CITY OF LEBANON
Storm Drainage Master Plan

CHAPTER 5

5.0 RAINFALL ANALYSIS

Cost effective design of a storm water drainage system depends upon the ability of the designer and planner to estimate the peak precipitation expected to occur during a given design period.

The design frequency, or recurrence interval, of a rainfall event is the period of time during which only one event of equal or greater intensity is expected to occur. For instance, the rainfall intensity of a two year storm will be exceeded, on the average, only once every two years. If the two year storm is used as the basis for design, in any given year there is a 50 percent chance that the design rainfall will be exceeded.

5.1 DEVELOPMENT OF INTENSITY DURATION FREQUENCY CURVES

The intensity-duration-frequency curves were derived using the procedure outlined in National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Precipitation-Frequency Atlas for the Western States, Volume X.

Depths for the 24 hour rainfall events were determined from Pearson Type III analysis of local rainfall data at the Waterloo gauge and regional rainfall data developed for Foster Dam obtained from the Oregon State Climatologist.

A Pearson Type III analysis requires three statistical parameters pertaining to the distribution of annual peak rainfall depths: the mean, standard deviation and skewness. The mean annual peak rainfall depth is indicative of the magnitude of the peak rainfall and is sensitive to the location of the gauge within a region, but not as sensitive to the length of record. The mean can be reasonably determined from the gauge record for a single station with data collected over relatively short periods (20 years or more). The standard deviation and skewness describe the shape of the probability distribution, which is relatively constant throughout a given region. These parameters, however, are very sensitive to length of record. Reasonable values for standard deviation and skewness can be obtained from a single gauge only by using long periods of record (100 years or more). Since gauging stations with this amount of data are not available in the northwest, values for skewness and standard deviation must be determined on a regional basis using several area gauging stations with shorter lengths of record. The Waterloo gauge data is in the form of 24 hour peak rainfall depths for each calendar year from 1948 through 1986. These annual peaks are based on daily gauge readings.

The mean annual peak rainfall depth used in the Pearson Type III analysis was determined by averaging these annual peaks. Regional values for skewness and standard deviation were obtained from the Oregon State Climatologist. These regional values were developed by the State Climatologist in a rainfall study for the Foster Dam area and are applicable to stations in Northwest Oregon.

The Waterloo gauge data and regional parameters used in the analysis are presented in Table 5.1, "Historical Rainfall Data - Waterloo Gauge". The gauge data was sorted by annual peak and compared with the theoretical predictions of the statistical analysis. The two year rainfall should be that rainfall depth exceeded by half of the values in the list (19); the predicted five year depth should be exceeded by 20 % of the values in the list (7); the predicted 10 year depth should be exceeded by 10 % of the values (4), etc.

The gauge data given was collected on a daily basis and represent the "observation day" peak rainfall depths. NOAA procedures recommend that a factor of 1.13 be used to convert design rainfall depths based on daily total rainfall to actual 24 hour peak rainfall depths. The resulting estimated total rainfall depths for various frequencies were compared to regionalized rainfall maps provided by the NOAA for recurrence intervals of 2, 5, 10, 25, 50, and 100 years. The Pearson Type III analysis showed significantly lower rainfall depths than the NOAA Atlas predicted. Values between the two methods were selected in order to be modestly conservative, yet to consider actual local rainfall data. See Figure 5.1, "NOAA Atlas/Waterloo Rainfall Comparison". See also Table 5.2, "Precipitation for the 6 Hour and 24 Hour Storm Events.

Precipitation depths at 5 min., 10 min., 15 min., 30 min., 1 hr., 2 hr., 3 hr., and 12 hr. of rainfall were calculated at each recurrence interval as prescribed by the NOAA procedure and using the US Soil Conservation Service's Type 1A rainfall distribution. This rainfall distribution is recommended for the Pacific Northwest west of the Cascades. See Figure 5.2, "SCS Rainfall Distribution Curves - Type 1A".

Figure 5.3, "Intensity-Duration-Frequency Curves", present a best-fit to the calculated data points. This figure may be used within the watershed to estimate rainfall intensities using the Rational Method for the design of on-site drainage facilities.

