# GRADING AND DRAINAGE ENGINEERING DESIGN REPORT

PREPARED IN ACCORDANCE WITH MDEQ'S CIRCULAR DEQ-8 AND THE CITY OF MISSOULA'S STANDARDS FOR DESIGN AND CONSTRUCTION

for

**ASPIRE SUBDIVISION**

On a property located near 110 Somers St., Missoula, MT 59802
legally described as Parcel A of COS 6338, Tract 7 and 8 of COS 5298,
and Parcels 1, 2, 3, 4, and 5 of COS 6629

Published: April 1, 2024

**Prepared For:**
Denova Homes
1500 Willow Pass Court
Concord, CA 94520

**Prepared By:**
406 Engineering, Inc.
1201 South 6th Street West
Missoula, MT 59801
(406) 317-1131

**NOTE TO REVIEWER**

Items with a gray highlight indicate revisions to this design report based upon comments received from the City of Missoula on March 15, 2024, and subsequent conversation with City Engineering on March 20, 2024. All tables and calculations have been revised regardless of highlighting.

## 1.0 INTRODUCTION

### 1.1 Location

#### a) Existing and Proposed Streets

The project is located at the end of Sommers Street in East Missoula. The property lies north of I-90, west of the Clark Fork. The site is bordered by existing homes located off Canyon View Drive, Montana Avenue, and Waterside Drive. New Roads are proposed within the subdivision as shown on Appendix B.

#### b) Surrounding Developments or Properties

Single family homes border the property to the west and north. The site is bordered to the south by I-90 and to the west by the Clark Fork River.

The land is currently zoned R Residential. The property is proposed to be annexed and zoned RT5.4 with a neighborhood character overlay. A Vicinity Map of the area is provided in Appendix C.

### 1.2 Description of Property

a) **Area:** 31.52 acres

b) **Ground Cover:** Existing ground cover consists of primarily grasses with some shrubs and a gravel driveway to serve the two homes.

c) **Existing Land Use:** Existing land use is primarily vacant and open agricultural land that was used for hay. There are two existing residences on the west edge of the property.

d) **Topographic features:** The property generally slopes from west to east towards the Clark Fork River. The steepest slopes are along the west edge of the property and vary from 5-33%. There are also steeper slopes along the bank of the Clark Fork at 15-33%. The remainder of the site is flat and slopes south and east at 0-5%. There are some internally drained basins as shown on Pre-Development Basin Layout (Appendix A).

e) **Drainage ways:** Existing onsite drainage is sheet flow from west to east. There is a defined drainage swale along the South that collects water from I-90. Drainage from west developed areas enters the site but does not runoff to the Clark Fork as there are multiple areas that are internally drained within the site or have soils capable of infiltrating the additional run on. Drainage from the north is collected infiltrated in the median of Waterside Dr.

f) **Existing drainage facilities:** The only existing drainage facility is the grassed swale along I-90.

g) **Flood hazard zones:** The property does not lie within the 100-year floodplain as shown In Appendix D.

h) **Existing irrigation ditches:** There is no irrigation ditch onsite.

i) **Geologic Features:** There are no geologic features to note.

### 1.3 Previous Drainage Studies

No known drainage studies have been conducted on the property.

### 1.4 General Project Description

The proposed Aspire Subdivision is a 182-lot subdivision with a mix of single-family homes and multi-family buildings. The project is subject to subdivision review from the City of Missoula. The property is planned to be developed with access from Sommers St. and Waterside Dr. New buildings will be serviced by Missoula municipal sewer and water. Stormwater plans will be reviewed by the City of Missoula as a First-Class Municipality. Solid waste will be managed by Republic Services and delivered to the Republic Services Landfill in Missoula.

This report is written to address the details of the Grading and Drainage requirements of the Subdivision Review Joint Application Part II Section E and is provided to the City of Missoula for review as an MS4 entity. This report has been prepared in accordance with the drainage requirements of the City of Missoula and Montana Circular DEQ 8.

### 1.5 State or Federal Regs

The project requires approval from the Montana Department of Environmental Quality (MDEQ) under the Sanitation in Subdivision laws but is to be reviewed by the City of Missoula as an MS4 entity.

### 1.6 Geotech Report

A geotechnical Report is included as Appendix F to this report.

## 2.0 EXISTING SITE CONDITIONS

### 2.1 Major Basin Description

The proposed subdivision lies within the Clark Fork River Drainage Basin with an approximate drainage basin upstream of the site of 6,000 $mi^2$. The site is located directly adjacent to the river and runoff currently sheet flows to the river. A StreamStats delineation of this basin is provided in Appendix E.

### 2.2 Sub-Basin Description

Pre-Development sub-basins are delineated on the layout in Appendix A. The subbasins in teal drain directly to the Clark Fork and the orange subbasins are internally drained. Offsite drainage is shown in red and flows to the internally drained areas.

Offsite flows from Sommers Street will be managed with stormwater sumps and will not contribute to the post development flows from the Aspire Subdivision. Stormwater plans will be submitted to and reviewed by Missoula County.

Offsite drainage from Canyon View Drive is limited to the runoff from the lots only. It is assumed that the runoff from Canyon View Drive is infiltrated by the stormwater sump on Canyon View Drive. Further north along Montana Ave., offsite runoff is assumed to be contributing from the project side of the roadways. No Runoff is assumed from Waterside Drive because runoff is diverted to the median and stormwater sumps in this existing development.

### 2.3 Groundwater

The geotechnical report for the site predicts static groundwater level in the area to be 25-30 feet in depth below existing grade. During site exploration, no groundwater was observed in any of the test pits which explored to a maximum depth of 10.2 feet. The geotechnical report is attached as Appendix F.

### 2.4 Waterways and Wetlands

The nearest waterway is the Clark Fork River. There are no mapped wetlands onsite.

## 3.0 STORMWATER DESIGN CRITERIA

### 3.1 Design Concepts

The project will use curb and gutter to collect runoff and divert runoff. Dry wells (sumps) will infiltrate additional stormwater runoff generated by proposed impervious area to maintain pre-development runoff rates to adjacent properties.

## 3.2 Drainage Criteria

### a) Application Standards

This report follows the design standards described in the Missoula City Public Works Standards and Specifications Manual Chapter 6 – Storm Water System, January 1, 2023. Specifically, the system is designed for post-development stormwater from the project to be completed retained and infiltrated on the site for the 100-year storm event per Section 6.2.1.J.1.a. Additionally, during the 10-year event, flow in the curb line will be restricted from overtopping the curb and the crown of the street per Section 6.3.2.A, Table 6-2.

### b) Minor and Major Storm Frequencies

Storm frequencies to be analyzed are the 2-year, 10-year, and 100-year 24-hr storm events.

### c) Hydrologic Methods

#### i. Rainfall

Rainfall amounts are taken from the MDT Hydraulics Manual, Chapter 7, Appendix B (MDT, 2017) for the Missoula International Airport for 24-hr storm events for the 2-yr, 10-yr, and 100-yr frequencies. The rainfall amounts are summarized in Table 3-1 below.

**Table 3-1**

| Storm Frequency | Storm Event | Rainfall Amount |
|---|---|---|
| 2-year | 24-hour | 1.17” |
| 10-year | 24-hour | 1.66” |
| 100-year | 24-hour | 2.28” |

#### ii. Design Storms

Design storms are the 2yr-24hr, 10yr-24hr, and 100yr-24hr events with a Type II distribution using the SCS TR-55 analysis method.

#### iii. Stormwater Quality and Treatment Methods

Stormwater management controls will be infiltration dry wells. Per Section 6.2.6.C. of the Missoula City Public Works Standards and Specifications Manual, no additional treatment is required if the drywells infiltrate 100% of the runoff reduction volume requirement. See Section 4.13.a for details.

For the lots in post-development basin EE (32-46, 68-84), stormwater from roof drains will be diverted to residential rock sumps via gutters.

#### iv. Runoff Methods

The TR-55 SCS runoff method will be used to calculate pre- and post-development runoff peak flow and volume. The Hydraflow extension for AutoCAD Civil 3D is used to build a runoff model.

The predevelopment site was divided into 4 sub-basins to estimate runoff and peak flow. Sub-basin parameters are included in Table 3-2 below. Additional information for computation of time of concentration is included with the Hydroflow Summary Report (Appendix G).

| Table 3-2 | | | | | |
|---|---|---|---|---|---|
| **Pre-Development Basins** | | | | | |
| **BASIN** | **Impervious Area(ac)** | **Pervious Area (ac)** | **Total Area (ac)** | **Curve Number** | **Time of Concentration (min)** |
| A | 0.37 | 9.46 | 9.83 | 39 | 31.6 |
| B | 0 | 2.96 | 2.96 | 41 | 25.1 |
| C | 0 | 4.97 | 4.97 | 39 | 26.0 |
| D | 0 | 0.43 | 0.43 | 39 | 14.0 |
| Internally Drained | 0 | 18.85 | 18.85 | N/A | N/A |
| **Total** | 0.37 | 36.67 | 37.04 | - | - |

Predevelopment storm runoff characteristics are summarized in Table 3-3. Given the high infiltrative capacity of the soil and the topography, the pre-development conditions yield no runoff. A Hydraflow Summary Report is included as an attachment to this report in Appendix G.

| Table 3-3 | | |
|---|---|---|
| **Storm Event** | **Peak Flow** | **Volume** |
| 2-year 24-hour | 0 cfs | 0 cfs |
| 10-year 24-hour | 0 cfs | 0 cfs |
| 100-year 24-hour | 0 cfs | 0 cfs |

Post-development drainage basins are delineated and shown on the Post-Development Basin layout (Appendix B). Each basin, except Basin EE, drains to a number of sumps to infiltrate the runoff volume. Post-development basins were delineated using proposed street profiles and locating sumps in low spots and before intersections. Additionally, it is assumed that the driveways will drain to the adjacent roadways. The remainder of the lot is assumed to follow the existing topography. However, where roof runoff would enter an adjacent lot, individual gutter sumps will be used to contain runoff on the applicable lot.

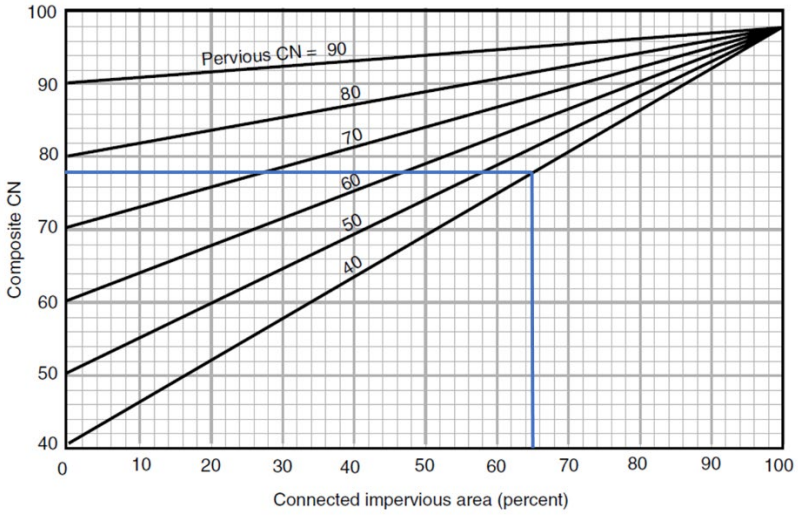
Basin EE drains east towards the river. The homes in this basin will have individual rock sumps from the house downspouts, eliminating the runoff from impervious areas. Runoff from lawns is expected to be negligible.

To develop a post development curve number, the amount of impervious area is estimated. For multifamily and single-family lots, the average lot size and structure size are used to develop the estimate. For roadway, it is assumed that the full Right-of-Way is impervious. The resulting impervious percentage is 64.7% as shown in Table 3-4 below.

| Table 3-4 | | | |
|---|---|---|---|
| | **Total Area** | **Assumed Impervious Percent** | **Total Impervious Area** |
| Total Road Area | 10.35 | 100% | 10.35 |
| Single Family Home | 16.38 | 46% | 7.5348 |
| Multifamily | 4.1 | 50% | 2.05 |
| Subtotal | 30.83 | - | 19.93 |
| **Assumed Impervious Percentage** | | **64.7%** | |

Using Figure 2-3 from the TR-55 manual, a post development curve number of 78 is assumed for runoff calculations for on-site developed areas. Off-site contributions will have a CN of 61 based upon Table 2-2a of the TR55 Manual for ¼ acre lots with Type A soils. The contributing offsite lots range from approximately 0.2 acres to 0.7acres, making ¼ acre lots a conservative assumption.

**Figure 2-3** Composite CN with connected impervious area.




One exception to the curve number of 78 is Basin Z. A curve number of 84 is utilized for this basin which corresponds to an assumed impervious are of 76% per Figure 2-3 of the TR-55 Manual. This is due to the basin being comprised of only right of way.

Another exception is Basins BB and CC which are comprised solely of alleyways. These will utilize a curve number of 98.

Time of concentration for each basin is calculated for the longest flow path to a sump. Where the time of concentration is less than 5 minutes, a manual time of 5 minutes was entered. Tables 3-5 and 3-6 on the following pages represent the runoff volume and peak flow for each basin, respectively. A summary report from Hydraflow is included in Appendix G with more detailed input data for each basin.

| Table 3-5 | | | |
|---|---|---|---|
| Peak Flow (cfs) | | | |
| Basin | 2-year | 10-year | 100-year |
| E | 0.003 | 0.048 | 0.373 |
| F | 0.027 | 0.159 | 0.423 |
| G | 0.019 | 0.092 | 0.217 |
| H | 0.022 | 0.107 | 0.258 |
| I | 0.039 | 0.190 | 0.481 |
| J | 0.029 | 0.147 | 0.366 |
| K | 0.113 | 0.563 | 1.370 |
| L | 0.060 | 0.297 | 0.723 |
| M | 0.002 | 0.033 | 0.362 |
| N | 0.005 | 0.095 | 0.655 |
| O | 0.092 | 0.408 | 0.930 |
| P | 0.016 | 0.072 | 0.163 |
| Q | 0.067 | 0.320 | 0.814 |
| R | 0.073 | 0.358 | 0.864 |
| S | 0.152 | 0.754 | 1.837 |
| T | 0.034 | 0.169 | 0.407 |
| U | 0.024 | 0.105 | 0.267 |
| V | 0.029 | 0.129 | 0.294 |
| W | 0.196 | 0.930 | 2.185 |
| X | 0.036 | 0.171 | 0.434 |
| Y | 0.011 | 0.188 | 1.006 |
| Z | 0.238 | 0.622 | 1.202 |
| AA | 0.028 | 0.137 | 0.331 |
| BB | 0.376 | 0.551 | 0.770 |
| CC | 0.602 | 0.884 | 1.237 |
| DD | 0.475 | 2.108 | 4.801 |
| **TOTAL** | **2.768** | **9.637** | **22.772** |

| Table 3-6 | | | |
|---|---|---|---|
| Volume ($ft^3$) | | | |
| Basin | 2-year | 10-year | 100-year |
| E | 72 | 867 | 2,883 |
| F | 221 | 668 | 1,453 |
| G | 84 | 240 | 509 |
| H | 116 | 333 | 705 |
| I | 350 | 1,002 | 2,120 |
| J | 204 | 584 | 1,237 |

| Table 3-6 | | | |
|---|---|---|---|
| Volume ($ft^3$) | | | |
| Basin | 2-year | 10-year | 100-year |
| K | 676 | 1,937 | 4,100 |
| L | 357 | 1,022 | 2,164 |
| M | 24 | 865 | 3,335 |
| N | 155 | 1,390 | 4,324 |
| O | 310 | 887 | 1,877 |
| P | 54 | 155 | 329 |
| Q | 644 | 1,845 | 3,905 |
| R | 389 | 1,113 | 2,357 |
| S | 907 | 2,597 | 5,497 |
| T | 183 | 525 | 1,110 |
| U | 307 | 878 | 1,859 |
| V | 98 | 281 | 594 |
| W | 846 | 2,423 | 5,129 |
| X | 387 | 1,110 | 2,349 |
| Y | 402 | 2,855 | 8,438 |
| Z | 1,033 | 2,297 | 4,239 |
| AA | 149 | 426 | 901 |
| BB | 920 | 1,383 | 1,974 |
| CC | 1,654 | 2,487 | 3,549 |
| DD | 1,599 | 4,587 | 9,696 |
| **Total** | **12,141** | **34,757** | **76,666** |

**v. Detention/Infiltration Calculation Methods**

Geotechnical evaluation completed by ALLWEST (see Appendix F) included infiltration tests at 7 locations within the proposed subdivision. Measured infiltration rates on-site range from 126 in/hr to 28,826 in/hr. a safety factor of 3 is then applied to these rates per section 6.2.3.B.6.b of the Missoula Public Works manual to account for infiltration degradation over time. As a conservative design estimate, the design infiltration rate maximums were capped at 250 in/hour for those test pits exceeding this value. Table 3-7 below displays Test Pit, measured infiltration rate and design infiltration rate, and the corresponding subbasins for which the design rate is used.

| Table 3-7 | | | | |
|---|---|---|---|---|
| **Test Pit** | **Measured Rate** | **1/3 Rate** | **Design Rate** | **Basins** |
| | in/hr | | | |
| TP-01 | 24,820 | 8273 | 250 | E, F, G, H, I |
| TP-02 | 16,792 | 5597 | 250 | L, M |
| TP-04 | 14,983 | 4994 | 250 | K, O, P, T |
| TP-05 | 168 | 56 | 56 | J, Q, R, S |
| TP-07 | 126 | 42 | 42 | N, U, V, X, Y |
| TP-08 | 1,528 | 509 | 250 | W, Z, AA, BB, CC |
| TP-10 | 28,826 | 9609 | 250 | DD |

**vi. Detention Storage Release Rate**

A standard 8' Precast Dry Well (STD – 616) has an approximate storage volume of 160 $ft^3$ and bottom area of 61.23 $ft^2$ (6.2.6.B). Applying the design infiltration rates from Table 3-7 above, each sump has an infiltration flow rate measured in $ft^3$/hr per sump as defined in Table 3-8 below.

| Table 3-8 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **TP-01** | **TP-02** | **TP-04** | **TP-05** | **TP-07** | **TP-08** | **TP-10** | **Unit** |
| 1275.6 | 1275.6 | 1275.6 | 285.7 | 214.3 | 1275.6 | 1275.6 | cfs/hr |

**d) Hydraulic Methods**

**i. Design Standards**

This report follows the design standards described in the Missoula City Public Works Standards and Specifications Manual Chapter 6 – Storm Water System, January 2023. All flows across the site are anticipated to be sheet flows until runoff reaches the gutter. Once in the gutter, the runoff is treated as channelized flow. The gutters are evaluated to ensure no curb overtopping or flow over the crown of the street during the 10-year storm event per Section 6.3.2.A, Table 6.2 of the Missoula Public Works Manual. During the 100-year event, structures will be protected by grading the sidewalks and boulevards towards the roadway as well as providing a 5% slope from foundations for a minimum of 10'.

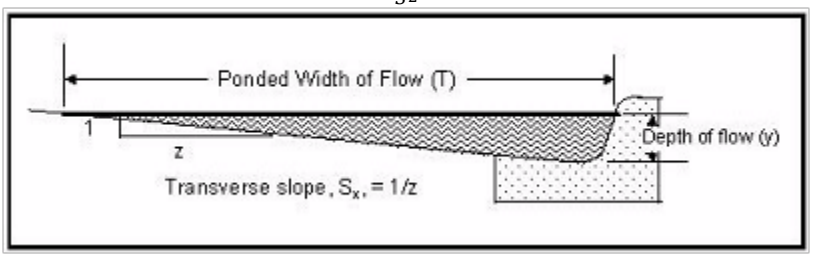
**ii. Hydraulic Models**

The Hydraflow Extension for Civil 3D was used to input the relevant sheet flow and channelized flow variables. The Hydraflow Summary Report in Appendix G to this report includes the time of concentration data for each subbasin.

**iii. Methods Used for Open Channel Design**

Depth of flow in the gutter and width of flow into the road were determined using the following equations;

$$y = z\left(\frac{QnS_x}{S^{\frac{1}{2}}}\right)^{3/8} \quad \text{and} \quad T = \frac{y}{S_x}$$




Where:
y= depth of water in the gutter (ft)
Q = gutter flow (cfs)
*N* = Manning's roughness coefficient (0.013)
*S* = longitudinal slope (ft/ft)
$S_x$ = pavement cross slope (2%)
Z = 1.24
T = Ponded Width (ft)

The depth of water in the gutter and ponded width were computed for each post-development basin using the 10-year peak flow rate (Q), the pavement cross slope (2%), and the slope of the gutter line (see the Hydraflow Report in Appendix G for summary of channelized flow slopes). The maximum depth of flow in the gutter is 0.116 ft (1.4in) and the maximum width of flow is 5.8 ft indicating that flow is contained within the gutter and roadways will not be overtopped. A summary of each basin's gutter flow depth and ponded width are listed below in Table 3-9. Basins DD, the multifamily lots, are excluded from this analysis because they will not have curb and gutter in the right of way. Basin EE is excluded since this is the basin along the river without curb and gutter.

**Table 3-9**

| Basin | Q (cfs) | n | S (ft/ft) | $S_x$ (ft/ft) | z | Y (ft) | T (ft) |
|---|---|---|---|---|---|---|---|
| **E** | 0.048 | 0.013 | 0.015 | 0.02 | 1.24 | 0.039 | 1.974 |
| **F** | 0.159 | 0.013 | 0.015 | 0.02 | 1.24 | 0.062 | 3.094 |
| **G** | 0.092 | 0.013 | 0.037 | 0.02 | 1.24 | 0.043 | 2.128 |
| **H** | 0.107 | 0.013 | 0.15 | 0.02 | 1.24 | 0.035 | 1.732 |
| **I** | 0.19 | 0.013 | 0.015 | 0.02 | 1.24 | 0.066 | 3.308 |
| **J** | 0.165 | 0.013 | 0.007 | 0.02 | 1.24 | 0.072 | 3.619 |
| **K** | 0.563 | 0.013 | 0.007 | 0.02 | 1.24 | 0.115 | 5.734 |
| **L** | 0.297 | 0.013 | 0.005 | 0.02 | 1.24 | 0.096 | 4.805 |
| **M** | 0.033 | 0.013 | 0.005 | 0.02 | 1.24 | 0.042 | 2.108 |
| **N** | 0.095 | 0.013 | 0.005 | 0.02 | 1.24 | 0.063 | 3.134 |
| **O** | 0.408 | 0.013 | 0.005 | 0.02 | 1.24 | 0.108 | 5.413 |
| **P** | 0.072 | 0.013 | 0.015 | 0.02 | 1.24 | 0.046 | 2.299 |
| **Q** | 0.32 | 0.013 | 0.014 | 0.02 | 1.24 | 0.081 | 4.074 |
| **R** | 0.358 | 0.013 | 0.014 | 0.02 | 1.24 | 0.085 | 4.249 |

| Table 3-9 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Basin** | **Q (cfs)** | **n** | **S (ft/ft)** | **$S_x$ (ft/ft)** | **z** | **Y (ft)** | **T (ft)** |
| **S** | 0.754 | 0.013 | 0.0138 | 0.02 | 1.24 | 0.113 | 5.634 |
| **T** | 0.169 | 0.013 | 0.005 | 0.02 | 1.24 | 0.078 | 3.890 |
| **U** | 0.105 | 0.013 | 0.005 | 0.02 | 1.24 | 0.065 | 3.254 |
| **V** | 0.129 | 0.013 | 0.008 | 0.02 | 1.24 | 0.064 | 3.218 |
| **W** | 0.93 | 0.013 | 0.02 | 0.02 | 1.24 | 0.114 | 5.685 |
| **X** | 0.171 | 0.013 | 0.009 | 0.02 | 1.24 | 0.070 | 3.499 |
| **Y** | 0.188 | 0.013 | 0.0129 | 0.02 | 1.24 | 0.068 | 3.389 |
| **Z** | 0.622 | 0.013 | 0.011 | 0.02 | 1.24 | 0.109 | 5.469 |
| **AA** | 0.137 | 0.013 | 0.006 | 0.02 | 1.24 | 0.069 | 3.474 |
| **BB** | 0.551 | 0.013 | 0.013 | 0.02 | 1.24 | 0.101 | 5.065 |
| **CC** | 0.884 | 0.013 | 0.0166 | 0.02 | 1.24 | 0.116 | 5.776 |

**iv. Methods Used for Hydraulic Structure Design**

N/A

**v. Methods Used for Stormwater Pond Outlet Structure Design**

N/A

### 3.3 Down-Gradient Analysis

Post-development runoff will not exceed pre-development rates. A down-gradient analysis is therefore not required.

### 3.4 Analysis Points

The post-development site is divided into 27 basins. Within each basin, the longest flow path to the sump was analyzed to develop peak flow and runoff volume. These time of concentration flow paths are shown on the Drainage Design Layout in Appendix B. Basins were delineated with sumps at low spots and prior to intersections.

The only exception is Basin EE where the runoff from structures is captured and infiltrated in individual home rock sumps connected to the downspouts. The remaining runoff from the impervious area in this basin is being released unmitigated to the Clark Fork. Per communication with the City on March 29, 2024, runoff control from the trail has been deemed unnecessary.

## 4.0 PROPOSED DESIGN

All design discussions are absolute and are not relative to pre-development runoff rates and volumes.

### 4.1 Conveyance

All conveyance will be surface sheet flow and then curb and gutter with grading towards proposed sumps. The alleys serving the multifamily lots will manage stormwater with sumps.

The multifamily lots (Basin DD) have a design volume and flow calculated. A Time of concentration of 5 minutes was used as for this basin, since each lot is likely to develop its own

stormwater design for zoning compliance. Conveyance for these lots will need to be determined during individual site planning. The flow estimates are intended to show the water can be managed with sumps and can help guide future designs.

### 4.2 Drainage Path

Drainage paths begin as sheet flow from the downspouts, driveways or lawns to the roadways. In the roadways, curb and gutters carry water to the stormwater sumps. The minimum time of concentration that will be used in runoff calculations is 5 minutes.

All houses will utilize individual sumps from the gutters to prevent runoff from entering adjacent properties. This affects lots 19-31, 47-57, 83-102, 114-182, which have part of the lot draining to an adjacent lot.

### 4.3 Storm Sewer Design

No storm sewers are proposed.

### 4.4 Street Capacities

The proposed streets will have 10 feet drive lanes and 8 feet parking lanes with a 2% crown. The flow width and gutter capacity during the 10-year event were calculated for each basin, and the widest flow at the curb line is 5.8 feet. See Table 3-9 for more information about curb flow. The roadways will not be overtopped during the 10-year storm.

### 4.5 Storm Sewer Outfall

N/A

### 4.6 Stormwater Quality Control

Stormwater management controls will be infiltration dry wells. Per Section 6.2.6.C.1 of the Missoula City Public Works Standards and Specifications Manual, no additional treatment is required if the drywells infiltrate 100% of the runoff reduction volume requirement. See Section 4.13.a for details.

### 4.7 Conveyance to Public Systems

All runoff is anticipated to infiltrate in the proposed drywells. No conveyance to Public Systems is proposed.

### 4.8 Open Channel Design

No open channels are proposed.

### 4.9 Easements, Maintenance, and Access

All stormwater sumps are proposed within the ROW or alleyway. This will allow for access and maintenance of all landscaping and drywells.

Stormwater facilities for the multifamily lots will be the responsibility of that lot owner. The individual gutter sumps will be the responsibility of the homeowner.

### 4.10 Offsite Facilities

No offsite facilities are proposed.

**4.11 Flooding Hazards**

No buildings are anticipated to be inundated during large flood events. Buildings are to be constructed with positive drainage, directing stormwater away from proposed structures. Downspouts should be directed away from building foundations.

**4.12 Detention Ponds**

No detention ponds are proposed.

**4.13 Infiltration Facilities**

**a) Design**

Standard 8-foot dry wells are proposed. The proposed subdivision will have 75 sumps installed to mitigate additional runoff generated by proposed improvements. Per city standard 6.2.6.b, drywells have a contributing storage volume of 160 $ft^3$ each, with an infiltrative surface area of 61.23 $ft^2$.

Runoff Reduction Volume (RRV)

The Runoff Reduction Volume (RRV) is defined by Montana Circular DEQ-8 as the 1st half-inch of rain that runs off impervious area. Total impervious area (A) proposed for the project is 19.93 acres (868,151 sqft), resulting in an RRV of:

$$RRV = 0.5'' \text{ X } A = \frac{0.5}{12} \text{ ft X } 868{,}151 \text{ ft}^2 = \mathbf{36{,}173\ ft^3}$$

With 75 sumps infiltrating the cumulative infiltrative capacity is 15.73 cfs. This equates to 56,622 cf/hr meaning the RRV will be infiltrated in approximately **0.64 hours.**

10yr-24hr Storm

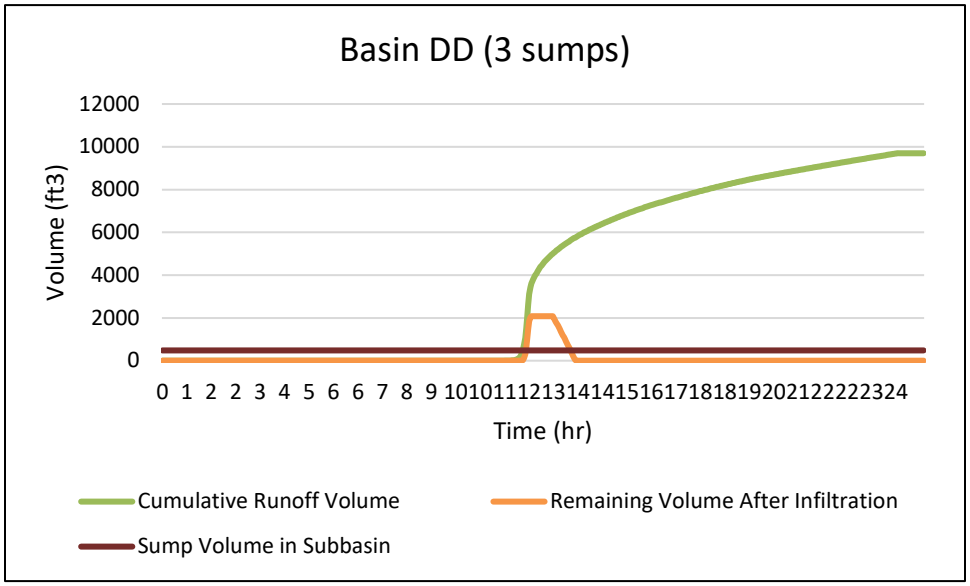
During the 10yr-24hr storm, flow is restricted from overtopping the curbs or the crown of the street. Table 3-9 in Section 3.2.d.iii demonstrates that no curbs or road crowns will be overtopped during the 10-year event.

100yr-24hr Storm

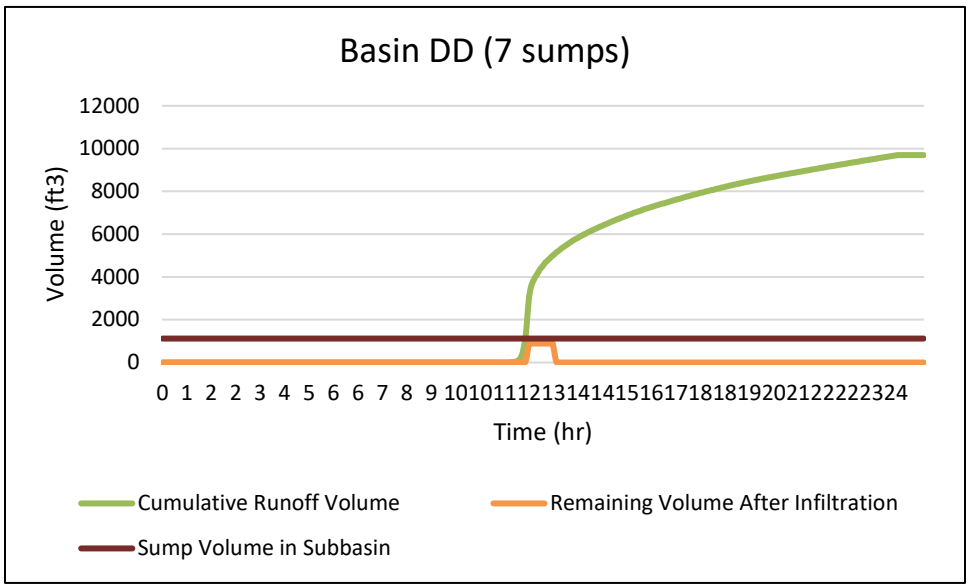
During the 100yr-24hr storm, post-development runoff will be completely contained onsite. To achieve this, each subbasin was evaluated to ensure adequate infiltration and storage within the sumps. The 100yr-24hr storm event was analyzed in Hydraflow to obtain a hydrograph of the unmitigated runoff with 2-minute data intervals. This data set is then used to calculate incremental volume at each time step. The effect of the sumps is then evaluated by subtracting the incremental runoff from the bottom of the sump if there is runoff reaching the sump. When runoff exceeds the infiltration rate, the sumps are assumed to be filling up. To determine the number of sumps needed, the calculation is iterated until the total sump storage is greater than the volume accumulated in the sumps.

An example of this calculation is graphically shown below for Basin DD. The green line represents the cumulative runoff in the basin without any mitigation. The total storm volume is approximately 9,696 $ft^3$. The red line represents the total sump volume within the basin; 160 $ft^3$

per basin, 480 $ft^3$ for 3 proposed sumps. Lastly the orange line represents the remaining volume after infiltration. This is the difference between the runoff and the infiltration and represents the volume accumulating in the sumps. In this scenario, the volume remaining exceeds the total sump volume, and the 3 proposed sumps will overtop.




To prevent sumps from overtopping, the number of sumps required is defined by the volume that will keep the accumulating volume (orange line) below the total volume (red line). In the chart below, when 7 sumps are installed in Basin DD, the accumulated volume in the sumps (orange line) is less than the total sump volume (red line). This indicates that the 5 proposed sumps will be able to completely contain the 100-year, 24-hour storm event in Basin DD.




**b) Water Quality Treatment BMPs**

Additional runoff treatment is not required as 100% of the runoff reduction volume will be infiltrated.

**c) Easements, Maintenance, and Access**

All stormwater facilities are located within the proposed ROW or alleyway. This will allow for access and maintenance of all landscaping and drywells.

## 5.0 SUMMARY

### 5.1 Proposed Improvements

182 lots are proposed for the Aspire Subdivision. New impervious areas include buildings, streets, driveways, and sidewalks. Additional stormwater runoff will be mitigated and treated by proposed infiltration drywells and individual home gutter sumps.

**a) Pre- and Post-Development Flow Rates**

| Storm Event | Pre-development Runoff | Post-development Runoff[1] |
|---|---|---|
| 2-year 24-hour | 0.0 cfs | 0.0 cfs |
| 10-year 24-hour | 0.0 cfs | 0.0 cfs |
| 100-year 24-hour | 0.0 cfs | 0.0 cfs |

**TABLE 5-1**

100% of post-development runoff will be treated through drywell infiltration.

[1] Runoff from the walking trail in Basin EE will discharge to the Clark Fork unmitigated and is assumed to be zero.

**b) Storm Sewers**

No storm sewers proposed.

**c) Culverts**

No culverts proposed.

**d) Open Channels**

No open channels proposed.

**e) Detention Storage**

No detention is proposed.

**f) Infiltration Facilities**

75 drywells with a combined infiltration rate of 15.73 cfs are proposed to infiltrate the street and road runoff. 68 drywells are shown on Appendix B for the runoff from the subdivision streets, alleys, and homes. The remaining 7 sumps are not shown within the multifamily area since each lot will need to create an individual drainage plan.

Runoff from the homes in Basin EE will be collected in individual home gutter sumps.

**g) Geotechnical/groundwater Impacts**

No groundwater impacts are expected. See Appendix F for the Geotechnical Report.

**h) On and Off-site Impacts**

Post-development stormwater runoff will maintain pre-development runoff volumes and rates, treated by drywell infiltration.

### 5.2 Floodplain Impacts

None.

### 5.3 Compliance with Regs

No waivers or deviation are requested.

## 6.0 REFERENCES

Montana Department of Transportation Hydraulics Manual, 2017.
Missoula City Public Works Standards and Specifications Manual, Chapter 6, January 2023.

## 7.0 APPENDICES

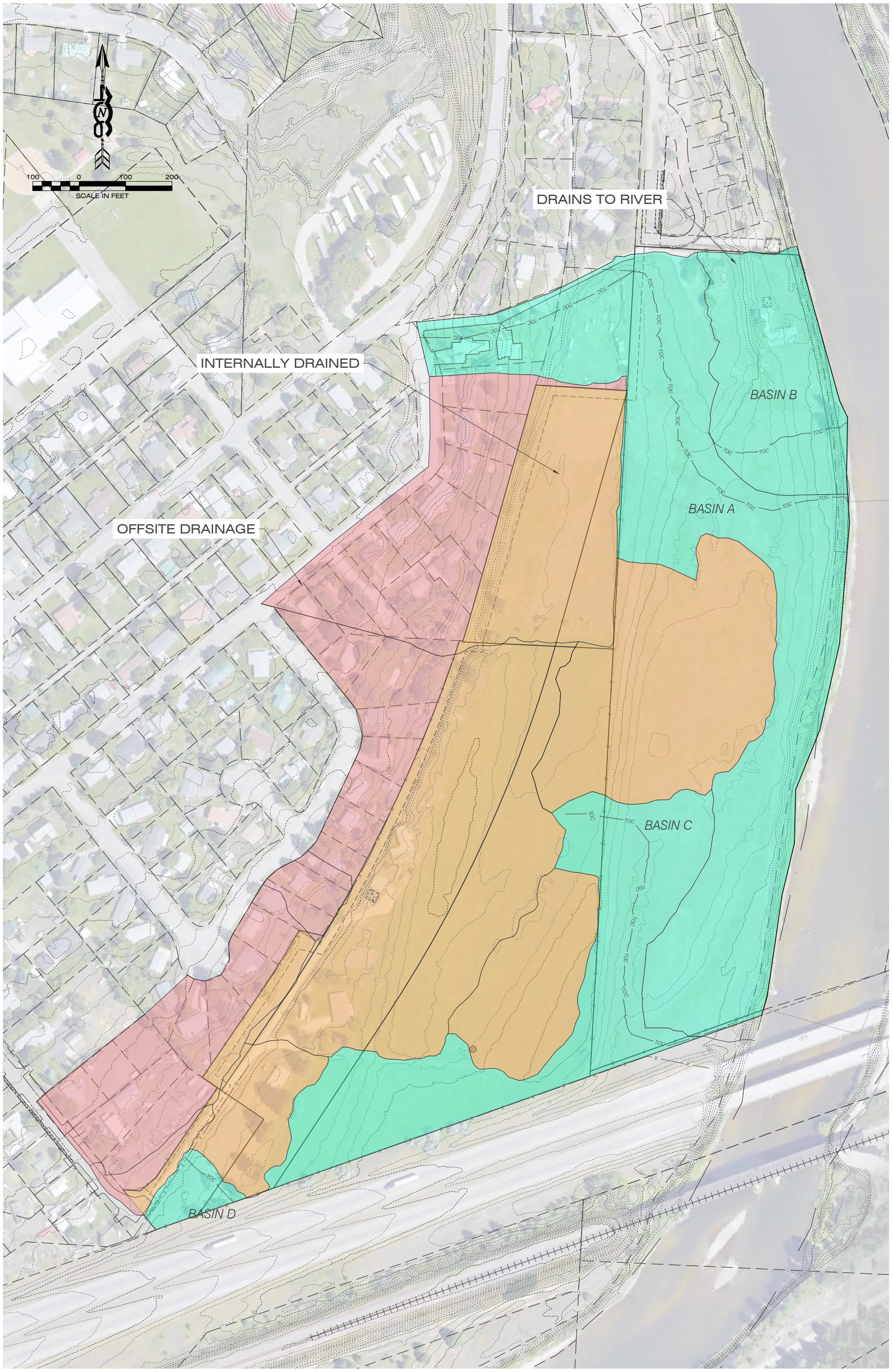
- **A.** Pre-Development Basins
- **B.** Post-Development Basins
- **C.** Vicinity Map
- **D.** FEMA Flood Map
- **E.** StreamStats Major Basin Delineation
- **F.** Geotech Report
- **G.** Hydraflow Summary Report
- **H.** NRCS Soil Report

Prepared by:
**406 Engineering, Inc.**

Jacob Zimmerman, PE

# Appendix A

# Pre-Development Basins Exhibit




SHEET: 1 OF 1

406 PROJECT NO. 21-001

PROJECT NAME: ASPIRE SUBDIVISION

SHEET TITLE: PRE-DEVELOPMENT BASINS

LOCATION: PARCEL TRACTS 1-5 OF COS 6629 SEC. 24, T.13N, R.19W, P.M.M. MISSOULA COUNTY, MONTANA

PREPARED FOR: DENOVA HOMES

| REVISIONS | DATE |
|---|---|
| | |

DESIGNED: -
DRAFTED: JZ
CHECKED: -
DATE: MARCH 2024

406 ENGINEERING
CIVIL ENGINEERING
LAND USE CONSULTING
1201 S. 6th St. W.
Missoula, MT 59801
(406) 317-1131
35 8th St. E.
Kalispell, MT 59901
(406) 257-0679
www.406engineeringinc.com

DWG LOCATION: C:\USERS\JACOB ZIMMERMAN\406\406 ENGINEERING - DOCUMENTS\406 WORK\1_PROJECTS\2021 PROJECTS\21-001 DENOVA HOMES\8_DRAFTING\8.1_DRAWINGS\LIDAR-21-001.DWG

PLOT DATE: 3/29/2024 12:27 PM BY JACOB ZIMMERMAN / JACOB ZIMMERMAN

# Appendix B

# Post-Development Basins Exhibit


SHEET: 1 OF 1

406 PROJECT NO.: 21-001

PROJECT NAME: ASPIRE SUBDIVISION

SHEET TITLE: POST-DEVELOPMENT BASINS

LOCATION: PARCEL TRACTS 1-5 OF COS 6629 SEC. 24, T.13N, R.19W, P.M.M. MISSOULA COUNTY, MONTANA

PREPARED FOR: DENOVA HOMES

| REVISIONS | DATE |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

DESIGNED: -
DRAFTED: JZ
CHECKED: -
DATE: APRIL 2024

406 ENGINEERING
CIVIL ENGINEERING
LAND USE CONSULTING
1201 S. 6th St. W.
Missoula, MT 59801
(406) 317-1131
35 8th St. E.
Kalispell, MT 59901
(406) 257-0679
www.406engineeringinc.com


| | | | | | |
|---|---|---|---|---|---|
| SHEET: 1 OF 1 | 406 PROJECT NO. 21-001 | PROJECT NAME: ASPIRE SUBDIVISION | LOCATION: PARCEL TRACTS 1-5 OF COS 6629 SEC. 24, T.13N, R.19W, P.M.M. MISSOULA COUNTY, MONTANA | REVISIONS / DATE | DESIGNED: - DRAFTED: JZ CHECKED: - DATE: APRIL 2024 |
| | | SHEET TITLE: DRAINAGE DESIGN LAYOUT | PREPARED FOR: DENOVA HOMES | | |

406 ENGINEERING
CIVIL ENGINEERING
LAND USE CONSULTING
1201 S. 6th St. W.
Missoula, MT 59801
(406) 317-1131
35 8th St. E.
Kalispell, MT 59901
(406) 257-0679
www.406engineeringinc.com

# Appendix C

# Vicinity Map


**Geocode:** 04-2201-19-1-01-04-0000

**Tax ID:** 1947101

**Owner:**
RANDASH CHAD E

**Physical Address:**
885 SPEEDWAY AVE 59802

**Legal Description:**
S19, T13 N, R18 W, C.O.S. 6338, PARCEL A, ACRES 17, IN NW4 - W OF RIVER

Missoula COUNTY

Date: 4/8/2021

Map Center: X: -113.93398 - Y: 46.87407

# Appendix D

# FEMA Flood Map

# Missoula County Floodplain



Missoula County
Community and Planning Services
127 E Main St, Suite 2
Missoula, MT 59802
406-258-4657
http://gis.missoulacounty.us/caps/floodplain

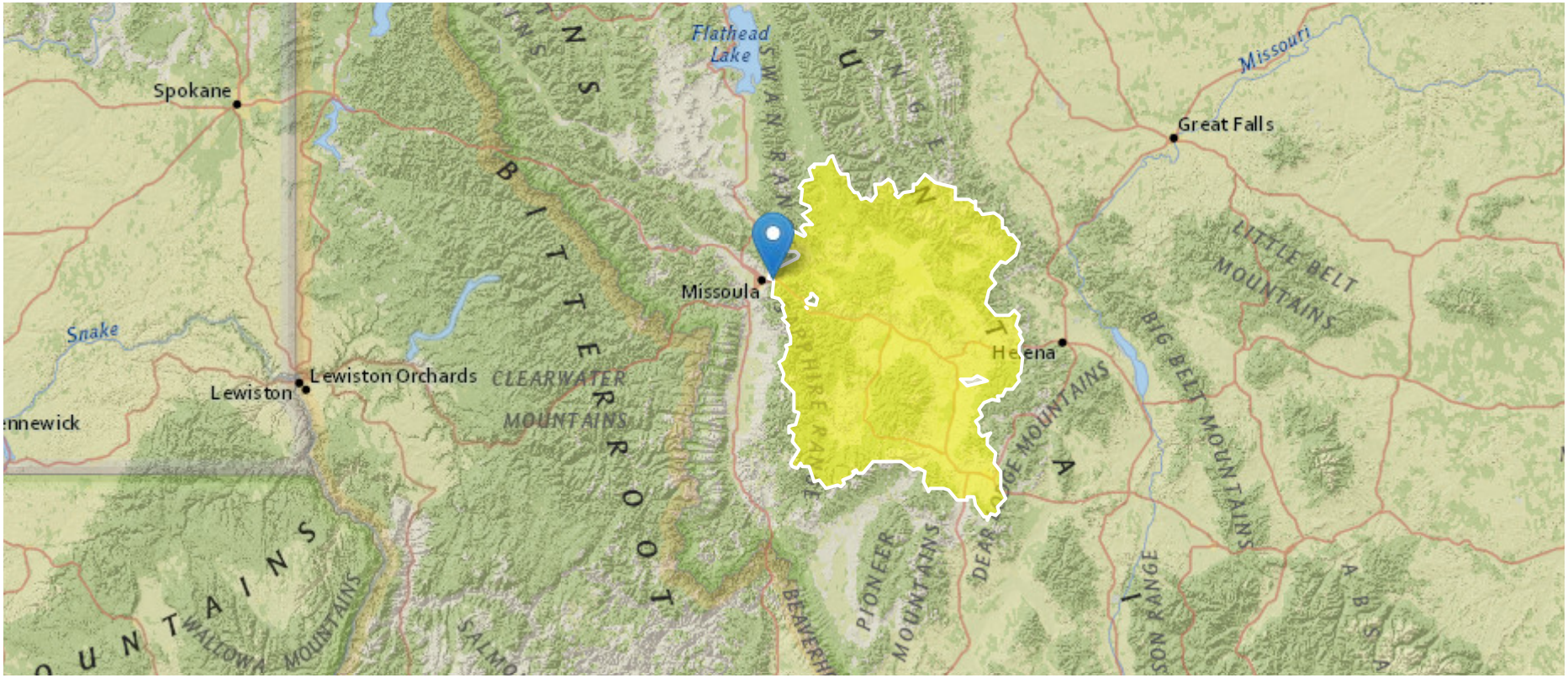

Printed: 4/7/2021

# Appendix E

# StreamStats Major Basin Delineation

# StreamStats Report

**Region ID:** MT
**Workspace ID:** MT20230309230631802000
**Clicked Point (Latitude, Longitude):** 46.87765, -113.93217
**Time:** 2023-03-09 16:06:54 -0700




Collapse All

## Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|---|---|---|---|
| CONTDA | Area that contributes flow to a point on a stream | 5999.9 | square miles |
| DRNAREA | Area that drains to a point on a stream | 5999.9 | square miles |

## Channel-width Methods Weighting

No method weighting results returned.



Application Version: 4.13.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

# Appendix F

# Geotech Report

March 1, 2023

Mr. Michael Evans
Denova Homes
1500 Willow Pass Court
Concord, California 94520

**RE: Preliminary Geotechnical Evaluation**
**Aspire Subdivision**
**East of Sommers Street**
**Missoula, Montana**
**ALLWEST Project No. 723-002G**

Mr. Evans,

**ALLWEST** has completed the following preliminary geotechnical evaluation for the proposed Aspire Subdivision to be located East of Sommers Street in Missoula, Montana. The purpose of this evaluation was to characterize the soil and geologic conditions on the property. The attached report presents the results of the field evaluation and our recommendations to assist with design and construction of the proposed project.

We appreciate the opportunity to provide these services to you on this project. If you have any questions or need additional information, please call us at (406) 206-5911.

Sincerely,

**ALLWEST**

Prepared by:

**Andrew Warren. P.E.**
Senior Geotechnical Engineer

Reviewed by:

**Shawn Turpin, P.E.**
Senior Geotechnical Engineer

# PRELIMINARY GEOTECHNICAL EVALUATION
# ASPIRE SUBDIVISION
# EAST OF SOMMERS STREET
# MISSOULA, MONTANA
# ALLWEST PROJECT NO. 723-002G

March 1, 2023

**Prepared for:**
Mr. Michael Evans
Denova Homes
1500 Willow Pass Court
Concord, California 94520

**Prepared by:**
ALLWEST
2720 Palmer St Unit A
Missoula, Montana 59808


ALLWEST

**WWW.ALLWESTTESTING.COM**

# TABLE OF CONTENTS

# TABLE OF CONTENTS (continued)



**APPENDICES**

# EXECUTIVE SUMMARY

**ALLWEST** has completed the authorized preliminary geotechnical evaluation for the proposed Aspire Subdivision project located east of Sommers Street in Missoula, Montana. The general location of the project is shown on the Vicinity Map, Figure A-1, in Appendix A of this report. The purpose of the evaluation was to assess the subsurface conditions throughout the project site with respect to the proposed design and construction. This report details the results of the field evaluation and presents recommendations to assist in the design and construction of the proposed development. A summary of geotechnical considerations follows:

- The general subsurface soil profile observed in the test pits consisted of a thin layer of topsoil covering varying thicknesses of silty sand or silt and clay. Gravel containing varying silt and sand content was then observed to the maximum depth explored, approximately 10.2 feet. The gravel contained regular to frequent cobbles and boulders up to approximately 16 inches in nominal size.
- Pavement sections consisting of 2.5 inches of asphalt over 8 inches of base course and 2.5 inches of asphalt over 9 inches of base course are recommended for use on local asphalt streets and minor collector roadways, respectively.
- This geotechnical evaluation was prepared based on preliminary plans that were made available at the time of exploration. The geotechnical engineer must be informed of future changes to the site layout, proposed structure locations/layout, and/or loading criteria that differ from the assumptions stated in this report.

Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. If we are not retained to provide required construction observation and materials testing services, we cannot be responsible for soil engineering related construction errors or omissions. This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The report section titled *10.0 EVALUATION LIMITATIONS* should be read for an understanding of the report limitations.

# 1.0 SCOPE OF SERVICES

To complete this geotechnical evaluation, ALLWEST accomplished the following scope of services:

1) Performed a field evaluation by observing the excavation of ten test pits throughout the project site. Subsurface conditions observed in the test pits were described and visually classified, and the subsurface profiles were logged.

2) Performed infiltration testing at seven of the test pit locations in accordance with Appendix 6-F of the current City of Missoula Public Works Standards and Specifications Manual.

3) Performed laboratory tests on soil samples to assess the appropriate engineering soil properties and characteristics for the proposed development.

4) Performed engineering analyses and prepared recommendations to assist project planning, design, and construction.

Services were provided in general accordance with ALLWEST's proposal 723-003P dated January 11, 2023.

# 2.0 PROJECT DESCRIPTION

The project will consist of the development of approximately 35 acres into a subdivision containing a variety of residential units. Preliminary drawings provided by 406 Engineering indicates approximately 174 single-family and townhome lots throughout the property. Along the southern end of the property, there will be four 5-plexes, five 8-plexes, and three 10-plexes. Stormwater is planned to be managed on-site.

A network of asphalt paved roadways will also be constructed throughout the development serving the various lots and multiplexes. Preliminary anticipated traffic conditions were not available to ALLWEST at the time the report was prepared. However, based on the type of development proposed, a mixture of passenger car and occasional delivery vehicle traffic is anticipated.

Site grading plans were not provided to ALLWEST at the time of report preparation, but it is assumed that cut on the order of 5 feet or less is anticipated for construction of the structures and associated foundations. Fill above existing grades is anticipated to be 5 feet or less to match surrounding site contours and to provide positive drainage away from the new structures.

# 3.0 EVALUATION PROCEDURES

To complete this evaluation, ALLWEST reviewed soil and geologic literature for the project area. Subsurface conditions were evaluated at the site by excavating four test pits at the project

site on January 26, 2023. The test pits were excavated using a track-mounted Sany SY5OU mini-excavator equipped with a 30-inch soil excavation bucket. Approximate locations of the test pits are shown on Figure A-2, Test Pit Location Map in Appendix A.

Prior to mobilization, Montana 811 was contacted to request the location and clearance of public underground utilities. Review of the site was also performed to determine possible access limitations to proposed exploration locations prior to excavation.

Disturbed grab and bulk samples representative of soil conditions from select locations were obtained from excavation spoils.

Subsurface conditions observed in the test pits were visually described and classified in general accordance with ASTM D2488 and the subsurface profiles were logged by an ALLWEST geotechnical engineer. Detailed descriptions of the soil observed in the test pits are presented on the test pit logs found in Appendix B of this report. The descriptive soil terms used on the test pit logs, and in this report, can be referenced by the Unified Soil Classification System (USCS). A summary of the USCS is included in Appendix B.

# 4.0 SITE CONDITIONS

The project site is a mostly vacant parcel currently used for agricultural purposes. Currently, there are several structures located along the western and northern edges of the proposed development. The structures are assumed to be demolished as part of construction. Existing site topography is relatively flat to gently sloping toward the east. There is approximately 10 feet of elevation difference across the site. The property is bordered by Interstate 90 to the south, the Clark Fork River to the east, and residential development to the north and west.

## 4.1 GENERAL GEOLOGIC CONDITIONS

The site is in an area mapped as Quaternary alluvium of the youngest alluvial terrace (Qat1) by the Montana Bureau of Mines and Geology (MBMG). Based on the mapping and previous experience at nearby project sites, soil and geologic conditions in the site vicinity were expected to consist of gravel and sand deposits. The natural soils observed in the test pits were generally consistent with the MBMG geologic mapping and assumptions made by ALLWEST.

## 4.2 SEISMICITY

ALLWEST anticipates the 2018 International Building Code (IRC) will be used as the basis for design of the proposed structures as part of this project. Based on laboratory testing results, subsurface exploration information, and knowledge of the local geology, the natural soils at the site can be characterized as Site Class C for seismic design, in accordance with the previously referenced standard. Soils categorized as Site Class C have a generally very dense relative density, with average standard penetration resistance values greater than 50 blows per foot in the upper 100 feet. These blow counts correlate to average undrained shear strengths in excess of 2,000 pounds per square foot (psf).

The following seismic parameters may be used for design of the proposed structures:

| Parameter | Value | Description |
|---|---|---|
| Latitude (degrees) | 46.873427° | Project site geographic position |
| Longitude (degrees) | -113.933283° | Project site geographic position |
| Seismic Site Class | C | Seismic Design Site Classification |
| Risk Category | II | Seismic design risk category |
| $S_S$ | 0.436 | $MCE_R$ ground motion (period = 0.2s) |
| $S_1$ | 0.144 | $MCE_R$ ground motion (period = 1.0s) |
| $S_{DS}$ | 0.378 | Numeric seismic design value at 0.2s SA |
| $S_{D1}$ | 0.144 | Numeric seismic design value at 1.0s SA |
| $F_a$ | 1.3 | Site amplification factor at 0.2s |
| $F_v$ | 1.5 | Site amplification factor at 1.0s |
| PGA | 0.193 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1.207 | Site amplification factor at PGA |
| $PGA_M$ | 0.233 | Site modified peak ground acceleration |

# 5.0 SUBSURFACE CONDITIONS

General characterization of the subsurface profile observed follows, grouping soils with similar physical and engineering properties. The test pit logs should be referenced for more detailed descriptions of the soil types and their estimated depths. It should be noted that depths shown as boundaries between various strata on boring logs are approximate. Transitions between soil types/layers may be gradual. In addition, subsurface conditions may vary between exploration locations from those observed at discrete boring locations. Such changes in conditions would not be apparent until construction. If subsurface conditions deviate from those observed in the test pits, construction timing, plans, and costs may change.

The general subsurface soil profile observed in the test pits consisted of a thin layer of topsoil covering varying thicknesses of silty sand or silt and clay. Gravel containing varying silt and sand content was then observed to the maximum depth explored, approximately 10.2 feet. The gravel contained regular to frequent cobbles and boulders up to approximately 16 inches in nominal size.

## 5.1 TOPSOIL

Topsoil was observed from the surface to depths on the order of 3 to 10 inches in the test pits.

## 5.2 SAND

Silty sand was observed below the topsoil in all of the test pits except TP-03 and TP-04 to depths ranging from approximately 3 to 7.5 feet. The silty sand was tan to brown in color, fine- to medium-grained, generally subrounded, and appeared medium dense to dense in relative density.

## 5.3 SILT & CLAY

Silt or clay with varying sand and gravel was observed in test pits TP-06, TP-08, TP-09, and TP-10, generally below the topsoil to depths on the order of 2 to 5 feet. The fine-grained soils

were low plasticity, and generally tan to beige. Test pit observations indicate the fine-grained soils ranged in relative consistency from medium stiff to hard.

### 5.4 GRAVEL

Gravel with varying silt and sand content was observed in all the test pits below sandy or fine-grained soils at various depths throughout the subject parcel to the maximum depth explored, approximately 10.2 feet. The gravel contained regular to frequent cobbles and boulders up to approximately 16 inches in nominal size. The gravel varied in color from brown to multi-colored, was fine- to coarse-grained, subangular to subrounded, and appeared dense in relative density.

### 5.5 GROUNDWATER CONDITIONS

At the time of exploration, groundwater was not observed in any of the test pits to the maximum depth explored, approximately 10.2 feet. A review of groundwater well data indicates the static groundwater level in this area is variable but is likely 25 to 30 feet in depth below existing grades. Changes in precipitation, irrigation, construction, or other factors may impact depth to groundwater and surface water flow on the property and therefore, conditions may be different during construction.

## 6.0 INFILTRATION TESTING

In-situ infiltration testing was performed at seven of the test pit locations to assist in on-site stormwater management design. Infiltration testing was performed in accordance with the procedures outlined in Appendix 6-F (Test Pit Infiltration Method) of the current Missoula Public Works Standard Specifications Manual.

At each testing location, test pits were excavated to depths on the order of 9 to 10 feet below existing grades. Upon drilling to depth, solid 4-inch schedule 40 PVC pipe was installed through the hollow-stem augers to the bottom of the boring. The PVC was seated on approximately 4 to 6 inches of pea gravel. Following installation of the pipe and pea gravel, the excavation surrounding the pipe was backfilled with excavation spoils.

ALLWEST returned to the site to perform infiltration testing February 7 through 9, 2023. Approximately 1-foot of water head was introduced into the PVC pipe for a one-hour saturation period. Following the saturation period of one hour, an approximate 6-foot head of water was used to begin each trial, and the time for the water column to drop 24 inches was recorded. Per test method procedures, locations requiring less than one hour for the water column to drop 24 inches, the average rate of the final four trials not varying by more than 10 percent for each test is reported as the infiltration rate. For trials with extremely rapid infiltration rates, the limitations of water depth recording instruments may not allow for the capture of precise time results, however, measured rates are assumed to be representative. These data are presented in the following table. It is recommended the civil engineer apply appropriate factors of safety to the measured values or select lower values based on previously observed and documented performance of drywells in the vicinity of the project.

| Test Location | Depth of Test Below Ground Surface (in) | Infiltration Rate (in/hr) | Soil Classification (USCS) |
|---|---|---|---|
| TP-01 | 98 | 24,820 | Silty gravel (GM) |
| TP-02 | 96 | 16,792 | Poorly graded gravel with sand, cobbles, and boulders (GP) |
| TP-04 | 95 | 14,983 | Poorly graded gravel with silt, sand, and cobbles (GP-GM) |
| TP-05 | 84 | 168 | Well graded gravel with sand, cobbles, and boulders (GP) |
| TP-07 | 95 | 126 | Poorly graded gravel with silt, sand, and cobbles (GP-GM) |
| TP-08 | 100 | 1,528 | Poorly graded gravel with silt, sand, cobbles, and boulders (GP-GM) |
| TP-10 | 100 | 28,826 | Poorly graded gravel with silt, sand, cobbles, and boulders (GP-GM) |

## 7.0 LABORATORY TESTING

ALLWEST performed laboratory testing to supplement field classifications and to assess the appropriate soil engineering properties for use in design of the proposed structures.

The laboratory testing program conducted for this evaluation included the following tests:

| Test Performed: | Information Acquired: |
|---|---|
| Natural Water Content (ASTM D2216) | Water content representative of soil conditions at the time and location samples were collected |
| Particle-size Distribution (ASTM D6913) | Size and distribution of soil particles (i.e., gravel, sand, and silt/clay) of a particular sample |
| Atterberg Limits (ASTM D4318) | Effects of varying water content on the consistency of fine-grained soils present in a particular sample |
| Moisture-Density Relationship (ASTM D698) | Relationship between the laboratory maximum dry density and corresponding water content of a soil for a particular compaction effort |
| California Bearing Ratio (ASTM D1883) | The ability of a soil to support a particular pavement section subjected to known traffic loading |
| Chemical Analysis (ASTM D4972, G187, C1580) | The potential of a soil to corrode metal or concrete used in construction |

Laboratory test results are presented and summarized in Appendix C. Discussion of some of the laboratory testing results follows.

## 7.1 MOISTURE CONTENT

Results of natural water content testing of representative samples obtained at the time of exploration indicates the near surface subsurface materials are generally slightly moist and are likely below the presumed optimum moisture content for compaction. Please refer to the in-situ moisture content laboratory test results shown on the Summary of Natural Water Content in Appendix C for further details of existing soil-moisture conditions (at the time of exploration).

## 7.2 CLASSIFICATION

Gradation analyses in conjunction with Atterberg limits testing were performed on representative samples from test pits TP-01 (6 to 9 feet), TP-02 (7 to 10 feet), TP-05 (7 to 9 feet), TP-09 (1 to 4 feet), and a composite sample from test pits TP-01 (1 to 4 feet), TP-02 (1 to 4 feet), TP-05 (1 to 2 feet), and TP-07 (1 to 6 feet). Soil classifications of silty sand with gravel, poorly graded gravel with sand and cobbles, well graded gravel with sand and cobbles, silty sand, and sandy, silty clay with gravel were determined by the testing of each sample. Atterberg limits testing performed on the portion passing the No. 40 sieve indicate the materials are generally non-plastic, with the exception of the sample from TP-09, where a liquid limit of 25 percent and plasticity index of 4 percent was determined. Graphical results of the laboratory testing are presented in Figures C-1 through C-8 in Appendix C.

## 7.3 MOISTURE-DENSITY RELATIONSHIP

Moisture-density relationship testing was performed on a composite sample of representative material obtained from test pits TP-01 (1 to 4 feet), TP-02 (1 to 4 feet), TP-05 (1 to 2 feet), and TP-07 (1 to 6 feet) in accordance with ASTM D698 (standard Proctor). Through a series of controlled trials using a variety of moisture contents, a moisture-density curve was established for the subject soil. Results of the testing indicate a maximum dry density of approximately 115.3 pounds per cubic foot (pcf) at an optimum moisture content of 13.2 percent for the sample tested (Figure C-6, Appendix C).

## 7.4 CALIFORNIA BEARING RATIO

California Bearing Ratio (CBR) testing was performed in accordance with ASTM D1883 on a composite sample of representative material obtained from test pits TP-01 (1 to 4 feet), TP-02 (1 to 4 feet), TP-05 (1 to 2 feet), and TP-07 (1 to 6 feet). Testing determined a CBR value of 13.0 percent when compacted to 95 percent of the maximum dry density (Figure C-7, Appendix C). CBR strengths in this range are considered a medium strength subgrade for supporting pavements under controlled placement conditions.

## 7.5 CHEMICAL ANALYSIS

Factors which contribute to soil corrosion of buried metal structures include soil resistivity, pH, presence of water and oxygen, and soluble salts. Soil minimum resistivity and pH are typically regarded as the primary indicators of soil corrosion potential. In general, fine-grained soils (silt and clay) have lower resistivity and present a greater potential for corrosion. With an increase in soil moisture content, resistivity generally decreases, and corrosion potential generally increases. Soils with low pH and relatively high resistivity are also corrosive.

