

# STORMWATER MANAGMENT SUMMARY

FOR

## PROPOSED TAKE 5 OIL CHANGE

Missouri Hwy 291

Lee's Summit, Missouri

October 7, 2022

Revised September 8, 2023

PREPARED FOR

**DRIVEN ASSESTS, L.L.C.**

**2101 Pearl Street**

**Boulder, CO 80302**

PREPARED BY:

HIGH TIDE CONSULTANTS, LLC  
700 CANAL BLVD.

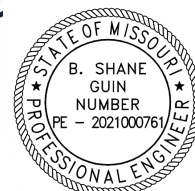
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SIGNATURE:

SEPTEMBER 8, 2023

DATE:

## **Stormwater Management Summary**

### **Introduction:**

The purpose of this document is to provide a summary of the pre and post development drainage conditions for the +/- 0.50 acre site located along the west side of Highway 291, and just north of the Meineke Car Care which is located at 320 NE 291 Hwy, Lee's Summit, MO 64086. The site is made up of a vacant grass lot which will be developed into a Take 5 Oil Change facility. This analysis will demonstrate that the proposed developments drainage system will meet the requirements set forth by the City of Lee's Summit.

### **Methodology:**

The hydraulic calculations, for this site, were performed using the SCS Method (TR-55), in accordance with the City of Lee's Summit and APWA Sections 5602 and 5608 requirements. Hydraflow Hydrographs Extension for Autodesk Civil 3D was utilized for the detention calculations. Detention storage data can be found in the appendix of the report, under the Post Development Calculations. A Point of Interest was used to determine the allowable release rate for the developed site. The site has been analyzed for the 2-year, 10-year and 100-year storm events.

### **Existing Conditions:**

The proposed site is located along the west side of Highway 291, and just north of the Meineke Car Care, which is located at 320 NE 291 Hwy, Lee's Summit, MO 64086. The site is located on the northwest side of the intersection of SE Langsford Rd. & NE Hwy 291. The site is currently occupied by a vacant grass lot that sits on approximately 0.50 acres of pervious cover.

The site is contained within an existing retaining wall, and it is bordered by overgrown vegetation to the north and west. There is an existing stream located to the west of the site and the approximate location of the stream buffer can be seen on the Stream Exhibit, which is included in Appendix A. Since no disturbance shall take place beyond the retaining wall that is currently in place, it has been determined that the site can encroach into the 100' stream buffer.

The site has high points on the southwestern property line and slopes northeast towards Highway 291 with a slope of approximately 4.6%. The site drains via sheet flow to an existing roadside ditch located on the eastern side of the property, along Hwy. 291. The point at which this flow exits the property is considered the point of interest for the existing condition. The point of interest can be viewed on the Pre-Development Drainage Plan, which is included in Appendix A.

The site also receives off-site flow from the adjacent strip mall to the south. Approximately 0.09 Acres, from the adjacent strip mall, flows through a flume or sheet flows onto the Take-5 site.

Per the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel Number 29095C0436G, which is dated 1/20/2017, the site is located in flood zone X.

The time of concentration for the existing condition of the Take-5 site is 18.20 minutes and the SCS Curve Number (CN) value has been determined to be 74.

The time of concentration for the off-site area is 5 minutes and the SCS Curve Number (CN) value has been determined to be 87.

The total pre-development runoff values for the site are as follows:

| <b>Storm Event/Rainfall Return Period</b> | <b>50% / 2 YR</b>            | <b>10% / 10 YR</b>          | <b>1% / 100 YR</b>          |
|---|------------------------------|-----------------------------|-----------------------------|
| <b>Off-Site Runoff (Pre DA 1) (CFS):</b>  | 0.161 CFS                    | 0.883 CFS                   | 1.493 CFS                   |
| <b>Take-5 Site Runoff (DA 2) (CFS):</b>   | 0.215 CFS                    | 2.752 CFS                   | 5.229 CFS                   |
| <b>Combined Runoff (CFS):</b>             | 0.284 CFS                    | 3.118 CFS                   | 5.855 CFS                   |
| <b>Allowable Release Rate (CFS):</b>      | 0.5CFS X 0.5AC<br>= 0.25 CFS | 2.0CFS X 0.5AC<br>= 1.0 CFS | 3.0CFS X 0.5AC<br>= 1.5 CFS |

A pre-development drainage area exhibit has been provided in Appendix A.

**Proposed Development:**

For the purposes of this analysis, the proposed development will consist of a 1,415 SF Take 5 Oil Change Facility along with associated parking and access drives.

The redevelopment of the site will increase the impervious area which will require the excess runoff to be stored on site. Green space areas will be provided internally to the parking areas as well as around the entire perimeter of the site.

The Take 5 site receives off-site flow from the adjacent strip mall to the south and this will be rerouted so that it bypasses the Take 5 drainage system. Approximately 0.09 Acres, from the adjacent strip mall, flows through a flume or sheet flows onto the Take-5 site. An inlet will be installed, and this runoff will outfall into the roadside ditch. This will be considered one point of interest for the post-developed condition.

The post-developed site will be broken into two drainage areas. Drainage Area 2 is shown in green on the Post-Development Drainage Plan and is generally the west side of the site. The time of concentration for Drainage Area 2 is 5 minutes and the SCS Curve Number (CN) value has been determined to be 87. Drainage area 2 will be routed into an underground detention basin which is located to the east of the Take 5 building. The underground detention basin will then discharge into the roadside ditch. This will be considered the second point of interest for the post developed condition.

Drainage Area 3 is shown in pink on the Post-Development Drainage Plan and is generally the east side of the site. The time of concentration for Drainage Area 3 is 5 minutes and the SCS Curve Number (CN) value has been determined to be 87. Drainage area 3 will be routed to a detention pond which is located on the east side of the site. The detention pond will then

discharge into the roadside ditch. This will be considered the third point of interest for the post developed condition.

The total post-development runoff values, into the pond/underground storage, are as follows:

| <b>Storm Event/Rainfall Return Period</b> | <b>50% / 2 YR</b>            | <b>10% / 10 YR</b>          | <b>1% / 100 YR</b>          |
|---|------------------------------|-----------------------------|-----------------------------|
| <b>Off-Site Runoff (Pre DA 1) (CFS):</b>  | 0.161 CFS                    | 0.883 CFS                   | 1.493 CFS                   |
| <b>Take-5 Site Runoff (DA 2) (CFS):</b>   | 0.431 CFS                    | 2.354 CFS                   | 3.980 CFS                   |
| <b>Take-5 Site Runoff (DA 3) (CFS):</b>   | 0.467 CFS                    | 2.550 CFS                   | 4.312 CFS                   |
| <b>Combined Detained Runoff (CFS):</b>    | 0.227 CFS                    | 0.625 CFS                   | 1.411 CFS                   |
| <b>Allowable Release Rate (CFS):</b>      | 0.5CFS X 0.5AC<br>= 0.25 CFS | 2.0CFS X 0.5AC<br>= 1.0 CFS | 3.0CFS X 0.5AC<br>= 1.5 CFS |

A post-development drainage area exhibit has been provided in Appendix B.

**Stormwater Requirements:**

Drainage calculations will conform to the requirements of the City of Lee’s Summit Storm Drainage Design Criteria, as well as section 5600 of the *Kansas City Metropolitan Chapter American Public Works Association Standard Specifications & Design Criteria*.

Runoff for a portion of the site shall be routed to an on-site detention pond and an underground detention basin, which has been appropriately sized to reduce the post-developed runoff exiting the site. Discharge from the pond will be via an outlet structure utilizing a 2” orifice and a 6” orifice, which will both be set at different elevations, followed by a 12” discharge pipe which will outfall into the right-of-way. Discharge from the underground detention basin will be via an outlet structure utilizing a 3” orifice followed by a 12” discharge pipe.

Summary of On-Site Runoff Calculations:

| Storm Event | Pre-Developed | Post-Developed | Allowable Release Rate          | Calculated Pond Storage Volume | POND WSE  | Calculated Underground Storage Volume | Underground Storage WSE |
|-------------|---------------|----------------|---------------------------------|--------------------------------|-----------|---------------------------------------|-------------------------|
| 2-year      | 0.284 cfs     | 0.227 cfs      | 0.5CFS X<br>0.5AC =<br>0.25 CFS | 267 cuft                       | 982.54 ft | 326 cuft                              | 981.63 ft               |
| 10-year     | 3.118 cfs     | 0.625 cfs      | 2.0CFS X<br>0.5AC =<br>1.0 CFS  | 2,207 cuft                     | 984.75 ft | 2,173 cuft                            | 982.78 ft               |
| 100-year    | 5.855 cfs     | 1.411 cfs      | 3.0CFS X<br>0.5AC =<br>1.5 CFS  | 3,703 cuft                     | 985.59 ft | 3,992 cuft                            | 983.74 ft               |

**Stormwater Quality:**

A stormwater treatment facility has been designed for this site. Even though there are no “Hot Spots” located within the project area, there are large amounts of impervious area. Due to the large amounts of impervious area that could contaminate the stormwater, a treatment facility is necessary. An Extended Dry Detention basin was chosen and designed to treat on-site stormwater discharge. The Extended Dry Detention basin did not provide an acceptable level of service by itself, so catch basin inserts have been added to supplement the detention basin. These calculations can be found in Appendix B.

The 2012 MARC BMP manual has been consulted for the proposed BMP mitigation plan.

The total contributing area draining into the detention facility is 0.5 acres. A required water quality volume of 1,306.8 cuft was calculated. The total available pond volume is 4,505 cuft and the total available underground detention volume is 7,986 cuft, while the combined detention volume plus the water quality volume is 9,001.8 cuft. This leaves an excess volume of 3,489.2 cuft available within the detention facilities.

The Extended Dry Detention Basin, that has been provided for this Take 5, will be a privately maintained and operated facility. Maintenance and inspections shall follow the activities and frequencies listed in Appendix B.

**Conclusion:**

All the referenced material and supporting documentation can be found below. Based on the findings, the proposed Take 5 Oil Change Facility will not have an adverse effect on the downstream storm system, and it meets the City of Lee’s Summit stormwater requirements.

# Appendix A

# ALTA/NSPS LAND TITLE SURVEY

Sec. 5-47-31

SHAFER, KLINE & WARREN, INC.

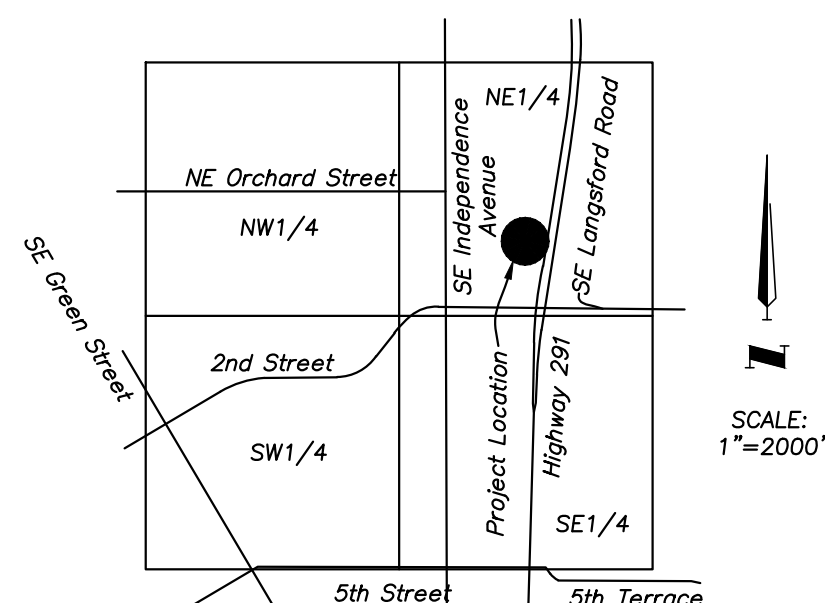
11250 Corporate Avenue  
 Lenexa, KS 66219-1392  
 913.888.7800 FAX: 913.888.7868  
 SURVEYING | ENGINEERING | CONSTRUCTION



CLIENT

Byram Realty, LLC  
 5350 W. 94th Terrace, Suite 201  
 Prairie Village KS, 66207  
 Phone: (913) 722-5229

Job No. 170159-010 March 6, 2017 Hg



VICINITY MAP  
5-47-31

DESCRIPTION:

**TRACT I:**  
 The South 150 feet of the East 150 feet of the North 300 feet of the South 902 feet of the East 880 feet of the West One Half of the Northeast Quarter of Section 5, Township 47, Range 31, in Lee's Summit, Jackson County, Missouri, more particularly described as follows: Commencing at the Southwest corner of the Northeast Quarter of said Section 5, Township 47, Range 31; thence South 89 Degrees, 22 Minutes, 09 Seconds East along the South line of the West One Half of said Quarter Section a distance of 1321.26 feet to the Southeast corner of said West One Half; thence North 00 Degrees, 40 Minutes, 00 Seconds East along the East line of said West One Half, a distance of 602.00 feet to the point of beginning; thence North 89 Degrees, 22 Minutes, 09 Seconds East, parallel with the South line of said West One Half, a distance of 150.00 feet; thence North 00 Degrees, 40 Minutes, 00 Seconds East, parallel with the East line of said West One Half, a distance of 150.00 feet; thence South 89 Degrees, 22 Minutes, 09 Seconds East, parallel with the South line of said West One Half, a distance of 150.00 feet to a point on the East line of said West One Half, thence South 00 Degrees, 40 Minutes, 00 Seconds West along said East line, a distance of 150.00 feet to the point of beginning.

**TRACT II:**  
 Commencing at the Southwest corner of the East 1/2 of the Northeast 1/4 of Section 5, Township 47, Range 31, Lee's Summit, Jackson County, Missouri; thence along the West line of said 1/2 of 1/4 Section North 2 Degrees, 33 Minutes, 49 Seconds East 602 feet to the true point of beginning of this tract; thence along said West line North 2 Degrees, 33 Minutes, 49 Seconds East 478.79 feet; thence South 88 Degrees, 27 Minutes, 48 Seconds East 152.53 feet to a point on the West line of the Right-of-Way of M-291; thence along said Right-of-Way line as follows: South 16 Degrees, 32 Minutes, 36 Seconds West 73.03 feet to a point 135 feet opposite center line Station 117+00; thence South 11 Degrees, 23 Minutes, 57 Seconds West 200 feet to a point 135 feet opposite center line Station 119+00; thence South 1 Degree, 11 Minutes, 44 Seconds West 101.61 feet to a point 117 feet opposite center line Station 120+00; thence parallel to said center line South 11 Degrees, 23 Minutes, 57 Seconds West 50 feet; thence South 64 Degrees, 21 Minutes, 40 Seconds West 66.40 feet to a point 170 feet opposite center line Station 120+90; thence parallel to said center line South 11 Degrees, 23 Minutes, 57 Seconds West 31.03 feet; thence leaving said Right-of-Way North 87 Degrees, 26 Minutes, 43 Seconds West 35.61 feet to the true point of beginning.

TITLE NOTE:

Title information shown hereon was taken from Old Republic National Title Insurance Company commitment for Title insurance No. SKC0037555C and Dated October 18, 2016 at 8:00 A.M.

- c. Easement granted to Missouri Public Service Corporation as set forth in instrument filed June 20, 1950, under Document No. 565542 in Book 862 at Page 458. (Affects all of Tract I)
- d. Easement granted to the City of Lee's Summit as set forth in instrument filed July 6, 1962, under Document No. 792933 in Book 1577 at Page 301. (Does not Affect)
- e. Easements for the benefit of the premises in question as set forth in Case No. 108618 filed November 20, 1950 under Document No. 571966 in Book 899 at Page 171, and as defined by instrument filed under Document No. 792062 in Book 1575 at Page 21. (Affects Tract I)
- f. Easement over a portion of the premises in question, granted to The State of Missouri, by the instrument recorded as Document No. 653850 in Book 1302 at Page 81. (Affects Subject Property)
- g. Easement and Right-of-Way Agreement granted to The City of Lee's Summit, by the instrument filed May 23, 1962 as Document No. 790138 in Book 1569 at Page 695. (As shown hereon)
- h. Easement and Right-of-Way Agreement granted to The City of Lee's Summit, by the instrument filed June 11, 1962, under Document No. 791375 in Book 1573 at Page 199. (As shown hereon)
- i. Easement over a portion of the premises in question, granted to The City of Lee's Summit, Missouri, by the instrument recorded as Document No. 868740 in Book 1781 at Page 176. (As shown hereon)
- j. Lack of abutter's rights of direct access to Highway No. 291 from the premises in question as set forth in instrument filed January 9, 1969, under Document No. 1-31092 in Book 189 at Page 661, except such rights of access as provided therein. (Affects subject property not plottable)
- k. Terms and provisions and easement contained in Easement Agreement by and between Royal Acres Limited, a Missouri Limited Partnership and Pine Woods Associates, a Missouri general partnership, filed for record May 9, 1986, as Document No. 1-688562 in Book 11536 at Page 2123. (As shown hereon)
- l. Sanitary Sewer Easement granted to the City of Lee's Summit as set forth in instrument filed October 15, 2002, under Document No. 200210091852. (As shown hereon)

To: Vivion Properties, LLC; LSMO I, LLC; Bennisonvestments, LLC; Silverlake Holdings, LLC; and Old Republic National Title Insurance Company  
 This is to certify that this map or plat and the survey on which it is based were made in accordance with the 2016 Minimum Standard Detail Requirements for ALTA/NSPS Land Title Surveys, jointly established and adopted by ALTA and NSPS, and includes items 1, 3, 4, 5, 6a, 8, and 11 of Table A thereof. The fieldwork was completed on February 24, 2017.



Note:

1. Visual indications of utilities are as shown. Underground locations shown, as furnished by the respective utility companies, are approximate and shall be verified in the field at the time of construction. For actual field locations of underground utilities, call 1-800-344-7233.
2. The contractor shall be responsible for contacting all utility companies for field location of all underground utility lines prior to any excavation and for the coordination and scheduling with utility owners of all work required to resolve conflicts with installations, constructions, excavations, removals, placements, relocation and other miscellaneous work.

FLOOD NOTE:

This property lies within flood Zone X, defined as areas determined to be outside the limits of the 0.2% annual chance flood plane, and Other Flood areas as shown on the Flood Insurance rate map prepared by the Federal Emergency Management Agency for the City of Overland Park, Johnson County, Kansas, Community No. 29 174, Panel No. 0436G and dated January 20, 2017

General Notes:

The horizontal datum is based on the State plane coordinate system MO West Zone NAD 83

Adjusted to Ground Plane CAF=0.999901213

Elevations shown hereon are based upon NAVD88 Datum.

Contours shown hereon are at 1' contour intervals.

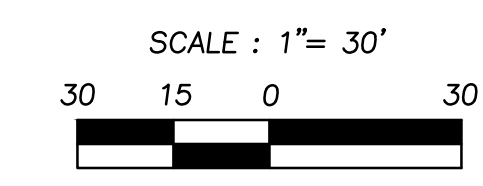
The accuracy standard for this survey is in accordance with type "URBAN"

ZONING NOTE:

No Zoning report or letter was furnished at the time of survey.

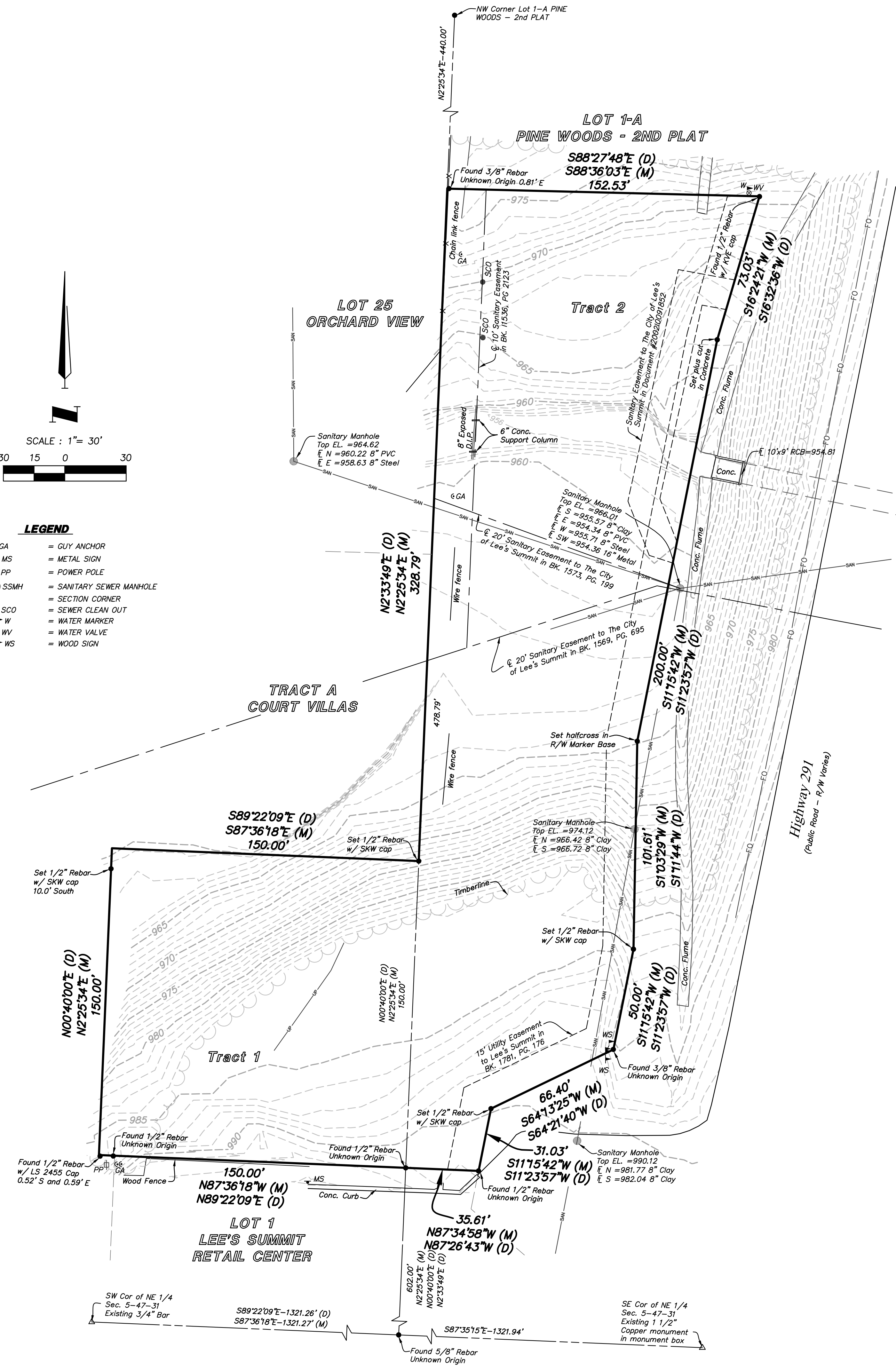
- BENCHMARK 1** ELEV.: 982.13  
 Set square cut in the top of the South side of a 15" light pole base 100± North of the Northeast property corner. East side of parking lot 70± West of 291 HWY.
- BENCHMARK 2** ELEV.: 991.62  
 Existing square cut on back of curb 50± East Northeast of the Northeast corner of meineke on the North side drive at the flume.

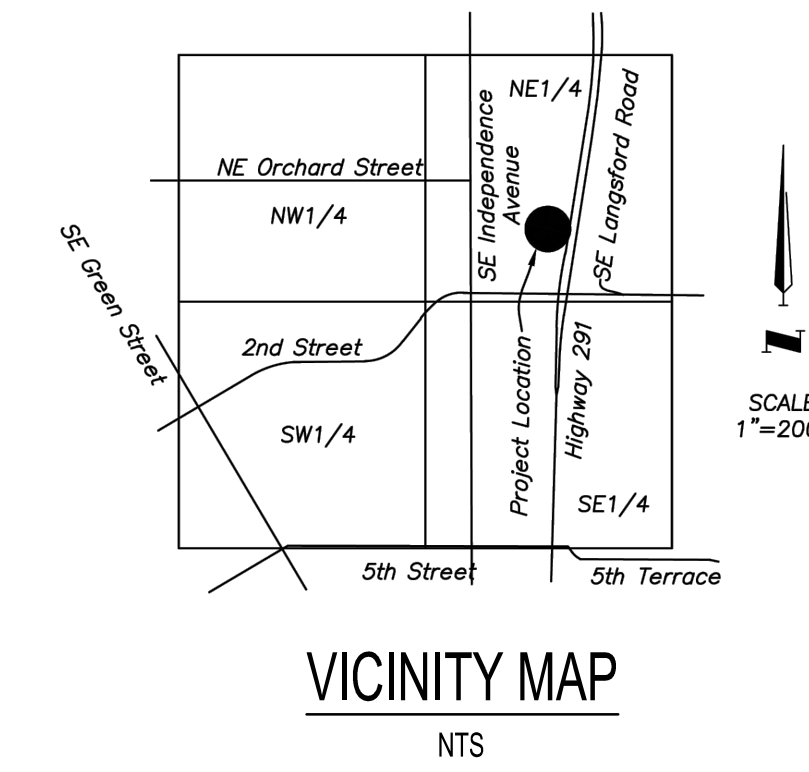
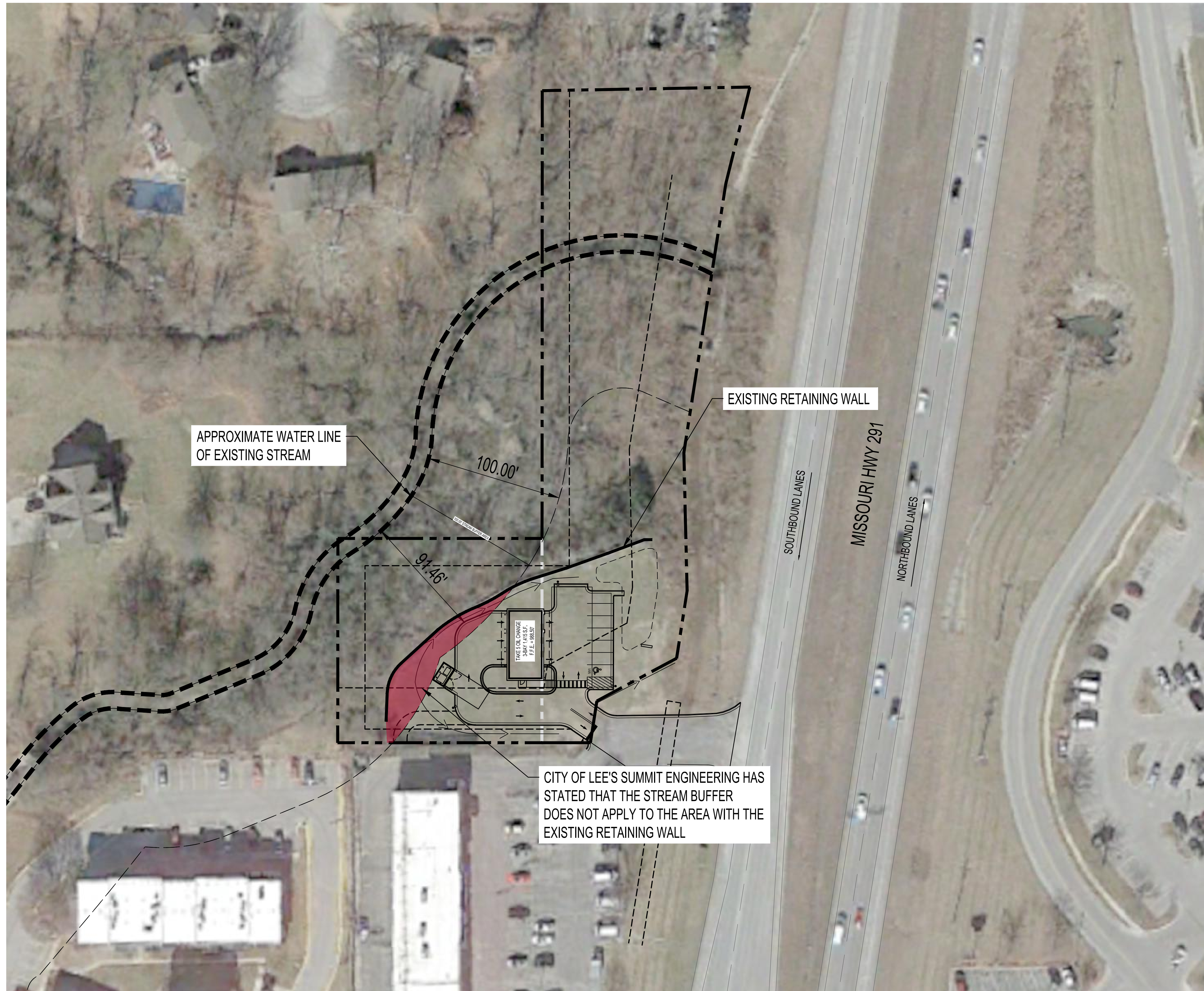
Area = 75,218± Sq. Ft. or 1.727± Acres