5.2 SELECTION OF DESIGN STORM

A design storm is a storm event selected to determine the peak flows, or design flows, in a system. The volume of precipitation may be similar for different storm events. However, it is the distribution of that volume over time that is most important for drainage design. Based on sensitivity runs, it was determined that the 24 hour storm generates larger peak flows than the 6 hour storm in nearly all sub-basins. In those sub-basins where the 6 hour storm was found to produce higher peak rates of runoff, the 6 hour storm flows were used.

5.3 DEVELOPMENT OF RAINFALL HYETOGRAPHS

Using the total 24 hour precipitation, design hyetographs can be developed for various frequency events by applying the Soil Conservation Service's Rainfall Distribution Curves. See Figure 5.2, "SCS Rainfall Distribution Curves". The resulting rainfall hyetographs are shown in Figure 5.4, "24 Hour Rainfall Hyetographs". Rainfall hyetographs are used as input for the HEC-1 computer model which utilizes the distribution of rainfall over time to compute runoff from the basin of interest.

TABLE 5.1
HISTORICAL RAINFALL DATA -- WATERLOO GUAGE

Sorted by Year YEAR	ANNUAL PEAK (IN.)		Sorted by Annual Peak YEAR	ANNUAL PEAK (IN.)	Estimated Frequency Distribution 24 Hour Depth (in)
1948	1.55	*DISCARDED	1976	1.32	
1949	4.04		1952	1.50	
1950	2.64		1967	1.51	
1951	2.00		1977	1.58	
1952	1.50		1985	1.60	
1953	2.00		1968	1.60	
1954	2.55		1972	1.62	
1955	2.40		1971	1.71	
1956	2.14		1970	1.73	
1957	2.80		1973	0.76	
1958	2.22		1975	1.76	
1959	2.85		1983	1.77	
1960	3.02		1982	1.90	
1961	2.50		1979	1.90	
1962	2.02		1964	1.92	
1963	1.94		1963	1.94	
1964	1.92		1986	1.95	
1965	2.50		1969	2.00	
1966	2.39		1951	2.00	
1967	1.51		1953	2.00	
1968	1.60		1962	2.02	
1969	2.00		1978	2.05	
1970	1.73		1956	2.14	2 YR = 2.12
1971	1.71		1984	2.20	
1972	1.62		1958	2.22	
1973	1.76		1980	2.28	
1974	2.68		1966	2.39	
1975	1.76		1955	2.40	
1976	1.32		1961	2.50	
1977	1.58		1965	2.50	
1978	2.05		1954	2.55	
1979	1.90		1950	2.64	
1980	2.28		1974	2.68	5 YR = 2.65
1981	2.97		1957	2.80	
1982	1.90		1959	2.85	
1983	1.77		1981	2.97	10 YR = 2.96
1984	2.20		1960	3.02	
1985	1.60		1949	4.04	25 YR = 3.37
1986	1.95				
Mean	2.14				
Coeff. of Variance**	0.26				
Skewness **	0.92				

Note: Rainfall depths represent daily guage readings. True 24 hour peak rainfall depths can be found by multiplying the observation day values by 1.13

