

**Mando Ditch Petition
Preliminary Engineering Study
For
The Franklin County Engineer's Office**



December 8, 2023

Prepared By:



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1.1 Introduction

Moody Engineering has been commissioned by the Franklin County Engineer's Office to study the Mando petition area and design a proposed surface and subsurface drainage system to improve the drainage conditions in the area. The region is a mix of agriculture and rural residential development which is experiencing flooding during rain events. A petition has been filed with the Franklin County Commissioners under Ohio Revised Code 6131 to improve the drainage within the area. Petition signees include the following properties (See Map Exhibit 1):

- | | | |
|-----|--------------------|------------|
| 1. | 8669 Patterson Rd. | 120-000780 |
| 2. | 8384 Morris Rd. | 120-000652 |
| 3. | 8234 Morris Rd. | 120-000560 |
| 4. | 8178 Morris Rd. | 120-000509 |
| 5. | 8166 Morris Rd. | 120-000552 |
| 6. | 7900 Morris Rd. | 120-001041 |
| 7. | 7936 Morris Rd. | 120-000995 |
| 8. | 7864 Morris Rd. | 120-001032 |
| 9. | 7882 Morris Rd. | 120-001024 |
| 10. | 8025 Patterson Rd. | 120-001087 |
| 11. | 8390 Morris Rd. | 120-000726 |
| 12. | 8400 Morris Rd. | 120-000554 |

This report outlines the drainage issues that resulted in the petition and breaks out specific problem areas identified by Moody Engineering and the Franklin County Engineer's Office staff within the project area. Potential improvements to solve the drainage issue are outlined. A plan outline of the existing drainage improvements in the project area as well as the proposed improvements is included in Exhibit 2.

1.2 Description of Study Area

The drainage area is roughly bound by Amity Rd. to the west, Patterson Rd. to the north, Morris Rd. to the South and Walker Rd. to the East (See Map Exhibit 2). Amity Rd., Patterson Rd., and Walker Rd. are maintained by the Franklin County Engineer. Morris Rd. is a township road maintained by Brown Township. There is an existing open ditch running between Morris Rd. and Patterson Rd. and going NE from Amity Rd. for approximately 5,600 ft. where it turns southeast and crosses to southeast side of Morris Rd. The ditch then travels 1200 ft on the south side of Morris Rd before it crosses back under to the north side at the S bend then terminates 620 ft later where it meets Morris Rd. again near the intersection of Jerman Lane. The remainder of the project area does not have any open ditch. There are several older existing tiles installed in the project area (refer to Exhibit 2).

Tile Ex-1 begins on the North side of Patterson Rd. at the 8210 Patterson Rd. lot and then crosses to the south side of Patterson Rd. from 8300 to 8361 Patterson Rd. and runs south through 8351 Patterson Rd. and 8372 Morris Rd. before turning to the southwest and continuing across 8384 and 8390 Morris Rd. and then outletting to the ditch at the southwest corner of 8396 Morris Rd. Tile Ex-1 is an old tile running through wooded areas and suspected to be in poor condition.

Tile Ex-2 begins at the south of the lot at 8001 Patterson Rd. and then runs west to 8115 Patterson Rd. where it turns and runs generally southwest making several sharp bends until outletting to the ditch at 8154 Morris Rd. This tile is newer and may still be functioning, with installation plans dated 1997. However, it appears that construction on the property at 8043 Patterson Rd. may have disturbed the eastern terminus of the tile resulting in issues at 8025 Patterson Rd. (refer to Exhibit 2).

Tile Ex-3 begins at the NE corner of the 8166 Morris Rd. lot and runs south until meeting Morris Rd. at 8234 Morris Rd. and continues southwest along Morris Rd. until intersecting the ditch. Ex-3 is in poor condition and based on discussion with residents and Franklin County Engineers office personnel and currently is not sufficient to prevent significant ponding on the properties it drains.

Tile Ex-4 begins at the ditch on the east side of 8154 Morris Rd. and runs on the North side of Morris Rd. to 8000 Morris Rd. where it angles to the north running to the Mando parcel at 7864 Morris Rd. Tile Ex-3 also appears to be damaged and is not functioning well. There are additional tiles indicated on the historic farm drainage map (refer to exhibit 6) that have not been verified at this time but do not appear to be currently functional. Ponding in this area was observed after significant rainfall.



1.3 Utilities in the project area

Utilities in the project area include:

- AEP (Telecom)
- AEP Ohio (Electric)
- AT&T
- Charter Communications
- Columbia Gas
- Franklin County Engineer
- Franklin County Engineer (Traffic)
- City of Hilliard (Electric/Traffic)
- City of Hilliard (Fiber)
- City of Hilliard (Stormwater/Sewer)

1.4 Project Objectives

The objective of this project is to develop a wholistic drainage solution for the study area that will improve the level of service of the drainage system in place and mitigate the repeated flooding that is impacting the petitioner's ability to utilize their property.

As stated in the petition filed, the objective is "To generally improve the drainage, both surface and subsurface, to a good and sufficient outlet by replacing, repairing or altering the existing improvements as required and or creating new surface and subsurface drainage mains or laterals as requested by this petition". This report will outline a method to meet this goal by:

- 1) Evaluation of the existing drainage condition to pinpoint restrictions and deficiencies contributing to the flooding.
- 2) Review of alternatives to improve the drainage system level of service and alleviate flooding frequency and intensity.
- 3) Evaluation of opportunities to reduce the run-off rates to protect downstream watercourses.
- 4) Evaluation of improvements to the Right of Way drainage to meet requirements of the Franklin County Stormwater Drainage Manual.

1.5 Causes of Flooding

The rural residential and agricultural drainage system is a combination of open drainage ditch, storm sewer, and clay tile. The natural topography of the area in combination with the installed drainage system and soil type affects the rate at which run-off can leave the area. Evaluating the area, we have reviewed the topography to identify trapped areas, the existing tiles in place and their condition and capacity. For public Right of Way, we have evaluated the existing system vs. the Franklin County Stormwater Drainage Manual which requires a 5-year design storm for the road drainage system if the speed limit is greater than 45 mph. The existing improvements in place appear to have been implemented over time as part of the agricultural system and are significantly deficient when compared to the 5-year design storm. Residential areas require a higher level of service from the drainage system than traditional agricultural uses and areas in the public right of way also have a higher level of service in order to assure public safety and maintain the road pavement.

The condition of the existing perforated tiles in place can have a significant impact on their level of service. Perforated tiles are susceptible to root intrusion and clogging. In addition, older tiles were typically clay pipe that can become crushed or be removed as the area is converted to rural residential. Additionally, trees that would have been cut when the land was farmed have been left to grow on now residential lots. The process of development can also alter the traditional drainage patterns through grading and placement of fill and severing or damaging existing tile runs. Localized low areas that do not have surface routing and are not served by functioning tiles will hold water and flood after rain events.

2.0 Existing Conditions

Review of picture and video evidence from past storms indicates areas of flooding and slow drainage throughout the project area. Through review of the petition, communication between residents and Franklin County Engineer Staff, and drone and photographic evidence, areas of existing ponding and poor drainage have been identified and potential strategies to improve the drainage condition in the project area are outlined in the following section. For the purpose of this study, the problem areas have been divided into four separate segments.

Area 1 includes the rear portion of 8669 Patterson Rd. where water is standing and unable to continue south to the Southwest across portions of 8558 Morris Rd. as well as unaddressed parcel 120-000561 and 8566 Morris Rd.



Photo 1 (8669 Patterson Rd. Frontage looking South; Area 1)

Area 2 includes the rear of 8166 to 8360 Morris Road. These properties are in a low lying area that is cut off from the drainage ditch by Morris Rd. to the south and the shared driveway to 8384-8396 Morris Rd. to the west. Water running from the agricultural field to the northeast becomes trapped at these properties and unable to continue to the ditch on the South Side of Morris Rd. There is an existing tile (EX-2) traversing from the northeast and passing between 8234 and 8196 Morris Rd. before outletting to the ditch. This tile is not operating with sufficient capacity to prevent ponding during larger rain events. The residents have created a ditch at the rear of the property to help convey run-off to the west, under the shared driveway to 8384-8396 Morris Rd. and to the ditch. (Photo 2) However, creation of the ditch has not mitigated the flooding issues being experienced and currently surface flow makes its way on the east side of 8166 Morris Rd. and creates a ponding condition that inundates portions of the property during rain events. (Photo 3)



Photo 2(Middle of 8360 Morris Rd. looking east; Area 2)



Photo 3(Middle of 8166 Morris Rd. looking south; Area 2)

Area 3 includes the properties along Morris Road east of the S curve, also including 7864 to 7936 Morris Rd. Tile EX-3 runs along Morris Rd. from the receiving ditch to 7864 Morris Rd. There is a branch of this existing tile running diagonally from NE to SW across 7882, 7900, 7936, 7976, and 8000 Morris Rd.(Photo 5). Based on historic records the existing tile turned north and tied to several branches at the approximate location of the current residential structure at 7864 Morris Rd. There are multiple ponds present on the properties and inadequate outlet capacity for the overall system. Flooding over the driveway at 7864 Morris Rd. is frequently observed and standing water is frequently present on the adjacent properties. (Photo 4)



Photo 4(South portion of 7864 Morris Rd. looking east; Area 3)



Photo 5 (Looking North from 7900 Morris Rd., Area 3)

Area 4 includes the Patterson Rd. corridor and from 8001 to 8351 Patterson Rd. and includes the Patterson Rd. right of way in this vicinity. The existing right of way drainage is picked up in a 5" tile and conveyed west along the south right of way line. There is an additional tile on the southern portion of 8001 and 8147 Patterson Rd. (tile EX-4) which picks up tile outlet from the home sewage treatment systems. This tile was installed in 1997 and picks up the properties and then zigzags to the southwest before tying into the ditch at 8142 Morris Rd. The tile follows the property lines and does not appear to have any associated swale for conveyance of surface flows.

3.0 Environmental Considerations:

At the onset of the project, concerns were raised regarding the potential effect on the downstream watercourse. With the current condition of the drainage system, areal flooding occurs during larger rain events and the flooded area acts as an informal detention system attenuating the rate of runoff reaching the downstream watercourse. While the project objective is to reduce the flooding conditions and move water out of the flooded areas, the project team has been tasked with evaluating the incorporation of detention basins into the proposed improvements. Since no improvements are proposed that alter the impervious area in the watershed, there are no regulations addressing the release rate for the proposed basins. Three areas have been identified for potential basin installations.

Proposed detention basin 1 is proposed to be located just NW of 8166 Morris Rd. and will pick up the drainage from Patterson Rd. Installing a more formal roadway drainage system that complies with the Franklin County Stormwater Drainage Manual will result in an increased rate of flow from the open storm sewer when compared to an agricultural tile system. In order to mitigate the impact of rapidly draining the road corridor, detention basin 1 is placed at the storm outlet for storm sewer #4 and will attenuate the release from the road corridor.

Basin #1		
Storm (yr)	Uncontrolled Run-Off (cfs)	Basin Release (cfs)
1-yr	36	9
2-yr	52	28
5-yr	77	56
10-yr	99	78
25-yr	130	111
50-yr	157	138
100-yr	185	166

The second place a detention basin was reviewed is in area three where there is significant field flooding west of 7864 Morris Rd.. This area is more problematic for obtaining a reasonable detention volume due to the limited outlet depth. However, a shallow basin with around 3' of ponding depth can be installed to provide some attenuation to the most frequent storm events.

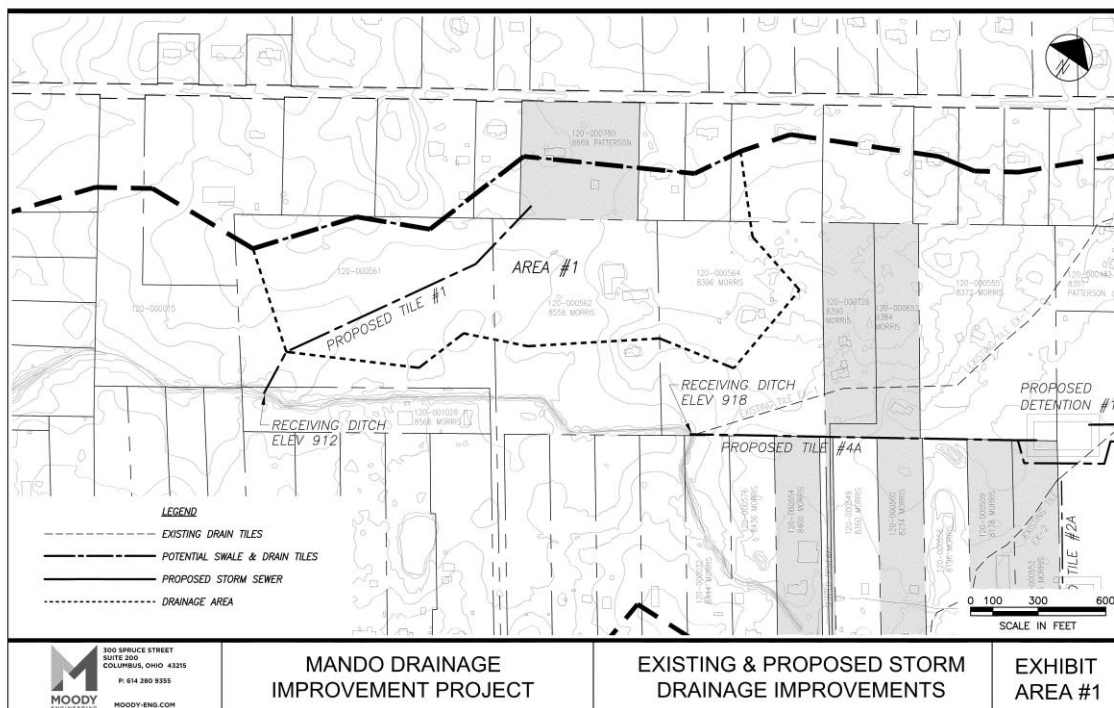
Basin #2		
Storm (yr)	Uncontrolled Run-Off (cfs)	Basin Release (cfs)
1-yr	28	20
2-yr	37	28
5-yr	51	41
10-yr	62	52
25-yr	79	66
50-yr	92	79
100-yr	106	91

A third potential basin location is to the east of 8166 Morris Rd. A basin in this location would help contain the ponding that is impacting the 8166 Morris Rd. property as well as attenuate the flow coming off the agricultural field to the east. The disadvantage of installing a basin in this location is the current tree growth in the area that would require clearing prior to installation. The benefits of additional detention need to be balanced with the impact of tree and brush removal.

Basin #3		
Storm (yr)	Uncontrolled Run-Off (cfs)	Basin Release (cfs)
1-yr	33	11
2-yr	45	12
5-yr	61	21
10-yr	74	32
25-yr	93	48
50-yr	109	61
100-yr	125	75

3.1 Proposed Improvements:

3.1.1 Flooding Area 1

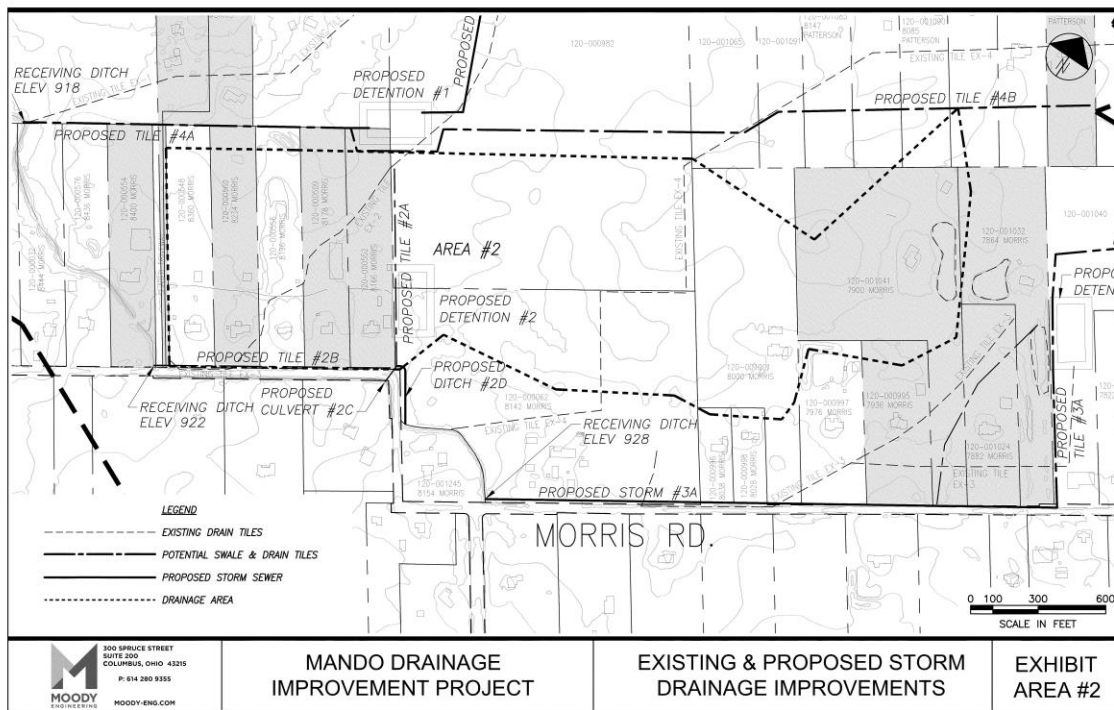


The drainage issue in Area 1 is an isolated ponding area in the southwest corner of the property located at 8669 Patterson Rd. Extending a tile (proposed tile #1) from the existing ditch approximately 1500 ft. across the farmed parcel 120-000561 and the NW

corner of 120-000562 to the property will provide a subsurface and surface drainage path to relieve ponding in the area. Ohio revised code 6131 encourages construction of drainage improvements along property lines when possible. In this situation there is a natural low point running diagonally across the agricultural field and following that route will minimize grading and swale depth to provide an overland flow path. The total drainage is for the tile is 35 acres and based on a 3/8 in coefficient the agricultural sizing calls for an 8" tile. A 12" minimum size of tile is proposed for this project for better long term maintenance access. A summary of the proposed improvements to Area 1 includes:

- 1500 ft. 12" tile and swale

3.1.2 Flooding Area 2



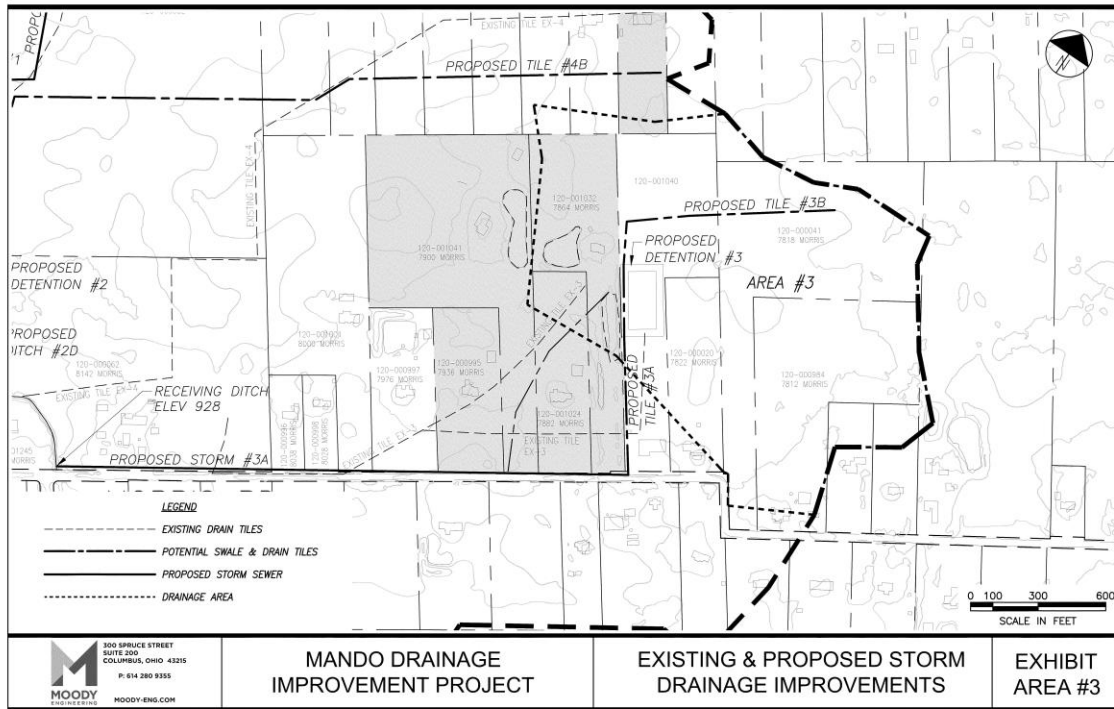
The drainage issue in area 2 involves water from the adjacent agricultural area becoming trapped and ponding in the vicinity of 8166-8360 Morris Rd. and ponding within the residential properties. Solving the problem in Area 2 will require a combination of diverting the incoming run-off around Area 2, and improvements to the existing outlet to the ditch, to ensure that any run-off that does make its way to this area does not become trapped and cause flooding issues. The installation of a tile and swale system on the northern property line of 8166-8360 Morris Rd. will intercept runoff coming from the northern portion of the parcel associated with unaddressed parcel 120-000982, as well as portions of the adjacent parcels on Patterson Rd. This proposal would remove approximately 56 acres of drainage area that is currently flowing towards area 2 and causing flooding on the lots of 8166-8360 Morris Rd. With this additional area removed, 76 acres of drainage area will remain that will be required to be conveyed through this area. In the current condition, the surface flow makes its way toward Morris Rd. on the east side of the property located at 8166 Morris Rd. The flow path along the side of this property should be managed with a swale and tile to better convey the

drainage, avoiding undue impacts to this property (see proposed tile routing #2A on Exhibit 2). When the drainage collects at Morris Road, the current restriction in flow will be required to be removed and there are several options to outlet to the ditch. One option is to construct proposed storm sewer 3B along Morris Rd. An alternative option would be construction of culvert 3C under Morris Rd. directly to the ditch on the south side. A third alternative is extending ditch 2D along the north side of Morris until it intersects the existing ditch. The options for conveying this area are summarized below:

- Construct tile #2A and swale on the east side of 8166 Morris Rd.
 - 890' 12" tile and swale
 - 3 catch basin access points
- Construct detention basin #2 to reduce release rates
- Outlet tile #2A and swale by one of the following
 - Construct approximately 1050' of tile and swale or storm sewer on the North side of Morris Rd. and provide an adequate culvert under the shared drive to 8351-8390 Morris Rd. See proposed tile 2B on Exhibit 2.
 - Outlet tile directly across Morris Rd. just east of the drive to 8166 Morris Rd. See proposed culvert #2C on Exhibit 2.
 - Extend swale and tile to the east around the curve to intersect the existing ditch. See ditch #2D on Exhibit 2.

There is the potential to slow the run-off from Area 2 with the construction of a detention basin. In the area just east of 8166 Morris Rd. the land is currently depressed and vegetated with trees and brush. Incorporating a detention basin into this location can help reduce flow associated with typical runoff. The primary challenge with the installation of detention in this location is the limited depth of the outlet pipe, as this will constrain the depth/volume available for detention. Therefore, the available capacity will not be fully known until a detailed survey is completed. Additionally, the vegetation present would need to be removed to facilitate the installation of this infrastructure.

3.1.3 Flooding Area 3



The area 3 drainage issue is flooding over the residential properties resulting from an inadequate conveyance from the area to the receiving ditch. The drainage of the properties in Area 3 can be improved by construction of a new outlet for the tile and pond systems. The depth of the receiving ditch is fairly shallow at 928' compared to the pond surface elevations of 935'. Replacement of the existing tile along Morris Rd. (Proposed Tile #3A) will improve the roadway drainage as well as provide an improved outlet for the affected properties. Morris Rd. storm drainage falls under the Franklin County Drainage Manual (Section 2.3, Tables 2-9 and 2-10) for a low volume road which requires a 2-year design storm for speed limits <45mph and 5-year design storms for speed limits >45 mph. The road is an unposted 55 mph zone resulting in a 5 year design requirement. SCS calculations for the overall tributary area result in storm sewer in excess of 36" for this run and will be challenged to meet cover requirements. A reduced flow rate in combination with agricultural tile is recommended for this line, rather than complying with the roadway drainage standards.

In addition to the improved outlet, the field tile in the farmed land on 120-000041 and 120-001040 needs to be re-established to properly drain those areas. Proposed Tile #3B will pick up this area and convey it to the proposed storm line. In conjunction with the tile, a graded swale will be added to allow a surface flow path out of the field.

If attenuation of flows from the field area is required, a detention basin (Proposed Detention #3) could be located along the Tile #3B route. The detention basin can attenuate lower frequency storms. Due to the large tributary area, the basin will have limited effect on the release from larger storm events.

The drainage issue in Area 4 is the result of disruption of the existing tile system during residential construction, as well as road drainage system that was not designed to meet the conveyance standards of Franklin County. The northeastern portion of the drainage area off of Patterson Rd. comprises Area 4. The 5" tile in the Patterson Rd. Right of Way is not sized appropriately for conveying surface drainage from the 50.63 acre tributary area that drains to it. There are numerous surface inlets along that stretch directly feeding the tile. Patterson Rd. which is also an unposted 55 mph zone is required to follow the Franklin County Drainage Manual which indicates the 5 year

design requirement (Section 2.3, Tables 2-9 and 2-10). SCS calculations indicate an expected flow of 28.63 cfs from a 5 year storm. Assuming flowing full at .20% slope, this would require a 36" storm sewer.

Additional consideration must be given to the drainage at the rear (south) of these properties. The existing tile has been disrupted by construction of the 8025 and 8043 Patterson Road residences and should be replaced. The HSTS system for the houses along Patterson predominantly tie into this tile. With the new Tile and Ditch Proposed #4A, the new tile from the rear of the Patterson Rd. properties (Proposed Tile #4B) can tie in where they intersect. The existing tile can be cut and bulkheaded prior to this tie in point and the downstream portion can and should remain functional since there are additional tie-ins downstream.

As noted in Section 2.0, due to the higher flow rate that upsizing the Patterson Rd storm sewer would create, a detention basin can be installed prior to outletting proposed storm #4C to proposed tile #4A. Running the tile at minimum slope from the tie in point with the existing ditch will give approximately 8' of potential depth.

A summary of options for area 4 includes:

- Construct tile #4A and swale on the north side of area 2 to cut off 56 acres of drainage
 - 3115' 18" tile and swale
 - 11 catch basin access points
- 3500' of 12"-30" storm sewer on Patterson Rd.
- 12 catch basin
- 1796' 12" tile on south side of Patterson Rd. properties
- 6 catch basin access points
- Detention Basin #1

4.0 Conclusion

The study of the area has uncovered multiple areas of poor drainage and ponding within the study area. The ponding areas are not directly tied to a common cause, but rather due to locally entrapped drainage due to the former agricultural use of the area, deteriorating tile system, and disruptions from residential development. The solutions presented each address the primary ponding areas that currently affect the residents of the study area. In addition, solutions are presented that adapt the current right of way infrastructure to meet the current standards of the Franklin County Engineer's office and bring it in line with the rural residential character the area has developed. Due to the sensitivity of the downstream waterway, detention options have been presented to help mitigate the increased flow rates caused by the elimination of the de-facto detention occurring due to the current poor drainage system and provide storage in controlled locations where the effect on adjacent properties is minimized.

The proposed improvements will improve the drainage systems level of service within the study area and relieve the flooding issues that necessitated the petition filed with the County Commissioners.

