Hydraulic Analysis

Summary of Interior Drainage Discharge and Rational Formula Data

Interior Drainage Discharge and Rational Formula Data

	Drainage Areas							
Drainage Areas	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Drainage Areas (acre)	37.3	22.2	48.9	134.5	4.9	33.5	108.8	127.7
Runoff Coefficient C	0.69	0.61	0.59	0.58	0.48	---	0.50	0.58
Time of Concentration Tc (min)	15	12	19	54	23	---	19	22
10-Year Rainfall Intensity (in/hr) *	4.0	4.5	3.7	2.0	3.4	---	3.7	3.4
100-Year Rainfall Intensity (in/hr) *	5.5	6.1	5.2	3.0	4.8	---	5.2	4.9
10-Year Peak Discharge Rate (cfs)	102.8	60.8	106.5	155.0	7.9	---	200.3	252.8
100-Year Peak Discharge Rate (cfs)	141.4	82.4	149.7	232.5	11.2	---	281.5	364.3
Discharge for 1.5 in/hr. Rainsfall Rate (cfs)	38.6	20.3	43.2	116.3	3.5	---	81.2	111.5

* From ConnDOT Drainage Manual 2000

	Design Discharges (cfs)								Total
Housatonic River									
Outfall 1 (36" RCP Pressure Conduit)	141.4								**141.4**
Outfall 2 (8'x6' Gravity Conduit)		82.4	149.7	232.5	11.2				**475.9**
Derby Pump Station		20.3	43.2	116.3	3.5				**183.2**
Naugatuck River									
Outfall 3 (6'x6' Gravity Conduit)	---------- separate analysis (Hydraulic Analysis - Outfall 3) ----------								
Outfall 4 (48" RCP Pressure Conduit)							281.5		**281.5**
Outfall 5 (6'x5' Gravity Conduit)								364.3	**364.3**
Division Street Pump Station - Ansonia								111.5	**111.5**

Hydraulic Analysis - Input Computations

Existing Conditions

Derby / Ansonia - Drainage Areas

DRAINAGE AREA	TOTAL AREA (AC)	WOODS (AC)	OPEN (AC)	SUBURBAN (AC)	GRAVEL (AC)	INDUST. PARK (AC)	RESID. (AC)	COMM/IND LIGHT (AC)	DOWNTOWN (AC)	COMM/IND HEAVY (AC)	HIGHWAY CORRIDOR (AC)	PAVED (AC)	RC
1	**37.30**	0.00	0.00	0.00	0.00	0.00	3.00	0.00	33.39	0.91	0.00	0.00	**0.69**
2	**22.19**	0.00	5.59	0.00	0.00	0.00	0.00	0.00	13.01	3.32	0.00	0.27	**0.61**
3	**48.93**	0.03	2.42	4.91	0.11	0.00	21.11	0.00	12.48	7.60	0.00	0.26	**0.59**
4	**134.51**	21.67	13.87	1.72	1.01	16.25	10.89	2.22	0.00	44.89	18.92	3.06	**0.58**
5	**4.89**	1.36	1.28	0.00	0.04	0.00	0.00	0.00	0.00	2.15	0.06	0.00	**0.48**
6	**33.45**	----------separate analysis----------											**---**
7	**108.77**	21.80	0.90	0.00	0.17	0.00	56.34	24.89	0.00	4.66	0.00	0.00	**0.50**
8	**127.73**	6.74	4.22	0.00	1.57	0.00	50.62	34.95	0.00	29.63	0.00	0.00	**0.58**
TOTAL	***517.78***												

C Values:

Woods	0.20
Open	0.30
Suburban	0.35
Gravel	0.45
Industrial Park	0.50
Residential	0.55
Comm / Indust. Light	0.60
Downtown	0.70
Comm / Indust. Heav	0.75
Highway Corridor	0.85
Paved / Bitum.	0.90

Figure 9-2 - Values of Runoff Coefficient (C) for Rational Formula

Land use	C
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.50-0.70
Residential:	
Single-family areas	0.30-0.50
Multi units, detached	0.40-0.60
Multi units, attached	0.60-0.75
Suburban	0.25-0.40
Industrial:	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard areas	0.20-0.40
Unimproved areas	0.10-0.30
Streets:	
Asphaltic	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.85
Roofs	0.75-0.95

Land use	C
Lawns:	
Sandy soil, flat, 2%	0.05-0.10
Sandy soil, average, 2-7%	0.10-0.15
Sandy soil, steep, 7%	0.15-0.20
Heavy soil, flat, 2%	0.13-0.17
Heavy soil, average, 2-7%	0.18-0.22
Heavy soil, steep, 7 %	0.25-0.35
Agricultural land:	
Bare packed soil	
Smooth	0.30-0.60
Rough	0.20-0.50
Cultivated rows	
Heavy soil no crop	0.30-0.60
Heavy soil with crop	0.20-0.50
Sandy soil no crop	0.20-0.40
Sandy soil with crop	0.10-0.25
Pasture	
Heavy soil	0.15-0.45
Sandy soil	0.05-0.25
Woodlands	0.05-0.25

Note: The designer must use judgement to select the appropriate C value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have lowest (C) values. Smaller areas with dense soils, moderate to steep slopes, and sparce vegetation should be assigned highest (C) values.

Source: Virginia Erosion and Sediment Control Handbook, 1980. Virginia Soil and Water Conservation Commission.

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #1
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		GRSS		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3.	Flow Length, L (< 300ft)	ft.	100		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.080		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.161	=	0.161

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D				
7.	Surface description		GRSS	BIT				
8.	Manning's roughness coeff., n		0.080	0.015				
9.	Paved or unpaved		UNPVD	PVD				
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.20				
11.	Flow Length, L	ft.	325	30				
12.	Watercourse slope, s	ft./ft.	0.068	0.040				
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.63	6.79				
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.034	+ 0.001	+	+	+	= 0.036

Channel flow

		Segment ID	D-E	E-F	F-G			
15.	Channel Bottom width, b	ft.	12" STM	24" STM	36" STM			
16.	Horizontal side slope component, z (z horiz:1 vert)		---	---	---			
17.	Depth of flow, d	ft.	FULL	FULL	FULL			
18.	Cross sectional flow area, A	$ft.^2$	0.79	3.14	7.07	0.00	0.00	
19.	Wetted perimeter, P_w	ft.	3.14	6.28	9.42	0.00	0.00	
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25	0.50	0.75	0.00	0.00	
21.	Channel slope, s	ft./ft.	0.018	0.047	0.050			
22.	Manning's roughness coeff., n		0.012	0.012	0.012			
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	6.67	16.94	22.93	0.00	0.00	
24.	Flow length, L	ft.	770	725	185			
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.032	+ 0.012	+ 0.002	+ 0.000	+ 0.000	= 0.046

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.243

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #2
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		GRSS		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3.	Flow Length, L (< 300ft)	ft.	100		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.105		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.144	=	0.144

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D				
7.	Surface description		GRSS	BIT				
8.	Manning's roughness coeff., n		0.080	0.015				
9.	Paved or unpaved		UNPVD	PVD				
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.20				
11.	Flow Length, L	ft.	165	190				
12.	Watercourse slope, s	ft./ft.	0.100	0.050				
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	3.20	7.60				
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.014	+ 0.007	+	+	+	= 0.021

Channel flow

		Segment ID	D-E	E-F	F-G			
15.	Channel Bottom width, b	ft.	12" STM	15" STM	42" STM			
16.	Horizontal side slope component, z (z horiz:1 vert)		---	---	---			
17.	Depth of flow, d	ft.	FULL	FULL	FULL			
18.	Cross sectional flow area, A	$ft.^2$	0.79	1.23	9.62	0.00	0.00	
19.	Wetted perimeter, P_w	ft.	3.14	3.93	11.00	0.00	0.00	
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25	0.31	0.87	0.00	0.00	
21.	Channel slope, s	ft./ft.	0.167	0.058	0.010			
22.	Manning's roughness coeff., n		0.012	0.012	0.012			
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	20.22	13.78	11.36	0.00	0.00	
24.	Flow length, L	ft.	850	120	890			
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.012	+ 0.002	+ 0.022	+ 0.000	+ 0.000	= 0.036

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.20

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #3
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B	
1.	Surface description (Table 3-1)		GRSS	
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3.	Flow Length, L (< 300ft)	ft.	100	
4.	Two-year 24-hr rainfall, P_2	in.	3.30	
5.	Land slope, s	ft./ft.	0.085	
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.157	= 0.157

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D				
7.	Surface description		GRSS	BIT				
8.	Manning's roughness coeff., n		0.080	0.015				
9.	Paved or unpaved		UNPVD	PVD				
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.20				
11.	Flow Length, L	ft.	405	115				
12.	Watercourse slope, s	ft./ft.	0.069	0.020				
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.66	4.80				
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.042	+ 0.007	+	+	+	= 0.049

Channel flow

		Segment ID	D-E	E-F				
15.	Channel Bottom width, b	ft.	24" STM	42" STM				
16.	Horizontal side slope component, z (z horiz:1 vert)		---	---				
17.	Depth of flow, d	ft.	FULL	FULL				
18.	Cross sectional flow area, A	$ft.^2$	3.14	9.62		0.00	0.00	
19.	Wetted perimeter, P_w	ft.	6.28	11.00		0.00	0.00	
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.50	0.87		0.00	0.00	
21.	Channel slope, s	ft./ft.	0.025	0.010				
22.	Manning's roughness coeff., n		0.012	0.012				
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	12.37	11.36		0.00	0.00	
24.	Flow length, L	ft.	4210	335				
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.095	+ 0.008	+	+ 0.000	+ 0.000	= 0.103

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.309

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #4
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		WOOD		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400		
3.	Flow Length, L (< 300ft)	ft.	100		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.008		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.508	=	0.508

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C		C-D		D-E					
7.	Surface description		GRSS		GRAV		WOOD					
8.	Manning's roughness coeff., n		0.080		0.025		0.100					
9.	Paved or unpaved		UNPVD		UNPVD		UNPVD					
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40		0.40		0.40					
11.	Flow Length, L	ft.	400		150		80					
12.	Watercourse slope, s	ft./ft.	0.010		0.003		0.069					
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.99		1.86		2.12					
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.113	+	0.022	+	0.010	+		+		= 0.146

Channel flow

		Segment ID	E-F		F-G							
15.	Channel Bottom width, b	ft.	10.0		48" STM							
16.	Horizontal side slope component, z (z horiz:1 vert)		3.0		---							
17.	Depth of flow, d	ft.	1.0		FULL							
18.	Cross sectional flow area, A (assume trapez.)	$ft.^2$	13.00		12.57				0.00		0.00	
19.	Wetted perimeter, P_w	ft.	16.32		12.57				0.00		0.00	
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.80		1.00				0.00		0.00	
21.	Channel slope, s	ft./ft.	0.0020		0.003							
22.	Manning's roughness coeff., n		0.035		0.012							
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	1.64		7.11				0.00		0.00	
24.	Flow length, L	ft.	800		2610							
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.136	+	0.102	+		+	0.000	+	0.000	= 0.238

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.89

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #5
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		BRUSH		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.350		
3.	Flow Length, L (< 300ft)	ft.	90		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.111		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.147	=	0.147

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D					
7.	Surface description		BRUSH	GRSS					
8.	Manning's roughness coeff., n		0.090	0.080					
9.	Paved or unpaved		UNPVD	UNPVD					
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.40					
11.	Flow Length, L	ft.	365	140					
12.	Watercourse slope, s	ft./ft.	0.004	0.009					
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.58	0.94					
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.176	+ 0.042	+	+	+	=	0.218

Channel flow

		Segment ID	D-E						
15.	Channel Bottom width, b	ft.	24" STM						
16.	Horizontal side slope component, z (z horiz:1 vert)		---						
17.	Depth of flow, d	ft.	FULL						
18.	Cross sectional flow area, A (assume trapez.)	$ft.^2$	3.14			0.00	0.00		
19.	Wetted perimeter, P_w	ft.	6.28			0.00	0.00		
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.50			0.00	0.00		
21.	Channel slope, s	ft./ft.	0.008						
22.	Manning's roughness coeff., n		0.012						
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	7.01			0.00	0.00		
24.	Flow length, L	ft.	355						
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.014	+	+	+ 0.000	+ 0.000	=	0.014
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)							hr.	0.378

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #7
Circle one: ***T_c*** T_t Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		WOOD		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400		
3.	Flow Length, L (< 300ft)	ft.	100		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.067		
6.	$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.218	=	0.218

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D	D-E				
7.	Surface description		WOOD	WOOD	BIT				
8.	Manning's roughness coeff., n		0.100	0.100	0.015				
9.	Paved or unpaved		UNPVD	UNPVD	PVD				
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.40	0.20				
11.	Flow Length, L	ft.	105	345	170				
12.	Watercourse slope, s	ft./ft.	0.067	0.260	0.010				
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.09	4.12	3.40				
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.014	+ 0.023	+ 0.014	+	+	=	0.051

Channel flow

		Segment ID	E-F	F-G	G-H	H-I	I-J		
15.	Channel Bottom width, b	ft.	12" STM	15" STM	18" STM	36" STM	48" STM		
16.	Horizontal side slope component, z (z horiz:1 vert)		---	---	---	---	---		
17.	Depth of flow, d	ft.	FULL	FULL	FULL	FULL	FULL		
18.	Cross sectional flow area, A (assume trapez.)	$ft.^2$	0.79	1.23	1.77	7.07	12.57		
19.	Wetted perimeter, P_w	ft.	3.14	3.93	4.71	9.42	12.57		
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25	0.31	0.38	0.75	1.00		
21.	Channel slope, s	ft./ft.	0.090	0.050	0.015	0.100	0.018		
22.	Manning's roughness coeff., n		0.012	0.012	0.012	0.012	0.012		
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	14.85	12.80	7.91	32.42	16.66		
24.	Flow length, L	ft.	380	435	735	965	1280		
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.007	+ 0.009	+ 0.026	+ 0.008	+ 0.021	=	0.051
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)							hr.	0.31

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Levee Certification Project (#1197-08) By: FAB Date: 11/19/10
Location: Derby / Ansonia - Connecticut Checked: Date:
Circle one: ***Present*** Developed Watershed: Drainage Area #8
Circle one: T_c T_t Subwatershed:

Sheet flow (applicable to T_c only)

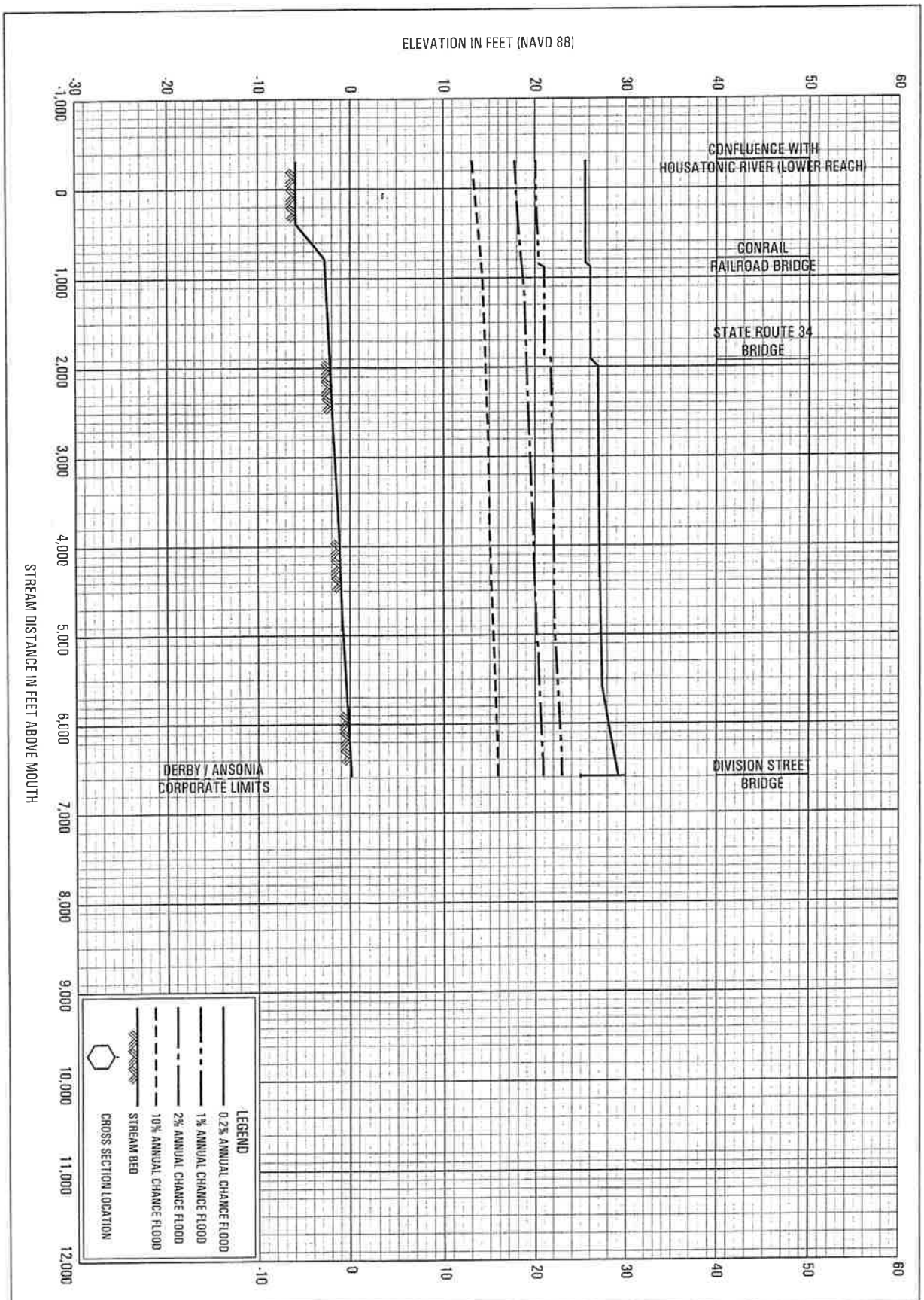
		Segment ID	A-B	
1.	Surface description (Table 3-1)		GRSS	
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3.	Flow Length, L (< 300ft)	ft.	100	
4.	Two-year 24-hr rainfall, P_2	in.	3.30	
5.	Land slope, s	ft./ft.	0.080	
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.161	= 0.161

