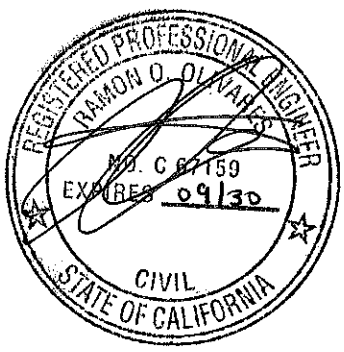
Appendix S
Stormwater Calculations

Pre and Post Development Preliminary Calculations

Watson Cogeneration Steam and Electric Reliability Project

Carson, California



Kiewit Power Engineers
Lenexa, Kansas
September 2008

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Appendix A

Figure 1

Hydrograph Return Period Recap

Hydraflow Hydrographs by Intelisolve v9.23

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	-------	-------	2.320	-------	-------	-------	-------	-------	9.846	Pre Development
2	Reservoir	1	-------	0.000	-------	-------	-------	-------	-------	0.000	Pre Development Pondin
3	SCS Runoff	-------	-------	0.536	-------	-------	-------	-------	-------	2.275	Carson Pond S
4	Reservoir	3	-------	0.000	-------	-------	-------	-------	-------	0.000	South Ponding
5	SCS Runoff	-------	-------	0.505	-------	-------	-------	-------	-------	1.344	Carson Inlet 1
6	SCS Runoff	-------	-------	0.505	-------	-------	-------	-------	-------	1.344	Carson Inlet 2
7	SCS Runoff	-------	-------	0.543	-------	-------	-------	-------	-------	1.443	Carson Inlet 3
8	SCS Runoff	-------	-------	0.374	-------	-------	-------	-------	-------	0.995	Carson Inlet 9
9	SCS Runoff	-------	-------	0.561	-------	-------	-------	-------	-------	1.493	Carson Inlet 5
10	SCS Runoff	-------	-------	0.374	-------	-------	-------	-------	-------	0.995	Carson Inlet 6
11	SCS Runoff	-------	-------	0.337	-------	-------	-------	-------	-------	0.896	Carson Inlet 7
12	SCS Runoff	-------	-------	0.225	-------	-------	-------	-------	-------	0.597	Carson Inlet 8

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

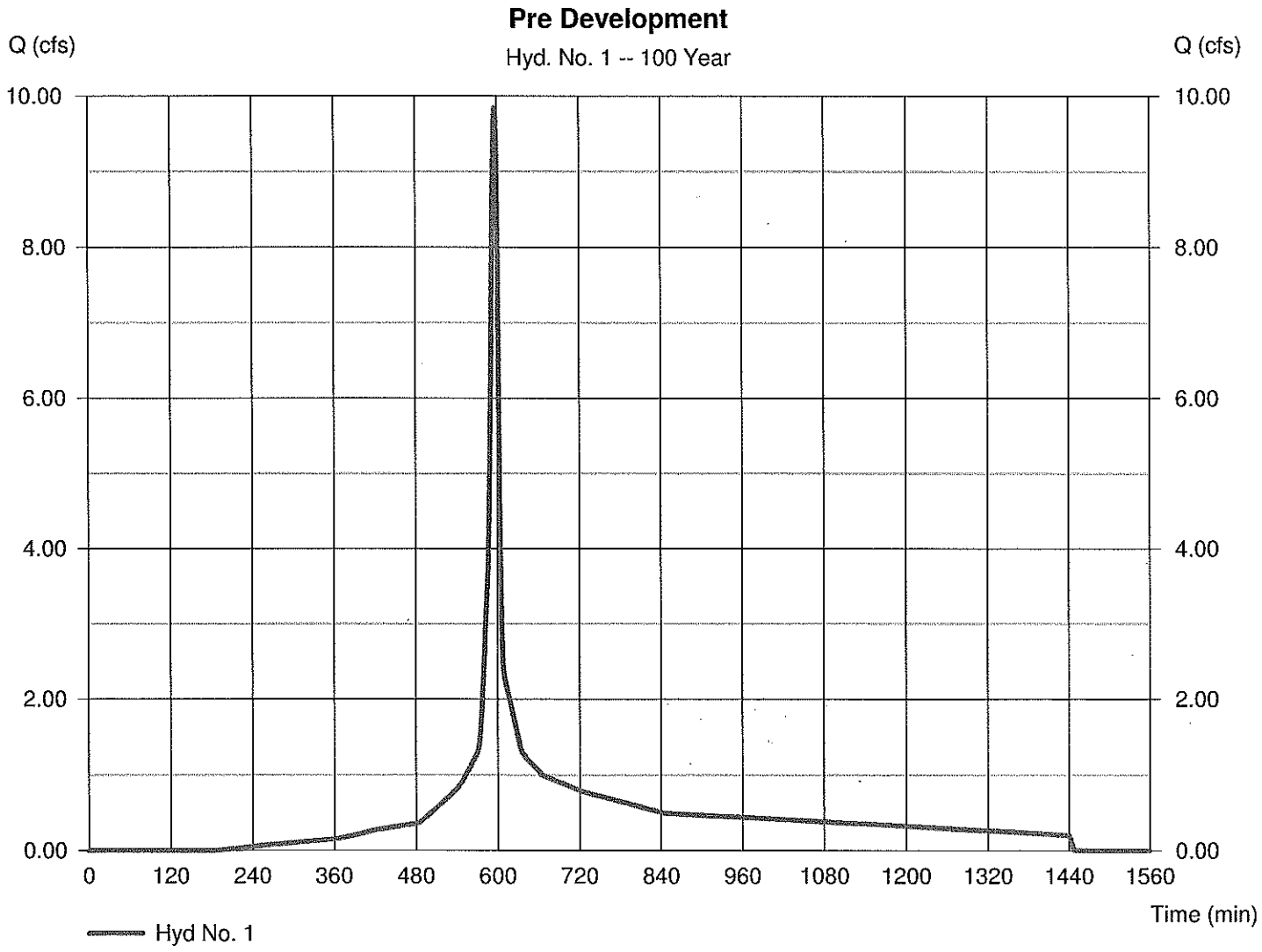
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	9.846	1	597	42,551	----	------	------	Pre Development
2	Reservoir	0.000	1	n/a	0	1	100.58	42,551	Pre Development Pondin
3	SCS Runoff	2.275	1	597	9,833	----	------	------	Carson Pond S
4	Reservoir	0.000	1	n/a	0	3	100.67	9,833	South Ponding
5	SCS Runoff	1.344	1	596	6,329	----	------	------	Carson Inlet 1
6	SCS Runoff	1.344	1	596	6,329	----	------	------	Carson Inlet 2
7	SCS Runoff	1.443	1	596	6,797	----	------	------	Carson Inlet 3
8	SCS Runoff	0.995	1	596	4,688	----	------	------	Carson Inlet 9
9	SCS Runoff	1.493	1	596	7,032	----	------	------	Carson Inlet 5
10	SCS Runoff	0.995	1	596	4,688	----	------	------	Carson Inlet 6
11	SCS Runoff	0.896	1	596	4,219	----	------	------	Carson Inlet 7
12	SCS Runoff	0.597	1	596	2,813	----	------	------	Carson Inlet 8

Hydrograph Report

Hyd. No. 1

Pre Development

Hydrograph type	= SCS Runoff	Peak discharge	= 9.846 cfs
Storm frequency	= 100 yrs	Time to peak	= 597 min
Time interval	= 1 min	Hyd. volume	= 42,551 cuft
Drainage area	= 2.380 ac	Curve number	= 85
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



