Storm Water Requirements of the McLean County Subdivision Ordinance

Part of Chapter 6 of the Manual of Practice

6.01 INTRODUCTION

No subdivision plan or plat shall be recommended for approval, which does not make adequate provision for storm or flood water runoff channels or basins. The storm water drainage system shall be separate and independent of any sanitary sewer or collection tile system. Storm sewers, where required, shall be designed by the Rational Method or any other reasonable method as approved by the County Engineer. A copy of all design computations shall be submitted along with the engineering plans. Underground and/or surface storm water drainage systems shall be installed to service the entire subdivision. On site stormwater detention/retention shall be provided unless otherwise approved.

6.02 Design Standards

All subdivisions shall include a storm water drainage system designed in such a way to provide that all lots and outlots in the subdivision will be graded and shaped so as to provide an adequate outlet for that property. This drainage system shall provide for any drainage that naturally flows through the development from adjoining property.

A. Storm Sewers

1. Design Criteria

a. Design Formula - Unless otherwise approved by the County Engineer, formulas to be used in connection with the calculation of run-off reasonably expected from the minimum design storm shall be the Rational Method for total contributing areas of twenty (20) acres (8 hectares) or less and the Soil Conservation Service Method as outlined in their Technical Release No. 55 for areas greater than twenty (20) acres (8 hectares). Calculations are to be submitted substantially in the form provided in Exhibit P of the Appendix.

b. Minimum Design Storm - The minimum design storm used in calculating run-off in the Design Formula will be the average rainfall intensity associated with an average recurrence interval of five (5) years for the storm period calculated by the Time of Concentration as outlined by the latest Technical Letters of the Illinois State Water Survey for rainfall frequencies. The corresponding charts and tables have been provided in Exhibit P of the Appendix for time of concentration, run-off factors and coefficients and frequency intensities for use in either method for

run-off estimation.

c. When changing sewer sizes the sewers shall match at the 9/10 diameter point.

2. The stormwater drainage system shall connect all inlets and catch basins to a storm sewer, pipe or conduit of sufficient size, grade and capacity to carry the run-off reasonably expected from the Minimum Design Storm on the area in the natural drainage area if that area is improved with the type of improvements permitted and to a maximum density authorized by the then-existing zoning ordinances of the County for property within the jurisdiction of the County; however no storm sewer shall be smaller than twelve (12) inches (300mm) in diameter.

3. The stormwater drainage system shall connect all storm sewers to other storm sewers or improved drainageways of sufficient size, grade, and capacity to carry the runoff reasonably expected from the Minimum Design Storm in the natural drainage area if that area was improved with the type of improvements permitted and to the maximum density authorized by the then-existing zoning ordinances of the County for property within the jurisdiction of the County.
4. Manholes

    a. Public manholes shall be installed at the end of each storm sewer line, at all changes in grade or alignment, at all intersections and at distances not greater than 400 feet (120m) between manholes for sewers of 15 inches (375mm) or less and 500 feet (150m) for sewers of 18 to 30 inches (450mm-750mm). Greater spacing will be permitted in larger sewers and in those carrying a settled effluent.
    b. Public manholes in improved streets or other hard surfaced public rights-of-way accessible to vehicular traffic shall be not more than 800 feet (360m) apart or at such lesser distances as is required to permit every storm sewer in the proposed development to be inspected, tested and cleaned from two surfaced manholes separated by not more than 1,200 feet (360m) measured in a straight line along the sewer.
    c. Minimum drop in a manhole shall be 1 inch (25mm) and the maximum drop in a manhole shall be 24 inches (600mm).

5. Inlets

    Inlets for local streets shall be provided for all low points and the maximum spacing shall not exceed four hundred (400) feet (120m), except that the first inlet shall be spaced approximately four hundred feet from the high point or at no greater distance than six hundred (600) feet (180m) when approved by the County Engineer. Inlets for all other street classifications shall meet IDOT design criteria.

B. Drainage Ways

1. All drainage ways through the proposed development shall be improved to a size and in a way adequate to carry the runoff reasonably expected from the Minimum Design Storm in the natural drainage area if that area was improved with the type of improvements permitted and to the maximum density authorized by the then-existing zoning ordinances of the County for property within the unincorporated areas of McLean County and the land use element of the County's Comprehensive Plan.

a. Design Formula: Unless otherwise approved by the County Engineer, formulas to be used in connection with the calculation of runoff reasonably expected from the Minimum Design Storm shall be the Rational Method for total contributing areas of 20 acres (8 hectares) or less and the Soil Conservation Service Method as outlined in their Technical release No. 55 for areas greater than 20 acres (8 hectares).

b. Minimum Design Storm: The Minimum Design Storm used in calculating runoff in the Design Formula will be the average rainfall intensity associated with an average recurrence interval of twenty-five (25) years for the storm period calculated by the Time of Concentration as outlined by the latest Technical Letters of the Illinois State Water Survey for rainfall frequencies. The corresponding charts and tables have been provided in Exhibit P of the Appendix for Time of Concentration, runoff factors, and coefficients and frequency intensities for use in either method for runoff estimation.

2. Drainage ways shall have a flat bottom, maximum 3:1 side slopes, the top of the bank shall be constructed one foot above computed water surface elevation for the Minimum Design Storm, and have a ten (10) foot (3m) maintenance/access lane on each side of the drainage way.

C. Retention and Detention Facilities

1. No development shall be authorized in McLean County unless it has an approved on-site detention or retention facility. Such facility shall be designed based on the Design Formula.

a. Design Formula: Unless otherwise approved by the County Engineer, formulas to be used in connection with the calculation of runoff volumes and allowable release rates reasonably expected from the Minimum Design Storm shall be the Rational Method as outlined of the latest Illinois Division of Highway Standards for the Storm Water Runoff and the method outlined by the Metropolitan Sanitary District of Greater Chicago's sewer permit ordinance of 1972 as modified in Exhibit P of the Appendix for Storage for total contributing areas of twenty (20) acres (8 hectares) or less and the Soil Conservation Hydrograph Method for areas greater than twenty (20) acres (8 hectares). The corresponding instructions, charts, tables and forms have been provided in Exhibit P of the Appendix of this Manual for use in either method of calculation. For areas of development up to five (5) acres (2 hectares), the following shall be required.

