WGMGROUP

Stormwater Summary
Trinity Subdivision
WGM Project Number: 19-11-19
10.8.2020

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REPORT DATE:

10.8.2020

AUTHOR:

Kevin Bilant, P.E.

Project Engineer

WGM Group, Inc.

1.0 INTRODUCTION

The Trinity Subdivision is located north of Mullan Road and West of West Broadway within the city limits of Missoula. An affordable housing development is proposed on a vacant 4.95-acre parcel on Lot 1 of the Trinity Mullan Subdivision Located in the N ½ of S. 17, T. 13 N, R. 19 W Principal Meridian, Montana. The vacant 4.95 acre parcel is being subdivided from the existing 22.39 acre parcel and gifted to the Missoula Housing Authority for development. See Appendix 1 for preliminary plat showing lot layout. The project also consists of reconstructing the north portion of Maple Street adjacent to Lot 1.

The existing Detention Center parcel (Lot 2 on the attached Preliminary Plat) is currently served by onsite drywell injection sumps. These sumps are scattered throughout the site and are responsible for the onsite stormwater management. Lot 1 currently has sumps located in the existing parking lot on the south side of the parcel adjacent to the irrigation ditch.

Since the existing Detention Center parcel (Lot 2) has a functioning stormwater management system, only the vacant portion of Lot 2 located north of Lot 1 and east of the existing security fence, will be considered in this report. The topography of the northernmost portion of the vacant Lot 1 drains west into Lot 2 and is assumed to be managed by the onsite sumps.

The proposed development on Lot 1 consists of a new mixed-use building and associated site infrastructure such as parking lot improvements, landscaping, utilities, and stormwater management infrastructure. The stormwater management plan (SWM) consists of a vegetated swale, closed conduits roof drains, inlets, and drywell well sumps. This report outlines the storm drainage design criteria and how the proposed SWM plan meets the current City of Missoula's stormwater requirements.

2.0 DESIGN CRITERIA

The City of Missoula requires that the SWM plan for this subdivision meet the requirements outline in DEQ Circular 8. This consists of conveyance structures to be designed to convey post-development peak flow without overtopping roadways or driveways during a 10-year storm event and without inundating any buildings during a 100-year storm event. It is also understood that The City of Missoula accepts the use of the Montana Post-Construction Stormwater BMP Design Guidance Manual 2017 as the stormwater performance design standard which requires that all new developments implement post-construction stormwater management controls designed to infiltrate, evapotranspire, and/or capture for reuse the post-construction runoff from the first 0.5 inches of rainfall from a 24-hour storm preceded by 48-hours of no measurable precipitation. This report will use the DEQ Circular 8 design storms for runoff volume calculations and the BMP Manual's performance standard for measuring the first 0.5 inches of runoff from impervious areas.

The City of Missoula requires that an infiltration test be performed within 300 feet of a proposed sump or other proposed infiltration device. WGM Group tested existing sumps surrounding the site to determine infiltration rates with a city approved test method. The test method consisted of using a water truck/s to presoak the sump. A typical presoak period lasts for at least an hour. Once the presoak is complete, the water level in the sump is increased to approximately 4.0 feet from the bottom of the sump. This level is used to replicate the head anticipated from a storm event. Next, the time for the water level to drop 1.0 foot was measured. The sump is then refilled to the 4.0 foot elevation and the process was repeated to find an average infiltration rate.

The City of Missoula requires a factor of safety be applied to infiltration rates on new sumps. A factor of safety of 2.0 is required for sumps that are equipped with pretreatment device. The pretreatment device is intended to filter out fines before they enter the sump and clog the sump rock. Pretreatment can be a vegetated swale, catch basin or other device. A factor of safety of 3.0 is required for sumps without

pretreatment. Since the sumps on the east side of the site were noted to have mud and debris clogging the sump rock, it is assumed that a factor of safety has already been applied to the infiltration rates and therefore a factory of safety was not applied to the proposed sumps on the east side of the parcel. Refer to Appendix 2 for tested sump locations and infiltration test data. Engineering judgement was used to not apply the factor of safety to the sumps with mud and debris. If the sumps are not properly maintained by the property owner, this may result reduced infiltration rates which may create standing water in the parking lot and may increase asphalt deterioration. This surface ponding and asphalt deterioration may be a safety issue. Over time, surface ponding may occur around any of the proposed sumps and the property owner is responsible for maintenance all storm water infrastructure located on their property outside of the right-of-way.

The subject property has been evaluated using the SCS Method, also known as the Curve Number Method, using Hydraflow Hydrographs Extension for AutoCAD. The SCS Method uses soil classification and land-use to determine storm runoff. A curve number (CN) is assigned to each soil type and land use combination. Engineering judgement is used to determine the land use and the CN. The CN represents the amount of initial abstraction that will occur during a storm event. The higher the CN, the high the runoff potential. The site soils are assumed to be classified as hydraulic soil classification B and the curve numbers for each land-use were assigned using Table 7-8, "Montana Department of Transportation Hydraulics Manual, Chapter 7 – Hydrology – 2017." And Table 2-2a in the "USDA TR-55 Urban Hydrology for Small Watersheds". MDT Chapter 7 was also used for the 24-hour rainfall depths for a NRCS Type II storm distribution and the time of concentration for unimproved and landscape drainage area was calculated in Hydraflow using the TR-55 Method. For the small parking lot drainage areas, a time of concentration of 5 minutes was manually input. Table 3.0 below summarizes the hydrologic soil group, curve numbers, and time of concentrations for each drainage area.

3.0 STORMWATER MANAGEMENT SYSTEM

The proposed SWM system conveys the onsite runoff to proposed onsite sumps via overland flow and a system of drain pipes. Uphill of Lot 1, a portion of Lot 2 drains south towards Lot 1. This runoff will be captured in vegetated swale on Lot 2 before it can cross the property line. The runoff from this undeveloped area will be routed to new sumps where it will infiltrate. See attached Stormwater Management Plan in Appendix 3 for routing, anticipated sump locations, and 300' radius from the tested sumps.

Based on the provided formulas in Section 3.2 of the BMP Manual, the calculated Runoff Reduction Volume (RRV) = 5,400 cubic feet. See Appendix 5 for RRV volume determination. Since the RRV will be infiltrated through the sumps, the Runoff Treatment Volume equals zero and therefore not calculated. The impervious area used in the calculation and the RRV volume were rounded up to be conservative. Based on these Hydraflow calculations, the sumps can adequately manage the RRV of 5,400 cubic feet.

The infiltration data collected during the sump testing was used to calculate the maximum area that can contribute to each onsite sump and is based on the required 300' radius. The maximum area for each sump is influenced by the anticipated infiltration rate and surface type (impervious versus landscape). Hydraflow was used to route a 10-year storm through sump to determine the maximum contributing area. Table 1.0 below summarizes the infiltration rates, maximum contributing area, and relative location on to the site. These areas are also depicted on the attached Stormwater Management plan included in Appendix 3.

Table 1.0 – Sump Infiltration Data and Maximum Impervious Area

Sump Name - Location	Average Infiltration Rate (in/hour)	Factor of Safety Applied (Y/N)	Factor of Safety	Infiltration Rate Used in Calculation (in/hour)	Maximum Impervious contributing Area (Sq. Ft)
Northwest – Detention Center Landscape area	621.8	Y	3.0	200.0	11,761
Southwest – Detention Center Parking Lot	199.2	Y	2.0	100.0	10,890
Northeast – Dollar Car Rental Lot	67.19*	N	0.0	67.0	6,534
Southeast – Maple Street	75.49*	N	0.0	75.0	6,969

*indicates sumps that were noted to have mud and debris in bottom of sump. Engineering judgement was used and factor of safety was not applied to these sumps.

To simplify the stormwater calculations, the site will be divided into two regions, east, and west. The east region will use a maximum impervious contributing area of 6,500 square feet per sump and includes the Maples Street improvements. The west region will use a maximum contributing impervious area of 10,000 square feet per sump. Rounding the contributing area down will apply an additional factor of safety to each of the proposed sumps. The area for interior parking lot islands were assumed to be impervious thus creating more runoff than will be anticipated adding additional safety factor built into the calculations. The regions and number of sumps are shown on the attached SWM plan in Appendix 4. The sumps along the south portion of the site will utilize a remote inlet piped to a sump to justify applying a factor of safety of 2.0 to the infiltration rate.

Table 2.0 below summarizes minimum number of sumps required for each drainage area based on the infiltration rate and surface type. The sump routing calculations are included in Appendix 4 with the Hydraflow calculations. Table 3.0 summarizes the weighted curve numbers and time of concentrations for each drainage area used in the calculations.

Table 2.0 – Drainage Areas and Number of Sumps Required/Anticipated

Location	Area (Sq. Ft)**	Area Per Sump	Number of Sumps Required	Anticipated Number of Sumps Provided
West Parking Lot	48,804	1 per 10,000 sf	5 Sumps	8 Sumps
East Parking Lot	41,753	1 per 6,500 sf	7 Sumps	8 Sumps
Maple Street	7,522	1 per 6,500 sf	2 Sumps	2 Sumps
Building*	40,780	1 per 6,500 sf	7 Sumps	10 Sumps
Landscape	84,285	1 per 43,560 sf	3 Sumps	4 Sumps
North Unimproved Area	46,863	1 per 47,916 sf	1 Sump	3 Sumps
TOTALS	270,008 = (6.2 Acres)	-	25 Sumps	35 Sumps

*If roof drain sumps are placed in area where higher infiltration rate is expected the number of sumps will be reduced.
**All areas are impervious except "Landscape", and "North Unimproved Area". All interior parking lot landscape islands were calculated as impervious area.

Table 3.0 – Hydrologic Soil Groups, Curve Numbers, and Time of Concentrations

Location	Hydrologic Soil Group	Curve Number	Time of Concentration
West Parking Lot	-	98	5.0 Minutes
East Parking Lot	-	98	5.0 Minutes
Maple Street	-	98	5.0 Minutes
Building	-	98	5.0 Minutes
Landscape – Good Condition (Grass Cover >75%)	B	61	36.3 Minutes
North Unimproved Area – Poor Condition (Brush-weed-grass mixture with brush the major element)	B	67	18.2 Minutes

4.0 HYDROLOGY & HYDRAULICS

The City of Missoula requires that post-development peak flow does not overtop roadways or driveways during a 10-year storm event and without inundating any buildings during a 100-year storm event. Hydraflow Extensions in AutoCAD was used to calculate the stormwater runoff volumes from the site as well as route the design storms through the proposed sumps. The storm volumes generated by a 100-year event over a 6,500 square foot (east) and 10,000 square foot (west and southwest) parking lot drainage areas were analyzed to ensure that adequate surface storage is provided in the parking lot and to ensure the sumps can manage the 100-year storm event.

The volume for both an east and west parking lot "node" was calculated using the pyramid volume equation.

$$V = \frac{L * W * H}{3}$$

The average 6,500 square foot east parking lot node has a Length = 108 ft, Width = 60 ft, and a Height (depth) = 0.5 ft. This results in a volume of 1,080 cubic feet of storage capacity and does not include the volume of the sump. The volume of a sump and sump rock is approximately 168 cubic feet and was calculated in Hydraflow for the sump routing and modeling. The total storage volume available for the average east parking lot node is approximately 1,248 cubic feet. The total drainage area contributing to each sump in the east portion of the site will likely be less than 6,500 square feet and will be based on the final parking lot configuration and grading constraints.

The average west and southwest parking lot nodes drain 10,000 square feet of impervious area and have a Length = 206 ft, Width = 48 ft, and a Height (depth) = 0.5 ft. This results in a volume of 1,648 cubic feet of storage capacity and does not include the volume of the sump. With the volume of a sump and sump rock the total storage volume available for the average west and southwest parking lot node is approximately 1,816 cubic feet. The total drainage area contributing to each sump in

the west and southwest portion of the site will likely be less than 10,000 square feet and will be based on the final parking lot configuration and grading constraints.

The 100-year 24-hour storm was routed through sumps with applicable infiltration rates. Table 4.0 below summarizes the storm volume, available surface storage, and surface ponding surcharge volume generated by the 100-year 24-hour storm event.

Table 4.0 – 100-year storm volumes and storage

	Sump Infiltration Rate (in/hr)	Storm Volume (cubic feet)	Available Surface Storage (cubic feet)	Surface Storage Required (cubic feet)*
East Parking Node	67	1,048	1,248	327
West Parking Node	200	1,886	1,648	403
Southwest Parking Node	100	1,886	1,648	439

*Surface storage required indicates total surcharge volume above sump rim.

Based on the Hydraflow routing and the data presented in Table 4.0, the average parking lot nodes will have adequate capacity to store the surcharge stormwater volume generated by the 100-year 24-hour storm event on the surface of the parking lot without overtopping adjacent curb while the proposed sumps simultaneously infiltrates the stormwater into the ground. Any ponding on the surface will meet the DEQ 8 requirement to drain within 48 hours. Additional sumps will be added to those mentioned above if the storage capacity in the parking lot is inadequate without overtopping the curb. For events larger than the 100-year storm, stormwater will flow within the parking lot south and overtop the curb and discharge into the irrigation ditch. Revisions to this report may be issued once final site grading has been completed.

5.0 CONCLUSION

The stormwater management system outlined above was designed in accordance with the City of Missoula's current requirements including Montana DEQ Circular 8 and the Montana Post-Construction Stormwater BMP Design Guidance Manual 2017. Based on the attached calculations, the proposed stormwater management system is adequately designed to convey, retain, and treat the onsite stormwater while simultaneously meeting the post-construction performance standard outlined in the BMP Manual. The ten supplementary proposed sumps, shown in Table 2.0, exceeds the minimum number of sumps required to manage the calculated storm volumes and provides additional stormwater management capacity.

If stormwater overwhelms the proposed sumps serving the north unimproved area, stormwater will flow along preconstruction drainage pathways and be managed by the existing onsite storm drain infrastructure located throughout the Detention Center's property. If overwhelmed, the total volume discharged to the preconstruction drainage paths will be reduced by the proposed sumps. The calculations presented above indicate that the proposed drainage improvements to serve the unimproved portion are adequate to manage the design storm. The stormwater system and drainage pathways will need to be reevaluated if the vacant portion is redeveloped in the future.

