

BOGIA ENGINEERING INC.

1340 Penn Avenue

Wyomissing, PA 19160

Phone: 610.678.3071

Fax: 610.678.3517

www.bogiaeng.com

New

EXISTING LOW LAND ANALYSIS

EASTON COMMERCE PARK

JAN 31 2025

FOR EASTON WOOD AVE PROPCO, LLC

CITY OF EASTON, PLAMER TOWNSHIP, AND WILSON BOROUGH

NORTHAMPTON COUNTY

PENNSYLVANIA

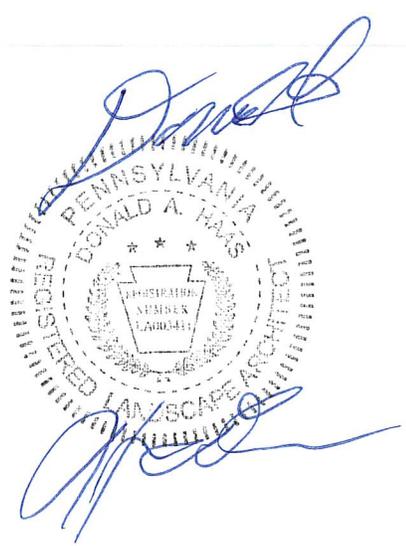
Prepared by: Ali Behbahani, Ph.D., EIT

Donald Haas, RLA

Date: September 2024

Revised: January, 2025

Project: 2022-528



Project Description

EASTON WOOD AVE PROPCO, LLC is proposing to construct an industrial building on the existing tract located in City of Easton/Palmer Township/Wilson Borough, Northampton County, Pennsylvania. The existing tract is located in three municipalities of City of Easton, Palmer Township, and Wilson Borough, and is bound by Bushkill Creek and Bushkill Drive at the north, Bushkill Creek on the east, adjacent properties to the West, and Hackett Avenue and Route 22 on the south. The proposed improvements include construction of a warehouse building and supporting office area, access drives off of Hackett Avenue, truck loading areas, parking lots, storm sewer system and stormwater Best Management Practice (BMP) facilities. The improvements propose a total of around 81 acres of land disturbance that includes 23.11 acres of building.

The site presently consists of developed portions with access driveways and buildings as well as and undeveloped portions with meadow, wooded and cultivated cover conditions. The site drains in an eastern direction and discharges from the site via Bushkill Creek. After construction of the proposed improvements, the majority of the storm runoff will be directed into proposed managed release concept (MRC) BMPs. The main reason for choosing MRC BMPs was contamination of the existing media that would adversely impact groundwater in case infiltration-based BMPs were employed. Roof runoff from the proposed building will be collected by the proposed roof drain system and conveyed directly to the MRC BMPs. Bogia Engineering, Inc. plans show the existing and proposed contours, soils information, the proposed utility and storm sewer systems, drainage areas and construction details. The discharge from the MRC BMPs would be released on the land adjacent to the receiving water course and its tributaries. The main receiving water course is Bushkill Creek that is and impaired stream, categorized as HQ, CWF per chapter 93 classification. Individual NPDES permit would be applied for due to the characteristics of the receiving water course and the size of proposed project.

Per LVPC, we studied the existing low land areas (i.e., depressions) to analyze if they can significantly impact the pre-development stormwater modeling by absorbing notable amount of existing hydrographs. To do so, the closed contours were identified and the ones that were elevated ones were not studied, while the low land ones that created topographic depressions were separately modeled. The depressions are part of larger drainage areas in the existing condition hydrograph modeling because the depressions are smaller than being capable of storing notable amount of the hydrographs, therefore, they quickly are filled up, and overflow into the larger drainage areas that were delineated in the project existing condition modeling. This analysis presents the results from depression hydrograph modeling and how they compare to the storage volumes.

The hydrographs extension for Autodesk Civil 3D was used for modeling by employing SCS TR-55 Method and type II distribution for the 1-, 2-, 5-, 10-, 25-, 50- and 100-year storms.

The delineated sub-drainage areas and the corresponding table are reported below:

Sub-drainage area 3A

This area drains into a small depression enclosed by contour 232 with an area of 198 SF. Even if a 0.5 foot depression is assumed with a 1-foot topsoil, the runoff entering into this area will quickly fill in the depression and then continue toward the general path of runoff in EX-DA3 as a contributor as shown below:



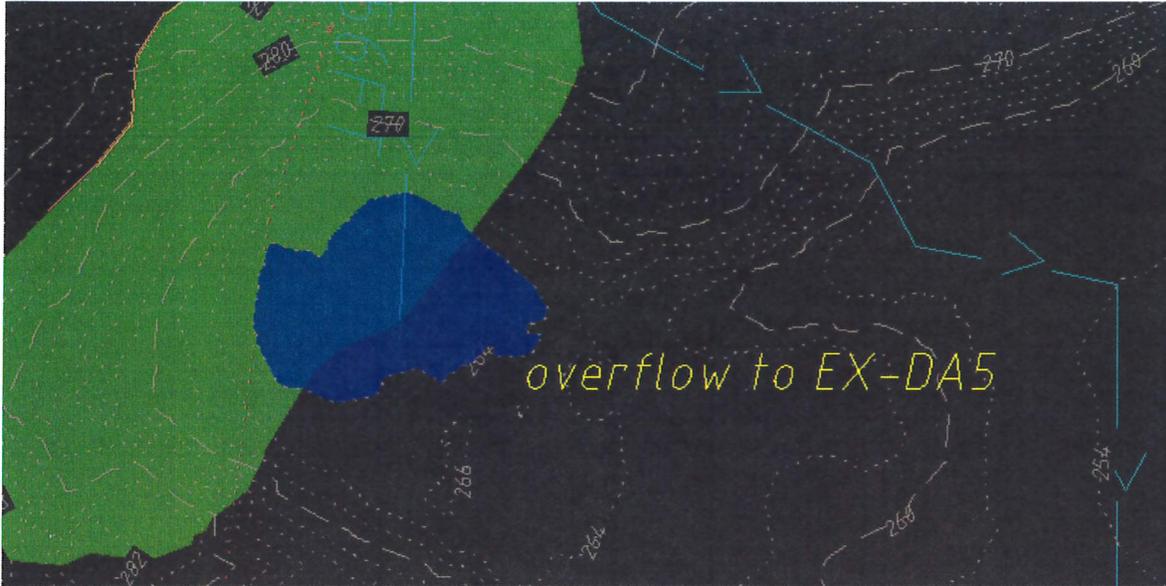
Storm	Inflow to Depression (CF)	Storage volume (CF)	Soil credit (CF)	Overflow from Depression (CF)	% Overflow
1-year	133	99	65	0	0%
2-year	640	99	65	476	74%
5-year	1465	99	65	1301	89%
10-year	3342	99	65	3178	95%
25-year	5765	99	65	5601	97%
50-year	8626	99	65	8462	98%
100-year	11839	99	65	11675	99%