*1948 record discarded due to excessive missing data

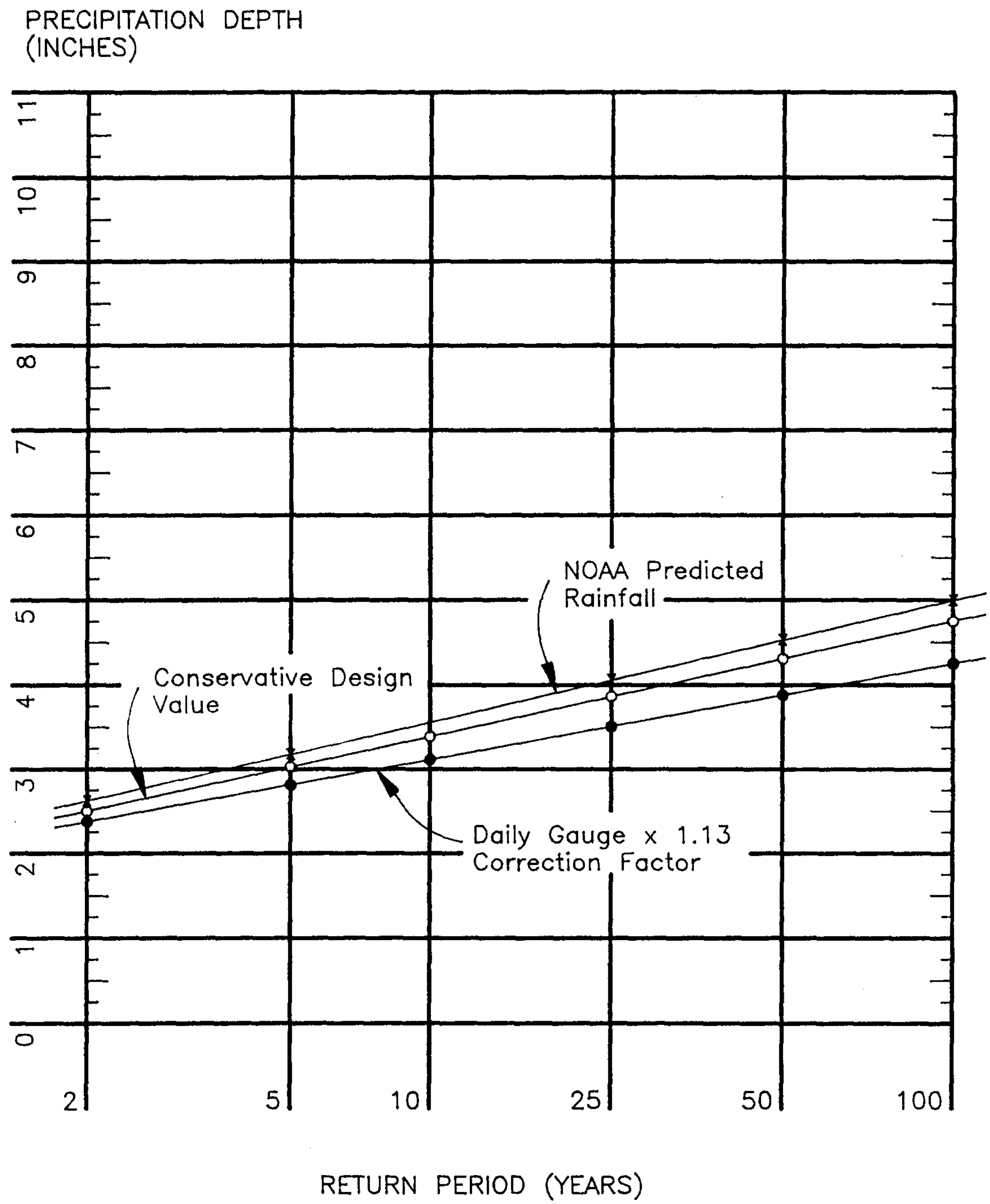
**Coefficient of Variance and Skewness represent regional values applicable to Northwest Oregon