**LEGEND**

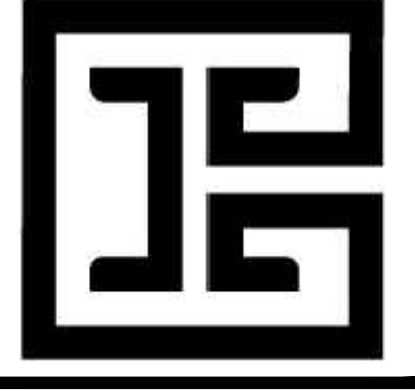
- GA = GUY ANCHOR
- MS = METAL SIGN
- PP = POWER POLE
- SSMH = SANITARY SEWER MANHOLE
- SCD = SEWER CLEAN OUT
- W = WATER MARKER
- WV = WATER VALVE
- WS = WOOD SIGN

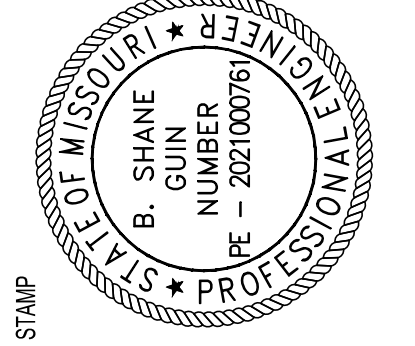




| REVISION | BY |
|----------|----|
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|          |    |
|          |    |
|          |    |

**HIGHTIDE CONSULTANTS LLC**  
 434 N. COLUMBIA ST, SUITE 200A  
 COVINGTON, LA 70433  
 www.hightidelc.com

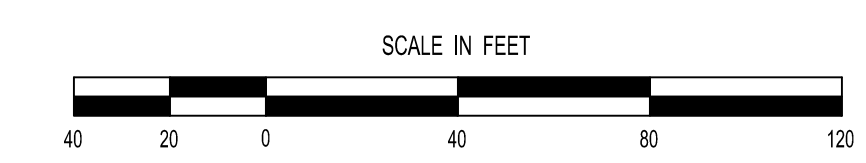


  
 SIGNATURE  
 SEPTEMBER 8, 2023  
 DATE  
  
 STAMP  
 B. SHANE GUIN  
 NUMBER  
 PE - 202100076  
 MISSOURI PROFESSIONAL ENGINEER

PROPOSED TAKE 5  
 LEE'S SUMMIT, MISSOURI  
 FOR DRIVEN ASSETS, LLC  
 2101 PEARL STREET  
 BOULDER, CO 80302



Not For Construction  
**STREAM EXHIBIT**



|                   |                                 |
|-------------------|---------------------------------|
| DRAWN             | KRG                             |
| CHECKED           | RCG                             |
| ISSUED DATE       | 09/08/23                        |
| ISSUED FOR REVIEW |                                 |
| PROJECT NO.       | 22-218                          |
| FILE              | 22-218 EX Stream Buffer Exhibit |

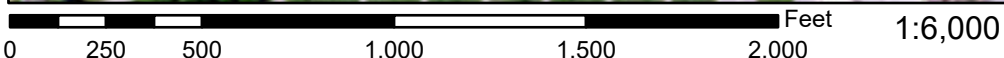
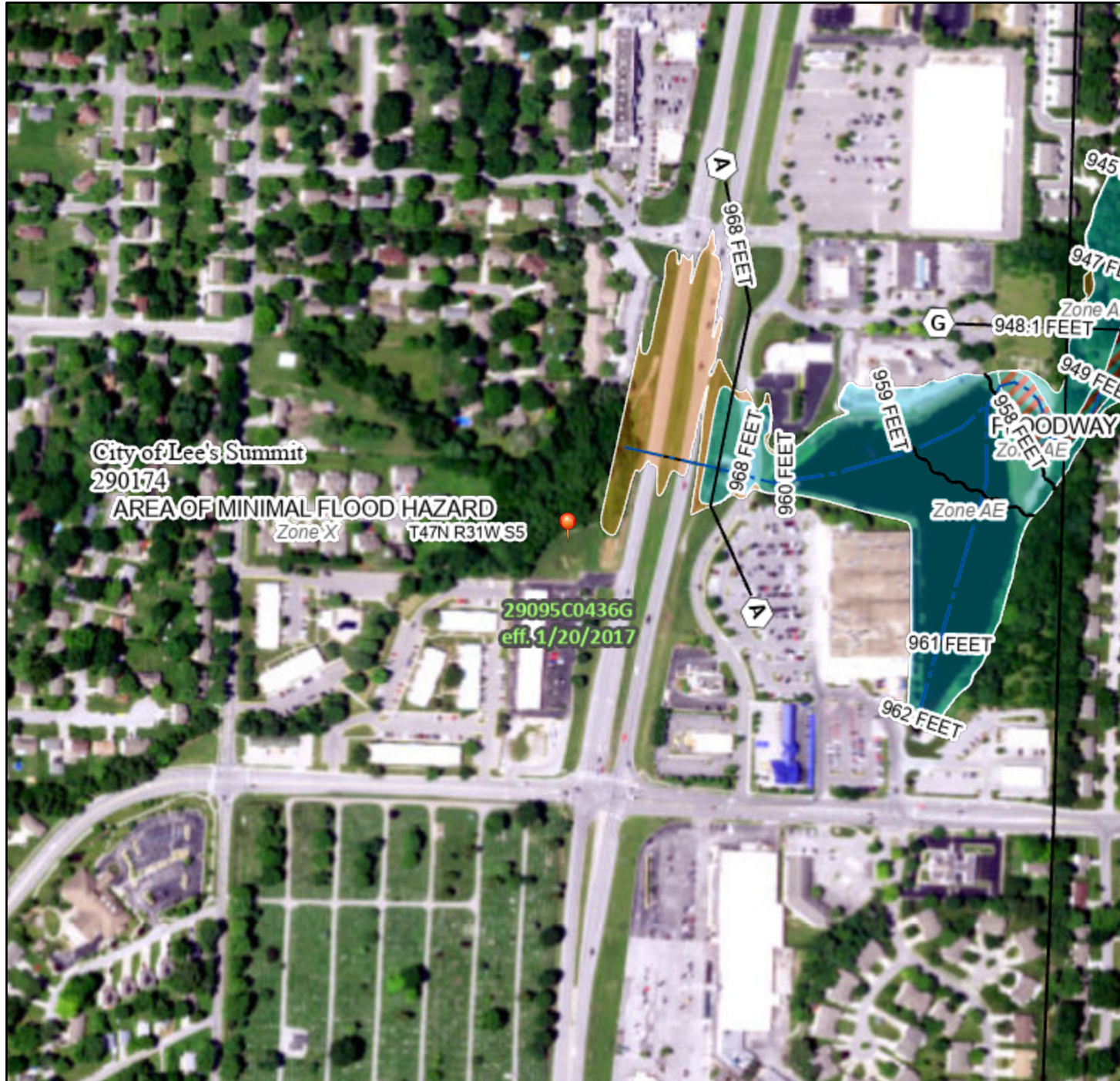
SHEET  
**ZONE-EX**



# National Flood Hazard Layer FIRMMette



94°22'3"W 38°55'24"N



Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

|                             |  |   |
|-----------------------------|--|---|
| SPECIAL FLOOD HAZARD AREAS  |  | Without Base Flood Elevation (BFE)<br>Zone A, V, A99  |
|                             |  | With BFE or Depth Zone AE, AO, AH, VE, AR   |
|                             |  | Regulatory Floodway   |
| OTHER AREAS OF FLOOD HAZARD |  | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X |
|                             |  | Future Conditions 1% Annual Chance Flood Hazard Zone X  |
|                             |  | Area with Reduced Flood Risk due to Levee. See Notes. Zone X  |
|                             |  | Area with Flood Risk due to Levee Zone D  |
| OTHER AREAS                 |  | NO SCREEN Area of Minimal Flood Hazard Zone X   |
|                             |  | Effective LOMRs   |
| GENERAL STRUCTURES          |  | Area of Undetermined Flood Hazard Zone D  |
|                             |  | Channel, Culvert, or Storm Sewer  |
| OTHER FEATURES              |  | Levee, Dike, or Floodwall   |
|                             |  | 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation   |
| MAP PANELS                  |  | 17.5 Coastal Transect   |
|                             |  | Base Flood Elevation Line (BFE)   |
|                             |  | Limit of Study  |
|                             |  | Jurisdiction Boundary   |
|                             |  | Coastal Transect Baseline   |
|                             |  | Profile Baseline  |
|                             |  | Hydrographic Feature  |
|                             |  | Digital Data Available  |
|                             |  | No Digital Data Available   |
|                             |  | Unmapped  |
|                             |  | The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.                              |

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

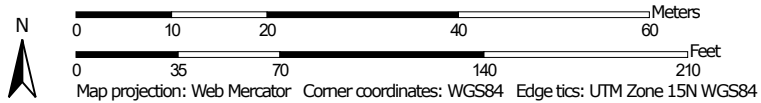
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/29/2022 at 11:09 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Soil Map—Jackson County, Missouri



Map Scale: 1:791 if printed on A portrait (8.5" x 11") sheet.



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Jackson County, Missouri

Survey Area Data: Version 24, Aug 31, 2022

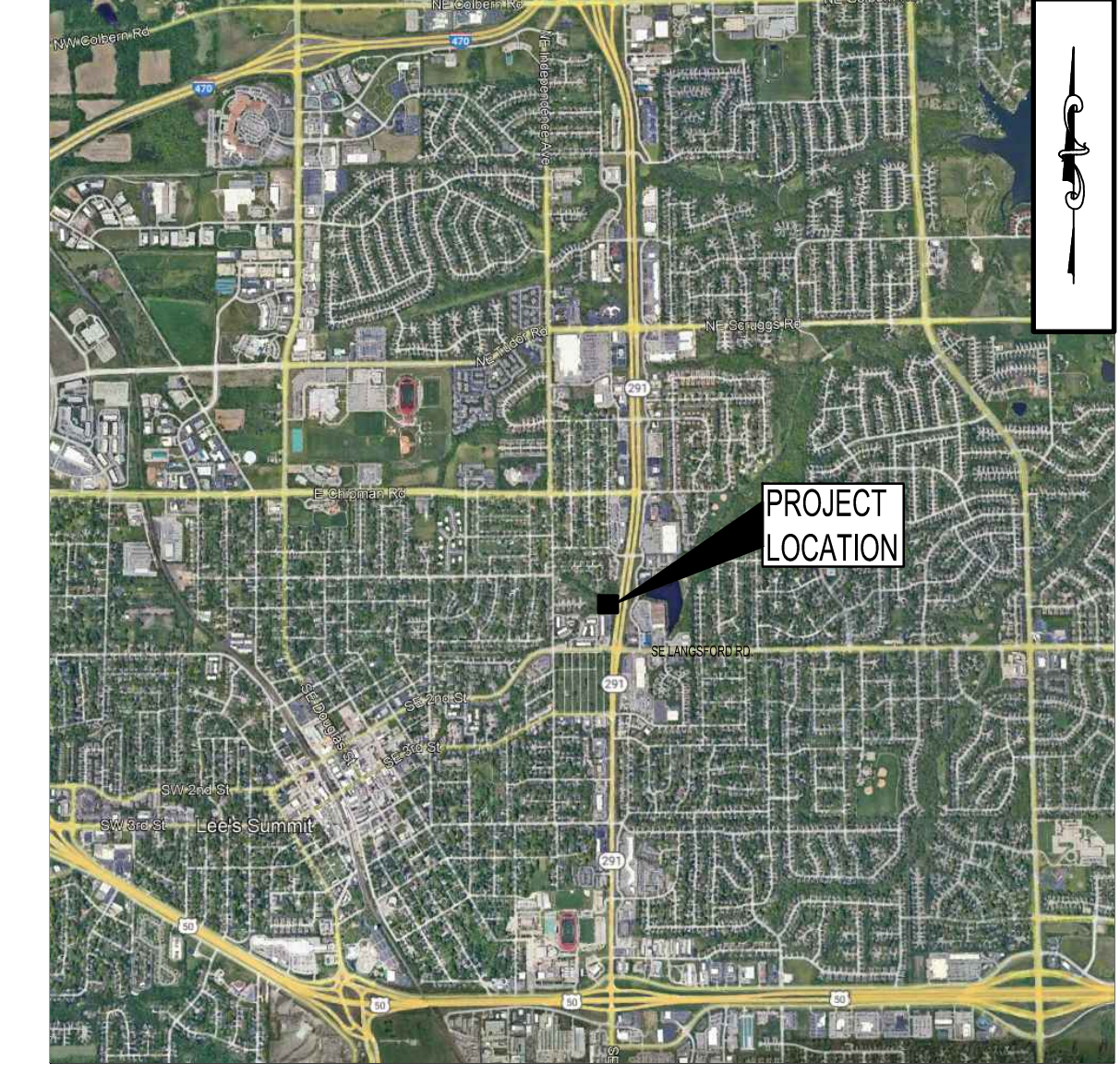
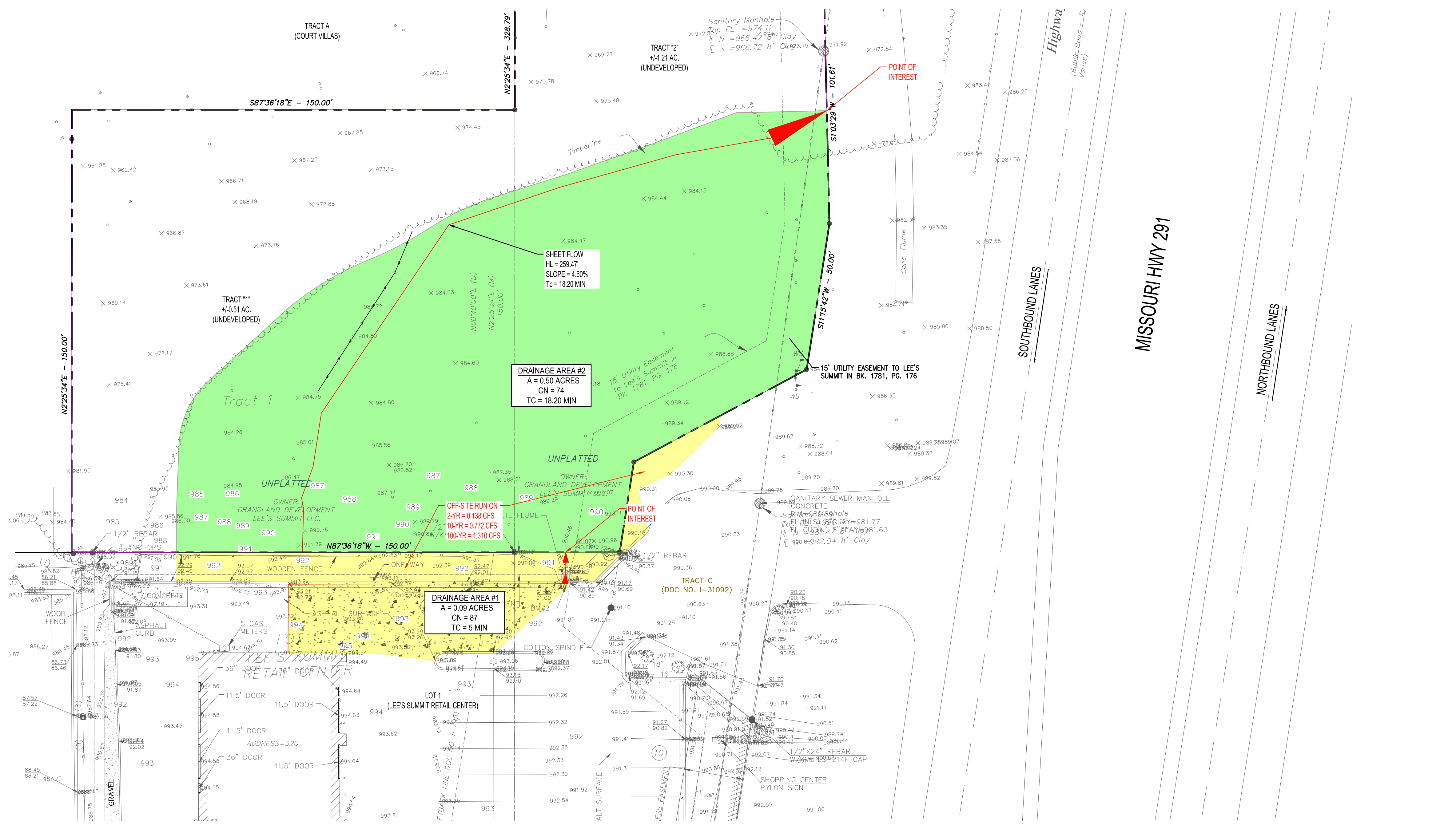
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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

## Map Unit Legend

| Map Unit Symbol                    | Map Unit Name  | Acres in AOI | Percent of AOI |
|------------------------------------|--|--------------|----------------|
| 10082                              | Arisburg-Urban land complex,<br>1 to 5 percent slopes            | 0.0          | 1.5%           |
| 10180                              | Udarents-Urban land-Sampsel<br>complex, 2 to 5 percent<br>slopes | 2.1          | 98.5%          |
| <b>Totals for Area of Interest</b> |  | <b>2.1</b>   | <b>100.0%</b>  |



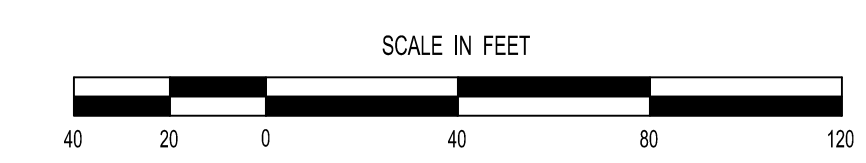
VICINITY MAP  
NTS

THE PROJECT SITE IS INCLUDED WITHIN THE WEST PRAIRIE LEE WATERSHED AREA AS SHOWN ON THE CITY OF LEE'S SUMMIT WATERSHED & OUTFALL MAP

| OFF-SITE DRAINAGE AREA 1 TOTAL RUNOFF: |         | ON-SITE DRAINAGE AREA 2 TOTAL RUNOFF: |         | COMBINED PRE-DEVELOPED TOTAL RUNOFF: |         |
|--|---------|---------------------------------------|---------|--------------------------------------|---------|
| RETURN PERIOD                          | Q (CFS) | RETURN PERIOD                         | Q (CFS) | RETURN PERIOD                        | Q (CFS) |
| 2 - YEAR                               | 0.161   | 2 - YEAR                              | 0.215   | 2 - YEAR                             | 0.284   |
| 10 - YEAR                              | 0.883   | 10 - YEAR                             | 2.752   | 10 - YEAR                            | 3.118   |
| 100 - YEAR                             | 1.493   | 100 - YEAR                            | 5.229   | 100 - YEAR                           | 5.855   |



Not For Construction  
**PRE-DEVELOPMENT  
DRAINAGE PLAN**



| REVISION | BY |
|----------|----|
|          |    |
|          |    |
|          |    |

**HIGHTIDE CONSULTANTS LLC**  
434 N. COLUMBIA ST, SUITE 200A  
COVINGTON, LA 70433  
www.hightidel.com

SEPTEMBER 8, 2023  
DATE

B. SHANE  
SIGNATURE

PROFESSIONAL ENGINEER  
STATE OF MISSOURI  
B. SHANE  
QUIN  
NUMBER  
PE - 202100076

STAMP

PROPOSED TAKE 5  
LEE'S SUMMIT, MISSOURI

FOR DRIVEN ASSETS, LLC  
2101 PEARL STREET  
BOULDER, CO 80302

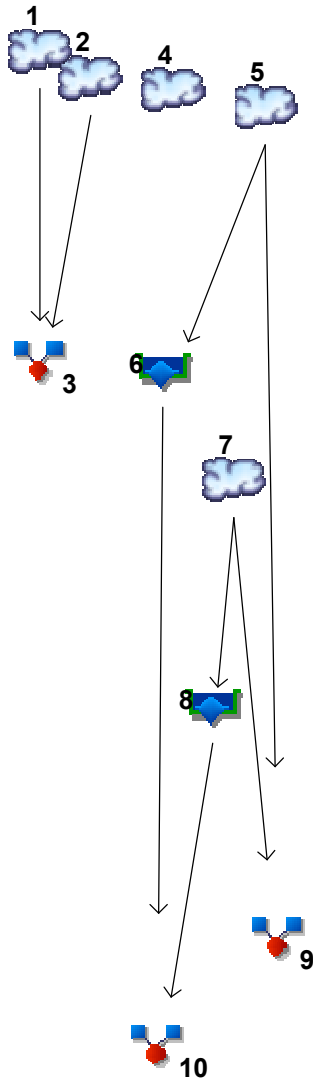
|                   |                                |
|-------------------|--------------------------------|
| DRAWN             | KRG                            |
| CHECKED           | RCG                            |
| ISSUED DATE       | 09/08/23                       |
| ISSUED FOR REVIEW |                                |
| PROJECT NO.       | 22-218                         |
| FILE              | 22-218 PRE PreDevelopment Plan |

SHEET  
**PRE**

|  |           |
|--|-----------|
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# Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023



## Legend

| Hyd. | Origin     | Description                               |
|------|------------|---|
| 1    | SCS Runoff | Pre Off-Site Area (Pre DA 1)(Bypass Site) |
| 2    | SCS Runoff | Pre On-Site Area (DA 2)                   |
| 3    | Combine    | Combined Pre-Developed Flow               |
| 4    | SCS Runoff | Post Off-Site Area (Post DA 1)(Diverted)  |
| 5    | SCS Runoff | Post On-Site Area 2 (Post DA 2)           |
| 6    | Reservoir  | Chamber Flow                              |
| 7    | SCS Runoff | Post On-Site Area 3 (Post DA 3)           |
| 8    | Reservoir  | Pond Flow                                 |
| 9    | Combine    | Combined Undetained Runoff                |
| 10   | Combine    | Combined Detained Runoff                  |

# Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| Hyd. No. | Hydrograph type (origin) | Inflow hyd(s) | Peak Outflow (cfs) |       |       |       |       |       |       |        | Hydrograph Description                |
|----------|--------------------------|---------------|--------------------|-------|-------|-------|-------|-------|-------|--------|---------------------------------------|
|          |                          |               | 1-yr               | 2-yr  | 3-yr  | 5-yr  | 10-yr | 25-yr | 50-yr | 100-yr |                                       |
| 1        | SCS Runoff               | -----         | -----              | 0.161 | ----- | ----- | 0.883 | ----- | ----- | 1.493  | Pre Off-Site Area (Pre DA 1)(Bypass   |
| 2        | SCS Runoff               | -----         | -----              | 0.215 | ----- | ----- | 2.752 | ----- | ----- | 5.229  | Pre On-Site Area (DA 2)               |
| 3        | Combine                  | 1, 2          | -----              | 0.284 | ----- | ----- | 3.118 | ----- | ----- | 5.855  | Combined Pre-Developed Flow           |
| 4        | SCS Runoff               | -----         | -----              | 0.161 | ----- | ----- | 0.883 | ----- | ----- | 1.493  | Post Off-Site Area (Post DA 1)(Divert |
| 5        | SCS Runoff               | -----         | -----              | 0.431 | ----- | ----- | 2.354 | ----- | ----- | 3.980  | Post On-Site Area 2 (Post DA 2)       |
| 6        | Reservoir                | 5             | -----              | 0.106 | ----- | ----- | 0.264 | ----- | ----- | 0.347  | Chamber Flow                          |
| 7        | SCS Runoff               | -----         | -----              | 0.467 | ----- | ----- | 2.550 | ----- | ----- | 4.312  | Post On-Site Area 3 (Post DA 3)       |
| 8        | Reservoir                | 7             | -----              | 0.122 | ----- | ----- | 0.362 | ----- | ----- | 1.071  | Pond Flow                             |
| 9        | Combine                  | 5, 7,         | -----              | 0.897 | ----- | ----- | 4.903 | ----- | ----- | 8.292  | Combined Undetained Runoff            |
| 10       | Combine                  | 6, 8,         | -----              | 0.227 | ----- | ----- | 0.625 | ----- | ----- | 1.411  | Combined Detained Runoff              |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| 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               | 0.161           | 2                   | 716                | 326                   | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 0.215           | 2                   | 726                | 812                   | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 0.284           | 2                   | 720                | 1,138                 | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 0.161           | 2                   | 716                | 326                   | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 0.431           | 2                   | 716                | 869                   | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.106           | 2                   | 724                | 860                   | 5             | 981.63                 | 326                     | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 0.467           | 2                   | 716                | 942                   | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 0.122           | 2                   | 724                | 941                   | 7             | 982.54                 | 267                     | Pond Flow                             |  |
| 9                                      | Combine                  | 0.897           | 2                   | 716                | 1,811                 | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 0.227           | 2                   | 724                | 1,801                 | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

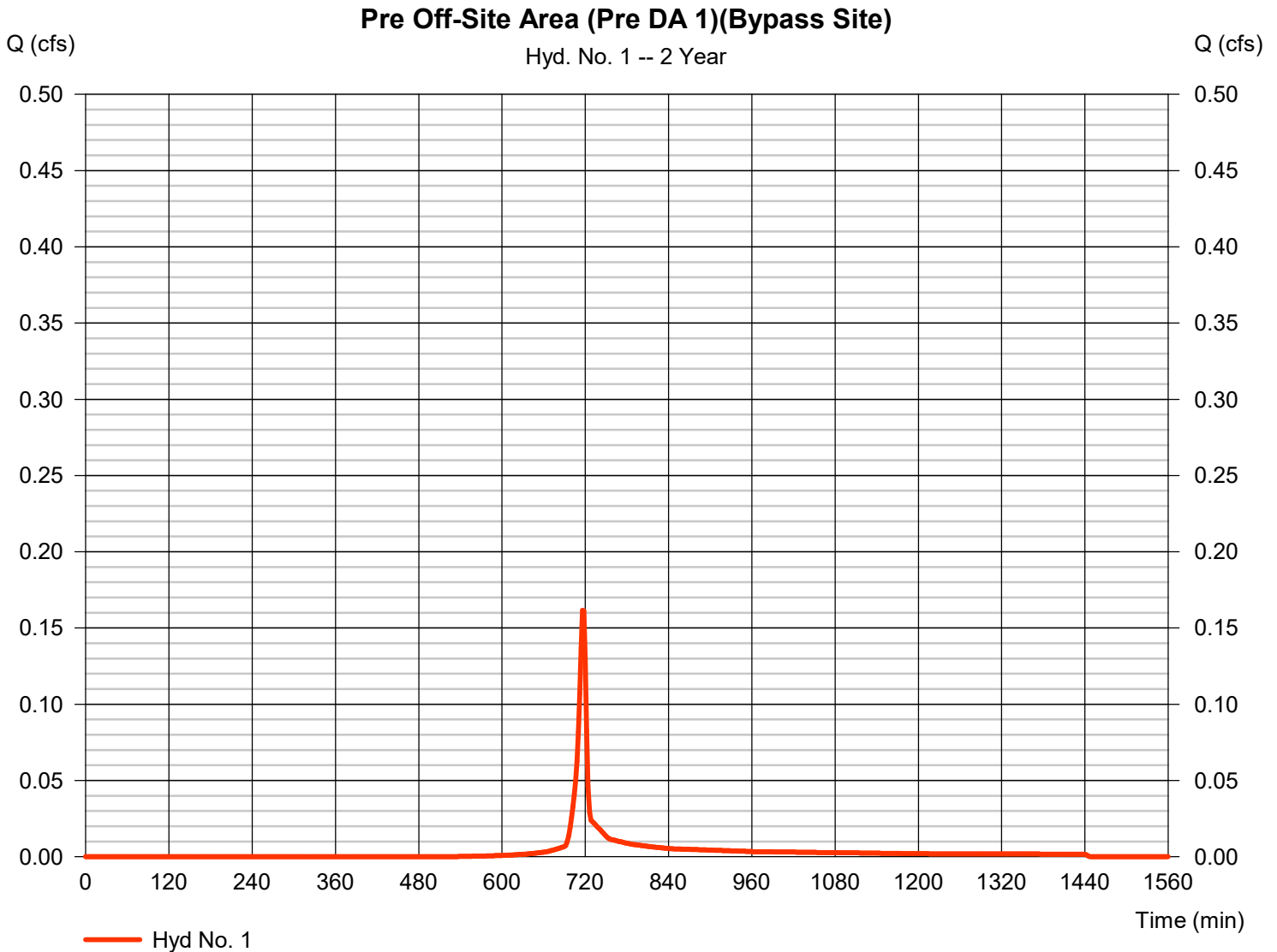
# Hydrograph Report

## Hyd. No. 1

Pre Off-Site Area (Pre DA 1)(Bypass Site)

