

# STORMWATER MANAGMENT SUMMARY

FOR

## PROPOSED TAKE 5 OIL CHANGE

Missouri Hwy 291  
Lee's Summit, Missouri

December 13, 2024

PREPARED FOR

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

**1601 High Street  
Boulder, CO 80302**



A handwritten signature in black ink, appearing to read "B. Guin", written over a horizontal line.

SIGNATURE:

DECEMBER 13, 2024

DATE:



PREPARED BY:

**HIGH TIDE  
CONSULTANTS LLC**

409 W 21ST AVENUE - SUITE B  
COVINGTON, LA 70433

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## Stormwater Management Summary

### **Introduction:**

The purpose of this document is to provide a summary of the pre and post development drainage conditions for the +/- 0.49-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. The proposed detention basin, and the associated water quality elements will be required to meet the standards of Comprehensive Control Strategy described in the City of Lee's Summit Design & Constuction Manual (i.e., KCAPWA Section 5600 and Lee's Summit Addendum). 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. Points of Interest were 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.

Per the Kansas City Metropolitan Chapter American Public Works Association Standard Specifications & Design Criteria – Section 5600 Storm Drainage Systems & Facilities, the maximum release rate from any development under the runoff control strategies shall be as follows:

- 50% storm peak rate less than or equal to 0.5 CFS per site acre.
- 10% storm peak rate less than or equal to 2.0 CFS per site acre.
- 1% storm peak rate less than or equal to 3.0 CFS per site acre.

The site-specific allowable release rates are shown in the table below.

Allowable Release Rate (CFS):	0.5 CFS/AC X 0.49AC = 0.245 CFS	2.0 CFS/AC X 0.49AC = 0.98 CFS	3.0 CFS/AC X 0.49AC = 1.47 CFS
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### **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 0.49 acres of pervious cover. There has not been any wetlands identified in the area where the proposed improvements will take place, and therefore, no mitigation is proposed.

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. Per an email from Mike Weisenborn, dated 9/12/22, "I spoke with the engineers and based on a rough estimate of the upstream drainage area the stream buffer is 100 feet on each side of the stream. This is measured from the normal high-water mark.

They also indicated that the stream buffer would not apply to the area that already has a retaining wall in place.” Therefore, since no disturbance shall take place beyond the retaining wall that is currently in place, it has been determined that the developed portion of the site, within the retaining wall, can encroach into the 100’ stream buffer.

The site receives off-site run-on from the existing strip mall to the south. This area is +/-0.1 acres, with a CN of 86. The point at which most of the off-site impervious area enters the proposed site, through a concrete flume, has been labeled as point of interest “A”.

The site has high points on the south property line and slopes northeast towards Highway 291 with a slope of approximately 5.0%. 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 “B” for the existing condition. The points of interest can be viewed on the Pre-Development Drainage Plan, which is included in Appendix A.

Per the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel Number 29095C0436G, which is dated 1/20/2017, the majority of the site is located in Flood Zone X (unshaded), while a portion bordering Hwy. 291 is located in Flood Zone x (shaded).

The time of concentration for the existing condition of the Take-5 site is 13.50 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 86.

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>	0.380 CFS	0.663 CFS	1.177 CFS
<b>Take-5 Site Runoff (DA 2) (CFS):</b>	0.836 CFS	1.799 CFS	3.719 CFS
<b>Combined Runoff (CFS):</b>	1.074 CFS	2.213 CFS	4.461 CFS
<b>Allowable Release Rate (CFS):</b>	0.5 CFS/AC X 0.49AC = 0.245 CFS	2.0 CFS/AC X 0.49AC = 0.98 CFS	3.0 CFS/AC X 0.49AC = 1.47 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. A swale will pick up the off-site flow and route it through a trench drain which will be located under the driveway. This off-site flow will ultimately outfall into the existing roadside ditch. This will be considered point of interest "A" 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 7.4 minutes and the SCS Curve Number (CN) value has been determined to be 85. 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 point of interest "B" 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 point of interest "C" for the post developed condition.

The proposed detention pond will include an emergency spillway, as required by the City of Lee's Summit. The emergency spillway will be located on the eastern side of the pond, adjacent to Highway 291, and will be comprised of a rectangular weir, which will be 15' wide, and approximately 1.56' tall. The weir will be located as close as possible to the roadside concrete flume, that the site ultimately outfalls to. The 100-year water surface elevation in the pond is 983.92'. Therefore, the crest of the weir will be set at an elevation 6" above the 100-year WSE (983.92') at an elevation of 984.42. The water surface elevation of the 100% clogged/zero available storage -100-year storm, flowing through the weir, will be 984.58. The City of Lee's Summit requires 1' of freeboard between the 100-year water surface elevation flowing through the weir and the top of the dam. Therefore, the minimum required top dam elevation is 985.58'. The top of the pond is set at 986.00, which meets the freeboard requirement. Since the dam is less than 10' in height, it has been determined that the dam is not subject to TR-60.

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>	0.375 CFS	0.630 CFS	1.088 CFS
<b>Take-5 Site Runoff (DA 2) (CFS):</b>	0.903 CFS	1.603 CFS	2.855 CFS
<b>Take-5 Site Runoff (DA 3) (CFS):</b>	1.060 CFS	1.824 CFS	3.208 CFS
<b>Combined Detained Runoff (CFS):</b>	0.226 CFS	0.534 CFS	1.237 CFS
<b>Allowable Release Rate (CFS):</b>	0.5 CFS/AC X 0.49AC = 0.245 CFS	2.0 CFS/AC X 0.49AC = 0.98 CFS	3.0 CFS/AC X 0.49AC = 1.47 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 2" 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	1.074 cfs	0.226 cfs	0.5CFS X 0.49AC = 0.245 CFS	878 cuft	982.40 ft	877 cuft	983.04 ft
10-year	2.213 cfs	0.534 cfs	2.0CFS X 0.49AC = 0.98 CFS	1,558 cuft	983.07 ft	1,755 cuft	983.61 ft
100-year	4.461 cfs	1.237 cfs	3.0CFS X 0.49AC = 1.47 CFS	2,623 cuft	983.92 ft	3,541 cuft	984.76 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 0.49 acres. A required water quality volume of 1,481.03 cuft was calculated. The total available pond volume is 5,282 cuft and the total available underground detention volume is 7,124 cuft, while the combined detention volume plus the water quality volume is 7,844.03 cuft. This leaves an excess volume of 4,561.97 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.

### **Storm Water Pollution Prevention Plan (SWPPP):**

Since the total disturbed area is only +/-0.66 acres, and since it does not exceed 1 acre, a SWPPP will not be required. However, erosion control plans and details have been provided for the contractor to implement during construction.

### **Downstream Analysis:**

Per the attached Watershed Report, which can be viewed in Appendix A, the size of the overall catchment area is 2.16km<sup>2</sup> (+/-533.74 acres). The area where improvements are being

made is +/-0.49 acres (0.09% of the overall catchment area). Therefore, since our site is significantly less than 10% of the overall catchment area, our site will not increase the flooding potential downstream of the site where the runoff from our site meets the existing stream.

**Conclusion:**

All the referenced material and supporting documentation can be found below. The proposed detention basin, and the associated water quality elements meets the standards of Comprehensive Control Strategy described in the City of Lee's Summit Design & Construction Manual (i.e., KCAPWA Section 5600 and Lee's Summit Addendum).

# Appendix A



TOPOGRAPHIC SURVEY

SURVEY PREPARED FOR

DRIVEN ASSETS, LLC  
2101 PEARL STREET  
BOULDER, CO. 80302  
TODD MINIS, MANAGING PARNTER  
todd@drivenassets.com

SURVEY NOTES

1. INFORMATION AS SHOWN FOR UNDERGROUND UTILITIES HAS BEEN COMPILED FROM THE RECORDS OF VARIOUS UTILITY COMPANIES CONCERNED, AND AS MARKED IN THE FIELD BY THE MISSOURI ONE CALL SYSTEM, 1 (800) 344-7483. WHEN PRECISE LOCATIONS OF UNDERGROUND UTILITIES ARE NEEDED PRIOR TO EXCAVATION OR CONNECTIONS, THE VARIOUS UTILITY COMPANIES CONCERNED ARE TO FURNISH A CREW TO POINT OUT THE LOCATIONS AT THE JOB SITE. Missouri One Call Ticket #232351453.
3. CONTOURS SHOWN HEREON ARE 1 FOOT INTERVALS AND BASED NAVD88.
4. BASIS OF BEARINGS: MISSOURI STATE PLANE, WEST ZONE.
5. CLASS OF SURVEY: URBAN
6. WE HAVE REVIEWED THE "FLOOD INSURANCE RATE MAP", COMMUNITY PANEL NO. 29095C0436G HAVING AN EFFECTIVE JANUARY 20, 2017 AS PUBLISHED BY FEDERAL EMERGENCY MANAGEMENT AGENCY. OUR REVIEW OF THIS MAP INDICATES THAT THIS PARCEL OF LAND LIES WITHIN ZONE X OTHER FLOOD AREAS, WHICH IS "AREAS OF 0.2%; AREAS OF 1% ANNUAL CHANCE FLOOD WITH AVERAGE DEPTHS OF LESS THAN 1 FOOT OR WITH DRAINAGE AREAS LESS THAN 1 SQUARE MILE; AND AREAS PROTECTED BY LEVEES FORM 1% ANNUAL CHANCE FLOOD."

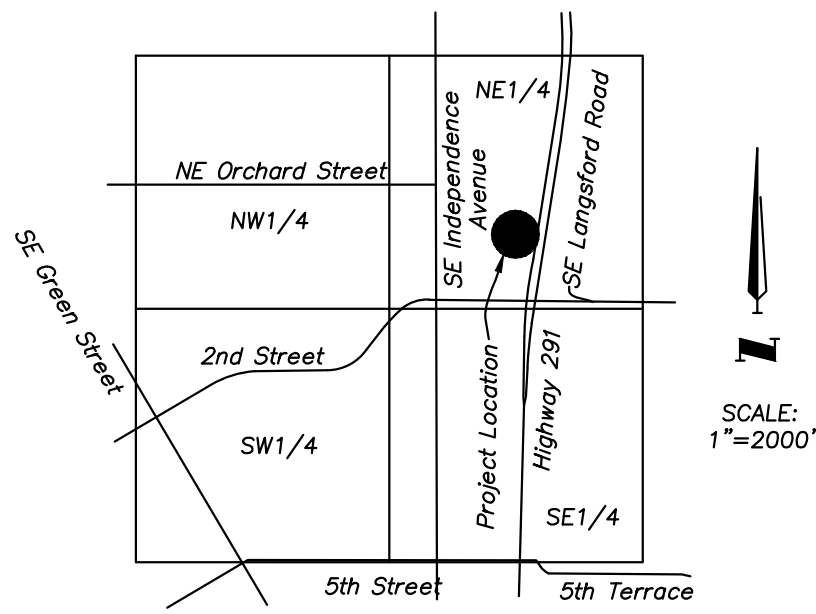
LEGAL DESCRIPTION PER TITLE COMMITMENT

TRACT I:

THE SOUTH 150 FEET OF THE EAST 150 FEET OF THE NORTH 300 FEET OF THE SOUTH 802 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 15 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



VICINITY MAP  
5-47-31

LEGEND

- GA = GUY ANCHOR
- MS = METAL SIGN
- PP = POWER POLE
- SSMH = SANITARY SEWER MANHOLE
- SC = SECTION CORNER
- SCO = SEWER CLEAN OUT
- W = WATER MARKER
- WV = WATER VALVE
- WS = WOOD SIGN
- B = BOLLARD
- PM = GAS METER
- LP = LIGHT POLE w/CONC. BASE

- CP 50  
1/2" IRON BAR WITH SKW TRAVERSE CAP  
1. NORTH 3.0 FEET TO THE SOUTH EDGE OF AN ASPHALT ENTRANCE.  
2. SOUTHWEST 8.5 FEET TO THE WEST CURB RETURN.  
3. SOUTHEAST 24.0 FEET TO THE SOUTH END OF AN 18" CMP.

- CP 51  
1/2" IRON BAR WITH SKW CAP  
1. EAST 10.50 FEET TO THE WEST EDGE OF HIGHWAY 291.  
2. WEST 15.5 FEET TO THE EAST EDGE OF A CONCRETE FLUME.

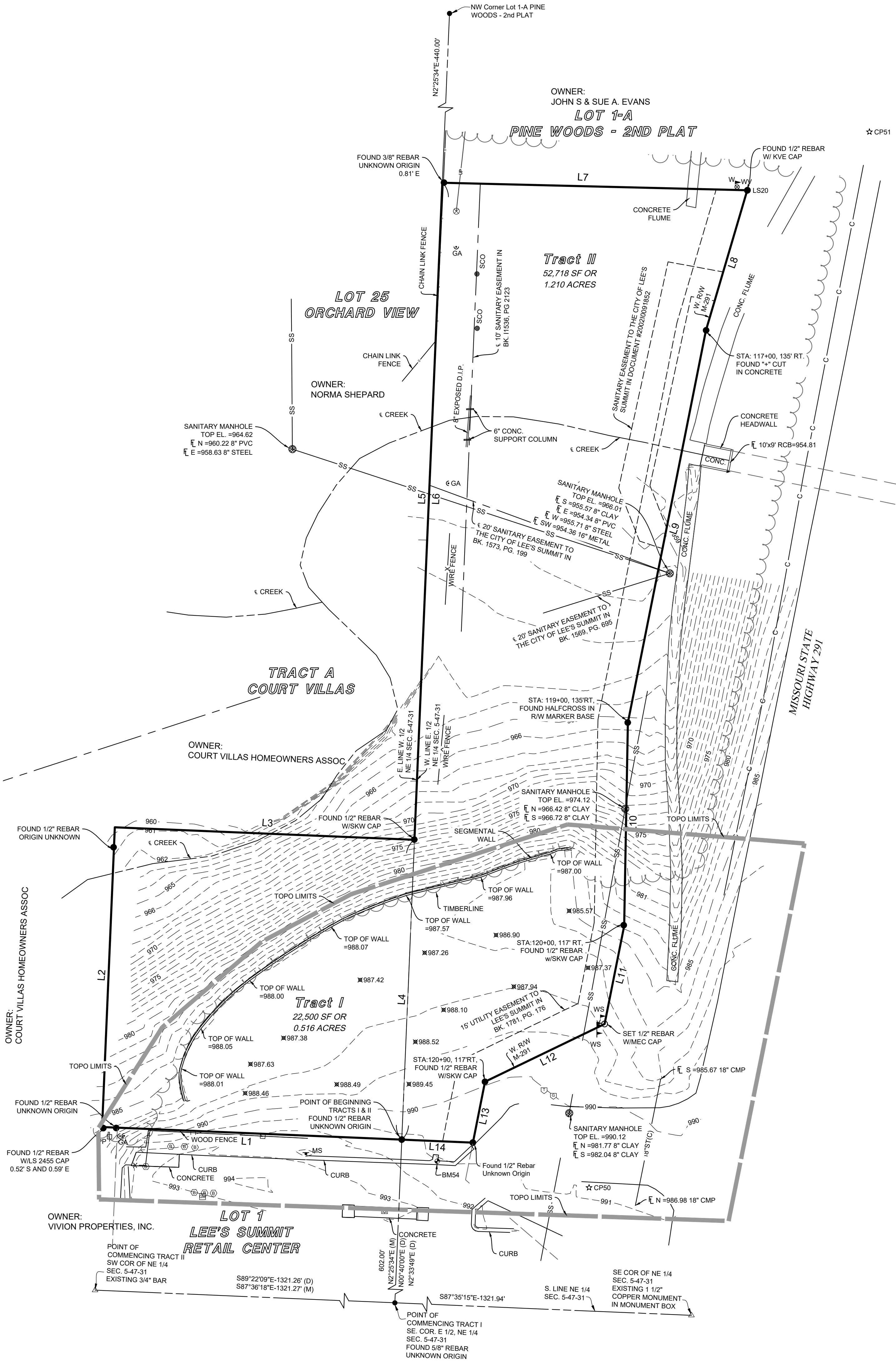
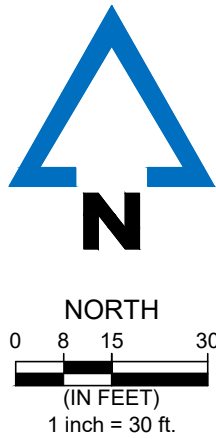
- CP 52  
MAG & SHINER IN THE TOP OF A CURB AT THE NORTH END OF YELLOW NO PARKING.  
1. WEST 28.0 FEET TO THE EAST END OF AN ISLAND.  
2. EAST 41.8 FEET TO THE WEST EDGE OF HIGHWAY 291.  
3. SOUTH 36.8 FEET TO A FIRE HYDRANT.

- BENCHMARK 53  
ELEV.: 994.99  
SET + CUT THE NORTH BOLT TOP FLANGE OF A FIRE HYDRANT ±150' SOUTHEAST OF THE SOUTHEAST CORNER OF THIS SURVEY.

- BENCHMARK 54  
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.

PROJECT CONTROL POINTS TABLE				
CP#	NORTHING	EASTING	ELEV.	DESCRIPTION
50	1002321.14'	2828279.79'	990.78'	CP 50
51	1002848.95'	2828419.99'	979.14'	CP 51
52	1001994.38'	2828211.00'	997.15'	CP 52
53	1002195.40'	2828248.41'	994.99'	BM 53
54	1002334.35'	2828203.90'	991.68'	BM 54

LINE TABLE		
LINE NO.	BEARING	DISTANCE
L1	N87°36'18"W (M) N89°22'09"E (D)	150.00'
L2	N2°25'34"E (M) N00°40'00"E (D)	150.00'
L3	S89°22'09"E (D) S87°36'18"E (M)	150.00'
L4	N00°40'00"E (D) N2°25'34"E (M)	150.00'
L5	N2°33'48"E (D) N2°25'34"E (M)	328.79'
L6	N2°33'48"E (D) N2°25'34"E (M)	478.79'
L7	S88°27'48"E (D) S89°38'03"E (M)	152.53'
L8	S16°24'21"W (M) S16°32'38"W (D)	73.03'
L9	N11°15'42"W (M) S11°23'57"W (D)	200.00'
L10	S11°11'44"W (D) S1°03'29"W (D)	101.61'
L11	S11°15'42"W (M) S11°23'57"W (D)	50.00'
L12	S64°13'25"W (M) S64°21'40"W (D)	66.40'
L13	S11°15'42"W (M) S11°23'57"W (D)	31.03'
L14	N87°34'58"W (M) N87°26'43"W (D)	35.61'



UTILITY WARNING

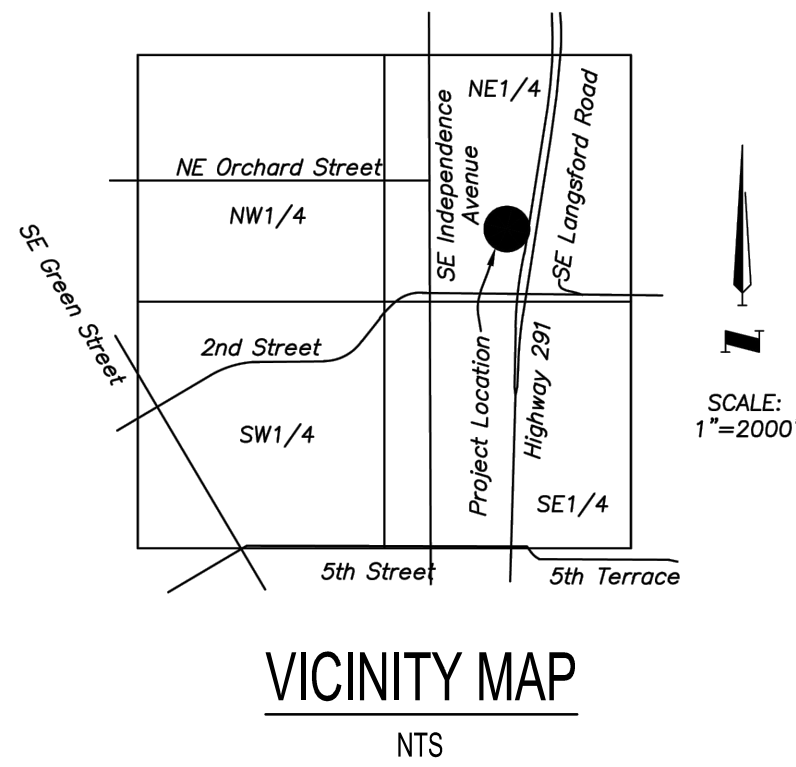
THE UTILITIES DEPICTED ON THIS DOCUMENT HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION AND/OR RECORDS OBTAINED. THE SURVEYOR MAKES NO GUARANTEE THAT THE UTILITIES OR SUBSURFACE FEATURES SHOWN COMPRISE ALL SUCH ITEMS IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UTILITIES OR SUBSURFACE FEATURES SHOWN ARE IN THE EXACT LOCATION INDICATED EXCEPT WHERE NOTED AS QUALITY LEVEL A.

TOPOGRAPHIC SURVEY

ENGINEER		DRAWN BY		REVISIONS	
J. BURNETTE		J. BURNETTE		LEE'S SUMMIT, JACKSON CO. MISSOURI	
S. WHITAKER		CREW CHIEF		SEC. 5-47-R31	
SHEET NO.		2023001249-000		9/13/2023	
01/01					





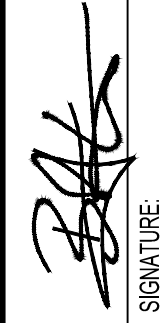


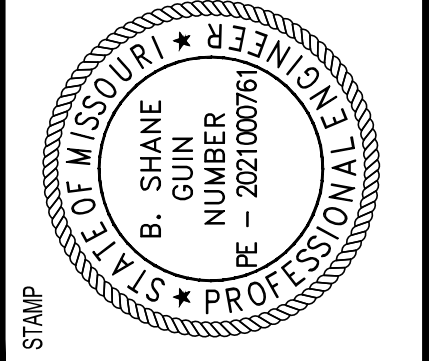
Not For Construction  
**STREAM EXHIBIT**

SCALE IN FEET  
40 20 0 40 80 120

REVISION	BY

**HIGH TIDE**  
**CONSULTANTS LLC**  
434 N. COLUMBIA ST, SUITE 200A  
COVINGTON, LA 70433  
[www.hightidelc.com](http://www.hightidelc.com)

  
SIGNATURE  
DATE: SEPTEMBER 8, 2023

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

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 EX Stream Buffer Exhibit

SHEET  
**ZONE-EX**



# National Flood Hazard Layer FIRMeTte



94°22'3"W 38°55'24"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

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) 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
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		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.

