SECTION 10
STREETS

CITY OF FORT LUPTON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

SECTION 10 STREETS

10.1 INTRODUCTION

The criteria presented in this section shall be used in the evaluation of the allowable drainage encroachment for public streets. The allowable encroachment limits are outlined in Section 3.4.4 for both the major and minor storm events.

Cross-pans are prohibited on arterial streets, collector streets, and local streets where storm sewers are present. Cross-pans are not allowed on local streets except at locations where traffic stops are intended at intersections

10.2 FUNCTION OF STREETS IN THE DRAINAGE SYSTEM

Urban and rural streets, specifically the curb and gutter or the roadside ditches, are part of the minor drainage system. The streets are also part of the major drainage system subject to certain limitations. When the flow in the street exceeds allowable limits, a storm sewer system or a channel is required to convey the excess flows. The primary function of the streets is for traffic movement. Therefore, the drainage function is subservient and must not interfere with the traffic function of the street.

Design criteria for the collection and moving of runoff water on public streets is based on a reasonable frequency and magnitude of traffic interference. Depending on the character and classification of the street, certain traffic lanes can be fully inundated during the minor design storm. The primary function of the streets in the minor drainage system is to convey the nuisance flows quickly and efficiently to the storm sewer system or channel without interference with the traffic movement or detriment to the pavement. For the major drainage system, the function of the streets is to provide an emergency passageway for the flows with minimal damage to the urban environment.

10.3 STREET CLASSIFICATION

The streets in the CITY are classified for drainage use as Type A, B, or C according to the traffic classification for which the street is designed. The allowable drainage encroachment into the driving lanes is more restrictive for the higher street classifications. The encroachment limits of storm runoff for each traffic classification and storm condition is set forth in Section 3.4.4 of the CRITERIA.

The traffic classification (i.e., Arterial, Collector, etc.), the corresponding drainage classification (i.e., Type A, B, or C), and the corresponding maximum theoretical allowable flow depth is presented below for the minor storm.

MAXIMUM THEORITICAL ALLOWABLE FLOW DEPTH
MINOR STORM EVENT

Traffic Classification	Drainage Classification	Maximum Theoretical Allowable Minor Storm Flow Depth
Major Arterial – 6 lane	Type C	0.50 ft
Major Arterial – 4 lane	Type C	0.41 ft
Minor Arterial	Type C	0.41 ft
Major Collector	Type B	0.50 ft
Minor Collector	Type B	0.37 ft
Residential (6" V.C.)	Type A	0.50 ft
Residential (Hollywood Curb)	Type A	0.50 ft

10.4 HYDRAULIC EVALUATION

10.4.1 Allowable Gutter Capacity - Minor Storm

Based upon the policy outlined in Section 3.4.4, the drainage classification of the street, and the maximum theoretical allowable flow depth, the theoretical allowable minor storm capacity of each street section is calculated using the modified Manning's formula as presented in Figure 1001.

$$Q = (0.56)(\frac{Z}{n})S^{1/2}Y^{8/3} \qquad (10\text{-}1)$$

Where:
Q = discharge (cfs)
Z = $1/S_X$, where S_X is the cross-slope of the pavement (ft/ft)
Y = depth of water at face of curb (feet)
S = longitudinal slope of the streets (ft/ft)
n = Manning's roughness coefficient

The allowable gutter capacity is then computed by multiplying the theoretical allowable gutter capacity by the appropriate reduction factor. The purpose of the reduction factor is to account for various street conditions, which decrease the street capacity such as street overlays, parked vehicles, debris and hail accumulation, and deteriorated pavement. The reduction factor also is used to minimize damaging gutter flow velocities.

The allowable gutter capacity for each street classification has been calculated and is presented in Figure 1002. The calculations are on file with the CITY. The calculations

were performed for various street slopes. A Manning's n-value of 0.016 was used for all street flow calculations.

The allowable gutter capacity was computed using a symmetrical street cross-section. Gutter capacity calculations shall be computed at critical locations for the non-symmetrical streets. The computed gutter capacity for non-symmetrical streets must never exceed the allowable gutter capacity presented in Figure 1002.

10.4.2 Allowable Gutter Capacity - Major Storm

The allowable gutter capacity for a major storm event is subject to the limitations set forth in the Section 3.4.4. Gutter capacity calculations were performed for each street classification and various street slopes. The results of the calculations are shown in Figure 1003. The maximum theoretical allowable depth at the gutter in all cases is 12 inches. The allowable gutter capacity for the major storm event is calculated using the Manning's formula. The street cross-section is divided into the pavement area and the sidewalk/grass area. The total gutter flow is the sum of the individual flow area contributions. A Manning's n-value of 0.016 for the pavement area and 0.025 for the sidewalk/grass area was used. The slope away from the curb towards the lot was assumed to be 2 percent. The capacity calculations are on file with the CITY.

