

STORMWATER SYSTEM & EROSION CONTROL CALCULATIONS

BAKER BMW OF WILMINGTON

4900 New Centre Drive

Wilmington, North Carolina

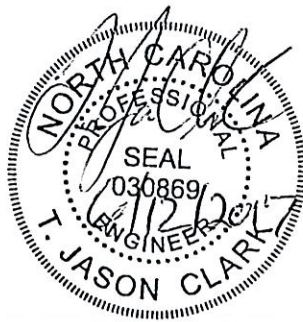
For

Baker Motor Company, LLC

4920 New Centre Drive

Wilmington, NC 28403

(910) 624-6060



Revised June 2017 (C.O.W. SW Response)

April 2017

Prepared by:

NORRIS & TUNSTALL CONSULTING ENGINEERS, P.C.

902 Market Street
Wilmington, North Carolina 28401

(910) 343-9653
(910) 343-9604 (Fax)

License # C-3641
N&T Project No. 16038

Final SW Calcs
8/4/2017
99032R1
kac

Date 3/21/17	Design ZJC	NORRIS & TUNSTALL — CONSULTING ENGINEERS P.C. —	Wilmington, NC	Sheet
			Brunswick County, NC	Of
Check	Job Baker BMW		For SW:EC	Job No. 16038

Existing Pond is Being Expanded. Pond Permitted in SW8 990330 (COW SW Permit 99032). Original Pond was Designed to meet STATE & COW Design Requirements at The Time.

2017 - Design Expanded Pond to Meet State Requirements and COW (Pre-Post) Requirements. All Storm Drainage is Designed to COW Requirements.

Pond DA = 218,854 SF / 5.02 Ac

Imp => Existing = 33,267 SF (Tract B - Includes Existing DA & Existing Portions of DA's (5-9) - Existing NOT TO BE REMOVED.)
 Parking = 97,431 SF
 Building = 30,238 SF
 Sidewalk = 6,878 SF
 Parking = 17,017 SF (Tract B - New) % Imp = 79.88%
174,831 SF / 4.01 Ac. $R_v = 0.05 + 0.9(0.7988) = 0.76892$

Required Volume = $3630 \times 5.02 \text{ Ac} \times 1.5' \times 0.76892 = 21,018 \text{ CF}$

Provided Volume @ 37.6' = 53,507 CF (OK)

Ppe 35.3' — 2.25" Ø Orifice

Tpe 37.6'

Em. Spillway — 75' @ 38.2'

WET DETENTION BASIN CALCULATIONS

Project Name:	Baker BMW	N&T No:	16038
Contact Person:	T. Jason Clark, P.E.	Phone:	(910) 343-9653
For projects with multiple basins, specify which basin this worksheet applies to:		DA #:	#1

Description	Qty	Units	Notes:
1-year, 24-hour rain event, D_{1Yr}	3.83	inches	
TSS Removal Rate	90.00	%	
Drainage Area, DA =	5.02	ac	
Pre-existing Impervious Area =	0.00	ac	
Pre-existing Overall % Impervious, I_{pre} =	0.00	%	
Proposed Impervious Area =	4.01	ac	
Post Development Pervious Area =	1.01	ac	
Post Development Overall % Impervious, I_{post} =	79.88	%	

Storage Volume Required (Simple Method):

Within 0.5 mile & drain to SA waters?	n		USE FIRST 1.5 INCH
Design Rainfall Depth, $D_{1.5}$ =	1.50	in	
Design Rainfall Depth, D_{1Yr} =	3.83	in	
Pre-Development Runoff Volume factor, $R_{V_{pre}}$ =	0.05	in/in	$R_{V_{pre}} = 0.05 + 0.009 * I_{pre}$
Post Development Runoff Volume factor, $R_{V_{post}}$ =	0.76892	in/in	$R_{V_{post}} = 0.05 + 0.009 * I_{post}$
1.5" Post-Dev Runoff Volume, $V_{1.5" post}$ =	21,017.70	ft ³	$V_{1.5" Post} = 3630 * D_{1.5} * R_{V_{post}} * DA$
1 Yr Pre-Dev Runoff Volume, $V_{1Yr pre}$ =	3,489.63	ft ³	$V_{1Yr pre} = 3630 * D_{1Yr} * R_{V_{pre}} * DA$
1 Yr Post-Dev Runoff Volume, $V_{1Yr post}$ =	53,665.19	ft ³	$V_{1Yr post} = 3630 * D_{1Yr} * R_{V_{post}} * DA$
Required Storage Volume =	21,018	ft ³	Post Dev. @ 1.5 inch Rainfall Depth
SHWT Elevation	35.00	ft	
Normal-Permanent Pool Elevation	35.30	ft	OK!
Normal-Permanent Pool surface area	20,977.00	sf	
State Temporary Pool Elevation	37.60	ft	
State Temporary Pool Surface Area	25,400.00	sf	
Provided Storage Volume =	53,507	ft ³	OK! Provided V > Required V

Peak Flow Calculations (Rational Method)

C value - pre-development	0.20		
C value - impervious surface	0.95		
C value post-developed	0.80		
Tc = Time of Concentration	5.00	min	
Depth @ Tc & 1-yr = d	0.15	inches	
Intensity Peak, 1 YR= I	1.80	in/hr	
Pre-development runoff rate (rational method)	1.81	cfs	$Q_{pre} = C_{pre} * I * DA$
Post-development runoff rate (rational method)	7.23	cfs	$Q_{post} = C_{post} * I * DA$

Volume Calculations--All Volumes Calculated Using Avg. End Area Method

	Elevation (msl)	Area (sf)	Increm. V (cf)	Accum. V (cf)
Combined (Above Normal Pool)				
Normal-Permanent Pool	35.30	20,977.00		
Top of Vegetated Shelf	35.80	22,089.00	10,766.50	10,766.50
Temporary Pool -Required State Storage	37.60	25,400.00	42,740.10	53,506.60
Top of Pond	39.00	27,985.00	37,369.50	90,876.10

	Elevation (msl)	Area (sf)	Increm. V (cf)	Accum. V (cf)
Main Pond Volume (Excluding Forebay)				
Main Pond Bottom (Volume Ignored)	28.00			
Sediment Removal	29.00	8,741.00		
Bottom of Veg Shelf	34.80	14,080.00	66,180.90	66,180.90
Normal Pool	35.30	14,880.00	7,240.00	73,420.90

	Elevation (msl)	Area (sf)	Increm. V (cf)	Accum. V (cf)
Forebay Volume (Excluding Main Pond)				
Forebay Bottom (Volume Ignored)	29.00			
Sediment Removal	31.00	2,750.00		
Normal Pool	35.30	6,097.00	19,021.05	19,021.05

Permanent Pool Volume = Main + Forebay	92,441.95	cf
Total Pond Volume = Top to Normal + Main to Sediment Removal + Forebay to Sediment Removal	183,318.05	cf
Percent Forebay Volume: (18 - 22% Required)	20.6%	OK!

Average Depth & Required Surface Area

Permanent Pool Area	20,977.00	sf	
Permanent Volume	92,441.95	cf	
Average Depth	4.41	ft	
Rounded Avg Depth =	4.00	ft	
SA/DA at specified % impervious & average depth=	SA/DA # from "Green Sheet" of Interpolated values for Coastal Region rounded	7.00	ft
Required Surface Area =	15,306.98	sf	
Provided Surface Area =	20,977.00	sf	
		OK!	

Drawdown Calculations

Drawdown Orifice:		
Avg. Head = 1/3 of Flood Pool Elev	0.77	ft
C _D = Coefficient of Discharge	0.60	
Drawdown Time =	2.00	days
	172,800	s
Internal Diameter =	0.19	ft
	2.30	in
Drawdown Time =	5.00	days
	432,000	s
Internal Diameter =	0.12	ft
	1.45	in
Avg Internal Diameter =	1.88	in
Design Orifice Diameter =	2.25	in
	0.03	ft
Design Drawdown rate	0.12	cfs
Design Drawdown time	2.06	days
		OK!

Baker BMW

Drainage Area	Total Area		IMP Area		Rational 'C' Used
	(SF)	(AC)	(SF)	(AC)	
1	4550	0.10	3902	0.09	0.86
2	8100	0.19	7907	0.18	0.93
3	5465	0.13	5041	0.12	0.90
4	3610	0.08	3053	0.07	0.85
5	10740	0.25	10740	0.25	0.95
6	7564	0.17	7564	0.17	0.95
7	9516	0.22	9516	0.22	0.95
8	9800	0.22	9800	0.22	0.95
9	7128	0.16	7128	0.16	0.95
10	8650	0.20	8434	0.19	0.93
11	29185	0.67	25442	0.58	0.87
13	3500	0.08	3500	0.08	0.95
14	3900	0.09	3900	0.09	0.95
15	7740	0.18	7740	0.18	0.95
16	9430	0.22	9193	0.21	0.93
B1	4125	0.09	4125	0.09	0.95
B2	4125	0.09	4125	0.09	0.95
B3	2400	0.06	2400	0.06	0.95
B4	1200	0.03	1200	0.03	0.95
B5	1050	0.02	1050	0.02	0.95
B6	1000	0.02	1000	0.02	0.95
B7	1600	0.04	1600	0.04	0.95
B8	1750	0.04	1750	0.04	0.95
B9	1600	0.04	1600	0.04	0.95
B10	1750	0.04	1750	0.04	0.95
B11	2625	0.06	2625	0.06	0.95
B12	2625	0.06	2625	0.06	0.95
B13	1800	0.04	1800	0.04	0.95
B14	1280	0.03	1280	0.03	0.95
B15	1410	0.03	1410	0.03	0.95
B16	1800	0.04	1800	0.04	0.95
B17	1800	0.04	1800	0.04	0.95
Existing Pond	18031	0.41	18031	0.41	0.95
	38005	0.87	0	0.00	0.30

Pond Total					
DA	218854	5.02	174831	4.01	0.82

Inlet ID	Contributing DA	Total Area		IMP Area		Rational 'C' Used
		(SF)	(AC)	(SF)	(AC)	
DI-1	1	4550	0.10	3902	0.09	0.86
CI-2	2	8100	0.19	7907	0.18	0.93
CI-3	3	5465	0.13	5041	0.12	0.90
DI-4	4	3610	0.08	3053	0.07	0.85
DI-5	5, B1	14865	0.34	14865	0.34	0.95
DI-6	6, B2	11689	0.27	11689	0.27	0.95
DI-7	7, B3	11916	0.27	11916	0.27	0.95
DI-8	8, B4-B6	13050	0.30	13050	0.30	0.95
DI-9	9, B8, B10	10628	0.24	10628	0.24	0.95
CI-10	10	8650	0.20	8434	0.19	0.93
DI-11	11	29185	0.67	25442	0.58	0.87
JB-12	-	-	-	-	-	-
CI-13	13, B11	6125	0.14	6125	0.14	0.95
CI-14	14, B12	6525	0.15	6525	0.15	0.95
CI-15	15, B7, B9, B13-B17	19030	0.44	19030	0.44	0.95
CI-16	16	9430	0.22	9193	0.21	0.93

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

1 - BMW Pre



2 - BMW Post



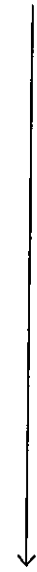
Type III Storm ✓

Pre $Q_2 = 0.077 \text{ cfs}$ ✓

$Q_{10} = 2.066 \text{ cfs}$ ✓

$Q_{25} = 3.903 \text{ cfs}$ ✓

* COW Rainfall ✓
Depths used



* Existing Outfall Conditions
Require a Tailwater (TW)
Condition to be used in Routing
TW Elevation used = 37.0'

3 - Routing Post



Post $Q_2 = 0.075 \text{ cfs}$ ✓

$Q_{10} = 2.072 \text{ cfs}$ ✓ (OK)

$Q_{25} = 3.892 \text{ cfs}$ ✓

50yr Peak Eleu = 38.12' (Top e 39') ✓
(OK)

* Maintenance of Outfall Ditch
System is Critical to the
Function of Engineered SW Pond.