Generalized effects of soil resistivity and pH with respect to corrosion potential are summarized in the following table, based on information available from the National Association of Corrosion Engineers (NACE).

| Parameter | Soil Corrosivity |
|---|---|
| ***Soil Resistivity (ohm-cm)*** | |
| >20,000 | Essentially Non-corrosive |
| 10,000 – 20,000 | Mildly corrosive |
| 5,000 – 10,000 | Moderately corrosive |
| 3,000 – 5,000 | Corrosive |
| 1,000 – 3,000 | Highly Corrosive |
| <1,000 | Extremely Corrosive |
| ***Soil pH*** | |
| <5.5 | Extremely corrosive |
| 5.5 – 6.5 | Moderately corrosive |
| 6.5 – 7.5 | Neutral |
| >7.5 | None (alkaline) |

The American Concrete Institute Standard 318 (ACI 318) presents durability requirements for concrete based on the exposure category and class of the structure, dependent on the ground and weather situation of the area. Sulfate attack (exposure category S) is one of the most important factors that influences the long-term durability of concrete structures when exposed to potentially corrosive environments such as soil or groundwater. The exposure class influences proportion of mixture, type of cement and cementitious materials, and percentage of chemical admixtures like air-entrainment admixture.

Durability requirements for concrete in contact with water or soil that contains sulfate ions which can solute in water are summarized in the following table, based on information available from ACI 318. The degree of severity of concrete exposure to sulfate attack constitute the four classes presented.

| Exposure Class | Water-Soluble Sulfate ($SO_4^{2-}$) in Soil (percent by mass) | Maximum Water/Cement Ratio | ASTM C150 Cement Type |
|---|---|---|---|
| S0 | $SO_4^{2-} < 0.10$ | N/A | No type restriction |
| S1 | $0.10 \leq SO_4^{2-} < 0.20$ | 0.50 | II |
| S2 | $0.20 \leq SO_4^{2-} < 2.00$ | 0.45 | V |
| S3 | $SO_4^{2-} > 2.00$ | 0.45 | V plus pozzolan or slag |

Chemical analyses, including pH, resistivity, and water-soluble sulfate content testing, was performed using samples of representative material from test pit TP-09. Results of the testing are summarized in the following table.

| Boring | Depth (feet) | pH | Minimum Resistivity (ohm-cm) | Conductivity (mmhos/cm) | Soluble Sulfate Content (%) |
|---|---|---|---|---|---|
| TP-09 | 1 – 4 | 8.3 | 5,860 | 0.2 | <0.01 |

Results of resistivity testing suggest these on-site soils have the potential to exhibit moderately corrosive behavior to buried metal in contact with them. A licensed engineer experienced with corrosion should be consulted to determine appropriate protection measures. Where possible, it is recommended that non-corrosive materials be used in lieu of metal conduits, and ductile iron pipe (if used) be encased with polyethylene tubing.

Water-soluble sulfate content testing results indicate a low exposure to sulfate attack in normal strength concrete exposed to these materials. Based on testing results, Exposure Category S0 (ACI 318) may be specified for concrete in direct contact with on-site soils.

# 8.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are presented to assist in planning and design of the proposed structures and improvements. Recommendations are based on ALLWEST's understanding of the proposed construction, conditions observed in the test pits, laboratory testing, and engineering analyses. If the construction scope changes, or if conditions are encountered during construction which are different than those described in this report, ALLWEST should be notified so the recommendations herein can be reviewed and revisions can be provided, if necessary. Additionally, ALLWEST should be given the opportunity to review plans and specifications to determine whether the recommendations presented in this report were properly incorporated as intended.

## 8.1 SITE GRADING

The following recommendations are provided for site grading considerations.

### 8.1.1 Clearing and Stripping

Prior to placement of fill, the site should be stripped of organics, debris, and other deleterious material in the construction footprint. Based on observations of subsurface conditions in the test pits and general site reconnaissance, the stripping depth for removal of topsoil within structure and pavement envelops is estimated to be on the order of 6 inches (varying in thickness across the site). Removed materials should be replaced with compacted granular structural fill to achieve design elevations, if required. Where feasible, extend removal of organics, and other debris or deleterious material a minimum of five feet beyond the perimeter of building footprints.

### 8.1.2 Excavation

Based on conditions observed in the test pits, it is anticipated that excavation of the on-site soil can be achieved with typical heavy-duty excavation equipment.

Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. Cuts should be adequately sloped, shored, or supported to prevent injury to personnel from local sloughing and spalling. Excavations should conform to applicable federal, state, and local regulations. Regarding trench wall support, the site soil is considered Type C soil according to OSHA guidelines and therefore should not exceed a 1.5H:1V temporary slope.

### 8.1.3 Subgrade Preparation

ALLWEST defines the subgrade as the native soil exposed at the base of excavation prior to placement of fill, concrete, or asphalt. Soils at subgrade elevations are anticipated to vary across the site, but are anticipated to mostly consist of silty sand or gravel containing varying silt and sand content depending on locale and depth within the parcel.

The subgrade requires an evaluation by the geotechnical engineer-of-record or staff under their supervision to confirm the site conditions are consistent with those observed during our geotechnical evaluation. Following clearing and stripping, the subgrade should be compacted to a firm and unyielding condition and proof rolled with heavy rubber-tired construction equipment such as a loader with a full bucket or a loaded dump truck.

In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, the materials should be removed to a sufficient depth to develop stable subgrade soils that can be compacted to the minimum recommended levels. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the subgrade soils.

Prior to construction of footings or slabs, or placement of imported granular structural fill where necessary, the natural subgrade soils should be properly moisture conditioned and compacted as described in the Fill Placement & Compaction section of this report. Moisture conditioning of the subgrade surface may involve wetting or drying of the soil to help facilitate compaction. No moisture specification for subgrade soil preparation is provided herein but the earthwork contractor should adhere to typical good practice and not attempt to compact soils that are visually either too dry or too moist. Please refer to the in-situ moisture content laboratory test results for an estimation of existing soil-moisture conditions (at the time of exploration).

Pavement and exterior slab subgrades should be sloped to promote runoff and reduce the potential for ponding of water on the subgrade surface. Proper grading of pavement subgrades is critical to their long-term performance. Any areas of soft or saturated subgrade soils which exhibit pumping or significant deflection should be over-excavated to firm, non-yielding soil and replaced with import granular structural fill placed and compacted as described in the *Fill Placement & Compaction* section.

Weather conditions should be given careful attention during subgrade preparation to prevent excess moisture from collecting on or penetrating and possibly saturating the subgrade before and after compaction. It is recommended that the subgrade be temporarily sloped to provide drainage to a low area of the excavation and any excess water pumped from the excavation. Such collection and discharge must be in compliance with the Contractor's site-specific storm water pollution prevention plan (SWPPP). Should portions of the subgrade become excessively saturated, those areas should be sufficiently excavated, replaced with moisture conditioned soil, and properly compacted.

### 8.1.4 Materials

#### 8.1.4.1 On-site Soil

The sand and fine-grained soils present throughout the project site are not suitable for re-use as structural fill beneath foundations or slabs but may be used for backfill of exterior foundation

walls, trench backfill in utility trenches, and general site grading fill provided deleterious materials are removed, and the material is placed in accordance with the recommendations outlined in the *Fill Placement and Compaction* section.

Gravel of varying silt and sand content was observed throughout the property. If a significant volume of gravel is generated from excavation, it is suitable for re-use as structural fill beneath foundations and slabs, provided material greater than 3-inches in size (i.e., cobbles and boulders) and deleterious materials are removed, and the material is placed in accordance with the recommendations outlined in the *Fill Placement and Compaction* section. In addition, on-site soils used for such purposes should be thoroughly mixed prior to placement to achieve a uniform texture.

#### 8.1.4.2 Import Soil

Import soil, where required should be free of organics, debris, and other deleterious material and meet the recommendations in the following table. Import materials should approved by the Geotechnical Engineer prior to delivery to the site.

| Fill Type | Recommendations | |
|---|---|---|
| | ***Sieve*** | ***Percent Passing*** |
| Import Granular Structural Fill[1,2] | 3-inch | 100 |
| | ¾-inch | 70 – 100 |
| | No. 40 | 10 – 20 |
| | No. 200 | 0 – 15 |

[1] Soils with more than 30% retained on the ¾-inch sieve are considered 'oversized' and may require method-based compaction methods.
[2] Material should be non-plastic.

#### 8.1.4.3 Fill Placement and Compaction

Fill should be placed in lift thicknesses appropriate for the compaction equipment used. Typically, six to eight-inch loose lifts are appropriate for typical rubber tire and steel drum compaction equipment. Lift thicknesses should be reduced to a maximum of four inches for hand operated compaction equipment. Fill should be moisture conditioned to within two percentage points of the optimum moisture content prior to placement to facilitate compaction. Non-expansive low-permeability fill, however, should be moisture conditioned to two percentage points over the optimum moisture content to facilitate desired effects of the material.

Fill placed for on-site improvements and in structural areas should be compacted to the following percentages of the maximum dry density as determined by ASTM D698 (standard Proctor).

| Fill Area | Compaction (%) ASTM D698 |
|---|---|
| Subgrade | Proof Roll |
| Site Grading | 95 |
| Foundations / Slabs / Wall Backfill | 98 |
| Utility Trench Backfill | 95 |
| Base Course | 95 |

### 8.1.5 Wet Weather Construction

Due to the climatic effects in this region during late fall, winter, and spring (generally wet conditions), it is recommended that construction (especially site grading) take place during the summer and early fall season, if possible. If construction occurs during or immediately after excessive precipitation, it may be necessary to over-excavate and replace wet subgrade soil which might otherwise be suitable.

If construction is undertaken in wet periods of the year, it will be important to slope the ground surface to provide drainage away from construction. In addition, groundwater levels will likely be higher during wet periods of the year.

### 8.1.6 Cold Weather Construction

Foundations should be embedded adequately to protect against frost action as recommended in the *Foundation Recommendations* section of this report. Removal of frost susceptible soil within the frost-depth zone (approximately 42 inches) below concrete flatwork (walkways, entryway pads, etc.) is recommended to help reduce the potential detrimental effects of frost heave.

If site grading and construction are anticipated during cold weather, proper winter construction practices should be observed. Snow and ice should be removed from excavated and fill areas prior to additional earthwork or construction. Structural portions of the construction should not be placed on frozen ground; nor should the supporting soils for buildings be permitted to freeze during or after construction. Frozen soils should not be used as fill.

## 8.2 STORMWATER AND DRAINAGE

The grading plan should include slopes such that stormwater run-off is directed away from the building and pavement areas to a stormwater management system. The ground surface adjacent to foundations should be sloped a minimum of five percent within 10 feet of the building. If the adjoining ground surface consists of hardscapes, it may be sloped a minimum of two percent in the first 10 feet. Water should not be allowed to infiltrate or pond adjacent to foundations.

Landscaping which requires watering is discouraged adjacent to structures due to the potential to introduce water into the subgrade soils by the irrigation system. Such introduction of water could result in greater movement of foundations than those discussed herein.

## 8.3 PAVEMENT

Based on the subsurface conditions observed in the test pits, it is anticipated that the pavement subgrade will vary across the development, mostly consisting of silty sand, with areas along the southern portion of the site consisting of clay or silt depending on exact locale within the development. CBR testing was performed on a representative sample of the silty sand subgrade soil and determined a CBR value of 13.0 percent. The silty and clayey subgrade soils which underlie portions of the development are presumed to be the limiting subgrade soil, however. A CBR of 5 percent was assumed for the fine-grained soils and was used for pavement design purposes.

Recommended pavement sections for the project are based on the following assumptions.

| Criteria | Assumed Value |
|---|---|
| Pavement Life | 20 years |
| Subgrade California Bearing Ratio (CBR) | 5% |
| Reliability | 85% |
| Initial Serviceability | 4.2 |
| Terminal Serviceability | 2.0 |

### 8.3.1 Roadways

Roadway loading for the proposed residential street sections for this project is estimated based on the assumption that traffic loading conditions totaling 50,000 and 100,000 equivalent single-axle loads (ESALs) or less will be required for local asphalt streets and minor collector streets, respectively, for the assumed pavement design life (20 years).

The pavement sections presented in the following table are recommended for the proposed roadway sections for this project based on assumed ESAL values.

| Roadway Type | Section Type | AC[1] (in) | CBC[2] (in) | Total (in) |
|---|---|---|---|---|
| Local Asphalt Street | Unreinforced | 2.5 | 8 | 10.5 |
| Minor Collector Steet | Unreinforced | 2.5 | 9 | 11.5 |

[1]AC = Asphalt Concrete
[2]CBC = Crushed Base Course

Crushed base course meeting the requirements of MPWSS section 02235 gradation for crushed base course should be specified for use. It is recommended the asphaltic concrete surface be compacted per MPWSS requirements.

Crack maintenance on asphalt pavement should be performed at a minimum of every three years, or immediately when cracking is evident. Crack sealing will help reduce surface water infiltration into the underlying clay soils. A shortened pavement life will result from an improper or inadequate maintenance program.

## 8.4 OWNER OPERATION AND MAINTENANCE RESPONSIBILITIES

Property owners must accept the responsibility for maintaining the site grading, drainage, monitoring utility connections, and have a defined schedule for verifying and making necessary repairs as necessary to maintain the overall as designed positive site grading to ensure long term performance of the foundations as defined herein. The property owner shall not make modifications to site grading that compromises the as-designed positive surface drainage. In addition, landscaping and irrigation must be designed, installed, and maintained so as to not impact the overall site grading and/or become a source of water to the site soils which could result in movement of the support structures, pavement, or slabs.

## 9.0 ADDITIONAL RECOMMENDED SERVICES

ALLWEST should be retained to provide construction materials testing and observation to verify the soil and geologic conditions and the report recommendations are incorporated into the actual construction. The design engineer-of-record should determine applicable testing and special inspection requirements in accordance with the governing code documents. If ALLWEST is not retained to provide required construction observation and materials testing services, ALLWEST cannot be responsible for soil engineering related construction errors or omissions.

## 10.0 EVALUATION LIMITATIONS

This report has been prepared to assist the planning and design for the proposed Aspire Subdivision project located East of Sommers Street in Missoula, Montana. The evaluation was provided based on preliminary plans that were made available at the time of exploration. The geotechnical engineer must be informed of significant changes to the building layout and/or loading criteria that differ from the assumptions stated in this report. Reliance by any other party is prohibited without the written authorization of ALLWEST. Services consist of professional opinions and conclusions made in accordance with generally accepted geotechnical engineering principles and practices in the local area at the time this report was prepared. This acknowledgement is in lieu of all warranties, express or implied.

# Important Information about This

# Geotechnical-Engineering Report

**Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.**

**While you cannot eliminate all such risks, you can manage them. The following information is provided to help.**

**The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.**

## Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

## Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

*Do not rely on this report* if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

## Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

## You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

*responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

## Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

## This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

## This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

## Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

## Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

## Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

## Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

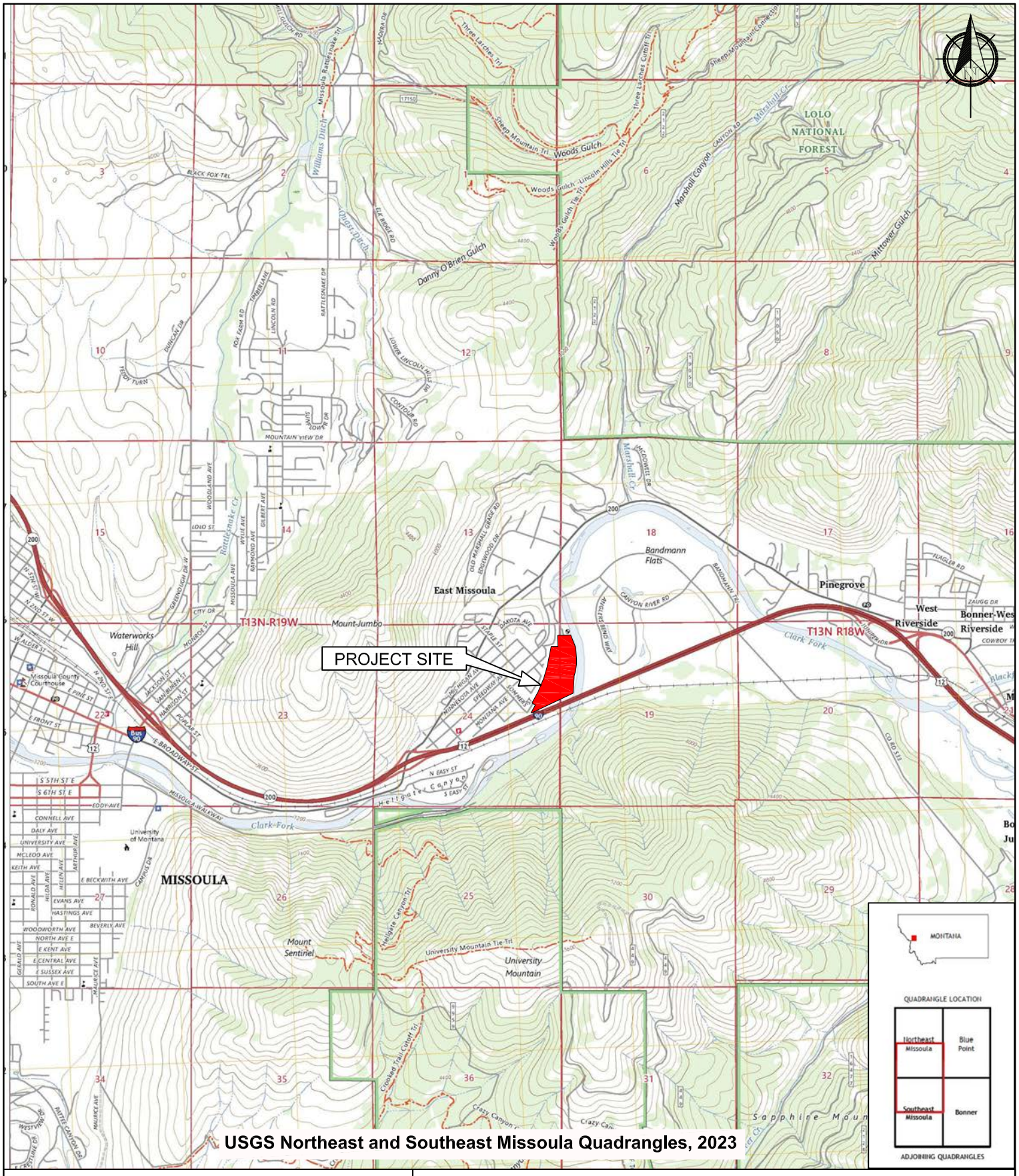
While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

# Appendix A

## Vicinity Map (Figure A-1)
## Test Pit Location Map (Figure A-2)



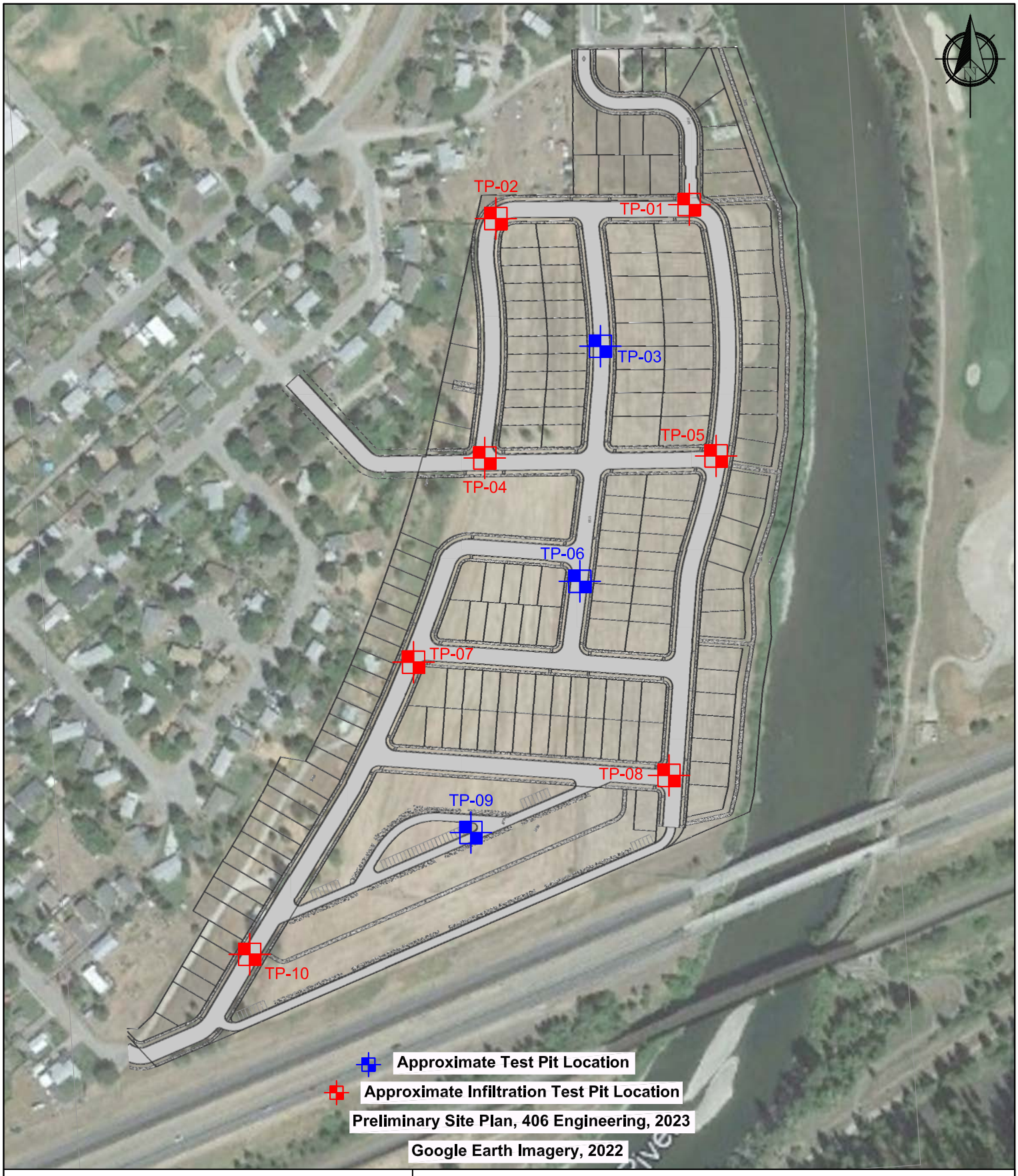

**USGS Northeast and Southeast Missoula Quadrangles, 2023**


ALLWEST

2720 Palmer St Unit A
Missoula, Montana 59808
(406) 206-5911
www.allwesttesting.com


## FIGURE A-1: VICINITY MAP

| | |
|---|---|
| PROJECT: | 723-002G - Aspire Subdivision |
| LOCATION: | Missoula, Montana |
| CLIENT NAME: | Denova Homes |
| DATE: | March 2023 |




ALLWEST

2720 Palmer St Unit A
Missoula, Montana 59808
(406) 206-5911
www.allwesttesting.com

| FIGURE A-2: TEST PIT LOCATION MAP | |
|---|---|
| PROJECT: | 723-002G - Aspire Subdivision |
| LOCATION: | Missoula, Montana |
| CLIENT NAME: | Denova Homes |
| DATE: | March 2023 |

# Appendix B

## Test Pit Logs
## Unified Soil Classification System

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-01

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'32.0736" (46.875576°)
LONGITUDE (DEGREES): W -113°55'56.7732" (-113.932437°)

TOTAL DEPTH: 10.2'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | Grab sample: 0' - 1' |
| 1 | SM | Silty SAND (SM), tan, slightly moist, fine- to medium-grained, subangular, medium dense. | | | Grab sample: 1' - 2' |
| 2 | | | | | |
| 3 | | | | | Grab sample: 3' - 4' |
| 4 | | | | | |
| 5 | SM | Silty SAND with gravel (SM), tan to brown, slightly moist, fine- to coarse-grained, subangular, medium dense to dense. | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | GM | Silty GRAVEL (GM), tan to brown, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. | | | Bulk sample: 6' - 9'<br>Grab sample: 7' - 8' |
| 8 | | | | | |
| 9 | | | | | Grab sample: 9' - 10.2' |
| 10 | | | | | |
| 11 | | Test pit terminated at 10.2 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-02

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'31.6776" (46.875466°)
LONGITUDE (DEGREES): W -113°56'2.3136" (-113.933976°)

TOTAL DEPTH: 10'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| 1 | SM | Silty SAND (SM), tan, slightly moist, fine- to medium-grained, subangular, medium dense. | | | Grab sample: 0' - 1' |
| 2 | | | | | Grab sample: 1' - 2' |
| 3 | | | | | Grab sample: 3' - 4' |
| 4 | GP | Poorly graded GRAVEL with sand, cobbles, and boulders (GP), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles and boulders up to approximately 14" nominal size. | | | |
| 5 | | | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | Grab sample: 7' - 8' |
| 8 | | | | | Bulk sample: 7' - 10' |
| 9 | | | | | Grab sample: 9' - 10' |
| 10 | | Test pit terminated at 10.0 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-03

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'29.4348" (46.874843°)
LONGITUDE (DEGREES): W -113°55'59.2968" (-113.933138°)

TOTAL DEPTH: 9.8'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| 1 | GP-GM | Poorly graded GRAVEL with silt, sand, and cobbles (GP-GM), brown, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles up to approximately 12" nominal size. | | | Grab sample: 0' - 1' |
| 2 | | | | | Grab sample: 1' - 2' |
| 3 | | | | | |
| 4 | | | | | Grab sample: 3' - 4' |
| 5 | | | | | |
| 6 | | | | | Grab sample: 5' - 6' |
| 7 | | | | | |
| 8 | | | | | Grab sample: 7' - 8' |
| 9 | | | | | |
| 10 | | Test pit terminated at 9.8 feet.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | Grab sample: 9' - 9.8' |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS
NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-04

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'26.6448" (46.874068°)
LONGITUDE (DEGREES): W -113°56'2.4036" (-113.934001°)

TOTAL DEPTH: 10.1'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND with gravel (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | Grab sample: 0' - 1' |
| 1 | GP-GM | Poorly graded GRAVEL with silt, sand, and cobbles (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles up to approximately 12" nominal size. | | | Grab sample: 1' - 2' |
| 2 | | | | | |
| 3 | | | | | Grab sample: 3' - 4' |
| 4 | | | | | |
| 5 | | | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | Grab sample: 7' - 8' |
| 8 | | | | | |
| 9 | | | | | Grab sample: 9' - 10.1' |
| 10 | | Test pit terminated at 10.1 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-05

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'26.2236" (46.873951°)
LONGITUDE (DEGREES): W -113°55'56.1576" (-113.932266°)

TOTAL DEPTH: 10'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | Grab sample: 0' - 1' |
| 1 | SM | Silty SAND (SM), tan to brown, slightly moist, fine- to medium-grained, subangular, medium dense. Occasional gravel. | | | Grab sample: 1' - 2' |
| 2 | | | | | |
| 3 | GP | Well graded GRAVEL with sand, cobbles, and boulders (GP), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles and boulders up to approximately 14" nominal size. | | | Grab sample: 3' - 4' |
| 4 | | | | | |
| 5 | | | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | Grab sample: 7' - 8' |
| 8 | | | | | Bulk sample: 7' - 9' |
| 9 | | | | | Grab sample: 9' - 10' |
| 10 | | Test pit terminated at 10.0 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

| | |
|---|---|
| NE | ▽ WHILE EXCAVATING |
| NE | ▼ AT COMPLETION |
| NE | ▼ AFTER EXCAVATING |

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-06

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'24.0708" (46.873353°)
LONGITUDE (DEGREES): W -113°55'59.8008" (-113.933278°)

TOTAL DEPTH: 10'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| 1 | SM | Silty SAND with gravel (SM), tan to brown, slightly moist, fine- to medium-grained, subangular, medium dense. | | | Grab sample: 0' - 1' |
| 2 | | | | | Grab sample: 1' - 2' |
| 3 | | | | | |
| 4 | ML | SILT with sand (ML), tan, slightly moist, low plasticity, stiff. | | | Grab sample: 3' - 4' |
| 5 | GP-GM | Poorly graded GRAVEL with silt, sand, cobbles, and boulders (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles and boulders up to approximately 14" nominal size. | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | Grab sample: 7' - 8' |
| 8 | | | | | |
| 9 | | | | | Grab sample: 9' - 10' |
| 10 | | | | | |
| 11 | | Test pit terminated at 10.0 feet.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-07

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'21.8532" (46.872737°)
LONGITUDE (DEGREES): W -113°56'4.6428" (-113.934623°)

TOTAL DEPTH: 10.1'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| | SM | Silty SAND (SM), beige to brown, slightly moist, fine- to medium-grained, subangular to subrounded, medium dense. Occasional gravel. | | | Grab sample: 0' - 1' |
| 1 | | | | | |
| | | | | | Grab sample: 1' - 2' |
| 2 | | | | | |
| 3 | | | | | |
| | | | | | Grab sample: 3' - 4' |
| 4 | | | | | |
| 5 | | | | | |
| | | | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | |
| | GP-GM | Poorly graded GRAVEL with silt, sand, and cobbles (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Trace cobbles up to approximately 12" nominal size. | | | Grab sample: 7' - 8' |
| 8 | | | | | |
| 9 | | | | | Grab sample: 9' - 10.1' |
| 10 | | Test pit terminated at 10.1 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

| WATER LEVELS | |
|---|---|
| NE | ▽ WHILE EXCAVATING |
| NE | ▼ AT COMPLETION |
| NE | ▼ AFTER EXCAVATING |

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-08

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'19.8804" (46.872189°)
LONGITUDE (DEGREES): W -113°55'57.2952" (-113.932582°)

TOTAL DEPTH: 10'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| 1 | ML | SILT with sand (ML), tan to brown, slightly moist, low plasticity, stiff. | | | Grab sample: 0' - 1' |
| | | | | | Grab sample: 1' - 2' |
| 2 | SM | Silty SAND with gravel (SM), tan to brown, slightly moist, fine- to medium-grained, subangular, medium dense to dense. | | | |
| 3 | | | | | Grab sample: 3' - 4' |
| 4 | GP-GM | Poorly graded GRAVEL with silt, sand, cobbles, and boulders (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles and boulders up to approximately 16" nominal size | | | |
| 5 | | | | | |
| 6 | | | | | Grab sample: 5' - 6' |
| 7 | | | | | |
| 8 | | | | | Grab sample: 7' - 8' |
| 9 | | | | | |
| 10 | | Test pit terminated at 10.0 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | Grab sample: 9' - 10' |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-09

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'18.768" (46.87188°)
LONGITUDE (DEGREES): W -113°56'2.688" (-113.93408°)

TOTAL DEPTH: 10'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | Grab sample: 0' - 1' |
| 1 | CL-ML | Sandy, silty CLAY with gravel (CL-ML), tan, slightly moist, low plasticity, medium stiff to stiff. | | | Grab sample: 1' - 2' |
| 2 | | | | | |
| 3 | | | | | Grab sample: 3' - 4' |
| 4 | GP-GM | Poorly graded GRAVEL with silt, sand, and cobbles (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense. Frequent cobbles up to approximately 12" nominal size | | | |
| 5 | | | | | Grab sample: 5' - 6' |
| 6 | | | | | |
| 7 | | | | | Grab sample: 7' - 8' |
| 8 | | | | | |
| 9 | | | | | Grab sample: 9' - 10' |
| 10 | | Test pit terminated at 10.0 feet.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

**ALLWEST**
**MISSOULA, MONTANA**
**GEOTECHNICAL SECTION**

# TEST PIT LOG

DATE STARTED: 1/27/2023
DATE FINISHED: 1/27/2023
OPERATOR: Pat Malone
COMPANY: MFCII406, LLC
LOGGER: Bridger Logan
WEATHER: Cold, Cloudy

## TEST PIT TP-10

EXCAVATOR: Sany SY 5OU
EXCAVATION METHOD: 30" soil excavation bucket

PROJECT: 723-002G - Aspire Subdivision

NOTES:

LATITUDE (DEGREES): N 46°52'16.68" (46.8713°)
LONGITUDE (DEGREES): W -113°56'8.124" (-113.93559°)

TOTAL DEPTH: 10.2'

| DEPTH (ft) | USCS | DESCRIPTION | GRAPHIC LOG | SAMPLE # | NOTES |
|---|---|---|---|---|---|
| 0 | TOPSOIL | TOPSOIL; Silty SAND (SM), black to dark brown, slightly moist, fine- to medium-grained, subangular. | | | |
| 1 | ML | SILT with sand (ML), tan to beige, slightly moist, low plasticity, medium stiff to stiff. | | | Grab sample: 0' - 1' |
| 2 | | | | | Grab sample: 1' - 2' |
| 3 | | | | | |
| 4 | SM | Gravelly SILT (ML), tan to beige, slightly moist, low plasticity, stiff to hard. | | | Grab sample: 3' - 4' |
| 5 | | | | | Bulk sample: 5' - 7' |
| 6 | GP-GM | Poorly graded GRAVEL with silt, sand, cobbles, and boulders (GP-GM), brown to multi-colored, slightly moist, fine- to coarse-grained, subangular to subrounded, dense to very dense. Frequent cobbles (up to approximately 10" nominal size) and trace boulders (up to approximately 18" nominal size). | | | Grab sample: 5' - 6' |
| 7 | | | | | |
| 8 | | | | | Grab sample: 7' - 8' |
| 9 | | | | | |
| 10 | | | | | Grab sample: 9' - 10.2' |
| 11 | | Test pit terminated at 10.2 feet.<br>4" PVC installed.<br>Groundwater not observed.<br>Backfilled with excavation spoils. | | | |
| 12 | | | | | |
| 13 | | | | | |
| 14 | | | | | |
| 15 | | | | | |

WATER LEVELS

NE ▽ WHILE EXCAVATING
NE ▼ AT COMPLETION
NE ▼ AFTER EXCAVATING

# Unified Soil Classification System

| MAJOR DIVISIONS | | | SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|
| COARSE GRAINED SOILS | GRAVELS | CLEAN GRAVELS | GW | Well-Graded Gravel, Gravel-Sand Mixtures. |
| | | | GP | Poorly-Graded Gravel, Gravel-Sand Mixtures. |
| | | GRAVELS WITH FINES | GM | Silty Gravel, Gravel-Sand-Silt Mixtures. |
| | | | GC | Clayey Gravel, Gravel-Sand-Clay Mixtures. |
| | SANDS | CLEAN SANDS | SW | Well-Graded Sand, Gravelly Sand. |
| | | | SP | Poorly-Graded Sand, Gravelly Sand. |
| | | SANDS WITH FINES | SM | Silty Sand, Sand-Silt Mixtures. |
| | | | SC | Clayey Sand, Sand-Clay Mixtures. |
| FINE GRAINED SOILS | SILTS AND CLAYS<br>LIQUID LIMIT LESS THAN 50% | | ML | Inorganic Silt, Silty or Clayey Fine Sand. |
| | | | CL | Inorganic Clay of Low to Medium Plasticity, Sandy or Silty Clay. |
| | | | OL | Organic Silt and Clay of Low Plasticity. |
| | SILTS AND CLAYS<br>LIQUID LIMIT GREATER THAN 50% | | MH | Inorganic Silt, Elastic Silt, Micaceous Silt, Fine Sand or Silt. |
| | | | CH | Inorganic Clay of High Plasticity, Fat Clay. |
| | | | OH | Organic Clay of Medium to High Plasticity. |
| Highly Organic Soils | | | PT | Peat, Muck and Other Highly Organic Soils. |

ALLWEST

# Appendix C

## Laboratory Test Results (Figures C-1 through C-7)

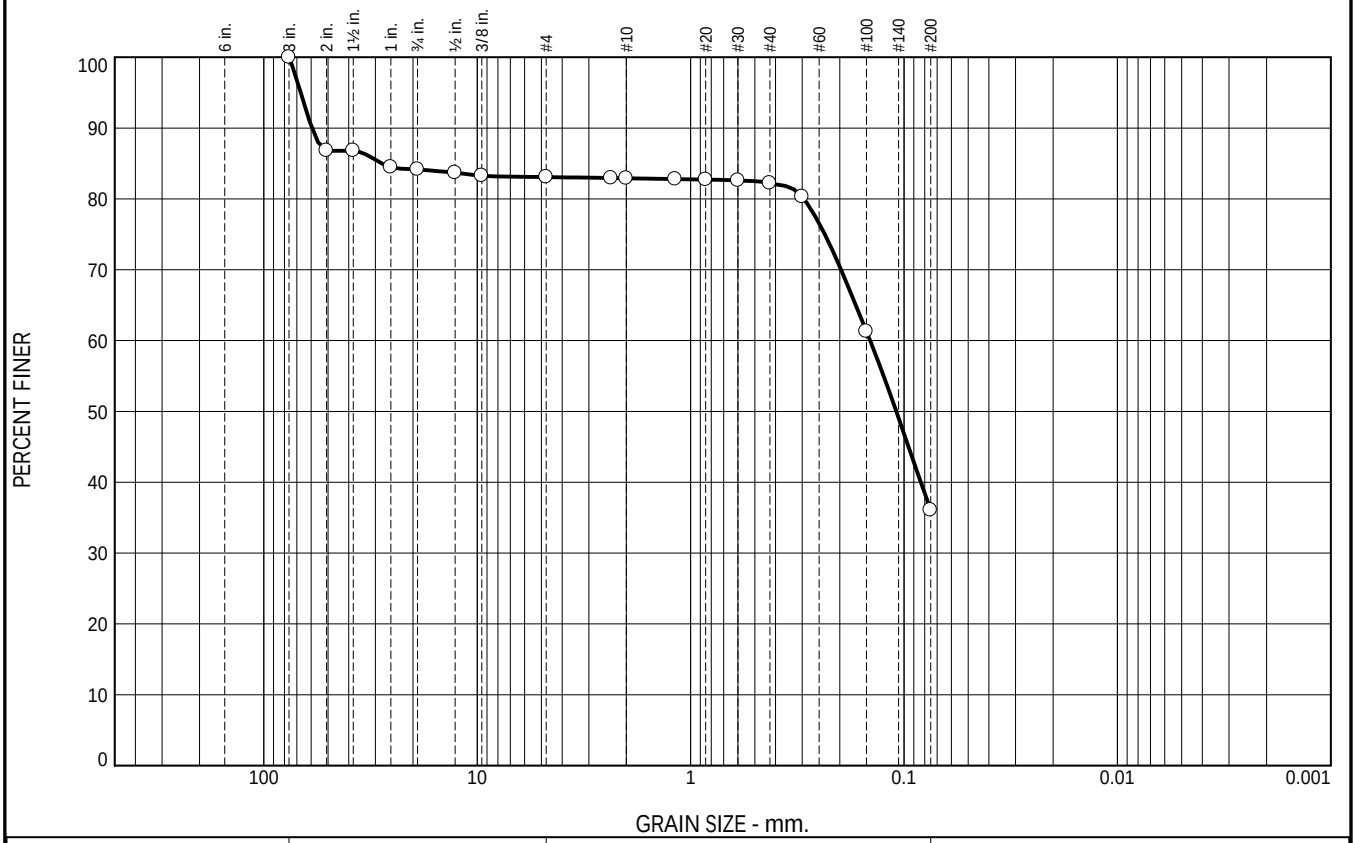
# TABLE C-1
# SUMMARY OF NATURAL WATER CONTENT

| | |
|---|---|
| **CLIENT** | Denova Homes |
| **PROJECT NUMBER** | 723-002G |
| **PROJECT NAME** | Aspire Subdivision |
| **PROJECT LOCATION** | Missoula, Montana |

| Sample Location | Depth (ft) | Water Content (%) |
|---|---|---|
| TP-01 | 1 - 2 | 6 |
| | 3 - 4 | 3 |
| | 5 - 6 | 4 |
| | 7 - 8 | 2 |
| | 9 - 10.2 | 2 |
| TP-02 | 1 - 2 | 9 |
| | 3 - 4 | 4 |
| | 5 - 6 | 4 |
| | 7 - 8 | 2 |
| | 9 - 10 | 2 |
| TP-03 | 1 - 2 | 11 |
| | 3 - 4 | 5 |
| | 5 - 6 | 4 |
| | 7 - 8 | 2 |
| | 9 - 9.8 | 2 |
| TP-04 | 1 - 2 | 2 |
| | 3 - 4 | 3 |
| | 5 - 6 | 2 |
| | 7 - 8 | 1 |
| | 9 - 10.1 | 1 |
| TP-05 | 1 - 2 | 3 |
| | 3 - 4 | 2 |
| | 5 - 6 | 2 |
| | 7 - 8 | 2 |
| | 9 - 10.1 | 2 |
| TP-06 | 1 - 2 | 6 |
| | 3 - 4 | 3 |
| | 5 - 6 | 2 |
| | 7 - 8 | 2 |
| | 9 - 10.2 | 3 |

| Sample Location | Depth (ft) | Water Content (%) |
|---|---|---|
| TP-07 | 1 - 2 | 8 |
| | 3 - 4 | 3 |
| | 5 - 6 | 6 |
| | 7 - 8 | 3 |
| | 9 - 10.1 | 3 |
| TP-08 | 3 - 4 | 3 |
| | 5 - 6 | 2 |
| | 7 - 8 | 2 |
| | 9 - 10 | 3 |
| TP-09 | 1 - 2 | 8 |
| | 3 - 4 | 6 |
| | 5 - 6 | 6 |
| | 7 - 8 | 3 |
| | 9 - 10 | 2 |
| TP-10 | 1 - 2 | 4 |
| | 3 - 4 | 4 |
| | 5 - 6 | 2 |
| | 7 - 8 | 2 |
| | 9 - 10.2 | 2 |

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 16 | 1 | 0 | 1 | 46 | 36 | |

| SIEVE SIZE OR DIAMETER | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 3" | 100 | | |
| 2" | 87 | | |
| 1 1/2" | 87 | | |
| 1" | 84 | | |
| 3/4" | 84 | | |
| 1/2" | 84 | | |
| 3/8" | 83 | | |
| #4 | 83 | | |
| #8 | 83 | | |
| #10 | 83 | | |
| #16 | 83 | | |
| #20 | 83 | | |
| #30 | 83 | | |
| #40 | 82 | | |
| #50 | 80 | | |
| #100 | 61 | | |
| #200 | 36 | | |

* (no specification provided)

**Soil Description**

Silty SAND with gravel

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 59.4532 $D_{85}$= 27.9925 $D_{60}$= 0.1441
$D_{50}$= 0.1087 $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= SM AASHTO= A-4(0)

**Remarks**

Procedure A (entire sample)
Sampled by B. Logan (ALLWEST)

Location: TP-01
Sample Number: S723-0015 Depth: 6'-9' Date: 2.9.2023

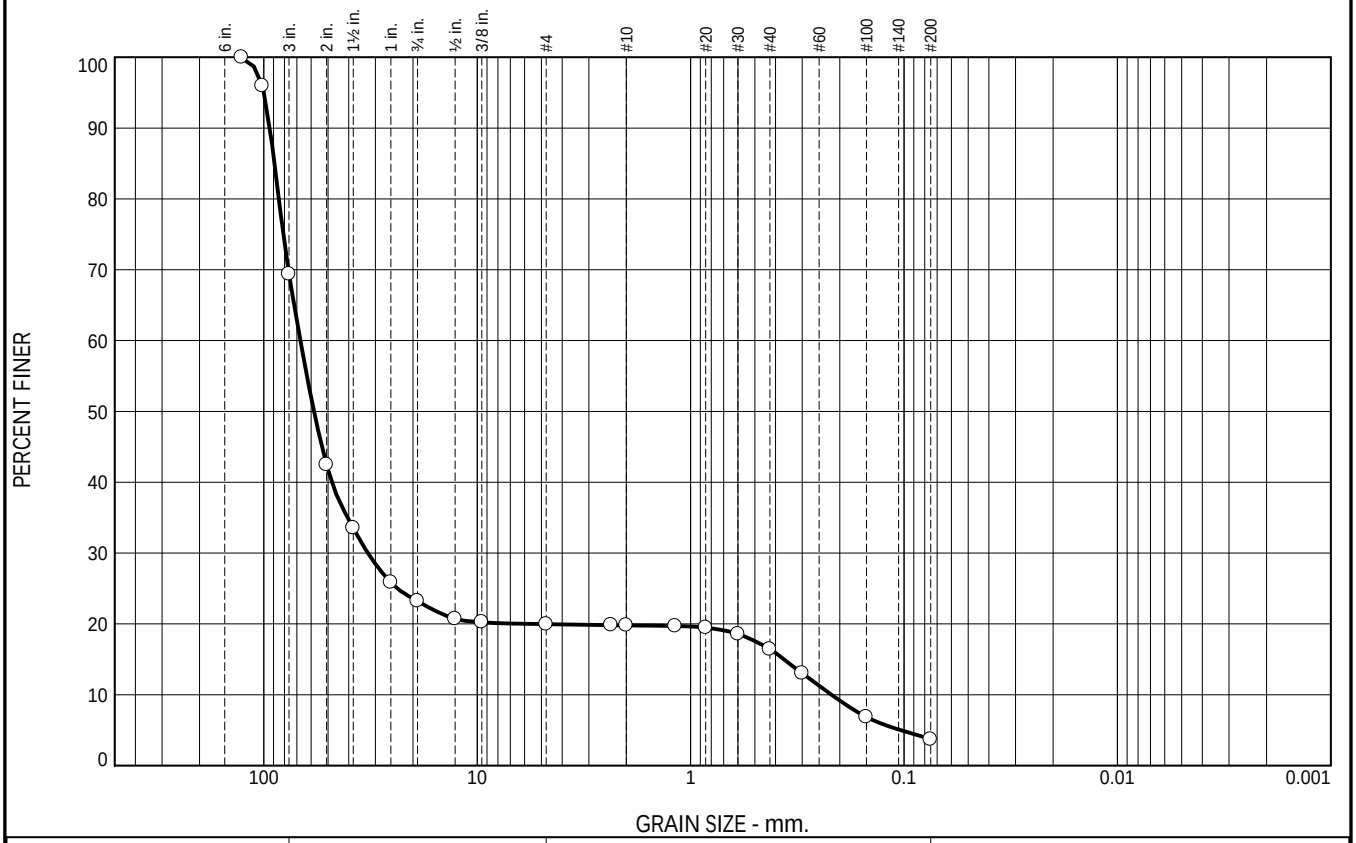
ALLWEST

Client: DeNova Homes
Project: Aspire Subdivision

Project No: 723-002G Figure C-1

Checked By: A. Warren, PE

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 31 | 46 | 3 | 0 | 4 | 12 | 4 | |

| SIEVE SIZE OR DIAMETER | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 5" | 100 | | |
| 4" | 96 | | |
| 3" | 69 | | |
| 2" | 42 | | |
| 1 1/2" | 34 | | |
| 1" | 26 | | |
| 3/4" | 23 | | |
| 1/2" | 21 | | |
| 3/8" | 20 | | |
| #4 | 20 | | |
| #8 | 20 | | |
| #10 | 20 | | |
| #16 | 20 | | |
| #20 | 19 | | |
| #30 | 19 | | |
| #40 | 16 | | |
| #50 | 13 | | |
| #100 | 7 | | |
| #200 | 3.7 | | |

* (no specification provided)

**Soil Description**

Poorly graded GRAVEL with sand and cobbles

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 93.7302 $D_{85}$= 89.1131 $D_{60}$= 67.4122
$D_{50}$= 58.1831 $D_{30}$= 32.5168 $D_{15}$= 0.3648
$D_{10}$= 0.2187 $C_u$= 308.28 $C_c$= 71.73

**Classification**

USCS= GP-GM AASHTO= A-1-a

**Remarks**

Procedure A (entire sample)
Sampled by B. Logan (ALLWEST)

Location: TP-02
Sample Number: S723-0016 Depth: 7'-10' Date: 2.9.2023

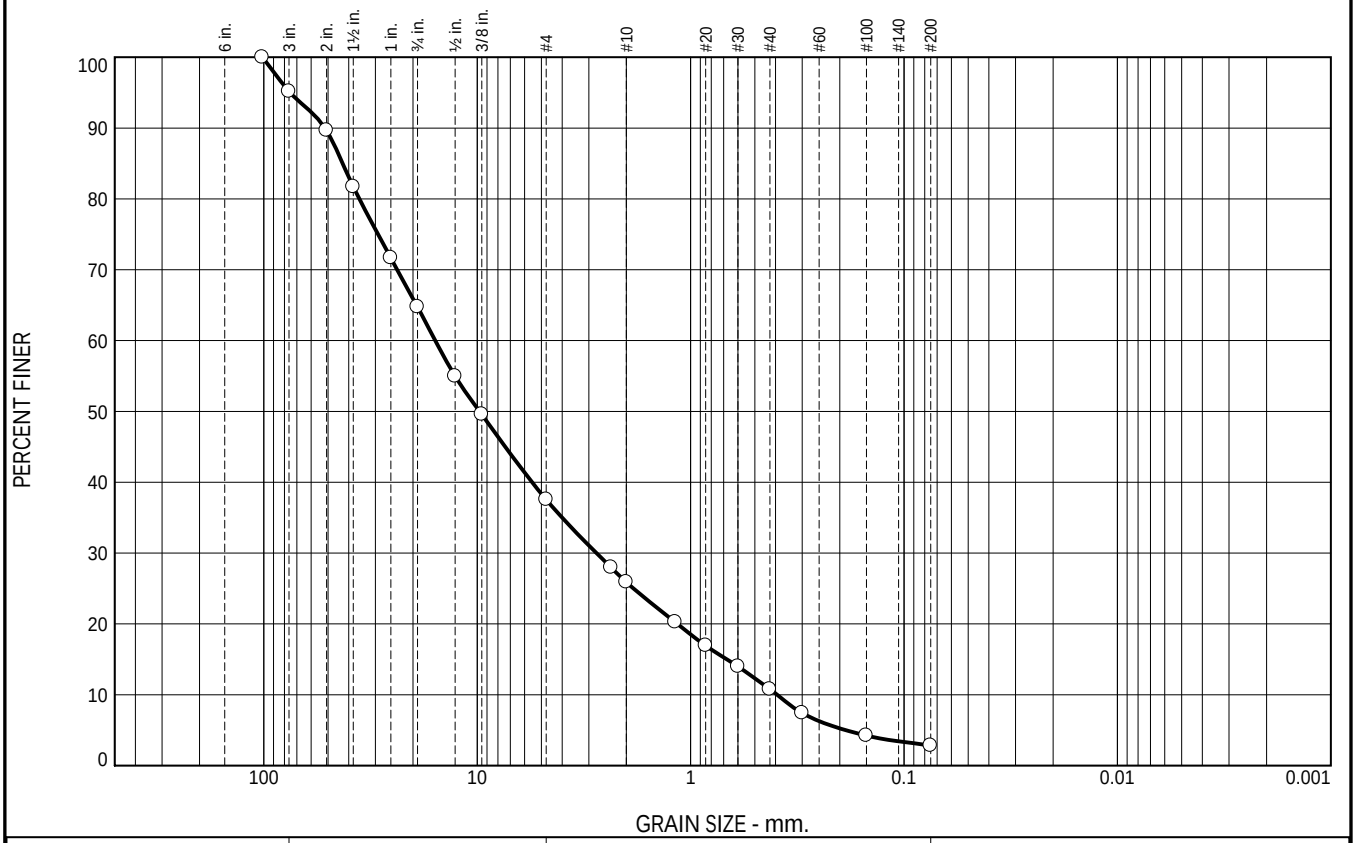
ALLWEST

Client: DeNova Homes
Project: Aspire Subdivision

Project No: 723-002G Figure C-2

Tested By: H. Love Checked By: A. Warren, PE

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 5 | 30 | 27 | 12 | 15 | 8 | 3 | |

| SIEVE SIZE OR DIAMETER | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 4" | 100 | | |
| 3" | 95 | | |
| 2" | 90 | | |
| 1 1/2" | 82 | | |
| 1" | 72 | | |
| 3/4" | 65 | | |
| 1/2" | 55 | | |
| 3/8" | 50 | | |
| #4 | 38 | | |
| #8 | 28 | | |
| #10 | 26 | | |
| #16 | 20 | | |
| #20 | 17 | | |
| #30 | 14 | | |
| #40 | 11 | | |
| #50 | 7 | | |
| #100 | 4 | | |
| #200 | 2.8 | | |

* (no specification provided)

**Soil Description**

Well graded GRAVEL with sand and cobbles

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 51.6507 $D_{85}$= 42.7067 $D_{60}$= 15.7293
$D_{50}$= 9.7541 $D_{30}$= 2.7612 $D_{15}$= 0.6768
$D_{10}$= 0.3931 $C_u$= 40.01 $C_c$= 1.23

**Classification**

USCS= GW AASHTO= A-1-a

**Remarks**

Procedure A (entire sample)
Sampled by B. Logan (ALLWEST)

Location: TP-05
Sample Number: S723-0019 Depth: 7'-9' Date: 2.9.2023

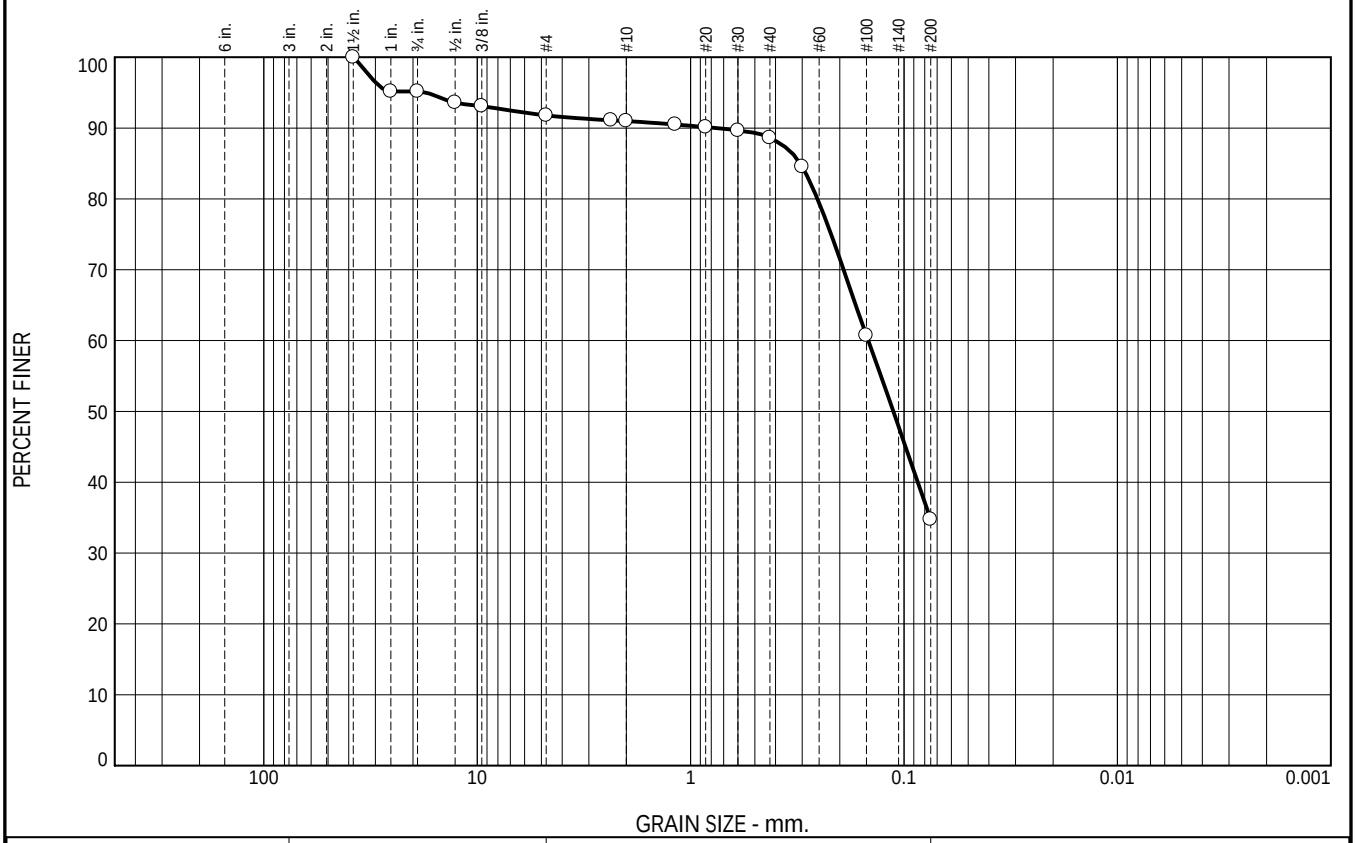
ALLWEST

Client: DeNova Homes
Project: Aspire Subdivision

Project No: 723-002G Figure C-3

Tested By: H. Love Checked By: A. Warren, PE

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 5 | 3 | 1 | 2 | 54 | 35 | |

| SIEVE SIZE OR DIAMETER | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 1/2" | 100 | | |
| 1" | 95 | | |
| 3/4" | 95 | | |
| 1/2" | 94 | | |
| 3/8" | 93 | | |
| #4 | 92 | | |
| #8 | 91 | | |
| #10 | 91 | | |
| #16 | 91 | | |
| #20 | 90 | | |
| #30 | 90 | | |
| #40 | 89 | | |
| #50 | 85 | | |
| #100 | 61 | | |
| #200 | 35 | | |

* (no specification provided)

**Soil Description**

Silty SAND

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 0.7601 $D_{85}$= 0.3065 $D_{60}$= 0.1470
$D_{50}$= 0.1122 $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= SM AASHTO= A-2-4(0)

**Remarks**

Procedure A (entire sample)
Sampled by B. Logan (ALLWEST)

Location: Composite Sample: TP-01 (1'-4'), TP-02 (1'-4'), TP-05 (1'-2'), TP-07 (1'-6')
Sample Number: S723-0021 Depth: Varying

Date: 2.03.2023

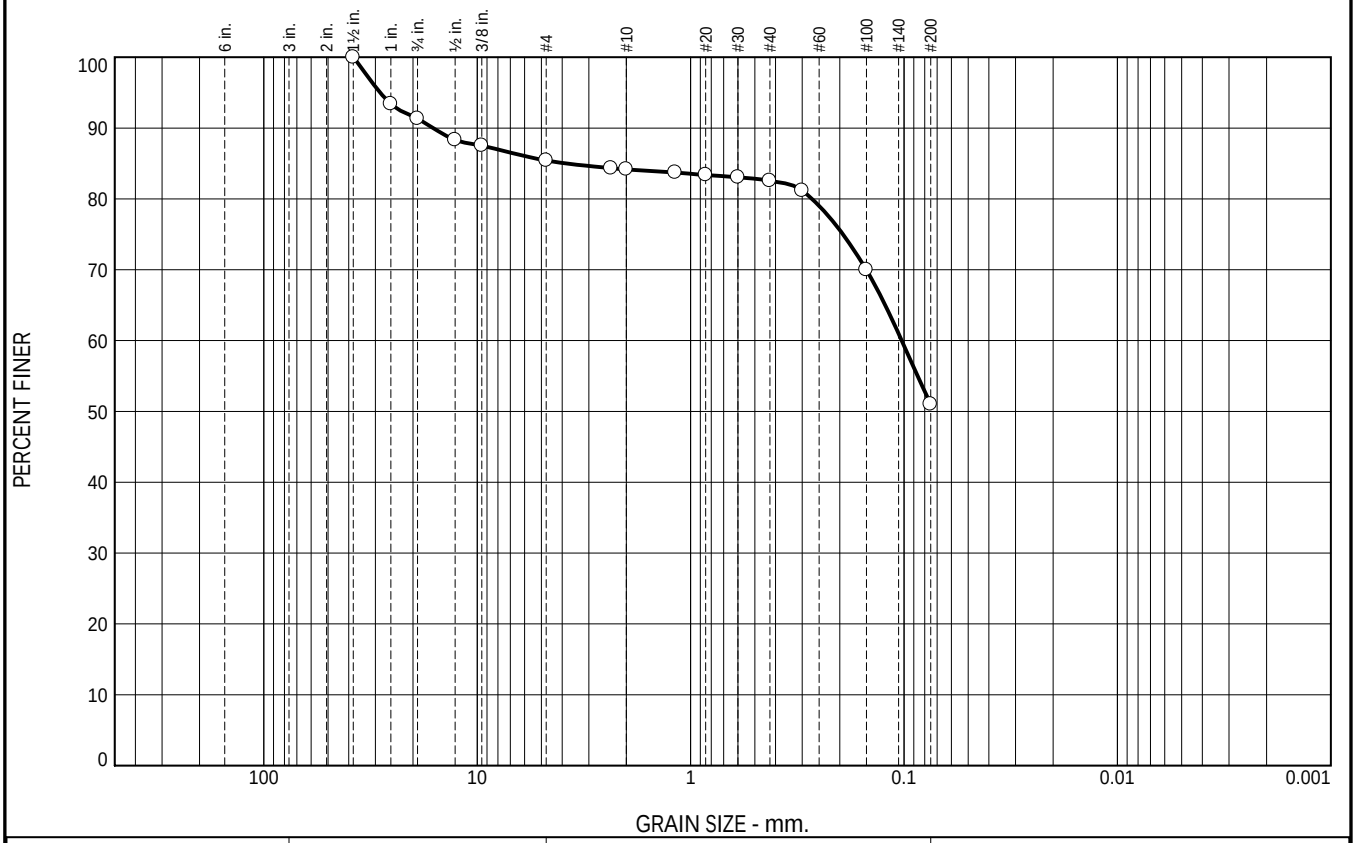
ALLWEST

Client: DeNova Homes
Project: Aspire Subdivision

Project No: 723-002G Figure C-4

Tested By: K. Himmelreich Checked By: A. Warren, PE

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 9 | 6 | 1 | 1 | 32 | 51 | |

| SIEVE SIZE OR DIAMETER | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 1/2" | 100 | | |
| 1" | 93 | | |
| 3/4" | 91 | | |
| 1/2" | 88 | | |
| 3/8" | 88 | | |
| #4 | 85 | | |
| #8 | 84 | | |
| #10 | 84 | | |
| #16 | 84 | | |
| #20 | 83 | | |
| #30 | 83 | | |
| #40 | 83 | | |
| #50 | 81 | | |
| #100 | 70 | | |
| #200 | 51 | | |

* (no specification provided)

**Soil Description**

Sandy silty CLAY with gravel

**Atterberg Limits**

PL= 21 LL= 25 PI= 4

**Coefficients**

$D_{90}$= 16.0939 $D_{85}$= 3.8265 $D_{60}$= 0.1025
$D_{50}$= $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= CL-ML AASHTO= A-4(0)

**Remarks**

Procedure A (entire sample)
Sampled by B. Logan (ALLWEST)

Location: TP-09
Sample Number: S723-0023 Depth: 1'-4' Date: 2.9.2023

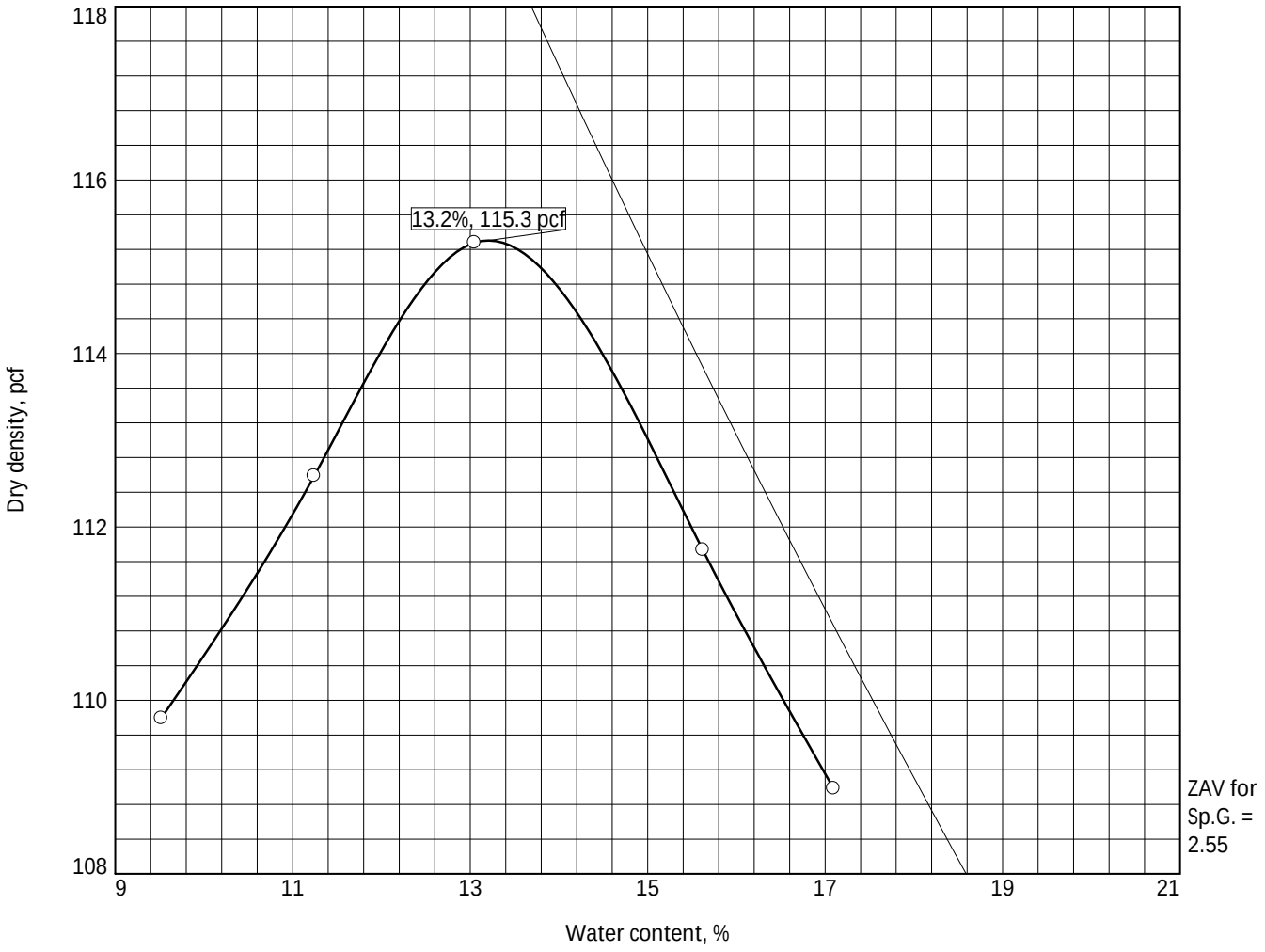
ALLWEST

Client: DeNova Homes
Project: Aspire Subdivision

Project No: 723-002G Figure C-5

Tested By: K. Himmelreich Checked By: A. Warren, PE

# Moisture-Density Relationship for Curve No. S723-0021




Test specification: ASTM D 698-12 Method C Standard

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > 3/4 in. | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| Varying | SM | A-2-4(0) | NT | NT | NV | NP | 5 | 35 |

| TEST RESULTS | MATERIAL DESCRIPTION |
|---|---|
| Maximum dry density = 115.3 pcf<br>Optimum moisture = 13.2 % | Silty SAND |