AREA	REQUIRED STORAGE RATE	MAXIMUM RELEASE RATE ALLOWED
up to 1 acre (0.4 hectare)	10700 cu. ft/acre (750 cu. m/hectare)	1.05 cfs/ acre (0.073 cu. m/hectare)
up to 2 acres (0.8 hectare)	9100 cu. ft./acre (640 cu. m/hectare)	0.90 cfs/ acre (0.063 cu. m/hectare)
up to 3 acres (1.2 hectare)	7800 cu. ft./acre (545 cu. m/hectare)	0.78 cfs/ acre (0.055 cu. m/hectare)
up to 4 acres (1.6 hectare)	6900 cu. ft./acre (480 cu. m/hectare)	0.64 cfs/ acre (0.045 cu. m/hectare)
up to 5 acres (2.0 hectare)	6200 cu. ft./acre (435 cu. m/hectare)	0.60 cfs/ acre (0.042 cu. m/hectare)

b. Minimum Design Storm:

i Storage volume will be determined from inflow hydrographs generated by the Design Formula using a minimum design storm with a range of rainfall intensities associated with an average occurrence interval of one hundred (100) years and an assumed coefficient for the post development zoning district as set forth in Exhibit P of the Appendix of this Manual.

ii Allowable release rate will be determined by the Design Formula using a minimum design storm with an average rainfall intensity associated with an average recurrence interval of three (3) years for the storm period calculated by the Time of Concentration as outline by the latest Technical Letters of the Illinois State Water Survey for rainfall frequencies and a runoff coefficient of 0.25.

2. Bank Stabilization

a. Retention facilities shall be provided with wave shelves along the entire perimeter in accordance with standards in this manual.

b. Retention and detention facilities shall have a maximum 4:1 bank slope.

c. Shoreline surfaces subject to wave action shall be stabilized with structural material such as riprap, revetment matting, retaining walls, etc.

6.03 DESIGN CALCULATION REQUIREMENTS

Calculations required to demonstrate compliance with the design standards enumerated in the previous section of this Manual shall be submitted substantially in the form and content as shown and provided in Exhibit P of the Appendix. Calculations submitted with Preliminary Plans are not required to be of greater detail as the calculations required to be submitted with Public Improvement Engineering Plans and Specifications.

EXHIBIT P
DESIGN FORMULAS, CHARTS, TABLES, FORMS & EXAMPLES OF CALCULATIONS FOR STORM SEWERS, DRAINAGE WAYS, & RETENTION/DETENTION FACILITIES

TABLE OF CONTENTS

Exhibit P
1.a

STORM FREQUENCY INTENSITIES

TIME	YEAR 2	3	5	10	25	50	100
1	4.32	4.68	5.40	6.36	7.68	8.76	9.96
2	4.32	4.68	5.40	6.36	7.68	8.76	9.96
3	4.32	4.68	5.40	6.36	7.68	8.76	9.96
4	4.32	4.68	5.40	6.36	7.68	8.76	9.96
5	4.32	4.68	5.40	6.36	7.68	8.76	9.96
6	4.25	4.60	5.31	6.26	7.55	8.62	9.79
7	4.18	4.53	5.23	6.17	7.42	8.47	9.62
8	4.10	4.45	5.15	6.07	7.28	8.33	9.46
9	4.03	4.38	5.06	5.98	7.15	8.18	2.29
10	3.96	4.30	4.98	5.88	7.02	8.04	9.12
11	3.82	4.14	4.80	5.66	6.77	7.74	8.79
12	3.67	3.99	4.62	5.45	6.52	7.45	8.46
13	3.53	3.83	4.44	5.23	6.26	7.15	8.14
14	3.38	3.68	4.26	5.07	6.01	6.86	7.81
15	3.24	3.52	4.08	4.80	5.76	6.56	7.48
16	3.14	3.40	3.95	4.65	5.58	6.35	7.24
17	3.04	3.30	3.82	4.50	5.40	6.14	7.01
18	2.93	3.18	3.68	4.35	5.22	5.94	6.77
19	2.83	3.07	3.55	4.20	5.04	5.73	6.54
20	2.73	2.96	3.42	4.05	4.86	5.52	6.30
21	2.66	2.89	3.35	3.96	4.75	5.40	6.16
22	2.60	2.82	3.27	3.86	4.64	5.28	6.02
23	2.53	2.76	3.20	3.77	4.52	5.16	5.87
24	2.47	2.69	3.12	3.67	4.41	5.04	5.73
25	2.40	2.62	3.05	3.58	4.30	4.92	5.59
26	2.37	2.58	3.00	3.52	4.23	4.84	5.50
27	2.34	2.54	2.94	3.46	4.16	4.75	5.40
28	2.30	2.50	2.89	3.40	4.08	4.67	5.31
29	2.27	2.46	2.83	3.34	4.01	4.58	5.21
30	2.24	2.42	2.78	3.28	3.94	4.50	5.12
31	2.19	2.37	2.72	3.21	3.86	4.41	5.01
32	2.14	2.32	2.66	3.15	3.78	4.31	4.91
33	2.10	2.26	2.61	3.08	3.69	4.22	4.80
34	2.05	2.21	2.55	3.02	3.61	4.12	4.70
35	2.00	2.16	2.49	2.95	3.53	4.03	4.59
36	1.97	2.12	2.45	2.90	3.47	3.96	4.51
37	1.93	2.09	2.41	2.85	3.41	3.89	4.43
38	1.90	2.05	2.36	2.79	3.35	3.82	4.35
39	1.86	2.02	2.32	2.74	3.29	3.75	4.27
40	1.83	1.98	2.28	2.69	3.23	3.68	4.19
41	1.80	1.95	2.25	2.65	3.18	3.63	4.13
42	1.77	1.92	2.21	2.61	3.13	3.57	4.07