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D	D-E			
7.	Surface description		GRSS	GRSS	BIT			
8.	Manning's roughness coeff., n		0.080	0.080	0.015			
9.	Paved or unpaved		UNPVD	UNPVD	PVD			
10.	Depth of flow, d (default: d=.4 unpaved, d=.2 pav	ft.	0.40	0.40	0.20			
11.	Flow Length, L	ft.	235	270	295			
12.	Watercourse slope, s	ft./ft.	0.070	0.010	0.010			
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.68	1.01	3.40			
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.024	+ 0.074	+ 0.024	+	+	= 0.123

Channel flow

		Segment ID	E-F	F-G	G-H	H-I		
15.	Channel Bottom width, b	ft.	15" STM	24" STM	65"X40"	54" STM		
16.	Horizontal side slope component, z (z horiz:1 vert)		---	---	---	---		
17.	Depth of flow, d	ft.	FULL	FULL	FULL	FULL		
18.	Cross sectional flow area, A (assume trapez.)	$ft.^2$	1.23	3.14	14.18	15.90		
19.	Wetted perimeter, P_w	ft.	3.93	6.28	13.94	14.14		
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.31	0.50	1.02	1.12		
21.	Channel slope, s	ft./ft.	0.010	0.100	0.010	0.010		
22.	Manning's roughness coeff., n		0.012	0.012	0.012	0.012		
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	5.72	24.74	12.56	13.43		
24.	Flow length, L	ft.	870	820	1185	310		
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.042	+ 0.009	+ 0.026	+ 0.006	+	= 0.084
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.						0.368



287P

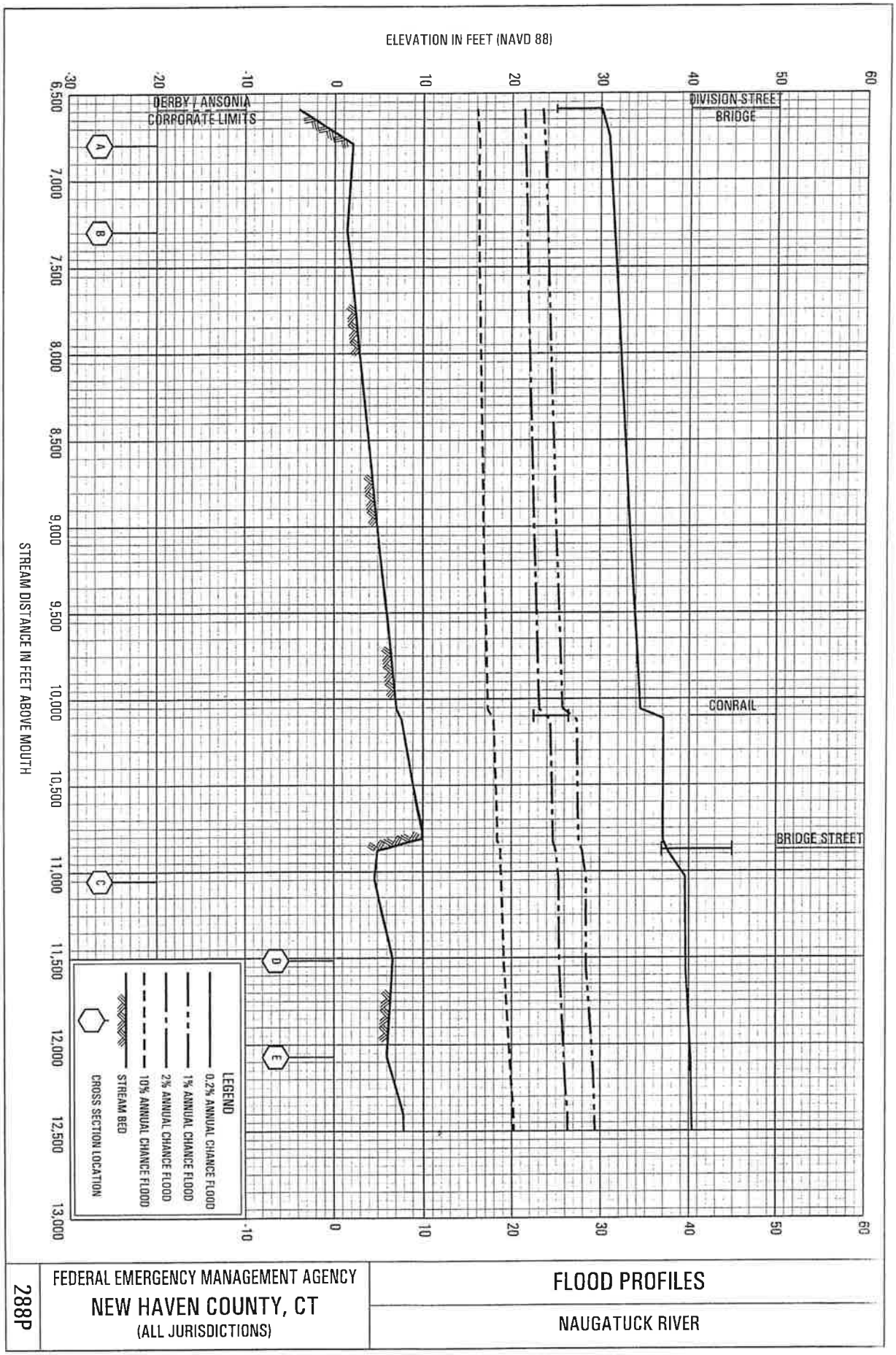
FEDERAL EMERGENCY MANAGEMENT AGENCY

NEW HAVEN COUNTY, CT

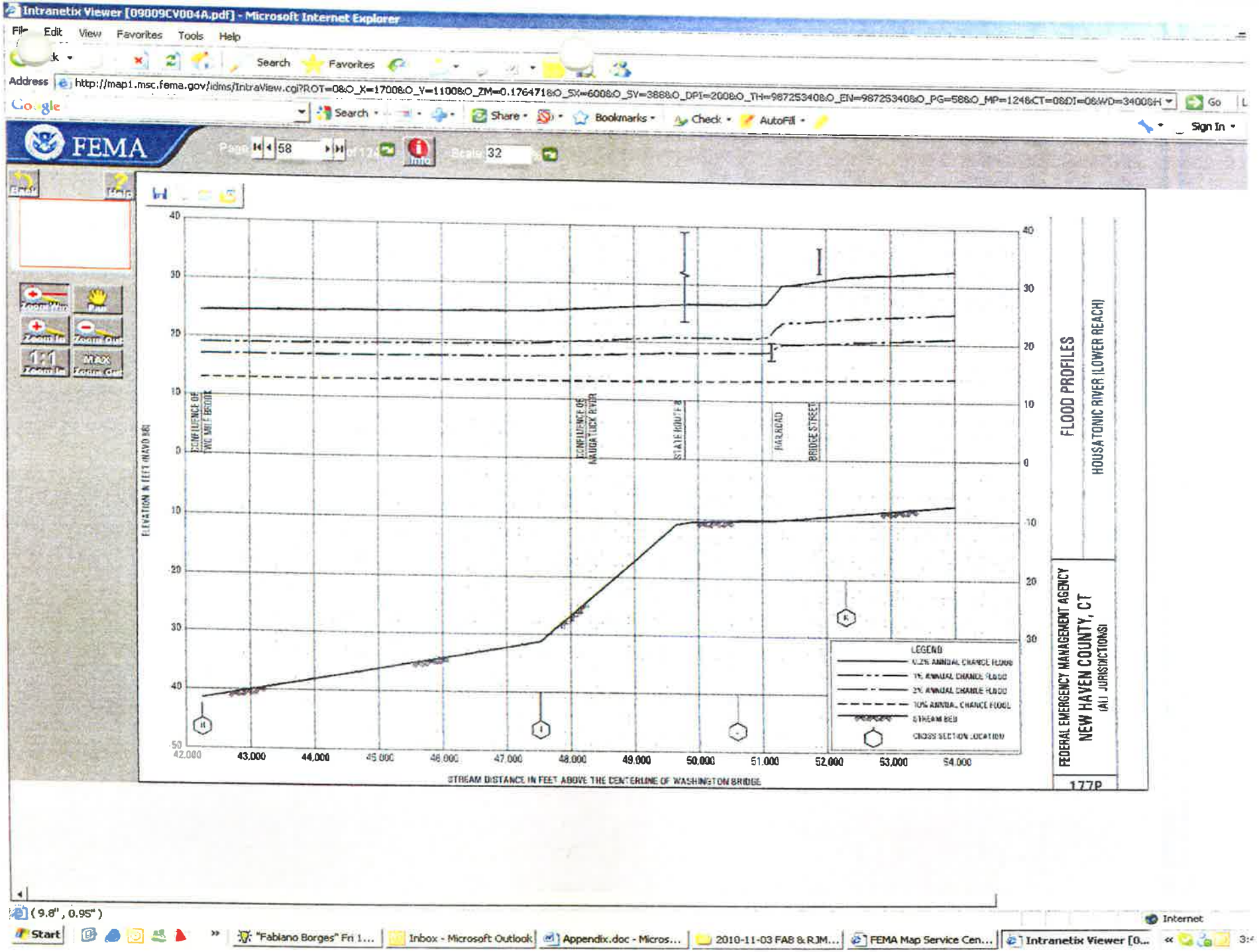
(ALL JURISDICTIONS)

FLOOD PROFILES

NAUGATUCK RIVER



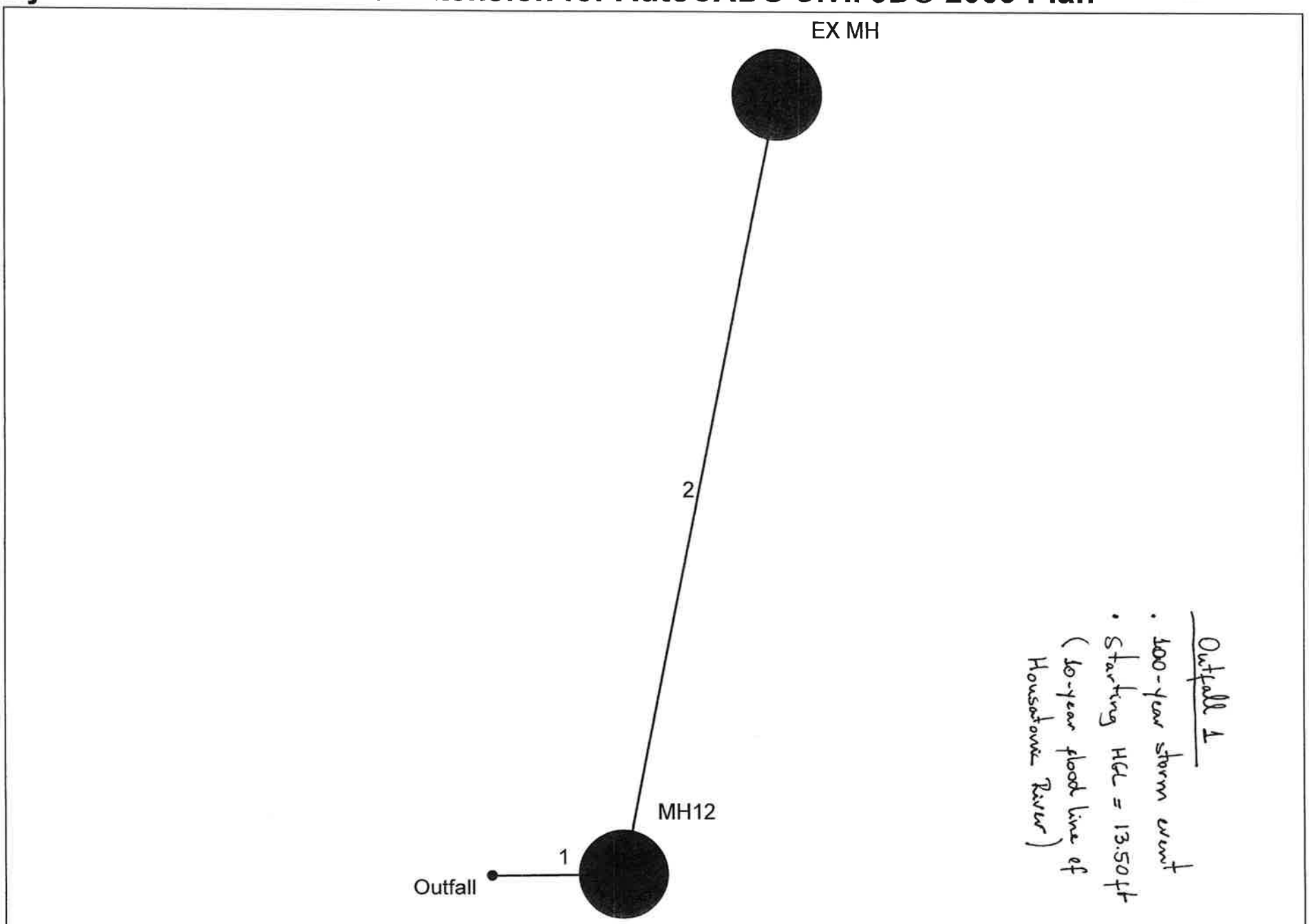
288P	FEDERAL EMERGENCY MANAGEMENT AGENCY NEW HAVEN COUNTY, CT (ALL JURISDICTIONS)	FLOOD PROFILES NAUGATUCK RIVER


Intranetix Viewer [09009CV004A.pdf] - Microsoft Internet Explorer
FEMA
Page 58 of 124
Scale 32
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE THE CENTERLINE OF WASHINGTON BRIDGE
42,000
43,000
44,000
45,000
46,000
47,000
48,000
49,000
50,000
51,000
52,000
53,000
54,000
CONFLUENCE OF TWO MILE BROOK
CONFLUENCE OF NAUGATUCK RIVER
STATE ROUTE 8
RAILROAD
BRIDGE STREET
LEGEND
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
HOUSATONIC RIVER (LOWER REACH)
FEDERAL EMERGENCY MANAGEMENT AGENCY
NEW HAVEN COUNTY, CT
(ALL JURISDICTIONS)
177P
(9.8", 0.95")
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2010-11-03 FAB & RJM...
FEMA Map Service Cen...
Intranetix Viewer [0...
Internet

Hydraulic Analysis

Outfall 1 (Drainage Area 1)

Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: Outfall 1 - 100-yr.stm	Number of lines: 2	Date: 11-29-2010

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line shape	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	6.00	-0.51	MH	0.00	0.00	0.00	0.0	8.00	1.00	8.06	36	Cir	0.013	0.98	24.00	OUT - MH12
2	1	36.00	-78.18	MH	141.40	0.00	0.00	0.0	8.06	1.22	8.50	36	Cir	0.013	1.00	35.60	MH12 - EXMH

Project File: Outfall 1 - 100-yr.stm | Number of lines: 2 | Date: 11-29-2010

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	6.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	141.4	66.69	20.01	36	1.00	8.00	8.06	13.50	13.77	11.00	24.00	OUT - MH12
2	1	36.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	141.4	73.73	20.01	36	1.22	8.06	8.50	19.87	21.49	24.00	35.60	MH12 - EXMH