Project No. 723-002G Client: DeNova Homes

Project: Aspire Subdivision

Location: Composite Sample: TP-01 (1'-4'), TP-02 (1'-4'), TP-05 (1'-2'), TP-07 (1'-6') Date: 2.09.2023 Sample Number: S723-0021

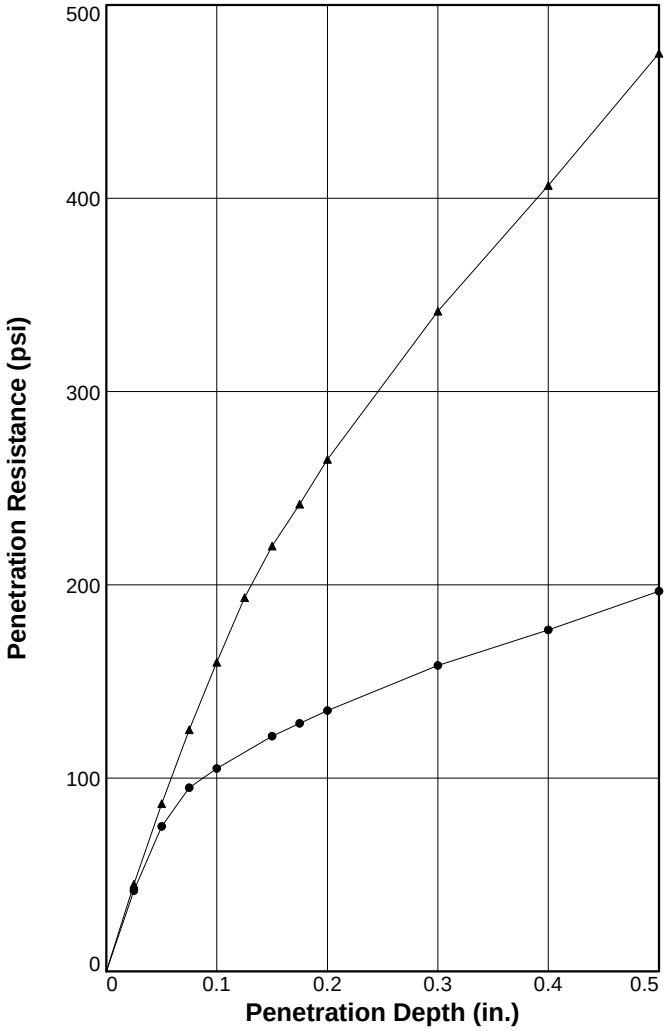
Remarks:
Sampled by B. Logan (ALLWEST)
Dry preparation method
Mechanical rammer

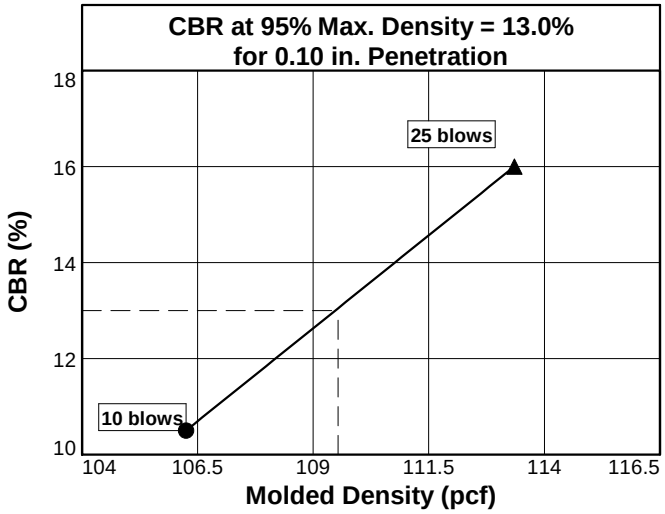
ALLWEST

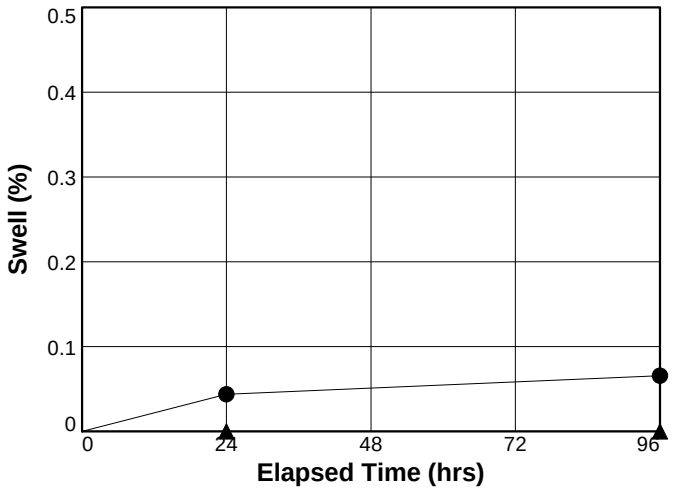
Figure C-6

Tested By: H. Love Checked By: A. Warren, PE

# BEARING RATIO TEST REPORT
## ASTM D1883-16




| | Molded | | | Soaked | | | CBR (%) | | Linearity Correction (in.) | Surcharge (lbs.) | Max. Swell (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Density (pcf) | Percent of Max. Dens. | Moisture (%) | Density (pcf) | Percent of Max. Dens. | Moisture (%) | 0.10 in. | 0.20 in. | | | |
| 1 ○ | 106.3 | 92.2 | 12.8 | 106.2 | 92.1 | 13.0 | 10.5 | 9.0 | 0.000 | 10 | 0.1 |
| 2 △ | 113.3 | 98.3 | 13.0 | 113.3 | 98.3 | 12.8 | 16.0 | 17.7 | 0.000 | 10 | 0 |
| 3 □ | | | | | | | | | | | |

| Material Description | USCS | Max. Dens. (pcf) | Optimum Moisture (%) | LL | PI |
|---|---|---|---|---|---|
| Silty sand | SM | 115.3 | 13.2 | - | - |

**Project No:** 723-002G

**Project:** Aspire Subdivision

**Location:** Composite: TP-01 (1'-4'), TP-02 (1'-4'), TP-05 (1'-2'), TP-07 (1'-6')

**Sample Number:** S723-0021 **Depth:** Varying

**Date:** 2/20/23

ALLWEST

**Test Description/Remarks:**

B. Logan sampled 1/30/23

Figure C-7

# Appendix G

# Hydraflow Summary Report

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024

| 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 | 2 | n/a | 0 | ------ | ------ | ------ | Basin B |
| 2 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin A |
| 3 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin C |
| 4 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin D |
| 5 | SCS Runoff | 0.003 | 2 | 1440 | 72 | ------ | ------ | ------ | Post Basin E |
| 6 | SCS Runoff | 0.027 | 2 | 730 | 221 | ------ | ------ | ------ | Post Basin F |
| 7 | SCS Runoff | 0.019 | 2 | 722 | 84 | ------ | ------ | ------ | Post Basin G |
| 8 | SCS Runoff | 0.022 | 2 | 724 | 116 | ------ | ------ | ------ | Post Basin H |
| 9 | SCS Runoff | 0.039 | 2 | 738 | 350 | ------ | ------ | ------ | Post Basin I |
| 10 | SCS Runoff | 0.033 | 2 | 726 | 199 | ------ | ------ | ------ | Post Basin J |
| 11 | SCS Runoff | 0.113 | 2 | 726 | 676 | ------ | ------ | ------ | Post Basin K |
| 12 | SCS Runoff | 0.060 | 2 | 726 | 357 | ------ | ------ | ------ | Post Basin L |
| 13 | SCS Runoff | 0.002 | 2 | 1440 | 24 | ------ | ------ | ------ | Post Basin M |
| 14 | SCS Runoff | 0.005 | 2 | 1110 | 155 | ------ | ------ | ------ | Post Basin N |
| 15 | SCS Runoff | 0.092 | 2 | 720 | 310 | ------ | ------ | ------ | Post Basin O |
| 16 | SCS Runoff | 0.016 | 2 | 720 | 54 | ------ | ------ | ------ | Post Basin P |
| 17 | SCS Runoff | 0.067 | 2 | 742 | 644 | ------ | ------ | ------ | Post Basin Q |
| 18 | SCS Runoff | 0.073 | 2 | 724 | 389 | ------ | ------ | ------ | Post Basin R |
| 19 | SCS Runoff | 0.152 | 2 | 726 | 907 | ------ | ------ | ------ | Post Basin S |
| 20 | SCS Runoff | 0.034 | 2 | 724 | 183 | ------ | ------ | ------ | Post Basin T |
| 21 | SCS Runoff | 0.024 | 2 | 764 | 307 | ------ | ------ | ------ | Post Basin U |
| 22 | SCS Runoff | 0.029 | 2 | 720 | 98 | ------ | ------ | ------ | Post Basin V |
| 23 | SCS Runoff | 0.196 | 2 | 722 | 846 | ------ | ------ | ------ | Post Basin W |
| 24 | SCS Runoff | 0.036 | 2 | 748 | 387 | ------ | ------ | ------ | Post Basin X |
| 25 | SCS Runoff | 0.011 | 2 | 1080 | 402 | ------ | ------ | ------ | Post Basin Y |
| 26 | SCS Runoff | 0.238 | 2 | 728 | 1,033 | ------ | ------ | ------ | Post Basin Z |
| 27 | SCS Runoff | 0.028 | 2 | 724 | 149 | ------ | ------ | ------ | Post Basin AA |
| 28 | SCS Runoff | 0.376 | 2 | 718 | 920 | ------ | ------ | ------ | Post Basin BB |
| 29 | SCS Runoff | 0.602 | 2 | 720 | 1,654 | ------ | ------ | ------ | Post Basin CC |
| 30 | SCS Runoff | 0.475 | 2 | 720 | 1,599 | ------ | ------ | ------ | Post Basin DD |
| 31 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Post Basin EE |

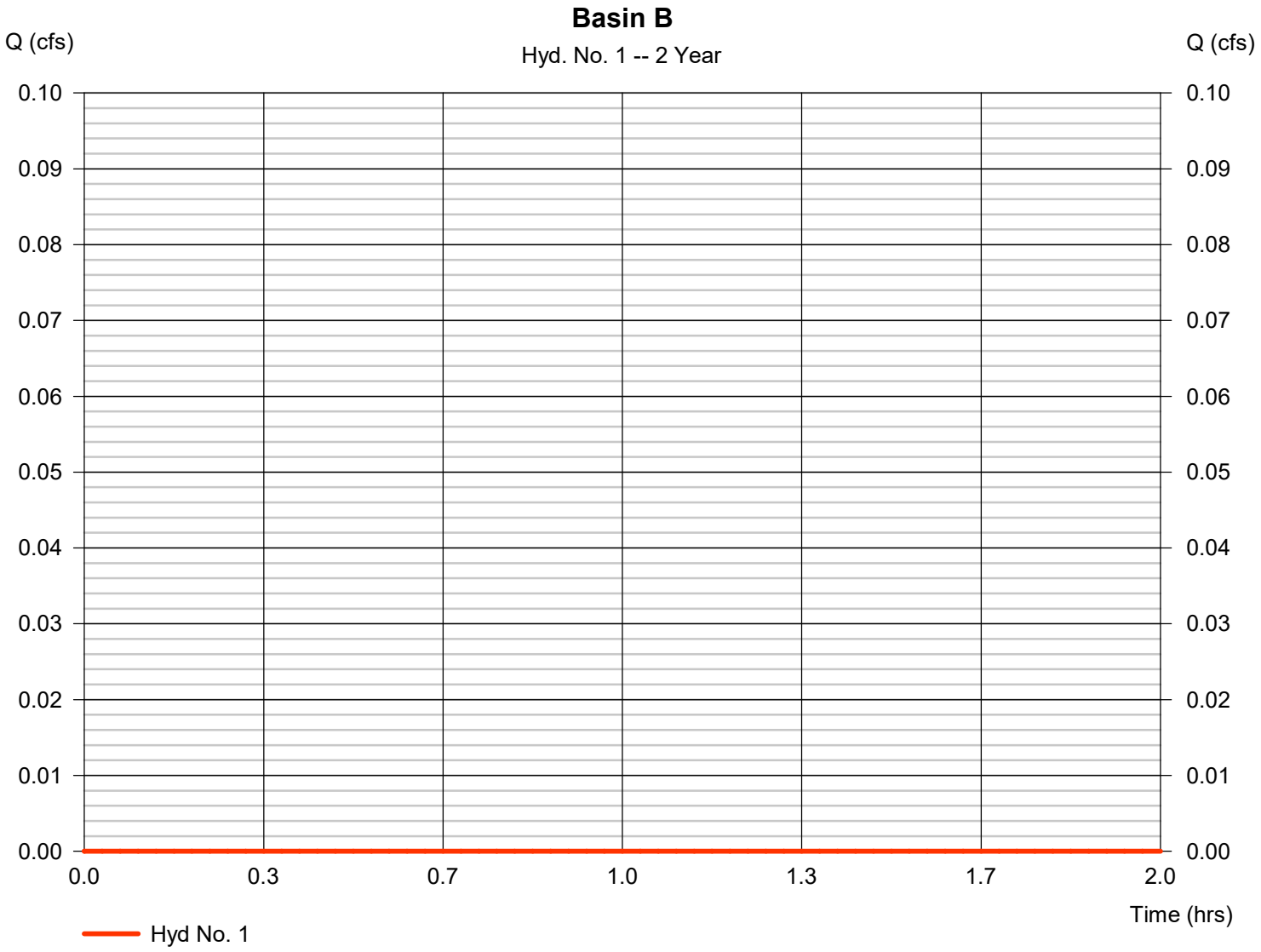
# Hydrograph Report



## Hyd. No. 1

Basin B

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | n/a |
| Time interval | = | 2 min | Hyd. volume | = | 0 cuft |
| Drainage area | = | 2.960 ac | Curve number | = | 39 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 25.10 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 1

Basin B

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 206.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 3.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 24.56** | **+** | **0.00** | **+** | **0.00** | **=** | **24.56** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 135.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 7.00 | | 0.00 | | 0.00 | | |
| Surface description | = Unpaved | | Paved | | Paved | | |
| Average velocity (ft/s) | =4.27 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.53** | **+** | **0.00** | **+** | **0.00** | **=** | **0.53** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.00 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})0.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |

**Total Travel Time, Tc ..... 25.10 min**

# Hydrograph Report

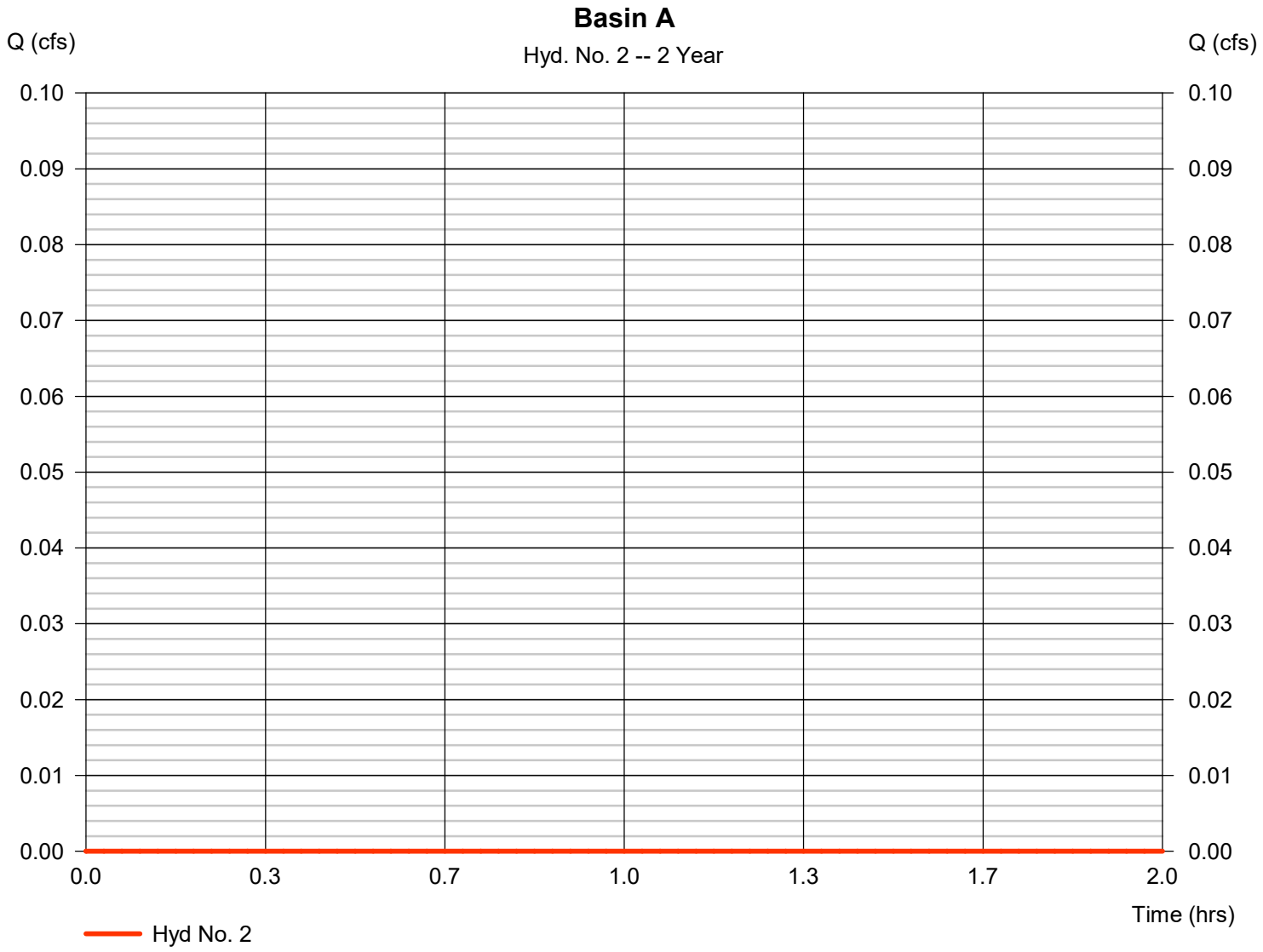


## Hyd. No. 2

Basin A

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 9.830 ac | Curve number | = 41* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 31.60 min |
| Total precip. | = 1.17 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(9.460 x 39) + (0.370 x 98)] / 9.830



# TR55 Tc Worksheet



## Hyd. No. 2

Basin A

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 300.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 6.60 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 24.21** | **+** | **0.00** | **+** | **0.00** | **=** | **24.21** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 190.00 | | 515.00 | | 361.00 | | |
| Watercourse slope (%) | = 6.60 | | 1.10 | | 3.70 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =4.15 | | 1.69 | | 3.91 | | |
| **Travel Time (min)** | **= 0.76** | **+** | **5.07** | **+** | **1.54** | **=** | **7.37** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.00 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})0.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |

**Total Travel Time, Tc ..... 31.60 min**

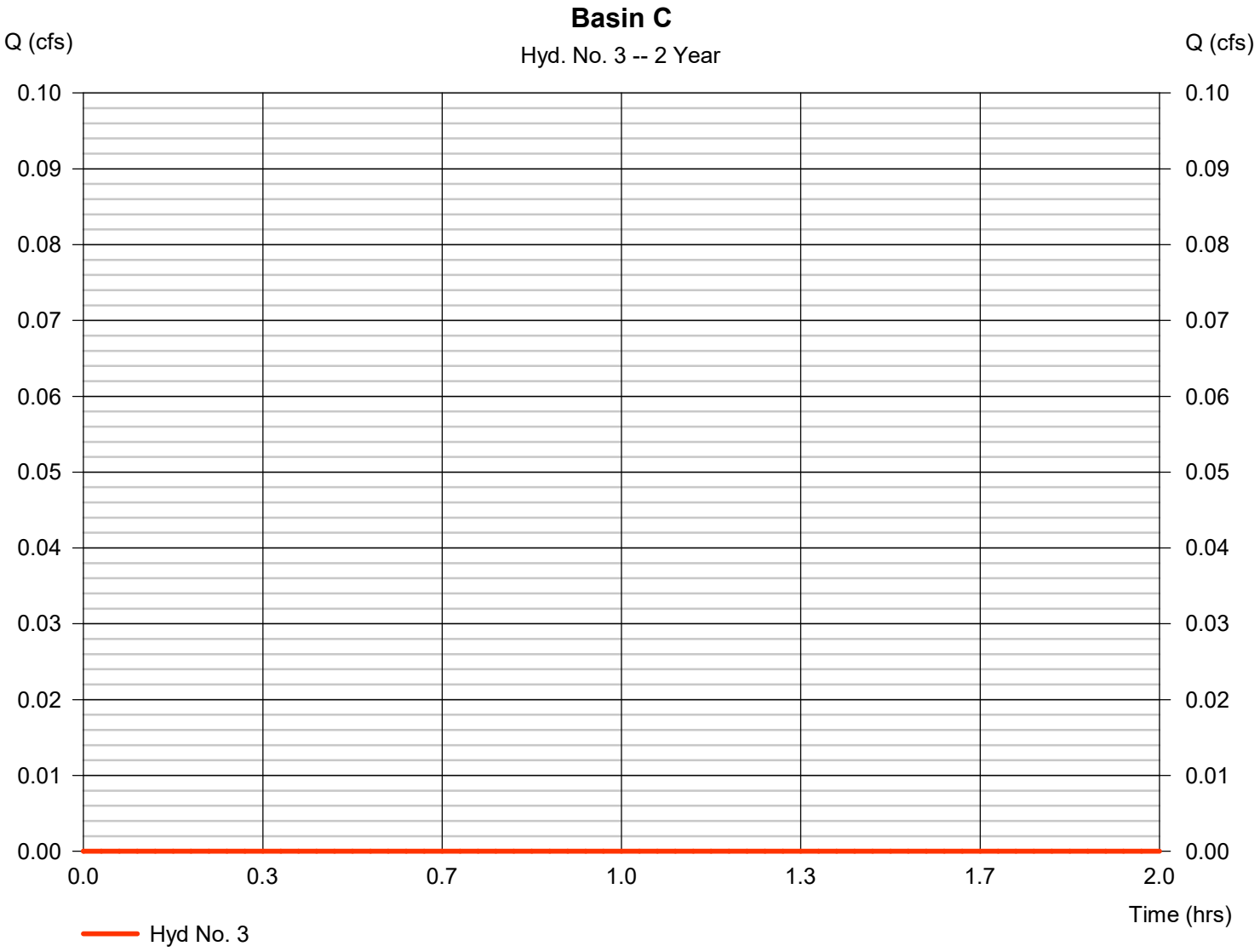
# Hydrograph Report



## Hyd. No. 3

Basin C

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 4.970 ac | Curve number | = 39 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 26.00 min |
| Total precip. | = 1.17 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



# TR55 Tc Worksheet



## Hyd. No. 3

Basin C

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 204.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 5.30 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 19.41** | **+** | **0.00** | **+** | **0.00** | **=** | **19.41** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 409.00 | | 296.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.70 | | 3.80 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =1.35 | | 3.15 | | 0.00 | | |
| **Travel Time (min)** | **= 5.05** | **+** | **1.57** | **+** | **0.00** | **=** | **6.62** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.00 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})0.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |

**Total Travel Time, Tc ..... 26.00 min**

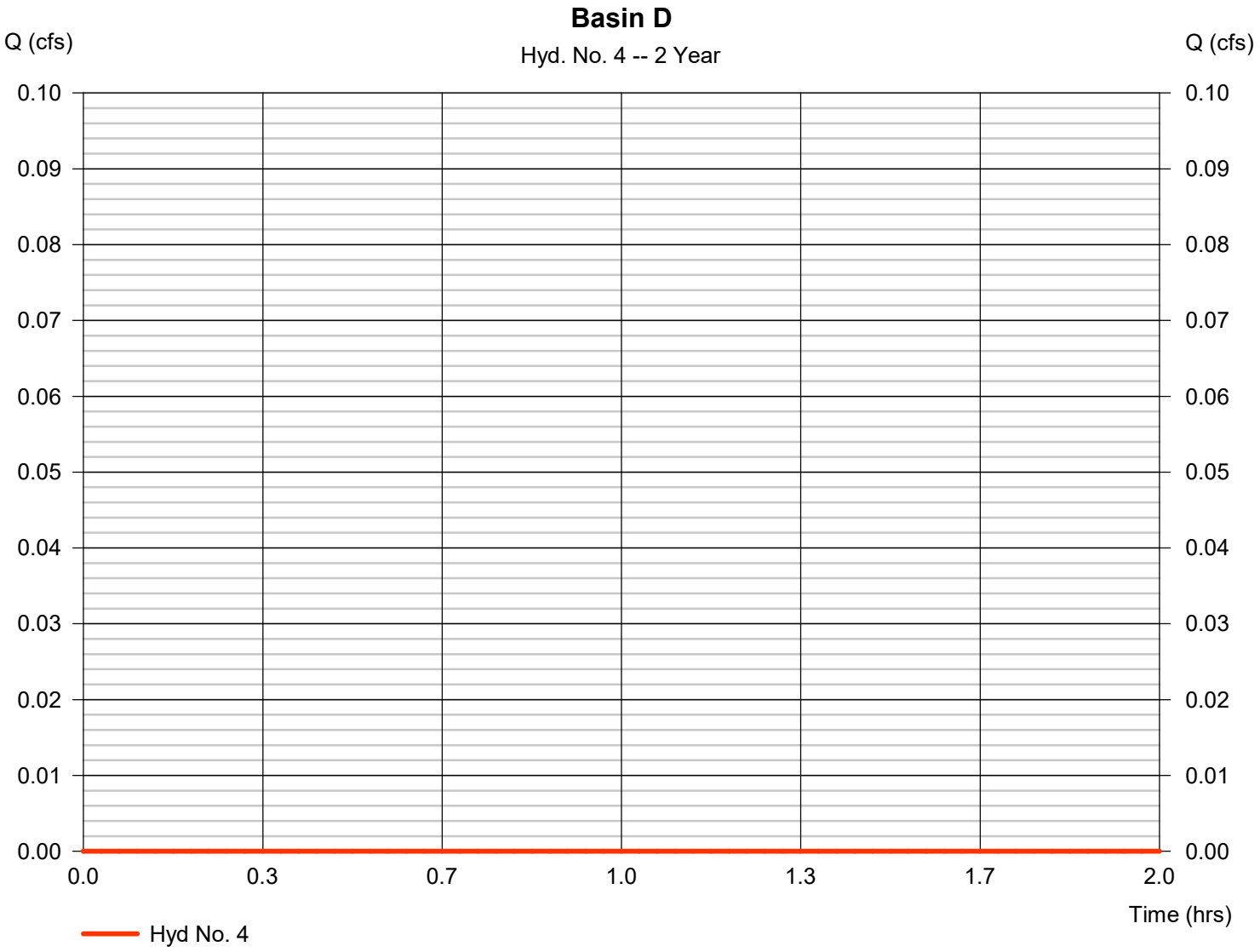
# Hydrograph Report



## Hyd. No. 4

Basin D

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 2 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 0.430 ac | Curve number | = 39 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 14.00 min |
| Total precip. | = 1.17 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



# TR55 Tc Worksheet



## Hyd. No. 4

Basin D

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 140.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 0.00 | | 0.00 | | |
| Land slope (%) | = 5.60 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 14.05** | **+** | **0.00** | **+** | **0.00** | **=** | **14.05** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.00 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.00 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})0.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |

**Total Travel Time, Tc ..... 14.00 min**

# Hydrograph Report

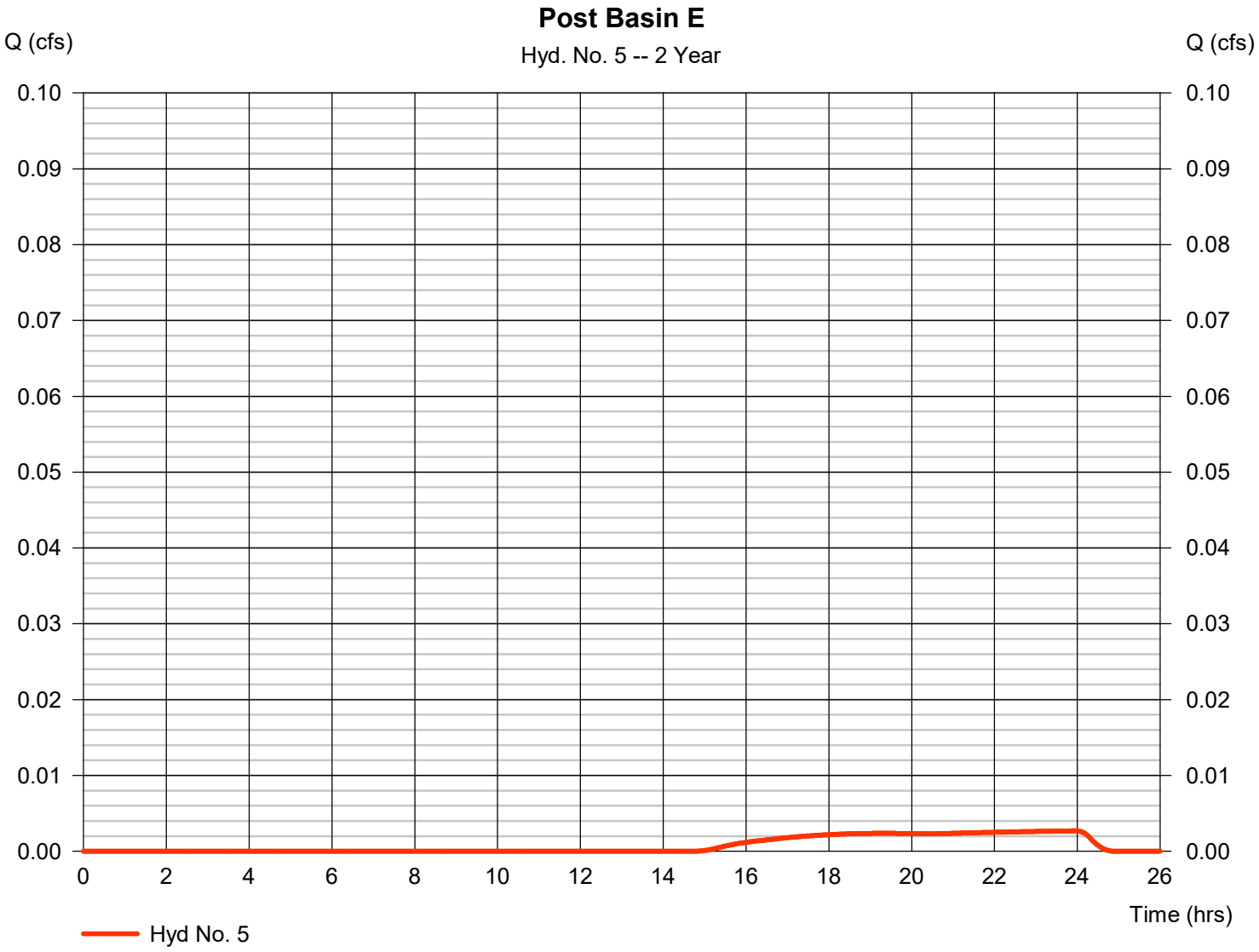


## Hyd. No. 5

Post Basin E

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.003 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 24.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 72 cuft |
| Drainage area | = | 2.910 ac | Curve number | = | 67* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.10 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(1.810 x 61) + (1.100 x 78)] / 2.910



# TR55 Tc Worksheet



## Hyd. No. 5

Post Basin E

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 300.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 7.70 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 22.76** | **+** | **0.00** | **+** | **0.00** | **=** | **22.76** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 60.00 | | 146.00 | | 0.00 | | |
| Watercourse slope (%) | = 7.70 | | 3.10 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =5.64 | | 3.58 | | 0.00 | | |
| **Travel Time (min)** | **= 0.18** | **+** | **0.68** | **+** | **0.00** | **=** | **0.86** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.04 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 1.97 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.88 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})449.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 8.52** | **+** | **0.00** | **+** | **0.00** | **=** | **8.52** |

**Total Travel Time, Tc ..... 32.10 min**

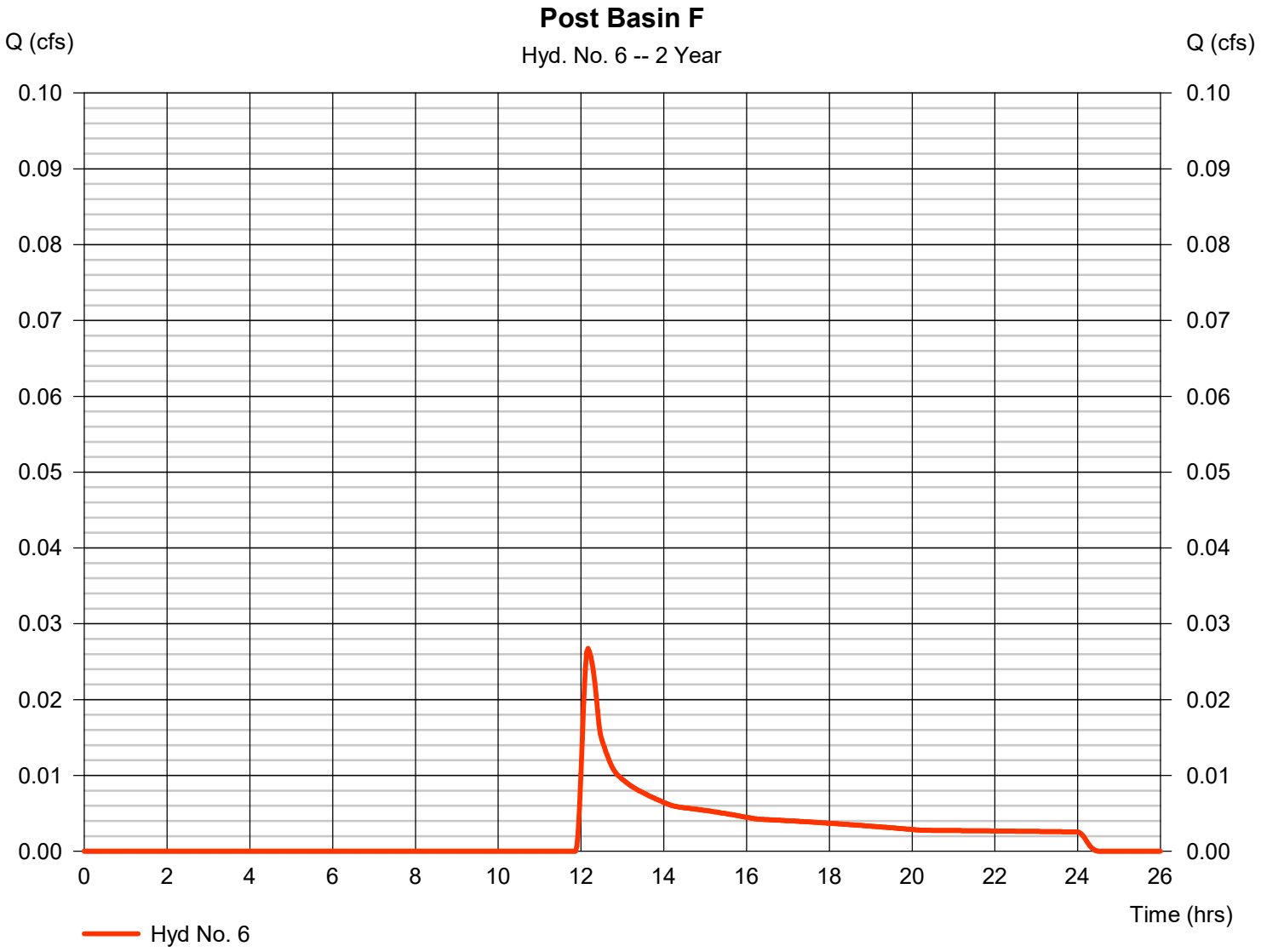
# Hydrograph Report



## Hyd. No. 6

Post Basin F

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.027 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.17 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 221 cuft |
| Drainage area | = | 0.660 ac | Curve number | = | 77 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 18.20 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 6

Post Basin F

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 104.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 3.20 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 13.85** | **+** | **0.00** | **+** | **0.00** | **=** | **13.85** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.10 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.09 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.19 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})313.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 4.39** | **+** | **0.00** | **+** | **0.00** | **=** | **4.39** |

**Total Travel Time, Tc ..... 18.20 min**

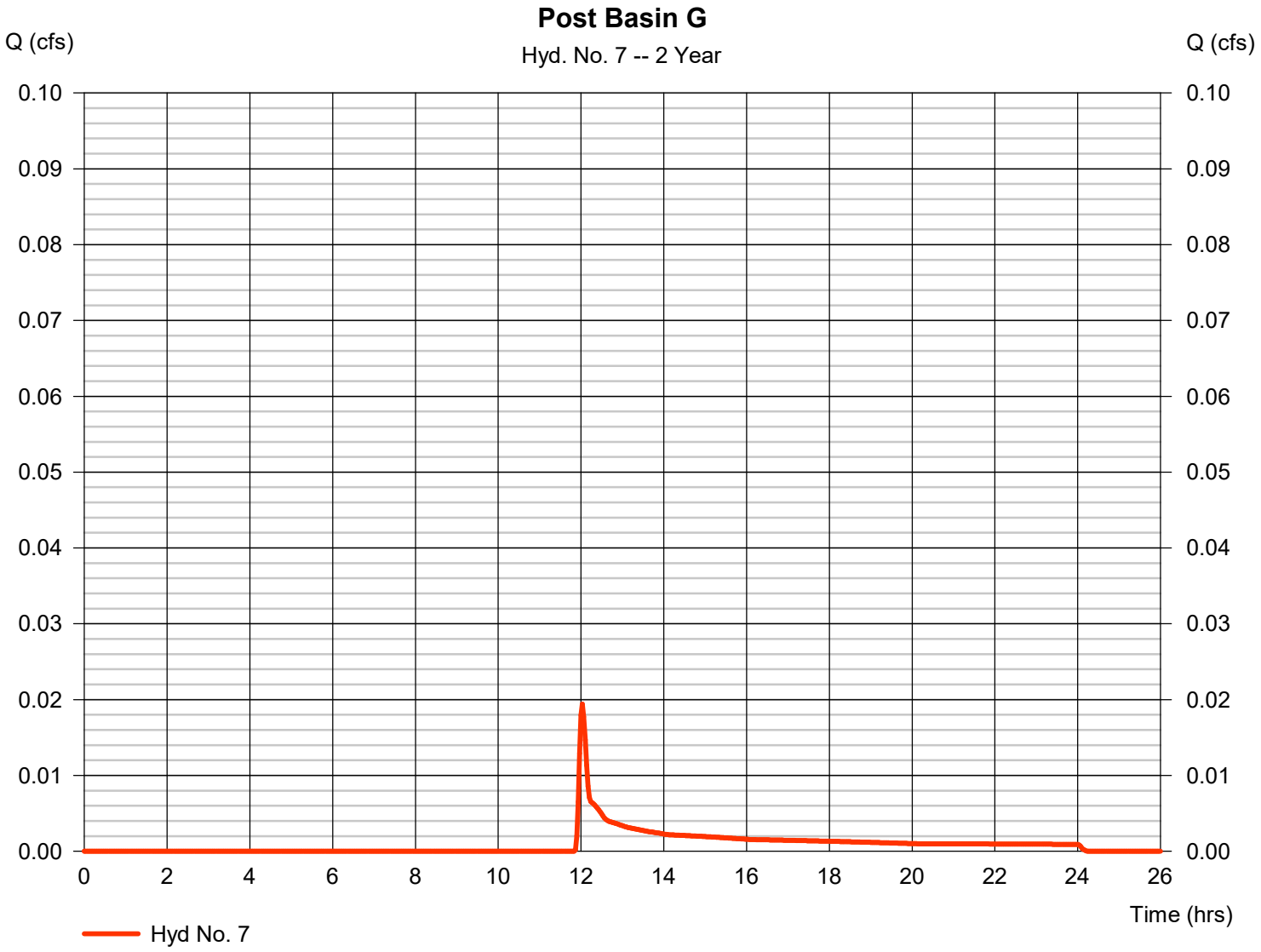
# Hydrograph Report



## Hyd. No. 7

Post Basin G

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.019 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 84 cuft |
| Drainage area | = | 0.216 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.30 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 7

Post Basin G

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 34.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.30 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.46** | **+** | **0.00** | **+** | **0.00** | **=** | **6.46** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.05 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 2.13 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 3.70 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.44 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})160.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 1.85** | **+** | **0.00** | **+** | **0.00** | **=** | **1.85** |

**Total Travel Time, Tc ..... 8.30 min**

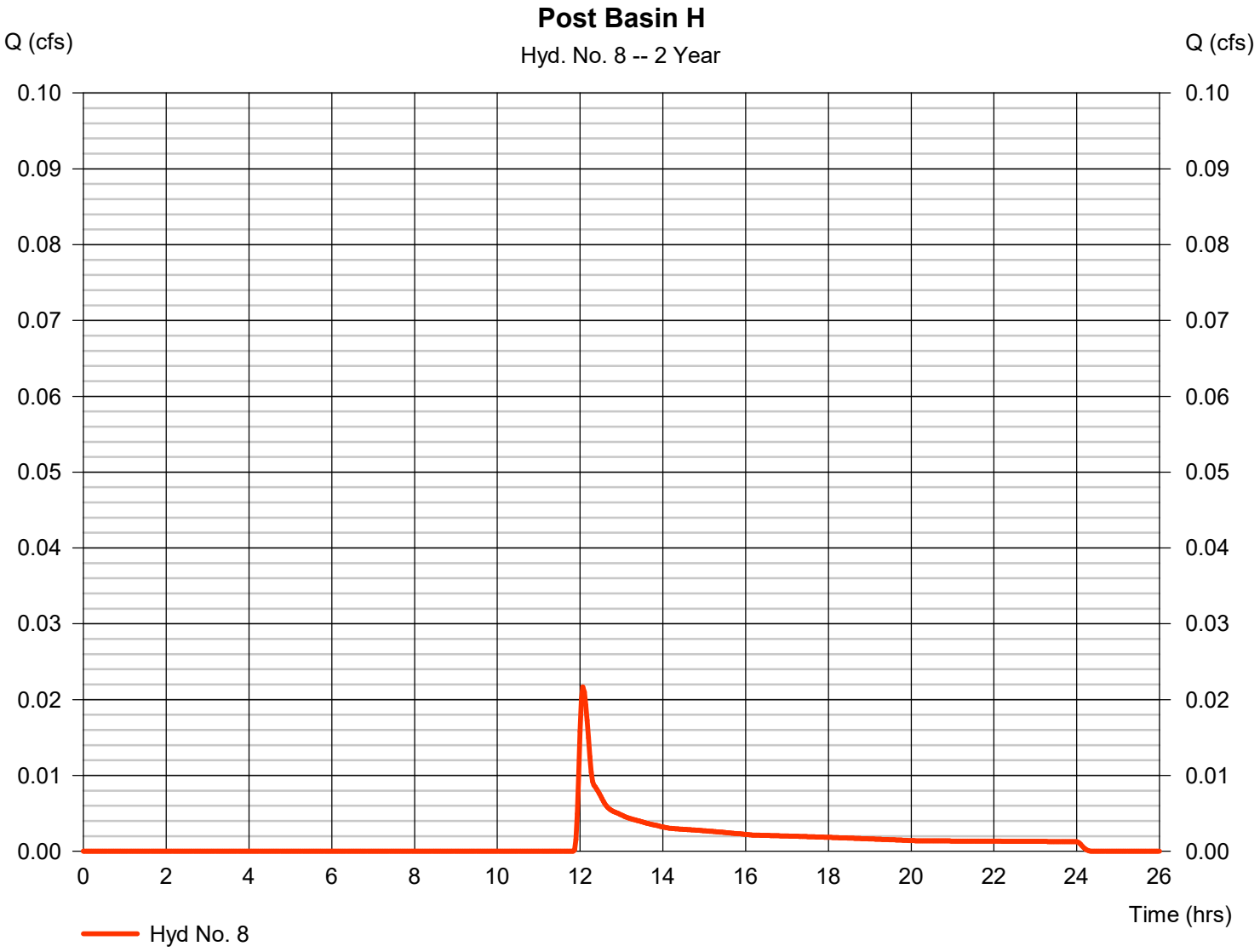
# Hydrograph Report



## Hyd. No. 8

Post Basin H

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.022 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 116 cuft |
| Drainage area | = | 0.290 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 10.60 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 8

Post Basin H

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 33.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.67** | **+** | **0.00** | **+** | **0.00** | **=** | **6.67** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.03 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 1.73 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.80 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})189.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 3.93** | **+** | **0.00** | **+** | **0.00** | **=** | **3.93** |

**Total Travel Time, Tc ..... 10.60 min**

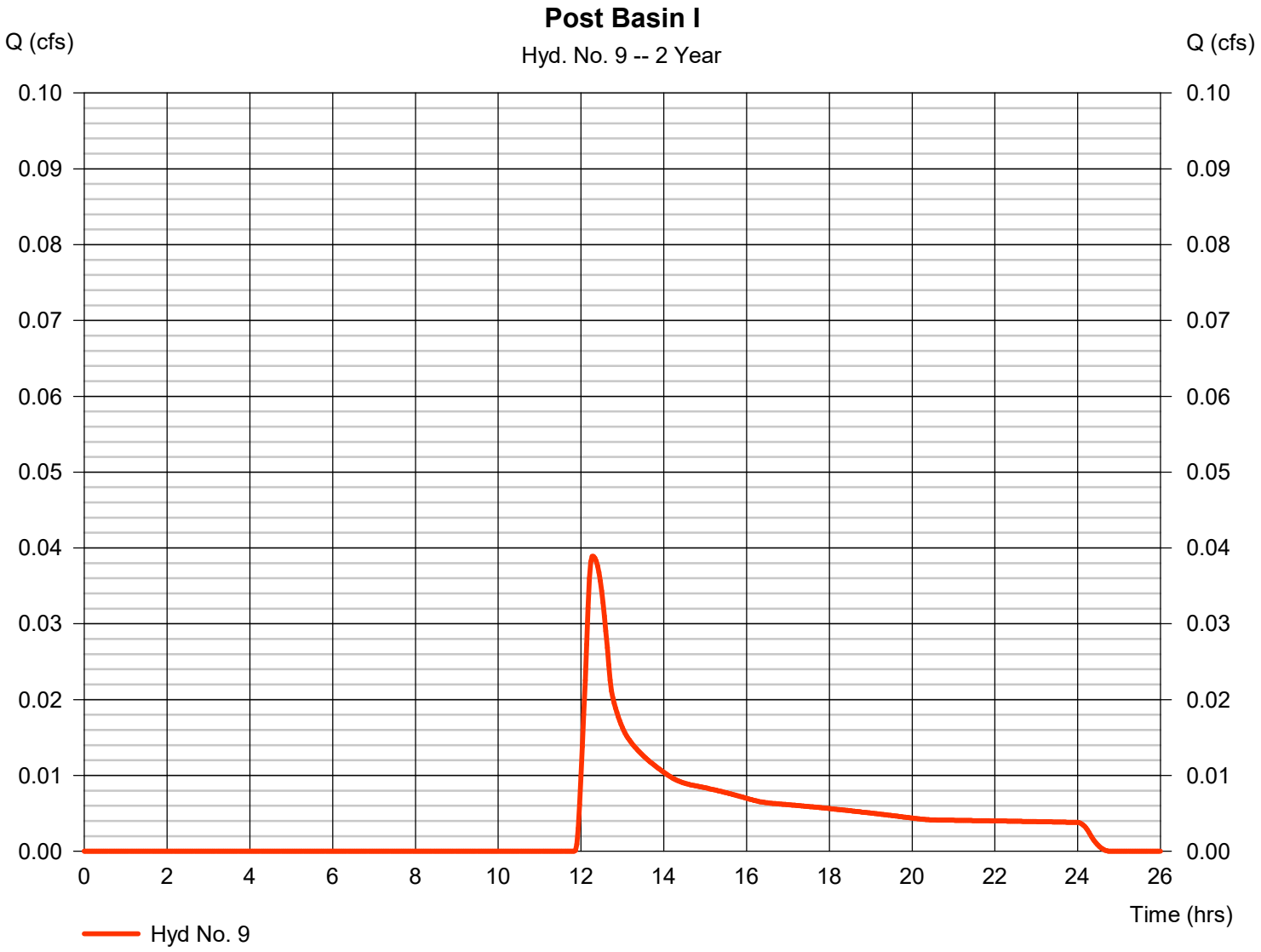
# Hydrograph Report



## Hyd. No. 9

Post Basin I

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.039 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.30 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 350 cuft |
| Drainage area | = | 0.900 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 29.00 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 9

Post Basin I

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 192.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.10 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 26.78** | **+** | **0.00** | **+** | **0.00** | **=** | **26.78** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.11 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.04 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.50 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.31 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})175.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 2.23** | **+** | **0.00** | **+** | **0.00** | **=** | **2.23** |

**Total Travel Time, Tc ..... 29.00 min**

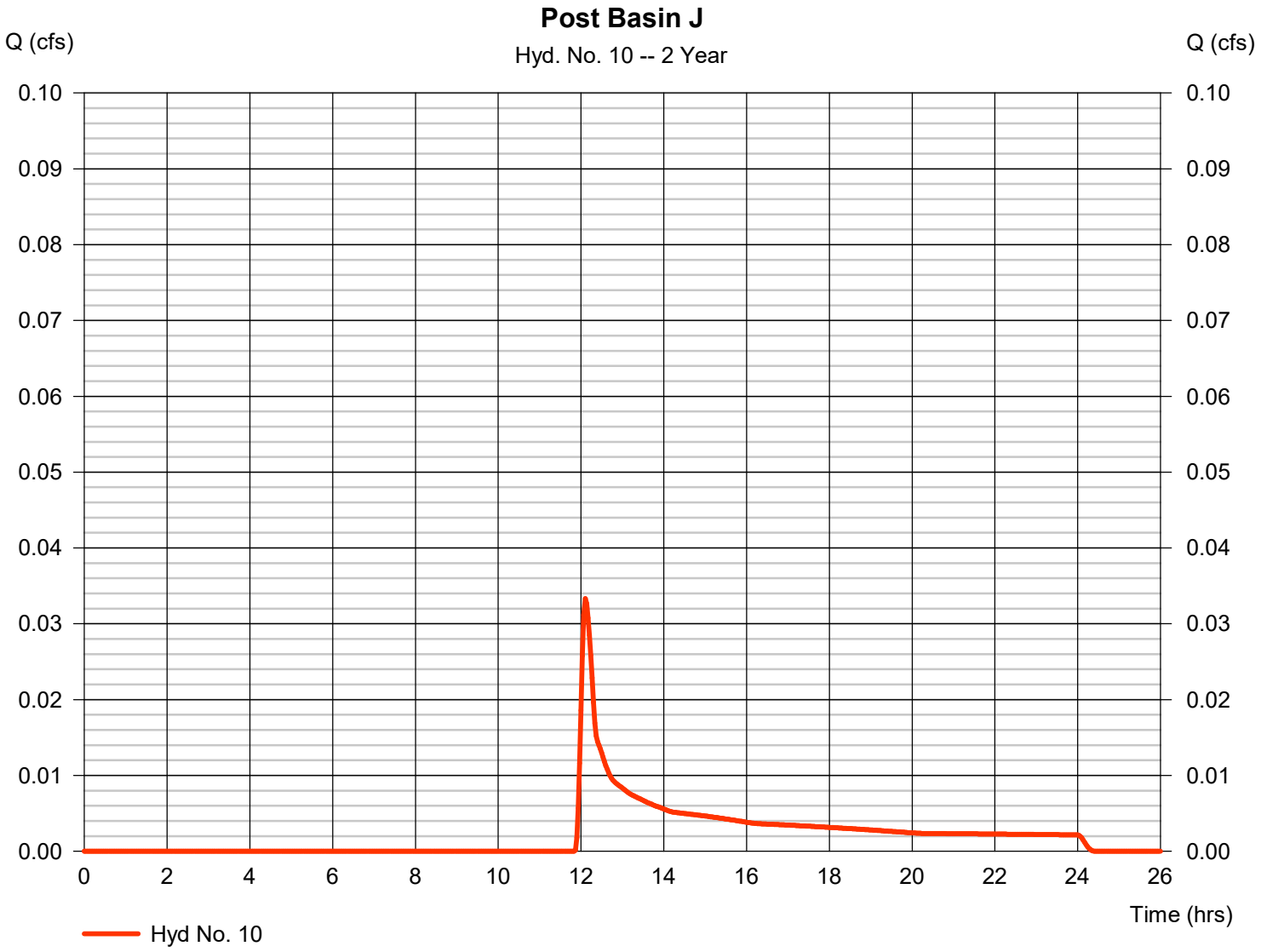
# Hydrograph Report



## Hyd. No. 10

Post Basin J

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.033 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 199 cuft |
| Drainage area | = | 0.525 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.80 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 10

Post Basin J

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 32.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.51** | **+** | **0.00** | **+** | **0.00** | **=** | **6.51** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.13 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.62 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.70 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.90 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})447.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 8.29** | **+** | **0.00** | **+** | **0.00** | **=** | **8.29** |

**Total Travel Time, Tc ..... 14.80 min**

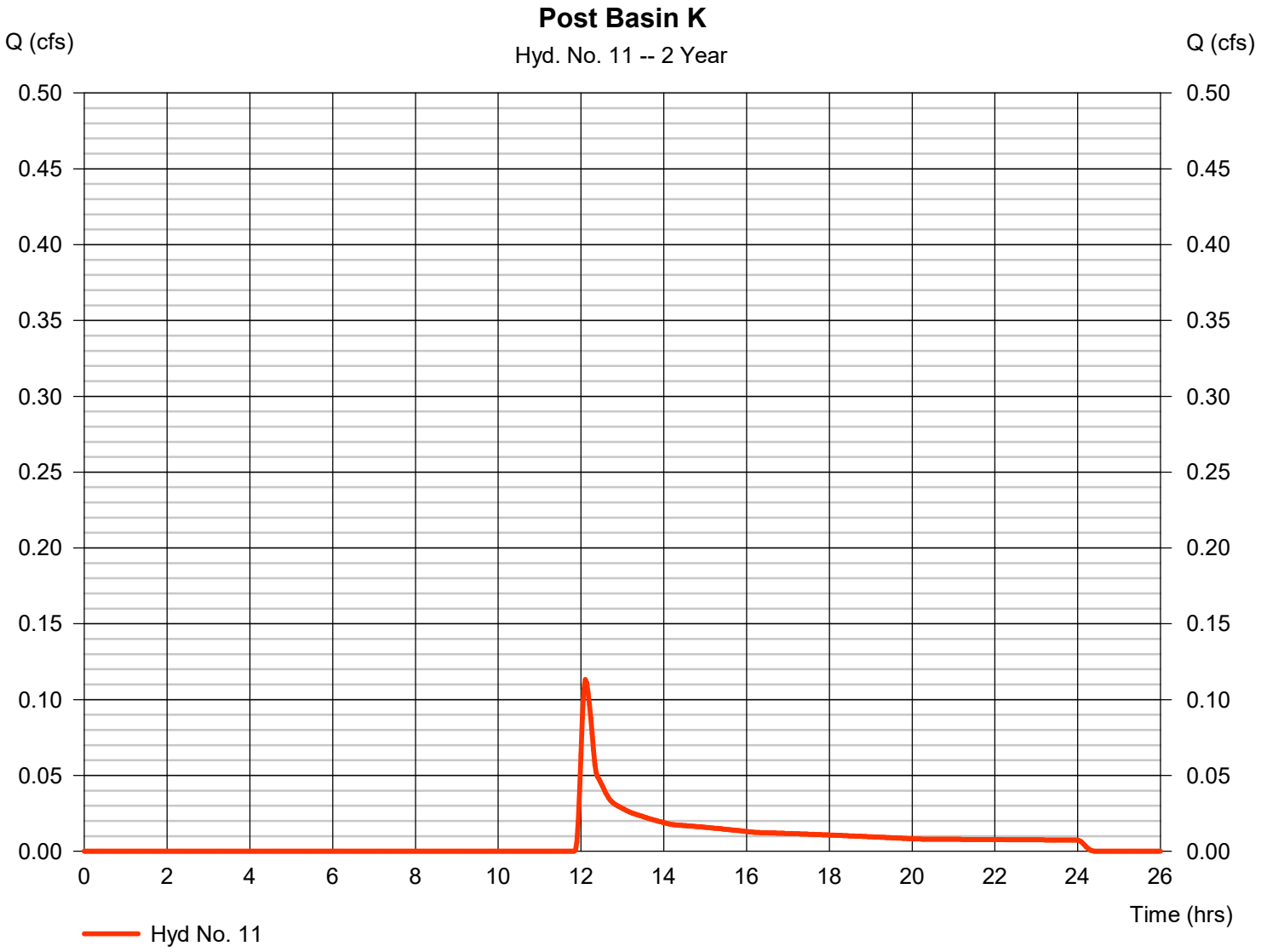
# Hydrograph Report



## Hyd. No. 11

Post Basin K

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.113 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 676 cuft |
| Drainage area | = | 1.785 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 15.60 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 11

Post Basin K

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 50.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 9.31** | **+** | **0.00** | **+** | **0.00** | **=** | **9.31** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.33 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.74 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.70 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.22 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})462.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 6.31** | **+** | **0.00** | **+** | **0.00** | **=** | **6.31** |

**Total Travel Time, Tc ..... 15.60 min**

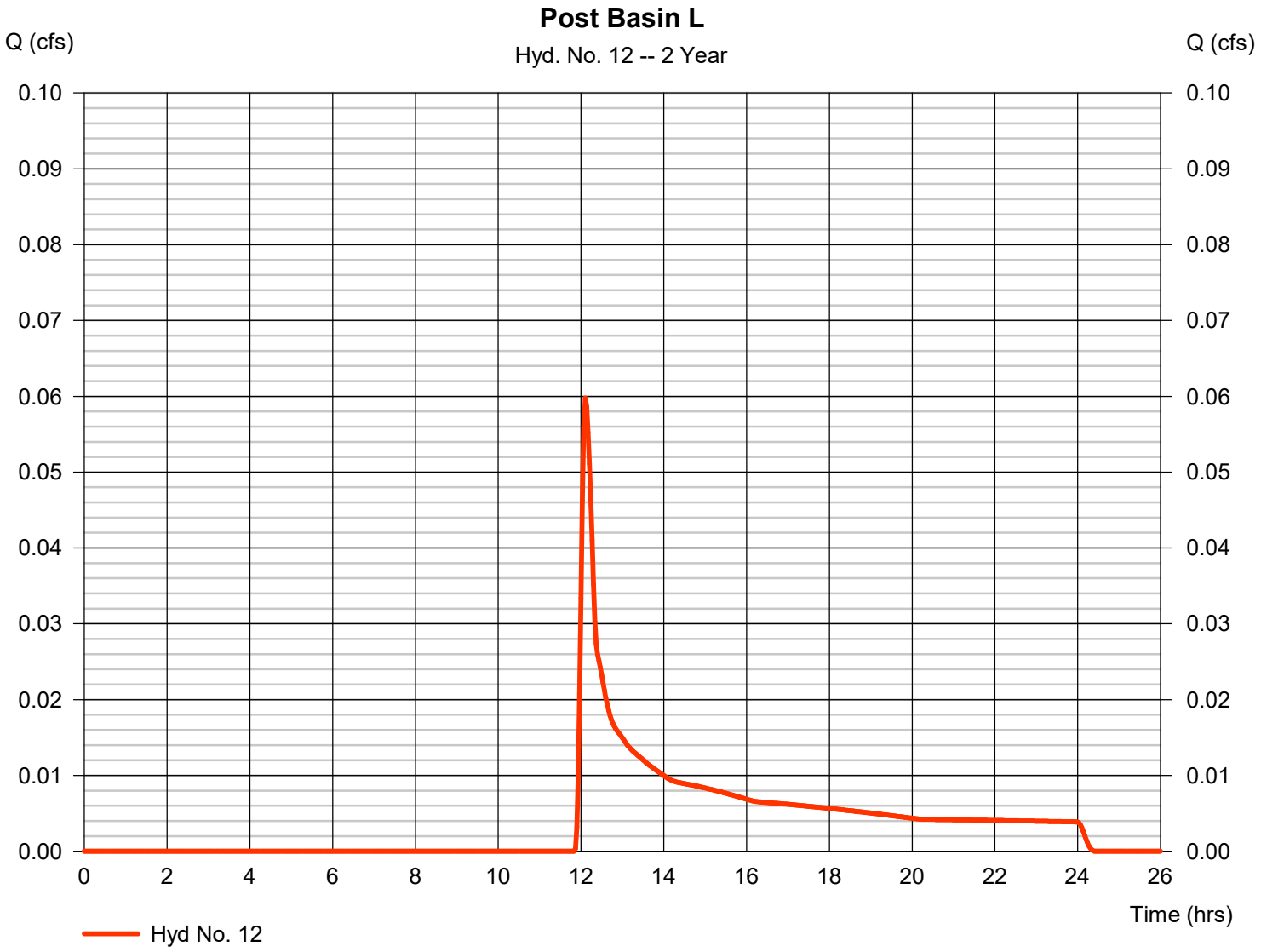
# Hydrograph Report



## Hyd. No. 12

Post Basin L

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.060 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 357 cuft |
| Drainage area | = | 0.942 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.10 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 12

Post Basin L

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 33.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.67** | **+** | **0.00** | **+** | **0.00** | **=** | **6.67** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.23 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 4.81 | | 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) | =0.92 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})406.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 7.39** | **+** | **0.00** | **+** | **0.00** | **=** | **7.39** |

**Total Travel Time, Tc ..... 14.10 min**

# Hydrograph Report

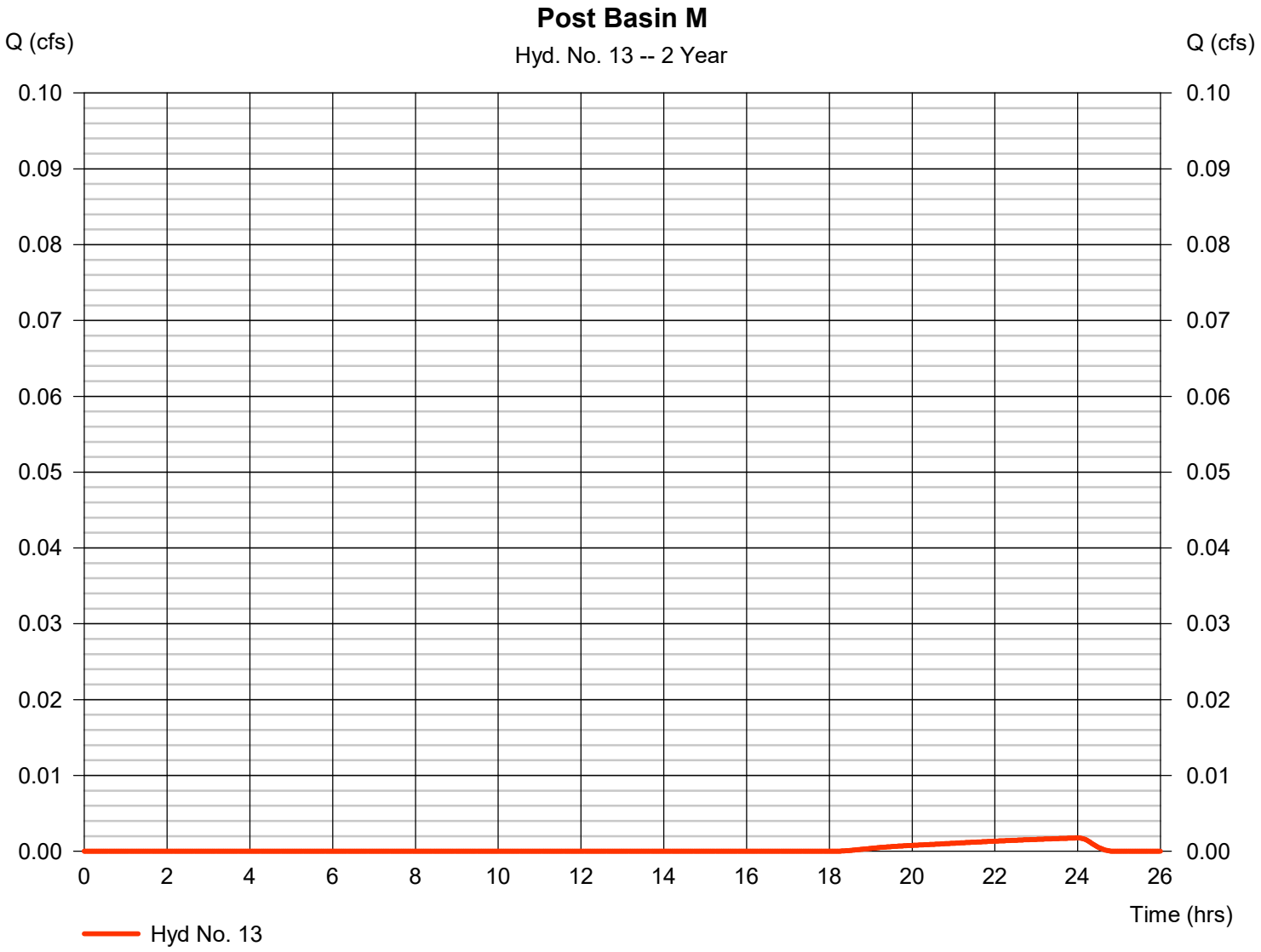


## Hyd. No. 13

Post Basin M

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.002 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 24.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 24 cuft |
| Drainage area | = | 4.130 ac | Curve number | = | 65* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.20 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.050 x 61) + (1.080 x 78)] / 4.130



