berm B

STORAGE VOLUME                      885 CF  
DESIGN INFILTRATION RATE        0.2 IN/HR      BASED ON IT-A  
INFILTRATION AREA                 941 SF

DEWATERING TIME = STORAGE VOLUME / ((DESIGN INFILTRATION RATE /12) \* INFILTRATION AREA)

**DEWATERING TIME =                      56.4 HOURS**

## Worksheet for Circular Pipe - 1

### Project Description

|                 |                    |
|-----------------|--------------------|
| Friction Method | Manning Formula    |
| Solve For       | Full Flow Capacity |

### Input Data

|                       |         |                    |
|-----------------------|---------|--------------------|
| Roughness Coefficient | 0.012   |                    |
| Channel Slope         | 0.00500 | ft/ft              |
| Normal Depth          | 0.33    | ft                 |
| Diameter              | 0.33    | ft                 |
| Discharge             | 0.15    | ft <sup>3</sup> /s |

### Results

|                   |             |                    |
|-------------------|-------------|--------------------|
| Discharge         | 0.15        | ft <sup>3</sup> /s |
| Normal Depth      | 0.33        | ft                 |
| Flow Area         | 0.09        | ft <sup>2</sup>    |
| Wetted Perimeter  | 1.05        | ft                 |
| Hydraulic Radius  | 0.08        | ft                 |
| Top Width         | 0.00        | ft                 |
| Critical Depth    | 0.21        | ft                 |
| Percent Full      | 100.0       | %                  |
| Critical Slope    | 0.00897     | ft/ft              |
| Velocity          | 1.67        | ft/s               |
| Velocity Head     | 0.04        | ft                 |
| Specific Energy   | 0.38        | ft                 |
| Froude Number     | 0.00        |                    |
| Maximum Discharge | 0.16        | ft <sup>3</sup> /s |
| Discharge Full    | 0.15        | ft <sup>3</sup> /s |
| Slope Full        | 0.00500     | ft/ft              |
| Flow Type         | SubCritical |                    |

### GVF Input Data

|                  |      |    |
|------------------|------|----|
| Downstream Depth | 0.00 | ft |
| Length           | 0.00 | ft |
| Number Of Steps  | 0    |    |

### GVF Output Data

|                             |      |    |
|-----------------------------|------|----|
| Upstream Depth              | 0.00 | ft |
| Profile Description         |      |    |
| Profile Headloss            | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | %  |

---

## Worksheet for Circular Pipe - 1

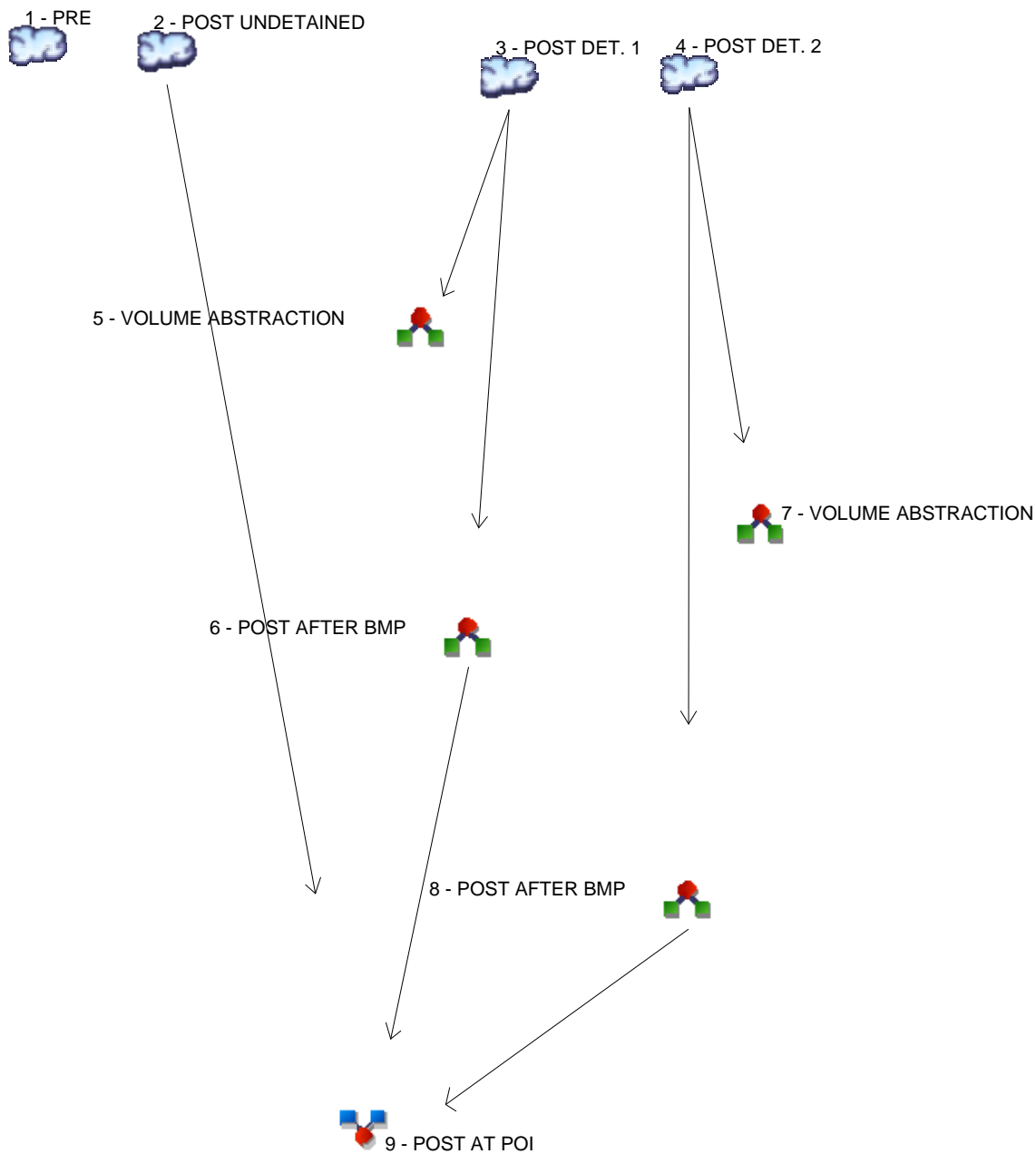
---

### GVF Output Data

|                        |          |       |
|------------------------|----------|-------|
| Normal Depth Over Rise | 100.00   | %     |
| Downstream Velocity    | Infinity | ft/s  |
| Upstream Velocity      | Infinity | ft/s  |
| Normal Depth           | 0.33     | ft    |
| Critical Depth         | 0.21     | ft    |
| Channel Slope          | 0.00500  | ft/ft |
| Critical Slope         | 0.00897  | ft/ft |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. | Origin     | Description        |
|------|------------|--------------------|
| 1    | SCS Runoff | PRE                |
| 2    | SCS Runoff | POST UNDETAINED    |
| 3    | SCS Runoff | POST DET. 1        |
| 4    | SCS Runoff | POST DET. 2        |
| 5    | Diversion1 | VOLUME ABSTRACTION |
| 6    | Diversion2 | POST AFTER BMP     |
| 7    | Diversion1 | VOLUME ABSTRACTION |
| 8    | Diversion2 | POST AFTER BMP     |
| 9    | Combine    | POST AT POI        |

# Hydrograph Return Period Recap

Hydranow 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               | -----         | -----              | 0.000 | ----- | ----- | 0.010 | ----- | 0.147 | 0.628  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | 0.006 | ----- | 0.090 | 0.383  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | 0.003 | ----- | 0.125 | 0.329  | POST DET. 1            |
| 4        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | 0.014 | ----- | 0.409 | 0.797  | POST DET. 2            |
| 5        | Diversion1               | 3             | -----              | 0.000 | ----- | ----- | 0.003 | ----- | 0.125 | 0.329  | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 3             | -----              | 0.000 | ----- | ----- | 0.000 | ----- | 0.010 | 0.028  | POST AFTER BMP         |
| 7        | Diversion1               | 4             | -----              | 0.000 | ----- | ----- | 0.014 | ----- | 0.409 | 0.797  | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 4             | -----              | 0.000 | ----- | ----- | 0.000 | ----- | 0.019 | 0.053  | POST AFTER BMP         |
| 9        | Combine                  | 2, 6, 8       | -----              | 0.000 | ----- | ----- | 0.006 | ----- | 0.090 | 0.383  | POST AT POI            |

# 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               | 0.000           | 1                   | n/a                | 0                     | -----         | -----                  | -----                    | PRE                    |  |
| 2                 | SCS Runoff               | 0.000           | 1                   | n/a                | 0                     | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3                 | SCS Runoff               | 0.000           | 1                   | n/a                | 0                     | -----         | -----                  | -----                    | POST DET. 1            |  |
| 4                 | SCS Runoff               | 0.000           | 1                   | 1440               | 2                     | -----         | -----                  | -----                    | POST DET. 2            |  |
| 5                 | Diversion1               | 0.000           | 1                   | n/a                | 0                     | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 6                 | Diversion2               | 0.000           | 1                   | n/a                | 0                     | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 7                 | Diversion1               | 0.000           | 1                   | 1440               | 2                     | 4             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 8                 | Diversion2               | 0.000           | 1                   | n/a                | 0                     | 4             | -----                  | -----                    | POST AFTER BMP         |  |
| 9                 | Combine                  | 0.000           | 1                   | n/a                | 0                     | 2, 6, 8       | -----                  | -----                    | POST AT POI            |  |
| Fairview Road.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Thursday, 10 / 27 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

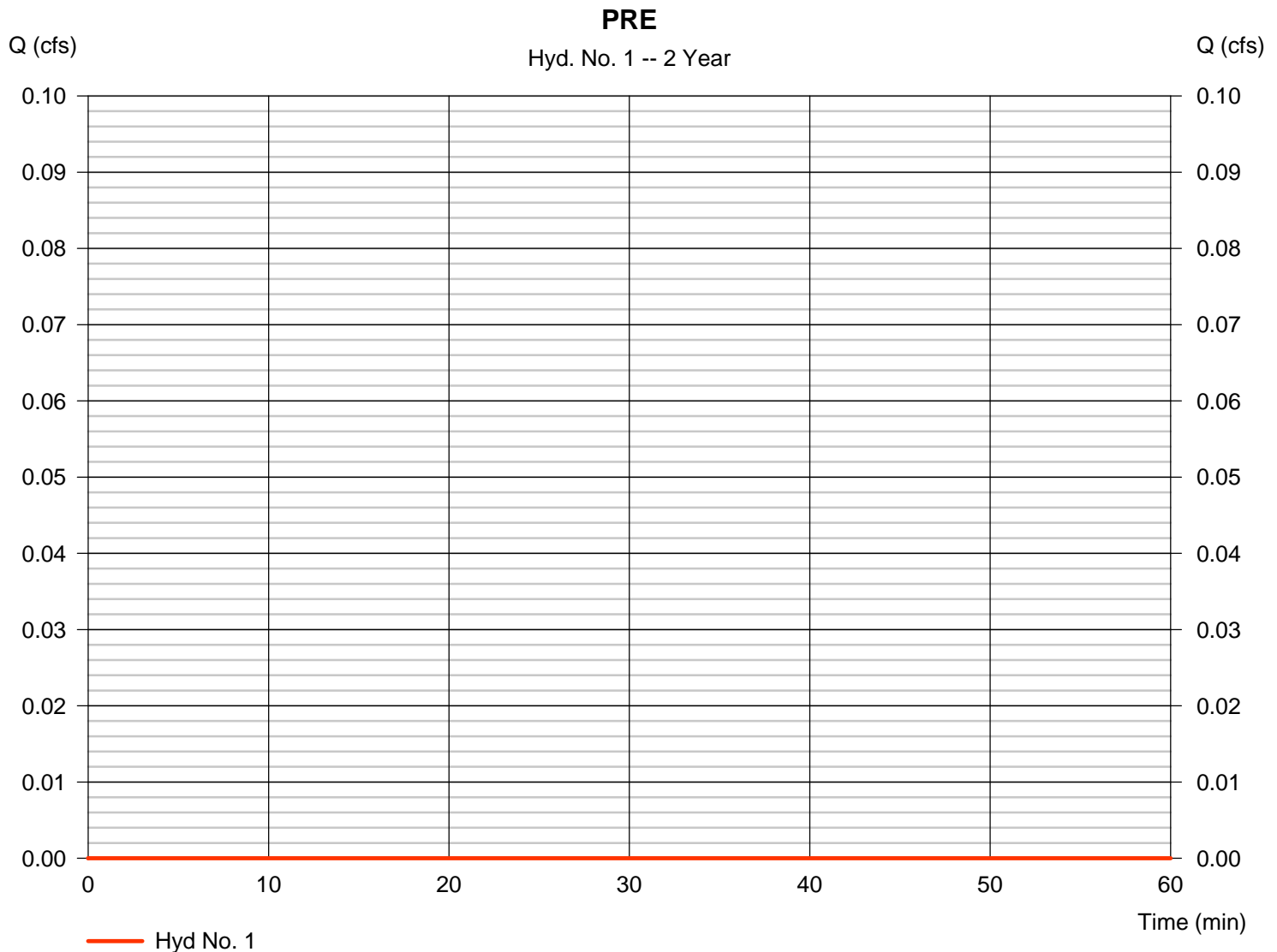
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

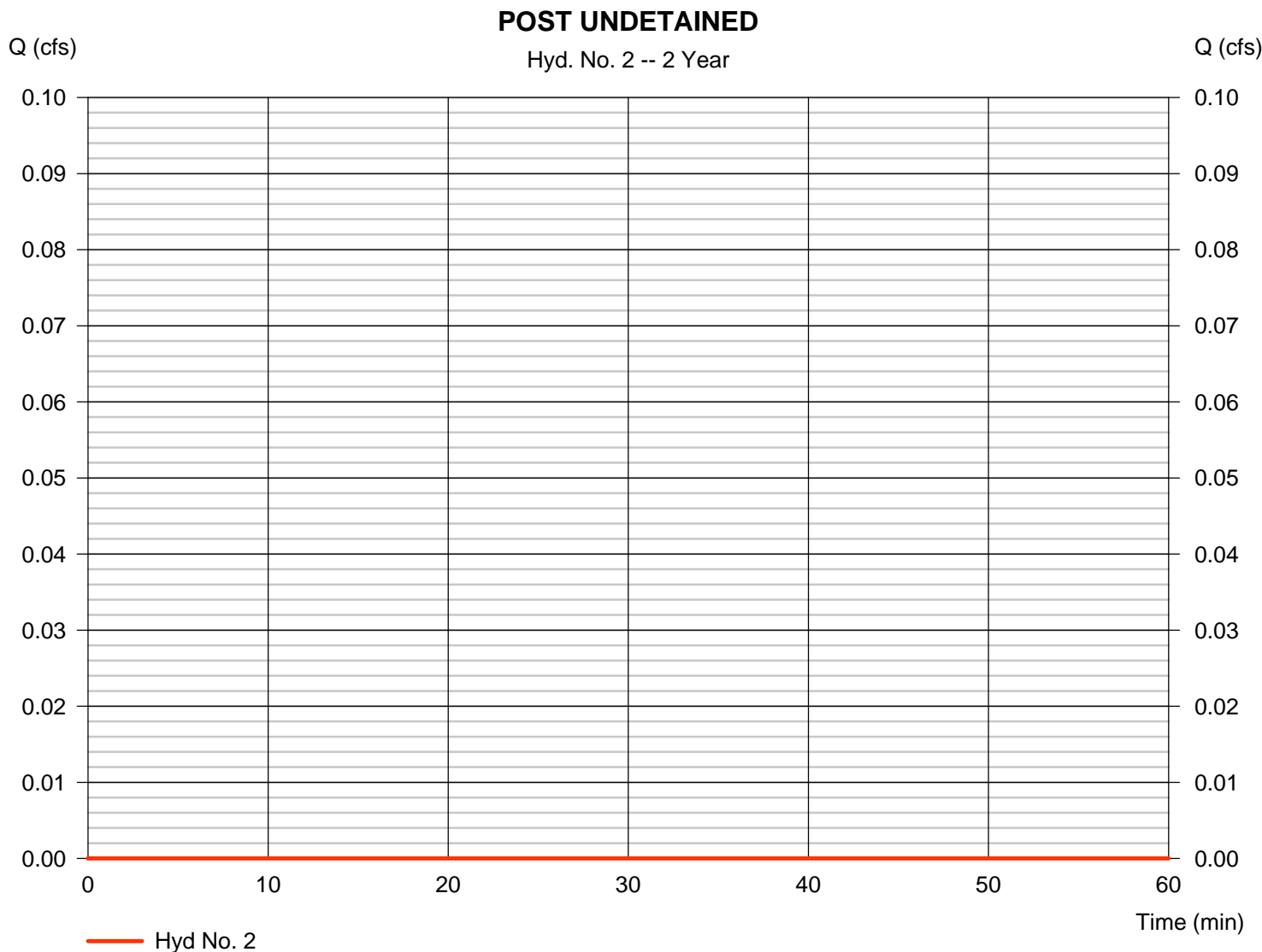
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|---------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |               |               |               |                  |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.24        | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 1.31        | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 9.65</b>    |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                  |
| Flow length (ft)                   | = 493.00      | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 10.30       | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved     | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =5.18         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 1.59</b>    |
| <b>Channel Flow</b>                |               |               |               |                  |
| X sectional flow area (sqft)       | = 16.00       | 0.00          | 0.00          |                  |
| Wetted perimeter (ft)              | = 28.00       | 0.00          | 0.00          |                  |
| Channel slope (%)                  | = 7.65        | 0.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015       | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =18.88        | 0.00          | 0.00          |                  |
| Flow length (ft)                   | 432.0         | 0.0           | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.38</b>    |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

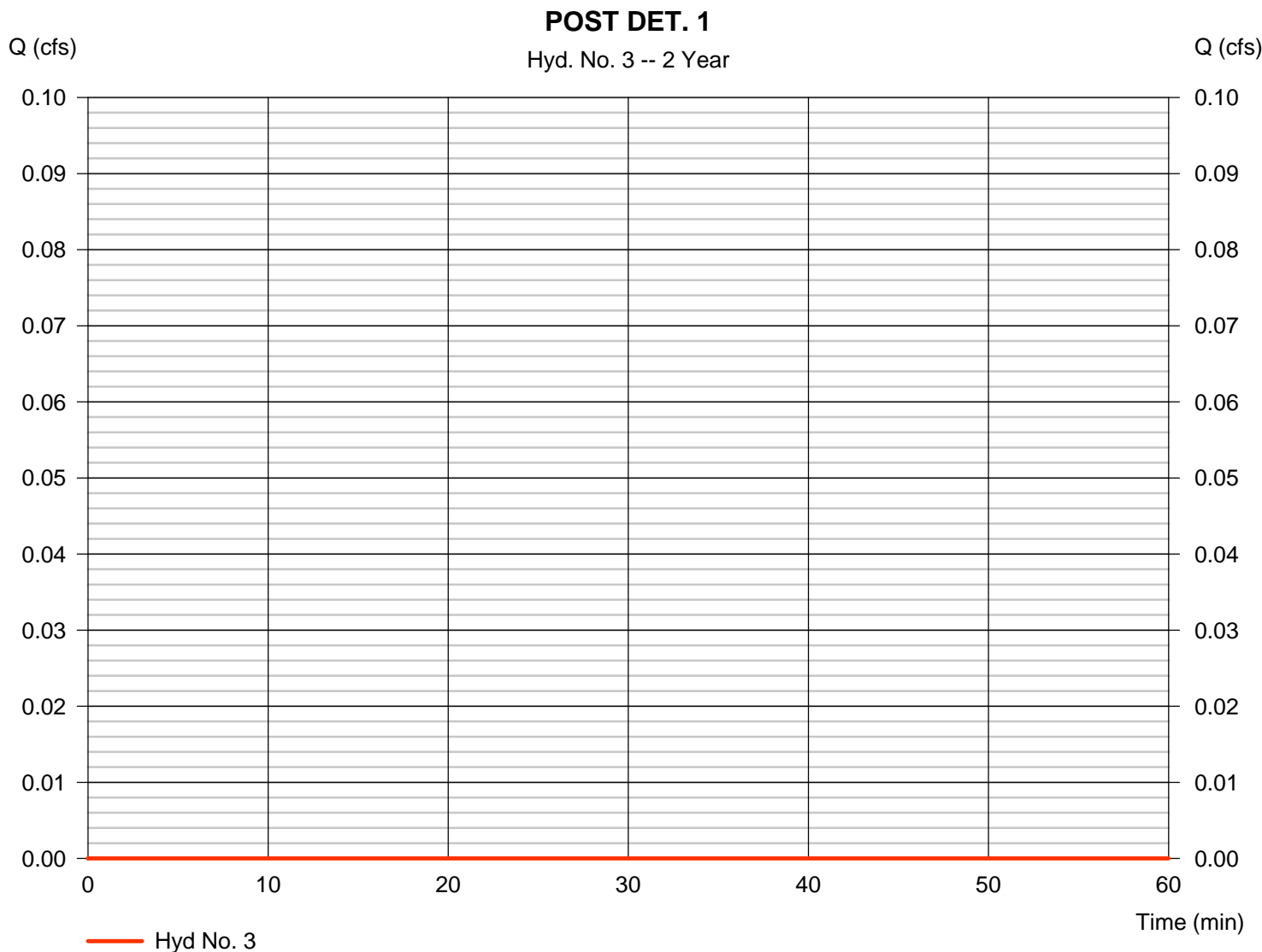
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 6.30 min  |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 3

POST DET. 1

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.24        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.50        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 5.43</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 5.43</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 192.00      | 94.00                | 22.00                |                 |
| Watercourse slope (%)              | = 14.60       | 6.90                 | 50.00                |                 |
| Surface description                | = Unpaved     | Paved                | Unpaved              |                 |
| Average velocity (ft/s)            | =6.16         | 5.34                 | 11.41                |                 |
| <b>Travel Time (min)</b>           | <b>= 0.52</b> | <b>+</b> <b>0.29</b> | <b>+</b> <b>0.03</b> | <b>= 0.84</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>6.30 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

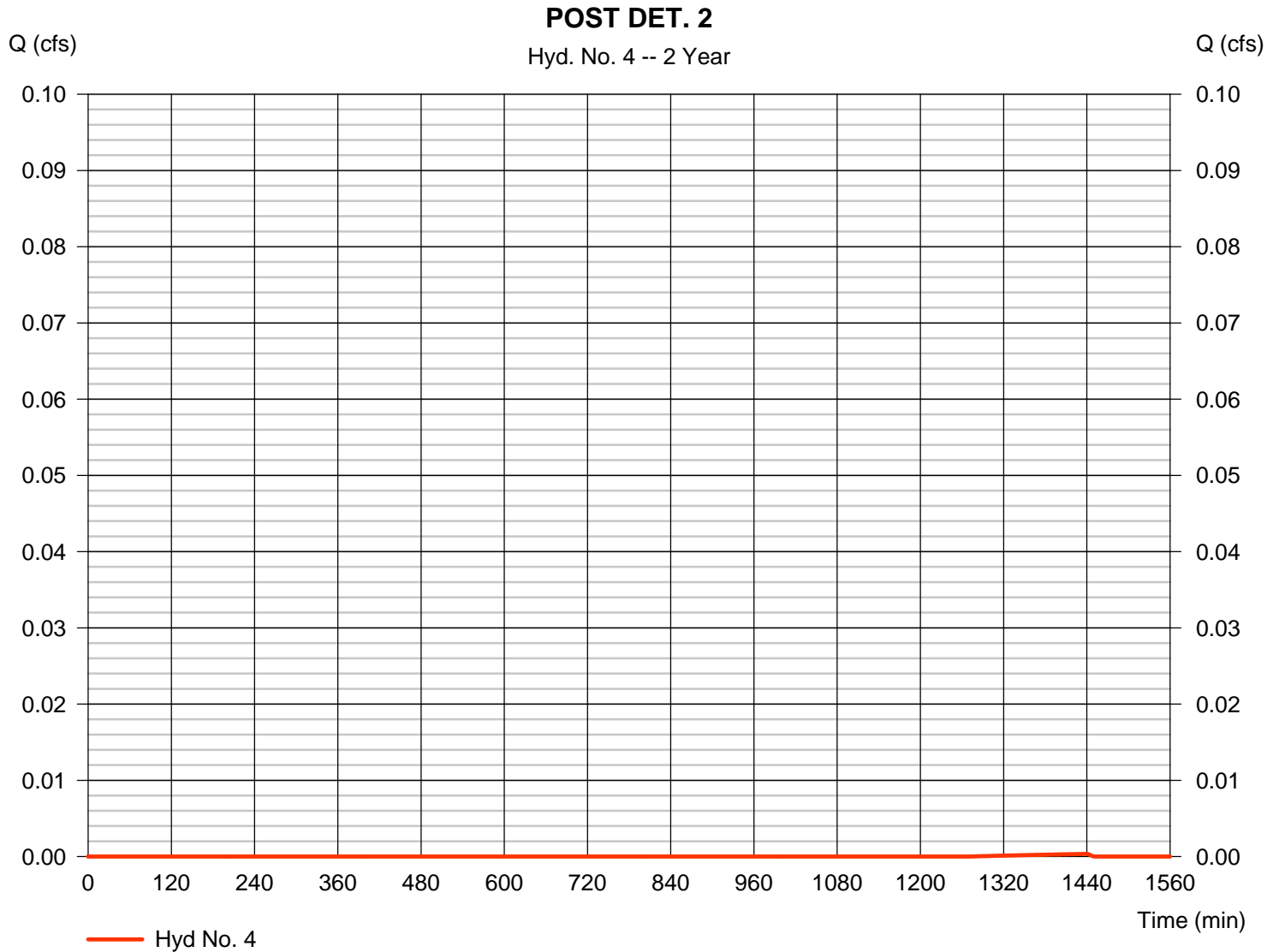
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 1440 min  |
| Time interval   | = 1 min      | Hyd. volume        | = 2 cuft    |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.30 min  |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 4

POST DET. 2

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 4.50        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 5.89</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>5.89</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 233.00      |          | 142.00      |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 10.10       |          | 8.20        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Unpaved     |          | Paved       |          |                 |
| Average velocity (ft/s)            | =5.13         |          | 4.62        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.76</b> | <b>+</b> | <b>0.51</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.27</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 0.09        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 1.05        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 0.50        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =1.32         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | 87.0          |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 1.10</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.10</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>8.30 min</b> |

# Hydrograph Report

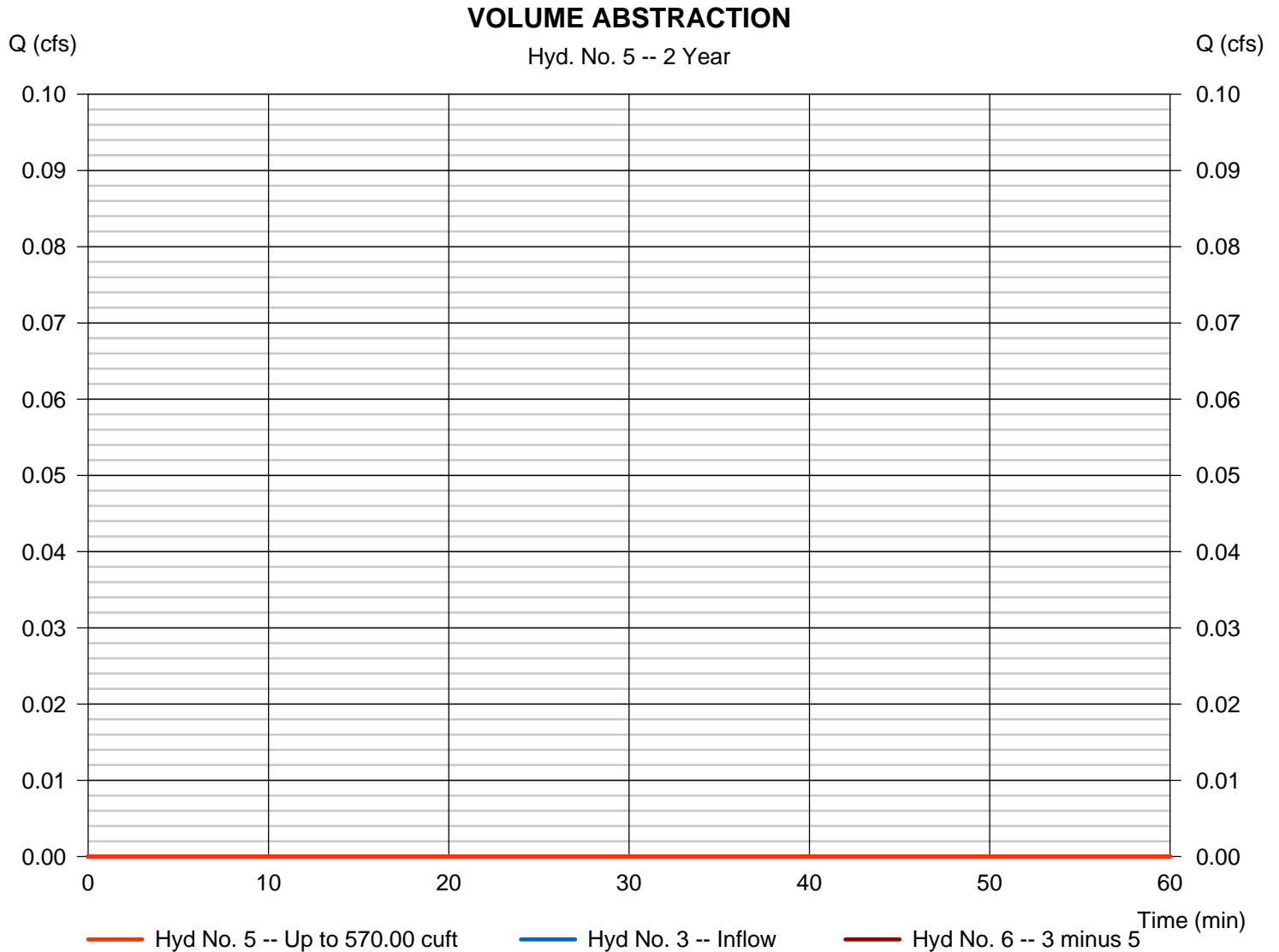
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

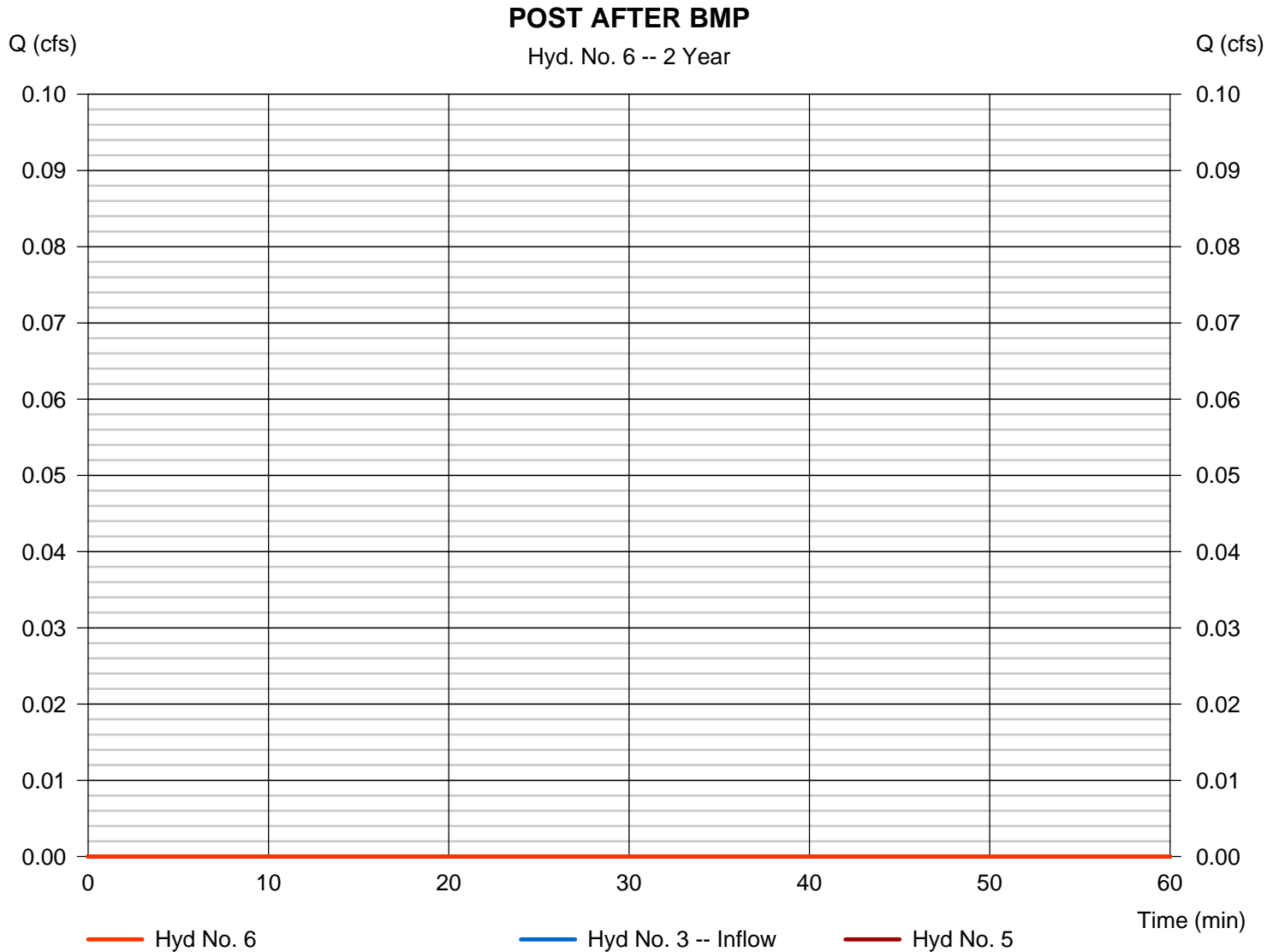
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

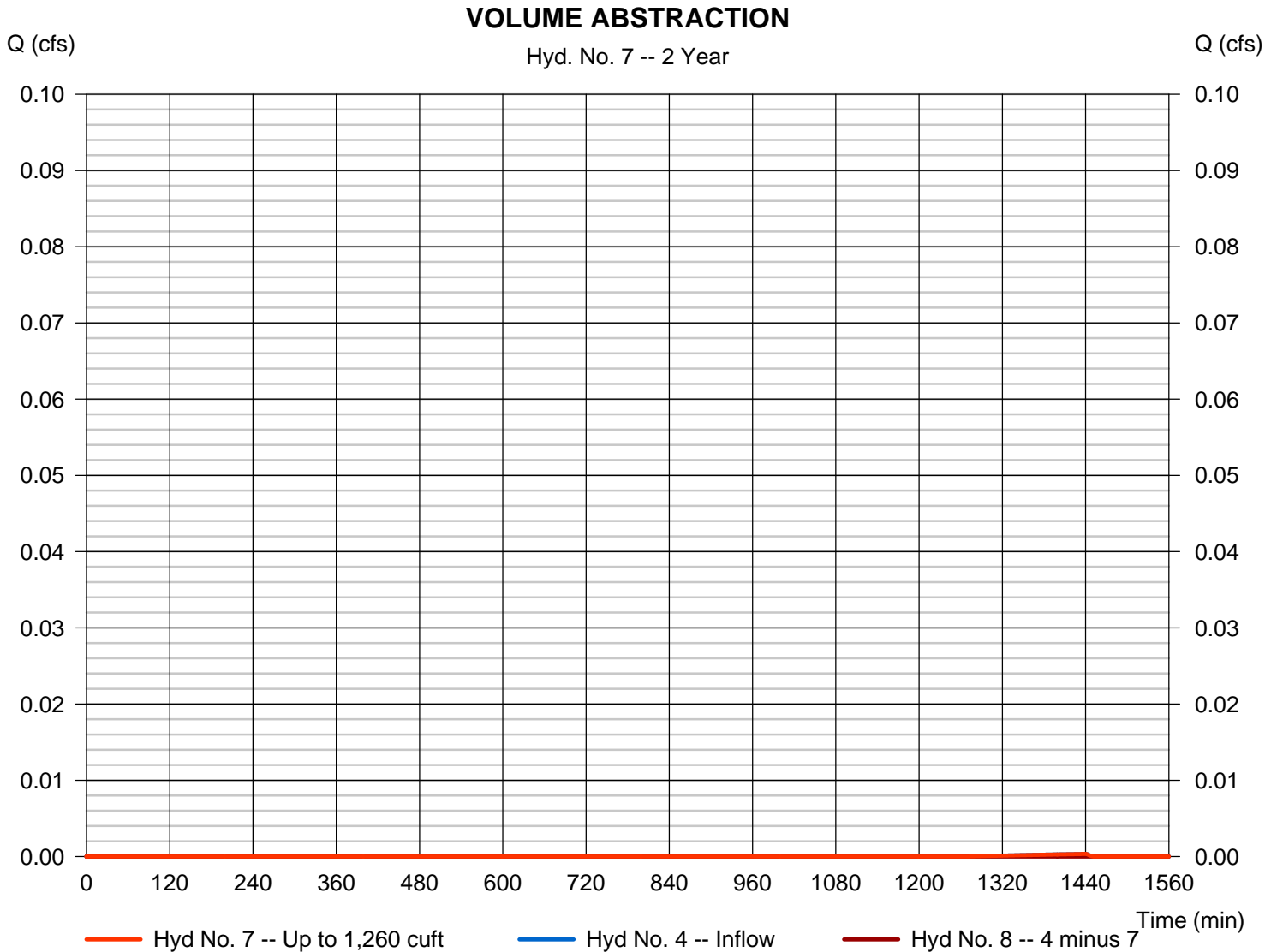
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 1440 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 2 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

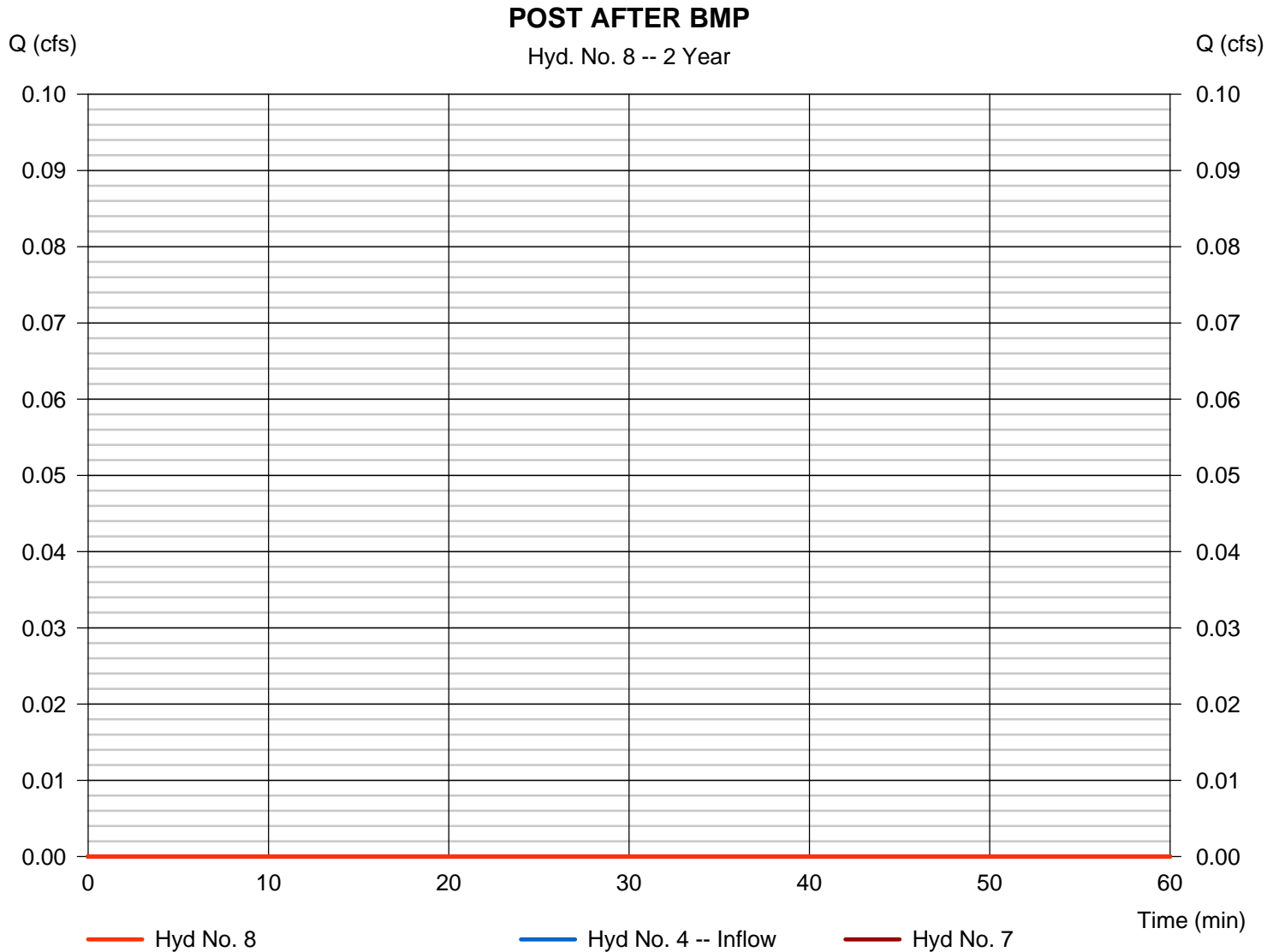
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

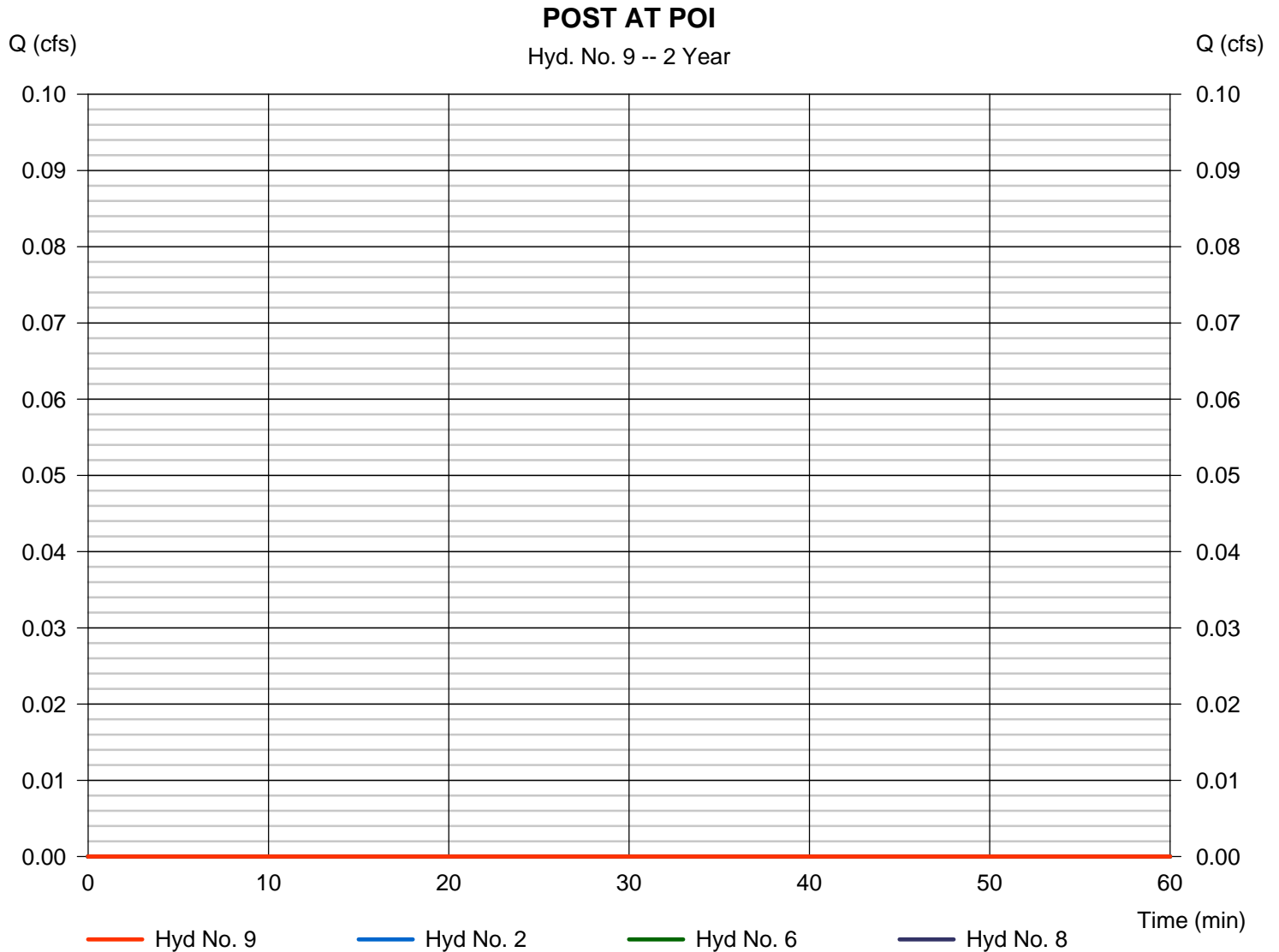
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
Storm frequency = 2 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 6, 8

Peak discharge = 0.000 cfs  
Time to peak = n/a  
Hyd. volume = 0 cuft  
Contrib. drain. area = 1.790 ac



# 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               | 0.010           | 1                   | 1440               | 238                    | -----         | -----                  | -----                    | PRE                    |  |
| 2                 | SCS Runoff               | 0.006           | 1                   | 1440               | 145                    | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3                 | SCS Runoff               | 0.003           | 1                   | 918                | 122                    | -----         | -----                  | -----                    | POST DET. 1            |  |
| 4                 | SCS Runoff               | 0.014           | 1                   | 747                | 378                    | -----         | -----                  | -----                    | POST DET. 2            |  |
| 5                 | Diversion1               | 0.003           | 1                   | 918                | 122                    | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 6                 | Diversion2               | 0.000           | 1                   | n/a                | 0                      | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 7                 | Diversion1               | 0.014           | 1                   | 747                | 378                    | 4             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 8                 | Diversion2               | 0.000           | 1                   | n/a                | 0                      | 4             | -----                  | -----                    | POST AFTER BMP         |  |
| 9                 | Combine                  | 0.006           | 1                   | 1440               | 145                    | 2, 6, 8       | -----                  | -----                    | POST AT POI            |  |
| Fairview Road.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Thursday, 10 / 27 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

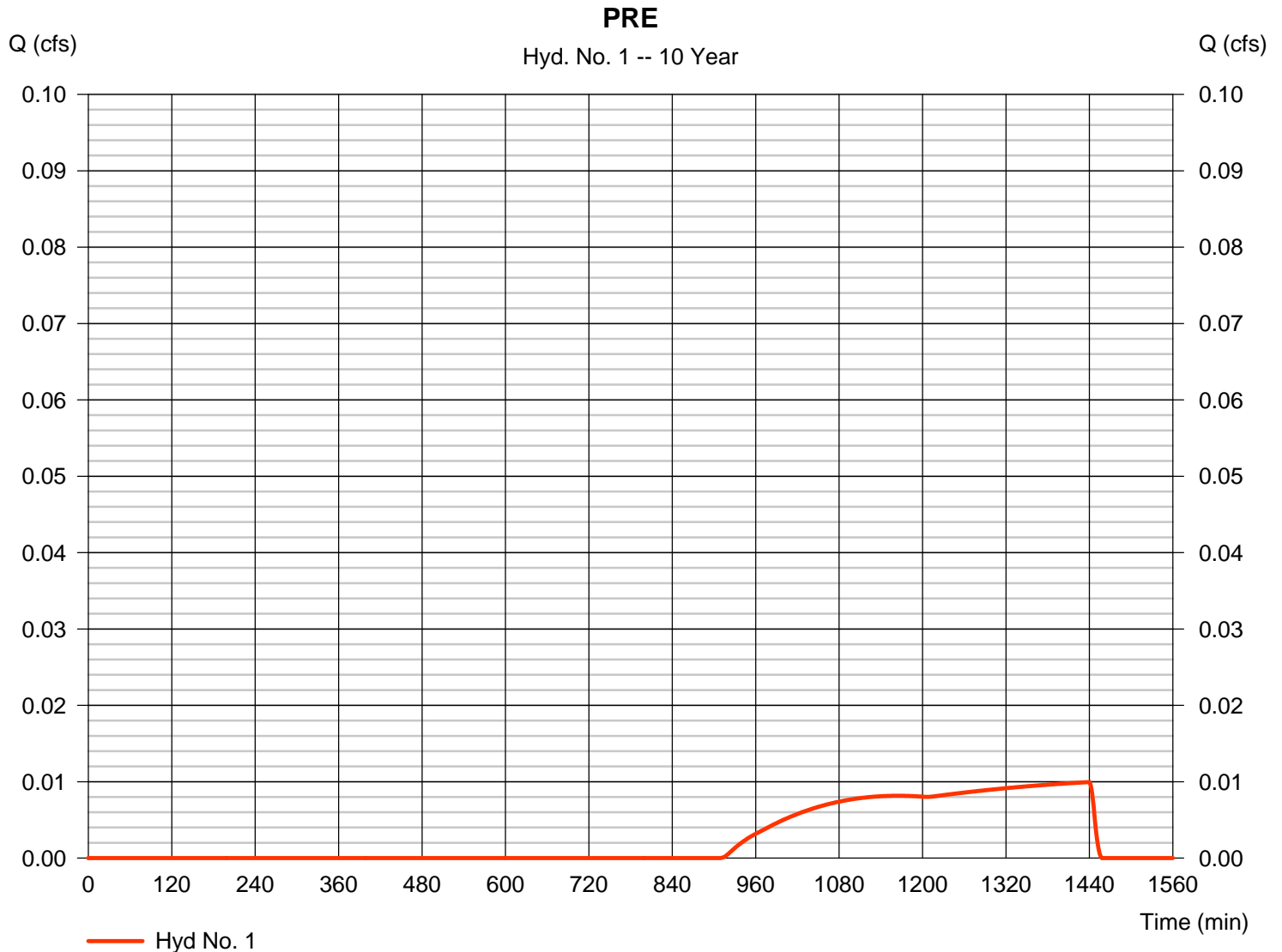
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.010 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 1440 min  |
| Time interval   | = 1 min      | Hyd. volume        | = 238 cuft  |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

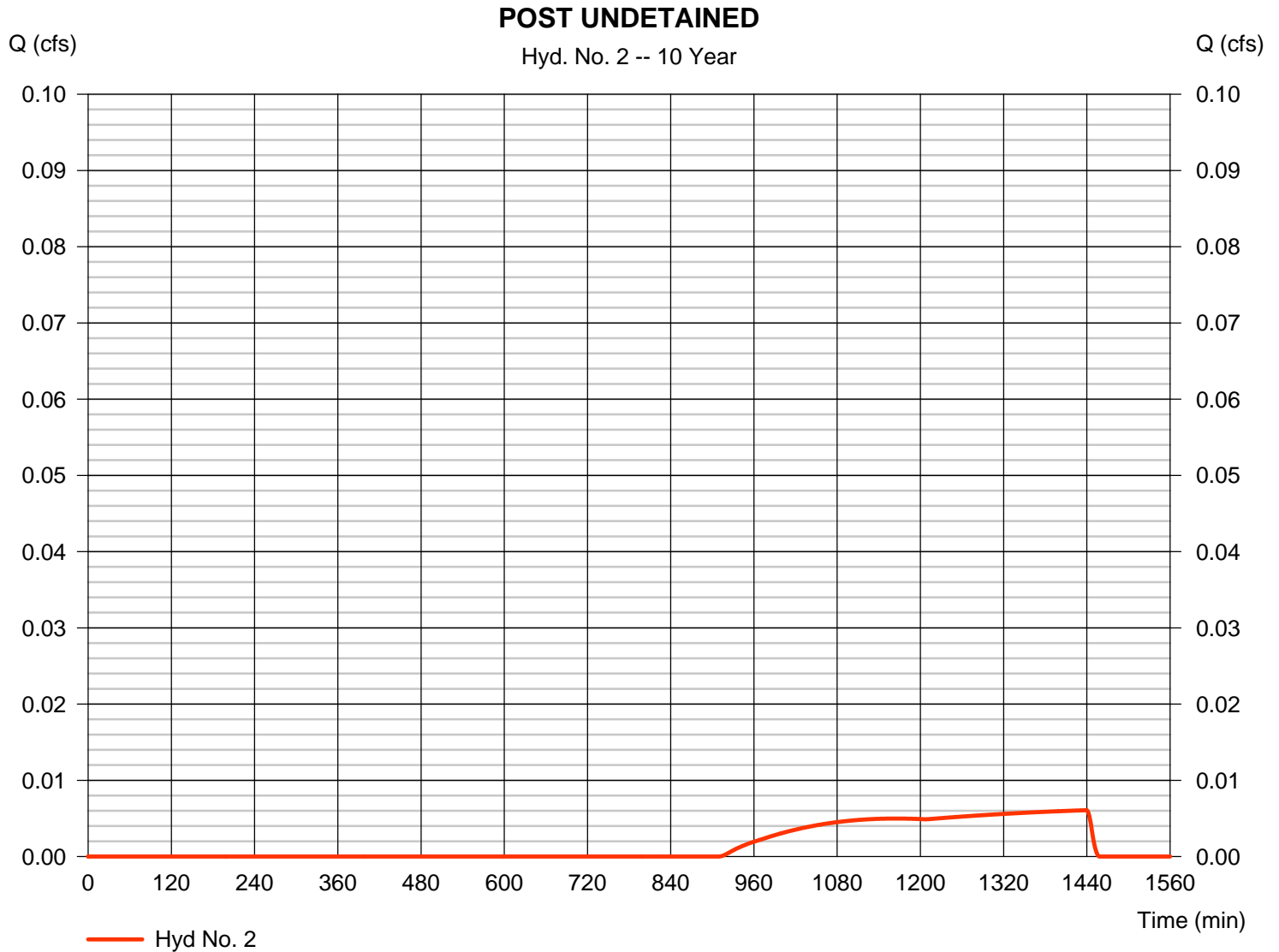
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.006 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 1440 min  |
| Time interval   | = 1 min      | Hyd. volume        | = 145 cuft  |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

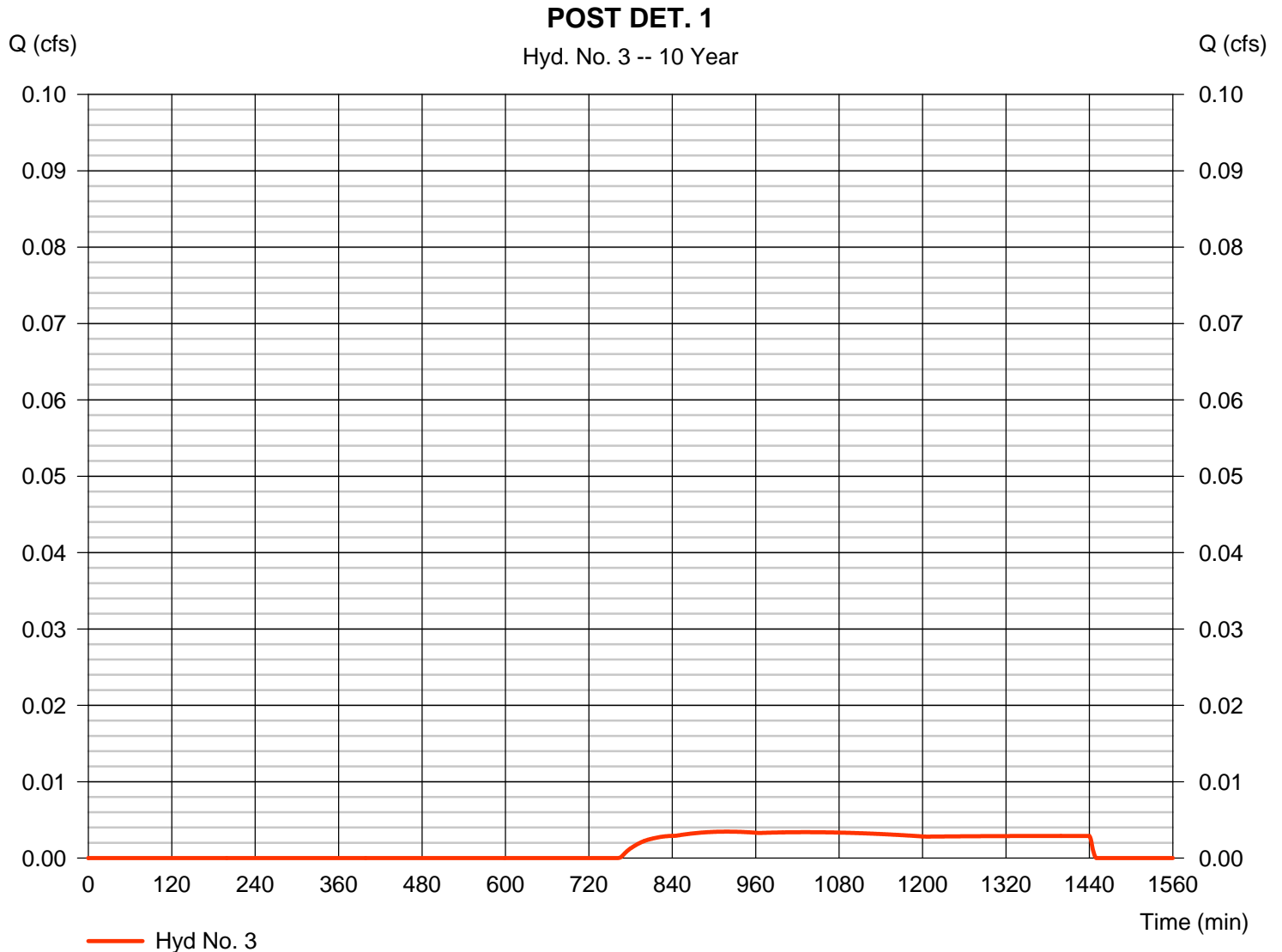
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.003 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 918 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 122 cuft  |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 6.30 min  |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

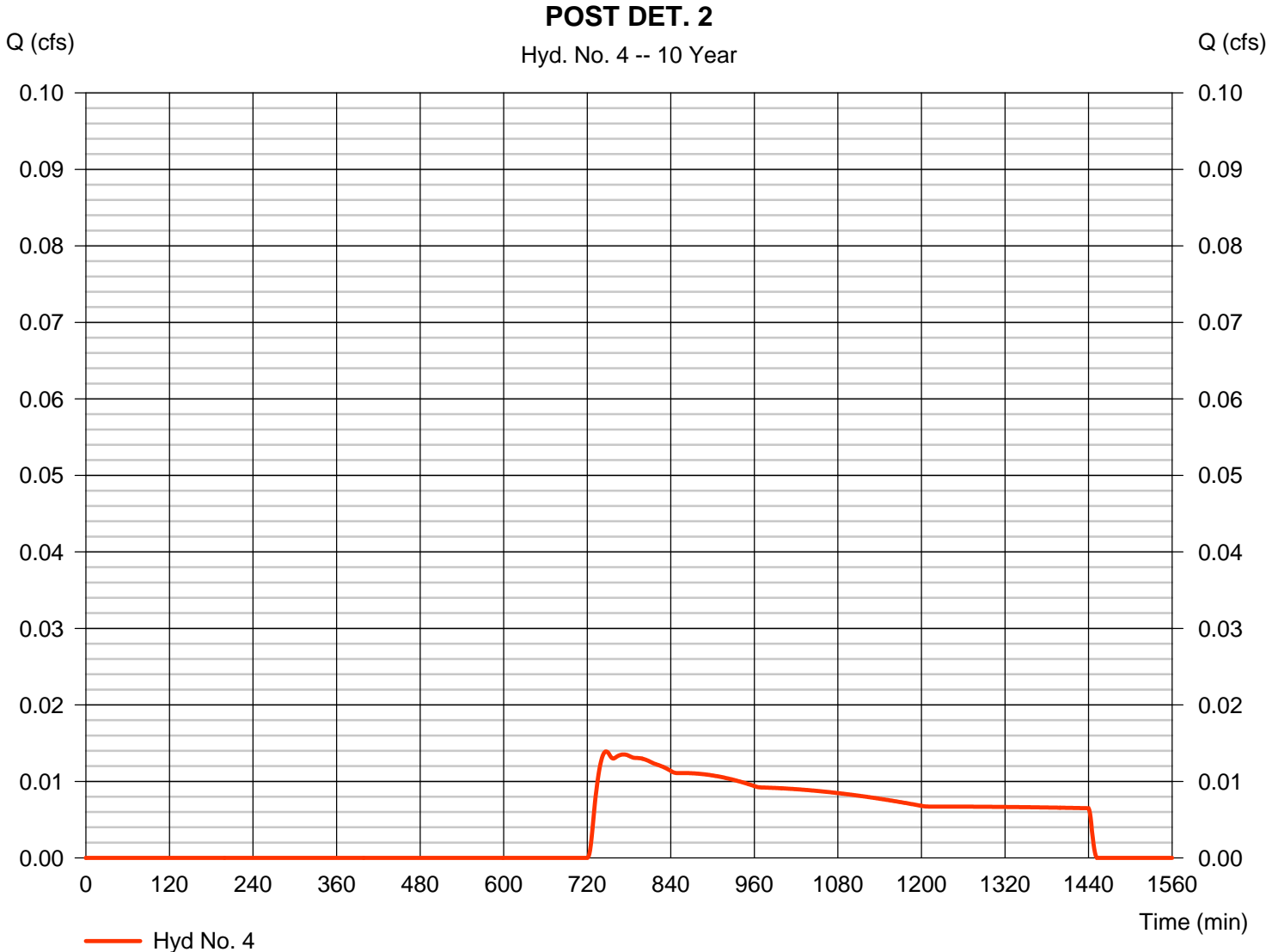
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.014 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 747 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 378 cuft  |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.30 min  |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

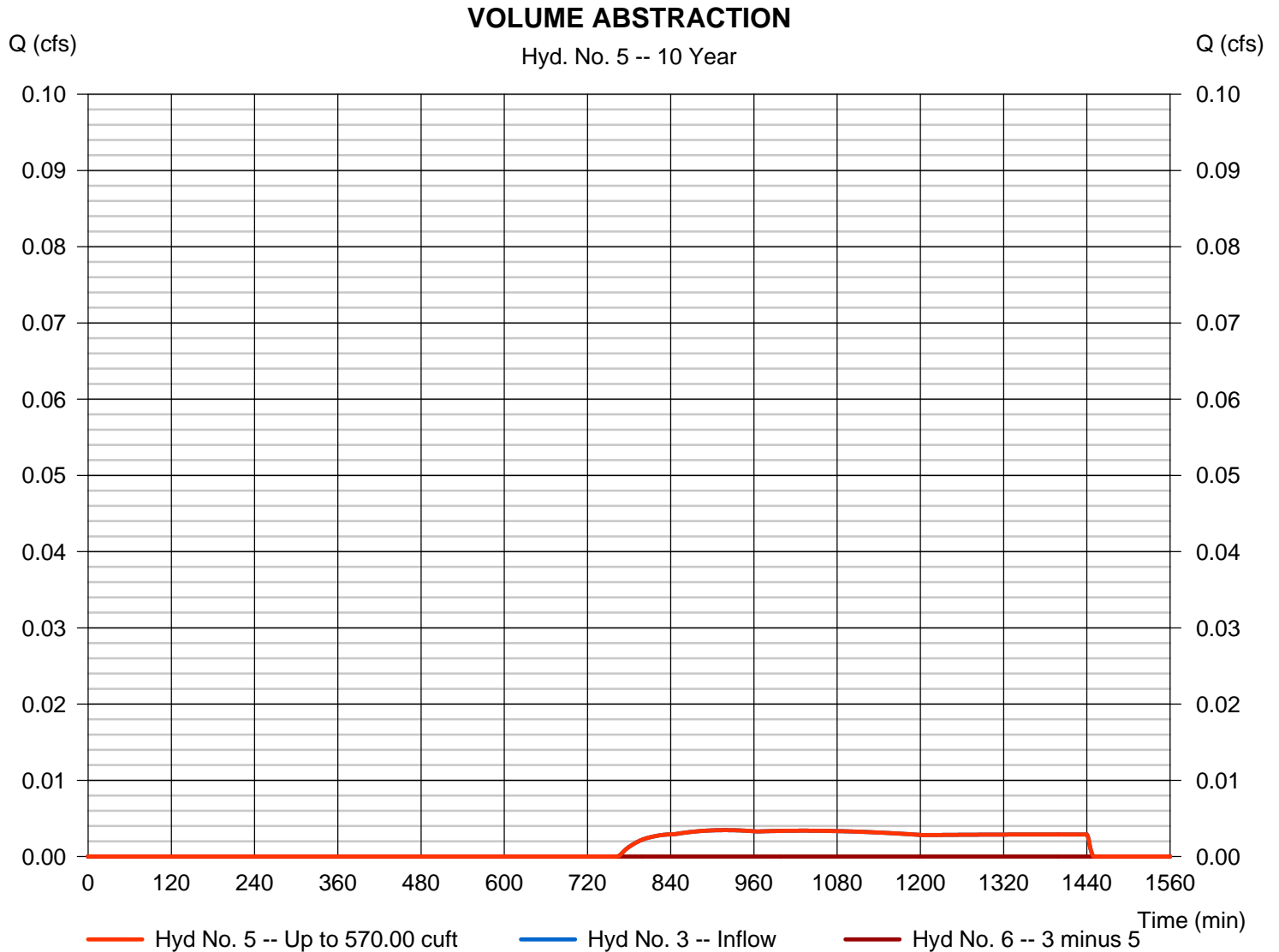
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.003 cfs   |
| Storm frequency   | = 10 yrs             | Time to peak      | = 918 min     |
| Time interval     | = 1 min              | Hyd. volume       | = 122 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

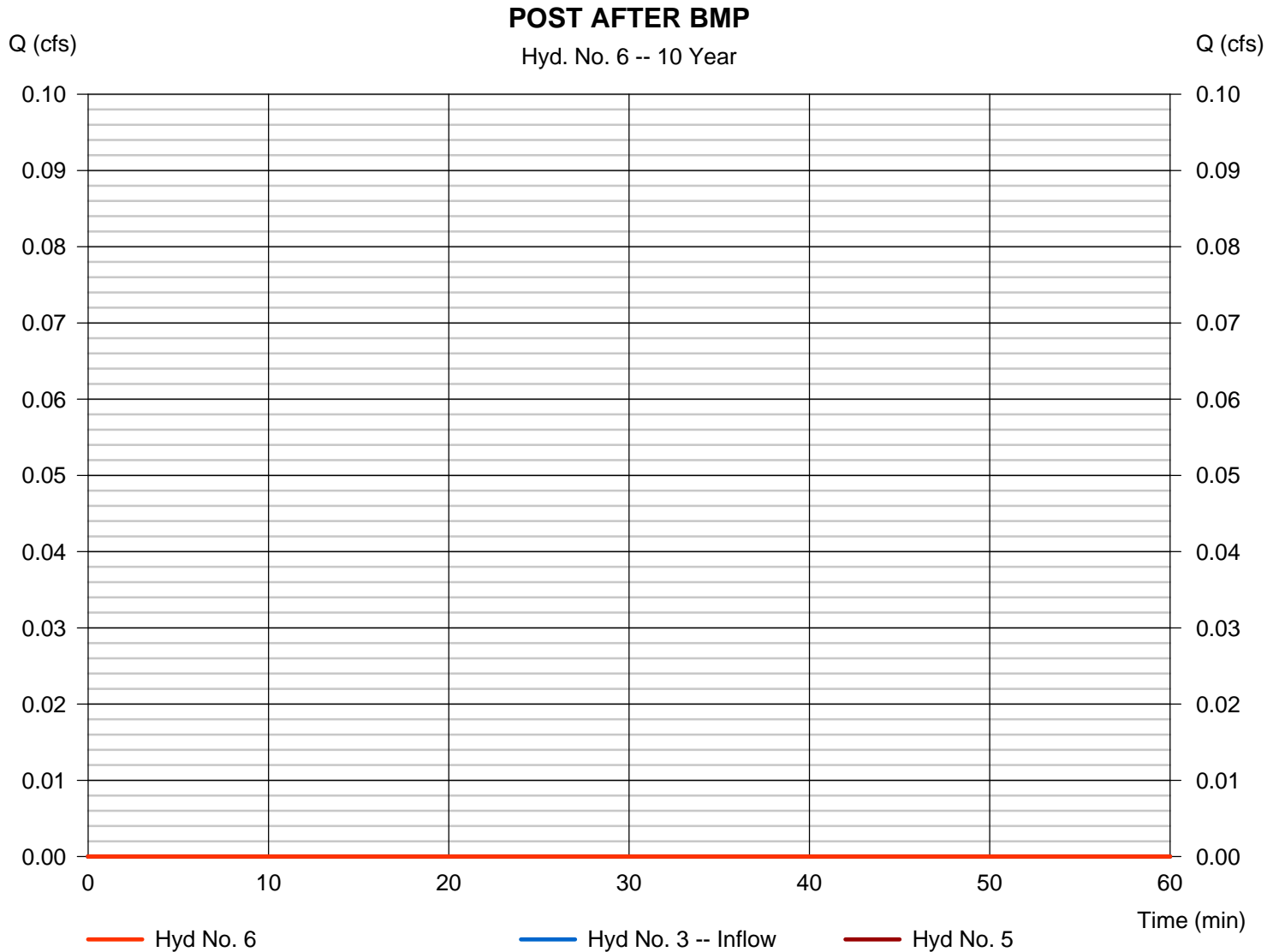
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

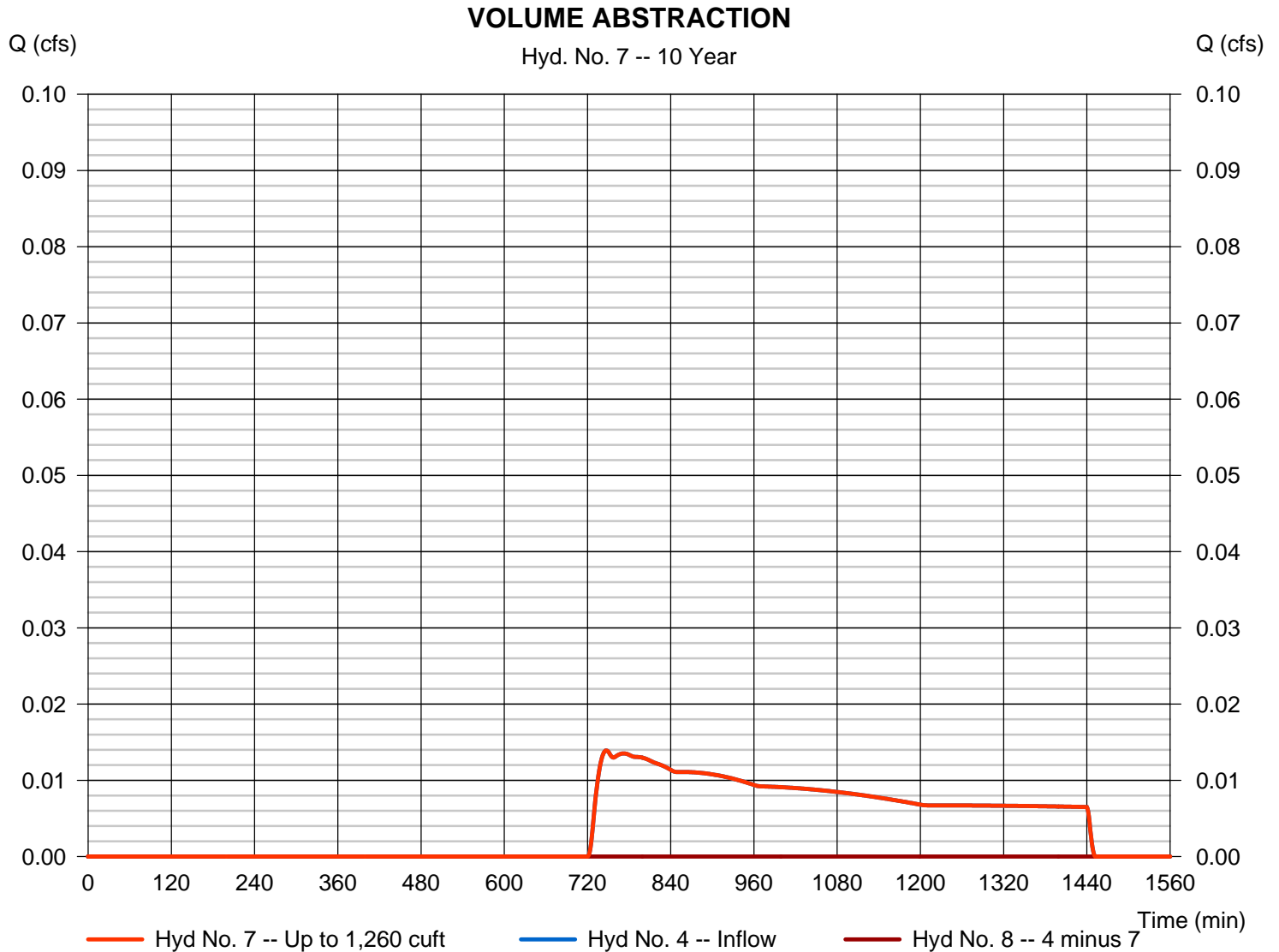
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.014 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 747 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 378 cuft   |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

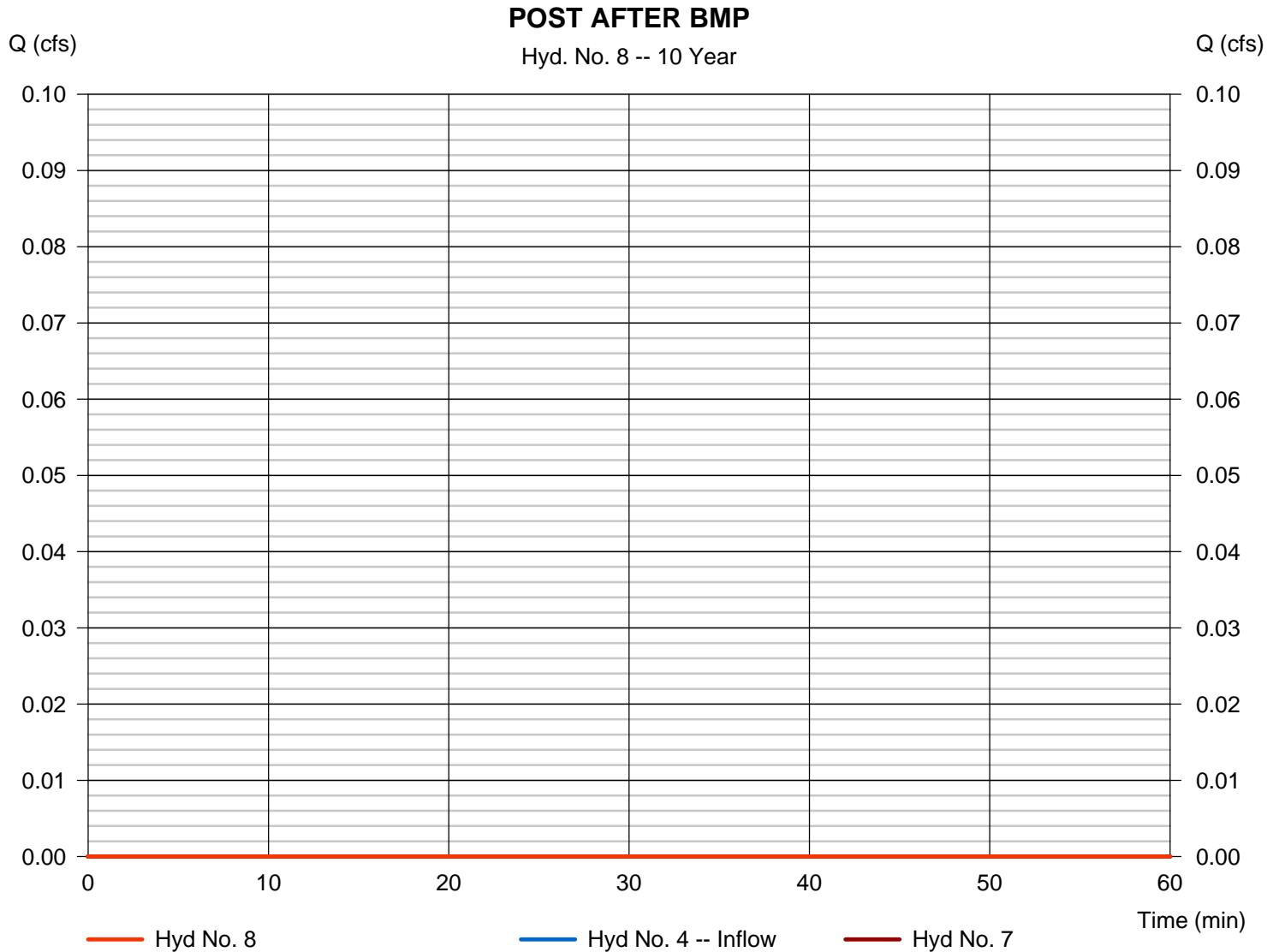
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

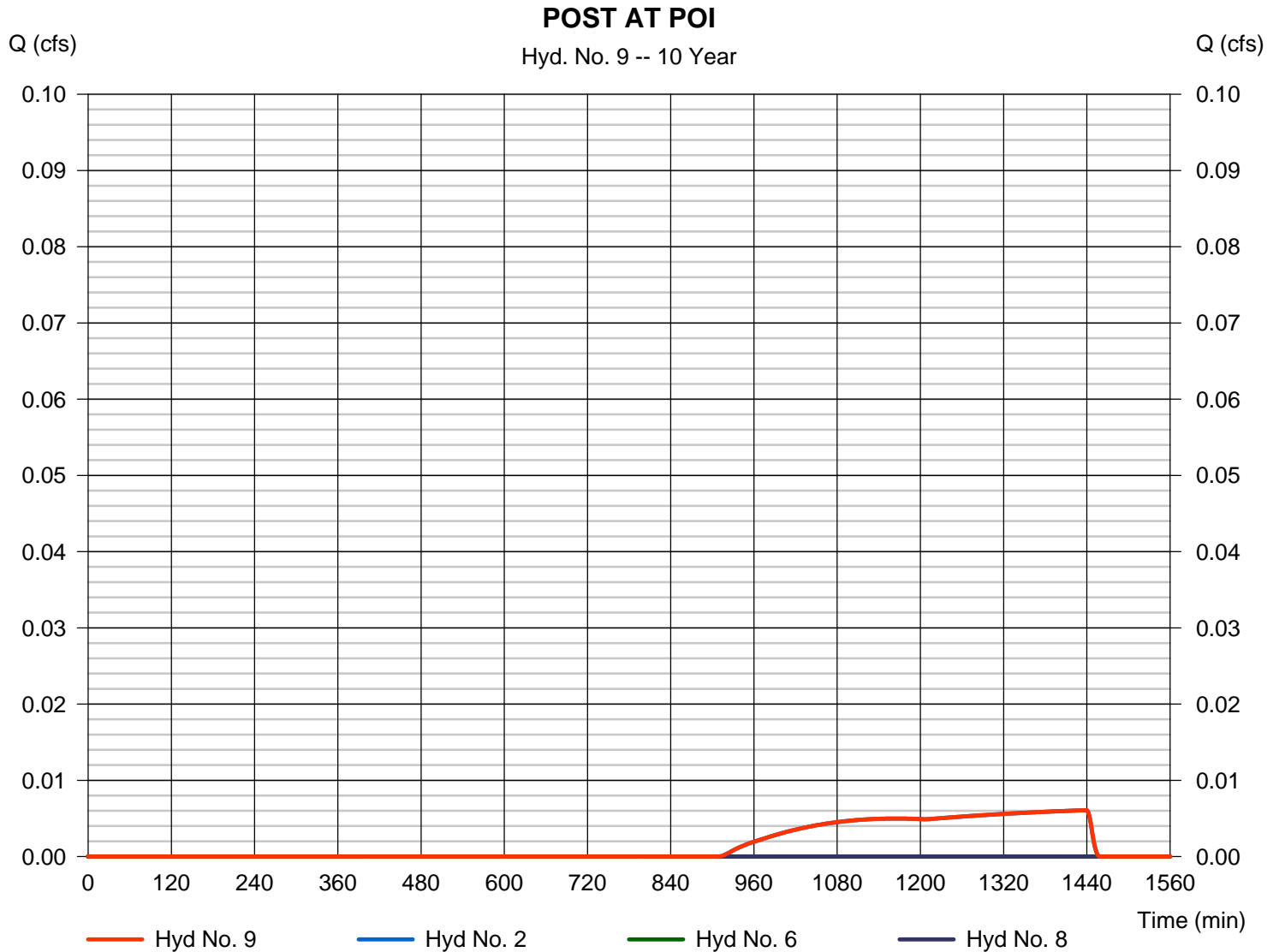
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 6, 8

Peak discharge = 0.006 cfs  
Time to peak = 1440 min  
Hyd. volume = 145 cuft  
Contrib. drain. area = 1.790 ac



# 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               | 0.147           | 1                   | 744                | 2,921                  | -----         | -----                  | -----                    | PRE                    |  |
| 2                 | SCS Runoff               | 0.090           | 1                   | 744                | 1,784                  | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3                 | SCS Runoff               | 0.125           | 1                   | 721                | 707                    | -----         | -----                  | -----                    | POST DET. 1            |  |
| 4                 | SCS Runoff               | 0.409           | 1                   | 721                | 1,535                  | -----         | -----                  | -----                    | POST DET. 2            |  |
| 5                 | Diversion1               | 0.125           | 1                   | 721                | 570                    | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 6                 | Diversion2               | 0.010           | 1                   | 1198               | 136                    | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 7                 | Diversion1               | 0.409           | 1                   | 721                | 1,261                  | 4             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 8                 | Diversion2               | 0.019           | 1                   | 1183               | 274                    | 4             | -----                  | -----                    | POST AFTER BMP         |  |
| 9                 | Combine                  | 0.090           | 1                   | 744                | 2,194                  | 2, 6, 8       | -----                  | -----                    | POST AT POI            |  |
| Fairview Road.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Thursday, 10 / 27 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

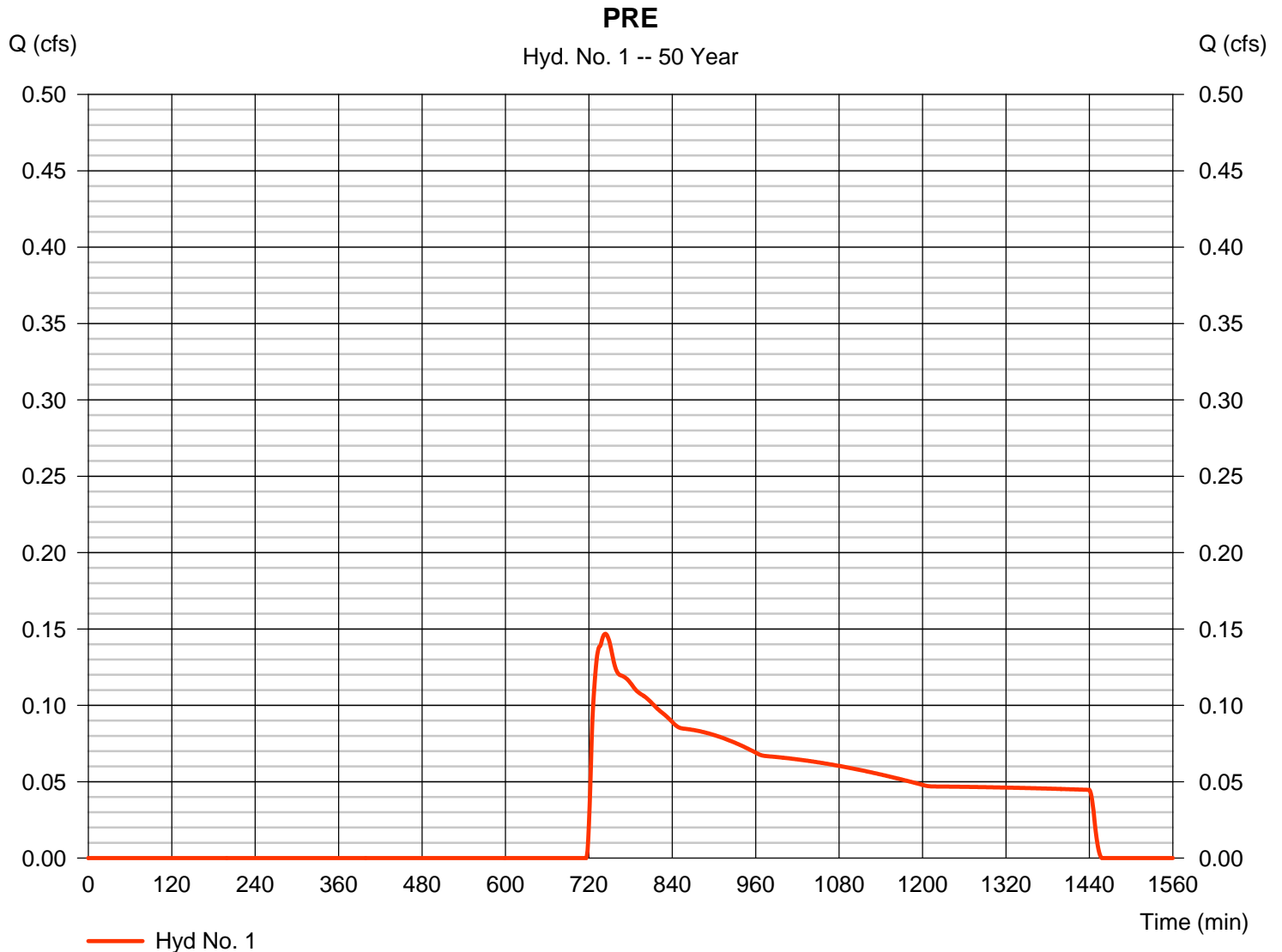
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.147 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 744 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,921 cuft |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

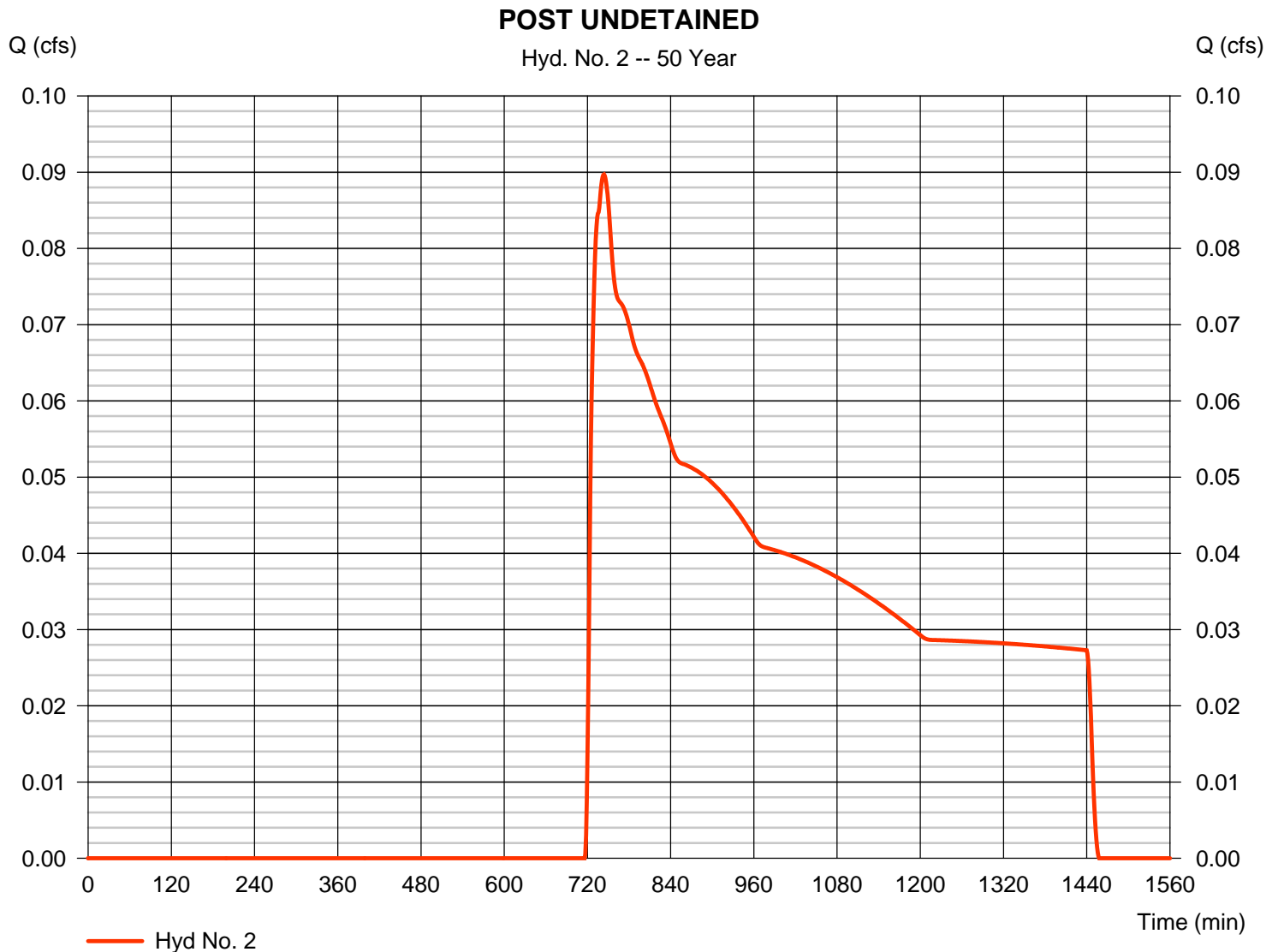
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.090 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 744 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,784 cuft |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

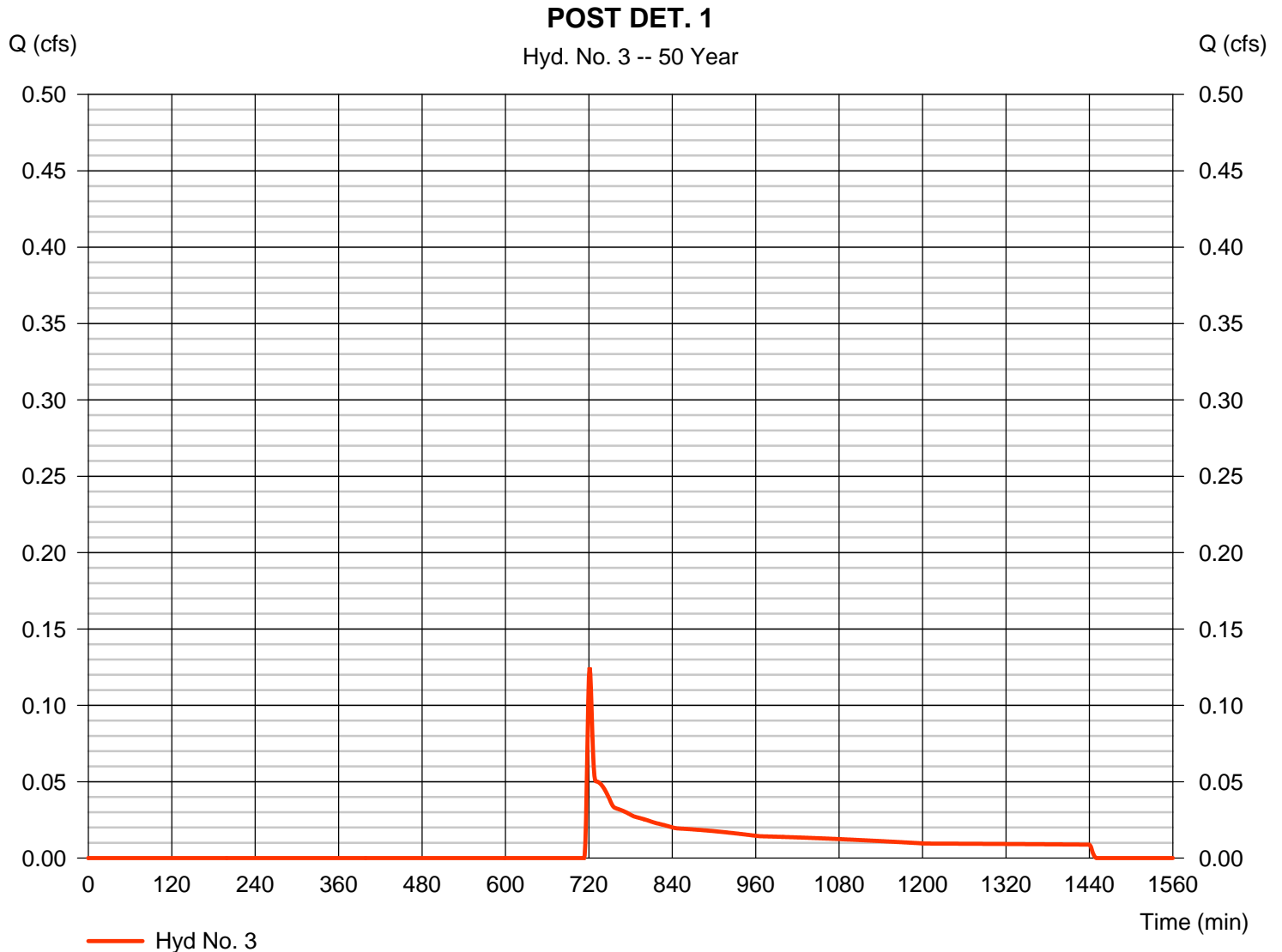
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.125 cfs |
| Storm frequency | = 50 yrs     | Time to peak       | = 721 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 707 cuft  |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 6.30 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

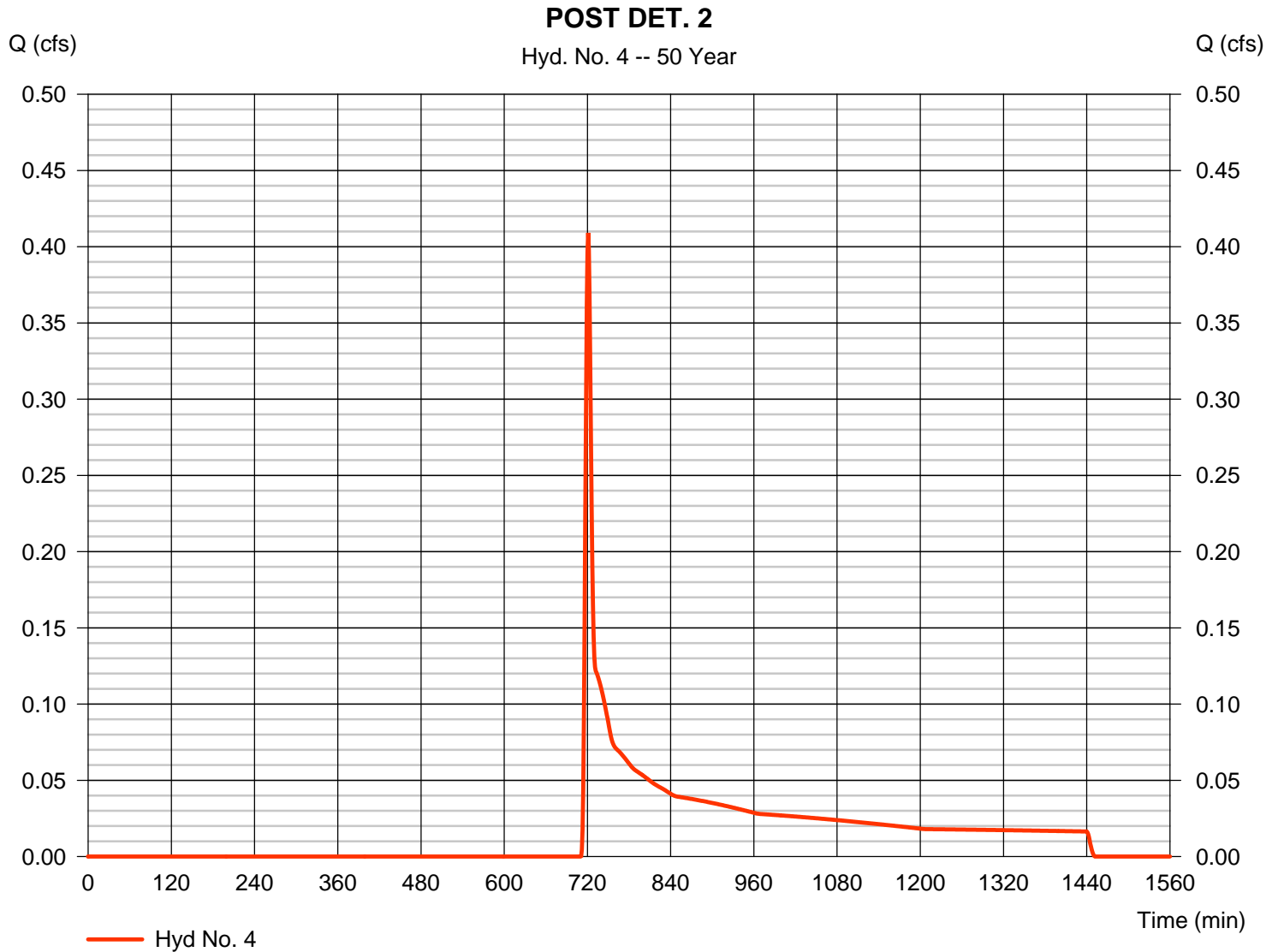
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.409 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 721 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,535 cuft |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.30 min   |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

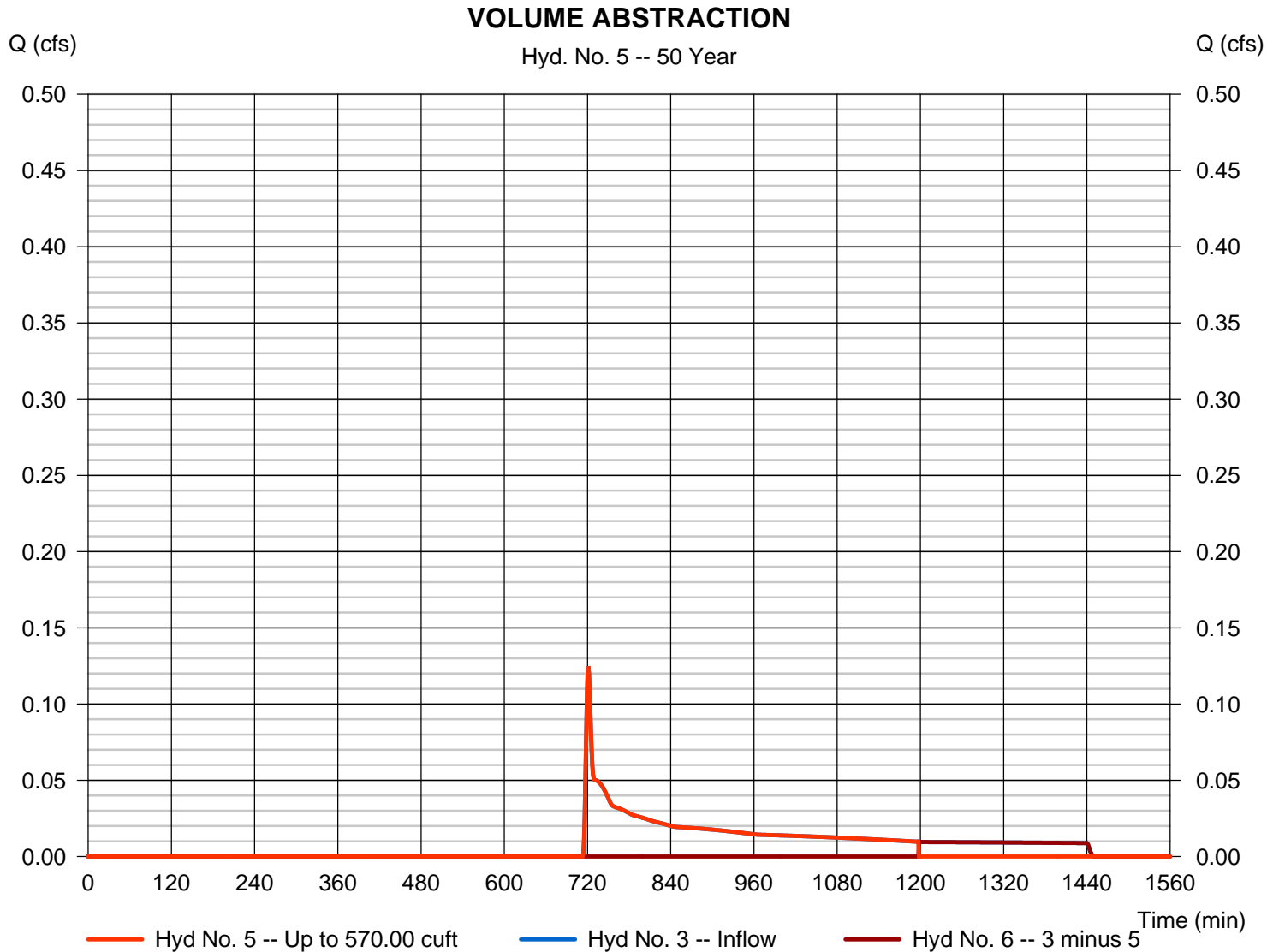
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.125 cfs   |
| Storm frequency   | = 50 yrs             | Time to peak      | = 721 min     |
| Time interval     | = 1 min              | Hyd. volume       | = 570 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

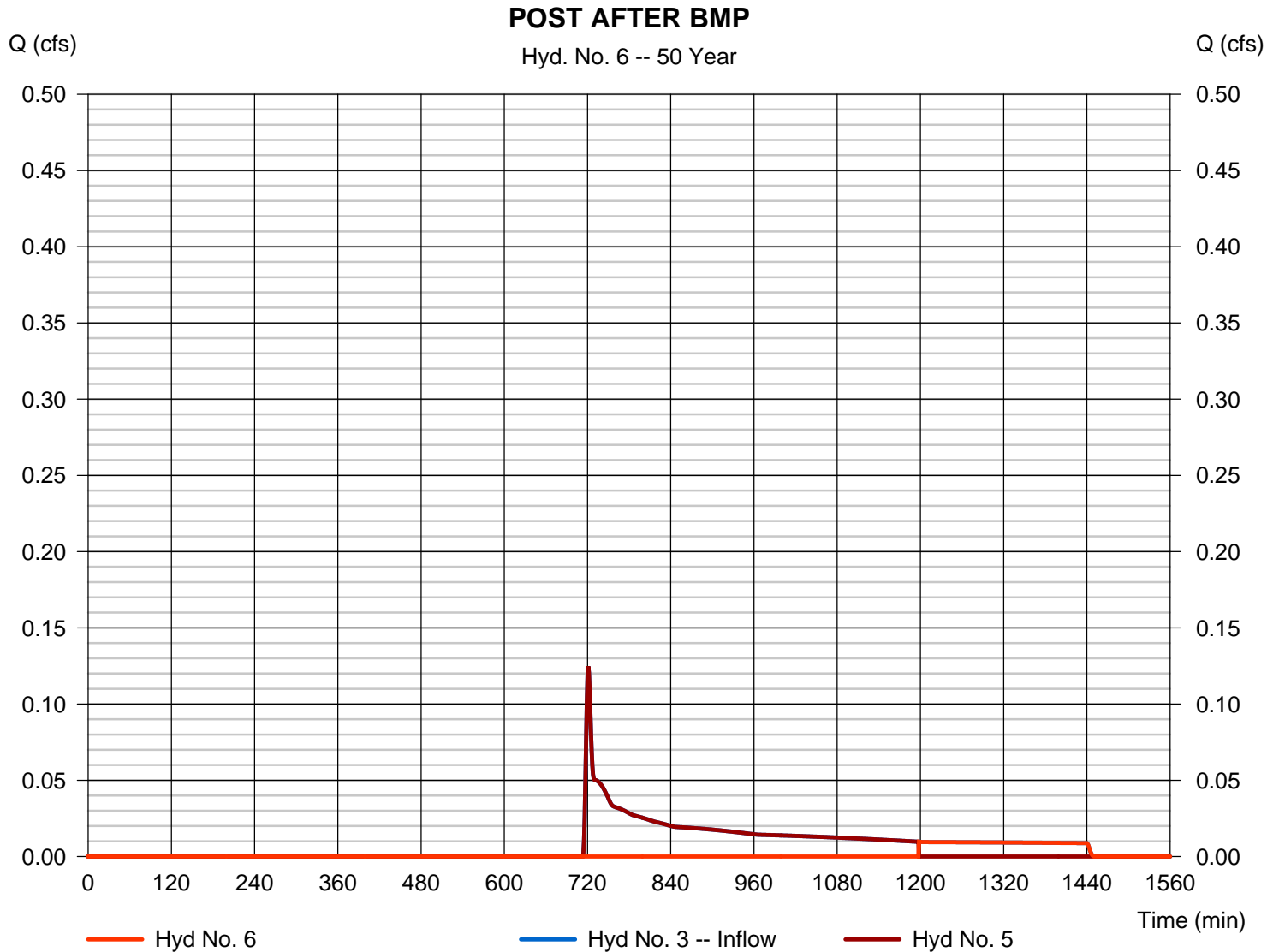
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.010 cfs   |
| Storm frequency   | = 50 yrs             | Time to peak      | = 1198 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 136 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

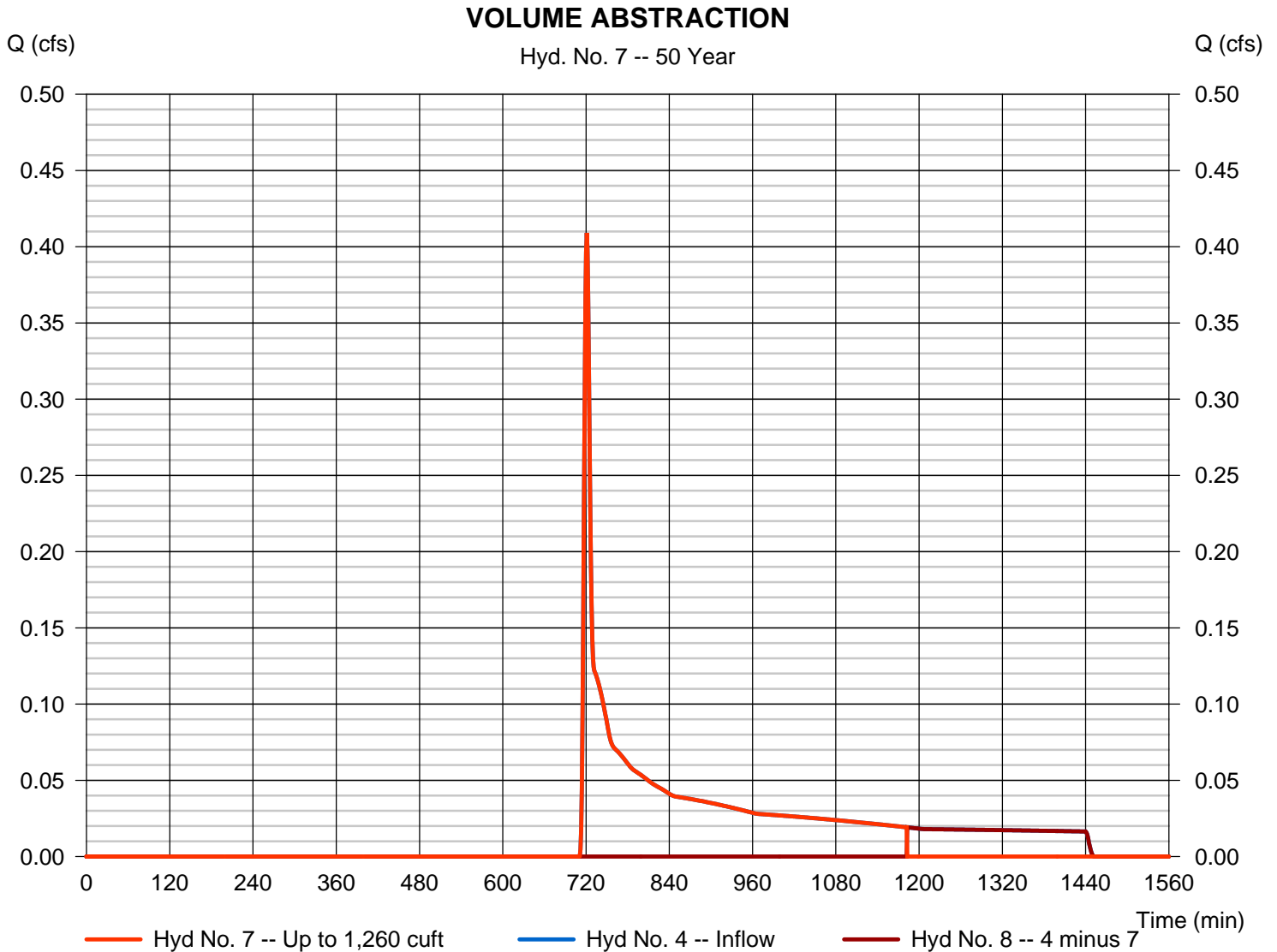
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.409 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 721 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,261 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

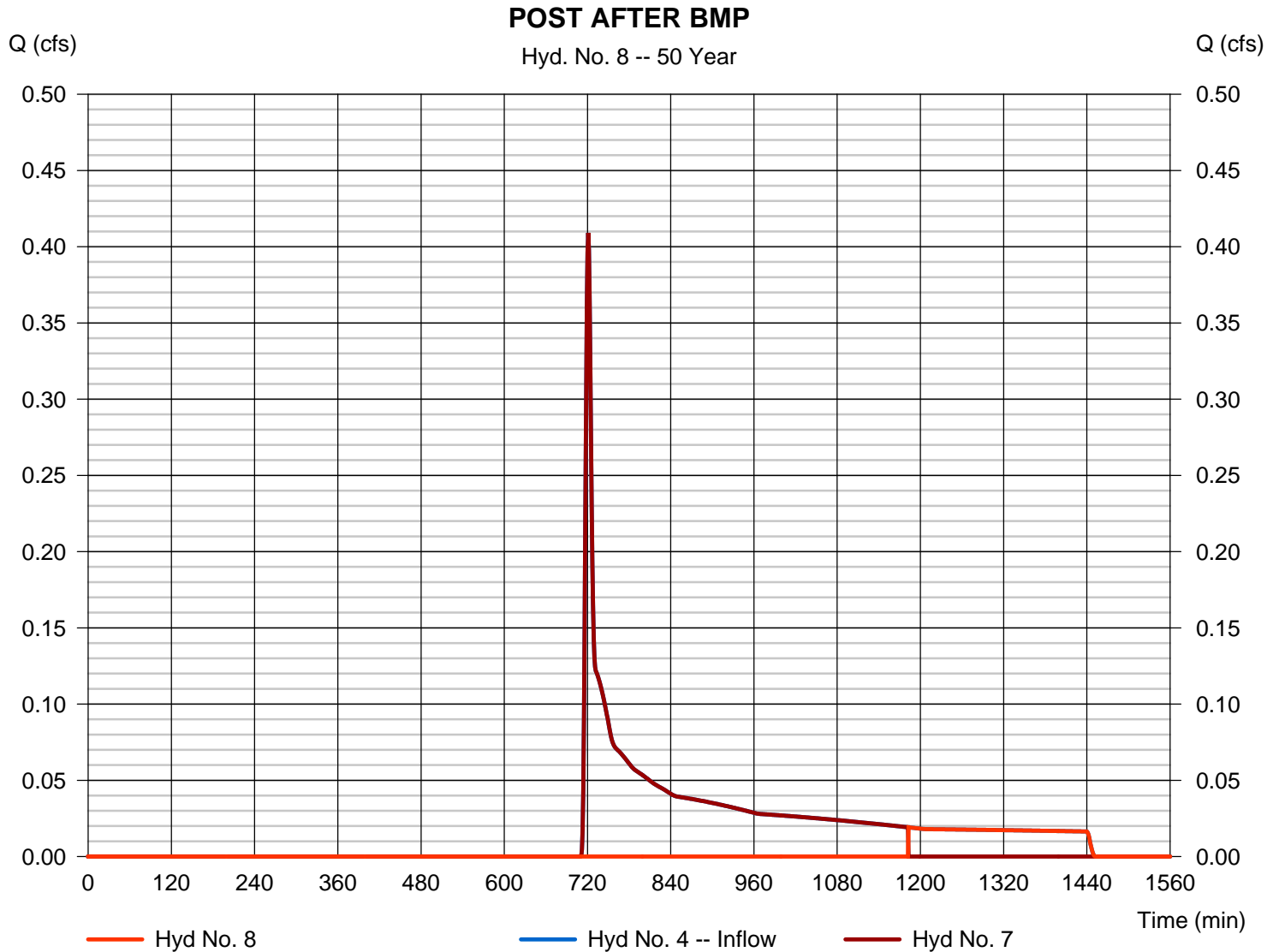
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.019 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 1183 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 274 cuft   |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

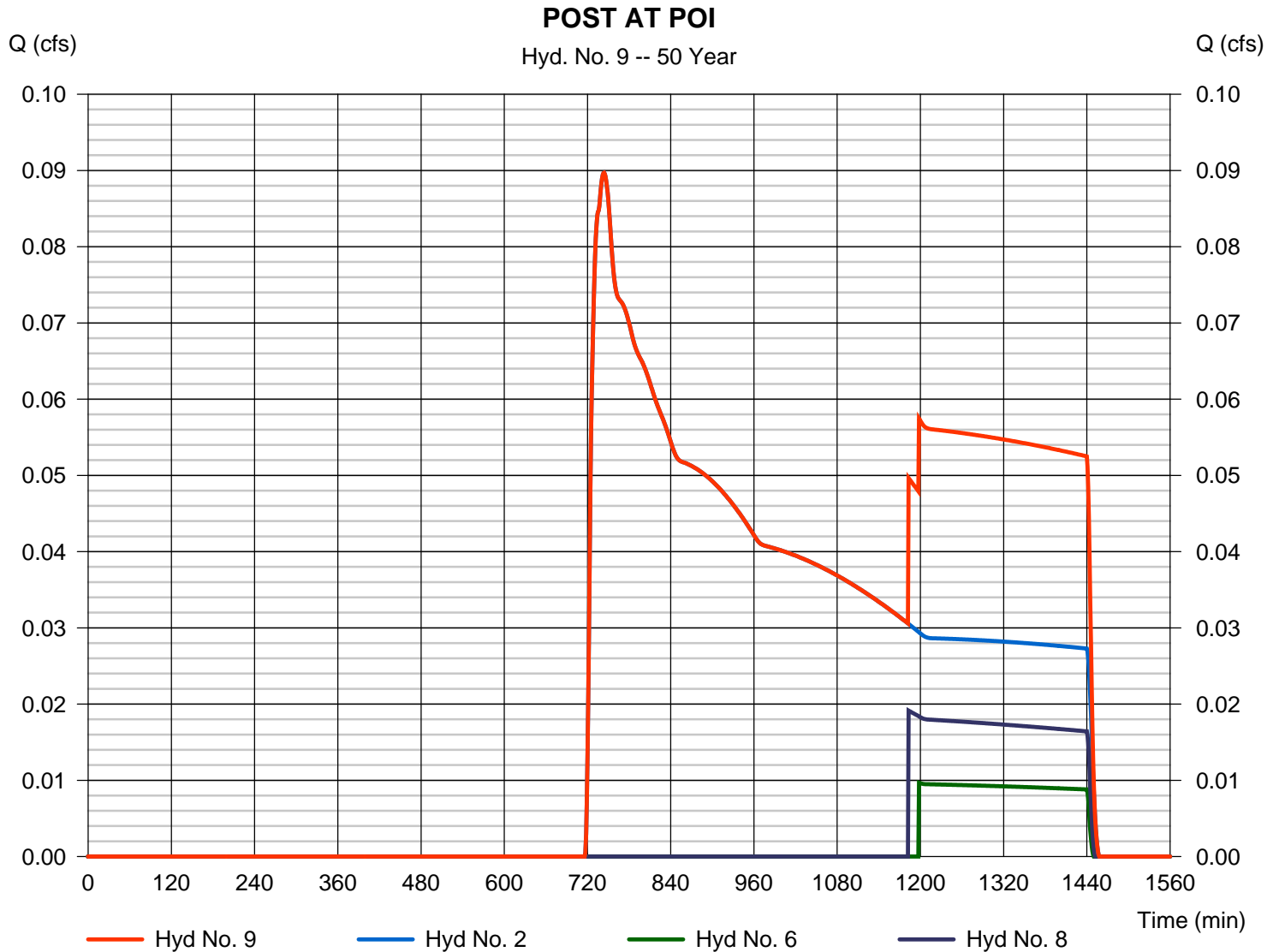
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
 Storm frequency = 50 yrs  
 Time interval = 1 min  
 Inflow hyds. = 2, 6, 8

Peak discharge = 0.090 cfs  
 Time to peak = 744 min  
 Hyd. volume = 2,194 cuft  
 Contrib. drain. area = 1.790 ac



# 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               | 0.628           | 1                   | 725                | 5,162                   | -----         | -----                  | -----                    | PRE                    |  |
| 2                 | SCS Runoff               | 0.383           | 1                   | 725                | 3,153                   | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3                 | SCS Runoff               | 0.329           | 1                   | 720                | 1,136                   | -----         | -----                  | -----                    | POST DET. 1            |  |
| 4                 | SCS Runoff               | 0.797           | 1                   | 720                | 2,322                   | -----         | -----                  | -----                    | POST DET. 2            |  |
| 5                 | Diversion1               | 0.329           | 1                   | 720                | 571                     | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 6                 | Diversion2               | 0.028           | 1                   | 876                | 565                     | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 7                 | Diversion1               | 0.797           | 1                   | 720                | 1,262                   | 4             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 8                 | Diversion2               | 0.053           | 1                   | 871                | 1,059                   | 4             | -----                  | -----                    | POST AFTER BMP         |  |
| 9                 | Combine                  | 0.383           | 1                   | 725                | 4,778                   | 2, 6, 8       | -----                  | -----                    | POST AT POI            |  |
| Fairview Road.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Thursday, 10 / 27 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

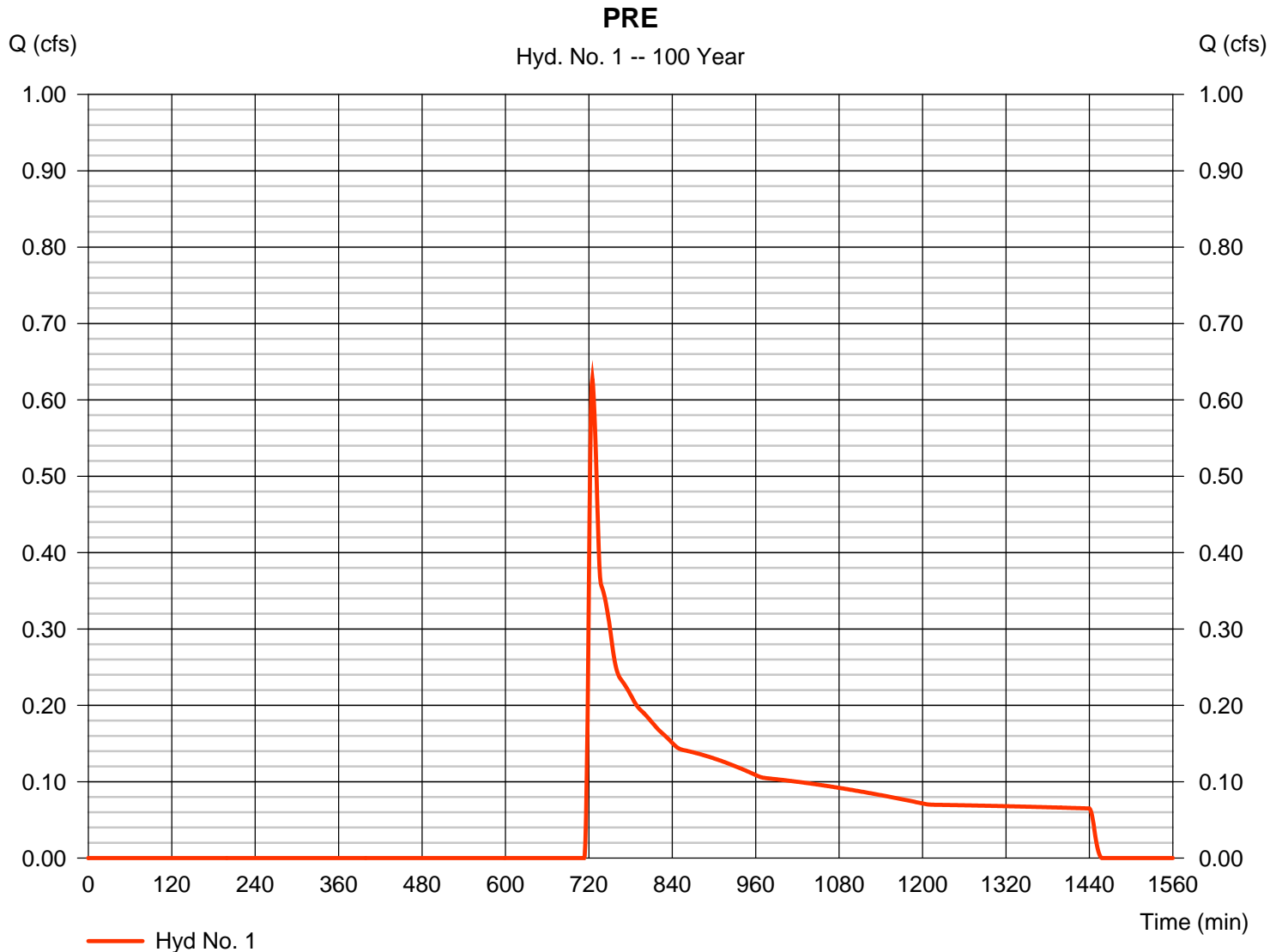
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.628 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 5,162 cuft |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

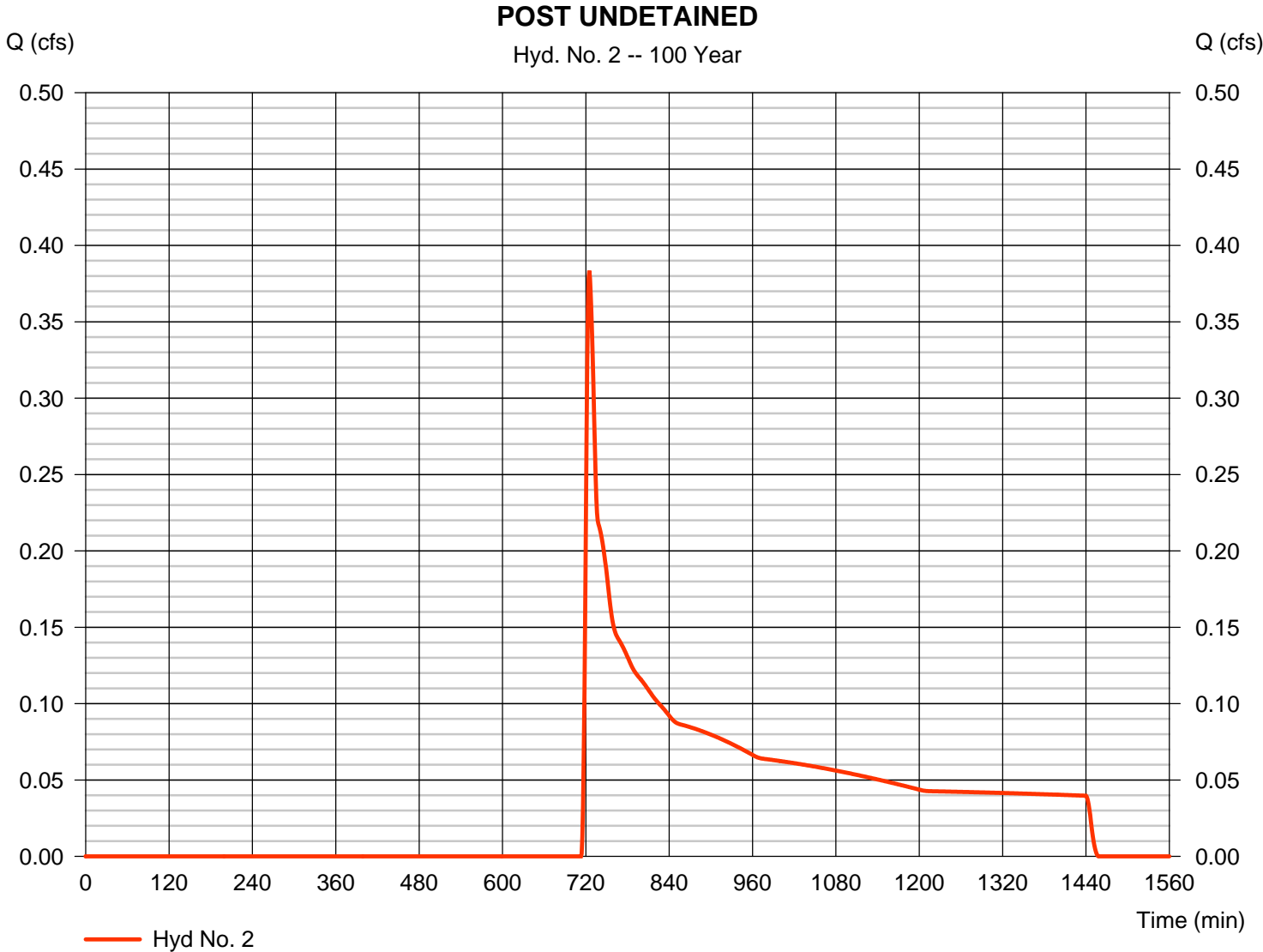
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.383 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,153 cuft |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

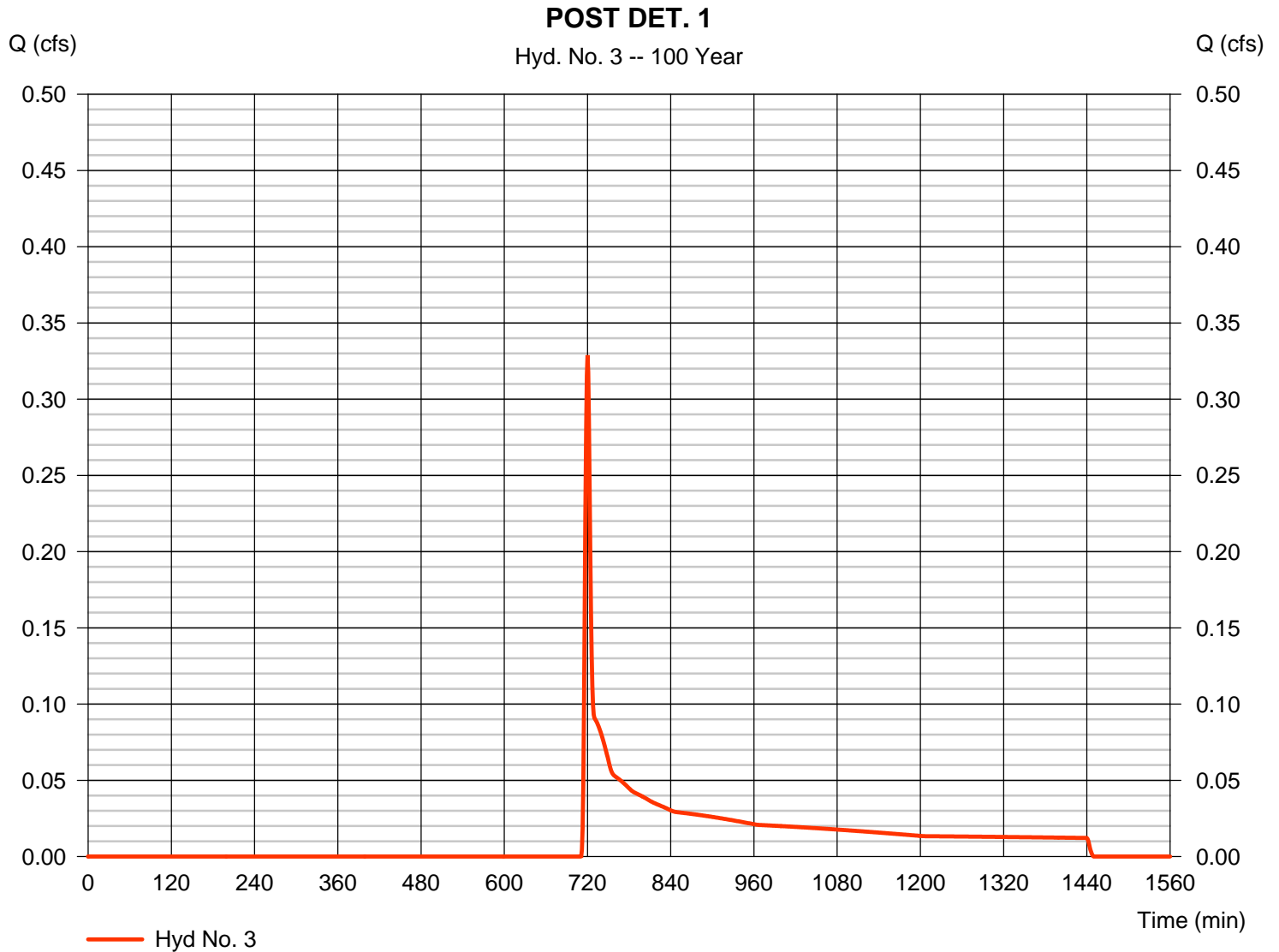
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.329 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 720 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,136 cuft |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 6.30 min   |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

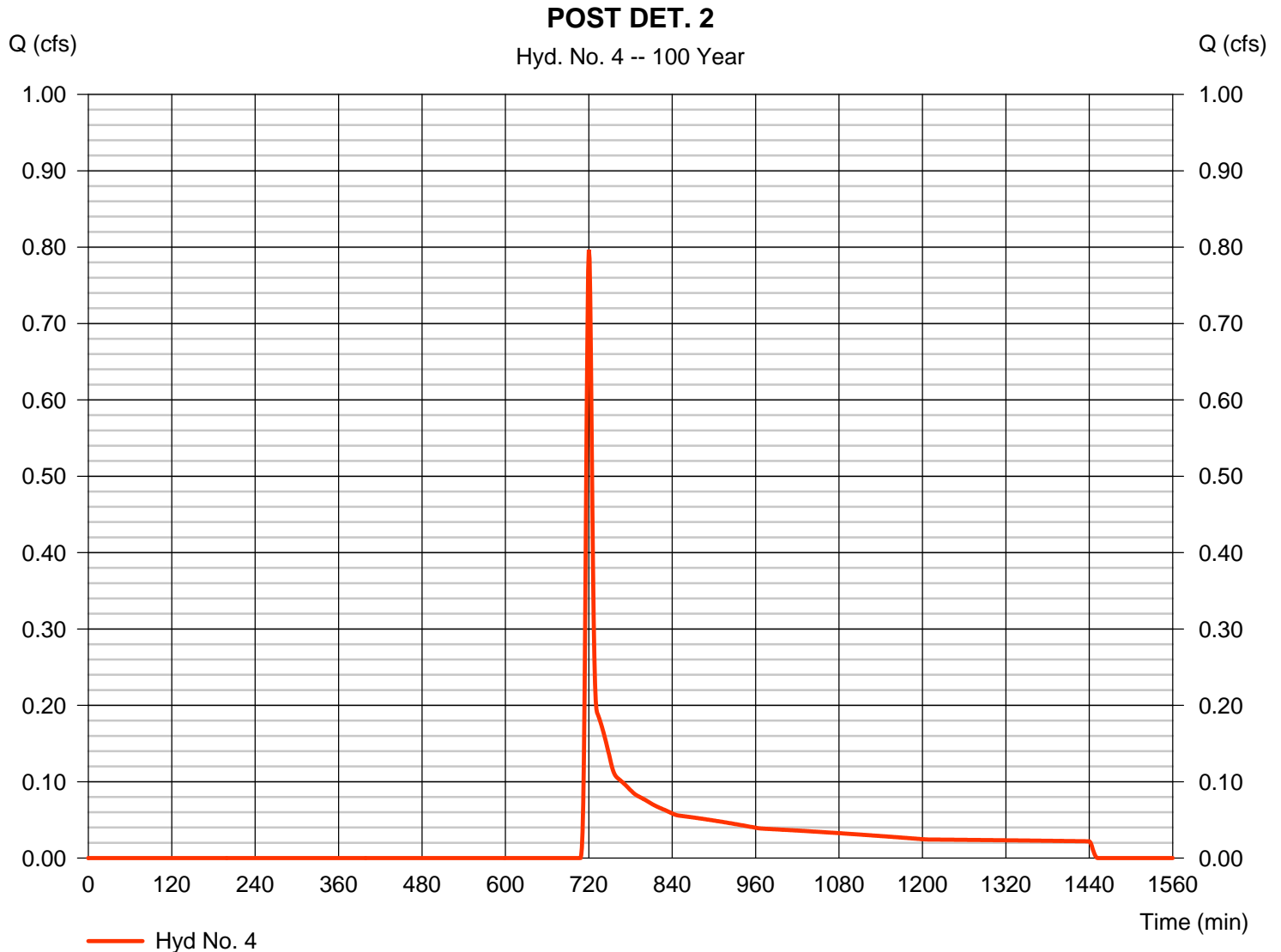
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.797 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 720 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,322 cuft |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.30 min   |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

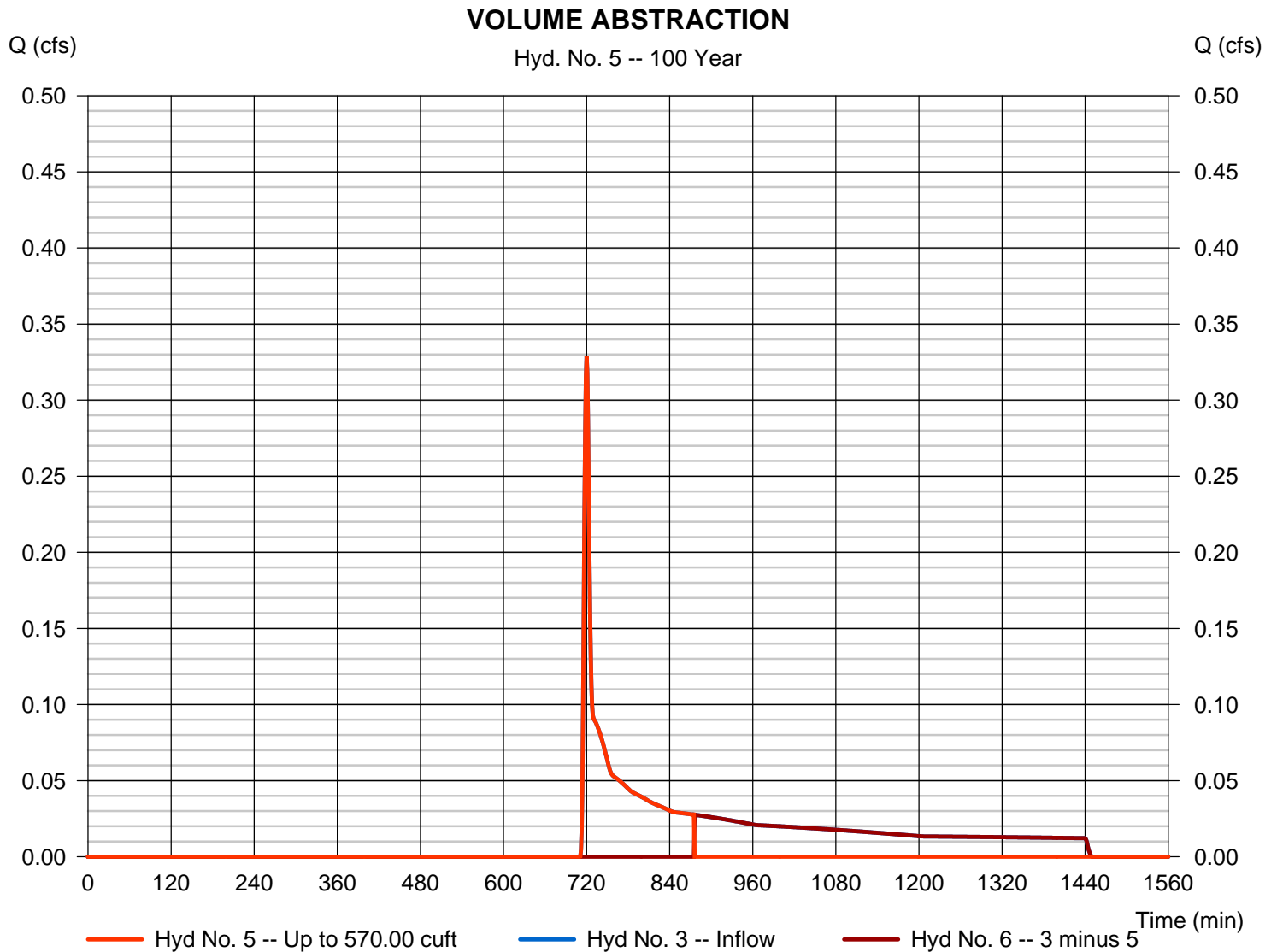
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.329 cfs   |
| Storm frequency   | = 100 yrs            | Time to peak      | = 720 min     |
| Time interval     | = 1 min              | Hyd. volume       | = 571 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

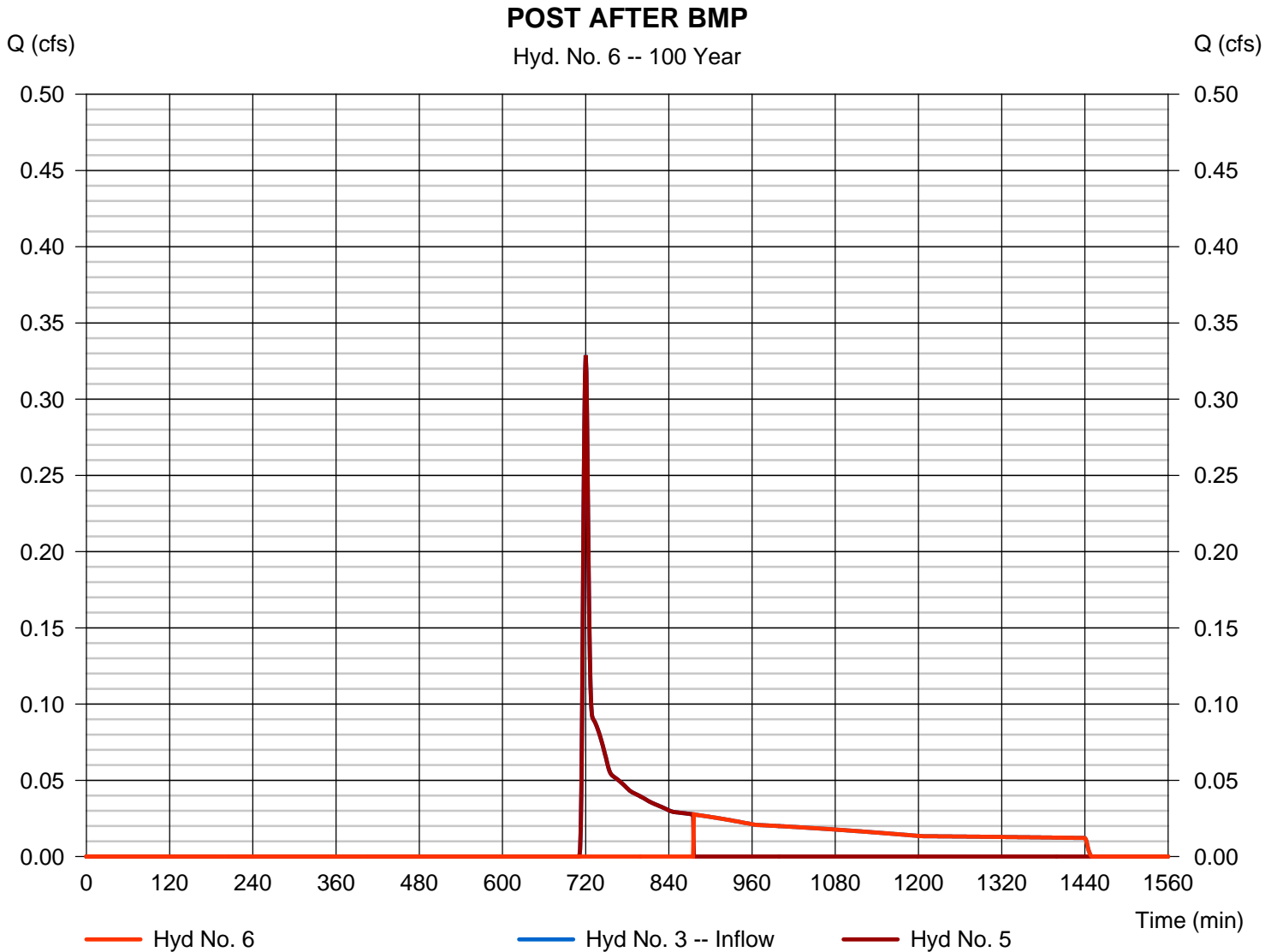
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.028 cfs   |
| Storm frequency   | = 100 yrs            | Time to peak      | = 876 min     |
| Time interval     | = 1 min              | Hyd. volume       | = 565 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

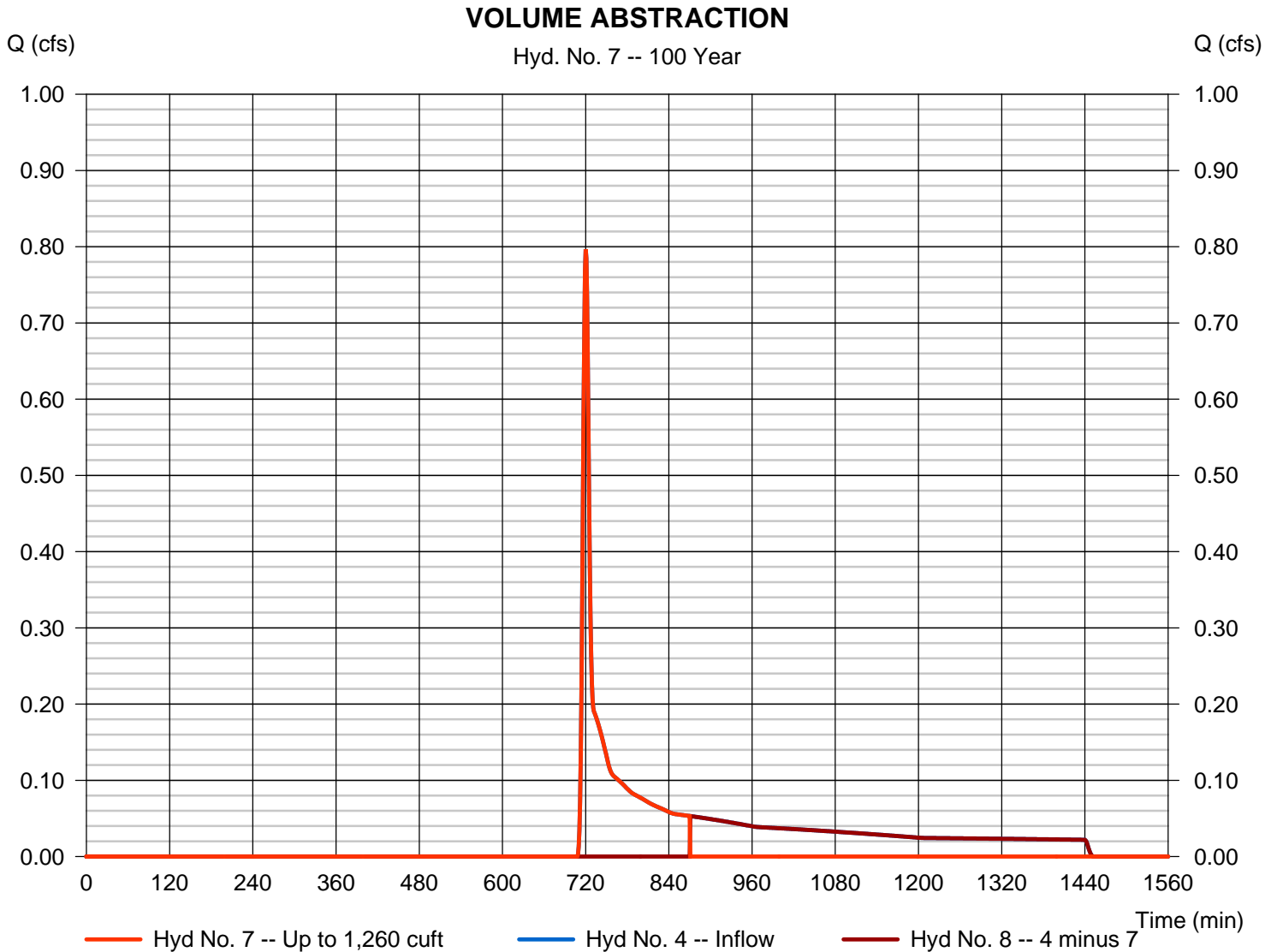
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.797 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 720 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,262 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

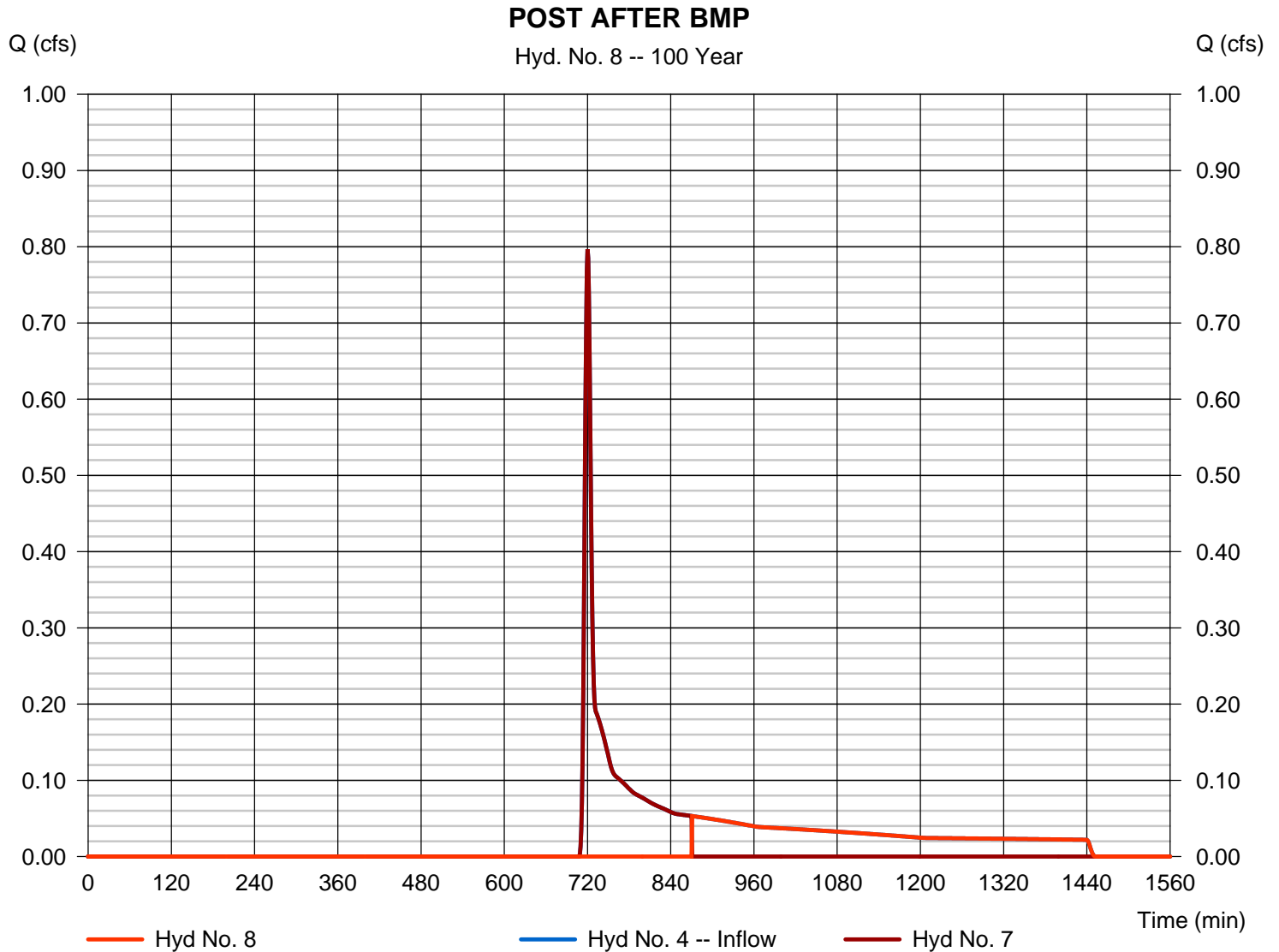
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.053 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 871 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,059 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

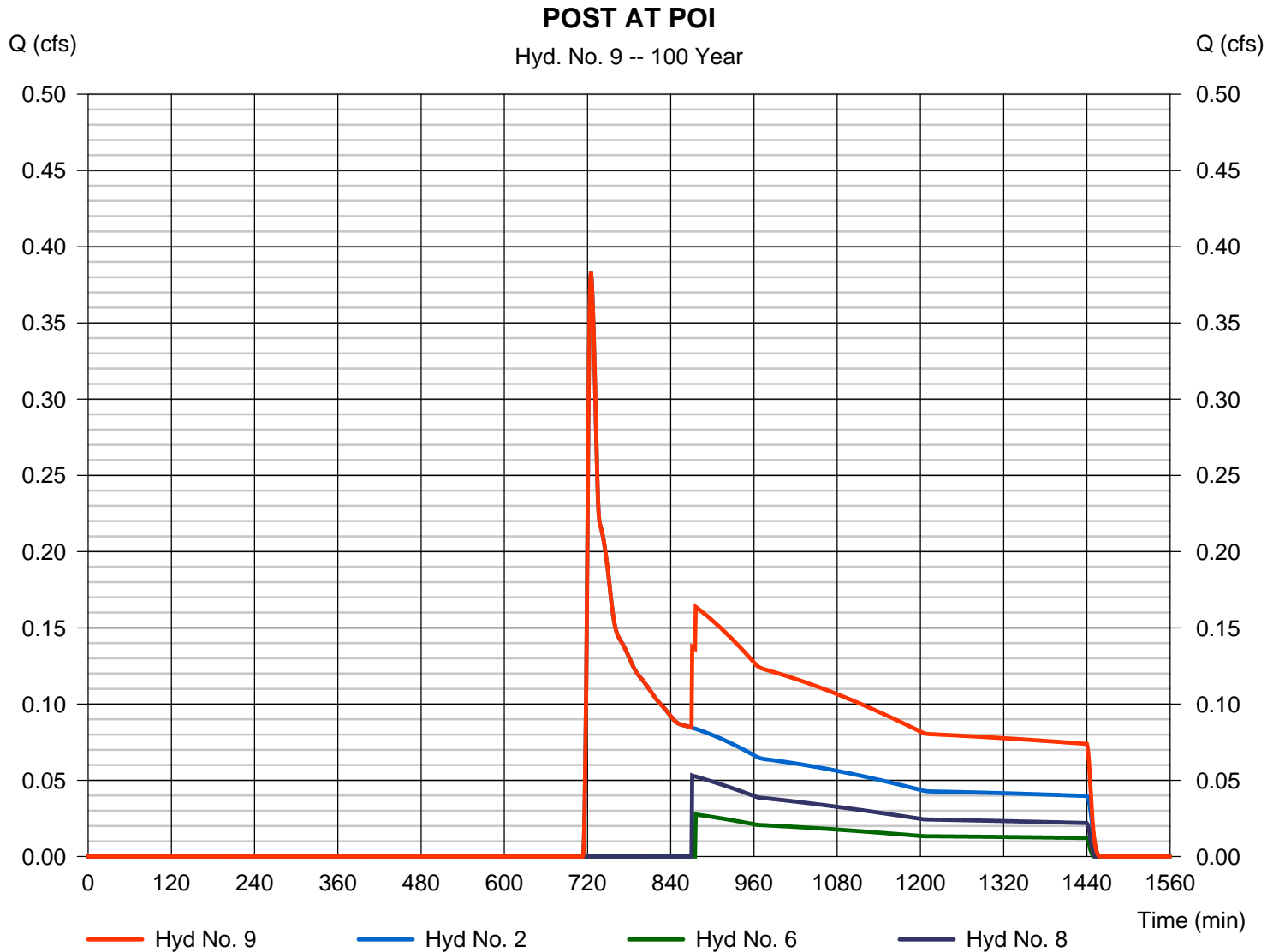
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
 Storm frequency = 100 yrs  
 Time interval = 1 min  
 Inflow hyds. = 2, 6, 8

Peak discharge = 0.383 cfs  
 Time to peak = 725 min  
 Hyd. volume = 4,778 cuft  
 Contrib. drain. area = 1.790 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 51.6066  | 12.5000 | 0.8820 | ----- |
| 2                   | 61.7637  | 12.8000 | 0.8782 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 64.3712  | 12.9000 | 0.8379 | ----- |
| 10                  | 58.5497  | 11.8000 | 0.7889 | ----- |
| 25                  | 53.6357  | 10.9000 | 0.7370 | ----- |
| 50                  | 51.9530  | 10.6000 | 0.7090 | ----- |
| 100                 | 44.2162  | 9.1000  | 0.6540 | ----- |

File name: Fairview Road.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.13                     | 3.31 | 2.77 | 2.39 | 2.11 | 1.89 | 1.71 | 1.57 | 1.45 | 1.35 | 1.26 | 1.18 |
| 2                   | 4.93                     | 3.96 | 3.33 | 2.88 | 2.54 | 2.28 | 2.07 | 1.90 | 1.75 | 1.63 | 1.52 | 1.43 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.74                     | 4.67 | 3.96 | 3.45 | 3.06 | 2.76 | 2.52 | 2.32 | 2.15 | 2.00 | 1.88 | 1.77 |
| 10                  | 6.32                     | 5.15 | 4.37 | 3.82 | 3.41 | 3.08 | 2.82 | 2.60 | 2.42 | 2.26 | 2.13 | 2.01 |
| 25                  | 6.98                     | 5.71 | 4.87 | 4.28 | 3.83 | 3.48 | 3.20 | 2.96 | 2.76 | 2.60 | 2.45 | 2.32 |
| 50                  | 7.41                     | 6.08 | 5.21 | 4.59 | 4.13 | 3.76 | 3.46 | 3.22 | 3.01 | 2.83 | 2.68 | 2.54 |
| 100                 | 7.83                     | 6.42 | 5.52 | 4.88 | 4.40 | 4.02 | 3.72 | 3.46 | 3.25 | 3.07 | 2.91 | 2.77 |

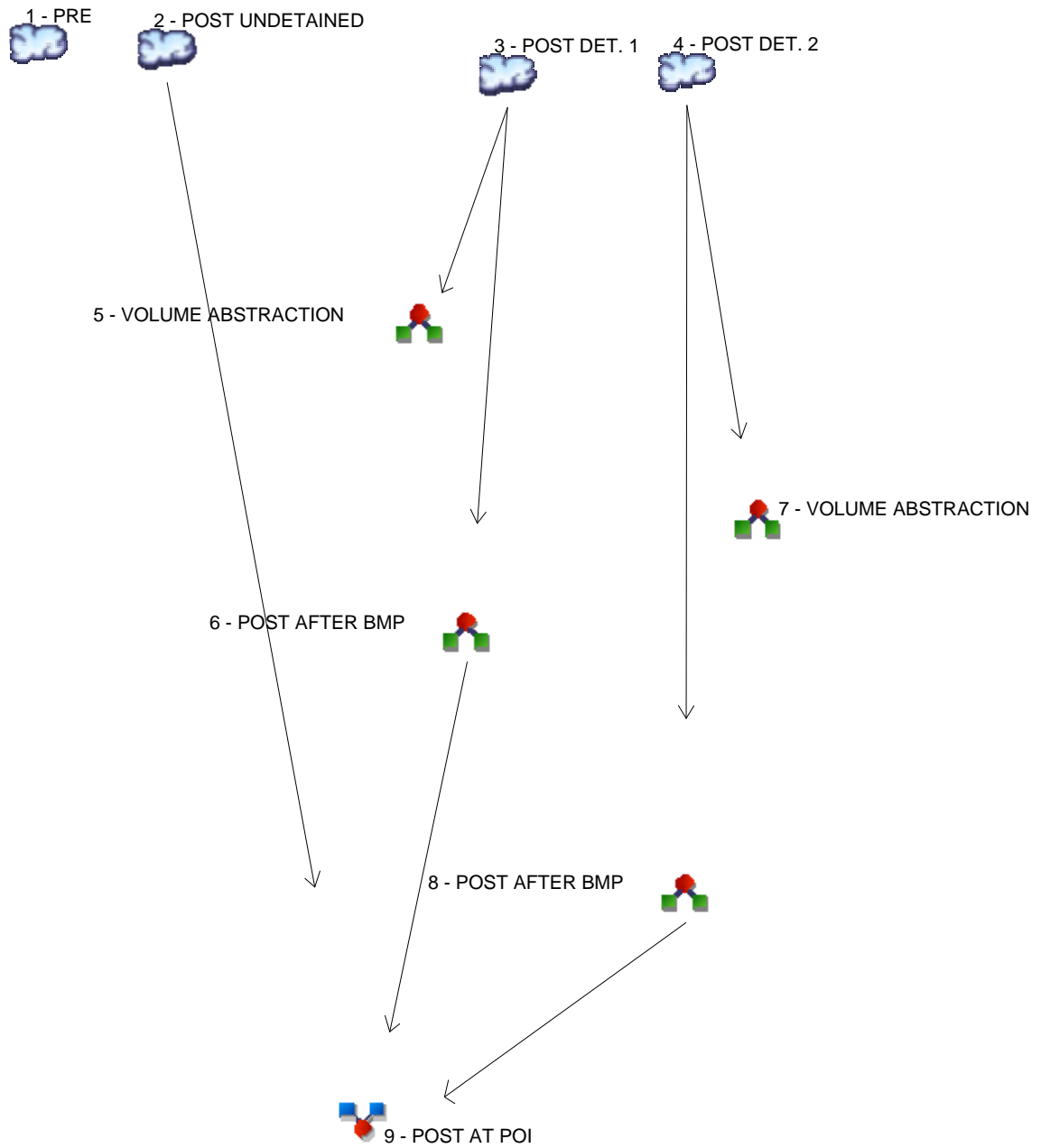
T<sub>c</sub> = time in minutes. Values may exceed 60.

D:\07 PCSM\Attachment 4 - Stormwater Calcs\Fairview Road (Walnut Bank)\Hydraflow Rev 1\Fairview Road Precip.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.69                              | 3.24 | 0.00 | 4.06 | 4.74  | 5.72  | 6.54  | 7.42   |
| SCS 6-Hr           | 1.90                              | 2.29 | 0.00 | 2.85 | 3.30  | 3.92  | 4.42  | 4.94   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. | Origin     | Description        |
|------|------------|--------------------|
| 1    | SCS Runoff | PRE                |
| 2    | SCS Runoff | POST UNDETAINED    |
| 3    | SCS Runoff | POST DET. 1        |
| 4    | SCS Runoff | POST DET. 2        |
| 5    | Diversion1 | VOLUME ABSTRACTION |
| 6    | Diversion2 | POST AFTER BMP     |
| 7    | Diversion1 | VOLUME ABSTRACTION |
| 8    | Diversion2 | POST AFTER BMP     |
| 9    | Combine    | POST AT POI        |

# Hydrograph Return Period Recap

Hydranow 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               | -----         | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST DET. 1            |
| 4        | SCS Runoff               | -----         | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST DET. 2            |
| 5        | Diversion1               | 3             | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 3             | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST AFTER BMP         |
| 7        | Diversion1               | 4             | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 4             | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST AFTER BMP         |
| 9        | Combine                  | 2, 6, 8       | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST AT POI            |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

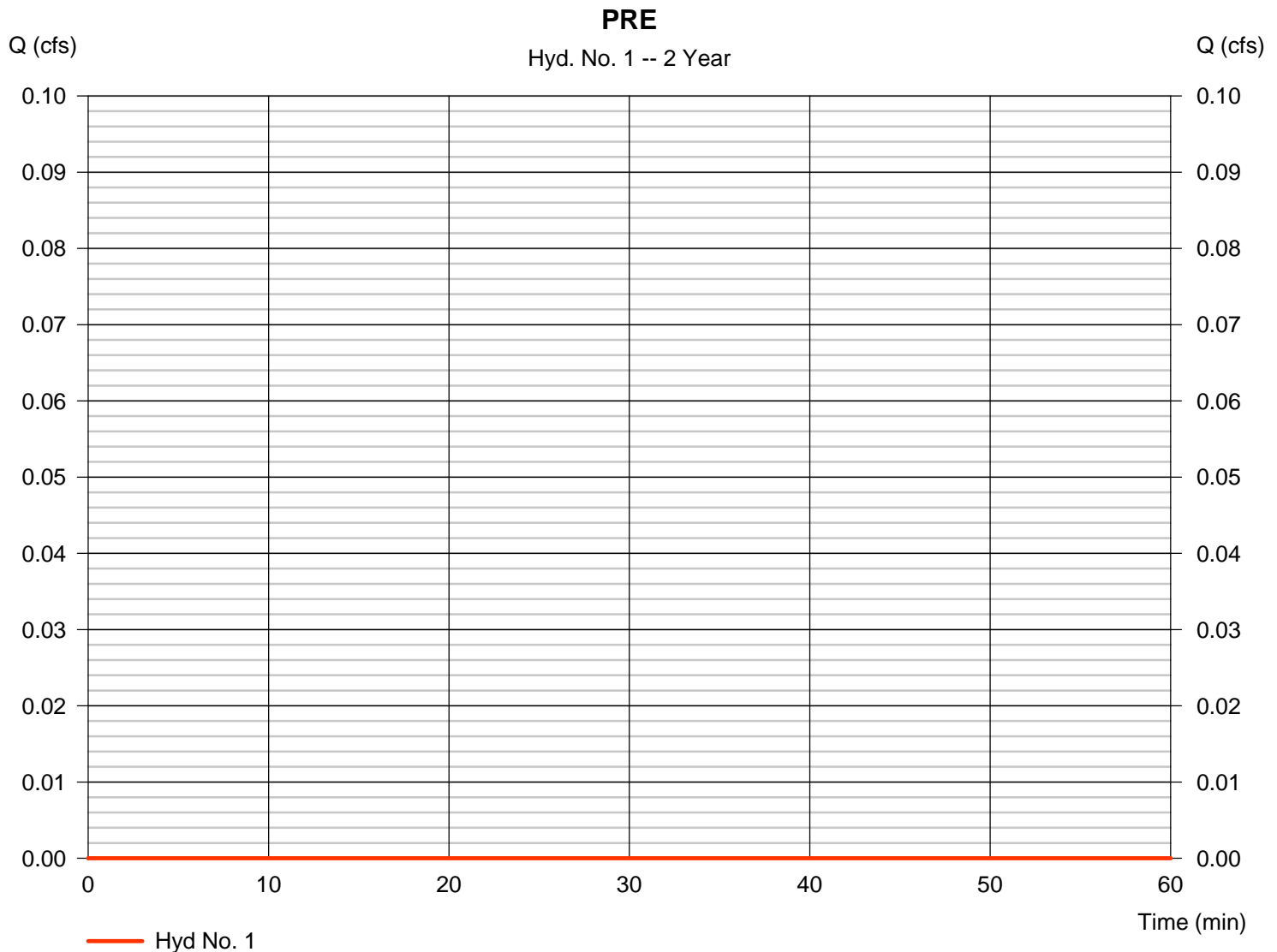
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 9.65</b>    |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 1.59</b>    |
| <b>Channel Flow</b>                |               |          |             |          |             |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.38</b>    |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

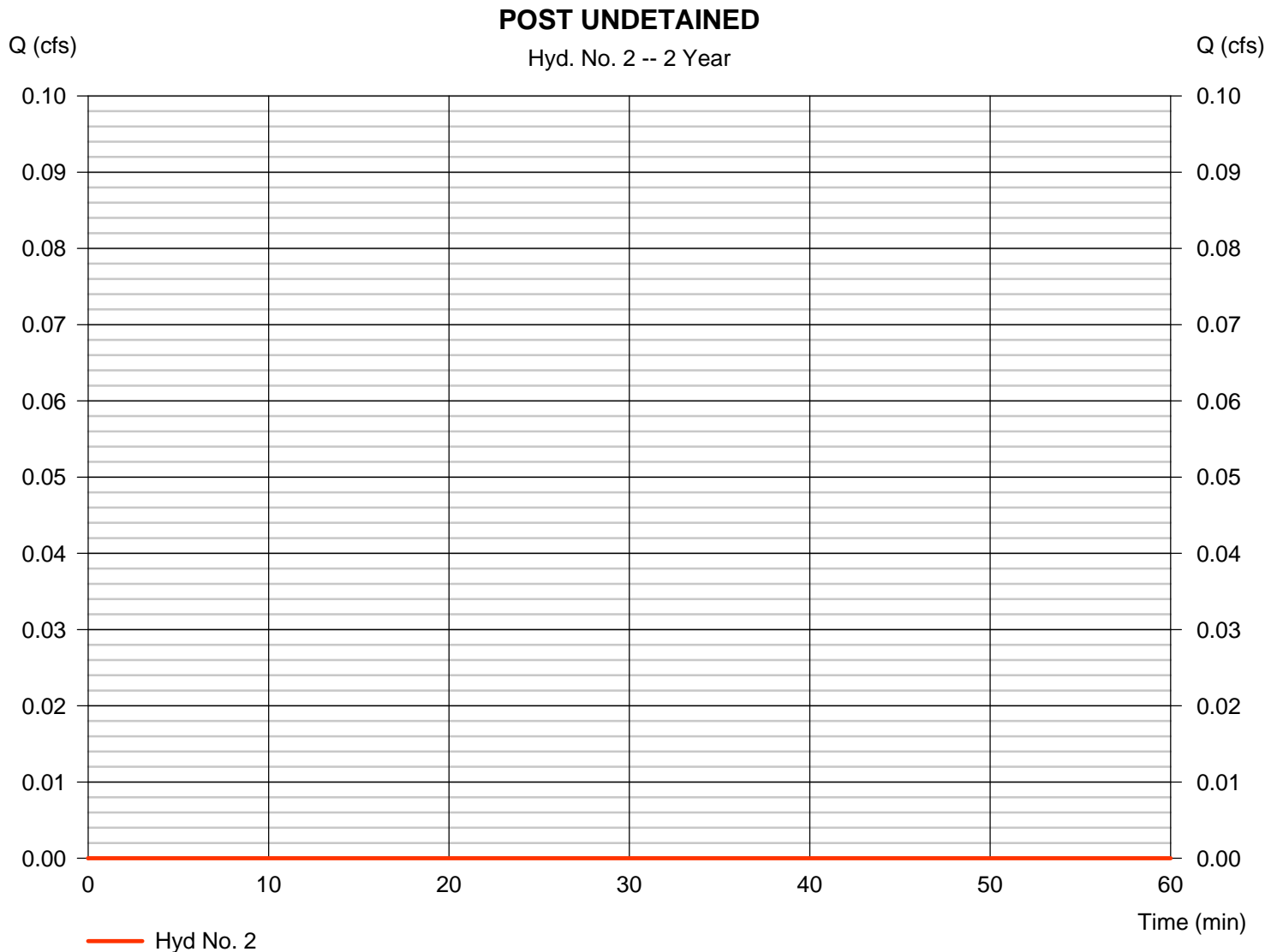
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | 432.0         |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

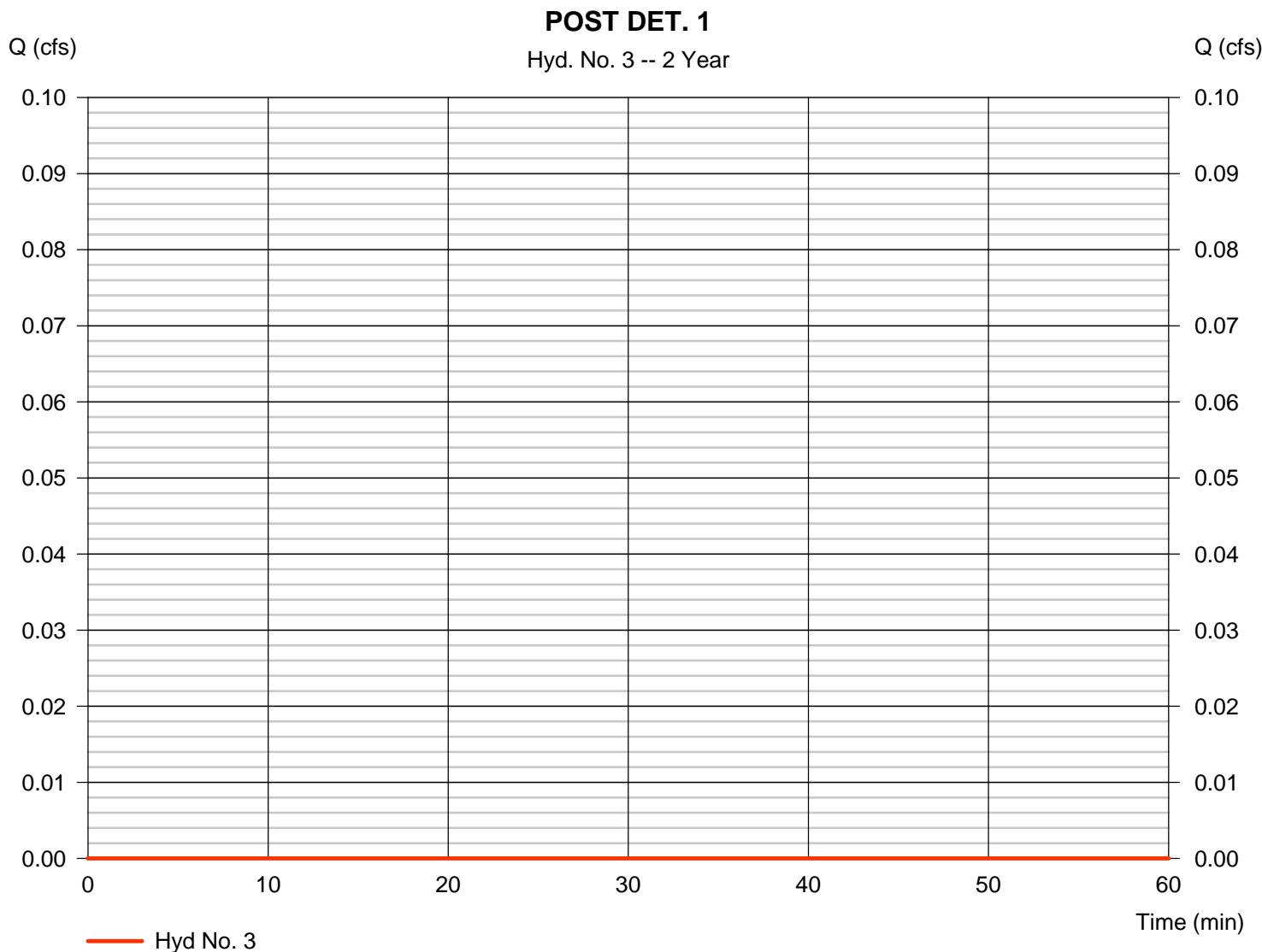
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = n/a       |
| Time interval   | = 1 min      | Hyd. volume        | = 0 cuft    |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 6.30 min  |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 3

POST DET. 1

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.24        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.50        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 5.43</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 5.43</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 192.00      | 94.00                | 22.00                |                 |
| Watercourse slope (%)              | = 14.60       | 6.90                 | 50.00                |                 |
| Surface description                | = Unpaved     | Paved                | Unpaved              |                 |
| Average velocity (ft/s)            | =6.16         | 5.34                 | 11.41                |                 |
| <b>Travel Time (min)</b>           | <b>= 0.52</b> | <b>+</b> <b>0.29</b> | <b>+</b> <b>0.03</b> | <b>= 0.84</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>6.30 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

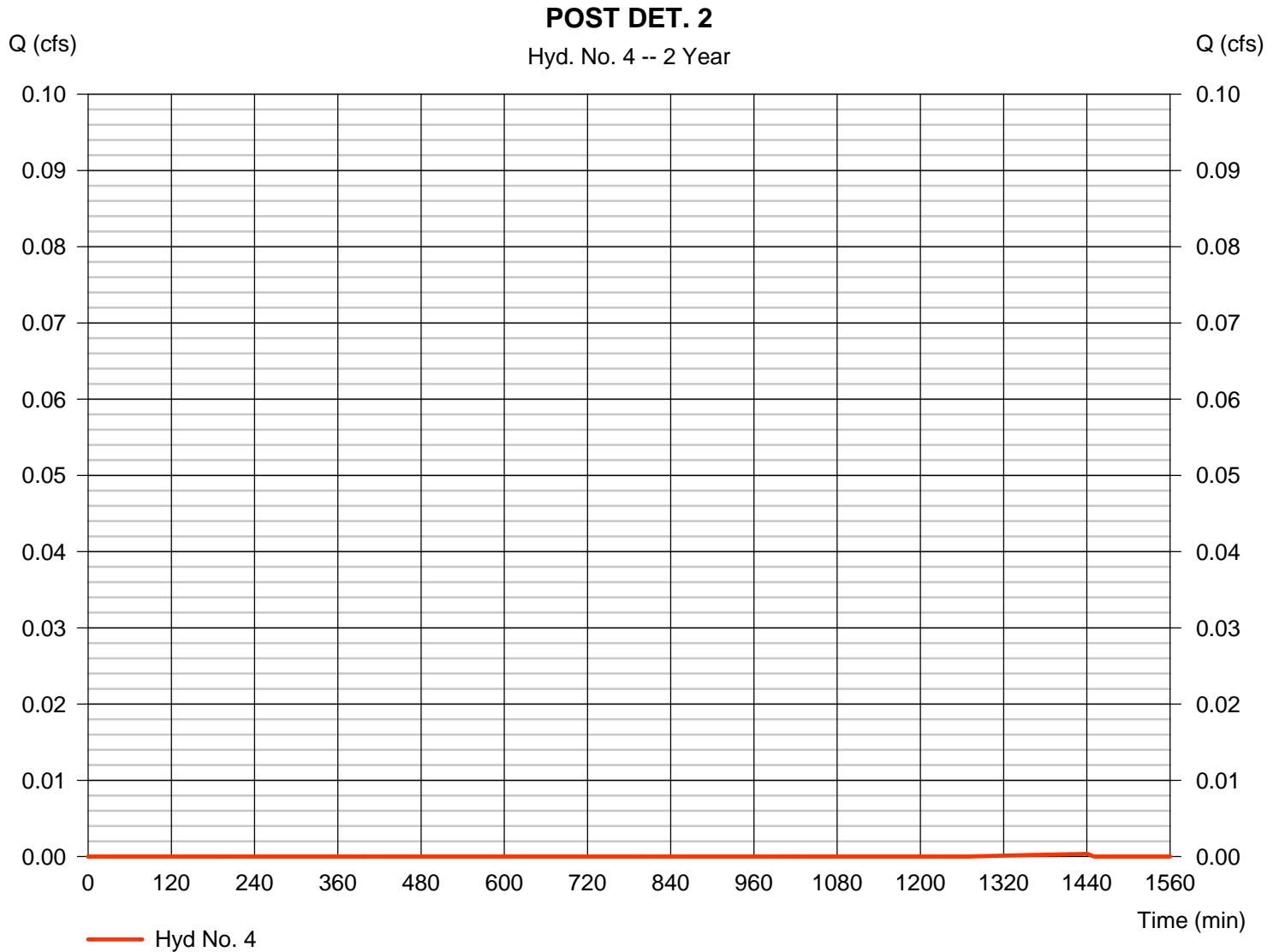
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.000 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 1440 min  |
| Time interval   | = 1 min      | Hyd. volume        | = 2 cuft    |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.30 min  |
| Total precip.   | = 3.24 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 4

POST DET. 2

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                 |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                 |
| Two-year 24-hr precip. (in)        | = 3.24        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 4.50        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 5.89</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 5.89</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 233.00      | 142.00        | 0.00          |                 |
| Watercourse slope (%)              | = 10.10       | 8.20          | 0.00          |                 |
| Surface description                | = Unpaved     | Unpaved       | Paved         |                 |
| Average velocity (ft/s)            | =5.13         | 4.62          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.76</b> | <b>+ 0.51</b> | <b>+ 0.00</b> | <b>= 1.27</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| X sectional flow area (sqft)       | = 0.09        | 0.00          | 0.00          |                 |
| Wetted perimeter (ft)              | = 1.05        | 0.00          | 0.00          |                 |
| Channel slope (%)                  | = 0.50        | 0.00          | 0.00          |                 |
| Manning's n-value                  | = 0.015       | 0.015         | 0.015         |                 |
| Velocity (ft/s)                    | =1.32         | 0.00          | 0.00          |                 |
| Flow length (ft)                   | 87.0          | 0.0           | 0.0           |                 |
| <b>Travel Time (min)</b>           | <b>= 1.10</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 1.10</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>8.30 min</b> |

# Hydrograph Report

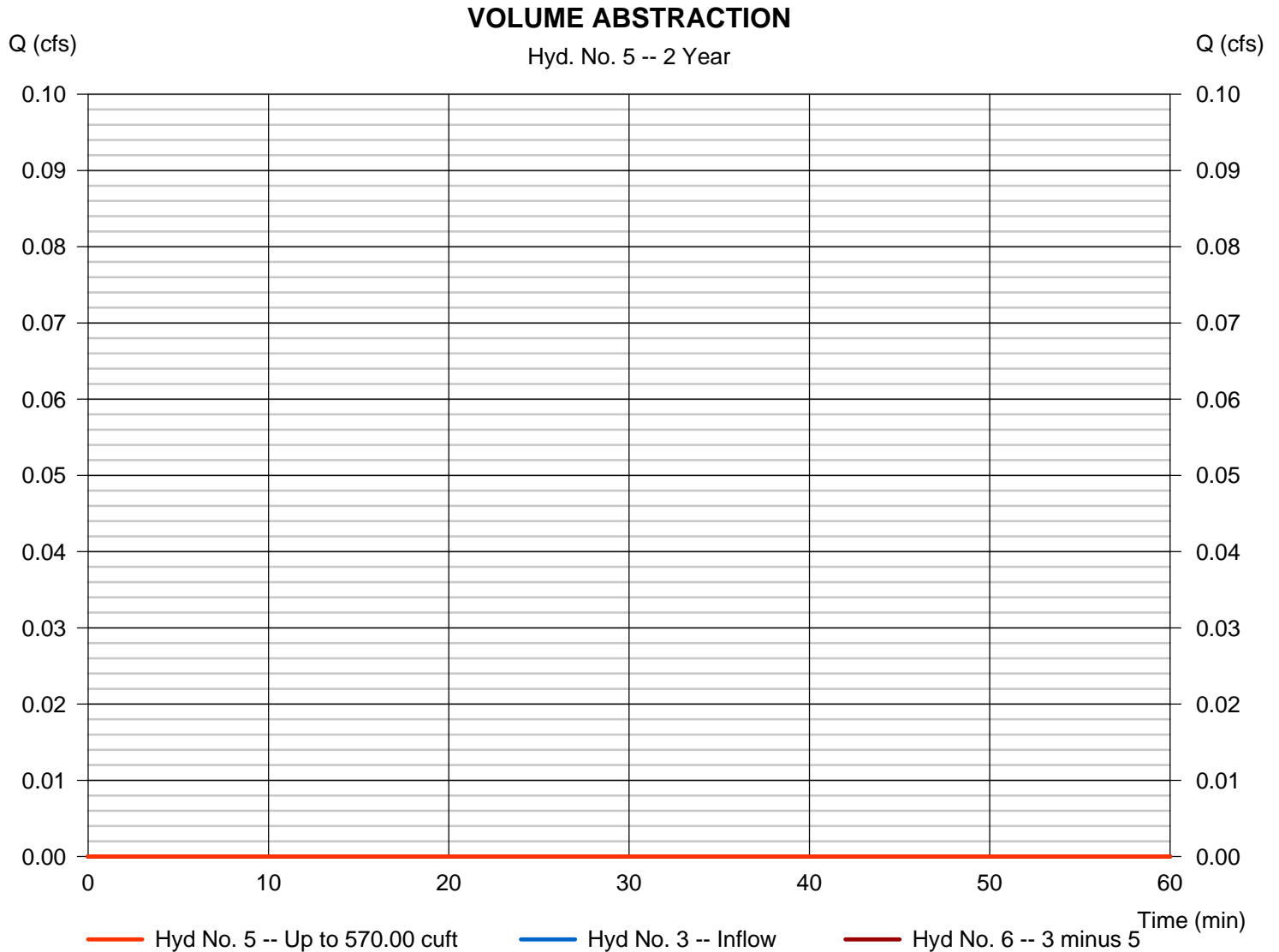
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

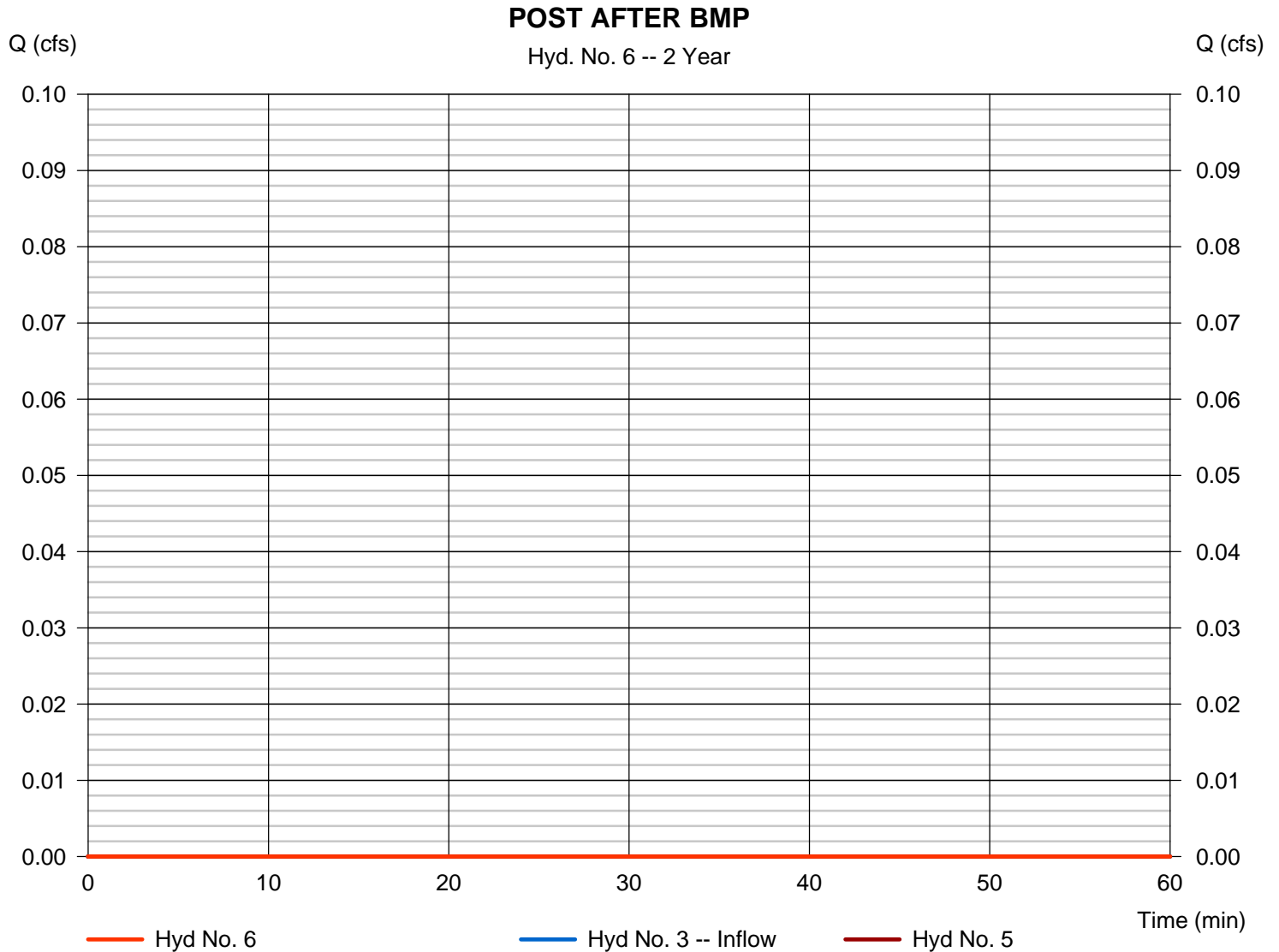
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

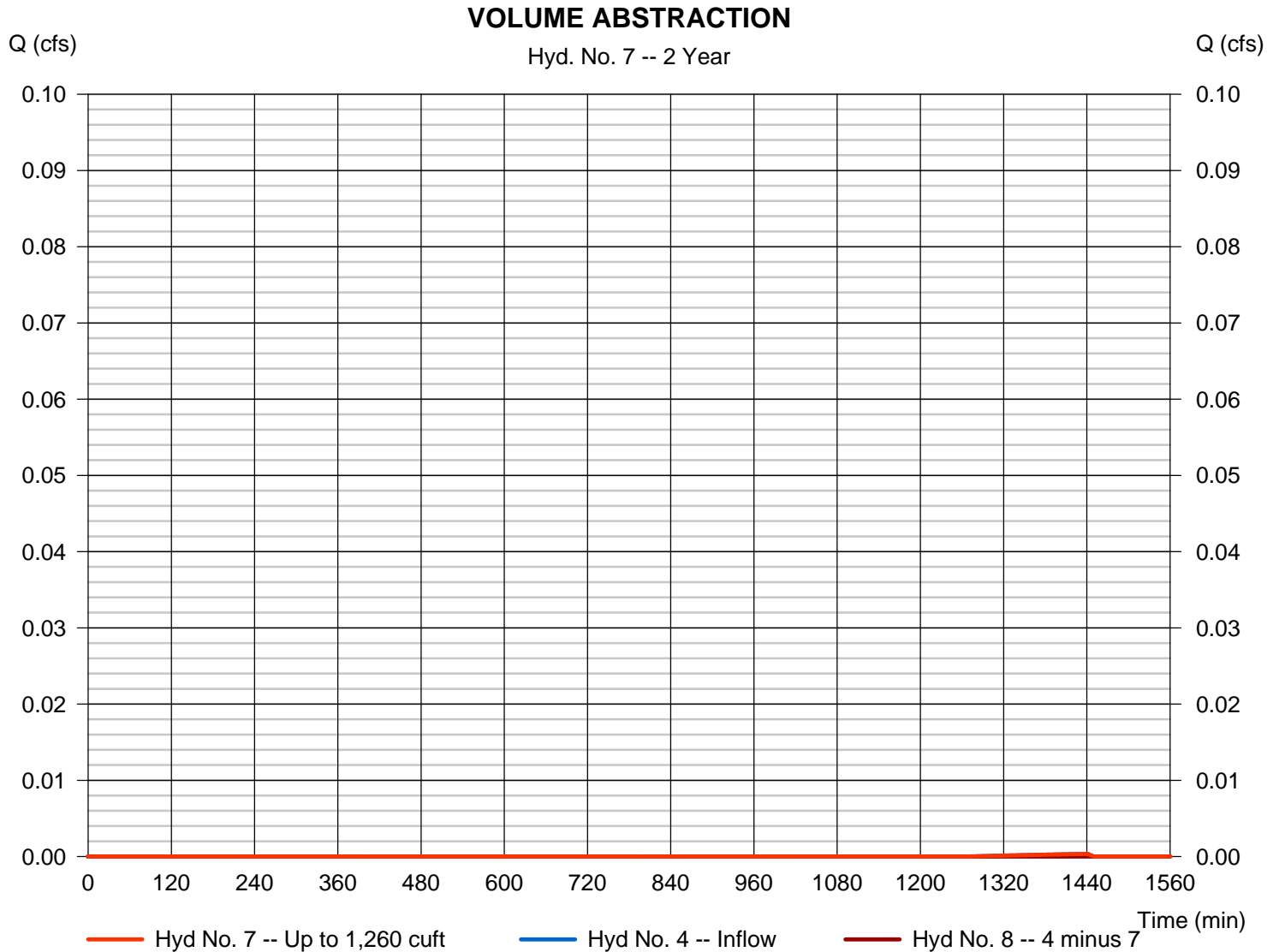
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 1440 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 2 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

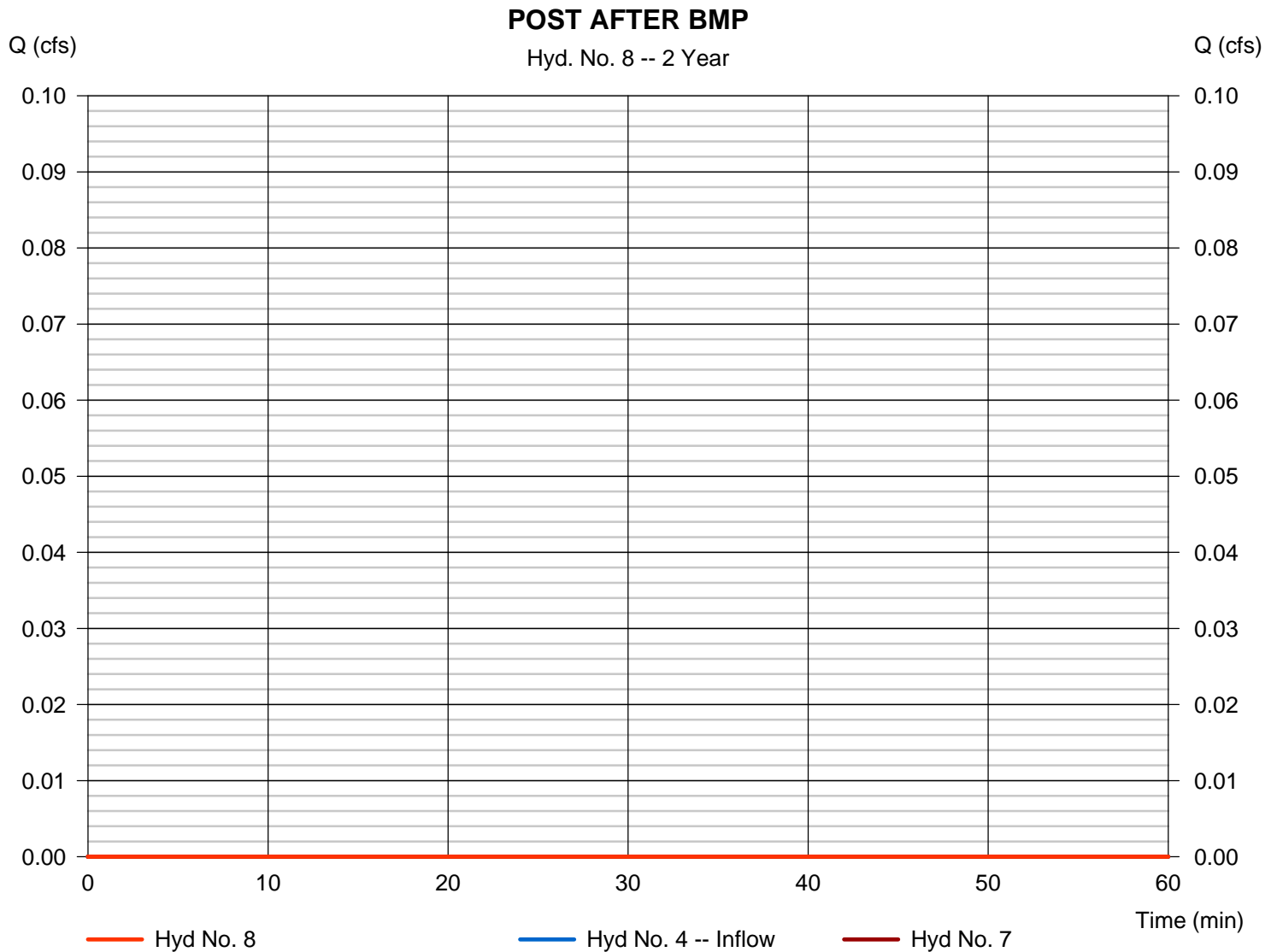
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

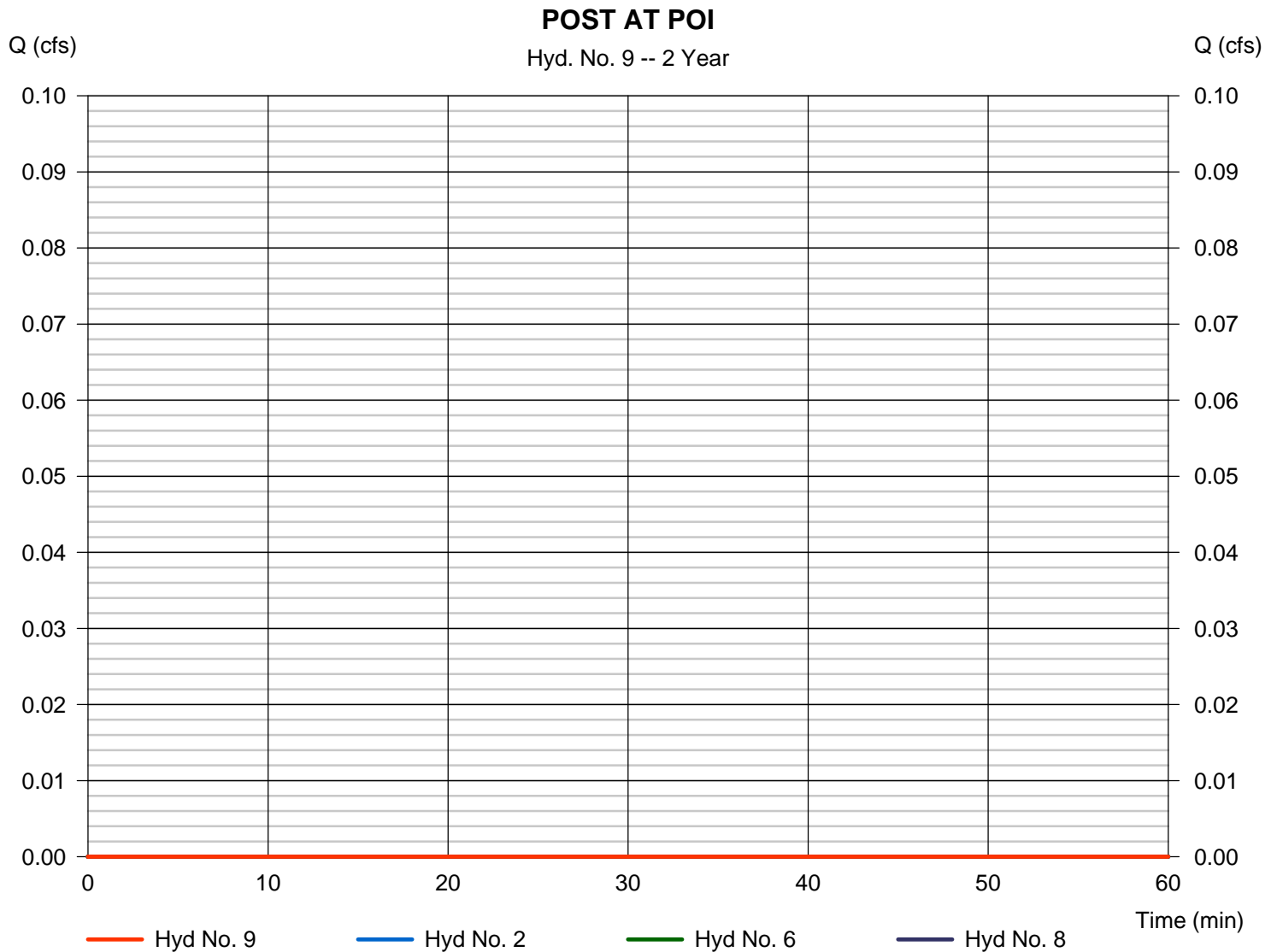
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
Storm frequency = 2 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 6, 8

Peak discharge = 0.000 cfs  
Time to peak = n/a  
Hyd. volume = 0 cuft  
Contrib. drain. area = 1.790 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 51.6066  | 12.5000 | 0.8820 | ----- |
| 2                   | 61.7637  | 12.8000 | 0.8782 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 64.3712  | 12.9000 | 0.8379 | ----- |
| 10                  | 58.5497  | 11.8000 | 0.7889 | ----- |
| 25                  | 53.6357  | 10.9000 | 0.7370 | ----- |
| 50                  | 51.9530  | 10.6000 | 0.7090 | ----- |
| 100                 | 44.2162  | 9.1000  | 0.6540 | ----- |

File name: Fairview Road.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.13                     | 3.31 | 2.77 | 2.39 | 2.11 | 1.89 | 1.71 | 1.57 | 1.45 | 1.35 | 1.26 | 1.18 |
| 2                   | 4.93                     | 3.96 | 3.33 | 2.88 | 2.54 | 2.28 | 2.07 | 1.90 | 1.75 | 1.63 | 1.52 | 1.43 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.74                     | 4.67 | 3.96 | 3.45 | 3.06 | 2.76 | 2.52 | 2.32 | 2.15 | 2.00 | 1.88 | 1.77 |
| 10                  | 6.32                     | 5.15 | 4.37 | 3.82 | 3.41 | 3.08 | 2.82 | 2.60 | 2.42 | 2.26 | 2.13 | 2.01 |
| 25                  | 6.98                     | 5.71 | 4.87 | 4.28 | 3.83 | 3.48 | 3.20 | 2.96 | 2.76 | 2.60 | 2.45 | 2.32 |
| 50                  | 7.41                     | 6.08 | 5.21 | 4.59 | 4.13 | 3.76 | 3.46 | 3.22 | 3.01 | 2.83 | 2.68 | 2.54 |
| 100                 | 7.83                     | 6.42 | 5.52 | 4.88 | 4.40 | 4.02 | 3.72 | 3.46 | 3.25 | 3.07 | 2.91 | 2.77 |

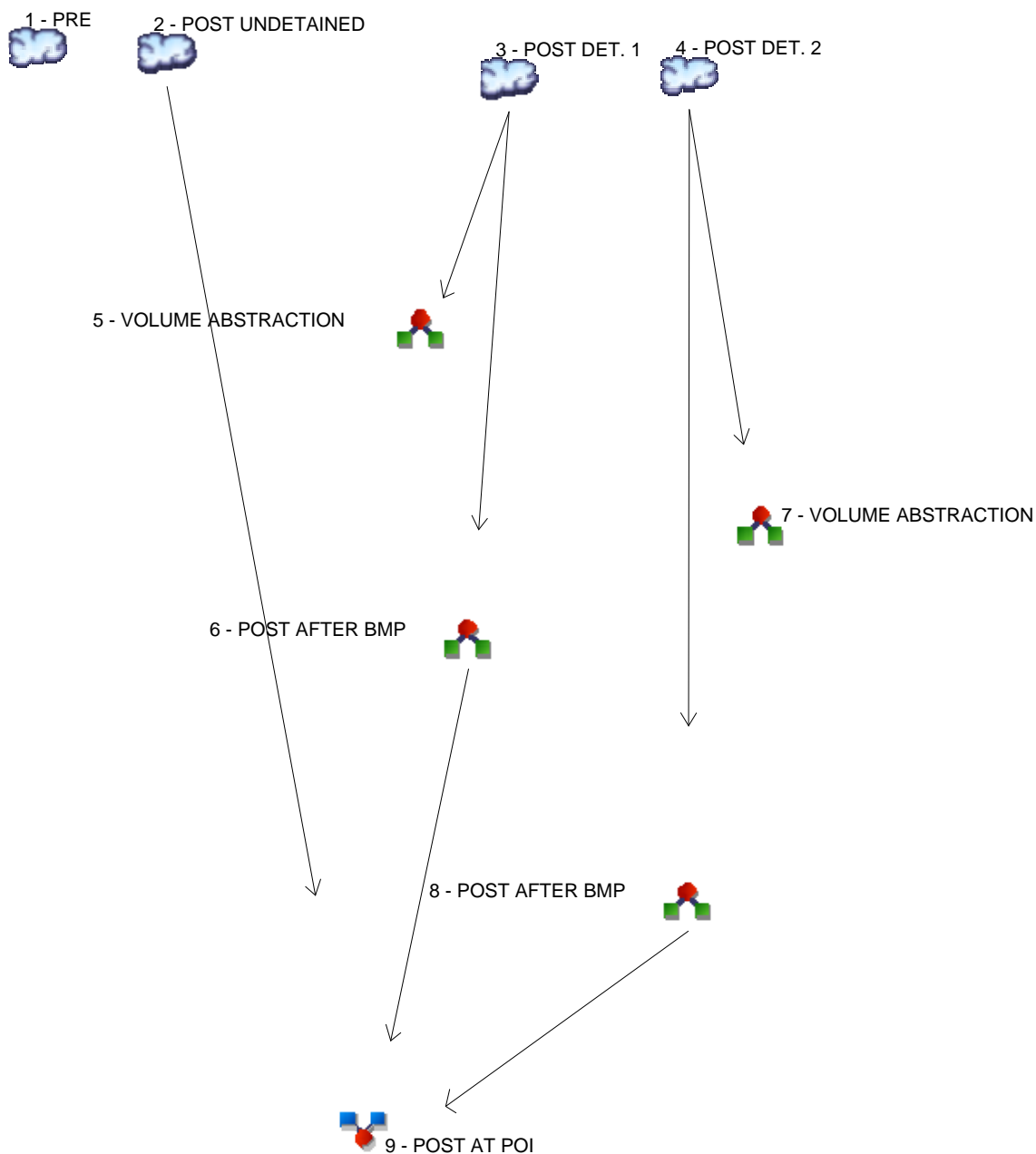
T<sub>c</sub> = time in minutes. Values may exceed 60.

