Roof Runoff Structure (558)

Information Sheet

Natural Resources Conservation Service (NRCS)

PURPOSE:

This information sheet provides references for the design of roof runoff structures. The information was taken from the following sources:

- Agricultural Waste Management Field Handbook, Part 651
- WQ 322, Roof Gutters for Dairy Barns, University Extension, University of Missouri
- Design Guide Maryland #1 Roof Gutter Design Method

CONDITION WHERE JOBSHEET APPLIES:

This information sheet applies where:

- Roof runoff structures are a component of an overall resource management system.
- Roof runoff needs to be diverted away from structures or contaminated areas.
- There is a need to collect, control, and transport runoff from roofs to a stable outlet.
- Roof runoff is collected and used for other purposes.

CRITERIA

Design Capacity. At minimum, a 10-year frequency, 5-minute rainfall precipitation event shall be used to design roof runoff structures, except where excluding roof runoff from manure management systems. In that case, a 25-year frequency, 5-minute precipitation event shall be used to design roof runoff structures. When gutters are used, the capacity of the downspout(s) must equal or exceed the gutter flow rate.

Design information can be found at multiple sources and a design process from 3 sources will be described in this information sheet. Each referenced source emphasizes a specific type of installation.

One common parameter for all the sources is to use a Mannings roughness coefficient of 0.012 for the hydraulic flow calculation. Agricultural Waste Management Field Handbook, NEH Part 651, Appendix 10B rainfall maps 10B-3 and 10B-4 can also be used for all design procedures.

Level Roof Gutter Example

The level gutter design process is taken from University of Missouri WQ 322 Roof Gutters for Dairy Barns. The first steps in the process is to estimate the length of gutter and the gutter depth to width ratio. The Figure 1, below, is used to determine gutter width.

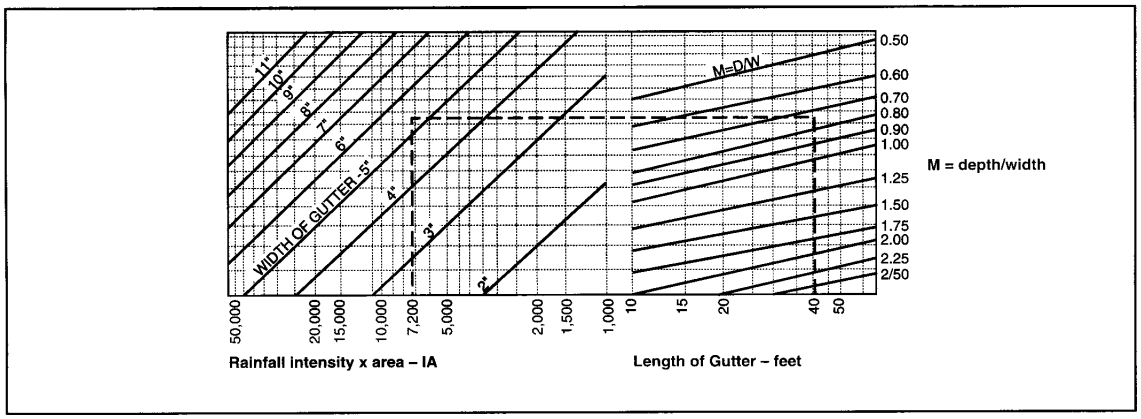

Figure 1. Width of level rectangular gutters for given roof areas and rainfall intensities.

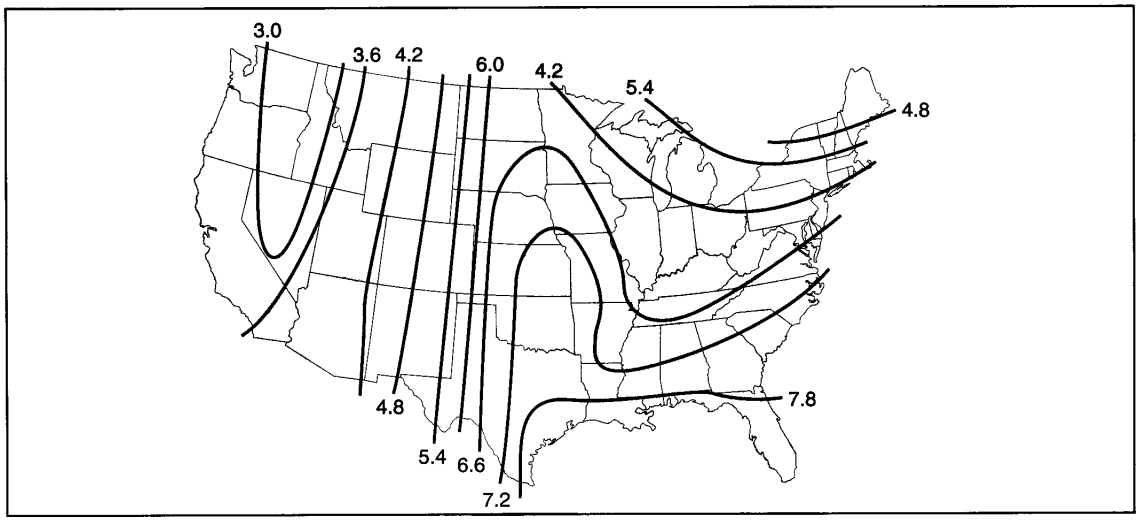

Figure 2. Map shows rainfall intensity in inches per hour for 5-minute periods to be expected once in 10 years. Normally, this is adequate for design, but storms have been twice as intense in some areas. See local records for more accurate data.