# TR55 Tc Worksheet



## Hyd. No. 13

Post Basin M

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 300.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 13.70 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 18.07** | **+** | **0.00** | **+** | **0.00** | **=** | **18.07** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 30.00 | | 70.00 | | 0.00 | | |
| Watercourse slope (%) | = 27.60 | | 0.30 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =8.48 | | 0.88 | | 0.00 | | |
| **Travel Time (min)** | **= 0.06** | **+** | **1.32** | **+** | **0.00** | **=** | **1.38** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.04 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 2.11 | | 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) | =0.53 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})402.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 12.75** | **+** | **0.00** | **+** | **0.00** | **=** | **12.75** |

**Total Travel Time, Tc ..... 32.20 min**

# Hydrograph Report

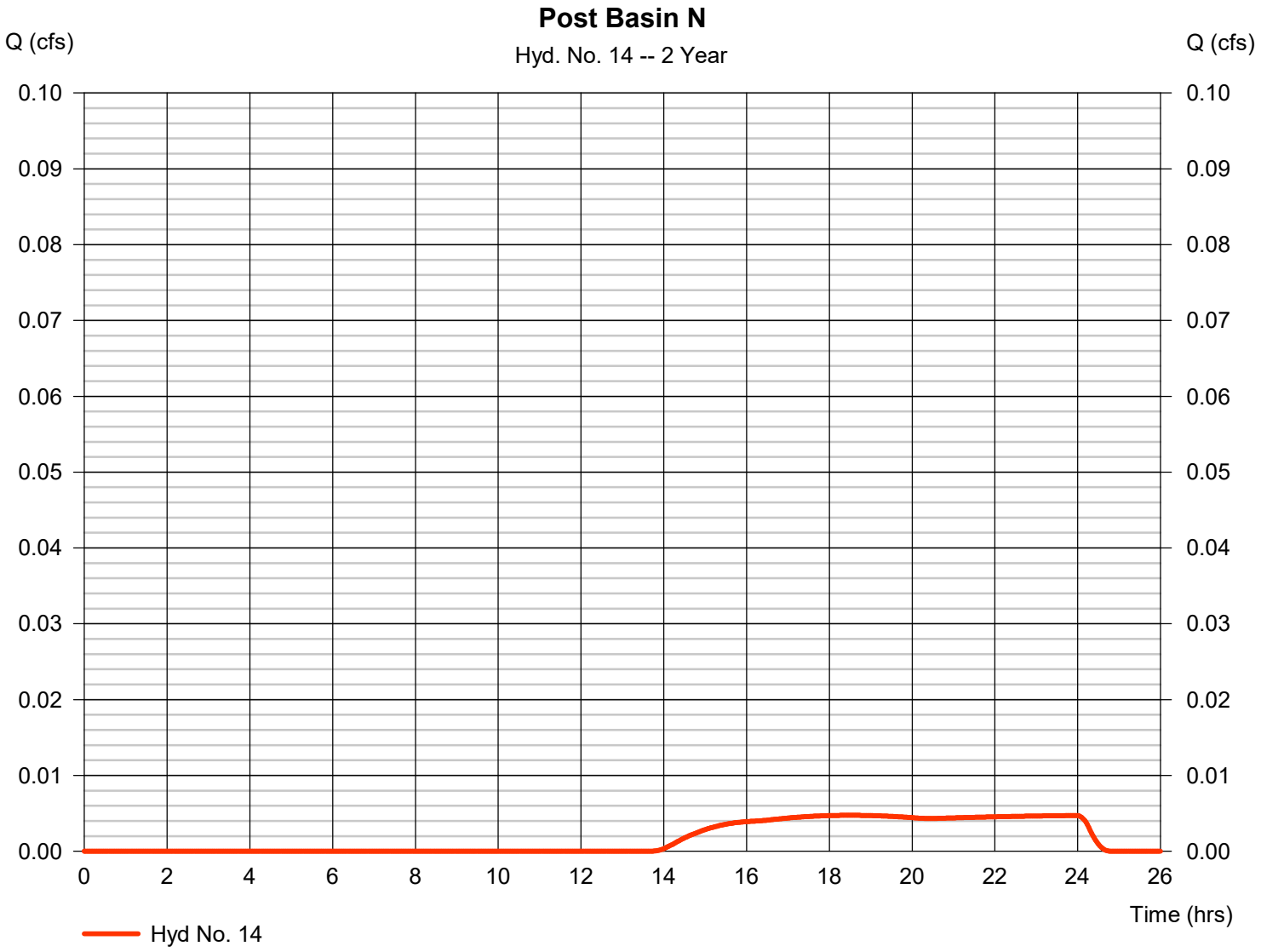


## Hyd. No. 14

Post Basin N

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.005 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 18.50 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 155 cuft |
| Drainage area | = | 4.020 ac | Curve number | = | 68* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 30.10 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(2.390 x 61) + (1.630 x 78)] / 4.020



# TR55 Tc Worksheet



## Hyd. No. 14

Post Basin N

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 300.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 8.60 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 21.77** | **+** | **0.00** | **+** | **0.00** | **=** | **21.77** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 55.00 | | 165.00 | | 0.00 | | |
| Watercourse slope (%) | = 29.20 | | 1.40 | | 0.00 | | |
| Surface description | = Unpaved | | Unpaved | | Paved | | |
| Average velocity (ft/s) | =8.72 | | 1.91 | | 0.00 | | |
| **Travel Time (min)** | **= 0.11** | **+** | **1.44** | **+** | **0.00** | **=** | **1.55** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.10 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.14 | | 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) | =0.69 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})279.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 6.74** | **+** | **0.00** | **+** | **0.00** | **=** | **6.74** |

**Total Travel Time, Tc ..... 30.10 min**

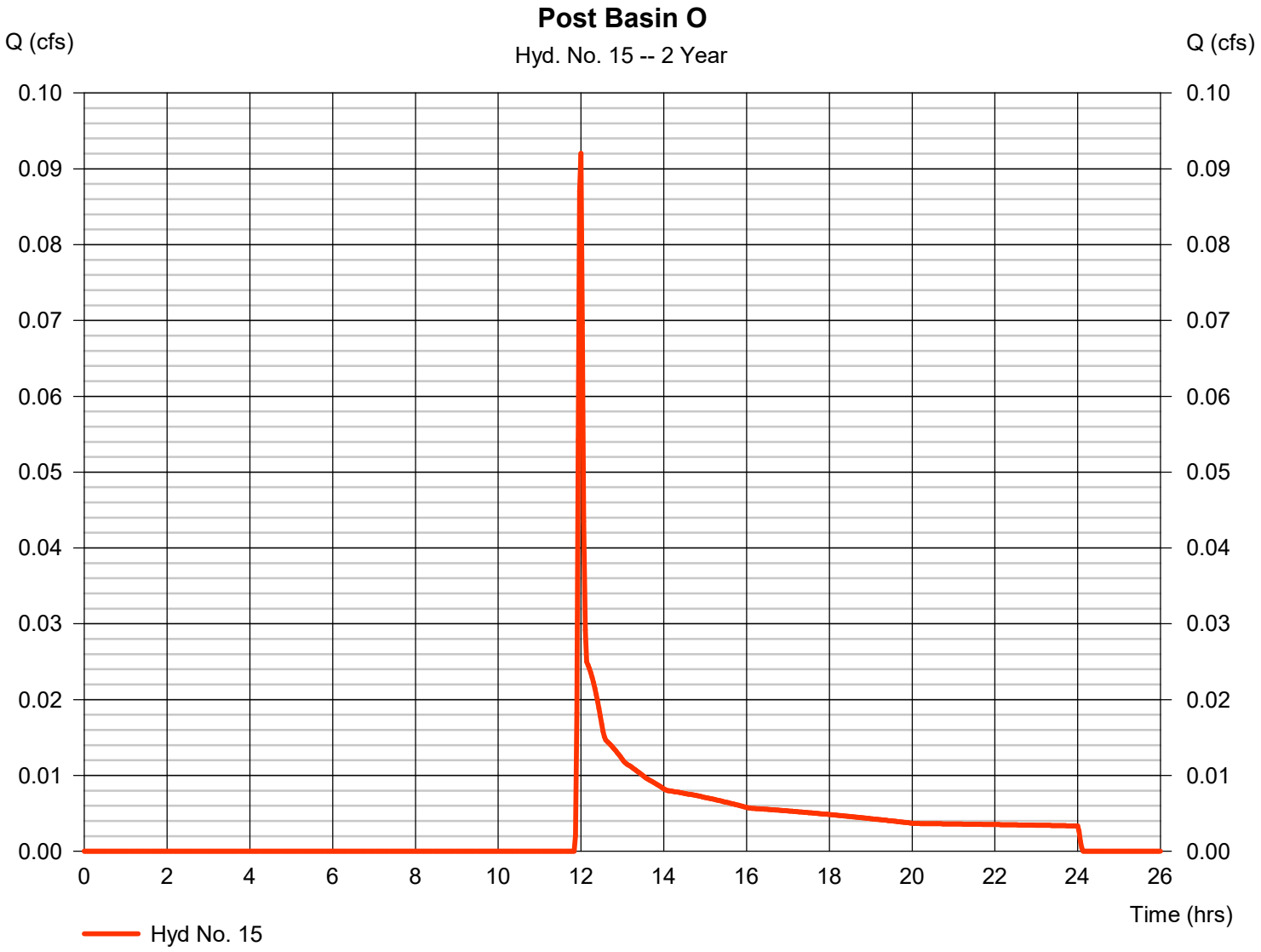
# Hydrograph Report



## Hyd. No. 15

Post Basin O

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.092 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 310 cuft |
| Drainage area | = | 0.850 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.70 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 15

Post Basin O

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.011 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 50.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 1.40 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 1.33** | **+** | **0.00** | **+** | **0.00** | **=** | **1.33** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.29 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.42 | | 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) | =0.99 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})260.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 4.36** | **+** | **0.00** | **+** | **0.00** | **=** | **4.36** |

**Total Travel Time, Tc ..... 5.70 min**

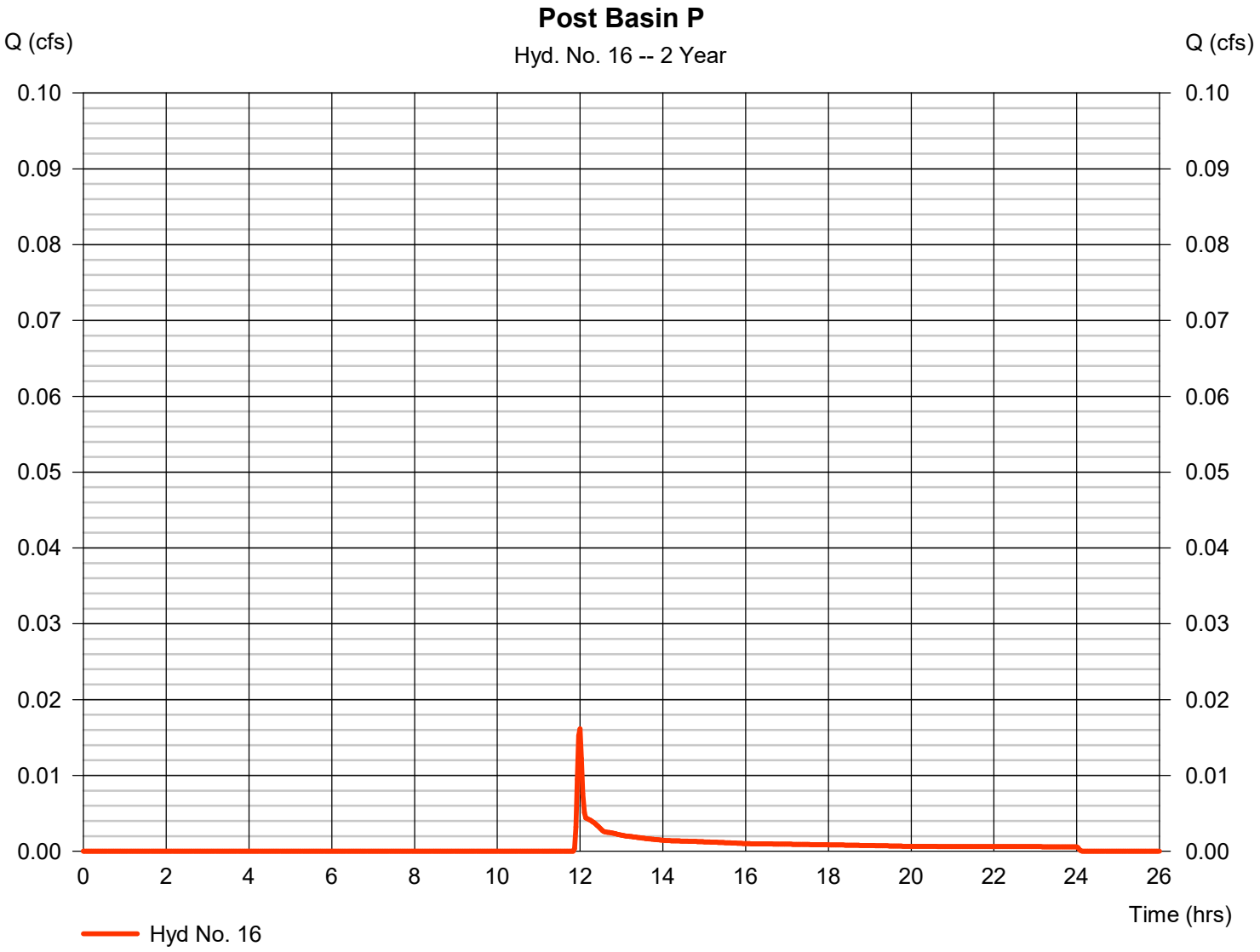
# Hydrograph Report



## Hyd. No. 16

Post Basin P

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.016 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 54 cuft |
| Drainage area | = | 0.149 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.80 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 16

Post Basin P

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 22.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 4.20 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 3.59** | **+** | **0.00** | **+** | **0.00** | **=** | **3.59** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.05 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 2.30 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.90 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.09 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})145.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 2.21** | **+** | **0.00** | **+** | **0.00** | **=** | **2.21** |

**Total Travel Time, Tc ..... 5.80 min**

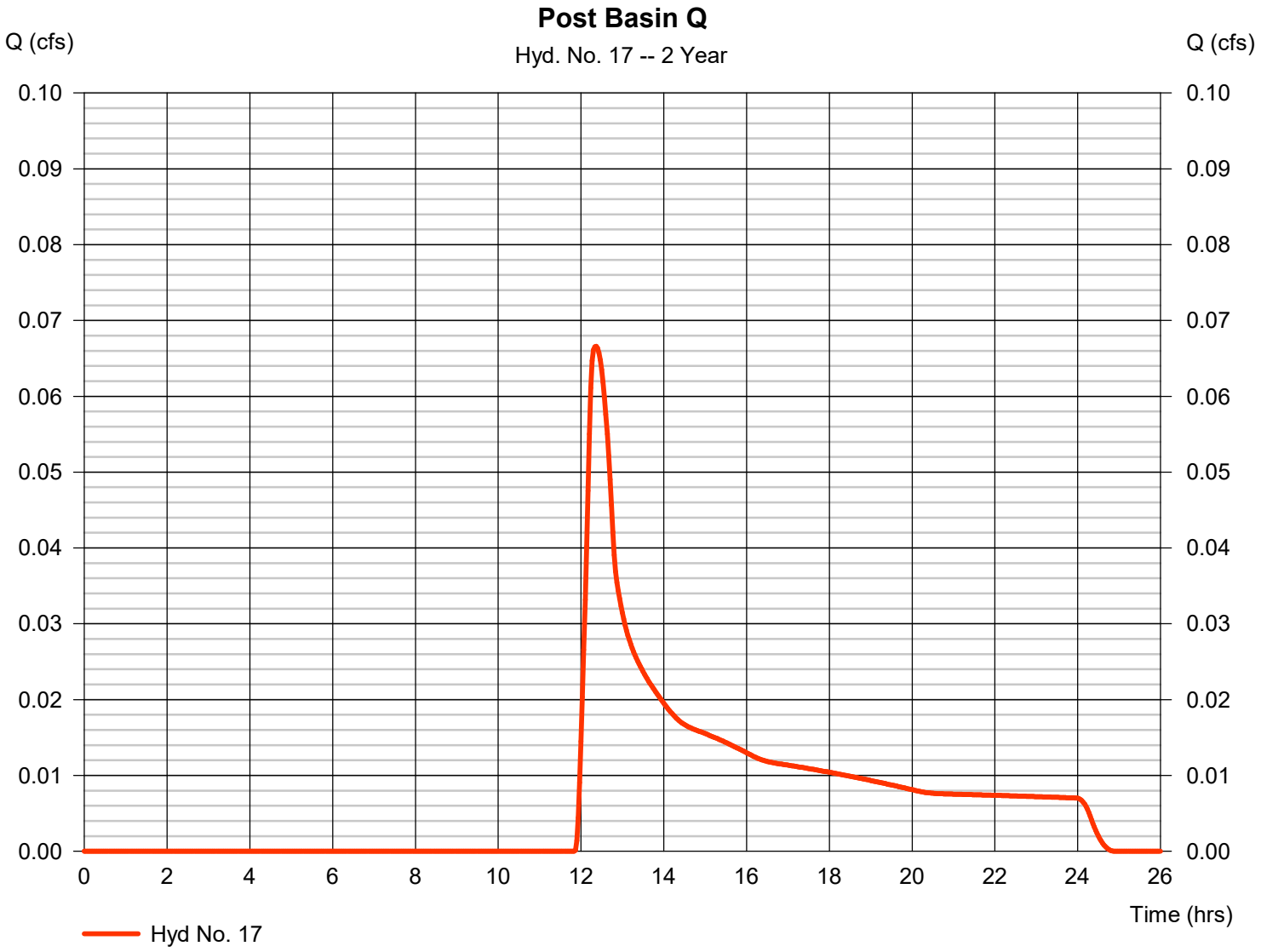
# Hydrograph Report



## Hyd. No. 17

Post Basin Q

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.067 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.37 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 644 cuft |
| Drainage area | = | 1.637 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 31.40 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 17

Post Basin Q

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 198.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 27.99** | **+** | **0.00** | **+** | **0.00** | **=** | **27.99** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.17 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 4.08 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.40 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.37 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})284.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 3.45** | **+** | **0.00** | **+** | **0.00** | **=** | **3.45** |

**Total Travel Time, Tc ..... 31.40 min**

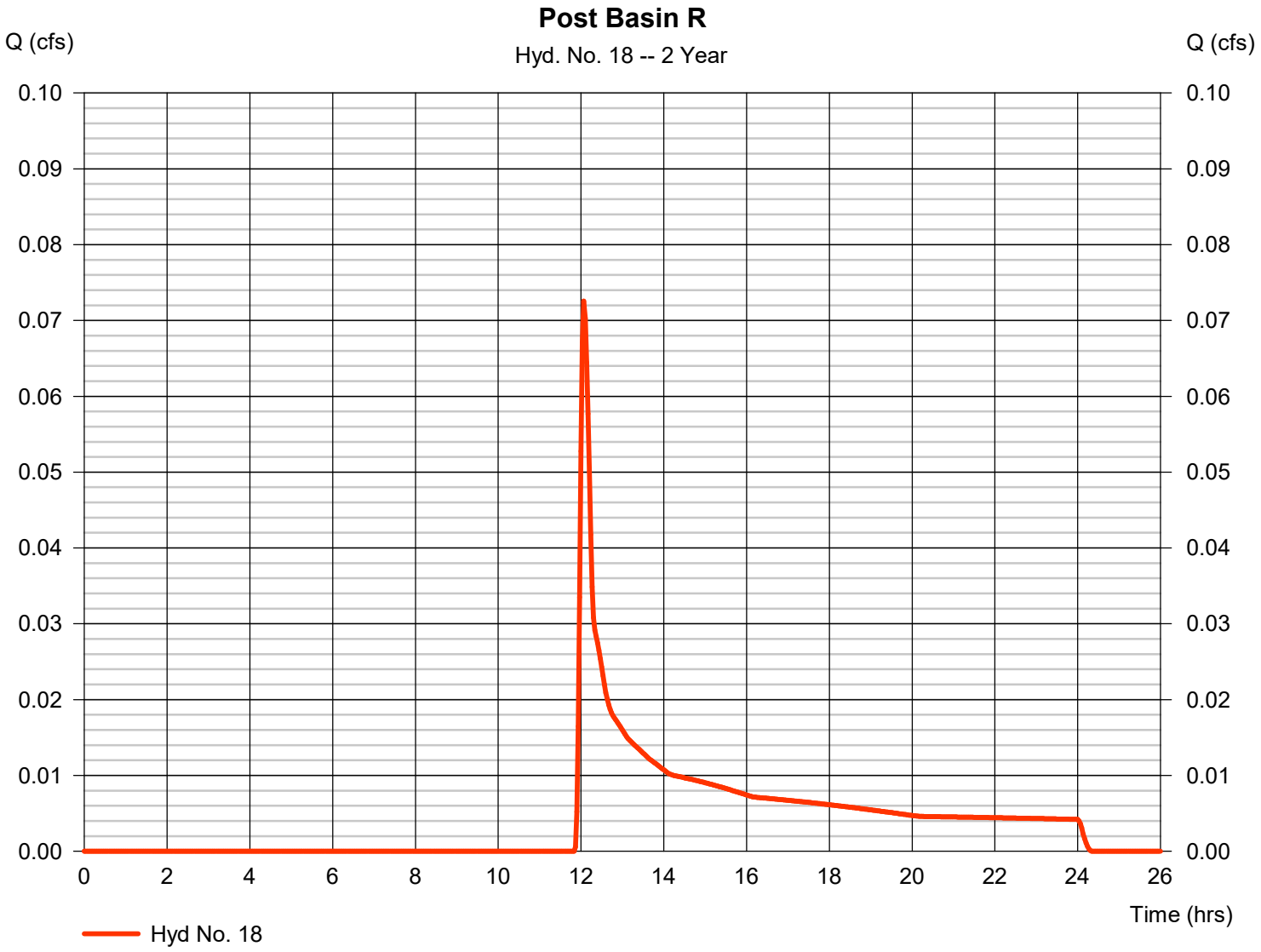
# Hydrograph Report



## Hyd. No. 18

Post Basin R

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.073 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 389 cuft |
| Drainage area | = | 0.970 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.90 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 18

Post Basin R

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 30.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.18** | **+** | **0.00** | **+** | **0.00** | **=** | **6.18** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.18 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 4.25 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.40 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.41 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})482.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 5.69** | **+** | **0.00** | **+** | **0.00** | **=** | **5.69** |

**Total Travel Time, Tc ..... 11.90 min**

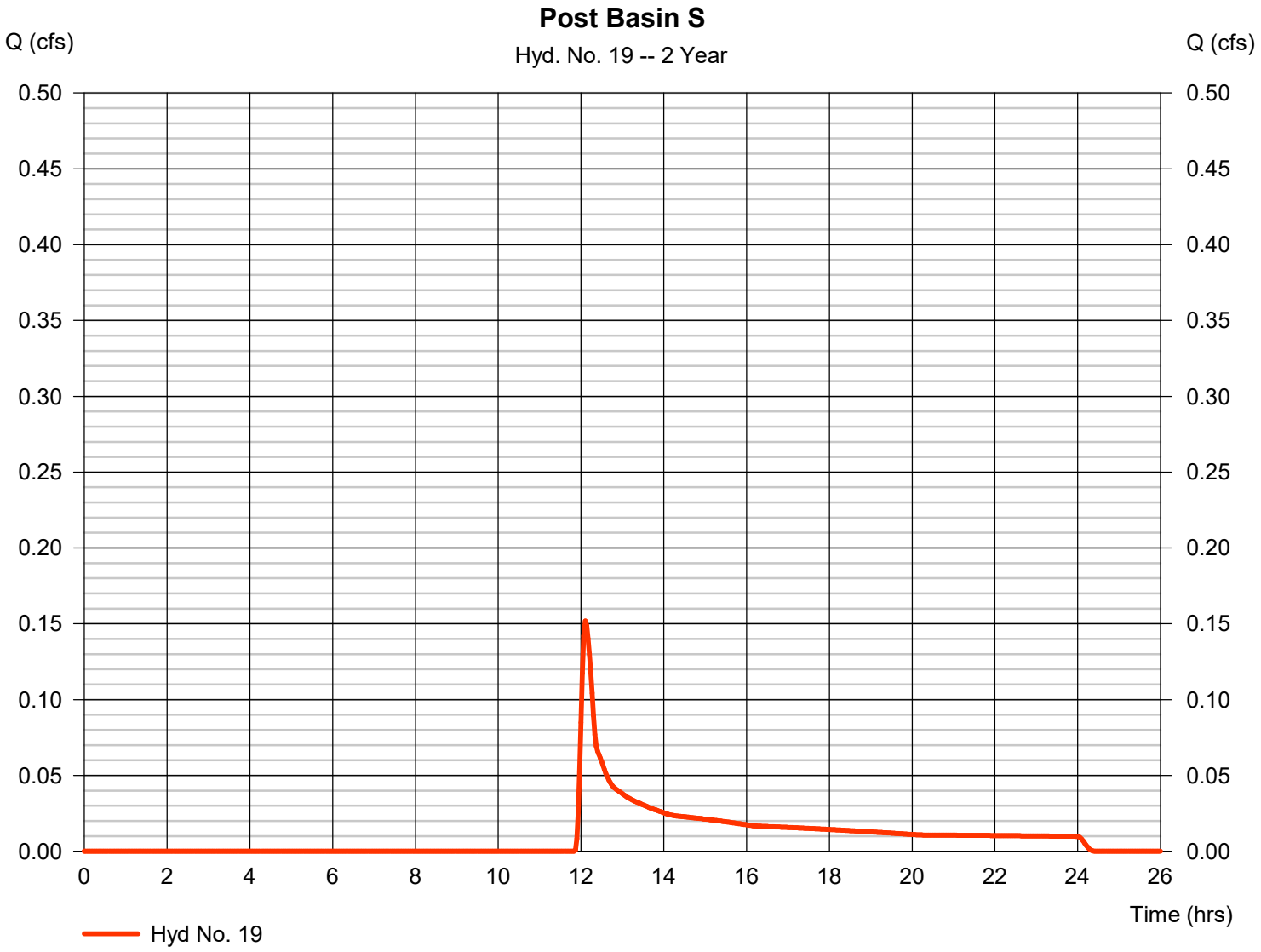
# Hydrograph Report



## Hyd. No. 19

Post Basin S

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.152 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 907 cuft |
| Drainage area | = | 2.393 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.80 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 19

Post Basin S

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 15.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 3.55** | **+** | **0.00** | **+** | **0.00** | **=** | **3.55** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.32 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.64 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.61 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.13 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})690.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 10.20** | **+** | **0.00** | **+** | **0.00** | **=** | **10.20** |

**Total Travel Time, Tc ..... 13.80 min**

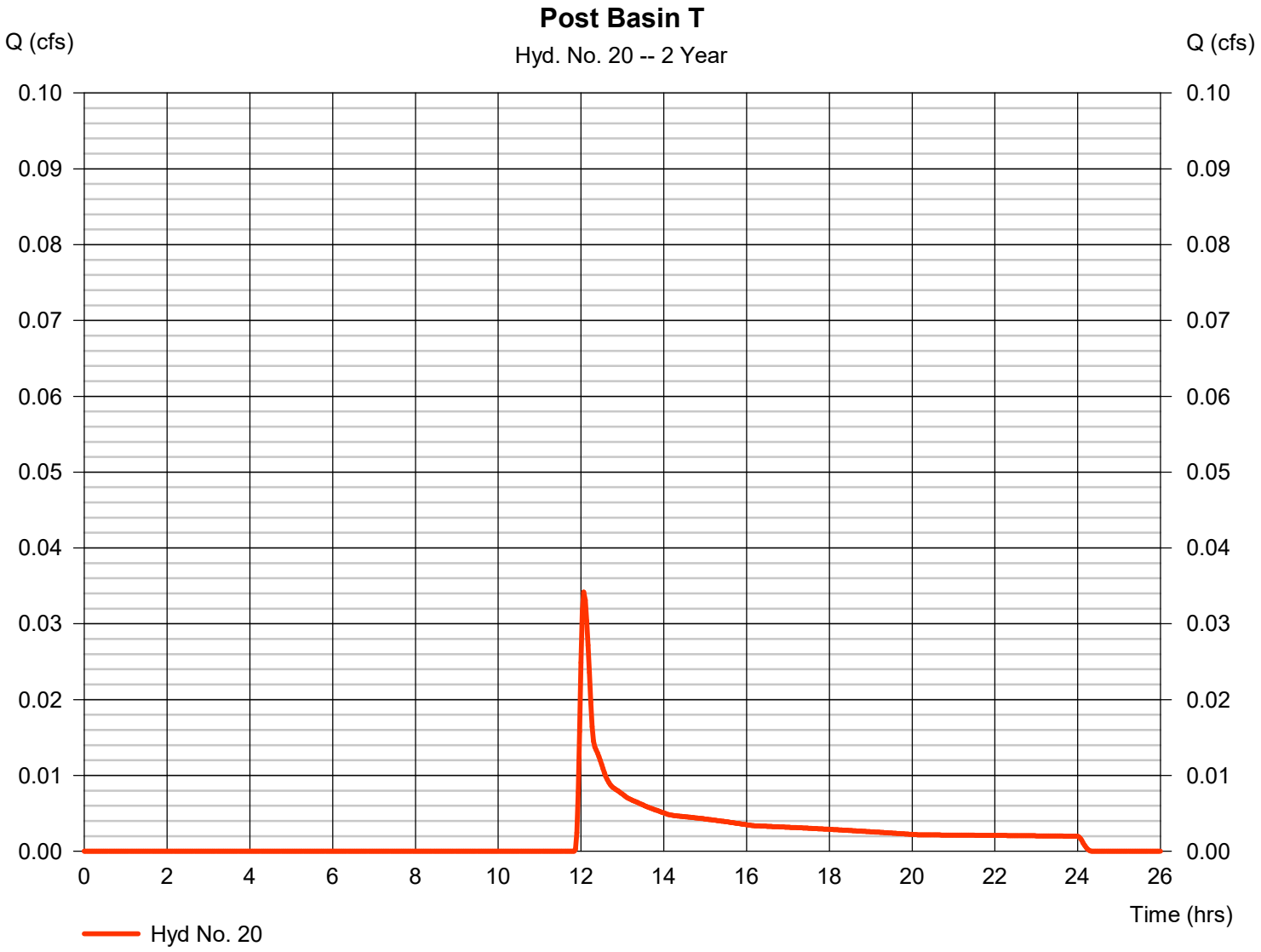
# Hydrograph Report



## Hyd. No. 20

Post Basin T

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.034 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 183 cuft |
| Drainage area | = | 0.457 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 12.30 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 20

Post Basin T

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 33.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 1.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 8.81** | **+** | **0.00** | **+** | **0.00** | **=** | **8.81** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.15 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.89 | | 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) | =0.80 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})169.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 3.54** | **+** | **0.00** | **+** | **0.00** | **=** | **3.54** |

**Total Travel Time, Tc ..... 12.30 min**

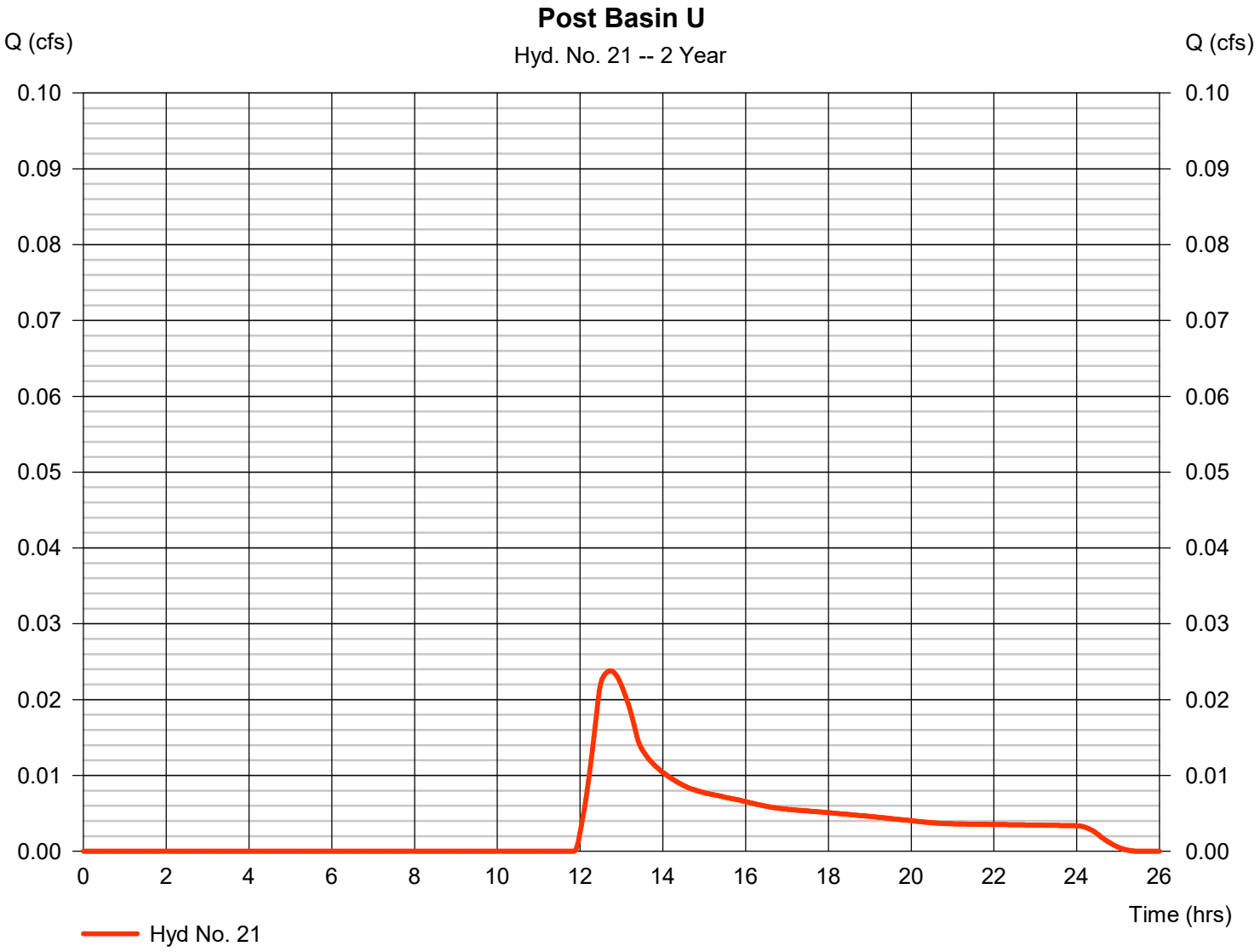
# Hydrograph Report



## Hyd. No. 21

Post Basin U

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.024 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.73 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 307 cuft |
| Drainage area | = | 0.795 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 54.70 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 21

Post Basin U

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 224.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 0.50 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 53.78** | **+** | **0.00** | **+** | **0.00** | **=** | **53.78** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.11 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.26 | | 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) | =0.71 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})40.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 0.94** | **+** | **0.00** | **+** | **0.00** | **=** | **0.94** |

**Total Travel Time, Tc ..... 54.70 min**

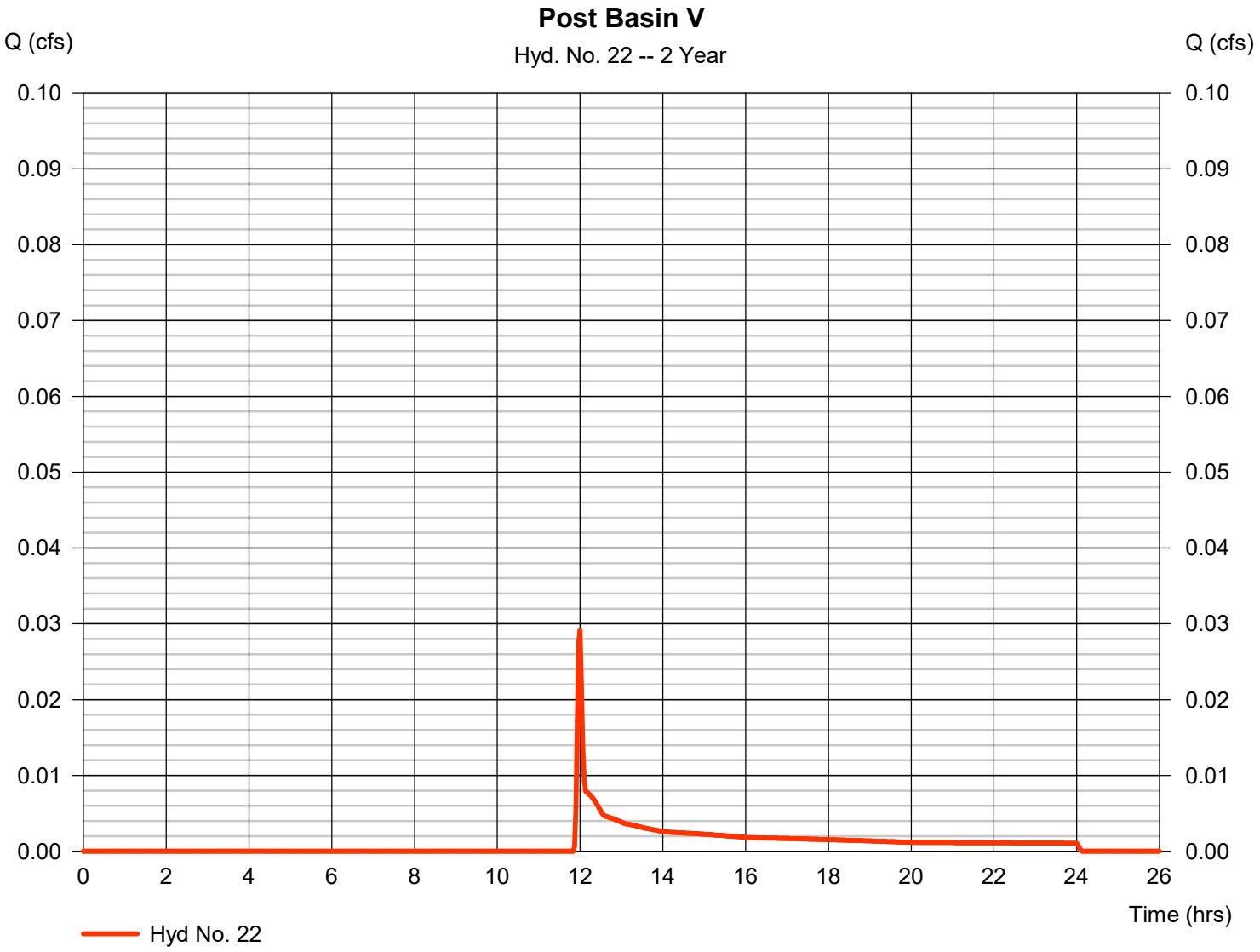
# Hydrograph Report



## Hyd. No. 22

Post Basin V

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.029 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 98 cuft |
| Drainage area | = | 0.269 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | User | Time of conc. (Tc) | = | 5.00 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



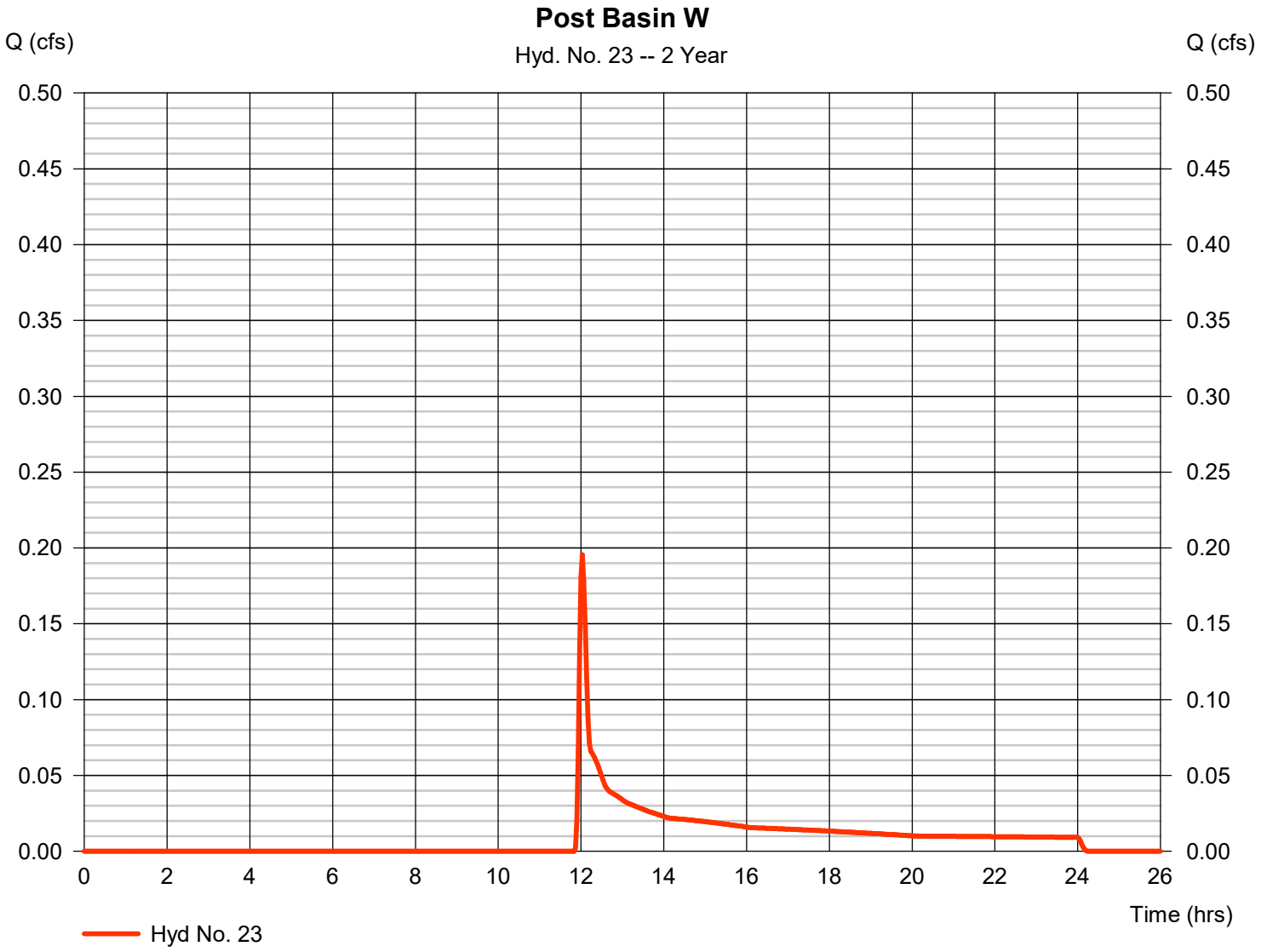
# Hydrograph Report



## Hyd. No. 23

Post Basin W

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.196 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 846 cuft |
| Drainage area | = | 2.177 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.50 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 23

Post Basin W

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 18.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 4.11** | **+** | **0.00** | **+** | **0.00** | **=** | **4.11** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.32 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.69 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =2.05 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})537.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 4.36** | **+** | **0.00** | **+** | **0.00** | **=** | **4.36** |

**Total Travel Time, Tc ..... 8.50 min**

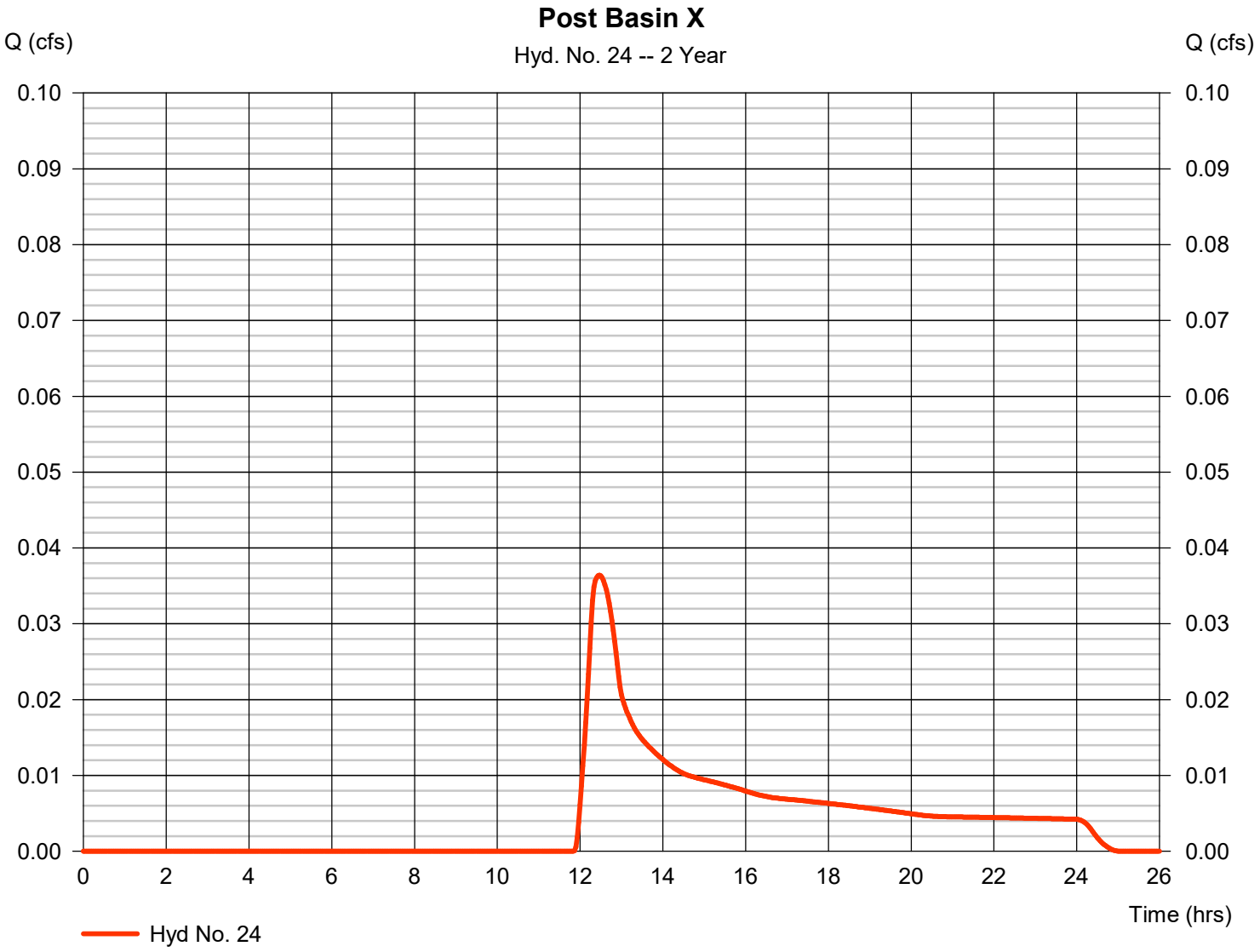
# Hydrograph Report



## Hyd. No. 24

Post Basin X

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.036 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.47 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 387 cuft |
| Drainage area | = | 0.997 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 39.50 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 24

Post Basin X

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 147.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 0.50 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 38.40** | **+** | **0.00** | **+** | **0.00** | **=** | **38.40** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.12 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.05 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.90 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.09 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})74.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 1.13** | **+** | **0.00** | **+** | **0.00** | **=** | **1.13** |

**Total Travel Time, Tc ..... 39.50 min**

# Hydrograph Report

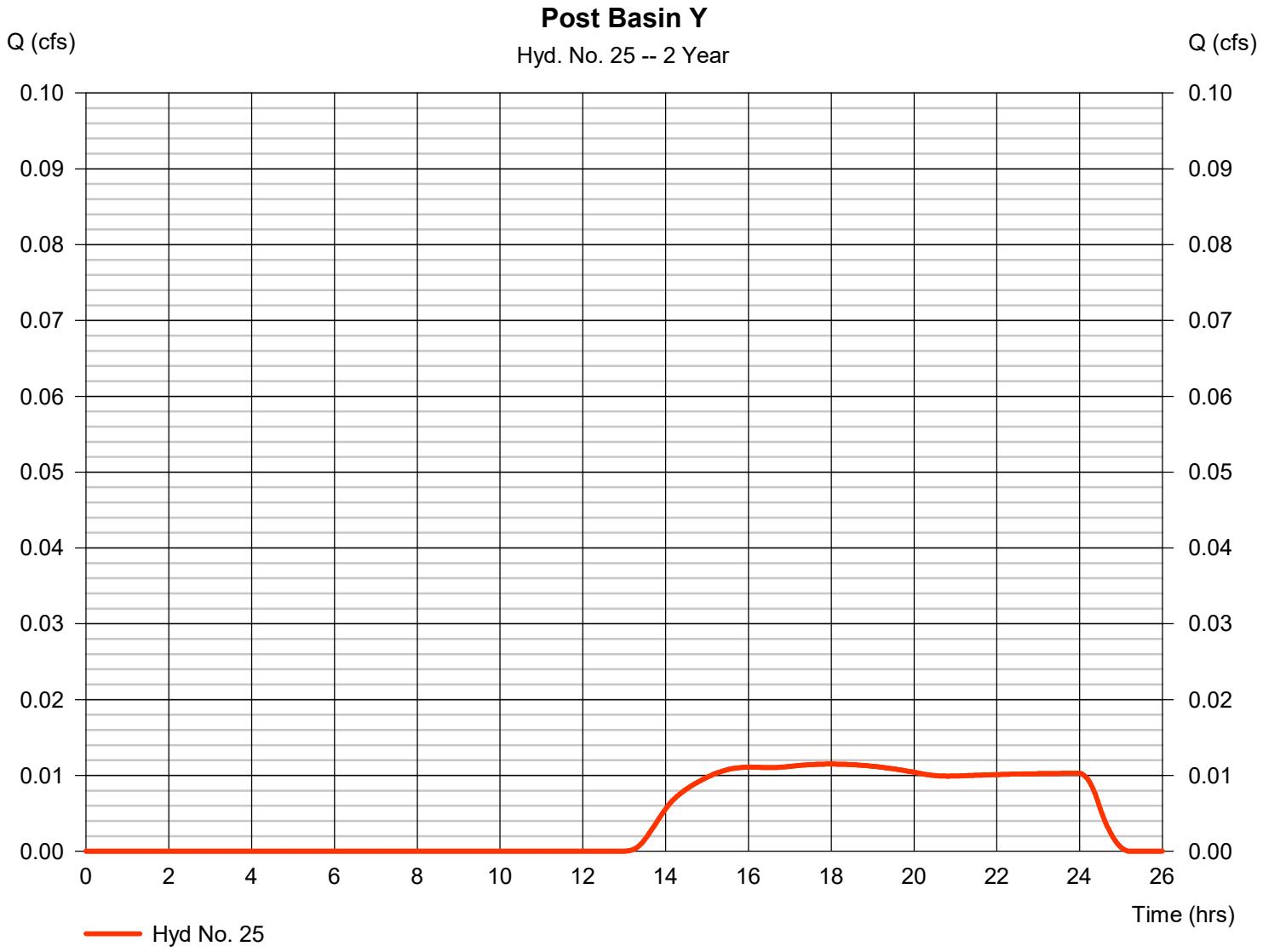


## Hyd. No. 25

Post Basin Y

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.011 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 18.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 402 cuft |
| Drainage area | = | 7.220 ac | Curve number | = | 69* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 44.60 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.896 x 61) + (3.323 x 78)] / 7.220



# TR55 Tc Worksheet



## Hyd. No. 25

Post Basin Y

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 270.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 3.50 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 28.67** | **+** | **0.00** | **+** | **0.00** | **=** | **28.67** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 63.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.60 | | 0.00 | | 0.00 | | |
| Surface description | = Unpaved | | Paved | | Paved | | |
| Average velocity (ft/s) | =1.25 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.84** | **+** | **0.00** | **+** | **0.00** | **=** | **0.84** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.11 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.39 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.29 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.16 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})1050.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 15.06** | **+** | **0.00** | **+** | **0.00** | **=** | **15.06** |

**Total Travel Time, Tc ..... 44.60 min**

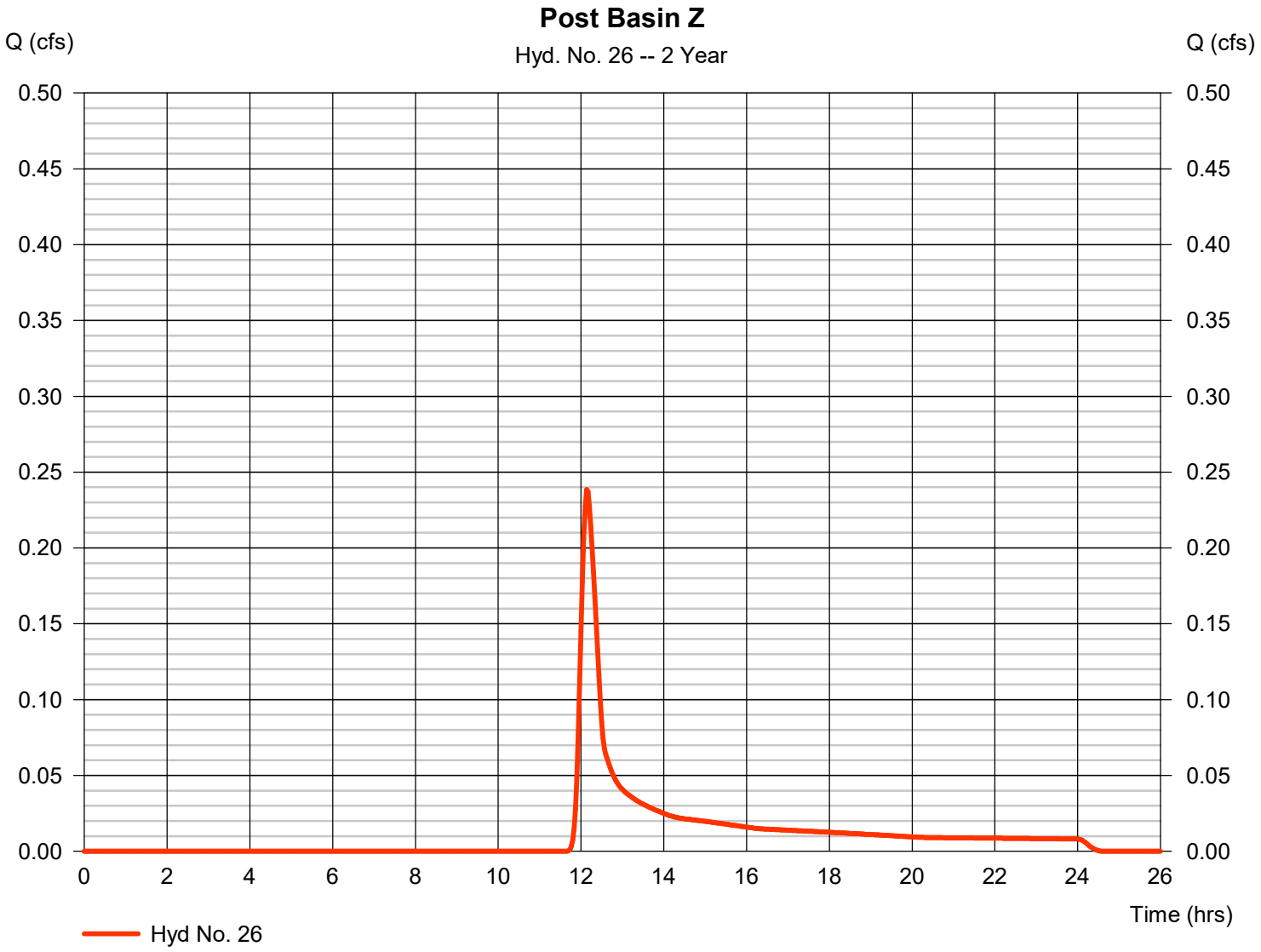
# Hydrograph Report



## Hyd. No. 26

Post Basin Z

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.238 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.13 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,033 cuft |
| Drainage area | = | 1.210 ac | Curve number | = | 84 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 21.00 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 26

Post Basin Z

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 18.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 4.11** | **+** | **0.00** | **+** | **0.00** | **=** | **4.11** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.30 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.48 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.10 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.48 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})1501.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 16.85** | **+** | **0.00** | **+** | **0.00** | **=** | **16.85** |

**Total Travel Time, Tc ..... 21.00 min**

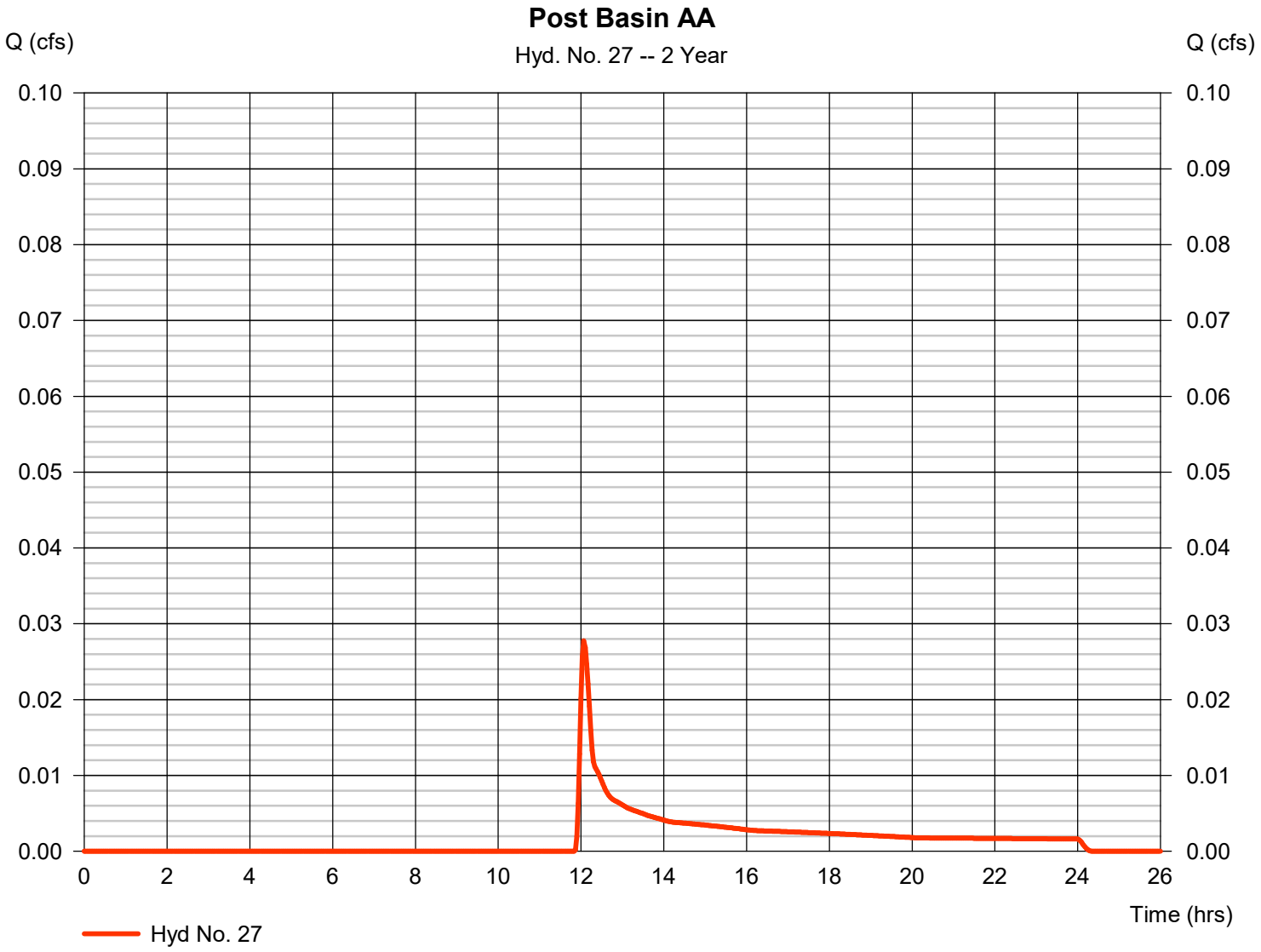
# Hydrograph Report



## Hyd. No. 27

Post Basin AA

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.028 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 149 cuft |
| Drainage area | = | 0.371 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.30 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 27

Post Basin AA

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 33.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 6.67** | **+** | **0.00** | **+** | **0.00** | **=** | **6.67** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.12 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 3.48 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 0.60 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =0.81 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})324.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 6.66** | **+** | **0.00** | **+** | **0.00** | **=** | **6.66** |

**Total Travel Time, Tc ..... 13.30 min**

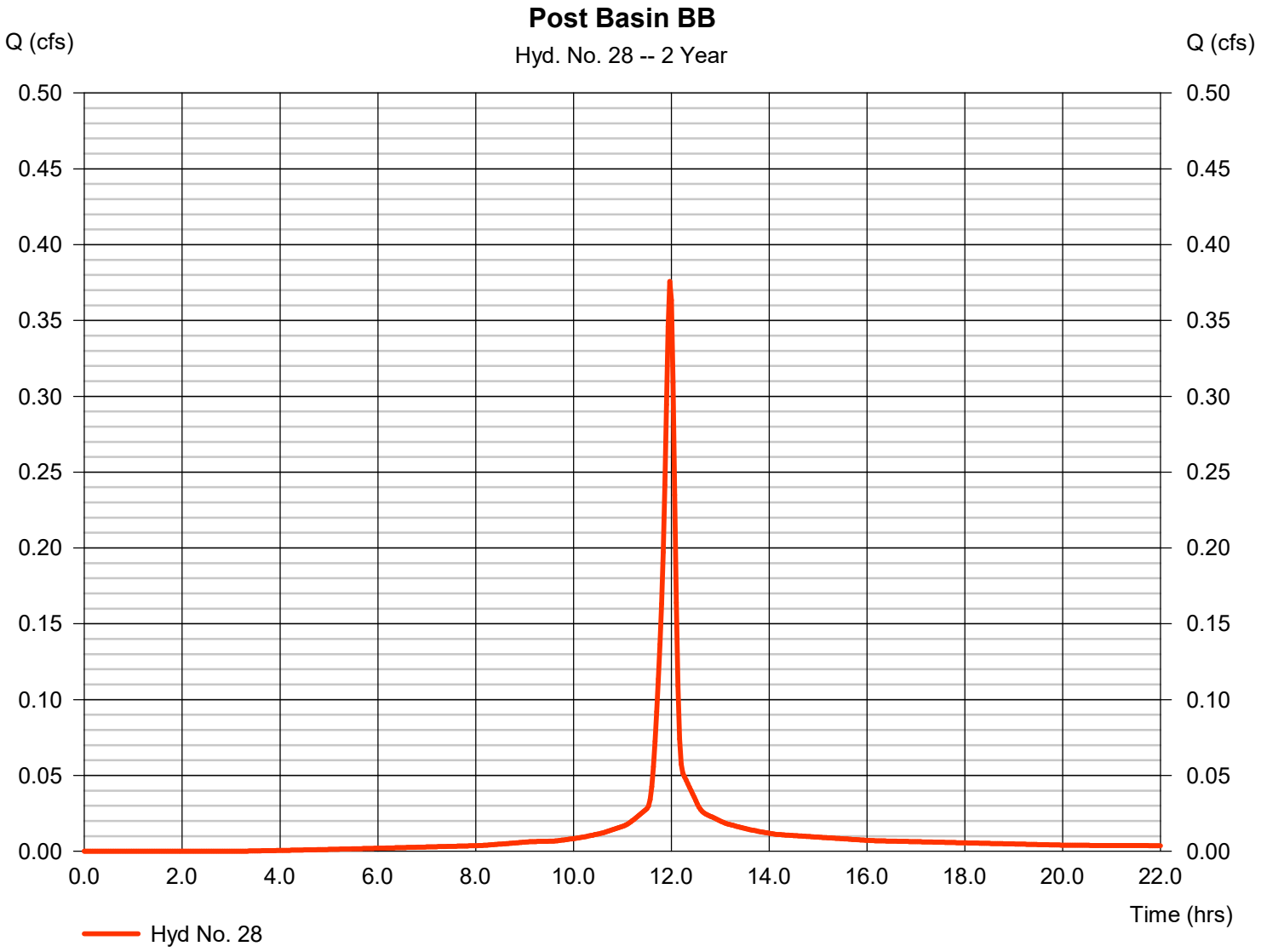
# Hydrograph Report



## Hyd. No. 28

Post Basin BB

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.376 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 920 cuft |
| Drainage area | = | 0.265 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 7.10 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 28