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	0.077	2	886	2,078	----	----	----	BMW Pre	
2	SCS Runoff	16.01	2	724	48,118	----	----	----	BMW Post	
3	Reservoir	0.075	2	1444	9,411	2	37.31	46,301	Routing Post	
BMW Routing 2017 May 2017.gpw					Return Period: 2 Year			Tuesday, 06 / 13 / 2017		

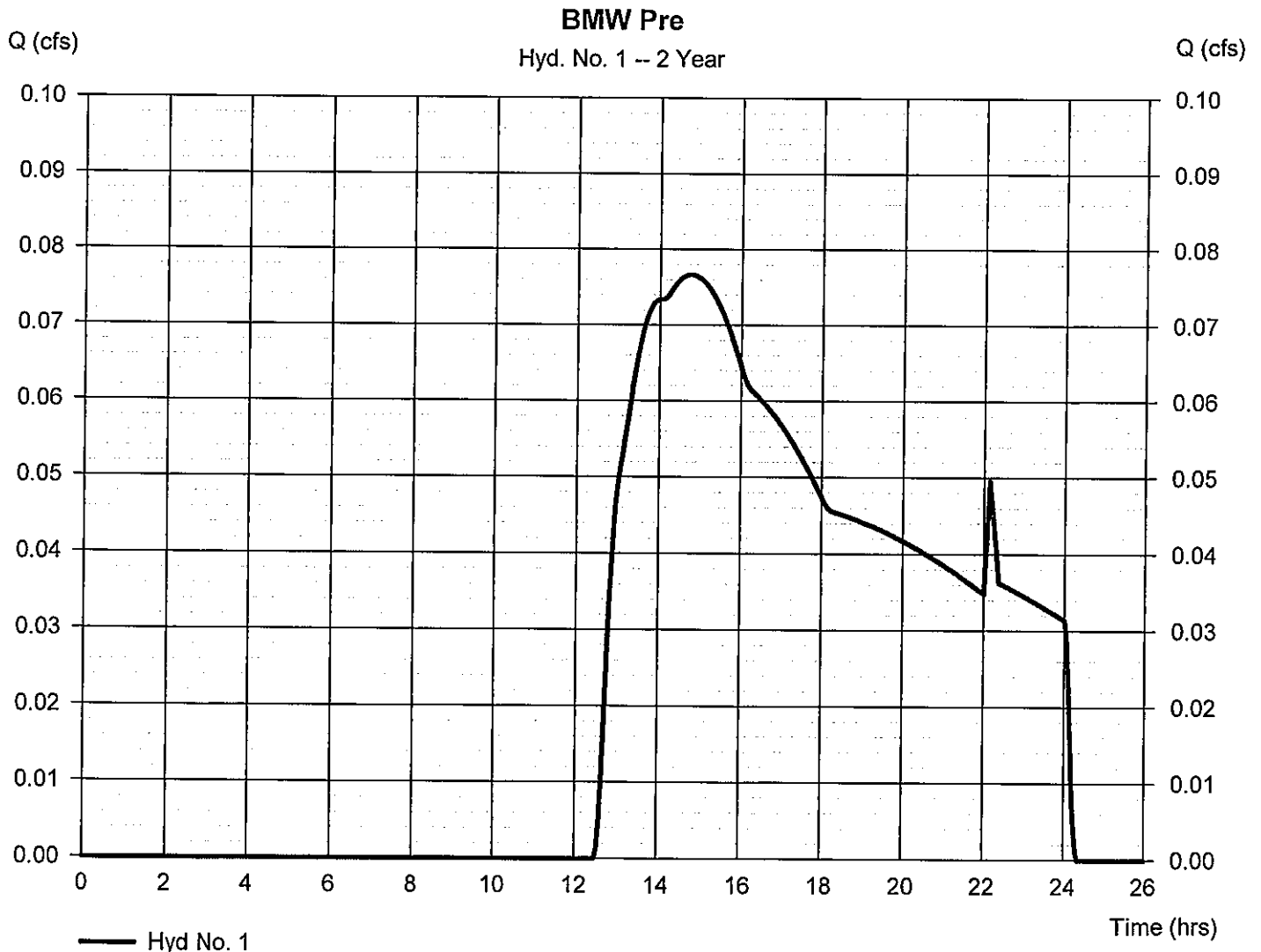
Hydrograph Report

Hyd. No. 1

BMW Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 0.077 cfs
Storm frequency	= 2 yrs	Time to peak	= 14.77 hrs
Time interval	= 2 min	Hyd. volume	= 2,078 cuft
Drainage area	= 5.020 ac	Curve number	= 39*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 4.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.020 x 39)] / 5.020



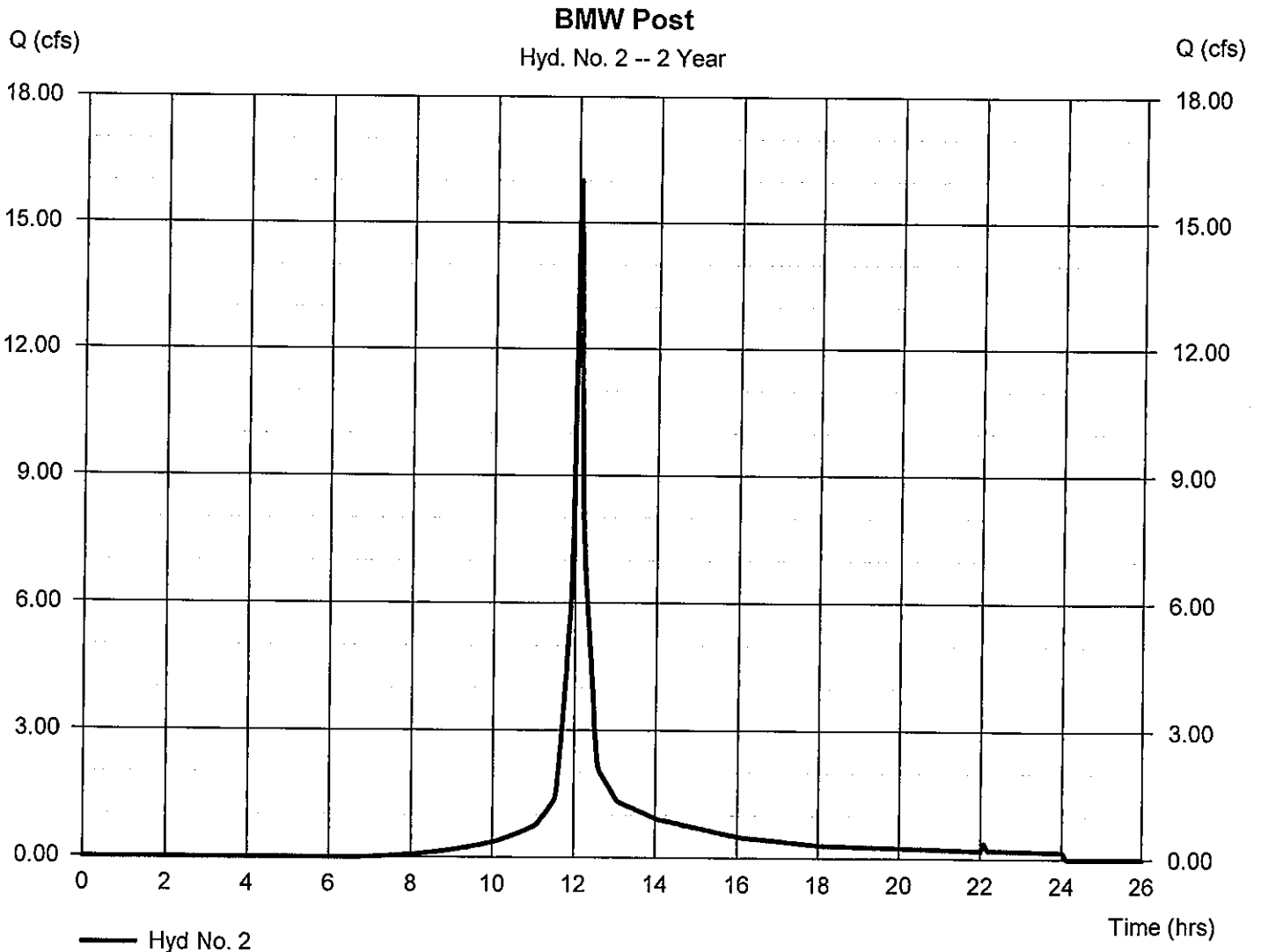
Hydrograph Report

Hyd. No. 2

BMW Post

Hydrograph type	= SCS Runoff	Peak discharge	= 16.01 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 48,118 cuft
Drainage area	= 5.020 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(4.010 \times 98) + (1.010 \times 30)] / 5.020$



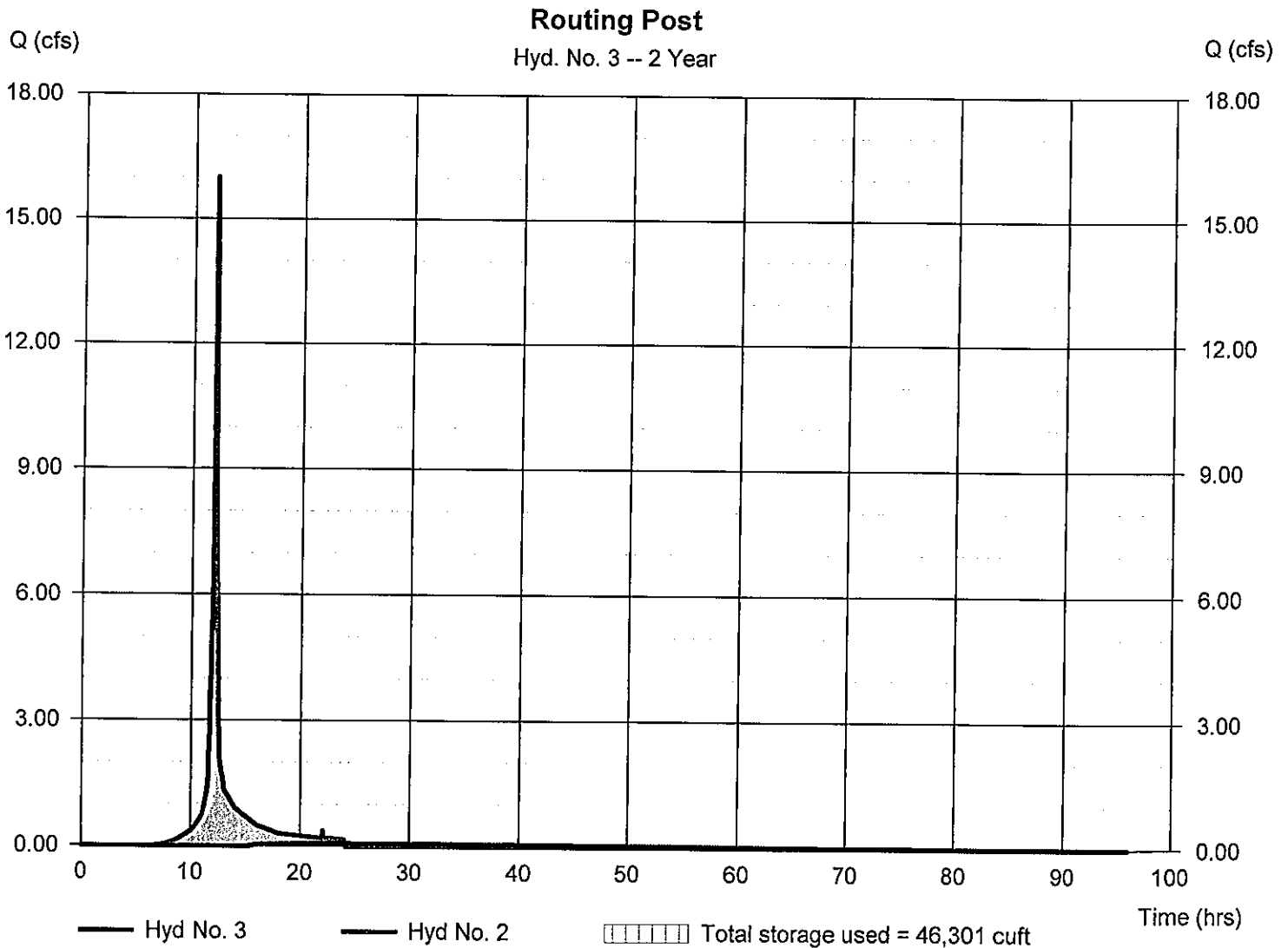
Hydrograph Report

Hyd. No. 3

Routing Post

Hydrograph type	= Reservoir	Peak discharge	= 0.075 cfs
Storm frequency	= 2 yrs	Time to peak	= 24.07 hrs
Time interval	= 2 min	Hyd. volume	= 9,411 cuft
Inflow hyd. No.	= 2 - BMW Post	Max. Elevation	= 37.31 ft
Reservoir name	= Wet Detention Pond #1	Max. Storage	= 46,301 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Wet Detention Pond #1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 35.30 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	35.30	20,977	0	0
0.50	35.80	22,089	10,764	10,764
0.70	36.00	22,534	4,462	15,226
1.70	37.00	24,310	23,414	38,640
2.30	37.60	25,400	14,910	53,550
2.70	38.00	26,127	10,304	63,854
3.70	39.00	27,985	27,048	90,902

