5.0 Rainfall

5.1 Introduction

Rainfall patterns have a strong influence on the volume and rate of stormwater runoff in a drainage system. The Urban Drainage Flood Control District (UDFCD) has maintained an ongoing study of rainfall patterns in the Denver Region since the publication of the UDFCD Drainage Criteria Manual in 1969. These studies have confirmed the accuracy and reasonableness of the rainfall maps published in 1973 by the National Oceanic and Atmospheric Administration (NOAA) for Colorado. As a result, the UDFCD has adopted the NOAA maps as a starting point for the procedures for determining the different rainfall patterns that are likely to occur throughout the Denver region.

The highest rainfall tends to occur in the higher elevation areas such as the foothills in Jefferson County, Douglas County near Sedalia, and the eastern parts of Aurora. The rainfall depths in the City of Greenwood Village (Village) tend to be very similar to the rainfall depths within the City and County of Denver.

The stormwater management policies of the Village strongly encourage the use of local on-site detention, grass-lined swales, and stormwater infiltration systems to attenuate peak flood discharges and improve stormwater quality. As a result, many of the facilities are designed for drainage basins smaller than 90 acres with times to the peak rate of discharge that are less than 30 minutes. This requires the use of rainfall patterns in the design of facilities that are shorter than one-hour duration.

The Village recognizes the methodologies developed by the UDFCD as the standard method of practice for determining design rainfall patterns for design storms equal to or larger than one hour duration. These methods shall be used in the preparation of any drainage study or drawings submitted to the Village.

5.2 Flood Control Design Storms

Storms used in the design of flood control facilities are selected on the basis of

1) A temporal distribution that reflects the regional climatological and meteorological conditions.
2) A duration that produces the highest peak rate of runoff consistent with the size, shape, slope, and proposed development characteristics of the basin.

Flood control facilities are typically designed for storms with 1, 2, 3 or 6–hour durations. The selection of the proper storm duration depends on the size, shape, slope and development

characteristics of the basin. The proper storm duration for flood control purposes is the storm which produces the highest peak rate of runoff for the proposed development conditions in the study area. The proper duration is usually equal to the time of concentration when using the Rational Method or the closest standard duration (1, 2, 3 or 6-hour) when using the Colorado Unit Hydrograph Procedure (CUHP) for calculating runoff. For unusual shaped basins (e.g. length to width ratio greater than four to one), the basin should be divided into smaller sub-basins and a trial and error method should be used to determine the storm duration which produces the highest peak rate of runoff.

The rainfall depths for the 1, 2, 3, and 6-hour storms in the Village are summarized in Table 5-1. The depths were taken from the UDFCD Rainfall Depth-Duration-Frequency Maps found in the Rainfall Chapter, Volume 1 of the UDFCD Drainage Criteria for the 2, 5,10, 50 and 100-year return periods. The 2-hour and 3-hour rainfall depths were interpolated from the 1-hour and 6-hour depths using the methodology described in the Rainfall Chapter, Volume 1 of the UDFCD Drainage Criteria Manual.

Table 5-1: Rainfall Depths for Greenwood Village

	Duration			
Frequency (years)	1-hr (in)	2-hr (in)	3-hr (in)	6-hr (in)
2	0.97	1.18	1.28	1.44
5	1.34	1.58	1.73	1.96
10	1.55	1.82	2.02	2.29
50	2.24	2.79	2.79	3.09
100	2.58	2.88	3.17	3.46

The methodologies for estimating the runoff coefficient for the Rational Method and effective rainfall for CUHP are described in detail in Chapter 6.0. The Time-Intensity-Frequency curves for storms less than one hour duration were developed using the methodology described in the Rainfall Chapter, Volume 1 of the UDFCD Drainage Criteria Manual. The factors used for calculating the intermediate rainfall depths after 5, 10, 15 and 30 minutes were taken from the NOAA Atlas 2, Volume III, 1973 as reported in the Rainfall Chapter, Volume 1 of the UDFCD Drainage Criteria Manual.

Figure 5-1 is a plot of the Flood Flows – Time-Intensity-Frequency curves. The curves were developed according to the methodologies provided in the Rainfall Chapter, Volume 1 of the UDFCD Drainage Criteria Manual. These curves shall be used to estimate rainfall intensity as needed for the Rational Method Formula when calculating peak rates of runoff.

