DRAINAGE REPORT

FOR

AG MINOR SUBDIVISION

OWNER: INDUSTRIAL CONTRACTOR, INC.

ENGINEER: MORLEY AND ASSOCIATES, INC.

DECEMBER 10, 1993

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AG MINOR SUBDIVISION

NARRATIVE

Existing conditions at this + 6.5 acre site include flat cultivated farm land which has been recently cultivated. Because of this area is extremely flat, it is not anticipated that drainage will enter the development from off site areas. Therefore, the drainage calculations were developed using the area bounded by the development master plan which is ultimately proposed to be 4.2 acres. 2.3 acres is shown as undeveloped on the master plan for this site. This undeveloped portion of the site will have to be addressed in the future when the development plan is prepared. Currently, the storm water is conveyed by overland flow to Stockfleth Ditch approximately 1000 feet east of the proposed minor subdivision.

The proposed development will detain all storm water on site while at the same time releasing storage at a controlled rate not to exceed the un-developed run-off rate. The retention basin is proposed to cover approximately 12,500 square feet of land at normal pool elevation. The capacity required for storing developed run-off generated by the 25 year storm is 27347 cubic feet. Approximately 12,160 cubic feet of storage is provided for freeboard above that of the 25 year storage level. Undeveloped storm runoff rates where calculated using a runoff coefficient of 0.20 which corresponds with the Vanderburgh County Drainage Board approved master plan of the entire basin.

The on-site storm water will be conveyed to the retention area by pipes. Because this is a phased project, the total design storm runoff will not all be carried via piping until all three phases of the project are completed.

The interior piping system for the private parking lot is designed to carry runoff for a reoccurrence interval of 10 years with no surcharge on the system. The 25 year storm will be conveyed by pipes in a surcharged condition. This will creating situations of brief ponding around the inlets during the 25 year event.

SECTION I

Formulas

Intensity – i

$$i = \frac{cT^m}{(t+d)^n}$$

T = Recurrence Interval
t = t_c in hours

COEFFIENTS & EXPONENTS

Station	c	m	d	n
Evansville	1.9533	0.1747	0.522	1.6408

Time of Concentration t_c

$$t_c = .827\left[\frac{NL}{\sqrt{S}}\right]^{0.467}$$

N = Land Use Coefficients
L = Length of Basin
S = Slope of Basin

Note: Intensity is not taken off the Evansville intensive curve. The above formula was used to determine intensity! This formula is the latest curve fitting criteria for rainfall intensity. It is published by Purdue University, Environmental and Hydraulic Engineering, Statistical Characteristics of Short Time Increment Rainfall, August 26, 1992

SECTION II

DEVELOPED/UNDEVELOPED Watershed Calc's

$$t_{c_{u}} = .827\left[\frac{0.20(750)}{\sqrt{.0005}}\right]^{0.467} = 50.64$$ = time of concentration undeveloped

$i_{ud} = 2.05$ = intensity undeveloped

$C_{u} = 0.20$ = "C" undeveloped

$$C_d = \frac{[(1.03)(.876)+(.906)(.877)+(0.643)(.842)+(.658)(.871)+(0.509)(.832)+(.458)(.9)]}{4.2} = .868$$ = "C" developed

Developed cfs = cfs = 12 + 5.4 = 17.4 cfs
(See Storm Sewer Design Sheet - SECTION V)

$Q_{ud} = cia \longrightarrow .2(2.05)4.2 = 1.72$ cfs

SUMMARY OF Variables

- Developed Area = 4.2 ac.
- Undeveloped Area = 4.2 ac
- Developed Slope = 0.5%
- Undeveloped Slope = 0.05%
- Developed Runoff Coefficient = 0.868
- Undeveloped Runoff Coefficient = 0.20
  (Per Drainage Master Plan of Area)

SECTION III

Area 1 A Refer to Key Drainage Map

$2.80 \times 40^2 = \frac{44800 \text{ sq ft}}{43560} = 1.03$ ac

Area 1B

24.41
24.90
$24.65 \times 40^2 = \frac{39448 \text{ sq ft}}{43560} = .906$

Area 1C

17.72
17.29
$17.50 \times 40^2 = \frac{28000}{43560} = .643$ ac

Area 2A

17.85
18.00
$17.92 \times 40^2 = \frac{28680}{43560} = .658$ ac

Area 2B

14.0
13.72
$13.86 \times 40^2 = \frac{22176}{43560} = .509$ ac

Area 3

12.55

12.38

$12.46 \times 40^2 = \frac{19936}{43560} = .458\ ac$

Area 4

30.24

30.56

$30.37 \times 40^2 = 48{,}592 + 260 \times 200 = \frac{100{,}592}{43560} = 2.31\ ac$