TABLE 5.2

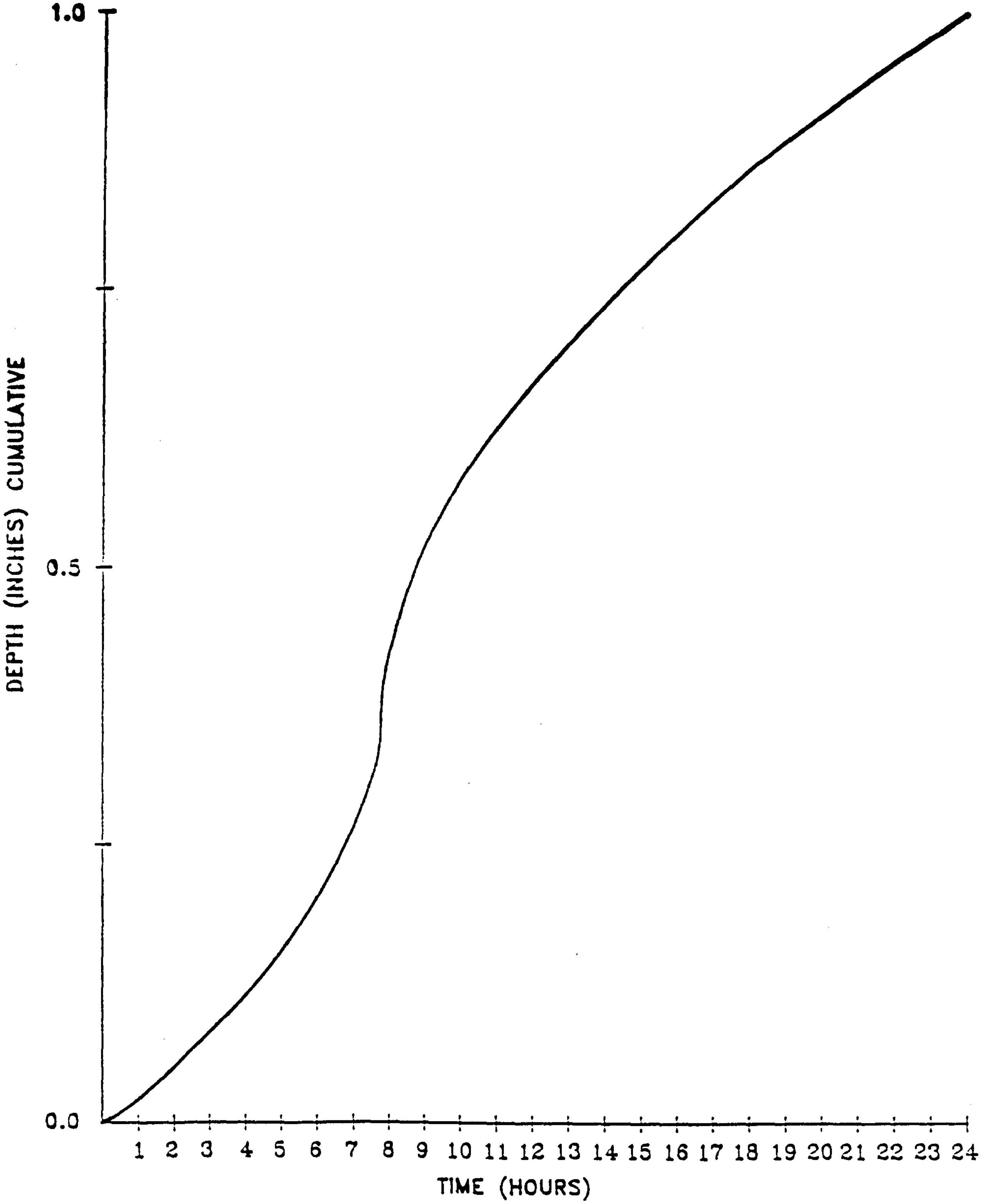
PRECIPITATION FOR THE

6 HOUR AND 24 HOUR STORM EVENTS

STORM EVENT	6 HOUR (in.)	24 HOUR (in.)
2 YEAR	1.2	2.4
5 YEAR	1.5	3.0
10 YEAR	1.7	3.4
25 YEAR	1.9	3.8
50 YEAR	2.1	4.3
100 YEAR	2.3	4.7