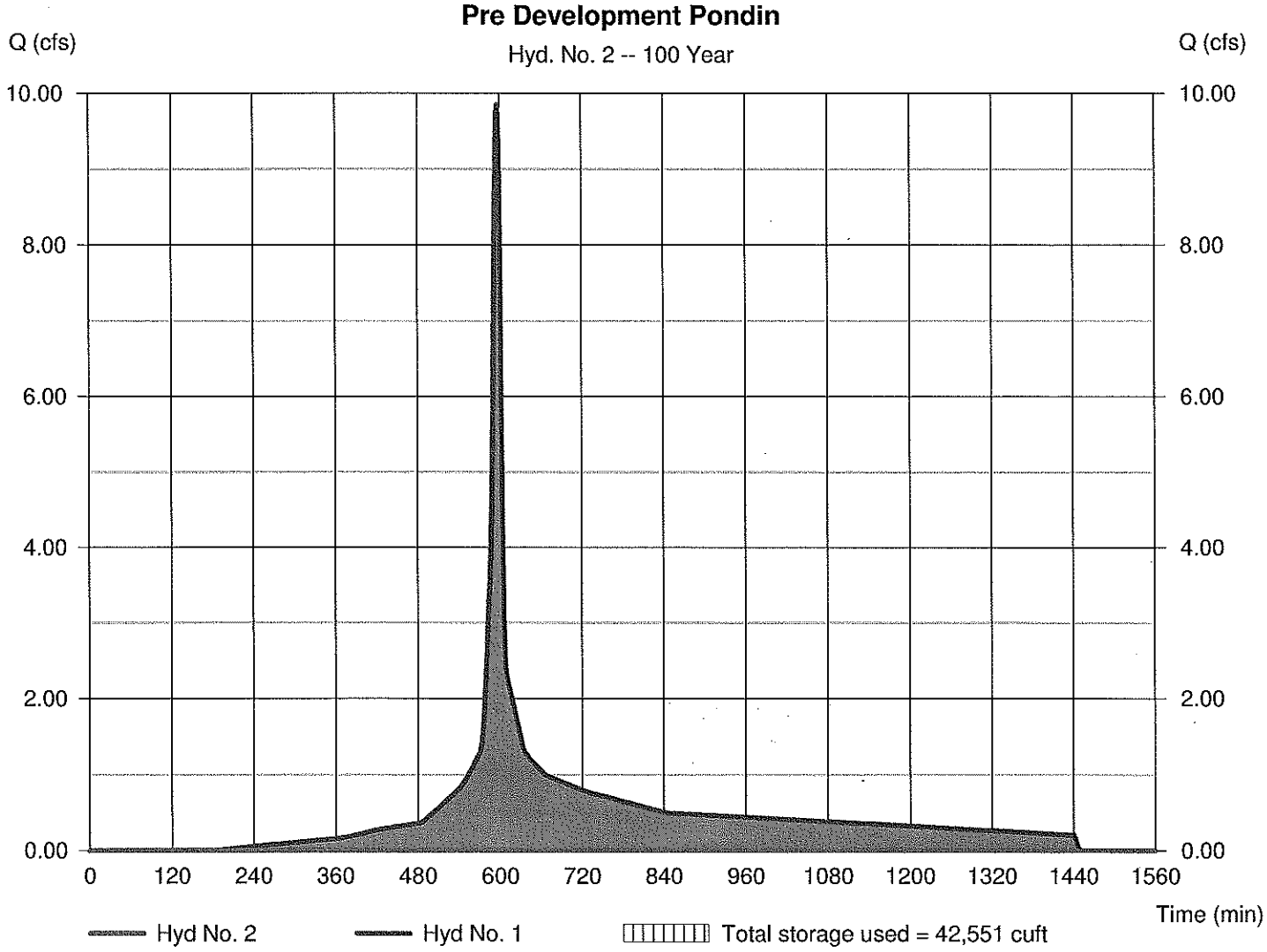
Hydrograph Report

Hyd. No. 2

Pre Development Pondin

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - Pre Development	Max. Elevation	= 100.58 ft
Reservoir name	= Pre Development	Max. Storage	= 42,551 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Tuesday, Sep 2, 2008

Pond No. 21 - Pre Development

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 100.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	71,027	0	0
1.00	101.00	75,043	73,018	73,018

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	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
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.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

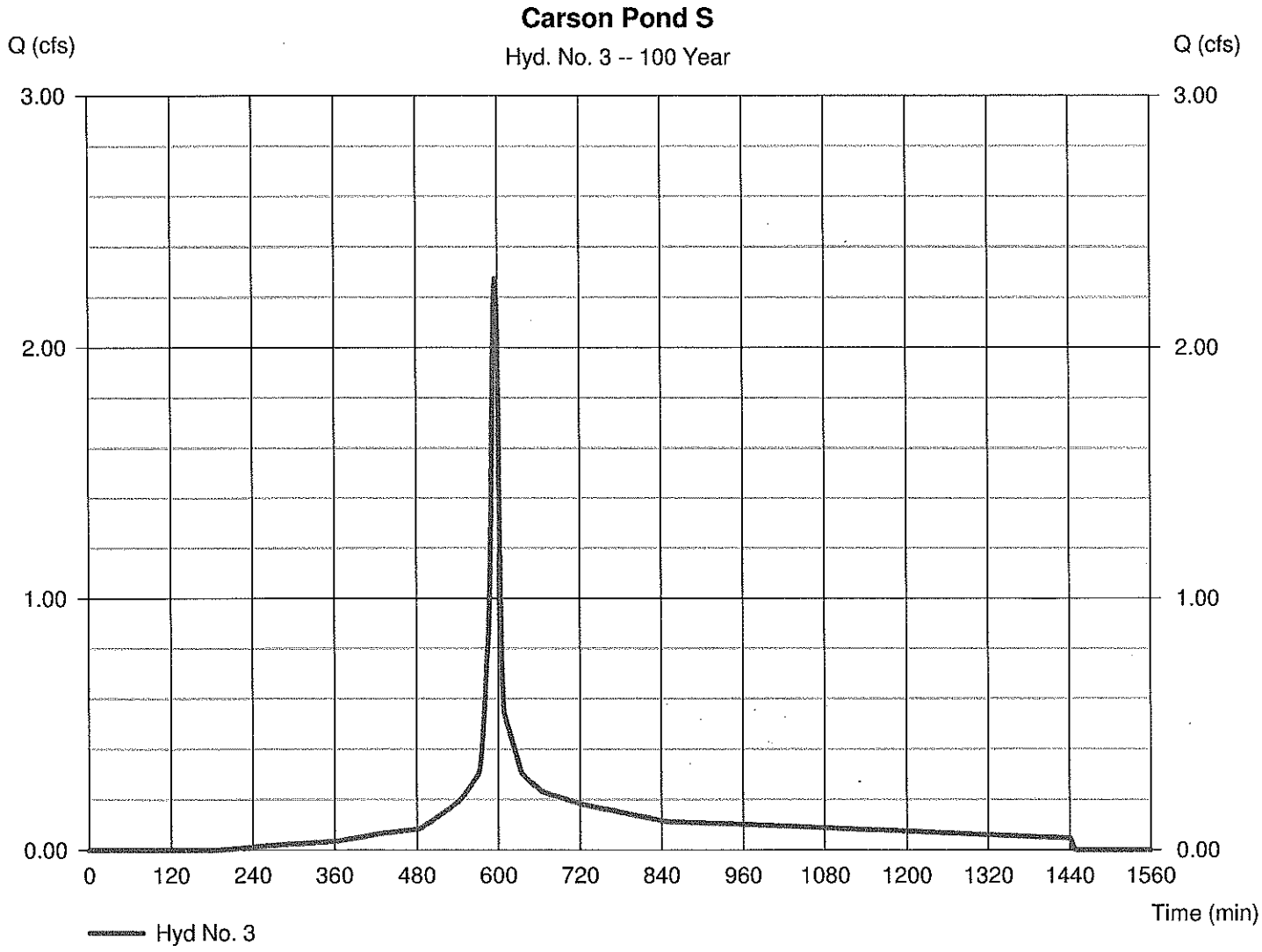
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	7,302	100.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	14,604	100.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	21,906	100.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	29,207	100.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	36,509	100.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	43,811	100.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	51,113	100.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	58,415	100.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	65,717	100.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	73,018	101.00	---	---	---	---	---	---	---	---	---	---	0.000

Hydrograph Report

Hyd. No. 3

Carson Pond S

Hydrograph type	= SCS Runoff	Peak discharge	= 2.275 cfs
Storm frequency	= 100 yrs	Time to peak	= 597 min
Time interval	= 1 min	Hyd. volume	= 9,833 cuft
Drainage area	= 0.550 ac	Curve number	= 85
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