$\Sigma ac =$ 1.03
.906
.643
.658
.509
.458
2.31 → Undeveloped

6.51 ac

MM

PROJECT: AG MINOR SUBDIVISION 93-2718-1 DATE: 12/09/93
ENGINEER:MORLEY AND ASSOCIATES,INC

DESIGN RETURN PERIOD:	25
RELEASE RATE PERIOD:	25
WATERSHED AREA (ACRES):	4.2
TIME OF CONCENTRATION(UNDEVELOPED):	50.6
RAINFALL INTENSITY (INCHES/HR):	2.05
UNDEVELOPED RUNOFF COEFFICIENT:	0.2
UNDEVELOPED RUNOFF RATE (CFS):	1.72
DEVELOPED RUNOFF COEFFICIENT:	0.868

25 YEAR STORM

STORM DURATION (HRS)	RAINFALL INTENSITY (INCH/HR)	INFLOW RATE (CFS)	OUTFLOW RATE (CFS)	STORAGE RATE (CFS)	REQUIRED STORAGE (ACRE-FT)
0.08	6.85	24.97	1.72	23.25	0.155
0.17	5.45	19.87	1.72	18.15	0.257
0.25	4.65	16.95	1.72	15.23	0.317
0.33	4.15	15.13	1.72	13.41	0.369
0.42	3.80	13.85	1.72	12.13	0.425
0.50	3.40	12.40	1.72	10.67	0.445
0.58	3.20	11.67	1.72	9.94	0.481
0.67	2.85	10.39	1.72	8.67	0.484
0.75	2.75	10.03	1.72	8.30	0.519
0.83	2.60	9.48	1.72	7.76	0.536
0.92	2.45	8.93	1.72	7.21	0.553
1.00	2.30	8.38	1.72	6.66	0.555
1.25	2.05	7.47	1.72	5.75	0.599
1.50	1.85	6.74	1.72	5.02	0.628
1.75	1.60	5.83	1.72	4.11	0.600
2.00	1.40	5.10	1.72	3.38	0.564
2.50	1.25	4.56	1.72	2.84	0.591
3.00	1.10	4.01	1.72	2.29	0.572
4.00	0.84	3.06	1.72	1.34	0.447

PEAK STORAGE (ACRE/FT): 0.63
PEAK STORAGE (CUBIC FT): 27346.75

Storage Provide = ± 39,500 cu.ft.

RETENTION BASIN STORAGE CHART

ELEVATION	SQUARE FEET COVERAGE	ΔH	TOTAL Storage ft³
384.5	12,381	0	0
385.0	13,388	.5	6694
386.0	15,402	1.5	22096
387.0	17,416	2.5	39512

25 Yr Basin Elevation = 386.23

CONTROL OUTLET CALCULATIONS

- 12" Control outlet is to have a maximum discharge rate of 1.72 cfs. during 25 Yr Storm Events.

To calculate this discharge rate, some assumptions had to be made. The assumptions are as follows:

- 3' Water Depth in Stockfleth Ditch
  (Botom Ditch = 381 ∴ Water Level = 384)
- High Level Water in Retention Pond is 1.73 feet above the Normal Pool
  ∴ High Water Level = 384.5 + 1.73 = 386.23

- Assuming a straight line hydralic gradient

386.23 - High Water (Retention)
384.0 - High Water in Stockfleth
2.23

Length of Run to Stockfleth Ditch = 1450 ft

$$\text{Hydralic Gradient} = \frac{2.23}{1450} = .154\ \%$$

Maximum Discharge = 1.55 cfs (See Nomograph Next Page)