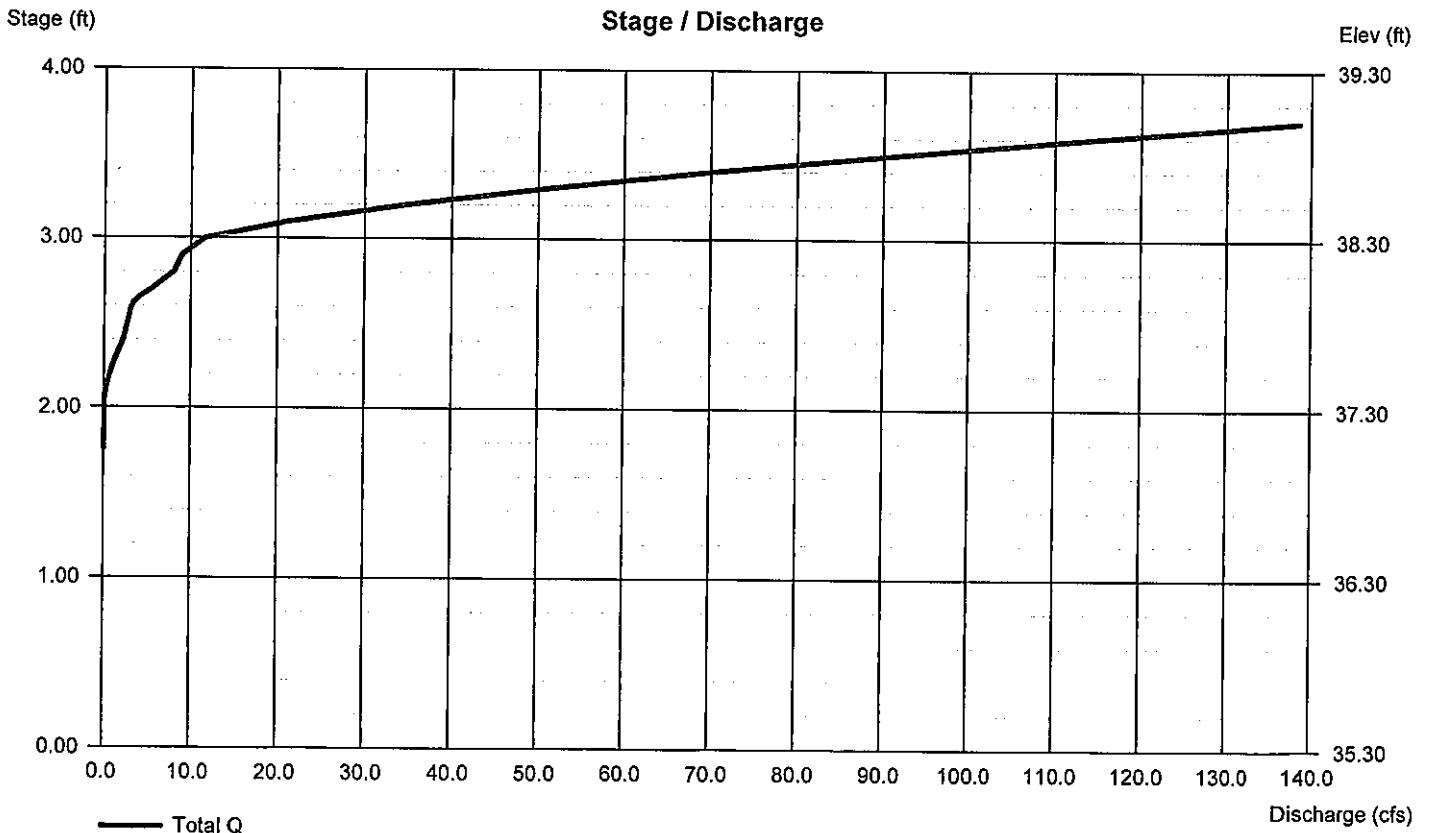
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	2.25	4.00	0.00
Span (in)	= 18.00	2.25	36.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 35.30	35.30	37.35	0.00
Length (ft)	= 25.00	0.50	0.50	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	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	Inactive	75.00	0.00
Crest El. (ft)	= 37.90	0.00	38.25	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= 1	Rect	Broad	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 37.00			

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



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	2.066	2	738	14,430	----	----	----	BMW Pre	
2	SCS Runoff	28.58	2	724	87,809	----	----	----	BMW Post	
3	Reservoir	2.072	2	798	49,053	2	37.69	55,745	Routing Post	
BMW Routing 2017 May 2017.gpw					Return Period: 10 Year			Tuesday, 06 / 13 / 2017		

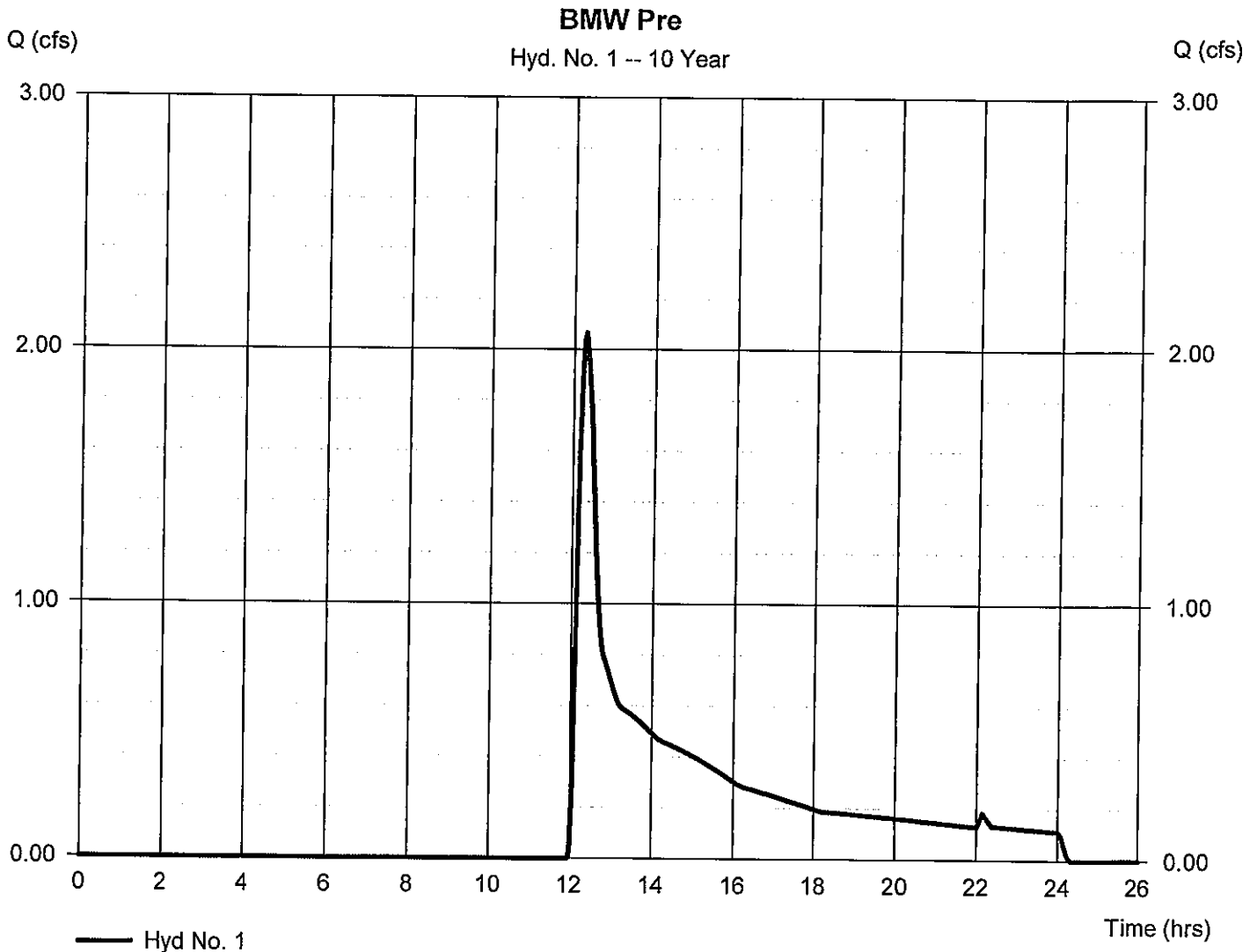
Hydrograph Report

Hyd. No. 1

BMW Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 2.066 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.30 hrs
Time interval	= 2 min	Hyd. volume	= 14,430 cuft
Drainage area	= 5.020 ac	Curve number	= 39*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 7.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.020 x 39)] / 5.020



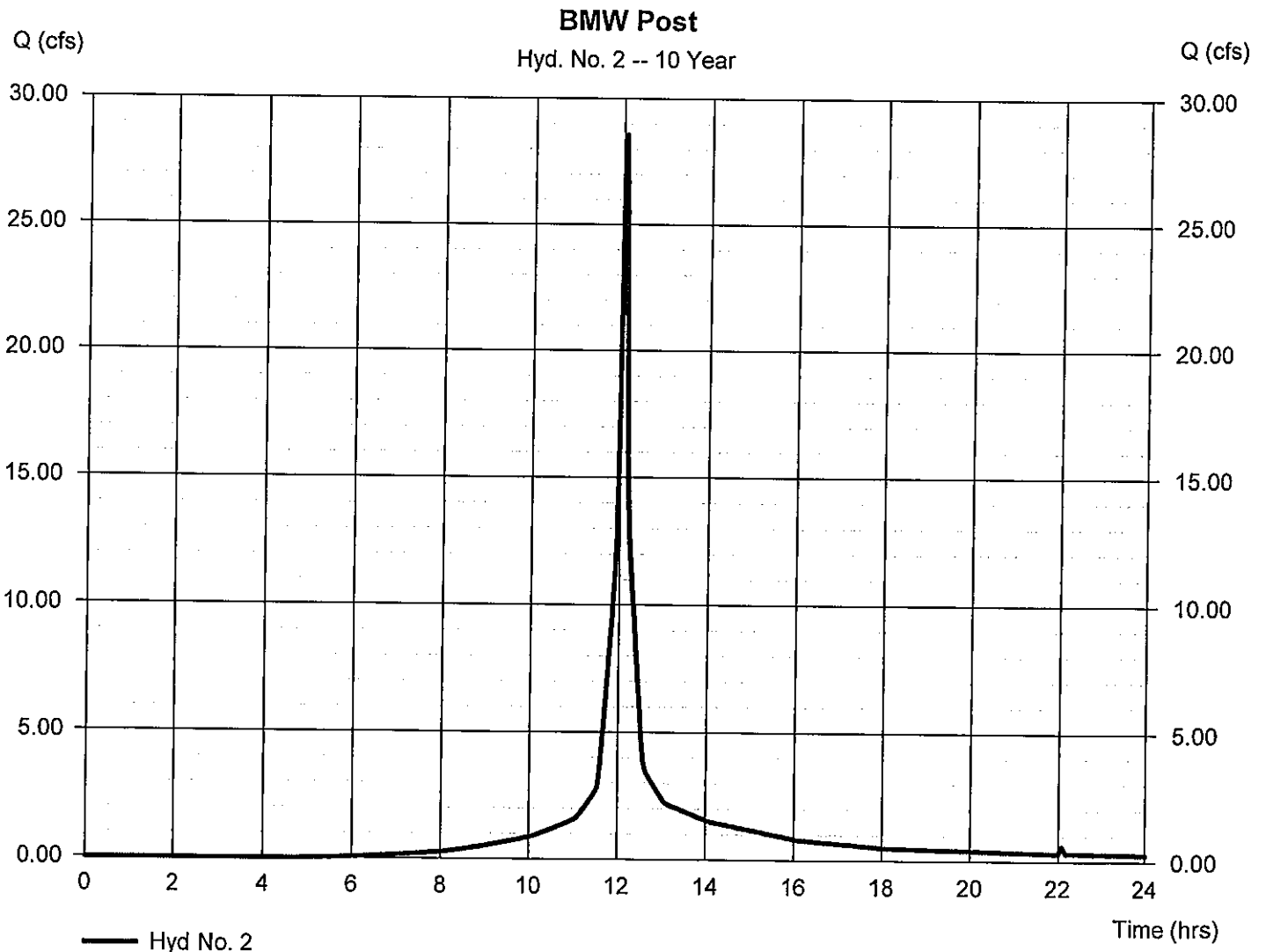
Hydrograph Report

Hyd. No. 2

BMW Post

Hydrograph type	= SCS Runoff	Peak discharge	= 28.58 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 87,809 cuft
Drainage area	= 5.020 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.010 x 98) + (1.010 x 30)] / 5.020



