STORMWATER DETENTION ANALYSIS
the estates of
SPRING HILL

Prepared For:

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SUITE 318
DES PERES, MISSOURI 63131
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Prepared By:

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6240 MEXICO ROAD
ST. PETERS, MISSOURI 63376
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NOVEMBER 9, 1992

REVISED: DECEMBER 10, 1992

I. Purpose

The purpose of this report is to estimate the expected increase in stormwater runoff due to development of the 34.133 acre tract of land known as "the estates of Spring Hill" along with a 6.50 acre tract of land known as the "Schneller Tract" and to estimate the attenuation characteristics of the detention facility that is proposed to be constructed as part of the subdivision improvements.

II. Detention Concept

The proposed site improvements include construction of a normally dry detention basin along the southern property line of the site. The storage volumes and outflow rates of this facility have been proportioned to insure that the peak rate of runoff leaving the sites under post-developed conditions is equal to or lower than the peak rate of runoff leaving the site under pre-developed conditions for the design storms.

III. Stormwater Runoff Information

1. Area of Tract: 34.133 Ac

Pre-developed land use: Unimproved, 5% Impervious

Post-developed land use: SFR Subdivision, 40% Impervious

2. Run-Off Estimates

Pre-developed:

100 Year: $Q = P.I. \times A$

$Q = 2.95 \times 34.133\ Ac$

$Q = 100.69\ cfs$

Post-developed:

100 Year: $Q = P.I. \times A$

$Q = 4.17 \times 34.133\ Ac$

$Q = 142.33\ cfs$

Estimate of Runoff Increase:

100 Year: Increase $\cong 142.33 - 100.69 \cong 41.64\ cfs$

∴ Minimum Attenuation Required in Detention Basin: 41.64 cfs

III A. Stormwater Runoff Information (Schneller Tract)

Area of Tract: 5.7394 Ac

Pre-developed land use: Unimproved, 5% Impervious

Post-developed land use: SFR Subdivision, 40% Impervious

Run-Off Estimates for 100 Year

Pre-developed: $Q = PI \times A$

$Q = 2.95 \times 5.7394$

$Q = 16.93$ cfs

Post-developed: $Q = PI \times A$

$Q = 4.17 \times 5.7394$

$Q = 23.93$ cfs

Estimate of Runoff Increase for 100 Year

$23.93 - 16.93 \cong 7.0$ cfs

Area of Tract: 0.7607 Ac

Pre-developed land use: Unimproved, 5% Impervious

Post-developed land use: C-3 Commercial, 100% Impervious

Run-Off Estimates for 100 Year

Pre-developed: $Q = PI \times A$

$Q = 2.95 \times 0.7607$

$Q = 2.24$ cfs

Post-developed: $Q = PI \times \Delta$

$Q = 6.08 \times 0.7607$

$Q = 4.63$ cfs

ESTIMATE OF RUNOFF INCREASE FOR 100 YEAR

$4.63 - 2.24 \cong 2.39$ cfs

∴ MINIMUM ATTENUATION REQUIRED IN DETENTION BASIN $\cong$ 9.39 cfs

TOTAL RUNOFF INCREASE FOR 100 YEAR STORM SPRING HILL & SCHNELLER TRACT : 41.64 + 9.39

∴ MINIMUM ATTENUATION REQUIRED IN DETENTION BASIN : 51.03 cfs

$51.03 \times 20_{MIN} \times 60_{SEC} = 61,240_{CF}$

22.2 ACRES $= 125 \times 22 \times 2 = 5,500$ CF $+ 61,240$

TOTAL DET REQD. $= 66,740$ C.F.

APPROX 70,710 SUPPLIED.

