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Storm Water Detention/Retention Design

Date: 6/7/2007 Revised: 6/20/2007 Design Method: SCS & TR-55 Method Using Hydroflow Hydrographs

Design By: JAG Revised:

Checked By: RWB Revised:

Project: Interstate Commerce Center 1 File No.: 06F070.000

County: Butler City/Township: Fairfield/West Chester Twp.

Design Criteria And Comments:

Reduce 50 year post-developed storm runoff to that of a 10 year pre-developed storm runoff. Check 100 year runoff for post-developed conditions.

Site Area: 29.92 Acres

Soils: See A

Soils Type: ____ % A 45 % B 55 % C ____ % D

Cover: Grass/Cropland/Wooded Area

Present: CN = 79.6 ? high (See A)

Time of Concentration: 1627' @ 3.52%

t_c = 33.40 minutes

Q_{10} = 46.68 cfs (See B)

Future: 15.34 Impervious Area 14.58 Grass Area

CN = 83.3 (See A)

t_c = From Storm Sewer Calculations

t_c = 12.84 minutes (See Storm Calcs)

Q_{50} = 112.00 cfs (See C)

L (ft) =	1627.00
L' (ft) =	1627.00
Elev 1 =	662.35
Elev 2 =	605.00
s (%) =	3.52
c =	0.40
t_c (min) =	33.40

$=1.8(1.1-c)L^{1/2}/s^{1/3}$

Detention/Retention must detain $Q_{50} - Q_{10}$ = 65.32 cfs

Detention to be provided in the northeast corner of the site. Water quality is incorporated in basin design. (See Water Quality Calcs For Orifice Sizing)

Offsite Area: 21.27 Acres
Site Area: 15.34 Acres
Total Drainage Area: 36.61 Acres

Basin Description: Basin A - North East

Soils: See D

Soils Type: ____ % A 84 % B 16 % C ____ % D

Cover: Impervious Area = 11.44 Acres, Grass/Other Area = 25.17 Acres

CN = 78.4 (See D)
Time of Concentration: From Storm Sewer Calculations
t_c = 12.84 minutes (See Storm Calcs)
Q_{50} = 118.25 cfs (See E)

Basin must reduce flow by: 65.32 cfs
Detention Volume: 5.69 Acre-ft at Elevation: 617.14 (See F)
Outflow Structure: 110'-12" Stm. @ 1.82%
Inlet Inv. = 608.00 Outlet Inv = 606.00 (See F)

Riser Structure		
Orifice	Number - Size (in)	Inv Elev
T/Grate		615.81
3		
2	2-2'x6"	611.79
1	1-2.125" Ø	608.00

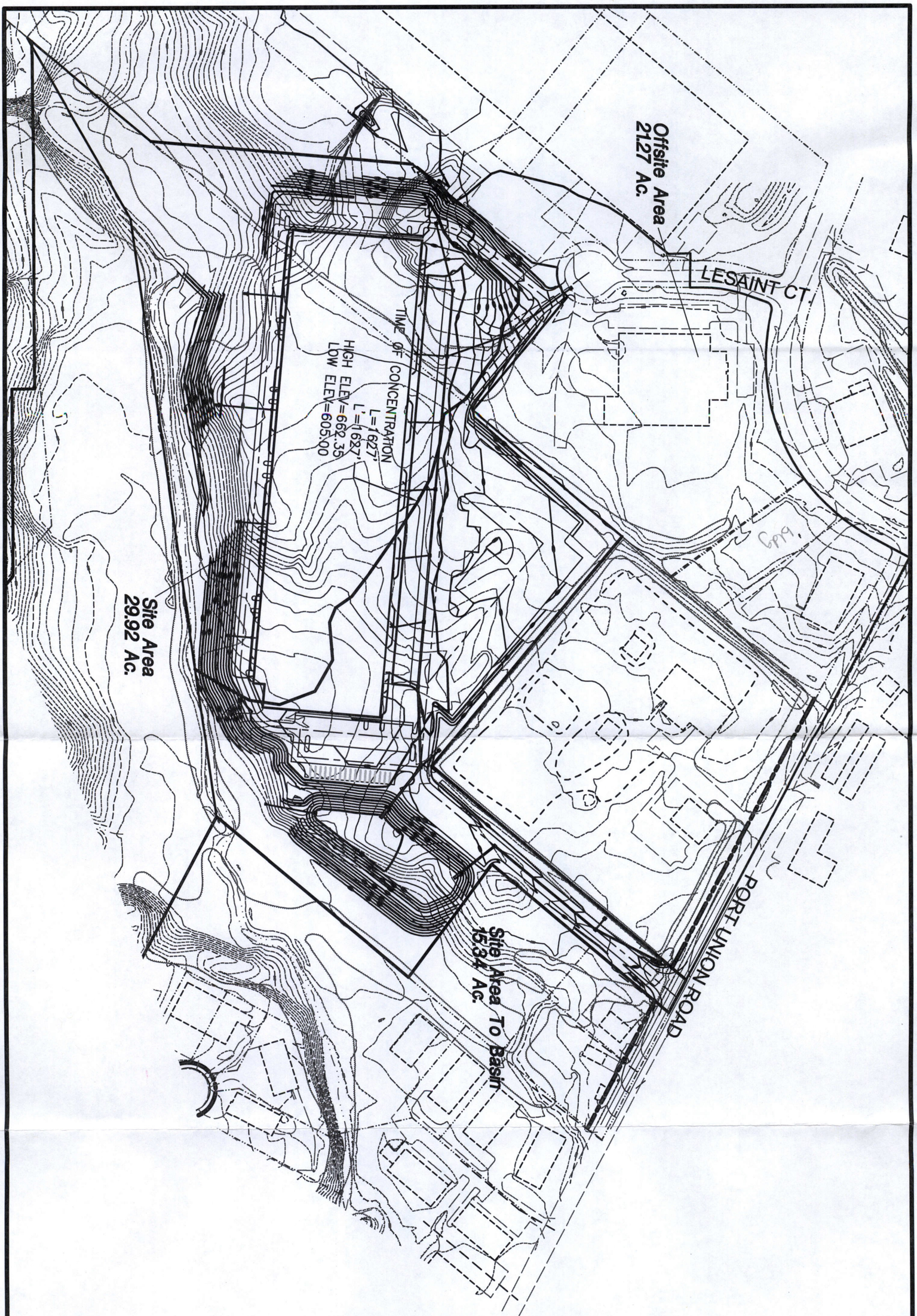
Route Through Basin
Basin Reduces Flow By:
118.25 cfs Inflow - 8.81 cfs Outflow 109.44 cfs - OK
Detention/Retention Elevation: 616.81 (See G)
(With Water Quality Orifice And Volume, Outflow = 8.51 cfs; Elev = 616.06) (See H)

100 Year Flow:
CN = 78.4 (See D)
Time of Concentration: From Storm Sewer Calculations
t_c = 12.84 minutes (See Storm Calculations)
Q_{100} = 134.96 cfs (See I)

Rout Through Basin
Basin Reduces Flow By:
134.96 cfs Inflow - 18.80 cfs Outflow 116.16 cfs
$Elev_{100}$ = 617.14 (See J)
(With Water Quality Orifice And Volume, Outflow = 9.53 cfs; Elev = 616.84) (See K)

Spillway: $Q_{100} = C L H^{3/2}$ C = 2.6 L = 30.00 H = 1.44
Spillway Invert = 616.81 100-Yr Weir Flow = 618.25
Top of Dike Elevation = 618.75 Freeboard = 0.50
Spillway Side Slope (_ : 1) = 3.00

Comments: Detention basin needs to detain 69 CFS. As designed, the basin will detain 109.44 CFS. Detention basin is adequate as designed.