Exhibit 1____Petitioners

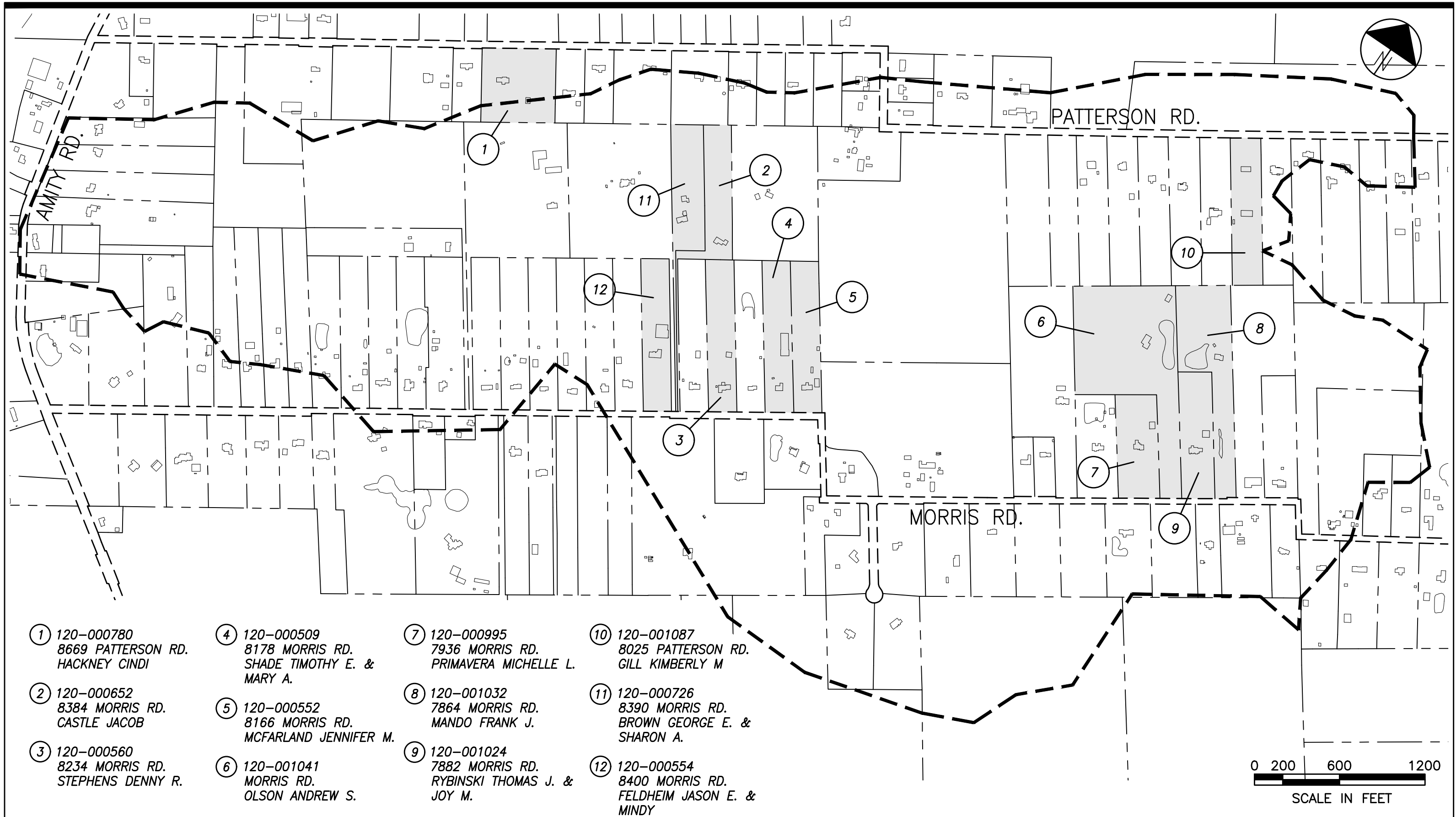


Exhibit 2__Existing and Proposed Drainage Improvements

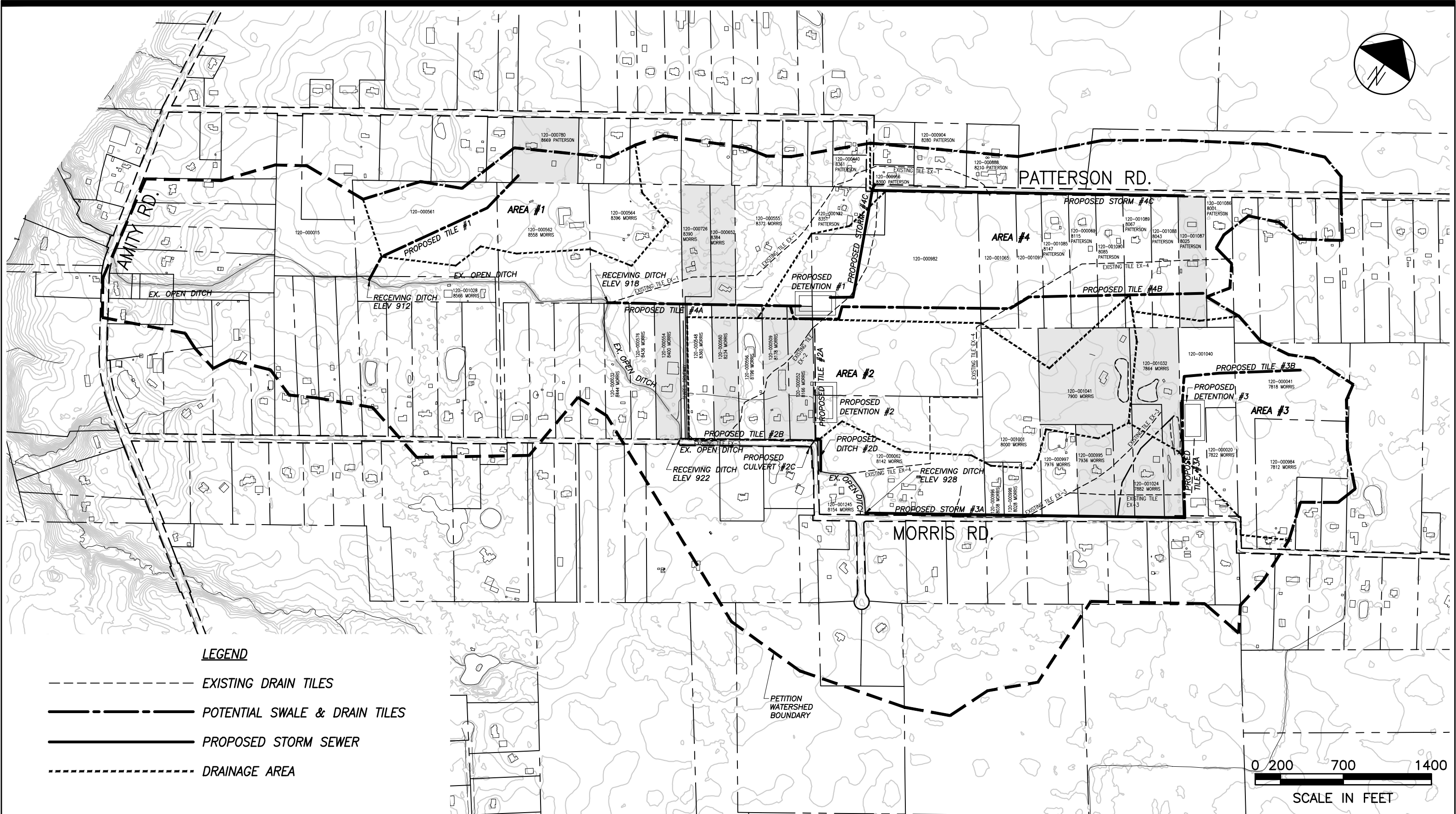


Exhibit 3___HSTS Locations

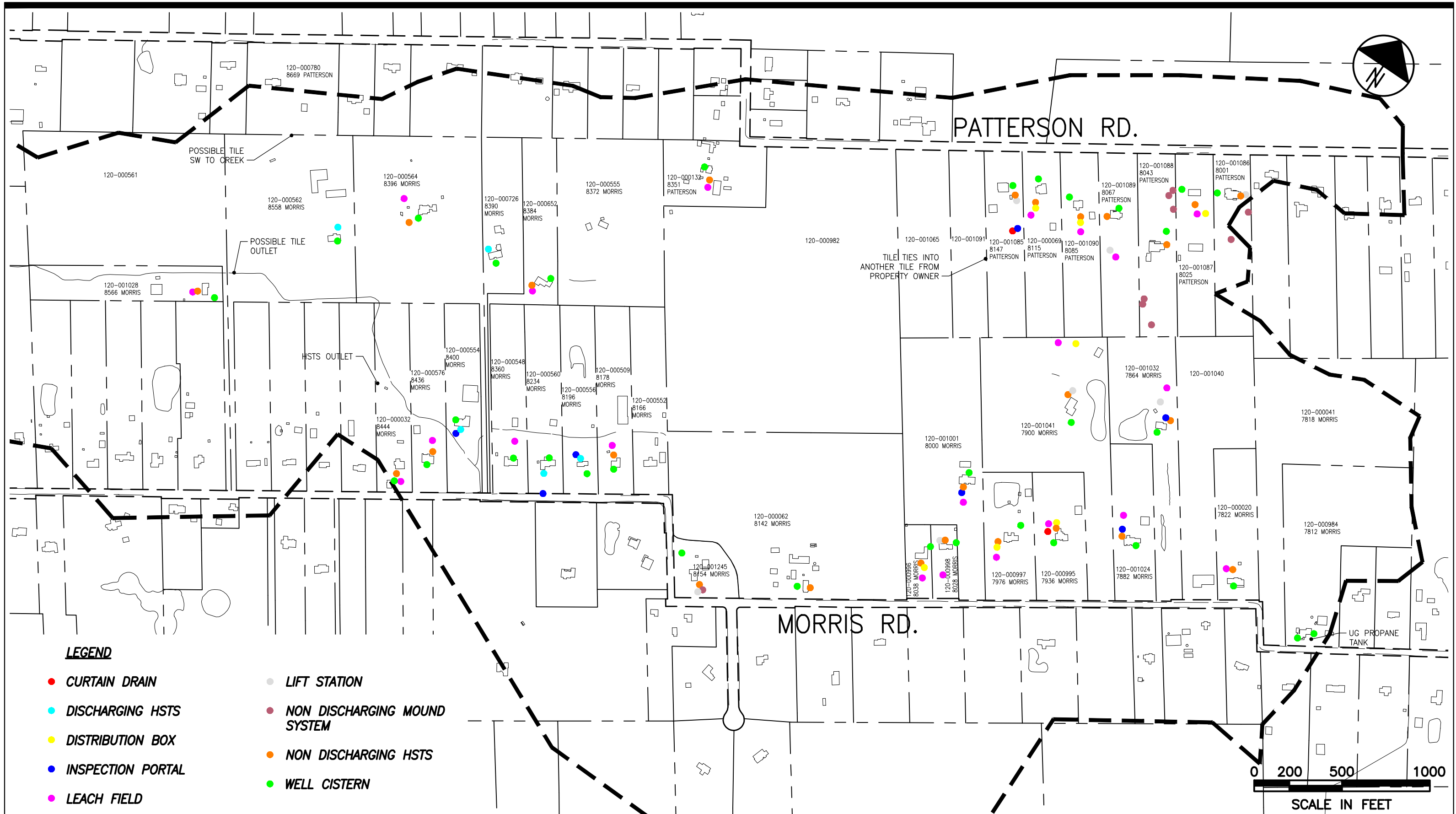
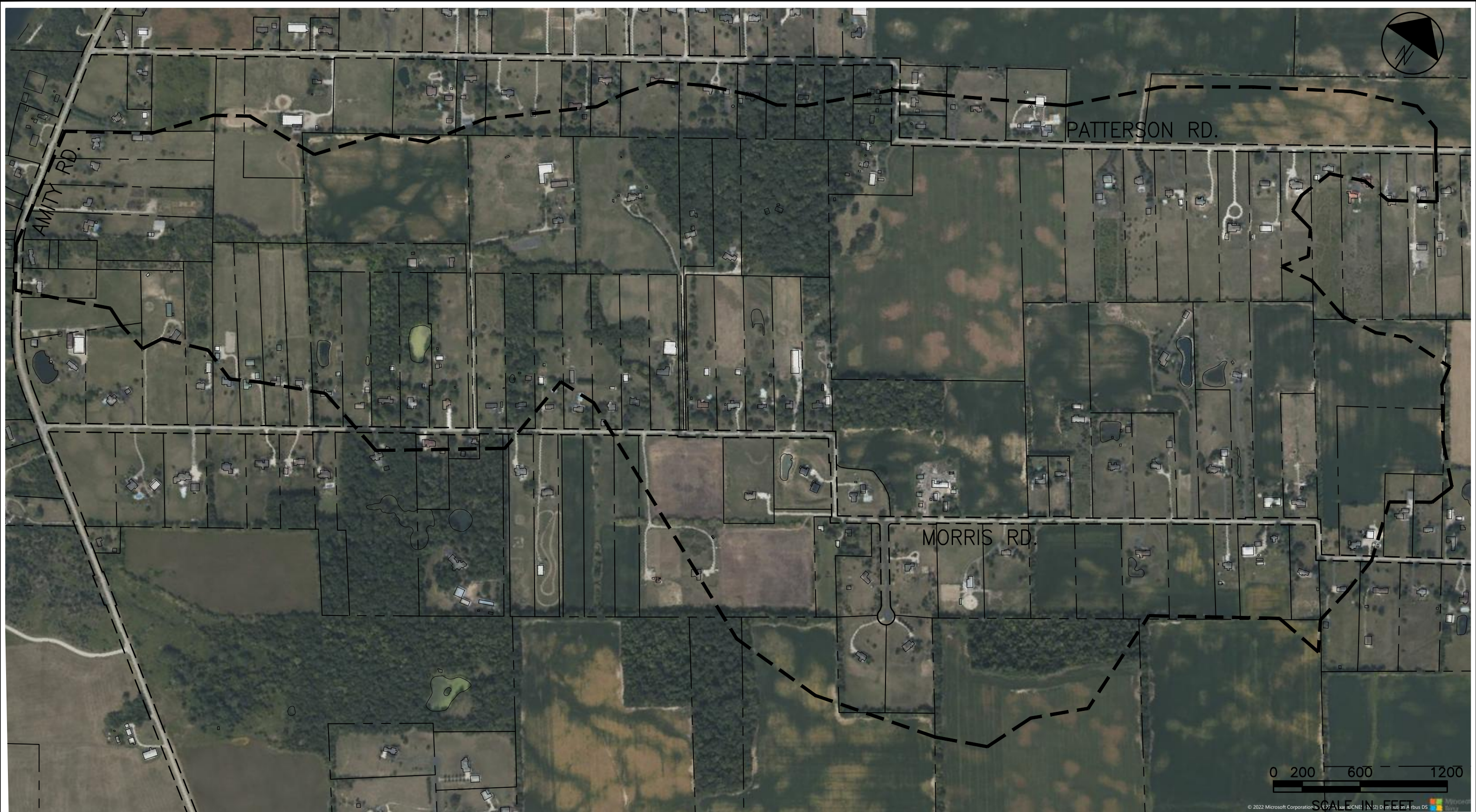


Exhibit 4____Site Aerial



 300 SPRUCE STREET SUITE 200 COLUMBUS, OHIO 43215 P: 614 280 9355 MOODY-ENG.COM	MANDO DRAINAGE IMPROVEMENT PROJECT	AERIAL	EXHIBIT-4
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Exhibit 5____Historic Farm Drainage Map

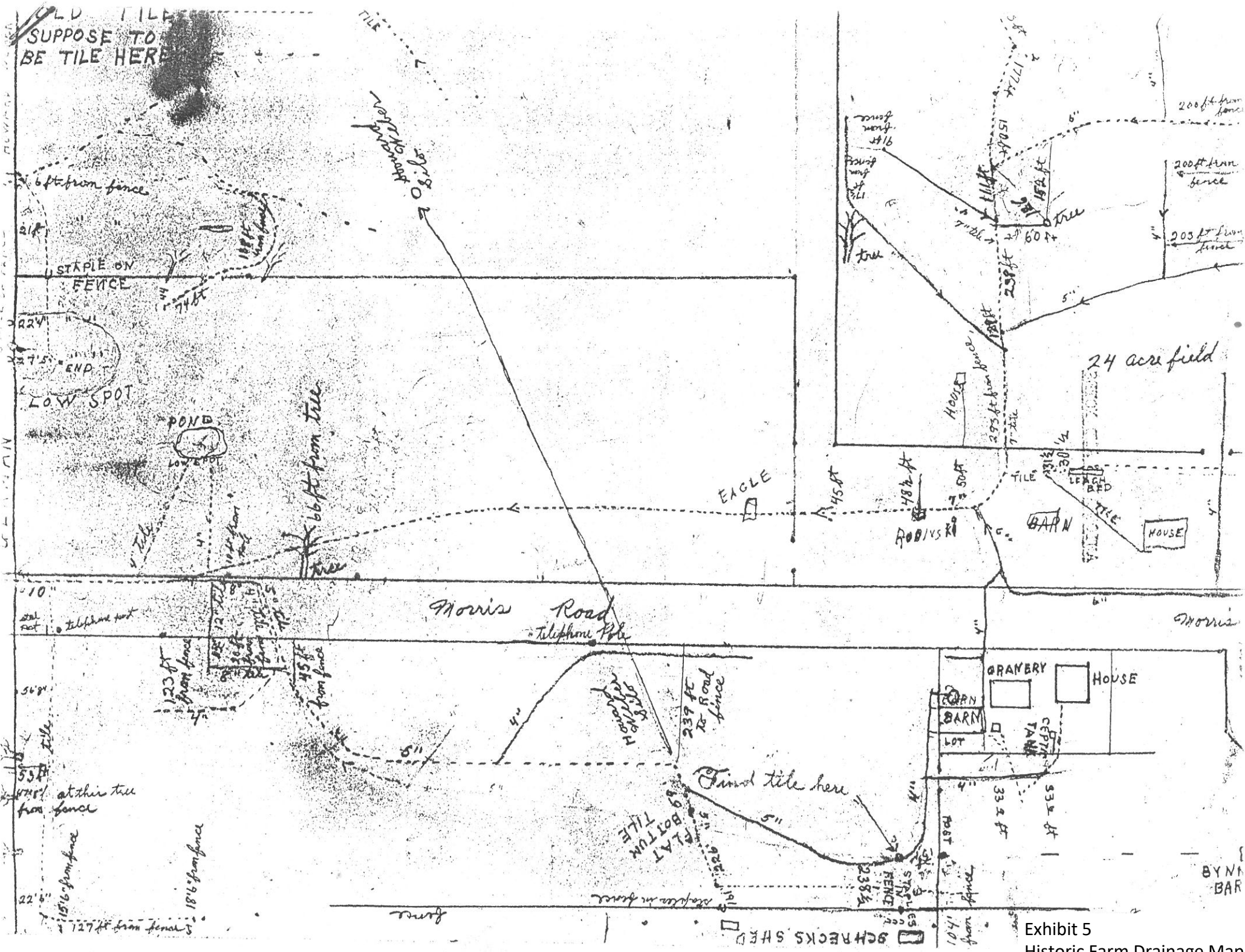


Exhibit 5
Historic Farm Drainage Map

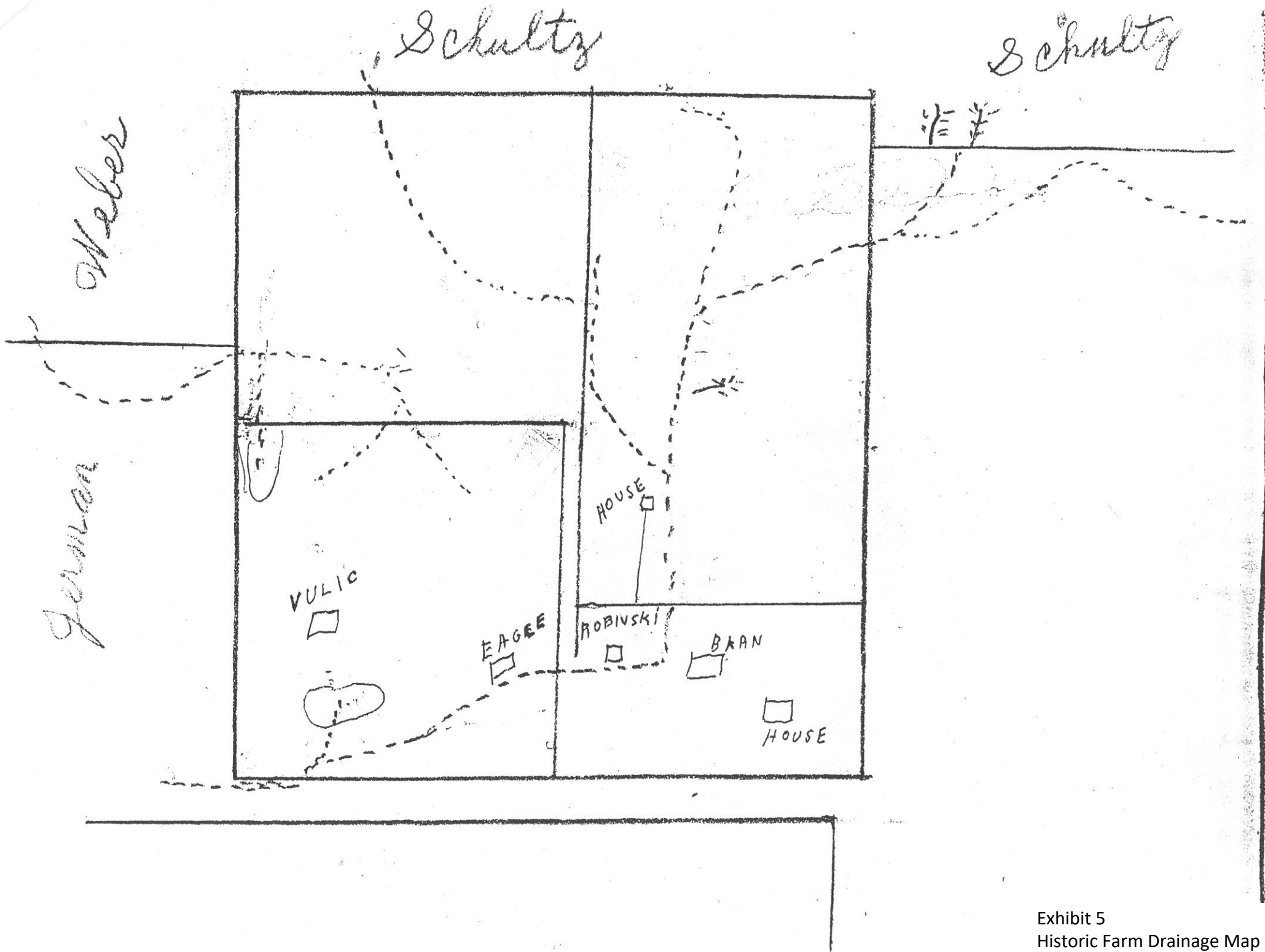


Exhibit 5
Historic Farm Drainage Map

Exhibit 6 ____ Agricultural Tile Sizing Calculation

Project: Tile #1
Date: 5/13/2022

Agricultural Run-Off Calculation

Tributary Area=	1558690 sf	35.7826 ac
Drainage Coefficient=	3/8 in	
Run-Off Rate=	0.56 cfs	

Project: Tile #4 (Upstream from Patterson Drainage)
Date: 5/13/2022

Agricultural Run-Off Calculation

Tributary Area= 2789150 sf 64.03007 ac

Drainage Coefficient= 3/8 in

Run-Off Rate= 1.01 cfs

Project: Tile #2
Date: 5/13/2022

Agricultural Run-Off Calculation

Tributary Area= 2371763 sf 54.44819 ac

Drainage Coefficient= 3/8 in

Run-Off Rate= 0.86 cfs

Project: Tile #3
Date: 5/13/2022

Agricultural Run-Off Calculation

Tributary Area= 3427749 sf 78.69029

Drainage Coefficient= 3/8 in

Run-Off Rate= 1.24 cfs

Exhibit 7____SCS Run Off Calculation

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

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	-----	12.31	18.67	-----	28.63	37.36	50.16	61.10	72.84	Area 4 Patterson Rd
2	SCS Runoff	-----	27.99	37.34	-----	51.02	62.42	78.54	91.94	106.08	Area 3 Pond Tributary
3	Reservoir	2	19.91	28.51	-----	41.09	51.62	66.33	78.53	91.47	Basin #3
4	SCS Runoff	-----	23.65	33.62	-----	48.71	61.62	80.21	95.89	112.56	Area 4 South of Patterson
5	Combine	1, 4	35.96	52.27	-----	77.34	98.99	130.37	157.00	185.40	Detention Basin 1 Tributary
6	Reservoir	5	8.799	28.42	-----	55.77	78.22	110.89	137.67	166.38	Basin #1
7	SCS Runoff	-----	33.48	44.55	-----	60.71	74.23	93.32	109.18	125.88	Area 2 Detention Tributary
8	Reservoir	7	10.79	12.40	-----	21.61	32.67	48.27	61.16	75.22	Basin #2
Proj. file: Mando Drainage.gpw										Wednesday, 11 / 2 / 2022	

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No. 1

Area 4 Patterson Rd

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.170	0.011	0.011	
Flow length (ft)	= 150.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.63	0.00	0.00	
Land slope (%)	= 0.35	0.00	0.00	
Travel Time (min)	= 33.18	+ 0.00	+ 0.00	= 33.18
Shallow Concentrated Flow				
Flow length (ft)	= 2110.00	0.00	0.00	
Watercourse slope (%)	= 0.35	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=0.95	0.00	0.00	
Travel Time (min)	= 36.84	+ 0.00	+ 0.00	= 36.84
Channel Flow				
X sectional flow area (sqft)	= 1.76	0.00	0.00	
Wetted perimeter (ft)	= 4.71	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)	=2.30	0.00	0.00	
Flow length (ft)	()2104.0	0.0	0.0	
Travel Time (min)	= 15.27	+ 0.00	+ 0.00	= 15.27
Total Travel Time, Tc				85.30 min

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No. 2

Area 3 Pond Tributary

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>			
Sheet Flow							
Manning's n-value	= 0.170	0.011	0.011				
Flow length (ft)	= 150.0	0.0	0.0				
Two-year 24-hr precip. (in)	= 2.63	0.00	0.00				
Land slope (%)	= 0.13	0.00	0.00				
Travel Time (min)	= 49.31	+	0.00	+	0.00	=	49.31
Shallow Concentrated Flow							
Flow length (ft)	= 1387.00	0.00	0.00				
Watercourse slope (%)	= 0.13	0.00	0.00				
Surface description	= Unpaved	Paved	Paved				
Average velocity (ft/s)	=0.58	0.00	0.00				
Travel Time (min)	= 39.74	+	0.00	+	0.00	=	39.74
Channel Flow							
X sectional flow area (sqft)	= 0.00	0.00	0.00				
Wetted perimeter (ft)	= 0.00	0.00	0.00				
Channel slope (%)	= 0.00	0.00	0.00				
Manning's n-value	= 0.015	0.015	0.015				
Velocity (ft/s)	=0.00	0.00	0.00				
Flow length (ft)	(0)0.0	0.0	0.0				
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc				89.00 min			

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No. 7

Area 2 Detention Tributary

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 150.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.63	0.00	0.00	
Land slope (%)	= 1.00	0.00	0.00	
Travel Time (min)	= 28.73	+ 0.00	+ 0.00	= 28.73
Shallow Concentrated Flow				
Flow length (ft)	= 2631.00	0.00	0.00	
Watercourse slope (%)	= 1.00	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=1.61	0.00	0.00	
Travel Time (min)	= 27.18	+ 0.00	+ 0.00	= 27.18
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				55.90 min

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Pond No. 2 - Basin #1 Area 4-Patterson Road

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 921.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	921.00	00	0	0
1.00	922.00	31,640	10,546	10,546
2.00	923.00	34,744	33,177	43,722
3.00	924.00	37,975	36,344	80,066
4.00	925.00	41,334	39,639	119,705
5.00	926.00	44,821	43,061	162,766
6.00	927.00	48,436	46,612	209,378
7.00	928.00	52,179	50,291	259,669
8.00	929.00	56,051	54,098	313,767

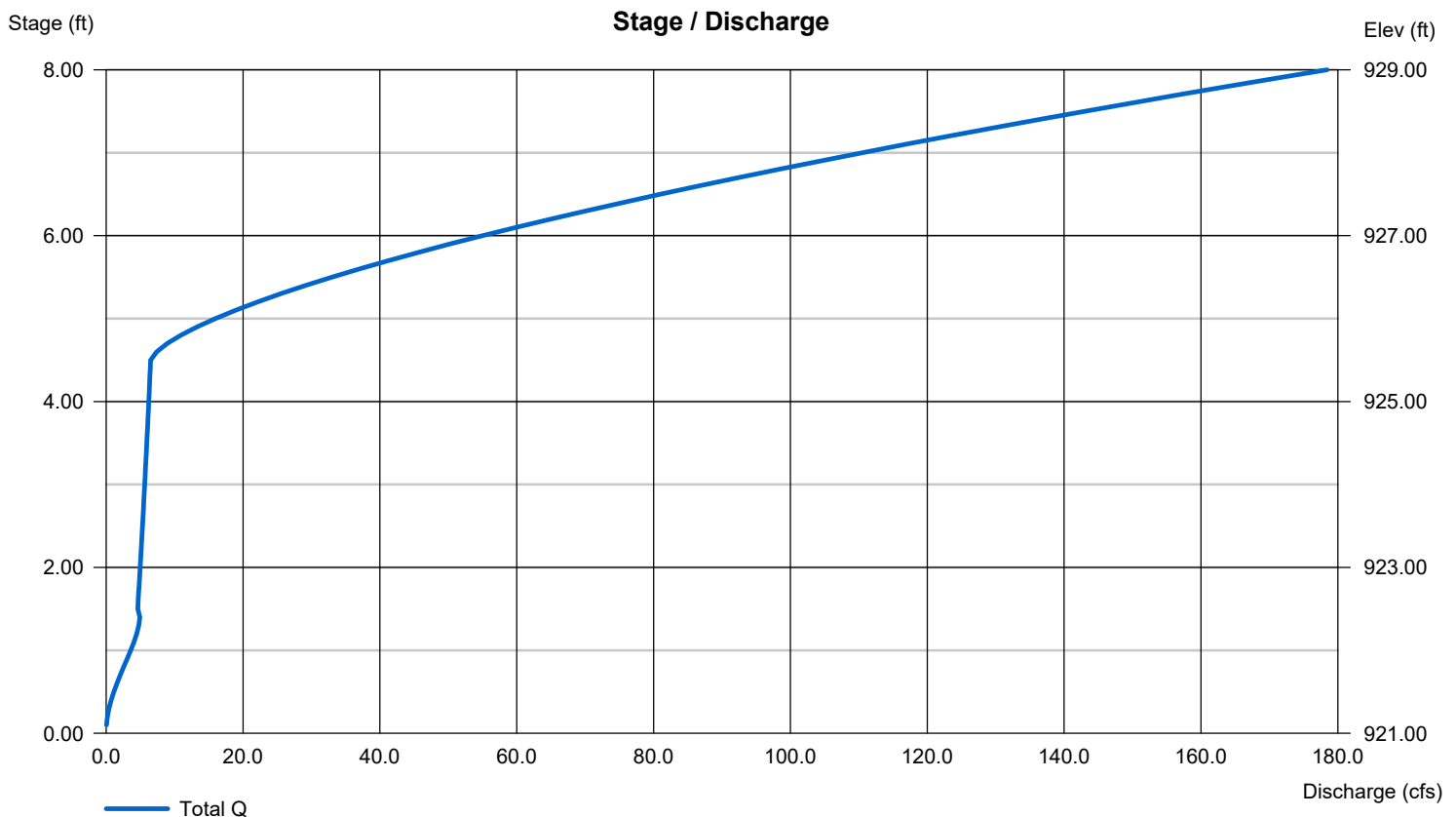
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	0.00	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 921.00	0.00	0.00	0.00
Length (ft)	= 1500.00	0.00	0.00	0.00
Slope (%)	= 0.20	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	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 10.00	0.00	0.00	0.00
Crest El. (ft)	= 925.50	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
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).



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Pond No. 3 - Basin #2 Area 2-Field Drainage

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 925.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	925.00	00	0	0
1.00	926.00	31,641	10,546	10,546
2.00	927.00	60,050	45,089	55,635
3.00	928.00	70,000	64,955	120,590
4.00	929.00	80,000	74,937	195,527
5.00	930.00	100,000	89,805	285,332

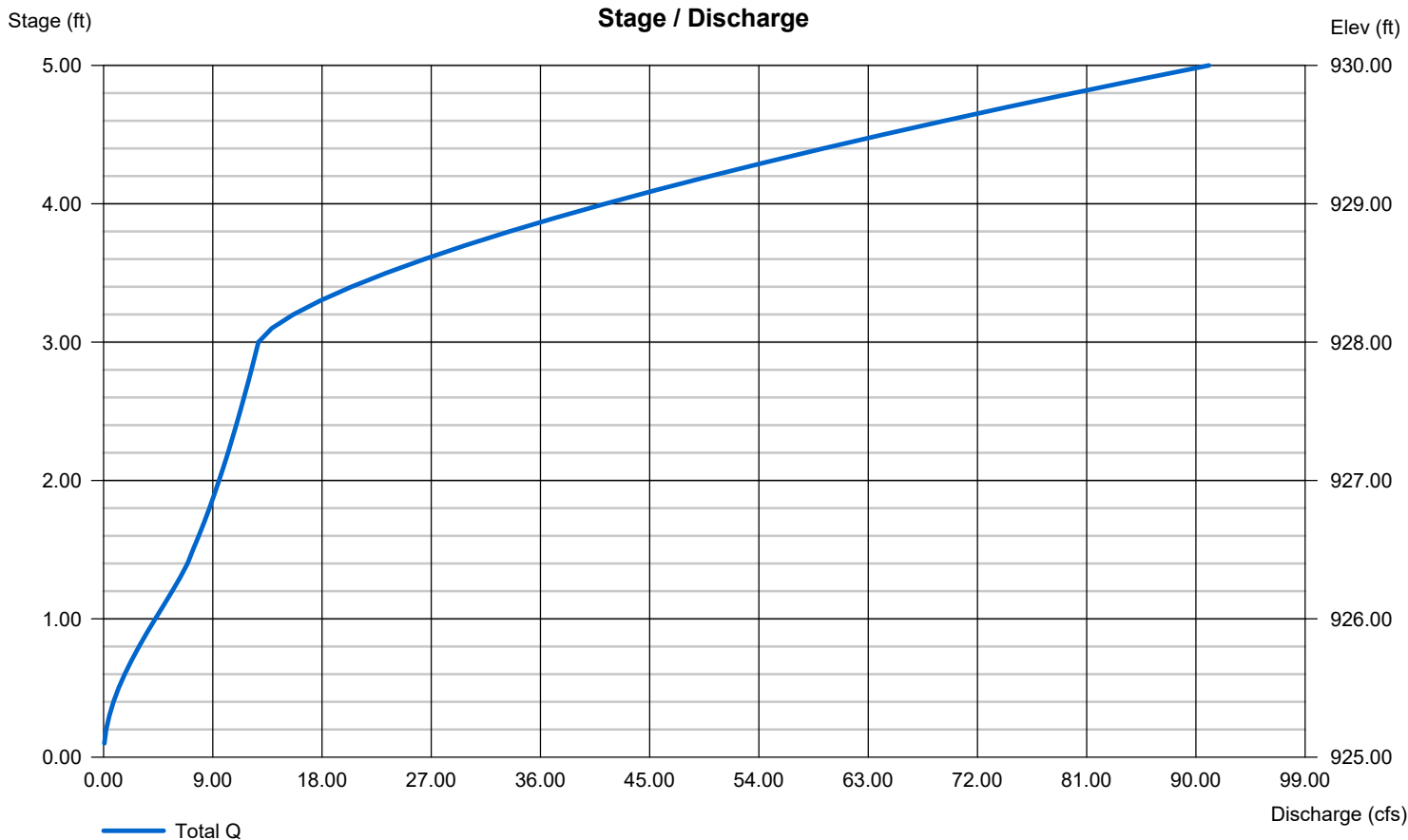
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	0.00	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 925.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	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	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 10.00	0.00	0.00	0.00
Crest El. (ft)	= 928.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
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).



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Pond No. 1 - Basin #3-Area 3-Mando

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 935.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	935.00	63,871	0	0
1.00	936.00	65,000	64,428	64,428
2.00	937.00	68,000	66,488	130,916
3.00	938.00	70,000	68,991	199,907

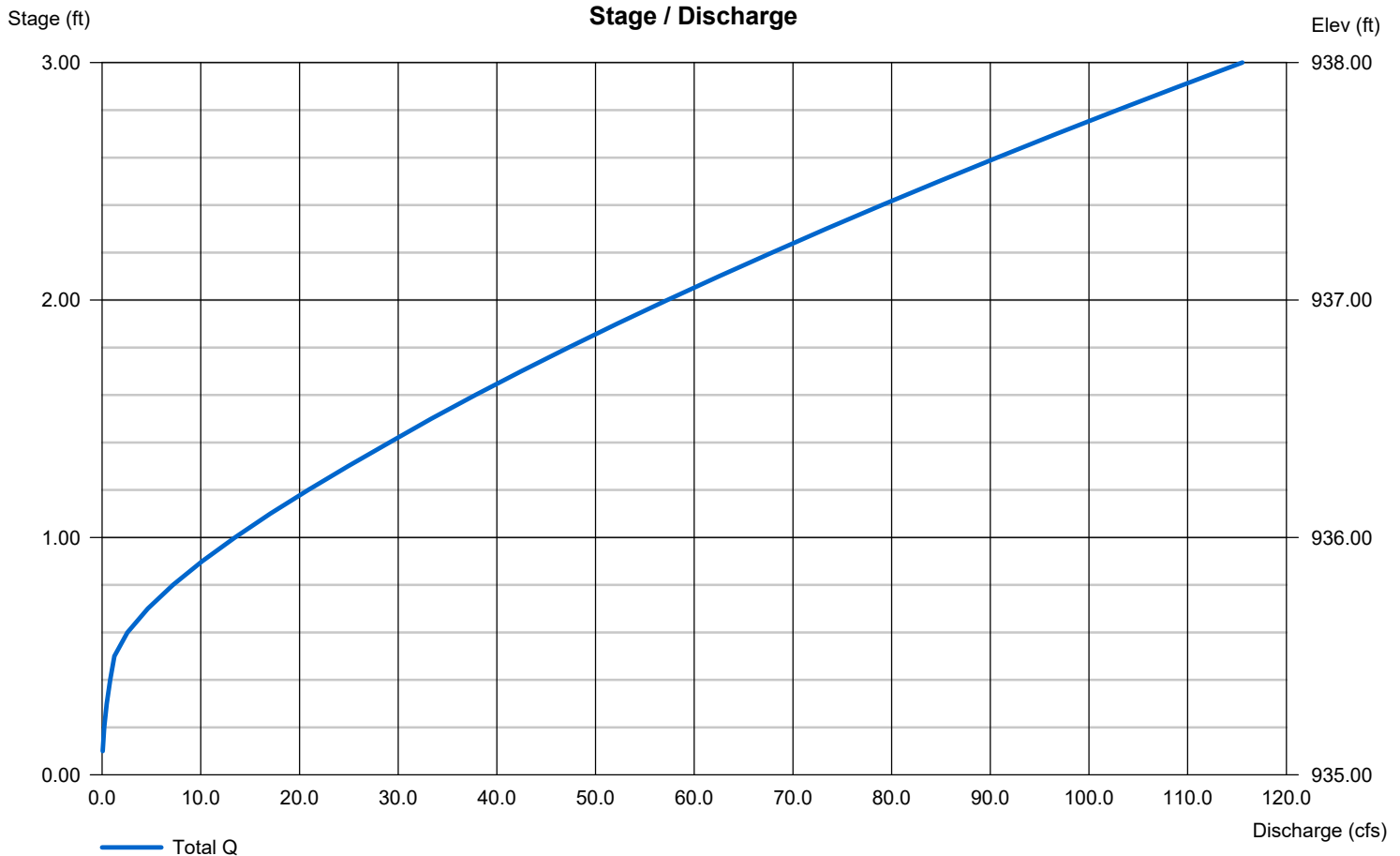
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	0.00	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 935.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	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	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 10.00	0.00	0.00	0.00
Crest El. (ft)	= 935.50	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
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).