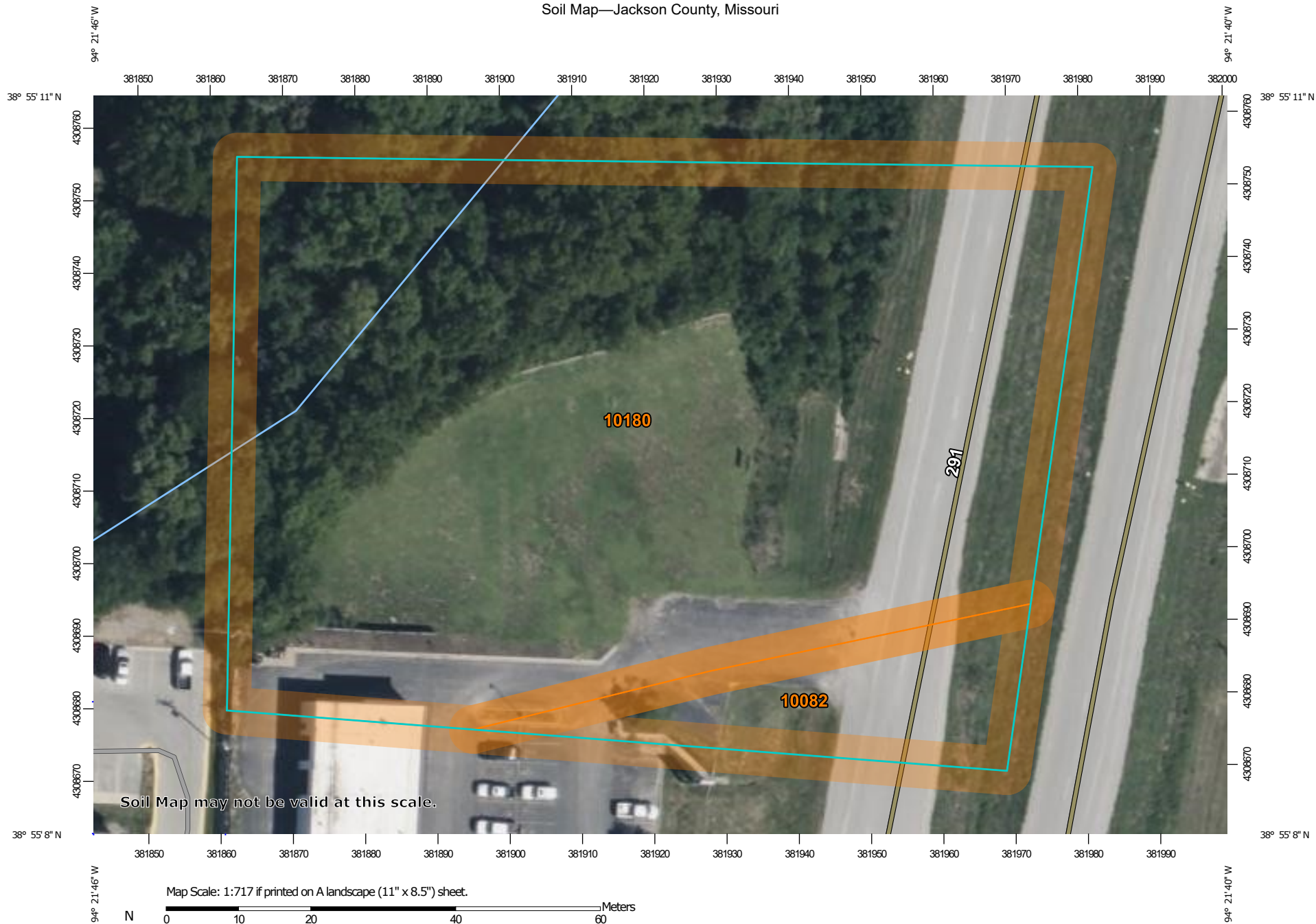
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

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



**Natural Resources  
Conservation Service**

Web Soil Survey  
National Cooperative Soil Survey

5/21/2024  
Page 1 of 3



## 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 25, Aug 22, 2023

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

Date(s) aerial images were photographed: Aug 30, 2022—Sep 8, 2022

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

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	0.2	9.8%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	2.0	90.2%
<b>Totals for Area of Interest</b>		<b>2.2</b>	<b>100.0%</b>

## Jackson County, Missouri

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

#### Map Unit Setting

*National map unit symbol:* 2w7ld

*Elevation:* 750 to 1,130 feet

*Mean annual precipitation:* 39 to 45 inches

*Mean annual air temperature:* 50 to 55 degrees F

*Frost-free period:* 177 to 220 days

*Farmland classification:* All areas are prime farmland

#### Map Unit Composition

*Arisburg and similar soils:* 61 percent

*Urban land:* 30 percent

*Minor components:* 9 percent

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

#### Description of Arisburg

##### Setting

*Landform:* Interfluves

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Loess

##### Typical profile

*Ap - 0 to 6 inches:* silt loam

*A - 6 to 13 inches:* silt loam

*Bt - 13 to 19 inches:* silty clay loam

*Btg - 19 to 56 inches:* silty clay loam

*BCg - 56 to 79 inches:* silty clay loam

##### Properties and qualities

*Slope:* 1 to 5 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Somewhat poorly drained

*Capacity of the most limiting layer to transmit water*

*(Ksat):* Moderately high (0.20 to 0.60 in/hr)

*Depth to water table:* About 18 to 30 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water supply, 0 to 60 inches:* High (about 11.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2e

*Hydrologic Soil Group:* C  
*Ecological site:* R107XB007MO - Loess Upland Prairie  
*Hydric soil rating:* No

### **Description of Urban Land**

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 8  
*Hydric soil rating:* No

### **Minor Components**

#### **Sampsel**

*Percent of map unit:* 3 percent  
*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Convex  
*Across-slope shape:* Concave  
*Ecological site:* R109XY010MO - Interbedded Sedimentary Upland  
Savanna  
*Hydric soil rating:* Yes

#### **Greenton**

*Percent of map unit:* 3 percent  
*Landform:* Hillslopes  
*Landform position (two-dimensional):* Shoulder  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Ecological site:* R109XY002MO - Loess Upland Prairie  
*Hydric soil rating:* No

#### **Sharpsburg**

*Percent of map unit:* 3 percent  
*Landform:* Ridges  
*Landform position (two-dimensional):* Summit  
*Landform position (three-dimensional):* Interfluve  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Ecological site:* R109XY002MO - Loess Upland Prairie  
*Hydric soil rating:* No

## **Data Source Information**

Soil Survey Area: Jackson County, Missouri  
Survey Area Data: Version 25, Aug 22, 2023

## Jackson County, Missouri

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

#### Map Unit Setting

*National map unit symbol:* 1n85h

*Elevation:* 600 to 900 feet

*Mean annual precipitation:* 33 to 43 inches

*Mean annual air temperature:* 50 to 57 degrees F

*Frost-free period:* 175 to 220 days

*Farmland classification:* All areas are prime farmland

#### Map Unit Composition

*Udarents and similar soils:* 46 percent

*Urban land:* 39 percent

*Sampsel and similar soils:* 15 percent

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

#### Description of Udarents

##### Setting

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Crest

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Mine spoil or earthy fill

##### Typical profile

*C1 - 0 to 5 inches:* silt loam

*C2 - 5 to 80 inches:* silty clay loam

##### Properties and qualities

*Slope:* 2 to 5 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Somewhat poorly drained

*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water*

*(Ksat):* Moderately low to moderately high (0.14 to 0.57 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water supply, 0 to 60 inches:* Moderate (about 9.0 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* C

*Ecological site:* R107XB002MO - Deep Loess Upland Prairie  
*Other vegetative classification:* Mixed/Transitional (Mixed Native Vegetation)  
*Hydric soil rating:* No

### **Description of Urban Land**

#### **Setting**

*Landform:* Interfluves  
*Landform position (two-dimensional):* Summit  
*Landform position (three-dimensional):* Interfluve  
*Across-slope shape:* Convex

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 8  
*Hydric soil rating:* No

### **Description of Sampsel**

#### **Setting**

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

#### **Typical profile**

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

#### **Properties and qualities**

*Slope:* 2 to 5 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Somewhat poorly drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* About 0 to 18 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water supply, 0 to 60 inches:* Moderate (about 8.6 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 2e  
*Hydrologic Soil Group:* C/D  
*Ecological site:* R109XY010MO - Interbedded Sedimentary Upland Savanna

*Other vegetative classification:* Grass/Prairie (Herbaceous  
Vegetation)

*Hydric soil rating:* No

## Data Source Information

Soil Survey Area: Jackson County, Missouri

Survey Area Data: Version 25, Aug 22, 2023

# Watershed Report

The Watershed Report provides a variety of stream, catchment and watershed related information from the [National Hydrography Dataset Plus](#) (NHDPlus Version 2) and other sources including the extensive collection of [StreamCat](#) landscape layers. A catchment is the local area draining directly to the selected stream segment. A watershed is the drainage area extending from the downstream end of the stream segment (outlet) upstream to the headwaters. The map displays the stream segment and catchment.



For the stream segment	Value
Stream Name	Not Available
Stream Order	1
Stream Level	6
Mean annual flow volume (estimate)	1.46 cfs
Mean annual flow velocity (estimate)	0.75 fps
Stream Length	1.68 km
Stream Time of Travel (estimate)	0.08 days

View catchment and watershed data from either the NHDPlus or StreamCat datasets by clicking on the appropriate tab below:

[NHDPlus Catchment and Watershed Data](#)

[StreamCat Catchment and Watershed Data](#)



**For the catchment (local area draining directly to the selected stream segment)**

Metrics	Catchment Total
Catchment area measurement	2.16 km <sup>2</sup>
Mean annual temperature	12.38 °C
Mean annual precipitation	1,065.53 mm

2011 National Land Cover Dataset	Catchment Total
Open Water (11)	0.46%
Low Intensity Residential (21)	17.25%
Commercial (23)	19.66%
Deciduous Forest (41)	0%
Evergreen Forest (42)	0%
Mixed Forest (43)	0%
Other	62.64%

**For the watershed (drainage area extending from the outlet upstream to the headwaters)**

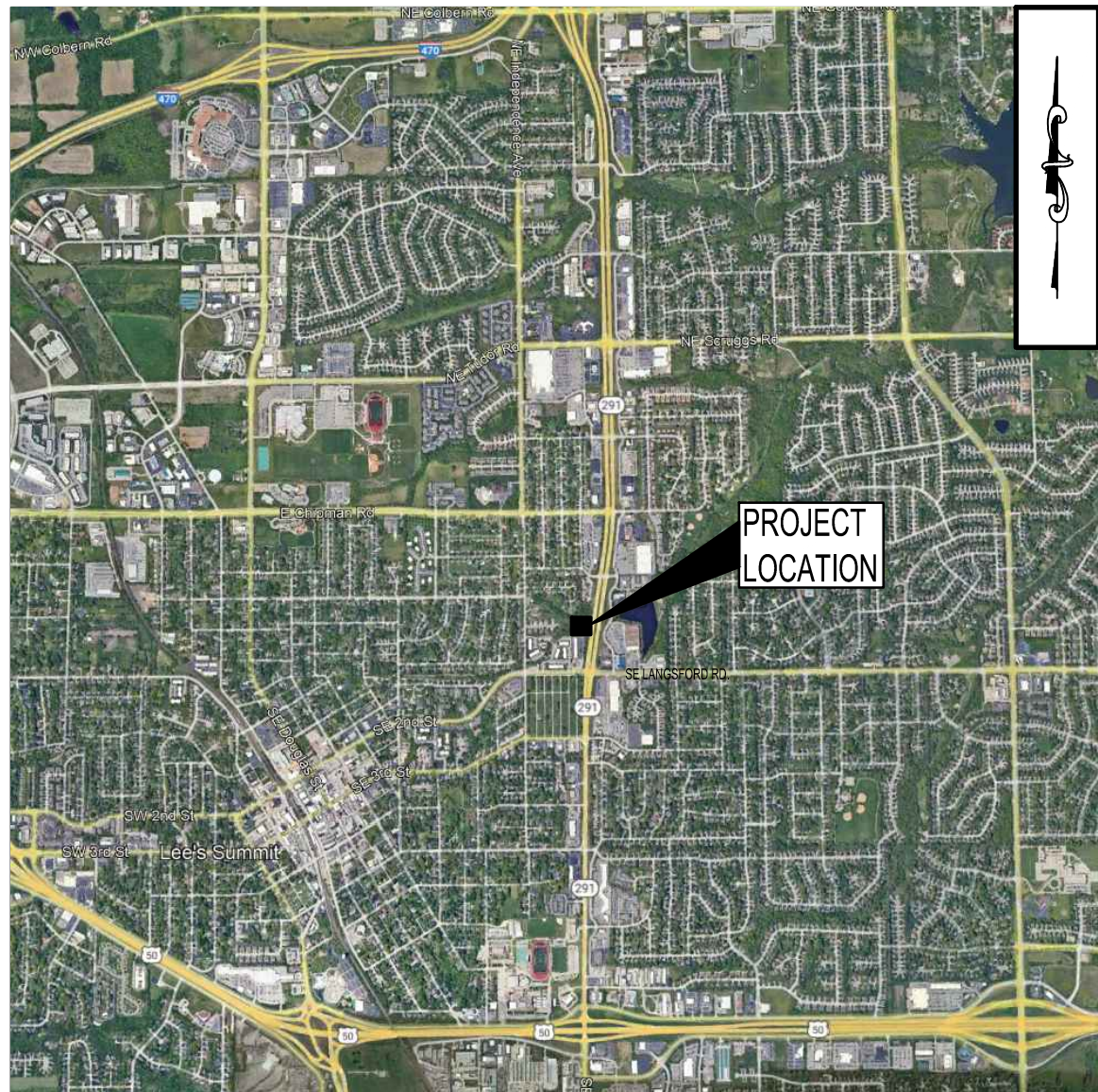
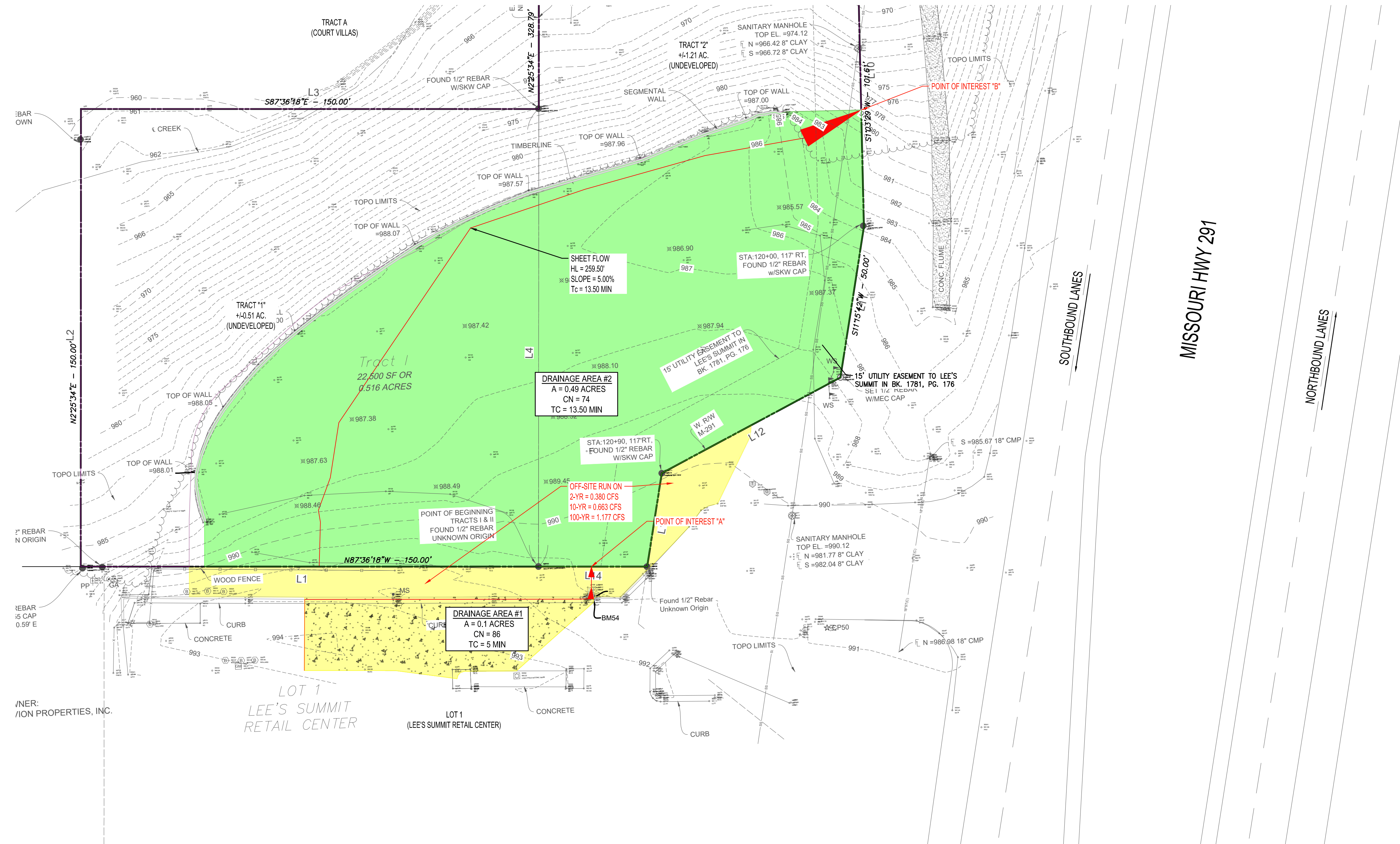
Since this is a headwater stream segment, its catchment and watershed are the same.

[Download Full Report \(.json\)](#)

NHDPlus data extracted as of March 2019.  
More information on the [NHDPlus dataset](#).

LAST UPDATED ON FEBRUARY 15, 2017





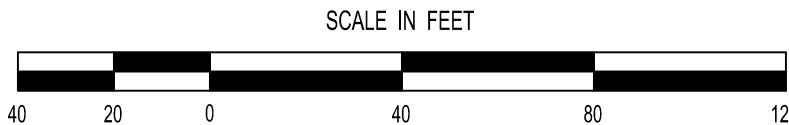
VICINITY MAP  
NTS

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	0.380	2 - YEAR	0.836	2 - YEAR	1.074
10 - YEAR	0.663	10 - YEAR	1.799	10 - YEAR	2.213
100 - YEAR	1.177	100 - YEAR	3.719	100 - YEAR	4.461



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



REVISION	BY

**HIGH TIDE**  
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STATE OF MISSOURI  
B. SHANE GUIN  
NUMBER  
PE - 2021000761  
PROFESSIONAL ENGINEER

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FOR THE ISSUANCE OF A PERMIT.

PROPOSED TAKE 5  
LEE'S SUMMIT, MISSOURI

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

DRAWN KRG
CHECKED RCG
ISSUED DATE 07/30/2024
ISSUED FOR PERMITTING
PROJECT NO. 22-218
FILE 22-218 PRE PreDevelopment Plan
SHEET <b>PRE</b>



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**2 - Year**

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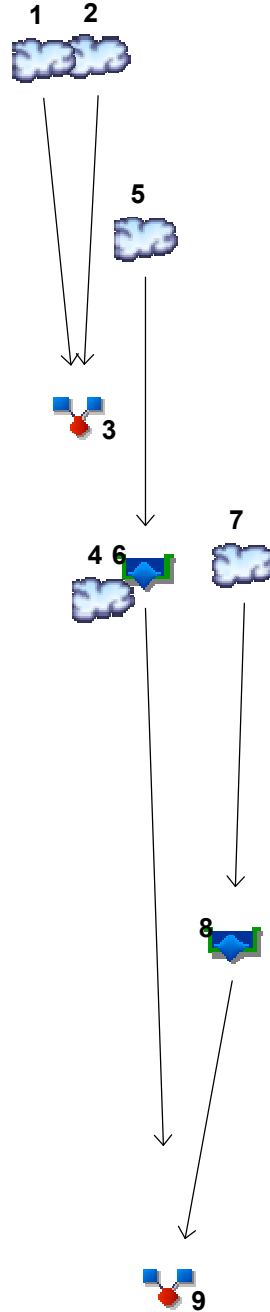
        Hydrograph No. 2, SCS Runoff, Pre On-Site Area (DA 2)..... 14

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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 (DA2)
6	Reservoir	Underground Detention
7	SCS Runoff	Post On-Site Area (DA 3)
8	Reservoir	Pond
9	Combine	Combined Post-Developed Flow

# 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	-----	-----	0.380	-----	-----	0.663	-----	-----	1.177	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	-----	-----	0.836	-----	-----	1.799	-----	-----	3.719	Pre On-Site Area (DA 2)
3	Combine	1, 2	-----	1.074	-----	-----	2.213	-----	-----	4.461	Combined Pre-Developed Flow
4	SCS Runoff	-----	-----	0.375	-----	-----	0.630	-----	-----	1.088	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	-----	-----	0.903	-----	-----	1.603	-----	-----	2.885	Post On-Site Area (DA2)
6	Reservoir	5	-----	0.102	-----	-----	0.128	-----	-----	0.170	Underground Detention
7	SCS Runoff	-----	-----	1.060	-----	-----	1.824	-----	-----	3.208	Post On-Site Area (DA 3)
8	Reservoir	7	-----	0.124	-----	-----	0.413	-----	-----	1.080	Pond
9	Combine	6, 8	-----	0.226	-----	-----	0.534	-----	-----	1.237	Combined Post-Developed Flow
Proj. file: Lees Summit Hydrographs_2024-12-09.gpw										Monday, 12 / 16 / 2024	

# 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	0.380	2	716	778	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	0.836	2	722	2,405	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	1.074	2	720	3,183	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	0.375	2	716	782	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	0.903	2	718	2,077	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.102	2	746	2,075	5	983.04	877	Underground Detention
7	SCS Runoff	1.060	2	716	2,180	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	0.124	2	736	2,178	7	982.40	878	Pond
9	Combine	0.226	2	740	4,253	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 2 Year			Monday, 12 / 16 / 2024	

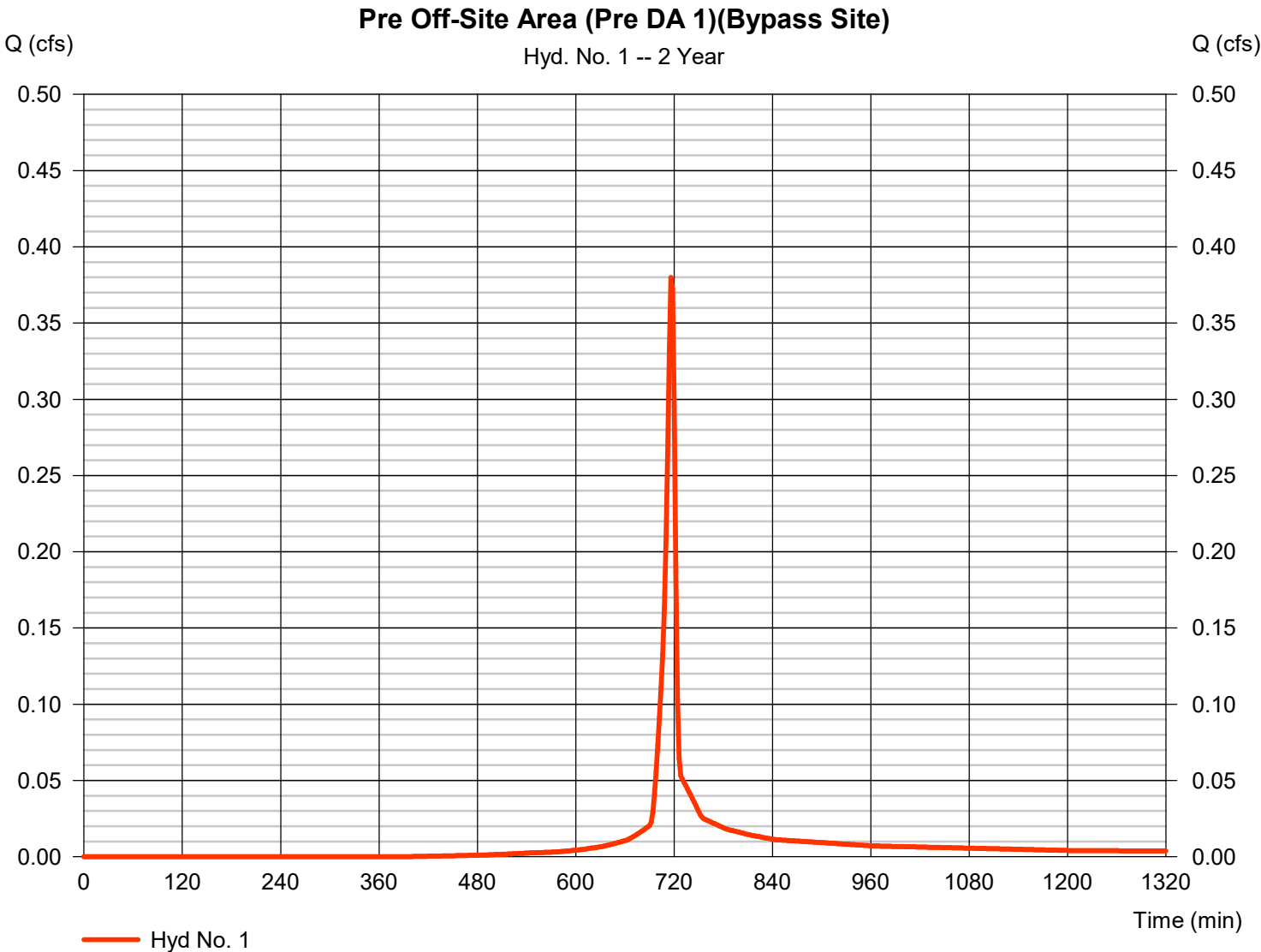
# Hydrograph Report

## Hyd. No. 1

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

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.380 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	778 cuft
Drainage area	=	0.100 ac	Curve number	=	86*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.050 x 98) + (0.050 x 74)] / 0.100