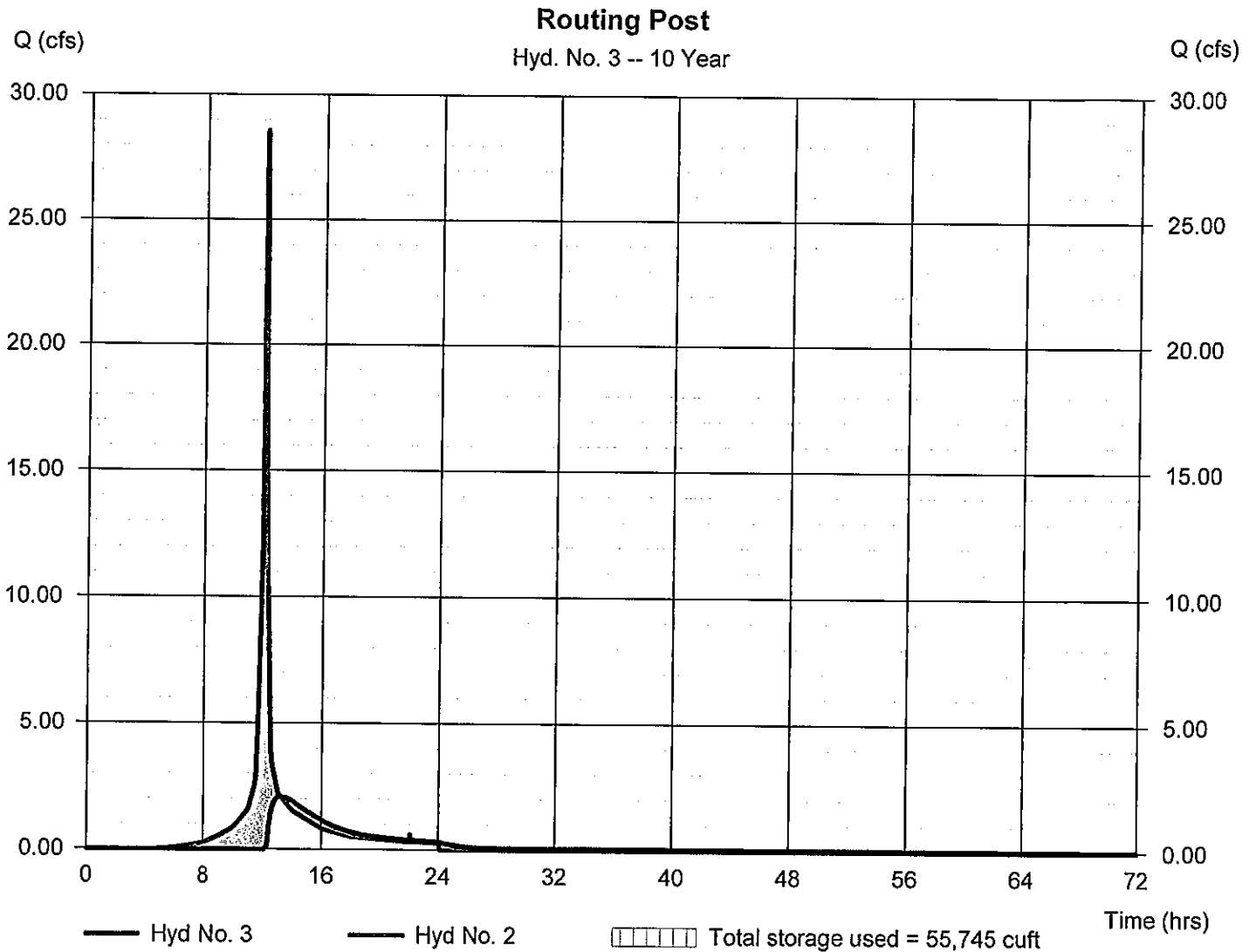
Hydrograph Report

Hyd. No. 3

Routing Post

Hydrograph type	= Reservoir	Peak discharge	= 2.072 cfs
Storm frequency	= 10 yrs	Time to peak	= 13.30 hrs
Time interval	= 2 min	Hyd. volume	= 49,053 cuft
Inflow hyd. No.	= 2 - BMW Post	Max. Elevation	= 37.69 ft
Reservoir name	= Wet Detention Pond #1	Max. Storage	= 55,745 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	3.903	2	734	22,138	-----	-----	-----	BMW Pre	
2	SCS Runoff	33.85	2	724	104,949	-----	-----	-----	BMW Post	
3	Reservoir	3.892	2	760	66,191	2	37.94	62,377	Routing Post	
BMW Routing 2017 May 2017.gpw					Return Period: 25 Year			Tuesday, 06 / 13 / 2017		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

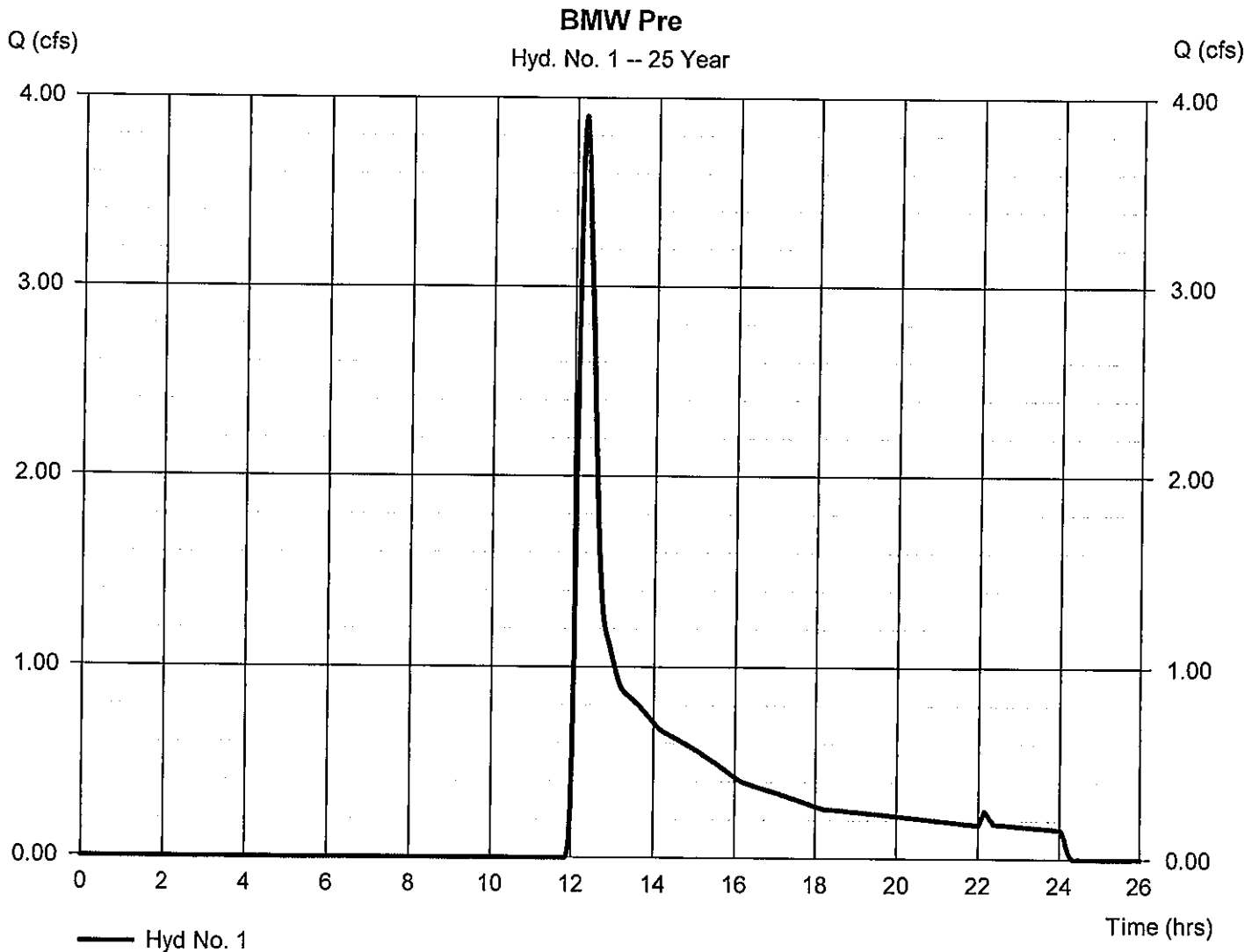
Tuesday, 06 / 13 / 2017

Hyd. No. 1

BMW Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 3.903 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 22,138 cuft
Drainage area	= 5.020 ac	Curve number	= 39*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.05 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.020 x 39)] / 5.020



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

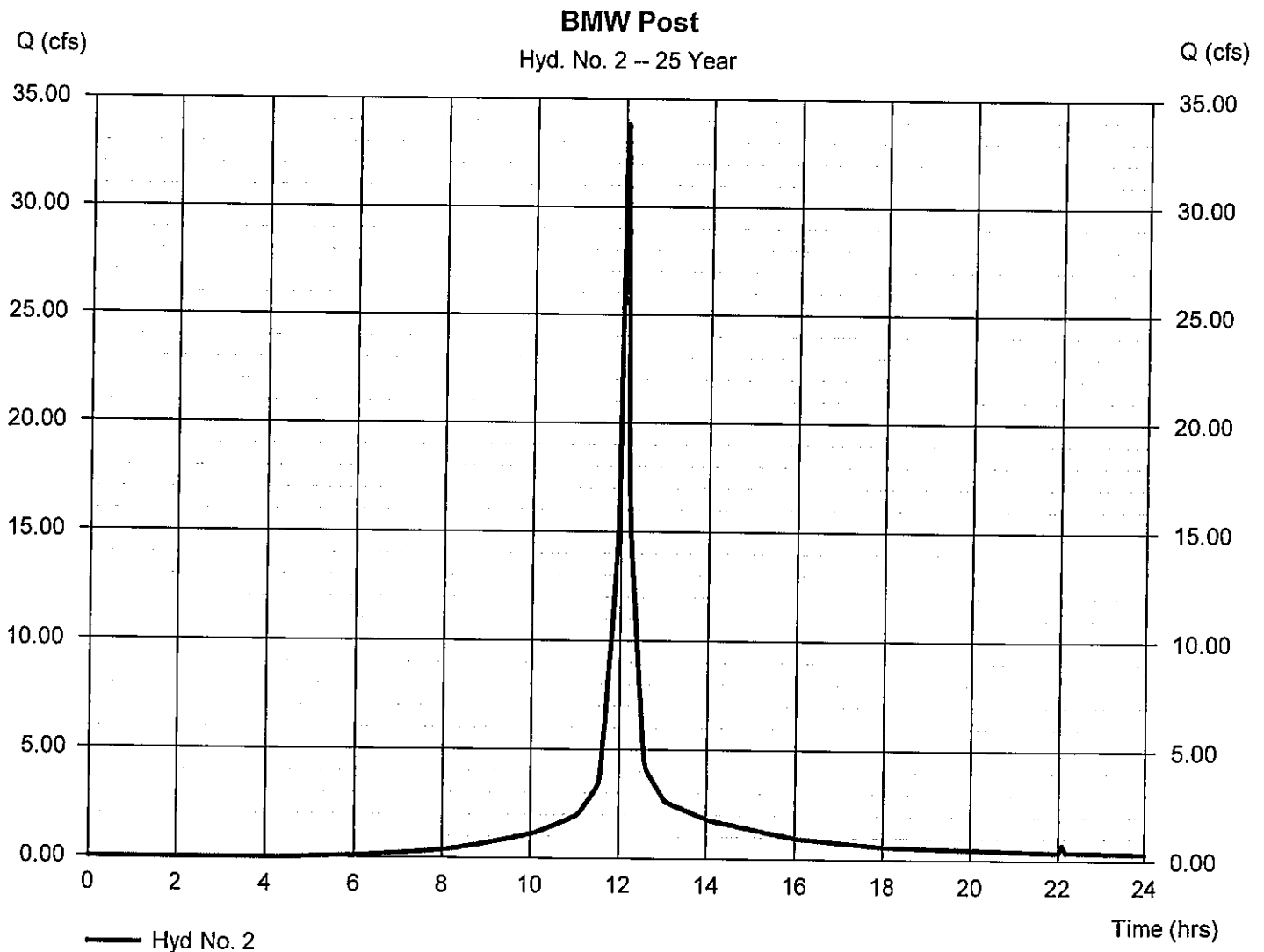
Tuesday, 06 / 13 / 2017

Hyd. No. 2

BMW Post

Hydrograph type	= SCS Runoff	Peak discharge	= 33.85 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 104,949 cuft
Drainage area	= 5.020 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.05 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(4.010 \times 98) + (1.010 \times 30)] / 5.020$