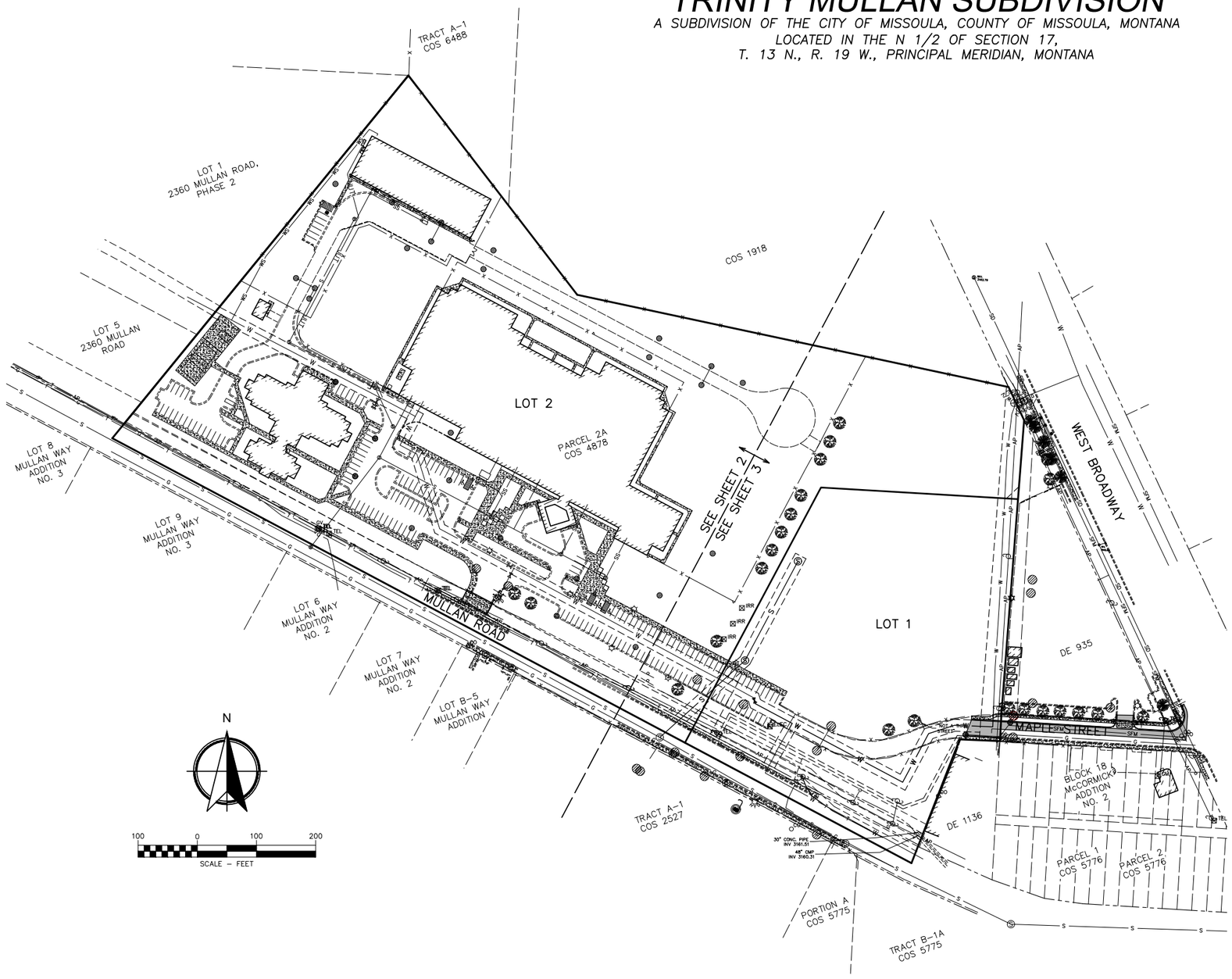
All stormwater infrastructure must be properly maintained to function correctly. It is recommend that all sumps and inlets have sediment and debris vacuumed out approximately every 5 years. All swales and drainage paths should be clear of overgrown vegetation and be kept clean from garbage. The property owner is responsible for all operation and maintenance of the stormwater system located on their property. The City of Missoula is responsible for operation and maintenance for all stormwater infrastructure located within public rights-of-ways.

APPENDIX 1 – PRELIMINARY PLAT

PRELIMINARY PLAT OF

TRINITY MULLAN SUBDIVISION

A SUBDIVISION OF THE CITY OF MISSOULA, COUNTY OF MISSOULA, MONTANA
LOCATED IN THE N 1/2 OF SECTION 17,
T. 13 N., R. 19 W., PRINCIPAL MERIDIAN, MONTANA

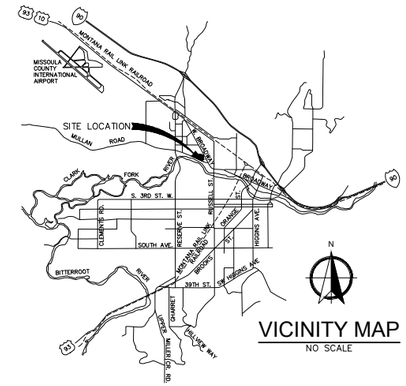


LEGEND-EXISTING

- SUBJECT PROPERTY BOUNDARY
- RIGHT-OF-WAY
- EASEMENT LINE
- LOT LINE
- EXTERIOR BUILDING WALL
- CONCRETE SIDEWALK
- EDGE OF ASPHALT
- CURB AND GUTTER
- W — WATER MAIN
- WS — WATER SERVICE
- S — GRAVITY SANITARY SEWER MAIN
- SS — SANITARY SEWER SERVICE
- SFM — SEWER FORCE MAIN
- SD — STORM DRAIN LINE
- RD — ROOF DRAIN LINE
- AP — AERIAL POWER LINE
- BE — BURIED POWER LINE
- T — BURIED TELEPHONE LINE
- G — GAS MAIN
- JUT — JOINT UTILITY TRENCH
- X — FENCE
- IRRIGATION DITCH
- CONTOUR (1 FOOT INTERVAL)
- W/V — WATER VALVE
- FIRE HYDRANT
- W — WELL
- S — SANITARY SEWER MANHOLE
- CO — SANITARY SEWER CLEANOUT
- DRAINAGE SUMP
- DS — ROOF DRAIN DOWNSPOUT
- UTILITY POLE
- GUY WIRE
- LIGHT POLE
- ELEC — ELECTRIC PEDESTAL
- TEL — COMMUNICATIONS PEDESTAL
- GR — GAS RISER
- GV — GAS MAIN VALVE
- EVERGREEN TREE
- DECIDUOUS TREE
- SIGN
- F2.0% — APPROXIMATE ROAD GRADE

LEGEND-PROPOSED

- LOT LINE
- EASEMENT LINE
- EDGE OF ASPHALT
- CURB AND GUTTER (CATCH)
- CURB AND GUTTER W/DRIVEWAY OPENING
- 4" THICK CONCRETE SIDEWALK
- ASPHALT
- W — WATER MAIN
- S — SANITARY SEWER MAIN
- WATER VALVE
- SANITARY SEWER MANHOLE
- DRAINAGE SUMP
- 2.0% — ROAD GRADE
- UE — UTILITY EASEMENT
- WE — PUBLIC WATER MAIN EASEMENT
- SE — PUBLIC SANITARY SEWER MAIN EASEMENT
- NMAE — PUBLIC NON-MOTORIZED ACCESS EASEMENT
- IDE — PRIVATE IRRIGATION DITCH EASEMENT
- (N) — NET LOT AREA (EXCLUDES PUBLIC ROAD EASEMENT)
- (G) — GROSS LOT AREA (INCLUDES PUBLIC ROAD EASEMENT)



VICINITY MAP
NO SCALE

AREAS

LOT AREA = 21.24 ACRES
STREET AREA = 1.15 ACRES
TOTAL AREA = 22.39 ACRES

LEGAL DESCRIPTION

PARCEL 2A OF CERTIFICATE OF SURVEY NO. 4878, LESS AND EXCEPTING THAT TRACT OF LAND DESCRIBED IN BOOK 217 DEEDS, PAGE 587 AND SURVEYED PER DEED EXHIBIT NO. 935, ALL ON FILE AND OF PUBLIC RECORD IN MISSOULA COUNTY, MONTANA; AND THAT CERTAIN 30 FEET OF THE 66-FOOT WIDE MULLAN ROAD PUBLIC ROAD EASEMENT LYING NORTHERLY OF, AND ADJOINING, THE CENTERLINE OF SAID MULLAN ROAD, ALL LOCATED IN THE SOUTH ONE-HALF (S1/2) OF SECTION 17, TOWNSHIP 13 NORTH, RANGE 19 WEST, PRINCIPAL MERIDIAN, CITY OF MISSOULA, MISSOULA COUNTY, MONTANA.

BASIS OF BEARINGS

GRID NORTH OF MONTANA 2500 STATE PLANE
COORDINATE SYSTEM – NORTH AMERICAN DATUM 1983

OWNER/SUBDIVIDER

MISSOULA COUNTY

COMPREHENSIVE PLAN

REGIONAL COMMERCIAL AND SERVICES

TYPE OF SUBDIVISION

MULTI-FAMILY

ZONING

M1R-2

VERTICAL DATUM

NORTH AMERICAN VERTICAL DATUM 1988

THE FOLLOWING NOTE IS PLACED HEREON AS REQUIRED BY THE CITY OF MISSOULA:

ACCEPTANCE OF A DEED FOR A LOT WITHIN THIS SUBDIVISION SHALL CONSTITUTE THE ASSENT OF THE OWNERS TO ANY FUTURE SID/RSID, BASED ON BENEFIT, FOR THE UPGRADING OF MULLAN ROAD, WEST BROADWAY, AND MAPLE STREET, INCLUDING BUT NOT LIMITED TO PAVING, CURBS AND GUTTERS, NON-MOTORIZED FACILITIES, STREET WIDENING AND DRAINAGE FACILITIES, AND MAY BE USED IN LIEU OF THEIR SIGNATURES ON AN SID/RSID PETITION.

CERTIFICATE OF ENGINEER

I HEREBY CERTIFY THAT THE PRELIMINARY STREET, STORM DRAINAGE, SEWER, AND WATER PLANS WERE PREPARED UNDER MY SUPERVISION.

_____

CERTIFICATE OF SURVEYOR

I HEREBY CERTIFY THAT THE BOUNDARY AND PRELIMINARY LOT DESIGNS OF THIS PROPOSED SUBDIVISION WERE PREPARED UNDER MY SUPERVISION.

_____

1/4	SEC.	T.	R.
⊠	17	13N.	19W.

SHEET 1 OF 4
DATE: SEPTEMBER 2020
DRAFT: CEG
PROJECT NO.: 19-11-19.3
FILE NO.: 191119.3_PPLAT.DWG
LAYOUT TAB: PPLAT-1

WGM GROUP
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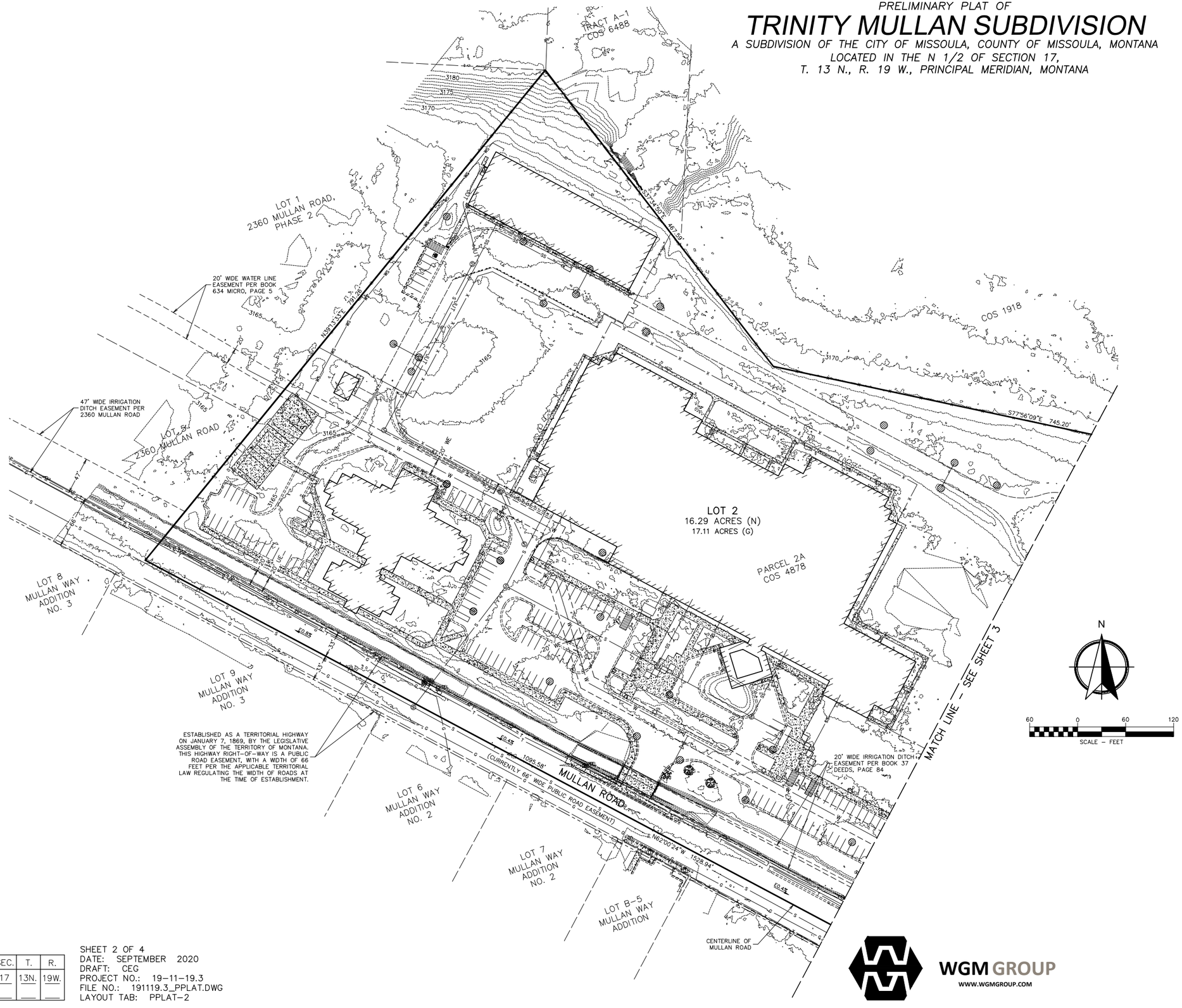
PRELIMINARY
PLOTTED: 9/1/20
SAVED: 9/1/20

PRELIMINARY PLAT OF

TRINITY MULLAN SUBDIVISION

A SUBDIVISION OF THE CITY OF MISSOULA, COUNTY OF MISSOULA, MONTANA
LOCATED IN THE N 1/2 OF SECTION 17,
T. 13 N., R. 19 W., PRINCIPAL MERIDIAN, MONTANA



1/4	SEC.	T.	R.
⊠	17	13N.	19W.