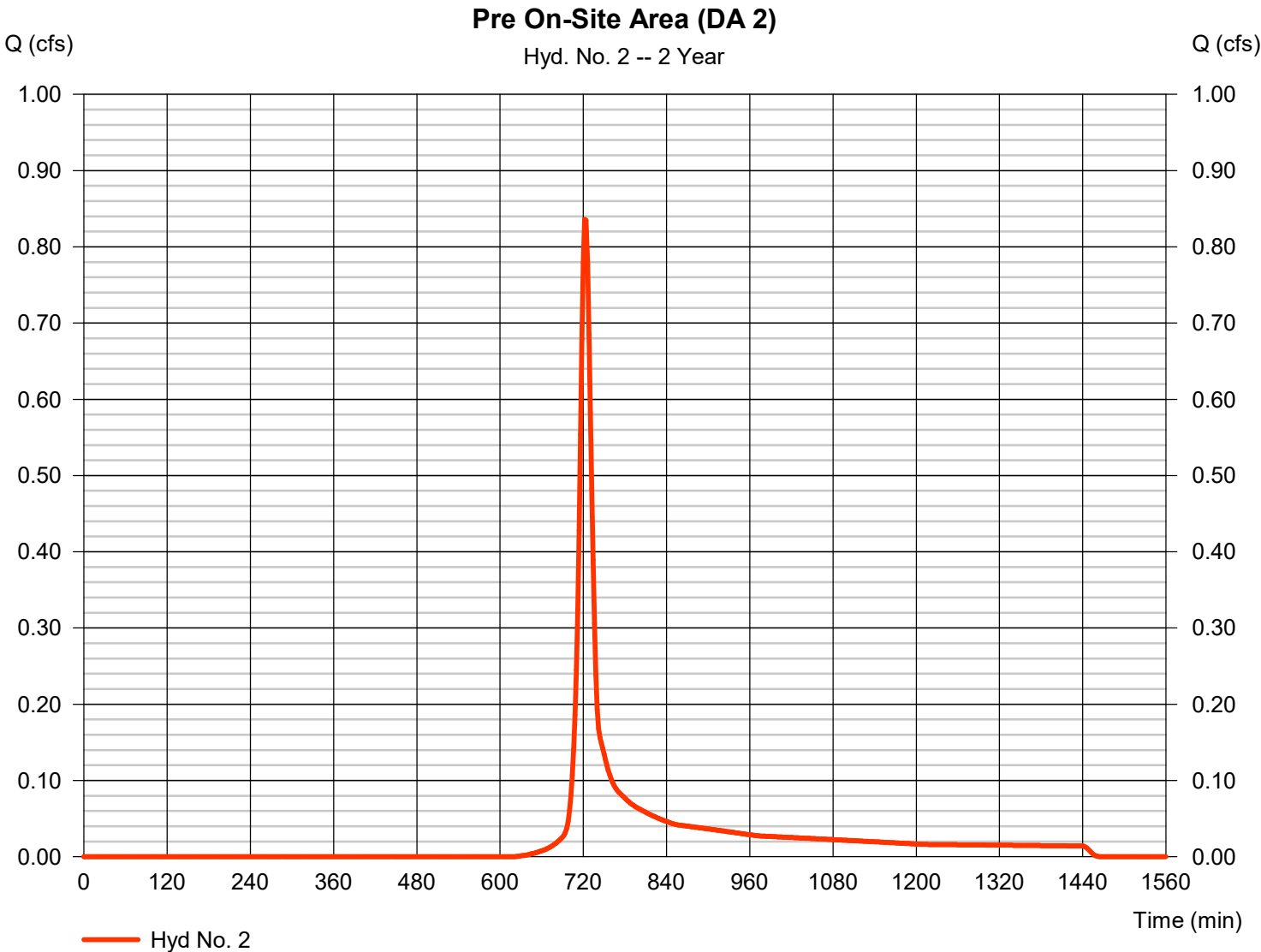
# Hydrograph Report

## Hyd. No. 2

Pre On-Site Area (DA 2)

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.836 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	2,405 cuft
Drainage area	=	0.490 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.53 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.493 x 74)] / 0.490





# TR55 Tc Worksheet

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

## Hyd. No. 2

Pre On-Site Area (DA 2)

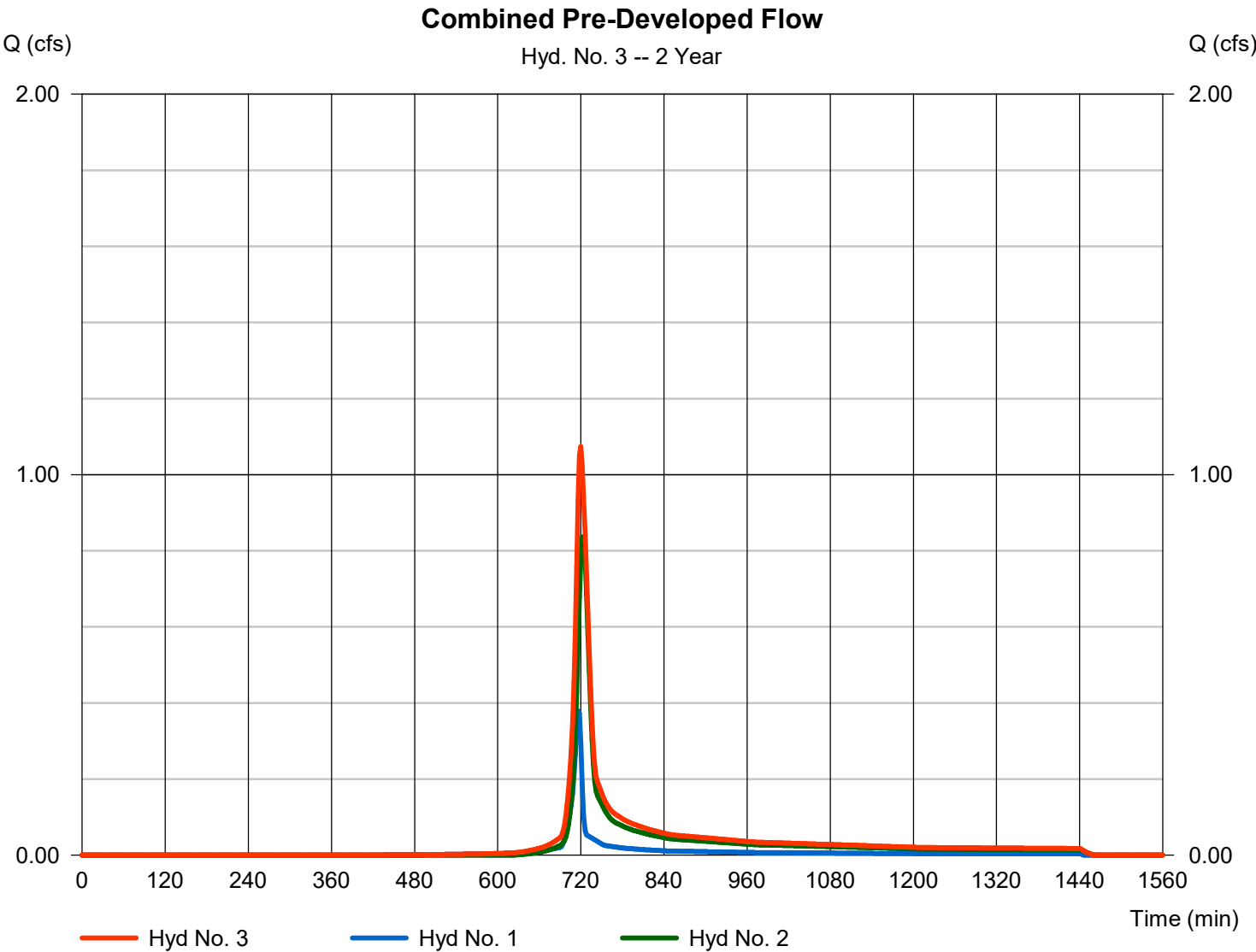
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
<b>Sheet Flow</b>				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 259.5	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.71	0.00	0.00	
Land slope (%)	= 5.00	0.00	0.00	
<b>Travel Time (min)</b>	<b>= 13.53</b>	<b>+</b>	<b>0.00</b>	<b>+</b>
			<b>0.00</b>	<b>= 13.53</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>+</b>	<b>0.00</b>	<b>+</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	0.0	
<b>Travel Time (min)</b>	<b>= 0.00</b>	<b>+</b>	<b>0.00</b>	<b>+</b>
			<b>0.00</b>	<b>= 0.00</b>
<b>Total Travel Time, Tc .....</b>				<b>13.53 min</b>

# Hydrograph Report

## Hyd. No. 3

Combined Pre-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 1.074 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 3,183 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	0.663	2	716	1,394	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	1.799	2	722	5,046	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	2.213	2	720	6,440	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	0.630	2	716	1,353	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	1.603	2	718	3,768	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.128	2	754	3,766	5	983.61	1,755	Underground Detention
7	SCS Runoff	1.824	2	716	3,861	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	0.413	2	724	3,860	7	983.07	1,558	Pond
9	Combine	0.534	2	724	7,625	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 10 Year			Monday, 12 / 16 / 2024	

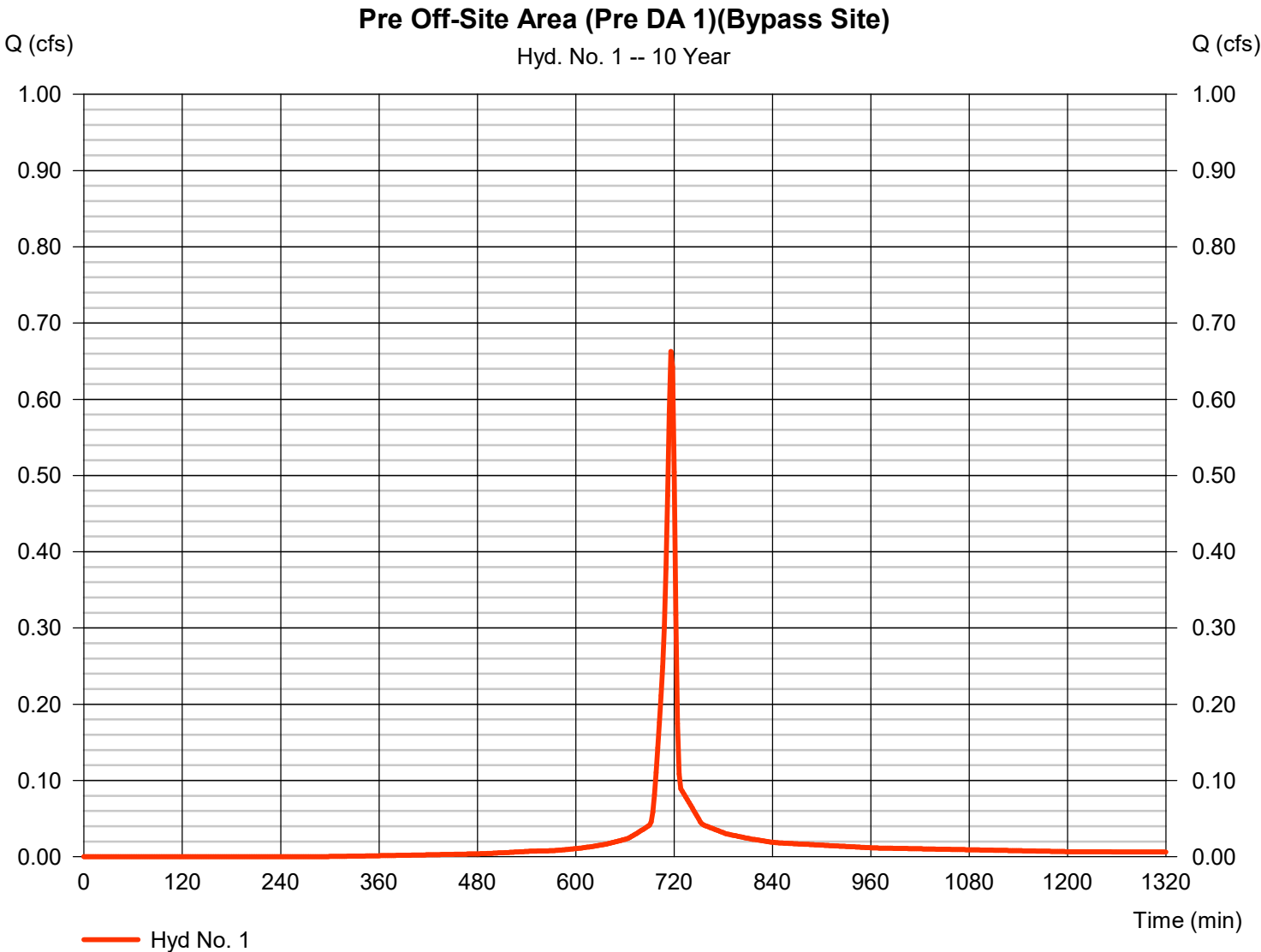
# Hydrograph Report

## Hyd. No. 1

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

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.663 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	1,394 cuft
Drainage area	=	0.100 ac	Curve number	=	86*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.67 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.050 x 98) + (0.050 x 74)] / 0.100



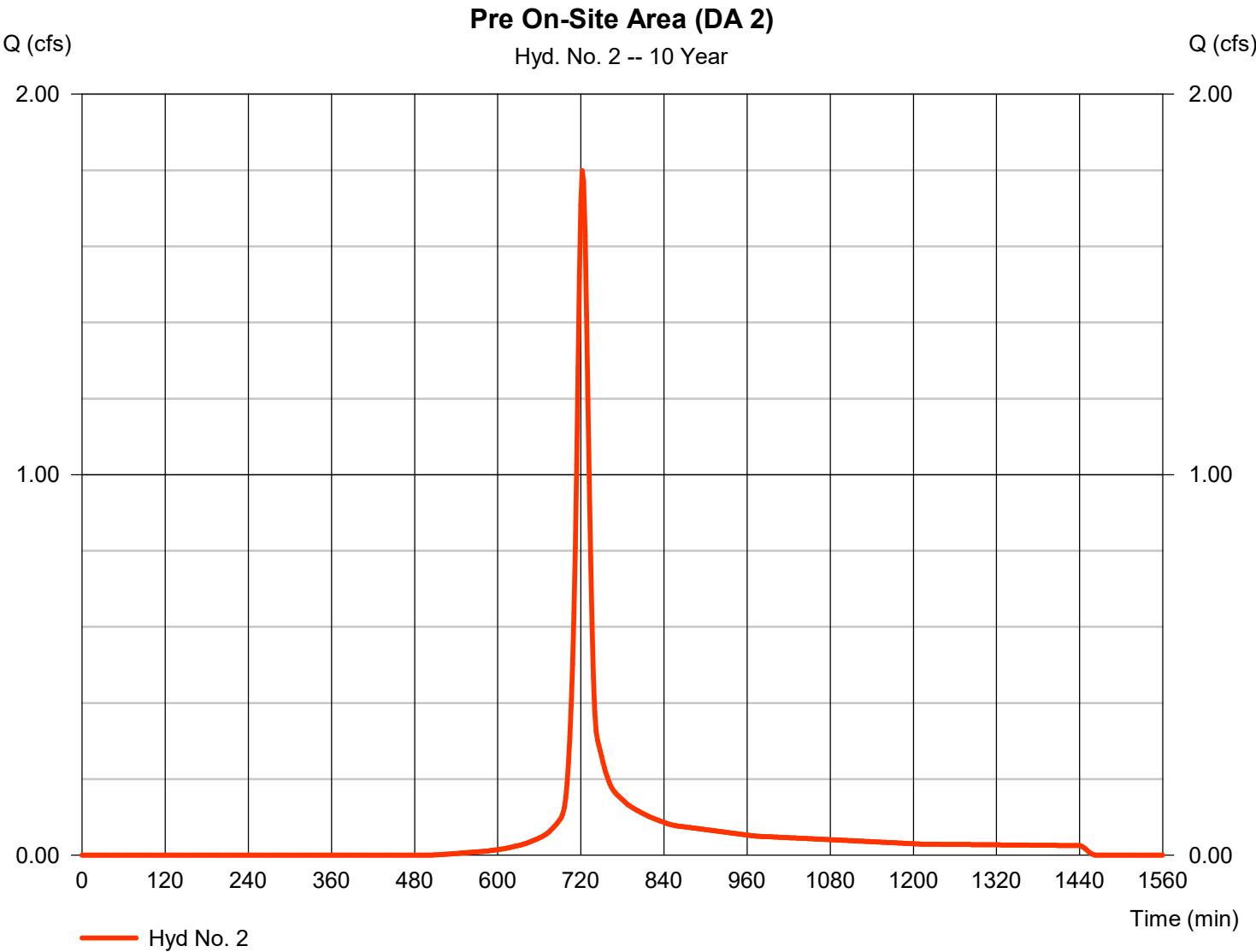
# Hydrograph Report

## Hyd. No. 2

Pre On-Site Area (DA 2)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.799 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	5,046 cuft
Drainage area	=	0.490 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.53 min
Total precip.	=	5.67 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.493 x 74)] / 0.490

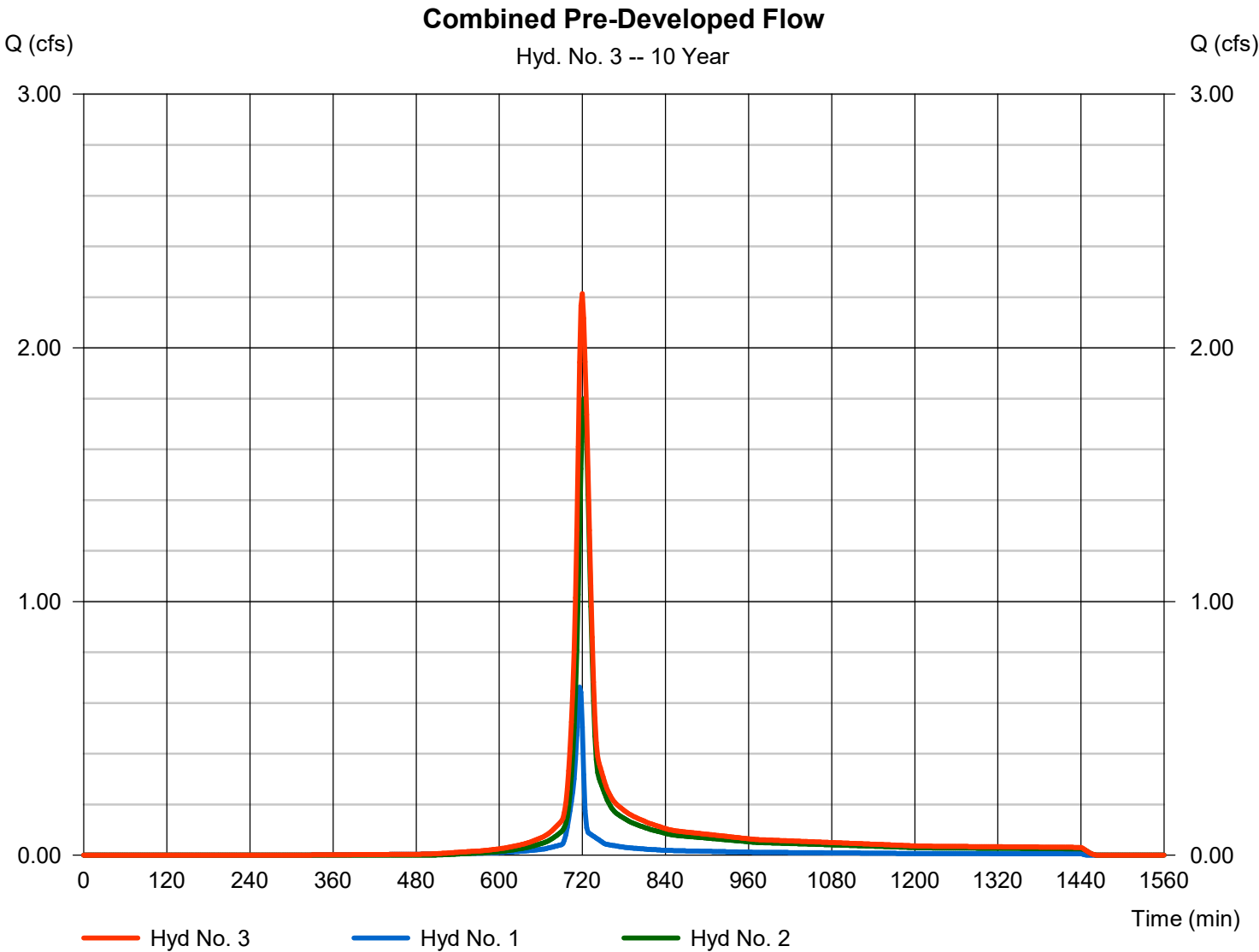


# Hydrograph Report

## Hyd. No. 3

Combined Pre-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 2.213 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 6,440 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	1.177	2	716	2,572	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	3.719	2	722	10,521	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	4.461	2	720	13,093	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	1.088	2	716	2,428	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	2.885	2	718	7,016	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.170	2	772	7,014	5	984.76	3,541	Underground Detention
7	SCS Runoff	3.208	2	716	7,057	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	1.080	2	724	7,056	7	983.92	2,623	Pond
9	Combine	1.237	2	724	14,070	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 100 Year			Monday, 12 / 16 / 2024	

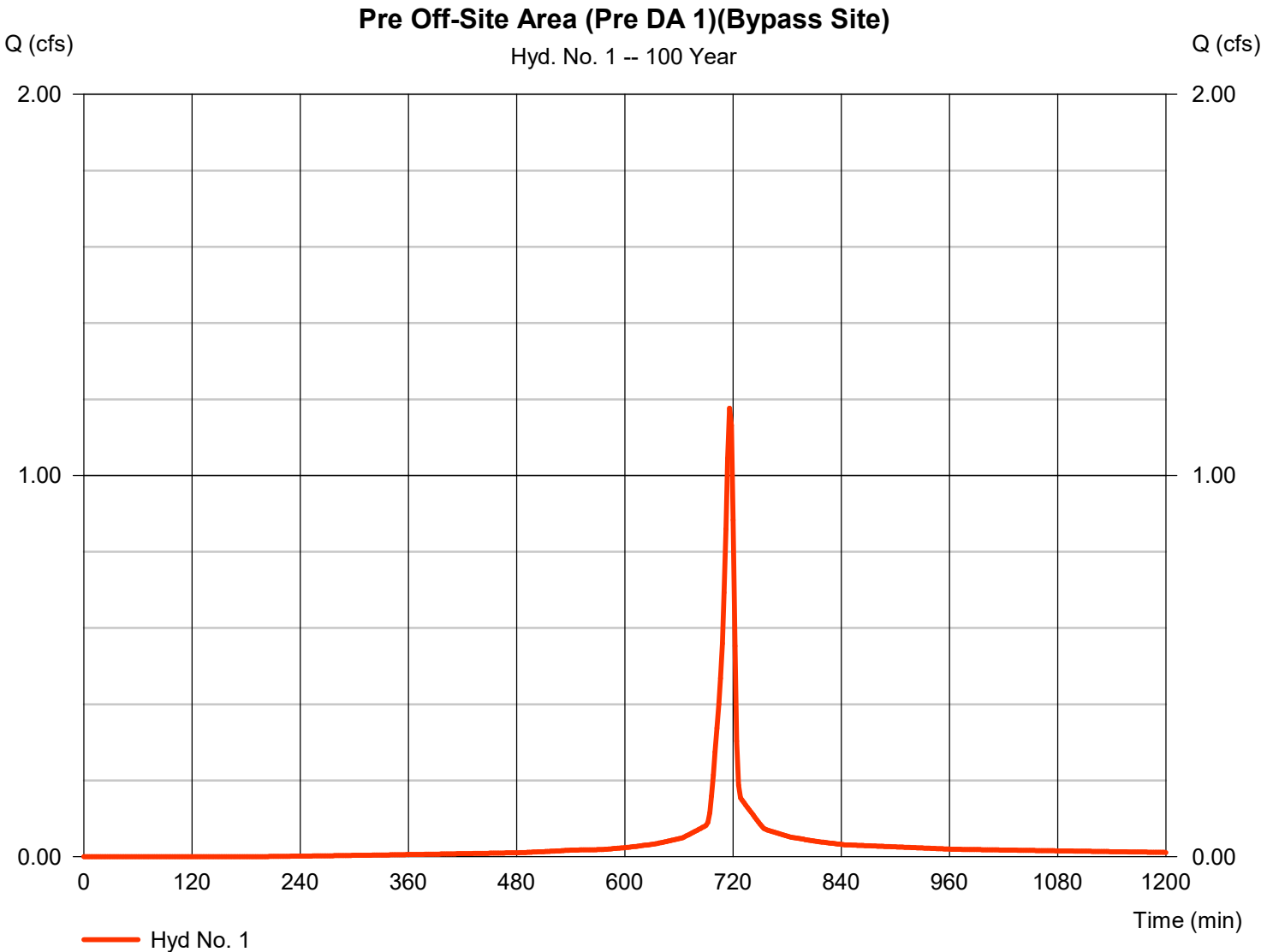
# Hydrograph Report

## Hyd. No. 1

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

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.177 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	2,572 cuft
Drainage area	=	0.100 ac	Curve number	=	86*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.050 x 98) + (0.050 x 74)] / 0.100