oo should be no flow attenuation #
no impact on flow targets

As can be seen from the above table, the depression can remove the 1-year storm in the best case scenario, which assumes 0.5-foot bowl storage volume plus 1-foot of topsoil with 30% void. In larger storms, the majority of the storm hydrograph (ranging from 74% to 99%) would almost immediately overflow from the depression, continuing to flow toward EX-DA3 discharge point.

Sub-drainage area 5

This area drains into a small depression enclosed by contour 264 with an area of 3835 SF. Even if a 0.5 foot depression is assumed with a 1-foot topsoil, the runoff entering into this area will quickly fill in the depression and then continue toward the general path of runoff in EX-DA3 as a contributor as shown below:



Storm	Inflow to Depression (CF)	Storage volume (CF)	Soil credit (CF)	Overflow from Depression (CF)	% Overflow
1-year	0	1918	1266	0	N/A
2-year	88	1918	1266	0	0%
5-year	621	1918	1266	0	0%
10-year	2353	1918	1266	0	0%
25-year	5001	1918	1266	1818	36%
50-year	8410	1918	1266	5227	62%
100-year	12459	1918	1266	9276	74%

Handwritten notes in red:
 100% flow with attenuation input
 but 261
 50
 100% flow with attenuation input
 should be significant flow attenuation but 2185
 little or no attenuation likely so no target flow impact

As can be seen from the above table, the depression can remove the 1-year to 10-year storm and up to 36% of the 25-year storm in the best case scenario, which assumes 0.5-foot bowl storage volume plus 1-foot of topsoil with 30% void. In larger storms, the majority of the storm hydrograph would almost immediately overflow from the depression, continuing to flow toward EX-DA3 discharge point. However, such results will not significantly impact the EX-DA 5 discharge rates because this subdrainage area only constitutes 36% of the EX-DA 5. It should be iterated that as topography and site characteristic shows there is no overland storage volume, or topsoil with 33% void and infiltration on the site, therefore, this is very conservative scenario of modeling existing hydrographs. Runoff entering into this low land areas is expected to continue toward the EX-DA5 discharge point. Nonetheless, even separating this sub-drainage

Appendix A

Hydrograph Modeling of the Existing Depressions

~~to~~
no routing

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

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	----	0.004	0.027	-----	0.147	0.653	1.421	2.384	3.461	SUB of EX-DA3-A
2	SCS Runoff	----	0.001	0.019	-----	0.085	0.762	2.398	4.704	7.584	SUB of EX-DA3-B
3	SCS Runoff	----	0.000	0.005	-----	0.018	0.167	0.848	1.982	3.471	SUB of EX-DA5