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.161 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 2 min      | Hyd. volume        | = 326 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min  |
| Total precip.   | = 2.20 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

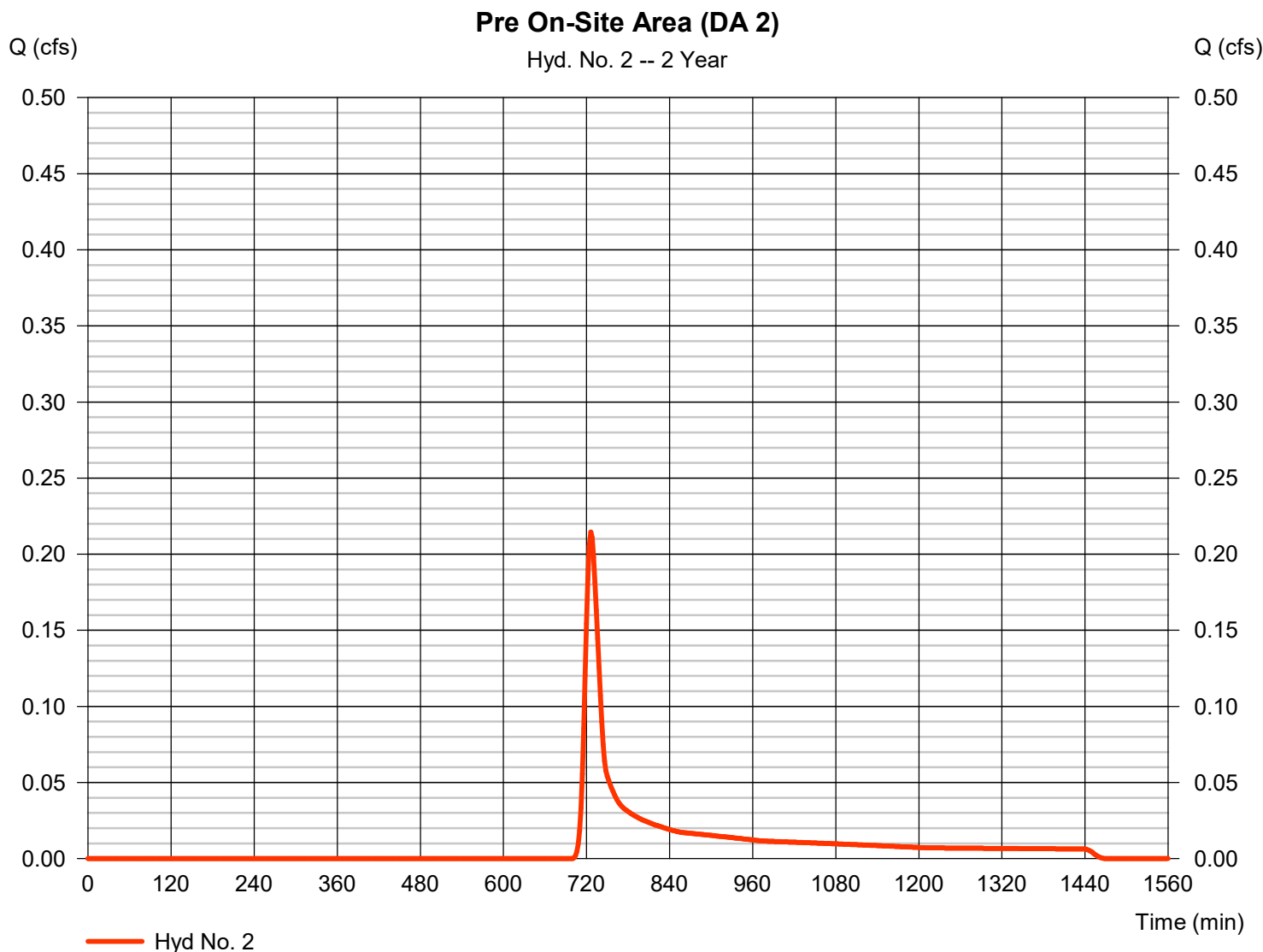
Thursday, 09 / 7 / 2023

## Hyd. No. 2

Pre On-Site Area (DA 2)

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.215 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 726 min   |
| Time interval   | = 2 min      | Hyd. volume        | = 812 cuft  |
| Drainage area   | = 0.500 ac   | Curve number       | = 74*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = TR55       | Time of conc. (Tc) | = 18.16 min |
| Total precip.   | = 2.20 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.500 x 74)] / 0.500



# TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

## Hyd. No. 2

Pre On-Site Area (DA 2)

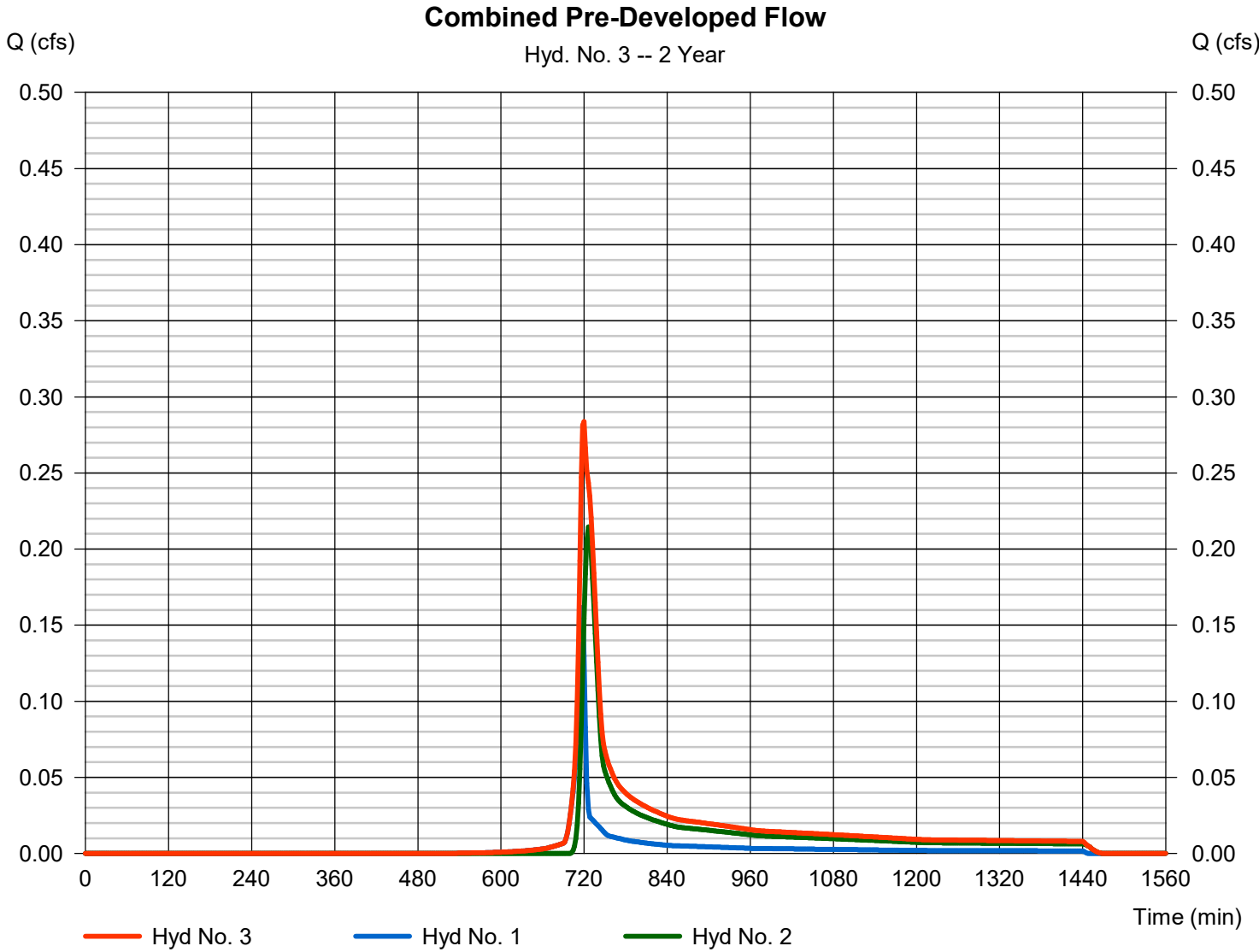
| <u>Description</u>                 | <u>A</u>       | <u>B</u>      | <u>C</u>      | <u>Totals</u>    |
|------------------------------------|----------------|---------------|---------------|------------------|
| <b>Sheet Flow</b>                  |                |               |               |                  |
| Manning's n-value                  | = 0.150        | 0.011         | 0.011         |                  |
| Flow length (ft)                   | = 259.5        | 0.0           | 0.0           |                  |
| Two-year 24-hr precip. (in)        | = 2.20         | 0.00          | 0.00          |                  |
| Land slope (%)                     | = 4.60         | 0.00          | 0.00          |                  |
| <b>Travel Time (min)</b>           | <b>= 18.16</b> | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 18.16</b>   |
| <b>Shallow Concentrated Flow</b>   |                |               |               |                  |
| 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          |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Channel Flow</b>                |                |               |               |                  |
| X sectional flow area (sqft)       | = 0.00         | 0.00          | 0.00          |                  |
| Wetted perimeter (ft)              | = 0.00         | 0.00          | 0.00          |                  |
| Channel slope (%)                  | = 0.00         | 0.00          | 0.00          |                  |
| Manning's n-value                  | = 0.015        | 0.015         | 0.015         |                  |
| Velocity (ft/s)                    | =0.00          | 0.00          | 0.00          |                  |
| Flow length (ft)                   | 0.0            | 0.0           | 0.0           |                  |
| <b>Travel Time (min)</b>           | <b>= 0.00</b>  | <b>+ 0.00</b> | <b>+ 0.00</b> | <b>= 0.00</b>    |
| <b>Total Travel Time, Tc .....</b> |                |               |               | <b>18.16 min</b> |

# Hydrograph Report

## Hyd. No. 3

Combined Pre-Developed Flow

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.284 cfs  |
| Storm frequency | = 2 yrs   | Time to peak         | = 720 min    |
| Time interval   | = 2 min   | Hyd. volume          | = 1,138 cuft |
| Inflow hyds.    | = 1, 2    | Contrib. drain. area | = 0.590 ac   |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| 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               | 0.883           | 2                   | 716                | 1,916                  | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 2.752           | 2                   | 724                | 8,616                  | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 3.118           | 2                   | 720                | 10,532                 | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 0.883           | 2                   | 716                | 1,916                  | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 2.354           | 2                   | 716                | 5,109                  | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.264           | 2                   | 736                | 5,099                  | 5             | 982.78                 | 2,173                   | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 2.550           | 2                   | 716                | 5,535                  | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 0.362           | 2                   | 728                | 5,534                  | 7             | 984.75                 | 2,207                   | Pond Flow                             |  |
| 9                                      | Combine                  | 4.903           | 2                   | 716                | 10,643                 | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 0.625           | 2                   | 728                | 10,633                 | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

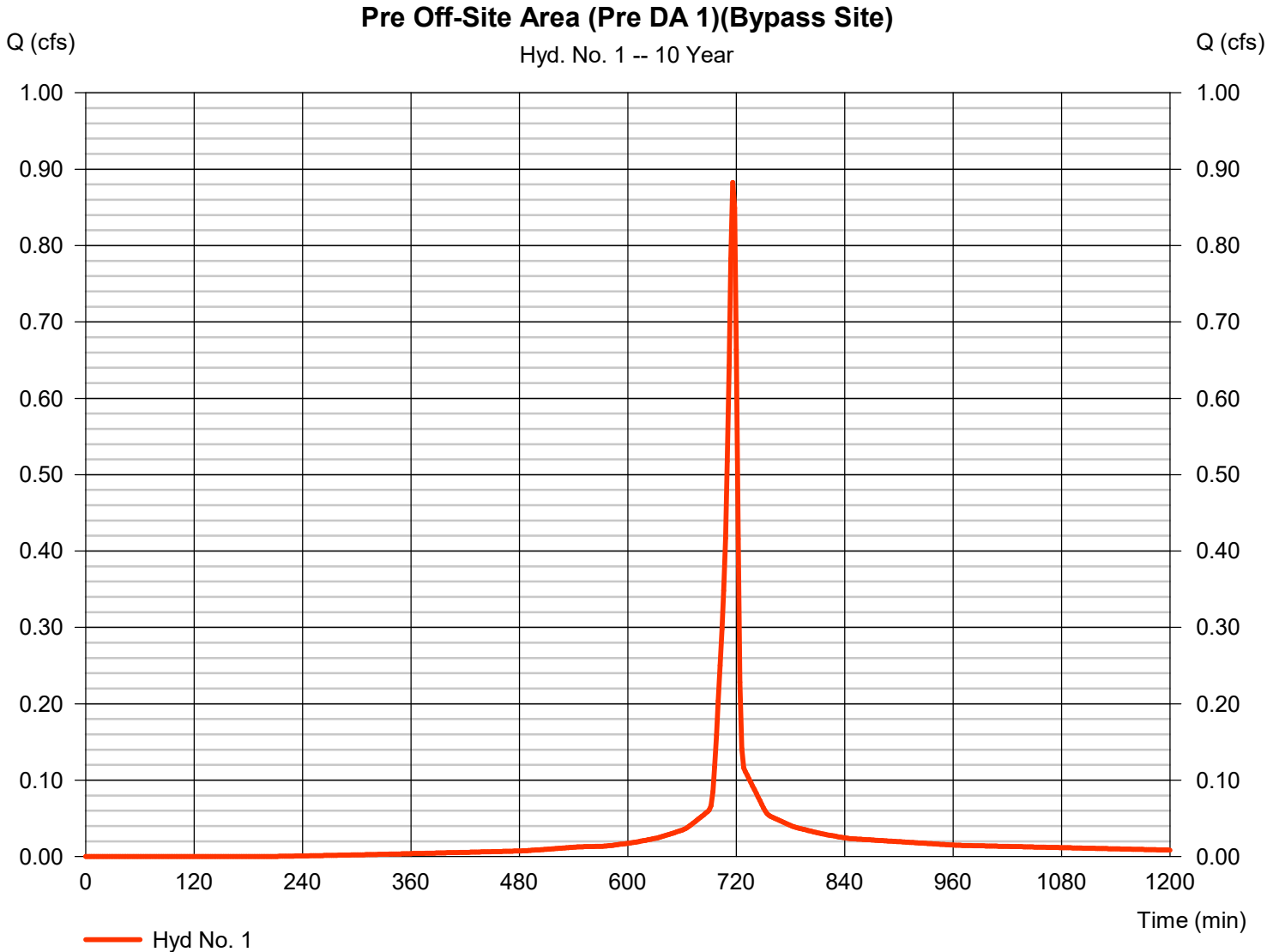
# Hydrograph Report

## Hyd. No. 1

Pre Off-Site Area (Pre DA 1)(Bypass Site)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.883 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 1,916 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 7.80 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090



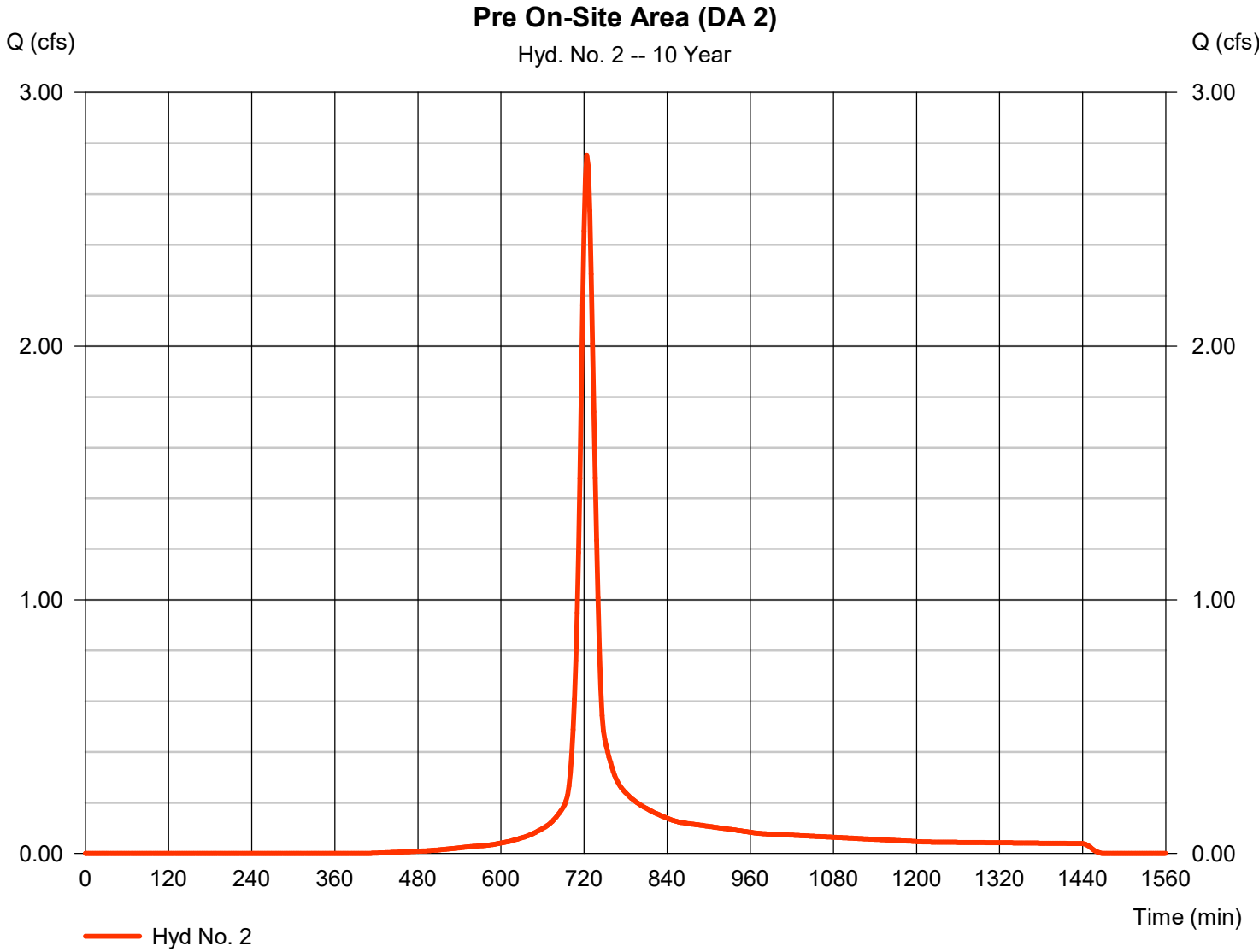
# Hydrograph Report

## Hyd. No. 2

Pre On-Site Area (DA 2)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.752 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 724 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 8,616 cuft |
| Drainage area   | = 0.500 ac   | Curve number       | = 74*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = TR55       | Time of conc. (Tc) | = 18.16 min  |
| Total precip.   | = 7.80 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.500 x 74)] / 0.500





# Hydrograph Report

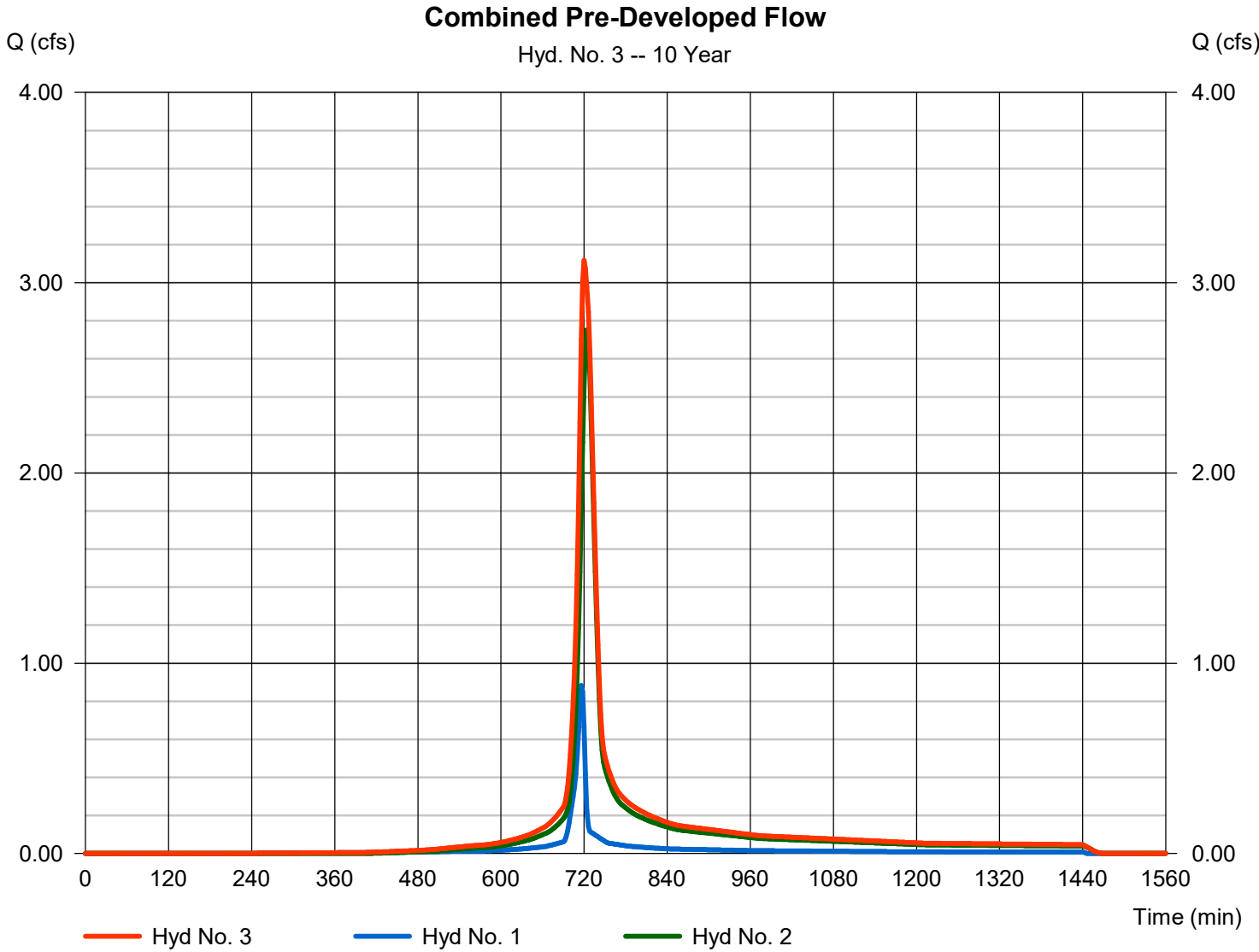
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

## Hyd. No. 3

Combined Pre-Developed Flow

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 3.118 cfs   |
| Storm frequency | = 10 yrs  | Time to peak         | = 720 min     |
| Time interval   | = 2 min   | Hyd. volume          | = 10,532 cuft |
| Inflow hyds.    | = 1, 2    | Contrib. drain. area | = 0.590 ac    |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| Hyd. No.                               | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description                |  |
|--|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|-------------------------|---------------------------------------|--|
| 1                                      | SCS Runoff               | 1.493           | 2                   | 716                | 3,360                   | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 5.229           | 2                   | 724                | 16,670                  | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 5.855           | 2                   | 720                | 20,030                  | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 1.493           | 2                   | 716                | 3,360                   | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 3.980           | 2                   | 716                | 8,959                   | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.347           | 2                   | 744                | 8,949                   | 5             | 983.74                 | 3,992                   | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 4.312           | 2                   | 716                | 9,705                   | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 1.071           | 2                   | 724                | 9,705                   | 7             | 985.59                 | 3,703                   | Pond Flow                             |  |
| 9                                      | Combine                  | 8.292           | 2                   | 716                | 18,664                  | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 1.411           | 2                   | 724                | 18,654                  | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

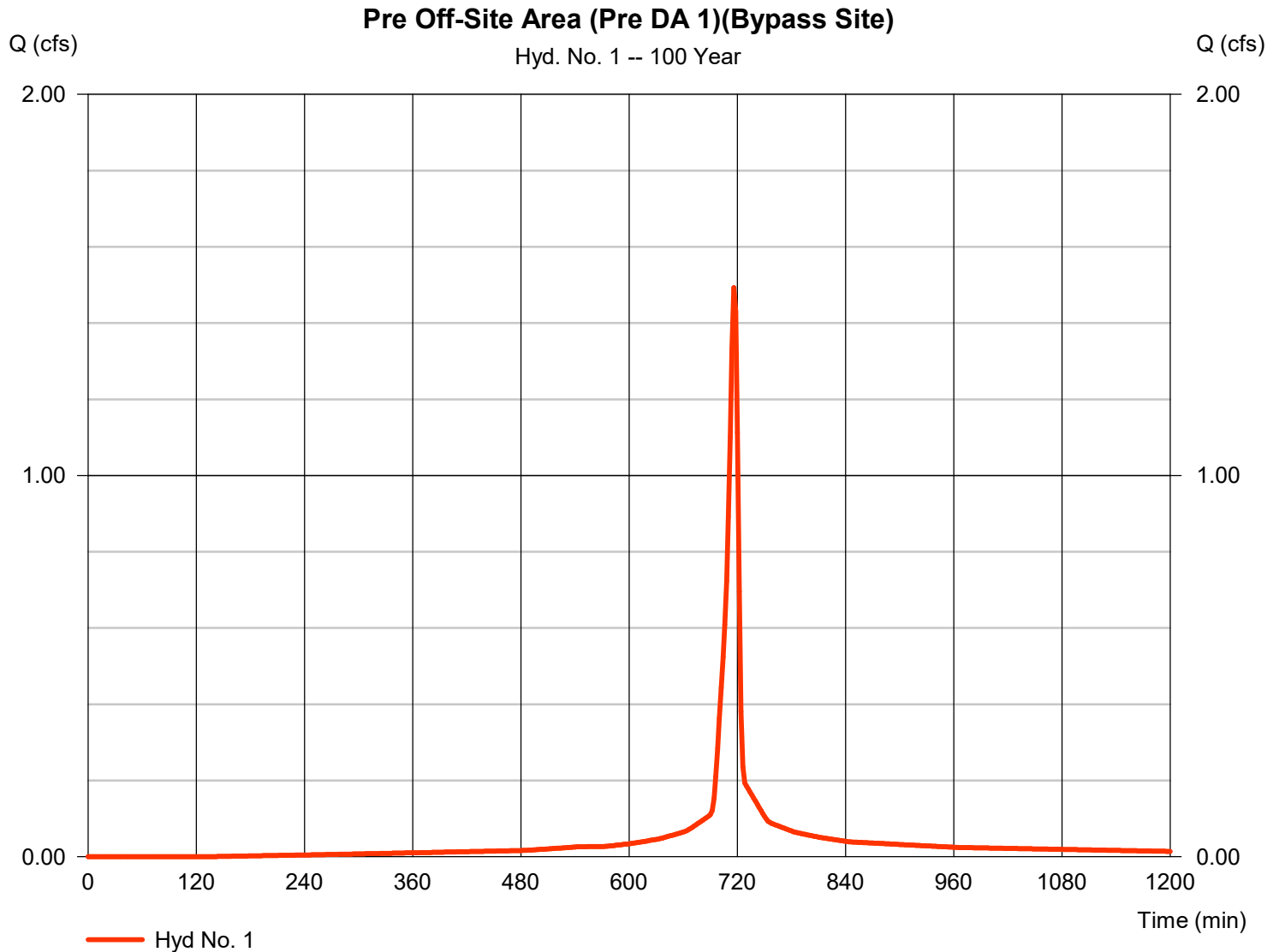
Thursday, 09 / 7 / 2023

## Hyd. No. 1

Pre Off-Site Area (Pre DA 1)(Bypass Site)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.493 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 3,360 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 12.60 in   | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