SHEET 2 OF 4
DATE: SEPTEMBER 2020
DRAFT: CEG
PROJECT NO.: 19-11-19.3
FILE NO.: 191119.3_PPLAT.DWG
LAYOUT TAB: PPLAT-2

WGM GROUP
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PRELIMINARY
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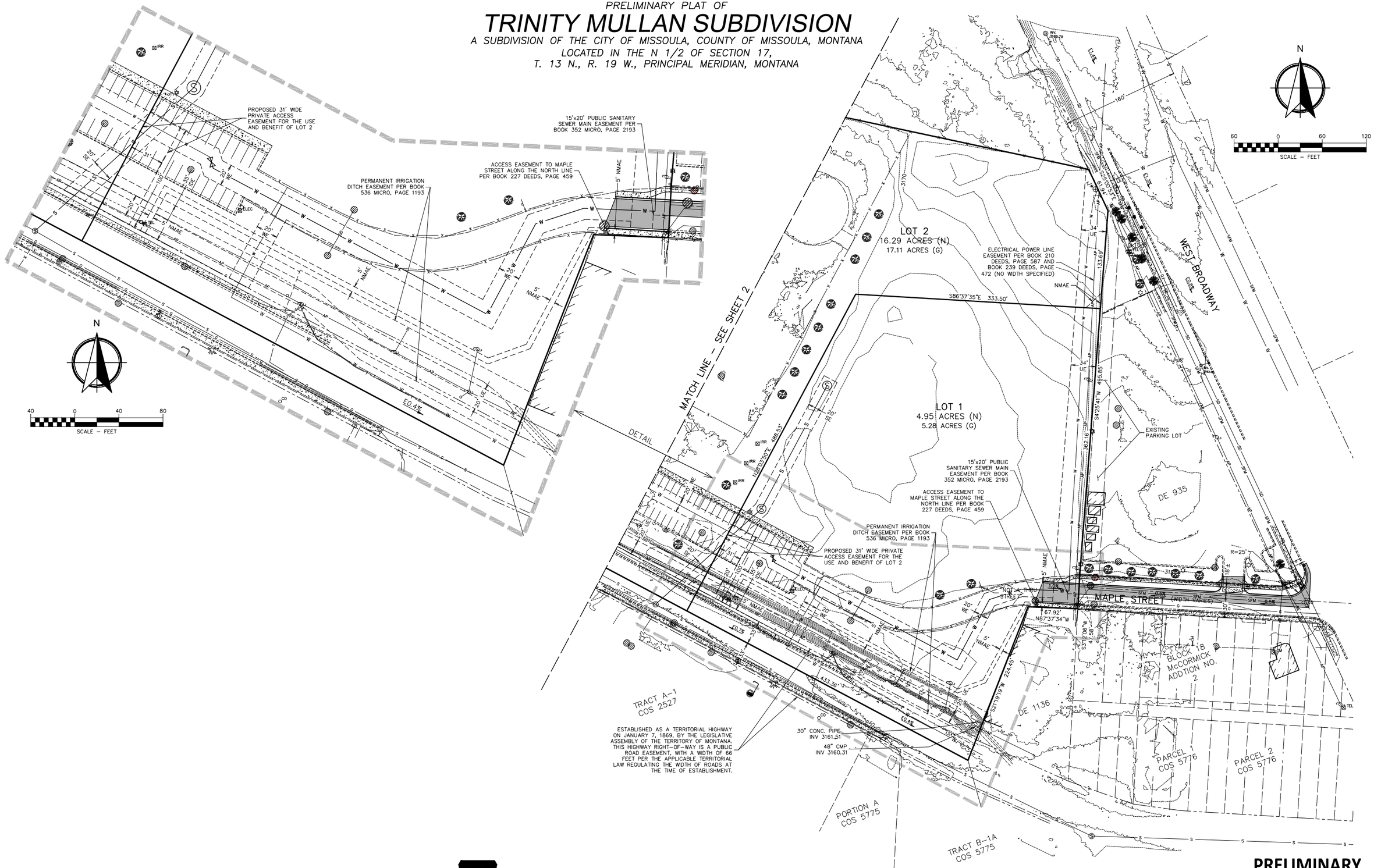

1/4	SEC.	T.	R.
☒	17	13N.	19W.
⊞			

SHEET 3 OF 4
DATE: SEPTEMBER 2020
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LAYOUT TAB: PPLAT-3

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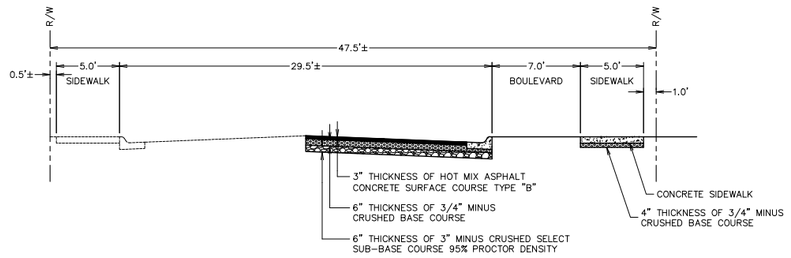
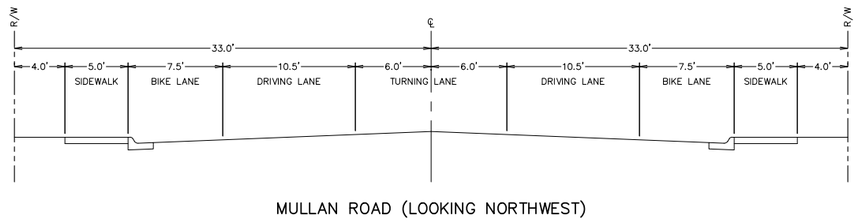


MAPLE STREET (LOOKING WEST)

PROPOSED STREET CROSS SECTION

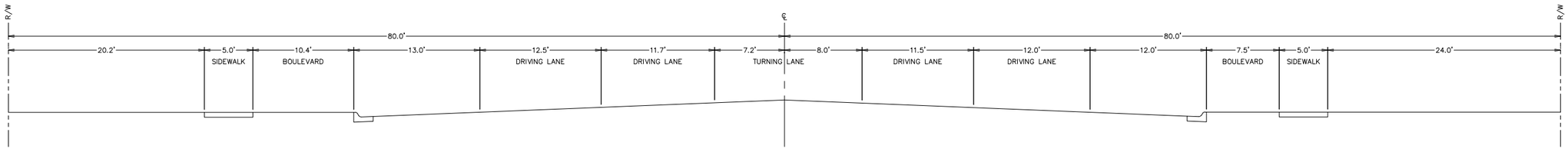
(STREET SECTION WITHIN EXISTING RIGHT-OF-WAY)



MULLAN ROAD (LOOKING NORTHWEST)

EXISTING STREET CROSS SECTION

(NO CHANGES PROPOSED)



BROADWAY (LOOKING NORTHWEST)

EXISTING STREET CROSS SECTION

(NO CHANGES PROPOSED)

1/4	SEC.	T.	R.
☒	17	13N.	19W.

SHEET 4 OF 4
DATE: SEPTEMBER 2020
DRAFT: CEG
PROJECT NO.: 19-11-19.3
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LAYOUT TAB: PPLAT-4

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PRELIMINARY
PLOTTED: 9/1/20
SAVED: 9/1/20

APPENDIX 2 – EXISTING SUMP INFILTRATION RATE SUMMARY AND DATA

WGMGROUP
Community Values. Inspired Futures.

MEMORANDUM

DATE: September 1, 2020

TO: Kevin Bilant, P.E. WGM Group Project Engineer

FROM: Emily Clark WGM Group Project Engineer

RE: Sump Testing Results at Trinity-Mullan

Sumps surrounding the Trinity-Mullan site were tested for infiltration capacity on August 13, 2020. Four sumps were tested in the following locations: the detention center's eastern parking lot adjacent to Mullan Rd (Parking Lot), the field in the detention center near the recreational yard (Detention Field), the northwest corner of the Dollar Rental Car parking lot (Dollar Lot), and on the northern side of Maple St, south of the Dollar Rental Car property (Maple St).

Two water trucks were used to pre-soak each sump before the test began and then to fill the sump between timed infiltration trials. At the Parking Lot sump location, only one trial could be completed with two water trucks. Water levels were measured from the rim of the sump at ground surface with an electric water tape. The depth of the four sumps from the rim to the rock ranged from 9.72 ft in Maple St to 7.45 ft in Detention Field. Each trial was initiated when the water level in the sump stabilized at four feet above the bottom rocks. Infiltration rates were measured for a one-ft drop in the water column. The starting head value in the Parking Lot sump was only 0.77 ft above the rock bottom. The table below summarizes of average infiltration rates in inches per hour for each sump.

Sump Location	Average Infiltration Rate (in/hr)
Parking Lot*	199.20
Detention Field	621.80
Dollar Lot**	67.19
Maple St**	75.85

*Only one trial of sump with two water trucks

**Sump contained a lot of mud and debris

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SUMP INFLITRATION TEST LOCATIONS EXHIBIT

TRINITY MULLAN SITE

MISSOULA, MONTANA

REVISIONS:

NO.	DESCRIPTION	DATE

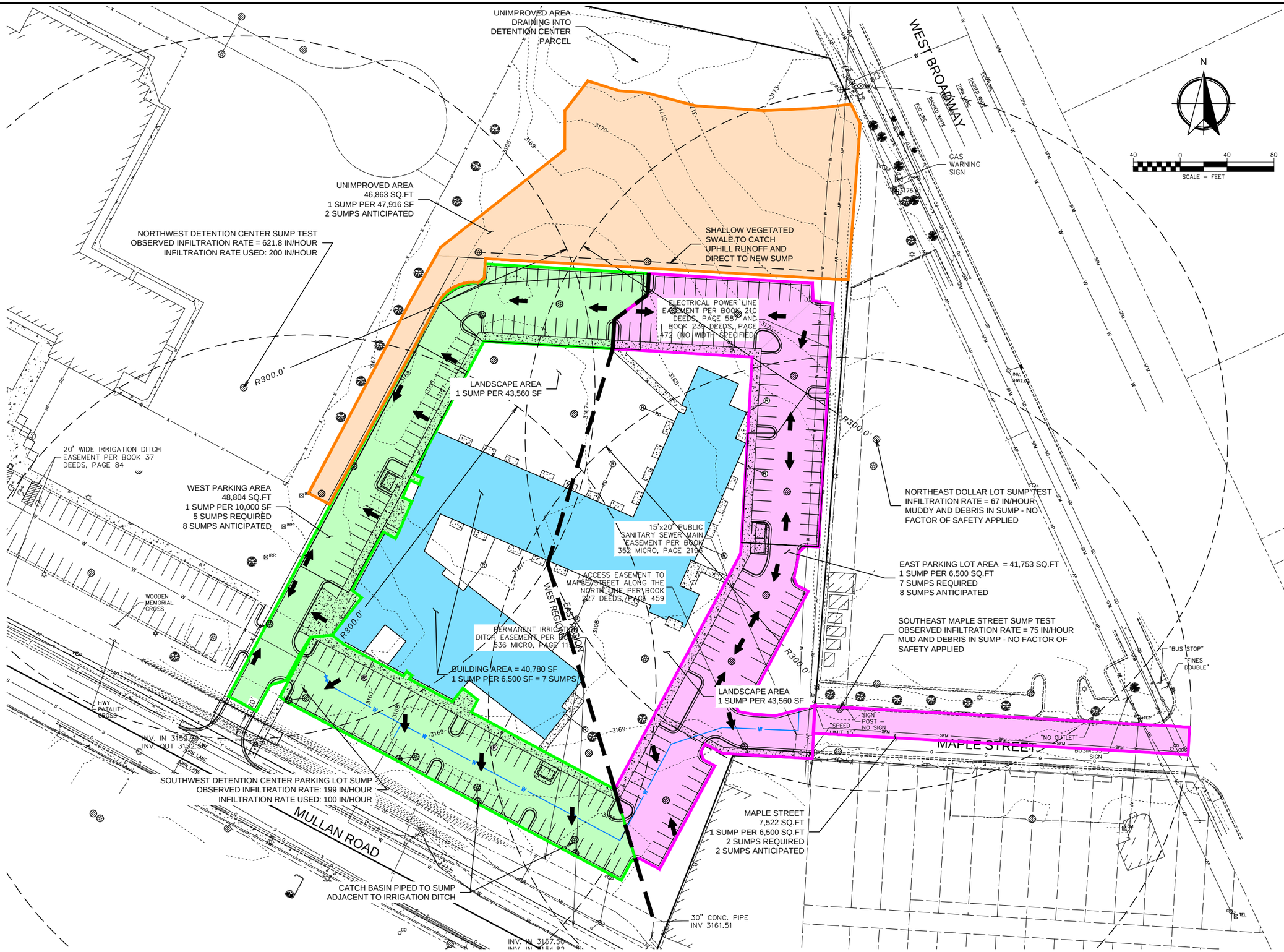
PROJECT: 19-11-19
LAYOUT: ...
SURVEYED: ...
DESIGN: ...
DRAFT: KB
APPROVE: ...
DATE:

SEPTEBMER 2020

SHEET EXH

FILE: W:\Projects\191119\CAD Data\Exhibits\191119 SumpTesting Location Exhibit.dwg

APPENDIX 3 – STORMWATER MANAGEMENT PLAN



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PRELIMINARY
PLOTTED: 10/8/20
SAVED: 10/8/20

STORMWATER MANAGMENT PLAN
TRINITY APARTMENTS
MISSOULA, MONTANA

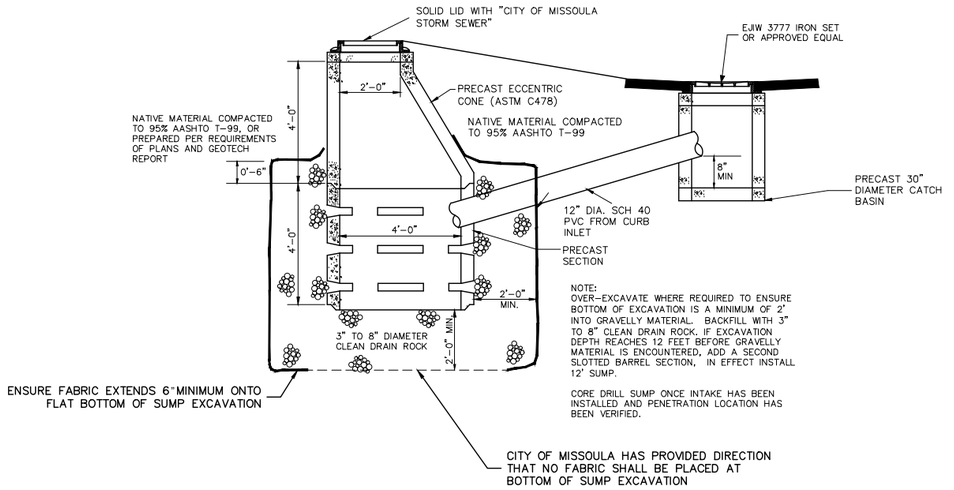
REVISIONS:

NO.	DESCRIPTION	DATE

PROJECT: 19-11-19
LAYOUT: CONCEPT
SURVEYED: ...
DESIGN: KB
DRAFT: KB
APPROVE: ...
DATE:
SEPTEMBER 2020

SHEET 1 OF 1

FILE: W:\Projects\191119\Docs\Misc\Storm Drainage\191119Stormwater Management Exhibit.dwg



8' REMOTE SUMP AND INLET DETAILS

NO SCALE

WGM GROUP
WWW.WGMGROUP.COM

PRELIMINARY

PLOTTED: 10/8/20
SAVED: 10/8/20

STORM DRAIN DETAILS
TRINITY MULLAN SUBDIVISION
MISSOULA, MONTANA

REVISIONS:

NO.	DESCRIPTION	DATE

PROJECT: 19-11-19
LAYOUT: ....
SURVEYED: ...
DESIGN: ...
DRAFT: ...
APPROVE: ...
DATE:

AUGUST 2020

SHEET SD DT

FILE: W:\Projects\191119\Docs\Misc\Storm Drainage\191119Stormwater Managment Exhibit.dwg

APPENDIX 4 – HYDRAFLOW CALCULATIONS

Hydrograph Summary Report

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

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	0.016	10	760	295	------	------	------	North Unimproved
2	Reservoir	0.016	10	760	295	1	100.06	0.934	Unimproved routing
4	SCS Runoff	0.327	2	716	734	------	------	------	Northeast East Impervious Area
5	Reservoir	0.095	2	706	734	4	101.00	161	NorthEast Sump Routing
7	SCS Runoff	0.002	2	1054	73	------	------	------	Landscaping ares per sump
8	Reservoir	0.002	2	1056	73	7	100.02	0.332	LS to SouthEast Sump
10	SCS Runoff	0.589	2	716	1,321	------	------	------	Northwest Impervious Area
11	Reservoir	0.284	2	710	1,321	10	101.00	160	West Sump Routing
13	SCS Runoff	0.349	2	716	783	------	------	------	Southeast Impervious
14	Reservoir	0.106	2	706	783	13	101.00	164	Southeast Routing
16	SCS Runoff	0.545	2	716	1,223	------	------	------	Southwest impervious area
17	Reservoir	0.284	2	710	1,223	16	101.00	132	Southwest Sump Routing

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Pond No. 6 - Northwest Sump 200 in/hr

Pond Data

Trapezoid -Bottom L x W = 7.7 x 8.0 ft, Side slope = 0.00:1, Bottom elev. = 100.00 ft, Depth = 10.00 ft, Voids = 27.40%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	61	0	0
1.00	101.00	61	17	17
2.00	102.00	61	17	34
3.00	103.00	61	17	50
4.00	104.00	61	17	67
5.00	105.00	61	17	84
6.00	106.00	61	17	101
7.00	107.00	61	17	118
8.00	108.00	61	17	134
9.00	109.00	61	17	151
10.00	110.00	61	17	168

POND PARAMETERS WERE MODIFIED UNTIL STORAGE VOLUME OF SUMP WAS ACHIEVED. TYPICAL FOR ALL SUMPS MODELED

TOTAL STORAGE VOLUME OF A SUMP

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	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)	= 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) = 200.000 (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	100.00	---	---	---	---	---	---	---	---	0.000	---	0.000
1.00	17	101.00	---	---	---	---	---	---	---	---	0.284	---	0.284
2.00	34	102.00	---	---	---	---	---	---	---	---	0.284	---	0.284
3.00	50	103.00	---	---	---	---	---	---	---	---	0.284	---	0.284
4.00	67	104.00	---	---	---	---	---	---	---	---	0.284	---	0.284
5.00	84	105.00	---	---	---	---	---	---	---	---	0.284	---	0.284
6.00	101	106.00	---	---	---	---	---	---	---	---	0.284	---	0.284
7.00	118	107.00	---	---	---	---	---	---	---	---	0.284	---	0.284
8.00	134	108.00	---	---	---	---	---	---	---	---	0.284	---	0.284
9.00	151	109.00	---	---	---	---	---	---	---	---	0.284	---	0.284
10.00	168	110.00	---	---	---	---	---	---	---	---	0.284	---	0.284

Hydrograph Report

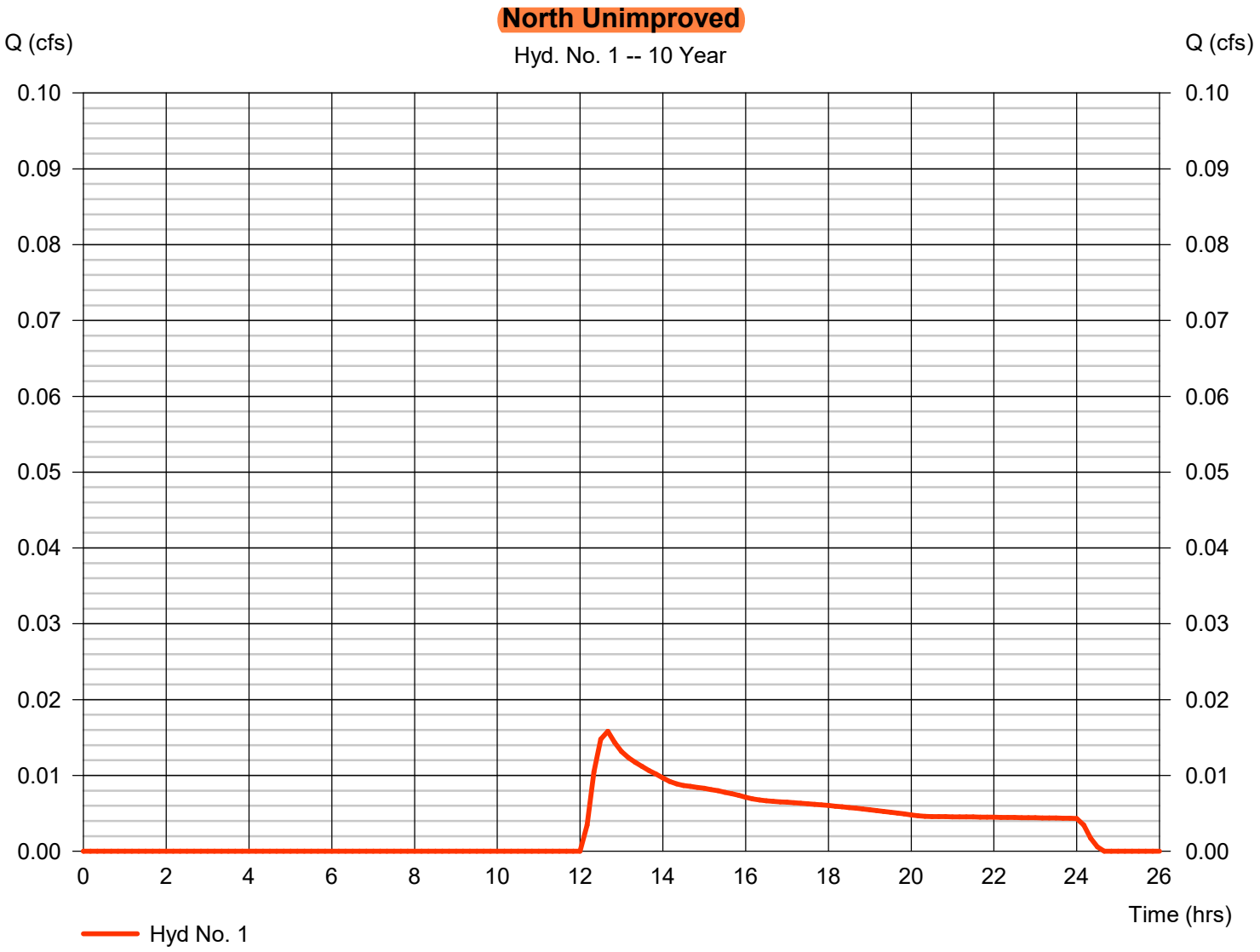
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 1

North Unimproved

Hydrograph type	= SCS Runoff	Peak discharge	= 0.016 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.67 hrs
Time interval	= 10 min	Hyd. volume	= 295 cuft
Drainage area	= 1.100 ac	Curve number	= 67*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.20 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.950 x 68) + (0.150 x 61)] / 1.100



Hydrograph Report

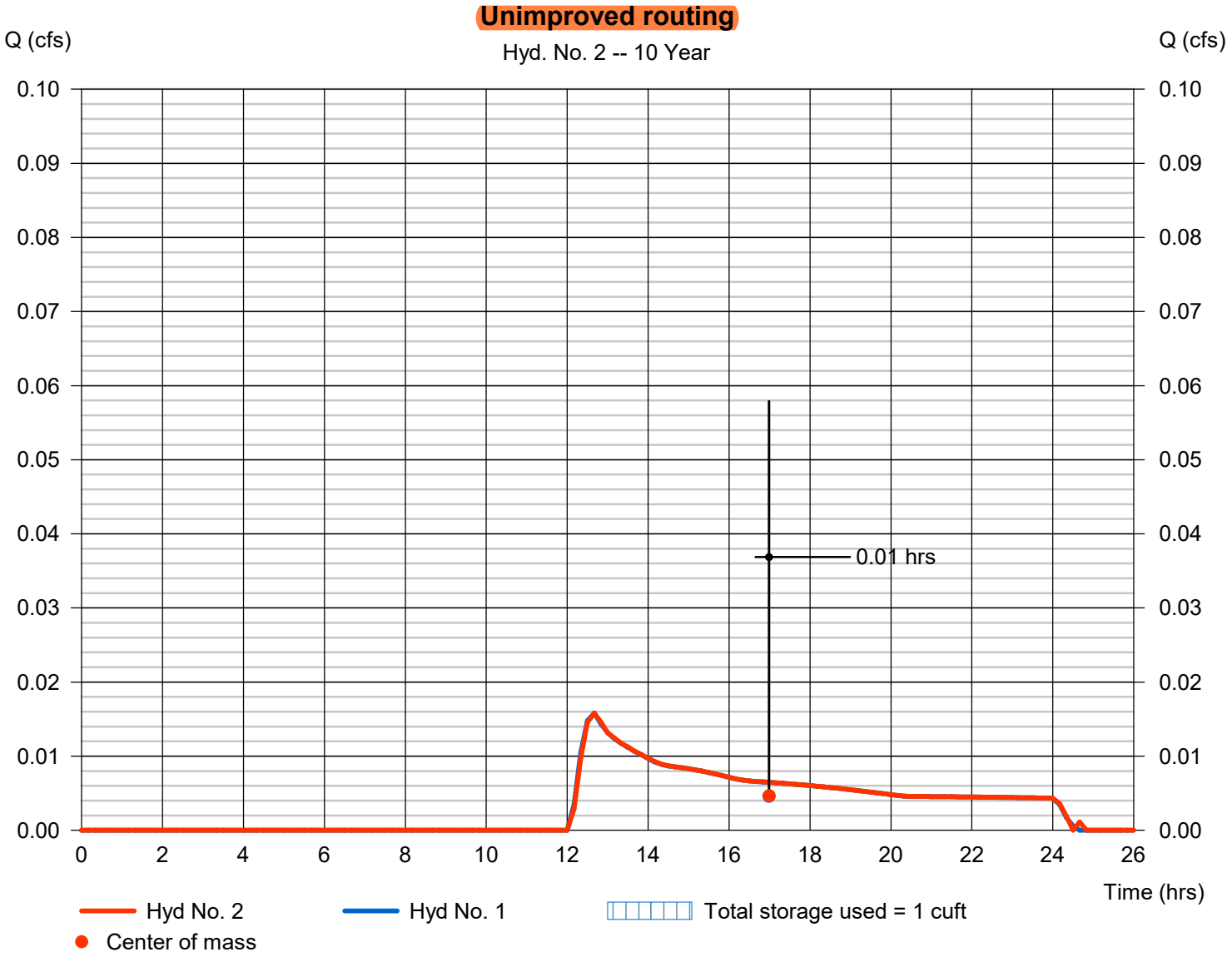
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 2

Unimproved routing

Hydrograph type	=	Reservoir	Peak discharge	=	0.016 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.67 hrs
Time interval	=	10 min	Hyd. volume	=	295 cuft
Inflow hyd. No.	=	1 - North Unimproved	Max. Elevation	=	100.06 ft
Reservoir name	=	Northwest Sump 200 in/hr	Max. Storage	=	1 cuft

Storage Indication method used. Outflow includes exfiltration.