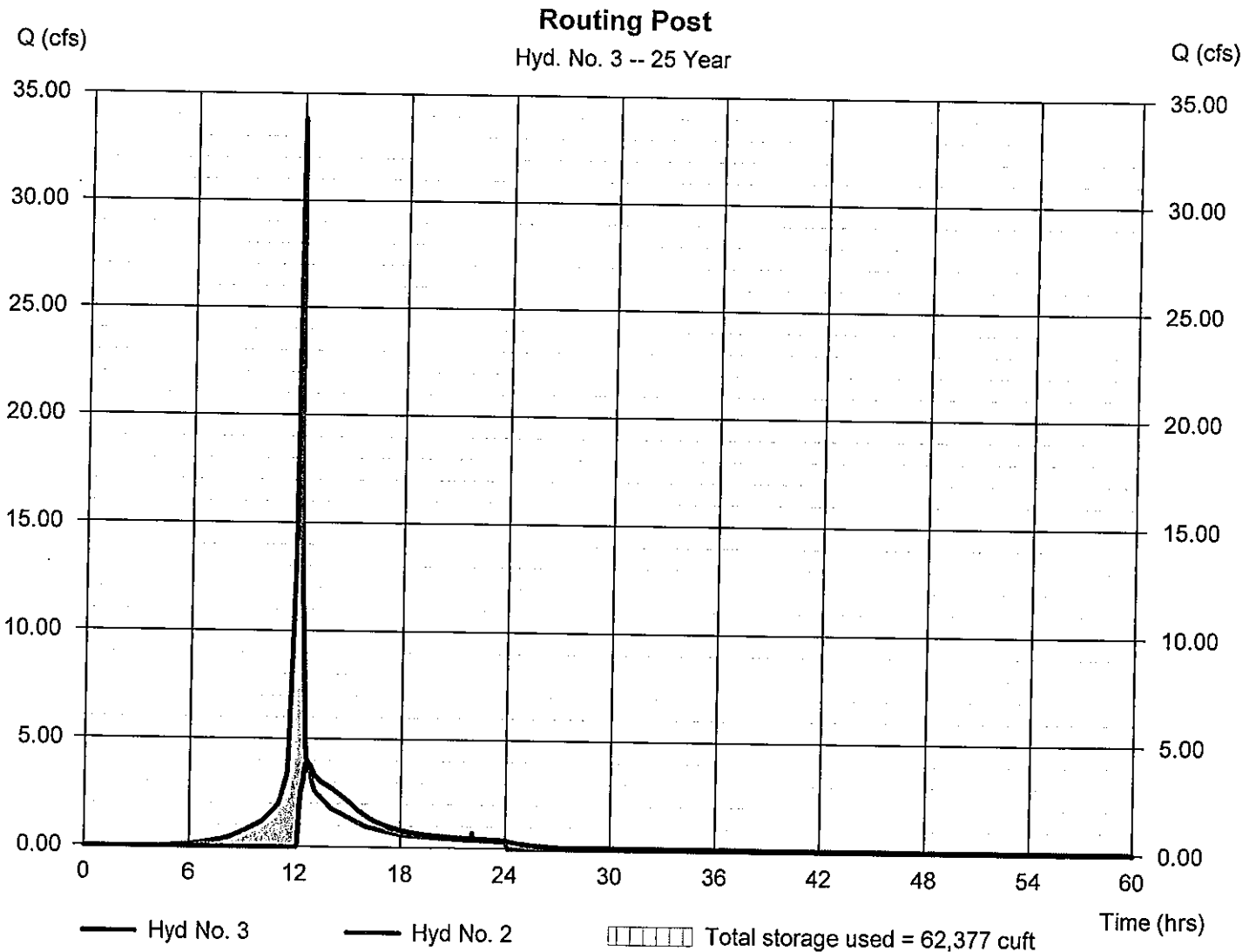
Hydrograph Report

Hyd. No. 3

Routing Post

Hydrograph type	= Reservoir	Peak discharge	= 3.892 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.67 hrs
Time interval	= 2 min	Hyd. volume	= 66,191 cuft
Inflow hyd. No.	= 2 - BMW Post	Max. Elevation	= 37.94 ft
Reservoir name	= Wet Detention Pond #1	Max. Storage	= 62,377 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	6.008	2	732	30,117	----	----	----	BMW Pre
2	SCS Runoff	38.60	2	724	120,594	----	----	----	BMW Post
3	Reservoir	8.249	2	748	81,835	2	38.12	66,995	Routing Post
BMW Routing 2017 May 2017.gpw					Return Period: 50 Year		Tuesday, 06 / 13 / 2017		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

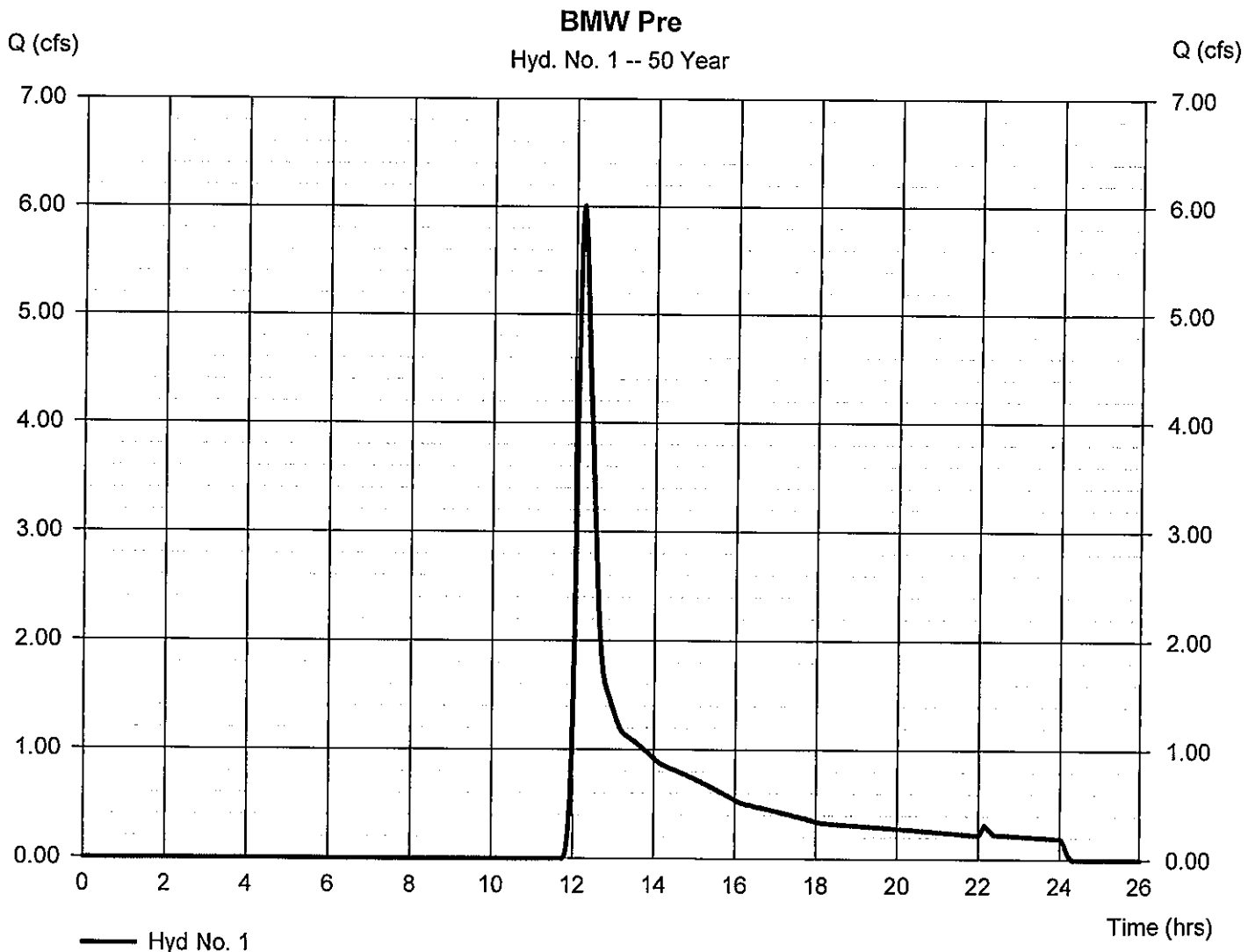
Tuesday, 06 / 13 / 2017

Hyd. No. 1

BMW Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 6.008 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.20 hrs
Time interval	= 2 min	Hyd. volume	= 30,117 cuft
Drainage area	= 5.020 ac	Curve number	= 39*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 9.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.020 x 39)] / 5.020



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

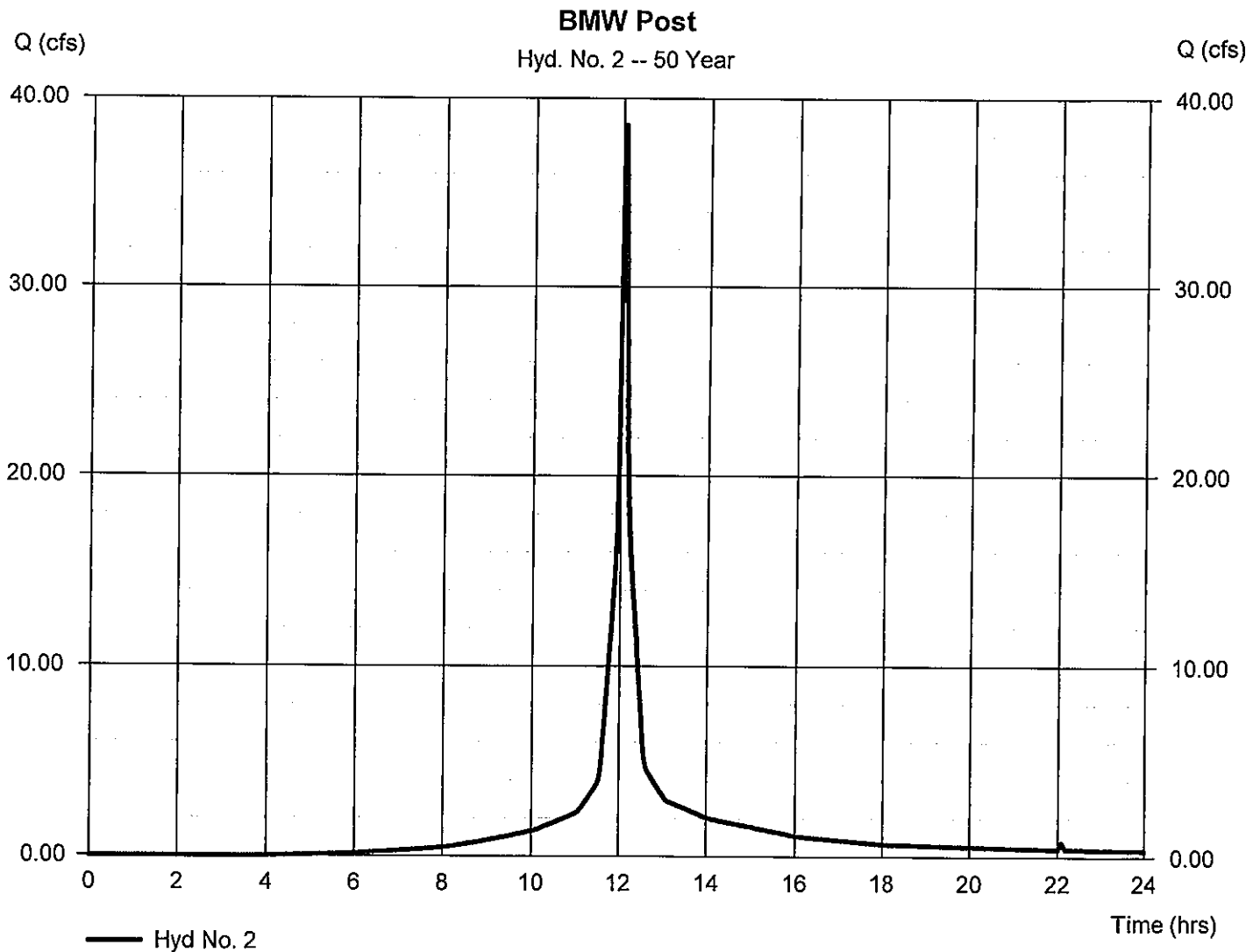
Tuesday, 06 / 13 / 2017

Hyd. No. 2

BMW Post

Hydrograph type	= SCS Runoff	Peak discharge	= 38.60 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 120,594 cuft
Drainage area	= 5.020 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 9.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.010 x 98) + (1.010 x 30)] / 5.020