# Hydrograph Report

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

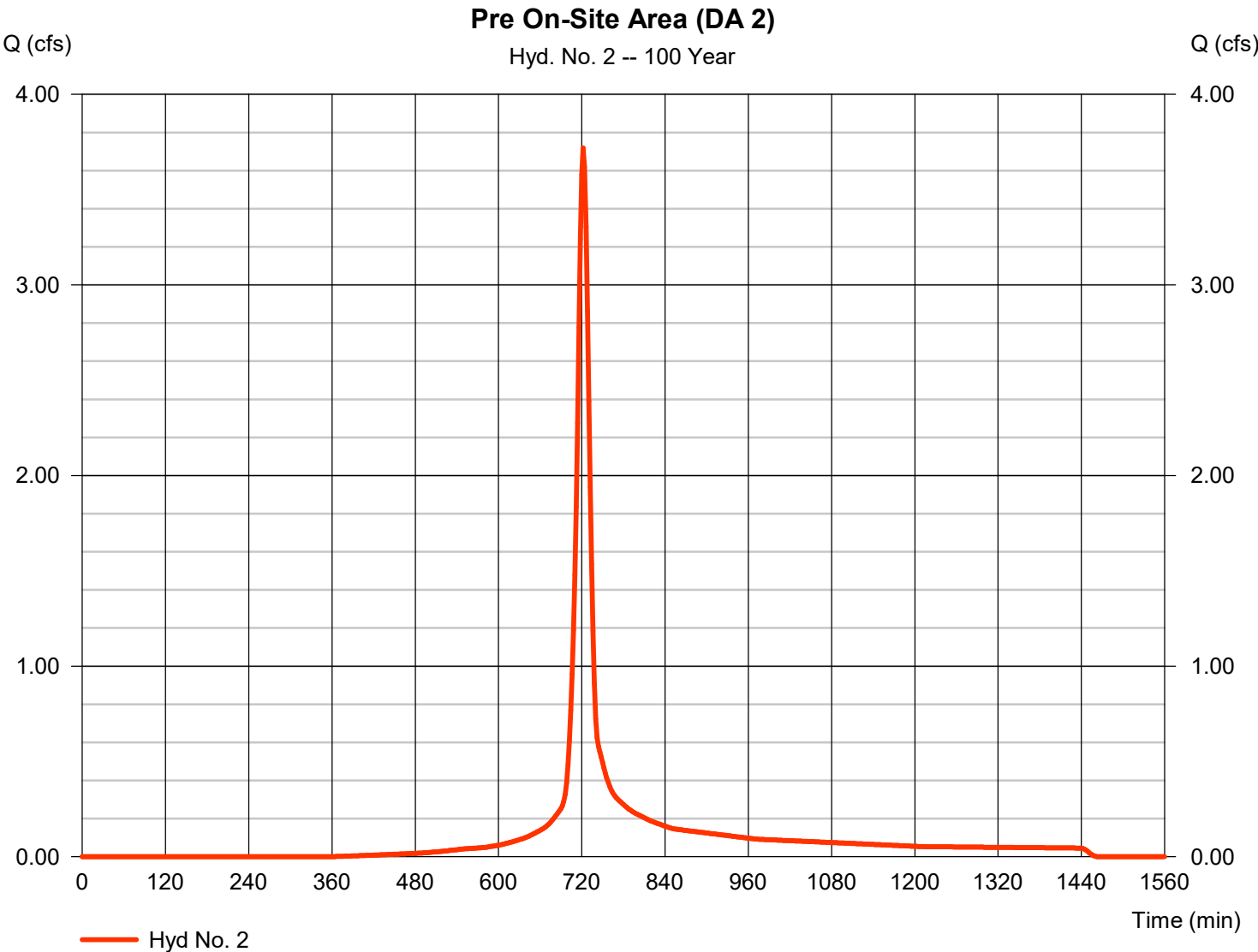
Monday, 12 / 16 / 2024

## Hyd. No. 2

Pre On-Site Area (DA 2)

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.719 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	10,521 cuft
Drainage area	=	0.490 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.53 min
Total precip.	=	9.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.493 x 74)] / 0.490



# Hydrograph Report

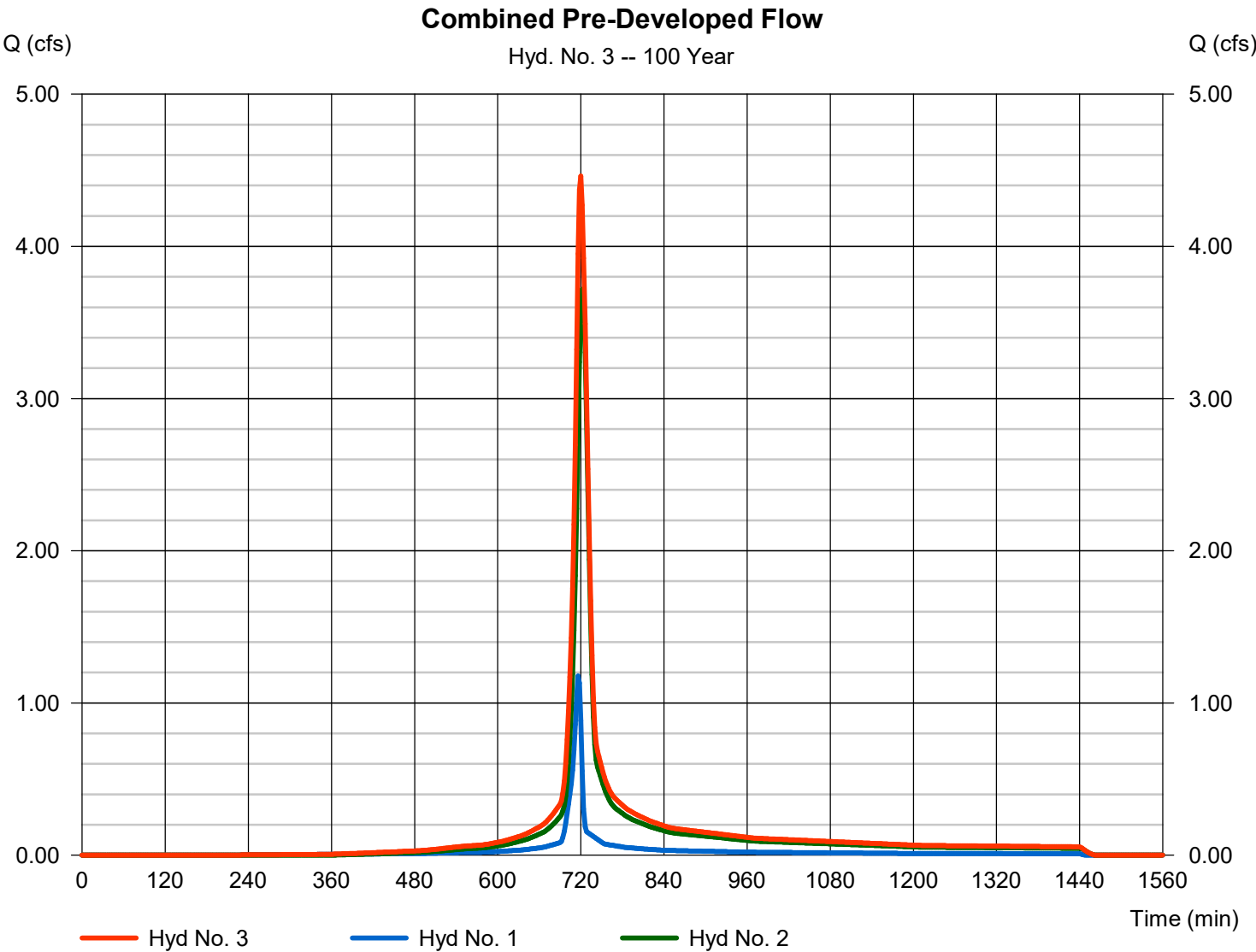
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Monday, 12 / 16 / 2024

## Hyd. No. 3

Combined Pre-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 4.461 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 13,093 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 0.590 ac



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

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

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

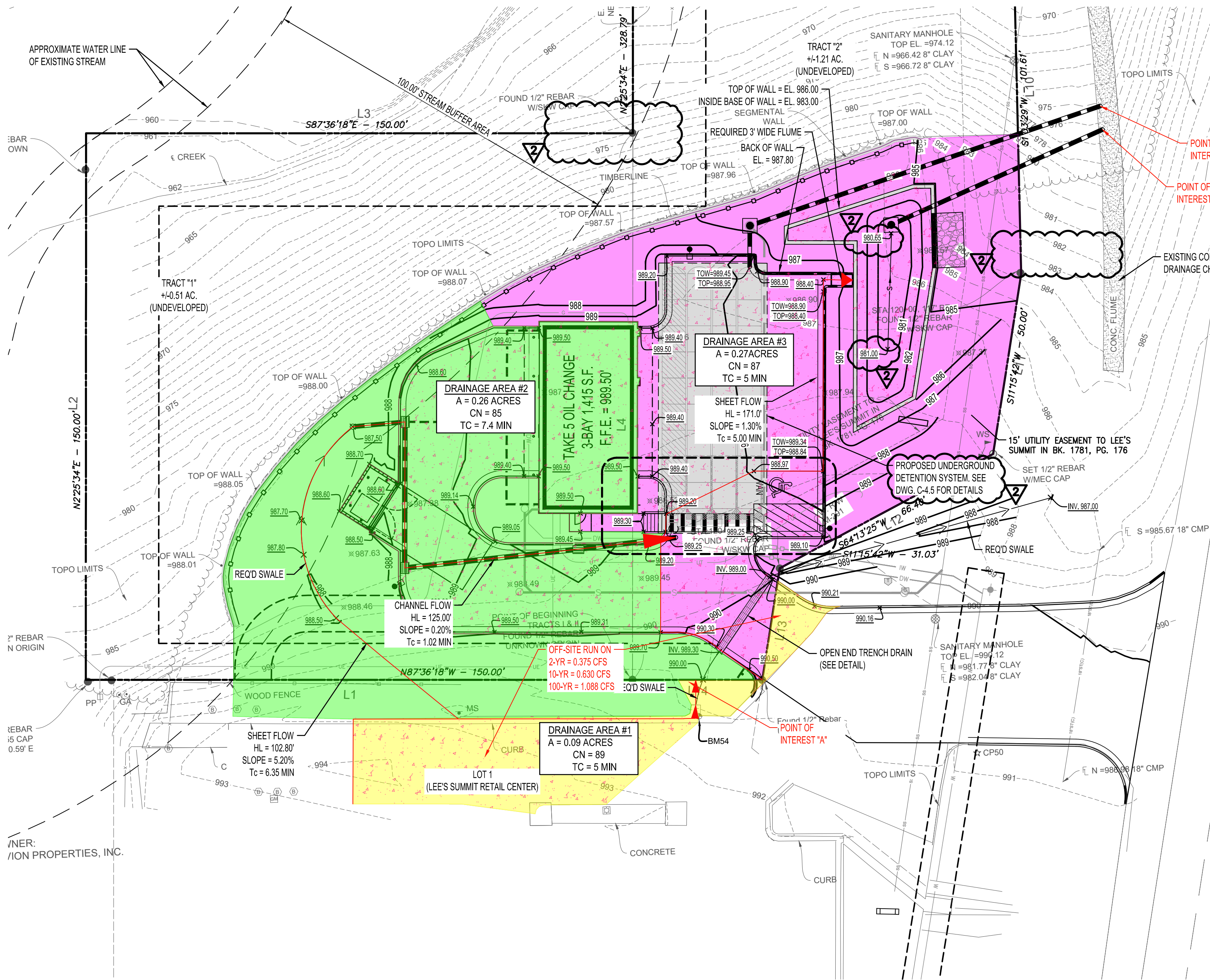
Tc = time in minutes. Values may exceed 60.

s\2022\22-218 Take 5 - Lee's Summit, MO - Todd Minnis\Design\Drainage\Lee's Summit Precipitation\_2024-04-17.pcp

[illegible]

# Appendix B





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

RETURN PERIOD	Q (CFS)
2 - YEAR	0.375
10 - YEAR	0.630
100 - YEAR	1.088

ON-SITE DRAINAGE AREA 2 TOTAL RUNOFF:

RETURN PERIOD	Q (CFS)
2 - YEAR	0.903
10 - YEAR	1.603
100 - YEAR	2.855

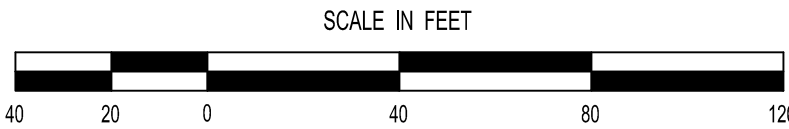
OFF-SITE DRAINAGE AREA 3 TOTAL RUNOFF:

RETURN PERIOD	Q (CFS)
2 - YEAR	1.060
10 - YEAR	1.824
100 - YEAR	3.208

MAXIMUM ALLOWABLE RELEASE RATE PER 0.5 ACRE: TOTAL COMBINED DETAINED RUNOFF:

RETURN PERIOD	Q (CFS)	RETURN PERIOD	Q (CFS)
2 - YEAR	0.245	2 - YEAR	0.226
10 - YEAR	0.98	10 - YEAR	0.534
100 - YEAR	1.47	100 - YEAR	1.237

Not For Construction  
POST-DEVELOPMENT  
DRAINAGE PLAN



REVISION		BY
1	10/24/2024 REVISED PER CITY	KRG
2	12/13/2024 REVISED PER CITY	KRG

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

SIGNATURE:   
DATE: DECEMBER 13, 2024

PROPOSED TAKE 5  
LEE'S SUMMIT, MISSOURI

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

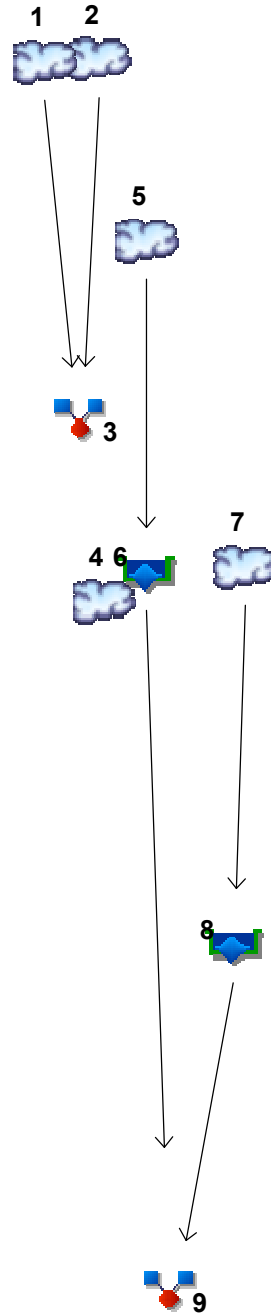
DRAWN  
KRG  
CHECKED  
RCG  
ISSUED DATE  
07/30/2024  
ISSUED FOR  
PERMITTING  
PROJECT NO.  
22-218  
FILE  
22-218 Post-Developed Plan\_2024-12-14  
SHEET  
C-2



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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 (DA2)
6	Reservoir	Underground Detention
7	SCS Runoff	Post On-Site Area (DA 3)
8	Reservoir	Pond
9	Combine	Combined Post-Developed Flow

# 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	-----	-----	0.380	-----	-----	0.663	-----	-----	1.177	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	-----	-----	0.836	-----	-----	1.799	-----	-----	3.719	Pre On-Site Area (DA 2)
3	Combine	1, 2	-----	1.074	-----	-----	2.213	-----	-----	4.461	Combined Pre-Developed Flow
4	SCS Runoff	-----	-----	0.375	-----	-----	0.630	-----	-----	1.088	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	-----	-----	0.903	-----	-----	1.603	-----	-----	2.885	Post On-Site Area (DA2)
6	Reservoir	5	-----	0.102	-----	-----	0.128	-----	-----	0.170	Underground Detention
7	SCS Runoff	-----	-----	1.060	-----	-----	1.824	-----	-----	3.208	Post On-Site Area (DA 3)
8	Reservoir	7	-----	0.124	-----	-----	0.413	-----	-----	1.080	Pond
9	Combine	6, 8	-----	0.226	-----	-----	0.534	-----	-----	1.237	Combined Post-Developed Flow
Proj. file: Lees Summit Hydrographs_2024-12-09.gpw										Monday, 12 / 16 / 2024	



# 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	0.380	2	716	778	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	0.836	2	722	2,405	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	1.074	2	720	3,183	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	0.375	2	716	782	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	0.903	2	718	2,077	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.102	2	746	2,075	5	983.04	877	Underground Detention
7	SCS Runoff	1.060	2	716	2,180	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	0.124	2	736	2,178	7	982.40	878	Pond
9	Combine	0.226	2	740	4,253	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 2 Year			Monday, 12 / 16 / 2024	

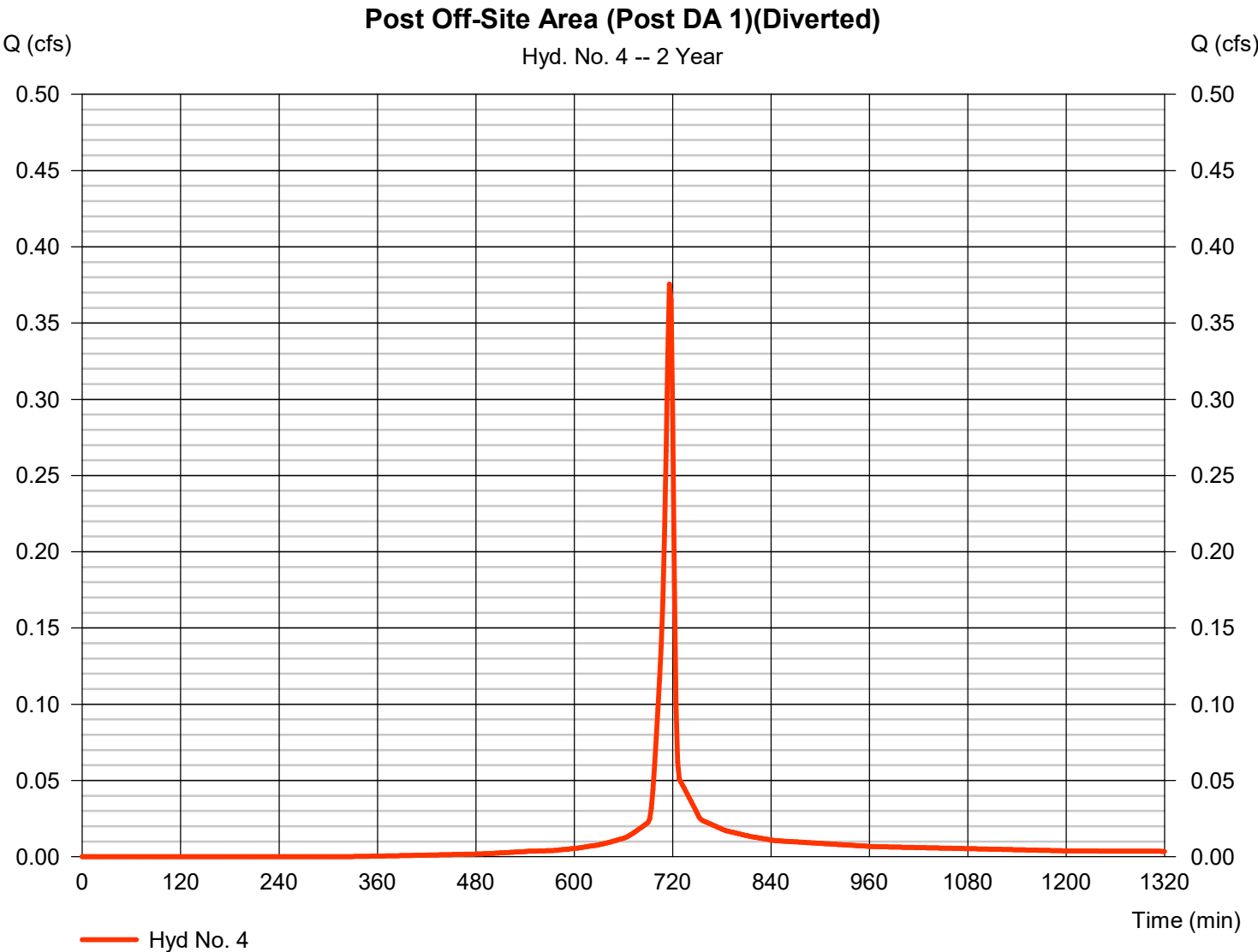
# Hydrograph Report

## Hyd. No. 4

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

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.375 cfs
Storm frequency	=	2 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	782 cuft
Drainage area	=	0.090 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.71 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.052 x 98) + (0.033 x 74)] / 0.090



# Hydrograph Report

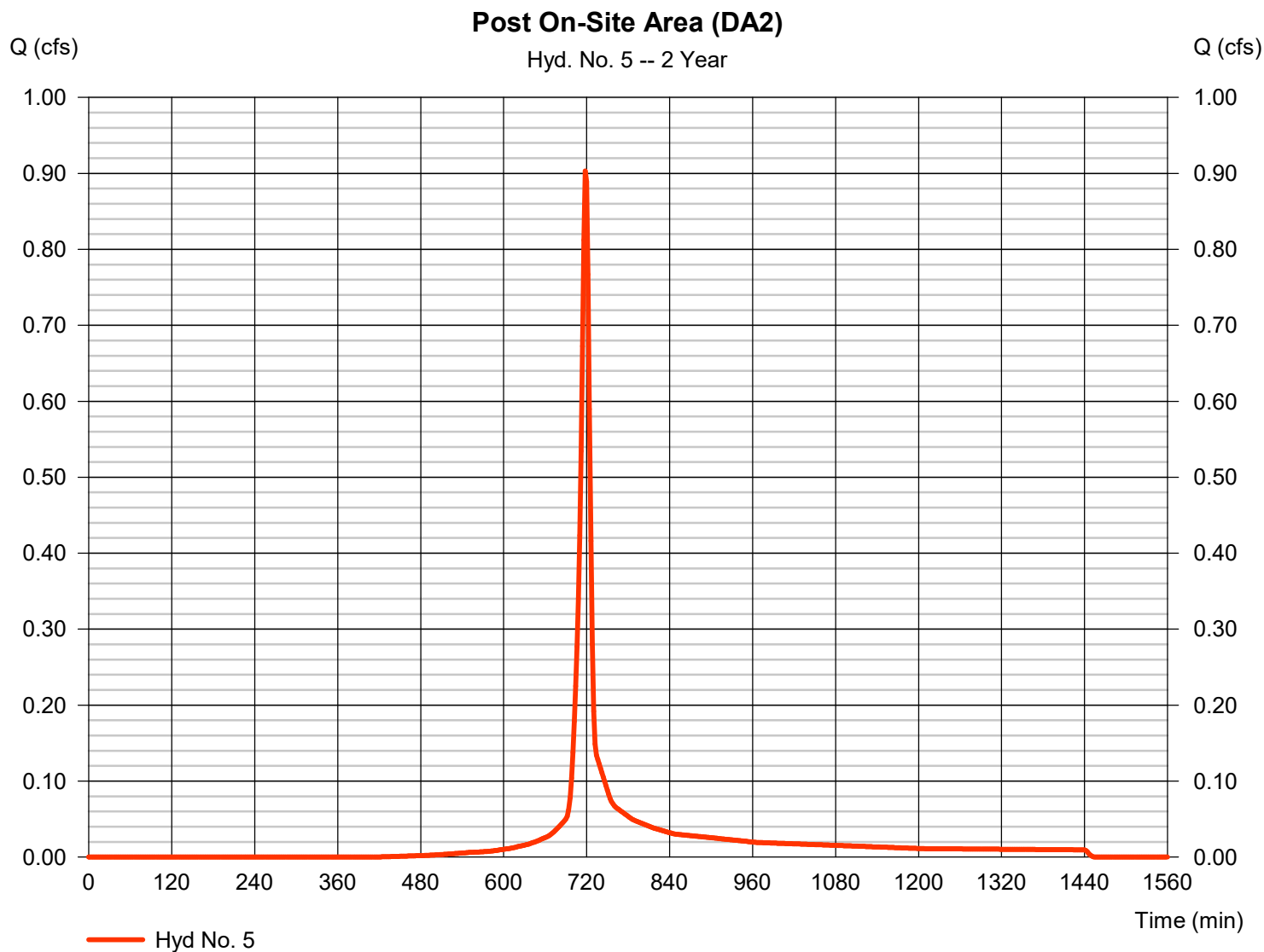
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Monday, 12 / 16 / 2024