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

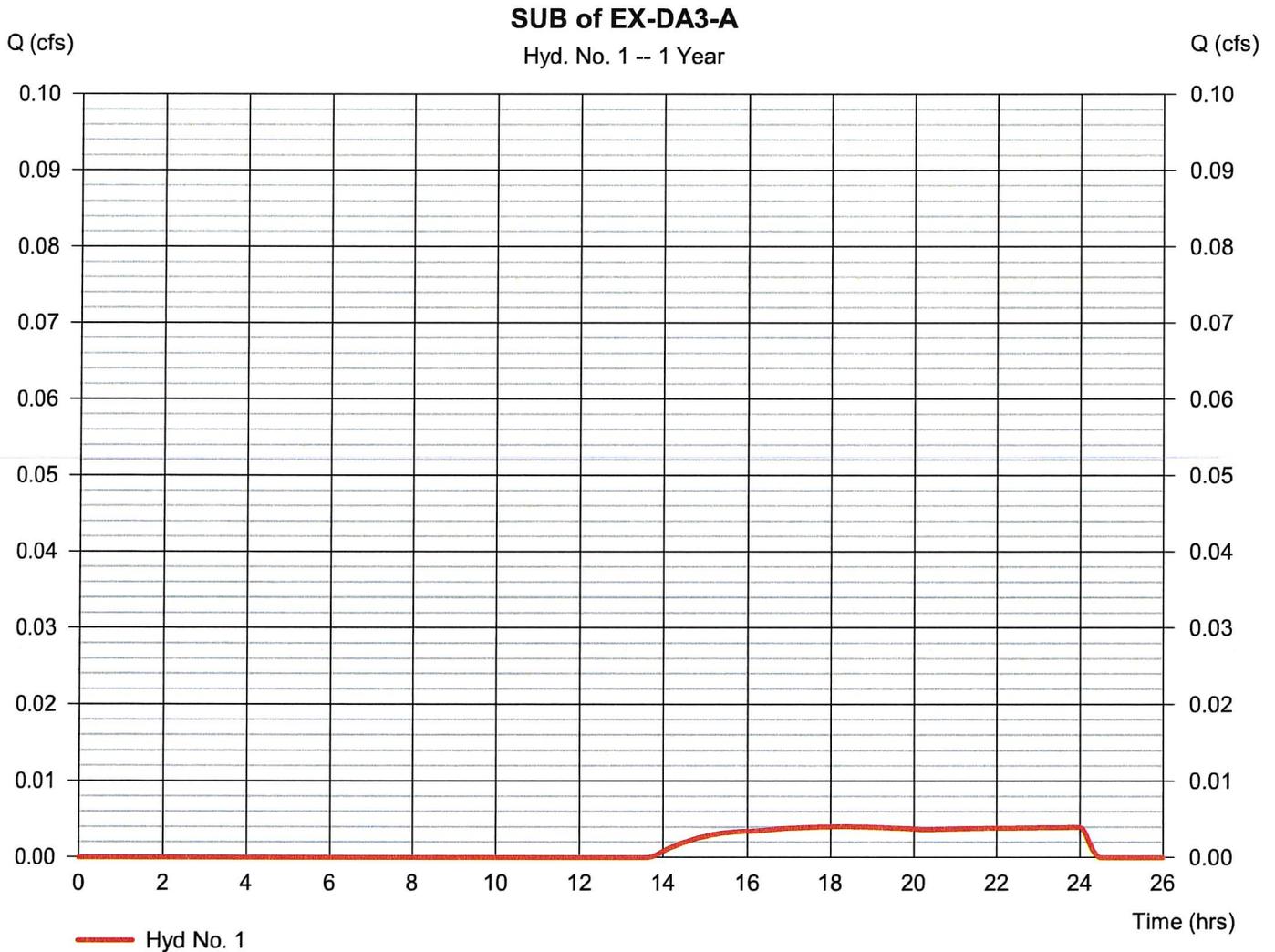
Monday, 09 / 23 / 2024

Hyd. No. 1

SUB of EX-DA3-A

Hydrograph type	= SCS Runoff	Peak discharge	= 0.004 cfs
Storm frequency	= 1 yrs	Time to peak	= 18.30 hrs
Time interval	= 2 min	Hyd. volume	= 133 cuft
Drainage area	= 1.620 ac	Curve number	= 51*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.30 min
Total precip.	= 2.40 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.460 x 30) + (0.270 x 39) + (0.140 x 55) + (0.350 x 61) + (0.400 x 74)] / 1.620



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

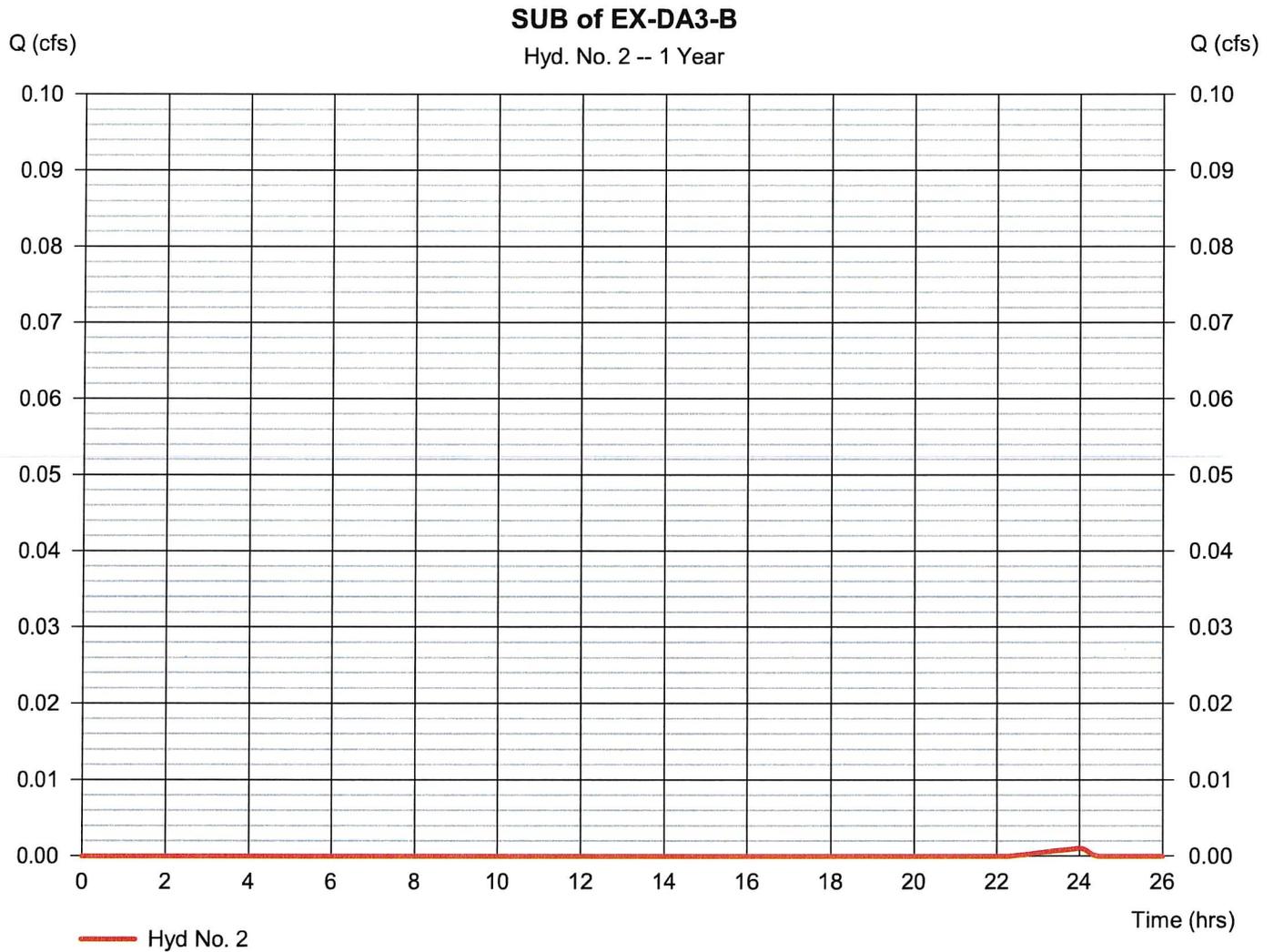
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.001 cfs
Storm frequency	= 1 yrs	Time to peak	= 24.00 hrs
Time interval	= 2 min	Hyd. volume	= 4 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 2.40 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

