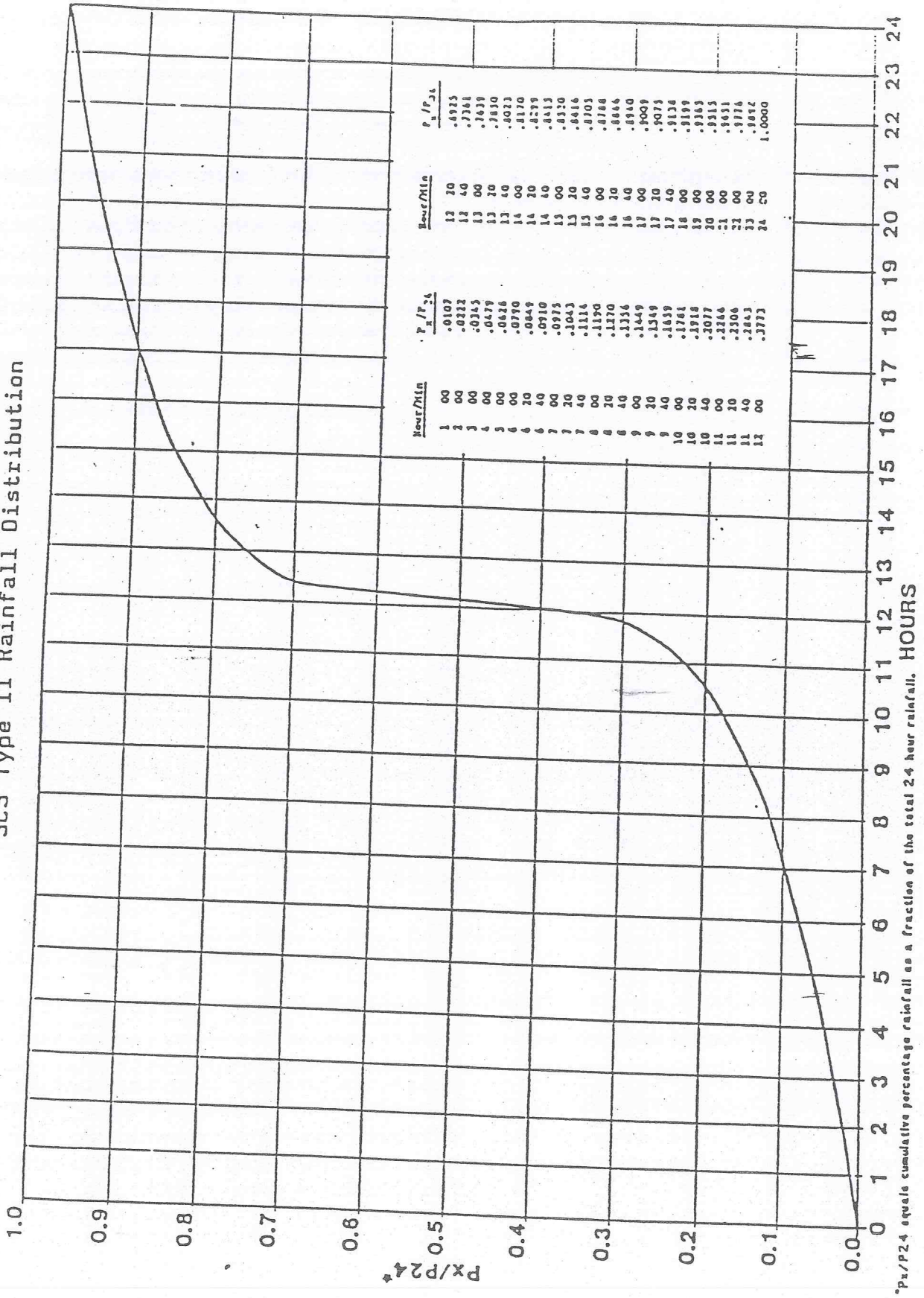


Figure C-2
SCS Type II Rainfall Distribution



* P_x/P_{24} equals cumulative percentage rainfall as a fraction of the total 24 hour rainfall.

Source: U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, 1986, Urban Hydrology for Small Watersheds, Technical Release 55, Washington, DC.

