APPENDIX D

SIZING STORM WATER DRAINAGE SYSTEMS

D 1 Roof Drainage.

The rainfall rates in Table D-1 should be used for design unless higher values are established locally.

D 2 Sizing by Flow Rate.

Storm drainage systems can be sized by storm water flow rates, using the appropriate GPM/square foot of rainfall listed in Table D-1 for the local area. Multiplying the listed GPM/square foot by the roof area being drained by each inlet (in square feet) produces the gallons per minute (GPM) of required flow for sizing each drain inlet. The flow rates (GPM) can then be added to determine the flows in each section of the drainage system. Required pipe sizes for various flow rates (GPM) are listed in Table 11-1 and Table 11-2.

D 3 Sizing by Roof Area.

Storm drainage systems can be sized using the roof area served by each section of the drainage system. Maximum allowable roof areas with various rainfall rates are listed in Table 11-1 and Table 11-2, along with the required pipe sizes. Using this method, it may be necessary to interpolate between two listed rainfall rate columns (inches per hour). To determine the allowable roof area for a listed pipe size at a listed slope, divide the allowable square feet of roof for a one (1) inch (25.4 mm/h) rainfall rate by the listed rainfall rate for the local area. For example, the allowable roof area for a six (6) inch (152 mm) drain at one-eighth (1/8) inch (3.2 mm) slope with a rainfall rate of 3.2 inches (81 mm/h) is 21,400/3.2 = 6,688 square feet (621.3 m^2).

D 4 Capacity of Rectangular Scuppers.

Table D-2 lists the discharge capacity of rectangular roof scuppers of various widths with various heads of water. The maximum allowable level of water on the roof should be obtained from the structural engineer, based on the design of the roof.

TABLE D-1
Maximum Rates of Rainfall for Various Cities

The rainfall rates in this table are based on U.S. Weather Bureau Technical Paper No. 40, Chart 14: 100-Year 60-Minute Rainfall (inches).

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
ALABAMA		
Birmingham	3.7	0.038
Huntsville	3.3	0.034
Mobile	4.5	0.047
Montgomery	3.8	0.039
ALASKA		
Aleutian Islands	1.0	0.010
Anchorage	0.6	0.006
Bethel	0.8	0.008
Fairbanks	1.0	0.010
Juneau	0.6	0.006
ARIZONA		
Flagstaff	2.3	0.024
Phoenix	2.2	0.023
Tucson	3.0	0.031

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
ARKANSAS		
Eudora	3.8	0.039
Ft. Smith	3.9	0.041
Jonesboro	3.5	0.036
Little Rock	3.7	0.038
CALIFORNIA		
Eureka	1.5	0.016
Lake Tahoe	1.3	0.014
Los Angeles	2.0	0.021
Lucerne Valley	2.5	0.026
Needles	1.5	0.016
Palmdale	3.0	0.031
Redding	1.5	0.016
San Diego	1.5	0.016
San Francisco	1.5	0.016
San Luis Obispo	1.5	0.016
COLORADO		
Craig	1.5	0.016
Denver	2.2	0.023
Durango	1.8	0.019
Stratton	3.0	0.031
CONNECTICUT		
Hartford	2.8	0.029
New Haven	3.0	0.031
DELAWARE		
Dover	3.5	0.036
Rehobeth Beach	3.6	0.037
DISTRICT OF COLUMBIA		
Washington	4.0	0.042
FLORIDA		
Daytona Beach	4.0	0.042
Ft. Myers	4.0	0.042
Jacksonville	4.3	0.045
Melbourne	4.0	0.042
Miami	4.5	0.047
Palm Beach	5.0	0.052
Tampa	4.2	0.044
Tallahassee	4.1	0.043
GEORGIA		
Atlanta	3.5	0.036
Brunswick	4.0	0.042
Macon	3.7	0.038
Savannah	4.0	0.042
Thomasville	4.0	0.042

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
HAWAII		
Rainfall rates in the Hawaiian Islands vary from 1-1/2 inches/hour to 8 inches/hour, depending on location and elevation. Consult local data.		
IDAHO		
Boise	1.0	0.010
Idaho Falls	1.2	0.012
Lewiston	1.0	0.010
Twin Falls	1.1	0.011
ILLINOIS		
Chicago	2.7	0.028
Harrisburg	3.1	0.032
Peoria	2.9	0.030
Springfield	3.0	0.031
INDIANA		
Evansville	3.0	0.031
Indianapolis	2.8	0.029
Richmond	2.7	0.028
South Bend	2.7	0.028
IOWA		
Council Bluffs	3.7	0.038
Davenport	3.0	0.031
Des Moines	3.4	0.035
Sioux City	3.6	0.037
KANSAS		
Goodland	3.5	0.036
Salina	3.8	0.039
Topeka	3.8	0.039
Wichita	3.9	0.041
KENTUCKY		
Bowling Green	2.9	0.030
Lexington	2.9	0.030
Louisville	2.8	0.029
Paducah	3.0	0.031
LOUISIANA		
Monroe	3.8	0.039
New Orleans	4.5	0.047
Shreveport	4.0	0.042
MAINE		
Bangor	2.2	0.023
Kittery	2.4	0.025
Millinocket	2.0	0.021