## Hyd. No. 5

Post On-Site Area (DA2)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.903 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 2,077 cuft
Drainage area	= 0.260 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.37 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

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

# TR55 Tc Worksheet

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

## Hyd. No. 5

Post On-Site Area (DA2)

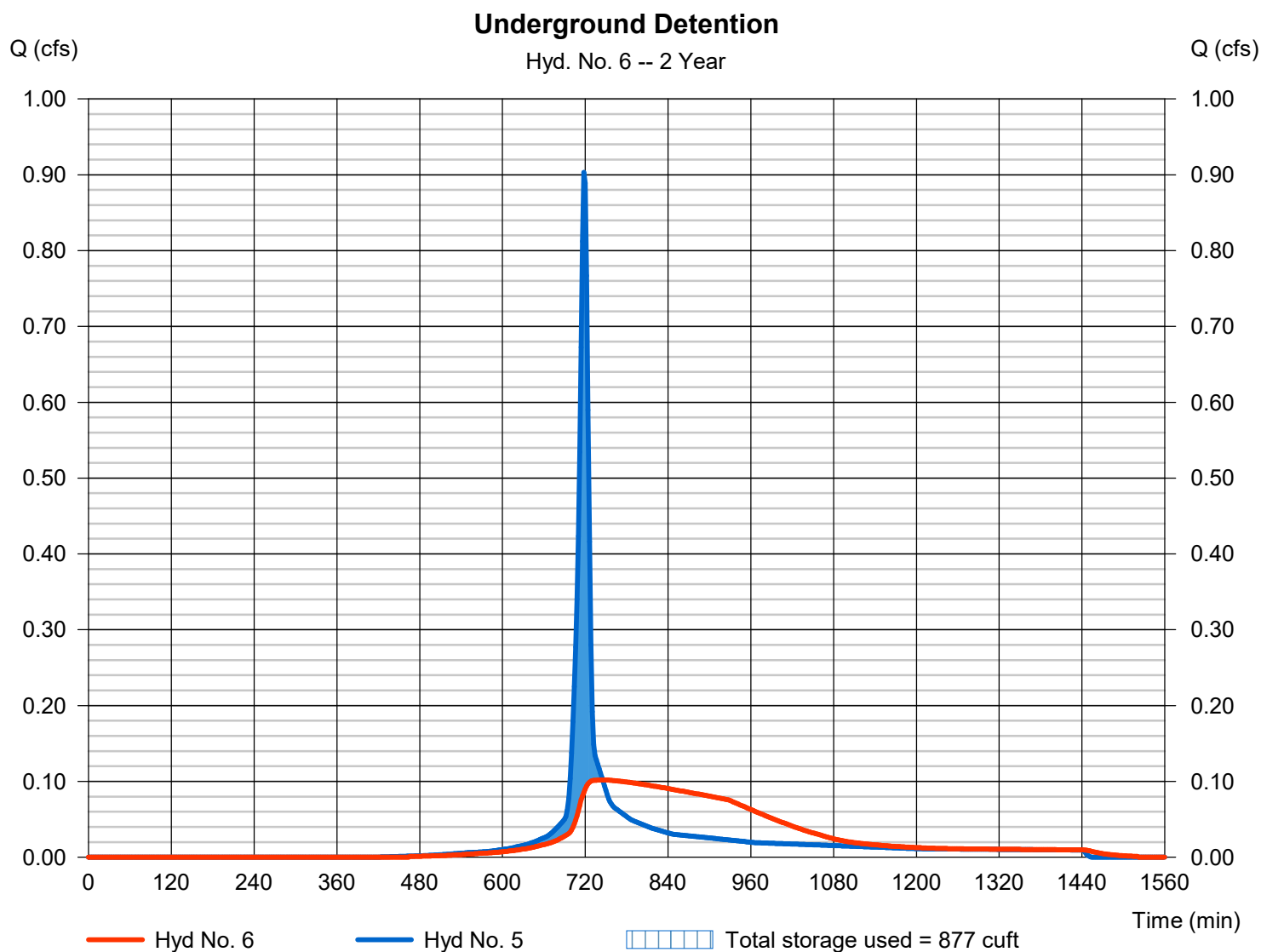
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
<b>Sheet Flow</b>							
Manning's n-value	= 0.150	0.011	0.011				
Flow length (ft)	= 102.8	0.0	0.0				
Two-year 24-hr precip. (in)	= 3.71	0.00	0.00				
Land slope (%)	= 5.20	0.00	0.00				
<b>Travel Time (min)</b>	<b>= 6.35</b>	<b>+</b>	<b>0.00</b>	<b>+</b>	<b>0.00</b>	<b>=</b>	<b>6.35</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>+</b>	<b>0.00</b>	<b>+</b>	<b>0.00</b>	<b>=</b>	<b>0.00</b>
<b>Channel Flow</b>							
X sectional flow area (sqft)	= 1.23	0.00	0.00				
Wetted perimeter (ft)	= 3.93	0.00	0.00				
Channel slope (%)	= 0.20	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=2.04	0.00	0.00				
Flow length (ft)	(0)}125.0	0.0	0.0				
<b>Travel Time (min)</b>	<b>= 1.02</b>	<b>+</b>	<b>0.00</b>	<b>+</b>	<b>0.00</b>	<b>=</b>	<b>1.02</b>
<b>Total Travel Time, Tc .....</b>				<b>7.37 min</b>			

**Hyd. No. 6**

## Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.102 cfs
Storm frequency	= 2 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 2,075 cuft
Inflow hyd. No.	= 5 - Post On-Site Area (DA2)	Max. Elevation	= 983.04 ft
Reservoir name	= Underground Detention	Max. Storage	= 877 cuft

Storage Indication method used.



Pond No. 2 - Underground Detention

Pond Data

UG Chambers -Invert elev. = 982.80 ft, Rise x Span = 3.50 x 5.60 ft, Barrel Len = 7.12 ft, No. Barrels = 38, Slope = 0.00%, Headers = No  
Encasement -Invert elev. = 982.05 ft, Width = 7.17 ft, Height = 5.50 ft, Voids = 30.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	982.05	n/a	0	0
0.55	982.60	n/a	320	320
1.10	983.15	n/a	691	1,011
1.65	983.70	n/a	894	1,905
2.20	984.25	n/a	869	2,774
2.75	984.80	n/a	827	3,600
3.30	985.35	n/a	762	4,363
3.85	985.90	n/a	662	5,024
4.40	986.45	n/a	453	5,477
4.95	987.00	n/a	320	5,797
5.50	987.55	n/a	320	6,118

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	2.00	0.00	0.00
Span (in)	= 12.00	2.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 981.95	982.00	0.00	0.00
Length (ft)	= 124.00	0.00	0.00	0.00
Slope (%)	= 5.63	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	0.00	0.00	0.00
Crest El. (ft)	= 984.58	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	982.05	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
0.05	32	982.10	0.04 ic	0.02 ic	---	---	0.00	---	---	---	---	---	0.016
0.11	64	982.16	0.04 ic	0.03 ic	---	---	0.00	---	---	---	---	---	0.029
0.16	96	982.21	0.04 ic	0.04 ic	---	---	0.00	---	---	---	---	---	0.038
0.22	128	982.27	0.05 ic	0.05 ic	---	---	0.00	---	---	---	---	---	0.045
0.28	160	982.32	0.05 ic	0.05 ic	---	---	0.00	---	---	---	---	---	0.052
0.33	192	982.38	0.06 ic	0.06 ic	---	---	0.00	---	---	---	---	---	0.057
0.39	224	982.43	0.06 ic	0.06 ic	---	---	0.00	---	---	---	---	---	0.062
0.44	256	982.49	0.07 ic	0.07 ic	---	---	0.00	---	---	---	---	---	0.067
0.50	288	982.54	0.07 ic	0.07 ic	---	---	0.00	---	---	---	---	---	0.071
0.55	320	982.60	0.08 ic	0.08 ic	---	---	0.00	---	---	---	---	---	0.075
0.61	389	982.65	0.08 ic	0.08 ic	---	---	0.00	---	---	---	---	---	0.079
0.66	458	982.71	0.08 ic	0.08 ic	---	---	0.00	---	---	---	---	---	0.083
0.72	527	982.76	0.09 ic	0.09 ic	---	---	0.00	---	---	---	---	---	0.086
0.77	596	982.82	0.09 ic	0.09 ic	---	---	0.00	---	---	---	---	---	0.090
0.83	666	982.87	0.09 ic	0.09 ic	---	---	0.00	---	---	---	---	---	0.093
0.88	735	982.93	0.10 ic	0.10 ic	---	---	0.00	---	---	---	---	---	0.096
0.94	804	982.98	0.10 ic	0.10 ic	---	---	0.00	---	---	---	---	---	0.099
0.99	873	983.04	0.11 ic	0.10 ic	---	---	0.00	---	---	---	---	---	0.102
1.05	942	983.09	0.11 ic	0.10 ic	---	---	0.00	---	---	---	---	---	0.105
1.10	1,011	983.15	0.11 ic	0.11 ic	---	---	0.00	---	---	---	---	---	0.107
1.15	1,100	983.20	0.11 ic	0.11 ic	---	---	0.00	---	---	---	---	---	0.110
1.21	1,190	983.26	0.11 ic	0.11 ic	---	---	0.00	---	---	---	---	---	0.113
1.26	1,279	983.31	0.12 ic	0.12 ic	---	---	0.00	---	---	---	---	---	0.115
1.32	1,368	983.37	0.12 ic	0.12 ic	---	---	0.00	---	---	---	---	---	0.118
1.37	1,458	983.42	0.12 ic	0.12 ic	---	---	0.00	---	---	---	---	---	0.120
1.43	1,547	983.48	0.12 ic	0.12 ic	---	---	0.00	---	---	---	---	---	0.123
1.48	1,636	983.53	0.13 ic	0.12 ic	---	---	0.00	---	---	---	---	---	0.125
1.54	1,726	983.59	0.13 ic	0.13 ic	---	---	0.00	---	---	---	---	---	0.127
1.59	1,815	983.64	0.13 ic	0.13 ic	---	---	0.00	---	---	---	---	---	0.130
1.65	1,905	983.70	0.13 ic	0.13 ic	---	---	0.00	---	---	---	---	---	0.132
1.70	1,991	983.76	0.14 ic	0.13 ic	---	---	0.00	---	---	---	---	---	0.134

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## Underground Detention

**Stage / Storage / Discharge Table**

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.76	2,078	983.81	0.14 ic	0.14 ic	---	---	0.00	---	---	---	---	---	0.136
1.82	2,165	983.86	0.14 ic	0.14 ic	---	---	0.00	---	---	---	---	---	0.139
1.87	2,252	983.92	0.14 ic	0.14 ic	---	---	0.00	---	---	---	---	---	0.141
1.93	2,339	983.97	0.15 ic	0.14 ic	---	---	0.00	---	---	---	---	---	0.143
1.98	2,426	984.03	0.15 ic	0.14 ic	---	---	0.00	---	---	---	---	---	0.145
2.04	2,513	984.08	0.15 ic	0.15 ic	---	---	0.00	---	---	---	---	---	0.147
2.09	2,600	984.14	0.15 ic	0.15 ic	---	---	0.00	---	---	---	---	---	0.149
2.15	2,687	984.19	0.16 ic	0.15 ic	---	---	0.00	---	---	---	---	---	0.151
2.20	2,774	984.25	0.16 ic	0.15 ic	---	---	0.00	---	---	---	---	---	0.153
2.26	2,856	984.30	0.16 ic	0.15 ic	---	---	0.00	---	---	---	---	---	0.155
2.31	2,939	984.36	0.16 ic	0.16 ic	---	---	0.00	---	---	---	---	---	0.157
2.37	3,022	984.41	0.16 ic	0.16 ic	---	---	0.00	---	---	---	---	---	0.158
2.42	3,104	984.47	0.17 ic	0.16 ic	---	---	0.00	---	---	---	---	---	0.160
2.48	3,187	984.52	0.17 ic	0.16 ic	---	---	0.00	---	---	---	---	---	0.162
2.53	3,270	984.58	0.17 ic	0.16 ic	---	---	0.00	---	---	---	---	---	0.164
2.59	3,352	984.63	0.17 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.166
2.64	3,435	984.69	0.17 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.168
2.70	3,518	984.74	0.17 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.169
2.75	3,600	984.80	0.18 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.171
2.81	3,677	984.85	0.18 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.173
2.86	3,753	984.91	0.18 ic	0.17 ic	---	---	0.00	---	---	---	---	---	0.174
2.92	3,829	984.96	0.18 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.176
2.97	3,905	985.02	0.18 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.178
3.03	3,982	985.07	0.18 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.180
3.08	4,058	985.13	0.19 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.181
3.14	4,134	985.18	0.19 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.183
3.19	4,210	985.24	0.19 ic	0.18 ic	---	---	0.00	---	---	---	---	---	0.184
3.25	4,286	985.29	0.19 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.186
3.30	4,363	985.35	0.19 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.188
3.36	4,429	985.40	0.19 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.189
3.41	4,495	985.46	0.19 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.191
3.47	4,561	985.51	0.20 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.192
3.52	4,627	985.57	0.20 ic	0.19 ic	---	---	0.00	---	---	---	---	---	0.194
3.58	4,693	985.62	0.20 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.195
3.63	4,760	985.68	0.20 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.197
3.69	4,826	985.73	0.20 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.199
3.74	4,892	985.79	0.20 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.200
3.80	4,958	985.84	0.20 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.201
3.85	5,024	985.90	0.21 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.203
3.90	5,069	985.95	0.21 ic	0.20 ic	---	---	0.00	---	---	---	---	---	0.204
3.96	5,115	986.01	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.206
4.01	5,160	986.06	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.207
4.07	5,205	986.12	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.209
4.12	5,251	986.17	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.210
4.18	5,296	986.23	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.212
4.23	5,341	986.28	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.213
4.29	5,387	986.34	0.21 ic	0.21 ic	---	---	0.00	---	---	---	---	---	0.214
4.34	5,432	986.39	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.216
4.40	5,477	986.45	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.217
4.45	5,509	986.51	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.219
4.51	5,541	986.56	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.220
4.56	5,573	986.61	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.221
4.62	5,605	986.67	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.223
4.67	5,637	986.72	0.22 ic	0.22 ic	---	---	0.00	---	---	---	---	---	0.224
4.73	5,669	986.78	0.23 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.225
4.78	5,701	986.83	0.23 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.227
4.84	5,733	986.89	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.228
4.89	5,765	986.94	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.229
4.95	5,797	987.00	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.231
5.01	5,829	987.05	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.232
5.06	5,861	987.11	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.233
5.11	5,893	987.16	0.24 ic	0.23 ic	---	---	0.00	---	---	---	---	---	0.234
5.17	5,925	987.22	0.24 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.236
5.22	5,957	987.27	0.24 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.237
5.28	5,989	987.33	0.24 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.238
5.33	6,022	987.38	0.25 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.239
5.39	6,054	987.44	0.25 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.241
5.44	6,086	987.49	0.25 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.242
5.50	6,118	987.55	0.25 ic	0.24 ic	---	---	0.00	---	---	---	---	---	0.243

...End

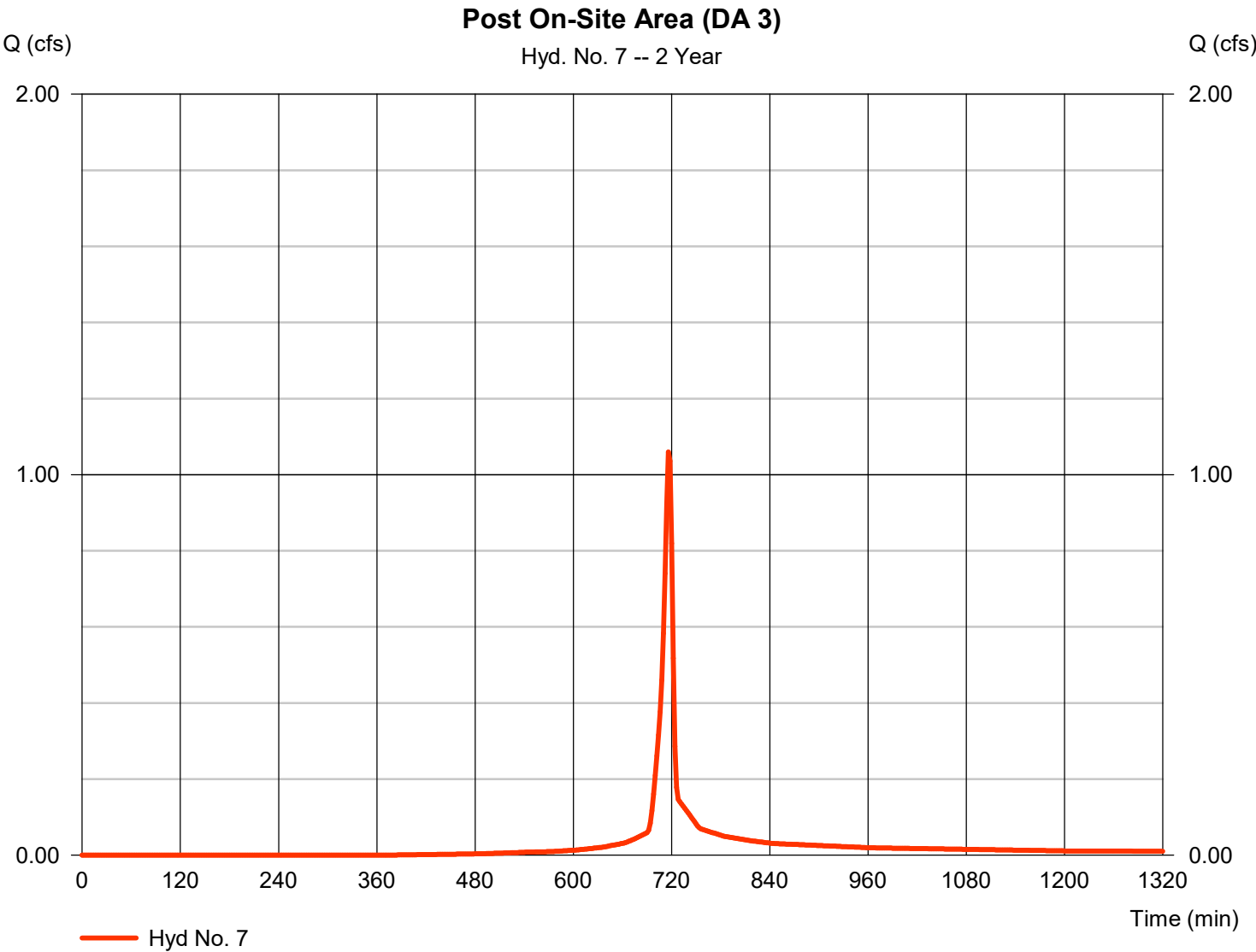
# Hydrograph Report

## Hyd. No. 7

Post On-Site Area (DA 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.060 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,180 cuft
Drainage area	= 0.270 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) = [(0.150 x 98) + (0.120 x 74)] / 0.270





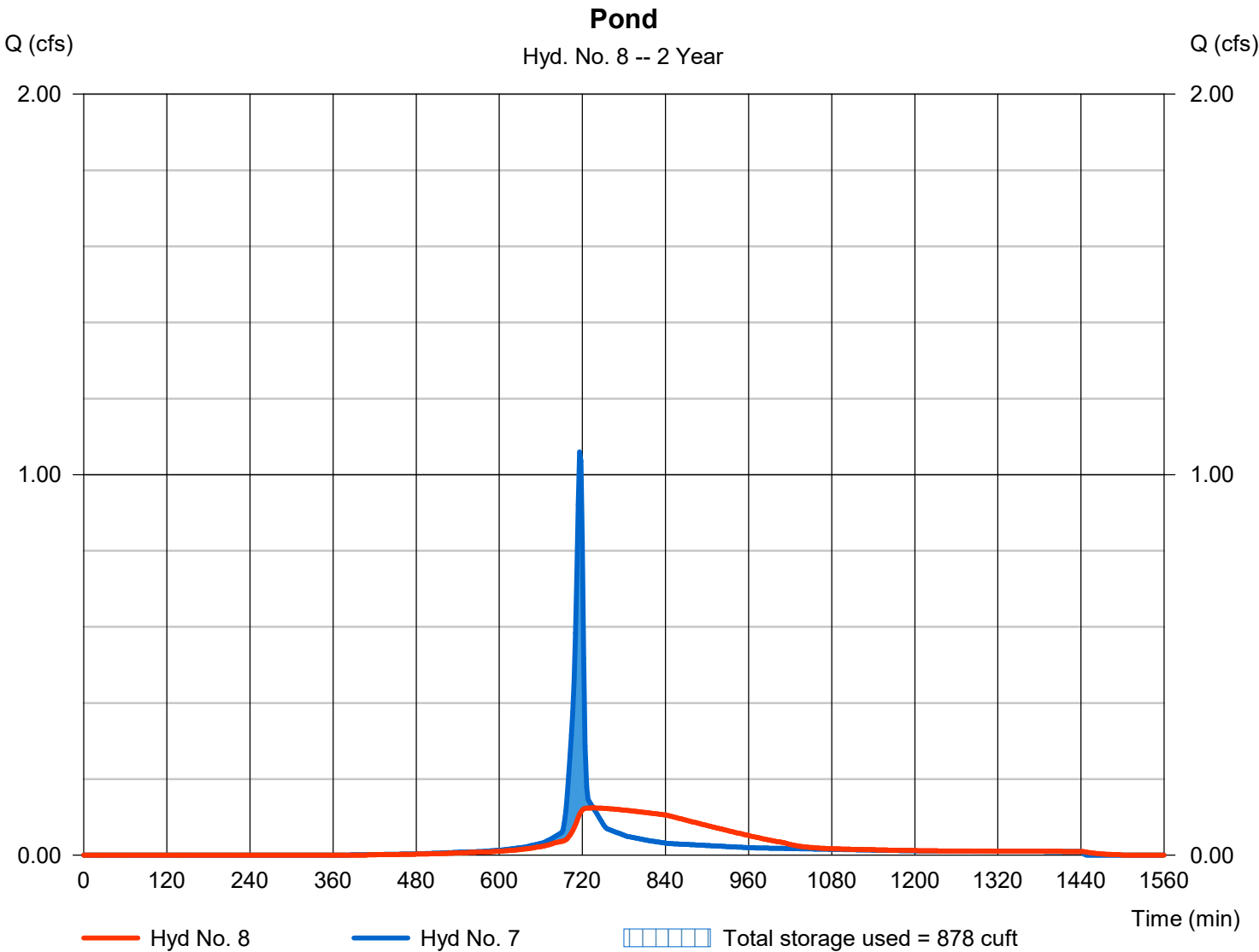
# Hydrograph Report

## Hyd. No. 8

Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.124 cfs
Storm frequency	= 2 yrs	Time to peak	= 736 min
Time interval	= 2 min	Hyd. volume	= 2,178 cuft
Inflow hyd. No.	= 7 - Post On-Site Area (DA 3)	Max. Elevation	= 982.40 ft
Reservoir name	= Pond	Max. Storage	= 878 cuft

Storage Indication method used.