INTERSTATE COMMERCE CENTER 1

PORT UNION ROAD AND LeSAINT COURT
HAMILTON, OHIO, WEST CHESTER TOWNSHIP
BUTLER COUNTY, OHIO
SECTION 9, TOWN 2, RANGE 2

DRAINAGE EXHIBIT

Drawing:	06F070DR
Scale	1"=150'
Drawn by:	JAG
Checked By:	RWB
Issue Date:	6/7/2007

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INTERSTATE COMMERCE CENTER 1

PORT UNION ROAD AND LeSAINT COURT
HAMILTON, OHIO, WEST CHESTER TOWNSHIP
BUTLER COUNTY, OHIO
SECTION 9, TOWN 2, RANGE 2

SOIL EXHIBIT

Drawing:	06F070DR
Scale	1"=150'
Drawn by:	JAG
Checked By:	RWB
Issue Date:	6/7/2007

Soil Information

A

Site Drainage Area

Soils		Area (ft^2)	A Soil (ft^2)	B Soil (ft^2)	C Soil (ft^2)	D Soil (ft^2)
XeB	Xenia	52140	-	52140	-	-
XeB2	Xenia	451466	-	451466	-	-
MsC2	Miamian	188769	-	-	144408	-
	Russell		-	44361	-	-
RdA	Raub	81167	-	-	81167	-
Ee	Eel	402971	-	-	402971	-
HeE2	Miamian	104956	-	30868	-	-
	Hennepin		-	-	74088	-
RvB2	Miamian	21970	-	-	8239	-
	Russell		-	13731	-	-
Totals		1303439		592566	710873	
Percentages		100		45	55	

Note:

Soil areas calculated based on A, B, C, and D soils rather than individually. B/C soils were calculated based on the percentages of B and C soils.

Curve Number Calculations

Predeveloped Site

Land Use	%	A Soil	B Soil	C Soil	D Soil
Agricultural	85.0	67	78	85	89
Wooded	15.0	36	60	73	79
Composite	79.6		34.2	45.4	

Developed Site

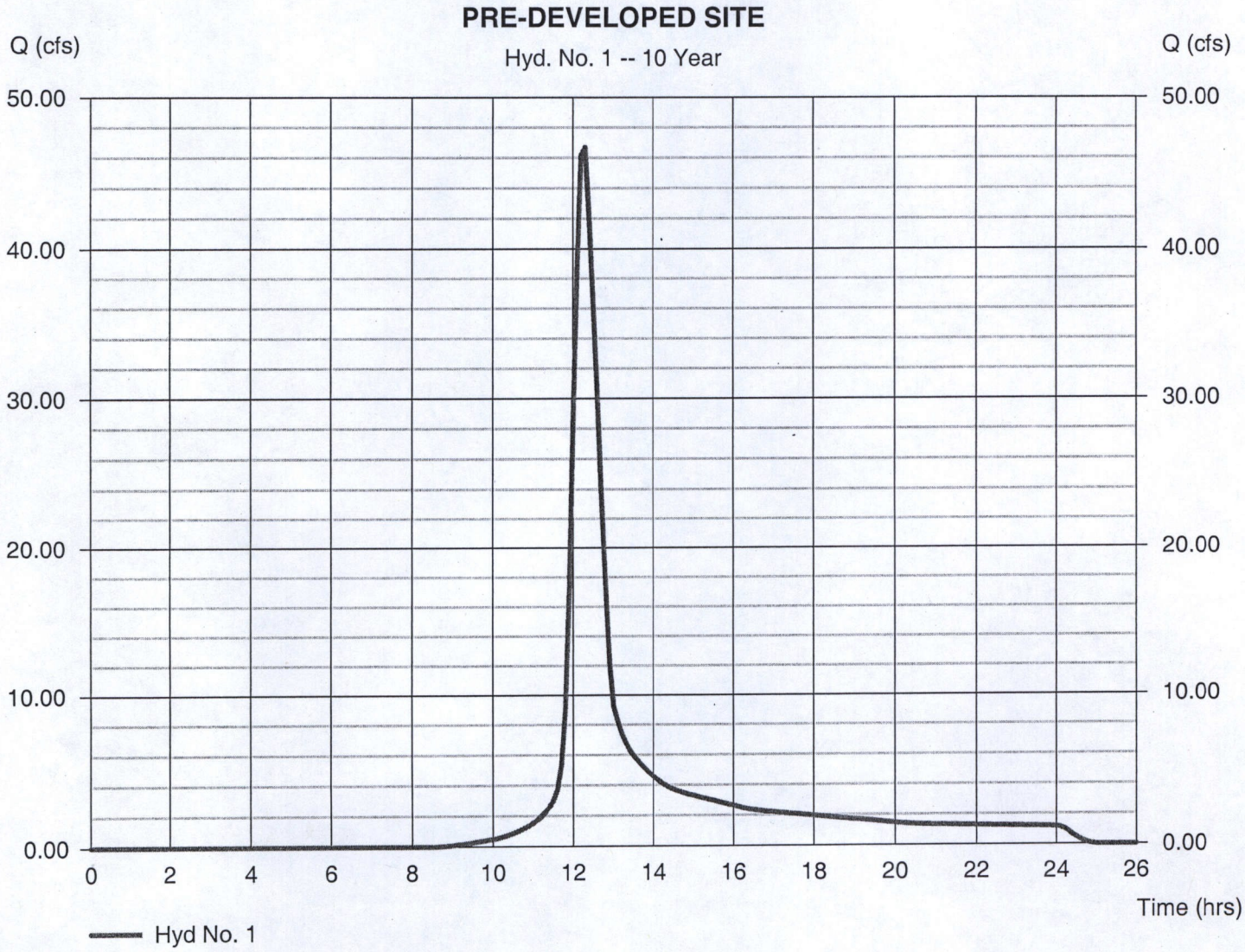
Land Use	%	A Soil	B Soil	C Soil	D Soil
Impervious	51.0	98	98	98	98
Grass	49.0	39	61	74	80
Composite	83.3		36.3	47.0	