Hydrograph Report

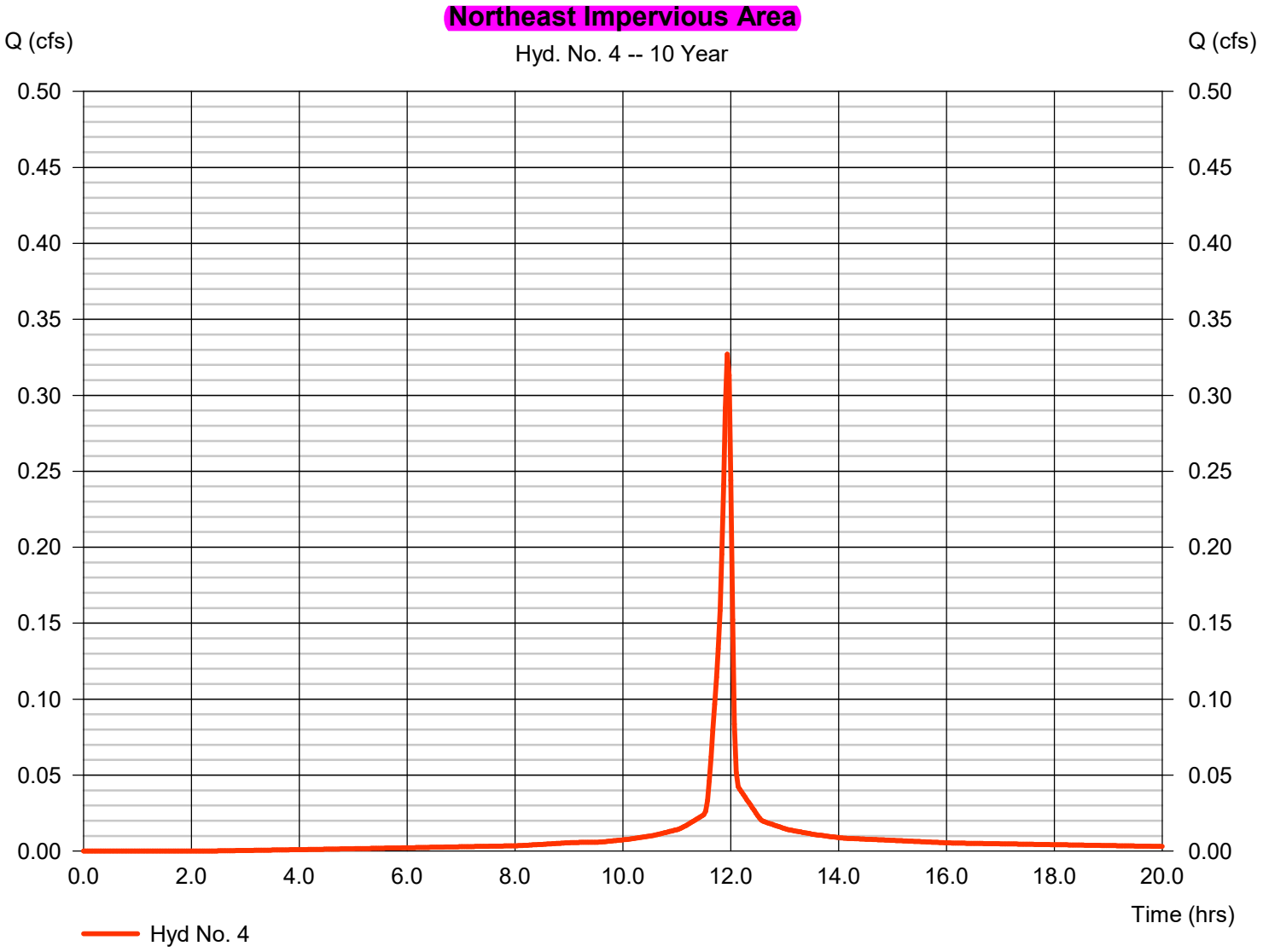
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 — Tuesday, 09 / 1 / 2020

Hyd. No. 4

Northeast Impervious Area

Hydrograph type	= SCS Runoff	Peak discharge	= 0.327 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 734 cuft
Drainage area	= 0.150 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

MAXIMUM AREA TO SUMP = 6,534 SF



Hydrograph Report

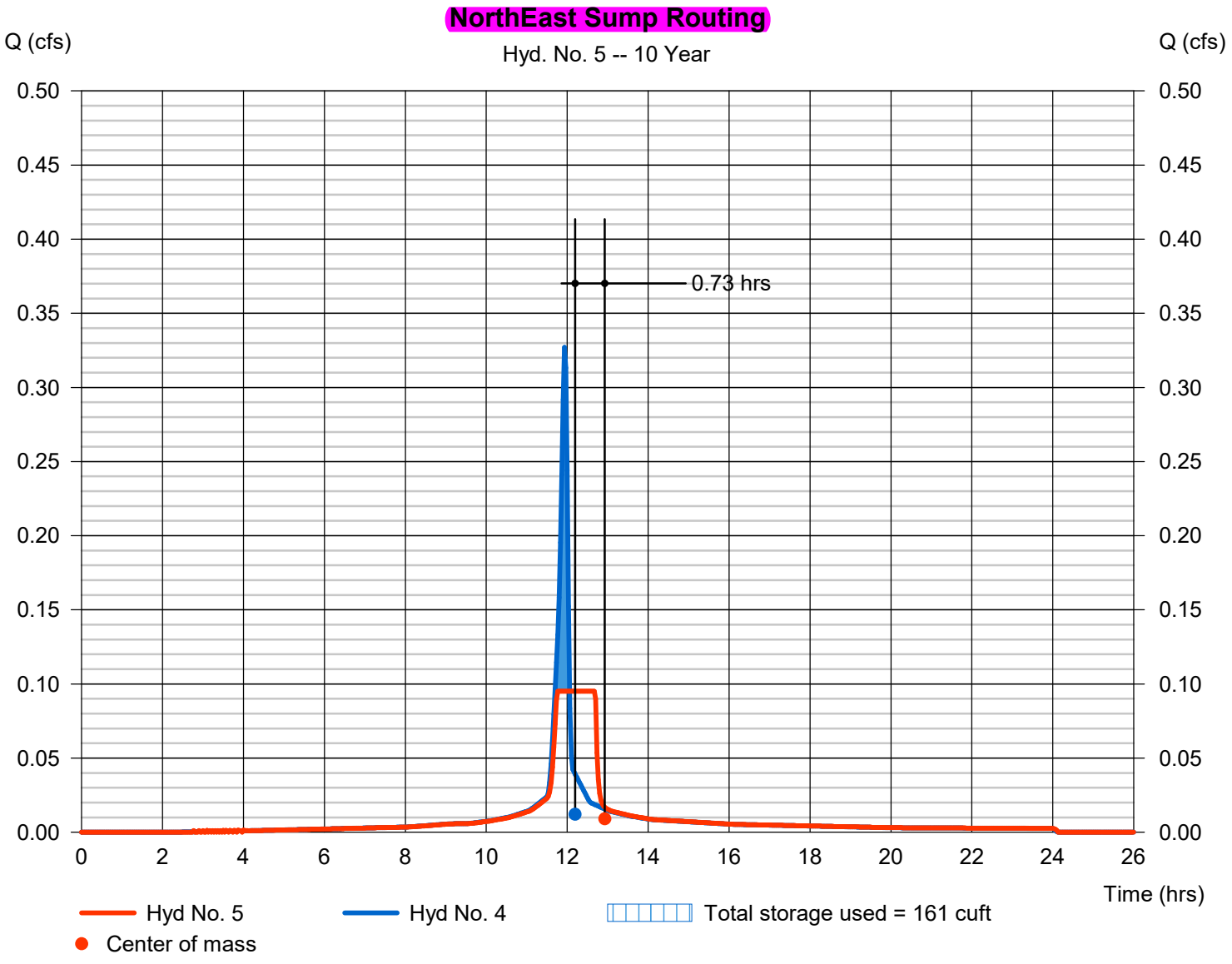
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 5

NorthEast Sump Routing

Hydrograph type	= Reservoir	Peak discharge	= 0.095 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.77 hrs
Time interval	= 2 min	Hyd. volume	= 734 cuft
Inflow hyd. No.	= 4 - Northeast Impervious Area	Max. Elevation	= 101.00 ft
Reservoir name	= NorthEast 67in/hr - Dollar	Max. Storage	= 161 cuft

Storage Indication method used. Outflow includes exfiltration.



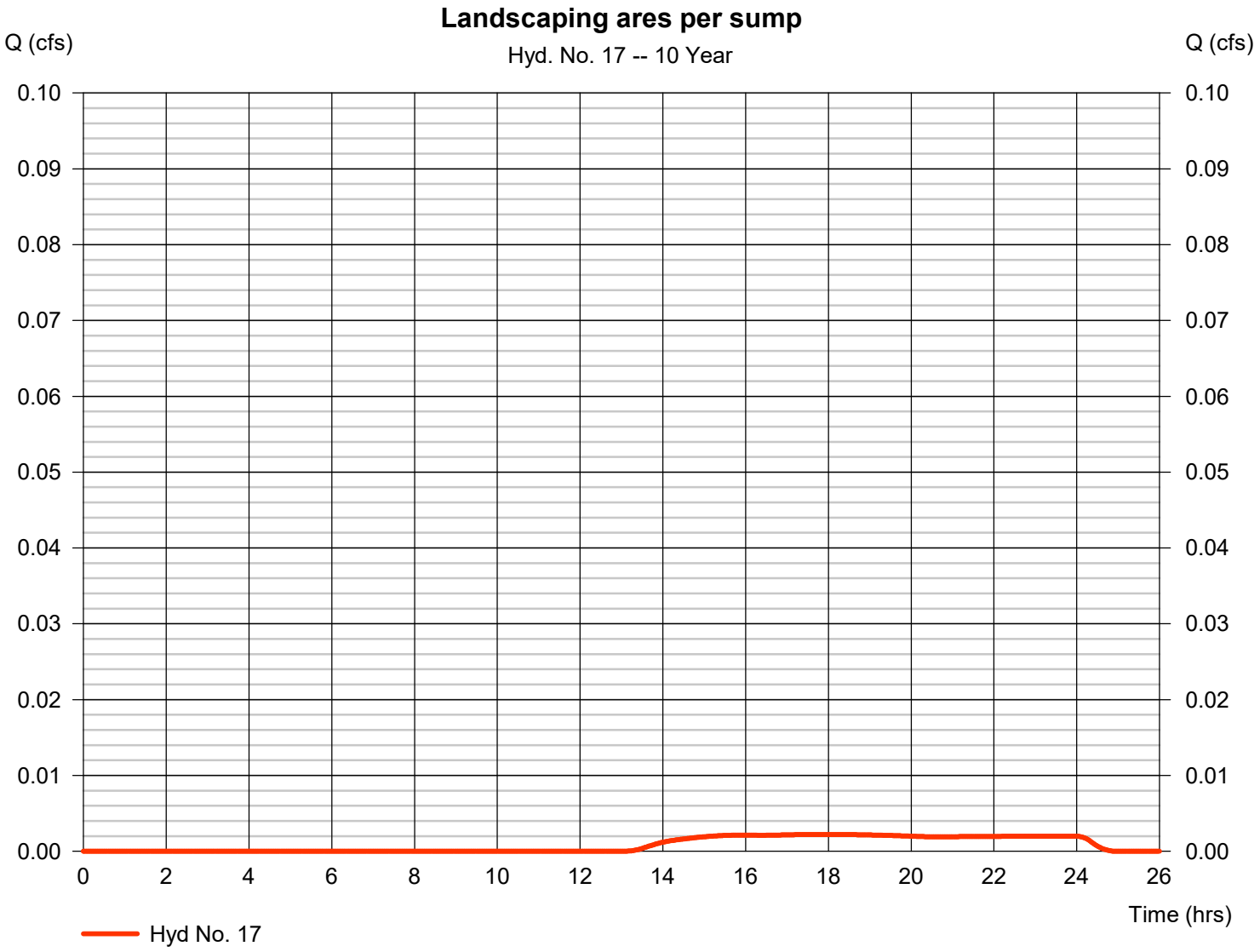
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Thursday, 10 / 8 / 2020

Hyd. No. 17

Landscaping ares per sump

Hydrograph type	= SCS Runoff	Peak discharge	= 0.002 cfs
Storm frequency	= 10 yrs	Time to peak	= 17.90 hrs
Time interval	= 2 min	Hyd. volume	= 77 cuft
Drainage area	= 1.000 ac	Curve number	= 61
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 36.30 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