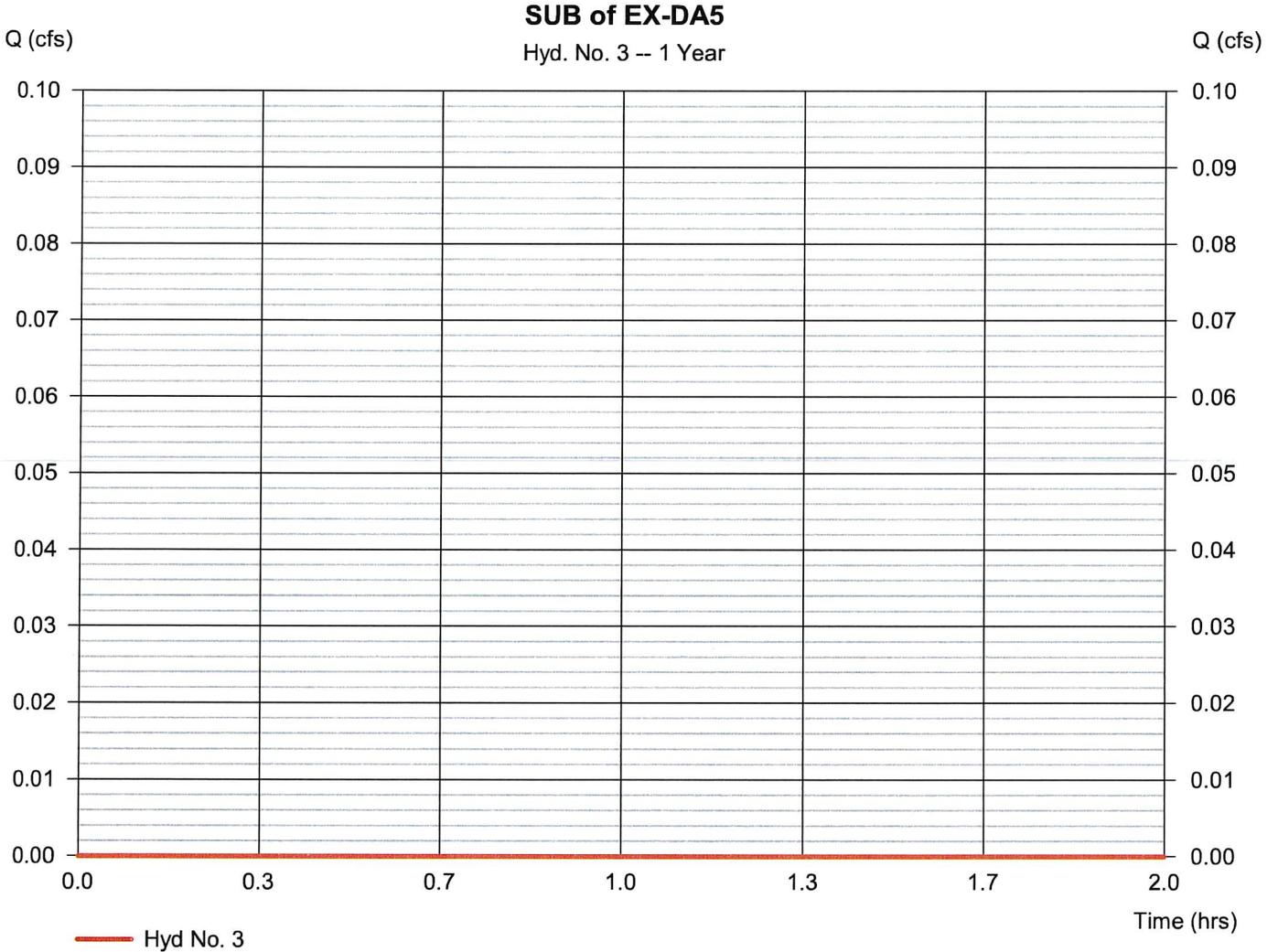
Monday, 09 / 23 / 2024

Hyd. No. 3

SUB of EX-DA5

Hydrograph type	= SCS Runoff	Peak discharge	= 0.000 cfs
Storm frequency	= 1 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Drainage area	= 2.770 ac	Curve number	= 43*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.30 min
Total precip.	= 2.40 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.160 x 30) + (0.250 x 39) + (1.360 x 55)] / 2.770



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

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	0.027	2	754	640	----	----	----	SUB of EX-DA3-A
2	SCS Runoff	0.019	2	1076	634	----	----	----	SUB of EX-DA3-B
3	SCS Runoff	0.005	2	1440	88	----	----	----	SUB of EX-DA5