1.55 < 1.72 ∴ OK

Control Outlet - Pipe, Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

25 Yr Storm

Q = 1.55 → Pipe Size Given

S_H = 0.154%

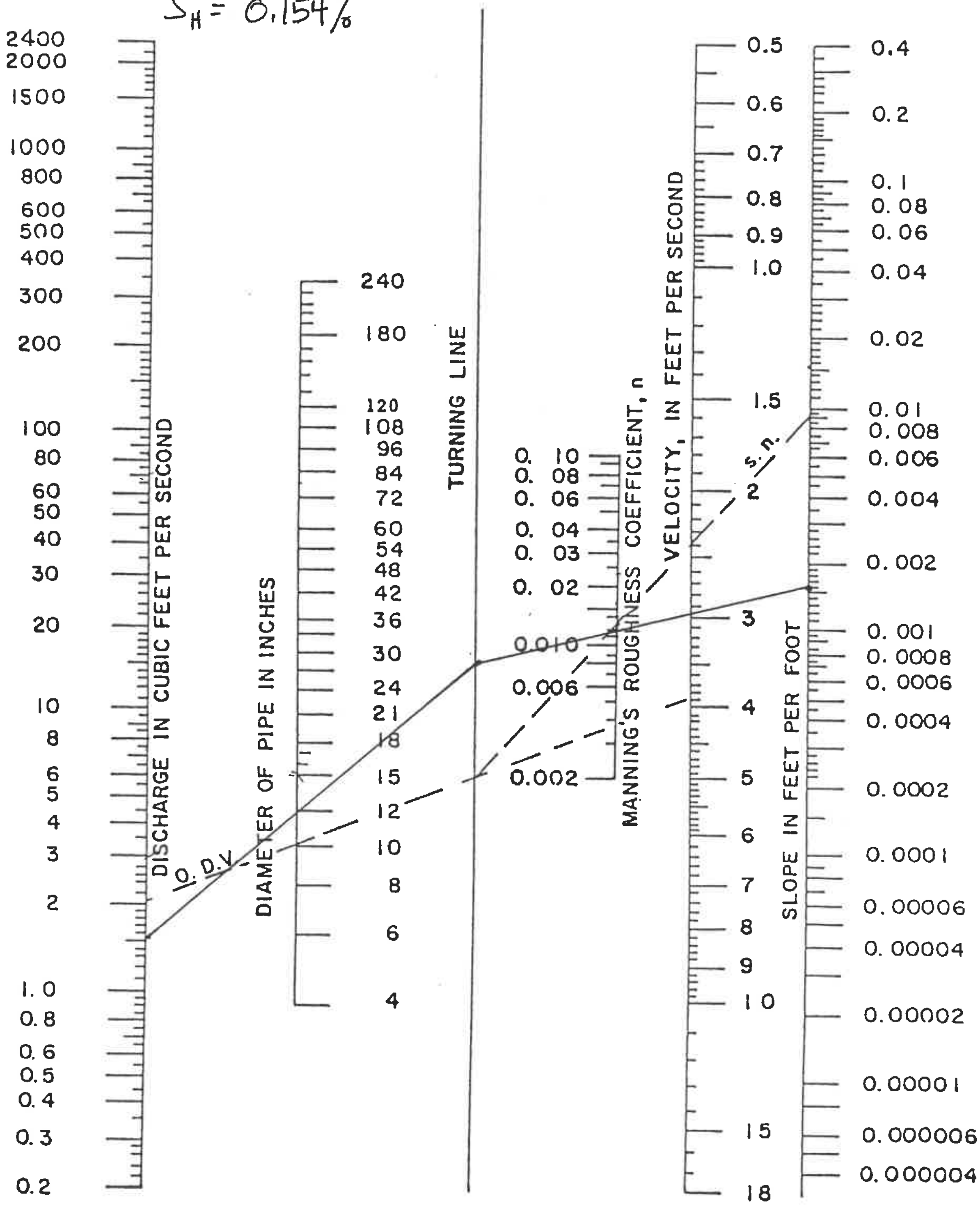


FIG. 7-415.04 D

SECTION IV

Sub-basin # 1A - Str#701 A = 1.03ac

Structures 15600 ft^2 = .358 ac (.95)

Drives —

Pavement 24626 ft^2 = .565ac (.825)

Patios —

Sidewalks 4640 ft^2 = .107 ac (.9)

Terrain 1 —

Terrain 2 —

Terrain 3 —

Composit "C" = $\frac{(.95)(.358)+(.565)(.825)+(.107)(.9)}{1.03}$ = .876

N = 0.02 (All Smooth Impervious Surfaces)

H = — N/A
L = 270'
S = .005

$t^c = .827\left[\frac{NL}{\sqrt{S}}\right]^{0.467} = .827\left[\frac{.02(270)}{\sqrt{.005}}\right]^{0.467} = 6.26$

∴ Use 10 min as min!