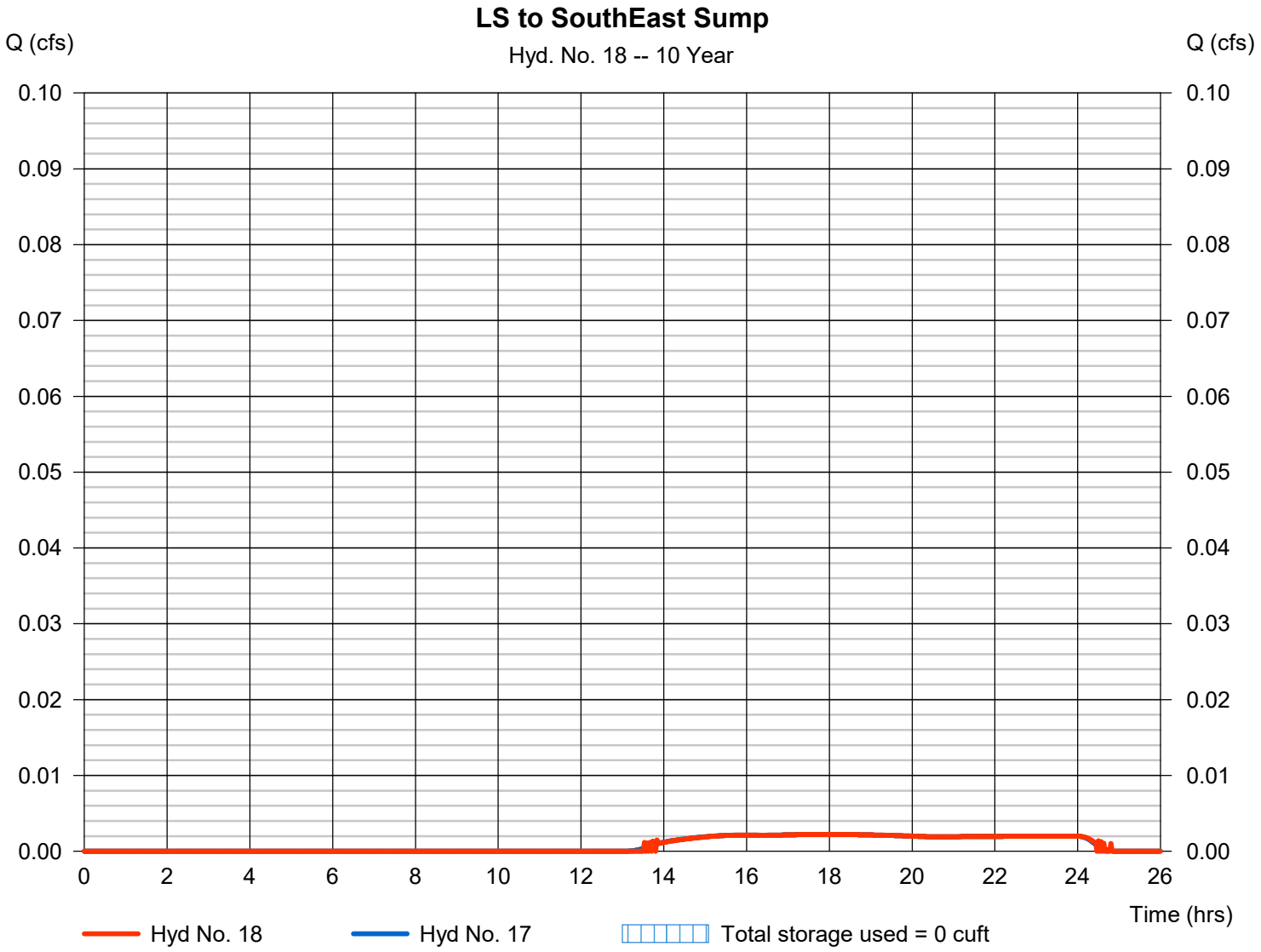
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Thursday, 10 / 8 / 2020

Hyd. No. 18

LS to SouthEast Sump

Hydrograph type	= Reservoir	Peak discharge	= 0.002 cfs
Storm frequency	= 10 yrs	Time to peak	= 17.97 hrs
Time interval	= 2 min	Hyd. volume	= 77 cuft
Inflow hyd. No.	= 17 - Landscaping ares per sump	Max. Elevation	= 100.02 ft
Reservoir name	= SouthEast 75in/hr - Maple	Max. Storage	= 0 cuft

Storage Indication method used. Outflow includes exfiltration.



Hydrograph Report

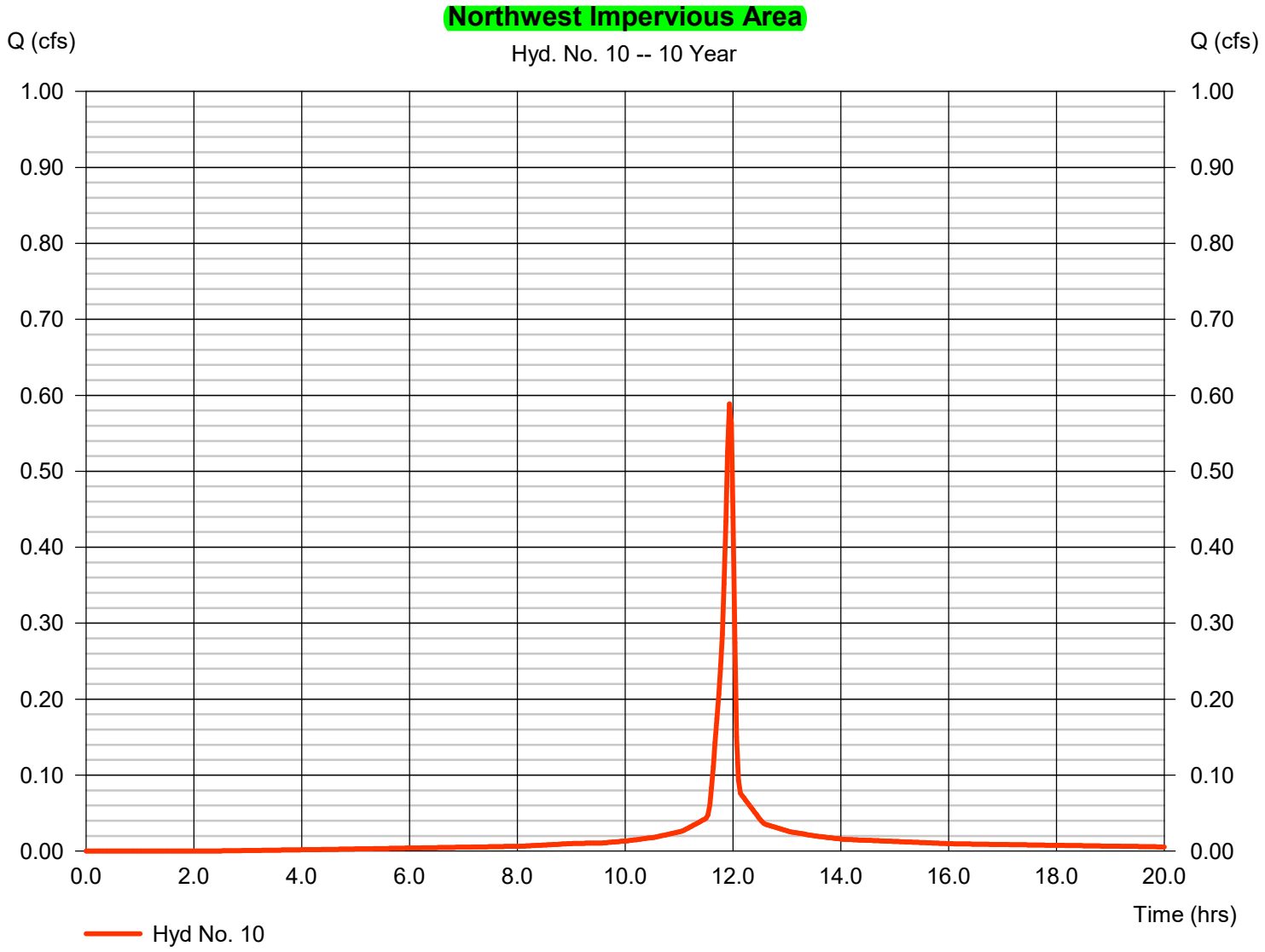
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 10

Northwest Impervious Area

Hydrograph type	= SCS Runoff	Peak discharge	= 0.589 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 1,321 cuft
Drainage area	= 0.270 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.250 x 98)] / 0.270



Hydrograph Report

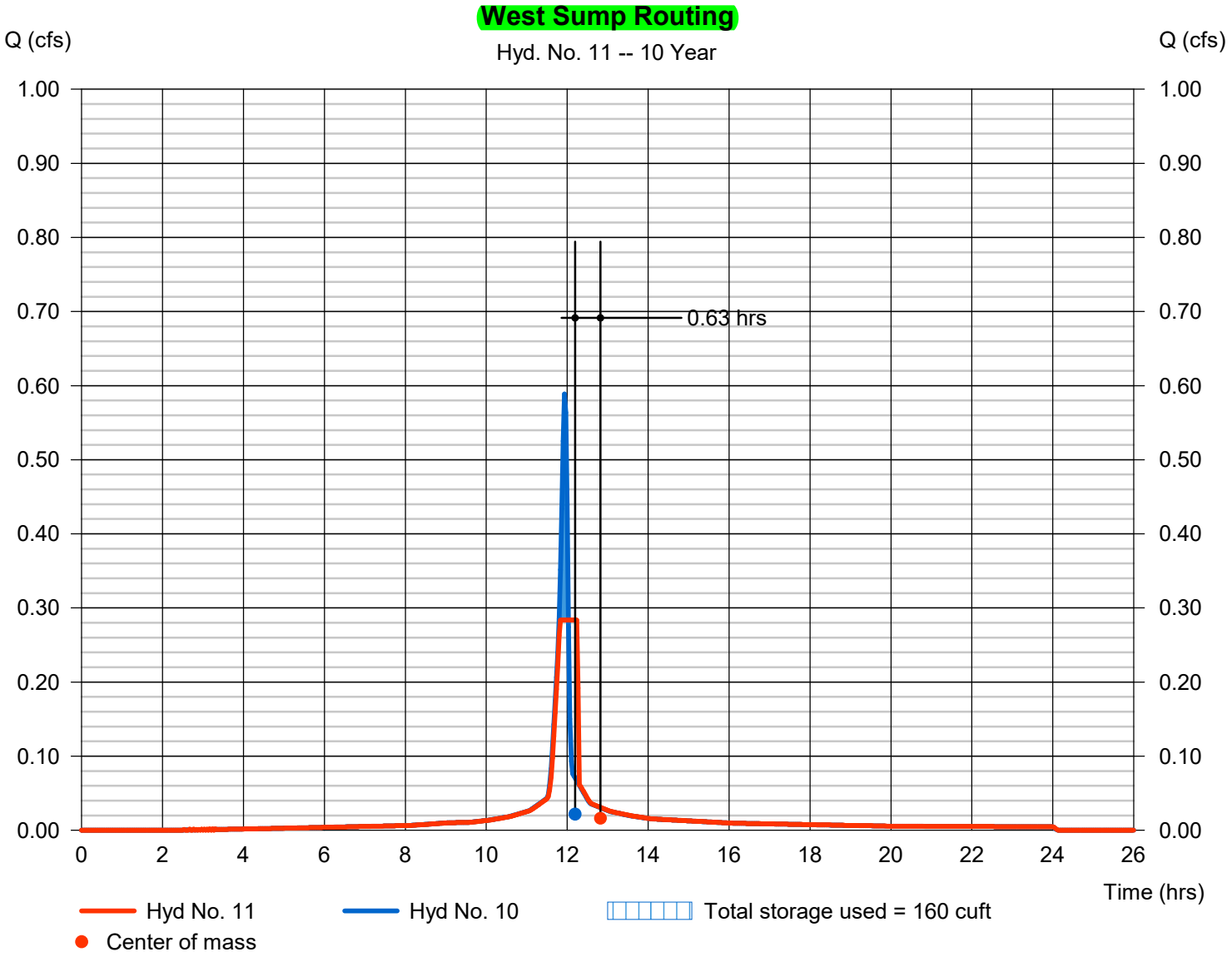
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 11

West Sump Routing

Hydrograph type	= Reservoir	Peak discharge	= 0.284 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.83 hrs
Time interval	= 2 min	Hyd. volume	= 1,321 cuft
Inflow hyd. No.	= 10 - Northwest Impervious Area	Max. Elevation	= 101.00 ft
Reservoir name	= Northwest Sump 200 in/hr	Max. Storage	= 160 cuft

Storage Indication method used. Outflow includes exfiltration.



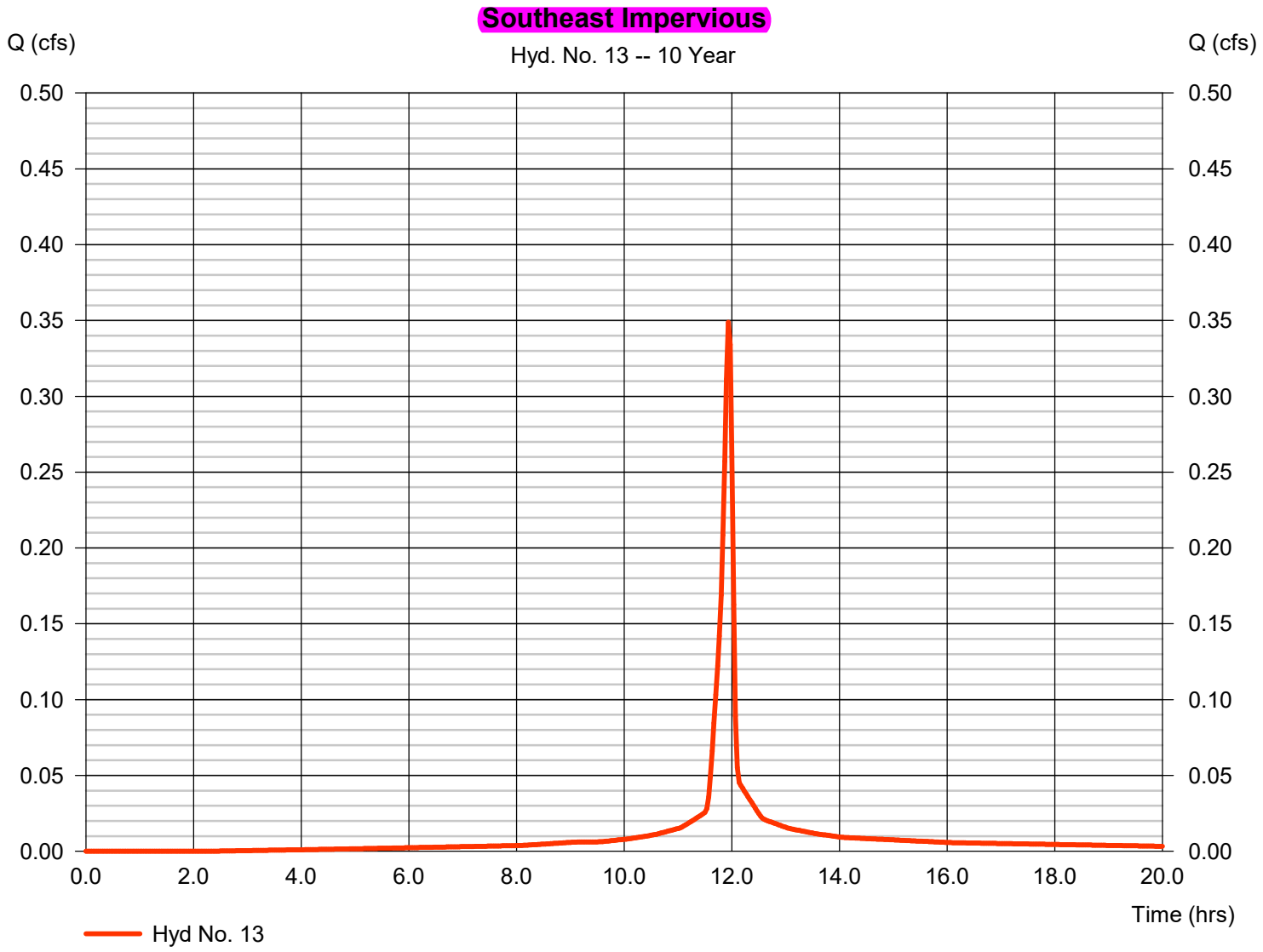
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 13