The dashed line illustrates an example for a level gutter design.

The length of gutter is 40 feet and the depth to width (depth/width) ratio is 0.75. The rainfall intensity is taken from Figure 2, and for Boone County use 7.2 inches per hour. The roof area is calculated by using the dimensions of the plan view projections and an adjustment factor as illustrated in the following table. Example: a 4/12 pitch roof with plan view projections of 40 feet by 25 feet is 40*25*1.05= 1,020 square feet of roof area.

Roof Pitch	Adjustment Factor
Level to 3 inches per foot slope (3/12 pitch)	1.00
4 inches to 5 inches per foot slope	1.05
6 inches to 8 inches per foot slope	1.10
9 inches to 11 inches per foot slope	1.20
12 inches per foot slope (12/12 pitch)	1.30

The rainfall intensity times area, IA value for Figure 1, is 7.2 inches per hour * 1,020 square feet = 7,344.

Go to Figure 1 and start with the gutter length (40 feet) and go straight vertical to the depth to width ratio (0.75). From this point use a horizontal projection to intersect a vertical line projected from IA (7,344). Read the gutter width from the next size to the left from the intersection point, gutter width 6 inch. The result is a 6 inch wide by 4 inch deep.

The downspout capacity is determined from Table 5 in the water quality bulletin or by any of the methods listed in this guide sheet.

Fixed Slope Roof Gutter Example

The Agricultural Waste Management Field Handbook, NEH Part 651 section 651.1001 (a) Roof runoff management for gutters and downspouts. The area of a roof that can be served by a gutter and downspout system is controlled by the capacity of each component. The rainfall intensity maps and the horizontal projection area of the roof is used to determine the amount of runoff from the roof that must be handled by the system.

This process is specific to sloped gutters with a fixed and constant slope of 1/16 inch per foot of length. Overview of the process is to choose a gutter and downspout and to calculate the capacity of each. The capacities are then compared in order to establish if more than one downspout is needed for the chosen gutter.

Step 1 – Compute the capacity of the selected Gutter

$q_g = 0.01184 \times A_g \times r^{0.67}$

Where:

q_g = capacity of gutter, ft^3 / sec

A_g = cross sectional area of gutter, in^2

r = A_g /wp, inches

wp = wetted perimeter of gutter, inches

Step 2 - Compute Capacity of downspout

Using an orifice discharge coefficient of 0.65, the orifice equation can be expressed as follows:

$q_d = 0.010457 \times A_d \times h^{0.5}$

where:

q_d = capacity of downspout, ft^3/sec

A_d = cross sectional area of downspout, in^2

h = head, inches (generally the depth of the gutter minus 0.5 inch)

Step 3 - Determine controlling capacity, gutter or downspout

Calculate the ratio of gutter capacity to the downspout capacity.

$N_d = q_g / q_d$

where:

N_d = number of downspouts

If the ratio is less than 1 , the system is gutter capacity controlled. If it is equal to or greater than 1, the system is downspout capacity controlled. The ratio is the determination of the number of downspouts for the capacity. N_d is rounded up the next whole number.

Step 4 - Determine the roof area that can be served by the system

The area of roof that can be served by the controlling capacity, gutter or downspout, is expressed as follows:

$A_r = (q \times 3{,}600) / P$

where:

A_r = area of roof served, ft^2

q = capacity of system, either q_g or q_d whichever is smaller, ft^3/sec

P = 5-minute precipitation (or other design storm), inches

When choosing the contributing roof area to the gutter and downspout system it is important to document the number of contributing sections that are used in order to account for all of the potential runoff from the roof.

Maryland Design Guide MD#1 Roof Gutter Design Method

Maryland NRCS has prepared a design guide that has a list of conventional gutter styles installed at different slopes. This document can be found at: http://www.md.nrcs.usda.gov/technical/eng/desquide.html

The manual contains 31 pages and includes instructions, calculation sheets and examples of gutter system design.

Summary

The design of roof runoff structures includes a gutter and downspout system. This process is varied and there are several different procedures that can be used based on the specific application. If the application is not covered in the references of this information sheet contact the state office for assistance.

References

Agricultural Waste Management Field Handbook, National Engineering Handbook, Part 651, Natural Resources Conservation Service.

Water Quality, WQ 322 Roof Gutters for Dairy Barns, University of Missouri, Extension and Outreach.

Maryland Design Guide MD#1 Roof Gutter Design Method, Maryland Natural Resources Conservation Service

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