i_{10} 5.38
i_{25} = 6.32

Q_{25} = Cia = 1.1(.876)(6.32)(1.03) = 6.27 cfs
Q_{10} = 5.34 cfs

Sub-basin # 1B - Str#702 A = 0.906 ac

Structures 3300 ft^2 = 0.076 ac

Drives —

Pavement 37,125 ft^2 = 0.852 ac

Patios —

Sidewalks 960 ft^2 = 0.022 ac

Terrain 1 —

Terrain 2 —

Terrain 3 —

Composit "C" = $\frac{(.95)(.076)+.852(.825)+(.022)(.9)}{0.906}$ = .877

N = 0.02

H = — N/A
L = 180
S = .005

$t^c = .827\left[\frac{(.02)(180)}{\sqrt{0.005}}\right]^{0.467}$ = 5.18 ∴ Use 10 min

i_{10} 5.38
i_{25} = 6.32

Q_{10} = 4.70
Q_{25} = 1.1(.877)(6.32)(.906) = 5.52 cfs

①

Sub-basin # 1C - Future Str. A = 0.643

Structures 3300 ft^2 = 0.076 ac

Drives —

Pavement 23929 ft^2 = 0.549 ac

Patios —

Sidewalks 780 ft^2 = 0.018 ac

Terrain 1 —

Terrain 2 —

Terrain 3 —

$$\text{Composite "C"} = \frac{(0.076)(.95)+(0.549)(.825)+(0.018)(.90)}{0.643} = .842$$

N = 0.02

H = N/A
L = 170
S = 0,005

$$t^C = .827\left[\frac{0.02(170)}{\sqrt{0.005}}\right]^{0.467} = 5.05\ \text{min} \therefore \text{Use } 10\ \text{min}$$

i_{10} 5.38
i_{25} = 6.32 , ∴ Q_{10} = 3.20
Q_{25} = 1.1(6.32)(.643)(.842) = 3.76 cfs

Sub-basin # A =

Structures

Drives

Pavement

Patios

Sidewalks

Terrain 1

Terrain 2

Terrain 3

N =

H =
L =
S =

t^C = .827

i = , ∴ Q =

Sub-basin # 2A -Str.# 703 A = 0.658ac

Structures 9600 ft² = 0.220

Drives —

Pavement 17,467 ft² = 0.401

Patios —

Sidewalks 1595 ft² = 0.037

Terrain 1 —

Terrain 2 —

Terrain 3 —

$$\text{Composit "C"} = \frac{(.95)(0.22) + (.401)(.825) + 0.037(.9)}{0.658} = .871$$

N = 0.02

H = N/A
L = 250
S = 0.005

$$t^C = .827\left[\frac{.02(250)}{\sqrt{0.005}}\right]^{.467} = 6.04 \therefore \text{Use } 10\text{ min}$$

i_{10} 5.38
i_{25} = 6.32

$Q_{10} = 3.39$

$$\ldots\ Q_{25} = 1.1(.871)(6.32)(0.658) = 3.98\text{ cfs}$$

Sub-basin # 2B -Str# 704 A = 0.509

Structures 600 ft² = .014

Drives —

Pavement 20482 ft² = 0.470

Patios —

Sidewalks 1090 ft² = 0.025

Terrain 1 —

Terrain 2 —

Terrain 3 —

$$\text{Composit "C"} = \frac{(.95)(.014) + (.825)(0.470) + (.9)(.025)}{0.509} = .832$$

N = 0.02

H = N/A
L = 150
S = 0.005

$$t^C = .827\left[\frac{.02(15)}{\sqrt{0.005}}\right]^{.467} < 10\text{ min} \therefore \text{Use } 10\text{ min}$$

i_{10} 5.38
i_{25} = 6.32

$$\ldots\ Q = 1.1(.832)(5.5)(0.509) = 2.56$$

Undeveloped Area

Sub-basin # 4 A = 2.31 ac

Structures	—
Drives	—
Pavement	—
Patios	—
Sidewalks	—
Terrain 1	2.31 ac
Terrain 2	
Terrain 3	

C = 0.20 (Undeveloped Area)

N = 0.20

H = .5'
L = 480
S = .001

$$t^c = .827 \left[\frac{0.20\,(480)}{\sqrt{.001}} \right]^{0.467} = 34.97 \text{ min}$$

$i_{10} = 2.48$
$i_{25} = 2.91$ in/hr , ∴ $Q_{25} = 1.1\,(0.20)(3.20)(2.91) = 2.05$ cfs
$Q_{10} = 1.75$