43	1.75	1.89	2.18	2.57	3.09	3.52	4.00
44	1.72	1.86	2.14	2.53	3.04	3.46	3.94
45	1.69	1.83	2.11	2.49	2.99	3.41	3.88
46	1.67	1.81	2.08	2.46	2.95	3.37	3.83
47	1.65	1.79	2.05	2.43	2.91	3.32	3.78
48	1.62	1.76	2.03	2.39	2.86	3.28	3.72
49	1.60	1.74	2.00	2.36	2.82	3.23	3.67
50	1.58	1.71	1.97	2.33	2.78	3.19	3.62
51	1.56	1.69	1.95	2.30	2.75	3.15	3.58
52	1.54	1.67	1.93	2.28	2.72	3.12	3.54
53	1.53	1.66	1.91	2.25	2.69	3.08	3.51
54	1.51	1.64	1.89	2.23	2.66	3.05	3.47
55	1.49	1.62	1.87	2.20	2.63	3.01	3.43
56	1.48	1.62	1.85	2.18	2.60	2.98	3.39
57	1.46	1.61	1.83	2.16	2.58	2.95	3.36
58	1.45	1.61	1.81	2.13	2.55	2.92	3.32
59	1.43	1.60	1.79	2.11	2.53	2.89	3.29
60	1.42	1.60	1.77	2.09	2.50	2.86	3.00
65	1.38	1.55	1.72	2.02	2.42	2.77	2.92
70	1.33	1.49	1.66	1.96	2.35	2.68	2.84
75	1.29	1.44	1.61	1.90	2.27	2.60	2.76
80	1.24	1.39	1.55	1.83	2.20	2.51	2.68
85	1.2	1.33	1.50	1.77	2.18	2.42	2.60
90	1.16	1.28	1.44	1.70	2.04	2.33	2.52
95	1.11	1.23	1.39	1.64	1.96	2.24	2.44
100	1.07	1.17	1.33	1.57	1.89	2.15	2.36
105	1.02	1.12	1.28	1.51	1.81	2.07	2.28
110	0.98	1.07	1.22	1.44	1.73	1.98	2.20
115	0.93	1.01	1.17	1.38	1.65	1.89	2.12
120	0.89	0.96	1.11	1.31	1.57	1.80	2.04

This table is derived from the Illinois State Water Survey Circular 172; dated 1989; "Frequency Distributions of Heavy Rainstorms in Illinois."