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

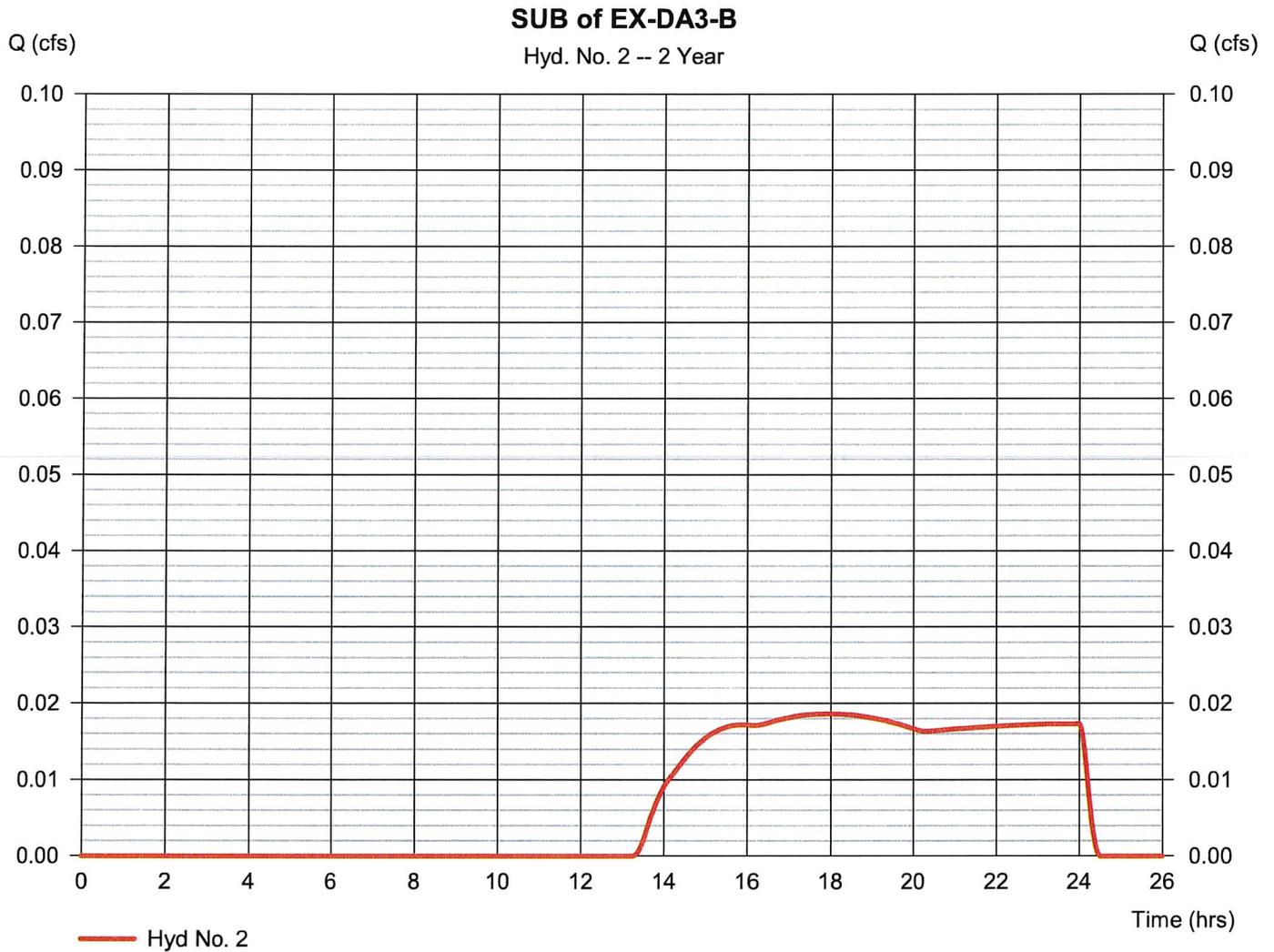
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.019 cfs
Storm frequency	= 2 yrs	Time to peak	= 17.93 hrs
Time interval	= 2 min	Hyd. volume	= 634 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 3.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.147	2	732	1,465	----	----	----	SUB of EX-DA3-A
2	SCS Runoff	0.085	2	756	2,230	----	----	----	SUB of EX-DA3-B
3	SCS Runoff	0.018	2	914	621	----	----	----	SUB of EX-DA5
<p>X:\2022-528 Easton Commerce Park\ENG\STORM\PC1245\readepressions from day.gw 2024-09-23 / 2024</p>									

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

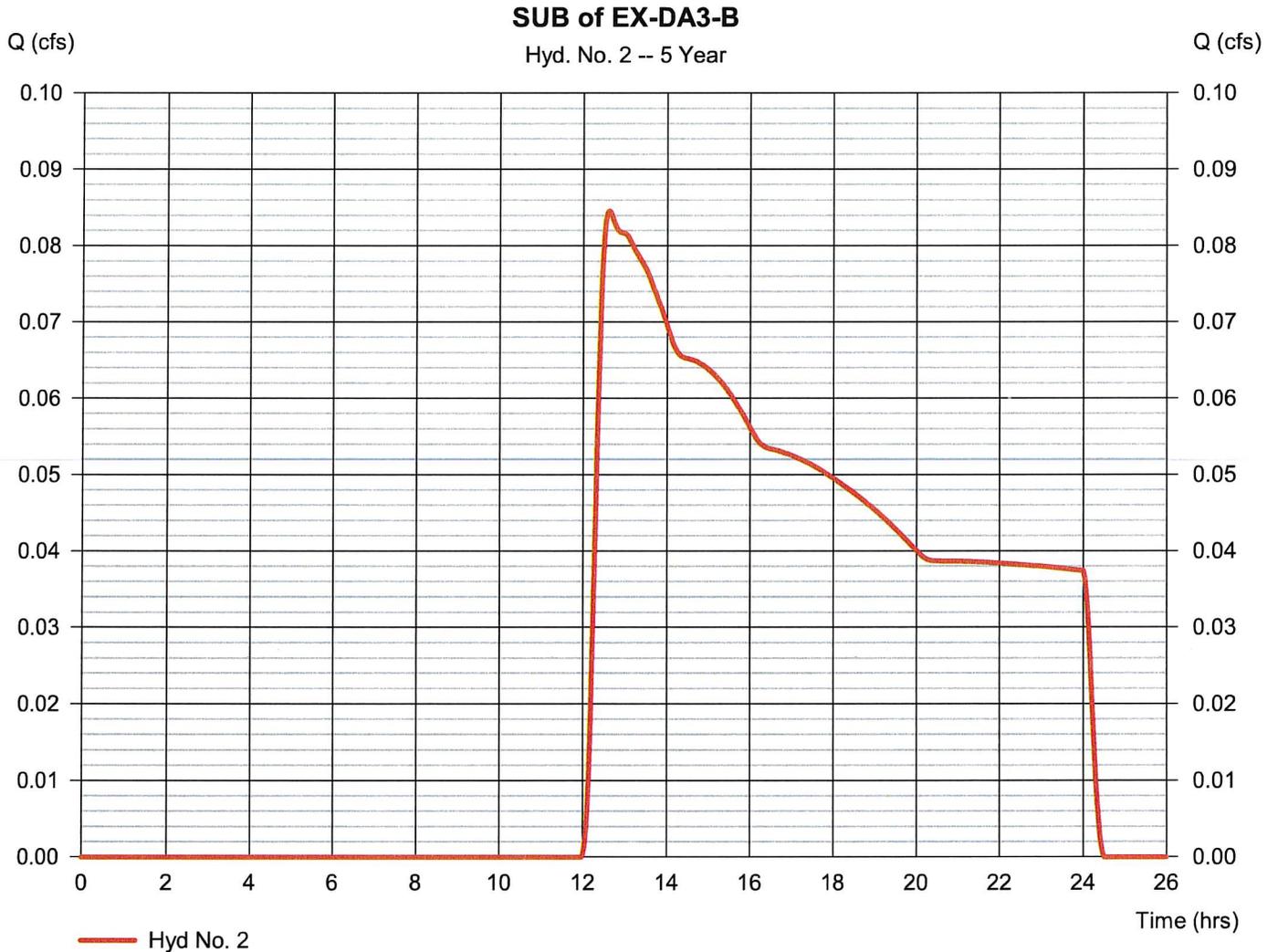
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.085 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.60 hrs
Time interval	= 2 min	Hyd. volume	= 2,230 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 3.60 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