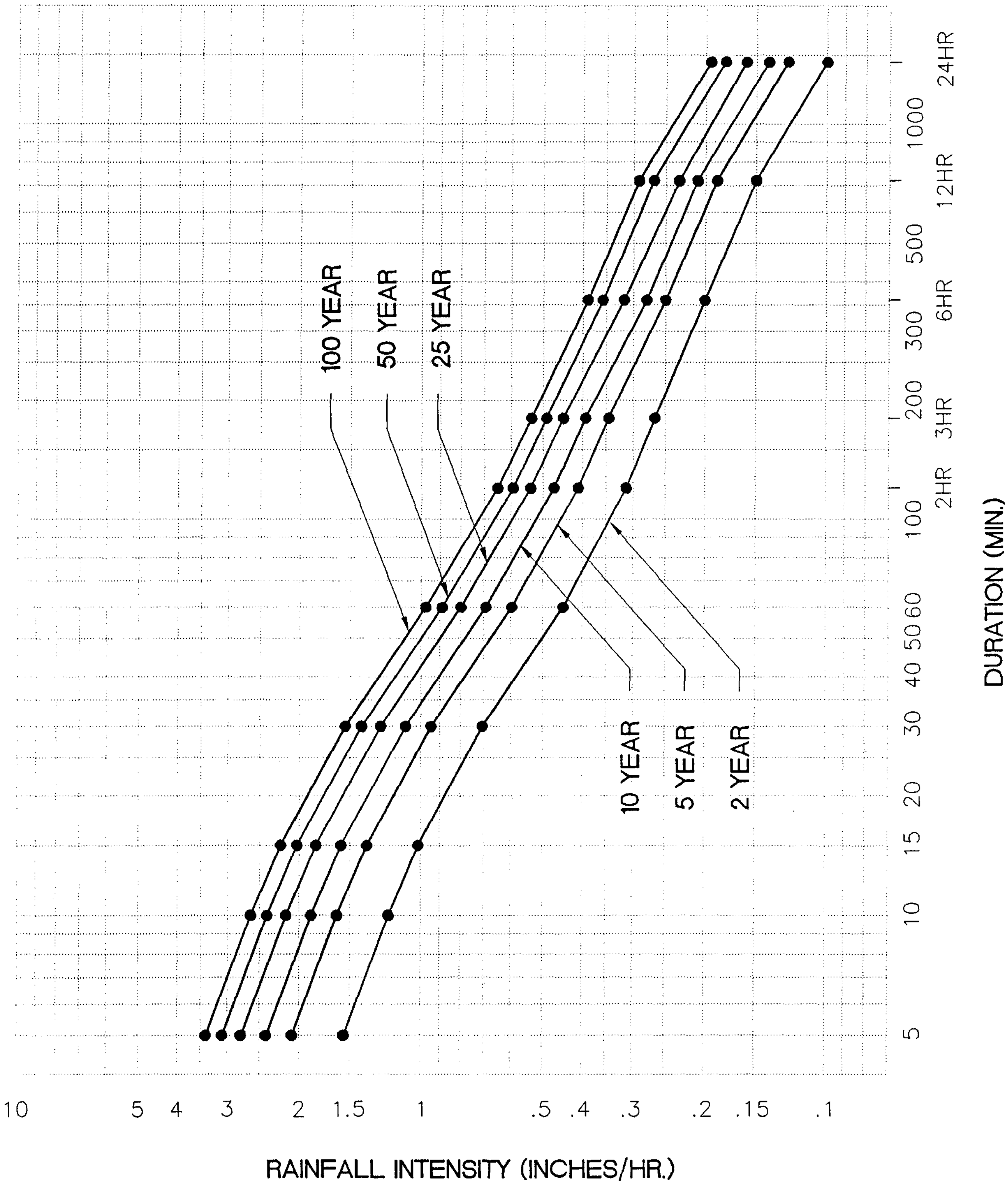


DATE MAR 1991	**DAVID J. NEWTON ASSOCIATES** INCORPORATED CIVIL & GEOLOGICAL ENGINEERING 1201 S.W. 12TH AVE., SUITE 620 PORTLAND, ORE. 97205 • 228-7718	**NOAA ATLAS/WATERLOO GAUGE RAINFALL COMPARISON**	FIGURE **5.1**
PROJECT NO. 292 DP 11		**CITY OF LEBANON** **Storm Drainage Master Plan**	



DESIGNED: DLS DRAWN: DLS CHECKED: DWO	**DAVID J. NEWTON ASSOCIATES** INCORPORATED CIVIL & GEOLOGICAL ENGINEERING 1201 S.W. 12TH AVE., SUITE 620 PORTLAND, ORE. 97205 • 2..8-7718	SCS RAINFALL DISTRIBUTION CURVE TYPE 1A	DATE 1991
PROJECT NO. 292 DP 11		CITY OF LEBANON Storm Drainage Master Plan	FIGURE 5.2

228 DP 12 - TRD-RAINLOWG



DATE MAR 1991	DAVID J. NEWTON ASSOC. INCORPORATED	RAINFALL INTENSITY, DURATION AND FREQUENCY CURVES	FIGURE 5.3
ROJECT NO. 292 DP 101	CIVIL & GEOLOGICAL ENGINEERING 1201 S.W. 12TH AVE., SUITE 400 PORTLAND, ORE. 97205 • 228-7718	CITY OF LEBANON Storm Drainage Master Plan	