Table C-1

Runoff Curve Numbers and Average Imperviousness
For Various Land Uses by Hydrologic Soil Group

Cover Description Land Use/Cover Type	Average Imperviousness (%)	Curve Numbers For Hydrologic Soil Group			
		A	B	C	D
Open Space (lawns, parks, golf courses, cemeteries, etc.):					
Good condition (grass cover greater than 75%)	n/a ^a	39	61	74	80
Impervious Areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	n/a	98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)	n/a	98	98	98	98
Paved; open ditches (including right-of-way)	n/a	98	98	98	98
Urban Districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size:					
1/8 acre or less (town houses)	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
2 acres	12	46	65	77	82
Woods:	n/a	30	55	70	77

^a Not applicable.

Source: U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, 1988, "Urban Hydrology for Small Watersheds," Technical Release 55, Washington, DC.

Table C-2
Runoff Coefficients for the Rational Formula
By Hydrologic Soil Group and Overland Slope (X)

Land Use	A			B			C			D		
	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Cultivated Land	0.08 ^a	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14 ^b	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential Lot Size 1/8 Acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.36	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Lot Size 1/4 Acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Lot Size 1/3 Acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Lot Size 1/2 Acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Lot Size 1 Acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open Space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.28	0.18	0.23	0.32	0.22	0.27	0.33
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

^a Runoff coefficients for storm recurrence intervals less than 25 years.
^b Runoff coefficients for storm recurrence intervals of 25 years or more.

Source: Rawls, W.J., S.L. Wong and R.H. McCuen, 1981, "Comparison of Urban Flood Frequency Procedures," Preliminary Draft, U.S. Department of Agriculture, Soil Conservation Service, Beltsville, MD.

Table C-3
Manning Roughness Coefficients

	Manning's n range		Manning's n range
I. Closed Conduits:			
A. Concrete pipe	0.011-0.013	B. Earth, fairly uniform section:	
B. Corrugated-metal pipe or pipe arch:		1. No vegetation	0.022-0.025
1. 2-2/3 by 1/2 in. corrugation (riveted) pipe):		2. Grass, some weeds	0.025-0.030
a. Plain or fully coated	0.024	3. Dense weeds or aquatic plants in deep channels	0.030-0.035
b. Paved invert (range values are for 25 and 50 percent of circumference paved):		4. Sides clean, gravel bottom ...	0.025-0.030
(1) Flow full depth	0.021-0.018	5. Sides clean, cobble bottom ...	0.030-0.040
(2) Flow 0.8 depth	0.021-0.016	C. Dragline excavated or dredged:	
(3) Flow 0.6 depth	0.019-0.013	1. No vegetation	0.028-0.033
2. 6 by 2-in. corrugation (field bolted)	0.030	2. Light brush on banks	0.035-0.050
C. Cast-iron pipe, uncoated	0.013	D. Rock:	
D. Steel pipe	0.009-0.011	1. Based on design section	0.035
E. Monolithic concrete:		2. Based on actual mean section:	
1. Wood forms, rough	0.015-0.017	a. Smooth and uniform	0.035-0.040
2. Wood forms, smooth	0.012-0.014	b. Jagged and irregular	0.040-0.045
3. Steel forms	0.012-0.013	E. Channels not maintained, weeds and brush uncut:	
F. Cemented rubble masonry walls:		1. Dense weeds, high as flow depth	0.080-0.120
1. Concrete floor and top	0.017-0.022	2. Clean bottom, brush on sides .	0.050-0.080
2. Natural floor	0.019-0.025	3. Clean bottom, brush on sides, highest stage of flow	0.070-0.110
II. Open Channels, Lined (straight alignment):			
A. Concrete, with surfaces as indicated:		4. Dense brush, high stage	0.100-0.140
1. Formed, no finish	0.013-0.017	IV. Channels & Swales w/Maintained Vegetation (Values shown are for velocities of 2 & 6 f.p.s.):	
2. Trowel finish	0.012-0.014	A. Depth of flow up to 0.7 foot:	
3. Float finish	0.013-0.015	1. Bermudagrass, Kentucky bluegrass, buffalograss	
4. Float finish, some gravel on bottom	0.015-0.017	a. Mowed to 2 inches	0.045-0.070
5. Gunite, good section	0.016-0.019	b. Length 4-6 inches	0.050-0.090
6. Gunite, wavy section	0.018-0.022	2. Good stand, any grass:	
B. Concrete, bottom float finished, sides as indicated:		a. Length about 12 inches	0.090-0.180
1. Dressed stone in mortar	0.015-0.017	b. Length about 24 inches	0.150-0.300
2. Random stone in mortar	0.017-0.020	3. Fair stand, any grass:	
3. Cement rubble masonry	0.020-0.025	a. Length about 12 inches	0.080-0.140
4. Cement rubble masonry, plastered	0.016-0.020	b. Length about 24 inches	0.130-0.250
5. Dry rubble (riprap)	0.020-0.030	B. Depth of flow 0.7-1.5 feet:	
C. Gravel bottom, sides as indicated:		1. Bermudagrass, Kentucky bluegrass, buffalograss:	
1. Formed concrete	0.017-0.020	a. Mowed to 2 inches	0.035-0.050
2. Random stone in mortar	0.020-0.023	b. Length 4 to 6 inches	0.040-0.060
3. Dry rubble (riprap)	0.023-0.033	2. Good stand, any grass:	
D. Asphalt		a. Length about 12 inches	0.070-0.120
1. Smooth	0.013	b. Length about 24 inches	0.100-0.200
2. Rough	0.016	3. Fair stand, any grass:	
E. Concrete-lined excavated rock:		a. Length about 12 inches	0.060-0.100
1. Good section	0.017-0.020	b. Length about 24 inches	0.090-0.170
2. Irregular section	0.022-0.027	V. Street and Expressway Gutters:	
III. Open Channels, Excavated (straight alignment, natural lining):			
A. Earth, uniform section:		A. Concrete gutter, troweled finish	0.012
1. Clean, recently completed	0.016-0.018	B. Asphalt pavement:	
2. Clean, after weathering	0.018-0.020	1. Smooth texture	0.013
3. With short grass, few weeds ..	0.022-0.027	2. Rough texture	0.016
4. In gravelly soil, uniform section, clean	0.022-0.025	C. Concrete gutter with asphalt pavement	
Source: Chow, V.T., 1959, "Open Channel Hydraulics," McGraw Hill, New York.			