Pond No. 3 - Pond

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Beginning Elevation = 981.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	981.00	286	0	0
1.00	982.00	694	490	490
2.00	983.00	1,261	978	1,468
3.00	984.00	1,261	1,261	2,729
4.00	985.00	1,261	1,261	3,990
5.00	986.00	1,261	1,261	5,251

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	2.00	6.00	0.00
Span (in)	= 12.00	2.00	6.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 980.60	980.65	982.75	0.00
Length (ft)	= 64.00	0.00	0.00	0.00
Slope (%)	= 7.80	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

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

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	981.00	0.00	0.00	0.00	---	---	---	---	---	---	---	0.000
0.10	49	981.10	0.65 ic	0.03 ic	0.00	---	---	---	---	---	---	---	0.033
0.20	98	981.20	0.65 ic	0.05 ic	0.00	---	---	---	---	---	---	---	0.047
0.30	147	981.30	0.65 ic	0.06 ic	0.00	---	---	---	---	---	---	---	0.058
0.40	196	981.40	0.65 ic	0.07 ic	0.00	---	---	---	---	---	---	---	0.066
0.50	245	981.50	0.65 ic	0.07 ic	0.00	---	---	---	---	---	---	---	0.074
0.60	294	981.60	0.65 ic	0.08 ic	0.00	---	---	---	---	---	---	---	0.081
0.70	343	981.70	0.65 ic	0.09 ic	0.00	---	---	---	---	---	---	---	0.088
0.80	392	981.80	0.65 ic	0.09 ic	0.00	---	---	---	---	---	---	---	0.094
0.90	441	981.90	0.65 ic	0.10 ic	0.00	---	---	---	---	---	---	---	0.100
1.00	490	982.00	0.65 ic	0.11 ic	0.00	---	---	---	---	---	---	---	0.105
1.10	588	982.10	0.65 ic	0.11 ic	0.00	---	---	---	---	---	---	---	0.110
1.20	686	982.20	0.65 ic	0.12 ic	0.00	---	---	---	---	---	---	---	0.115
1.30	783	982.30	0.65 ic	0.12 ic	0.00	---	---	---	---	---	---	---	0.120
1.40	881	982.40	0.65 ic	0.12 ic	0.00	---	---	---	---	---	---	---	0.124
1.50	979	982.50	0.65 ic	0.13 ic	0.00	---	---	---	---	---	---	---	0.129
1.60	1,077	982.60	0.65 ic	0.13 ic	0.00	---	---	---	---	---	---	---	0.133
1.70	1,174	982.70	0.65 ic	0.14 ic	0.00	---	---	---	---	---	---	---	0.137
1.80	1,272	982.80	0.65 ic	0.14 ic	0.01 ic	---	---	---	---	---	---	---	0.149
1.90	1,370	982.90	0.65 ic	0.14 ic	0.07 ic	---	---	---	---	---	---	---	0.210
2.00	1,468	983.00	0.65 ic	0.15 ic	0.17 ic	---	---	---	---	---	---	---	0.316
2.10	1,594	983.10	0.65 ic	0.15 ic	0.30 ic	---	---	---	---	---	---	---	0.451
2.20	1,720	983.20	0.65 ic	0.16 ic	0.43 ic	---	---	---	---	---	---	---	0.582
2.30	1,846	983.30	0.69 ic	0.16 ic	0.52 ic	---	---	---	---	---	---	---	0.677
2.40	1,972	983.40	0.76 ic	0.16 ic	0.60 ic	---	---	---	---	---	---	---	0.759
2.50	2,098	983.50	0.84 ic	0.16 ic	0.67 ic	---	---	---	---	---	---	---	0.832
2.60	2,224	983.60	0.91 ic	0.17 ic	0.73 ic	---	---	---	---	---	---	---	0.899
2.70	2,350	983.70	0.96 ic	0.17 ic	0.79 ic	---	---	---	---	---	---	---	0.960
2.80	2,476	983.80	1.02 ic	0.17 ic	0.85 ic	---	---	---	---	---	---	---	1.017
2.90	2,602	983.90	1.07 ic	0.17 ic	0.90 ic	---	---	---	---	---	---	---	1.071
3.00	2,729	984.00	1.13 ic	0.18 ic	0.95 ic	---	---	---	---	---	---	---	1.123
3.10	2,855	984.10	1.18 ic	0.18 ic	0.99 ic	---	---	---	---	---	---	---	1.171
3.20	2,981	984.20	1.22 ic	0.18 ic	1.04 ic	---	---	---	---	---	---	---	1.218
3.30	3,107	984.30	1.27 ic	0.19 ic	1.08 ic	---	---	---	---	---	---	---	1.263
3.40	3,233	984.40	1.32 ic	0.19 ic	1.12 ic	---	---	---	---	---	---	---	1.306
3.50	3,359	984.50	1.35 ic	0.19 ic	1.16 ic	---	---	---	---	---	---	---	1.348
3.60	3,485	984.60	1.41 ic	0.19 ic	1.20 ic	---	---	---	---	---	---	---	1.389

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Pond

**Stage / Storage / Discharge Table**

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
3.70	3,611	984.70	1.44 ic	0.20 ic	1.23 ic	---	---	---	---	---	---	---	1.428
3.80	3,737	984.80	1.47 ic	0.20 ic	1.27 ic	---	---	---	---	---	---	---	1.466
3.90	3,863	984.90	1.52 ic	0.20 ic	1.30 ic	---	---	---	---	---	---	---	1.503
4.00	3,990	985.00	1.55 ic	0.20 ic	1.34 ic	---	---	---	---	---	---	---	1.540
4.10	4,116	985.10	1.58 ic	0.21 ic	1.37 ic	---	---	---	---	---	---	---	1.575
4.20	4,242	985.20	1.61 ic	0.21 ic	1.40 ic	---	---	---	---	---	---	---	1.610
4.30	4,368	985.30	1.66 ic	0.21 ic	1.43 ic	---	---	---	---	---	---	---	1.644
4.40	4,494	985.40	1.69 ic	0.21 ic	1.46 ic	---	---	---	---	---	---	---	1.677
4.50	4,620	985.50	1.71 ic	0.22 ic	1.49 ic	---	---	---	---	---	---	---	1.710
4.60	4,746	985.60	1.74 ic	0.22 ic	1.52 ic	---	---	---	---	---	---	---	1.742
4.70	4,872	985.70	1.77 ic	0.22 ic	1.55 ic	---	---	---	---	---	---	---	1.773
4.80	4,998	985.80	1.82 ic	0.22 ic	1.58 ic	---	---	---	---	---	---	---	1.804
4.90	5,124	985.90	1.85 ic	0.22 ic	1.61 ic	---	---	---	---	---	---	---	1.834
5.00	5,251	986.00	1.87 ic	0.23 ic	1.64 ic	---	---	---	---	---	---	---	1.864

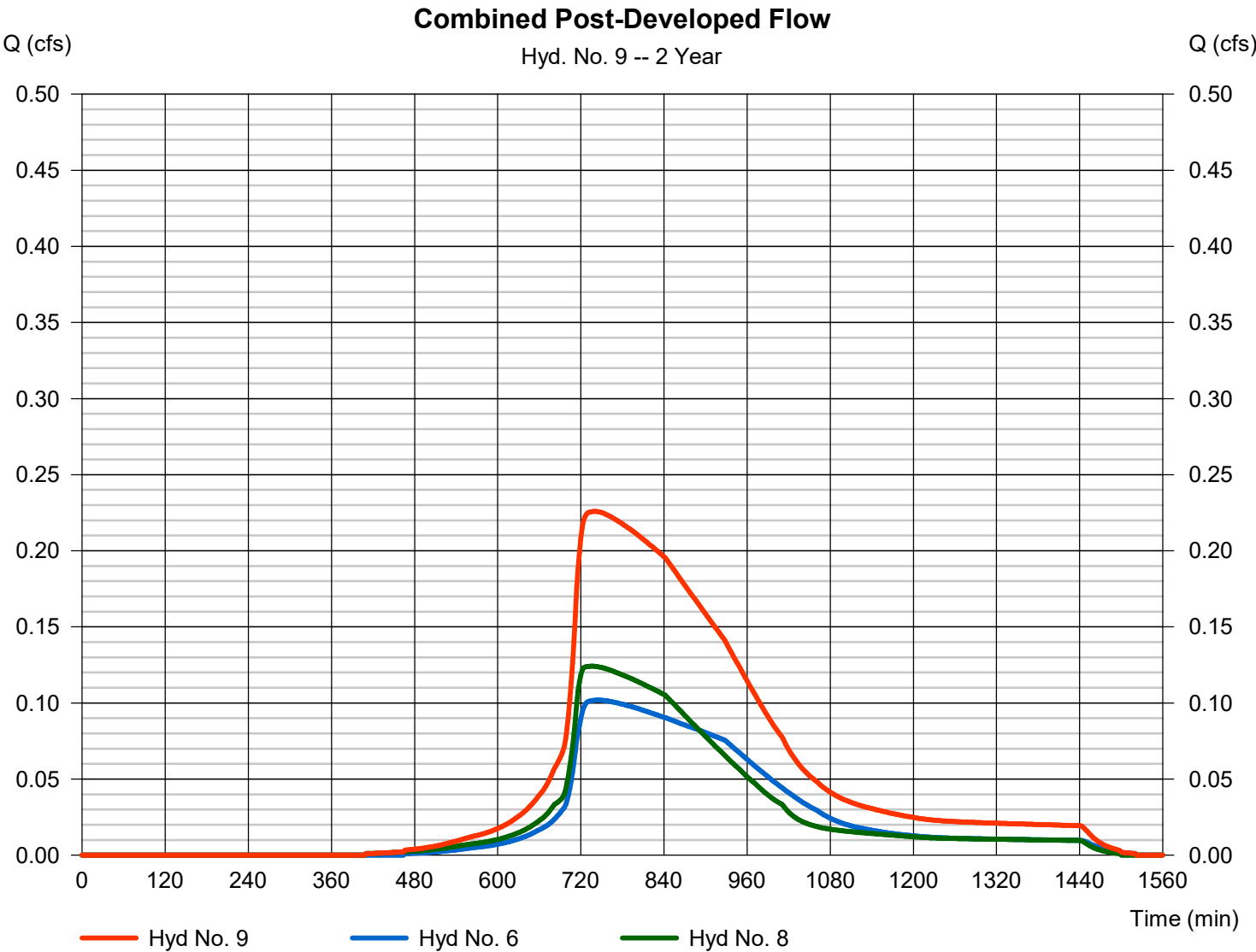
...End

# Hydrograph Report

## Hyd. No. 9

### Combined Post-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 0.226 cfs
Storm frequency	= 2 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 4,253 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	0.663	2	716	1,394	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	1.799	2	722	5,046	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	2.213	2	720	6,440	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	0.630	2	716	1,353	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	1.603	2	718	3,768	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.128	2	754	3,766	5	983.61	1,755	Underground Detention
7	SCS Runoff	1.824	2	716	3,861	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	0.413	2	724	3,860	7	983.07	1,558	Pond
9	Combine	0.534	2	724	7,625	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 10 Year			Monday, 12 / 16 / 2024	

# Hydrograph Report

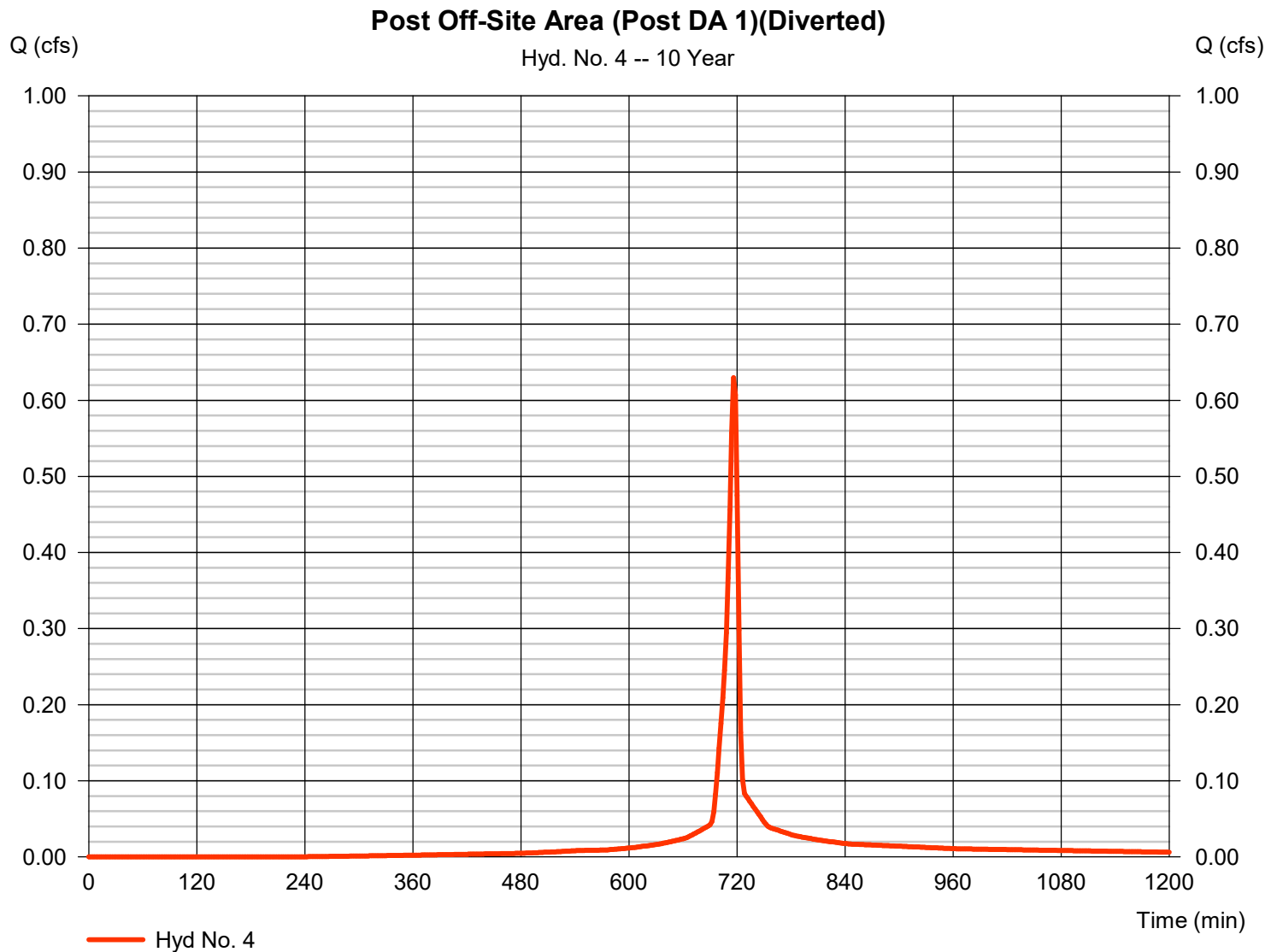
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Monday, 12 / 16 / 2024

## Hyd. No. 4

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

Hydrograph type	= SCS Runoff	Peak discharge	= 0.630 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,353 cuft
Drainage area	= 0.090 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

\* Composite (Area/CN) =  $[(0.052 \times 98) + (0.033 \times 74)] / 0.090$ 

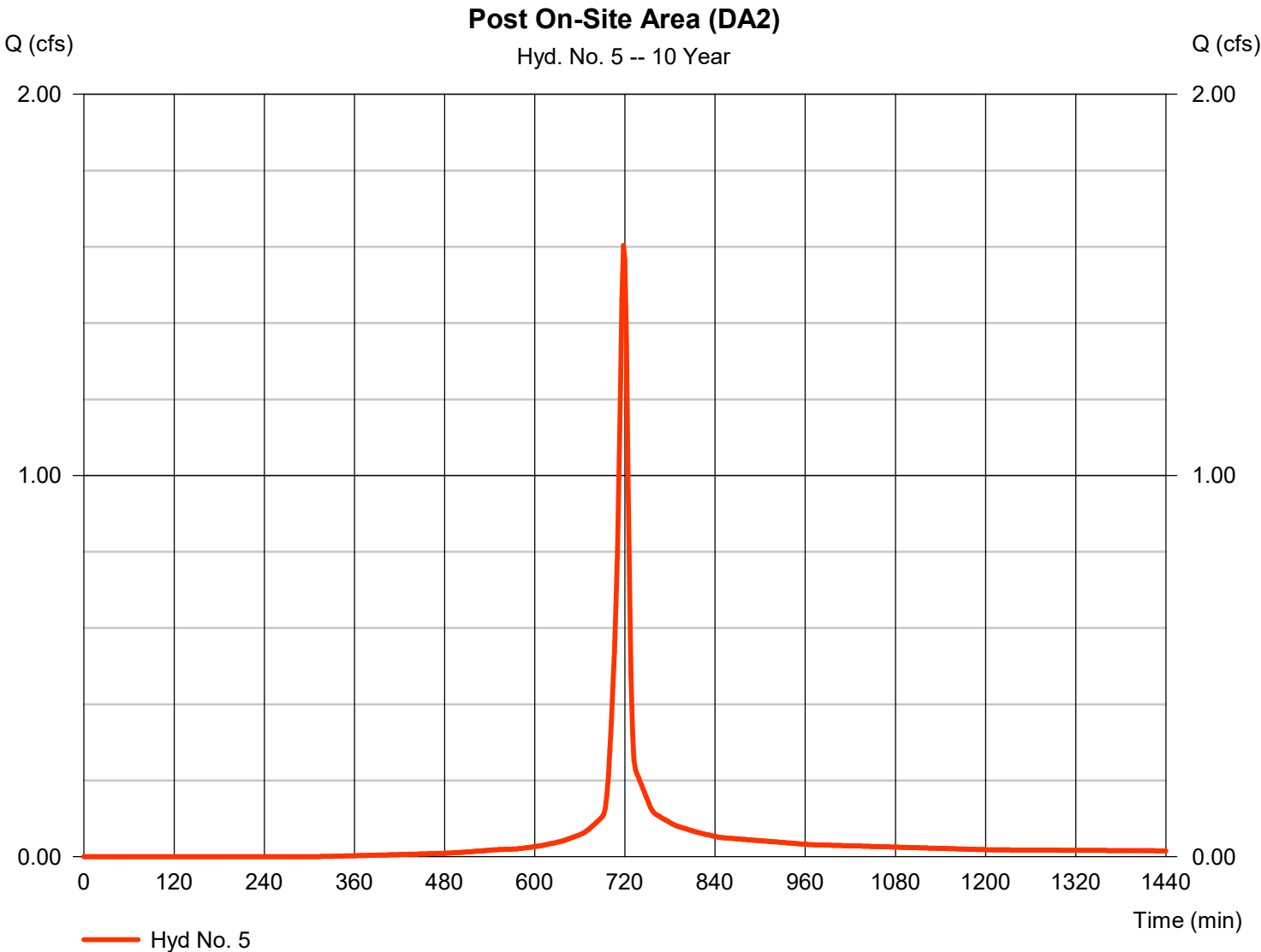
# Hydrograph Report

## Hyd. No. 5

Post On-Site Area (DA2)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.603 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	3,768 cuft
Drainage area	=	0.260 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.37 min
Total precip.	=	5.67 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

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



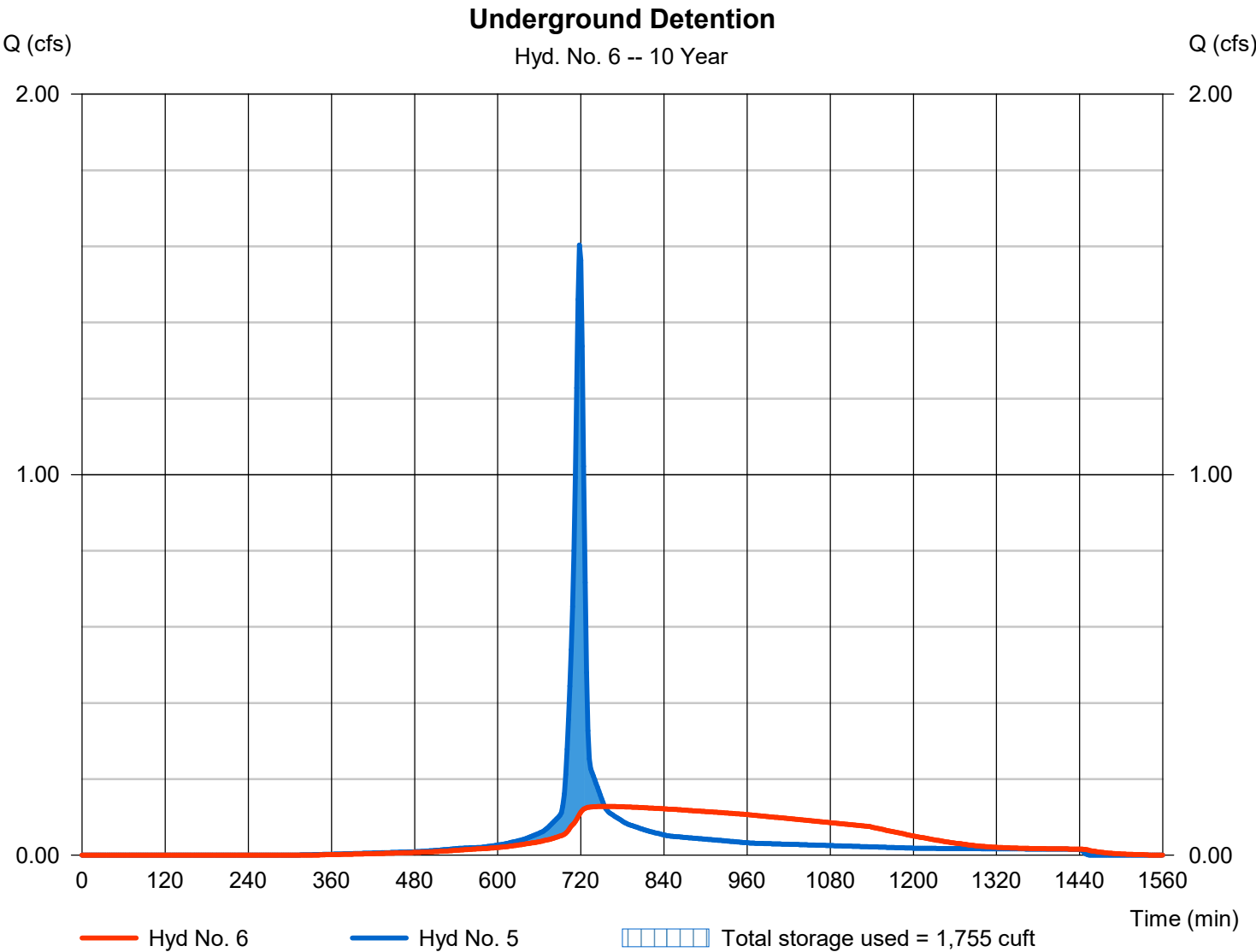
# Hydrograph Report

## Hyd. No. 6

### Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.128 cfs
Storm frequency	= 10 yrs	Time to peak	= 754 min
Time interval	= 2 min	Hyd. volume	= 3,766 cuft
Inflow hyd. No.	= 5 - Post On-Site Area (DA2)	Max. Elevation	= 983.61 ft
Reservoir name	= Underground Detention	Max. Storage	= 1,755 cuft

Storage Indication method used.