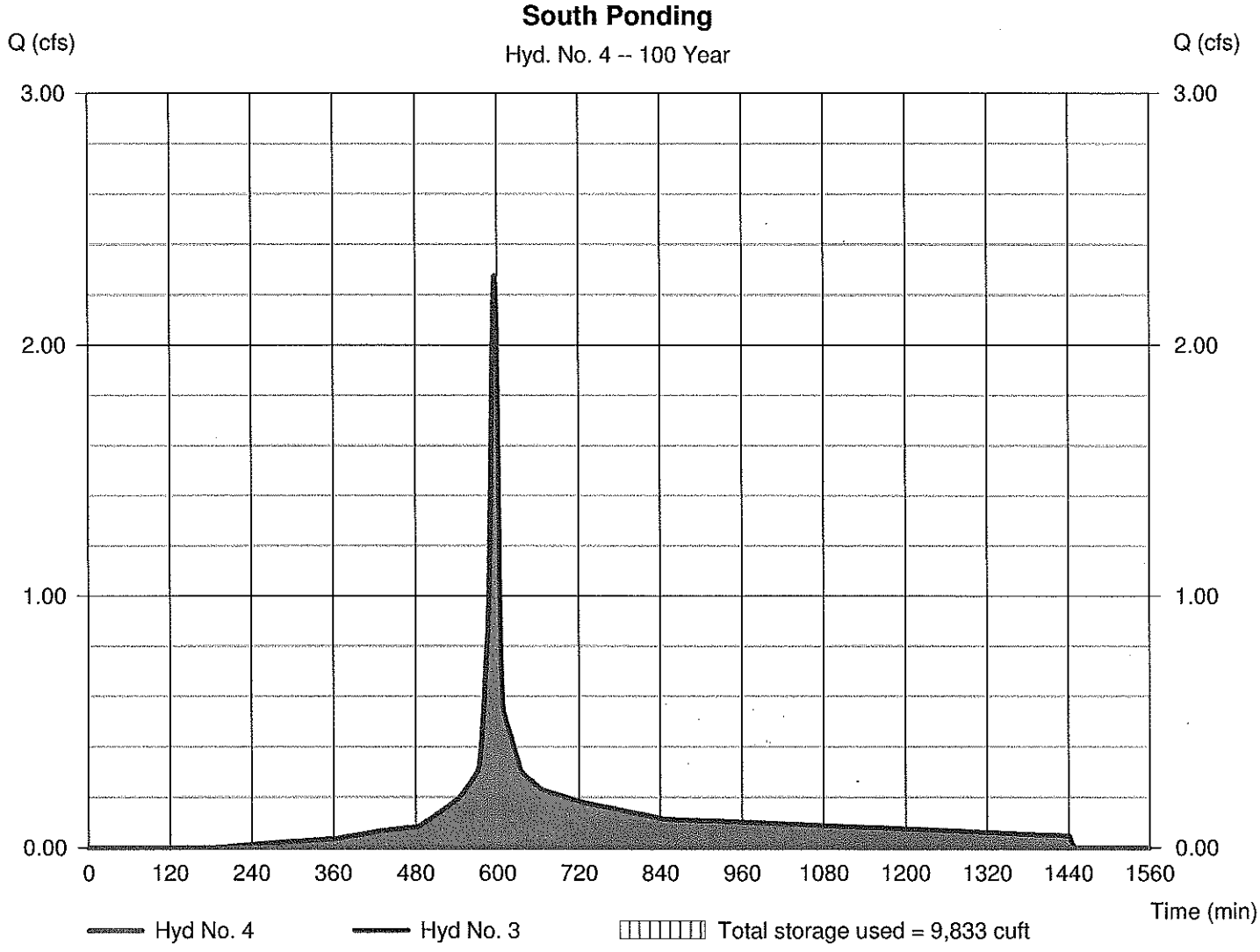
Hydrograph Report

Hyd. No. 4

South Ponding

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 3 - Carson Pond S	Max. Elevation	= 100.67 ft
Reservoir name	= South Pond	Max. Storage	= 9,833 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.23 Tuesday, Sep 2, 2008

Pond No. 20 - South Pond

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 100.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	14,773	0	0
1.00	101.00	14,773	14,772	14,772

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	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
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.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

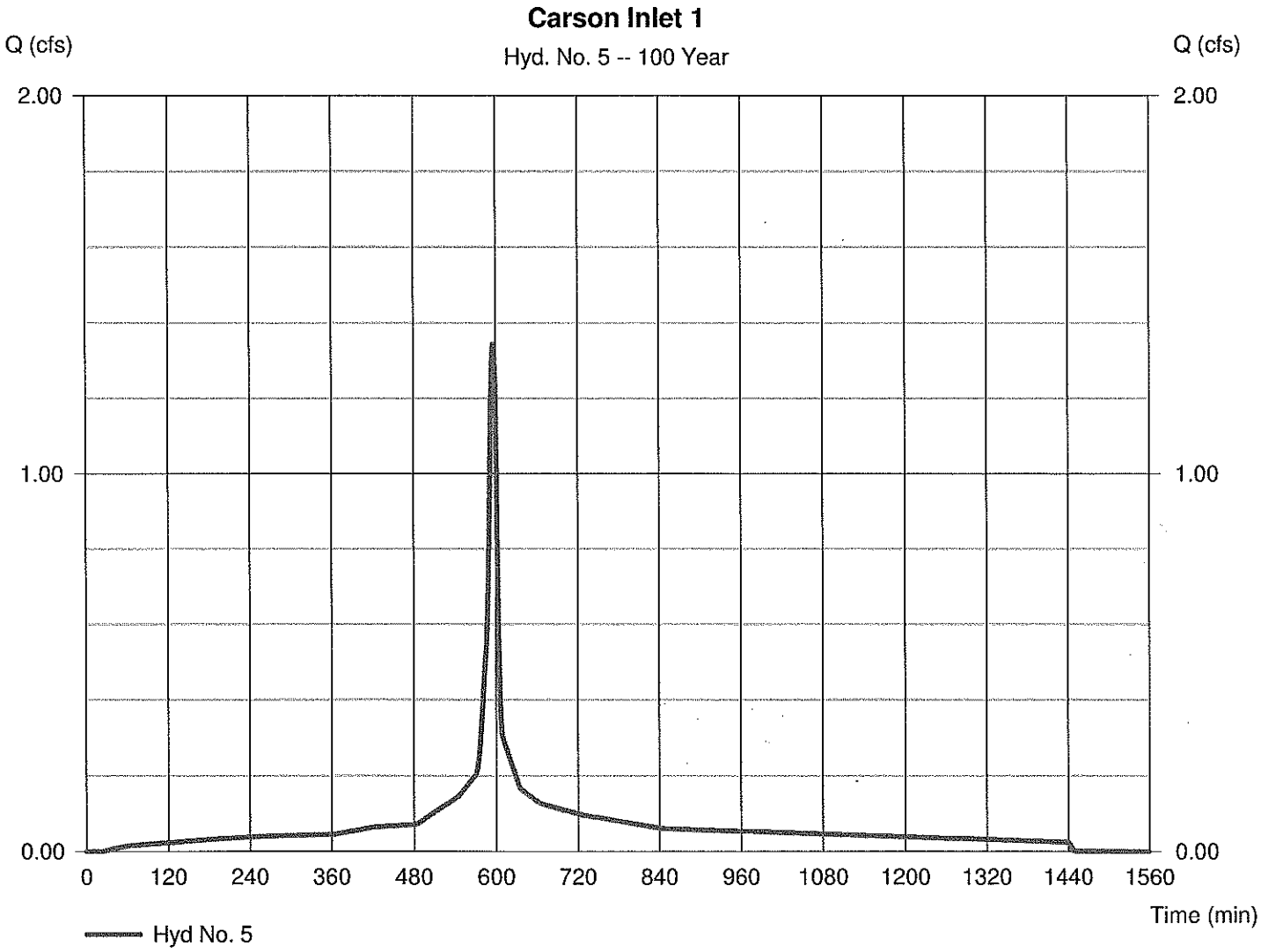
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	---	---	---	---	---	---	---	---	---	---	0.000
0.10	1,477	100.10	---	---	---	---	---	---	---	---	---	---	0.000
0.20	2,954	100.20	---	---	---	---	---	---	---	---	---	---	0.000
0.30	4,431	100.30	---	---	---	---	---	---	---	---	---	---	0.000
0.40	5,909	100.40	---	---	---	---	---	---	---	---	---	---	0.000
0.50	7,386	100.50	---	---	---	---	---	---	---	---	---	---	0.000
0.60	8,863	100.60	---	---	---	---	---	---	---	---	---	---	0.000
0.70	10,340	100.70	---	---	---	---	---	---	---	---	---	---	0.000
0.80	11,817	100.80	---	---	---	---	---	---	---	---	---	---	0.000
0.90	13,294	100.90	---	---	---	---	---	---	---	---	---	---	0.000
1.00	14,772	101.00	---	---	---	---	---	---	---	---	---	---	0.000