EXHIBIT P
1 b

Ex. P1b
Rev. March, 1975

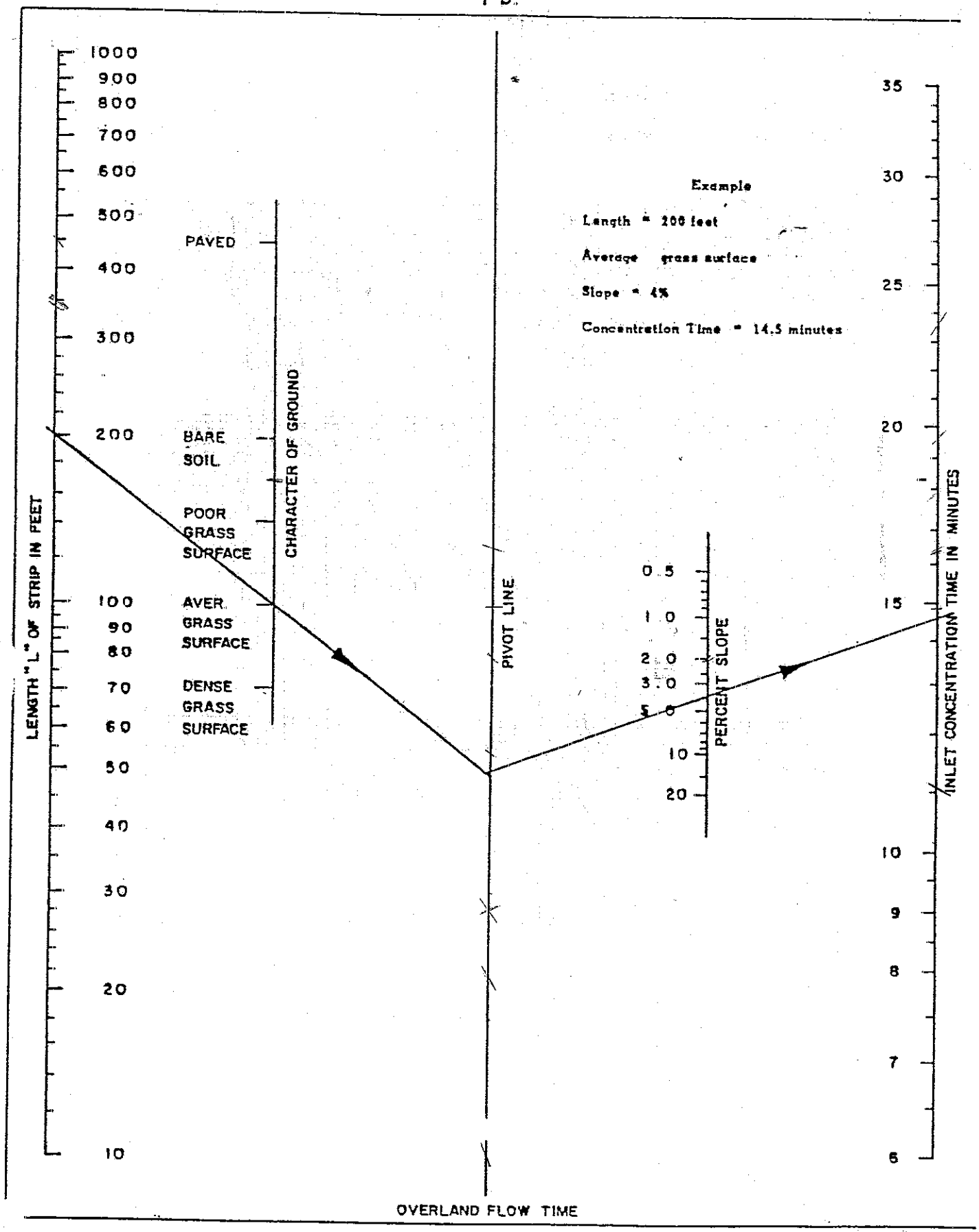

Figure 6-110.01 f

EXHIBIT P

Ic.

AVERAGE VELOCITY FOR

ESTIMATED TRAVEL TIME FOR OVERLAND FLOW

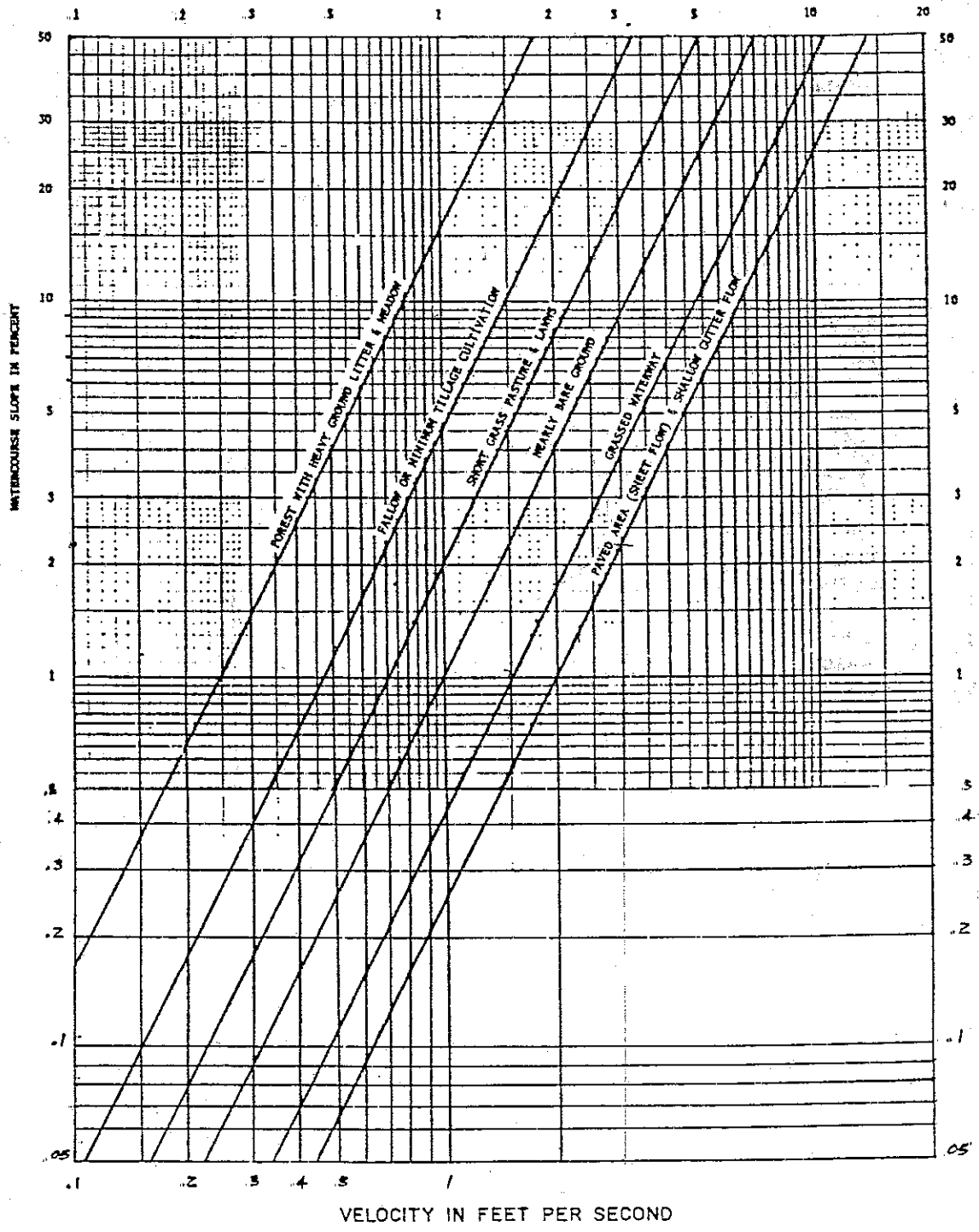

EXHIBIT P

Rev. March, 1975

I d.

RUNOFF COEFFICIENTS

VALUES OF C = Runoff / Rainfall			RUNOFF COEFFICIENT C	
TYPE OF DRAINAGE AREA SURFACES			MIN.	MAX.
ROOFS, slag to metal			0.75	0.95
PAVEMENTS	Asphalt		0.70	0.95
	Concrete		0.80	0.95
	Gravel, from clean and loose to clayey and compact		0.25	0.70
R.R. YARDS			0.20	0.40
EARTH SURFACES	Sand, from uniform grain size, no fines to well graded some clay or silt	Bare	0.15	0.50
		Light Vegetation	0.10	0.40
		Dense Vegetation	0.05	0.30
	Loam, from sandy or gravelly to clayey	Bare	0.20	0.60
		Light Vegetation	0.10	0.45
		Dense Vegetation	0.05	0.35
	Gravel, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content	Bare	0.25	0.65
		Light Vegetation	0.15	0.50
		Dense Vegetation	0.10	0.40
	Clay, from coarse sandy or silty to pure colloidal clays	Bare	0.30	0.75
		Light Vegetation	0.20	0.60
		Dense Vegetation	0.15	0.50
COMPOSITE AREAS	City, business areas		0.70	0.95
	City, dense residential areas, vary as to soil & Vegetation		0.50	0.65
	Suburban residential areas, vary as to soil & vegetation		0.35	0.55
	Rural Districts, vary as to soil & vegetation		0.10	0.25
	Parks, Golf Courses, etc., vary as to soil & vegetation		0.10	0.35
LAWNS	Sandy soil, flat 2%		0.05	0.10
	Sandy soil, average 2% to 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% to 7%		0.18	0.22
	Heavy soil, steep 7%		0.25	0.35