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
MARYLAND		
Baltimore	3.6	0.037
Frostburg	2.9	0.030
Ocean City	3.7	0.038
MASSACHUSETTS		
Adams	2.6	0.027
Boston	2.7	0.028
Springfield	2.7	0.028
MICHIGAN		
Detroit	2.5	0.026
Grand Rapids	2.6	0.027
Kalamazoo	2.7	0.028
Sheboygan	2.1	0.022
Traverse City	2.2	0.023
MINNESOTA		
Duluth	2.6	0.027
Grand Forks	2.5	0.026
Minneapolis	3.0	0.031
Worthington	3.4	0.035
MISSISSIPPI		
Biloxi	4.5	0.047
Columbus	3.5	0.036
Jackson	3.8	0.039
MISSOURI		
Independence	3.7	0.038
Jefferson City	3.4	0.035
St. Louis	3.2	0.033
Springfield	3.7	0.038
MONTANA		
Billings	1.8	0.019
Glendive	2.5	0.026
Great Falls	1.8	0.019
Missoula	1.3	0.014
NEBRASKA		
Omaha	3.6	0.037
North Platte	3.5	0.036
Scotts Bluff	2.8	0.029
NEVADA		
Las Vegas	1.5	0.016
Reno	1.2	0.012
Winnemucca	1.0	0.010

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
NEW HAMPSHIRE		
Berlin	2.2	0.023
Manchester	2.5	0.026
NEW JERSEY		
Atlantic City	3.4	0.035
Paterson	3.0	0.031
Trenton	3.2	0.033
NEW MEXICO		
Albuquerque	2.0	0.021
Carlsbad	2.6	0.027
Gallup	2.1	0.022
NEW YORK		
Binghamton	2.4	0.025
Buffalo	2.3	0.024
New York City	3.1	0.032
Schenectady	2.5	0.026
Syracuse	2.4	0.025
NORTH CAROLINA		
Asheville	3.2	0.033
Charlotte	3.4	0.035
Raleigh	4.0	0.042
Wilmington	4.4	0.046
NORTH DAKOTA		
Bismarck	2.7	0.028
Fargo	2.9	0.030
Minot	2.6	0.027
OHIO		
Cincinnati	2.8	0.029
Cleveland	2.4	0.025
Columbus	2.7	0.028
Toledo	2.6	0.027
Youngstown	2.4	0.025
OKLAHOMA		
Boise City	3.4	0.035
Muskogee	4.0	0.042
Oklahoma City	4.1	0.043
OREGON		
Medford	1.3	0.014
Ontario	1.0	0.010
Portland	1.3	0.014

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
PENNSYLVANIA		
Erie	2.4	0.025
Harrisburg	2.9	0.030
Philadelphia	3.2	0.033
Pittsburgh	2.5	0.026
Scranton	2.8	0.029
RHODE ISLAND		
Newport	3.0	0.031
Providence	2.9	0.030
SOUTH CAROLINA		
Charleston	4.1	0.043
Columbia	3.5	0.036
Greenville	3.3	0.034
SOUTH DAKOTA		
Lemmon	2.7	0.028
Rapid City	2.7	0.028
Sioux Falls	3.4	0.035
TENNESSEE		
Knoxville	3.1	0.032
Memphis	3.5	0.036
Nashville	3.0	0.031
TEXAS		
Corpus Christi	4.6	0.048
Dallas	4.2	0.044
El Paso	2.0	0.021
Houston	4.6	0.048
Lubbock	3.3	0.034
San Antonio	4.4	0.046
UTAH		
Bluff	2.0	0.021
Cedar City	1.5	0.016
Salt Lake City	1.3	0.014
VERMONT		
Bennington	2.5	0.026
Burlington	2.3	0.024
Rutland	2.4	0.025
VIRGINIA		
Charlottesville	3.4	0.035
Norfolk	4.0	0.042
Richmond	4.0	0.042
Roanoke	3.3	0.034

TABLE D-1 Continued

States and Cities	Storm Drainage 60-Minute Duration, 100-Year Return	
	Inches/Hour	GPM/Square Foot
WASHINGTON		
Seattle	1.0	0.010
Spokane	1.0	0.010
Walla Walla	1.0	0.010
WEST VIRGINIA		
Charleston	2.9	0.030
Martinsburg	3.0	0.031
Morgantown	2.7	0.028
WISCONSIN		
Green Bay	2.5	0.026
Lacrosse	2.9	0.030
Milwaukee	2.7	0.028
Wausau	2.5	0.026
WYOMING		
Casper	1.9	0.020
Cheyenne	2.5	0.026
Evanston	1.3	0.014
Rock Springs	1.4	0.015

TABLE D-2
Discharge from Rectangular Scuppers – Gallons per Minute

Water Head, Inches	Width of Scupper in Inches 6	12	18	24	30	36
1/2	6	13	19	25	32	38
1	17	35	53	71	89	107
1-1/2	31	64	97	130	163	196
2		98	149	200	251	302
2-1/2		136	207	278	349	420
3		177	271	364	458	551
3-1/2			339	457	575	693
4			412	556	700	844

TABLE D-2 (Metric)
Discharge from Rectangular Scuppers – Liters per Second

Water Head (mm)	Width of Scupper in Millimeters 152	305	457	610	762	914
13	0.4	0.8	1.2	1.6	2.0	2.4
25	1.1	2.2	3.3	4.5	5.6	6.8
38	2.0	4.0	6.1	8.2	10.3	12.4
51		6.2	9.4	12.6	15.8	19.1
64		8.6	13.1	17.5	22.0	26.5
76		11.2	17.1	23.0	28.9	34.8
89			21.4	28.8	36.3	43.7
102			26.0	35.1	44.2	53.3

Notes:
1. Table D-2 is based on discharge over a rectangular weir with end contractions.
2. Head is the depth of water above bottom of the scupper opening.
3. The height of the scupper opening should be at least two (2) times the design head.
4. Coordinate the allowable head of water with the structural design of the roof.