Hydrograph Report

Hyd. No. 5

Carson Inlet 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.344 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 6,329 cuft
Drainage area	= 0.270 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

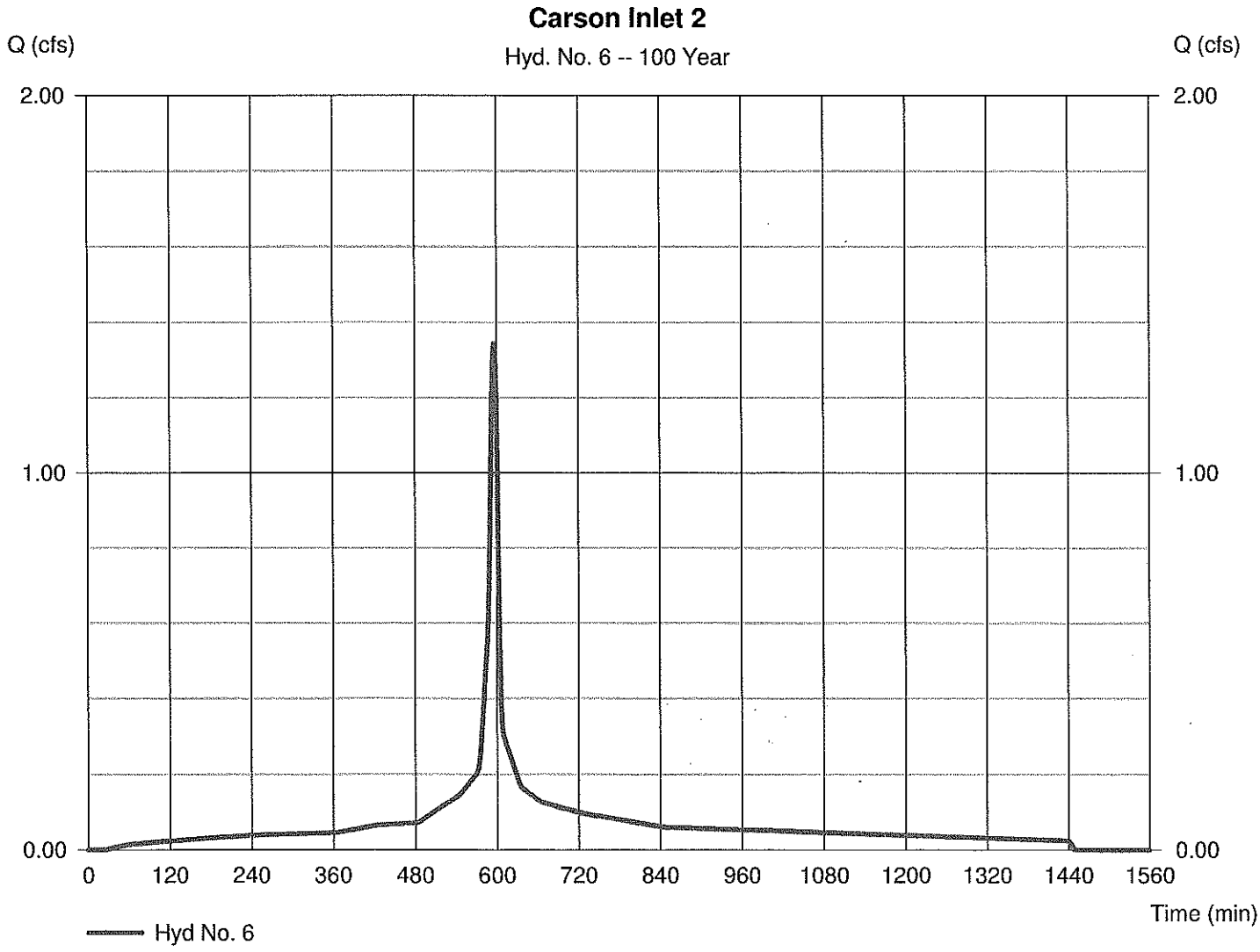


Hydrograph Report

Hyd. No. 6

Carson Inlet 2

Hydrograph type	= SCS Runoff	Peak discharge	= 1.344 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 6,329 cuft
Drainage area	= 0.270 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

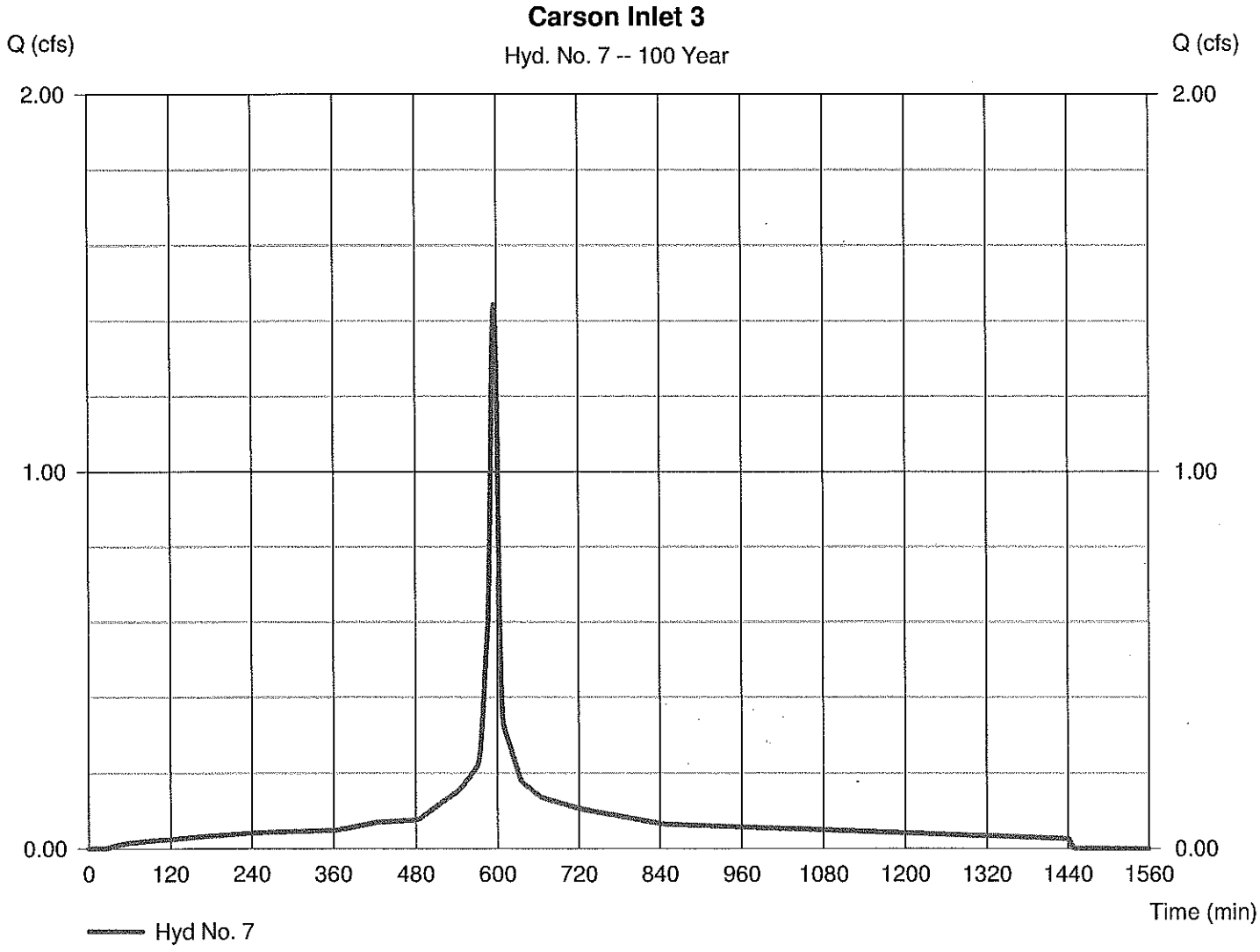


Hydrograph Report

Hyd. No. 7

Carson Inlet 3

Hydrograph type	= SCS Runoff	Peak discharge	= 1.443 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 6,797 cuft
Drainage area	= 0.290 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