Hydrograph Report

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.31 cfs
Storm frequency	=	1 yrs	Time to peak	=	768 min
Time interval	=	2 min	Hyd. volume	=	117,690 cuft
Drainage area	=	50.640 ac	Curve number	=	79
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	85.30 min
Total precip.	=	2.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

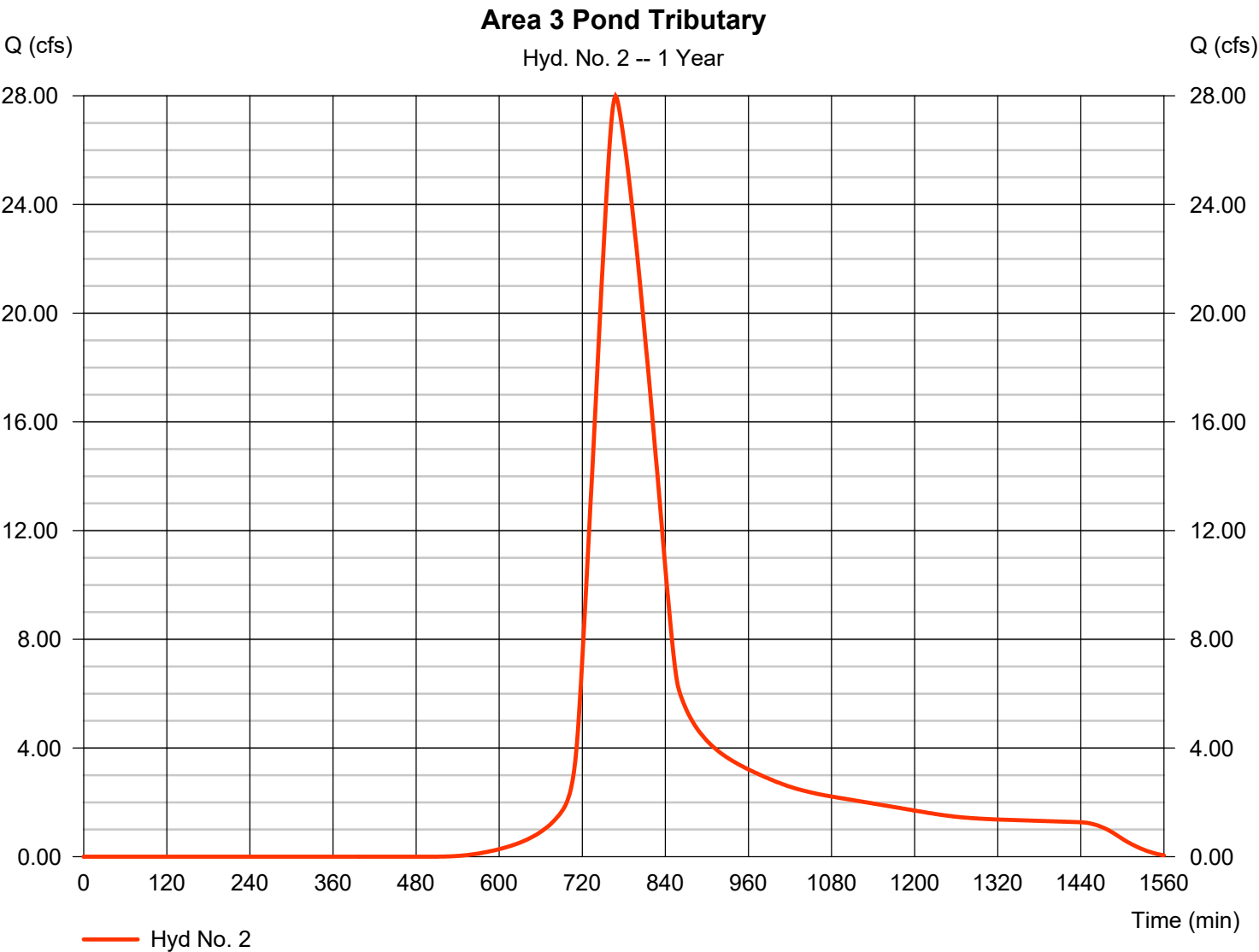


Hydrograph Report

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	27.99 cfs
Storm frequency	=	1 yrs	Time to peak	=	768 min
Time interval	=	2 min	Hyd. volume	=	245,826 cuft
Drainage area	=	60.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	89.00 min
Total precip.	=	2.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

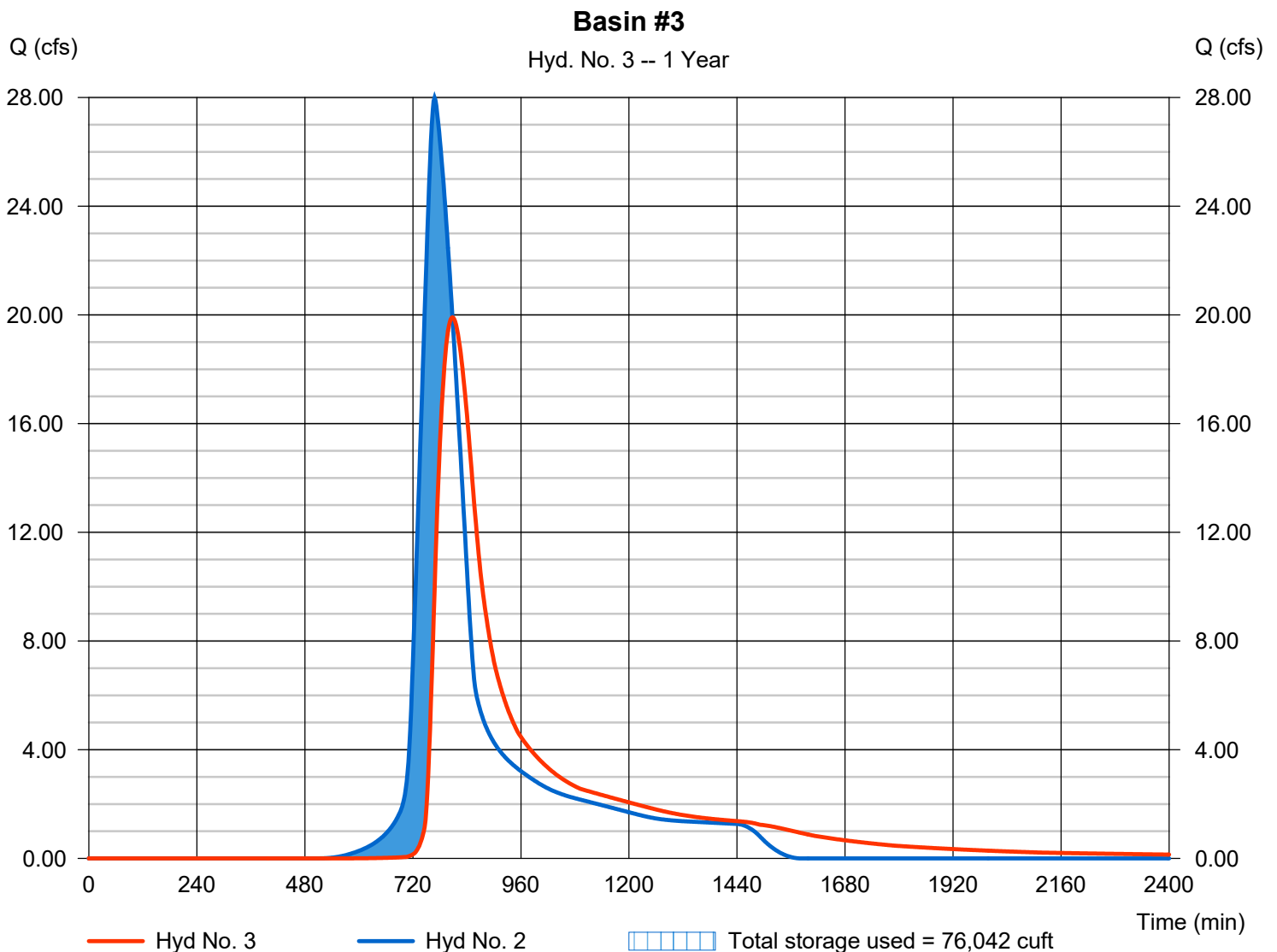
Wednesday, 11 / 2 / 2022

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 19.91 cfs
Storm frequency	= 1 yrs	Time to peak	= 808 min
Time interval	= 2 min	Hyd. volume	= 244,215 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 936.17 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 76,042 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

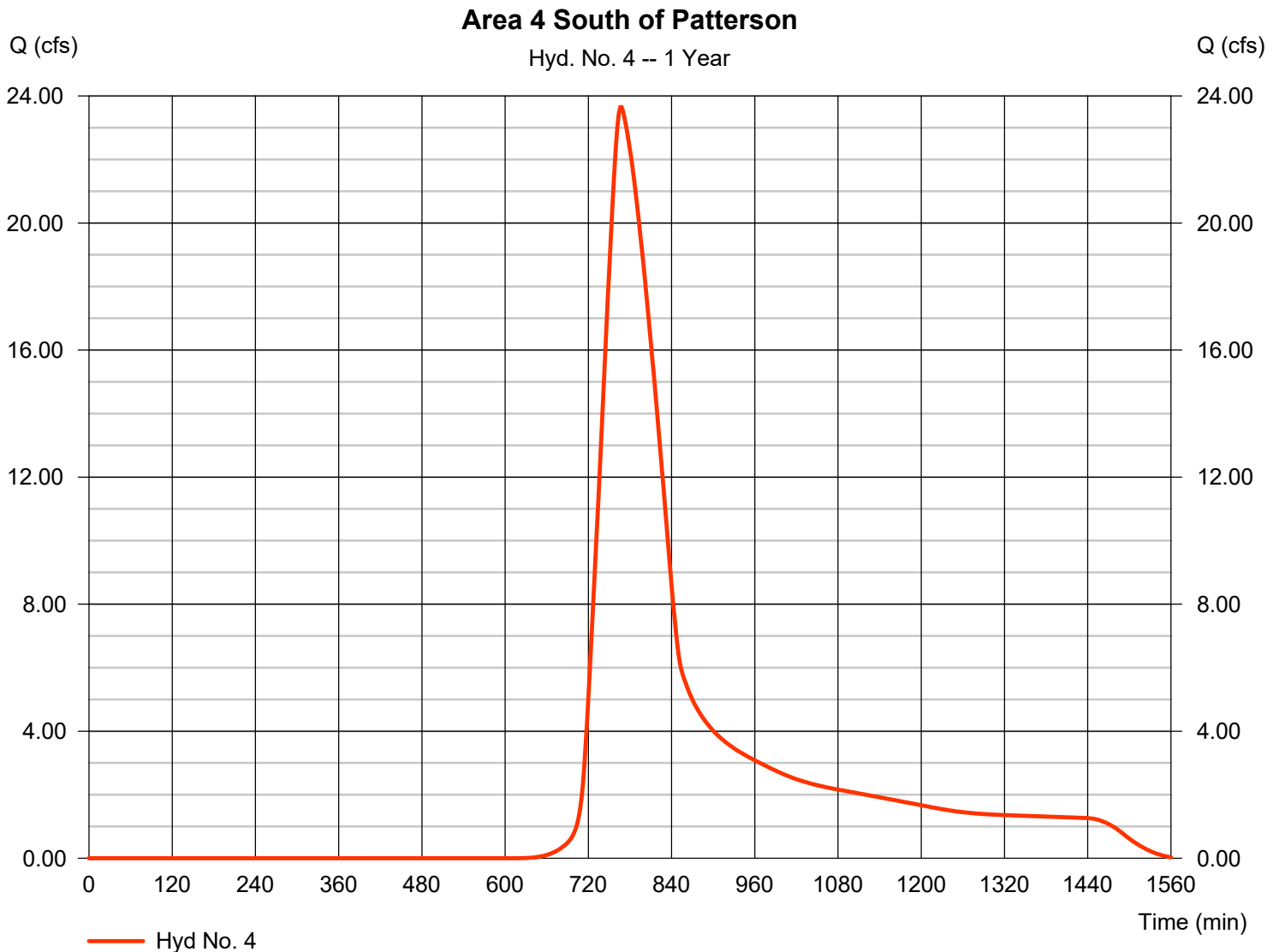
Hyd. No. 4

Area 4 South of Patterson

Hydrograph type = SCS Runoff
Storm frequency = 1 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 2.20 in
Storm duration = 24 hrs

Peak discharge = 23.65 cfs
Time to peak = 768 min
Hyd. volume = 210,865 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

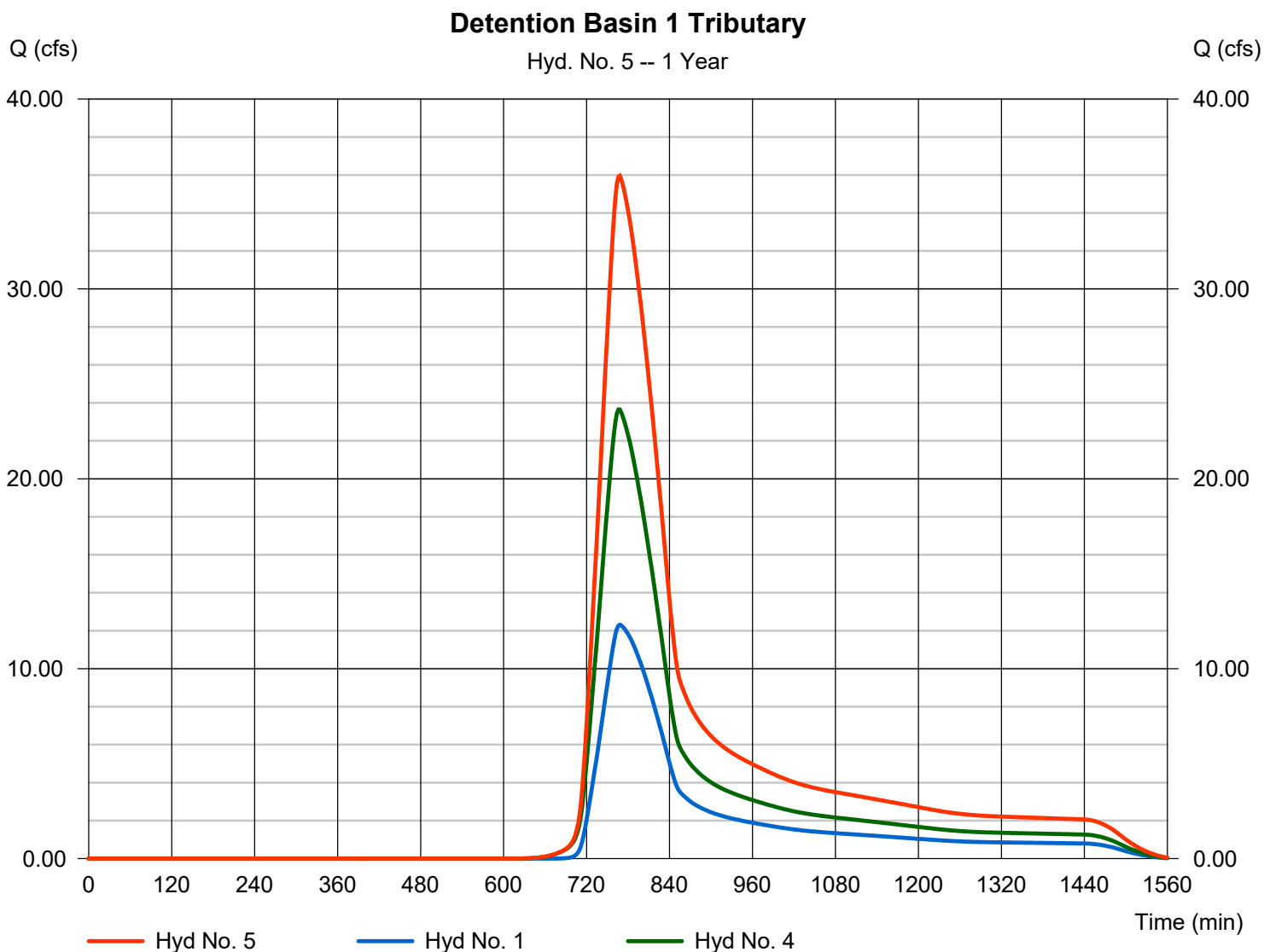
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 35.96 cfs
Time to peak = 768 min
Hyd. volume = 328,555 cuft
Contrib. drain. area = 120.540 ac



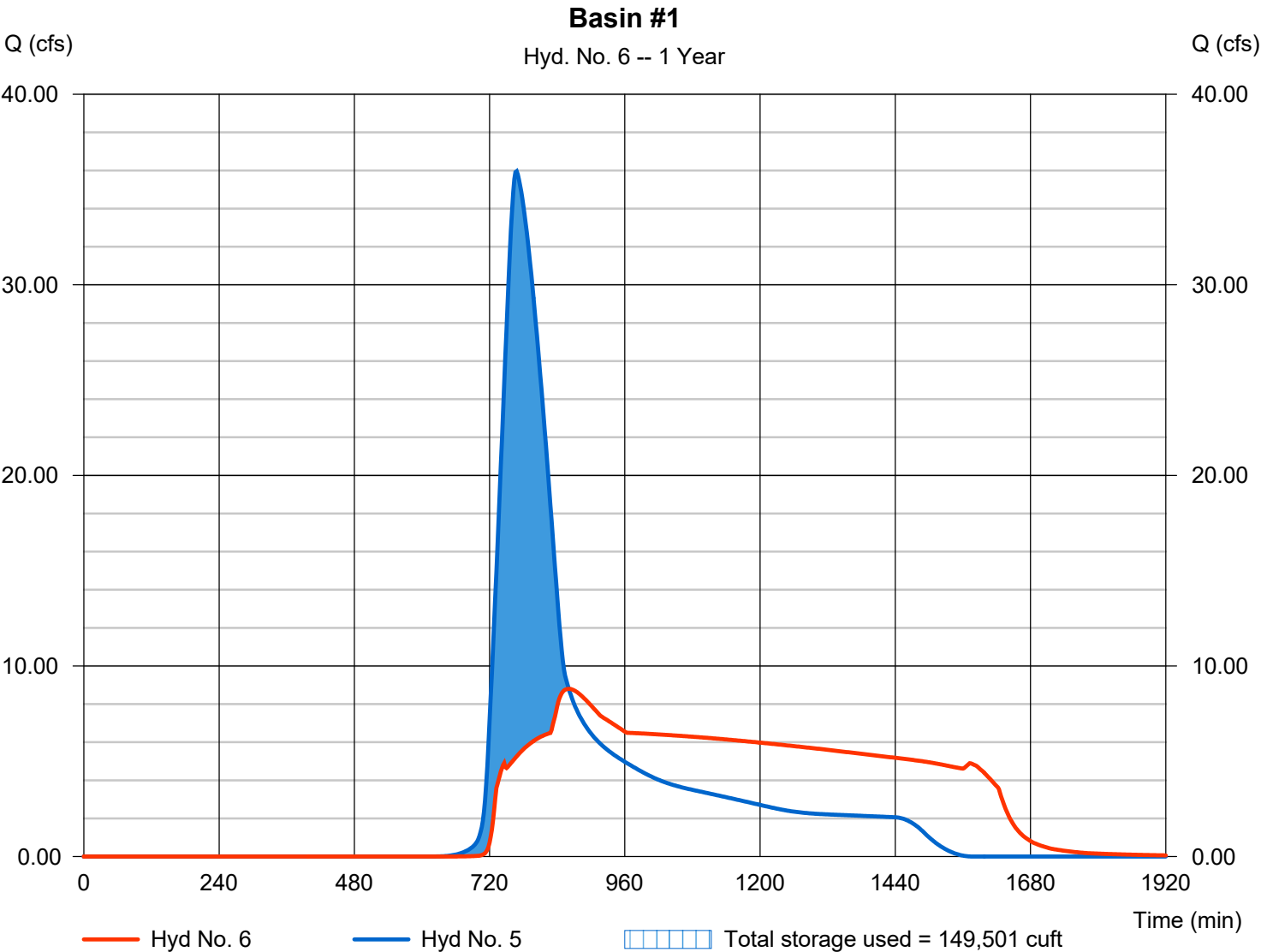
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 8.799 cfs
Storm frequency	= 1 yrs	Time to peak	= 860 min
Time interval	= 2 min	Hyd. volume	= 328,529 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 925.69 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 149,501 cuft

Storage Indication method used.

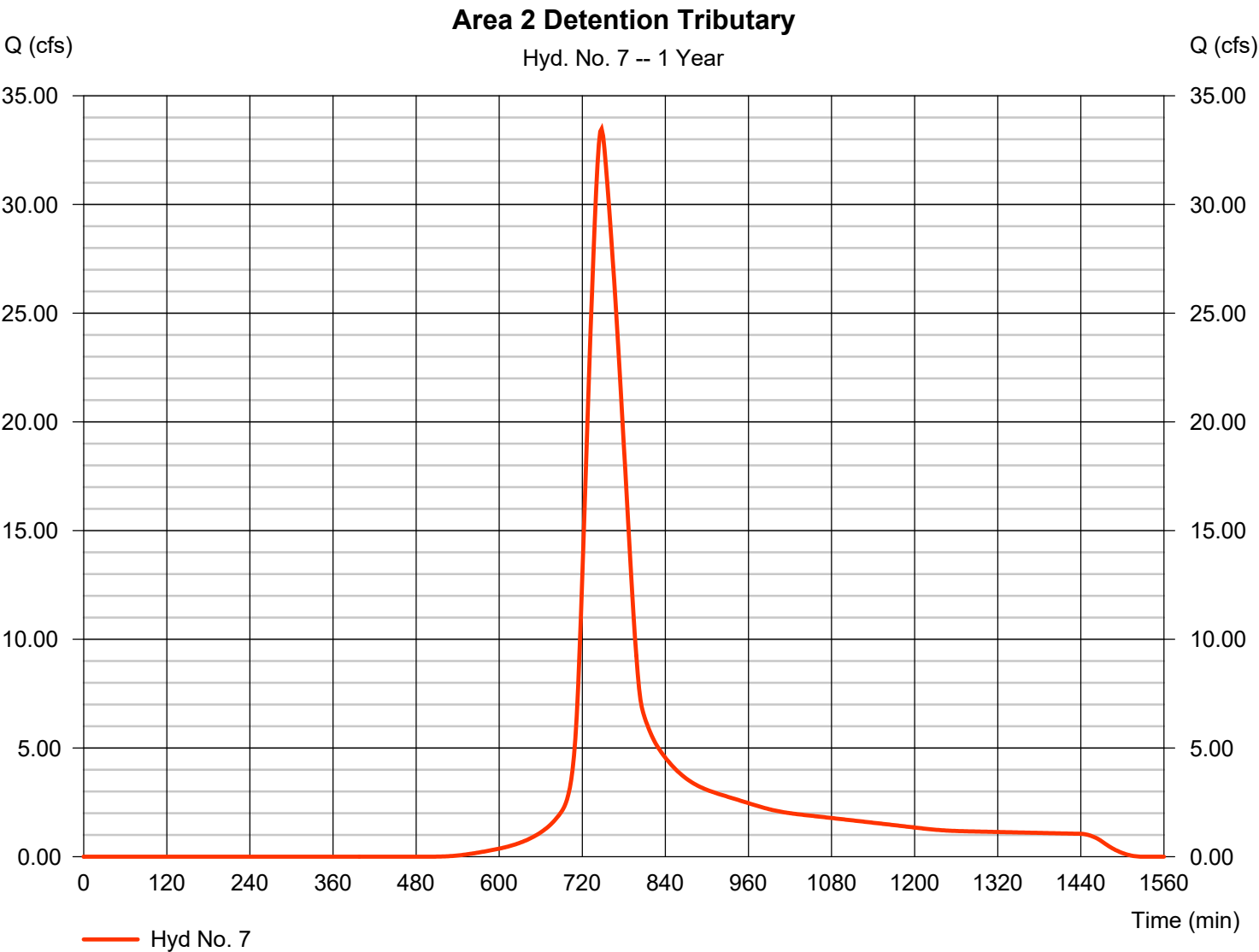


Hydrograph Report

Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	33.48 cfs
Storm frequency	=	1 yrs	Time to peak	=	748 min
Time interval	=	2 min	Hyd. volume	=	207,416 cuft
Drainage area	=	51.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	55.90 min
Total precip.	=	2.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



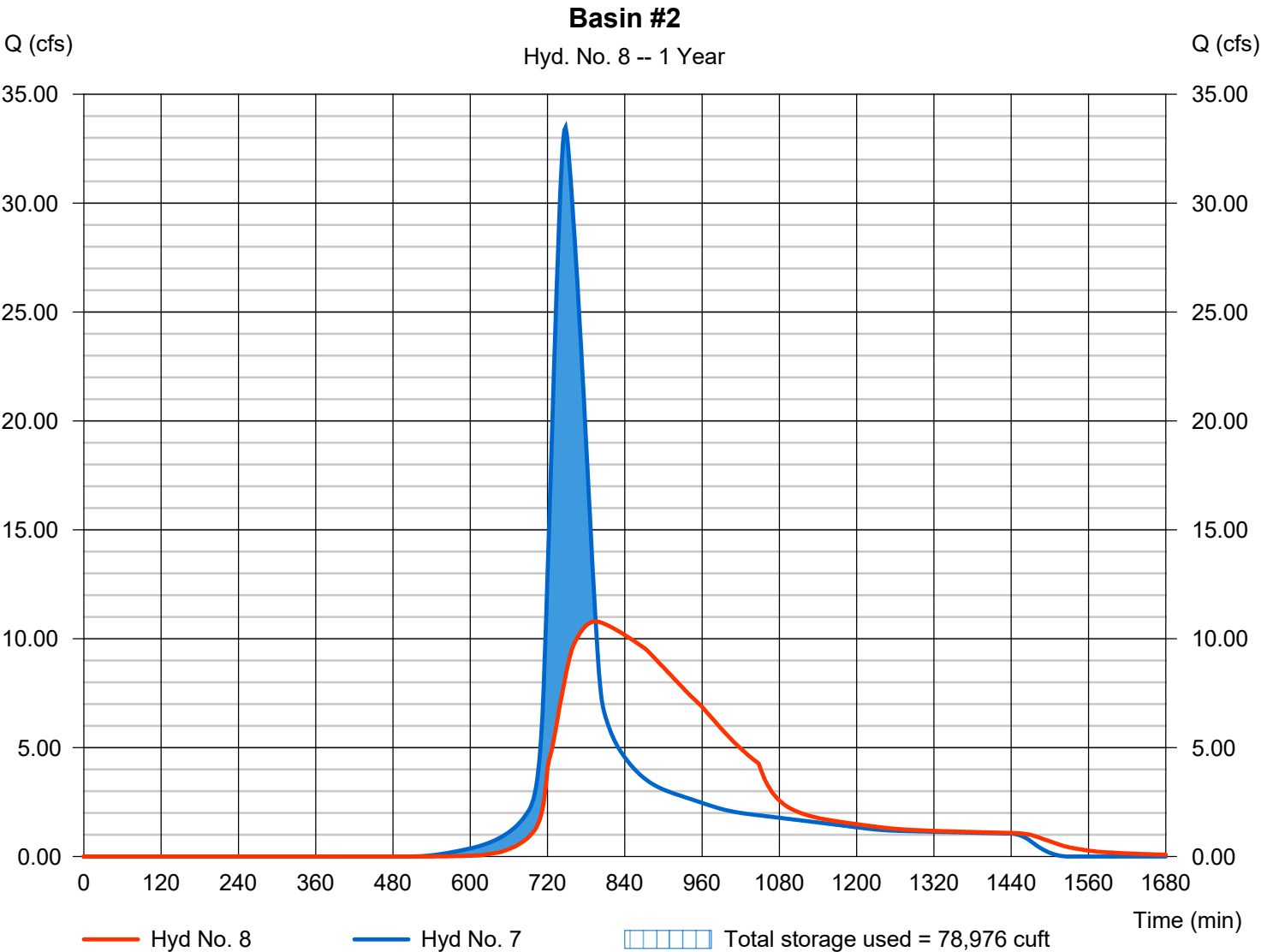
Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 10.79 cfs
Storm frequency	= 1 yrs	Time to peak	= 794 min
Time interval	= 2 min	Hyd. volume	= 207,397 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 927.36 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 78,976 cuft

Storage Indication method used.

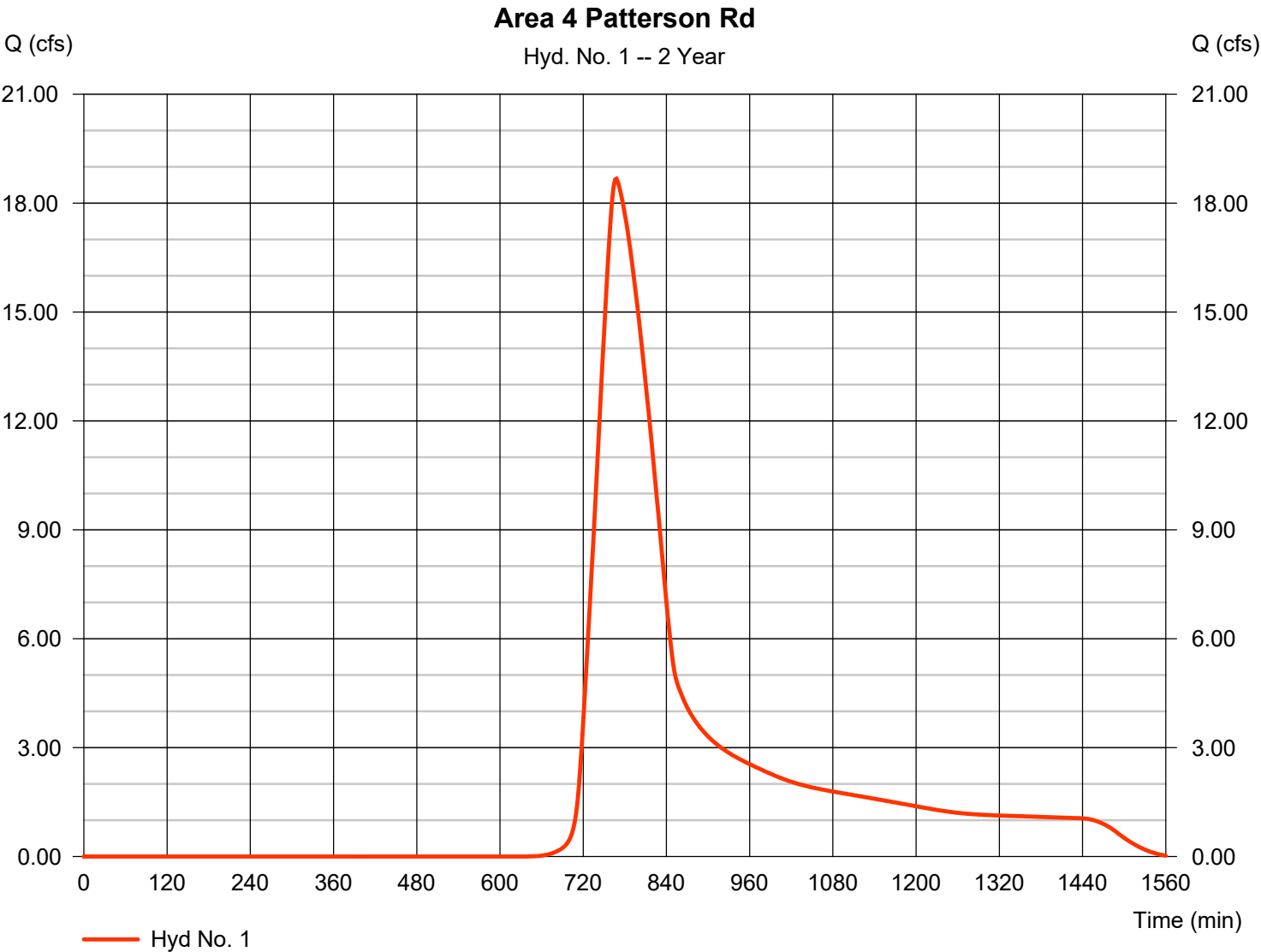


Hydrograph Report

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type	= SCS Runoff	Peak discharge	= 18.67 cfs
Storm frequency	= 2 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 169,344 cuft
Drainage area	= 50.640 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 85.30 min
Total precip.	= 2.63 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

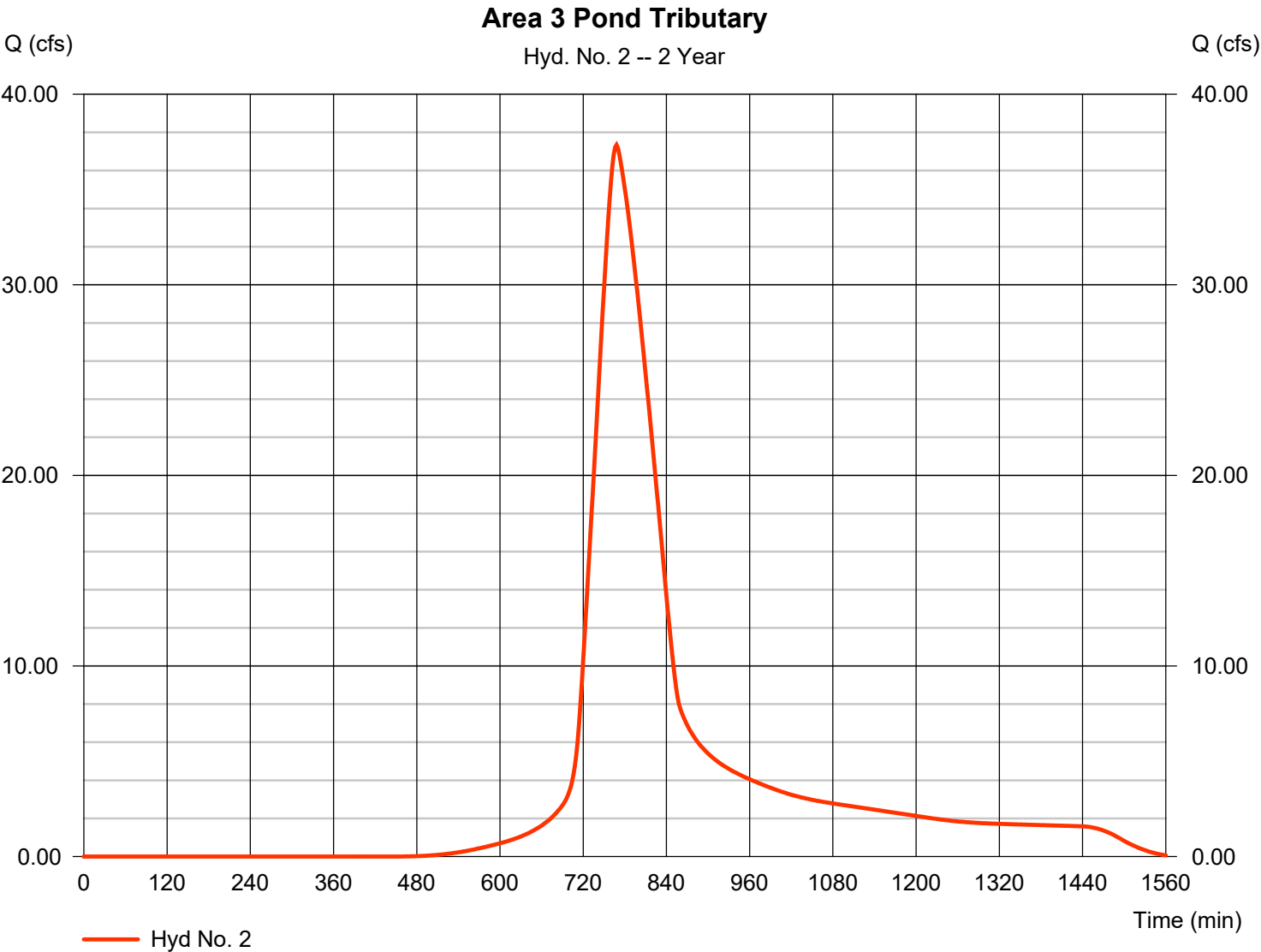


Hydrograph Report

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	= SCS Runoff	Peak discharge	= 37.34 cfs
Storm frequency	= 2 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 325,259 cuft
Drainage area	= 60.000 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 89.00 min
Total precip.	= 2.63 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

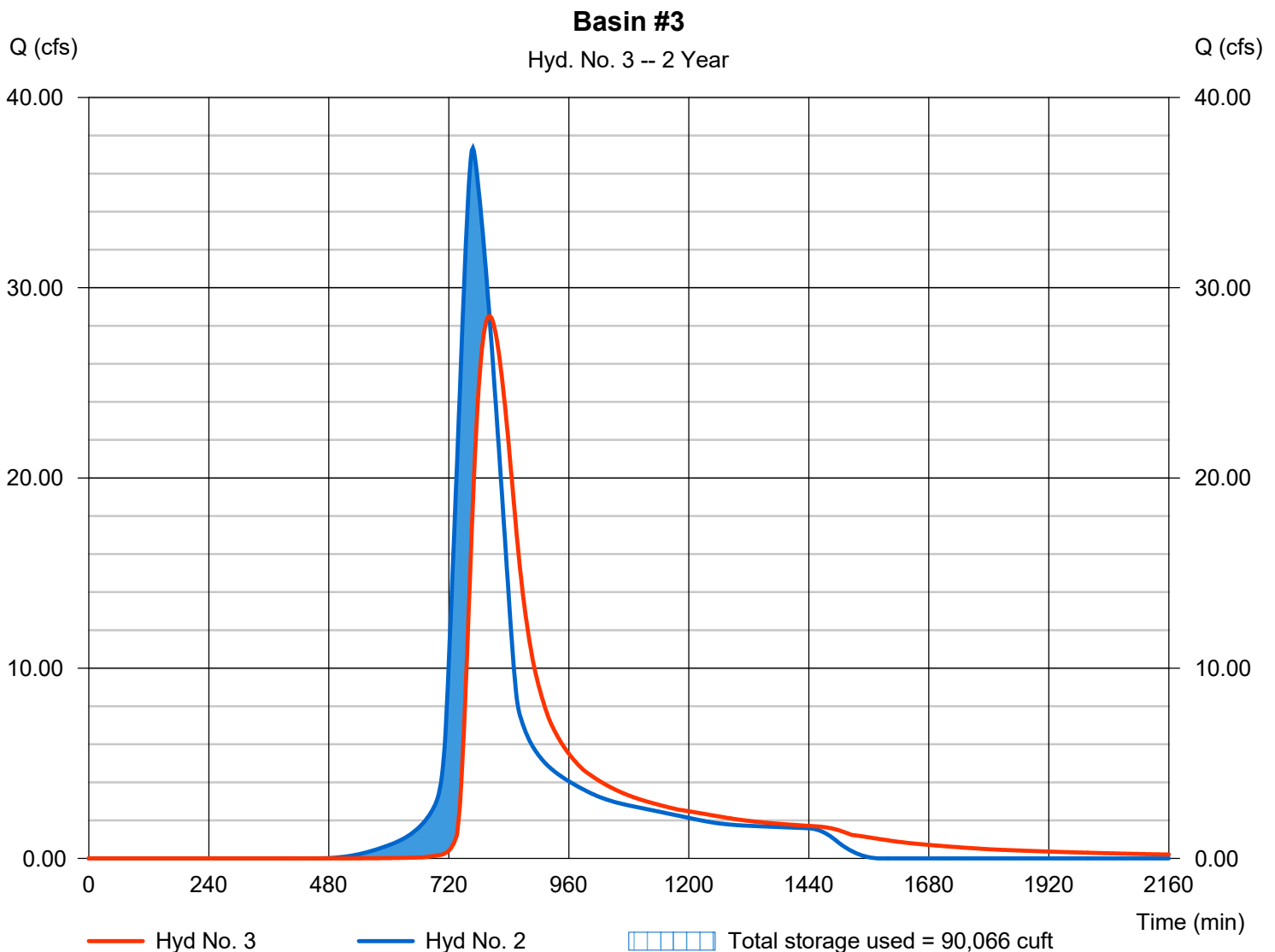
Wednesday, 11 / 2 / 2022

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 28.51 cfs
Storm frequency	= 2 yrs	Time to peak	= 802 min
Time interval	= 2 min	Hyd. volume	= 323,630 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 936.39 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 90,066 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