Sub-basin # A =

Structures	
Drives	
Pavement	
Patios	
Sidewalks	
Terrain 1	
Terrain 2	
Terrain 3	

N =

H =
L =
S =

t^c = .827

i = , ∴ Q =

SECTION V

STORM SEWER DESIGN SHEET – RATIONAL METHOD

PROJECT AG Minor Subdivision DATE 12/2/93 SHEET 1 OF 1

ENGINEER D. Hynes DESIGN STORM 10 Yr MANNINGS n 0.13

System	Line Number (1)	Upstream Manhole (2)	Downstream Manhole (3)	Length (Ft) (4)	C_j (5)	A_j (Acres) (6)	C_jA_j (7)	ΣA_jC_j (8)	t_j (min) (9)	t_{cum} (min) (10)	i [inches/hr] (11)	Q (CFS) (12)	Pipe Diameter (inches) (13)	Pipe Slope (%) (14)	Pipe Capacity (CFS) (15)	Velocity (Ft/Sec) (16)	Travel Time (min) (17)	Rim Elevation Upstream (18)	Rim Elevation Downstream (19)	Invert Elevation Upstream (20)	Invert Elevation Downstream (21)	Pipe Cover Upstream (22)	Pipe Cover Downstream (23)
SYSTEM 1	A	701	702	308	0.876	1.03	.893	–	10	–	5.38	4.8	18"	0.22	4.8			387.68	387.50	387.68	384.83		
	B	702	Fut.	182	0.877	.906	.794	1.69	10	10	5.38	9.1	24"	0.15	9.0								
	C	Fut	out	36	0.842	0.643	.541	2.23	10	10	5.38	12.0	30"	0.15	–	–	–	–	–	–	–		
											To be made seperete in future!												
SYSTEM #2	A	703	704	138	0.871	0.658	0.573	–	10	–	5.38	3.1	18"	0.22									
	B	704	Out	153	0.832	0.509	0.423	0.997	10	10	5.38	5.36	21"	0.15									