Hydrograph Report

Hyd. No. 1

PRE-DEVELOPED SITE

Hydrograph type	= SCS Runoff	Peak discharge	= 46.68 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 6 min	Hyd. volume	= 5.404 acft
Drainage area	= 29.920 ac	Curve number	= 79.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 33.40 min
Total precip.	= 4.15 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



C

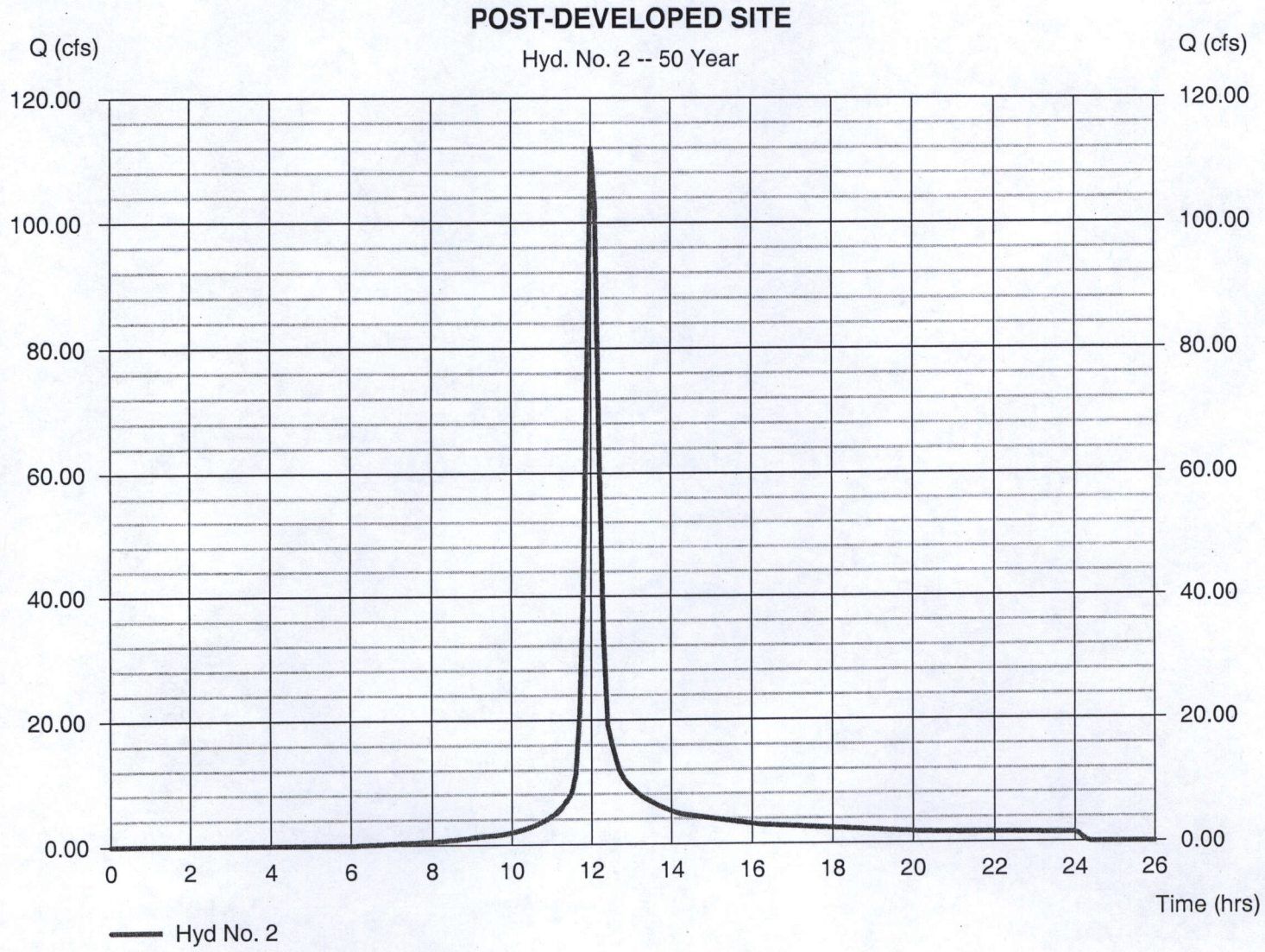
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Hyd. No. 2

POST-DEVELOPED SITE

Hydrograph type	= SCS Runoff	Peak discharge	= 112.00 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 7.912 acft
Drainage area	= 29.920 ac	Curve number	= 83.3
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 12.80 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Soil Information

D

Basin Description: Basin A-North East

Soils		Area (ft^2)	A Soil (ft^2)	B Soil (ft^2)	C Soil (ft^2)	D Soil (ft^2)
Ud	Udorthents	124133	-	124133	-	-
XeB2	Xenia	1137329	-	1137329	-	-
MsC2	Miamian	229221	-	-	175354	-
	Russell		-	53867	-	-
RdA	Raub	43507	-	-	43507	-
Ee	Eel	20550	-	-	20550	-
RvB2	Miamian	39992	-	-	14997	-
	Russell		-	24995	-	-
Totals		1594732	0	1340324	254408	0
Percentages		100		84	16	

Note:

Soil areas calculated based on A, B, C, and D soils rather than individually. B/C soils were calculated based on the percentages of B and C soils.

Curve Number Calculations

Land Use	%	A Soil	B Soil	C Soil	D Soil
Impervious	31.3	98	98	98	98
Grass	10.6	39	61	74	80
Offsite	58.1	49	69	79	84
Composite	78.4		64.9	13.5	

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Project:	Interstate Commerce Center 1	Designed By:	JAG	Date:	6/7/07
Job No.:	06F-070	Checked By:		Date:	
Basin ID:	Basin A-North East	Revised By:	JAG	Date:	6/21/07

Required Water Quality Volume

$WQ_v = P\ C\ A/12$

Site Drainage Area (A) = 15.34 acres (To Basin)

Rainfall Depth (P) = 0.75 in.

Runoff Coefficient (C) = 0.8

WQ_v = 0.767 acre-ft.

Sediment Storage Allowance = 20 %

Sediment Storage Allowance = 0.15 Ac-ft

Total WQ_v = 0.920 Ac-ft

= 40,093 cu.ft.