Project File: Outfall 1 - 100-yr.stm

Number of lines: 2

Run Date: 11-29-2010

NOTES: Intensity = 106.59 / (Inlet time + 17.00) ^ 0.85; Return period = 100 Yrs. ; c = cir e = ellip b = box

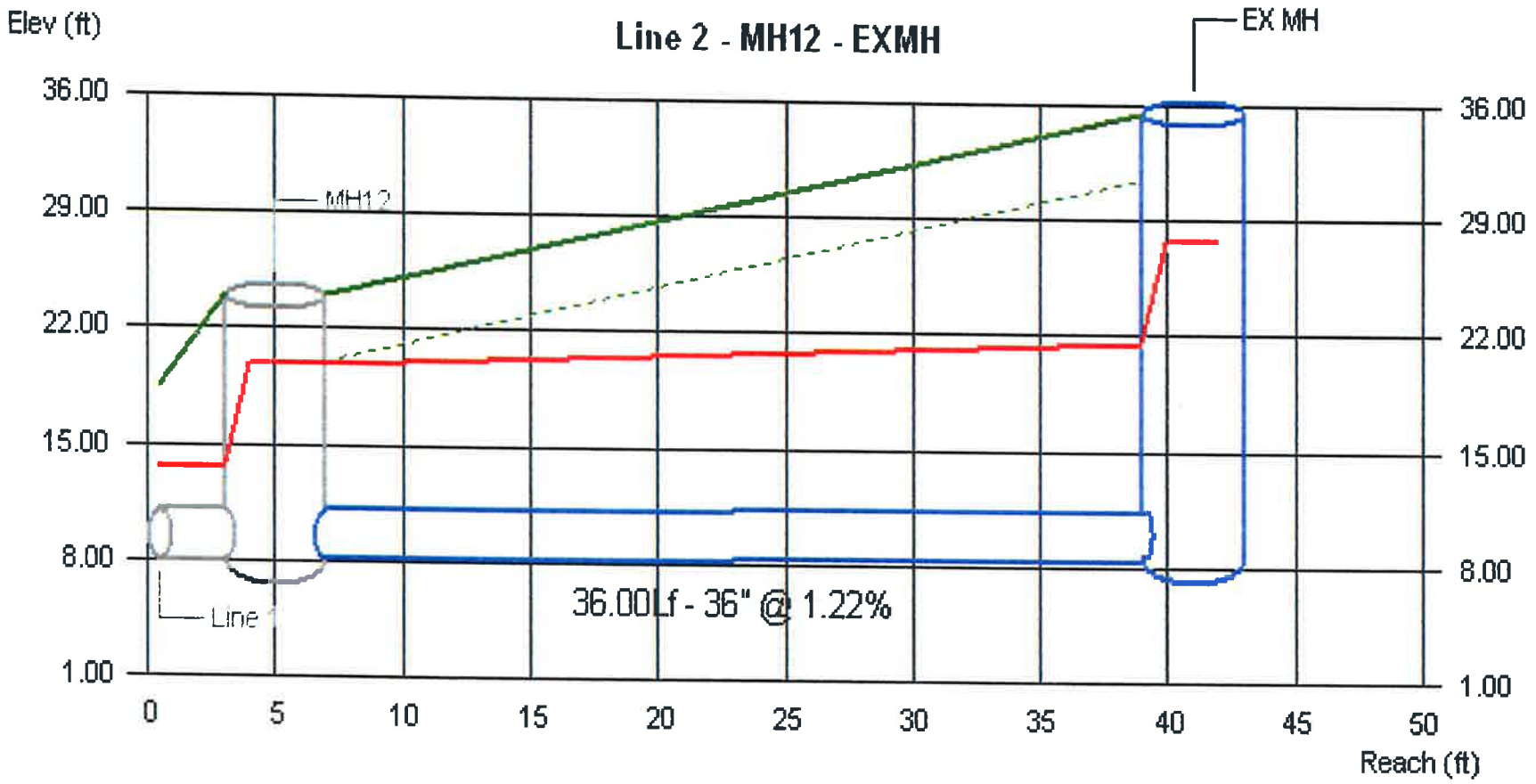
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	36	141.4	8.00	13.50	3.00	7.07	20.01	6.22	19.72	4.497	6.00	8.06	13.77	3.00	7.07	20.00	6.22	19.99	4.495	4.496	0.270	0.98	6.10
2	36	141.4	8.06	19.87	3.00	7.07	20.01	6.22	26.09	4.497	36.00	8.50	21.49	3.00	7.07	20.00	6.22	27.71	4.495	4.496	1.619	1.00	6.22

Project File: Outfall 1 - 100-yr.stm | Number of lines: 2 | Run Date: 11-29-2010

; c = cir e = ellip b = box

Line Profile (Line 2) - MH12 - EXMH



Line #	Q (cfs)	Invert Elevation		Depth of Flow			Hydraulic Grade Line			Velocity		Cover	
		Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Hw (ft)	Dn (ft)	Up (ft)	Jnct (ft)	Dn (ft/s)	Up (ft/s)	Dn (ft)	Up (ft)
2	141.40	8.06	8.50	3.00	3.00	19.21	19.87	21.49	27.71	20.01	20.00	12.94	24.10

Project File: | No. Lines: 2 | Run Date: 11-29-2010

Hydraulic Analysis

Outfall 2 (Drainage Areas 2+3+4+5)

Manning Pipe Calculator

Given Input Data:

Shape	Rectangular
Solving for	Flowrate
Height	72.0000 in
Width	96.0000 in
Depth	71.9999 in
Slope	0.0031 ft/ft
Manning's n	0.0130

Computed Results:

Flowrate	547.6095 cfs
Area	48.0000 ft2
Wetted Area	47.9999 ft2
Wetted Perimeter	239.9998 in
Perimeter	336.0000 in
Velocity	11.4085 fps
Hydraulic Radius	28.8000 in
Percent Full	99.9999 %
Full flow Flowrate	437.5755 cfs
Full flow velocity	9.1162 fps

- Maximum flow capacity of 8' x 6' gravity outlet flowing full: ± 548 cfs
- 100-year storm runoff = 475.9 cfs (Outfall 2)

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	42.0000 in
Flowrate	84.2000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0130

Computed Results:

Depth	29.3908 in
Area	9.6211 ft2
Wetted Area	7.1911 ft2
Wetted Perimeter	83.2372 in
Perimeter	131.9469 in
Velocity	11.7089 fps
Hydraulic Radius	12.4406 in
Percent Full	69.9782 %
Full flow Flowrate	100.6098 cfs
Full flow velocity	10.4572 fps

- Drainage Area 2 - 100-yr storm runoff = 84.2 cfs
- Depth of flow within 42" RCP @ 100-yr storm flow:

  29.39 in //
- The 42" RCP can convey the 100-yr storm runoff

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	42.0000 in
Flowrate	106.5000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0130

Computed Results:

Depth	37.2447 in
Area	9.6211 ft2
Wetted Area	9.0205 ft2
Wetted Perimeter	103.1199 in
Perimeter	131.9469 in
Velocity	11.8065 fps
Hydraulic Radius	12.5965 in
Percent Full	88.6780 %
Full flow Flowrate	100.6098 cfs
Full flow velocity	10.4572 fps

- Drainage Area 3

10-yr storm runoff = 106.5 cfs

- Depth of flow within 42" RCP @ 10-yr storm:

37.24 in //

- The pipe can carry the 10-year storm runoff

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Flowrate
Diameter	48.0000 in
Depth	48.0000 in
Slope	0.0050 ft/ft
Manning's n	0.0130

Computed Results:

Flowrate	101.5711 cfs
Area	12.5664 ft2
Wetted Area	12.5664 ft2
Wetted Perimeter	150.7964 in
Perimeter	150.7964 in
Velocity	8.0828 fps
Hydraulic Radius	12.0000 in
Percent Full	100.0000 %
Full flow Flowrate	101.5711 cfs
Full flow velocity	8.0828 fps

- Drainage Area 4:

  - Capacity of 48" RCP ≈ 102 cfs
  - 10-yr flow = 155 cfs
  - 100-yr flow = 233 cfs

▶ Area 4 is susceptible for temporary street flooding

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Flowrate
Diameter	24.0000 in
Depth	23.9000 in
Slope	0.0080 ft/ft
Manning's n	0.0130

Computed Results:

Flowrate	20.7927 cfs
Area	3.1416 ft2
Wetted Area	3.1402 ft2
Wetted Perimeter	72.2977 in
Perimeter	75.3982 in
Velocity	6.6215 fps
Hydraulic Radius	6.2545 in
Percent Full	99.5833 %
Full flow Flowrate	20.2341 cfs
Full flow velocity	6.4407 fps

- Drainage Area 5

10-year storm runoff = 7.9 cfs

100-year storm runoff = 11.2 cfs

▶ - Capacity of 24" RCP > 21 cfs with the system surcharged

Hydraulic Analysis

Outfall 3 (Drainage Area 6)

Worksheet 2: Runoff curve number and runoff

Project: Access Drive for Commerce Park | By: FAB | Date: 12/10/10
Location: DOT Parcel - Derby, CT (1560-33-7) | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.] Table 2-2	Figure 2-3	Figure 2-4	Area Acres Sq. Ft. %	Product of CN x Area
A soil	Woods - good condition	30			2.32	69.65
A soil	Lawn/open space - good condition	39			10.38	404.87
A soil	Dirt Trail	72			0.93	66.73
A soil	Gravel	76			0.65	49.68
N/A	Existing building	98			0.35	34.05
N/A	Existing paved / impervious	98			3.35	327.91
N/A	Surface Water	98			0.54	52.79
Totals =					18.52	1005.67
					(0.02893	sq mi)

[1.] Use only one CN value source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1005.67}{18.52}$ Use CN = 54

Worksheet 2: Runoff curve number and runoff

Project: Access Drive for Commerce Park | By: FAB | Date: 12/10/10
Location: DOT Parcel - Derby, CT (1560-33-7) | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 20 - Existing Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.] Table 2-2	Figure 2-3	Figure 2-4	Area (Acres / Sq. Ft. / %)	Product of CN x Area
A soil	Woods - good condition	30			3.85	115.39
A soil	Lawn/open space - good condition	39			7.01	273.20
A soil	Dirt Trail	72			0.79	56.99
A soil	Gravel	76			0.50	38.34
A soil	Bare Soil	77			2.16	166.06
N/A	Existing paved / impervious	98			0.51	49.68
N/A	Surface Water	98			0.12	12.23
Totals =					14.94	711.89
					(0.02334	sq mi)

[1.] Use only one CN value source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{711.89}{14.94}$ Use CN = **48**

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Access Drive for Commerce Park | By: FAB | Date: 12/10/10
Location: DOT Parcel - Derby, CT (1560-33-7) | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		GRSS		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3.	Flow Length, L (< 300ft)	ft.	80.0		
4.	Two-year 24-hr rainfall, P_2	in.	3.30		
5.	Land slope, s	ft./ft.	0.070		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.142	=	0.142

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D	D-E			
7.	Surface description		GRSS	DIRT	FRST			
8.	Manning's roughness coeff., n		0.080	0.030	0.100			
9.	Paved or unpaved		UNPVD	UNPVD	UNPVD			
10.	Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40	0.40			
11.	Flow Length, L	ft.	125.0	340.0	255.0			
12.	Watercourse slope, s	ft./ft.	0.054	0.018	0.005			
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.34	3.58	0.57	0.00		
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.015	+ 0.026	+ 0.124	+ 0.000	=	0.165

Channel flow

		Segment ID						
15.	Channel Bottom width, b	ft.						
16.	Horizontal side slope component, z (z horiz:1 vert)	ft.						
17.	Depth of flow, d	ft.						
18.	Cross sectional flow area, A (assume trapazoidal)	$ft.^2$			0.00	0.00		
19.	Wetted perimeter, P_w	ft.			0.00	0.00		
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.			0.00	0.00		
21.	Channel slope, s	ft./ft.						
22.	Manning's roughness coeff., n							
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.			0.00	0.00		
24.	Flow length, L	ft.						
25.	$T_t = \frac{L}{3600 * V}$	hr.		+	+ 0.000	+ 0.000	=	0.000
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)						hr.	0.307

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Access Drive for Commerce Park | By: FAB | Date: 12/10/10
Location: DOT Parcel - Derby, CT (1560-33-7) | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 20 - Existing Conditions
Circle one: ***Tc*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B	
1. Surface description (Table 3-1)			GRSS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)			0.300	
3. Flow Length, L (< 300ft)		ft.	25.0	
4. Two-year 24-hr rainfall, P_2		in.	3.30	
5. Land slope, s		ft./ft.	0.010	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$		hr.	0.122	= 0.122

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D	D-E		
7. Surface description			GRSS	GRSS	DIRT		
8. Manning's roughness coeff., n			0.080	0.080	0.030		
9. Paved or unpaved			UNPVD	UNPVD	UNPVD		
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.		0.40	0.40	0.40		
11. Flow Length, L		ft.	70.0	80.0	75.0		
12. Watercourse slope, s		ft./ft.	0.010	0.025	0.080		
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$		fps.	1.01	1.60	7.63		
14. $T_t = \frac{L}{3600 * V}$		hr.	0.019	+ 0.014	+ 0.003	+	= 0.036

Channel flow

		Segment ID					
15. Channel Bottom width, b		ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.						
17. Depth of flow, d		ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$				0.00	0.00	
19. Wetted perimeter, P_w		ft.			0.00	0.00	
20. Hydraulic Radius, $R = \frac{A}{P_w}$		ft.			0.00	0.00	
21. Channel slope, s		ft./ft.					
22. Manning's roughness coeff., n							
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$		fps.			0.00	0.00	
24. Flow length, L		ft.					
25. $T_t = \frac{L}{3600 * V}$		hr.		+	+ 0.000	+ 0.000	= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)						hr.	0.15

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Dec 10, 2010

Pond No. 1 - RSVR 100

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 3.30 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	3.30	00	0.000	0.000
0.70	4.00	32,206	0.172	0.172
1.70	5.00	48,143	0.916	1.089
2.70	6.00	64,079	1.284	2.372
3.70	7.00	123,889	2.120	4.492
4.70	8.00	183,698	3.508	8.000

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) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

Stage ft	Storage acft	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	0.000	3.30	---	---	---	---	---	---	---	---	---	---	0.000
0.70	0.172	4.00	---	---	---	---	---	---	---	---	---	1.310	1.310
1.70	1.089	5.00	---	---	---	---	---	---	---	---	---	3.530	3.530
2.70	2.372	6.00	---	---	---	---	---	---	---	---	---	5.740	5.740
3.70	4.492	7.00	---	---	---	---	---	---	---	---	---	14.05	14.05
4.70	8.000	8.00	---	---	---	---	---	---	---	---	---	22.35	22.35

Exfiltrated Flows

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Dec 10, 2010

Pond No. 2 - RSVR 200

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 4.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	4.00	5,695	0.000	0.000
1.00	5.00	26,147	0.337	0.337
2.00	6.00	109,884	1.451	1.788
3.00	7.00	202,753	3.534	5.322
4.00	8.00	250,496	5.192	10.515

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)	= 50.00	0.00	0.00	0.00
Crest El. (ft)	= 8.00	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 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 acft	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	0.000	4.00	---	---	---	---	0.00	---	---	---	---	---	0.000
1.00	0.337	5.00	---	---	---	---	0.00	---	---	---	---	2.870	2.870
2.00	1.788	6.00	---	---	---	---	0.00	---	---	---	---	14.50	14.50
3.00	5.322	7.00	---	---	---	---	0.00	---	---	---	---	27.40	27.40
4.00	10.515	8.00	---	---	---	---	0.00	---	---	---	---	34.03	34.03

Exfiltrated Flows

Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax (203) 272-9733

JOB Derby / Ansonia Levee Certification
SHEET NO. 1 OF 1
CALCULATED BY FAB DATE 12/9/10
CHECKED BY EAH DATE 12/9/10
SCALE Exfiltration Outflows

- Exfiltration outflow:

$$Q_{ex} = \left(\frac{ER \times SA}{12 \times 3,600}\right), \text{ where: } Q_{ex} = \text{Outflow (cfs)}$$
$$ER = \text{Exfiltration rate (in/hr)}$$
$$SA = \text{Surface area of infiltration (ft}^2\text{)}$$

- Area not used for exfiltration – existing water impoundments on site

WS 10 – ± 22,750 ft²
WS 20 – ± 5,500 ft²

- Exfiltration rate:

  - from New Haven Soil Survey:

    HME (Hinckley soils): permeability = 6-20 in/hr

  - Used 6.0 in/hr ◄

- Exfiltration outflow based on contour areas:

- RSVR 100 (WS 10):

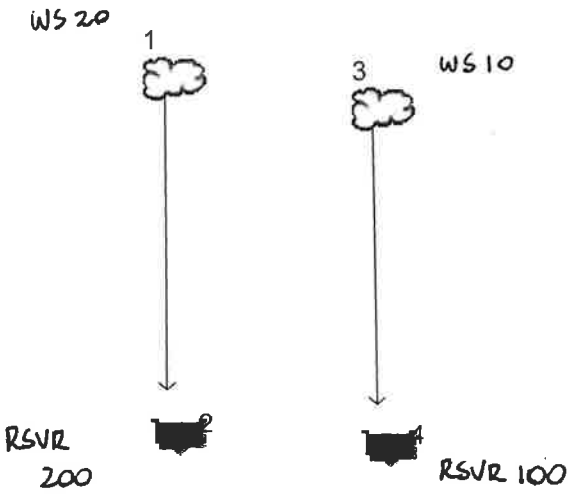
Elev (ft)	Q_{ex} (cfs)
3.3	0
4.0	1.31
5.0	3.53
6.0	5.74
7.0	14.05
8.0	22.35

- RSVR 200 (WS 20):

Elev (ft)	Q_{ex} (cfs)
4.0	0
5.0	2.87
6.0	14.50
7.0	24.40
8.0	34.03

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066



Legend

Hyd.	Origin	Description
1	SCS Runoff	WS 20
2	Reservoir	RSVR 200
3	SCS Runoff	WS 10
4	Reservoir	RSVR 100

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Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	------	-------	0.208	-------	-------	4.844	8.408	13.20	19.77	WS 20
2	Reservoir	1	-------	0.173	-------	-------	1.283	2.008	3.027	4.358	RSVR 200
3	SCS Runoff	------	-------	1.738	-------	-------	11.24	15.98	22.27	30.05	WS 10
4	Reservoir	3	-------	0.608	-------	-------	2.067	2.620	3.344	4.078	RSVR 100

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

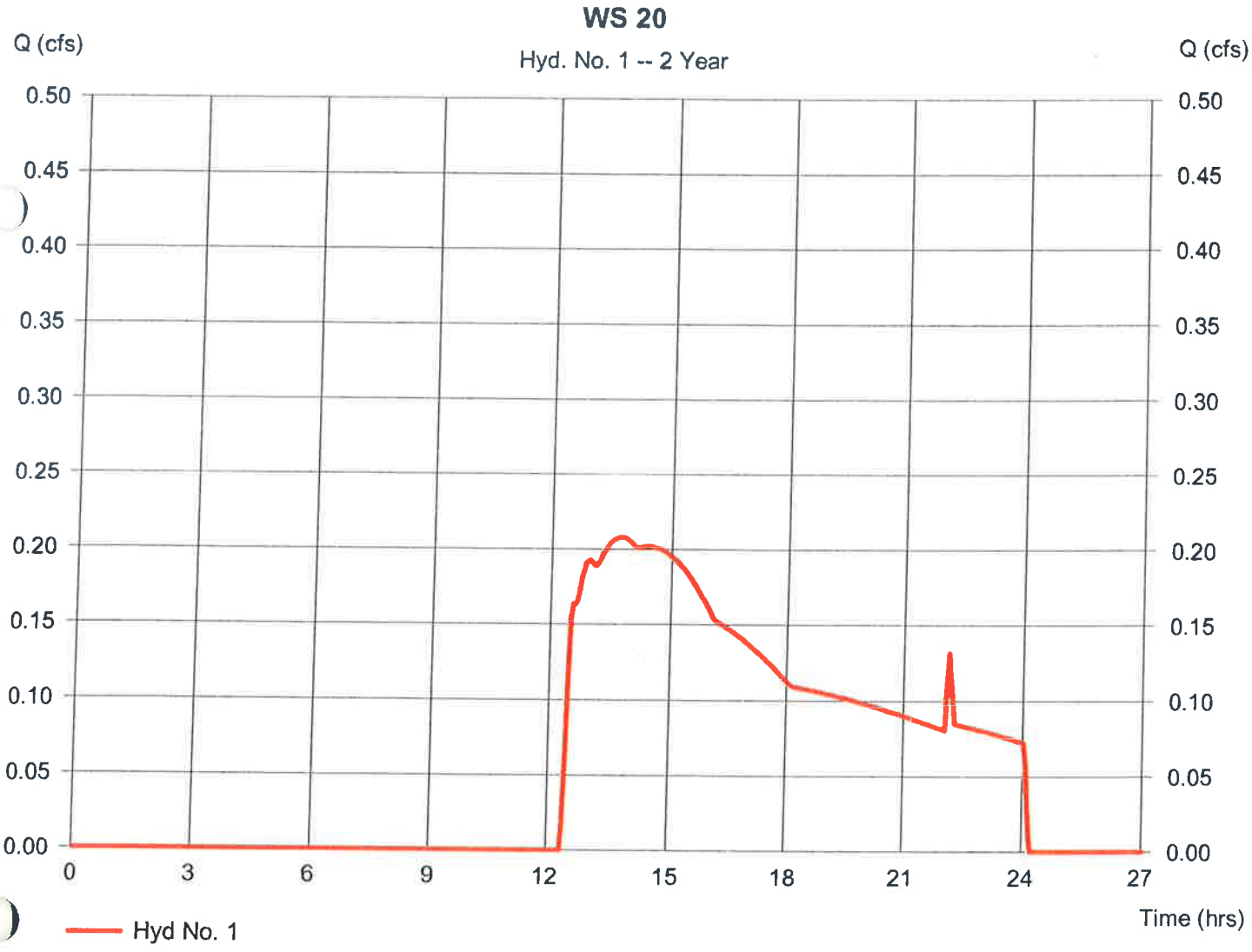
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph description
1	SCS Runoff	0.208	3	822	0.125	------	------	------	WS 20
2	Reservoir	0.173	3	939	0.125	1	4.06	0.020	RSVR 200
3	SCS Runoff	1.738	3	750	0.400	------	------	------	WS 10
4	Reservoir	0.608	3	855	0.400	3	3.62	0.080	RSVR 100

Hydrograph Report

Hyd. No. 1

WS 20

Hydrograph type	= SCS Runoff	Peak discharge	= 0.208 cfs
Storm frequency	= 2 yrs	Time to peak	= 13.70 hrs
Time interval	= 3 min	Hyd. volume	= 0.125 acft
Drainage area	= 14.940 ac	Curve number	= 48
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 9.50 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

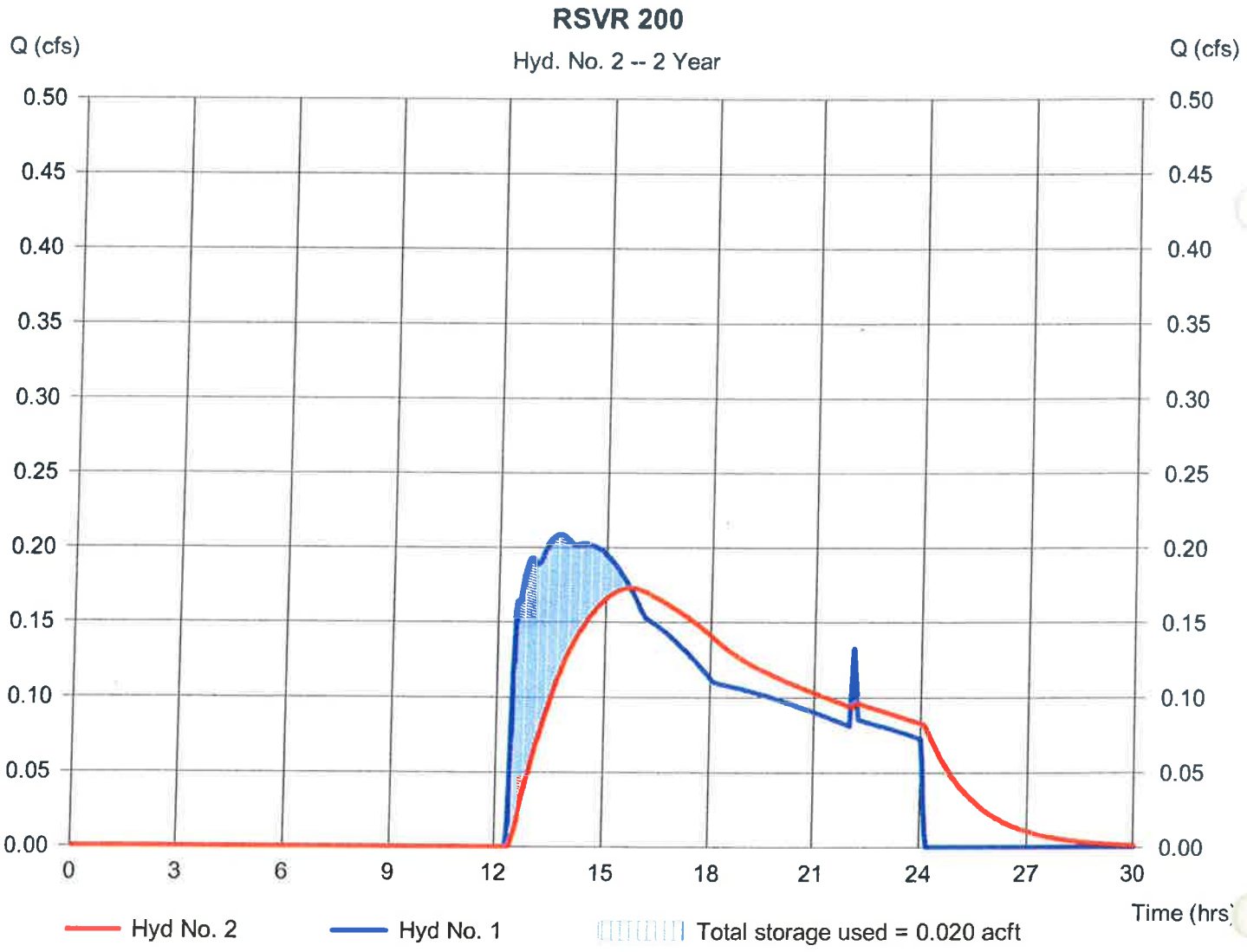
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Friday, Dec 10, 2010

Hyd. No. 2

RSVR 200

Hydrograph type	= Reservoir	Peak discharge	= 0.173 cfs
Storm frequency	= 2 yrs	Time to peak	= 15.65 hrs
Time interval	= 3 min	Hyd. volume	= 0.125 acft
Inflow hyd. No.	= 1 - WS 20	Max. Elevation	= 4.06 ft
Reservoir name	= RSVR 200	Max. Storage	= 0.020 acft

Storage Indication method used.

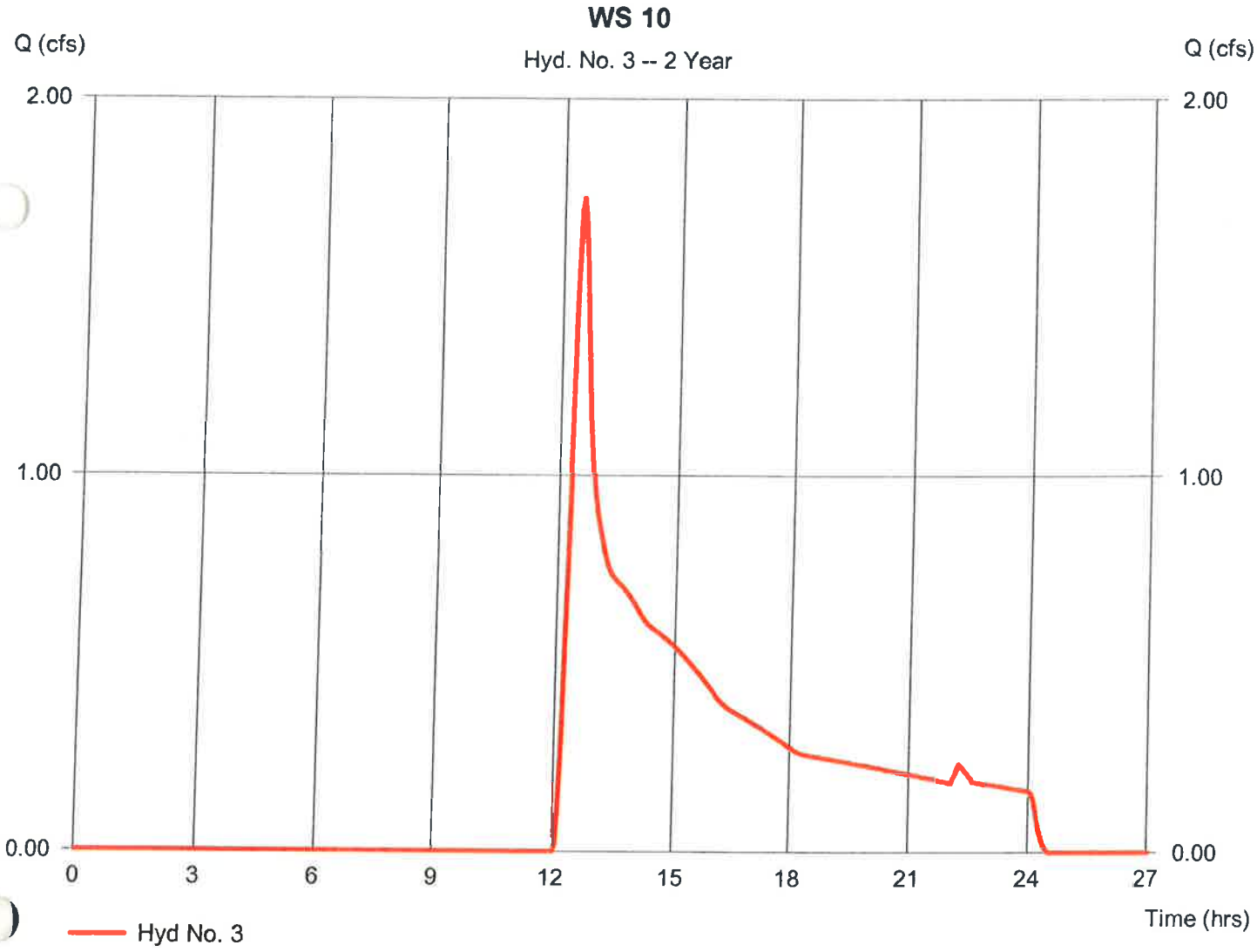


Hydrograph Report

Hyd. No. 3

WS 10

Hydrograph type	= SCS Runoff	Peak discharge	= 1.738 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.50 hrs
Time interval	= 3 min	Hyd. volume	= 0.400 acft
Drainage area	= 18.520 ac	Curve number	= 54
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 18.40 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