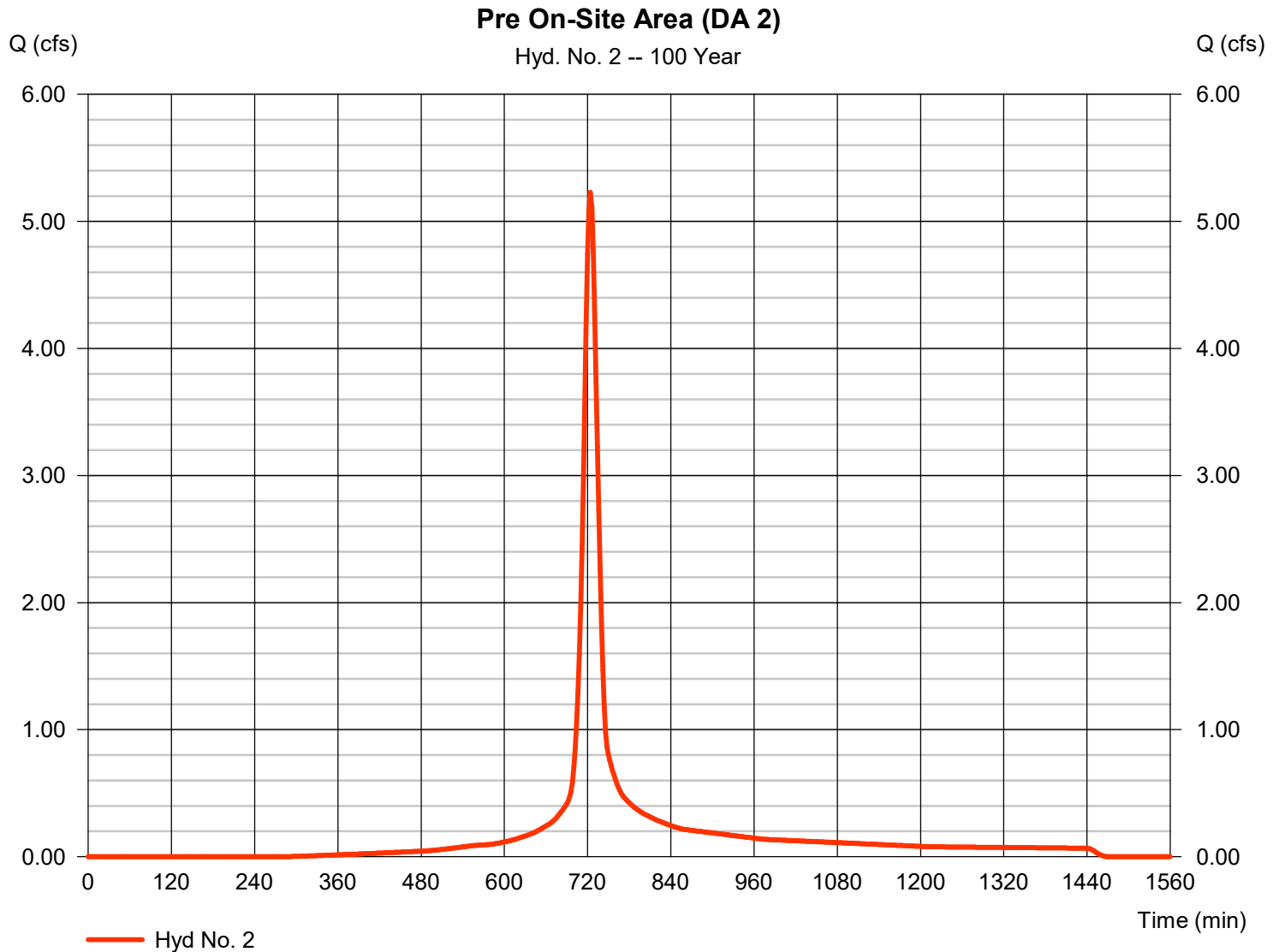
Thursday, 09 / 7 / 2023

## Hyd. No. 2

Pre On-Site Area (DA 2)

|                 |              |                    |               |
|-----------------|--------------|--------------------|---------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 5.229 cfs   |
| Storm frequency | = 100 yrs    | Time to peak       | = 724 min     |
| Time interval   | = 2 min      | Hyd. volume        | = 16,670 cuft |
| Drainage area   | = 0.500 ac   | Curve number       | = 74*         |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft        |
| Tc method       | = TR55       | Time of conc. (Tc) | = 18.16 min   |
| Total precip.   | = 12.60 in   | Distribution       | = Type II     |
| Storm duration  | = 24 hrs     | Shape factor       | = 484         |

\* Composite (Area/CN) = [(0.500 x 74)] / 0.500



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

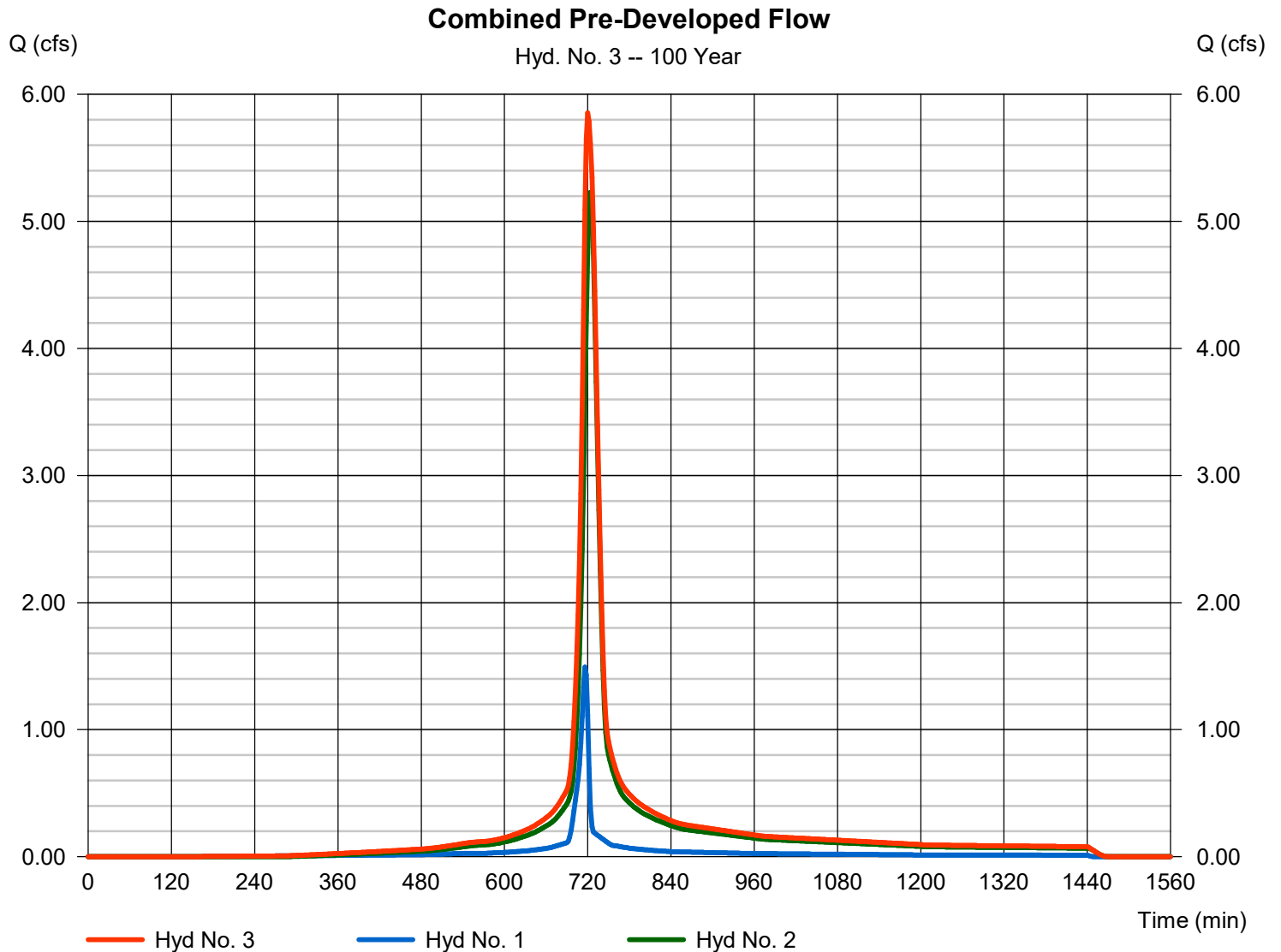
Thursday, 09 / 7 / 2023

## Hyd. No. 3

Combined Pre-Developed Flow

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

Peak discharge = 5.855 cfs  
Time to peak = 720 min  
Hyd. volume = 20,030 cuft  
Contrib. drain. area = 0.590 ac



# Hydraflow Rainfall Report

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 2                   | 80.1702  | 15.0000 | 0.9000 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 10                  | 183.3473   | 19.2000 | 1.0096 | ----- |
| 25                  | 197.2999   | 18.6000 | 0.9937 | ----- |
| 50                  | 235.4014   | 19.9000 | 1.0020 | ----- |
| 100                 | 252.3450   | 19.7000 | 0.9969 | ----- |

File name: IDF Curve APWA5600.IDF

**Intensity = B / (Tc + D)^E**

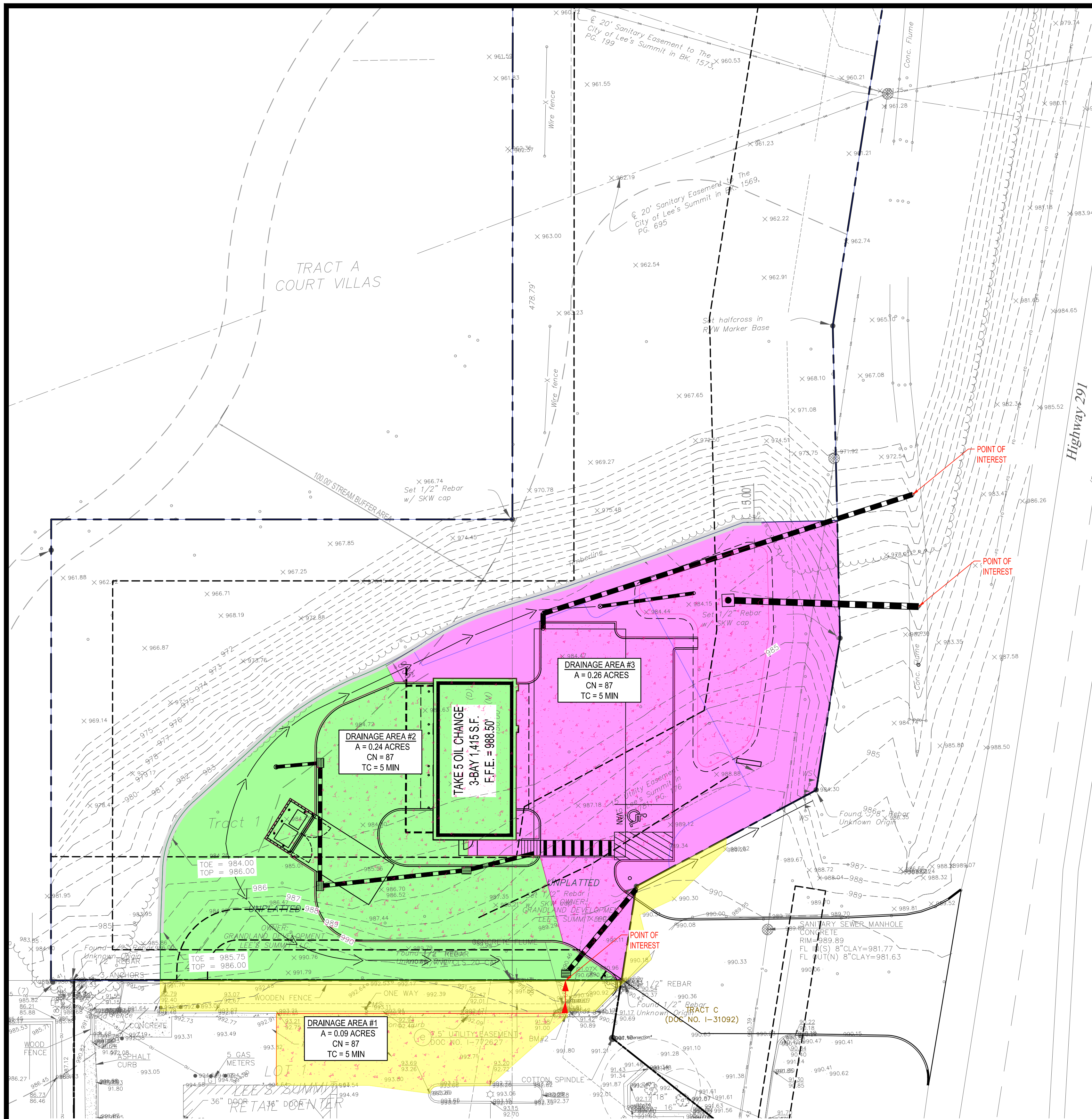
| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2                   | 5.41                     | 4.42 | 3.76 | 3.27 | 2.90 | 2.61 | 2.37 | 2.18 | 2.01 | 1.87 | 1.75 | 1.65 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10                  | 7.35                     | 6.08 | 5.18 | 4.52 | 4.00 | 3.59 | 3.26 | 2.98 | 2.74 | 2.54 | 2.37 | 2.22 |
| 25                  | 8.53                     | 7.05 | 6.00 | 5.23 | 4.63 | 4.16 | 3.77 | 3.45 | 3.18 | 2.95 | 2.75 | 2.58 |
| 50                  | 9.39                     | 7.82 | 6.70 | 5.86 | 5.20 | 4.68 | 4.25 | 3.90 | 3.60 | 3.34 | 3.12 | 2.92 |
| 100                 | 10.32                    | 8.59 | 7.35 | 6.43 | 5.71 | 5.14 | 4.67 | 4.28 | 3.95 | 3.67 | 3.42 | 3.21 |

Tc = time in minutes. Values may exceed 60.

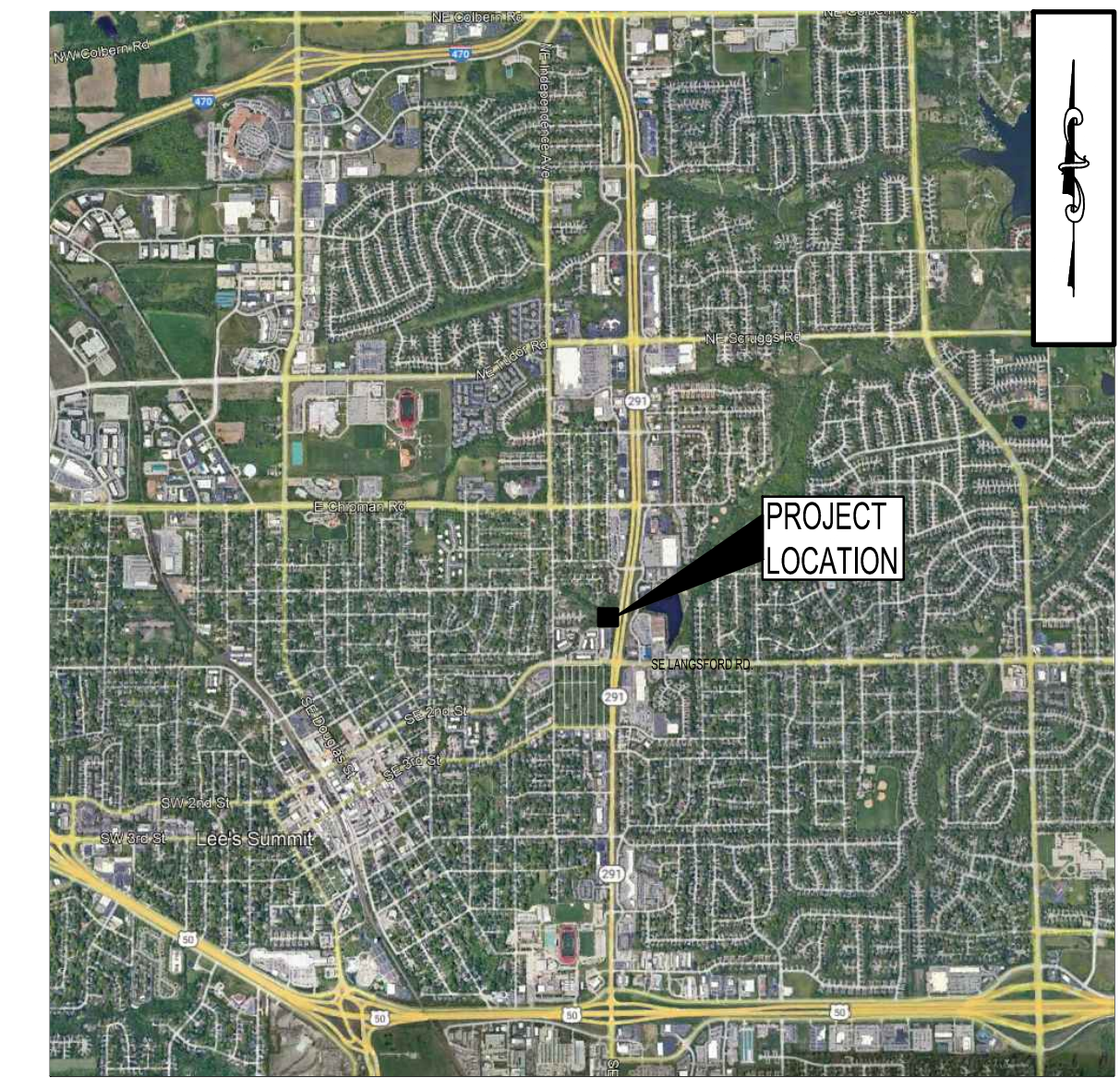
\\Users\Scott Poirrier\High Tide Consultant Dropbox\Projects\Reference Material\LADOTD\New\LADOTD Region 1.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 1.37                              | 2.20 | 0.00 | 3.30 | 7.80  | 9.60  | 11.10 | 12.60  |
| SCS 6-Hr           | 0.00                              | 1.80 | 0.00 | 0.00 | 2.60  | 0.00  | 0.00  | 4.00   |
| Huff-1st           | 0.00                              | 1.55 | 0.00 | 2.75 | 4.00  | 5.38  | 6.50  | 8.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 1.37                              | 1.75 | 0.00 | 2.80 | 3.90  | 5.25  | 6.00  | 7.10   |

# Appendix B



THE PROJECT SITE IS INCLUDED WITHIN THE WEST PRAIRIE LEE WATERSHED AREA AS SHOWN ON THE CITY OF LEE'S SUMMIT WATERSHED & OUTFALL MAP



VICINITY MAP  
NTS

OFF-SITE DRAINAGE AREA 1 TOTAL RUNOFF (DIVERTED):

| RETURN PERIOD | Q (CFS) |
|---------------|---------|
| 2 - YEAR      | 0.161   |
| 10 - YEAR     | 0.883   |
| 100 - YEAR    | 1.493   |

ON-SITE DRAINAGE AREA 2 TOTAL RUNOFF:

| RETURN PERIOD | Q (CFS) |
|---------------|---------|
| 2 - YEAR      | 0.431   |
| 10 - YEAR     | 2.354   |
| 100 - YEAR    | 3.980   |

OFF-SITE DRAINAGE AREA 3 TOTAL RUNOFF:

| RETURN PERIOD | Q (CFS) |
|---------------|---------|
| 2 - YEAR      | 0.467   |
| 10 - YEAR     | 2.550   |
| 100 - YEAR    | 4.312   |

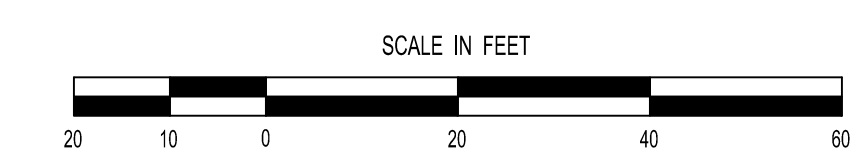
TOTAL COMBINED DETAINED RUNOFF:

| RETURN PERIOD | Q (CFS) |
|---------------|---------|
| 2 - YEAR      | 0.227   |
| 10 - YEAR     | 0.625   |
| 100 - YEAR    | 1.411   |

MAXIMUM ALLOWABLE RELEASE RATE PER 0.5 ACRE:

| RETURN PERIOD | Q (CFS) |
|---------------|---------|
| 2 - YEAR      | 0.25    |
| 10 - YEAR     | 1.00    |
| 100 - YEAR    | 1.50    |

Not For Construction  
**POST-DEVELOPMENT  
DRAINAGE  
PLAN**



| REVISION | BY |
|----------|----|
|          |    |
|          |    |
|          |    |

**HIGH TIDE  
CONSULTANTS LLC**  
434 N. COLUMBIA ST, SUITE 200A  
COVINGTON, LA 70433  
www.hightidela.com



SIGNATURE: *[Signature]*  
DATE: SEPTEMBER 8, 2023  
STAMP: MISSOURI PROFESSIONAL ENGINEER  
B. SHANE GUIN  
NUMBER PE - 202100076

PROPOSED TAKE 5  
LEE'S SUMMIT, MISSOURI  
FOR DRIVEN ASSETS, LLC  
2101 PEARL STREET  
BOULDER, CO 80302

|   |
|---|
| DRAWN<br>KRG                            |
| CHECKED<br>RCG                          |
| ISSUED DATE<br>09/08/23                 |
| ISSUED FOR REVIEW                       |
| PROJECT NO.<br>22-218                   |
| FILE<br>22-218 POST Post-Developed Plan |

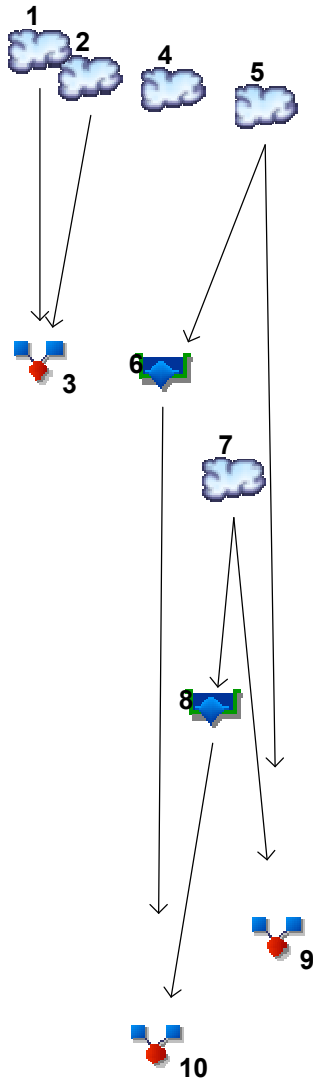
SHEET  
**POST**



|   |           |
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# Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023



## Legend

| Hyd. | Origin     | Description                               |
|------|------------|---|
| 1    | SCS Runoff | Pre Off-Site Area (Pre DA 1)(Bypass Site) |
| 2    | SCS Runoff | Pre On-Site Area (DA 2)                   |
| 3    | Combine    | Combined Pre-Developed Flow               |
| 4    | SCS Runoff | Post Off-Site Area (Post DA 1)(Diverted)  |
| 5    | SCS Runoff | Post On-Site Area 2 (Post DA 2)           |
| 6    | Reservoir  | Chamber Flow                              |
| 7    | SCS Runoff | Post On-Site Area 3 (Post DA 3)           |
| 8    | Reservoir  | Pond Flow                                 |
| 9    | Combine    | Combined Undetained Runoff                |
| 10   | Combine    | Combined Detained Runoff                  |

# Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| Hyd. No. | Hydrograph type (origin) | Inflow hyd(s) | Peak Outflow (cfs) |       |       |       |       |       |       |        | Hydrograph Description                |
|----------|--------------------------|---------------|--------------------|-------|-------|-------|-------|-------|-------|--------|---------------------------------------|
|          |                          |               | 1-yr               | 2-yr  | 3-yr  | 5-yr  | 10-yr | 25-yr | 50-yr | 100-yr |                                       |
| 1        | SCS Runoff               | -----         | -----              | 0.161 | ----- | ----- | 0.883 | ----- | ----- | 1.493  | Pre Off-Site Area (Pre DA 1)(Bypass   |
| 2        | SCS Runoff               | -----         | -----              | 0.215 | ----- | ----- | 2.752 | ----- | ----- | 5.229  | Pre On-Site Area (DA 2)               |
| 3        | Combine                  | 1, 2          | -----              | 0.284 | ----- | ----- | 3.118 | ----- | ----- | 5.855  | Combined Pre-Developed Flow           |
| 4        | SCS Runoff               | -----         | -----              | 0.161 | ----- | ----- | 0.883 | ----- | ----- | 1.493  | Post Off-Site Area (Post DA 1)(Divert |
| 5        | SCS Runoff               | -----         | -----              | 0.431 | ----- | ----- | 2.354 | ----- | ----- | 3.980  | Post On-Site Area 2 (Post DA 2)       |
| 6        | Reservoir                | 5             | -----              | 0.106 | ----- | ----- | 0.264 | ----- | ----- | 0.347  | Chamber Flow                          |
| 7        | SCS Runoff               | -----         | -----              | 0.467 | ----- | ----- | 2.550 | ----- | ----- | 4.312  | Post On-Site Area 3 (Post DA 3)       |
| 8        | Reservoir                | 7             | -----              | 0.122 | ----- | ----- | 0.362 | ----- | ----- | 1.071  | Pond Flow                             |
| 9        | Combine                  | 5, 7,         | -----              | 0.897 | ----- | ----- | 4.903 | ----- | ----- | 8.292  | Combined Undetained Runoff            |
| 10       | Combine                  | 6, 8,         | -----              | 0.227 | ----- | ----- | 0.625 | ----- | ----- | 1.411  | Combined Detained Runoff              |

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| 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               | 0.161           | 2                   | 716                | 326                   | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 0.215           | 2                   | 726                | 812                   | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 0.284           | 2                   | 720                | 1,138                 | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 0.161           | 2                   | 716                | 326                   | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 0.431           | 2                   | 716                | 869                   | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.106           | 2                   | 724                | 860                   | 5             | 981.63                 | 326                     | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 0.467           | 2                   | 716                | 942                   | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 0.122           | 2                   | 724                | 941                   | 7             | 982.54                 | 267                     | Pond Flow                             |  |
| 9                                      | Combine                  | 0.897           | 2                   | 716                | 1,811                 | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 0.227           | 2                   | 724                | 1,801                 | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 2 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

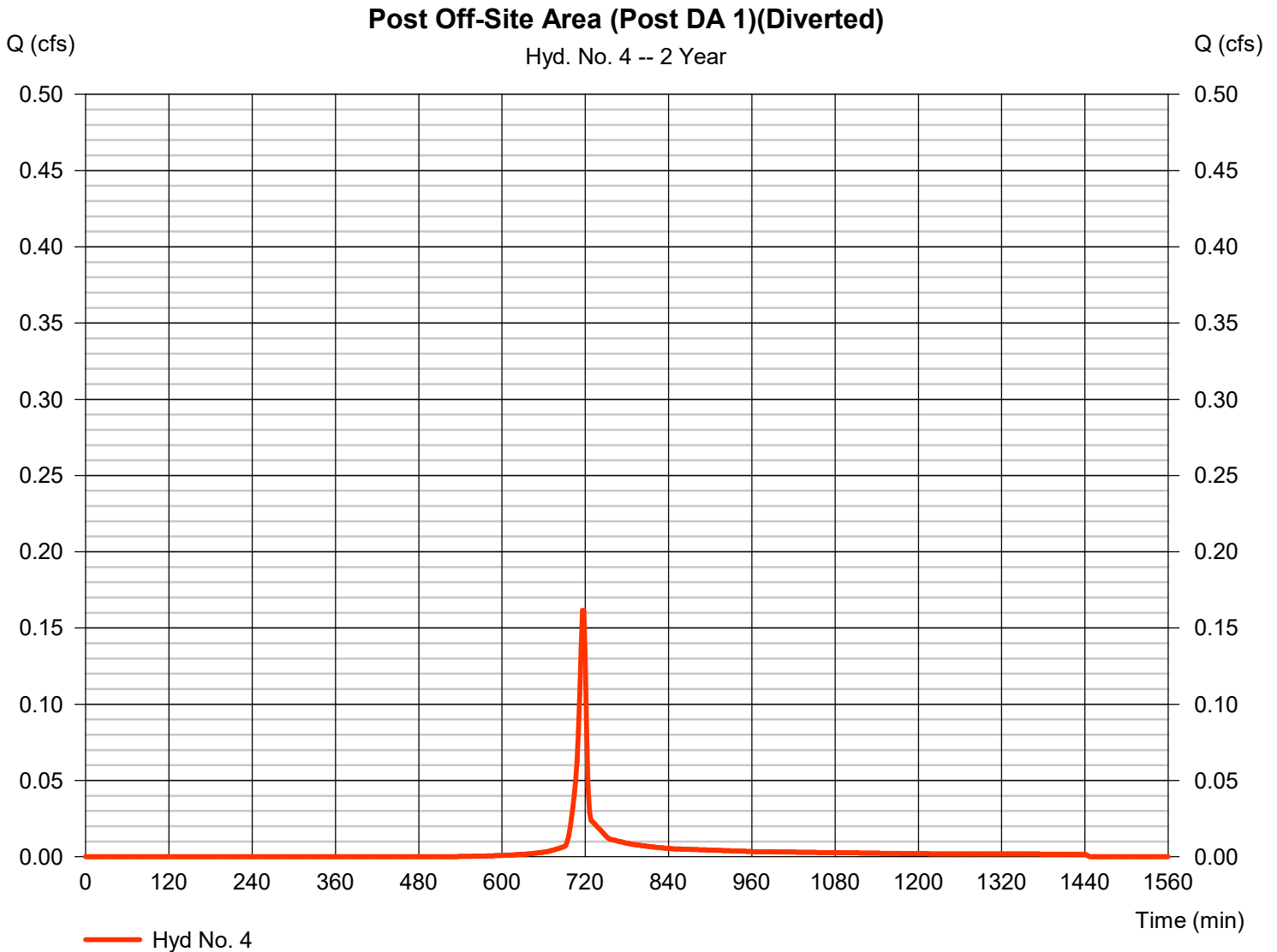
# Hydrograph Report

## Hyd. No. 4

Post Off-Site Area (Post DA 1)(Diverted)