5.3 Water Quality Design Storm

For reasons to be discussed in Chapter 6.0 Runoff, it is likely that stormwater quality

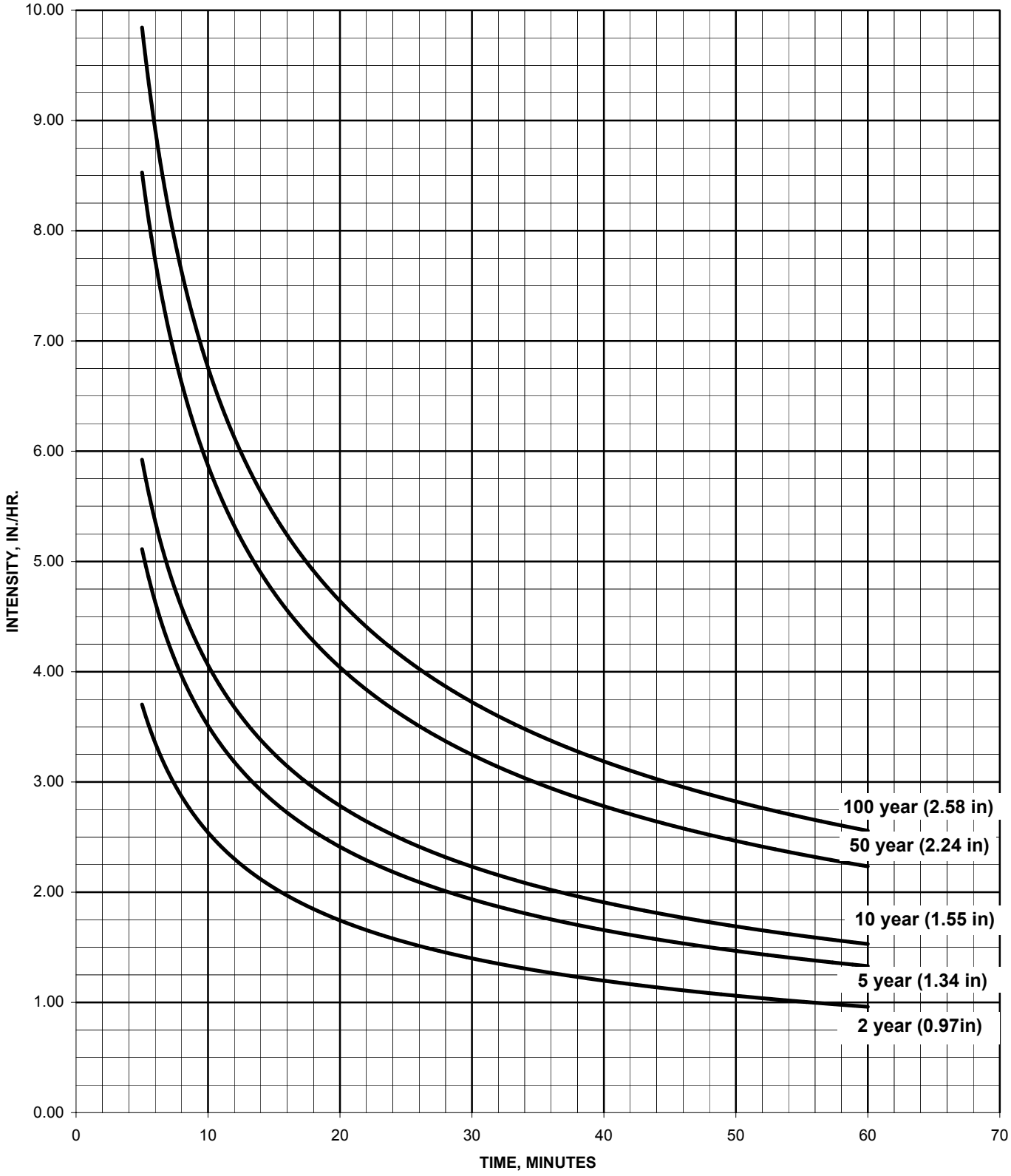
management facilities in the Village will be designed to capture and treat storms that are around the 2-year event.

Figure 5-2 contains the Water Quality – Time-Intensity-Depth curves for several storms that may be selected as the water quality design storm for the Rational Method. Values can be interpolated for design storm depths that are not plotted in Figure 5-2. If the CUHP is used, the same temporal distributions discussed in Sections 5.2.1 can be used to estimate the effective rainfall for the selected design rainfall.