Post Basin BB

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.013 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 20.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.63** | **+** | **0.00** | **+** | **0.00** | **=** | **0.63** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.26 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.07 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.30 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.53 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})595.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 6.47** | **+** | **0.00** | **+** | **0.00** | **=** | **6.47** |

**Total Travel Time, Tc ..... 7.10 min**

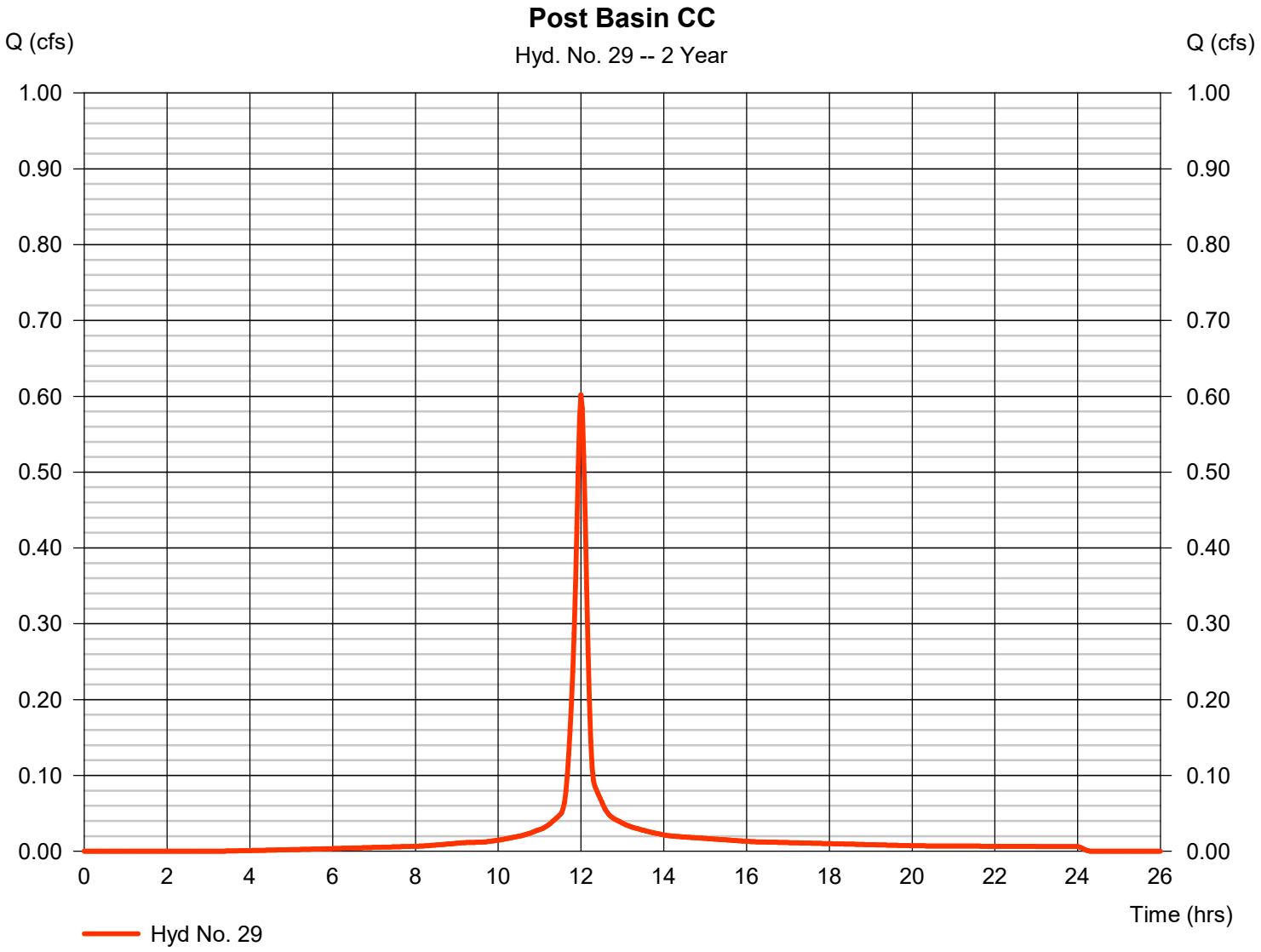
# Hydrograph Report



## Hyd. No. 29

Post Basin CC

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.602 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,654 cuft |
| Drainage area | = | 0.462 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.60 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# TR55 Tc Worksheet



## Hyd. No. 29

Post Basin CC

| Description | A | | B | | C | | Totals |
|---|---|---|---|---|---|---|---|
| **Sheet Flow** | | | | | | | |
| Manning's n-value | = 0.150 | | 0.011 | | 0.011 | | |
| Flow length (ft) | = 10.0 | | 0.0 | | 0.0 | | |
| Two-year 24-hr precip. (in) | = 1.17 | | 1.17 | | 1.17 | | |
| Land slope (%) | = 2.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 2.57** | **+** | **0.00** | **+** | **0.00** | **=** | **2.57** |
| **Shallow Concentrated Flow** | | | | | | | |
| Flow length (ft) | = 0.00 | | 0.00 | | 0.00 | | |
| Watercourse slope (%) | = 0.00 | | 0.00 | | 0.00 | | |
| Surface description | = Paved | | Paved | | Paved | | |
| Average velocity (ft/s) | =0.00 | | 0.00 | | 0.00 | | |
| **Travel Time (min)** | **= 0.00** | **+** | **0.00** | **+** | **0.00** | **=** | **0.00** |
| **Channel Flow** | | | | | | | |
| X sectional flow area (sqft) | = 0.33 | | 0.00 | | 0.00 | | |
| Wetted perimeter (ft) | = 5.79 | | 0.00 | | 0.00 | | |
| Channel slope (%) | = 1.66 | | 0.00 | | 0.00 | | |
| Manning's n-value | = 0.015 | | 0.015 | | 0.015 | | |
| Velocity (ft/s) | =1.89 | | | | | | |
| | | | 0.00 | | | | |
| | | | | | 0.00 | | |
| Flow length (ft) | ({0})1023.0 | | 0.0 | | 0.0 | | |
| **Travel Time (min)** | **= 9.02** | **+** | **0.00** | **+** | **0.00** | **=** | **9.02** |

**Total Travel Time, Tc ..... 11.60 min**

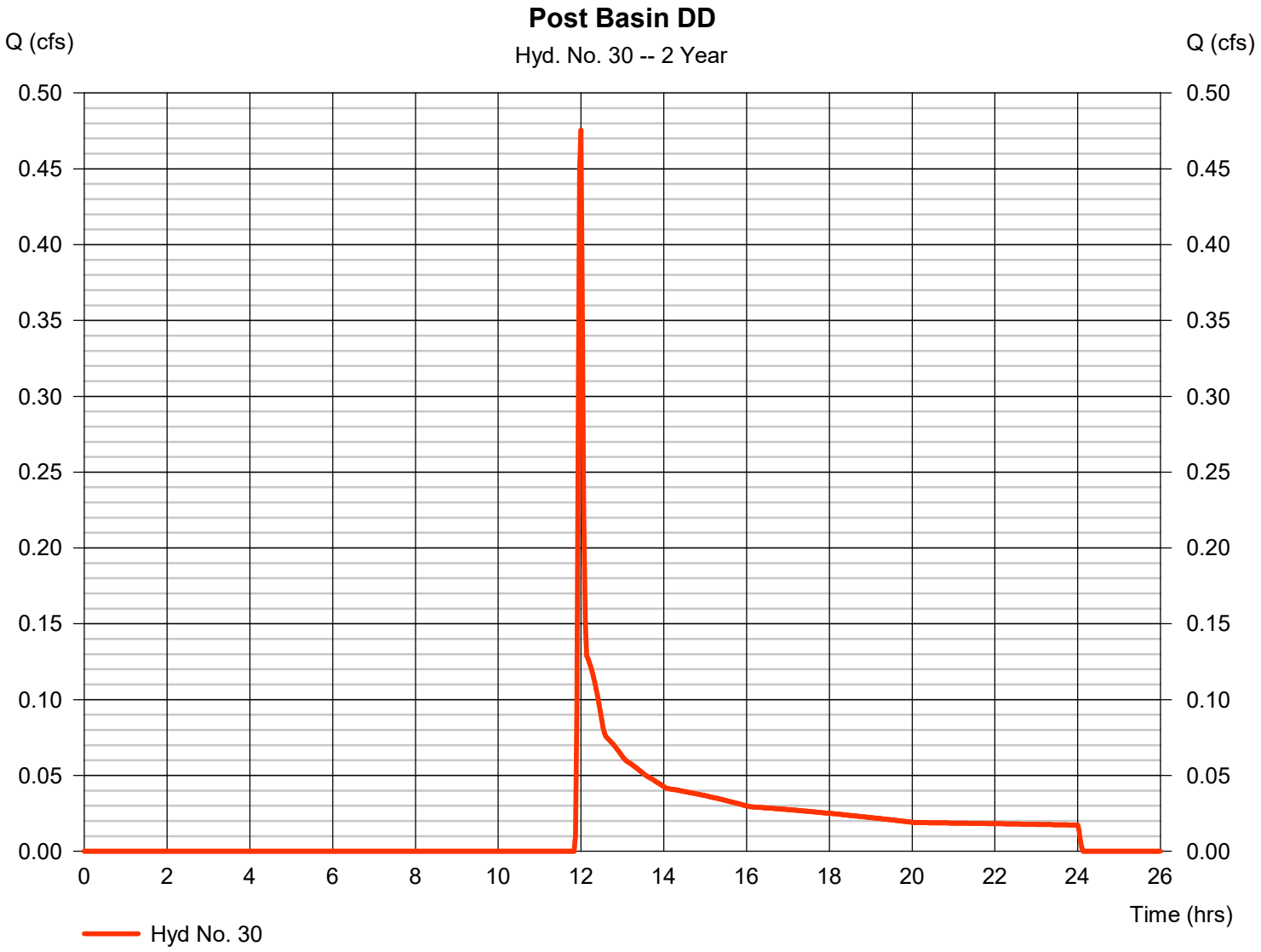
# Hydrograph Report



## Hyd. No. 30

Post Basin DD

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.475 cfs |
| Storm frequency | = | 2 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,599 cuft |
| Drainage area | = | 4.390 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | User | Time of conc. (Tc) | = | 5.00 min |
| Total precip. | = | 1.17 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024

| 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 | 2 | n/a | 0 | ------ | ------ | ------ | Basin B |
| 2 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin A |
| 3 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin C |
| 4 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin D |
| 5 | SCS Runoff | 0.048 | 2 | 758 | 867 | ------ | ------ | ------ | Post Basin E |
| 6 | SCS Runoff | 0.159 | 2 | 726 | 668 | ------ | ------ | ------ | Post Basin F |
| 7 | SCS Runoff | 0.092 | 2 | 720 | 240 | ------ | ------ | ------ | Post Basin G |
| 8 | SCS Runoff | 0.107 | 2 | 722 | 333 | ------ | ------ | ------ | Post Basin H |
| 9 | SCS Runoff | 0.190 | 2 | 734 | 1,002 | ------ | ------ | ------ | Post Basin I |
| 10 | SCS Runoff | 0.165 | 2 | 724 | 570 | ------ | ------ | ------ | Post Basin J |
| 11 | SCS Runoff | 0.563 | 2 | 724 | 1,937 | ------ | ------ | ------ | Post Basin K |
| 12 | SCS Runoff | 0.297 | 2 | 724 | 1,022 | ------ | ------ | ------ | Post Basin L |
| 13 | SCS Runoff | 0.033 | 2 | 776 | 865 | ------ | ------ | ------ | Post Basin M |
| 14 | SCS Runoff | 0.095 | 2 | 750 | 1,390 | ------ | ------ | ------ | Post Basin N |
| 15 | SCS Runoff | 0.408 | 2 | 718 | 887 | ------ | ------ | ------ | Post Basin O |
| 16 | SCS Runoff | 0.072 | 2 | 718 | 155 | ------ | ------ | ------ | Post Basin P |
| 17 | SCS Runoff | 0.320 | 2 | 736 | 1,845 | ------ | ------ | ------ | Post Basin Q |
| 18 | SCS Runoff | 0.358 | 2 | 722 | 1,113 | ------ | ------ | ------ | Post Basin R |
| 19 | SCS Runoff | 0.754 | 2 | 724 | 2,597 | ------ | ------ | ------ | Post Basin S |
| 20 | SCS Runoff | 0.169 | 2 | 722 | 525 | ------ | ------ | ------ | Post Basin T |
| 21 | SCS Runoff | 0.105 | 2 | 750 | 878 | ------ | ------ | ------ | Post Basin U |
| 22 | SCS Runoff | 0.129 | 2 | 718 | 281 | ------ | ------ | ------ | Post Basin V |
| 23 | SCS Runoff | 0.930 | 2 | 720 | 2,423 | ------ | ------ | ------ | Post Basin W |
| 24 | SCS Runoff | 0.171 | 2 | 740 | 1,110 | ------ | ------ | ------ | Post Basin X |
| 25 | SCS Runoff | 0.188 | 2 | 762 | 2,855 | ------ | ------ | ------ | Post Basin Y |
| 26 | SCS Runoff | 0.622 | 2 | 728 | 2,297 | ------ | ------ | ------ | Post Basin Z |
| 27 | SCS Runoff | 0.137 | 2 | 722 | 426 | ------ | ------ | ------ | Post Basin AA |
| 28 | SCS Runoff | 0.551 | 2 | 718 | 1,383 | ------ | ------ | ------ | Post Basin BB |
| 29 | SCS Runoff | 0.884 | 2 | 720 | 2,487 | ------ | ------ | ------ | Post Basin CC |
| 30 | SCS Runoff | 2.108 | 2 | 718 | 4,581 | ------ | ------ | ------ | Post Basin DD |
| 31 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Post Basin EE |

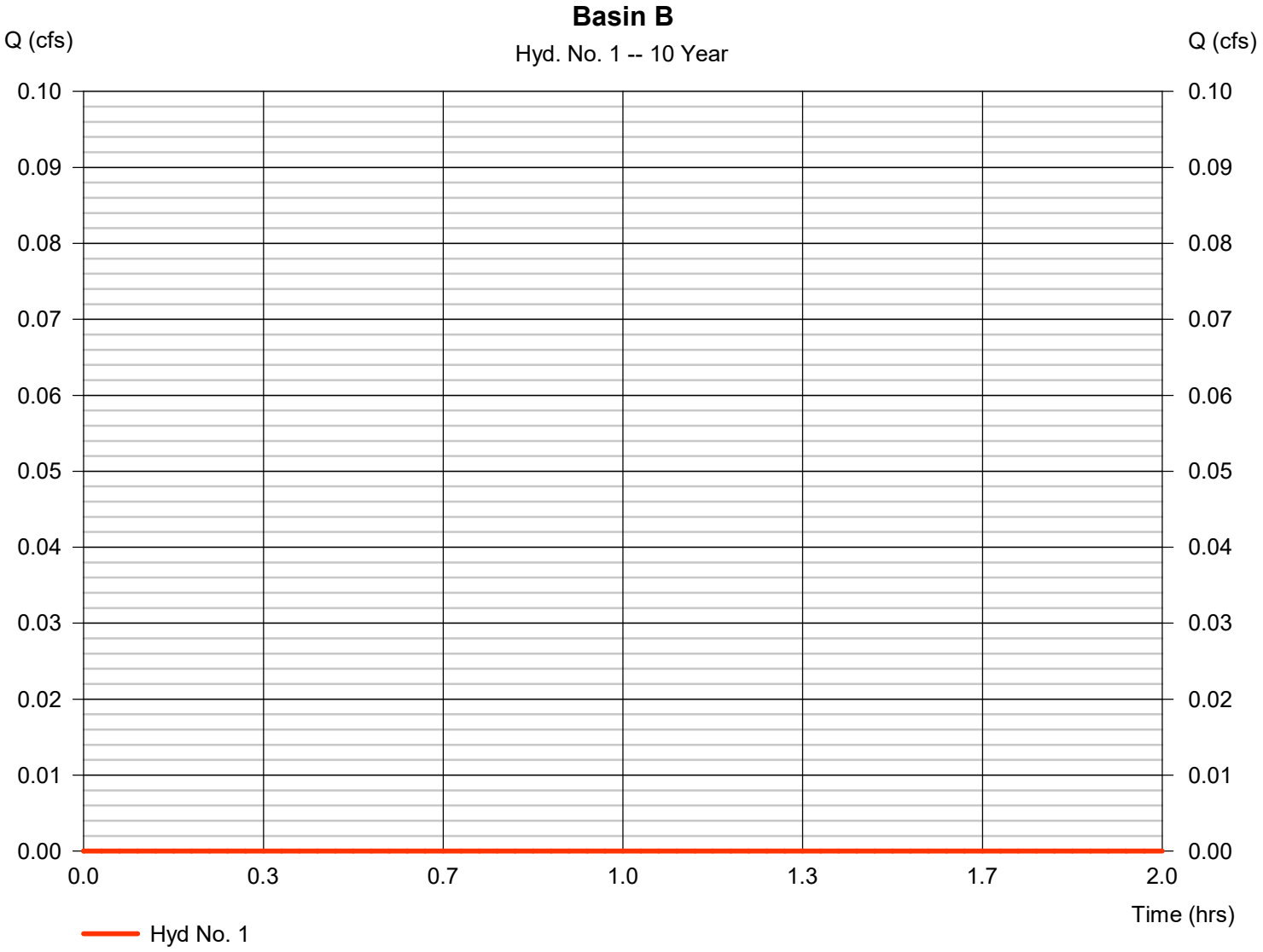
# Hydrograph Report



## Hyd. No. 1

Basin B

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 2.960 ac | Curve number | = 39 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 25.10 min |
| Total precip. | = 1.66 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



# Hydrograph Report

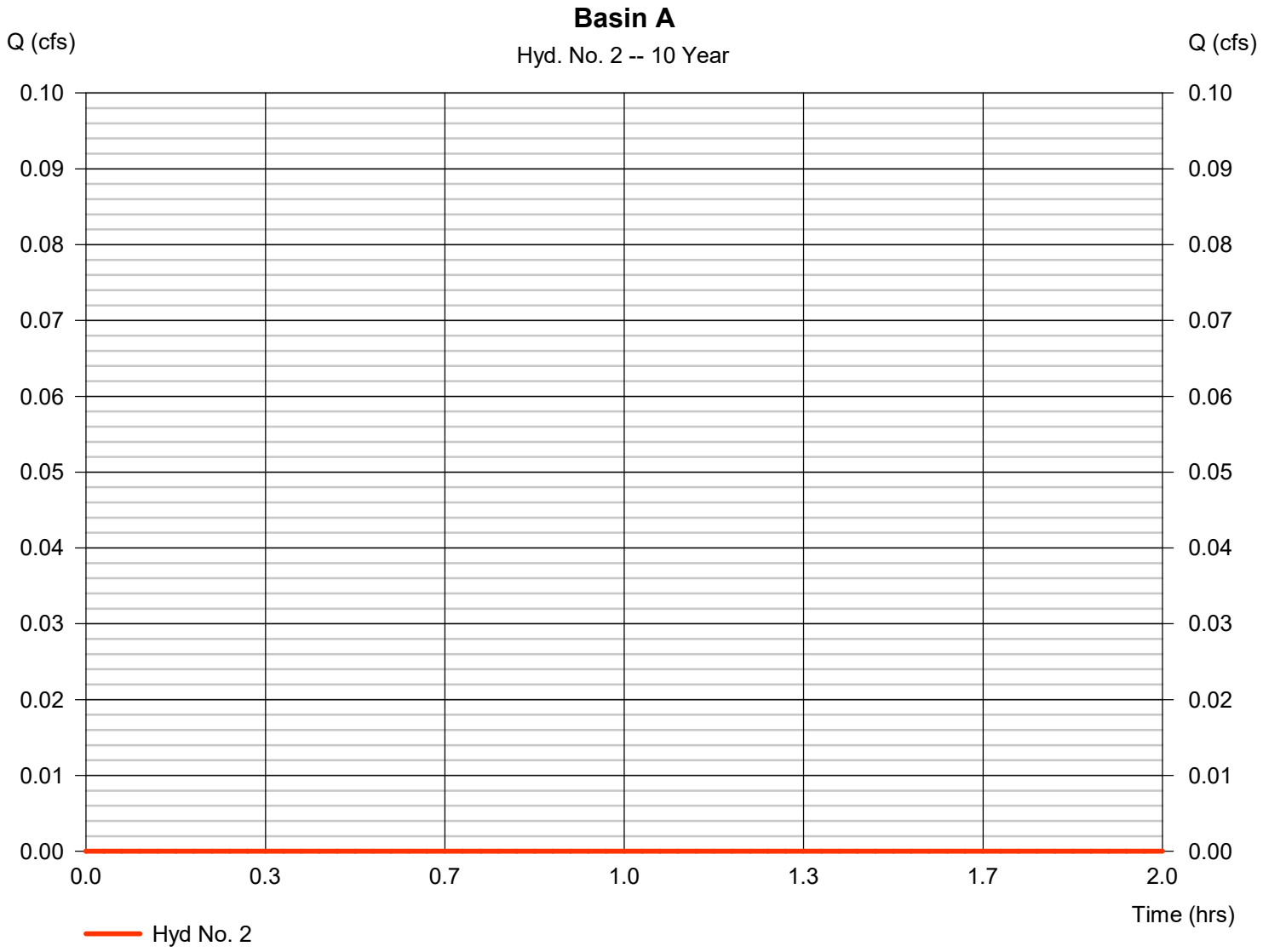


## Hyd. No. 2

Basin A

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 9.830 ac | Curve number | = 41* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 31.60 min |
| Total precip. | = 1.66 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(9.460 x 39) + (0.370 x 98)] / 9.830



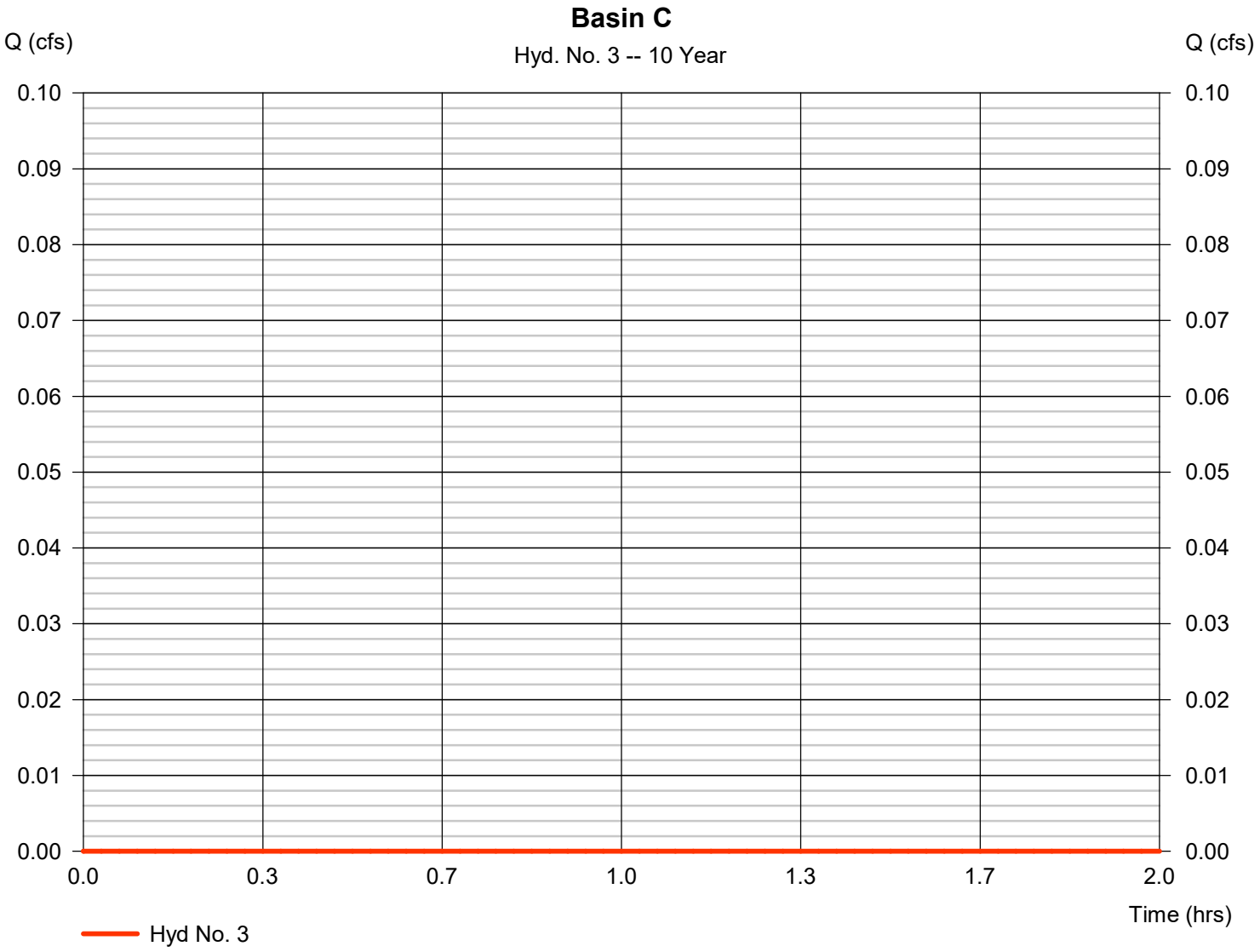
# Hydrograph Report



## Hyd. No. 3

Basin C

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 10 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 4.970 ac | Curve number | = 39 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 26.00 min |
| Total precip. | = 1.66 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



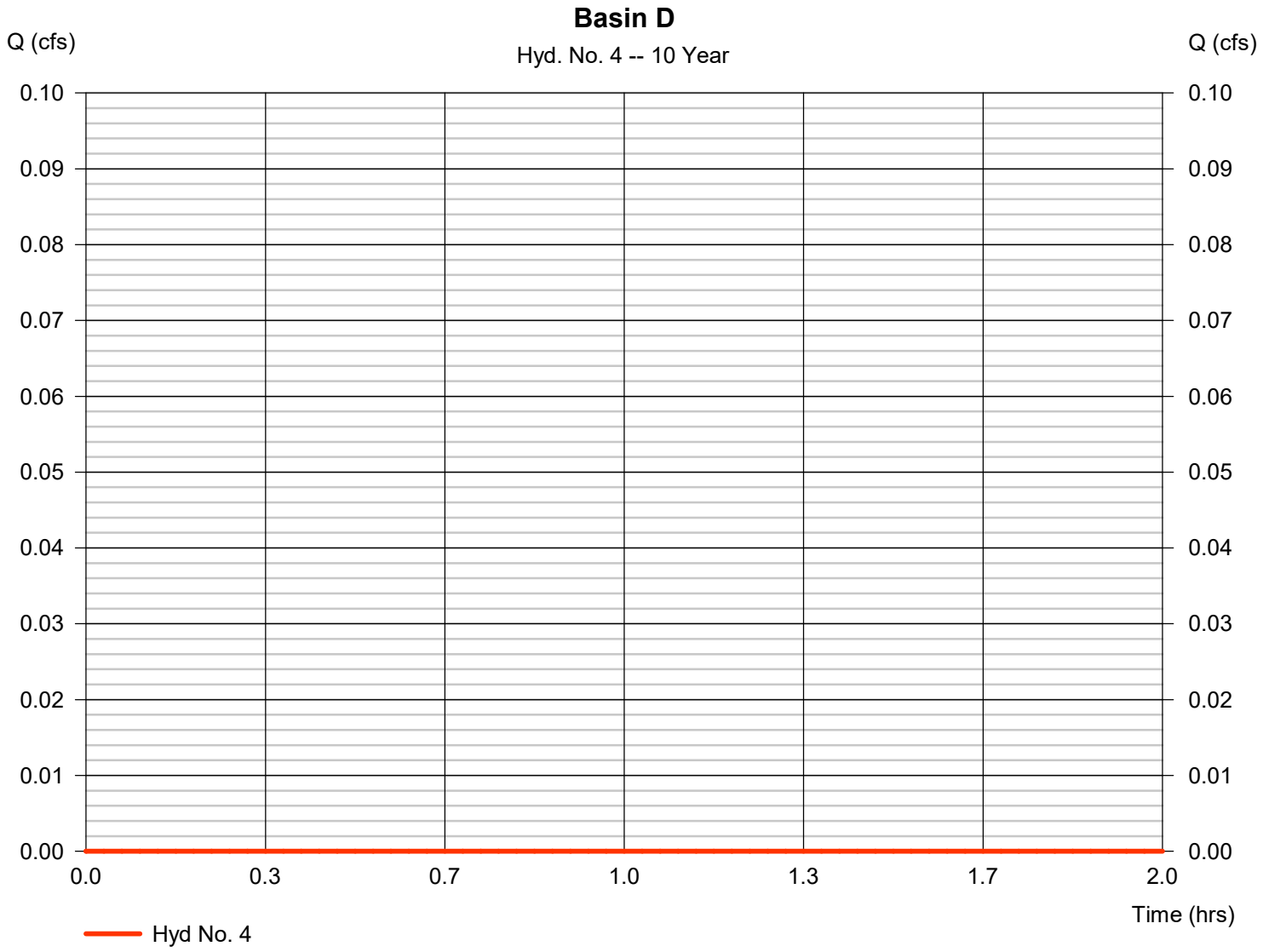
# Hydrograph Report



## Hyd. No. 4

Basin D

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | n/a |
| Time interval | = | 2 min | Hyd. volume | = | 0 cuft |
| Drainage area | = | 0.430 ac | Curve number | = | 39 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.00 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

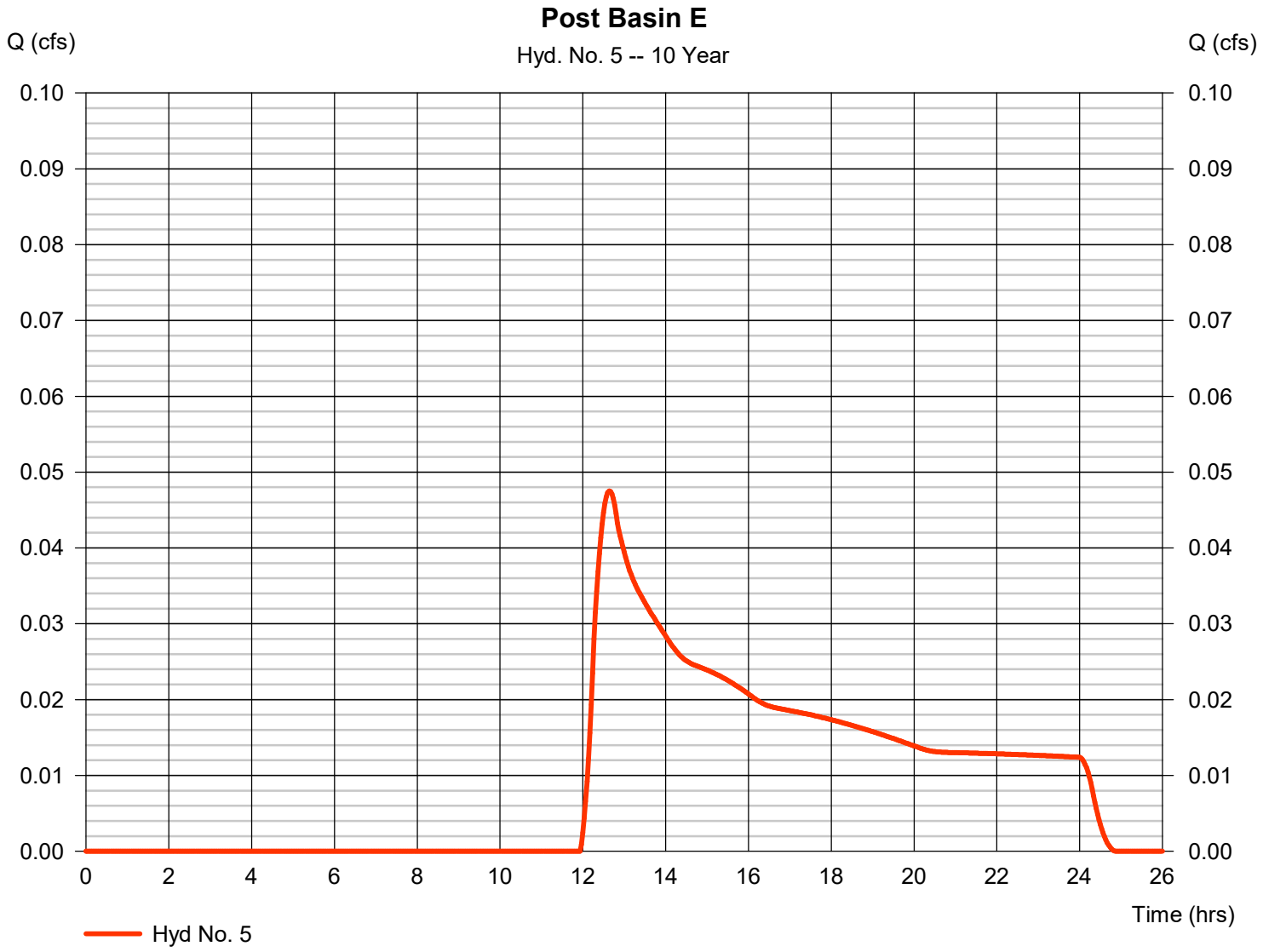


## Hyd. No. 5

Post Basin E

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.048 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.63 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 867 cuft |
| Drainage area | = | 2.910 ac | Curve number | = | 67* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.10 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(1.810 x 61) + (1.100 x 78)] / 2.910



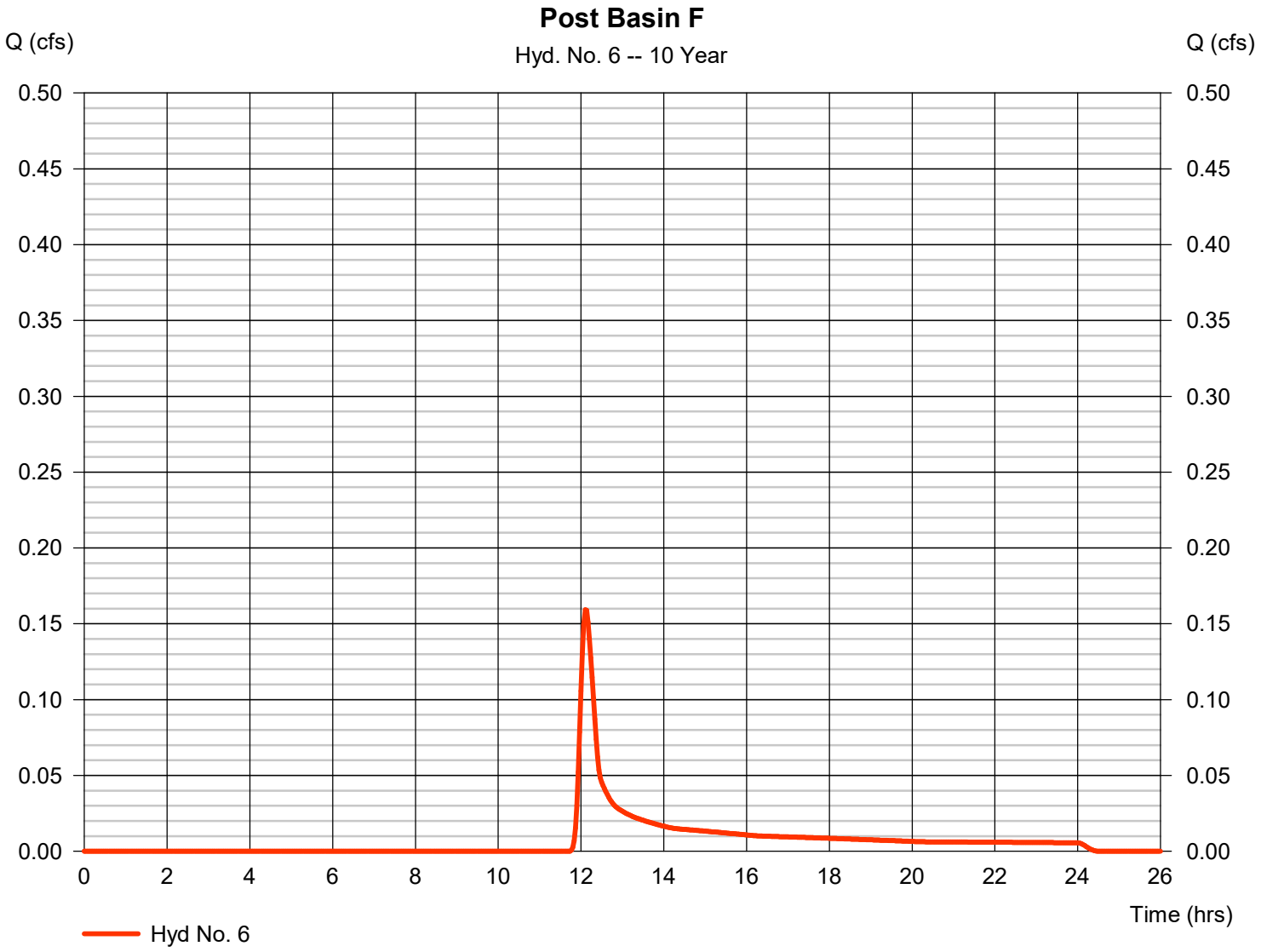
# Hydrograph Report



## Hyd. No. 6

Post Basin F

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.159 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 668 cuft |
| Drainage area | = | 0.660 ac | Curve number | = | 77 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 18.20 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



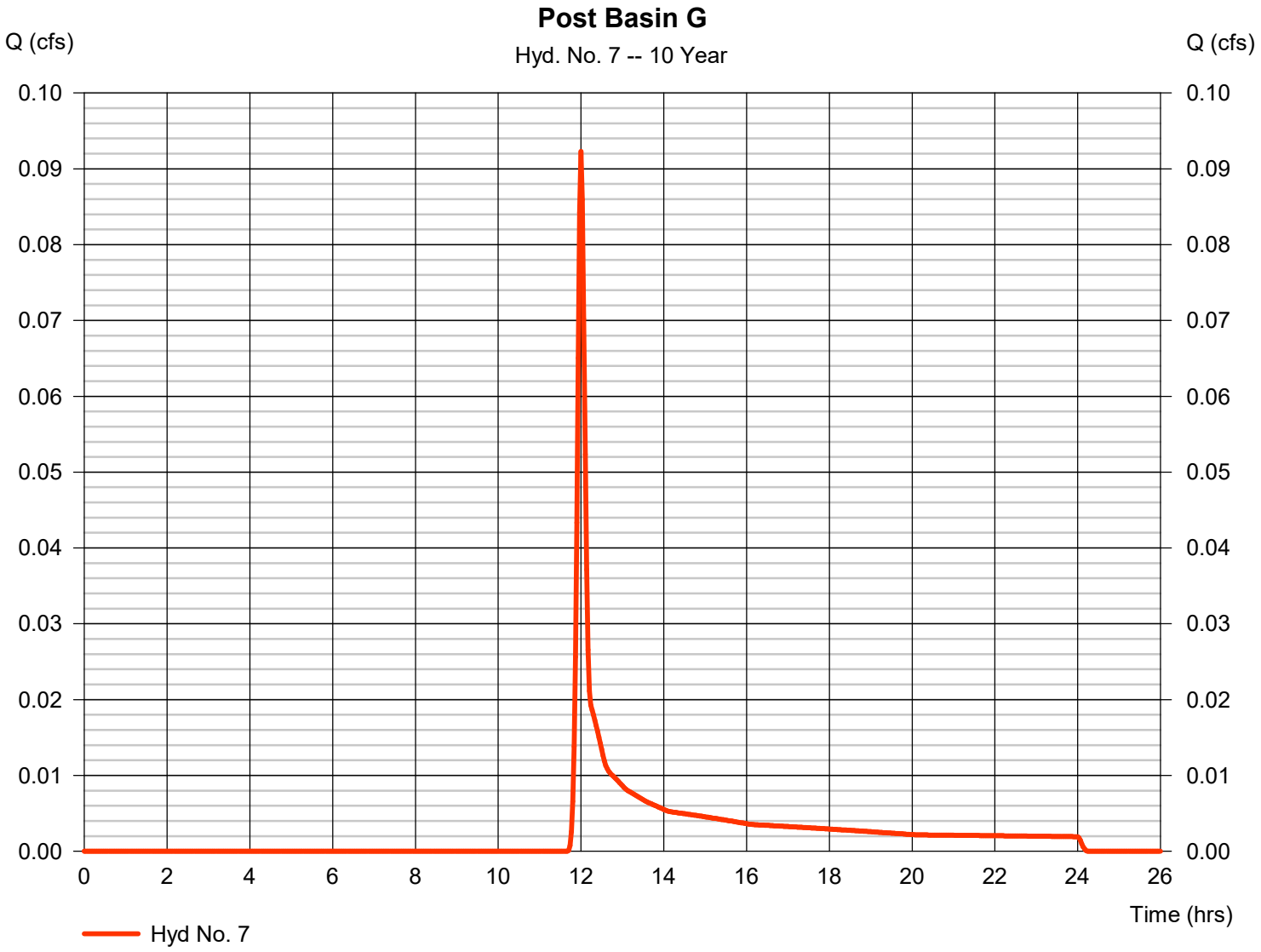
# Hydrograph Report



## Hyd. No. 7

Post Basin G

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.092 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 240 cuft |
| Drainage area | = | 0.216 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.30 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



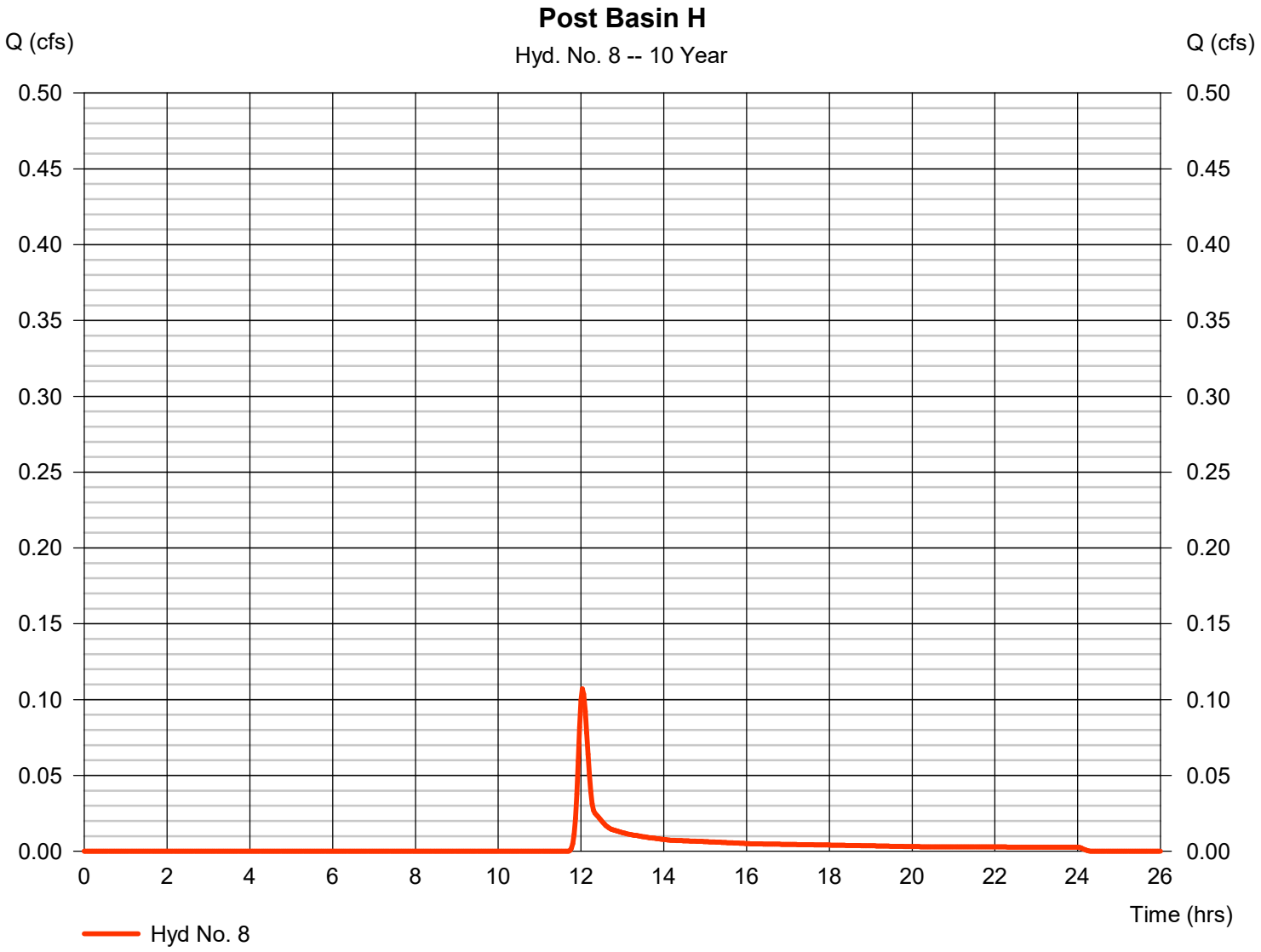
# Hydrograph Report



## Hyd. No. 8

Post Basin H

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.107 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 333 cuft |
| Drainage area | = | 0.290 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 10.60 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



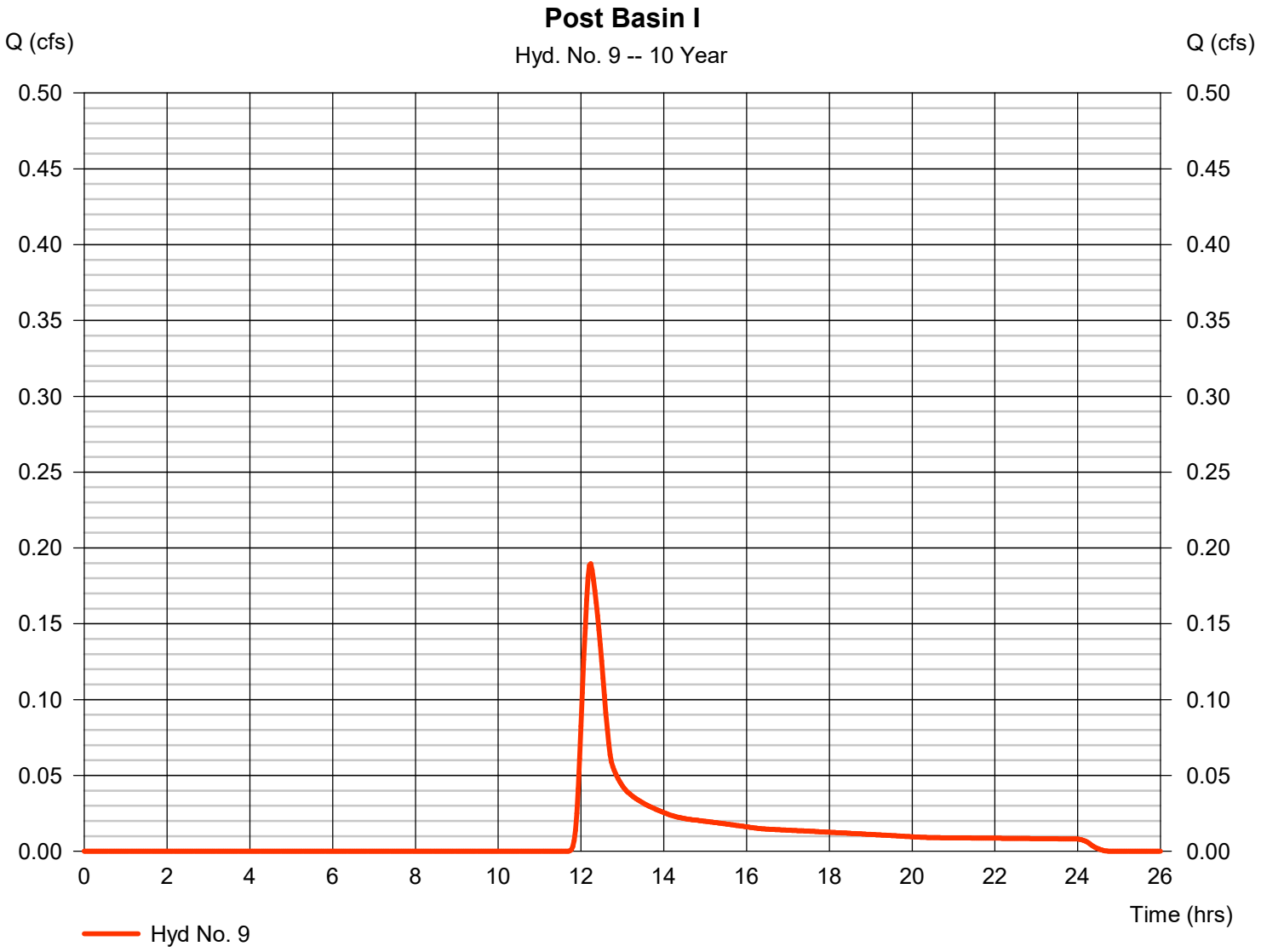
# Hydrograph Report



## Hyd. No. 9

Post Basin I

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.190 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.23 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,002 cuft |
| Drainage area | = | 0.900 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 29.00 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



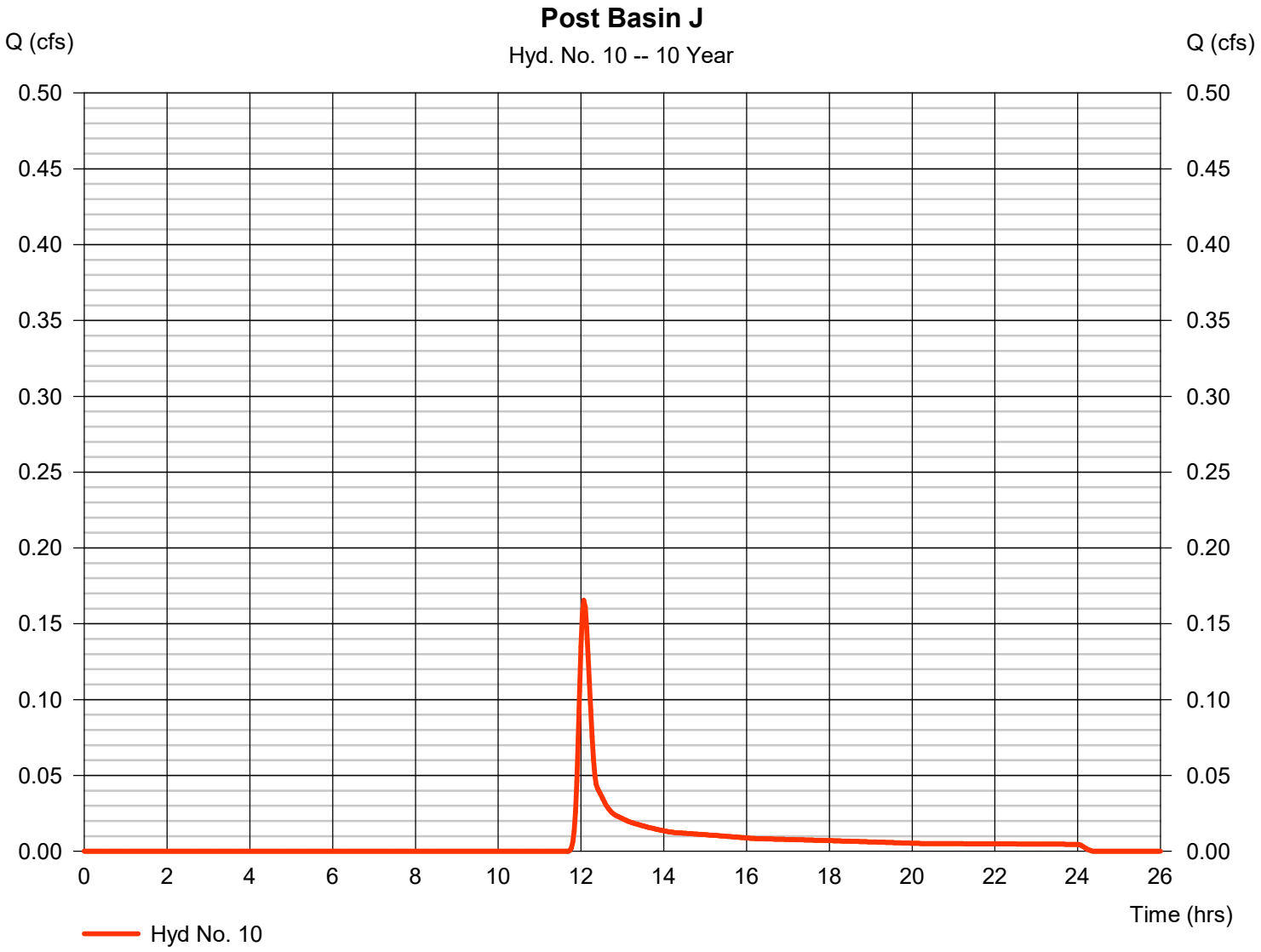
# Hydrograph Report



## Hyd. No. 10

Post Basin J

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.165 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 570 cuft |
| Drainage area | = | 0.525 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.80 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



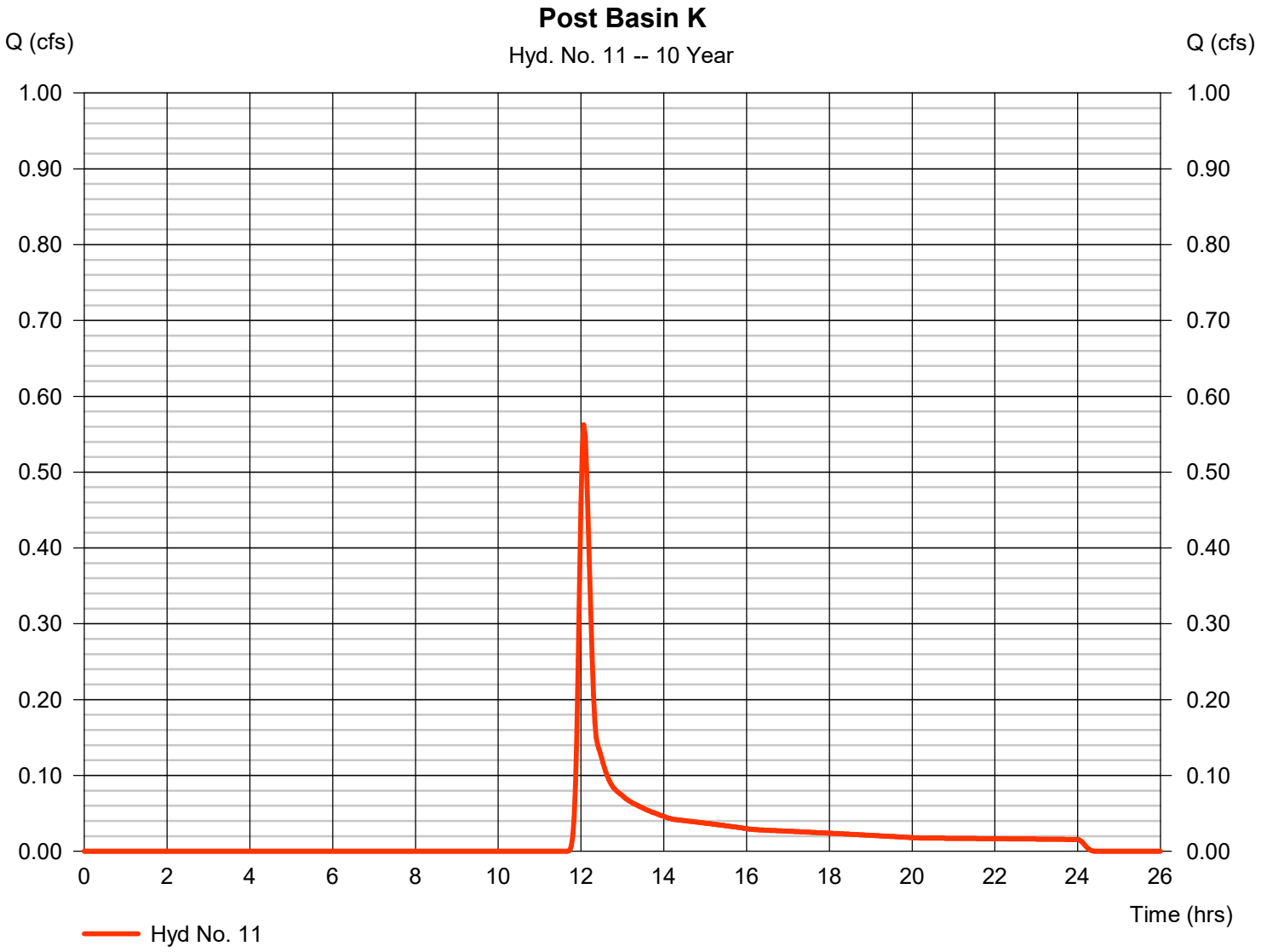
# Hydrograph Report



## Hyd. No. 11

Post Basin K

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.563 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,937 cuft |
| Drainage area | = | 1.785 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 15.60 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



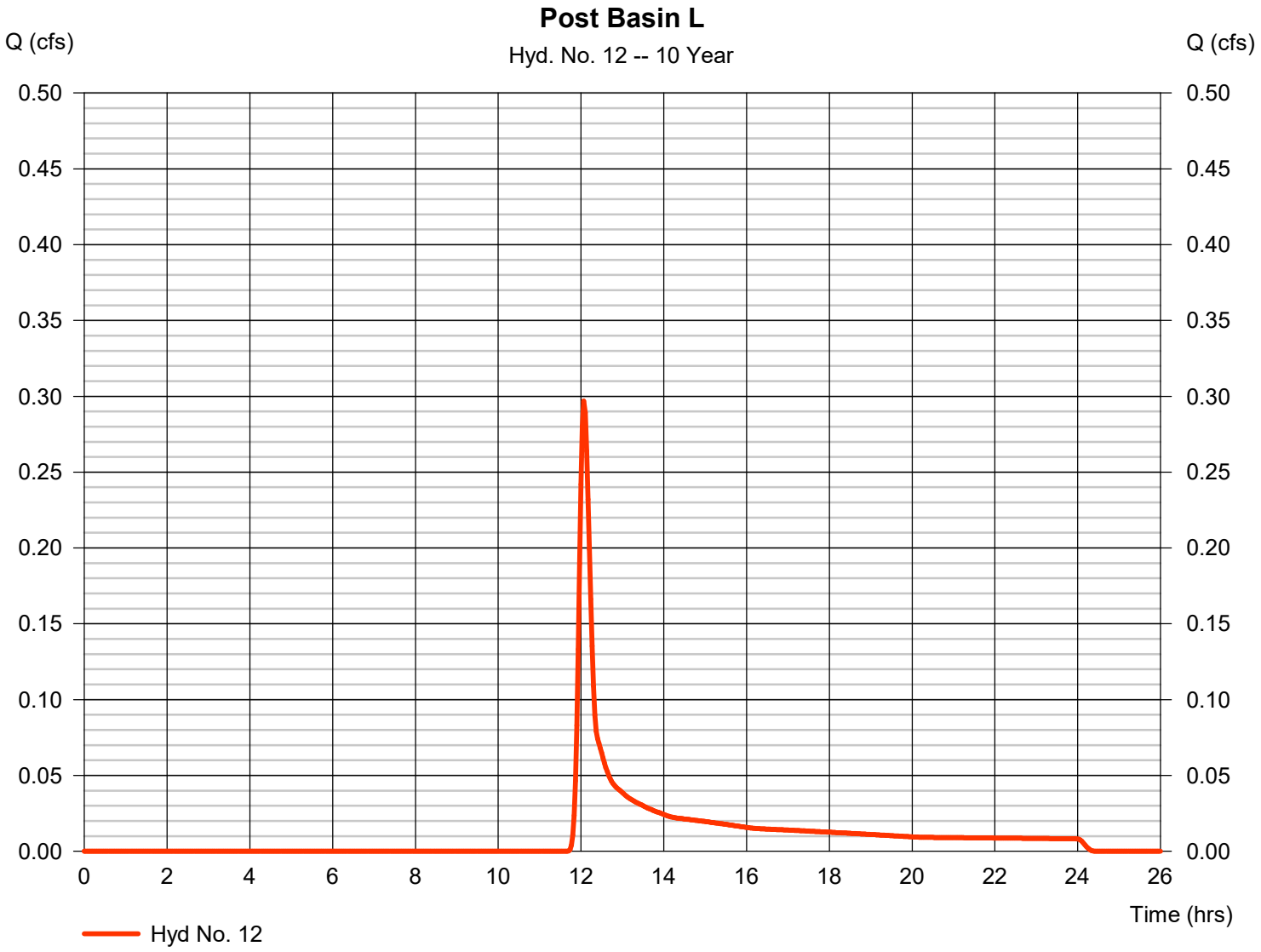
# Hydrograph Report



## Hyd. No. 12

Post Basin L

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.297 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,022 cuft |
| Drainage area | = | 0.942 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.10 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

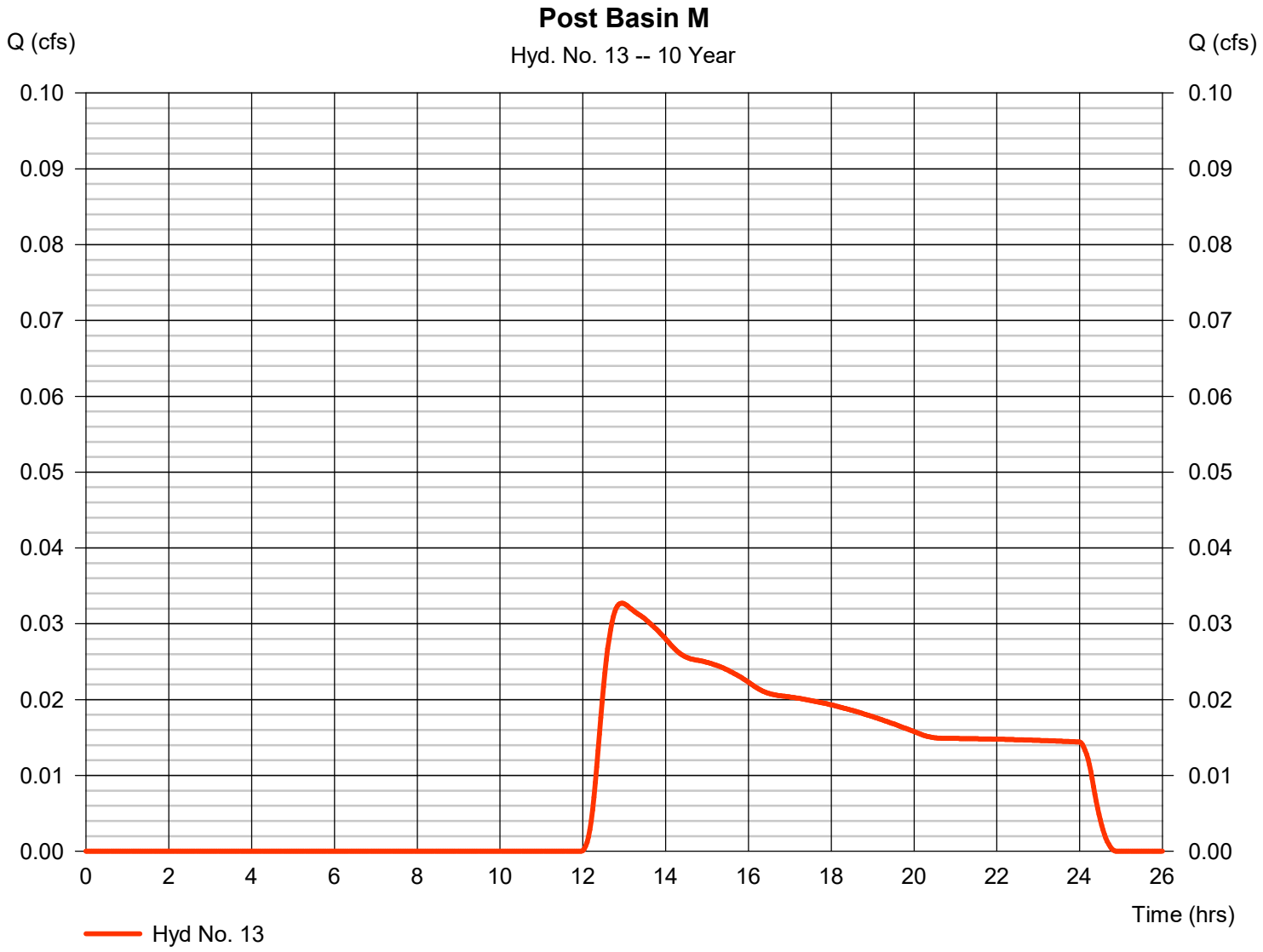


## Hyd. No. 13

Post Basin M

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.033 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.93 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 865 cuft |
| Drainage area | = | 4.130 ac | Curve number | = | 65* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.20 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.050 x 61) + (1.080 x 78)] / 4.130