D:\07 PCSM\Attachment 4 - Stormwater Calcs\Fairview Road (Walnut Bank)\Hydraflow Rev 1\Fairview Road Precip.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.69                              | 3.24 | 0.00 | 4.06 | 4.74  | 5.72  | 6.54  | 7.42   |
| SCS 6-Hr           | 1.90                              | 2.29 | 0.00 | 2.85 | 3.30  | 3.92  | 4.42  | 4.94   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. | Origin     | Description        |
|------|------------|--------------------|
| 1    | SCS Runoff | PRE                |
| 2    | SCS Runoff | POST UNDETAINED    |
| 3    | SCS Runoff | POST DET. 1        |
| 4    | SCS Runoff | POST DET. 2        |
| 5    | Diversion1 | VOLUME ABSTRACTION |
| 6    | Diversion2 | POST AFTER BMP     |
| 7    | Diversion1 | VOLUME ABSTRACTION |
| 8    | Diversion2 | POST AFTER BMP     |
| 9    | Combine    | POST AT POI        |

# 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               | -----         | -----              | ----- | ----- | ----- | 0.010 | ----- | ----- | -----  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 0.006 | ----- | ----- | -----  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 0.001 | ----- | ----- | -----  | POST DET. 1            |
| 4        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 0.006 | ----- | ----- | -----  | POST DET. 2            |
| 5        | Diversion1               | 3             | -----              | ----- | ----- | ----- | 0.001 | ----- | ----- | -----  | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 3             | -----              | ----- | ----- | ----- | 0.000 | ----- | ----- | -----  | POST AFTER BMP         |
| 7        | Diversion1               | 4             | -----              | ----- | ----- | ----- | 0.006 | ----- | ----- | -----  | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 4             | -----              | ----- | ----- | ----- | 0.000 | ----- | ----- | -----  | POST AFTER BMP         |
| 9        | Combine                  | 2, 6, 8       | -----              | ----- | ----- | ----- | 0.006 | ----- | ----- | -----  | POST AT POI            |

# 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               | 0.010           | 1                   | 1440               | 238                | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 0.006           | 1                   | 1440               | 145                | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.001           | 1                   | 2879               | 40                 | -----         | -----                  | -----                   | POST DET. 1            |
| 4        | SCS Runoff               | 0.006           | 1                   | 1722               | 387                | -----         | -----                  | -----                   | POST DET. 2            |
| 5        | Diversion1               | 0.001           | 1                   | 2879               | 40                 | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 0.000           | 1                   | n/a                | 0                  | 3             | -----                  | -----                   | POST AFTER BMP         |
| 7        | Diversion1               | 0.006           | 1                   | 1722               | 387                | 4             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 0.000           | 1                   | n/a                | 0                  | 4             | -----                  | -----                   | POST AFTER BMP         |
| 9        | Combine                  | 0.006           | 1                   | 1440               | 145                | 2, 6, 8       | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

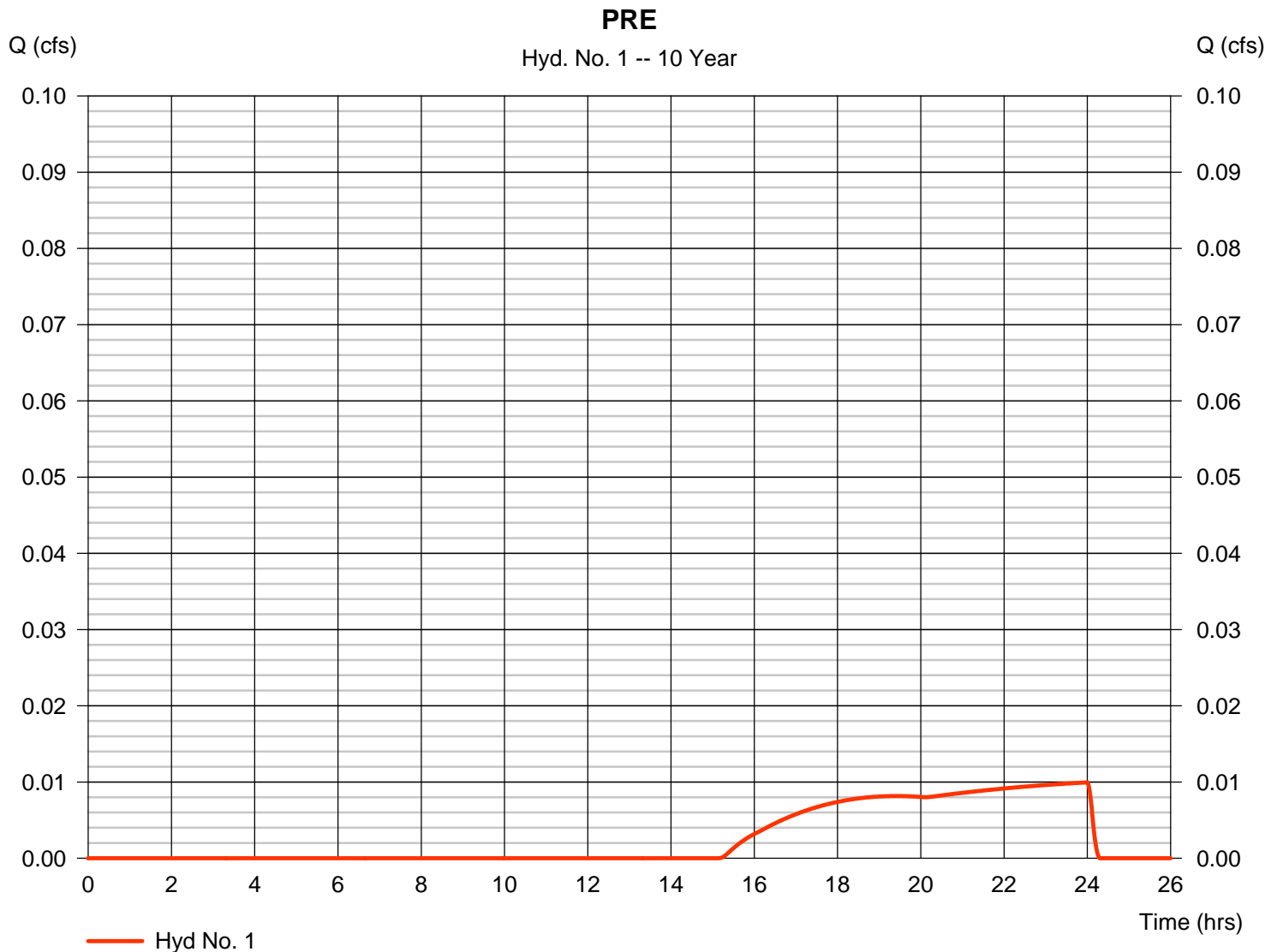
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.010 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 24.00 hrs |
| Time interval   | = 1 min      | Hyd. volume        | = 238 cuft  |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

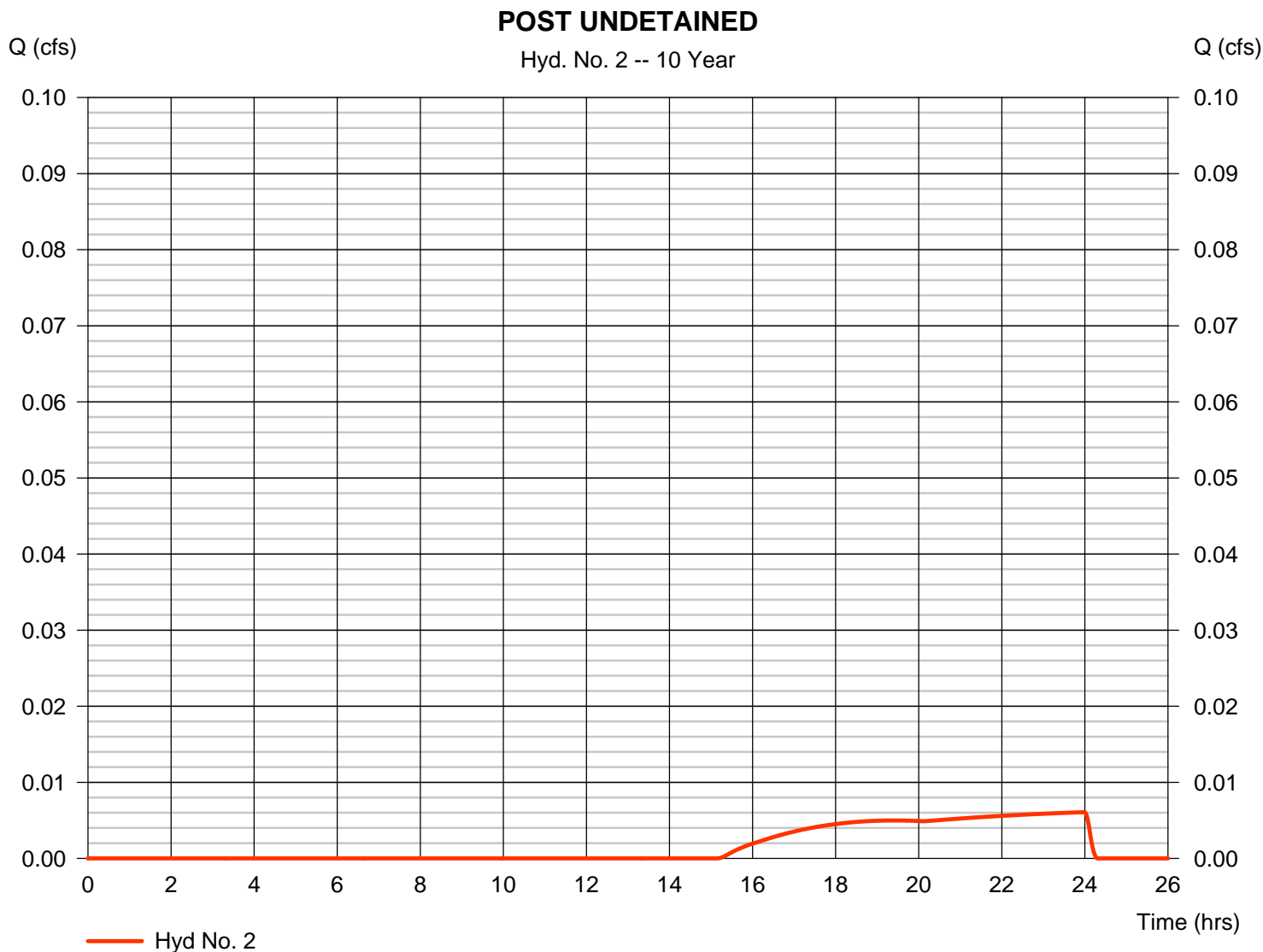
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.006 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 24.00 hrs |
| Time interval   | = 1 min      | Hyd. volume        | = 145 cuft  |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | 432.0         |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

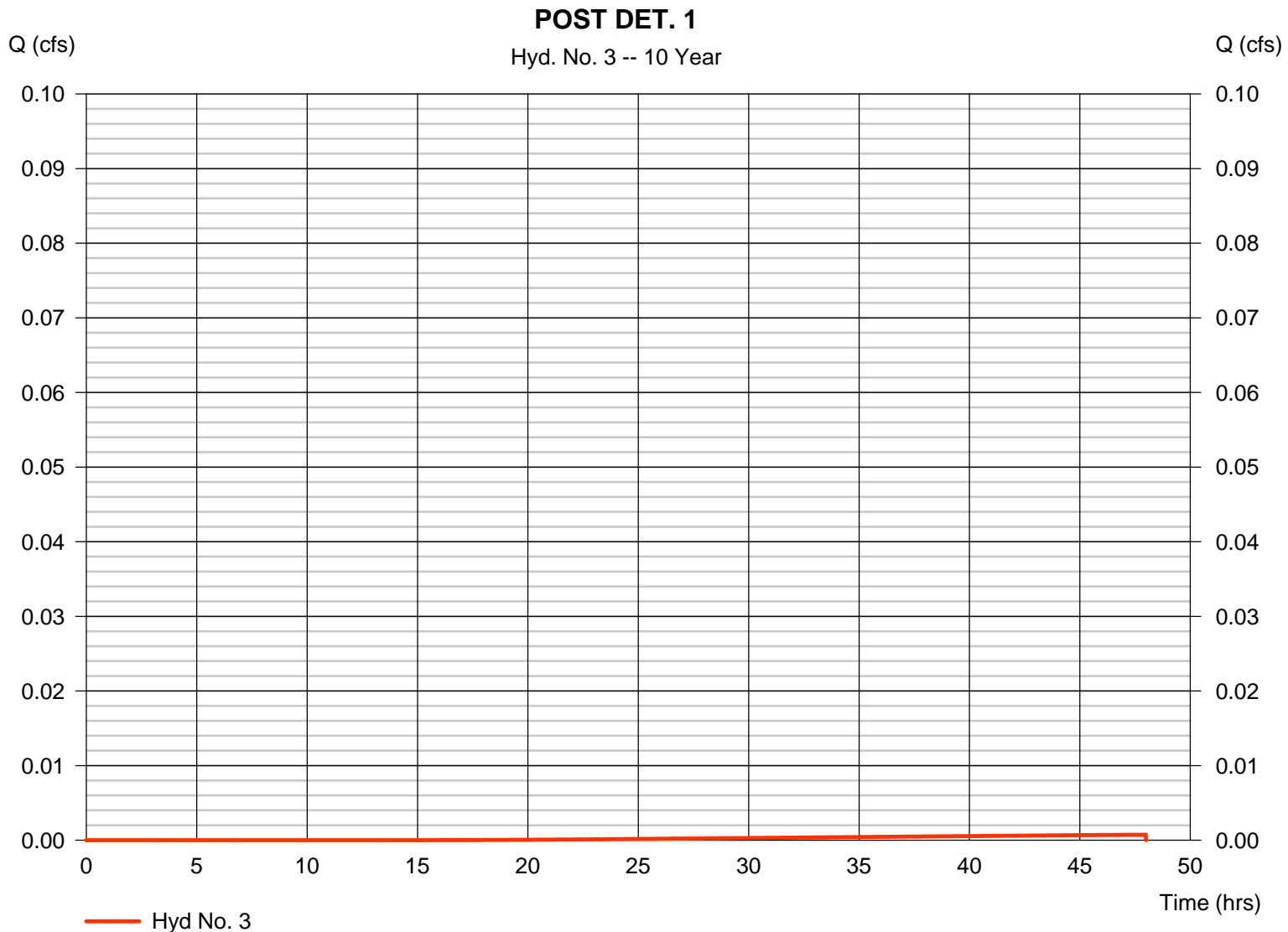
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.001 cfs   |
| Storm frequency | = 10 yrs     | Time to peak       | = 47.98 hrs   |
| Time interval   | = 1 min      | Hyd. volume        | = 40 cuft     |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = User       | Time of conc. (Tc) | = 3173.00 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

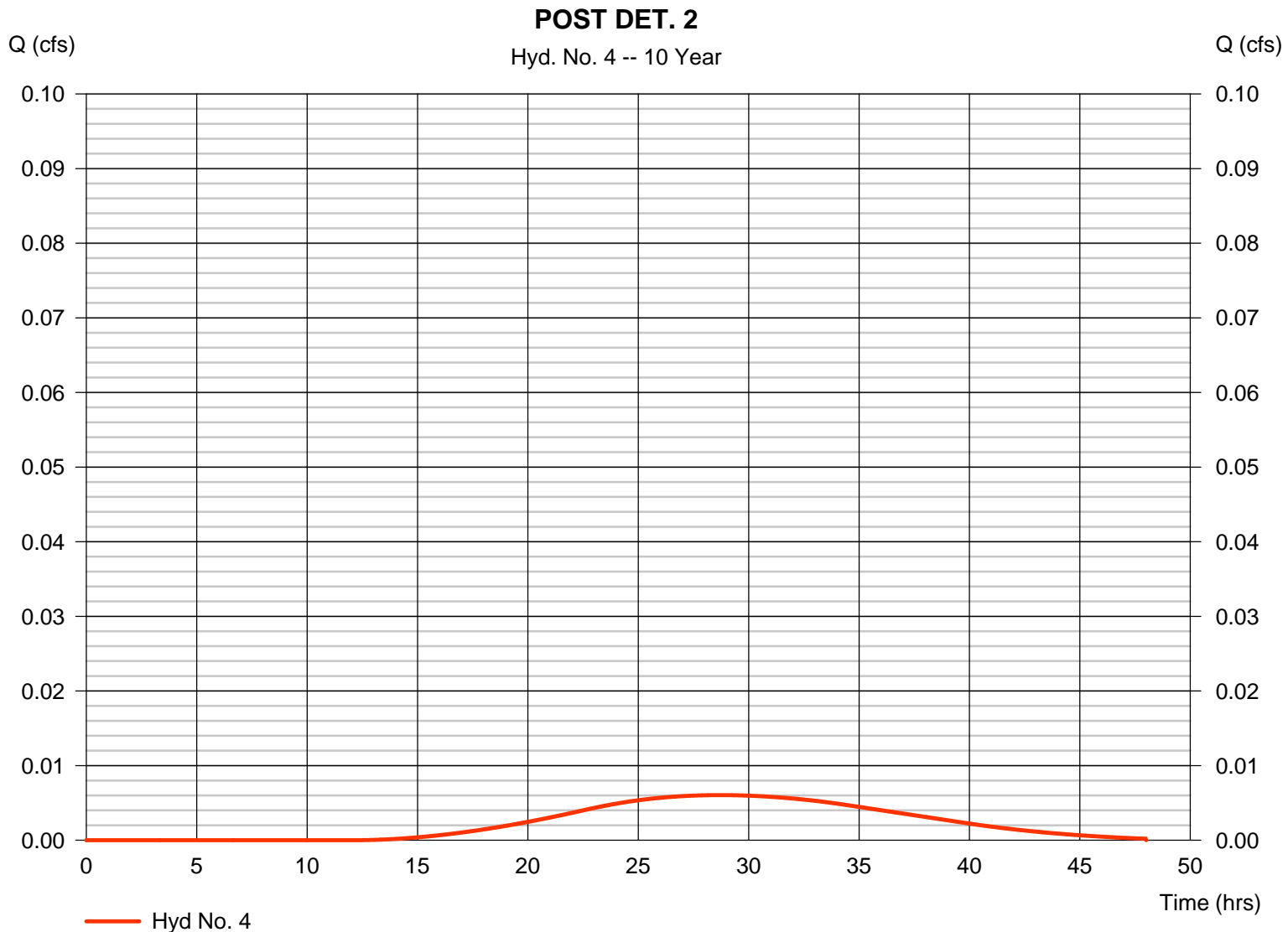
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.006 cfs   |
| Storm frequency | = 10 yrs     | Time to peak       | = 28.70 hrs   |
| Time interval   | = 1 min      | Hyd. volume        | = 387 cuft    |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = User       | Time of conc. (Tc) | = 1062.00 min |
| Total precip.   | = 4.74 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

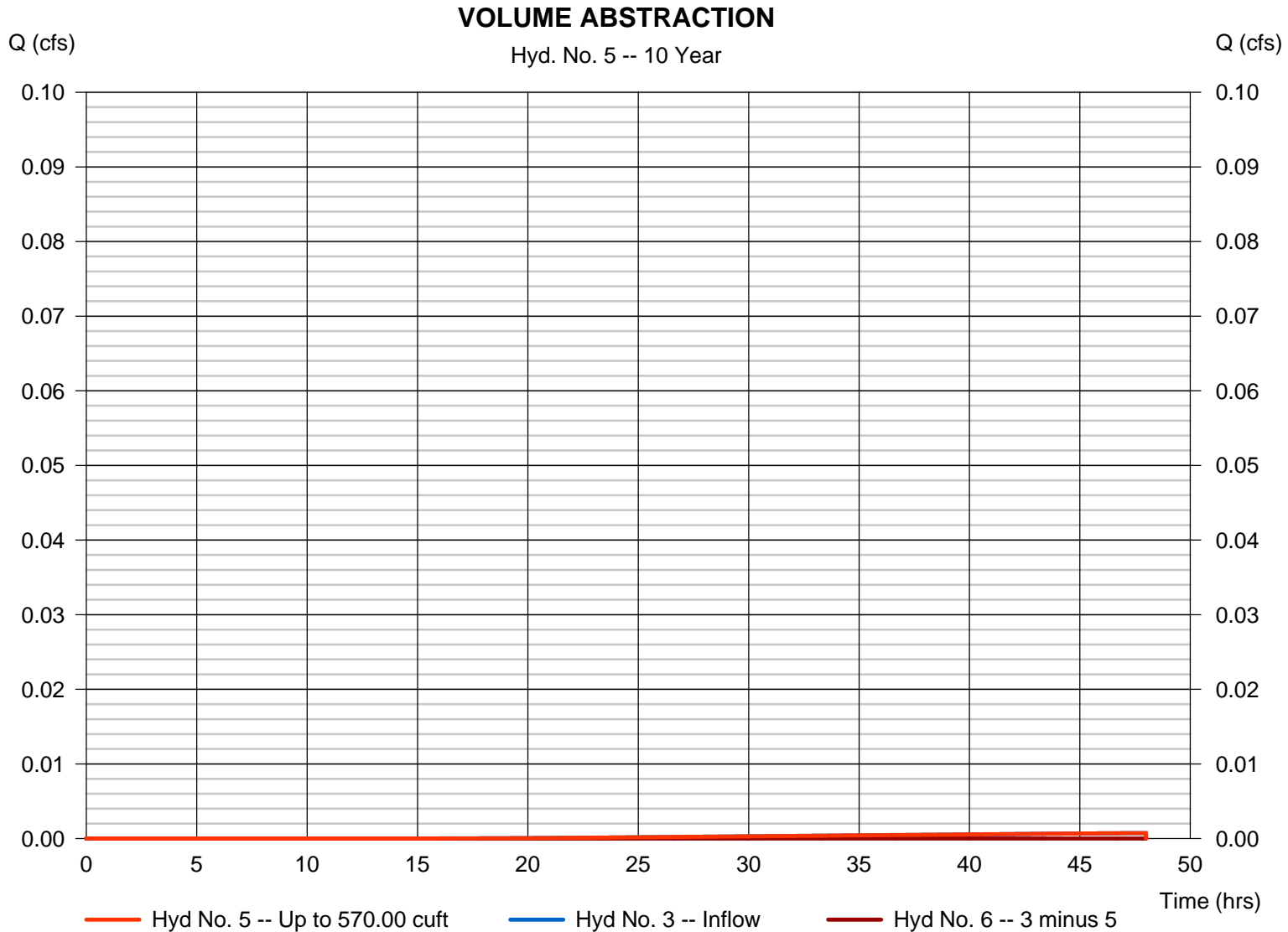
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.001 cfs   |
| Storm frequency   | = 10 yrs             | Time to peak      | = 47.98 hrs   |
| Time interval     | = 1 min              | Hyd. volume       | = 40 cuft     |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |

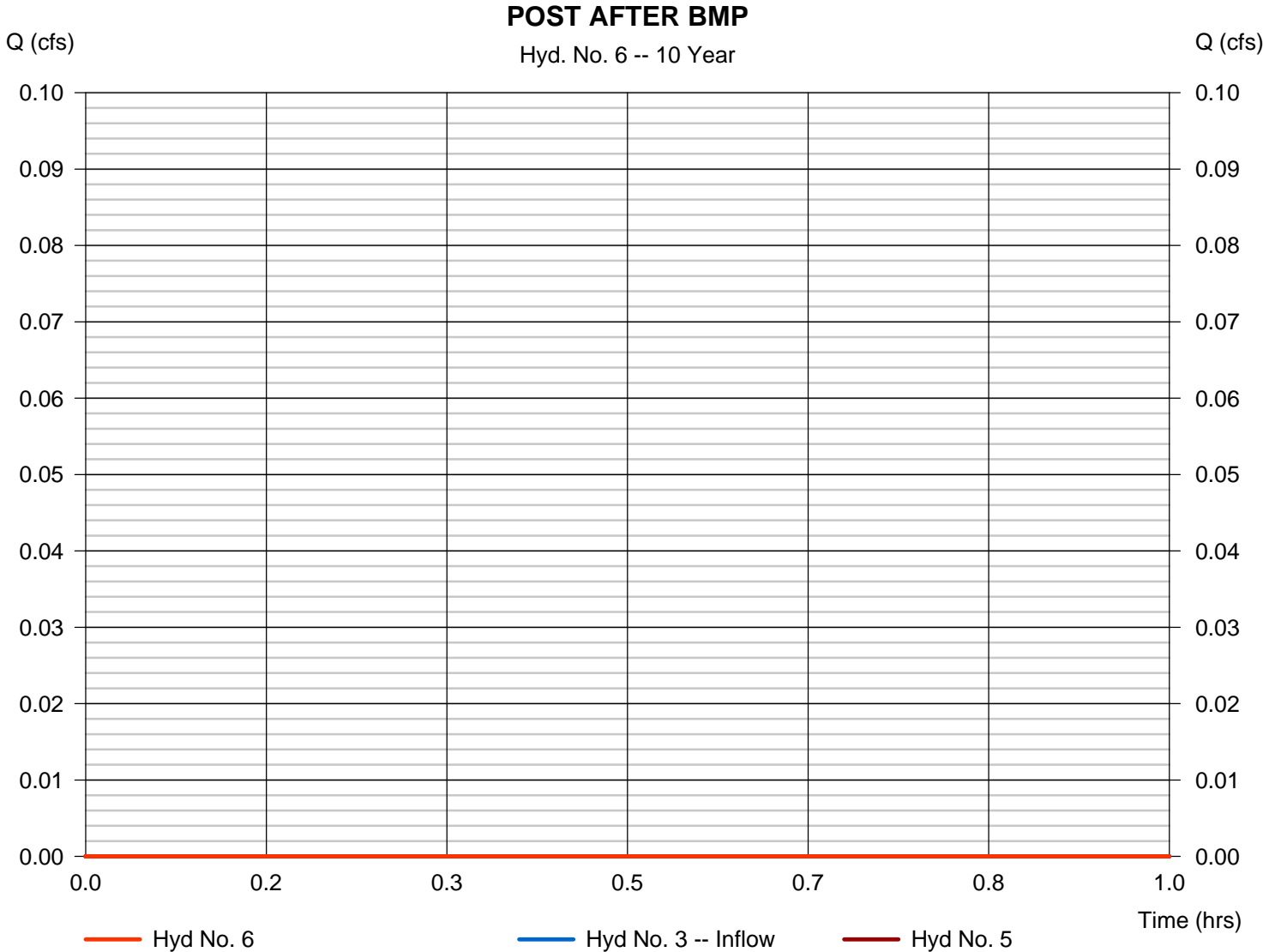


# Hydrograph Report

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs   |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a         |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

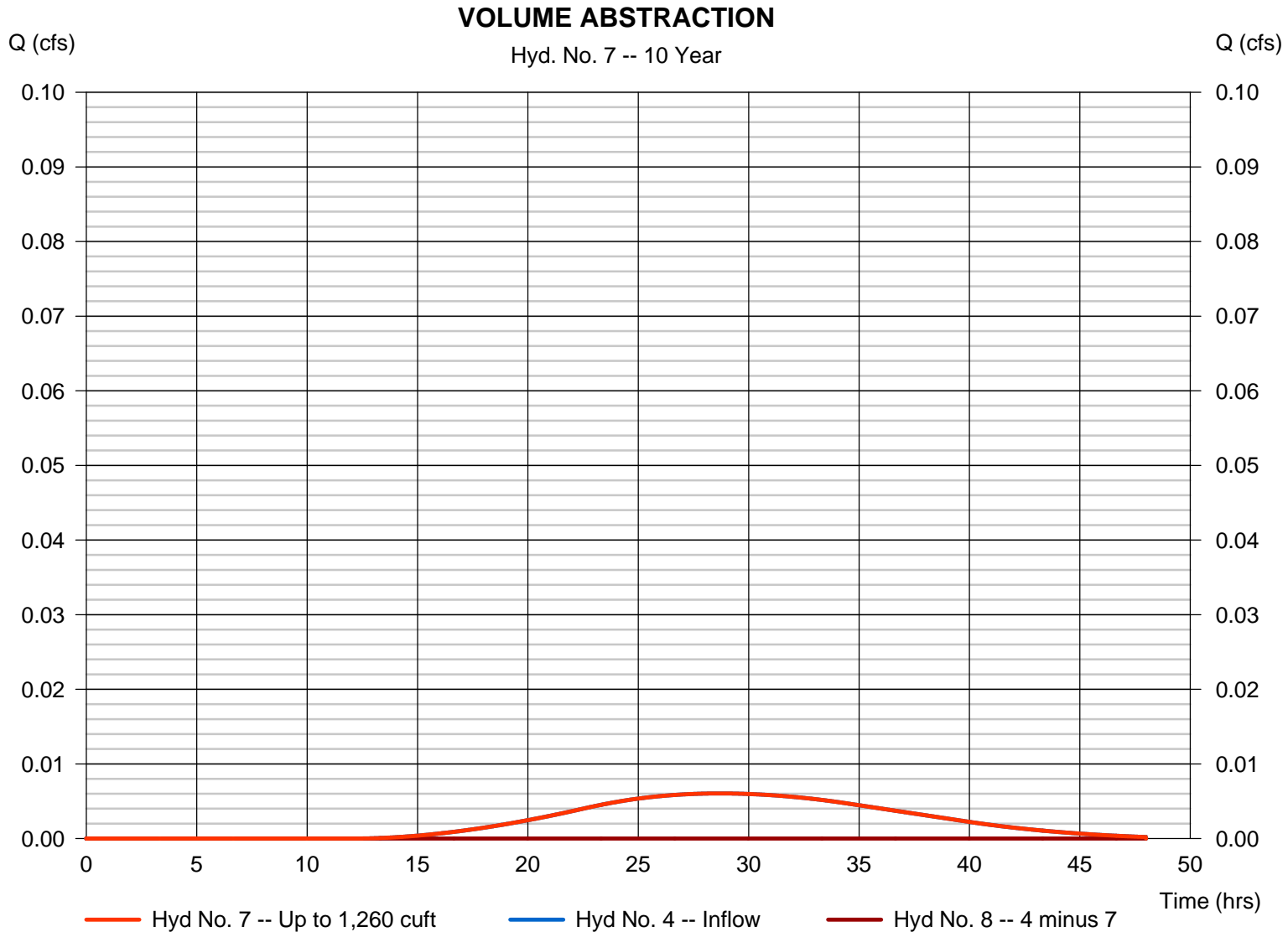
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.006 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 28.70 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 387 cuft   |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

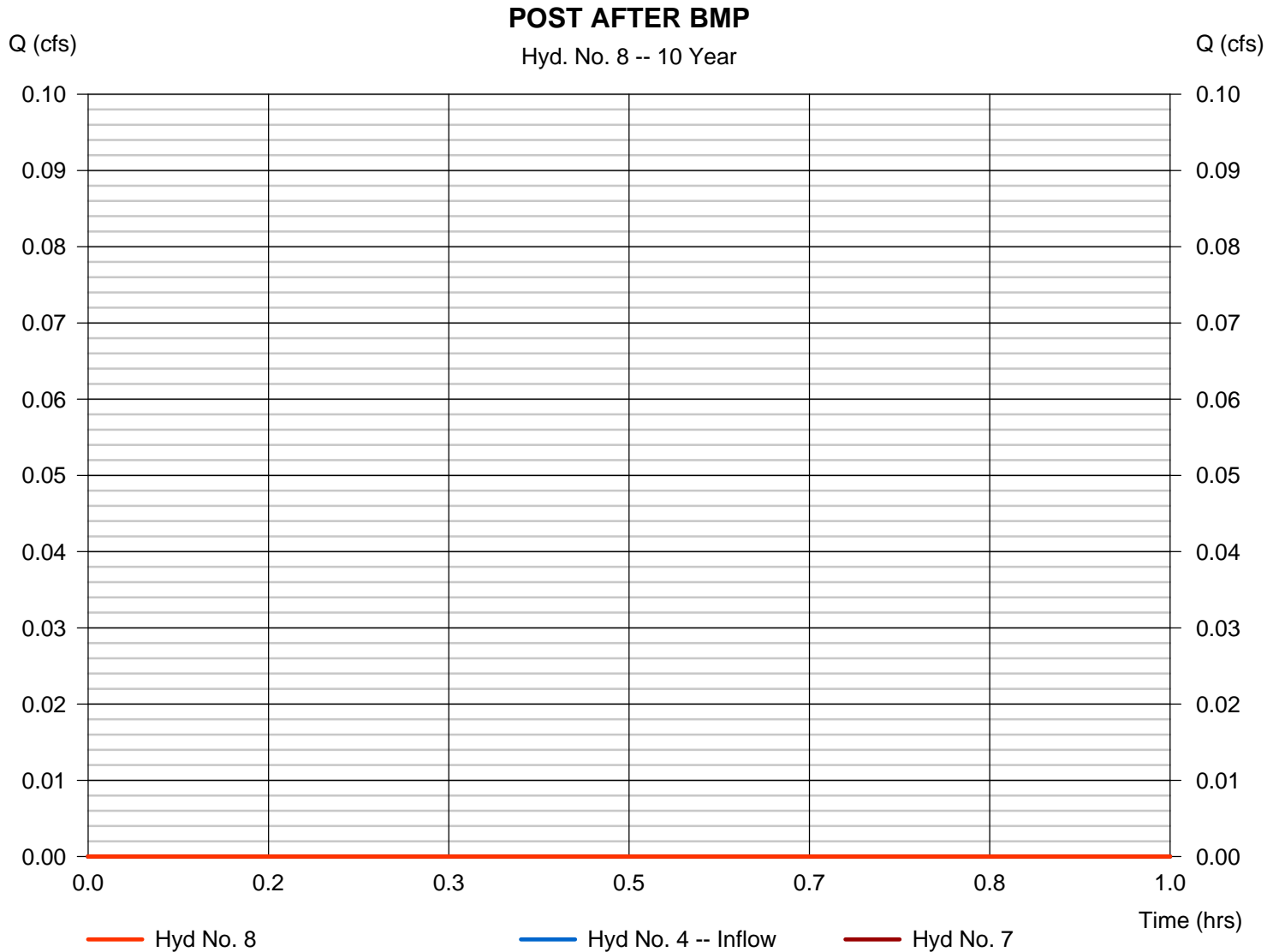
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

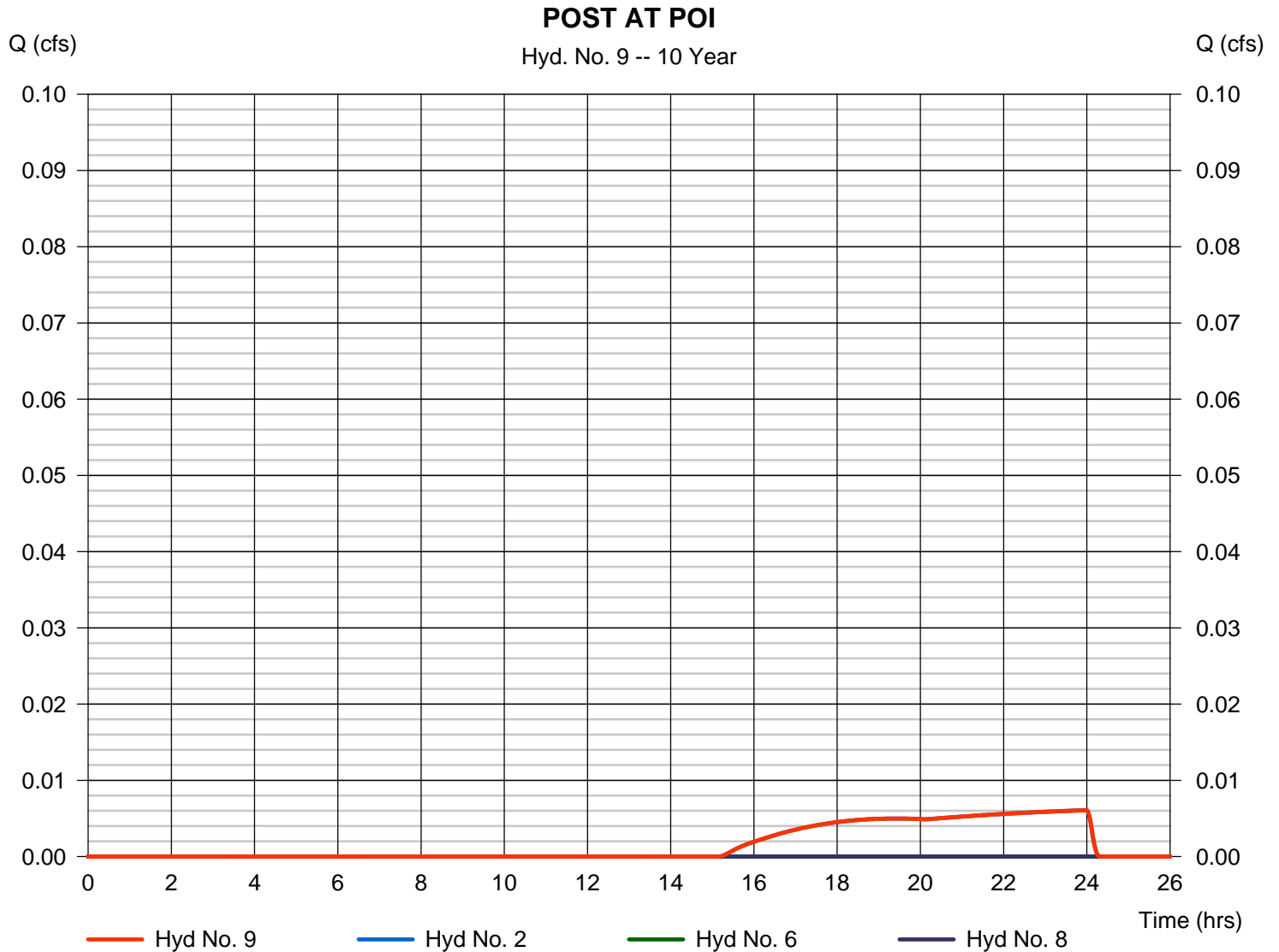
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 6, 8

Peak discharge = 0.006 cfs  
Time to peak = 24.00 hrs  
Hyd. volume = 145 cuft  
Contrib. drain. area = 1.790 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 51.6066  | 12.5000 | 0.8820 | ----- |
| 2                   | 61.7637  | 12.8000 | 0.8782 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 64.3712  | 12.9000 | 0.8379 | ----- |
| 10                  | 58.5497  | 11.8000 | 0.7889 | ----- |
| 25                  | 53.6357  | 10.9000 | 0.7370 | ----- |
| 50                  | 51.9530  | 10.6000 | 0.7090 | ----- |
| 100                 | 44.2162  | 9.1000  | 0.6540 | ----- |

File name: Fairview Road.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.13                     | 3.31 | 2.77 | 2.39 | 2.11 | 1.89 | 1.71 | 1.57 | 1.45 | 1.35 | 1.26 | 1.18 |
| 2                   | 4.93                     | 3.96 | 3.33 | 2.88 | 2.54 | 2.28 | 2.07 | 1.90 | 1.75 | 1.63 | 1.52 | 1.43 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.74                     | 4.67 | 3.96 | 3.45 | 3.06 | 2.76 | 2.52 | 2.32 | 2.15 | 2.00 | 1.88 | 1.77 |
| 10                  | 6.32                     | 5.15 | 4.37 | 3.82 | 3.41 | 3.08 | 2.82 | 2.60 | 2.42 | 2.26 | 2.13 | 2.01 |
| 25                  | 6.98                     | 5.71 | 4.87 | 4.28 | 3.83 | 3.48 | 3.20 | 2.96 | 2.76 | 2.60 | 2.45 | 2.32 |
| 50                  | 7.41                     | 6.08 | 5.21 | 4.59 | 4.13 | 3.76 | 3.46 | 3.22 | 3.01 | 2.83 | 2.68 | 2.54 |
| 100                 | 7.83                     | 6.42 | 5.52 | 4.88 | 4.40 | 4.02 | 3.72 | 3.46 | 3.25 | 3.07 | 2.91 | 2.77 |

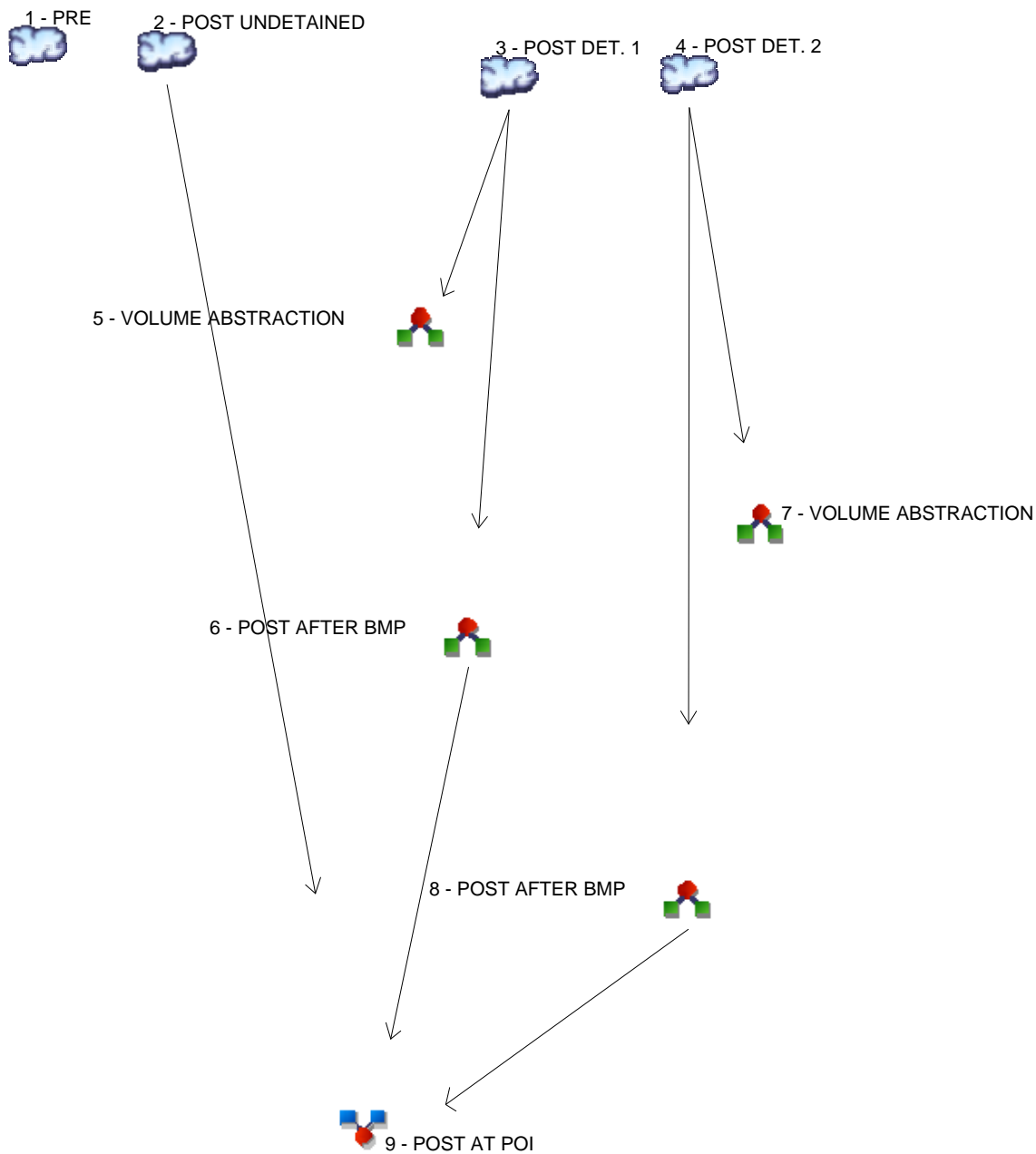
T<sub>c</sub> = time in minutes. Values may exceed 60.

D:\07 PCSM\Attachment 4 - Stormwater Calcs\Fairview Road (Walnut Bank)\Hydraflow Rev 1\Fairview Road Precip.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.69                              | 3.24 | 0.00 | 4.06 | 4.74  | 5.72  | 6.54  | 7.42   |
| SCS 6-Hr           | 1.90                              | 2.29 | 0.00 | 2.85 | 3.30  | 3.92  | 4.42  | 4.94   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. | Origin     | Description        |
|------|------------|--------------------|
| 1    | SCS Runoff | PRE                |
| 2    | SCS Runoff | POST UNDETAINED    |
| 3    | SCS Runoff | POST DET. 1        |
| 4    | SCS Runoff | POST DET. 2        |
| 5    | Diversion1 | VOLUME ABSTRACTION |
| 6    | Diversion2 | POST AFTER BMP     |
| 7    | Diversion1 | VOLUME ABSTRACTION |
| 8    | Diversion2 | POST AFTER BMP     |
| 9    | Combine    | POST AT POI        |

# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.147  | -----                  | PRE                |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.090  | -----                  | POST UNDETAINED    |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.035  | -----                  | POST DET. 1        |
| 4        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.141  | -----                  | POST DET. 2        |
| 5        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.035  | -----                  | VOLUME ABSTRACTION |
| 6        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.009  | -----                  | POST AFTER BMP     |
| 7        | Diversion1               | 4             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.141  | -----                  | VOLUME ABSTRACTION |
| 8        | Diversion2               | 4             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.021  | -----                  | POST AFTER BMP     |
| 9        | Combine                  | 2, 6, 8       | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.090  | -----                  | POST AT POI        |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

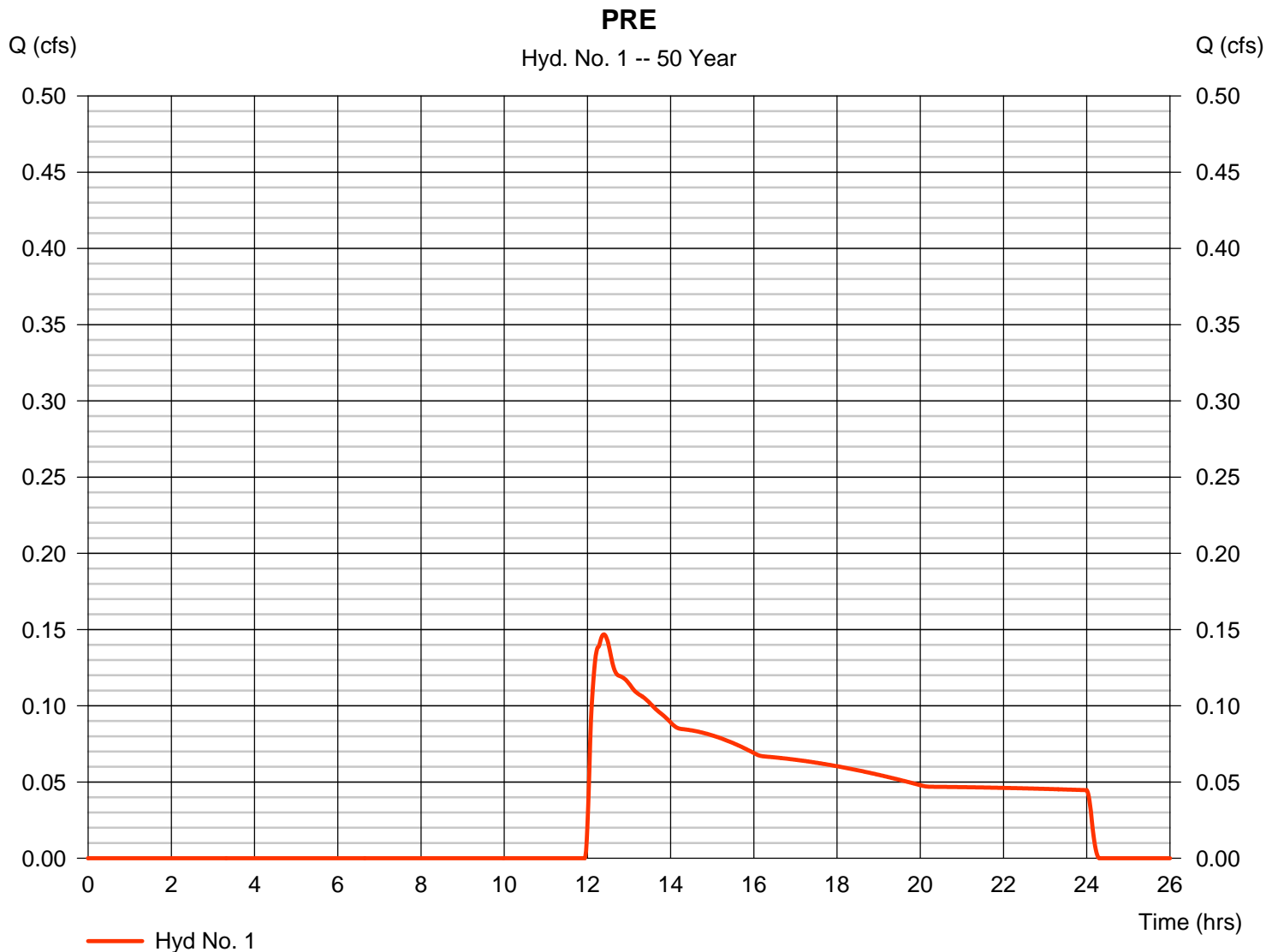
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.147 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 12.40 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 2,921 cuft |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

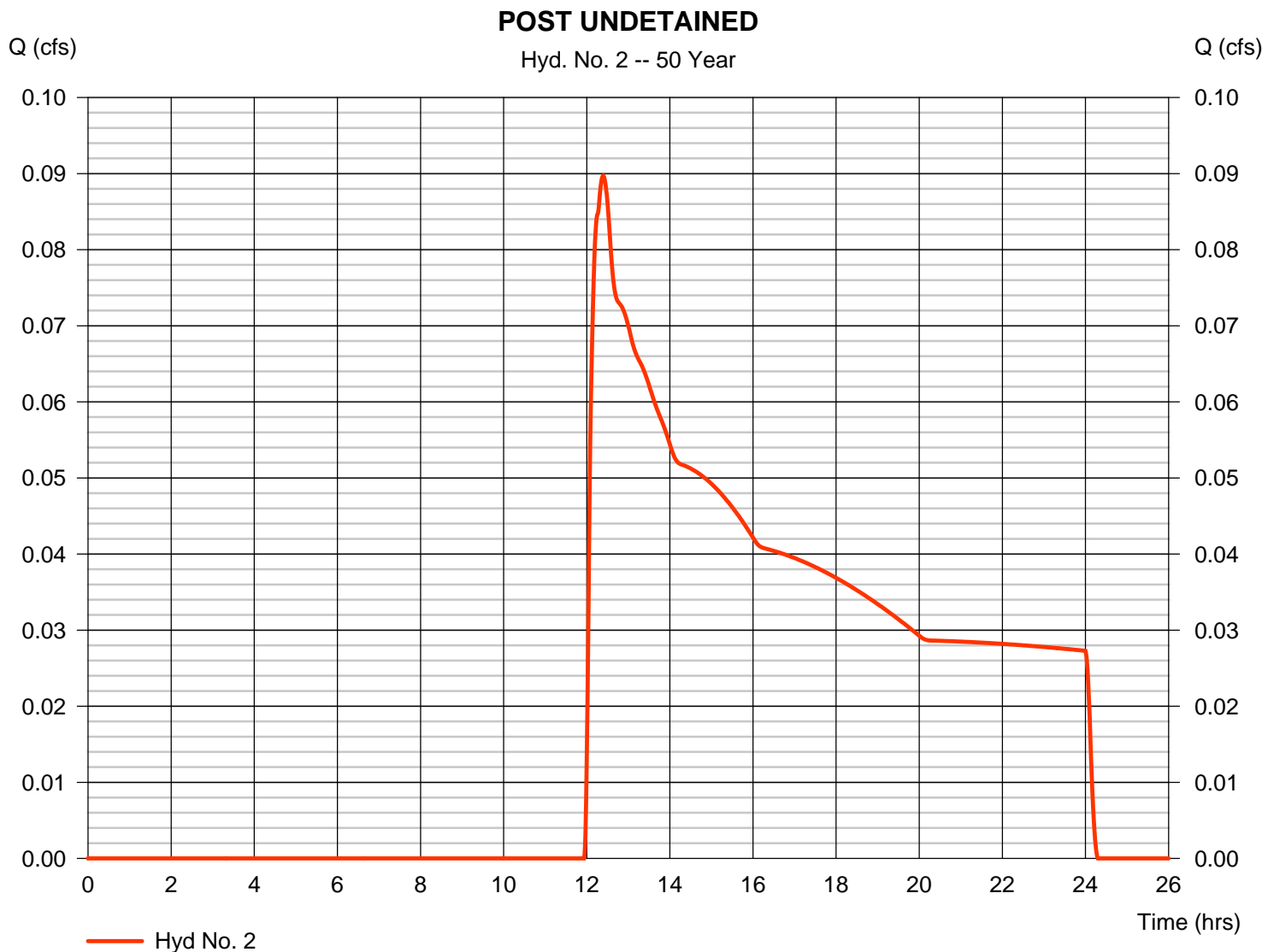
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.090 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 12.40 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 1,784 cuft |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

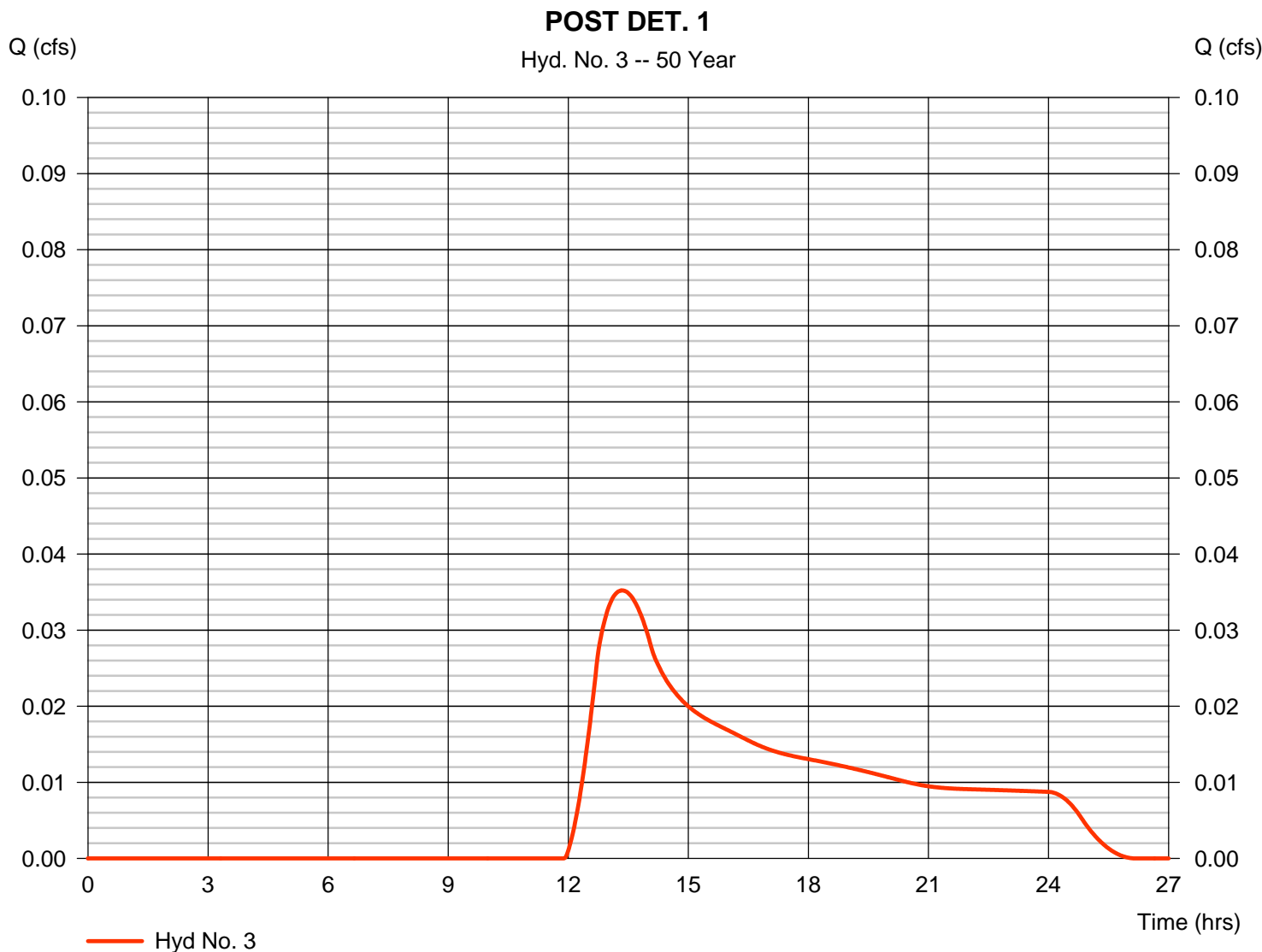
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.035 cfs |
| Storm frequency | = 50 yrs     | Time to peak       | = 13.35 hrs |
| Time interval   | = 1 min      | Hyd. volume        | = 687 cuft  |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 82.30 min |
| Total precip.   | = 6.54 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

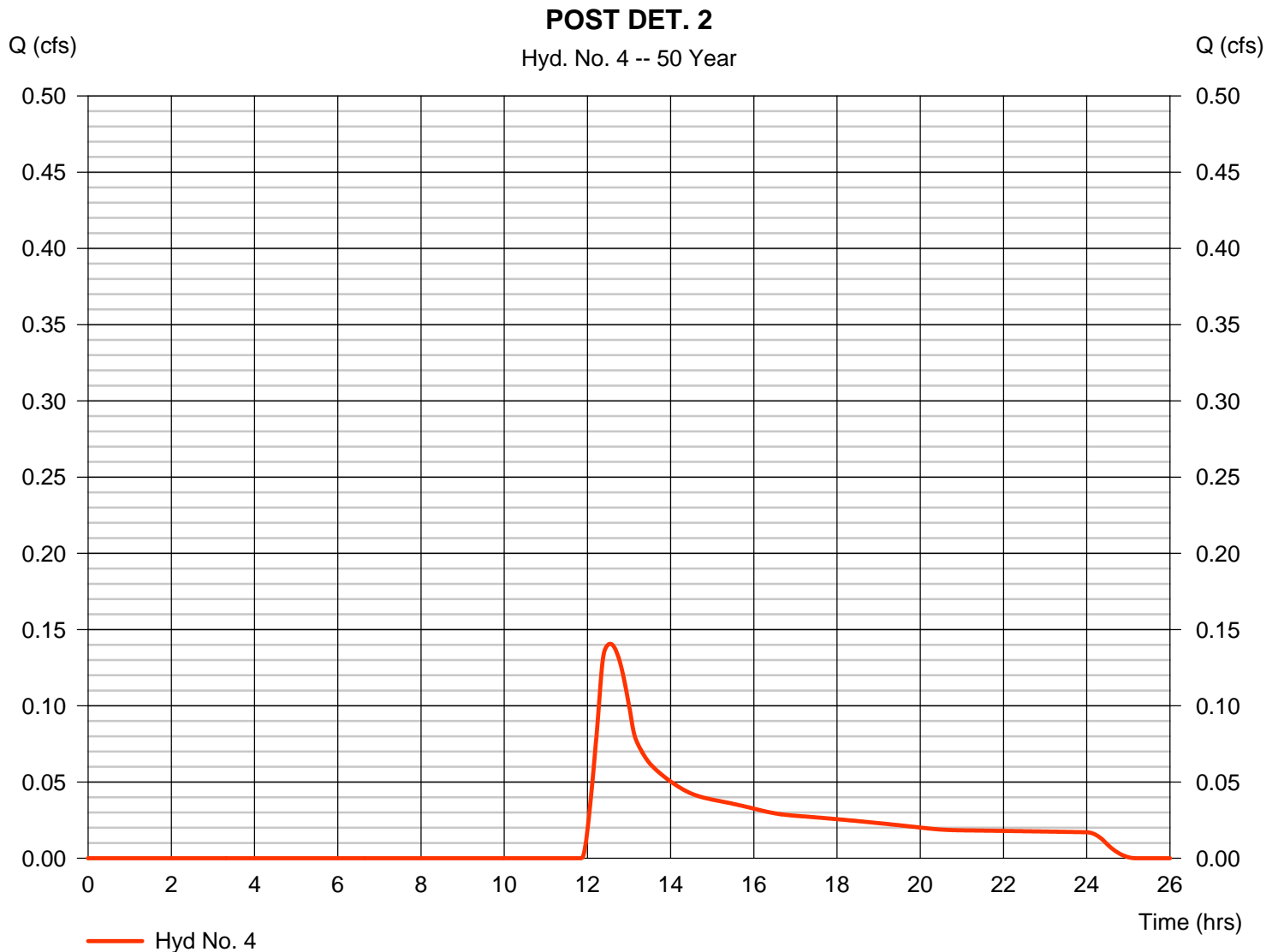
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.141 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 12.55 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 1,574 cuft |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 44.36 min  |
| Total precip.   | = 6.54 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

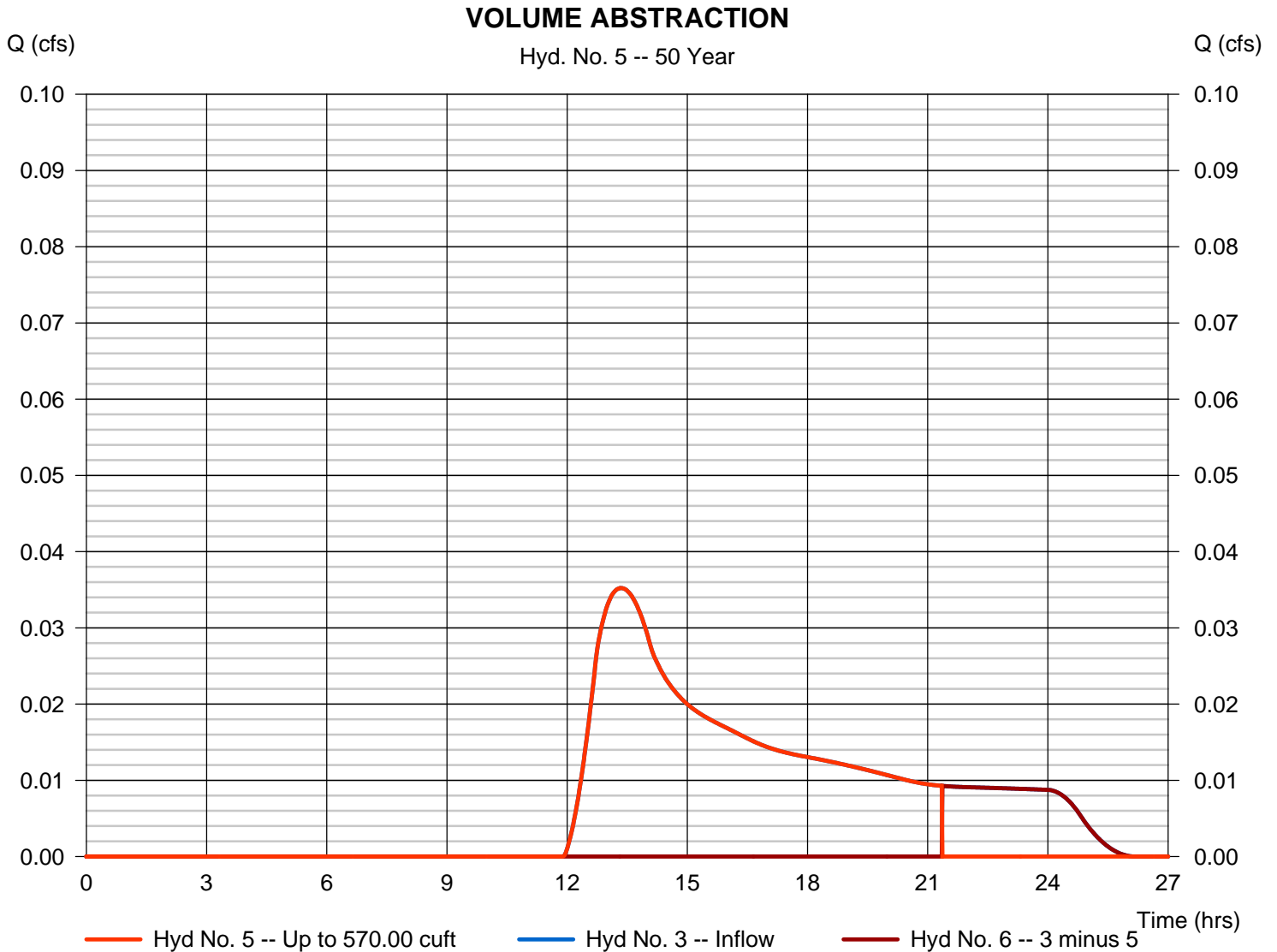
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.035 cfs   |
| Storm frequency   | = 50 yrs             | Time to peak      | = 13.35 hrs   |
| Time interval     | = 1 min              | Hyd. volume       | = 570 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

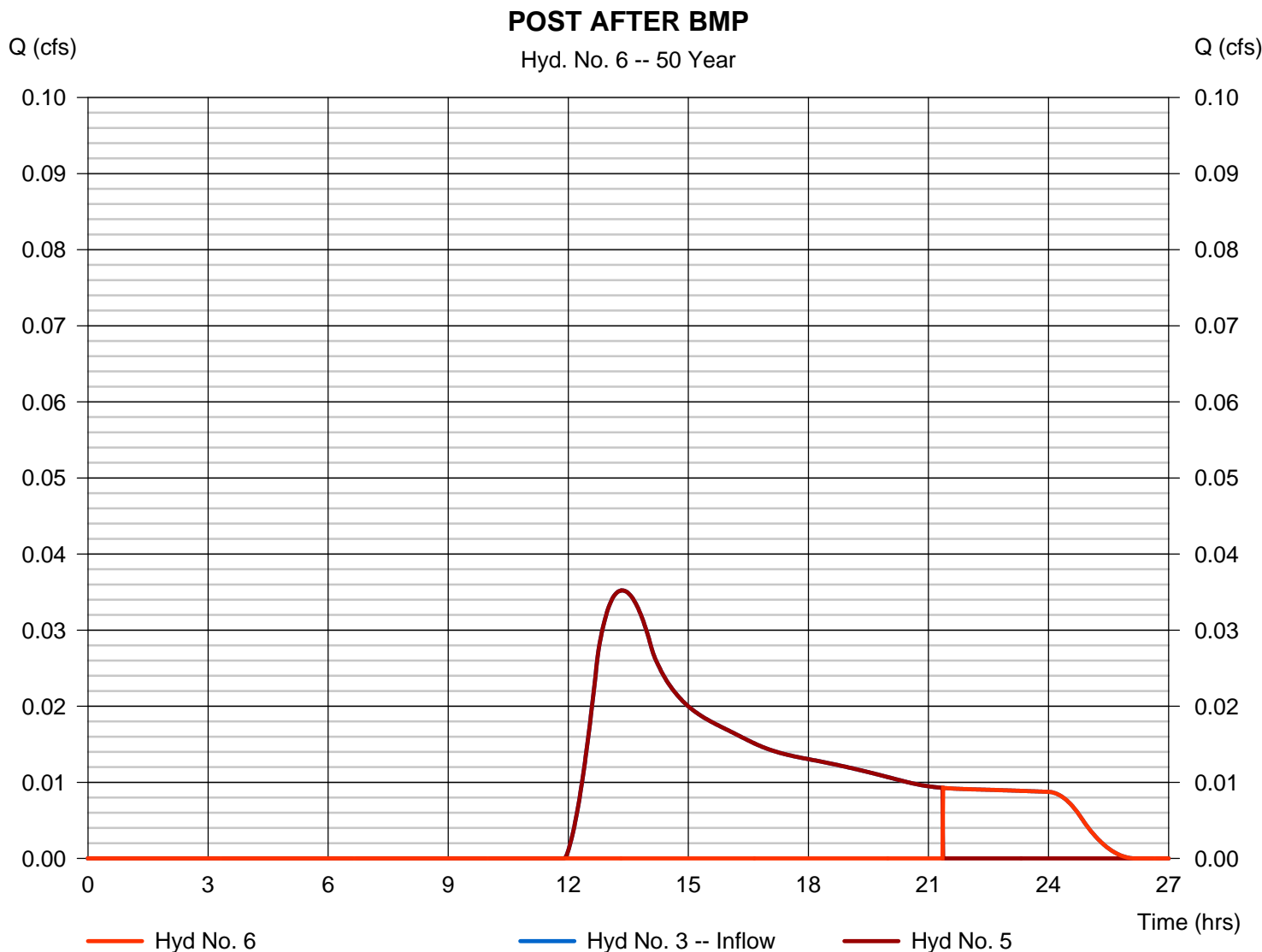
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.009 cfs   |
| Storm frequency   | = 50 yrs             | Time to peak      | = 21.37 hrs   |
| Time interval     | = 1 min              | Hyd. volume       | = 116 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

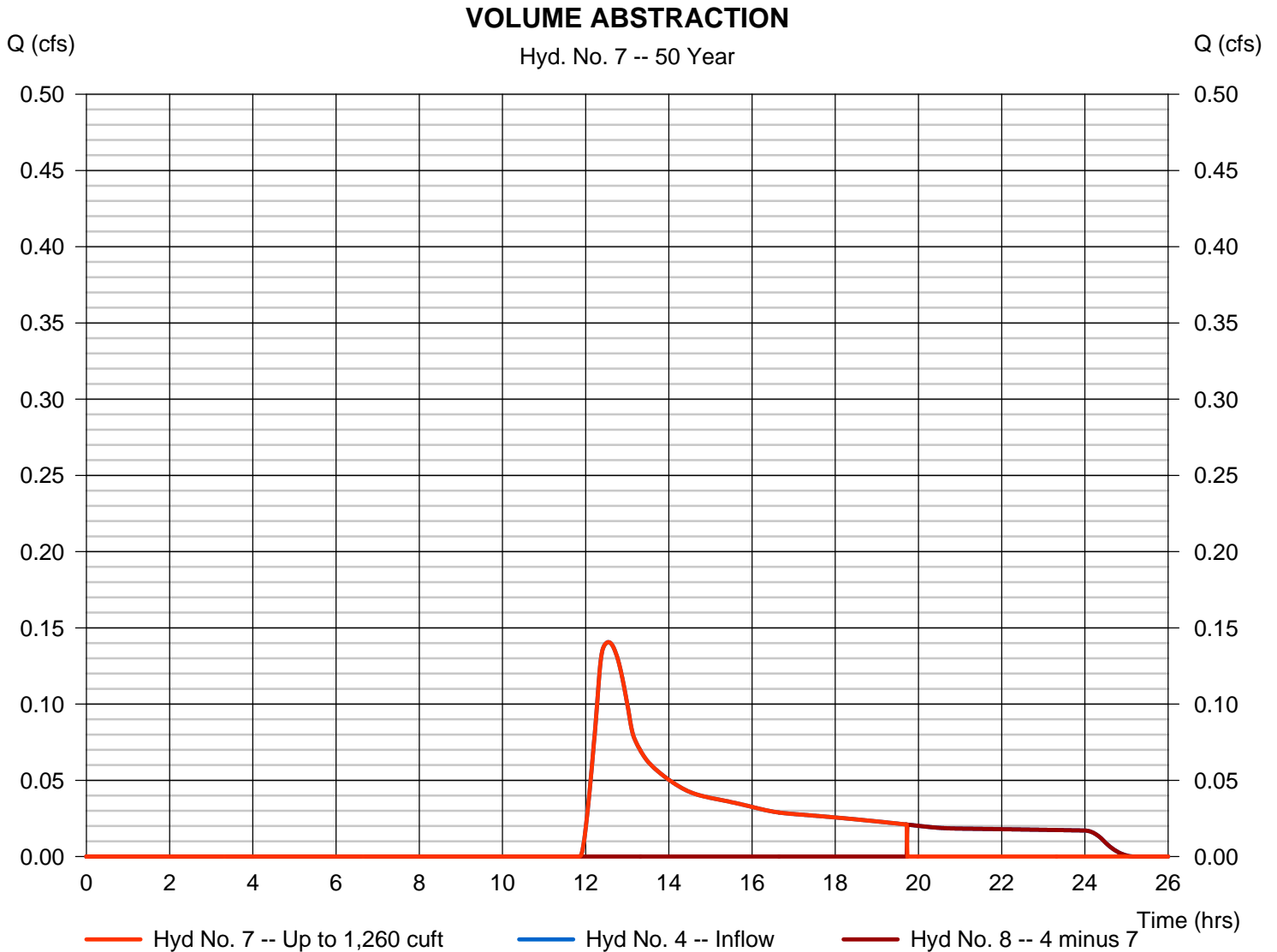
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.141 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 12.55 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 1,261 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

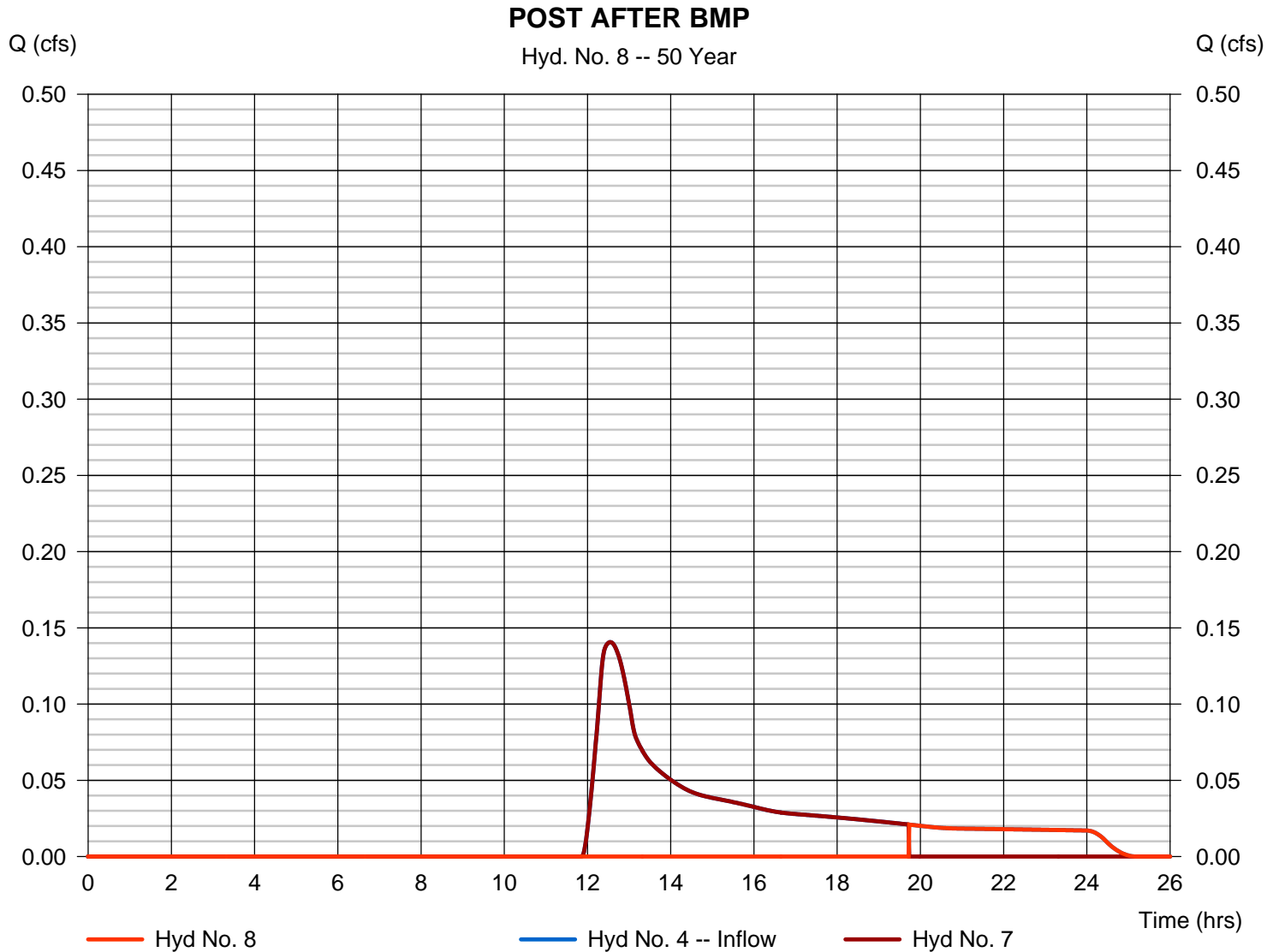
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.021 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 19.73 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 313 cuft   |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

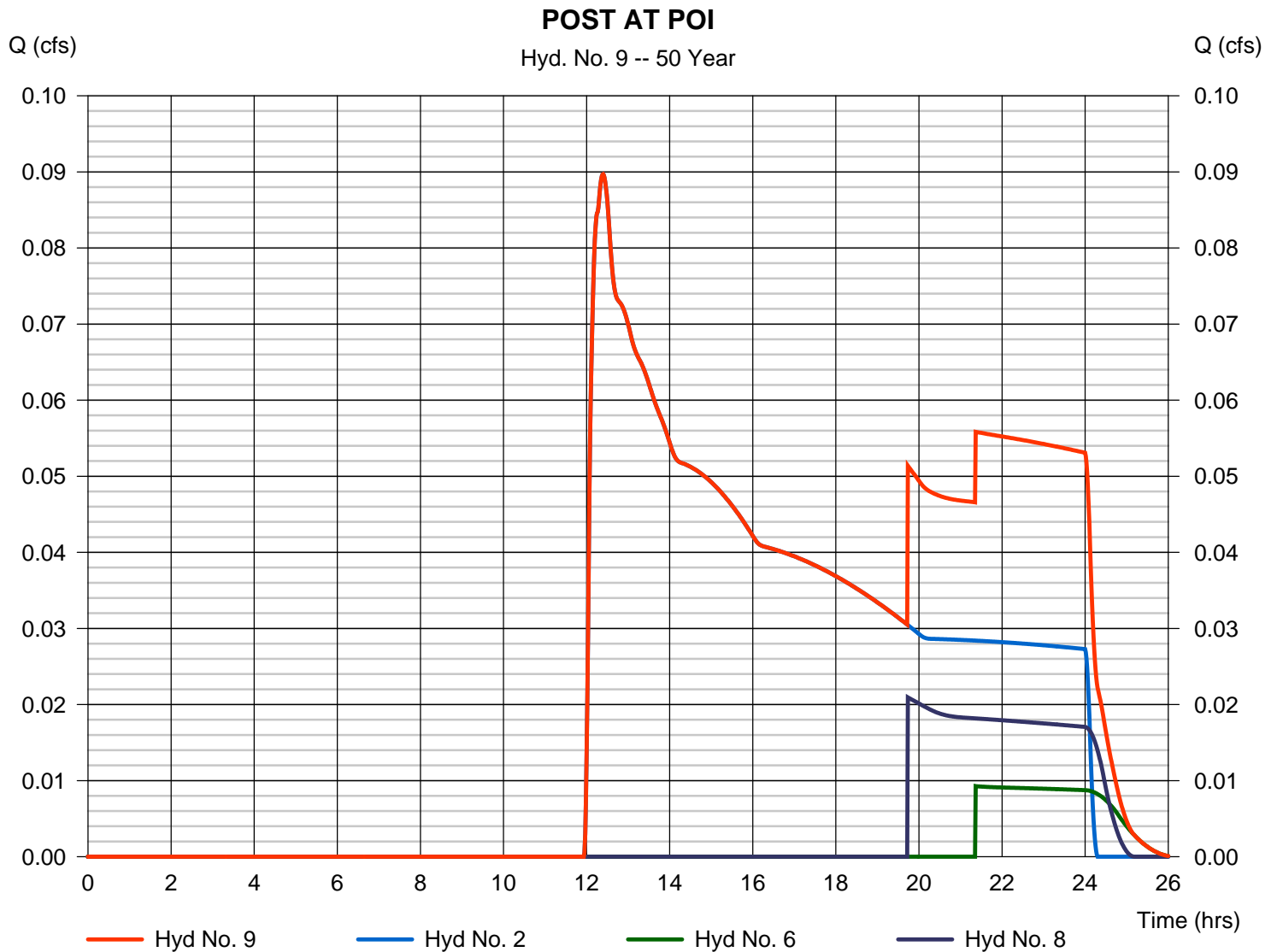
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
Storm frequency = 50 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 6, 8

Peak discharge = 0.090 cfs  
Time to peak = 12.40 hrs  
Hyd. volume = 2,214 cuft  
Contrib. drain. area = 1.790 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 51.6066  | 12.5000 | 0.8820 | ----- |
| 2                   | 61.7637  | 12.8000 | 0.8782 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 64.3712  | 12.9000 | 0.8379 | ----- |
| 10                  | 58.5497  | 11.8000 | 0.7889 | ----- |
| 25                  | 53.6357  | 10.9000 | 0.7370 | ----- |
| 50                  | 51.9530  | 10.6000 | 0.7090 | ----- |
| 100                 | 44.2162  | 9.1000  | 0.6540 | ----- |

File name: Fairview Road.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.13                     | 3.31 | 2.77 | 2.39 | 2.11 | 1.89 | 1.71 | 1.57 | 1.45 | 1.35 | 1.26 | 1.18 |
| 2                   | 4.93                     | 3.96 | 3.33 | 2.88 | 2.54 | 2.28 | 2.07 | 1.90 | 1.75 | 1.63 | 1.52 | 1.43 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.74                     | 4.67 | 3.96 | 3.45 | 3.06 | 2.76 | 2.52 | 2.32 | 2.15 | 2.00 | 1.88 | 1.77 |
| 10                  | 6.32                     | 5.15 | 4.37 | 3.82 | 3.41 | 3.08 | 2.82 | 2.60 | 2.42 | 2.26 | 2.13 | 2.01 |
| 25                  | 6.98                     | 5.71 | 4.87 | 4.28 | 3.83 | 3.48 | 3.20 | 2.96 | 2.76 | 2.60 | 2.45 | 2.32 |
| 50                  | 7.41                     | 6.08 | 5.21 | 4.59 | 4.13 | 3.76 | 3.46 | 3.22 | 3.01 | 2.83 | 2.68 | 2.54 |
| 100                 | 7.83                     | 6.42 | 5.52 | 4.88 | 4.40 | 4.02 | 3.72 | 3.46 | 3.25 | 3.07 | 2.91 | 2.77 |

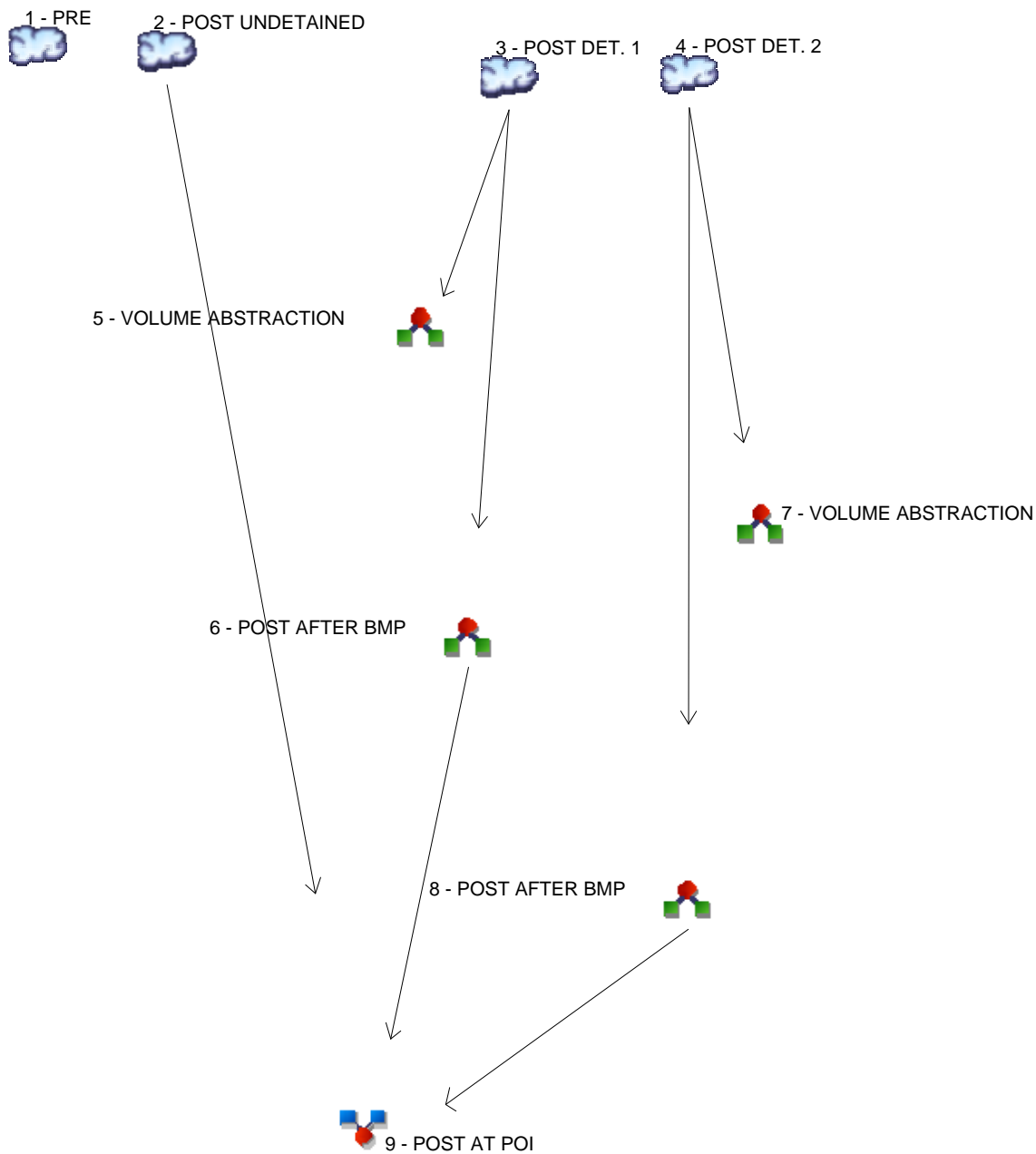
T<sub>c</sub> = time in minutes. Values may exceed 60.

D:\07 PCSM\Attachment 4 - Stormwater Calcs\Fairview Road (Walnut Bank)\Hydraflow Rev 1\Fairview Road Precip.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.69                              | 3.24 | 0.00 | 4.06 | 4.74  | 5.72  | 6.54  | 7.42   |
| SCS 6-Hr           | 1.90                              | 2.29 | 0.00 | 2.85 | 3.30  | 3.92  | 4.42  | 4.94   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. | Origin     | Description        |
|------|------------|--------------------|
| 1    | SCS Runoff | PRE                |
| 2    | SCS Runoff | POST UNDETAINED    |
| 3    | SCS Runoff | POST DET. 1        |
| 4    | SCS Runoff | POST DET. 2        |
| 5    | Diversion1 | VOLUME ABSTRACTION |
| 6    | Diversion2 | POST AFTER BMP     |
| 7    | Diversion1 | VOLUME ABSTRACTION |
| 8    | Diversion2 | POST AFTER BMP     |
| 9    | Combine    | POST AT POI        |

# Hydrograph Return Period Recap

Hydranow 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.628  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.383  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.113  | POST DET. 1            |
| 4        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.380  | POST DET. 2            |
| 5        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.113  | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.026  | POST AFTER BMP         |
| 7        | Diversion1               | 4             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.380  | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 4             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.057  | POST AFTER BMP         |
| 9        | Combine                  | 2, 6, 8       | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.383  | POST AT POI            |

# 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               | 0.628           | 1                   | 725                | 5,162              | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 0.383           | 1                   | 725                | 3,153              | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.113           | 1                   | 743                | 1,102              | -----         | -----                  | -----                   | POST DET. 1            |
| 4        | SCS Runoff               | 0.380           | 1                   | 733                | 2,400              | -----         | -----                  | -----                   | POST DET. 2            |
| 5        | Diversion1               | 0.113           | 1                   | 743                | 570                | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 6        | Diversion2               | 0.026           | 1                   | 907                | 532                | 3             | -----                  | -----                   | POST AFTER BMP         |
| 7        | Diversion1               | 0.380           | 1                   | 733                | 1,262              | 4             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 8        | Diversion2               | 0.057           | 1                   | 872                | 1,138              | 4             | -----                  | -----                   | POST AFTER BMP         |
| 9        | Combine                  | 0.383           | 1                   | 725                | 4,823              | 2, 6, 8       | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

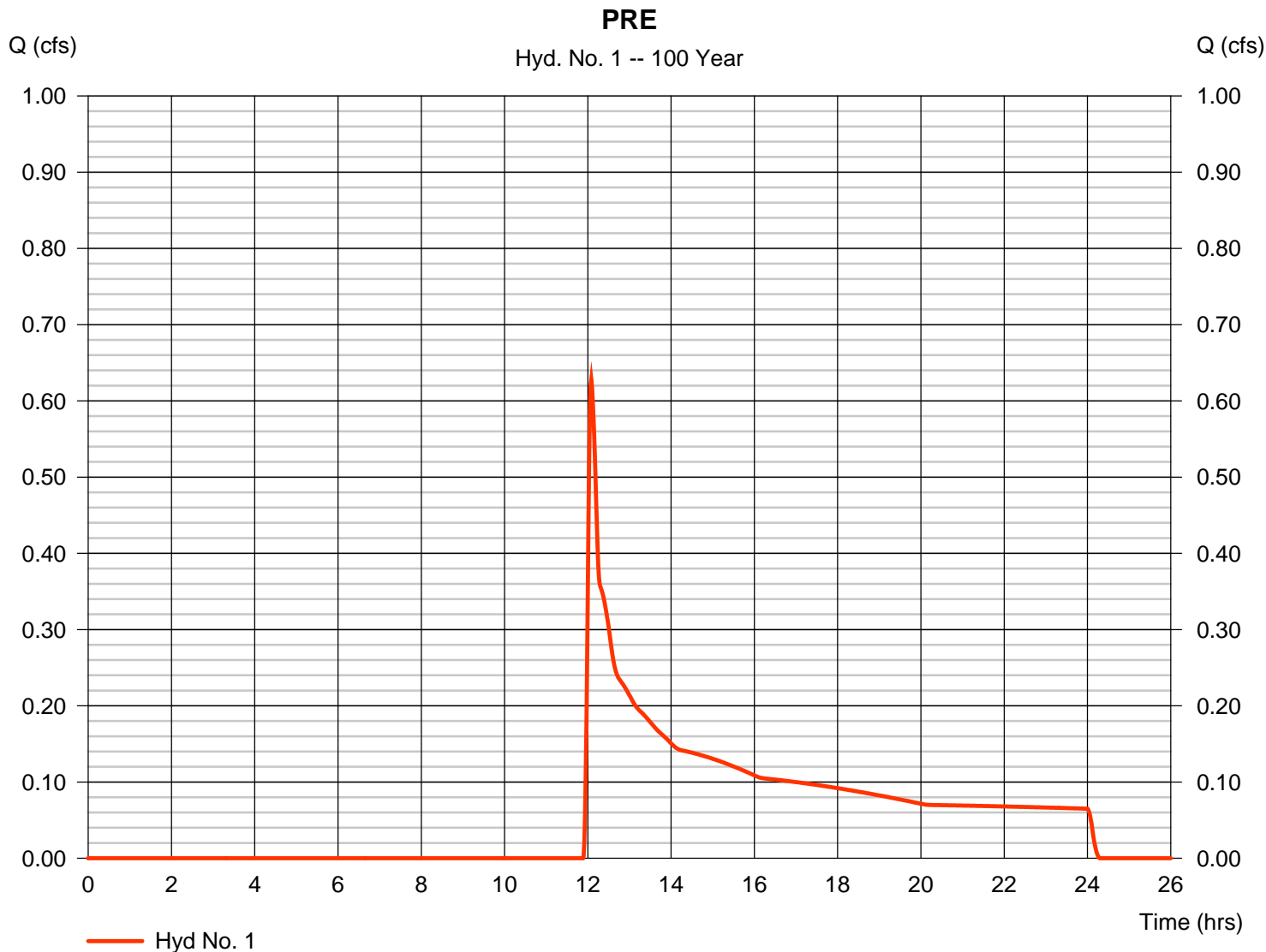
Thursday, 10 / 27 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.628 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 12.08 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 5,162 cuft |
| Drainage area   | = 2.930 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(1.821 x 30) + (0.108 x 98) + (1.006 x 30)] / 2.930



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                  |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                  |
| Two-year 24-hr precip. (in)        | = 3.24        |          | 0.00        |          | 0.00        |          |                  |
| Land slope (%)                     | = 1.31        |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.65</b>      |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 493.00      |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 10.30       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.18         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.59</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| X sectional flow area (sqft)       | = 16.00       |          | 0.00        |          | 0.00        |          |                  |
| Wetted perimeter (ft)              | = 28.00       |          | 0.00        |          | 0.00        |          |                  |
| Channel slope (%)                  | = 7.65        |          | 0.00        |          | 0.00        |          |                  |
| Manning's n-value                  | = 0.015       |          | 0.015       |          | 0.015       |          |                  |
| Velocity (ft/s)                    | =18.88        |          | 0.00        |          | 0.00        |          |                  |
| Flow length (ft)                   | {{0}}432.0    |          | 0.0         |          | 0.0         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.38</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

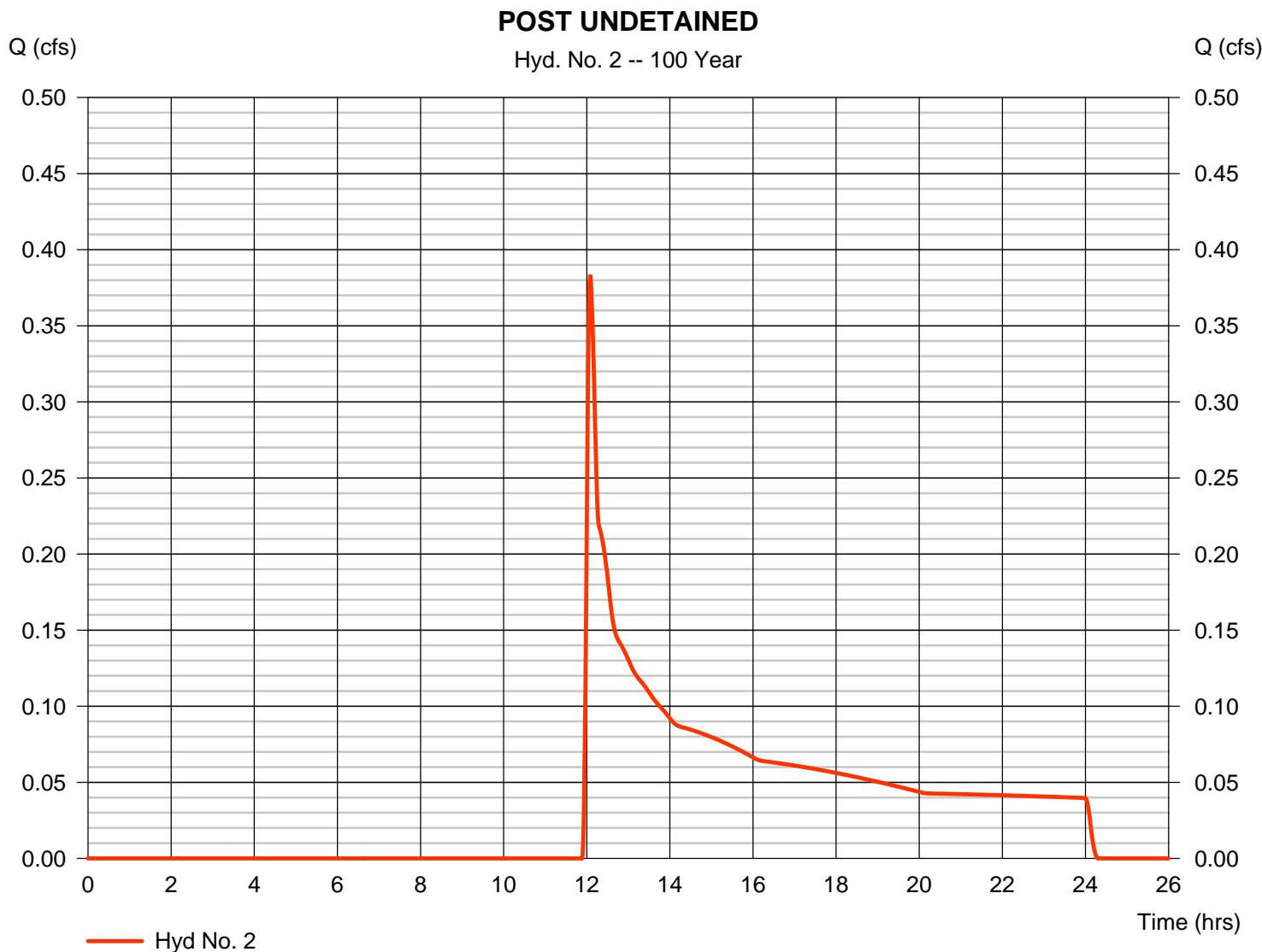
Thursday, 10 / 27 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.383 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 12.08 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 3,153 cuft |
| Drainage area   | = 1.790 ac   | Curve number       | = 33*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 11.60 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.080 x 98) + (0.740 x 30) + (0.960 x 30) + (0.010 x 76)] / 1.790



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|---------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |               |               |               |                  |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.24        | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 1.31        | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 9.65</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 9.65</b>    |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                  |
| Flow length (ft)                   | = 493.00      | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 10.30       | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved     | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =5.18         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 1.59</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 1.59</b>    |
| <b>Channel Flow</b>                |               |               |               |                  |
| X sectional flow area (sqft)       | = 16.00       | 0.00          | 0.00          |                  |
| Wetted perimeter (ft)              | = 28.00       | 0.00          | 0.00          |                  |
| Channel slope (%)                  | = 7.65        | 0.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015       | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =18.88        | 0.00          | 0.00          |                  |
| Flow length (ft)                   | 432.0         | 0.0           | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.38</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.38</b>    |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>11.60 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

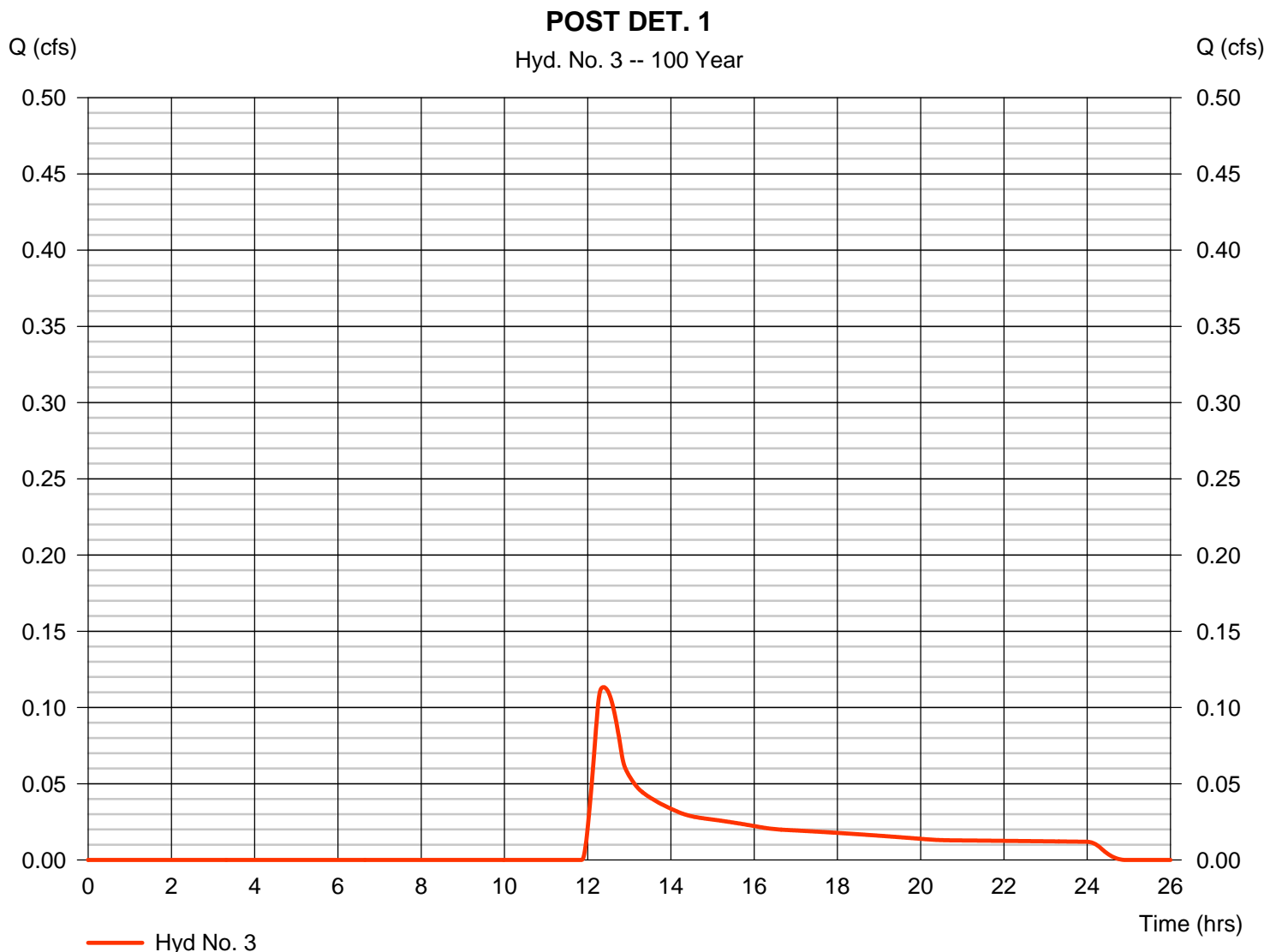
Thursday, 10 / 27 / 2016

## Hyd. No. 3

POST DET. 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.113 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 12.38 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 1,102 cuft |
| Drainage area   | = 0.440 ac   | Curve number       | = 36*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 35.18 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.340 x 30) + (0.040 x 30) + (0.060 x 76)] / 0.440



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

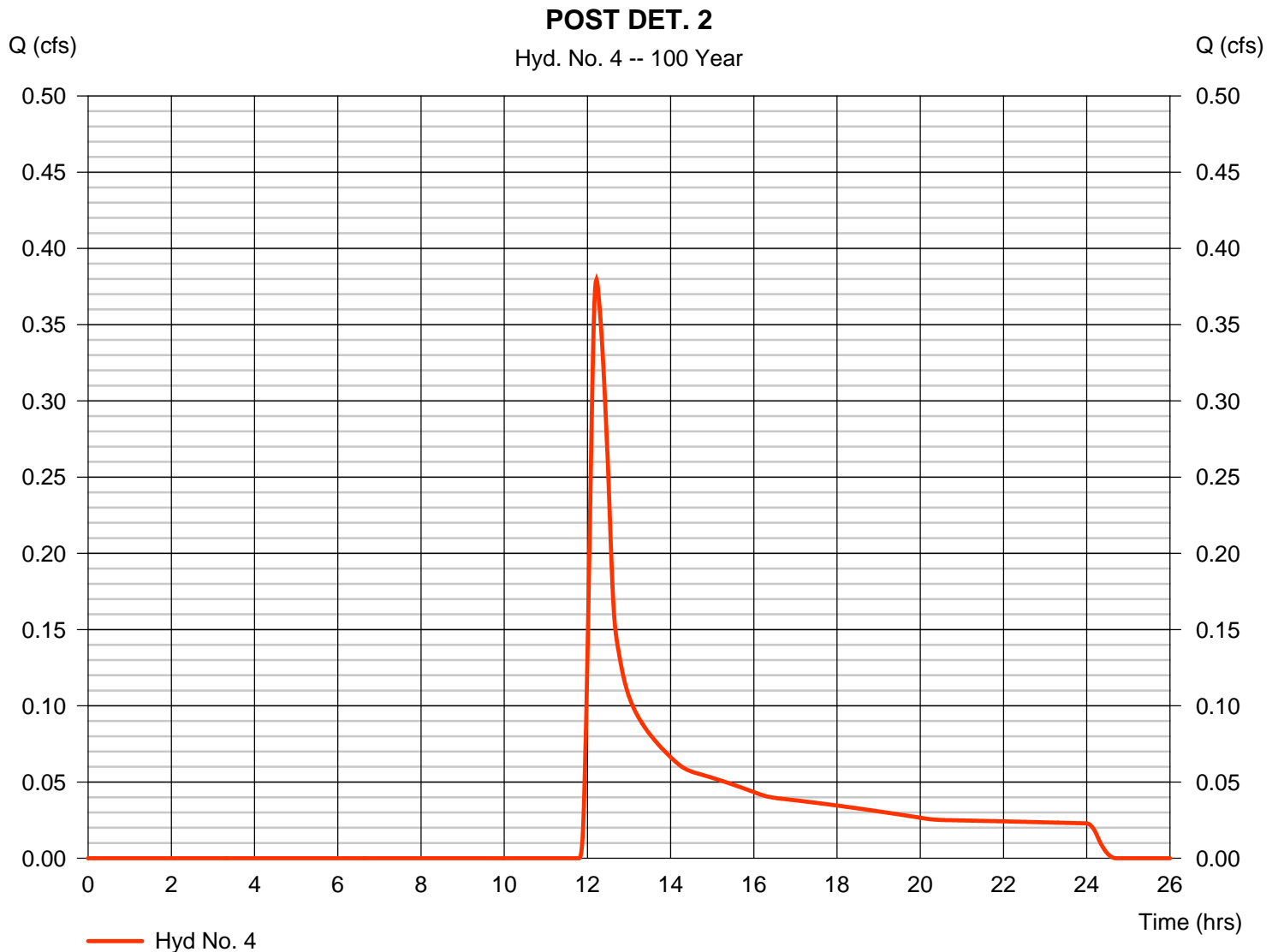
Thursday, 10 / 27 / 2016

## Hyd. No. 4

POST DET. 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.380 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 12.22 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 2,400 cuft |
| Drainage area   | = 0.710 ac   | Curve number       | = 39*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 26.81 min  |
| Total precip.   | = 7.42 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.110 x 76) + (0.110 x 30) + (0.020 x 98) + (0.470 x 30)] / 0.710



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

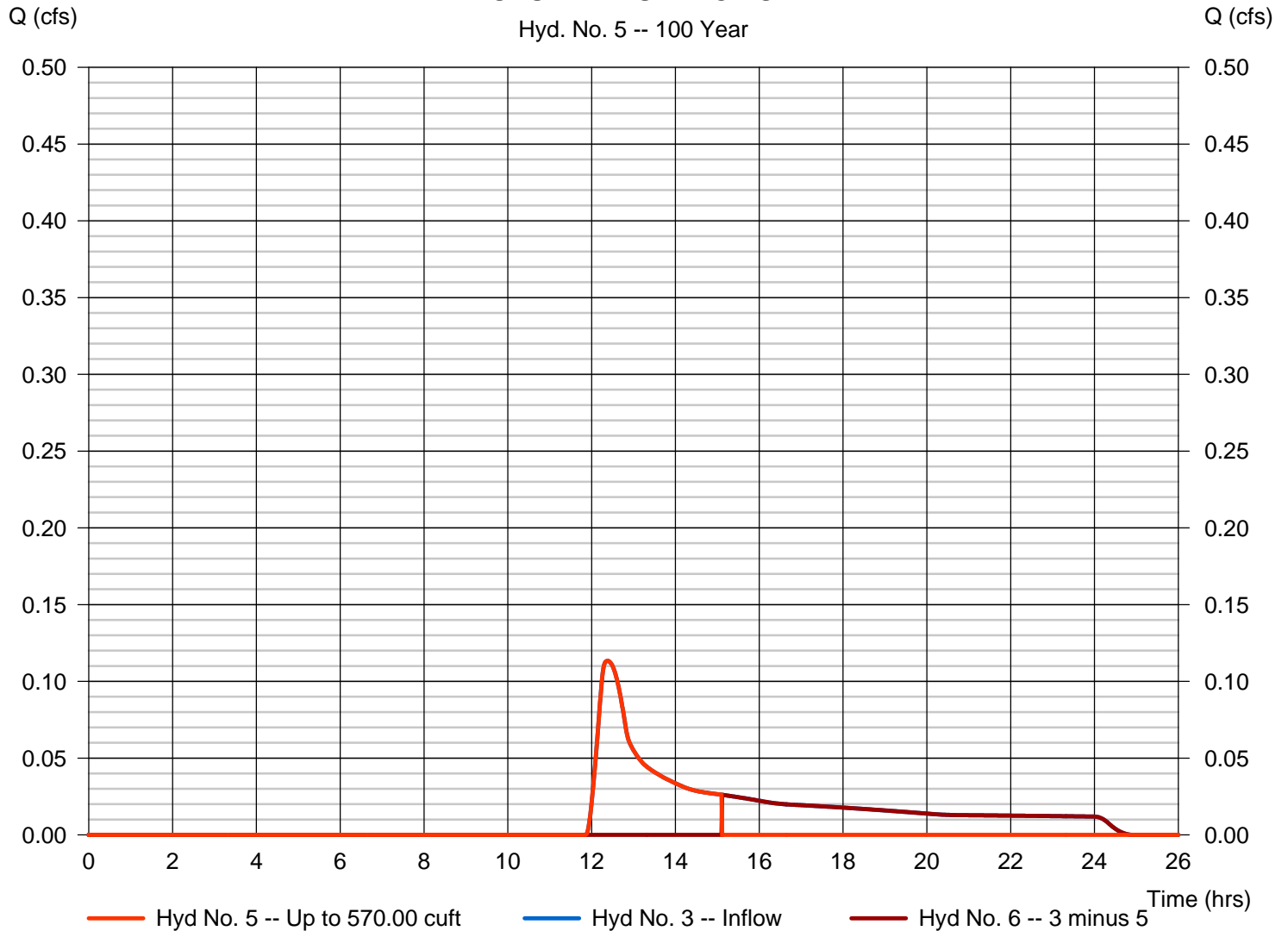
Thursday, 10 / 27 / 2016

## Hyd. No. 5

### VOLUME ABSTRACTION

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.113 cfs   |
| Storm frequency   | = 100 yrs            | Time to peak      | = 12.38 hrs   |
| Time interval     | = 1 min              | Hyd. volume       | = 570 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 6           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |

### VOLUME ABSTRACTION

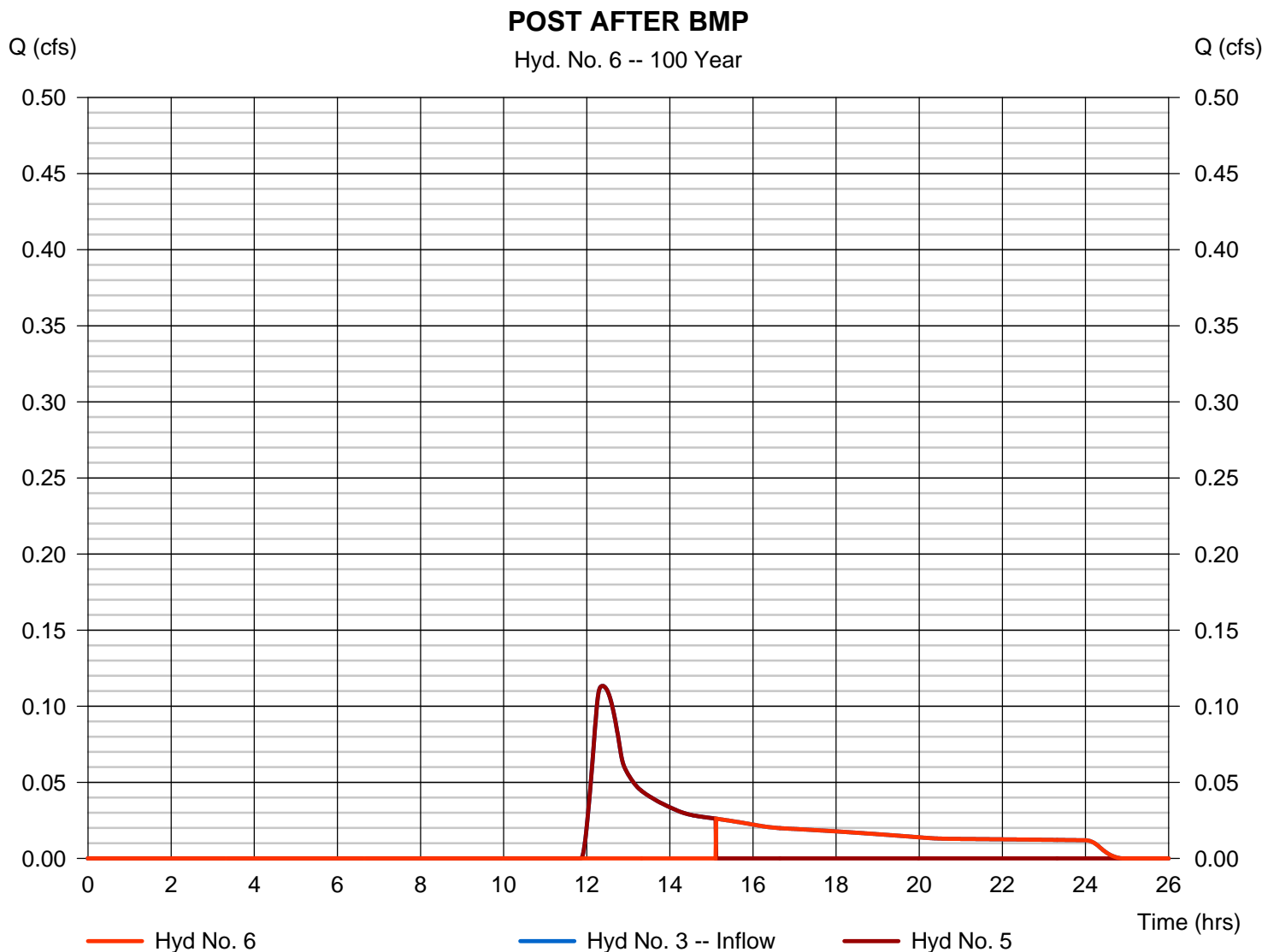


# Hydrograph Report

## Hyd. No. 6

POST AFTER BMP

|                   |                      |                   |               |
|-------------------|----------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.026 cfs   |
| Storm frequency   | = 100 yrs            | Time to peak      | = 15.12 hrs   |
| Time interval     | = 1 min              | Hyd. volume       | = 532 cuft    |
| Inflow hydrograph | = 3 - POST DET. 1    | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume | Volume Up To      | = 570.00 cuft |



# Hydrograph Report

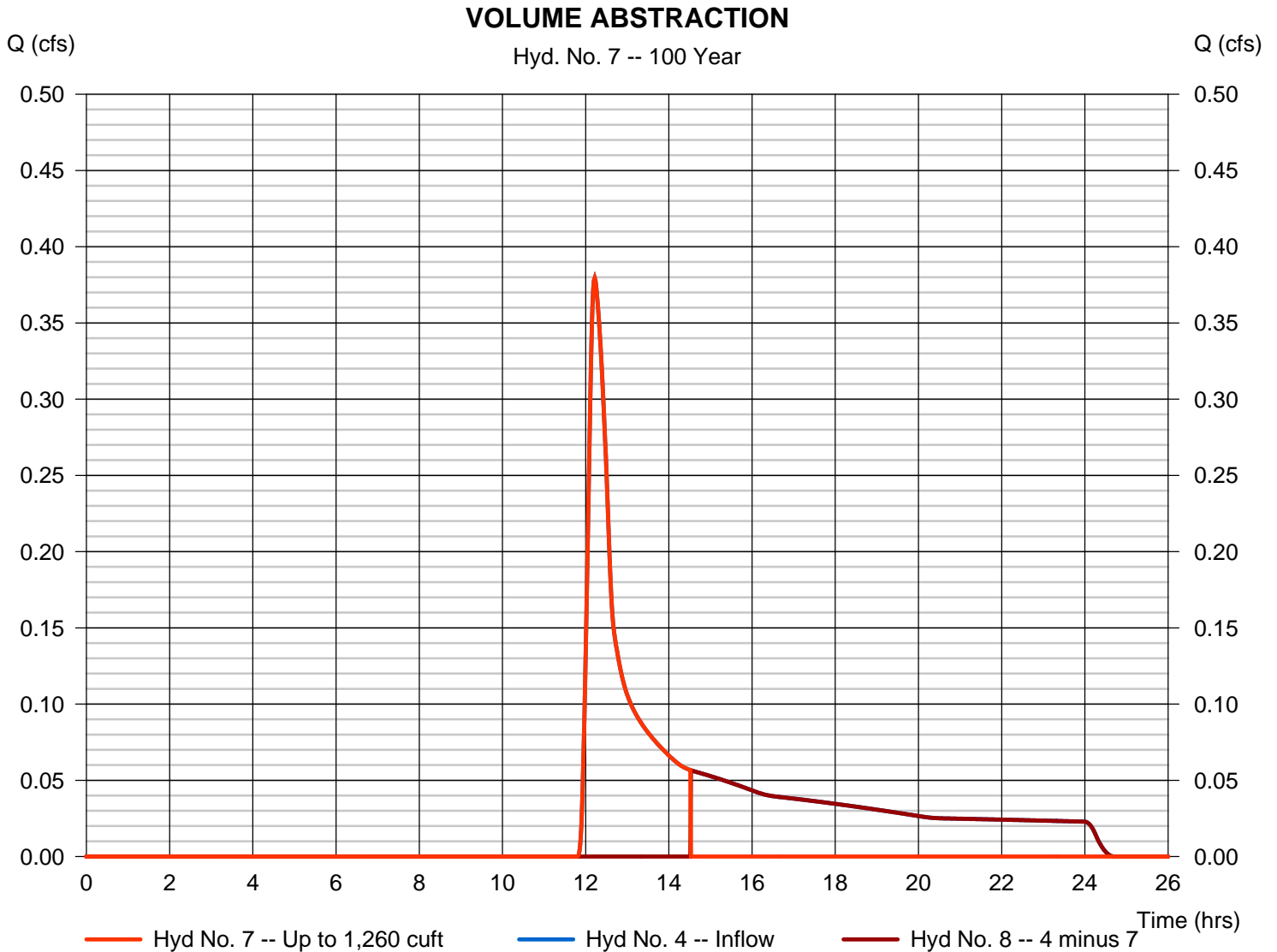
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 7

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.380 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 12.22 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 1,262 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

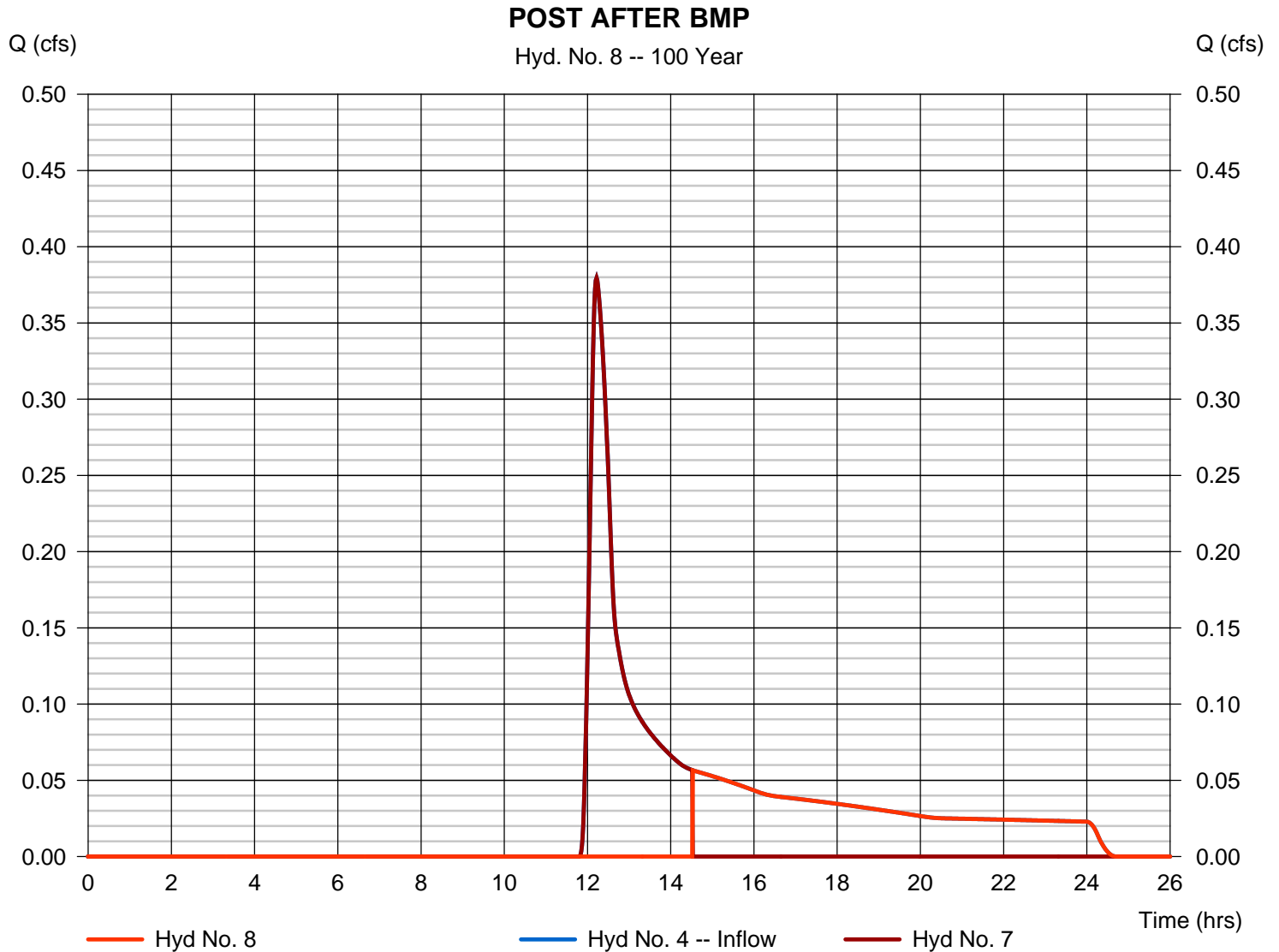
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

## Hyd. No. 8

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.057 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 14.53 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 1,138 cuft |
| Inflow hydrograph | = 4 - POST DET. 2    | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,260 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

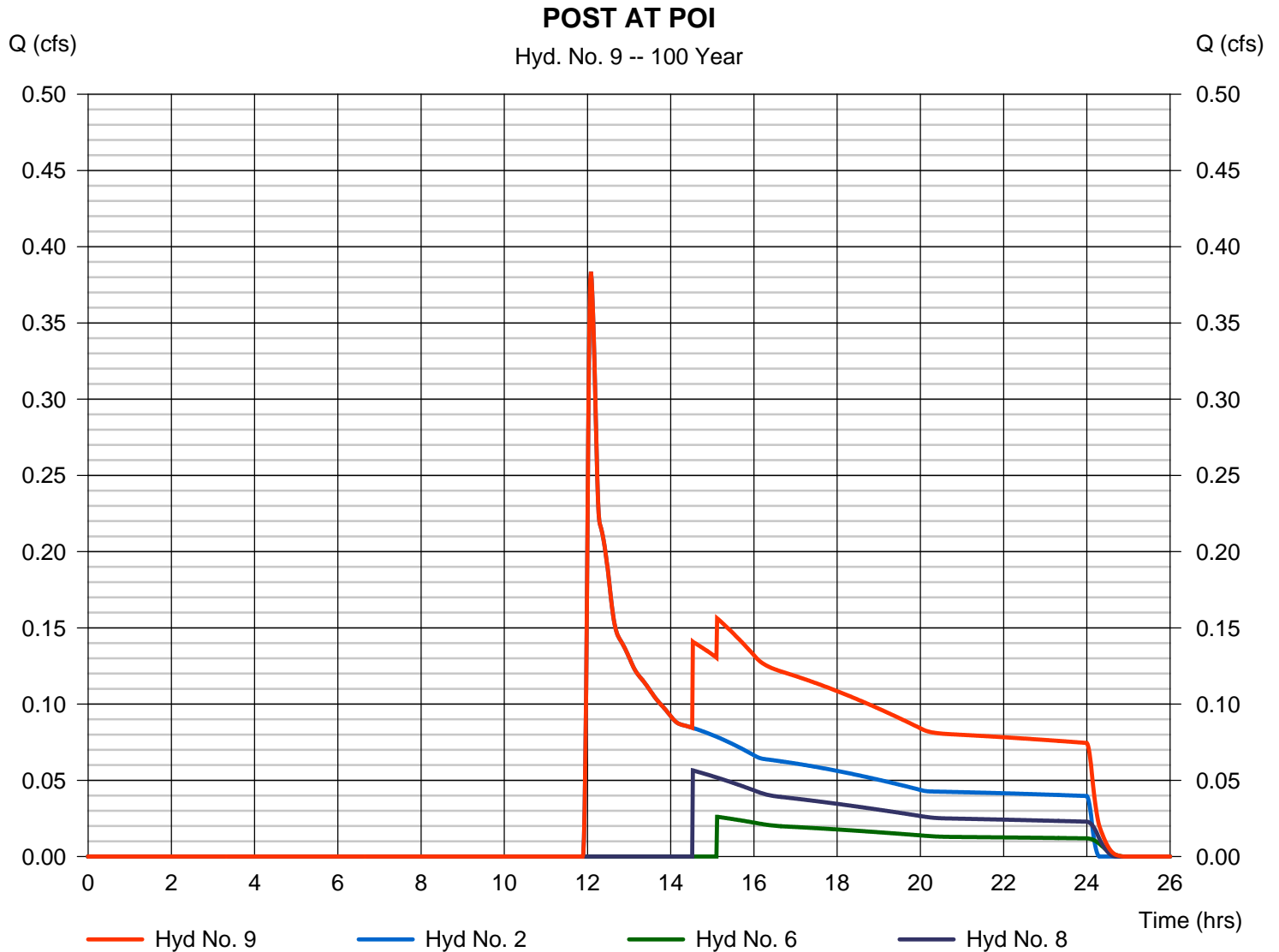
Thursday, 10 / 27 / 2016

## Hyd. No. 9

POST AT POI

Hydrograph type = Combine  
 Storm frequency = 100 yrs  
 Time interval = 1 min  
 Inflow hyds. = 2, 6, 8

Peak discharge = 0.383 cfs  
 Time to peak = 12.08 hrs  
 Hyd. volume = 4,823 cuft  
 Contrib. drain. area = 1.790 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Thursday, 10 / 27 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 51.6066  | 12.5000 | 0.8820 | ----- |
| 2                   | 61.7637  | 12.8000 | 0.8782 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 64.3712  | 12.9000 | 0.8379 | ----- |
| 10                  | 58.5497  | 11.8000 | 0.7889 | ----- |
| 25                  | 53.6357  | 10.9000 | 0.7370 | ----- |
| 50                  | 51.9530  | 10.6000 | 0.7090 | ----- |
| 100                 | 44.2162  | 9.1000  | 0.6540 | ----- |

File name: Fairview Road.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.13                     | 3.31 | 2.77 | 2.39 | 2.11 | 1.89 | 1.71 | 1.57 | 1.45 | 1.35 | 1.26 | 1.18 |
| 2                   | 4.93                     | 3.96 | 3.33 | 2.88 | 2.54 | 2.28 | 2.07 | 1.90 | 1.75 | 1.63 | 1.52 | 1.43 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.74                     | 4.67 | 3.96 | 3.45 | 3.06 | 2.76 | 2.52 | 2.32 | 2.15 | 2.00 | 1.88 | 1.77 |
| 10                  | 6.32                     | 5.15 | 4.37 | 3.82 | 3.41 | 3.08 | 2.82 | 2.60 | 2.42 | 2.26 | 2.13 | 2.01 |
| 25                  | 6.98                     | 5.71 | 4.87 | 4.28 | 3.83 | 3.48 | 3.20 | 2.96 | 2.76 | 2.60 | 2.45 | 2.32 |
| 50                  | 7.41                     | 6.08 | 5.21 | 4.59 | 4.13 | 3.76 | 3.46 | 3.22 | 3.01 | 2.83 | 2.68 | 2.54 |
| 100                 | 7.83                     | 6.42 | 5.52 | 4.88 | 4.40 | 4.02 | 3.72 | 3.46 | 3.25 | 3.07 | 2.91 | 2.77 |

T<sub>c</sub> = time in minutes. Values may exceed 60.

D:\07 PCSM\Attachment 4 - Stormwater Calcs\Fairview Road (Walnut Bank)\Hydraflow Rev 1\Fairview Road Precip.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.69                              | 3.24 | 0.00 | 4.06 | 4.74  | 5.72  | 6.54  | 7.42   |
| SCS 6-Hr           | 1.90                              | 2.29 | 0.00 | 2.85 | 3.30  | 3.92  | 4.42  | 4.94   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# **East Lincoln Highway**



## TETRA TECH, INC.

By: RH Date: 11/17/2016 Subject: East Lincoln Highway  
Checked By: JB Date: 11/19/2016 PCSM Design and Evaluation

### PURPOSE:

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the East Lincoln Highway as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The site is located within West Whiteland Township, Chester County, Pennsylvania. Permanent stormwater controls will be developed to satisfy PADEP and Chester County's approved Act 167 Plan.

### 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). The design criteria evaluated for the site are summarized below.

#### Act 167 Consistency

The East Lincoln Highway block valve site is located in Chester County, which has enacted an Act 167 Plan. This plan requires that NRCS curve numbers be used for the runoff calculations. In addition, certain watersheds within Chester County have release rate requirements. East Lincoln Highway is not in an area with release rate requirements. The PCSM design at the East Lincoln Highway block valve site has been designed for consistency with Chester County's approved Act 167 Plan.

#### 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 2-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plan.
- The curve numbers that were utilized in the PCSM design for the East Lincoln Highway block valve site mirror the requirements of Chester County. Additionally, since there are no release

rate requirements within this watershed, all requirements of Chester County's Act 167 Plan have been met.

This site will utilize an infiltration berm to manage the two-year through 100-year peak rate increases. This BMP will also help to increase the time of concentration for the detained drainage area encompassing the block valve.

### **Recommended Water Quality Control Guideline**

Control Guideline 1 will provide water quality control and stream channel protection as well as flood control protection.

### **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 Site Restoration/Post Construction Stormwater Management Plan. Infiltration test locations and recommended design rates are also labeled on the PCSM Plan Drawings in Attachment 6.

During the onsite infiltration tests, the depth to seasonal high groundwater and shallow bedrock or another confining layer were evaluated. The post-construction stormwater management facility for the site has been designed to maintain 2 feet of separation between the ponding elevation of the facility and the seasonal high water table and bedrock.

The proposed infiltration berm is located such that drainage from the block valve site reaches the berm while avoiding wetland impacts. This has forced the infiltration berm ponding area to be located over an existing Sunoco pipeline. However, infiltration tests were performed after construction of this pipeline. Because the tests yielded favorable results despite any compaction that potentially occurred during construction of the existing line, an infiltration berm is feasible in this location.

The post-construction stormwater management design will utilize onsite infiltration to meet Volume Control Guideline 1.

### **Loading Ratio**

Loading ratios have been considered for the design of infiltration BMPs. In general, the following Loading Ratio guidelines are recommended:

- Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.
- Maximum Drainage Area Loading Ratio of 8:1 relating total drainage area to infiltration area.

The maximum impervious loading ratio of 5:1 has been met. The impervious loading ratio for the site is 1.5:1.

The maximum drainage area loading ratio of 8:1 has not been met. The drainage area loading ratio for the site is 13.4:1. However, runoff from the site and upslope drainage area will be dispersed to an infiltration berm. The infiltration berm has been placed to maximize the loading ratio to the maximum extent practicable, and other infiltration design parameters from the PA Stormwater BMP Manual have been met.

## **Disturbed Area**

To meet Standard Worksheet 10 guidelines, 90% of the disturbed area is contained by the proposed PCSM BMPs.

## **Karst Topography**

East Lincoln Highway block valve is located within the vicinity of known depressions or sinkholes. Several design principles were incorporated to minimize the risk of sinkholes to the maximum extent practicable, including reducing the proposed impervious area to the maximum extent practicable.

Stormwater runoff from the site is being spread out over a relatively large area. The site will achieve a 1.5:1 impervious loading ratio by directing stormwater runoff into a long infiltration berm. The infiltration berm will avoid concentrating stormwater runoff and will encourage relatively shallow and broad ponding areas.

Additional post-construction inspection and maintenance will be required onsite as documented in the Sinkhole Repair Plan in Attachment 2. In areas of known karst terrain, stormwater BMPs shall be inspected at regular intervals of at least once every quarter for the first two years following installation and then at regular periods thereafter. Inspections shall also be made after every storm event greater than 1 inch during the establishment period. Inspections shall consist of an examination of any noticeable subsidence, surface depressions, or sinkholes. Inspections shall include an evaluation of all inlet and outlet structures and document any areas to be cleaned, maintained, or repaired.

## **Special Protection Watershed**

East Lincoln Highway block valve is located within a siltation impaired watershed. The project site was designed to minimize the total amount of impervious area. The impervious area for the East Lincoln Highway valve was limited to the amount that is required to safely construct and operate the block valve. In addition, the previously proposed gravel turn-around was eliminated, and replaced with a grass area.

Non-discharge alternatives were analyzed for this block valve site. The location of the East Lincoln Highway block valve site was evaluated by ASME B31.4 Valve Spacing 434.15.2(e) which states that mainline valves should not be more than 7.5 miles apart. The valve sites were located in such a way that they avoided environmentally sensitive areas (such as wetlands and floodplains), were close to an existing road, and close to power. Land owner preference was also accounted for while locating the block valve sites. Once all of these factors were taken into account, several block valve sites, including East Lincoln Highway, were located in special protection or siltation impaired watersheds.

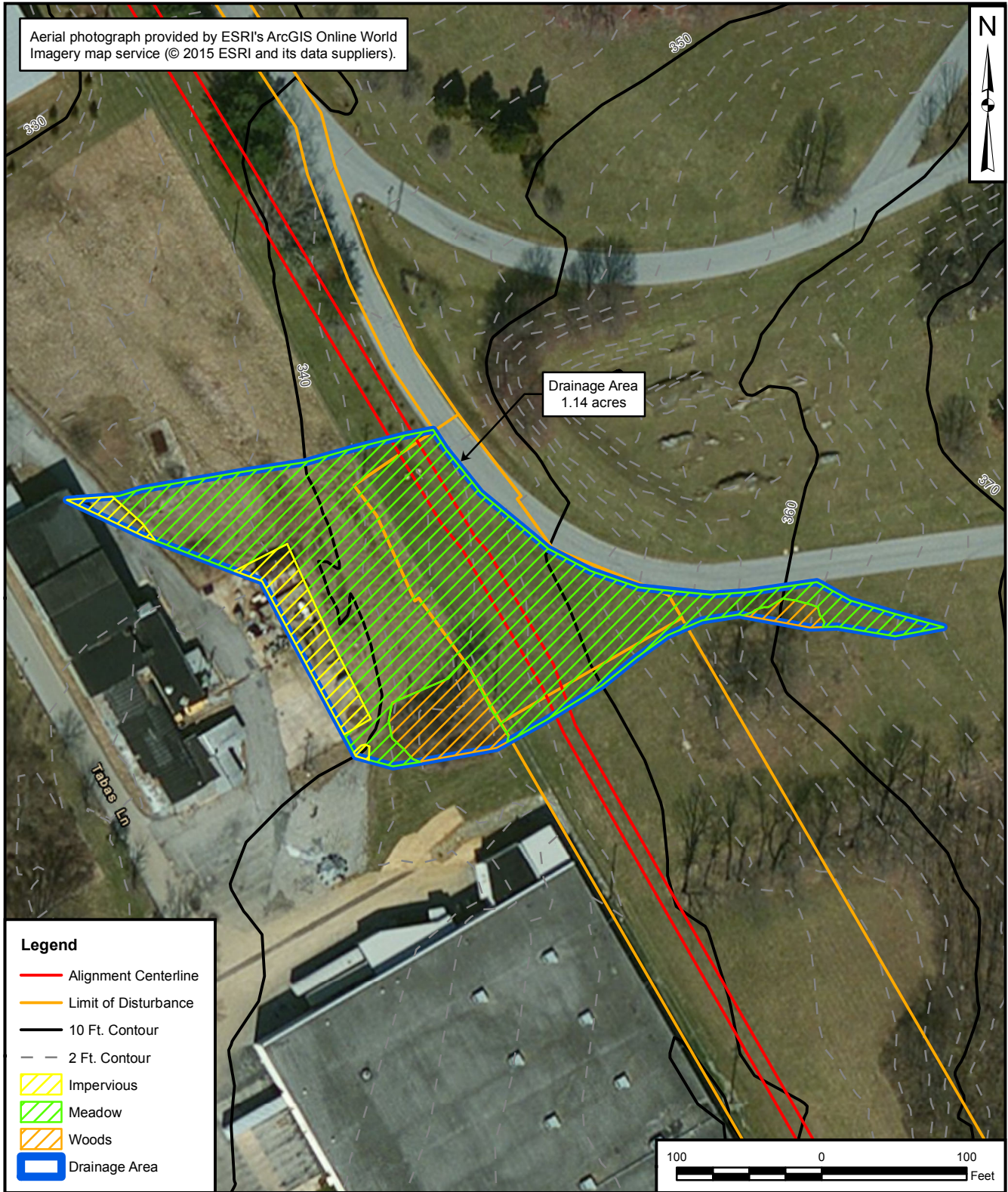
Non-discharge alternatives were also considered when determining the type of BMP proposed. East Lincoln Highway block valve site utilizes an infiltration berm to manage stormwater. Stormwater runoff is infiltrated to the maximum extent possible. Stormwater runoff is spread out to flow through areas that have been restored to meadow conditions, to an infiltration berm, or to undisturbed area. There will not be an increase in stormwater runoff rate or volume to prevent the physical degradation of the receiving water, such as scour, and stream bank destabilization. Stormwater runoff volume is not increasing throughout post-construction, and any post-construction stormwater discharge is managed so that it will not degrade the physical, chemical or biological characteristics of the receiving stream.

Runoff from the site will be managed by a downslope infiltration berm. Pondered runoff will be temporarily stored upslope of the berm until it infiltrates and filters through the soil media. Due to the design of the berm, which maintains a constant elevation through the entire berm length, the stormwater runoff will be released in sheet flow down a stabilized slope, without causing erosion, rather than concentrating the flow. Filtration through the existing vegetation and soil is an efficient way to remove suspended stormwater pollutants such as sediment, as the suspended particles are physically filtered from the stormwater as it flows through the vegetation and percolates into the soil.

The extent of the disturbed area will be minimized, and the duration of disturbance will be minimized by stabilizing disturbed areas as soon as practicable. Cut and fill for the project site has been minimized. Where possible based on the criteria listed above, sites were located in areas with shallow slopes to minimize the amount of cut and fill required. There is minimal cut and fill required at the East Lincoln Highway block valve site. All of the block valve sites were graded towards the natural slope. No direct discharge to surface water occurs at the site. The site will be restored promptly with proper vegetative cover techniques.

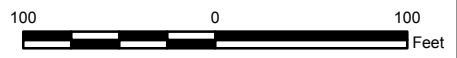
Antidegradation requirements for the special protection watershed are met because the post-construction stormwater infiltration volume equals or exceeds the pre-construction stormwater infiltration volume, and post-construction stormwater discharge is pretreated via infiltration berms. The runoff is managed so that it will not degrade the physical, chemical, or biological characteristics of the receiving stream.

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).



**Legend**

- Alignment Centerline
- Limit of Disturbance
- 10 Ft. Contour
- 2 Ft. Contour
- Impervious
- Meadow
- Woods
- Drainage Area



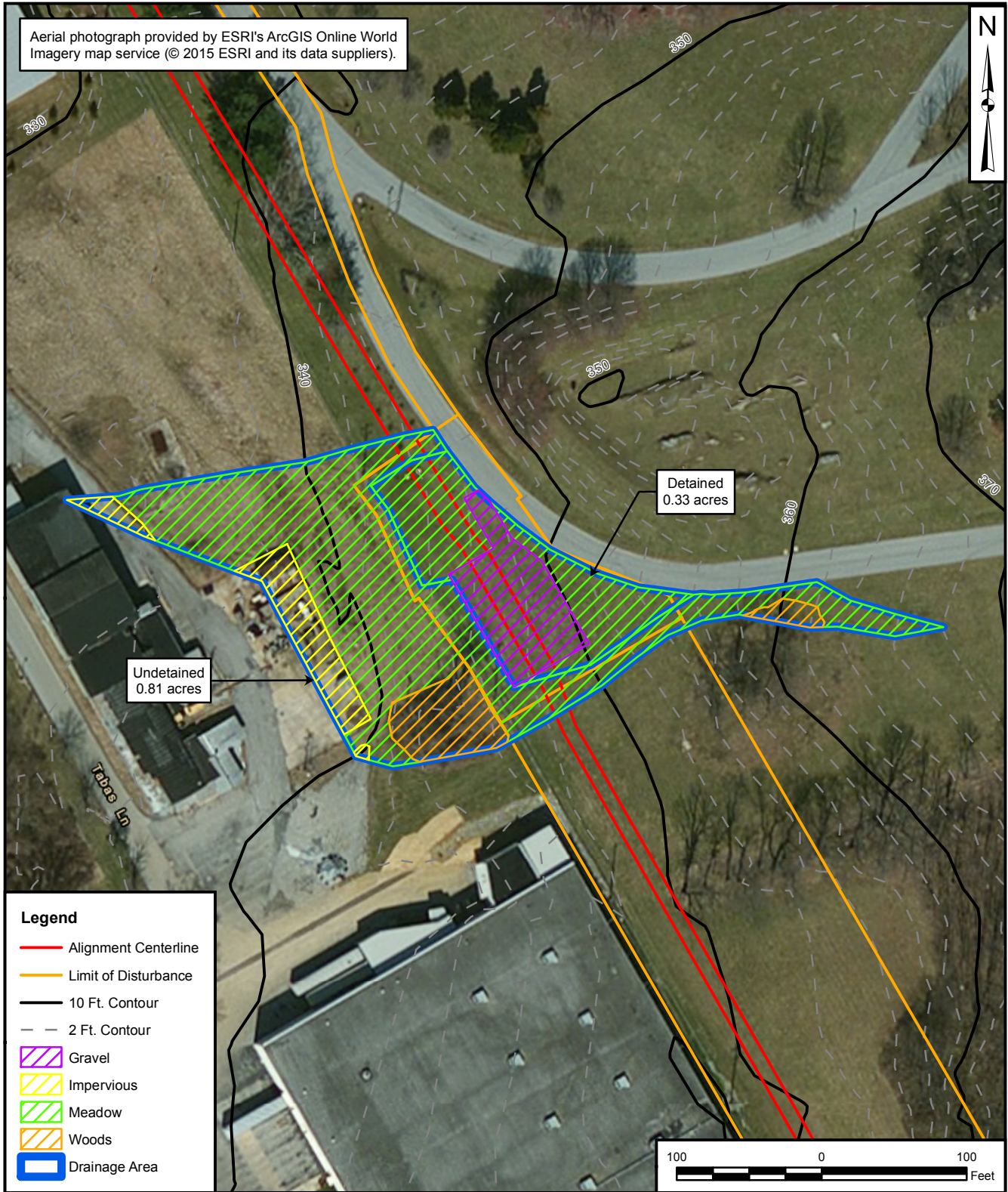
**PRE-DEVELOPMENT DRAINAGE AREA MAP**  
**EAST LINCOLN HIGHWAY**  
**PENNSYLVANIA PIPELINE PROJECT**  
**SUNOCO LOGISTICS, L.P.**  
**CHESTER COUNTY, PENNSYLVANIA**

DRAWN BY: J. HERNING 04/30/15  
 CHECKED BY: J. BRODY 11/09/16  
 APPROVED BY:  
 CONTRACT NUMBER: 112IC05958

|               |   |     |   |
|---------------|---|-----|---|
| FIGURE NUMBER | 1 | REV | 0 |
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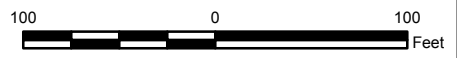


Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).



**Legend**

- Alignment Centerline
- Limit of Disturbance
- 10 Ft. Contour
- 2 Ft. Contour
- Gravel
- Impervious
- Meadow
- Woods
- Drainage Area



**POST-DEVELOPMENT DRAINAGE AREA MAP**  
**EAST LINCOLN HIGHWAY**  
**PENNSYLVANIA PIPELINE PROJECT**  
**SUNOCO LOGISTICS, L.P.**  
**CHESTER COUNTY, PENNSYLVANIA**

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| APPROVED BY:                  |     |
| CONTRACT NUMBER: 112IC05958   |     |
| FIGURE NUMBER                 | REV |
| 2                             | 0   |





**NOAA Atlas 14, Volume 2, Version 3**  
**Location name: West Whiteland Twp,**  
**Pennsylvania, USA\***  
**Latitude: 40.027°, Longitude: -75.6167°**  
**Elevation: 342.96 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**

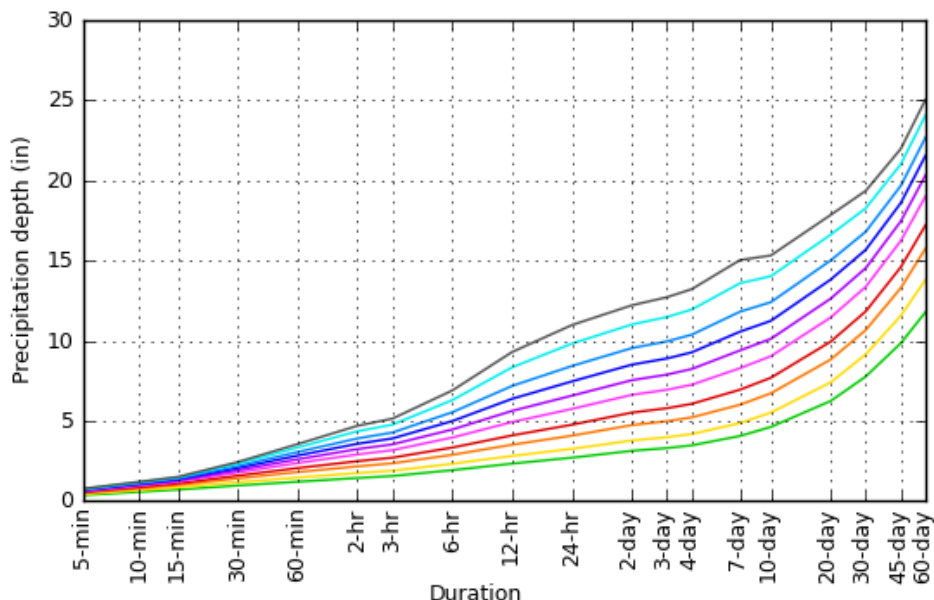
| <b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b> |  |                               |                               |                               |                               |                               |                               |                               |                               |                               |
|--|--|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>Duration</b>  | <b>Average recurrence interval (years)</b> |                               |                               |                               |                               |                               |                               |                               |                               |                               |
|  | <b>1</b>                                   | <b>2</b>                      | <b>5</b>                      | <b>10</b>                     | <b>25</b>                     | <b>50</b>                     | <b>100</b>                    | <b>200</b>                    | <b>500</b>                    | <b>1000</b>                   |
| <b>5-min</b>   | <b>0.350</b><br>(0.321-0.383)              | <b>0.418</b><br>(0.383-0.457) | <b>0.488</b><br>(0.446-0.533) | <b>0.537</b><br>(0.490-0.586) | <b>0.593</b><br>(0.538-0.647) | <b>0.631</b><br>(0.569-0.688) | <b>0.667</b><br>(0.600-0.729) | <b>0.699</b><br>(0.625-0.765) | <b>0.733</b><br>(0.650-0.804) | <b>0.758</b><br>(0.668-0.835) |
| <b>10-min</b>  | <b>0.560</b><br>(0.513-0.612)              | <b>0.668</b><br>(0.612-0.730) | <b>0.781</b><br>(0.713-0.854) | <b>0.858</b><br>(0.783-0.937) | <b>0.945</b><br>(0.858-1.03)  | <b>1.00</b><br>(0.906-1.10)   | <b>1.06</b><br>(0.953-1.16)   | <b>1.11</b><br>(0.990-1.21)   | <b>1.16</b><br>(1.03-1.27)    | <b>1.19</b><br>(1.05-1.31)    |
| <b>15-min</b>  | <b>0.700</b><br>(0.641-0.765)              | <b>0.840</b><br>(0.769-0.918) | <b>0.988</b><br>(0.903-1.08)  | <b>1.08</b><br>(0.991-1.19)   | <b>1.20</b><br>(1.09-1.31)    | <b>1.27</b><br>(1.15-1.39)    | <b>1.34</b><br>(1.21-1.47)    | <b>1.40</b><br>(1.25-1.53)    | <b>1.46</b><br>(1.29-1.60)    | <b>1.50</b><br>(1.32-1.65)    |
| <b>30-min</b>  | <b>0.959</b><br>(0.879-1.05)               | <b>1.16</b><br>(1.06-1.27)    | <b>1.40</b><br>(1.28-1.53)    | <b>1.57</b><br>(1.44-1.72)    | <b>1.77</b><br>(1.61-1.94)    | <b>1.92</b><br>(1.73-2.09)    | <b>2.05</b><br>(1.84-2.24)    | <b>2.17</b><br>(1.95-2.38)    | <b>2.32</b><br>(2.06-2.55)    | <b>2.43</b><br>(2.14-2.67)    |
| <b>60-min</b>  | <b>1.20</b><br>(1.10-1.31)                 | <b>1.46</b><br>(1.33-1.59)    | <b>1.80</b><br>(1.64-1.97)    | <b>2.05</b><br>(1.87-2.24)    | <b>2.36</b><br>(2.14-2.58)    | <b>2.60</b><br>(2.34-2.83)    | <b>2.83</b><br>(2.54-3.09)    | <b>3.05</b><br>(2.73-3.34)    | <b>3.33</b><br>(2.96-3.65)    | <b>3.54</b><br>(3.12-3.90)    |
| <b>2-hr</b>  | <b>1.43</b><br>(1.29-1.58)                 | <b>1.73</b><br>(1.57-1.92)    | <b>2.15</b><br>(1.95-2.38)    | <b>2.48</b><br>(2.24-2.73)    | <b>2.90</b><br>(2.60-3.19)    | <b>3.23</b><br>(2.88-3.56)    | <b>3.56</b><br>(3.16-3.93)    | <b>3.90</b><br>(3.43-4.30)    | <b>4.34</b><br>(3.78-4.80)    | <b>4.69</b><br>(4.04-5.19)    |
| <b>3-hr</b>  | <b>1.55</b><br>(1.41-1.72)                 | <b>1.88</b><br>(1.71-2.08)    | <b>2.35</b><br>(2.12-2.59)    | <b>2.70</b><br>(2.44-2.98)    | <b>3.17</b><br>(2.84-3.49)    | <b>3.53</b><br>(3.15-3.88)    | <b>3.90</b><br>(3.46-4.29)    | <b>4.26</b><br>(3.75-4.70)    | <b>4.76</b><br>(4.14-5.26)    | <b>5.13</b><br>(4.42-5.69)    |
| <b>6-hr</b>  | <b>1.92</b><br>(1.74-2.13)                 | <b>2.31</b><br>(2.10-2.57)    | <b>2.88</b><br>(2.61-3.19)    | <b>3.33</b><br>(3.01-3.68)    | <b>3.95</b><br>(3.55-4.36)    | <b>4.46</b><br>(3.96-4.91)    | <b>4.98</b><br>(4.39-5.48)    | <b>5.53</b><br>(4.83-6.09)    | <b>6.29</b><br>(5.41-6.95)    | <b>6.89</b><br>(5.84-7.63)    |
| <b>12-hr</b>   | <b>2.33</b><br>(2.11-2.60)                 | <b>2.81</b><br>(2.54-3.14)    | <b>3.51</b><br>(3.17-3.91)    | <b>4.09</b><br>(3.68-4.55)    | <b>4.92</b><br>(4.39-5.46)    | <b>5.62</b><br>(4.96-6.22)    | <b>6.37</b><br>(5.56-7.06)    | <b>7.18</b><br>(6.19-7.95)    | <b>8.34</b><br>(7.05-9.25)    | <b>9.29</b><br>(7.72-10.3)    |
| <b>24-hr</b>   | <b>2.70</b><br>(2.48-2.95)                 | <b>3.25</b><br>(2.98-3.55)    | <b>4.07</b><br>(3.73-4.45)    | <b>4.75</b><br>(4.34-5.19)    | <b>5.74</b><br>(5.22-6.26)    | <b>6.57</b><br>(5.95-7.16)    | <b>7.46</b><br>(6.71-8.11)    | <b>8.42</b><br>(7.53-9.15)    | <b>9.82</b><br>(8.69-10.7)    | <b>11.0</b><br>(9.62-11.9)    |
| <b>2-day</b>   | <b>3.12</b><br>(2.86-3.43)                 | <b>3.77</b><br>(3.45-4.14)    | <b>4.73</b><br>(4.32-5.19)    | <b>5.51</b><br>(5.02-6.05)    | <b>6.62</b><br>(6.01-7.25)    | <b>7.53</b><br>(6.81-8.25)    | <b>8.50</b><br>(7.65-9.31)    | <b>9.54</b><br>(8.52-10.4)    | <b>11.0</b><br>(9.76-12.1)    | <b>12.2</b><br>(10.7-13.4)    |
| <b>3-day</b>   | <b>3.29</b><br>(3.01-3.62)                 | <b>3.97</b><br>(3.63-4.37)    | <b>4.97</b><br>(4.54-5.46)    | <b>5.78</b><br>(5.27-6.35)    | <b>6.93</b><br>(6.29-7.60)    | <b>7.88</b><br>(7.12-8.64)    | <b>8.89</b><br>(7.99-9.73)    | <b>9.95</b><br>(8.90-10.9)    | <b>11.5</b><br>(10.2-12.6)    | <b>12.7</b><br>(11.2-13.9)    |
| <b>4-day</b>   | <b>3.47</b><br>(3.17-3.81)                 | <b>4.17</b><br>(3.82-4.59)    | <b>5.21</b><br>(4.76-5.74)    | <b>6.05</b><br>(5.52-6.66)    | <b>7.25</b><br>(6.58-7.96)    | <b>8.23</b><br>(7.43-9.02)    | <b>9.27</b><br>(8.33-10.2)    | <b>10.4</b><br>(9.27-11.4)    | <b>11.9</b><br>(10.6-13.1)    | <b>13.2</b><br>(11.6-14.5)    |
| <b>7-day</b>   | <b>4.05</b><br>(3.74-4.42)                 | <b>4.86</b><br>(4.48-5.30)    | <b>6.00</b><br>(5.52-6.55)    | <b>6.94</b><br>(6.38-7.57)    | <b>8.28</b><br>(7.58-9.02)    | <b>9.39</b><br>(8.54-10.2)    | <b>10.6</b><br>(9.56-11.5)    | <b>11.8</b><br>(10.6-12.8)    | <b>13.6</b><br>(12.1-14.8)    | <b>15.0</b><br>(13.3-16.4)    |
| <b>10-day</b>  | <b>4.62</b><br>(4.28-5.00)                 | <b>5.51</b><br>(5.10-5.97)    | <b>6.71</b><br>(6.21-7.28)    | <b>7.68</b><br>(7.09-8.31)    | <b>9.03</b><br>(8.30-9.76)    | <b>10.1</b><br>(9.27-10.9)    | <b>11.2</b><br>(10.3-12.1)    | <b>12.4</b><br>(11.3-13.4)    | <b>14.0</b><br>(12.7-15.2)    | <b>15.3</b><br>(13.7-16.6)    |
| <b>20-day</b>  | <b>6.24</b><br>(5.81-6.71)                 | <b>7.40</b><br>(6.90-7.96)    | <b>8.82</b><br>(8.22-9.48)    | <b>9.94</b><br>(9.25-10.7)    | <b>11.4</b><br>(10.6-12.3)    | <b>12.6</b><br>(11.7-13.5)    | <b>13.8</b><br>(12.7-14.8)    | <b>15.0</b><br>(13.8-16.1)    | <b>16.6</b><br>(15.2-17.9)    | <b>17.8</b><br>(16.2-19.2)    |
| <b>30-day</b>  | <b>7.76</b><br>(7.30-8.24)                 | <b>9.14</b><br>(8.60-9.72)    | <b>10.7</b><br>(10.0-11.3)    | <b>11.8</b><br>(11.1-12.6)    | <b>13.4</b><br>(12.5-14.2)    | <b>14.5</b><br>(13.6-15.4)    | <b>15.7</b><br>(14.6-16.7)    | <b>16.8</b><br>(15.6-17.9)    | <b>18.3</b><br>(16.9-19.5)    | <b>19.4</b><br>(17.9-20.6)    |
| <b>45-day</b>  | <b>9.84</b><br>(9.32-10.4)                 | <b>11.6</b><br>(10.9-12.2)    | <b>13.3</b><br>(12.6-14.1)    | <b>14.6</b><br>(13.8-15.4)    | <b>16.2</b><br>(15.3-17.2)    | <b>17.4</b><br>(16.5-18.5)    | <b>18.6</b><br>(17.5-19.7)    | <b>19.7</b><br>(18.5-20.8)    | <b>21.0</b><br>(19.7-22.3)    | <b>22.0</b><br>(20.6-23.3)    |
| <b>60-day</b>  | <b>11.8</b><br>(11.2-12.4)                 | <b>13.8</b><br>(13.1-14.6)    | <b>15.8</b><br>(15.0-16.6)    | <b>17.2</b><br>(16.3-18.2)    | <b>19.0</b><br>(18.0-20.0)    | <b>20.3</b><br>(19.3-21.4)    | <b>21.6</b><br>(20.4-22.7)    | <b>22.7</b><br>(21.4-23.9)    | <b>24.1</b><br>(22.7-25.4)    | <b>25.1</b><br>(23.6-26.5)    |

<sup>1</sup> 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.