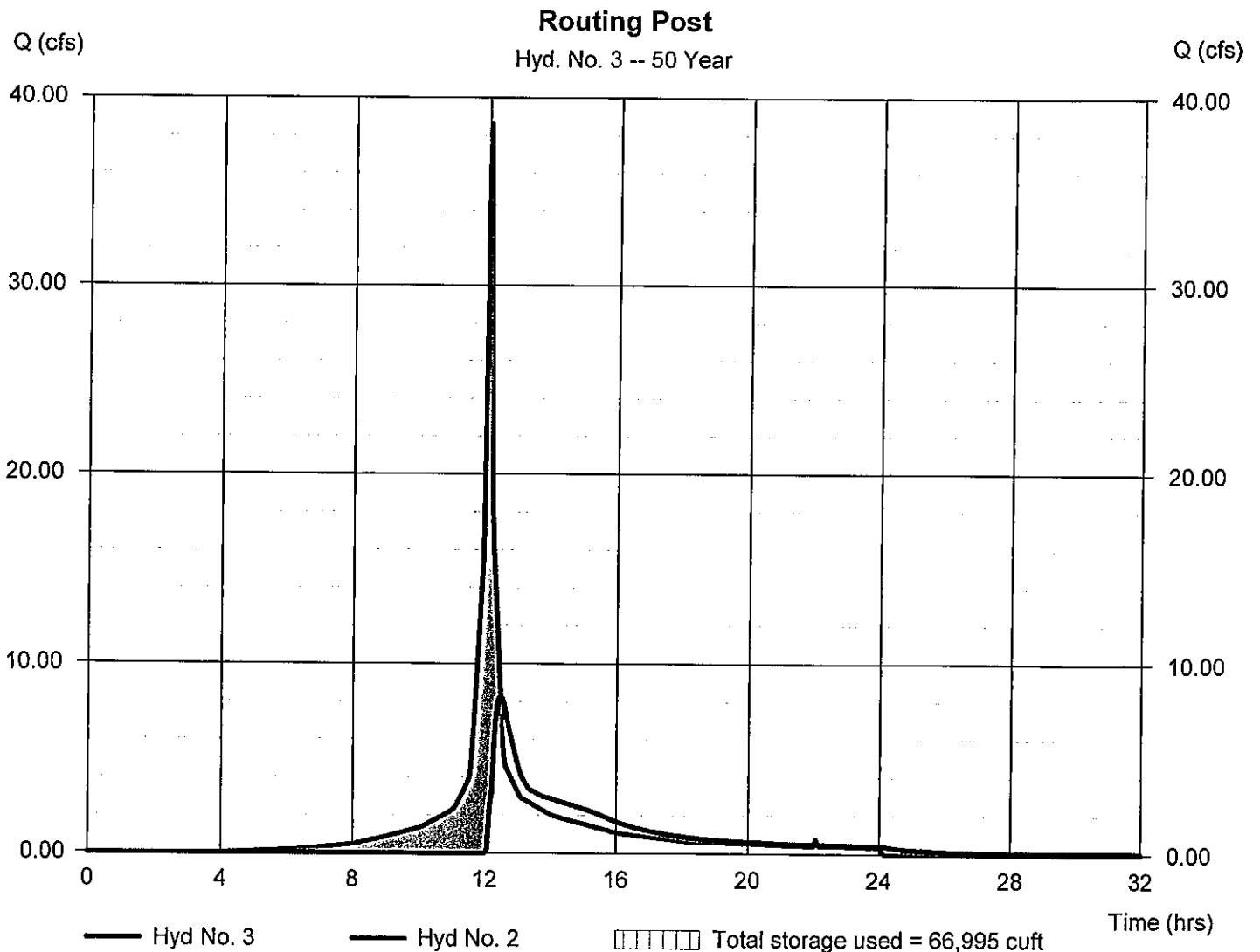
Hydrograph Report

Hyd. No. 3

Routing Post

Hydrograph type	= Reservoir	Peak discharge	= 8.249 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.47 hrs
Time interval	= 2 min	Hyd. volume	= 81,835 cuft
Inflow hyd. No.	= 2 - BMW Post	Max. Elevation	= 38.12 ft
Reservoir name	= Wet Detention Pond #1	Max. Storage	= 66,995 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	8.494	2	730	39,417	-----	-----	-----	BMW Pre
2	SCS Runoff	43.59	2	724	137,167	-----	-----	-----	BMW Post
3	Reservoir	12.25	2	744	98,406	2	38.31	72,123	Routing Post
BMW Routing 2017 May 2017.gpw					Return Period: 100 Year		Tuesday, 06 / 13 / 2017		

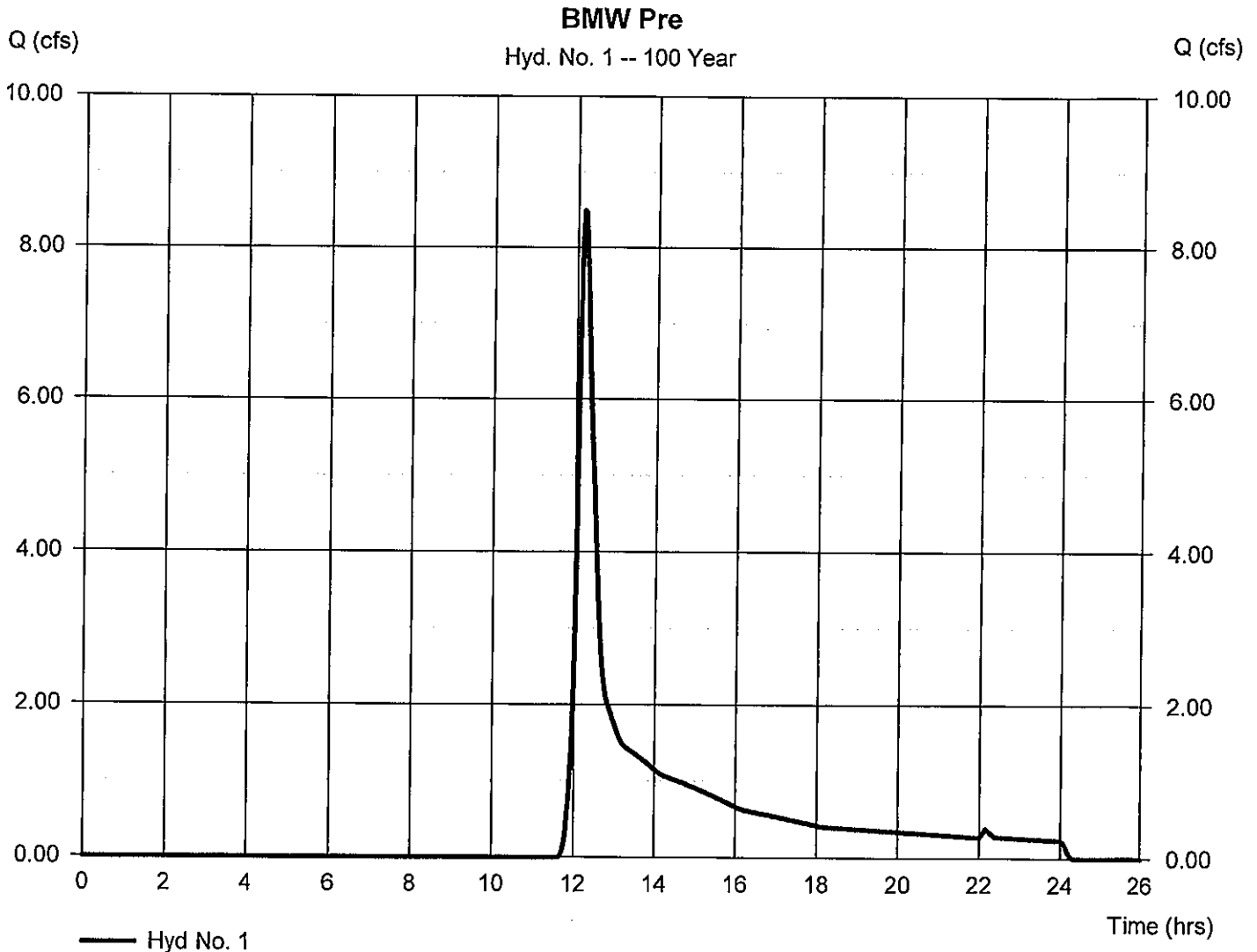
Hydrograph Report

Hyd. No. 1

BMW Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 8.494 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 39,417 cuft
Drainage area	= 5.020 ac	Curve number	= 39*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.020 x 39)] / 5.020



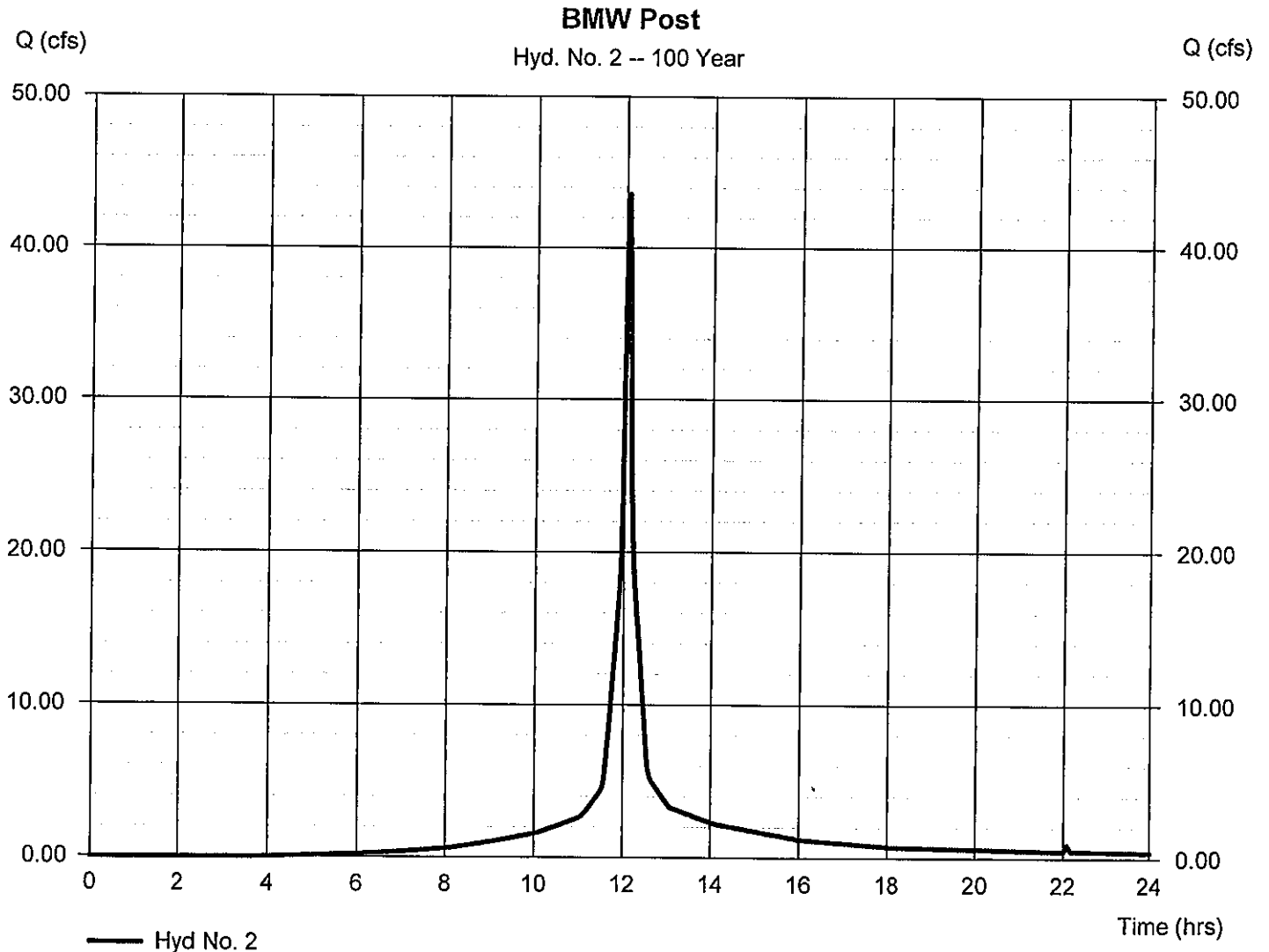
Hydrograph Report

Hyd. No. 2

BMW Post

Hydrograph type	= SCS Runoff	Peak discharge	= 43.59 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 137,167 cuft
Drainage area	= 5.020 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.010 x 98) + (1.010 x 30)] / 5.020