Table C-3 (continued)
Manning Roughness Coefficients

	Manning's n range	Manning's n range
Natural Stream Channels:		
A. Minor streams (surface width at flood stage less than 100 feet):		
1. Fairly regular sections:		
a. Some grass & weeds, little or no brush	0.030-0.035	
b. Dense growth of weeds, depth of flow materially greater than weed height ..	0.035-0.050	
c. Some weeds, light brush on banks	0.035-0.050	
d. Some weeds, heavy brush on banks	0.050-0.070	
e. Some weeds, dense willows on banks	0.060-0.080	
f. For trees within channel with branches submerged at high stage, increase all above values by	0.010-0.020	
2. Irregular sections, with pools, slight channel meander; increase values given in 1a-e about		
3. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stage		
a. Bottom of gravel, cobbles and few boulders	0.040-0.050	
b. Bottom of cobbles, with large boulders	0.050-0.070	
B. Flood plains (adjacent to natural streams):		
1. Pasture, no brush:		
a. Short grass	0.030-0.035	
b. High grass	0.035-0.050	
2. Cultivated areas:		
a. No crop	0.030-0.040	
b. Mature row crops	0.035-0.045	
c. Mature field crops	0.040-0.050	
3. Heavy weeds, scattered brush ..		
4. Light brush and trees:		
a. Winter	0.050-0.060	
b. Summer	0.060-0.080	
5. Medium to dense brush:		
a. Winter	0.070-0.110	
b. Summer	0.100-0.160	
6. Dense willows, summer, not bent over by current		
7. Cleared land w/tree stumps, 100-150 per acre:		
a. No sprouts	0.040-0.050	
b. With heavy growth of sprouts	0.060-0.080	
8. Heavy stand of timber, a few down trees, little undergrowth:		
a. Flood depth below branches	0.100-0.120	
b. Flood depth reaches branches	0.120-0.160	
C. Major streams (surface width at flood stage more than 100 ft.):		
Roughness coefficient is usually less than for minor streams of similar description on account of less effective resistance offered by irregular banks or vegetation on banks. Values of n may be somewhat reduced. Follow recommendation in publication cited if possible. The value of n for larger streams of most regular section, with no boulders or brush, may be in the range of....		
	0.028-0.033	

Source: Chow, V.T., 1959, "Open Channel Hydraulics," McGraw Hill, New York.