# Hydrograph Report

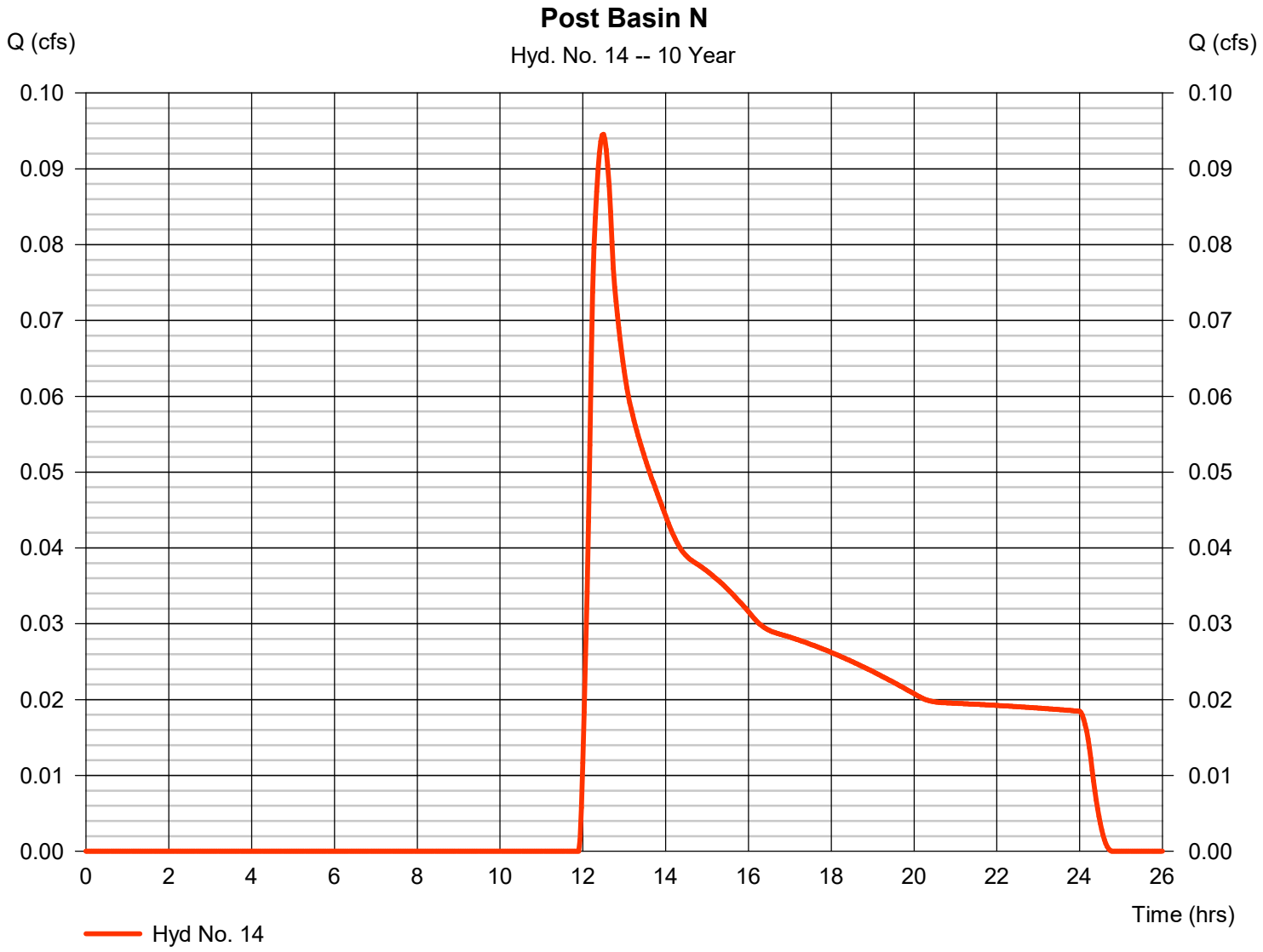


## Hyd. No. 14

Post Basin N

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.095 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.50 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,390 cuft |
| Drainage area | = | 4.020 ac | Curve number | = | 68* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 30.10 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(2.390 x 61) + (1.630 x 78)] / 4.020



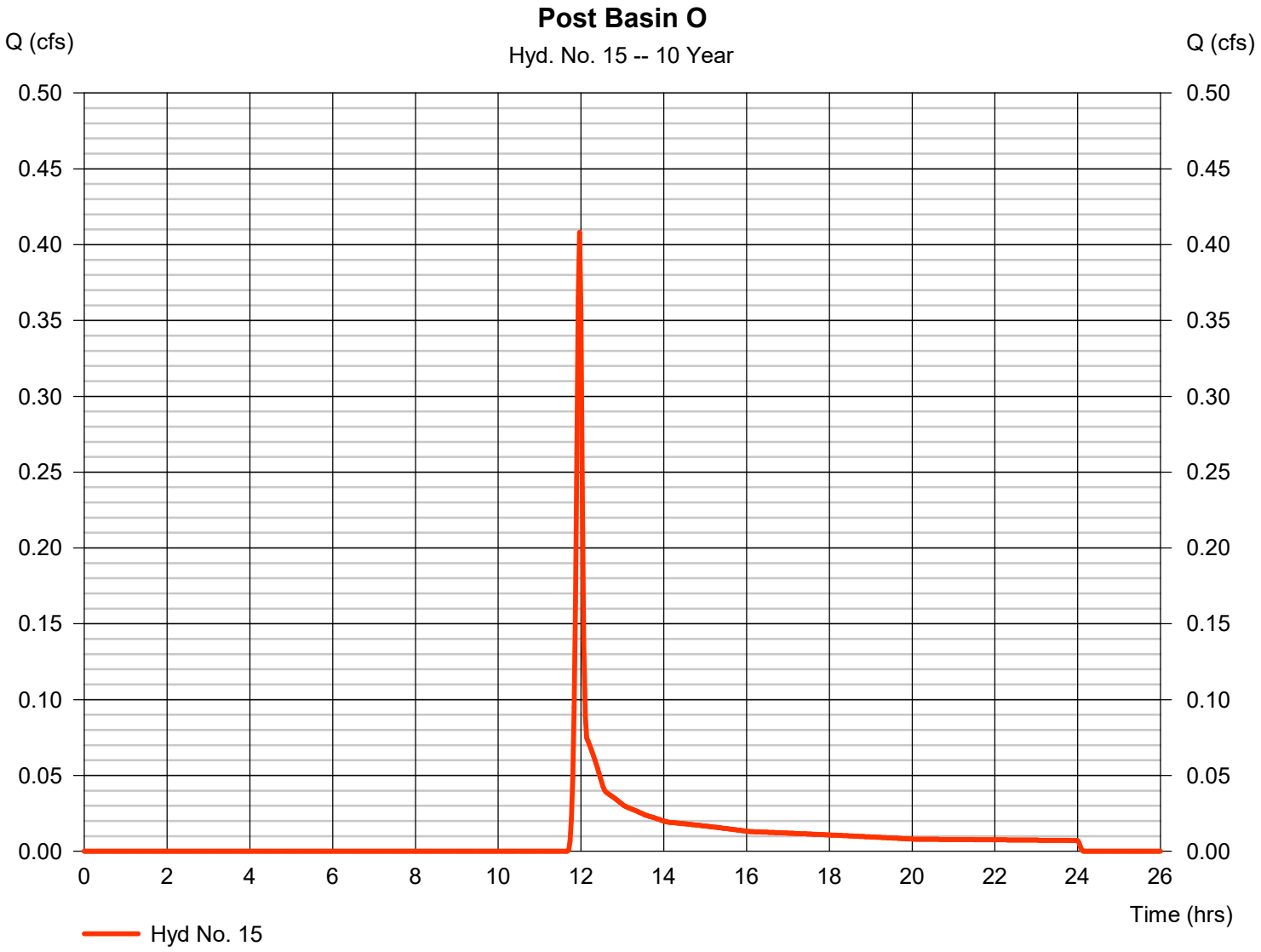
# Hydrograph Report



## Hyd. No. 15

Post Basin O

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.408 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 887 cuft |
| Drainage area | = | 0.850 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.70 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



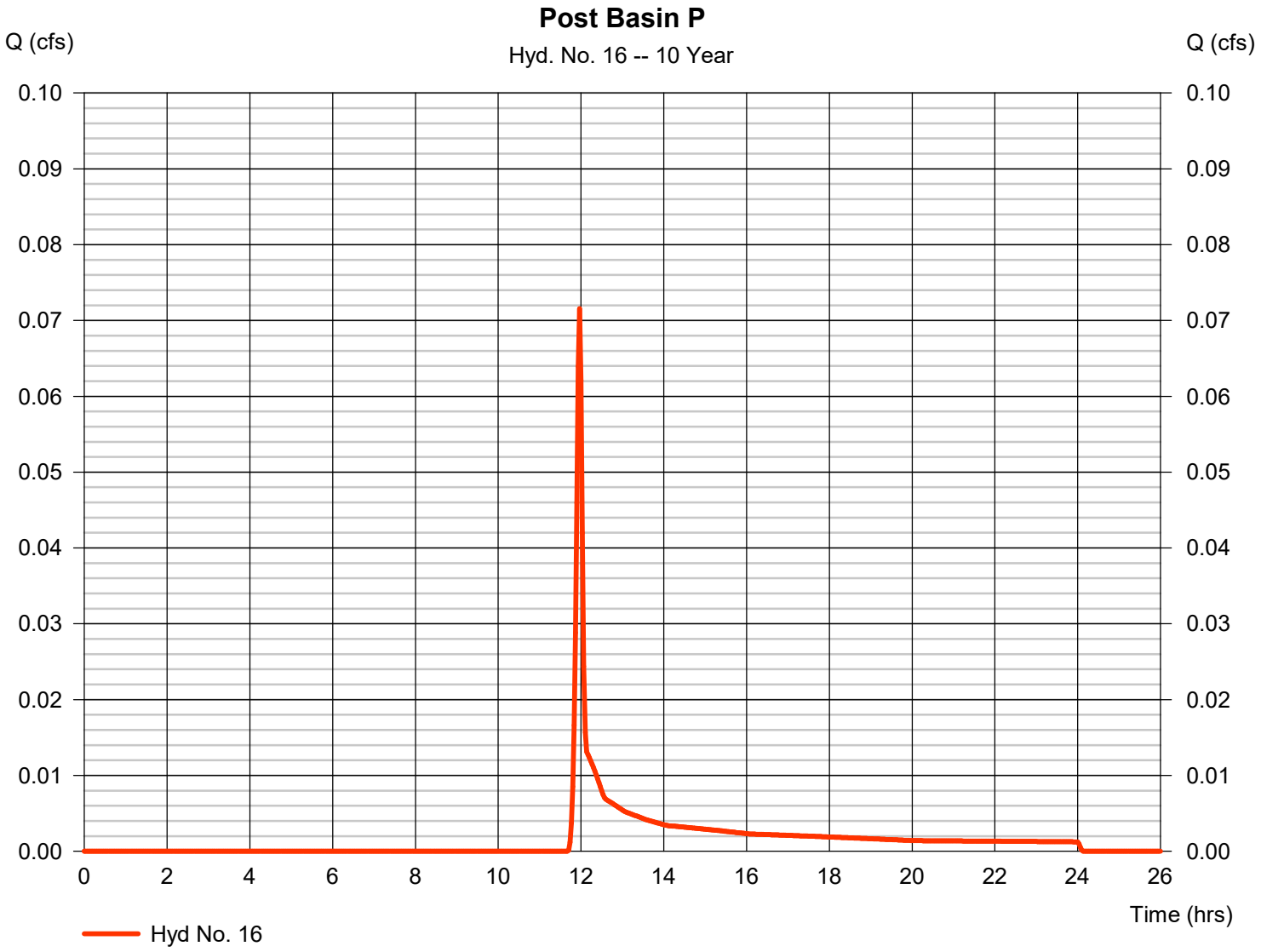
# Hydrograph Report



## Hyd. No. 16

Post Basin P

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.072 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 155 cuft |
| Drainage area | = | 0.149 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.80 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



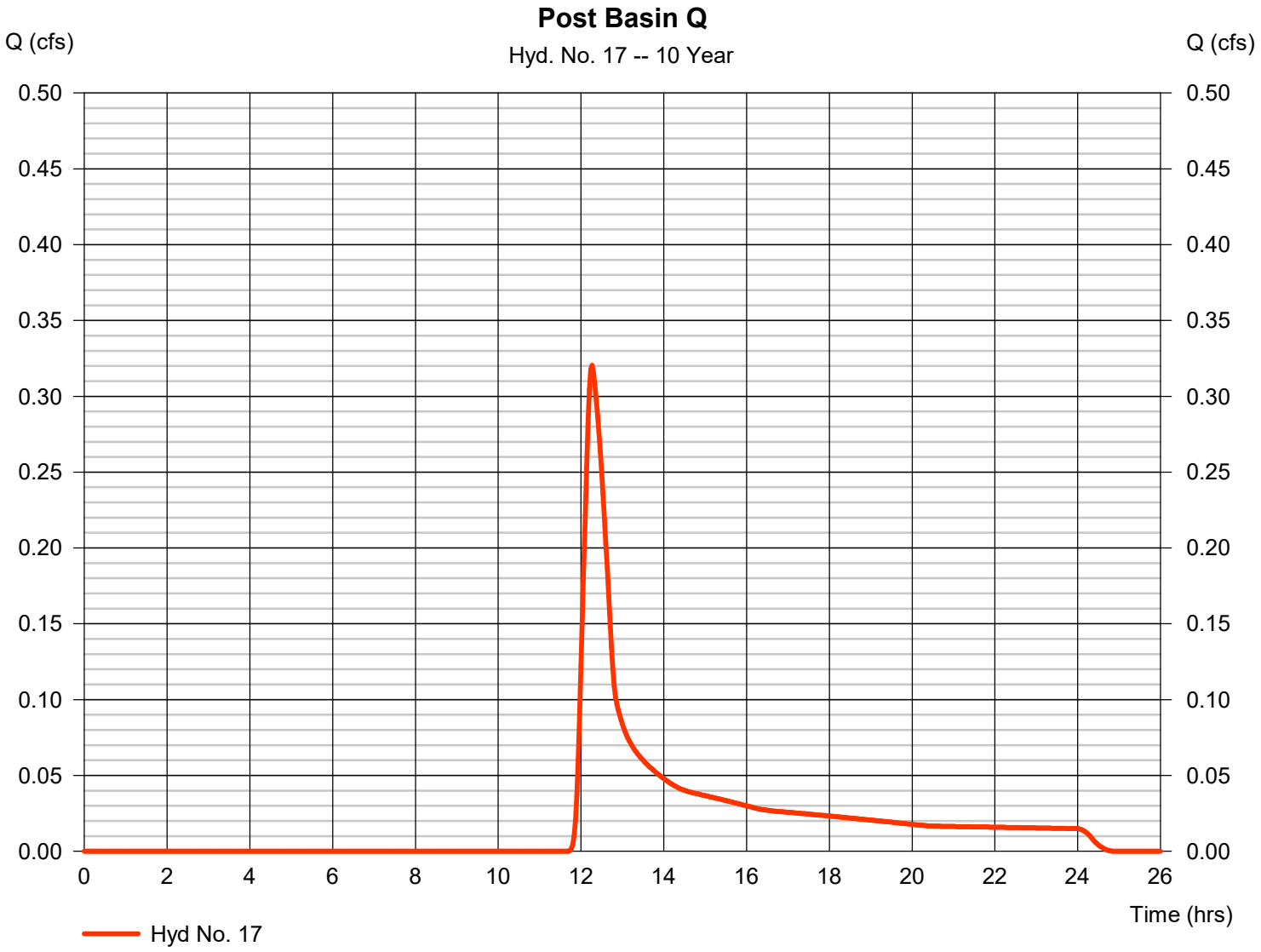
# Hydrograph Report



## Hyd. No. 17

Post Basin Q

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.320 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.27 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,845 cuft |
| Drainage area | = | 1.637 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 31.40 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



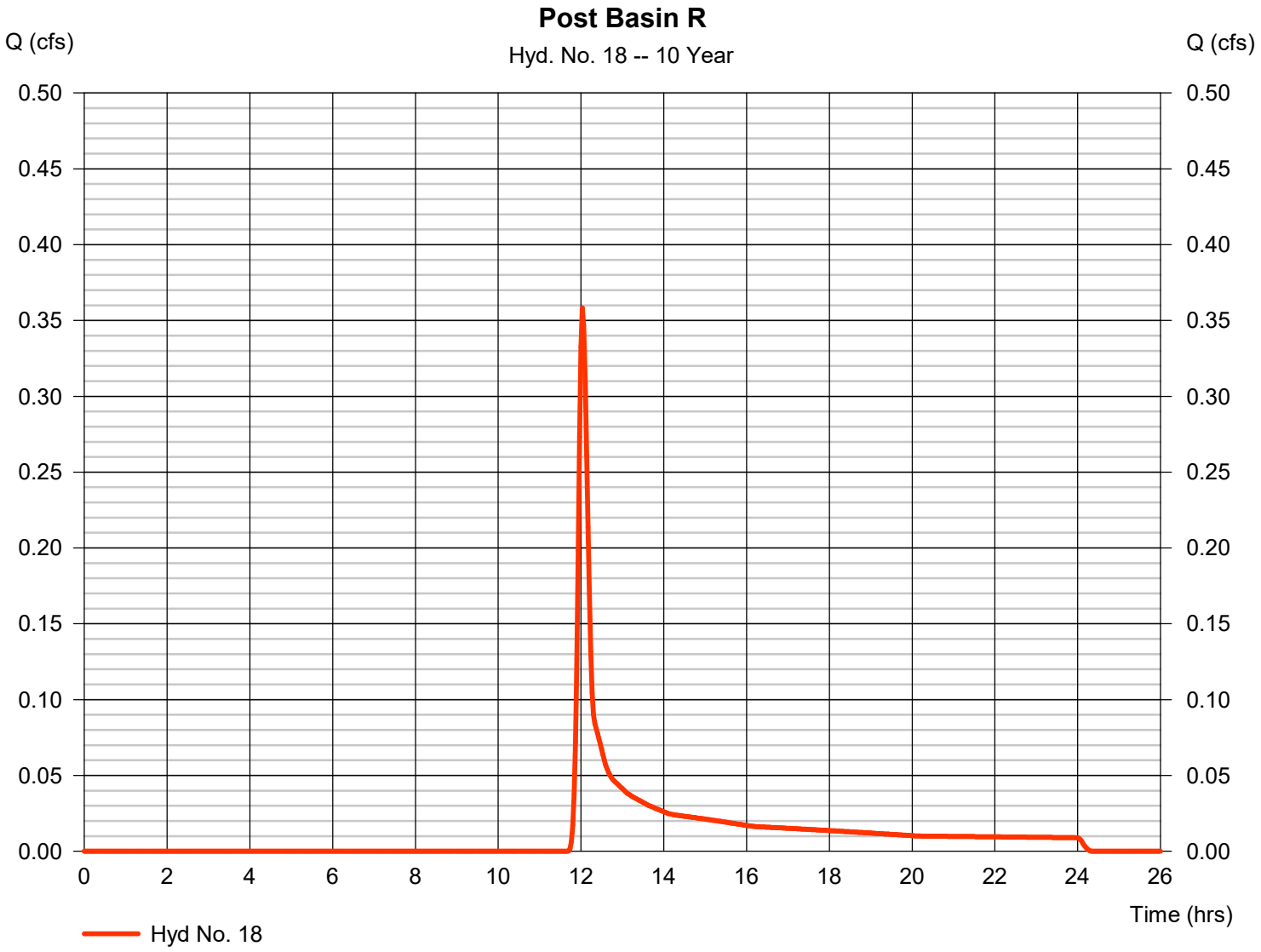
# Hydrograph Report



## Hyd. No. 18

Post Basin R

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.358 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,113 cuft |
| Drainage area | = | 0.970 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.90 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



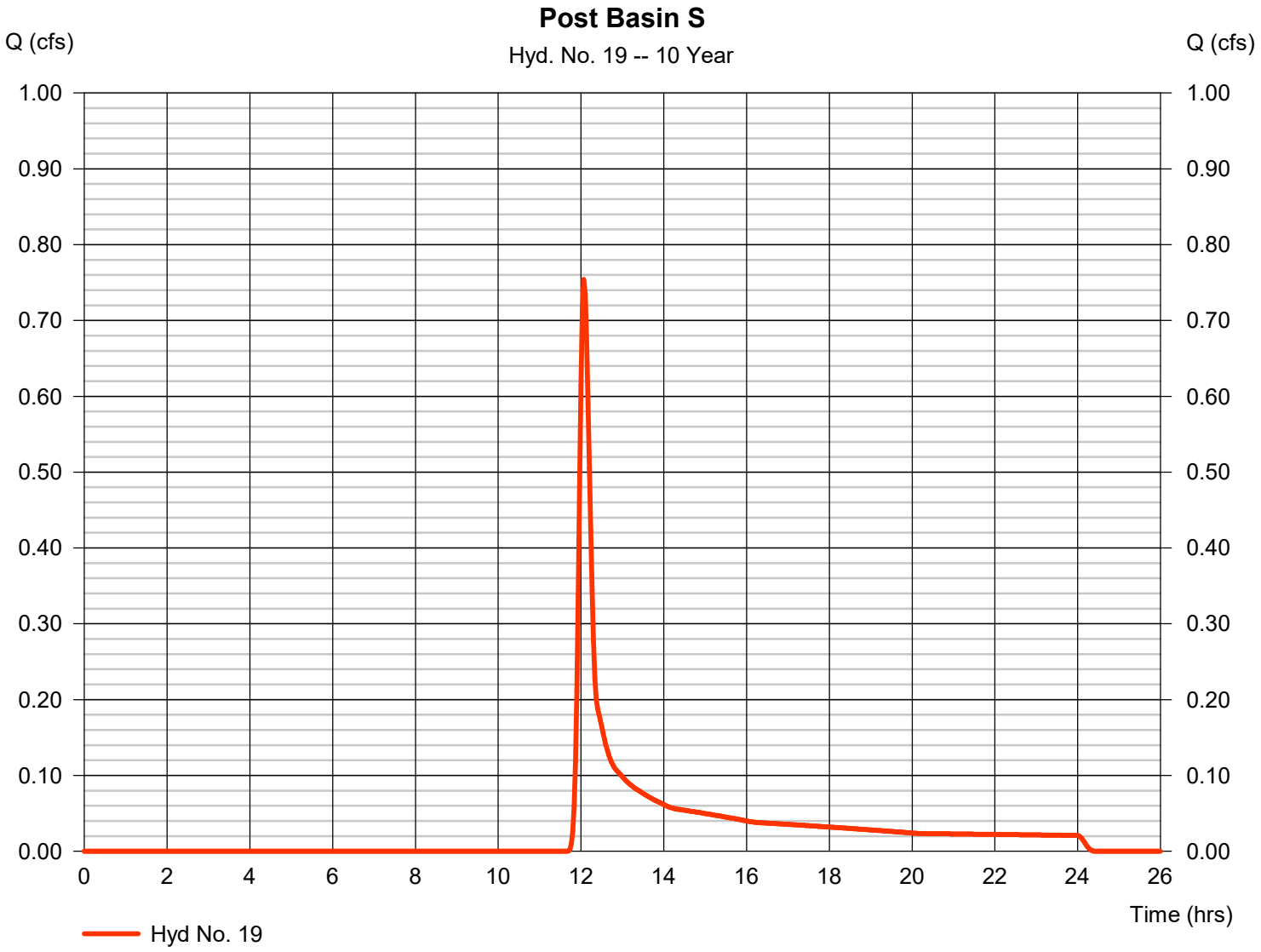
# Hydrograph Report



## Hyd. No. 19

Post Basin S

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.754 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,597 cuft |
| Drainage area | = | 2.393 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.80 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



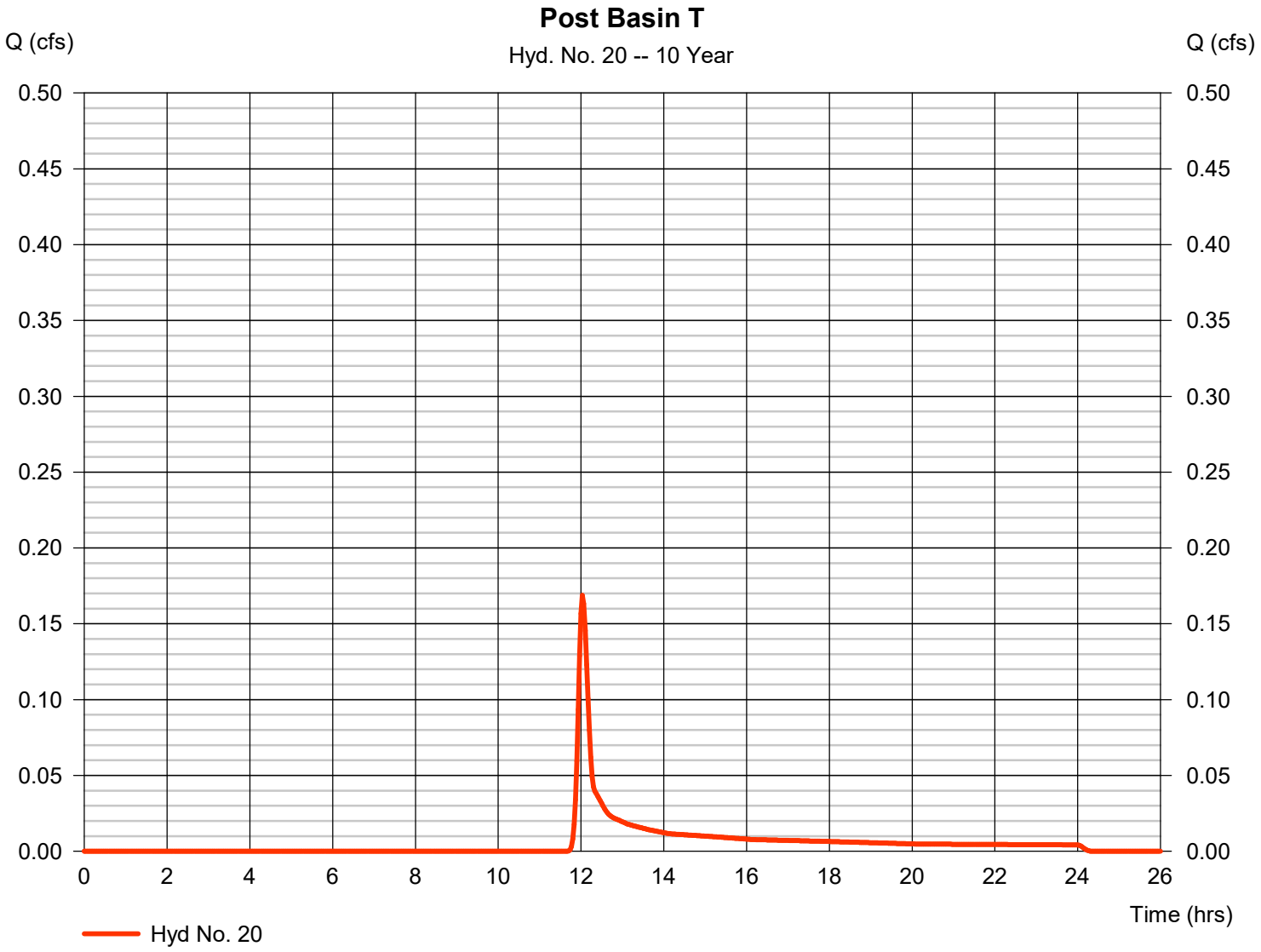
# Hydrograph Report



## Hyd. No. 20

Post Basin T

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.169 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 525 cuft |
| Drainage area | = | 0.457 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 12.30 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



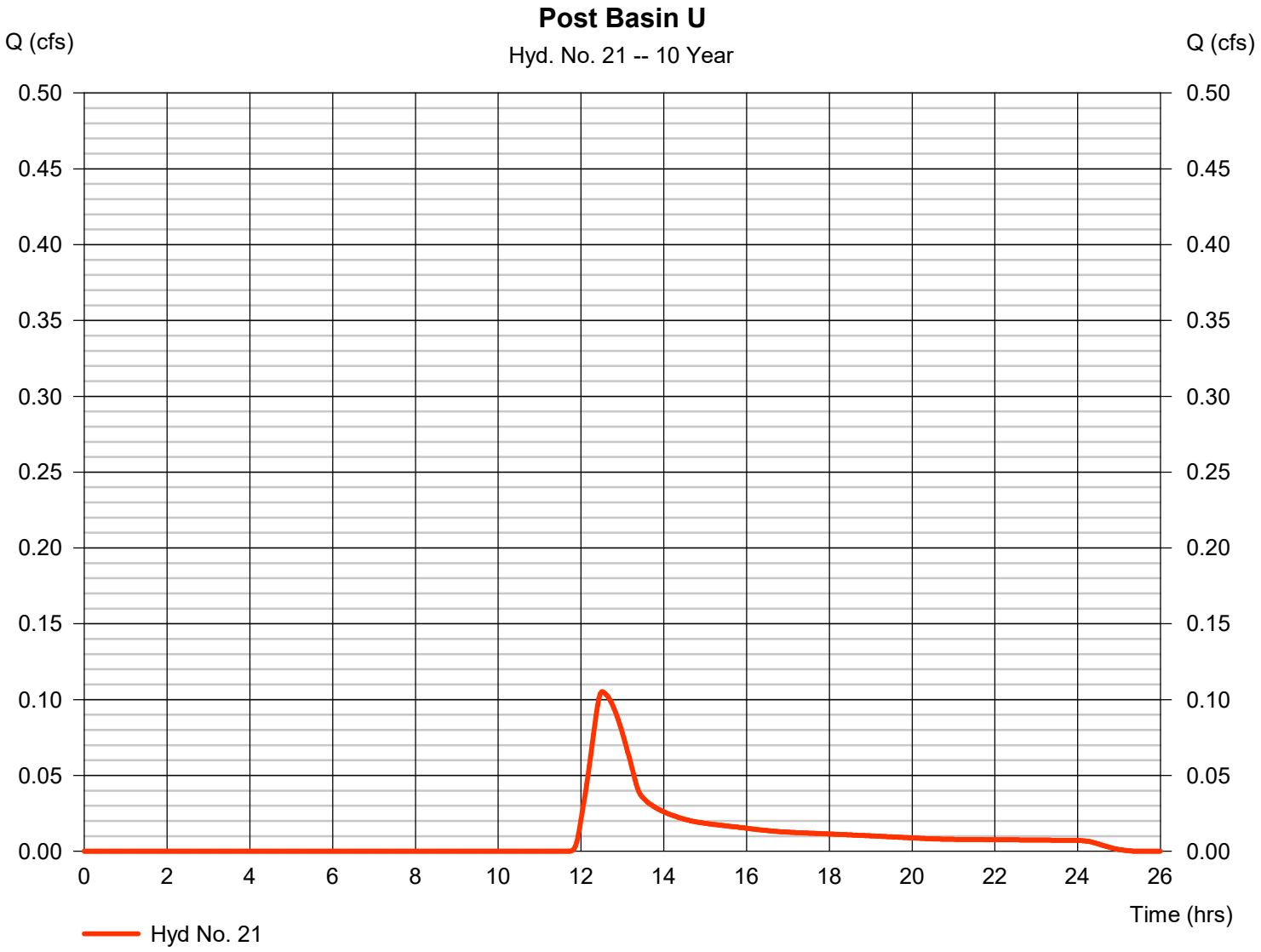
# Hydrograph Report



## Hyd. No. 21

Post Basin U

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.105 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.50 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 878 cuft |
| Drainage area | = | 0.795 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 54.70 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



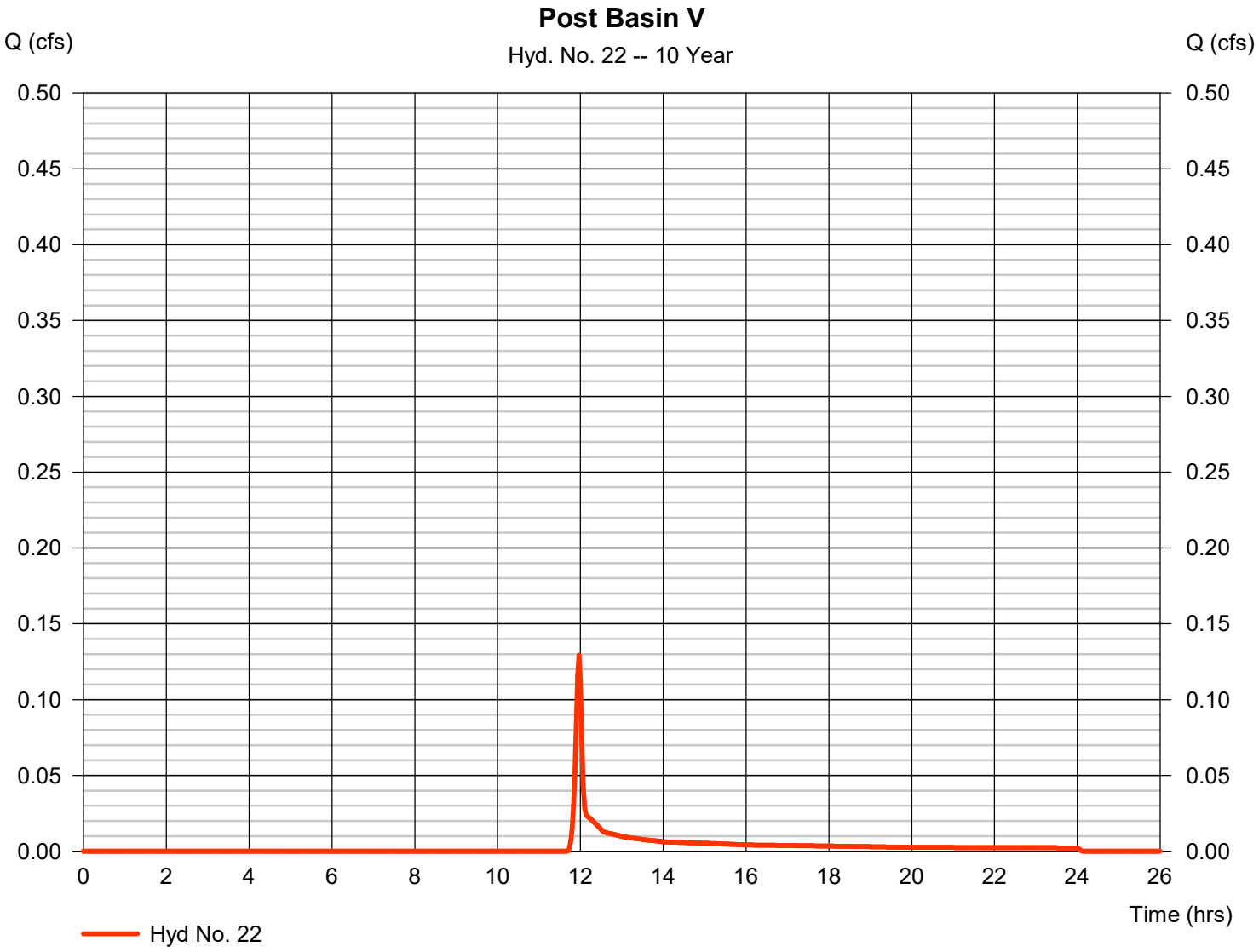
# Hydrograph Report



## Hyd. No. 22

Post Basin V

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.129 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 281 cuft |
| Drainage area | = | 0.269 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | User | Time of conc. (Tc) | = | 5.00 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



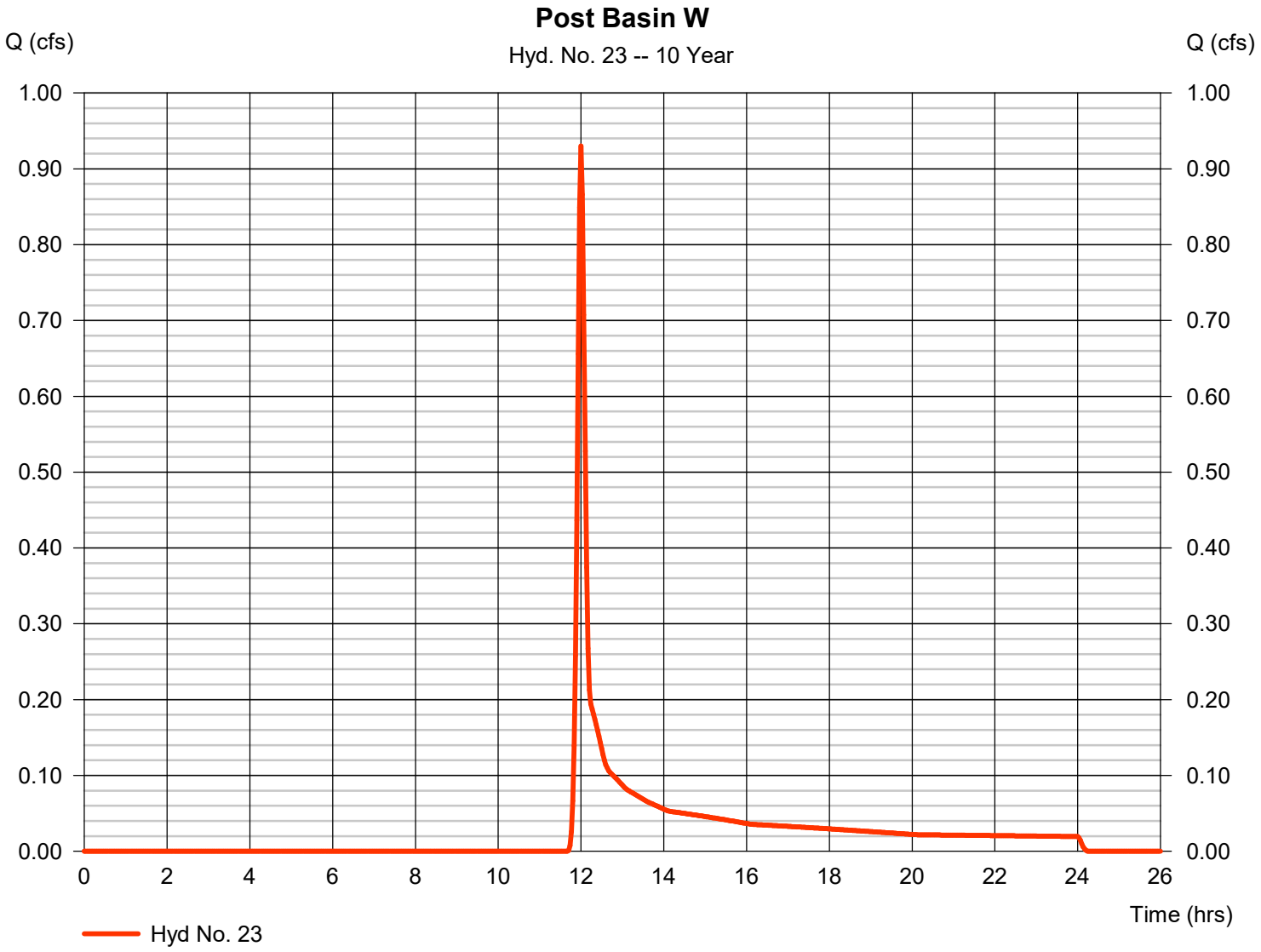
# Hydrograph Report



## Hyd. No. 23

Post Basin W

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.930 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,423 cuft |
| Drainage area | = | 2.177 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.50 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



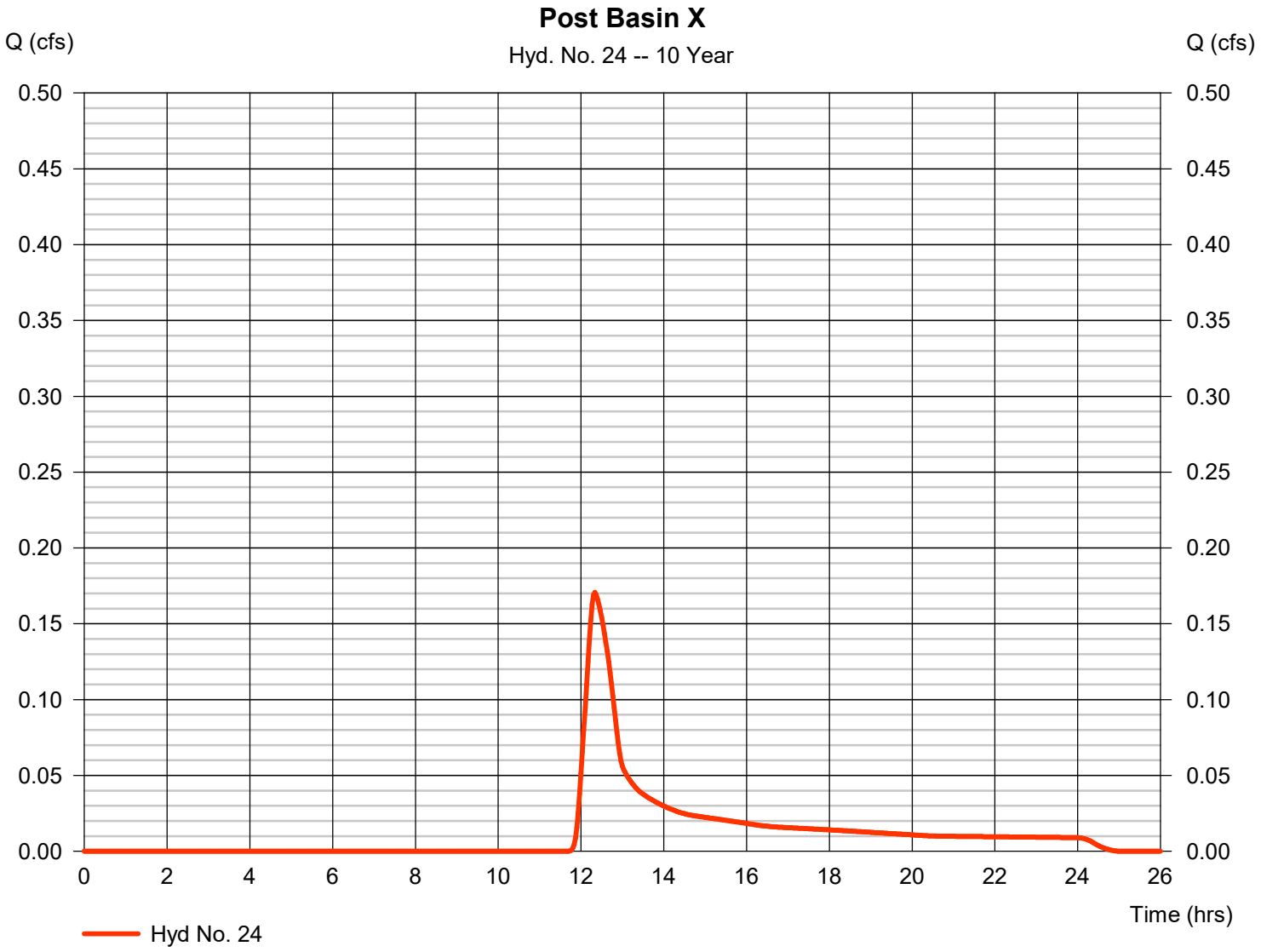
# Hydrograph Report



## Hyd. No. 24

Post Basin X

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.171 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.33 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,110 cuft |
| Drainage area | = | 0.997 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 39.50 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

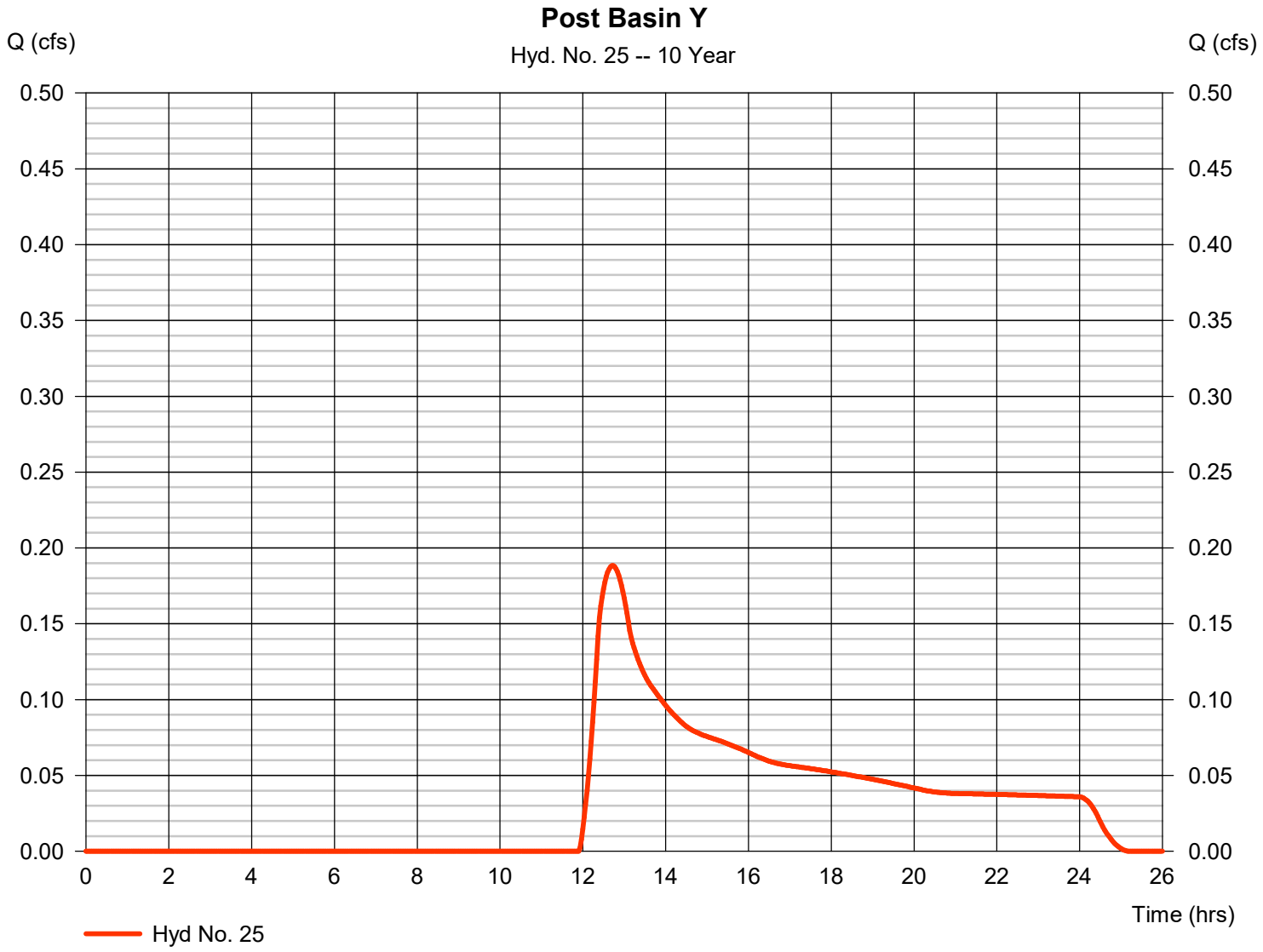


## Hyd. No. 25

Post Basin Y

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.188 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.70 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,855 cuft |
| Drainage area | = | 7.220 ac | Curve number | = | 69* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 44.60 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.896 x 61) + (3.323 x 78)] / 7.220



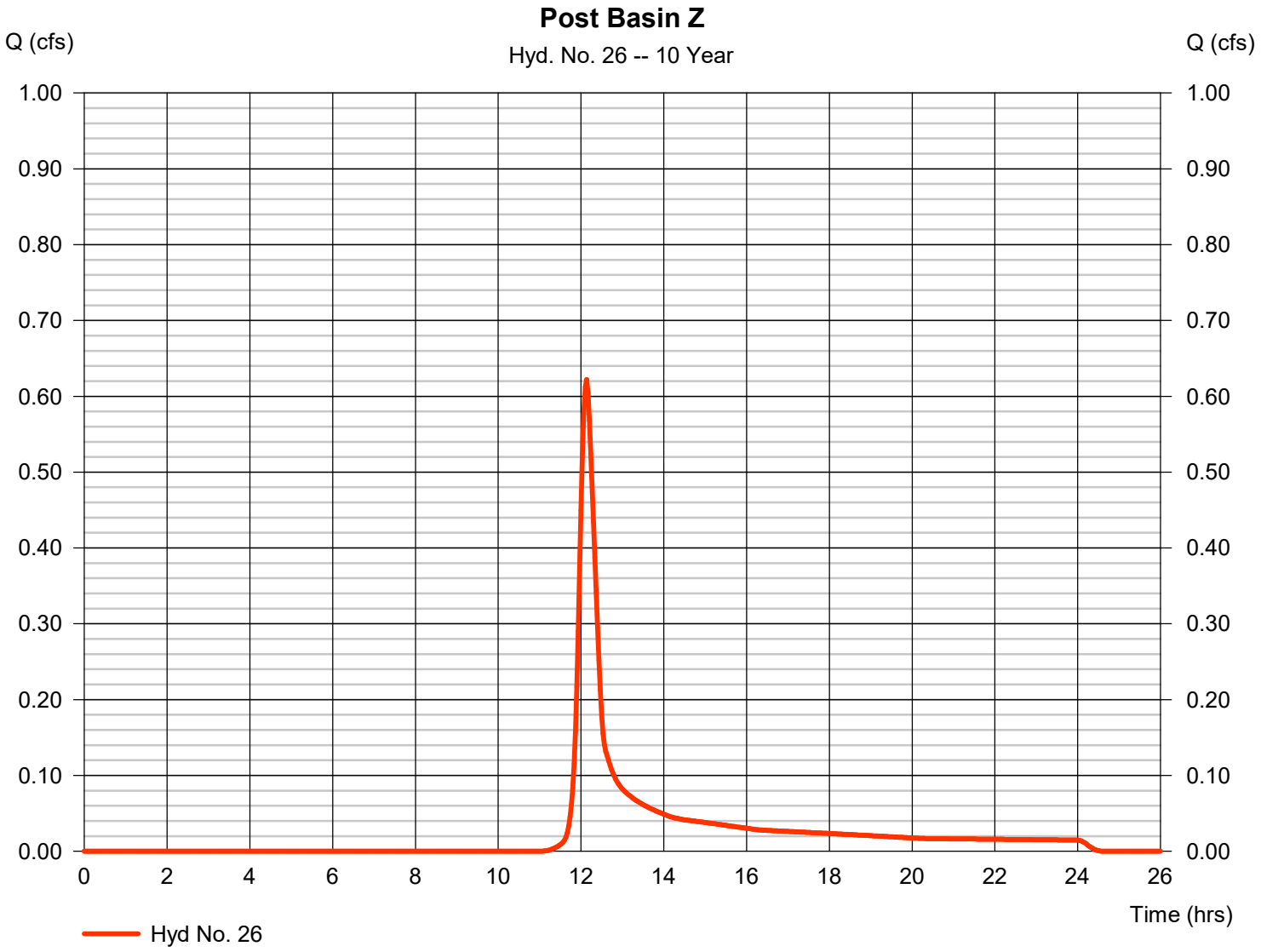
# Hydrograph Report



## Hyd. No. 26

Post Basin Z

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.622 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.13 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,297 cuft |
| Drainage area | = | 1.210 ac | Curve number | = | 84 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 21.00 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



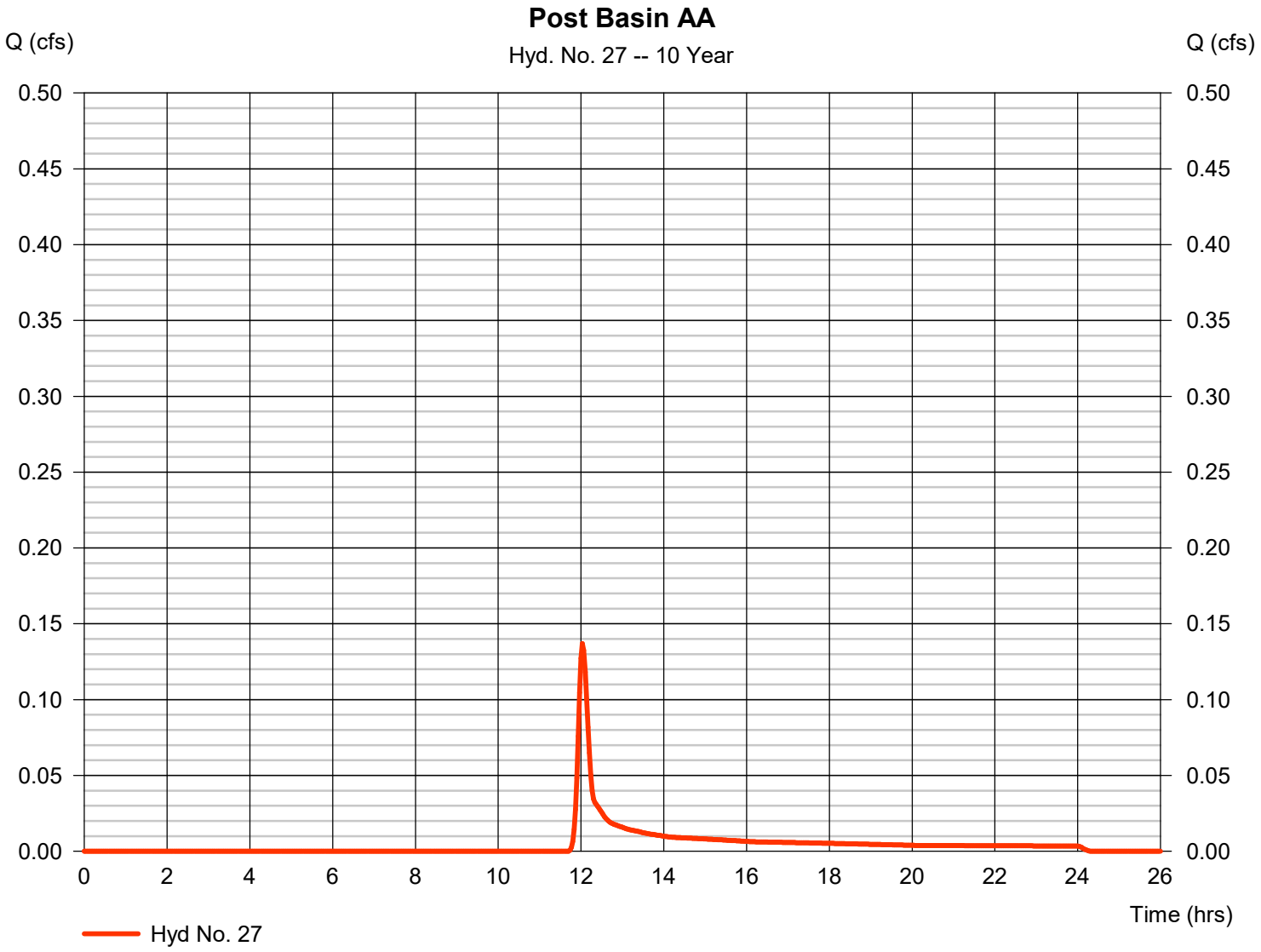
# Hydrograph Report



## Hyd. No. 27

Post Basin AA

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.137 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 426 cuft |
| Drainage area | = | 0.371 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.30 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



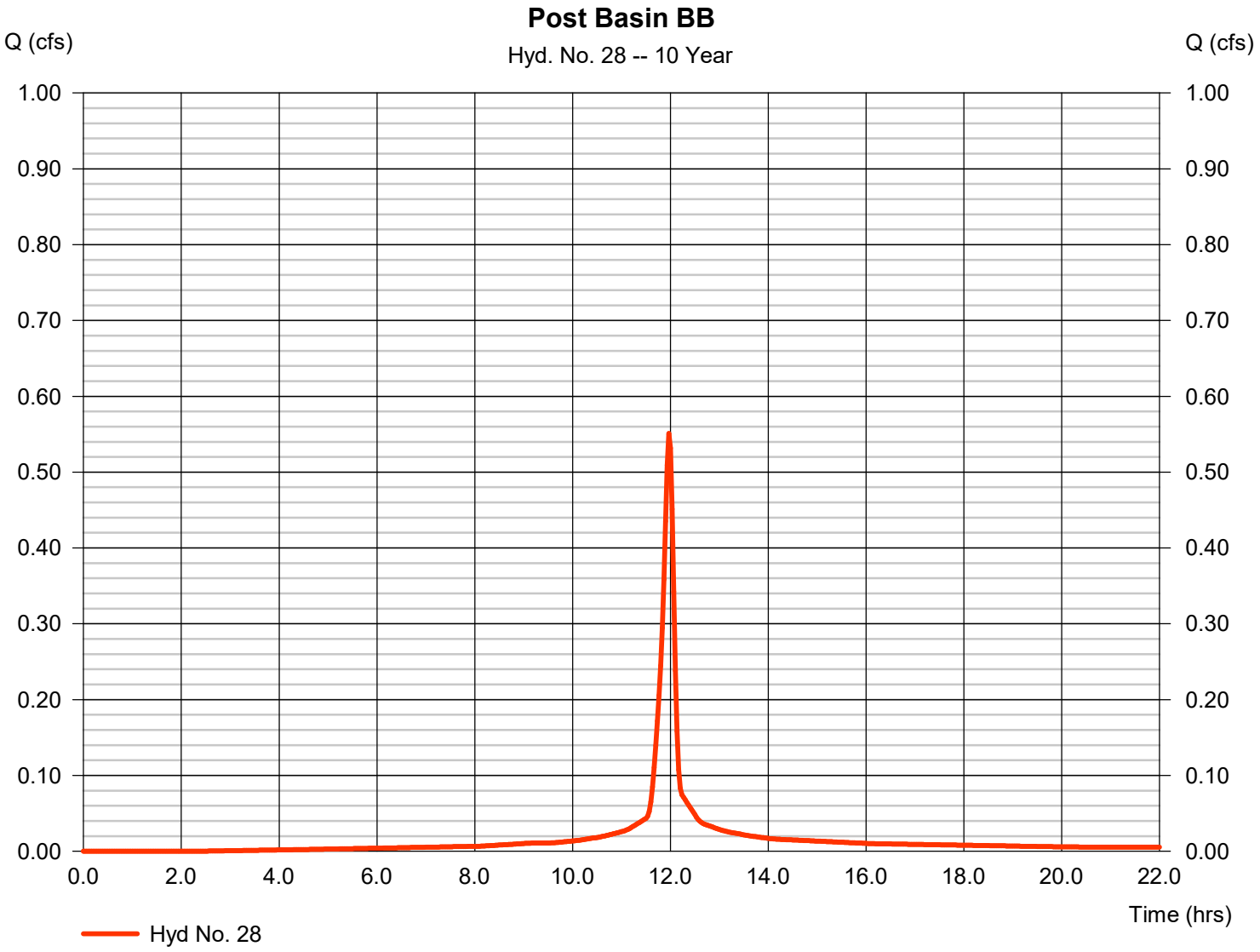
# Hydrograph Report



## Hyd. No. 28

Post Basin BB

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.551 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,383 cuft |
| Drainage area | = | 0.265 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 7.10 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



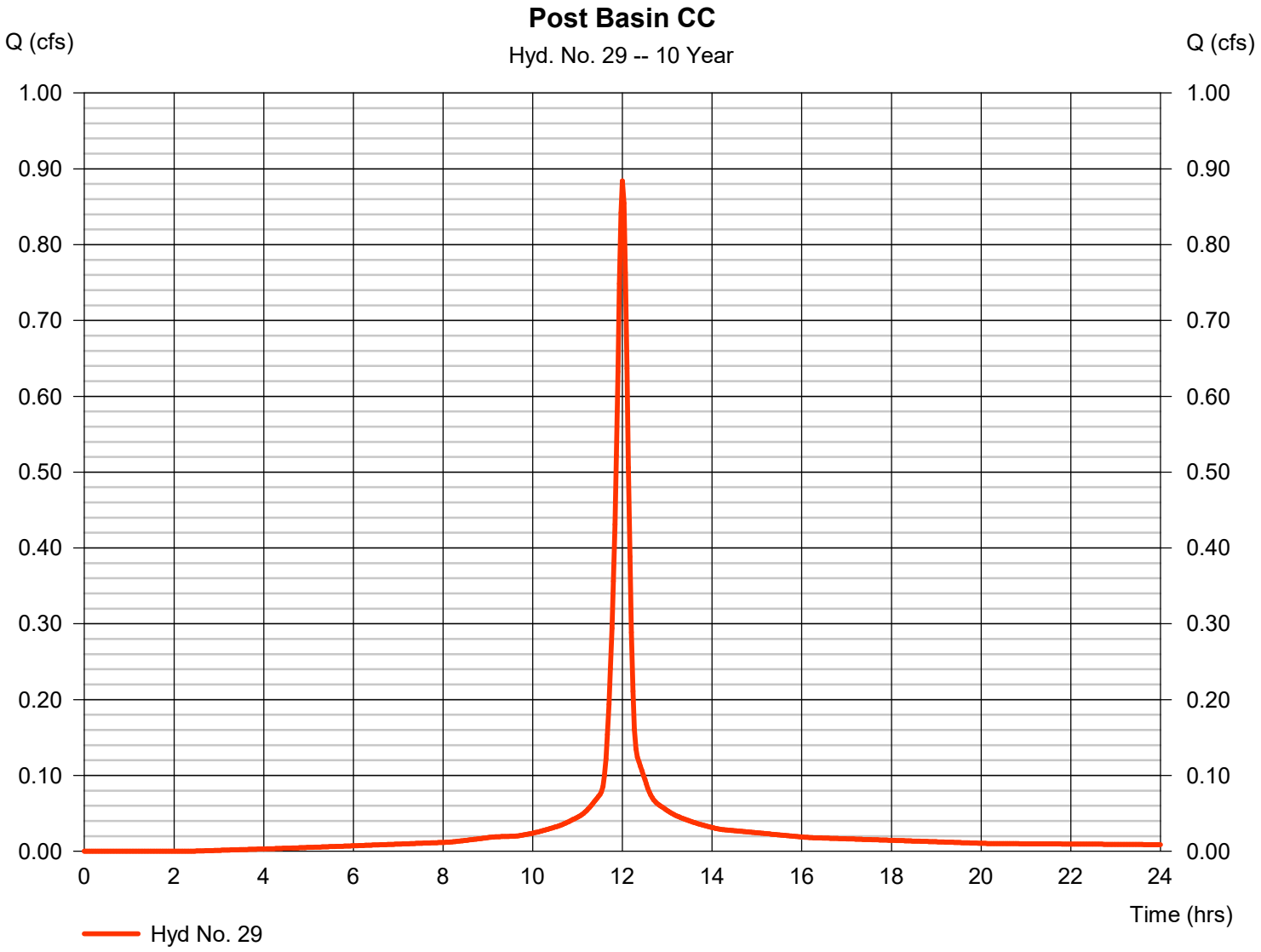
# Hydrograph Report



## Hyd. No. 29

Post Basin CC

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.884 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,487 cuft |
| Drainage area | = | 0.462 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.60 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