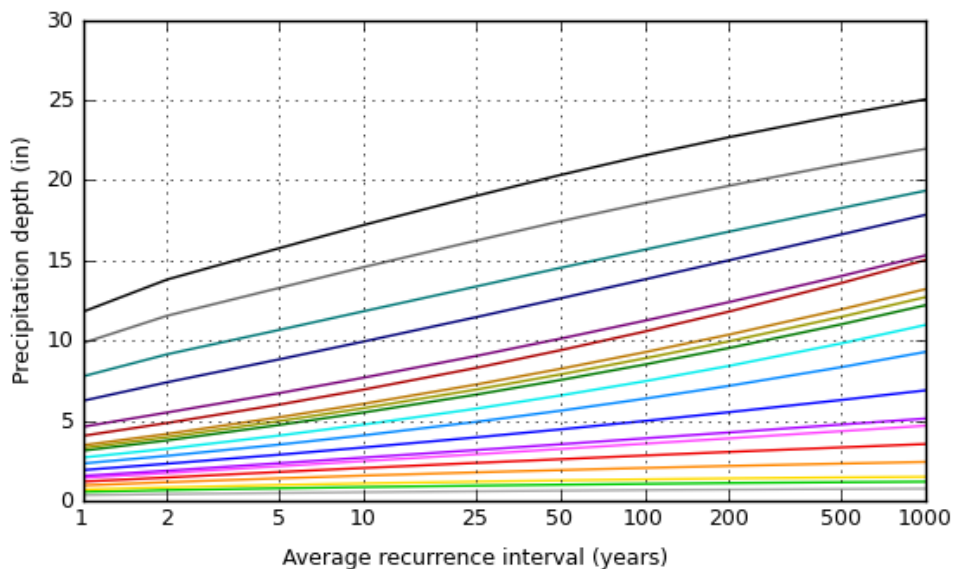
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### PF graphical

PDS-based depth-duration-frequency (DDF) curves  
 Latitude: 40.0270°, Longitude: -75.6167°



| Average recurrence interval (years) |
|-------------------------------------|
| 1                                   |
| 2                                   |
| 5                                   |
| 10                                  |
| 25                                  |
| 50                                  |
| 100                                 |
| 200                                 |
| 500                                 |
| 1000                                |



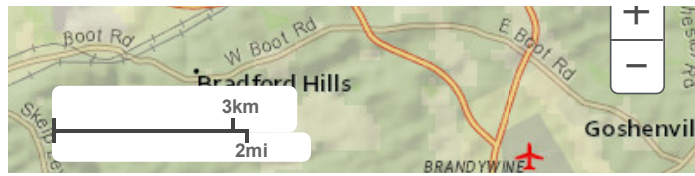
| Duration |
|----------|
| 5-min    |
| 10-min   |
| 15-min   |
| 30-min   |
| 60-min   |
| 2-hr     |
| 3-hr     |
| 6-hr     |
| 12-hr    |
| 24-hr    |
| 2-day    |
| 3-day    |
| 4-day    |
| 7-day    |
| 10-day   |
| 20-day   |
| 30-day   |
| 45-day   |
| 60-day   |

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### Maps & aerials

Small scale terrain





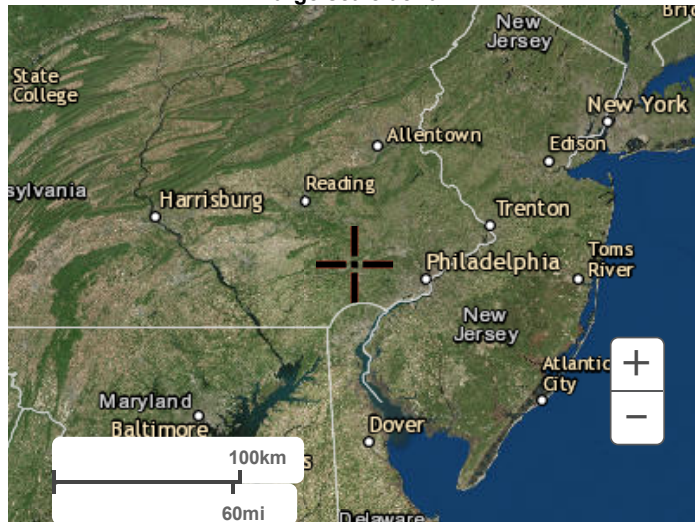
Large scale terrain



Large scale map



Large scale aerial



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**WORKSHEET 1. GENERAL SITE INFORMATION**

**Date:** November 11, 2016

**Project Name:** East Lincoln Highway Valve Site

**Municipality:** West Whiteland

**County:** Chester

**Total Area (acres):** 1.14

**Major River Basin:** Brandywine Creek

**Watershed:** East Branch Brandywine Creek

**Sub Basin:** Valley Creek

**Nearest Surface Water to Receive Runoff:** Tributary 00276 to Valley Creek

**Chapter 93 - Designated Water Use:** Cold Water Fishes (CWF)

**Impaired according to Chapter 303(d) list?** YES   
**List Causes of Impairment:** NO   
Urban Runoff/Storm Sewers - Water/Flow Variability ; Urban Runoff/Storm Sewers - Siltation

***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.

See pre-development drainage area map

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

0.00 acres

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

0.00 acres

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?<br>Yes/no/n/a | TOTAL AREA<br>(Ac.) | PROTECTED AREA (Ac.) |
|-------------------------------------|-----------------------|---------------------|----------------------|
| Waterbodies                         | N/A                   |                     |                      |
| Floodplains                         | N/A                   |                     |                      |
| Riparian Areas                      | N/A                   |                     |                      |
| Wetlands                            | N/A                   |                     |                      |
| Woodlands                           | N/A                   |                     |                      |
| Natural Drainage Ways               | N/A                   |                     |                      |
| Steep Slopes, 15% - 25%             | N/A                   |                     |                      |
| Steep Slopes, over 25%              | N/A                   |                     |                      |
| Other:                              |                       |                     |                      |
| Other:                              |                       |                     |                      |
| <b>TOTAL EXISTING:</b>              |                       | <b>0.00</b>         | <b>0.00</b>          |

## Worksheet 3. Nonstructural BMP Credits

### PROTECTED AREA

|   |                |
|---|----------------|
| 1.1 Area of Protected Sensitive/Special Value Features (see WS 2) | 0.00 Ac.       |
| 1.2 Area of Riparian Forest Buffer Protection                     | 0.00 Ac.       |
| 3.1 Area of Minimum Disturbance/Reduced Grading                   | 0.00 Ac.       |
| <b>TOTAL</b>  | <b>0.00 Ac</b> |

|           |       |                |   |   |
|-----------|-------|----------------|---|---|
| Site Area | Minus | Protected Area | = | Stormwater Management Area                              |
| 0.47      | -     | 0              | = | 0.47  |
|           |       |                |   | This is the area that requires<br>stormwater management |

### VOLUME CREDITS

#### 3.1 Minimum Soil Compaction (See Chapter 8, page 22 – SW BMP Manual)

|        |                       |               |   |                       |
|--------|-----------------------|---------------|---|-----------------------|
| Lawn   | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|        | _____                 |               |   |                       |
| Meadow | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |

#### 3.3 Protect Existing Trees (See Chapter 8, page 23 – SW BMP Manual)

*For Trees within 100 feet of impervious area:*

|             |                       |               |   |                       |
|-------------|-----------------------|---------------|---|-----------------------|
| Tree Canopy | _____ ft <sup>2</sup> | x 1/2" x 1/12 | = | _____ ft <sup>3</sup> |
|             | _____                 |               |   |                       |

#### 5.1 Disconnect Roof Leaders to Vegetated Areas (See Chapter 8 page 25 – SW BMP Manual)

*For runoff directed to areas protected under 5.8.1 and 5.8.2*

|           |                       |               |   |                       |
|-----------|-----------------------|---------------|---|-----------------------|
| Roof Area | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------|-----------------------|---------------|---|-----------------------|

*For all other disconnected roof areas*

|           |                       |               |   |                       |
|-----------|-----------------------|---------------|---|-----------------------|
| Roof Area | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------|-----------------------|---------------|---|-----------------------|

#### 5.2 Disconnect Non-Roof impervious to Vegetated Areas (See Chapter 8, page 26 – SW BMP Manual)

*For Runoff directed to areas protected under 5.8.1 and 5.8.2*

|                 |                       |               |   |                       |
|-----------------|-----------------------|---------------|---|-----------------------|
| Impervious Area | _____ ft <sup>2</sup> | x 1/3" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------------|-----------------------|---------------|---|-----------------------|

*For all other disconnected roof areas*

|                 |                       |               |   |                       |
|-----------------|-----------------------|---------------|---|-----------------------|
| Impervious Area | _____ ft <sup>2</sup> | x 1/4" x 1/12 | = | _____ ft <sup>3</sup> |
|-----------------|-----------------------|---------------|---|-----------------------|

**TOTAL NON-STRUCTURAL VOLUME CREDIT\*** \_\_\_\_\_ ft<sup>3</sup>

\*For use on Worksheet 5

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

PROJECT: East Lincoln Highway Valve Site  
 Drainage Area: 1.14 acres  
 2-Year Rainfall: 3.25 in

Total Site Area: 0.47 acres  
 Protected Site Area: N/A acres  
 Managed Site Area: 0.47 acres

Existing Conditions

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Impervious           | -         | 0             | 0.00        | 98 | 0.20 | 0.04       | 3.02                       | 0   |
| Woods                | -         | 0             | 0.00        | 55 | 8.18 | 1.64       | 0.27                       | 0   |
| Meadow               | B         | 20,473        | 0.47        | 58 | 7.24 | 1.45       | 0.36                       | 612   |
| Gravel               | -         | 0             | 0.00        | 85 | 1.76 | 0.35       | 1.80                       | 0   |
| <b>TOTAL:</b>        |           | <b>20,473</b> | <b>0.47</b> |    |      |            |                            | <b>612</b>                                    |

Developed Conditions

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | la (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>3</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Impervious           | -         | 0             | 0.00        | 98 | 0.20 | 0.04       | 3.02                       | 0   |
| Woods                | -         | 0             | 0.00        | 55 | 8.18 | 1.64       | 0.27                       | 0   |
| Meadow               | B         | 14,810        | 0.34        | 58 | 7.24 | 1.45       | 0.36                       | 443   |
| Gravel               | B         | 5,663         | 0.13        | 85 | 1.76 | 0.35       | 1.80                       | 850   |
| <b>TOTAL:</b>        |           | <b>20,473</b> | <b>0.47</b> |    |      |            |                            | <b>1,293</b>                                  |

2-Year Volume Increase (ft<sup>3</sup>): **680**

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

1. Runoff (in) =  $Q = (P - 0.2S) / (P + 0.8S)$  where  
 $P = 2\text{-Year Rainfall (in)}$   
 $S = (1000/CN) - 10$

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: East Lincoln Highway Valve Site  
 SUB-BASIN: \_\_\_\_\_

Required Control Volume (ft<sup>3</sup>) - from Worksheet 4: 680  
 Non-structural Volume Credit (ft<sup>3</sup>) - from Worksheet 3: N/A  
 (maximum is 25% of required volume)  
 Structural Volume Reqmt (ft<sup>3</sup>) 680  
 (Required Control Volume minus Non-structural Credit)

| Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 6 | Area (ft <sup>2</sup> ) | Volume Reduction Permanently Removed (ft <sup>3</sup> ) |
|---|-------------------------|---|
| 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   | 1,124                   | 965   |
| 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/Riparian Forest 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:  |                         |   |
| <b>Total Structural Volume (ft<sup>3</sup>):</b>                            |                         | <b>965</b>  |
| <b>Structural Volume Requirement (ft<sup>3</sup>):</b>                      |                         | <b>680</b>  |
| <b>VOLUME CREDIT DETERMINATION</b>  |                         | <b>DIFFERENCE:</b>                                      |
|   |                         | <b>-285</b>   |

- 1 Detained area runoff volume from Hydraflow = 965 cf
- 2 Storage volume of the BMP = 2,800 cf
- 3 Infiltrated volume within 72 hours after the 2-yr/24-hr event  
 (Infiltration Rate/12) x Infiltration Area x 72 hrs = 2,698 cf

## 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*

**PRIMARY BMPs FOR NITRATE:**

|   | YES                                 | NO                       |
|---|-------------------------------------|--------------------------|
| NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers            | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.5.4 - Cluster Uses at Each Site                                | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.6.1 - Minimize Total Disturbed Area                            | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| NS BMP 5.9.1 - Street Sweeping / Vacuuming                              | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.1 - Riparian Buffer Restoration                      | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.2 - Landscape Restoration                            | <input type="checkbox"/>            | <input type="checkbox"/> |

**SECONDARY BMPs FOR NITRATE:**

|  |                                     |                          |
|--|-------------------------------------|--------------------------|
| NS BMP 5.4.1 - Protect Sensitive / Special Value Features  | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features | <input type="checkbox"/>            | <input type="checkbox"/> |
| NS BMP 5.6.2 - Minimize Soil Compaction                    | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Structural BMP 6.4.5 - Rain Garden / Bioretention          | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.4.8 - Vegetated Swale                     | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.4.9 - Vegetated Filter Strip              | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.6.1 - Constructed Wetland                 | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.1 - Riparian Buffer Restoration         | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.2 - Landscape Restoration               | <input type="checkbox"/>            | <input type="checkbox"/> |
| Structural BMP 6.7.3 - Soils Amendment/Restoration         | <input checked="" type="checkbox"/> | <input type="checkbox"/> |

**TIME OF CONCENTRATION ADJUSTMENT**

POST CONSTRUCTION TC TO BMP (DETAINED TC) BEFORE ADJUSTMENT 14.6 MIN

STRUCTURAL VOLUME PROVIDED BY BMP 965 CF - 2 YEAR/24-HR STORM ONLY  
2800 CF - FOR ALL OTHER REMAINING STORM EVENTS

RATES OF RUNOFF TO THE BMP (FROM HYDRAFLOW REPORT)

| Storm Event  | Q (CFS) |
|--------------|---------|
| 2 YR/24 HR   | 0.319   |
| 10 YR/24 HR  | 0.754   |
| 50 YR/24 HR  | 1.366   |
| 100 YR/24 HR | 1.683   |

ADDITIONAL RESIDENCE TIME (MIN) = (STRUCTURAL VOLUME PROVIDED BY BMP / RATE OF RUNOFF TO BMP) / 60

| Storm Event  | Q (CFS) | Additional Residence Time (min.) |
|--------------|---------|----------------------------------|
| 2 YR/24 HR   | 0.319   | 50.418                           |
| 10 YR/24 HR  | 0.754   | 61.892                           |
| 50 YR/24 HR  | 1.366   | 34.163                           |
| 100 YR/24 HR | 1.683   | 27.728                           |

ADJUSTED TC = POST CONSTRUCTION TC TO BMP BEFORE ADJUSTMENT + ADDITIONAL RESIDENCE TIME

| Storm Event  | Q (CFS) | Additional Residence Time (min.) | Adjusted Time of Concentration (min.) |
|--------------|---------|----------------------------------|---------------------------------------|
| 2 YR/24 HR   | 0.319   | 50.418                           | 65.018                                |
| 10 YR/24 HR  | 0.754   | 61.892                           | 76.492                                |
| 50 YR/24 HR  | 1.366   | 34.163                           | 48.763                                |
| 100 YR/24 HR | 1.683   | 27.728                           | 42.328                                |

INFILTRATION BERM DEWATERING CALCULATION

SITE NAME: EAST LINCOLN

STORAGE VOLUME 938 CF 2-YEAR/24-HR RUNOFF FROM DETAINED DA  
DESIGN INFILTRATION RATE 0.4 IN/HR BASED ON A, IT-01, IT-02, AND IT-03  
INFILTRATION AREA 1124 SF

DEWATERING TIME = STORAGE VOLUME / ((DESIGN INFILTRATION RATE /12) \* INFILTRATION AREA)

**DEWATERING TIME = 25.0 HOURS**

## Worksheet for Circular Pipe - 1

### Project Description

|                 |                    |
|-----------------|--------------------|
| Friction Method | Manning Formula    |
| Solve For       | Full Flow Capacity |

### Input Data

|                       |         |                    |
|-----------------------|---------|--------------------|
| Roughness Coefficient | 0.012   |                    |
| Channel Slope         | 0.00800 | ft/ft              |
| Normal Depth          | 0.33    | ft                 |
| Diameter              | 0.33    | ft                 |
| Discharge             | 0.18    | ft <sup>3</sup> /s |

### Results

|                   |             |                    |
|-------------------|-------------|--------------------|
| Discharge         | 0.18        | ft <sup>3</sup> /s |
| Normal Depth      | 0.33        | ft                 |
| Flow Area         | 0.09        | ft <sup>2</sup>    |
| Wetted Perimeter  | 1.05        | ft                 |
| Hydraulic Radius  | 0.08        | ft                 |
| Top Width         | 0.00        | ft                 |
| Critical Depth    | 0.24        | ft                 |
| Percent Full      | 100.0       | %                  |
| Critical Slope    | 0.01037     | ft/ft              |
| Velocity          | 2.11        | ft/s               |
| Velocity Head     | 0.07        | ft                 |
| Specific Energy   | 0.40        | ft                 |
| Froude Number     | 0.00        |                    |
| Maximum Discharge | 0.20        | ft <sup>3</sup> /s |
| Discharge Full    | 0.18        | ft <sup>3</sup> /s |
| Slope Full        | 0.00800     | ft/ft              |
| Flow Type         | SubCritical |                    |

### GVF Input Data

|                  |      |    |
|------------------|------|----|
| Downstream Depth | 0.00 | ft |
| Length           | 0.00 | ft |
| Number Of Steps  | 0    |    |

### GVF Output Data

|                             |      |    |
|-----------------------------|------|----|
| Upstream Depth              | 0.00 | ft |
| Profile Description         |      |    |
| Profile Headloss            | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | %  |

---

## Worksheet for Circular Pipe - 1

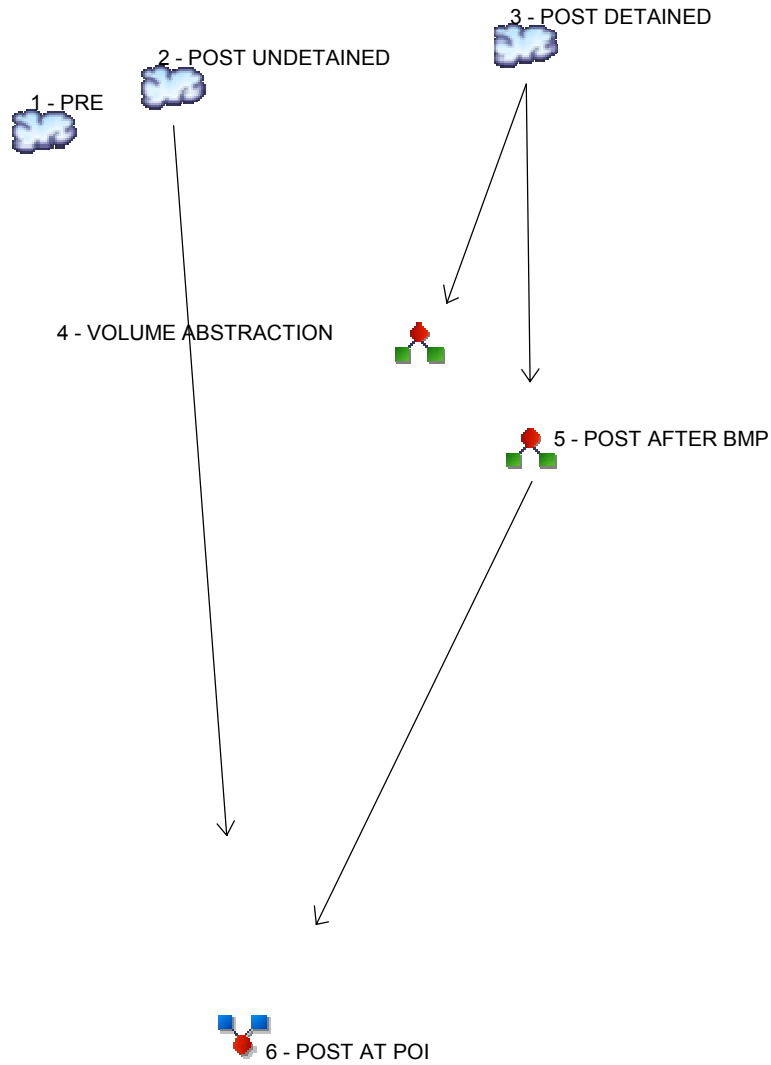
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### GVF Output Data

|                        |          |       |
|------------------------|----------|-------|
| Normal Depth Over Rise | 100.00   | %     |
| Downstream Velocity    | Infinity | ft/s  |
| Upstream Velocity      | Infinity | ft/s  |
| Normal Depth           | 0.33     | ft    |
| Critical Depth         | 0.24     | ft    |
| Channel Slope          | 0.00800  | ft/ft |
| Critical Slope         | 0.01037  | ft/ft |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. Origin | Description                   |
|-------------|-------------------------------|
| 1           | SCS Runoff PRE                |
| 2           | SCS Runoff POST UNDETAINED    |
| 3           | SCS Runoff POST DETAINED      |
| 4           | Diversion1 VOLUME ABSTRACTION |
| 5           | Diversion2 POST AFTER BMP     |
| 6           | Combine POST AT POI           |

# 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               | -----         | -----              | 0.700 | ----- | ----- | 2.247 | ----- | 4.571 | 5.814  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | 0.559 | ----- | ----- | 1.696 | ----- | 3.379 | 4.274  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | 0.329 | ----- | ----- | 0.777 | ----- | 1.409 | 1.736  | POST DETAINED          |
| 4        | Diversion1               | 3             | -----              | 0.329 | ----- | ----- | 0.777 | ----- | 1.409 | 1.736  | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 3             | -----              | 0.000 | ----- | ----- | 0.000 | ----- | 0.055 | 0.162  | POST AFTER BMP         |
| 6        | Combine                  | 2, 5          | -----              | 0.559 | ----- | ----- | 1.696 | ----- | 3.379 | 4.274  | POST AT POI            |

# 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               | 0.700           | 1                   | 720                | 1,874                 | -----         | -----                  | -----                    | PRE                    |  |
| 2         | SCS Runoff               | 0.559           | 1                   | 720                | 1,441                 | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3         | SCS Runoff               | 0.329           | 1                   | 723                | 968                   | -----         | -----                  | -----                    | POST DETAINED          |  |
| 4         | Diversion1               | 0.329           | 1                   | 723                | 968                   | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 5         | Diversion2               | 0.000           | 1                   | n/a                | 0                     | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 6         | Combine                  | 0.559           | 1                   | 720                | 1,441                 | 2, 5          | -----                  | -----                    | POST AT POI            |  |
| Exton.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

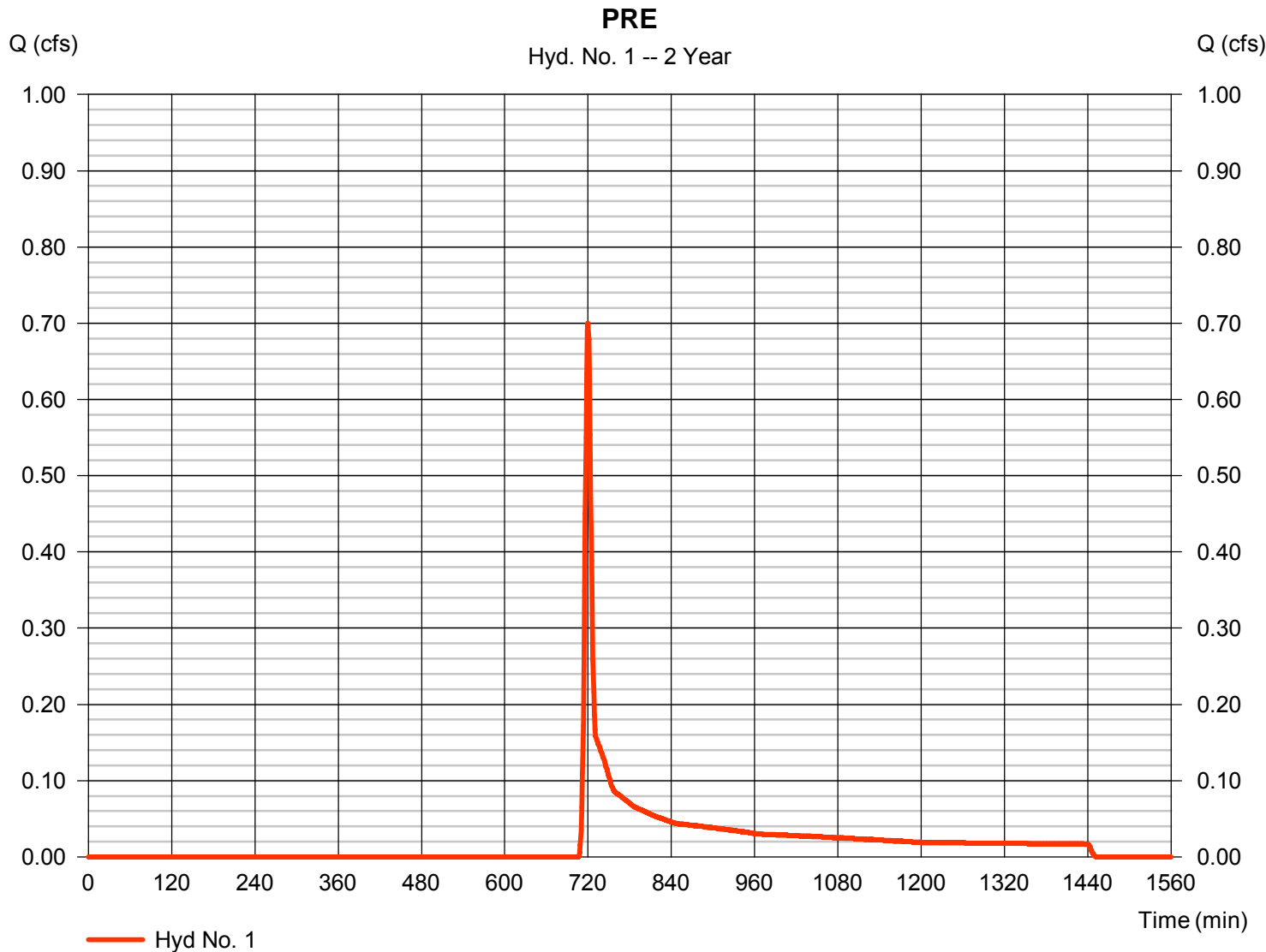
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.700 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 720 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,874 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 6.80        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 654.00      | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 5.14        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =3.66         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

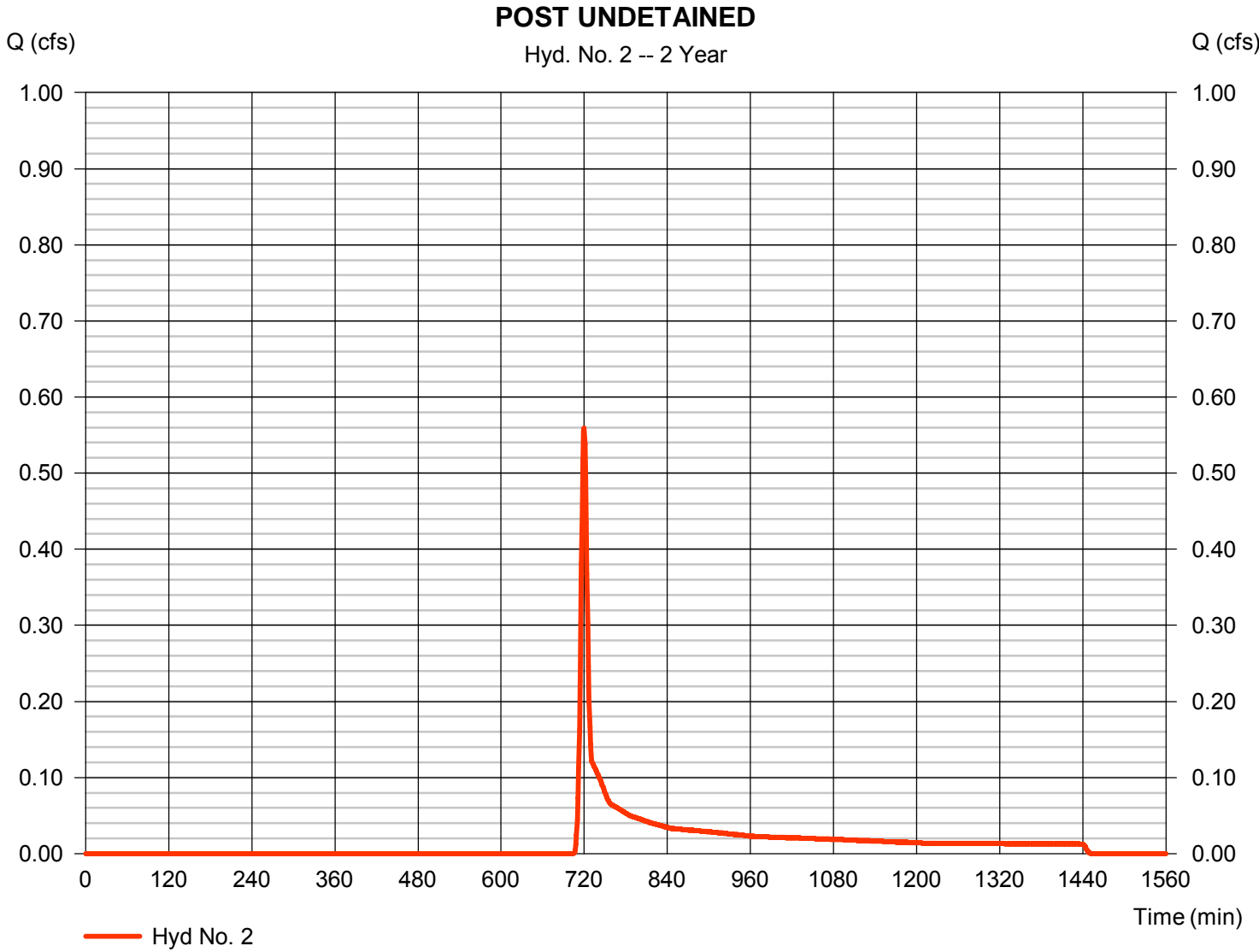
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.559 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 720 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,441 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 6.80        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 654.00      | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 5.14        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =3.66         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

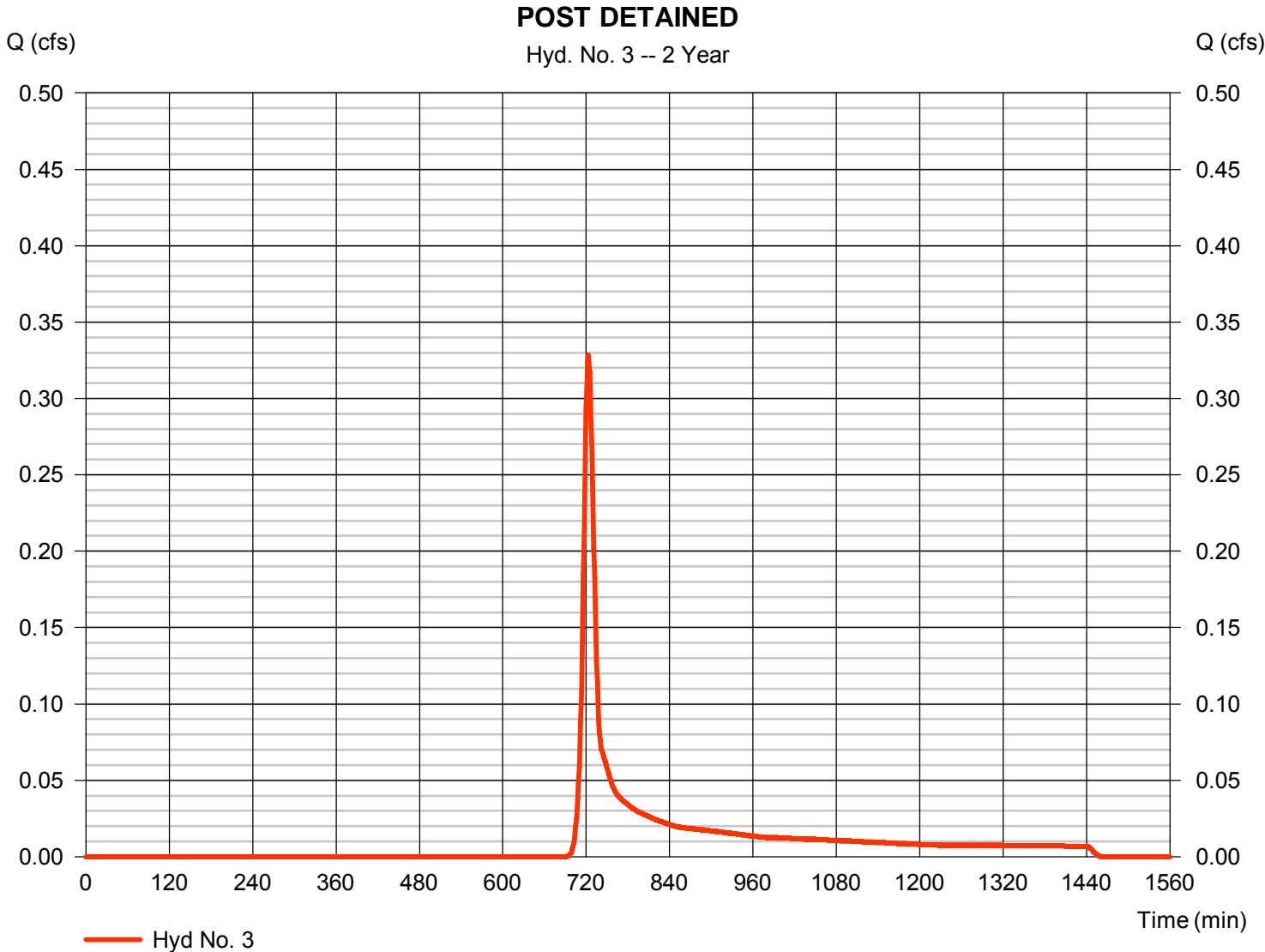
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.329 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 723 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 968 cuft  |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 14.60 min |
| Total precip.   | = 3.25 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 3

POST DETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|---------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |               |               |               |                  |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 7.00        | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 4.93</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 4.93</b>    |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                  |
| Flow length (ft)                   | = 87.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 6.30        | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved     | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.05         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.36</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.36</b>    |
| <b>Channel Flow</b>                |               |               |               |                  |
| X sectional flow area (sqft)       | = 0.35        | 0.00          | 0.00          |                  |
| Wetted perimeter (ft)              | = 1.05        | 0.00          | 0.00          |                  |
| Channel slope (%)                  | = 0.01        | 0.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015       | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =0.42         | 0.00          | 0.00          |                  |
| Flow length (ft)                   | ({0})238.0    | 0.0           | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 9.34</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 9.34</b>    |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>14.60 min</b> |

# Hydrograph Report

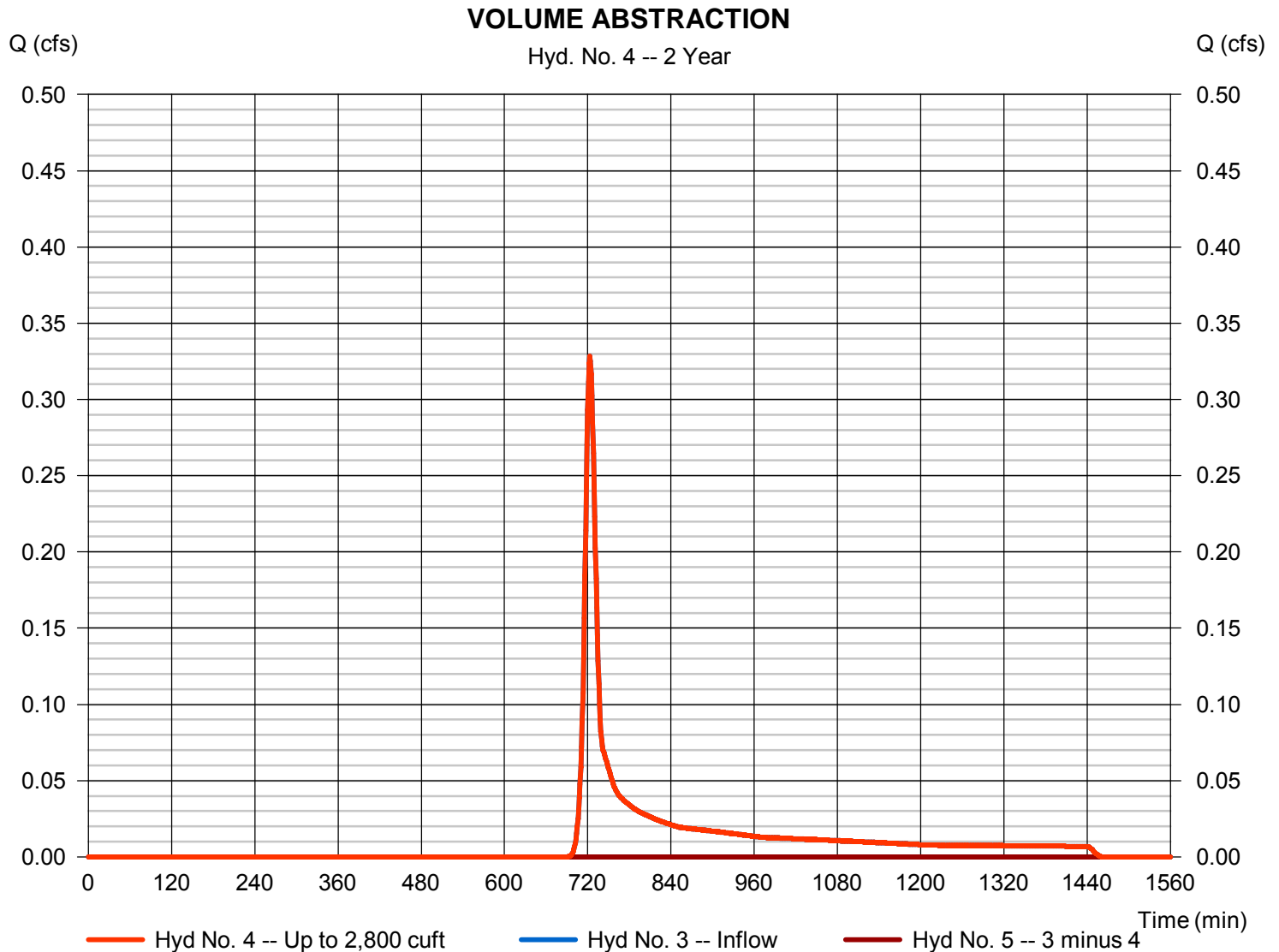
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.329 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 723 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 968 cuft   |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

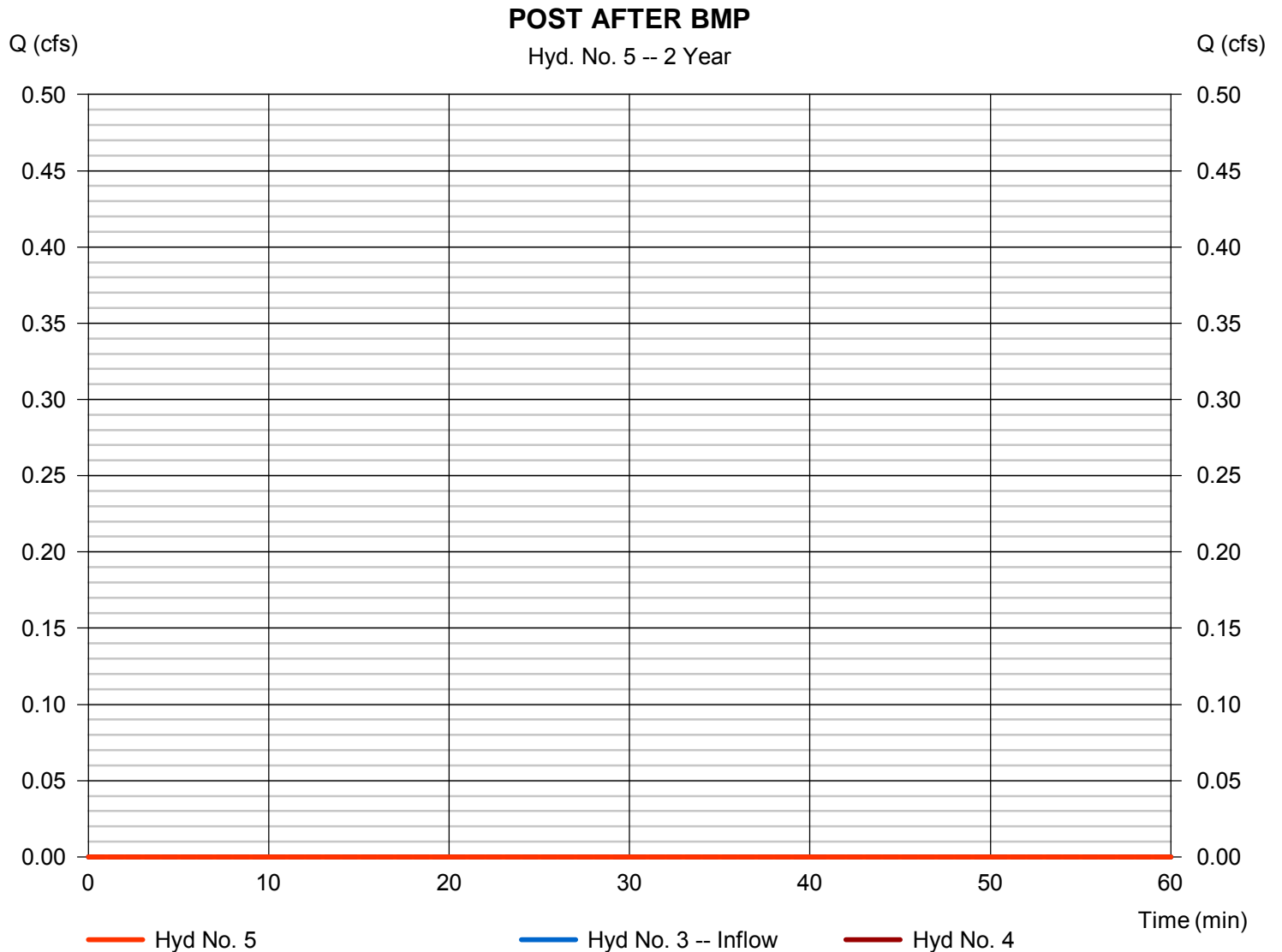
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

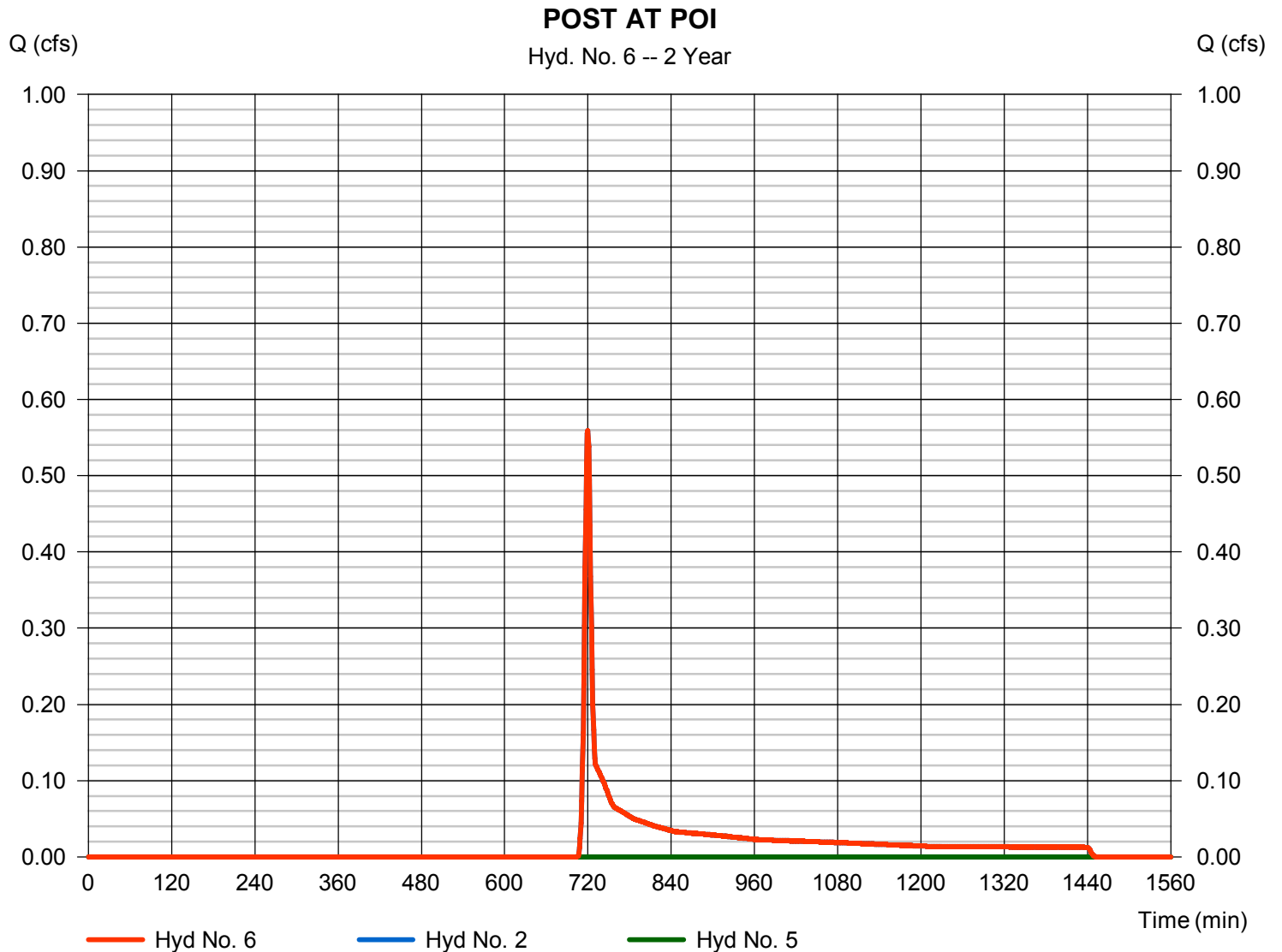
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

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

Peak discharge = 0.559 cfs  
Time to peak = 720 min  
Hyd. volume = 1,441 cuft  
Contrib. drain. area = 0.810 ac



# 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               | 2.247           | 1                   | 719                | 4,929                  | -----         | -----                  | -----                    | PRE                    |  |
| 2         | SCS Runoff               | 1.696           | 1                   | 719                | 3,688                  | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3         | SCS Runoff               | 0.777           | 1                   | 723                | 2,130                  | -----         | -----                  | -----                    | POST DETAINED          |  |
| 4         | Diversion1               | 0.777           | 1                   | 723                | 2,130                  | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 5         | Diversion2               | 0.000           | 1                   | n/a                | 0                      | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 6         | Combine                  | 1.696           | 1                   | 719                | 3,688                  | 2, 5          | -----                  | -----                    | POST AT POI            |  |
| Exton.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

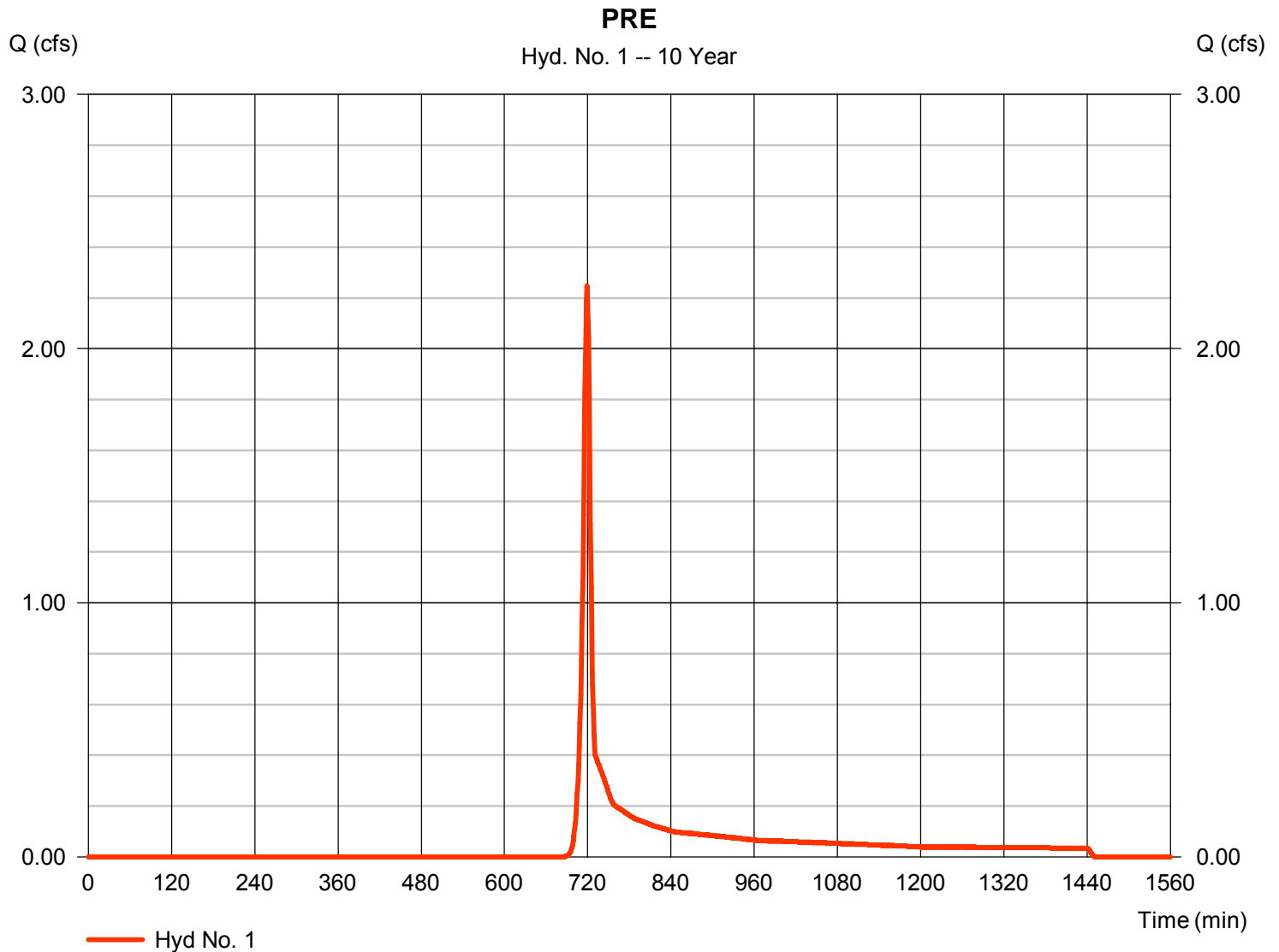
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.247 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,929 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

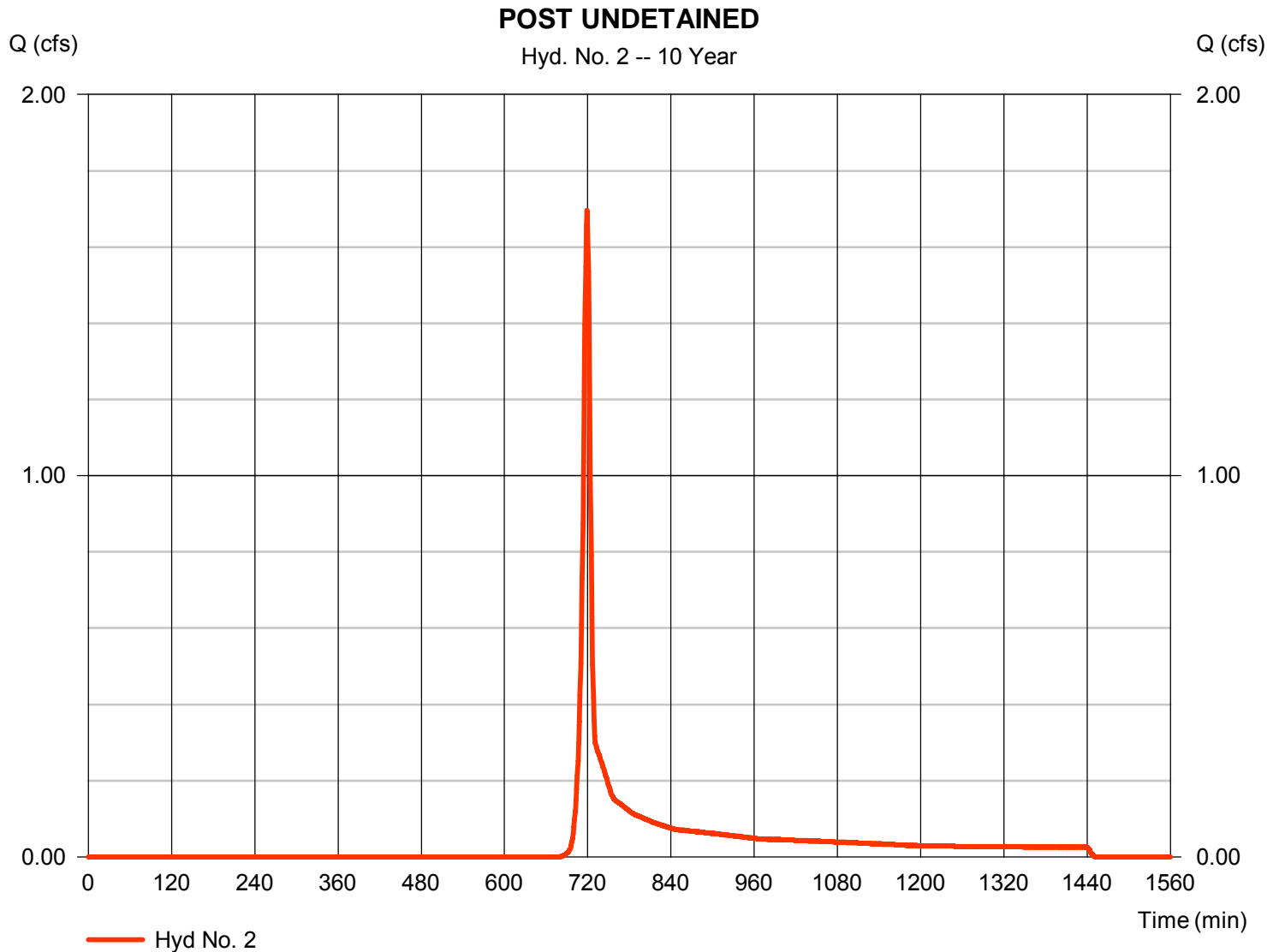
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.696 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,688 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

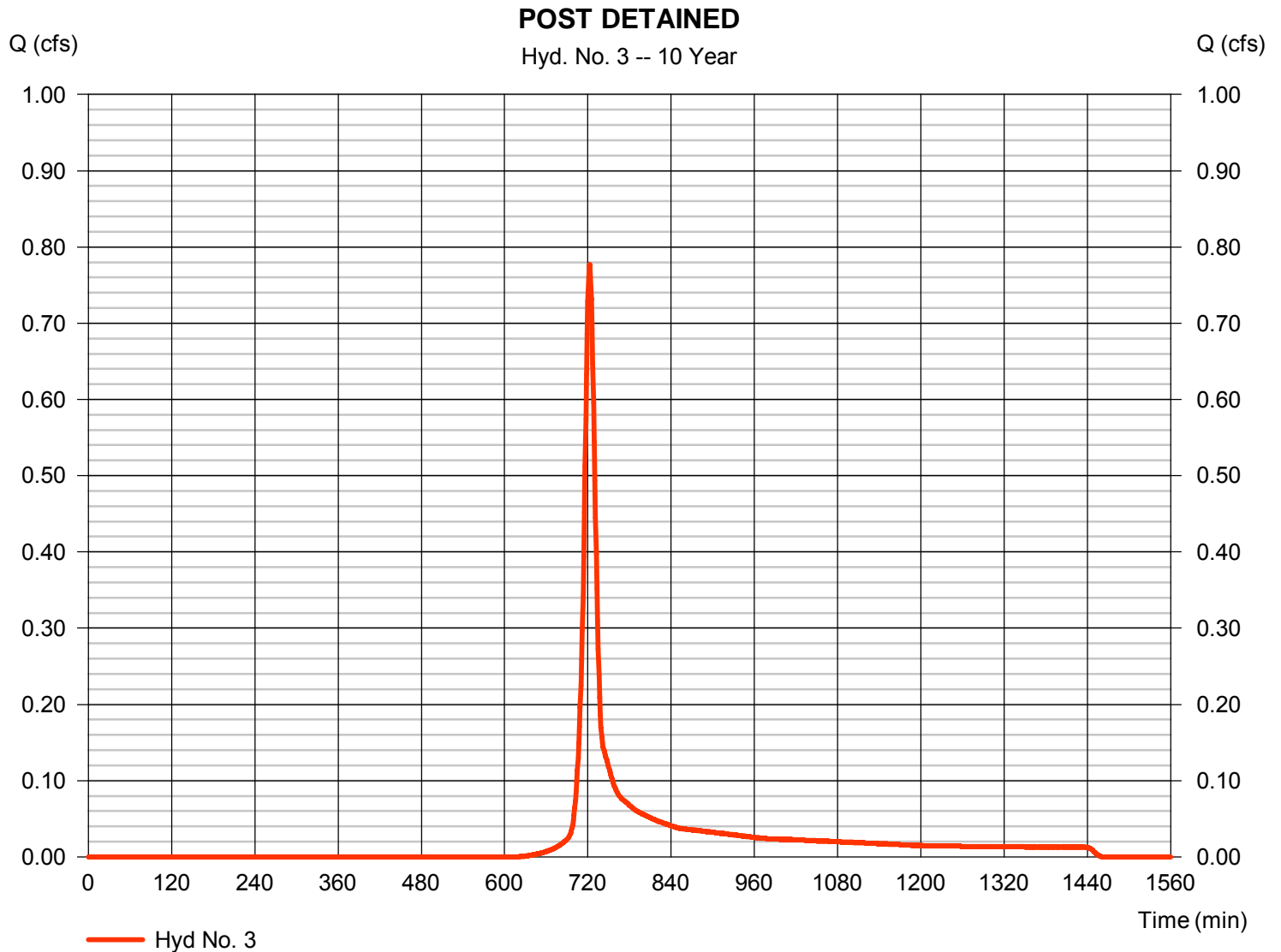
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.777 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 723 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,130 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 14.60 min  |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

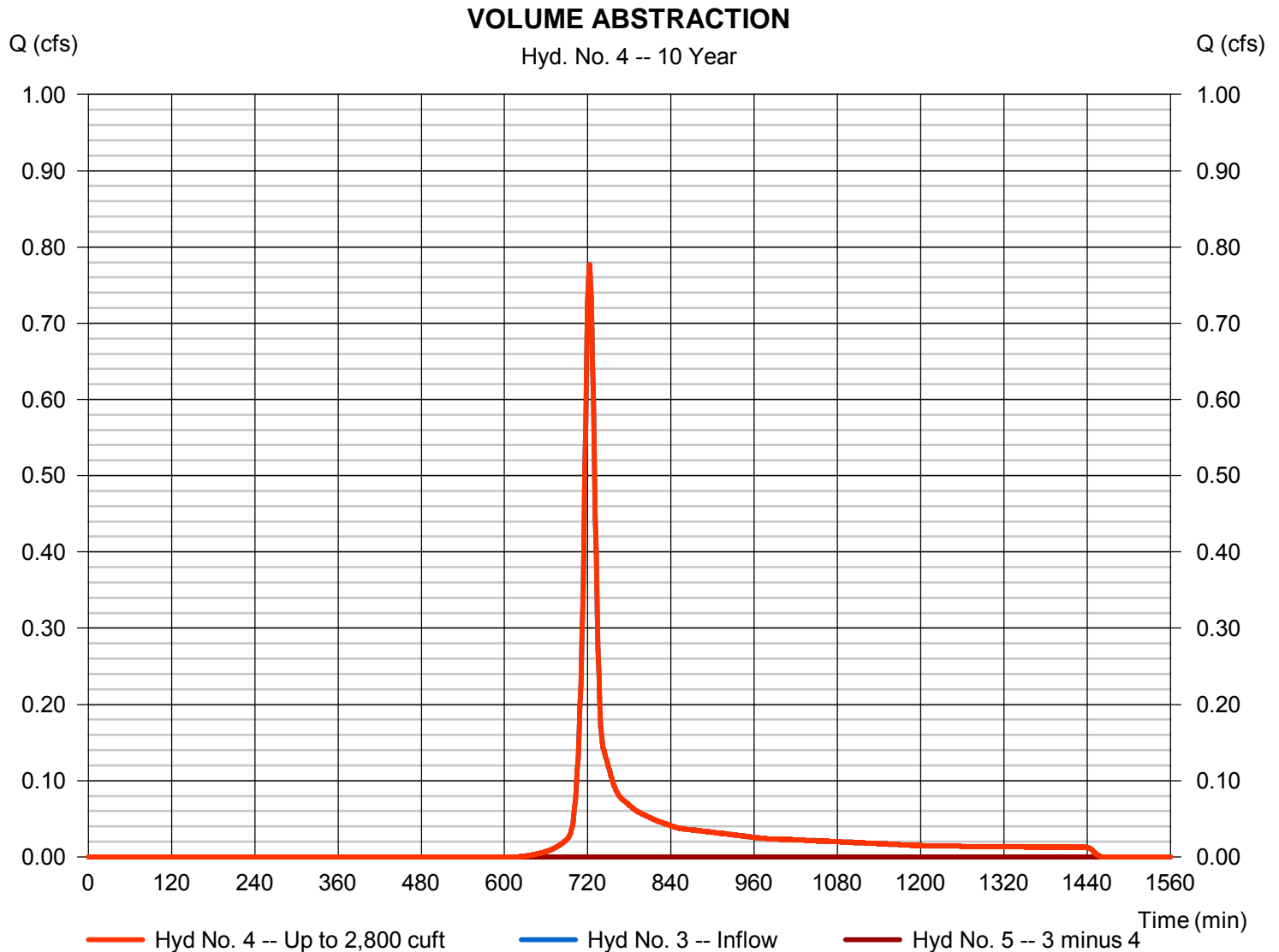
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.777 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 723 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,130 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

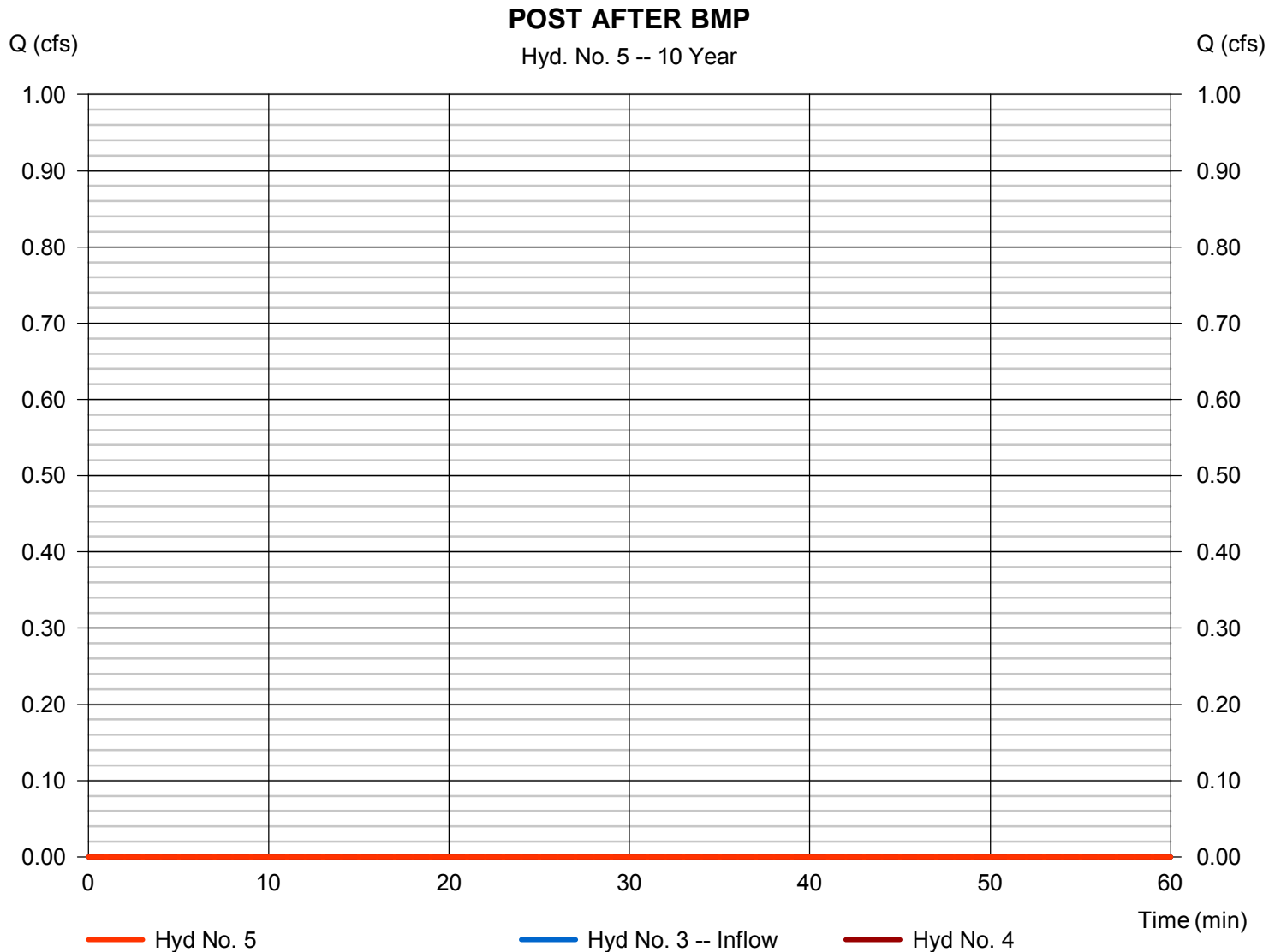
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

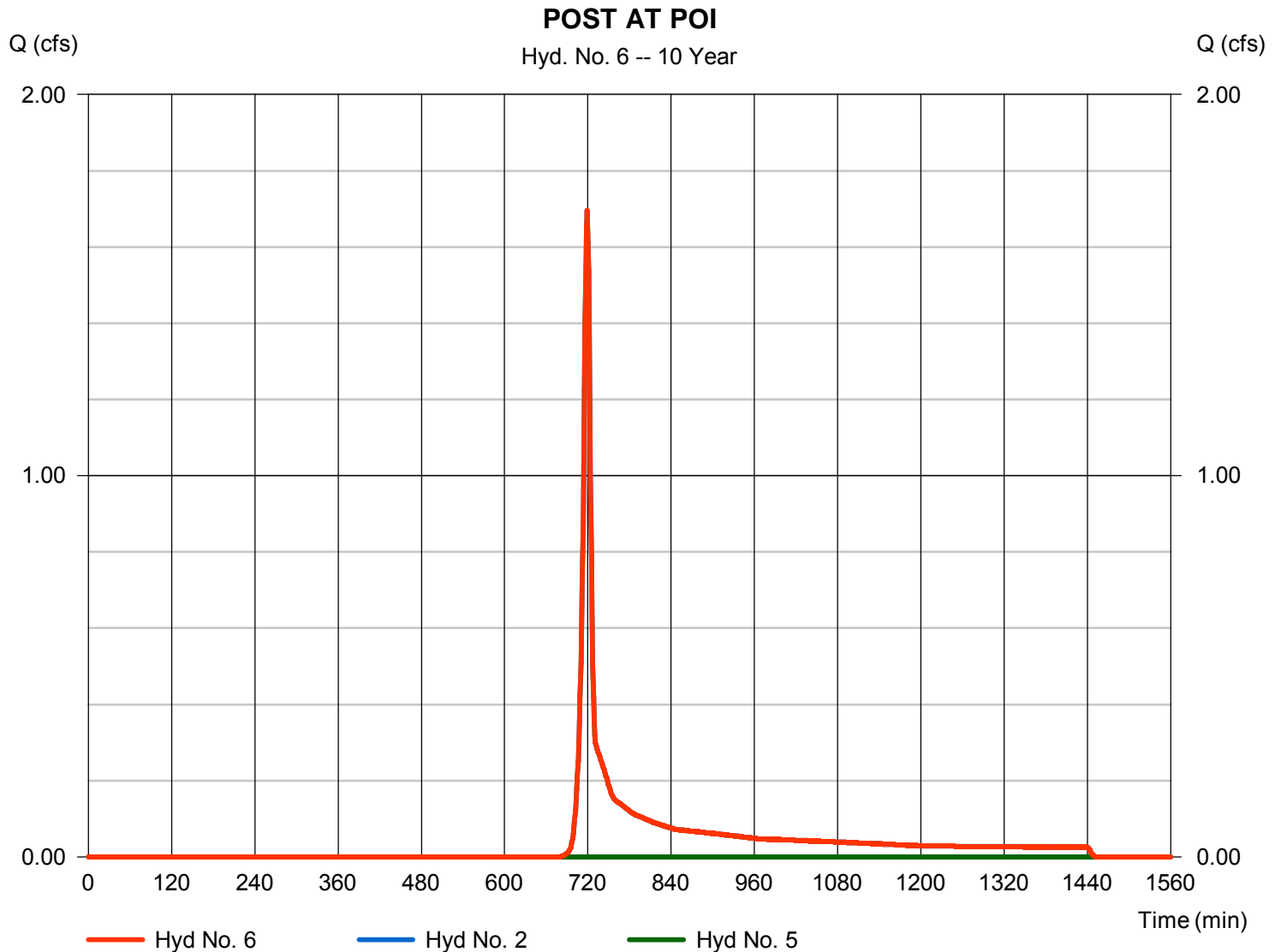
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

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

Peak discharge = 1.696 cfs  
Time to peak = 719 min  
Hyd. volume = 3,688 cuft  
Contrib. drain. area = 0.810 ac



# 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               | 4.571           | 1                   | 719                | 9,668                  | -----         | -----                  | -----                    | PRE                    |  |
| 2         | SCS Runoff               | 3.379           | 1                   | 719                | 7,136                  | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3         | SCS Runoff               | 1.409           | 1                   | 722                | 3,791                  | -----         | -----                  | -----                    | POST DETAINED          |  |
| 4         | Diversion1               | 1.409           | 1                   | 722                | 2,802                  | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 5         | Diversion2               | 0.055           | 1                   | 884                | 989                    | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 6         | Combine                  | 3.379           | 1                   | 719                | 8,126                  | 2, 5          | -----                  | -----                    | POST AT POI            |  |
| Exton.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

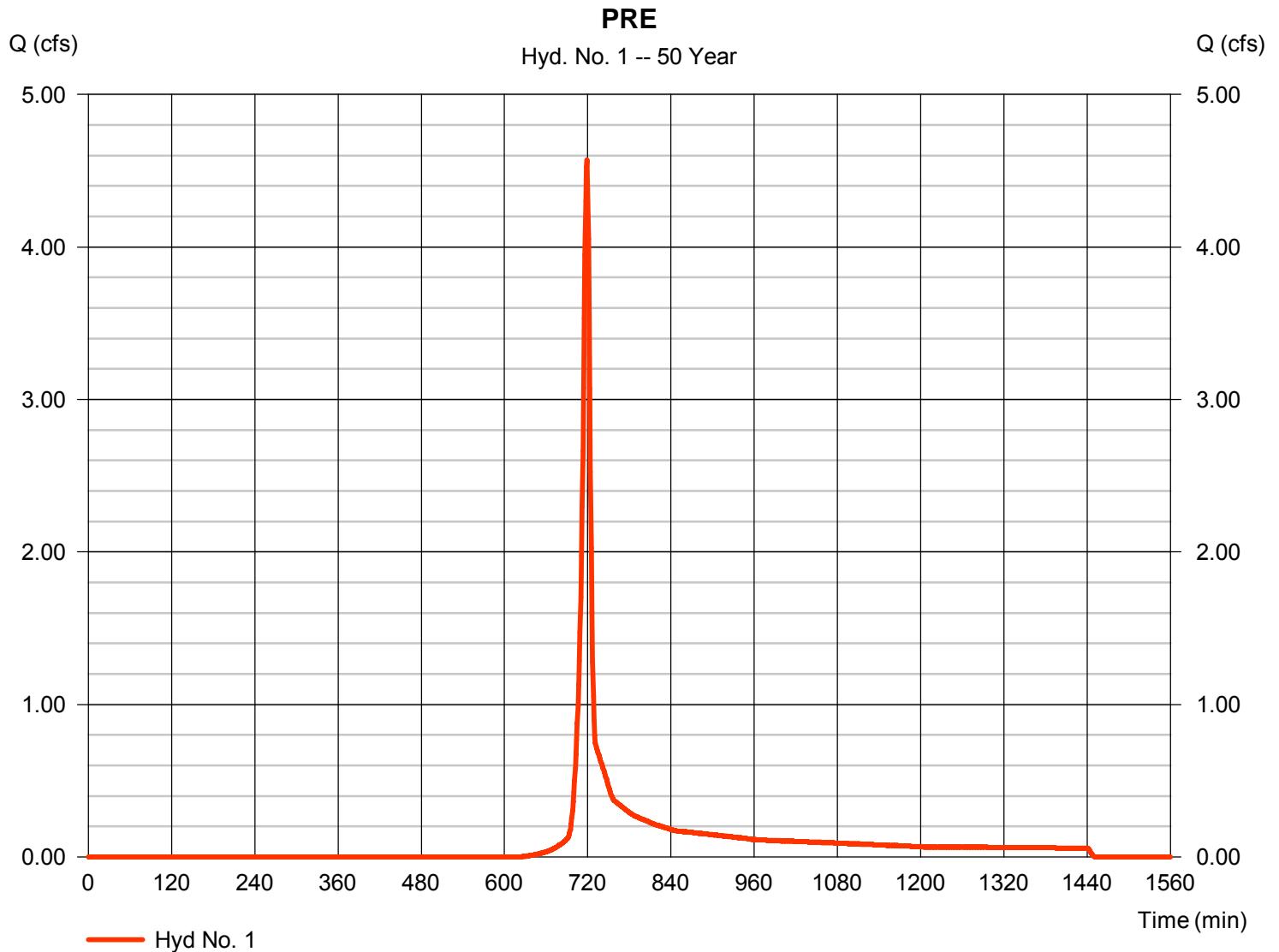
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.571 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 9,668 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

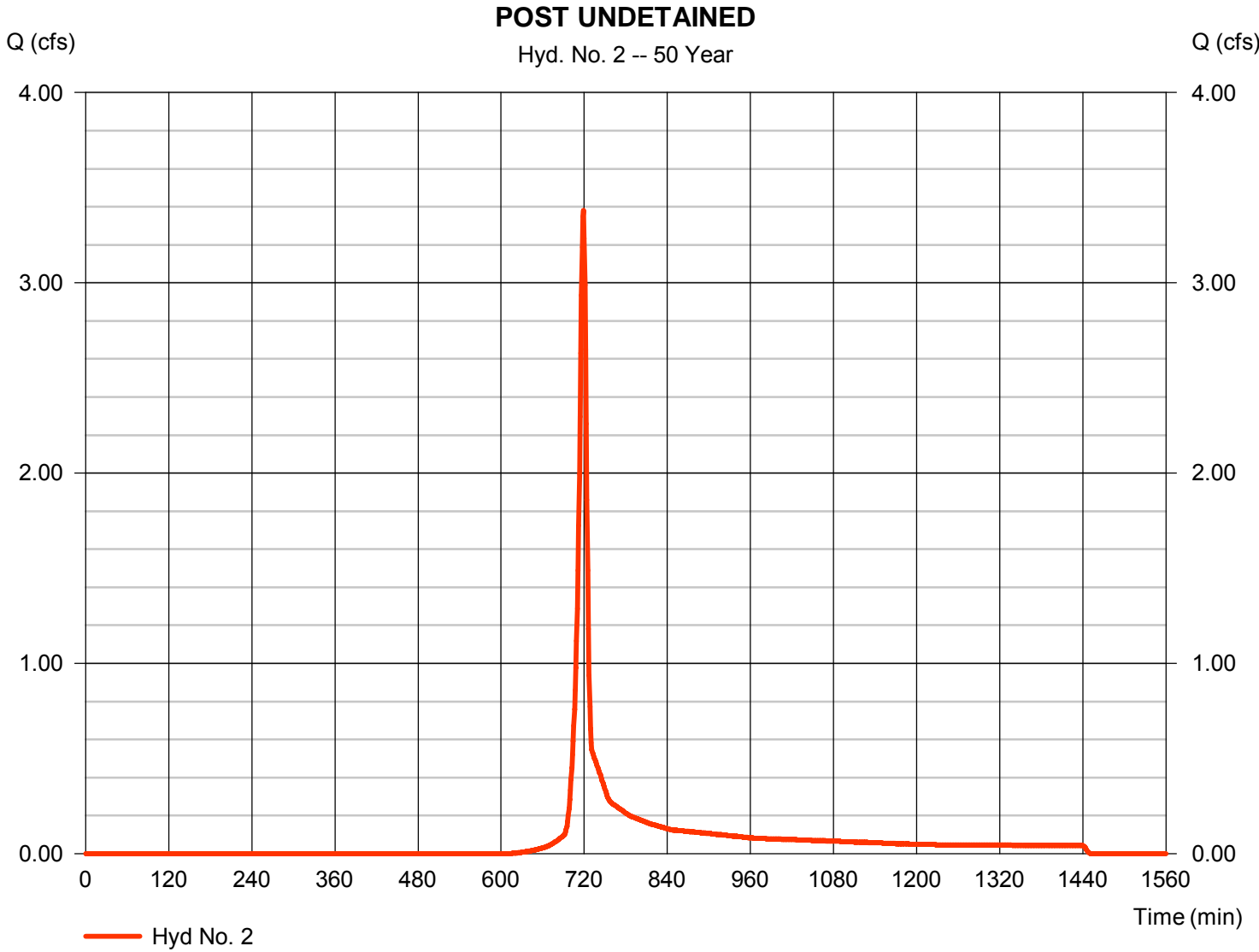
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.379 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 7,136 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

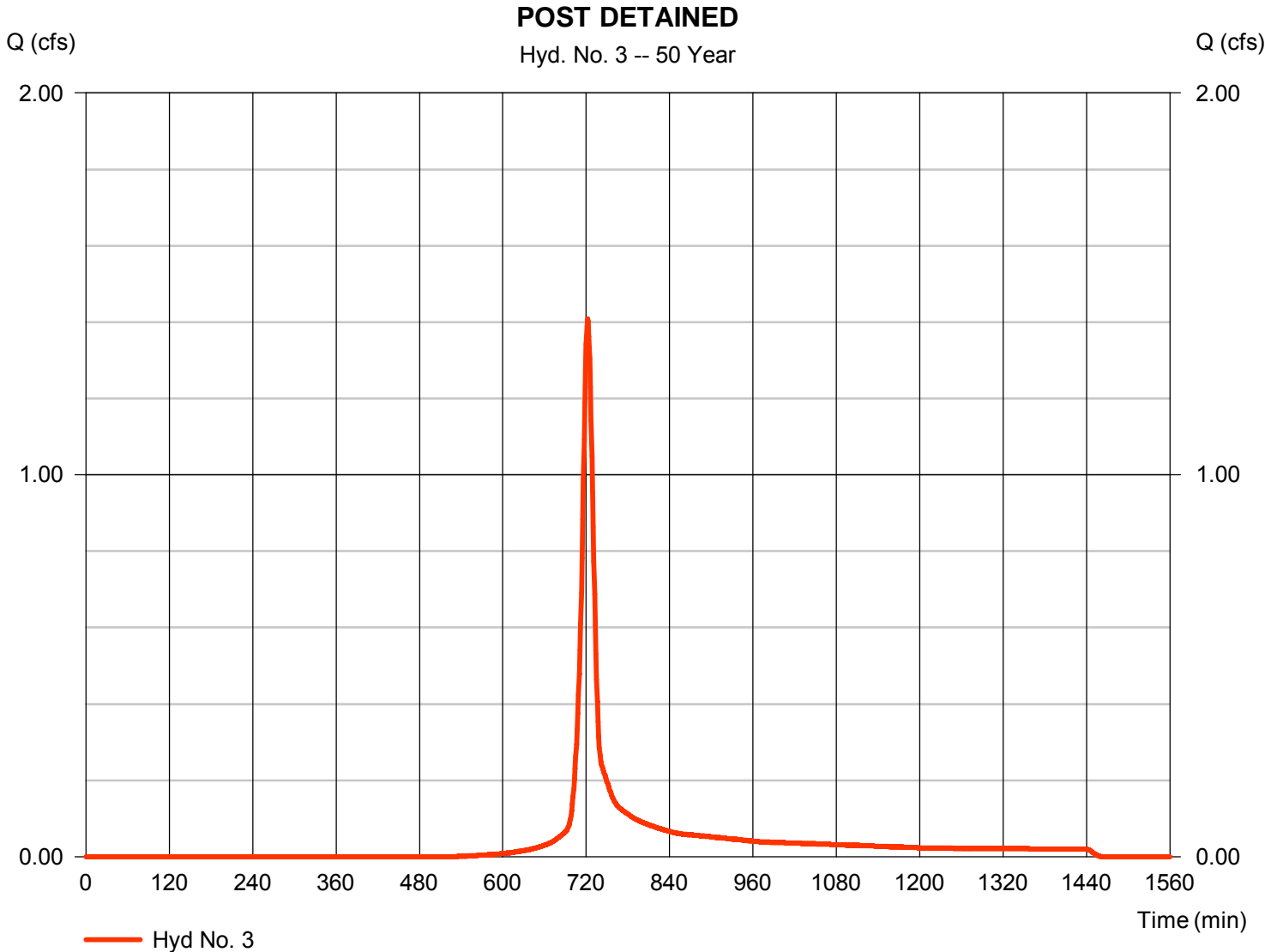
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.409 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 722 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,791 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 14.60 min  |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

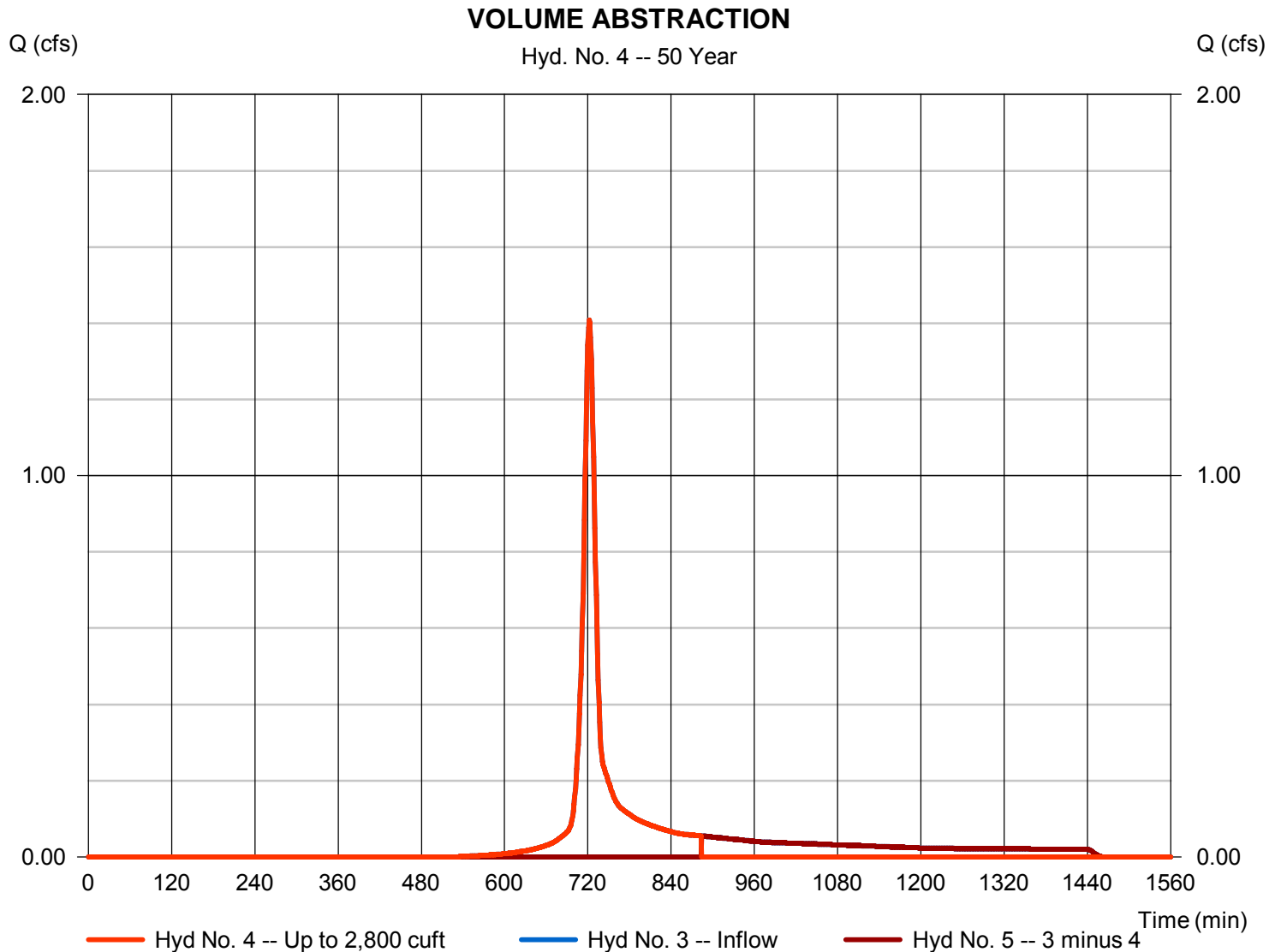
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 1.409 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 722 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,802 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

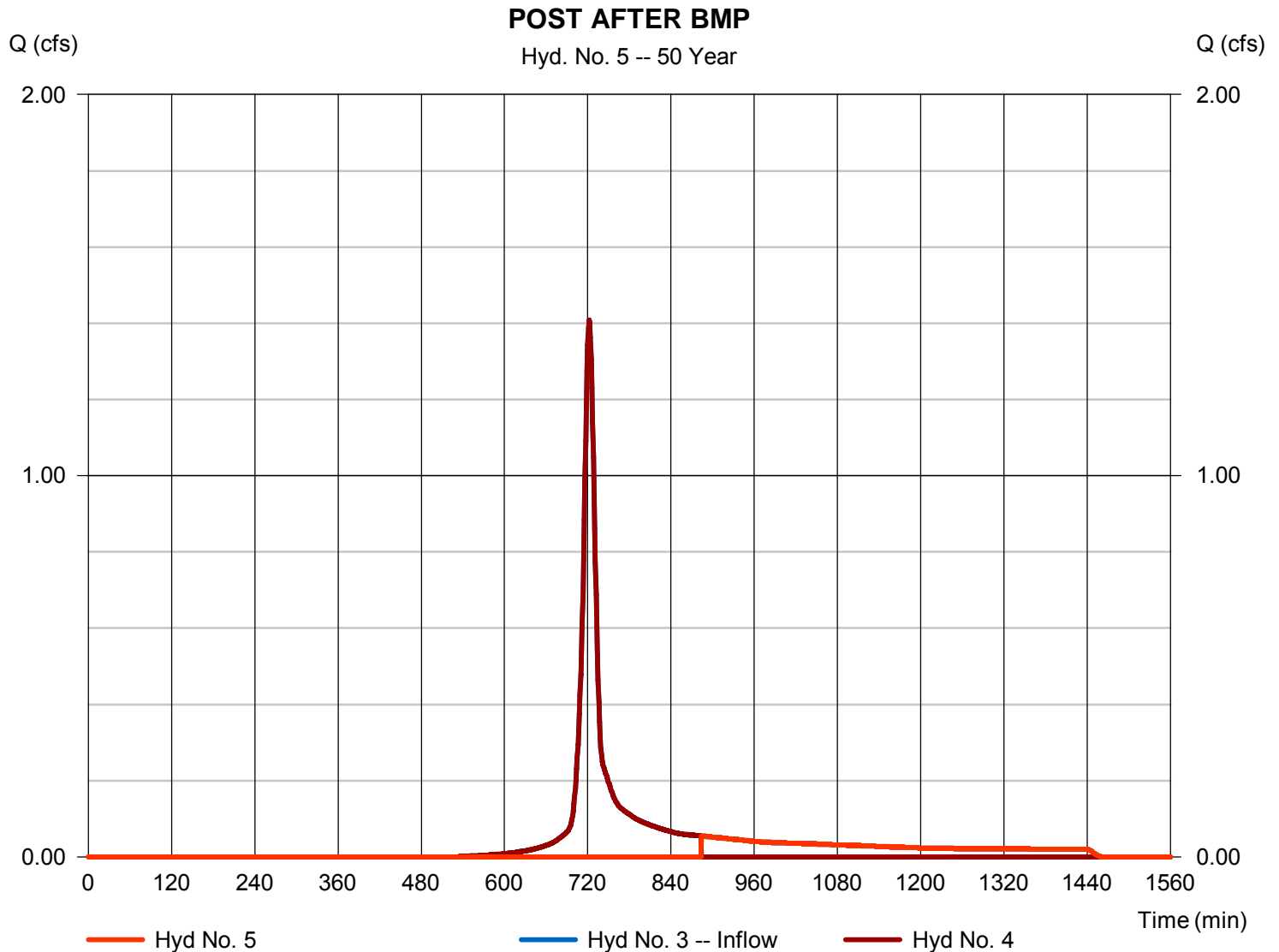
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.055 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 884 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 989 cuft   |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

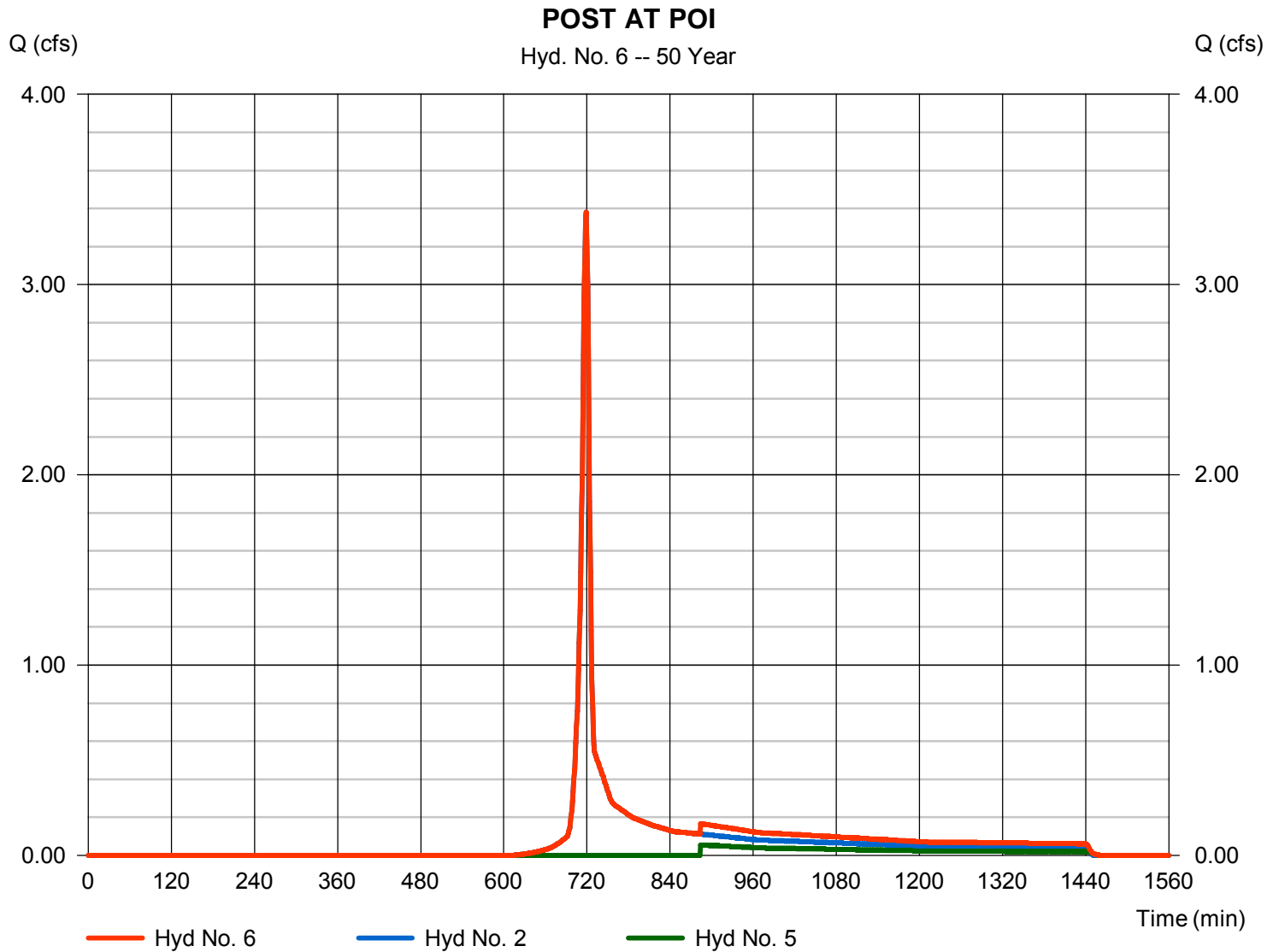
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

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

Peak discharge = 3.379 cfs  
Time to peak = 719 min  
Hyd. volume = 8,126 cuft  
Contrib. drain. area = 0.810 ac



# 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               | 5.814           | 1                   | 719                | 12,260                  | -----         | -----                  | -----                    | PRE                    |  |
| 2         | SCS Runoff               | 4.274           | 1                   | 719                | 9,012                   | -----         | -----                  | -----                    | POST UNDETAINED        |  |
| 3         | SCS Runoff               | 1.736           | 1                   | 722                | 4,665                   | -----         | -----                  | -----                    | POST DETAINED          |  |
| 4         | Diversion1               | 1.736           | 1                   | 722                | 2,801                   | 3             | -----                  | -----                    | VOLUME ABSTRACTION     |  |
| 5         | Diversion2               | 0.162           | 1                   | 764                | 1,865                   | 3             | -----                  | -----                    | POST AFTER BMP         |  |
| 6         | Combine                  | 4.274           | 1                   | 719                | 10,877                  | 2, 5          | -----                  | -----                    | POST AT POI            |  |
| Exton.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

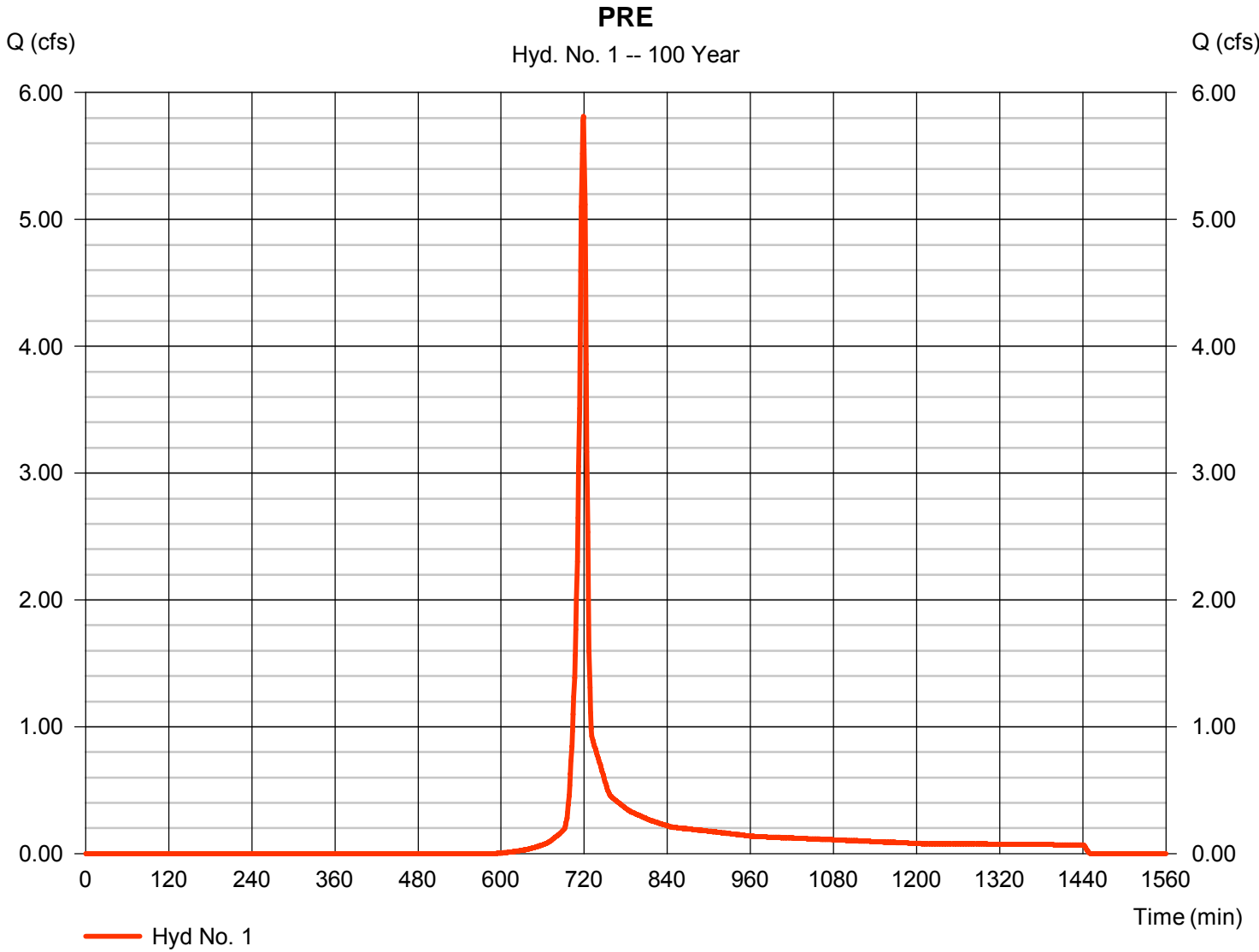
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 5.814 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 719 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 12,260 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min    |
| Total precip.   | = 7.46 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

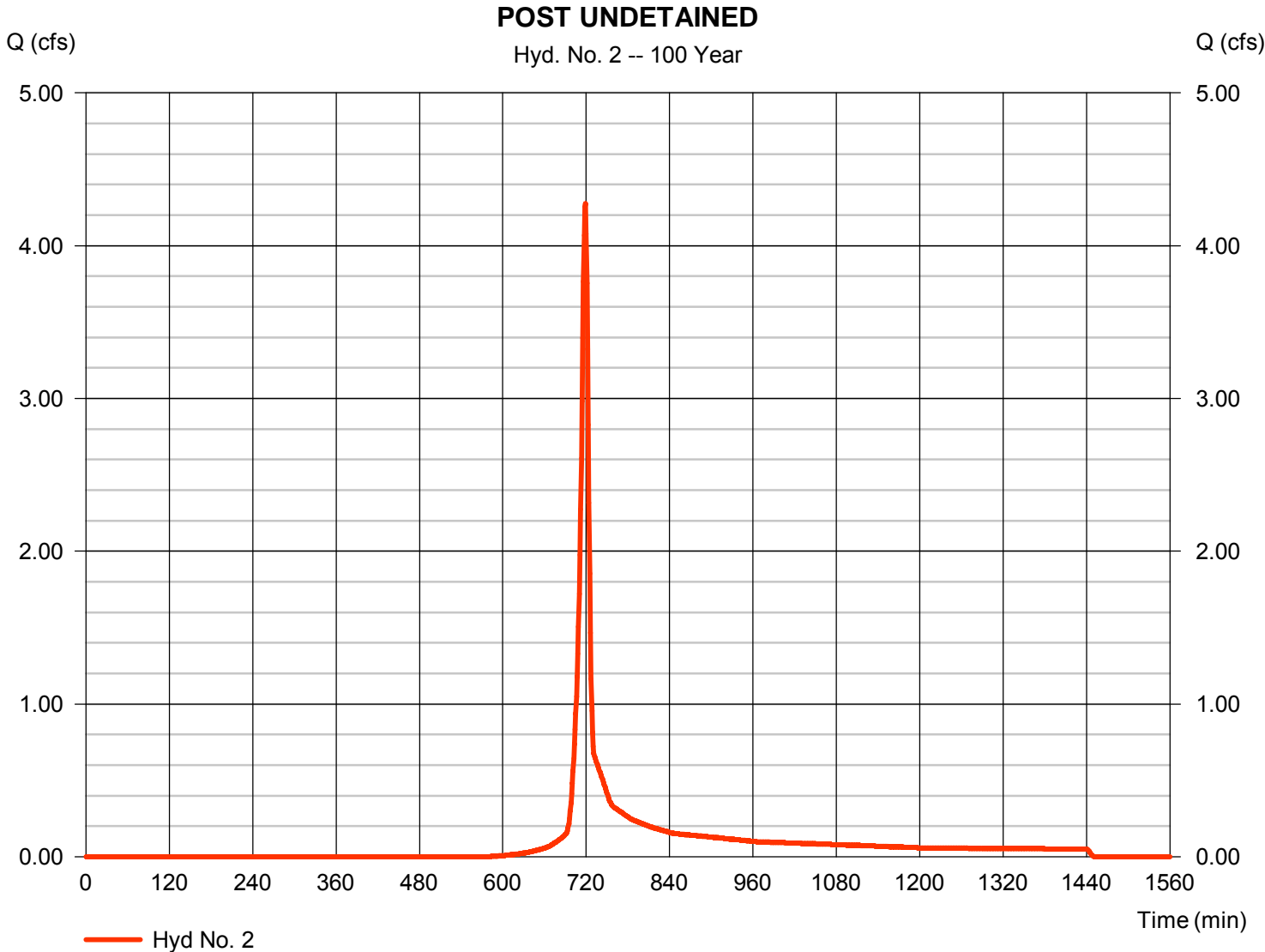
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.274 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 9,012 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 7.46 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

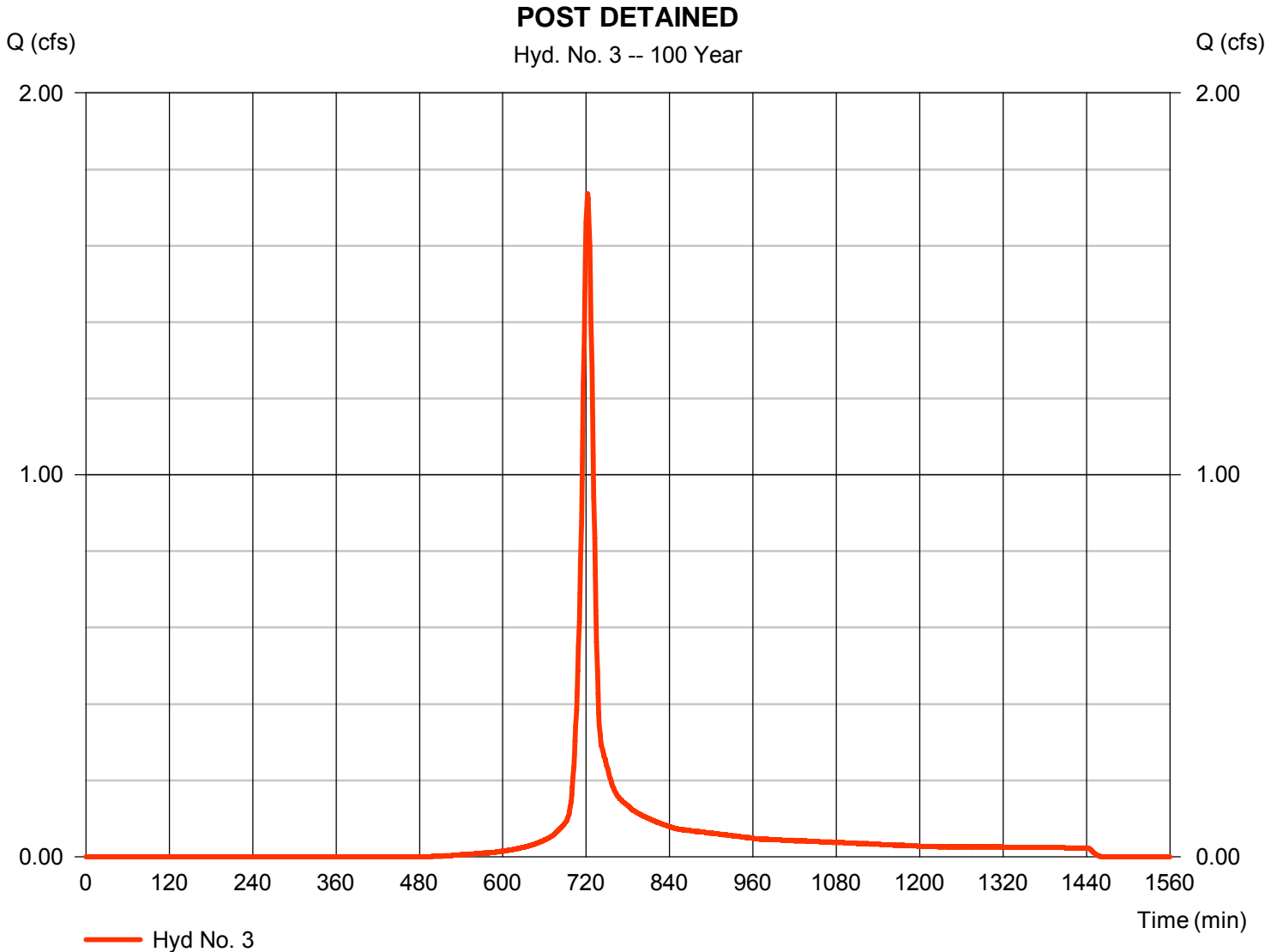
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.736 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 722 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,665 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 14.60 min  |
| Total precip.   | = 7.46 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

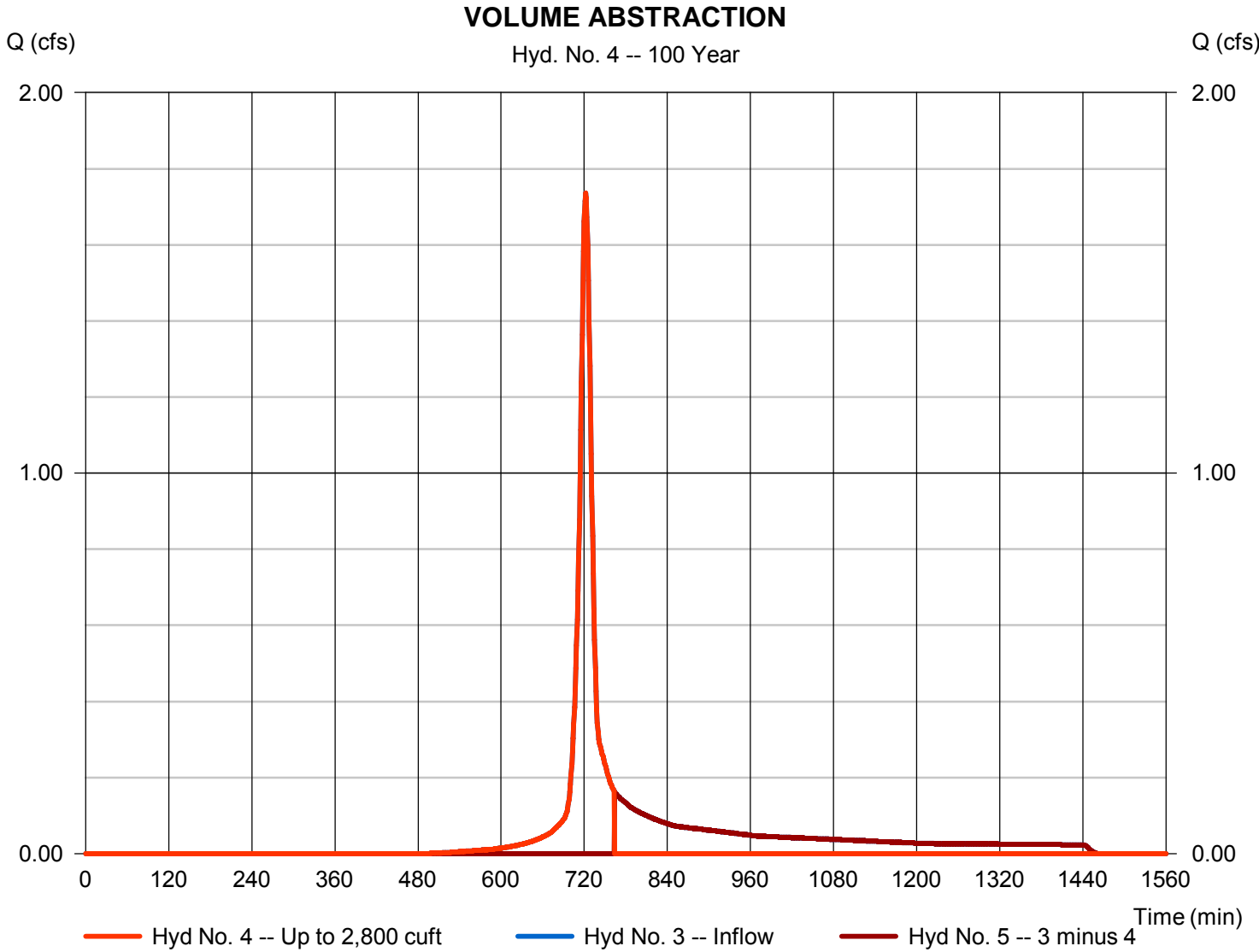
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 1.736 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 722 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,801 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

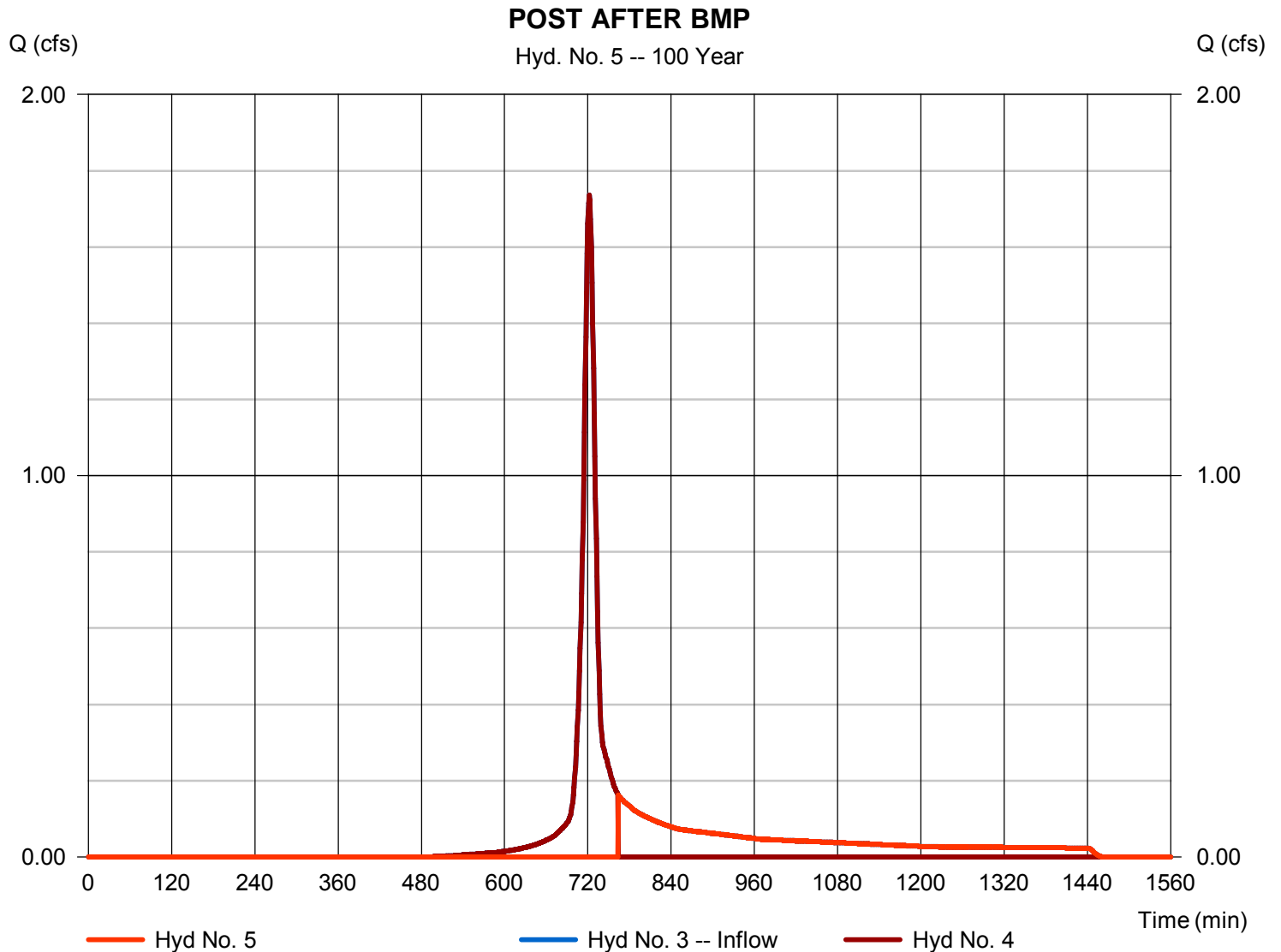
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.162 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 764 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,865 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

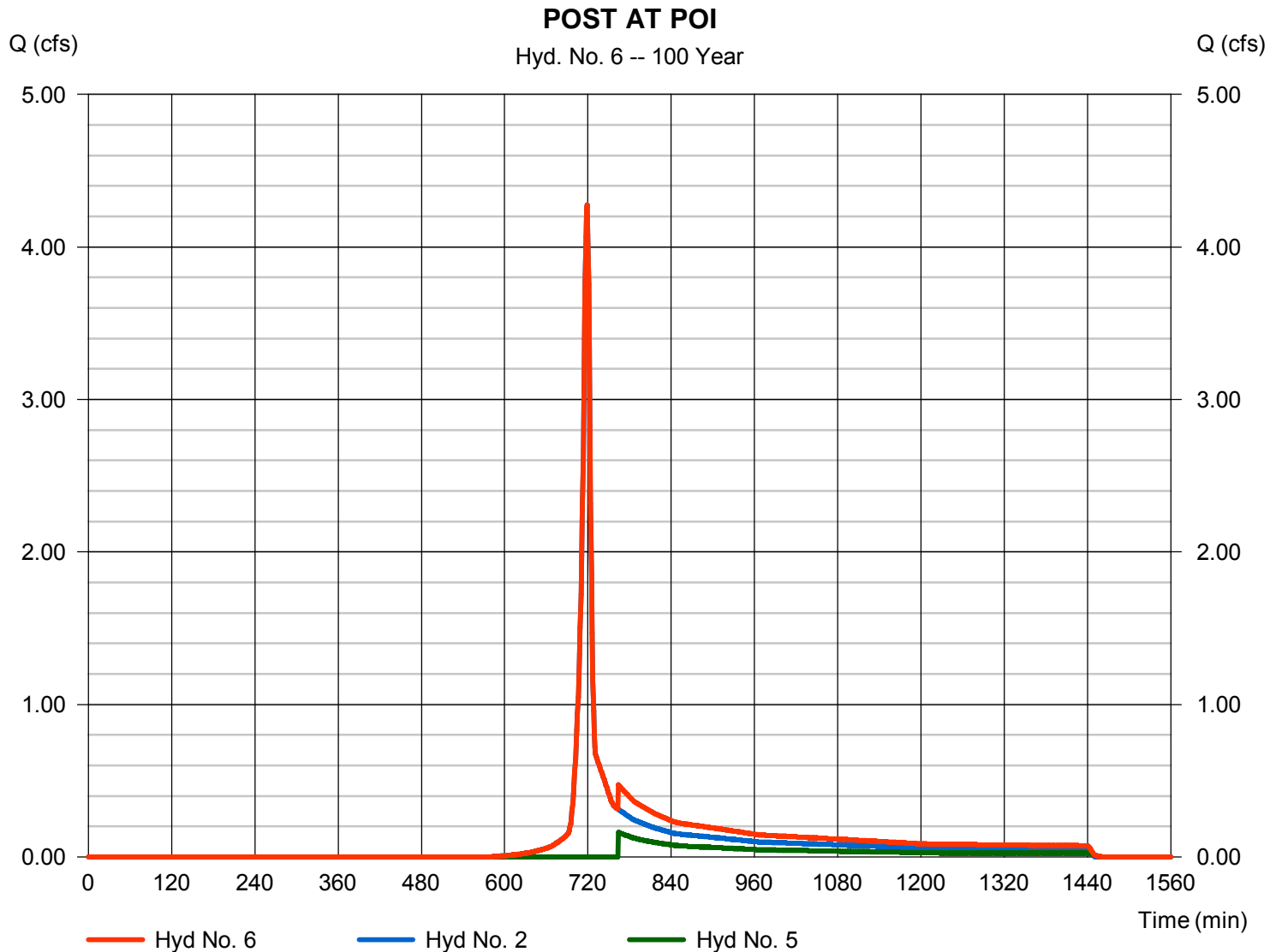
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 5

Peak discharge = 4.274 cfs  
Time to peak = 719 min  
Hyd. volume = 10,877 cuft  
Contrib. drain. area = 0.810 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 50.3708  | 12.2000 | 0.8733 | ----- |
| 2                   | 59.4413  | 12.4000 | 0.8656 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 61.3314  | 12.3000 | 0.8243 | ----- |
| 10                  | 59.5209  | 11.8000 | 0.7882 | ----- |
| 25                  | 54.1828  | 10.8000 | 0.7356 | ----- |
| 50                  | 51.2143  | 10.3000 | 0.7008 | ----- |
| 100                 | 44.0384  | 8.9000  | 0.6485 | ----- |

File name: Exton IDF.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.20                     | 3.36 | 2.81 | 2.43 | 2.14 | 1.92 | 1.74 | 1.59 | 1.47 | 1.37 | 1.28 | 1.20 |
| 2                   | 5.02                     | 4.03 | 3.39 | 2.93 | 2.59 | 2.32 | 2.11 | 1.93 | 1.78 | 1.66 | 1.55 | 1.46 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.85                     | 4.75 | 4.02 | 3.50 | 3.11 | 2.80 | 2.55 | 2.35 | 2.18 | 2.03 | 1.91 | 1.80 |
| 10                  | 6.44                     | 5.25 | 4.46 | 3.90 | 3.47 | 3.14 | 2.87 | 2.65 | 2.47 | 2.31 | 2.17 | 2.05 |
| 25                  | 7.11                     | 5.81 | 4.96 | 4.35 | 3.90 | 3.54 | 3.25 | 3.01 | 2.81 | 2.64 | 2.49 | 2.36 |
| 50                  | 7.57                     | 6.21 | 5.32 | 4.69 | 4.21 | 3.84 | 3.54 | 3.29 | 3.08 | 2.90 | 2.74 | 2.60 |
| 100                 | 7.99                     | 6.55 | 5.62 | 4.97 | 4.48 | 4.10 | 3.79 | 3.53 | 3.32 | 3.13 | 2.97 | 2.83 |

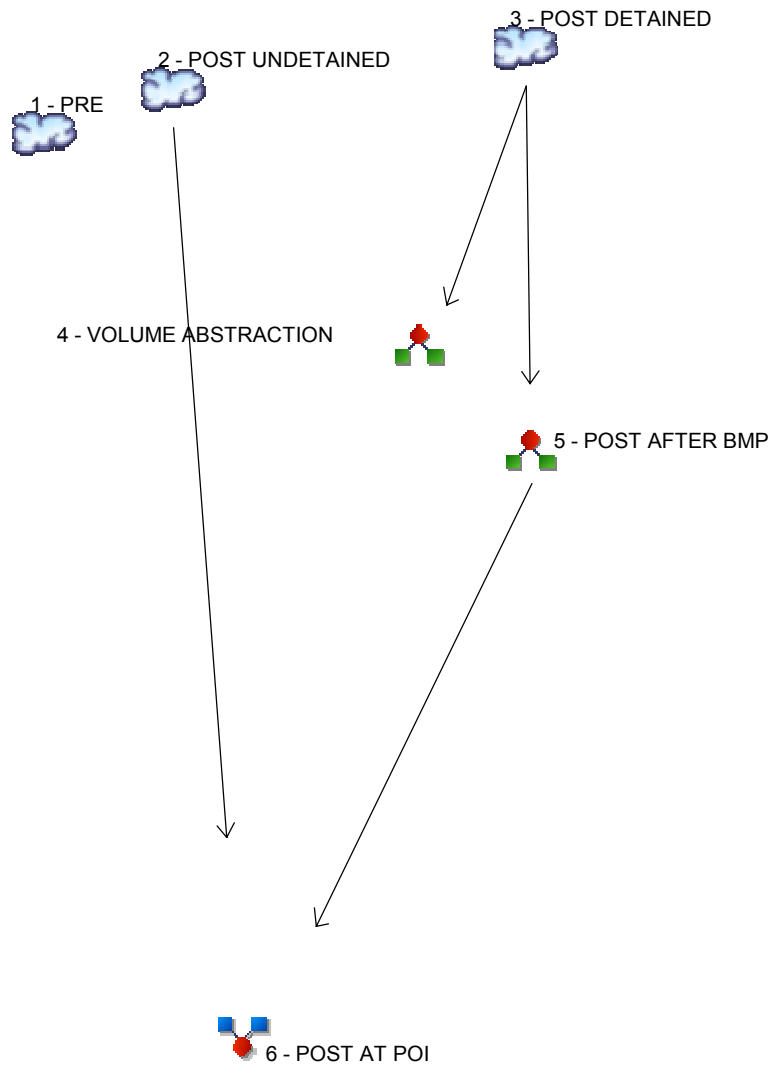
T<sub>c</sub> = time in minutes. Values may exceed 60.

07 PCSM\Attachment 4 - Stormwater Calcs\East Lincoln Highway (Exton Junction)\Hydraflow Rev 1\Exton Precip.pci

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.70                              | 3.25 | 0.00 | 4.07 | 4.75  | 5.74  | 6.57  | 7.46   |
| SCS 6-Hr           | 1.92                              | 2.31 | 0.00 | 2.88 | 3.33  | 3.95  | 4.46  | 4.98   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. Origin  | Description        |
|--------------|--------------------|
| 1 SCS Runoff | PRE                |
| 2 SCS Runoff | POST UNDETAINED    |
| 3 SCS Runoff | POST DETAINED      |
| 4 Diversion1 | VOLUME ABSTRACTION |
| 5 Diversion2 | POST AFTER BMP     |
| 6 Combine    | POST AT POI        |

# 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               | -----         | -----              | 0.700 | ----- | ----- | ----- | ----- | ----- | -----  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | 0.559 | ----- | ----- | ----- | ----- | ----- | -----  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | 0.119 | ----- | ----- | ----- | ----- | ----- | -----  | POST DETAINED          |
| 4        | Diversion1               | 3             | -----              | 0.119 | ----- | ----- | ----- | ----- | ----- | -----  | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 3             | -----              | 0.000 | ----- | ----- | ----- | ----- | ----- | -----  | POST AFTER BMP         |
| 6        | Combine                  | 2, 5          | -----              | 0.559 | ----- | ----- | ----- | ----- | ----- | -----  | POST AT POI            |

# 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               | 0.700           | 1                   | 720                | 1,874              | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 0.559           | 1                   | 720                | 1,441              | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.119           | 1                   | 756                | 968                | -----         | -----                  | -----                   | POST DETAINED          |
| 4        | Diversion1               | 0.119           | 1                   | 756                | 968                | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 0.000           | 1                   | n/a                | 0                  | 3             | -----                  | -----                   | POST AFTER BMP         |
| 6        | Combine                  | 0.559           | 1                   | 720                | 1,441              | 2, 5          | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

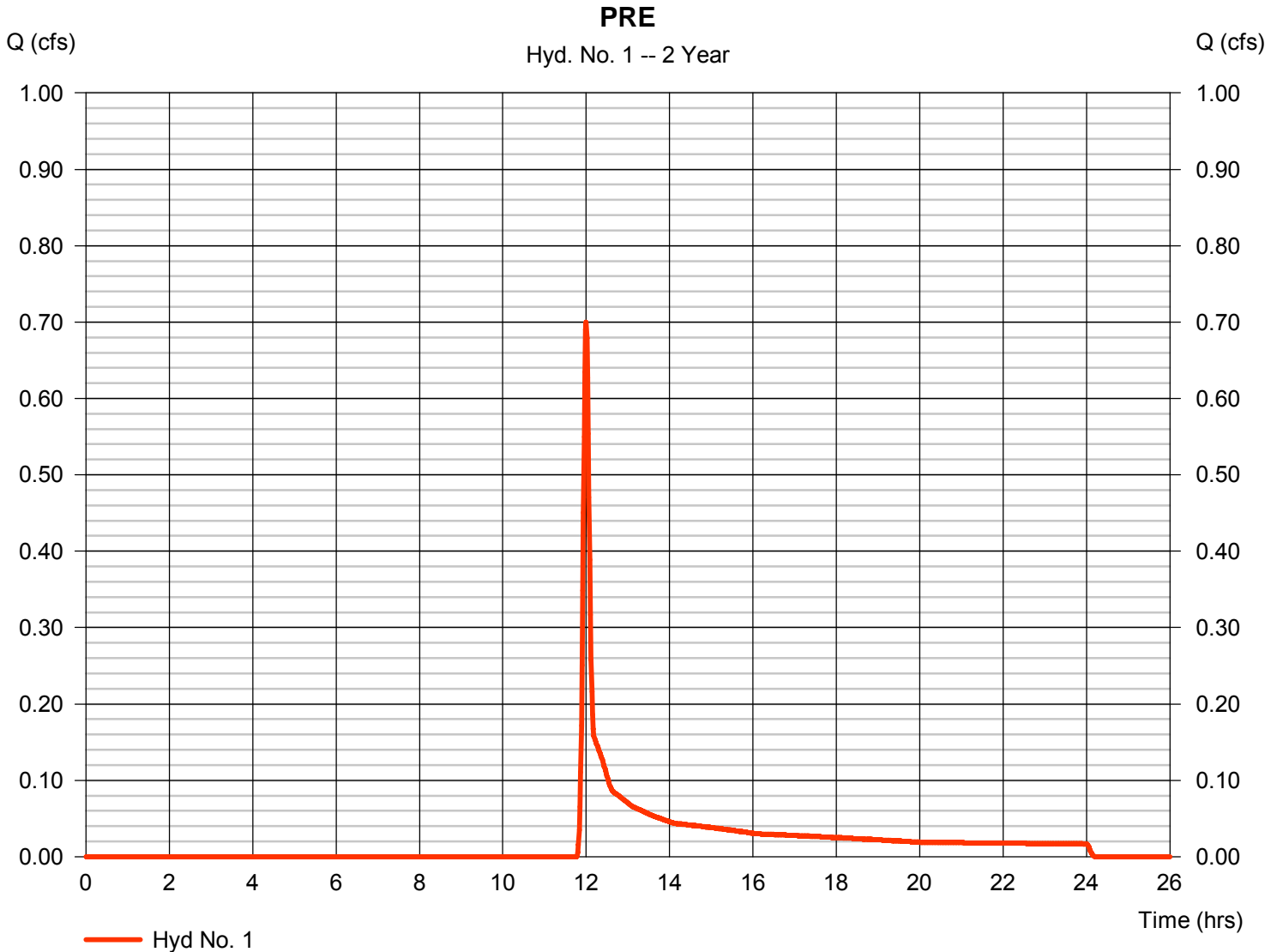
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.700 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 12.00 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 1,874 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 6.80        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>4.98</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 654.00      |          | 0.00        |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 5.14        |          | 0.00        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                 |
| Average velocity (ft/s)            | =3.66         |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>2.98</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

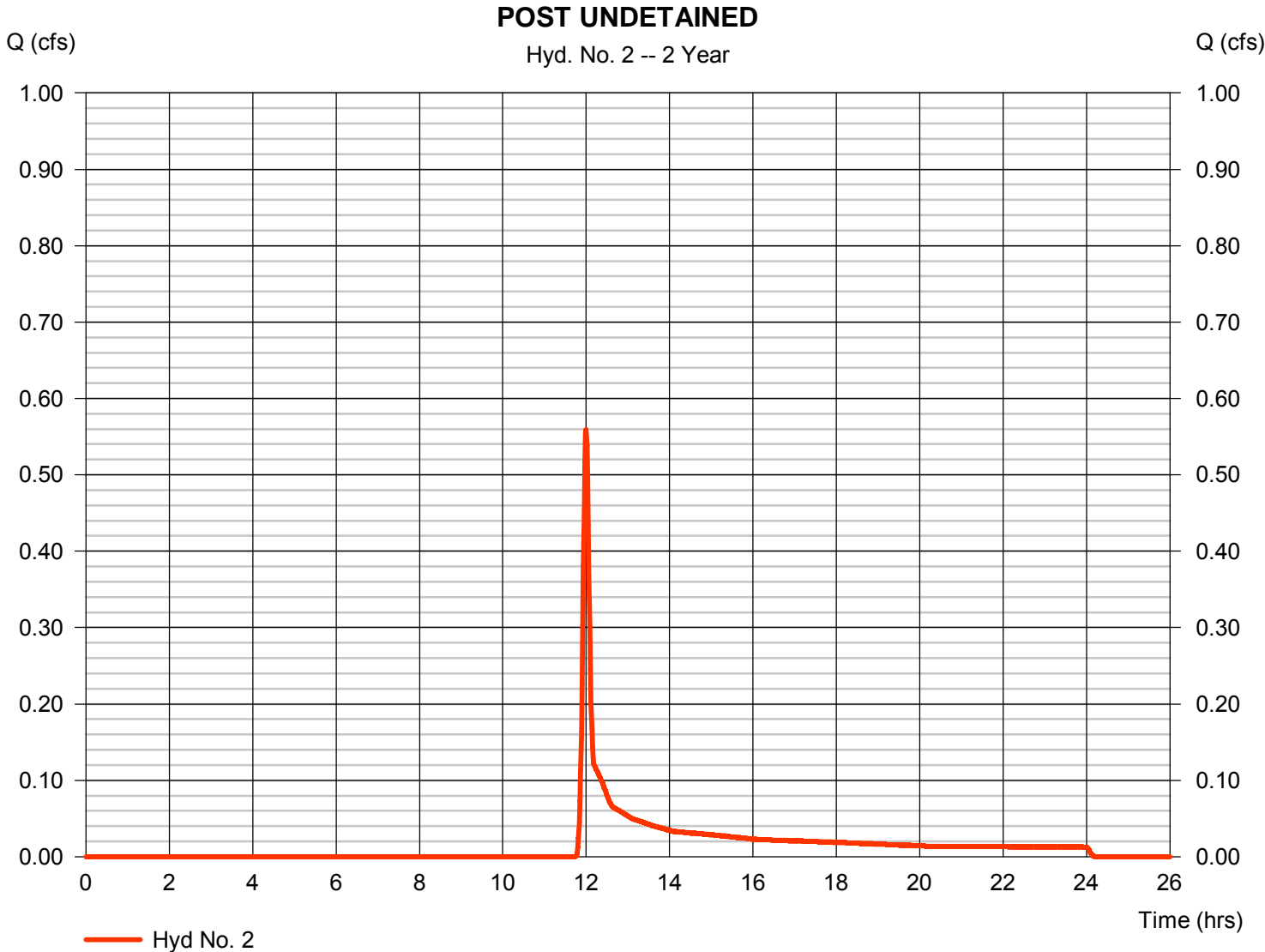
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.559 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 12.00 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 1,441 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                 |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 6.80        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 654.00      | 0.00          | 0.00          |                 |
| Watercourse slope (%)              | = 5.14        | 0.00          | 0.00          |                 |
| Surface description                | = Unpaved     | Paved         | Paved         |                 |
| Average velocity (ft/s)            | =3.66         | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| 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           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>8.00 min</b> |

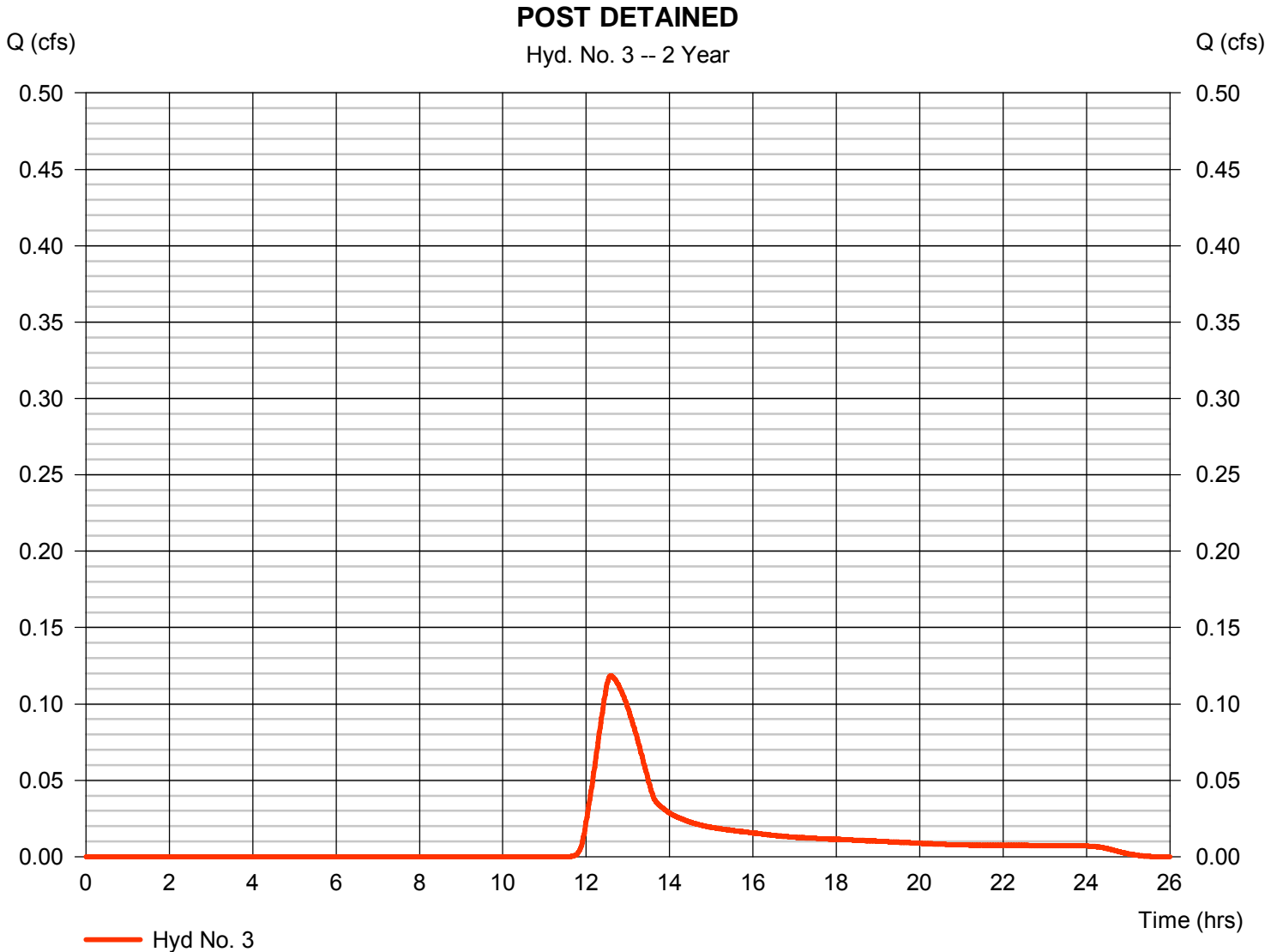
# Hydrograph Report

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.119 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 12.60 hrs |
| Time interval   | = 1 min      | Hyd. volume        | = 968 cuft  |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 65.00 min |
| Total precip.   | = 3.25 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

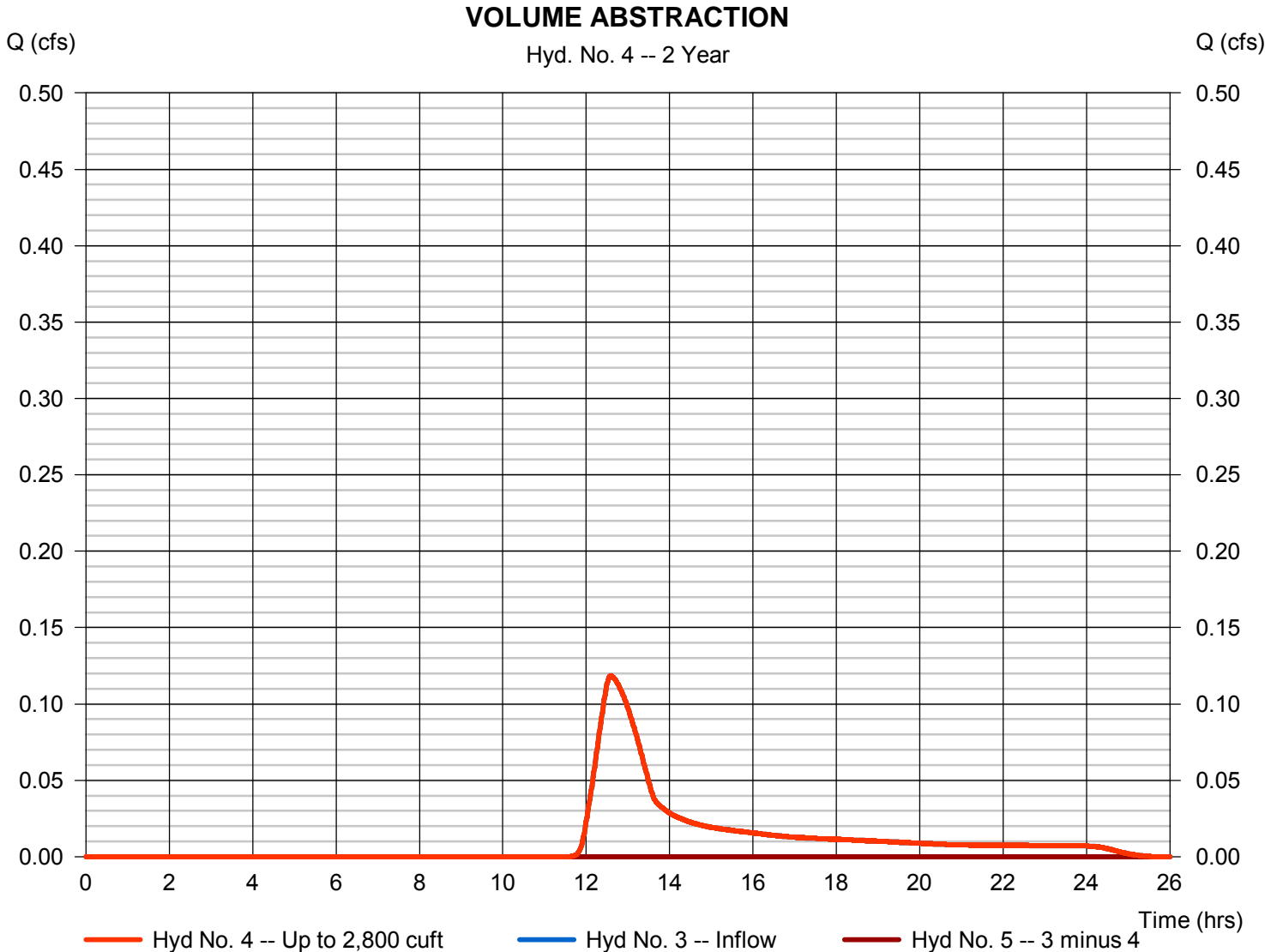
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.119 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 12.60 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 968 cuft   |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

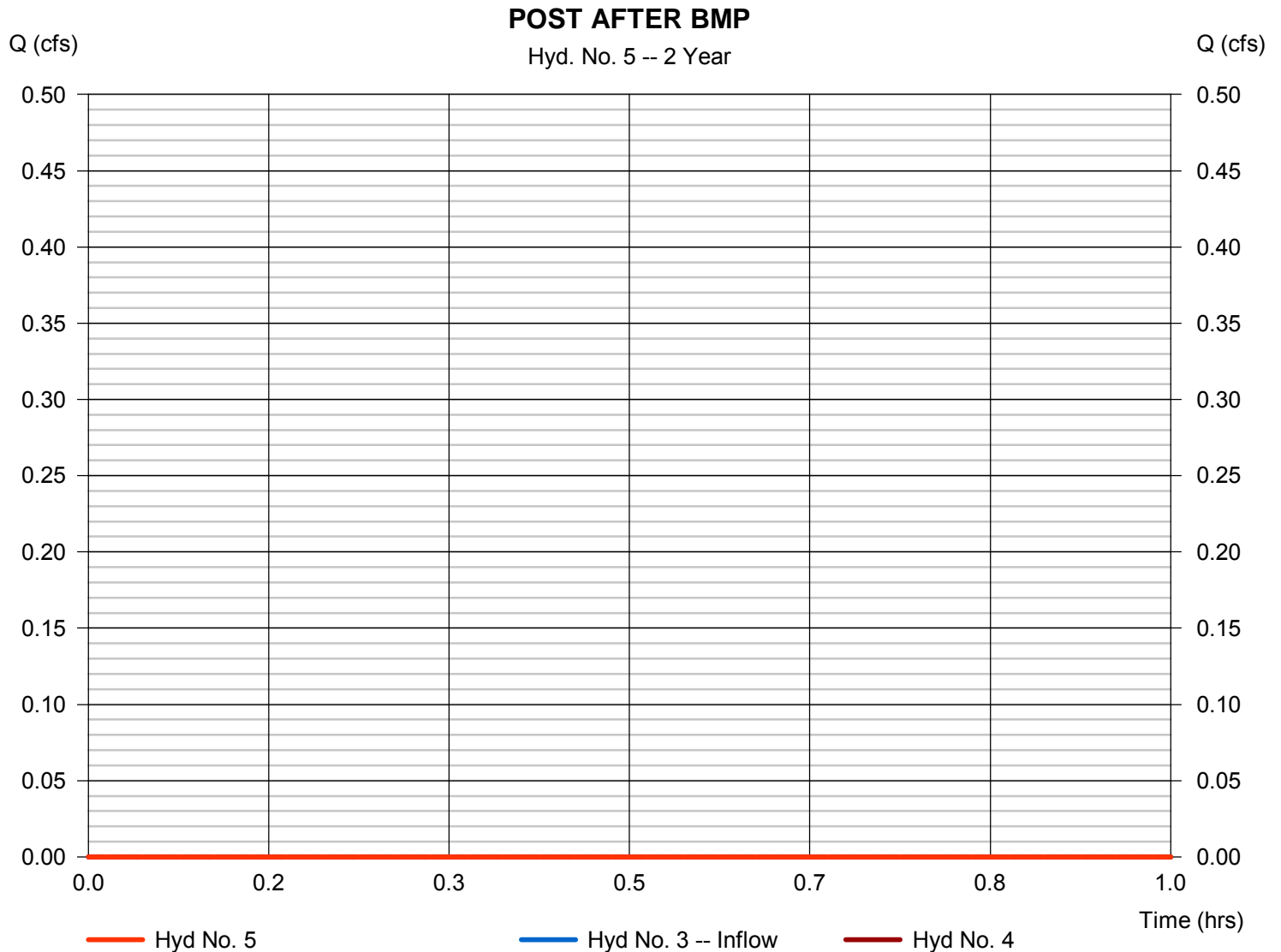
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

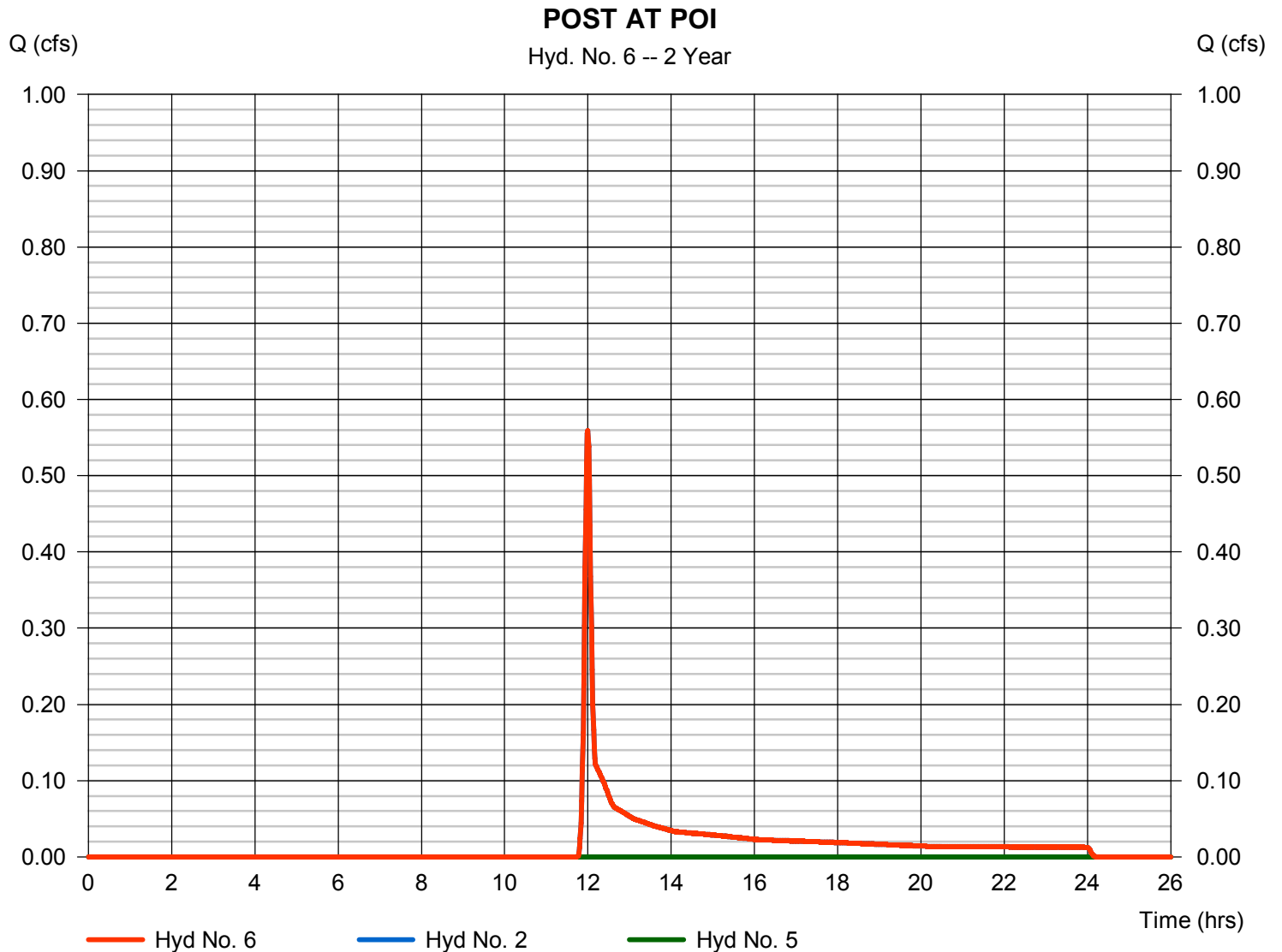
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

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

Peak discharge = 0.559 cfs  
Time to peak = 12.00 hrs  
Hyd. volume = 1,441 cuft  
Contrib. drain. area = 0.810 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 50.3708  | 12.2000 | 0.8733 | ----- |
| 2                   | 59.4413  | 12.4000 | 0.8656 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 61.3314  | 12.3000 | 0.8243 | ----- |
| 10                  | 59.5209  | 11.8000 | 0.7882 | ----- |
| 25                  | 54.1828  | 10.8000 | 0.7356 | ----- |
| 50                  | 51.2143  | 10.3000 | 0.7008 | ----- |
| 100                 | 44.0384  | 8.9000  | 0.6485 | ----- |

File name: Exton IDF.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.20                     | 3.36 | 2.81 | 2.43 | 2.14 | 1.92 | 1.74 | 1.59 | 1.47 | 1.37 | 1.28 | 1.20 |
| 2                   | 5.02                     | 4.03 | 3.39 | 2.93 | 2.59 | 2.32 | 2.11 | 1.93 | 1.78 | 1.66 | 1.55 | 1.46 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.85                     | 4.75 | 4.02 | 3.50 | 3.11 | 2.80 | 2.55 | 2.35 | 2.18 | 2.03 | 1.91 | 1.80 |
| 10                  | 6.44                     | 5.25 | 4.46 | 3.90 | 3.47 | 3.14 | 2.87 | 2.65 | 2.47 | 2.31 | 2.17 | 2.05 |
| 25                  | 7.11                     | 5.81 | 4.96 | 4.35 | 3.90 | 3.54 | 3.25 | 3.01 | 2.81 | 2.64 | 2.49 | 2.36 |
| 50                  | 7.57                     | 6.21 | 5.32 | 4.69 | 4.21 | 3.84 | 3.54 | 3.29 | 3.08 | 2.90 | 2.74 | 2.60 |
| 100                 | 7.99                     | 6.55 | 5.62 | 4.97 | 4.48 | 4.10 | 3.79 | 3.53 | 3.32 | 3.13 | 2.97 | 2.83 |

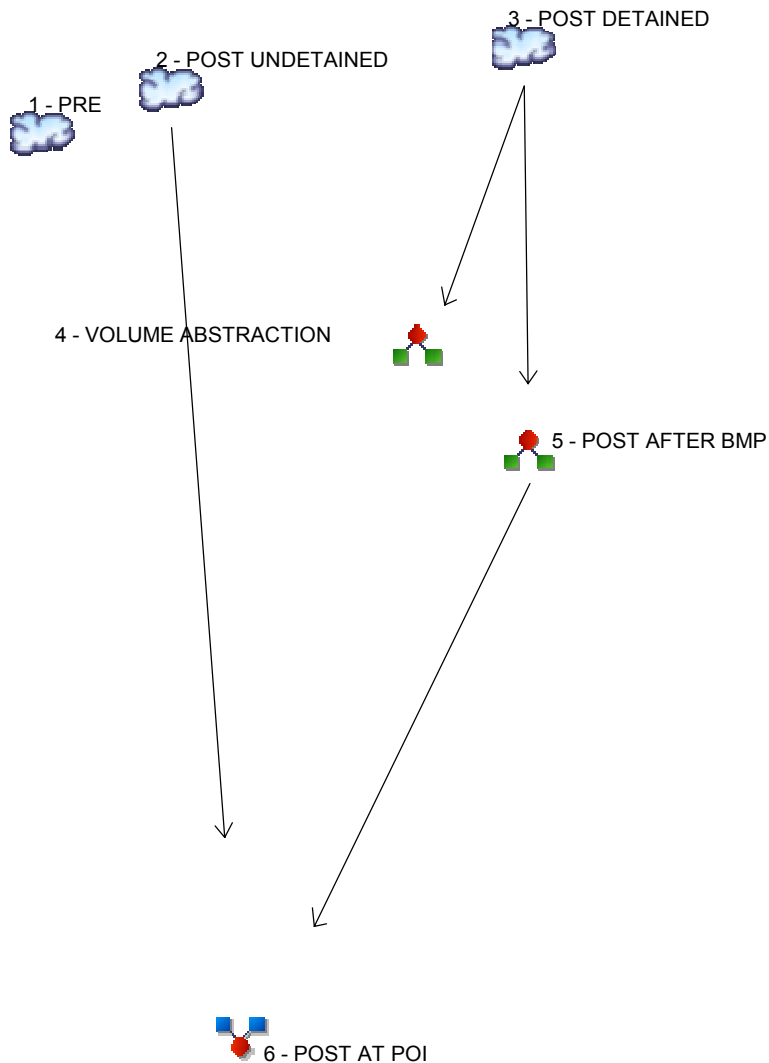
T<sub>c</sub> = time in minutes. Values may exceed 60.

07 PCSM\Attachment 4 - Stormwater Calcs\East Lincoln Highway (Exton Junction)\Hydraflow Rev 1\Exton Precip.pci

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.70                              | 3.25 | 0.00 | 4.07 | 4.75  | 5.74  | 6.57  | 7.46   |
| SCS 6-Hr           | 1.92                              | 2.31 | 0.00 | 2.88 | 3.33  | 3.95  | 4.46  | 4.98   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. Origin  | Description        |
|--------------|--------------------|
| 1 SCS Runoff | PRE                |
| 2 SCS Runoff | POST UNDETAINED    |
| 3 SCS Runoff | POST DETAINED      |
| 4 Diversion1 | VOLUME ABSTRACTION |
| 5 Diversion2 | POST AFTER BMP     |
| 6 Combine    | POST AT POI        |

# 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               | ----          | ----               | ---- | ---- | ---- | 2.247 | ----  | ----  | ----   | PRE                    |
| 2        | SCS Runoff               | ----          | ----               | ---- | ---- | ---- | 1.696 | ----  | ----  | ----   | POST UNDETAINED        |
| 3        | SCS Runoff               | ----          | ----               | ---- | ---- | ---- | 0.307 | ----  | ----  | ----   | POST DETAINED          |
| 4        | Diversion1               | 3             | ----               | ---- | ---- | ---- | 0.307 | ----  | ----  | ----   | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 3             | ----               | ---- | ---- | ---- | 0.000 | ----  | ----  | ----   | POST AFTER BMP         |
| 6        | Combine                  | 2, 5          | ----               | ---- | ---- | ---- | 1.696 | ----  | ----  | ----   | POST AT POI            |

# 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               | 2.247           | 1                   | 719                | 4,929              | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 1.696           | 1                   | 719                | 3,688              | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.307           | 1                   | 752                | 2,137              | -----         | -----                  | -----                   | POST DETAINED          |
| 4        | Diversion1               | 0.307           | 1                   | 752                | 2,137              | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 0.000           | 1                   | n/a                | 0                  | 3             | -----                  | -----                   | POST AFTER BMP         |
| 6        | Combine                  | 1.696           | 1                   | 719                | 3,688              | 2, 5          | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

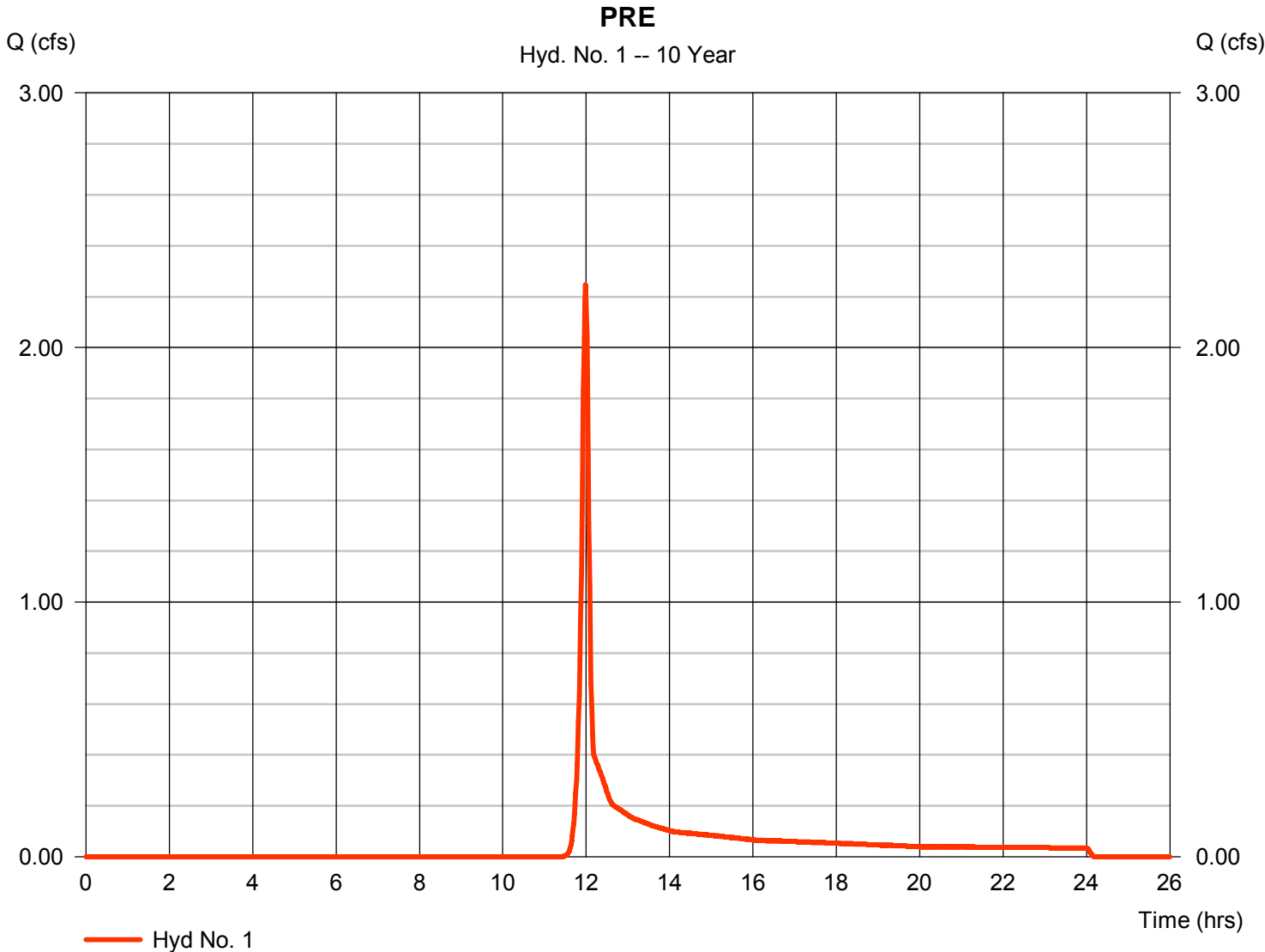
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.247 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 11.98 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 4,929 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 6.80        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 654.00      | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 5.14        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =3.66         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

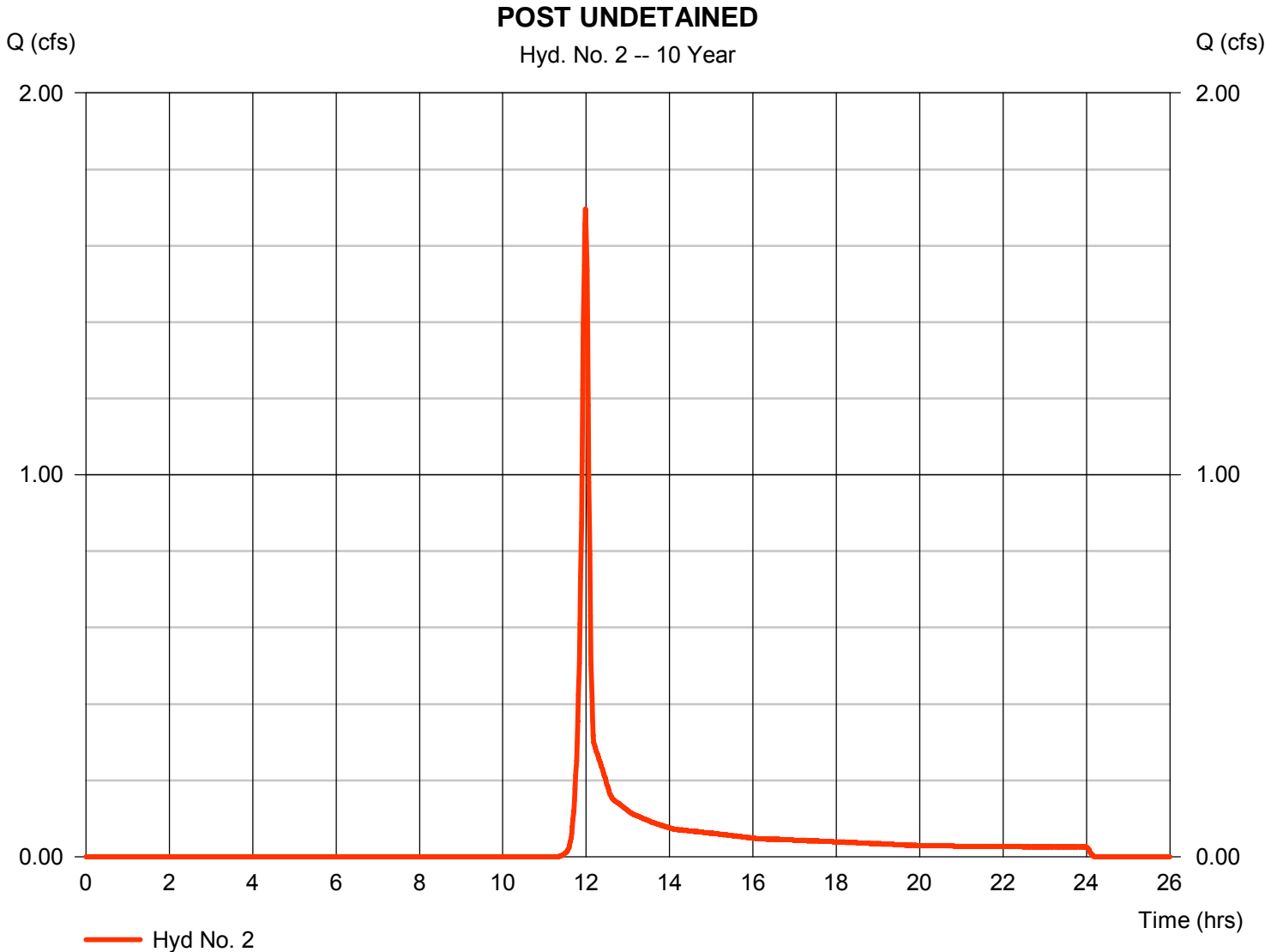
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.696 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 11.98 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 3,688 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 6.80        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 654.00      | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 5.14        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =3.66         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

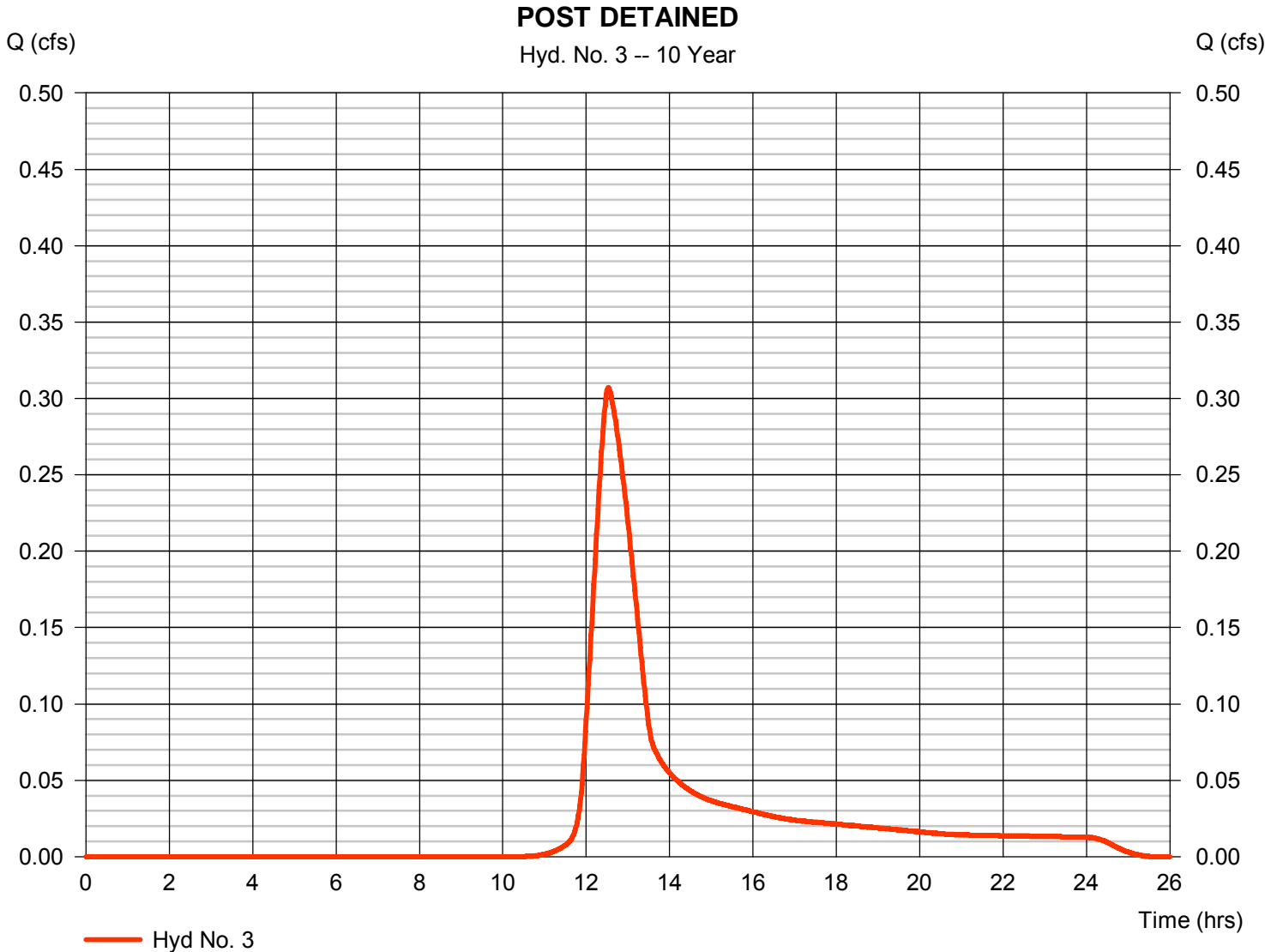
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.307 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 12.53 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 2,137 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 61.89 min  |
| Total precip.   | = 4.75 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

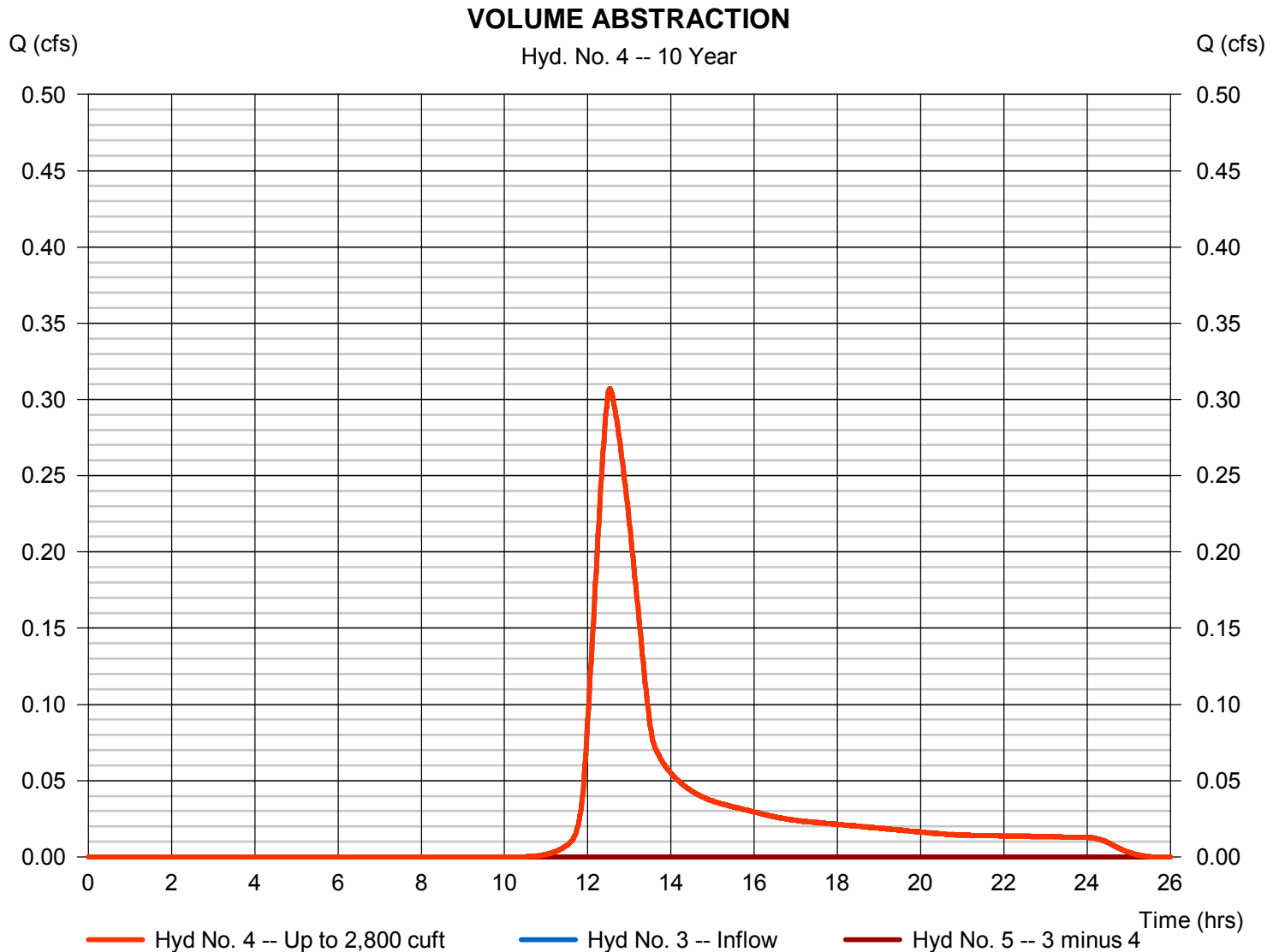
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.307 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 12.53 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 2,137 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

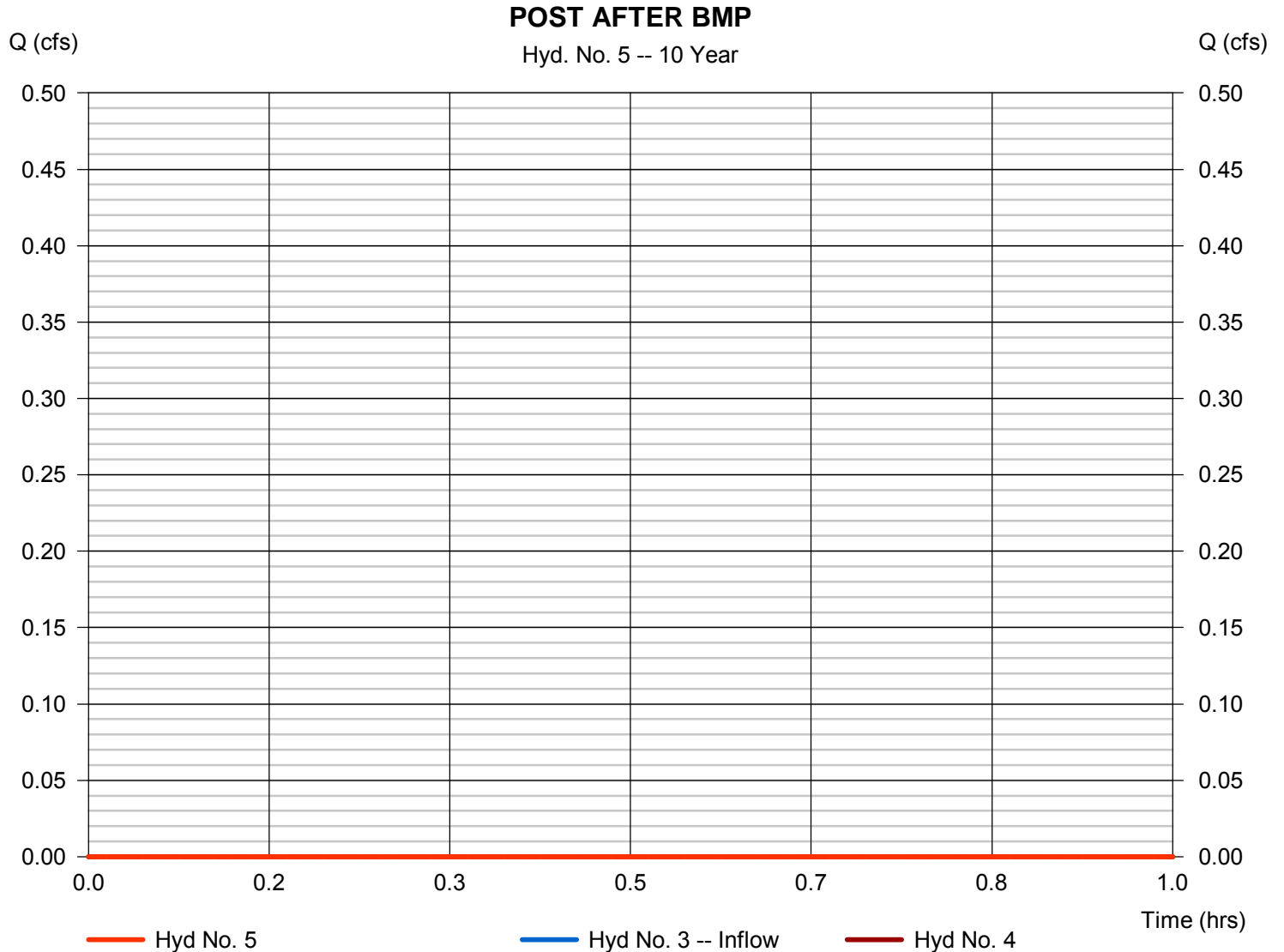
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.000 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = n/a        |
| Time interval     | = 1 min              | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

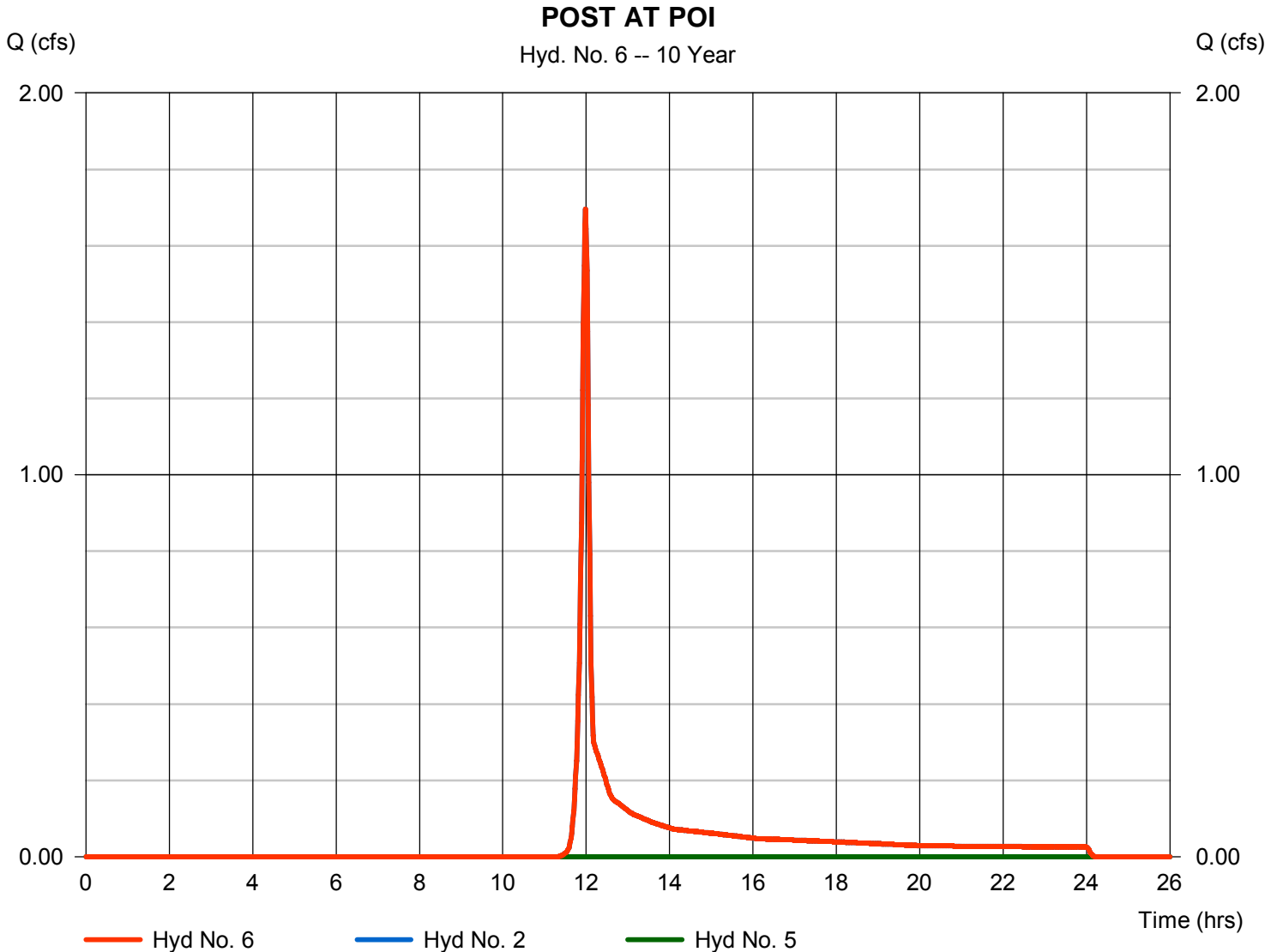
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 1.696 cfs  |
| Storm frequency | = 10 yrs  | Time to peak         | = 11.98 hrs  |
| Time interval   | = 1 min   | Hyd. volume          | = 3,688 cuft |
| Inflow hyds.    | = 2, 5    | Contrib. drain. area | = 0.810 ac   |



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 50.3708  | 12.2000 | 0.8733 | ----- |
| 2                   | 59.4413  | 12.4000 | 0.8656 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 61.3314  | 12.3000 | 0.8243 | ----- |
| 10                  | 59.5209  | 11.8000 | 0.7882 | ----- |
| 25                  | 54.1828  | 10.8000 | 0.7356 | ----- |
| 50                  | 51.2143  | 10.3000 | 0.7008 | ----- |
| 100                 | 44.0384  | 8.9000  | 0.6485 | ----- |

File name: Exton IDF.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.20                     | 3.36 | 2.81 | 2.43 | 2.14 | 1.92 | 1.74 | 1.59 | 1.47 | 1.37 | 1.28 | 1.20 |
| 2                   | 5.02                     | 4.03 | 3.39 | 2.93 | 2.59 | 2.32 | 2.11 | 1.93 | 1.78 | 1.66 | 1.55 | 1.46 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.85                     | 4.75 | 4.02 | 3.50 | 3.11 | 2.80 | 2.55 | 2.35 | 2.18 | 2.03 | 1.91 | 1.80 |
| 10                  | 6.44                     | 5.25 | 4.46 | 3.90 | 3.47 | 3.14 | 2.87 | 2.65 | 2.47 | 2.31 | 2.17 | 2.05 |
| 25                  | 7.11                     | 5.81 | 4.96 | 4.35 | 3.90 | 3.54 | 3.25 | 3.01 | 2.81 | 2.64 | 2.49 | 2.36 |
| 50                  | 7.57                     | 6.21 | 5.32 | 4.69 | 4.21 | 3.84 | 3.54 | 3.29 | 3.08 | 2.90 | 2.74 | 2.60 |
| 100                 | 7.99                     | 6.55 | 5.62 | 4.97 | 4.48 | 4.10 | 3.79 | 3.53 | 3.32 | 3.13 | 2.97 | 2.83 |

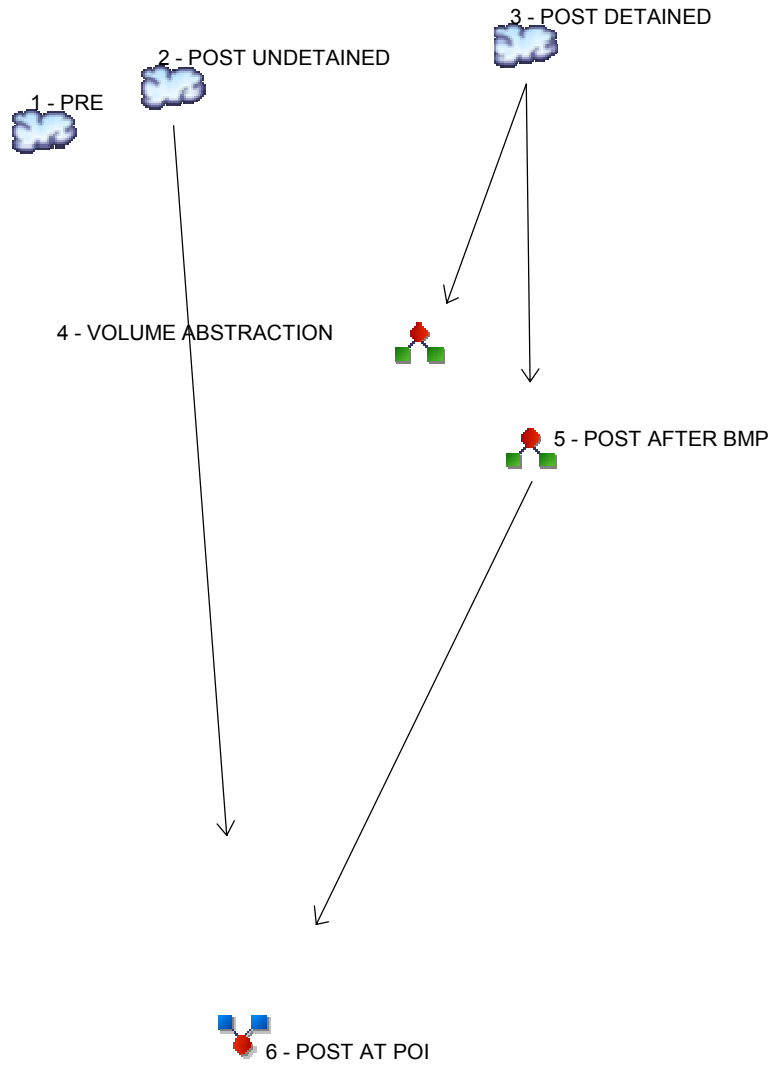
T<sub>c</sub> = time in minutes. Values may exceed 60.

07 PCSM\Attachment 4 - Stormwater Calcs\East Lincoln Highway (Exton Junction)\Hydraflow Rev 1\Exton Precip.pci

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.70                              | 3.25 | 0.00 | 4.07 | 4.75  | 5.74  | 6.57  | 7.46   |
| SCS 6-Hr           | 1.92                              | 2.31 | 0.00 | 2.88 | 3.33  | 3.95  | 4.46  | 4.98   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. Origin | Description                   |
|-------------|-------------------------------|
| 1           | SCS Runoff PRE                |
| 2           | SCS Runoff POST UNDETAINED    |
| 3           | SCS Runoff POST DETAINED      |
| 4           | Diversion1 VOLUME ABSTRACTION |
| 5           | Diversion2 POST AFTER BMP     |
| 6           | Combine POST AT POI           |

# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 4.571 | -----  | PRE                    |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 3.379 | -----  | POST UNDETAINED        |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 0.678 | -----  | POST DETAINED          |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 0.678 | -----  | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 0.054 | -----  | POST AFTER BMP         |
| 6        | Combine                  | 2, 5          | -----              | ----- | ----- | ----- | ----- | ----- | 3.379 | -----  | POST AT POI            |

# 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               | 4.571           | 1                   | 719                | 9,668              | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 3.379           | 1                   | 719                | 7,136              | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.678           | 1                   | 743                | 3,775              | -----         | -----                  | -----                   | POST DETAINED          |
| 4        | Diversion1               | 0.678           | 1                   | 743                | 2,800              | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 0.054           | 1                   | 912                | 974                | 3             | -----                  | -----                   | POST AFTER BMP         |
| 6        | Combine                  | 3.379           | 1                   | 719                | 8,111              | 2, 5          | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

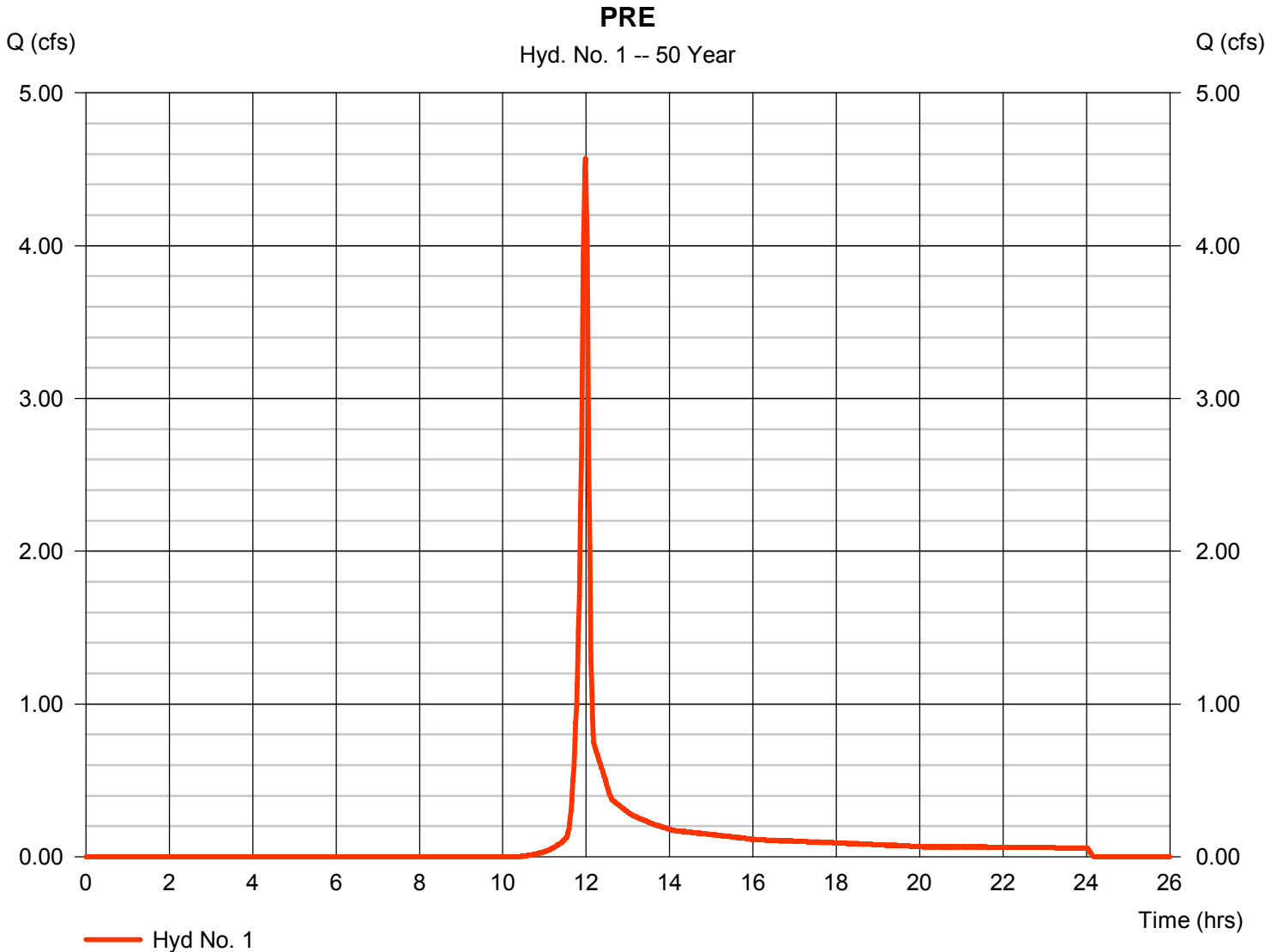
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.571 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.98 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 9,668 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.011                | 0.011                |                 |
| Flow length (ft)                   | = 50.0        | 0.0                  | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 6.80        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 654.00      | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 5.14        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =3.66         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

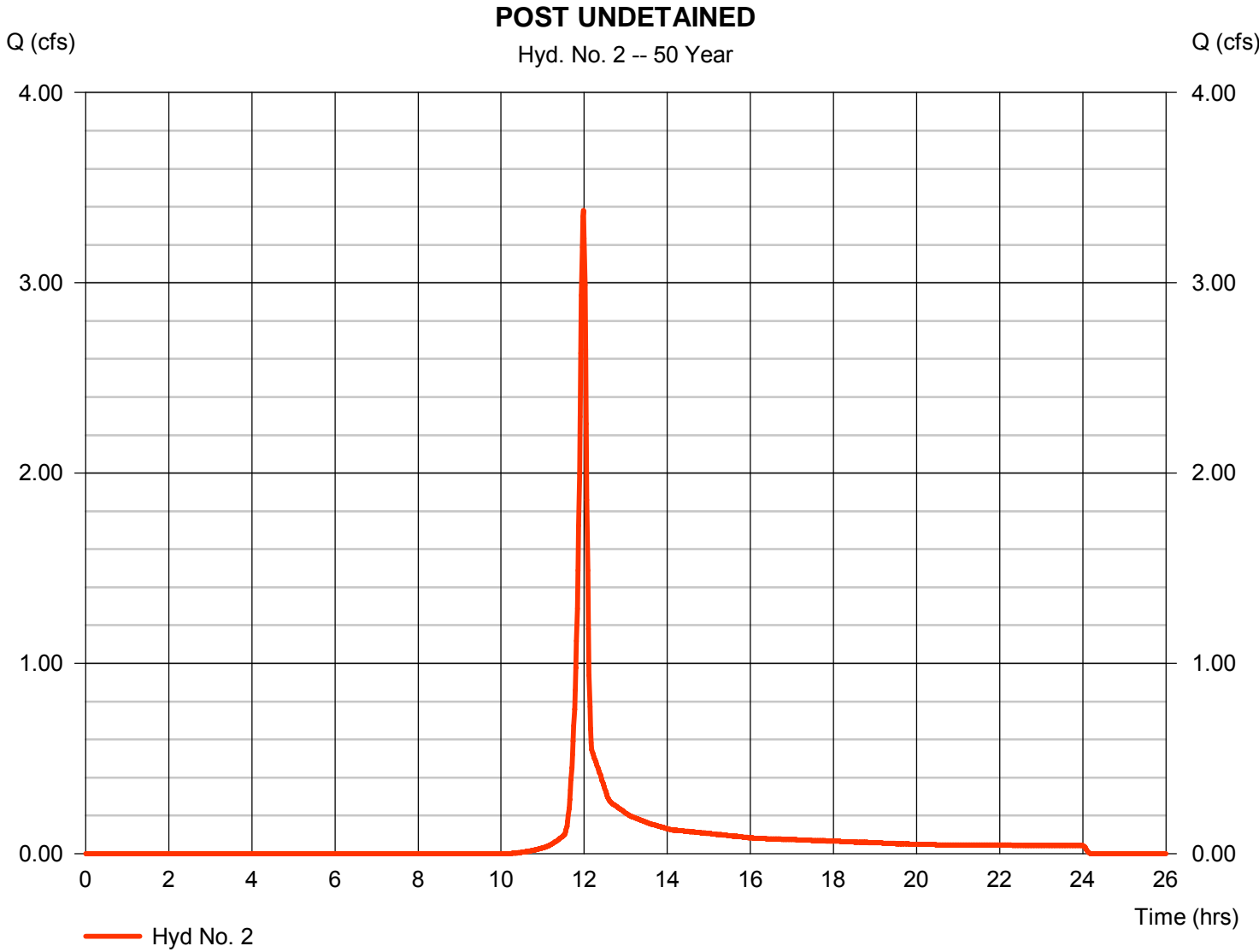
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.379 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.98 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 7,136 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                 |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 6.80        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 654.00      | 0.00          | 0.00          |                 |
| Watercourse slope (%)              | = 5.14        | 0.00          | 0.00          |                 |
| Surface description                | = Unpaved     | Paved         | Paved         |                 |
| Average velocity (ft/s)            | =3.66         | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| 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           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

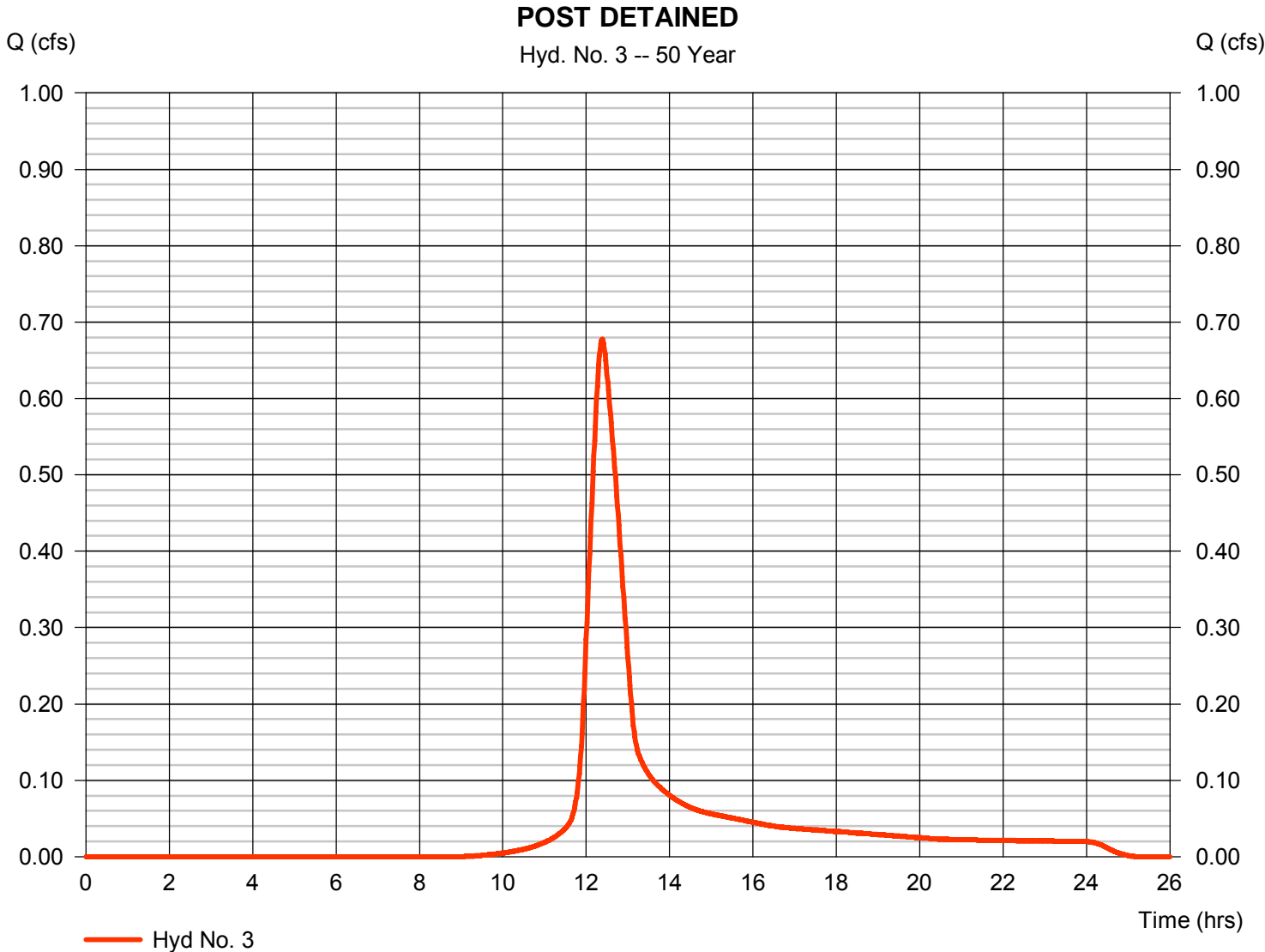
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.678 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 12.38 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 3,775 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 48.76 min  |
| Total precip.   | = 6.57 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

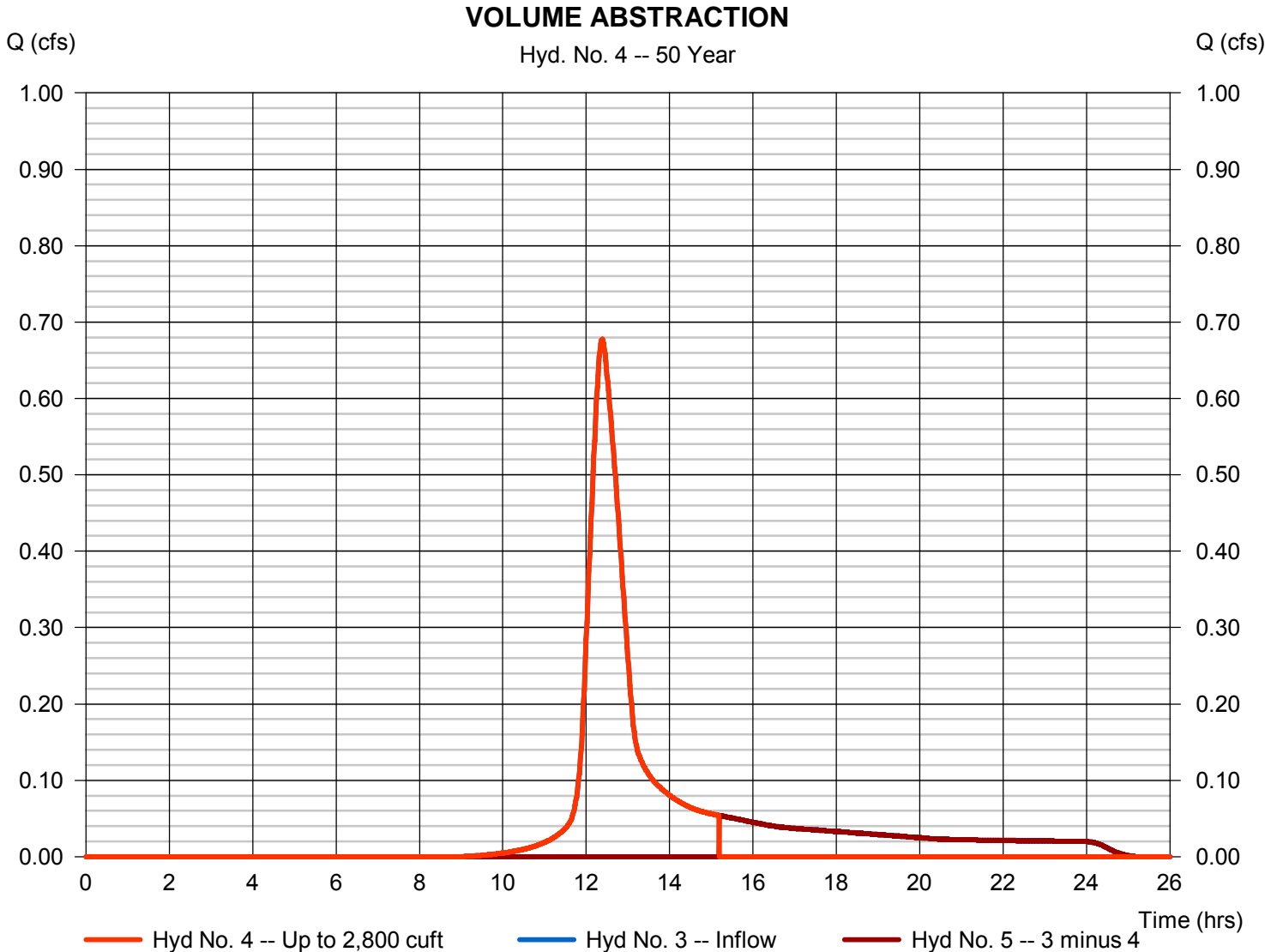
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.678 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 12.38 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 2,800 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

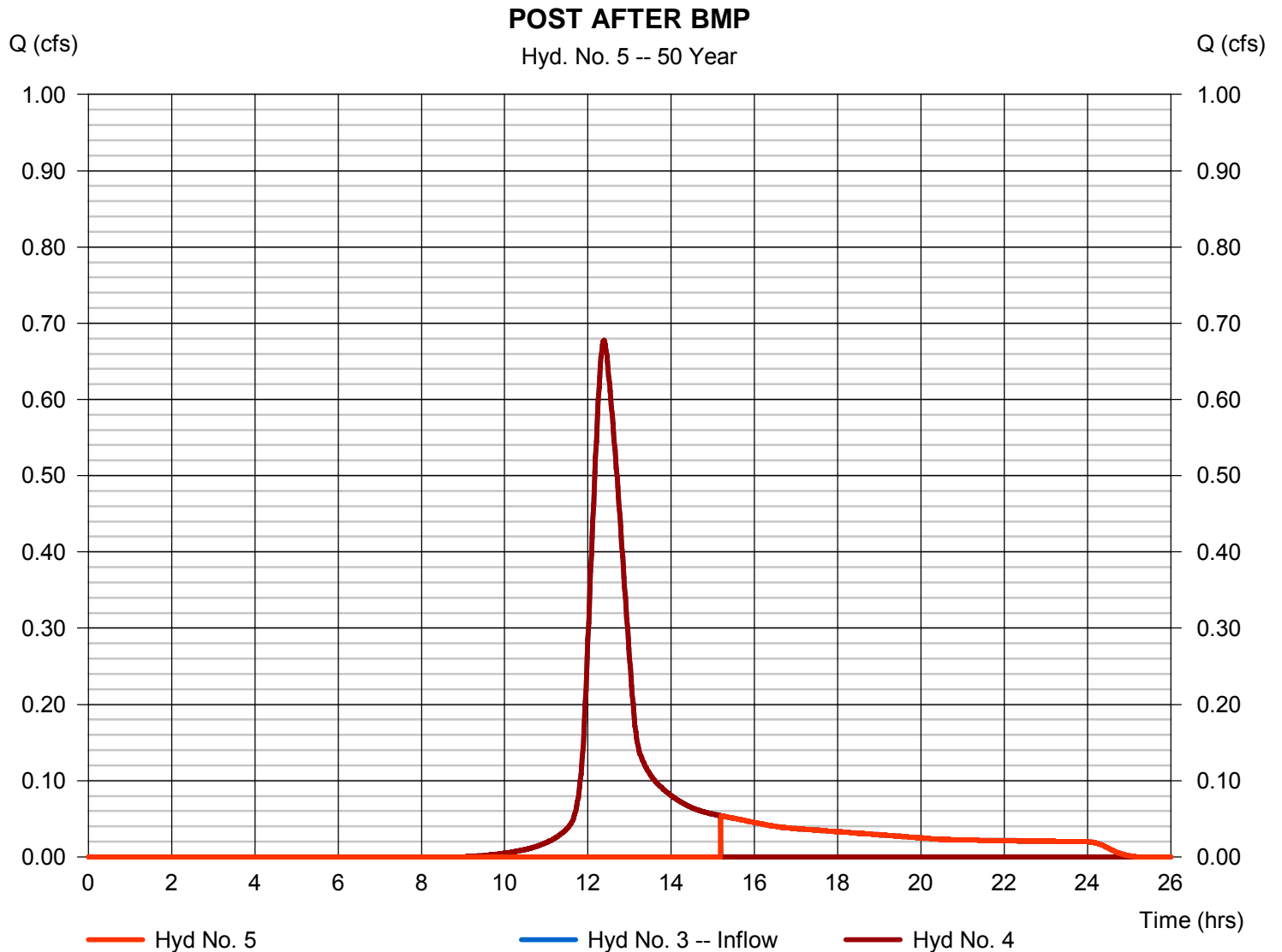
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

### POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.054 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 15.20 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 974 cuft   |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

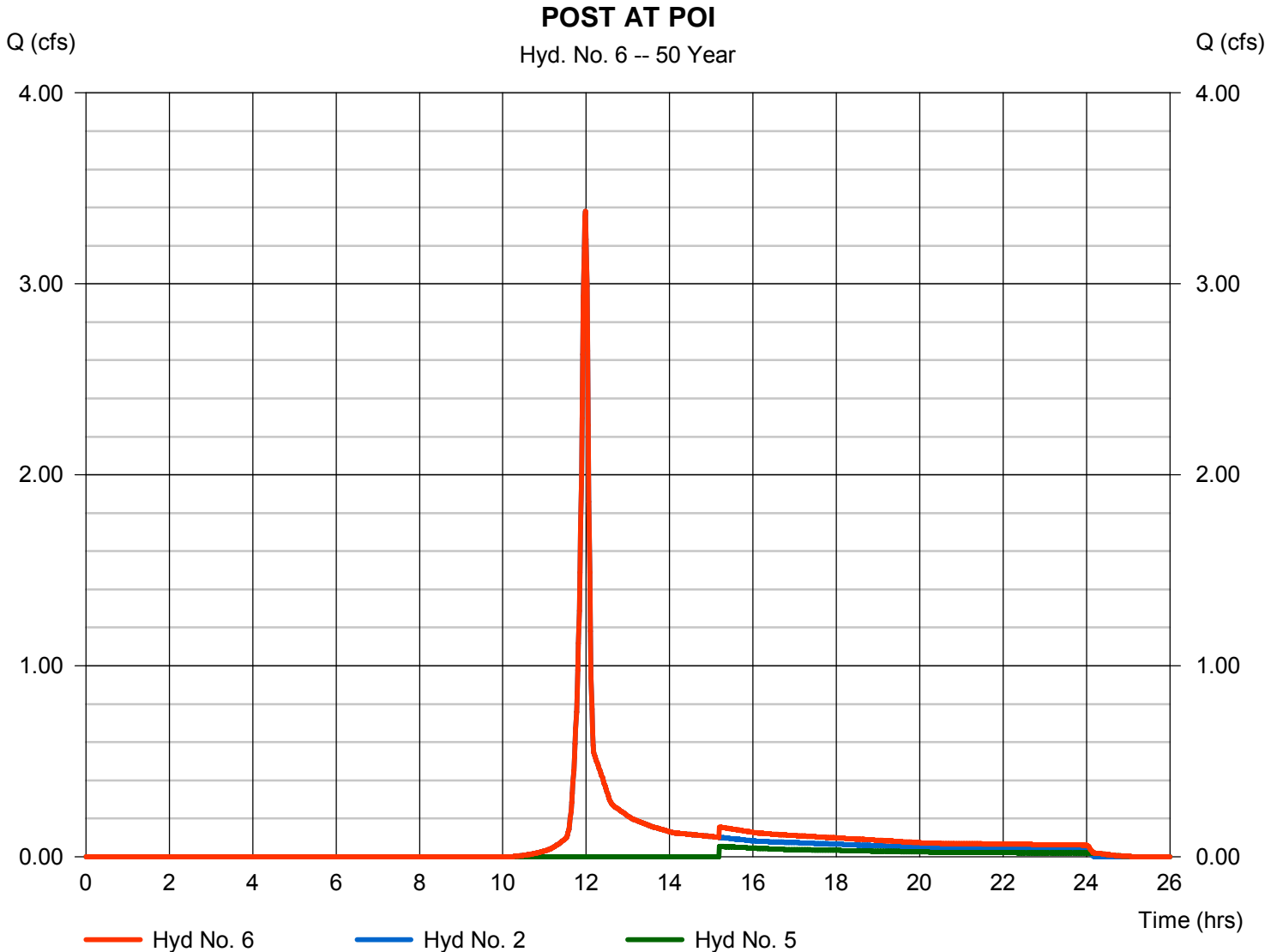
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 3.379 cfs  |
| Storm frequency | = 50 yrs  | Time to peak         | = 11.98 hrs  |
| Time interval   | = 1 min   | Hyd. volume          | = 8,111 cuft |
| Inflow hyds.    | = 2, 5    | Contrib. drain. area | = 0.810 ac   |



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 50.3708  | 12.2000 | 0.8733 | ----- |
| 2                   | 59.4413  | 12.4000 | 0.8656 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 61.3314  | 12.3000 | 0.8243 | ----- |
| 10                  | 59.5209  | 11.8000 | 0.7882 | ----- |
| 25                  | 54.1828  | 10.8000 | 0.7356 | ----- |
| 50                  | 51.2143  | 10.3000 | 0.7008 | ----- |
| 100                 | 44.0384  | 8.9000  | 0.6485 | ----- |

File name: Exton IDF.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.20                     | 3.36 | 2.81 | 2.43 | 2.14 | 1.92 | 1.74 | 1.59 | 1.47 | 1.37 | 1.28 | 1.20 |
| 2                   | 5.02                     | 4.03 | 3.39 | 2.93 | 2.59 | 2.32 | 2.11 | 1.93 | 1.78 | 1.66 | 1.55 | 1.46 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.85                     | 4.75 | 4.02 | 3.50 | 3.11 | 2.80 | 2.55 | 2.35 | 2.18 | 2.03 | 1.91 | 1.80 |
| 10                  | 6.44                     | 5.25 | 4.46 | 3.90 | 3.47 | 3.14 | 2.87 | 2.65 | 2.47 | 2.31 | 2.17 | 2.05 |
| 25                  | 7.11                     | 5.81 | 4.96 | 4.35 | 3.90 | 3.54 | 3.25 | 3.01 | 2.81 | 2.64 | 2.49 | 2.36 |
| 50                  | 7.57                     | 6.21 | 5.32 | 4.69 | 4.21 | 3.84 | 3.54 | 3.29 | 3.08 | 2.90 | 2.74 | 2.60 |
| 100                 | 7.99                     | 6.55 | 5.62 | 4.97 | 4.48 | 4.10 | 3.79 | 3.53 | 3.32 | 3.13 | 2.97 | 2.83 |

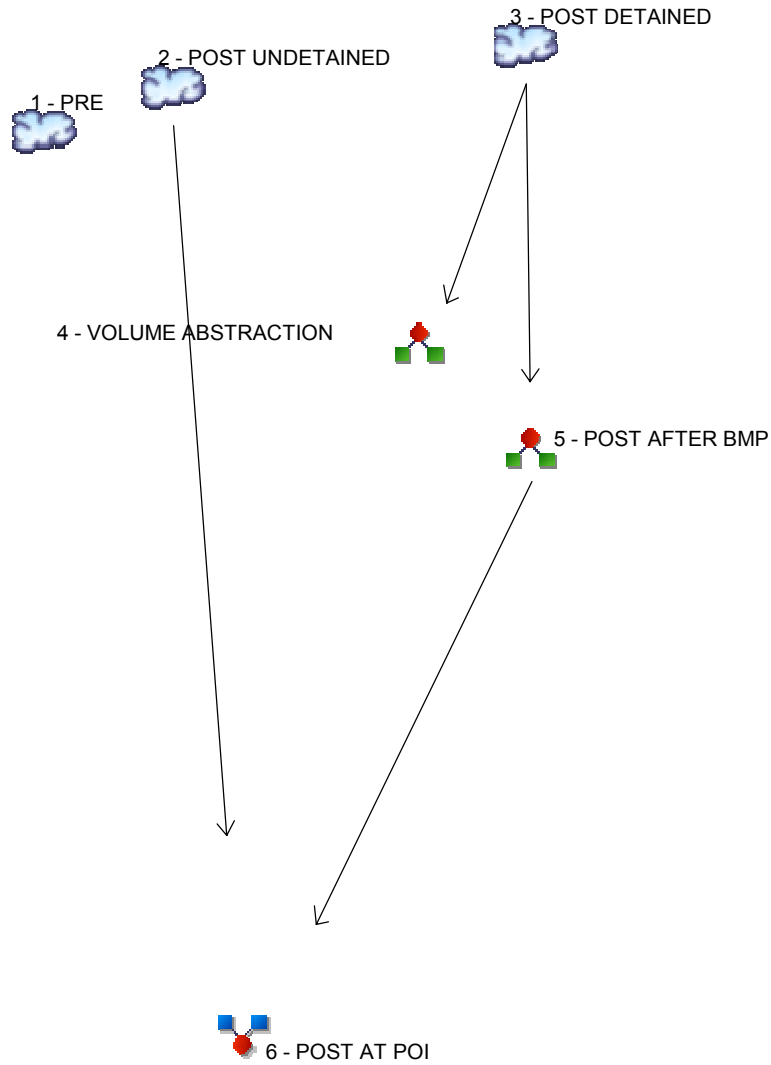
T<sub>c</sub> = time in minutes. Values may exceed 60.