Table C-4
Permissible Velocities for Channels

Channel Lining	n	Permissible Velocity (fps)
Bare Earth^a		
Fine sand, noncolloidal	.020	1.50 to 2.50
Sandy loam, noncolloidal	.020	1.75 to 2.50
Silt loam, noncolloidal	.020	2.00 to 3.00
Alluvial silts, noncolloidal	.020	2.00 to 3.50
Ordinary firm loam	.020	2.50 to 3.50
Stiff clay, very colloidal	.025	3.75 to 5.00
Alluvial silts, colloidal	.025	3.75 to 5.00
Shales and hardpan	.025	6.00 to 6.00
Fine gravel	.020	2.50 to 5.00
Graded loam-cobbles (when noncolloidal)	.030	3.75 to 5.00
Graded silt-cobbles (when noncolloidal)	.030	4.00 to 5.50
Coarse gravel, noncolloidal	.025	4.00 to 6.00
Cobbles and shingles	.035	5.00 to 5.50
Vegetation^b		
Kentucky Bluegrass		3 to 7
Tall Fescue		3 to 7
Grass Mixture		3 to 5
Reed Canarygrass		3 to 5
Sericea Lespedeza		2.5 to 3.5
Weeping Lovegrass		2.5 to 3.5
Redtop		2.5 to 3.5
Red Fescue		2.5 to 3.5
Annuals, temporary cover only		2.5 to 3.5
Sudangrass		2.5 to 3.5
Rock and Riprap^c		
R-1 (D ₅₀ = 0.75 inches)		2.5
R-2 (D ₅₀ = 1.50 inches)		4.5
R-3 (D ₅₀ = 3 inches)		6.5
R-4 (D ₅₀ = 6 inches)		9.0
R-5 (D ₅₀ = 9 inches)		11.5
R-6 (D ₅₀ = 12 inches)		13.0
R-7 (D ₅₀ = 15 inches)		14.5
Reno Mattress and Gabions^d		
Reno mattress, 6" thickness, rock 3-6"	.025	13.5
Reno mattress, 9" thickness, rock 3-6"	.025	16.0
Reno mattress, 12" thickness, rock 4-6"	.025	18.0
Gabion, 18+" thickness, rock 5-9"	.027	22.0

- Notes: a. Listed n values assume good to excellent construction techniques which provide uniform channel dimensions. Values should be adjusted using SCS Engineering Handbook #5, Supplement B, for other conditions. Velocities are for straight channels where slope < 0.02 ft/ft. Lower velocities are for clear water; higher velocities are for water transporting colloidal silts.
- b. Lowest values are for easily eroded soils at > 10 percent slope; highest values are for erosion resistant soils at < 5 percent slope. Velocities > 5 fps are for use only where good cover and proper maintenance are obtained. 3.0 fps is the maximum velocity for sparse cover conditions. When supplemented by stone centers or erosion resistant materials, velocities may be increased by 2.0 fps. When base flow exists, a rock lined low flow channel should be incorporated into the vegetative lined channel section.
- c. Permissible velocities based on rock at 165 lbs. per cubic foot. Adjust velocities for other rock weights in accordance with PA DER Erosion and Sediment Pollution Control Program Manual, 1990, Figure 4.6.
- d. Permissible velocities may be increased by the introduction of sand mastic grout in accordance with manufacturers' specifications.

For other materials not listed in this table, refer to PA DER Erosion and Sediment Pollution Control Program Manual, 1990.

Source: PA DER Bureau of Soil and Water Conservation, 1990, Erosion and Sediment Pollution Control Program Manual, Chapter 4.

APPENDIX D
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REFERENCES

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APPENDIX F
EXEMPTION CRITERIA

11

ACT 167 STORM WATER MANAGEMENT

EXEMPTION CRITERIA

<u>Total Parcel Size</u>	<u>Minimum Distance* (Feet)</u>	<u>Impervious Areas Exempt from Ordinance</u>
< 1 acre	0	5,000 sq. ft.
1 - 2 acres	100	10,000 sq. ft.
2 - 5 acres	250	15,000 sq. ft.
> 5 acres	500	20,000 sq. ft.

*The minimum distance between the proposed impervious area and/or stormwater controls / structure discharge point to the downslope property line.