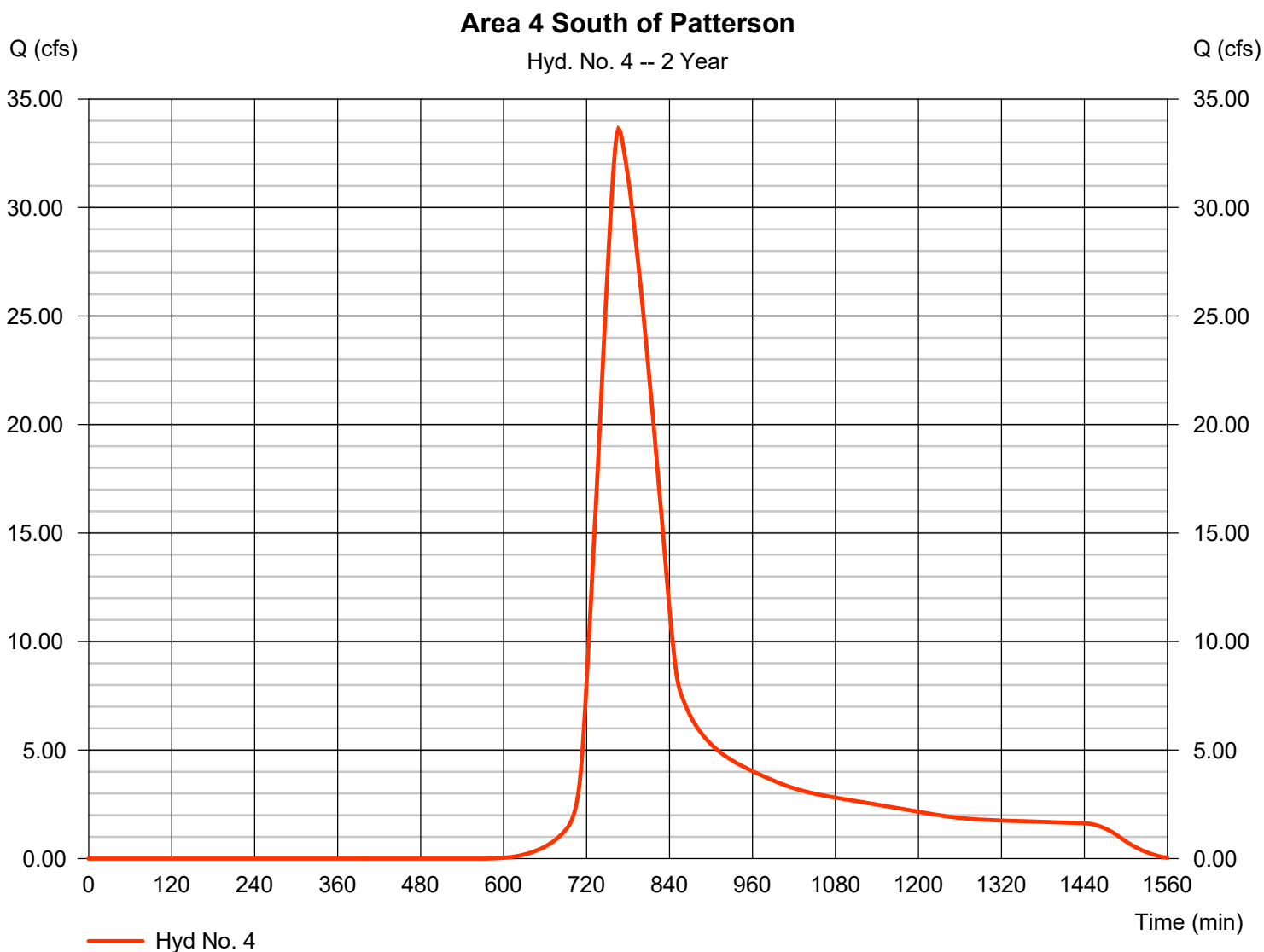
Hyd. No. 4

Area 4 South of Patterson

Hydrograph type = SCS Runoff
Storm frequency = 2 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 2.63 in
Storm duration = 24 hrs

Peak discharge = 33.62 cfs
Time to peak = 766 min
Hyd. volume = 291,647 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

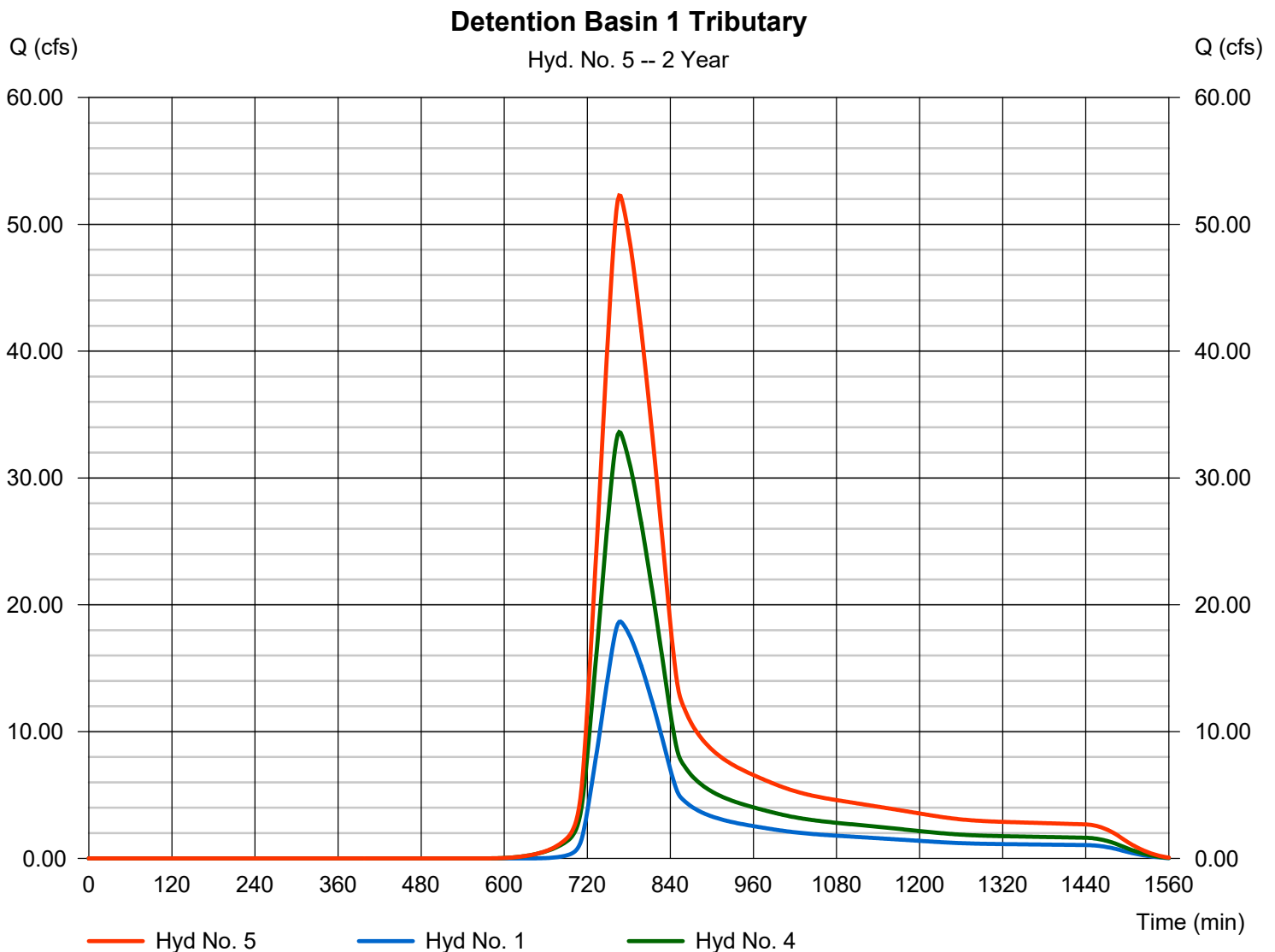
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 52.27 cfs
Time to peak = 766 min
Hyd. volume = 460,991 cuft
Contrib. drain. area = 120.540 ac



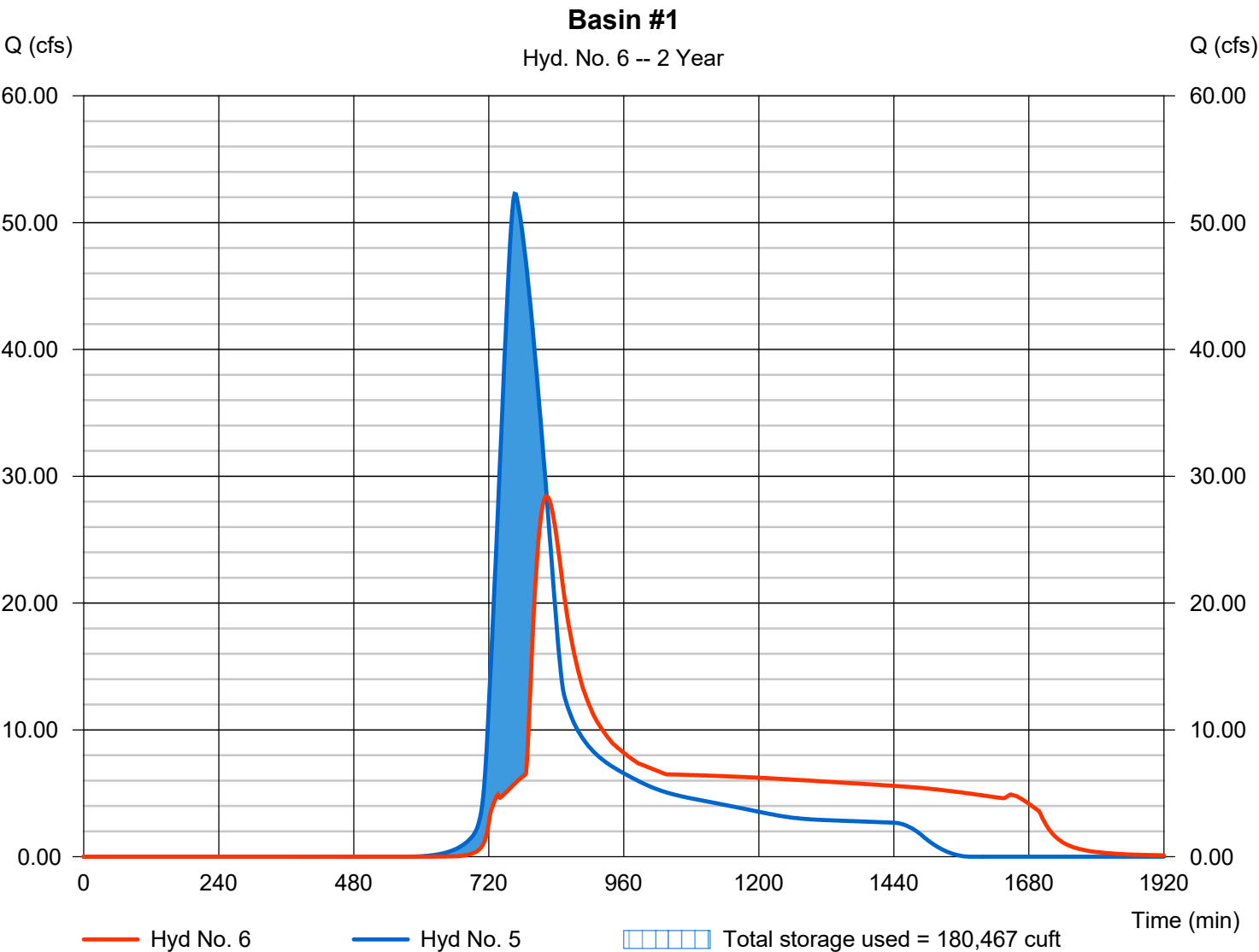
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 28.42 cfs
Storm frequency	= 2 yrs	Time to peak	= 822 min
Time interval	= 2 min	Hyd. volume	= 460,966 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 926.38 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 180,467 cuft

Storage Indication method used.

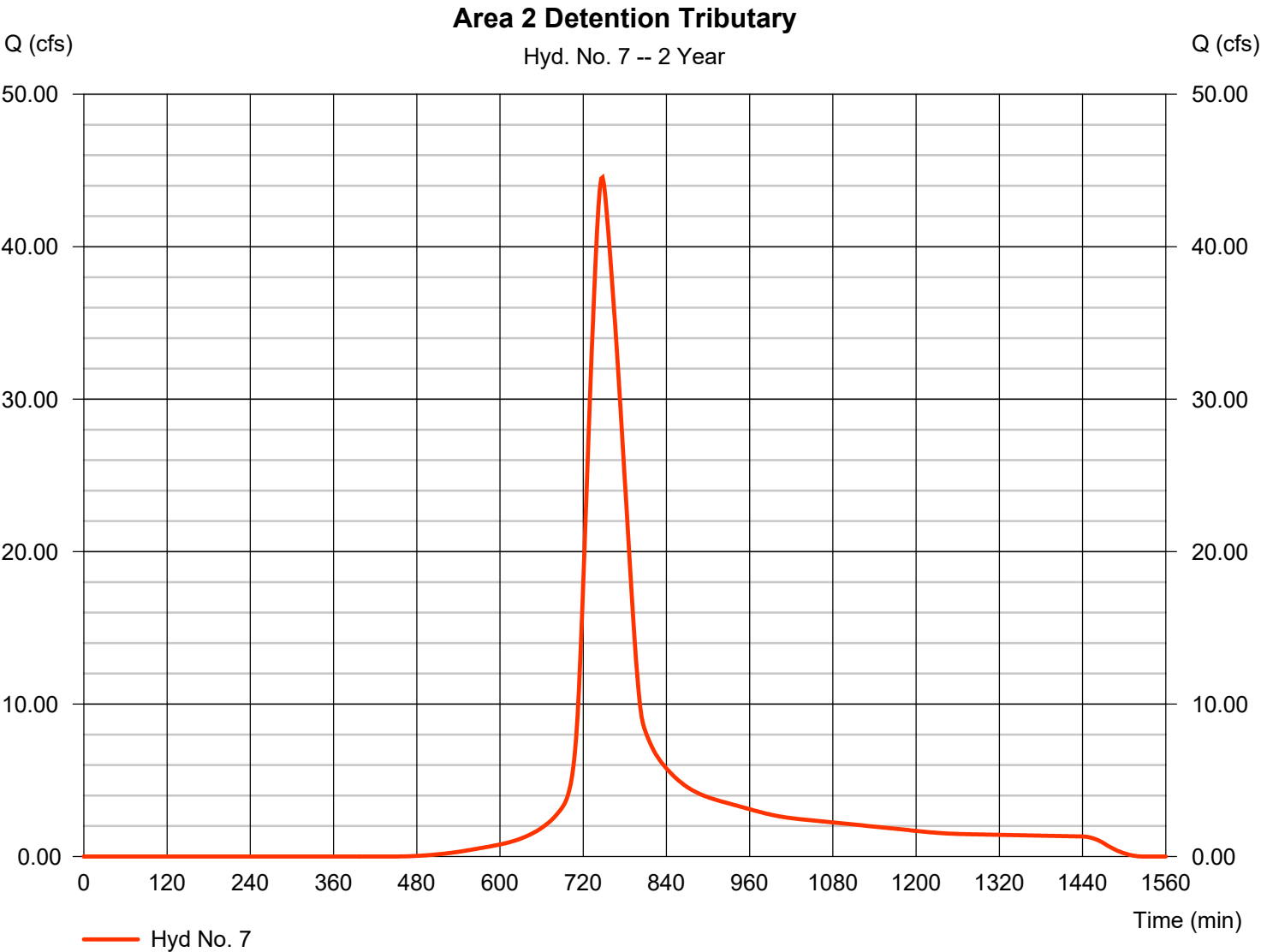


Hydrograph Report

Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	44.55 cfs
Storm frequency	=	2 yrs	Time to peak	=	748 min
Time interval	=	2 min	Hyd. volume	=	274,437 cuft
Drainage area	=	51.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	55.90 min
Total precip.	=	2.63 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



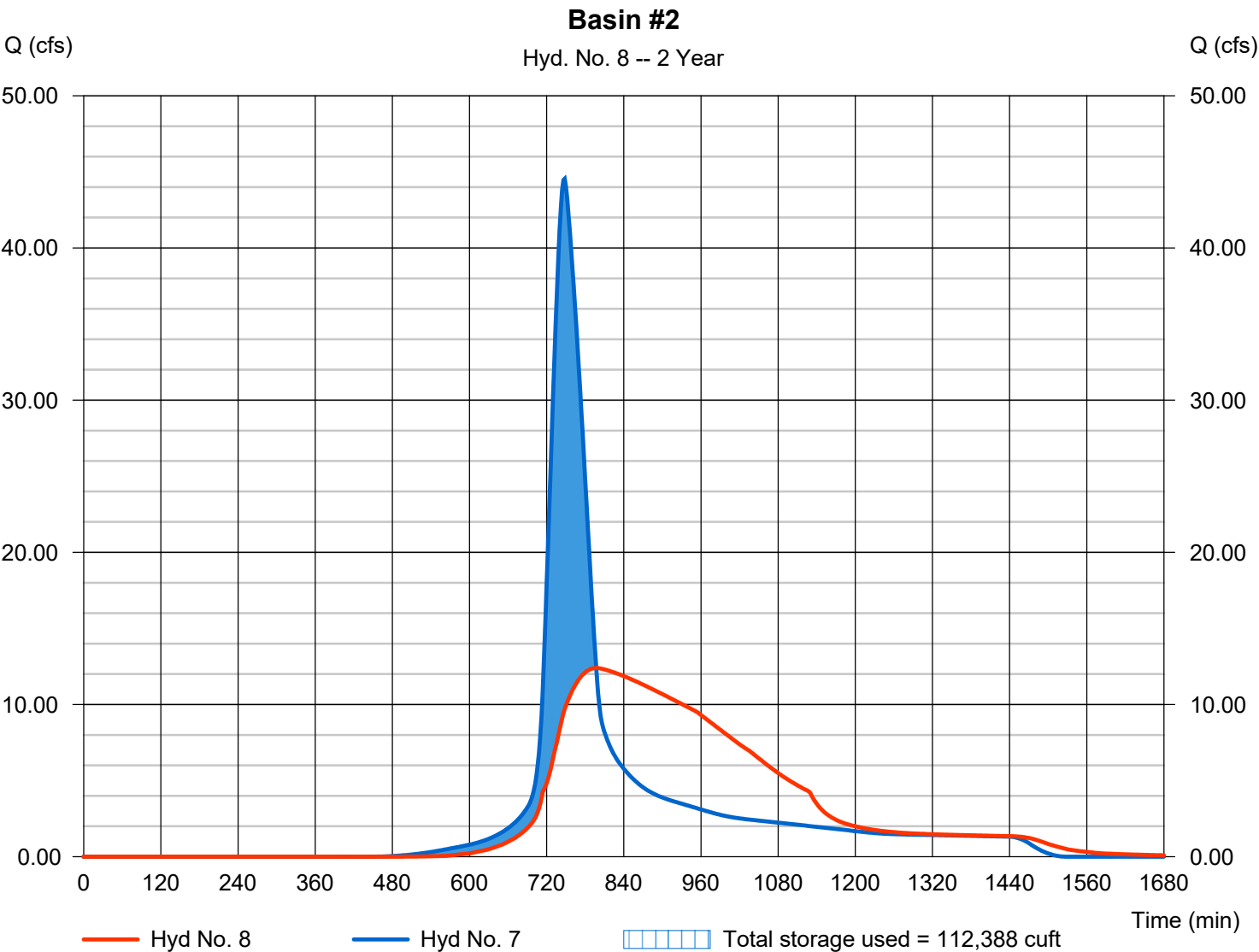
Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 12.40 cfs
Storm frequency	= 2 yrs	Time to peak	= 798 min
Time interval	= 2 min	Hyd. volume	= 274,417 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 927.87 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 112,388 cuft

Storage Indication method used.

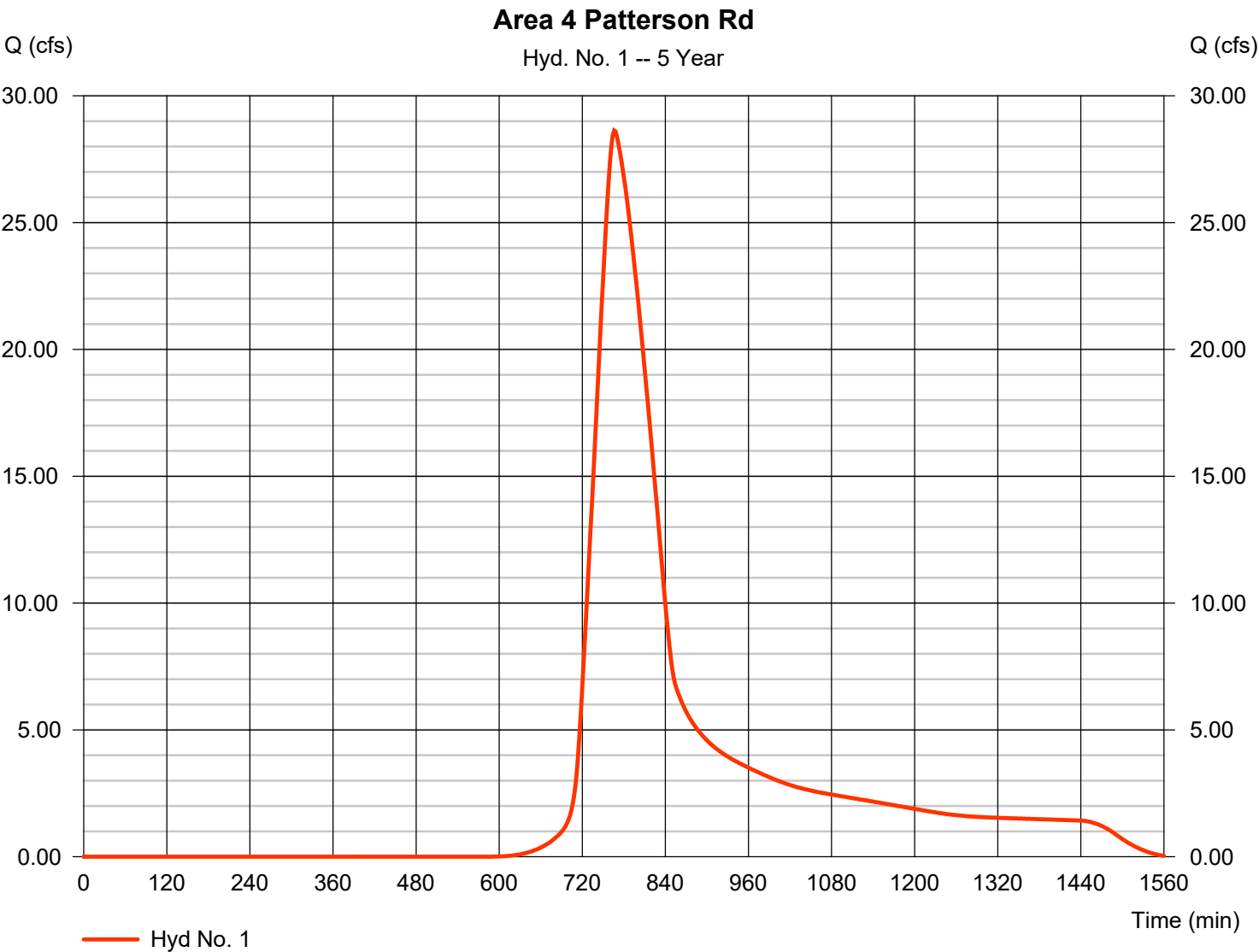


Hydrograph Report

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type	= SCS Runoff	Peak discharge	= 28.63 cfs
Storm frequency	= 5 yrs	Time to peak	= 766 min
Time interval	= 2 min	Hyd. volume	= 250,047 cuft
Drainage area	= 50.640 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 85.30 min
Total precip.	= 3.24 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

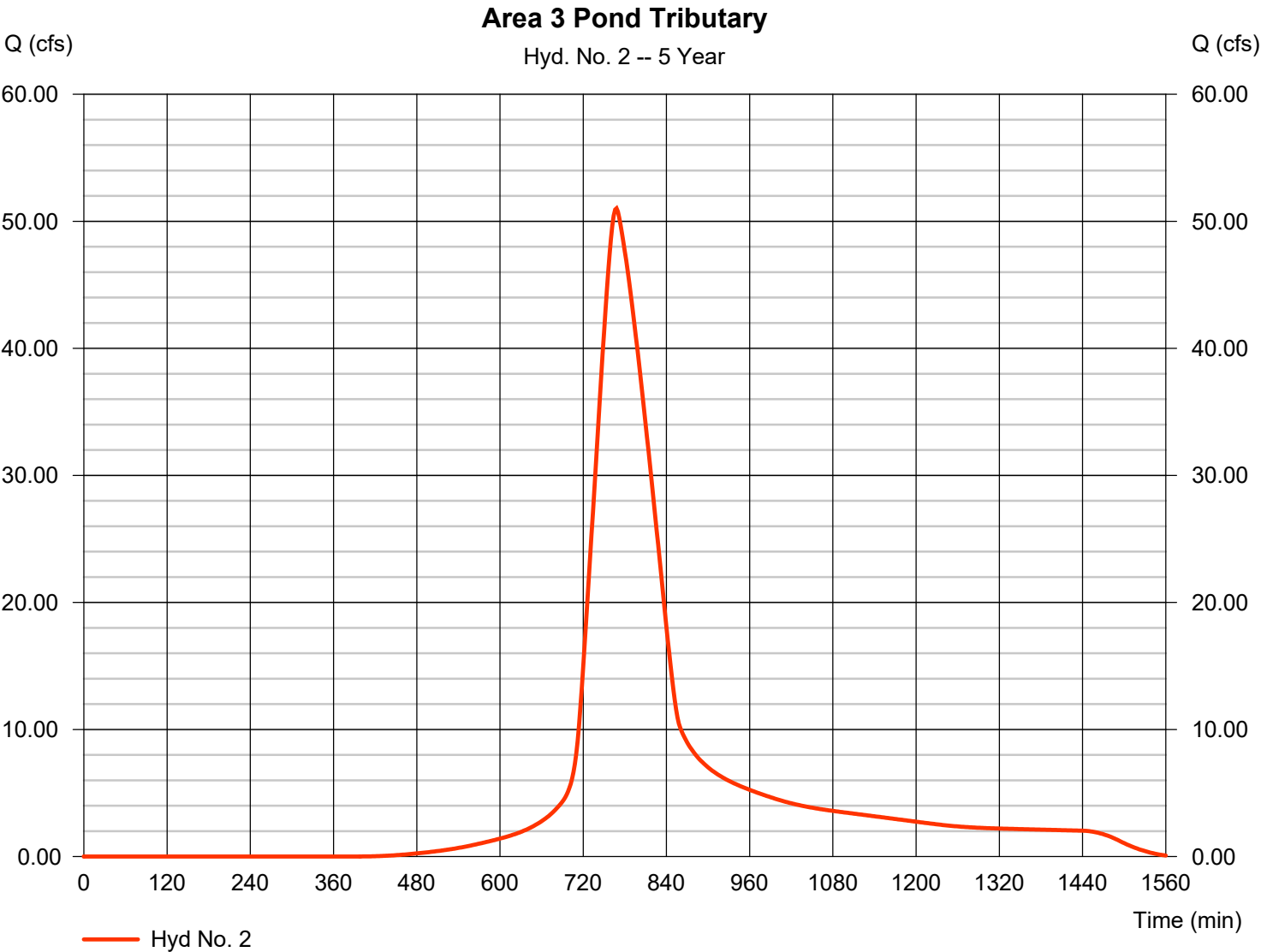


Hydrograph Report

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	51.02 cfs
Storm frequency	=	5 yrs	Time to peak	=	768 min
Time interval	=	2 min	Hyd. volume	=	442,786 cuft
Drainage area	=	60.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	89.00 min
Total precip.	=	3.24 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



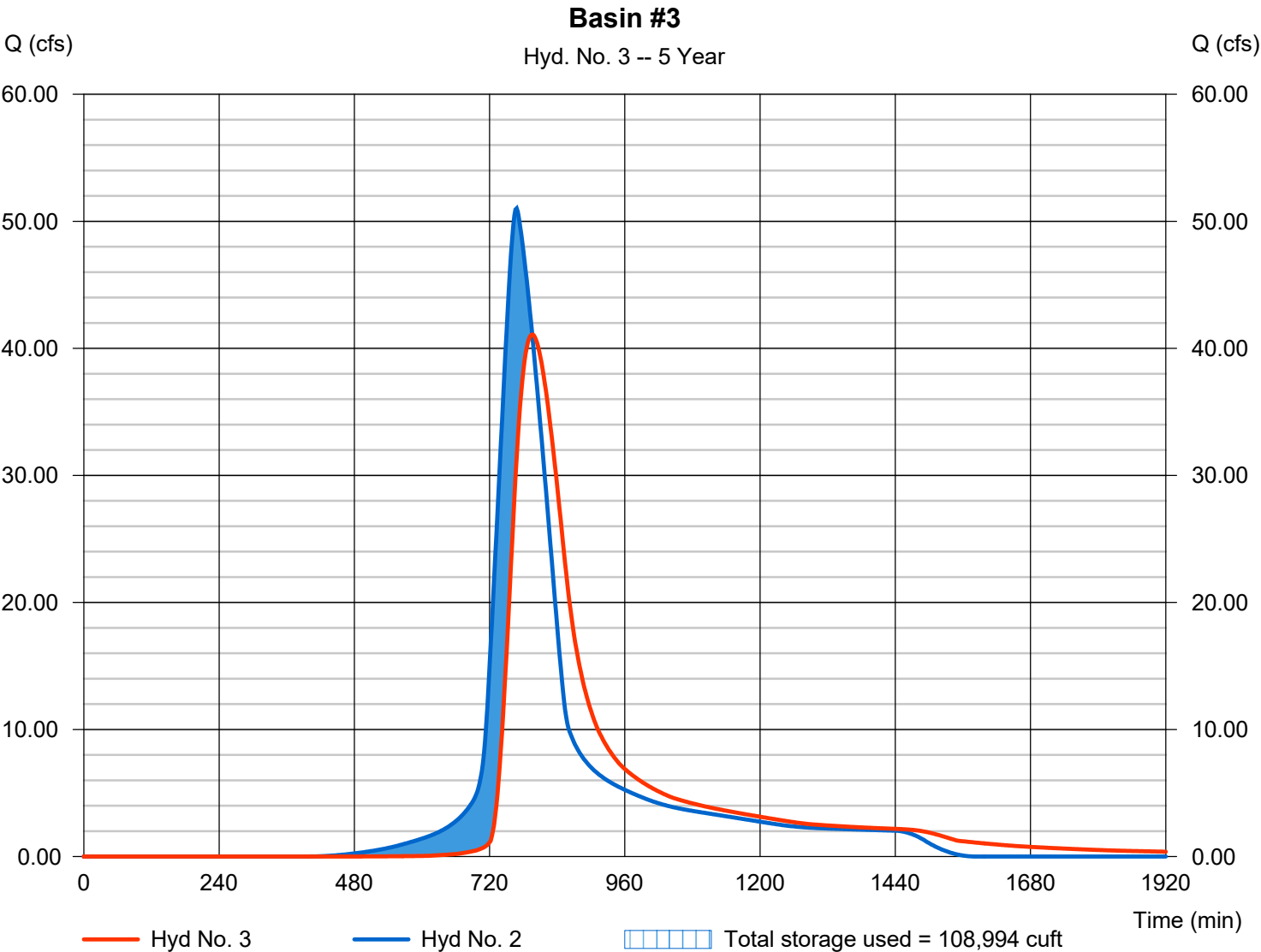
Hydrograph Report

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 41.09 cfs
Storm frequency	= 5 yrs	Time to peak	= 796 min
Time interval	= 2 min	Hyd. volume	= 441,141 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 936.67 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 108,994 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

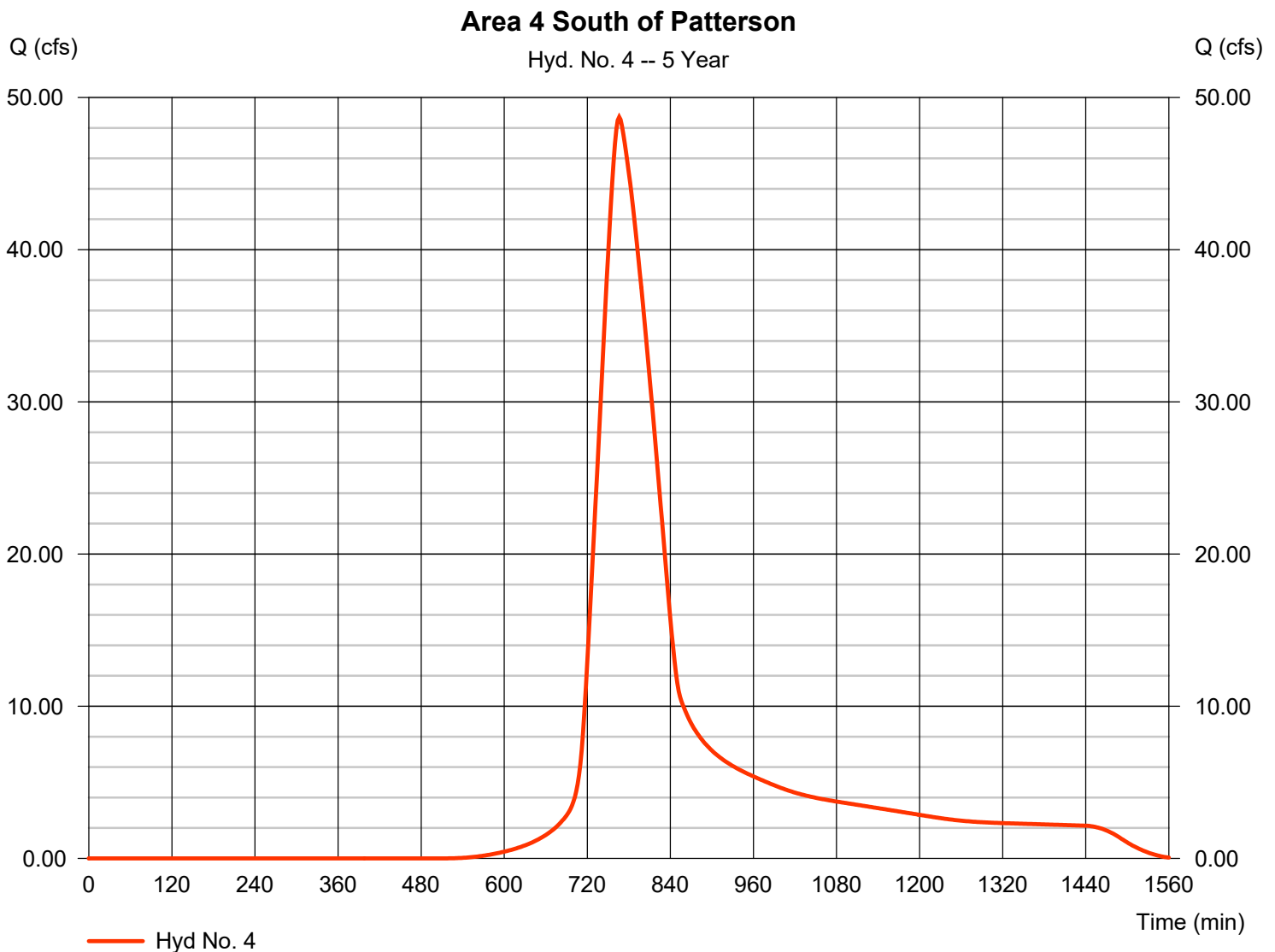
Hyd. No. 4

Area 4 South of Patterson

Hydrograph type = SCS Runoff
Storm frequency = 5 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 3.24 in
Storm duration = 24 hrs

Peak discharge = 48.71 cfs
Time to peak = 766 min
Hyd. volume = 414,652 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

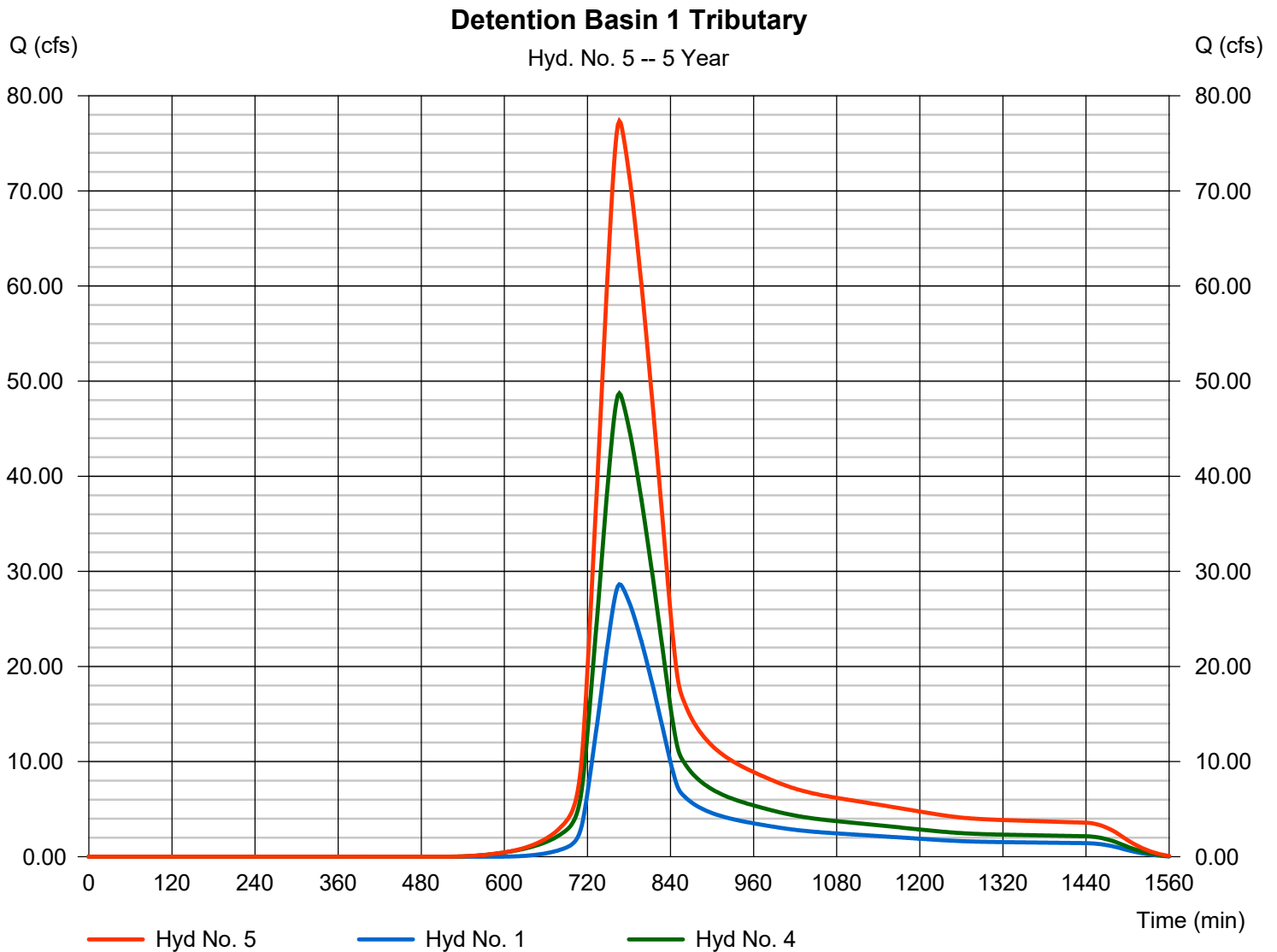
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 5 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 77.34 cfs
Time to peak = 766 min
Hyd. volume = 664,699 cuft
Contrib. drain. area = 120.540 ac