APPROX 6% OVER REQD STORAGE

ACTUAL OUTFLOW AT 100 YEAR IS 43.5 CFS < 51.03

6240 Mexico Rd.
St. Pete, MO 63376

Final Pr. No: 3/3

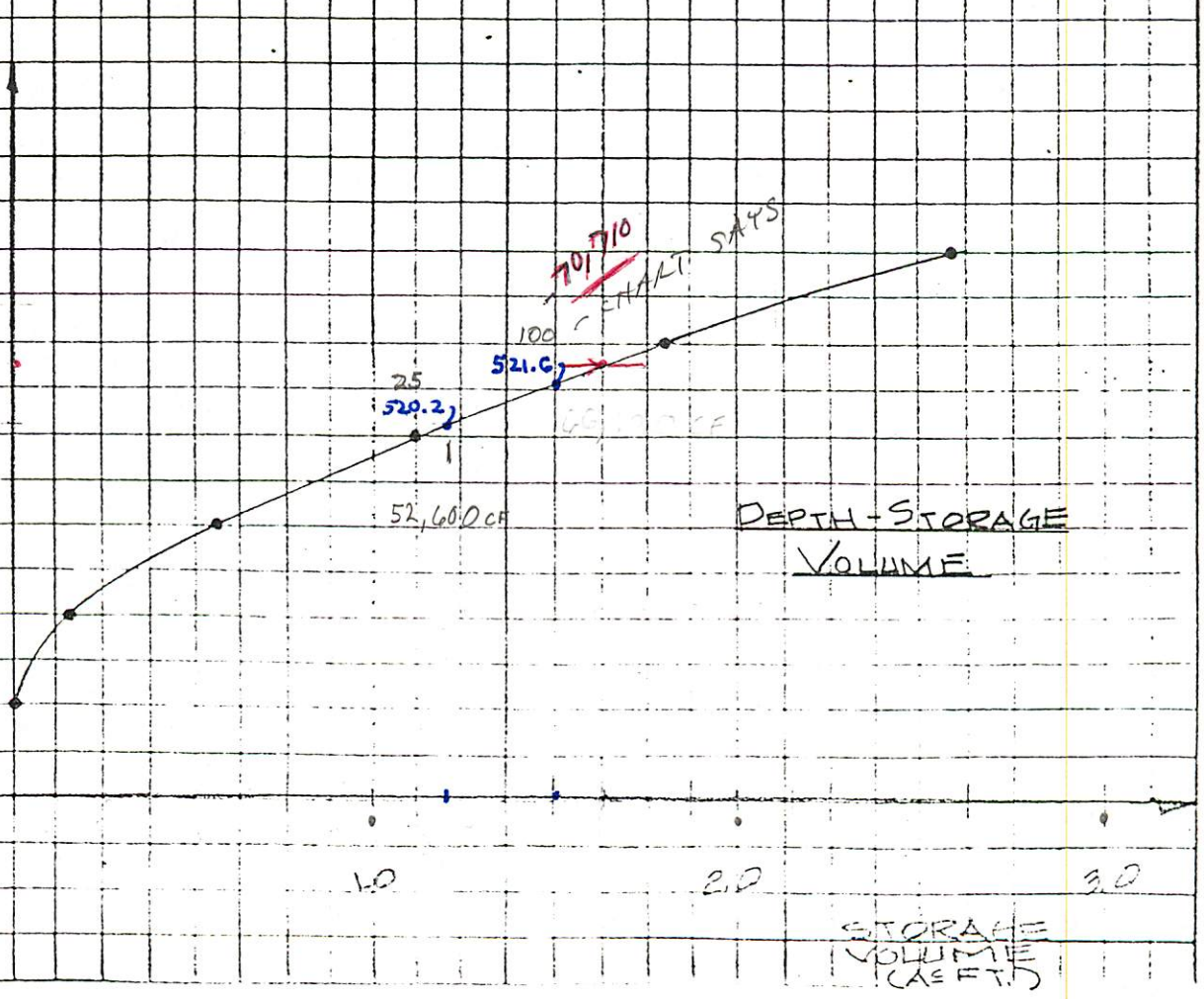
Client: BELDNER Prel. No: 92-016 Prel. Pr. No:

Location: SPRING HILL Calc: MEW Date: 9/25

Subject: DEPTH - STORAGE CALC. Chkd: RCM Date: 9/25/92

Bkchkd: Date:

ELEV.	AREA (AC)	AVG AREA (AC)	INC. DEPTH (FT)	INC. VOL. (AC FT)	TOTAL VOL. (AC FT)
514	0				0
		.0835	2.0	.1670	
516	0.1670				.1670
		.2026	2.0	.4052	
518	0.2382				.5722
		.2764	2.0	.5528	
520	0.3145				1.1250
521.6 = 1.674		.3429	2.0	.6858	
522	0.3713				1.8108
		.3966	2.0	.7932	
524	0.4218				2.6040



DEPTH - STORAGE VOLUME

24" RCP FE @ 514.0 ✓
℄ pipe @ 515.0

Ponding Elev.	HW	HW/D	Qout
514.0	0	0	0
515.0	1'	0.50	4.25
516.0	2'	1.00	13.75
517.0	3'	1.50	22.50
518.0	4'	2.00	28.00
519.0	5'	2.50	33.50
520.0	6'	3.00	37.50
521.0	7'	3.50	41.25
522.0	8'	4.00	45.00
523.0	9'	4.50	48.00