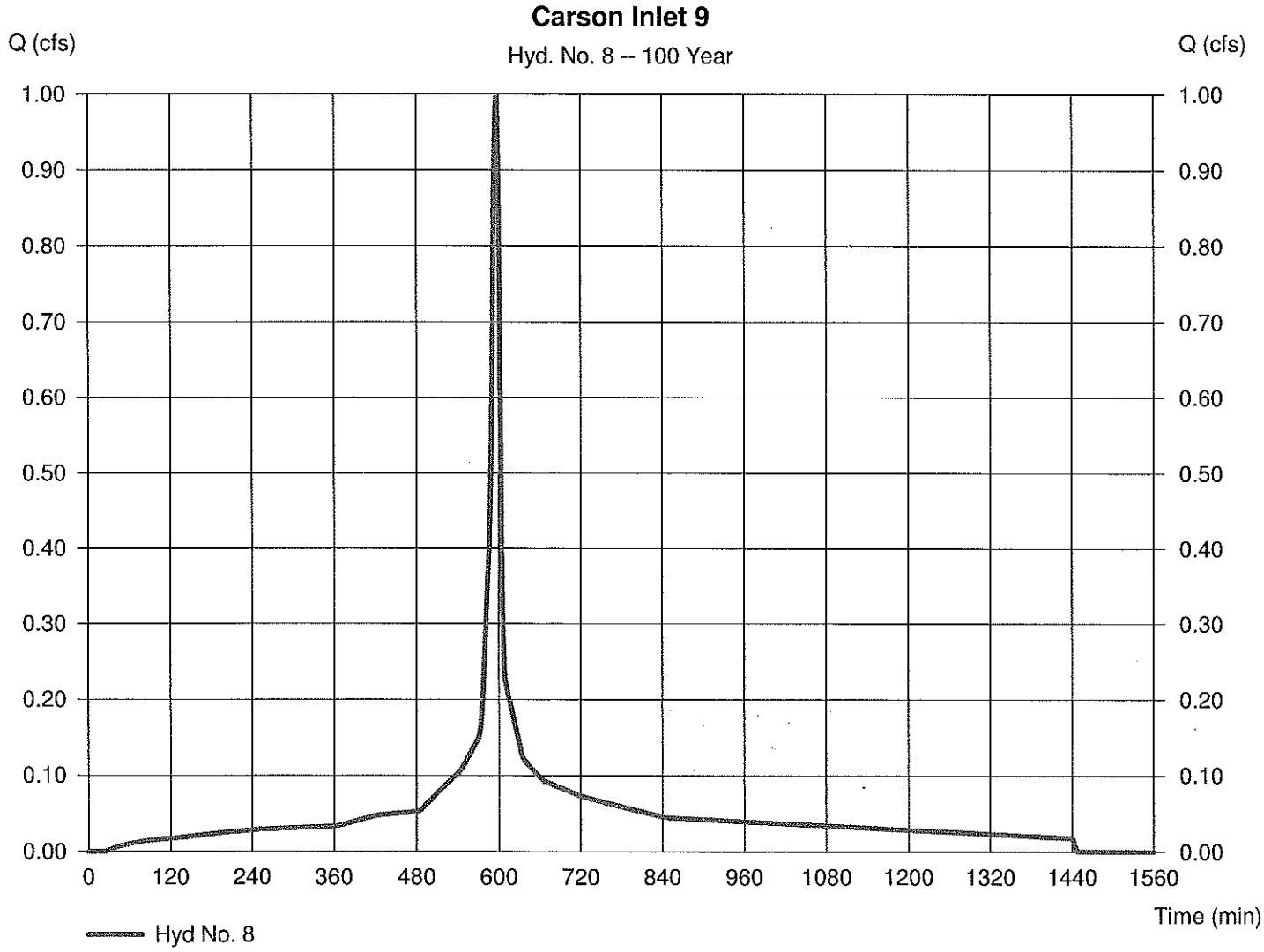


Hydrograph Report

Hyd. No. 8

Carson Inlet 9

Hydrograph type	= SCS Runoff	Peak discharge	= 0.995 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 4,688 cuft
Drainage area	= 0.200 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

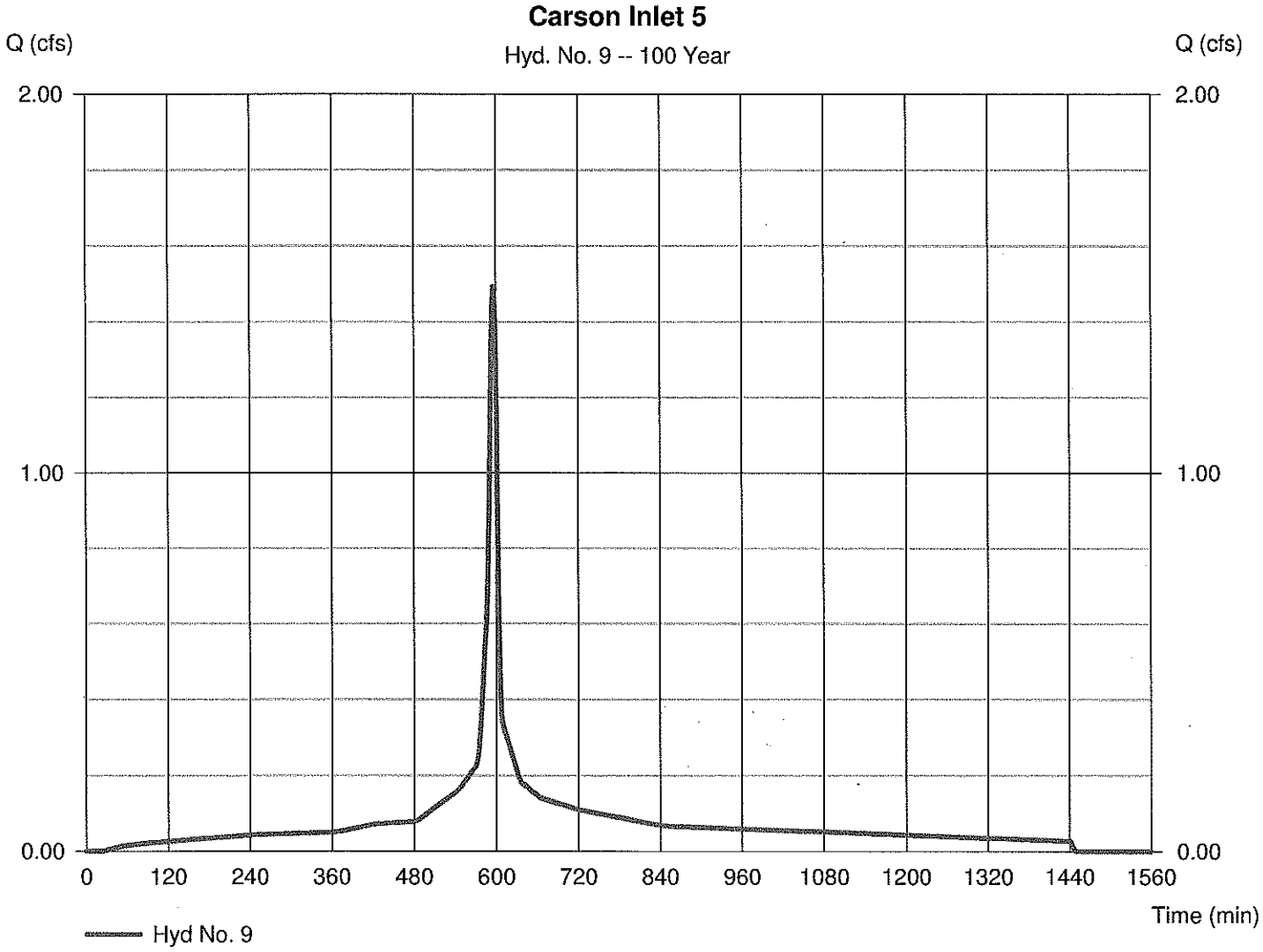


Hydrograph Report

Hyd. No. 9

Carson Inlet 5

Hydrograph type	= SCS Runoff	Peak discharge	= 1.493 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 7,032 cuft
Drainage area	= 0.300 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