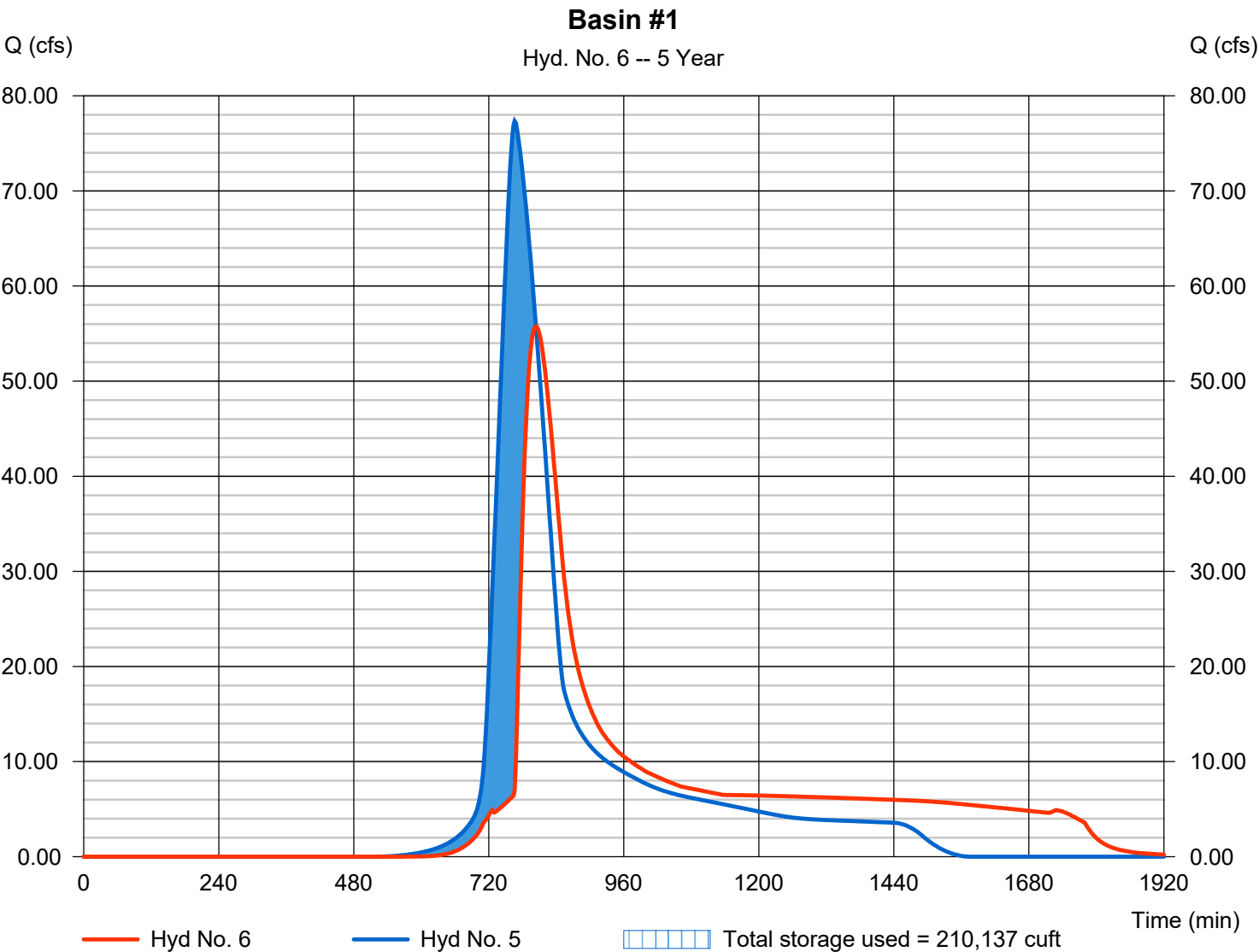
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 55.77 cfs
Storm frequency	= 5 yrs	Time to peak	= 804 min
Time interval	= 2 min	Hyd. volume	= 664,673 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 927.02 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 210,137 cuft

Storage Indication method used.

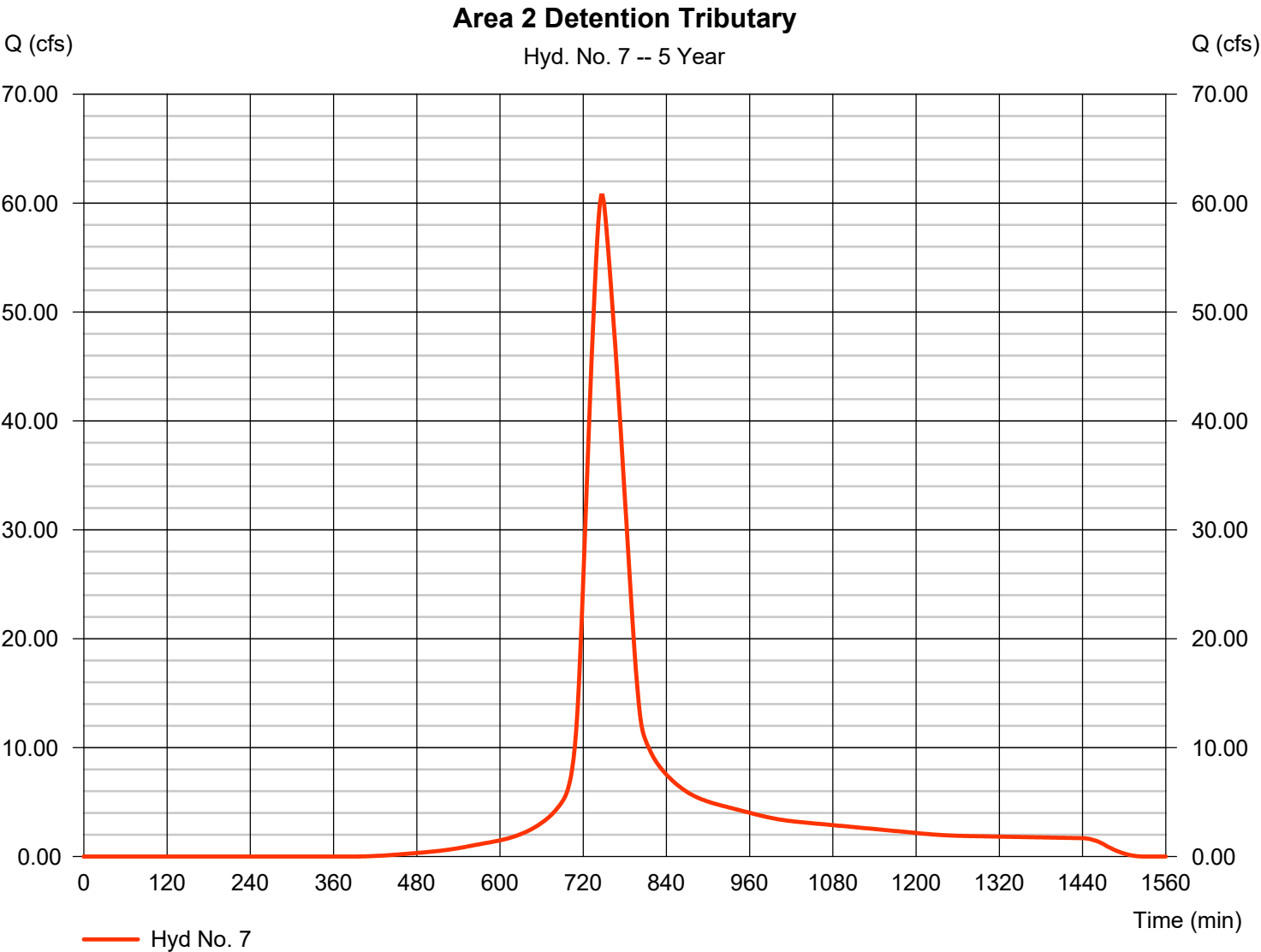


Hydrograph Report

Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	60.71 cfs
Storm frequency	=	5 yrs	Time to peak	=	748 min
Time interval	=	2 min	Hyd. volume	=	373,601 cuft
Drainage area	=	51.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	55.90 min
Total precip.	=	3.24 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

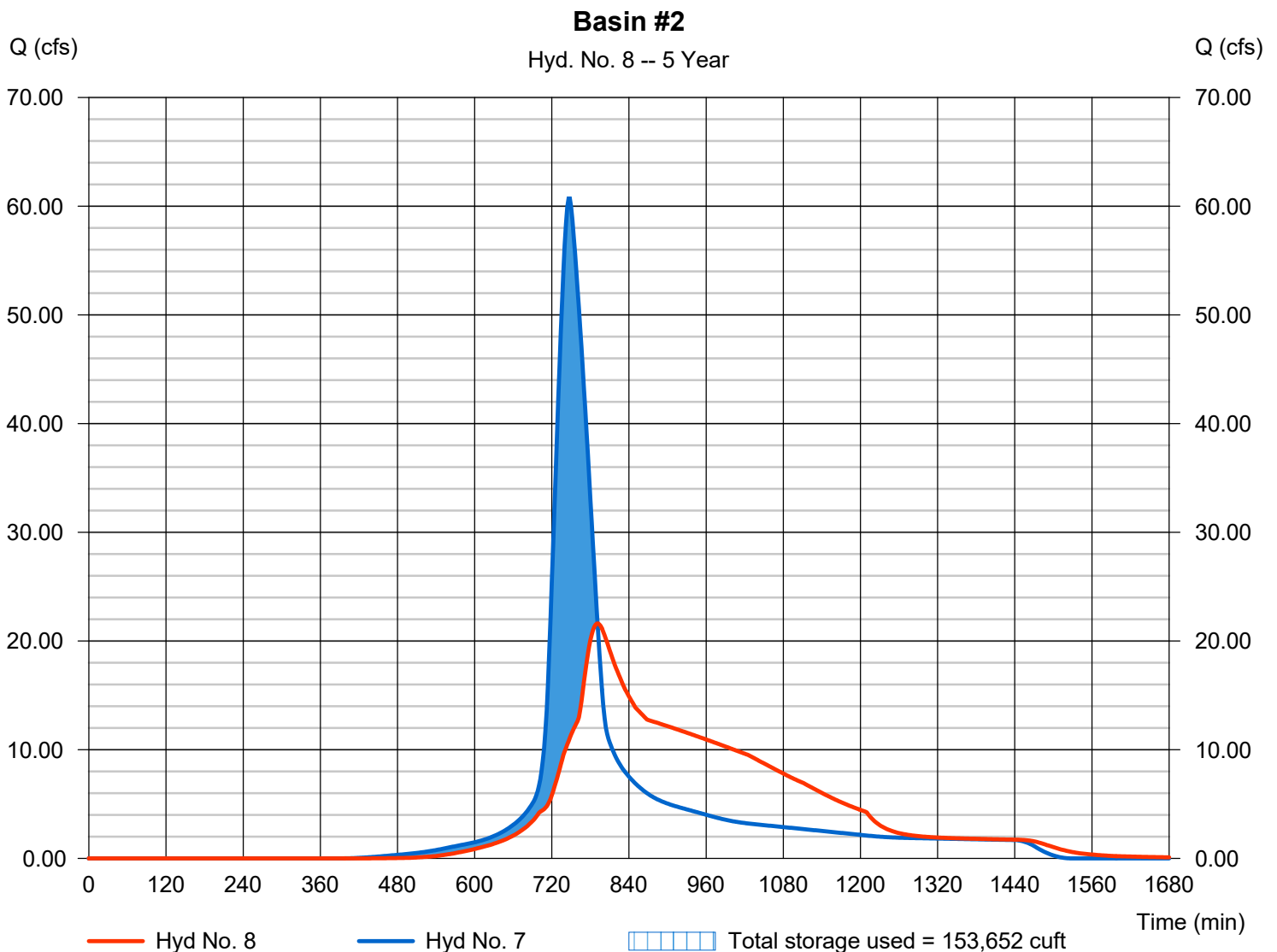
Wednesday, 11 / 2 / 2022

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 21.61 cfs
Storm frequency	= 5 yrs	Time to peak	= 792 min
Time interval	= 2 min	Hyd. volume	= 373,581 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 928.44 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 153,652 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

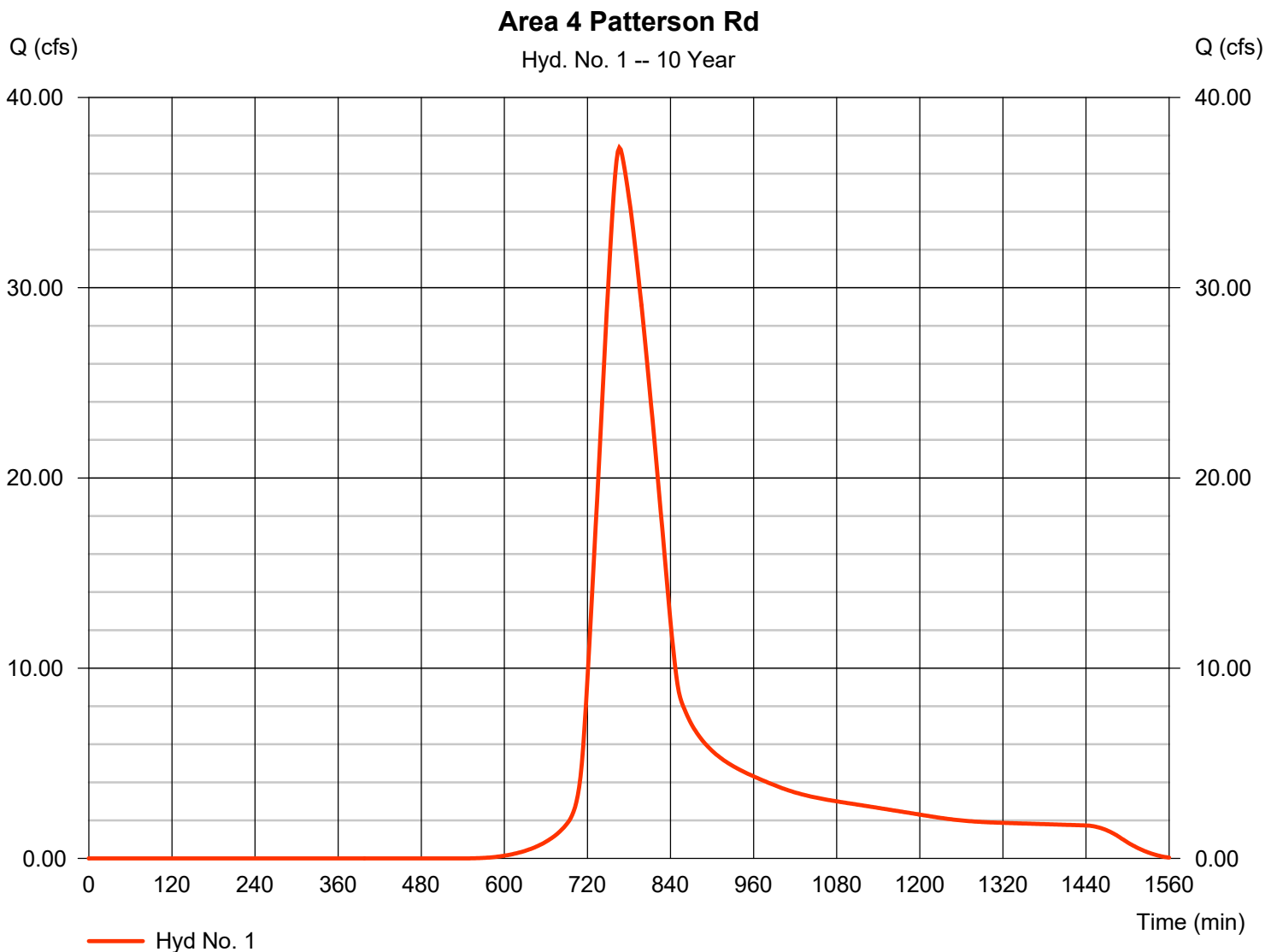
Wednesday, 11 / 2 / 2022

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type = SCS Runoff
Storm frequency = 10 yrs
Time interval = 2 min
Drainage area = 50.640 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 3.74 in
Storm duration = 24 hrs

Peak discharge = 37.36 cfs
Time to peak = 766 min
Hyd. volume = 320,986 cuft
Curve number = 79
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

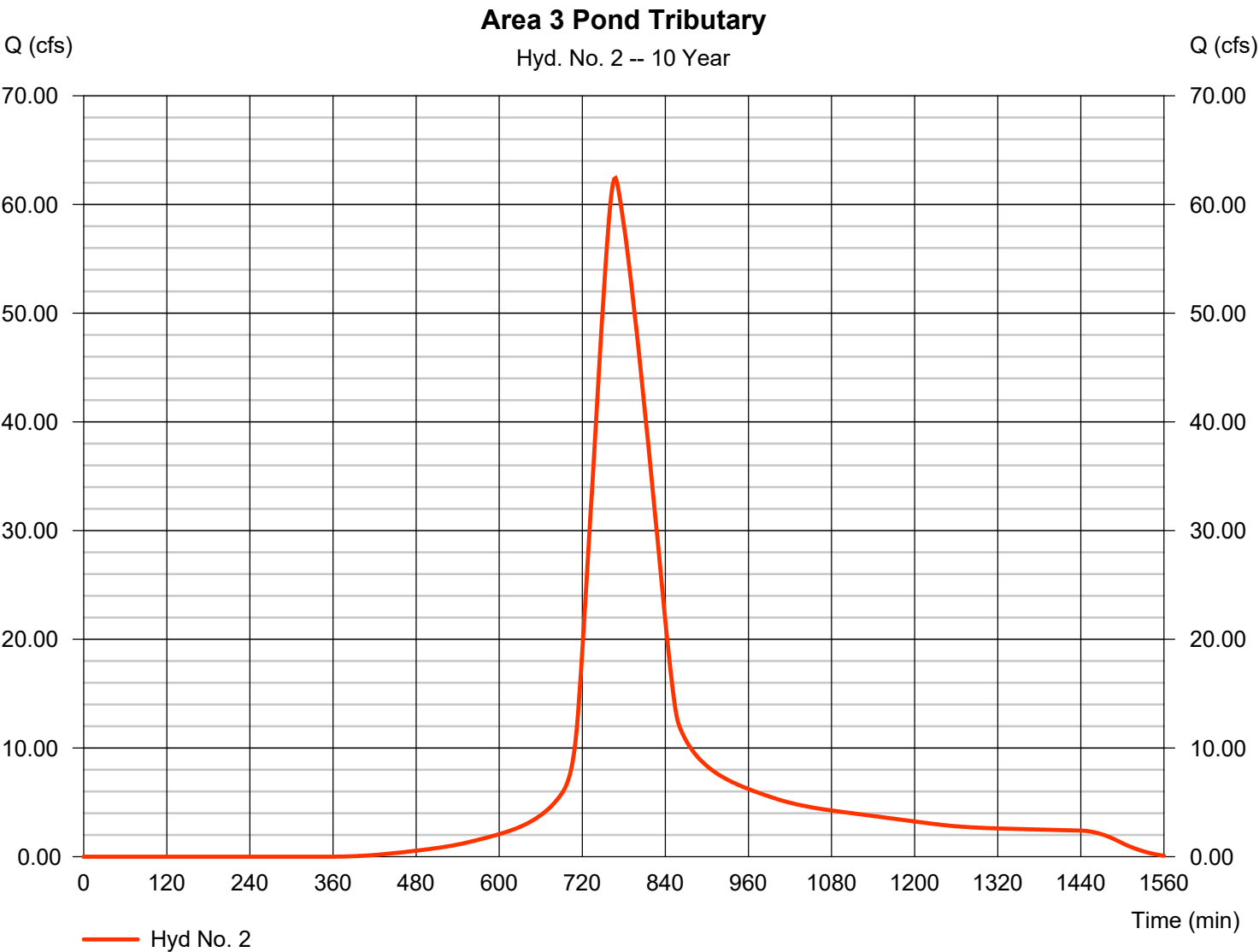


Hydrograph Report

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	62.42 cfs
Storm frequency	=	10 yrs	Time to peak	=	768 min
Time interval	=	2 min	Hyd. volume	=	542,007 cuft
Drainage area	=	60.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	89.00 min
Total precip.	=	3.74 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



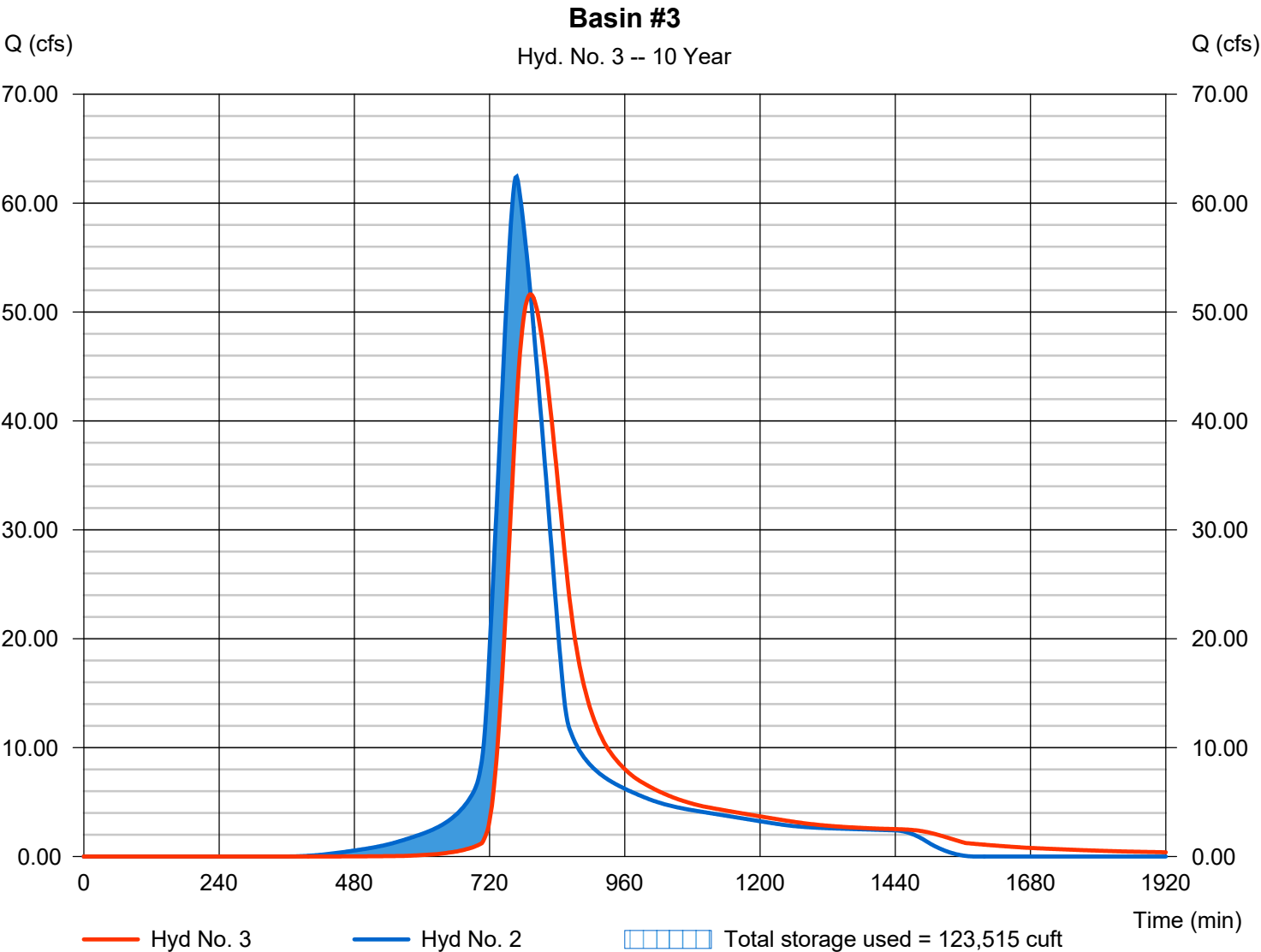
Hydrograph Report

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 51.62 cfs
Storm frequency	= 10 yrs	Time to peak	= 792 min
Time interval	= 2 min	Hyd. volume	= 540,352 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 936.89 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 123,515 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

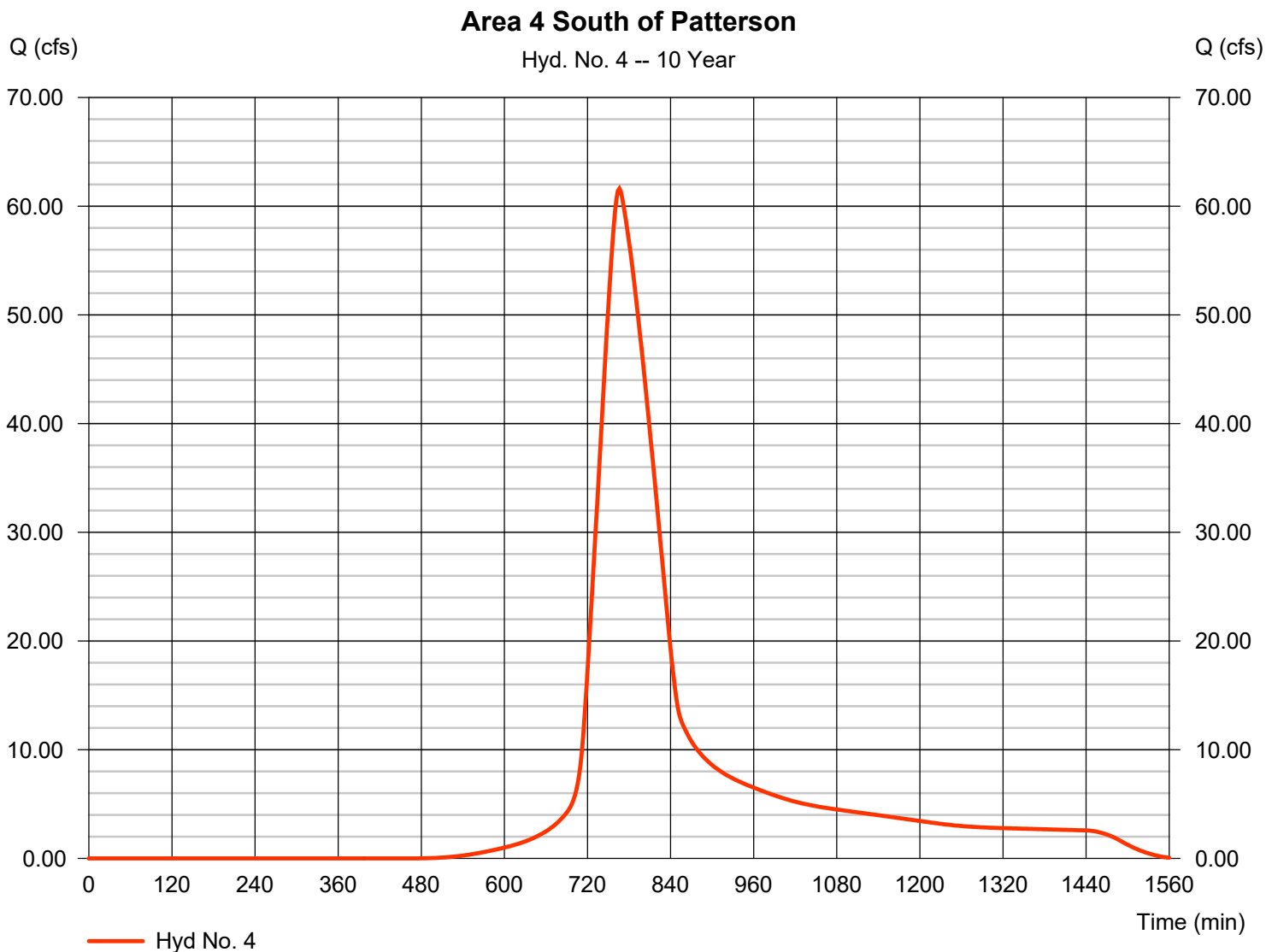
Hyd. No. 4

Area 4 South of Patterson

Hydrograph type = SCS Runoff
Storm frequency = 10 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 3.74 in
Storm duration = 24 hrs

Peak discharge = 61.62 cfs
Time to peak = 766 min
Hyd. volume = 520,724 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

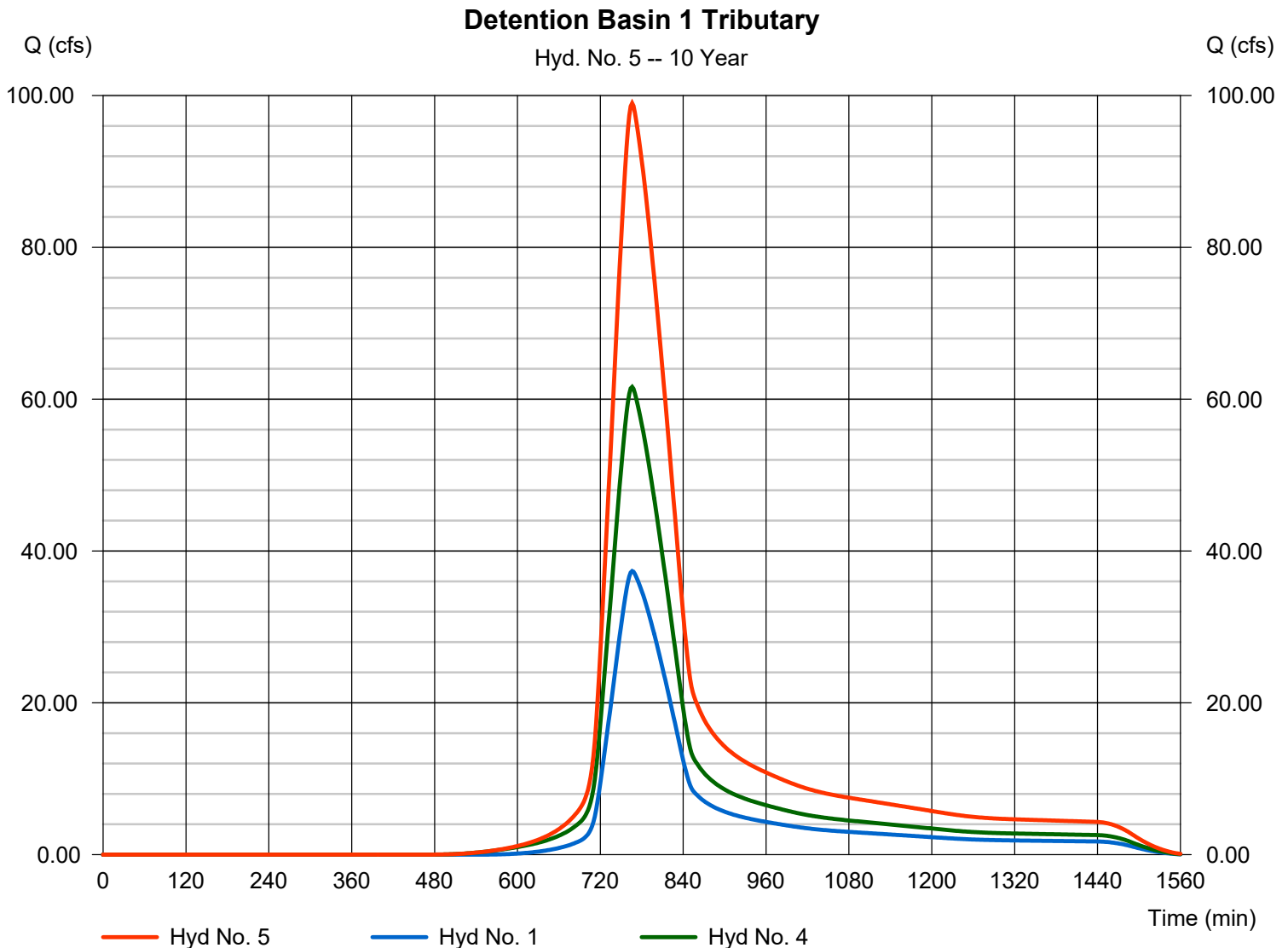
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 10 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 98.99 cfs
Time to peak = 766 min
Hyd. volume = 841,711 cuft
Contrib. drain. area = 120.540 ac



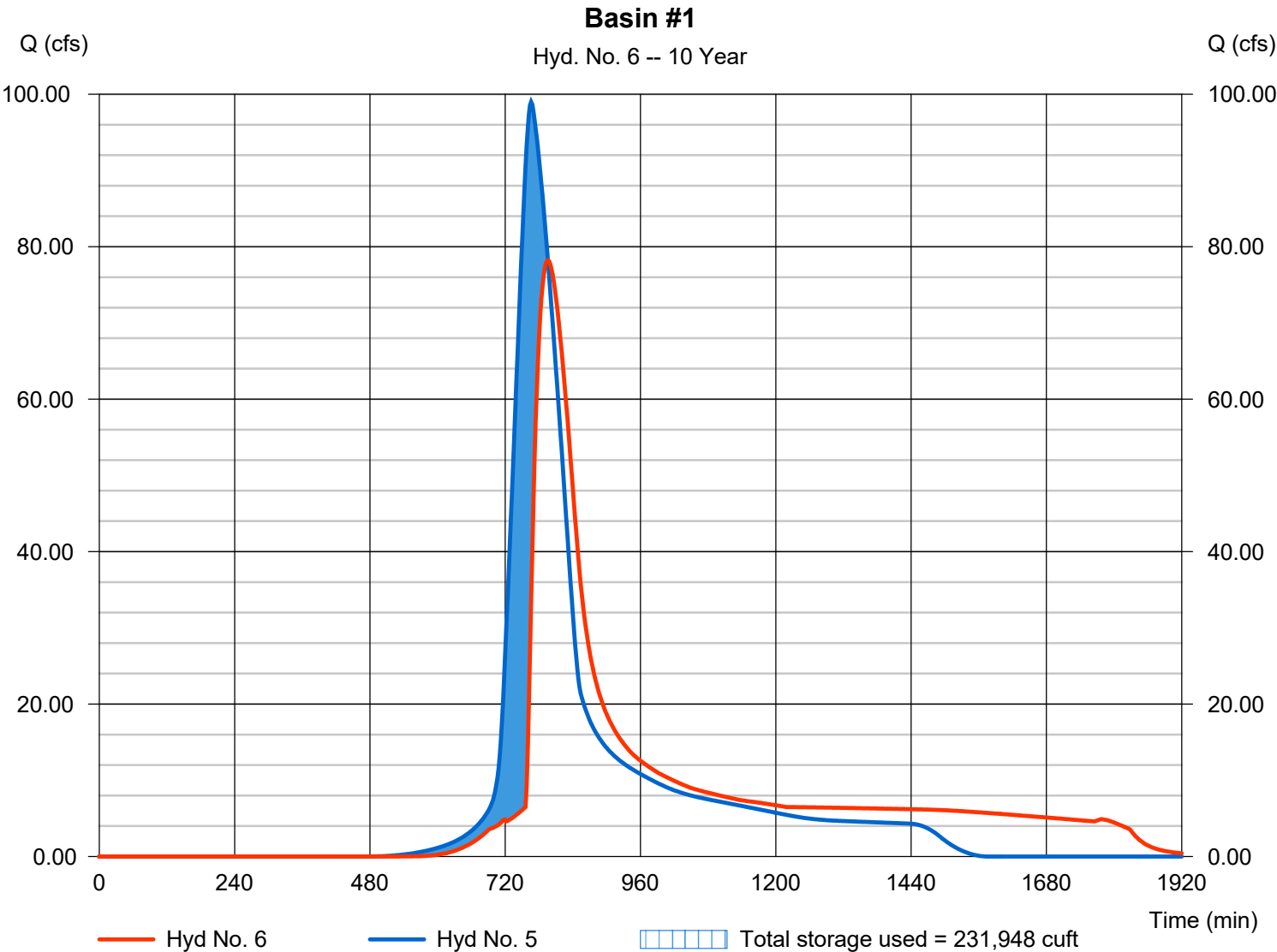
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 78.22 cfs
Storm frequency	= 10 yrs	Time to peak	= 796 min
Time interval	= 2 min	Hyd. volume	= 841,686 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 927.45 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 231,948 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