NOTE: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

TABLE 8-110.01

STORM SEWER COMPUTATION SHEET

DESIGN STORM ______ YEAR FREQUENCY

PROJECT: ______

DATE: ______ ENGINEER: ______

LOCATION		LENGTH (ft.)	BASIN NO.	AREA "A" (acres)		RUNOFF "C" COEFFICIENT	"A" X "C"		FLOW TIME (min.)			TIME OF CONCENTRATION	RAINFALL "I" INTENSITY	TOTAL RUNOFF Q=CIA (cfs)	DIAMETER PIPE (inches)	CAPACITY FULL (cfs)	VELOCITY (fps)		INVERT ELEVATION		MANHOLE INVERT DROP	SLOPE OF SEWER %
FROM STATION	TO STATION			INCREMENT	TOTAL		INCREMENT	TOTAL	TO UPPER END	IN GUTTER	IN SECTION						FLOWING FULL	DESIGN FLOW	UPPER END	LOWER END		

EXHIBIT P
1f
Capacity Design Calculations for Detention Facilities

The following calculation method is a modification of the method described in the information pamphlet: "Design Capacity of Storm Water Detention Reservoirs" of the Metropolitan Sanitary District of Greater Chicago; dated 1972.

Live Detention Storage = (Volume Runoff, 50 yr) - (Release Rate x Duration)
(Inches) $= V_{50} - Q_r t_d = c\, i_{50}\, t_d - 0.25\, i_3\, t_d$

Maximum storage volume calculated by this equation for any and all duration (t_d) will be the required storage. The terms of the above equation are defined as follows:

Q_r = The maximum release rate in inches per hour from the land in its natural undeveloped state.

0.25 = The coefficient of runoff for the undeveloped land.

i_3 = The intensity in inches per hour of the rainfall derived from ISWS/CIR/72/89; "Frequency Distributions of Heavy Rainstorms in Illinois" for three-year frequency for the time of concentration of the undeveloped land. (see Exhibit P/1a.)

i_{50} = The intensity in inches per hour of rainfall derived from ISWS/CIR/72/89; "Frequency Distributions of Heavy Rainstorms in Illinois" for 50-year frequency for any and all durations.

t_d = The duration of the 50-year storm, which must be varied to determine the most critical and therefore maximum required detention.

c = The coefficient of runoff for the completely developed drainage area tributary to the reservoir.

Note: i_{50} varies with t_d, however, i_{50} is calculated using the longest time of concentration for the undeveloped land and becomes a constant in the above equation.

The live detention storage, in inches of depth, is converted to acre-feet by multiplying the inches of depth by the drainage area in acres, and by the factor 0.0833.

Page Two
EXHIBIT P/1f

Name of Project _____
Date _____
Design Engineer _____

I. Determination of Allowable Release Rate - Undeveloped Site:

1. Area of site	_____acres
2. Average ground slope	_____foot/foot
3. Overland flow distance	_____feet
4. Overland flow time of concentration (Use Exhibit P/1b)	_____minutes
5. Average slope of channelized flow (See Note a)	_____foot/foot
6. Channelized flow distance (See note a)	_____feet
7. Channelized flow time of concentration (See note a)	_____minutes
8. Total time of concentration (line 4 + line 7)	_____minutes
9. Rainfall intensity for three-year storm, (Use Exhibit P/1a for the time duration on line 8)	_____inches/hr
10. Runoff coefficient	0.25
11. Allowable release rate, (line 1 x line 9 x line 10) Q=c1A	_____cfs

Note a: For flow in a well defined channel determine time of concentration from measured lengths, cross-sections and slopes and submit necessary calculations and drawings and/or use Exhibit P/1c.

II. Determination of Reservoir Size - Developed Site:

12. Impervious drainage area	_____acres
13. Impervious Runoff coefficient (Use Exhibit P/1d.)	_____
14. Pervious drainage area	_____acres
15. Pervious runoff coefficient (Use Exhibit P/1d)	_____
16. Coefficient of Runoff for completely developed drainage area (c =(line 12 X line 13)+(line 14 x line 15)/line 1)	_____

17. Formula: Live Storage

(Inches) = $c\, i_{50}\, t_d - 0.25\, i_3\, t\, d = (ci_{50} - 0.25i_3)$

A	B	C	D	E	F
T (MIN)	RAINFALL (50-YEAR) I50(in/hr)	RUNOFF RATE ci50	RELEASE RATE 0.25 I3	STORAGE RATE (ci50-0.25i3)	STORAGE (Inches)
5	8.76				
10	8.04				
15	6.56				
20	5.52				
25	4.92				
30	4.50				
35	4.03				
40	3.68				
45	3.41				
50	3.19				
55	3.01				
60	2.86				
65	2.77				
70	2.68				
75	2.60				
80	2.51				
85	2.42				
90	2.33				
95	2.24				
100	2.15				
105	2.07				
110	1.98				
115	1.89				
120	1.80				

18. Maximum live storage required
(Maximum Storage in Column F x Site Area x 0.0833) _____acre-feet

Ex. P1f (pg. 4)