Figure 7.1 Storm Sewer Design Sheet – Rational Method

Str # 701 - Pipe, Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

10Yr Storm
Q = 4.8 cfs
S = .22%
} 18" Minimum

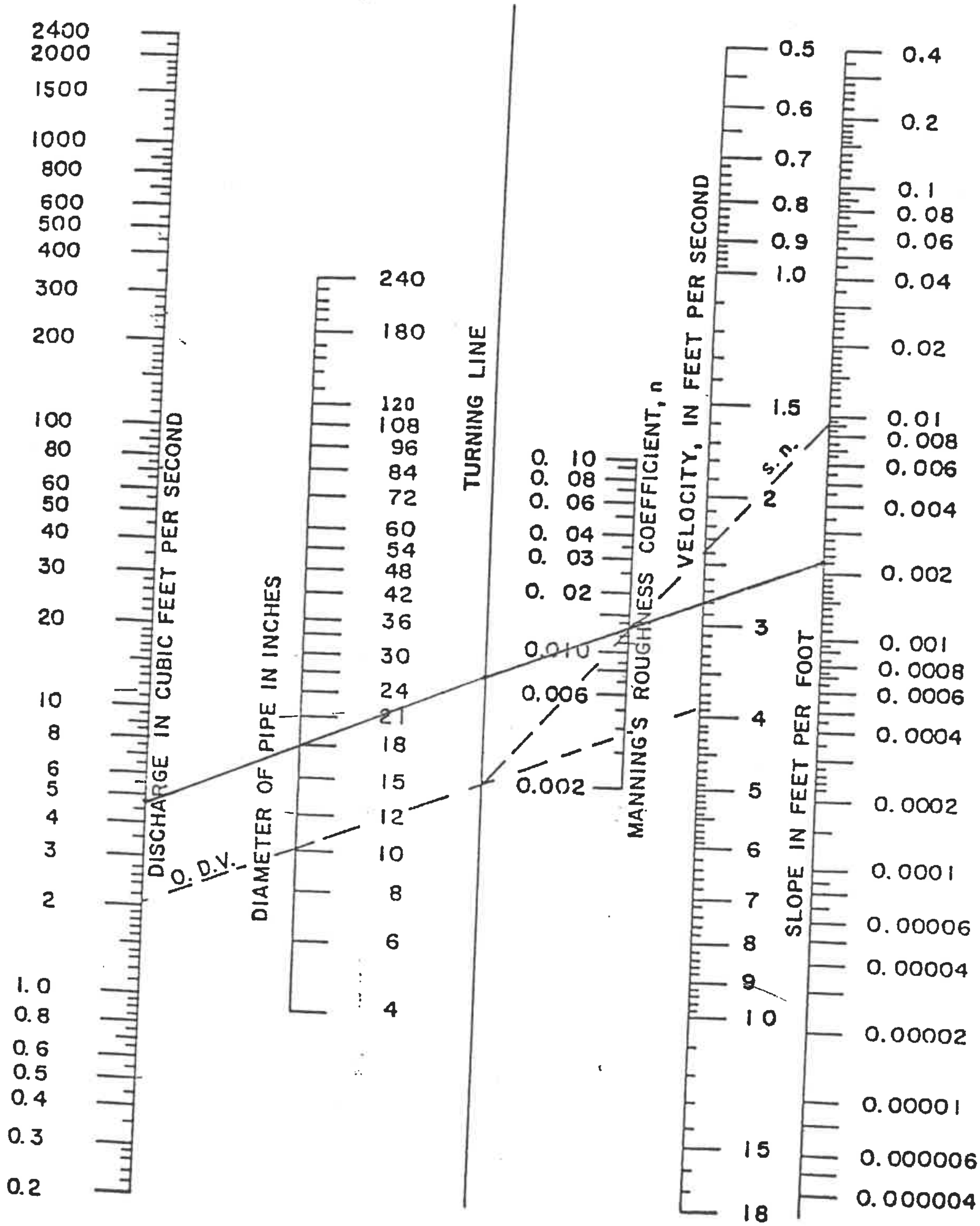


FIG. 7-415.04 D

Str #702 - Pipe, Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