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	0.653	2	728	3,342	----	----	----	SUB of EX-DA3-A
2	SCS Runoff	0.762	2	730	6,481	----	----	----	SUB of EX-DA3-B
3	SCS Runoff	0.167	2	734	2,353	----	----	----	SUB of EX-DA5

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

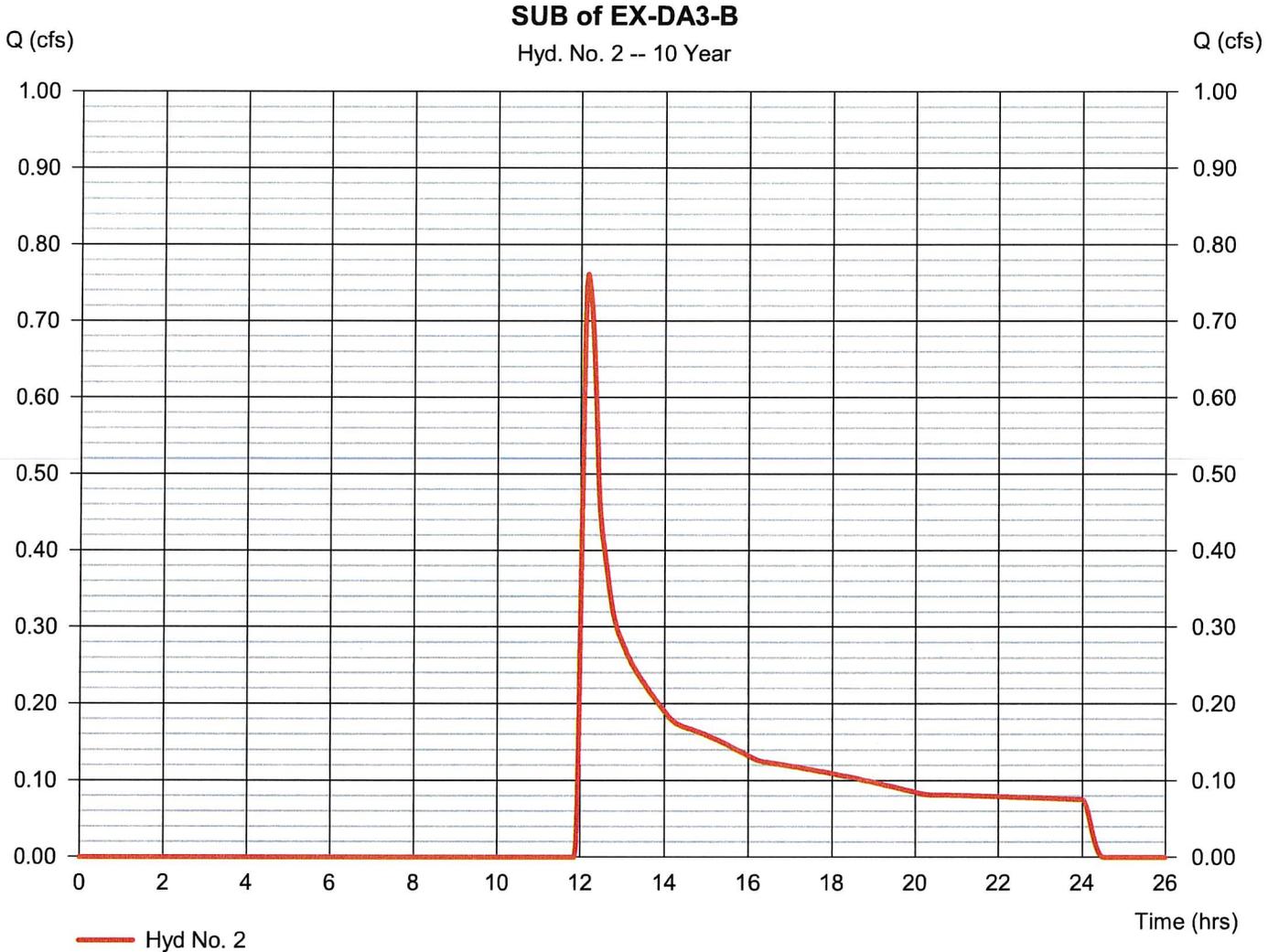
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 0.762 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 6,481 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 4.56 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