07 PCSM\Attachment 4 - Stormwater Calcs\East Lincoln Highway (Exton Junction)\Hydraflow Rev 1\Exton Precip.pci

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.70                              | 3.25 | 0.00 | 4.07 | 4.75  | 5.74  | 6.57  | 7.46   |
| SCS 6-Hr           | 1.92                              | 2.31 | 0.00 | 2.88 | 3.33  | 3.95  | 4.46  | 4.98   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |

# Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



## Legend

| Hyd. Origin | Description                   |
|-------------|-------------------------------|
| 1           | SCS Runoff PRE                |
| 2           | SCS Runoff POST UNDETAINED    |
| 3           | SCS Runoff POST DETAINED      |
| 4           | Diversion1 VOLUME ABSTRACTION |
| 5           | Diversion2 POST AFTER BMP     |
| 6           | Combine POST AT POI           |

# 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               | ----          | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 5.814  | PRE                    |
| 2        | SCS Runoff               | ----          | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 4.274  | POST UNDETAINED        |
| 3        | SCS Runoff               | ----          | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 0.934  | POST DETAINED          |
| 4        | Diversion1               | 3             | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 0.934  | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 3             | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 0.176  | POST AFTER BMP         |
| 6        | Combine                  | 2, 5          | ----               | ---- | ---- | ---- | ----  | ----  | ----  | 4.274  | POST AT POI            |

# 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               | 5.814           | 1                   | 719                | 12,260             | -----         | -----                  | -----                   | PRE                    |
| 2        | SCS Runoff               | 4.274           | 1                   | 719                | 9,012              | -----         | -----                  | -----                   | POST UNDETAINED        |
| 3        | SCS Runoff               | 0.934           | 1                   | 739                | 4,689              | -----         | -----                  | -----                   | POST DETAINED          |
| 4        | Diversion1               | 0.934           | 1                   | 739                | 2,811              | 3             | -----                  | -----                   | VOLUME ABSTRACTION     |
| 5        | Diversion2               | 0.176           | 1                   | 785                | 1,878              | 3             | -----                  | -----                   | POST AFTER BMP         |
| 6        | Combine                  | 4.274           | 1                   | 719                | 10,890             | 2, 5          | -----                  | -----                   | POST AT POI            |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

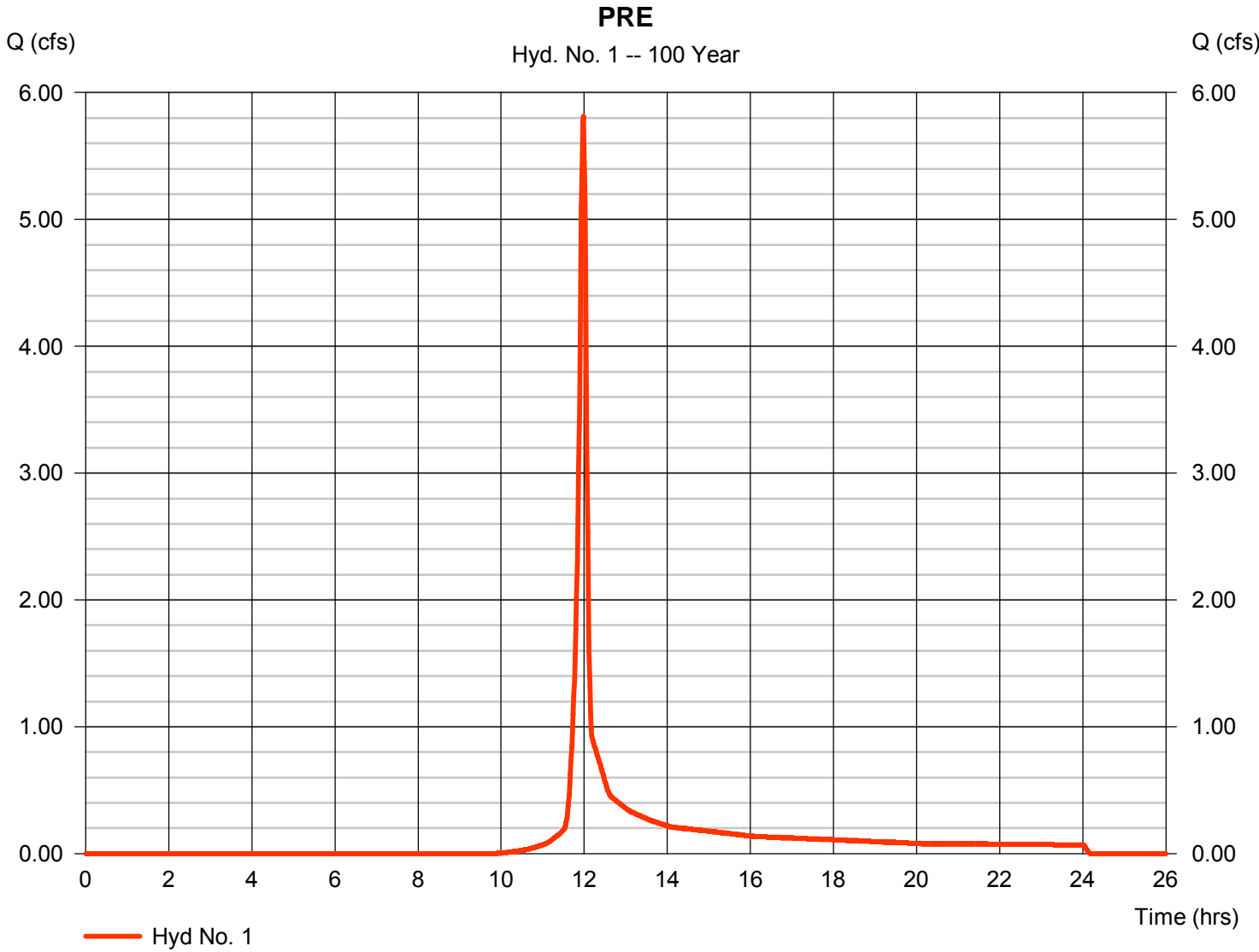
Wednesday, 11 / 9 / 2016

## Hyd. No. 1

PRE

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 5.814 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.98 hrs   |
| Time interval   | = 1 min      | Hyd. volume        | = 12,260 cuft |
| Drainage area   | = 1.140 ac   | Curve number       | = 61*         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min    |
| Total precip.   | = 7.46 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

\* Composite (Area/CN) = [(0.960 x 58) + (0.090 x 55) + (0.090 x 98)] / 1.140



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 1

PRE

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| Manning's n-value                  | = 0.240       |          | 0.011       |          | 0.011       |                 |
| Flow length (ft)                   | = 50.0        |          | 0.0         |          | 0.0         |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 6.80        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 654.00      |          | 0.00        |          | 0.00        |                 |
| Watercourse slope (%)              | = 5.14        |          | 0.00        |          | 0.00        |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |                 |
| Average velocity (ft/s)            | =3.66         |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

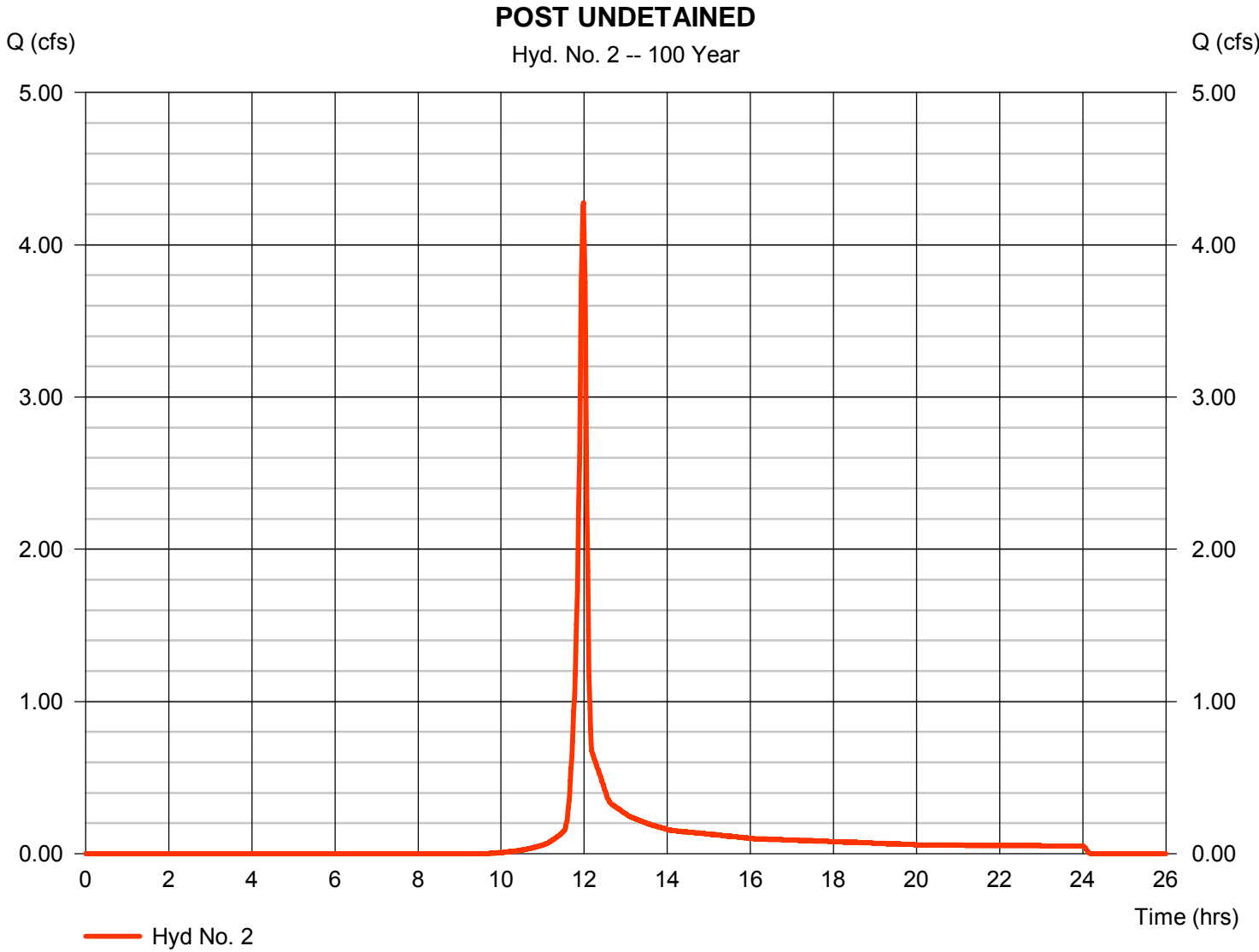
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

### POST UNDETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.274 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.98 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 9,012 cuft |
| Drainage area   | = 0.810 ac   | Curve number       | = 62*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 8.00 min   |
| Total precip.   | = 7.46 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.630 x 58) + (0.090 x 55) + (0.090 x 98)] / 0.810



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

## Hyd. No. 2

POST UNDETAINED

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| Manning's n-value                  | = 0.240       | 0.011         | 0.011         |                 |
| Flow length (ft)                   | = 50.0        | 0.0           | 0.0           |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 6.80        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 4.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 4.98</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 654.00      | 0.00          | 0.00          |                 |
| Watercourse slope (%)              | = 5.14        | 0.00          | 0.00          |                 |
| Surface description                | = Unpaved     | Paved         | Paved         |                 |
| Average velocity (ft/s)            | =3.66         | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 2.98</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 2.98</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| 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           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>8.00 min</b> |

# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

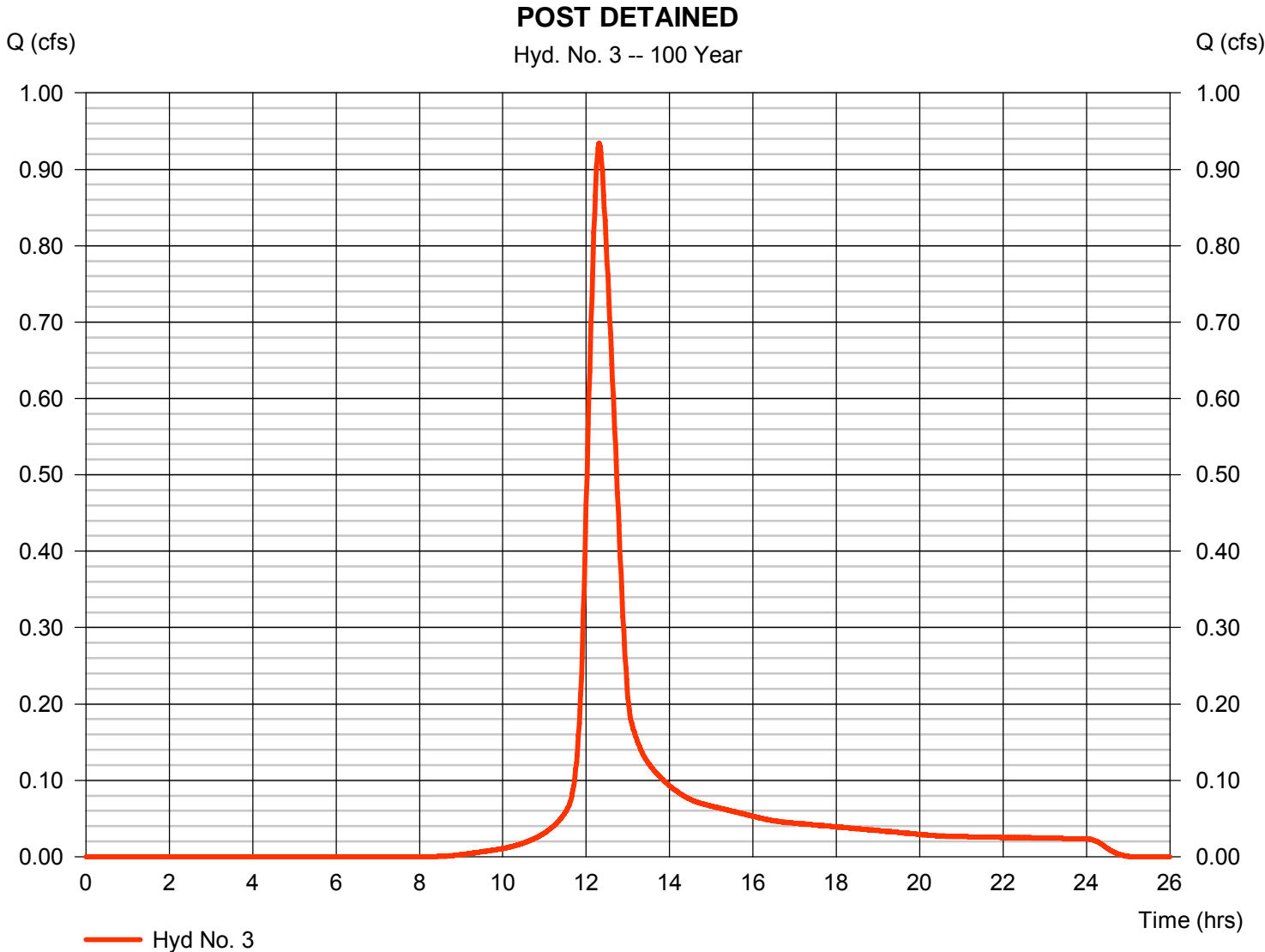
Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### POST DETAINED

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.934 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 12.32 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 4,689 cuft |
| Drainage area   | = 0.330 ac   | Curve number       | = 69*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 42.32 min  |
| Total precip.   | = 7.46 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 85) + (0.200 x 58)] / 0.330



# Hydrograph Report

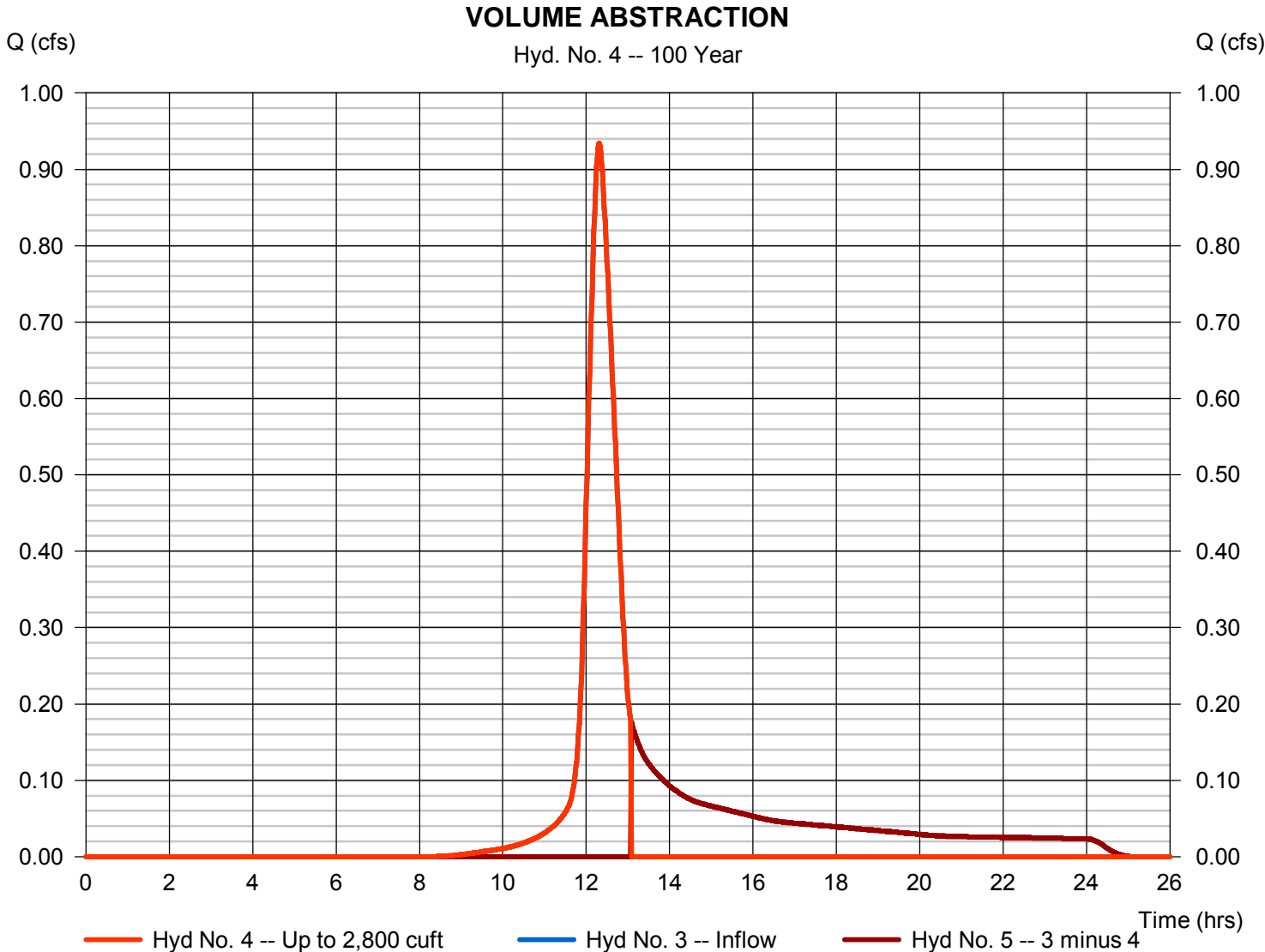
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### VOLUME ABSTRACTION

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.934 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 12.32 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 2,811 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

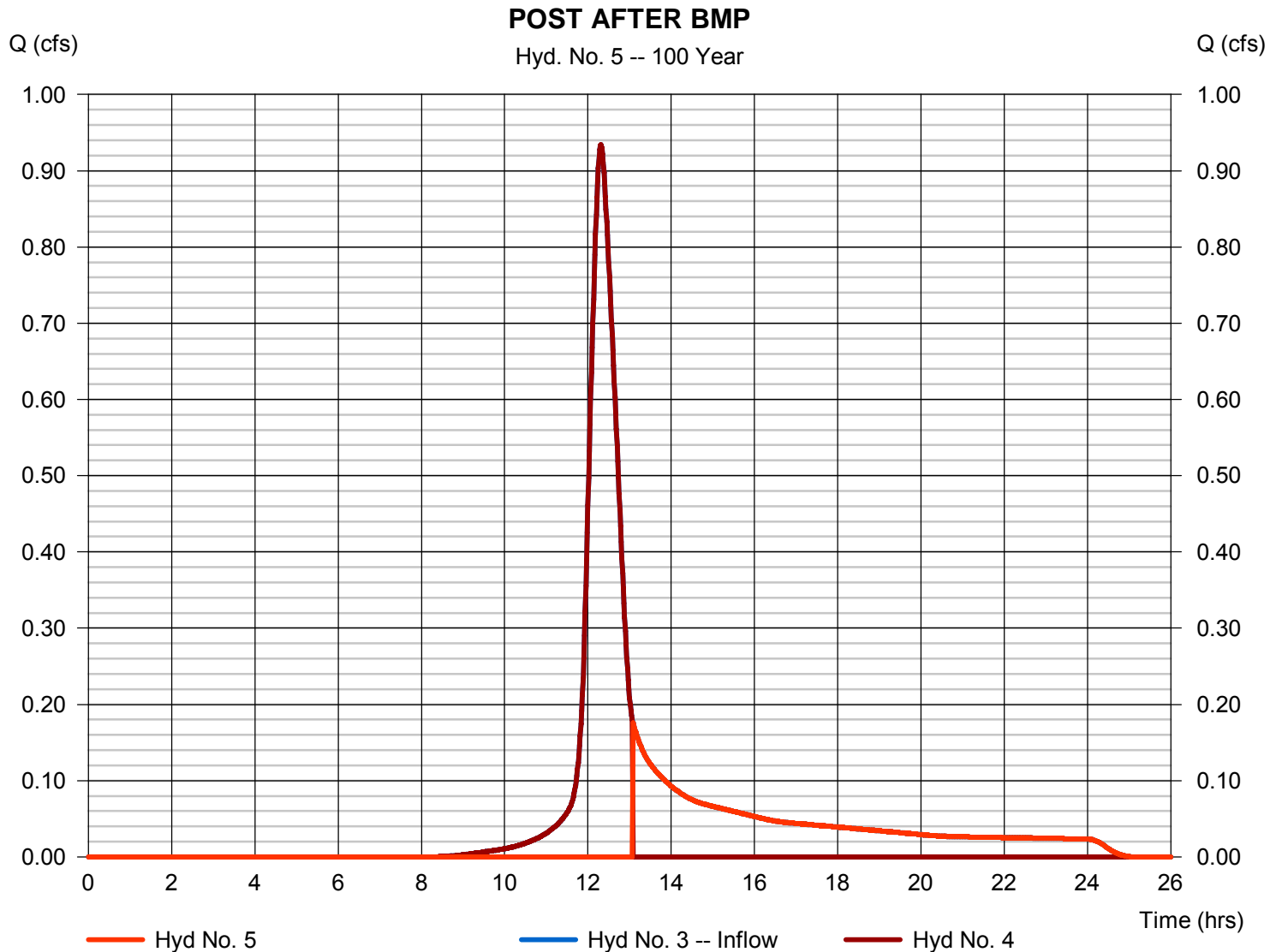
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

### POST AFTER BMP

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.176 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 13.08 hrs  |
| Time interval     | = 1 min              | Hyd. volume       | = 1,878 cuft |
| Inflow hydrograph | = 3 - POST DETAINED  | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,800 cuft |



# Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

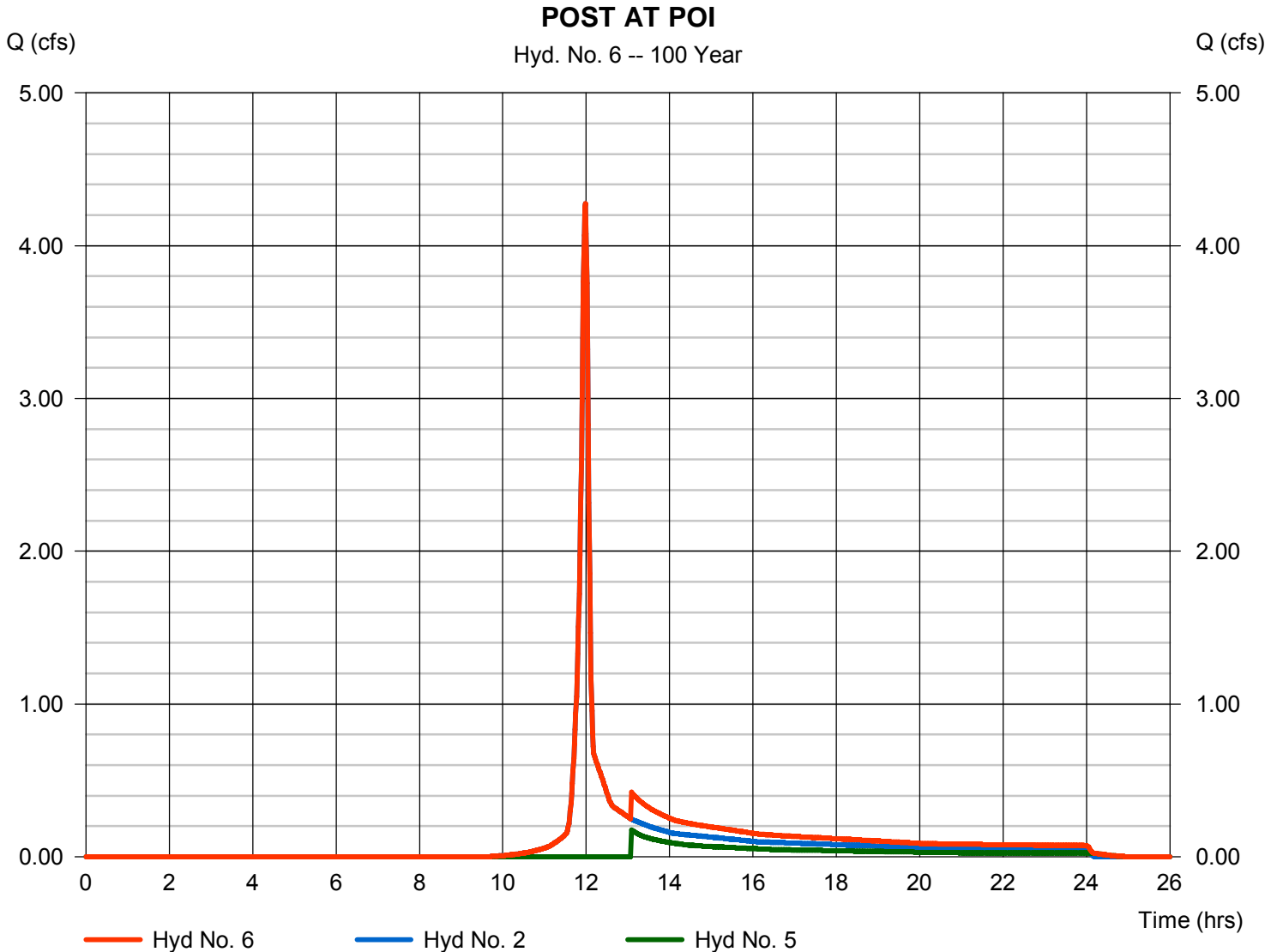
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POST AT POI

Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 5

Peak discharge = 4.274 cfs  
Time to peak = 11.98 hrs  
Hyd. volume = 10,890 cuft  
Contrib. drain. area = 0.810 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Wednesday, 11 / 9 / 2016

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 50.3708  | 12.2000 | 0.8733 | ----- |
| 2                   | 59.4413  | 12.4000 | 0.8656 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 61.3314  | 12.3000 | 0.8243 | ----- |
| 10                  | 59.5209  | 11.8000 | 0.7882 | ----- |
| 25                  | 54.1828  | 10.8000 | 0.7356 | ----- |
| 50                  | 51.2143  | 10.3000 | 0.7008 | ----- |
| 100                 | 44.0384  | 8.9000  | 0.6485 | ----- |

File name: Exton IDF.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 4.20                     | 3.36 | 2.81 | 2.43 | 2.14 | 1.92 | 1.74 | 1.59 | 1.47 | 1.37 | 1.28 | 1.20 |
| 2                   | 5.02                     | 4.03 | 3.39 | 2.93 | 2.59 | 2.32 | 2.11 | 1.93 | 1.78 | 1.66 | 1.55 | 1.46 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 5.85                     | 4.75 | 4.02 | 3.50 | 3.11 | 2.80 | 2.55 | 2.35 | 2.18 | 2.03 | 1.91 | 1.80 |
| 10                  | 6.44                     | 5.25 | 4.46 | 3.90 | 3.47 | 3.14 | 2.87 | 2.65 | 2.47 | 2.31 | 2.17 | 2.05 |
| 25                  | 7.11                     | 5.81 | 4.96 | 4.35 | 3.90 | 3.54 | 3.25 | 3.01 | 2.81 | 2.64 | 2.49 | 2.36 |
| 50                  | 7.57                     | 6.21 | 5.32 | 4.69 | 4.21 | 3.84 | 3.54 | 3.29 | 3.08 | 2.90 | 2.74 | 2.60 |
| 100                 | 7.99                     | 6.55 | 5.62 | 4.97 | 4.48 | 4.10 | 3.79 | 3.53 | 3.32 | 3.13 | 2.97 | 2.83 |

T<sub>c</sub> = time in minutes. Values may exceed 60.

07 PCSM\Attachment 4 - Stormwater Calcs\East Lincoln Highway (Exton Junction)\Hydraflow Rev 1\Exton Precip.pci

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 2.70                              | 3.25 | 0.00 | 4.07 | 4.75  | 5.74  | 6.57  | 7.46   |
| SCS 6-Hr           | 1.92                              | 2.31 | 0.00 | 2.88 | 3.33  | 3.95  | 4.46  | 4.98   |
| Huff-1st           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |



**BOOT RD**



**WORKSHEET 1. GENERAL SITE INFORMATION**

**Date:** October 24, 2016

**Project Name:** Boot Rd

**Municipality:** West Goshen Township

**County:** Chester

**Total Area (acres):** 1.65

**Major River Basin:** Delaware

**Watershed:** Darby - Crum Creeks

**Sub Basin:** Ridley Creek

**Nearest Surface Water to Receive Runoff:** Tributary 00682 to Ridley Creek

**Ch. 93 - Designated Water Use:** HQ-TSF

**Impaired according to Chapter 303(d) list?** YES

**List Causes of Impairment:** NO

- Urban Runoff/Storm Sewers - Cause Unknown
- Urban Runoff/Storm Sewers - Water Flow Variability
- Urban Runoff/Storm Sewers - Siltation

*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.

| <b>EXISTING NATURAL SENSITIVE RESOURCE</b> | <b>MAPPED?<br/>yes/no/n/a</b> | <b>TOTAL AREA<br/>(Ac.)</b> | <b>PROTECTED<br/>AREA (Ac.)</b> |
|--|-------------------------------|-----------------------------|---------------------------------|
| Waterbodies                                |                               |                             |                                 |
| Floodplains                                |                               |                             |                                 |
| Riparian Areas                             |                               |                             |                                 |
| Wetlands                                   |                               |                             |                                 |
| Woodlands                                  |                               |                             |                                 |
| Natural Drainage Ways                      |                               |                             |                                 |
| Steep Slopes, 15% - 25%                    |                               |                             |                                 |
| Steep Slopes, over 25%                     |                               |                             |                                 |
| Other:                                     | Yes                           | 1.65                        | 0.45                            |
| Other:                                     |                               |                             |                                 |
| <b>TOTAL EXISTING:</b>                     | Yes                           | 1.65                        | 0.45                            |

**WORKSHEET 3. NONSTRUCTURAL BMP CREDITS**

**PROTECED AREA**

|  |             |            |
|--|-------------|------------|
| <b>1.1 Area of Protected Sensitive/Special Value Features (see WS 2)</b> | <u>0.45</u> | <b>Ac.</b> |
| <b>1.2 Area of Riparian Forest Buffer Protection</b>                     | <u>0</u>    | <b>Ac.</b> |
| <b>3.1 Area of Minimum Disturbance/Reduced Grading</b>                   | <u>0</u>    | <b>Ac.</b> |
| <b>TOTAL</b>   | <u>0.45</u> | <b>Ac.</b> |

|   |       |  |   |   |
|---|-------|--|---|---|
| Site Area   | minus | Protected Area   | = | Stormwater Management Area                              |
| <input style="width: 80px;" type="text" value="1.65"/>      | -     | <input style="width: 80px;" type="text" value="0.45"/> | = | <input style="width: 150px;" type="text" value="1.20"/> |
| <i>This is the area that requires stormwater management</i> |       |  |   |   |

**VOLUME CREDITS**

**3.1 Minimum Soil Compaction**

|        |                                     |          |        |                                   |
|--------|-------------------------------------|----------|--------|-----------------------------------|
| Lawn   | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
| Meadow | <u>          </u> ft <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |

**3.3 Protected Existing Trees**

*For trees within 100 feet of impervious area:*

|             |                                     |          |        |                                   |
|-------------|-------------------------------------|----------|--------|-----------------------------------|
| Tree canopy | <u>          </u> ft <sup>2</sup> x | 1/2 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-------------|-------------------------------------|----------|--------|-----------------------------------|

**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 <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-----------|-------------------------------------|----------|--------|-----------------------------------|

*For all other disconnected roof areas*

|           |                                     |          |        |                                   |
|-----------|-------------------------------------|----------|--------|-----------------------------------|
| Roof Area | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-----------|-------------------------------------|----------|--------|-----------------------------------|

**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 <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|------------------|-------------------------------------|----------|--------|-----------------------------------|

*For all other disconnected roof areas*

|                  |                                     |          |        |                                   |
|------------------|-------------------------------------|----------|--------|-----------------------------------|
| Impervious Areas | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|------------------|-------------------------------------|----------|--------|-----------------------------------|

**TOTAL NON-STRUCTURAL VOLUME CREDIT\***

ft<sup>3</sup>

*\* For use on Workseet 5*

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

PROJECT: Boot Rd  
 Drainage Area: 1.65 acres  
 2-Year Rainfall: 3.25 in

Total Site Area: 1.65 acres  
 Protected Site Area: 0.45 acres  
 Managed Site Area: 1.20 acres

### Existing Conditions

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | Ia (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>2</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Meadow               | C         | 17008         | 0.39        | 71 | 4.08 | 0.82       | 0.91                       | 1,287   |
| Woods                | C         | 33556         | 0.77        | 70 | 4.29 | 0.86       | 0.86                       | 2,397   |
| Pavement             | N/A       | 1706          | 0.04        | 98 | 0.20 | 0.04       | 3.02                       | 429   |
| <b>TOTAL:</b>        |           | <b>52,270</b> | <b>1.20</b> |    |      |            |                            | <b>4,114</b>                                  |

### Developed Conditions

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | Ia (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>2</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Meadow               | C         | 44923         | 1.03        | 71 | 4.08 | 0.82       | 0.91                       | 3,400   |
| Gravel               | C         | 5699          | 0.13        | 89 | 1.24 | 0.25       | 2.13                       | 1,010   |
| Pavement             | N/A       | 1706          | 0.04        | 98 | 0.20 | 0.04       | 3.02                       | 429   |
| <b>TOTAL:</b>        |           | <b>52,328</b> | <b>1.20</b> |    |      |            |                            | <b>4,840</b>                                  |

|  |            |
|--|------------|
| 2-Year Volume Increase (ft <sup>3</sup> ): | <b>726</b> |
|--|------------|

**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:** Boot Rd  
**SUB-BASIN:** \_\_\_\_\_

**Required Control Volume (ft<sup>3</sup>) - from Worksheet 4:** 726

**Non-structural Volume Credit (ft<sup>3</sup>) - from Worksheet 3:** - N/A

**Structural Volume Reqmt (ft<sup>3</sup>)** 726  
*(Required Control Volume minus Non-structural Credit)*

| Proposed BMP  |                                     | Area (ft <sup>2</sup> ) | Storage Volume (ft <sup>3</sup> ) |
|---------------|-------------------------------------|-------------------------|-----------------------------------|
| 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                                | 2,437                   | 1,591                             |
| 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               |                         |                                   |
| <i>Other:</i> |                                     |                         |                                   |

|   |              |
|---|--------------|
| <b>Total Structural Volume Provided (ft<sup>3</sup>):</b> | <b>1,591</b> |
| <b>Structural Volume Requirement (ft<sup>3</sup>):</b>    | <b>726</b>   |
| <b>DIFFERENCE:</b>  | <b>-865</b>  |

**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 |
|---|-----|----|
| <b>Primary BMPs for Nitrate:</b>                                      |     |    |
| 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                          |     |    |
|   |     |    |
| <b>Secondary BMPs for Nitrate:</b>                                    |     |    |
| 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: Boot Road, Chester County, PA  
 DONE BY: RJM DATE: 10/24/2016  
 CHECKED BY: LMD DATE: 10/25/2016

|  |             |  |  |  |
|--|-------------|--|--|--|
| CHANNEL OR CHANNEL SECTION   | DD-1        |  |  |  |
| TEMPORARY OR PERMANENT? (T OR P)   | P           |  |  |  |
| DESIGN STORM (2, 5, 10, OR 100 YR)   | 100         |  |  |  |
| ACRES (AC)   | 0.74        |  |  |  |
| MULTIPLIER (1.6, 2.25, or 2.75) <sup>1</sup>   | N/A         |  |  |  |
| Q <sub>r</sub> (REQUIRED CAPACITY) (CFS)   | 6.80        |  |  |  |
| Q (CALCULATED AT FLOW DEPTH d) (CFS)   | 6.80        |  |  |  |
| S (BED SLOPE) <sup>3</sup> (FT/FT)   | 0.02        |  |  |  |
| DESIGN METHOD FOR PROTECTIVE LINING <sup>5</sup><br>PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S) | V           |  |  |  |
| PROTECTIVE LINING <sup>2</sup>   | NAG<br>P300 |  |  |  |
| n (MANNING'S COEFFICIENT) <sup>2</sup>   | 0.081       |  |  |  |
| V <sub>a</sub> (ALLOWABLE VELOCITY) (FPS)  | 5.00        |  |  |  |
| V (CALCULATED AT FLOW DEPTH) (FPS)   | 1.87        |  |  |  |
| t <sub>a</sub> (MAX ALLOWABLE SHEAR STRESS) (LB/FT <sup>2</sup> )                                | N/A         |  |  |  |
| t <sub>d</sub> (CALC'D SHEAR STRESS AT FLOW DEPTH d) (LB/FT <sup>2</sup> )                       | 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)   | 2.00        |  |  |  |
| CHANNEL TOP WIDTH @ D (FT)   | 9.00        |  |  |  |
| d (CALCULATED FLOW DEPTH) (FT)   | 1.12        |  |  |  |
| CHANNEL TOP WIDTH @ FLOW DEPTH d (FT)  | 5.48        |  |  |  |
| BOTTOM WIDTH : FLOW DEPTH RATIO (12:1 MAX)   | 0.89        |  |  |  |
| d <sub>50</sub> STONE SIZE (IN)  | N/A         |  |  |  |
| A (CROSS-SECTIONAL AREA) (SQ. FT.)   | 3.63        |  |  |  |
| R (HYDRAULIC RADIUS)   | 0.60        |  |  |  |
| S <sub>c</sub> (CRITICAL SLOPE) (FT/FT)  | 0.124       |  |  |  |
| .7S <sub>c</sub> (FT/FT)   | 0.087       |  |  |  |
| 1.3S <sub>c</sub> (FT/FT)  | 0.161       |  |  |  |
| STABLE FLOW? (Y/N)   | Y           |  |  |  |
| FREEBOARD BASED ON UNSTABLE FLOW (FT)  | N/A         |  |  |  |
| FREEBOARD BASED ON STABLE FLOW (FT)  | 0.88        |  |  |  |
| MINIMUM REQUIRED FREEBOARD <sup>4</sup>  | 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  
BOOT RD**



# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/16 Boot Rd Proj. No.: 112IC05958

## Post Construction Stormwater Management Plan - Design Calculations Boot Road

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### **PURPOSE**

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Boot Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Boot Road Block Valve Site is located in West Goshen Township, Chester County, PA. Permanent stormwater controls will be developed to satisfy PADEP and West Goshen stormwater control regulations. (*The West Goshen Stormwater Ordinance, Chapter 71, is considered in the design*)

### **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 2-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. The peak rate of the post development 2-year, 24-hour storm will be reduced to the pre-development 1-year, 24-hour storm rate. The peak rate of the post development 5-year, 24-hour storm and 10-year, 24-hour storm will be reduced to the pre-development 2-year, 24-hour storm rate. (*Peak rate reductions are in accordance with the West Goshen Stormwater Ordinance*)

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: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/16 Boot 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):

| <b>Storm Frequency</b> | <b>Depth (Inches)</b> |
|------------------------|-----------------------|
| 1-yr                   | 2.70                  |
| 2-yr                   | 3.25                  |
| 5-yr                   | 4.08                  |
| 10-yr                  | 4.77                  |
| 25-yr                  | 5.76                  |
| 50-yr                  | 6.60                  |
| 100-yr                 | 7.50                  |

# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
 Chkd. By: LMD Date: 10/25/16 Boot 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) 3.25 in

Total Site Area : 1.65 acres

Protected Site Area: 0.45 acres

Stormwater Management Area 1.20 acres

#### Pre-Development Condition within LOD

| Cover Type/Condition | Soil Type | Area (ac) | CN | S    | Ia   | Q (in) | Runoff Volume (cf) |
|----------------------|-----------|-----------|----|------|------|--------|--------------------|
| Meadow               | C         | 0.39      | 71 | 4.08 | 0.82 | 0.91   | 1,287              |
| Woods                | C         | 0.77      | 70 | 4.29 | 0.86 | 0.86   | 2,397              |
| Pavement             | N/A       | 0.04      | 98 | 0.20 | 0.04 | 3.02   | 429                |
| Total                |           | 1.20      |    |      |      |        | 4,114              |

Note: Boot Rd (pavement) is within the LOD but will not be disturbed, and therefore will not be adjusted to 20% meadow.

#### Post-Development Condition within LOD

| Cover Type/Condition | Soil Type | Area (ac) | CN | S    | Ia   | Q (in) | Runoff Volume (cf) |
|----------------------|-----------|-----------|----|------|------|--------|--------------------|
| Meadow               | C         | 1.03      | 71 | 4.08 | 0.82 | 0.91   | 3,400              |
| Gravel               | C         | 0.13      | 89 | 1.24 | 0.25 | 2.13   | 1,010              |
| Pavement             | N/A       | 0.04      | 98 | 0.20 | 0.04 | 3.02   | 429                |
| Total                |           | 1.20      |    |      |      |        | 4,840              |

|                                     |            |
|-------------------------------------|------------|
| <b>2-Year Volume Increase (cf):</b> | <b>726</b> |
|-------------------------------------|------------|

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.)

# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/16 Boot Rd Proj. No.: 112IC05958

## IMPERVIOUS LOADING RATE

|   | Area (ac) | Area (sf) |
|---|-----------|-----------|
| Detained Impervious Area (Gravel & Pavement): | 0.16      | 6781.00   |
| Maximum Impervious Ratio:                     | 5         | :1        |
| Minimum Infiltration Area (sf):               |           | 1,356     |
| Design Infiltration Area (sf):                |           | 2,437     |
| Design Impervious Ratio:                      | 2.8       | :1        |

## TOTAL WATERSHED LOADING RATE

|  | Area (ac) | Area (sf) |
|--|-----------|-----------|
| Detained Watershed Area (to Infiltration BMP): | 0.31      | 13517.00  |
| Maximum Total Watershed Ratio Ratio:           | 8         | :1        |
| Minimum Infiltration Area (sf):                |           | 1,690     |
| Design Infiltration Area (sf):                 |           | 2,437     |
| Design Total Watershed Ratio:                  | 5.5       | :1        |

A diversion channel has been added along the northwest 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 Boot Road Block Valve Site will be located along the southeastern edge of the pad and 91 percent of the disturbed area will be detained by the BMP.

# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
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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.

|   |            |
|---|------------|
| <b>Design Infiltration Rate (in/hr) - Infiltration Berm</b> | <b>0.2</b> |
|---|------------|

## 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) |
|-------------|-------------------------|-------------------|------------------------|---------------------|
| 152.3       | 16                      | 2,437             | 2.00                   | 2437                |

Infiltration Volume for "Volume Abstraction" in Routing Process:

| Infiltration Rate (in/hr) | Surface Area (sf) | Infiltration Period (hrs) | Infiltration Volume (cf) |
|---------------------------|-------------------|---------------------------|--------------------------|
| 0.2                       | 2,437             | 2                         | 81                       |

|  |                 |
|--|-----------------|
| <b>Volume Abstraction Potential (cf)</b> | <b>2,518.23</b> |
|--|-----------------|

## 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                                 | 1591                      | 2437                | 2437                                | 1591                          |
| <b>Total Structural Credit (cf) (Worksheet 5)</b> |                           |                     |                                     | <b>1591</b>                   |

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



# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
 Chkd. By: LMD Date: 10/25/16 Boot Rd Proj. No.: 112IC05958

## *Infiltration Berm 1 (Detained)*

| Hydrologic Group | Soil Name | Cover Description | Curve Number | Area (acres) |
|------------------|-----------|-------------------|--------------|--------------|
| C                | GgB       | Meadow            | 71           | 0.29         |
| C                | GgB       | Gravel            | 89           | 0.12         |
| N/A              | GgB/GLB   | Pavement          | 98           | 0.04         |
|                  |           |                   | Totals       | 0.45         |
|                  |           |                   | CN           | 78           |

## 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                 | 0.91                                 | 1,591                           | 29.1                             | 2.8  | 31.9                                  |
| 5                 | 1.30                                 | 2,309                           | 29.6                             | 2.8  | 32.4                                  |
| 10                | 1.63                                 | 2,437                           | 24.9                             | 2.8  | 27.7                                  |
| 25                | 2.12                                 | 2,437                           | 19.2                             | 2.8  | 22.0                                  |
| 50                | 2.54                                 | 2,437                           | 16.0                             | 2.8  | 18.8                                  |
| 100               | 2.99                                 | 2,437                           | 13.6                             | 2.8  | 16.4                                  |

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

# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.: of  
 Chkd. By: LMD Date: 10/25/16 Boot Rd Proj. No.: 1121C05958

## 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                 | 1,591                     | 2,518.23                          | 1,591                          |
| 5                 | 2,309                     | 2,518.23                          | 2,309                          |
| 10                | 2,936                     | 2,518.23                          | 2,518                          |
| 25                | 3,867                     | 2,518.23                          | 2,518                          |
| 50                | 4,678                     | 2,518.23                          | 2,518                          |
| 100               | 5,562                     | 2,518.23                          | 2,518                          |

## 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.

| 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) |              |
| 1-yr            | 2.43              | --                          | --                                     | --                            | --           |
| 2-yr            | 3.60              | 4.01                        | 5,955                                  | 2.86                          | -0.74        |
| 5-yr            | 5.52              | 6.00                        | 8,949                                  | 4.30                          | -1.22        |
| 10-yr           | 7.19              | 7.72                        | 12,052                                 | 5.55                          | -1.64        |
| 25-yr           | 9.68              | 10.26                       | 17,028                                 | 7.40                          | -2.28        |
| 50-yr           | 11.84             | 12.45                       | 21,422                                 | 9.00                          | -2.84        |
| 100-yr          | 14.20             | 14.81                       | 26,279                                 | 10.72                         | -3.48        |

# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/16 Boot Rd Proj. No.: 112IC05958

## STORMWATER ROUTING (West Goshen Stormwater Ordinance)

West Goshen Township Stormwater Ordinance requires the following additional peak outflow reductions must be met: 2-year post-development reduced to 1-year pre-development, 5-year post-development reduced to 2-year pre-development and 10-year post-development reduced to the 2-year pre-development. As required by the ordinance, only areas disturbed by block valve site development (Undetained Area 2 and Infiltration Berm 1) were considered for this analysis. 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 |                    | Change (cfs) |
|-----------------|-------------------|------------------|--------------------|--------------|
| Design Storm    | Peak Runoff (cfs) | Design Storm     | Peak Outflow (cfs) |              |
| 1-yr            | 0.91              | 2-yr             | 0.54               | -0.37        |
| 2-yr            | 1.35              | 5-yr             | 0.76               | -0.59        |
| 2-yr            | 1.35              | 10-yr            | 0.95               | -0.40        |

# TETRA TECH, INC.

By: RJM Date: 10/24/2016 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/2016 Boot 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 Chester 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 40.0048 N 75.5807 W 513.29 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.
- 9) West Goshen Township Ordinance, Chapter 71: Stormwater Management, Adopted November 13, 2013.

## **ATTACHMENT A**

# **NOAA PRECIPITATION FREQUENCY ESTIMATES**



**NOAA Atlas 14, Volume 2, Version 3**  
**Location name: West Goshen Twp, Pennsylvania,**  
**USA\***



**Latitude: 40.0048°, Longitude: -75.5807°**  
**Elevation: 513.29 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**

| <b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b> |                                     |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|--|-------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Duration   | Average recurrence interval (years) |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|  | 1                                   | 2                      | 5                      | 10                     | 25                     | 50                     | 100                    | 200                    | 500                    | 1000                   |
| 5-min  | 0.352<br>(0.323-0.384)              | 0.419<br>(0.385-0.458) | 0.490<br>(0.448-0.534) | 0.539<br>(0.493-0.588) | 0.596<br>(0.542-0.650) | 0.634<br>(0.573-0.692) | 0.672<br>(0.605-0.734) | 0.704<br>(0.630-0.771) | 0.740<br>(0.656-0.812) | 0.766<br>(0.675-0.844) |
| 10-min   | 0.562<br>(0.515-0.614)              | 0.671<br>(0.616-0.732) | 0.784<br>(0.718-0.856) | 0.862<br>(0.788-0.940) | 0.950<br>(0.864-1.04)  | 1.01<br>(0.913-1.10)   | 1.07<br>(0.962-1.17)   | 1.12<br>(0.999-1.22)   | 1.17<br>(1.04-1.28)    | 1.21<br>(1.06-1.33)    |
| 15-min   | 0.702<br>(0.644-0.767)              | 0.843<br>(0.774-0.920) | 0.992<br>(0.908-1.08)  | 1.09<br>(0.996-1.19)   | 1.20<br>(1.09-1.31)    | 1.28<br>(1.16-1.40)    | 1.35<br>(1.22-1.47)    | 1.41<br>(1.26-1.54)    | 1.47<br>(1.31-1.62)    | 1.51<br>(1.33-1.67)    |
| 30-min   | 0.962<br>(0.883-1.05)               | 1.16<br>(1.07-1.27)    | 1.41<br>(1.29-1.54)    | 1.58<br>(1.44-1.72)    | 1.78<br>(1.62-1.95)    | 1.93<br>(1.74-2.10)    | 2.07<br>(1.86-2.26)    | 2.19<br>(1.96-2.40)    | 2.34<br>(2.08-2.57)    | 2.45<br>(2.16-2.70)    |
| 60-min   | 1.20<br>(1.10-1.31)                 | 1.46<br>(1.34-1.59)    | 1.81<br>(1.65-1.97)    | 2.06<br>(1.88-2.24)    | 2.38<br>(2.16-2.59)    | 2.61<br>(2.36-2.85)    | 2.85<br>(2.56-3.11)    | 3.08<br>(2.75-3.37)    | 3.36<br>(2.98-3.69)    | 3.58<br>(3.15-3.94)    |
| 2-hr   | 1.43<br>(1.30-1.58)                 | 1.74<br>(1.58-1.92)    | 2.16<br>(1.96-2.39)    | 2.49<br>(2.25-2.74)    | 2.91<br>(2.62-3.20)    | 3.25<br>(2.90-3.57)    | 3.58<br>(3.18-3.94)    | 3.91<br>(3.45-4.31)    | 4.36<br>(3.81-4.82)    | 4.71<br>(4.07-5.21)    |
| 3-hr   | 1.56<br>(1.42-1.72)                 | 1.89<br>(1.72-2.08)    | 2.35<br>(2.14-2.60)    | 2.71<br>(2.45-2.99)    | 3.18<br>(2.86-3.50)    | 3.55<br>(3.17-3.90)    | 3.92<br>(3.48-4.31)    | 4.29<br>(3.78-4.73)    | 4.79<br>(4.17-5.29)    | 5.17<br>(4.46-5.73)    |
| 6-hr   | 1.92<br>(1.75-2.13)                 | 2.32<br>(2.11-2.57)    | 2.88<br>(2.62-3.19)    | 3.34<br>(3.02-3.69)    | 3.97<br>(3.56-4.38)    | 4.47<br>(3.98-4.92)    | 5.00<br>(4.42-5.51)    | 5.56<br>(4.86-6.12)    | 6.32<br>(5.44-6.99)    | 6.93<br>(5.88-7.68)    |
| 12-hr  | 2.33<br>(2.12-2.61)                 | 2.82<br>(2.56-3.15)    | 3.52<br>(3.19-3.92)    | 4.11<br>(3.70-4.57)    | 4.95<br>(4.42-5.48)    | 5.65<br>(5.00-6.25)    | 6.41<br>(5.60-7.10)    | 7.22<br>(6.23-8.01)    | 8.40<br>(7.10-9.33)    | 9.37<br>(7.79-10.4)    |
| 24-hr  | 2.70<br>(2.48-2.95)                 | 3.25<br>(2.99-3.56)    | 4.08<br>(3.74-4.46)    | 4.77<br>(4.36-5.20)    | 5.76<br>(5.24-6.28)    | 6.60<br>(5.97-7.18)    | 7.50<br>(6.75-8.15)    | 8.47<br>(7.58-9.20)    | 9.89<br>(8.75-10.7)    | 11.1<br>(9.70-12.0)    |
| 2-day  | 3.13<br>(2.86-3.43)                 | 3.77<br>(3.46-4.13)    | 4.74<br>(4.34-5.19)    | 5.52<br>(5.04-6.05)    | 6.64<br>(6.04-7.26)    | 7.56<br>(6.85-8.27)    | 8.55<br>(7.70-9.34)    | 9.59<br>(8.59-10.5)    | 11.1<br>(9.84-12.1)    | 12.3<br>(10.8-13.5)    |
| 3-day  | 3.30<br>(3.02-3.62)                 | 3.97<br>(3.64-4.36)    | 4.98<br>(4.56-5.46)    | 5.80<br>(5.29-6.35)    | 6.96<br>(6.33-7.61)    | 7.91<br>(7.17-8.65)    | 8.93<br>(8.04-9.76)    | 10.0<br>(8.96-10.9)    | 11.6<br>(10.3-12.6)    | 12.8<br>(11.3-14.0)    |
| 4-day  | 3.47<br>(3.18-3.81)                 | 4.18<br>(3.83-4.59)    | 5.22<br>(4.78-5.73)    | 6.07<br>(5.54-6.65)    | 7.27<br>(6.61-7.96)    | 8.26<br>(7.48-9.04)    | 9.31<br>(8.39-10.2)    | 10.4<br>(9.34-11.4)    | 12.0<br>(10.7-13.1)    | 13.3<br>(11.7-14.6)    |
| 7-day  | 4.05<br>(3.75-4.41)                 | 4.86<br>(4.49-5.29)    | 6.01<br>(5.54-6.55)    | 6.95<br>(6.40-7.56)    | 8.30<br>(7.61-9.02)    | 9.41<br>(8.59-10.2)    | 10.6<br>(9.62-11.5)    | 11.9<br>(10.7-12.9)    | 13.6<br>(12.2-14.8)    | 15.1<br>(13.4-16.4)    |
| 10-day   | 4.61<br>(4.28-4.99)                 | 5.51<br>(5.11-5.96)    | 6.72<br>(6.23-7.26)    | 7.69<br>(7.11-8.30)    | 9.04<br>(8.34-9.75)    | 10.1<br>(9.31-10.9)    | 11.3<br>(10.3-12.1)    | 12.4<br>(11.3-13.4)    | 14.1<br>(12.7-15.2)    | 15.4<br>(13.8-16.7)    |
| 20-day   | 6.23<br>(5.82-6.69)                 | 7.40<br>(6.91-7.94)    | 8.82<br>(8.23-9.47)    | 9.94<br>(9.27-10.7)    | 11.5<br>(10.7-12.3)    | 12.6<br>(11.7-13.5)    | 13.8<br>(12.8-14.8)    | 15.0<br>(13.8-16.1)    | 16.7<br>(15.2-17.9)    | 17.9<br>(16.3-19.3)    |
| 30-day   | 7.76<br>(7.30-8.23)                 | 9.14<br>(8.61-9.70)    | 10.7<br>(10.0-11.3)    | 11.8<br>(11.1-12.6)    | 13.4<br>(12.6-14.2)    | 14.6<br>(13.6-15.5)    | 15.7<br>(14.7-16.7)    | 16.8<br>(15.7-17.9)    | 18.3<br>(17.0-19.5)    | 19.4<br>(17.9-20.7)    |
| 45-day   | 9.84<br>(9.32-10.4)                 | 11.6<br>(10.9-12.2)    | 13.3<br>(12.6-14.0)    | 14.6<br>(13.8-15.4)    | 16.2<br>(15.4-17.2)    | 17.5<br>(16.5-18.5)    | 18.6<br>(17.6-19.7)    | 19.7<br>(18.5-20.8)    | 21.1<br>(19.8-22.3)    | 22.0<br>(20.6-23.4)    |
| 60-day   | 11.8<br>(11.2-12.4)                 | 13.8<br>(13.1-14.6)    | 15.8<br>(15.0-16.6)    | 17.2<br>(16.3-18.1)    | 19.0<br>(18.1-20.0)    | 20.3<br>(19.3-21.4)    | 21.6<br>(20.4-22.7)    | 22.7<br>(21.5-23.9)    | 24.1<br>(22.7-25.4)    | 25.1<br>(23.6-26.5)    |

<sup>1</sup> 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.

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**ATTACHMENT B**

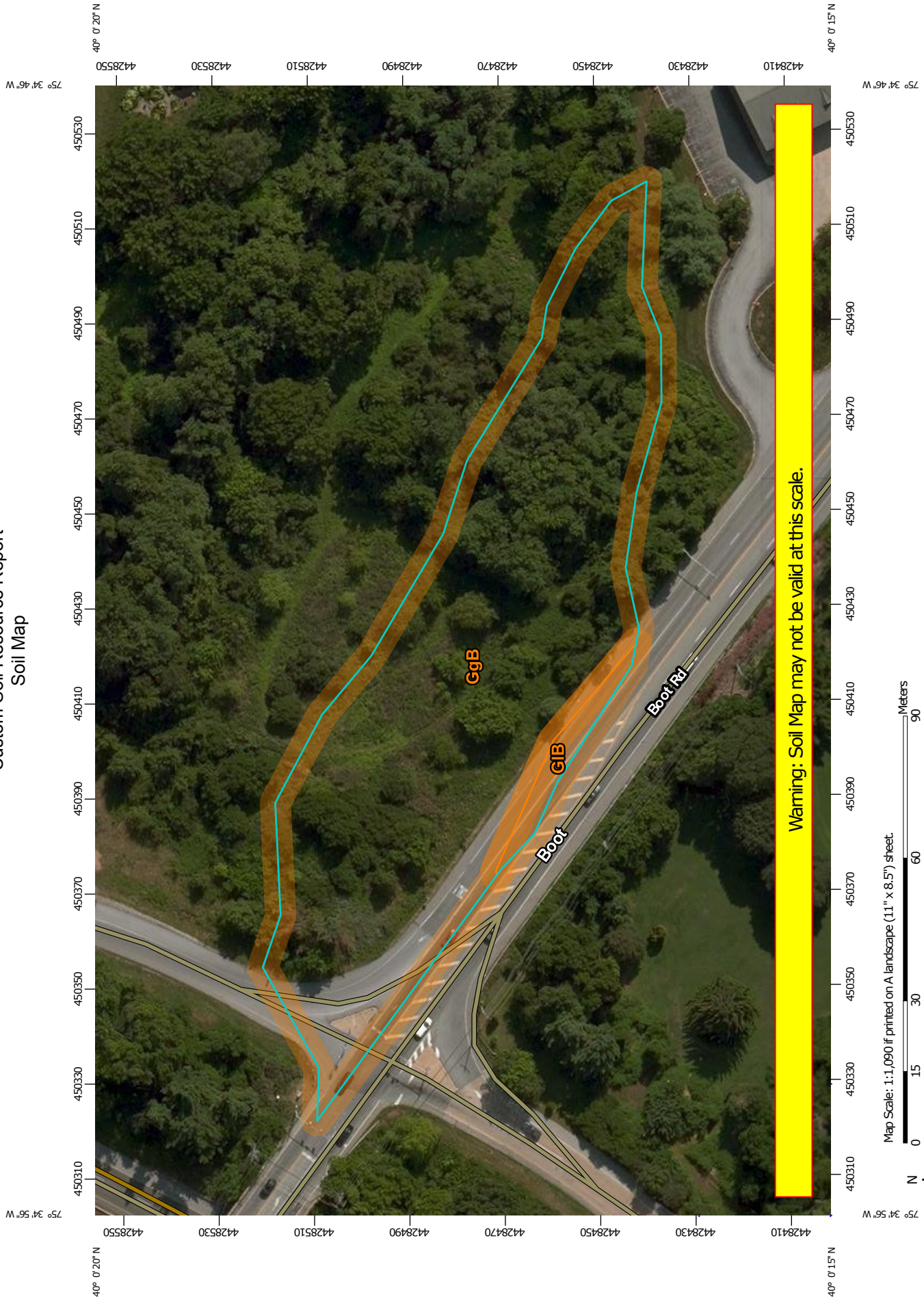
**USDA SOILS MAP & PROPERTIES**



# Custom Soil Resource Report for **Chester County, Pennsylvania**



# Custom Soil Resource Report Soil Map



Map Scale: 1:1,090 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

## 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: Chester County, Pennsylvania  
 Survey Area Data: Version 7, 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: Jul 25, 2014—Aug 11, 2014

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 LEGEND

|  |   |
|--|---|
|  Area of Interest (AOI) |  Spoil Area            |
|  Soil Map Unit Polygons |  Stony Spot            |
|  Soil Map Unit Lines    |  Very Stony Spot       |
|  Soil Map Unit Points   |  Wet Spot              |
|  Special Point Features |  Other                 |
|  Blowout                |  Special Line Features |
|  Borrow Pit             | <b>Water Features</b>   |
|  Clay Spot              |  Streams and Canals    |
|  Closed Depression      | <b>Transportation</b>   |
|  Gravel Pit             |  Rails                 |
|  Gravelly Spot          |  Interstate Highways   |
|  Landfill               |  US Routes             |
|  Lava Flow              |  Major Roads           |
|  Marsh or swamp         |  Local Roads           |
|  Mine or Quarry         | <b>Background</b>   |
|  Miscellaneous Water    |  Aerial Photography    |
|  Perennial Water        |   |
|  Rock Outcrop           |   |
|  Saline Spot            |   |
|  Sandy Spot             |   |
|  Severely Eroded Spot   |   |
|  Sinkhole              |   |
|  Slide or Slip        |   |
|  Sodic Spot           |   |

## Map Unit Legend

| Chester County, Pennsylvania (PA029) |  |              |                |
|--------------------------------------|--|--------------|----------------|
| Map Unit Symbol                      | Map Unit Name                              | Acres in AOI | Percent of AOI |
| GgB                                  | Glenelg silt loam, 3 to 8 percent slopes   | 1.7          | 97.1%          |
| GIB                                  | Glenville silt loam, 3 to 8 percent slopes | 0.1          | 2.9%           |
| <b>Totals for Area of Interest</b>   |  | <b>1.7</b>   | <b>100.0%</b>  |

## 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

## Custom Soil Resource Report

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.

## Chester County, Pennsylvania

### GgB—Glenelg silt loam, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2v7gr  
*Elevation:* 30 to 1,200 feet  
*Mean annual precipitation:* 40 to 55 inches  
*Mean annual air temperature:* 48 to 57 degrees F  
*Frost-free period:* 150 to 192 days  
*Farmland classification:* All areas are prime farmland

#### Map Unit Composition

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

#### Description of Glenelg

##### Setting

*Landform:* Interfluves, hillslopes  
*Landform position (two-dimensional):* Summit, shoulder, backslope  
*Landform position (three-dimensional):* Interfluve, side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear, concave, convex  
*Parent material:* Residuum weathered from mica schist

##### Typical profile

*Ap - 0 to 8 inches:* silt loam  
*Bt1 - 8 to 18 inches:* clay loam  
*Bt2 - 18 to 30 inches:* clay loam  
*BCt - 30 to 42 inches:* loam  
*CBt - 42 to 54 inches:* loam  
*C - 54 to 76 inches:* channery fine sandy loam

##### Properties and qualities

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.57 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* High (about 10.4 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 2e  
*Hydrologic Soil Group:* C  
*Hydric soil rating:* No

## Minor Components

### Gaila

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

### Glenville

*Percent of map unit:* 5 percent  
*Landform:* Swales, drainageways  
*Landform position (two-dimensional):* Shoulder, backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Linear  
*Hydric soil rating:* No

## GIB—Glenville silt loam, 3 to 8 percent slopes

### Map Unit Setting

*National map unit symbol:* 2tmch  
*Elevation:* 20 to 1,090 feet  
*Mean annual precipitation:* 40 to 55 inches  
*Mean annual air temperature:* 48 to 57 degrees F  
*Frost-free period:* 150 to 192 days  
*Farmland classification:* All areas are prime farmland

### Map Unit Composition

*Glenville and similar soils:* 75 percent  
*Minor components:* 25 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Glenville

#### Setting

*Landform:* Swales, drainageways  
*Landform position (two-dimensional):* Footslope, backslope  
*Landform position (three-dimensional):* Head slope, base slope, interfluvium  
*Down-slope shape:* Linear, concave  
*Across-slope shape:* Concave, linear  
*Parent material:* Colluvium derived from metamorphic rock over schist, gneiss or phyllite residuum

#### Typical profile

*Ap - 0 to 11 inches:* silt loam  
*Bt1 - 11 to 20 inches:* channery silt loam  
*Bt2 - 20 to 30 inches:* silt loam

## Custom Soil Resource Report

*Btx - 30 to 40 inches:* silt loam  
*C1 - 40 to 59 inches:* loam  
*C2 - 59 to 82 inches:* loam

### Properties and qualities

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* 29 to 31 inches to fragipan  
*Natural drainage class:* Moderately well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low (0.03 to 0.11 in/hr)  
*Depth to water table:* About 18 to 22 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

#### Unnamed

*Percent of map unit:* 15 percent  
*Landform:* Drainageways  
*Landform position (two-dimensional):* Footslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Linear, concave  
*Across-slope shape:* Concave, linear  
*Hydric soil rating:* No

#### Baile

*Percent of map unit:* 10 percent  
*Landform:* Swales, drainageways  
*Landform position (two-dimensional):* Footslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Concave, linear  
*Across-slope shape:* Linear, concave  
*Hydric soil rating:* Yes

**ATTACHMENT C**  
**HYDRAFLOW RESULTS**



**ATTACHMENT C-1  
BOOT RD  
1 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot Rd - 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# 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               | 2.428           | 1                   | 717                | 4,614                 | -----         | -----                    | -----                   | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 1 Year |               | Wednesday, 11 / 9 / 2016 |                         |                        |

# Hydrograph Report

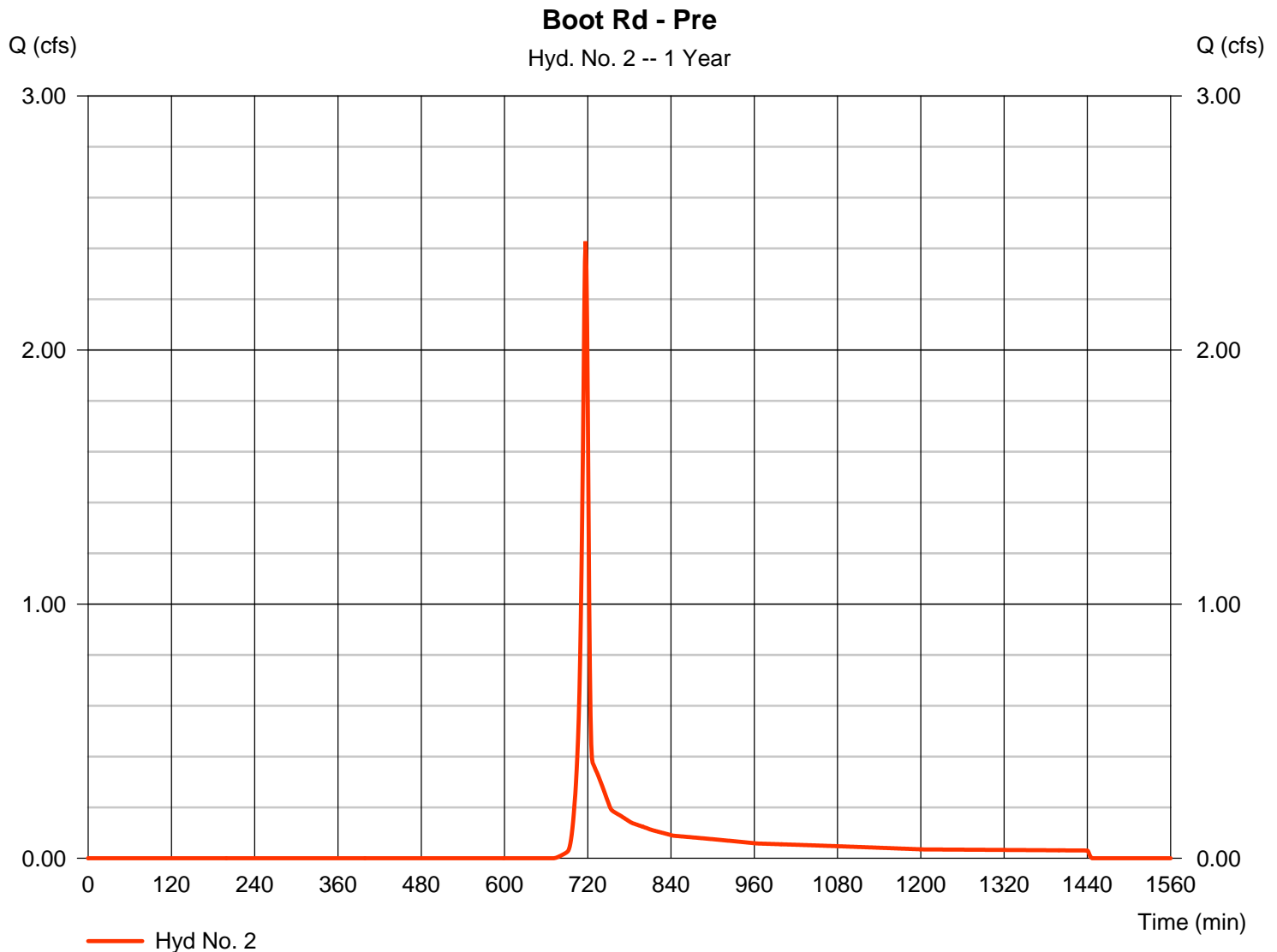
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.428 cfs  |
| Storm frequency | = 1 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,614 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min   |
| Total precip.   | = 2.70 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

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 484.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 3.70        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.10        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.60</b> | <b>=</b> | <b>2.70</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.50 min</b> |



**ATTACHMENT C-2**  
**BOOT RD**  
**2 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# Hydrograph Summary Report

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

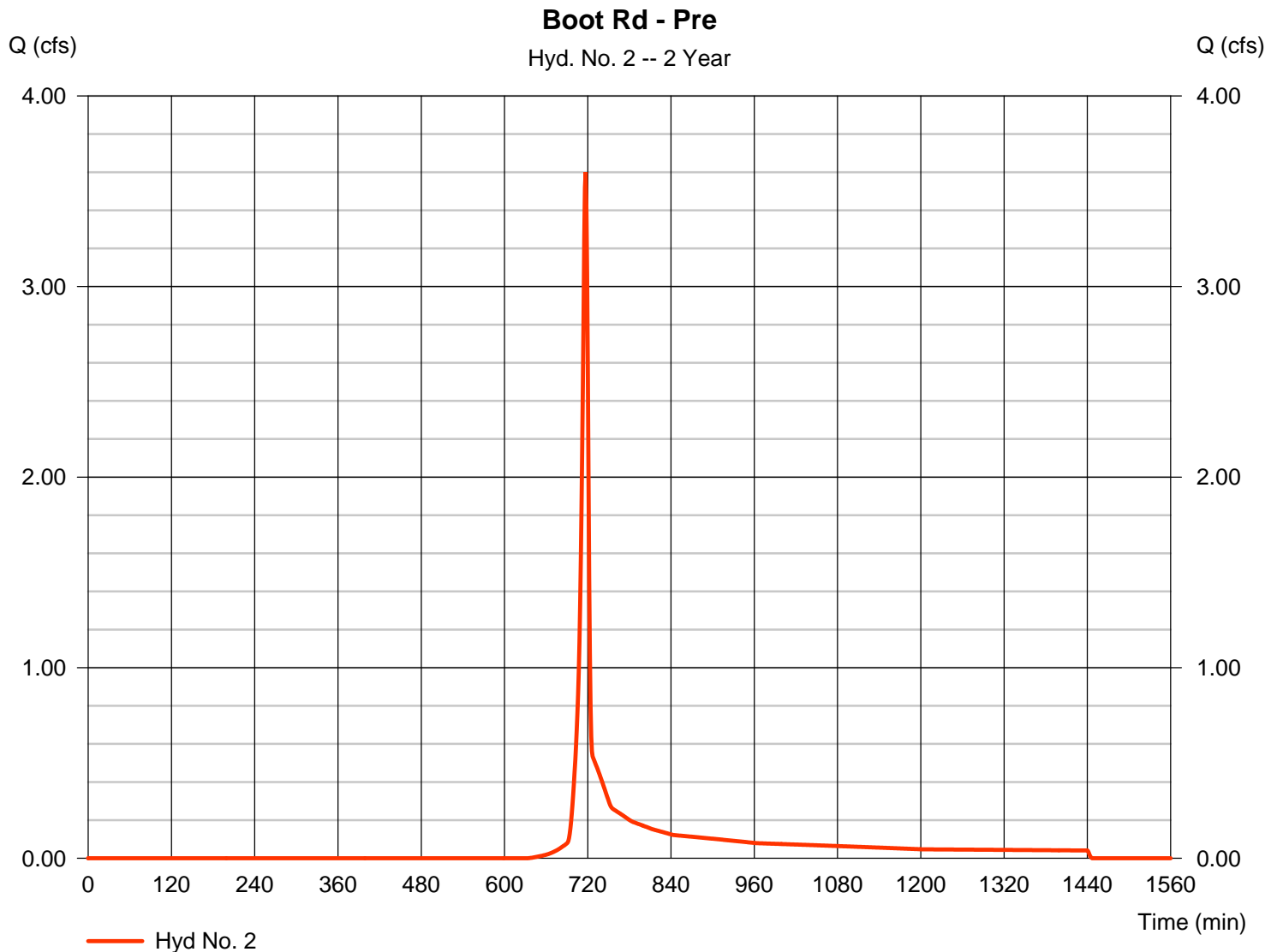
| Hyd. No.          | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft)   | Total strge used (cuft) | Hydrograph Description |
|-------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|--------------------------|-------------------------|------------------------|
| 2                 | SCS Runoff               | 3.600           | 1                   | 717                | 6,756                 | -----         | -----                    | -----                   | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 2 Year |               | Wednesday, 11 / 9 / 2016 |                         |                        |

# Hydrograph Report

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.600 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 6,756 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min   |
| Total precip.   | = 3.25 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

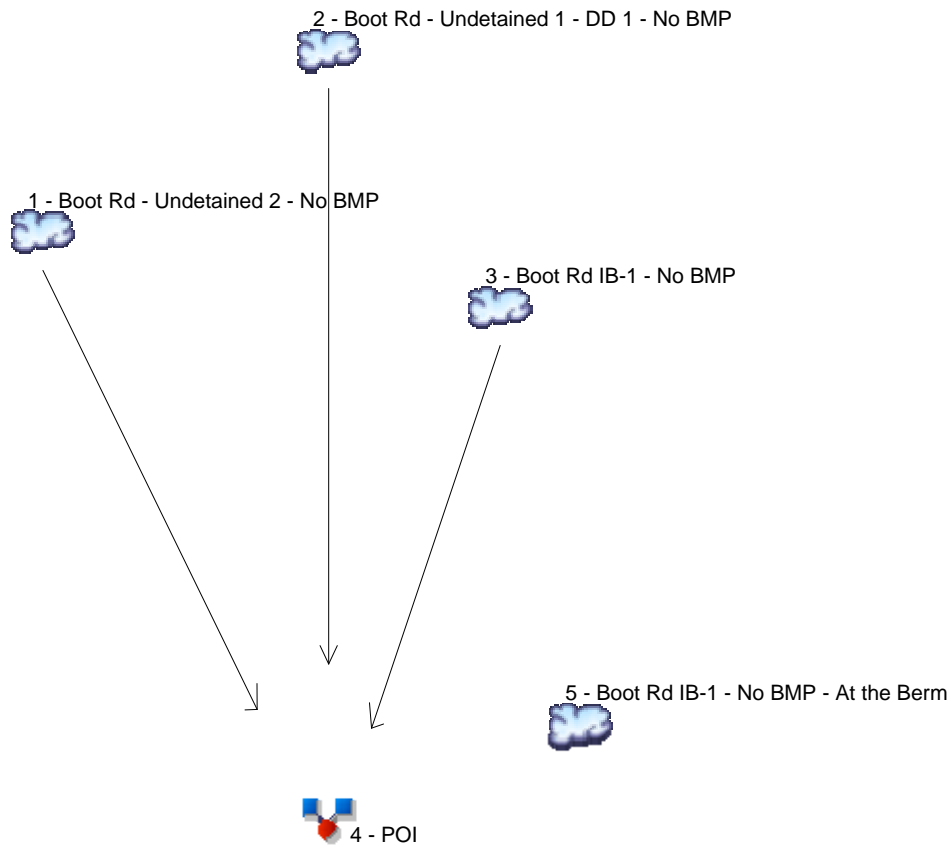
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 484.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 3.70                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.10                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.60</b> | <b>= 2.70</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.50 min</b> |

# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# 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               | 0.540           | 1                   | 716                | 955                   | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |
| 2                           | SCS Runoff               | 2.368           | 1                   | 717                | 4,438                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |
| 3                           | SCS Runoff               | 1.152           | 1                   | 716                | 2,006                 | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |
| 4                           | Combine                  | 4.012           | 1                   | 716                | 7,399                 | 1, 2, 3       | -----                  | -----                    | POI                                  |
| 5                           | SCS Runoff               | 0.907           | 1                   | 716                | 1,591                 | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |

# Hydrograph Report

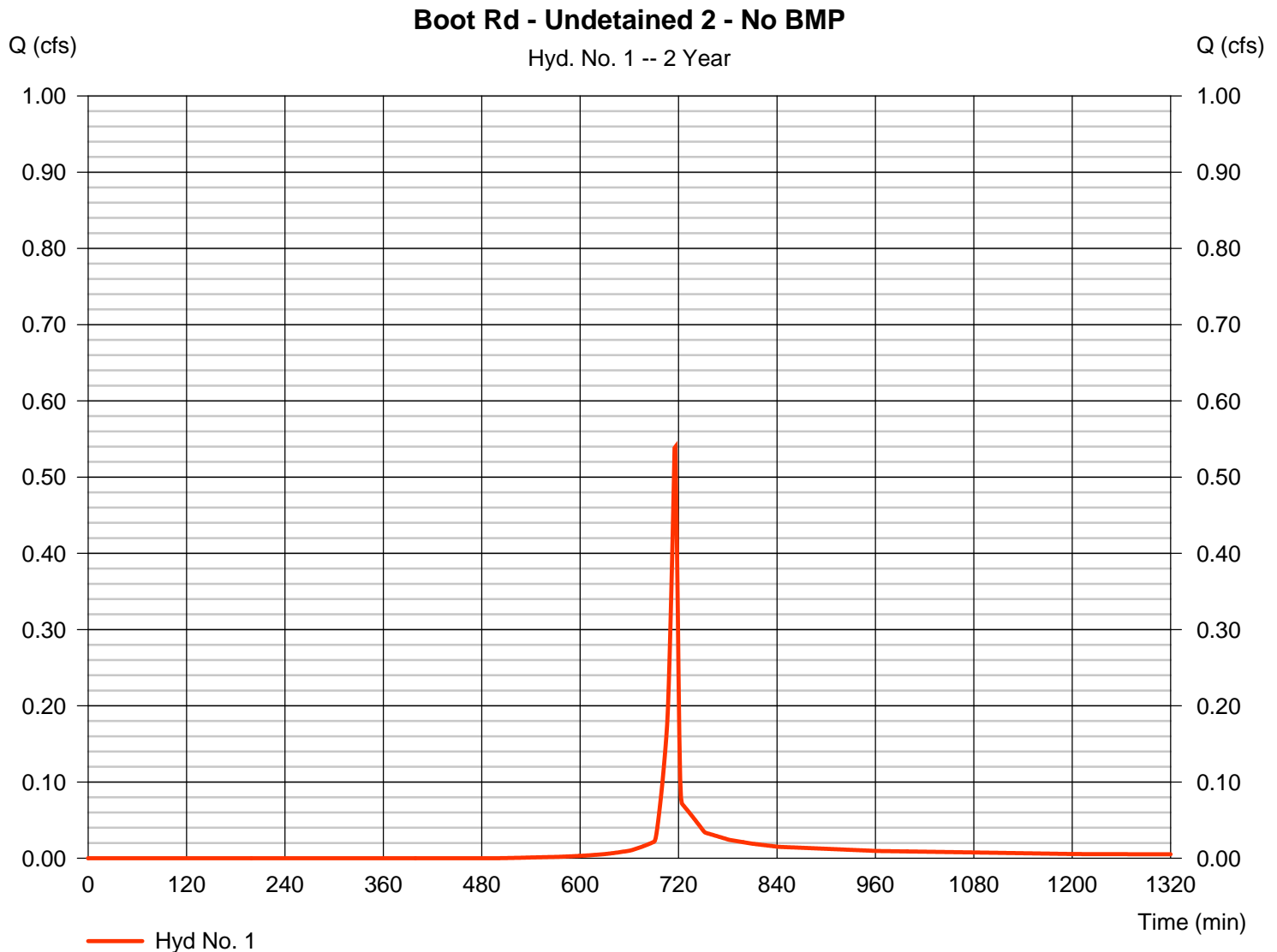
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.540 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 955 cuft  |
| Drainage area   | = 0.170 ac   | Curve number       | = 83        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min  |
| Total precip.   | = 3.25 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

Boot Rd - Undetained 2 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 50.00       | 280.00               | 0.00                 |                 |
| Watercourse slope (%)              | = 4.00        | 4.30                 | 0.00                 |                 |
| Surface description                | = Paved       | Unpaved              | Paved                |                 |
| Average velocity (ft/s)            | =4.07         | 3.35                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> <b>1.39</b> | <b>+</b> <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.40 min</b> |

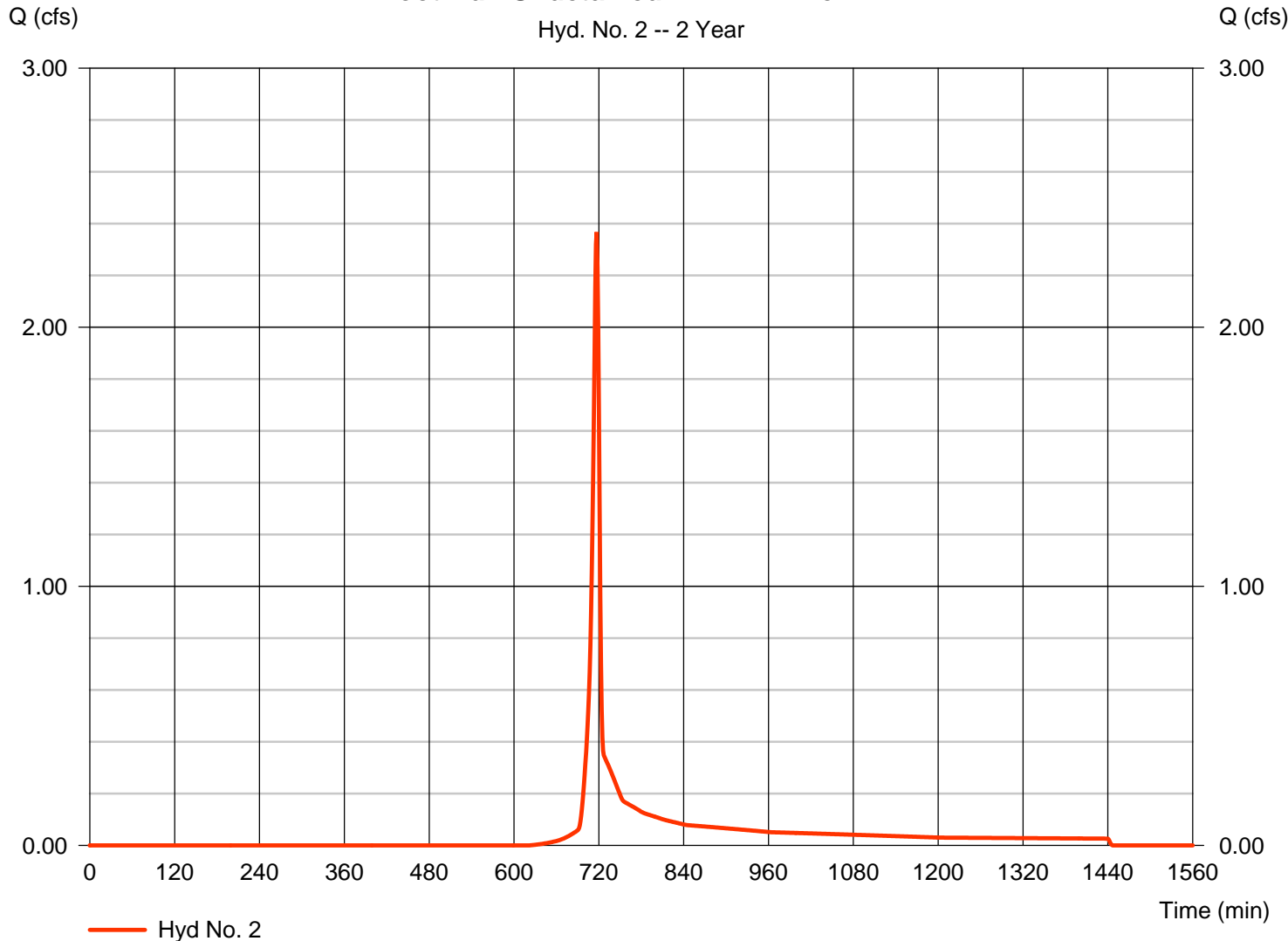
# Hydrograph Report

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.368 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,438 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd - Undetained 1 - DD 1 - No BMP**



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 408.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 4.10        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.27        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.08</b> | <b>=</b> | <b>2.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 5.40        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 7.46        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 2.00        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.070       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =2.42         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | {{0}}100.0    |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.69</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.70 min</b> |

# Hydrograph Report

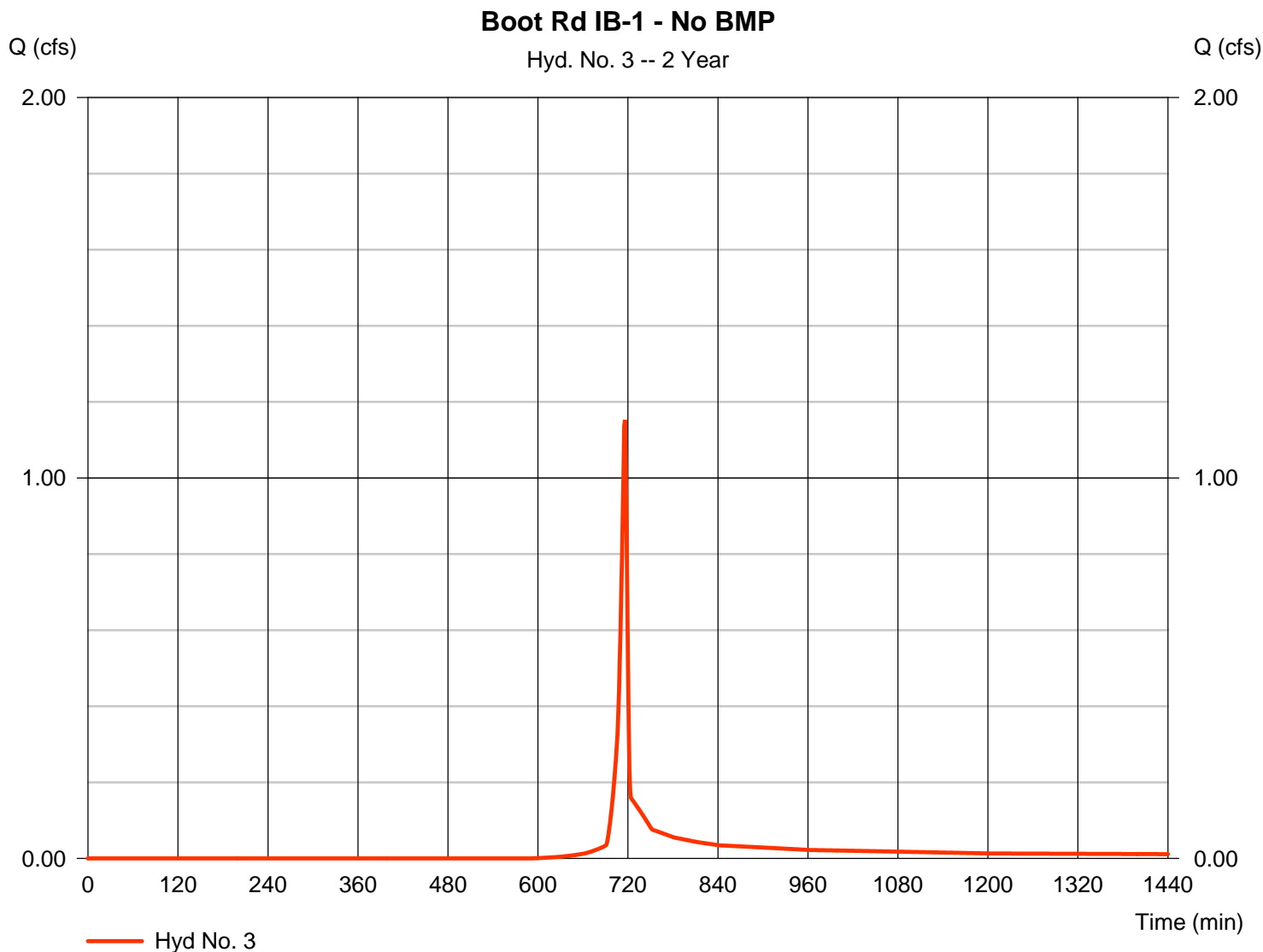
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.152 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,006 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 3.25 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 247.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>1.43</b> | <b>= 1.93</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.80 min</b> |

# Hydrograph Report

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

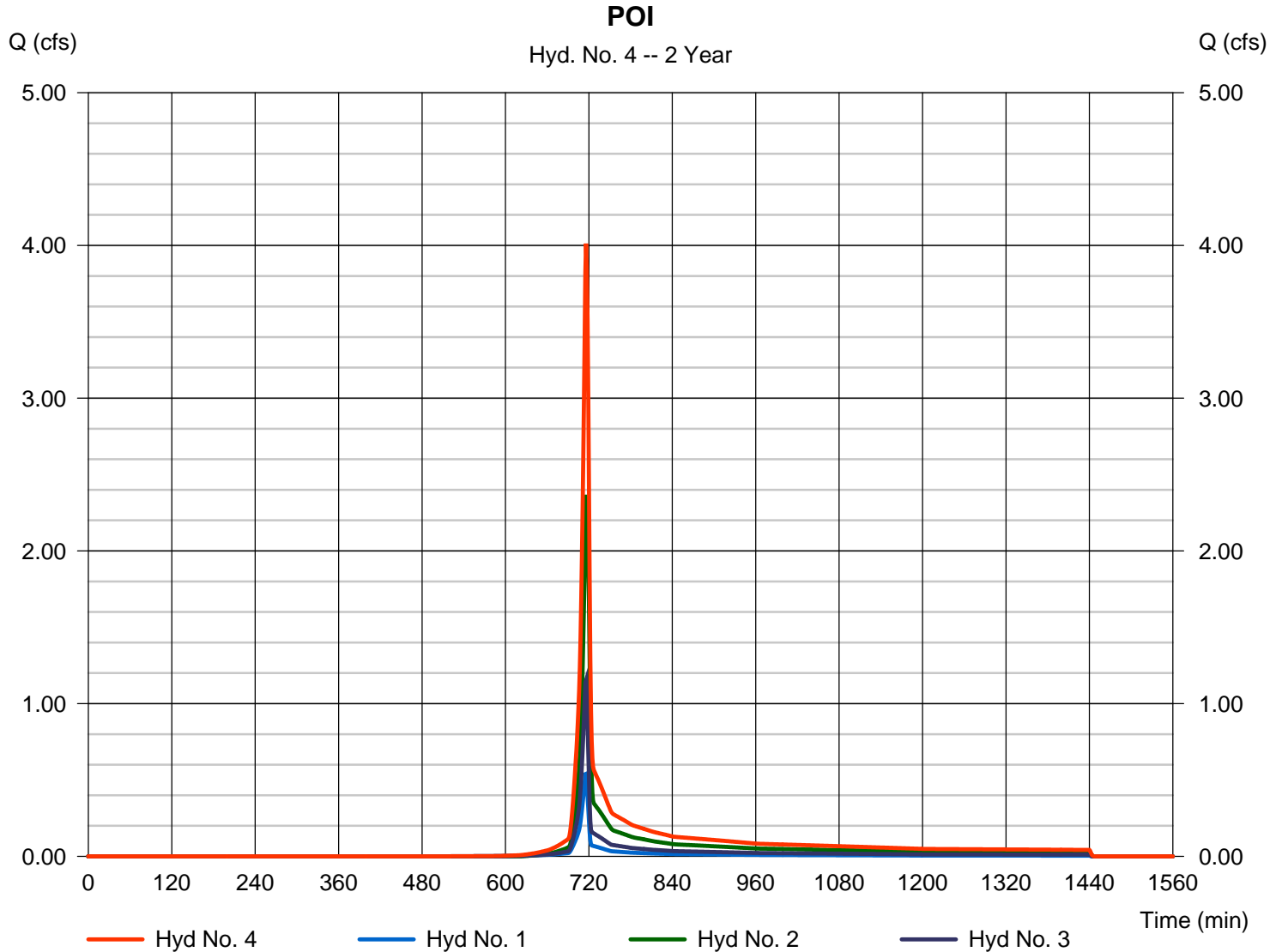
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

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

Peak discharge = 4.012 cfs  
Time to peak = 716 min  
Hyd. volume = 7,399 cuft  
Contrib. drain. area = 1.650 ac



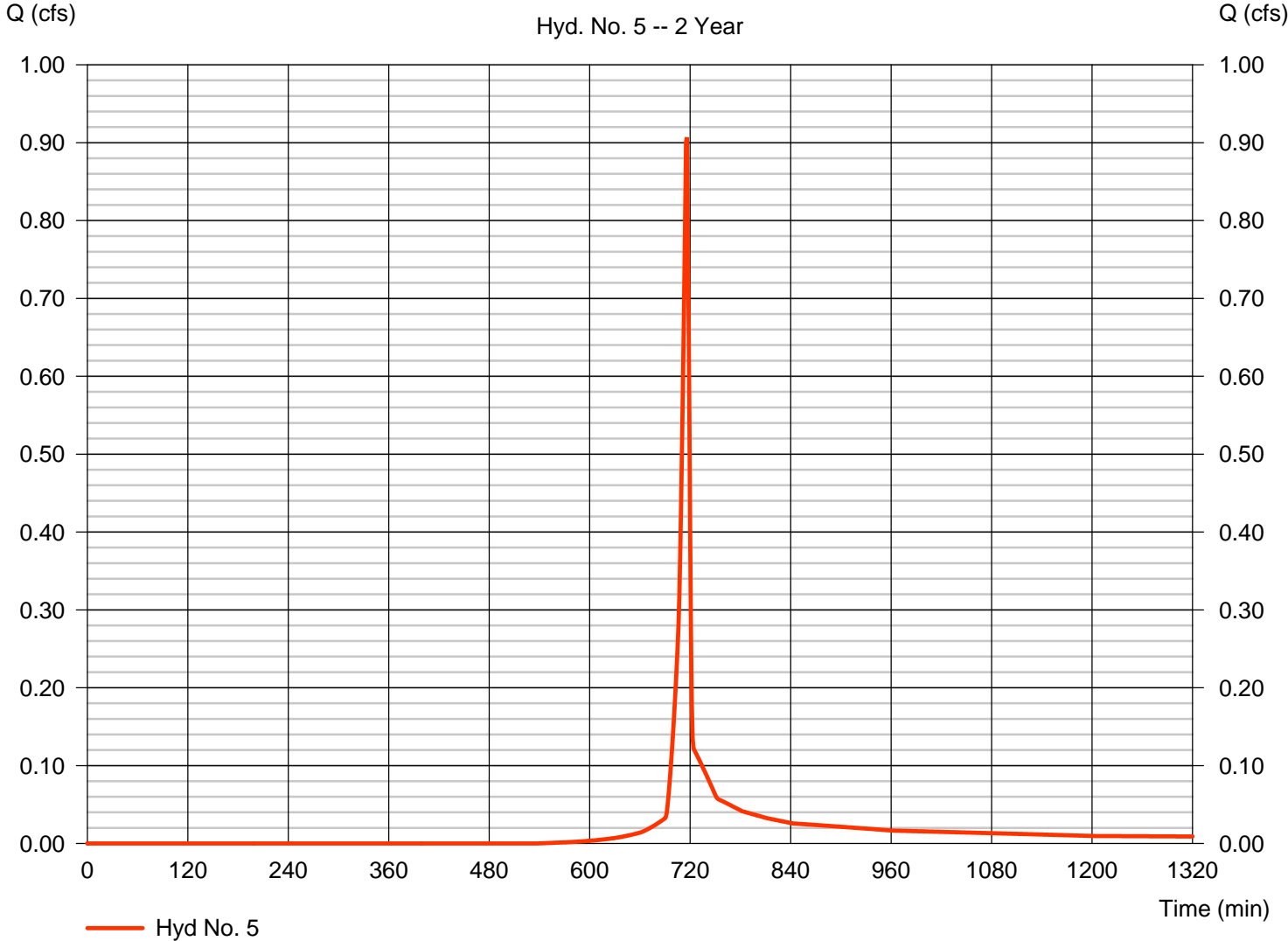
# Hydrograph Report

## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.907 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,591 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd IB-1 - No BMP - At the Berm**



# TR55 Tc Worksheet

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

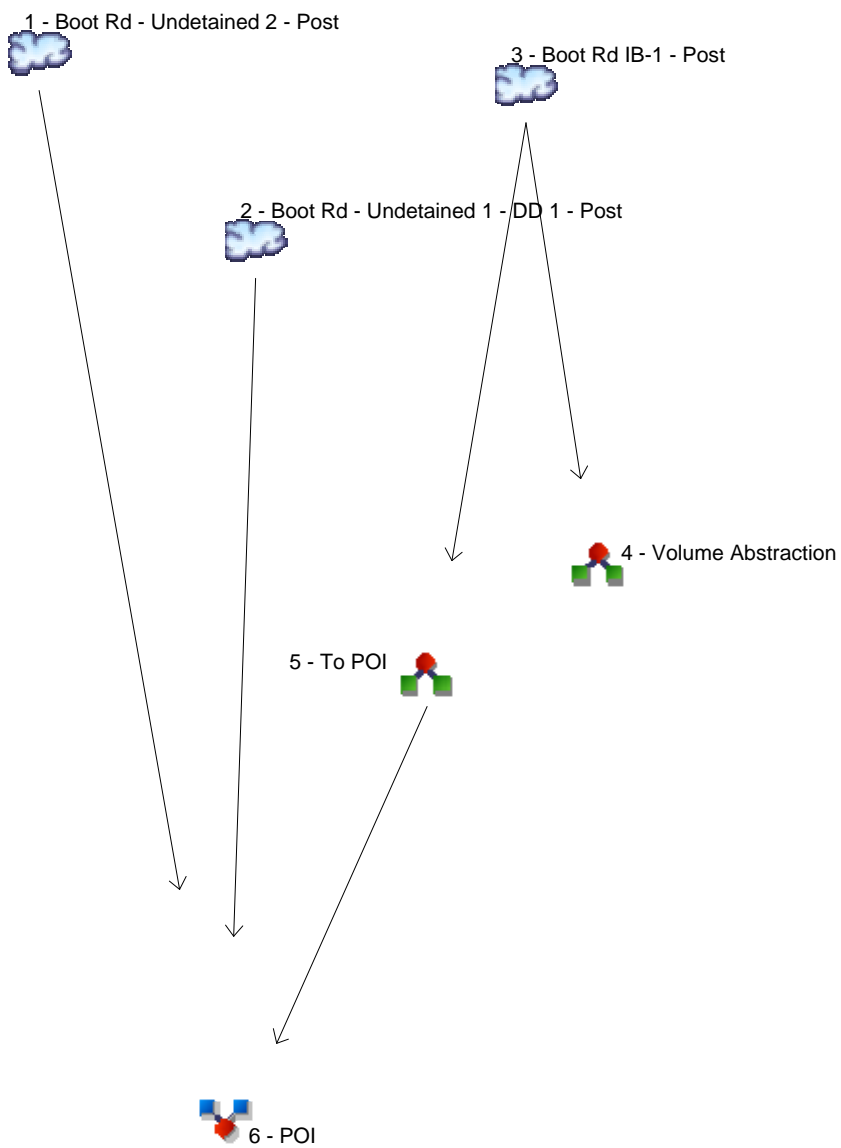
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.91</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 35.00       |          | 100.00      |          | 100.00      |          |                 |
| Watercourse slope (%)              | = 8.50        |          | 6.50        |          | 3.20        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.93         |          | 4.11        |          | 2.89        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.41</b> | <b>+</b> | <b>0.58</b> | <b>=</b> | <b>1.08</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>2.00 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.540 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | 2.368 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | 0.504 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | 0.504 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | 0.031 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | 2.860 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | 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               | 0.540           | 1                   | 716                | 955                   | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                           | SCS Runoff               | 2.368           | 1                   | 717                | 4,438                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                           | SCS Runoff               | 0.504           | 1                   | 733                | 2,154                 | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                           | Diversion1               | 0.504           | 1                   | 733                | 1,591                 | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                           | Diversion2               | 0.031           | 1                   | 921                | 563                   | 3             | -----                  | -----                    | To POI                               |  |
| 6                           | Combine                  | 2.860           | 1                   | 716                | 5,955                 | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 2 year.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

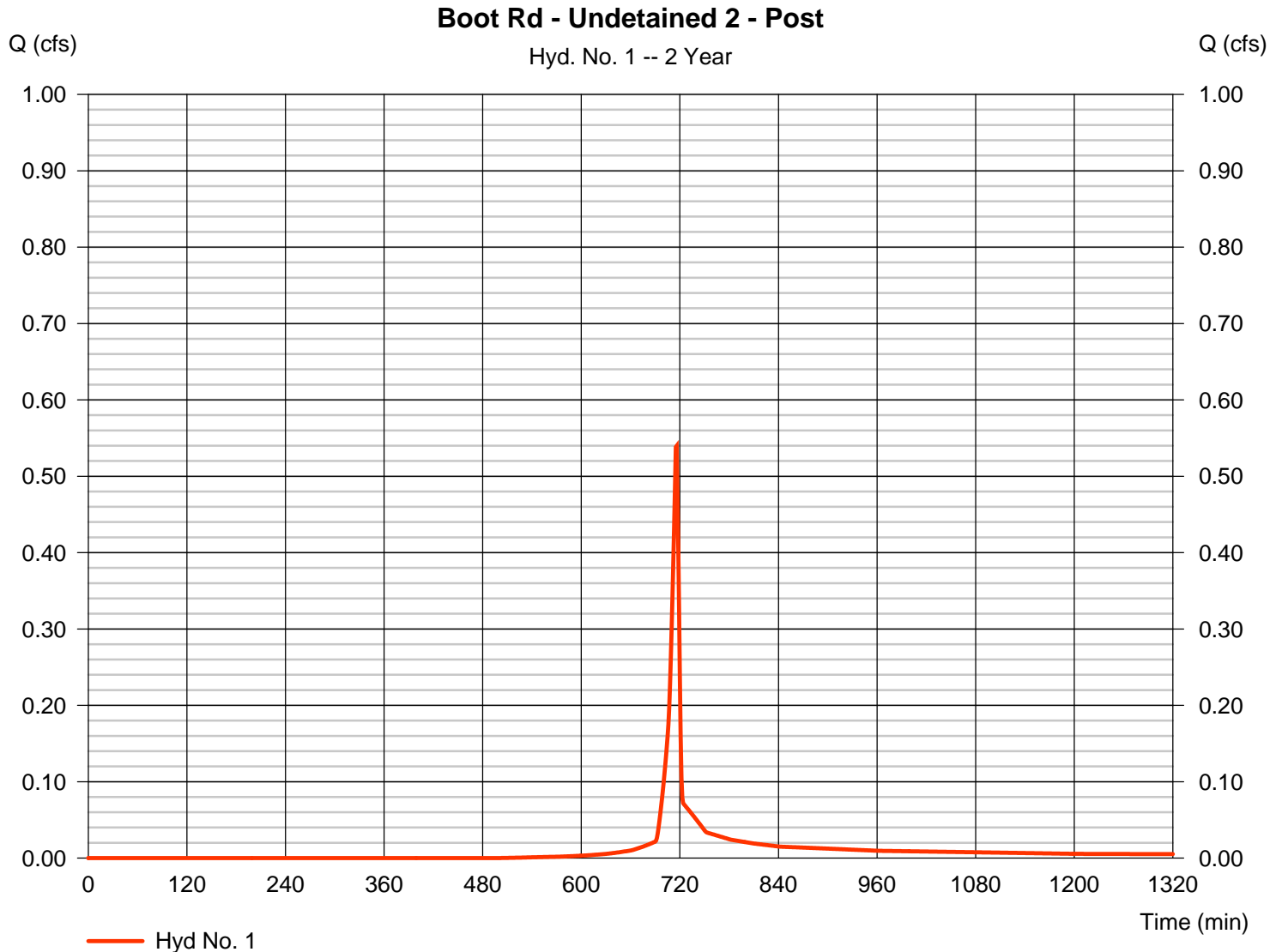
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.540 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 955 cuft  |
| Drainage area   | = 0.170 ac   | Curve number       | = 83        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min  |
| Total precip.   | = 3.25 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

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

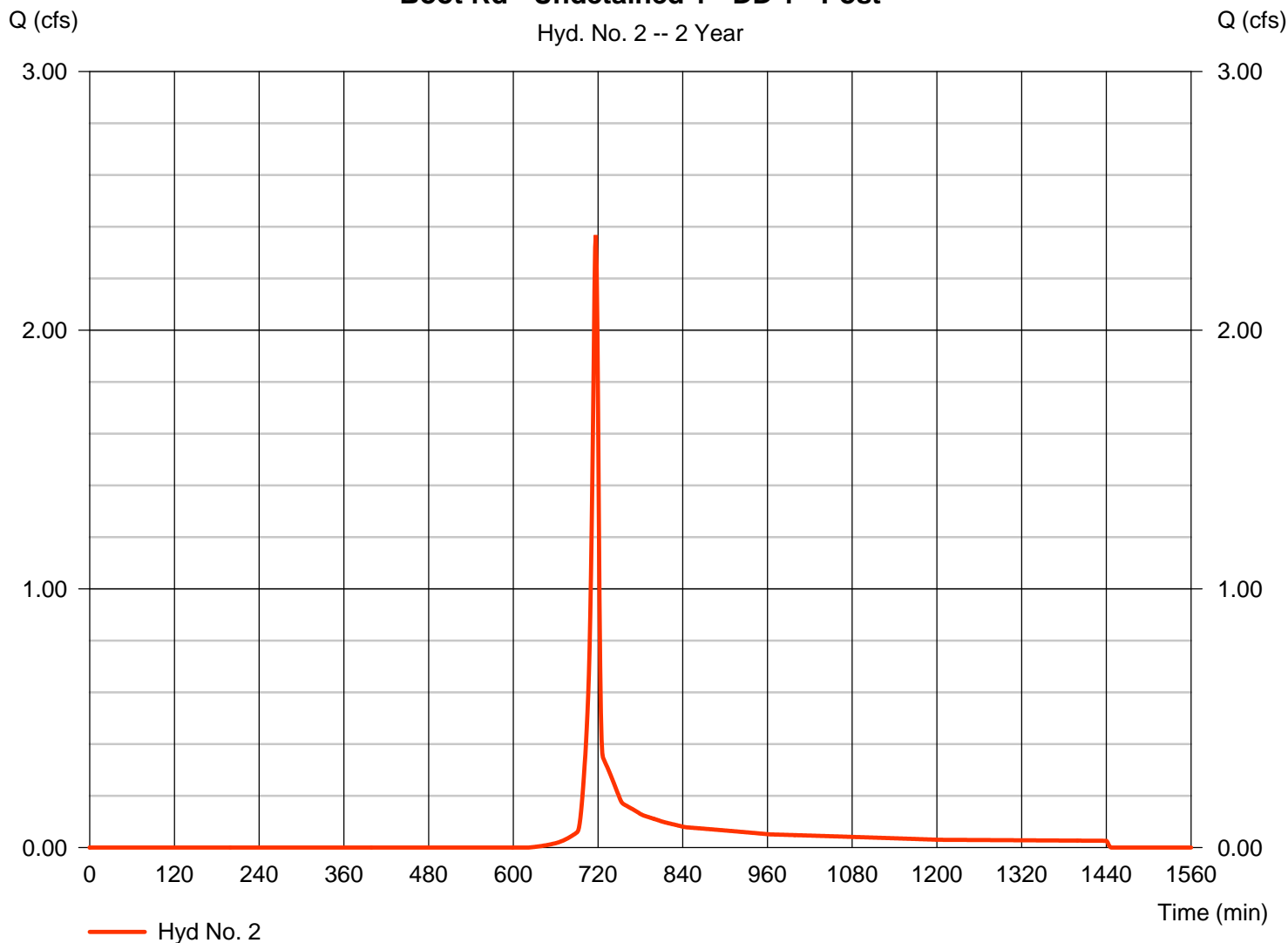
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.368 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,438 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd - Undetained 1 - DD 1 - Post**



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

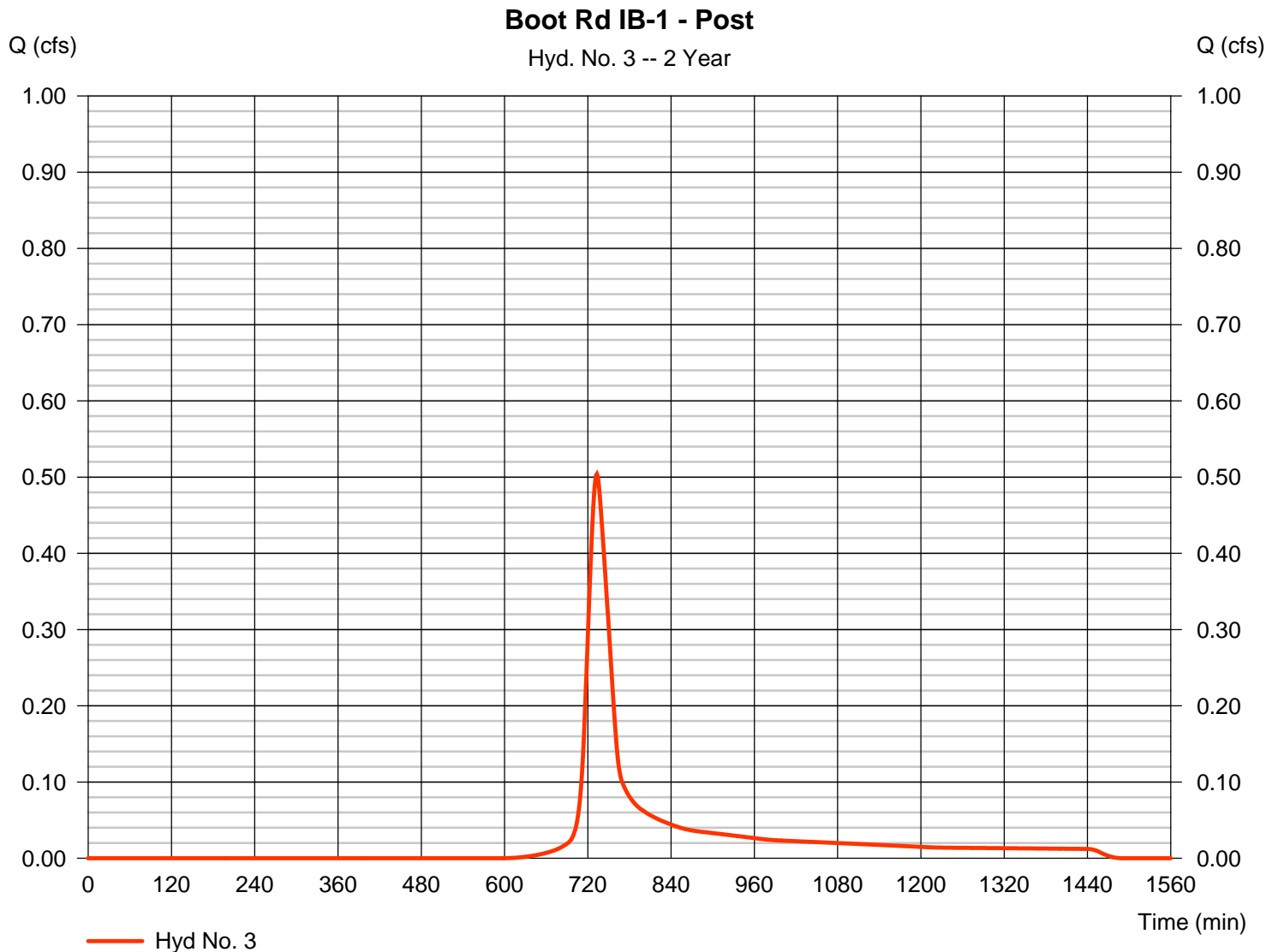
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Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.504 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 733 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,154 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 31.90 min  |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

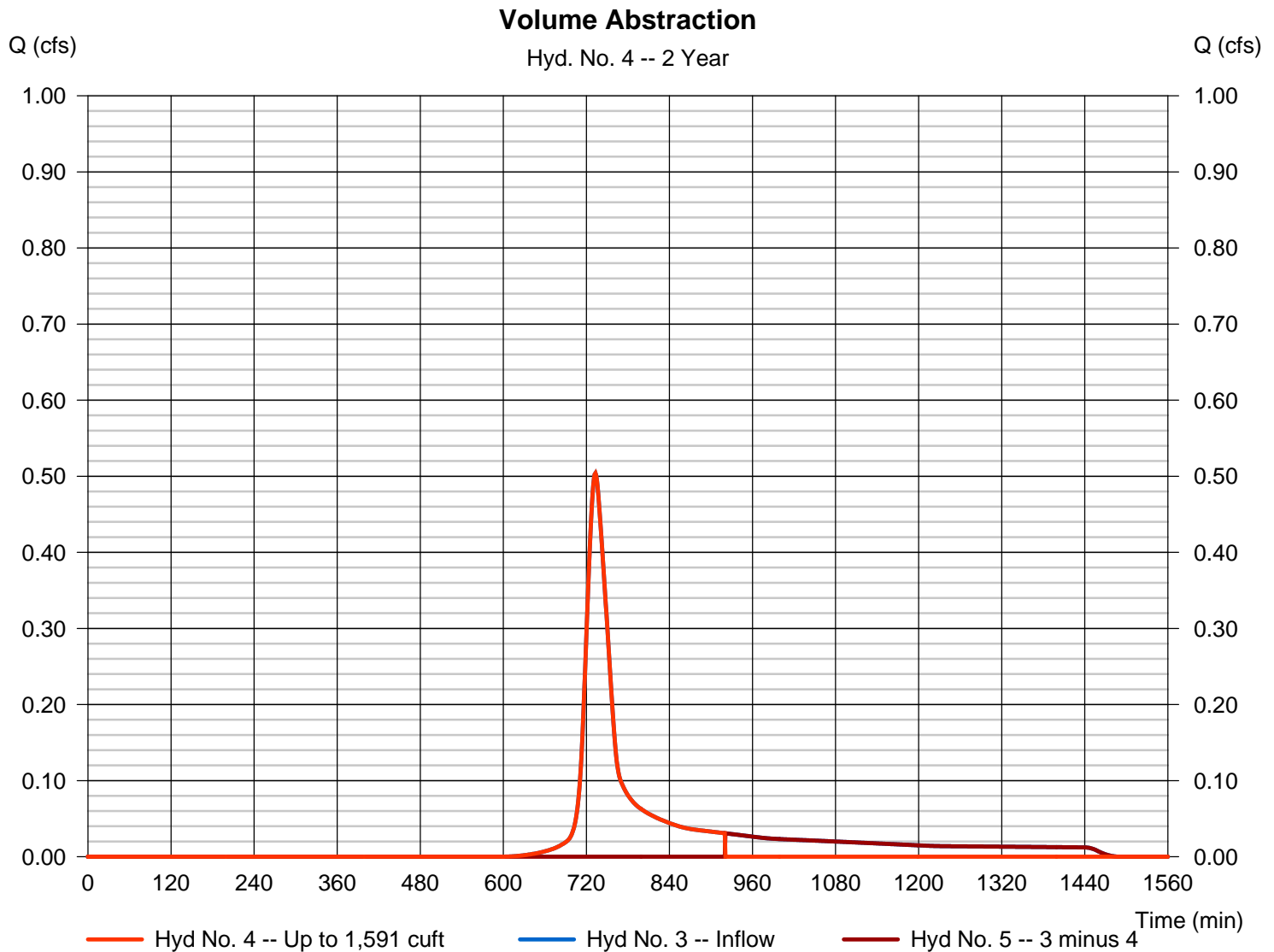


# Hydrograph Report

## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.504 cfs  |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 733 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,591 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,591 cuft |



# Hydrograph Report

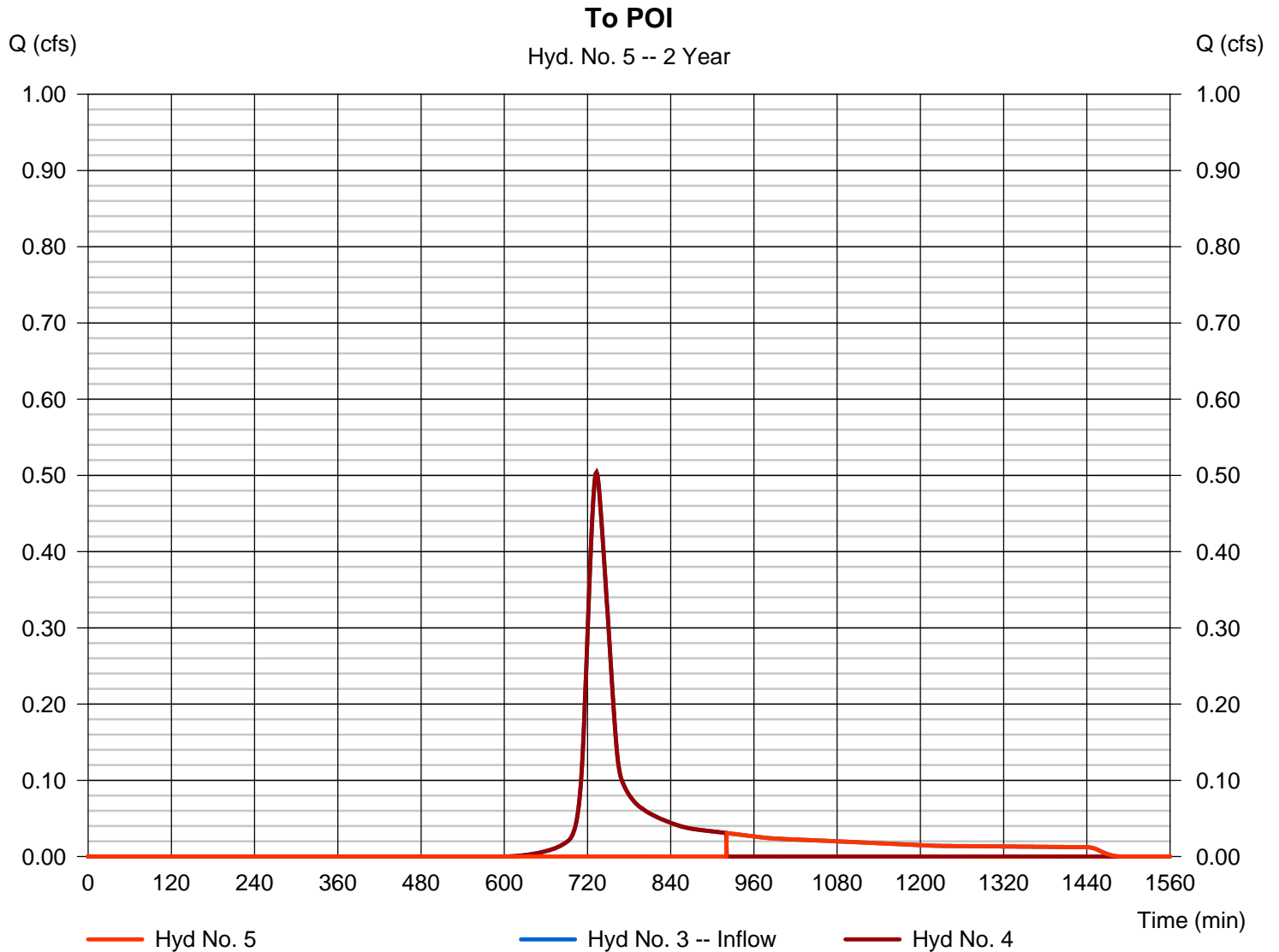
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Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.031 cfs  |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 921 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 563 cuft   |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,591 cuft |



# Hydrograph Report

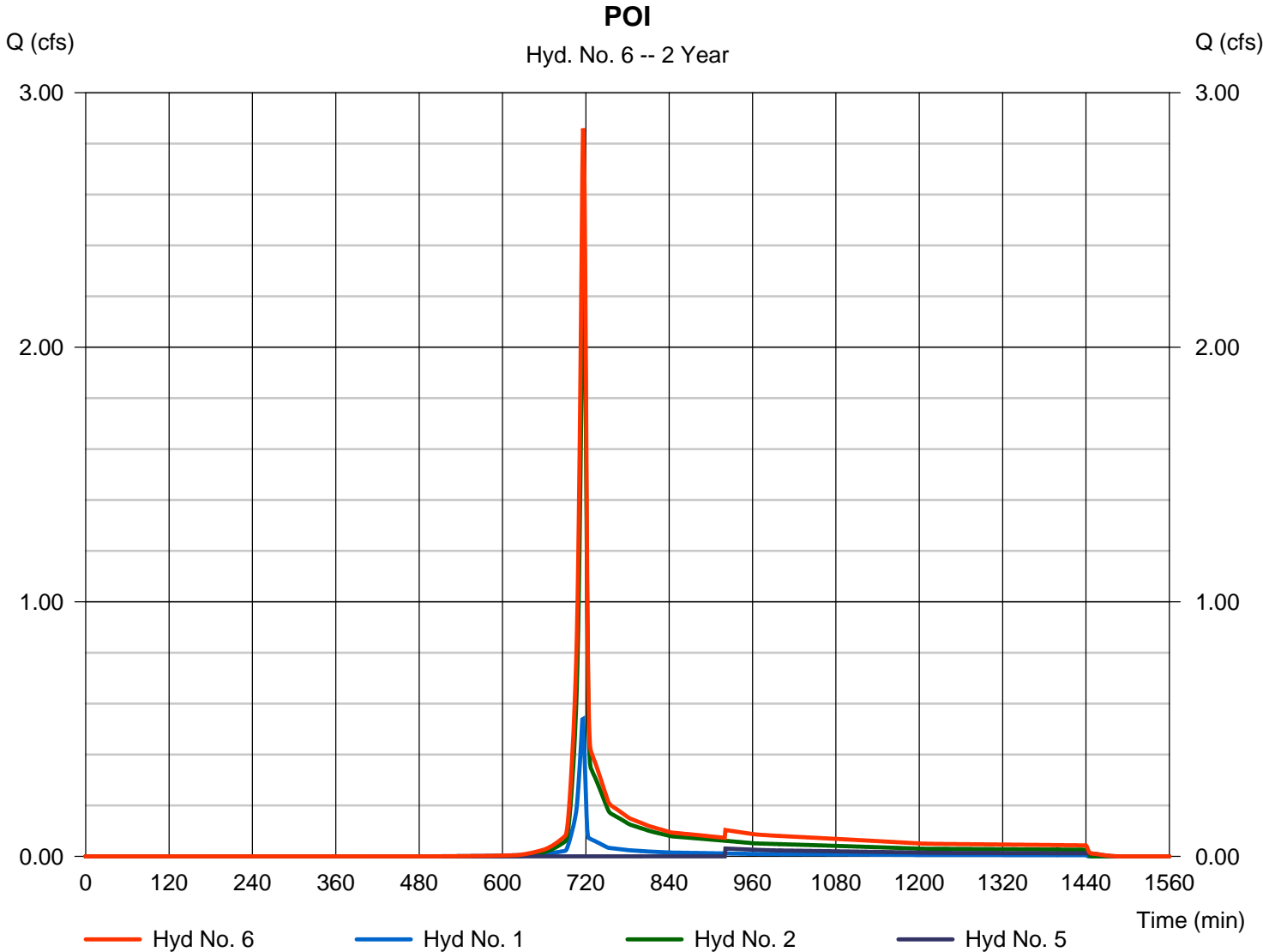
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Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 2.860 cfs  |
| Storm frequency | = 2 yrs   | Time to peak         | = 716 min    |
| Time interval   | = 1 min   | Hyd. volume          | = 5,955 cuft |
| Inflow hyds.    | = 1, 2, 5 | Contrib. drain. area | = 1.200 ac   |



**ATTACHMENT C-3**  
**BOOT RD**  
**5 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# 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               | 5.515           | 1                   | 717                | 10,343                | -----         | -----                  | -----                    | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |

# Hydrograph Report

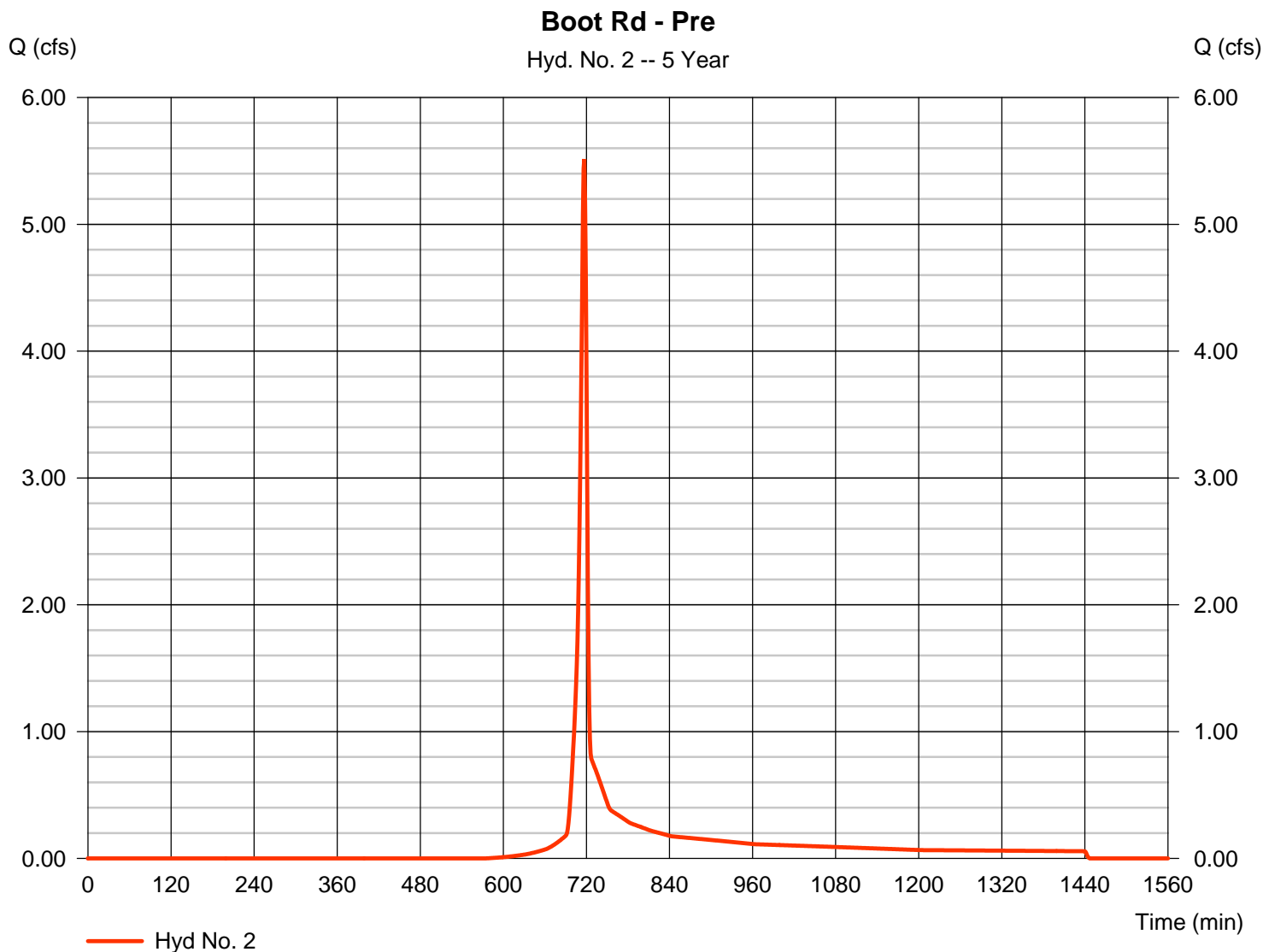
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 5.515 cfs   |
| Storm frequency | = 5 yrs      | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 10,343 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min    |
| Total precip.   | = 4.08 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

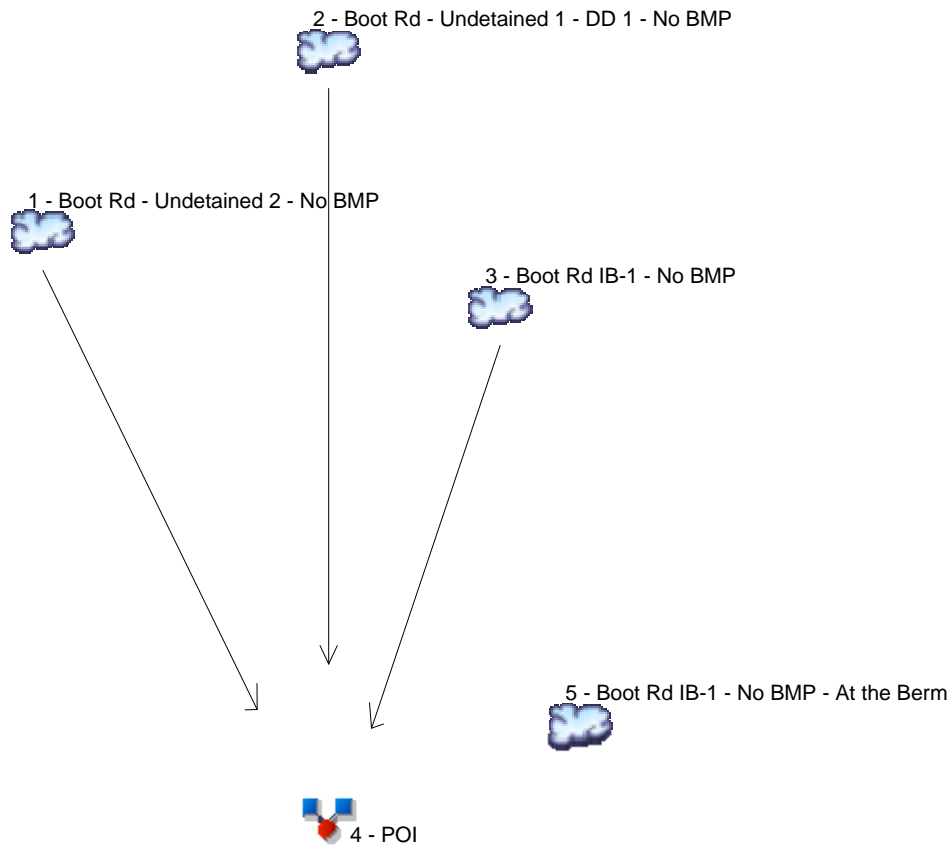
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 484.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 3.70                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.10                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.60</b> | <b>= 2.70</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.50 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# Hydrograph Summary Report

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

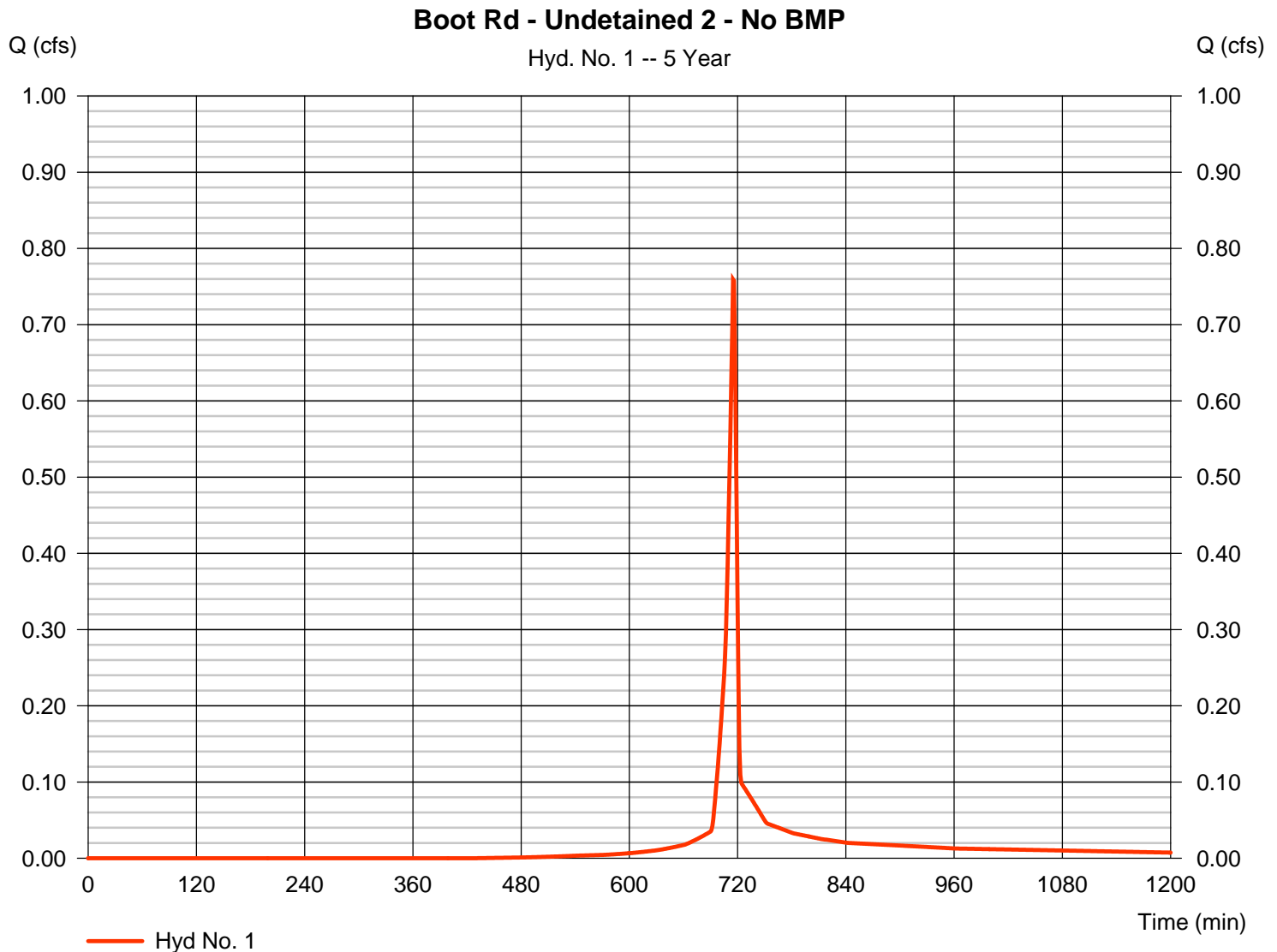
| Hyd. No.                    | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |  |
|-----------------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|------------------------|--------------------------|--------------------------------------|--|
| 1                           | SCS Runoff               | 0.759           | 1                   | 715                | 1,363                 | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |  |
| 2                           | SCS Runoff               | 3.583           | 1                   | 717                | 6,730                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |  |
| 3                           | SCS Runoff               | 1.698           | 1                   | 716                | 2,988                 | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |  |
| 4                           | Combine                  | 5.998           | 1                   | 716                | 11,081                | 1, 2, 3       | -----                  | -----                    | POI                                  |  |
| 5                           | SCS Runoff               | 1.297           | 1                   | 716                | 2,309                 | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.759 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,363 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.08 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

Boot Rd - Undetained 2 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| 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)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 5.00        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 50.00       | 280.00        | 0.00          |                 |
| Watercourse slope (%)              | = 4.00        | 4.30          | 0.00          |                 |
| Surface description                | = Paved       | Unpaved       | Paved         |                 |
| Average velocity (ft/s)            | =4.07         | 3.35          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+ 1.39</b> | <b>+ 0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| 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           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>2.40 min</b> |

# Hydrograph Report

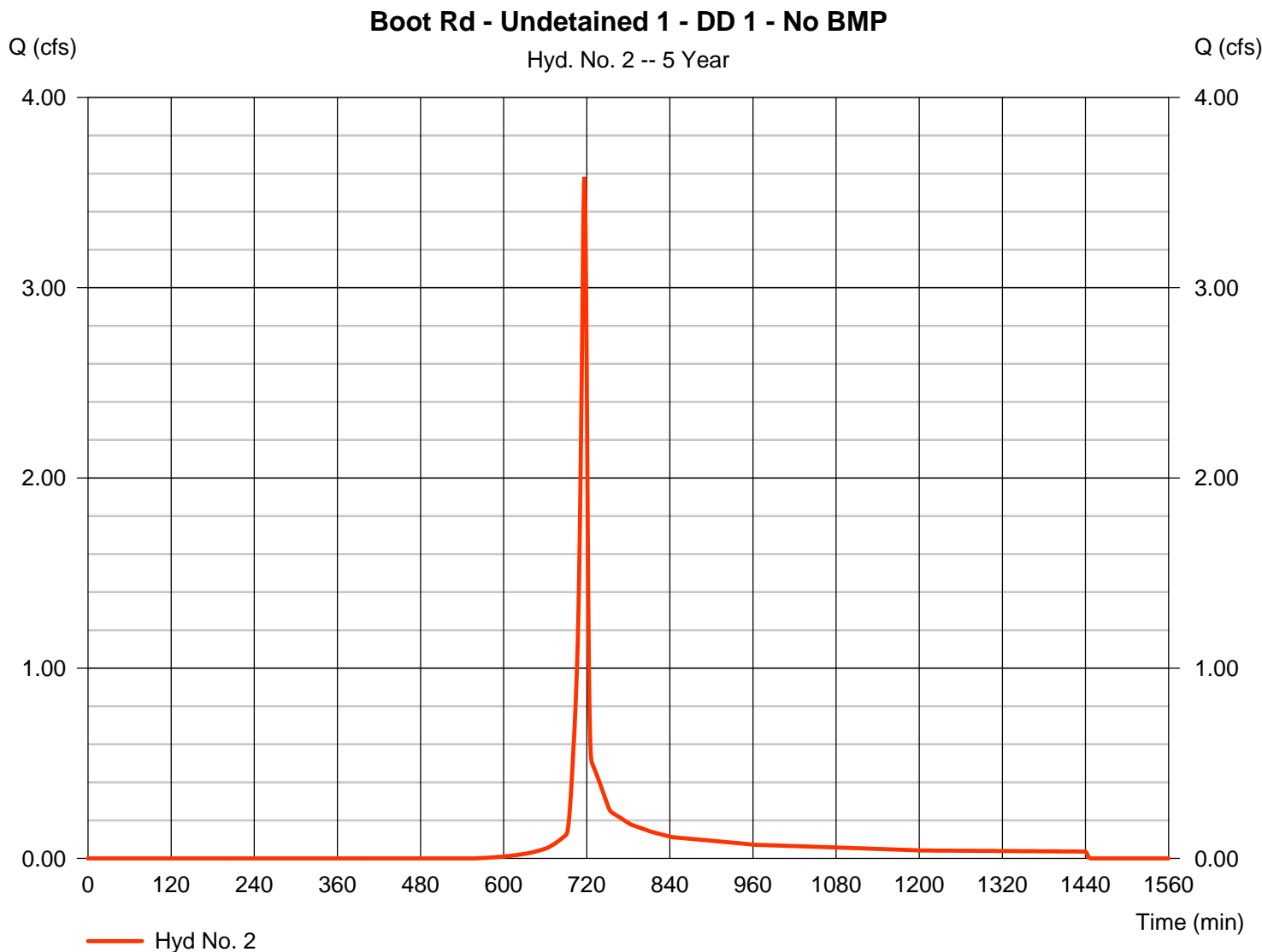
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.583 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 6,730 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 4.08 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

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| 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)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 5.00        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 13.00       | 27.00         | 408.00        |                 |
| Watercourse slope (%)              | = 7.70        | 18.50         | 4.10          |                 |
| Surface description                | = Paved       | Unpaved       | Unpaved       |                 |
| Average velocity (ft/s)            | =5.64         | 6.94          | 3.27          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+ 0.06</b> | <b>+ 2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00          | 0.00          |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00          | 0.00          |                 |
| Channel slope (%)                  | = 2.00        | 0.00          | 0.00          |                 |
| Manning's n-value                  | = 0.070       | 0.015         | 0.015         |                 |
| Velocity (ft/s)                    | =2.42         | 0.00          | 0.00          |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0           | 0.0           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>3.70 min</b> |

# Hydrograph Report

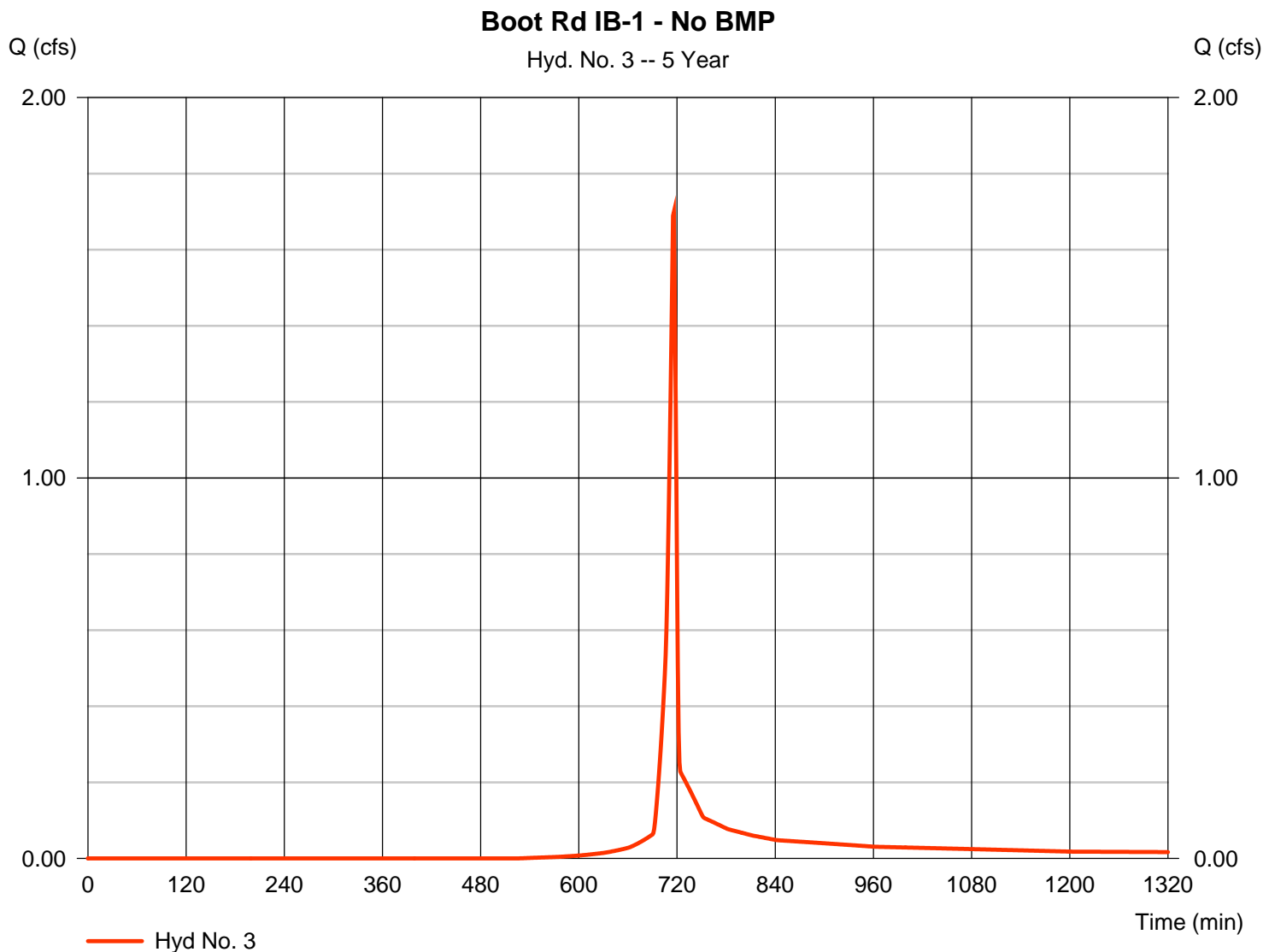
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.698 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,988 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 4.08 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 247.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>1.43</b> | <b>= 1.93</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.80 min</b> |

# Hydrograph Report

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

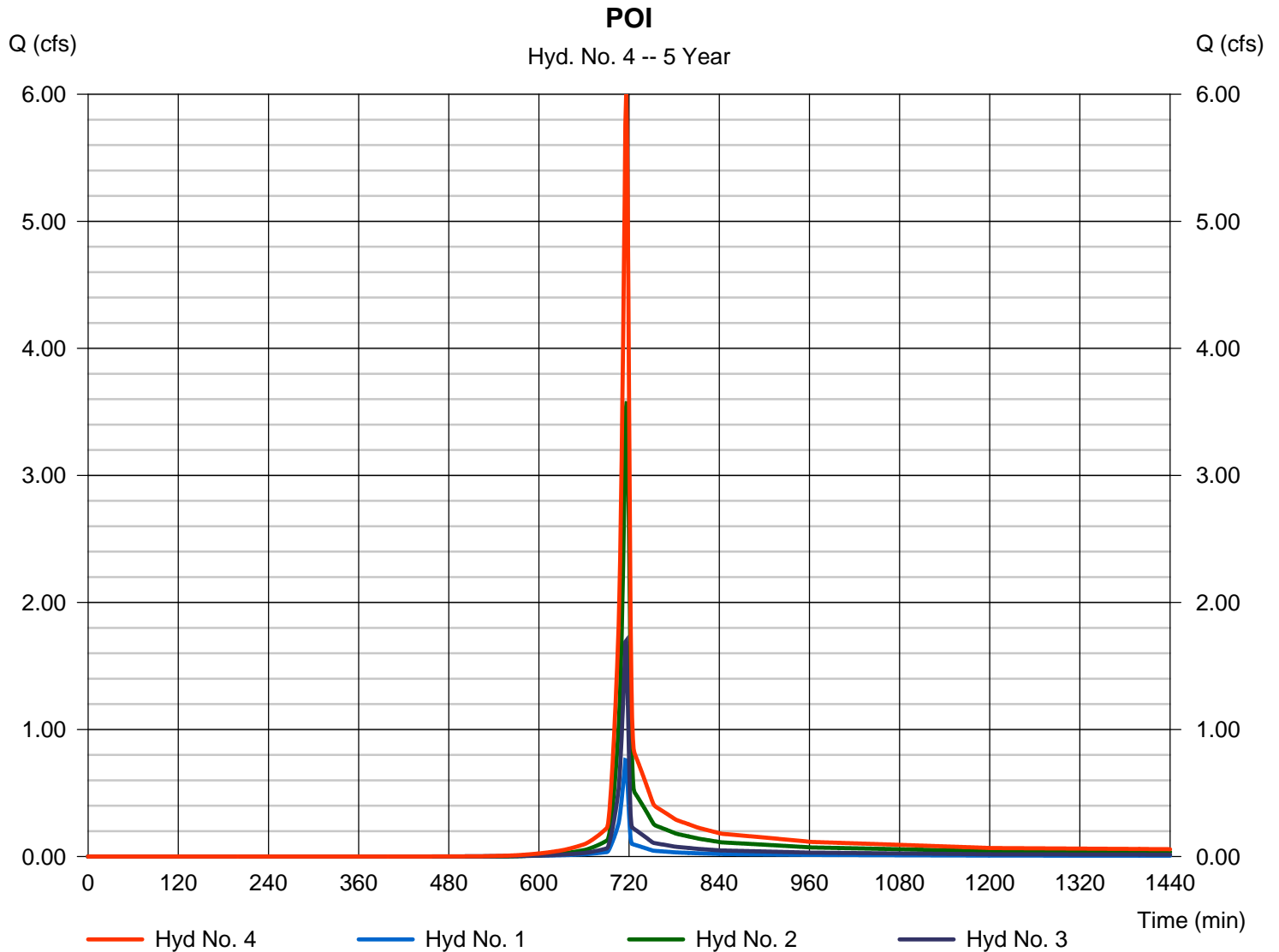
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

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

Peak discharge = 5.998 cfs  
Time to peak = 716 min  
Hyd. volume = 11,081 cuft  
Contrib. drain. area = 1.650 ac

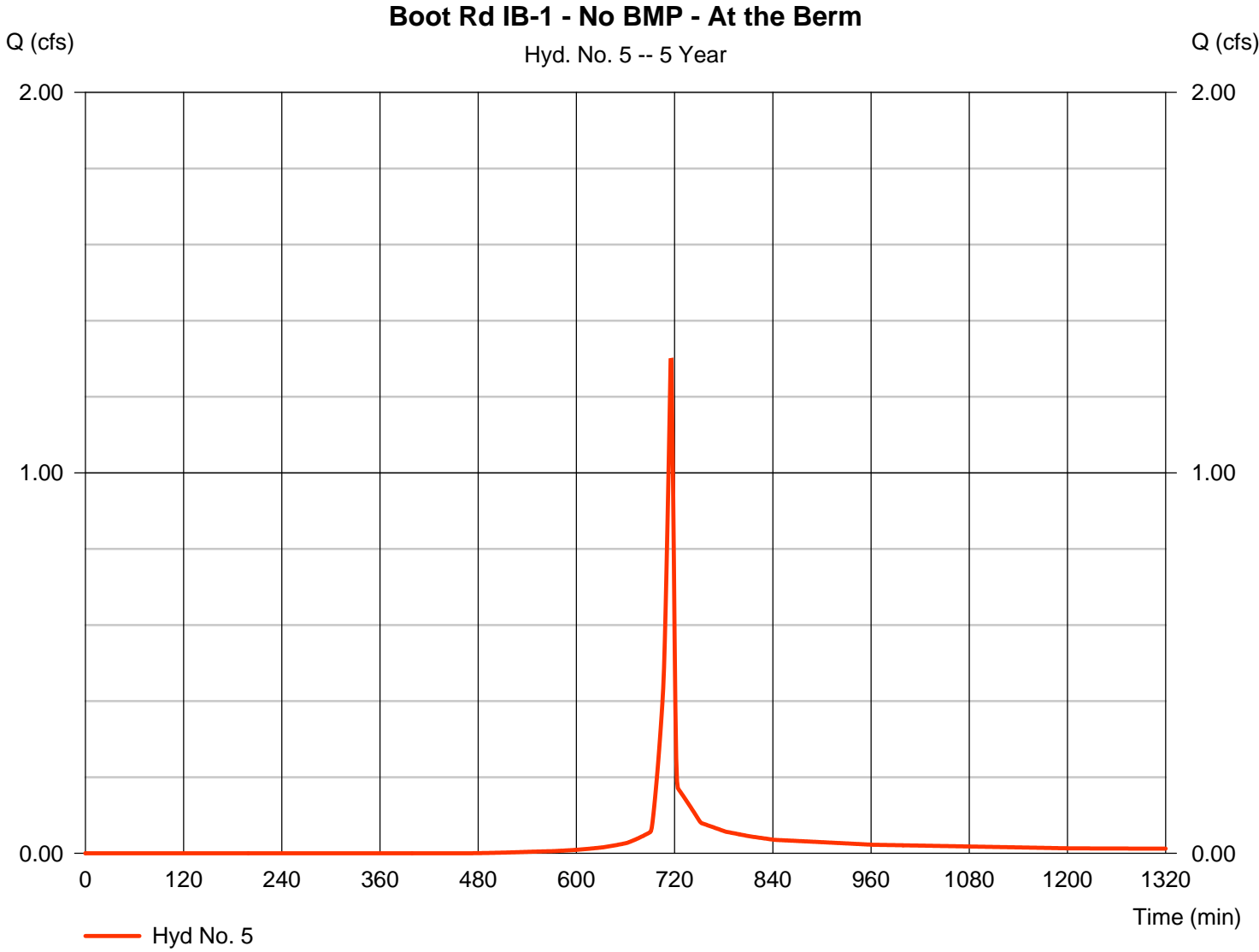


# Hydrograph Report

## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.297 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,309 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 4.08 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

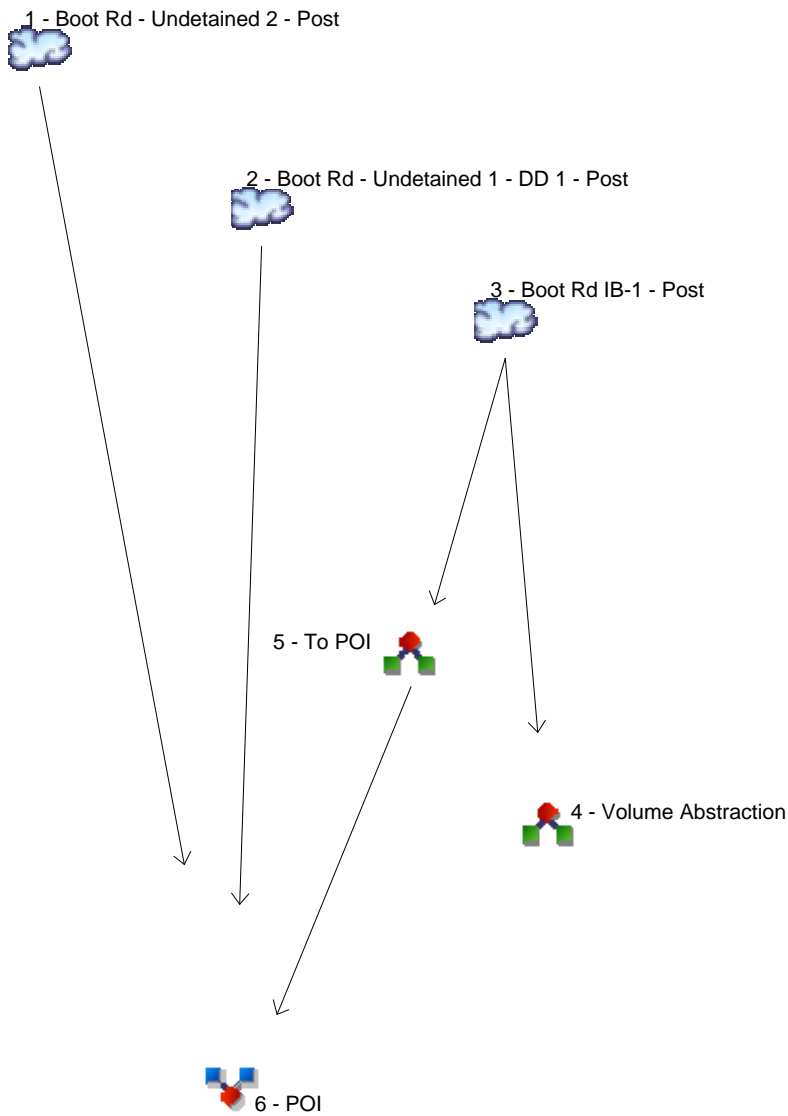
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.91</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 35.00       |          | 100.00      |          | 100.00      |          |                 |
| Watercourse slope (%)              | = 8.50        |          | 6.50        |          | 3.20        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.93         |          | 4.11        |          | 2.89        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.41</b> | <b>+</b> | <b>0.58</b> | <b>=</b> | <b>1.08</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>2.00 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | 0.759 | ----- | ----- | ----- | -----  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | 3.583 | ----- | ----- | ----- | -----  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | 0.736 | ----- | ----- | ----- | -----  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | 0.736 | ----- | ----- | ----- | -----  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | 0.047 | ----- | ----- | ----- | -----  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | ----- | ----- | 4.299 | ----- | ----- | ----- | -----  | POI                                  |

# Hydrograph Summary Report

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

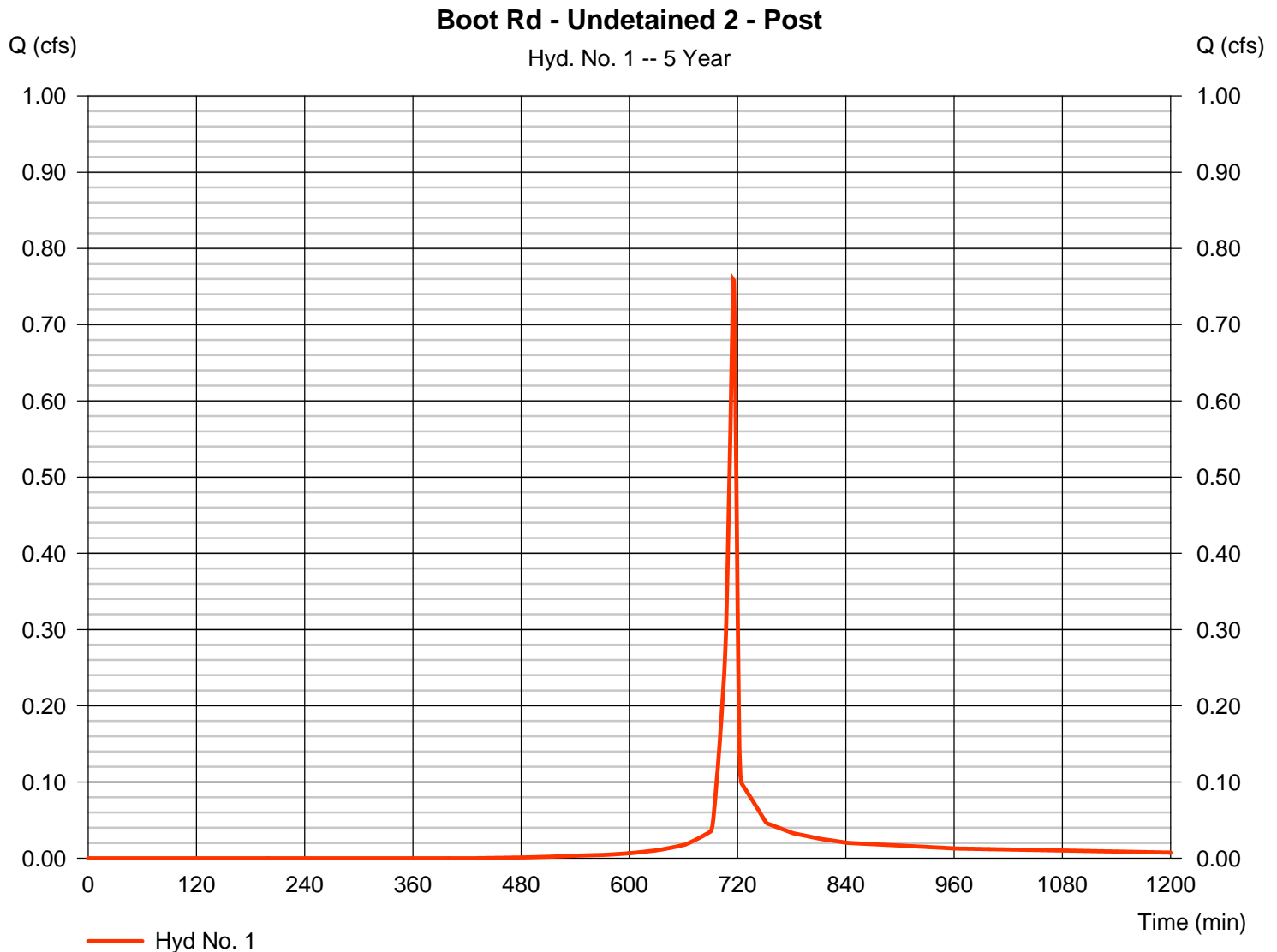
| Hyd. No.                    | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |  |
|-----------------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|------------------------|--------------------------|--------------------------------------|--|
| 1                           | SCS Runoff               | 0.759           | 1                   | 715                | 1,363                 | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                           | SCS Runoff               | 3.583           | 1                   | 717                | 6,730                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                           | SCS Runoff               | 0.736           | 1                   | 734                | 3,167                 | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                           | Diversion1               | 0.736           | 1                   | 734                | 2,311                 | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                           | Diversion2               | 0.047           | 1                   | 888                | 856                   | 3             | -----                  | -----                    | To POI                               |  |
| 6                           | Combine                  | 4.299           | 1                   | 716                | 8,949                 | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 5 year.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.759 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,363 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.08 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

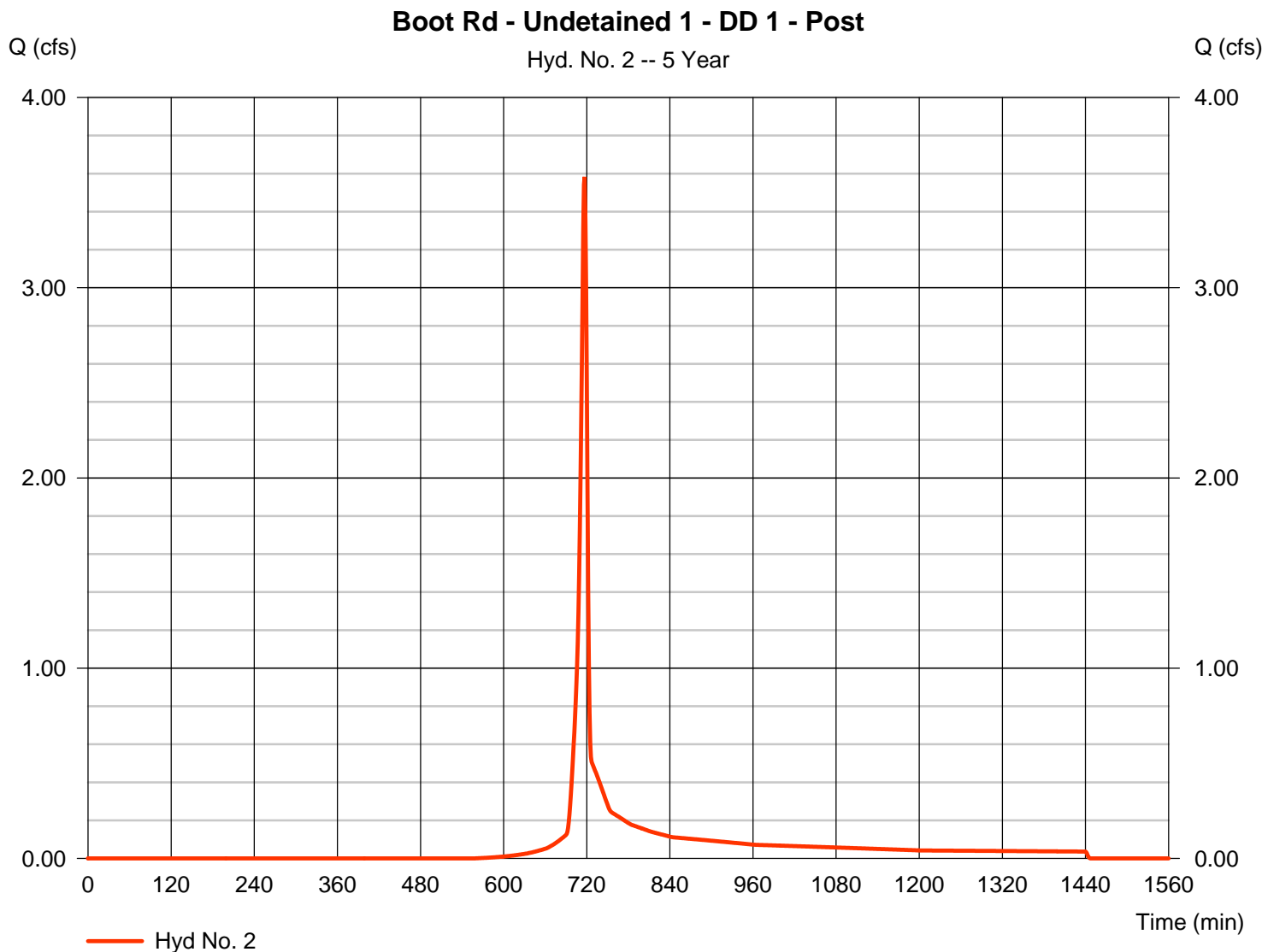
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.583 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 6,730 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 4.08 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

Boot Rd - Undetained 1 - DD 1 - Post

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

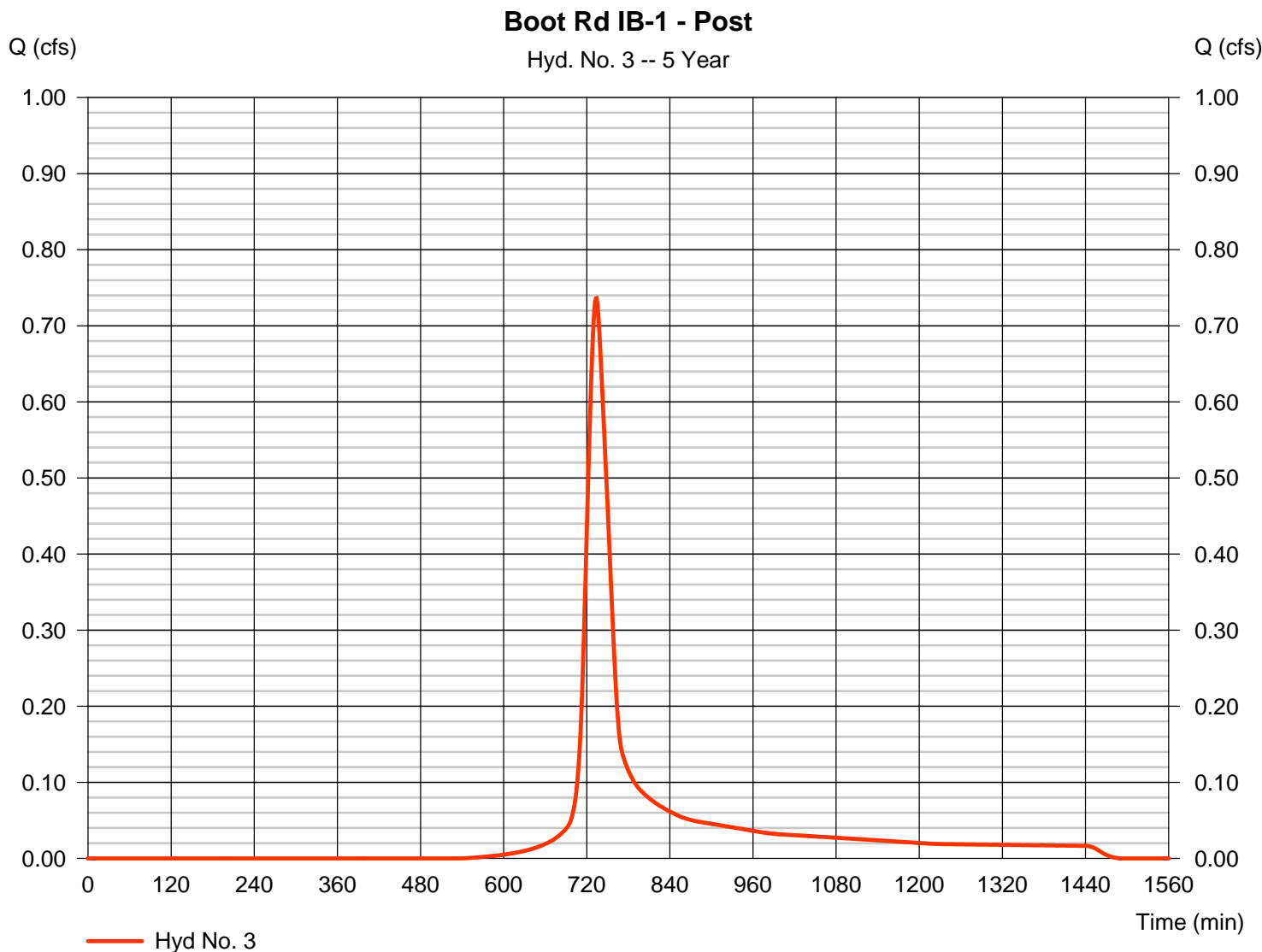
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.736 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 734 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,167 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 32.40 min  |
| Total precip.   | = 4.08 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

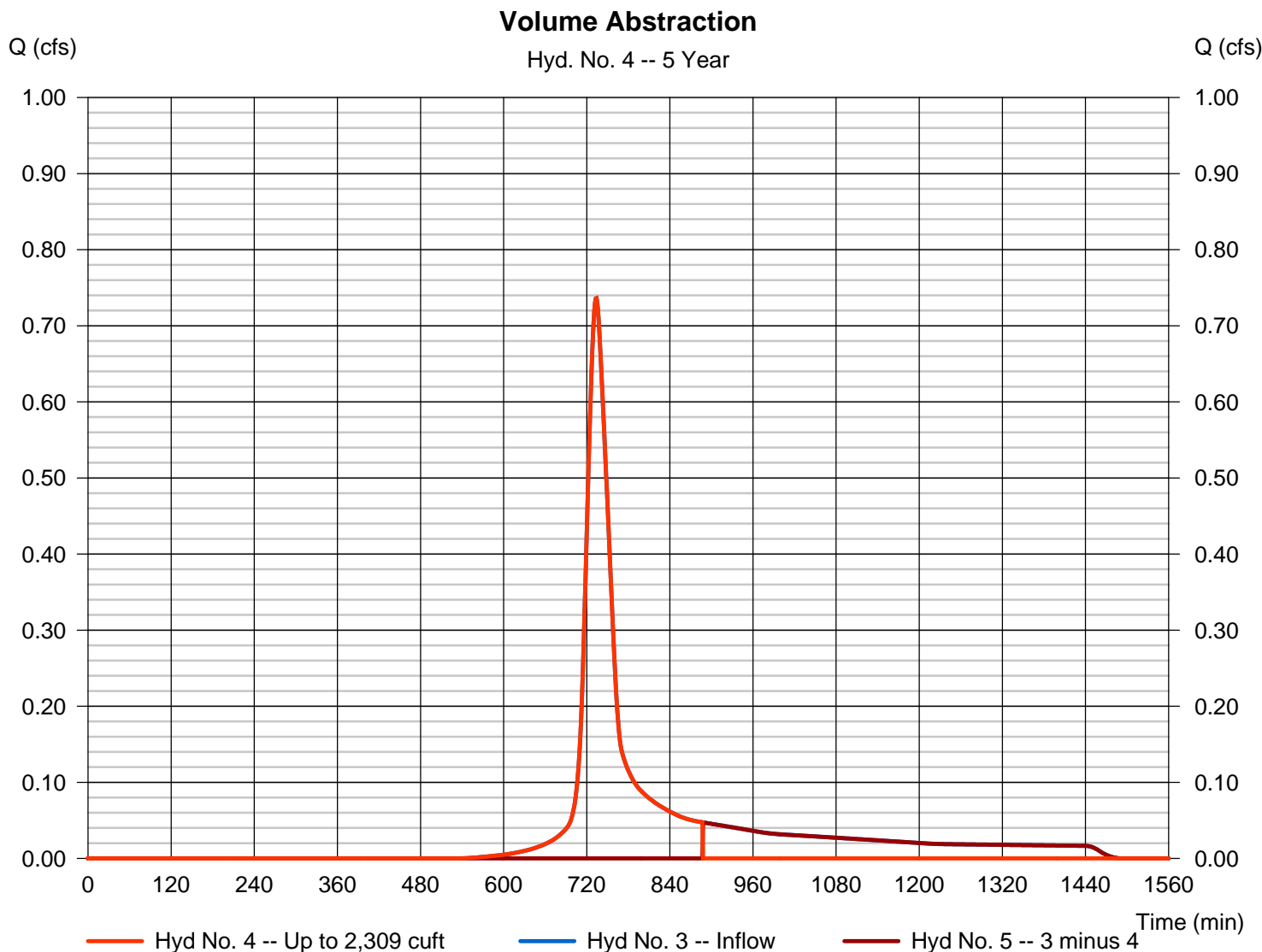
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Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.736 cfs  |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 734 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,311 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,309 cuft |



# Hydrograph Report

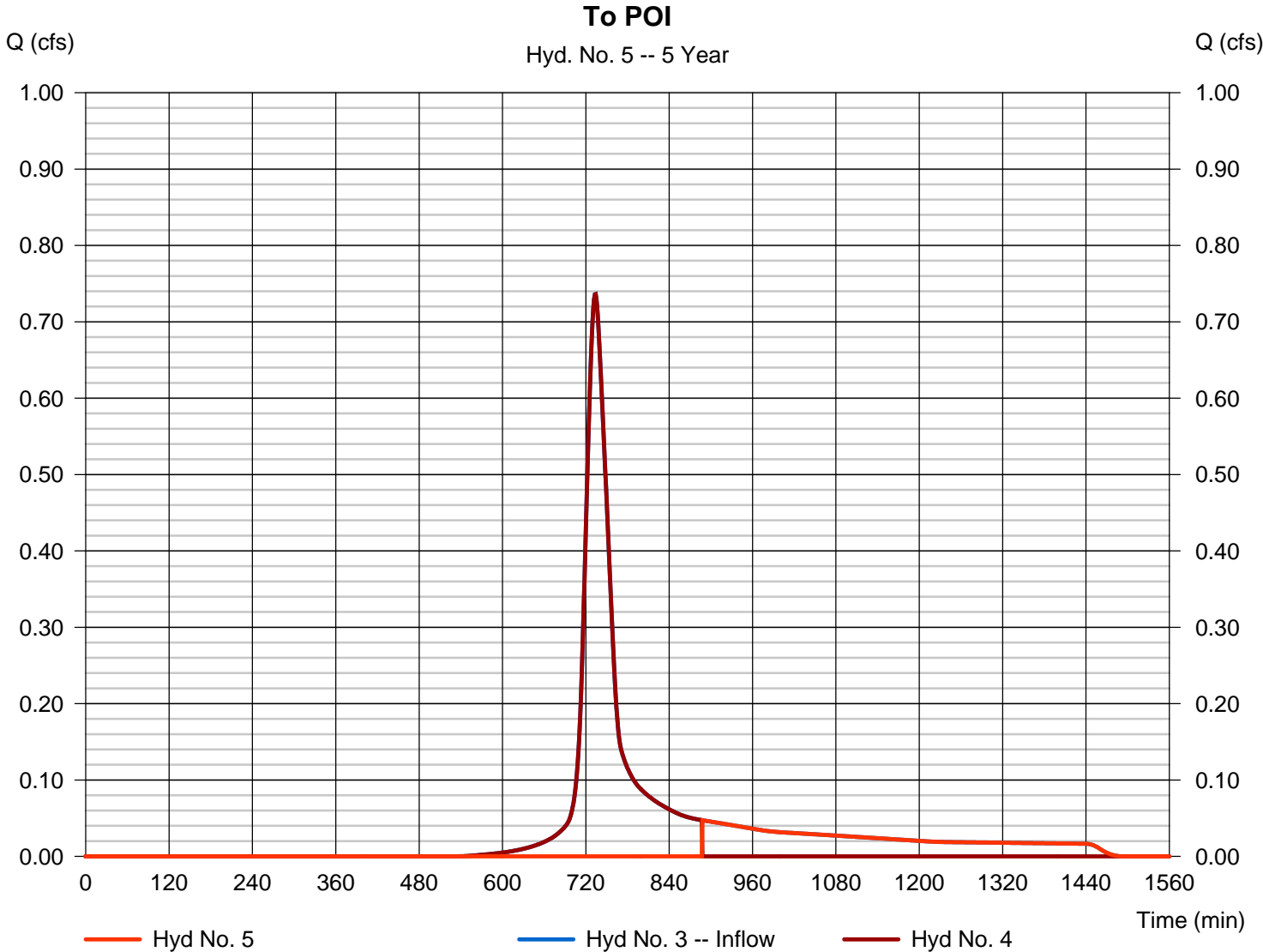
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.047 cfs  |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 888 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 856 cuft   |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,309 cuft |



# Hydrograph Report

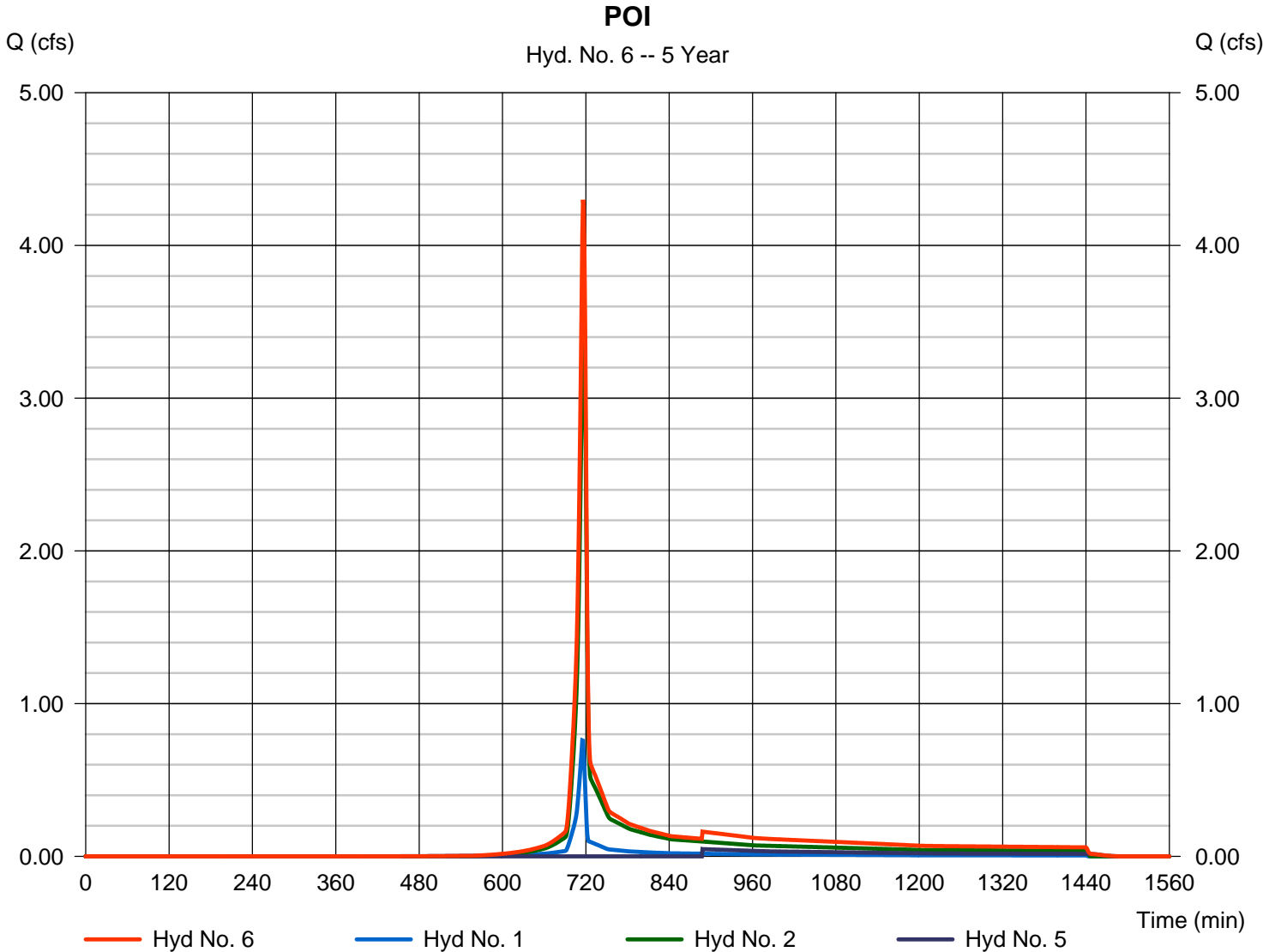
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 4.299 cfs  |
| Storm frequency | = 5 yrs   | Time to peak         | = 716 min    |
| Time interval   | = 1 min   | Hyd. volume          | = 8,949 cuft |
| Inflow hyds.    | = 1, 2, 5 | Contrib. drain. area | = 1.200 ac   |



**ATTACHMENT C-4  
BOOT RD  
10 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot Rd - 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# 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               | 7.193           | 1                   | 717                | 13,561                 | -----         | -----                    | -----                   | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 10 Year |               | Wednesday, 11 / 9 / 2016 |                         |                        |

# Hydrograph Report

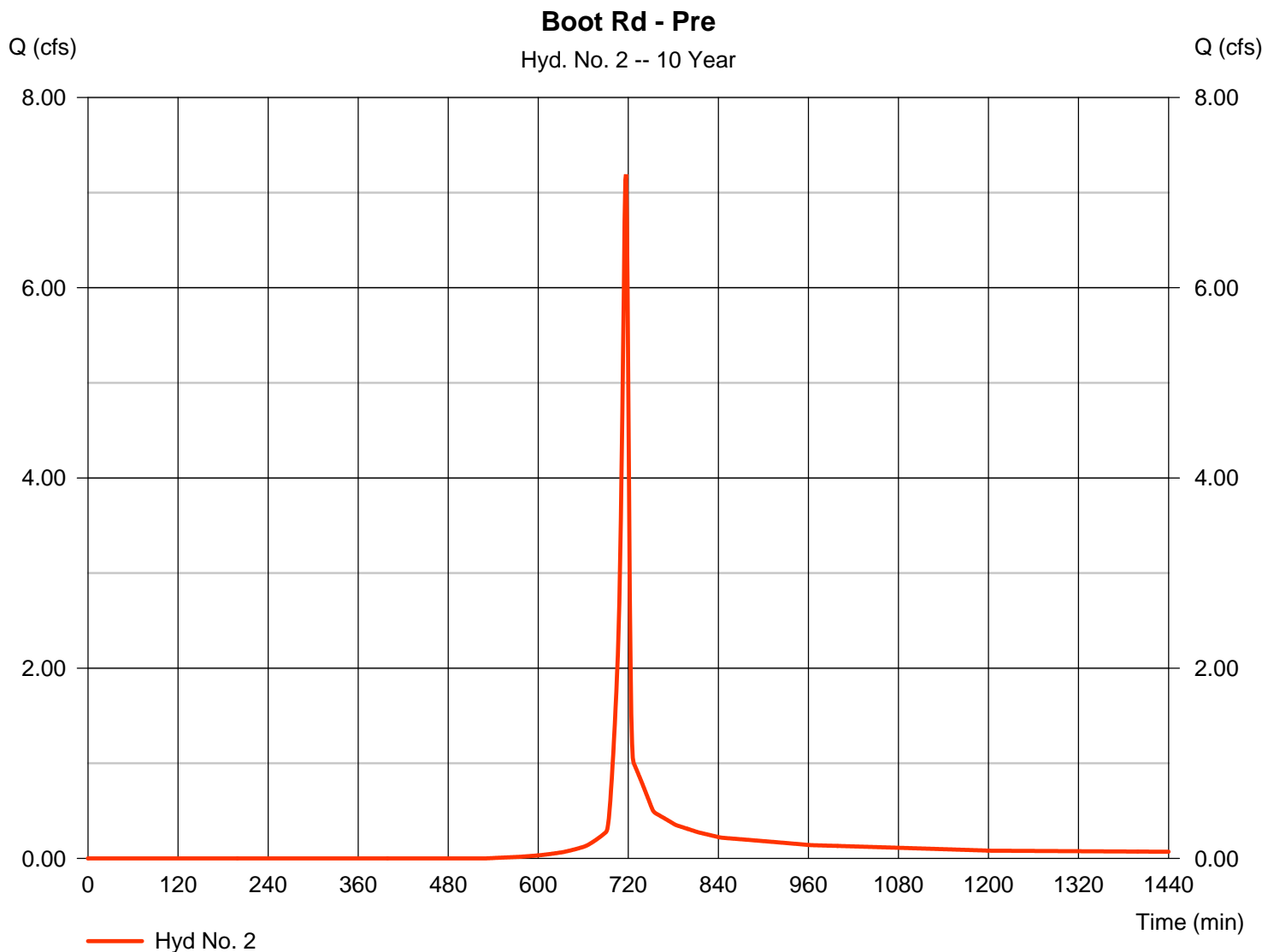
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 7.193 cfs   |
| Storm frequency | = 10 yrs     | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 13,561 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min    |
| Total precip.   | = 4.77 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

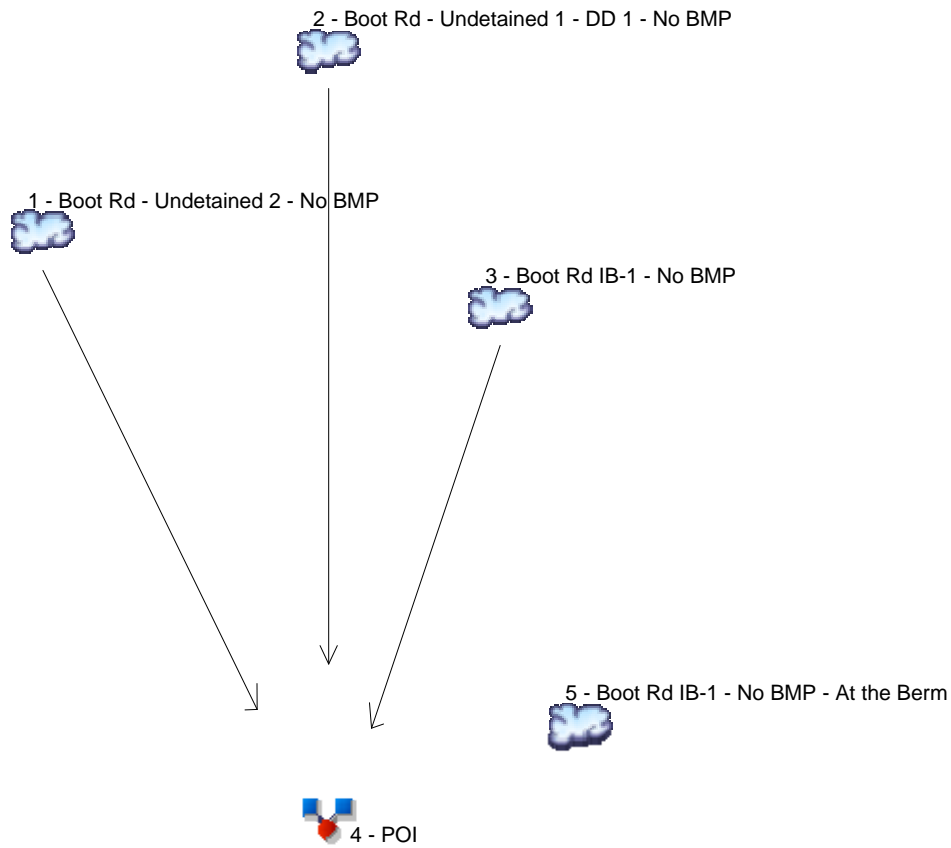
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 484.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 3.70                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.10                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.60</b> | <b>= 2.70</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.50 min</b> |

# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# 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               | 0.946           | 1                   | 715                | 1,716                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |
| 2                           | SCS Runoff               | 4.643           | 1                   | 717                | 8,776                  | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |
| 3                           | SCS Runoff               | 2.169           | 1                   | 716                | 3,855                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |
| 4                           | Combine                  | 7.721           | 1                   | 716                | 14,348                 | 1, 2, 3       | -----                  | -----                    | POI                                  |
| 5                           | SCS Runoff               | 1.634           | 1                   | 715                | 2,936                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |

# Hydrograph Report

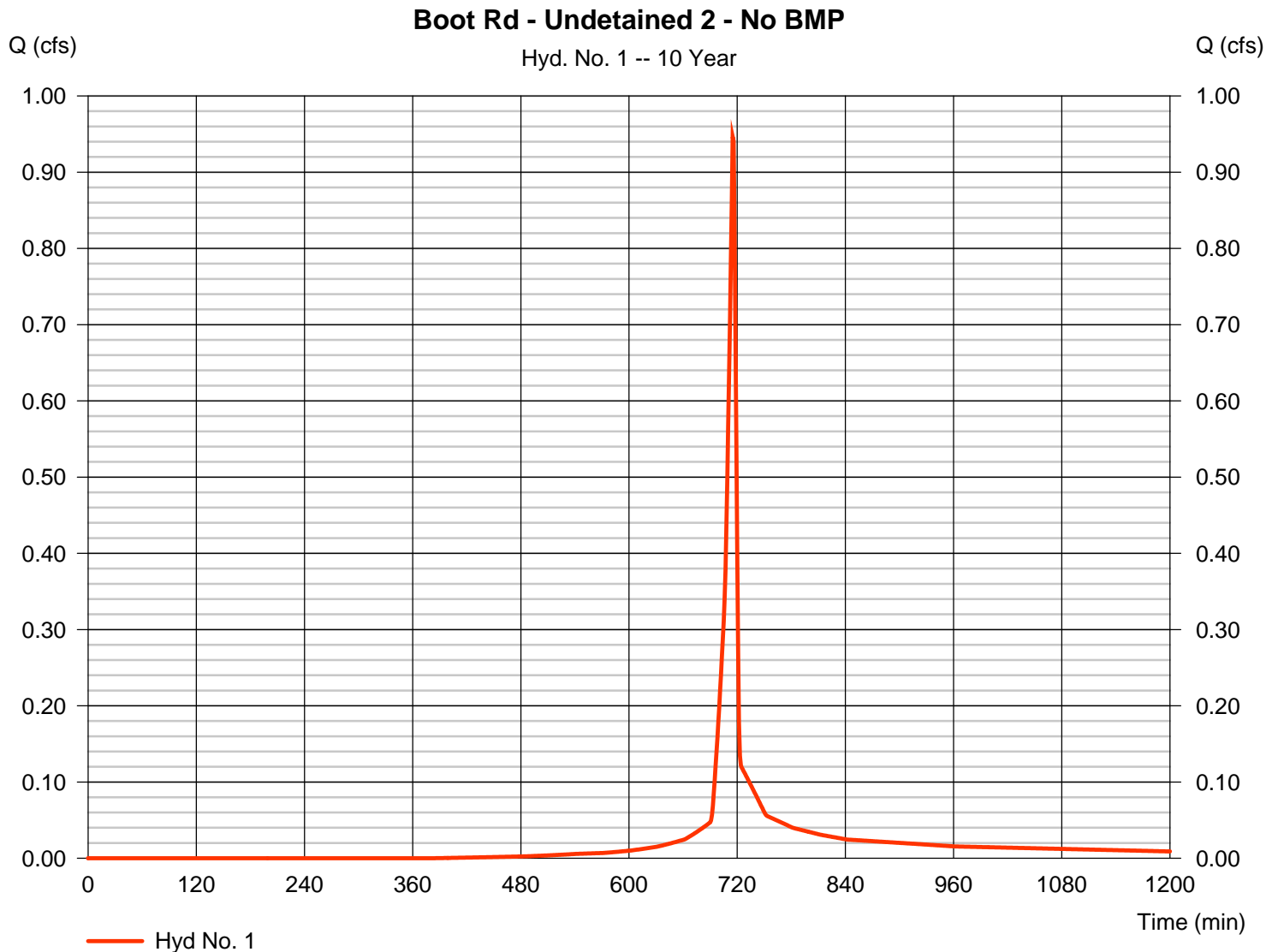
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.946 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,716 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.77 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

Boot Rd - Undetained 2 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 50.00       | 280.00               | 0.00                 |                 |
| Watercourse slope (%)              | = 4.00        | 4.30                 | 0.00                 |                 |
| Surface description                | = Paved       | Unpaved              | Paved                |                 |
| Average velocity (ft/s)            | =4.07         | 3.35                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> <b>1.39</b> | <b>+</b> <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.40 min</b> |

# Hydrograph Report

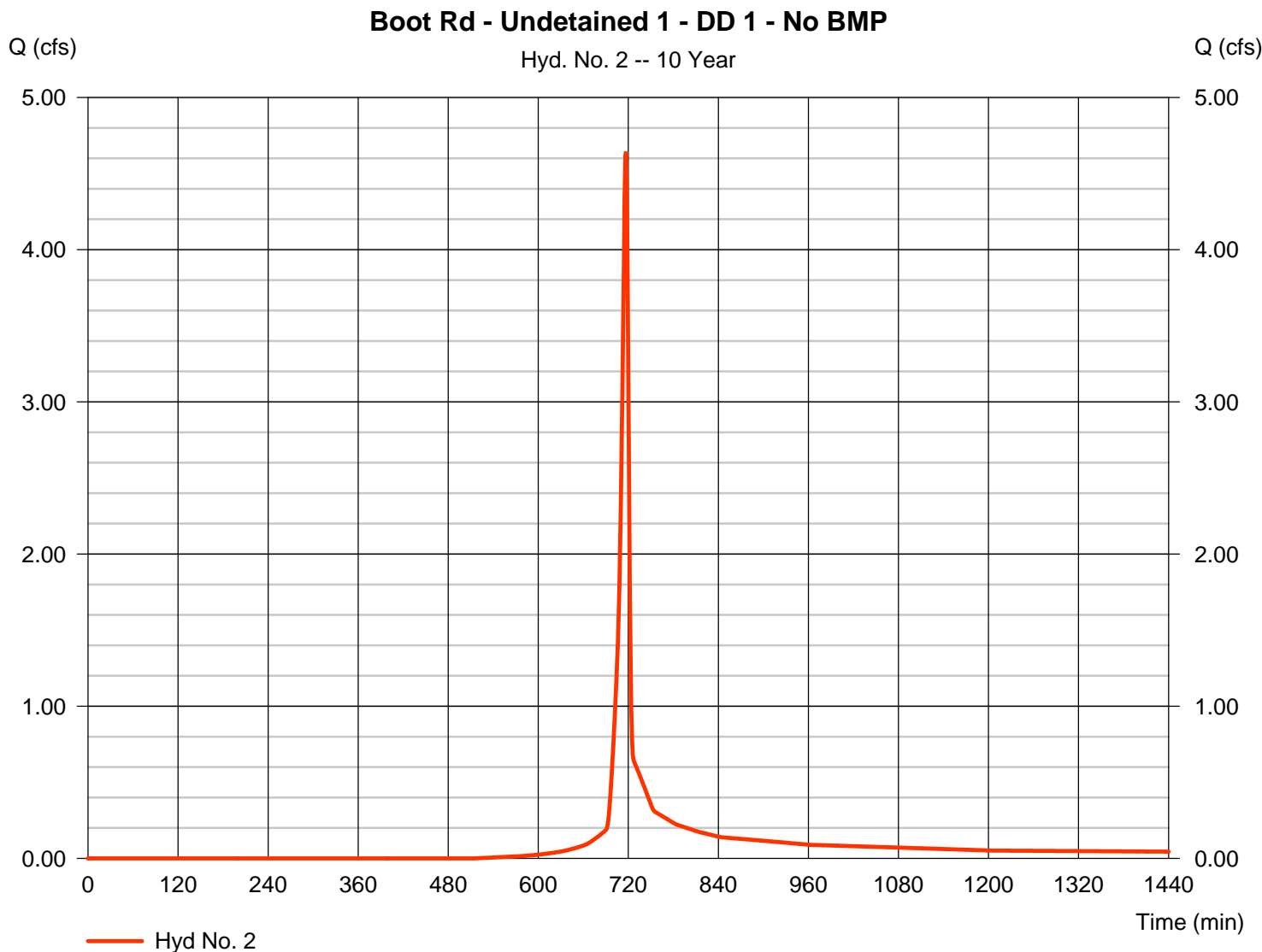
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.643 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 8,776 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 4.77 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