Water Quality Release Rate

Q_{wqv} = Total WQ_v/RT

Retention Time (RT) = 48 hours

Q_{wqv} = 0.23 cfs

Water Quality Outlet Orifice

Contour Areas

	Elevation ft	Area ft^2	Volume ft^3	Cum. Vol. ft^3	Elevation at V	Storage at Elev
Basin Inv. =	608.00	0.00	0.00	0.00		
Contour 1 =	610.00	13750.00	13750.00	13750.00		
Contour 2 =	612.00	30252.00	44002.00	57752.00	611.20	53175.41
Contour 3 =	614.00	35223.00	65475.00	123227.00		
Contour 4 =	616.00	40424.00	75647.00	198874.00		
Contour 5 =	618.00	45855.00	86279.00	285153.00		
Contour 6 =						
Contour 7 =						
Contour 8 =						
Contour 9 =						
Contour 10 =						
Contour 11 =						
Contour 12 =						
Contour 13 =						
Contour 14 =						

$Q = N\ C_d\ A_o\ (2\ g\ \Delta h)^{1/2}$

C_d = 0.61

$A_o = \pi\ D^2/4$ for circular orifices; = h * w for rectangular orifices

g = 32.20 ft/sec^2

$Q = Q_{wqv}$ = 0.23 cfs

Required Volume = V = 40093 ft^3

Elevation at V = 611.20

Number of orifices = N = 1

Orifice h = 2.125 inch

Orifice w = 0.00 inch (= 0 for circular orifice)

Δh_{min} = Elev at V - Basin Inv - 1/2 h = 3.11 ft

$A_{trial} = Q/(N\ C_d\ (2\ g\ \Delta h_{min})^{1/2})$ = 3.87 in^2

Actual $A = A_o$ = 3.55 in^2

$\Delta h = (Q/(N\ C_d\ A_o))^2/(2\ g)$ = 3.70 ft

Elev = 611.79 > Elevation at V = 611.20 Good

Storage = 53175.41 ft^3

Storm Sewer Design

10 yr. Storm

Project: INTERSTATE COMMERCE I
Job No.: 06F070-001

Formulas Used:
Q_r = ACI
V_p = 1.486 R^(2/3) S^(1/2)/n
Q_p = A_p V_p

Bayer Becker Engineers

Designed By: JLR Date:
Reviewed By: Date:
Revisions: Date:

Revisions: Date:
Revisions: Date:
Revisions: Date:

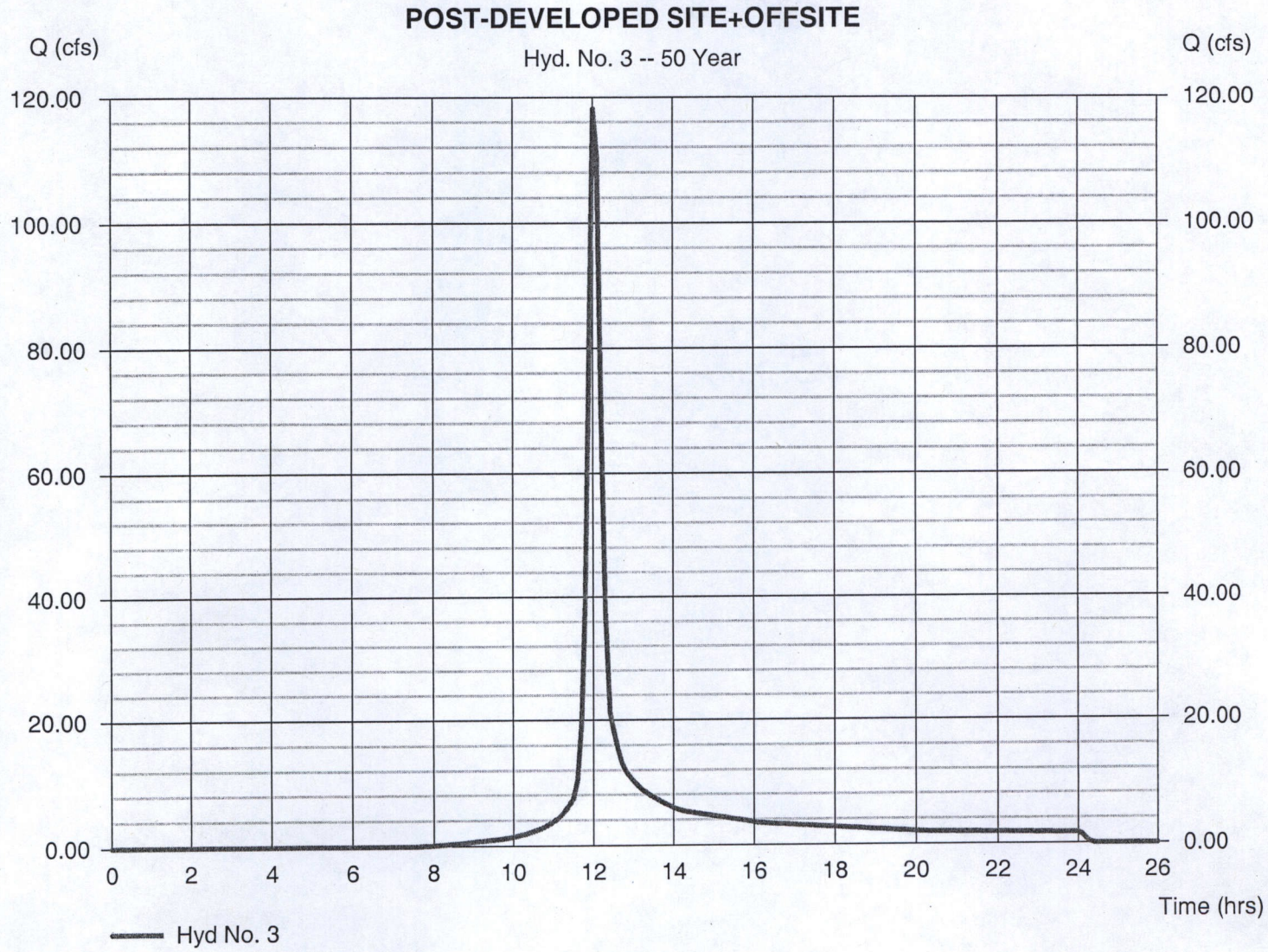
LOCATION			TOPOGRAPHY					TIME					DESIGN						Const
Street	From Structure	To Structure	Area No.	Area (acres)	"C"	A*C (acres)	Cumm. AC (acres)	T_o-inlet (min.)	T_p-pipe (min.)	T_c-conc. (min.)	Intensity (in./hr.)	Q_r (c.f.s.)	Pipe Size (inches)	"n"	Distance (ft.)	Slope (%)	Velocity (ft./sec)	Q_p (c.f.s.)	Flow Time (min.)
DOCK	1	2	1	0.53	0.72	0.38	0.38	10.00	0.00	10.00	5.15	1.97	12	0.015	170	7.10	10.48	8.23	0.27
DRIVE	2	7	2	0.11	0.80	0.09	0.47	10.00	0.27	10.27	5.11	2.40	12	0.015	144	4.00	7.86	6.18	0.31
	3	5	3	1.58	0.81	1.28	1.28	10.00	0.00	10.00	5.15	6.60	15	0.015	154	4.00	9.12	11.20	0.28