III. Determination of Discharge Orifice

Formula:

$A = Q/c\ 2GH$

A = Area (square feet) of Orifice required
Q = Allowable release rate
c = Coefficient 0.61 - orifice hole
0.82 - orifice tube
H = Headwater (depth from high water to the center line of the orifice)
G = 32.2 (feet/sec/sec) Acceleration of gravity

19. Coefficient c _____
20. Headwater (H) _____feet
21. Orifice Area
(A=line 11/line 19 x 2 x 32.2 x line 20) ½ _____sq.ft.
22. Orifice Type (Hole or Tube) _____

IV. Permissible Bypass Rate through Development Site from Upstream Area:

A. Determination of Bypass Rate:

23. Total area upstream ____acres
24. Future/present impervious area (cross out inappropriate case) ____acres
25. Future/present pervious area (cross out inappropriate case) ____acres
26. Composite runoff coefficient (must not be less than 0.40) ____
27. Design storm frequency for the upstream area 5 year
28. Time of concentration, for the upstream area at point of entry (upstream area to be considered as undeveloped by same method as line 8) ____minutes
29. Design storm intensity for above duration ____inches/hr.
30. Permissible bypass rate (line 23 x line 26 x line 29) ___cfs.

B. Determination of Required Size of Bypass System:

31. Bypass system will be open channel/closed conduit (cross out inappropriate case) _____
32. Water cross-section area for discharge in line 30 _____sq.ft.
33. Wetted perimeter for area in line 32 _____feet
34. Hydraulic radius (line 32 ÷ line 33) _____feet
35. Line 34 to the 2/3 power _____
36. Invert slope _____foot/foot
37. Line 36 to the ½ power _____
38. Manning's roughness coefficient, n = _____
39. Bypass capacity
[(1.49 x line 32 x line 35 x line 37)/(line 38)]

$$Q = \frac{1.49\ A\ R^{2/3}\ S^{1/2}}{n}$$

Ex. P2a

EXHIBIT P
2a

Frequency Distribution for 24-hour Rainfall Storm Period

FREQUENCY (YEARS)	RAINFALL (INCHES)
2	3.02
3	3.27
5	3.76
10	4.45
25	5.32
50	6.08
100	6.92

From: Illinois State Water Survey Circular 172; dated 1989; "Frequency Distributions of Heavy Rainstorms in Illinois".

EXHIBIT P
2b.
RUNOFF CURVE NUMBERS TABLE

USDA/Soil Conservation Service Technical Release No. 55;1975

Table 2-2.--Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and I_a = 0.2S)

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Cultivated land[1]: without conservation treatment	72	81	88	91
: with conservation treatment	62	71	78	81
Pasture or range land: poor condition	68	79	86	89
good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or Forest land: thin stand, poor cover, no mulch	45	66	77	83
good cover[2]	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	39	61	74	80
fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious).	81	88	91	93
Residential:[3]				
Average lot size — Average % Impervious[4]				
1/8 acre or less — 65	77	85	90	92
1/4 acre — 38	61	75	83	87
1/3 acre — 30	57	72	81	86
1/2 acre — 25	54	70	80	85
1 acre — 20	51	68	79	84
Paved parking lots, roofs, driveways, etc.[5]	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers[5]	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

1/ For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.

2/ Good cover is protected from grazing and litter and brush cover soil.

3/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

4/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

5/ In some warmer climates of the country a curve number of 95 may be used.

EXHIBIT P
2c.
RUNOFF DEPTH TABLE

USDA/Soil Conservation Service Technical Release No. 55; 1975

Table 2-1.--Runoff depth in inches for selected CN's and rainfall amounts

Rainfall (inches)	Curve Number (CN)[1/]								
	60	65	70	75	80	85	90	95	98
1.0	0	0	0	0.03	0.08	0.17	0.32	.56	.79
1.2	0	0	0.03	0.07	0.15	0.28	0.46	.74	.99
1.4	0	0.02	0.06	0.13	0.24	0.39	0.61	.92	1.18
1.6	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11	1.38
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98	2.45	2.78
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	1.92	2.35	2.80	3.28	3.78	4.31	4.85	5.41	5.76
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82	6.41	6.76
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81	7.40	7.76
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79	8.40	8.76
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78	9.40	9.76
11.0	5.72	6.44	7.13	7.82	8.48	9.14	9.77	10.39	10.76
12.0	6.56	7.32	8.05	8.76	9.45	10.12	10.76	11.39	11.76

[1/] To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use an arithmetic interpolation.

EXHIBIT P
2d.

Note: This chart is derived from Table 5-3 of the USDA/Soil Conservation Service Technical Release No. 55; 1975.

TABULAR HYDROGRAPH DISCHARGES (C.F.S./SQ.MILE/INCH OF RUNOFF)

Hydrograph Time →

Time of Concentration ↓	11.0	11.5	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	13.0	13.2	13.5	14.0	14.5	15.0	16.0	18.0	20.0
0.1 hr.	24	51	299	991	746	477	233	152	132	121	111	85	74	70	68	65	52	48	39	33	29	24	18	14
0.2 hr.	23	47	209	509	796	641	424	245	170	138	121	104	85	75	71	68	56	49	40	34	29	24	18	14
0.3 hr.	21	43	141	324	586	658	535	372	251	184	148	124	102	86	77	71	61	51	41	34	30	24	18	14
0.4 hr.	20	39	103	224	419	558	575	451	331	247	190	155	127	105	90	80	66	53	42	35	30	24	18	14
0.5 hr.	18	36	80	166	301	433	496	474	395	309	242	194	158	130	109	94	75	57	43	36	31	25	18	15
0.75 hr.	15	29	57	98	163	248	329	375	388	369	325	276	232	195	165	142	107	76	51	39	33	26	19	15
1.00 hr.	13	24	45	66	107	155	211	258	301	313	316	301	277	247	217	188	146	102	64	46	36	27	19	15
1.25 hr.	11	21	37	51	79	107	147	187	219	249	264	271	267	256	241	219	177	128	81	56	42	29	20	16
1.5 hr.	10	18	31	42	57	81	105	133	164	192	209	227	235	236	236	225	201	153	99	68	50	32	20	16
2.0 hr.	7	14	22	30	38	49	64	80	95	114	133	152	165	175	184	192	190	176	129	93	68	41	23	17

Note: This table is applicable to a basin located at the downstream end of the entire watershed area in question, and valley routing is not required.