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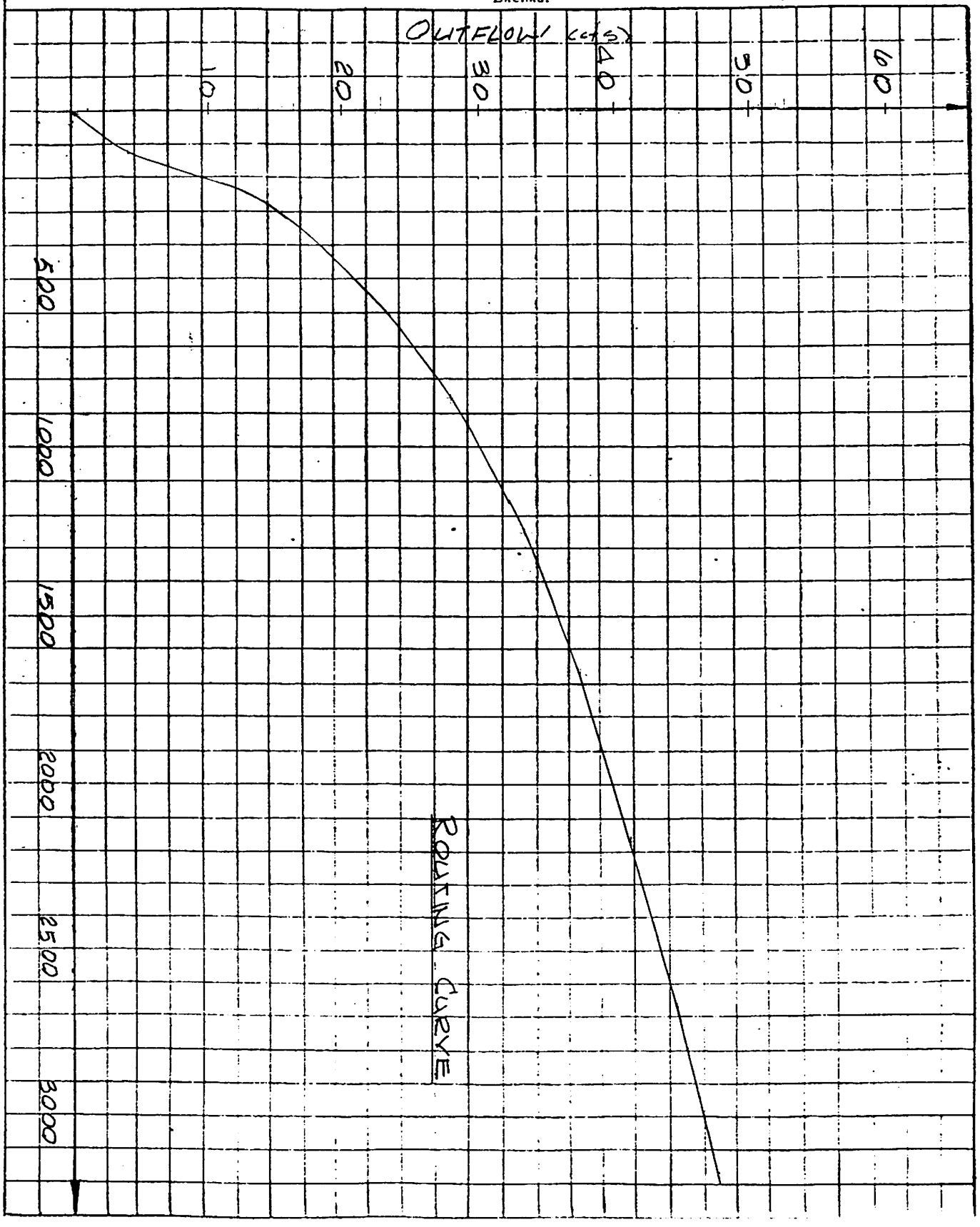

Design Pond Routing

	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0			0		0	
2	1	32.24	32.24	0	32.24		0.5	
3	2	64.48	96.72	31.24	127.96		4.0	
4	3	96.72	161.20	119.96	281.16		14.25	
5	4	96.72	193.44	252.66	446.10		19.00	
6	5	96.72	193.44	408.10	601.54		23.00	
7	6	96.72	193.44	555.54	748.98		26.00	
8	7	96.72	193.44	696.98	890.42		28.10	
9	8	96.72	193.44	834.22	1027.66		30.00	
10	9	96.72	193.44	967.66	1161.10		31.75	
11	10	96.72	193.44	1097.60	1291.04		33.50	
12	11	96.72	193.44	1224.04	1417.48		35.00	
13	12	96.72	193.44	1347.48	1540.92		36.00	
14	13	96.72	193.44	1468.92	1662.36		37.00	
15	14	96.72	193.44	1588.36	1781.80		38.00	

Design Pond Routing

	0	1	2	3	4	5	6	7	
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2	
1	15	96.72	193.44	1705.80	1899.24		39.00		
2	16	96.72	193.44	1821.24	2014.68		39.75		
3	17	96.72	193.44	1935.18	2128.62		40.50		
4	18	96.72	193.44	2047.62	2241.06		41.25		
5	19	96.72	193.44	2158.56	2352.00		42.00		
6	20	96.72	193.44	2268.00	2461.44		43.00		
7	21	64.48	161.20	2375.44	2536.64		43.25		
8	22	32.24	96.72	2450.14	2546.86	521.6	43.50	1.625 Ac-ft. 70785 cu.ft.	PEAK OUTFLOW
9	23	0	32.24	2459.86	2492.10		43.15		
10	24	0	0	2405.80					
11	25	0							
12									
13									
14									
15									

IV. Inflow Hydrograph Calculations

Gutter Flow Length, Entrance → CI 12 ≅ 360'
Estimated Flow Velocity ≅ 9.09 ft/sec
Overland Travel Time ≅ 39.6 sec

Storm Sewer Flow Length CI 12 → EP 1 ≅ 1100'
Estimated Flow Velocity ≅ 7.0 ft/sec
Sewer Travel Time ≅ 157.1 sec

Total Travel Time ≅ 157.1 + 39.6 ≅ 196.7 sec ≅ 3.28 min
∴ use t_c = 3.00 minutes for inflow hydrograph

From Drainage Area Maps, Total Acreage Tributary to Detention Basin = 22.22 A^s ✓