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

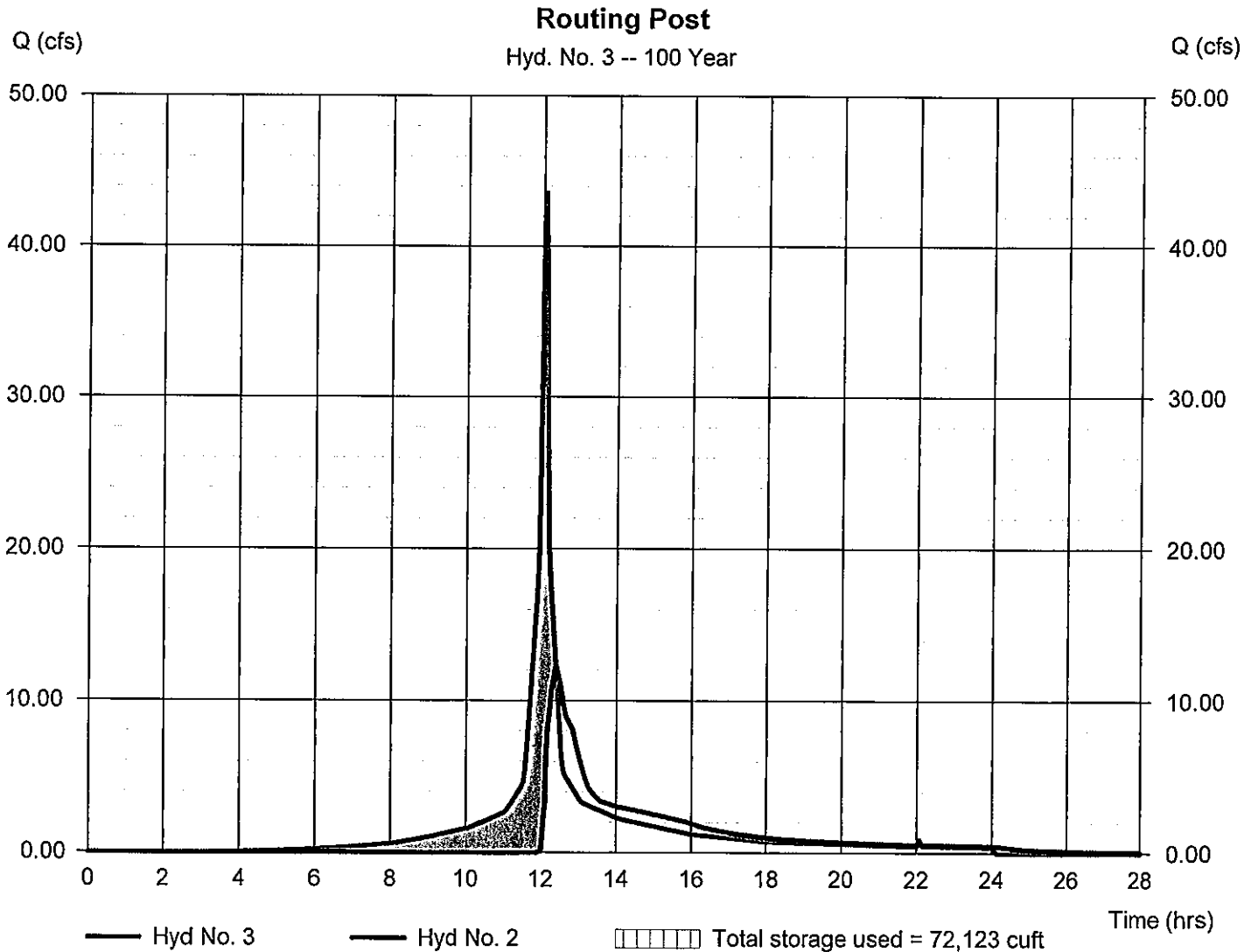
Tuesday, 06 / 13 / 2017

Hyd. No. 3

Routing Post

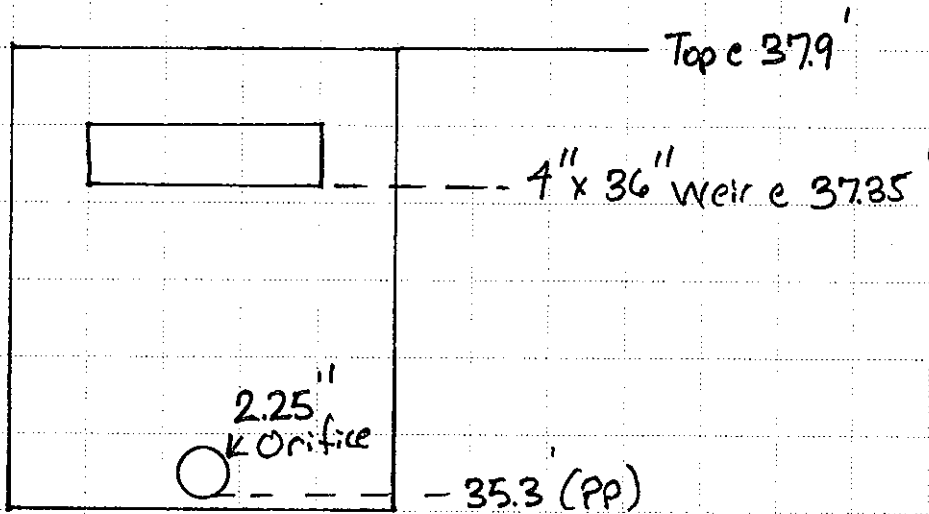
Hydrograph type	= Reservoir	Peak discharge	= 12.25 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.40 hrs
Time interval	= 2 min	Hyd. volume	= 98,406 cuft
Inflow hyd. No.	= 2 - BMW Post	Max. Elevation	= 38.31 ft
Reservoir name	= Wet Detention Pond #1	Max. Storage	= 72,123 cuft

Storage Indication method used.



Date 6/13/17	Design [Signature]	NORRIS & TUNSTALL — CONSULTING ENGINEERS P.C. —	Wilmington, NC Brunswick County, NC	Sheet Of
Check	Job BMW	For SW	Job No. 16038	

Per COW Both 1.5" Volume ! Temporary Volume must Drawdown
Within 2 to 5 days.



1.5" Storage Volume | 21,018 CF \Rightarrow Drawdown in 2.47 Days

Temp Volume (Between 35.3' - 37.9') | 61,278 CF

Volume A = (Between 35.3' - 37.35') = 47,338 CF

Drawdown Time (2.25" Orifice) = 4.92 Days

Volume B = (Between 37.35' - 37.9') = 13,940 CF

Drawdown Time (4" x 36" Weir) = 0.08 Days

Temp Volume Drawdown = 4.92 Days + 0.08 Days = 5.0 Days

OK ✓

Drawdown Calculations

Drainage Area =	5.02	AC
Normal Pool =	35.3	ft
Temporary Pool =	36.9	ft
Volume to be drawn down =	21018	CF

Drawdown Orifice:

Avg. Head = 1/3 of Flood Pool Elev	0.53	ft	
C_d = Coefficient of Discharge	0.60		
Drawdown Time =	2.00	days	
	172,800	s	
Internal Diameter =	0.21	ft	
	<u>2.52</u>	in	
Drawdown Time =	5.00	days	
	432,000	s	
Internal Diameter =	0.13	ft	
	<u>1.59</u>	in	
Avg Internal Diameter =	2.06	in	
Design Orifice Diameter =	2.25	in	OK!
	0.03	ft	
Design Drawdown rate	<u>0.10</u>	cfs	
Design Drawdown time	2.47	days	

1.5" Volume

Drawdown Calculations

Drainage Area =	5.02	AC
Normal Pool =	35.3	ft
Temporary Pool =	37.35	ft
Volume to be drawn down =	47338	CF

Drawdown Orifice:

Avg. Head = 1/3 of Flood Pool Elev	0.68	ft	
C_D = Coefficient of Discharge	0.60		
Drawdown Time =	2.00	days	
	172,800	s	
Internal Diameter =	0.30	ft	
	3.55	in	
Drawdown Time =	5.00	days	
	432,000	s	
Internal Diameter =	0.19	ft	
	2.25	in	
Avg Internal Diameter =	2.90	in	
Design Orifice Diameter =	2.25	in	
	0.03	ft	
Design Drawdown rate	0.11	cfs	
Design Drawdown time	4.92	days	

OK!

Temp Volume ; Volume A

Drawdown Calculations

Drainage Area =	5.02	AC
Normal Pool =	37.35	ft
Temporary Pool =	37.9	ft
Volume to be drawn down =	13940	CF

Drawdown Orifice:

Avg. Head = 1/3 of Flood Pool Elev	0.18		ft	
C_D = Coefficient of Discharge	0.60			
Drawdown Time =	2.00		days	
	172,800		s	
Internal Diameter =	0.22		ft	
	2.68		in	
Drawdown Time =	5.00		days	
	432,000		s	
Internal Diameter =	0.14		ft	
	1.69		in	
Avg Internal Diameter =	2.19		in	
Design Orifice Diameter =	2.25		in	OK!
	1.00	SF	ft	← 1" x 36"
Design Drawdown rate	2.06		cfs	
Design Drawdown time	0.08		days	

Temp Volume = Volume B

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 06 / 13 / 2017

Pond No. 1 - Wet Detention Pond #1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 35.30 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	35.30	20,977	0	0
0.50	35.80	22,089	10,764	10,764
0.70	36.00	22,534	4,462	15,226
1.70	37.00	24,310	23,414	38,640
2.30	37.60	25,400	14,910	53,550
2.70	38.00	26,127	10,304	63,854
3.70	39.00	27,985	27,048	90,902

Handwritten notes: 37.9' → 37.35' H = 47,338 CF
61,278 CF
37.9' H = 13,940 CF

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	2.25	4.00	0.00
Span (in)	= 18.00	2.25	36.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 35.30	35.30	37.35	0.00
Length (ft)	= 25.00	0.50	0.50	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	Yes	Yes	No

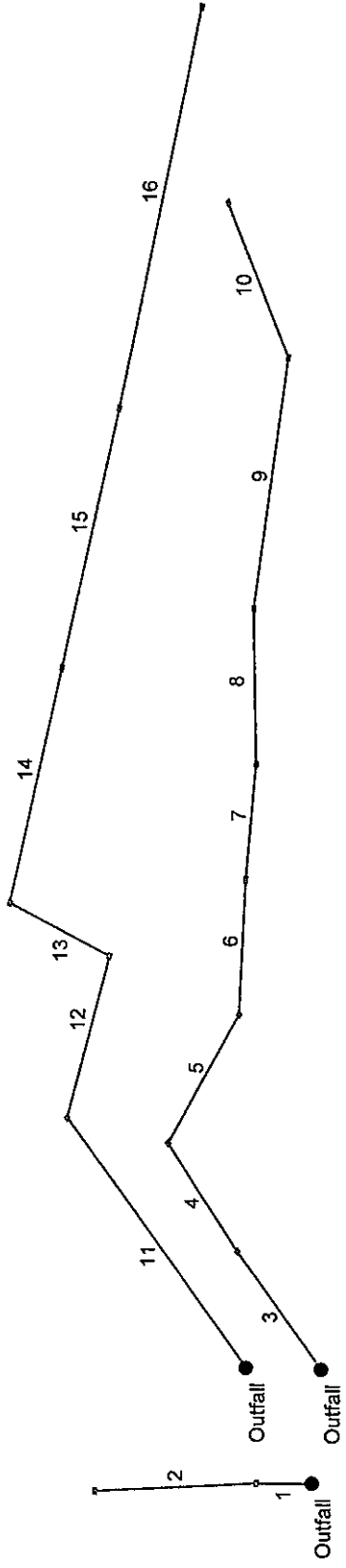
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 20.00	inactive	75.00	0.00
Crest El. (ft)	= 37.90	0.00	38.25	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= 1	Rect	Broad	---
Multi-Stage	= Yes	No	No	No
Exfil. (in/hr)	= 0.000	(by Wet area)		
TW Elev. (ft)	= 37.00			