EXHIBIT P
2e.
Page 1.
Single Stage Structure Routing Graph

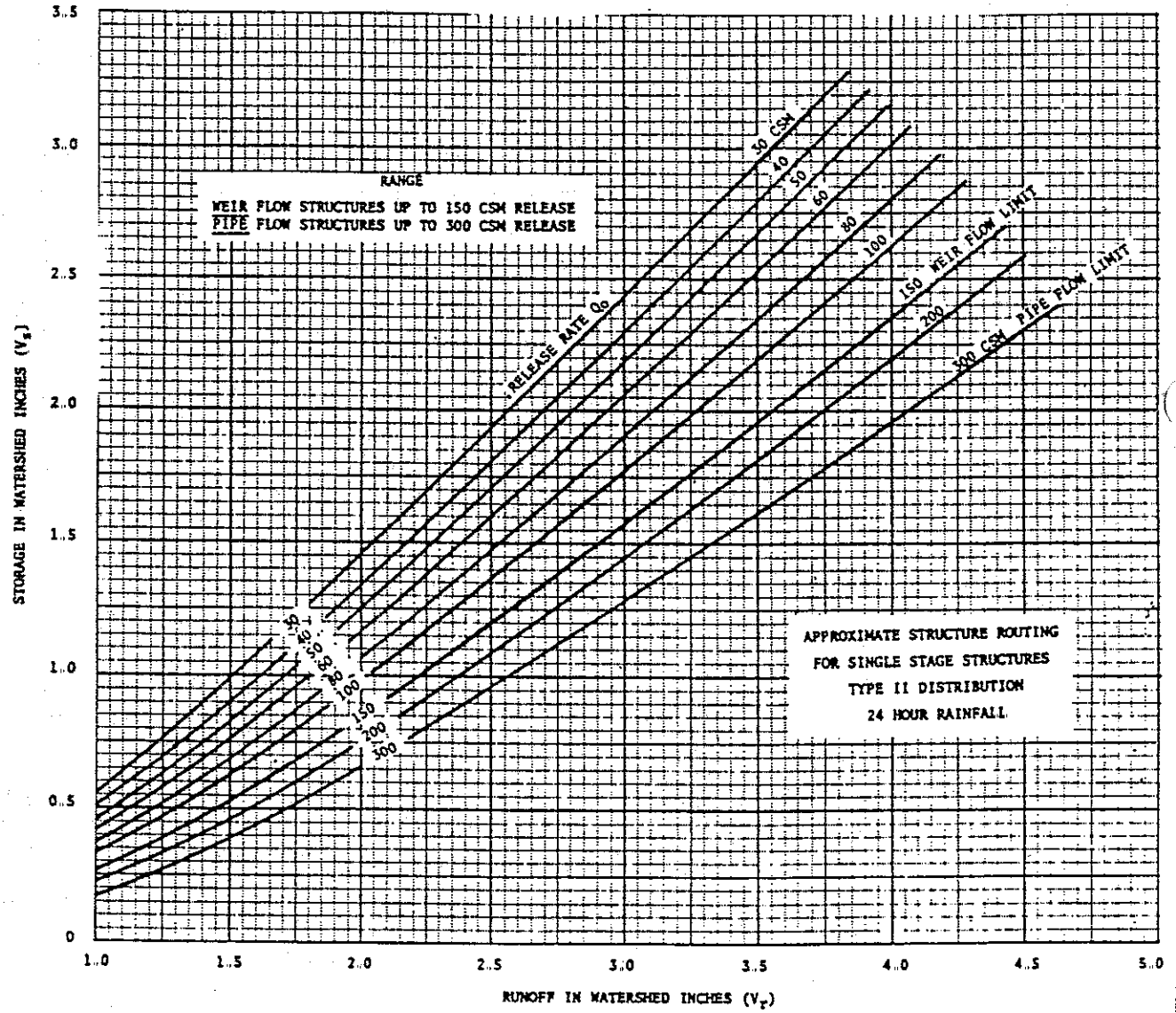

Figure 7-1.--Approximate single-stage structure routing for weir flow structures up to 150 csm release rate and pipe flow structures up to 300 csm release rate.

(USDA/Soil Conservation Service Technical Release No. 55; 1975)