For non-symmetrical streets (see Figure 1004), street capacity calculations shall be computed at critical locations. The computed street capacity must never exceed the allowable street capacity presented in Figure 1003.

10.5 DESIGN EXAMPLE

EXAMPLE: DETERMINATION OF STREET CAPACITY

Given:	Traffic classification	Minor Arterial
	Longitudinal street slope	1.0%

Find: Maximum allowable flow capacity for the major and minor storm events.

Procedure:

Step 1:

Determine the maximum theoretical allowable depth for the minor storm:

From Section 10.3 for an "Minor Arterial" street, the drainage classification is Type C with a maximum allowable theoretical depth for the minor storm of 0.41 feet.

Step 2:

Determine the allowable minor storm gutter capacity:

From Figure 1002, for an "Minor Arterial" with an allowable theoretical flow depth of 0.41 feet and a slope of 1.0 %, the allowable gutter capacity is 11.0 cfs per gutter assuming a symmetrical street cross-section. The flow velocity can also be obtained from Figure 1002 by interpolating between the velocity lines (V = 3.0 fps).

Step 3:

Determine the allowable major storm gutter capacity:

From Figure 1003 for an "Minor Arterial" with a slope of 1.0 %, the allowable gutter capacity is 109 cfs per gutter assuming the street cross-section is symmetrical.

10.6 CHECKLIST

To aid the designer and reviewer, the following checklist has been prepared:

1. Use the flattest street slope to calculate the allowable gutter capacity.

2. Determine the street classification, allowable depth, and allowable gutter capacity at all critical locations for both the major and minor storm events.