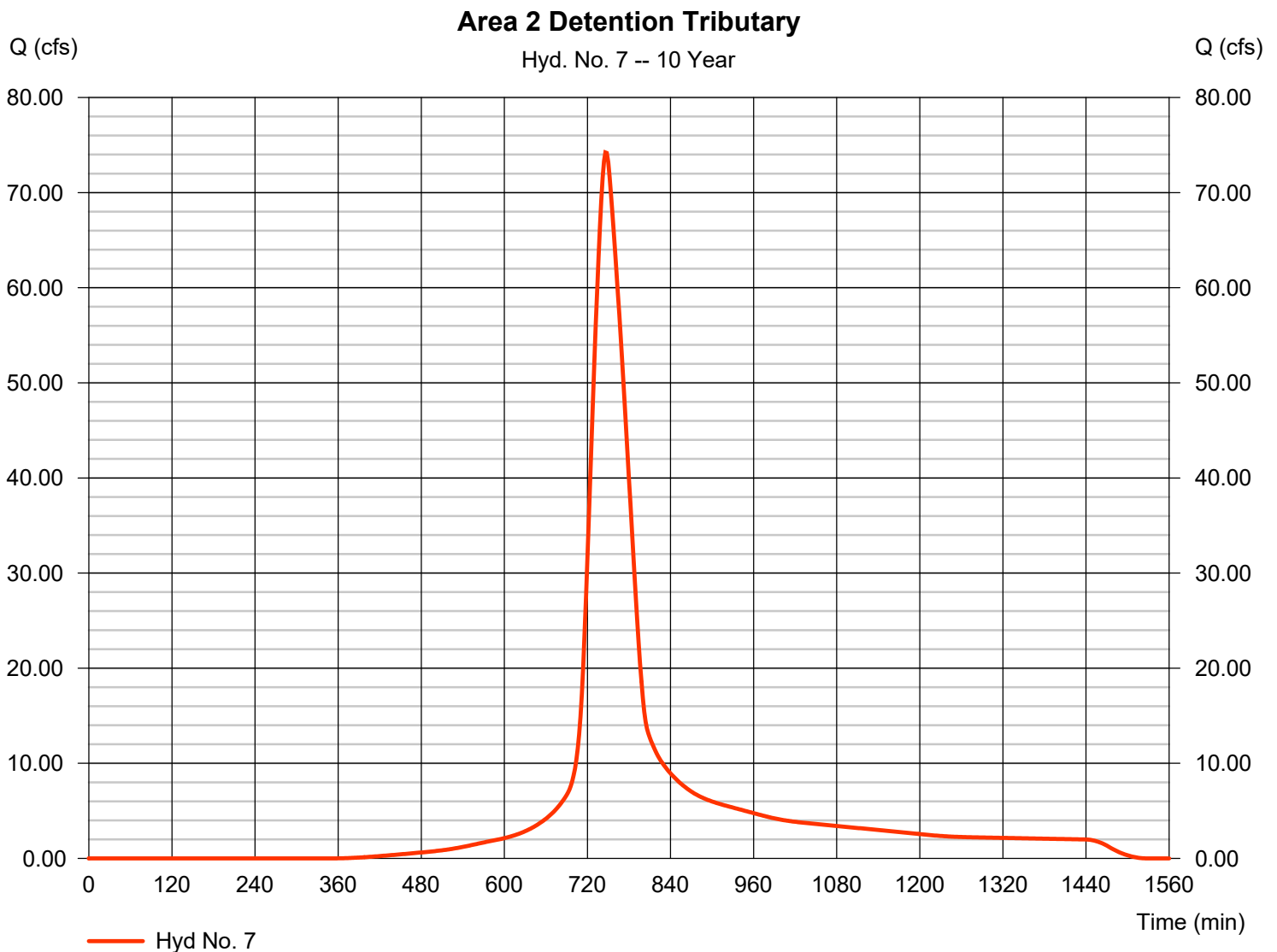
Wednesday, 11 / 2 / 2022

Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type = SCS Runoff
Storm frequency = 10 yrs
Time interval = 2 min
Drainage area = 51.000 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 3.74 in
Storm duration = 24 hrs

Peak discharge = 74.23 cfs
Time to peak = 746 min
Hyd. volume = 457,318 cuft
Curve number = 88
Hydraulic length = 0 ft
Time of conc. (Tc) = 55.90 min
Distribution = Type II
Shape factor = 484



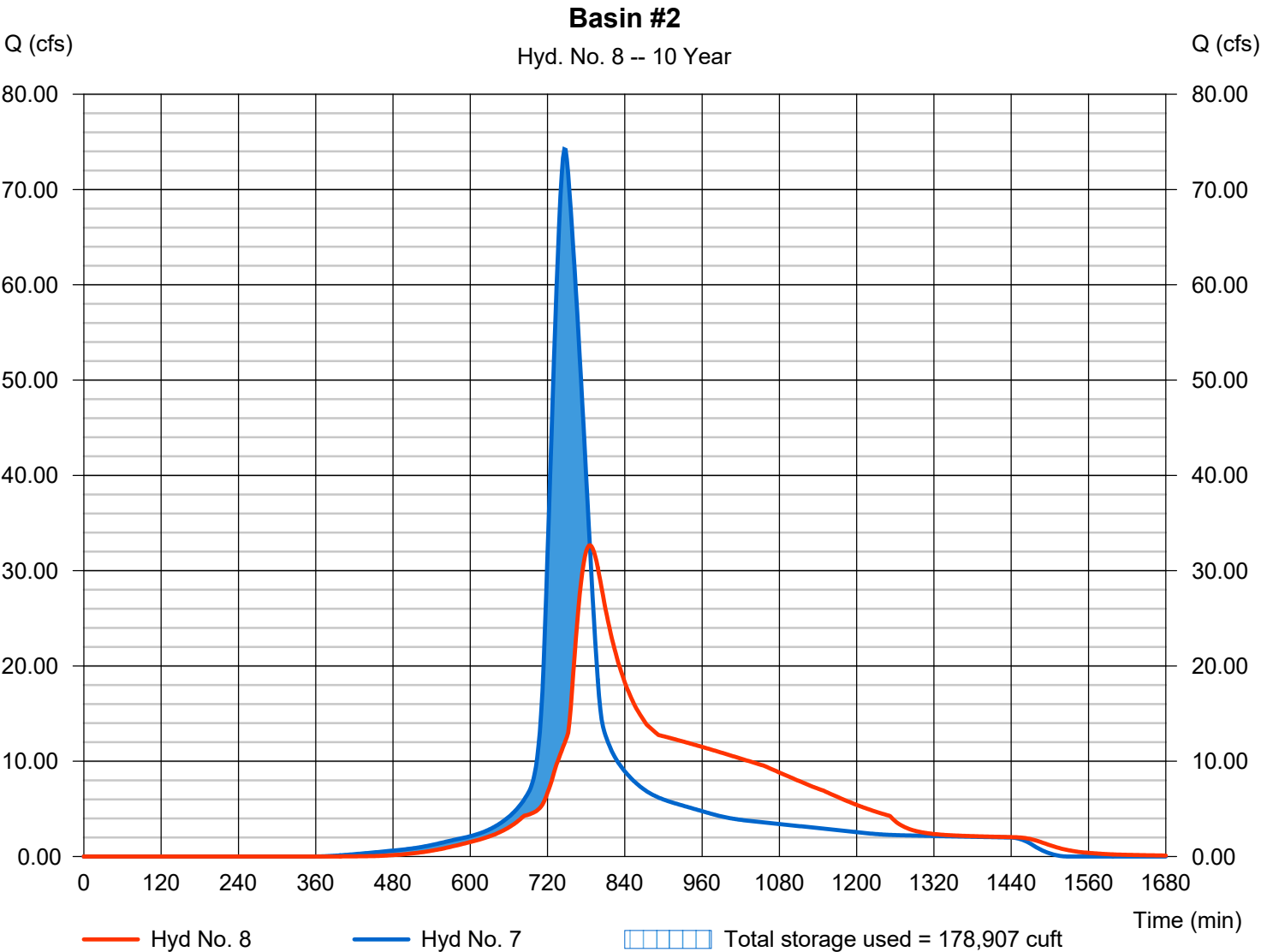
Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 32.67 cfs
Storm frequency	= 10 yrs	Time to peak	= 786 min
Time interval	= 2 min	Hyd. volume	= 457,300 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 928.78 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 178,907 cuft

Storage Indication method used.

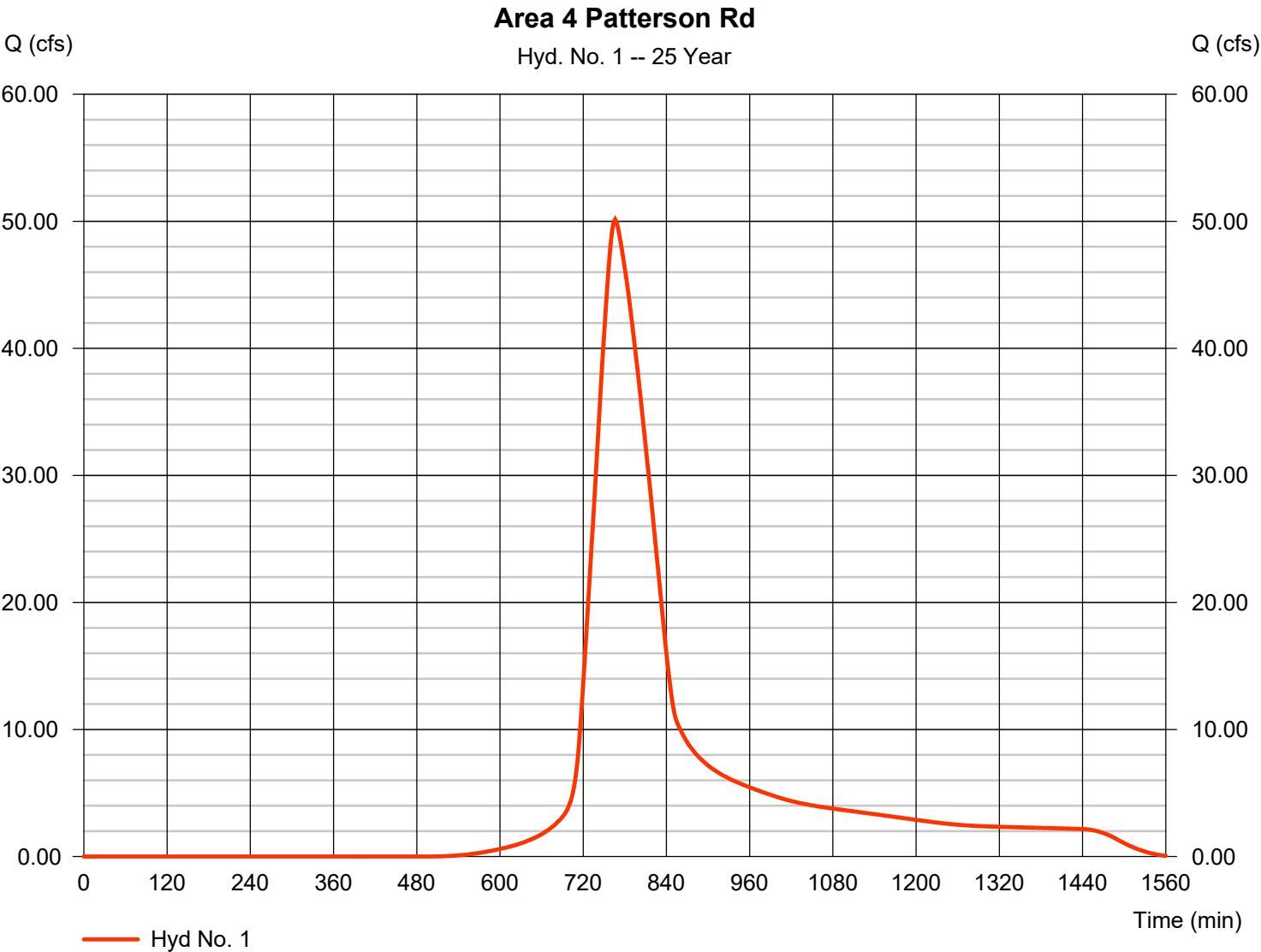


Hydrograph Report

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type	= SCS Runoff	Peak discharge	= 50.16 cfs
Storm frequency	= 25 yrs	Time to peak	= 766 min
Time interval	= 2 min	Hyd. volume	= 425,555 cuft
Drainage area	= 50.640 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 85.30 min
Total precip.	= 4.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

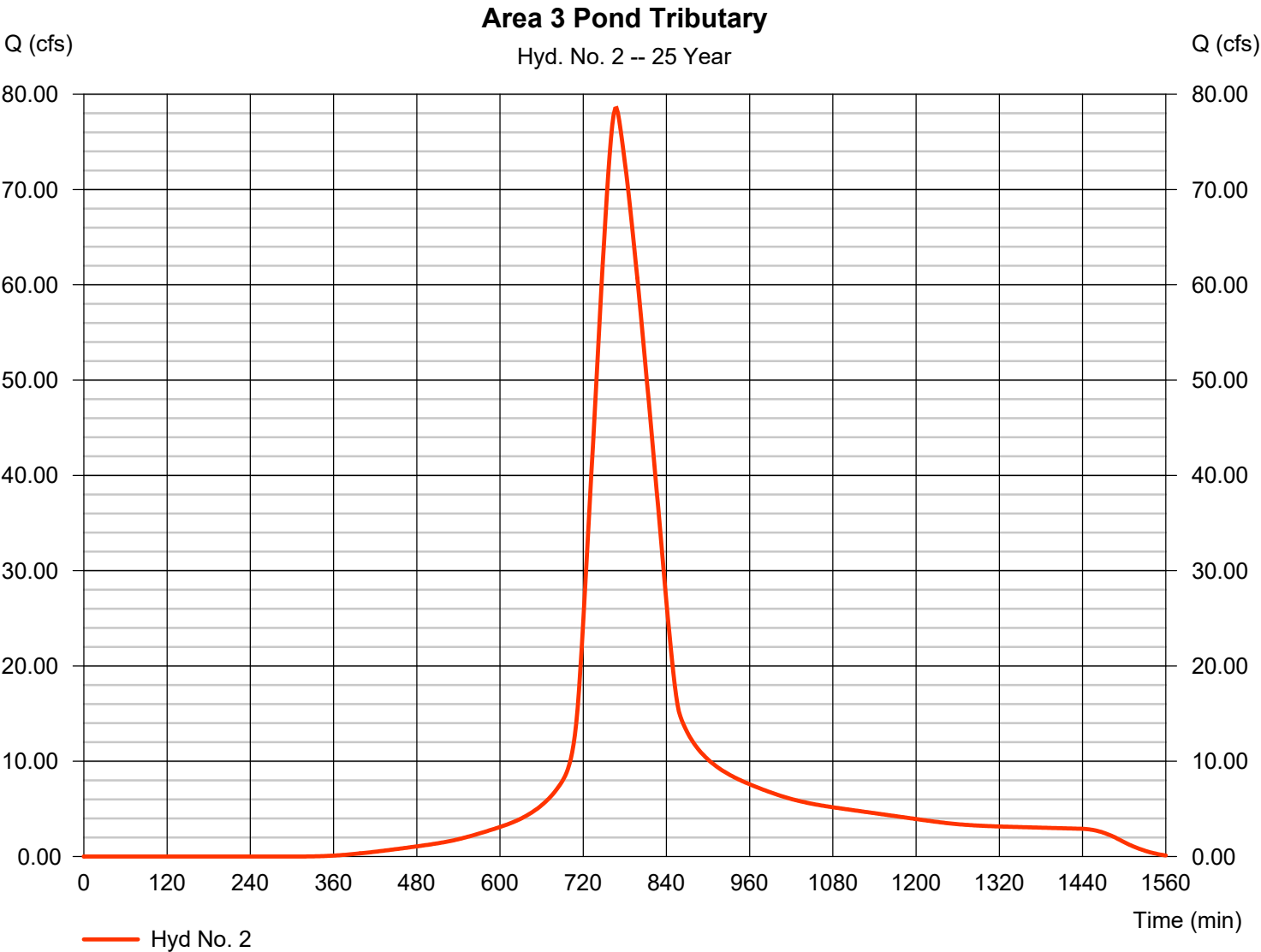


Hydrograph Report

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	= SCS Runoff	Peak discharge	= 78.54 cfs
Storm frequency	= 25 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 683,857 cuft
Drainage area	= 60.000 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 89.00 min
Total precip.	= 4.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



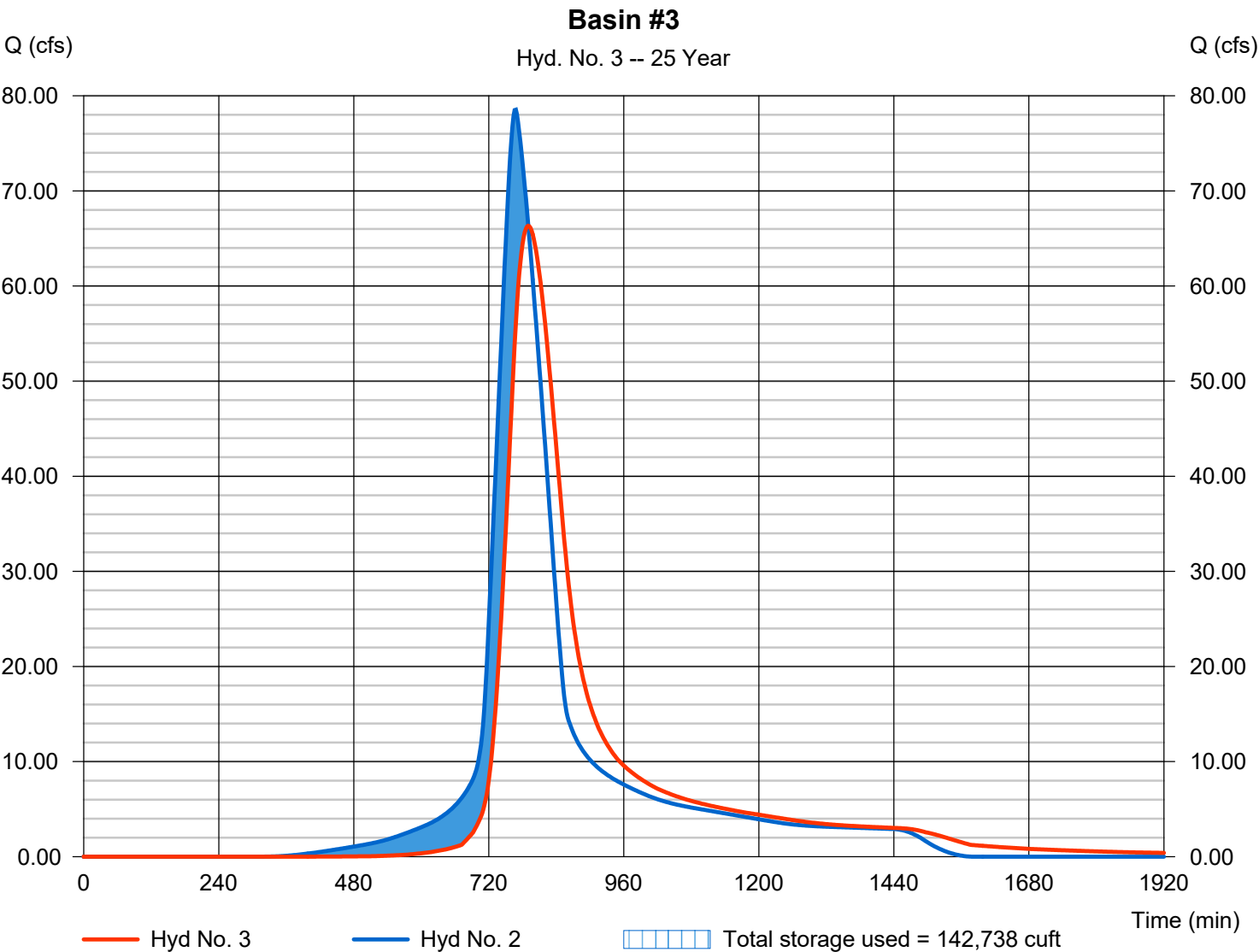
Hydrograph Report

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 66.33 cfs
Storm frequency	= 25 yrs	Time to peak	= 790 min
Time interval	= 2 min	Hyd. volume	= 682,191 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 937.17 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 142,738 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

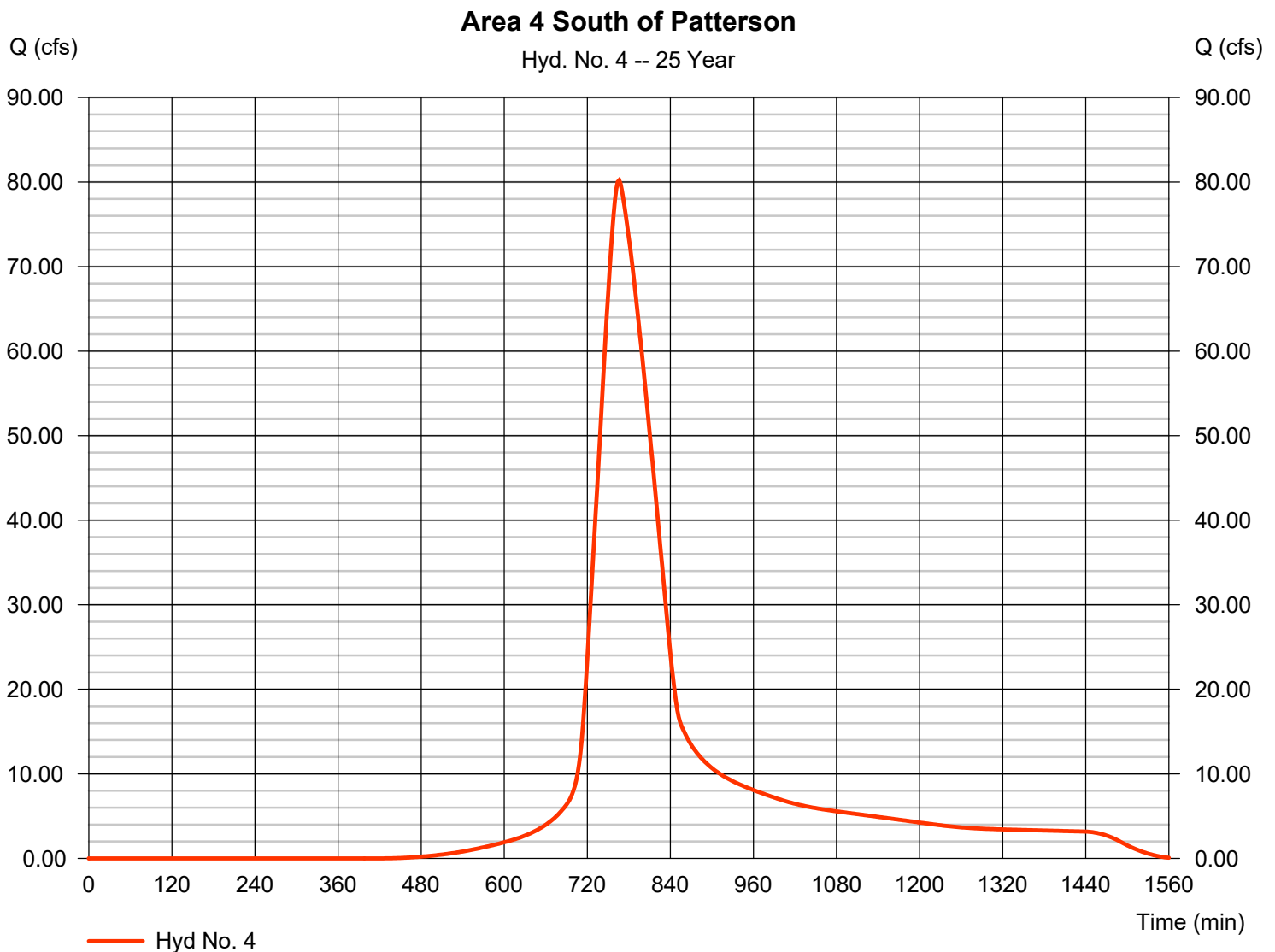
Hyd. No. 4

Area 4 South of Patterson

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 4.44 in
Storm duration = 24 hrs

Peak discharge = 80.21 cfs
Time to peak = 766 min
Hyd. volume = 674,805 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = [(35.700 x 88) + (34.200 x 77)] / 69.900



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Hyd. No. 5

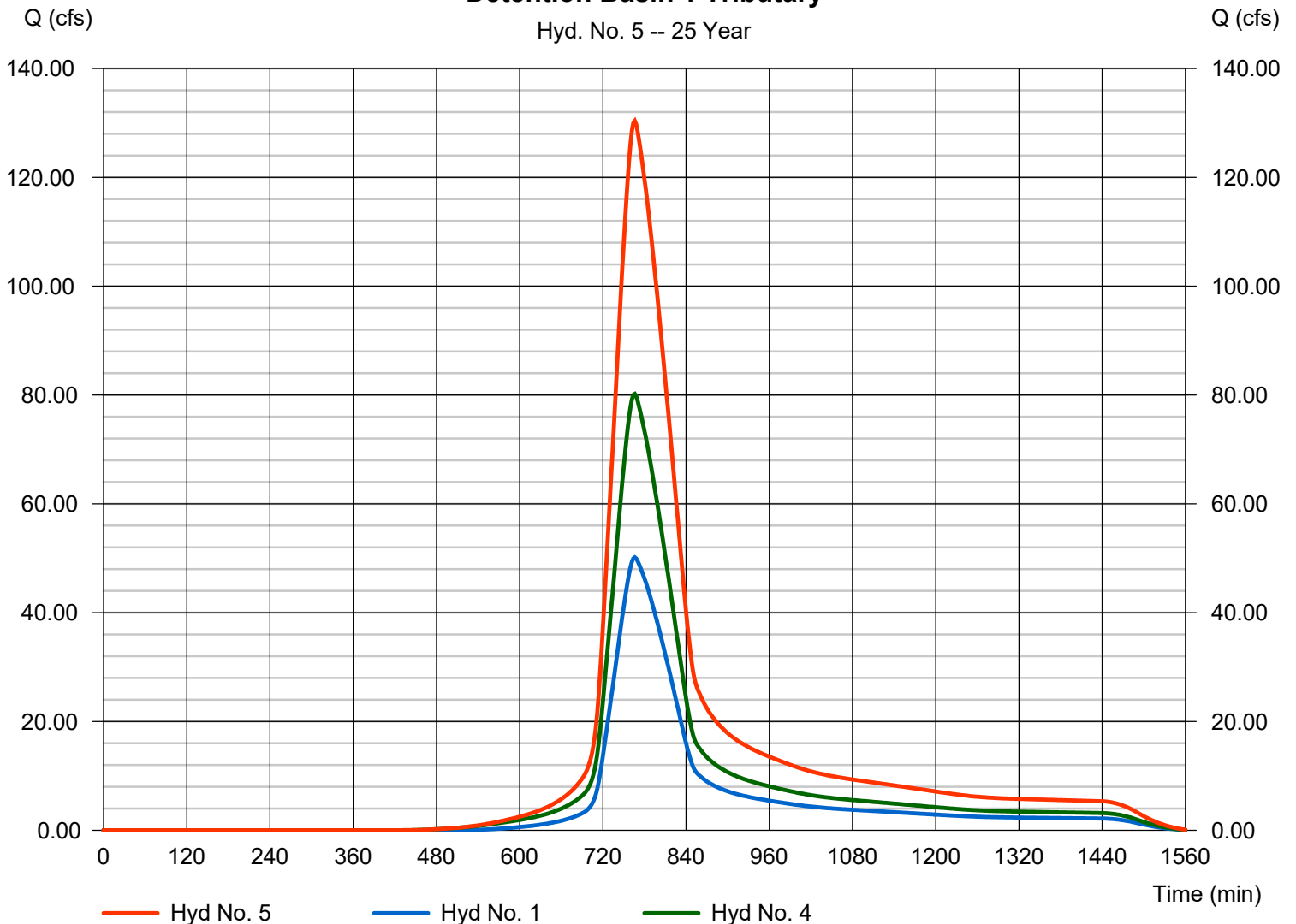
Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 130.37 cfs
Time to peak = 766 min
Hyd. volume = 1,100,361 cuft
Contrib. drain. area = 120.540 ac

Detention Basin 1 Tributary

Hyd. No. 5 -- 25 Year



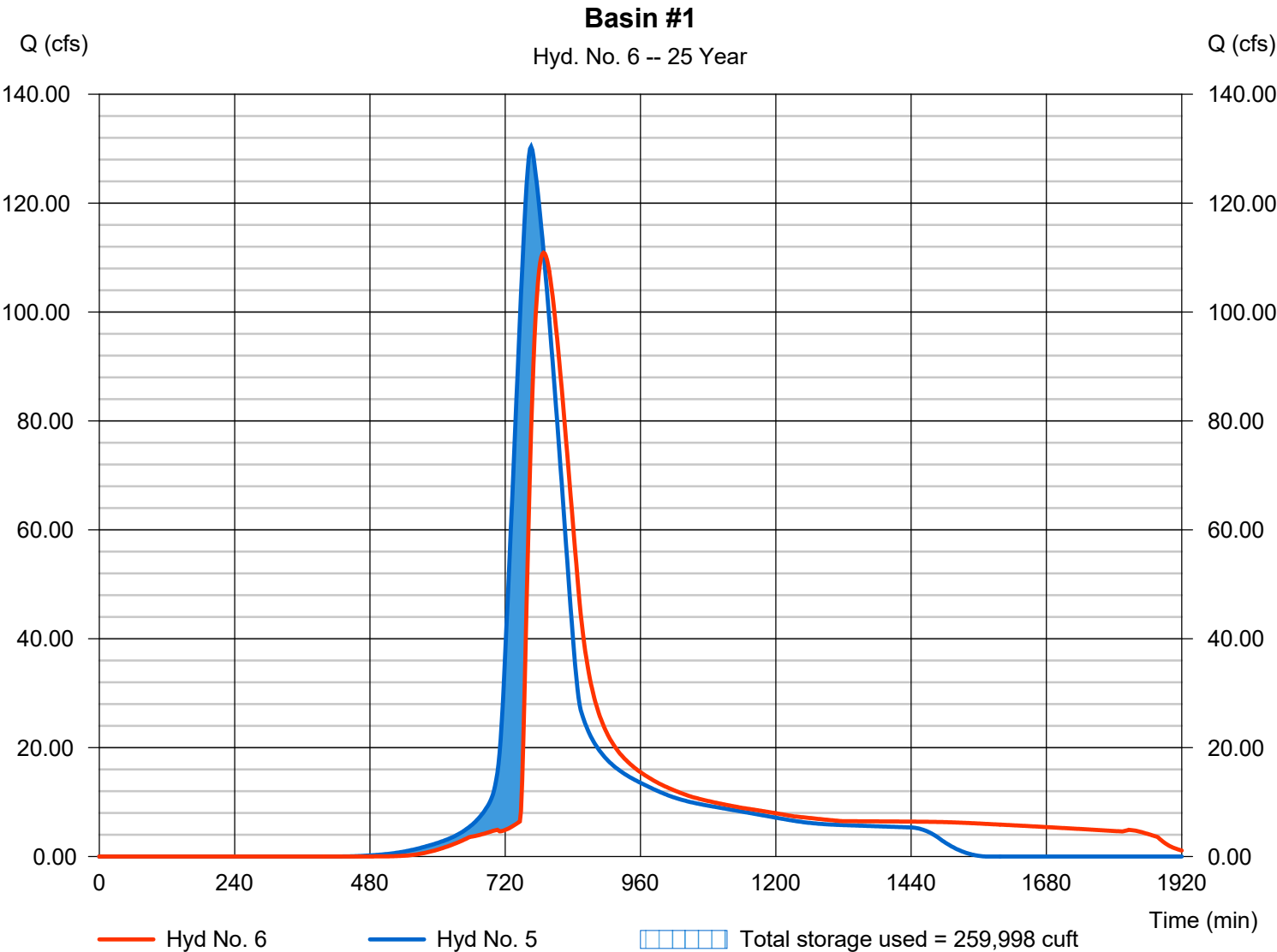
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 110.89 cfs
Storm frequency	= 25 yrs	Time to peak	= 788 min
Time interval	= 2 min	Hyd. volume	= 1,100,333 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 928.01 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 259,998 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Hyd. No. 7

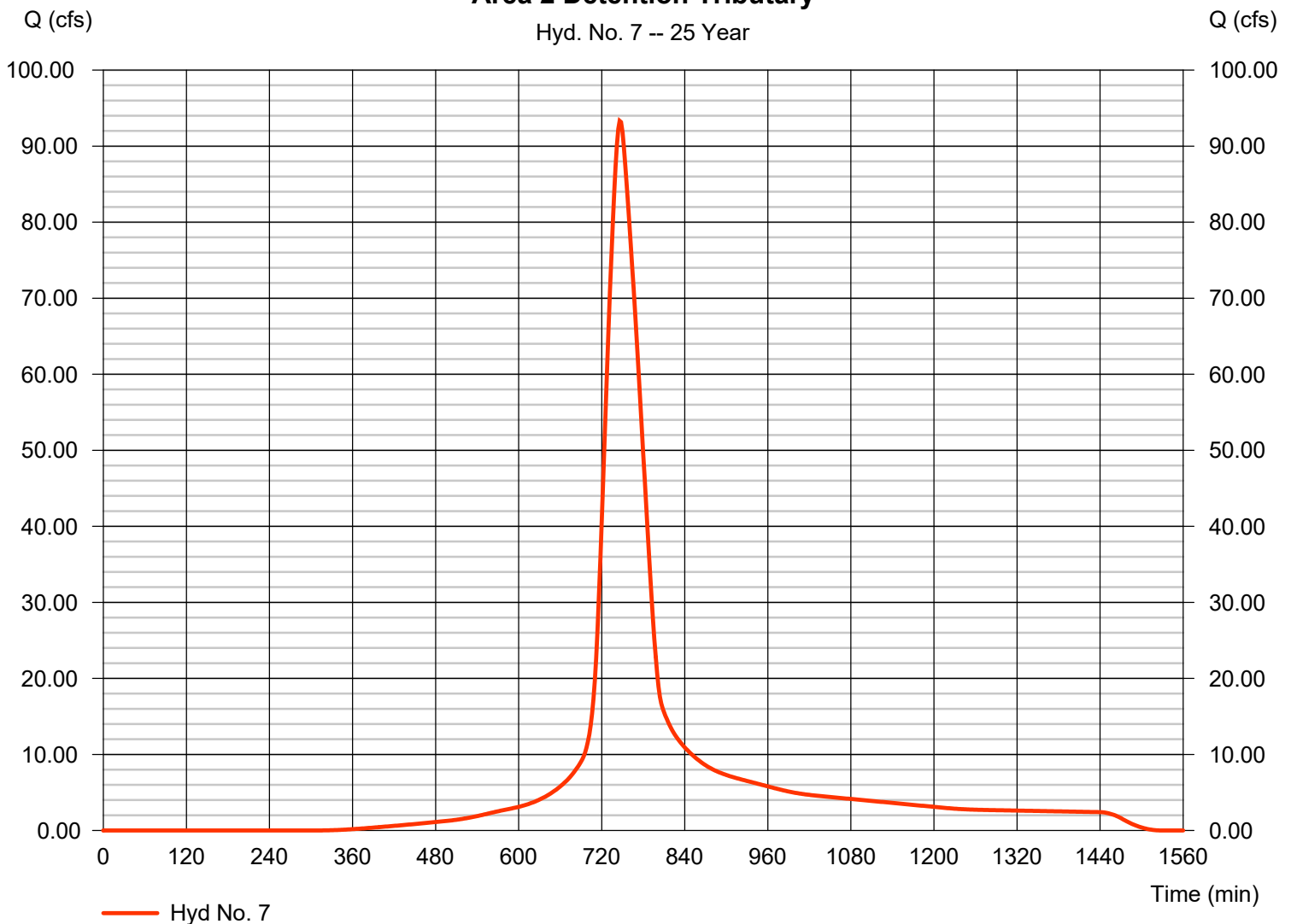
Area 2 Detention Tributary

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 51.000 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 4.44 in
Storm duration = 24 hrs

Peak discharge = 93.32 cfs
Time to peak = 746 min
Hyd. volume = 577,004 cuft
Curve number = 88
Hydraulic length = 0 ft
Time of conc. (Tc) = 55.90 min
Distribution = Type II
Shape factor = 484

Area 2 Detention Tributary

Hyd. No. 7 -- 25 Year



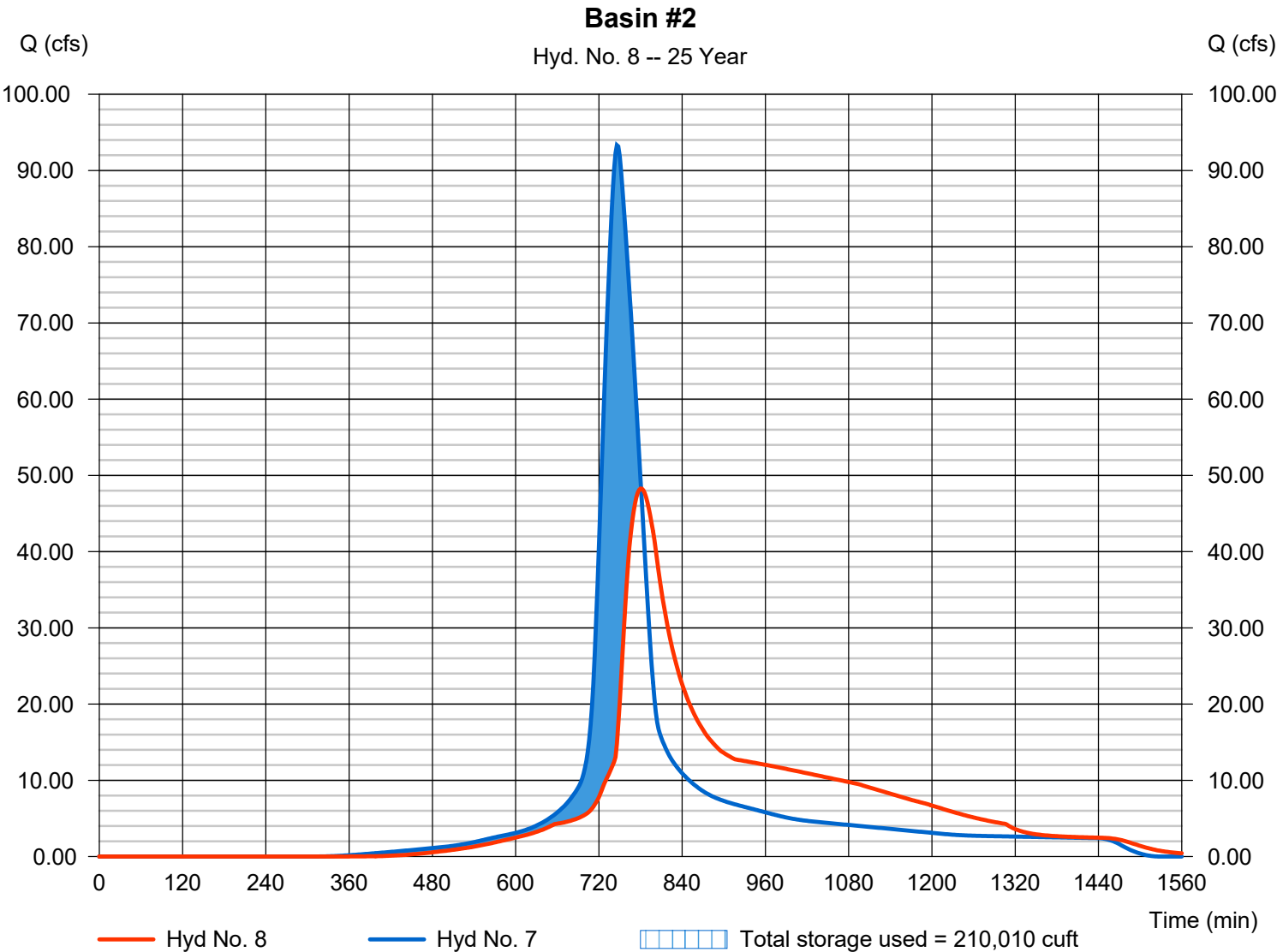
Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 48.27 cfs
Storm frequency	= 25 yrs	Time to peak	= 780 min
Time interval	= 2 min	Hyd. volume	= 576,985 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 929.16 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 210,010 cuft

Storage Indication method used.