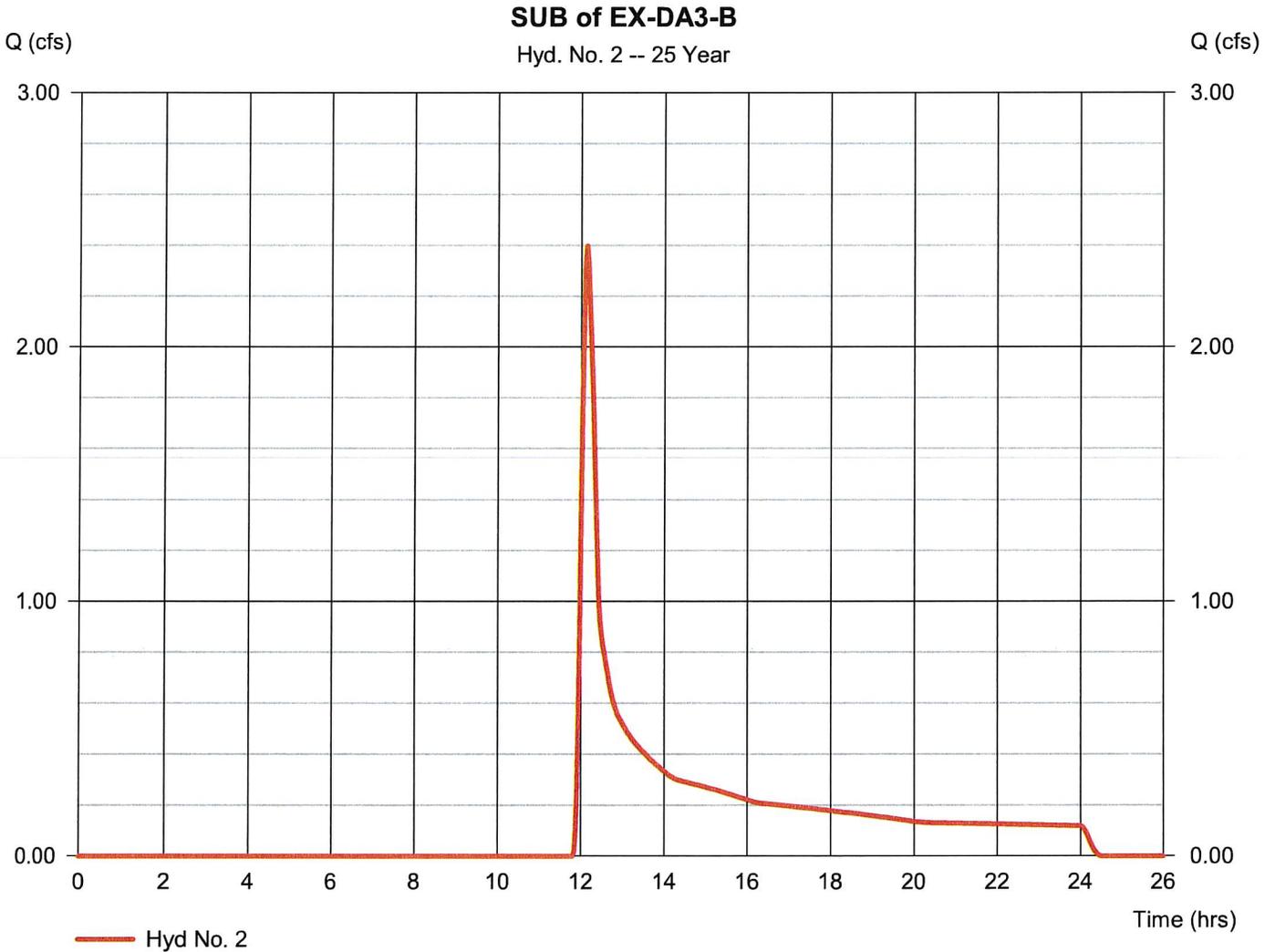
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.398 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 12,467 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.384	2	726	8,626	----	----	----	SUB of EX-DA3-A
2	SCS Runoff	4.704	2	726	19,874	----	----	----	SUB of EX-DA3-B
3	SCS Runoff	1.982	2	726	8,410	----	----	----	SUB of EX-DA5

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

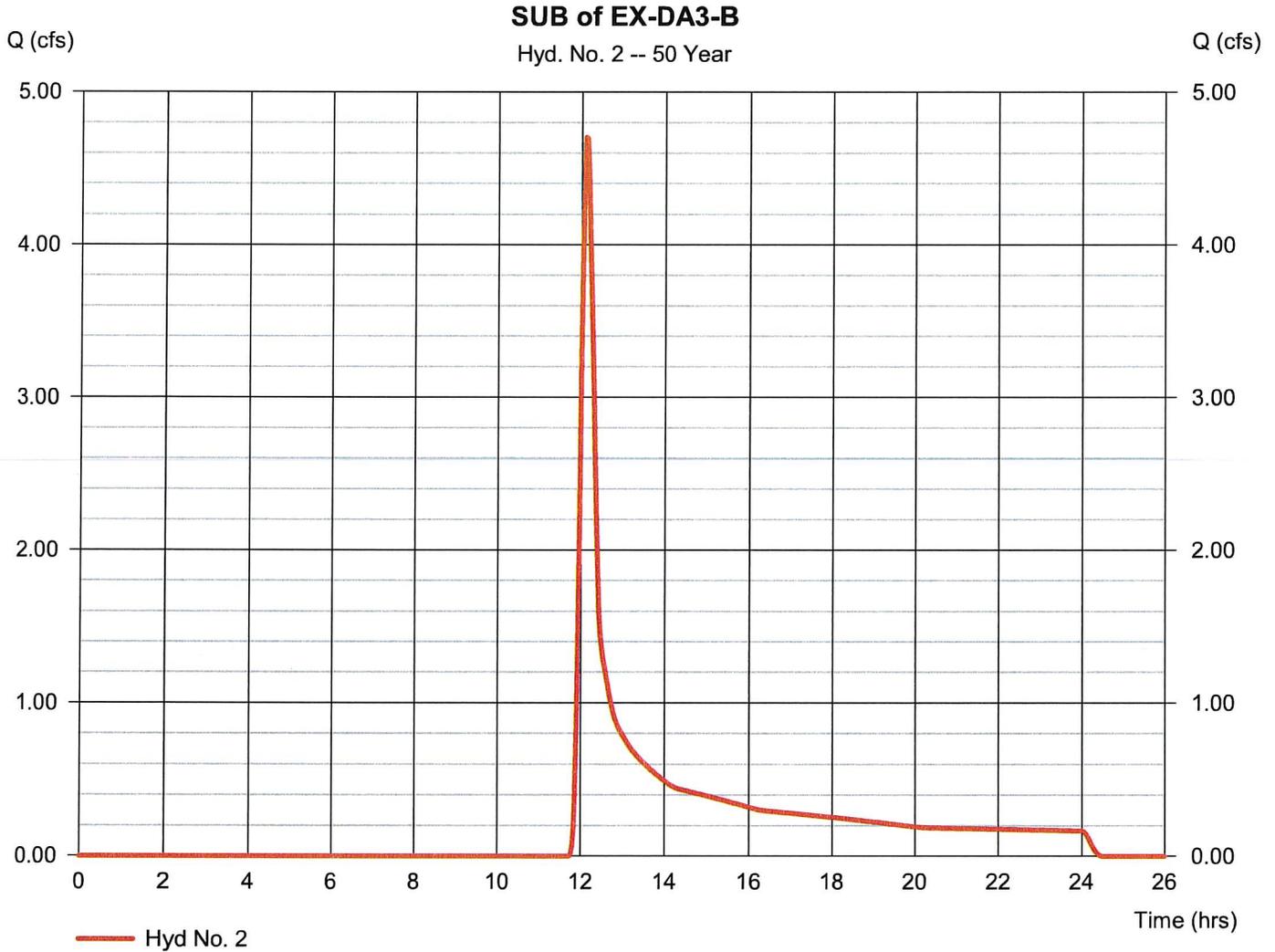
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 4.704 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 19,874 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.461	2	726	11,839	----	----	----	SUB of EX-DA3-A
2	SCS Runoff	7.584	2	726	28,463	----	----	----	SUB of EX-DA3-B
3	SCS Runoff	3.471	2	724	12,459	----	----	----	SUB of EX-DA5