Southeast Impervious

Hydrograph type	= SCS Runoff	Peak discharge	= 0.349 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 783 cuft
Drainage area	= 0.160 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

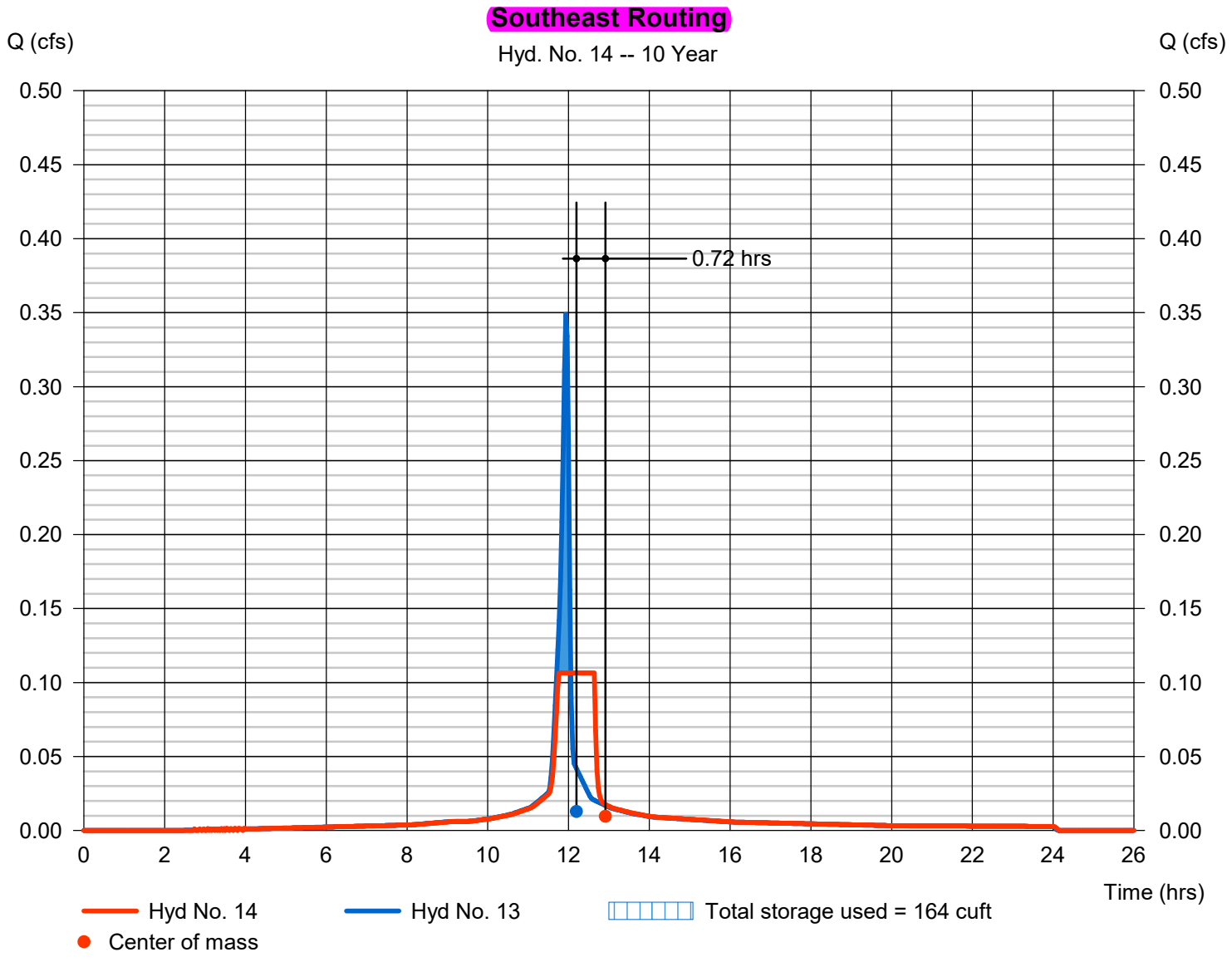
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 14

Southeast Routing

Hydrograph type	=	Reservoir	Peak discharge	=	0.106 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.77 hrs
Time interval	=	2 min	Hyd. volume	=	783 cuft
Inflow hyd. No.	=	13 - Southeast Impervious	Max. Elevation	=	101.00 ft
Reservoir name	=	SouthEast 75in/hr - Maple	Max. Storage	=	164 cuft

Storage Indication method used. Outflow includes exfiltration.



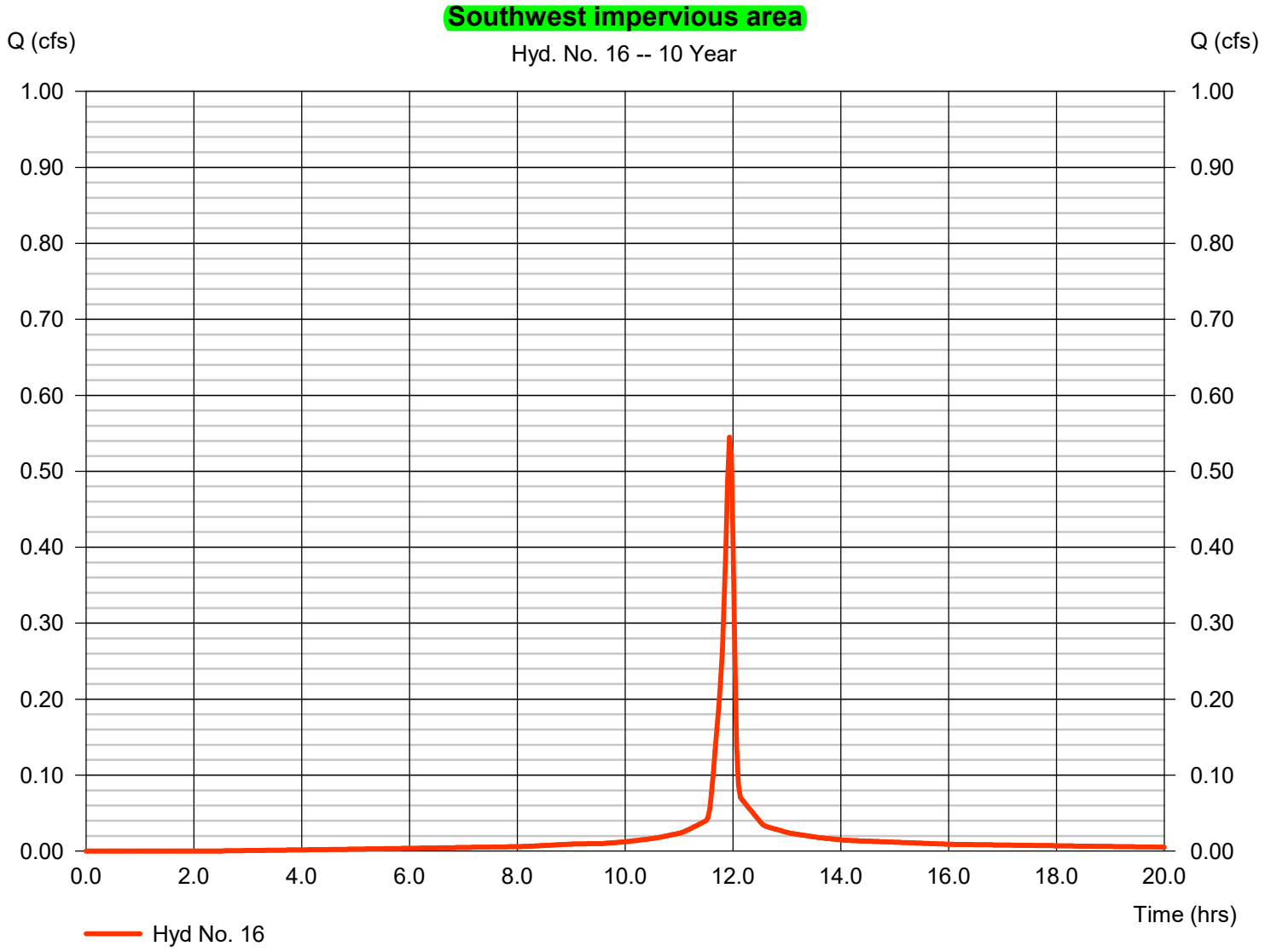
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 16

Southwest impervious area

Hydrograph type	= SCS Runoff	Peak discharge	= 0.545 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 1,223 cuft
Drainage area	= 0.250 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

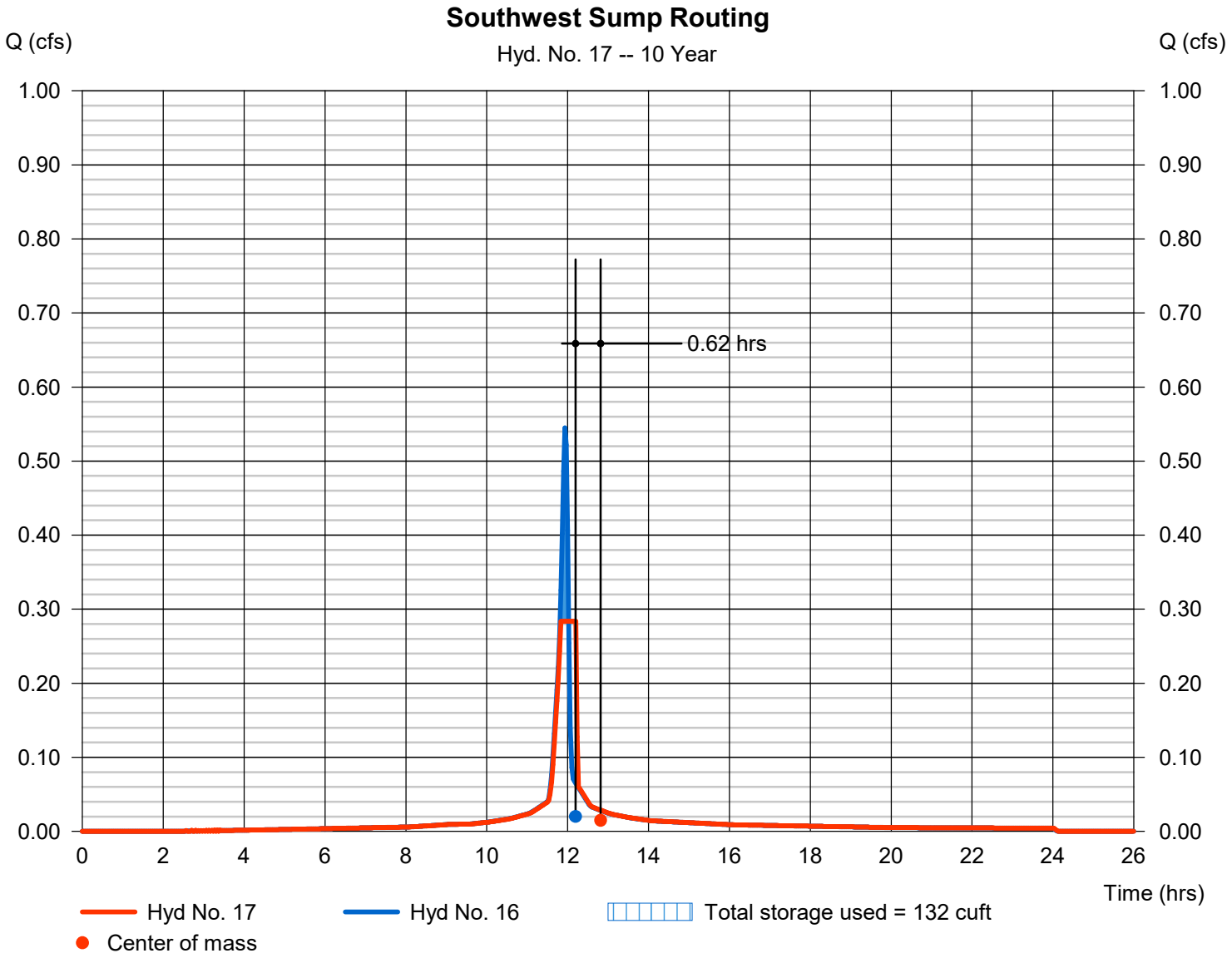
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Tuesday, 09 / 1 / 2020

Hyd. No. 17

Southwest Sump Routing

Hydrograph type	=	Reservoir	Peak discharge	=	0.284 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.83 hrs
Time interval	=	2 min	Hyd. volume	=	1,223 cuft
Inflow hyd. No.	=	16 - Southwest impervious area	Max. Elevation	=	101.00 ft
Reservoir name	=	Southwest Sump 100in/hr	Max. Storage	=	132 cuft

Storage Indication method used. Outflow includes exfiltration.