10 Yr Storm
Q = 9.1 cfs
S = 0.15%
24" Minimum

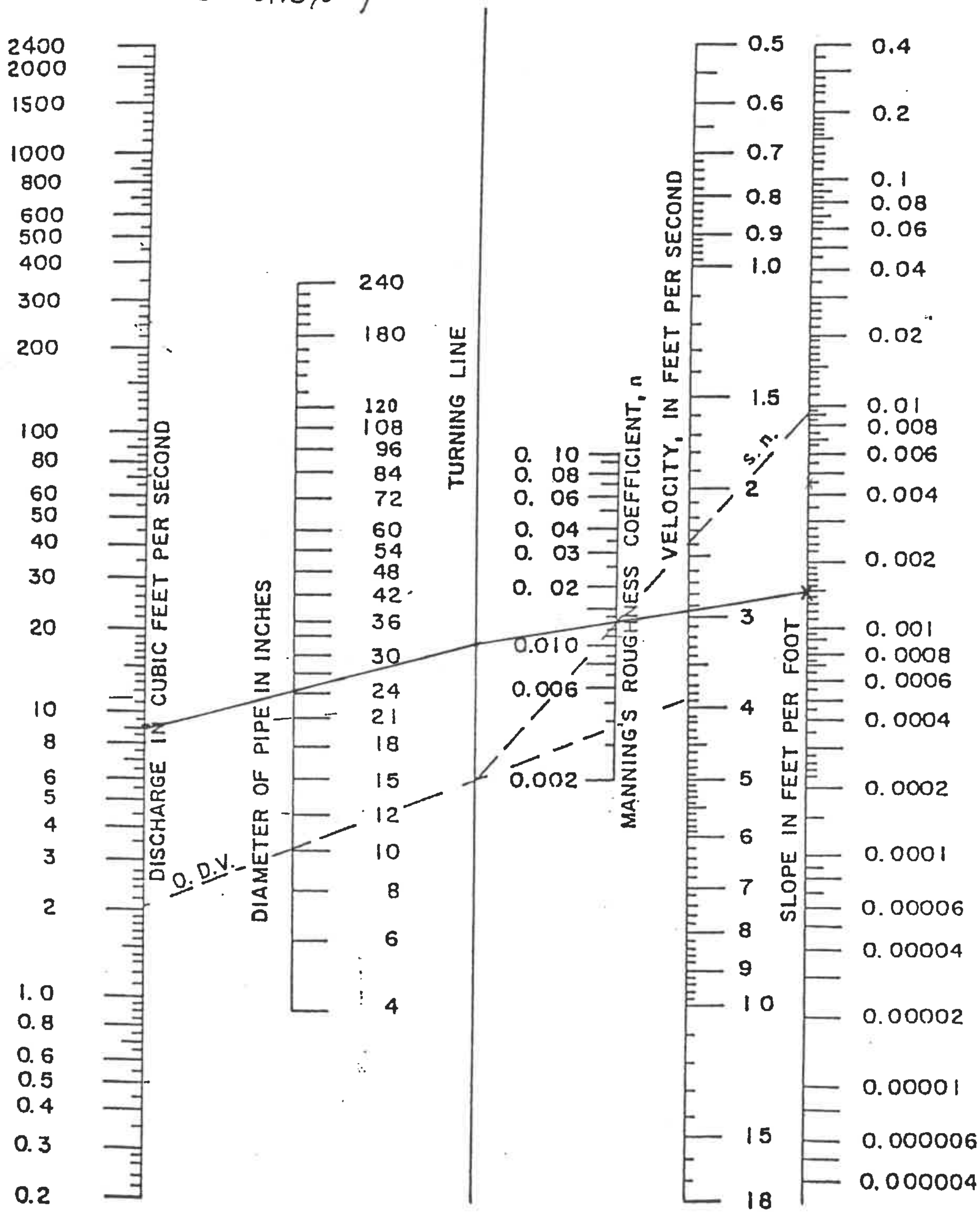


FIG. 7-415.04 D

Note: Development in the future will require sheet flow into retension pond or a separate pipe flowing into Pond. SYSTEM #1 will not accomodate any addition runoff!