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.161 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 2 min      | Hyd. volume        | = 326 cuft  |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min  |
| Total precip.   | = 2.20 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090



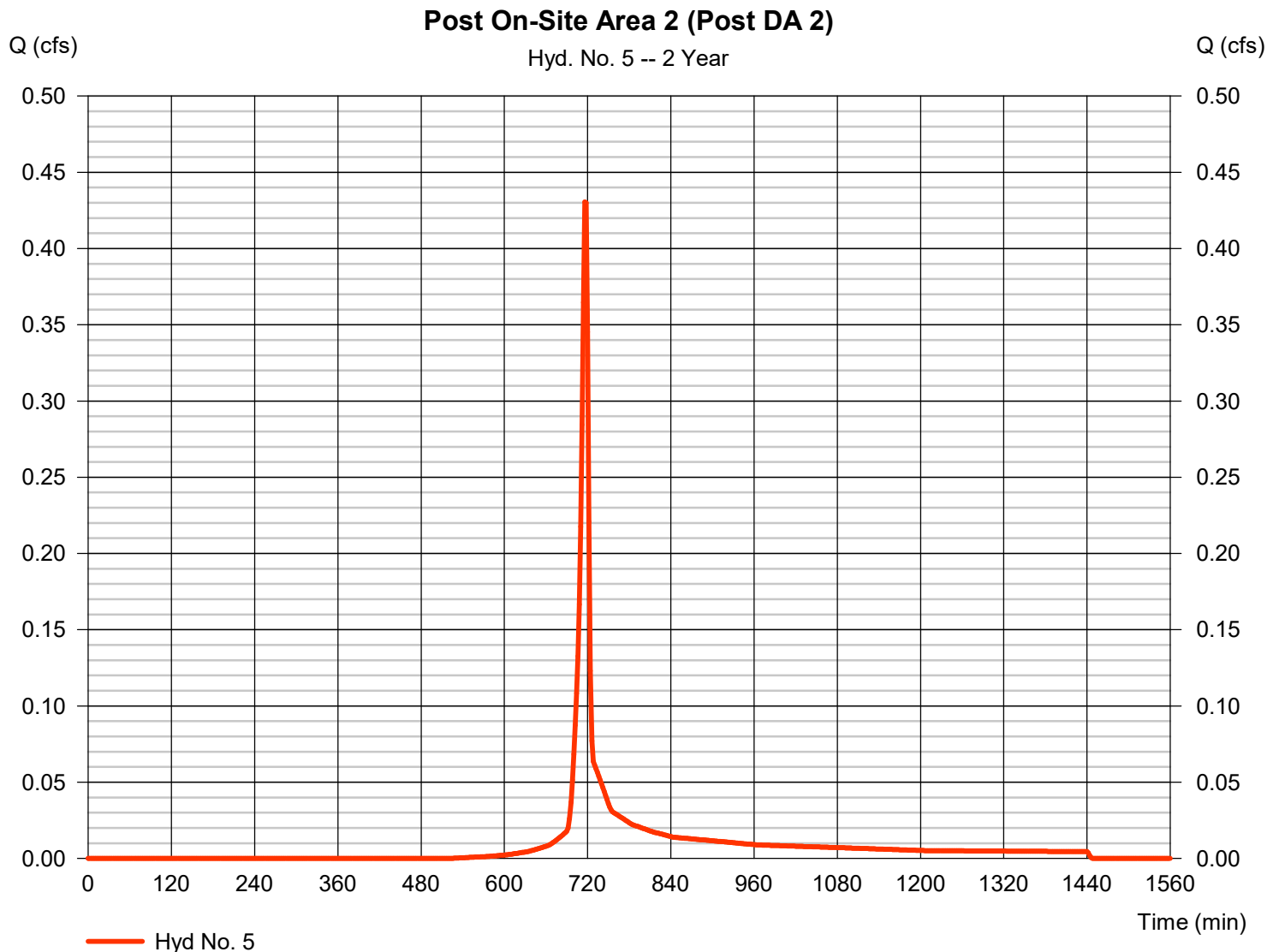
# Hydrograph Report

## Hyd. No. 5

Post On-Site Area 2 (Post DA 2)

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.431 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 2 min      | Hyd. volume        | = 869 cuft  |
| Drainage area   | = 0.240 ac   | Curve number       | = 87*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min  |
| Total precip.   | = 2.20 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.130 x 98) + (0.110 x 74)] / 0.240



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

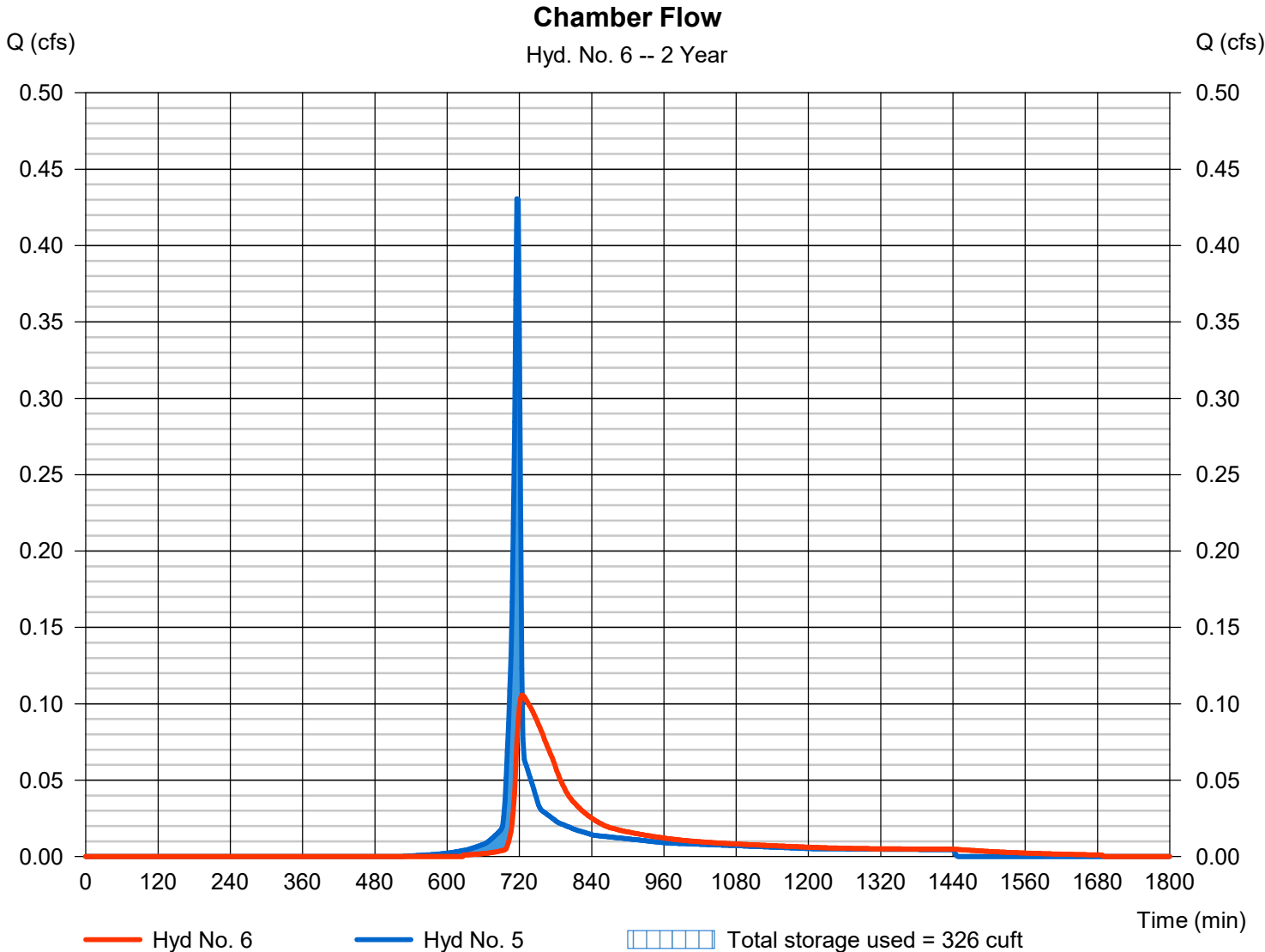
Thursday, 09 / 7 / 2023

## Hyd. No. 6

### Chamber Flow

|                 |                                      |                |             |
|-----------------|--------------------------------------|----------------|-------------|
| Hydrograph type | = Reservoir                          | Peak discharge | = 0.106 cfs |
| Storm frequency | = 2 yrs                              | Time to peak   | = 724 min   |
| Time interval   | = 2 min                              | Hyd. volume    | = 860 cuft  |
| Inflow hyd. No. | = 5 - Post On-Site Area 2 (Post Max) | Max. Elevation | = 981.63 ft |
| Reservoir name  | = Underground Detention              | Max. Storage   | = 326 cuft  |

Storage Indication method used.







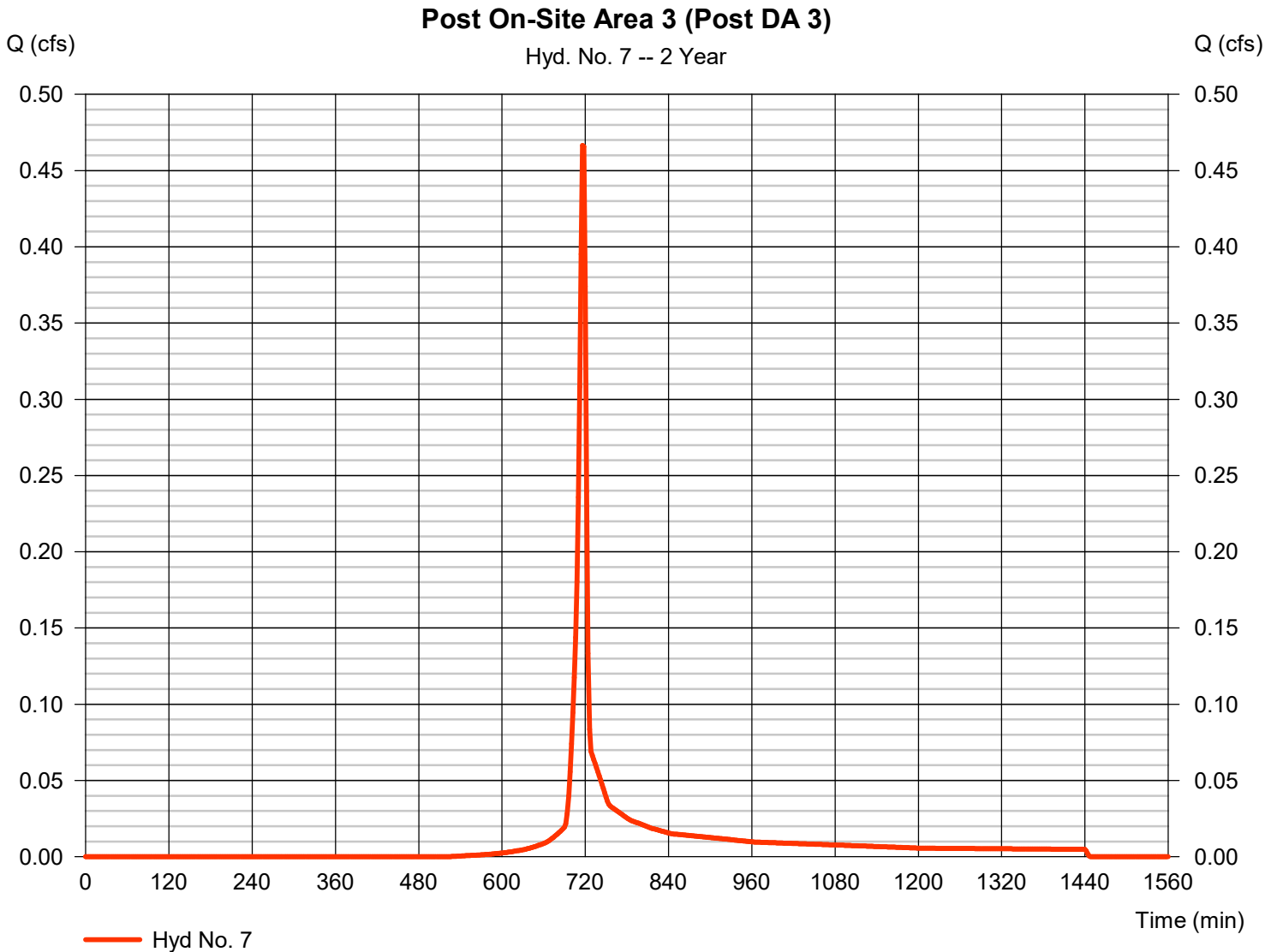
# Hydrograph Report

## Hyd. No. 7

Post On-Site Area 3 (Post DA 3)

|                 |              |                    |             |
|-----------------|--------------|--------------------|-------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.467 cfs |
| Storm frequency | = 2 yrs      | Time to peak       | = 716 min   |
| Time interval   | = 2 min      | Hyd. volume        | = 942 cuft  |
| Drainage area   | = 0.260 ac   | Curve number       | = 87*       |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft      |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min  |
| Total precip.   | = 2.20 in    | Distribution       | = Type II   |
| Storm duration  | = 24 hrs     | Shape factor       | = 484       |

\* Composite (Area/CN) = [(0.140 x 98) + (0.120 x 74)] / 0.260



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

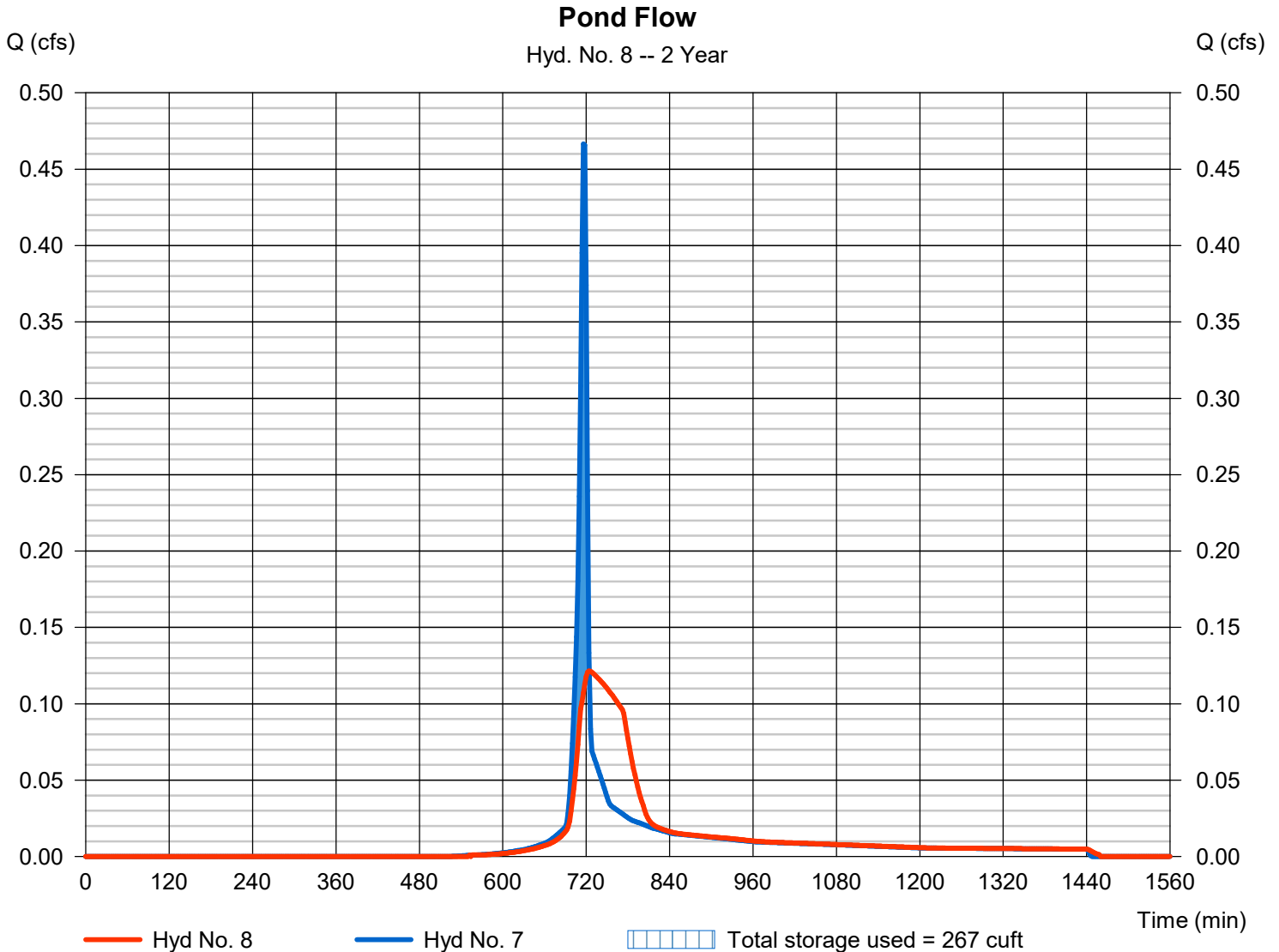
Thursday, 09 / 7 / 2023

## Hyd. No. 8

### Pond Flow

|                 |                                       |                |             |
|-----------------|---------------------------------------|----------------|-------------|
| Hydrograph type | = Reservoir                           | Peak discharge | = 0.122 cfs |
| Storm frequency | = 2 yrs                               | Time to peak   | = 724 min   |
| Time interval   | = 2 min                               | Hyd. volume    | = 941 cuft  |
| Inflow hyd. No. | = 7 - Post On-Site Area 3 (Post Mass) | Max. Elevation | = 982.54 ft |
| Reservoir name  | = Detention Pond                      | Max. Storage   | = 267 cuft  |

Storage Indication method used.



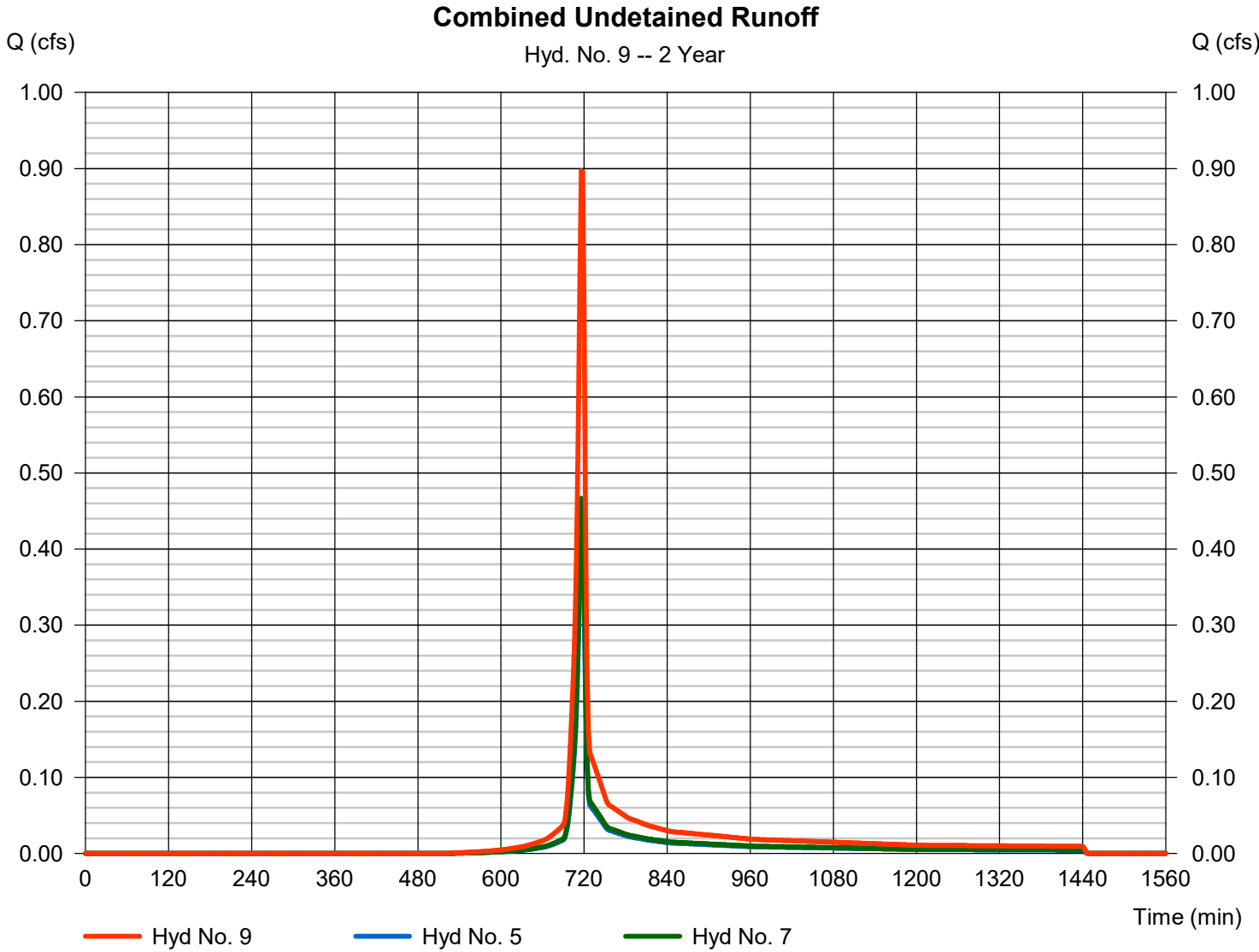


# Hydrograph Report

## Hyd. No. 9

### Combined Undetained Runoff

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.897 cfs  |
| Storm frequency | = 2 yrs   | Time to peak         | = 716 min    |
| Time interval   | = 2 min   | Hyd. volume          | = 1,811 cuft |
| Inflow hyds.    | = 5, 7    | Contrib. drain. area | = 0.500 ac   |



# Hydrograph Report

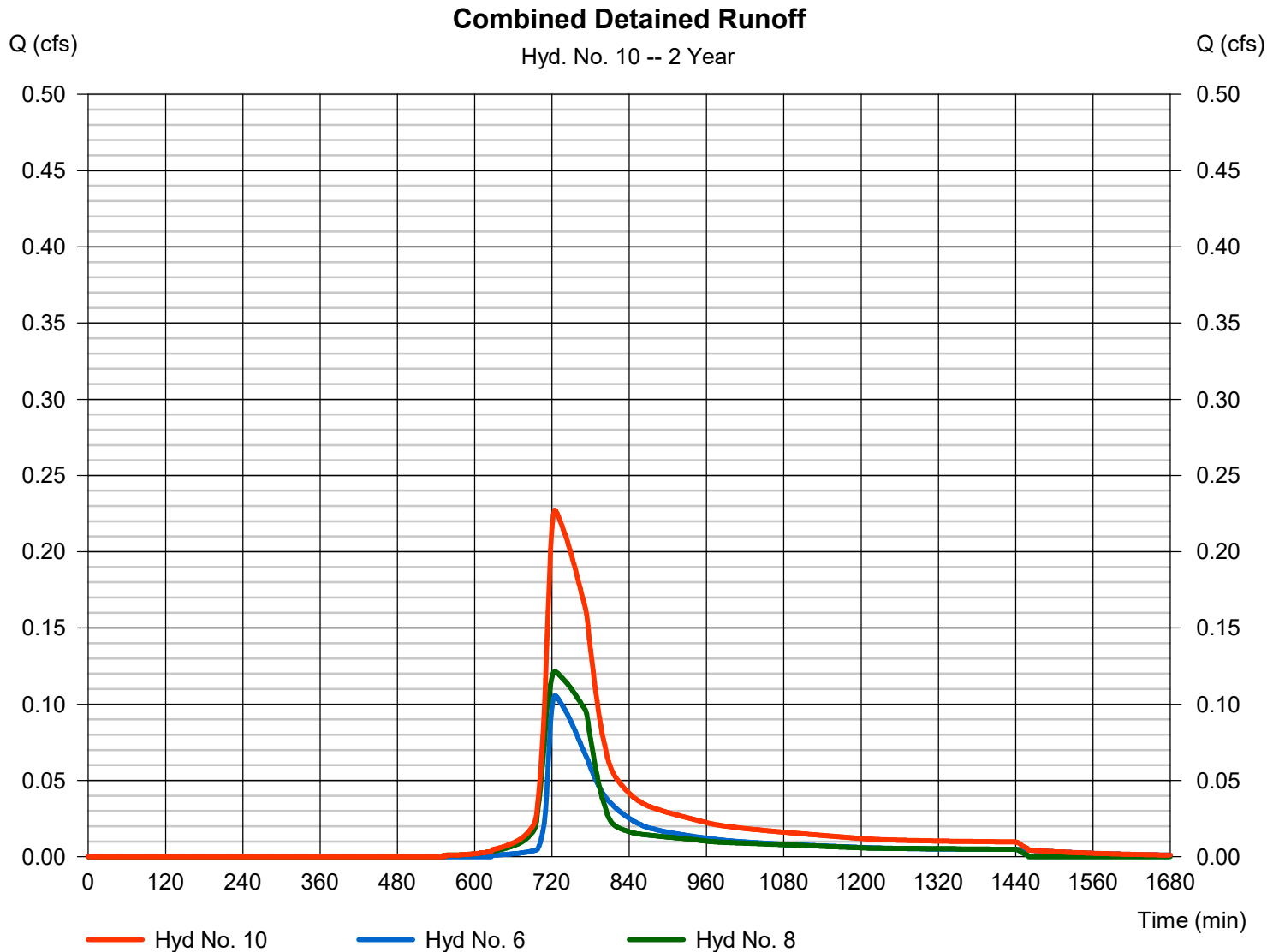
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

## Hyd. No. 10

### Combined Detained Runoff

|                 |           |                      |              |
|-----------------|-----------|----------------------|--------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.227 cfs  |
| Storm frequency | = 2 yrs   | Time to peak         | = 724 min    |
| Time interval   | = 2 min   | Hyd. volume          | = 1,801 cuft |
| Inflow hyds.    | = 6, 8    | Contrib. drain. area | = 0.000 ac   |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| 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               | 0.883           | 2                   | 716                | 1,916                  | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 2.752           | 2                   | 724                | 8,616                  | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 3.118           | 2                   | 720                | 10,532                 | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 0.883           | 2                   | 716                | 1,916                  | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 2.354           | 2                   | 716                | 5,109                  | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.264           | 2                   | 736                | 5,099                  | 5             | 982.78                 | 2,173                   | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 2.550           | 2                   | 716                | 5,535                  | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 0.362           | 2                   | 728                | 5,534                  | 7             | 984.75                 | 2,207                   | Pond Flow                             |  |
| 9                                      | Combine                  | 4.903           | 2                   | 716                | 10,643                 | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 0.625           | 2                   | 728                | 10,633                 | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 10 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