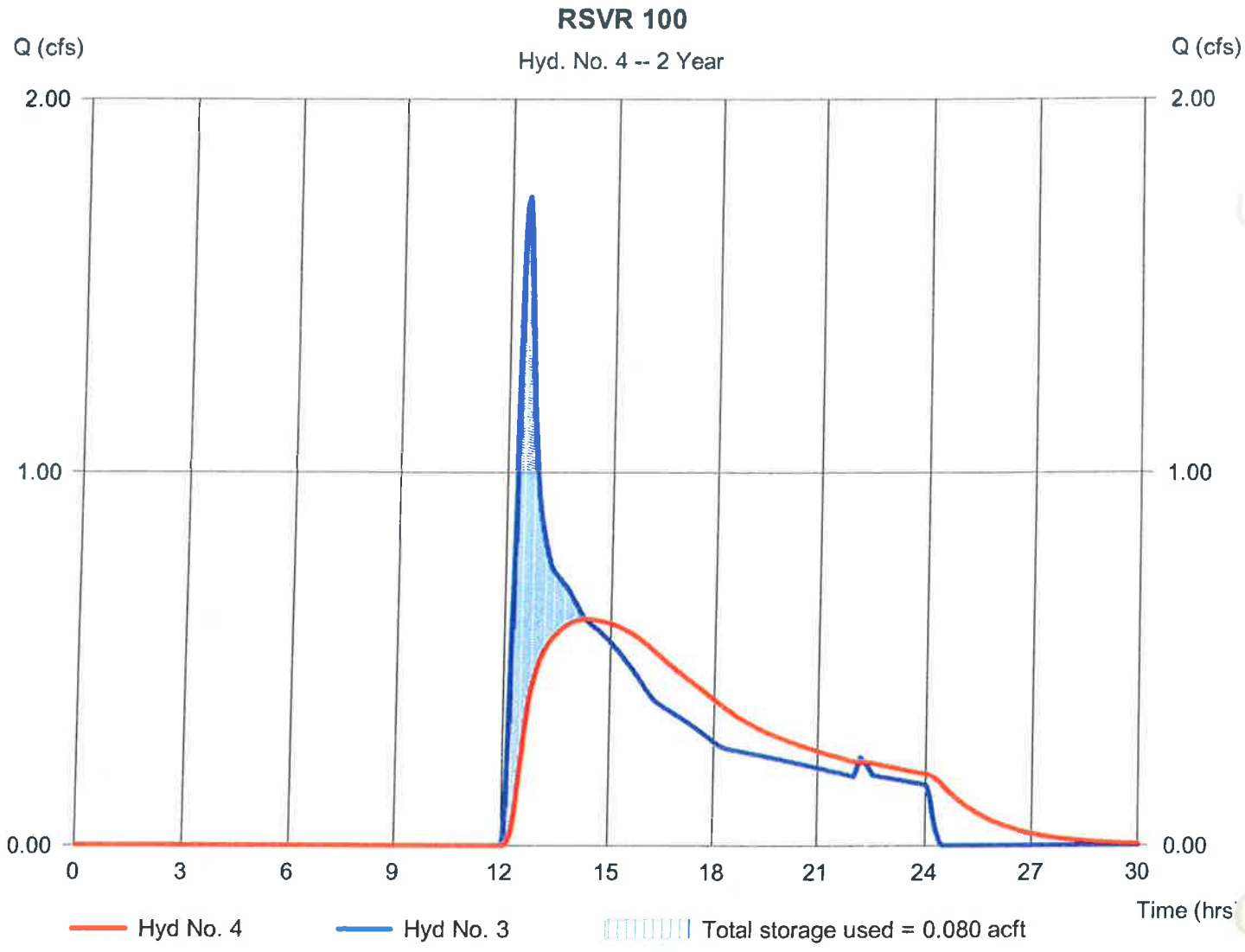
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Friday, Dec 10, 2010

Hyd. No. 4

RSVR 100

Hydrograph type	= Reservoir	Peak discharge	= 0.608 cfs
Storm frequency	= 2 yrs	Time to peak	= 14.25 hrs
Time interval	= 3 min	Hyd. volume	= 0.400 acft
Inflow hyd. No.	= 3 - WS 10	Max. Elevation	= 3.62 ft
Reservoir name	= RSVR 100	Max. Storage	= 0.080 acft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

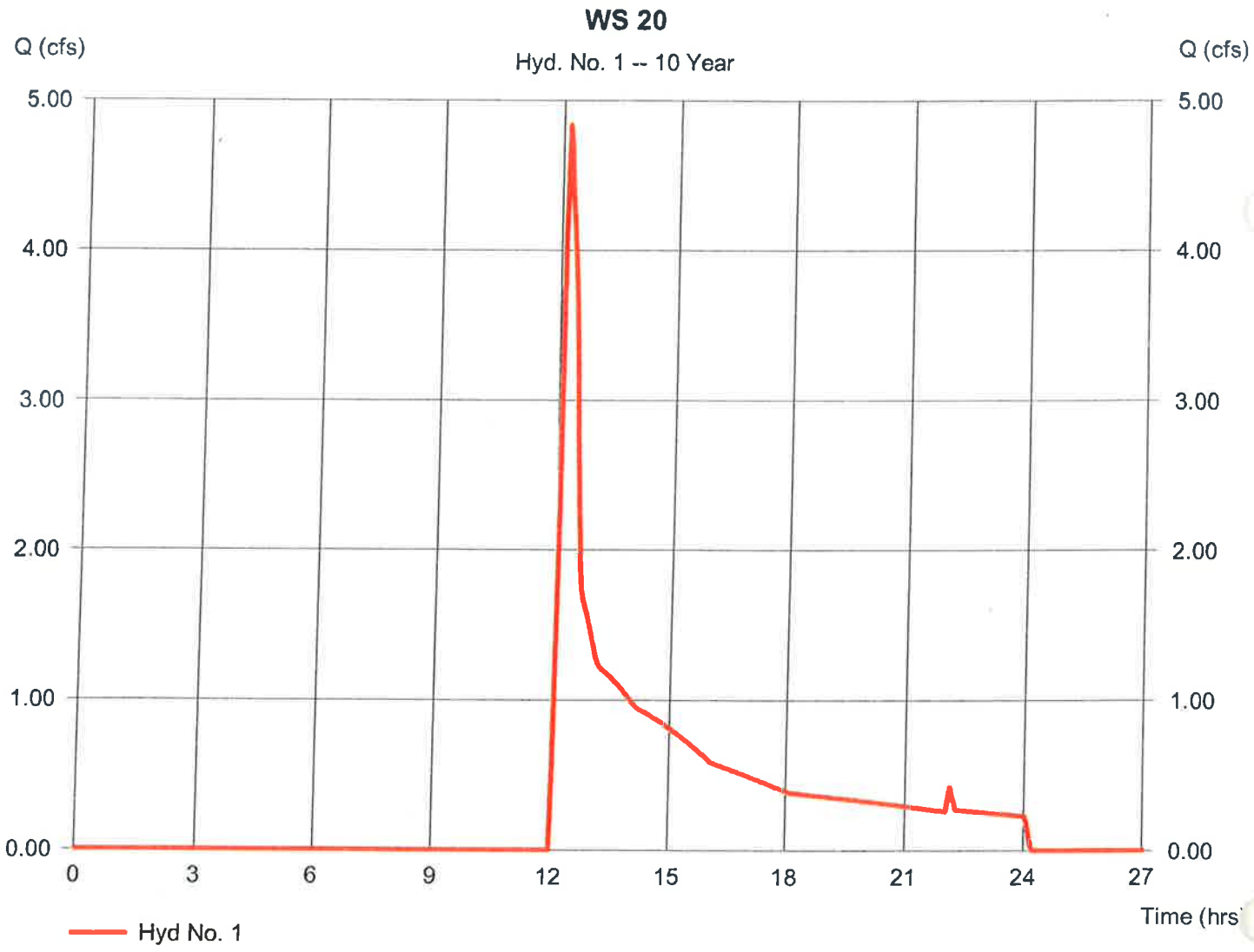
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph description
1	SCS Runoff	4.844	3	729	0.685	------	------	------	WS 20
2	Reservoir	1.283	3	783	0.685	1	4.45	0.151	RSVR 200
3	SCS Runoff	11.24	3	738	1.464	------	------	------	WS 10
4	Reservoir	2.067	3	834	1.464	3	4.34	0.485	RSVR 100

Hydrograph Report

Hyd. No. 1

WS 20

Hydrograph type	= SCS Runoff	Peak discharge	= 4.844 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.15 hrs
Time interval	= 3 min	Hyd. volume	= 0.685 acft
Drainage area	= 14.940 ac	Curve number	= 48
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 9.50 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



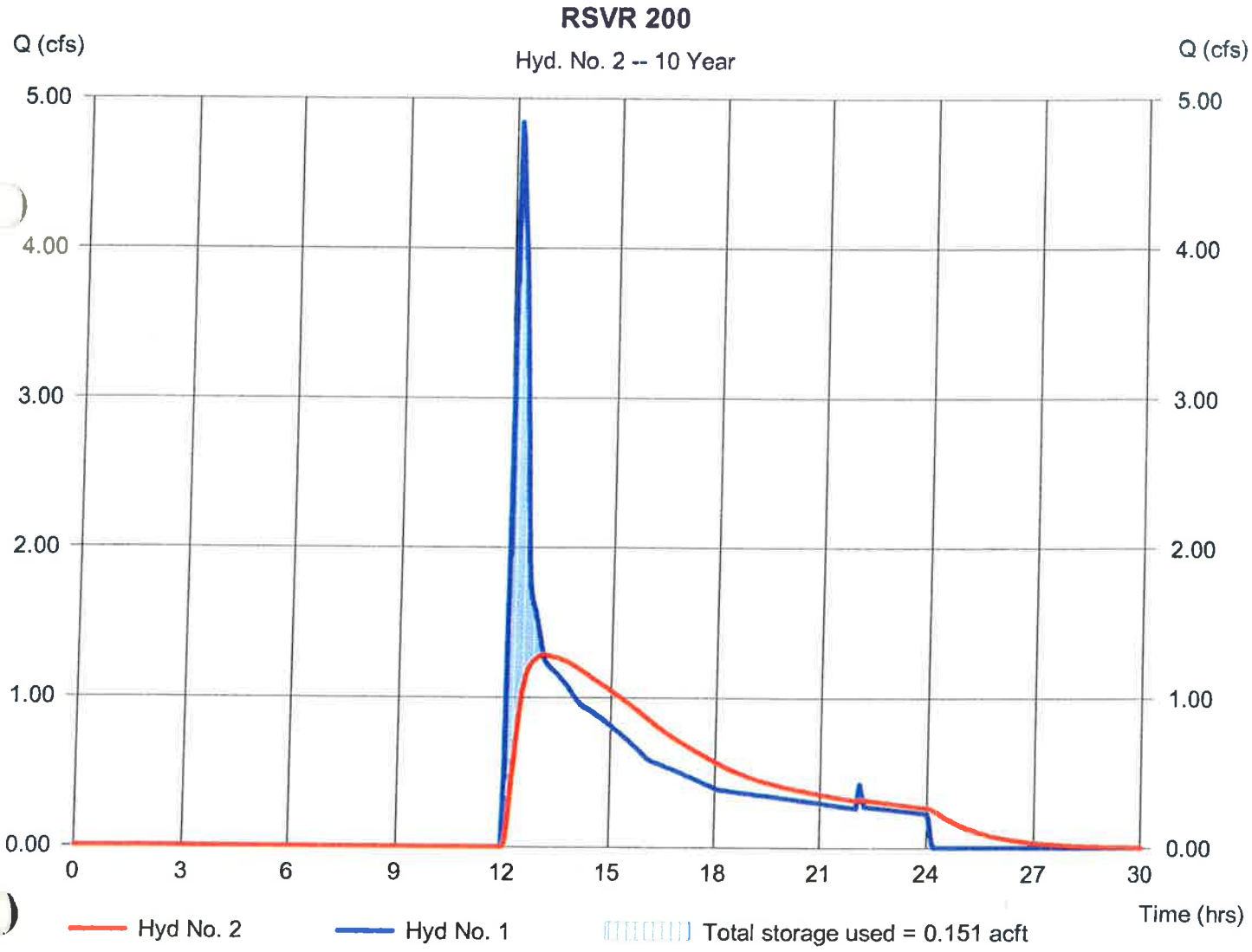
Hydrograph Report

Hyd. No. 2

RSVR 200

Hydrograph type	= Reservoir	Peak discharge	= 1.283 cfs
Storm frequency	= 10 yrs	Time to peak	= 13.05 hrs
Time interval	= 3 min	Hyd. volume	= 0.685 acft
Inflow hyd. No.	= 1 - WS 20	Max. Elevation	= 4.45 ft
Reservoir name	= RSVR 200	Max. Storage	= 0.151 acft

Storage Indication method used.

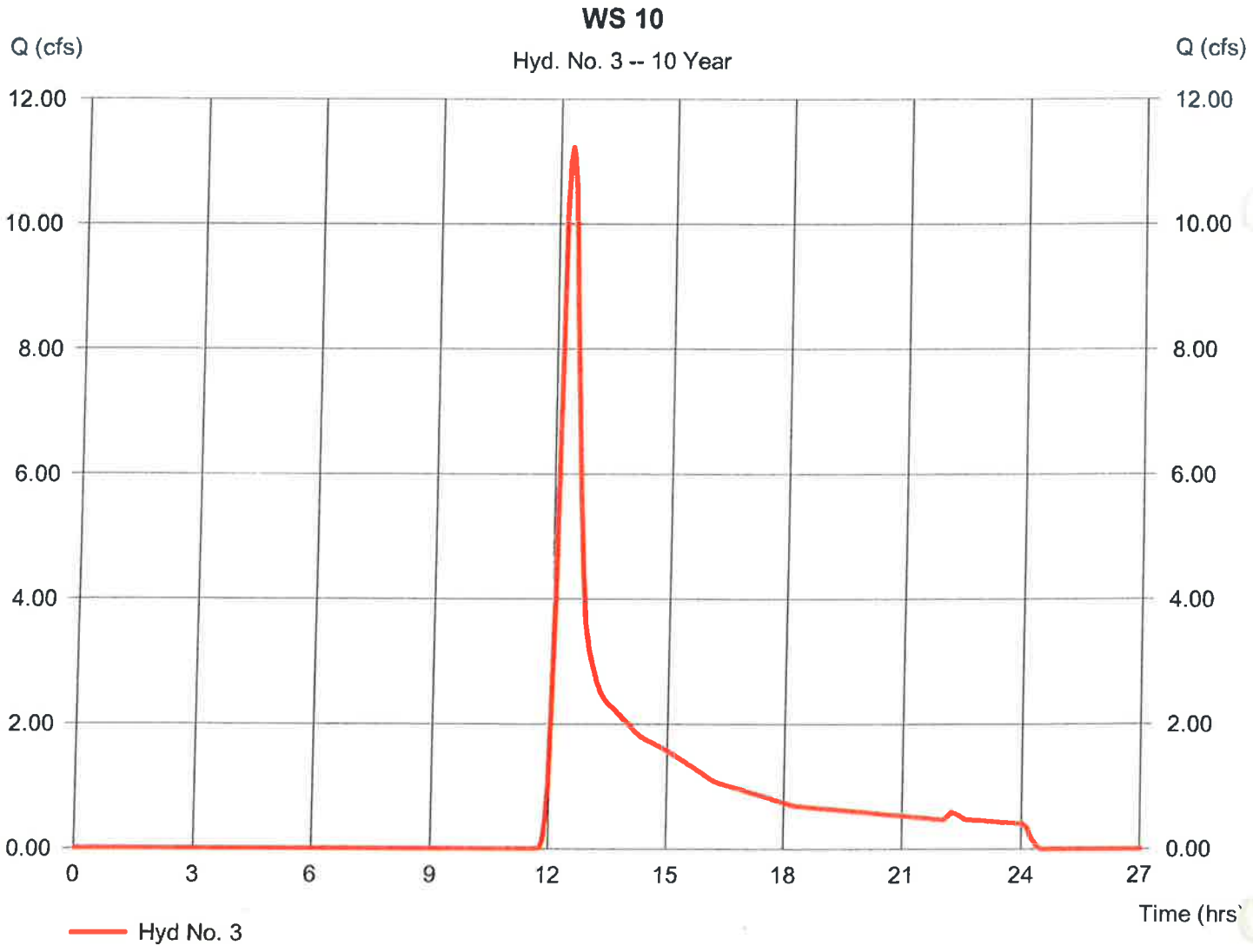


Hydrograph Report

Hyd. No. 3

WS 10

Hydrograph type	= SCS Runoff	Peak discharge	= 11.24 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.30 hrs
Time interval	= 3 min	Hyd. volume	= 1.464 acft
Drainage area	= 18.520 ac	Curve number	= 54
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 18.40 min
Total precip.	= 5.00 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