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

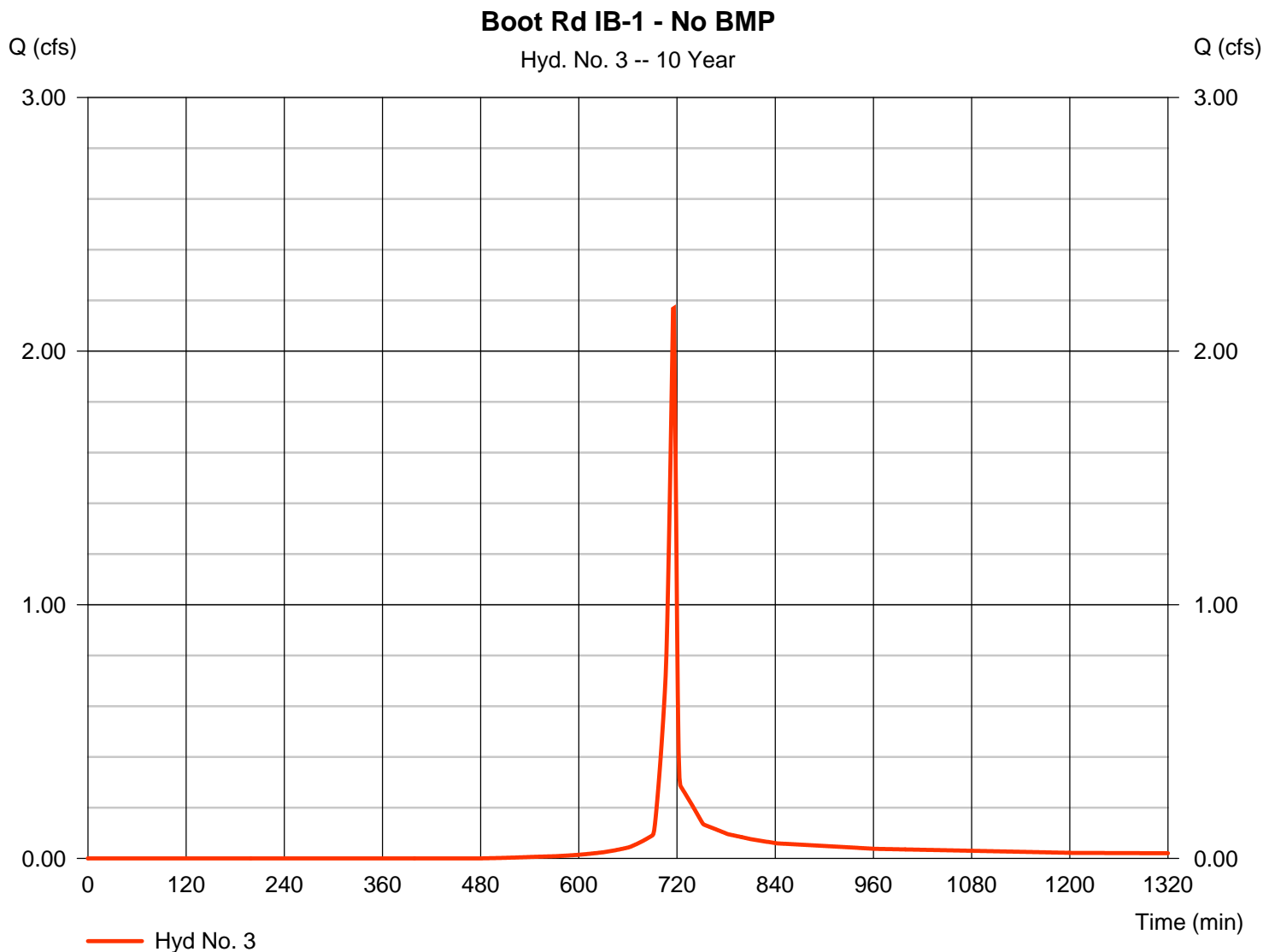
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.169 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,855 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 4.77 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.91</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 35.00       |          | 100.00      |          | 247.00      |          |                 |
| Watercourse slope (%)              | = 8.50        |          | 6.50        |          | 3.20        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.93         |          | 4.11        |          | 2.89        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.41</b> | <b>+</b> | <b>1.43</b> | <b>=</b> | <b>1.93</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>2.80 min</b> |

# Hydrograph Report

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

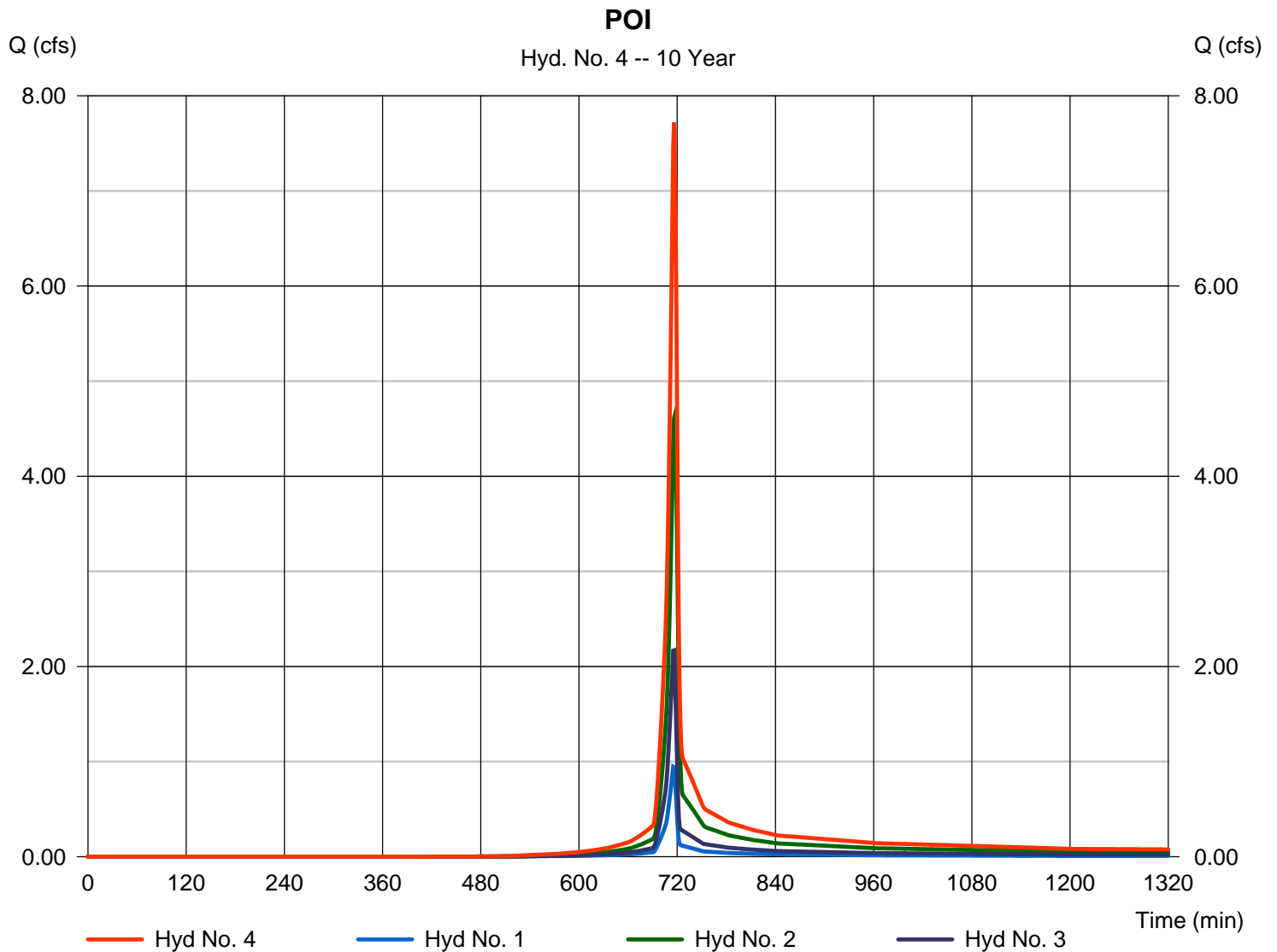
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

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

Peak discharge = 7.721 cfs  
 Time to peak = 716 min  
 Hyd. volume = 14,348 cuft  
 Contrib. drain. area = 1.650 ac



# Hydrograph Report

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

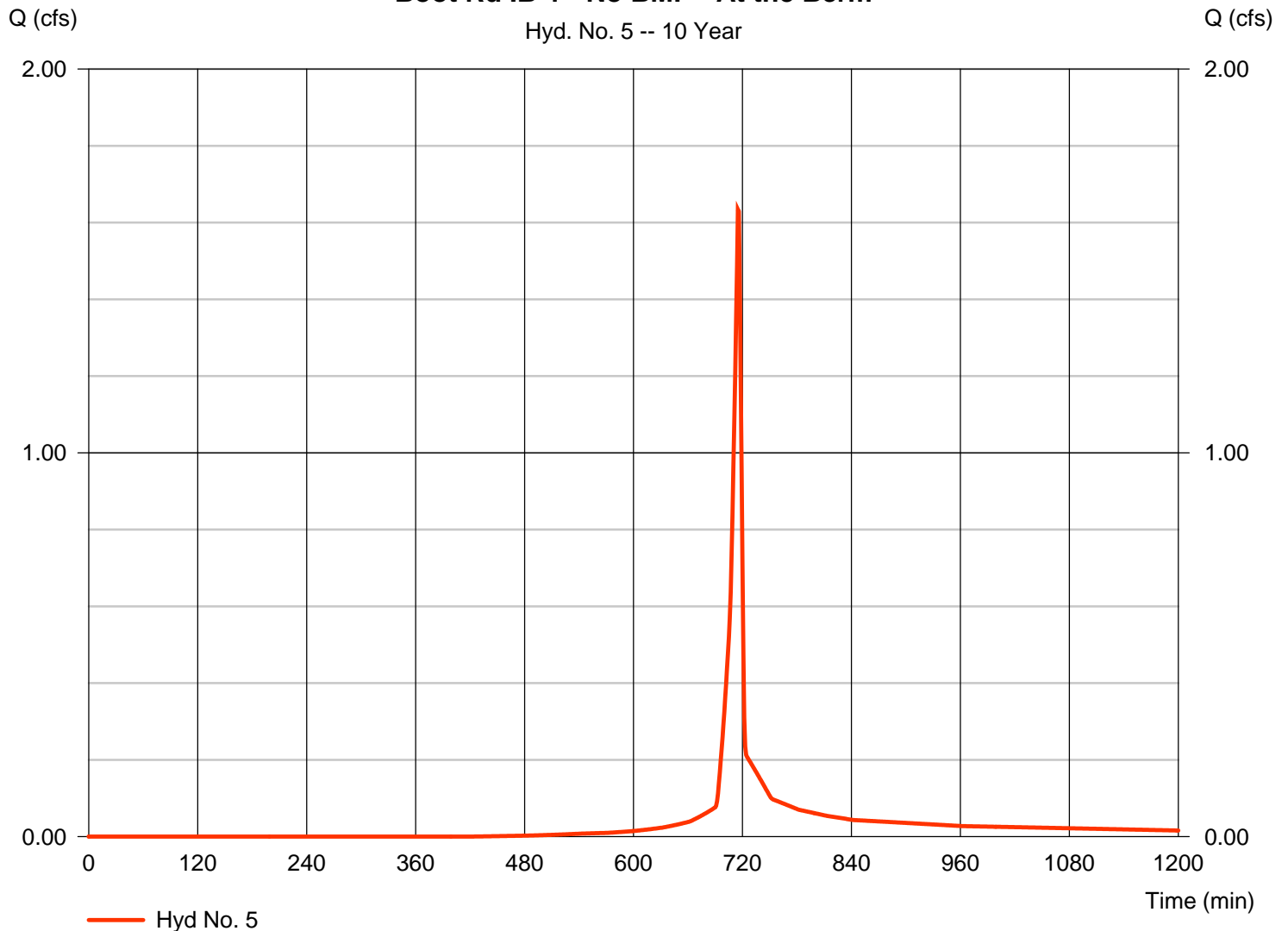
Wednesday, 11 / 9 / 2016

## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.634 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,936 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 4.77 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd IB-1 - No BMP - At the Berm**



# TR55 Tc Worksheet

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

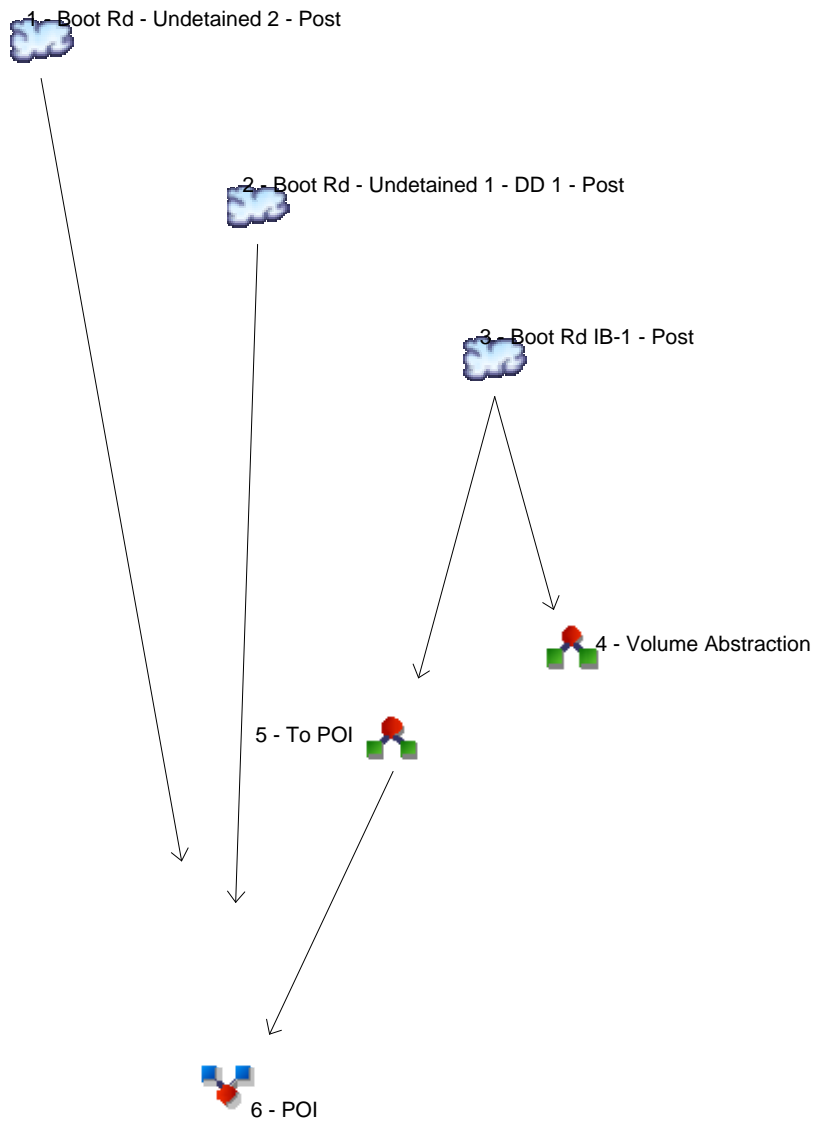
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      | <u>B</u>      | <u>C</u>      | <u>Totals</u>   |
|------------------------------------|---------------|---------------|---------------|-----------------|
| <b>Sheet Flow</b>                  |               |               |               |                 |
| 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)        | = 3.25        | 0.00          | 0.00          |                 |
| Land slope (%)                     | = 4.00        | 0.00          | 0.00          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |               |               |                 |
| Flow length (ft)                   | = 35.00       | 100.00        | 100.00        |                 |
| Watercourse slope (%)              | = 8.50        | 6.50          | 3.20          |                 |
| Surface description                | = Paved       | Unpaved       | Unpaved       |                 |
| Average velocity (ft/s)            | =5.93         | 4.11          | 2.89          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+ 0.41</b> | <b>+ 0.58</b> | <b>= 1.08</b>   |
| <b>Channel Flow</b>                |               |               |               |                 |
| 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           |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |               |               | <b>2.00 min</b> |

# 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               | -----         | -----              | ----- | ----- | ----- | 0.946 | ----- | ----- | -----  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 4.643 | ----- | ----- | -----  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 1.064 | ----- | ----- | -----  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | 1.064 | ----- | ----- | -----  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | 0.129 | ----- | ----- | -----  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | ----- | ----- | ----- | 5.552 | ----- | ----- | -----  | POI                                  |

# Hydrograph Summary Report

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

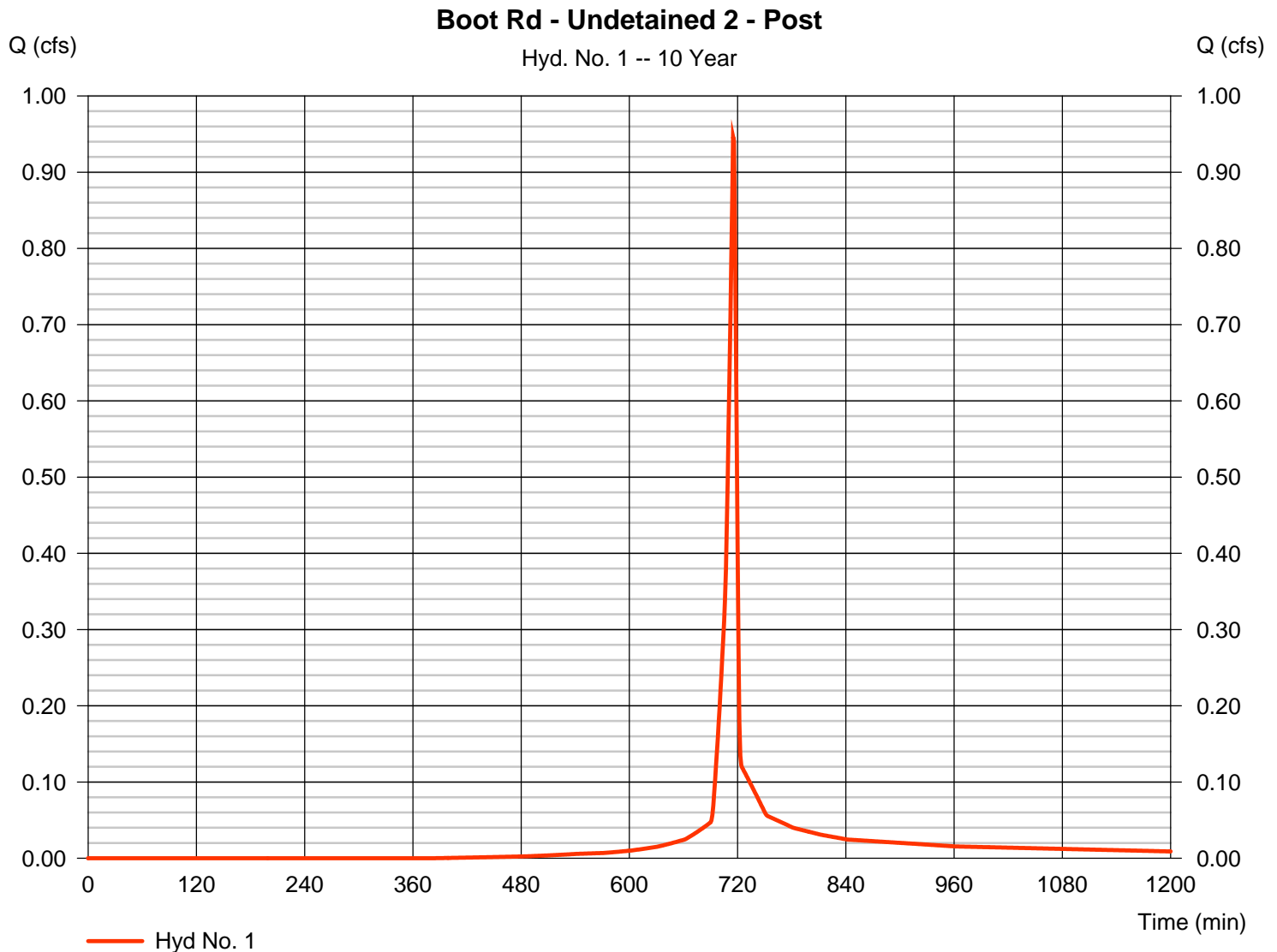
| Hyd. No.                     | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |  |
|------------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|--------------------------------------|--|
| 1                            | SCS Runoff               | 0.946           | 1                   | 715                | 1,716                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                            | SCS Runoff               | 4.643           | 1                   | 717                | 8,776                  | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                            | SCS Runoff               | 1.064           | 1                   | 730                | 4,082                  | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                            | Diversion1               | 1.064           | 1                   | 730                | 2,523                  | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                            | Diversion2               | 0.129           | 1                   | 782                | 1,559                  | 3             | -----                  | -----                    | To POI                               |  |
| 6                            | Combine                  | 5.552           | 1                   | 716                | 12,052                 | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 10 year.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.946 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,716 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.77 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

Boot Rd - Undetained 2 - Post

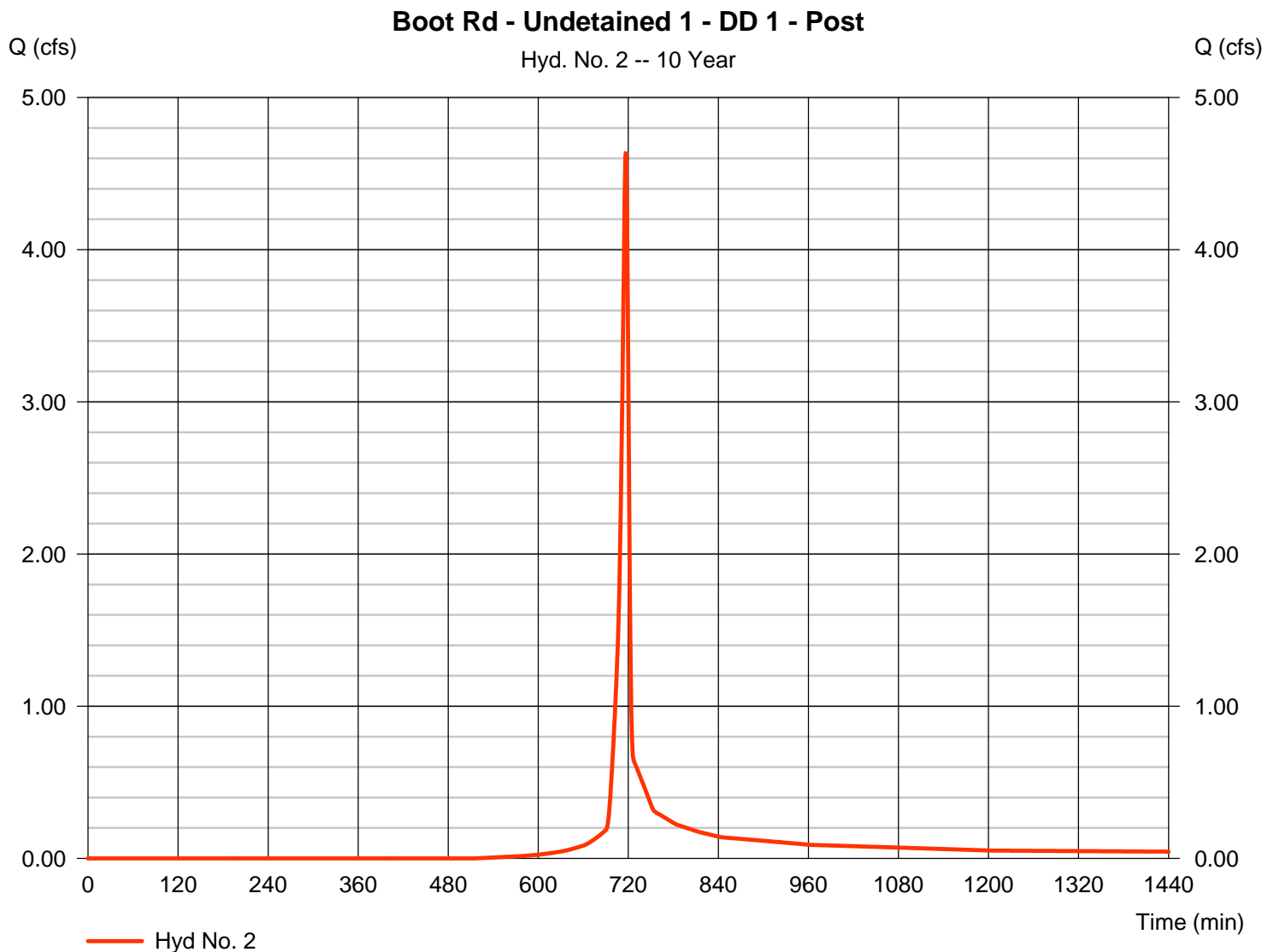
| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.643 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 8,776 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min   |
| Total precip.   | = 4.77 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

Boot Rd - Undetained 1 - DD 1 - Post

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

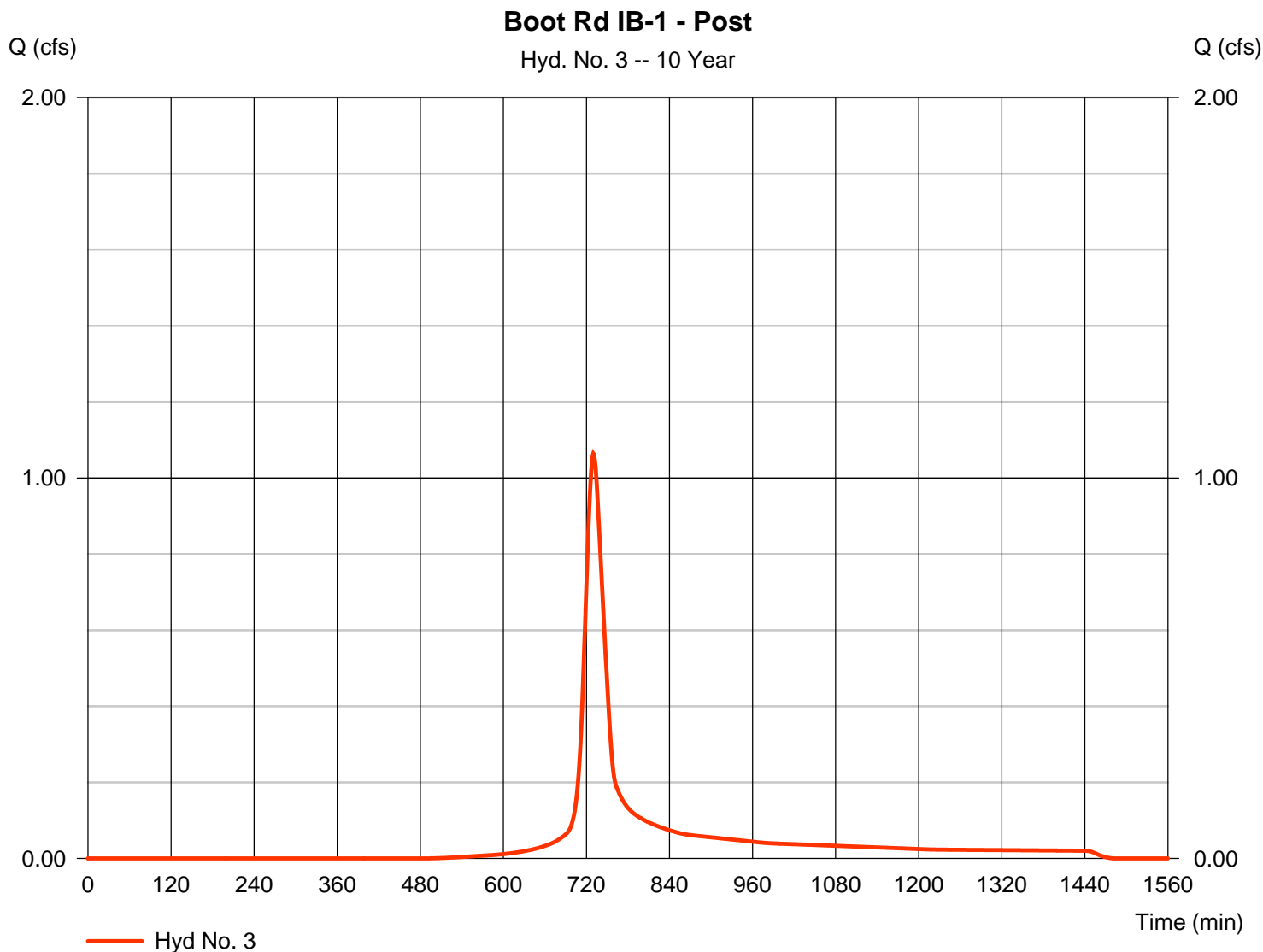
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.064 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 730 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,082 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 27.70 min  |
| Total precip.   | = 4.77 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

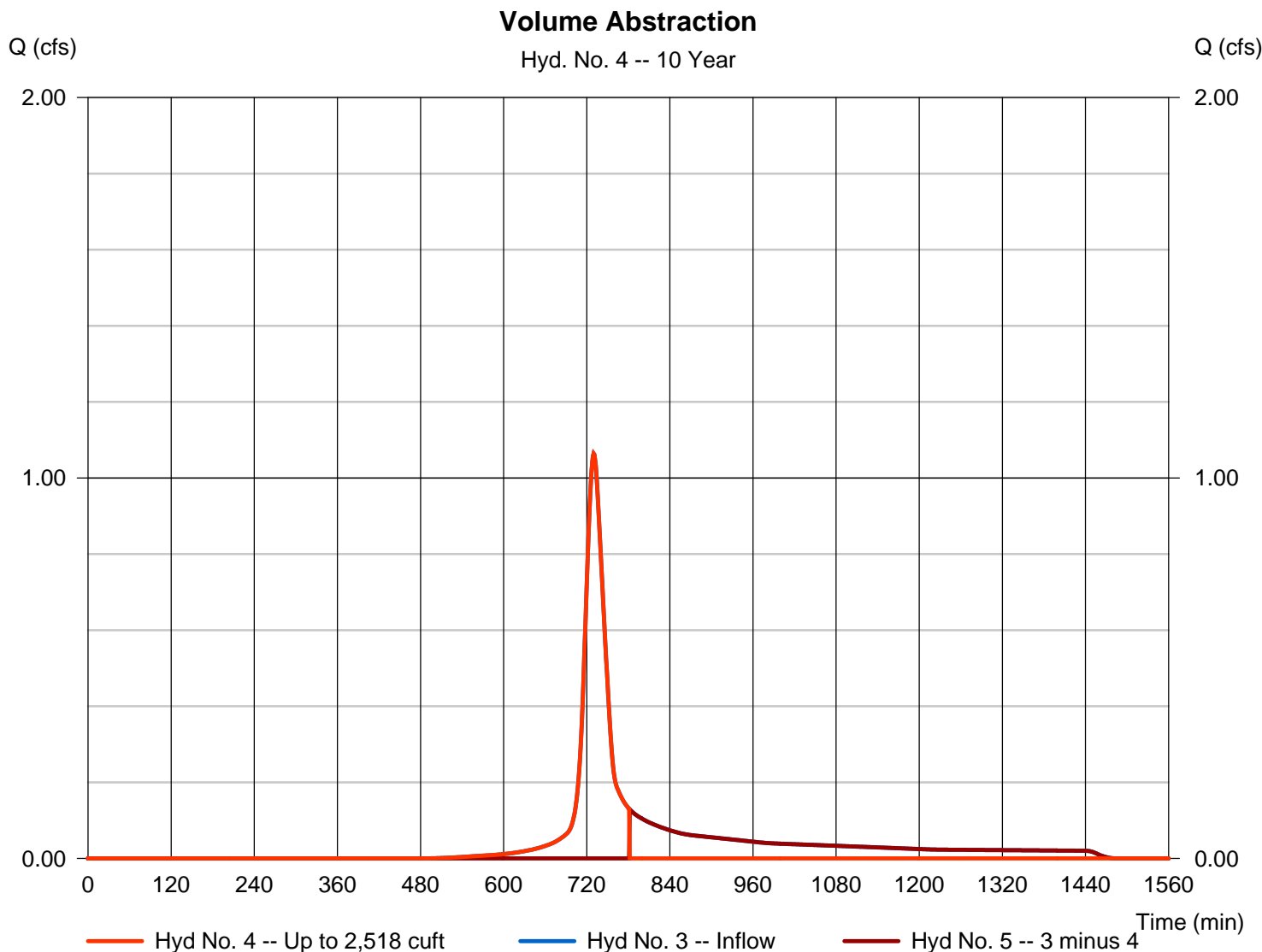
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 1.064 cfs  |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 730 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,523 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

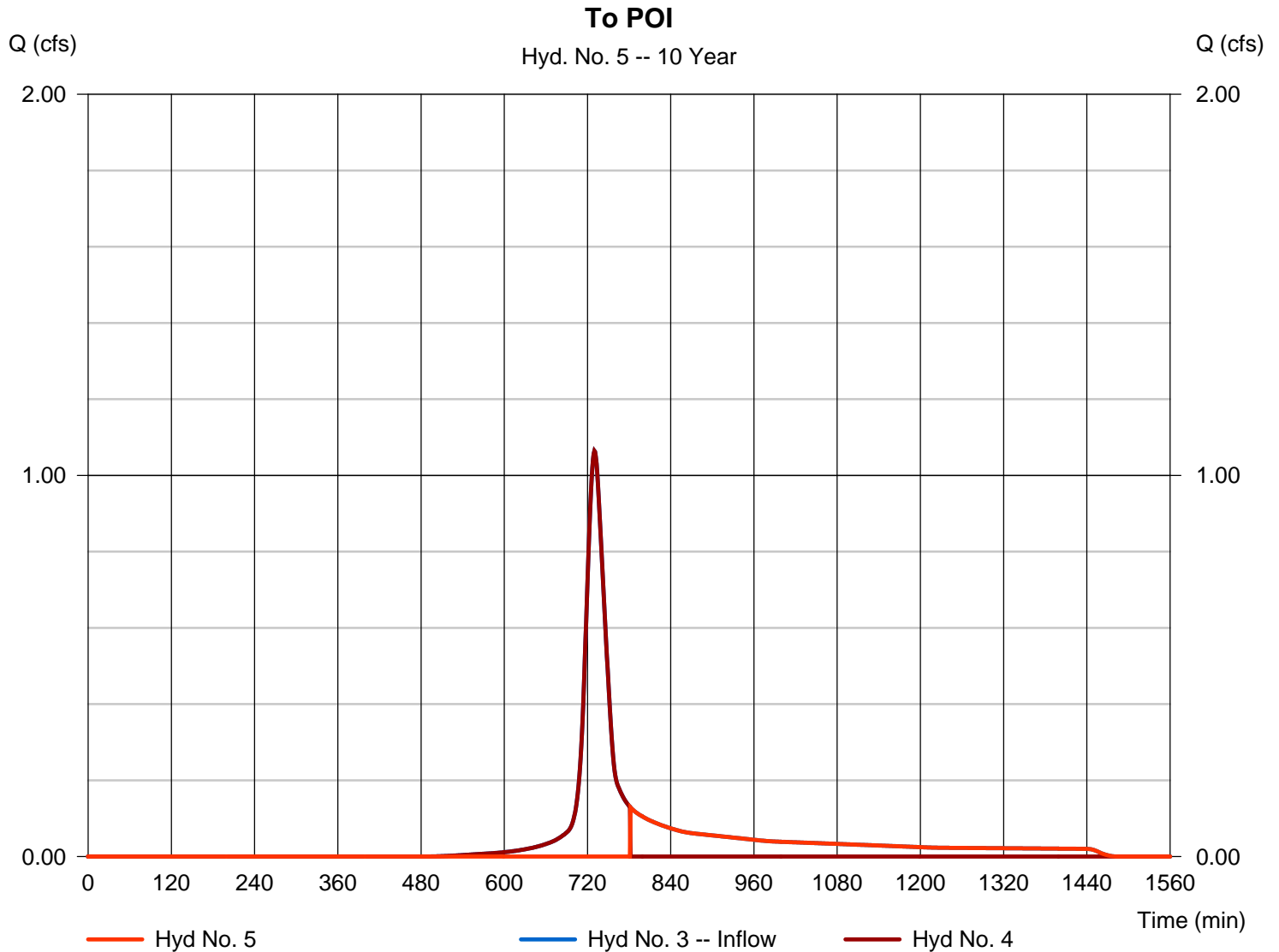
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.129 cfs  |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 782 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,559 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

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

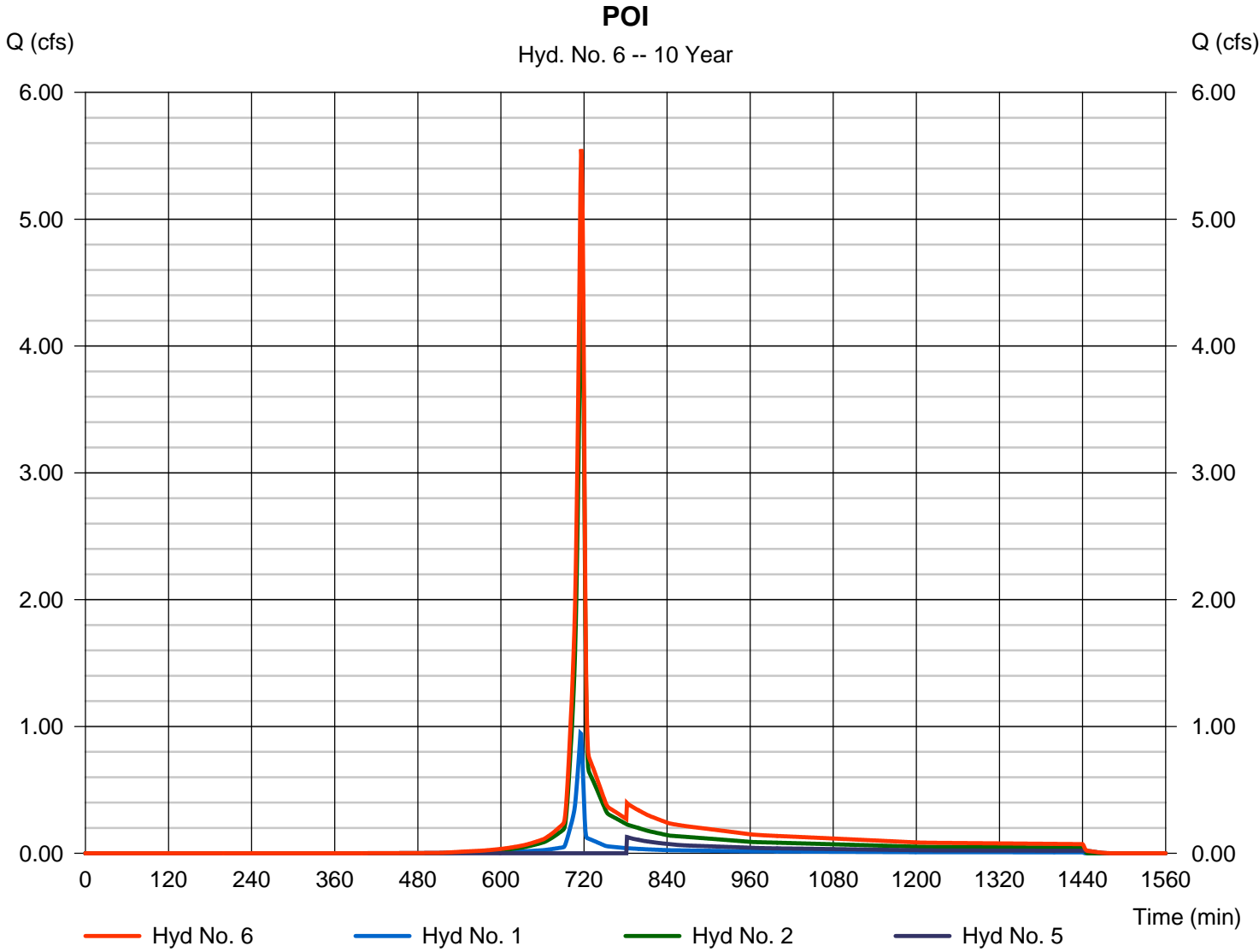
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

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

Peak discharge = 5.552 cfs  
Time to peak = 716 min  
Hyd. volume = 12,052 cuft  
Contrib. drain. area = 1.200 ac



**ATTACHMENT C-5  
BOOT RD  
25 Year-24 Hour Storm**



# Watershed Model Schematic

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



# 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# 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               | 9.681           | 1                   | 717                | 18,439                 | -----         | -----                  | -----                    | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 25 Year |               |                        | Wednesday, 11 / 9 / 2016 |                        |

# Hydrograph Report

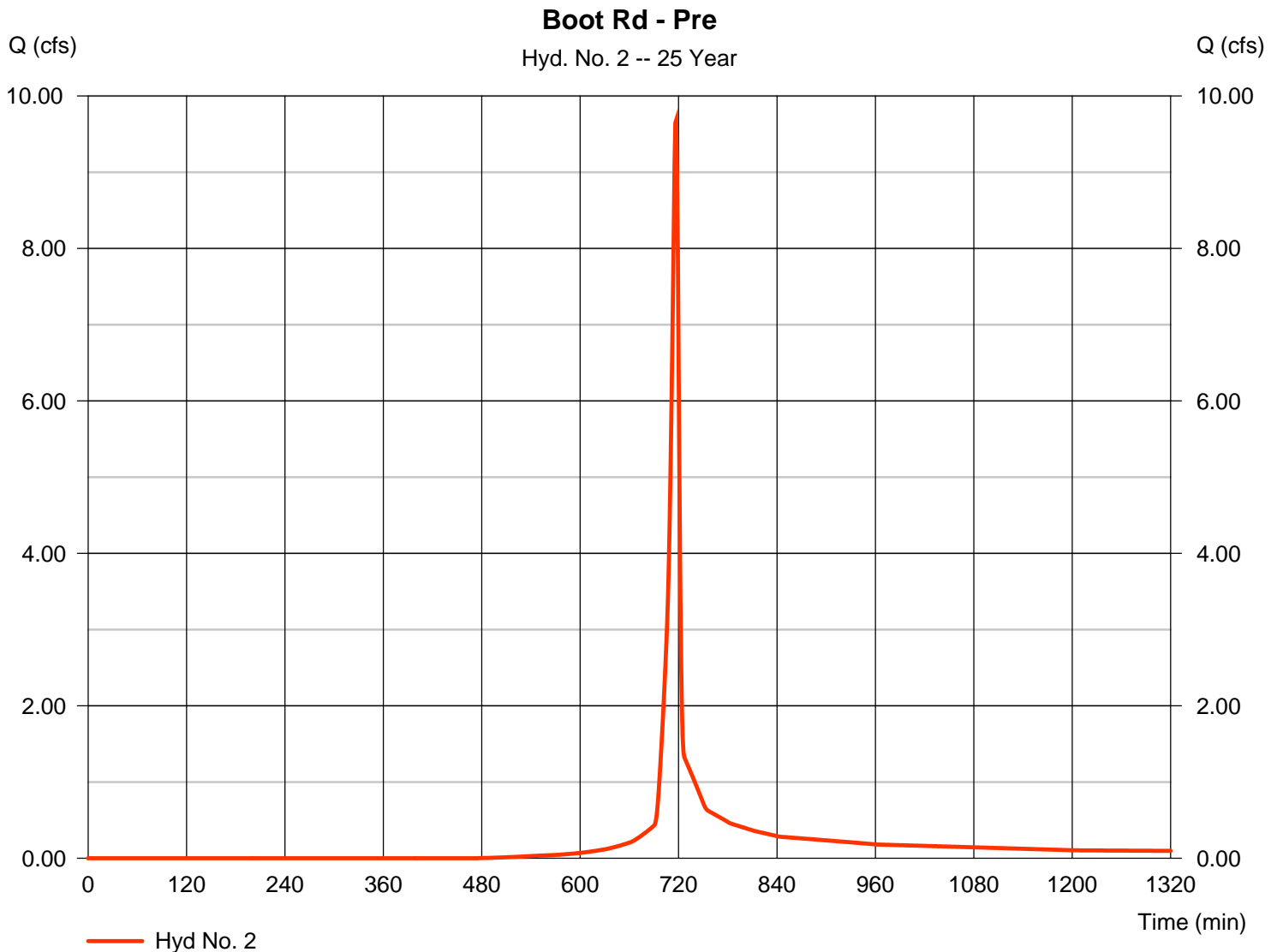
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 9.681 cfs   |
| Storm frequency | = 25 yrs     | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 18,439 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min    |
| Total precip.   | = 5.76 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

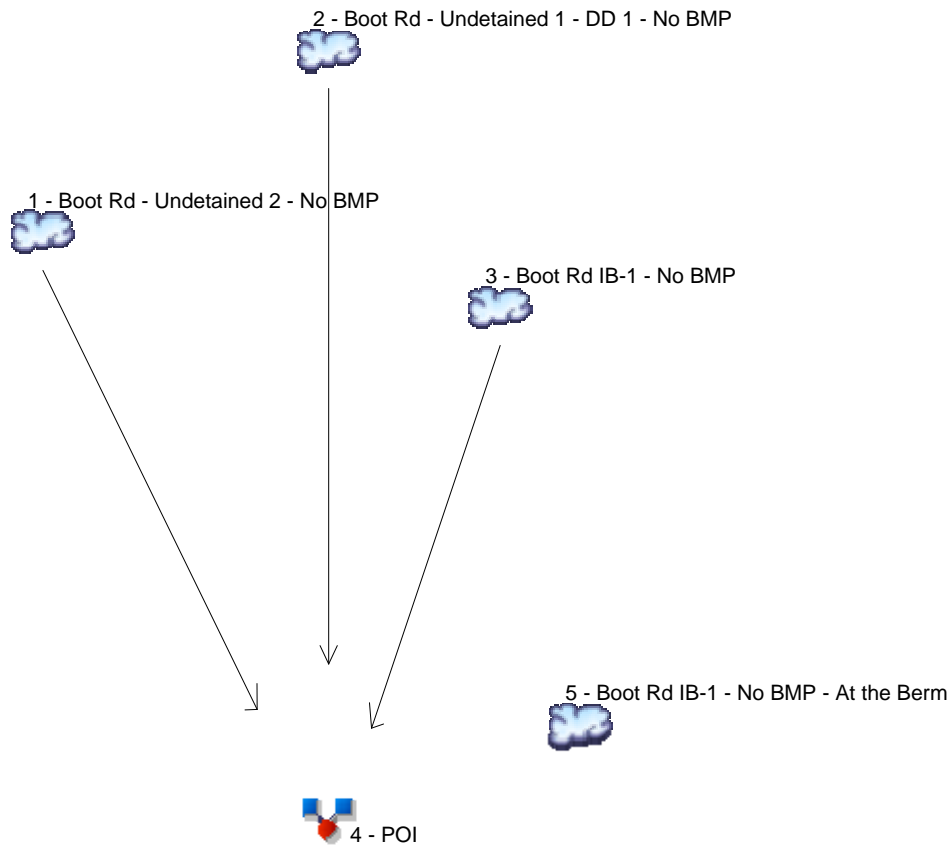
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 484.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 3.70        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.10        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.60</b> | <b>=</b> | <b>2.70</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.50 min</b> |

# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# Hydrograph Summary Report

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

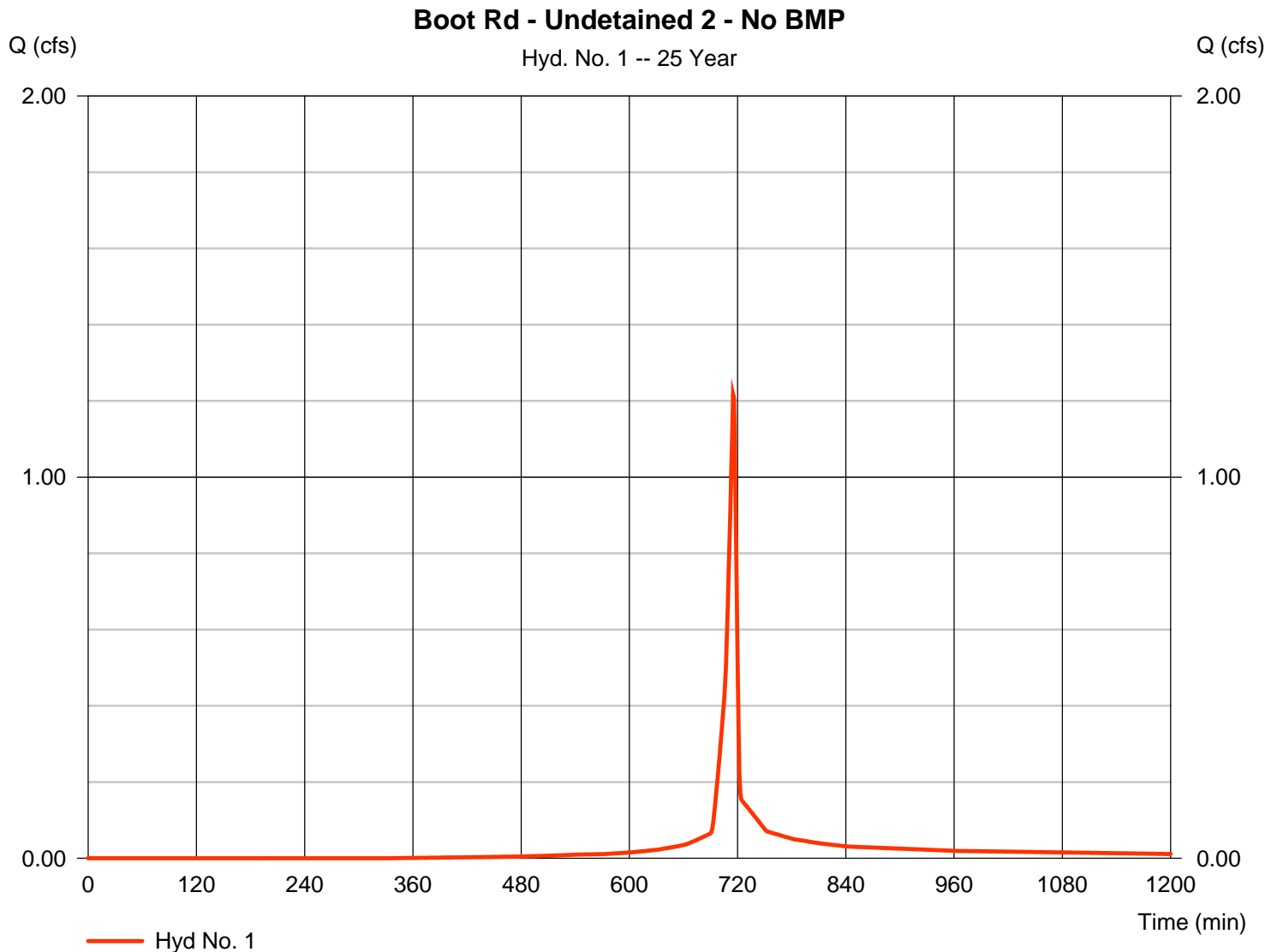
| Hyd. No.                    | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |
|-----------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|--------------------------------------|
| 1                           | SCS Runoff               | 1.217           | 1                   | 715                | 2,238                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |
| 2                           | SCS Runoff               | 6.209           | 1                   | 717                | 11,867                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |
| 3                           | SCS Runoff               | 2.869           | 1                   | 715                | 5,157                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |
| 4                           | Combine                  | 10.26           | 1                   | 716                | 19,263                 | 1, 2, 3       | -----                  | -----                    | POI                                  |
| 5                           | SCS Runoff               | 2.124           | 1                   | 715                | 3,867                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 25 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.217 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,238 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 5.76 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

Boot Rd - Undetained 2 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 50.00       | 280.00               | 0.00                 |                 |
| Watercourse slope (%)              | = 4.00        | 4.30                 | 0.00                 |                 |
| Surface description                | = Paved       | Unpaved              | Paved                |                 |
| Average velocity (ft/s)            | =4.07         | 3.35                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> <b>1.39</b> | <b>+</b> <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.40 min</b> |

# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

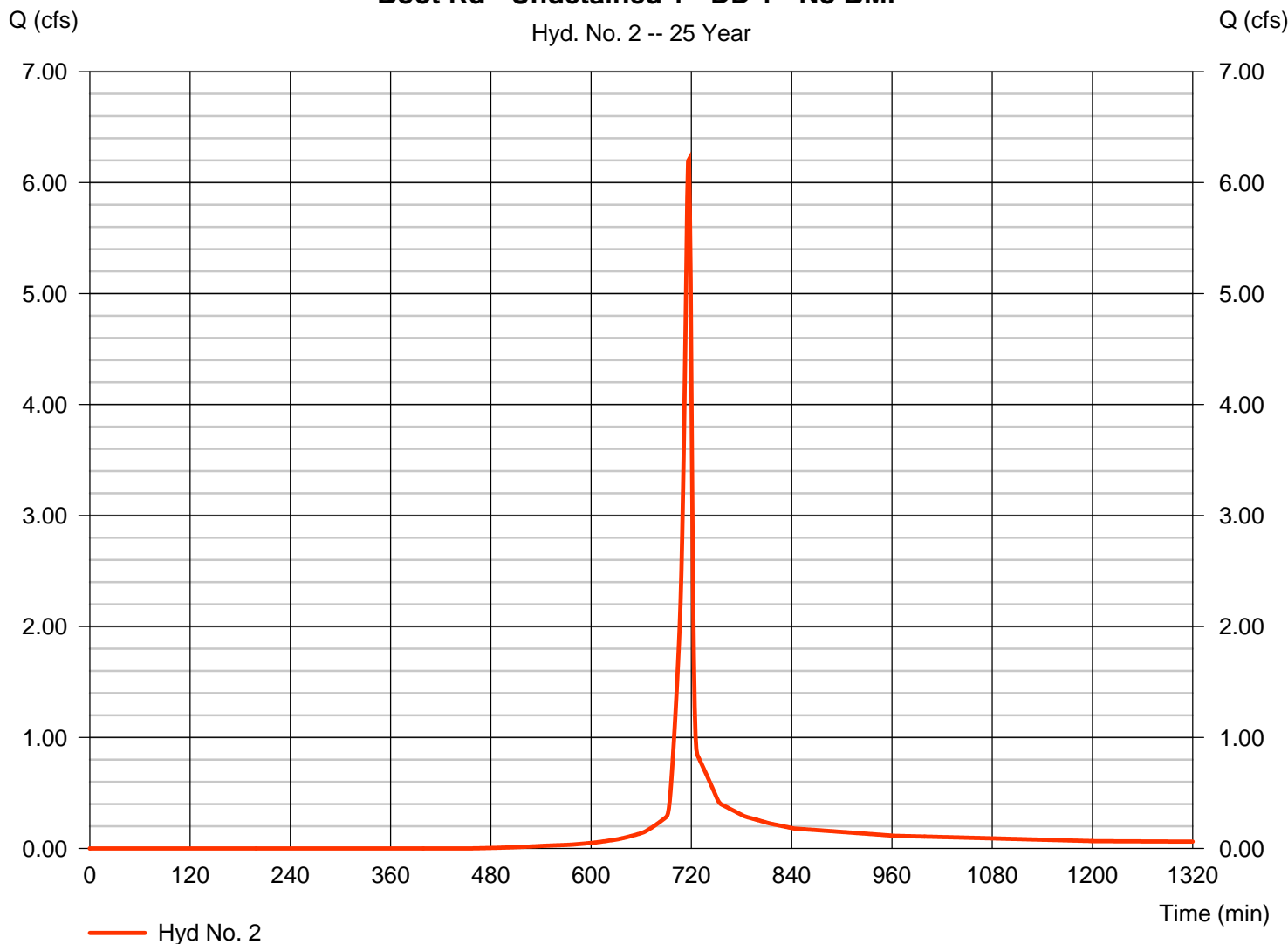
## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 6.209 cfs   |
| Storm frequency | = 25 yrs     | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 11,867 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 5.76 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

**Boot Rd - Undetained 1 - DD 1 - No BMP**

Hyd. No. 2 -- 25 Year



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 408.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 4.10        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.27        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.08</b> | <b>=</b> | <b>2.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 5.40        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 7.46        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 2.00        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.070       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =2.42         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | {{0}}100.0    |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.69</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.70 min</b> |

# Hydrograph Report

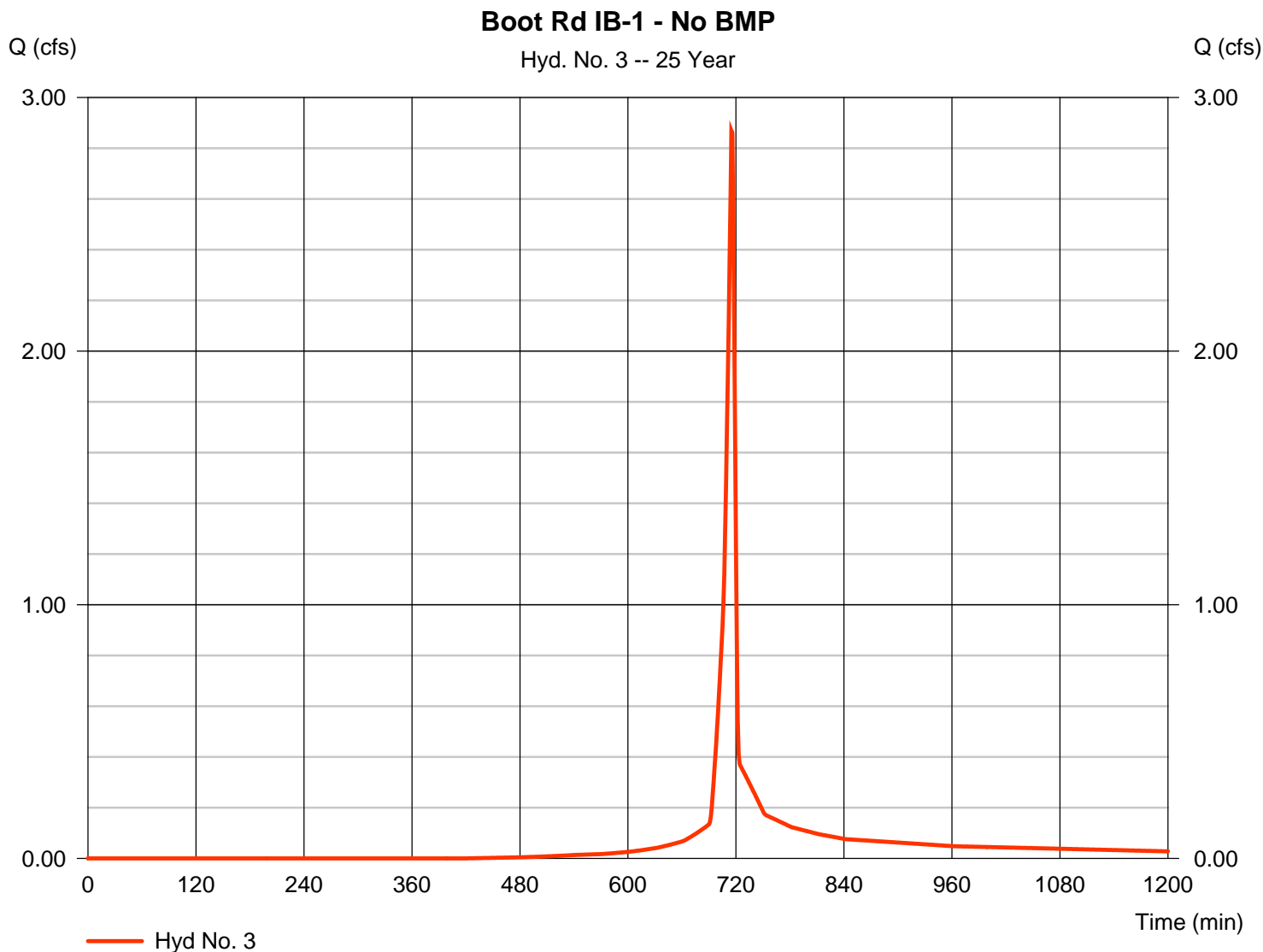
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.869 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 5,157 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 5.76 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 247.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>1.43</b> | <b>= 1.93</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.80 min</b> |

# Hydrograph Report

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

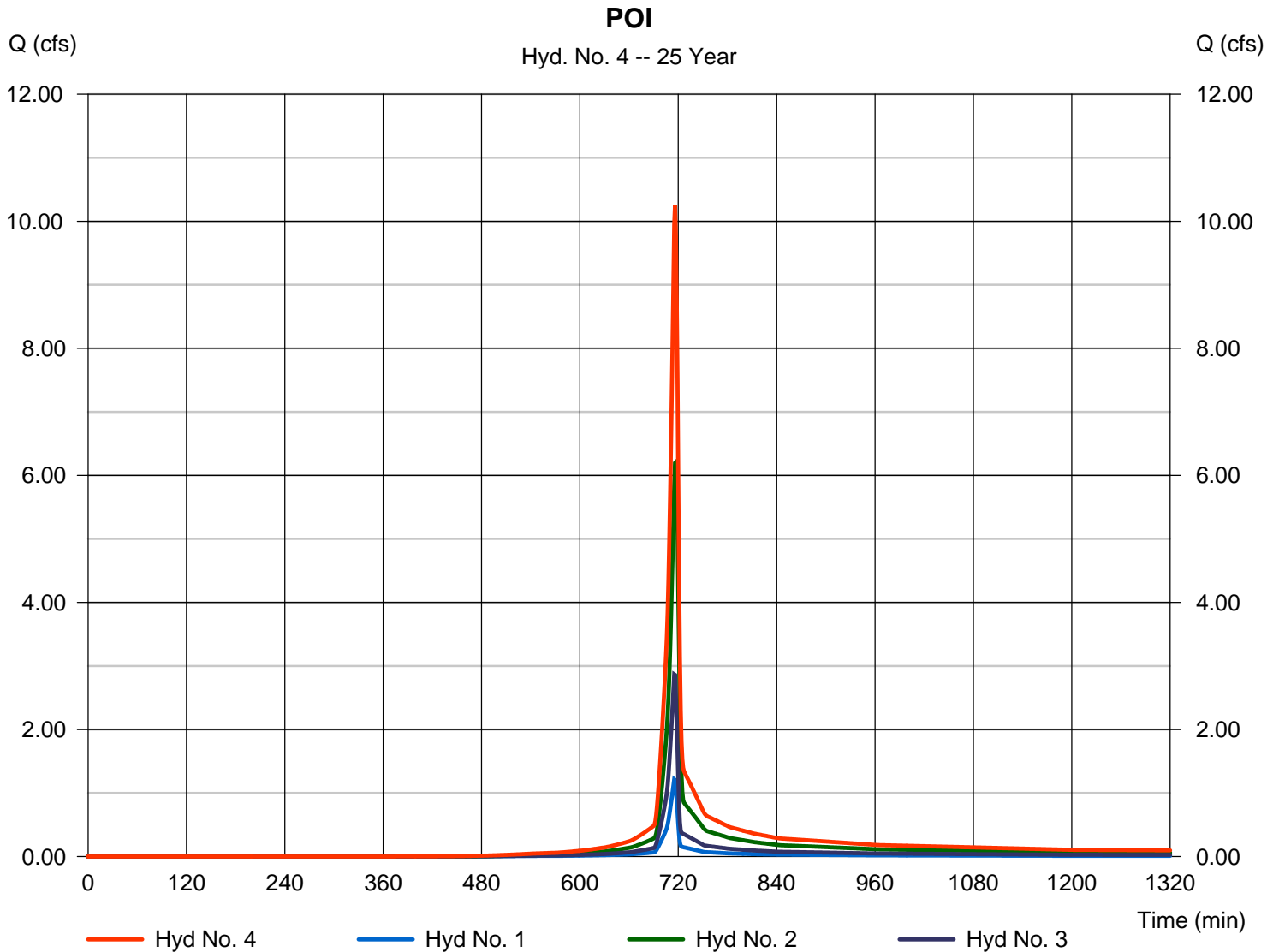
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

Hydrograph type = Combine  
Storm frequency = 25 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 10.26 cfs  
Time to peak = 716 min  
Hyd. volume = 19,263 cuft  
Contrib. drain. area = 1.650 ac



# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

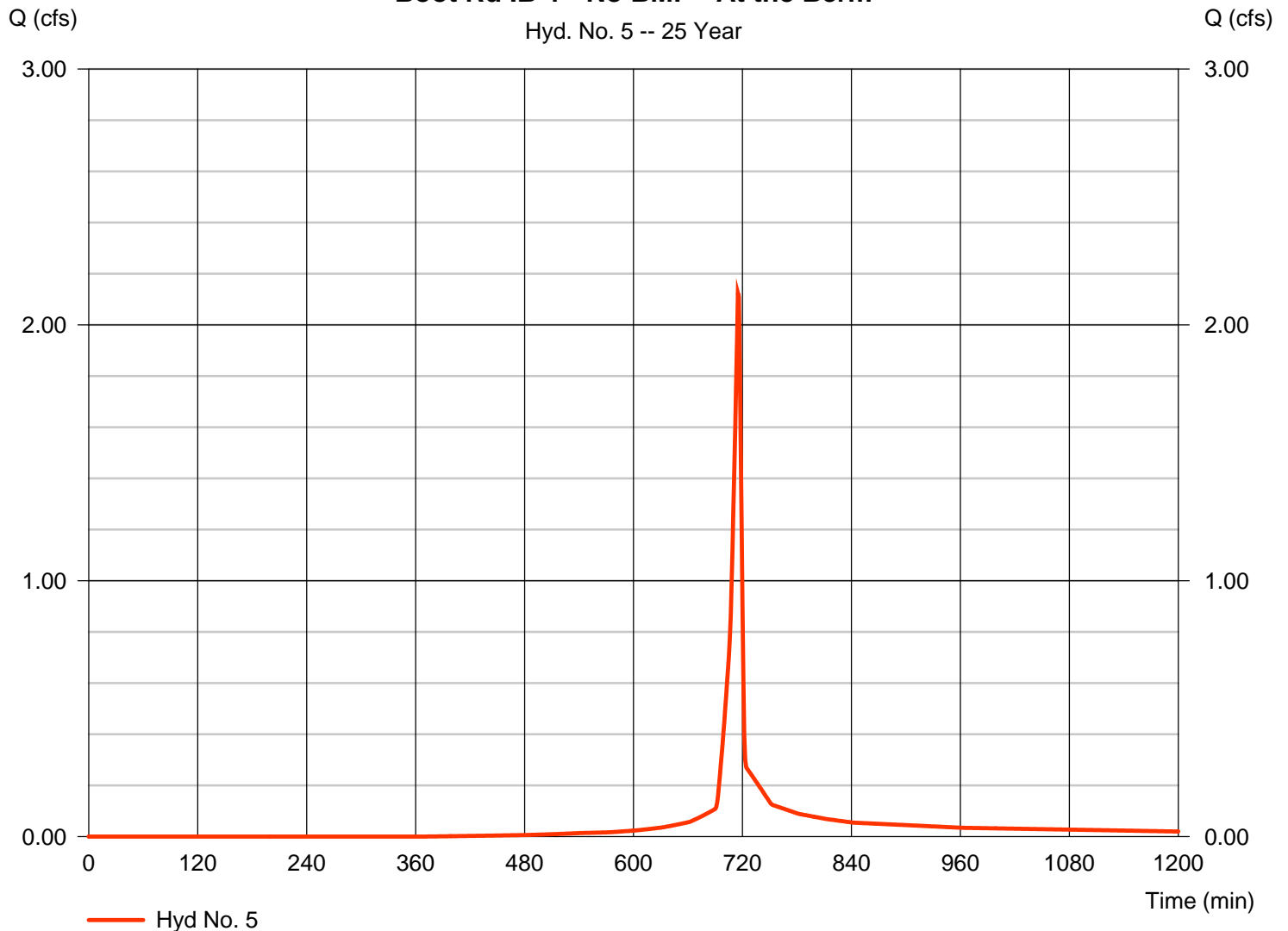
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.124 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,867 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 5.76 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd IB-1 - No BMP - At the Berm**

Hyd. No. 5 -- 25 Year



# TR55 Tc Worksheet

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

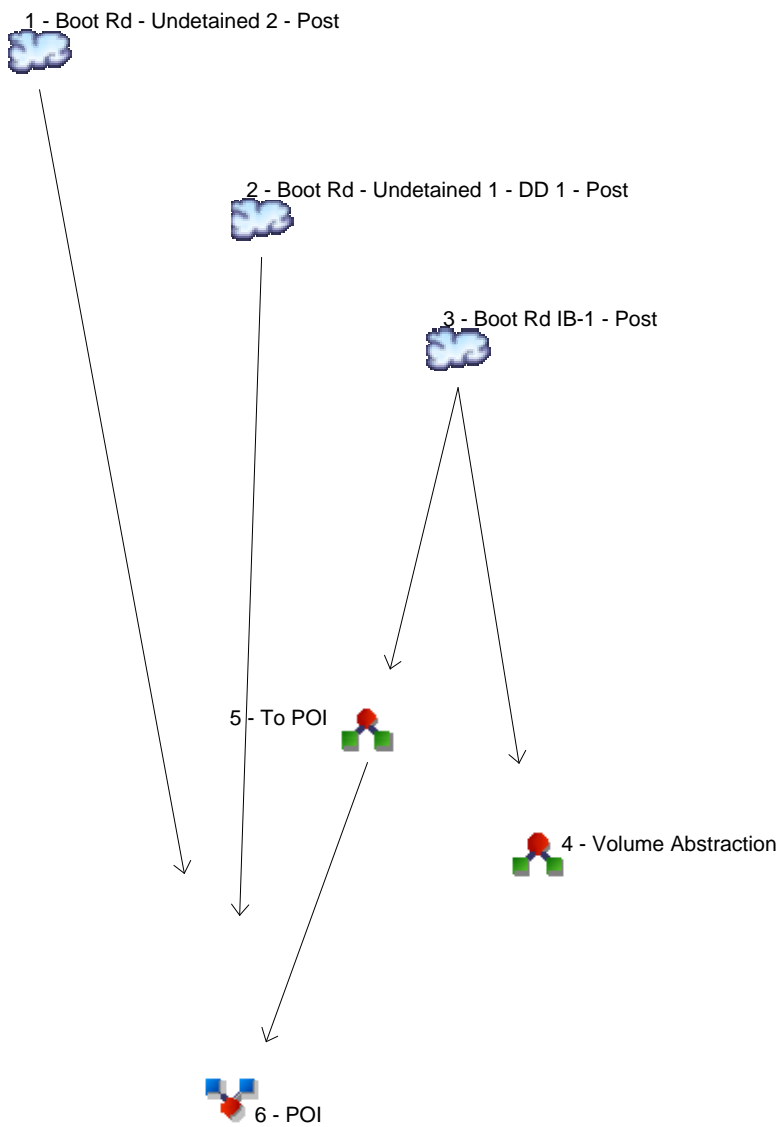
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 100.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>0.58</b> | <b>= 1.08</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.00 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 1.217 | -----  | -----                  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 6.209 | -----  | -----                  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 1.606 | -----  | -----                  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 1.606 | -----  | -----                  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 1.080 | -----  | -----                  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | ----- | ----- | ----- | ----- | ----- | 7.400 | -----  | -----                  | 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               | 1.217           | 1                   | 715                | 2,238                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                            | SCS Runoff               | 6.209           | 1                   | 717                | 11,867                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                            | SCS Runoff               | 1.606           | 1                   | 727                | 5,452                  | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                            | Diversion1               | 1.606           | 1                   | 727                | 2,530                  | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                            | Diversion2               | 1.080           | 1                   | 737                | 2,922                  | 3             | -----                  | -----                    | To POI                               |  |
| 6                            | Combine                  | 7.400           | 1                   | 716                | 17,028                 | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 25 year.gpw |                          |                 |                     |                    | Return Period: 25 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

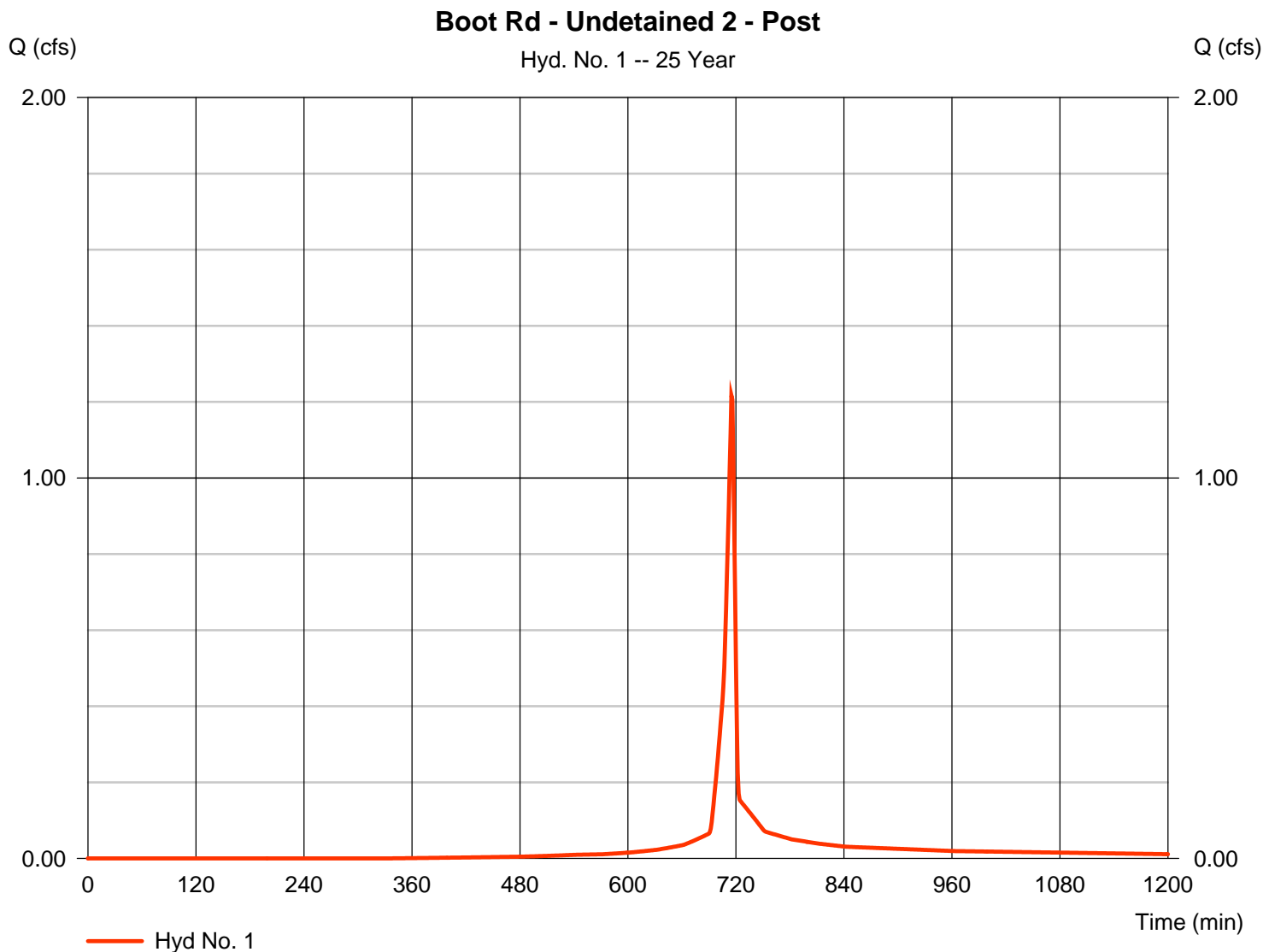
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.217 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,238 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 5.76 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

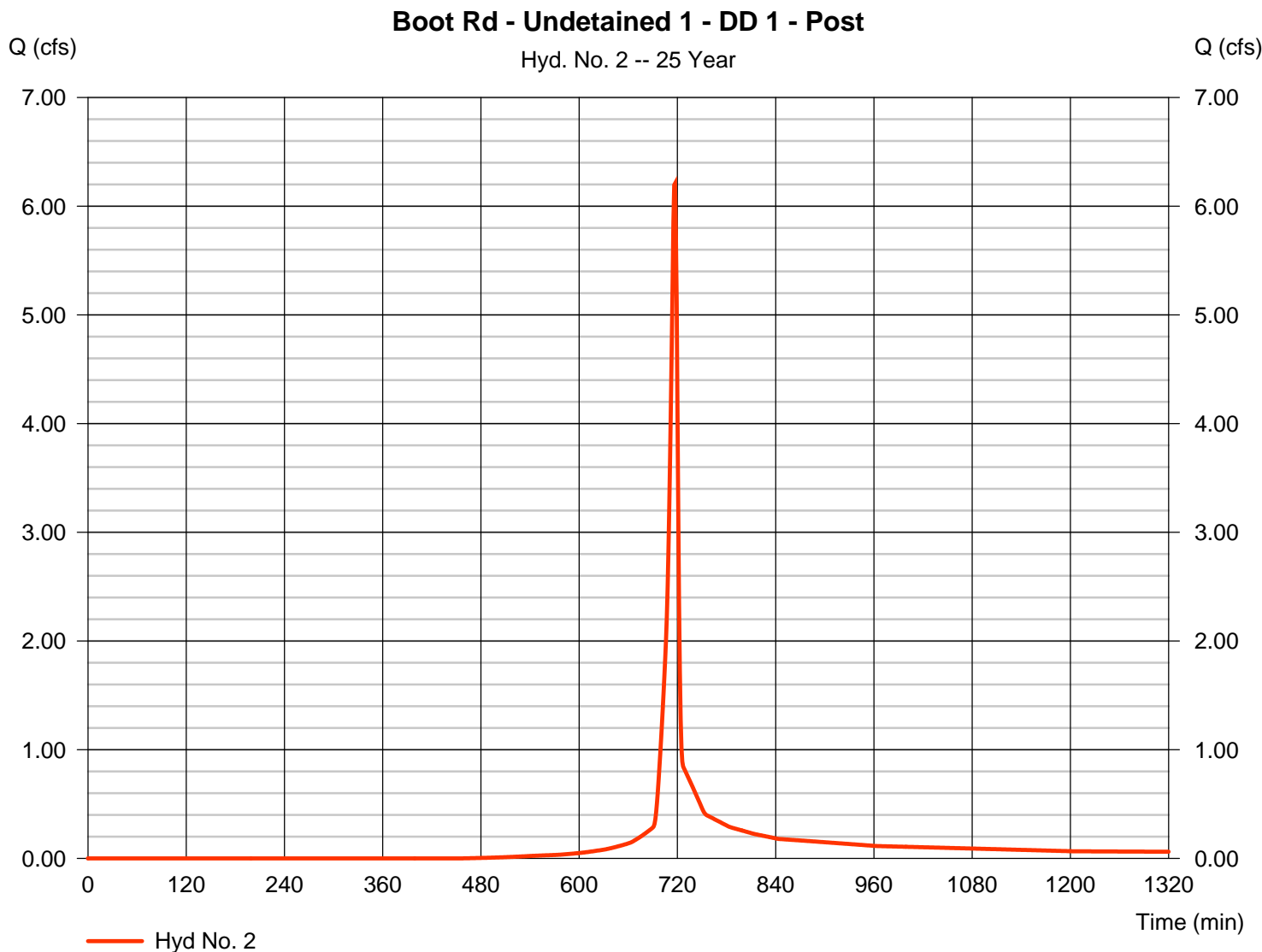
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 6.209 cfs   |
| Storm frequency | = 25 yrs     | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 11,867 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 5.76 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

Boot Rd - Undetained 1 - DD 1 - Post

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

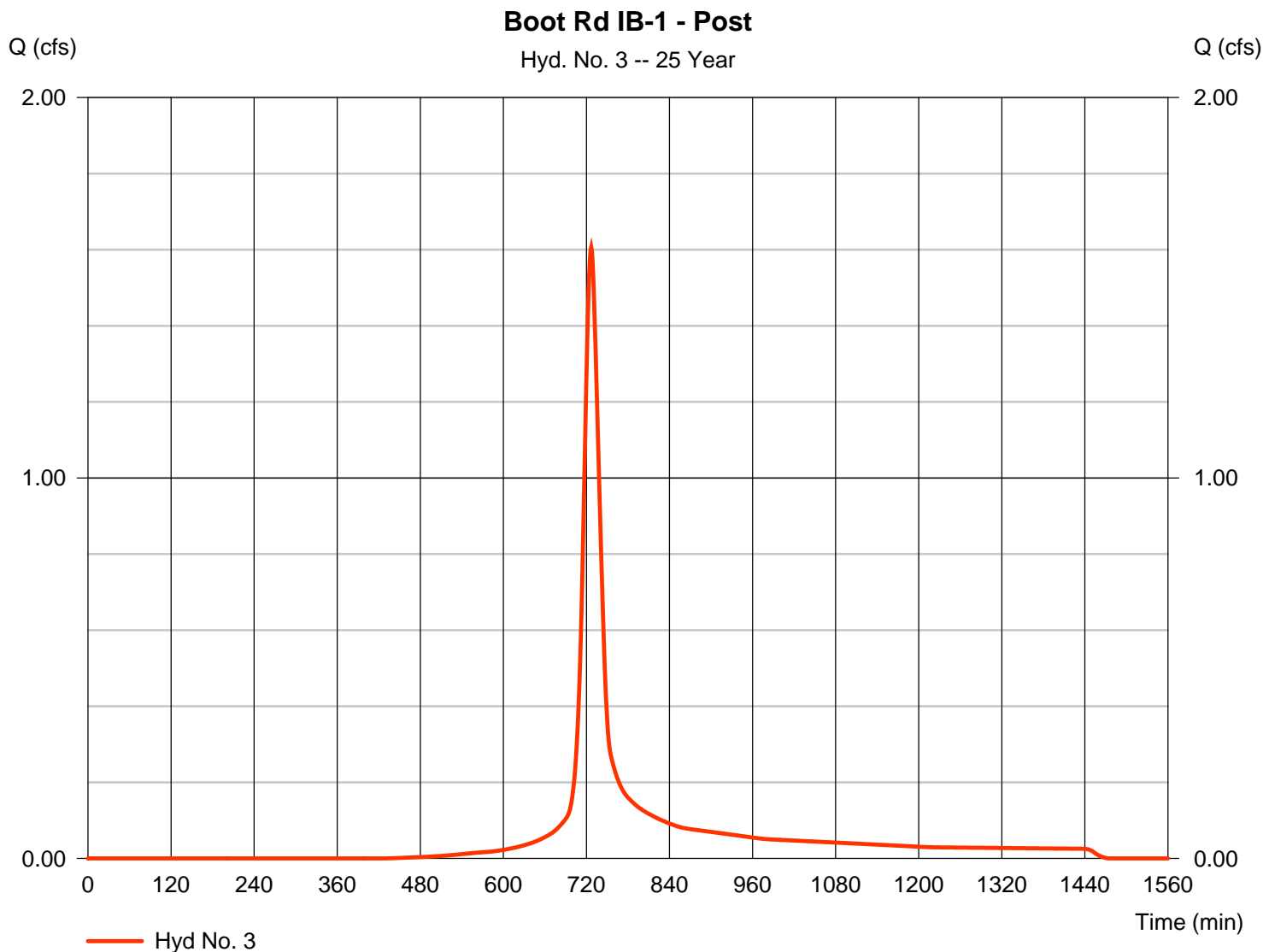
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## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.606 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 727 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 5,452 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 22.00 min  |
| Total precip.   | = 5.76 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

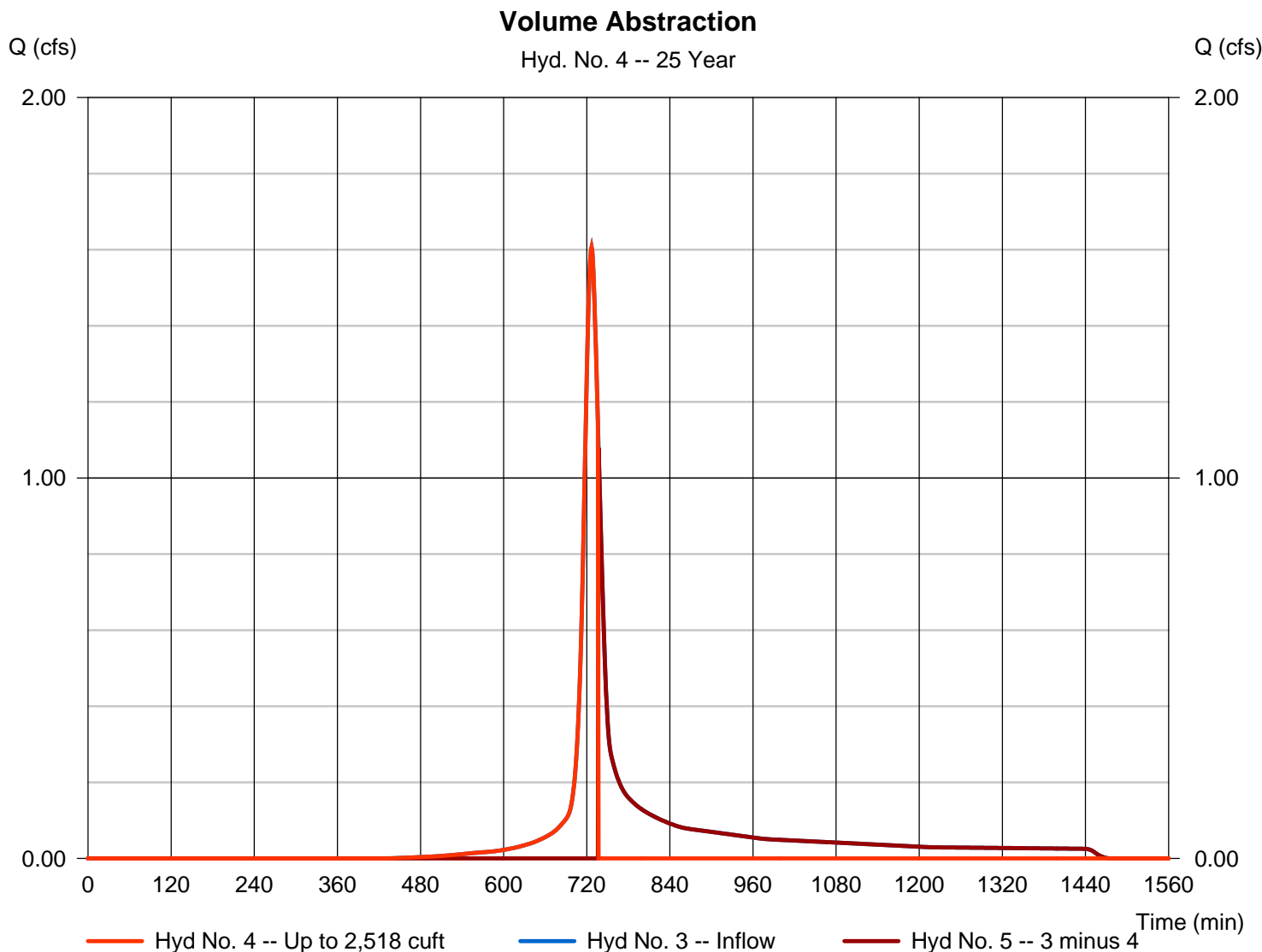
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## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 1.606 cfs  |
| Storm frequency   | = 25 yrs                  | Time to peak      | = 727 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,530 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

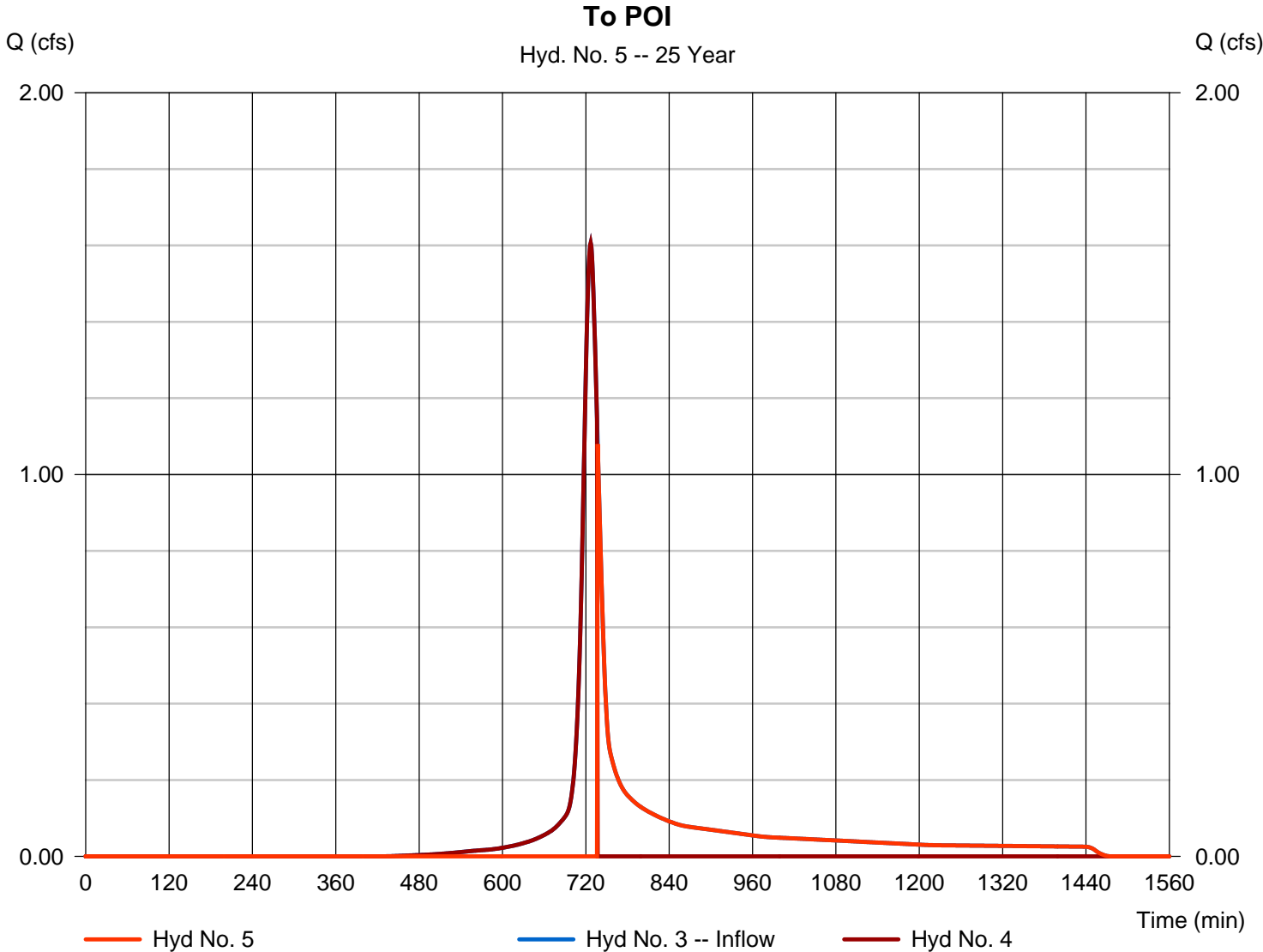
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Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 1.080 cfs  |
| Storm frequency   | = 25 yrs                  | Time to peak      | = 737 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,922 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

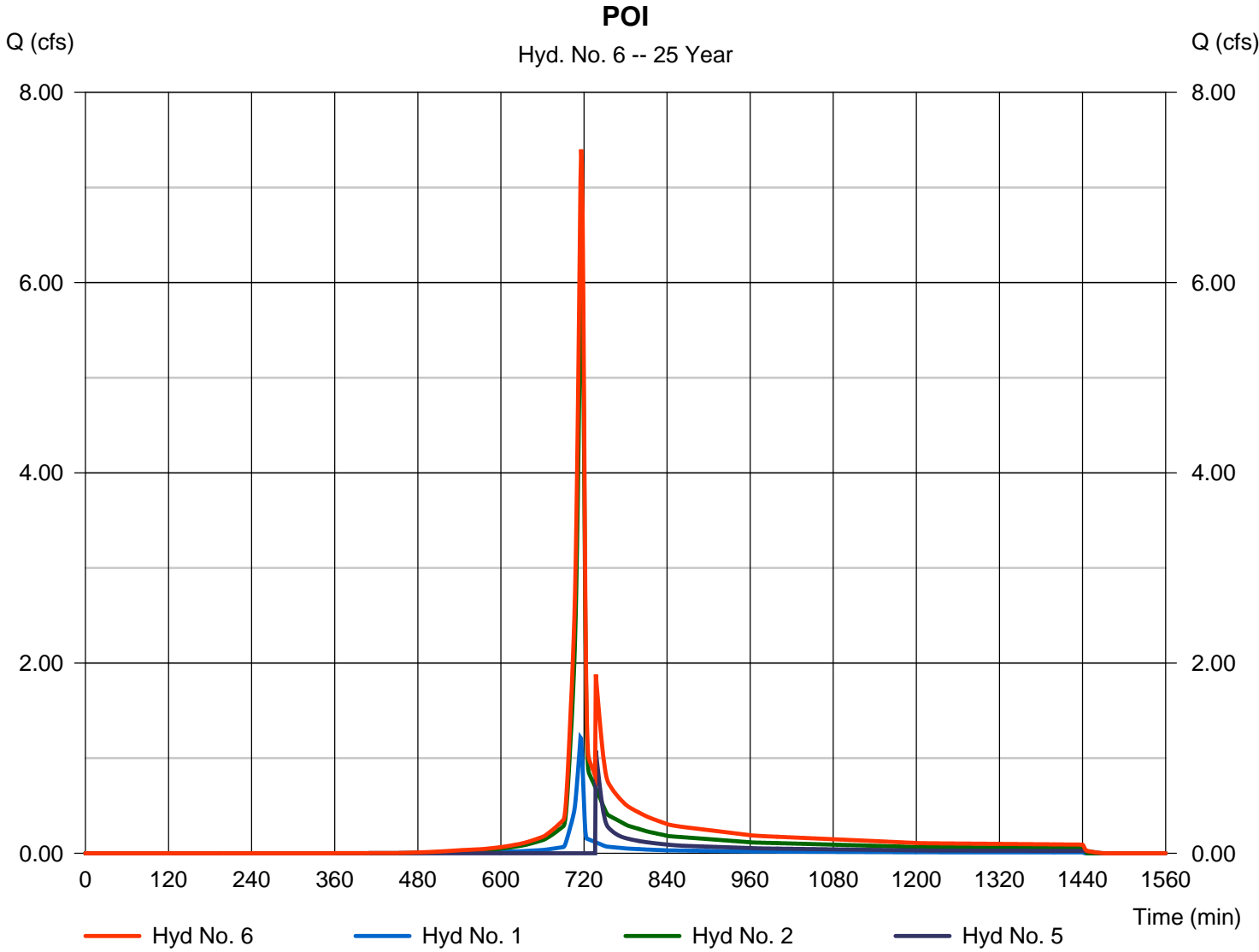
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Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 7.400 cfs   |
| Storm frequency | = 25 yrs  | Time to peak         | = 716 min     |
| Time interval   | = 1 min   | Hyd. volume          | = 17,028 cuft |
| Inflow hyds.    | = 1, 2, 5 | Contrib. drain. area | = 1.200 ac    |



**ATTACHMENT C-6**  
**BOOT 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

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               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# Hydrograph Summary Report

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

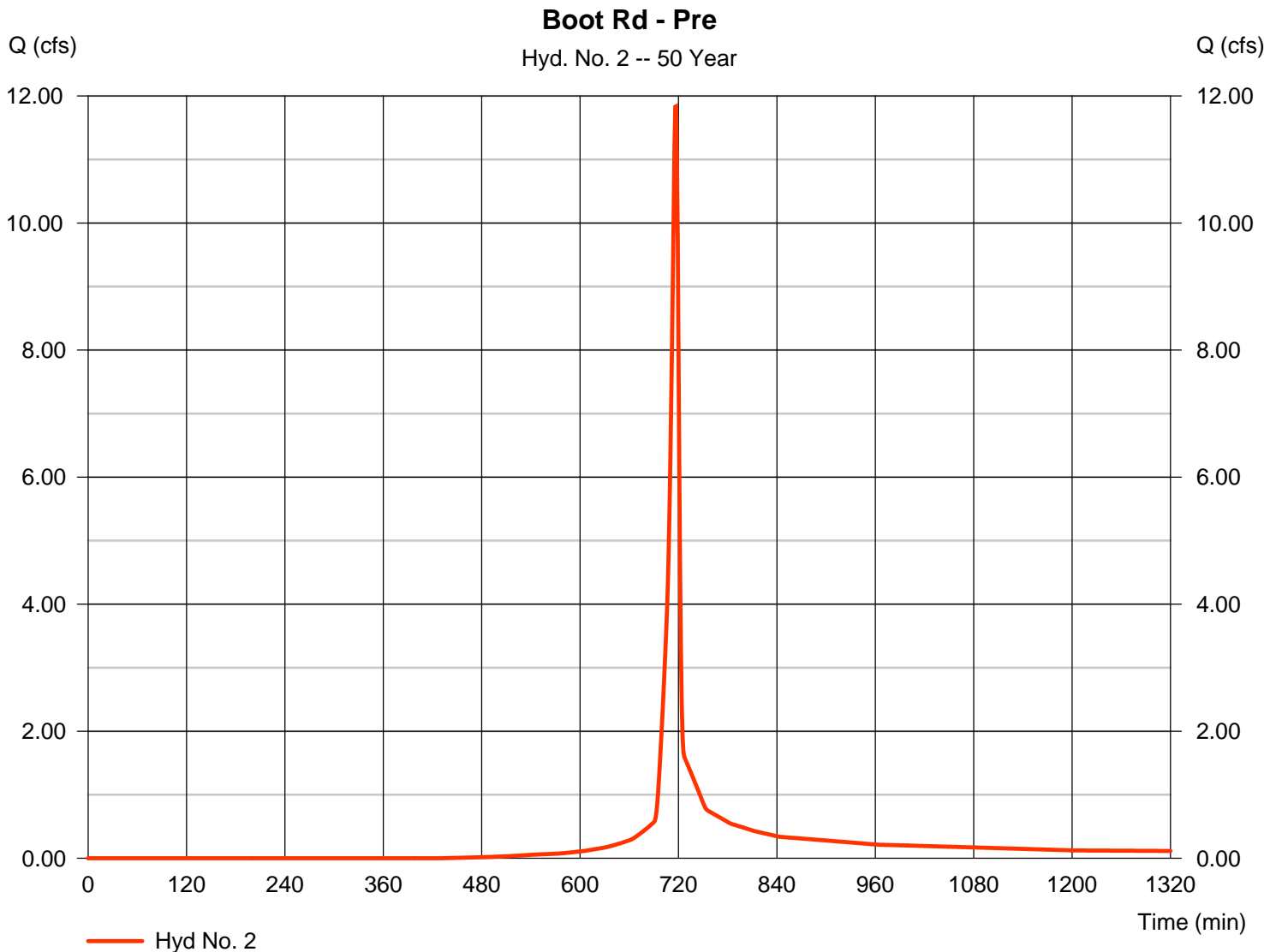
| Hyd. No.          | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft)   | Total strge used (cuft) | Hydrograph Description |
|-------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|--------------------------|-------------------------|------------------------|
| 2                 | SCS Runoff               | 11.84           | 1                   | 717                | 22,754                 | -----         | -----                    | -----                   | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 50 Year |               | Wednesday, 11 / 9 / 2016 |                         |                        |

# Hydrograph Report

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 11.84 cfs   |
| Storm frequency | = 50 yrs     | Time to peak       | = 717 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 22,754 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min    |
| Total precip.   | = 6.60 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

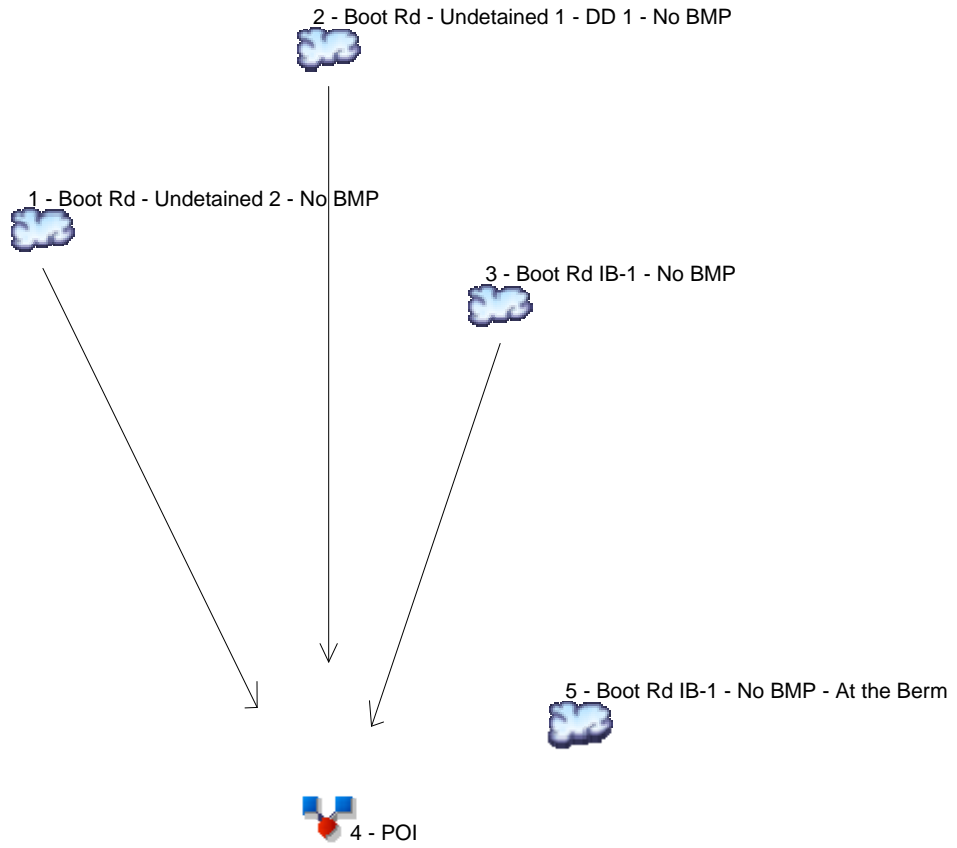
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 484.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 3.70        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.10        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.60</b> | <b>=</b> | <b>2.70</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.50 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# 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               | 1.446           | 1                   | 715                | 2,691                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |  |
| 2                           | SCS Runoff               | 7.565           | 1                   | 716                | 14,594                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |  |
| 3                           | SCS Runoff               | 3.472           | 1                   | 715                | 6,300                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |  |
| 4                           | Combine                  | 12.45           | 1                   | 716                | 23,584                 | 1, 2, 3       | -----                  | -----                    | POI                                  |  |
| 5                           | SCS Runoff               | 2.543           | 1                   | 715                | 4,678                  | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

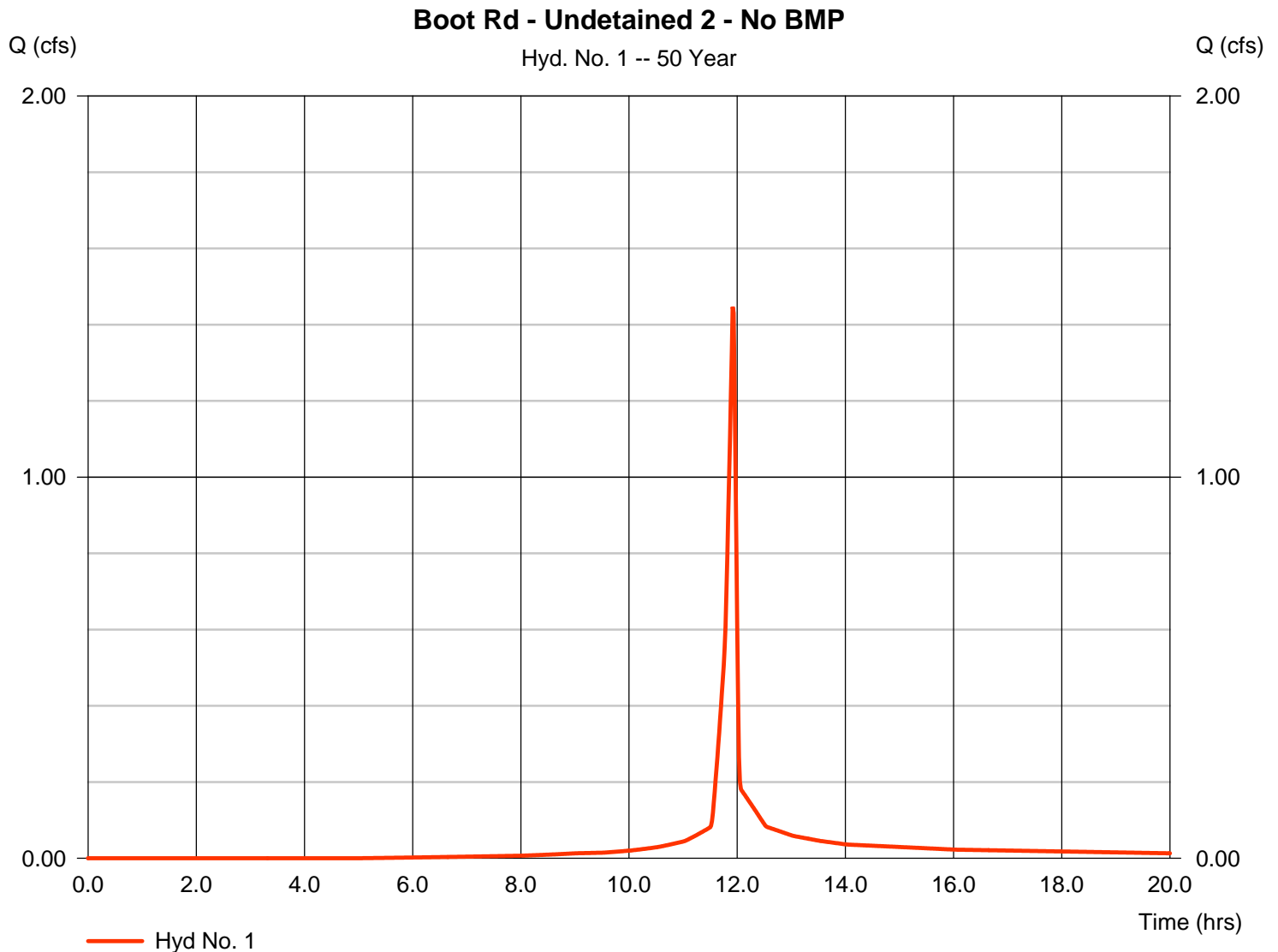
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.446 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 2,691 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 6.60 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

Boot Rd - Undetained 2 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc</b> ..... |               |          |             |          |             | <b>2.40 min</b> |

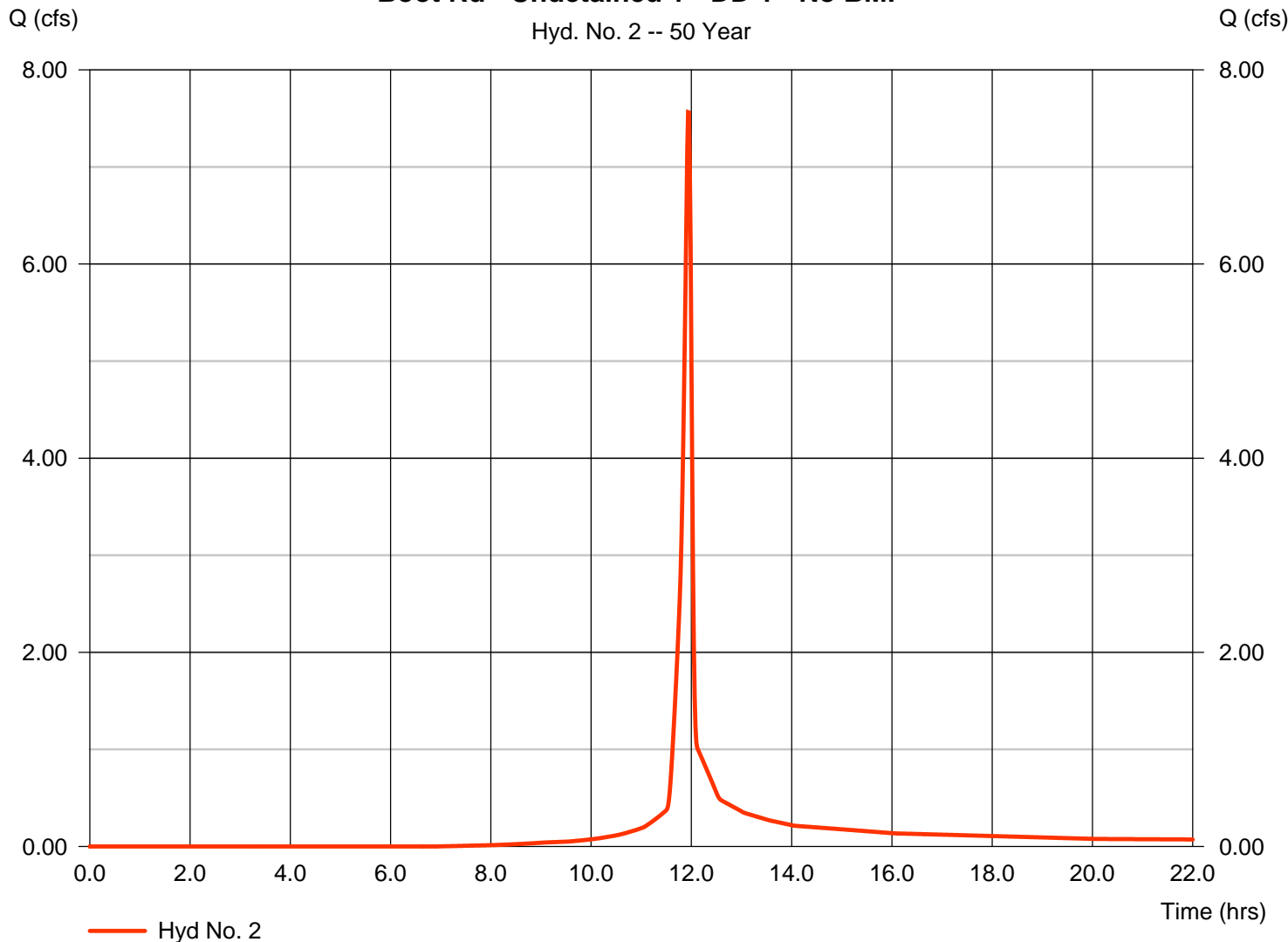
# Hydrograph Report

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 7.565 cfs   |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.93 hrs   |
| Time interval   | = 1 min      | Hyd. volume        | = 14,594 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 6.60 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

**Boot Rd - Undetained 1 - DD 1 - No BMP**



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 408.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 4.10        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.27        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.08</b> | <b>=</b> | <b>2.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 5.40        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 7.46        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 2.00        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.070       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =2.42         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | {{0}}100.0    |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.69</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.70 min</b> |

# Hydrograph Report

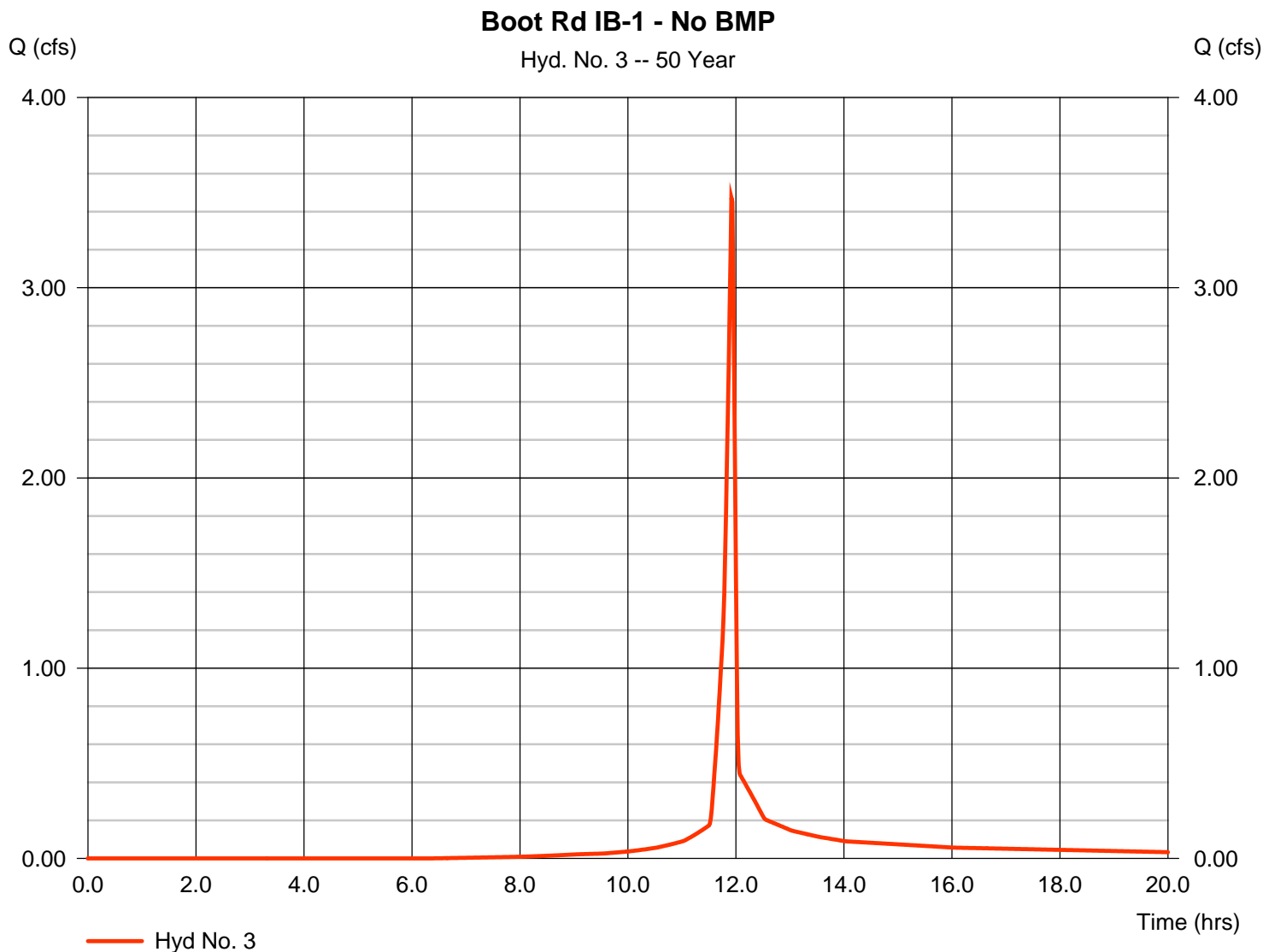
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.472 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 6,300 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 6.60 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 247.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>1.43</b> | <b>= 1.93</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.80 min</b> |

# Hydrograph Report

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

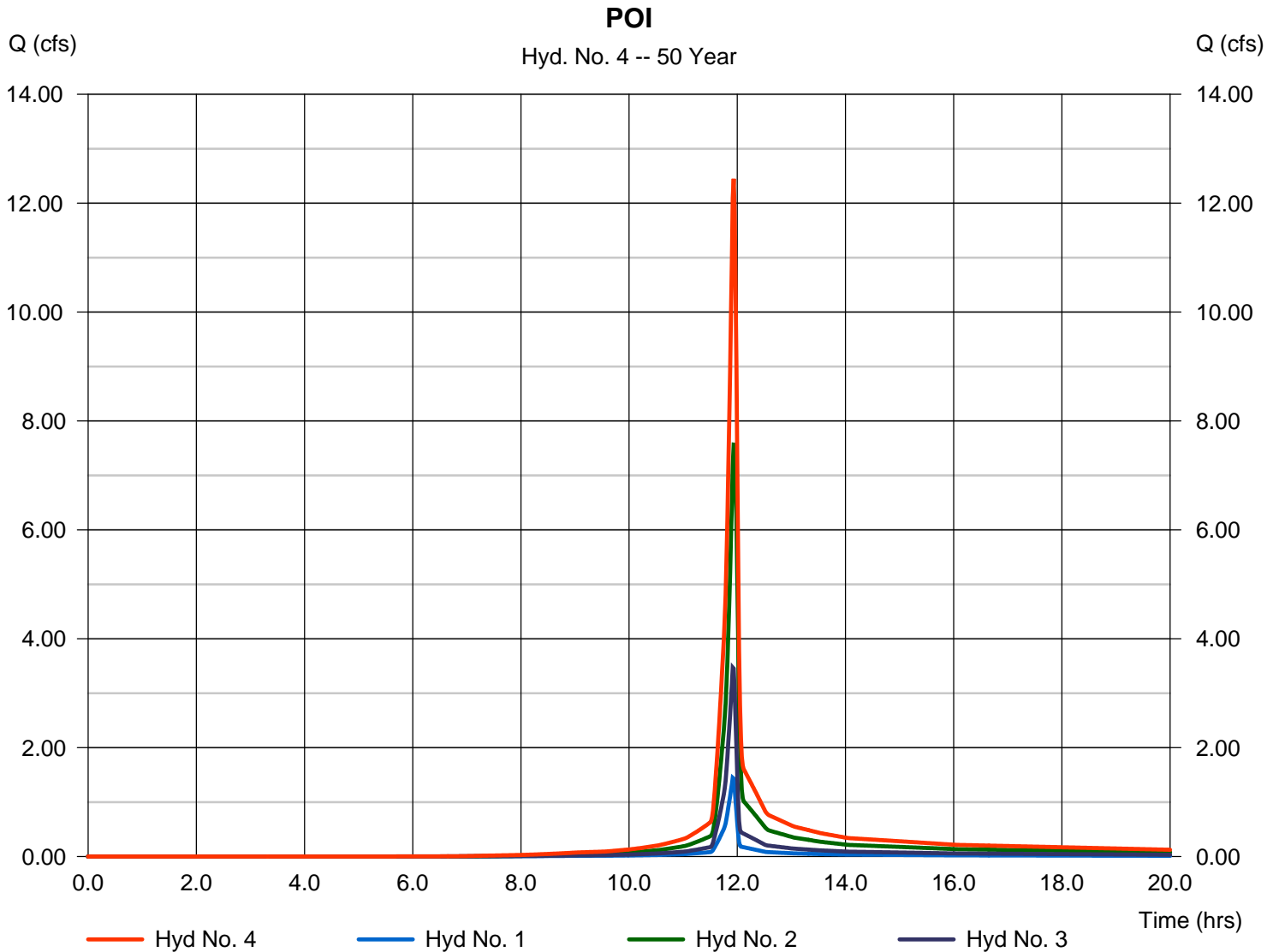
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

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

Peak discharge = 12.45 cfs  
Time to peak = 11.93 hrs  
Hyd. volume = 23,584 cuft  
Contrib. drain. area = 1.650 ac



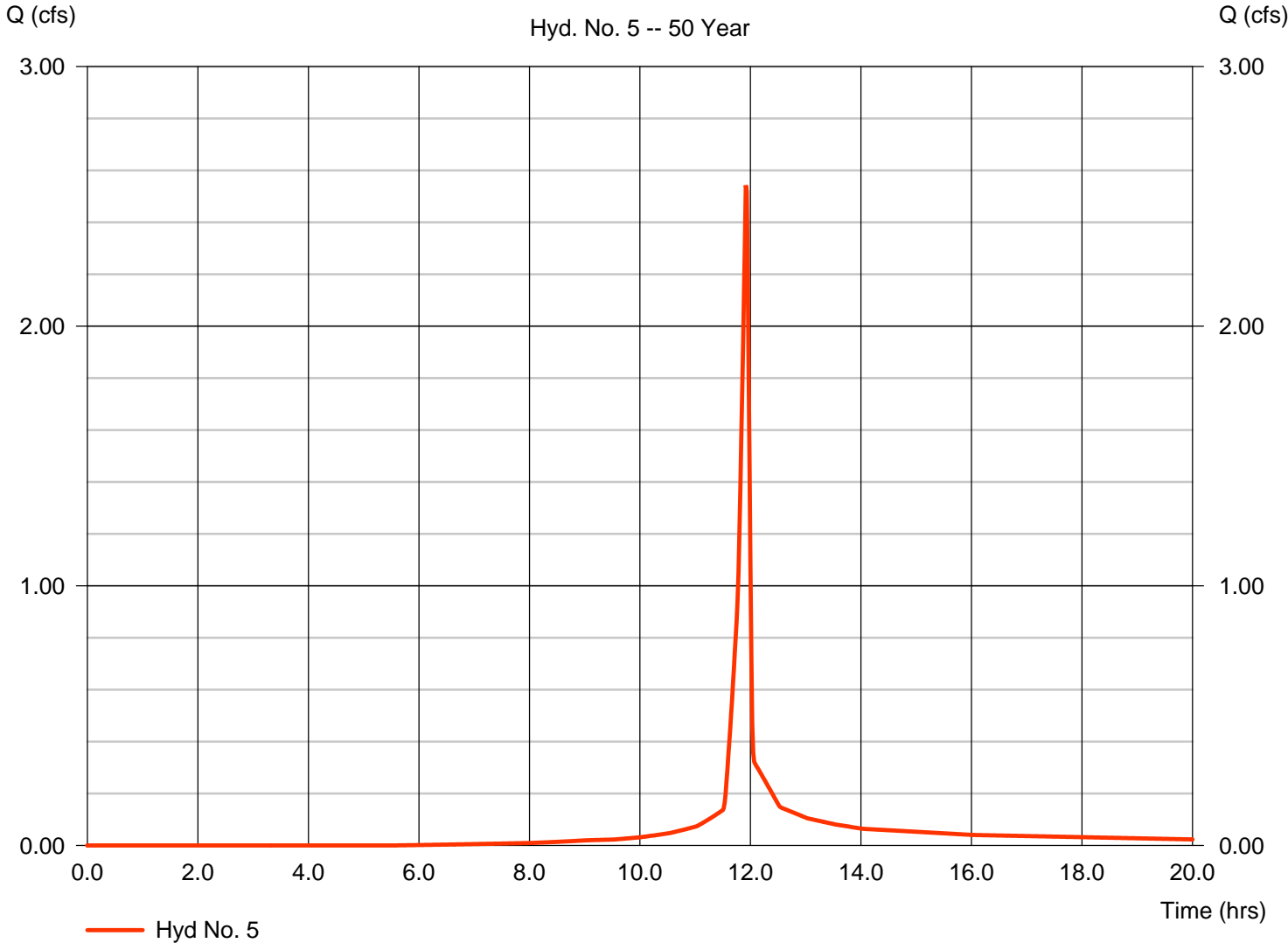
# Hydrograph Report

## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.543 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 4,678 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 6.60 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd IB-1 - No BMP - At the Berm**



# TR55 Tc Worksheet

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

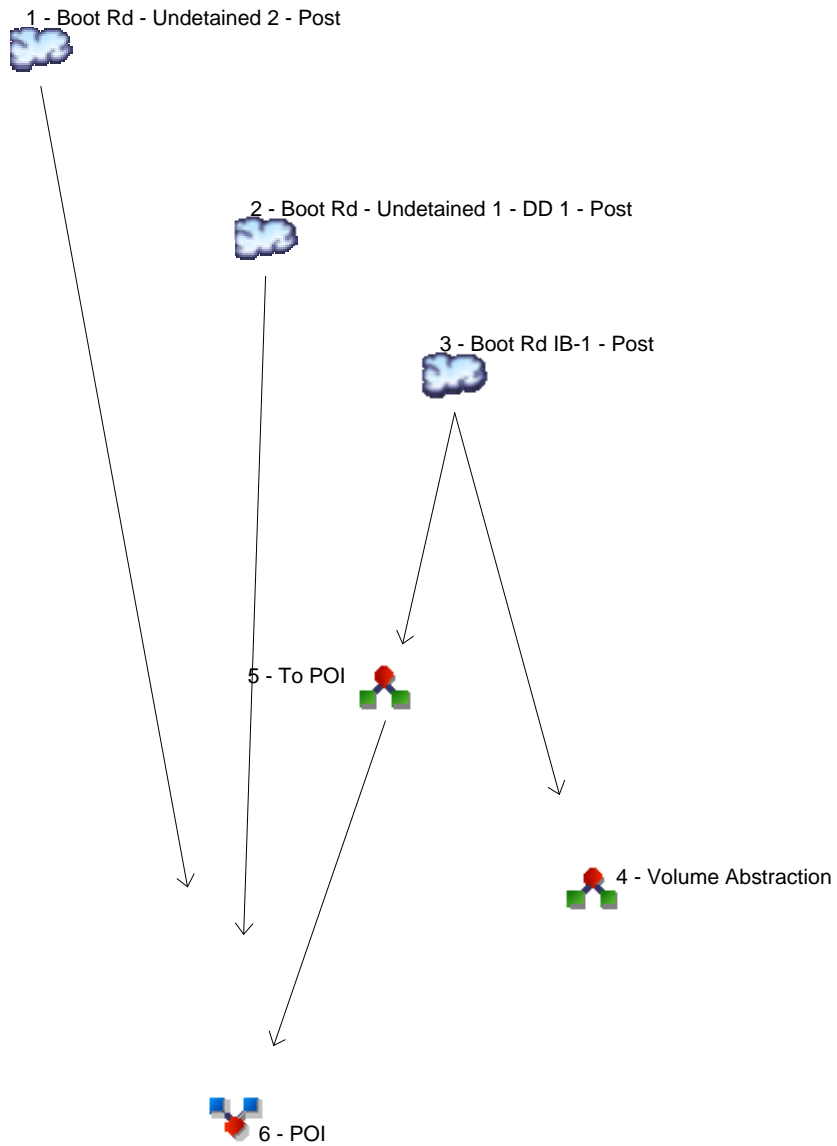
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 35.00       |          | 100.00      |          | 100.00      |                 |
| Watercourse slope (%)              | = 8.50        |          | 6.50        |          | 3.20        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |                 |
| Average velocity (ft/s)            | =5.93         |          | 4.11        |          | 2.89        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.41</b> | <b>+</b> | <b>0.58</b> | <b>= 1.08</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.00 min</b> |

# Watershed Model Schematic

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



# Hydrograph Return Period Recap

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| 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 1.446 | -----  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 7.565 | -----  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 2.144 | -----  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 2.144 | -----  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 2.008 | -----  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | ----- | ----- | ----- | ----- | ----- | 8.996 | -----  | POI                                  |

# Hydrograph Summary Report

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

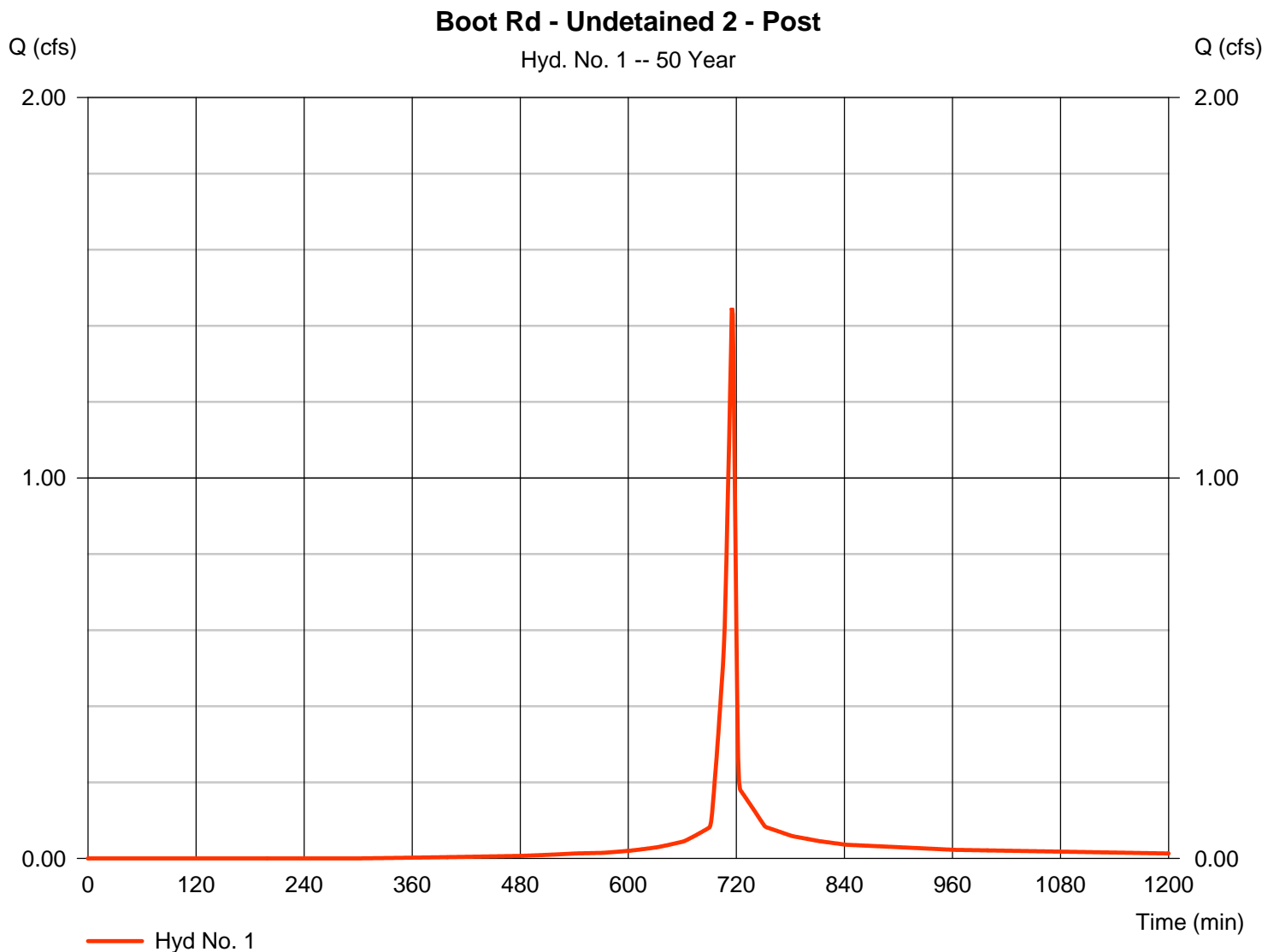
| Hyd. No.                     | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |  |
|------------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|--------------------------------------|--|
| 1                            | SCS Runoff               | 1.446           | 1                   | 715                | 2,691                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                            | SCS Runoff               | 7.565           | 1                   | 716                | 14,594                 | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                            | SCS Runoff               | 2.144           | 1                   | 725                | 6,720                  | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                            | Diversion1               | 2.144           | 1                   | 725                | 2,582                  | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                            | Diversion2               | 2.008           | 1                   | 728                | 4,138                  | 3             | -----                  | -----                    | To POI                               |  |
| 6                            | Combine                  | 8.996           | 1                   | 716                | 21,422                 | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 50 year.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.446 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,691 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 6.60 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

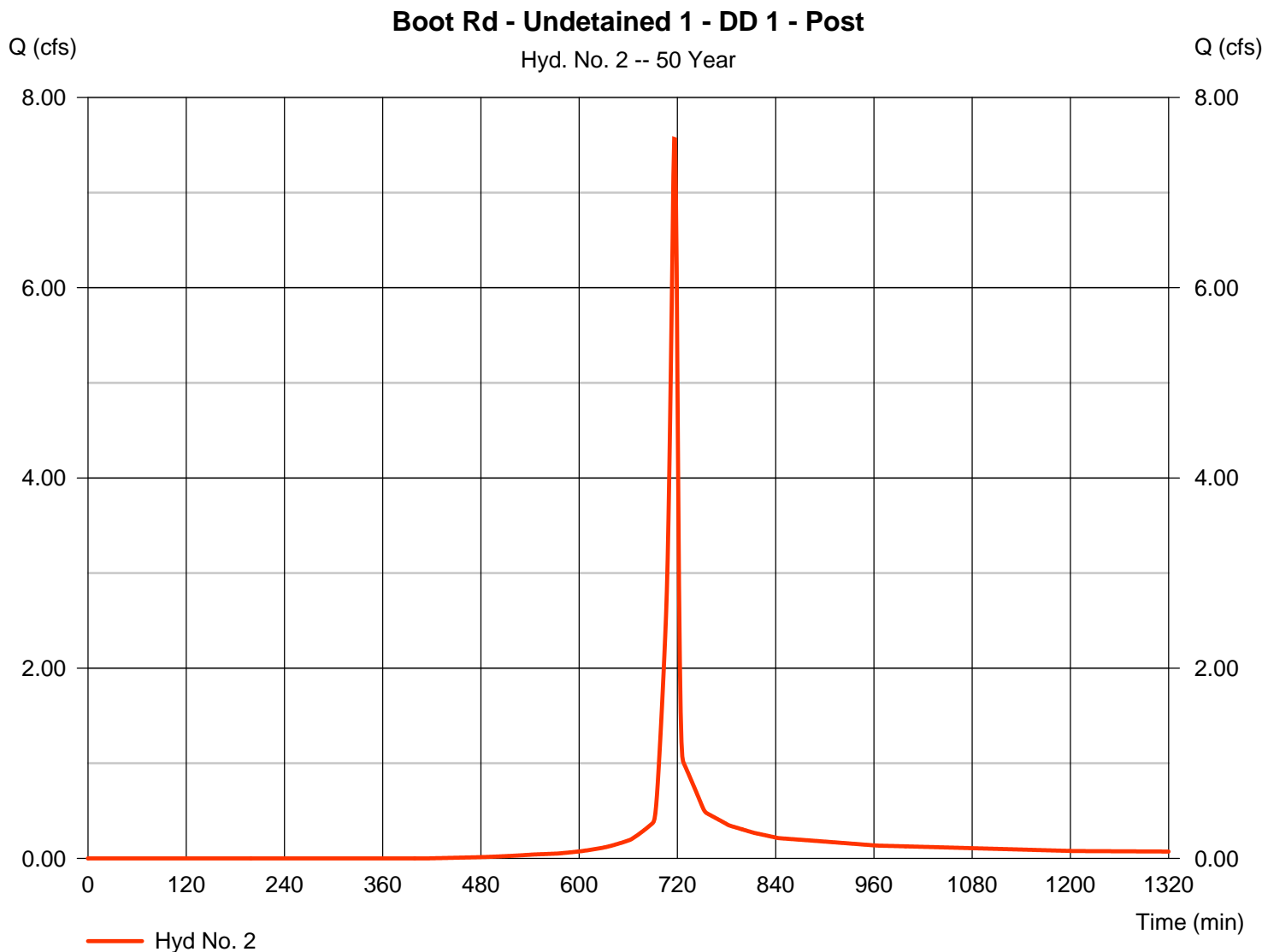
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 7.565 cfs   |
| Storm frequency | = 50 yrs     | Time to peak       | = 716 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 14,594 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 6.60 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

Boot Rd - Undetained 1 - DD 1 - Post

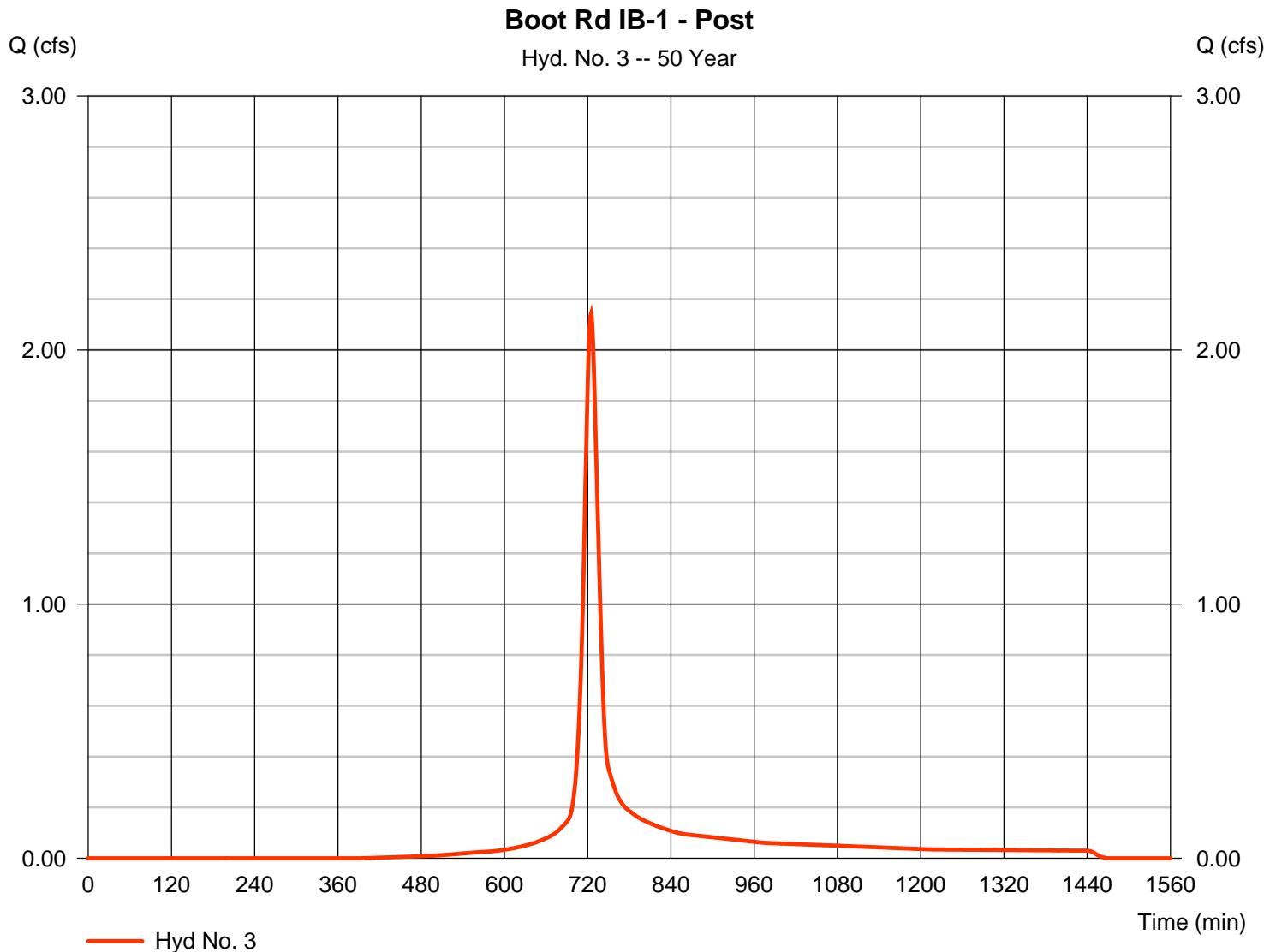
| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 408.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 4.10                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.27                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.08</b> | <b>= 2.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| X sectional flow area (sqft)       | = 5.40        | 0.00                 | 0.00                 |                 |
| Wetted perimeter (ft)              | = 7.46        | 0.00                 | 0.00                 |                 |
| Channel slope (%)                  | = 2.00        | 0.00                 | 0.00                 |                 |
| Manning's n-value                  | = 0.070       | 0.015                | 0.015                |                 |
| Velocity (ft/s)                    | =2.42         | 0.00                 | 0.00                 |                 |
| Flow length (ft)                   | {{0}}100.0    | 0.0                  | 0.0                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.69</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.70 min</b> |

# Hydrograph Report

## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.144 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 6,720 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 18.80 min  |
| Total precip.   | = 6.60 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

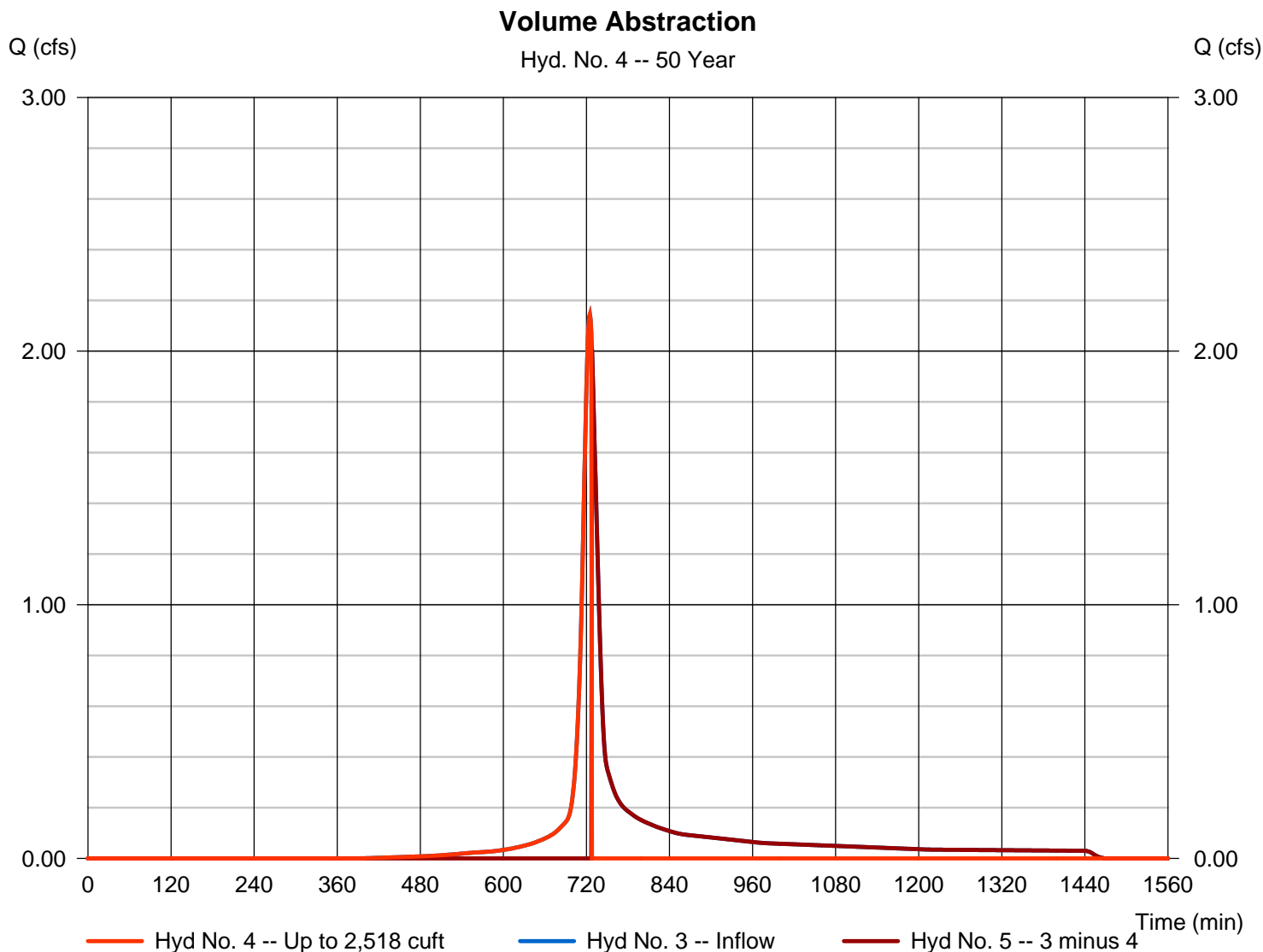
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 2.144 cfs  |
| Storm frequency   | = 50 yrs                  | Time to peak      | = 725 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,582 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

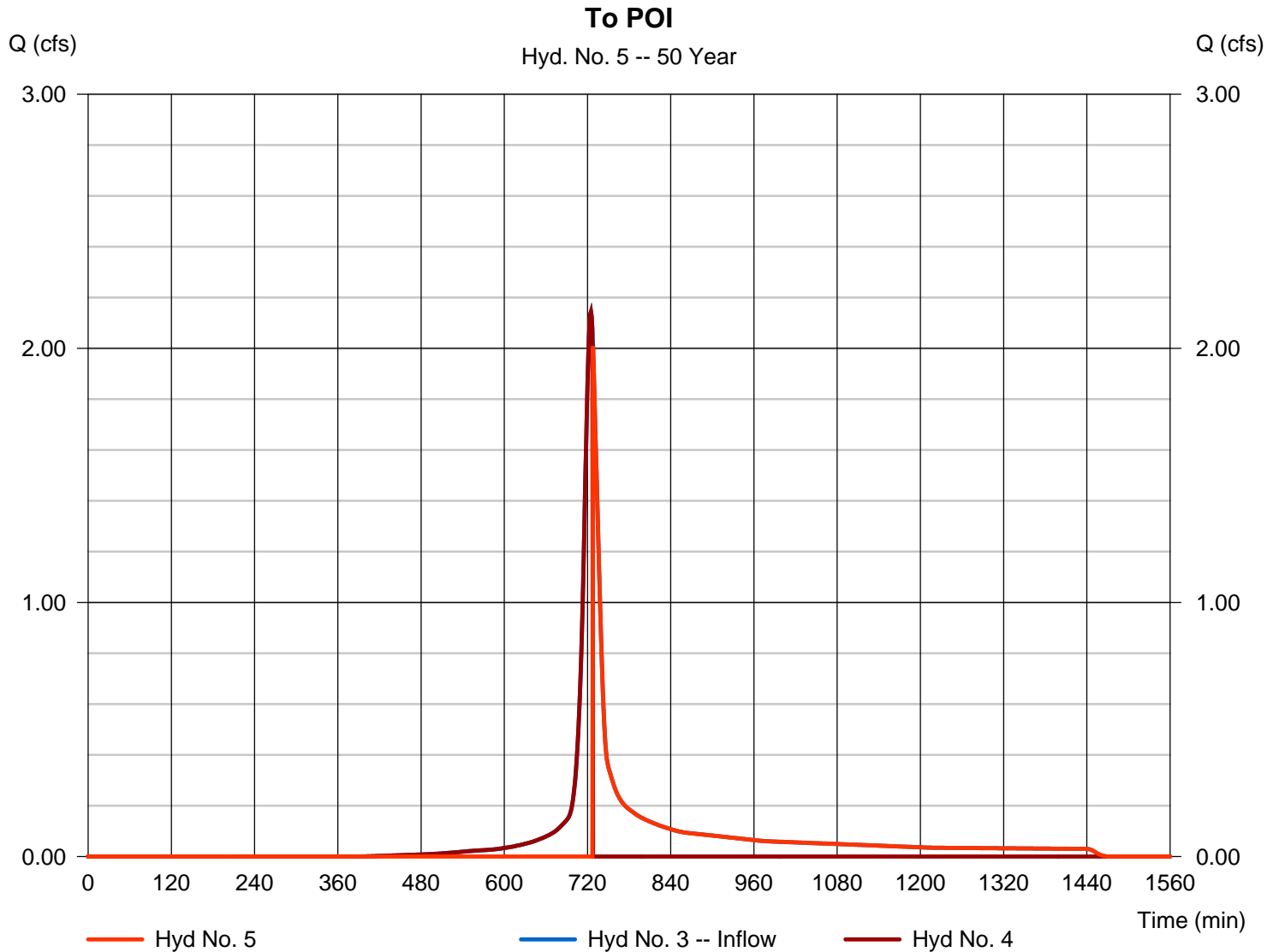
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Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 2.008 cfs  |
| Storm frequency   | = 50 yrs                  | Time to peak      | = 728 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 4,138 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

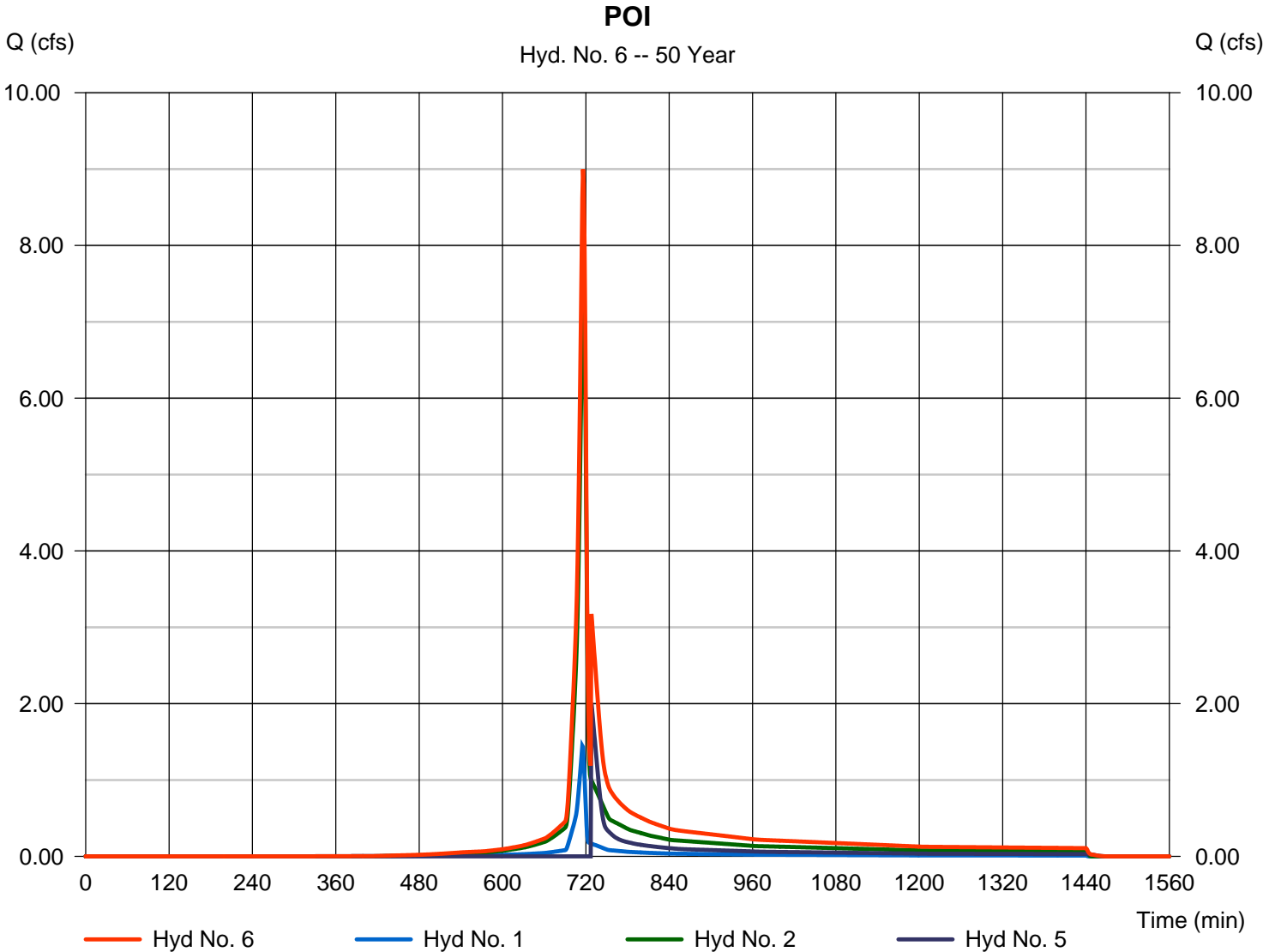
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 8.996 cfs   |
| Storm frequency | = 50 yrs  | Time to peak         | = 716 min     |
| Time interval   | = 1 min   | Hyd. volume          | = 21,422 cuft |
| Inflow hyds.    | = 1, 2, 5 | Contrib. drain. area | = 1.200 ac    |



**ATTACHMENT C-7**  
**BOOT RD**  
**100 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot Rd - 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 |                        |
| 2        | SCS Runoff               | -----         | 2.428              | 3.600 | ----- | 5.515 | 7.193 | 9.681 | 11.84 | 14.20  | Boot Rd - Pre          |

# 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               | 14.20           | 1                   | 716                | 27,509                  | -----         | -----                    | -----                   | Boot Rd - Pre          |
| Boot Rd - Pre.gpw |                          |                 |                     |                    | Return Period: 100 Year |               | Wednesday, 11 / 9 / 2016 |                         |                        |

# Hydrograph Report

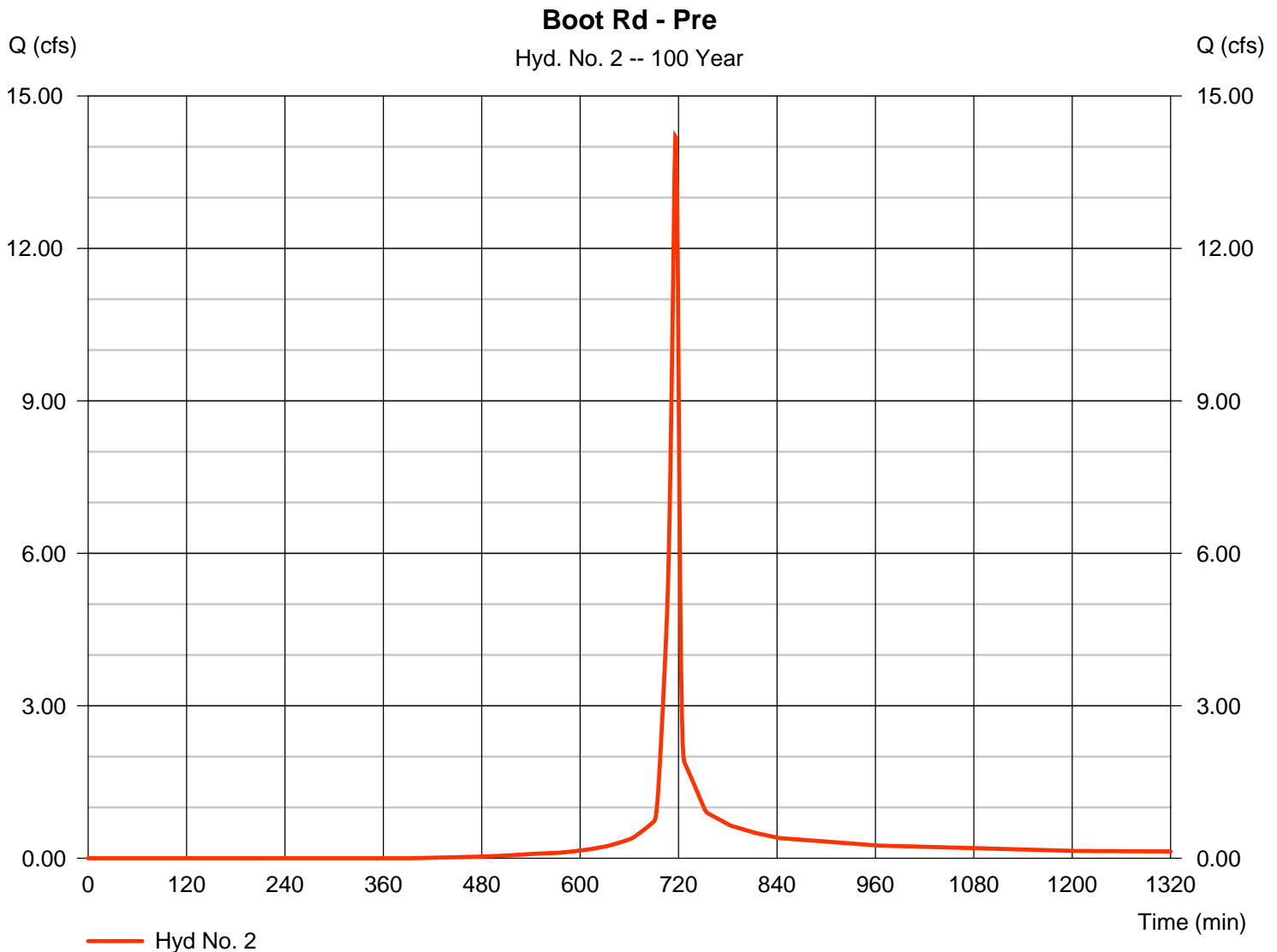
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Pre

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 14.20 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 27,509 cuft |
| Drainage area   | = 1.650 ac   | Curve number       | = 75          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.50 min    |
| Total precip.   | = 7.50 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

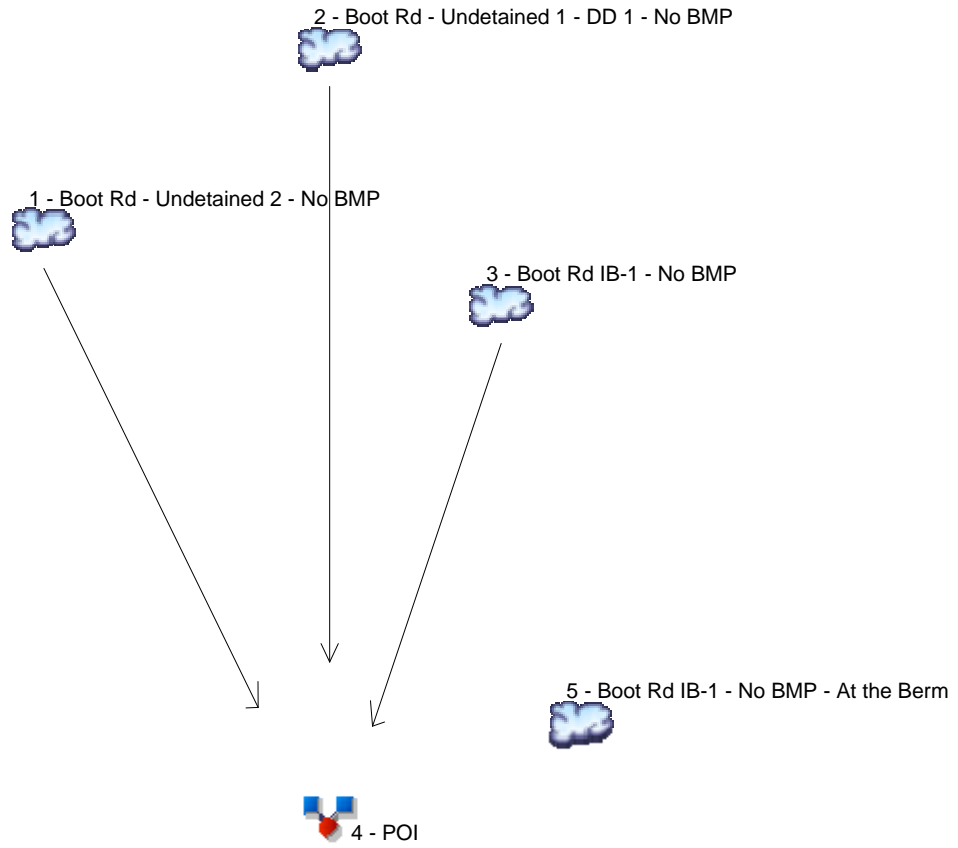
## Hyd. No. 2

Boot Rd - Pre

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 13.00       | 27.00                | 484.00               |                 |
| Watercourse slope (%)              | = 7.70        | 18.50                | 3.70                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.64         | 6.94                 | 3.10                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>2.60</b> | <b>= 2.70</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>3.50 min</b> |

# 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               | -----         | 0.400              | 0.540 | ----- | 0.759 | 0.946 | 1.217 | 1.446 | 1.692  | Boot Rd - Undetained 2 - No BMP      |
| 2        | SCS Runoff               | -----         | 1.619              | 2.368 | ----- | 3.583 | 4.643 | 6.209 | 7.565 | 9.049  | Boot Rd - Undetained 1 - DD 1 - No B |
| 3        | SCS Runoff               | -----         | 0.811              | 1.152 | ----- | 1.698 | 2.169 | 2.869 | 3.472 | 4.123  | Boot Rd IB-1 - No BMP                |
| 4        | Combine                  | 1, 2, 3       | 2.782              | 4.012 | ----- | 5.998 | 7.721 | 10.26 | 12.45 | 14.81  | POI                                  |
| 5        | SCS Runoff               | -----         | 0.659              | 0.907 | ----- | 1.297 | 1.634 | 2.124 | 2.543 | 2.992  | Boot Rd IB-1 - No BMP - At the Berm  |

# Hydrograph Summary Report

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

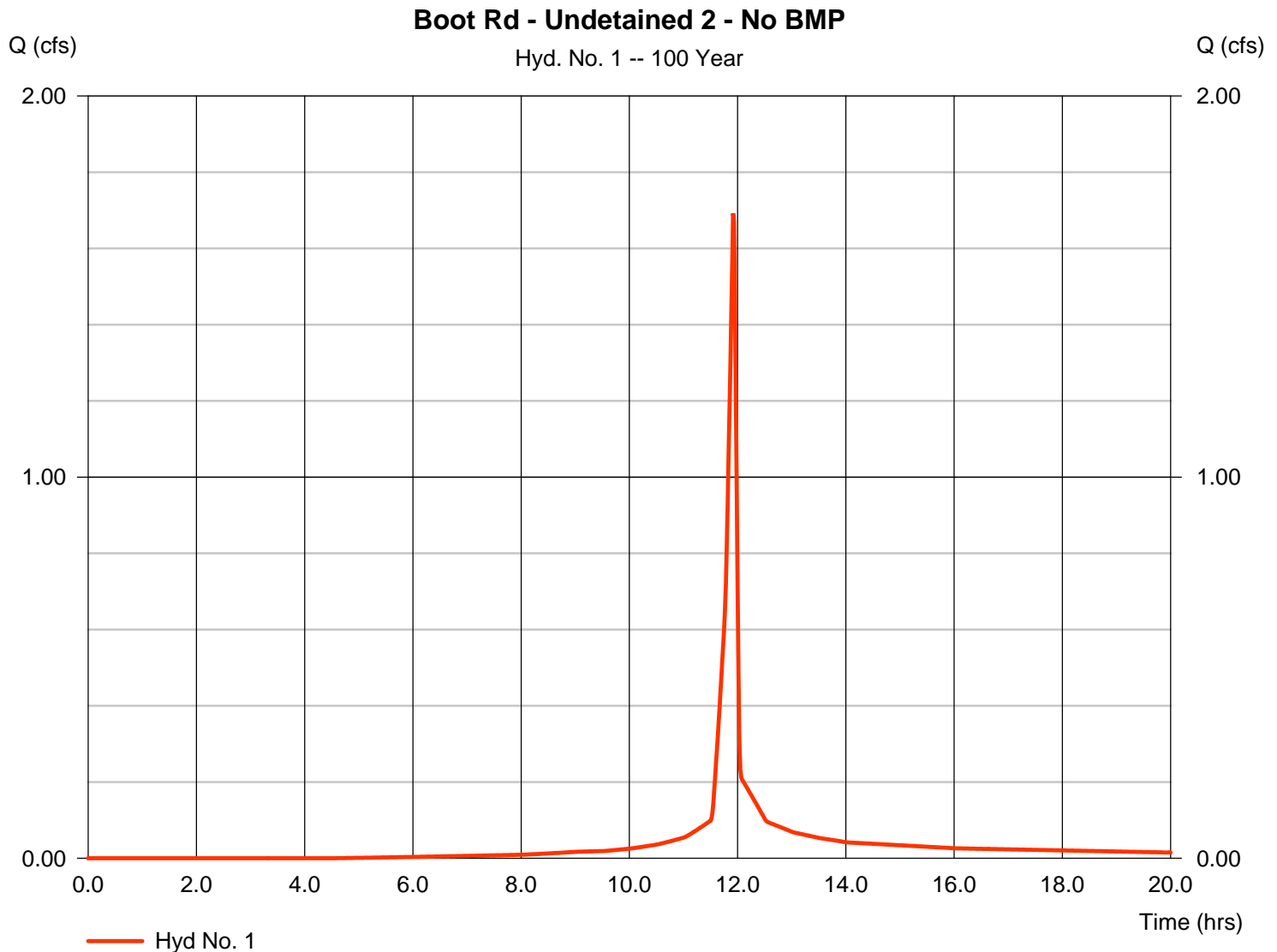
| Hyd. No.                    | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |
|-----------------------------|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|--------------------------|--------------------------------------|
| 1                           | SCS Runoff               | 1.692           | 1                   | 715                | 3,183                   | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - No BMP      |
| 2                           | SCS Runoff               | 9.049           | 1                   | 716                | 17,592                  | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - No B |
| 3                           | SCS Runoff               | 4.123           | 1                   | 715                | 7,551                   | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP                |
| 4                           | Combine                  | 14.81           | 1                   | 716                | 28,326                  | 1, 2, 3       | -----                  | -----                    | POI                                  |
| 5                           | SCS Runoff               | 2.992           | 1                   | 715                | 5,562                   | -----         | -----                  | -----                    | Boot Rd IB-1 - No BMP - At the Berm  |
| Boot Rd - Post - No BMP.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.692 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 3,183 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 7.50 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

Boot Rd - Undetained 2 - No BMP

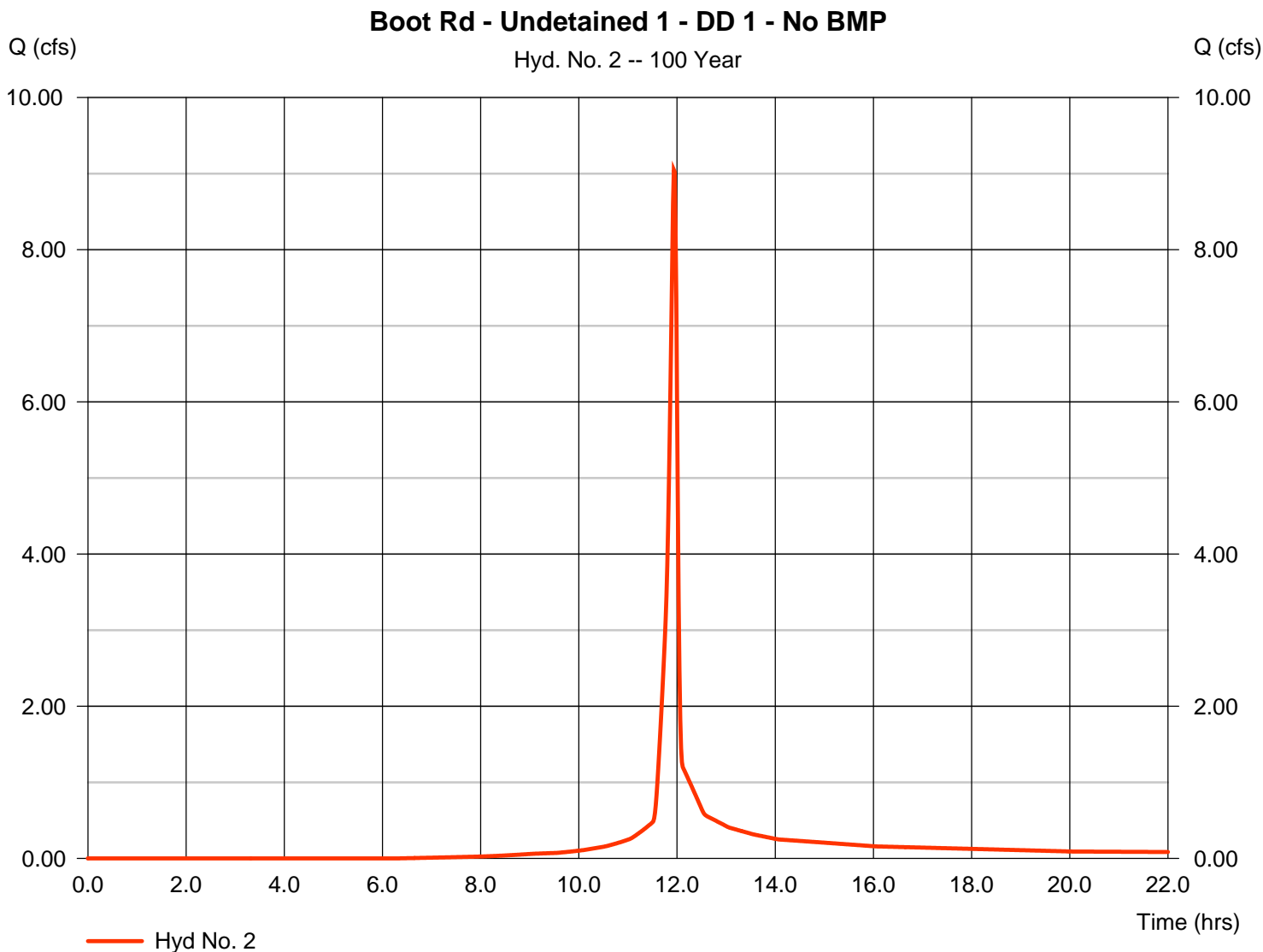
| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |          |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>1.60</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>2.40 min</b> |

# Hydrograph Report

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - No BMP

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 9.049 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.93 hrs   |
| Time interval   | = 1 min      | Hyd. volume        | = 17,592 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 7.50 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

Boot Rd - Undetained 1 - DD 1 - No BMP

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 408.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 4.10        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.27        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.08</b> | <b>=</b> | <b>2.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 5.40        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 7.46        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 2.00        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.070       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =2.42         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | {{0}}100.0    |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.69</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.70 min</b> |

# Hydrograph Report

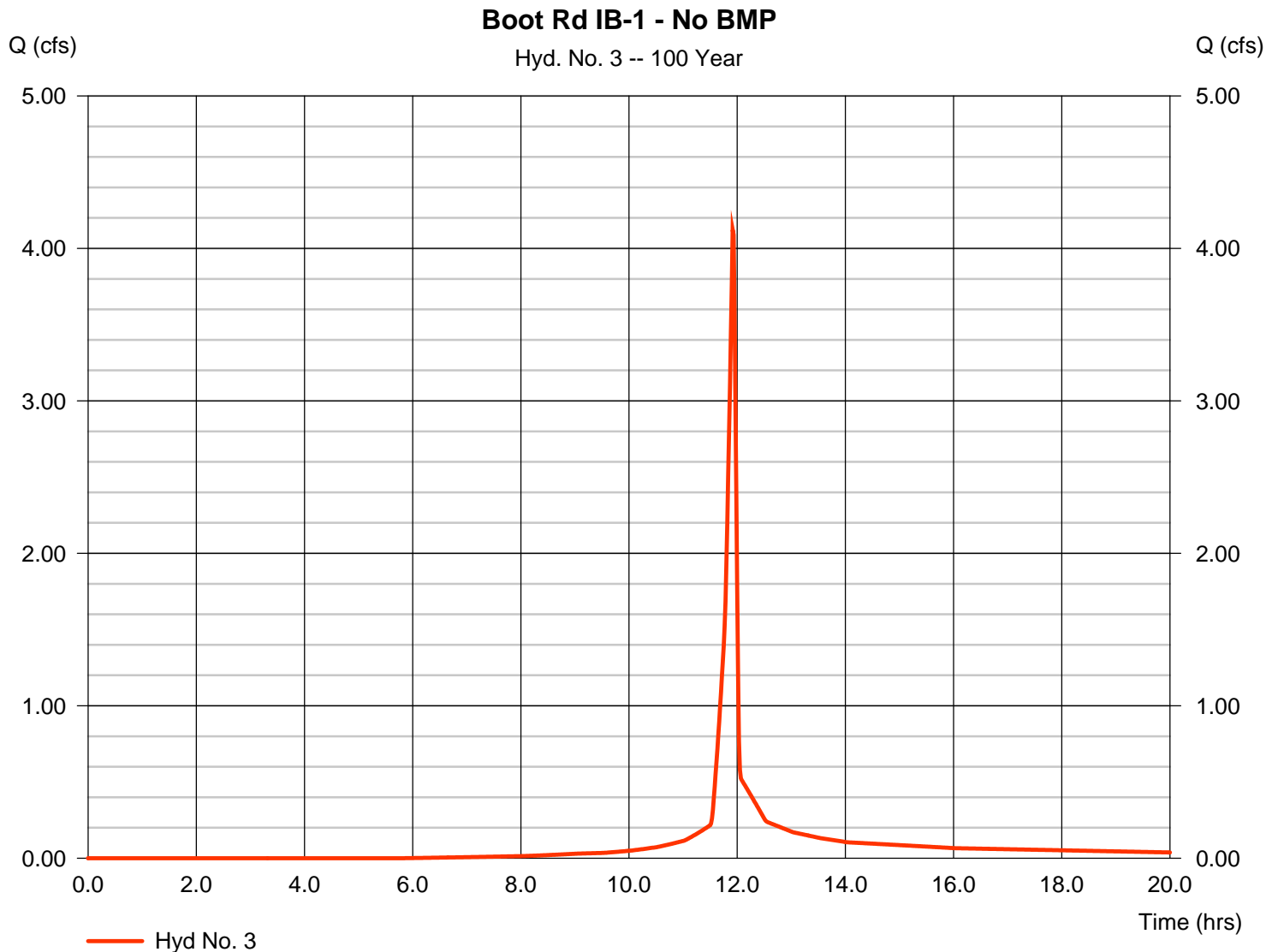
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - No BMP

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.123 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 7,551 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.80 min   |
| Total precip.   | = 7.50 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

Boot Rd IB-1 - No BMP

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 100.00               | 247.00               |                 |
| Watercourse slope (%)              | = 8.50        | 6.50                 | 3.20                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 4.11                 | 2.89                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.41</b> | <b>+</b> <b>1.43</b> | <b>= 1.93</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.80 min</b> |

# Hydrograph Report

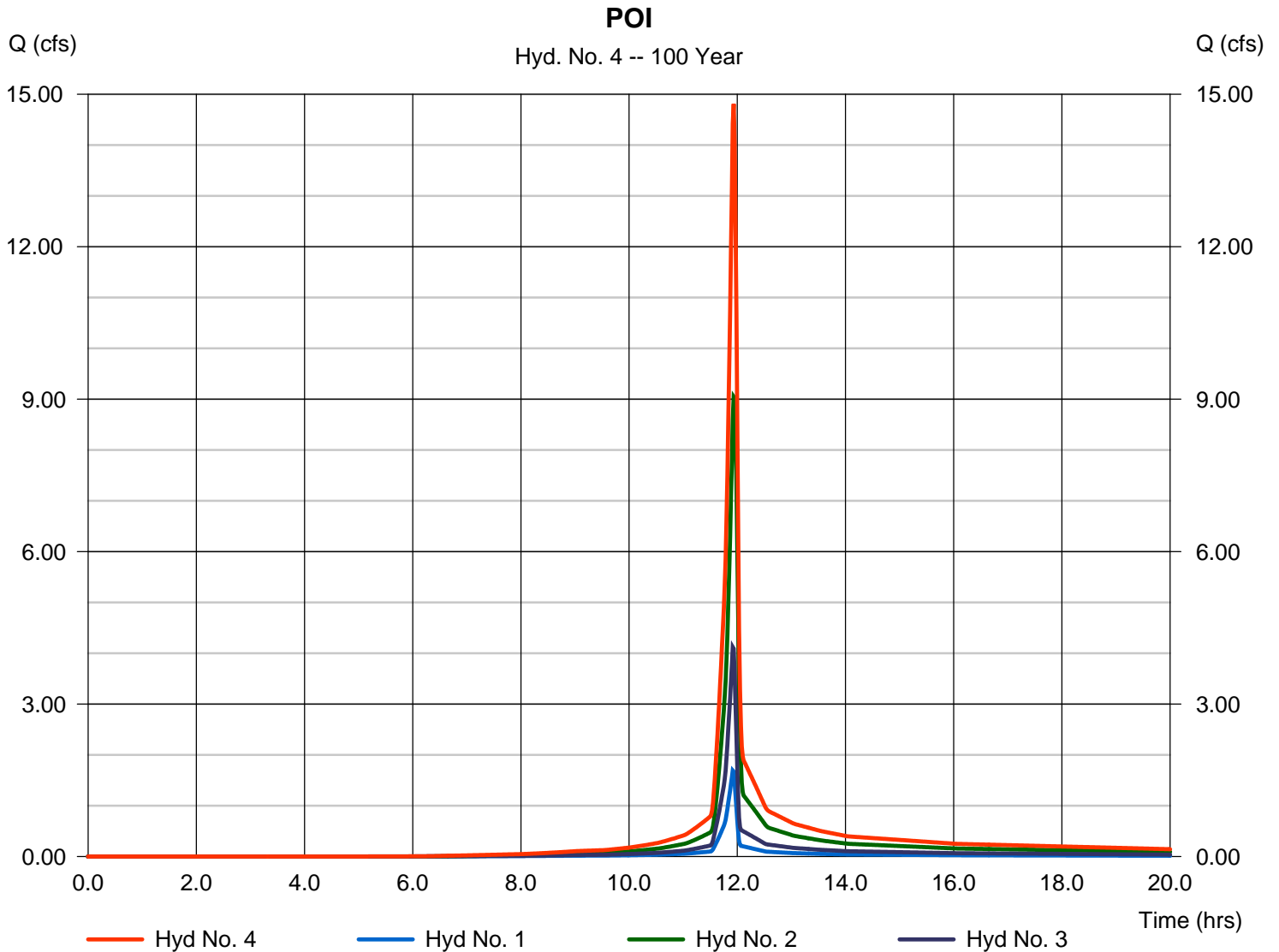
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 14.81 cfs   |
| Storm frequency | = 100 yrs | Time to peak         | = 11.93 hrs   |
| Time interval   | = 1 min   | Hyd. volume          | = 28,326 cuft |
| Inflow hyds.    | = 1, 2, 3 | Contrib. drain. area | = 1.650 ac    |



# Hydrograph Report

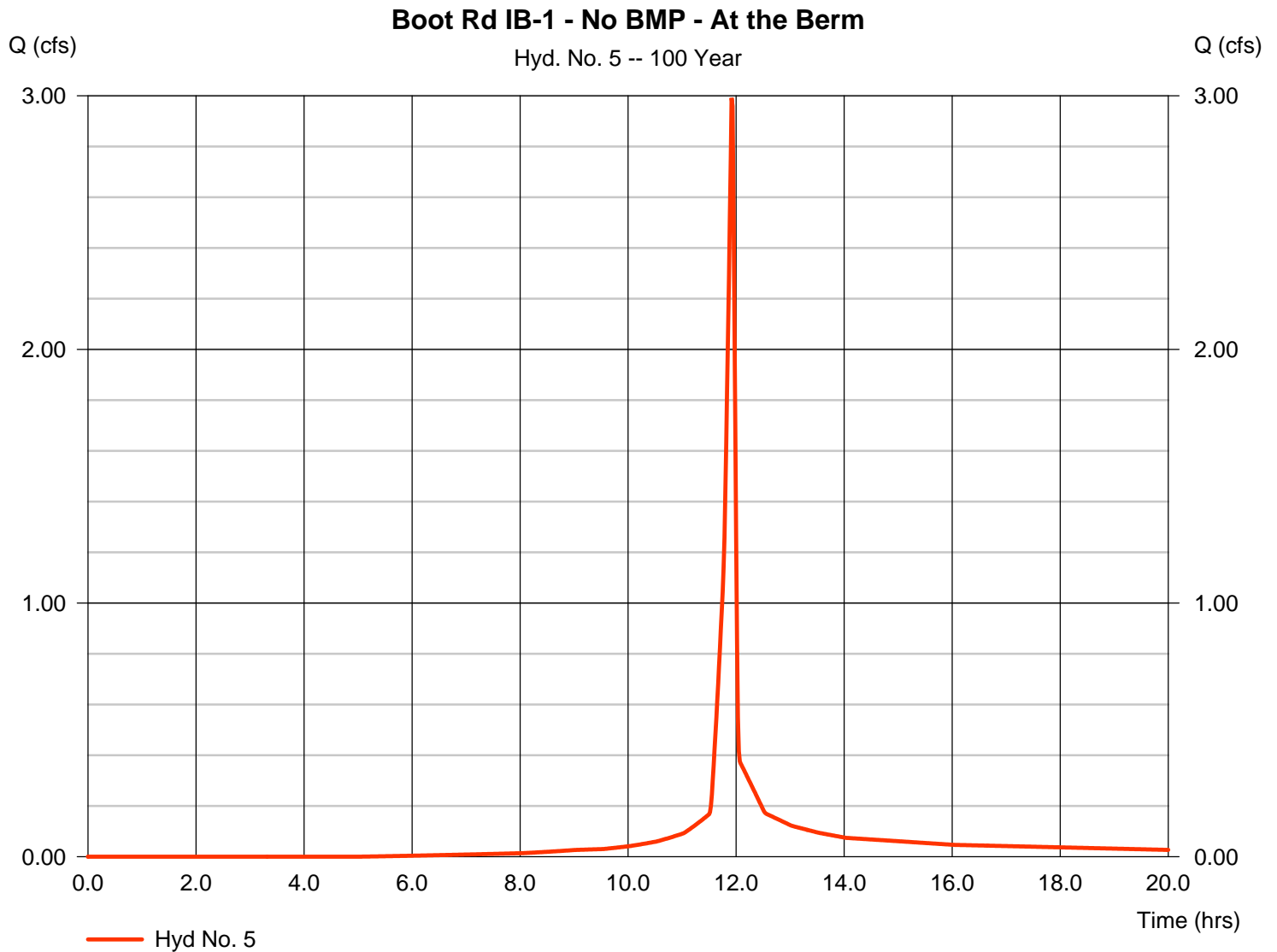
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.992 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 11.92 hrs  |
| Time interval   | = 1 min      | Hyd. volume        | = 5,562 cuft |
| Drainage area   | = 0.310 ac   | Curve number       | = 81         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.00 min   |
| Total precip.   | = 7.50 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

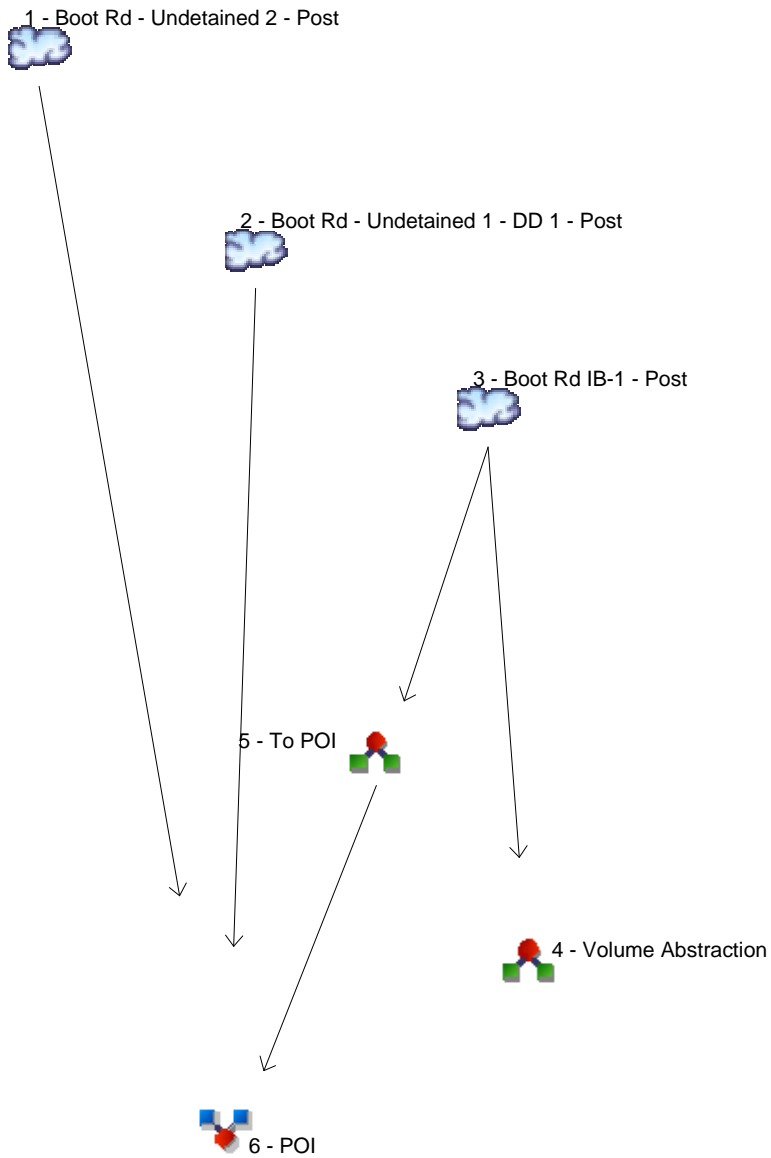
## Hyd. No. 5

Boot Rd IB-1 - No BMP - At the Berm

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.91</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 35.00       |          | 100.00      |          | 100.00      |          |                 |
| Watercourse slope (%)              | = 8.50        |          | 6.50        |          | 3.20        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.93         |          | 4.11        |          | 2.89        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.41</b> | <b>+</b> | <b>0.58</b> | <b>=</b> | <b>1.08</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>2.00 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 1.692  | Boot Rd - Undetained 2 - Post        |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 9.049  | Boot Rd - Undetained 1 - DD 1 - Post |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 2.831  | Boot Rd IB-1 - Post                  |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 2.758  | Volume Abstraction                   |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 2.831  | To POI                               |
| 6        | Combine                  | 1, 2, 5       | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 10.72  | POI                                  |

# Hydrograph Summary Report

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

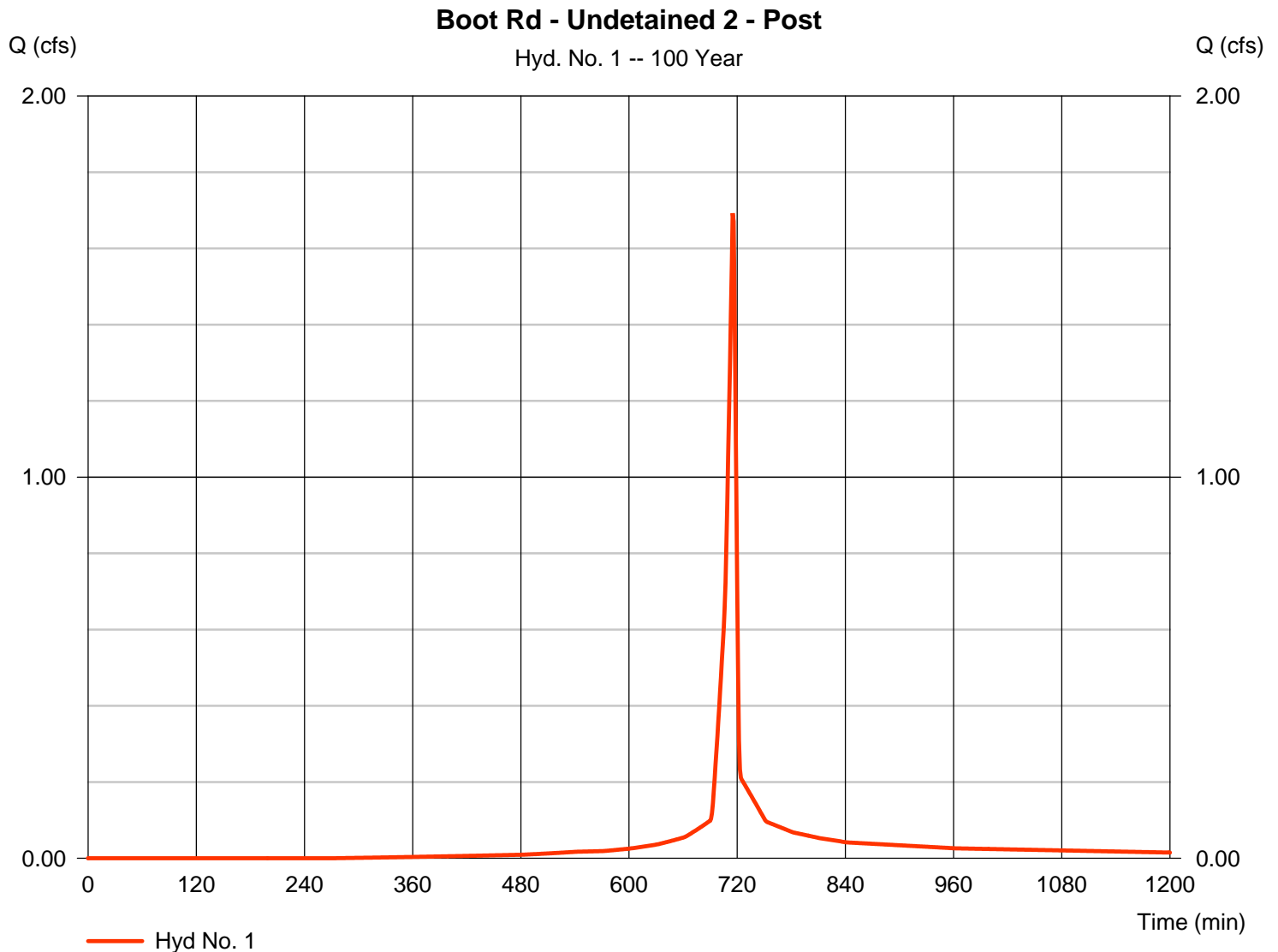
| Hyd. No.                      | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description               |  |
|-------------------------------|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|--------------------------|--------------------------------------|--|
| 1                             | SCS Runoff               | 1.692           | 1                   | 715                | 3,183                   | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post        |  |
| 2                             | SCS Runoff               | 9.049           | 1                   | 716                | 17,592                  | -----         | -----                  | -----                    | Boot Rd - Undetained 1 - DD 1 - Post |  |
| 3                             | SCS Runoff               | 2.831           | 1                   | 723                | 8,155                   | -----         | -----                  | -----                    | Boot Rd IB-1 - Post                  |  |
| 4                             | Diversion1               | 2.758           | 1                   | 721                | 2,650                   | 3             | -----                  | -----                    | Volume Abstraction                   |  |
| 5                             | Diversion2               | 2.831           | 1                   | 723                | 5,505                   | 3             | -----                  | -----                    | To POI                               |  |
| 6                             | Combine                  | 10.72           | 1                   | 716                | 26,279                  | 1, 2, 5       | -----                  | -----                    | POI                                  |  |
| Boot Rd - Post - 100 year.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |  |

# Hydrograph Report

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.692 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,183 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 7.50 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 5.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 50.00       | 280.00               | 0.00                 |                 |
| Watercourse slope (%)              | = 4.00        | 4.30                 | 0.00                 |                 |
| Surface description                | = Paved       | Unpaved              | Paved                |                 |
| Average velocity (ft/s)            | =4.07         | 3.35                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> <b>1.39</b> | <b>+</b> <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.40 min</b> |