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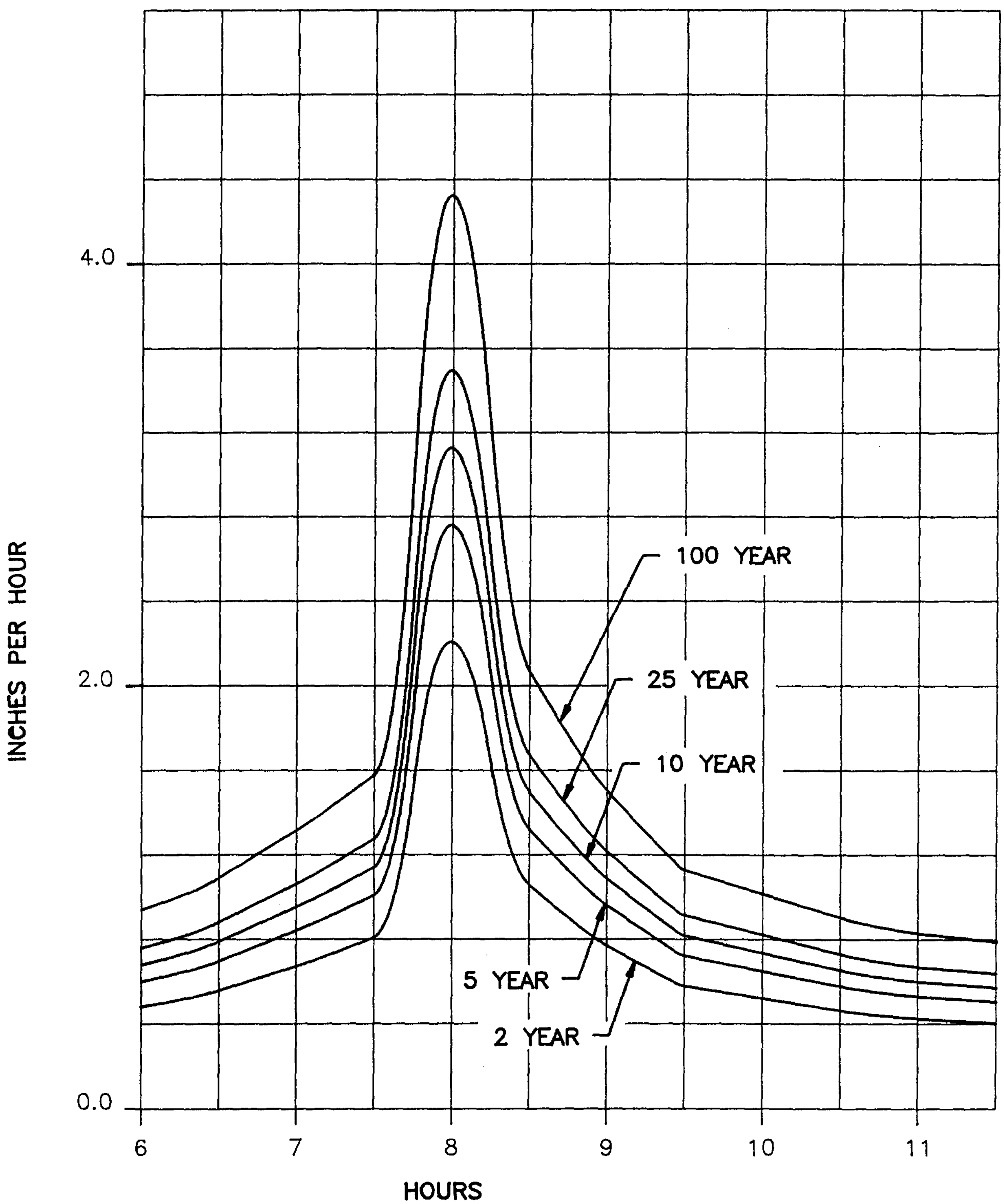

DESIGNED: JAS DRAWN: JAS CHECKED: DLS	**DAVID J. NEWTON ASSOCIATES** INCORPORATED CIVIL & GEOLOGICAL ENGINEERING 1201 S.W. 12TH AVE., SUITE 620 PORTLAND, ORE. 97205 • 228-7718	SCS TYPE 1A 24 HOUR RAINFALL HYETOGRAPH	DATE 1991
PROJECT NO. 292 DP 11		CITY OF LEBANON Storm Drainage Master Plan	FIGURE 5.4

292 DP 11 – LEB-HYET.DWG