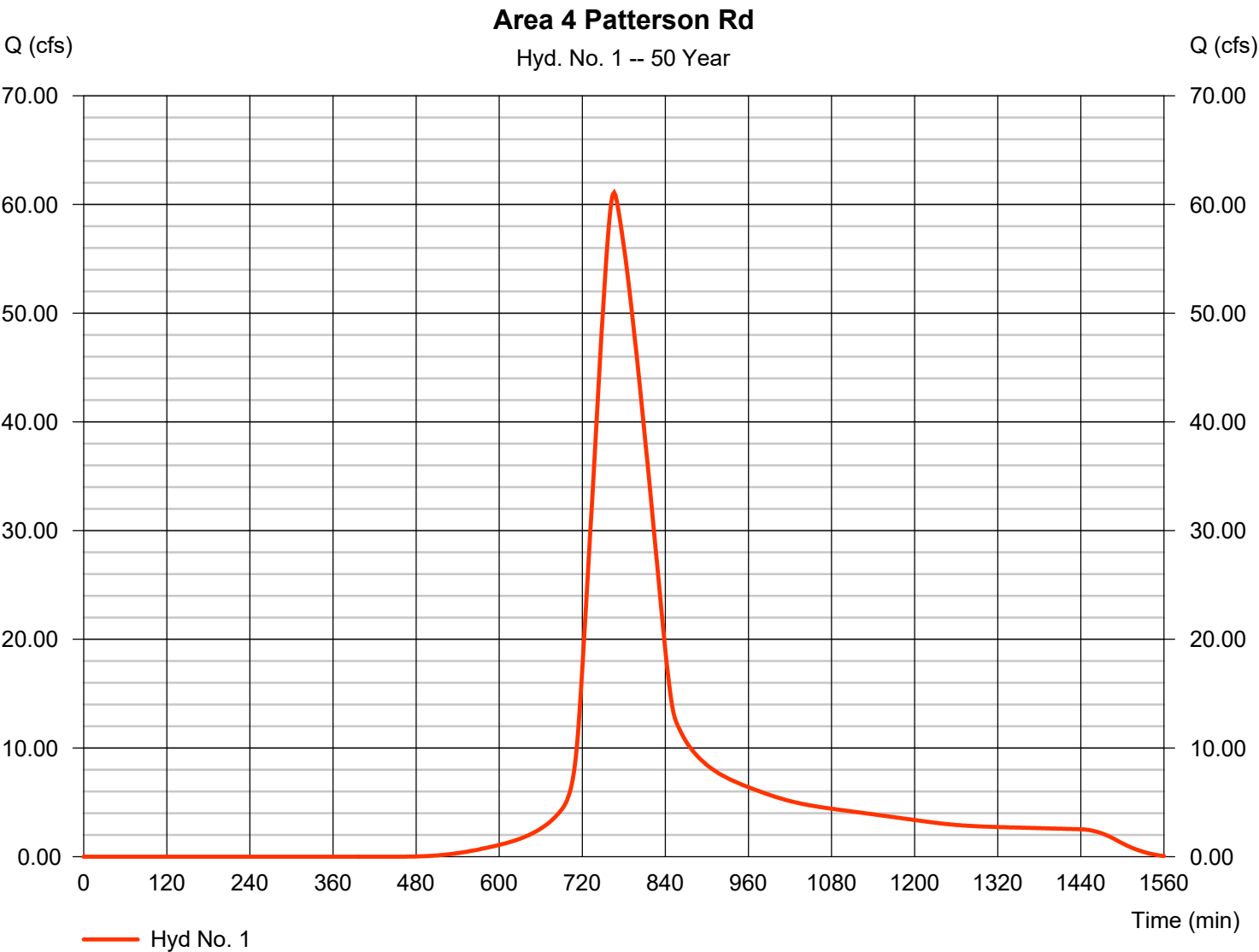


Hydrograph Report

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type	= SCS Runoff	Peak discharge	= 61.10 cfs
Storm frequency	= 50 yrs	Time to peak	= 766 min
Time interval	= 2 min	Hyd. volume	= 515,684 cuft
Drainage area	= 50.640 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 85.30 min
Total precip.	= 5.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

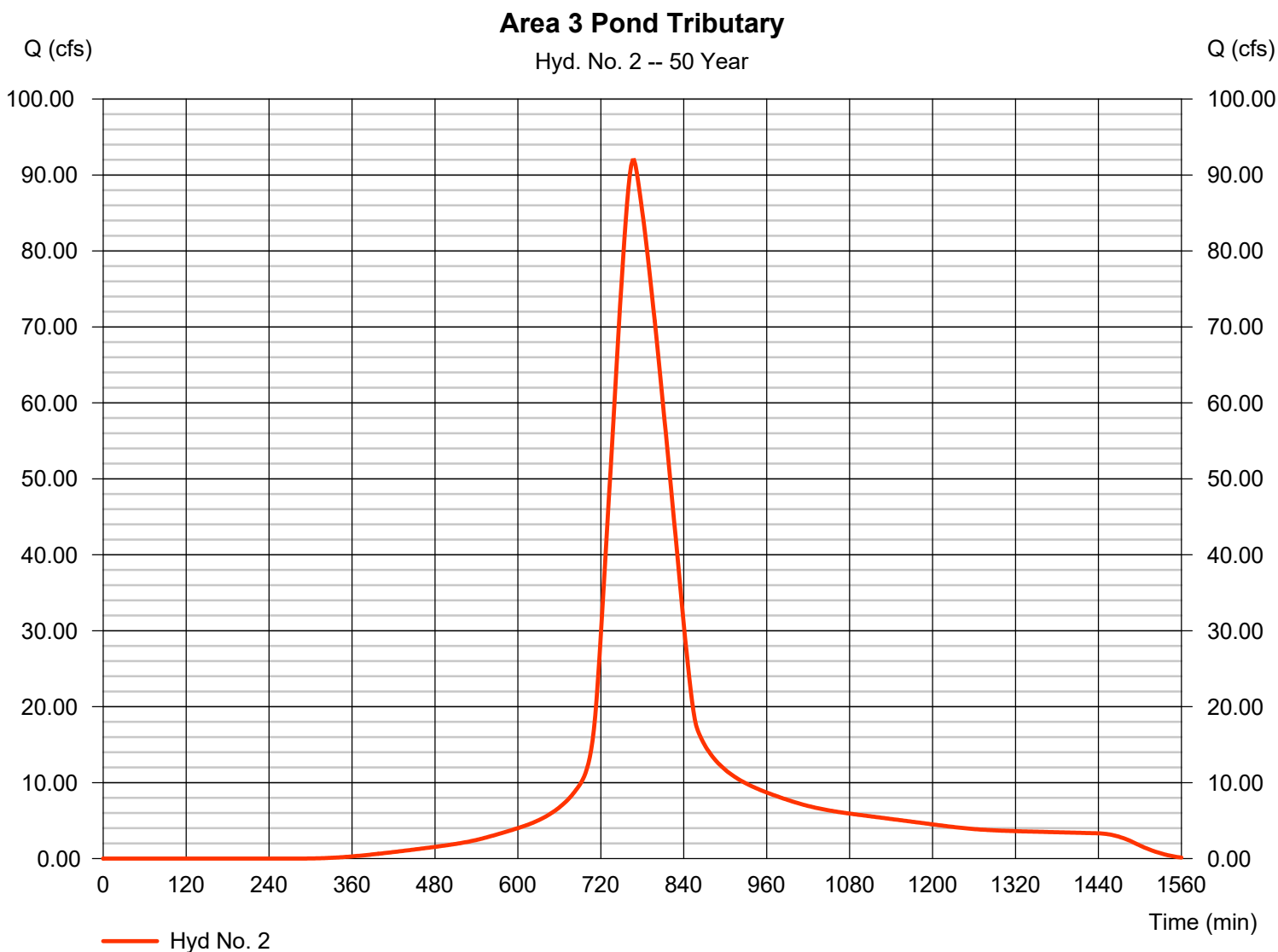
Wednesday, 11 / 2 / 2022

Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type = SCS Runoff
Storm frequency = 50 yrs
Time interval = 2 min
Drainage area = 60.000 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 5.02 in
Storm duration = 24 hrs

Peak discharge = 91.94 cfs
Time to peak = 768 min
Hyd. volume = 803,231 cuft
Curve number = 88
Hydraulic length = 0 ft
Time of conc. (Tc) = 89.00 min
Distribution = Type II
Shape factor = 484



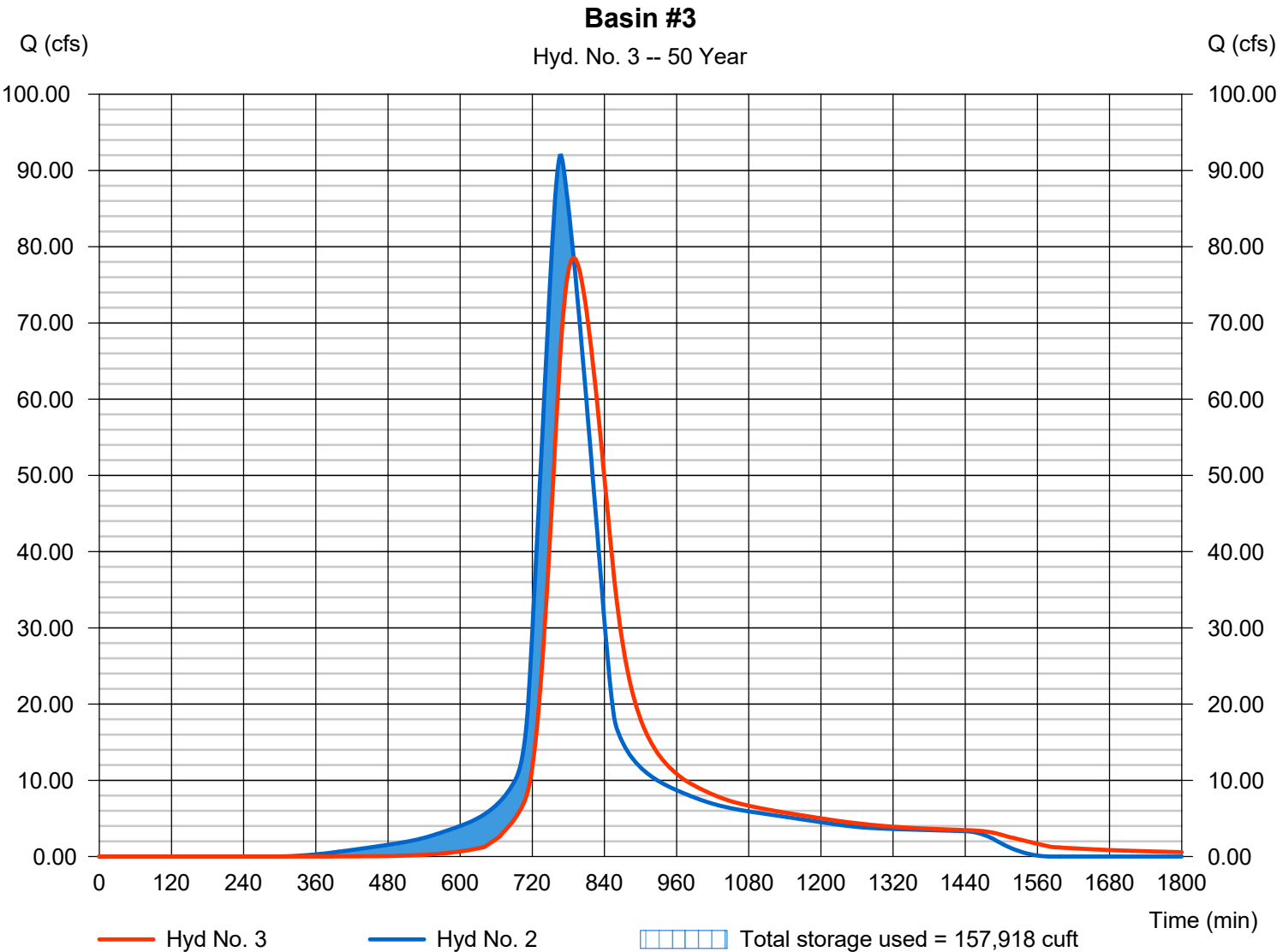
Hydrograph Report

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 78.53 cfs
Storm frequency	= 50 yrs	Time to peak	= 788 min
Time interval	= 2 min	Hyd. volume	= 801,558 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 937.39 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 157,918 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Hyd. No. 4

Area 4 South of Patterson

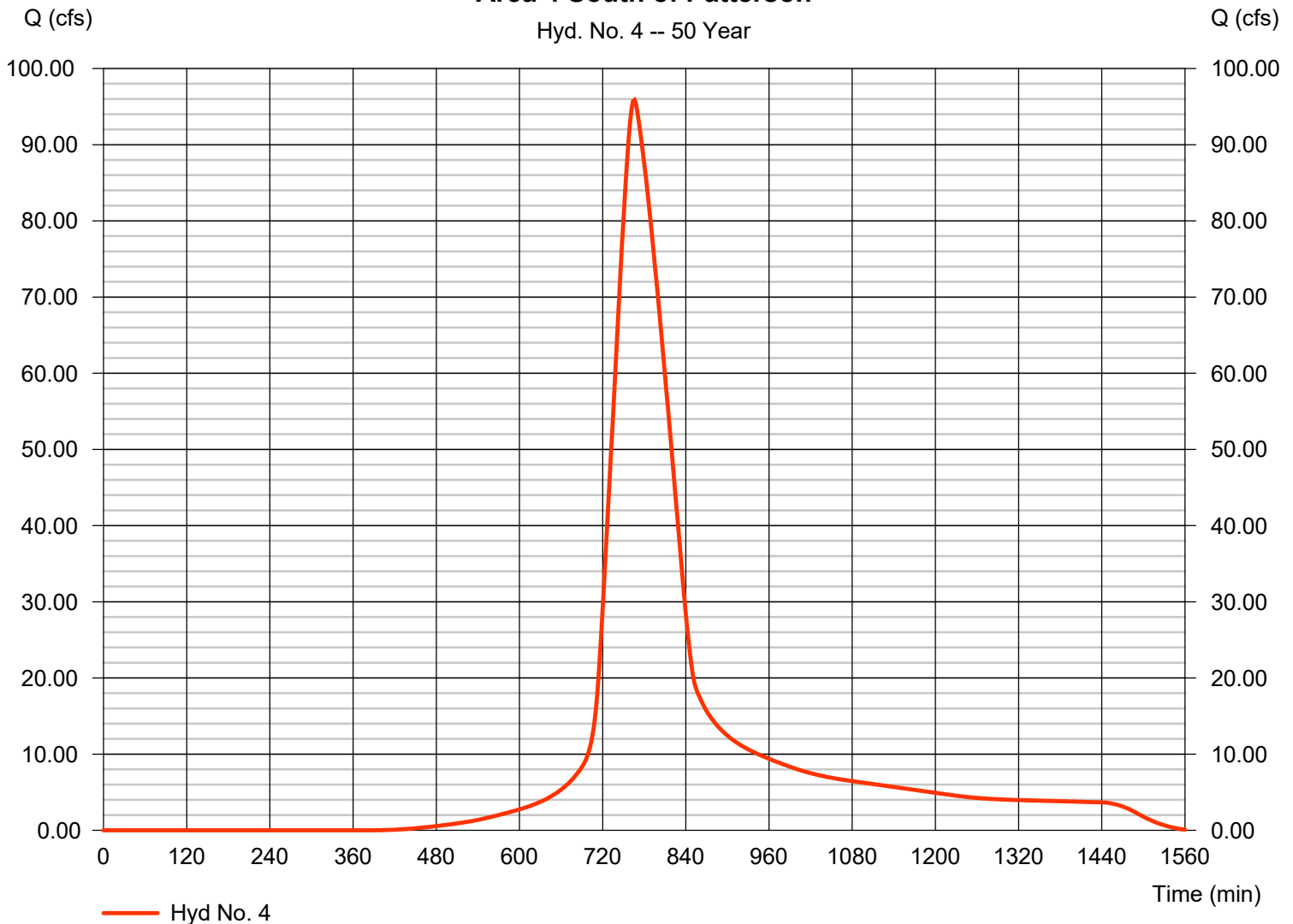
Hydrograph type = SCS Runoff
Storm frequency = 50 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 5.02 in
Storm duration = 24 hrs

Peak discharge = 95.89 cfs
Time to peak = 766 min
Hyd. volume = 806,085 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$

Area 4 South of Patterson

Hyd. No. 4 -- 50 Year



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

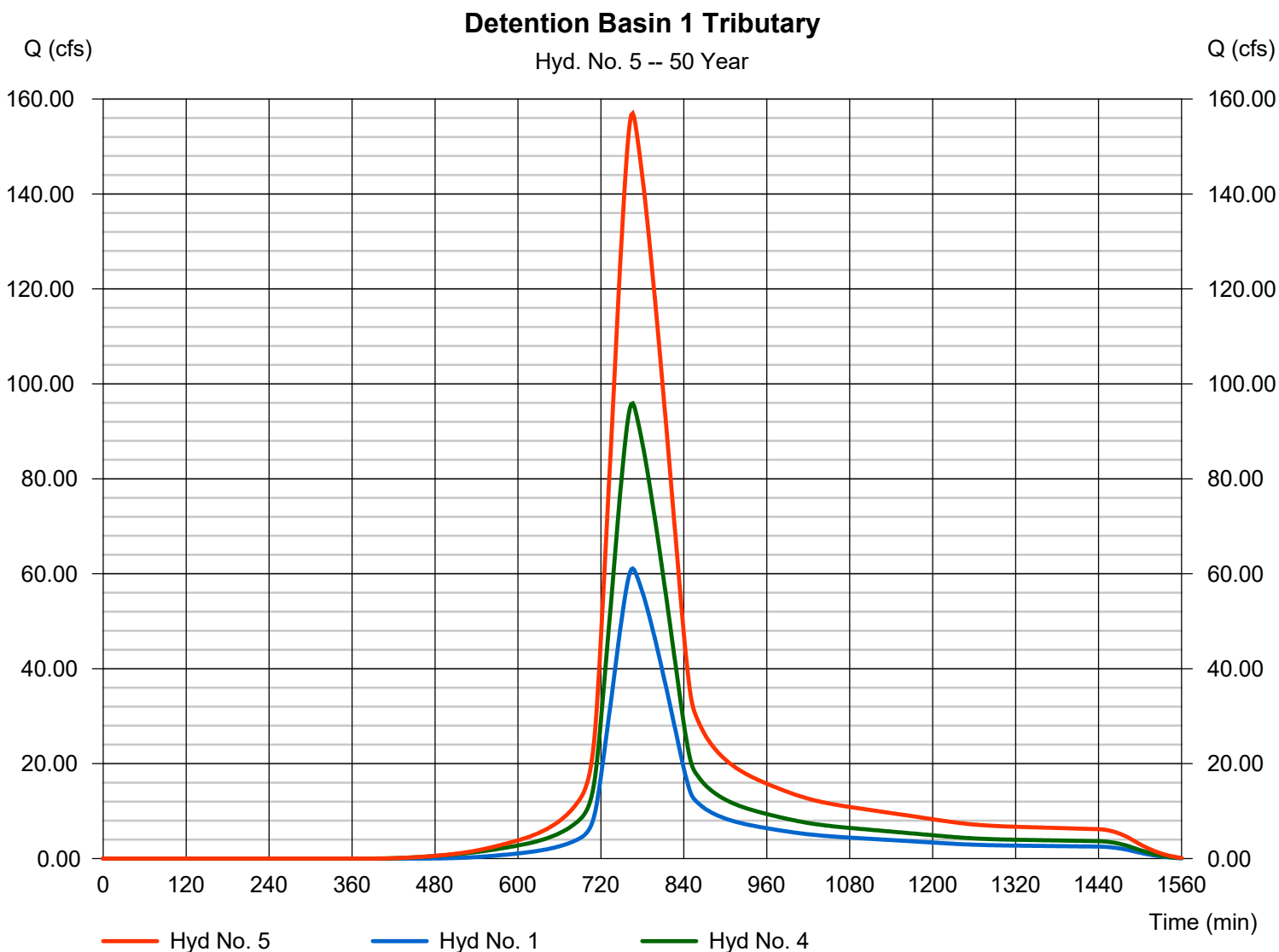
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 50 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 157.00 cfs
Time to peak = 766 min
Hyd. volume = 1,321,769 cuft
Contrib. drain. area = 120.540 ac



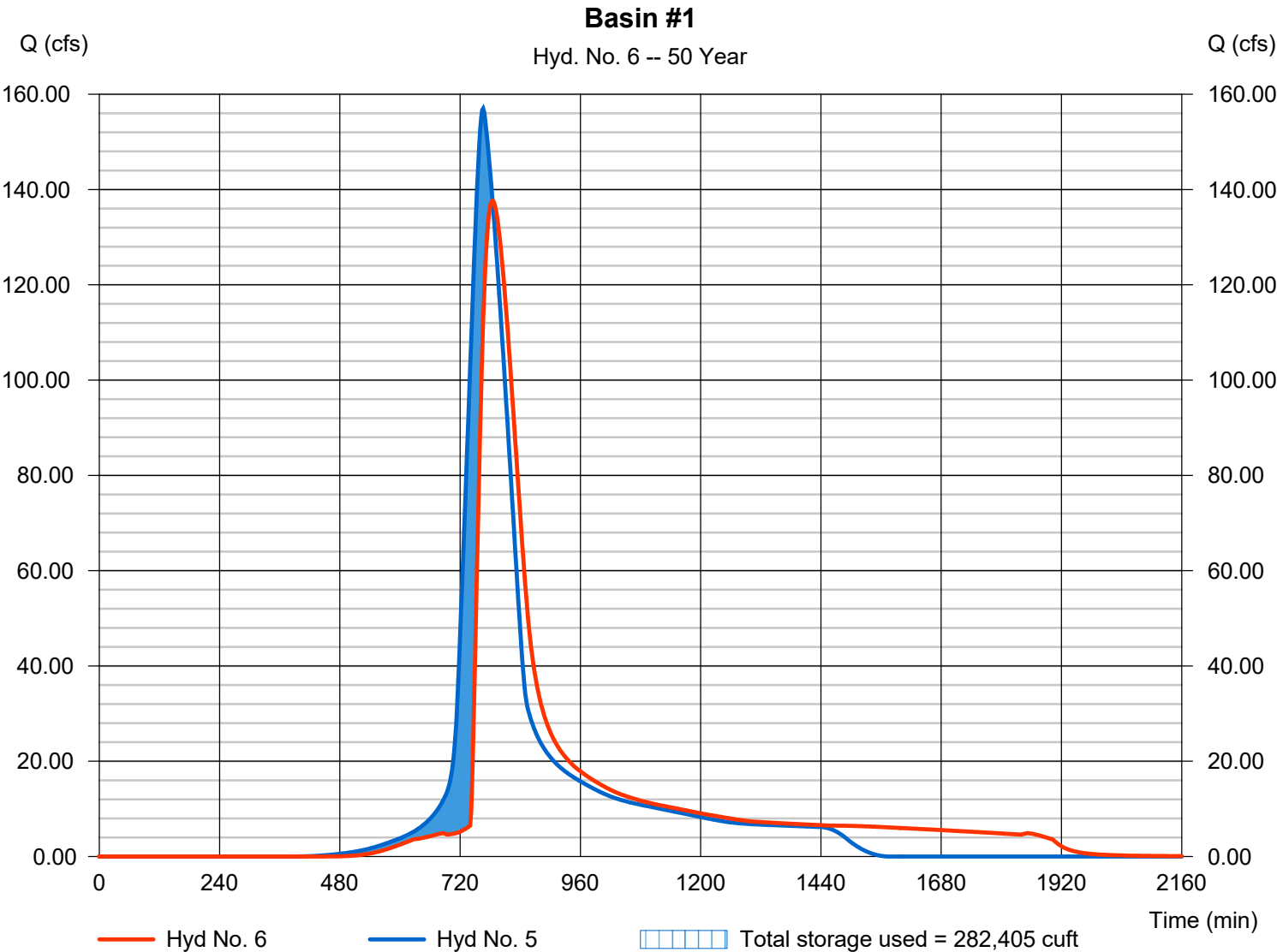
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 137.67 cfs
Storm frequency	= 50 yrs	Time to peak	= 784 min
Time interval	= 2 min	Hyd. volume	= 1,321,743 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 928.42 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 282,405 cuft

Storage Indication method used.



Hydrograph Report

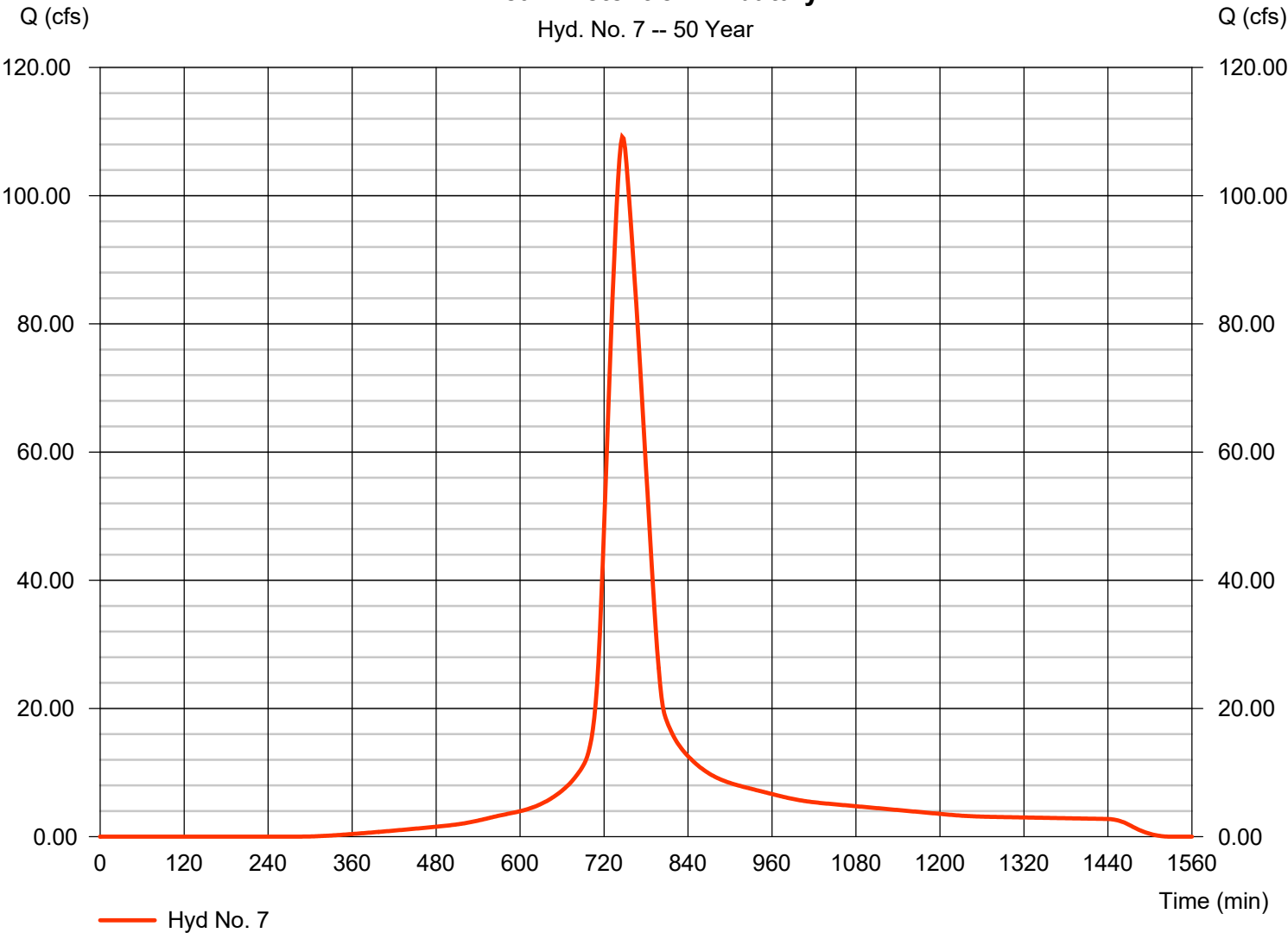
Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	109.18 cfs
Storm frequency	=	50 yrs	Time to peak	=	746 min
Time interval	=	2 min	Hyd. volume	=	677,726 cuft
Drainage area	=	51.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	55.90 min
Total precip.	=	5.02 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

Area 2 Detention Tributary

Hyd. No. 7 -- 50 Year



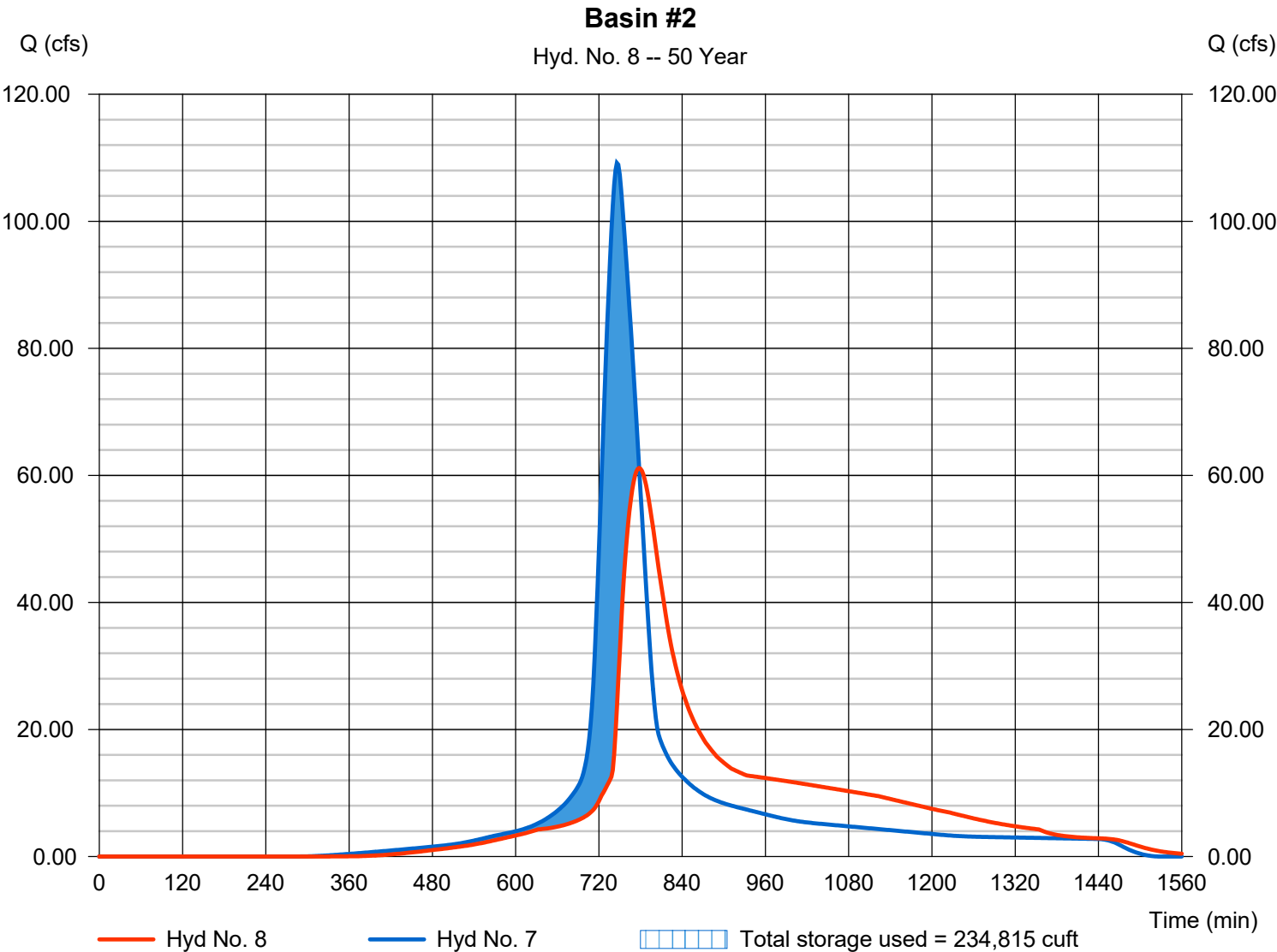
Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 61.16 cfs
Storm frequency	= 50 yrs	Time to peak	= 778 min
Time interval	= 2 min	Hyd. volume	= 677,706 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 929.44 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 234,815 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