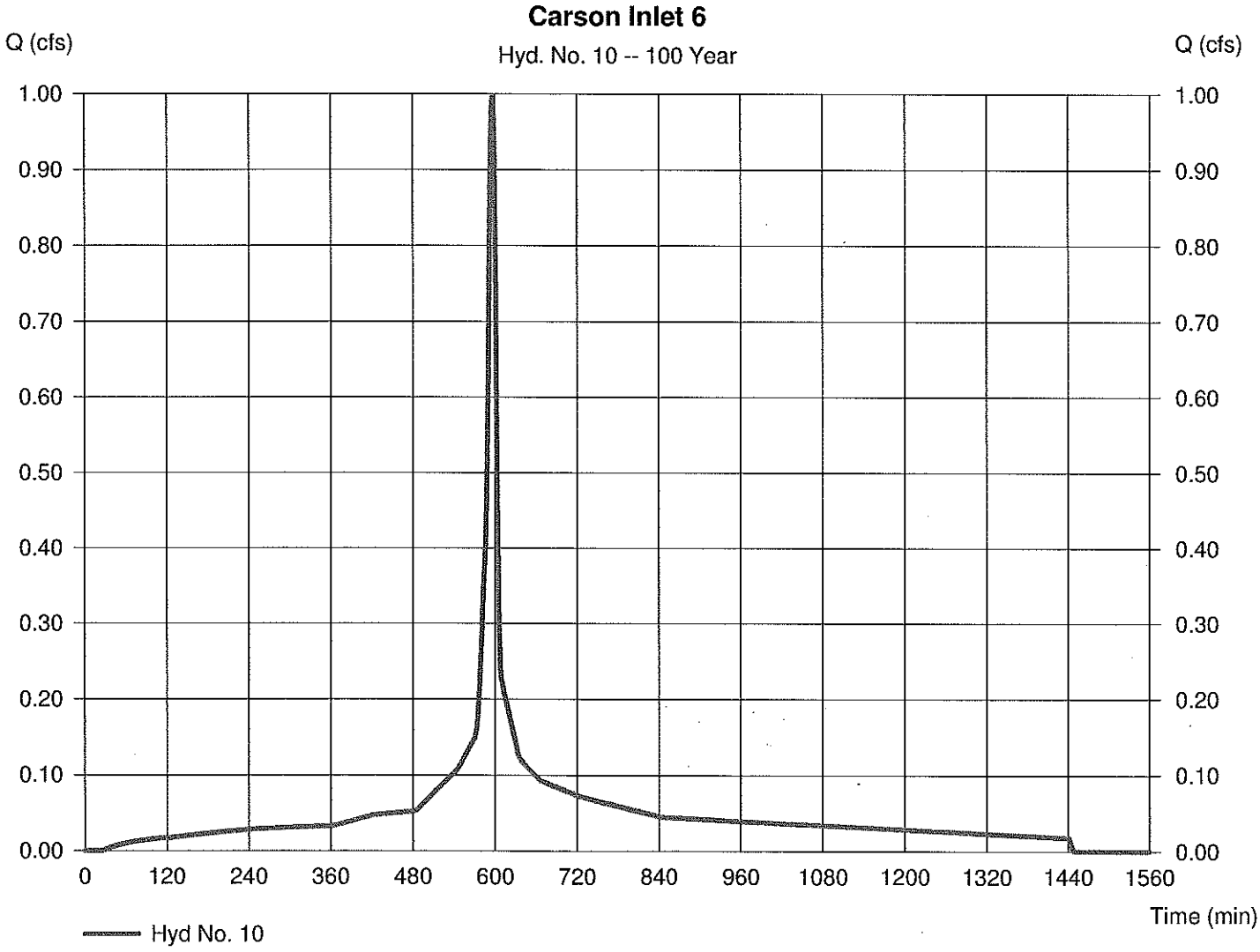


Hydrograph Report

Hyd. No. 10

Carson Inlet 6

Hydrograph type	= SCS Runoff	Peak discharge	= 0.995 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 4,688 cuft
Drainage area	= 0.200 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

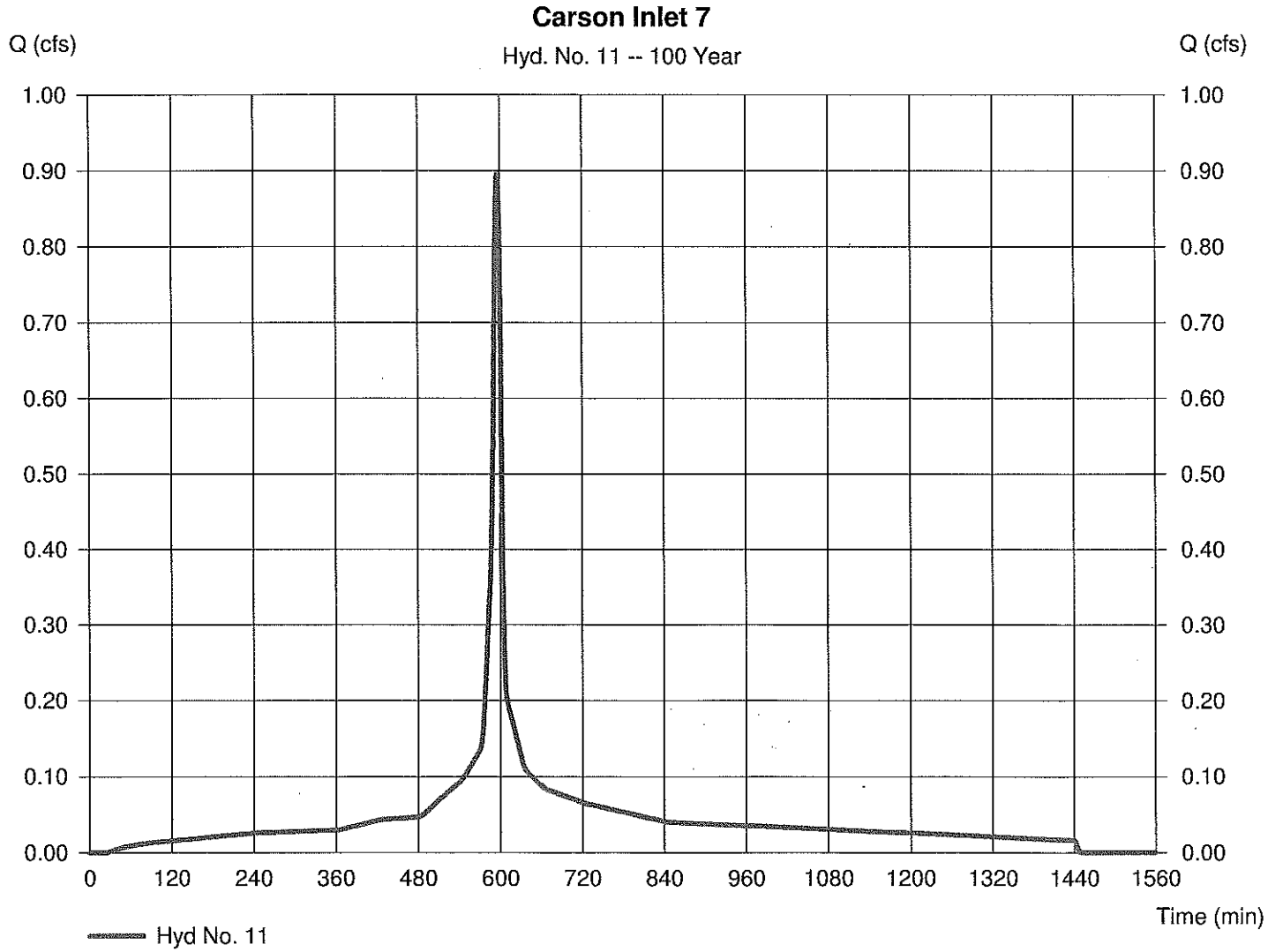


Hydrograph Report

Hyd. No. 11

Carson Inlet 7

Hydrograph type	= SCS Runoff	Peak discharge	= 0.896 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 4,219 cuft
Drainage area	= 0.180 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