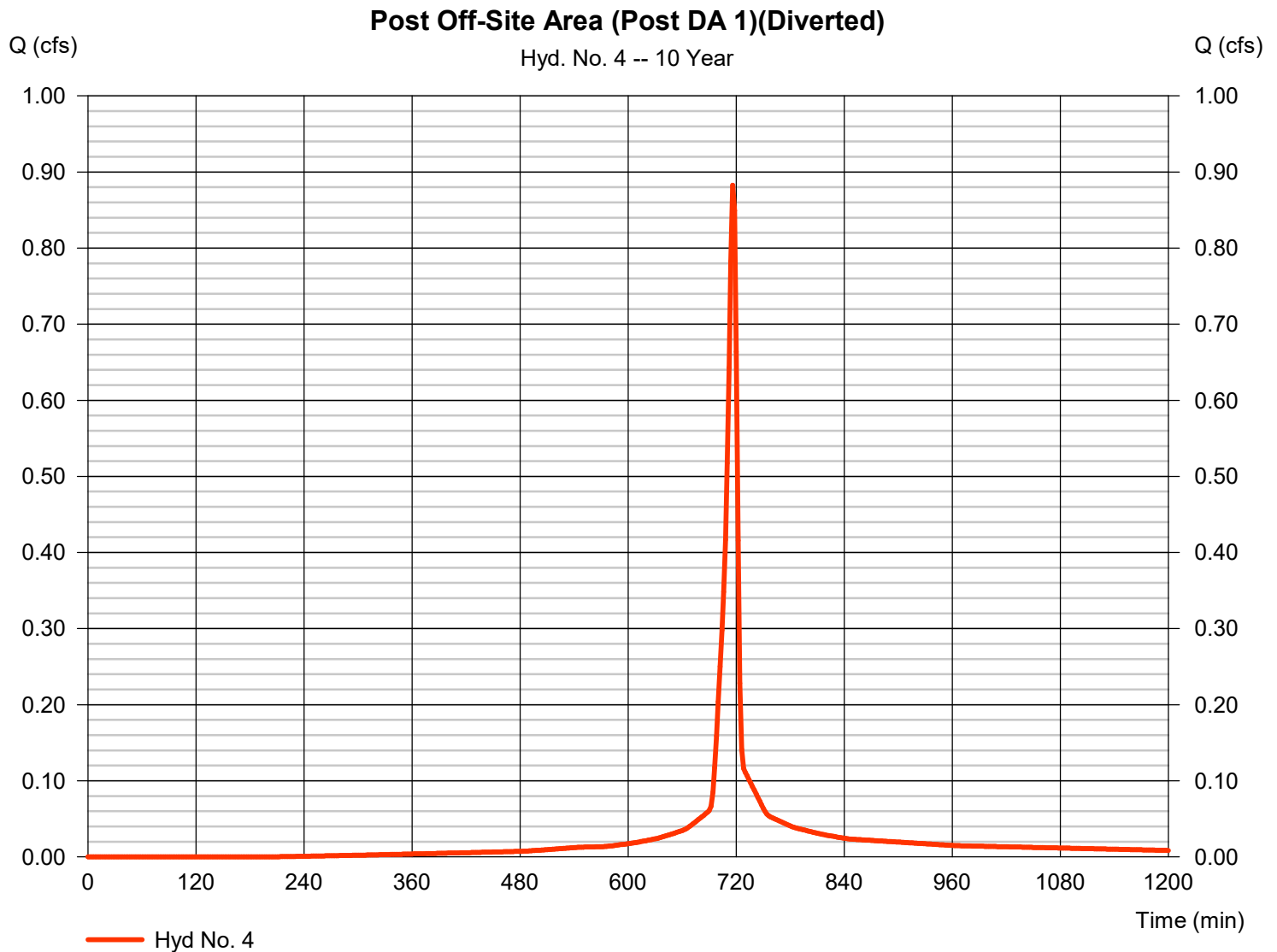
Thursday, 09 / 7 / 2023

## Hyd. No. 4

Post Off-Site Area (Post DA 1)(Diverted)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 0.883 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 1,916 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 7.80 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

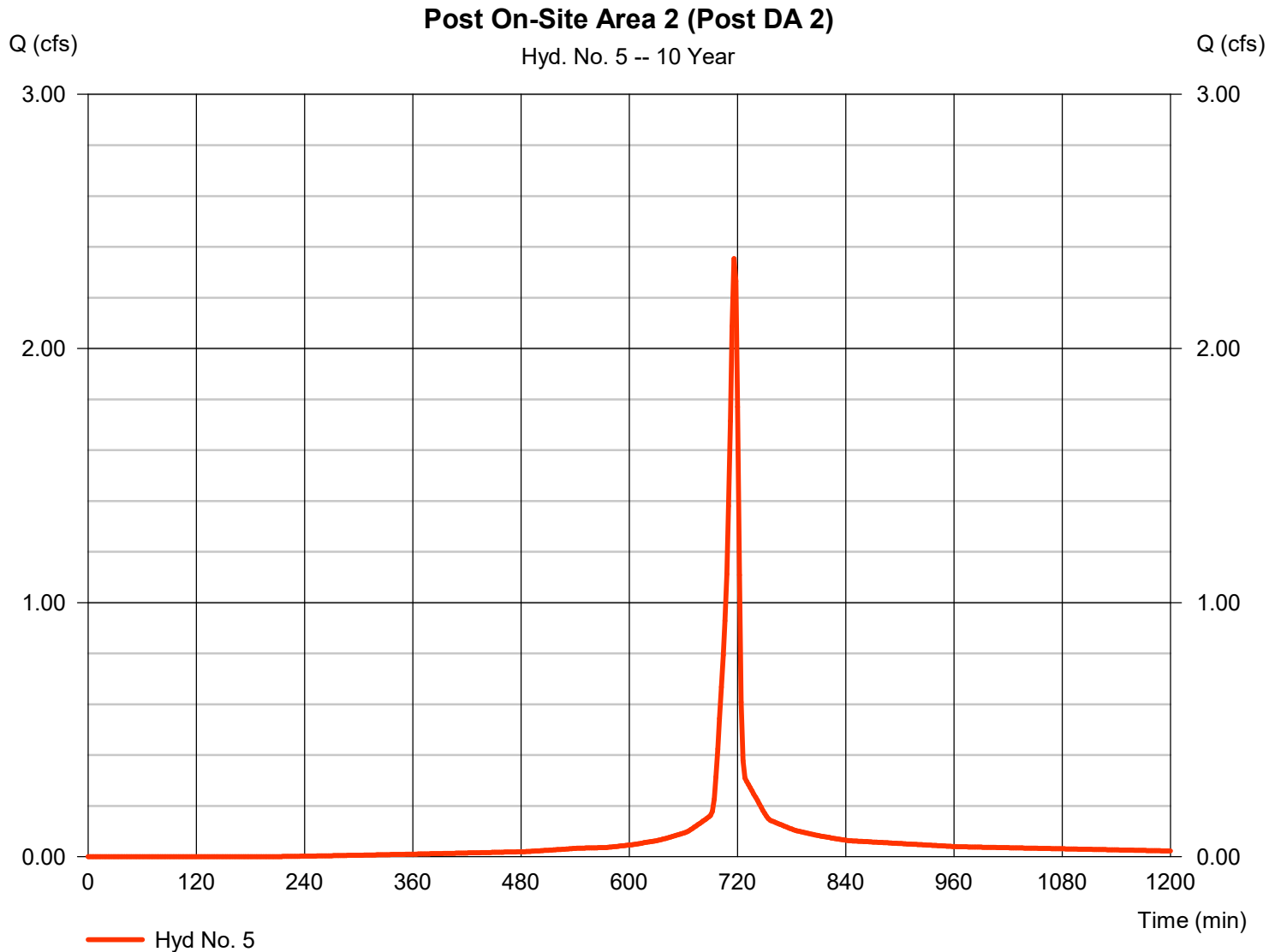
Thursday, 09 / 7 / 2023

## Hyd. No. 5

Post On-Site Area 2 (Post DA 2)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.354 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 5,109 cuft |
| Drainage area   | = 0.240 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 7.80 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 98) + (0.110 x 74)] / 0.240





# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

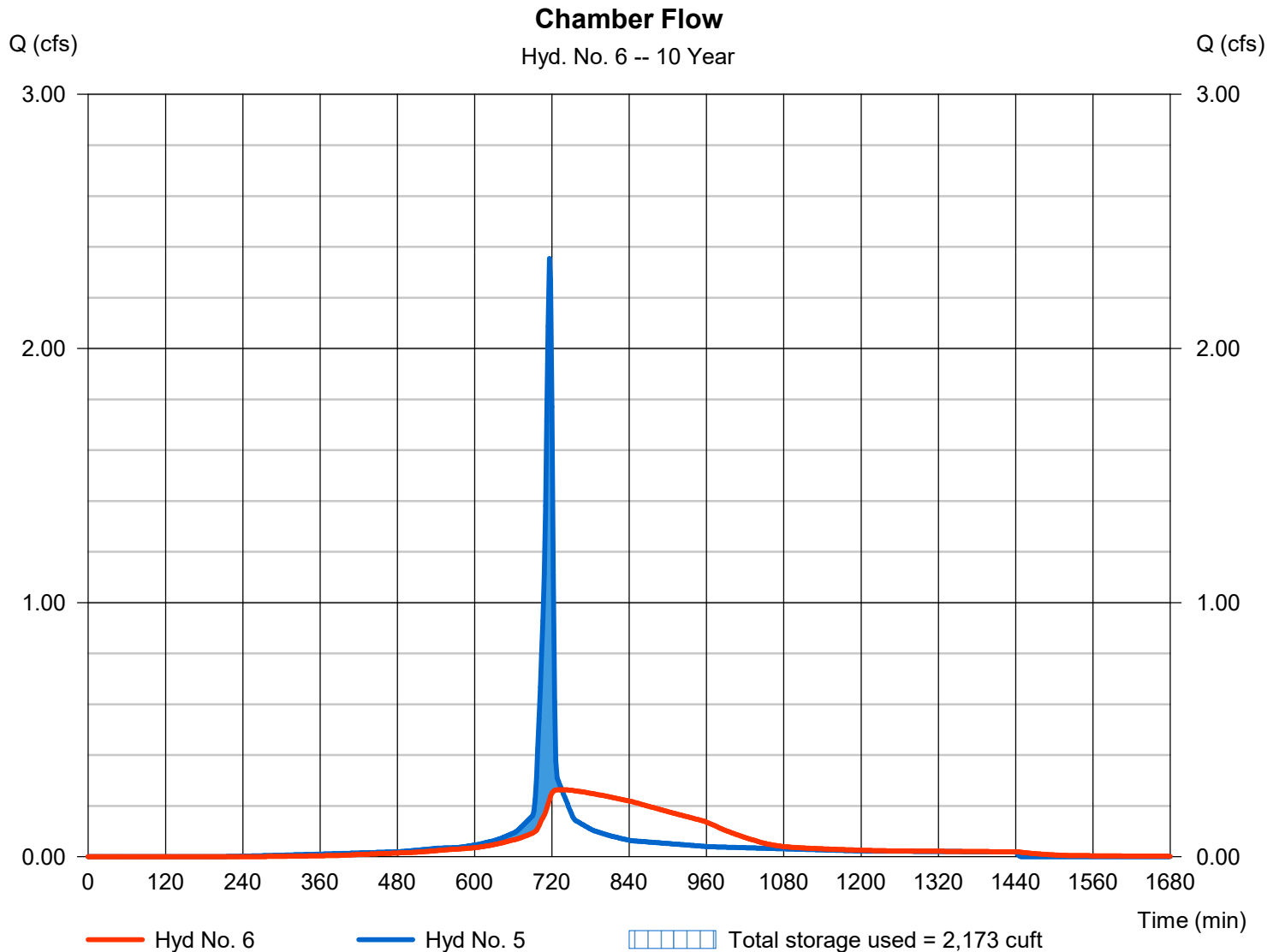
Thursday, 09 / 7 / 2023

## Hyd. No. 6

### Chamber Flow

|                 |                                      |                |              |
|-----------------|--------------------------------------|----------------|--------------|
| Hydrograph type | = Reservoir                          | Peak discharge | = 0.264 cfs  |
| Storm frequency | = 10 yrs                             | Time to peak   | = 736 min    |
| Time interval   | = 2 min                              | Hyd. volume    | = 5,099 cuft |
| Inflow hyd. No. | = 5 - Post On-Site Area 2 (Post Max) | Max. Elevation | = 982.78 ft  |
| Reservoir name  | = Underground Detention              | Max. Storage   | = 2,173 cuft |

Storage Indication method used.



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

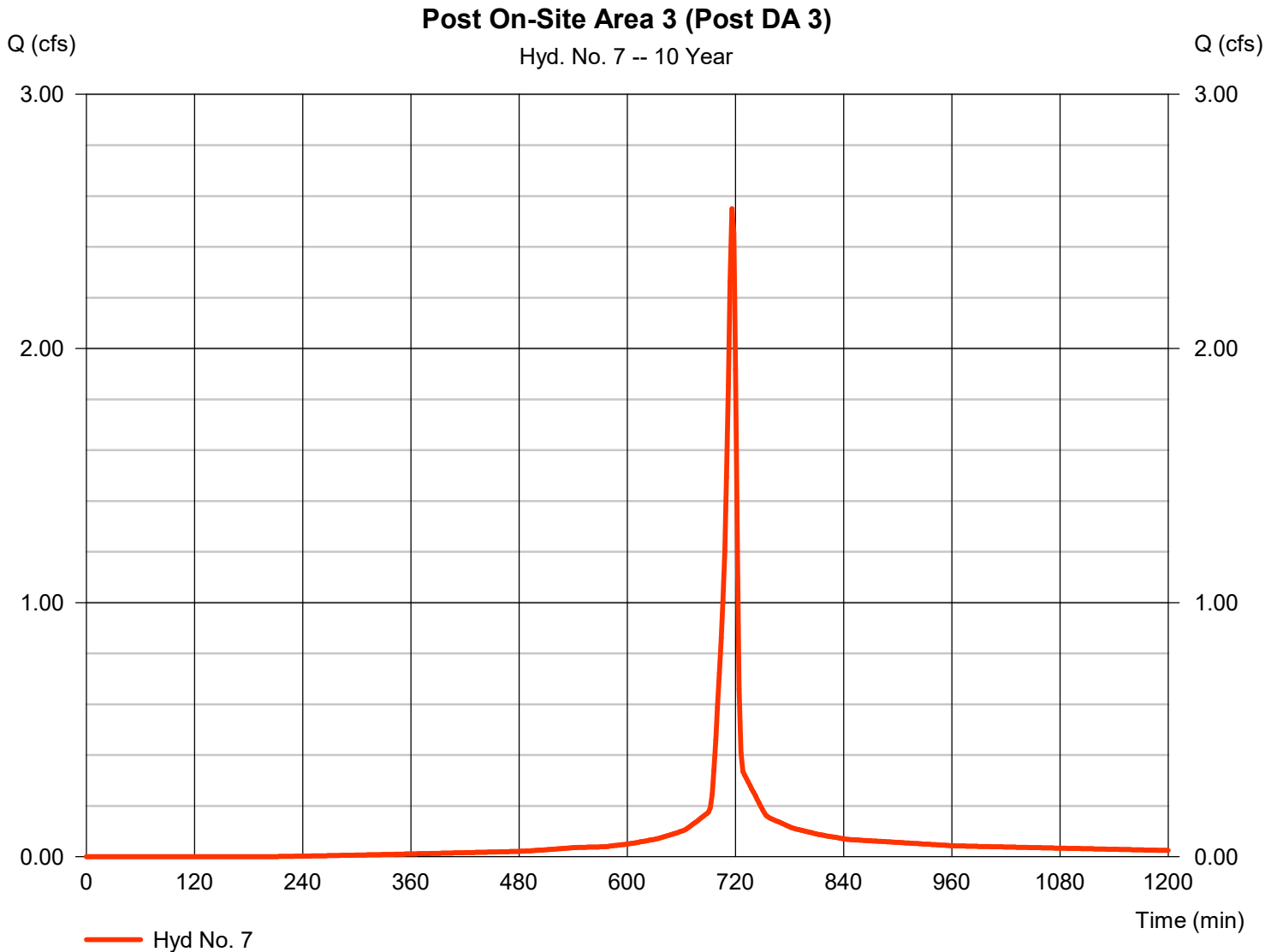
Thursday, 09 / 7 / 2023

## Hyd. No. 7

Post On-Site Area 3 (Post DA 3)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 2.550 cfs  |
| Storm frequency | = 10 yrs     | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 5,535 cuft |
| Drainage area   | = 0.260 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 7.80 in    | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.140 x 98) + (0.120 x 74)] / 0.260



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

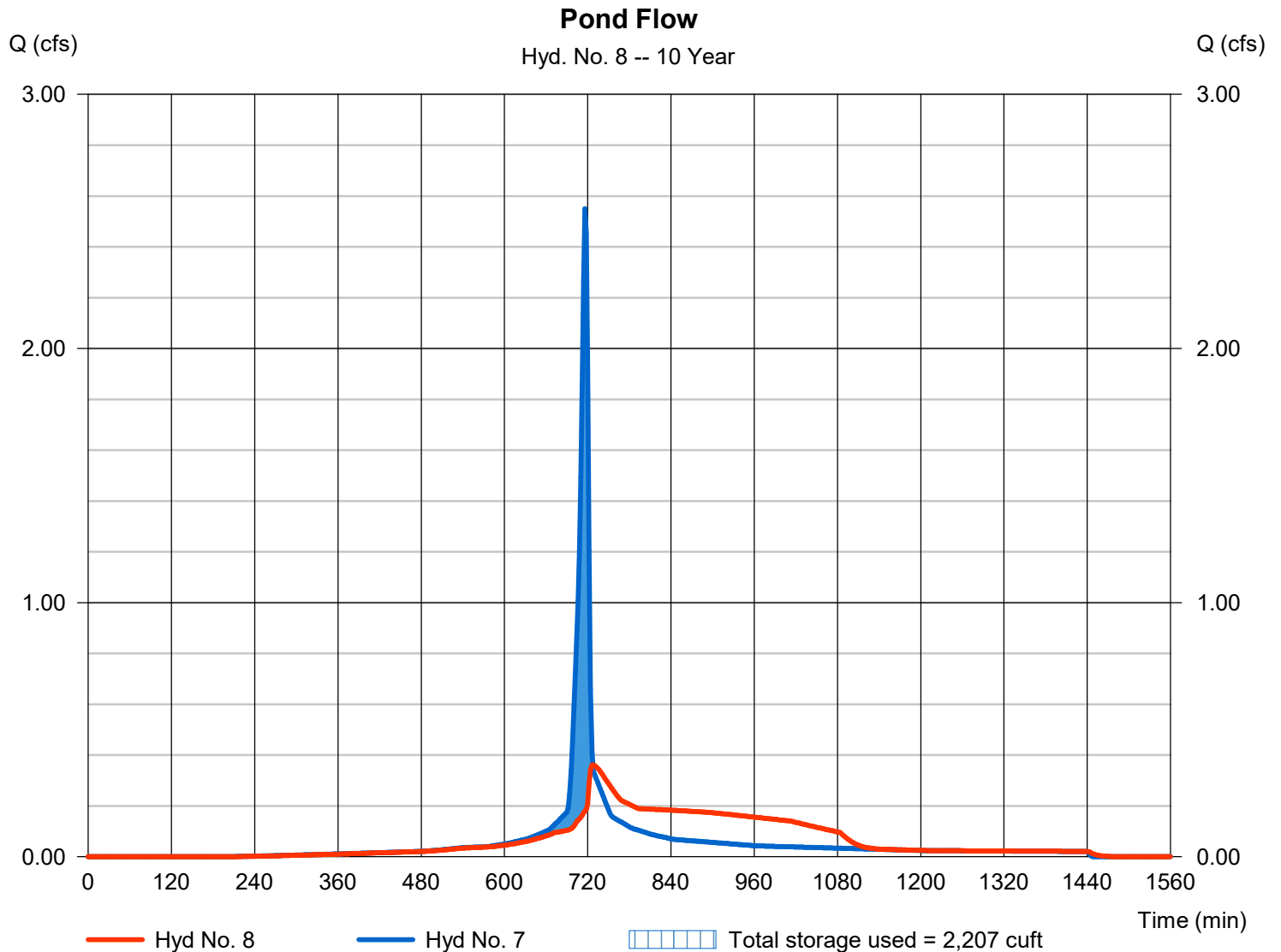
Thursday, 09 / 7 / 2023

## Hyd. No. 8

### Pond Flow

|                 |                                       |                |              |
|-----------------|---------------------------------------|----------------|--------------|
| Hydrograph type | = Reservoir                           | Peak discharge | = 0.362 cfs  |
| Storm frequency | = 10 yrs                              | Time to peak   | = 728 min    |
| Time interval   | = 2 min                               | Hyd. volume    | = 5,534 cuft |
| Inflow hyd. No. | = 7 - Post On-Site Area 3 (Post Mass) | Max. Elevation | = 984.75 ft  |
| Reservoir name  | = Detention Pond                      | Max. Storage   | = 2,207 cuft |

Storage Indication method used.



# Hydrograph Report

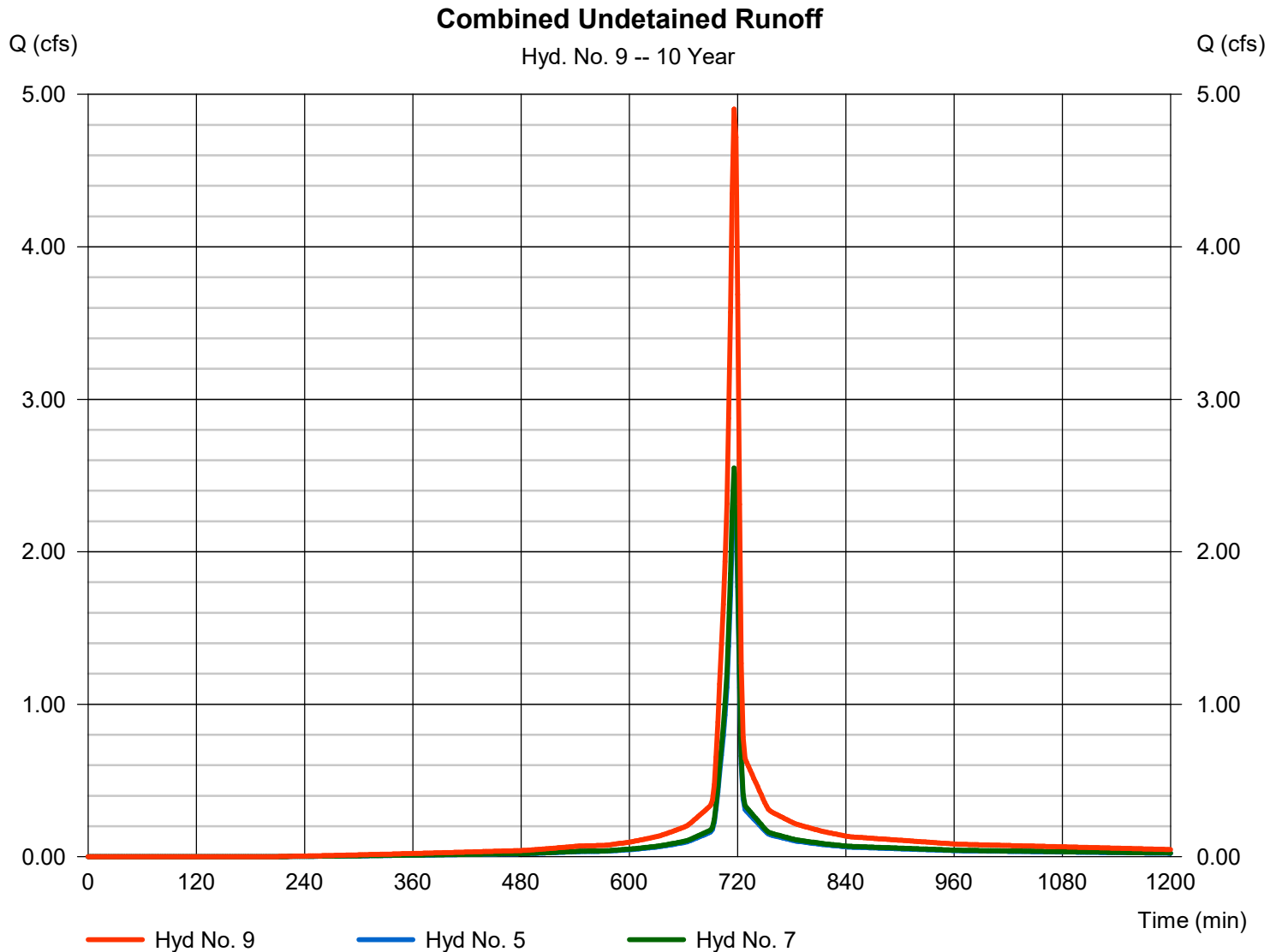
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

## Hyd. No. 9

### Combined Undetained Runoff

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 4.903 cfs   |
| Storm frequency | = 10 yrs  | Time to peak         | = 716 min     |
| Time interval   | = 2 min   | Hyd. volume          | = 10,643 cuft |
| Inflow hyds.    | = 5, 7    | Contrib. drain. area | = 0.500 ac    |



# Hydrograph Report

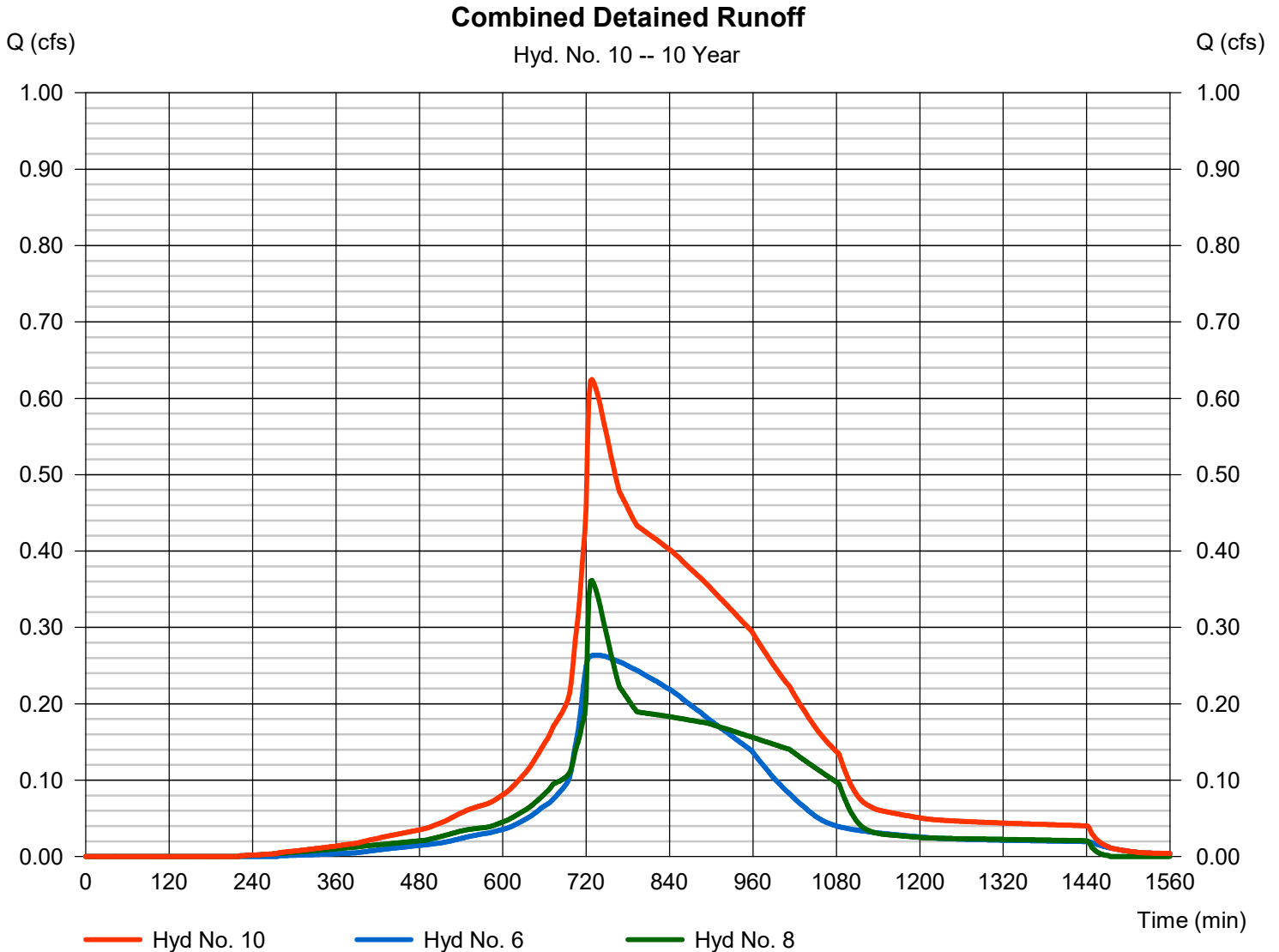
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

## Hyd. No. 10

### Combined Detained Runoff

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 0.625 cfs   |
| Storm frequency | = 10 yrs  | Time to peak         | = 728 min     |
| Time interval   | = 2 min   | Hyd. volume          | = 10,633 cuft |
| Inflow hyds.    | = 6, 8    | Contrib. drain. area | = 0.000 ac    |