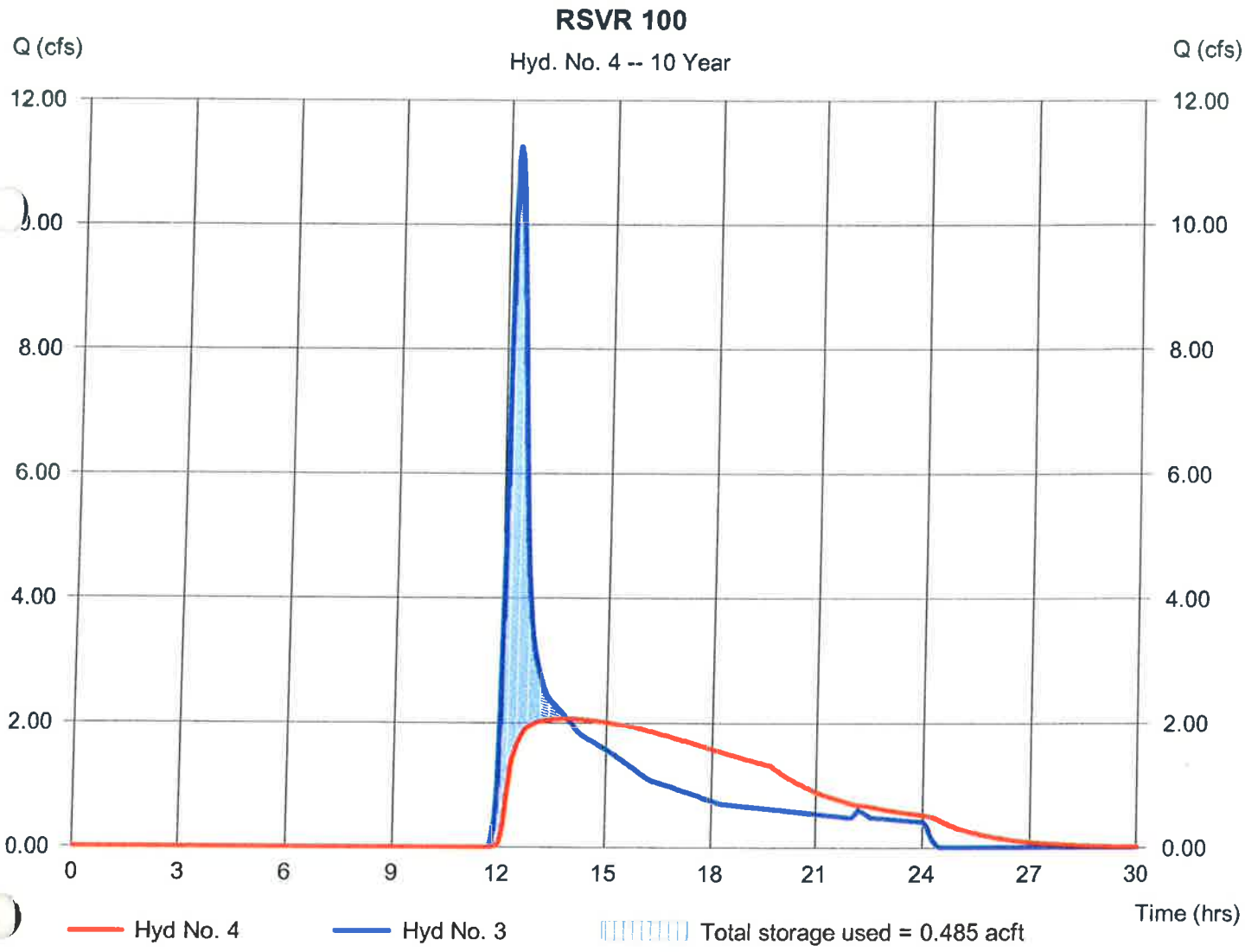
Hydrograph Report

Hyd. No. 4

RSVR 100

Hydrograph type	= Reservoir	Peak discharge	= 2.067 cfs
Storm frequency	= 10 yrs	Time to peak	= 13.90 hrs
Time interval	= 3 min	Hyd. volume	= 1.464 acft
Inflow hyd. No.	= 3 - WS 10	Max. Elevation	= 4.34 ft
Reservoir name	= RSVR 100	Max. Storage	= 0.485 acft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

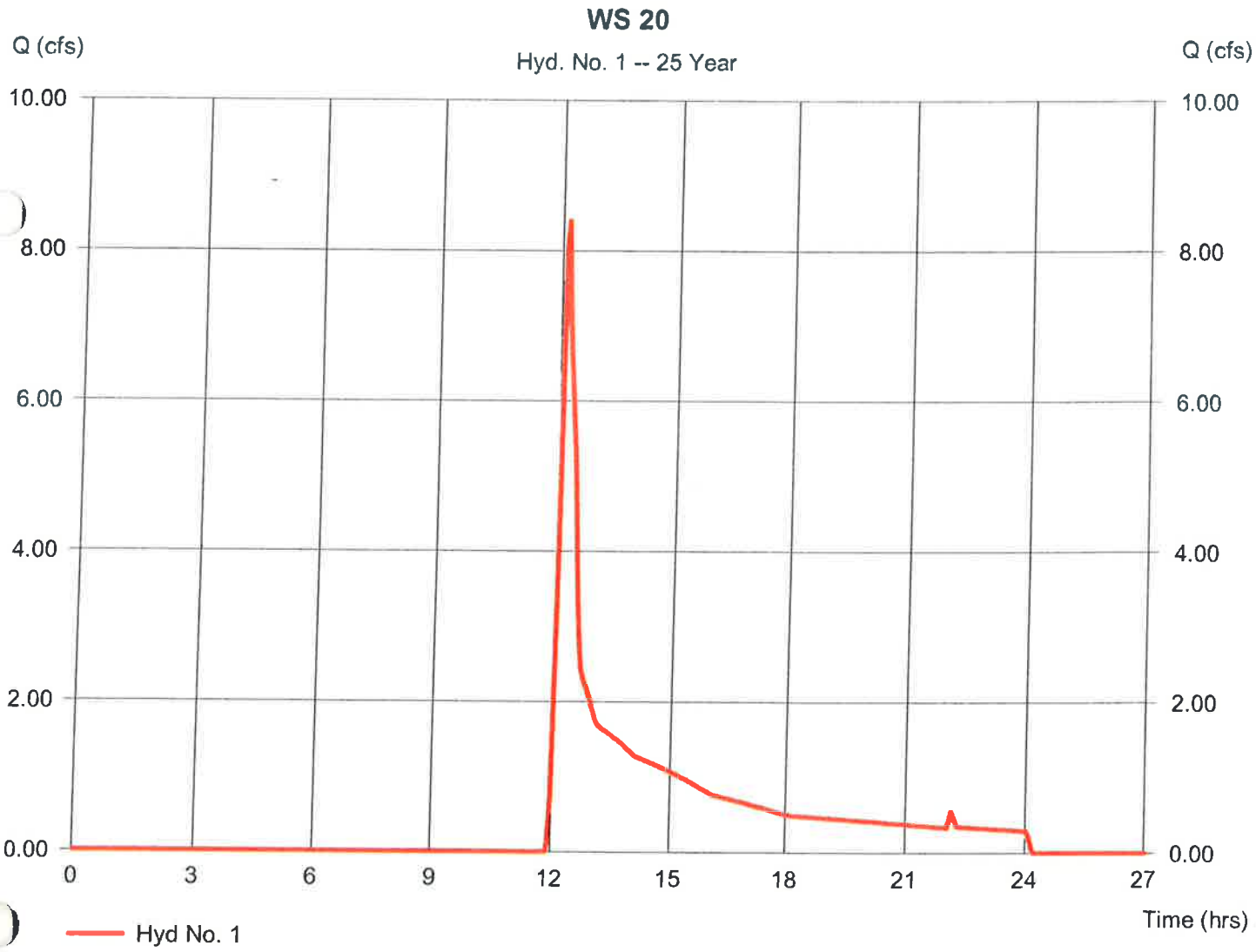
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph description
1	SCS Runoff	8.408	3	729	0.964	------	------	------	WS 20
2	Reservoir	2.008	3	774	0.964	1	4.70	0.236	RSVR 200
3	SCS Runoff	15.98	3	738	1.946	------	------	------	WS 10
4	Reservoir	2.620	3	834	1.946	3	4.59	0.713	RSVR 100

Hydrograph Report

Hyd. No. 1

WS 20

Hydrograph type	= SCS Runoff	Peak discharge	= 8.408 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.15 hrs
Time interval	= 3 min	Hyd. volume	= 0.964 acft
Drainage area	= 14.940 ac	Curve number	= 48
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 9.50 min
Total precip.	= 5.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



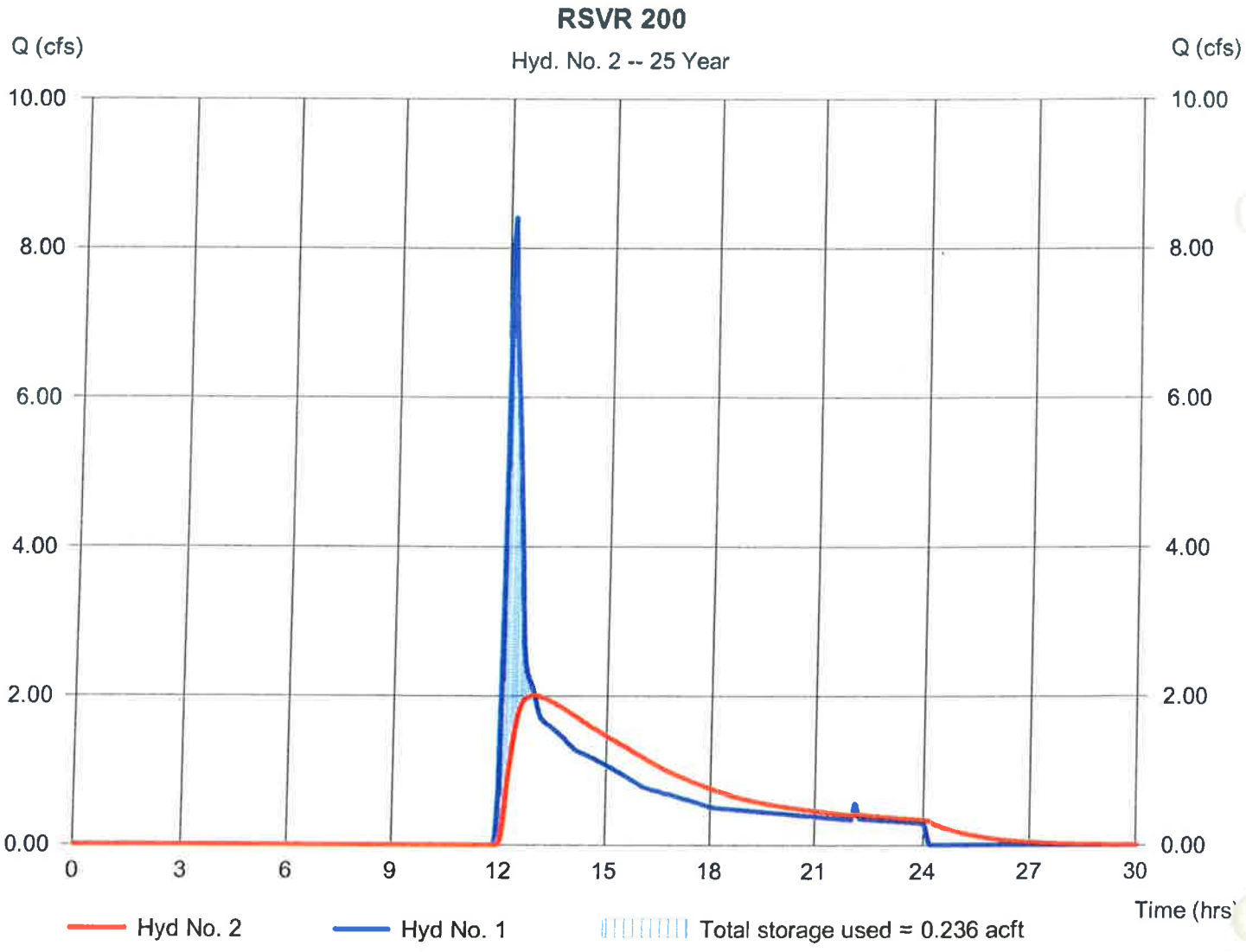
Hydrograph Report

Hyd. No. 2

RSVR 200

Hydrograph type	= Reservoir	Peak discharge	= 2.008 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.90 hrs
Time interval	= 3 min	Hyd. volume	= 0.964 acft
Inflow hyd. No.	= 1 - WS 20	Max. Elevation	= 4.70 ft
Reservoir name	= RSVR 200	Max. Storage	= 0.236 acft

Storage Indication method used.

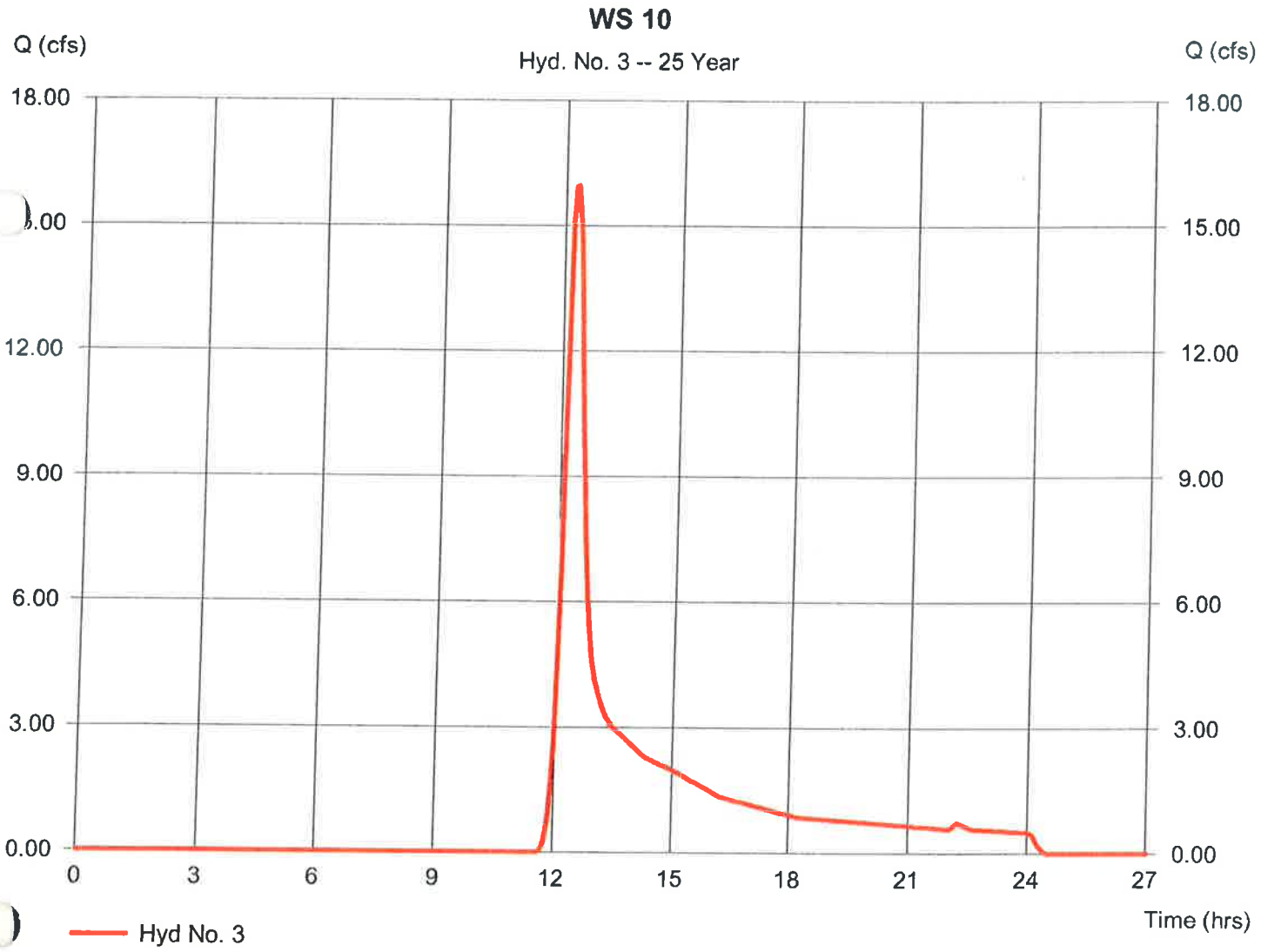


Hydrograph Report

Hyd. No. 3

WS 10

Hydrograph type	= SCS Runoff	Peak discharge	= 15.98 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.30 hrs
Time interval	= 3 min	Hyd. volume	= 1.946 acft
Drainage area	= 18.520 ac	Curve number	= 54
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 18.40 min
Total precip.	= 5.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