3. Include a non-symmetrical street evaluation if necessary.

4. A storm sewer system is required where the gutter capacity is exceeded.

5. Check the grading plan to insure that all existing and proposed structures are above the major storm flow depth.

6. Check the flow conditions at intersections, changes in flow direction, curb returns, and cross-pans.

Figure 1001
Nomograph for Flow in Triangular Gutters

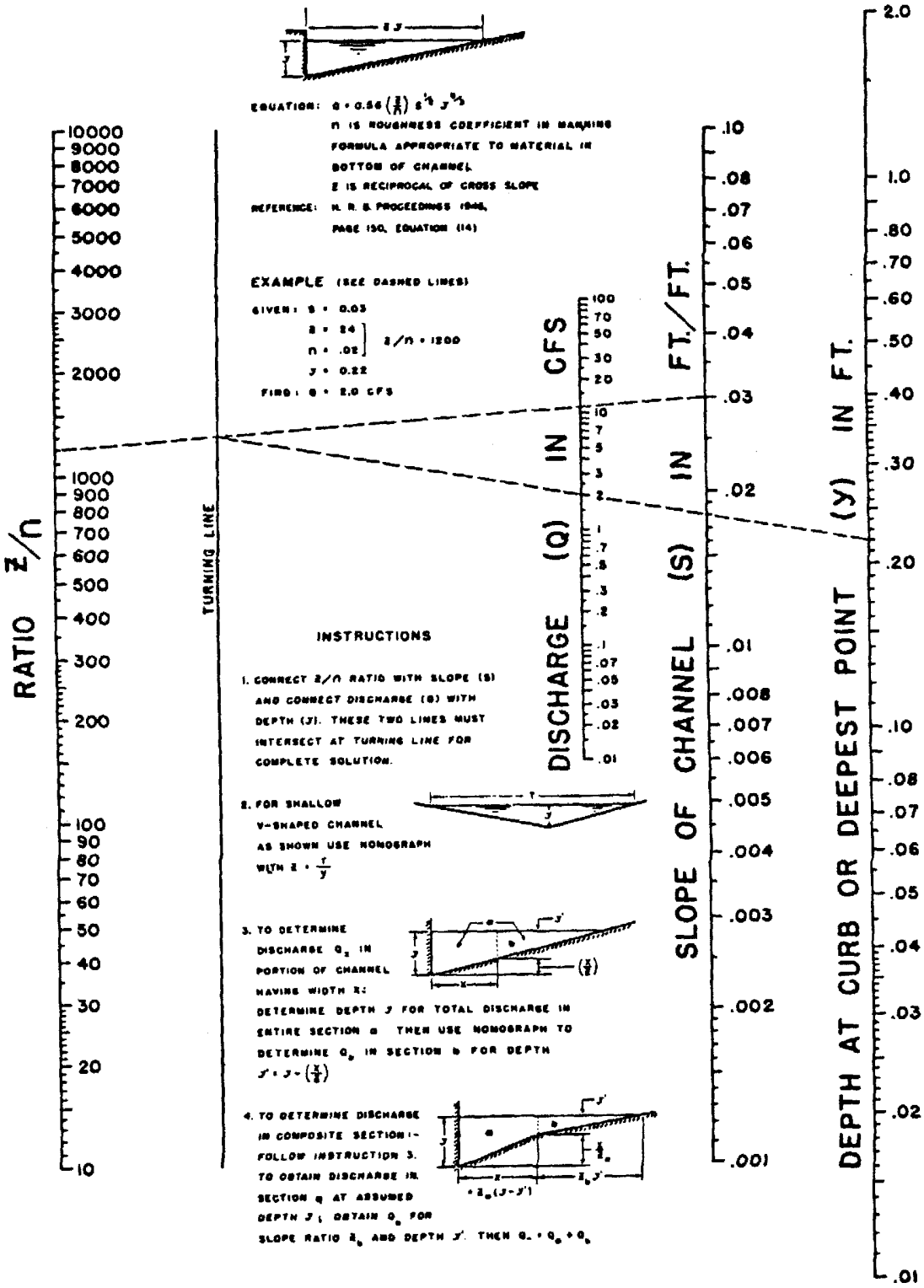


Figure 1002
Allowable Gutter Capacity
Minor Storm

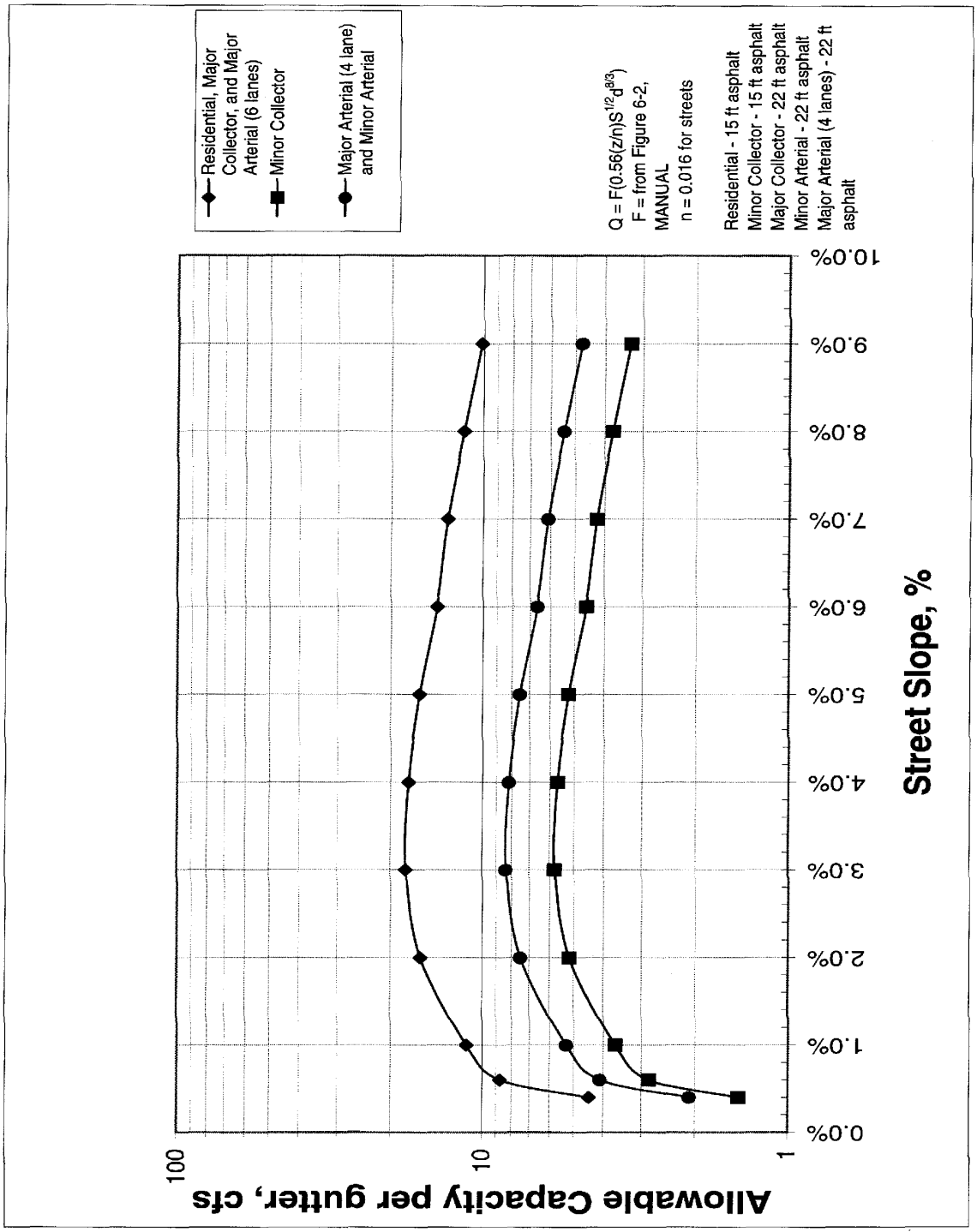


Figure 1003
Allowable Gutter Capacity
Major Storm

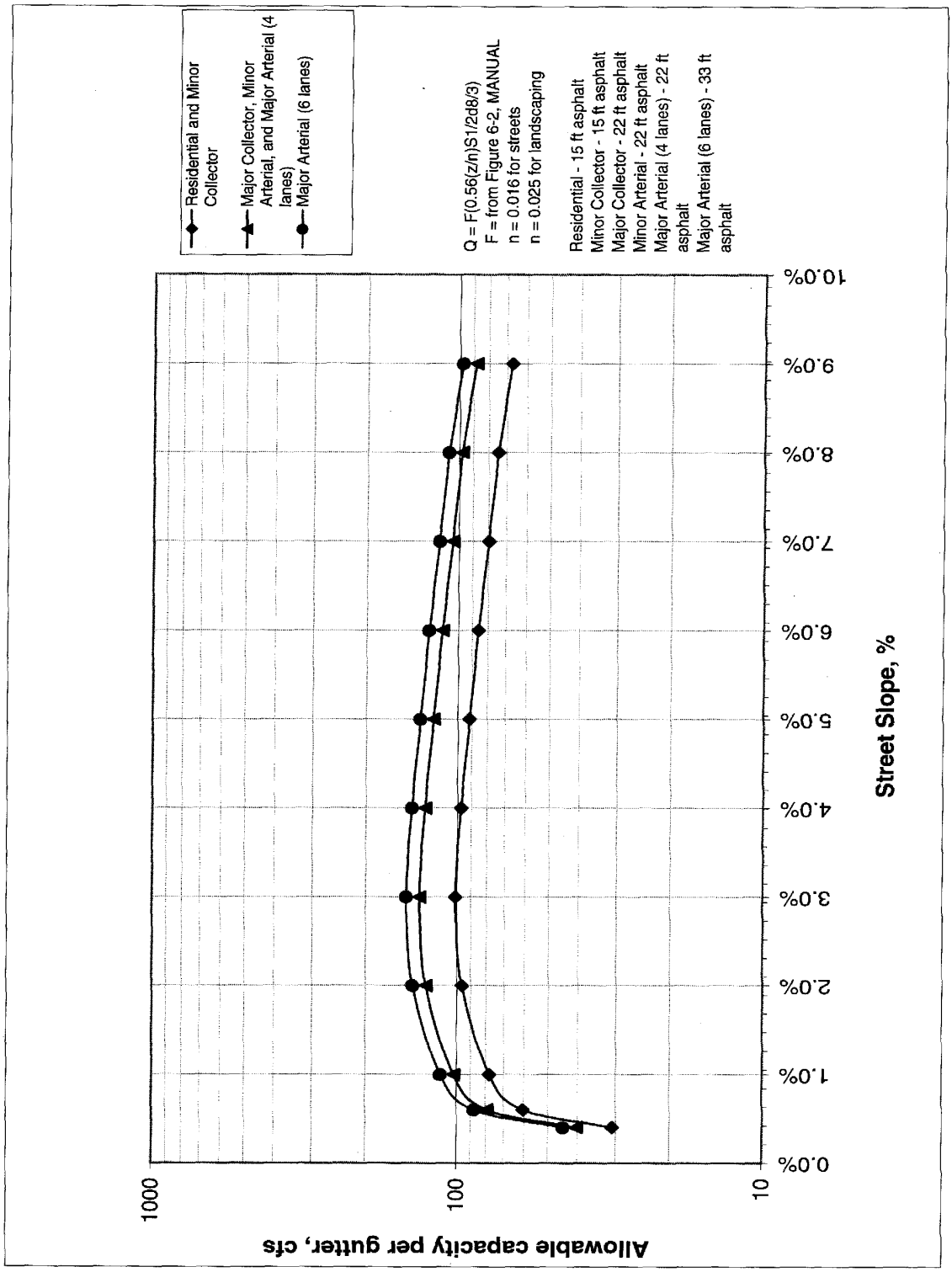
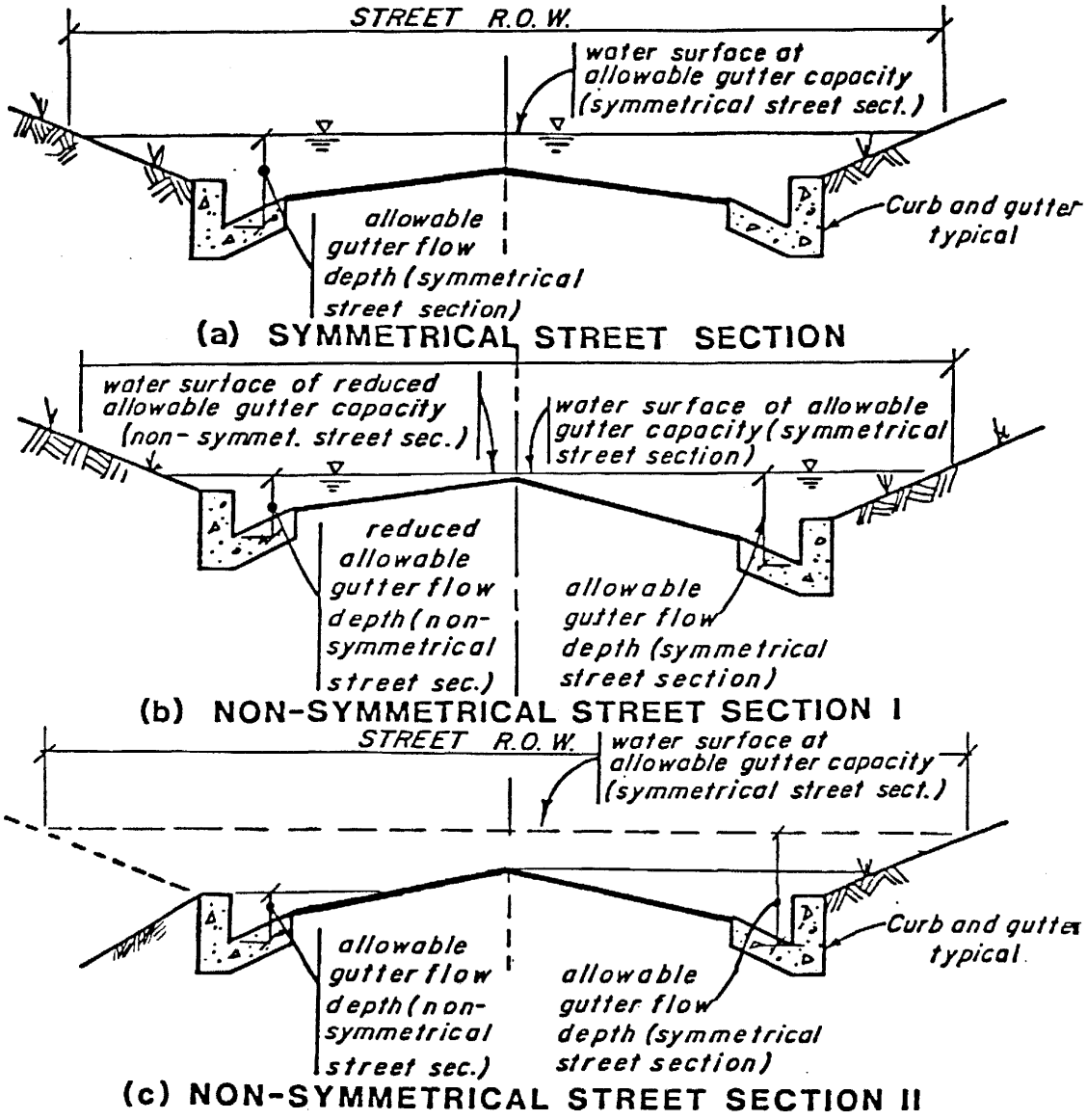


Figure 1004
Adjustment for Gutter Capacity with
Non-symmetrical Street Section
Major Storm



Note: For a non-symmetrical street section, adjust the total gutter capacity by reducing the allowable gutter capacity for the gutter with the higher flowline or for the entire section when property line slopes are different.