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

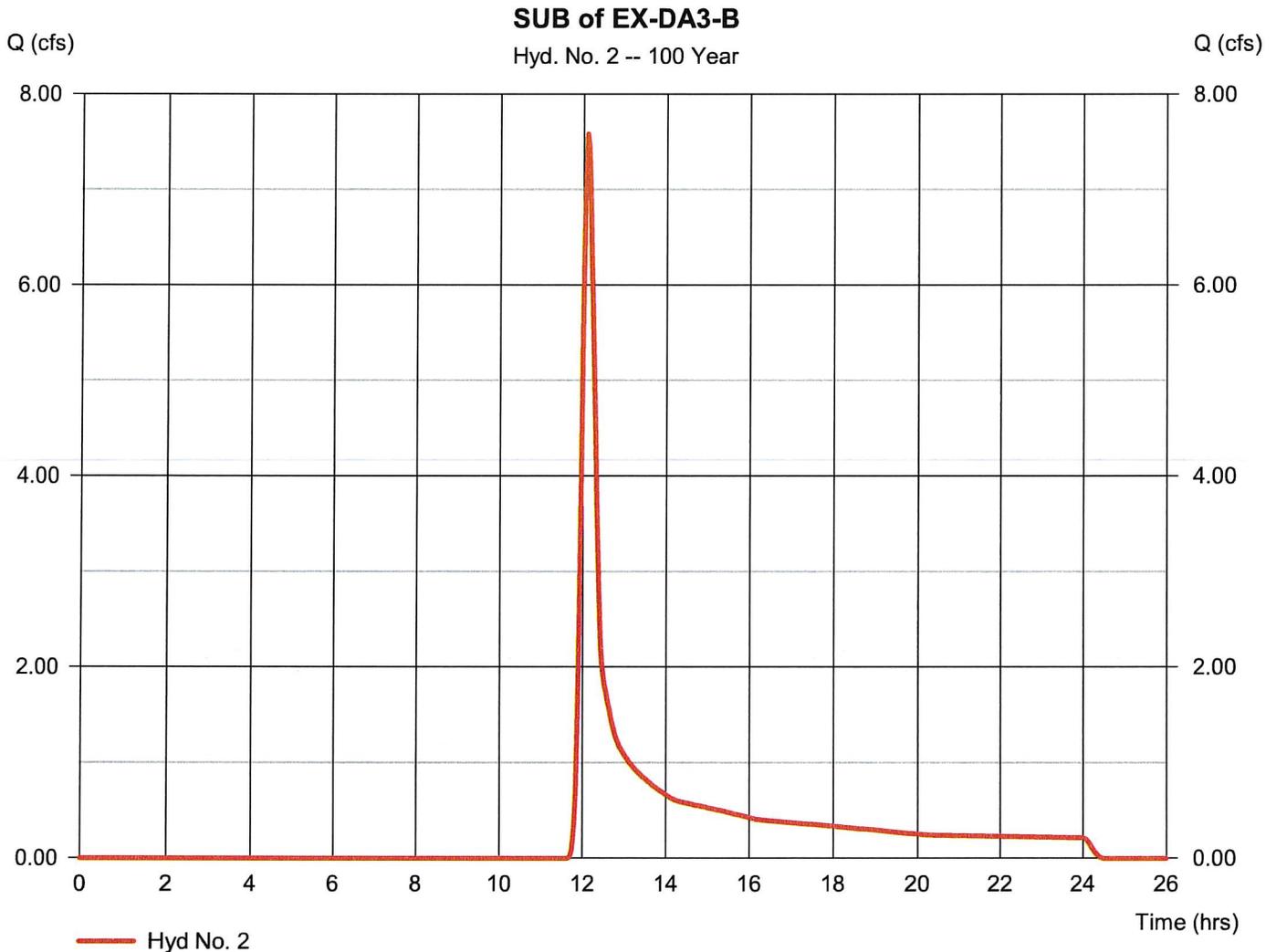
Monday, 09 / 23 / 2024

Hyd. No. 2

SUB of EX-DA3-B

Hydrograph type	= SCS Runoff	Peak discharge	= 7.584 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 28,463 cuft
Drainage area	= 5.090 ac	Curve number	= 46*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.80 min
Total precip.	= 7.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(3.230 x 30) + (0.200 x 39) + (0.350 x 55) + (0.120 x 61) + (0.510 x 74) + (0.680 x 98)] / 5.090



Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

Monday, 09 / 23 / 2024

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	69.8703	13.1000	0.8658	-----
3	0.0000	0.0000	0.0000	-----
5	79.2597	14.6000	0.8369	-----
10	88.2351	15.5000	0.8279	-----
25	102.6072	16.5000	0.8217	-----
50	114.8193	17.2000	0.8199	-----
100	127.1596	17.8000	0.8186	-----

File name: SampleFHA.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
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	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.40	3.00	0.00	3.60	4.56	5.52	6.48	7.44
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	2.40	3.00	0.00	3.60	4.56	5.52	6.48	7.44

Hydrograph No. 3, SCS Runoff, SUB of EX-DA5.....	29
100 - Year	
Summary Report	30
Hydrograph Reports	31
Hydrograph No. 1, SCS Runoff, SUB of EX-DA3-A.....	31
Hydrograph No. 2, SCS Runoff, SUB of EX-DA3-B.....	32
Hydrograph No. 3, SCS Runoff, SUB of EX-DA5.....	33
IDF Report	34