Hydrograph Report

100 YEAR PARKING LOT STORAGE AND SUMP ROUTING

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

Thursday, 10 / 8 / 2020

PARKING LOT AND SUMP STORAGE VOLUME

Hyd. No. 8

NE 100yr

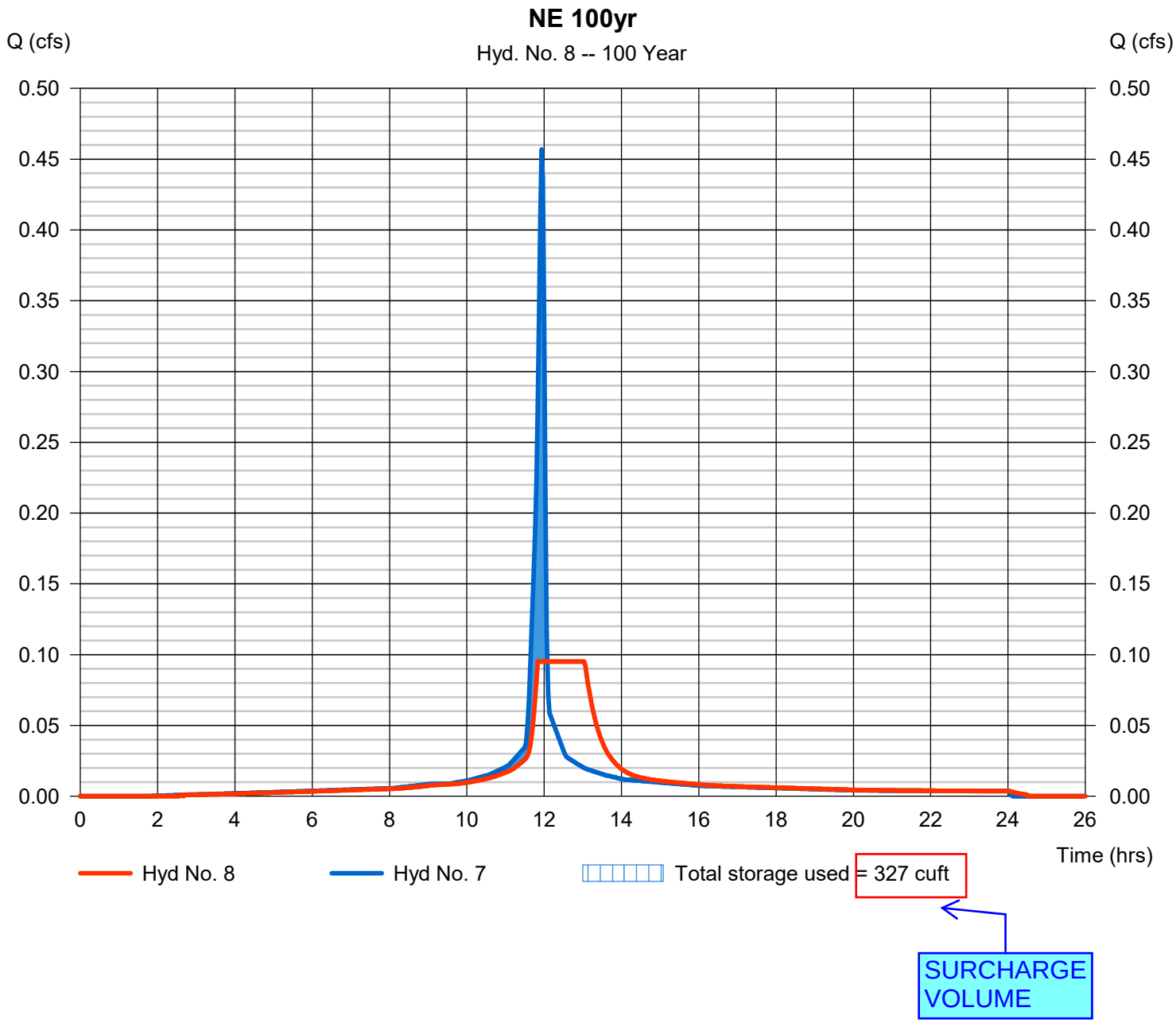
Hydrograph type	=	Reservoir	Peak discharge	=	0.095 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.83 hrs
Time interval	=	2 min	Hyd. volume	=	1,046 cuft
Inflow hyd. No.	=	7 - Northeast 100yr	Max. Elevation	=	107.00 ft
Reservoir name	=	NorthEast 100yr	Max. Storage	=	327 cuft

67in/hr

Storage Indication method used. Outflow includes exfiltration.

SUMP INFILTRATION RATE

SURCHRAGE VOLUME



SURCHARGE VOLUME

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 — Thursday, 10 / 8 / 2020

PARKING LOT AND SUMP STORAGE VOLUME

Hyd. No. 5

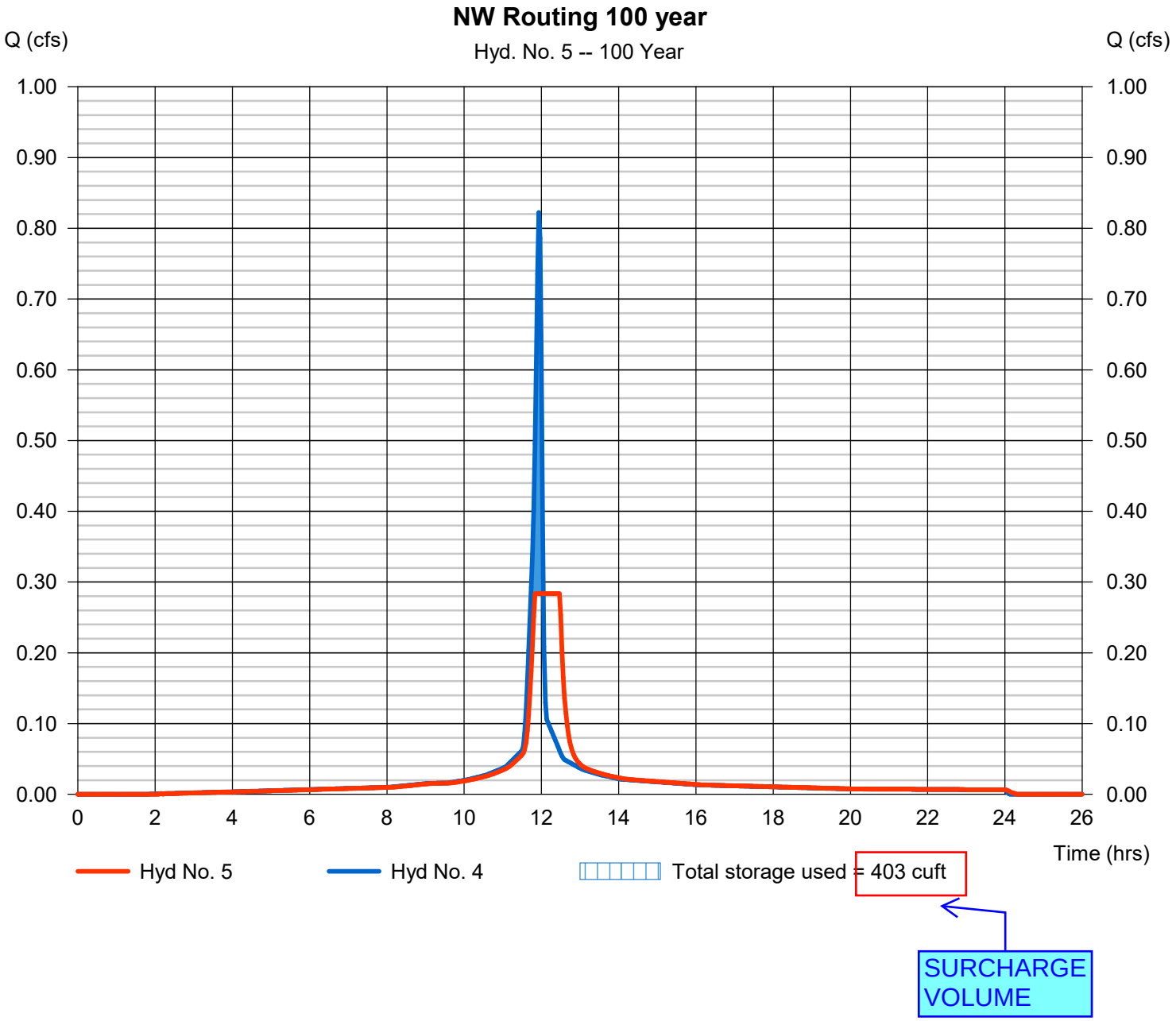
NW Routing 100 year

Hydrograph type	=	Reservoir	Peak discharge	=	0.284 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.83 hrs
Time interval	=	2 min	Hyd. volume	=	1,885 cuft
Inflow hyd. No.	=	4 - Northwest Impervious 100yr	Max. Elevation	=	106.96 ft
Reservoir name	=	Northwest 100 yr	Max. Storage	=	403 cuft

Storage Indication method used. Outflow includes exfiltration.

SUMP INFILTRATION RATE: 200 in/hr

SURCHRAGE VOLUME



SURCHARGE VOLUME

Hydrograph Report

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

Thursday, 10 / 8 / 2020

PARKING LOT AND SUMP STORAGE VOLUME

Hyd. No. 11

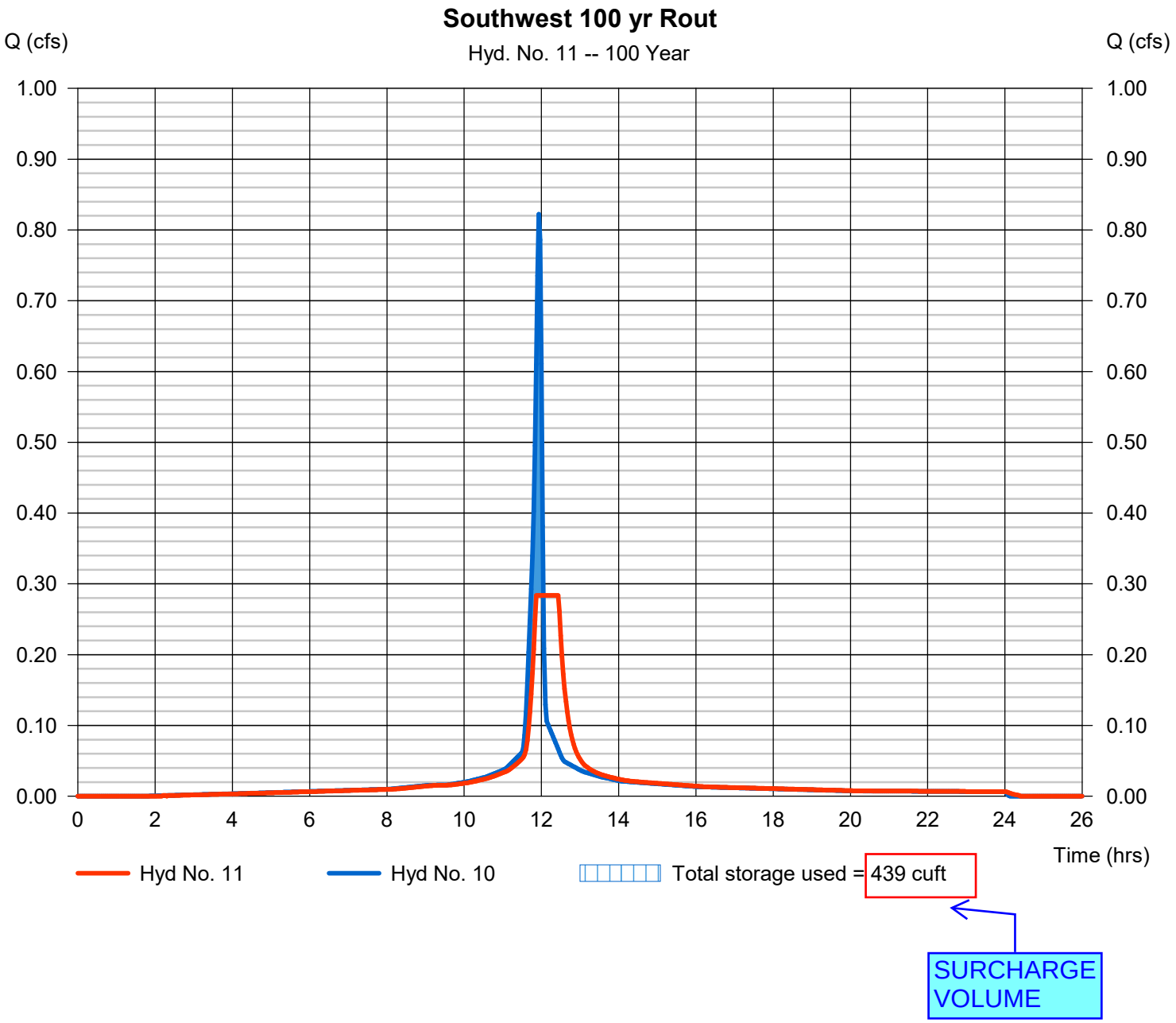
Southwest 100 yr Rout

Hydrograph type	=	Reservoir	Peak discharge	=	0.284 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.87 hrs
Time interval	=	2 min	Hyd. volume	=	1,885 cuft
Inflow hyd. No.	=	10 - Northwest Impervious 100yr	Max. Elevation	=	110.80 ft
Reservoir name	=	Southwest 100year 100in/hr	Max. Storage	=	439 cuft

Storage Indication method used. Outflow includes exfiltration.

SUMP INFILTRATION RATE

SURCHRAGE VOLUME



SURCHARGE VOLUME

APPENDIX 5 – RUNOFF REDUCTION VOLUME CALUCLATION

Montana BMP Manual

Chapter 3

equation 3-1 Runoff Reduction Volume

$$RRV = \frac{P \cdot R_v \cdot A}{12}$$

$P = 0.5$ inches

$R_v = 0.05 + 0.9(I) = .599 \Rightarrow 0.6$

I = % Impervious

$= 3.01 \text{ acres} / 4.95 \text{ acres}$

$= .61$

$A = 4.95$

$$= \frac{0.5(0.6)4.95}{12}$$

$= .12375$ acre-ft

$= 5,390$ cf

$\Rightarrow 5,400$ cf