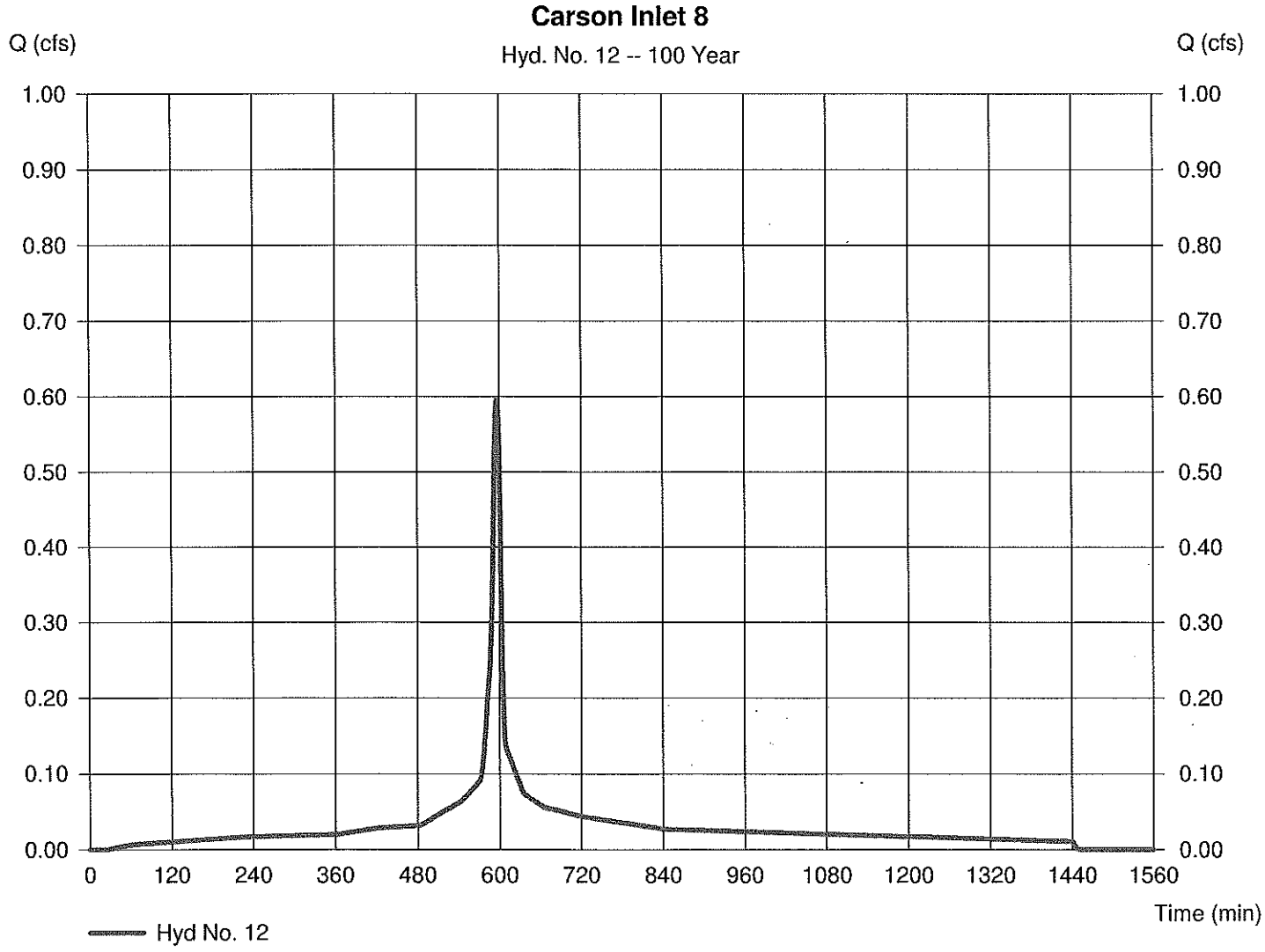


Hydrograph Report

Hyd. No. 12

Carson Inlet 8

Hydrograph type	= SCS Runoff	Peak discharge	= 0.597 cfs
Storm frequency	= 100 yrs	Time to peak	= 596 min
Time interval	= 1 min	Hyd. volume	= 2,813 cuft
Drainage area	= 0.120 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.50 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	36.2224	9.9000	0.8674	--------
3	0.0000	0.0000	0.0000	--------
5	44.3354	8.9000	0.8357	--------
10	56.0411	9.2000	0.8499	--------
25	69.6855	9.5000	0.8556	--------
50	77.7732	9.6000	0.8524	--------
100	86.2993	9.4000	0.8529	--------

File name: Bowie Coordinates July 2008 customIDF.IDF

Intensity = B / (Tc + D)^E

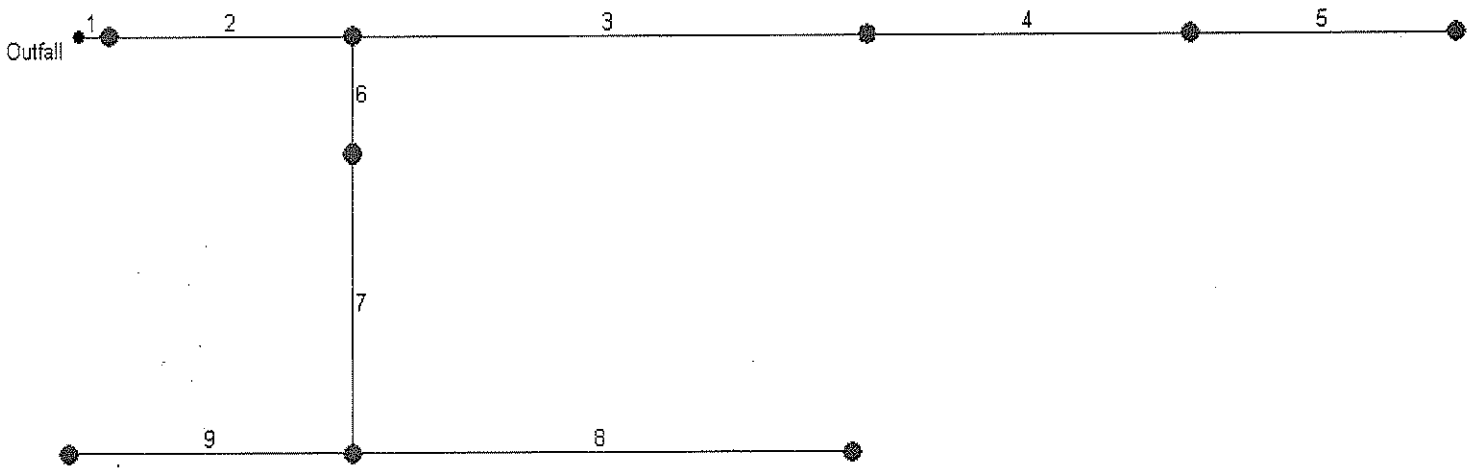
Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	3.48	2.71	2.23	1.90	1.66	1.48	1.34	1.22	1.12	1.04	0.97	0.91
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	4.92	3.80	3.13	2.67	2.33	2.08	1.88	1.72	1.58	1.47	1.37	1.29
10	5.88	4.55	3.74	3.19	2.78	2.48	2.24	2.04	1.88	1.75	1.63	1.53
25	7.07	5.49	4.51	3.85	3.37	3.00	2.71	2.47	2.28	2.11	1.97	1.85
50	7.91	6.16	5.07	4.33	3.79	3.38	3.05	2.79	2.57	2.39	2.23	2.09
100	8.87	6.88	5.66	4.83	4.22	3.76	3.40	3.10	2.86	2.65	2.47	2.32

Tc = time in minutes. Values may exceed 60.