# Hydrograph Report

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

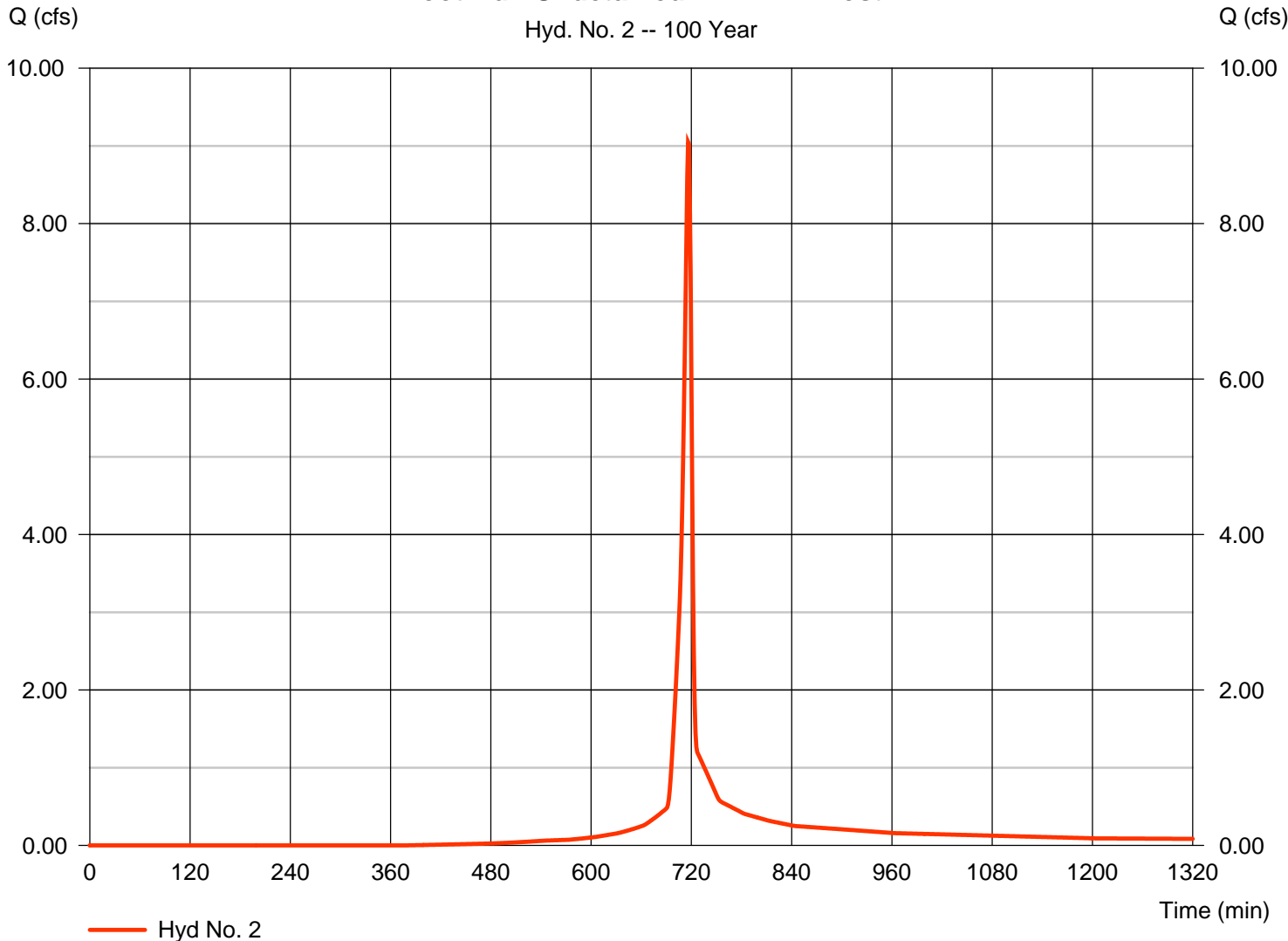
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 9.049 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min     |
| Time interval   | = 1 min      | Hyd. volume        | = 17,592 cuft |
| Drainage area   | = 1.030 ac   | Curve number       | = 76          |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 3.70 min    |
| Total precip.   | = 7.50 in    | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

**Boot Rd - Undetained 1 - DD 1 - Post**



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Undetained 1 - DD 1 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |          |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.83</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 13.00       |          | 27.00       |          | 408.00      |          |                 |
| Watercourse slope (%)              | = 7.70        |          | 18.50       |          | 4.10        |          |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |          |                 |
| Average velocity (ft/s)            | =5.64         |          | 6.94        |          | 3.27        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.04</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>2.08</b> | <b>=</b> | <b>2.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| X sectional flow area (sqft)       | = 5.40        |          | 0.00        |          | 0.00        |          |                 |
| Wetted perimeter (ft)              | = 7.46        |          | 0.00        |          | 0.00        |          |                 |
| Channel slope (%)                  | = 2.00        |          | 0.00        |          | 0.00        |          |                 |
| Manning's n-value                  | = 0.070       |          | 0.015       |          | 0.015       |          |                 |
| Velocity (ft/s)                    | =2.42         |          | 0.00        |          | 0.00        |          |                 |
| Flow length (ft)                   | {{0}}100.0    |          | 0.0         |          | 0.0         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.69</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.69</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>3.70 min</b> |

# Hydrograph Report

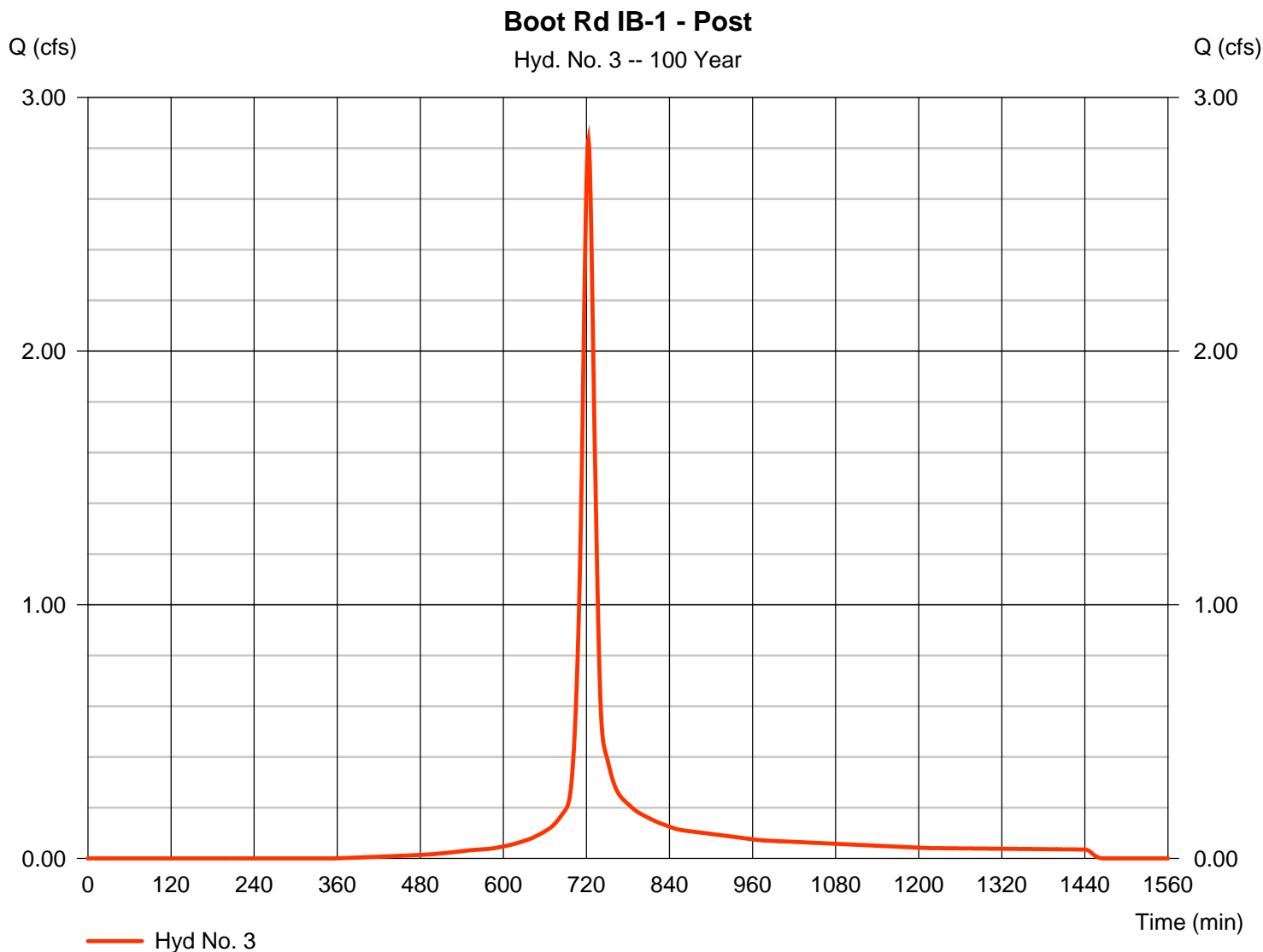
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.831 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 723 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 8,155 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 16.40 min  |
| Total precip.   | = 7.50 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

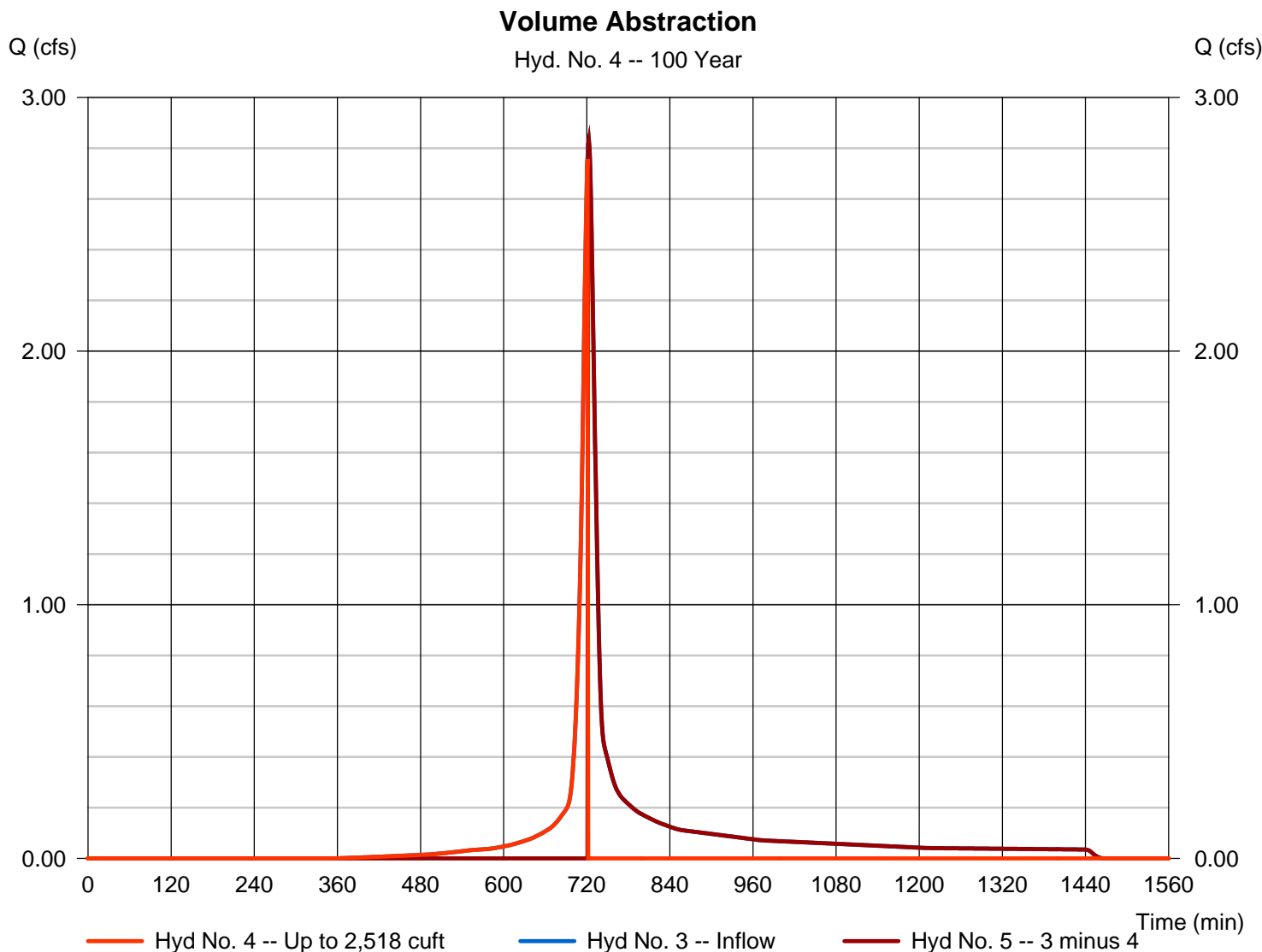
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Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 2.758 cfs  |
| Storm frequency   | = 100 yrs                 | Time to peak      | = 721 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,650 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

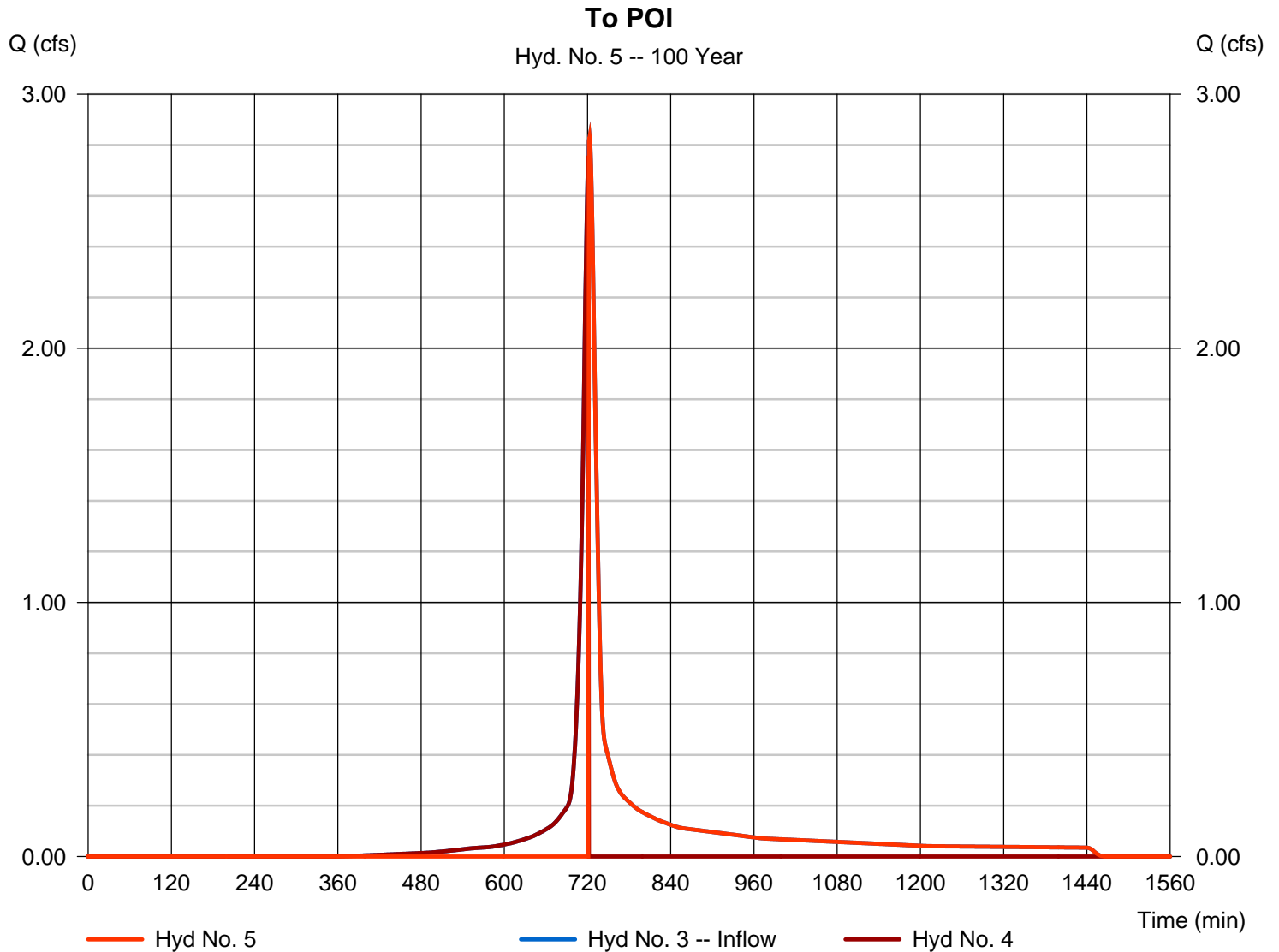
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 2.831 cfs  |
| Storm frequency   | = 100 yrs                 | Time to peak      | = 723 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 5,505 cuft |
| Inflow hydrograph | = 3 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

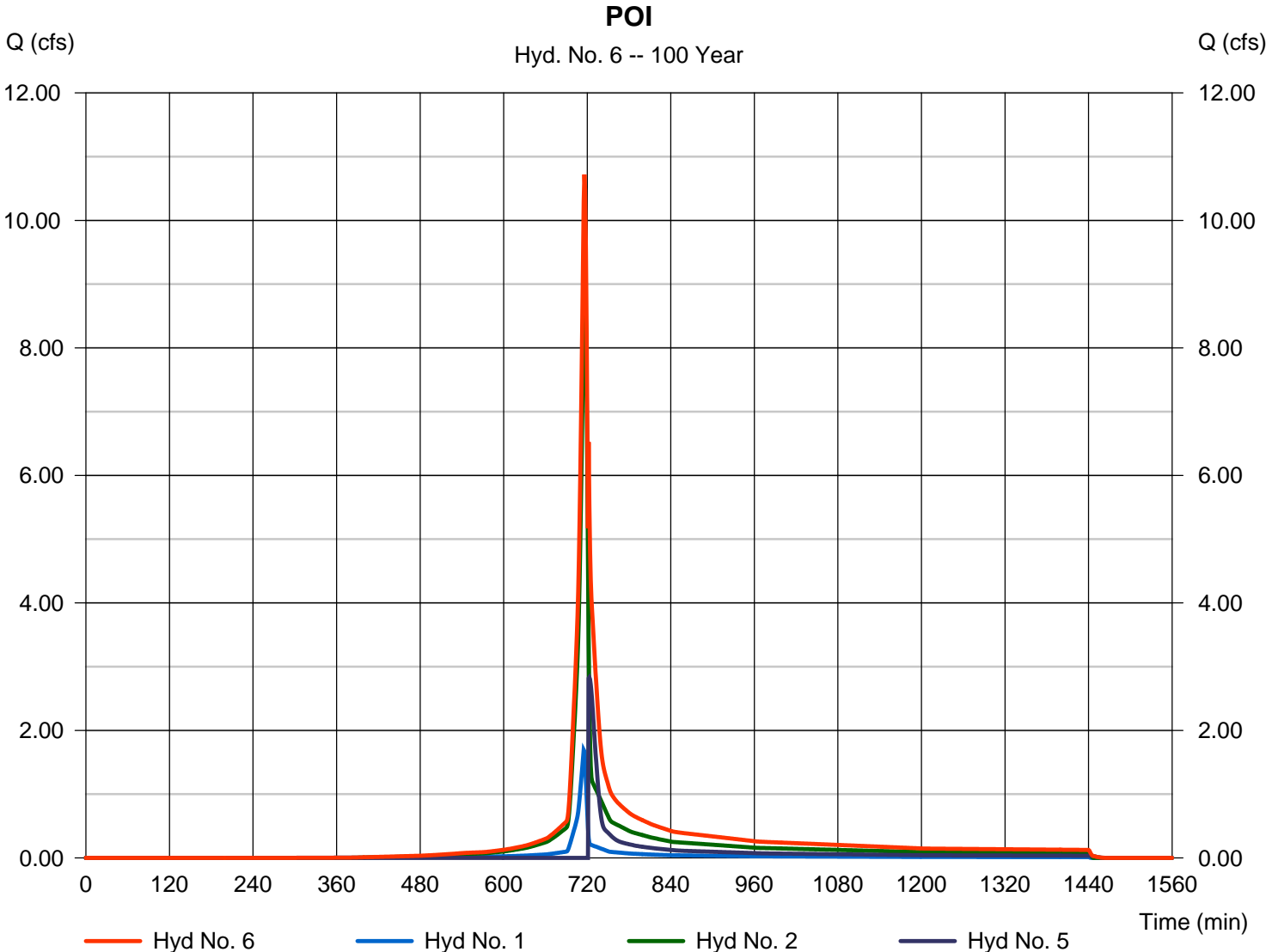
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 6

POI

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 10.72 cfs   |
| Storm frequency | = 100 yrs | Time to peak         | = 716 min     |
| Time interval   | = 1 min   | Hyd. volume          | = 26,279 cuft |
| Inflow hyds.    | = 1, 2, 5 | Contrib. drain. area | = 1.200 ac    |



**ATTACHMENT C-8**  
**BOOT RD - West Goshen**  
**1 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot Rd - Area to be Developed - 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 |                        |                                      |
| 2        | SCS Runoff               | -----         | 0.913              | 1.347 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd - Area to be Developed - Pre |

# 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               | 0.913           | 1                   | 716                | 1,599                 | -----         | -----                    | -----                   | Boot Rd - Area to be Developed - Pre |
| Boot Rd - West Goshen - Pre.gpw |                          |                 |                     |                    | Return Period: 1 Year |               | Wednesday, 11 / 9 / 2016 |                         |                                      |

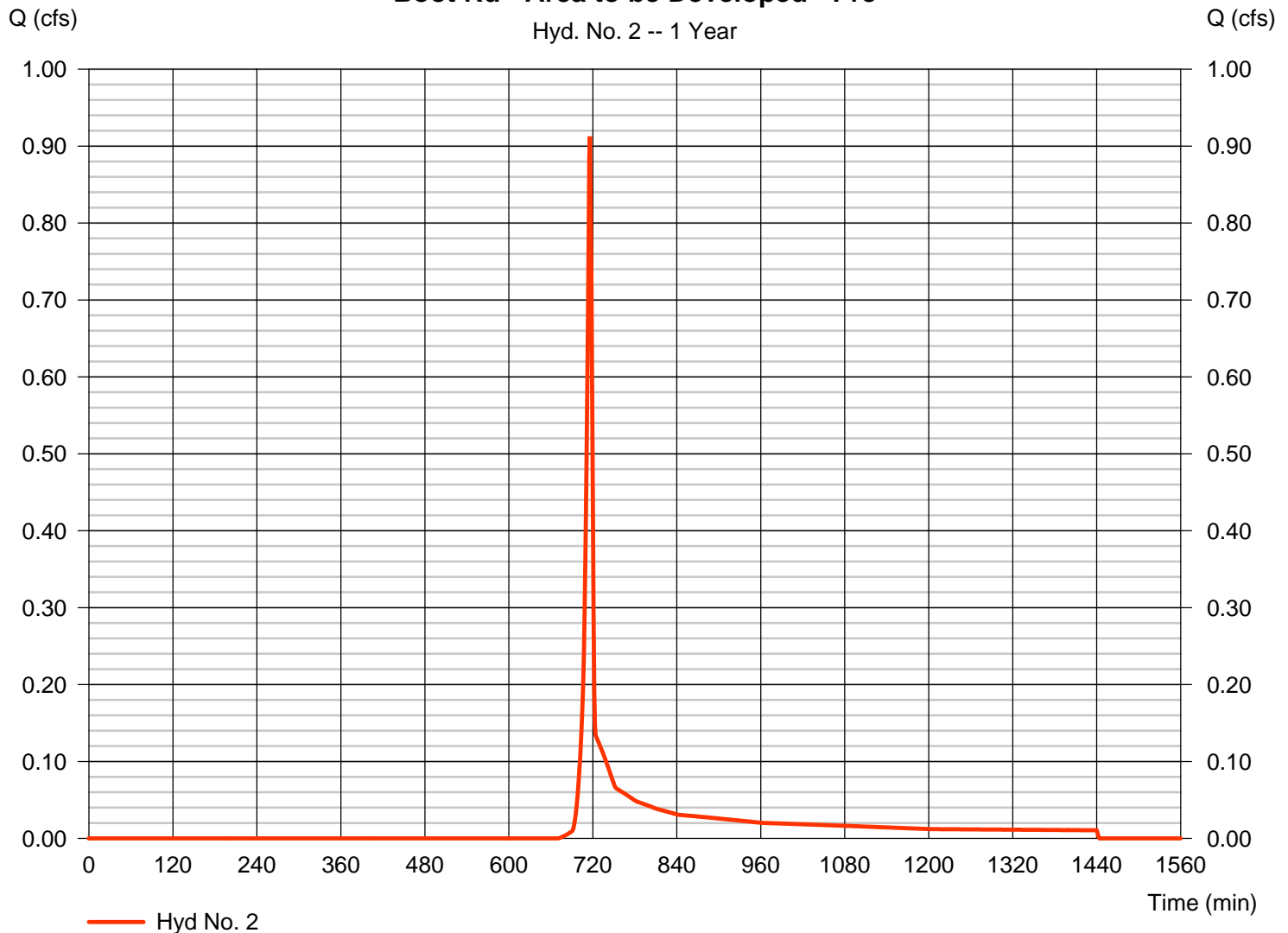
# Hydrograph Report

## Hyd. No. 2

Boot Rd - Area to be Developed - Pre

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.913 cfs  |
| Storm frequency | = 1 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,599 cuft |
| Drainage area   | = 0.610 ac   | Curve number       | = 75         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.90 min   |
| Total precip.   | = 2.70 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**Boot Rd - Area to be Developed - Pre**



# TR55 Tc Worksheet

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

## Hyd. No. 2

Boot Rd - Area to be Developed - Pre

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| 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)        | = 3.25        | 0.00                 | 0.00                 |                 |
| Land slope (%)                     | = 4.00        | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 35.00       | 25.00                | 325.00               |                 |
| Watercourse slope (%)              | = 8.50        | 16.00                | 3.40                 |                 |
| Surface description                | = Paved       | Unpaved              | Unpaved              |                 |
| Average velocity (ft/s)            | =5.93         | 6.45                 | 2.98                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> <b>0.06</b> | <b>+</b> <b>1.82</b> | <b>= 1.98</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>2.90 min</b> |



**ATTACHMENT C-9**  
**BOOT RD - West Goshen**  
**2 Year-24 Hour Storm**



# Watershed Model Schematic

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

2 - Boot Rd - Area to be Developed - 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 |                        |                                      |
| 2        | SCS Runoff               | -----         | 0.913              | 1.347 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd - Area to be Developed - Pre |

# 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               | 1.347           | 1                   | 716                | 2,341                 | -----         | -----                  | -----                    | Boot Rd - Area to be Developed - Pre |
| Boot Rd - West Goshen - Pre.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                      |

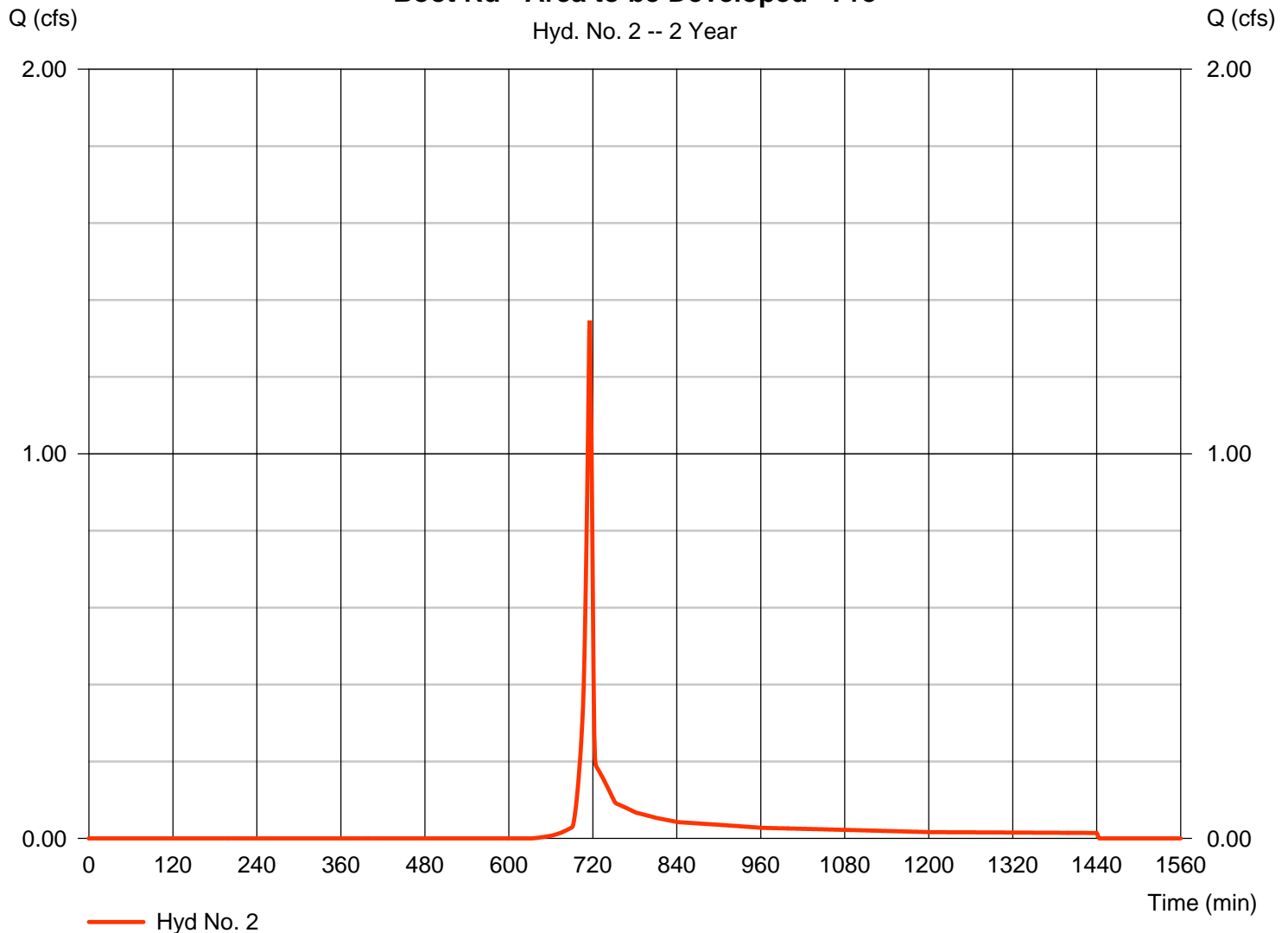
# Hydrograph Report

## Hyd. No. 2

Boot Rd - Area to be Developed - Pre

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.347 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,341 cuft |
| Drainage area   | = 0.610 ac   | Curve number       | = 75         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.90 min   |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

Boot Rd - Area to be Developed - Pre



# TR55 Tc Worksheet

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

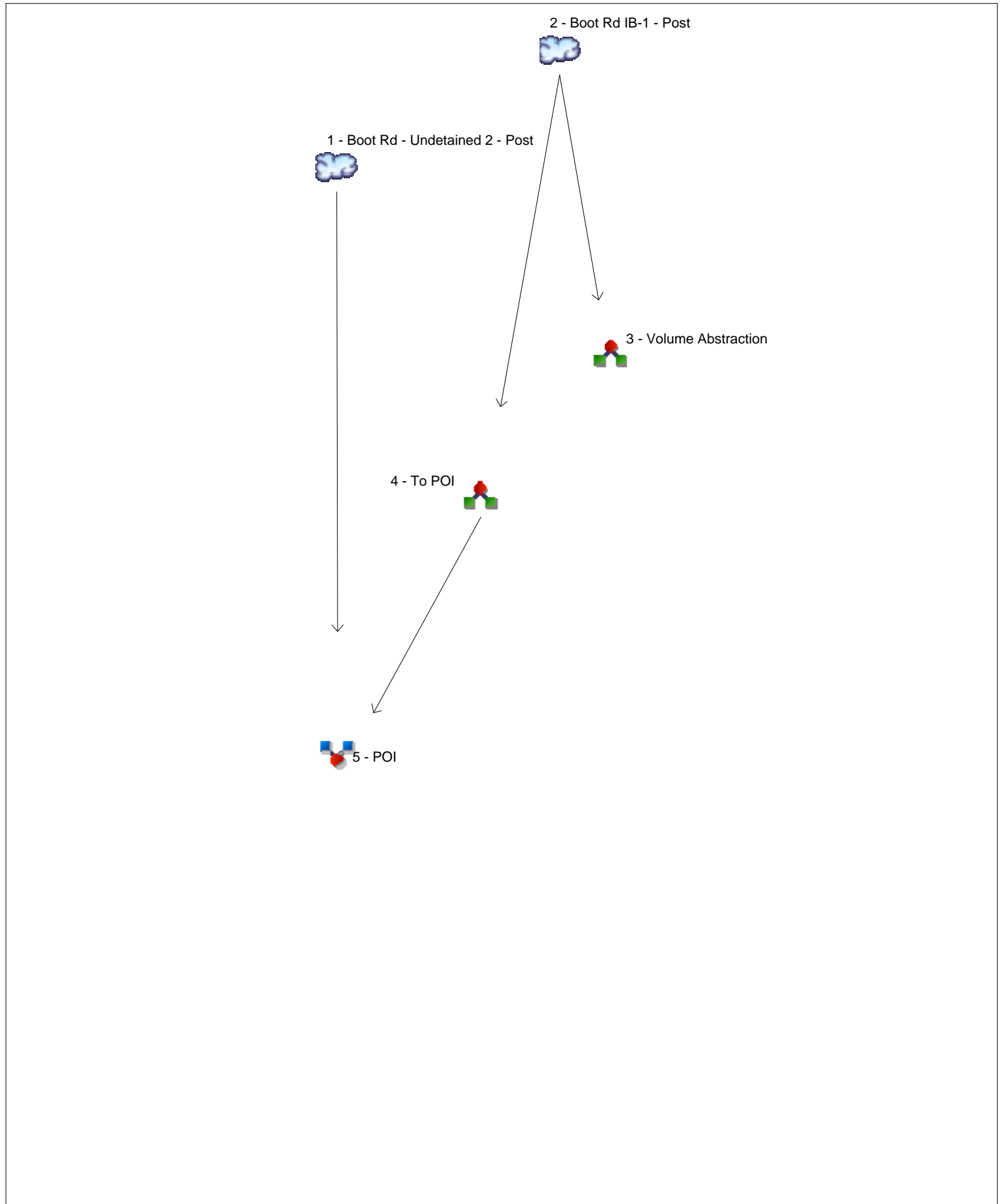
## Hyd. No. 2

Boot Rd - Area to be Developed - Pre

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 4.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.91</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.91</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 35.00       |          | 25.00       |          | 325.00      |                 |
| Watercourse slope (%)              | = 8.50        |          | 16.00       |          | 3.40        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Unpaved     |                 |
| Average velocity (ft/s)            | =5.93         |          | 6.45        |          | 2.98        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.10</b> | <b>+</b> | <b>0.06</b> | <b>+</b> | <b>1.82</b> | <b>= 1.98</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc</b> ..... |               |          |             |          |             | <b>2.90 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.540 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd - Undetained 2 - Post |
| 2        | SCS Runoff               | -----         | -----              | 0.504 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Boot Rd IB-1 - Post           |
| 3        | Diversion1               | 2             | -----              | 0.504 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | Volume Abstraction            |
| 4        | Diversion2               | 2             | -----              | 0.031 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | To POI                        |
| 5        | Combine                  | 1, 4          | -----              | 0.540 | ----- | ----- | ----- | ----- | ----- | -----  | -----                  | 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               | 0.540           | 1                   | 716                | 955                   | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post |  |
| 2   | SCS Runoff               | 0.504           | 1                   | 733                | 2,154                 | -----         | -----                  | -----                    | Boot Rd IB-1 - Post           |  |
| 3   | Diversion1               | 0.504           | 1                   | 733                | 1,591                 | 2             | -----                  | -----                    | Volume Abstraction            |  |
| 4   | Diversion2               | 0.031           | 1                   | 921                | 563                   | 2             | -----                  | -----                    | To POI                        |  |
| 5   | Combine                  | 0.540           | 1                   | 716                | 1,517                 | 1, 4          | -----                  | -----                    | POI                           |  |
| Boot Rd - West Goshen - Post - 2 year.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                               |  |

# Hydrograph Report

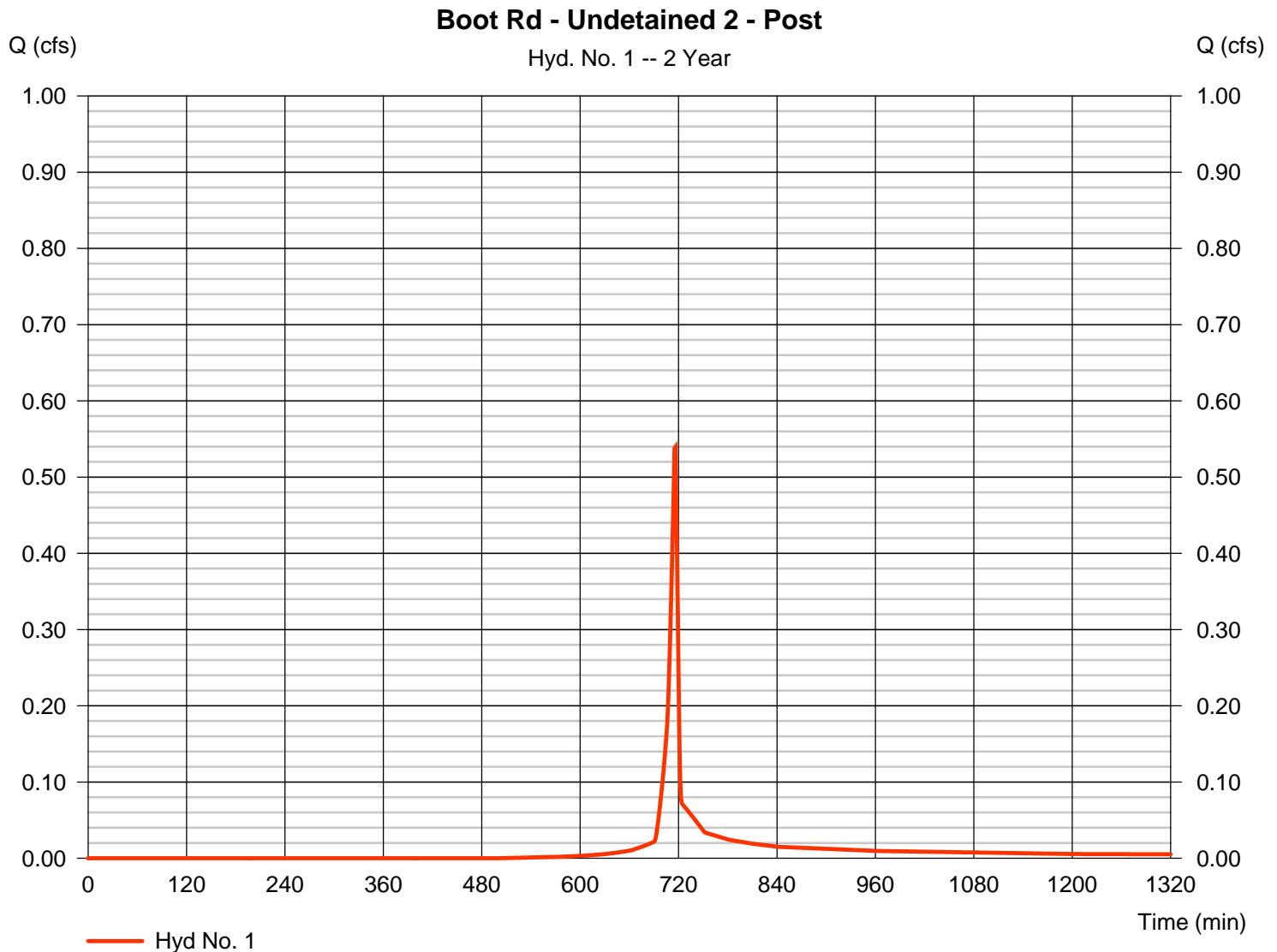
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.540 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 955 cuft  |
| Drainage area   | = 0.170 ac   | Curve number       | = 83        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min  |
| Total precip.   | = 3.25 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

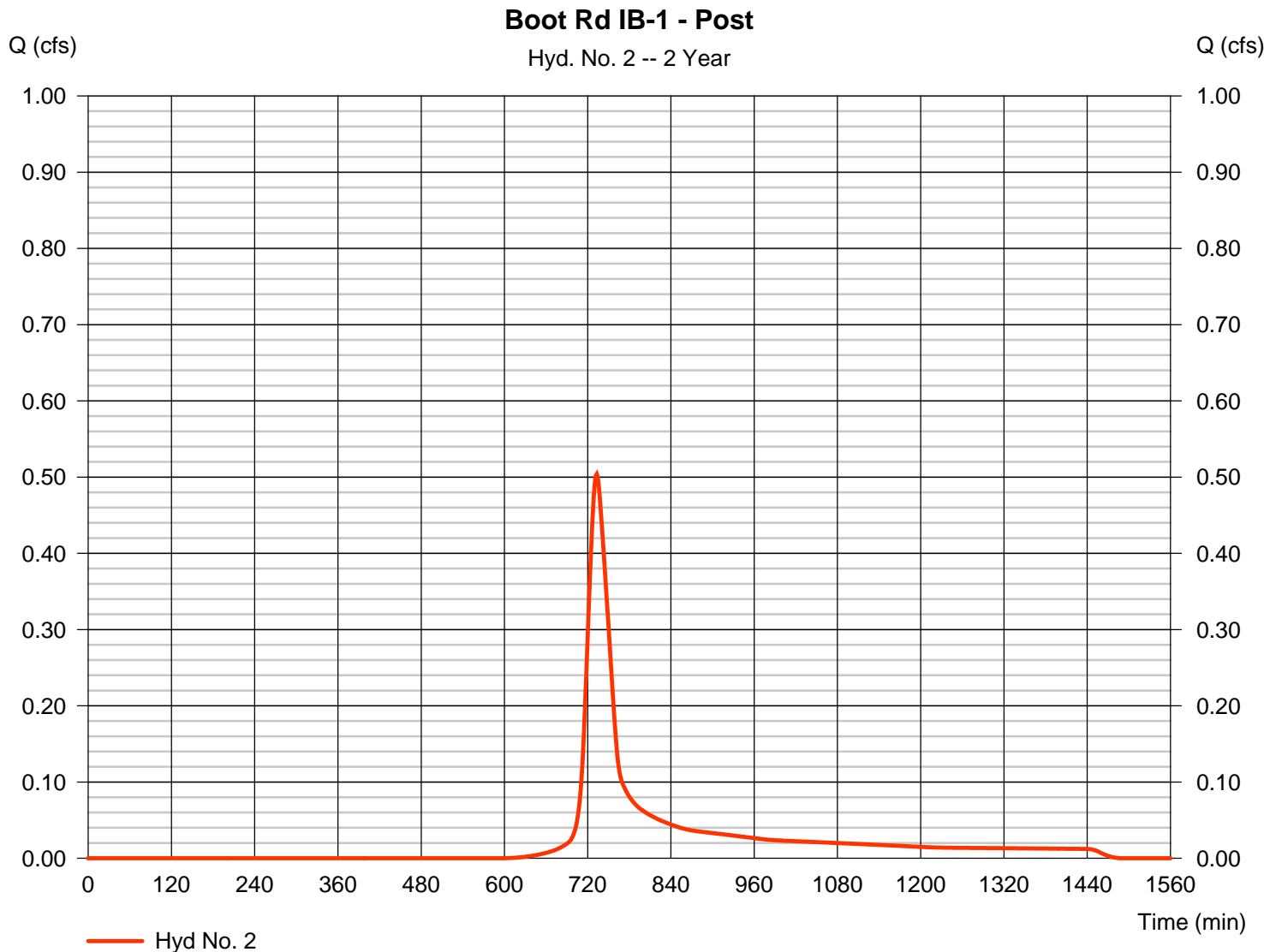
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.504 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 733 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,154 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 31.90 min  |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

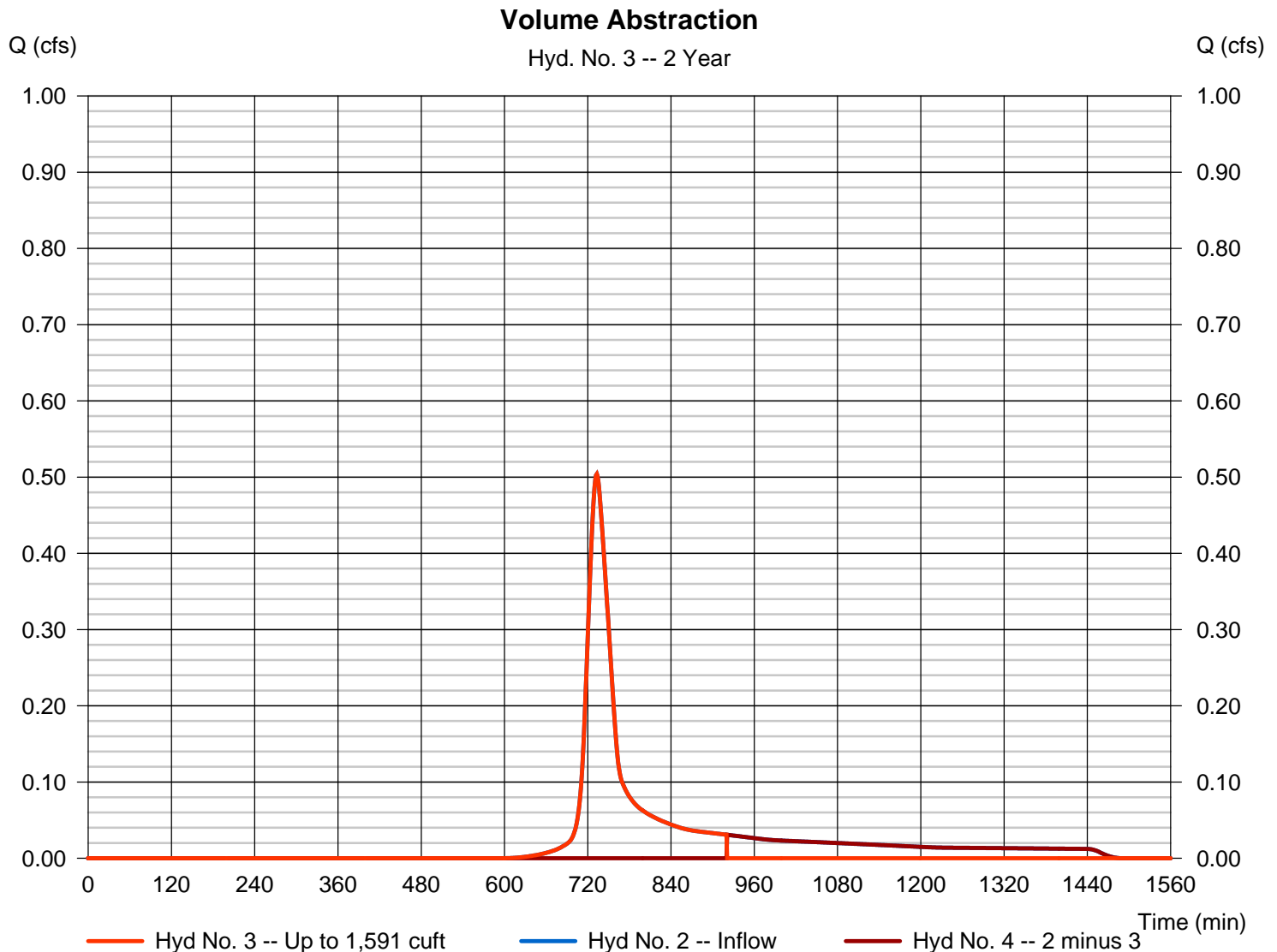
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.504 cfs  |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 733 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,591 cuft |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,591 cuft |



# Hydrograph Report

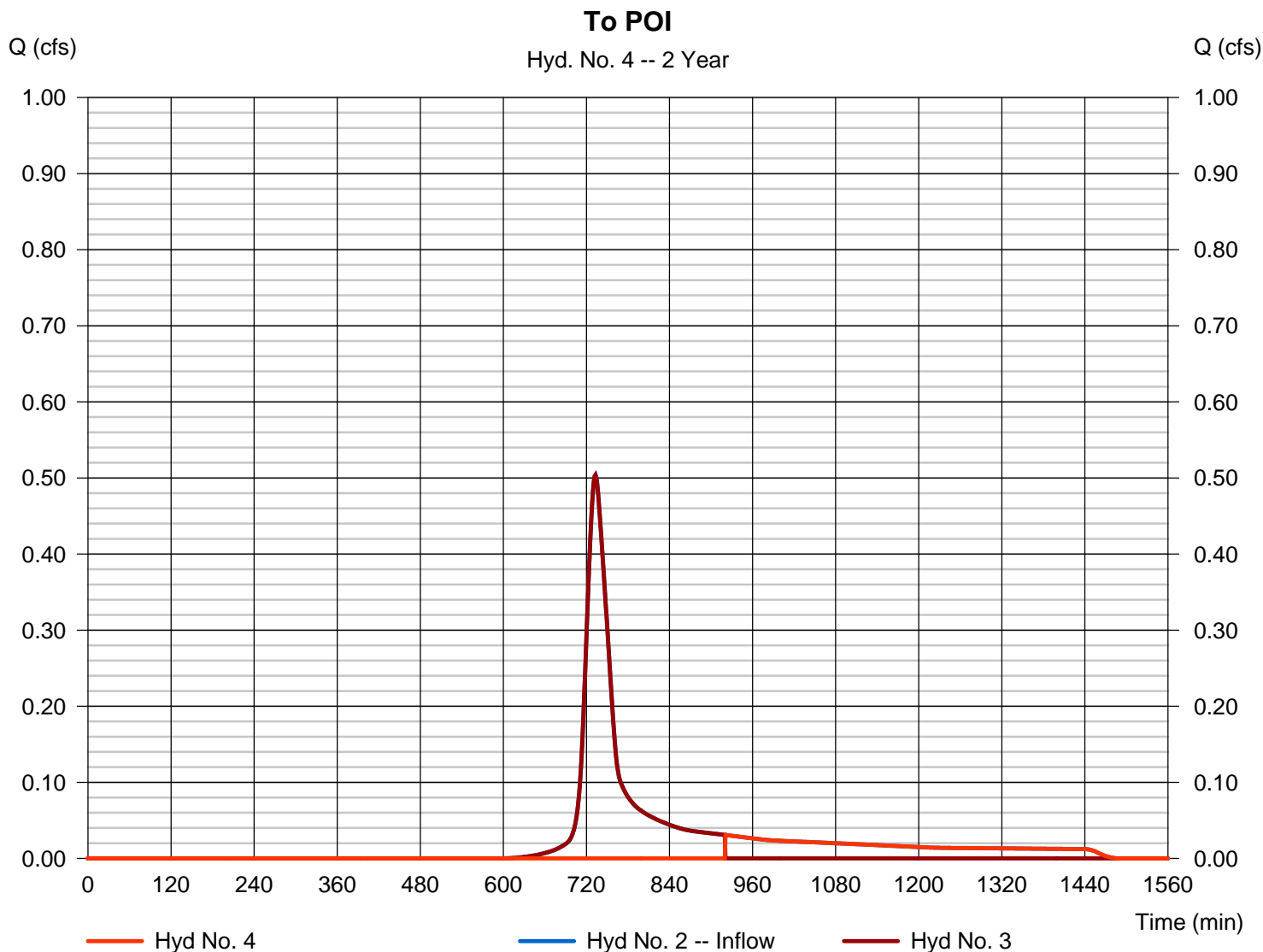
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.031 cfs  |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 921 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 563 cuft   |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 3          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,591 cuft |



# Hydrograph Report

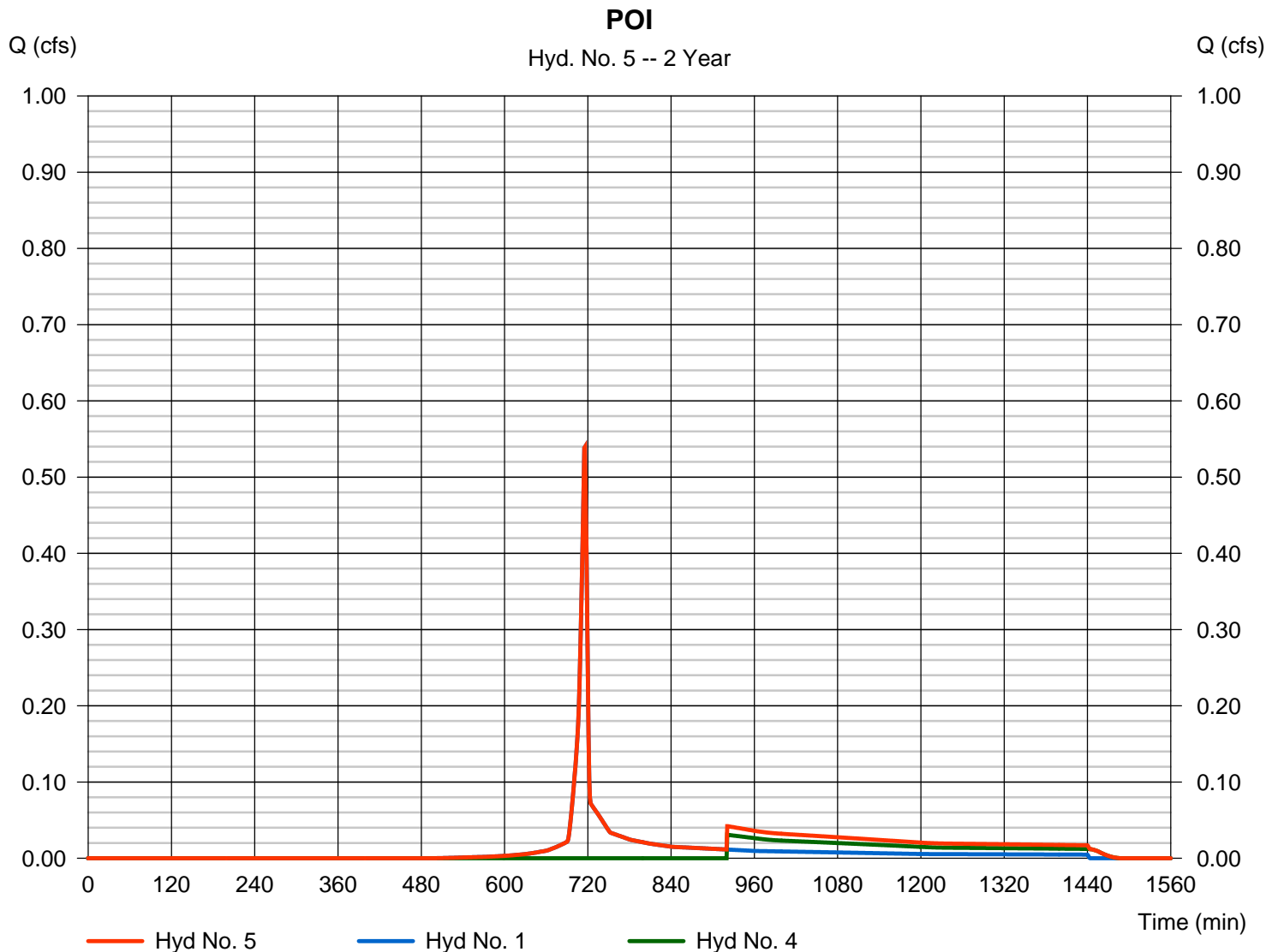
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.540 cfs  |
| Storm frequency | = 2 yrs   | Time to peak         | = 716 min    |
| Time interval   | = 1 min   | Hyd. volume          | = 1,517 cuft |
| Inflow hyds.    | = 1, 4    | Contrib. drain. area | = 0.170 ac   |

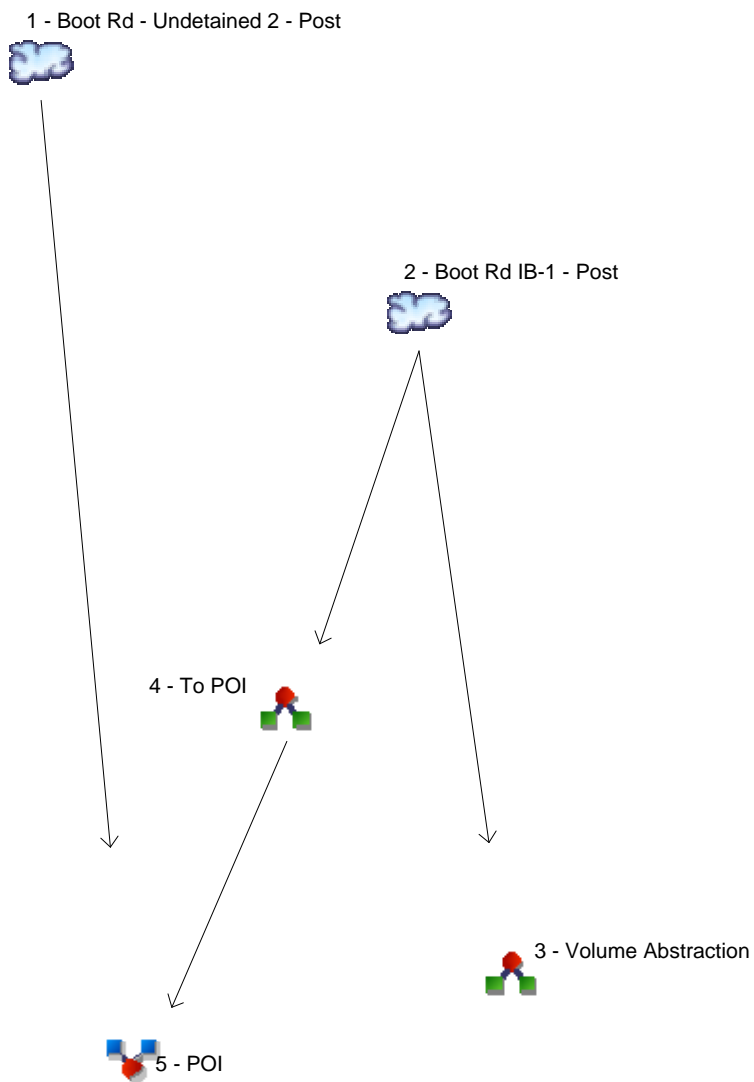


**ATTACHMENT C-10**  
**BOOT RD - West Goshen**  
**5 Year-24 Hour Storm**



# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | 0.759 | ----- | ----- | ----- | -----  | Boot Rd - Undetained 2 - Post |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | 0.736 | ----- | ----- | ----- | -----  | Boot Rd IB-1 - Post           |
| 3        | Diversion1               | 2             | -----              | ----- | ----- | 0.736 | ----- | ----- | ----- | -----  | Volume Abstraction            |
| 4        | Diversion2               | 2             | -----              | ----- | ----- | 0.047 | ----- | ----- | ----- | -----  | To POI                        |
| 5        | Combine                  | 1, 4          | -----              | ----- | ----- | 0.759 | ----- | ----- | ----- | -----  | 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               | 0.759           | 1                   | 715                | 1,363                 | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post |  |
| 2   | SCS Runoff               | 0.736           | 1                   | 734                | 3,167                 | -----         | -----                  | -----                    | Boot Rd IB-1 - Post           |  |
| 3   | Diversion1               | 0.736           | 1                   | 734                | 2,311                 | 2             | -----                  | -----                    | Volume Abstraction            |  |
| 4   | Diversion2               | 0.047           | 1                   | 888                | 856                   | 2             | -----                  | -----                    | To POI                        |  |
| 5   | Combine                  | 0.759           | 1                   | 715                | 2,219                 | 1, 4          | -----                  | -----                    | POI                           |  |
| Boot Rd - West Goshen - Post - 5 year.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                               |  |

# Hydrograph Report

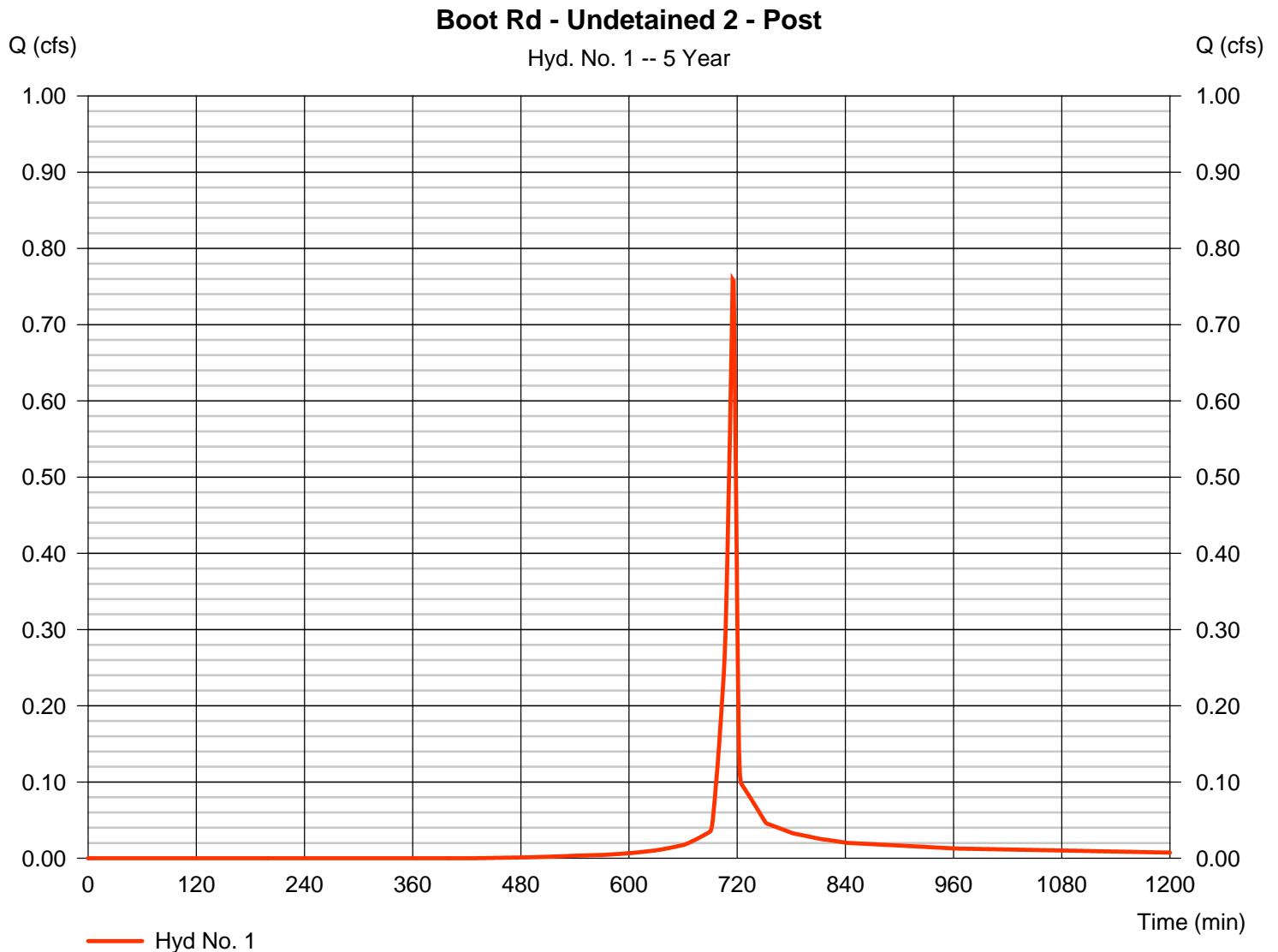
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.759 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,363 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.08 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

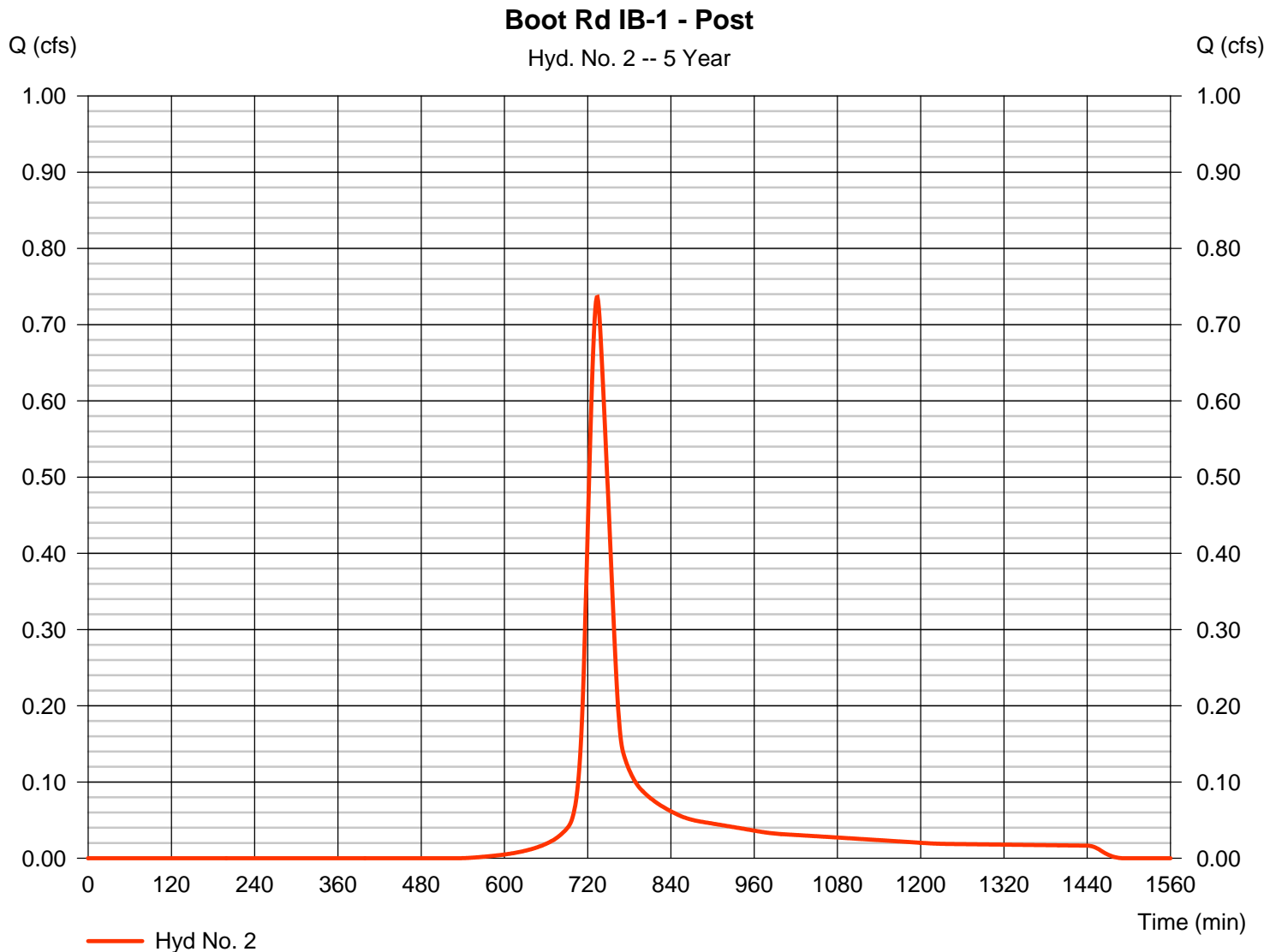
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.736 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 734 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,167 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 32.40 min  |
| Total precip.   | = 4.08 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

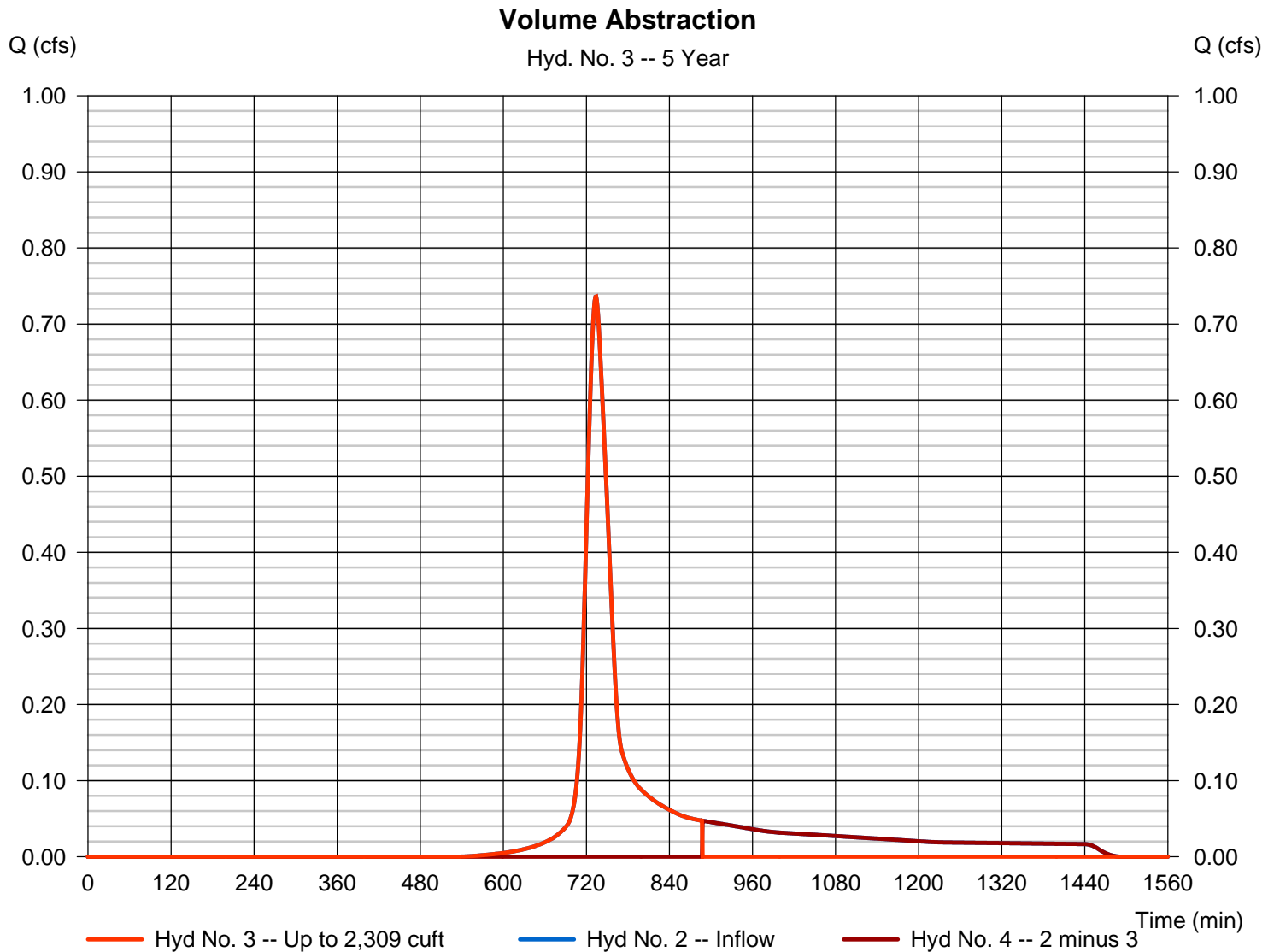
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.736 cfs  |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 734 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,311 cuft |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,309 cuft |



# Hydrograph Report

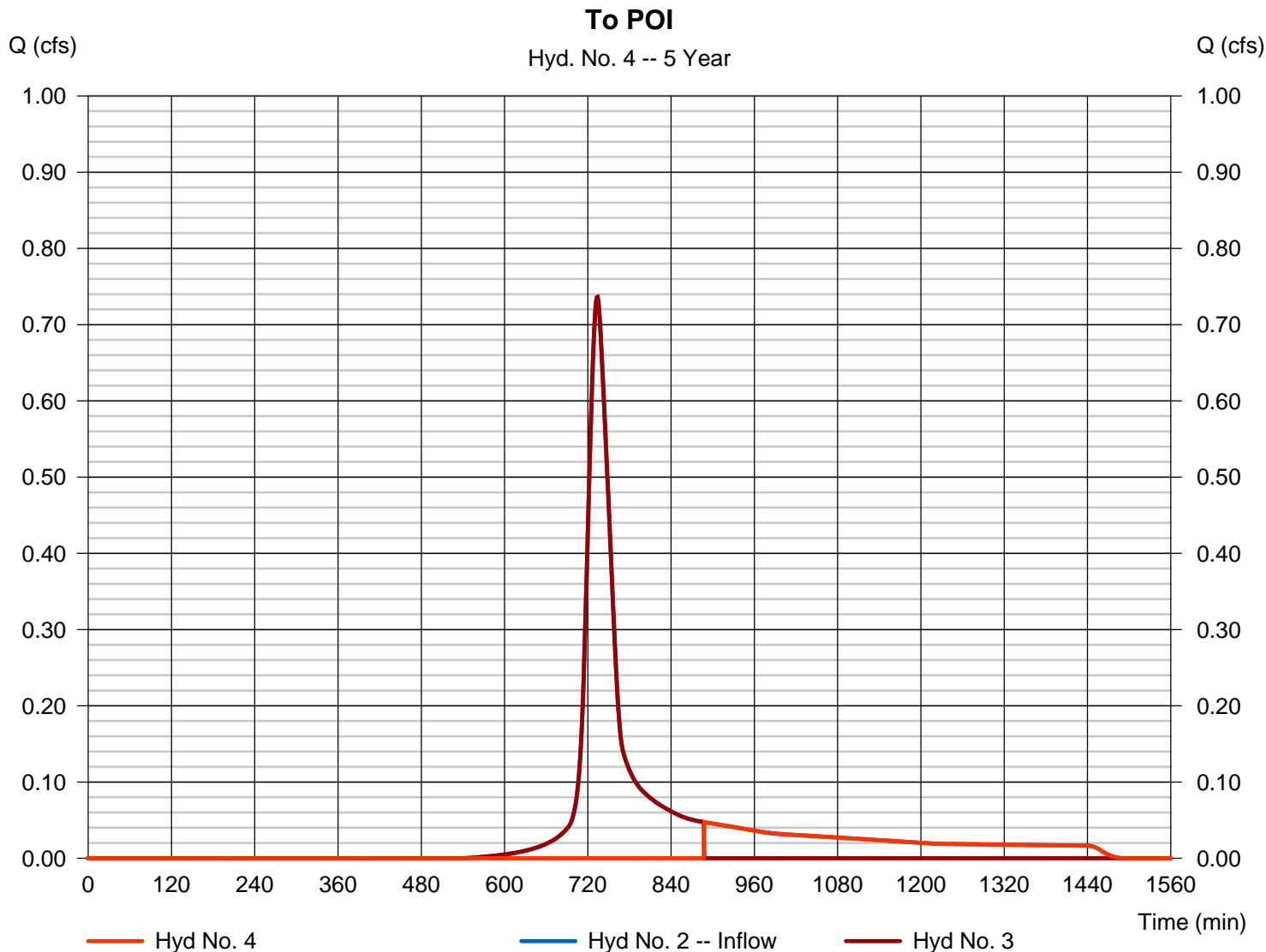
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.047 cfs  |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 888 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 856 cuft   |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 3          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,309 cuft |



# Hydrograph Report

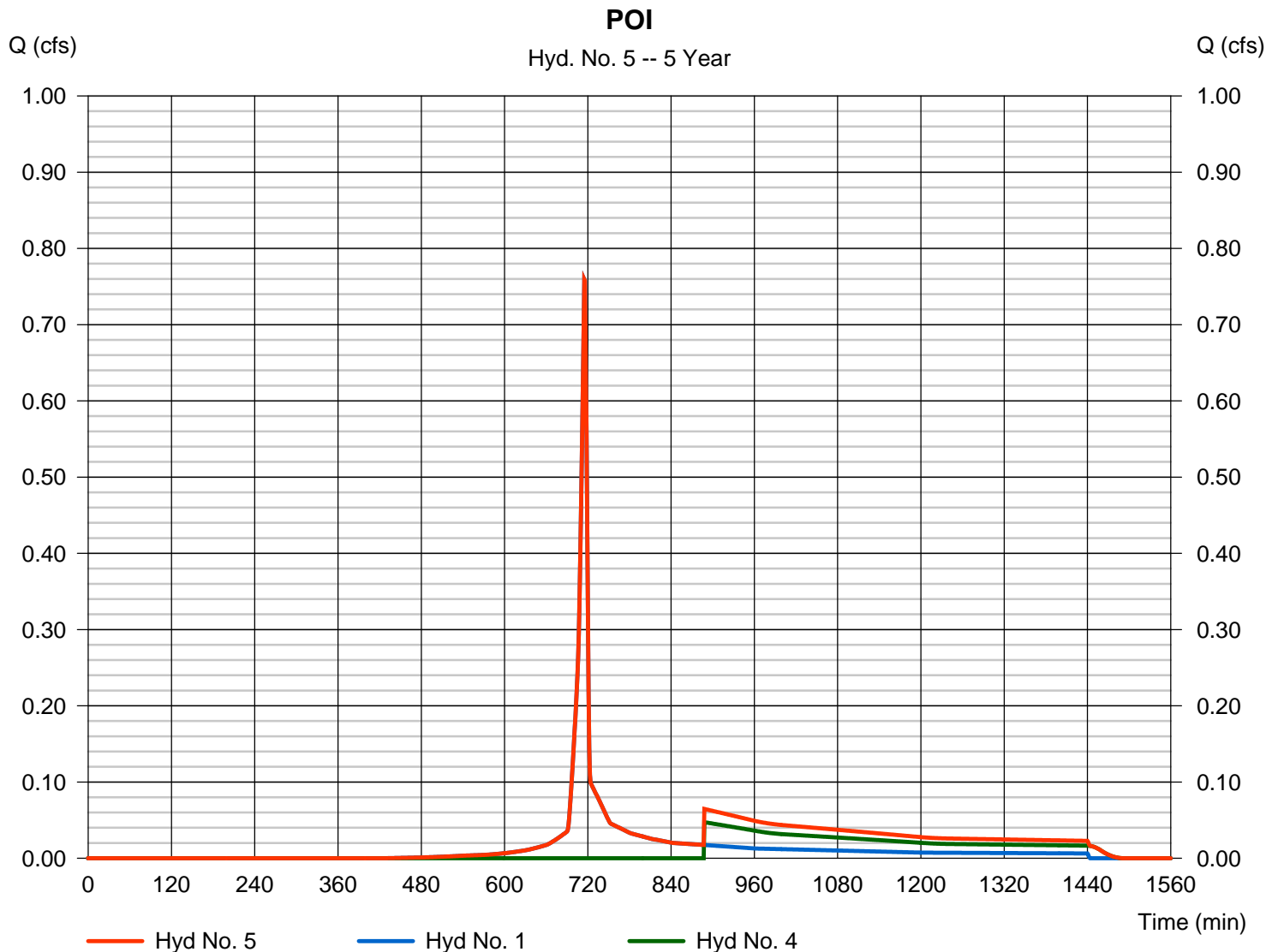
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.759 cfs  |
| Storm frequency | = 5 yrs   | Time to peak         | = 715 min    |
| Time interval   | = 1 min   | Hyd. volume          | = 2,219 cuft |
| Inflow hyds.    | = 1, 4    | Contrib. drain. area | = 0.170 ac   |



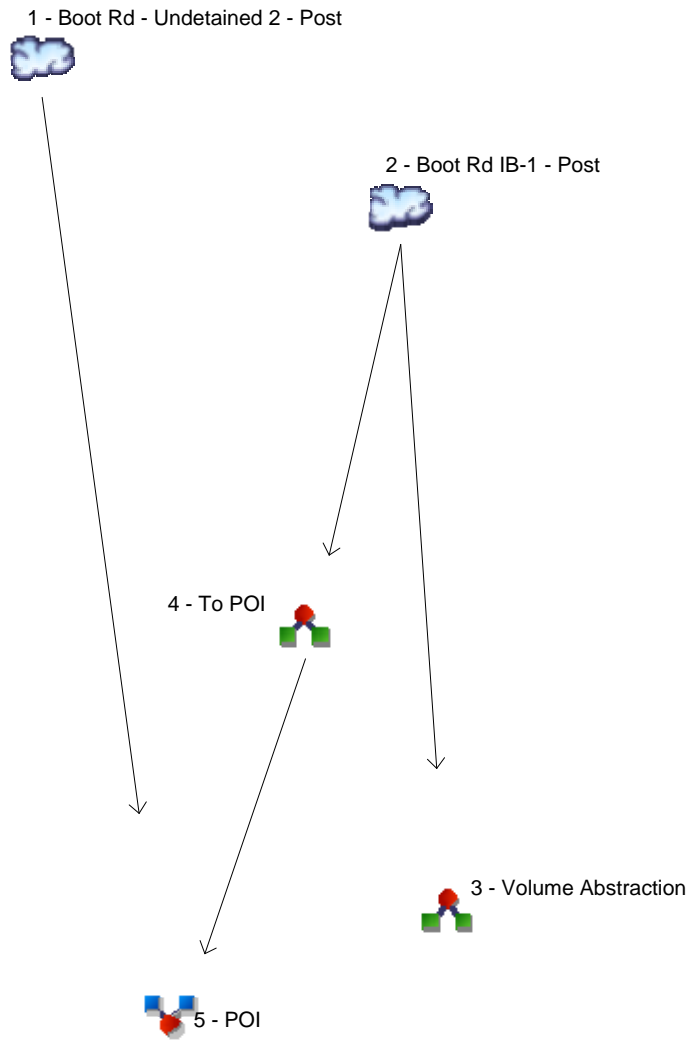


**ATTACHMENT C-11**  
**BOOT RD - West Goshen**  
**10 Year-24 Hour Storm**



# Watershed Model Schematic

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



# Hydrograph Return Period Recap

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               | -----         | -----              | ----- | ----- | ----- | 0.946 | ----- | ----- | -----  | Boot Rd - Undetained 2 - Post |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 1.064 | ----- | ----- | -----  | Boot Rd IB-1 - Post           |
| 3        | Diversion1               | 2             | -----              | ----- | ----- | ----- | 1.064 | ----- | ----- | -----  | Volume Abstraction            |
| 4        | Diversion2               | 2             | -----              | ----- | ----- | ----- | 0.129 | ----- | ----- | -----  | To POI                        |
| 5        | Combine                  | 1, 4          | -----              | ----- | ----- | ----- | 0.946 | ----- | ----- | -----  | 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               | 0.946           | 1                   | 715                | 1,716                  | -----         | -----                  | -----                    | Boot Rd - Undetained 2 - Post |  |
| 2  | SCS Runoff               | 1.064           | 1                   | 730                | 4,082                  | -----         | -----                  | -----                    | Boot Rd IB-1 - Post           |  |
| 3  | Diversion1               | 1.064           | 1                   | 730                | 2,523                  | 2             | -----                  | -----                    | Volume Abstraction            |  |
| 4  | Diversion2               | 0.129           | 1                   | 782                | 1,559                  | 2             | -----                  | -----                    | To POI                        |  |
| 5  | Combine                  | 0.946           | 1                   | 715                | 3,276                  | 1, 4          | -----                  | -----                    | POI                           |  |
| Boot Rd - West Goshen - Post - 10 year.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                               |  |

# Hydrograph Report

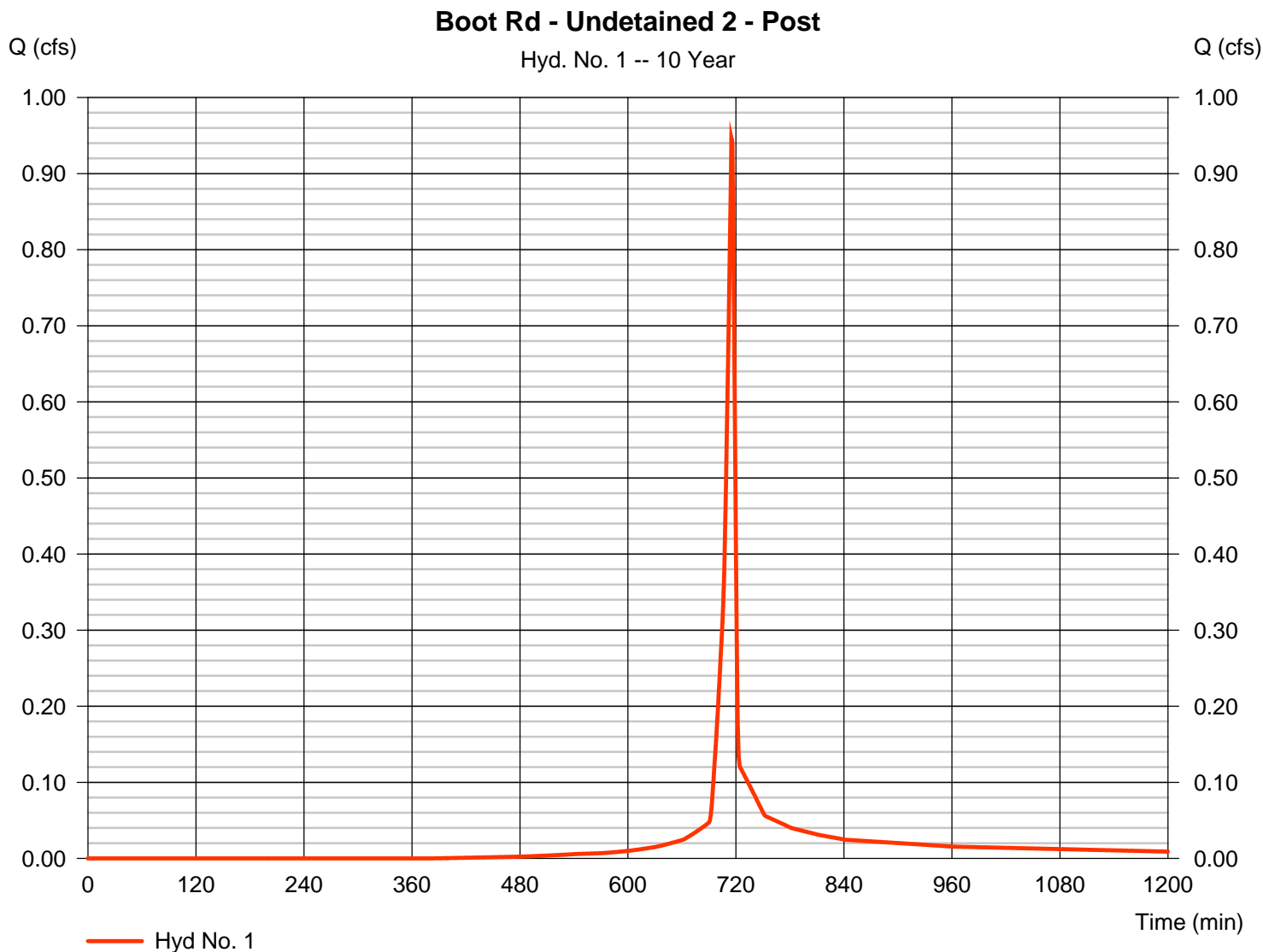
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

Boot Rd - Undetained 2 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.946 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 715 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,716 cuft |
| Drainage area   | = 0.170 ac   | Curve number       | = 83         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 2.40 min   |
| Total precip.   | = 4.77 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

Boot Rd - Undetained 2 - Post

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| 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)        | = 3.25        |          | 0.00        |          | 0.00        |                 |
| Land slope (%)                     | = 5.00        |          | 0.00        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.83</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.83</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 50.00       |          | 280.00      |          | 0.00        |                 |
| Watercourse slope (%)              | = 4.00        |          | 4.30        |          | 0.00        |                 |
| Surface description                | = Paved       |          | Unpaved     |          | Paved       |                 |
| Average velocity (ft/s)            | =4.07         |          | 3.35        |          | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.20</b> | <b>+</b> | <b>1.39</b> | <b>+</b> | <b>0.00</b> | <b>= 1.60</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>2.40 min</b> |

# Hydrograph Report

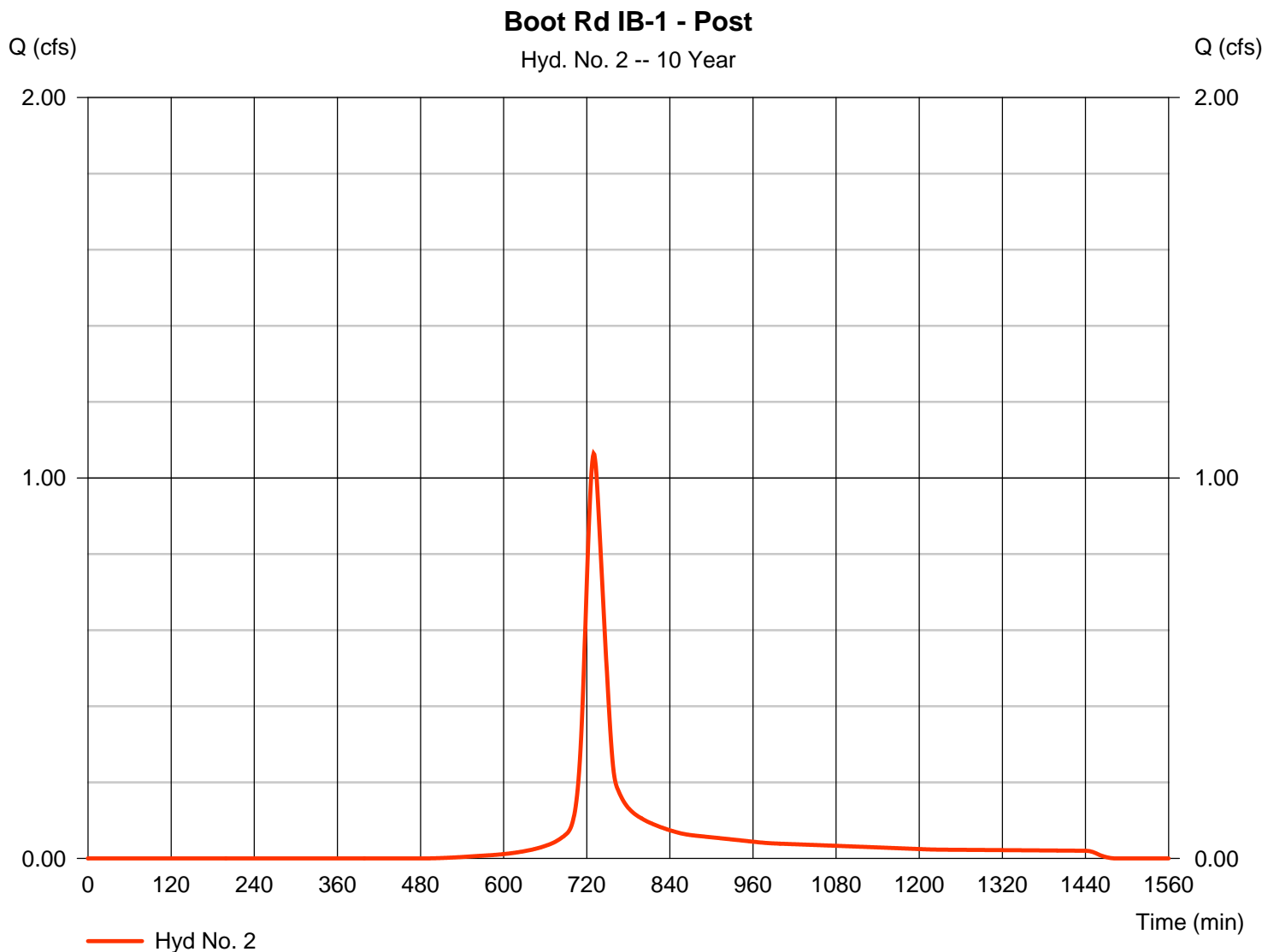
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

Boot Rd IB-1 - Post

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.064 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 730 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,082 cuft |
| Drainage area   | = 0.450 ac   | Curve number       | = 78         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 27.70 min  |
| Total precip.   | = 4.77 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

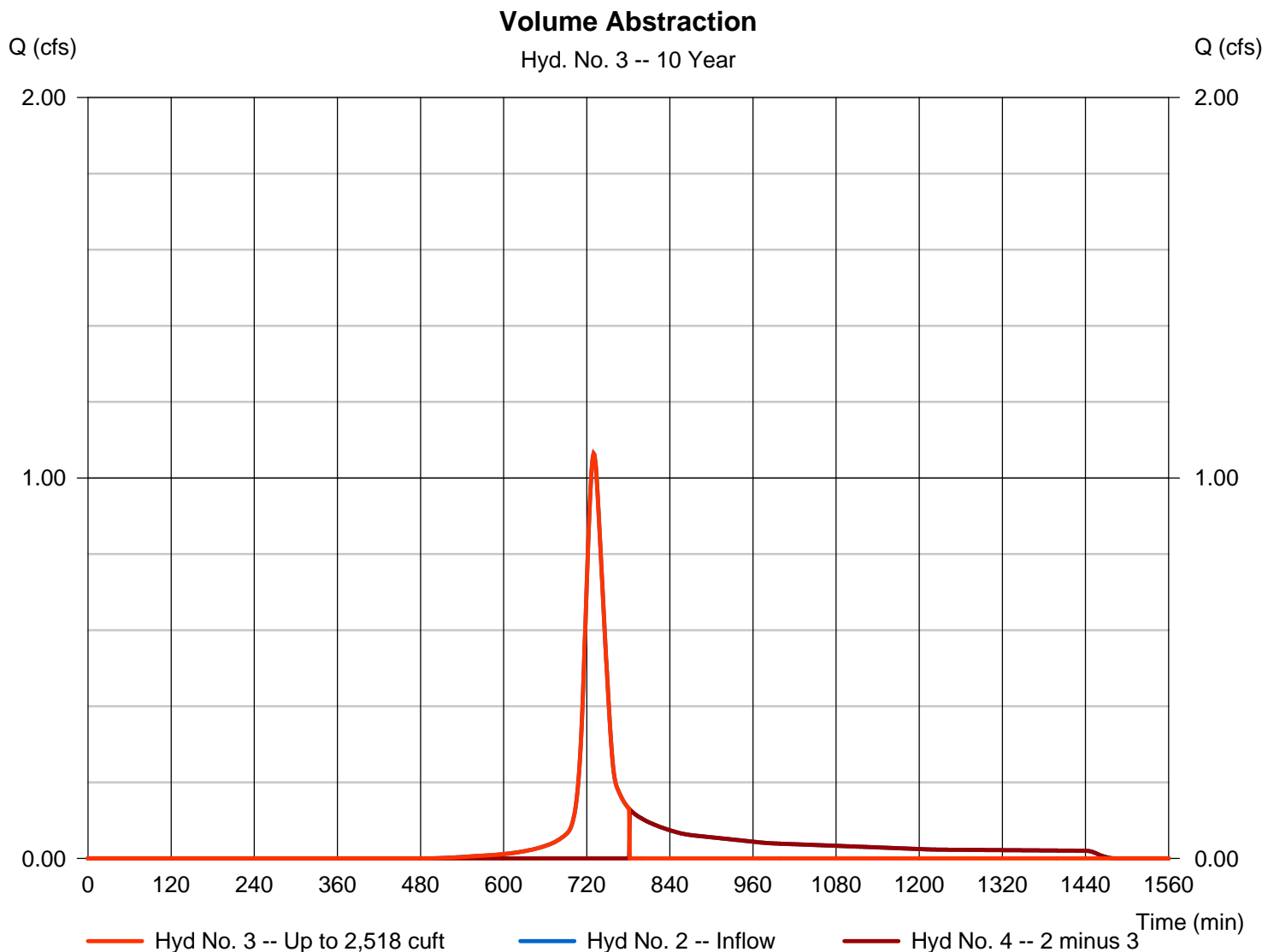
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

### Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 1.064 cfs  |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 730 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 2,523 cuft |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

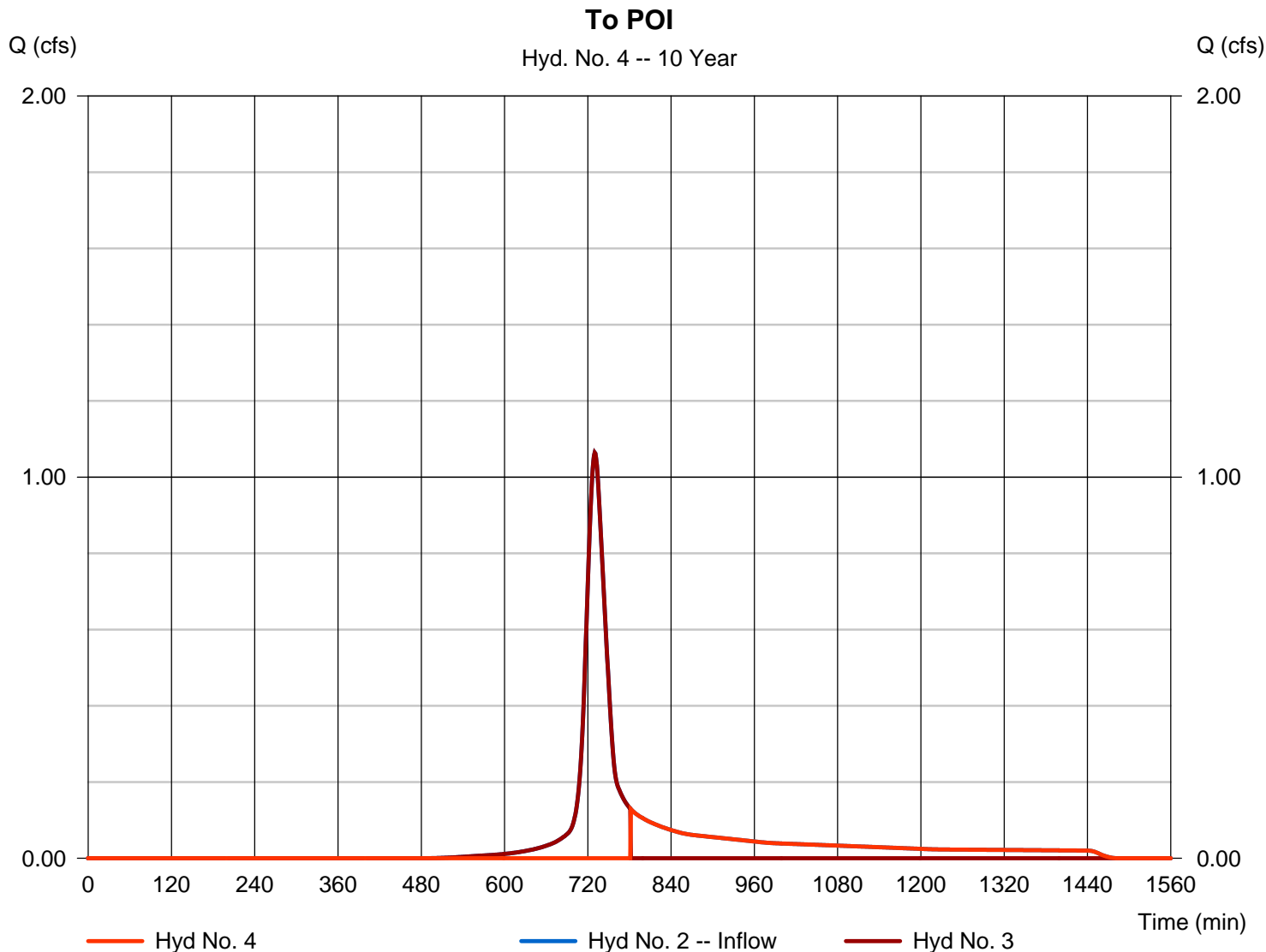
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

To POI

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.129 cfs  |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 782 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,559 cuft |
| Inflow hydrograph | = 2 - Boot Rd IB-1 - Post | 2nd diverted hyd. | = 3          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 2,518 cuft |



# Hydrograph Report

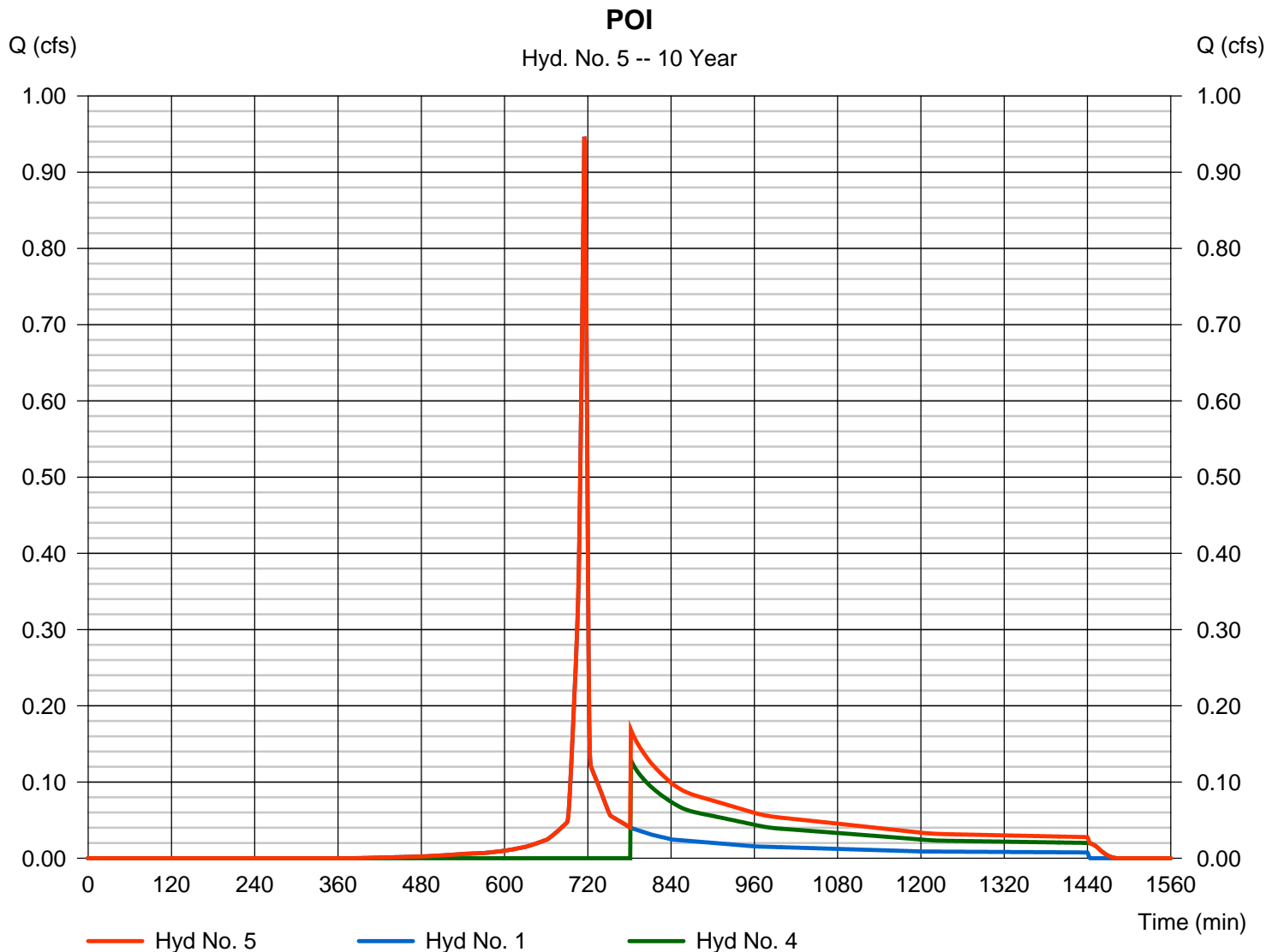
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

POI

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.946 cfs  |
| Storm frequency | = 10 yrs  | Time to peak         | = 715 min    |
| Time interval   | = 1 min   | Hyd. volume          | = 3,276 cuft |
| Inflow hyds.    | = 1, 4    | Contrib. drain. area | = 0.170 ac   |





**ATTACHMENT D**  
**BOOT RD**  
**DIVERSION CHANNEL DESIGN**









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: PPP  
 Project Number: 104958  
 Channel Name: Boot Rd DD-1**

|                      |                   |
|----------------------|-------------------|
| Discharge            | 6.8               |
| 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     | 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 | 6.8 cfs   | 3.73 ft/s | 0.74 ft      | 0.032      | 3 lbs/ft <sup>2</sup>    | 0.92 lbs/ft <sup>2</sup>  | 3.26          | STABLE  | E              |
| P300 Reinforced Vegetation | Straight | 6.8 cfs   | 1.87 ft/s | 1.12 ft      | 0.081      | 8 lbs/ft <sup>2</sup>    | 1.4 lbs/ft <sup>2</sup>   | 5.71          | STABLE  | E              |
| Underlying Substrate       | Straight | 6.8 cfs   | 1.87 ft/s | 1.12 ft      | --         | 2 lbs/ft <sup>2</sup>    | 0.043 lbs/ft <sup>2</sup> | 46.65         | STABLE  | --             |



**S PENNELL RD**



**WORKSHEET 1. GENERAL SITE INFORMATION**

**Date:** October 24, 2016

**Project Name:** S Pennell Rd

**Municipality:** Middletown Township

**County:** Delaware

**Total Area (acres):** 0.54

**Major River Basin:** Delaware

**Watershed:** Darby - Crum Creeks

**Sub Basin:** Chester Creek

**Nearest Surface Water to Receive Runoff:** Tributary 00576 to Chester Creek

**Ch. 93 - Designated Water Use:** TSF

**Impaired according to Chapter 303(d) list?** YES   
**List Causes of Impairment:** NO   
     Urban Runoff/Storm Sewers - Cause Unknown  
     Urban Runoff/Storm Sewers - Water Flow Variability  
     Urban Runoff/Storm Sewers - Siltation

***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.

| <b>EXISTING NATURAL SENSITIVE RESOURCE</b> | <b>MAPPED?<br/>yes/no/n/a</b> | <b>TOTAL AREA<br/>(Ac.)</b> | <b>PROTECTED<br/>AREA (Ac.)</b> |
|--|-------------------------------|-----------------------------|---------------------------------|
| Waterbodies                                |                               |                             |                                 |
| Floodplains                                |                               |                             |                                 |
| Riparian Areas                             |                               |                             |                                 |
| Wetlands                                   |                               |                             |                                 |
| Woodlands                                  |                               |                             |                                 |
| Natural Drainage Ways                      |                               |                             |                                 |
| Steep Slopes, 15% - 25%                    |                               |                             |                                 |
| Steep Slopes, over 25%                     |                               |                             |                                 |
| Other:                                     | Yes                           | 0.54                        | 0.06                            |
| Other:                                     |                               |                             |                                 |
| <b>TOTAL EXISTING:</b>                     | Yes                           | 0.54                        | 0.06                            |

**WORKSHEET 3. NONSTRUCTURAL BMP CREDITS**

**PROTECTED AREA**

|  |             |            |
|--|-------------|------------|
| <b>1.1 Area of Protected Sensitive/Special Value Features (see WS 2)</b> | <u>0.06</u> | <b>Ac.</b> |
| <b>1.2 Area of Riparian Forest Buffer Protection</b>                     | <u>0</u>    | <b>Ac.</b> |
| <b>3.1 Area of Minimum Disturbance/Reduced Grading</b>                   | <u>0</u>    | <b>Ac.</b> |
| <b>TOTAL</b>   | <u>0.06</u> | <b>Ac.</b> |

|   |       |   |   |   |
|---|-------|---|---|---|
| Site Area   | minus | Protected Area  | = | Stormwater Management Area                              |
| <input style="width: 100px;" type="text" value="0.54"/>     | -     | <input style="width: 100px;" type="text" value="0.06"/> | = | <input style="width: 150px;" type="text" value="0.49"/> |
| <i>This is the area that requires stormwater management</i> |       |   |   |   |

**VOLUME CREDITS**

**3.1 Minimum Soil Compaction**

|        |                                     |          |        |                                   |
|--------|-------------------------------------|----------|--------|-----------------------------------|
| Lawn   | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
| Meadow | <u>          </u> ft <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |

**3.3 Protected Existing Trees**

*For trees within 100 feet of impervious area:*

|             |                                     |          |        |                                   |
|-------------|-------------------------------------|----------|--------|-----------------------------------|
| Tree canopy | <u>          </u> ft <sup>2</sup> x | 1/2 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-------------|-------------------------------------|----------|--------|-----------------------------------|

**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 <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-----------|-------------------------------------|----------|--------|-----------------------------------|

*For all other disconnected roof areas*

|           |                                     |          |        |                                   |
|-----------|-------------------------------------|----------|--------|-----------------------------------|
| Roof Area | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|-----------|-------------------------------------|----------|--------|-----------------------------------|

**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 <sup>2</sup> x | 1/3 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|------------------|-------------------------------------|----------|--------|-----------------------------------|

*For all other disconnected roof areas*

|                  |                                     |          |        |                                   |
|------------------|-------------------------------------|----------|--------|-----------------------------------|
| Impervious Areas | <u>          </u> ft <sup>2</sup> x | 1/4 in x | 1/12 = | <u>          </u> ft <sup>3</sup> |
|------------------|-------------------------------------|----------|--------|-----------------------------------|

**TOTAL NON-STRUCTURAL VOLUME CREDIT\***  ft<sup>3</sup>

*\* For use on Worksheet 5*

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

PROJECT: S Pennell Rd  
 Drainage Area: 0.54 acres  
 2-Year Rainfall: 3.25 in

Total Site Area: 0.54 acres  
 Protected Site Area: 0.06 acres  
 Managed Site Area: 0.49 acres

**Existing Conditions**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | Ia (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>2</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Meadow               | C         | 1674          | 0.04        | 71 | 4.08 | 0.82       | 0.91                       | 127   |
| Woods                | C         | 19569         | 0.45        | 70 | 4.29 | 0.86       | 0.86                       | 1,398   |
| <b>TOTAL:</b>        |           | <b>21,243</b> | <b>0.49</b> |    |      |            |                            | <b>1,525</b>                                  |

**Developed Conditions**

| Cover Type/Condition | Soil Type | Area (sf)     | Area (ac)   | CN | S    | Ia (0.2*S) | Q Runoff <sup>1</sup> (in) | Runoff Volume <sup>2</sup> (ft <sup>3</sup> ) |
|----------------------|-----------|---------------|-------------|----|------|------------|----------------------------|---|
| Meadow               | C         | 16189         | 0.37        | 71 | 4.08 | 0.82       | 0.91                       | 1,225   |
| Gravel               | C         | 5100          | 0.12        | 89 | 1.24 | 0.25       | 2.13                       | 904   |
| <b>TOTAL:</b>        |           | <b>21,289</b> | <b>0.49</b> |    |      |            |                            | <b>2,129</b>                                  |

|  |            |
|--|------------|
| 2-Year Volume Increase (ft <sup>3</sup> ): | <b>605</b> |
|--|------------|

**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:** S Pennell Rd  
**SUB-BASIN:** \_\_\_\_\_

|   |       |
|---|-------|
| Required Control Volume (ft <sup>3</sup> ) - <i>from Worksheet 4:</i>   | 605   |
| Non-structural Volume Credit (ft <sup>3</sup> ) - <i>from Worksheet 3:</i>                                      | - N/A |
| <b>Structural Volume Reqmt (ft<sup>3</sup>)</b><br><i>(Required Control Volume minus Non-structural Credit)</i> | 605   |

| Proposed BMP                              | Area (ft <sup>2</sup> ) | Storage Volume (ft <sup>3</sup> ) |
|---|-------------------------|-----------------------------------|
| 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                               | 2,790                   | 1,604                             |
| 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               |                         |                                   |
| <i>Other:</i>                             |                         |                                   |

|   |              |
|---|--------------|
| <b>Total Structural Volume Provided (ft<sup>3</sup>):</b> | <b>1,604</b> |
| <b>Structural Volume Requirement (ft<sup>3</sup>):</b>    | <b>605</b>   |
| <b>DIFFERENCE:</b>  | <b>-999</b>  |

**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 |
|---|-----|----|
| <b>Primary BMPs for Nitrate:</b>                                      |     |    |
| 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                          |     |    |
|   |     |    |
| <b>Secondary BMPs for Nitrate:</b>                                    |     |    |
| 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  
S PENNELL RD**



# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
Chkd. By: LMD Date: 10/25/16 S Pennell Rd Proj. No.: 112IC05958

## Post Construction Stormwater Management Plan - Design Calculations S Pennell Road

---

### **PURPOSE**

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the S Pennell Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The S Pennell Road Block Valve Site is located in Middletown Township, Delaware County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations, including the Middletown Township Stormwater Ordinance (Chapter 198 of the township ordinance).

### **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.
- Post-development peak discharge for all design storms must be no greater than 50% of the pre-development peak discharges. (*Chester/Ridley Creek Watershed Stormwater Management District - Middletown Township Stormwater Ordinance*)

*Note: As stated in the Stormwater Ordinance, the 50% Reduction in peak discharges only applies to the disturbed area. In order to calculate the peak rate change, a pre-development watershed of just the disturbed area has been developed.*

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.

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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):

| <b>Storm Frequency</b> | <b>Depth (Inches)</b> |
|------------------------|-----------------------|
| 1-yr                   | 2.70                  |
| 2-yr                   | 3.25                  |
| 5-yr                   | 4.10                  |
| 10-yr                  | 4.82                  |
| 25-yr                  | 5.86                  |
| 50-yr                  | 6.74                  |
| 100-yr                 | 7.69                  |

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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) 3.25 in

Total Site Area : 0.54 acres

Protected Site Area: 0.06 acres

Stormwater Management Area 0.49 acres

#### Pre-Development Condition within LOD

| Cover Type/Condition | Soil Type | Area (ac) | CN | S    | Ia   | Q (in) | Runoff Volume (cf) |
|----------------------|-----------|-----------|----|------|------|--------|--------------------|
| Meadow               | C         | 0.04      | 71 | 4.08 | 0.82 | 0.91   | 127                |
| Woods                | C         | 0.45      | 70 | 4.29 | 0.86 | 0.86   | 1,398              |
| Total                |           | 0.49      |    |      |      |        | 1,525              |

#### Post-Development Condition within LOD

| Cover Type/Condition | Soil Type | Area (ac) | CN | S    | Ia   | Q (in) | Runoff Volume (cf) |
|----------------------|-----------|-----------|----|------|------|--------|--------------------|
| Meadow               | C         | 0.37      | 71 | 4.08 | 0.82 | 0.91   | 1,225              |
| Gravel               | C         | 0.12      | 89 | 1.24 | 0.25 | 2.13   | 904                |
| Total                |           | 0.49      |    |      |      |        | 2,129              |

|                                     |            |
|-------------------------------------|------------|
| <b>2-Year Volume Increase (cf):</b> | <b>605</b> |
|-------------------------------------|------------|

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      | 5100.00   |
| Maximum Impervious Ratio:                     | 5         | :1        |
| Minimum Infiltration Area (sf):               |           | 1,020     |
| Design Infiltration Area (sf):                |           | 1,916     |
| Design Impervious Ratio:                      | 2.7       | :1        |

#### TOTAL WATERSHED LOADING RATE

|  | Area (ac) | Area (sf) |
|--|-----------|-----------|
| Detained Watershed Area (to Infiltration BMP): | 0.24      | 10662.00  |
| Maximum Total Watershed Ratio Ratio:           | 8         | :1        |
| Minimum Infiltration Area (sf):                |           | 1,333     |
| Design Infiltration Area (sf):                 |           | 1,916     |
| Design Total Watershed Ratio:                  | 5.6       | :1        |

### Infiltration Berm 2

#### IMPERVIOUS LOADING RATE

|   | Area (ac) | Area (sf) |
|---|-----------|-----------|
| Detained Impervious Area (Gravel & Pavement): | 0.00      | 0.00      |
| Maximum Impervious Ratio:                     | 5         | :1        |
| Minimum Infiltration Area (sf):               |           | -         |
| Design Infiltration Area (sf):                |           | 874       |
| Design Impervious Ratio:                      | 0.0       | :1        |

No Impervious Area is draining to Infiltration Berm 2

#### TOTAL WATERSHED LOADING RATE

|  | Area (ac) | Area (sf) |
|--|-----------|-----------|
| Detained Watershed Area (to Infiltration BMP): | 0.09      | 4128.00   |
| Maximum Total Watershed Ratio Ratio:           | 8         | :1        |
| Minimum Infiltration Area (sf):                |           | 516       |
| Design Infiltration Area (sf):                 |           | 874       |
| Design Total Watershed Ratio:                  | 4.7       | :1        |

### DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berms for the S Pennell Block Valve Site will be located along the southwestern edge of the pad and 100 percent of the disturbed area will be detained by the BMPs.

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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.

|   |            |
|---|------------|
| <b>Design Infiltration Rate (in/hr) - Infiltration Berm 1</b> | <b>1.8</b> |
| <b>Design Infiltration Rate (in/hr) - Infiltration Berm 2</b> | <b>1.8</b> |

## 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) |
|-------------|-------------------------|-------------------|------------------------|---------------------|
| 72          | 26                      | 1,916             | 2.00                   | 1872                |

Infiltration Volume for "Volume Abstraction" in Routing Process:

| Infiltration Rate (in/hr) | Surface Area (sf) | Infiltration Period (hrs) | Infiltration Volume (cf) |
|---------------------------|-------------------|---------------------------|--------------------------|
| 1.8                       | 1,916             | 2                         | 575                      |

|  |                 |
|--|-----------------|
| <b>Volume Abstraction Potential (cf)</b> | <b>2,446.80</b> |
|--|-----------------|

### Infiltration Berm 2

Storage Volume

| Length (ft) | Cross Section Area (sf) | Surface Area (sf) | Depth to Overflow (ft) | Storage Volume (cf) |
|-------------|-------------------------|-------------------|------------------------|---------------------|
| 26          | 35                      | 874               | 2.00                   | 910                 |

Infiltration Volume for "Volume Abstraction" in Routing Process:

| Infiltration Rate (in/hr) | Surface Area (sf) | Infiltration Period (hrs) | Infiltration Volume (cf) |
|---------------------------|-------------------|---------------------------|--------------------------|
| 1.8                       | 874               | 2                         | 262                      |

|  |                 |
|--|-----------------|
| <b>Volume Abstraction Potential (cf)</b> | <b>1,172.20</b> |
|--|-----------------|

## 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                               | 1307                      | 1872                | 1872                                | 1307                          |
| Infiltration Berm 2                               | 297                       | 910                 | 910                                 | 297                           |
| <b>Total Structural Credit (cf) (Worksheet 5)</b> |                           |                     |                                     | <b>1604</b>                   |

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 0.54 acres. Based upon the soil survey of Delaware County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Neshaminy gravelly silt loam (NaB2 and NaC3) series which are primarily classified as HSG C. See the project drawings for watershed mapping.

### *Pre-Development Condition*

#### *Pre-Development - Entire Area*

| Hydrologic Group | Soil Name   | Cover Description | Curve Number | Area (acres) |
|------------------|-------------|-------------------|--------------|--------------|
| C                | NaB2 & NaC3 | Meadow            | 71           | 0.04         |
| C                | NaB2 & NaC3 | Woods             | 70           | 0.51         |
| Totals           |             |                   |              | 0.54         |

|    |    |
|----|----|
| CN | 70 |
|----|----|

#### *Pre-Development - Developed Area (Downslope of Proposed Diversion Channel)*

| Hydrologic Group | Soil Name   | Cover Description | Curve Number | Area (acres) |
|------------------|-------------|-------------------|--------------|--------------|
| C                | NaB2 & NaC3 | Meadow            | 71           | 0.04         |
| C                | NaB2 & NaC3 | Woods             | 70           | 0.30         |
| Totals           |             |                   |              | 0.34         |

|    |    |
|----|----|
| CN | 70 |
|----|----|

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## Post-Development Condition

### Diversion DD-1 (UnDetained)

| Hydrologic Group | Soil Name   | Cover Description | Curve Number | Area (acres) |
|------------------|-------------|-------------------|--------------|--------------|
| C                | NaB2 & NaC3 | Meadow            | 71           | 0.15         |
| C                | NaB2 & NaC3 | Woods             | 70           | 0.06         |
| Totals           |             |                   |              | 0.20         |

|    |    |
|----|----|
| CN | 71 |
|----|----|

### Infiltration Berm 1 (Detained)

| Hydrologic Group | Soil Name   | Cover Description | Curve Number | Area (acres) |
|------------------|-------------|-------------------|--------------|--------------|
| C                | NaB2 & NaC3 | Meadow            | 71           | 0.13         |
| C                | NaB2 & NaC3 | Gravel            | 89           | 0.12         |
| Totals           |             |                   |              | 0.25         |

|    |    |
|----|----|
| CN | 80 |
|----|----|

### Infiltration Berm 2 (Detained)

| Hydrologic Group | Soil Name   | Cover Description | Curve Number | Area (acres) |
|------------------|-------------|-------------------|--------------|--------------|
| C                | NaB2 & NaC3 | Meadow            | 71           | 0.09         |
| Totals           |             |                   |              | 0.09         |

|    |    |
|----|----|
| CN | 71 |
|----|----|

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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  $T_c$  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. 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                 | 0.7                                  | 1,307                           | 31.1                             | 4.8  | 35.9                                  |
| 5                 | 1.02                                 | 1,872                           | 30.6                             | 4.8  | 35.4                                  |
| 10                | 1.29                                 | 1,872                           | 24.2                             | 4.8  | 29.0                                  |
| 25                | 1.71                                 | 1,872                           | 18.2                             | 4.8  | 23.0                                  |
| 50                | 2.06                                 | 1,872                           | 15.1                             | 4.8  | 19.9                                  |
| 100               | 2.44                                 | 1,872                           | 12.8                             | 4.8  | <b>17.6</b>                           |

#### 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                 | 0.13                                 | 297                             | 38.1                             | 9.7  | 47.8                                  |
| 5                 | 0.21                                 | 478                             | 37.9                             | 9.7  | 47.6                                  |
| 10                | 0.29                                 | 647                             | 37.2                             | 9.7  | 46.9                                  |
| 25                | 0.40                                 | 910                             | 37.9                             | 9.7  | 47.6                                  |
| 50                | 0.51                                 | 910                             | 29.7                             | 9.7  | 39.4                                  |
| 100               | 0.62                                 | 910                             | 24.5                             | 9.7  | <b>34.2</b>                           |

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

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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                 | 1,307                     | 2,446.80                          | 1,307                          |
| 5                 | 1,928                     | 2,446.80                          | 1,928                          |
| 10                | 2,483                     | 2,446.80                          | 2,447                          |
| 25                | 3,317                     | 2,446.80                          | 2,447                          |
| 50                | 4,043                     | 2,446.80                          | 2,447                          |
| 100               | 4,842                     | 2,446.80                          | 2,447                          |

### *Infiltration Berm 2*

| Storm Event (Yr.) | Volume Runoff to BMP (cf) | Volume Abstraction Potential (cf) | Design Volume Abstraction (cf) |
|-------------------|---------------------------|-----------------------------------|--------------------------------|
| 2                 | 297                       | 1,172.20                          | 297                            |
| 5                 | 478                       | 1,172.20                          | 478                            |
| 10                | 647                       | 1,172.20                          | 647                            |
| 25                | 910                       | 1,172.20                          | 910                            |
| 50                | 1,145                     | 1,172.20                          | 1,145                          |
| 100               | 1,408                     | 1,172.20                          | 1,172                          |

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## 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, 5-yr, 10-yr, 25-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            | 0.51              | 0.92                        | 660                                    | 0.20                          | -0.3         |
| 5-yr            | 0.88              | 1.42                        | 1,051                                  | 0.34                          | -0.5         |
| 10-yr           | 1.22              | 1.87                        | 1,461                                  | 0.47                          | -0.8         |
| 25-yr           | 1.76              | 2.54                        | 2,840                                  | 0.67                          | -1.1         |
| 50-yr           | 2.23              | 3.12                        | 4,102                                  | 0.85                          | -1.4         |
| 100-yr          | 2.75              | 3.75                        | 5,650                                  | 1.60                          | -1.2         |

## PEAK FLOW REDUCTION FOR DEVELOPED AREA

In order to meet the requirements of Middletown Township Stormwater Ordinance, the peak flows from the post-development of the developed area must be 50% the pre-development peak discharges from the same area for each design storm. The analysis is summarized in the table below. Documentation can be found in Attachment C.

| Design Storm | Pre-Development Developed Area Peak Discharge (cfs) | Post-Development Developed Area Peak Discharge (cfs) | Percent Reduction |
|--------------|---|--|-------------------|
| 2-yr         | 0.39  | 0.00   | 100%              |
| 5-yr         | 0.66  | 0.00   | 100%              |
| 10-yr        | 0.91  | 0.01   | 99%               |
| 25-yr        | 1.29  | 0.05   | 96%               |
| 50-yr        | 1.64  | 0.20   | 88%               |
| 100-yr       | 2.02  | 0.96   | 52%               |

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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 Delaware 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 39.9025 N 75.4429 W 312.6 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.
- 9) Township of Middletown Ordinance, Chapter 198: Stormwater Management, Adopted August 27, 2012.



## **ATTACHMENT A**

# **NOAA PRECIPITATION FREQUENCY ESTIMATES**



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



**Latitude: 39.9025°, Longitude: -75.4429°**  
**Elevation: 312.6 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**

| <b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b> |                                     |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|--|-------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Duration   | Average recurrence interval (years) |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|  | 1                                   | 2                      | 5                      | 10                     | 25                     | 50                     | 100                    | 200                    | 500                    | 1000                   |
| 5-min  | 0.351<br>(0.322-0.383)              | 0.418<br>(0.383-0.456) | 0.490<br>(0.448-0.534) | 0.540<br>(0.493-0.589) | 0.600<br>(0.545-0.655) | 0.641<br>(0.579-0.700) | 0.681<br>(0.613-0.746) | 0.716<br>(0.640-0.786) | 0.756<br>(0.669-0.834) | 0.785<br>(0.689-0.871) |
| 10-min   | 0.560<br>(0.514-0.612)              | 0.668<br>(0.613-0.729) | 0.784<br>(0.717-0.855) | 0.864<br>(0.789-0.942) | 0.957<br>(0.869-1.04)  | 1.02<br>(0.922-1.11)   | 1.08<br>(0.974-1.19)   | 1.14<br>(1.01-1.25)    | 1.20<br>(1.06-1.32)    | 1.24<br>(1.08-1.37)    |
| 15-min   | 0.700<br>(0.642-0.765)              | 0.840<br>(0.770-0.916) | 0.992<br>(0.907-1.08)  | 1.09<br>(0.997-1.19)   | 1.21<br>(1.10-1.32)    | 1.29<br>(1.17-1.41)    | 1.37<br>(1.23-1.50)    | 1.43<br>(1.28-1.57)    | 1.50<br>(1.33-1.66)    | 1.55<br>(1.36-1.72)    |
| 30-min   | 0.960<br>(0.881-1.05)               | 1.16<br>(1.06-1.27)    | 1.41<br>(1.29-1.54)    | 1.58<br>(1.45-1.73)    | 1.80<br>(1.63-1.96)    | 1.95<br>(1.76-2.13)    | 2.10<br>(1.89-2.29)    | 2.23<br>(1.99-2.45)    | 2.40<br>(2.12-2.64)    | 2.51<br>(2.21-2.79)    |
| 60-min   | 1.20<br>(1.10-1.31)                 | 1.46<br>(1.33-1.59)    | 1.81<br>(1.65-1.97)    | 2.06<br>(1.88-2.25)    | 2.39<br>(2.17-2.61)    | 2.64<br>(2.38-2.88)    | 2.89<br>(2.60-3.16)    | 3.13<br>(2.79-3.43)    | 3.44<br>(3.04-3.79)    | 3.67<br>(3.22-4.07)    |
| 2-hr   | 1.43<br>(1.30-1.57)                 | 1.74<br>(1.58-1.91)    | 2.17<br>(1.97-2.39)    | 2.50<br>(2.26-2.74)    | 2.93<br>(2.63-3.22)    | 3.27<br>(2.92-3.59)    | 3.60<br>(3.20-3.97)    | 3.94<br>(3.48-4.35)    | 4.39<br>(3.83-4.87)    | 4.74<br>(4.08-5.28)    |
| 3-hr   | 1.56<br>(1.42-1.72)                 | 1.89<br>(1.72-2.08)    | 2.36<br>(2.15-2.60)    | 2.73<br>(2.47-3.00)    | 3.21<br>(2.89-3.52)    | 3.59<br>(3.21-3.94)    | 3.98<br>(3.53-4.38)    | 4.37<br>(3.84-4.82)    | 4.89<br>(4.24-5.42)    | 5.30<br>(4.55-5.89)    |
| 6-hr   | 1.93<br>(1.75-2.13)                 | 2.33<br>(2.12-2.57)    | 2.90<br>(2.63-3.20)    | 3.36<br>(3.04-3.71)    | 4.00<br>(3.60-4.41)    | 4.53<br>(4.03-4.99)    | 5.07<br>(4.48-5.59)    | 5.64<br>(4.92-6.24)    | 6.44<br>(5.52-7.16)    | 7.08<br>(5.98-7.92)    |
| 12-hr  | 2.35<br>(2.13-2.61)                 | 2.83<br>(2.57-3.15)    | 3.55<br>(3.22-3.94)    | 4.14<br>(3.74-4.59)    | 5.01<br>(4.48-5.54)    | 5.74<br>(5.08-6.35)    | 6.53<br>(5.70-7.23)    | 7.38<br>(6.36-8.20)    | 8.61<br>(7.26-9.62)    | 9.65<br>(7.98-10.8)    |
| 24-hr  | 2.70<br>(2.47-2.95)                 | 3.25<br>(2.98-3.56)    | 4.10<br>(3.76-4.50)    | 4.82<br>(4.39-5.27)    | 5.86<br>(5.32-6.40)    | 6.74<br>(6.08-7.35)    | 7.69<br>(6.90-8.38)    | 8.74<br>(7.77-9.50)    | 10.3<br>(9.04-11.2)    | 11.6<br>(10.1-12.5)    |
| 2-day  | 3.11<br>(2.85-3.40)                 | 3.76<br>(3.44-4.11)    | 4.75<br>(4.34-5.19)    | 5.56<br>(5.07-6.08)    | 6.72<br>(6.11-7.34)    | 7.70<br>(6.97-8.41)    | 8.75<br>(7.87-9.55)    | 9.87<br>(8.82-10.8)    | 11.5<br>(10.2-12.5)    | 12.8<br>(11.3-14.0)    |
| 3-day  | 3.28<br>(3.01-3.59)                 | 3.96<br>(3.63-4.33)    | 4.98<br>(4.57-5.45)    | 5.83<br>(5.33-6.37)    | 7.03<br>(6.40-7.67)    | 8.04<br>(7.29-8.77)    | 9.12<br>(8.21-9.93)    | 10.3<br>(9.20-11.2)    | 11.9<br>(10.6-13.0)    | 13.3<br>(11.7-14.5)    |
| 4-day  | 3.45<br>(3.17-3.78)                 | 4.16<br>(3.82-4.55)    | 5.22<br>(4.79-5.71)    | 6.09<br>(5.58-6.65)    | 7.34<br>(6.69-8.01)    | 8.38<br>(7.61-9.12)    | 9.48<br>(8.56-10.3)    | 10.7<br>(9.57-11.6)    | 12.4<br>(11.0-13.5)    | 13.8<br>(12.1-15.0)    |
| 7-day  | 4.02<br>(3.73-4.35)                 | 4.82<br>(4.47-5.22)    | 5.98<br>(5.54-6.48)    | 6.94<br>(6.42-7.51)    | 8.32<br>(7.66-9.00)    | 9.46<br>(8.67-10.2)    | 10.7<br>(9.73-11.6)    | 12.0<br>(10.9-13.0)    | 13.9<br>(12.4-15.0)    | 15.4<br>(13.7-16.7)    |
| 10-day   | 4.54<br>(4.24-4.89)                 | 5.43<br>(5.07-5.85)    | 6.65<br>(6.19-7.16)    | 7.63<br>(7.09-8.21)    | 9.00<br>(8.34-9.69)    | 10.1<br>(9.34-10.9)    | 11.3<br>(10.4-12.1)    | 12.5<br>(11.4-13.4)    | 14.2<br>(12.9-15.3)    | 15.7<br>(14.1-16.9)    |
| 20-day   | 6.14<br>(5.76-6.57)                 | 7.29<br>(6.83-7.80)    | 8.71<br>(8.16-9.32)    | 9.84<br>(9.20-10.5)    | 11.4<br>(10.6-12.1)    | 12.6<br>(11.7-13.4)    | 13.8<br>(12.8-14.7)    | 15.0<br>(13.9-16.1)    | 16.7<br>(15.3-17.9)    | 18.0<br>(16.4-19.3)    |
| 30-day   | 7.64<br>(7.20-8.11)                 | 9.01<br>(8.49-9.57)    | 10.5<br>(9.93-11.2)    | 11.7<br>(11.0-12.4)    | 13.3<br>(12.5-14.1)    | 14.5<br>(13.6-15.4)    | 15.7<br>(14.7-16.7)    | 16.9<br>(15.7-17.9)    | 18.4<br>(17.1-19.6)    | 19.6<br>(18.1-20.8)    |
| 45-day   | 9.70<br>(9.19-10.2)                 | 11.4<br>(10.8-12.0)    | 13.1<br>(12.4-13.9)    | 14.5<br>(13.7-15.3)    | 16.1<br>(15.2-17.0)    | 17.4<br>(16.4-18.4)    | 18.6<br>(17.5-19.6)    | 19.7<br>(18.5-20.8)    | 21.1<br>(19.8-22.3)    | 22.1<br>(20.7-23.4)    |
| 60-day   | 11.6<br>(11.0-12.2)                 | 13.6<br>(12.9-14.3)    | 15.6<br>(14.8-16.4)    | 17.0<br>(16.1-17.9)    | 18.8<br>(17.9-19.8)    | 20.1<br>(19.1-21.2)    | 21.4<br>(20.2-22.5)    | 22.5<br>(21.3-23.8)    | 24.0<br>(22.6-25.3)    | 25.0<br>(23.5-26.4)    |

<sup>1</sup> 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.

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**ATTACHMENT B**

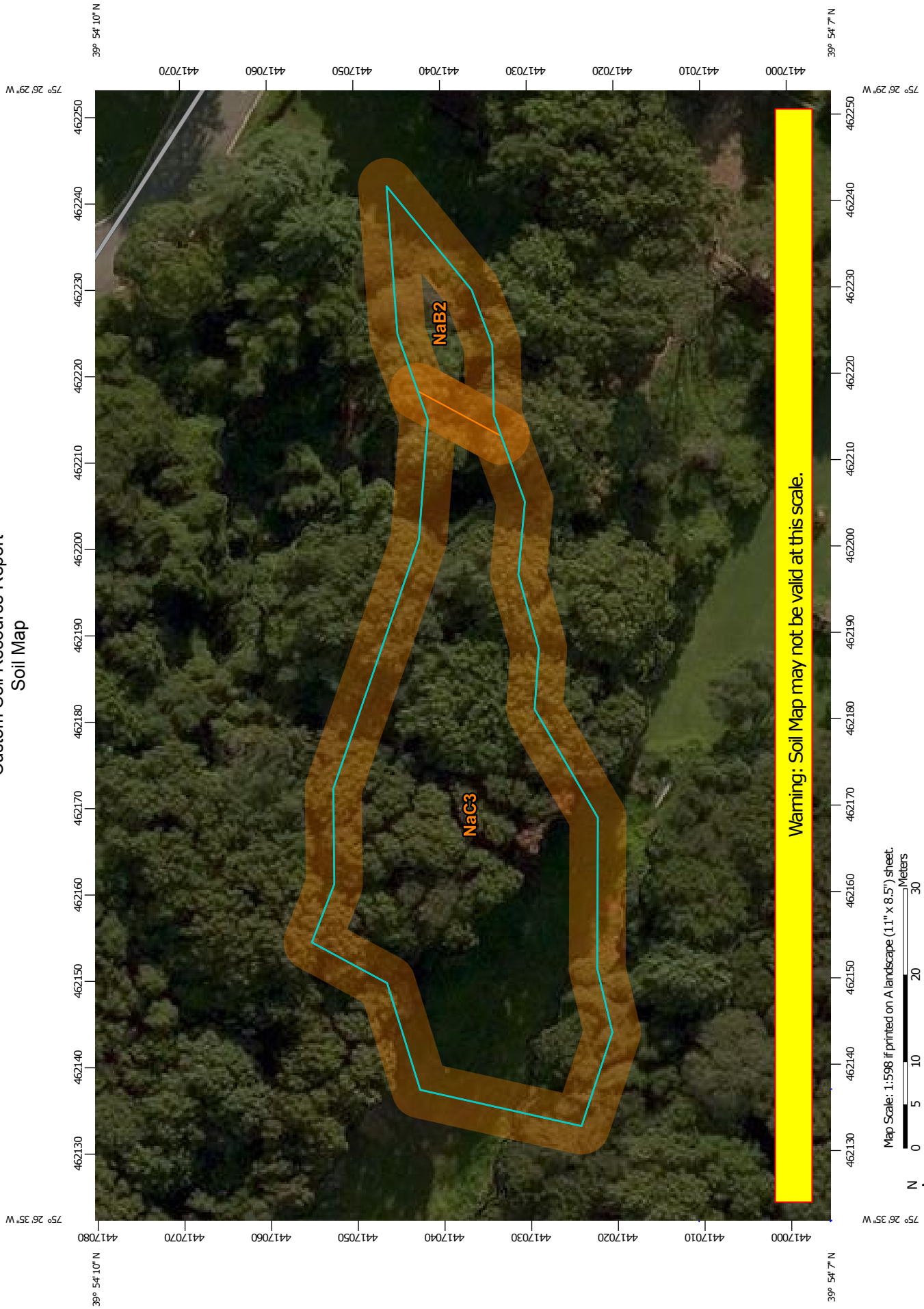
**USDA SOILS MAP & PROPERTIES**



# Custom Soil Resource Report for Delaware County, Pennsylvania



# Custom Soil Resource Report Soil Map



## 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: Delaware County, Pennsylvania  
 Survey Area Data: Version 10, 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: Aug 18, 2014—Sep 22, 2014

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 LEGEND

|  |   |
|--|---|
|  Area of Interest (AOI) |  Spoil Area            |
|  Soil Map Unit Polygons |  Stony Spot            |
|  Soil Map Unit Lines    |  Very Stony Spot       |
|  Soil Map Unit Points   |  Wet Spot              |
|  Special Point Features |  Other                 |
|  Blowout                |  Special Line Features |
|  Borrow Pit             | <b>Water Features</b>   |
|  Clay Spot              |  Streams and Canals    |
|  Closed Depression      | <b>Transportation</b>   |
|  Gravel Pit             |  Rails                 |
|  Gravelly Spot          |  Interstate Highways   |
|  Landfill               |  US Routes             |
|  Lava Flow              |  Major Roads           |
|  Marsh or swamp         |  Local Roads           |
|  Mine or Quarry         | <b>Background</b>   |
|  Miscellaneous Water    |  Aerial Photography    |
|  Perennial Water        |   |
|  Rock Outcrop           |   |
|  Saline Spot            |   |
|  Sandy Spot             |   |
|  Severely Eroded Spot   |   |
|  Sinkhole              |   |
|  Slide or Slip        |   |
|  Sodic Spot           |   |

## Map Unit Legend

| Delaware County, Pennsylvania (PA045) |  |              |                |
|---------------------------------------|--|--------------|----------------|
| Map Unit Symbol                       | Map Unit Name  | Acres in AOI | Percent of AOI |
| NaB2                                  | Neshaminy gravelly silt loam, 3 to 8 percent slopes, moderately eroded | 0.0          | 10.0%          |
| NaC3                                  | Neshaminy gravelly silt loam, 8 to 15 percent slopes, severely eroded  | 0.4          | 90.0%          |
| <b>Totals for Area of Interest</b>    |  | <b>0.5</b>   | <b>100.0%</b>  |

## 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

## Custom Soil Resource Report

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.

## Delaware County, Pennsylvania

### NaB2—Neshaminy gravelly silt loam, 3 to 8 percent slopes, moderately eroded

#### Map Unit Setting

*National map unit symbol:* 121gl  
*Elevation:* 300 to 1,500 feet  
*Mean annual precipitation:* 34 to 50 inches  
*Mean annual air temperature:* 46 to 57 degrees F  
*Frost-free period:* 130 to 214 days  
*Farmland classification:* All areas are prime farmland

#### Map Unit Composition

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

#### Description of Neshaminy

##### Setting

*Landform:* Hillslopes  
*Landform position (two-dimensional):* Summit, shoulder, backslope  
*Landform position (three-dimensional):* Side slope, nose slope, interfluve  
*Down-slope shape:* Linear, convex  
*Across-slope shape:* Convex, linear  
*Parent material:* Residuum weathered from diabase

##### Typical profile

*H1 - 0 to 9 inches:* gravelly silt loam  
*H2 - 9 to 60 inches:* gravelly clay loam  
*H3 - 60 to 64 inches:* bedrock

##### Properties and qualities

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* 48 to 72 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)  
*Depth to water table:* About 60 to 72 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Moderate (about 7.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 2e  
*Hydrologic Soil Group:* C  
*Hydric soil rating:* No

#### Minor Components

##### Mount lucas

*Percent of map unit:* 5 percent  
*Landform:* Hillslopes

## Custom Soil Resource Report

*Landform position (two-dimensional):* Footslope, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear, concave

*Across-slope shape:* Concave, linear

*Hydric soil rating:* No

### **Chester**

*Percent of map unit:* 5 percent

*Landform:* Hills

*Landform position (two-dimensional):* Summit, shoulder, backslope

*Landform position (three-dimensional):* Interfluvium, side slope

*Down-slope shape:* Linear, convex

*Across-slope shape:* Convex, linear

*Hydric soil rating:* No

### **Berks**

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

## **NaC3—Neshaminy gravelly silt loam, 8 to 15 percent slopes, severely eroded**

### **Map Unit Setting**

*National map unit symbol:* 121gn

*Elevation:* 200 to 2,000 feet

*Mean annual precipitation:* 36 to 55 inches

*Mean annual air temperature:* 45 to 61 degrees F

*Frost-free period:* 110 to 235 days

*Farmland classification:* Not prime farmland

### **Map Unit Composition**

*Neshaminy and similar soils:* 90 percent

*Minor components:* 10 percent

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

### **Description of Neshaminy**

#### **Setting**

*Landform:* Hillslopes

*Landform position (two-dimensional):* Summit, shoulder, backslope

*Landform position (three-dimensional):* Interfluvium, side slope, nose slope

*Down-slope shape:* Linear, convex

*Across-slope shape:* Convex, linear

*Parent material:* Residuum weathered from diabase

#### **Typical profile**

*H1 - 0 to 8 inches:* gravelly silt loam

*H2 - 8 to 37 inches:* gravelly silty clay loam

*H3 - 37 to 60 inches:* bedrock

## Custom Soil Resource Report

### Properties and qualities

*Slope:* 8 to 15 percent

*Depth to restrictive feature:* 37 to 99 inches to lithic bedrock

*Natural drainage class:* Well drained

*Runoff class:* High

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 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 4.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

### Minor Components

#### Glenelg

*Percent of map unit:* 5 percent

*Landform:* Hillslopes

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope, nose slope

*Down-slope shape:* Linear, convex

*Across-slope shape:* Convex, linear

*Hydric soil rating:* No

#### Glenville

*Percent of map unit:* 4 percent

*Landform:* Hillslopes

*Landform position (two-dimensional):* Foothslope, backslope

*Landform position (three-dimensional):* Side slope, head slope

*Down-slope shape:* Linear, concave

*Across-slope shape:* Concave, linear

*Hydric soil rating:* No

#### Aldino

*Percent of map unit:* 1 percent

*Landform:* Hillslopes

*Landform position (two-dimensional):* Foothslope, toeslope

*Landform position (three-dimensional):* Interfluvium, head slope

*Down-slope shape:* Linear, concave

*Across-slope shape:* Concave, linear

*Hydric soil rating:* No

**ATTACHMENT C**  
**HYDRAFLOW RESULTS**



**ATTACHMENT C-1**  
**S PENNELL RD**  
**2 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area



# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# Hydrograph Summary Report

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

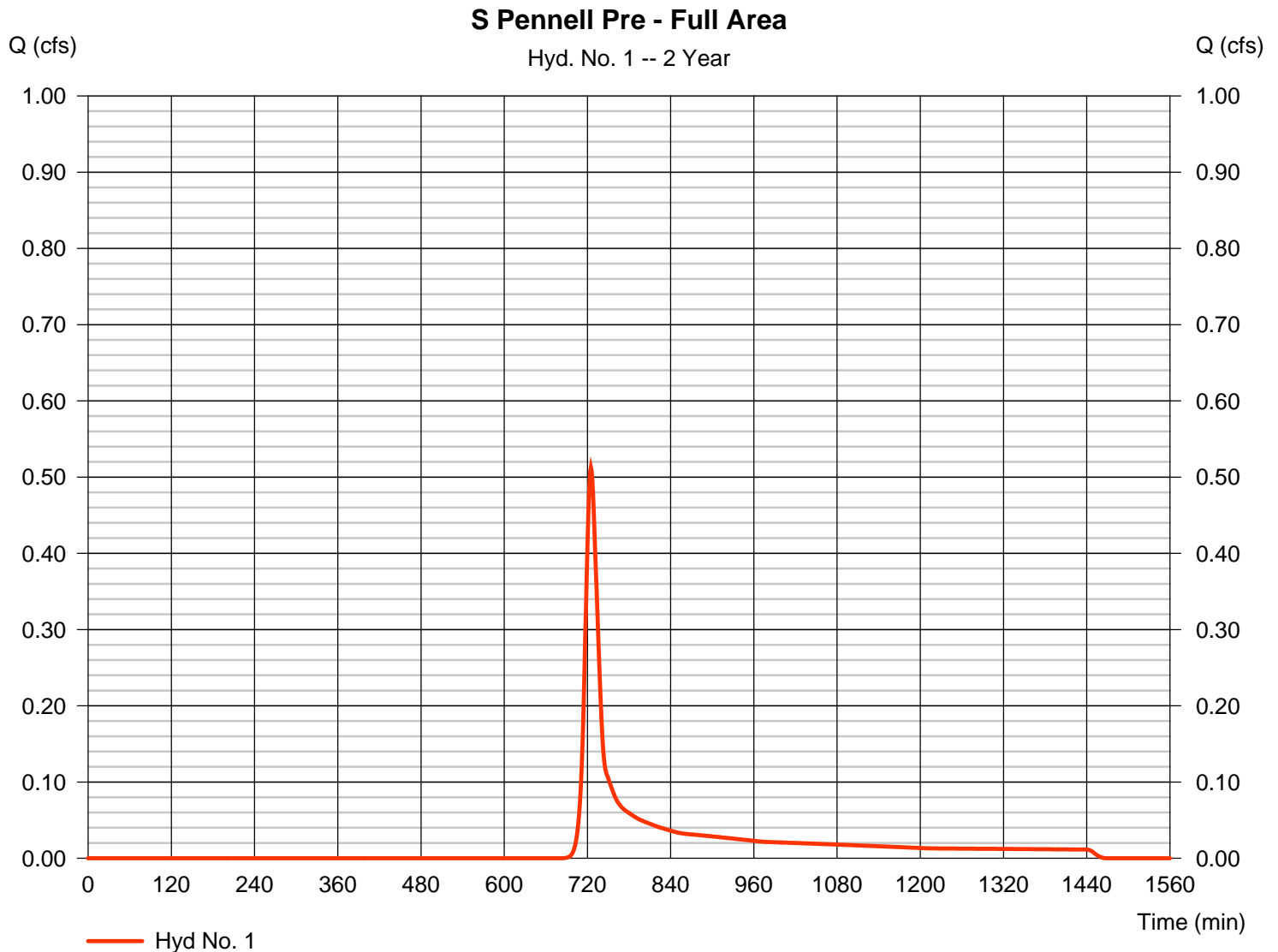
| Hyd. No.         | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft)   | Total strge used (cuft) | Hydrograph Description         |
|------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|--------------------------|-------------------------|--------------------------------|
| 1                | SCS Runoff               | 0.513           | 1                   | 725                | 1,661                 | -----         | -----                    | -----                   | S Pennell Pre - Full Area      |
| 2                | SCS Runoff               | 0.386           | 1                   | 722                | 1,042                 | -----         | -----                    | -----                   | S Pennell Pre - Developed Area |
| S Pennel Pre.gpw |                          |                 |                     |                    | Return Period: 2 Year |               | Wednesday, 11 / 9 / 2016 |                         |                                |

# Hydrograph Report

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.513 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,661 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 3.25 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

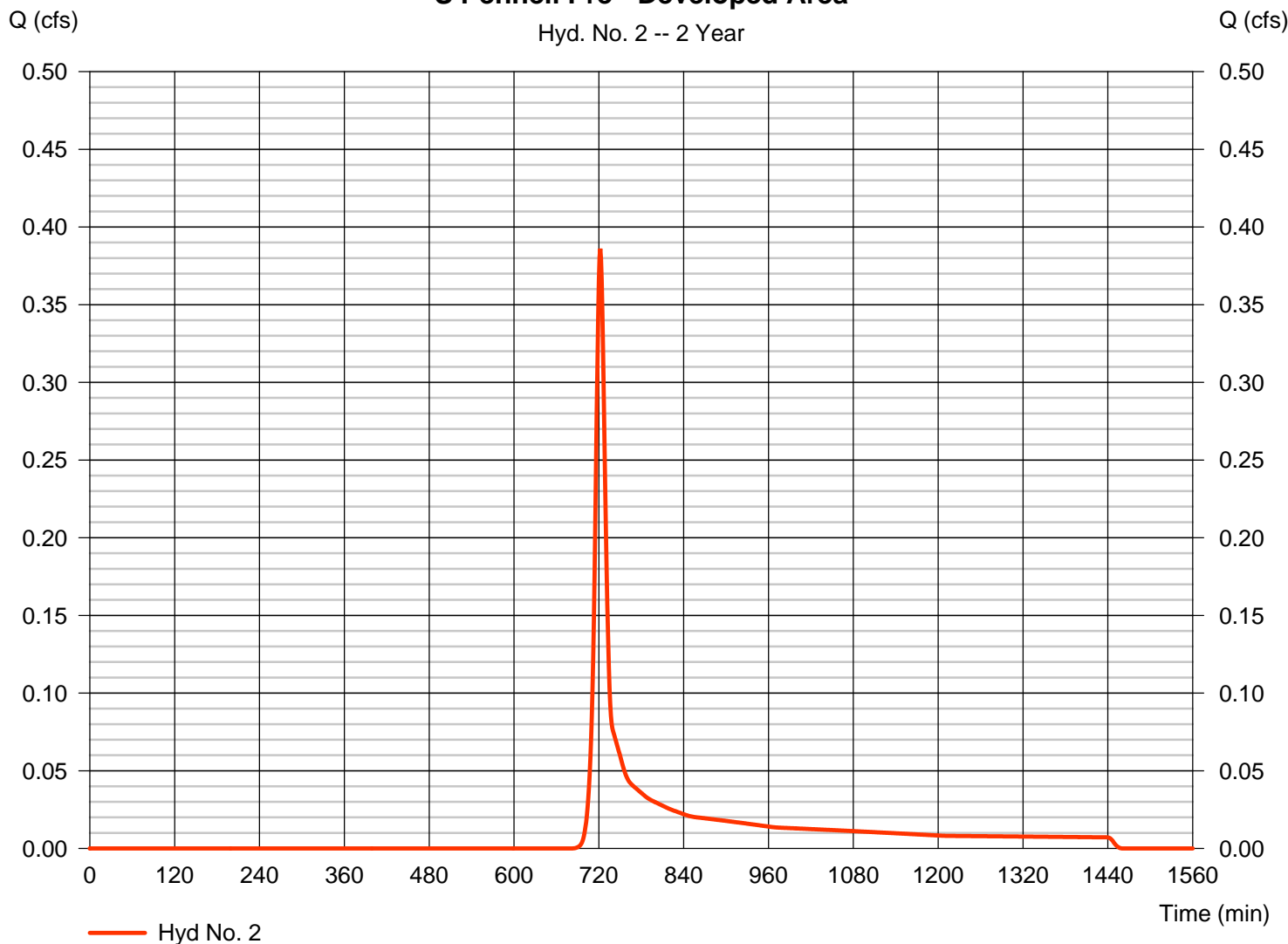
## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.386 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 722 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,042 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

### S Pennell Pre - Developed Area

Hyd. No. 2 -- 2 Year



# TR55 Tc Worksheet

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

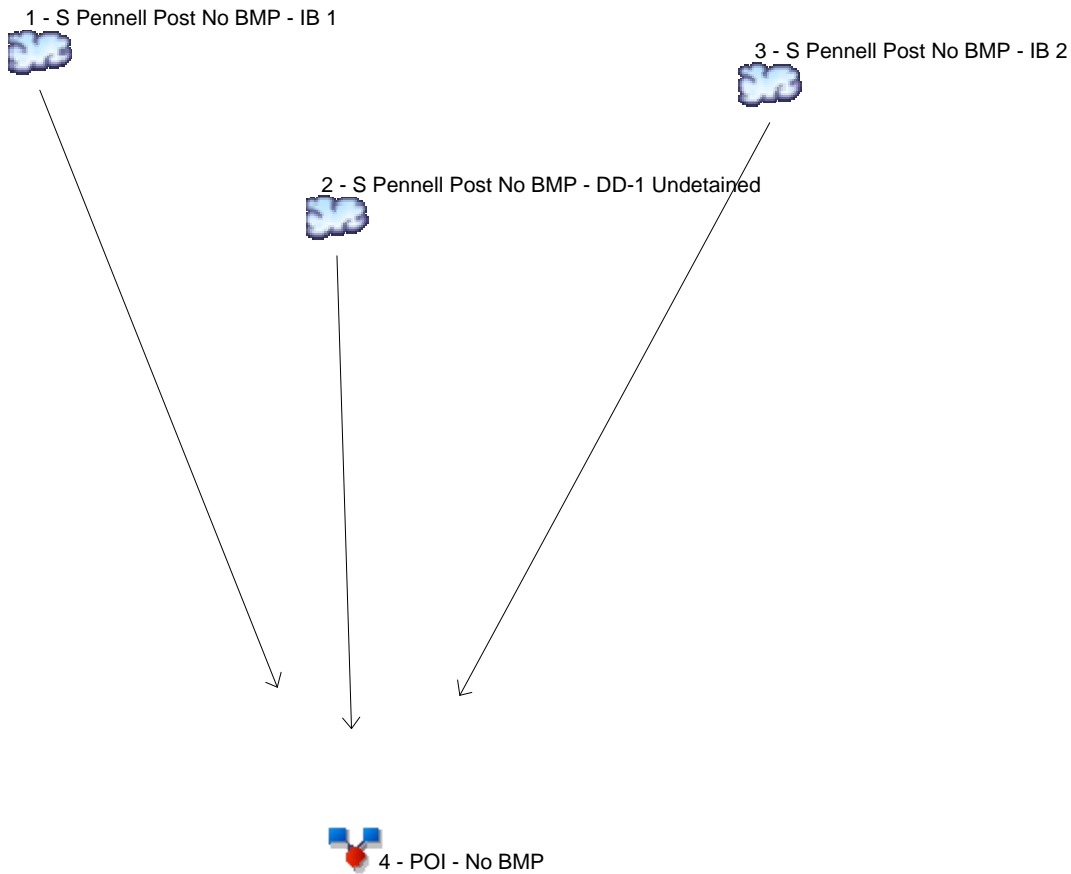
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |          |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |          |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |          |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>=</b> | <b>12.95</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.14</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| 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         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>13.10 min</b> |

# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - 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               | 0.696           | 1                   | 717                | 1,307                 | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |  |
| 2                        | SCS Runoff               | 0.204           | 1                   | 725                | 652                   | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |  |
| 3                        | SCS Runoff               | 0.127           | 1                   | 720                | 297                   | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |  |
| 4                        | Combine                  | 0.924           | 1                   | 717                | 2,256                 | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |  |
| S Pennel Post no BMP.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |  |

# Hydrograph Report

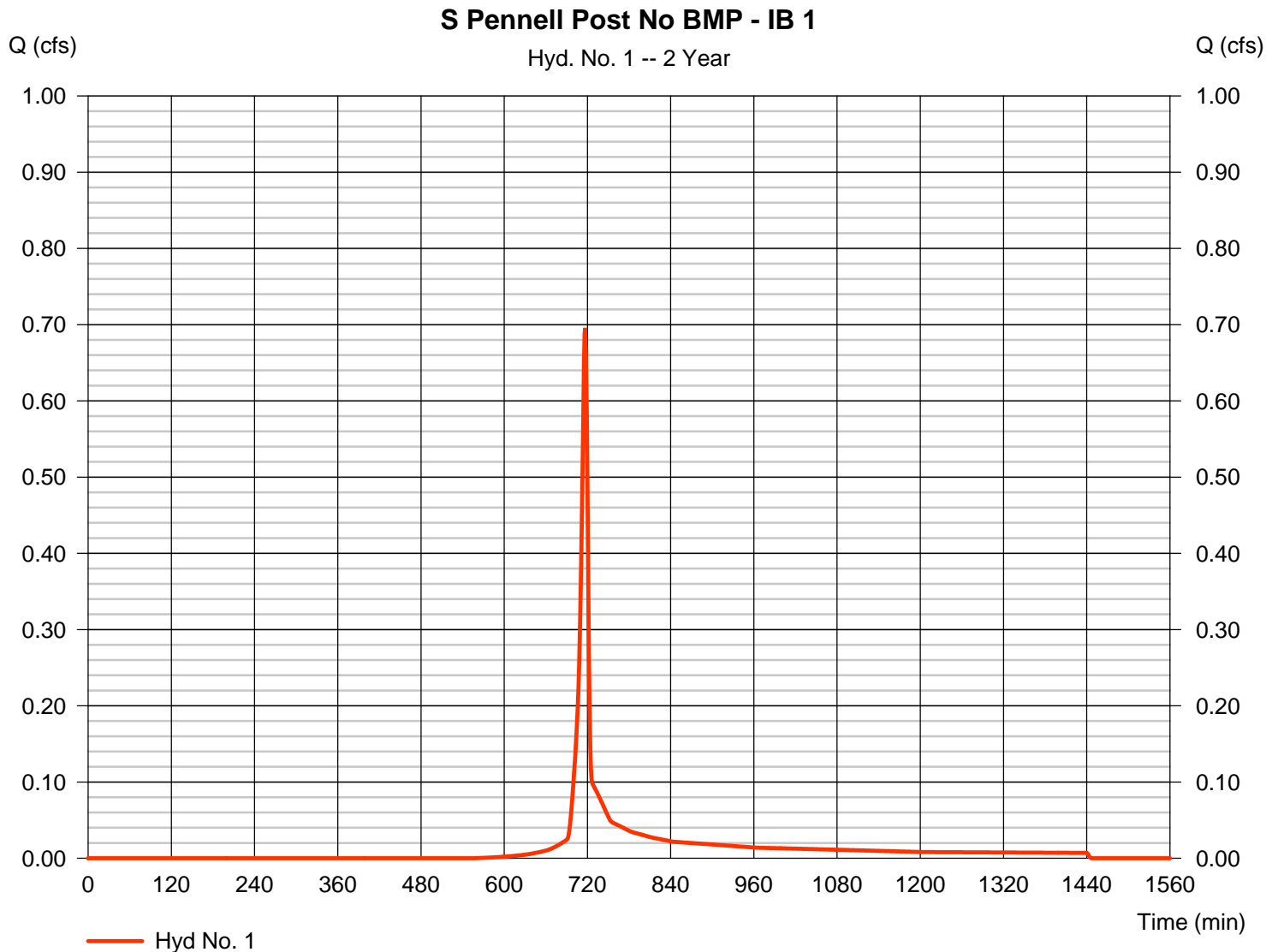
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.696 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,307 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 3.25 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 8.0         |          | 58.0        |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                 |
| Land slope (%)                     | = 7.40        |          | 50.00       |          | 5.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> | <b>0.52</b> | <b>+</b> | <b>0.54</b> | <b>=</b> | <b>4.60</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 55.00       |          | 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        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>4.80 min</b> |

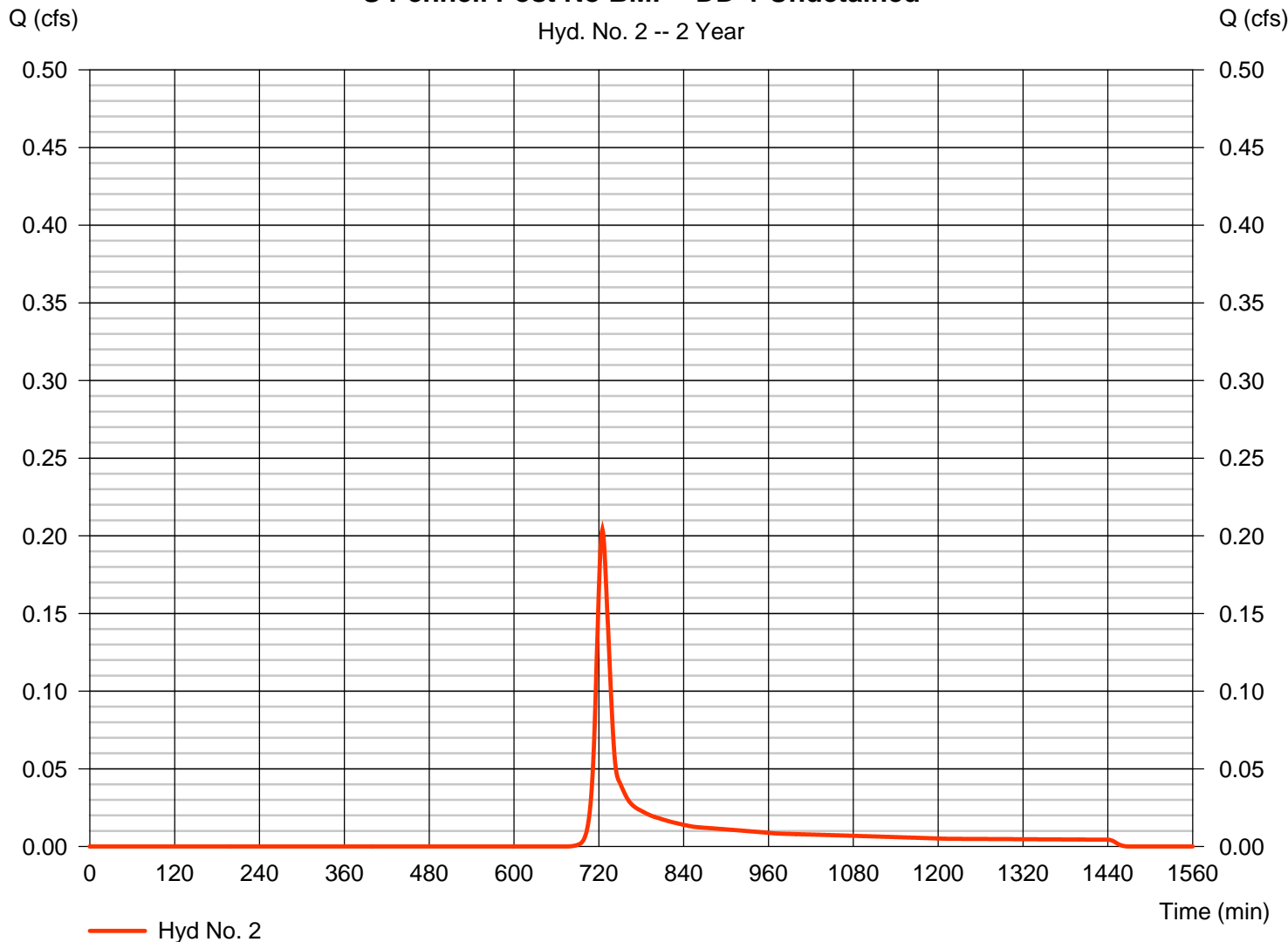
# Hydrograph Report

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.204 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 725 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 652 cuft  |
| Drainage area   | = 0.200 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min |
| Total precip.   | = 3.25 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

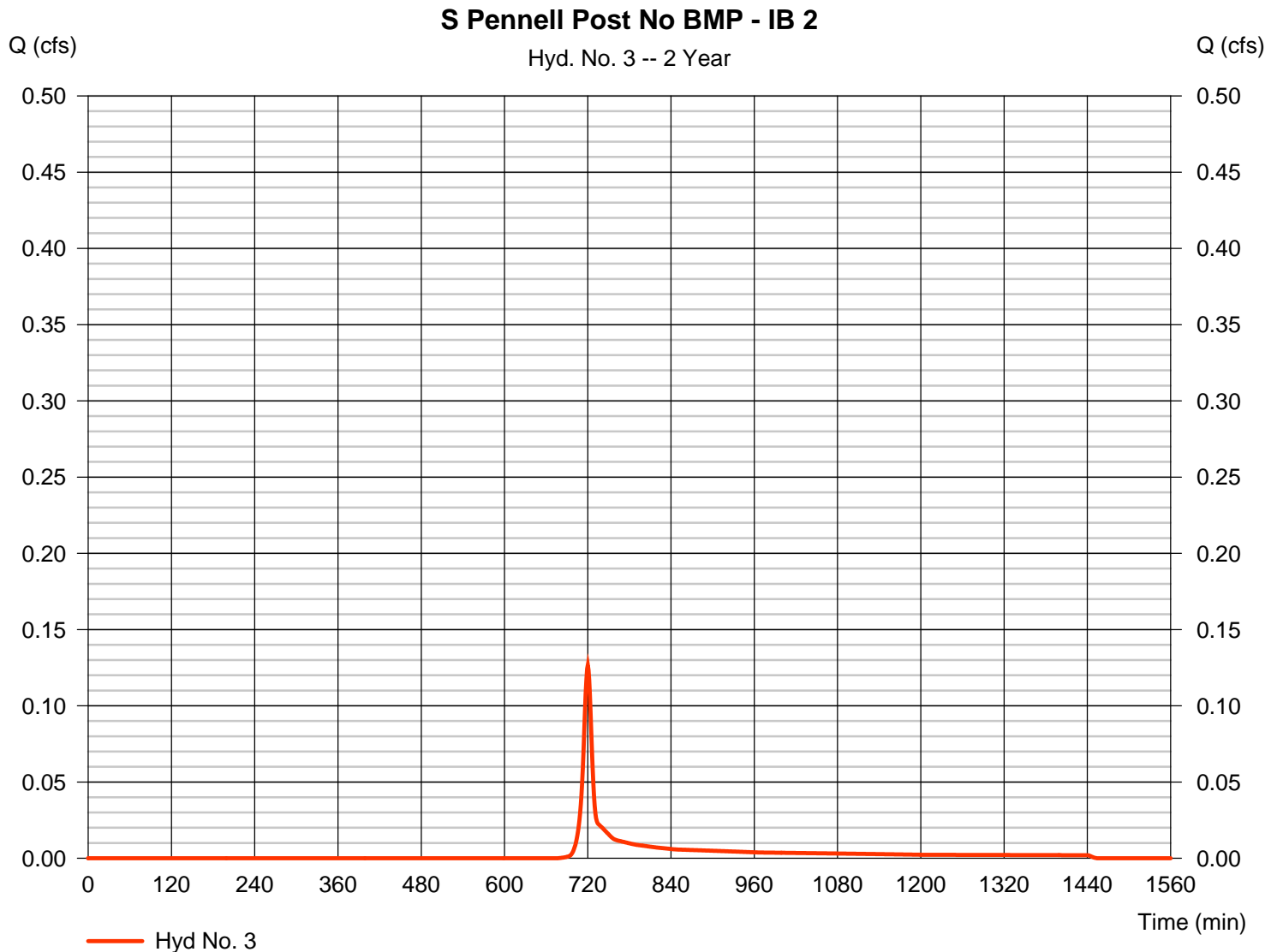
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.127 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 720 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 297 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min  |
| Total precip.   | = 3.25 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 66.0        |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 0.00        |          |                 |
| Land slope (%)                     | = 6.00        |          | 9.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> | <b>5.56</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.41</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 70.00       |          | 0.00        |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 9.00        |          | 0.00        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                 |
| Average velocity (ft/s)            | =4.84         |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.24</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc</b> ..... |               |          |             |          |             |          | <b>9.70 min</b> |

# Hydrograph Report

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

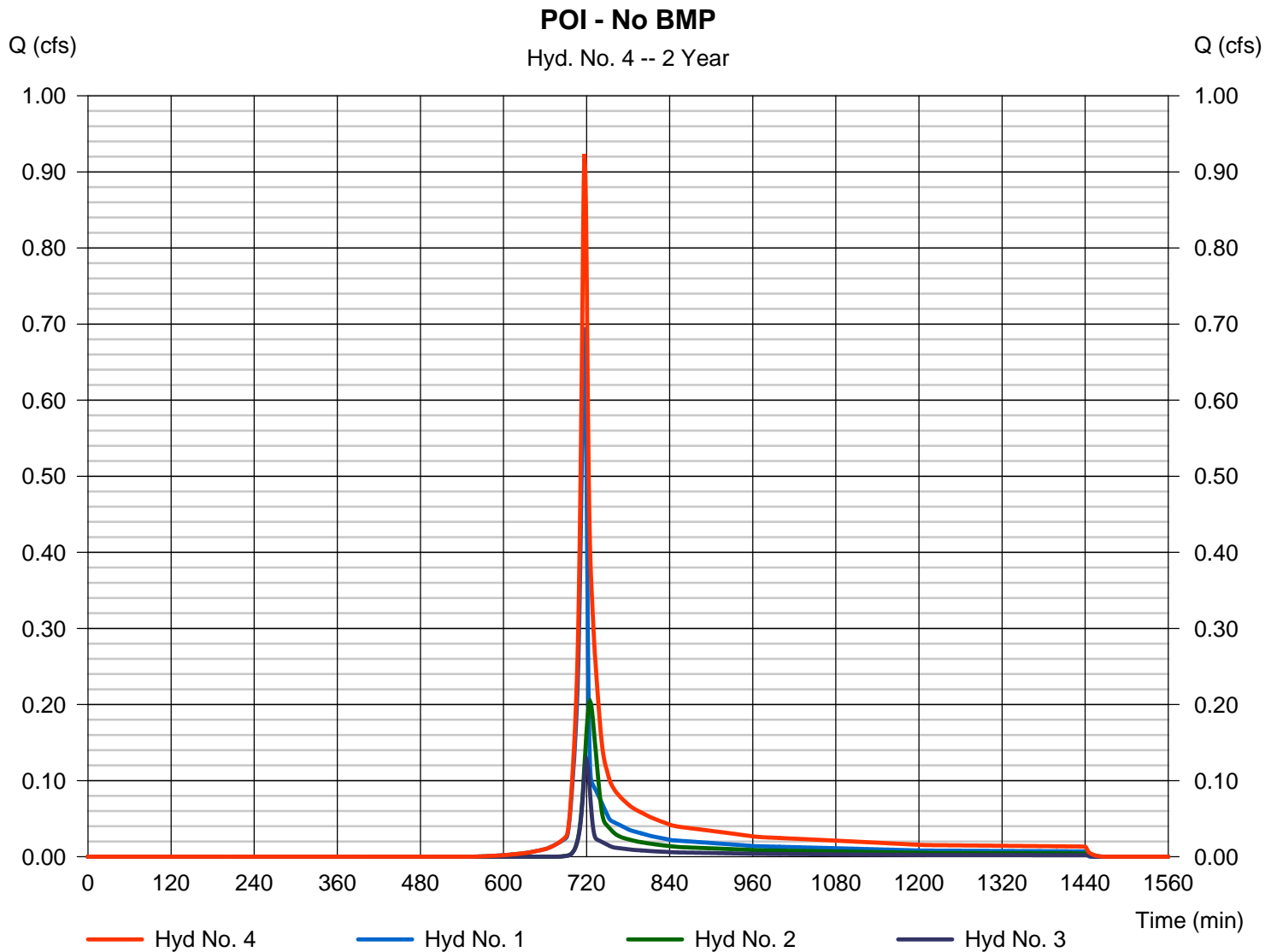
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

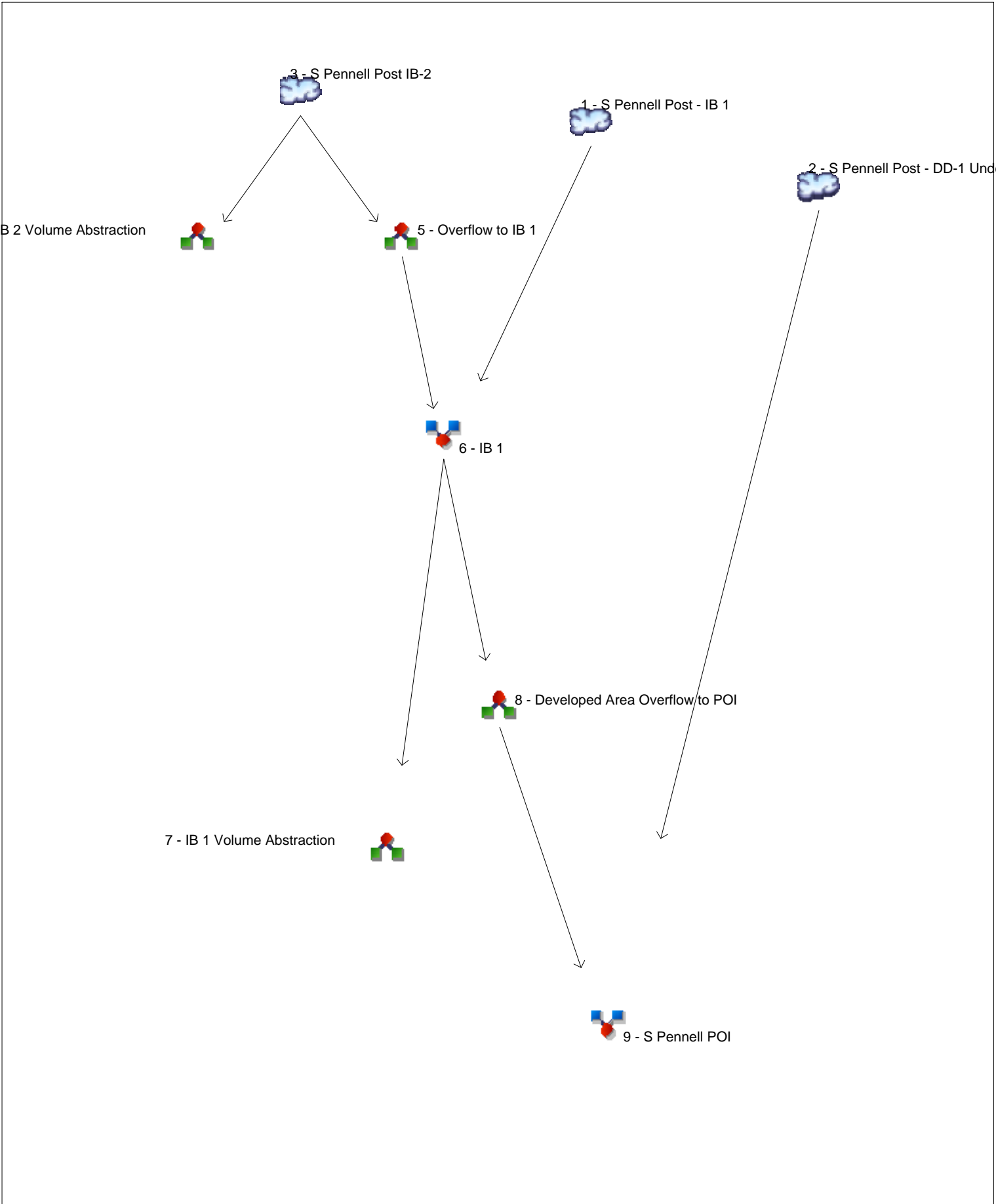
Hydrograph type = Combine  
Storm frequency = 2 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 0.924 cfs  
Time to peak = 717 min  
Hyd. volume = 2,256 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.282 | ----- | ----- | ----- | ----- | ----- | -----  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | ----- | ----- | ----- | ----- | -----  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | 0.047 | ----- | ----- | ----- | ----- | ----- | -----  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | 0.047 | ----- | ----- | ----- | ----- | ----- | -----  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | 0.001 | ----- | ----- | ----- | ----- | ----- | -----  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | 0.282 | ----- | ----- | ----- | ----- | ----- | -----  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | 0.282 | ----- | ----- | ----- | ----- | ----- | -----  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | 0.006 | ----- | ----- | ----- | ----- | ----- | -----  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | 0.204 | ----- | ----- | ----- | ----- | ----- | -----  | S Pennell POI                    |

# Hydrograph Summary Report

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

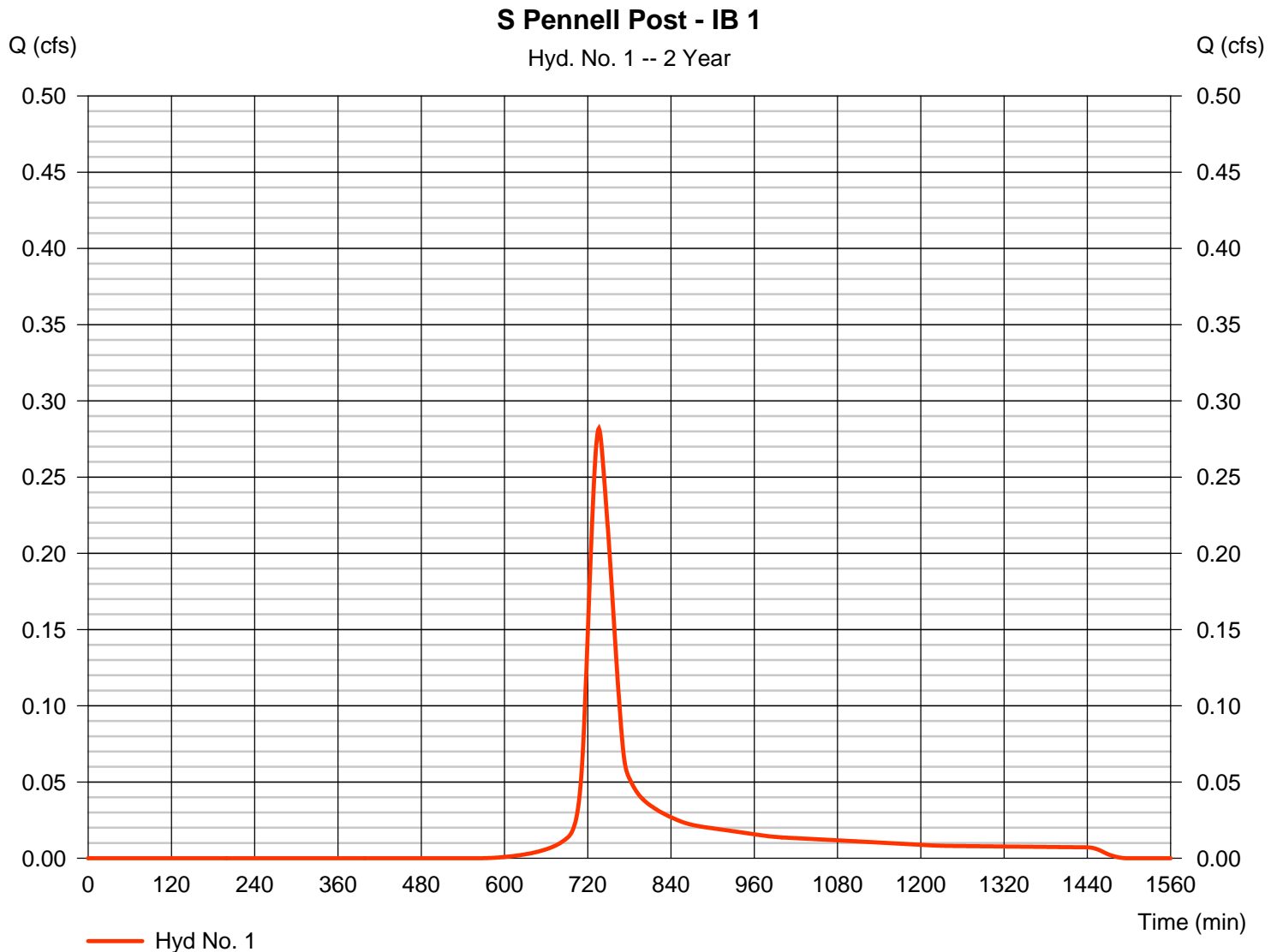
| Hyd. No.                 | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description           |
|--------------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|------------------------|--------------------------|----------------------------------|
| 1                        | SCS Runoff               | 0.282           | 1                   | 736                | 1,315                 | -----         | -----                  | -----                    | S Pennell Post - IB 1            |
| 2                        | SCS Runoff               | 0.204           | 1                   | 725                | 652                   | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |
| 3                        | SCS Runoff               | 0.047           | 1                   | 744                | 295                   | -----         | -----                  | -----                    | S Pennell Post IB-2              |
| 4                        | Diversion1               | 0.047           | 1                   | 744                | 295                   | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |
| 5                        | Diversion2               | 0.001           | 1                   | 1482               | 0                     | 3             | -----                  | -----                    | Overflow to IB 1                 |
| 6                        | Combine                  | 0.282           | 1                   | 736                | 1,315                 | 1, 5          | -----                  | -----                    | IB 1                             |
| 7                        | Diversion1               | 0.282           | 1                   | 736                | 1,307                 | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |
| 8                        | Diversion2               | 0.006           | 1                   | 1450               | 8                     | 6             | -----                  | -----                    | Developed Area Overflow to POI   |
| 9                        | Combine                  | 0.204           | 1                   | 725                | 660                   | 2, 8          | -----                  | -----                    | S Pennell POI                    |
| S Pennel Post - 2 yr.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.282 cfs  |
| Storm frequency | = 2 yrs      | Time to peak       | = 736 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,315 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 35.90 min  |
| Total precip.   | = 3.25 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



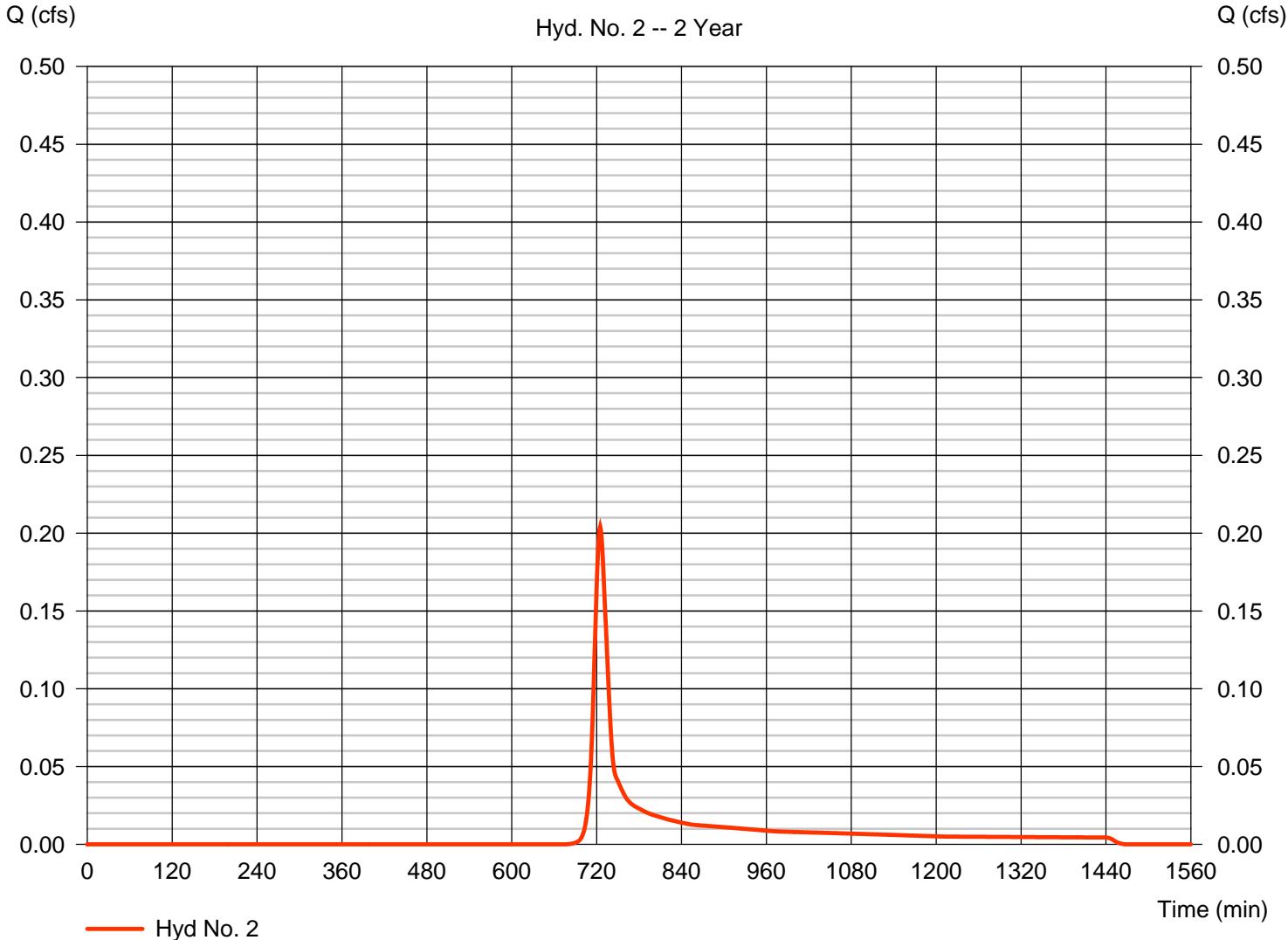
# Hydrograph Report

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.204 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 725 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 652 cuft  |
| Drainage area   | = 0.200 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min |
| Total precip.   | = 3.25 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

S Pennell Post - DD-1 Undetained



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | 35.0           | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

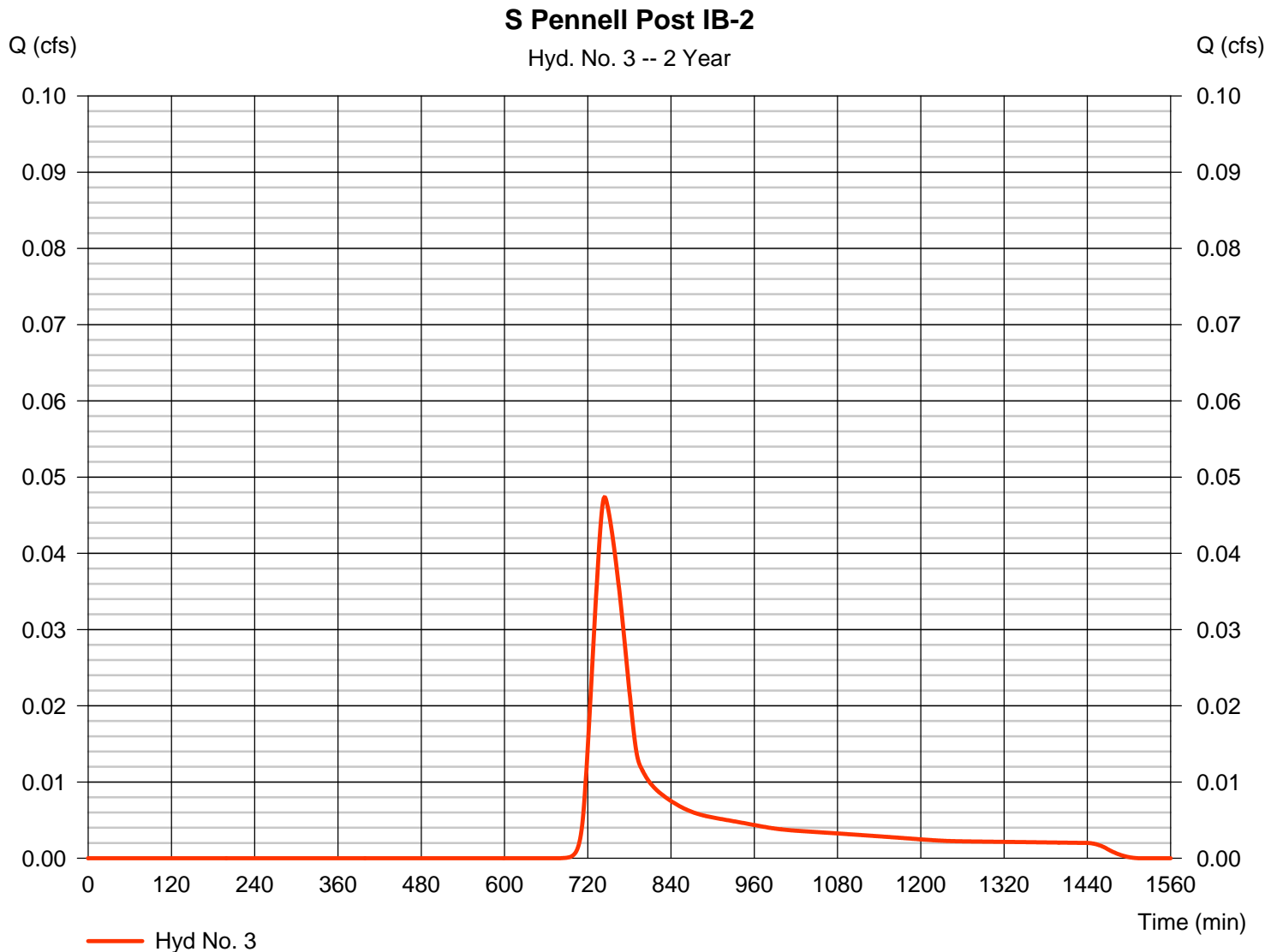
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.047 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 744 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 295 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 47.80 min |
| Total precip.   | = 3.25 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |



# Hydrograph Report

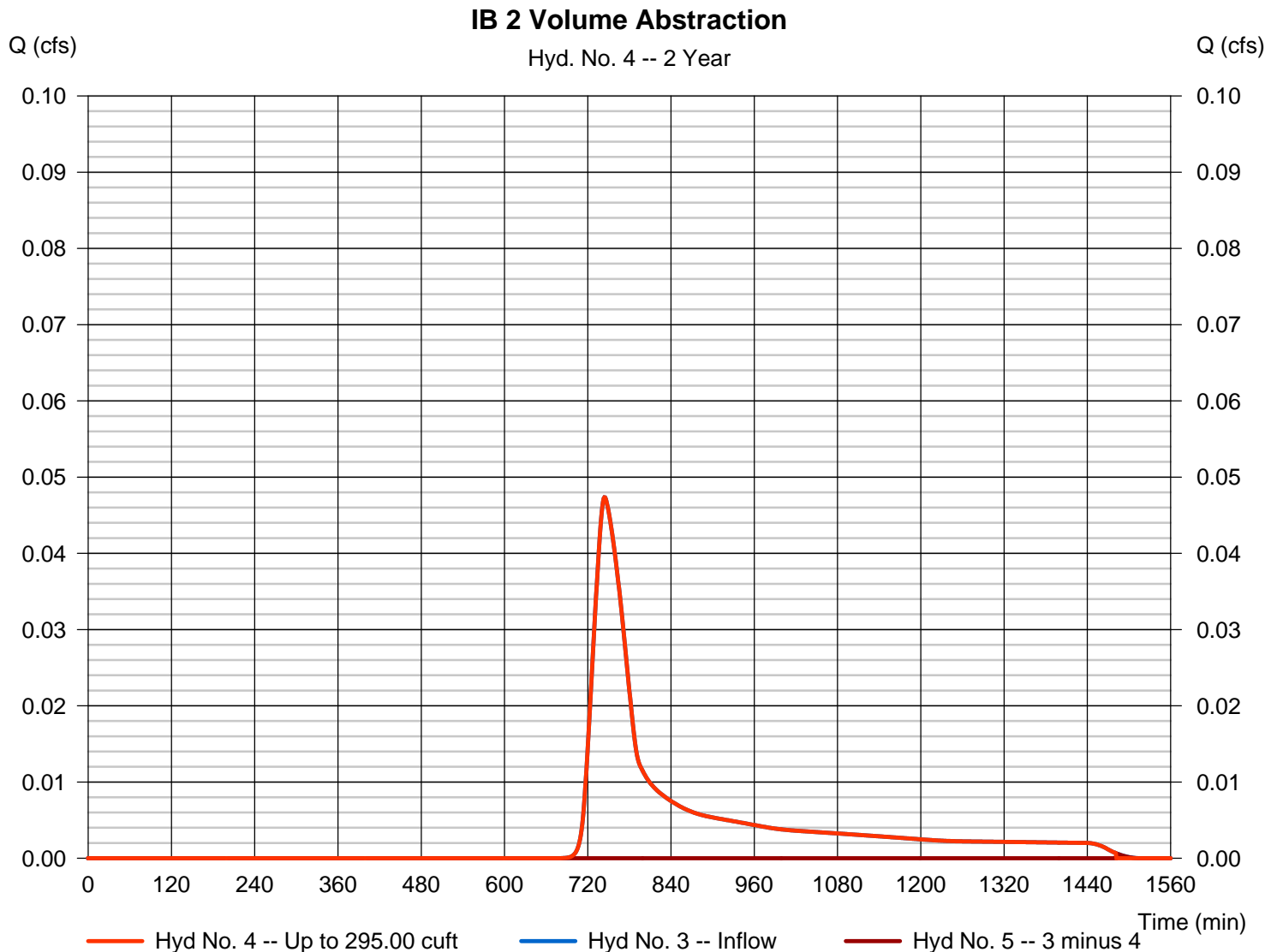
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Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.047 cfs   |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 744 min     |
| Time interval     | = 1 min                   | Hyd. volume       | = 295 cuft    |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 295.00 cuft |