100 Year Peak Inflow Rate

2.24 A^s (off-site) @ 6.08 cfs/A^s ✓
0.61 A^s (off-site) @ 3.82 cfs/A^s ✓
19.37 A^s (on-site to basin) @ 4.17 cfs/A^s ✓

≅ 96.72 cfs

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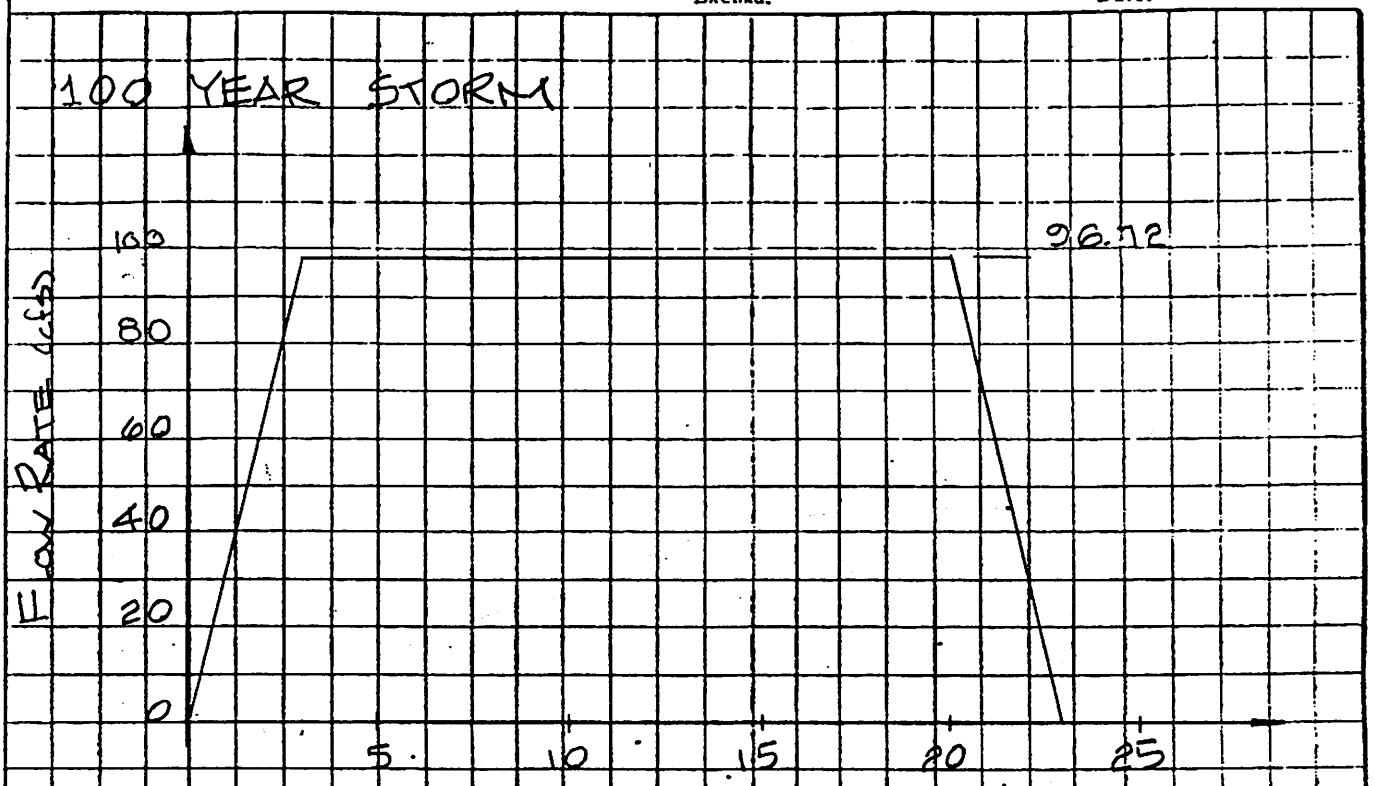
Bkchkd: | Date:



V. Depth-Outflow Calculations

'Rough' Volume Calc's

- 100 Year Storm, Req'd Attenuation ≅ 51.03 cfs
  Peak Inflow ≅ 96.72 cfs
∴ Max. Outflow ≤ 96.72 − 51.03 = 45.69 cfs

'Rough' Volume req'd ≅ $51.03 \frac{ft^3}{s} \times 30 \text{ min.} \times 60 \frac{s}{\text{min}}$
≅ 91,854 ft^3 ≅ 2.11 Ac-ft

'Rough' Volume achieved @ 522 ±

Orifice Equation: $Q = Ca\sqrt{2gh}$

where C = 0.60
h = height from ℄ orifice to ponding elev. ✓
a = area of orifice opening

for 100 Year, ponding elev. ≅ 522 ±
$FE_{out} \cong 514$ ±
∴ h = 7.8 ±

solving for a: $a = \frac{Q}{C\sqrt{2gh}} \cong \frac{45.69}{.60\sqrt{2(32.2)7.8}}$

a ≅ 3.40 ☐
∴ try 24" RCP (Groove End Projecting)