	4	5	4	0.57	0.95	0.54	0.54	10.00	0.00	10.00	5.15	2.79	12	0.015	66	1.00	3.93	3.09	0.28
	5	7	5	0.91	0.61	0.55	2.37	10.00	0.28	10.28	5.11	12.12	24	0.015	146	0.70	5.22	16.40	0.47
	6	7	6	0.49	0.95	0.47	0.47	10.00	0.00	10.00	5.15	2.40	12	0.015	67	1.00	3.93	3.09	0.28
	7	9	7	0.97	0.77	0.75	4.06	10.28	0.47	10.75	5.04	20.45	30	0.015	146	1.00	7.24	35.55	0.34
	8	9	8	0.49	0.95	0.47	0.47	10.00	0.00	10.00	5.15	2.40	12	0.015	66	1.00	3.93	3.09	0.28
	9	11	9	0.71	0.76	0.54	5.06	10.75	0.34	11.08	4.99	25.25	30	0.015	146	0.70	6.06	29.74	0.40
	10	11	10	0.49	0.95	0.47	0.47	10.00	0.00	10.00	5.15	2.40	12	0.015	67	1.00	3.93	3.09	0.28
	11	13	11	4.94	0.69	3.40	8.92	11.08	0.40	11.48	4.93	43.99	36	0.015	146	0.80	7.31	51.70	0.33
	12	13	12	0.49	0.95	0.47	0.47	10.00	0.00	10.00	5.15	2.40	12	0.015	67	1.00	3.93	3.09	0.28
	13	15	13	0.63	0.86	0.54	9.93	11.48	0.33	11.82	4.88	48.50	42	0.015	146	0.70	7.58	72.95	0.32
	14	15	14	0.49	0.95	0.47	0.47	10.00	0.00	10.00	5.15	2.40	12	0.015	72	1.00	3.93	3.09	0.31
	15	17	15	0.52	0.90	0.47	10.86	11.82	0.32	12.14	4.84	52.56	42	0.015	141	0.70	7.58	72.95	0.31
	16	17	16	0.41	0.95	0.39	0.39	10.00	0.00	10.00	5.15	2.01	12	0.015	70	1.00	3.93	3.09	0.30
	17	19	17	1.78	0.87	1.55	12.81	12.14	0.31	12.45	4.80	61.42	42	0.015	178	0.70	7.58	72.95	0.39
	18	19	18	4.41	0.45	2.00	2.00	10.00	0.00	10.00	5.15	10.28	15	0.015	54	4.40	9.57	11.74	0.09
	19	20	19	0.21	0.92	0.19	15.00	12.45	0.39	12.84	4.74	71.13	42	0.015	120	0.70	7.58	72.95	0.26
PORT	21	23	20	8.14	0.50	4.11	4.11	10.00	0.00	10.00	5.15	21.17	30	0.015	158	0.50	5.12	25.14	0.51
UNION	22	23	21	4.41	0.48	2.11	2.11	10.00	0.00	10.00	5.15	10.87	18	0.015	32	3.40	9.50	16.79	0.06
DRIVE	23	24	22	0.62	0.84	0.52	6.74	10.00	0.51	10.51	5.07	34.20	36	0.015	289	0.50	5.78	40.87	0.83
	24	25	23	0.45	0.93	0.42	7.16	10.51	0.83	11.35	4.95	35.43	36	0.015	96	0.50	5.78	40.87	0.28
COL. 4	26	27	24	0.90	0.95	0.86	0.86	10.00	0.00	10.00	5.15	4.40	15	0.015	72	1.00	4.56	5.60	0.26
COL. 9	28	29	25	0.82	0.95	0.78	0.78	10.00	0.00	10.00	5.15	4.01	15	0.015	128	1.00	4.56	5.60	0.47
COL. 14	30	31	26	0.82	0.95	0.78	0.78	10.00	0.00	10.00	5.15	4.01	15	0.015	52	1.00	4.56	5.60	0.19
COL. 19	32	33	27	0.88	0.95	0.84	0.84	10.00	0.00	10.00	5.15	4.31	15	0.015	52	1.00	4.56	5.60	0.19