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	35.30	0.00	0.00	0.00	---	0.00	---	0.00	---	---	---	0.000
0.50	10,764	35.80	0.00	0.00	0.00	---	0.00	---	0.00	---	---	---	0.000
0.70	15,226	36.00	0.00	0.00	0.00	---	0.00	---	0.00	---	---	---	0.000
1.70	38,640	37.00	0.00	0.00	0.00	---	0.00	---	0.00	---	---	---	0.000
2.30	53,550	37.60	1.38 ic	0.10 ic	1.28 ic	---	0.00	---	0.00	---	---	---	1.377
2.70	63,854	38.00	5.55 ic	0.10 ic	3.35 ic	---	2.11	---	0.00	---	---	---	5.554
3.70	90,902	39.00	12.02 ic	0.01 ic	0.35 ic	---	11.62 s	---	126.66	---	---	---	138.64



18" → ED ; Zone 1 6' x 5' x 12" CLASS B
24" → ED ; Zone 1 8' x 6' x 12" CLASS B

Storm Sewer Tabulation

Station Line	To Line	Len (ft)	Dmg Area (ac)		Rnoff coeff (C)	Area x C		Tc (min)		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev (ft)		HGL Elev (ft)		Grnd / Rim Elev (ft)		Line ID
			Incr	Total		Incr	Total	Inlet	Syst					Slope (%)	Size (in)	Dn	Up	Dn	Up	Dn	Up	
1	End	40	0.10	0.29	0.86	0.09	0.26	5.0	6.8	6.9	1.80	7.43	2.37	18	0.50	35.90	36.10	37.00	36.60	40.00	39.00	CI-1
2	1	113	0.19	0.19	0.93	0.18	0.18	5.0	5.0	7.2	1.28	3.84	2.40	15	0.35	36.10	36.50	36.77	36.99	39.00	39.00	CI-2
3	End	85	0.13	1.83	0.90	0.12	1.72	5.0	9.9	6.3	10.88	12.75	4.38	24	0.32	35.50	35.77	37.00	37.23	40.00	39.00	CI-3
4	3	74	0.08	1.70	0.85	0.07	1.60	5.0	9.5	6.4	10.24	12.05	3.88	24	0.28	35.77	35.98	37.37	37.52	39.00	39.75	DI-4
5	4	82	0.34	1.62	0.95	0.32	1.54	5.0	9.1	6.5	9.91	12.74	3.77	24	0.32	35.98	36.24	37.60	37.75	39.75	40.00	DI-5
6	5	69	0.27	1.28	0.95	0.26	1.21	5.0	8.6	6.5	7.92	11.55	3.13	24	0.26	36.24	36.42	37.79	37.87	40.00	40.00	DI-6
7	6	60	0.27	1.01	0.95	0.26	0.96	5.0	8.2	6.6	6.32	12.39	2.69	24	0.30	36.42	36.60	37.89	37.94	40.00	40.00	DI-7
8	7	80	0.30	0.74	0.95	0.29	0.70	5.0	7.7	6.7	4.68	5.75	2.92	18	0.30	36.60	36.84	37.94	38.07	40.00	40.00	DI-8
9	8	130	0.24	0.44	0.95	0.23	0.41	5.0	6.4	6.9	2.88	5.53	2.07	18	0.28	36.84	37.20	38.10	38.19	40.00	40.00	DI-9
10	9	90	0.20	0.20	0.93	0.19	0.19	5.0	5.0	7.2	1.34	3.73	1.50	15	0.33	37.20	37.50	38.21	38.25	40.00	40.00	CI-10
11	End	180	0.67	1.62	0.87	0.58	1.48	5.0	11.0	6.1	9.11	12.39	2.90	24	0.30	34.77	35.31	37.00	37.28	40.00	39.00	DI-11
12	11	87	0.00	0.95	0.00	0.00	0.90	5.0	10.3	6.3	5.63	8.74	1.80	24	0.15	35.31	35.44	37.35	37.40	39.00	41.00	JB-12
13	12	75	0.14	0.95	0.95	0.13	0.90	5.0	9.6	6.4	5.72	15.00	1.94	24	0.44	35.44	35.77	37.40	37.43	41.00	40.00	CI-13
14	13	126	0.15	0.81	0.95	0.14	0.77	5.0	8.9	6.5	4.97	6.13	2.81	18	0.34	35.77	36.20	37.43	37.70	40.00	40.00	CI-14
15	14	138	0.44	0.66	0.95	0.42	0.62	5.0	7.9	6.7	4.14	6.45	2.58	18	0.38	36.20	36.72	37.70	37.88	40.00	40.00	CI-15
16	15	212	0.22	0.22	0.93	0.20	0.20	5.0	5.0	7.2	1.48	3.92	1.71	15	0.37	36.72	37.50	37.98	38.17	40.00	40.00	CI-16

Baker BMW 2017

Number of lines: 16

Run Date: 6/13/17

NOTES: Intensity = 121.80 / (Inlet time + 23.50) ^ 0.84; Return period = Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station Line	Len (ft)	Dmg Area (ac)		Rnoff coeff (C)	Area x C		Tc (min)		Rain (l) (In/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe Size (in)		Slope (%)		Invert Elev (ft)		HGL Elev (ft)		Grnd / Rim Elev (ft)		Line ID
		Incr	Total		Incr	Total	Inlet	Syst					Incr	Total	Dn	Up	Dn	Up	Dn	Up	Dn	Up	
1	End	40	0.10	0.29	0.86	0.09	0.26	5.0	6.6	7.8	2.05	7.43	1.17	18	0.50	35.90	36.10	37.50	37.51	40.00	39.00	CI-1	
2	1	113	0.19	0.19	0.93	0.18	0.18	5.0	5.0	8.1	1.44	3.84	1.23	15	0.35	36.10	36.50	37.51	37.56	39.00	39.00	CI-2	
3	End	85	0.13	1.83	0.90	0.12	1.72	5.0	9.3	7.3	12.54	12.75	4.00	24	0.32	35.50	35.77	37.50	37.75	40.00	39.00	CI-3	
4	3	74	0.08	1.70	0.85	0.07	1.60	5.0	9.0	7.3	11.78	12.05	3.77	24	0.28	35.77	35.98	37.75	37.93	39.00	39.75	DI-4	
5	4	82	0.34	1.62	0.95	0.32	1.54	5.0	8.6	7.4	11.38	12.74	3.69	24	0.32	35.98	36.24	37.93	38.10	39.75	40.00	DI-5	
6	5	69	0.27	1.28	0.95	0.26	1.21	5.0	8.2	7.5	9.08	11.55	2.97	24	0.26	36.24	36.42	38.16	38.25	40.00	40.00	DI-6	
7	6	60	0.27	1.01	0.95	0.26	0.96	5.0	7.8	7.6	7.23	12.39	2.45	24	0.30	36.42	36.60	38.28	38.32	40.00	40.00	DI-7	
8	7	80	0.30	0.74	0.95	0.29	0.70	5.0	7.4	7.7	5.35	5.75	3.03	18	0.30	36.60	36.84	38.32	38.53	40.00	40.00	DI-8	
9	8	130	0.24	0.44	0.95	0.23	0.41	5.0	6.2	7.9	3.26	5.53	1.85	18	0.28	36.84	37.20	38.62	38.70	40.00	40.00	DI-9	
10	9	90	0.20	0.20	0.93	0.19	0.19	5.0	5.0	8.1	1.52	3.73	1.23	15	0.33	37.20	37.50	38.73	38.75	40.00	40.00	CI-10	
11	End	180	0.67	1.62	0.87	0.58	1.48	5.0	10.3	7.1	10.54	12.39	3.36	24	0.30	34.77	35.31	37.50	37.89	40.00	39.00	DI-11	
12	11	87	0.00	0.95	0.00	0.00	0.90	5.0	9.7	7.2	6.50	8.74	2.07	24	0.15	35.31	35.44	38.00	38.07	39.00	41.00	JB-12	
13	12	75	0.14	0.95	0.95	0.13	0.90	5.0	9.1	7.3	6.59	15.00	2.10	24	0.44	35.44	35.77	38.07	38.13	41.00	40.00	CI-13	
14	13	126	0.15	0.81	0.95	0.14	0.77	5.0	8.4	7.4	5.70	6.13	3.23	18	0.34	35.77	36.20	38.13	38.51	40.00	40.00	CI-14	
15	14	138	0.44	0.66	0.95	0.42	0.62	5.0	7.6	7.6	4.74	6.45	2.68	18	0.38	36.20	36.72	38.56	38.84	40.00	40.00	CI-15	
16	15	212	0.22	0.22	0.93	0.20	0.20	5.0	5.0	8.1	1.67	3.92	1.36	15	0.37	36.72	37.50	38.92	39.06	40.00	40.00	CI-16	

Baker BMW 2017

Number of lines: 16

Run Date: 6/13/17

NOTES: intensity = 155.43 / (Inlet time + 26.20) ^ 0.86; Return period = Yrs. 25 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station	Len		Drng Area		Rnoff coeff	Area x C		Tc		Rain (f)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
	To Line	(ft)	Incr	Total		Incr	Total	Inlet	Syst					(in)	Slope (%)	Dn	Up	Dn	Up	Dn	Up	
1	End	40	0.10	0.29	0.86	0.09	0.26	5.0	6.4	9.3	2.44	7.43	1.38	18	0.50	35.90	36.10	38.00	38.02	40.00	39.00	CI-1
2	1	113	0.19	0.19	0.93	0.18	0.18	5.0	5.0	9.6	1.70	3.84	1.38	15	0.35	36.10	36.50	38.02	38.10	39.00	39.00	CI-2
3	End	85	0.13	1.83	0.90	0.12	1.72	5.0	8.6	8.8	15.11	12.75	4.81	24	0.32	35.50	35.77	38.00	38.38	40.00	39.00	CI-3
4	3	74	0.08	1.70	0.85	0.07	1.60	5.0	8.4	8.8	14.18	12.05	4.51	24	0.28	35.77	35.98	38.42	38.71	39.00	39.75	DI-4
5	4	82	0.34	1.62	0.95	0.32	1.54	5.0	8.1	8.9	13.67	12.74	4.35	24	0.32	35.98	36.24	38.74	39.04	39.75	40.00	DI-5
6	5	69	0.27	1.28	0.95	0.26	1.21	5.0	7.7	9.0	10.88	11.55	3.46	24	0.26	36.24	36.42	39.14	39.30	40.00	40.00	DI-6
7	6	60	0.27	1.01	0.95	0.26	0.96	5.0	7.4	9.1	8.65	12.39	2.75	24	0.30	36.42	36.60	39.37	39.46	40.00	40.00	DI-7
8	7	80	0.30	0.74	0.95	0.29	0.70	5.0	7.0	9.1	6.38	5.75	3.61	18	0.30	36.60	36.84	39.46	39.76	40.00	40.00	DI-8
9	8	130	0.24	0.44	0.95	0.23	0.41	5.0	6.0	9.4	3.87	5.53	2.19	18	0.28	36.84	37.20	39.88	40.06	40.00	40.00	DI-9
10	9	90	0.20	0.20	0.93	0.19	0.19	5.0	5.0	9.6	1.79	3.73	1.45	15	0.33	37.20	37.50	40.10	40.17	40.00	40.00	CI-10
11	End	180	0.67	1.62	0.87	0.58	1.48	5.0	9.5	8.6	12.76	12.39	4.06	24	0.30	34.77	35.31	38.00	38.57	40.00	39.00	DI-11
12	11	87	0.00	0.95	0.00	0.00	0.90	5.0	8.9	8.7	7.84	8.74	2.50	24	0.15	35.31	35.44	38.73	38.84	39.00	41.00	JB-12
13	12	75	0.14	0.95	0.95	0.13	0.90	5.0	8.4	8.8	7.93	15.00	2.52	24	0.44	35.44	35.77	38.84	38.93	41.00	40.00	CI-13
14	13	126	0.15	0.81	0.95	0.14	0.77	5.0	7.9	8.9	6.84	6.13	3.87	18	0.34	35.77	36.20	38.93	39.46	40.00	40.00	CI-14
15	14	138	0.44	0.66	0.95	0.42	0.62	5.0	7.2	9.1	5.66	6.45	3.20	18	0.38	36.20	36.72	39.54	39.94	40.00	40.00	CI-15
16	15	212	0.22	0.22	0.93	0.20	0.20	5.0	5.0	9.6	1.96	3.92	1.60	15	0.37	36.72	37.50	40.06	40.25	40.00	40.00	CI-16

Baker BMW 2017

Number of lines: 16

Run Date: 6/13/17

NOTES: Intensity = 198.56 / (Inlet time + 28.80) ^ 0.86; Return period = Yrs. 100 ; c = cir e = ellip b = box