Precip. file name: Carson 24 hr 100 yr rain.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.50	0.00	0.00	0.00	0.00	0.00	6.50
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.30
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hydraflow Plan View



Project File: Storm Sewer.stm	No. Lines: 9	09-08-2008

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 type	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	10.0	0.0	MH	1.49	0.00	0.00	0.0	99.90	1.00	100.00	18	Cir	0.013	0.15	106.00	5 to oil water
2	1	79.0	0.0	MH	0.00	0.00	0.00	0.0	100.00	1.00	100.79	18	Cir	0.013	1.00	106.00	4 to 5
3	2	167.0	0.0	MH	1.44	0.00	0.00	0.0	100.79	1.00	102.46	18	Cir	0.013	0.15	106.00	3 to 4
4	3	105.0	0.0	MH	1.34	0.00	0.00	0.0	102.46	1.00	103.51	12	Cir	0.013	0.15	106.00	2 to 3
5	4	86.0	0.0	MH	1.34	0.00	0.00	0.0	103.51	1.00	104.37	12	Cir	0.013	1.00	106.00	1 to 2
6	2	35.0	90.0	MH	1.00	0.00	0.00	0.0	100.79	1.00	101.14	18	Cir	0.013	0.15	106.00	9 to 4
7	6	89.0	0.0	MH	0.90	0.00	0.00	0.0	101.14	1.00	102.03	12	Cir	0.013	1.00	106.00	7 to 9
8	7	162.0	-90.0	MH	1.00	0.00	0.00	0.0	102.03	1.00	103.65	12	Cir	0.013	1.00	106.00	6 to 7
9	7	92.0	90.0	MH	0.60	0.00	0.00	0.0	102.03	1.00	102.95	12	Cir	0.013	1.00	106.00	8 to 7

Project File: Storm Sewer.stm | Number of lines: 9 | Date: 09-08-2008

My Report

Line No.	DnStm Ln No	Crit Depth (ft)	Line Size (in)	EGL Dn (ft)	EGL Up (ft)	Flow Rate (cfs)	Gnd/Rim El Dn (ft)	HGL Dn (ft)	HGL Up (ft)	Vel Up (ft/s)	Vel Dn (ft/s)	Vel Ave (ft/s)	Line ID	Invert Up (ft)	Invert Dn (ft)
1	Outfall	1.15	18	101.66	101.76 i	9.11	0.00	101.06	101.16	6.24	6.21	6.23	5 to oil water	100.00	99.90
2	1	1.05	18	102.44	102.86	7.62	106.00	102.15	102.57	4.31	4.31	4.31	4 to 5	100.79	100.00
3	2	0.77	18	103.15	103.57 i	4.12	106.00	103.06	103.35	3.77	2.33	3.05	3 to 4	102.46	100.79
4	3	0.69	12	103.66	104.53 i	2.68	106.00	103.48	104.20 j	4.60	3.41	4.01	2 to 3	103.51	102.46
5	4	0.49	12	104.76	105.05 i	1.34	106.00	104.71	104.88	3.34	1.71	2.52	1 to 2	104.37	103.51
6	2	0.71	18	103.15	103.18	3.50	106.00	103.08	103.12	1.98	1.98	1.98	9 to 4	101.14	100.79
7	6	0.67	12	103.29	103.73	2.50	106.00	103.13	103.57	3.18	3.18	3.18	7 to 9	102.03	101.14
8	7	0.42	12	103.89	104.24 i	1.00	106.00	103.86	104.13	2.67	1.27	1.97	6 to 7	103.65	102.03
9	7	0.33	12	103.89	103.91	0.60	106.00	103.88	103.90	0.78	0.76	0.77	8 to 7	102.95	102.03

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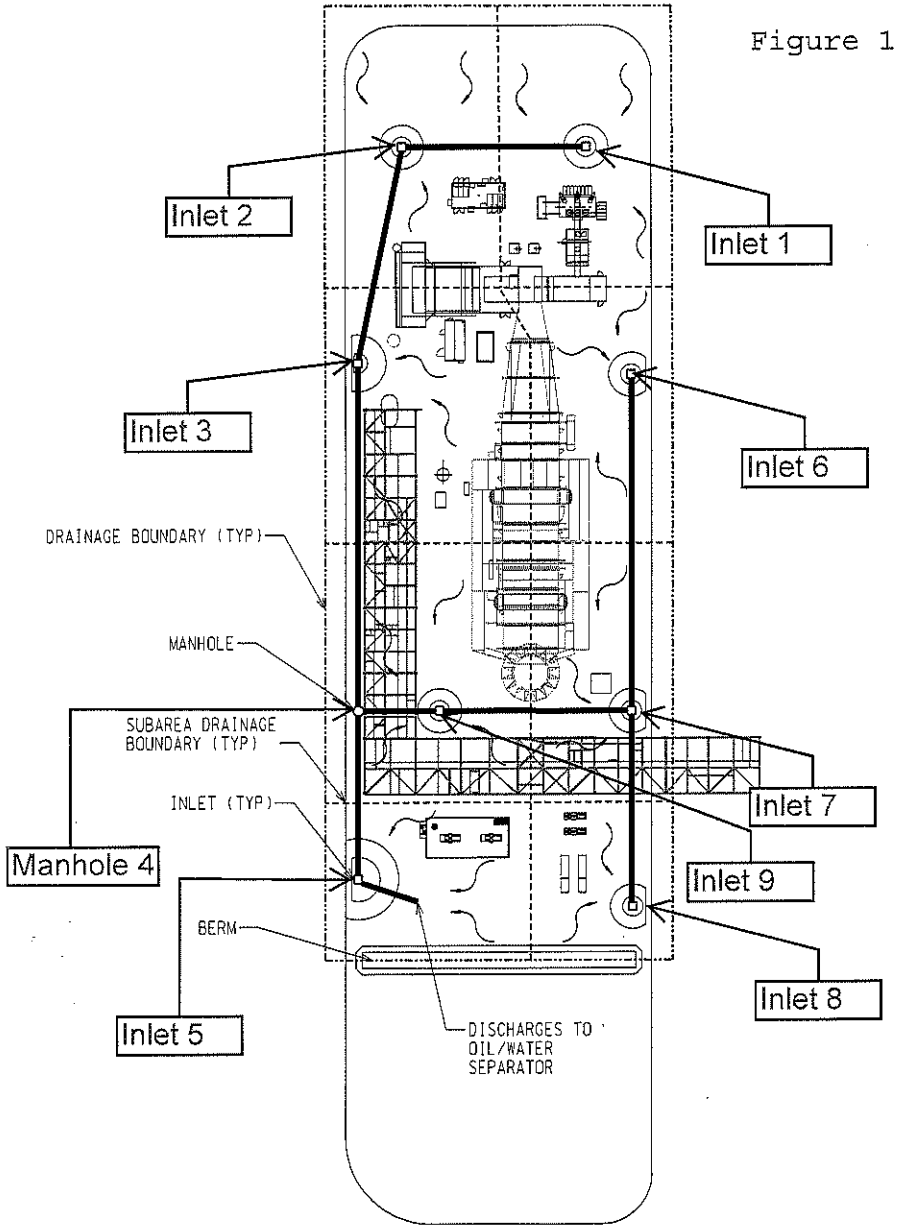
NOTES: i Inlet control; ** Critical depth

Appendix A

Figure 1


Inlet 2
Inlet 1
Inlet 3
Inlet 6
DRAINAGE BOUNDARY (TYP)
MANHOLE
SUBAREA DRAINAGE BOUNDARY (TYP)
INLET (TYP)
Inlet 7
Manhole 4
Inlet 9
BERM
Inlet 8
Inlet 5
DISCHARGES TO OIL/WATER SEPARATOR
N
30 0 30 60
SCALE IN FEET
SCALE: 1" = 30'-0"