Hydrograph Report

Hyd. No. 3

POST-DEVELOPED SITE+OFFSITE

Hydrograph type	= SCS Runoff	Peak discharge	= 118.25 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 8.349 acft
Drainage area	= 36.610 ac	Curve number	= 78.4
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 12.80 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Pond Report

Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Pond No. 1 - Basin A-North East

Pond Data

Contours - User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 608.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	608.00	00	0.000	0.000
2.00	610.00	13,750	0.316	0.316
4.00	612.00	30,252	1.010	1.326
6.00	614.00	35,223	1.503	2.829
8.00	616.00	40,424	1.737	4.566
10.00	618.00	45,855	1.981	6.546

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	2.13	0.00	0.00
Span (in)	= 12.00	2.13	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 608.00	608.00	0.00	0.00
Length (ft)	= 110.00	0.00	0.00	0.00
Slope (%)	= 1.82	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.61	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

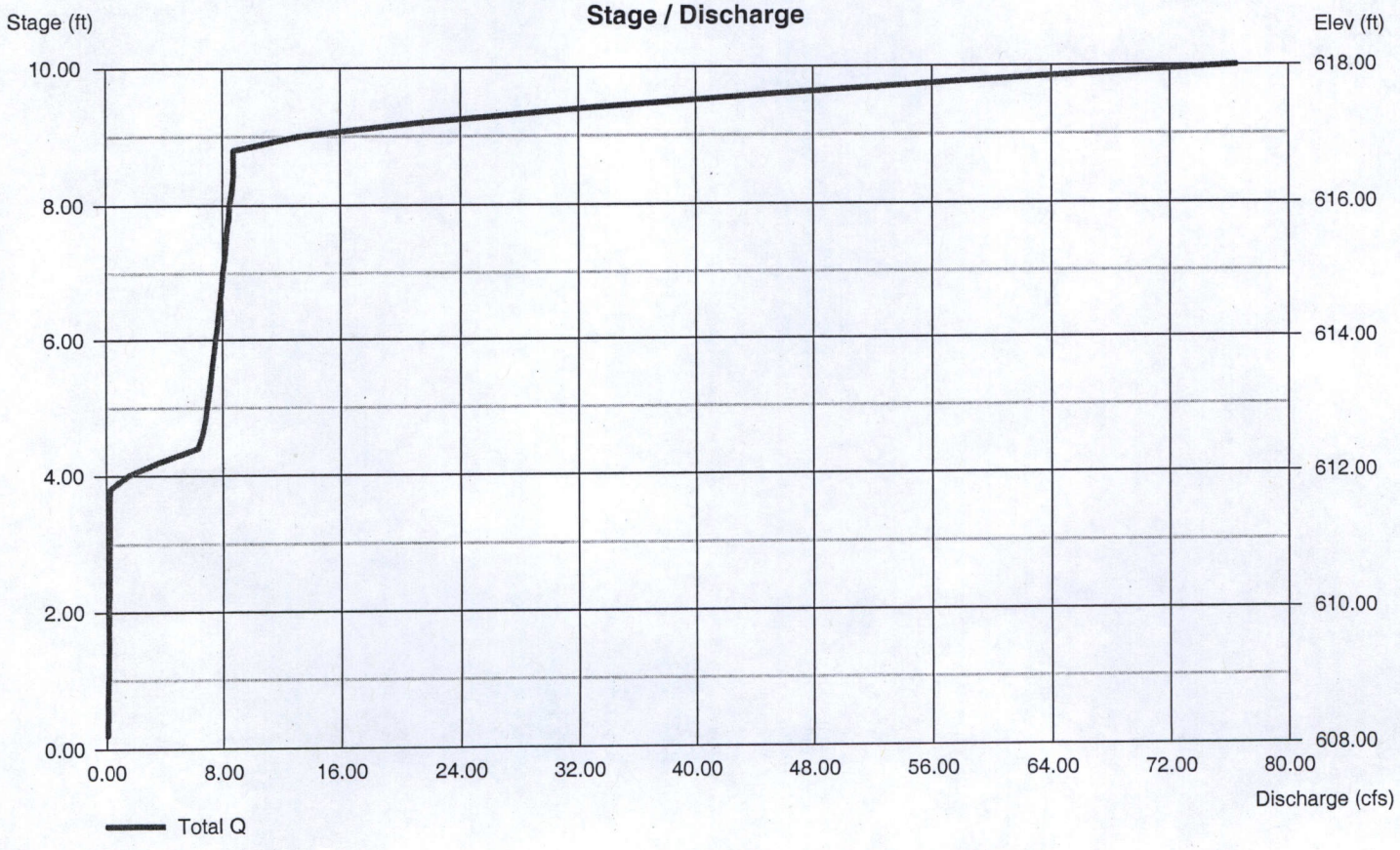
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	4.00	20.00	0.00
Crest El. (ft)	= 615.81	611.79	616.81	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= Riser	Rect	Broad	---
Multi-Stage	= Yes	Yes	No	No

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

TW Elev. (ft) = 0.00

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



Hydrograph Report

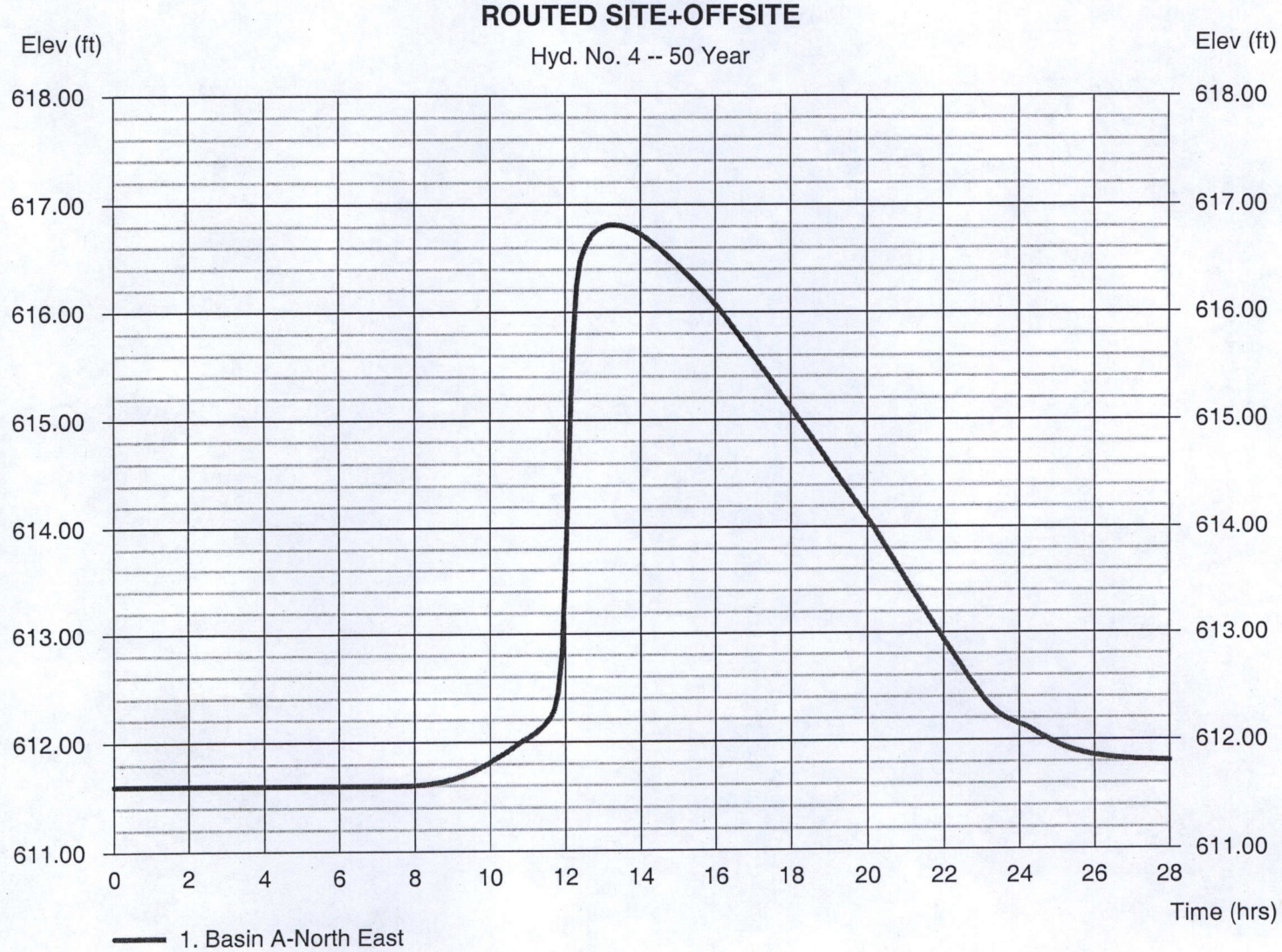
Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Hyd. No. 4

ROUTED SITE+OFFSITE

Hydrograph type	= Reservoir	Peak discharge	= 8.805 cfs
Storm frequency	= 50 yrs	Time to peak	= 864 min
Time interval	= 6 min	Hyd. volume	= 8.342 acft
Inflow hyd. No.	= 3 - POST-DEVELOPED SITE+OFFSITE	Max. Elevation	= 616.81 ft
Reservoir name	= Basin A-North East	Max. Storage	= 5.369 acft

Storage Indication method used. Wet pond routing start elevation = 611.60 ft.