EXHIBIT P
2e.
Page 2.
Single Stage Structure Routing Graph

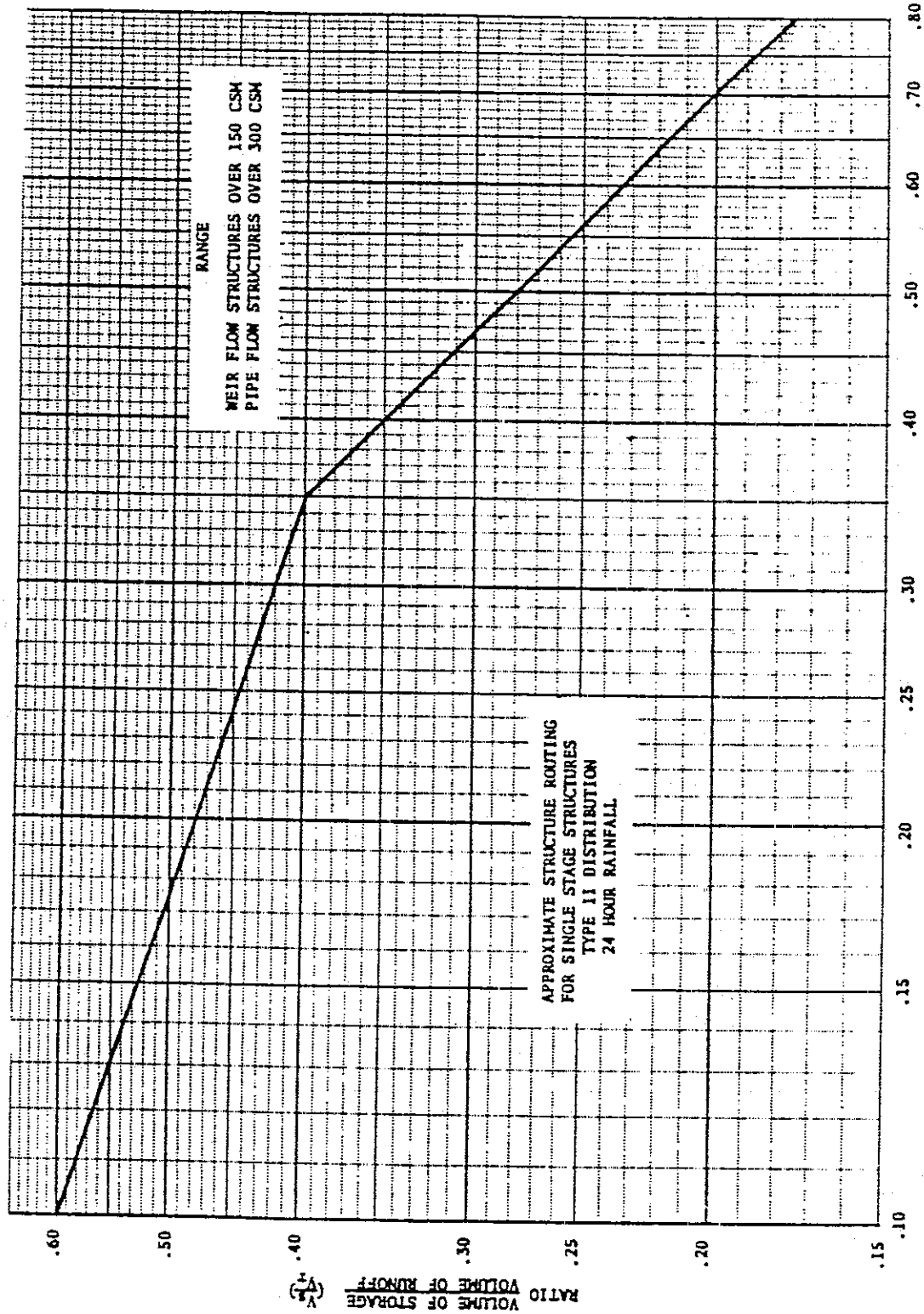

Figure 7-2.--Approximate single-stage structure routing for weir flow structures over 150 csm release rate and pipe flow structures over 300 csm release rate.

(USDA/Soil Conservation Service, Technical Release No. 55; 1975)

EXHIBIT P
2f.
CAPACITY DESIGN CALCULATIONS FOR DETENTION FACILITIES

URBAN HYDROLOGY FOR SMALL WAIERSHEDS (IR-55)
PEAK DISCHARGE WORKSHEET
FOR CHAPTER 4 (APPENDICES D & E)

(MODIFIED FOR THE TOWN OF NORMAL)

Project _____ By _____ Date _____

_____ Checked _____ Date _____

Steps Peak Discharge Computations for up to 3 Storms: Type II ; Duration 24 hours.

1. Data:

Drainage Area (DA) = _____ acres. Ave. Watershed Slope (S) = _____ %.

2. Runoff Curve Number (CN) PRESENT CONDITION

Hydrologic Soil Group (TR55/AP.B)	Land Use Description Include Treatment, Practice & Condition (Table 2-2)[Ex. P/2b]	CN (Table 2-2) (3)	% or Area (acres) (4)	Product (3)x(4) (5)
		Totals =		

CN (weighted) = $\frac{\text{total col. (5)}}{\text{total col. (4)}}$ [_____] = _____ ; use CN = _____

DEVELOPED CONDITION

Hydrologic Soil Group (TR55/AP.B)	Land Use Description Include Treatment, Practice & Condition (Table 2-2)[Ex. P/2b]	CN (Table 2-2) (3)	% or Area (acres) (4)	Product (3)x(4) (5)
		Totals =		

CN (weighted) = $\frac{\text{total col. (5)}}{\text{total col. (4)}}$ [_____] = _____ ; use CN = _____

EXHIBIT P
2f.
CAPACITY DESIGN CALCULATIONS
FOR DETENTION FACILITIES

	1st Storm	2nd Storm	3rd Storm	
3. **Rainfall Frequency** (F)	PRESENT 3	DEVELOPED 50	DEVELOPED 100	yrs.
Rainfall Depth (P)	3.27	6.08	6.92	inches
4. **Runoff Depth** (Q) Use P, CN, and Table 2-1. (2c.)				inches
5. Time of Concentration				minutes
	Qo	Qi	Qi	
6. Peak Discharge (Peak value from 2d. x P x DA)				c.f.s.
7. Allowable Peak Discharge (Q_o3)				c.f.s.

Estimation of Storage Volume Required

8. Ratio: Qo/Qi			
Volume of Storage/Volume of Runoff (2e.) Vs/Vr			
9. Volume of Storage (Vs) (Vs/Vr x (P/12) x DA			acre-feet
10. Volume of Storage Required			acre-feet

Note: This calculation is adequate for submittal for preliminary plan approval.

Detention reservoir routing calculations as outlined in Section 3 of Exhibit P of this manual will be required for approval of public improvement engineering plans and specifications.