# Hydrograph Report

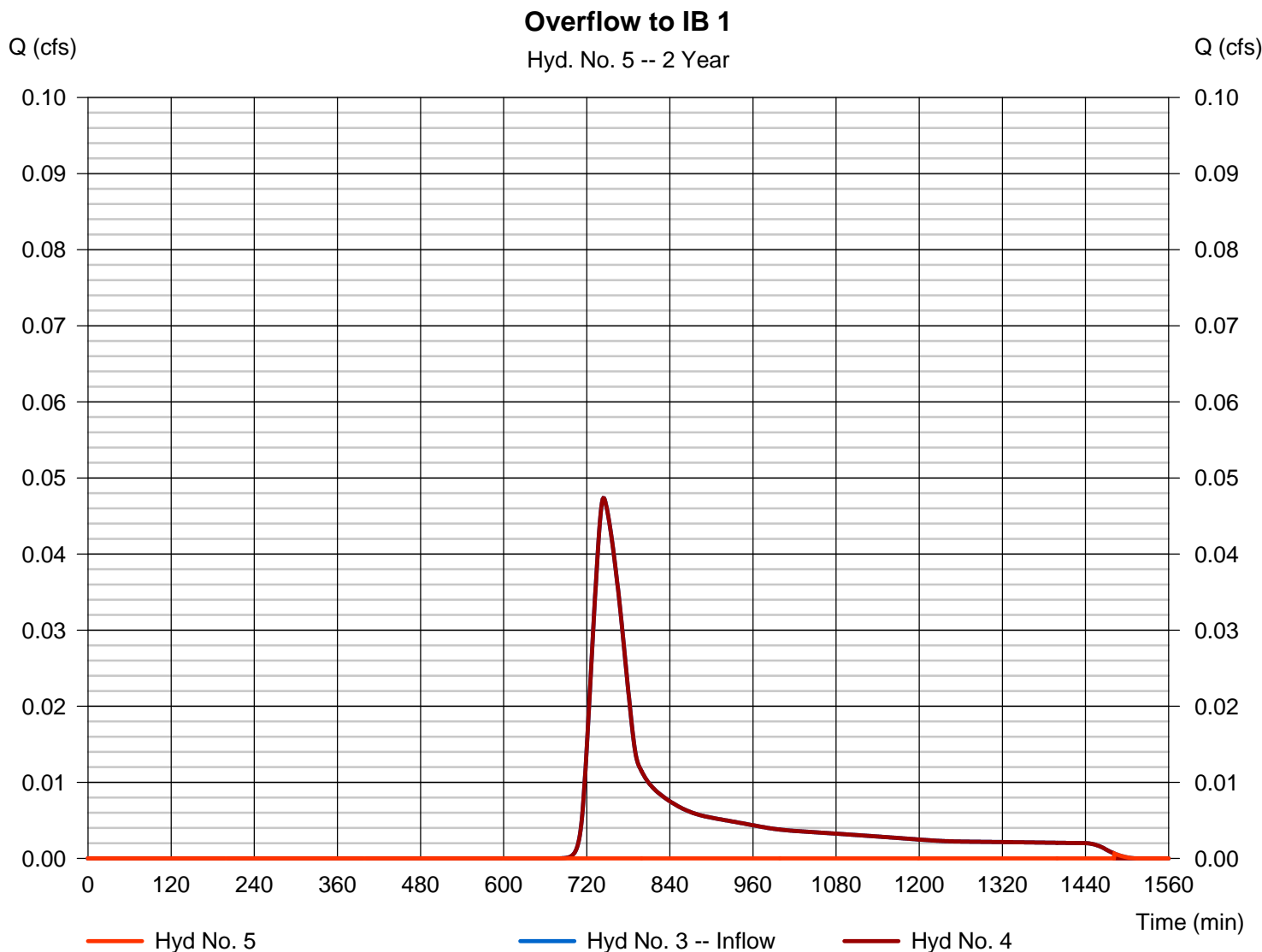
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## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.001 cfs   |
| Storm frequency   | = 2 yrs                   | Time to peak      | = 1482 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 0 cuft      |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 295.00 cuft |



# Hydrograph Report

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

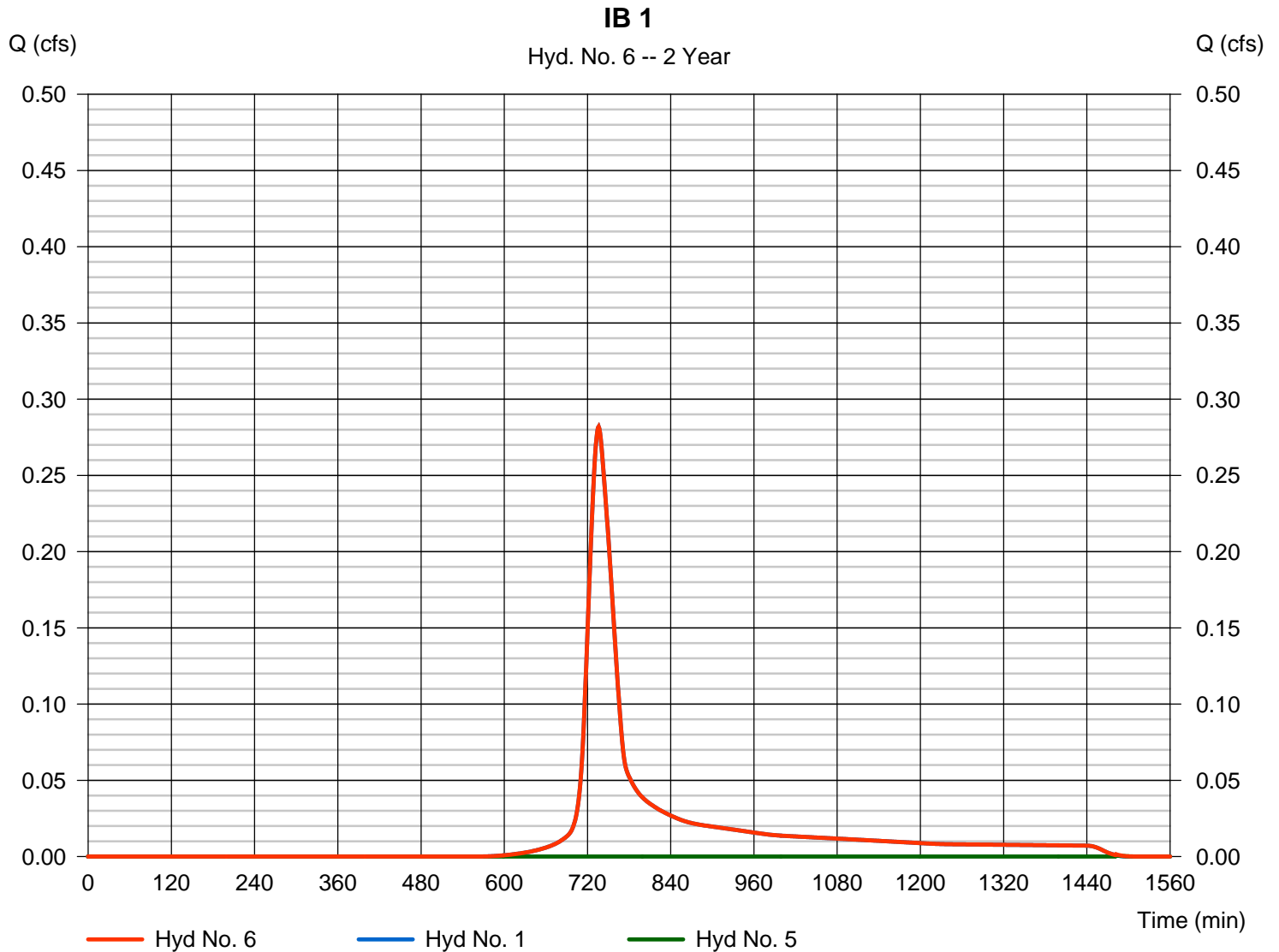
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

IB 1

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

Peak discharge = 0.282 cfs  
Time to peak = 736 min  
Hyd. volume = 1,315 cuft  
Contrib. drain. area = 0.250 ac

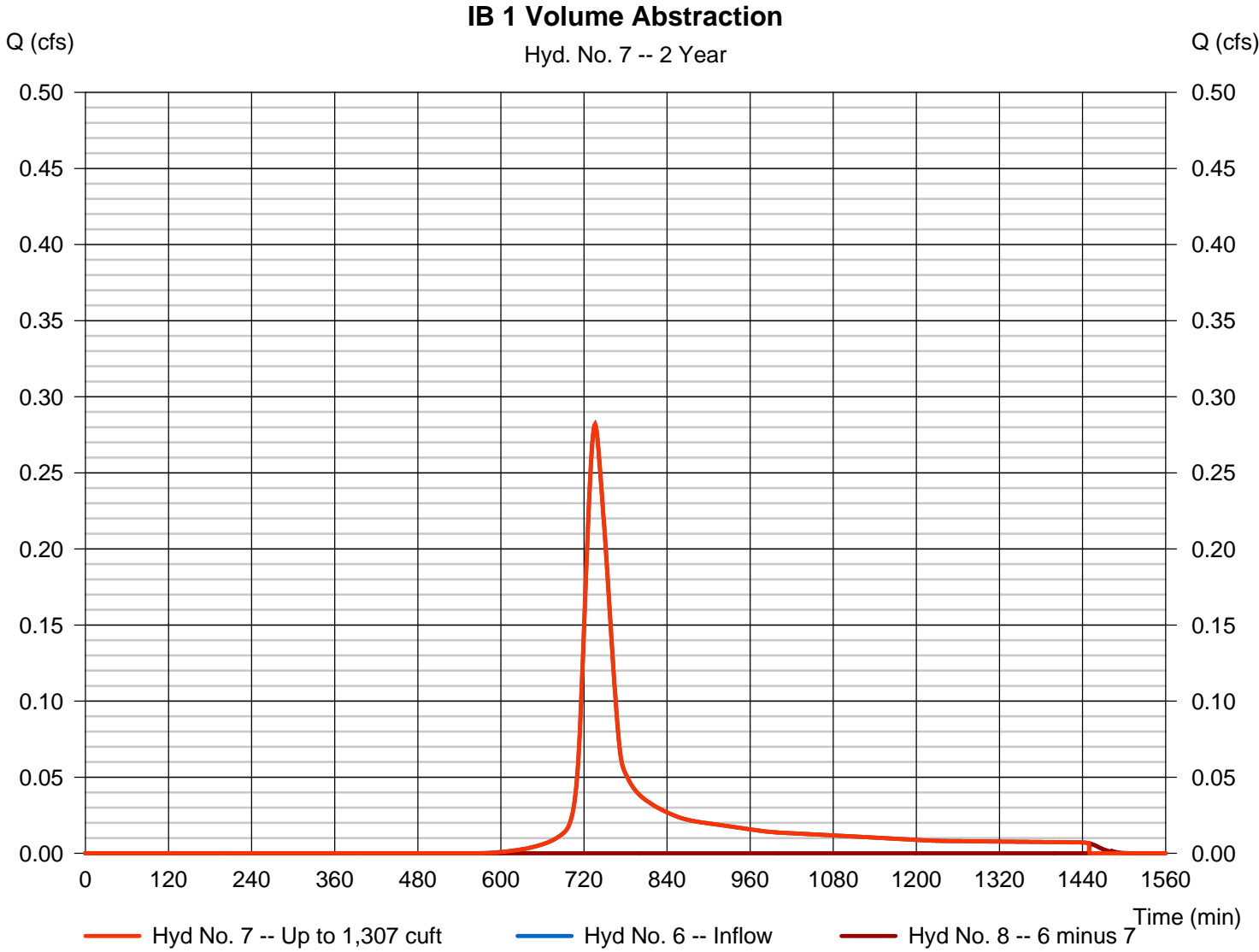


# Hydrograph Report

## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.282 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 736 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,307 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,307 cuft |



# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

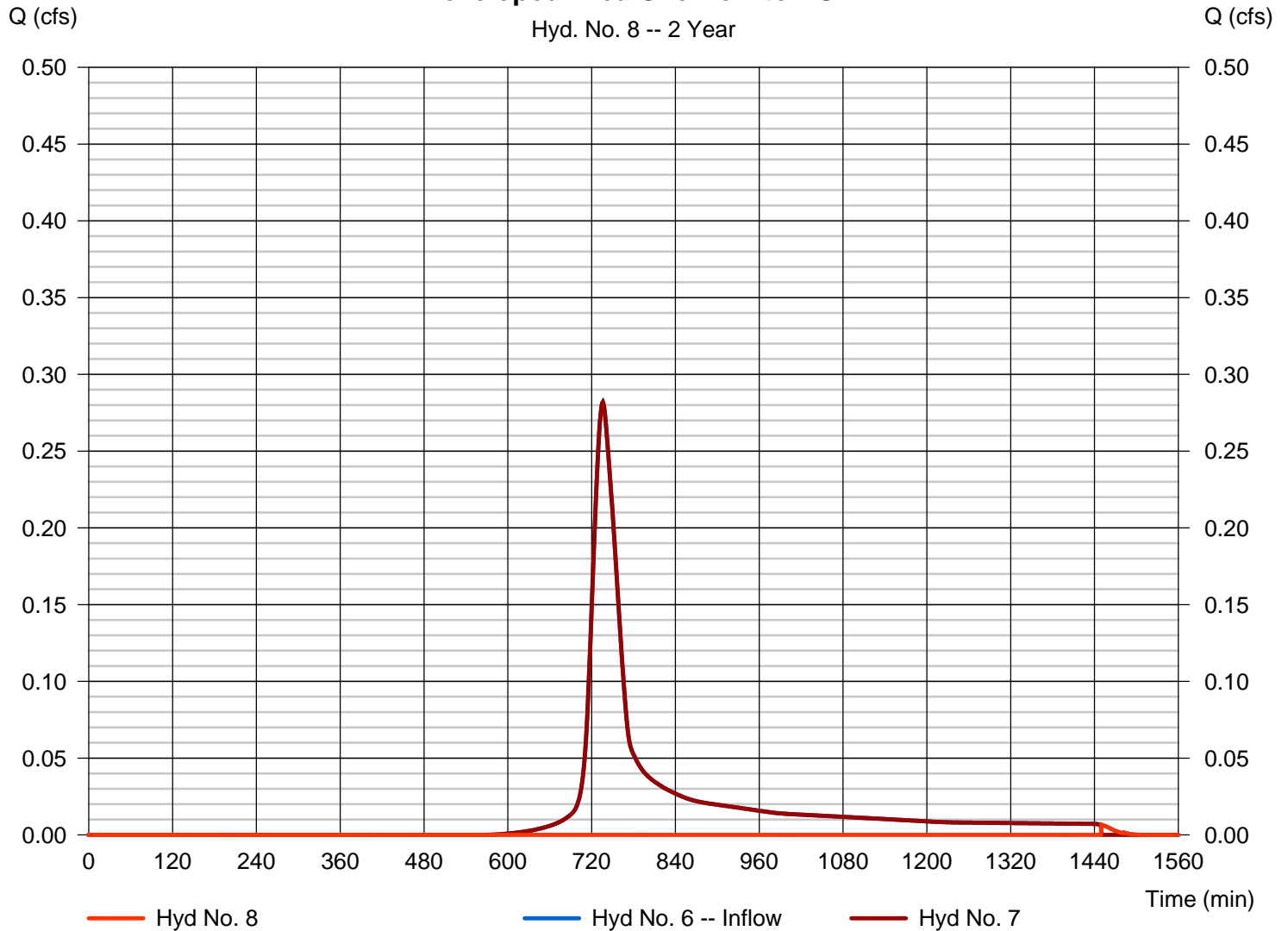
## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.006 cfs  |
| Storm frequency   | = 2 yrs              | Time to peak      | = 1450 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 8 cuft     |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,307 cuft |

### Developed Area Overflow to POI

Hyd. No. 8 -- 2 Year



# Hydrograph Report

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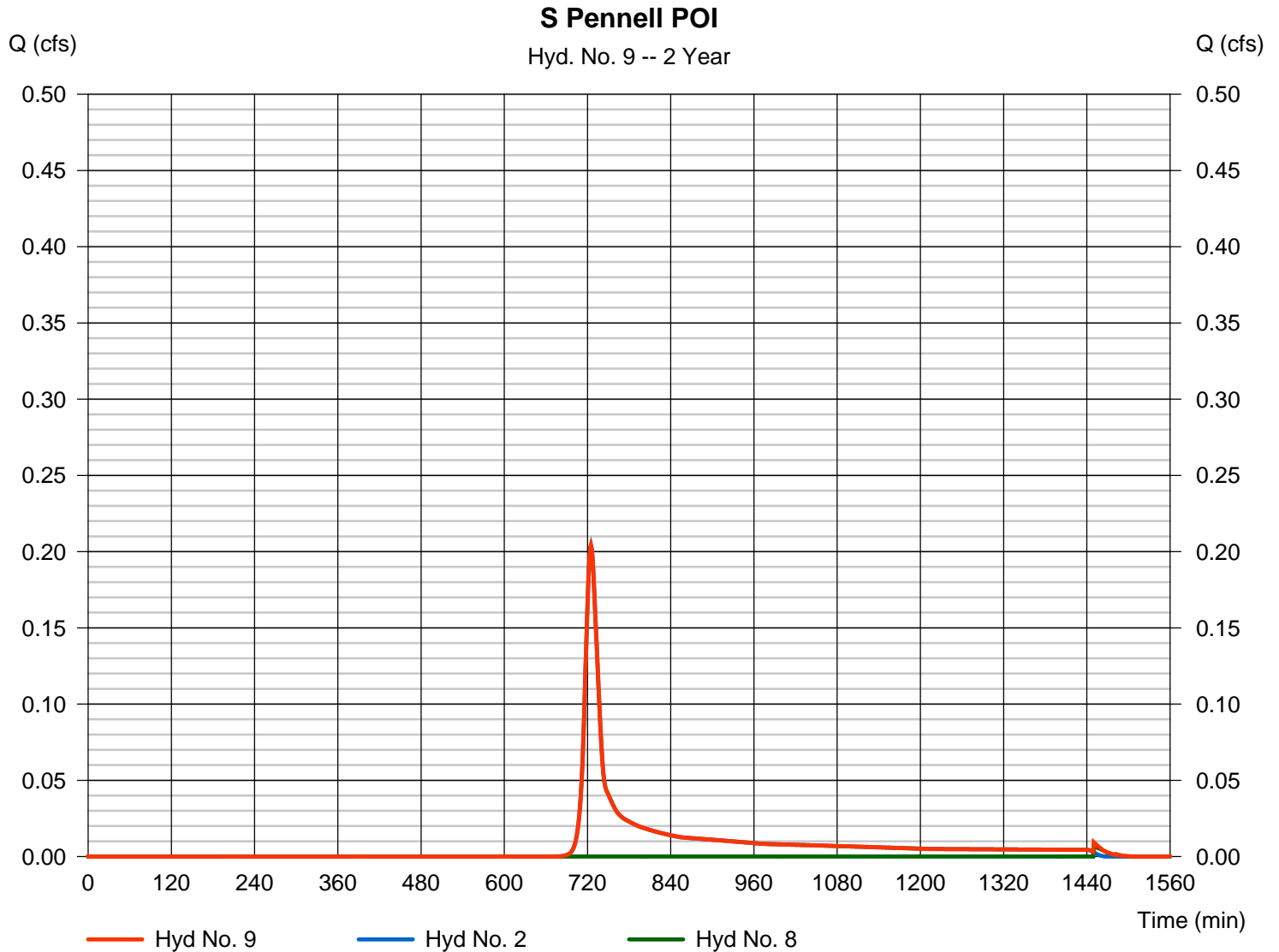
Wednesday, 11 / 9 / 2016

## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 2 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 0.204 cfs  
Time to peak = 725 min  
Hyd. volume = 660 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT C-2**  
**S PENNELL RD**  
**5 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area



# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# 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               | 0.881           | 1                   | 725                | 2,707                 | -----         | -----                  | -----                    | S Pennell Pre - Full Area      |
| 2                 | SCS Runoff               | 0.656           | 1                   | 722                | 1,697                 | -----         | -----                  | -----                    | S Pennell Pre - Developed Area |
| S Pennell Pre.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                |

# Hydrograph Report

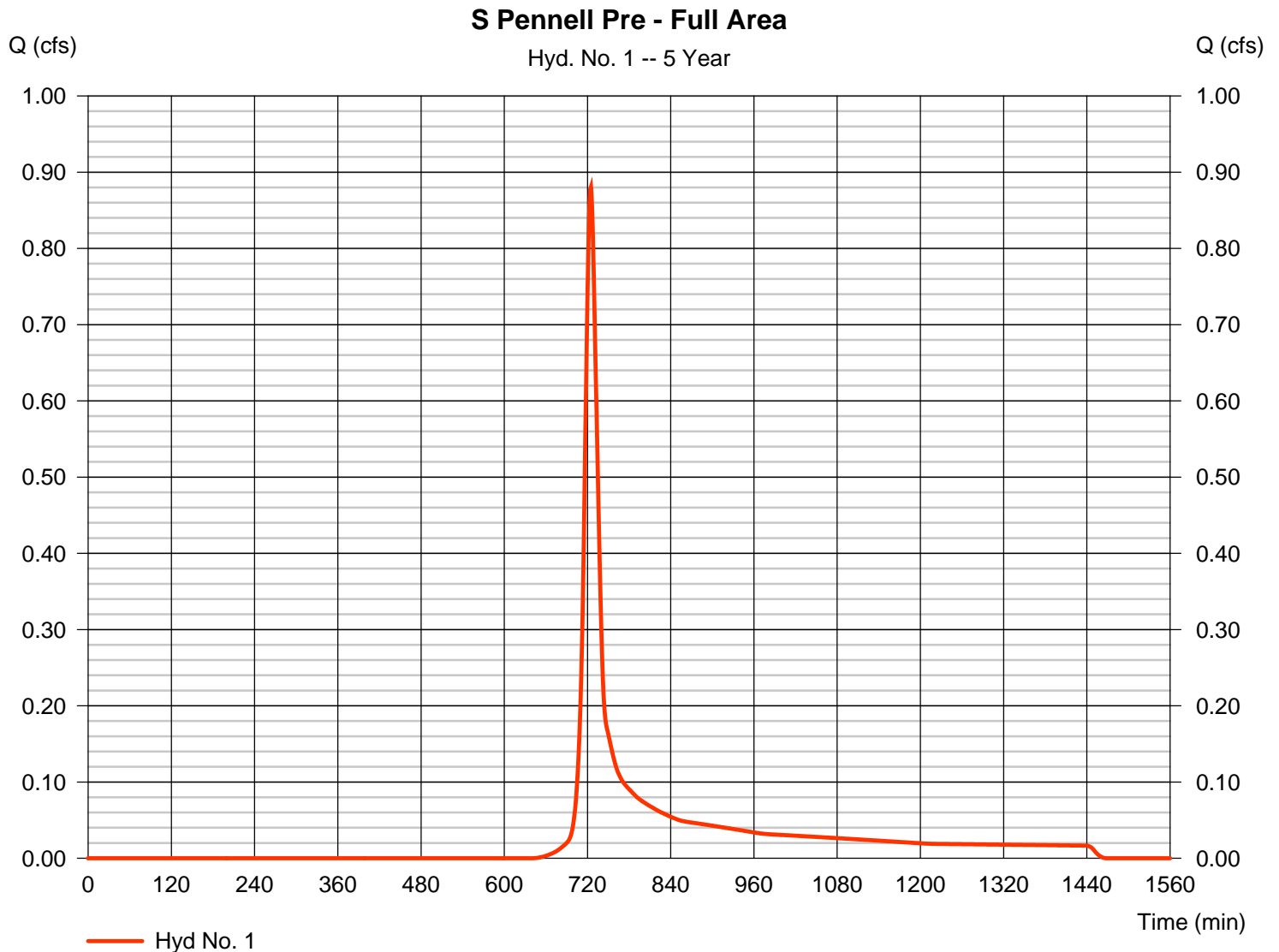
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Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.881 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,707 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.10 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

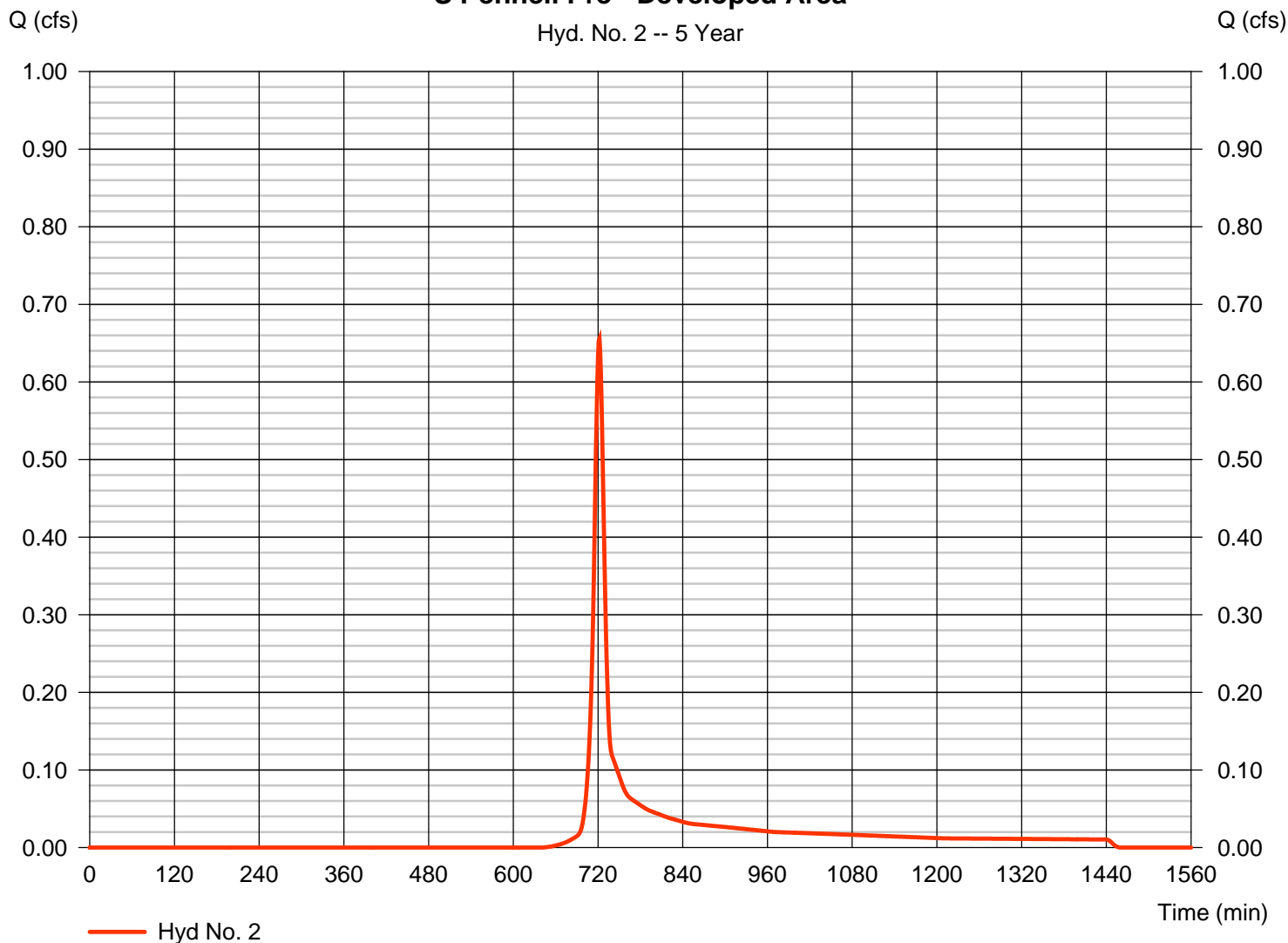
## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.656 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 722 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,697 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 4.10 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

### S Pennell Pre - Developed Area

Hyd. No. 2 -- 5 Year



# TR55 Tc Worksheet

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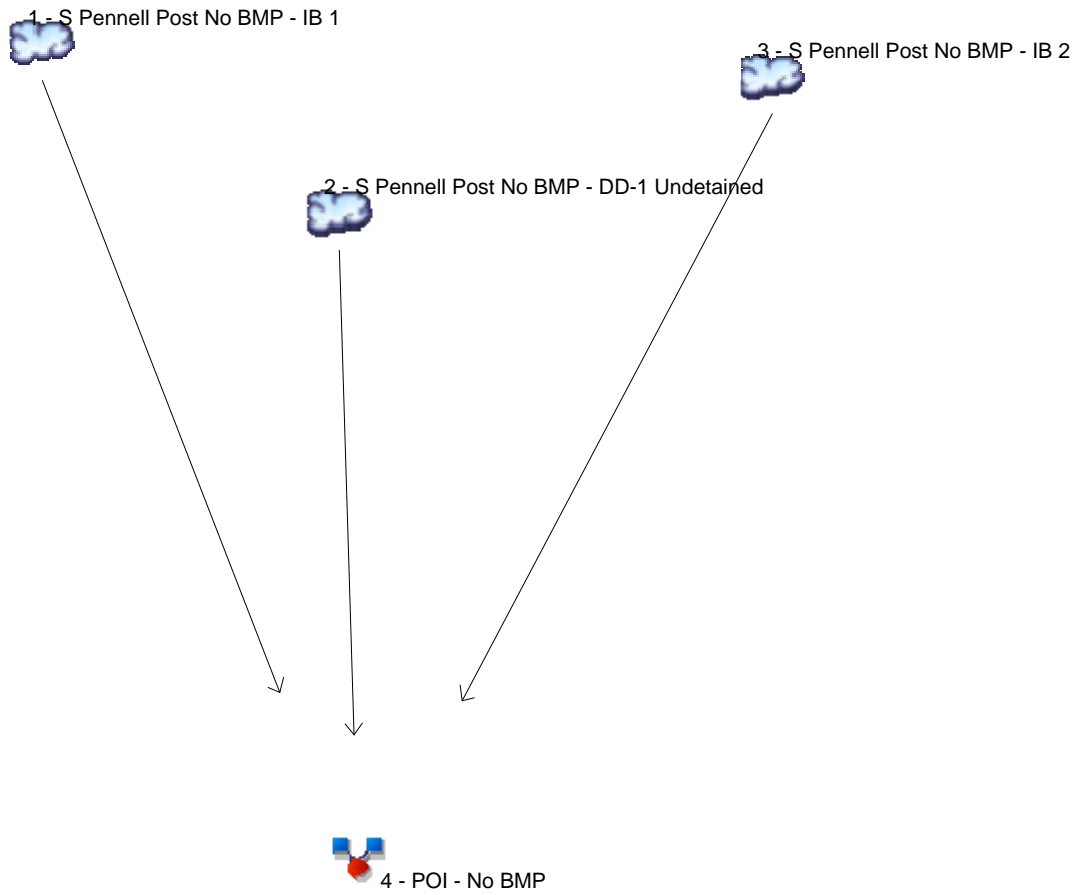
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |          |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |          |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |          |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>=</b> | <b>12.95</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.14</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| 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         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>13.10 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - No BMP                       |

# Hydrograph Summary Report

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

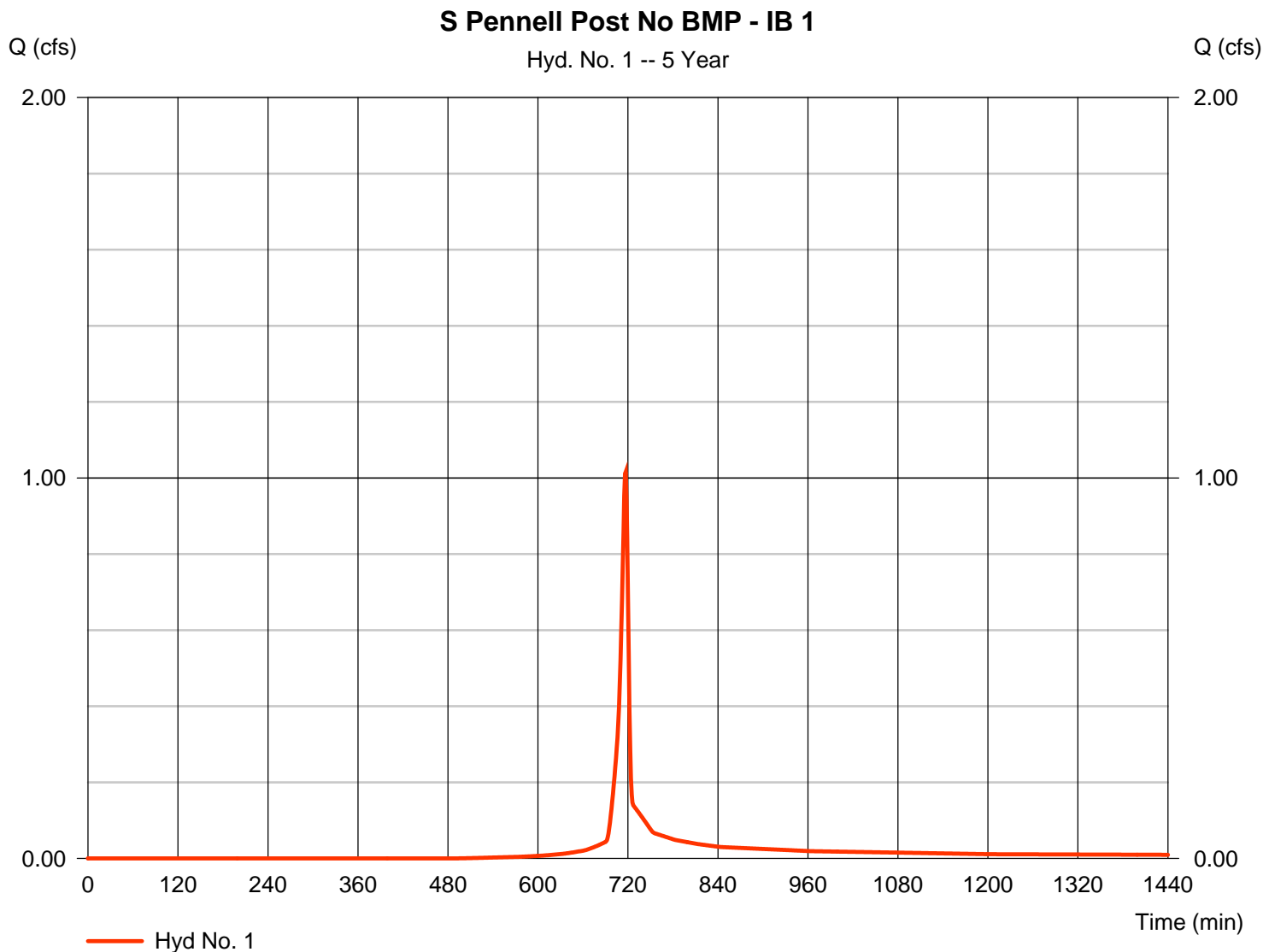
| Hyd. No.                 | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)    | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description             |  |
|--------------------------|--------------------------|-----------------|---------------------|--------------------|-----------------------|---------------|------------------------|--------------------------|------------------------------------|--|
| 1                        | SCS Runoff               | 1.016           | 1                   | 717                | 1,928                 | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |  |
| 2                        | SCS Runoff               | 0.344           | 1                   | 725                | 1,050                 | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |  |
| 3                        | SCS Runoff               | 0.210           | 1                   | 720                | 478                   | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |  |
| 4                        | Combine                  | 1.422           | 1                   | 717                | 3,456                 | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |  |
| S Pennel Post no BMP.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |  |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.016 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,928 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 4.10 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 8.0         |          | 58.0        |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                 |
| Land slope (%)                     | = 7.40        |          | 50.00       |          | 5.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> | <b>0.52</b> | <b>+</b> | <b>0.54</b> | <b>=</b> | <b>4.60</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 55.00       |          | 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        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>4.80 min</b> |

# Hydrograph Report

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

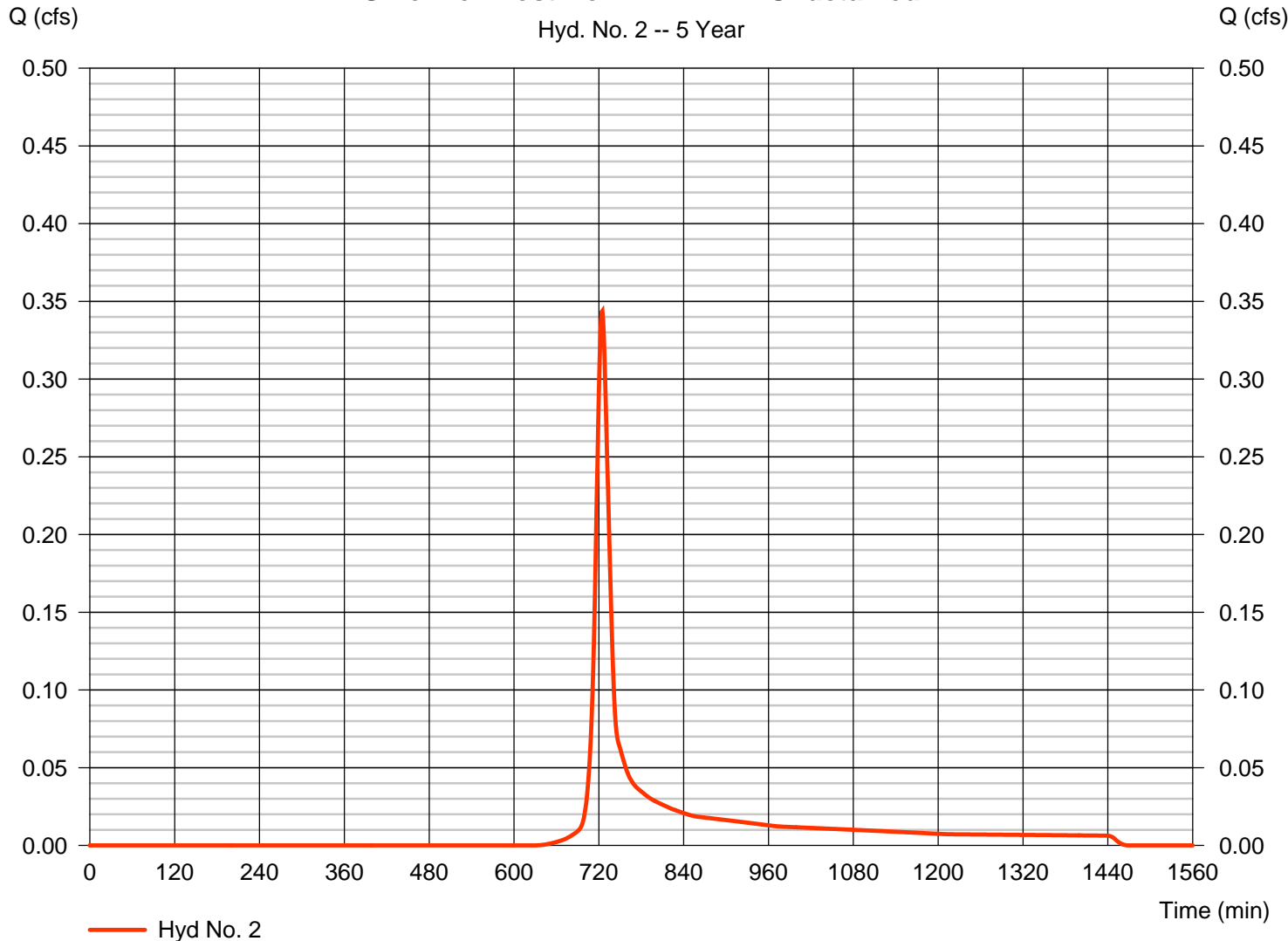
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.344 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,050 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.10 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

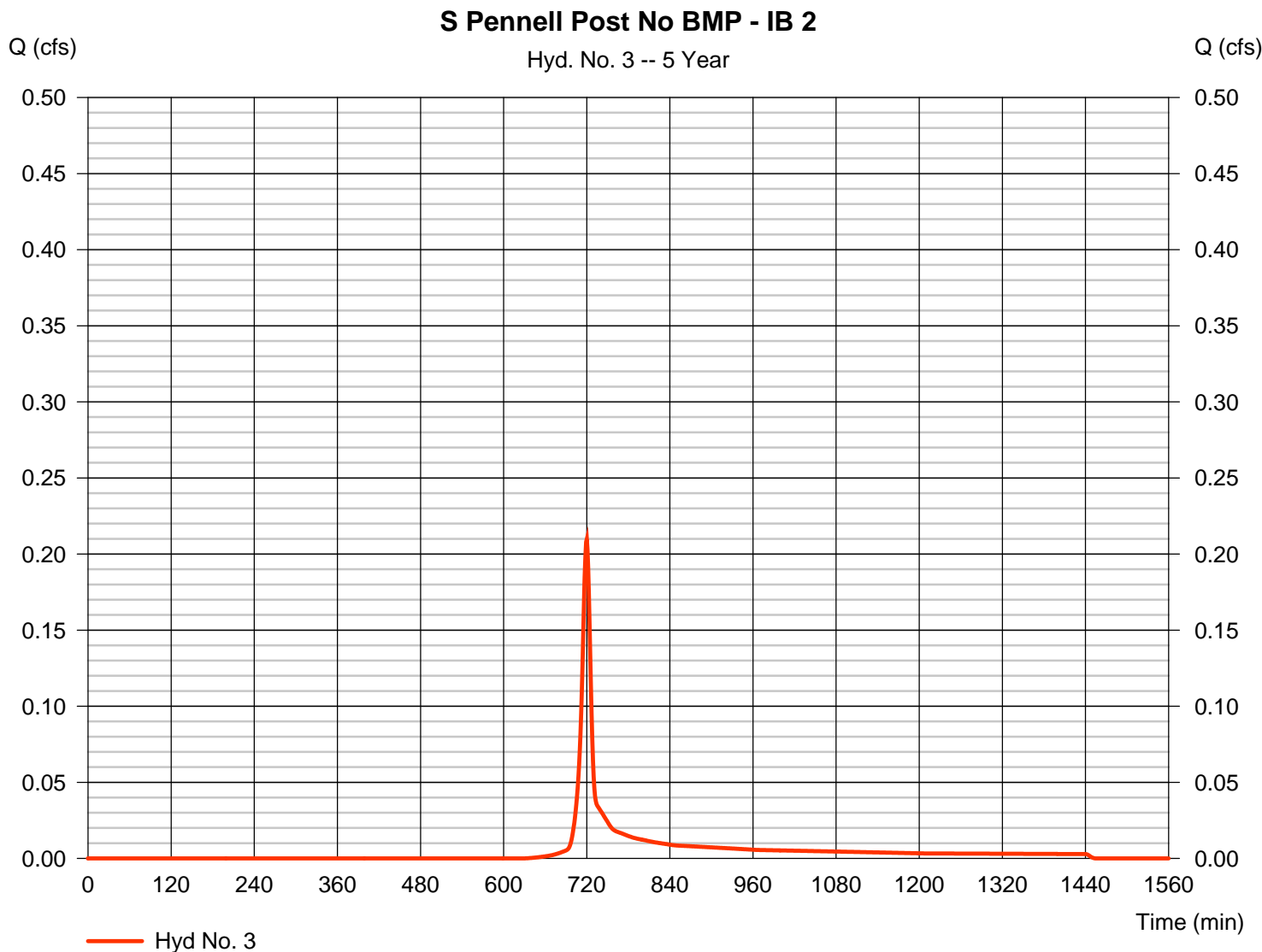
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.210 cfs |
| Storm frequency | = 5 yrs      | Time to peak       | = 720 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 478 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min  |
| Total precip.   | = 4.10 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 66.0        |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 0.00        |          |                 |
| Land slope (%)                     | = 6.00        |          | 9.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> | <b>5.56</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.41</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 70.00       |          | 0.00        |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 9.00        |          | 0.00        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                 |
| Average velocity (ft/s)            | =4.84         |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.24</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>9.70 min</b> |

# Hydrograph Report

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

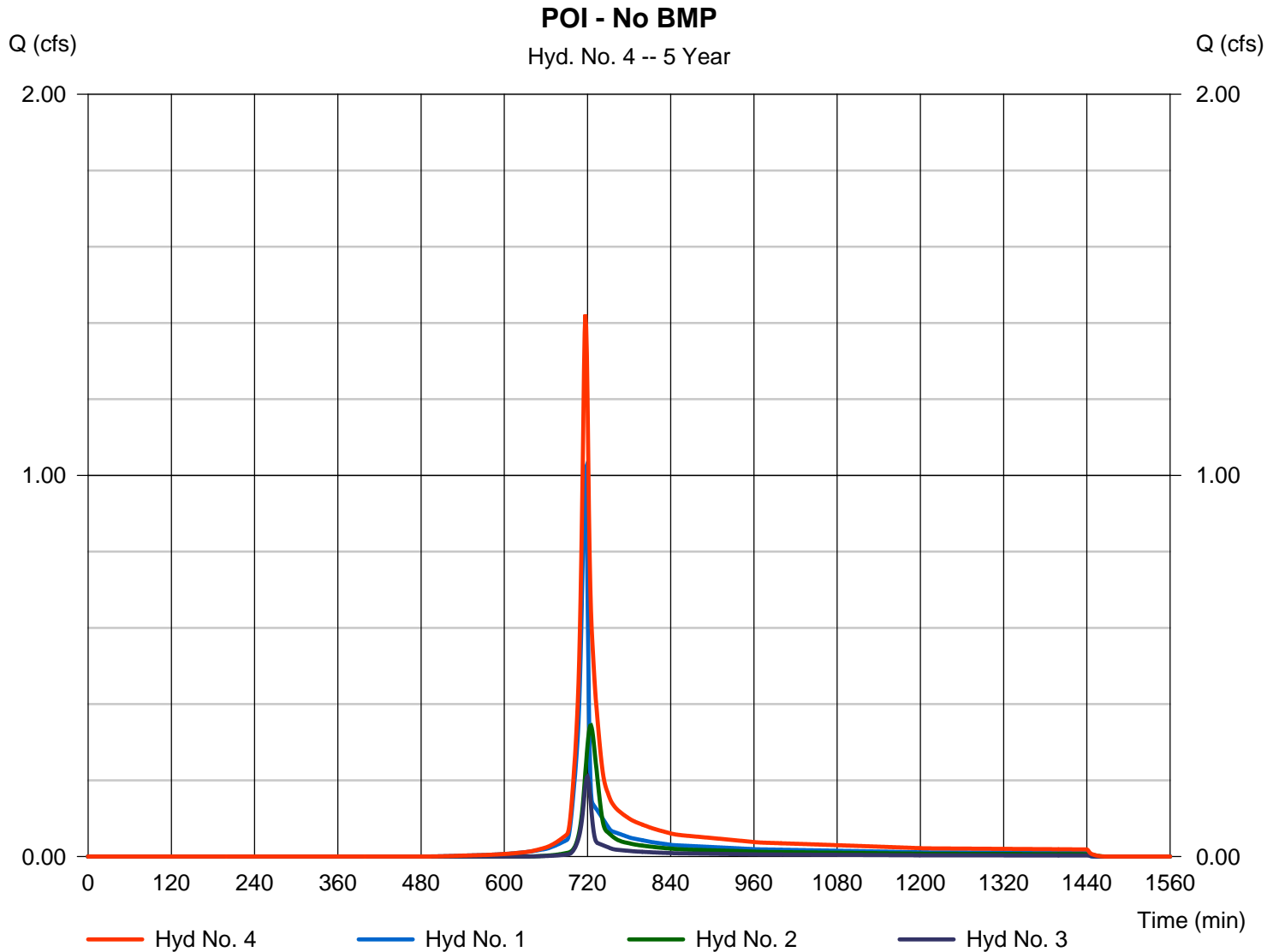
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

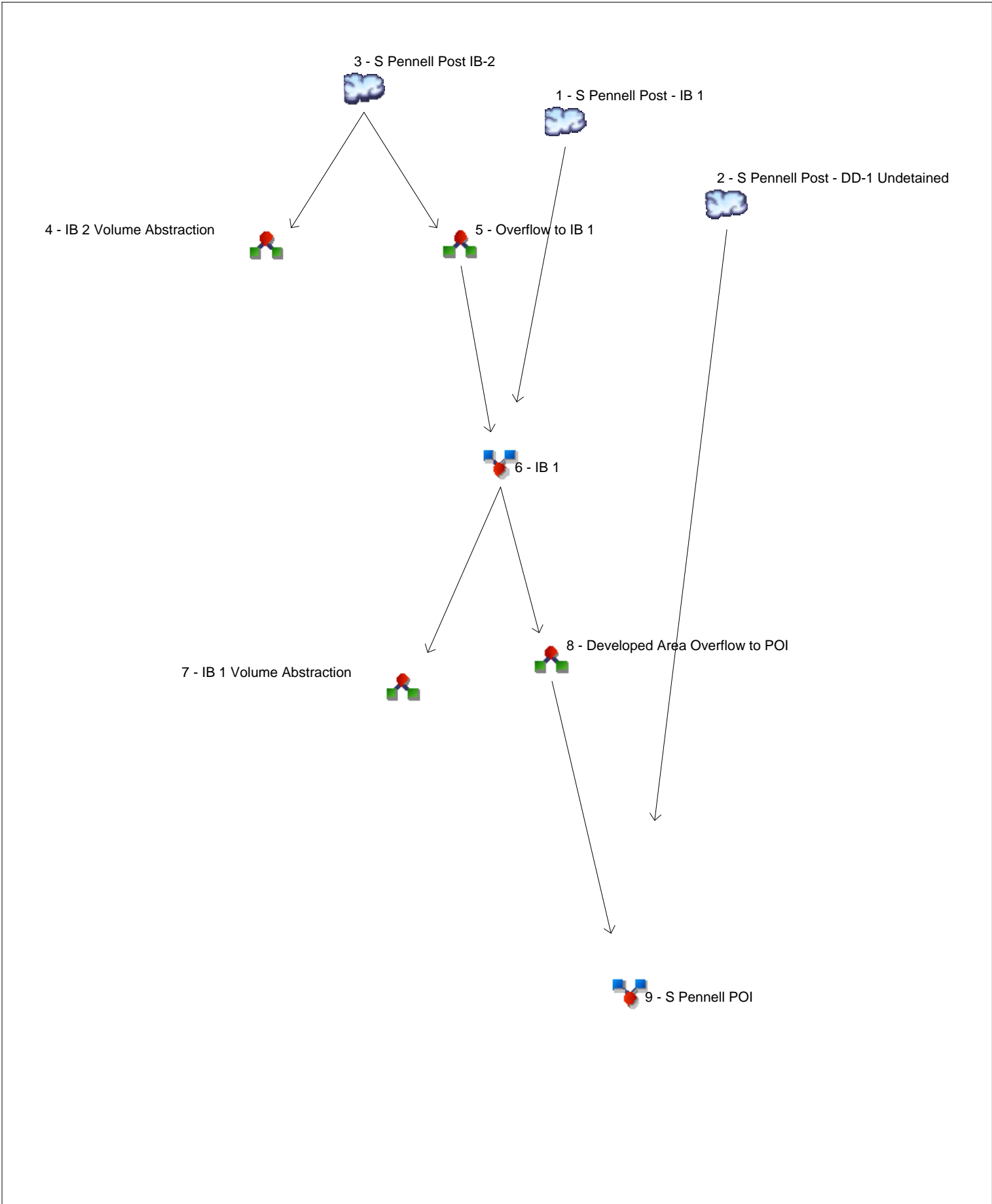
Hydrograph type = Combine  
Storm frequency = 5 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 1.422 cfs  
Time to peak = 717 min  
Hyd. volume = 3,456 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | 0.434 | ----- | ----- | ----- | -----  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | 0.344 | ----- | ----- | ----- | -----  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | 0.082 | ----- | ----- | ----- | -----  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | 0.082 | ----- | ----- | ----- | -----  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | 0.001 | ----- | ----- | ----- | -----  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | ----- | ----- | 0.434 | ----- | ----- | ----- | -----  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | ----- | ----- | 0.434 | ----- | ----- | ----- | -----  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | ----- | ----- | 0.002 | ----- | ----- | ----- | -----  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | ----- | ----- | 0.344 | ----- | ----- | ----- | -----  | S Pennell 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               | 0.434           | 1                   | 735                | 1,928                 | -----         | -----                  | -----                    | S Pennell Post - IB 1            |
| 2                        | SCS Runoff               | 0.344           | 1                   | 725                | 1,050                 | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |
| 3                        | SCS Runoff               | 0.082           | 1                   | 744                | 476                   | -----         | -----                  | -----                    | S Pennell Post IB-2              |
| 4                        | Diversion1               | 0.082           | 1                   | 744                | 475                   | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |
| 5                        | Diversion2               | 0.001           | 1                   | 1479               | 1                     | 3             | -----                  | -----                    | Overflow to IB 1                 |
| 6                        | Combine                  | 0.434           | 1                   | 735                | 1,929                 | 1, 5          | -----                  | -----                    | IB 1                             |
| 7                        | Diversion1               | 0.434           | 1                   | 735                | 1,928                 | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |
| 8                        | Diversion2               | 0.002           | 1                   | 1483               | 1                     | 6             | -----                  | -----                    | Developed Area Overflow to POI   |
| 9                        | Combine                  | 0.344           | 1                   | 725                | 1,051                 | 2, 8          | -----                  | -----                    | S Pennell POI                    |
| S Pennel Post - 5 yr.gpw |                          |                 |                     |                    | Return Period: 5 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |

# Hydrograph Report

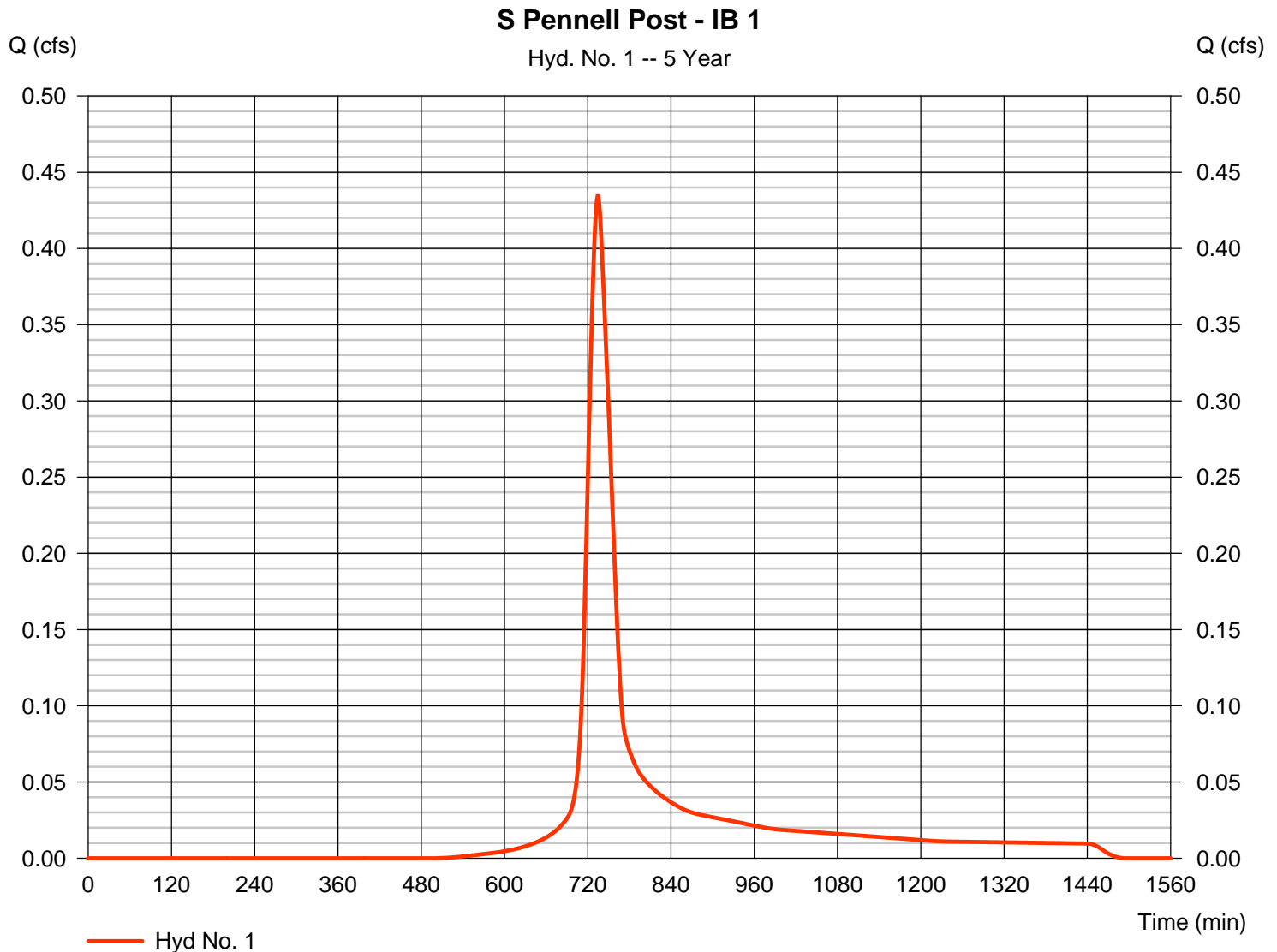
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.434 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 735 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,928 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 35.40 min  |
| Total precip.   | = 4.10 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

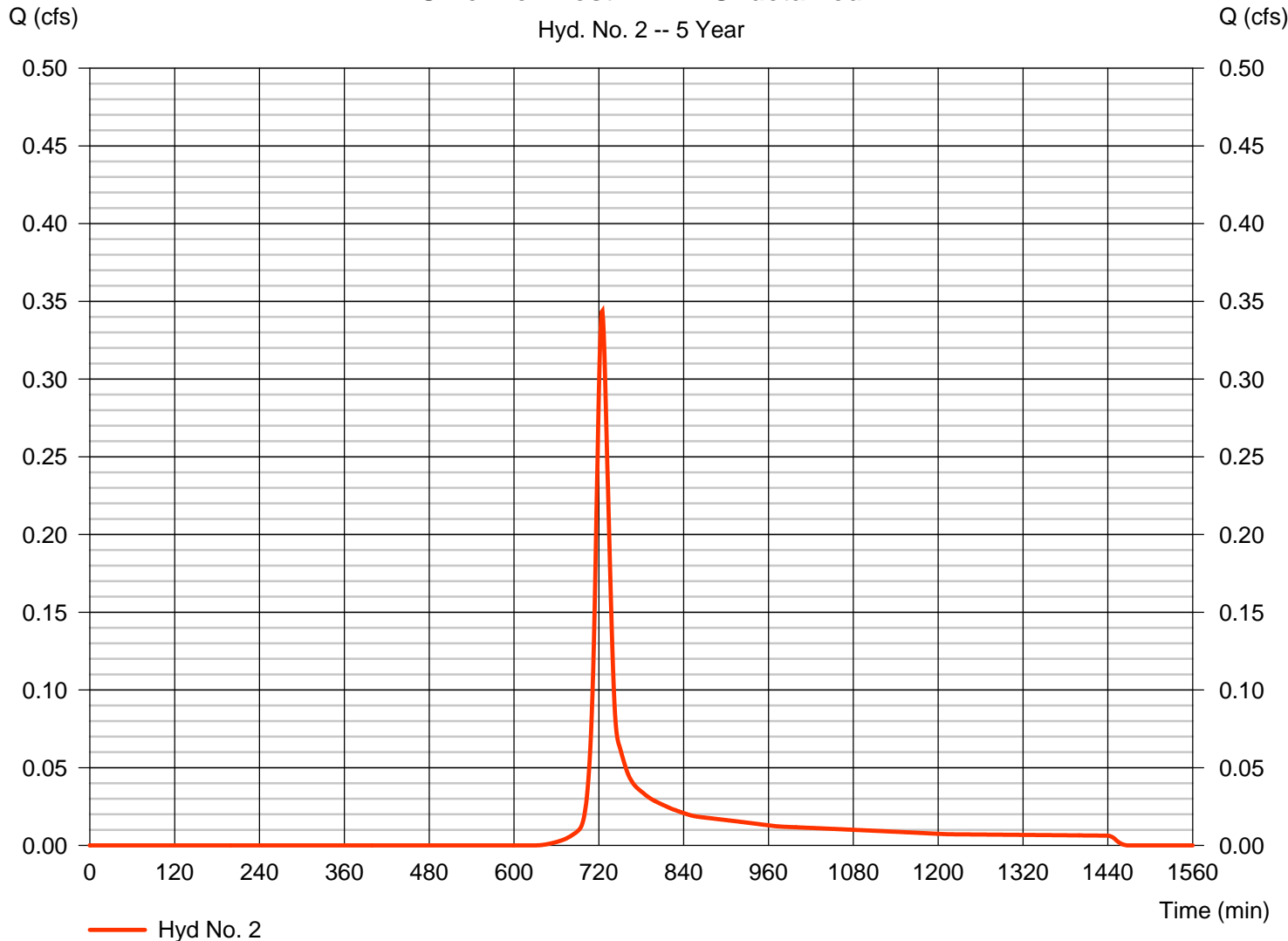
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.344 cfs  |
| Storm frequency | = 5 yrs      | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,050 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.10 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

### S Pennell Post - DD-1 Undetained



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

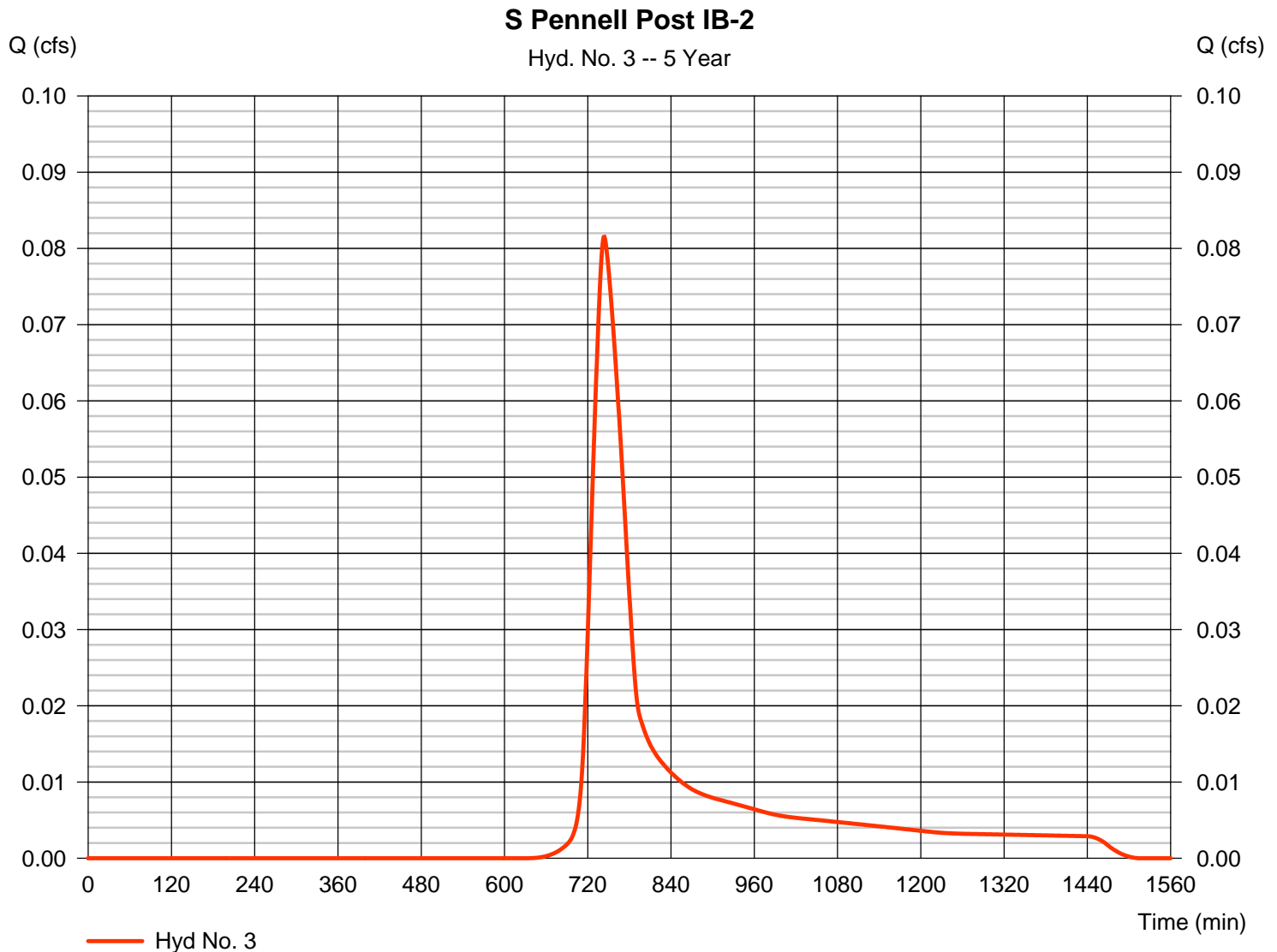
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.082 cfs |
| Storm frequency | = 5 yrs      | Time to peak       | = 744 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 476 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 47.60 min |
| Total precip.   | = 4.10 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |



# Hydrograph Report

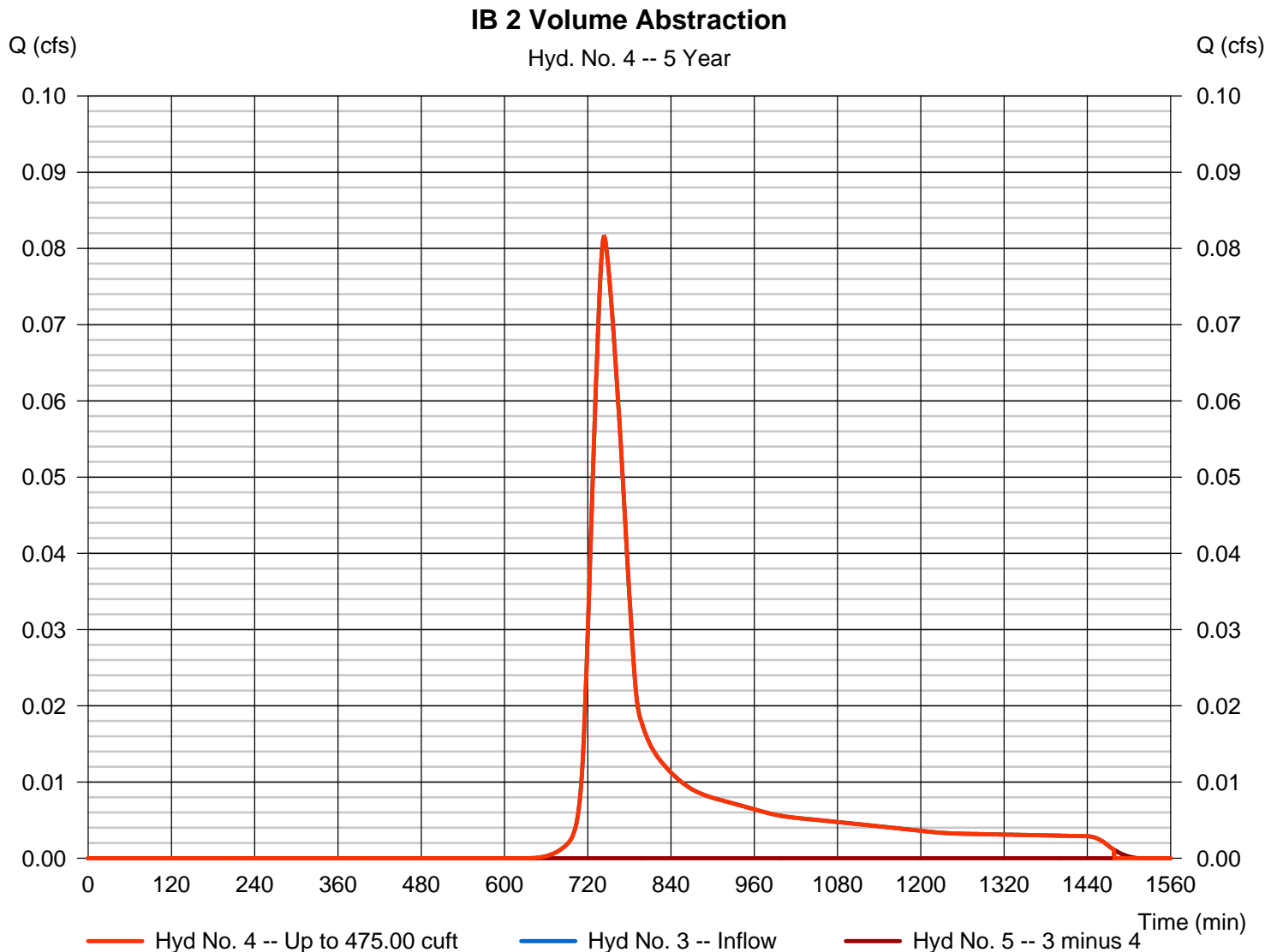
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.082 cfs   |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 744 min     |
| Time interval     | = 1 min                   | Hyd. volume       | = 475 cuft    |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 475.00 cuft |

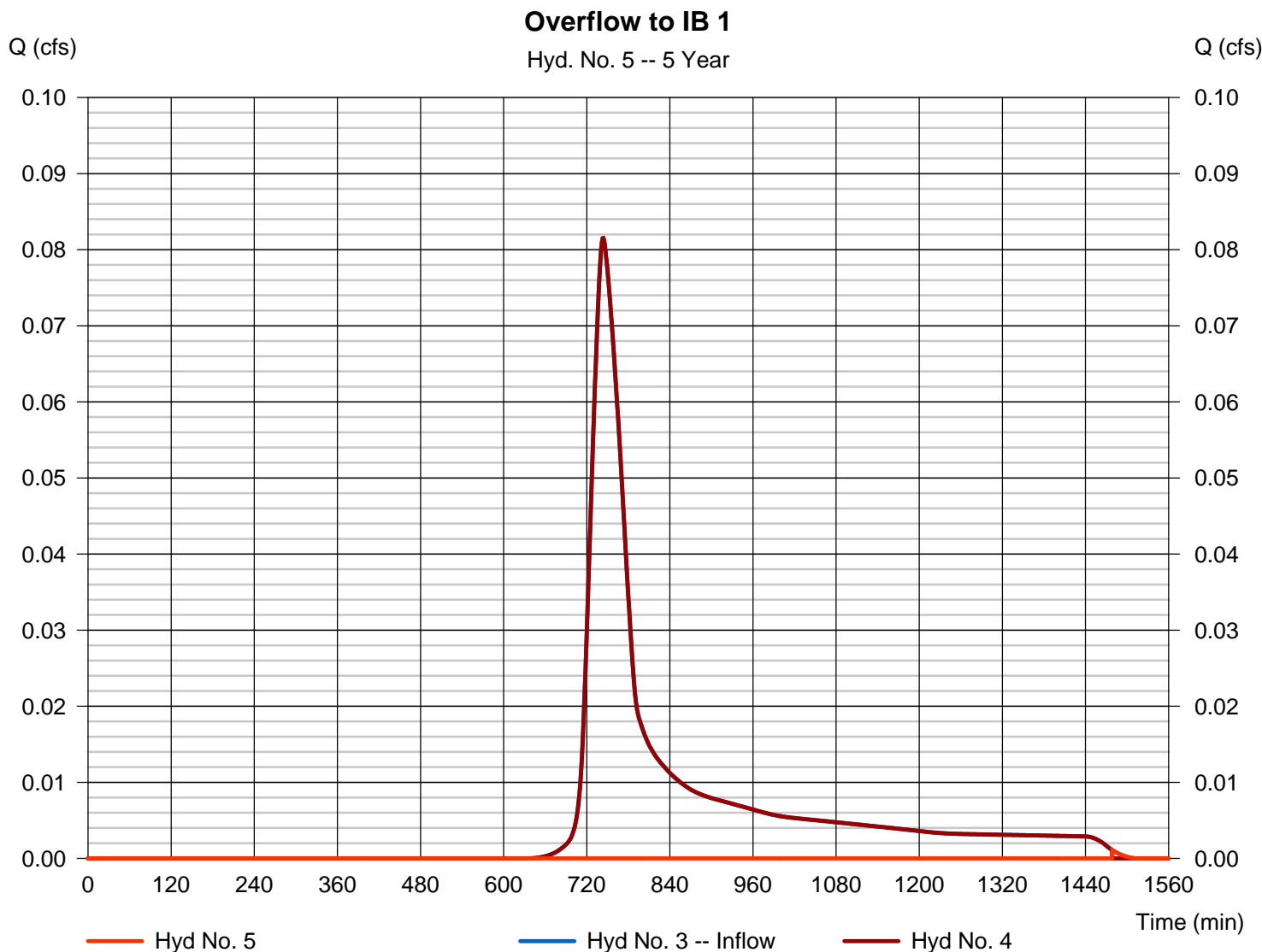


# Hydrograph Report

## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.001 cfs   |
| Storm frequency   | = 5 yrs                   | Time to peak      | = 1479 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1 cuft      |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 475.00 cuft |



# Hydrograph Report

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

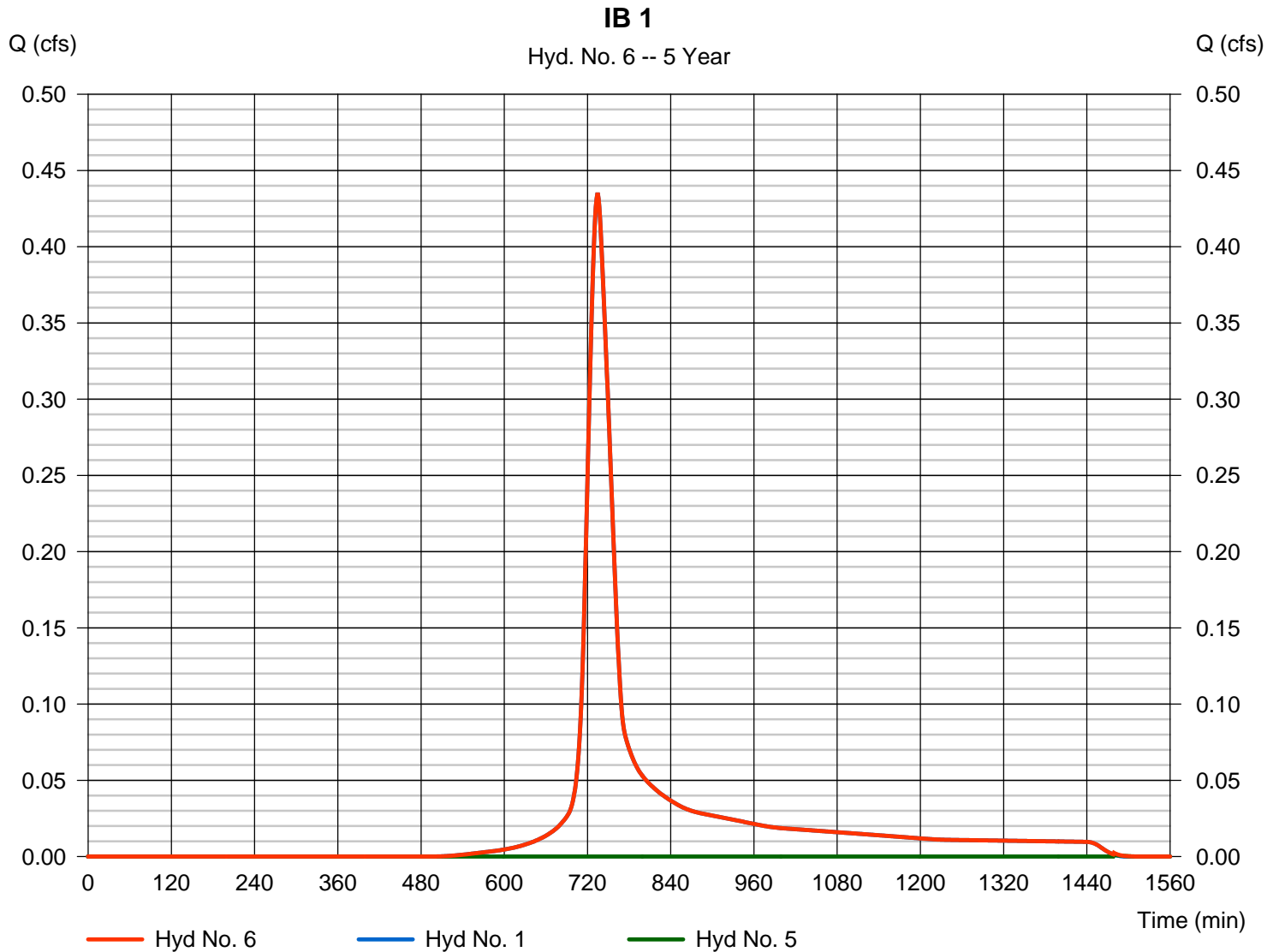
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

IB 1

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

Peak discharge = 0.434 cfs  
Time to peak = 735 min  
Hyd. volume = 1,929 cuft  
Contrib. drain. area = 0.250 ac

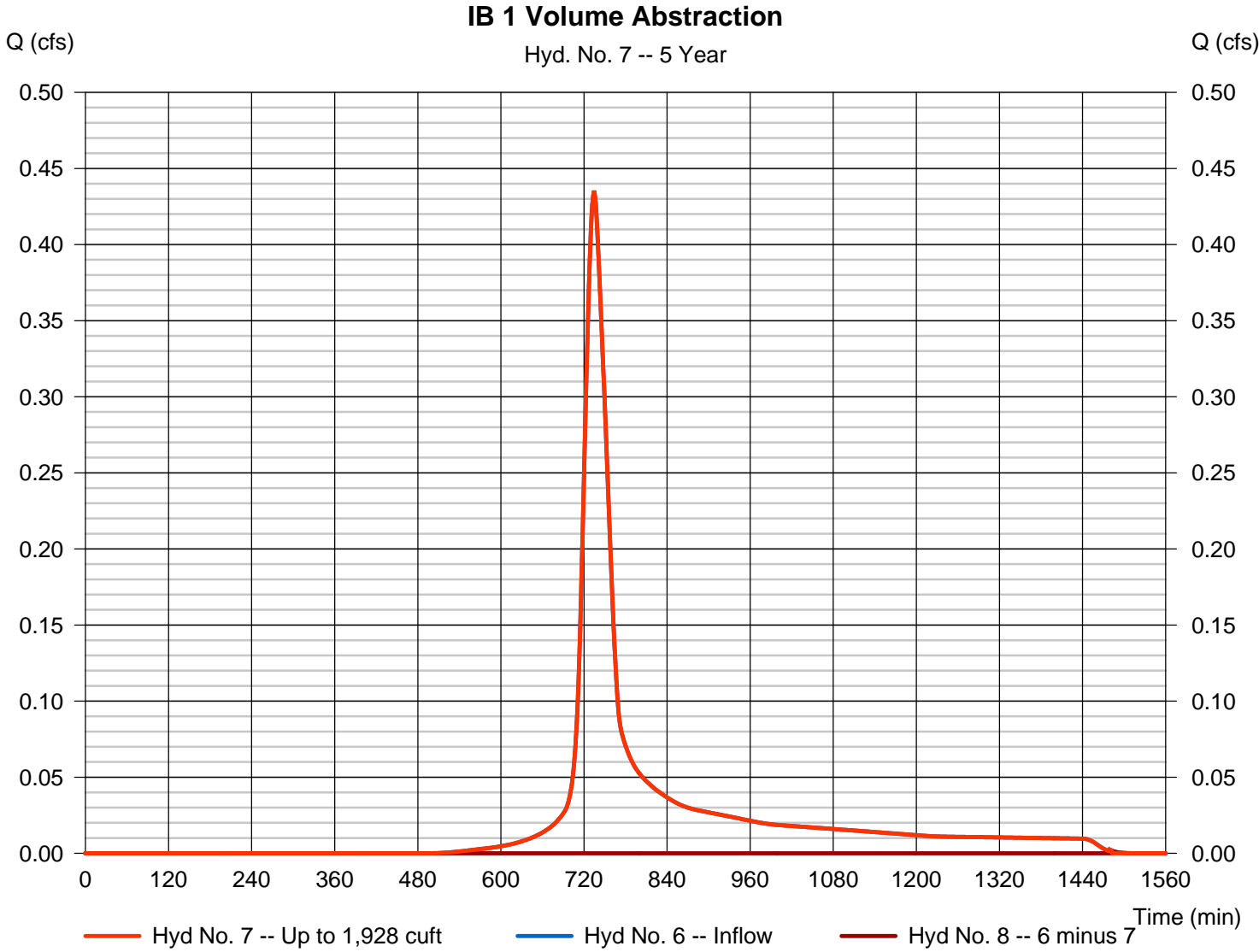


# Hydrograph Report

## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.434 cfs  |
| Storm frequency   | = 5 yrs              | Time to peak      | = 735 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,928 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,928 cuft |



# Hydrograph Report

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

Wednesday, 11 / 9 / 2016

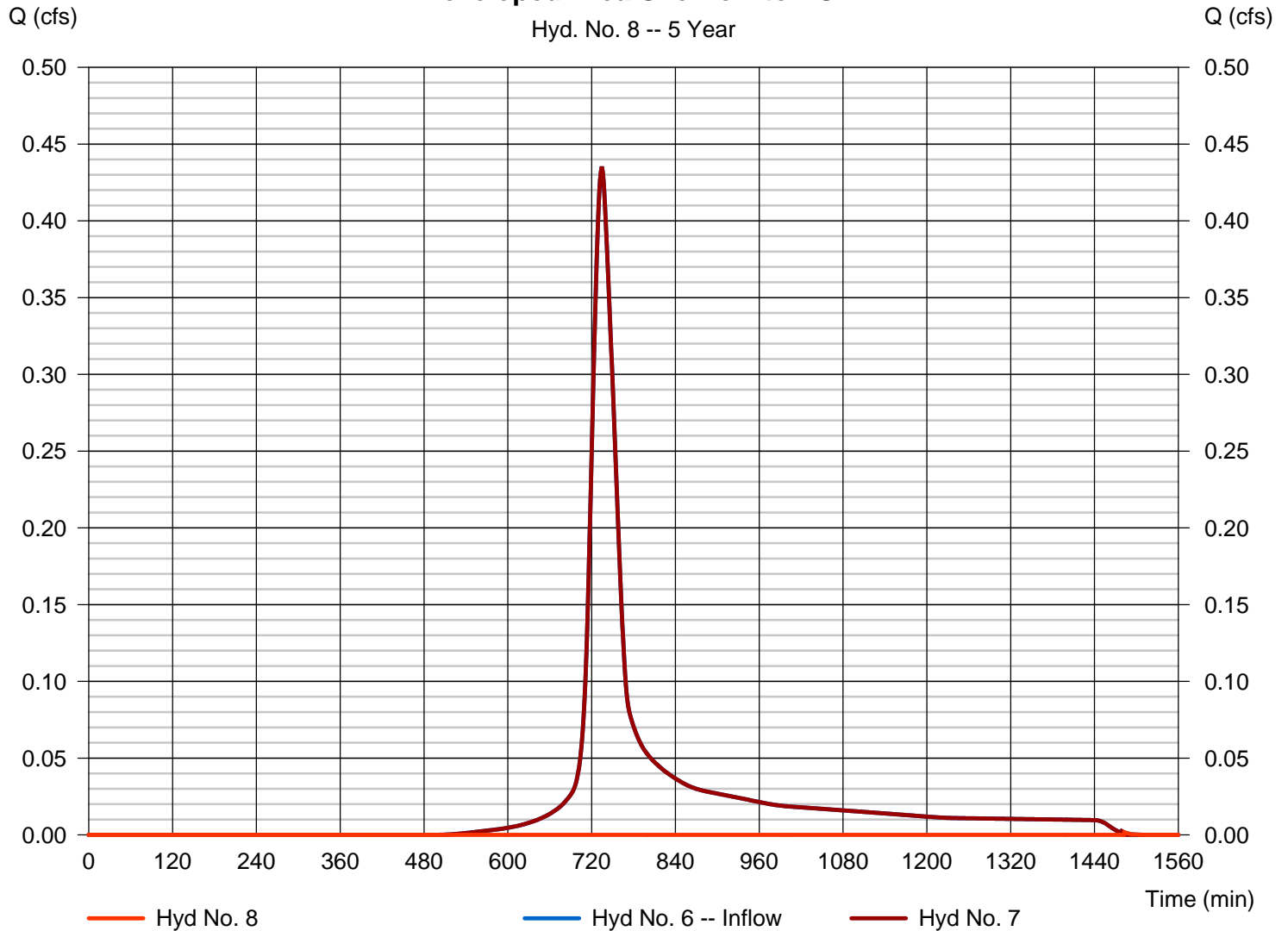
## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.002 cfs  |
| Storm frequency   | = 5 yrs              | Time to peak      | = 1483 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 1 cuft     |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 1,928 cuft |

### Developed Area Overflow to POI

Hyd. No. 8 -- 5 Year



# Hydrograph Report

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

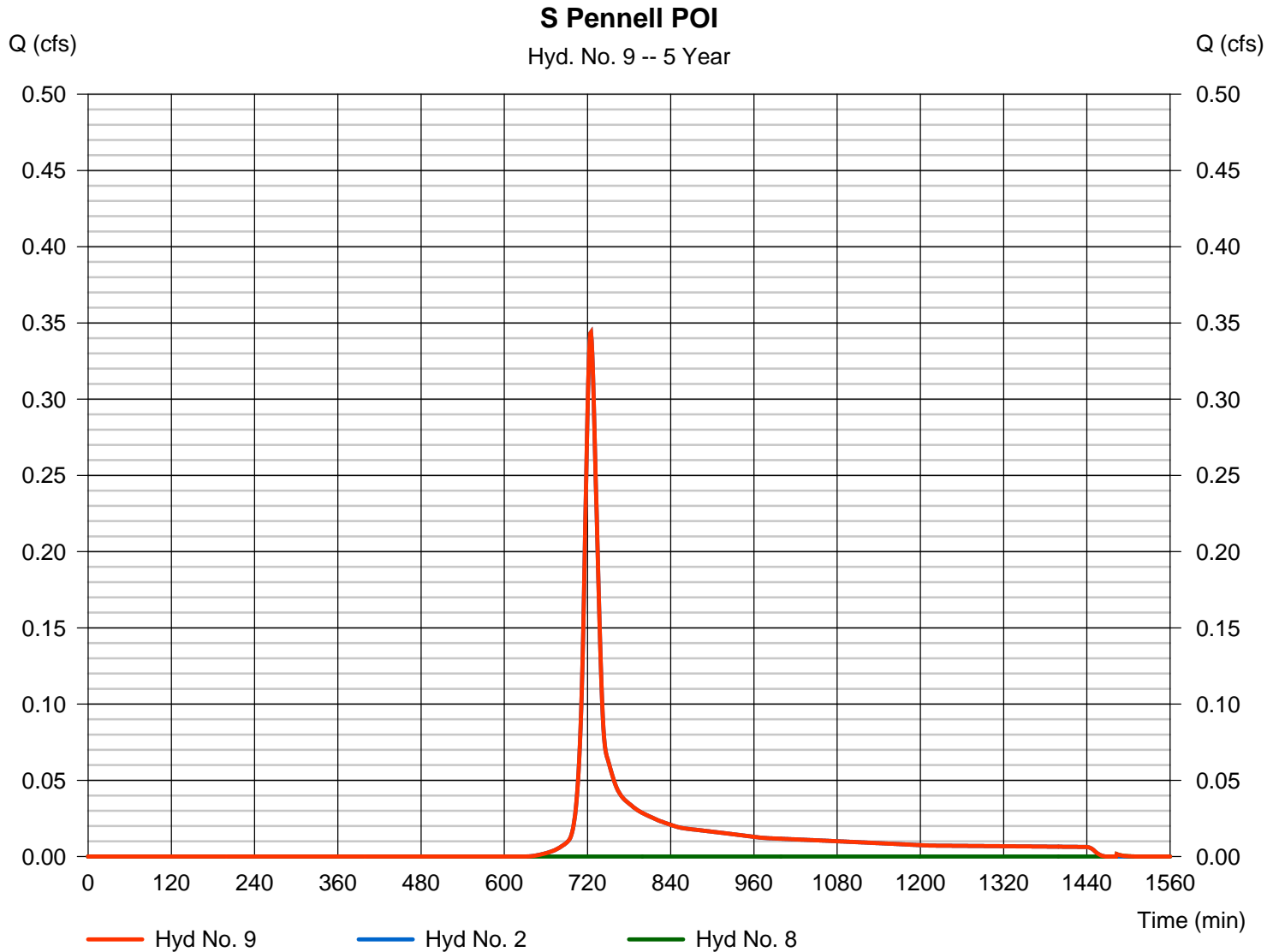
Wednesday, 11 / 9 / 2016

## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 5 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 0.344 cfs  
Time to peak = 725 min  
Hyd. volume = 1,051 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT C-3**  
**S PENNELL RD**  
**10 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area

# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# Hydrograph Summary Report

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

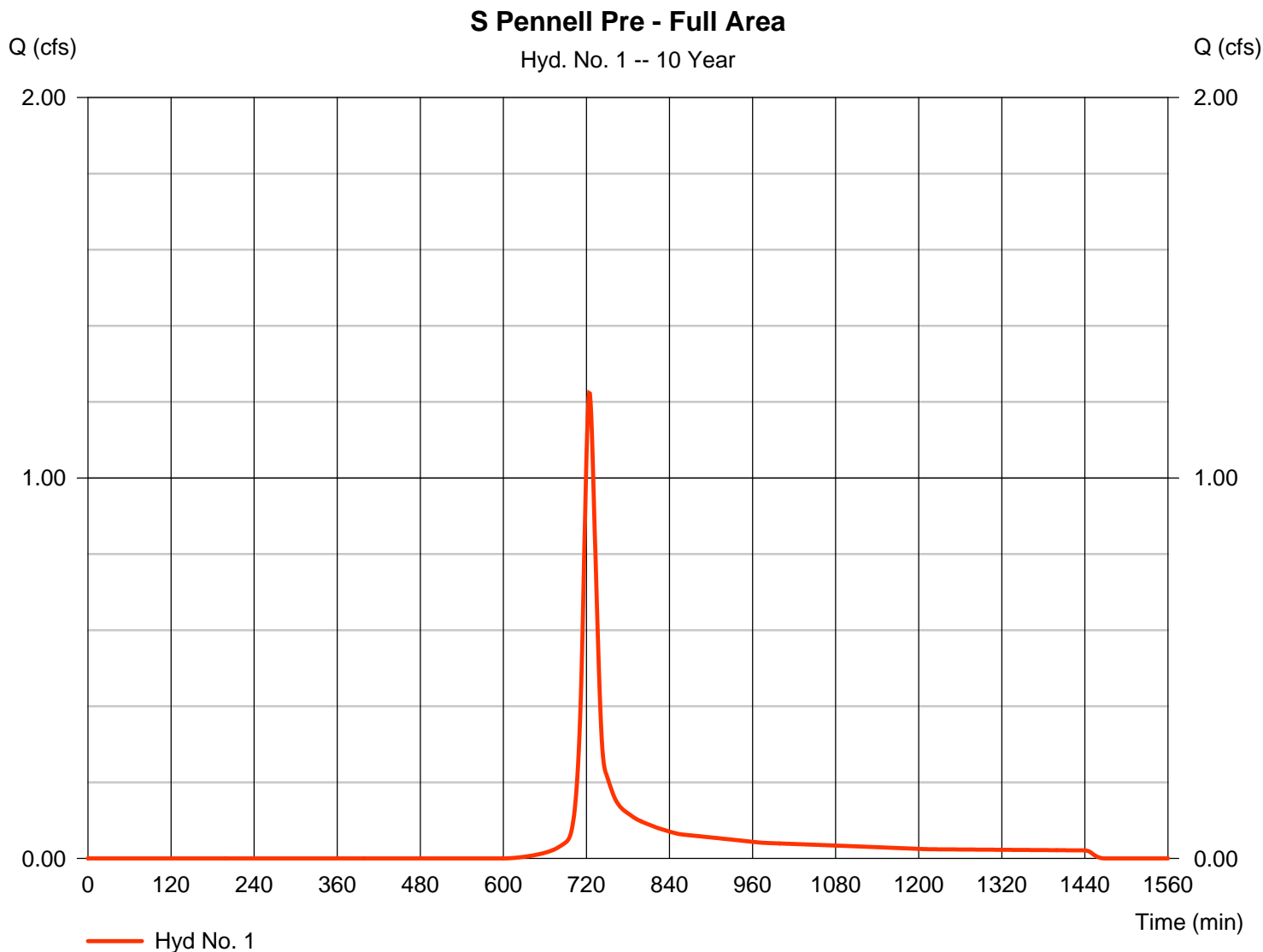
| Hyd. No.         | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft)   | Total strge used (cuft) | Hydrograph Description         |
|------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|--------------------------|-------------------------|--------------------------------|
| 1                | SCS Runoff               | 1.223           | 1                   | 724                | 3,690                  | -----         | -----                    | -----                   | S Pennell Pre - Full Area      |
| 2                | SCS Runoff               | 0.906           | 1                   | 721                | 2,313                  | -----         | -----                    | -----                   | S Pennell Pre - Developed Area |
| S Pennel Pre.gpw |                          |                 |                     |                    | Return Period: 10 Year |               | Wednesday, 11 / 9 / 2016 |                         |                                |

# Hydrograph Report

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.223 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,690 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.82 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

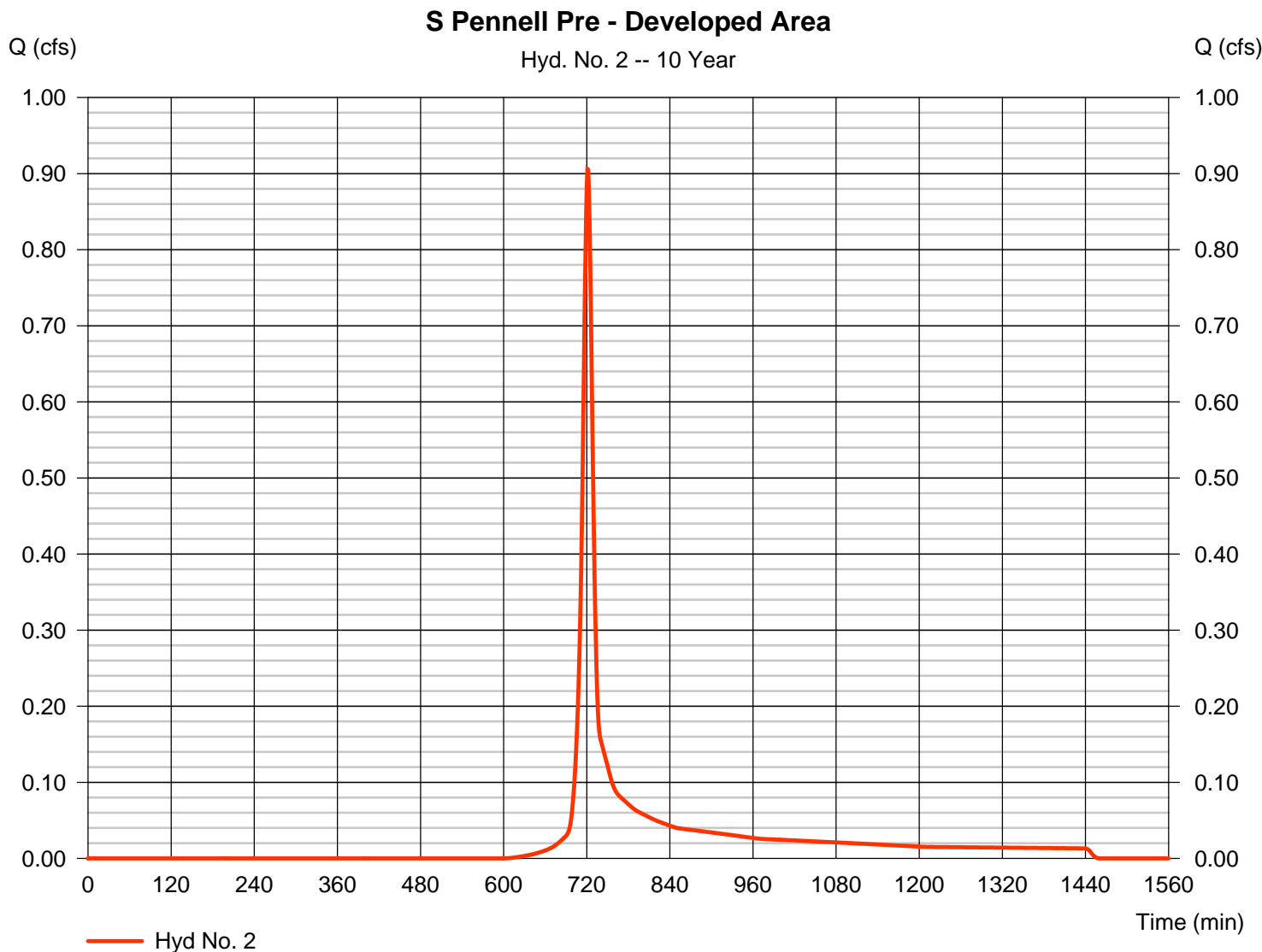
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.906 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 721 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,313 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 4.82 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

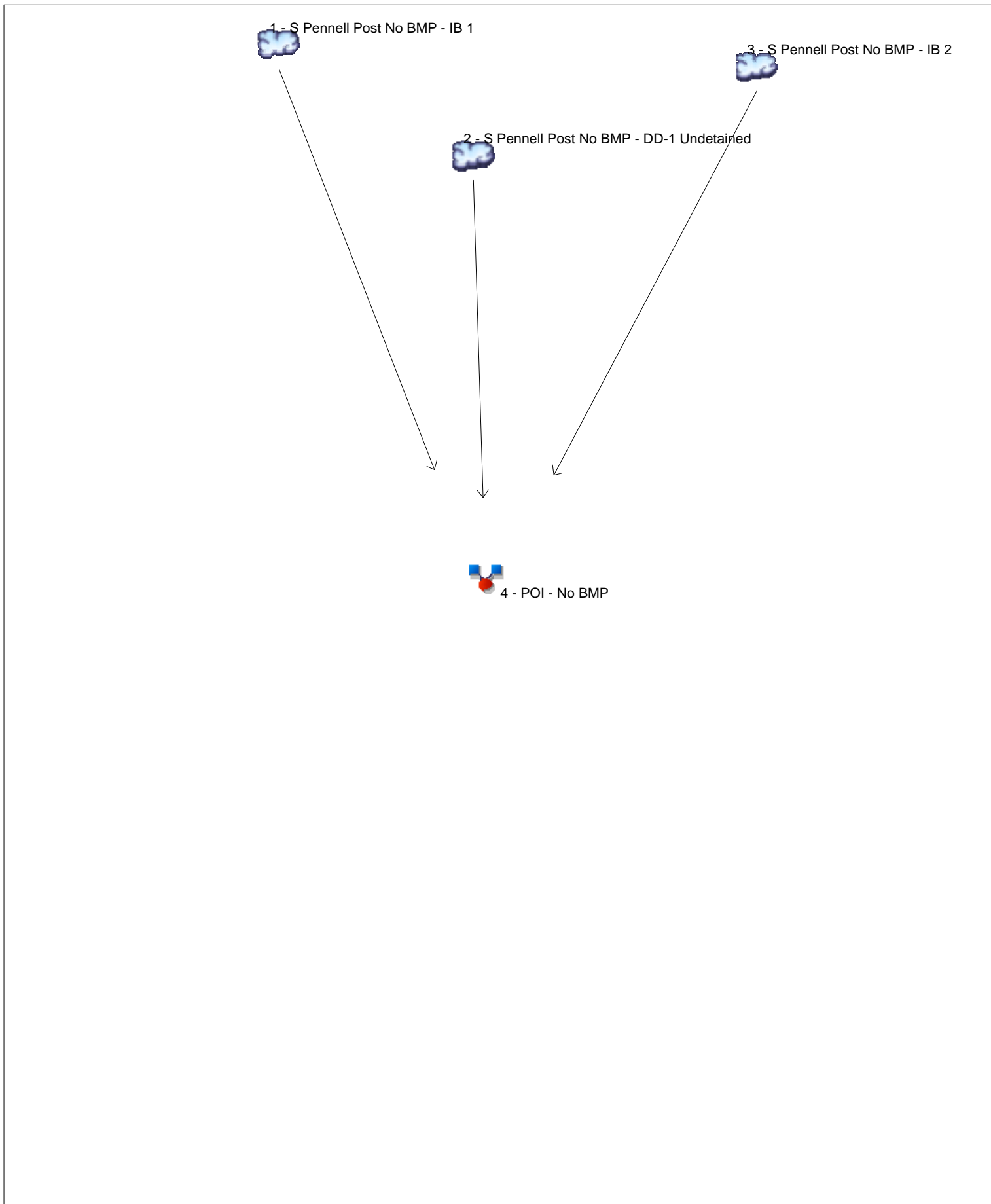
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |          |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |          |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |          |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>=</b> | <b>12.95</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.14</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| 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         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>13.10 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - 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               | 1.294           | 1                   | 717                | 2,483                  | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |  |
| 2                        | SCS Runoff               | 0.473           | 1                   | 724                | 1,422                  | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |  |
| 3                        | SCS Runoff               | 0.286           | 1                   | 720                | 647                    | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |  |
| 4                        | Combine                  | 1.868           | 1                   | 717                | 4,553                  | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |  |
| S Pennel Post no BMP.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |  |

# Hydrograph Report

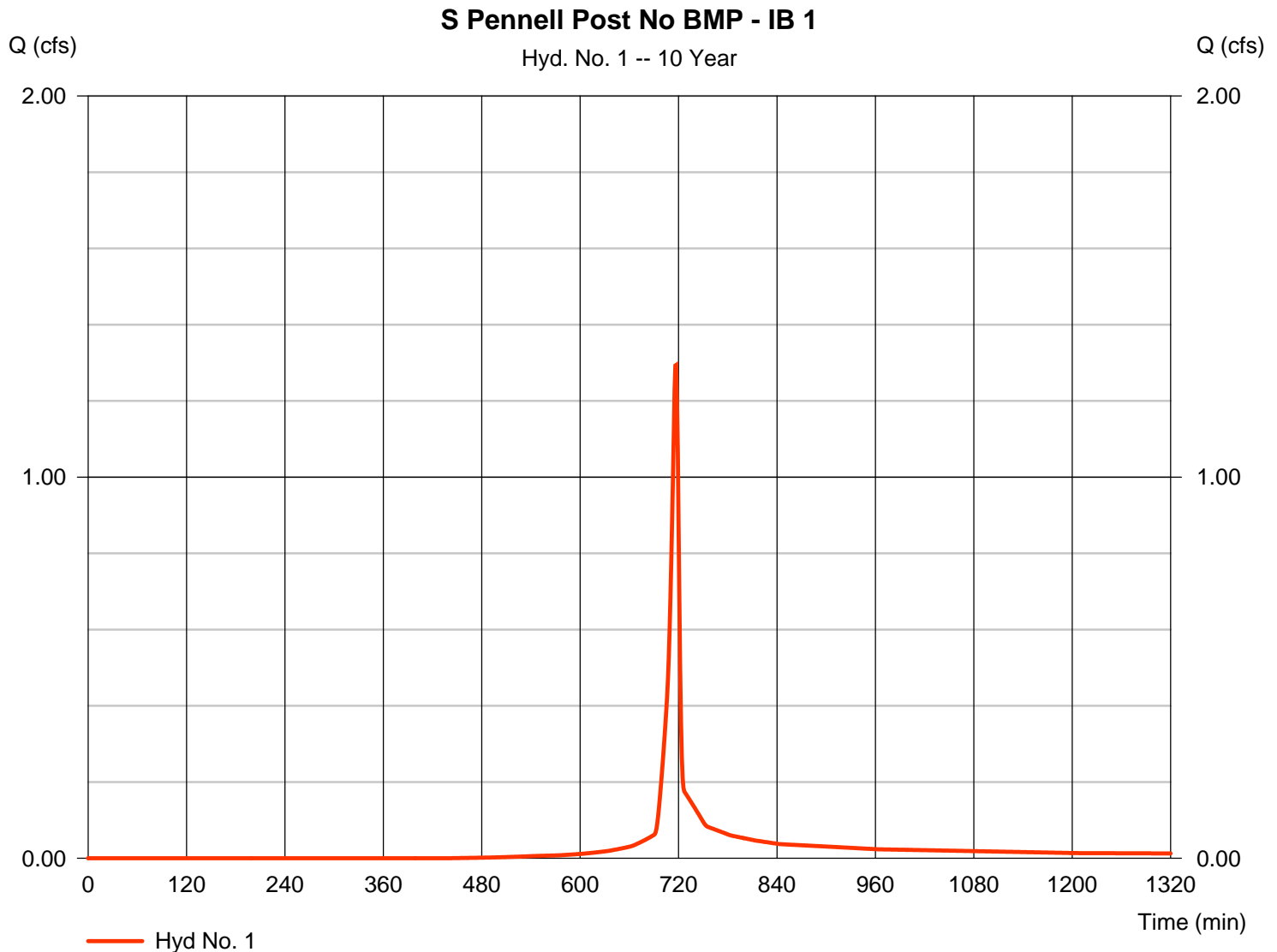
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.294 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 717 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,483 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 4.82 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 8.0         |          | 58.0        |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                 |
| Land slope (%)                     | = 7.40        |          | 50.00       |          | 5.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> | <b>0.52</b> | <b>+</b> | <b>0.54</b> | <b>=</b> | <b>4.60</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 55.00       |          | 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        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.18</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>4.80 min</b> |

# Hydrograph Report

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

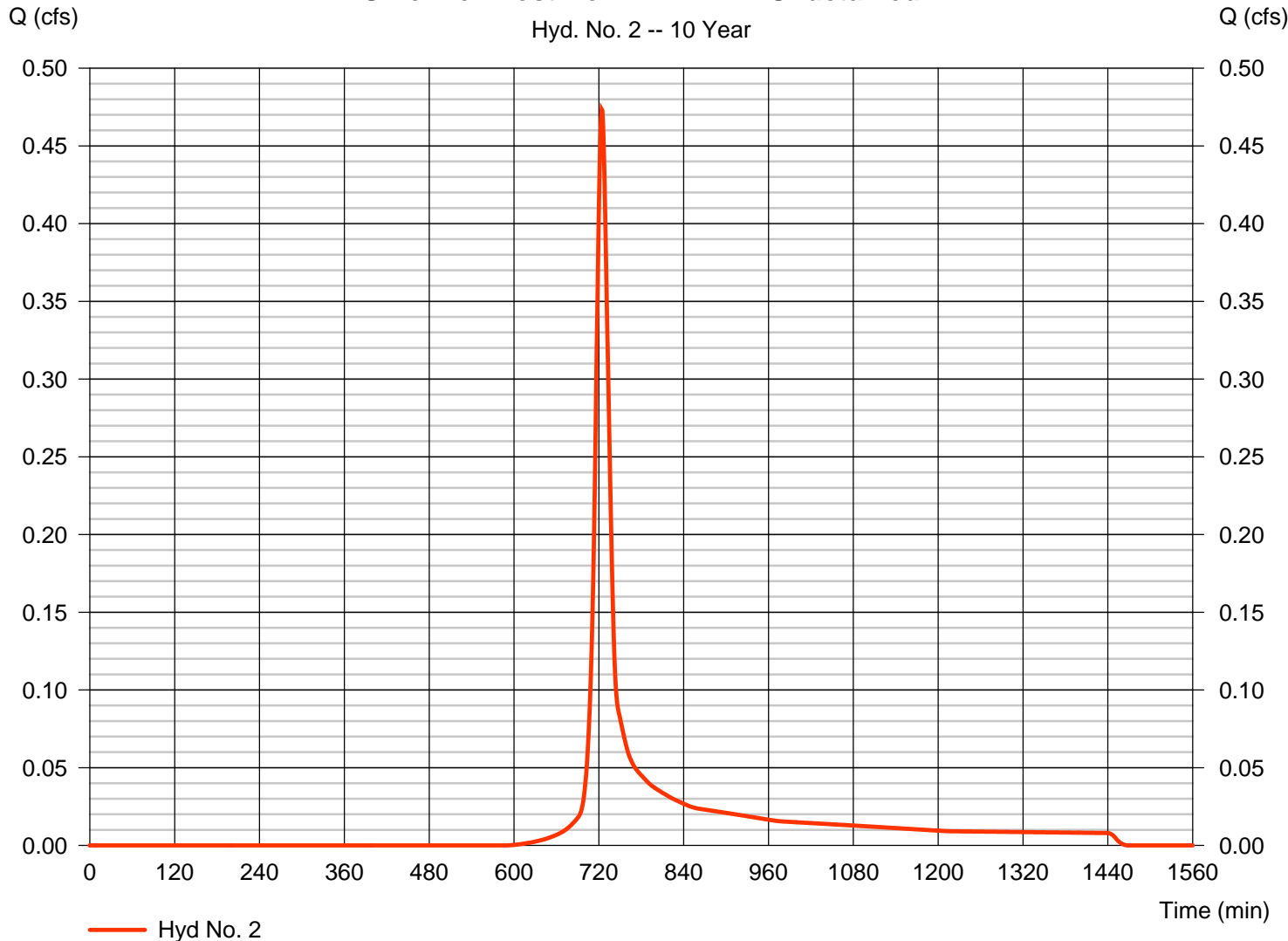
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.473 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,422 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.82 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

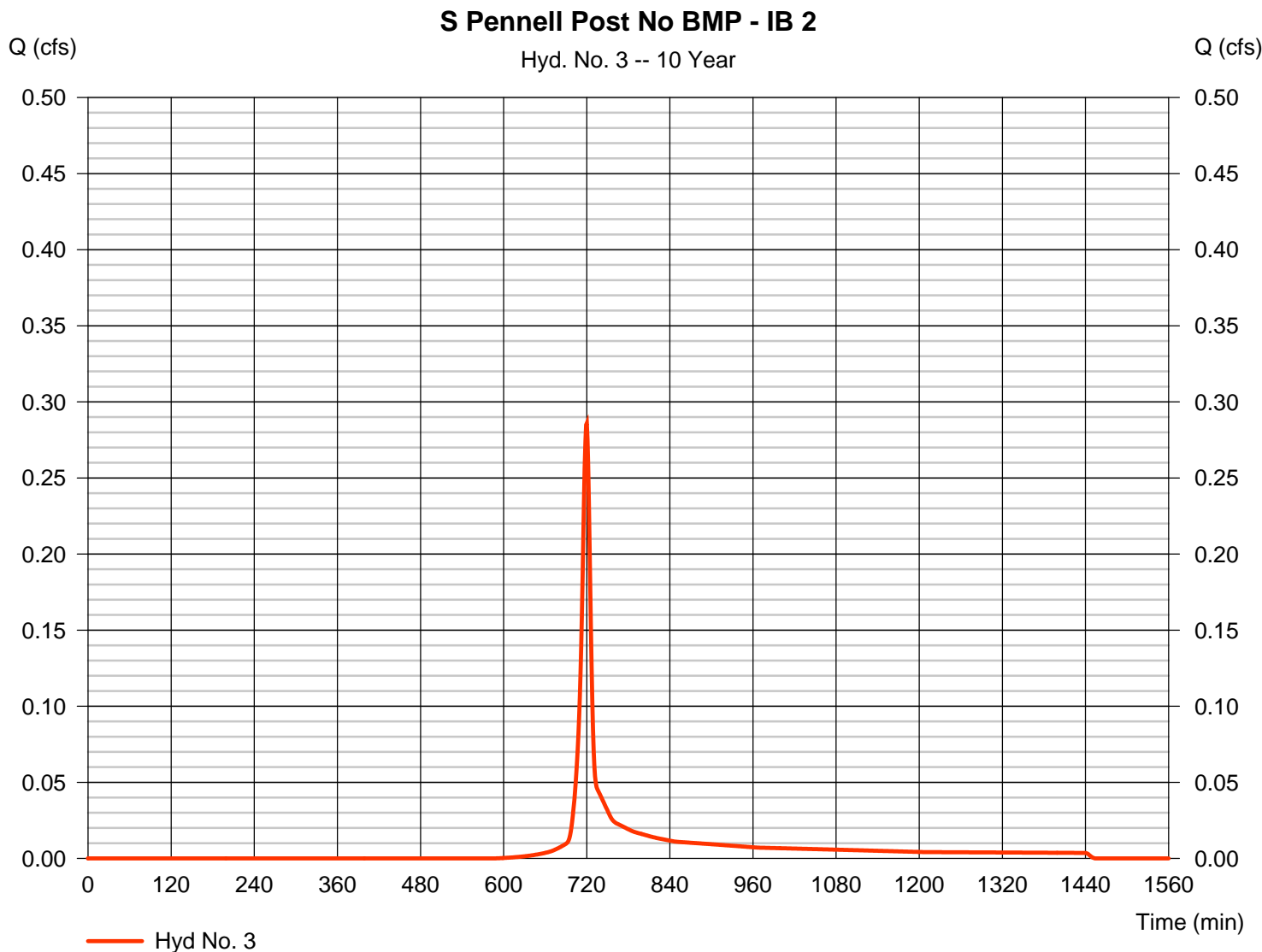
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.286 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 720 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 647 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min  |
| Total precip.   | = 4.82 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 66.0        |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 0.00        |          |                 |
| Land slope (%)                     | = 6.00        |          | 9.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> | <b>5.56</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.41</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 70.00       |          | 0.00        |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 9.00        |          | 0.00        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                 |
| Average velocity (ft/s)            | =4.84         |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.24</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>9.70 min</b> |

# Hydrograph Report

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

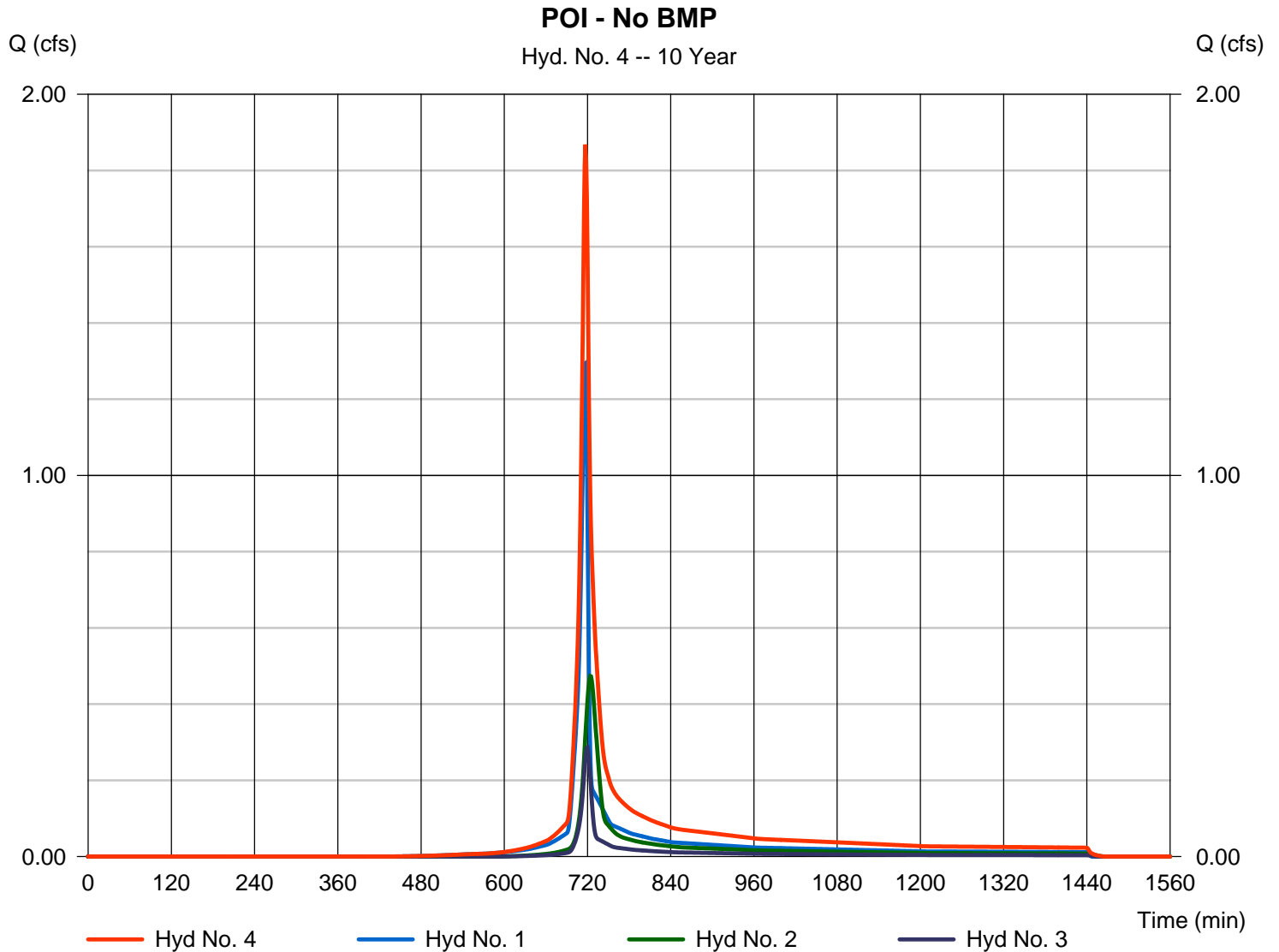
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

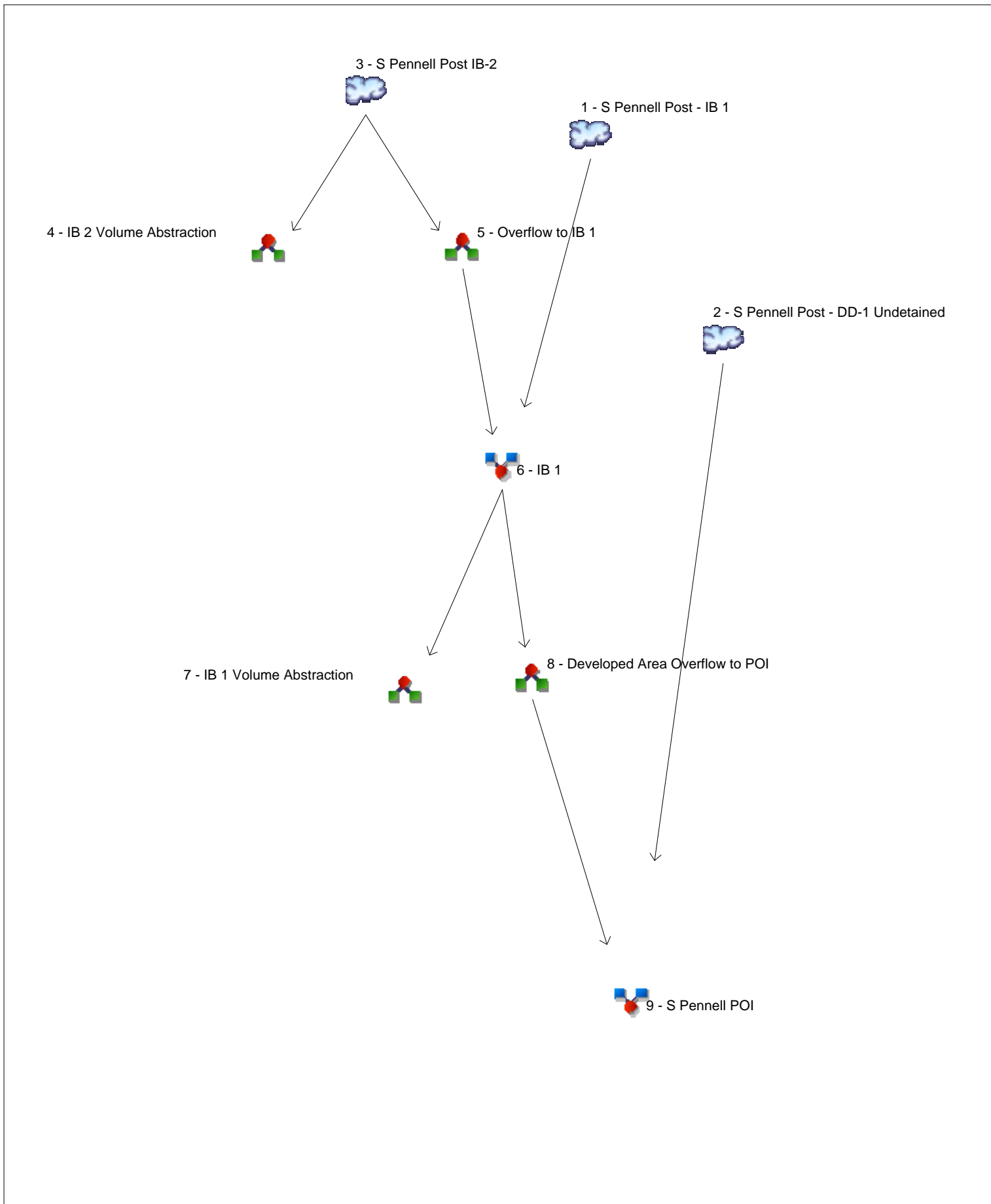
Hydrograph type = Combine  
Storm frequency = 10 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 1.868 cfs  
Time to peak = 717 min  
Hyd. volume = 4,553 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | ----- | 0.622 | ----- | ----- | -----  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 0.473 | ----- | ----- | -----  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | 0.116 | ----- | ----- | -----  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | 0.116 | ----- | ----- | -----  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | 0.003 | ----- | ----- | -----  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | ----- | ----- | ----- | 0.622 | ----- | ----- | -----  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | ----- | ----- | ----- | 0.622 | ----- | ----- | -----  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | ----- | ----- | ----- | 0.012 | ----- | ----- | -----  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | ----- | ----- | ----- | 0.473 | ----- | ----- | -----  | S Pennell 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               | 0.622           | 1                   | 731                | 2,483                  | -----         | -----                  | -----                    | S Pennell Post - IB 1            |  |
| 2                         | SCS Runoff               | 0.473           | 1                   | 724                | 1,422                  | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |  |
| 3                         | SCS Runoff               | 0.116           | 1                   | 742                | 650                    | -----         | -----                  | -----                    | S Pennell Post IB-2              |  |
| 4                         | Diversion1               | 0.116           | 1                   | 742                | 647                    | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |  |
| 5                         | Diversion2               | 0.003           | 1                   | 1462               | 3                      | 3             | -----                  | -----                    | Overflow to IB 1                 |  |
| 6                         | Combine                  | 0.622           | 1                   | 731                | 2,486                  | 1, 5          | -----                  | -----                    | IB 1                             |  |
| 7                         | Diversion1               | 0.622           | 1                   | 731                | 2,447                  | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |  |
| 8                         | Diversion2               | 0.012           | 1                   | 1411               | 39                     | 6             | -----                  | -----                    | Developed Area Overflow to POI   |  |
| 9                         | Combine                  | 0.473           | 1                   | 724                | 1,461                  | 2, 8          | -----                  | -----                    | S Pennell POI                    |  |
| S Pennel Post - 10 yr.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |  |

# Hydrograph Report

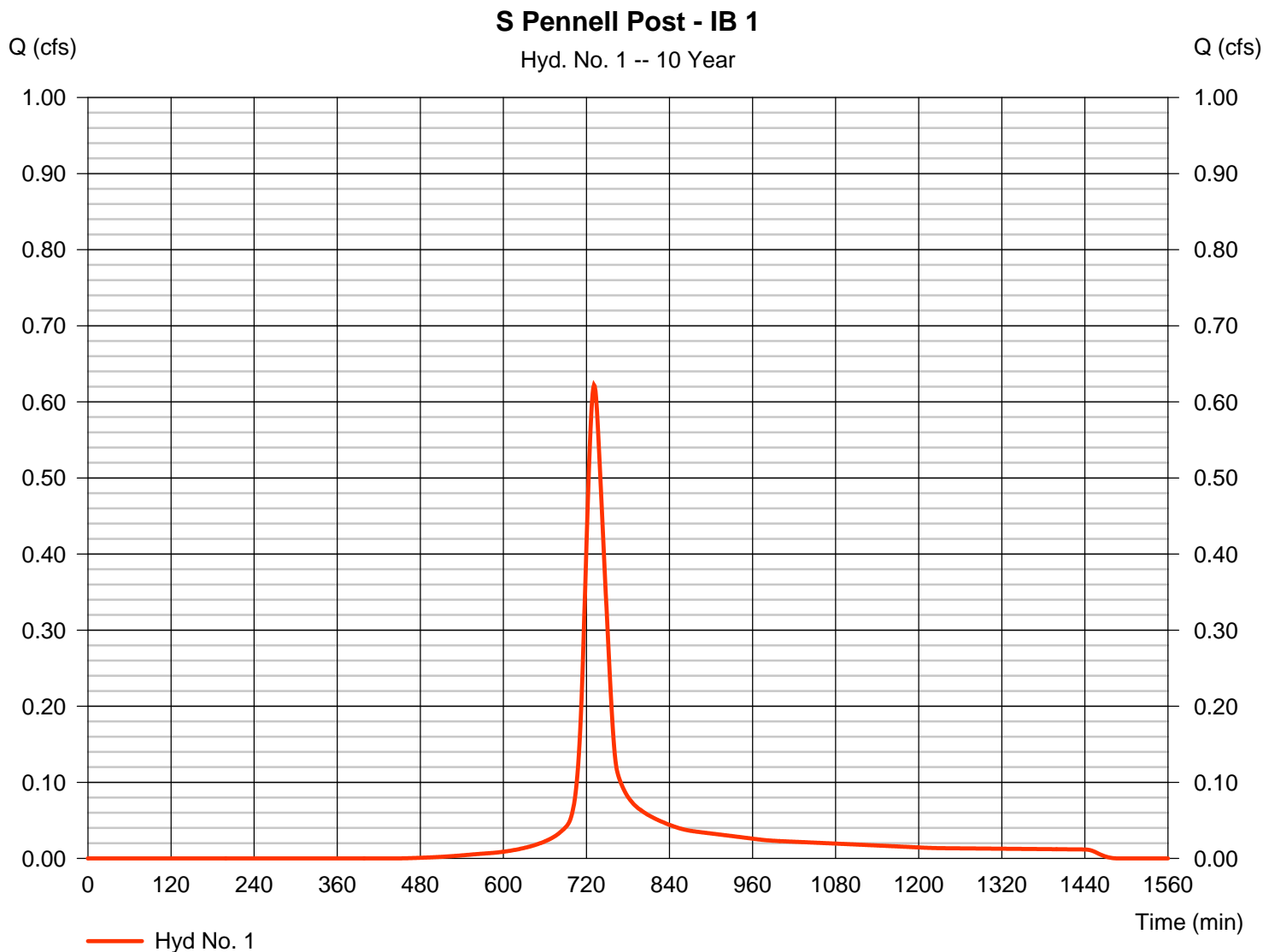
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.622 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 731 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,483 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 29.00 min  |
| Total precip.   | = 4.82 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

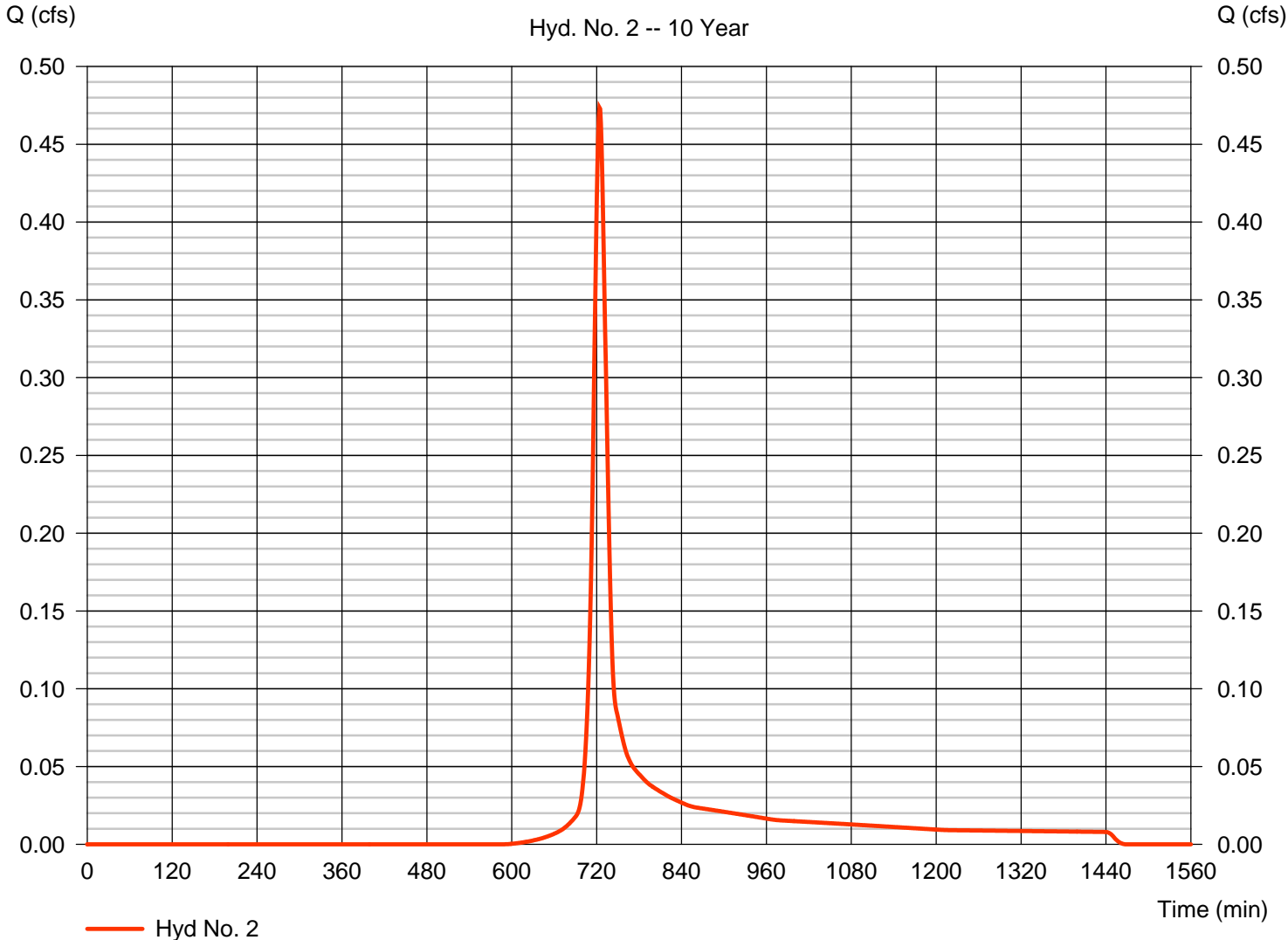
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.473 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,422 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 4.82 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | 35.0           | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

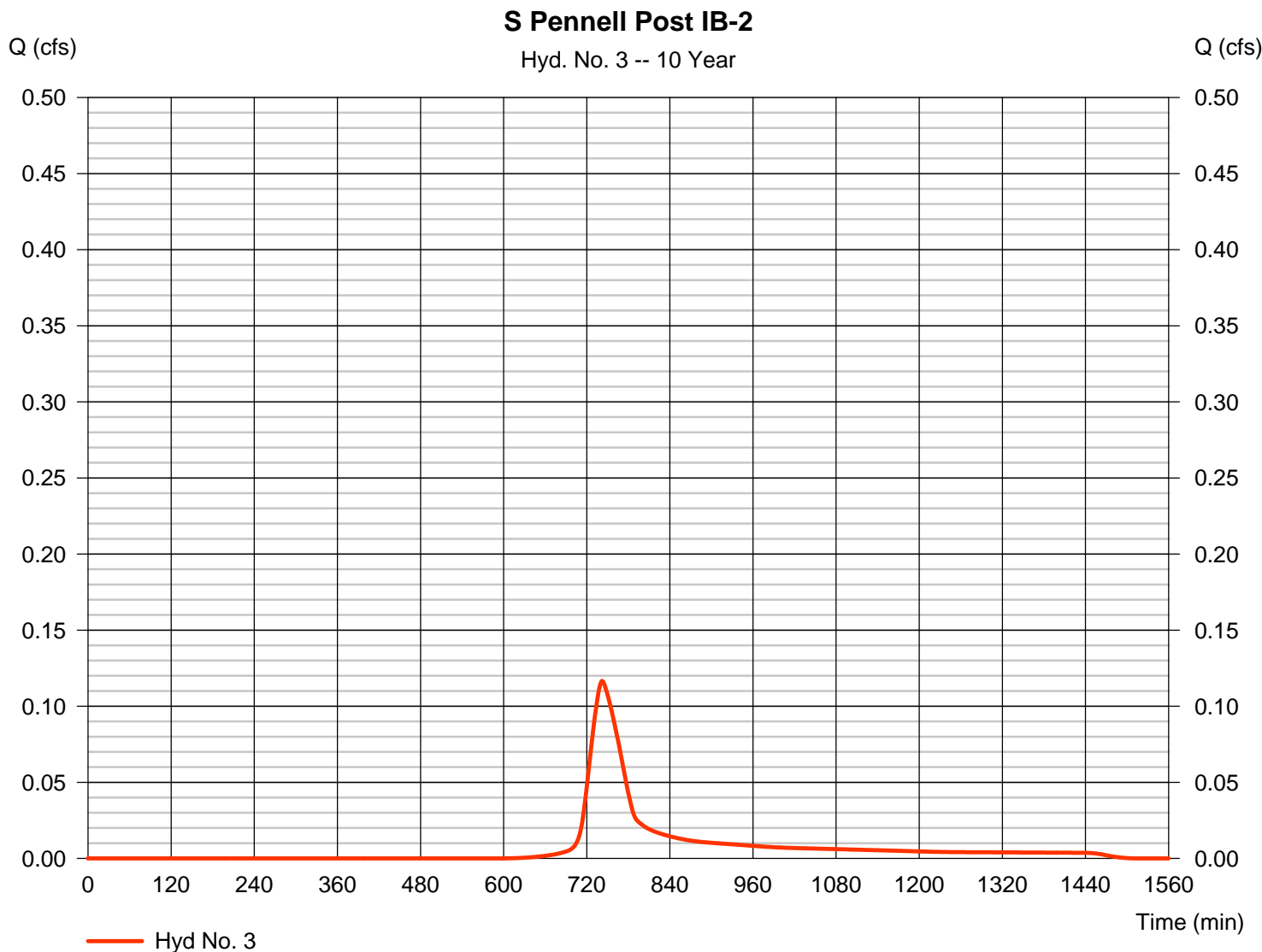
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.116 cfs |
| Storm frequency | = 10 yrs     | Time to peak       | = 742 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 650 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 46.90 min |
| Total precip.   | = 4.82 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |



# Hydrograph Report

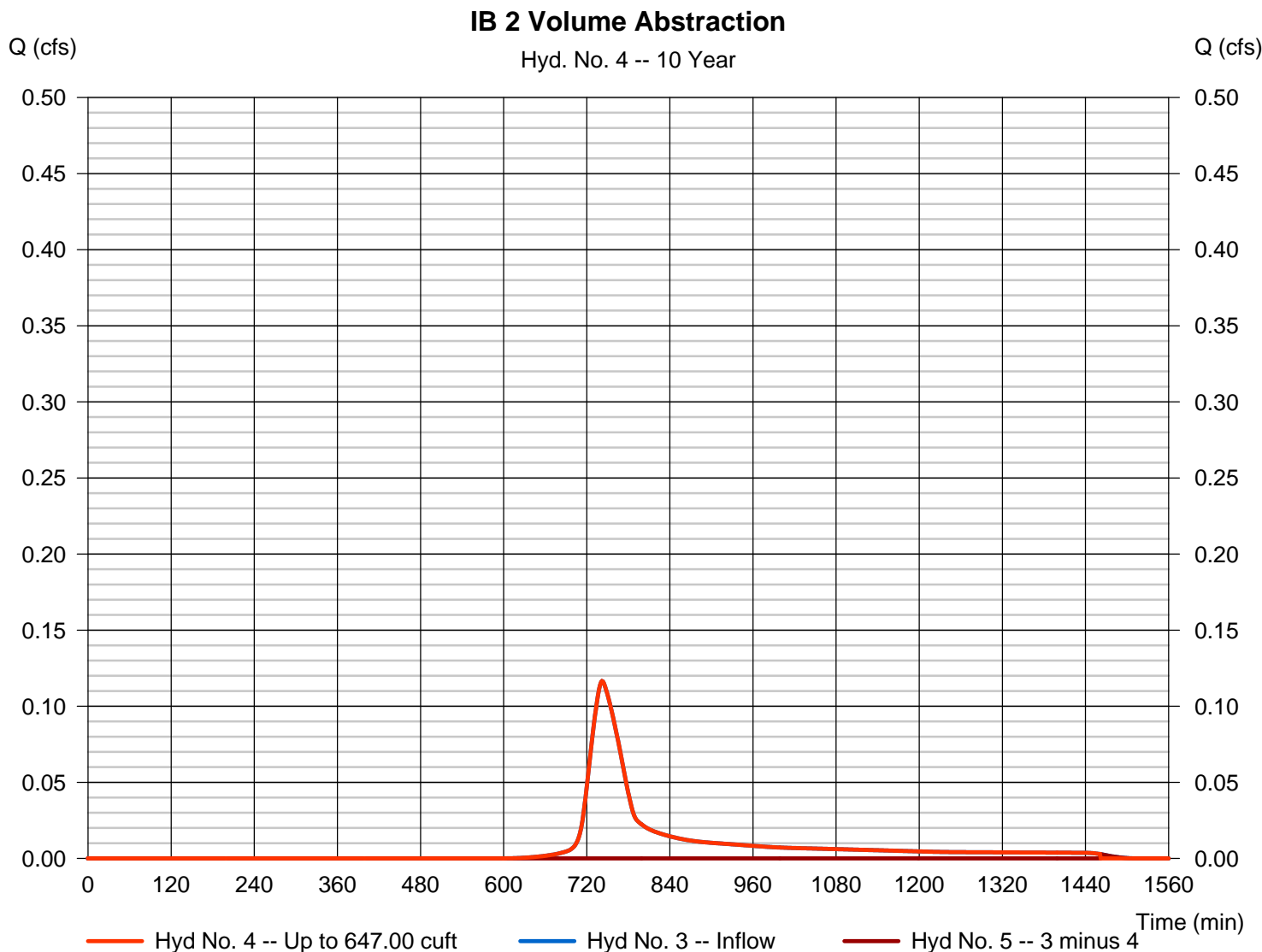
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Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.116 cfs   |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 742 min     |
| Time interval     | = 1 min                   | Hyd. volume       | = 647 cuft    |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 647.00 cuft |



# Hydrograph Report

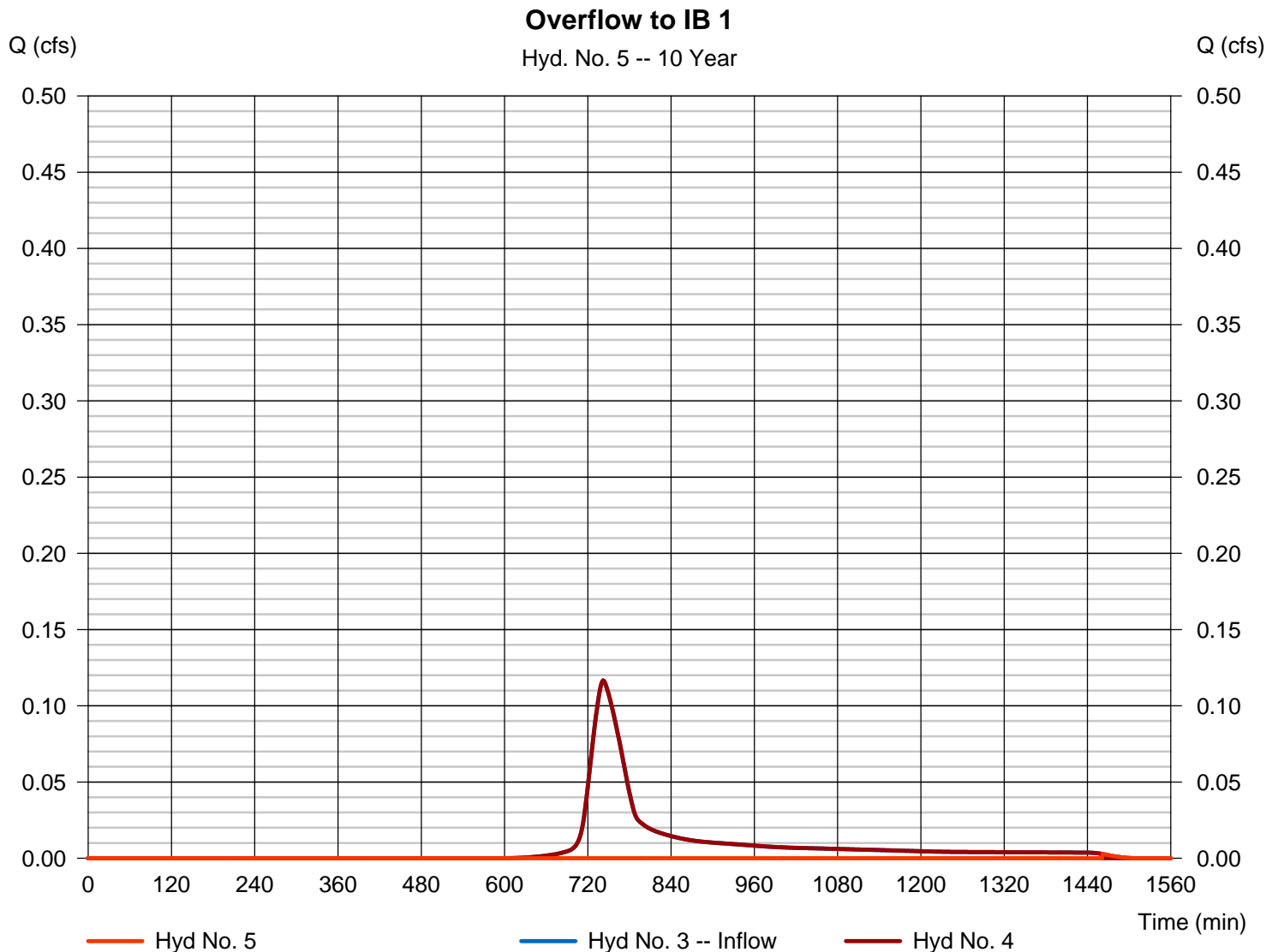
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## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.003 cfs   |
| Storm frequency   | = 10 yrs                  | Time to peak      | = 1462 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 3 cuft      |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 647.00 cuft |



# Hydrograph Report

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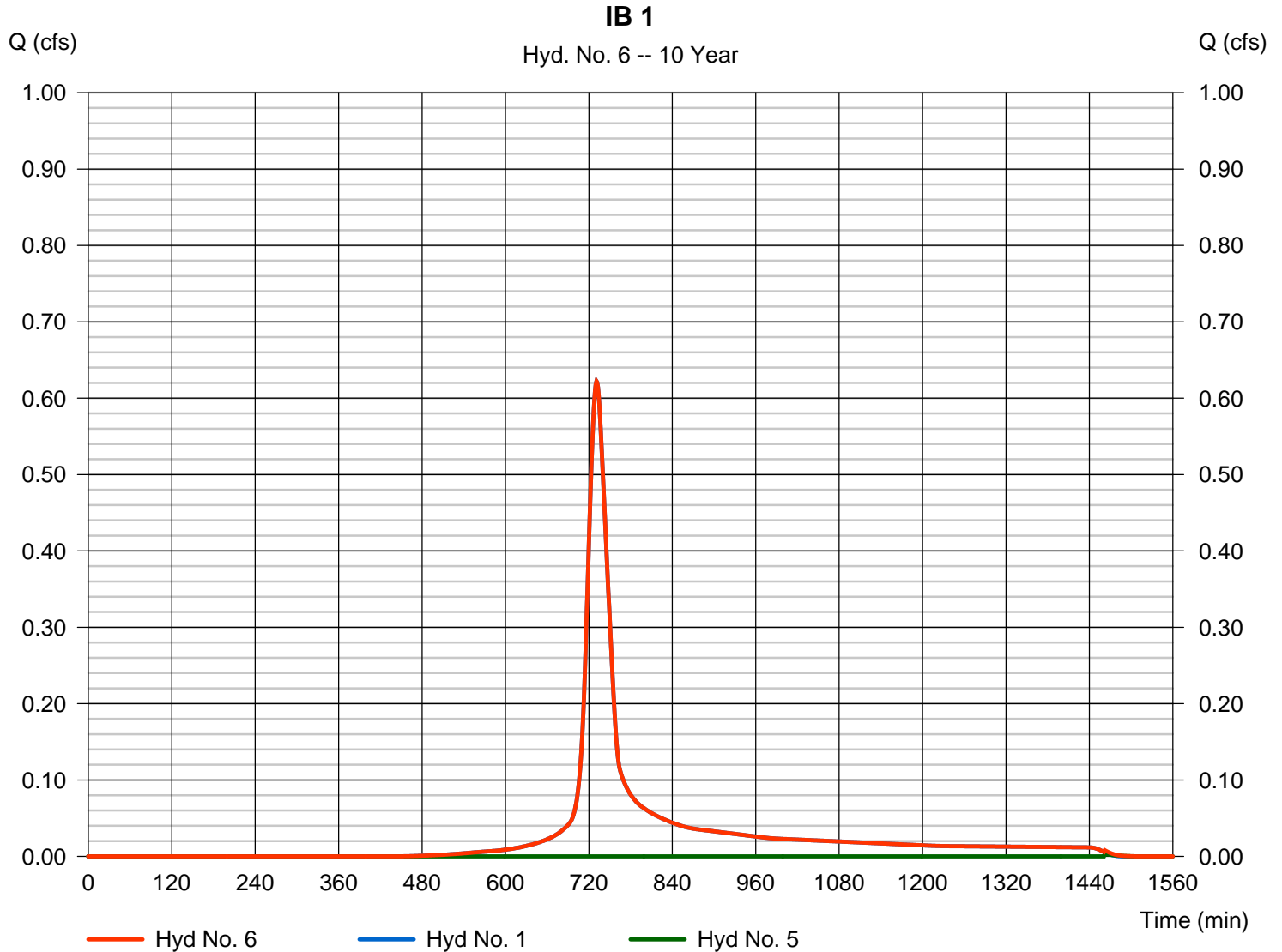
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

IB 1

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

Peak discharge = 0.622 cfs  
Time to peak = 731 min  
Hyd. volume = 2,486 cuft  
Contrib. drain. area = 0.250 ac



# Hydrograph Report

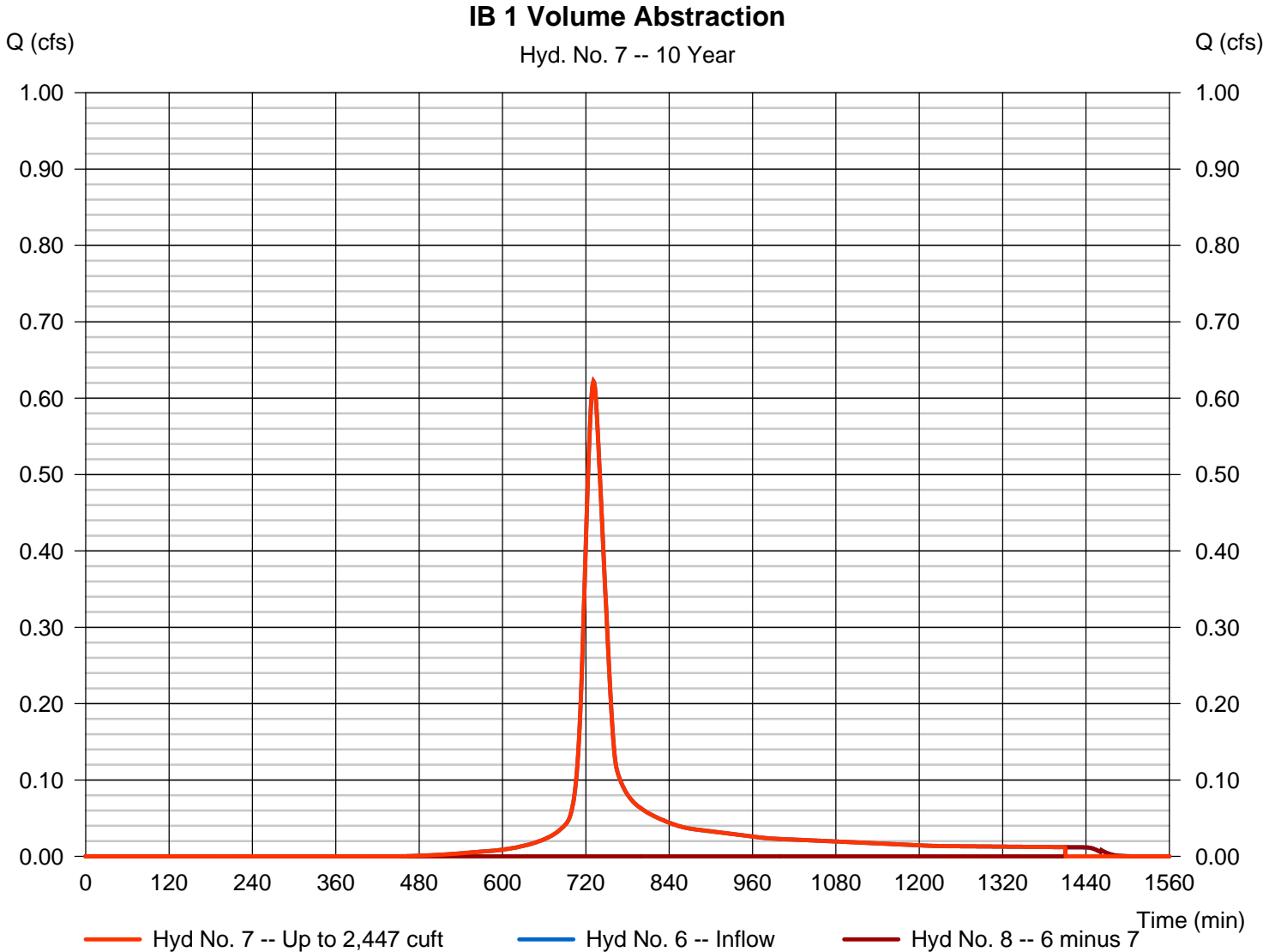
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Wednesday, 11 / 9 / 2016

## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.622 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 731 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,447 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

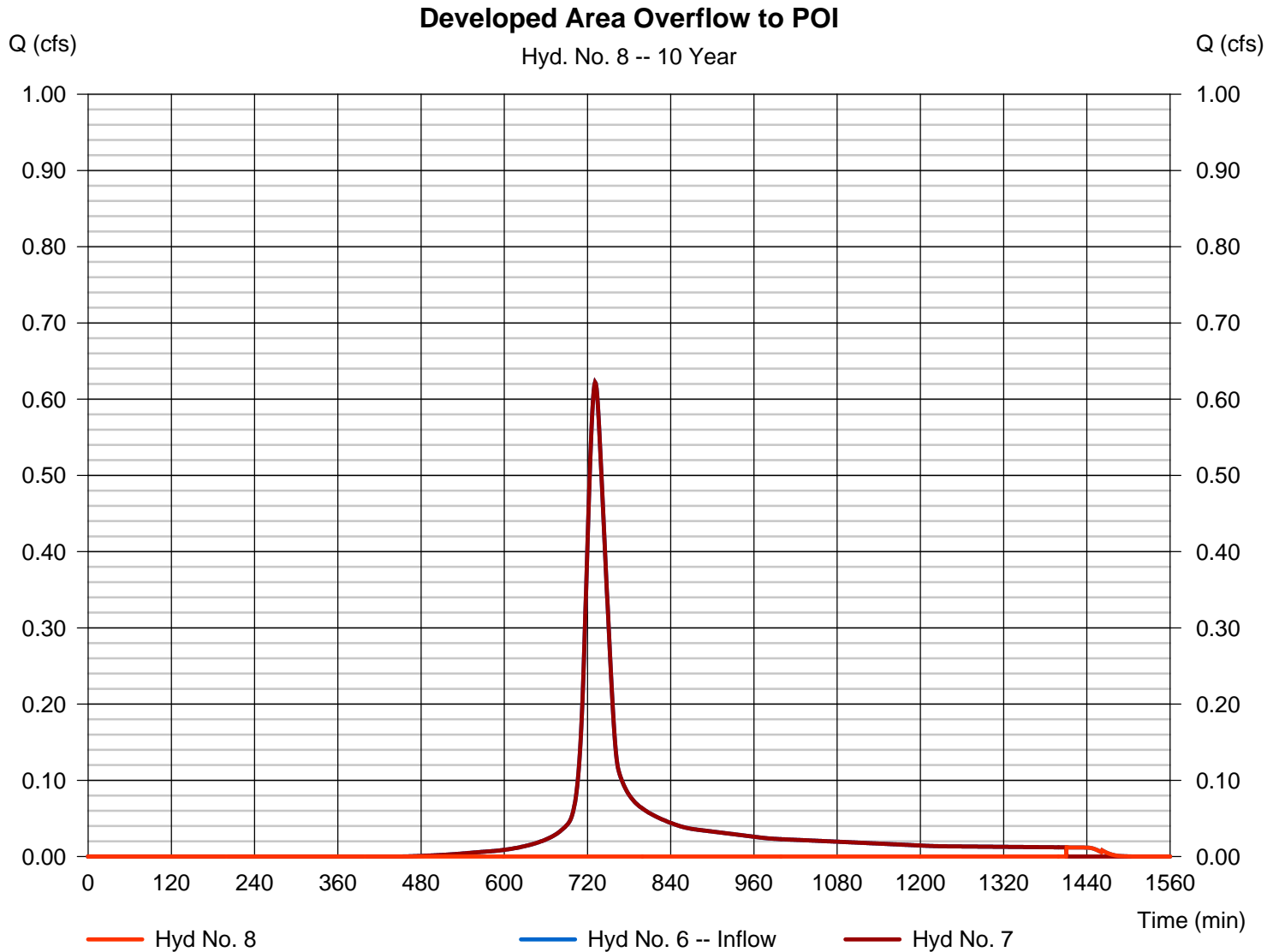
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.012 cfs  |
| Storm frequency   | = 10 yrs             | Time to peak      | = 1411 min   |
| Time interval     | = 1 min              | Hyd. volume       | = 39 cuft    |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

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

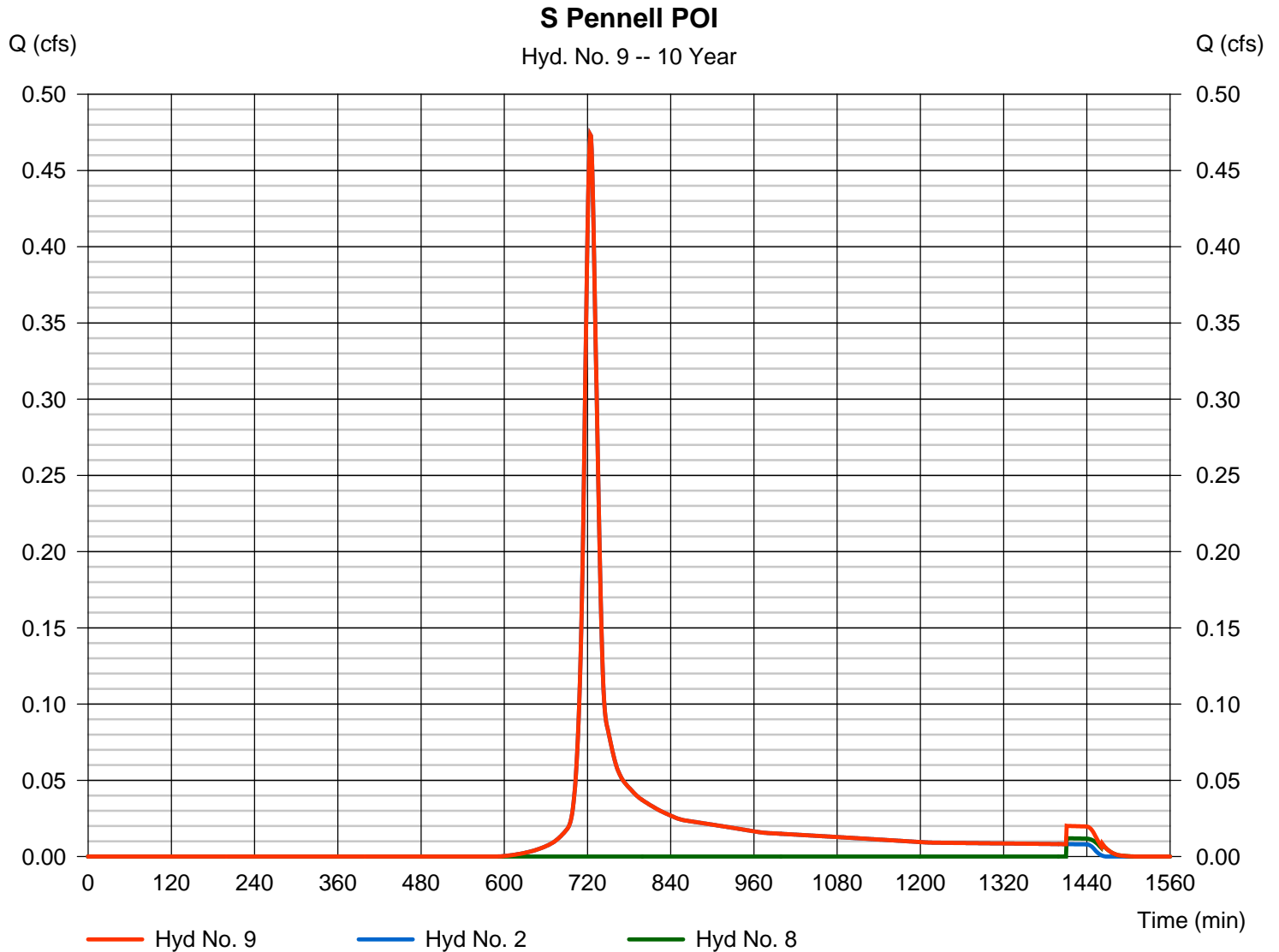
Wednesday, 11 / 9 / 2016

## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 0.473 cfs  
Time to peak = 724 min  
Hyd. volume = 1,461 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT C-4  
S PENNELL RD  
25 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area



# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# Hydrograph Summary Report

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

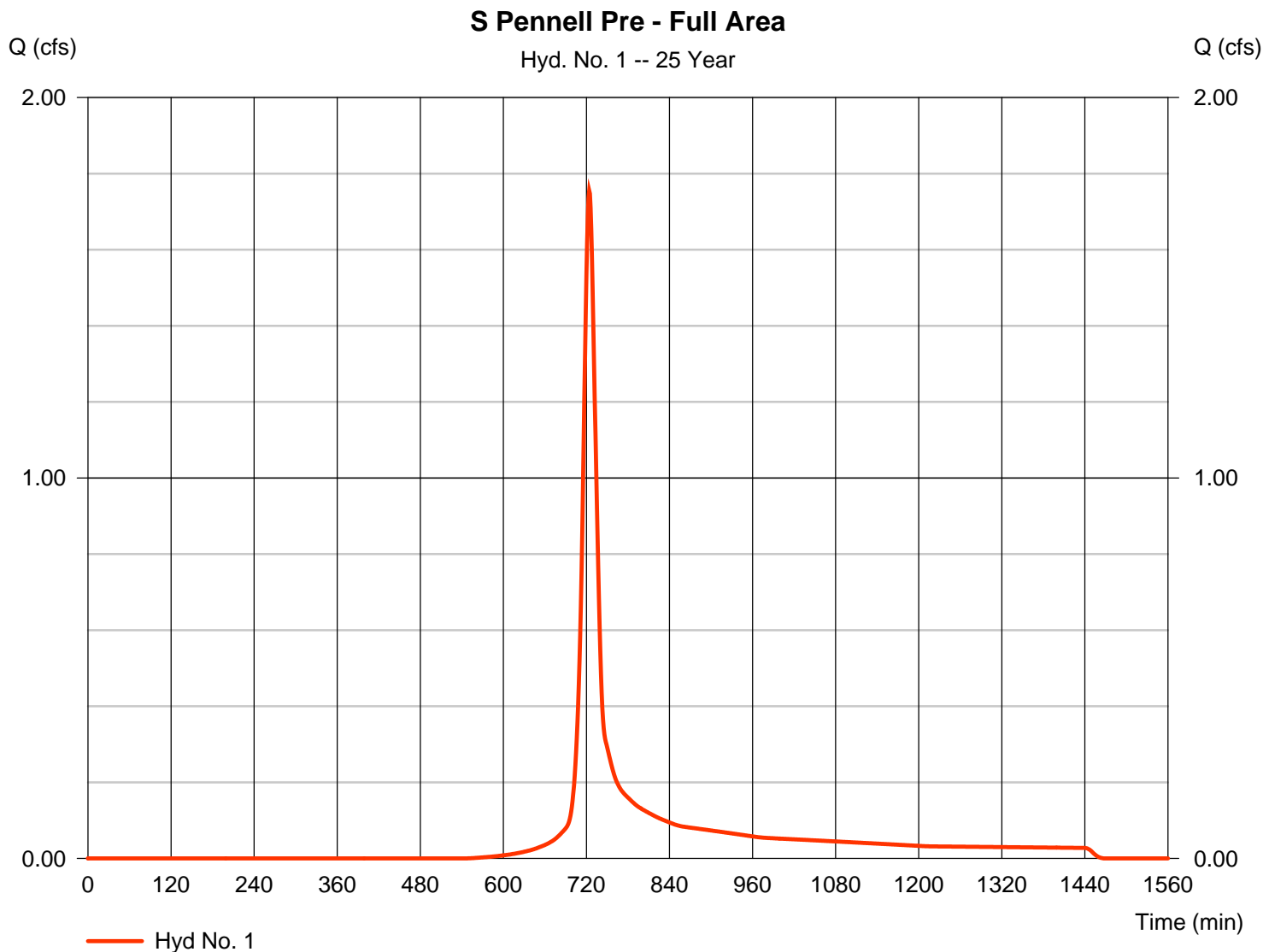
| Hyd. No.          | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft)   | Total strge used (cuft) | Hydrograph Description         |
|-------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|--------------------------|-------------------------|--------------------------------|
| 1                 | SCS Runoff               | 1.755           | 1                   | 724                | 5,222                  | -----         | -----                    | -----                   | S Pennell Pre - Full Area      |
| 2                 | SCS Runoff               | 1.294           | 1                   | 721                | 3,274                  | -----         | -----                    | -----                   | S Pennell Pre - Developed Area |
| S Pennell Pre.gpw |                          |                 |                     |                    | Return Period: 25 Year |               | Wednesday, 11 / 9 / 2016 |                         |                                |

# Hydrograph Report

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.755 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 5,222 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 5.86 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

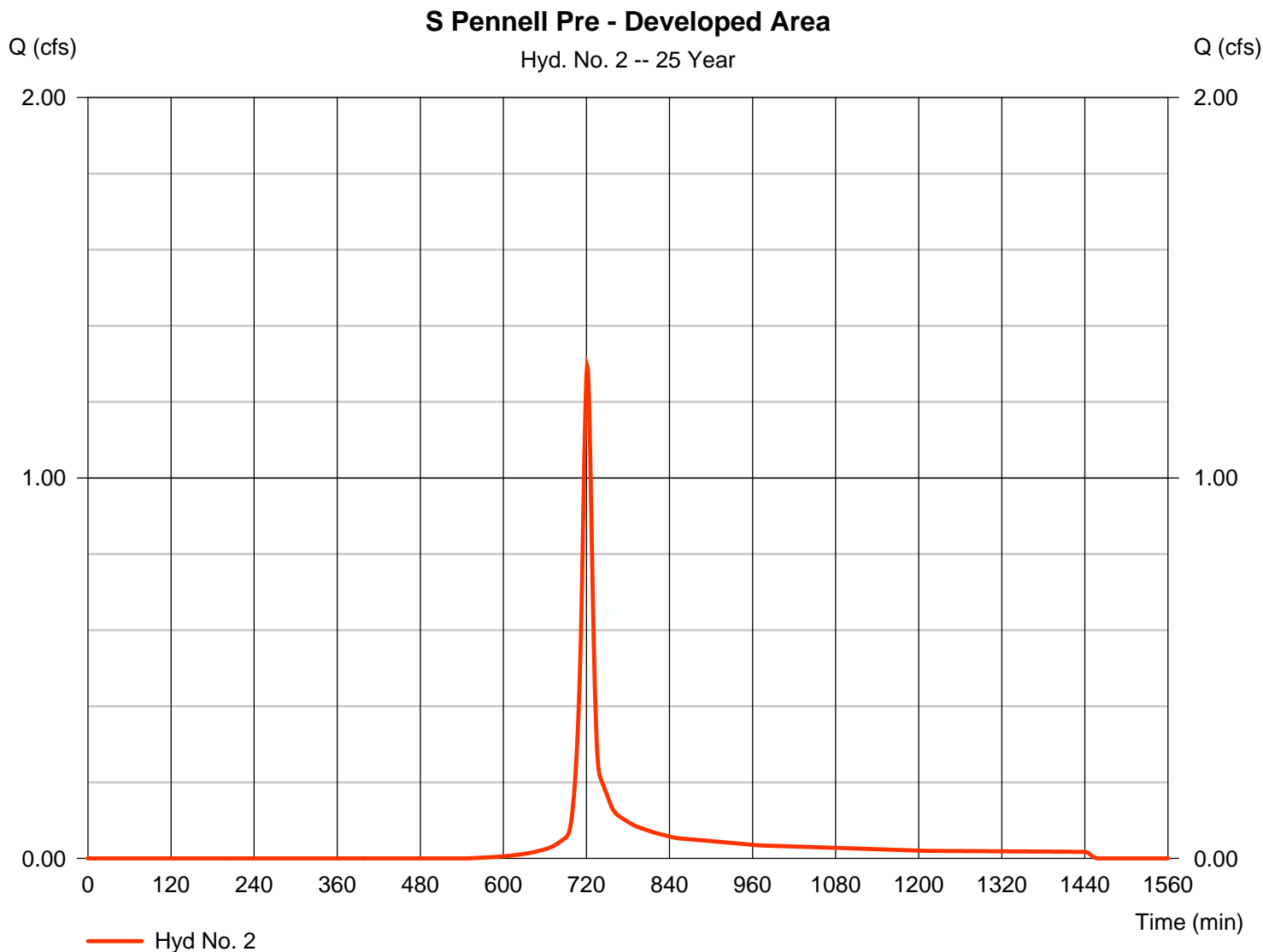
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.294 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 721 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,274 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 5.86 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

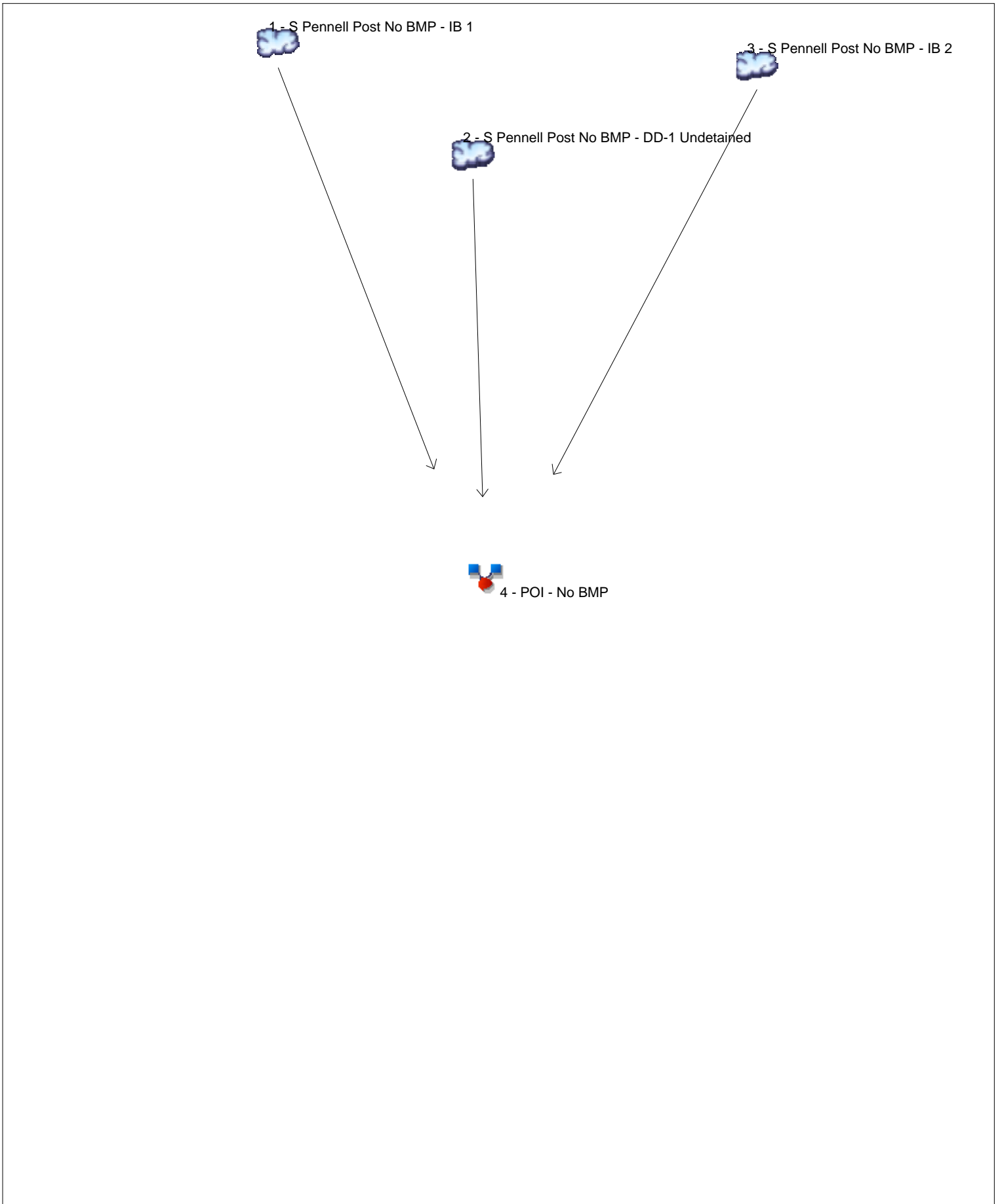
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |          |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |          |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |          |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>=</b> | <b>12.95</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.14</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| 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         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>13.10 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - No BMP                       |

# Hydrograph Summary Report

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

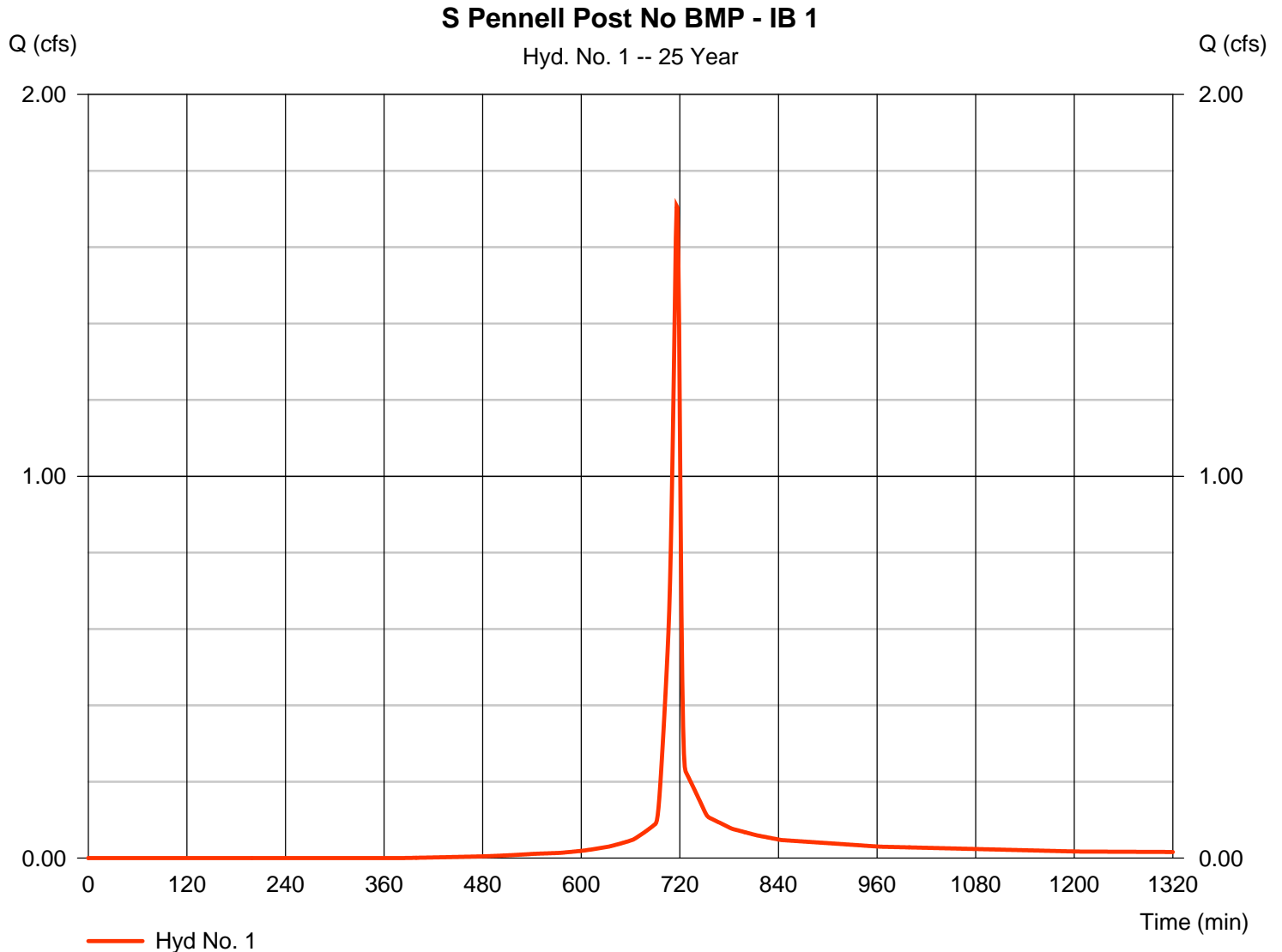
| Hyd. No.                 | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description             |  |
|--------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|------------------------------------|--|
| 1                        | SCS Runoff               | 1.708           | 1                   | 716                | 3,317                  | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |  |
| 2                        | SCS Runoff               | 0.673           | 1                   | 724                | 2,000                  | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |  |
| 3                        | SCS Runoff               | 0.402           | 1                   | 719                | 910                    | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |  |
| 4                        | Combine                  | 2.537           | 1                   | 717                | 6,227                  | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |  |
| S Pennel Post no BMP.gpw |                          |                 |                     |                    | Return Period: 25 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |  |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.708 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,317 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 5.86 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.240                | 0.011                |                 |
| Flow length (ft)                   | = 34.0        | 8.0                  | 58.0                 |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 3.25                 | 3.25                 |                 |
| Land slope (%)                     | = 7.40        | 50.00                | 5.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> <b>0.52</b> | <b>+</b> <b>0.54</b> | <b>= 4.60</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 55.00       | 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                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.18</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>4.80 min</b> |

# Hydrograph Report

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

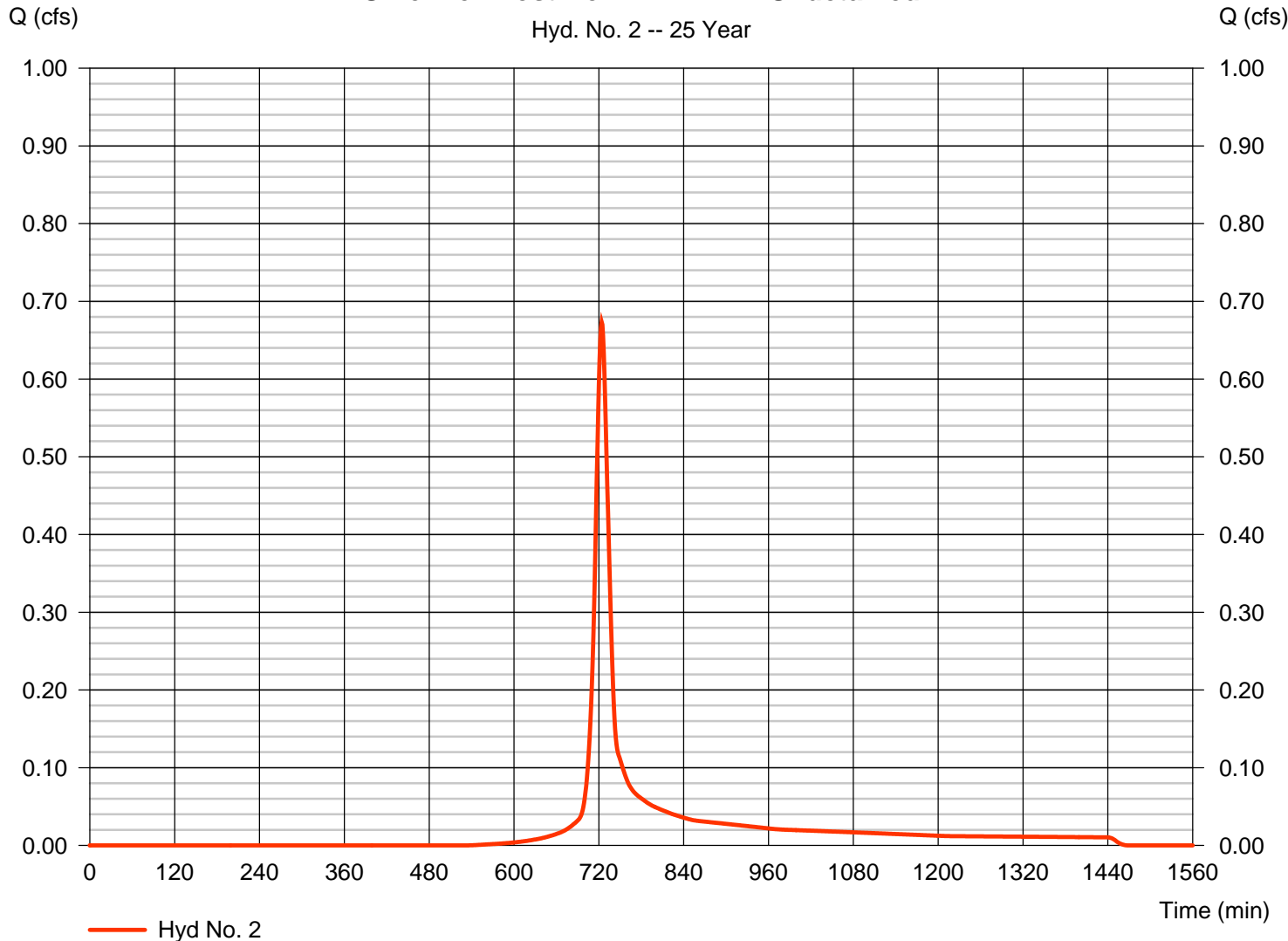
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.673 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,000 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 5.86 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | 35.0           | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

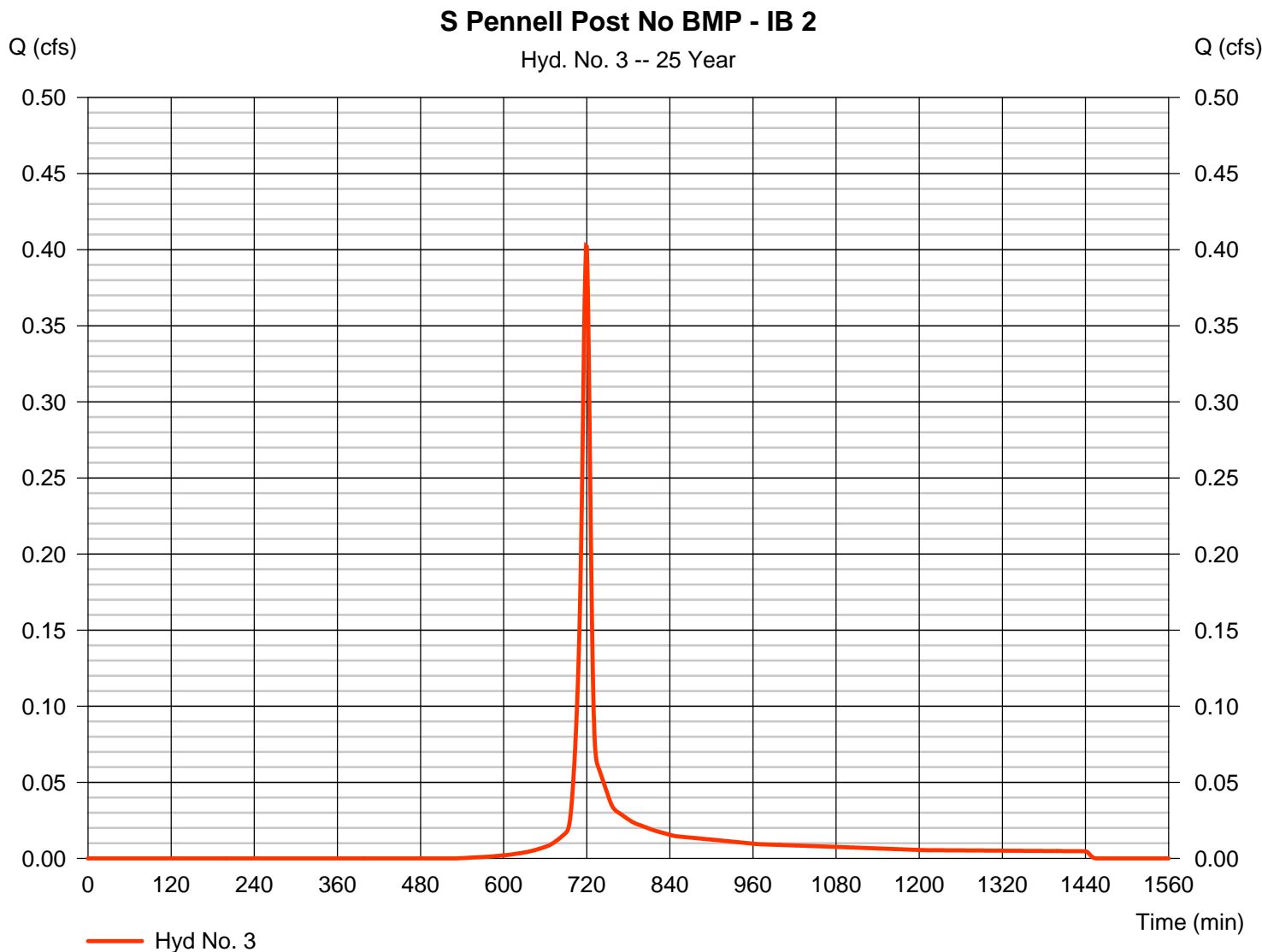
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.402 cfs |
| Storm frequency | = 25 yrs     | Time to peak       | = 719 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 910 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min  |
| Total precip.   | = 5.86 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      | <u>B</u>             | <u>C</u>             | <u>Totals</u>   |
|------------------------------------|---------------|----------------------|----------------------|-----------------|
| <b>Sheet Flow</b>                  |               |                      |                      |                 |
| Manning's n-value                  | = 0.240       | 0.240                | 0.011                |                 |
| Flow length (ft)                   | = 34.0        | 66.0                 | 0.0                  |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 3.25                 | 0.00                 |                 |
| Land slope (%)                     | = 6.00        | 9.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> <b>5.56</b> | <b>+</b> <b>0.00</b> | <b>= 9.41</b>   |
| <b>Shallow Concentrated Flow</b>   |               |                      |                      |                 |
| Flow length (ft)                   | = 70.00       | 0.00                 | 0.00                 |                 |
| Watercourse slope (%)              | = 9.00        | 0.00                 | 0.00                 |                 |
| Surface description                | = Unpaved     | Paved                | Paved                |                 |
| Average velocity (ft/s)            | =4.84         | 0.00                 | 0.00                 |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.24</b>   |
| <b>Channel Flow</b>                |               |                      |                      |                 |
| 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                  |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> <b>0.00</b> | <b>+</b> <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |                      |                      | <b>9.70 min</b> |

# Hydrograph Report

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

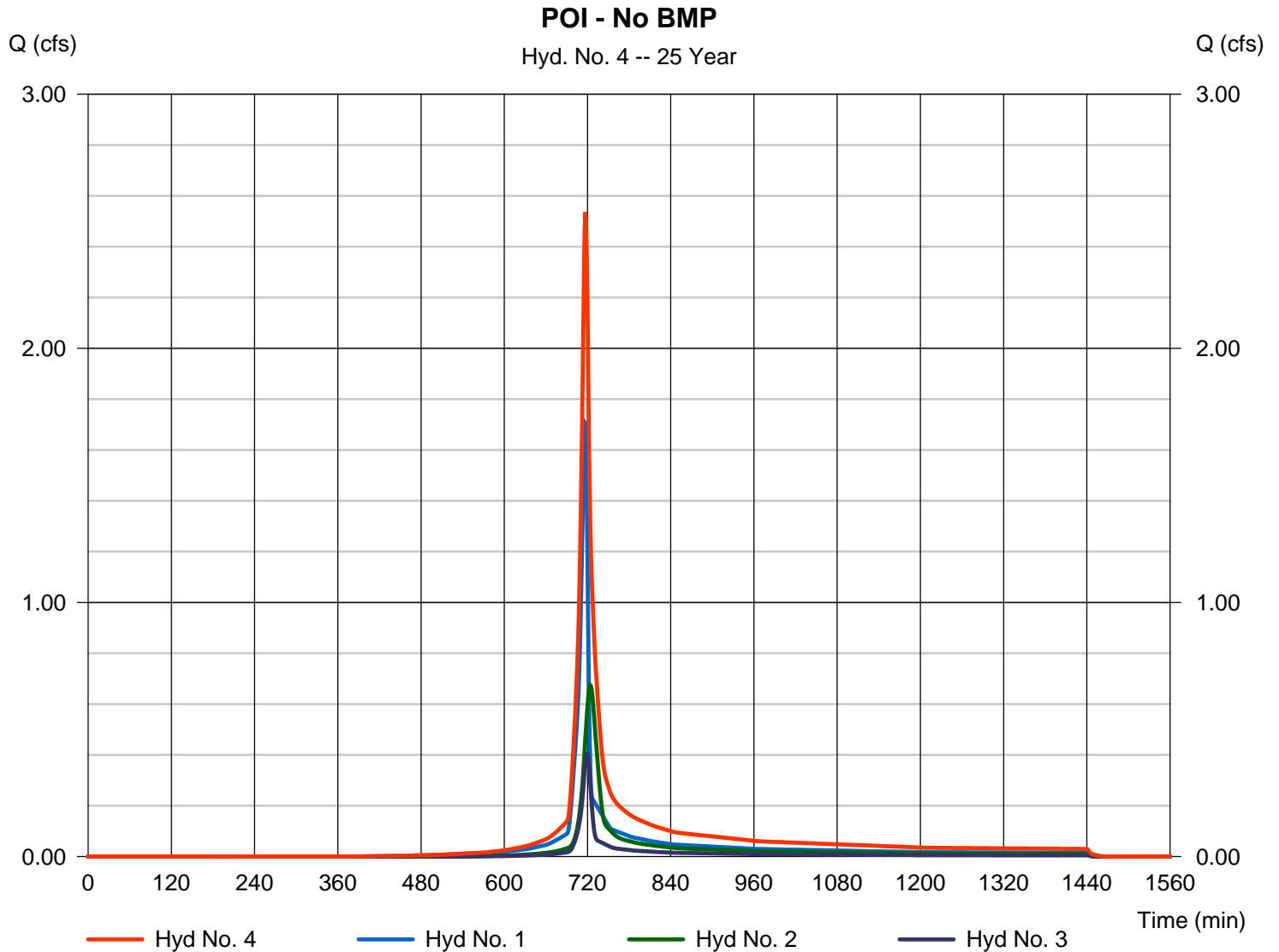
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