Hydrograph Report

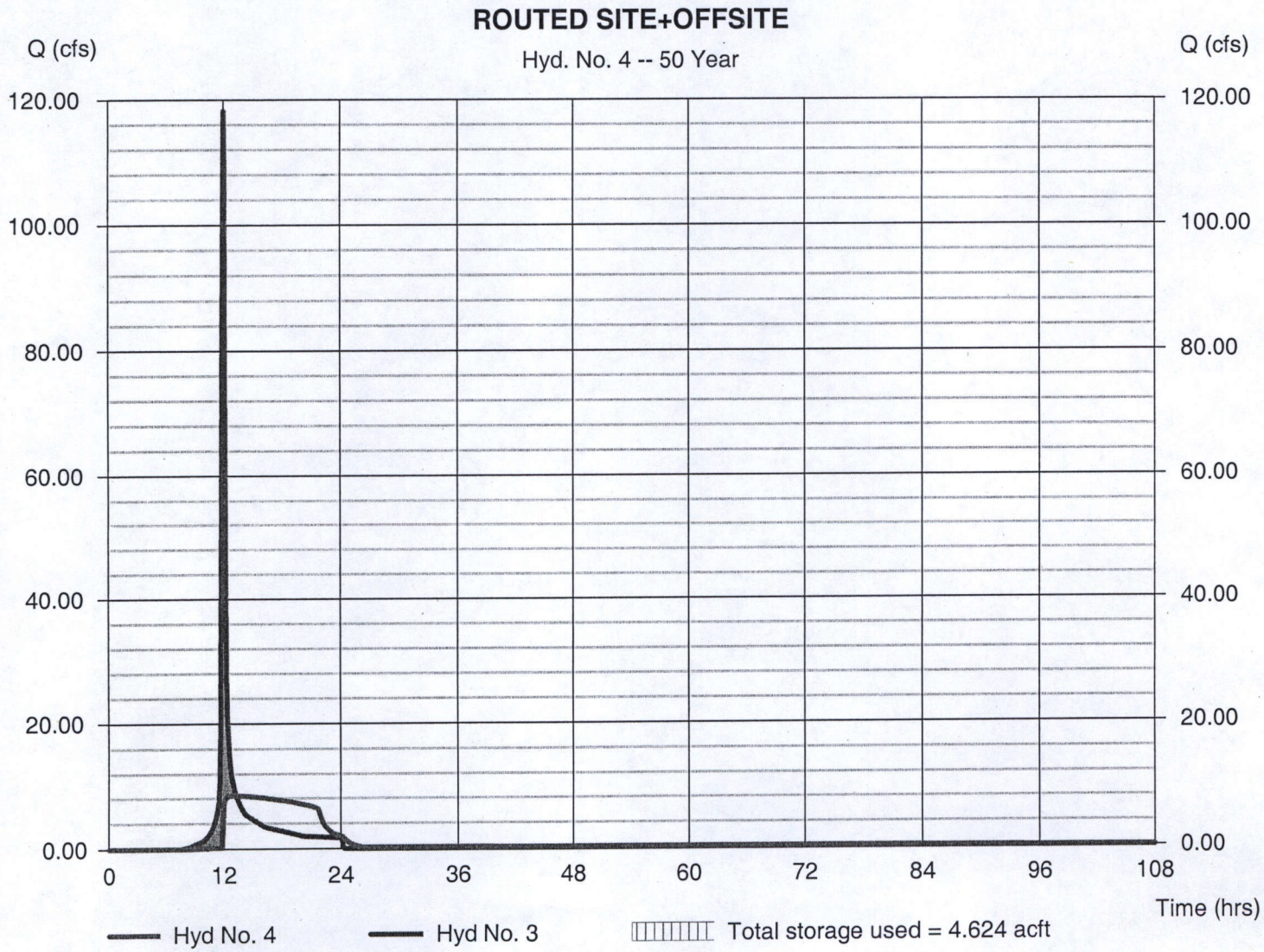
Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Hyd. No. 4

ROUTED SITE+OFFSITE

Hydrograph type	= Reservoir	Peak discharge	= 8.505 cfs
Storm frequency	= 50 yrs	Time to peak	= 798 min
Time interval	= 6 min	Hyd. volume	= 8.348 acft
Inflow hyd. No.	= 3 - POST-DEVELOPED SITE+OFFSITE	Max. Elevation	= 616.06 ft
Reservoir name	= Basin A-North East	Max. Storage	= 4.624 acft

Storage Indication method used.



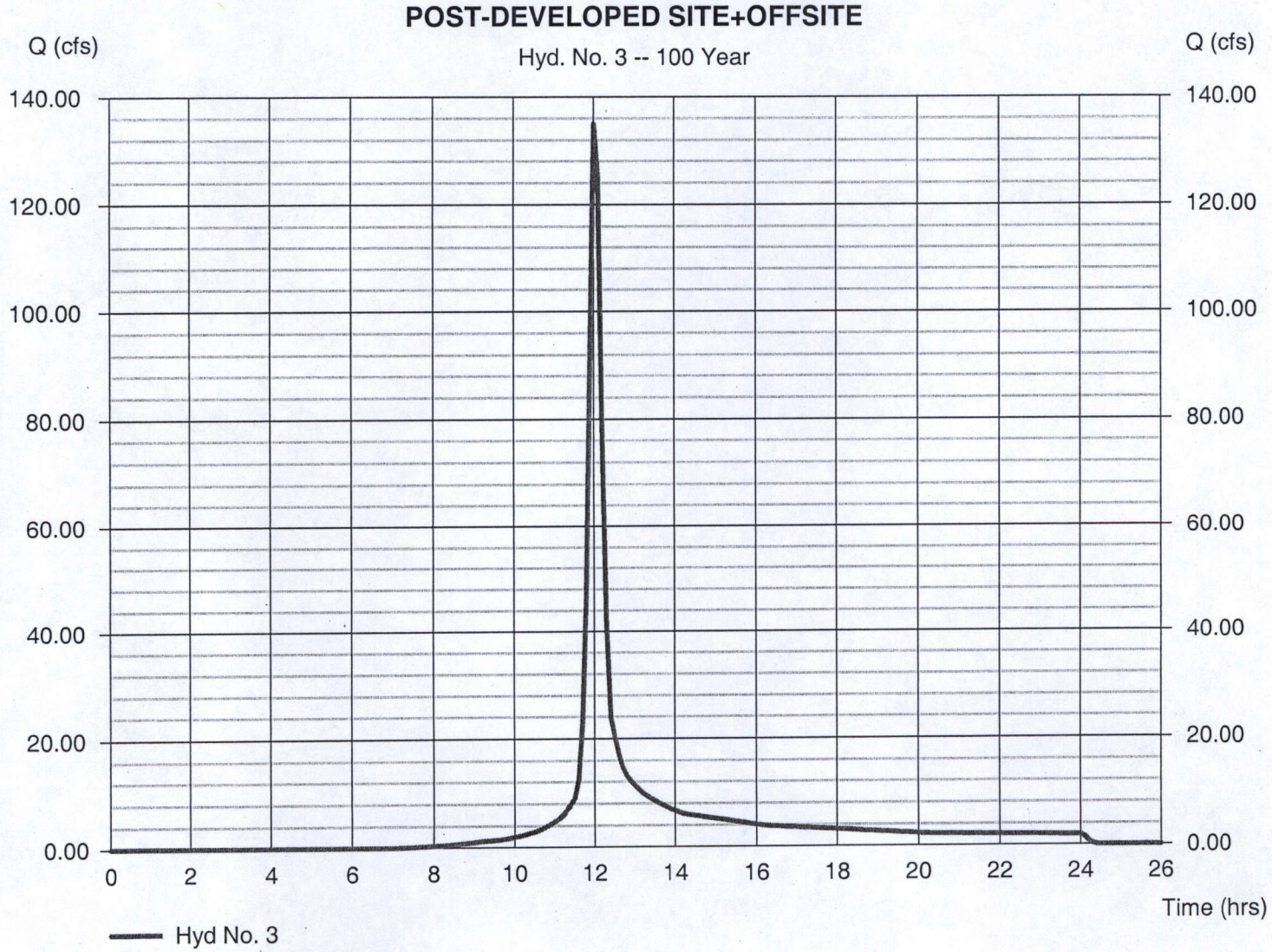
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Thursday, Jun 21, 2007