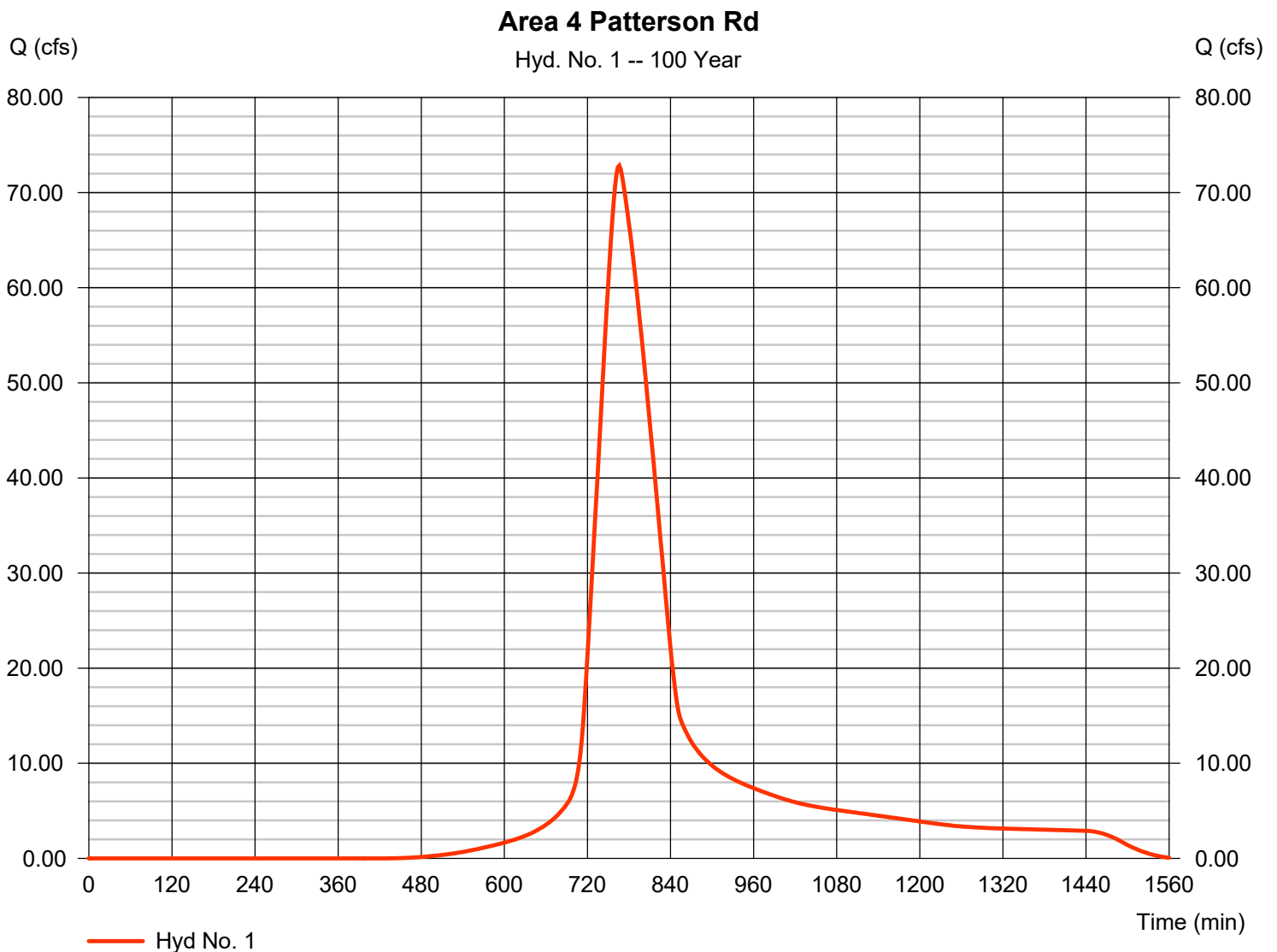
Wednesday, 11 / 2 / 2022

Hyd. No. 1

Area 4 Patterson Rd

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 50.640 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 5.63 in
Storm duration = 24 hrs

Peak discharge = 72.84 cfs
Time to peak = 766 min
Hyd. volume = 613,052 cuft
Curve number = 79
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484



Hydrograph Report

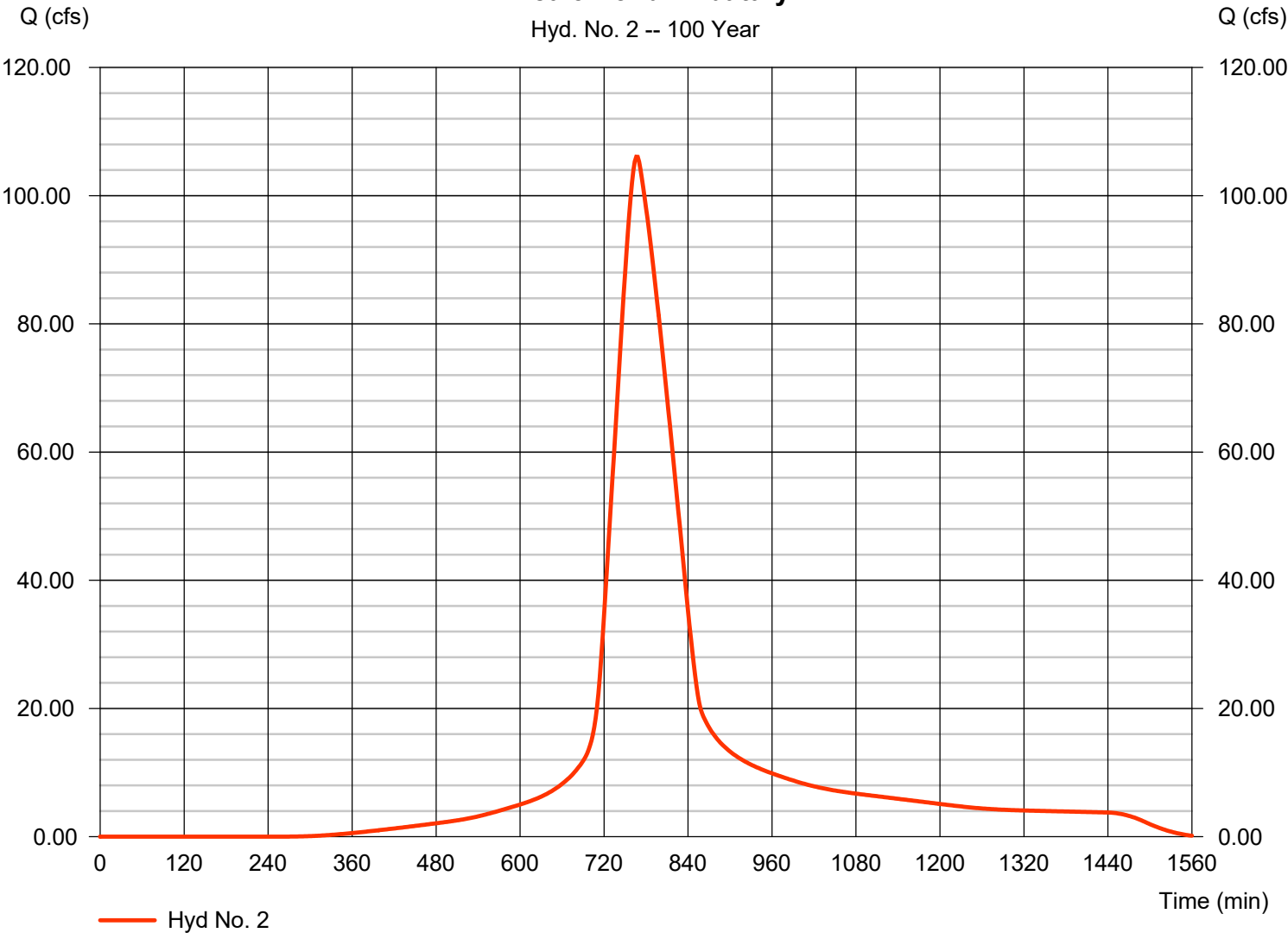
Hyd. No. 2

Area 3 Pond Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	106.08 cfs
Storm frequency	=	100 yrs	Time to peak	=	766 min
Time interval	=	2 min	Hyd. volume	=	930,074 cuft
Drainage area	=	60.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	89.00 min
Total precip.	=	5.63 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

Area 3 Pond Tributary

Hyd. No. 2 -- 100 Year



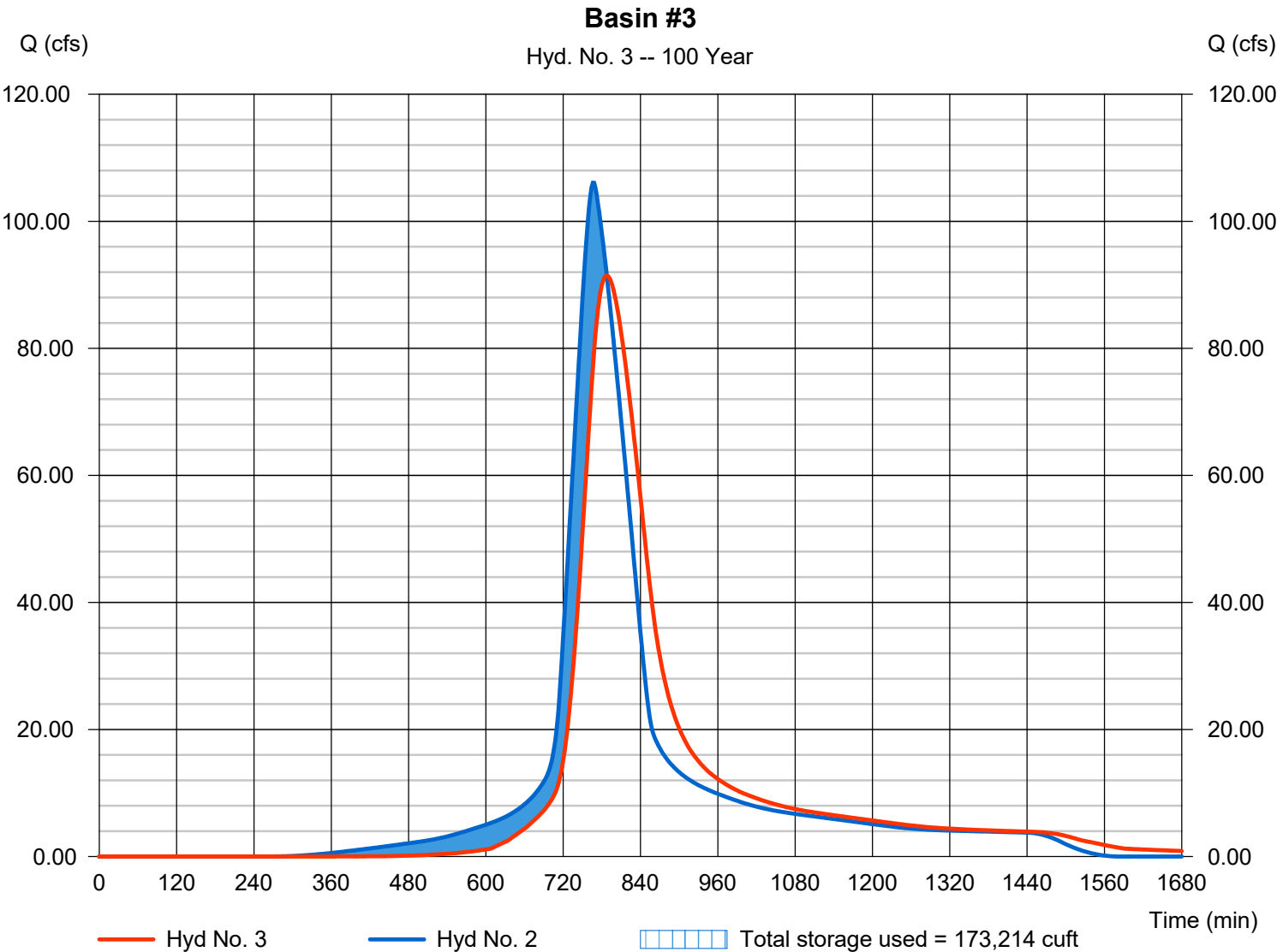
Hydrograph Report

Hyd. No. 3

Basin #3

Hydrograph type	= Reservoir	Peak discharge	= 91.47 cfs
Storm frequency	= 100 yrs	Time to peak	= 788 min
Time interval	= 2 min	Hyd. volume	= 928,396 cuft
Inflow hyd. No.	= 2 - Area 3 Pond Tributary	Max. Elevation	= 937.61 ft
Reservoir name	= Basin #3-Area 3-Mando	Max. Storage	= 173,214 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Wednesday, 11 / 2 / 2022

Hyd. No. 4

Area 4 South of Patterson

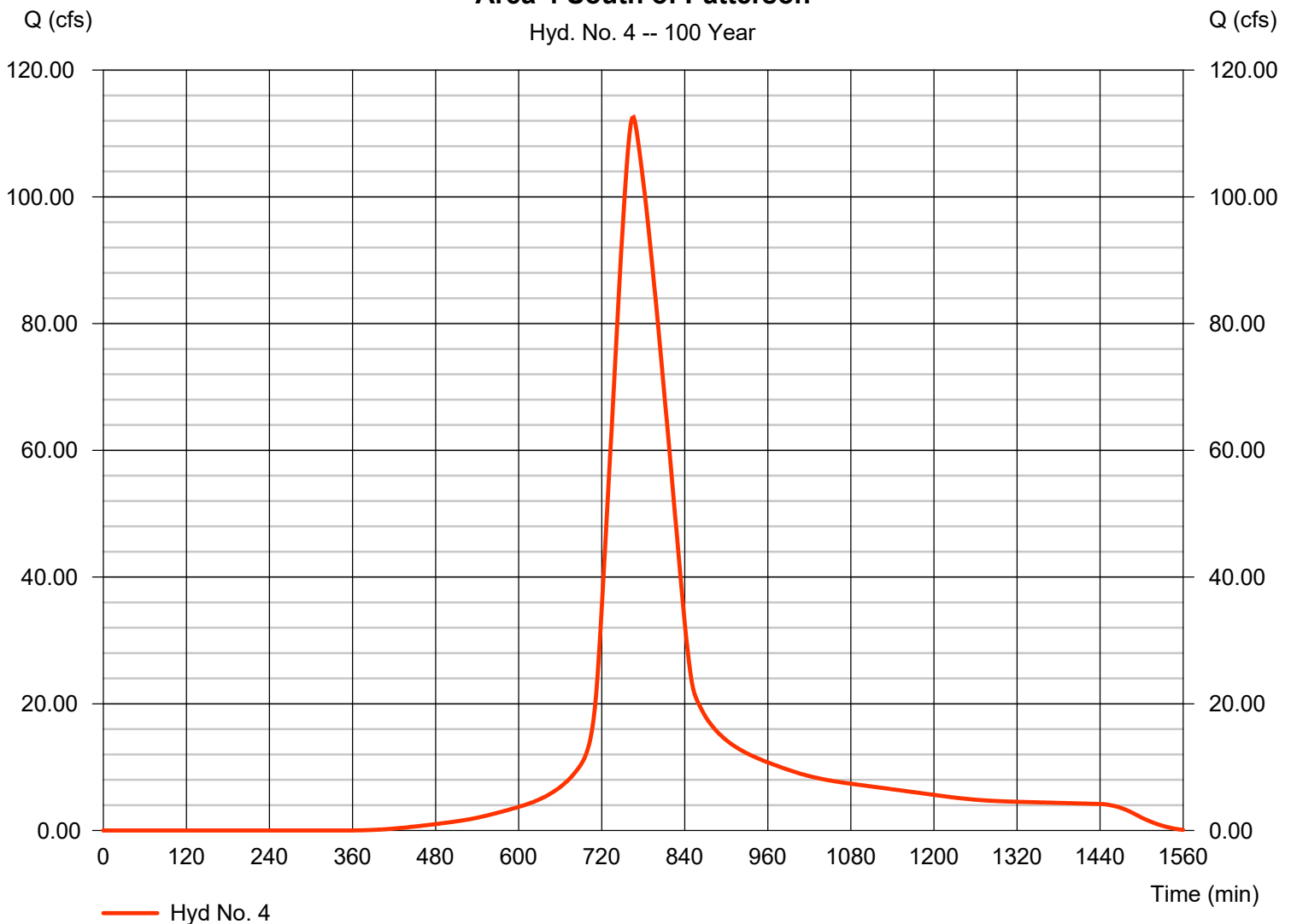
Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 69.900 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 5.63 in
Storm duration = 24 hrs

Peak discharge = 112.56 cfs
Time to peak = 766 min
Hyd. volume = 946,769 cuft
Curve number = 83*
Hydraulic length = 0 ft
Time of conc. (Tc) = 85.30 min
Distribution = Type II
Shape factor = 484

* Composite (Area/CN) = $[(35.700 \times 88) + (34.200 \times 77)] / 69.900$

Area 4 South of Patterson

Hyd. No. 4 -- 100 Year



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

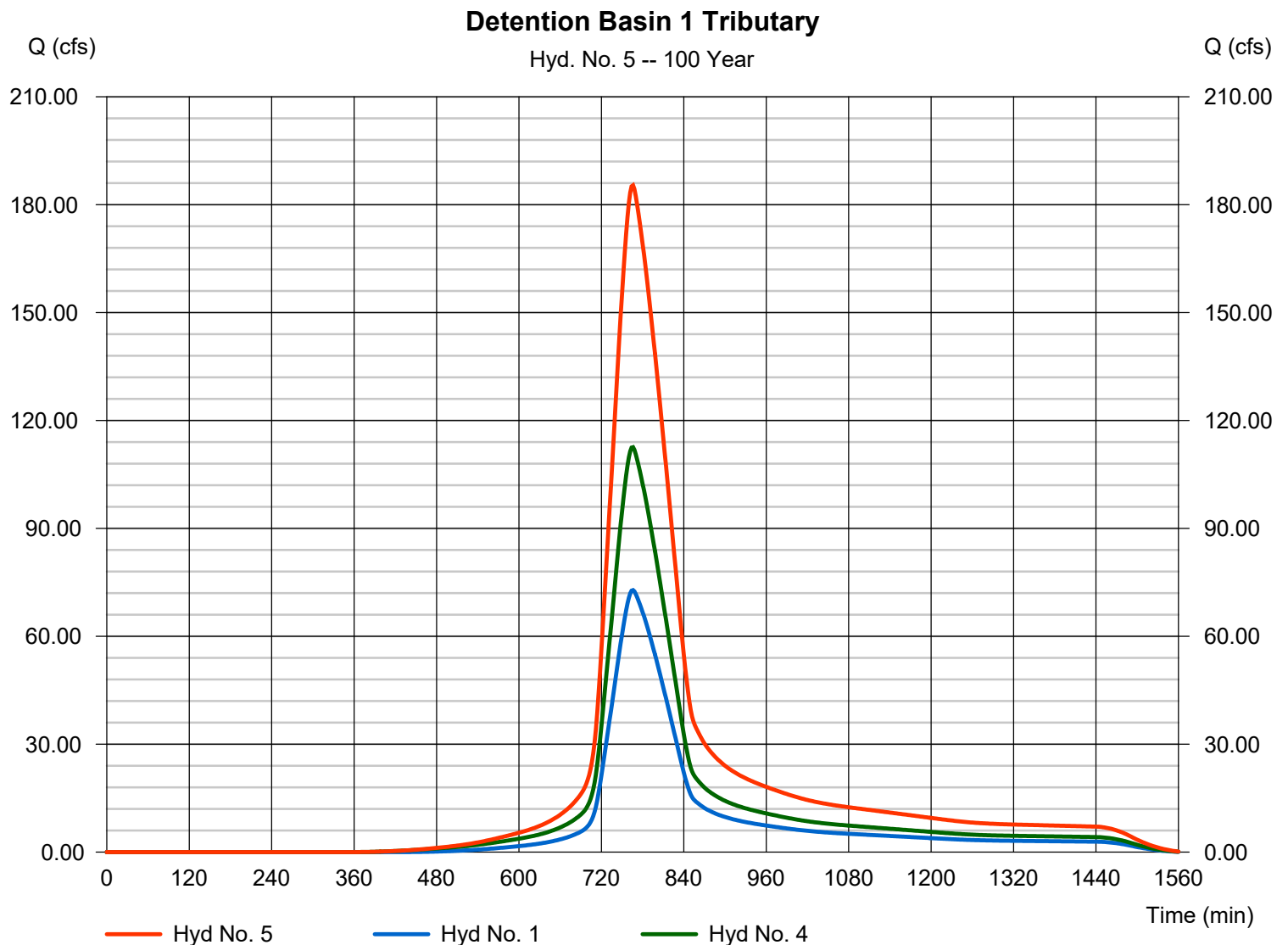
Wednesday, 11 / 2 / 2022

Hyd. No. 5

Detention Basin 1 Tributary

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 1, 4

Peak discharge = 185.40 cfs
Time to peak = 766 min
Hyd. volume = 1,559,820 cuft
Contrib. drain. area = 120.540 ac



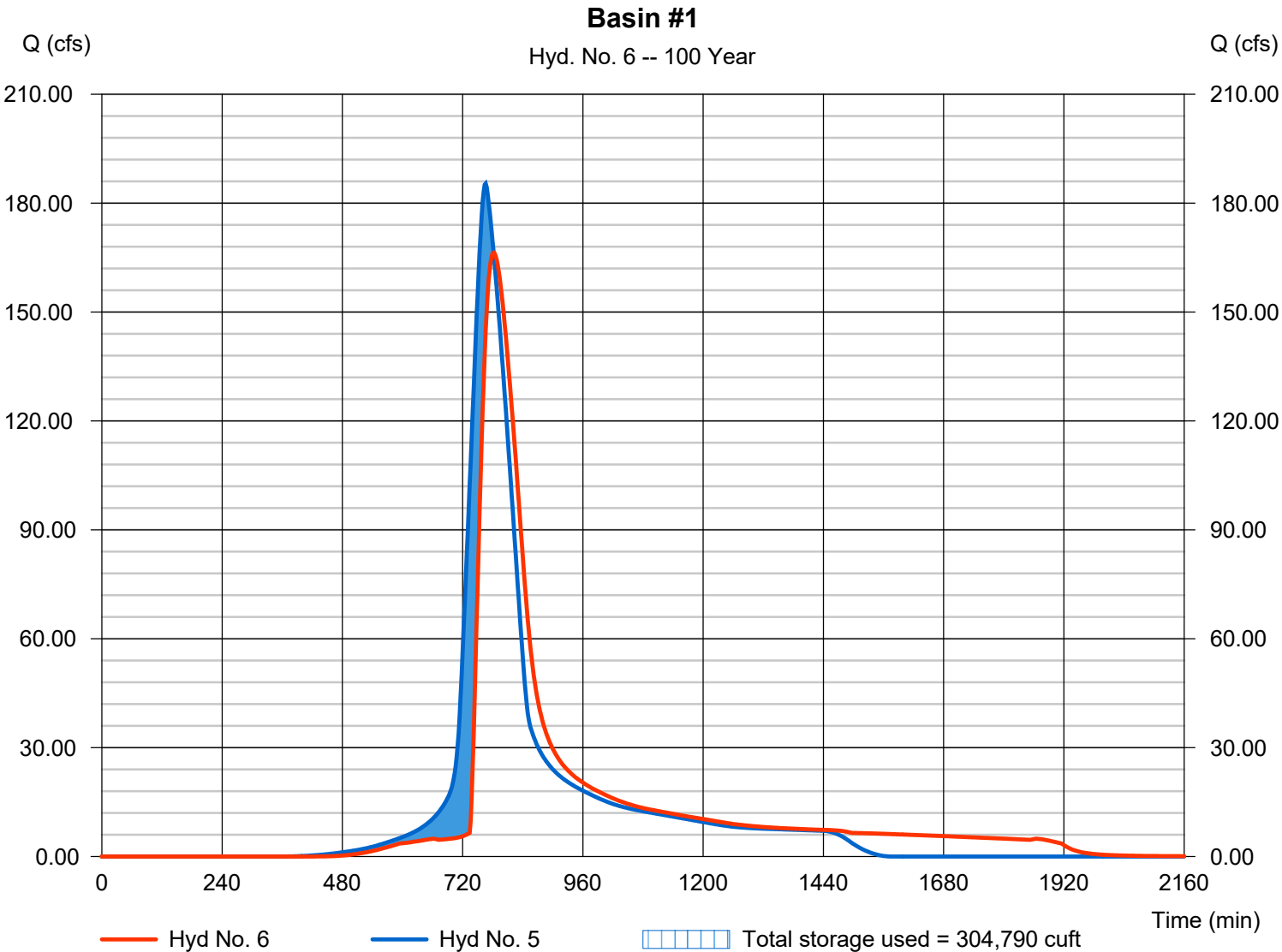
Hydrograph Report

Hyd. No. 6

Basin #1

Hydrograph type	= Reservoir	Peak discharge	= 166.38 cfs
Storm frequency	= 100 yrs	Time to peak	= 782 min
Time interval	= 2 min	Hyd. volume	= 1,559,794 cuft
Inflow hyd. No.	= 5 - Detention Basin 1 Tributary	Max. Elevation	= 928.83 ft
Reservoir name	= Basin #1 Area 4-Patterson Road	Max. Storage	= 304,790 cuft

Storage Indication method used.



Hydrograph Report

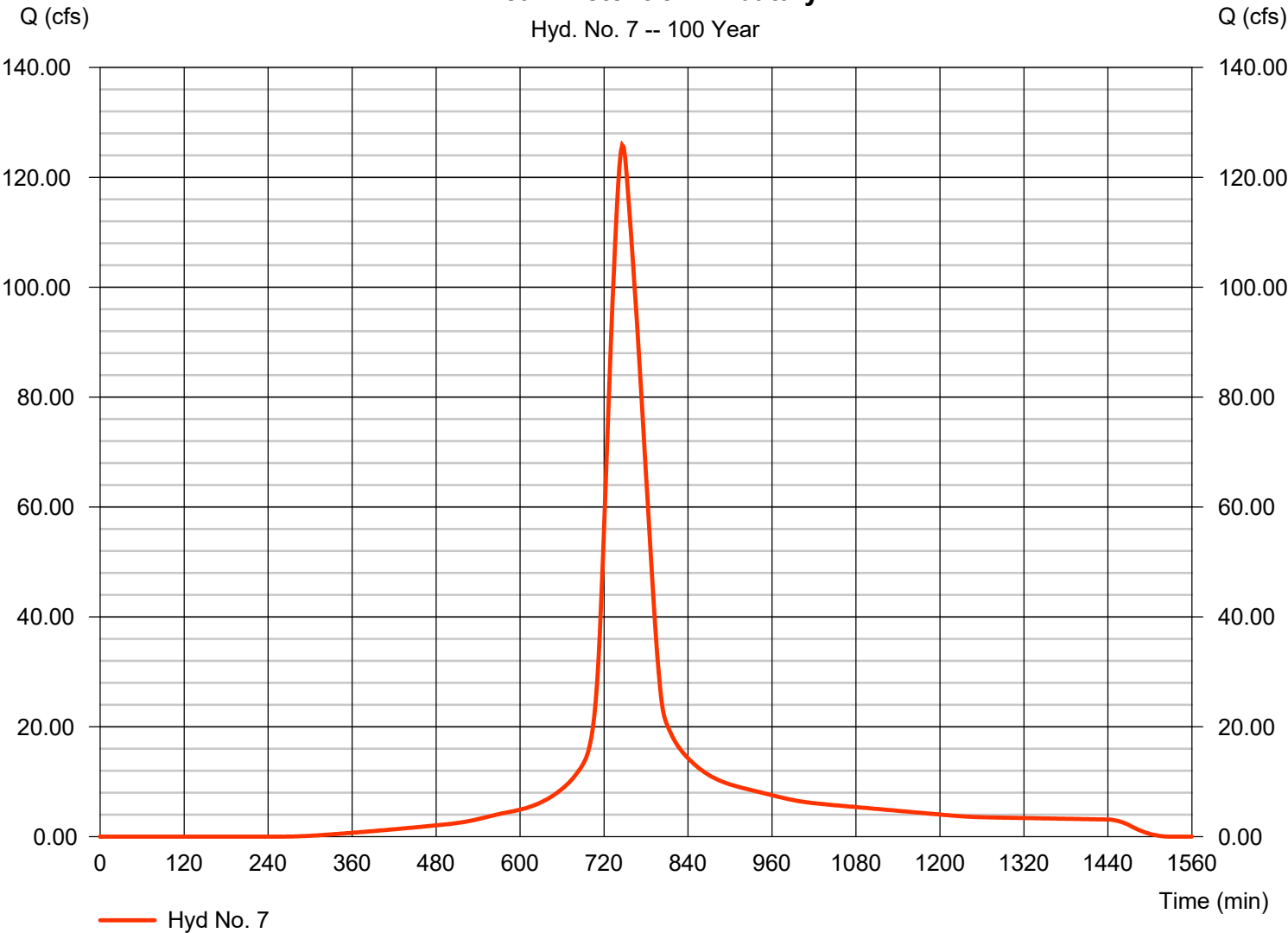
Hyd. No. 7

Area 2 Detention Tributary

Hydrograph type	=	SCS Runoff	Peak discharge	=	125.88 cfs
Storm frequency	=	100 yrs	Time to peak	=	746 min
Time interval	=	2 min	Hyd. volume	=	784,750 cuft
Drainage area	=	51.000 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	55.90 min
Total precip.	=	5.63 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

Area 2 Detention Tributary

Hyd. No. 7 -- 100 Year



Hydrograph Report

Hyd. No. 8

Basin #2

Hydrograph type	= Reservoir	Peak discharge	= 75.22 cfs
Storm frequency	= 100 yrs	Time to peak	= 776 min
Time interval	= 2 min	Hyd. volume	= 784,729 cuft
Inflow hyd. No.	= 7 - Area 2 Detention Tributary	Max. Elevation	= 929.71 ft
Reservoir name	= Basin #2 Area 2-Field Drainage	Max. Storage	= 259,544 cuft

Storage Indication method used.

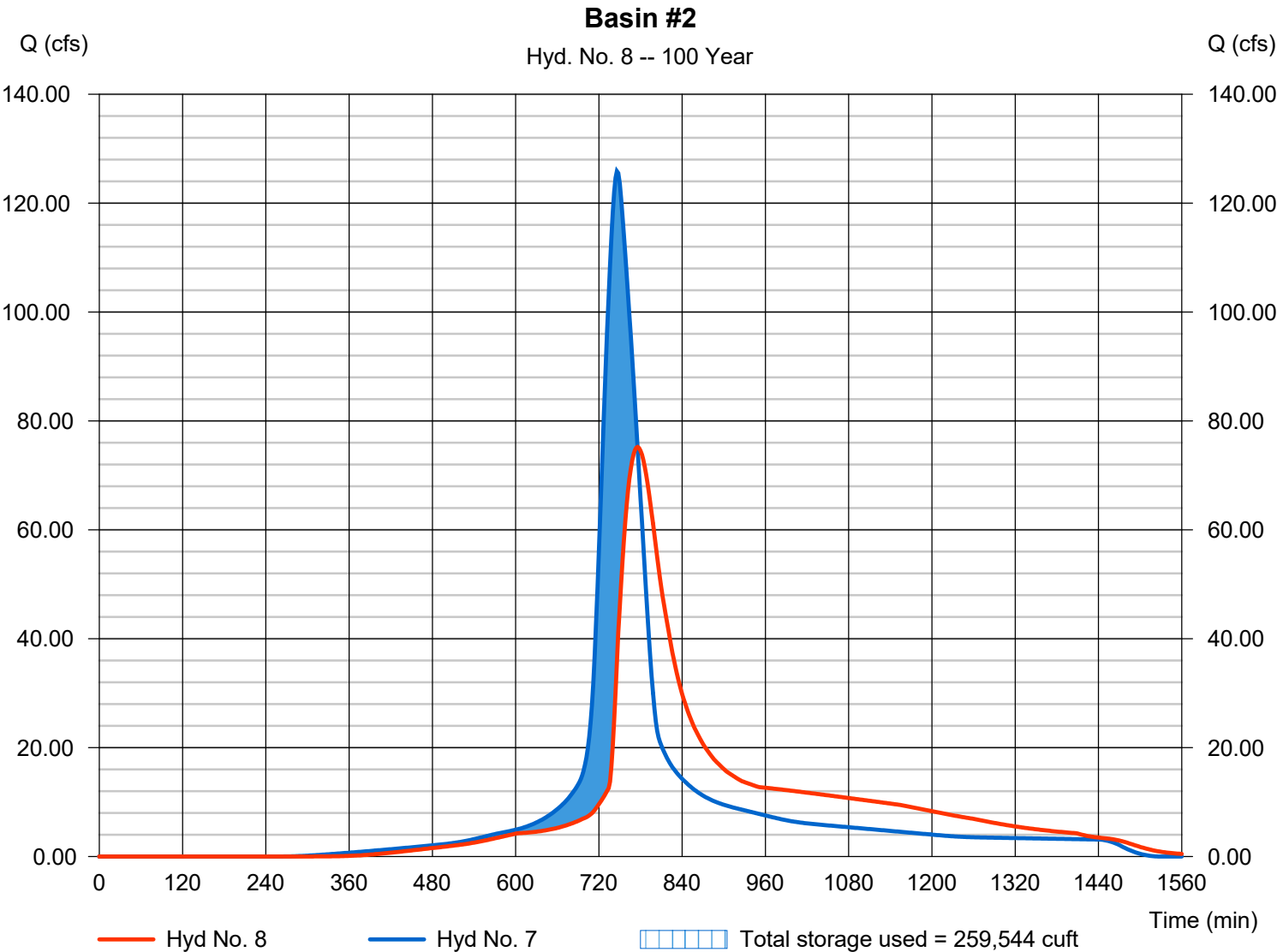


Exhibit 8 ____ Cost Estimates

Mando Improvements
PDR Magnitude of Cost



Prepared By: Mark Larrimer P.E.
Date: 11/2/2022

Area 1

Item	Unit	Quantity	Unit Cost	Cost
12" Tile #1 and Swale	LF	1500	\$120.00	\$180,000.00
Catch Basin	EA	5	\$2,500.00	\$12,500.00
				\$192,500.00

Area 2

Proposed Tile #2	LF	1796	\$40.00	\$71,840.00
Catch Basin	EA	17	\$2,500.00	\$42,500.00
Proposed Detention Basin #2	CF	195000	\$1.00	\$195,000.00
				\$309,340.00

Area 3

30" Storm Sewer	LF	2536	\$90.00	\$228,240.00
12" Tile #3 and Swale	LF	2049	\$70.00	\$143,430.00
Catch Basin	EA	16	\$2,500.00	\$40,000.00
Proposed Detention Basin #3	CF	200000	\$1.00	\$200,000.00
				\$611,670.00

Area 4

18" Tile #4A and Swale (outlet to detention)	LF	3115	\$150.00	\$467,250.00
12 Tile 4B	LF		\$40.00	
30" Storm Sewer	LF	1150	\$90.00	\$103,500.00
24" Storm Sewer	LF	1150	\$80.00	\$92,000.00
18" Storm Sewer	LF	700	\$70.00	\$49,000.00
12" Storm Sewer	LF	500	\$60.00	\$30,000.00
Catch Basin	EA	12	\$2,500.00	\$30,000.00
Proposed Detention Basin #1	CF	313000	\$1.00	\$313,000.00
				\$1,084,750.00

Project Total \$2,198,260.00