INSERT FIGURES 5-1 THROUGH 5-2

5.0 RAINFALL 1

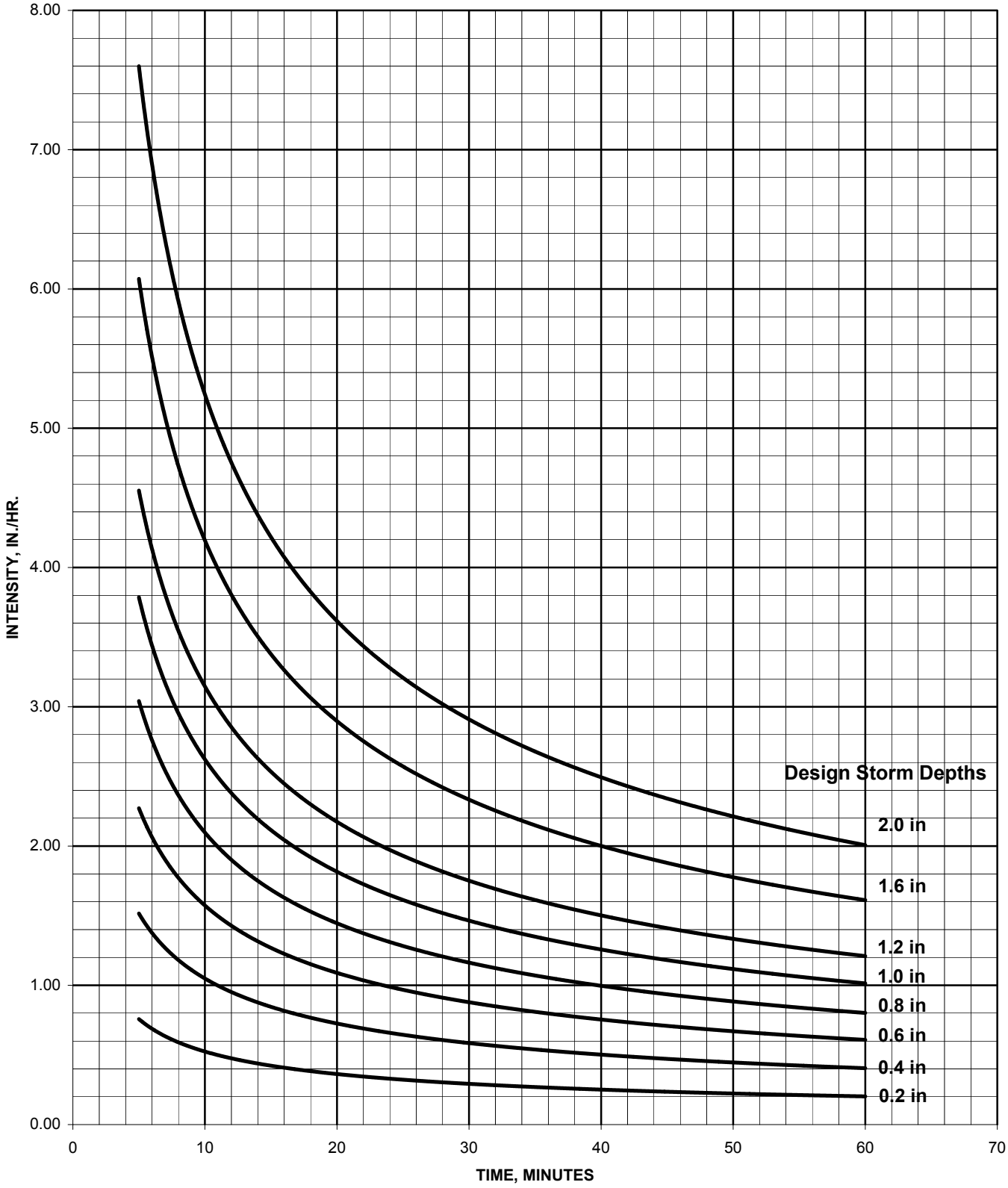
5.1 INTRODUCTION 1
5.2 FLOOD CONTROL DESIGN STORMS 1
5.3 WATER QUALITY DESIGN STORM 2



Greenwood Village
October 2003

Figure 5-1
Flood Flows
Time-Intensity-Frequency Curves

FIG 5-1,5-2.xls\Figure 5-1



Greenwood Village
October 2003

Figure 5-2
Water Quality Design Storm
Time-Intensity-Depth Curves

FIG 5-1,5-2.xls\Figure 5.2