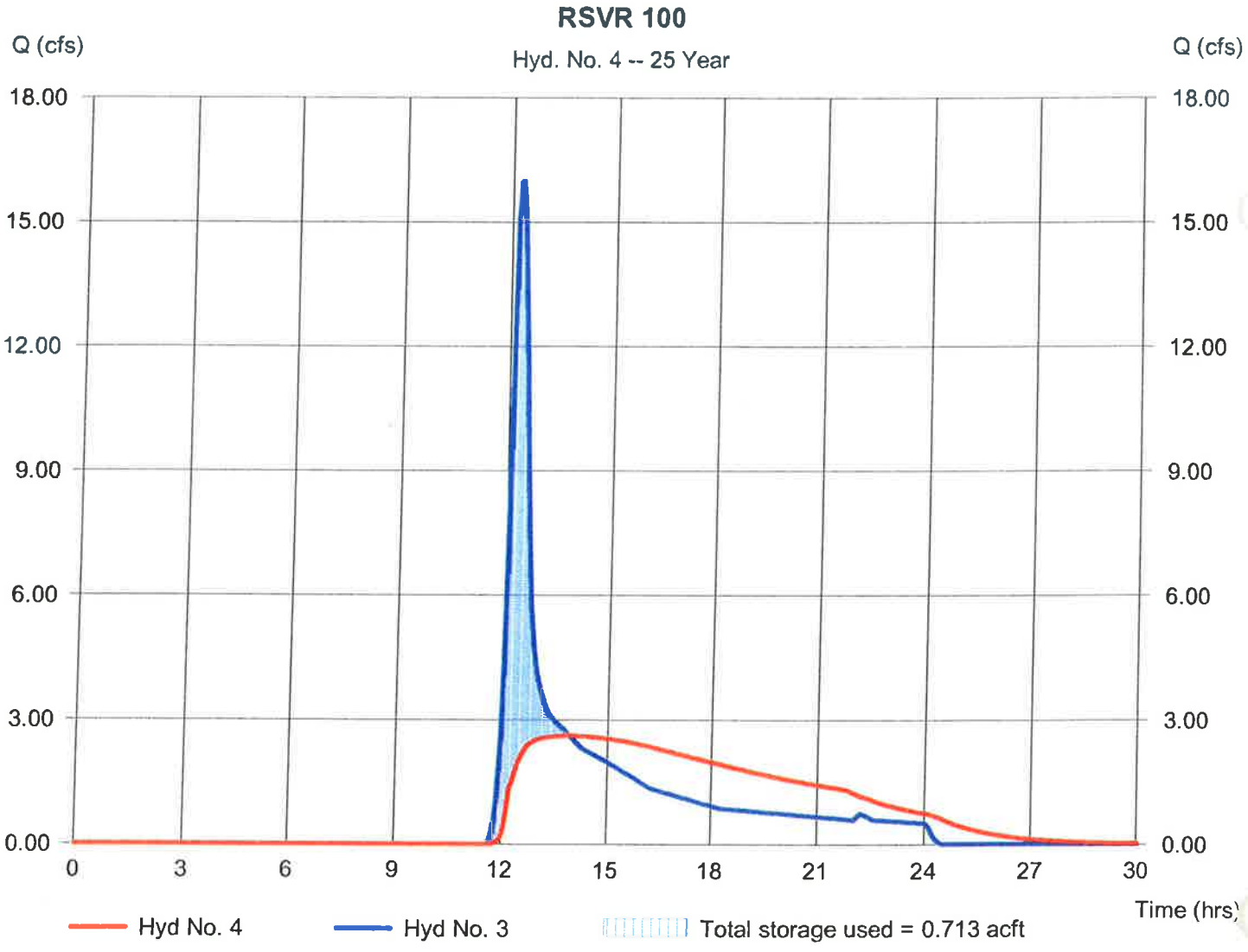
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Hyd. No. 4

RSVR 100

Hydrograph type	= Reservoir	Peak discharge	= 2.620 cfs
Storm frequency	= 25 yrs	Time to peak	= 13.90 hrs
Time interval	= 3 min	Hyd. volume	= 1.946 acft
Inflow hyd. No.	= 3 - WS 10	Max. Elevation	= 4.59 ft
Reservoir name	= RSVR 100	Max. Storage	= 0.713 acft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

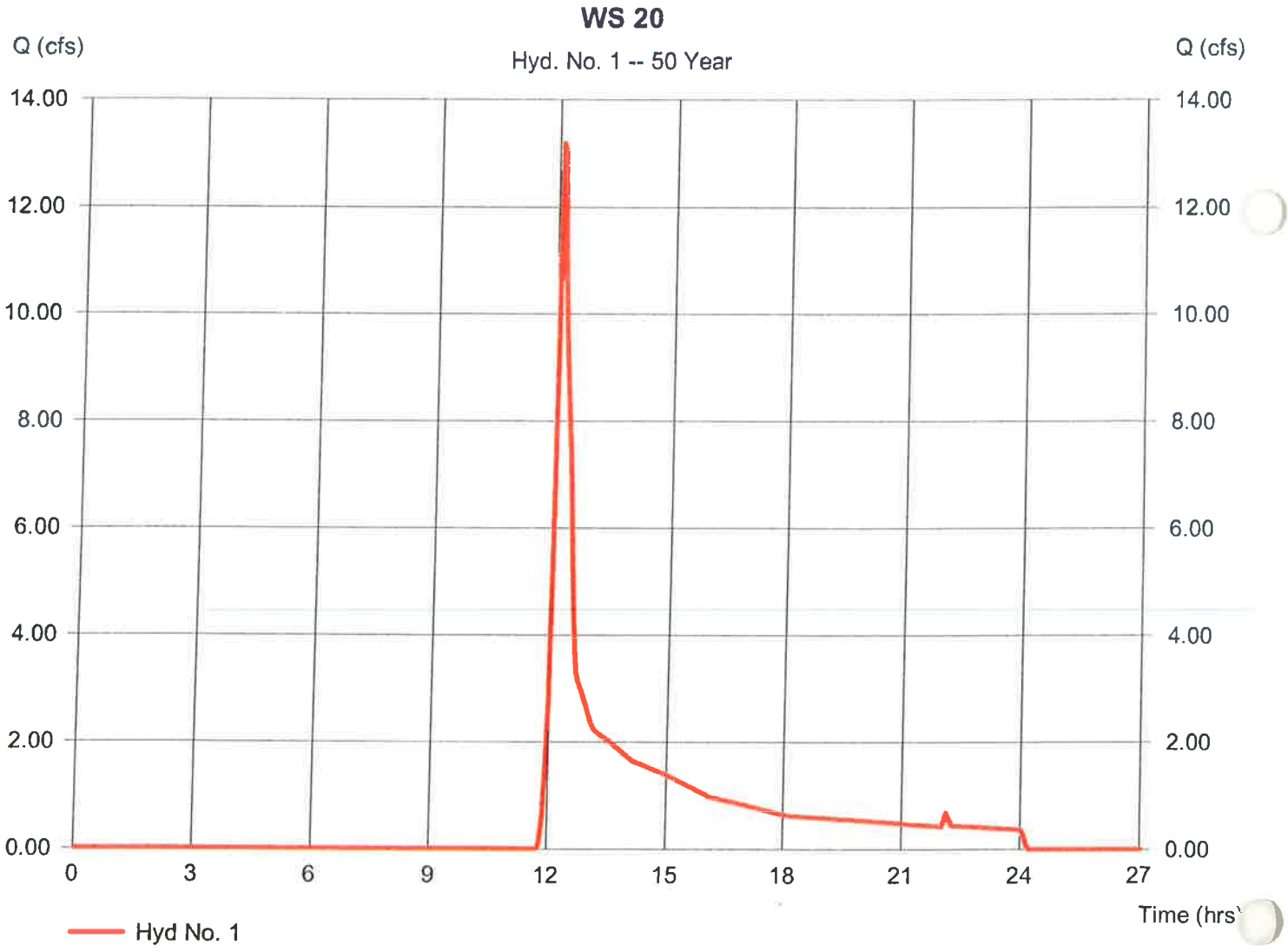
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph description
1	SCS Runoff	13.20	3	726	1.332	------	------	------	WS 20
2	Reservoir	3.027	3	765	1.332	1	5.01	0.357	RSVR 200
3	SCS Runoff	22.27	3	735	2.564	------	------	------	WS 10
4	Reservoir	3.344	3	831	2.564	3	4.92	1.01	RSVR 100

Hydrograph Report

Hyd. No. 1

WS 20

Hydrograph type	= SCS Runoff	Peak discharge	= 13.20 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.10 hrs
Time interval	= 3 min	Hyd. volume	= 1.332 acft
Drainage area	= 14.940 ac	Curve number	= 48
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 9.50 min
Total precip.	= 6.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



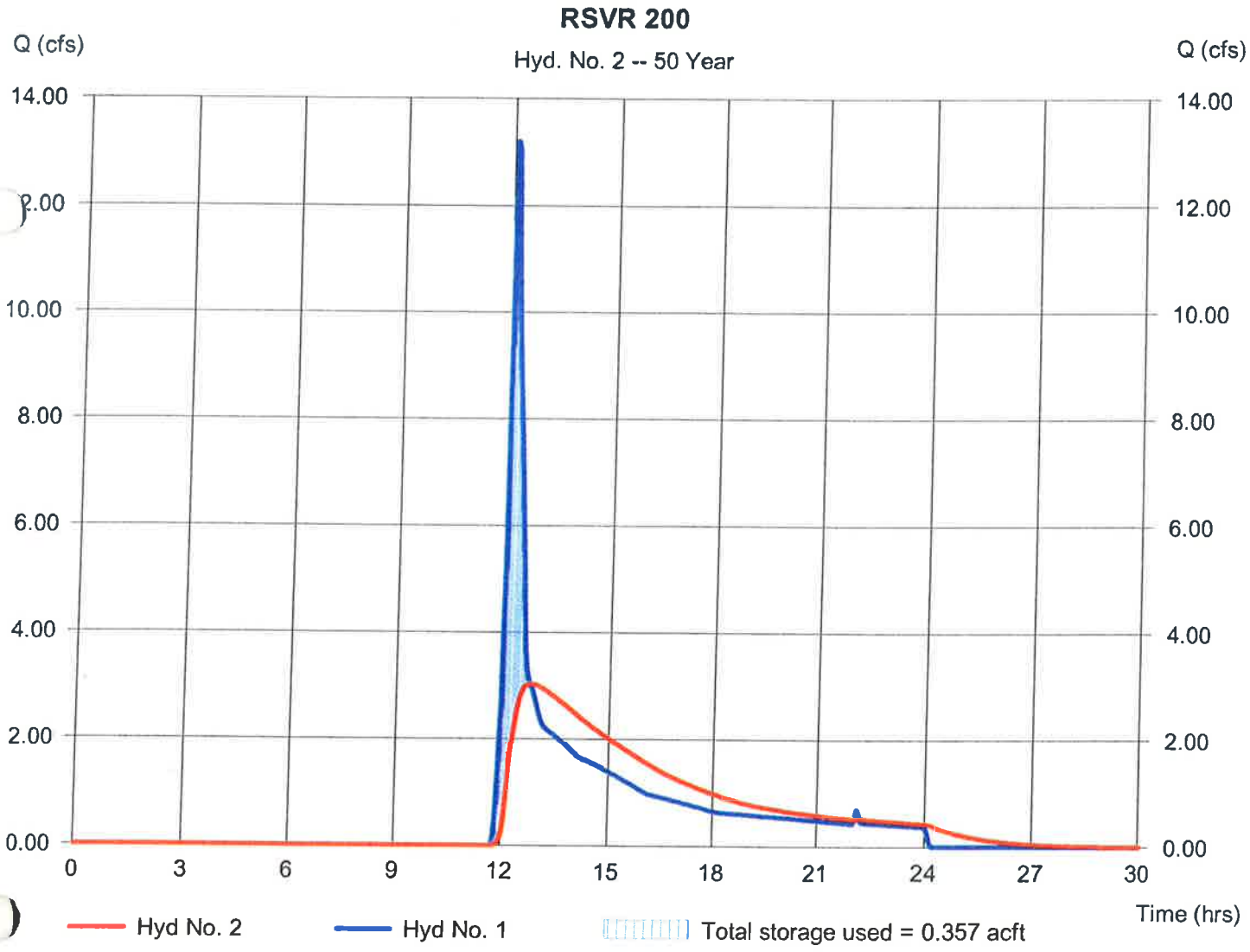
Hydrograph Report

Hyd. No. 2

RSVR 200

Hydrograph type	= Reservoir	Peak discharge	= 3.027 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.75 hrs
Time interval	= 3 min	Hyd. volume	= 1.332 acft
Inflow hyd. No.	= 1 - WS 20	Max. Elevation	= 5.01 ft
Reservoir name	= RSVR 200	Max. Storage	= 0.357 acft

Storage Indication method used.

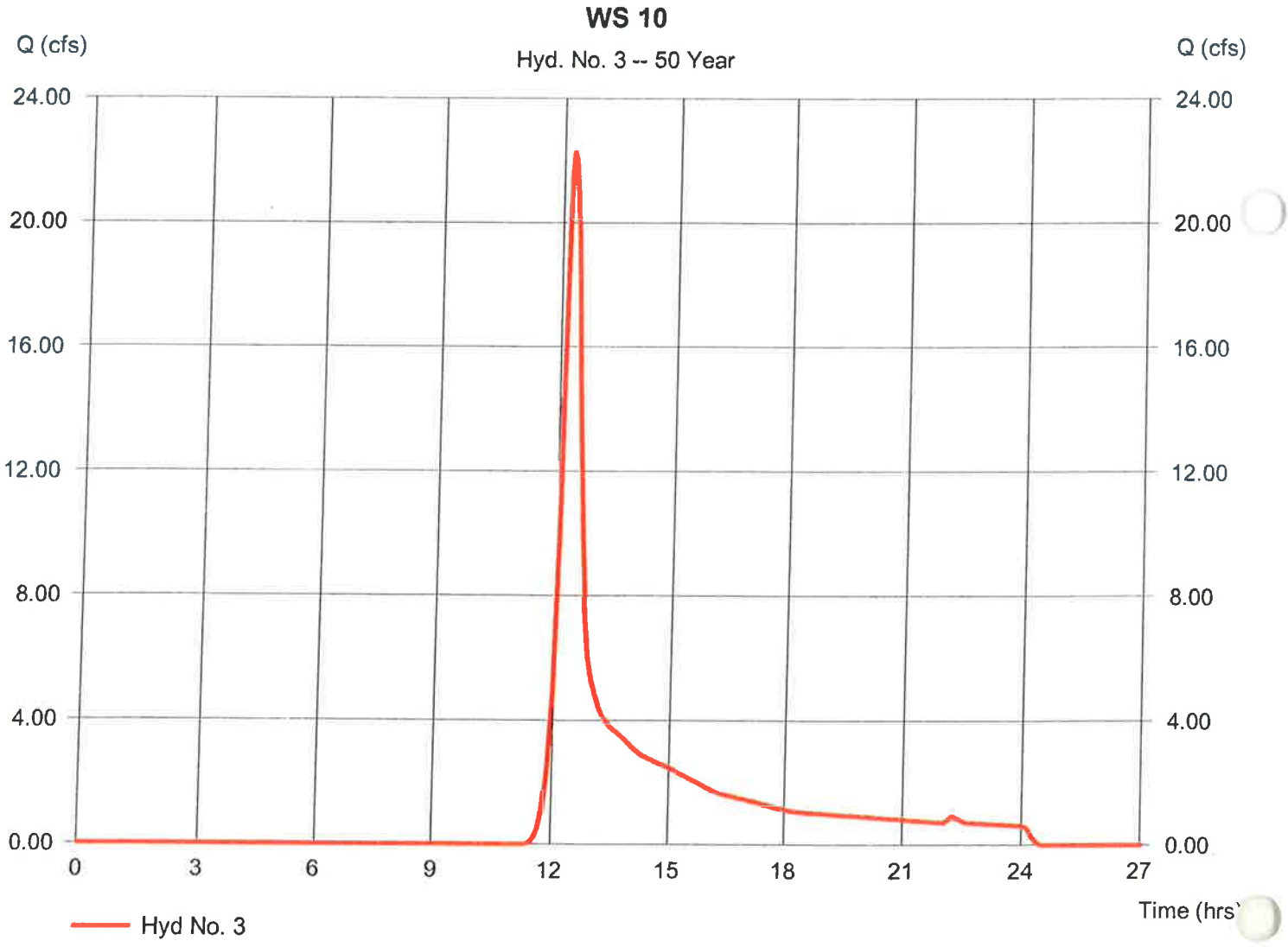


Hydrograph Report

Hyd. No. 3

WS 10

Hydrograph type	= SCS Runoff	Peak discharge	= 22.27 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.25 hrs
Time interval	= 3 min	Hyd. volume	= 2.564 acft
Drainage area	= 18.520 ac	Curve number	= 54
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 18.40 min
Total precip.	= 6.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