Future - Pipe Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

10Yr Storm
Q = 12.0 cfs
S = 0.15%
30" Req'd

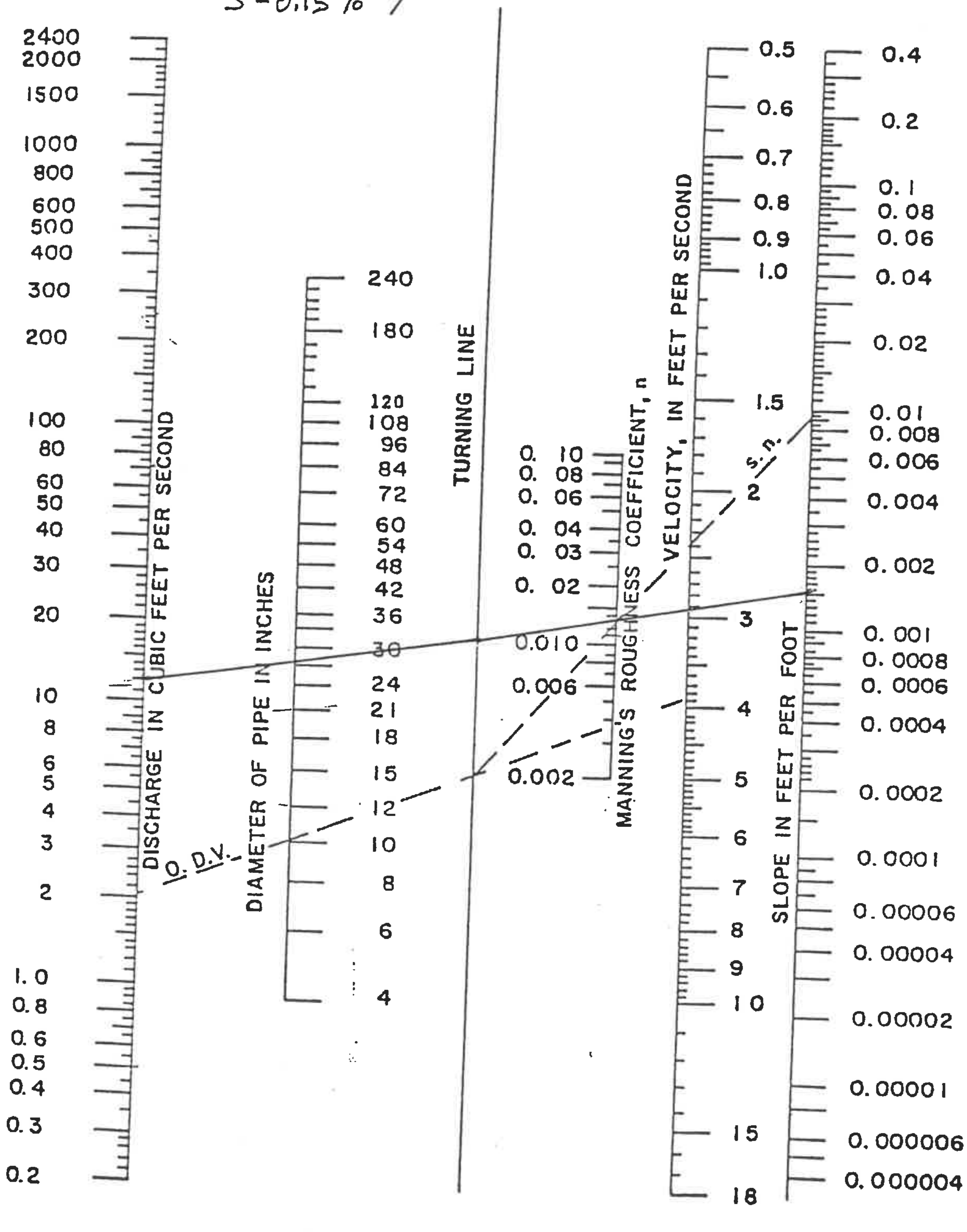
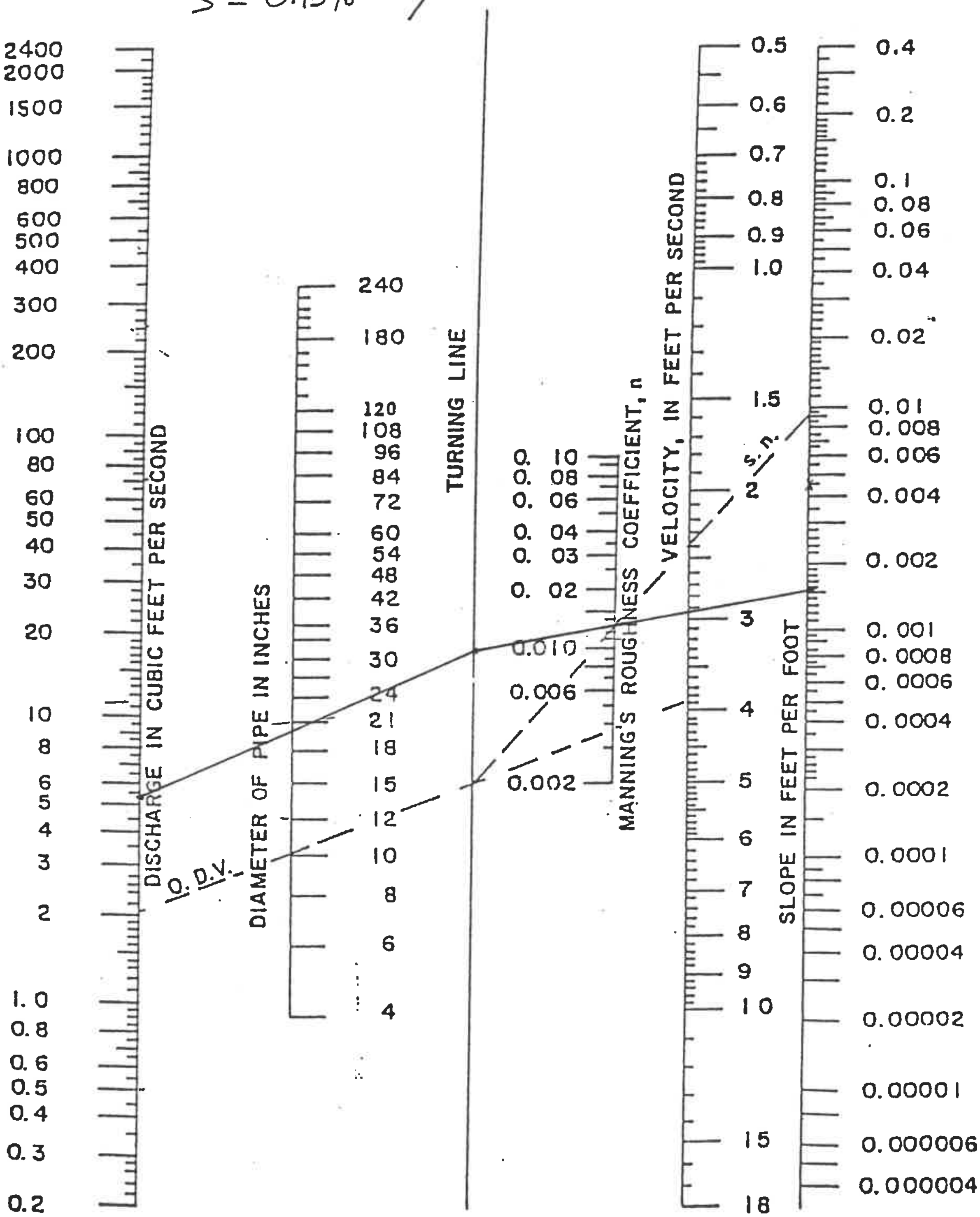


FIG. 7-415.04 D

Str # 704 Pipe, Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

10 Yr Storm
Q = 5.36 cfs
S = 0.15%
21" Required



Str #703 Pipe, Concrete

NOMOGRAPH FOR SOLUTION OF MANNING'S FORMULA FOR FLOW IN STORM SEWERS

10 Yr Storm
Q = 3.1 cfs
S = 0.22%
18" Required