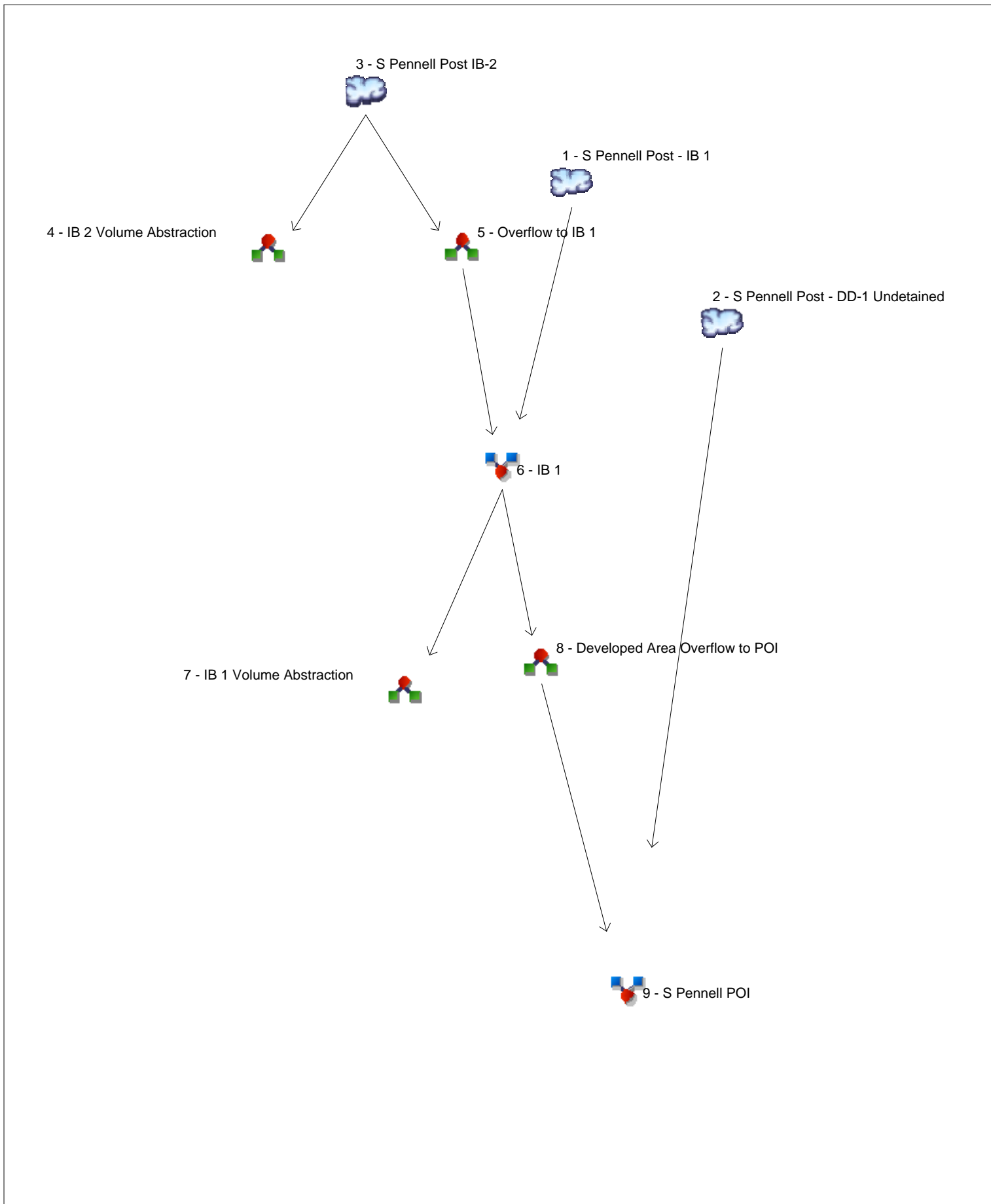
Hydrograph type = Combine  
Storm frequency = 25 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 2.537 cfs  
Time to peak = 717 min  
Hyd. volume = 6,227 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# Hydrograph Return Period Recap

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| 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 0.966 | -----  | -----                  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 0.673 | -----  | -----                  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | 0.163 | -----  | -----                  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 0.163 | -----  | -----                  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | 0.002 | -----  | -----                  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | ----- | ----- | ----- | ----- | ----- | 0.966 | -----  | -----                  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | 0.966 | -----  | -----                  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | 0.048 | -----  | -----                  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | ----- | ----- | ----- | ----- | ----- | 0.673 | -----  | -----                  | S Pennell 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               | 0.966           | 1                   | 727                | 3,287                  | -----         | -----                  | -----                    | S Pennell Post - IB 1            |
| 2                         | SCS Runoff               | 0.673           | 1                   | 724                | 2,000                  | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |
| 3                         | SCS Runoff               | 0.163           | 1                   | 743                | 906                    | -----         | -----                  | -----                    | S Pennell Post IB-2              |
| 4                         | Diversion1               | 0.163           | 1                   | 743                | 905                    | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |
| 5                         | Diversion2               | 0.002           | 1                   | 1480               | 1                      | 3             | -----                  | -----                    | Overflow to IB 1                 |
| 6                         | Combine                  | 0.966           | 1                   | 727                | 3,289                  | 1, 5          | -----                  | -----                    | IB 1                             |
| 7                         | Diversion1               | 0.966           | 1                   | 727                | 2,449                  | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |
| 8                         | Diversion2               | 0.048           | 1                   | 857                | 840                    | 6             | -----                  | -----                    | Developed Area Overflow to POI   |
| 9                         | Combine                  | 0.673           | 1                   | 724                | 2,840                  | 2, 8          | -----                  | -----                    | S Pennell POI                    |
| S Pennel Post - 25 yr.gpw |                          |                 |                     |                    | Return Period: 25 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |

# Hydrograph Report

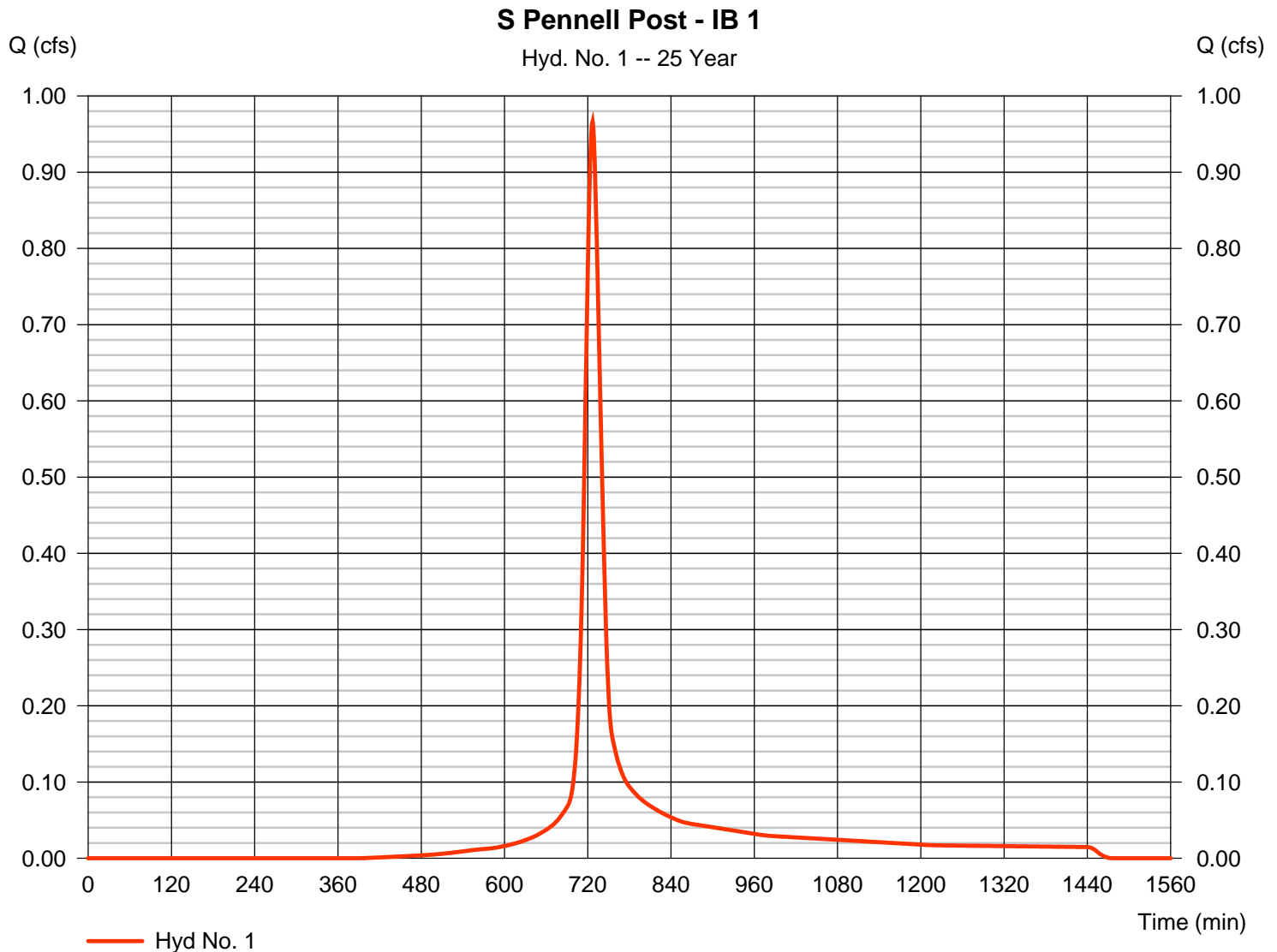
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.966 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 727 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,287 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 23.00 min  |
| Total precip.   | = 5.86 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



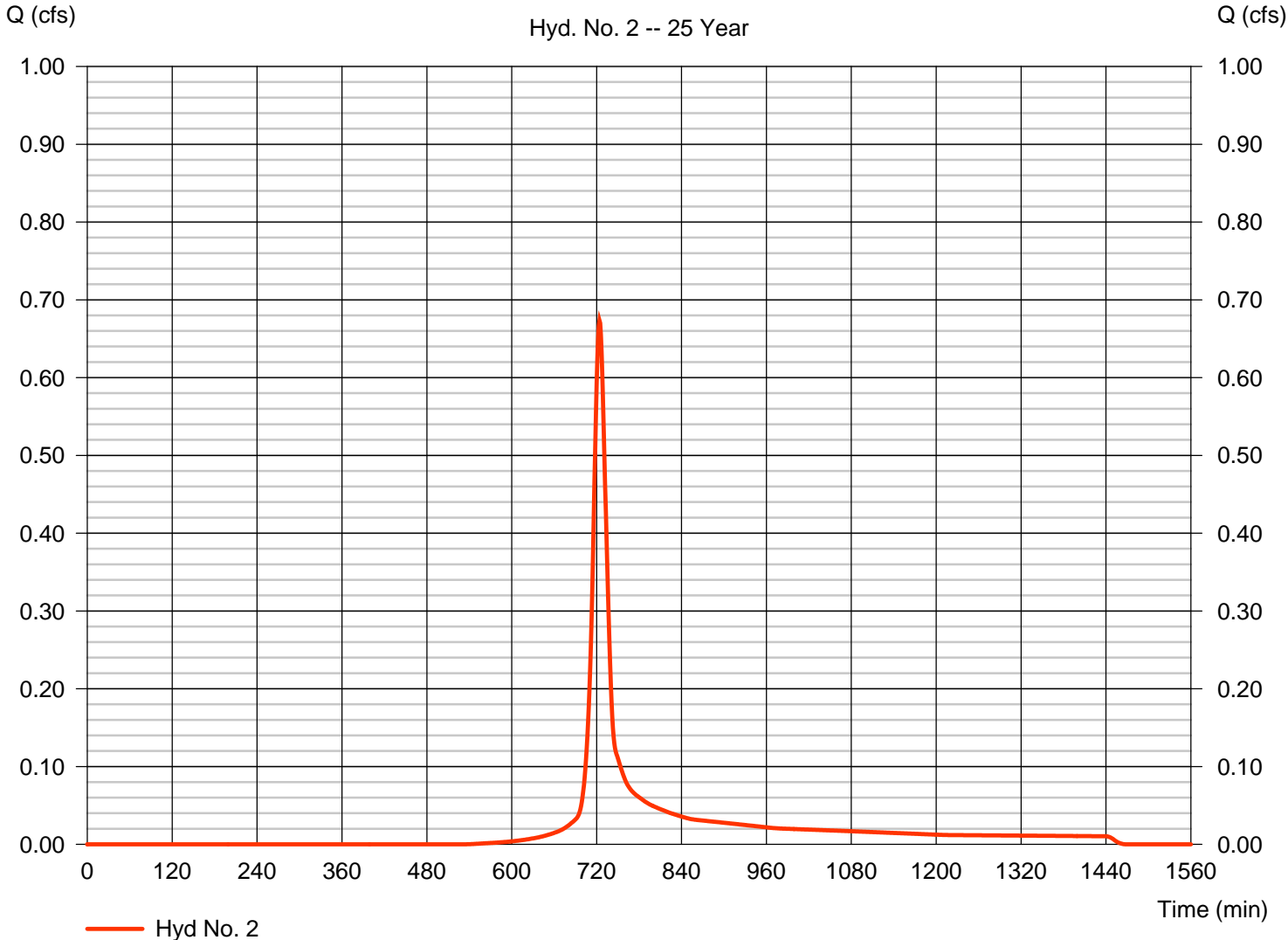
# Hydrograph Report

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.673 cfs  |
| Storm frequency | = 25 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,000 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 5.86 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

S Pennell Post - DD-1 Undetained



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

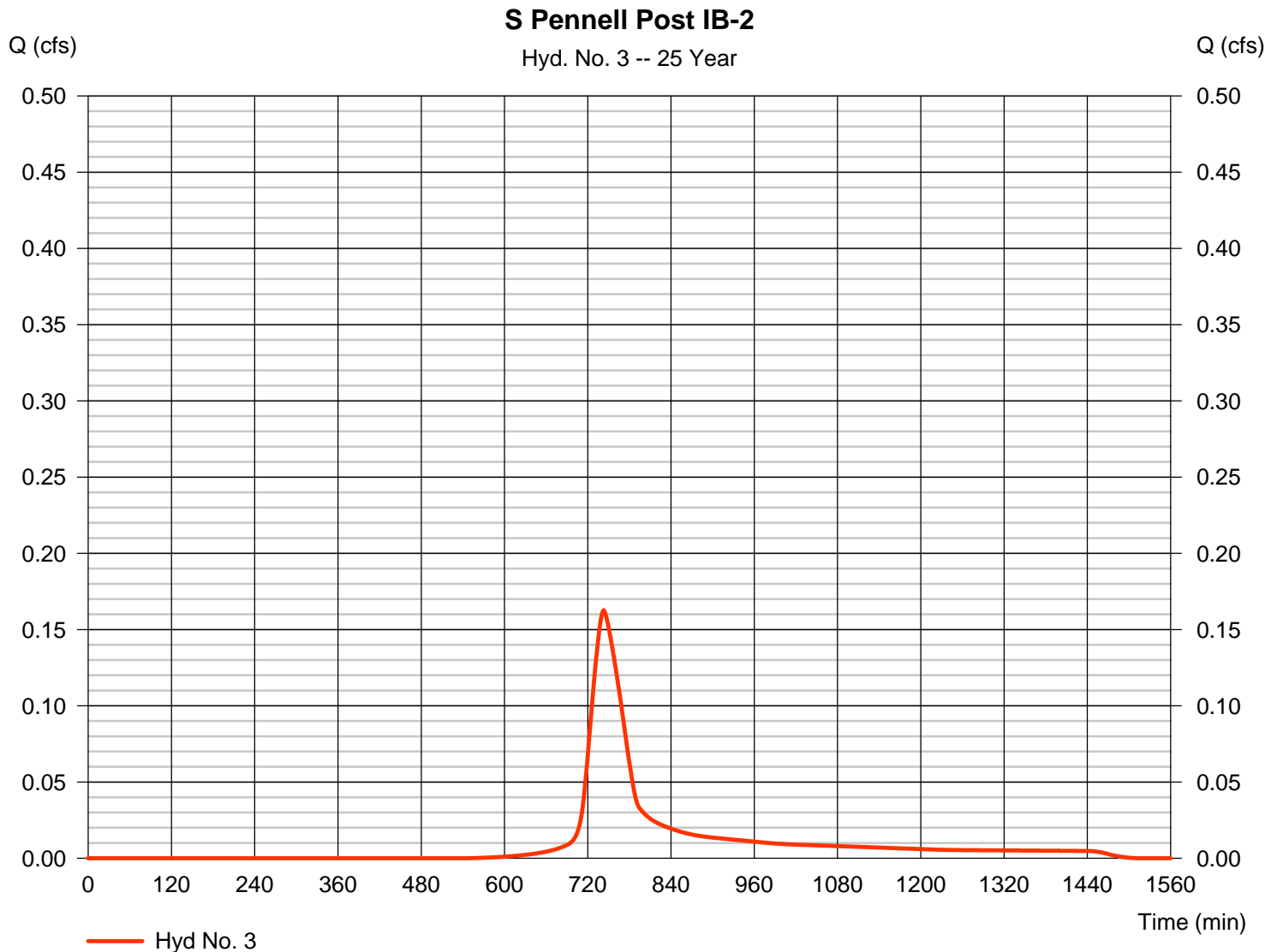
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.163 cfs |
| Storm frequency | = 25 yrs     | Time to peak       | = 743 min   |
| Time interval   | = 1 min      | Hyd. volume        | = 906 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 71        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 47.60 min |
| Total precip.   | = 5.86 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |



# Hydrograph Report

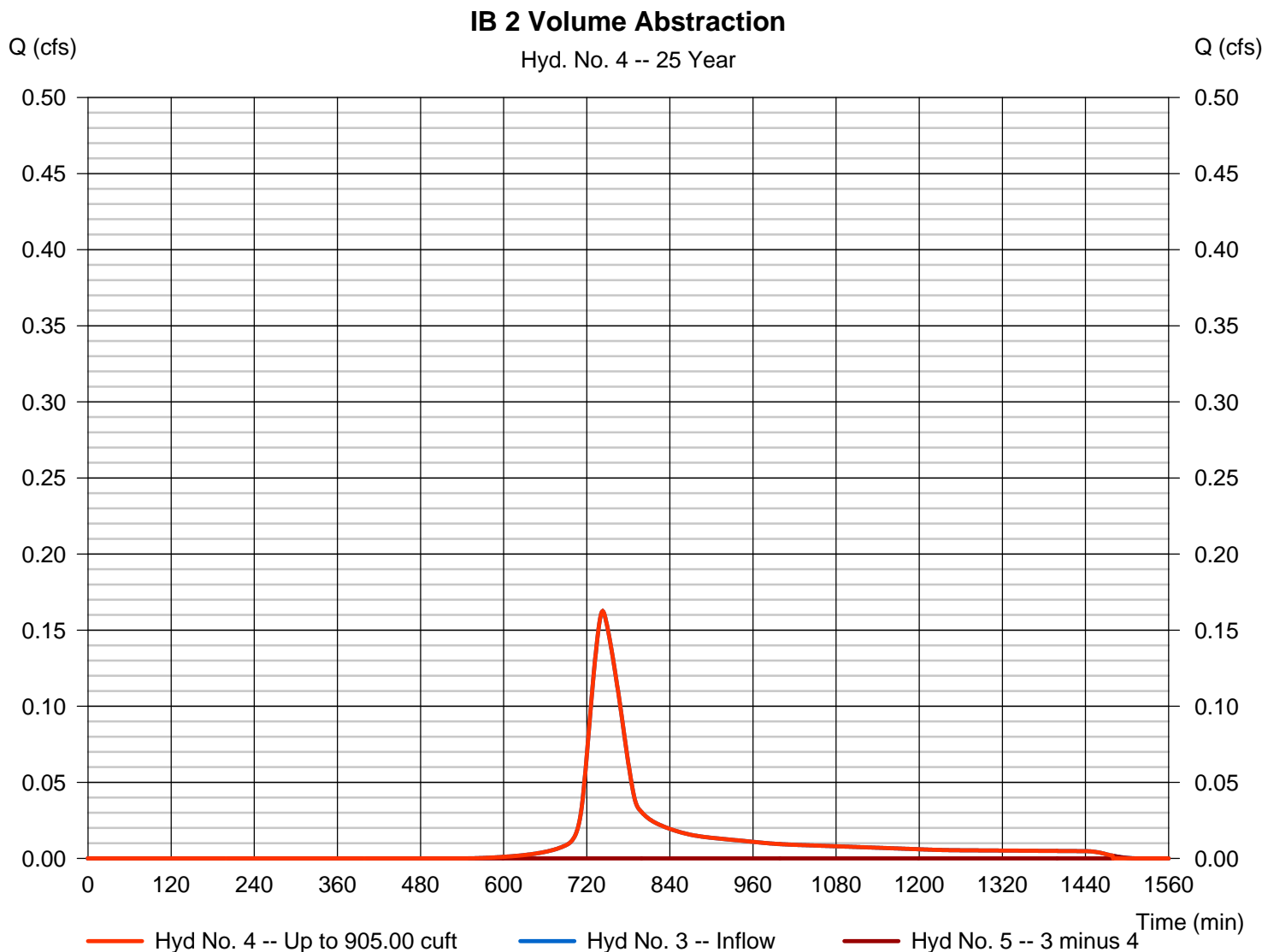
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.163 cfs   |
| Storm frequency   | = 25 yrs                  | Time to peak      | = 743 min     |
| Time interval     | = 1 min                   | Hyd. volume       | = 905 cuft    |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 905.00 cuft |



# Hydrograph Report

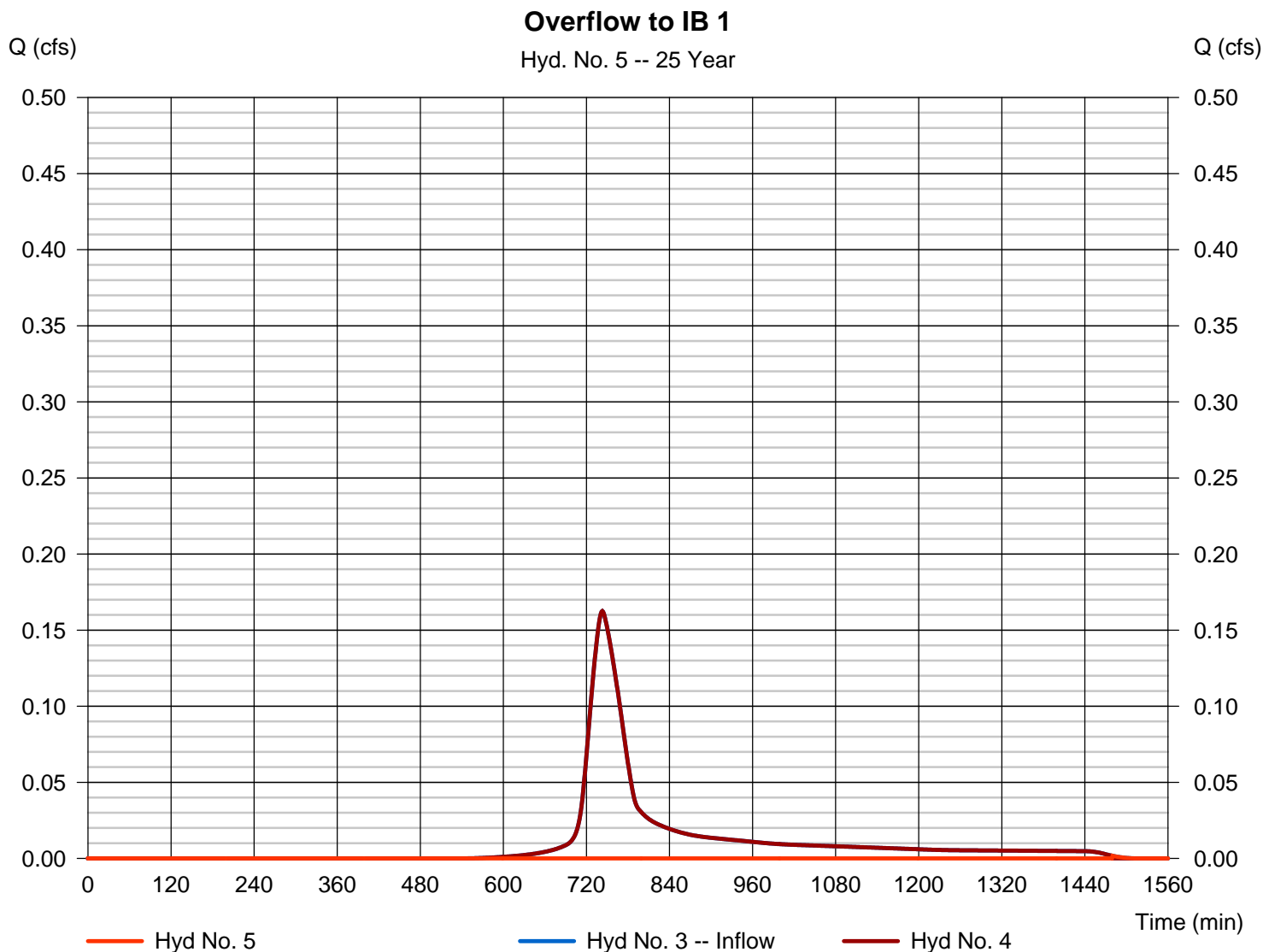
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |               |
|-------------------|---------------------------|-------------------|---------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.002 cfs   |
| Storm frequency   | = 25 yrs                  | Time to peak      | = 1480 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1 cuft      |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4           |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 905.00 cuft |



# Hydrograph Report

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

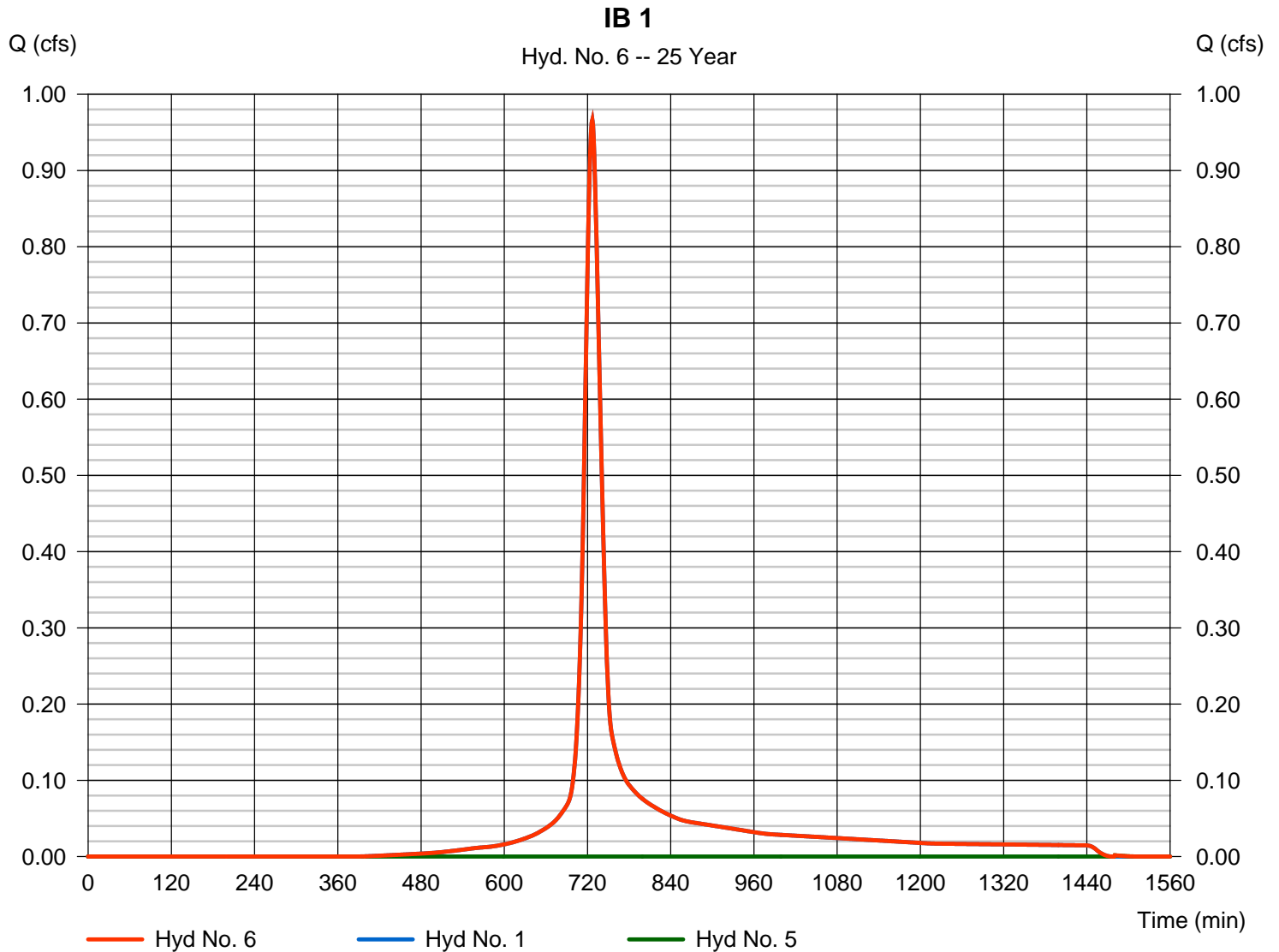
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

IB 1

Hydrograph type = Combine  
Storm frequency = 25 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 5

Peak discharge = 0.966 cfs  
Time to peak = 727 min  
Hyd. volume = 3,289 cuft  
Contrib. drain. area = 0.250 ac

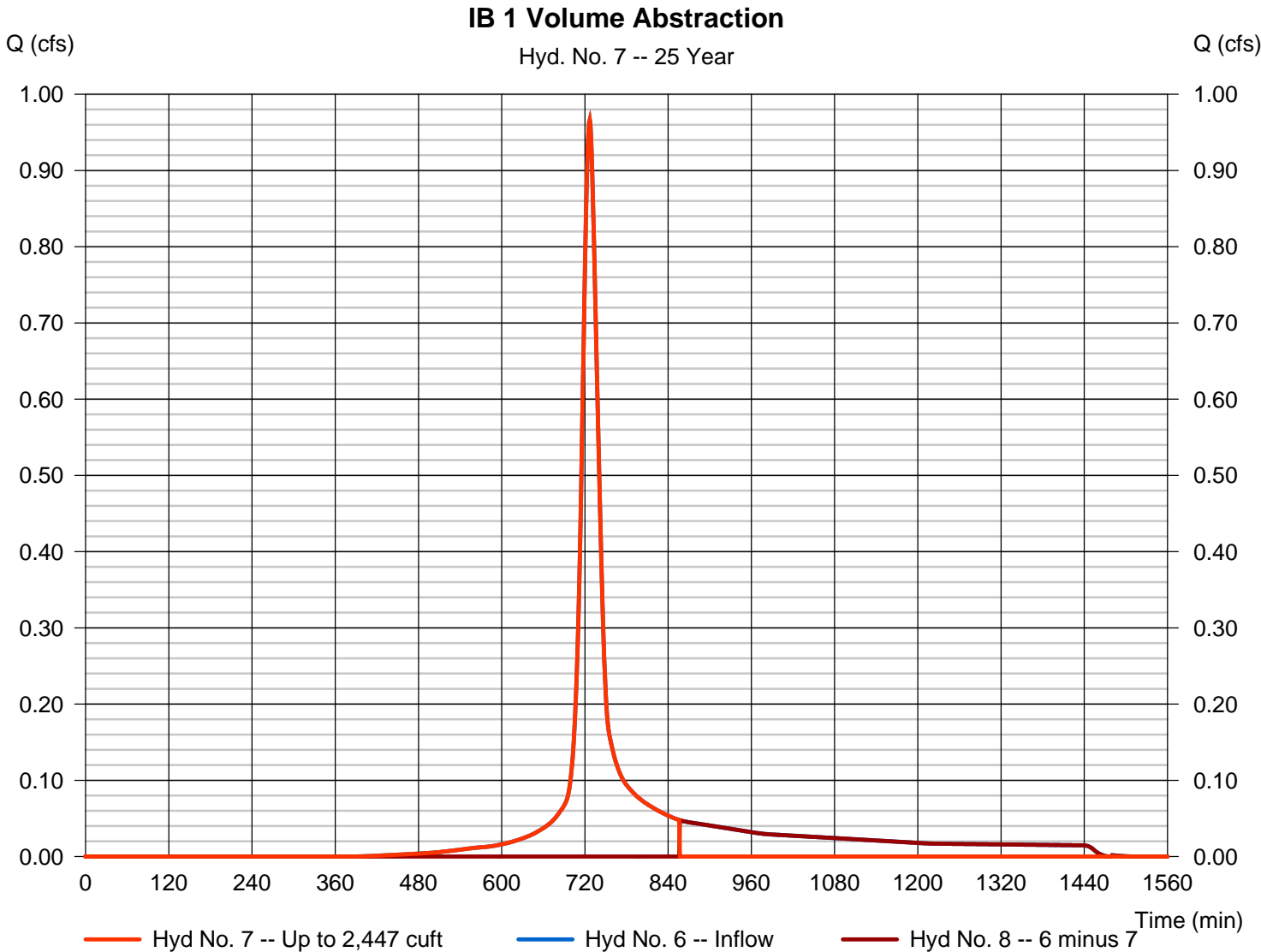


# Hydrograph Report

## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 0.966 cfs  |
| Storm frequency   | = 25 yrs             | Time to peak      | = 727 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,449 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

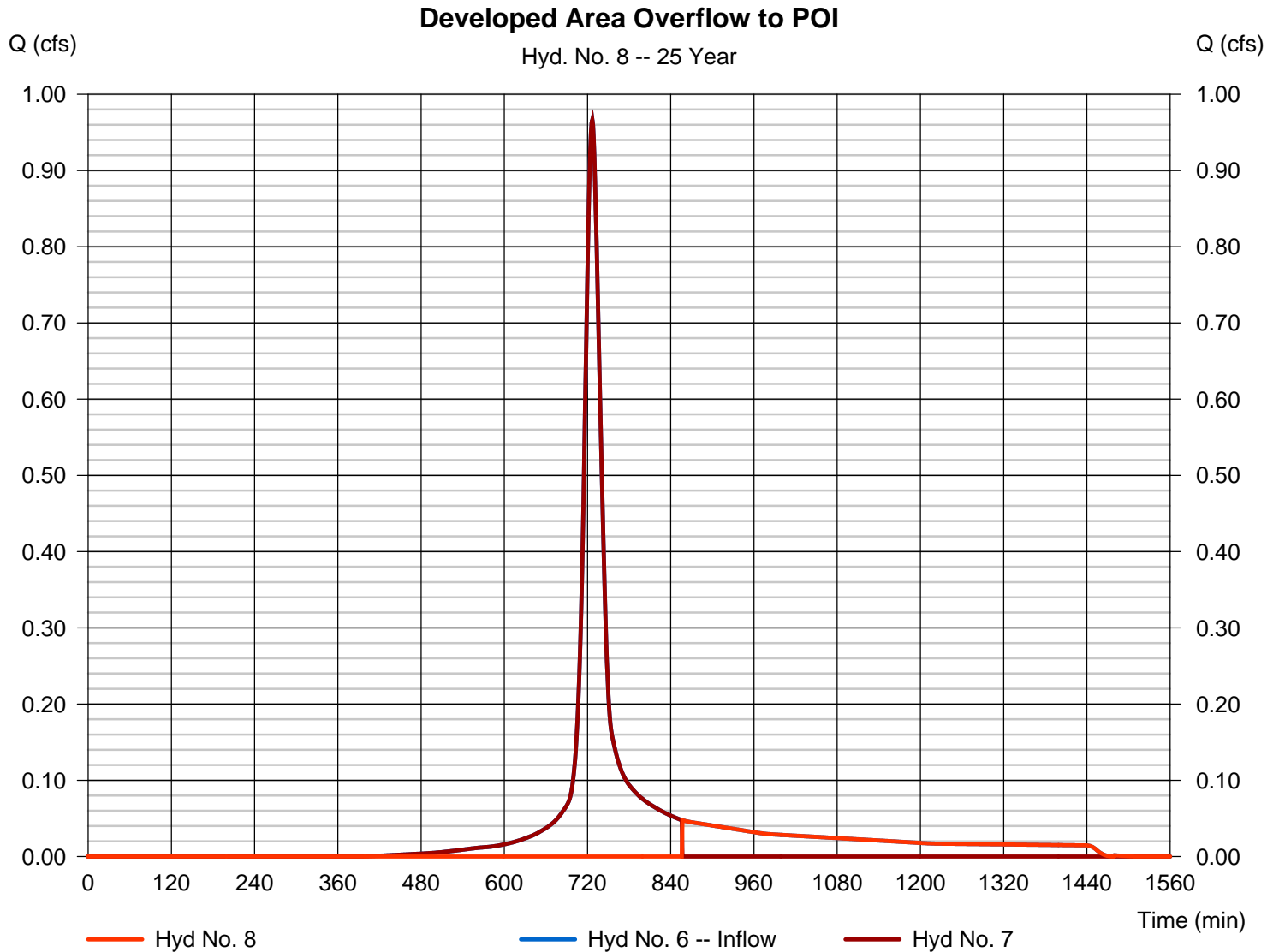
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.048 cfs  |
| Storm frequency   | = 25 yrs             | Time to peak      | = 857 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 840 cuft   |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

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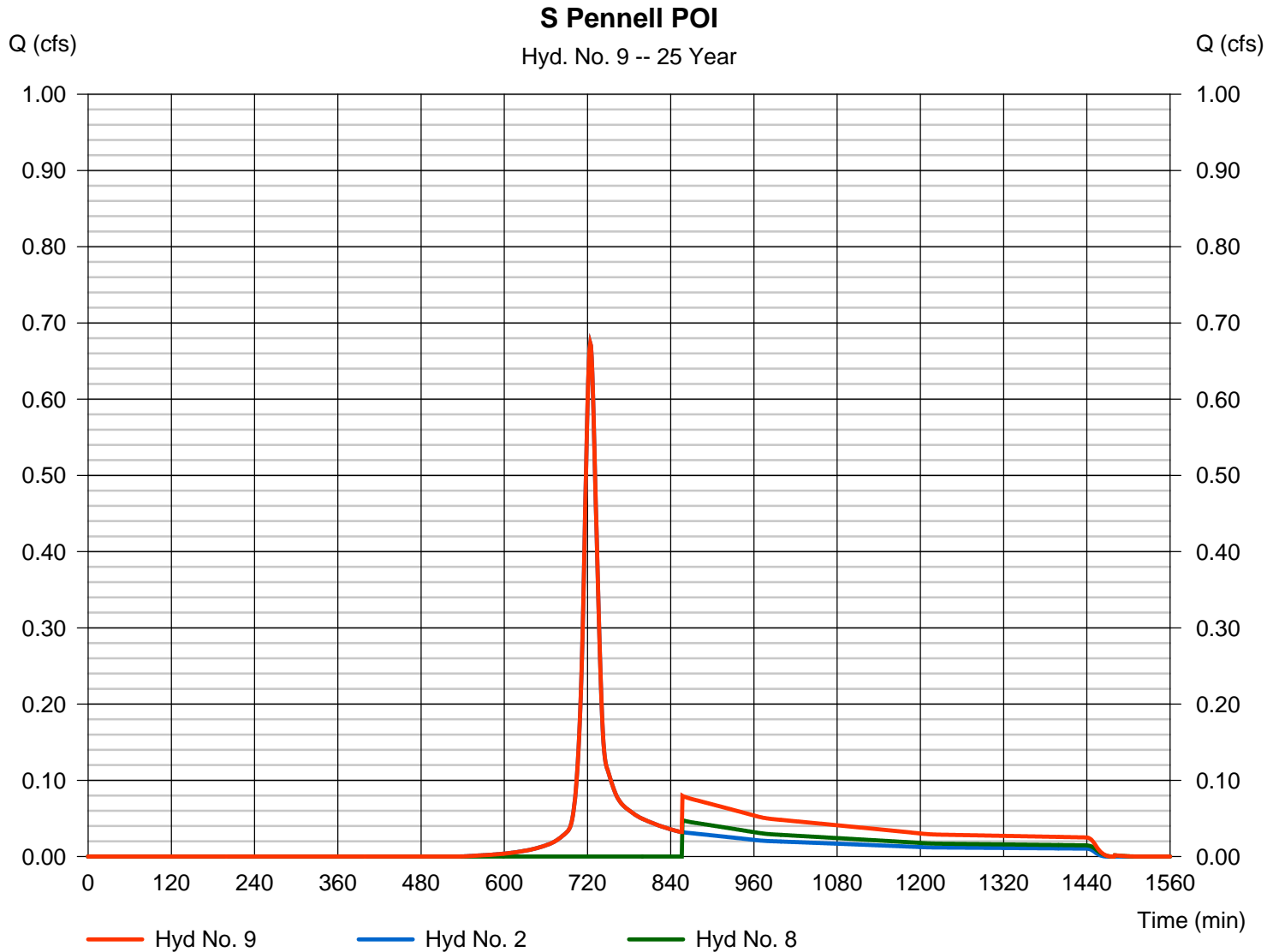
Wednesday, 11 / 9 / 2016

## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 25 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 0.673 cfs  
Time to peak = 724 min  
Hyd. volume = 2,840 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT C-5  
S PENNELL RD  
50 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area



# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# 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               | 2.226           | 1                   | 724                | 6,596                  | -----         | -----                    | -----                   | S Pennell Pre - Full Area      |
| 2                 | SCS Runoff               | 1.637           | 1                   | 721                | 4,135                  | -----         | -----                    | -----                   | S Pennell Pre - Developed Area |
| S Pennell Pre.gpw |                          |                 |                     |                    | Return Period: 50 Year |               | Wednesday, 11 / 9 / 2016 |                         |                                |

# Hydrograph Report

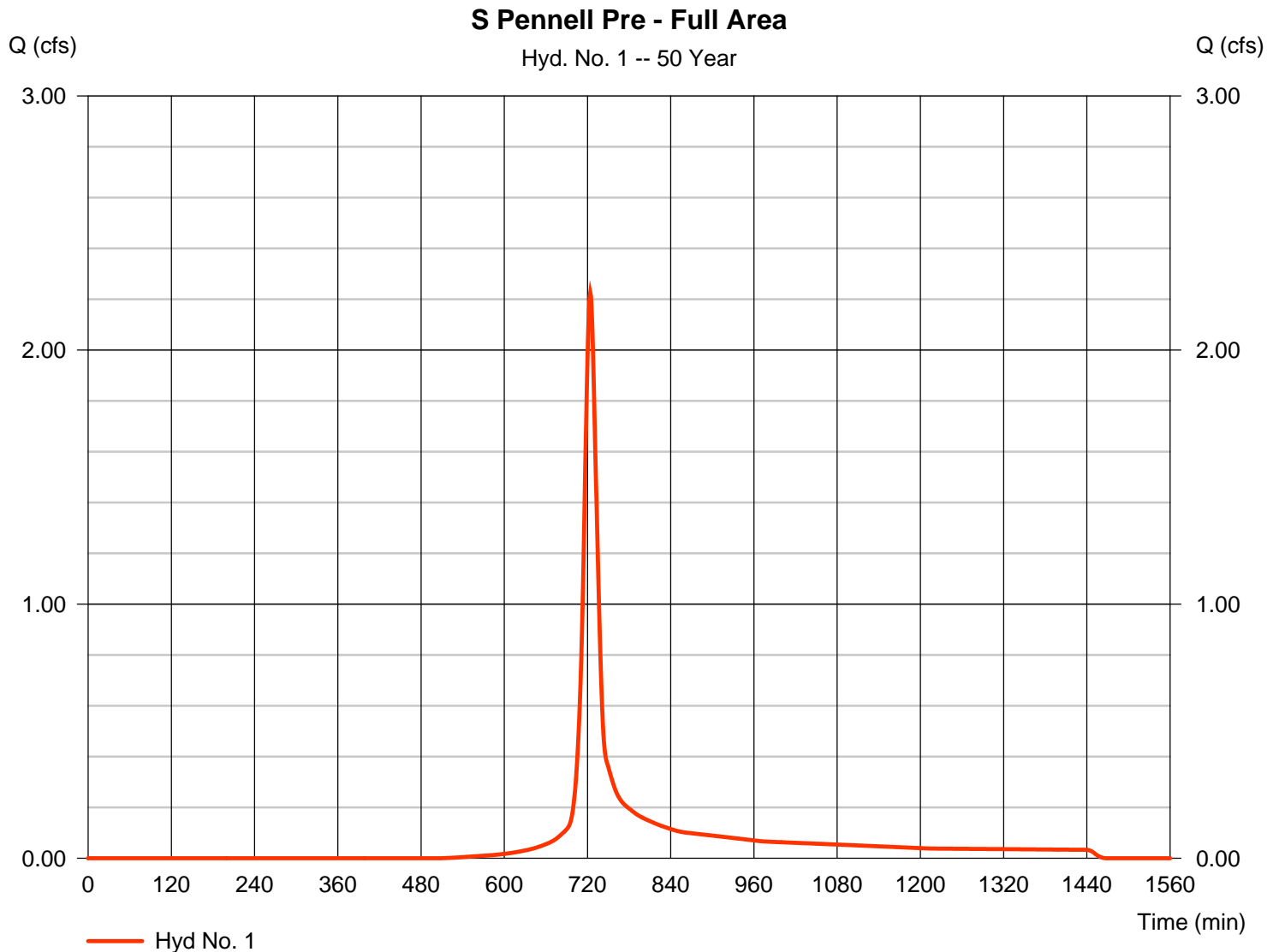
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.226 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 6,596 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 6.74 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

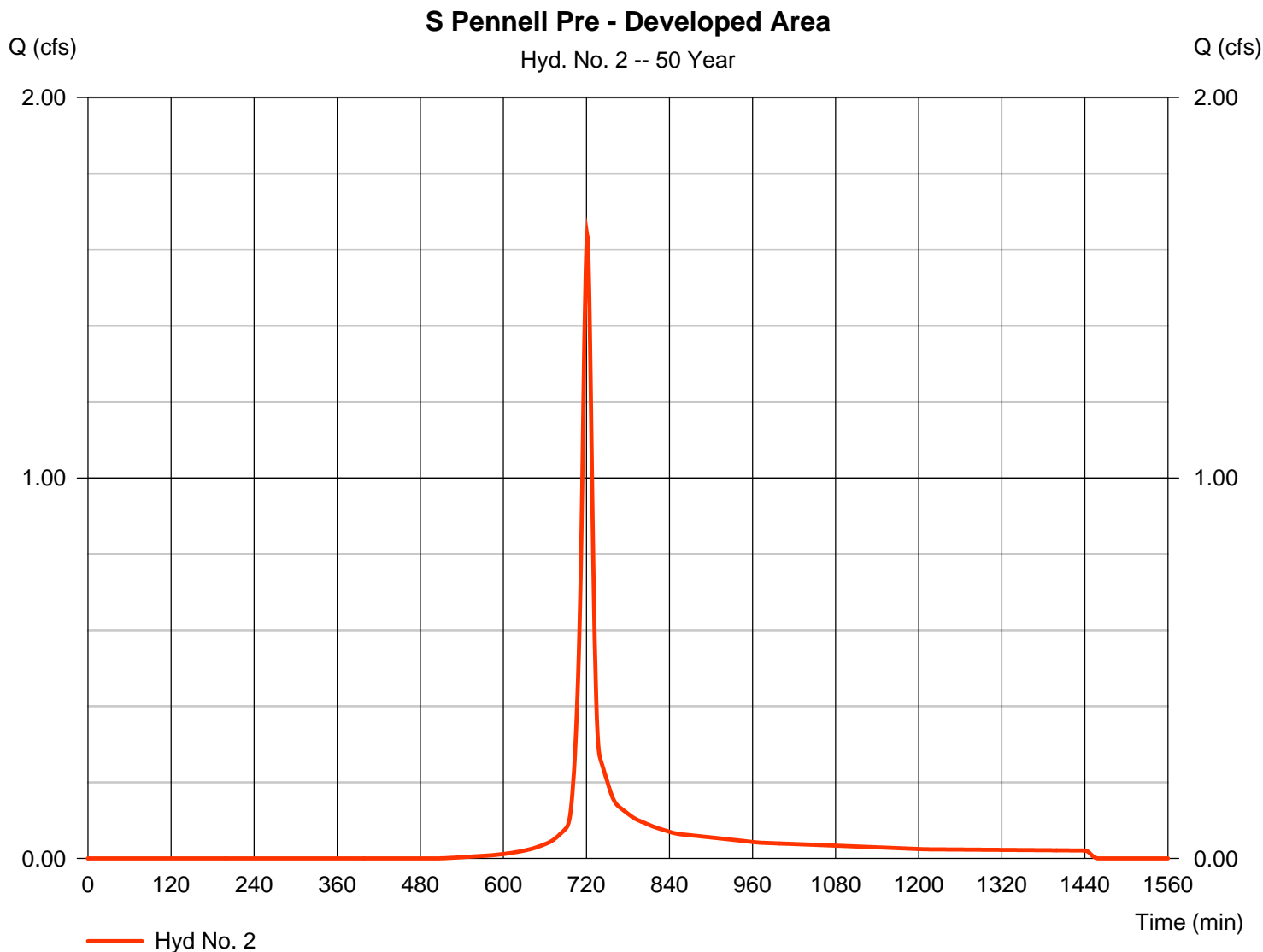
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.637 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 721 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,135 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 6.74 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

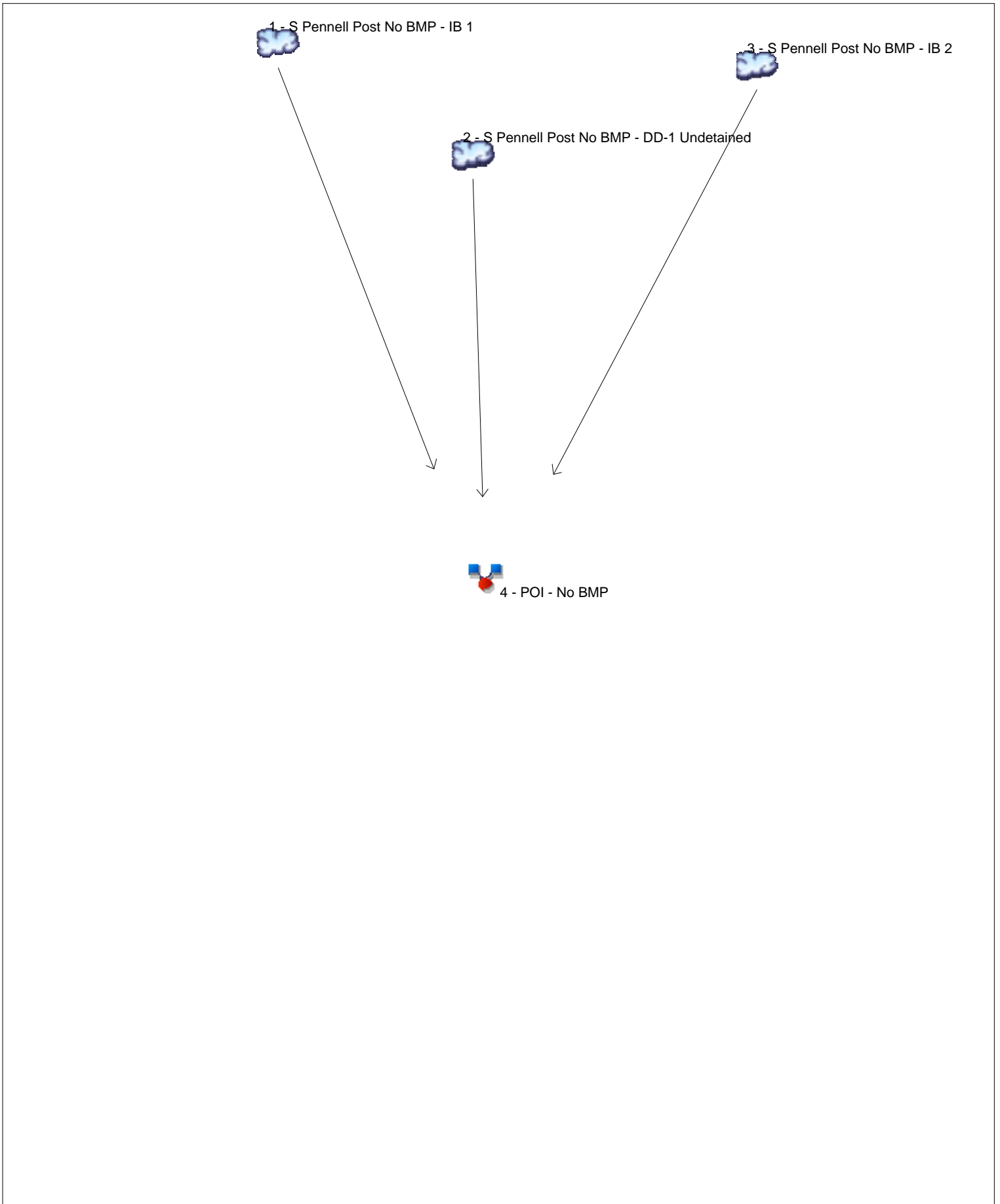
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>= 12.95</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.14</b>    |
| <b>Channel Flow</b>                |               |          |             |          |             |                  |
| 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         |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>13.10 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - No BMP                       |

# Hydrograph Summary Report

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

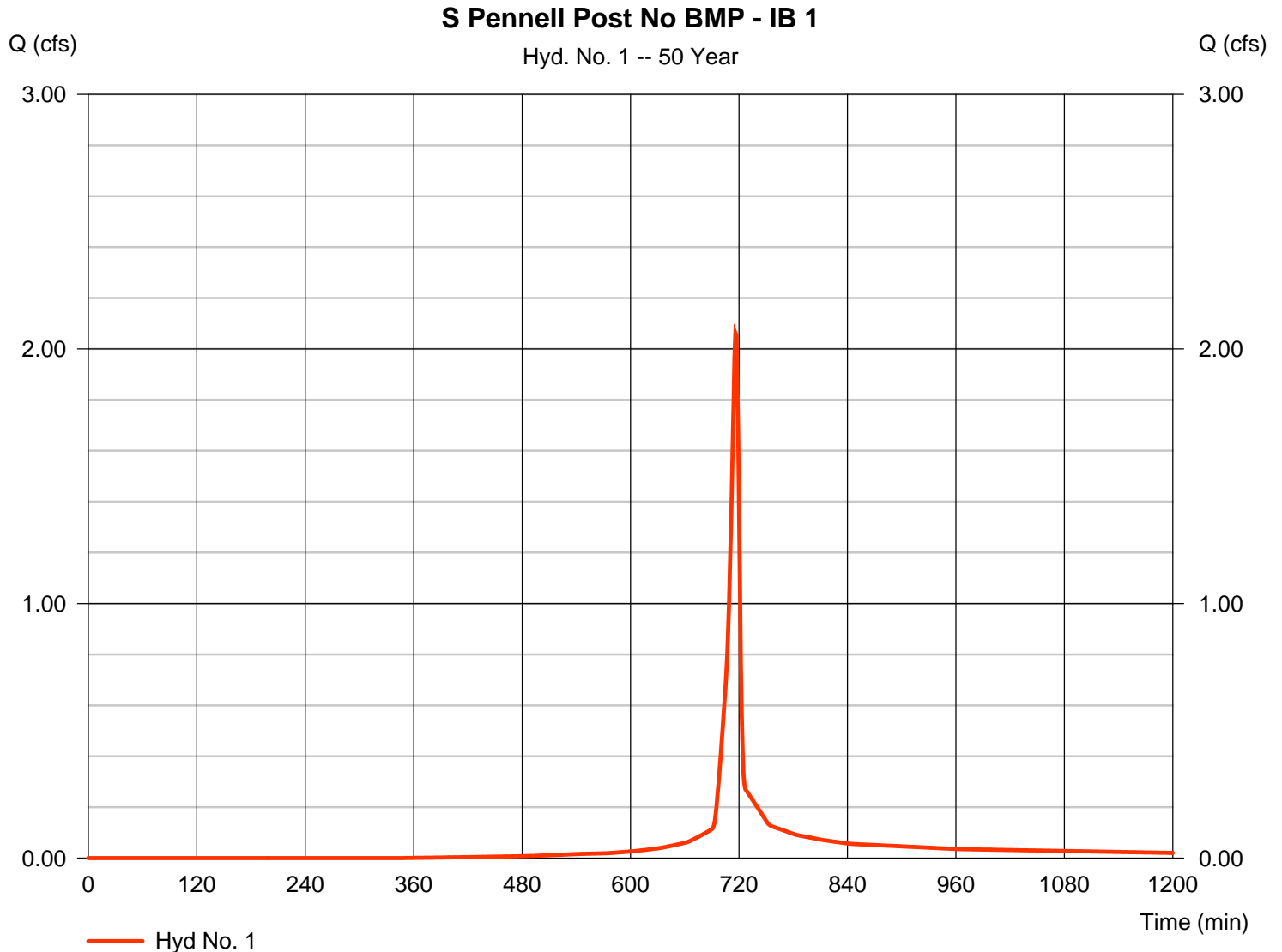
| Hyd. No.                  | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description             |
|---------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|------------------------------------|
| 1                         | SCS Runoff               | 2.061           | 1                   | 716                | 4,043                  | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |
| 2                         | SCS Runoff               | 0.850           | 1                   | 724                | 2,516                  | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |
| 3                         | SCS Runoff               | 0.506           | 1                   | 719                | 1,145                  | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |
| 4                         | Combine                  | 3.116           | 1                   | 717                | 7,704                  | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |
| S Pennell Post no BMP.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.061 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,043 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 6.74 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |                 |
| Flow length (ft)                   | = 34.0        |          | 8.0         |          | 58.0        |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |                 |
| Land slope (%)                     | = 7.40        |          | 50.00       |          | 5.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> | <b>0.52</b> | <b>+</b> | <b>0.54</b> | <b>= 4.60</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 55.00       |          | 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        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.18</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>4.80 min</b> |

# Hydrograph Report

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

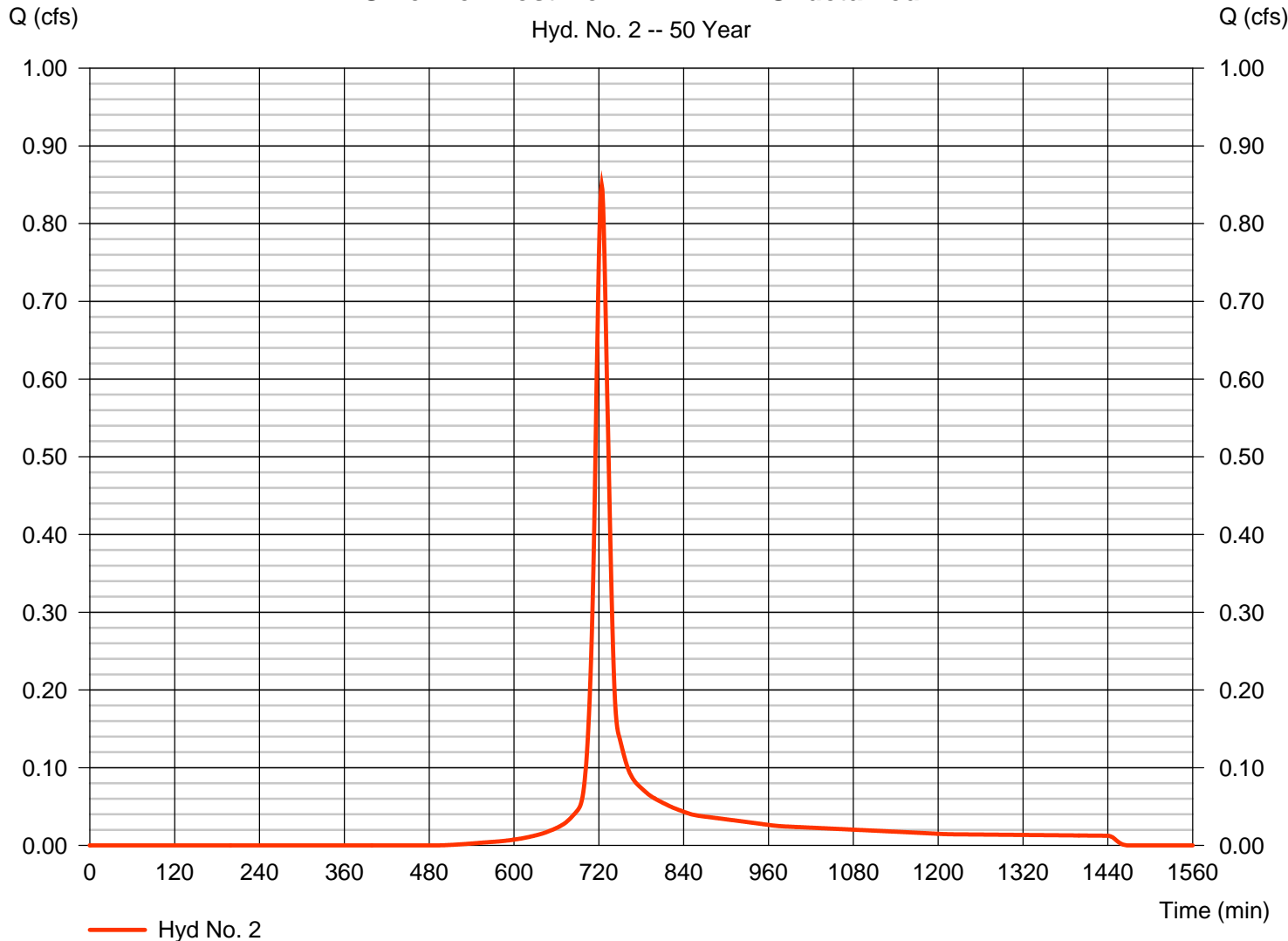
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.850 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,516 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 6.74 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

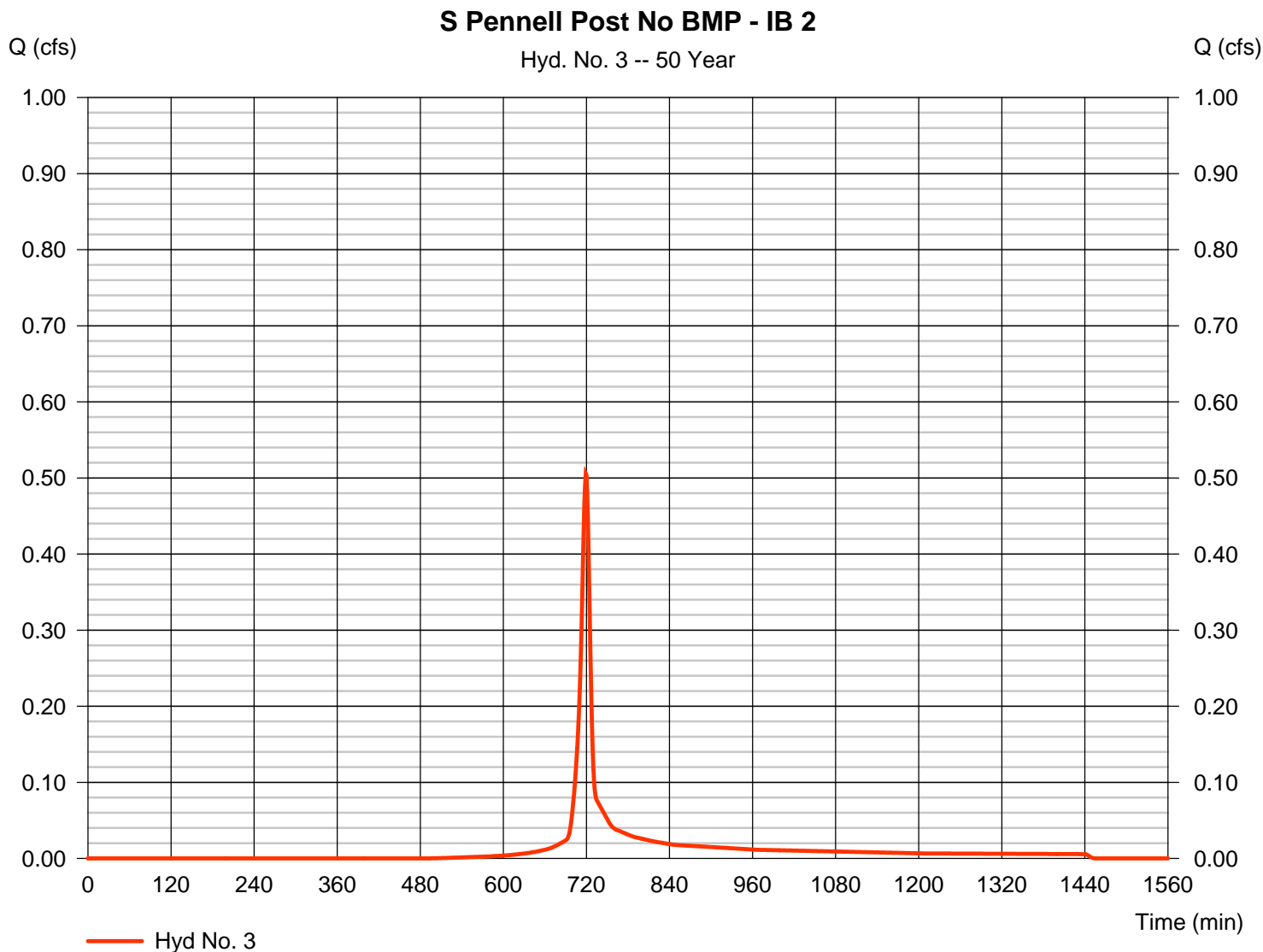
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.506 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,145 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min   |
| Total precip.   | = 6.74 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |          |                 |
| Flow length (ft)                   | = 34.0        |          | 66.0        |          | 0.0         |          |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 0.00        |          |                 |
| Land slope (%)                     | = 6.00        |          | 9.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> | <b>5.56</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>9.41</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                 |
| Flow length (ft)                   | = 70.00       |          | 0.00        |          | 0.00        |          |                 |
| Watercourse slope (%)              | = 9.00        |          | 0.00        |          | 0.00        |          |                 |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                 |
| Average velocity (ft/s)            | =4.84         |          | 0.00        |          | 0.00        |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.24</b>     |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                 |
| 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         |          |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>     |
| <b>Total Travel Time, Tc</b> ..... |               |          |             |          |             |          | <b>9.70 min</b> |

# Hydrograph Report

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

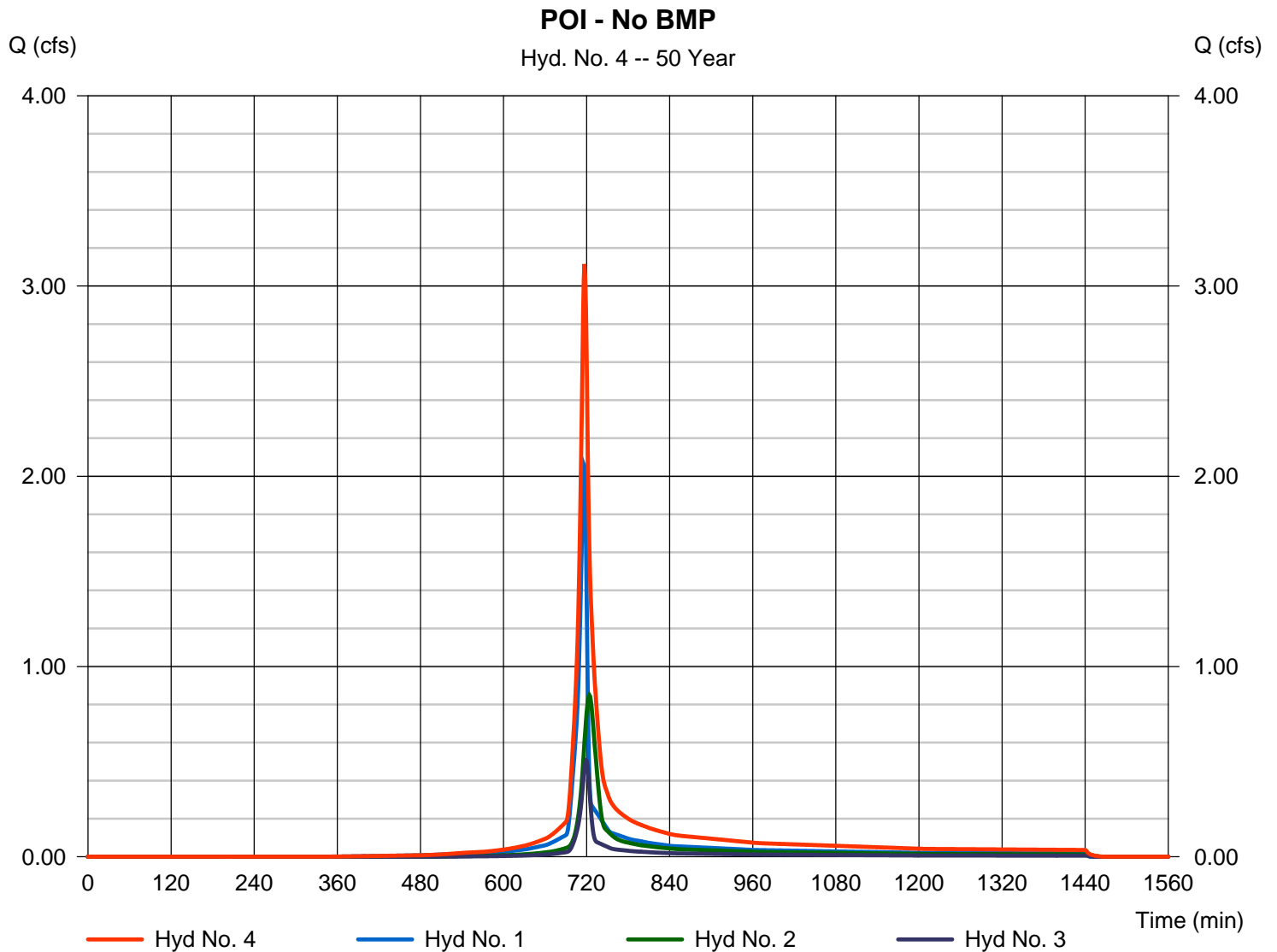
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

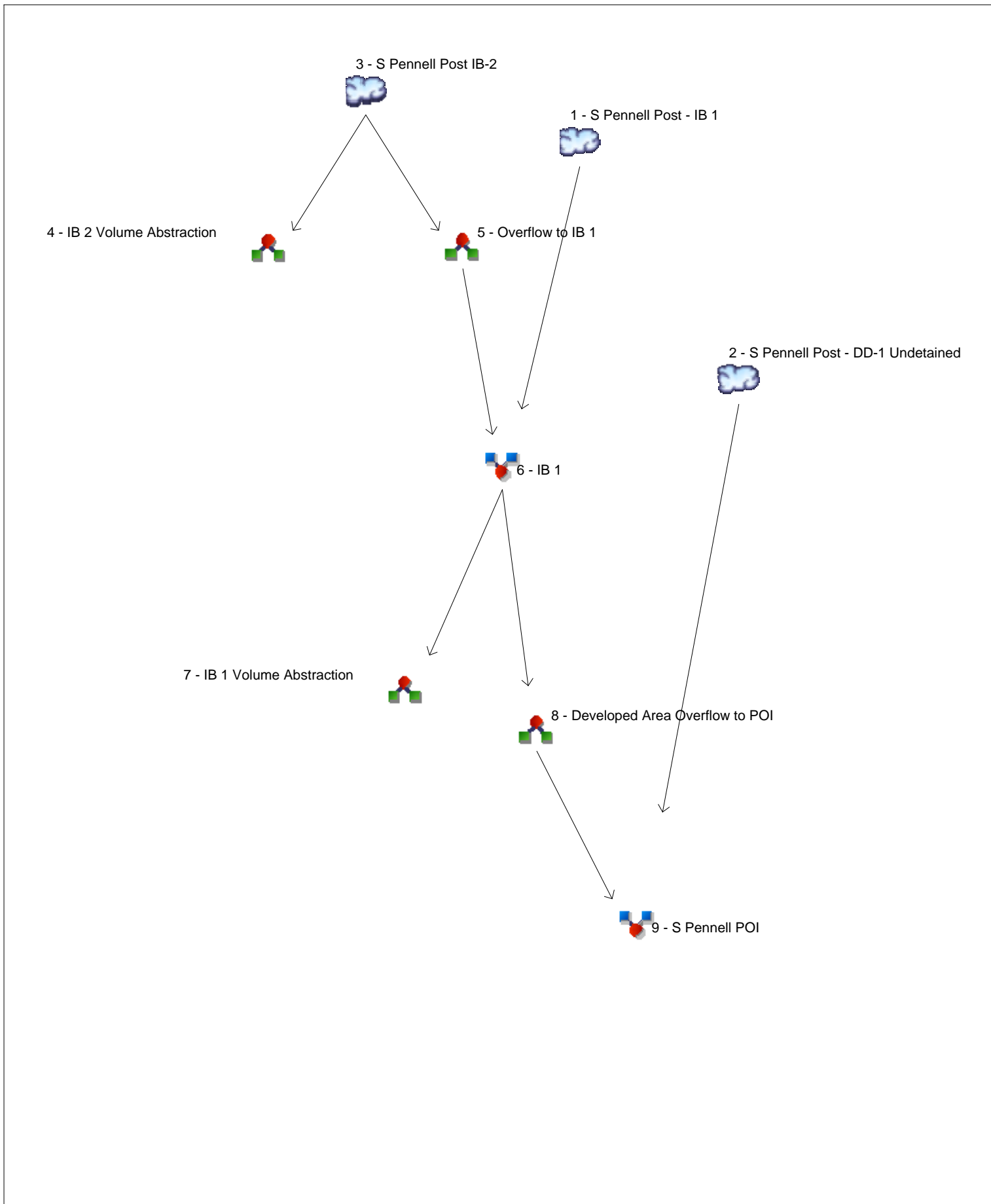
Hydrograph type = Combine  
Storm frequency = 50 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 3.116 cfs  
Time to peak = 717 min  
Hyd. volume = 7,704 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 1.284  | -----                  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.850  | -----                  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.236  | -----                  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.236  | -----                  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.001  | -----                  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 1.284  | -----                  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 1.284  | -----                  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.196  | -----                  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | ----- | ----- | ----- | ----- | ----- | ----- | 0.850  | -----                  | S Pennell POI                    |

# Hydrograph Summary Report

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

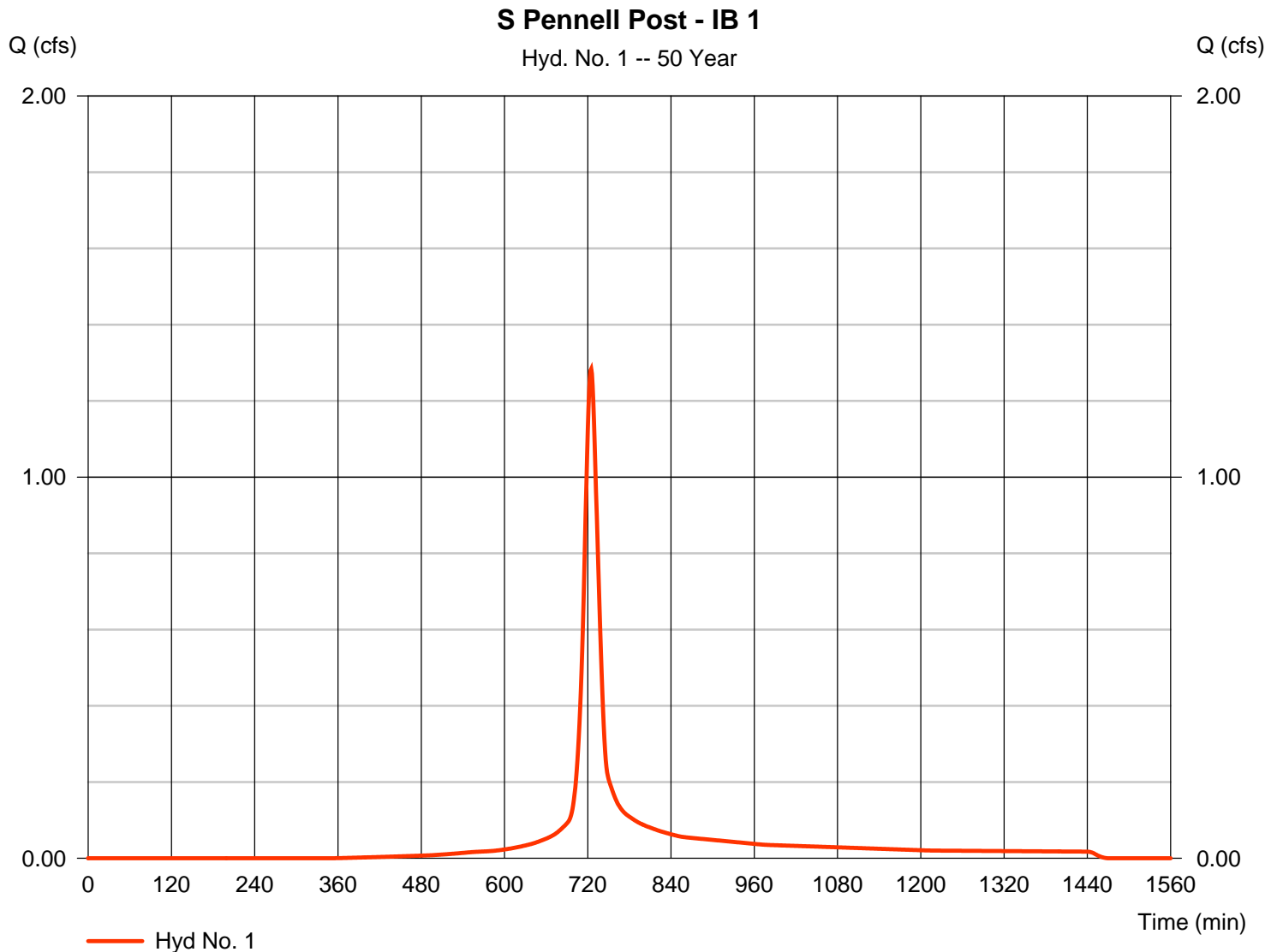
| Hyd. No.                  | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)     | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description           |
|---------------------------|--------------------------|-----------------|---------------------|--------------------|------------------------|---------------|------------------------|--------------------------|----------------------------------|
| 1                         | SCS Runoff               | 1.284           | 1                   | 725                | 4,043                  | -----         | -----                  | -----                    | S Pennell Post - IB 1            |
| 2                         | SCS Runoff               | 0.850           | 1                   | 724                | 2,516                  | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |
| 3                         | SCS Runoff               | 0.236           | 1                   | 738                | 1,145                  | -----         | -----                  | -----                    | S Pennell Post IB-2              |
| 4                         | Diversion1               | 0.236           | 1                   | 738                | 1,145                  | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |
| 5                         | Diversion2               | 0.001           | 1                   | 1486               | 0                      | 3             | -----                  | -----                    | Overflow to IB 1                 |
| 6                         | Combine                  | 1.284           | 1                   | 725                | 4,043                  | 1, 5          | -----                  | -----                    | IB 1                             |
| 7                         | Diversion1               | 1.284           | 1                   | 725                | 2,457                  | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |
| 8                         | Diversion2               | 0.196           | 1                   | 752                | 1,586                  | 6             | -----                  | -----                    | Developed Area Overflow to POI   |
| 9                         | Combine                  | 0.850           | 1                   | 724                | 4,102                  | 2, 8          | -----                  | -----                    | S Pennell POI                    |
| S Pennel Post - 50 yr.gpw |                          |                 |                     |                    | Return Period: 50 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.284 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 725 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,043 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 19.90 min  |
| Total precip.   | = 6.74 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

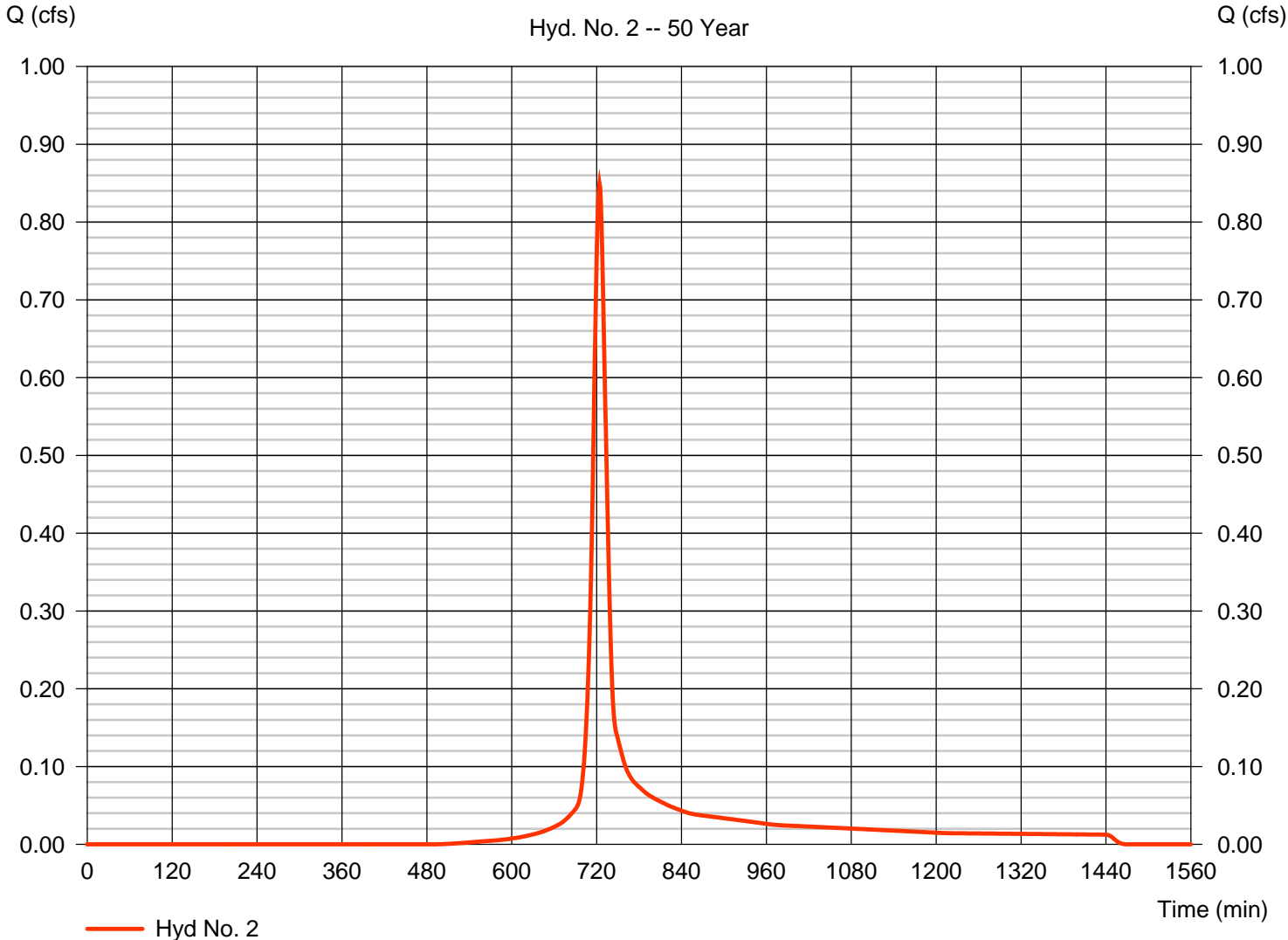
Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.850 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 2,516 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 6.74 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | 35.0           | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

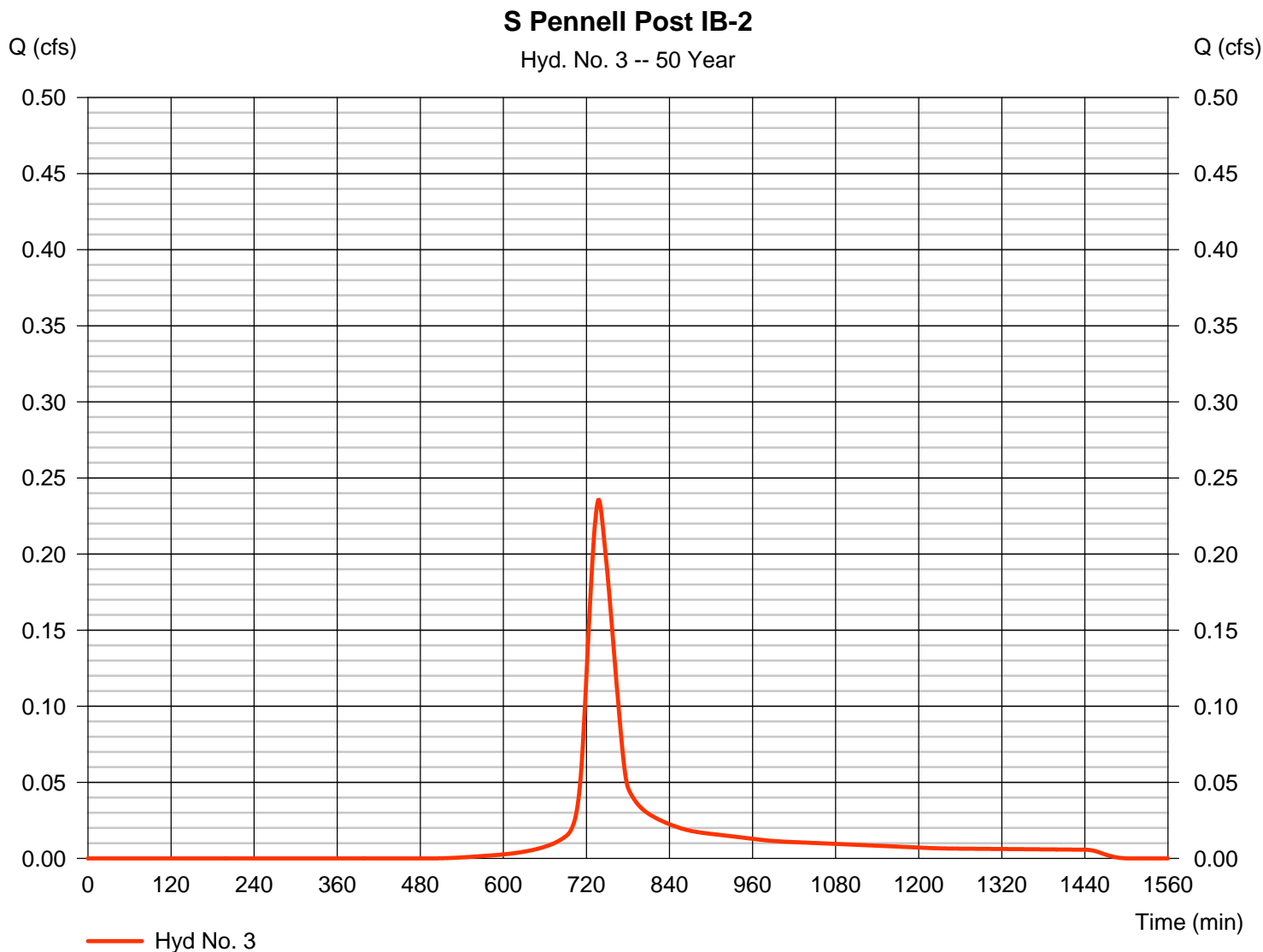
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.236 cfs  |
| Storm frequency | = 50 yrs     | Time to peak       | = 738 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,145 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 39.40 min  |
| Total precip.   | = 6.74 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

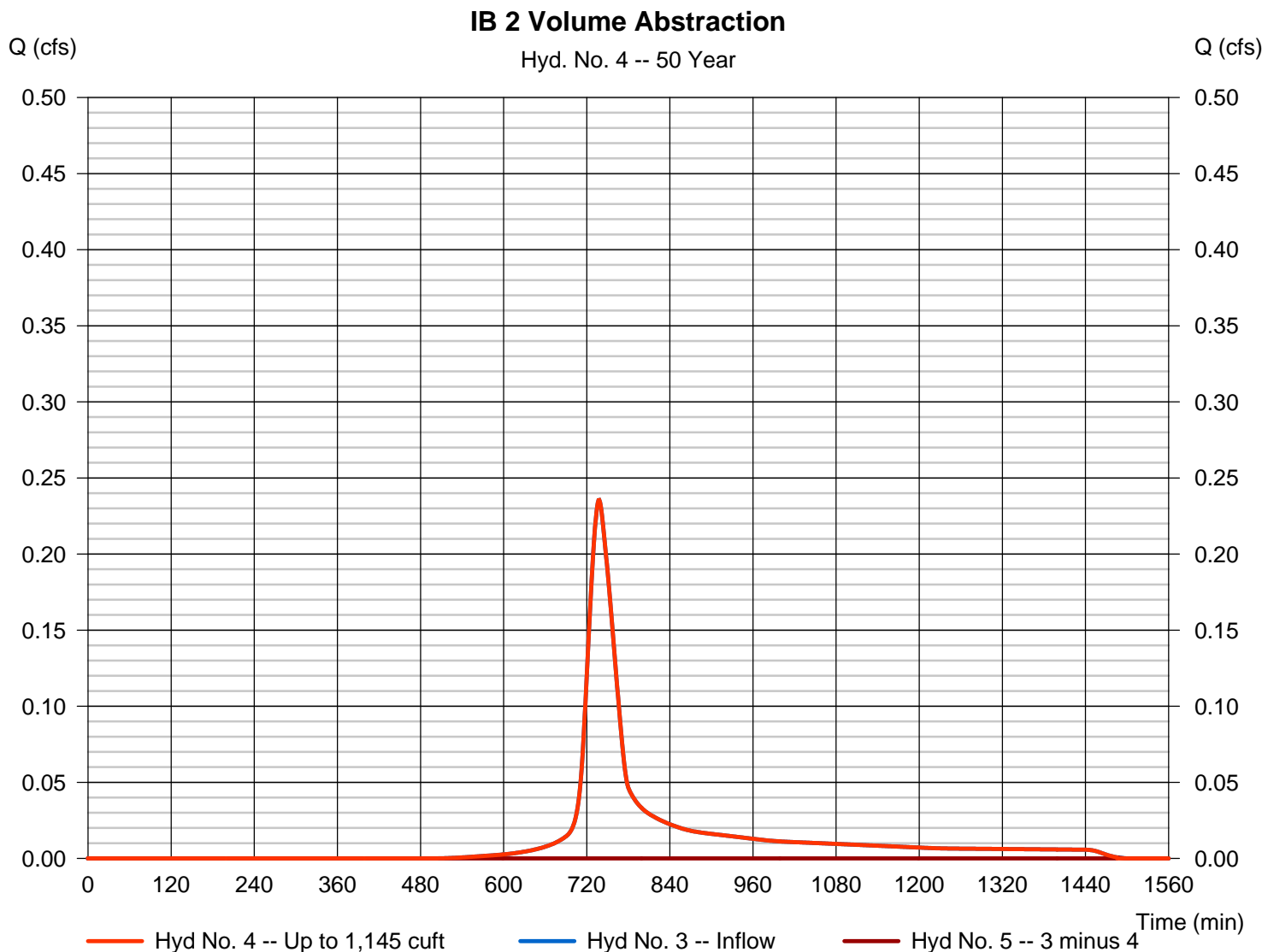
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.236 cfs  |
| Storm frequency   | = 50 yrs                  | Time to peak      | = 738 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,145 cuft |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,145 cuft |



# Hydrograph Report

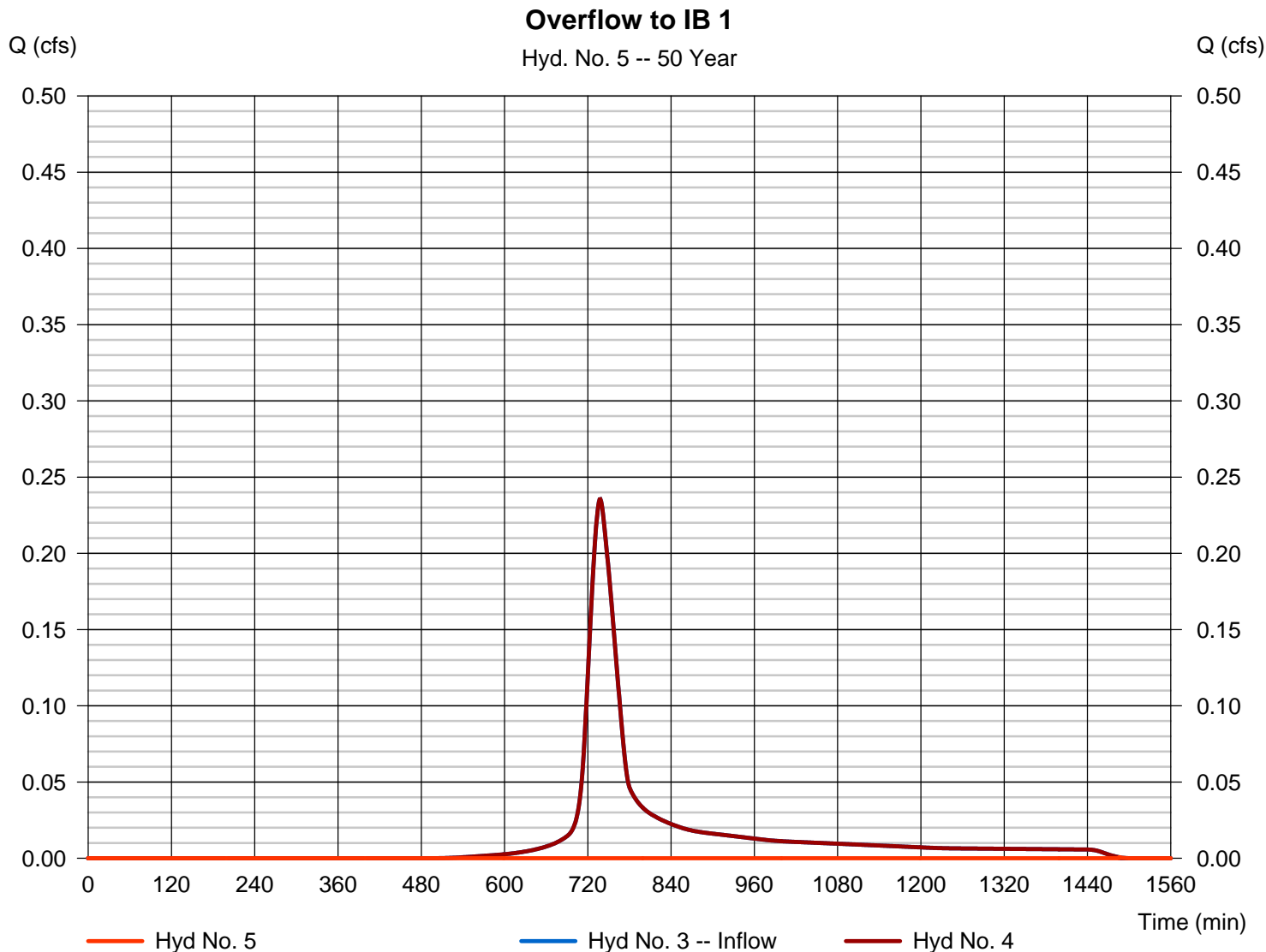
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Wednesday, 11 / 9 / 2016

## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.001 cfs  |
| Storm frequency   | = 50 yrs                  | Time to peak      | = 1486 min   |
| Time interval     | = 1 min                   | Hyd. volume       | = 0 cuft     |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,145 cuft |



# Hydrograph Report

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

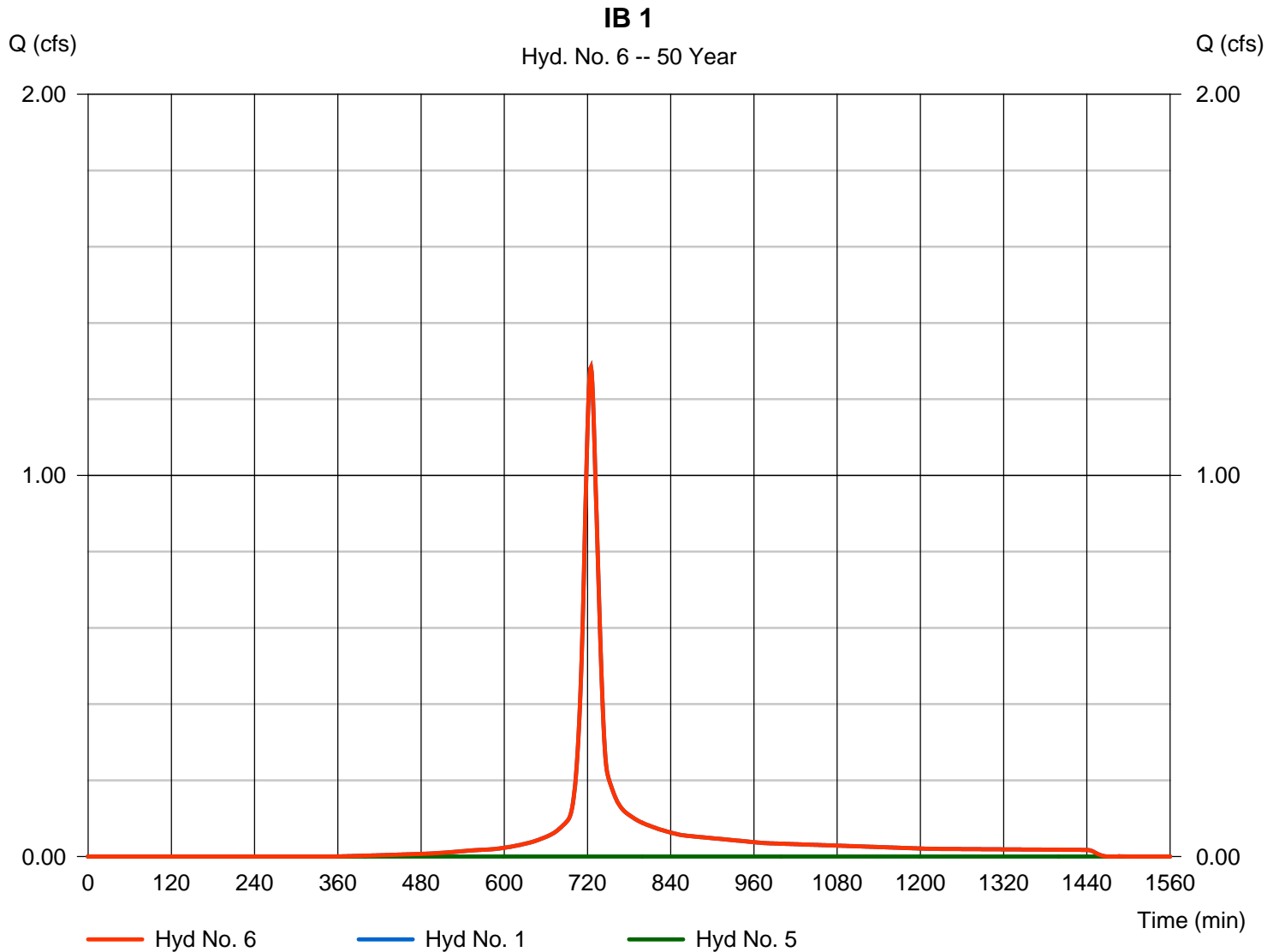
Wednesday, 11 / 9 / 2016

## Hyd. No. 6

IB 1

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

Peak discharge = 1.284 cfs  
Time to peak = 725 min  
Hyd. volume = 4,043 cuft  
Contrib. drain. area = 0.250 ac



# Hydrograph Report

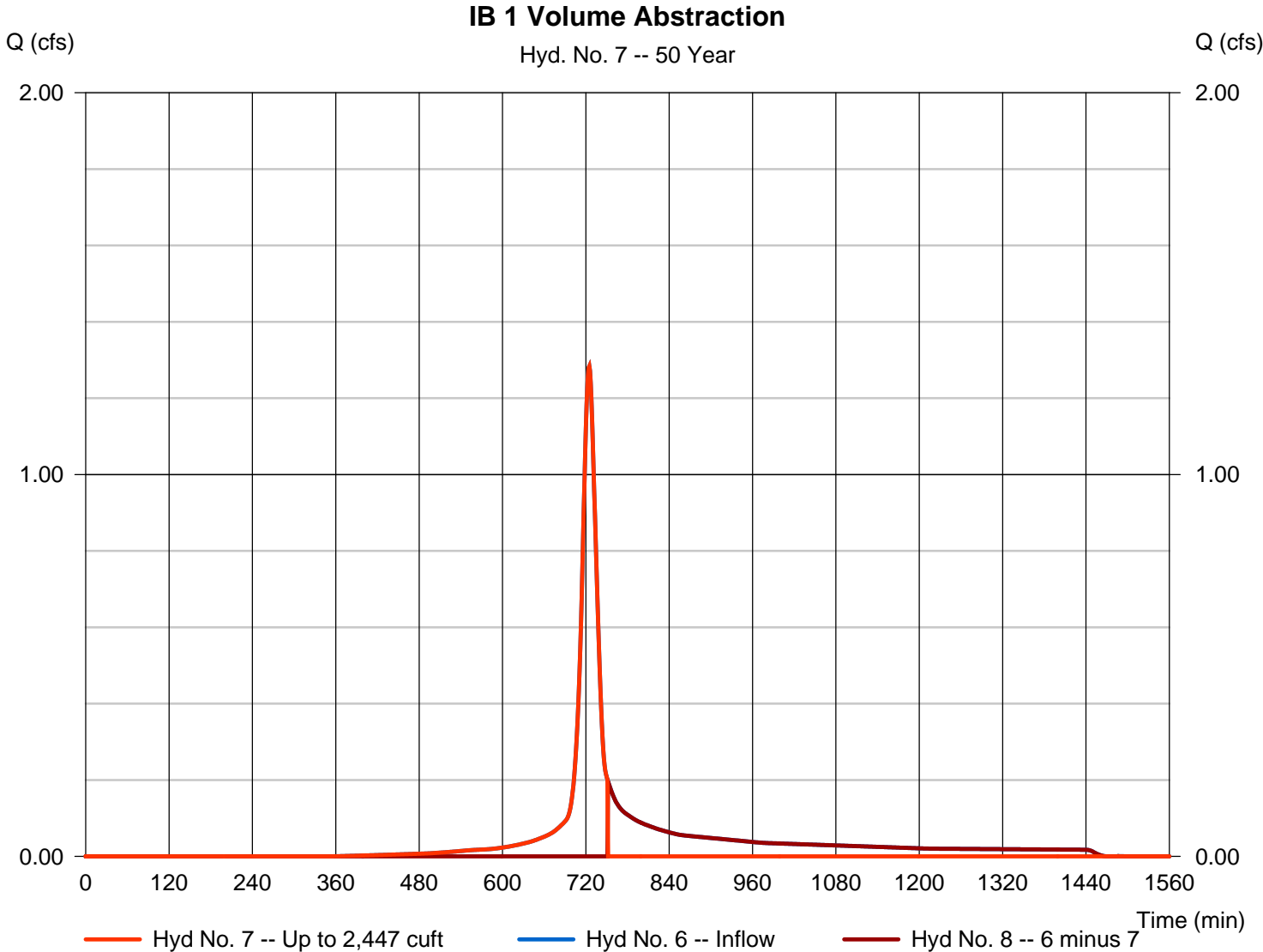
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 1.284 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 725 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,457 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

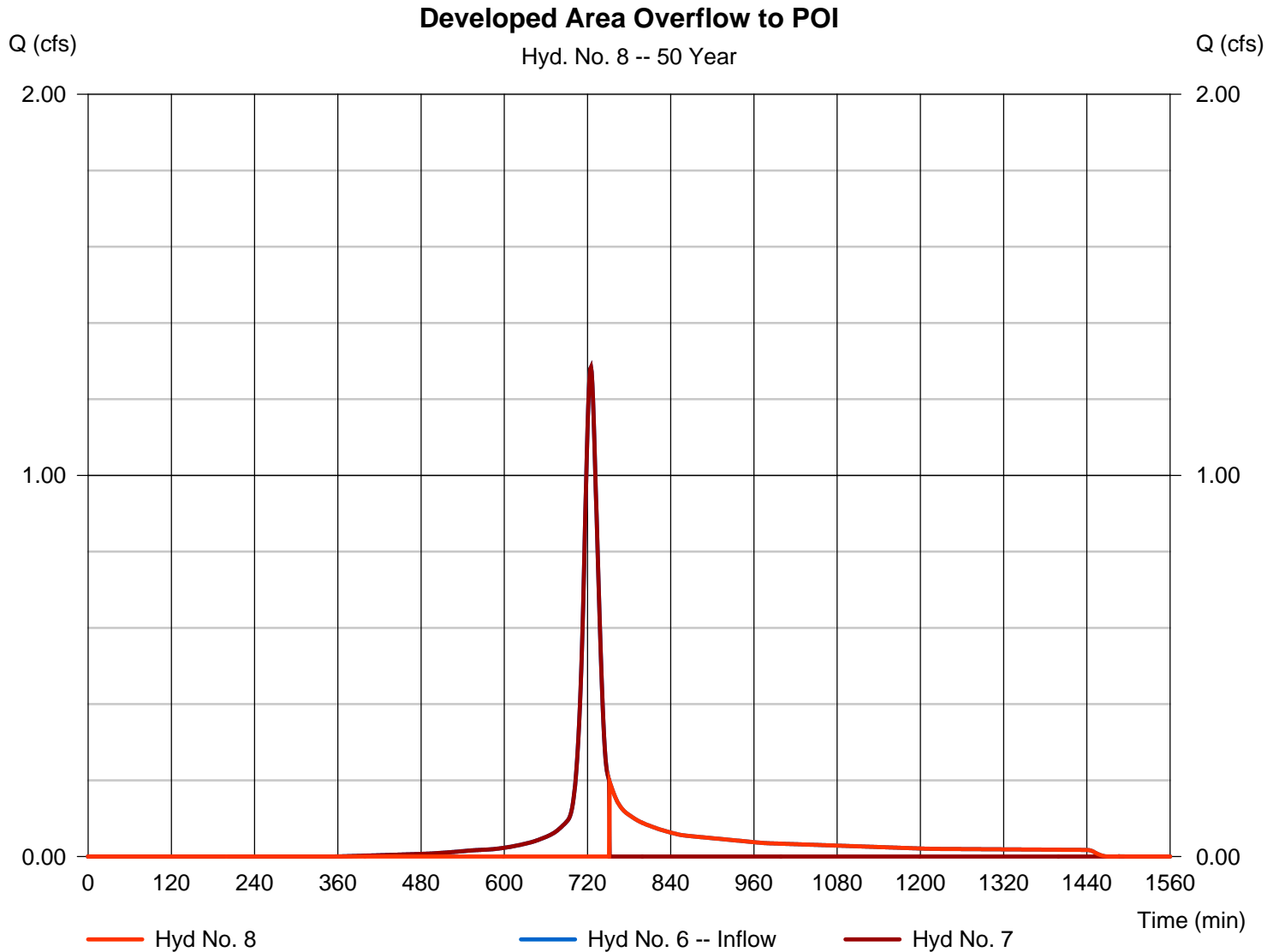
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.196 cfs  |
| Storm frequency   | = 50 yrs             | Time to peak      | = 752 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 1,586 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

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

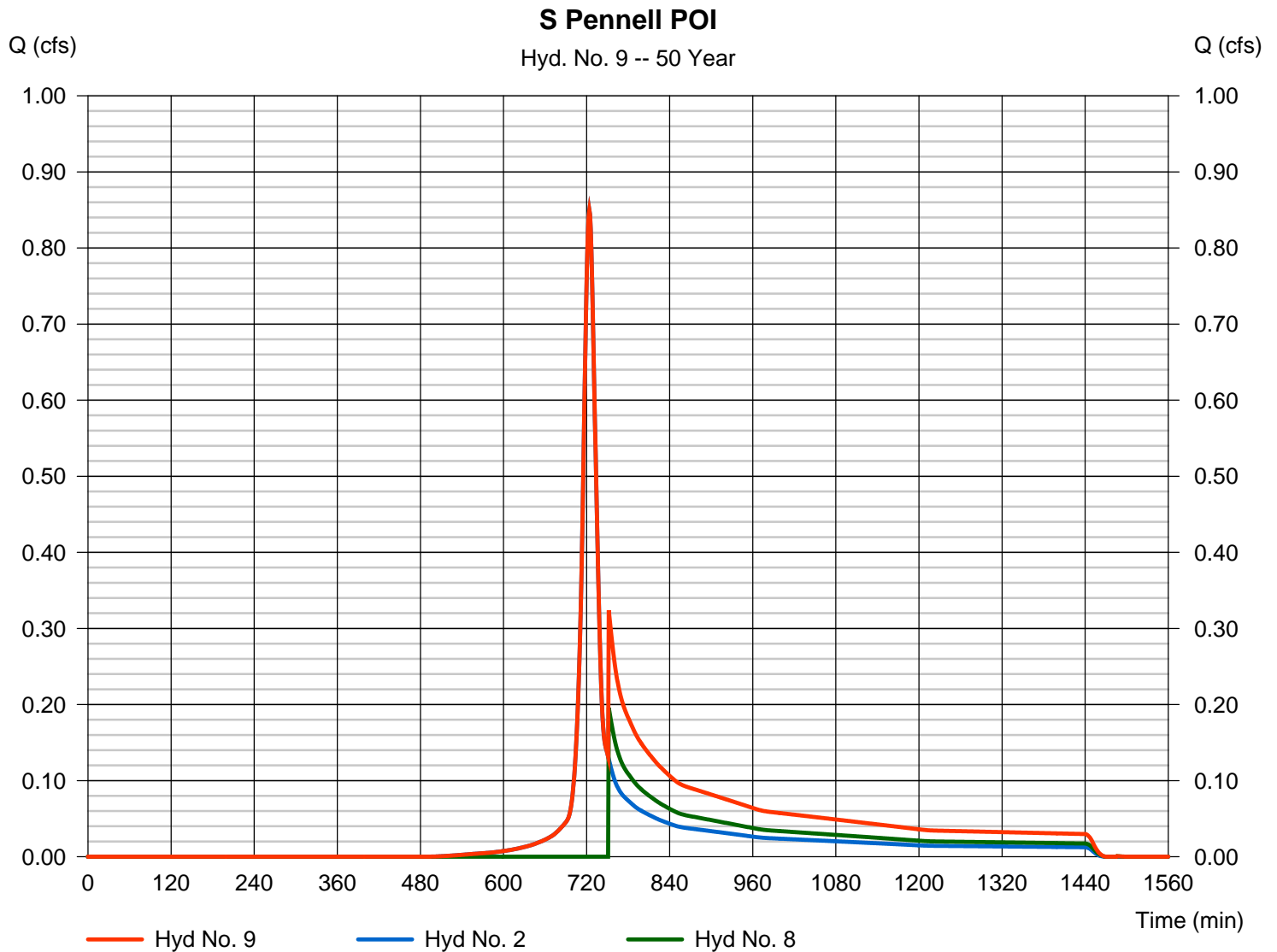
Wednesday, 11 / 9 / 2016

## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 50 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 0.850 cfs  
Time to peak = 724 min  
Hyd. volume = 4,102 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT C-6  
S PENNELL RD  
100 Year-24 Hour Storm**



# Watershed Model Schematic

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

1 - S Pennell Pre - Full Area



2 - S Pennell Pre - Developed Area



# 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               | -----         | -----              | 0.513 | ----- | 0.881 | 1.223 | 1.755 | 2.226 | 2.748  | S Pennell Pre - Full Area      |
| 2        | SCS Runoff               | -----         | -----              | 0.386 | ----- | 0.656 | 0.906 | 1.294 | 1.637 | 2.018  | S Pennell Pre - Developed Area |

# Hydrograph Summary Report

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

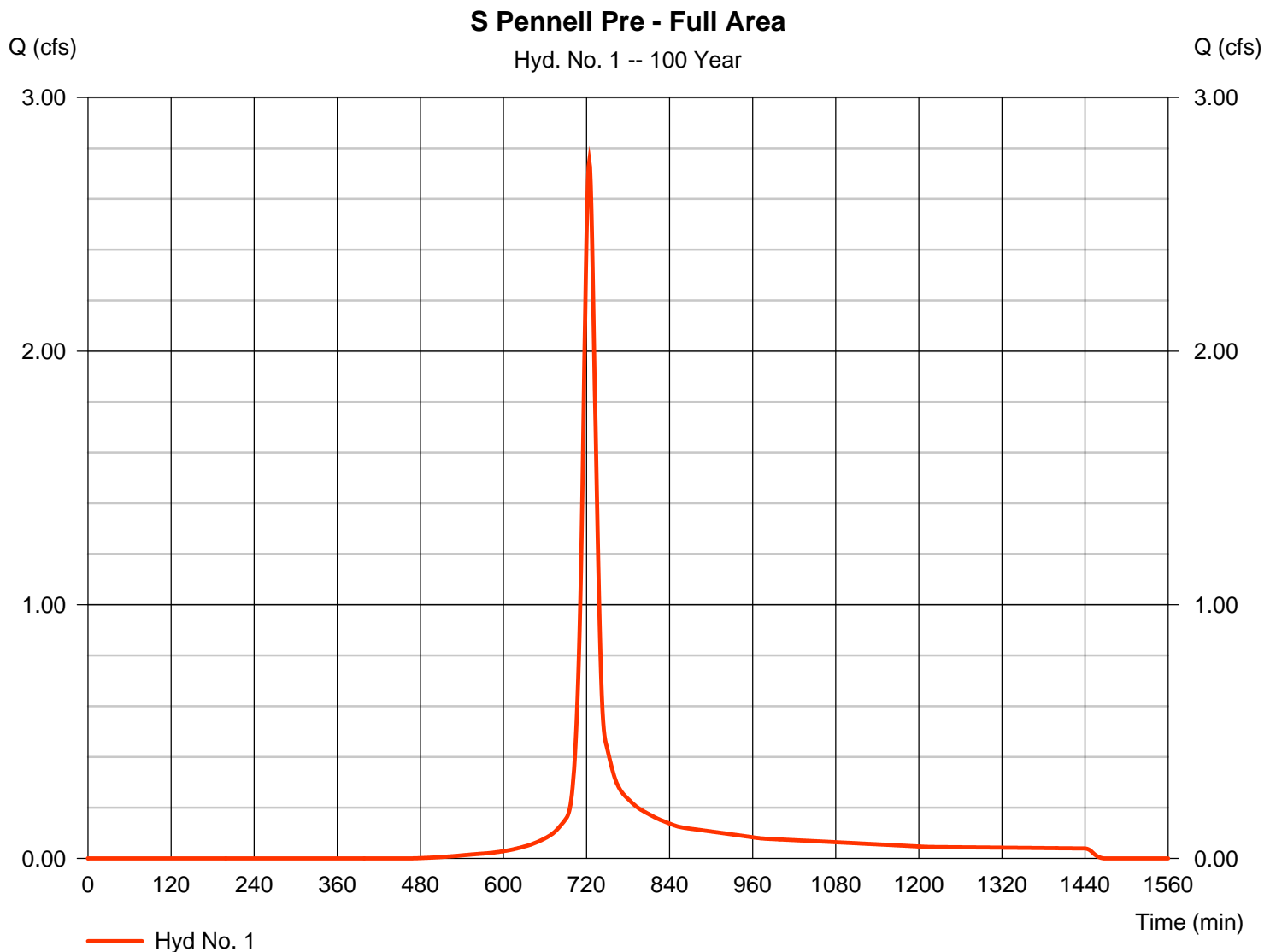
| Hyd. No.          | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description         |
|-------------------|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|--------------------------|--------------------------------|
| 1                 | SCS Runoff               | 2.748           | 1                   | 724                | 8,138                   | -----         | -----                  | -----                    | S Pennell Pre - Full Area      |
| 2                 | SCS Runoff               | 2.018           | 1                   | 721                | 5,102                   | -----         | -----                  | -----                    | S Pennell Pre - Developed Area |
| S Pennell Pre.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                |

# Hydrograph Report

## Hyd. No. 1

S Pennell Pre - Full Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.748 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 8,138 cuft |
| Drainage area   | = 0.540 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 7.69 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

S Pennell Pre - Full Area

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 100.0        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.00         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 16.15</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 16.15</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 246.00       | 0.00          | 0.00          |                  |
| Watercourse slope (%)              | = 8.10         | 0.00          | 0.00          |                  |
| Surface description                | = Unpaved      | Paved         | Paved         |                  |
| Average velocity (ft/s)            | =4.59          | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.89</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.89</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| 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           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

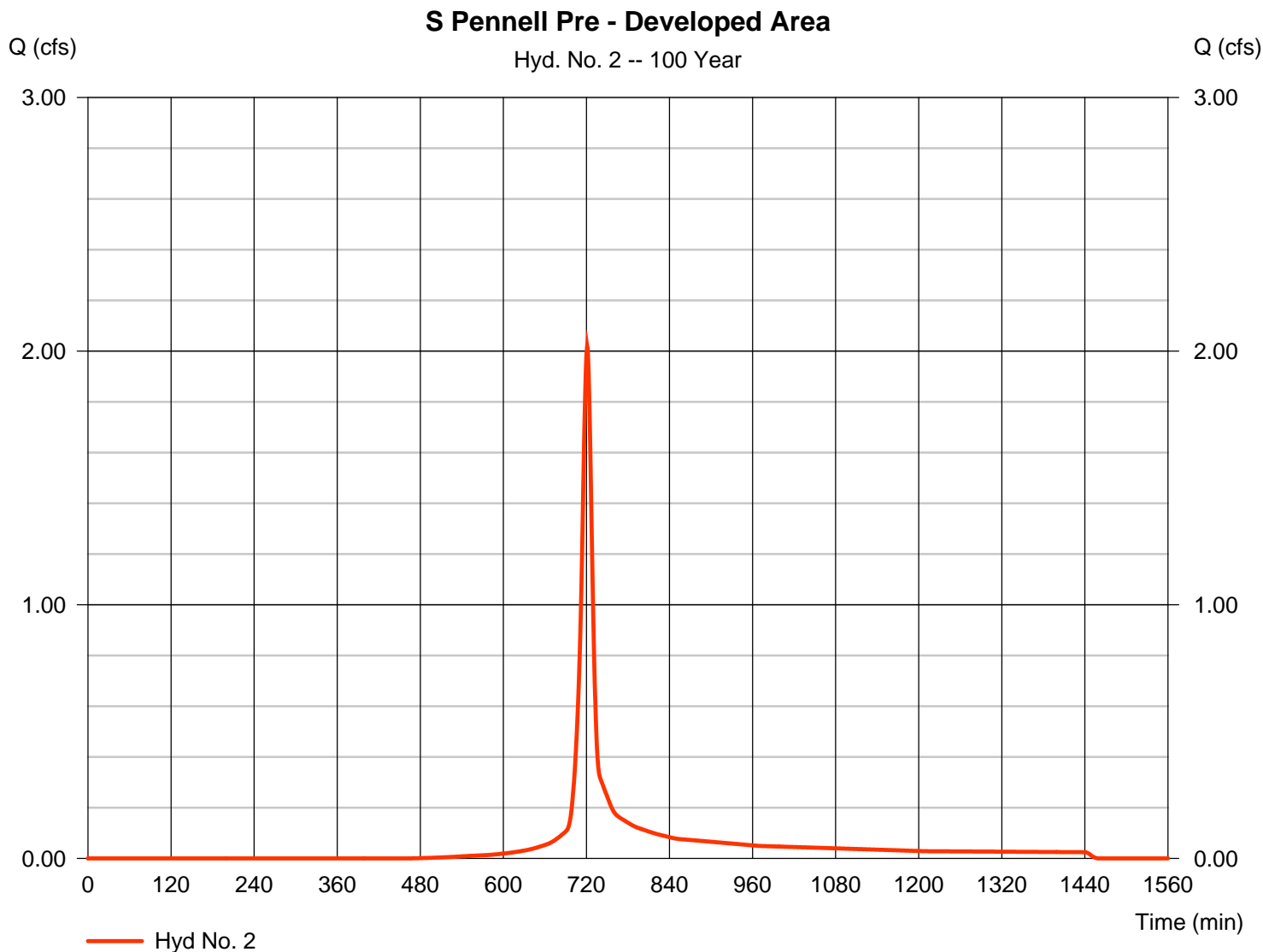
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 2

S Pennell Pre - Developed Area

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.018 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 721 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 5,102 cuft |
| Drainage area   | = 0.340 ac   | Curve number       | = 70         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 13.10 min  |
| Total precip.   | = 7.69 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

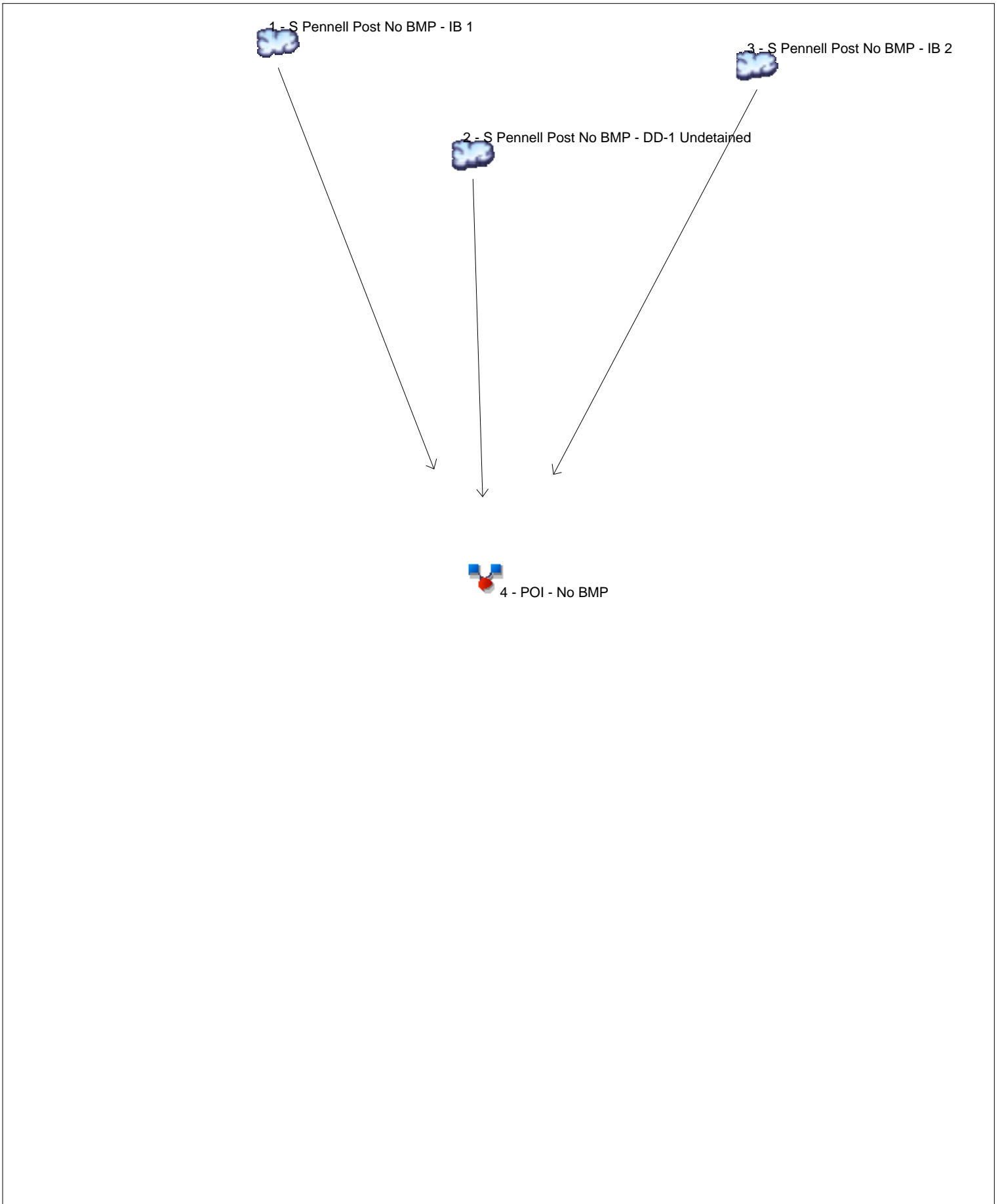
## Hyd. No. 2

S Pennell Pre - Developed Area

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    |          | <u>Totals</u>    |
|------------------------------------|---------------|----------|-------------|----------|-------------|----------|------------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |          |                  |
| Manning's n-value                  | = 0.400       |          | 0.240       |          | 0.400       |          |                  |
| Flow length (ft)                   | = 63.0        |          | 21.0        |          | 16.0        |          |                  |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |          |                  |
| Land slope (%)                     | = 8.00        |          | 10.00       |          | 12.50       |          |                  |
| <b>Travel Time (min)</b>           | <b>= 8.46</b> | <b>+</b> | <b>2.13</b> | <b>+</b> | <b>2.36</b> | <b>=</b> | <b>12.95</b>     |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |          |                  |
| Flow length (ft)                   | = 47.00       |          | 0.00        |          | 0.00        |          |                  |
| Watercourse slope (%)              | = 12.00       |          | 0.00        |          | 0.00        |          |                  |
| Surface description                | = Unpaved     |          | Paved       |          | Paved       |          |                  |
| Average velocity (ft/s)            | =5.59         |          | 0.00        |          | 0.00        |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.14</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.14</b>      |
| <b>Channel Flow</b>                |               |          |             |          |             |          |                  |
| 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         |          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>=</b> | <b>0.00</b>      |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             |          | <b>13.10 min</b> |

# Watershed Model Schematic

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



# 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               | -----         | -----              | 0.696 | ----- | 1.016 | 1.294 | 1.708 | 2.061 | 2.444  | S Pennell Post No BMP - IB 1       |
| 2        | SCS Runoff               | -----         | -----              | 0.204 | ----- | 0.344 | 0.473 | 0.673 | 0.850 | 1.045  | S Pennell Post No BMP - DD-1 Undet |
| 3        | SCS Runoff               | -----         | -----              | 0.127 | ----- | 0.210 | 0.286 | 0.402 | 0.506 | 0.620  | S Pennell Post No BMP - IB 2       |
| 4        | Combine                  | 1, 2, 3       | -----              | 0.924 | ----- | 1.422 | 1.868 | 2.537 | 3.116 | 3.750  | POI - No BMP                       |

# Hydrograph Summary Report

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

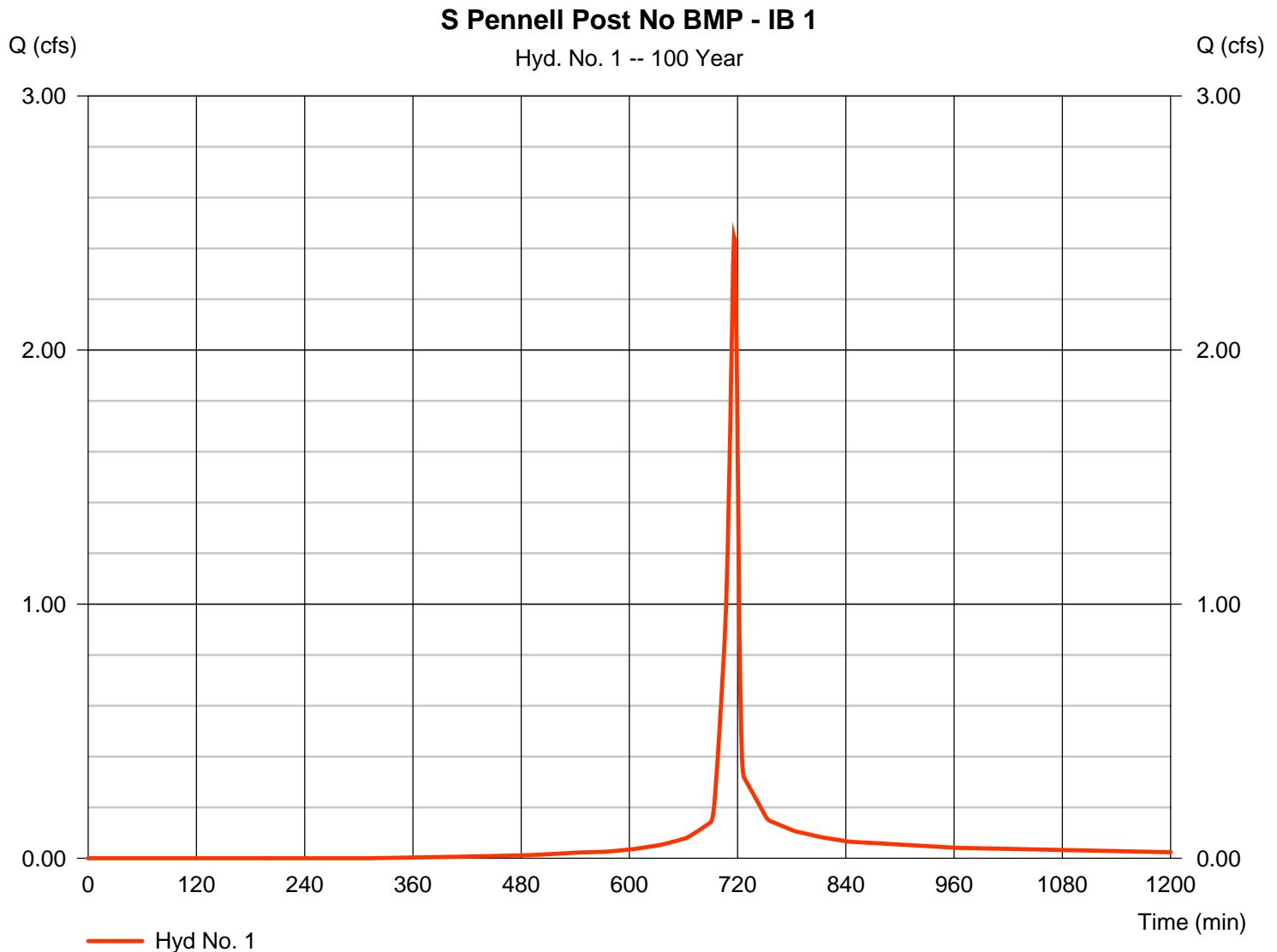
| Hyd. No.                 | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft)  | Hydrograph Description             |  |
|--------------------------|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|--------------------------|------------------------------------|--|
| 1                        | SCS Runoff               | 2.444           | 1                   | 716                | 4,842                   | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 1       |  |
| 2                        | SCS Runoff               | 1.045           | 1                   | 724                | 3,094                   | -----         | -----                  | -----                    | S Pennell Post No BMP - DD-1 Undet |  |
| 3                        | SCS Runoff               | 0.620           | 1                   | 719                | 1,408                   | -----         | -----                  | -----                    | S Pennell Post No BMP - IB 2       |  |
| 4                        | Combine                  | 3.750           | 1                   | 717                | 9,344                   | 1, 2, 3       | -----                  | -----                    | POI - No BMP                       |  |
| S Pennel Post no BMP.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                    |  |

# Hydrograph Report

## Hyd. No. 1

S Pennell Post No BMP - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.444 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,842 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 4.80 min   |
| Total precip.   | = 7.69 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

S Pennell Post No BMP - IB 1

| <u>Description</u>                 | <u>A</u>      |          | <u>B</u>    |          | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |          |             |                 |
| Manning's n-value                  | = 0.240       |          | 0.240       |          | 0.011       |                 |
| Flow length (ft)                   | = 34.0        |          | 8.0         |          | 58.0        |                 |
| Two-year 24-hr precip. (in)        | = 3.25        |          | 3.25        |          | 3.25        |                 |
| Land slope (%)                     | = 7.40        |          | 50.00       |          | 5.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 3.54</b> | <b>+</b> | <b>0.52</b> | <b>+</b> | <b>0.54</b> | <b>= 4.60</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |          |             |                 |
| Flow length (ft)                   | = 55.00       |          | 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        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.18</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.18</b>   |
| <b>Channel Flow</b>                |               |          |             |          |             |                 |
| 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         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b> | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             |          |             | <b>4.80 min</b> |

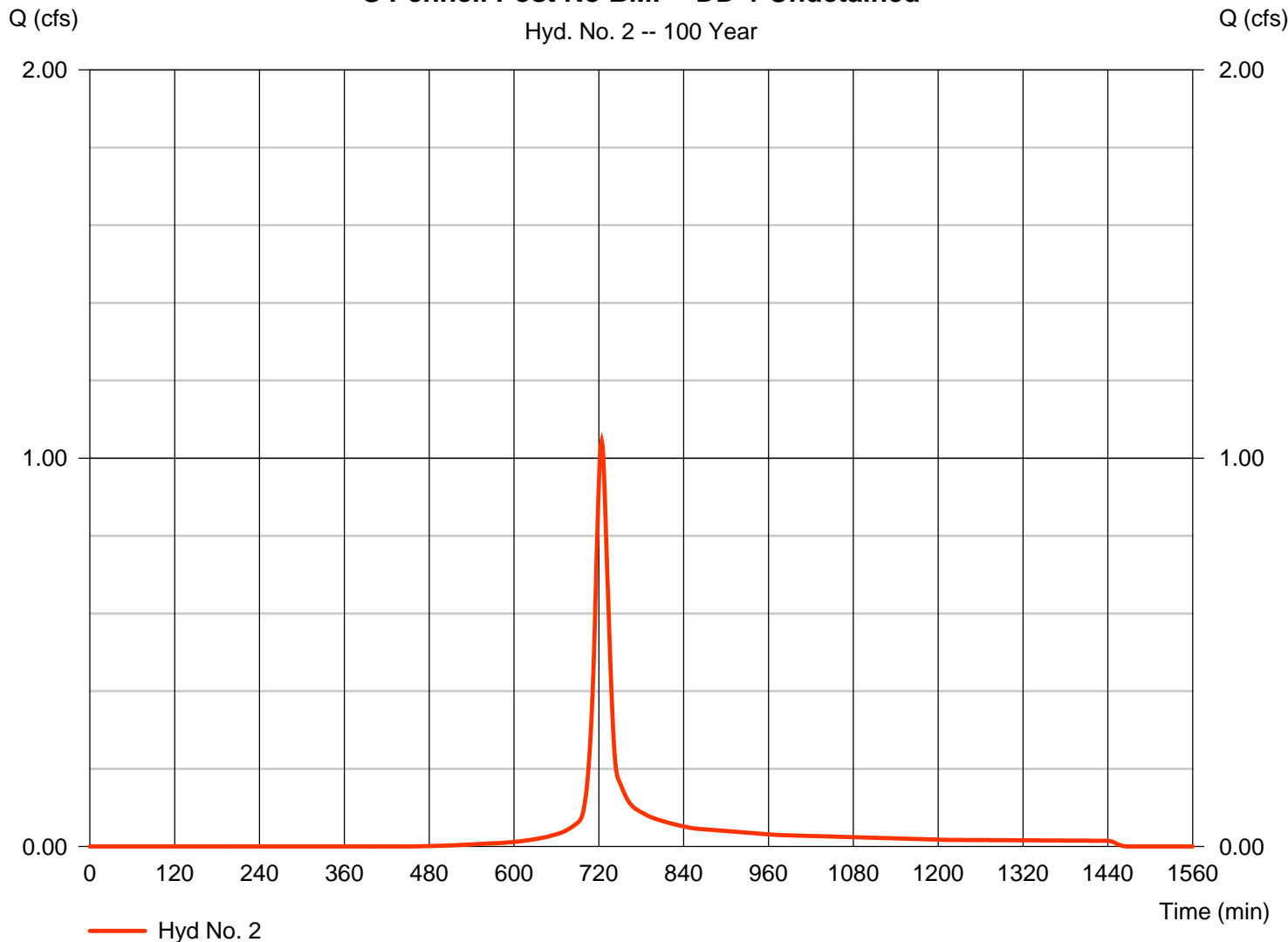
# Hydrograph Report

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.045 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,094 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 7.69 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post No BMP - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post No BMP - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | {{0}}35.0      | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

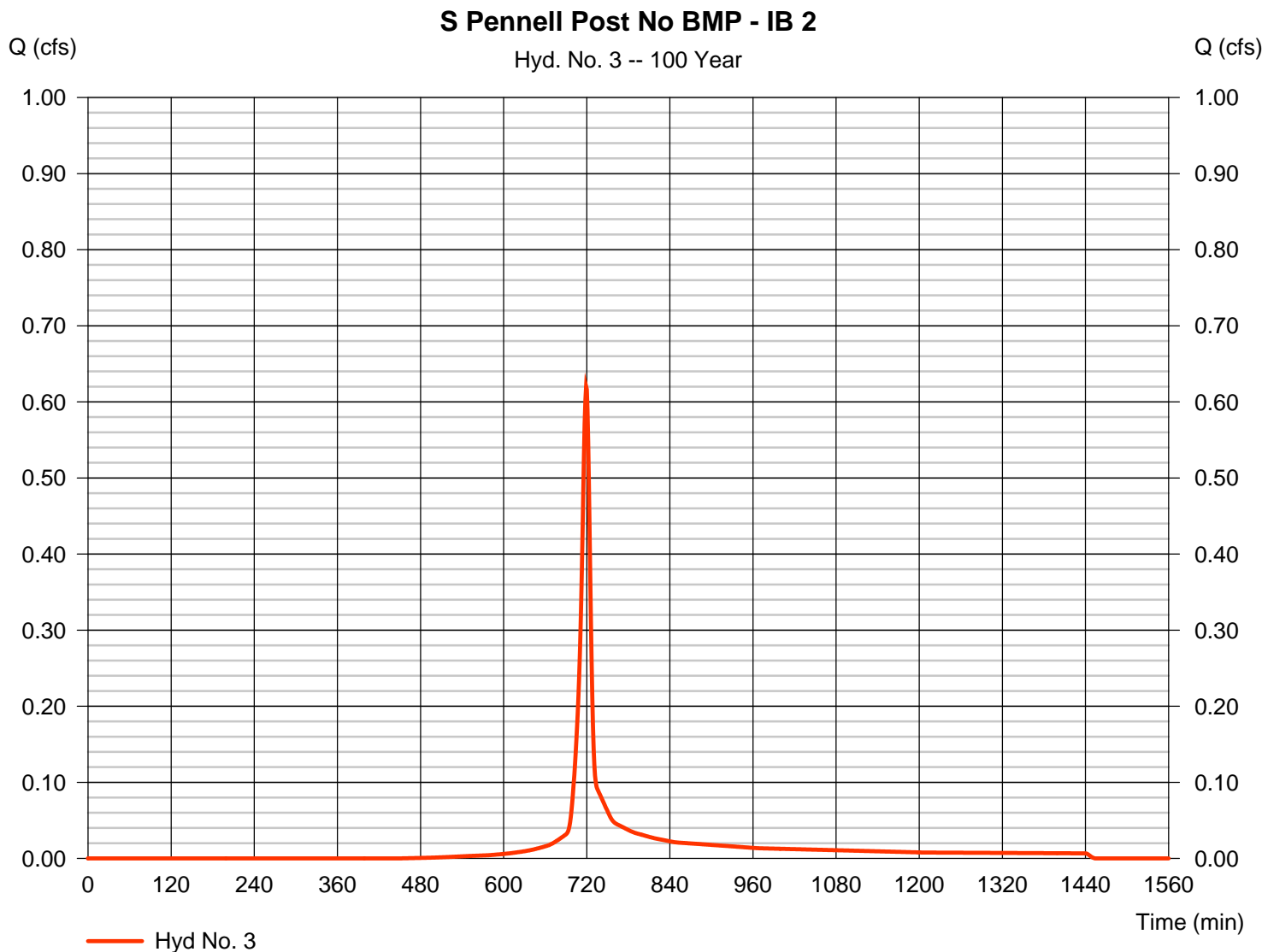
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 3

S Pennell Post No BMP - IB 2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.620 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 719 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,408 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 9.70 min   |
| Total precip.   | = 7.69 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

S Pennell Post No BMP - IB 2

| <u>Description</u>                 | <u>A</u>      | <u>B</u> | <u>C</u>    | <u>Totals</u>   |
|------------------------------------|---------------|----------|-------------|-----------------|
| <b>Sheet Flow</b>                  |               |          |             |                 |
| Manning's n-value                  | = 0.240       | 0.240    | 0.011       |                 |
| Flow length (ft)                   | = 34.0        | 66.0     | 0.0         |                 |
| Two-year 24-hr precip. (in)        | = 3.25        | 3.25     | 0.00        |                 |
| Land slope (%)                     | = 6.00        | 9.00     | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 3.85</b> | <b>+</b> | <b>5.56</b> | <b>+</b>        |
|                                    |               |          | <b>0.00</b> | <b>= 9.41</b>   |
| <b>Shallow Concentrated Flow</b>   |               |          |             |                 |
| Flow length (ft)                   | = 70.00       | 0.00     | 0.00        |                 |
| Watercourse slope (%)              | = 9.00        | 0.00     | 0.00        |                 |
| Surface description                | = Unpaved     | Paved    | Paved       |                 |
| Average velocity (ft/s)            | =4.84         | 0.00     | 0.00        |                 |
| <b>Travel Time (min)</b>           | <b>= 0.24</b> | <b>+</b> | <b>0.00</b> | <b>+</b>        |
|                                    |               |          | <b>0.00</b> | <b>= 0.24</b>   |
| <b>Channel Flow</b>                |               |          |             |                 |
| 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        |                 |
|                                    |               |          | 0.00        |                 |
| Flow length (ft)                   | {{0}}0.0      | 0.0      | 0.0         |                 |
| <b>Travel Time (min)</b>           | <b>= 0.00</b> | <b>+</b> | <b>0.00</b> | <b>+</b>        |
|                                    |               |          | <b>0.00</b> | <b>= 0.00</b>   |
| <b>Total Travel Time, Tc .....</b> |               |          |             | <b>9.70 min</b> |

# Hydrograph Report

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

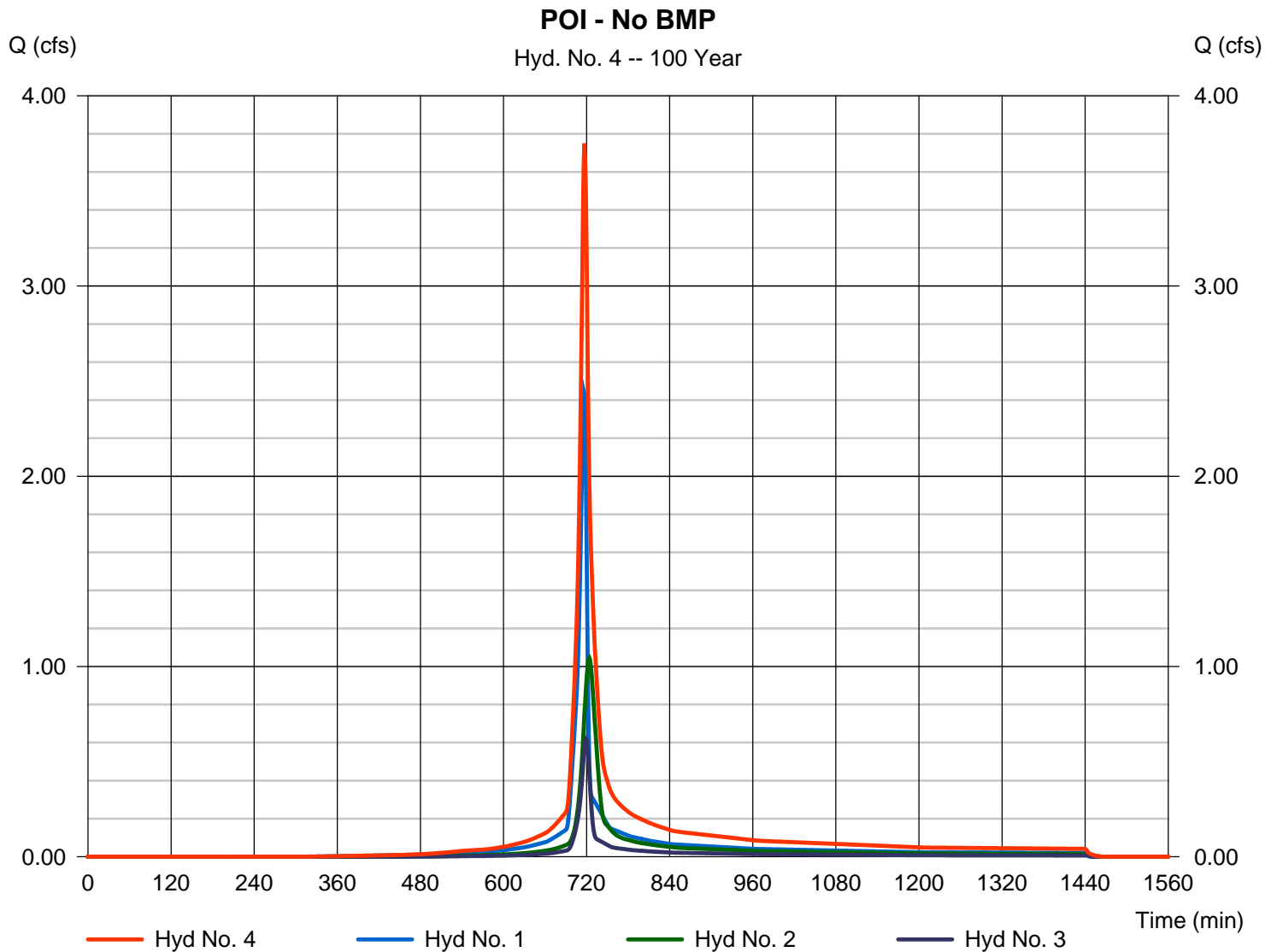
Wednesday, 11 / 9 / 2016

## Hyd. No. 4

POI - No BMP

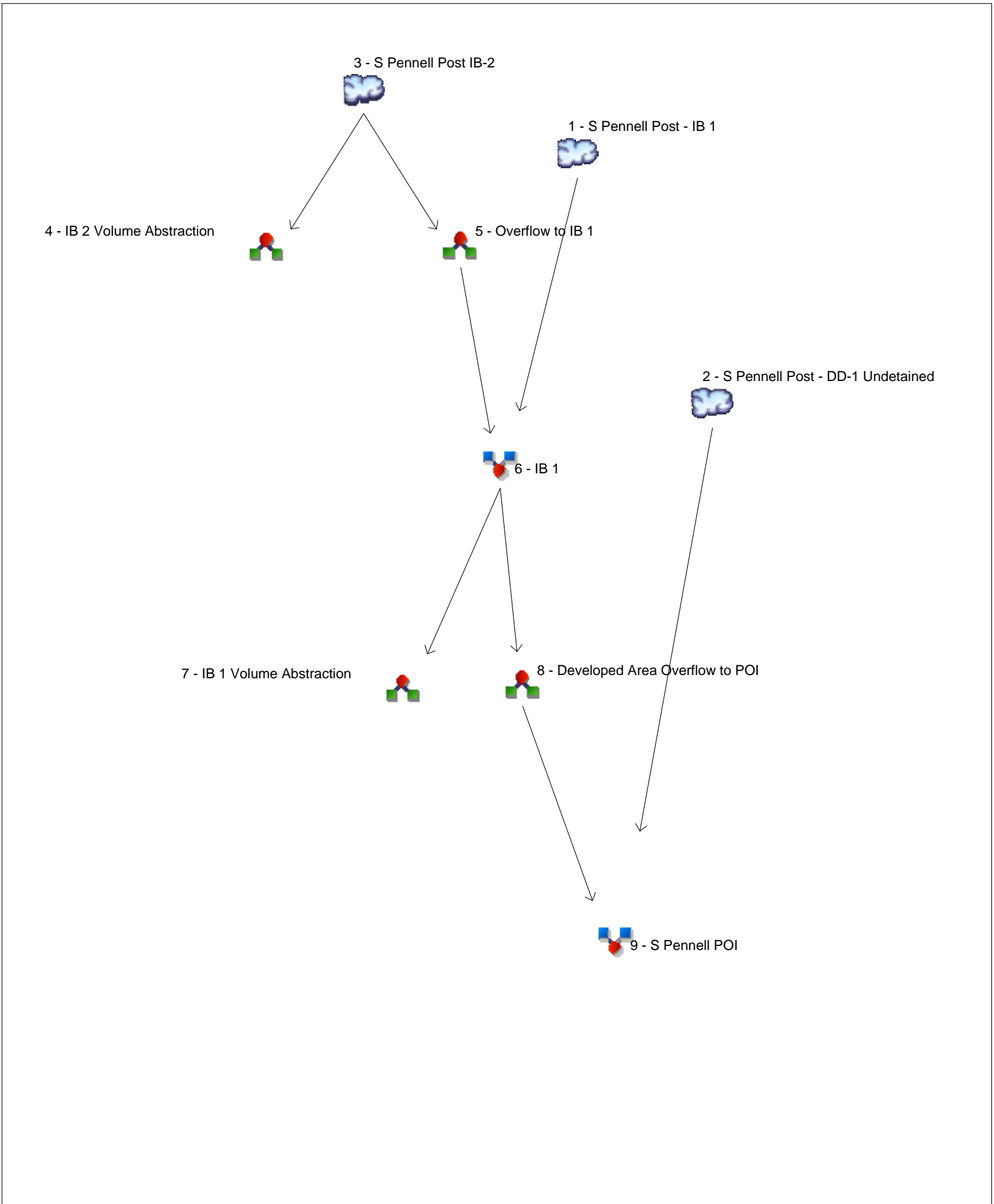
Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 2, 3

Peak discharge = 3.750 cfs  
Time to peak = 717 min  
Hyd. volume = 9,344 cuft  
Contrib. drain. area = 0.540 ac



# Watershed Model Schematic

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



# 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               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 1.590                  | S Pennell Post - IB 1            |
| 2        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 1.045                  | S Pennell Post - DD-1 Undetained |
| 3        | SCS Runoff               | -----         | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 0.318                  | S Pennell Post IB-2              |
| 4        | Diversion1               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 0.318                  | IB 2 Volume Abstraction          |
| 5        | Diversion2               | 3             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 0.013                  | Overflow to IB 1                 |
| 6        | Combine                  | 1, 5          | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 1.590                  | IB 1                             |
| 7        | Diversion1               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 1.590                  | IB 1 Volume Abstraction          |
| 8        | Diversion2               | 6             | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 0.955                  | Developed Area Overflow to POI   |
| 9        | Combine                  | 2, 8          | -----              | ----- | ----- | ----- | ----- | ----- | ----- | -----  | 1.601                  | S Pennell 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               | 1.590           | 1                   | 724                | 4,786                   | -----         | -----                  | -----                    | S Pennell Post - IB 1            |  |
| 2                          | SCS Runoff               | 1.045           | 1                   | 724                | 3,094                   | -----         | -----                  | -----                    | S Pennell Post - DD-1 Undetained |  |
| 3                          | SCS Runoff               | 0.318           | 1                   | 734                | 1,408                   | -----         | -----                  | -----                    | S Pennell Post IB-2              |  |
| 4                          | Diversion1               | 0.318           | 1                   | 734                | 1,173                   | 3             | -----                  | -----                    | IB 2 Volume Abstraction          |  |
| 5                          | Diversion2               | 0.013           | 1                   | 1011               | 236                     | 3             | -----                  | -----                    | Overflow to IB 1                 |  |
| 6                          | Combine                  | 1.590           | 1                   | 724                | 5,022                   | 1, 5          | -----                  | -----                    | IB 1                             |  |
| 7                          | Diversion1               | 1.590           | 1                   | 724                | 2,467                   | 6             | -----                  | -----                    | IB 1 Volume Abstraction          |  |
| 8                          | Diversion2               | 0.955           | 1                   | 733                | 2,556                   | 6             | -----                  | -----                    | Developed Area Overflow to POI   |  |
| 9                          | Combine                  | 1.601           | 1                   | 733                | 5,650                   | 2, 8          | -----                  | -----                    | S Pennell POI                    |  |
| S Pennel Post - 100 yr.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Wednesday, 11 / 9 / 2016 |                                  |  |

# Hydrograph Report

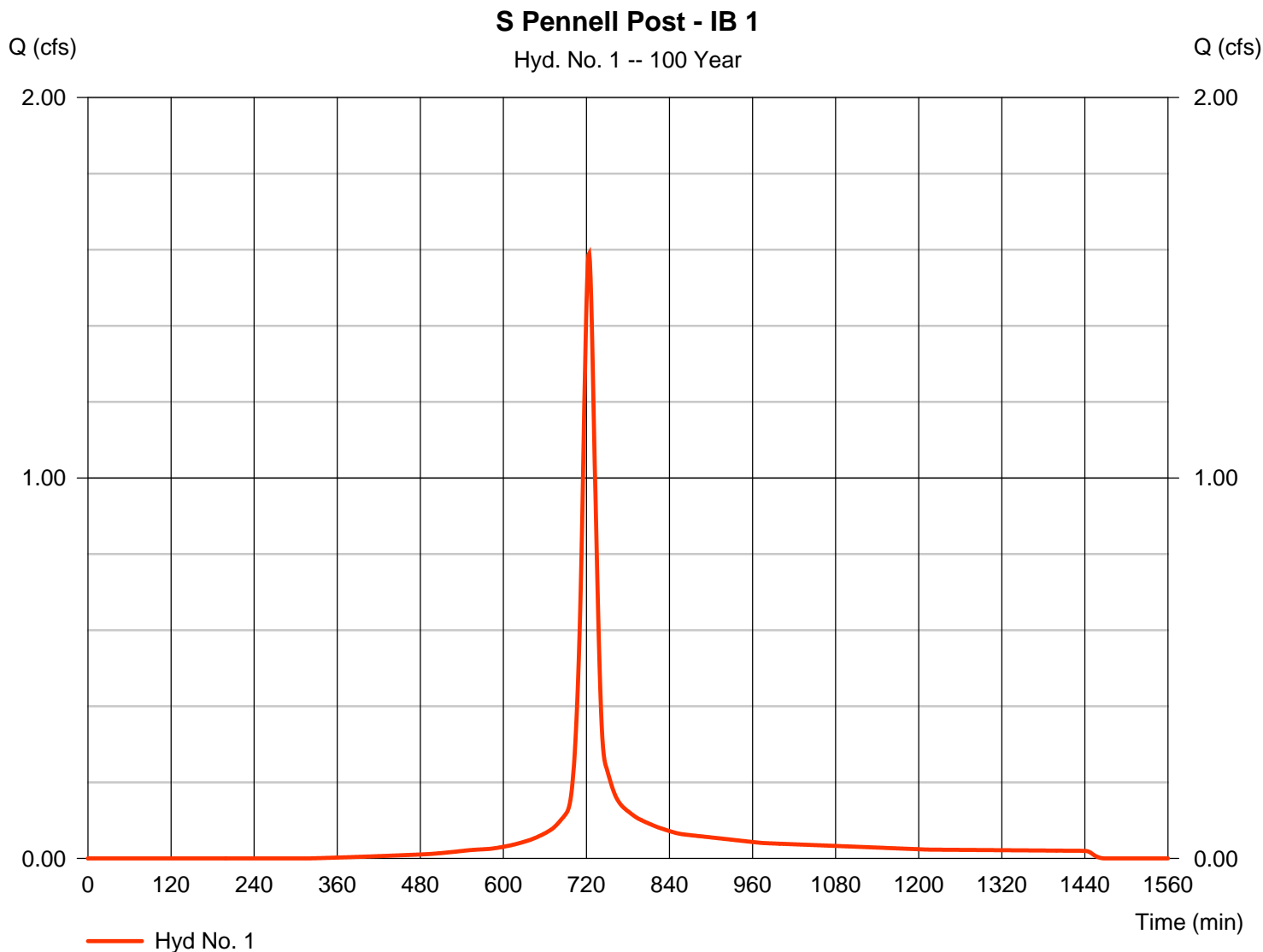
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Wednesday, 11 / 9 / 2016

## Hyd. No. 1

S Pennell Post - IB 1

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.590 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 4,786 cuft |
| Drainage area   | = 0.250 ac   | Curve number       | = 80         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 17.60 min  |
| Total precip.   | = 7.69 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



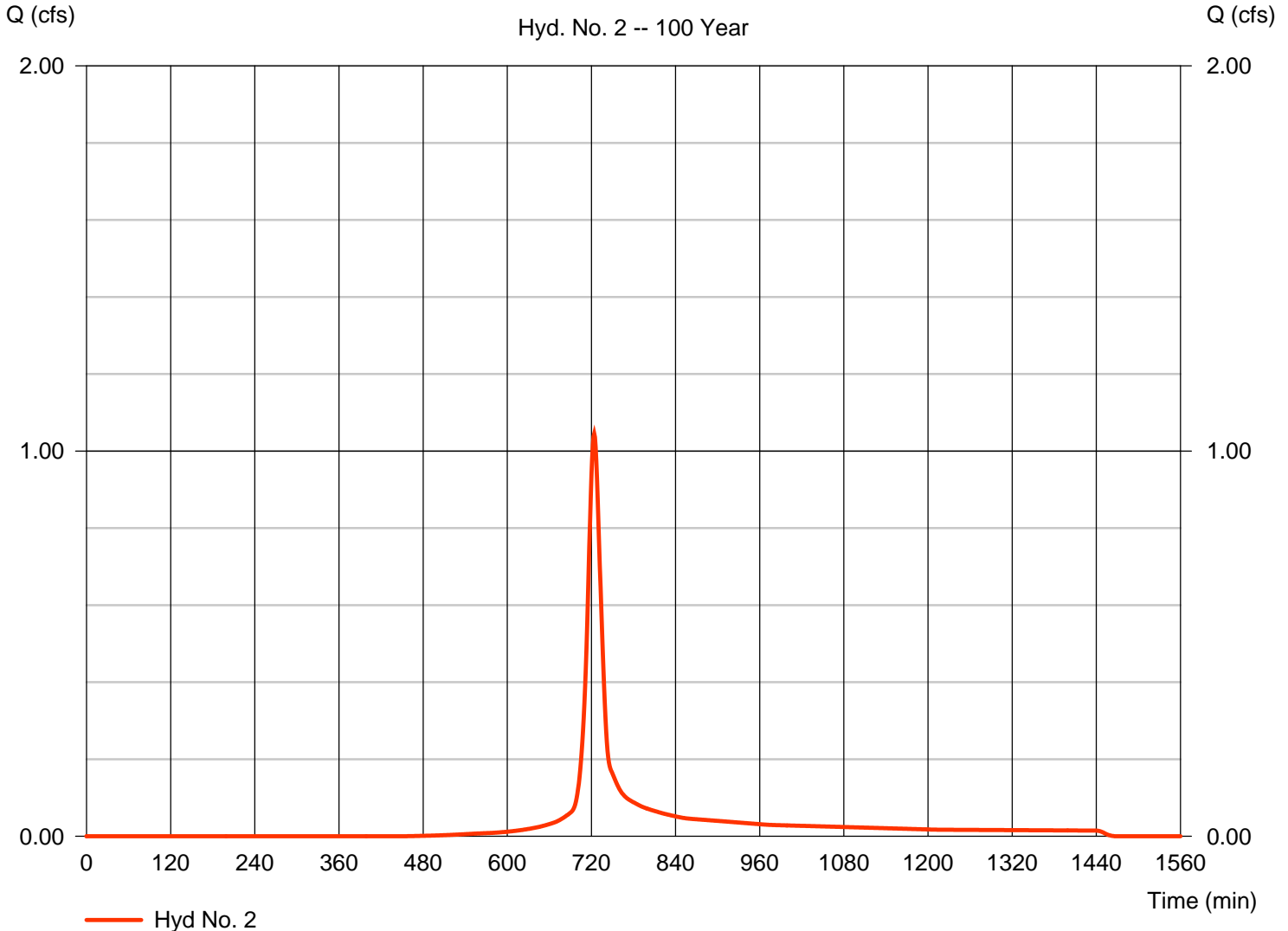
# Hydrograph Report

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.045 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 724 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 3,094 cuft |
| Drainage area   | = 0.200 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 17.00 min  |
| Total precip.   | = 7.69 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

**S Pennell Post - DD-1 Undetained**



# TR55 Tc Worksheet

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

## Hyd. No. 2

S Pennell Post - DD-1 Undetained

| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.400        | 0.240         | 0.011         |                  |
| Flow length (ft)                   | = 75.0         | 25.0          | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 3.25         | 3.25          | 3.25          |                  |
| Land slope (%)                     | = 4.00         | 4.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 12.83</b> | <b>+ 3.54</b> | <b>+ 0.00</b> | <b>= 16.37</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| Flow length (ft)                   | = 104.00       | 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.44</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.44</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 2.63         | 1.16          | 0.00          |                  |
| Wetted perimeter (ft)              | = 5.35         | 3.83          | 0.00          |                  |
| Channel slope (%)                  | = 1.40         | 9.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =7.30          | 13.39         | 0.00          |                  |
| Flow length (ft)                   | 35.0           | 100.0         | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.08</b>  | <b>+ 0.12</b> | <b>+ 0.00</b> | <b>= 0.20</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>17.00 min</b> |

# Hydrograph Report

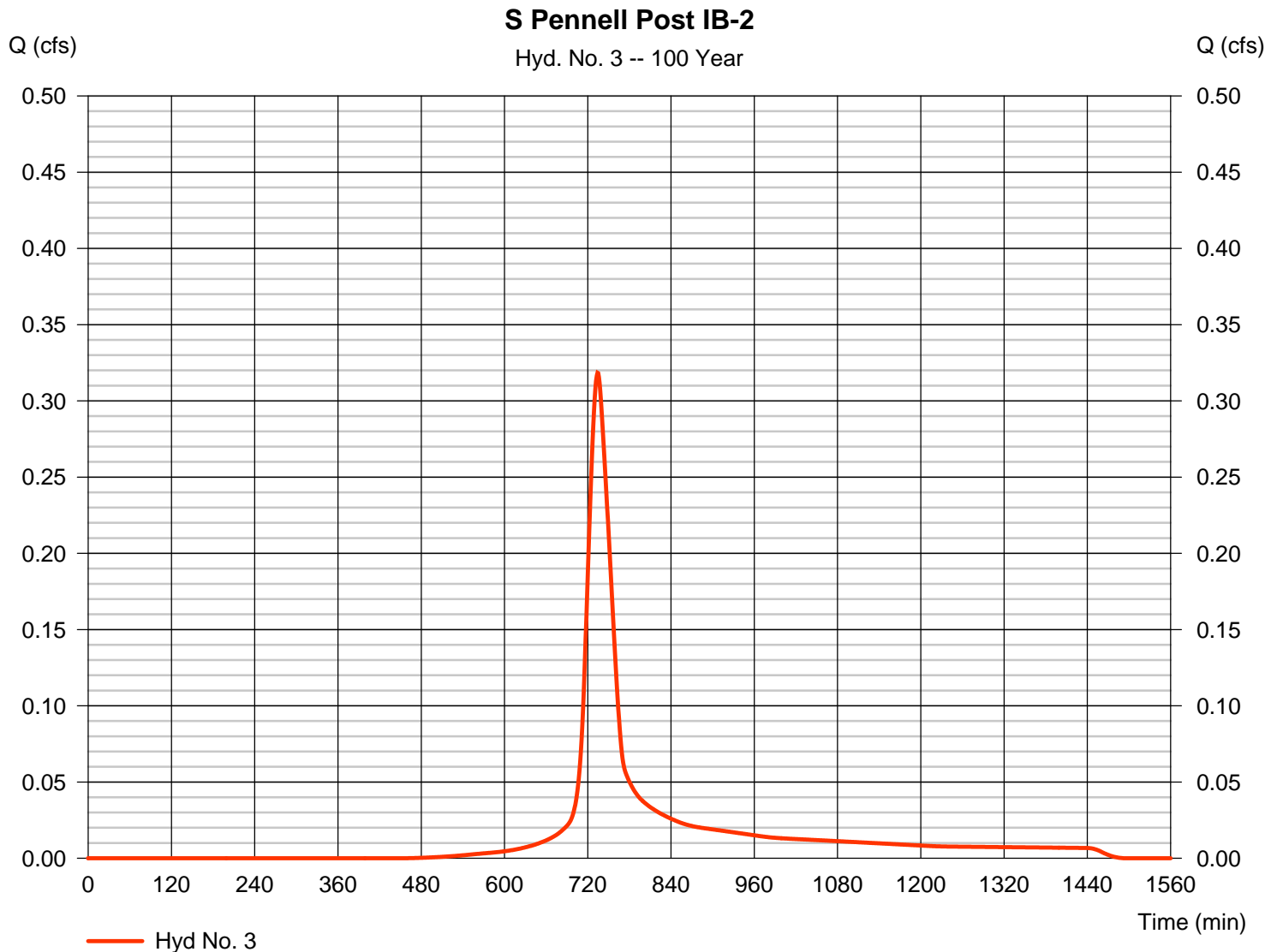
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## Hyd. No. 3

S Pennell Post IB-2

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.318 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 734 min    |
| Time interval   | = 1 min      | Hyd. volume        | = 1,408 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 71         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 34.20 min  |
| Total precip.   | = 7.69 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |



# Hydrograph Report

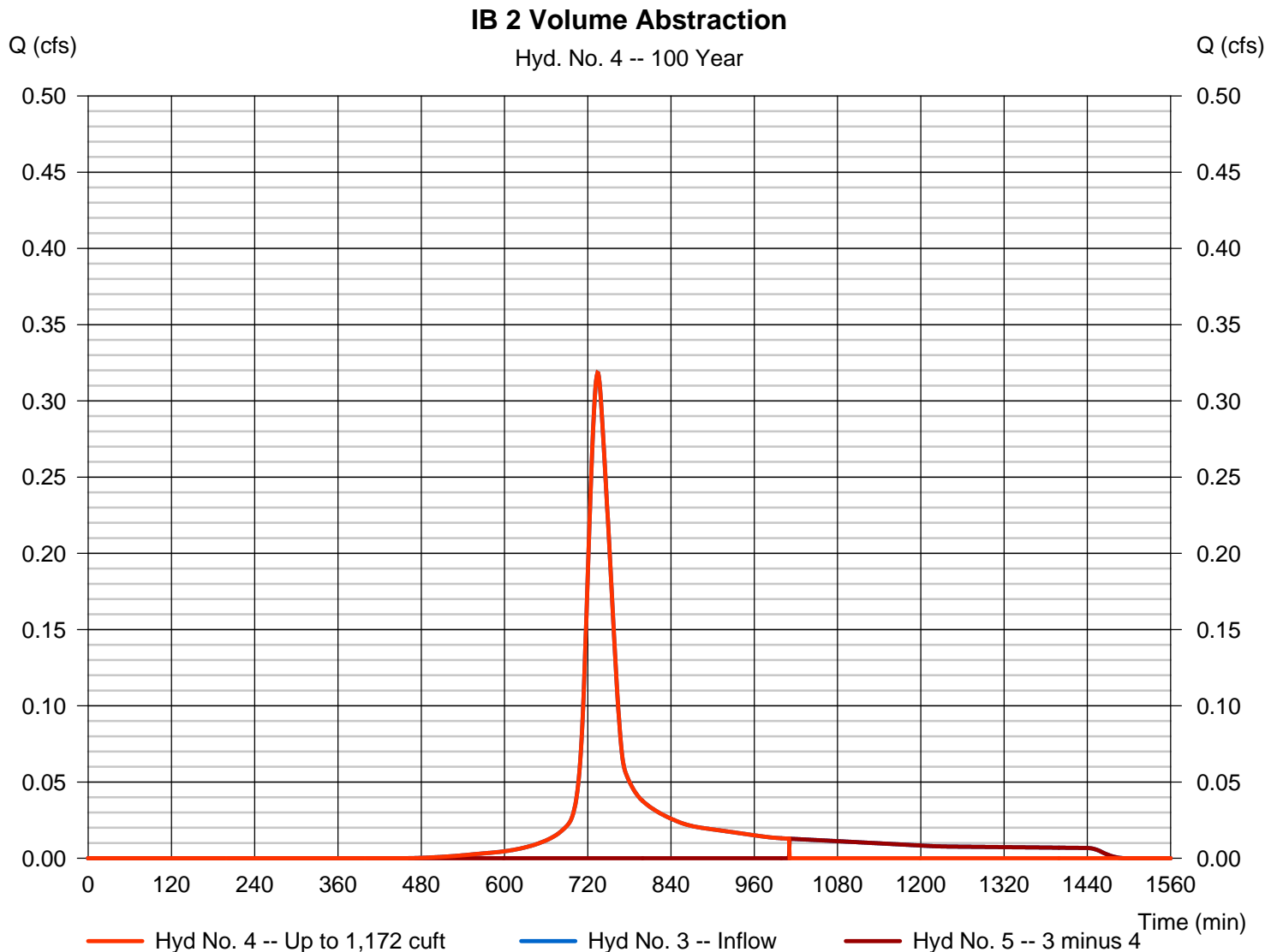
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## Hyd. No. 4

### IB 2 Volume Abstraction

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1              | Peak discharge    | = 0.318 cfs  |
| Storm frequency   | = 100 yrs                 | Time to peak      | = 734 min    |
| Time interval     | = 1 min                   | Hyd. volume       | = 1,173 cuft |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 5          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,172 cuft |



# Hydrograph Report

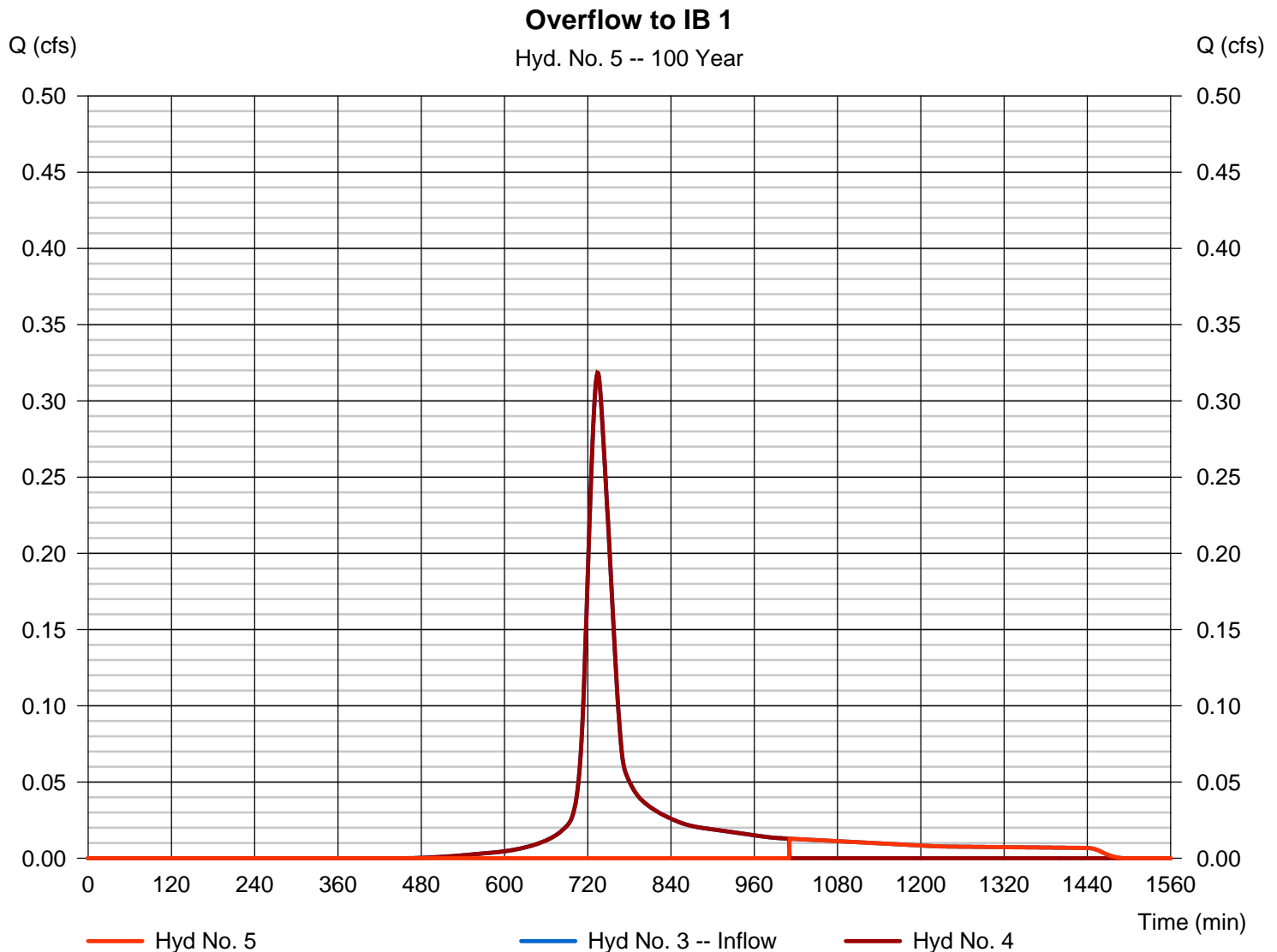
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## Hyd. No. 5

Overflow to IB 1

|                   |                           |                   |              |
|-------------------|---------------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2              | Peak discharge    | = 0.013 cfs  |
| Storm frequency   | = 100 yrs                 | Time to peak      | = 1011 min   |
| Time interval     | = 1 min                   | Hyd. volume       | = 236 cuft   |
| Inflow hydrograph | = 3 - S Pennell Post IB-2 | 2nd diverted hyd. | = 4          |
| Diversion method  | = First Flush Volume      | Volume Up To      | = 1,172 cuft |



# Hydrograph Report

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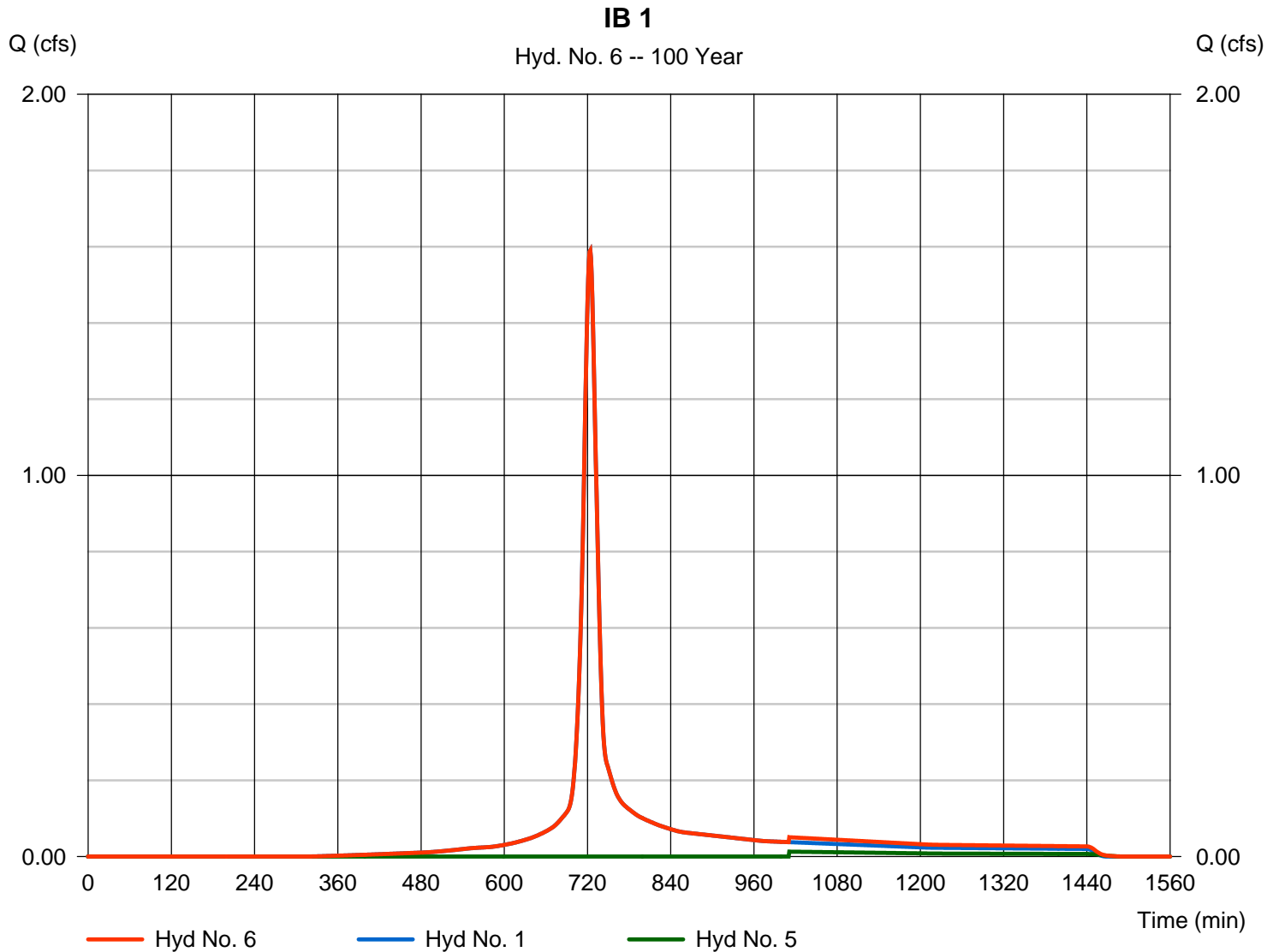
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## Hyd. No. 6

IB 1

Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 1 min  
Inflow hyds. = 1, 5

Peak discharge = 1.590 cfs  
Time to peak = 724 min  
Hyd. volume = 5,022 cuft  
Contrib. drain. area = 0.250 ac



# Hydrograph Report

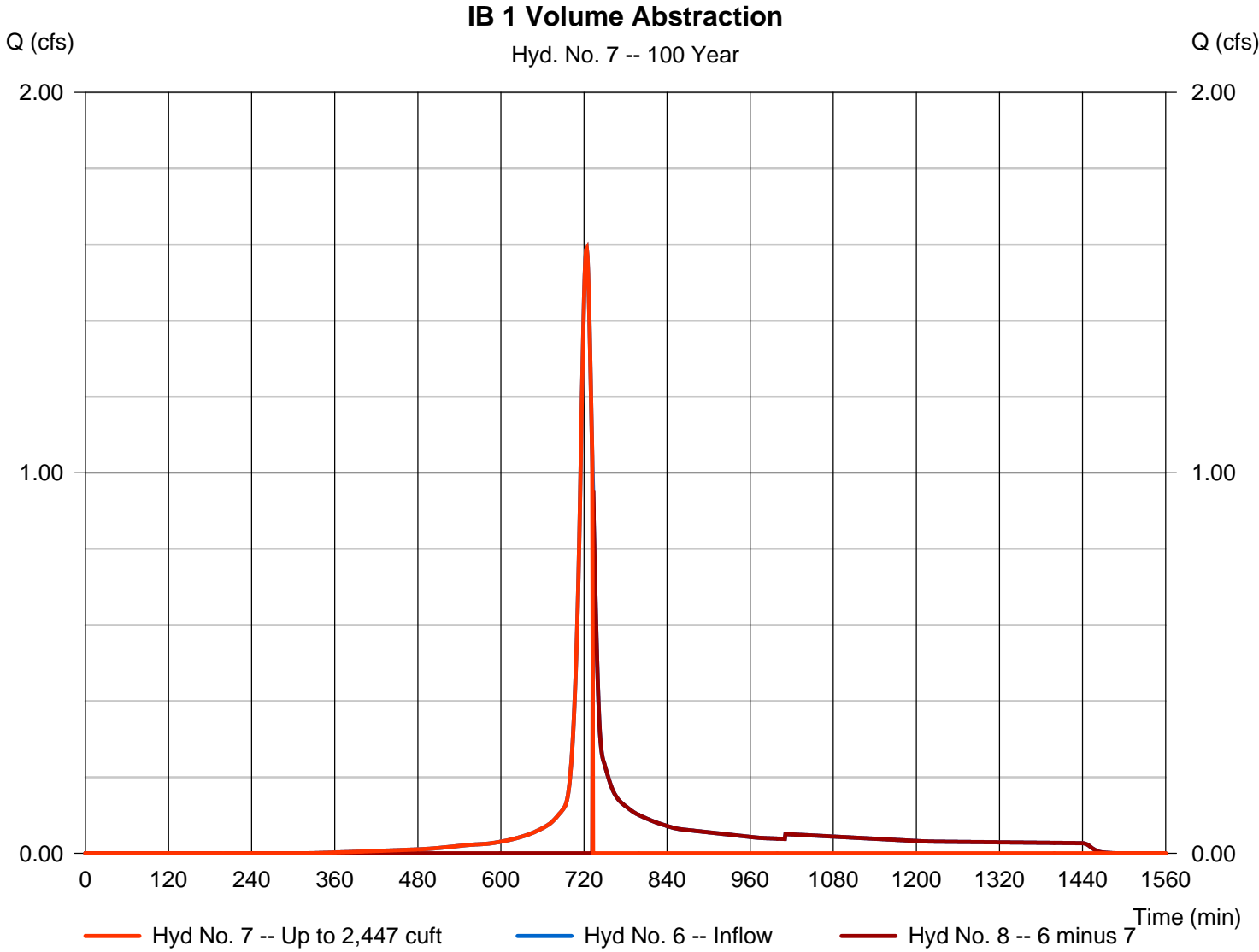
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## Hyd. No. 7

### IB 1 Volume Abstraction

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion1         | Peak discharge    | = 1.590 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 724 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,467 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 8          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

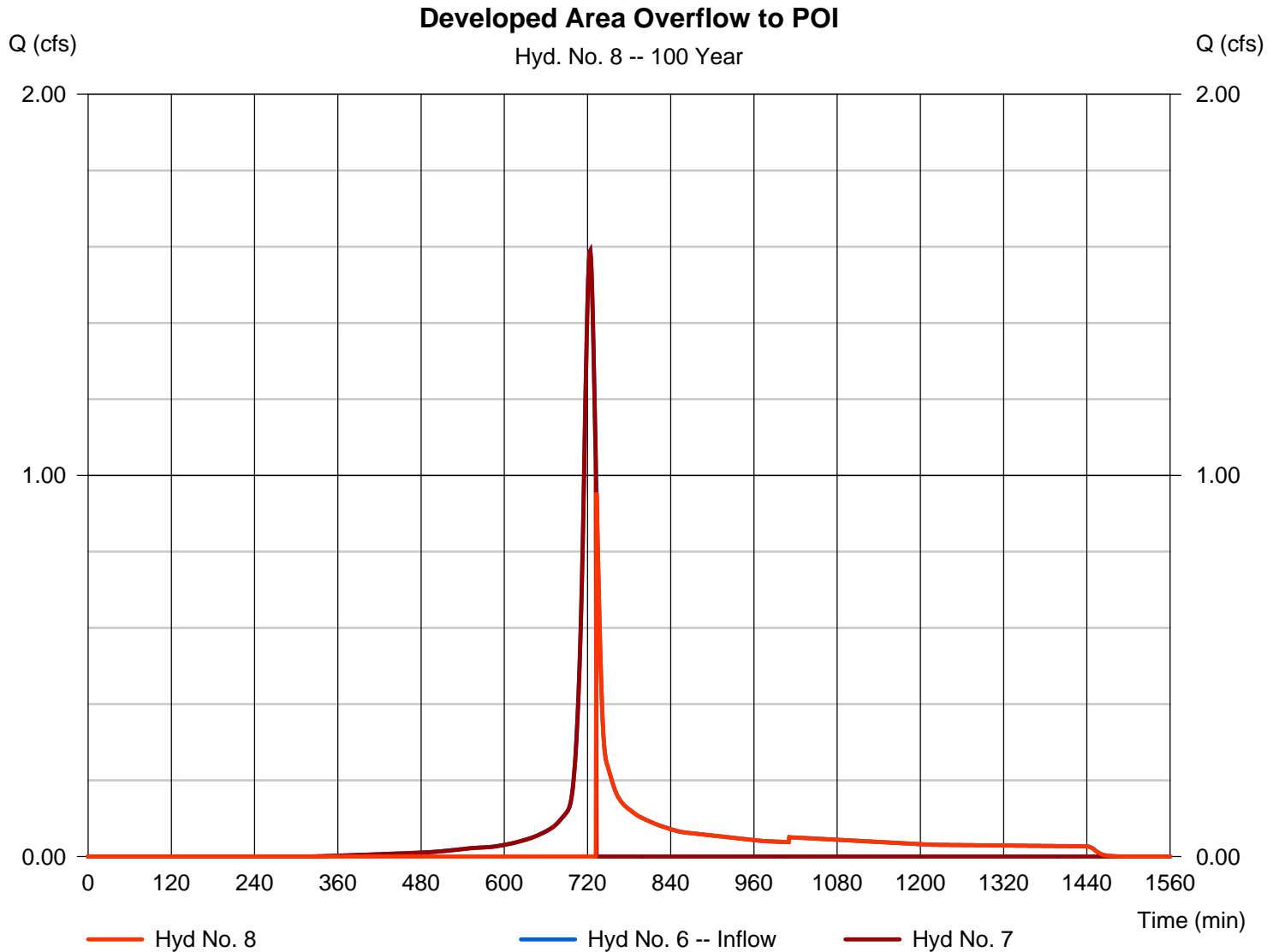
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## Hyd. No. 8

Developed Area Overflow to POI

|                   |                      |                   |              |
|-------------------|----------------------|-------------------|--------------|
| Hydrograph type   | = Diversion2         | Peak discharge    | = 0.955 cfs  |
| Storm frequency   | = 100 yrs            | Time to peak      | = 733 min    |
| Time interval     | = 1 min              | Hyd. volume       | = 2,556 cuft |
| Inflow hydrograph | = 6 - IB 1           | 2nd diverted hyd. | = 7          |
| Diversion method  | = First Flush Volume | Volume Up To      | = 2,447 cuft |



# Hydrograph Report

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

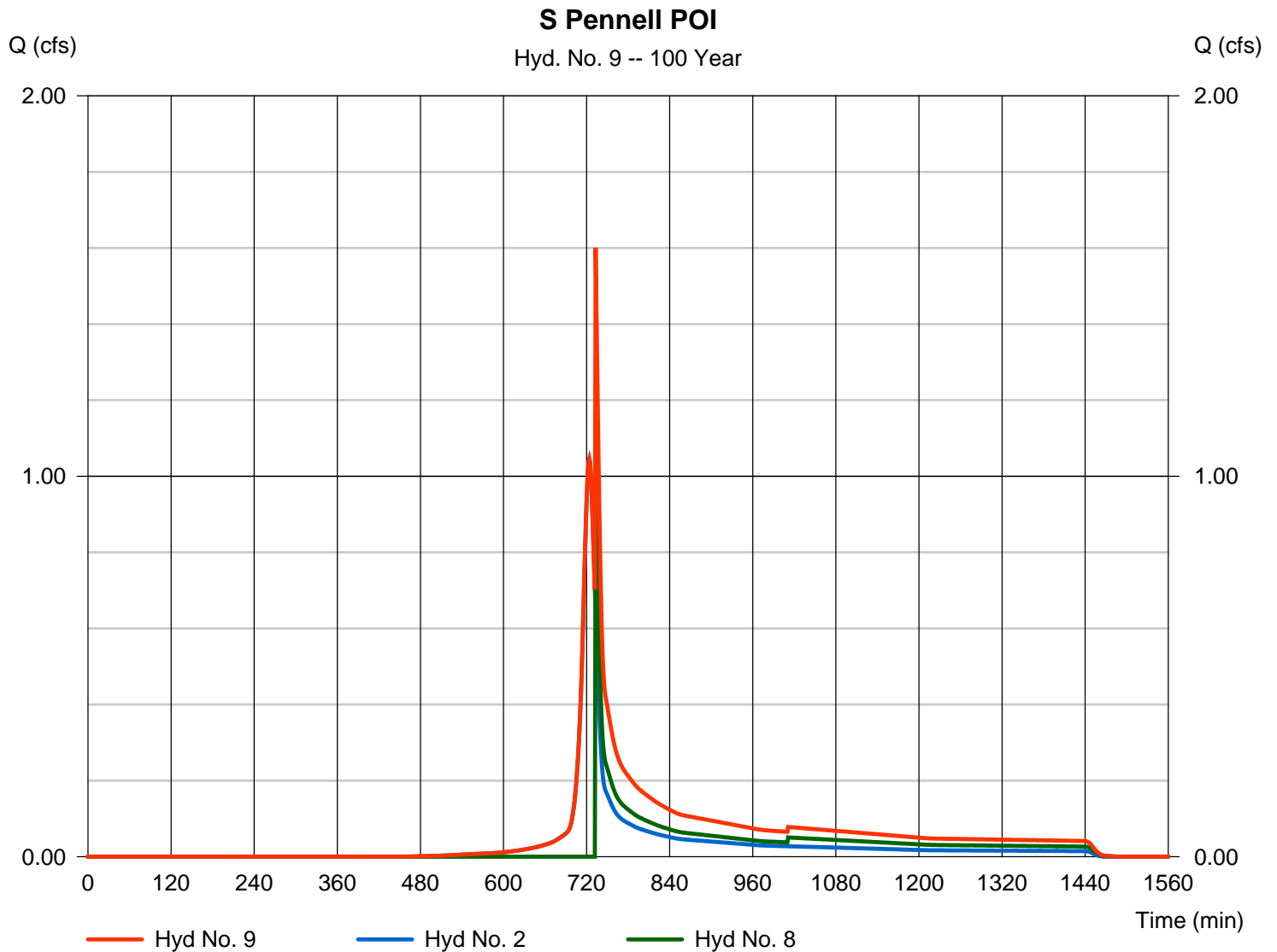
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## Hyd. No. 9

S Pennell POI

Hydrograph type = Combine  
Storm frequency = 100 yrs  
Time interval = 1 min  
Inflow hyds. = 2, 8

Peak discharge = 1.601 cfs  
Time to peak = 733 min  
Hyd. volume = 5,650 cuft  
Contrib. drain. area = 0.200 ac



**ATTACHMENT D**  
**S PENNELL RD**  
**DIVERSION CHANNEL DESIGN**



# TETRA TECH, INC.

By: RJM Date: 10/24/16 Subject: Sunoco PA Pipeline Project Sheet No.:      of       
 Chkd. By: LMD Date: 10/25/16 S Pennell Rd Proj. No.: 112IC05958

## DIVERSION DITCH DESIGN

### DESIGN DISCHARGE

| Channel | Design Discharge (cfs) |
|---------|------------------------|
| DD-1*   | 1.25                   |

DD-1 is designated as the watershed labeled as "S Pennell Post - DD-1 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    | 1.50            | 0.77       | 0.50                            | 1.27                        |

### CHANNEL CONFIGURATION SUMMARY

| Channel | Bed Slope (%) | Bottom Width (ft) | Side Slopes |          | Channel Lining | Total Depth (ft) |
|---------|---------------|-------------------|-------------|----------|----------------|------------------|
|         |               |                   | ( LH:1V)    | ( RH:1V) |                |                  |
| DD-1    | 1.4-9%        | 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: 10/24/16      Subject: Sunoco PA Pipeline Project      Sheet No.:      of       
 Chkd. By: LMD      Date: 10/25/16      S Pennell Rd      Proj. No.: 112IC05958

## LEVEL SPREADER DESIGN

| CHANNEL DESIGNATION | ENERGY DISSIPATOR TYPE    | LENGTH (ft) | Downslope Protection | Q (cfs) |
|---------------------|---------------------------|-------------|----------------------|---------|
| DD-1                | Structural Level Spreader | <b>19</b>   | Grass/Rock           | 1.25    |

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

Q = Flow (cfs)

L = Length of Level Spreader (ft)

C<sub>w</sub> = 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: PPP  
 Project Number: 104958  
 Channel Name: S Pennell DD-1A**

|                      |                   |
|----------------------|-------------------|
| Discharge            | 1.25              |
| Peak Flow Period     | 0.3               |
| Channel Slope        | 0.014             |
| 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 | 1.25 cfs  | 1.99 ft/s | 0.36 ft      | 0.034      | 3 lbs/ft <sup>2</sup>    | 0.32 lbs/ft <sup>2</sup>  | 9.45          | STABLE  | E              |
| P300 Reinforced Vegetation | Straight | 1.25 cfs  | 0.64 ft/s | 0.77 ft      | 0.16       | 8 lbs/ft <sup>2</sup>    | 0.67 lbs/ft <sup>2</sup>  | 11.86         | STABLE  | E              |
| Underlying Substrate       | Straight | 1.25 cfs  | 0.64 ft/s | 0.77 ft      | --         | 2 lbs/ft <sup>2</sup>    | 0.007 lbs/ft <sup>2</sup> | 306.9         | STABLE  | --             |



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 www.nagreen.com

**Erosion Control Materials Design Software  
 Version 5.0**

**Project Name: PPP  
 Project Number: 104958  
 Channel Name: S Pennell DD-1B**

|                      |                   |
|----------------------|-------------------|
| Discharge            | 1.25              |
| Peak Flow Period     | 0.3               |
| Channel Slope        | 0.09              |
| 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 | 1.25 cfs  | 3.88 ft/s | 0.22 ft      | 0.034      | 3 lbs/ft <sup>2</sup>    | 1.25 lbs/ft <sup>2</sup>  | 2.4           | STABLE  | E              |
| P300 Reinforced Vegetation | Straight | 1.25 cfs  | 1.5 ft/s  | 0.44 ft      | 0.127      | 8 lbs/ft <sup>2</sup>    | 2.48 lbs/ft <sup>2</sup>  | 3.22          | STABLE  | E              |
| Underlying Substrate       | Straight | 1.25 cfs  | 1.5 ft/s  | 0.44 ft      | --         | 2 lbs/ft <sup>2</sup>    | 0.045 lbs/ft <sup>2</sup> | 44.91         | STABLE  | --             |