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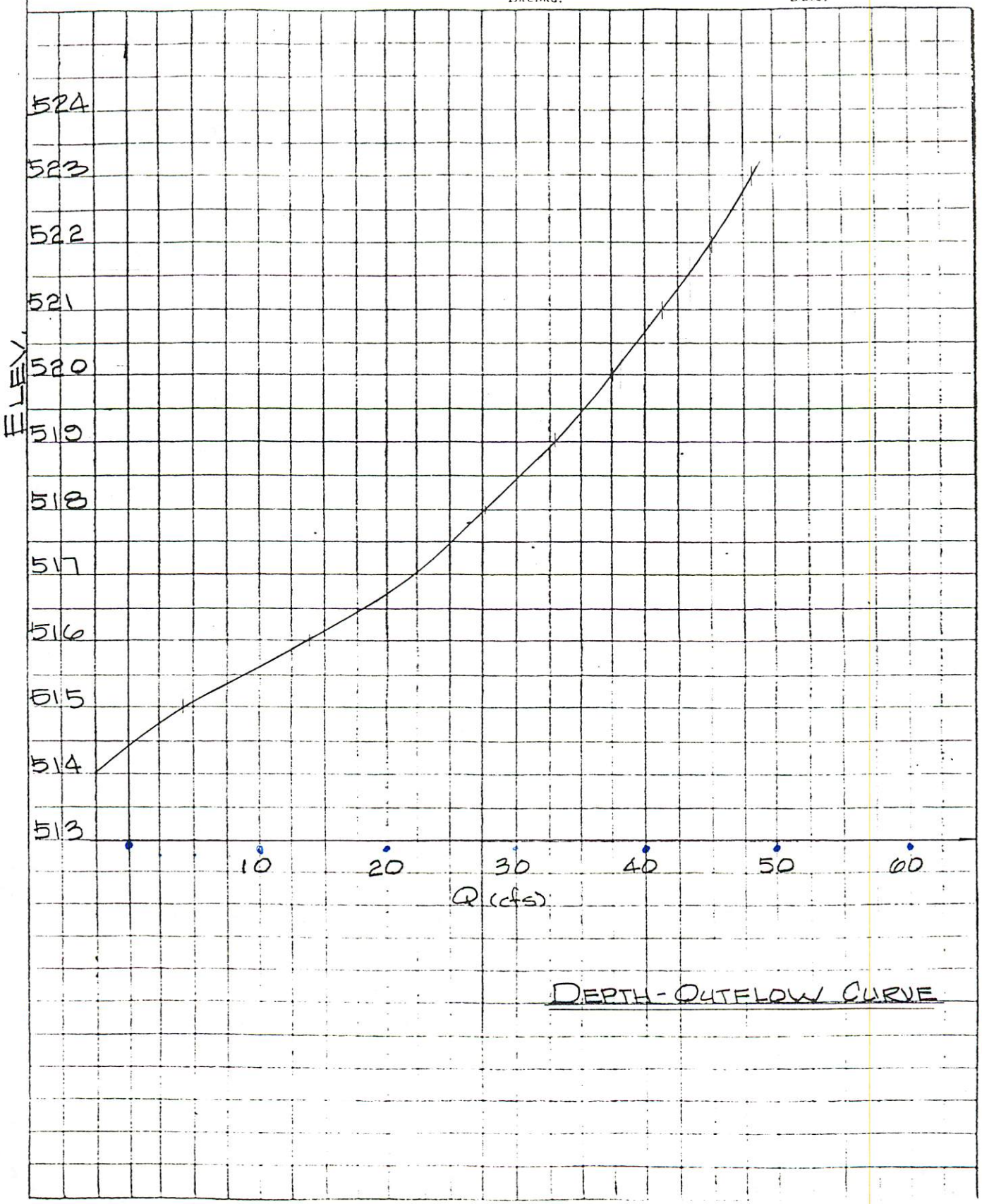


DEPTH - OUTFLOW CURVE

ORIGINAL

2 YEAR SEDIMENT STORAGE REQUIRED

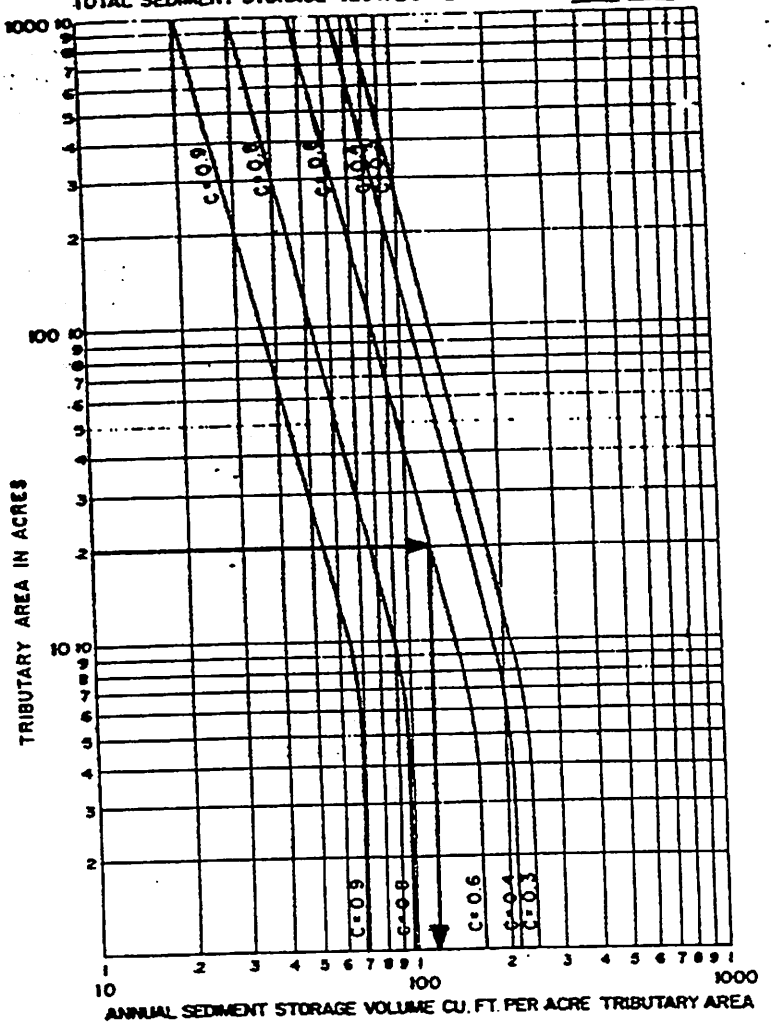
EXAMPLE:

TRIBUTARY AREA = 20 ACRES

RATIONAL METHOD RUNOFF COEFFICIENT "C" = 0.6

SEDIMENT STORAGE = 120 CU. FT. PER ACRE PER YEAR

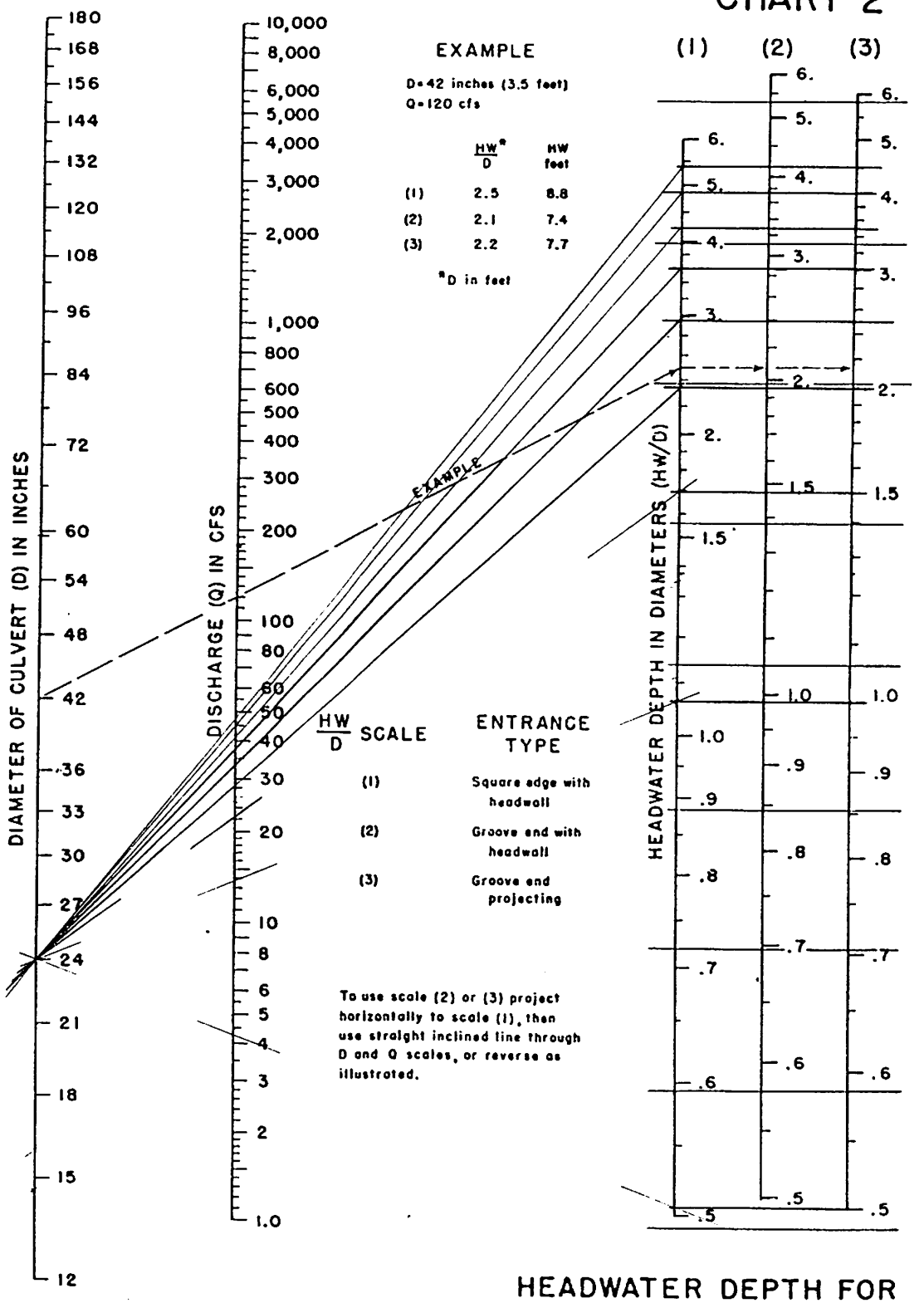
TOTAL SEDIMENT STORAGE = 120 X 20 = 2400 CU. FT. PER YEAR.



ANNUAL SEDIMENT STORAGE

FIG. 6

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

VI Routing Curve Calculations

Let Δt = 1 minute = 0.016 hrs

Then $\frac{2S}{\Delta t} + O = \frac{2S(\Delta ft)}{0.016 hrs} \times \frac{24 \text{ hrs/day}}{1.98 \Delta ft/ds\,day} + O\ ds$

$\frac{2S}{\Delta t} + O = 1454.545 + O$ (cfs)

Elev.	$\frac{S}{(\Delta ft)}$	$\frac{O}{(cfs)}$	$\frac{2S}{\Delta t} + O$ (cfs)
514°	0	0	0
515°	0.0835	4.25	125.70
516°	0.1670	13.75	256.66
517°	0.3696	22.50	560.10
518°	0.5722	28.00	860.29
519°	0.8486	33.50	1267.82
520°	1.1250	37.50	1673.86
521°	1.4679	41.25	2176.37
522°	1.8108	45.00	2678.88
523°	2.150	48.00	3175.26