Hyd. No. 3

POST-DEVELOPED SITE+OFFSITE

Hydrograph type	= SCS Runoff	Peak discharge	= 134.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 6 min	Hyd. volume	= 9.518 acft
Drainage area	= 36.610 ac	Curve number	= 78.4
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 12.80 min
Total precip.	= 5.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Hydrograph Report

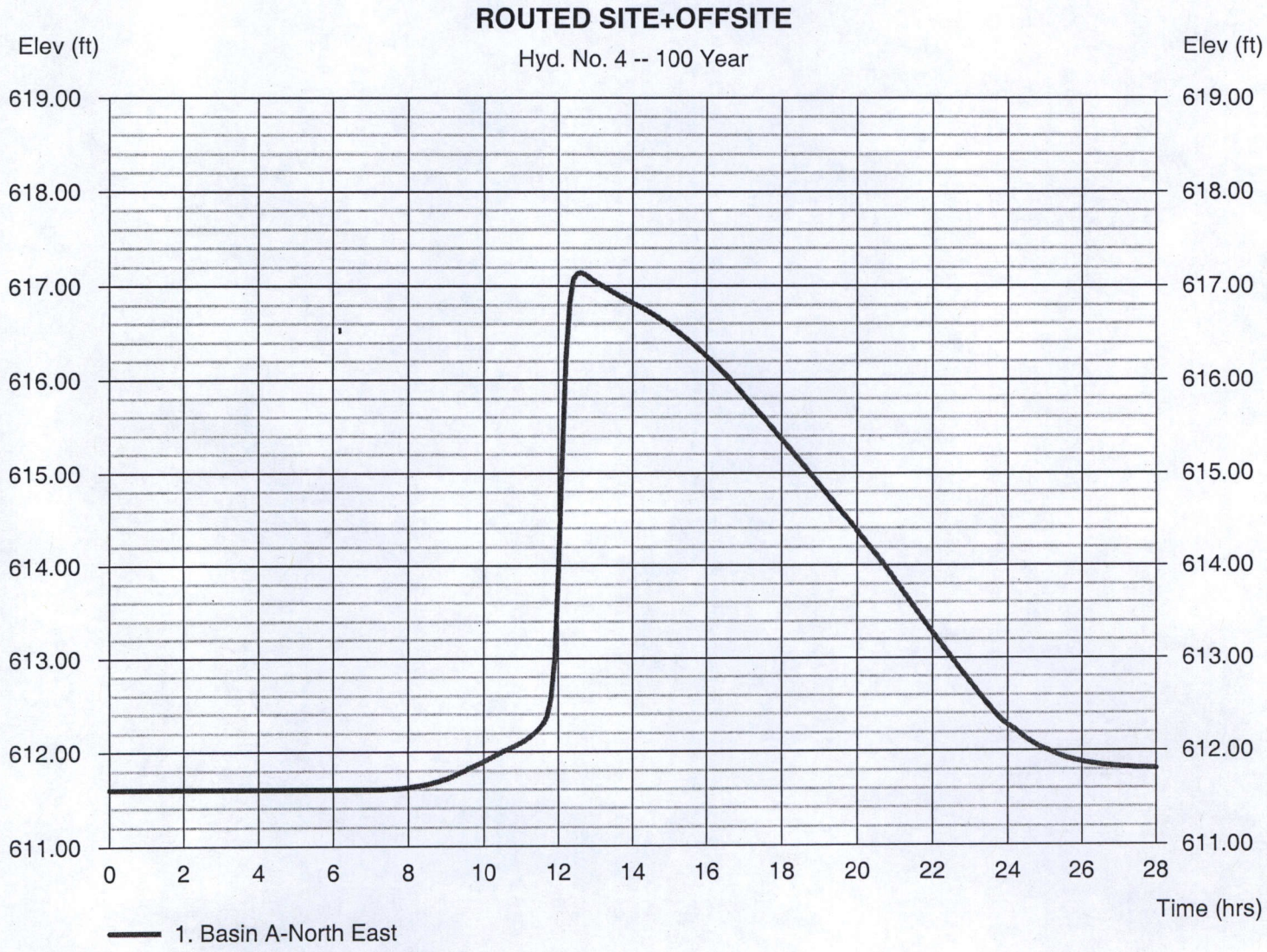
Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Hyd. No. 4

ROUTED SITE+OFFSITE

Hydrograph type	= Reservoir	Peak discharge	= 18.80 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 6 min	Hyd. volume	= 9.511 acft
Inflow hyd. No.	= 3 - POST-DEVELOPED SITE+OFFSITE	Max. Elevation	= 617.14 ft
Reservoir name	= Basin A-North East	Max. Storage	= 5.688 acft

Storage Indication method used. Wet pond routing start elevation = 611.60 ft.



Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 — Wednesday, Jun 20, 2007

Hyd. No. 4

ROUTED SITE+OFFSITE

Hydrograph type	= Reservoir	Peak discharge	= 9.530 cfs
Storm frequency	= 100 yrs	Time to peak	= 798 min
Time interval	= 6 min	Hyd. volume	= 9.517 acft
Inflow hyd. No.	= 3 - POST-DEVELOPED SITE+OFFSITE	Max. Elevation	= 616.84 ft
Reservoir name	= Basin A-North East	Max. Storage	= 5.394 acft

Storage Indication method used.