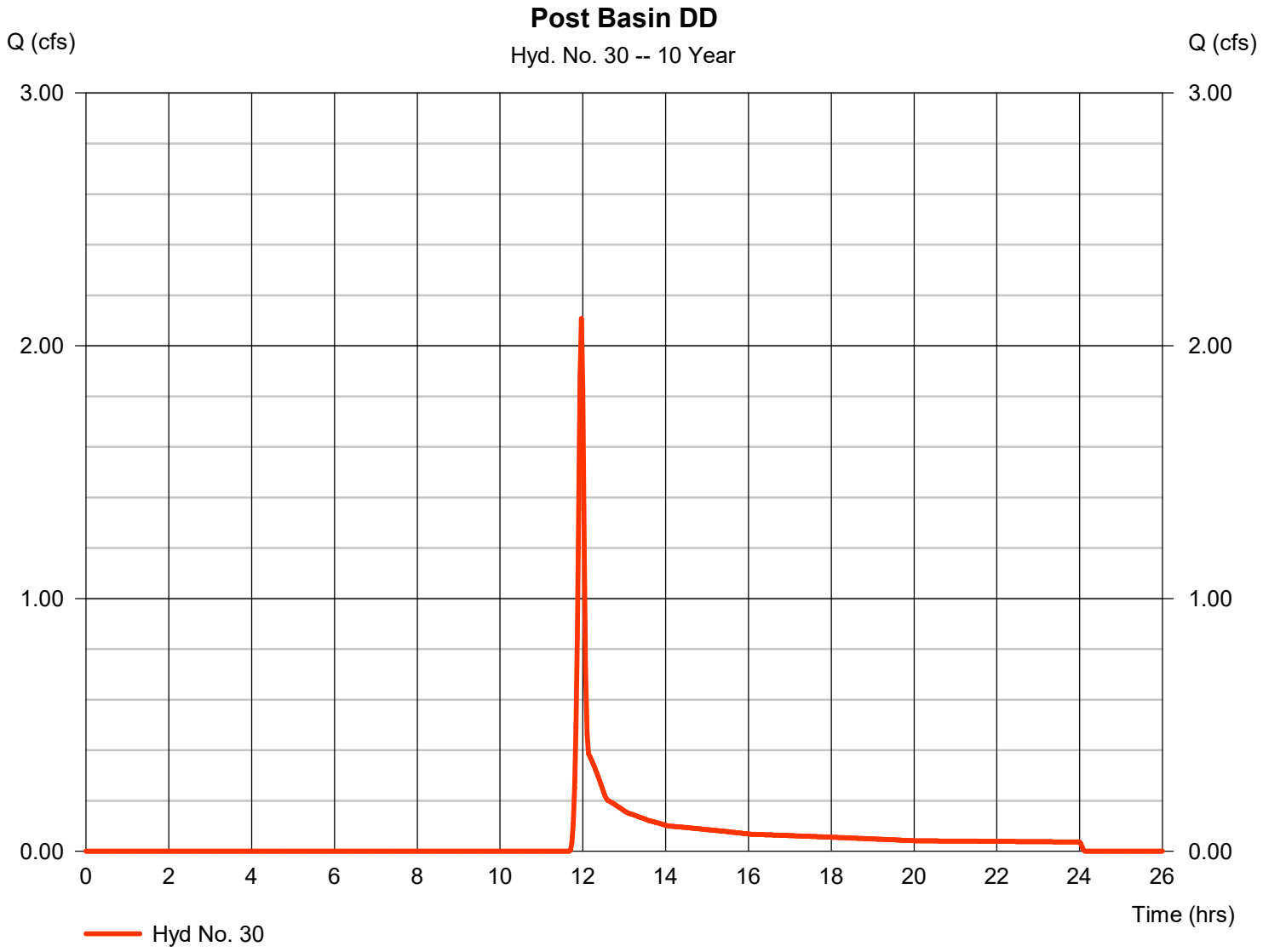
# Hydrograph Report



## Hyd. No. 30

Post Basin DD

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 2.108 cfs |
| Storm frequency | = | 10 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 4,581 cuft |
| Drainage area | = | 4.390 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | User | Time of conc. (Tc) | = | 5.00 min |
| Total precip. | = | 1.66 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024

| 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 | 2 | n/a | 0 | ------ | ------ | ------ | Basin B |
| 2 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin A |
| 3 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin C |
| 4 | SCS Runoff | 0.000 | 2 | n/a | 0 | ------ | ------ | ------ | Basin D |
| 5 | SCS Runoff | 0.373 | 2 | 738 | 2,883 | ------ | ------ | ------ | Post Basin E |
| 6 | SCS Runoff | 0.423 | 2 | 726 | 1,453 | ------ | ------ | ------ | Post Basin F |
| 7 | SCS Runoff | 0.217 | 2 | 720 | 509 | ------ | ------ | ------ | Post Basin G |
| 8 | SCS Runoff | 0.258 | 2 | 722 | 705 | ------ | ------ | ------ | Post Basin H |
| 9 | SCS Runoff | 0.481 | 2 | 732 | 2,120 | ------ | ------ | ------ | Post Basin I |
| 10 | SCS Runoff | 0.403 | 2 | 724 | 1,206 | ------ | ------ | ------ | Post Basin J |
| 11 | SCS Runoff | 1.370 | 2 | 724 | 4,100 | ------ | ------ | ------ | Post Basin K |
| 12 | SCS Runoff | 0.723 | 2 | 724 | 2,164 | ------ | ------ | ------ | Post Basin L |
| 13 | SCS Runoff | 0.362 | 2 | 740 | 3,335 | ------ | ------ | ------ | Post Basin M |
| 14 | SCS Runoff | 0.655 | 2 | 734 | 4,324 | ------ | ------ | ------ | Post Basin N |
| 15 | SCS Runoff | 0.930 | 2 | 718 | 1,877 | ------ | ------ | ------ | Post Basin O |
| 16 | SCS Runoff | 0.163 | 2 | 718 | 329 | ------ | ------ | ------ | Post Basin P |
| 17 | SCS Runoff | 0.814 | 2 | 734 | 3,905 | ------ | ------ | ------ | Post Basin Q |
| 18 | SCS Runoff | 0.864 | 2 | 722 | 2,357 | ------ | ------ | ------ | Post Basin R |
| 19 | SCS Runoff | 1.837 | 2 | 724 | 5,497 | ------ | ------ | ------ | Post Basin S |
| 20 | SCS Runoff | 0.407 | 2 | 722 | 1,110 | ------ | ------ | ------ | Post Basin T |
| 21 | SCS Runoff | 0.267 | 2 | 750 | 1,859 | ------ | ------ | ------ | Post Basin U |
| 22 | SCS Runoff | 0.294 | 2 | 718 | 594 | ------ | ------ | ------ | Post Basin V |
| 23 | SCS Runoff | 2.185 | 2 | 720 | 5,129 | ------ | ------ | ------ | Post Basin W |
| 24 | SCS Runoff | 0.434 | 2 | 738 | 2,349 | ------ | ------ | ------ | Post Basin X |
| 25 | SCS Runoff | 1.006 | 2 | 746 | 8,438 | ------ | ------ | ------ | Post Basin Y |
| 26 | SCS Runoff | 1.202 | 2 | 728 | 4,239 | ------ | ------ | ------ | Post Basin Z |
| 27 | SCS Runoff | 0.331 | 2 | 722 | 901 | ------ | ------ | ------ | Post Basin AA |
| 28 | SCS Runoff | 0.770 | 2 | 718 | 1,974 | ------ | ------ | ------ | Post Basin BB |
| 29 | SCS Runoff | 1.237 | 2 | 720 | 3,549 | ------ | ------ | ------ | Post Basin CC |
| 30 | SCS Runoff | 4.801 | 2 | 718 | 9,696 | ------ | ------ | ------ | Post Basin DD |
| 31 | SCS Runoff | 0.002 | 2 | 1440 | 33 | ------ | ------ | ------ | Post Basin EE |

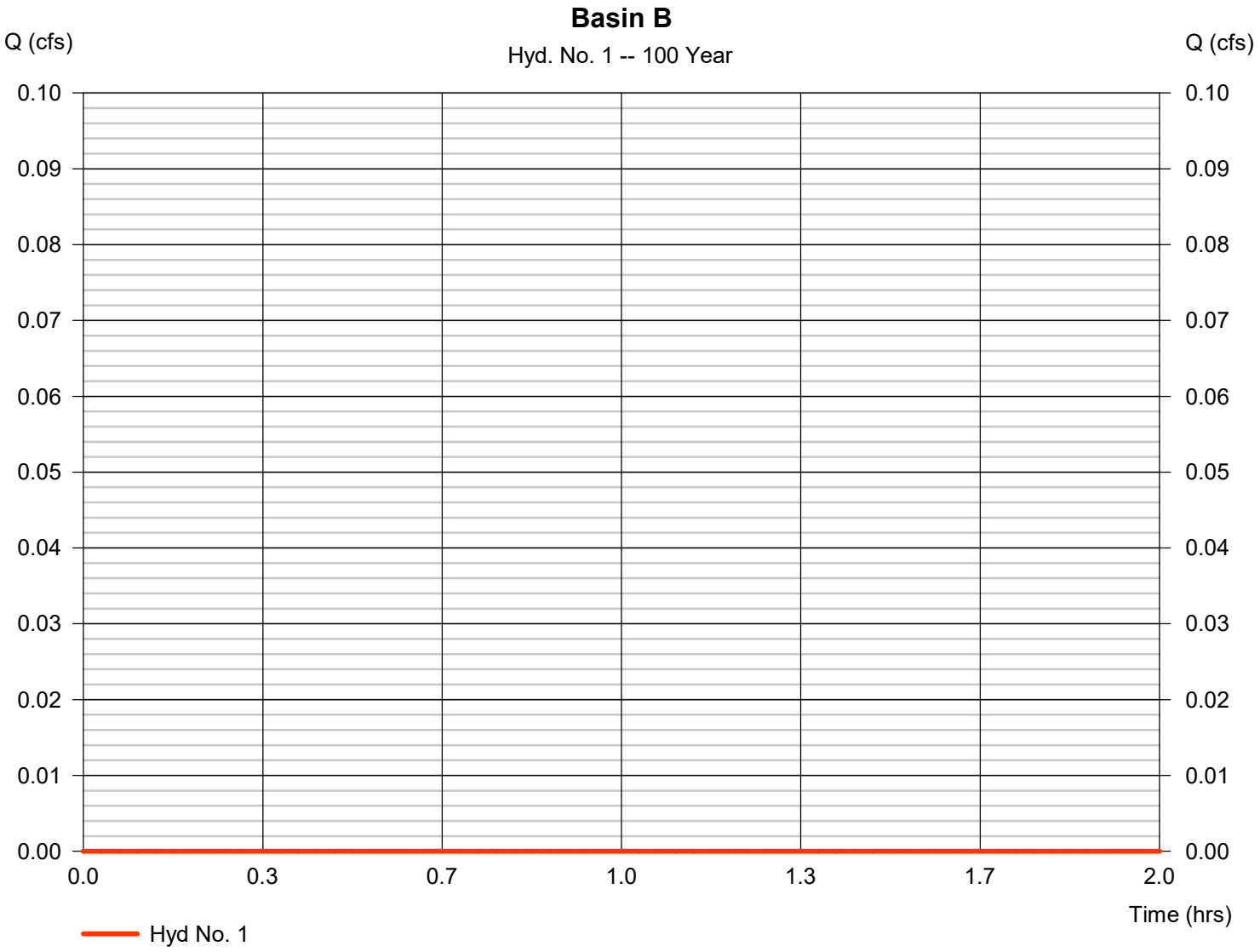
# Hydrograph Report



## Hyd. No. 1

Basin B

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 100 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 2.960 ac | Curve number | = 39 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 25.10 min |
| Total precip. | = 2.28 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



# Hydrograph Report

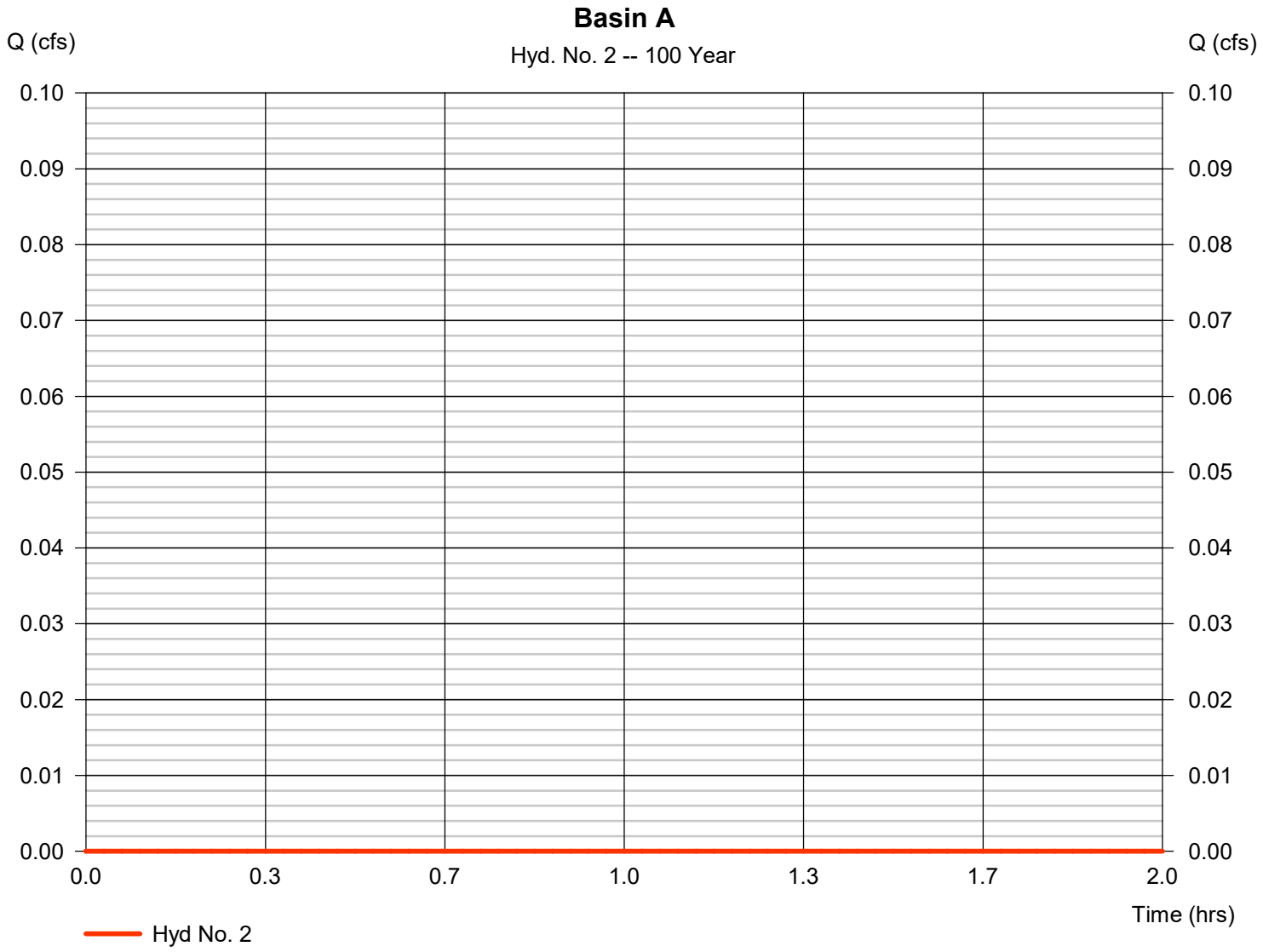


## Hyd. No. 2

Basin A

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.000 cfs |
| Storm frequency | = 100 yrs | Time to peak | = n/a |
| Time interval | = 2 min | Hyd. volume | = 0 cuft |
| Drainage area | = 9.830 ac | Curve number | = 41* |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 31.60 min |
| Total precip. | = 2.28 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |

* Composite (Area/CN) = [(9.460 x 39) + (0.370 x 98)] / 9.830



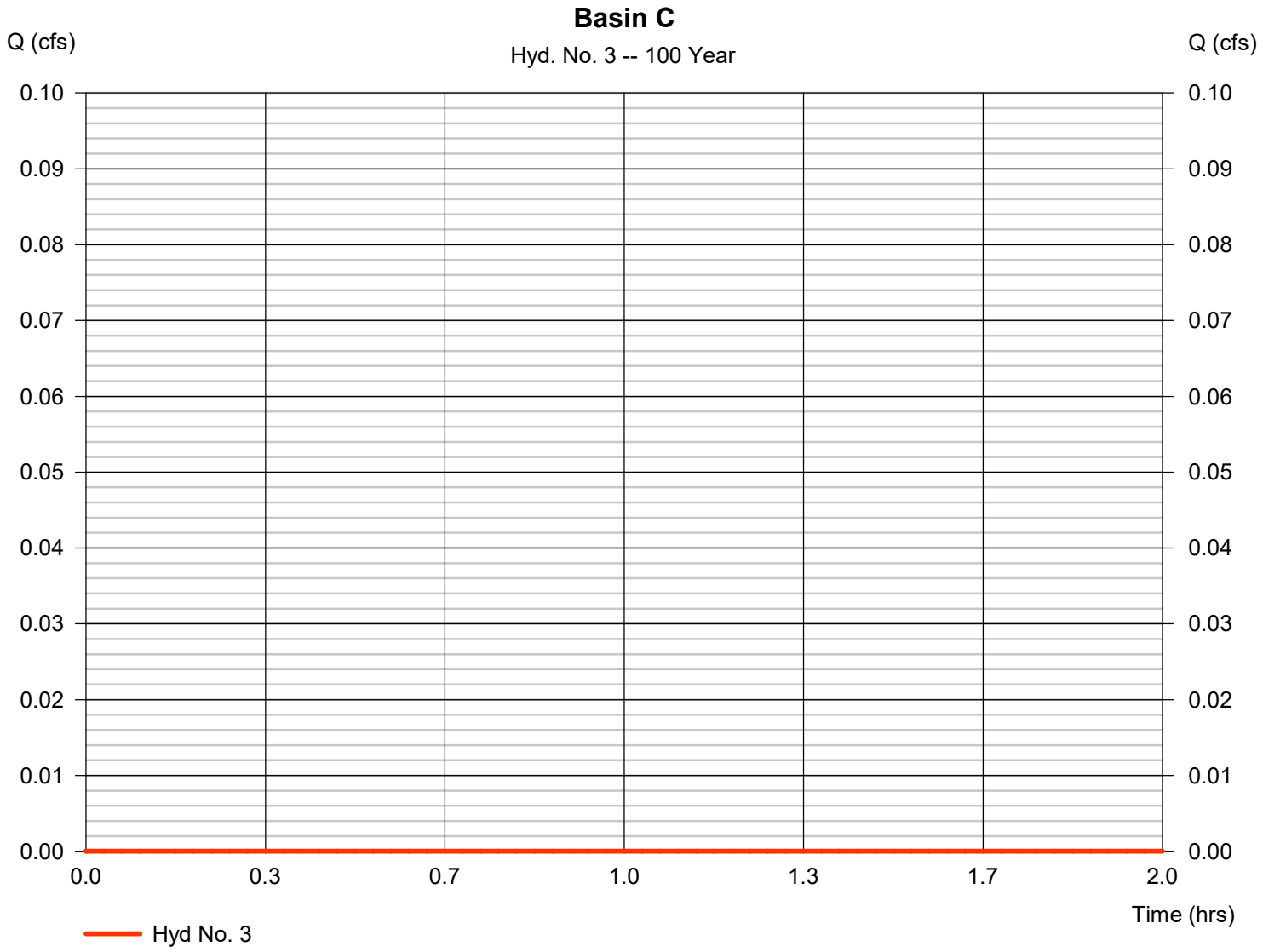
# Hydrograph Report



## Hyd. No. 3

Basin C

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | n/a |
| Time interval | = | 2 min | Hyd. volume | = | 0 cuft |
| Drainage area | = | 4.970 ac | Curve number | = | 39 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 26.00 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



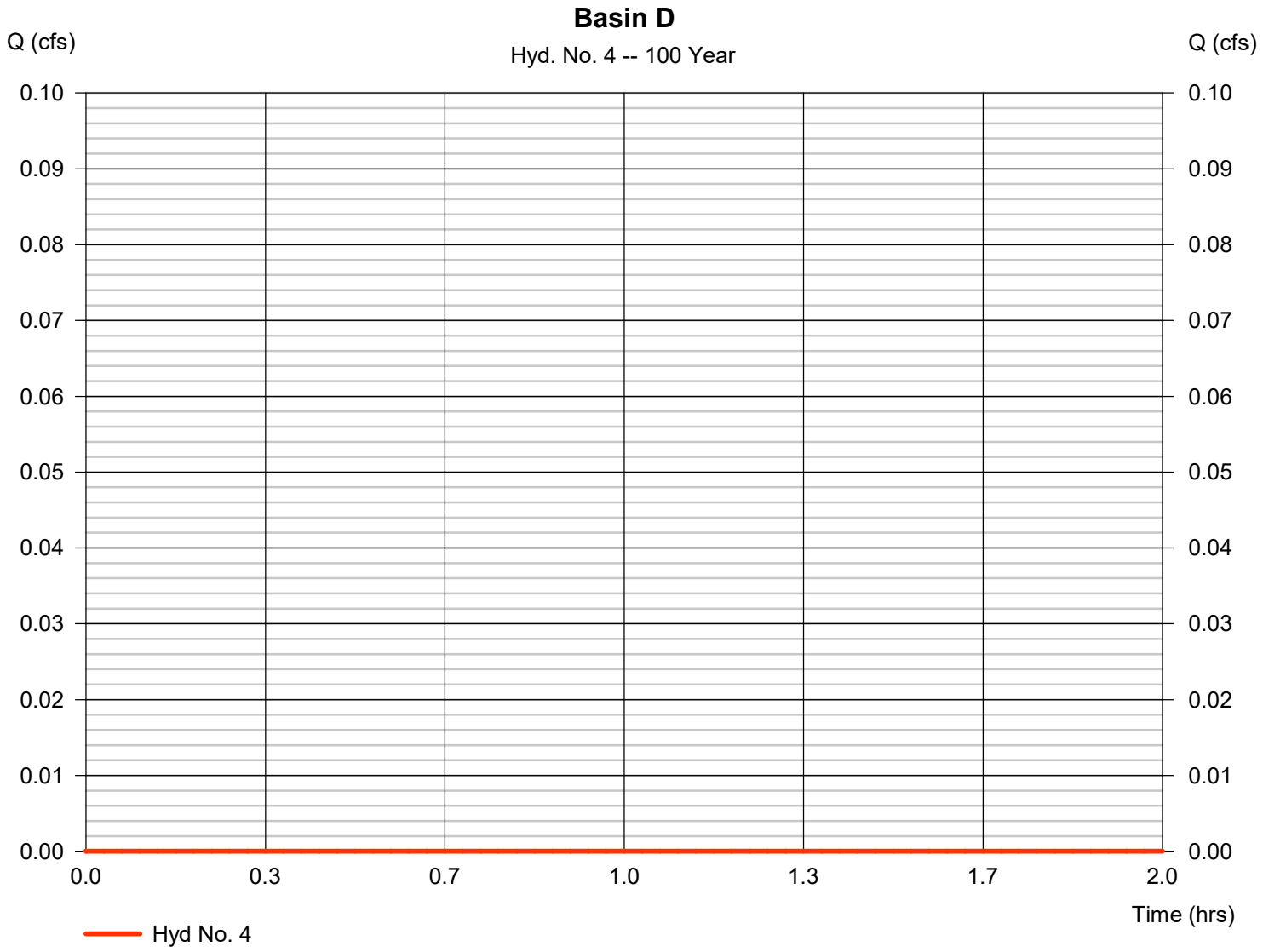
# Hydrograph Report



## Hyd. No. 4

Basin D

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.000 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | n/a |
| Time interval | = | 2 min | Hyd. volume | = | 0 cuft |
| Drainage area | = | 0.430 ac | Curve number | = | 39 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.00 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

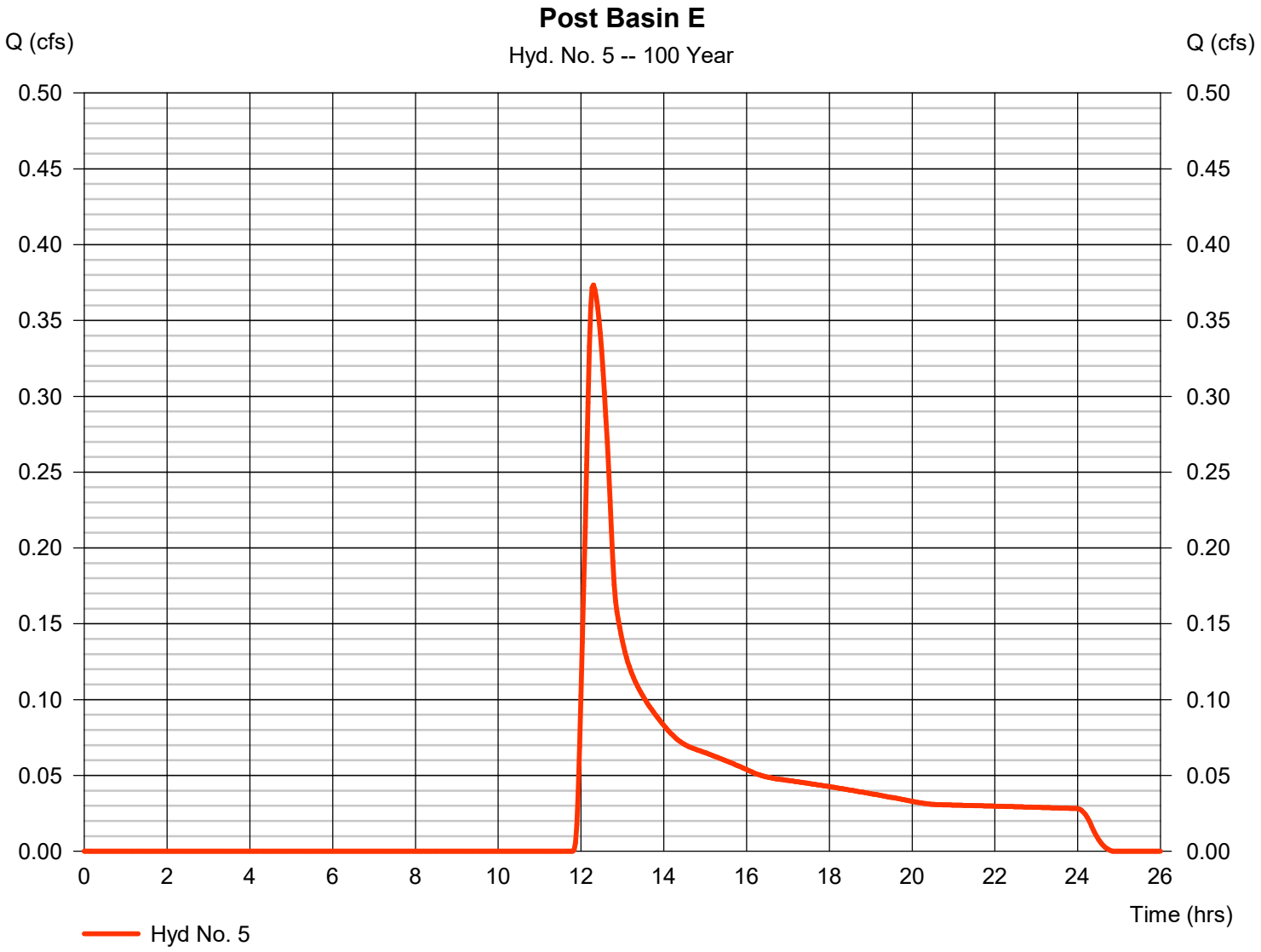


## Hyd. No. 5

Post Basin E

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.373 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.30 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,883 cuft |
| Drainage area | = | 2.910 ac | Curve number | = | 67* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.10 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(1.810 x 61) + (1.100 x 78)] / 2.910



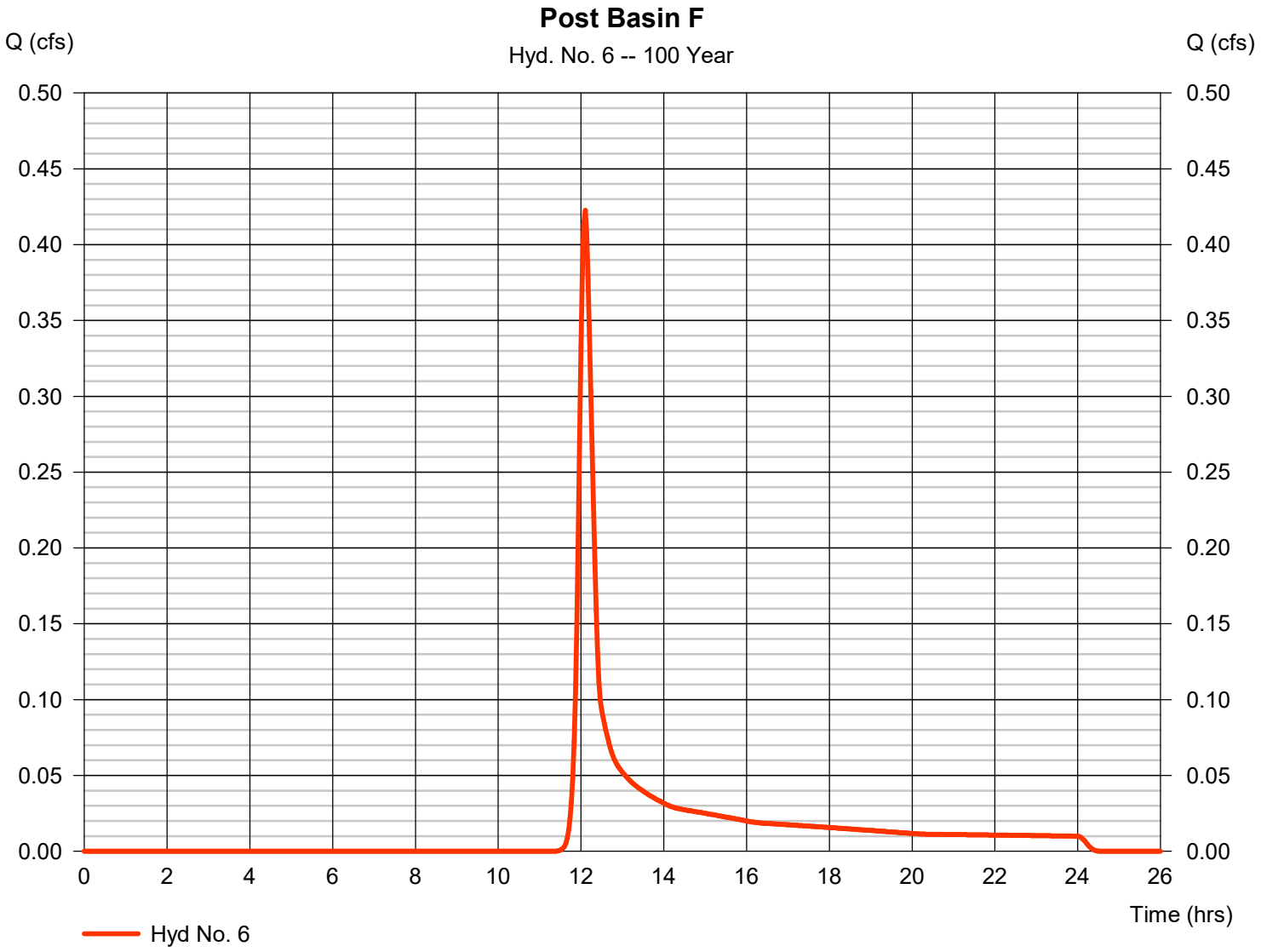
# Hydrograph Report



## Hyd. No. 6

Post Basin F

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.423 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.10 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,453 cuft |
| Drainage area | = | 0.660 ac | Curve number | = | 77 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 18.20 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



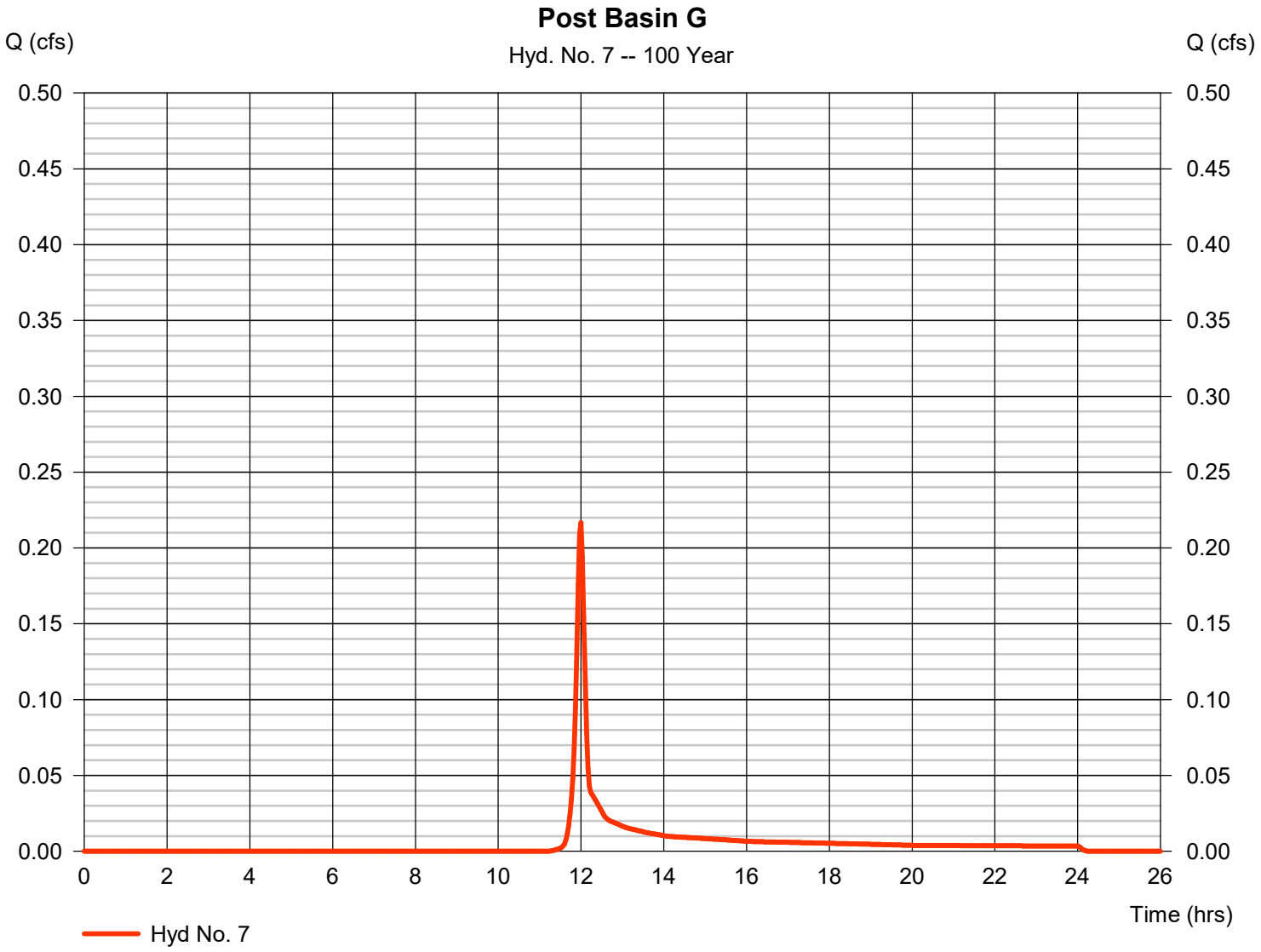
# Hydrograph Report



## Hyd. No. 7

Post Basin G

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.217 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 509 cuft |
| Drainage area | = | 0.216 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.30 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



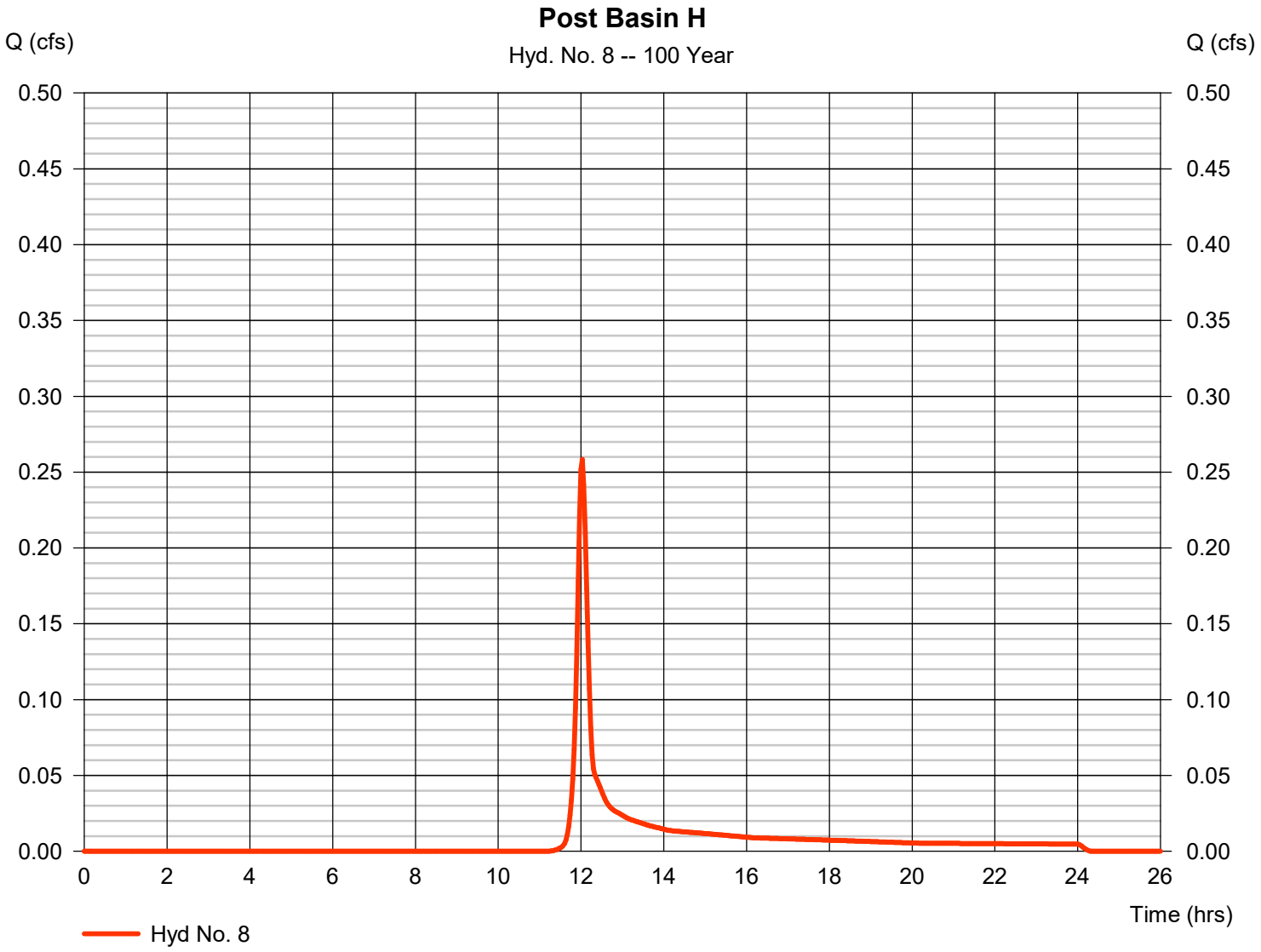
# Hydrograph Report



## Hyd. No. 8

Post Basin H

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.258 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 705 cuft |
| Drainage area | = | 0.290 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 10.60 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



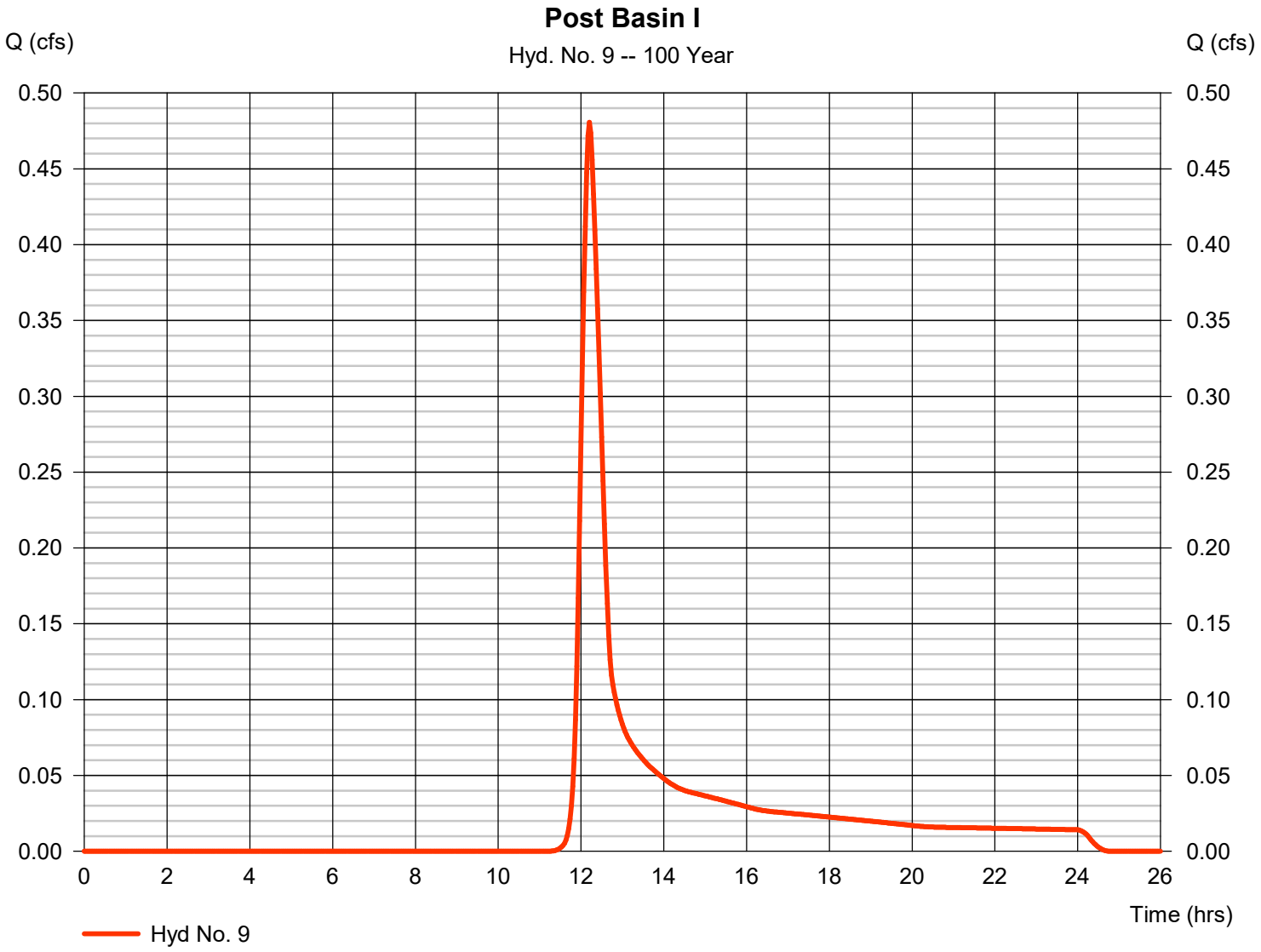
# Hydrograph Report



## Hyd. No. 9

Post Basin I

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.481 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.20 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,120 cuft |
| Drainage area | = | 0.900 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 29.00 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



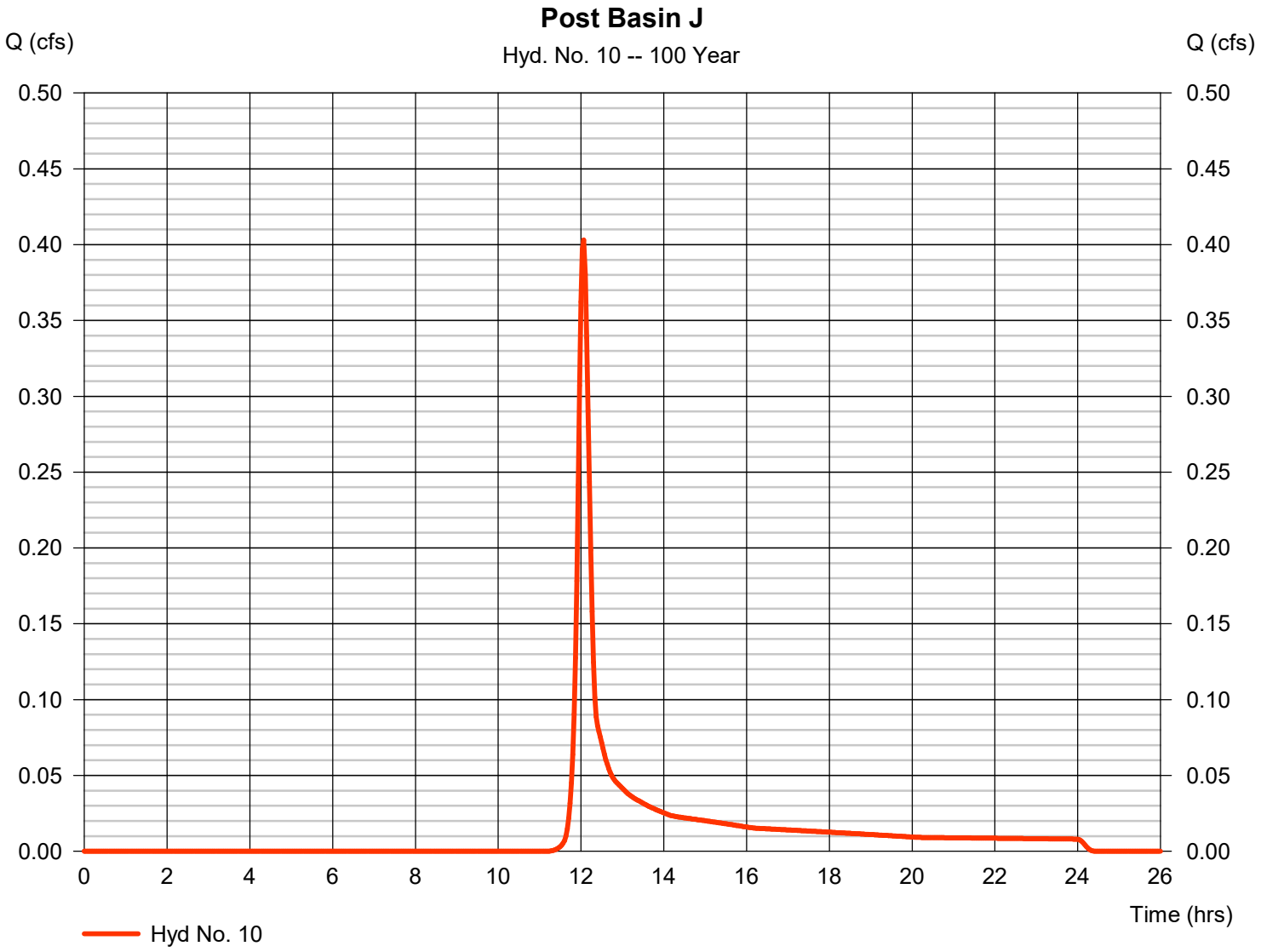
# Hydrograph Report



## Hyd. No. 10

Post Basin J

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.403 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,206 cuft |
| Drainage area | = | 0.525 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.80 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



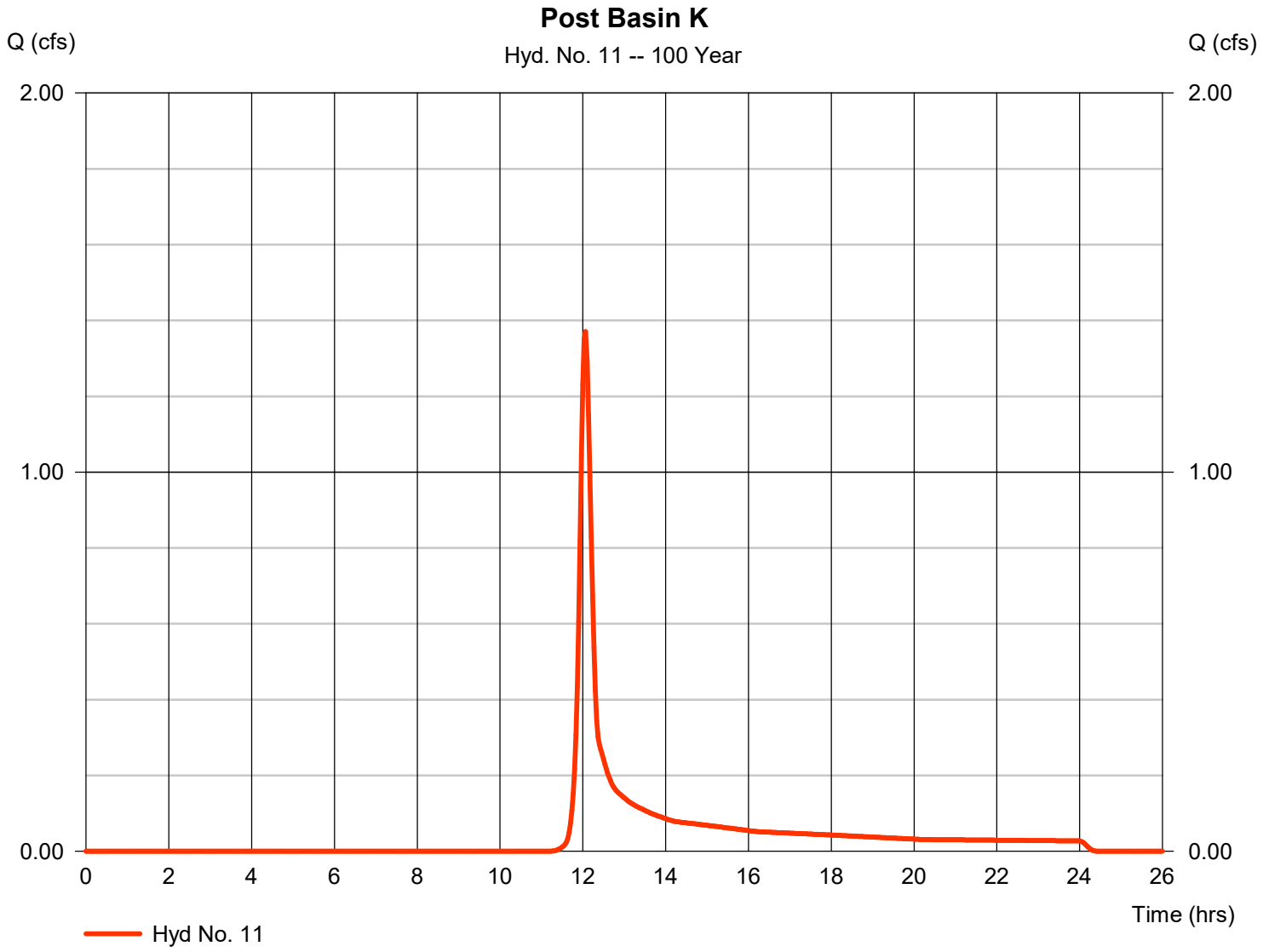
# Hydrograph Report



## Hyd. No. 11

Post Basin K

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.370 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 4,100 cuft |
| Drainage area | = | 1.785 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 15.60 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



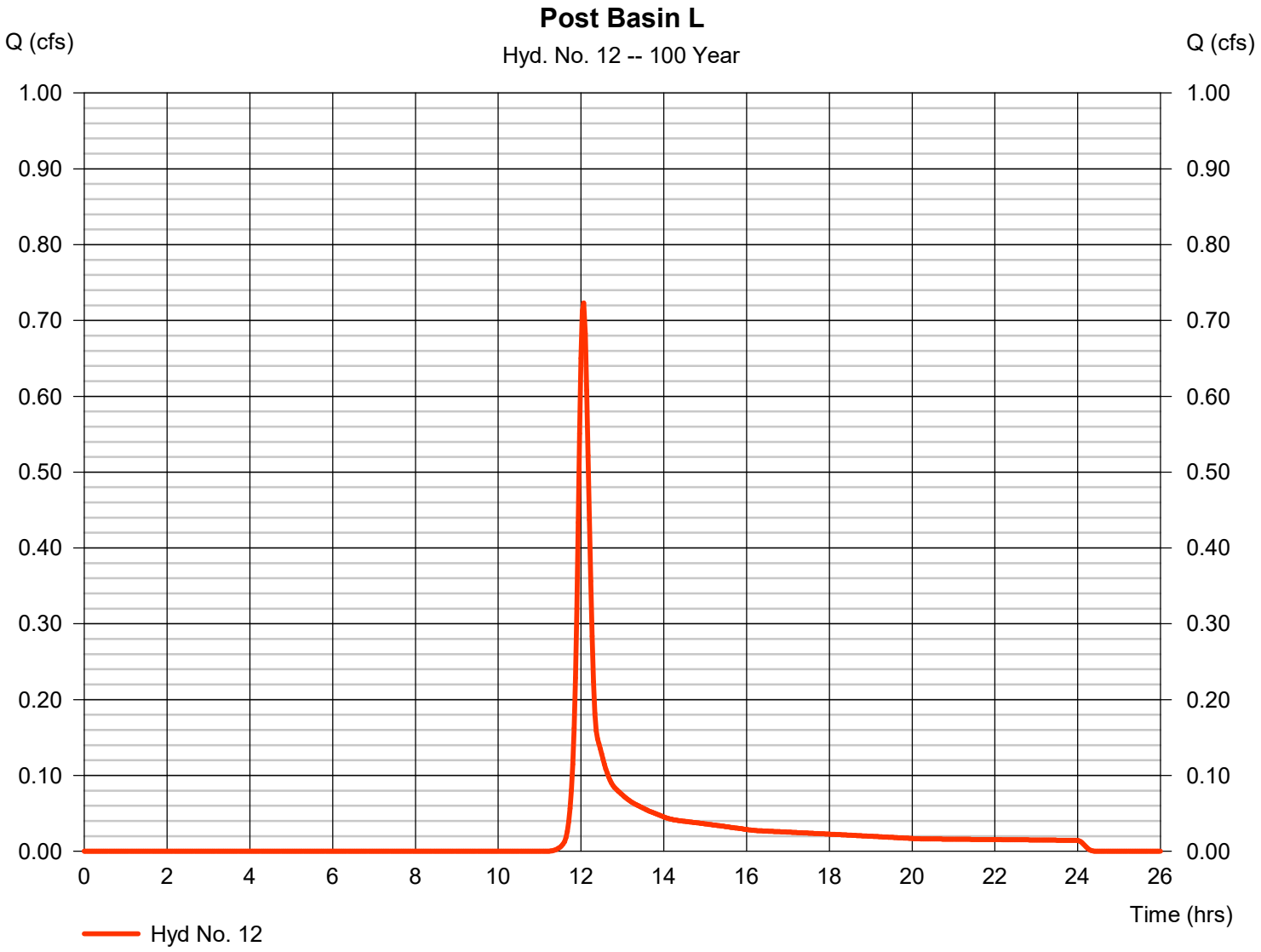
# Hydrograph Report



## Hyd. No. 12

Post Basin L

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.723 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,164 cuft |
| Drainage area | = | 0.942 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 14.10 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

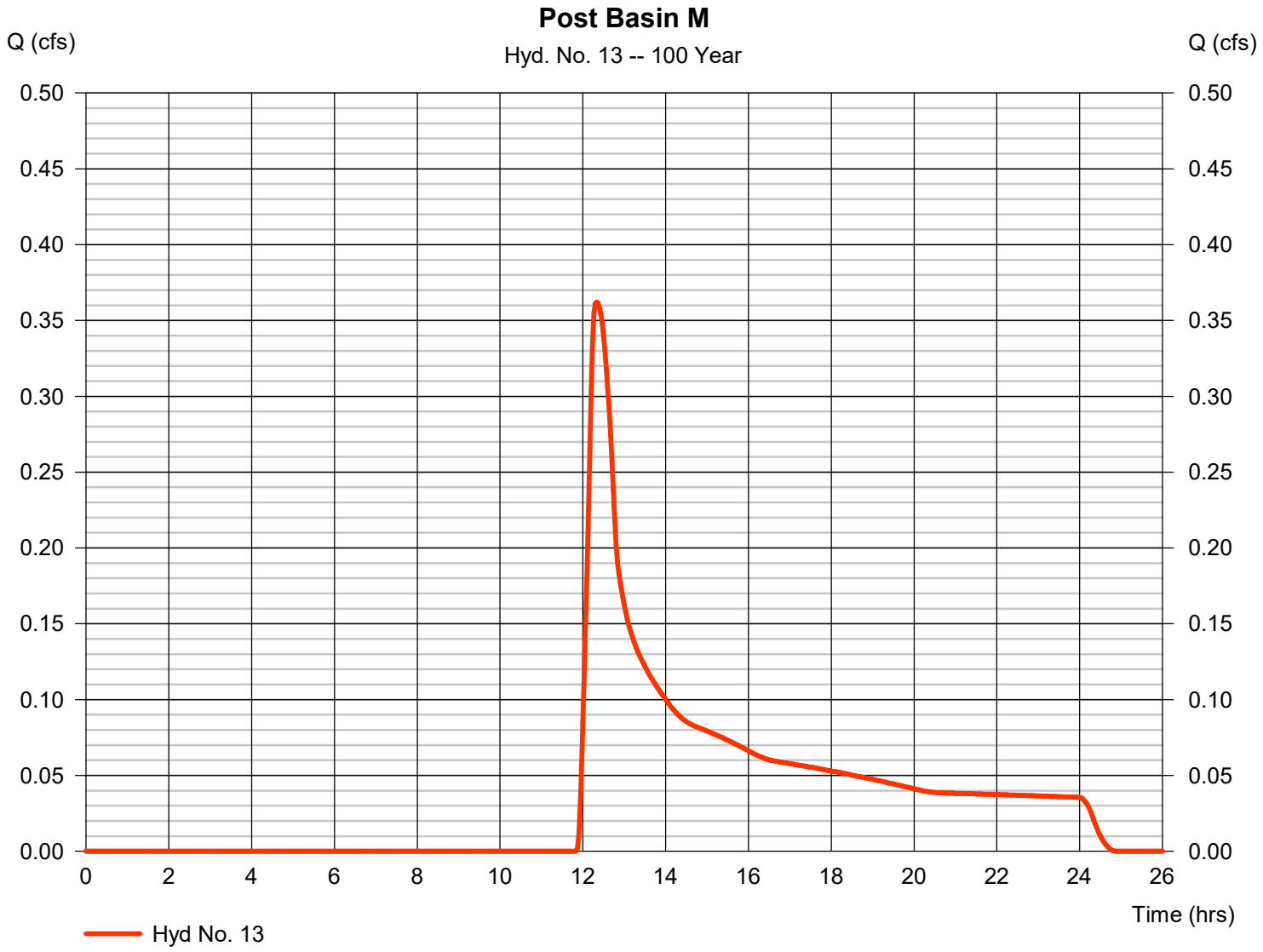


## Hyd. No. 13

Post Basin M

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.362 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.33 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 3,335 cuft |
| Drainage area | = | 4.130 ac | Curve number | = | 65* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 32.20 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.050 x 61) + (1.080 x 78)] / 4.130



# Hydrograph Report

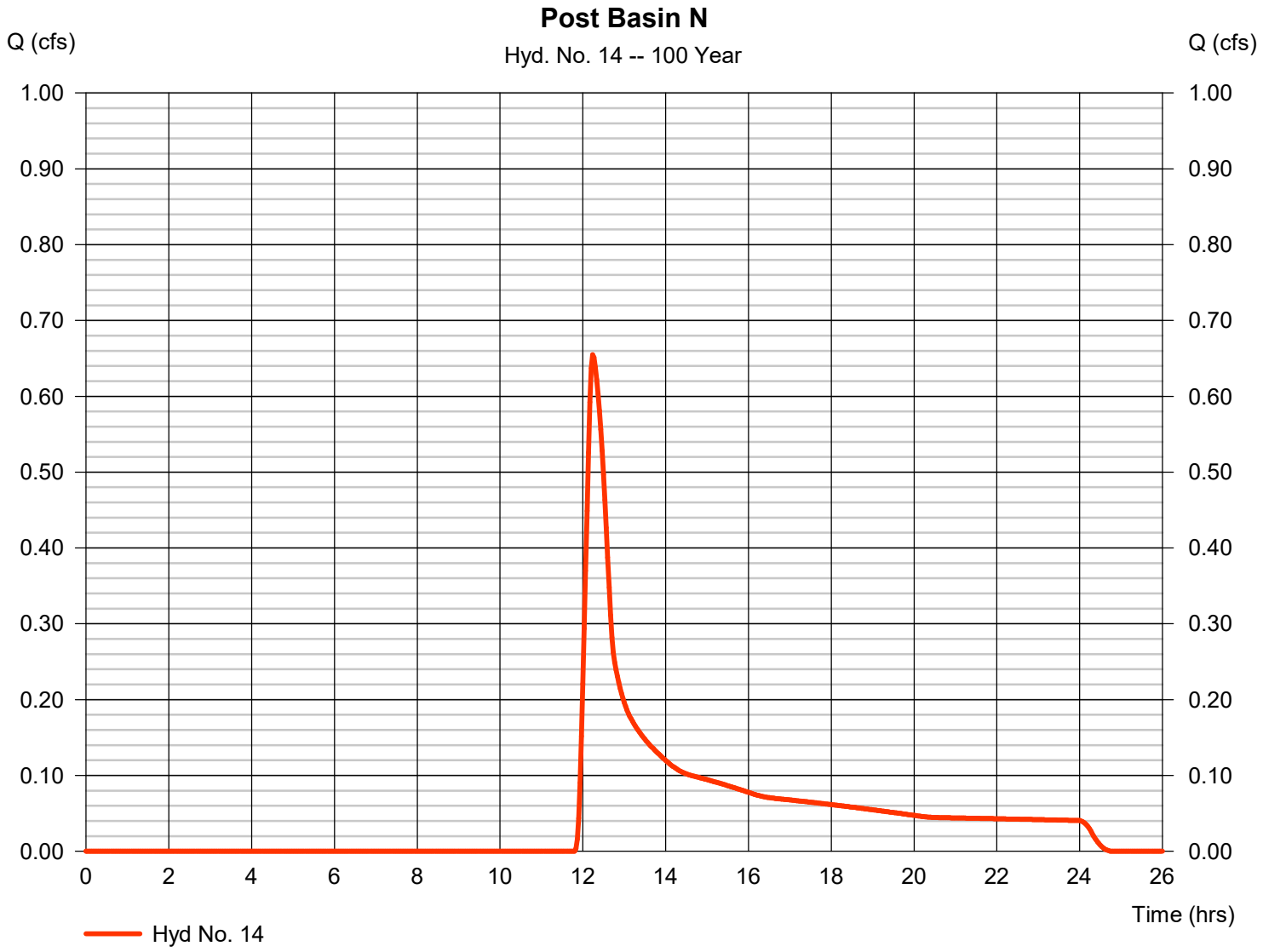


## Hyd. No. 14

Post Basin N

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.655 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.23 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 4,324 cuft |
| Drainage area | = | 4.020 ac | Curve number | = | 68* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 30.10 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(2.390 x 61) + (1.630 x 78)] / 4.020



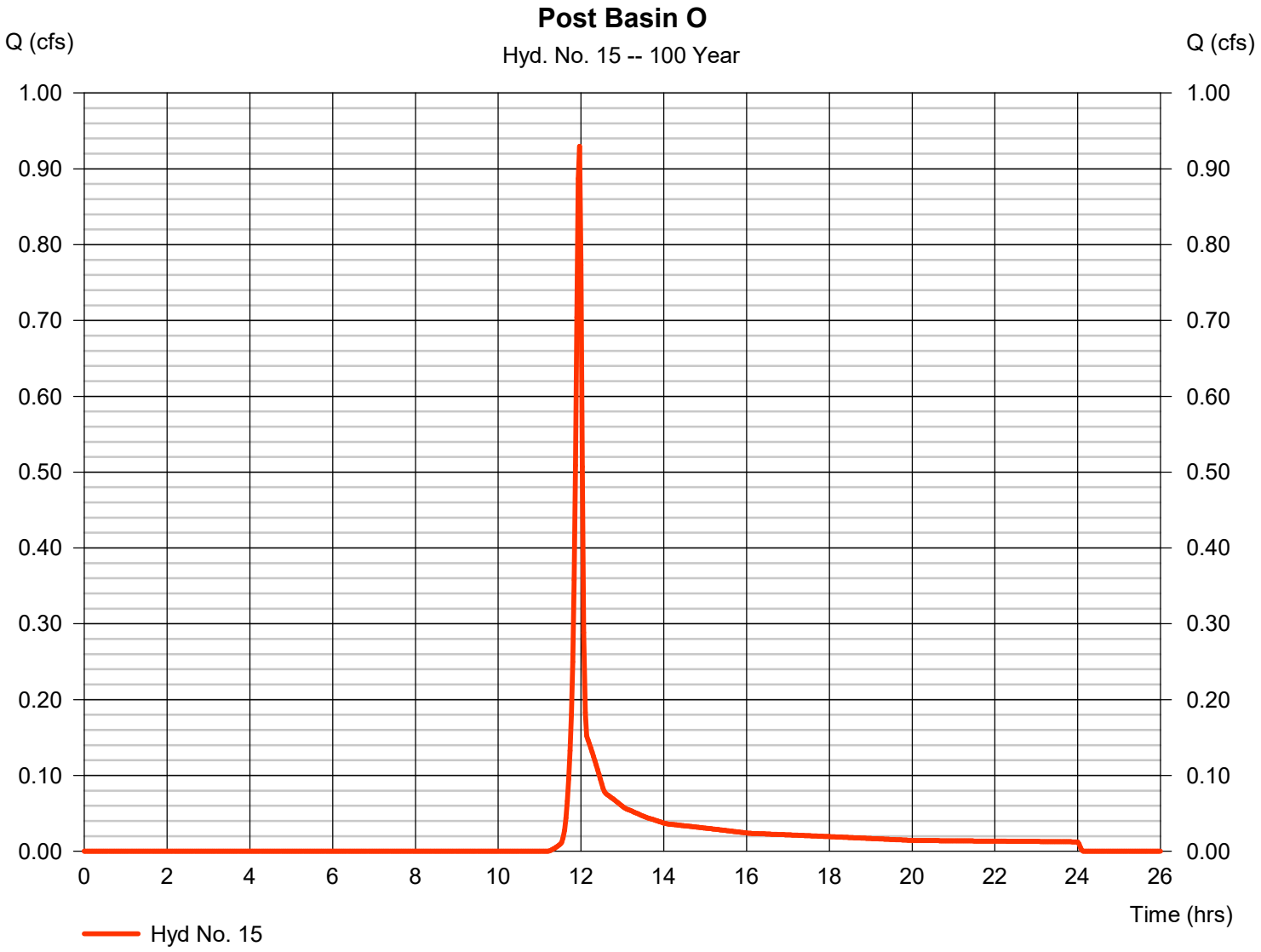
# Hydrograph Report



## Hyd. No. 15

Post Basin O

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.930 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,877 cuft |
| Drainage area | = | 0.850 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 5.70 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