VII. Overflow Structure

For $Q = 96.72$ cfs, 48" RCP

$HW/D = 1.16$

$\therefore HW = 4.64'$

HW elev. $= 514.0 + 4.64' = 518.64$ inlet control

HW elev. $= 518.02$ outlet control

For crest control approximate by weir equation

$$Q = CL(H)^{3/2}$$

for area inlet open 4 sides

Let $L = 11.66'$

$C = 3.0$

$96.72 = 3.0 \times 11.66 \times H^{3/2}$

$2.77 = H^{3/2}$

$1.97' = H$

Weir elevation at sill $= 521.0$

at top $= 523.0$

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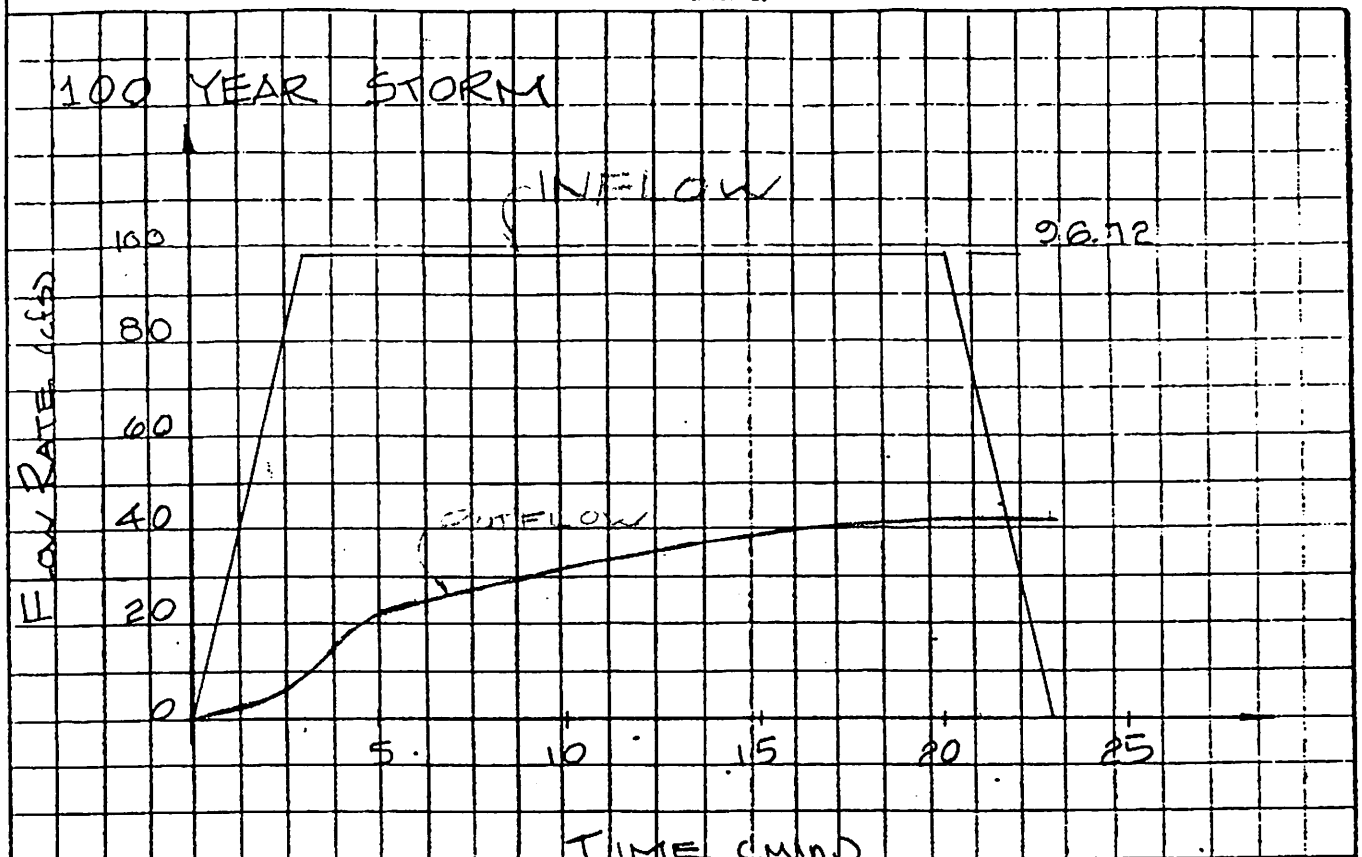

MUSLER ENGINEERING COMPANY
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Telephone: (314) 441-4555
CIVIL ENGINEERING - PLANNING - LAND SURVEYING

Transmittal HAND-DELIVER

FRANK GODWIN P.E.
Technical Engineer / Inspector
City of O'FALLON

Date; 10 DEC. 1992
Project; SPRING HILL
Project No.; 92-016
From; MIKE VORWERK
CC;

We are Sending You:

✓ *Attached*
___ *Under Separate Cover Via;*

___ *Shop Drawings*
___ *Copy of Letter*
___ *Prints*
___ *Photographs*
✓ REVISED DETENTION
___ ANALYSIS

___ *Plans*
___ *Change Order*
___ *Samples*
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Transmitted as Checked:

___ *For Approval*
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___ *Approved as Submitted*
___ *Approved as Noted*
___ *Returned for Corrections*

Copies	*Date*	*Description*

A comparison of the Eastern and Western Draws on the SCHNELLER TRACT show an overall decrease in post-developed run off rates.