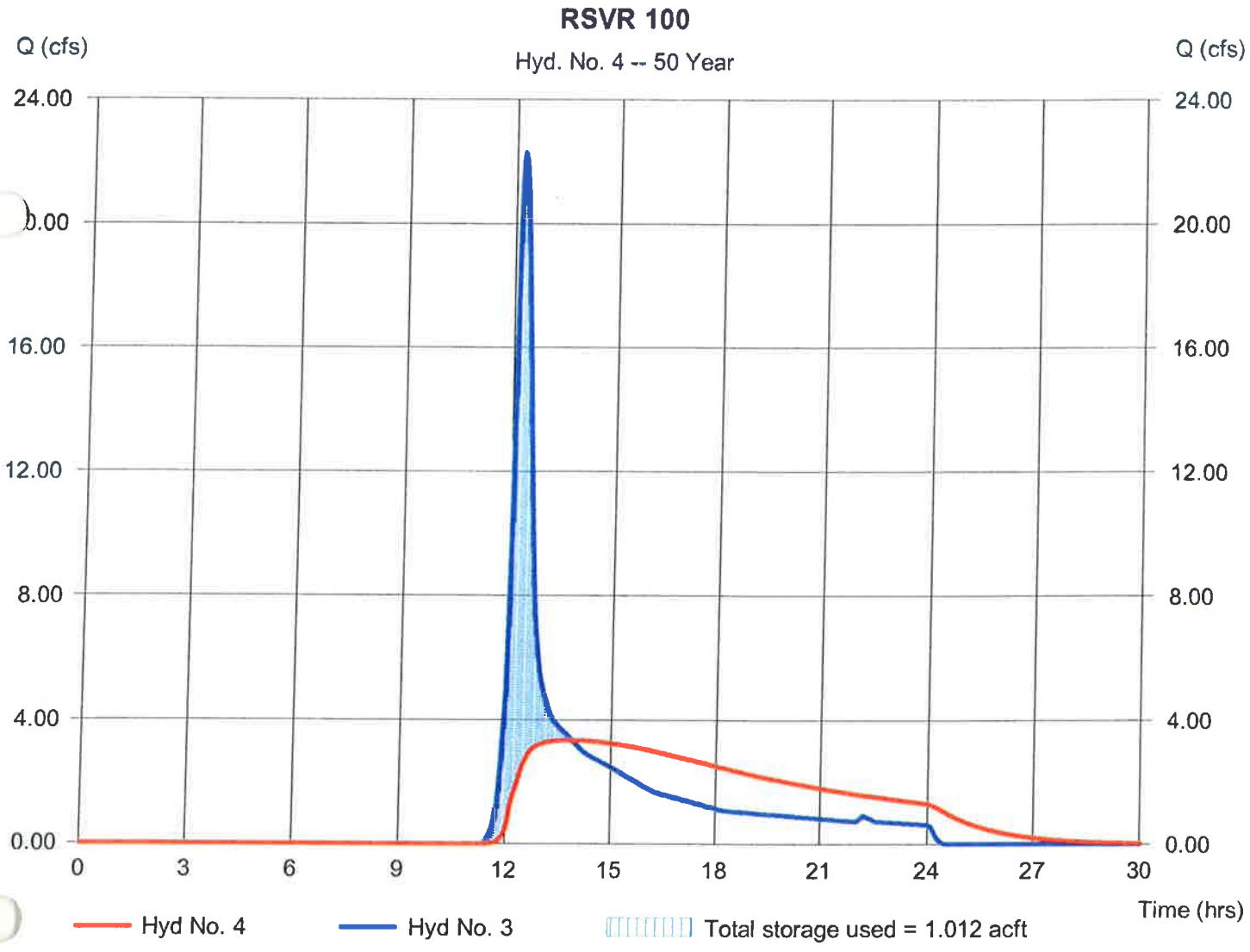
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Hyd. No. 4

RSVR 100

Hydrograph type	= Reservoir	Peak discharge	= 3.344 cfs
Storm frequency	= 50 yrs	Time to peak	= 13.85 hrs
Time interval	= 3 min	Hyd. volume	= 2.564 acft
Inflow hyd. No.	= 3 - WS 10	Max. Elevation	= 4.92 ft
Reservoir name	= RSVR 100	Max. Storage	= 1.012 acft

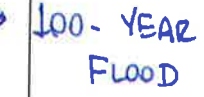
Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph description
1	SCS Runoff	19.77	3	726	1.802	------	------	------	WS 20
2	Reservoir	4.358	3	759	1.802	1	5.13	0.523	RSVR 200
3	SCS Runoff	30.05	3	735	3.331	------	------	------	WS 10
4	Reservoir	4.078	3	837	3.331	3	5.25	1.41	RSVR 100

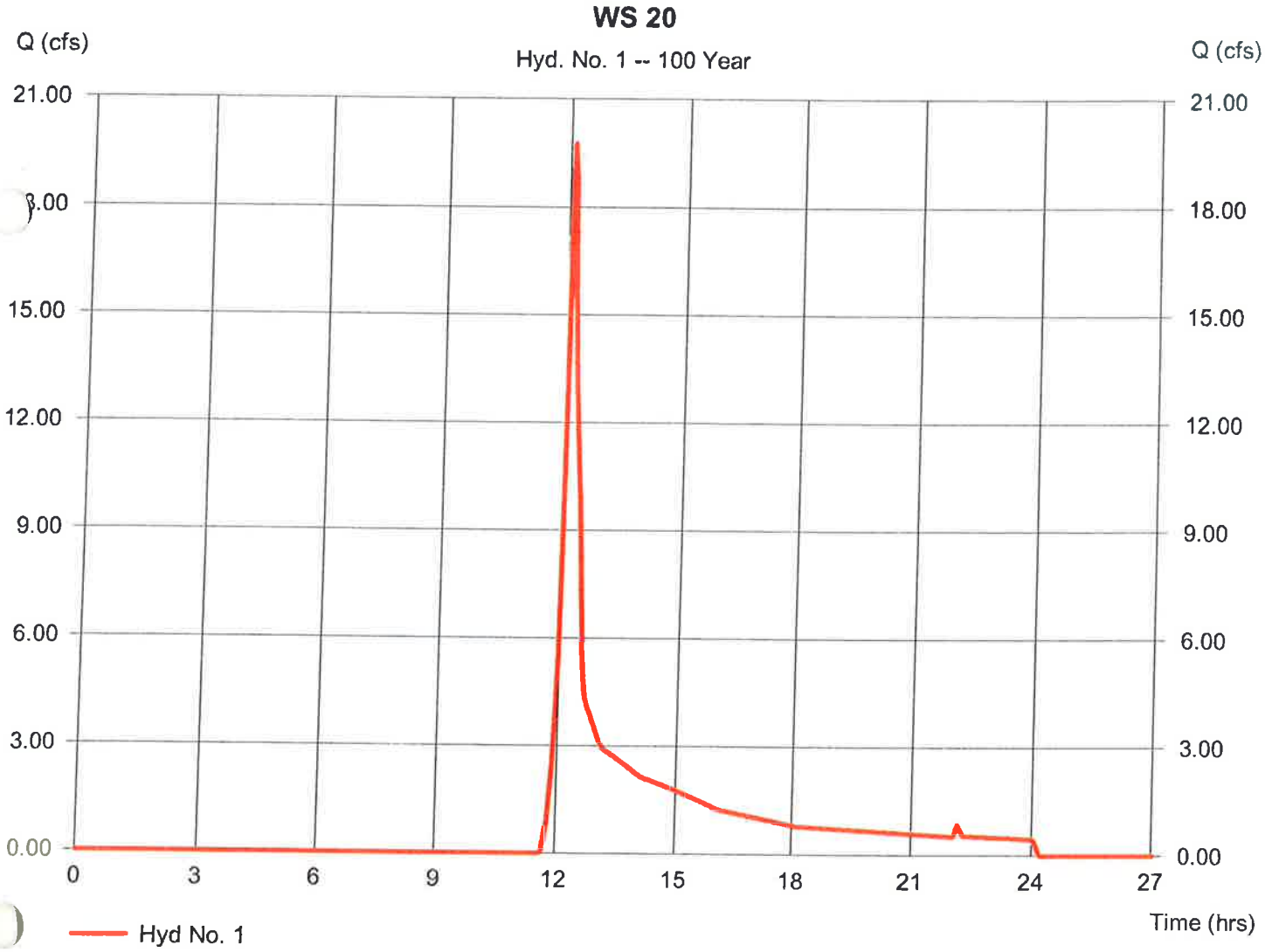


Hydrograph Report

Hyd. No. 1

WS 20

Hydrograph type	= SCS Runoff	Peak discharge	= 19.77 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.10 hrs
Time interval	= 3 min	Hyd. volume	= 1.802 acft
Drainage area	= 14.940 ac	Curve number	= 48
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 9.50 min
Total precip.	= 7.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



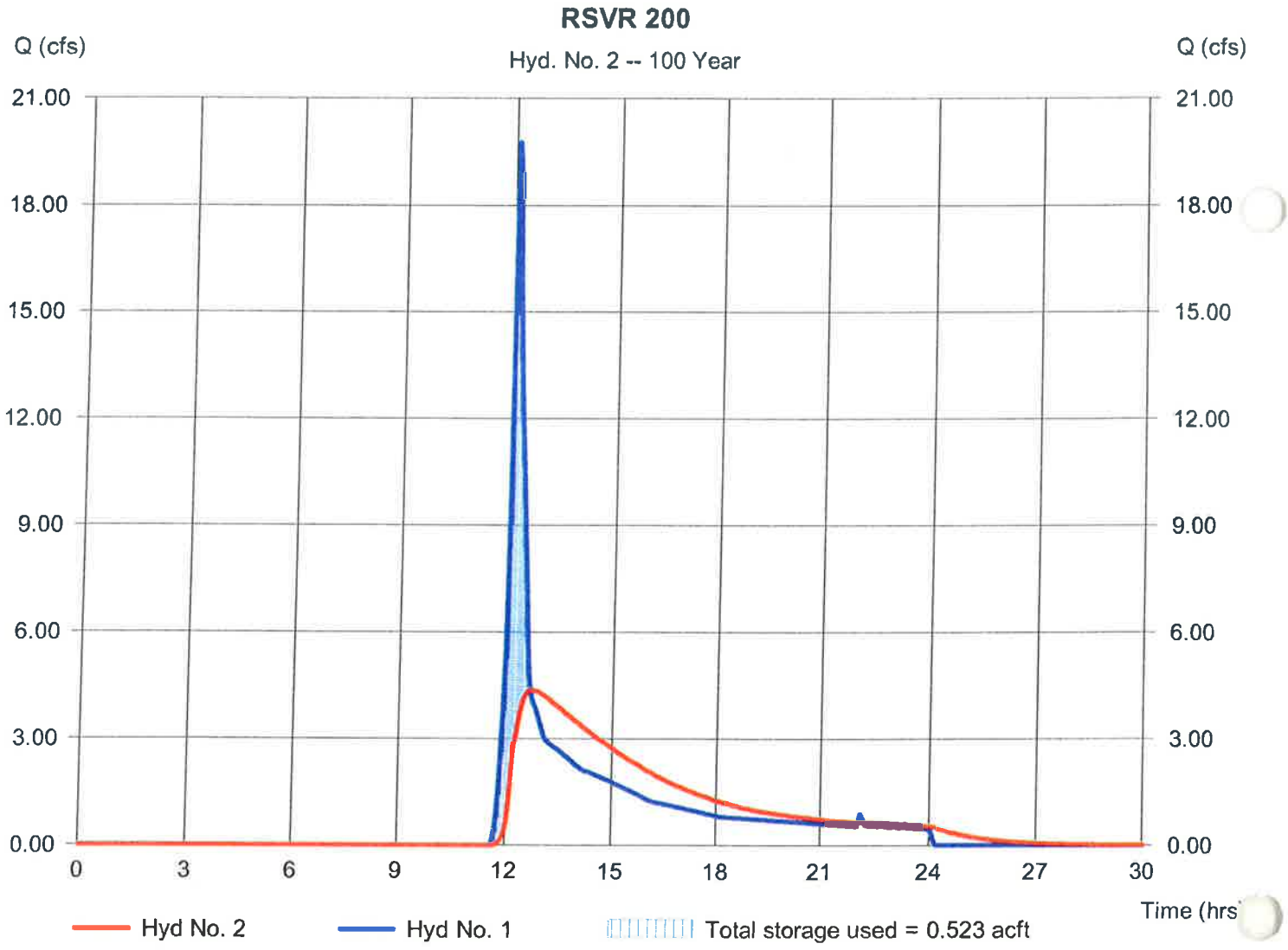
Hydrograph Report

Hyd. No. 2

RSVR 200

Hydrograph type	= Reservoir	Peak discharge	= 4.358 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.65 hrs
Time interval	= 3 min	Hyd. volume	= 1.802 acft
Inflow hyd. No.	= 1 - WS 20	Max. Elevation	= 5.13 ft
Reservoir name	= RSVR 200	Max. Storage	= 0.523 acft

Storage Indication method used.

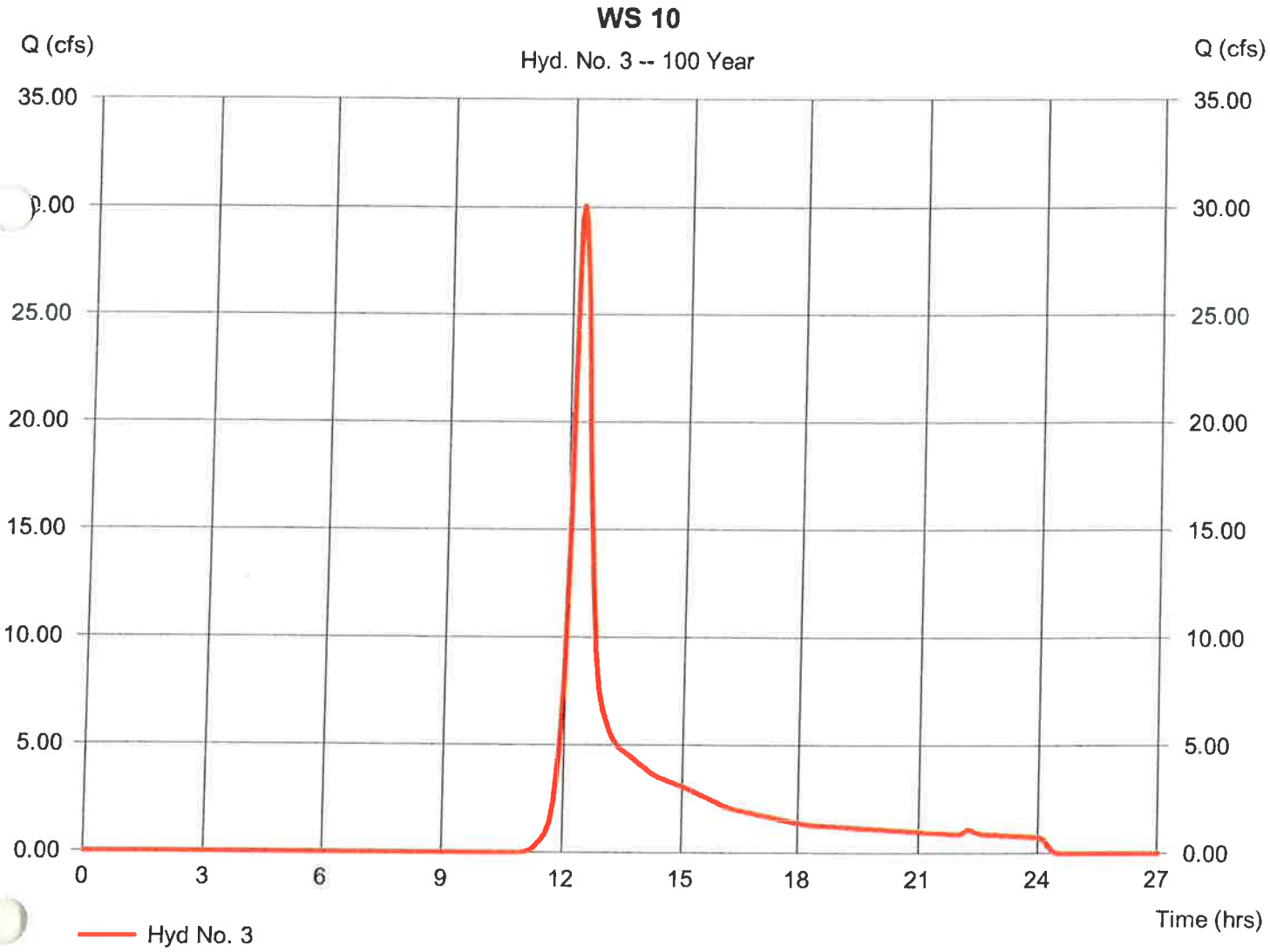


Hydrograph Report

Hyd. No. 3

WS 10

Hydrograph type	= SCS Runoff	Peak discharge	= 30.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.25 hrs
Time interval	= 3 min	Hyd. volume	= 3.331 acft
Drainage area	= 18.520 ac	Curve number	= 54
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 18.40 min
Total precip.	= 7.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hyd. No. 4

RSVR 100

Hydrograph type	= Reservoir	Peak discharge	= 4.078 cfs
Storm frequency	= 100 yrs	Time to peak	= 13.95 hrs
Time interval	= 3 min	Hyd. volume	= 3.331 acft
Inflow hyd. No.	= 3 - WS 10	Max. Elevation	= 5.25 ft
Reservoir name	= RSVR 100	Max. Storage	= 1.407 acft

Storage Indication method used.