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

| Hyd. No.                               | Hydrograph type (origin) | Peak flow (cfs) | Time interval (min) | Time to Peak (min) | Hyd. volume (cuft)      | Inflow hyd(s) | Maximum elevation (ft) | Total strge used (cuft) | Hydrograph Description                |  |
|--|--------------------------|-----------------|---------------------|--------------------|-------------------------|---------------|------------------------|-------------------------|---------------------------------------|--|
| 1                                      | SCS Runoff               | 1.493           | 2                   | 716                | 3,360                   | -----         | -----                  | -----                   | Pre Off-Site Area (Pre DA 1)(Bypass   |  |
| 2                                      | SCS Runoff               | 5.229           | 2                   | 724                | 16,670                  | -----         | -----                  | -----                   | Pre On-Site Area (DA 2)               |  |
| 3                                      | Combine                  | 5.855           | 2                   | 720                | 20,030                  | 1, 2          | -----                  | -----                   | Combined Pre-Developed Flow           |  |
| 4                                      | SCS Runoff               | 1.493           | 2                   | 716                | 3,360                   | -----         | -----                  | -----                   | Post Off-Site Area (Post DA 1)(Divert |  |
| 5                                      | SCS Runoff               | 3.980           | 2                   | 716                | 8,959                   | -----         | -----                  | -----                   | Post On-Site Area 2 (Post DA 2)       |  |
| 6                                      | Reservoir                | 0.347           | 2                   | 744                | 8,949                   | 5             | 983.74                 | 3,992                   | Chamber Flow                          |  |
| 7                                      | SCS Runoff               | 4.312           | 2                   | 716                | 9,705                   | -----         | -----                  | -----                   | Post On-Site Area 3 (Post DA 3)       |  |
| 8                                      | Reservoir                | 1.071           | 2                   | 724                | 9,705                   | 7             | 985.59                 | 3,703                   | Pond Flow                             |  |
| 9                                      | Combine                  | 8.292           | 2                   | 716                | 18,664                  | 5, 7,         | -----                  | -----                   | Combined Undetained Runoff            |  |
| 10                                     | Combine                  | 1.411           | 2                   | 724                | 18,654                  | 6, 8,         | -----                  | -----                   | Combined Detained Runoff              |  |
| Lees Summit Hydrographs_2023-09-01.gpw |                          |                 |                     |                    | Return Period: 100 Year |               |                        | Thursday, 09 / 7 / 2023 |                                       |  |

# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

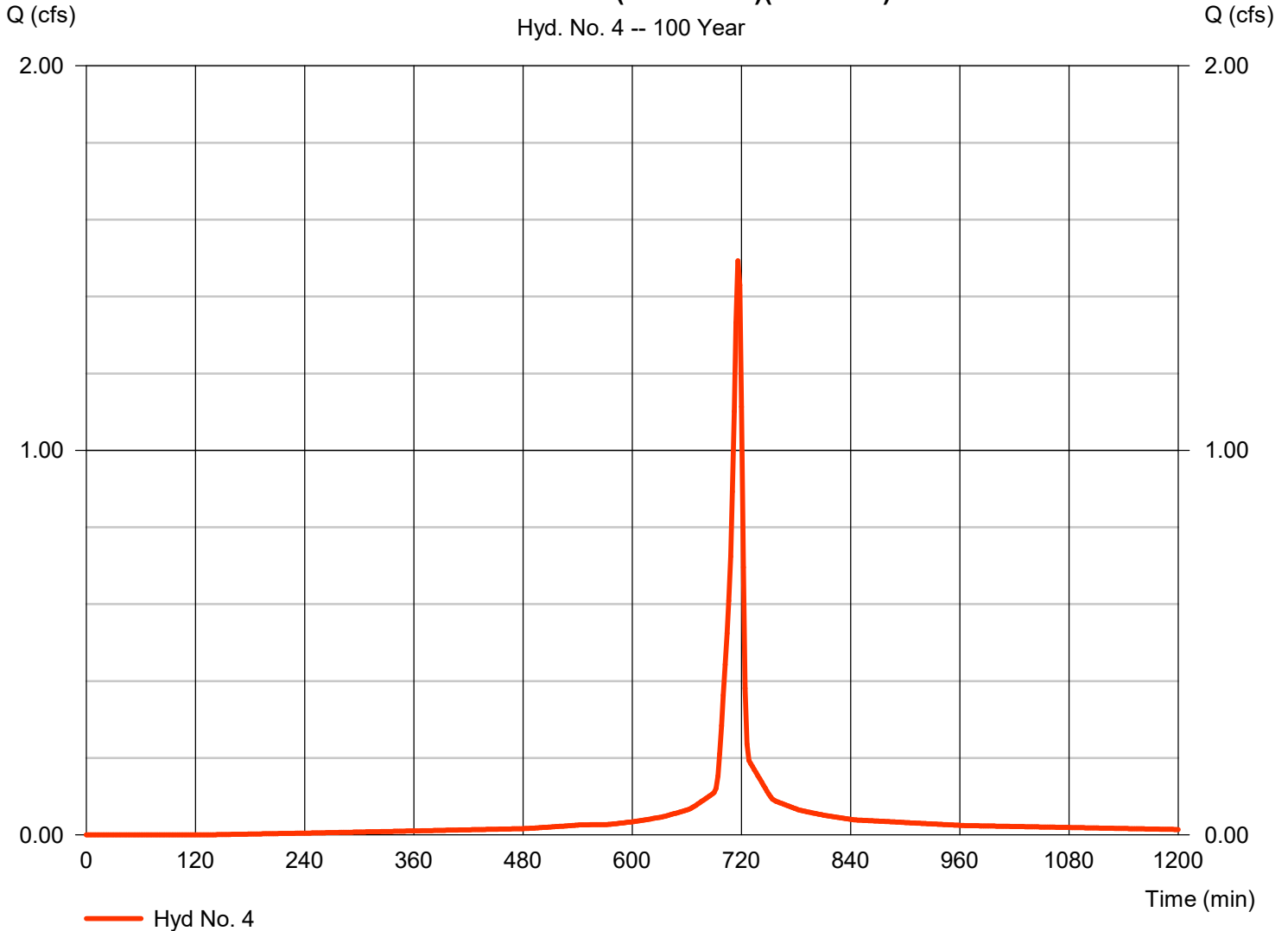
## Hyd. No. 4

Post Off-Site Area (Post DA 1)(Diverted)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 1.493 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 3,360 cuft |
| Drainage area   | = 0.090 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 12.60 in   | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.050 x 98) + (0.040 x 74)] / 0.090

### Post Off-Site Area (Post DA 1)(Diverted)



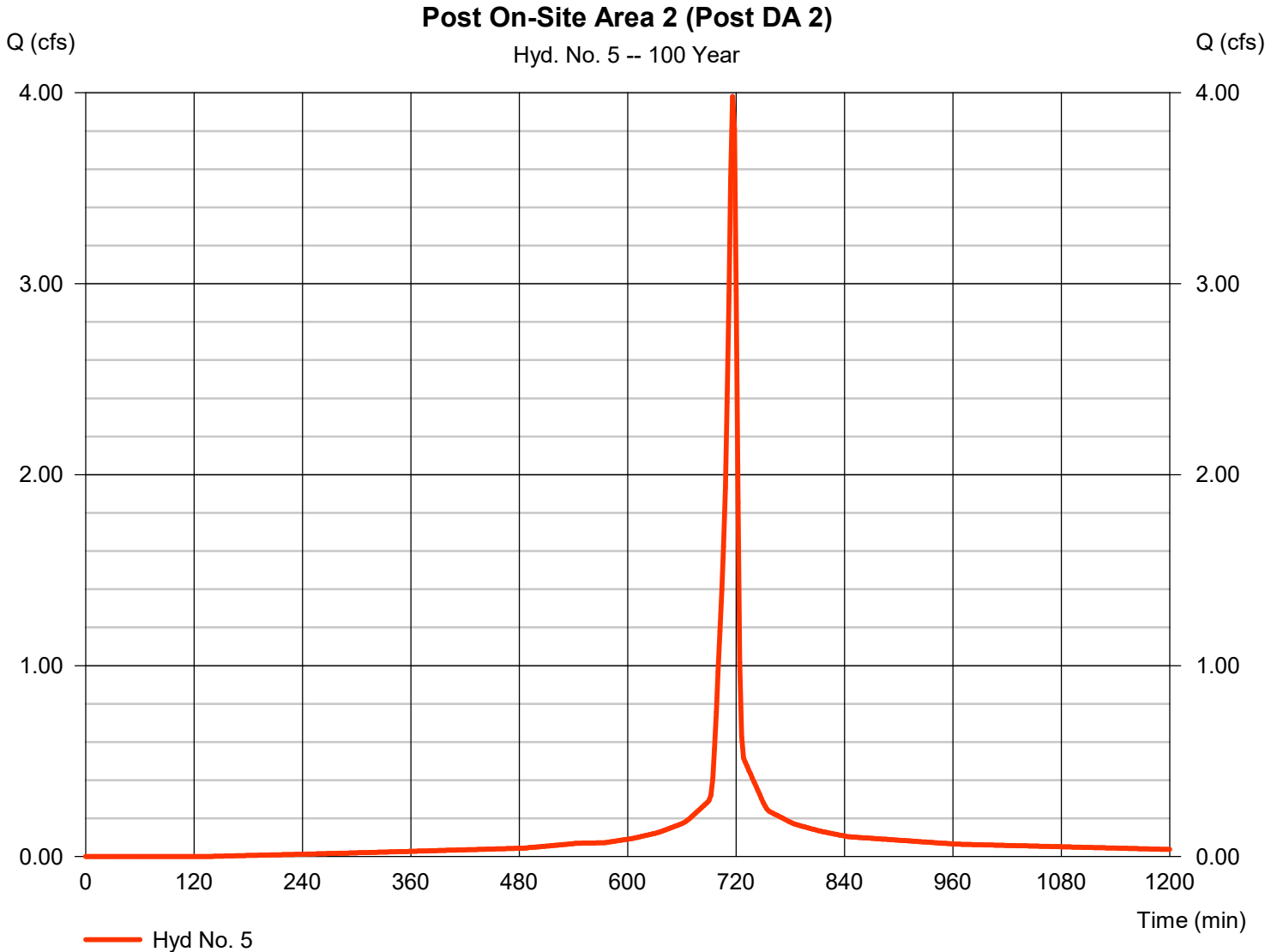
# Hydrograph Report

## Hyd. No. 5

Post On-Site Area 2 (Post DA 2)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 3.980 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 8,959 cuft |
| Drainage area   | = 0.240 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 12.60 in   | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.130 x 98) + (0.110 x 74)] / 0.240





# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

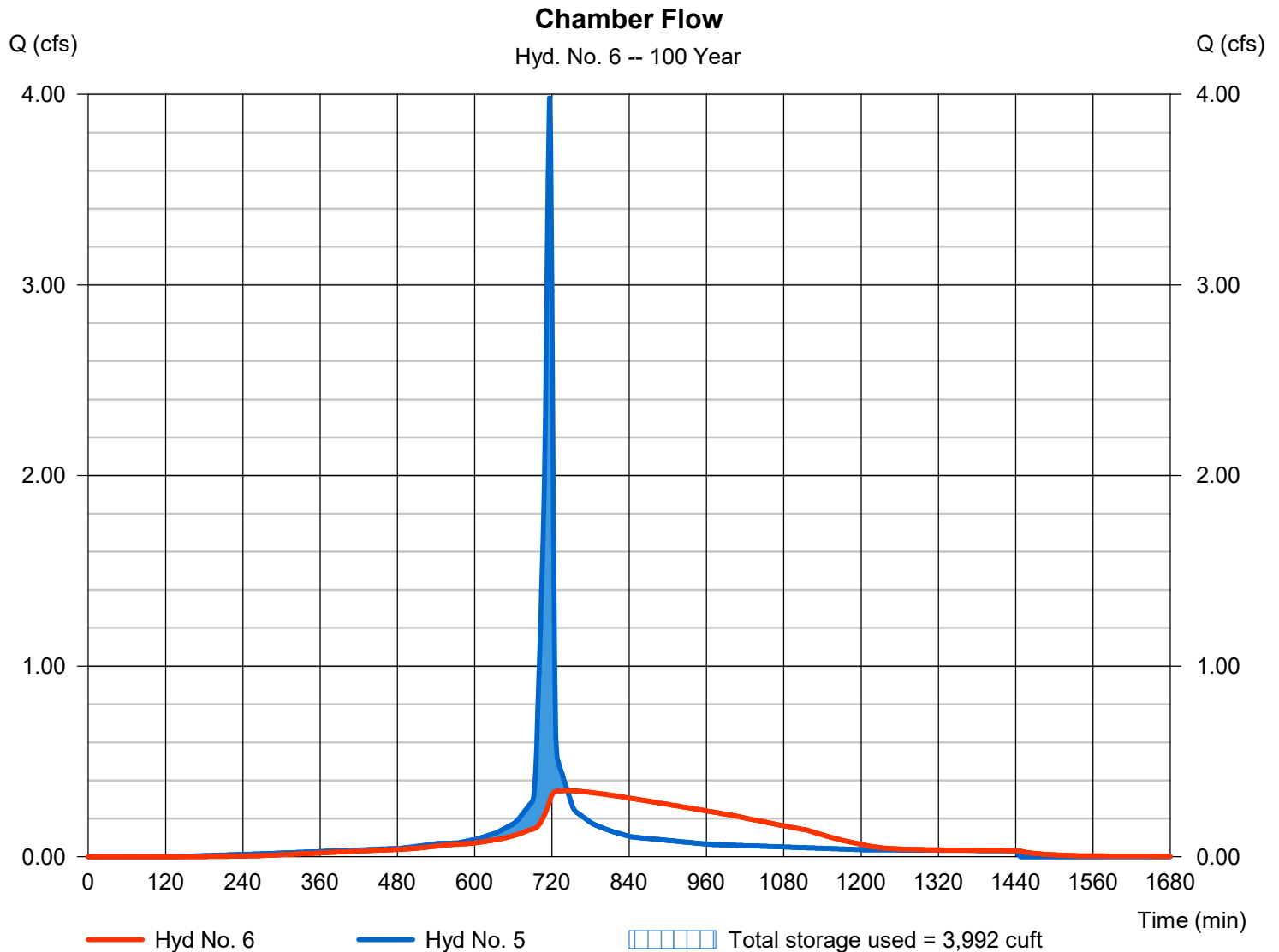
Thursday, 09 / 7 / 2023

## Hyd. No. 6

### Chamber Flow

|                 |                                      |                |              |
|-----------------|--------------------------------------|----------------|--------------|
| Hydrograph type | = Reservoir                          | Peak discharge | = 0.347 cfs  |
| Storm frequency | = 100 yrs                            | Time to peak   | = 744 min    |
| Time interval   | = 2 min                              | Hyd. volume    | = 8,949 cuft |
| Inflow hyd. No. | = 5 - Post On-Site Area 2 (Post Max) | Max. Elevation | = 983.74 ft  |
| Reservoir name  | = Underground Detention              | Max. Storage   | = 3,992 cuft |

Storage Indication method used.



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

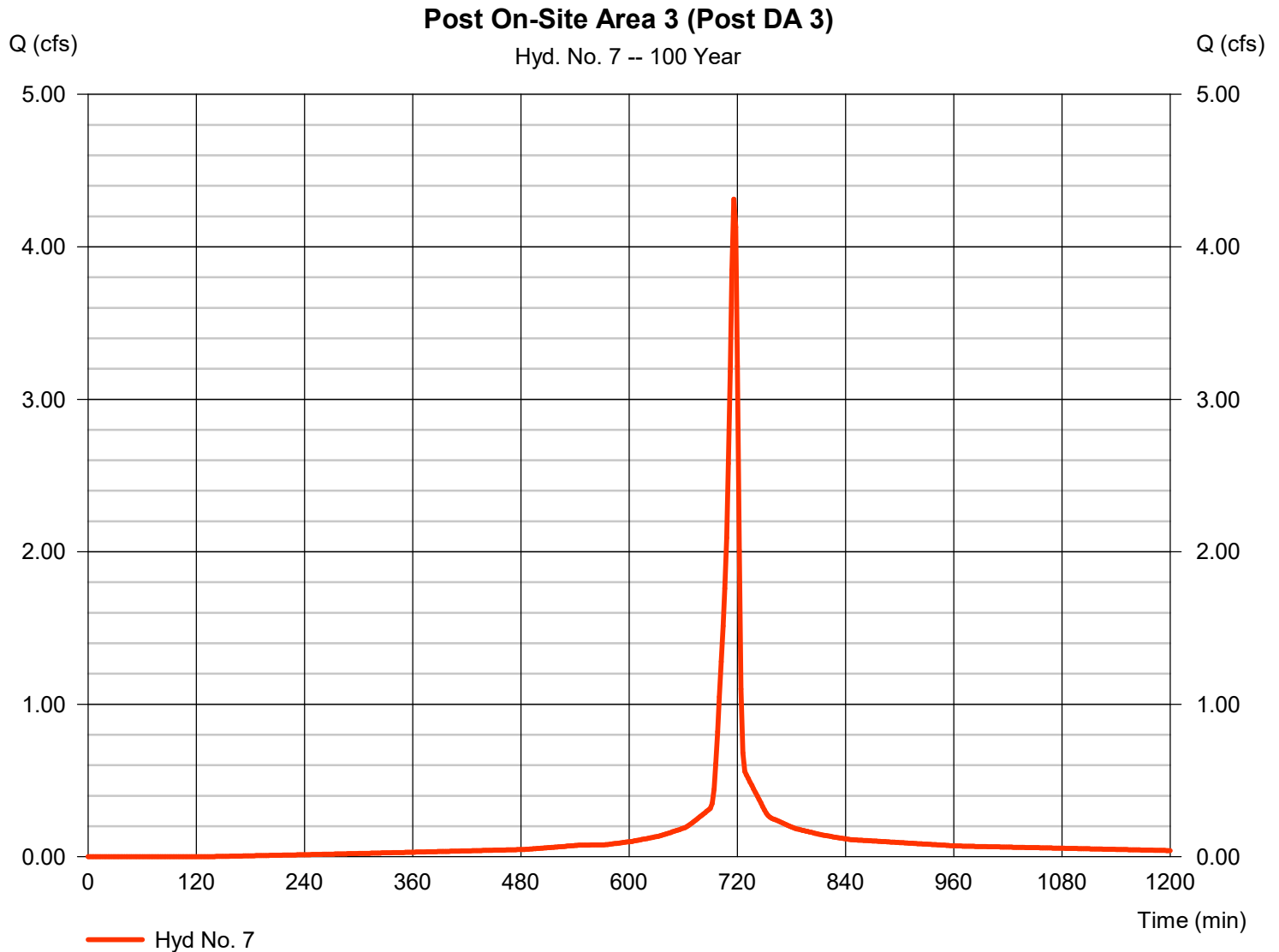
Thursday, 09 / 7 / 2023

## Hyd. No. 7

Post On-Site Area 3 (Post DA 3)

|                 |              |                    |              |
|-----------------|--------------|--------------------|--------------|
| Hydrograph type | = SCS Runoff | Peak discharge     | = 4.312 cfs  |
| Storm frequency | = 100 yrs    | Time to peak       | = 716 min    |
| Time interval   | = 2 min      | Hyd. volume        | = 9,705 cuft |
| Drainage area   | = 0.260 ac   | Curve number       | = 87*        |
| Basin Slope     | = 0.0 %      | Hydraulic length   | = 0 ft       |
| Tc method       | = User       | Time of conc. (Tc) | = 5.00 min   |
| Total precip.   | = 12.60 in   | Distribution       | = Type II    |
| Storm duration  | = 24 hrs     | Shape factor       | = 484        |

\* Composite (Area/CN) = [(0.140 x 98) + (0.120 x 74)] / 0.260



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

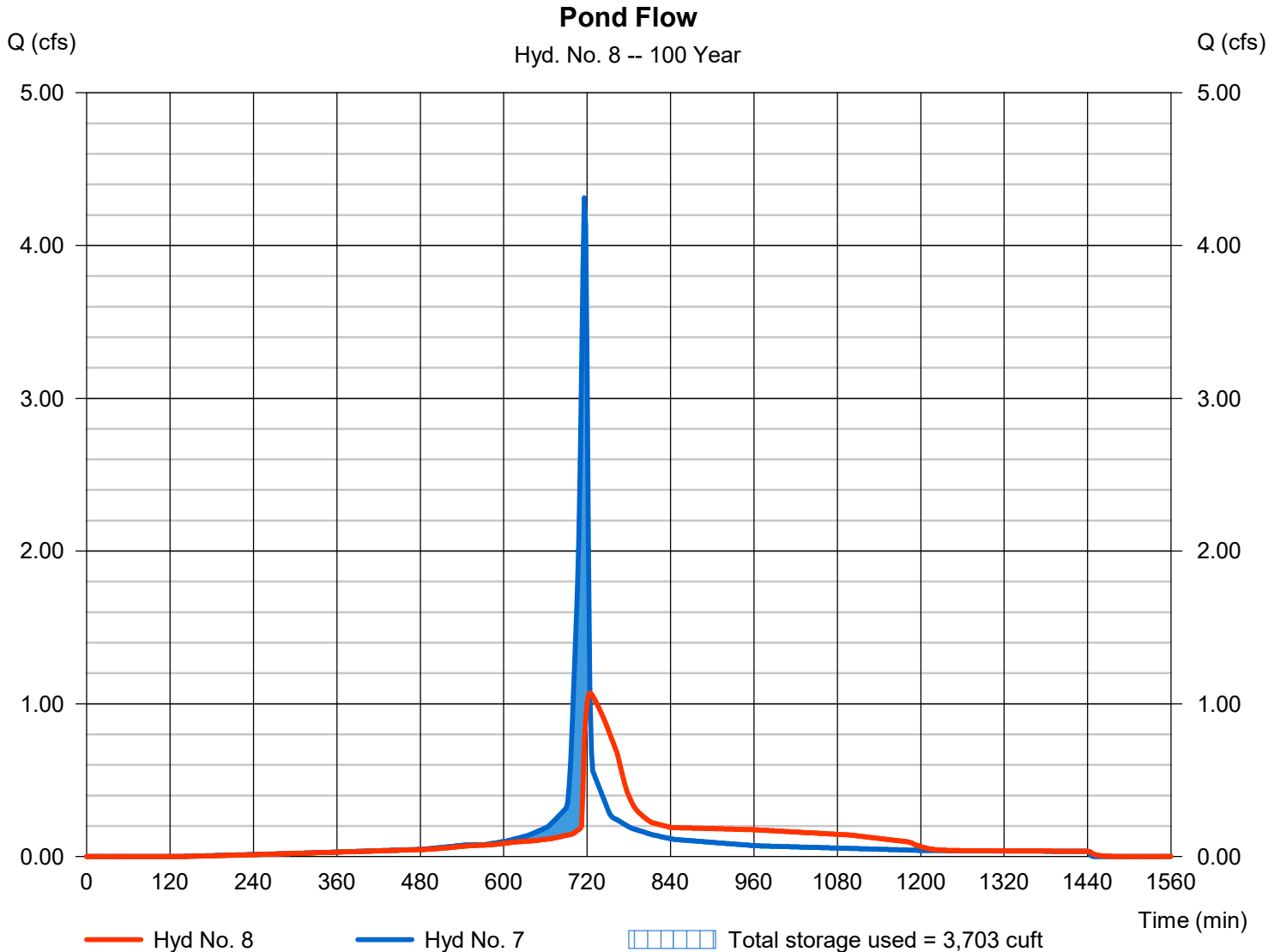
Thursday, 09 / 7 / 2023

## Hyd. No. 8

### Pond Flow

|                 |                                       |                |              |
|-----------------|---------------------------------------|----------------|--------------|
| Hydrograph type | = Reservoir                           | Peak discharge | = 1.071 cfs  |
| Storm frequency | = 100 yrs                             | Time to peak   | = 724 min    |
| Time interval   | = 2 min                               | Hyd. volume    | = 9,705 cuft |
| Inflow hyd. No. | = 7 - Post On-Site Area 3 (Post Mass) | Max. Elevation | = 985.59 ft  |
| Reservoir name  | = Detention Pond                      | Max. Storage   | = 3,703 cuft |

Storage Indication method used.



# Hydrograph Report

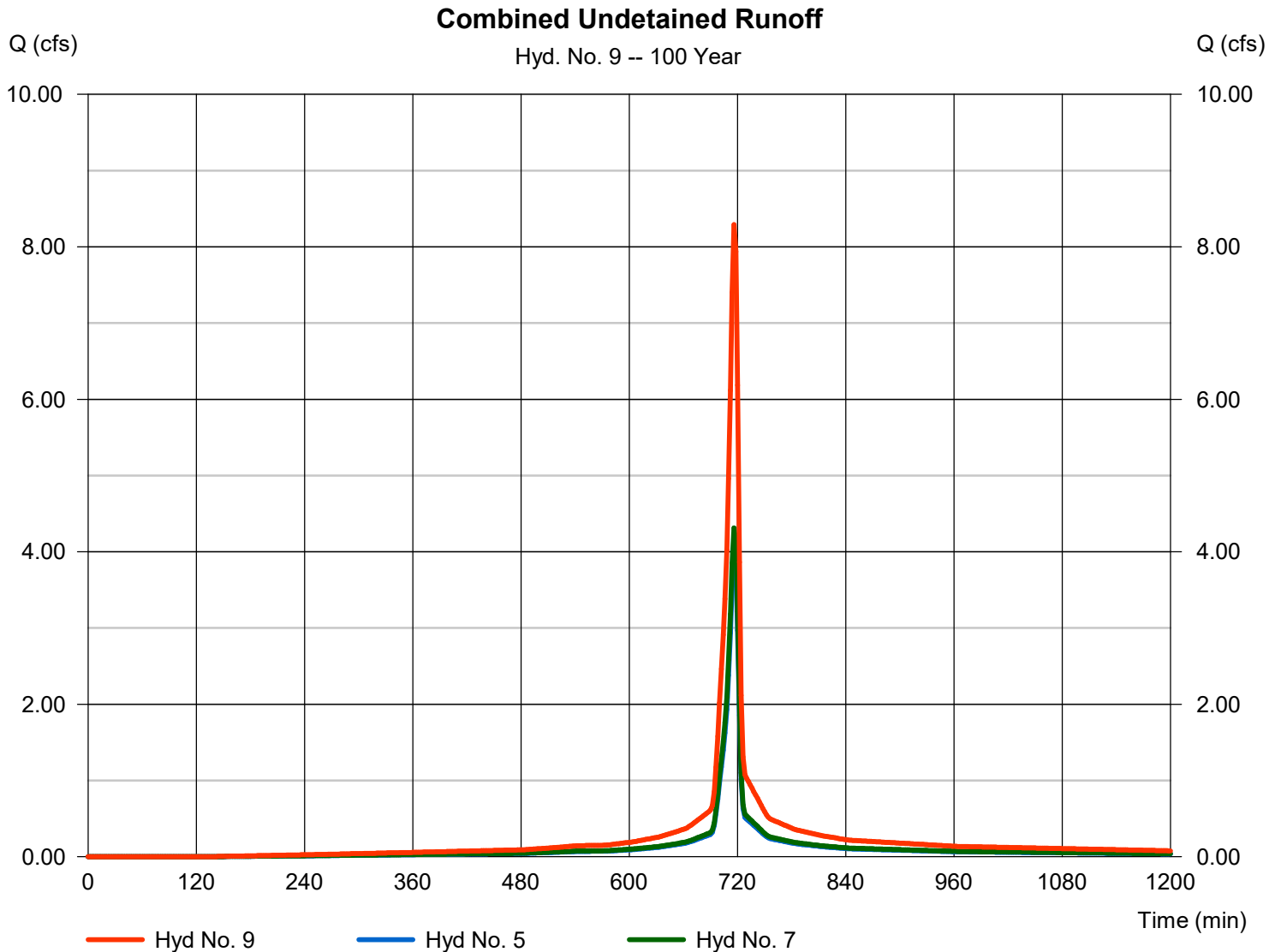
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

## Hyd. No. 9

### Combined Undetained Runoff

|                 |           |                      |               |
|-----------------|-----------|----------------------|---------------|
| Hydrograph type | = Combine | Peak discharge       | = 8.292 cfs   |
| Storm frequency | = 100 yrs | Time to peak         | = 716 min     |
| Time interval   | = 2 min   | Hyd. volume          | = 18,664 cuft |
| Inflow hyds.    | = 5, 7    | Contrib. drain. area | = 0.500 ac    |