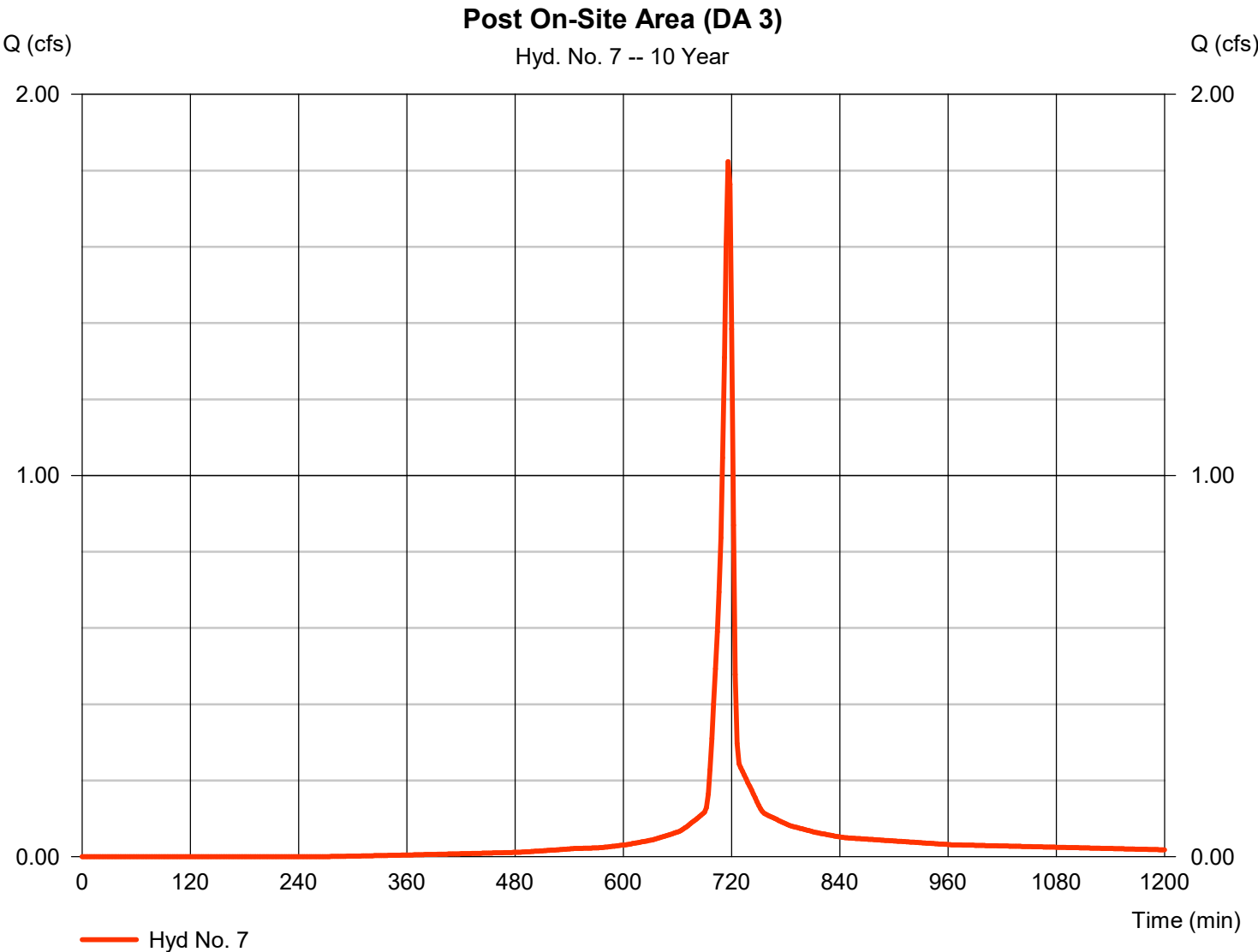
# Hydrograph Report

## Hyd. No. 7

Post On-Site Area (DA 3)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.824 cfs
Storm frequency	=	10 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	3,861 cuft
Drainage area	=	0.270 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.67 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.150 x 98) + (0.120 x 74)] / 0.270



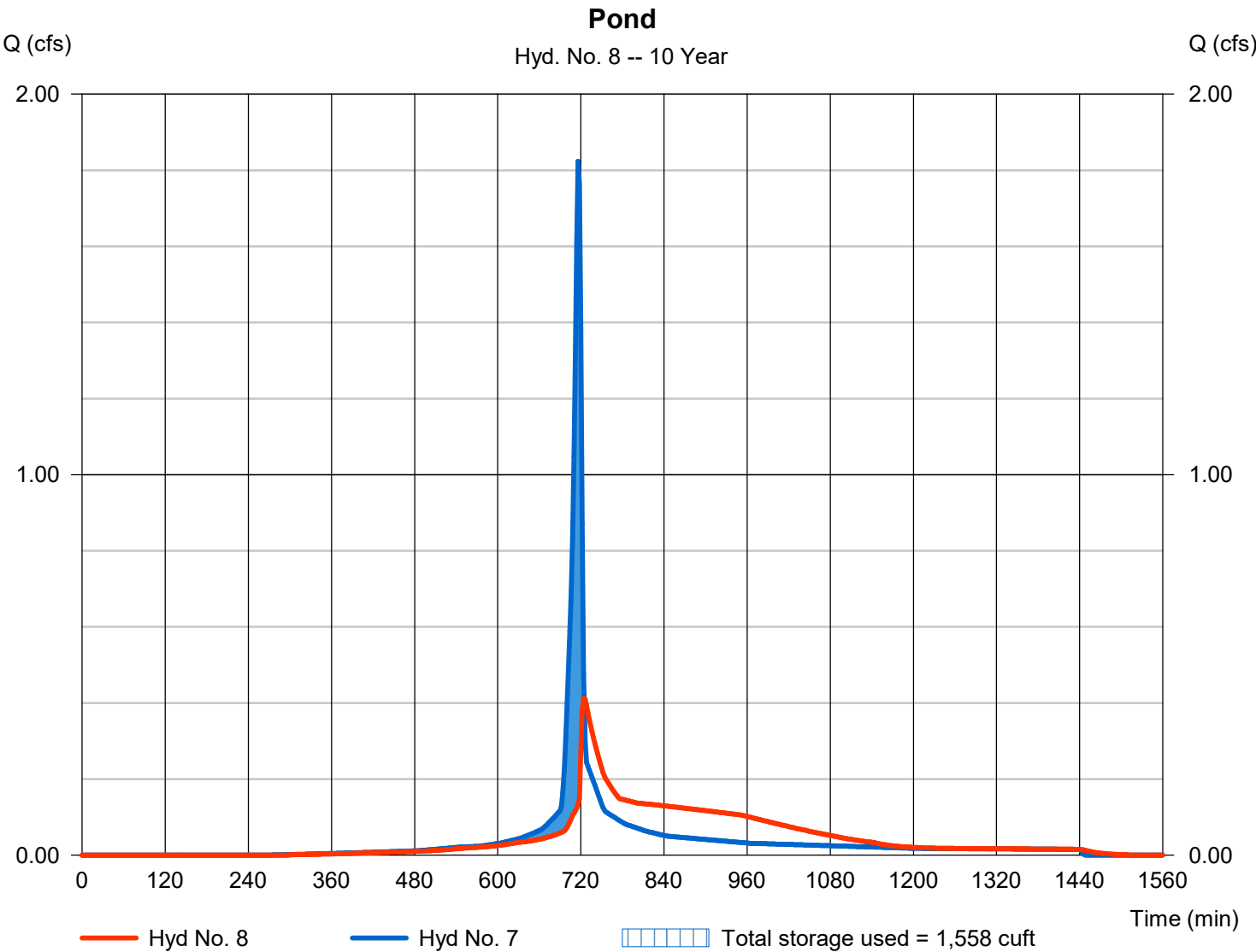
# Hydrograph Report

## Hyd. No. 8

Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.413 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 3,860 cuft
Inflow hyd. No.	= 7 - Post On-Site Area (DA 3)	Max. Elevation	= 983.07 ft
Reservoir name	= Pond	Max. Storage	= 1,558 cuft

Storage Indication method used.



# Hydrograph Report

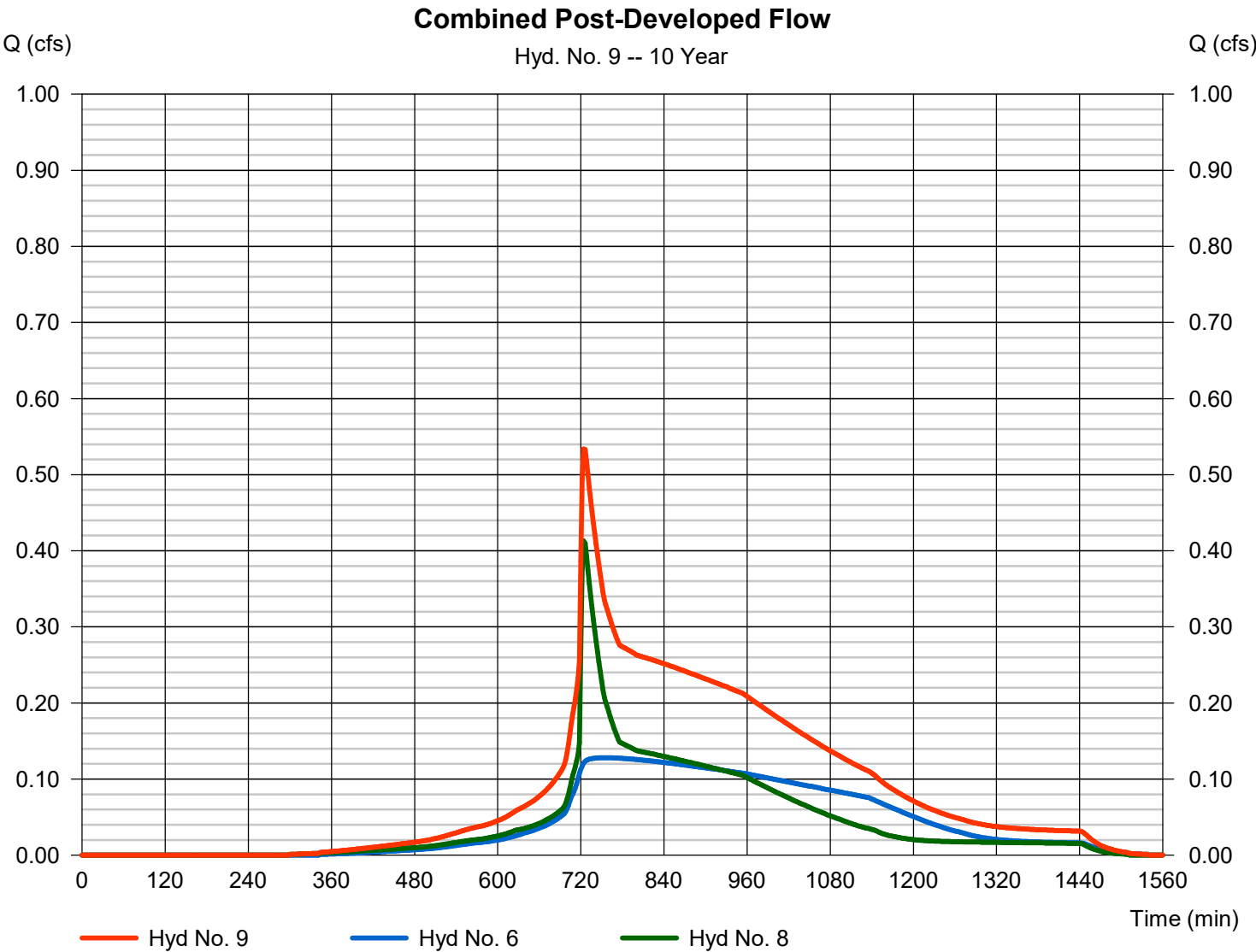
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Monday, 12 / 16 / 2024

## Hyd. No. 9

Combined Post-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 0.534 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 7,625 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	1.177	2	716	2,572	-----	-----	-----	Pre Off-Site Area (Pre DA 1)(Bypass
2	SCS Runoff	3.719	2	722	10,521	-----	-----	-----	Pre On-Site Area (DA 2)
3	Combine	4.461	2	720	13,093	1, 2	-----	-----	Combined Pre-Developed Flow
4	SCS Runoff	1.088	2	716	2,428	-----	-----	-----	Post Off-Site Area (Post DA 1)(Divert
5	SCS Runoff	2.885	2	718	7,016	-----	-----	-----	Post On-Site Area (DA2)
6	Reservoir	0.170	2	772	7,014	5	984.76	3,541	Underground Detention
7	SCS Runoff	3.208	2	716	7,057	-----	-----	-----	Post On-Site Area (DA 3)
8	Reservoir	1.080	2	724	7,056	7	983.92	2,623	Pond
9	Combine	1.237	2	724	14,070	6, 8	-----	-----	Combined Post-Developed Flow
Lees Summit Hydrographs_2024-12-09.gpw					Return Period: 100 Year			Monday, 12 / 16 / 2024	

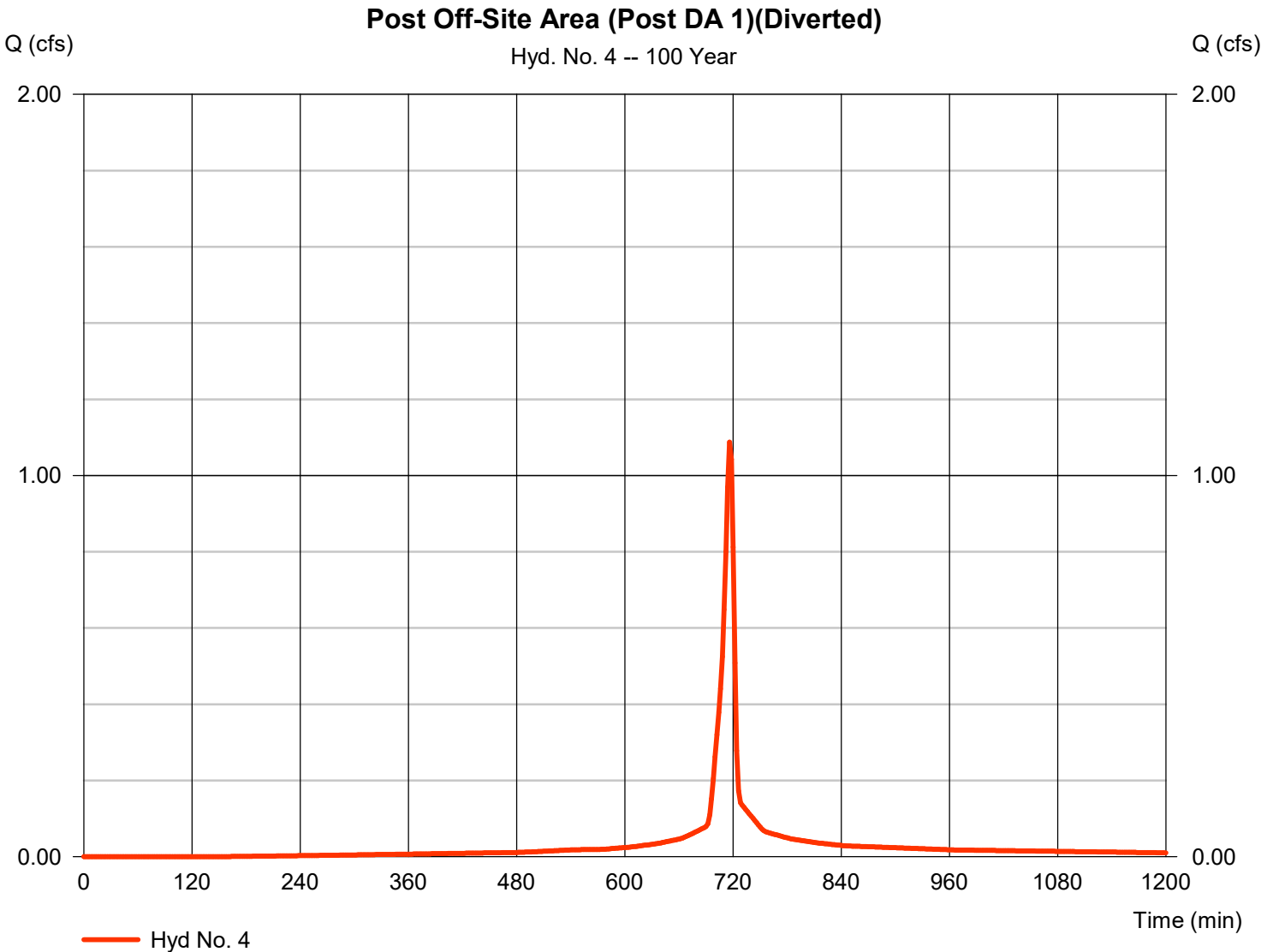
# Hydrograph Report

## Hyd. No. 4

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

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.088 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	2,428 cuft
Drainage area	=	0.090 ac	Curve number	=	89*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.052 x 98) + (0.033 x 74)] / 0.090



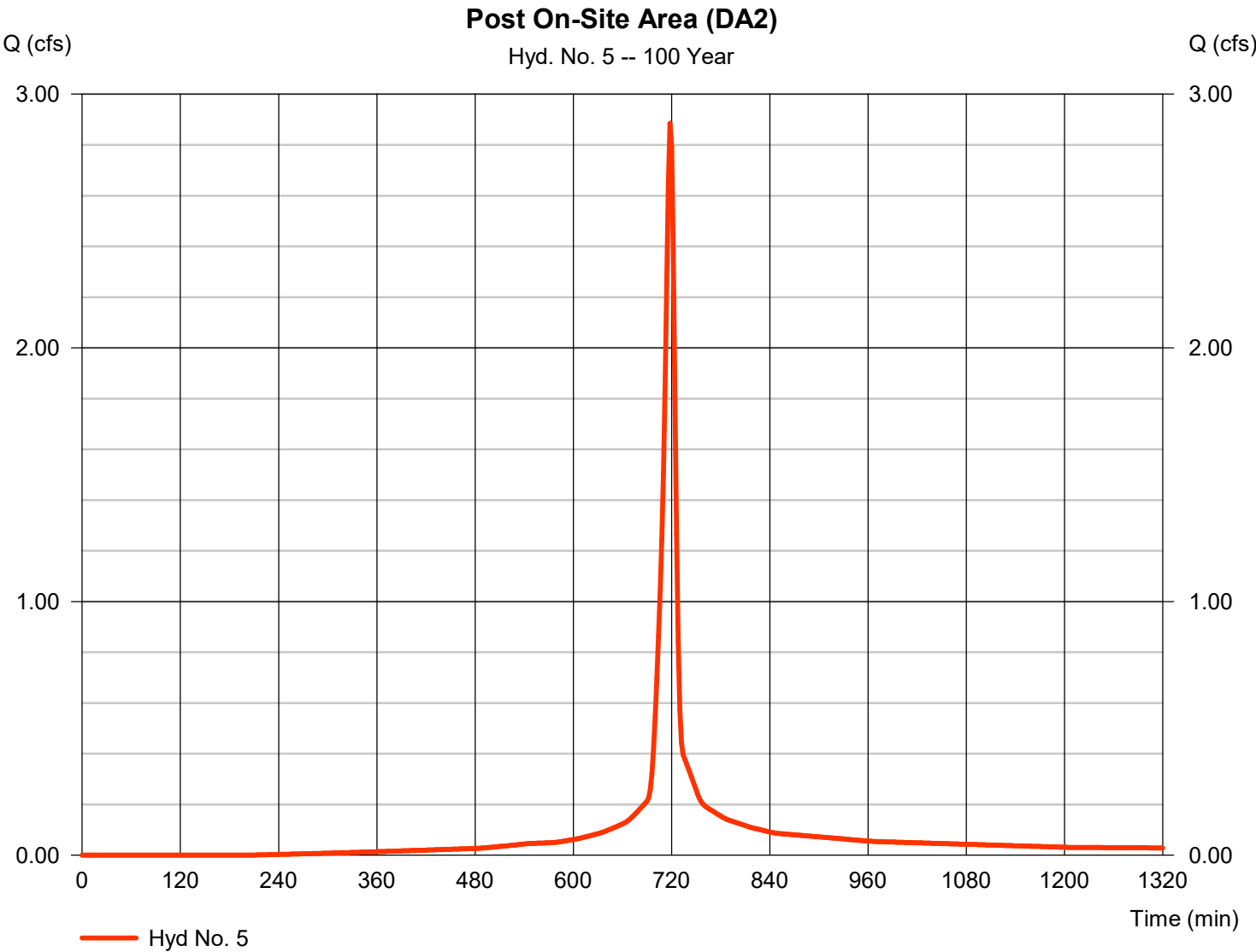
# Hydrograph Report

## Hyd. No. 5

Post On-Site Area (DA2)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.885 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	2 min	Hyd. volume	=	7,016 cuft
Drainage area	=	0.260 ac	Curve number	=	85*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.37 min
Total precip.	=	9.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

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



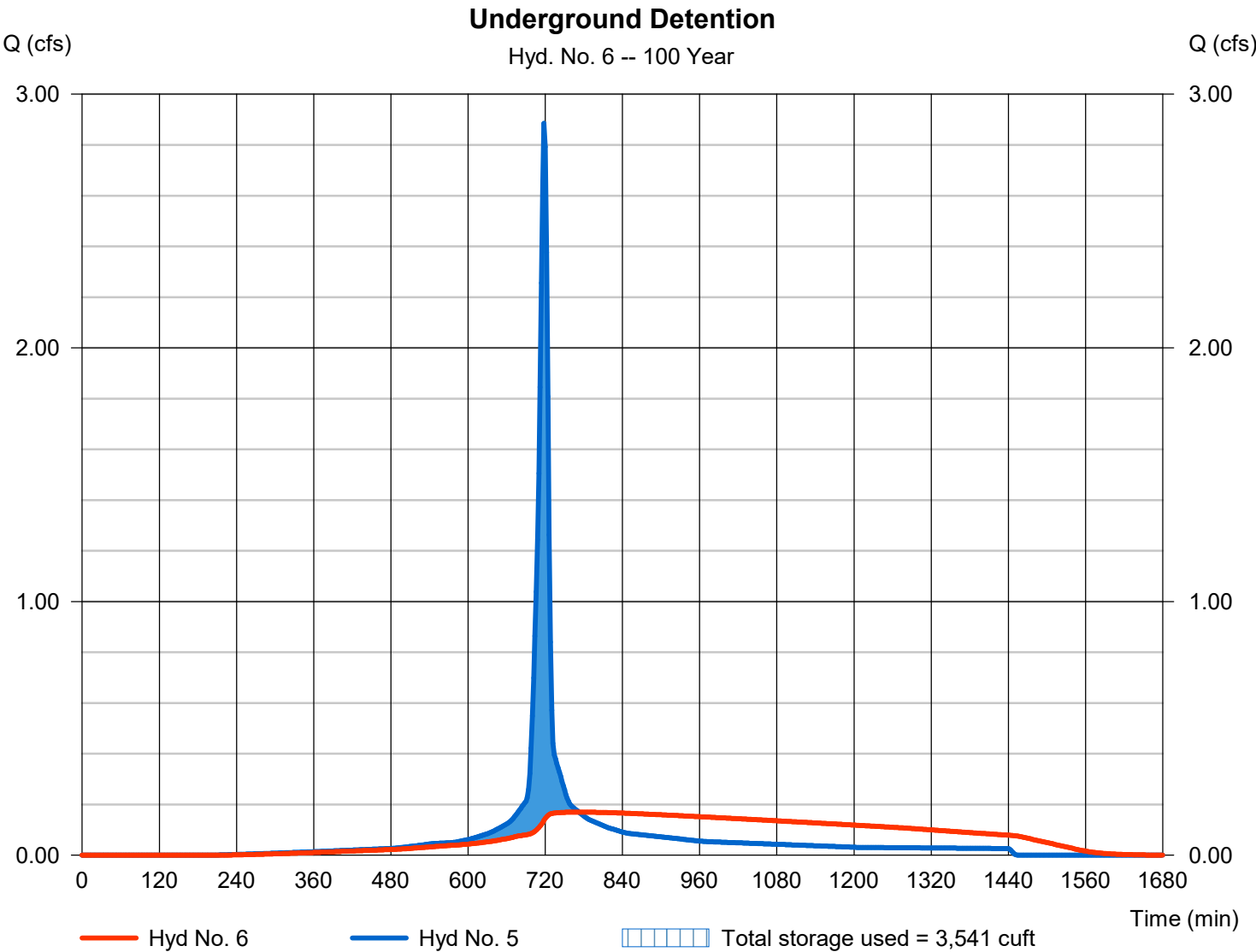
# Hydrograph Report

## Hyd. No. 6

### Underground Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.170 cfs
Storm frequency	= 100 yrs	Time to peak	= 772 min
Time interval	= 2 min	Hyd. volume	= 7,014 cuft
Inflow hyd. No.	= 5 - Post On-Site Area (DA2)	Max. Elevation	= 984.76 ft
Reservoir name	= Underground Detention	Max. Storage	= 3,541 cuft

Storage Indication method used.