WESTERN DRAW

Pre developed $\cong 11.1$ cfs

Post developed $\cong 24.5$ cfs

$\cong 24.5 - 11.1 \cong +13.4$ cfs

EASTERN DRAW

Pre developed $\cong 55.1$ cfs

Post developed $\cong 39.1$ cfs

$\cong 39.1 - 55.1 \cong -16.0$ cfs

$13.4 - 16.0 \cong -2.6$ cfs

$\Rightarrow$ DECREASE OF 2.6 cfs

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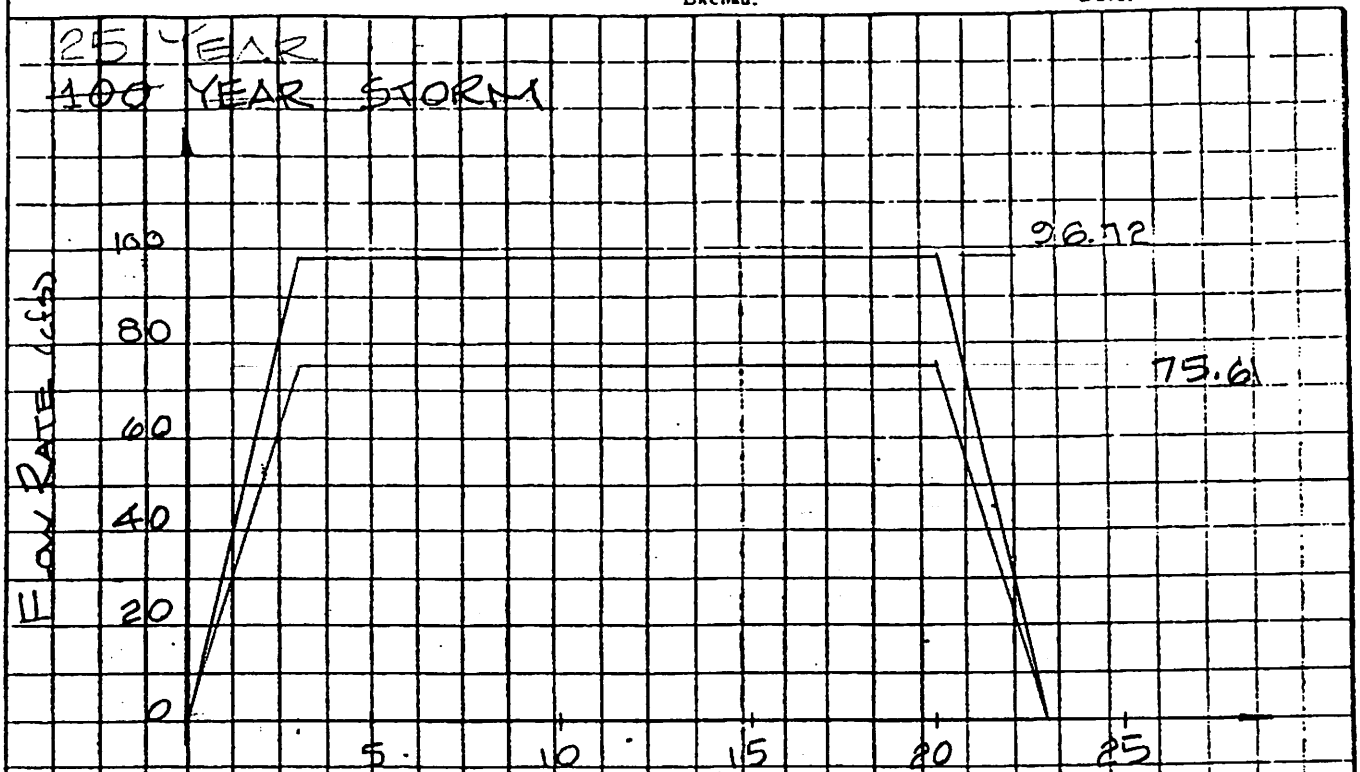
25 YEAR
~~100 YEAR STORM~~



PEAK INFLOW RATE

2.24 A^S (off-site) @ 4.75 cfs/A^S
0.61 A^E (off-site) @ 2.99 cfs/A^E
19.37 A^E (on-site$_b$) @ 3.26 cfs/A^E

$\doteq$ 75.61 cfs

Design Pond Routing

25 YEAR

	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0			0		0	
2	1	25.20	25.20	0	25.20		0.20	
3	2	50.41	75.61	24.80	100.41		3.00	
4	3	75.61	126.02	94.41	220.43		11.00	
5	4	75.61	151.22	198.43	349.65		16.75	
6	5	↓	↓	316.15	467.37		19.75	
7	6			427.87	579.09		22.25	
8	7			534.59	685.81		24.50	
9	8			636.81	788.03		26.50	
10	9			735.03	886.25		28.25	
11	10			829.75	980.97		30.00	
12	11			920.97	1072.19		30.50	
13	12			1011.19	1162.41		32.00	
14	13			1098.41	1249.63		33.00	
15	14			1183.63	1334.85		34.00	

Design Pond Routing

25 YEAR

	0	1	2	3	4	5	6	7	
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2	
1	15	75.61	151.22	1660.85	1418.07		35.00		
2	16	↓	↓	1348.07	1499.29		35.50		
3	17			1428.29	1579.51		36.25		
4	18			1507.01	1658.23		37.00		
5	19			1584.23	1735.45		37.50		
6	20	75.61	151.22	1660.45	1811.67		38.25		
7	21	50.41	126.02	1735.17	1861.19	520.2	38.50	1,225 Δ sft. 53361 cu. ft.	PEAK OUTFLOW
8	22	25.20	75.61	1784.19	1859.80		38.50		
9	23	0	25.20	1782.80	1808.00		38.25		
10	24	0	0	1731.50	1731.50		37.50		
11									
12									
13									
14									
15									