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

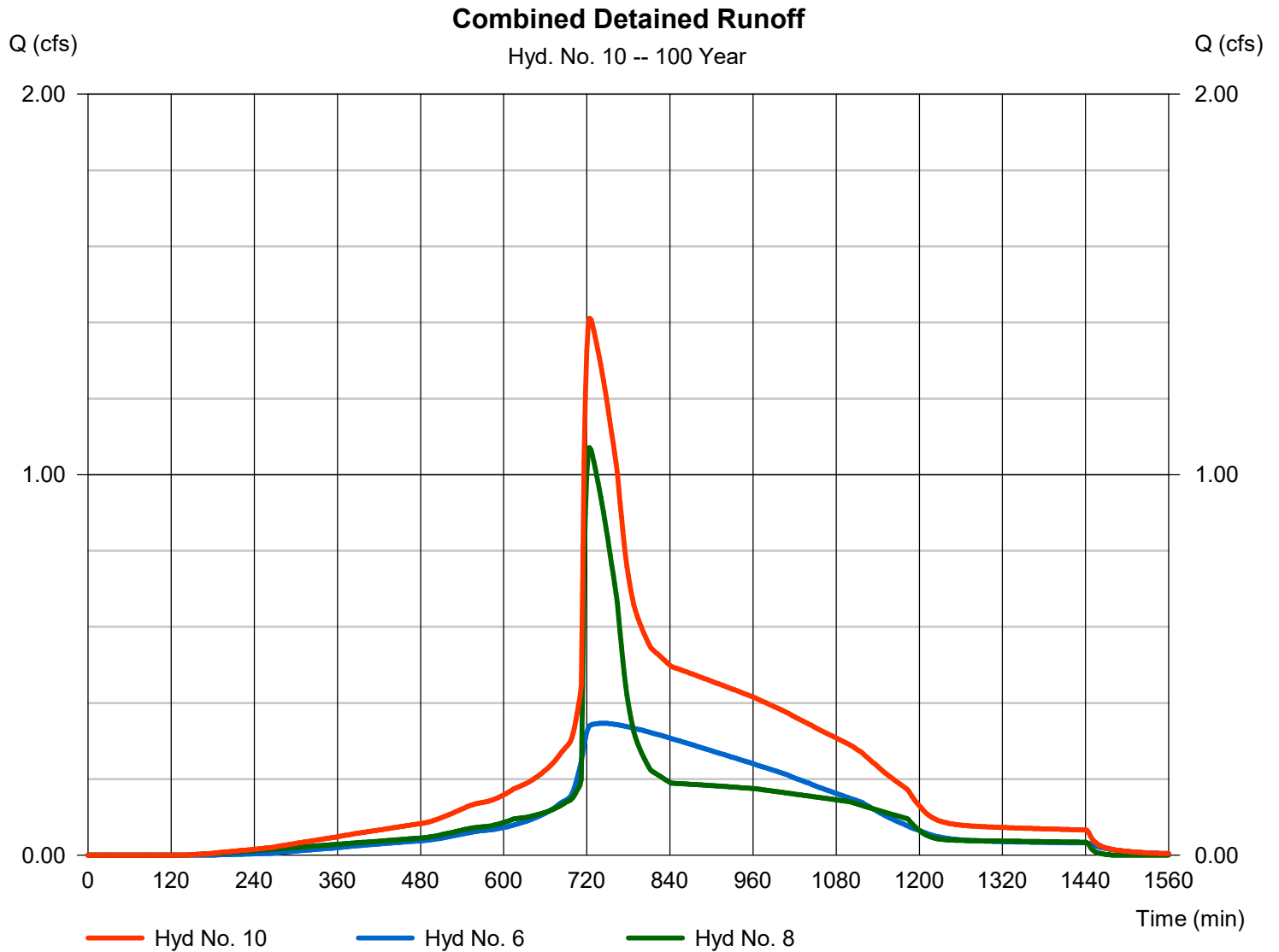
Thursday, 09 / 7 / 2023

## Hyd. No. 10

### Combined Detained Runoff

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

Peak discharge = 1.411 cfs  
Time to peak = 724 min  
Hyd. volume = 18,654 cuft  
Contrib. drain. area = 0.000 ac



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Thursday, 09 / 7 / 2023

| Return Period (Yrs) | Intensity-Duration-Frequency Equation Coefficients (FHA) |         |        |       |
|---------------------|--|---------|--------|-------|
|                     | B  | D       | E      | (N/A) |
| 1                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 2                   | 80.1702  | 15.0000 | 0.9000 | ----- |
| 3                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 5                   | 0.0000   | 0.0000  | 0.0000 | ----- |
| 10                  | 183.3473   | 19.2000 | 1.0096 | ----- |
| 25                  | 197.2999   | 18.6000 | 0.9937 | ----- |
| 50                  | 235.4014   | 19.9000 | 1.0020 | ----- |
| 100                 | 252.3450   | 19.7000 | 0.9969 | ----- |

File name: IDF Curve APWA5600.IDF

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

| Return Period (Yrs) | Intensity Values (in/hr) |      |      |      |      |      |      |      |      |      |      |      |
|---------------------|--------------------------|------|------|------|------|------|------|------|------|------|------|------|
|                     | 5 min                    | 10   | 15   | 20   | 25   | 30   | 35   | 40   | 45   | 50   | 55   | 60   |
| 1                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2                   | 5.41                     | 4.42 | 3.76 | 3.27 | 2.90 | 2.61 | 2.37 | 2.18 | 2.01 | 1.87 | 1.75 | 1.65 |
| 3                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5                   | 0.00                     | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10                  | 7.35                     | 6.08 | 5.18 | 4.52 | 4.00 | 3.59 | 3.26 | 2.98 | 2.74 | 2.54 | 2.37 | 2.22 |
| 25                  | 8.53                     | 7.05 | 6.00 | 5.23 | 4.63 | 4.16 | 3.77 | 3.45 | 3.18 | 2.95 | 2.75 | 2.58 |
| 50                  | 9.39                     | 7.82 | 6.70 | 5.86 | 5.20 | 4.68 | 4.25 | 3.90 | 3.60 | 3.34 | 3.12 | 2.92 |
| 100                 | 10.32                    | 8.59 | 7.35 | 6.43 | 5.71 | 5.14 | 4.67 | 4.28 | 3.95 | 3.67 | 3.42 | 3.21 |

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

\\Users\Scott Poirrier\High Tide Consultant Dropbox\Projects\Reference Material\LADOTD\New\LADOTD Region 1.pcp

| Storm Distribution | Rainfall Precipitation Table (in) |      |      |      |       |       |       |        |
|--------------------|-----------------------------------|------|------|------|-------|-------|-------|--------|
|                    | 1-yr                              | 2-yr | 3-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| SCS 24-hour        | 1.37                              | 2.20 | 0.00 | 3.30 | 7.80  | 9.60  | 11.10 | 12.60  |
| SCS 6-Hr           | 0.00                              | 1.80 | 0.00 | 0.00 | 2.60  | 0.00  | 0.00  | 4.00   |
| Huff-1st           | 0.00                              | 1.55 | 0.00 | 2.75 | 4.00  | 5.38  | 6.50  | 8.00   |
| Huff-2nd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-3rd           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-4th           | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Huff-Indy          | 0.00                              | 0.00 | 0.00 | 0.00 | 0.00  | 0.00  | 0.00  | 0.00   |
| Custom             | 1.37                              | 1.75 | 0.00 | 2.80 | 3.90  | 5.25  | 6.00  | 7.10   |

**Design Procedure Form: Extended Dry Detention Basin (EDDB)  
Main Worksheet**

Designer: \_\_\_\_\_  
Checked By: \_\_\_\_\_  
Company: \_\_\_\_\_

Date: \_\_\_\_\_  
Project: \_\_\_\_\_  
Location: \_\_\_\_\_  
Page: 1 of 3

**I. Basin Water Quality Storage Volume**

$$WQv = P(R_v)(A/12) \rightarrow R_v = 0.05 + 0.009(I) \rightarrow I = 47.7\%$$

$$= 1.37 \times [0.05 + 0.009(47.7)] \left( \frac{0.5Ac}{12 \times 1ft} \right)$$

Step 1) Tributary area to EDDB,  $A_T$  (ac)

$A_T$  (ac) = 0.5Ac

Step 2) Calculate WQv using methodology in Section 6

$$WQv = 0.027Ac-ft$$

WQv (ac-ft) = 0.027Ac-ft

Step 3) Add 20 percent to account for silt and sediment deposition in the basin

$$= 1,191.8 ft^3$$

$V_{design}$  (ac-ft) = 0.03 → 1,306.8 ft<sup>3</sup>

**IIa. Water Quality Outlet Type**

Step 1) Set water quality outlet type  
Type 1 = single orifice  
Type 2 = perforated riser or plate  
Type 3 = v-notch weir

Outlet Type = 1

Step 2) Proceed to Step IIb, IIc, or IId based on water quality outlet type selected

**IIb. Water Quality Outlet, Single Orifice**

Step 1) Depth of water quality volume at outlet,  $Z_{WQ}$  (ft)

$$HWQ = 0.5(3.5) = 1.75 ft$$

$Z_{WQ}$  (ft) = 3.5

Step 2) Average head of water quality volume over invert of orifice,  $h_{WQ}$  (ft)

$$h_{WQ} = 0.5 * Z_{WQ}$$

$$Q = \frac{0.027Ac-ft (43,560 ft^2)}{40(3,600)} =$$

$h_{WQ}$  (ft) = 1.75

Step 3) Average water quality outflow rate,  $Q_{WQ}$  (cfs)

$$Q_{WQ} = (WQ_v * 43,560) / (40 * 3,600)$$

$Q_{WQ}$  (cfs) = 0.008

Step 4) Set value of orifice discharge coefficient,  $C_o$

$C_o = 0.66$  when thickness of riser/weir plate is  $\leq$  orifice diameter  
 $C_o = 0.80$  when thickness of riser/weir plate is  $>$  orifice diameter

$$C_o = \frac{0.008}{0.66(\pi)[2(3.2)(1.75)]^{0.5}} = 0.66$$

Step 5) Water quality outlet orifice diameter (minimum of 4 inches),  $D_o$  (in)

$$D_o = 12 * 2 * (Q_{WQ} / (C_o * \pi * (2 * g * H)^{0.5}))^{0.5}$$

(if orifice diameter  $<$  4 inches, use outlet type 2 or 3)

$$D_o = 12(2) \left[ \frac{0.008}{0.66(\pi)[2(3.2)(1.75)]^{0.5}} \right]^{0.5}$$

$$D_o = 0.45 \Rightarrow 4in$$

$D_o$  (in) = 4in

Step 6) To size outlet orifice for EDDB with an irregular stage-volume relationship, use the Single Orifice Worksheet

**IIc. Water Quality Outlet, Perforated Riser**

Step 1) Depth at outlet above lowest perforation,  $Z_{WQ}$  (ft)

$Z_{WQ}$  (ft) = \_\_\_\_\_

Step 2) Recommended maximum outlet area per row,  $A_o$  (in<sup>2</sup>)

$$A_o = (WQ_v) / (0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)$$

$A_o$  (in<sup>2</sup>) = \_\_\_\_\_

Step 3) Circular perforation diameter per row assuming a single column,  $D_1$  (in)

$D_1$  (in) = \_\_\_\_\_

Step 4) Number of columns,  $n_c$

$n_c$  = \_\_\_\_\_

Step 5) Design circular perforation diameter (should be between 1 and 2 inches),  $D_{perf}$  (in)

$D_{perf}$  (in) = \_\_\_\_\_

Step 6) Horizontal perforation column spacing when  $n_c > 1$ , center to center,  $S_c$

If  $D_{perf} \geq 1.0$  inch,  $S_c = 4$

$S_c$  (in) = \_\_\_\_\_

Step 7) Number of rows (4" vertical spacing between perforations, center to center),  $r$

$r$  = \_\_\_\_\_

**WORKSHEET 1: REQUIRED LEVEL OF SERVICE - UNDEVELOPED SITE**

Project:  
Location:

By:  
Checked:

Date:  
Date:

**1. Runoff Curve Number**

**A. Predevelopment CN**

| Cover Description  | Soil HSG | CN from Table 1 | Area (ac.) | Product of CN x Area |
|--------------------|----------|-----------------|------------|----------------------|
| Woods-Grass (Fair) | C        | 76              | 0.5        | 38                   |
|                    |          |                 |            |                      |
|                    |          |                 |            |                      |
|                    |          |                 |            |                      |
|                    |          |                 |            |                      |
|                    |          |                 |            |                      |
| Totals:            |          |                 | 0.5        | 38                   |

Area-Weighted CN = total product/total area = 76 (Round to integer)

**B. Postdevelopment CN**

| Cover Description | Soil HSG <sup>1</sup> | CN from Table 1 | Area (ac.) | Product of CN x Area |
|-------------------|-----------------------|-----------------|------------|----------------------|
| Impervious        | C                     | 98              | 0.24       | 23.52                |
| Open Space (Good) | C                     | 74              | 0.26       | 19.24                |
|                   |                       |                 |            |                      |
|                   |                       |                 |            |                      |
|                   |                       |                 |            |                      |
|                   |                       |                 |            |                      |
| Totals:           |                       |                 | 0.5        | 42.76                |

<sup>1</sup> Postdevelopment CN is one HSG higher for all cover types except preserved vegetation, absent documentation showing how postdevelopment soil structure will be preserved.

Area-Weighted CN = total product/total area = 86 (Round to integer)

**C. Level of Service (LS) Calculation**

Predevelopment CN: 76  
 Postdevelopment CN: 86  
 Difference: 10  
 LS Required (see scale at right): 7

| Change in CN | LS |
|--------------|----|
| 17+          | 8  |
| 7 to 16      | 7  |
| 4 to 6       | 6  |
| 1 to 3       | 5  |
| 0            | 4  |
| -7 to -1     | 3  |
| -8 to -17    | 2  |
| -18 to -21   | 1  |
| -22 -        | 0  |



**WORKSHEET 2: DEVELOP MITIGATION PACKAGE(S) THAT MEET THE REQUIRED LS**

Project:  
 Location:  
 Sheet    of   

By: \_\_\_\_\_ Date: \_\_\_\_\_  
 Checked: \_\_\_\_\_ Date: \_\_\_\_\_

1. **Required LS (New Development, Wksht 1) or Total VR (Redevelopment, Wksht 1A):** 7

Note: Various BMPs may alter CN of proposed development, and LS; recalculate both if applicable.

2. **Proposed BMP Option Package No.**     

| Cover/BMP Description         | Treatment Area | VR from Table 4.4 or 4.6 <sup>1</sup> | Product of VR x Area  |
|-------------------------------|----------------|---------------------------------------|---|
| <i>Extended Dry Detention</i> | <i>0.5</i>     | <i>4</i>                              | <i>2</i>  |
|                               |                |                                       |   |
|                               |                |                                       |   |
|                               |                |                                       |   |
|                               |                |                                       |   |
| <b>Total<sup>2</sup>:</b>     | <i>0.5</i>     | <b>Total:</b>                         | <i>2</i>  |
|                               |                | <b>*Weighted VR:</b>                  | <span style="border: 1px solid black; padding: 2px 10px;"><i>4</i></span> |

= total product/total a

- <sup>1</sup> VR calculated for final BMP only in Treatment Train.
- <sup>2</sup> Total treatment area cannot exceed 100 percent of the actual site area.
- \* Blank In Redevelopment

**Meets required LS (Yes/No)?** NO (If No, or if additional options are being tested, proceed below.)

3. **Proposed BMP Option Package No.** 2

| Cover/BMP Description     | Treatment Area | VR from Table 4.4 or 4.6 <sup>1</sup> | Product of VR x Area  |
|---------------------------|----------------|---------------------------------------|---|
| <i>Catch Basin Insert</i> | <i>0.5</i>     | <i>5</i>                              | <i>2.5</i>  |
|                           |                |                                       |   |
|                           |                |                                       |   |
|                           |                |                                       |   |
|                           |                |                                       |   |
| <b>Total<sup>2</sup>:</b> | <i>0.5</i>     | <b>Total:</b>                         | <i>2.5</i>  |
|                           |                | <b>*Weighted VR:</b>                  | <span style="border: 1px solid black; padding: 2px 10px;"><i>5</i></span> |

= total product/total a

- <sup>1</sup> VR calculated for final BMP only in Treatment Train.
- <sup>2</sup> Total treatment area cannot exceed 100 percent of the actual site area.
- \* Blank In Redevelopment

**Meets required LS (Yes/No)?** YES (If No, or if additional options are being tested, move to next sheet.)

$$4 + 5 = 9 > 7$$

**TABLE 4.1**  
**Common Cover Types and Curve Numbers**

**How To Use This Table:**

1. This table presents the cover types that a site planner is most likely to encounter, but is not all-encompassing. See TR-55 for additional information.
2. Site planners may substitute curve numbers from APWA 5602.3 or other local regulations, if applicable, to be consistent with hydrology calculations.
3. "Undeveloped" cover types may be used on portions of developed sites where preexisting cover is preserved and protected from disturbance.
4. Postdevelopment HSG is assumed to be one group higher in runoff than predevelopment, unless soil treatment plan is provided to document otherwise. See Appendix A for soil preservation guidance.

| UNDEVELOPED                     |           |                                   |    |    | DEVELOPED   |           |    |    |  |
|---------------------------------|-----------|-----------------------------------|----|----|---|-----------|----|----|--|
| Cover Type                      | Condition | CN by Hydrologic Soil Group (HSG) |    |    | Cover Type  | CN by HSG |    |    |  |
|                                 |           | B                                 | C  | D  |   | B         | C  | D  |  |
| Fallow, bare soil               |           | 86                                | 91 | 94 | Parking lots, roofs, streets<br>with sewer, water, etc. | 98        | 98 | 98 |  |
| Fallow, crop residue            | Poor      | 85                                | 90 | 93 | Commercial, business                                    | 92        | 94 | 95 |  |
| Fallow, crop residue            | Good      | 83                                | 88 | 90 | Streets: paved, open ditch                              | 89        | 92 | 93 |  |
| Straight row crops              | Good      | 78                                | 85 | 89 | Industrial (or office park)                             | 88        | 91 | 93 |  |
| Contoured crops                 | Good      | 75                                | 82 | 86 | Newly graded areas                                      | 86        | 91 | 94 |  |
| Contoured and<br>terraced crops | Good      | 71                                | 78 | 81 | Streets: gravel   | 85        | 89 | 91 |  |
| Pasture                         | Poor      | 79                                | 86 | 89 | Streets: dirt   | 82        | 87 | 89 |  |
| Pasture                         | Fair      | 69                                | 79 | 84 | Residential, 1/8-acre                                   | 85        | 90 | 92 |  |
| Pasture                         | Good      | 61                                | 74 | 80 | Residential, 1/4-acre                                   | 75        | 83 | 87 |  |
| Woods-grass                     | Poor      | 67                                | 77 | 83 | Residential, 1/3-acre                                   | 72        | 81 | 86 |  |
| Woods-grass                     | Fair      | 65                                | 76 | 82 | Residential, 1/2-acre                                   | 70        | 80 | 85 |  |
| Woods-grass                     | Good      | 55                                | 70 | 77 | Residential, 1-acre                                     | 68        | 79 | 84 |  |
| Woods                           | Poor      | 66                                | 77 | 83 | Residential, 2-acre                                     | 65        | 77 | 82 |  |
| Woods                           | Fair      | 60                                | 73 | 79 | Open space (turf), poor                                 | 79        | 86 | 89 |  |
| Woods                           | Good      | 55                                | 70 | 77 | Open space (turf), fair                                 | 69        | 79 | 84 |  |
| Meadow                          |           | 58                                | 71 | 78 | Open space (turf), good                                 | 61        | 74 | 80 |  |
| Brush-weeds-grass               | Poor      | 67                                | 77 | 83 | Native grass  | 58        | 71 | 78 |  |
| Brush-weeds-grass               | Fair      | 56                                | 70 | 77 | Native grass, shrubs and<br>forbs (formal plantings)    | 56        | 70 | 77 |  |
| Brush-weeds-grass               | Good      | 48                                | 65 | 73 | Native grass, shrubs and<br>forbs (informal plantings)  | 48        | 65 | 73 |  |

Source: U.S. Department of Agriculture, Natural Resource Conservation Service Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55; 1986)

**Table 4.4  
Best Management Practice Value Ratings**

| Cover Type or BMP   | Median Expected Effluent EMC TSS (mg/L) <sup>a</sup> | Value Ratings       |                  |                       |                           | Overall Value Rating         |
|---|--|---------------------|------------------|-----------------------|---------------------------|------------------------------|
|   |  | Water Quality Value | Volume Reduction | Temperature Reduction | Oils/Floatables Reduction |                              |
| <b>Vegetation</b>   | N/A  | 5.25                | 2                | 1                     | 1                         | 9.25                         |
| Native Vegetation preserved or established  |  |                     |                  |                       |                           |                              |
| <b>Rain Garden</b>  | < 10   | 4                   | 2                | 1                     | 2                         | 9.0                          |
| A small residential depression planted with native vegetation designed to capture and infiltrate runoff                             |  |                     |                  |                       |                           |                              |
| <b>Infiltration Practices</b>   | < 10   | 4                   | 2                | 1                     | 2                         | 9.0                          |
| Infiltration Basin  |  |                     |                  |                       |                           |                              |
| Infiltration Trenches   |  |                     |                  |                       |                           |                              |
| <b>Bioretention</b>   | < 10   | 4                   | 1.5              | 1                     | 2                         | 8.5                          |
| Small engineered and landscaped basins designed to filter runoff before release   |  |                     |                  |                       |                           |                              |
| <b>Pervious or Porous Pavement</b>  | 10-20  | 3                   | 1.5              | 1                     | 2                         | 7.5                          |
| Pervious Concrete   |  |                     |                  |                       |                           |                              |
| Porous Asphalt  |  |                     |                  |                       |                           |                              |
| Modular Concrete Block  |  |                     |                  |                       |                           |                              |
| <b>Extended Detention Wetland</b>   | < 10   | 4                   | 2                | 0                     | 1                         | 7.0                          |
| A land area that is permanently wet with hydric soils sized to detain the WQv for a minimum of 40 hours.                            |  |                     |                  |                       |                           |                              |
| <b>Media Filtration Practices</b>   | < 10   | 4                   | 0                | 0                     | 2                         | 6.0                          |
| Surface Sand Filter   |  |                     |                  |                       |                           |                              |
| Underground Sand Filter   |  |                     |                  |                       |                           |                              |
| Pocket Sand Filter  |  |                     |                  |                       |                           |                              |
| Perimeter Sand Filter   |  |                     |                  |                       |                           |                              |
| <b>Extended Wet Detention</b>   | 10 - 20  | 3                   | 2                | -1                    | 1                         | 5.0                          |
| A basin intended to have a permanent pool and sized to detain the WQv for a minimum of 40 hours                                     |  |                     |                  |                       |                           |                              |
| <b>Vegetated Filter Strip</b>   | 10 - 20  | 3                   | 1                | 0                     | 1                         | 5.0                          |
| Buffer strip with native vegetation treating sheet flow   |  |                     |                  |                       |                           |                              |
| <b>Native Vegetation Swale</b>  | 10 - 20  | 3                   | 1                | 0                     | 0                         | 4.0                          |
| Native grasses and forbes planted in a swale to reduce velocity of runoff and promote infiltration                                  |  |                     |                  |                       |                           |                              |
| <b>Extended Dry Detention Basin</b>   | 20 - 50  | 2                   | 1                | 0                     | 1                         | 4.0                          |
| A basin lined with native plant species designed to detain the WQv for a minimum of 40 hours with no permanent impoundment of water |  |                     |                  |                       |                           |                              |
| <b>Other Systems</b>  | 10 - 100 <sup>(b)</sup>                              | 1-3 <sup>(c)</sup>  | 0                | 0                     | 2                         | 3.0-5.0 <sup>(d)</sup>       |
| Proprietary Media Filtration Devices  |  |                     |                  |                       |                           |                              |
| Hydrodynamic Devices  |  |                     |                  |                       |                           |                              |
| Baffle Boxes  |  |                     |                  |                       |                           |                              |
| Catch Basin Inserts   |  |                     |                  |                       |                           |                              |
| <b>Signage</b>  | N/A  | N/A                 | N/A              | N/A                   | N/A                       | BMP VR + 0.25 <sup>(e)</sup> |
| <b>Green Roofs –</b>  |  |                     |                  |                       |                           | CN Credit See Design         |
| <b>No VR, Credit for Post Construction CN Reduction, See Design Section</b>   |  |                     |                  |                       |                           |                              |

**Notes:**

- TSS** Total suspended solids
- mg/L** Milligrams per liter
- a** Expected median event mean concentrations of TSS is based on analysis of studies in International BMP Database [www.bmpdatabase.org](http://www.bmpdatabase.org)  
Source: *Analysis of Treatment System Performance, International Stormwater Best Management Practices (BMP) Database 1999-2005*. Feb. 2006
- b** Jurisdiction will assign the score based on independent 3rd party field data showing expected event mean concentrations TSS in the effluent. However, if the proprietary BMP relies on sedimentation as the primary pollutant removal mechanism, then performance data over the range of particle size distributions must be submitted for the range of expected flow rates.
- c** Water Quality Value will vary based on the median concentration of TSS in the effluent (measured in mg/l).
- d** Overall Value Rating will vary based on the sum of the four Value Ratings.
- e** See Section 7.7 for additional guidance on signage.

**TABLE 4.6  
Composite Value Ratings for Two BMPs in Series**

| VR 1 (First BMP in Series)   |                         |  | VR 2 (Second BMP in Series) |                   |             |                        |              |                             |                            |                            |                        |                        |                         |                              |               |
|------------------------------|-------------------------|--|-----------------------------|-------------------|-------------|------------------------|--------------|-----------------------------|----------------------------|----------------------------|------------------------|------------------------|-------------------------|------------------------------|---------------|
| Cover Type or BMP            | Overall Value Rating    | VR1 <sup>a</sup><br>VR2 <sup>a,b,c</sup> | Overall Value Rating        | Native Vegetation | Rain Garden | Infiltration Practices | Bioretention | Pervious or Porous Pavement | Extended Detention Wetland | Media Filtration Practices | Extended Wet Detention | Vegetated Filter Strip | Native Vegetation Swale | Extended Dry Detention Basin | Other Systems |
|                              |                         |  | 9.25                        | 9.0               | 9.0         | 8.5                    | 7.5          | 7.0                         | 6.0                        | 5.0                        | 5.0                    | 4.0                    | 4.0                     | 3.0-5.0                      |               |
| Native Vegetation            | N/A                     | 9.25                                     |                             |                   | 12.25       | 12.25                  | 11.75        | 11.75                       | 11.25                      | <b>9.25</b>                | 10.25                  | 10.25                  | <b>9.25</b>             | <b>9.25</b>                  | 10.25         |
| Rain Garden                  | < 10                    | 9.0                                      |                             |                   |             |                        |              |                             |                            |                            |                        |                        |                         |                              |               |
| Infiltration Practices       | < 10                    | 9.0                                      |                             |                   |             |                        |              |                             |                            |                            |                        |                        |                         |                              |               |
| Bioretention                 | < 10                    | 8.5                                      |                             |                   | 10.50       | 10.50                  | 10.00        | 10.00                       |                            |                            |                        |                        |                         |                              |               |
| Pervious or Porous Pavement  | 10-20                   | 7.5                                      |                             |                   |             | 10.50                  | 10.00        |                             | 9.50                       | <b>7.50</b>                | <b>8.50</b>            | <b>8.50</b>            | <b>8.50</b>             |                              |               |
| Extended Detention Wetland   | < 10                    | 7.0                                      |                             |                   |             |                        |              |                             | 10.00                      |                            | 9.00                   | 9.00                   | 8.00                    |                              |               |
| Media Filtration Practices   | < 10                    | 6.0                                      |                             |                   |             | 9.00                   | 8.50         |                             | 8.00                       | <b>6.00</b>                | 7.00                   | 7.00                   | 7.00                    |                              |               |
| Extended Wet Detention       | 10 - 20                 | 5.0                                      |                             |                   |             |                        |              |                             | 10.00                      |                            | 9.00                   | 9.00                   | 8.00                    |                              |               |
| Vegetated Filter Strip       | 10 - 20                 | 5.0                                      |                             |                   | 10.00       | 10.00                  | 9.50         | 9.50                        | 9.00                       | 7.00                       | 8.00                   | 8.00                   | 7.00                    | 7.00                         | <b>d</b>      |
| Native Vegetation Swale      | 10 - 20                 | 4.0                                      |                             |                   | 10.00       | 10.00                  | 9.50         |                             | 8.00                       | 7.00                       | 7.00                   | 7.00                   |                         | 7.00                         | <b>d</b>      |
| Extended Dry Detention Basin | 50 - 100 <sup>(b)</sup> | 4.0                                      |                             |                   |             | 10.00                  |              |                             |                            |                            | 8.00                   | 8.00                   | 7.00                    |                              |               |
| Other Systems                | 10 - 100                | 3.0-5.0                                  |                             |                   | <b>d</b>    | <b>d</b>               | <b>d</b>     | <b>d</b>                    | <b>d</b>                   | <b>d</b>                   | <b>d</b>               | <b>d</b>               | <b>d</b>                | <b>d</b>                     | <b>d</b>      |

- Note:**
- a Blank cells indicate BMP combinations that are either infeasible or highly unlikely.
  - b **Bold** cells indicate feasible treatment train combinations that would not increase the overall VR.
  - c Additional BMPs may be added using the formula above, provided that the sum of the A and D values (Table 3) do not exceed their respective maximum values, and only the C value for the final BMP in series is used.
  - d Calculate Composite Value Rating utilizing Other System Rating