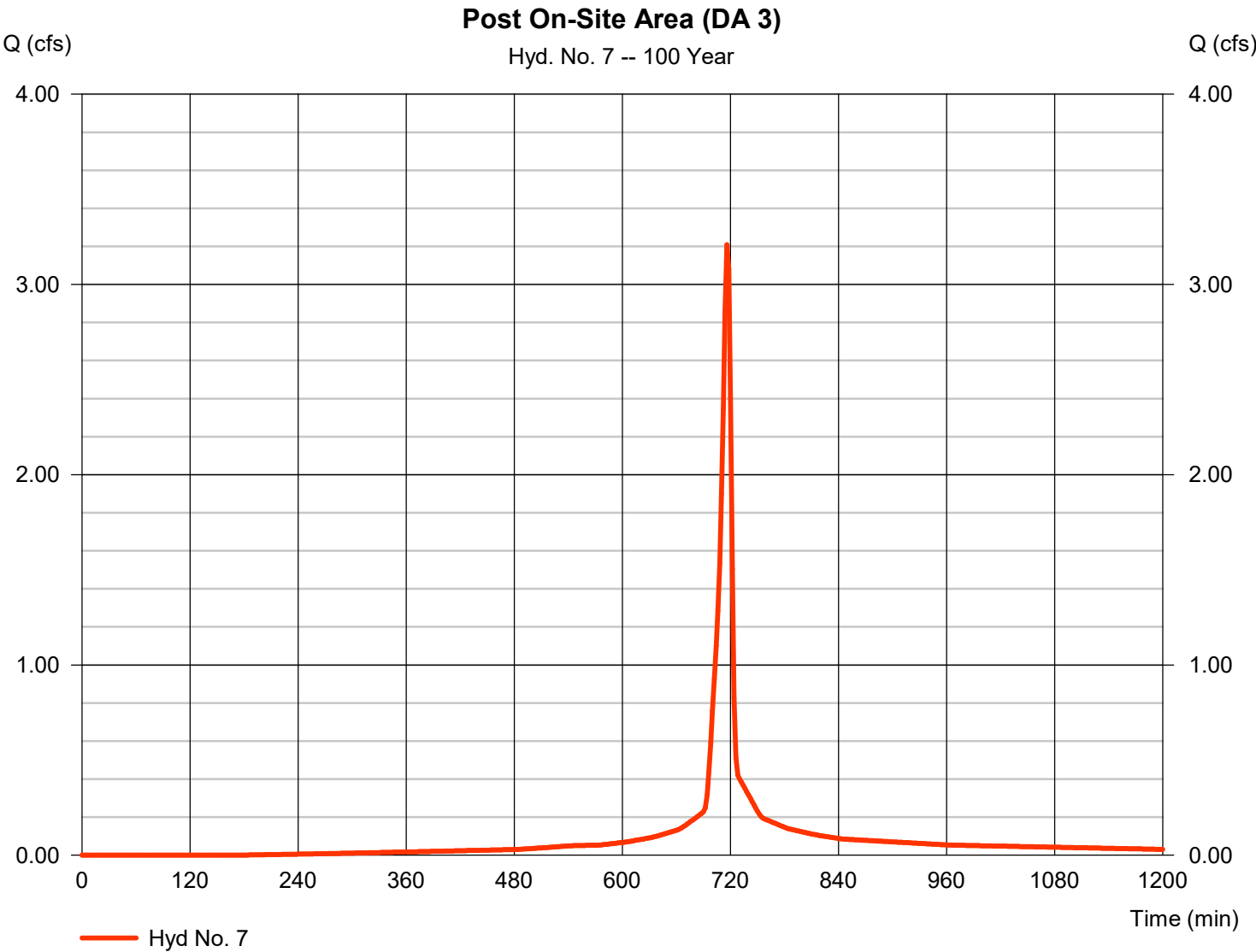
# Hydrograph Report

## Hyd. No. 7

Post On-Site Area (DA 3)

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.208 cfs
Storm frequency	=	100 yrs	Time to peak	=	716 min
Time interval	=	2 min	Hyd. volume	=	7,057 cuft
Drainage area	=	0.270 ac	Curve number	=	87*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	9.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

\* Composite (Area/CN) = [(0.150 x 98) + (0.120 x 74)] / 0.270





# Hydrograph Report

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

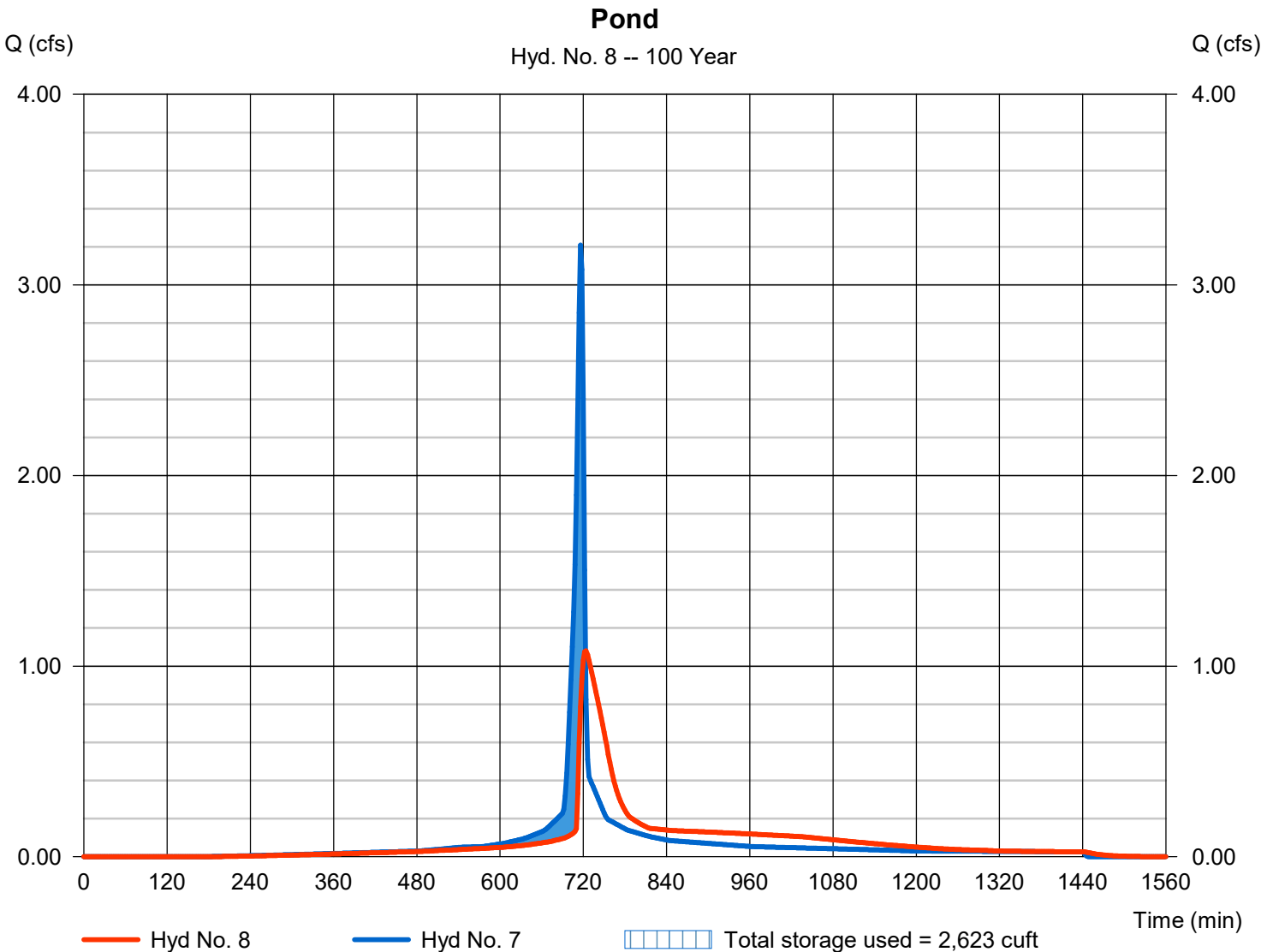
Monday, 12 / 16 / 2024

## Hyd. No. 8

Pond

Hydrograph type	= Reservoir	Peak discharge	= 1.080 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 7,056 cuft
Inflow hyd. No.	= 7 - Post On-Site Area (DA 3)	Max. Elevation	= 983.92 ft
Reservoir name	= Pond	Max. Storage	= 2,623 cuft

Storage Indication method used.

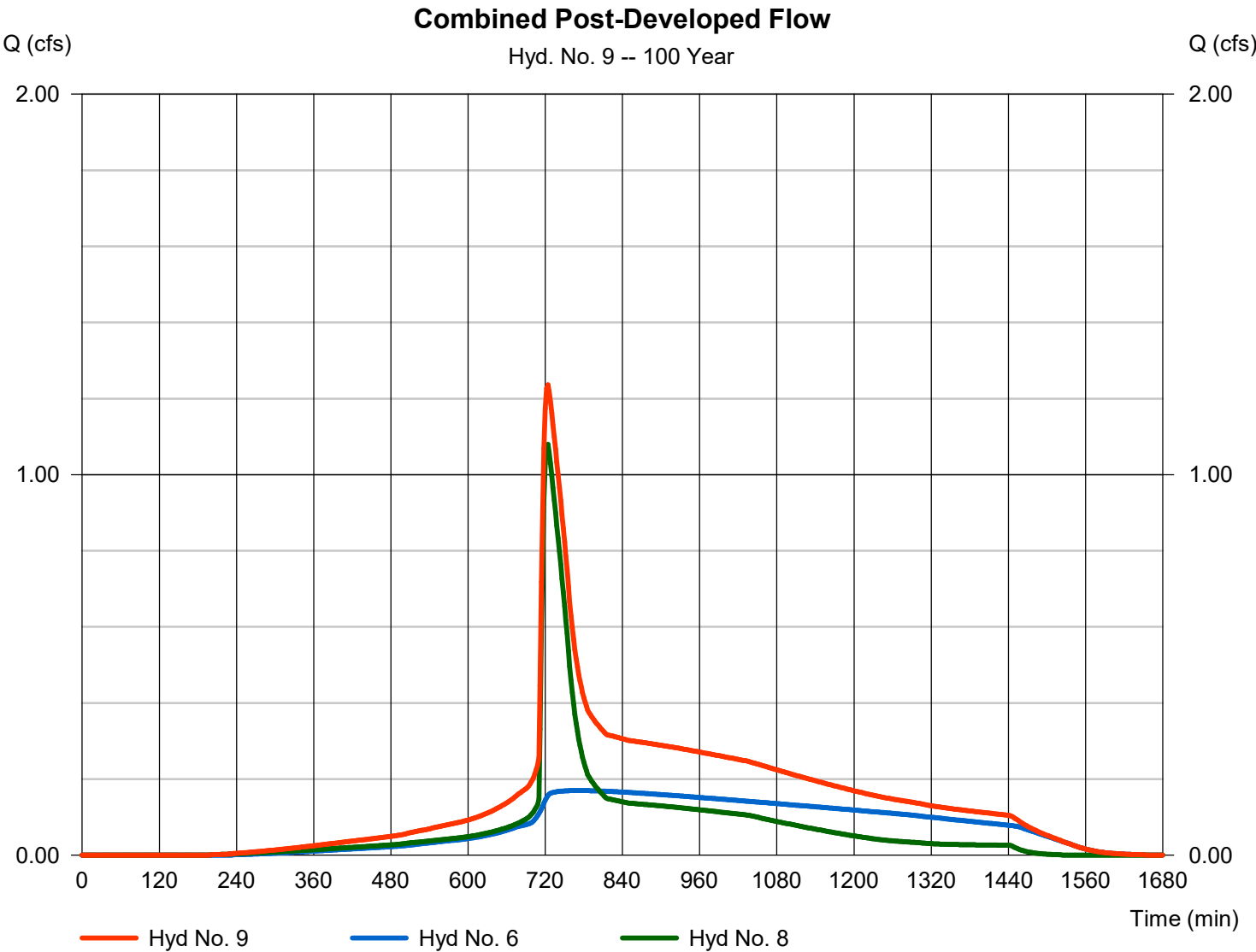


# Hydrograph Report

## Hyd. No. 9

Combined Post-Developed Flow

Hydrograph type	= Combine	Peak discharge	= 1.237 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 14,070 cuft
Inflow hyds.	= 6, 8	Contrib. drain. area	= 0.000 ac



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

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

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.

s\2022\22-218 Take 5 - Lee's Summit, MO - Todd Minnis\Design\Drainage\Lee's Summit Precipitation\_2024-04-17.pcp

[illegible]



$$I_{\text{pervious}} = 5,266.25 + 4,775.95 + 1,270.00 = 11,312.2 \text{ ft}^2$$

$$21,501.56 \text{ ft}^2 \Rightarrow I = 52.6\%$$

**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**  $WQV = P(R_v)(A/12) \rightarrow R_v = 0.05 + 0.009(I) \rightarrow I =$

Step 1) Tributary area to EDDB,  $A_T$  (ac)  $= 1.37[0.05 + 0.009(52.6)](0.49 \text{ ac}/12 \text{ in-ft})$   $A_T$  (ac) = 0.49 ac

Step 2) Calculate WQv using methodology in Section 6  $\therefore WQV = 0.029 \text{ ac-ft} = 1,263.2 \text{ ft}^3$   $WQV$  (ac-ft) = 0.029 ac-ft

Step 3) Add 20 percent to account for silt and sediment deposition in the basin  $V_{\text{design}}$  (ac-ft) = 0.034 ac-ft  $\rightarrow 1,481.03 \text{ ft}^3$

**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)  $Z_{WQ}$  (ft) = 2.94 ft

Step 2) Average head of water quality volume over invert of orifice,  $H_{WQ}$  (ft)  
 $H_{WQ} = 0.5 * Z_{WQ}$   $H_{WQ} = 0.5(2.94 \text{ ft}) \Rightarrow H_{WQ} = 1.47 \text{ ft}$   $H_{WQ}$  (ft) = 1.47 ft

Step 3) Average water quality outflow rate,  $Q_{WQ}$  (cfs)  $Q_{WQ} = \frac{0.029 \text{ ac-ft} (43,560 \text{ ft}^2)}{40(3,600)} = 0.008$   $Q_{WQ}$  (cfs) = 0.008 cfs

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

Step 5) Water quality outlet orifice diameter (minimum of 4 inches),  $D_o$  (in)  $D_o = 12(2) \left[ \frac{0.008}{0.66(\pi)[2(32.2)(1.47)]^{0.5}} \right]^{0.5}$   $C_o = 0.66$   
 $D_o = 12 * 2 * (Q_{WQ} / (C_o * \pi * (2 * g * H)^{0.5}))^{0.5}$   $D_o$  (in) = 4 in  
(if orifice diameter  $<$  4 inches, use outlet type 2 or 3)

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>)  
 $A_o = (WQV) / (0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} * 0.10)$   $A_o$  (in<sup>2</sup>) = \_\_\_\_\_

Step 3) Circular perforation diameter per row assuming a single column,  $C_1$  (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),  $C_{\text{perf}}$  (in)  $D_{\text{perf}}$  (in) = \_\_\_\_\_

Step 6) Horizontal perforation column spacing when  $n_c > 1$ , center to center,  $S_c$   
If  $D_{\text{perf}} \geq 1.0$  inch,  $S_c = 4$   $S_c$  (in) = \_\_\_\_\_

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



# 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
Pasture (Fair)	C	79	0.49	
Totals:			0.49	38.71

Area-Weighted CN = total product/total area =

**79** (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	0.26	25.48
Open Space (Grass)	C	74	0.23	17.02
Totals:			0.49	42.50

<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 =

**87** (Round to integer)

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

Predevelopment CN: **79**  
Postdevelopment CN: **87**  
Difference: **8**  
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
Extended Dry Detention	0.49	4	1.96
<b>Total<sup>2</sup>:</b>	0.49	<b>Total:</b>	1.96

**\*Weighted VR:** **4** = 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.

Cover/BMP Description	Treatment Area	VR from Table 4.4 or 4.6 <sup>1</sup>	Product of VR x Area
Catch Basin Inlet	0.49	5	2.45
<b>Total<sup>2</sup>:</b>	0.49	<b>Total:</b>	2.45

**\*Weighted VR:** **5** = 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 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 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
					Native grass, shrubs and forbs (formal plantings)	56	70	77
Brush-weeds-grass	Fair	56	70	77	Native grass, shrubs and forbs (informal plantings)	48	65	73
Brush-weeds-grass	Good	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
<b>No VR, Credit for Post Construction CN Reduction, See Design Section</b>						See Design

**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**

Cover Type or BMP	VR 1 (First BMP in Series)		VR 2 (Second BMP in Series)											Overall Value Rating	VR <sub>Composite</sub>
	Overall Value Rating	VR 1	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2	VR 2		
Native Vegetation	N/A	9.25													
Rain Garden	< 10	9.0													
Infiltration Practices	< 10	9.0													
Bioretention	< 10	8.5													
Pervious or Porous Pavement	10-20	7.5													
Extended Detention Wetland	< 10	7.0													
Media Filtration Practices	< 10	6.0													
Extended Wet Detention	10-20	5.0													
Vegetated Filter Strip	10-20	5.0													
Native Vegetation Swale	10-20	4.0													
Extended Dry Detention Basin	50-100 <sup>(a)</sup>	4.0													
Other Systems	10-100	3.0-5.0													

**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

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- Do not locate EDDBs on fill sites or on or near steep slopes if it is expected that much of the water will exit through the bottom of the facility, unless the bottom of the facility is modified to prevent excessive infiltration (Metropolitan Nashville – Davidson County, 2000).
  - Energy dissipation shall be included in the inlet design to reduce resuspension of accumulated sediment (California Stormwater Quality Association, 2003).
  - Erosion protection shall be placed at the facility's outfall. Energy dissipation may be required to reduce flow velocities from the primary spillway to nonerosive values (California Stormwater Quality Association, 2003).
  - A maintenance ramp and perimeter access shall be included in the design to facilitate access to the basin for maintenance activities (California Stormwater Quality Association, 2003).
  - When desirable and feasible, EDDBs shall be incorporated within a larger flood control basin or as a part of a full-spectrum detention facility. See APWA 5600 for design specifications if flood control is to be incorporated into the design of the EDDB. Also, whenever possible, designers should try to accommodate within the basin other urban uses such as passive recreation and wildlife habitat (Urban Drainage and Flood Control District, Denver, Colorado, 2005).
  - EDDBs that do not provide flood storage for the 1 percent storm shall be designed so that runoff flows from the 1 percent event safely pass through the facility. At a minimum, all facility embankments shall be protected from failure during the 1 percent event. An emergency spillway, which conveys large flood flows safely past earth embankments, must be provided for each dam unless the principal spillway is large enough to pass the peak flow expected from the 1 percent design storm without overtopping the dam (Natural Resources Conservation Service – Maryland, 2000).
  - The EDDB bottom should be 1 to 2 feet above the wet season groundwater table, as groundwater may surface within the basin or contribute baseflow to the basin (Urban Drainage and Flood Control District, Denver, Colorado, 2005). This also allows for some infiltration.
  - Outflow structures shall be protected by well screen, trash racks, grates, stone filters, or other approved devices to ensure that the outlet works will remain functional (Kansas City Metropolitan Chapter of the American Public Works Administration, 2006). No single outlet orifice shall be less than 4 inches in diameter (smaller orifices are more susceptible to clogging). If the calculated orifice diameter necessary to achieve a 40-hour drawdown is less than 4 inches, a perforated riser, orifice plate, or v-notch weir shall be used instead of a single orifice outlet. Keep perforations larger than 1 inch when using orifice plates or perforated risers. Smaller orifice sizes may be used if the weir plate is placed in a riser manhole in a sump-like condition.
  - Public safety shall be considered in EDDB design. Fences and landscaping can be used to impede access to the facility. The facility shall be contoured so as to eliminate any dropoffs or other hazards. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter shall be fenced (California Stormwater Quality Association, 2003).
  - Facilities that receive stormwater from contributing areas that have potential for oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility (Metropolitan Nashville – Davidson County, 2000).

#### **8.10.6 Maintenance and Inspections**

Extended dry detention basins (EDDB) provide stormwater volume control and may integrate water quality treatment through the use of deep-rooted native plantings. Native vegetation installed at least to the water quality event (WQv) storage elevation provides optimal function for the basin. The use of native vegetation also greatly improves stormwater infiltration into the soil, removes nutrients and trash from the contributing drainage area, and does not require the fertilizer or herbicides of turf-type plantings. Native vegetation provides exceptional erosion control and stabilization for EDDBs, but also needs intensive initial establishment activities and routine long-term maintenance to

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achieve optimal performance. Additionally, the flood control benefits of EDDBs are vulnerable to structural compromise by woody vegetation encroachment and animal burrowing that can cause leaks and dam failure.

Primary maintenance in EDDBs is related to maintaining dry conditions, repairing erosion, and managing vegetation. EDDB structures handle sporadic, intense runoff events, and are vulnerable to erosion on the side slopes and the flow line of the basin. Preserving design elevations through routine maintenance to forebays, swales, other pretreatment structures, and the contributing drainage area is critical to avoiding costly dredging. The side slopes shall conform as closely as possible to regraded or natural land contours, and shall not exceed 4:1 (H:V). Slopes showing excessive erosion may require erosion control and safety measures (Kansas City Metropolitan Chapter of the American Public Works Administration, 2006).

Routine inspection to ensure outlets are functioning properly prevents standing water issues. If a v-notch weir or orifice plate is used to control flow, weekly inspections may be required to ensure the opening is clear of vegetation, trash, or other debris. Blocked outlet structures create standing water that can kill desired vegetation, encourage undesirable weed growth, and damage trash racks or other outlet structures. Inspect for evidence of muskrats, beavers, and other animals that can severely degrade the function of the basin. Additionally, routine inspection of the outfall of the basin into a stream or subsequent stormwater facility to identify erosion and prevent any head-cutting will avoid degradation and costly repair to the basin.

Dense, well-established stands of desirable native vegetation in an EDDB can preclude weed infestation by occupying the root space and canopy sunlight. A combination of grasses and flowers reduces peak flows and provides year long visual interest, so maintenance activities must be targeted to foster continuity in this diversity over time. This can be established through regular flail-type mowing, removal of undesirable species, and spot treatment of noxious or woody vegetation. String trimming to prevent disturbance from mowing equipment on saturated soils is strongly recommended. Prescribed burning is an efficient and effective tool for managing native vegetation in EDDBs; however, if that option is not available, annual mowing may be followed up with tilling of small, select areas for overseeding with flowers, as grasses will come to dominate the seeding over time in the absence of prescribed burning. A diverse mix of native vegetation can provide valuable habitat for birds, and maintenance activities may be scheduled around primary nesting seasons.

TABLE 8.12 Extended Dry Detention Basin Typical Maintenance Activities		
Activity		Frequency
<b>Establishment (1-3yrs)</b>		
	Watering plants <i>(seeded areas up to 8 weeks, plugs in drought)</i>	1" per week as needed
	Weed control <i>(flail mow, string-trim, selective/preemerg herbicides)</i>	Monthly
	Remove litter and debris <i>(trash, leaves, sand, mower discharge)</i>	Monthly
	Monitor & repair erosion <i>(stabilize soil, replace plants, secure edging)</i>	Monthly
	Check for standing water <i>(longer than design, any puddles, saturated soil)</i>	Monthly
	Add mulch <i>(moisture &amp; weed control with plugs/containers, 3" or less)</i>	Annually
	Inspect drainage area <i>(parking lot sweeping, open dumpsters, etc)</i>	Annually
	Replace dead plants <i>(use design species/size: overseed, install deep cell plugs)</i>	Annually, as needed
<b>Maintenance (3+yrs, establishment activities may carry over, as needed)</b>		
	Vegetation cleanup <i>(spot treat, prescribed burn, prune)</i>	Annually, spring or fall
	Evaluate plant composition <i>(woody invasion, grass/flower ratio, "right plant right place")</i>	Annually
	Sediment removal, erosion control <i>(pretreatment structures: forebay, check dams)</i>	Annually
	Address animal damage <i>(beaver dams, muskrat burrows, deer rubs)</i>	Annually
	Verify structural component function <i>(v-notch weir, check dams, outlet protection )</i>	Annually
<b>Extended Dry Detention Basin</b>		
	String trim vegetation to minimize disturbance	Annually
	Inspect for erosion in flow lines and slopes	Annually

*Typical maintenance activities are outlined to provide a basis for scheduling and planning work but should not be considered wholly comprehensive or definitive. Activities and frequencies will vary depending on site conditions and expectations related to adjacent land use. Some activities shown may continue through the establishment and maintenance phases. It's important to use adaptive management based on the goals of the practice and to integrate evaluation and assessment into a long-term maintenance plan.*



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#### 8.10.6.1 *Sediment Removal*

Some sediment may contain contaminants of which the Kansas Department of Health and Environment (KDHE) or Missouri Department of Natural Resources (MDNR) requires special disposal procedures. If there is any uncertainty about what the sediment contains or it is known to contain contaminants, then KDHE or MDNR should be consulted and their disposal recommendations followed. Sampling and testing shall be performed on sediments accumulated in facilities serving industrial, manufacturing or heavy commercial sites, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants (other than “clean” soil) are suspected to accumulate and be conveyed via stormwater runoff (Metropolitan Nashville – Davidson County, 2000).

Some sediment collected may be innocuous (free of pollutants other than “clean” soil) and can be used as fill material, cover, or land spreading. It is important that this material not be placed in a way that will promote or allow resuspension in stormwater runoff. The sediment shall not be placed within the high water level area of the EDDB, other BMP, creek, waterway, buffer, runoff conveyance device, or other infrastructure. Some demolition or sanitary landfill operators will allow the sediment to be disposed at their facility for use as cover. This generally requires that the sediment be tested to ensure that it is innocuous (Metropolitan Nashville – Davidson County, 2000).

- Remove sediment when accumulation reaches 6 inches, or if resuspension is observed or probable. Sediment may be permitted to accumulate deeper than 6 inches if there is a permanent marker indicating the depth where sediment needs to be removed and that mark has not been met (Metropolitan Nashville – Davidson County, 2000).
- Remove sediments if they are within 18 inches of an orifice plate (Metropolitan Nashville – Davidson County, 2000).