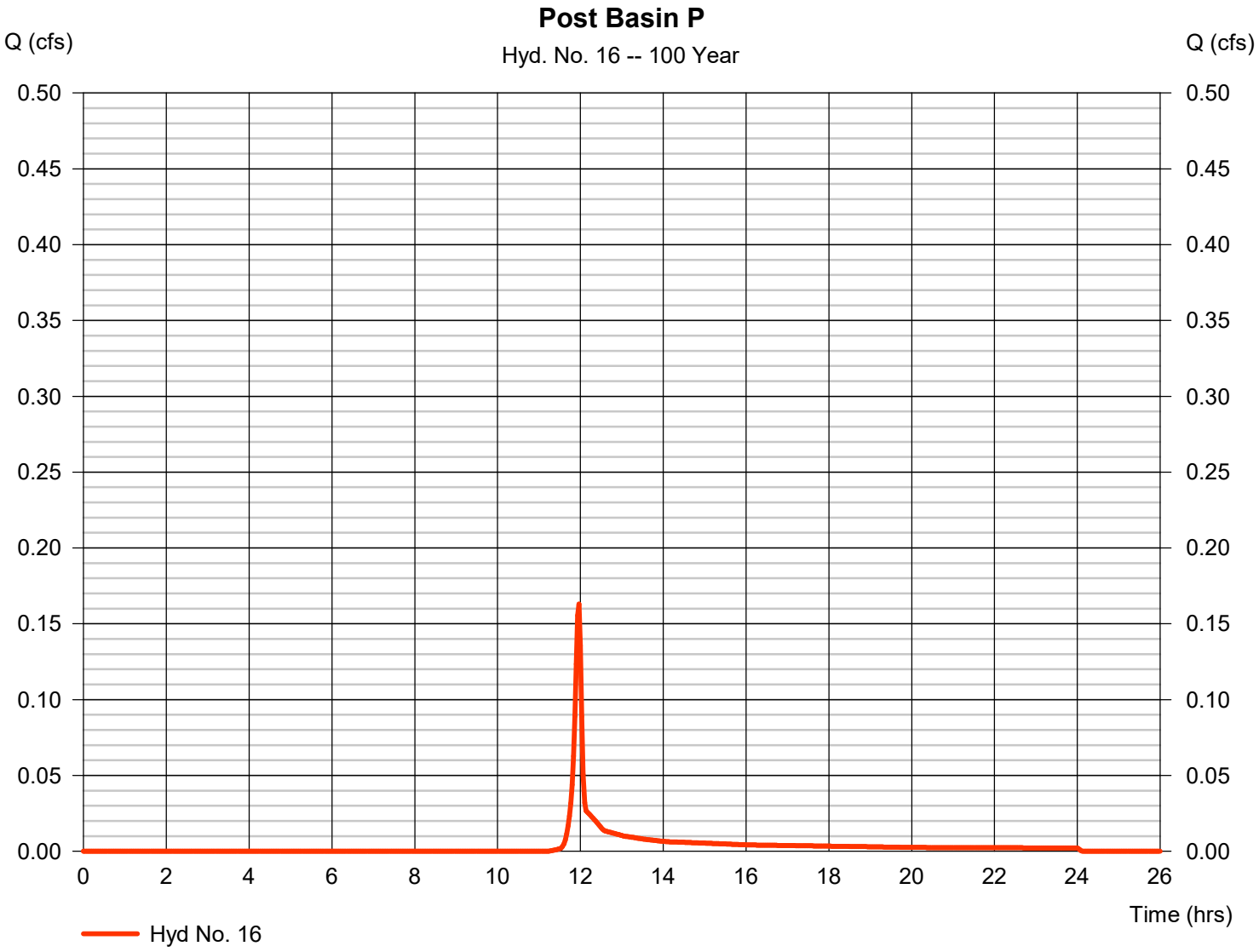
# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024 Saturday, 03 / 30 / 2024

## Hyd. No. 16

Post Basin P

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 0.163 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 11.97 hrs |
| Time interval | = 2 min | Hyd. volume | = 329 cuft |
| Drainage area | = 0.149 ac | Curve number | = 78 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = TR55 | Time of conc. (Tc) | = 5.80 min |
| Total precip. | = 2.28 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



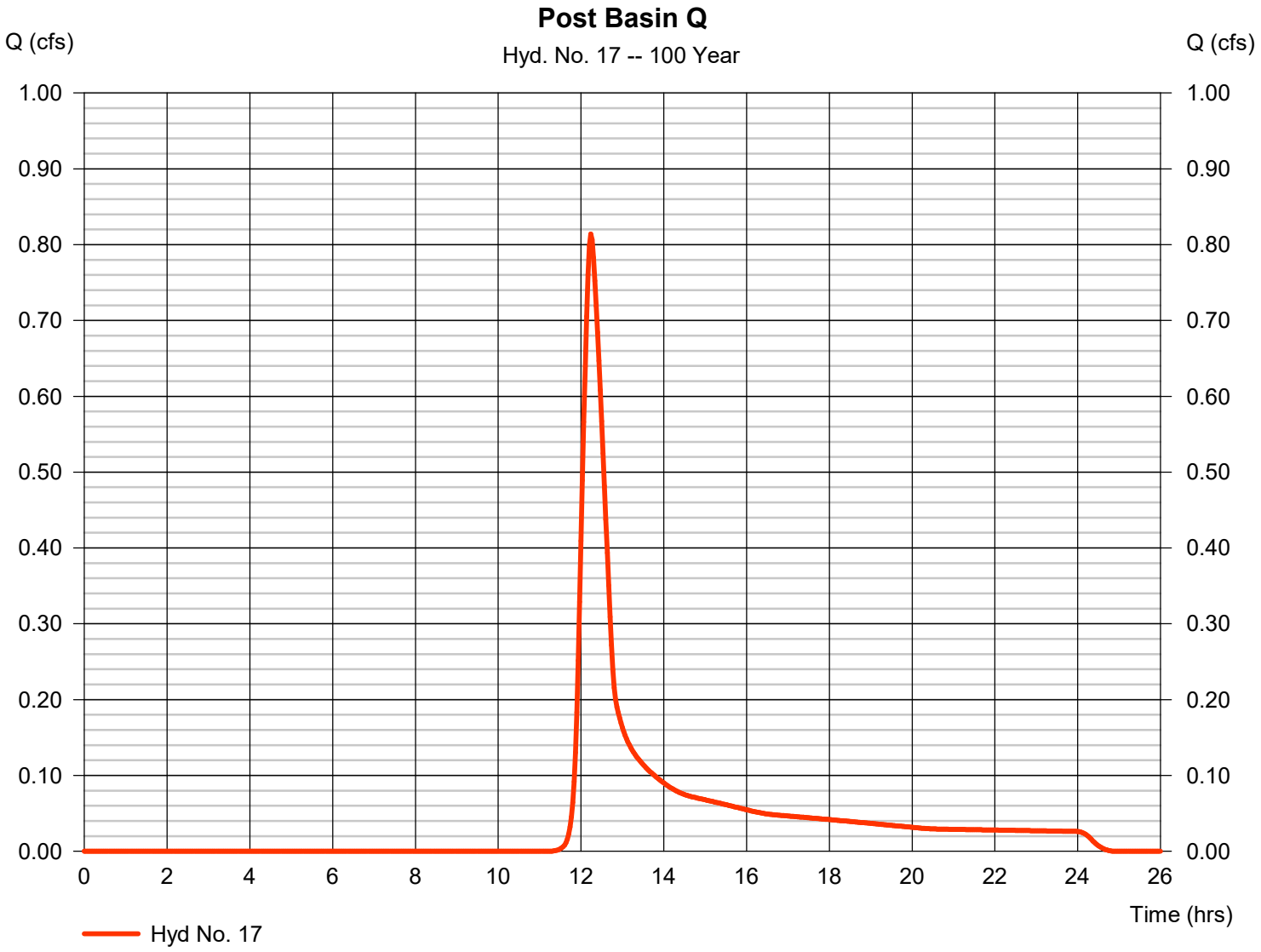
# Hydrograph Report



## Hyd. No. 17

Post Basin Q

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.814 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.23 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 3,905 cuft |
| Drainage area | = | 1.637 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 31.40 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



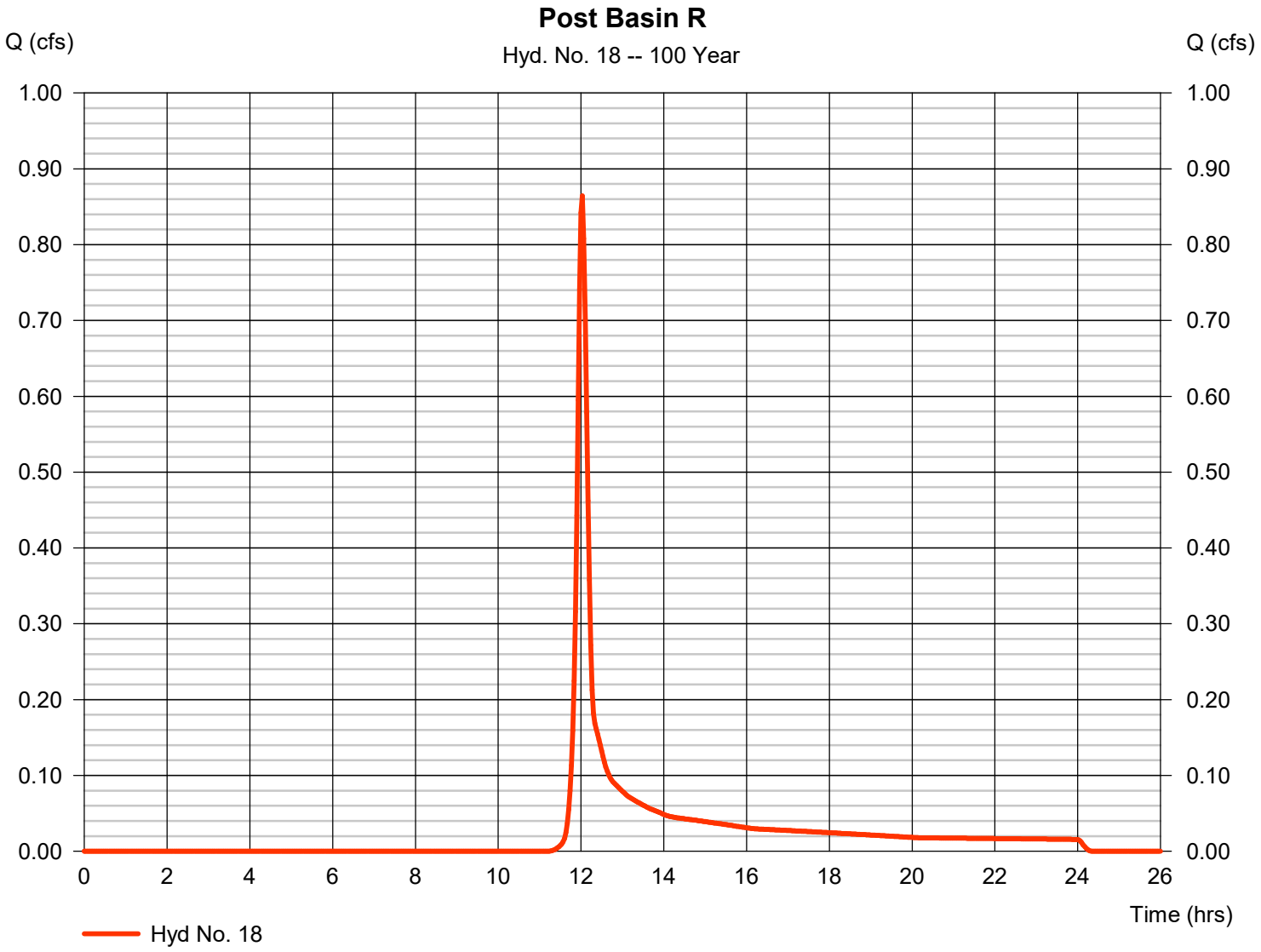
# Hydrograph Report



## Hyd. No. 18

Post Basin R

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.864 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,357 cuft |
| Drainage area | = | 0.970 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.90 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



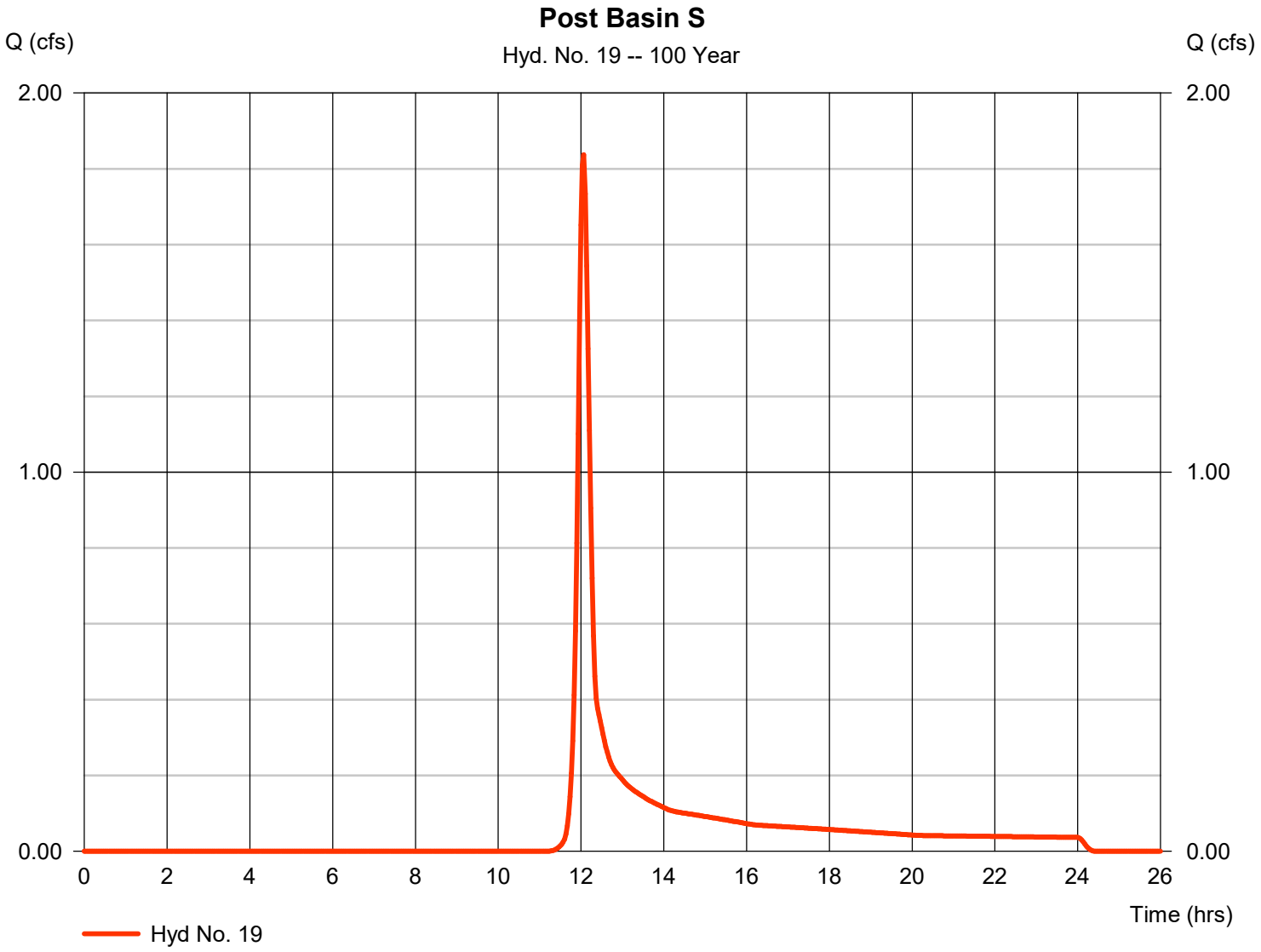
# Hydrograph Report



## Hyd. No. 19

Post Basin S

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.837 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.07 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 5,497 cuft |
| Drainage area | = | 2.393 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.80 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



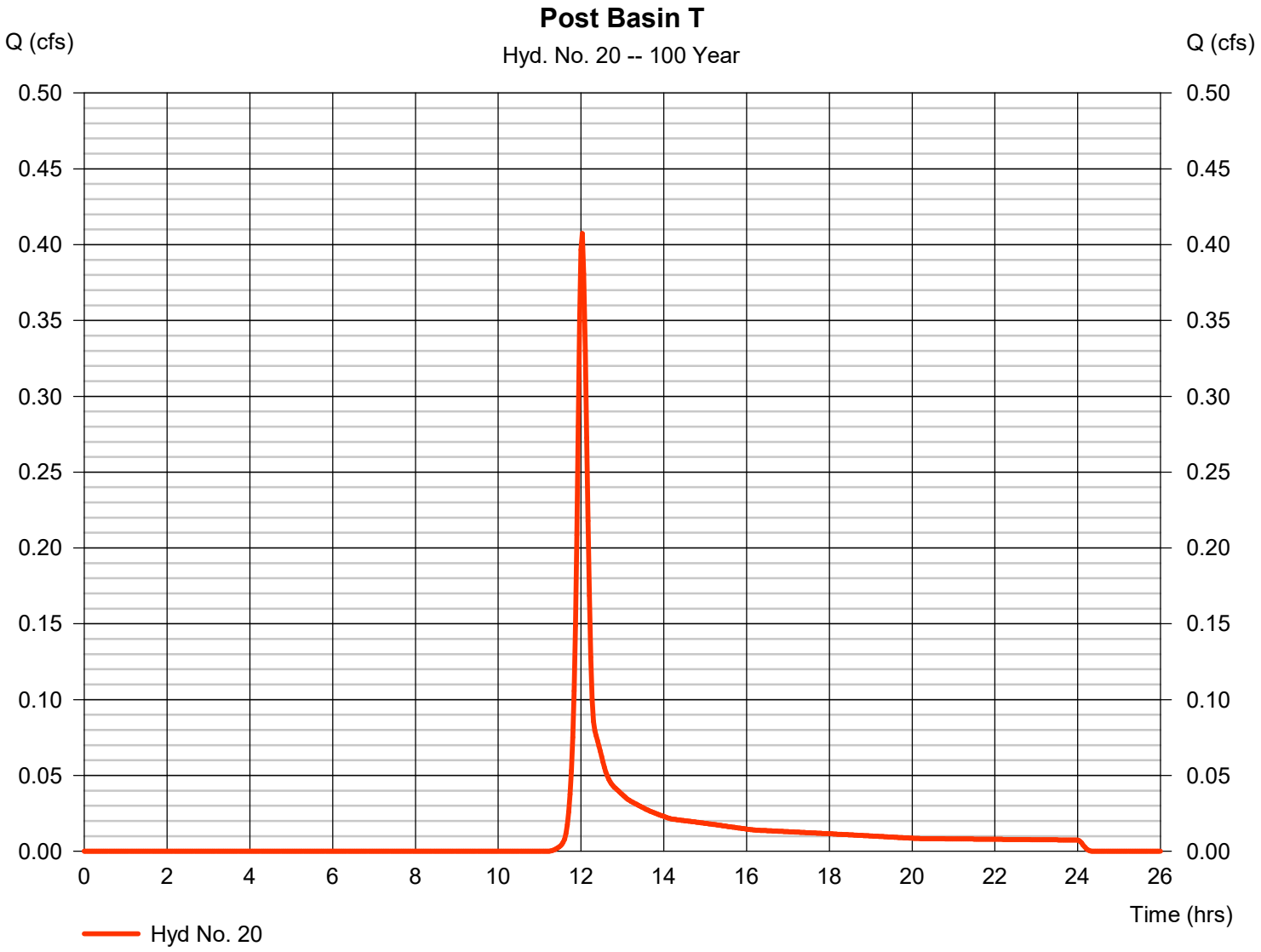
# Hydrograph Report



## Hyd. No. 20

Post Basin T

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.407 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,110 cuft |
| Drainage area | = | 0.457 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 12.30 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



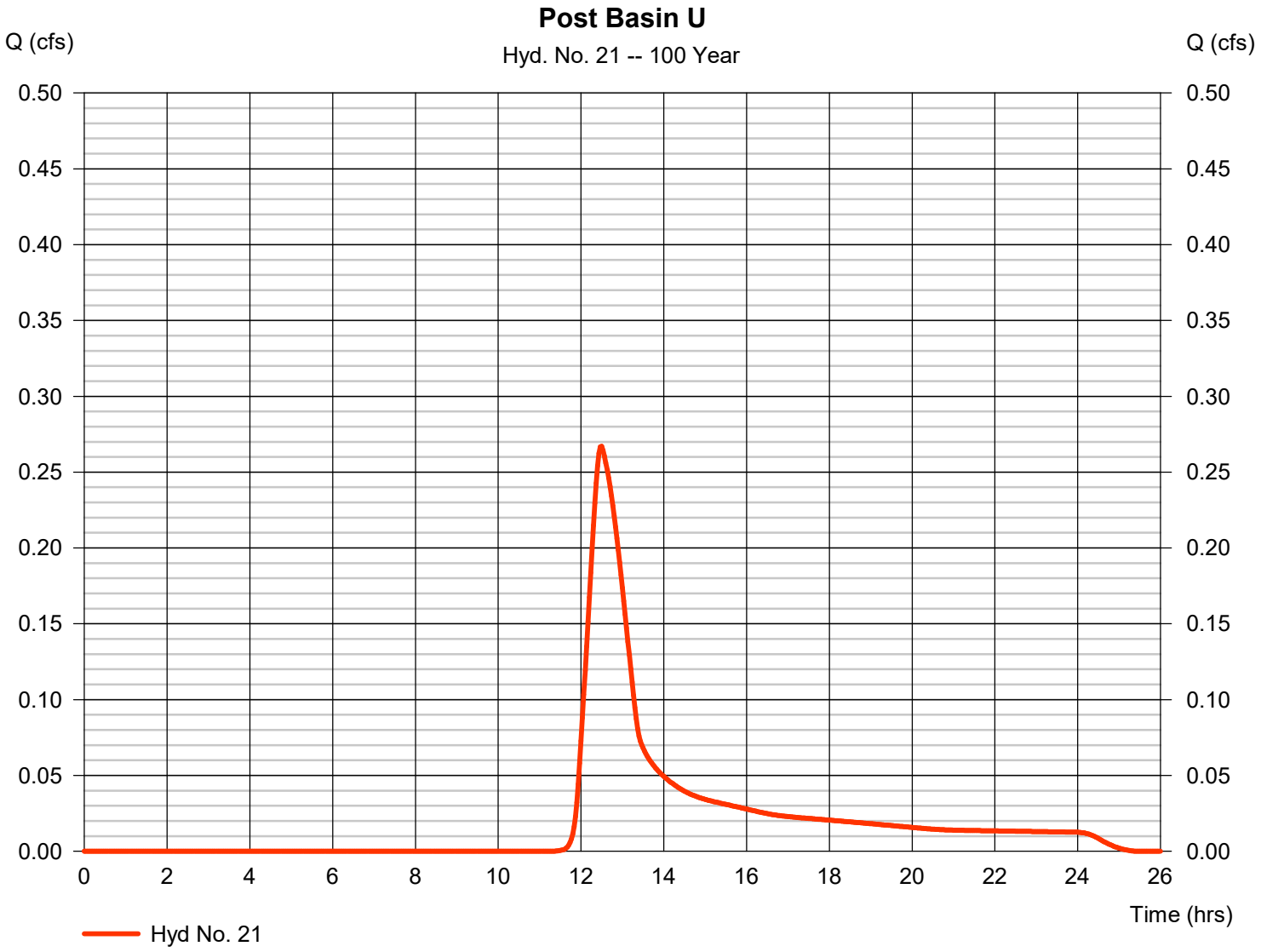
# Hydrograph Report



## Hyd. No. 21

Post Basin U

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.267 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.50 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,859 cuft |
| Drainage area | = | 0.795 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 54.70 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



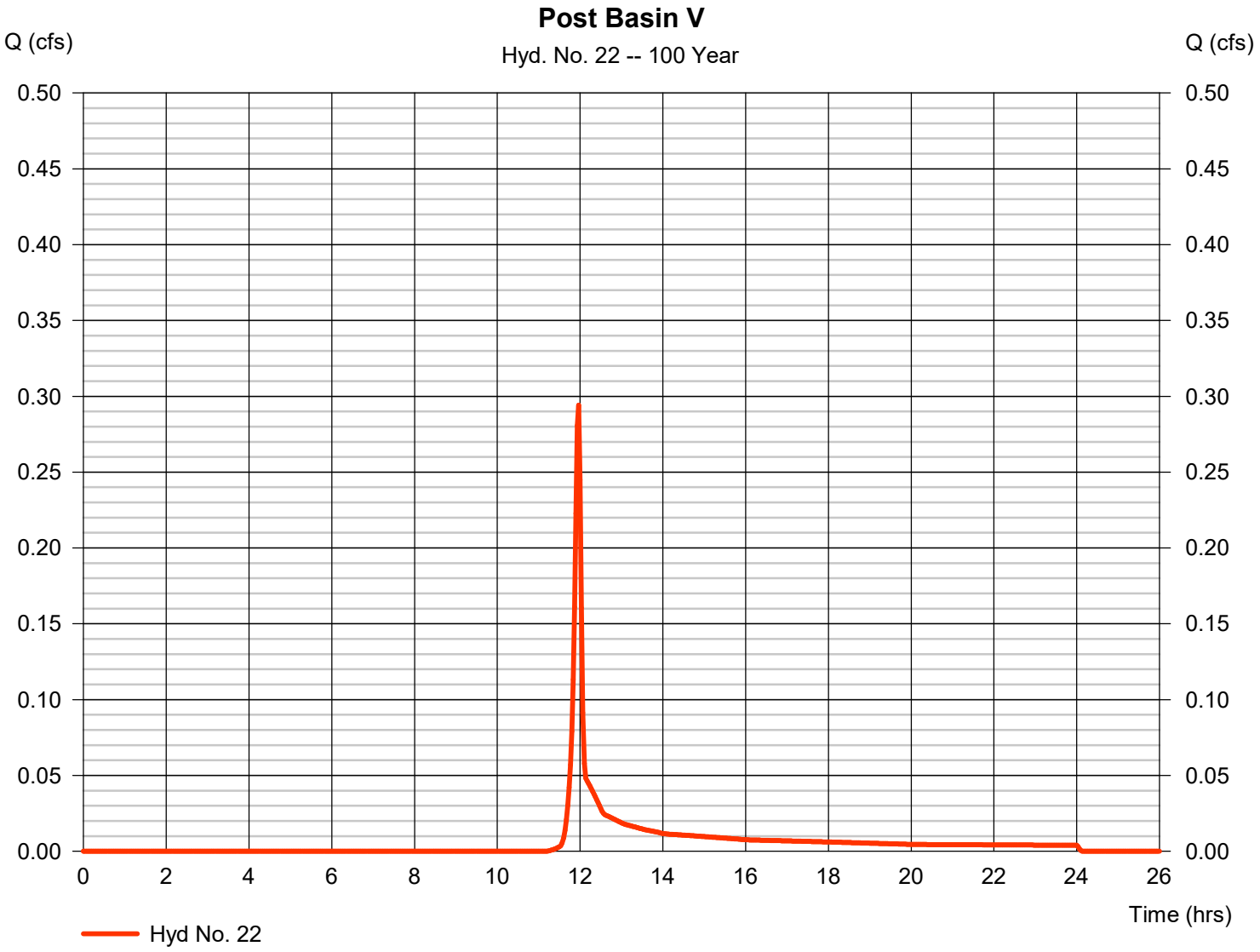
# Hydrograph Report



## Hyd. No. 22

Post Basin V

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.294 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 594 cuft |
| Drainage area | = | 0.269 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | User | Time of conc. (Tc) | = | 5.00 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



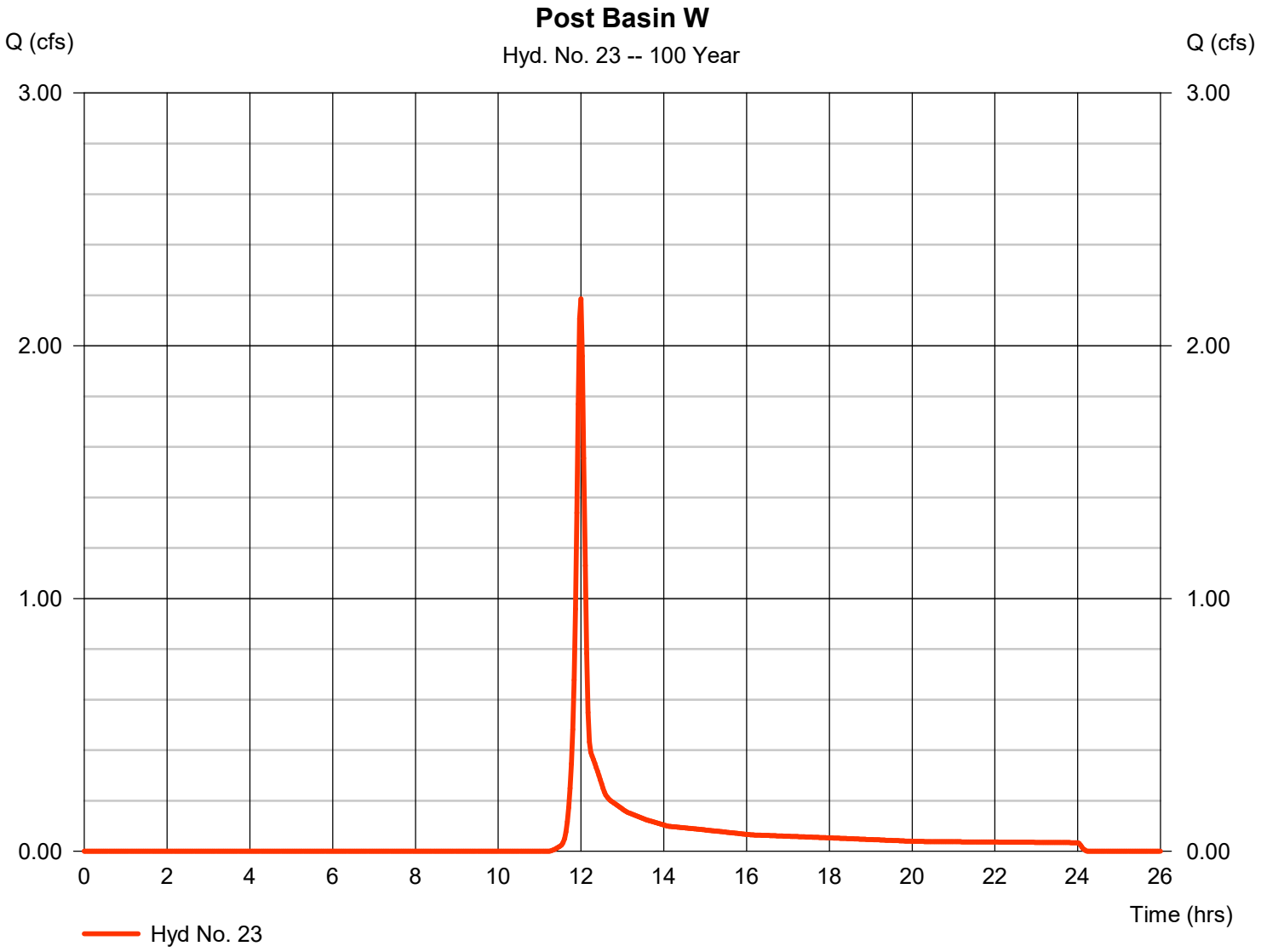
# Hydrograph Report



## Hyd. No. 23

Post Basin W

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 2.185 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 5,129 cuft |
| Drainage area | = | 2.177 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 8.50 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



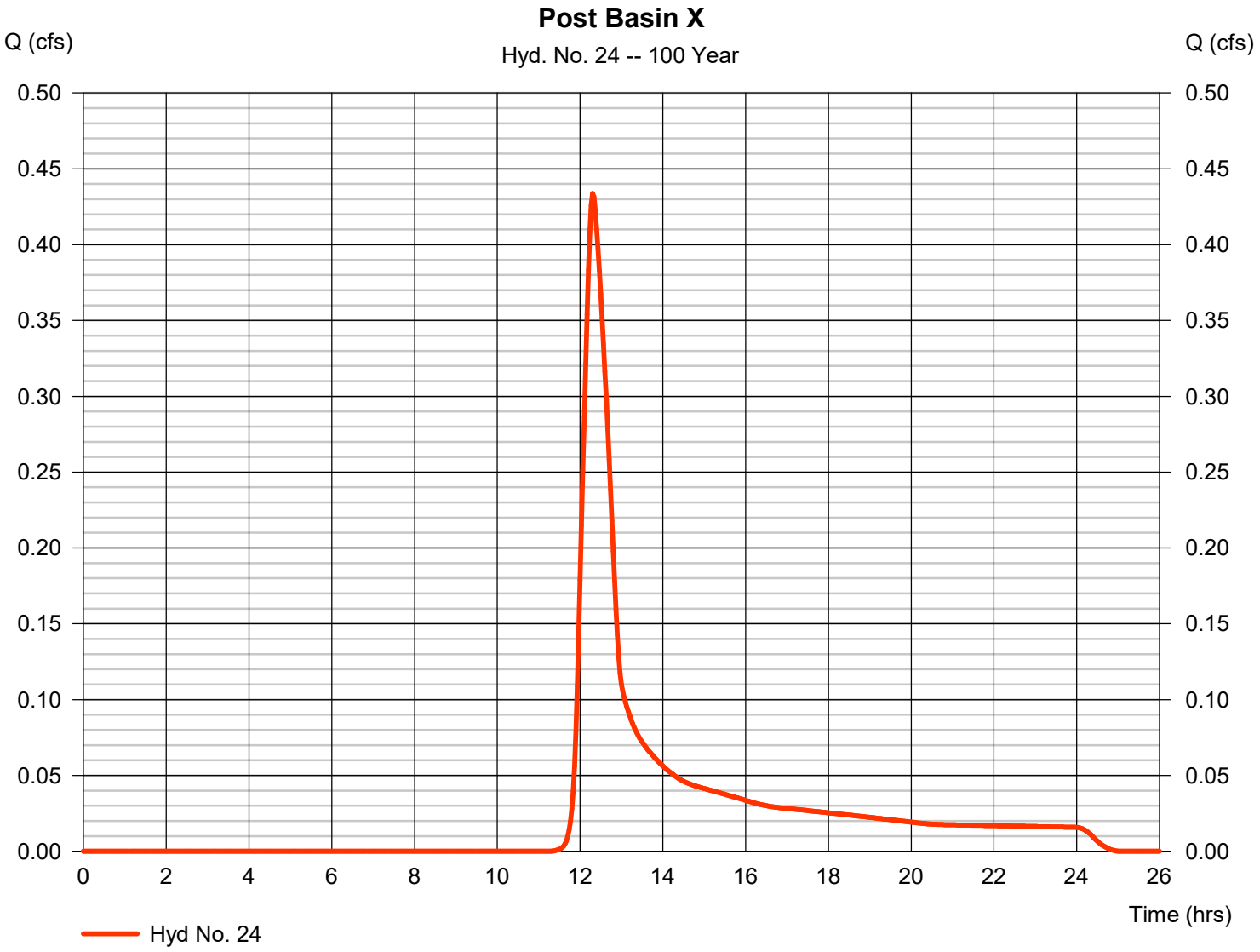
# Hydrograph Report



## Hyd. No. 24

Post Basin X

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.434 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.30 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 2,349 cuft |
| Drainage area | = | 0.997 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 39.50 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



# Hydrograph Report

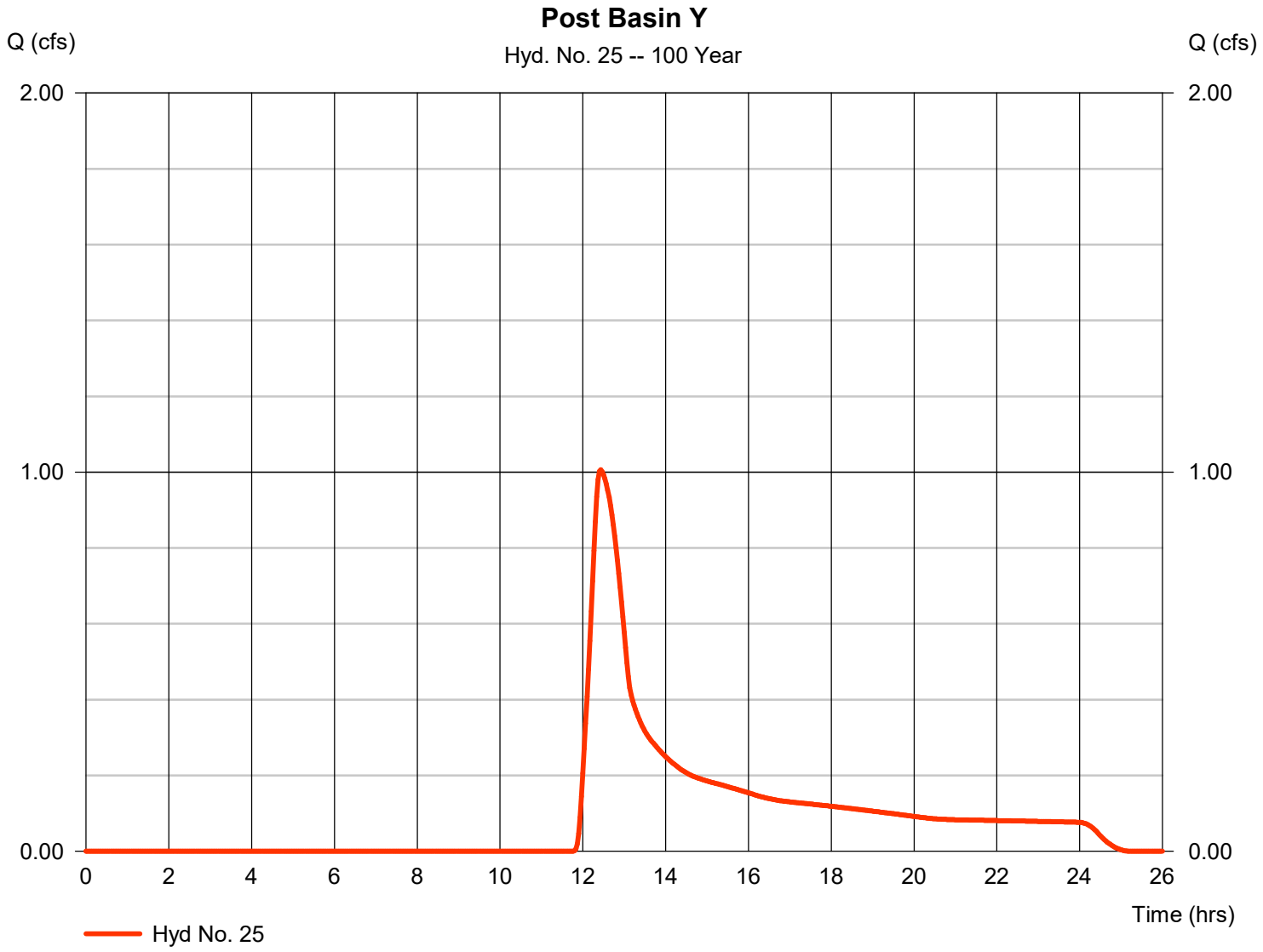


## Hyd. No. 25

Post Basin Y

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.006 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.43 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 8,438 cuft |
| Drainage area | = | 7.220 ac | Curve number | = | 69* |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 44.60 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |

* Composite (Area/CN) = [(3.896 x 61) + (3.323 x 78)] / 7.220



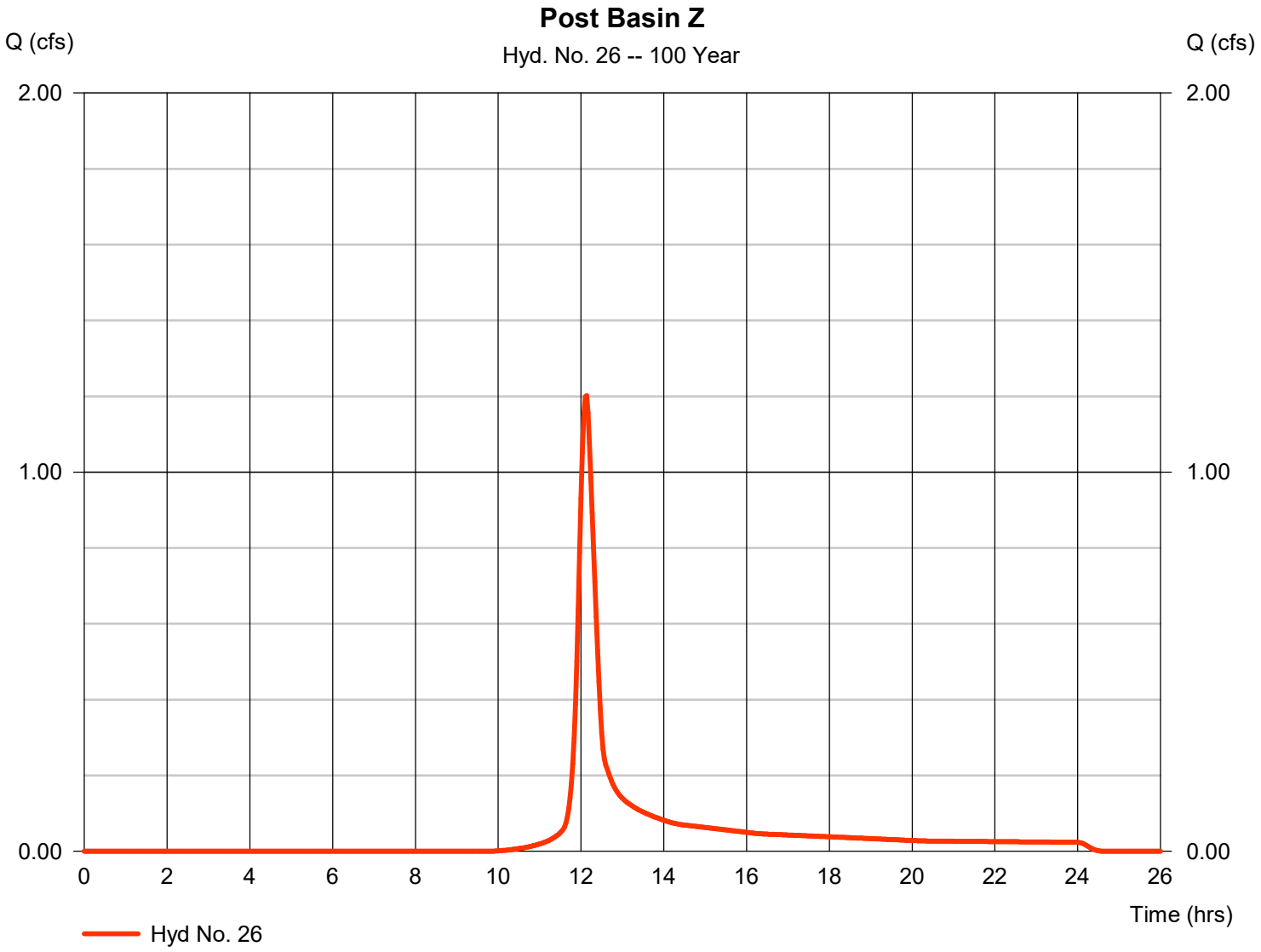
# Hydrograph Report



## Hyd. No. 26

Post Basin Z

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.202 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.13 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 4,239 cuft |
| Drainage area | = | 1.210 ac | Curve number | = | 84 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 21.00 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



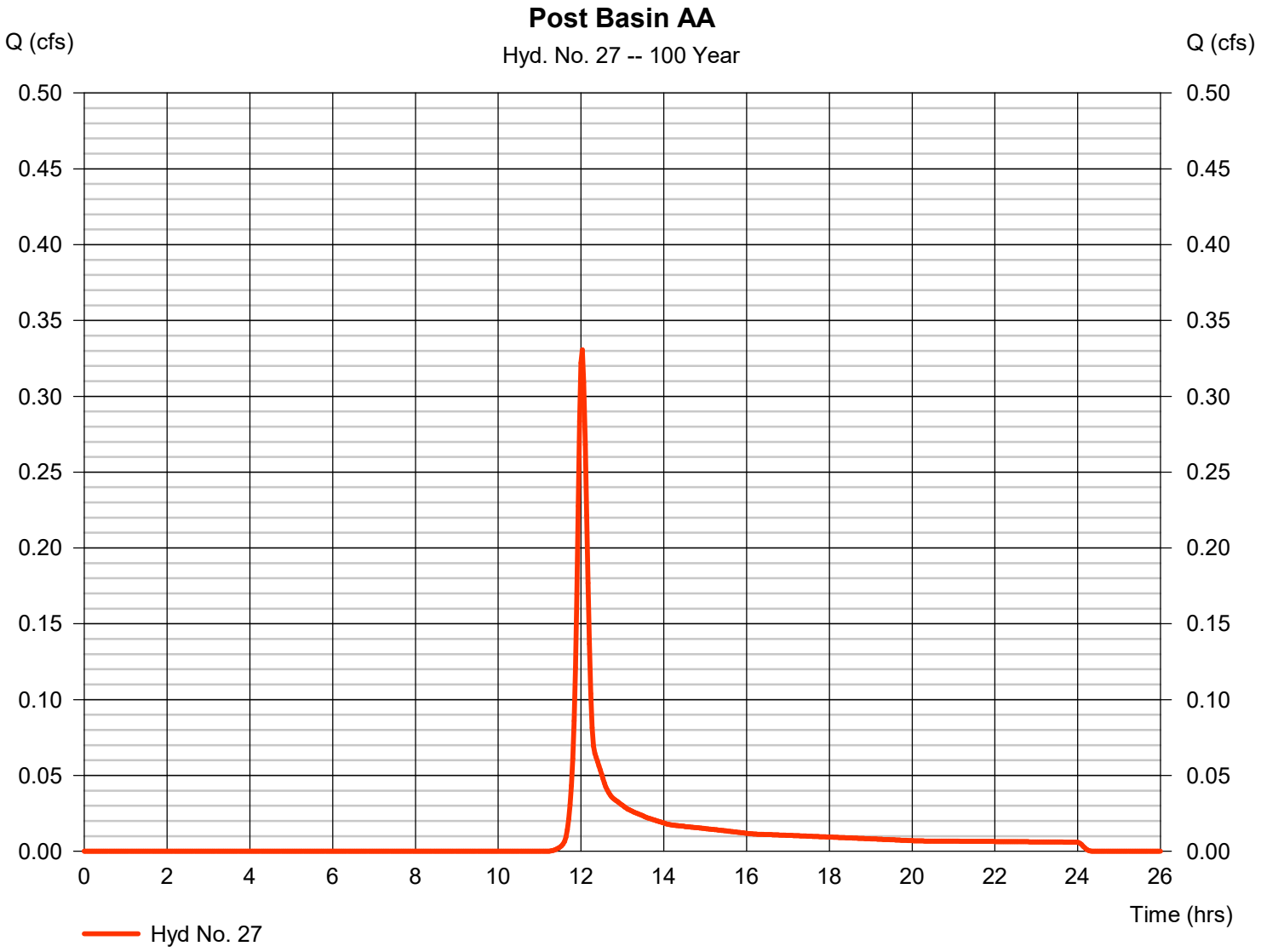
# Hydrograph Report



## Hyd. No. 27

Post Basin AA

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.331 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.03 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 901 cuft |
| Drainage area | = | 0.371 ac | Curve number | = | 78 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 13.30 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



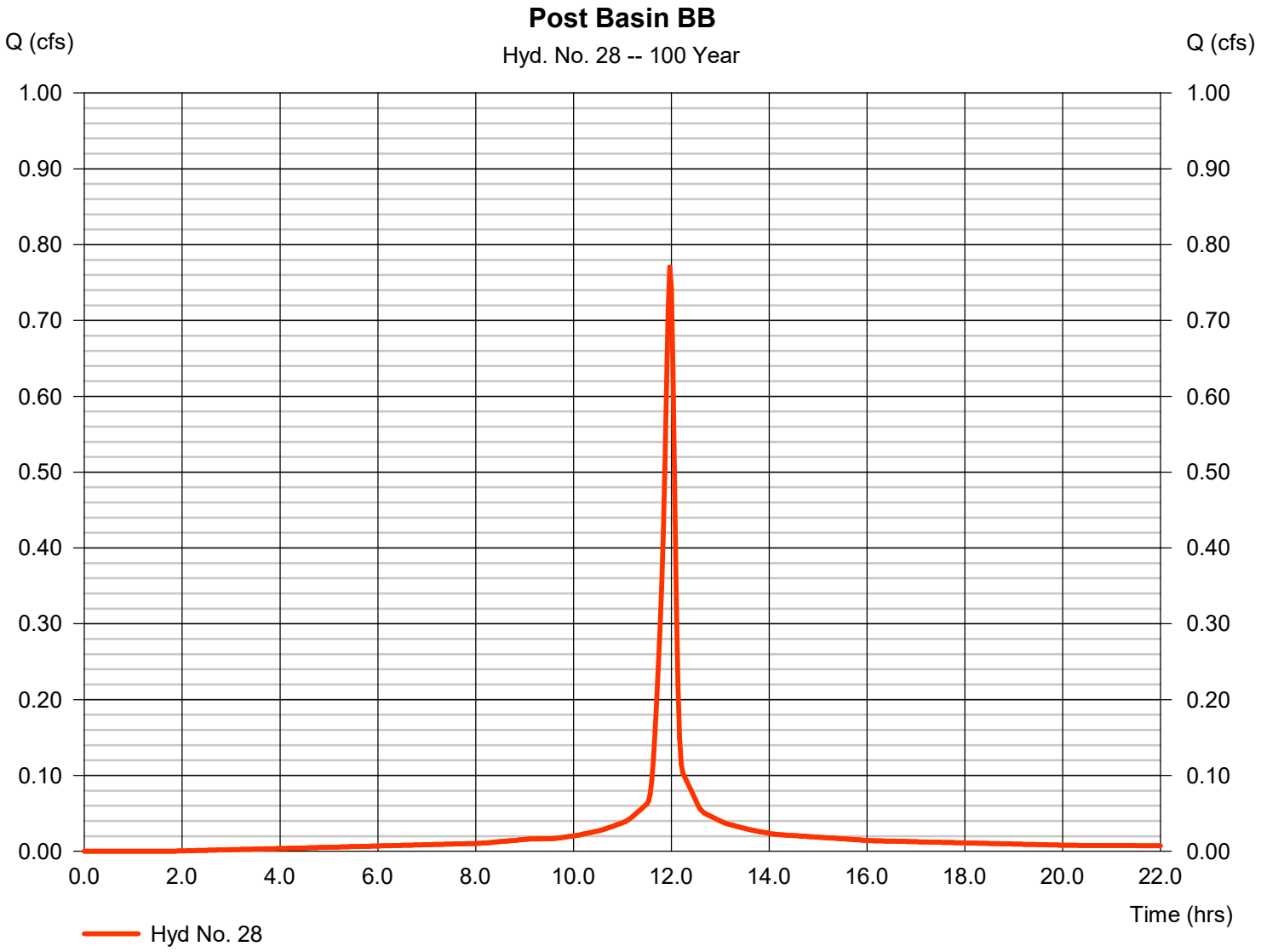
# Hydrograph Report



## Hyd. No. 28

Post Basin BB

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 0.770 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 11.97 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 1,974 cuft |
| Drainage area | = | 0.265 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 7.10 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



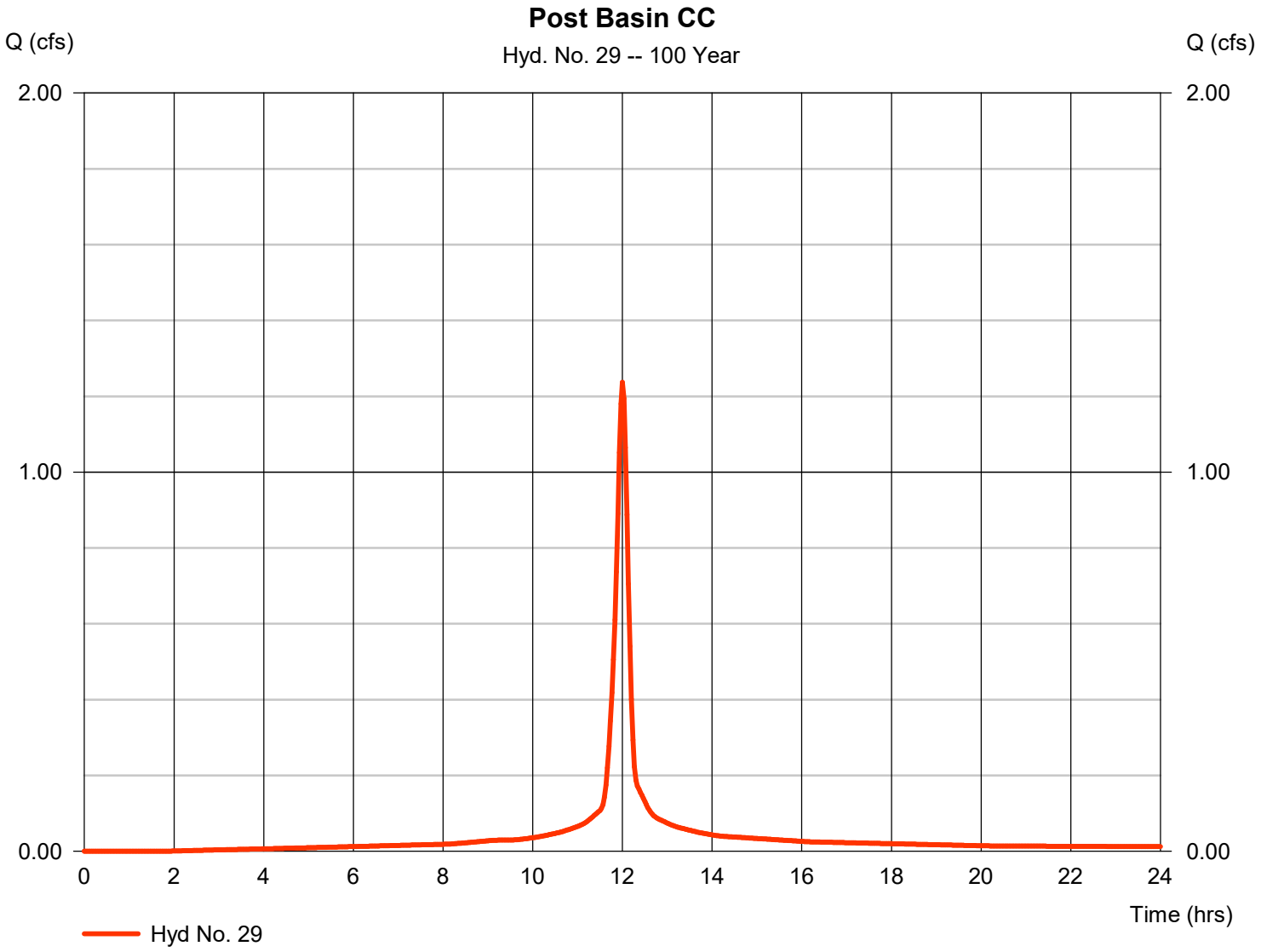
# Hydrograph Report



## Hyd. No. 29

Post Basin CC

| | | | | | |
|---|---|---|---|---|---|
| Hydrograph type | = | SCS Runoff | Peak discharge | = | 1.237 cfs |
| Storm frequency | = | 100 yrs | Time to peak | = | 12.00 hrs |
| Time interval | = | 2 min | Hyd. volume | = | 3,549 cuft |
| Drainage area | = | 0.462 ac | Curve number | = | 98 |
| Basin Slope | = | 0.0 % | Hydraulic length | = | 0 ft |
| Tc method | = | TR55 | Time of conc. (Tc) | = | 11.60 min |
| Total precip. | = | 2.28 in | Distribution | = | Type II |
| Storm duration | = | 24 hrs | Shape factor | = | 484 |



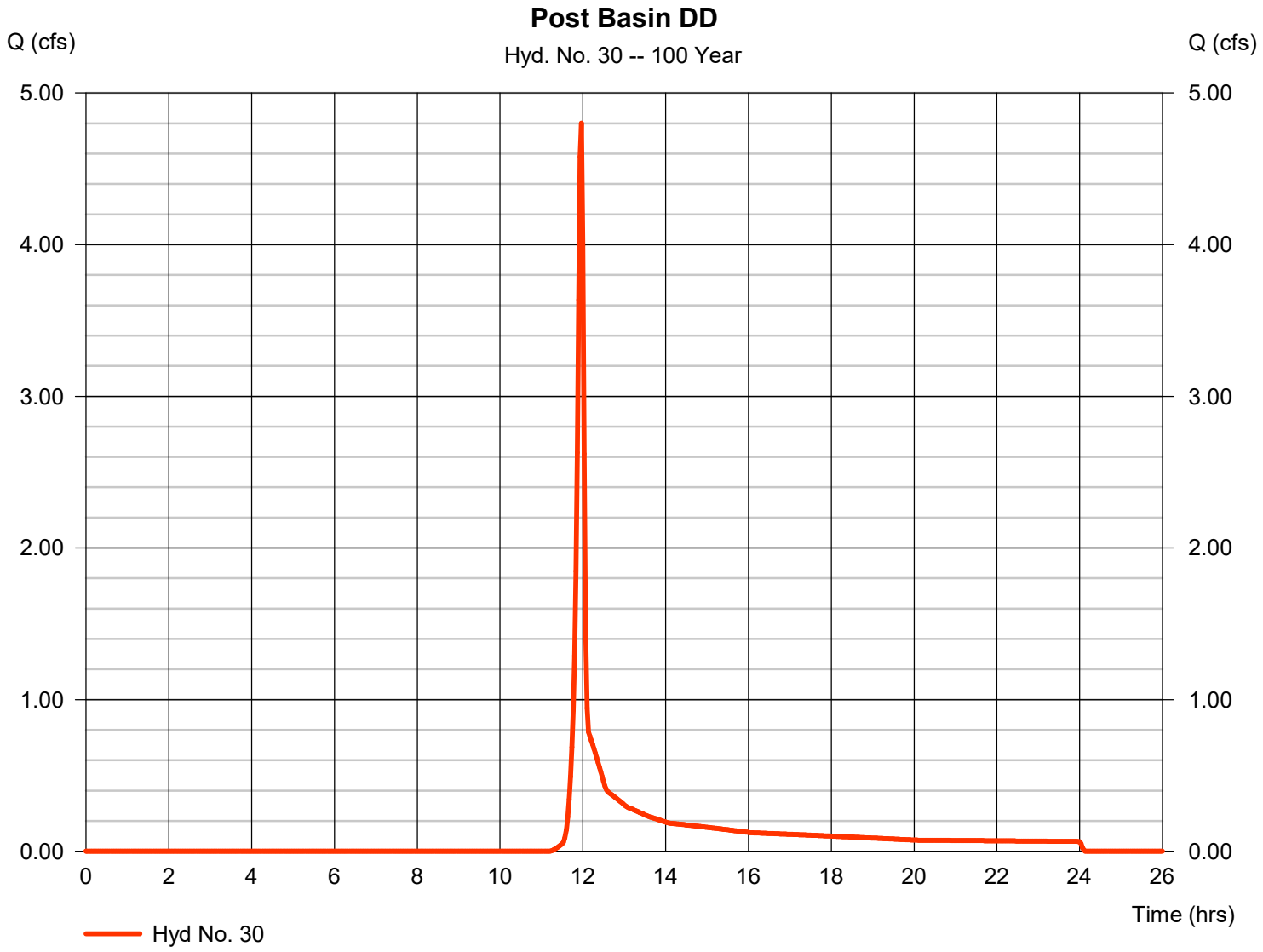
# Hydrograph Report



## Hyd. No. 30

Post Basin DD

| | | | |
|---|---|---|---|
| Hydrograph type | = SCS Runoff | Peak discharge | = 4.801 cfs |
| Storm frequency | = 100 yrs | Time to peak | = 11.97 hrs |
| Time interval | = 2 min | Hyd. volume | = 9,696 cuft |
| Drainage area | = 4.390 ac | Curve number | = 78 |
| Basin Slope | = 0.0 % | Hydraulic length | = 0 ft |
| Tc method | = User | Time of conc. (Tc) | = 5.00 min |
| Total precip. | = 2.28 in | Distribution | = Type II |
| Storm duration | = 24 hrs | Shape factor | = 484 |



# Hydraflow Table of Contents



## 2 - Year

# Appendix H

# NRCS Soil Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

# Custom Soil Resource Report for Missoula County Area, Montana


January 6, 2023

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

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

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map


Map Scale: 1:3,870 if printed on A portrait (8.5" x 11") sheet.

N

0 50 100 200 300 Meters

0 150 300 600 900 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Missoula County Area, Montana
Survey Area Data: Version 20, Aug 26, 2022

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

Date(s) aerial images were photographed: Aug 13, 2022—Aug 16, 2022

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 1 | Alberton very fine sandy loam, 0 to 2 percent slopes | 33.3 | 95.5% |
| 34 | Desmet loam, 0 to 2 percent slopes | 0.1 | 0.3% |
| 114 | Urban land | 1.2 | 3.6% |
| 138 | Water-Riverwash complex | 0.2 | 0.6% |
| **Totals for Area of Interest** | | **34.9** | **100.0%** |

# Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

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

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

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

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

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

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

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

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

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

# Missoula County Area, Montana

## 1—Alberton very fine sandy loam, 0 to 2 percent slopes

### Map Unit Setting

*National map unit symbol:* 4w8w
*Elevation:* 2,700 to 3,500 feet
*Mean annual precipitation:* 11 to 16 inches
*Mean annual air temperature:* 43 to 45 degrees F
*Frost-free period:* 105 to 120 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

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

### Description of Alberton

#### Setting

*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium

#### Typical profile

*Ap - 0 to 9 inches:* very fine sandy loam
*A - 9 to 16 inches:* sandy loam
*Bw - 16 to 30 inches:* sandy loam
*BC - 30 to 60 inches:* loamy sand

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High (1.98 to 5.95 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water supply, 0 to 60 inches:* Moderate (about 7.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 2c
*Land capability classification (nonirrigated):* 3c
*Hydrologic Soil Group:* A
*Ecological site:* R043AP810MT - Upland Grassland Group
*Hydric soil rating:* No

### Minor Components

#### Desmet

*Percent of map unit:* 5 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear

*Ecological site:* R044AA032MT - Loamy (Lo) LRU 44A-A
*Hydric soil rating:* No

**Grantsdale**

*Percent of map unit:* 5 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AB032MT - Loamy (Lo) LRU 44A-B
*Hydric soil rating:* No

**Moiese**

*Percent of map unit:* 5 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044BA134MT - Shallow to Gravel (SwGr) LRU 01 Subset A
*Hydric soil rating:* No

## 34—Desmet loam, 0 to 2 percent slopes

### Map Unit Setting

*National map unit symbol:* 4wbz
*Elevation:* 2,700 to 5,200 feet
*Mean annual precipitation:* 10 to 19 inches
*Mean annual air temperature:* 39 to 45 degrees F
*Frost-free period:* 90 to 120 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

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

### Description of Desmet

#### Setting

*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium

#### Typical profile

*Ap - 0 to 7 inches:* loam
*A - 7 to 15 inches:* loam
*Bk - 15 to 24 inches:* loam
*BC1 - 24 to 39 inches:* very fine sandy loam
*BC2 - 39 to 60 inches:* very fine sandy loam

#### Properties and qualities

*Slope:* 0 to 2 percent

*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 15 percent
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* High (about 9.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 2c
*Land capability classification (nonirrigated):* 3c
*Hydrologic Soil Group:* B
*Ecological site:* R043BP818MT - Upland Grassland Group
*Hydric soil rating:* No

## Minor Components

### Alberton

*Percent of map unit:* 5 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AB110MT - Sandy (Sy) LRU 44A-B
*Hydric soil rating:* No

### Grantsdale

*Percent of map unit:* 4 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AB032MT - Loamy (Lo) LRU 44A-B
*Hydric soil rating:* No

### Moiese

*Percent of map unit:* 4 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044BA134MT - Shallow to Gravel (SwGr) LRU 01 Subset A
*Hydric soil rating:* No

### Somewhat poorly drained soils

*Percent of map unit:* 2 percent
*Ecological site:* R044AP806MT - Subirrigated Grassland Group
*Hydric soil rating:* No

## 114—Urban land

### Map Unit Setting

*National map unit symbol:* 4w9f
*Elevation:* 2,600 to 5,500 feet
*Mean annual precipitation:* 11 to 19 inches
*Mean annual air temperature:* 41 to 45 degrees F
*Frost-free period:* 90 to 120 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

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

### Minor Components

#### Orthents

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

#### Argiborolls

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

#### Bigarm

*Percent of map unit:* 3 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AB032MT - Loamy (Lo) LRU 44A-B
*Hydric soil rating:* No

#### Grassvalley

*Percent of map unit:* 2 percent
*Landform:* Lake plains
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AA032MT - Loamy (Lo) LRU 44A-A
*Hydric soil rating:* No

#### Desmet

*Percent of map unit:* 2 percent
*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AA032MT - Loamy (Lo) LRU 44A-A
*Hydric soil rating:* No

#### Grantsdale

*Percent of map unit:* 2 percent

*Landform:* Stream terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R044AB032MT - Loamy (Lo) LRU 44A-B
*Hydric soil rating:* No

## 138—Water-Riverwash complex

### Map Unit Composition

*Water:* 65 percent
*Riverwash:* 35 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Riverwash

#### Setting

*Landform:* Flood plains
*Microfeatures of landform position:* Bars
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium

#### Properties and qualities

*Frequency of flooding:* FrequentNone

#### Interpretive groups

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

# References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf