INTERIM REPORT

DETERMINATION OF RAINFALL LOSSES IN VIRGINIA, PHASE II

by

Shaw L. Yu
Faculty Research Engineer

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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ABSTRACT

This interim report summarizes results obtained for the project through May 1981. The objective of the study is to develop rainfall loss parameters for localities in Virginia. For this purpose, the state has been divided into eleven hydrologic regions, and loss parameters will be determined for three or more selected in each of these watersheds. Parameter selection curves will then be derived for the regions.

To date 66 storm events across five hydrologic regions have been analyzed to obtain loss parameters. Of the five regions, Region P2, the piedmont portion of the James River Basin, has been completed. The results for this region are presented in this report.

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INTRODUCTION

The objective of the study is to develop rainfall loss parameters for localities in Virginia. With these parameters, a highway engineer can accurately estimate the storm runoff when using a rainfall-runoff model such as the Corps of Engineers' HEC-1 computer program considered in this study. Table 1 lists the parameters in the HEC-1 program and gives short descriptions of their physical significance.

Major work elements in this study include the

A) delineation of hydrologic regions;

B) selection of the test watersheds; and

C) development of regionalized parameters.

The state of Virginia has been divided into eleven hydrologic regions based on soils, topography, and major river basins, as shown in Figure 1. For each hydrologic region, loss parameters are being determined for three or more selected watersheds. Rainfall and stream flow data are being obtained from the U.S. Weather Bureau and the Virginia State Climatologist's Office, and the USGS, respectively. Candidate storm events are being selected from the records for HEC-1 analysis.

To date, 66 storm events across 5 hydrologic regions have been analyzed to obtain loss parameters. Of the 5 regions, only Region P2, the Piedmont portion of the James River Basin, has been completed (Figure 1). Region M649, the mountainous portion of the Tennessee, Roanoke, and New Basins, will soon be completed.

This report summarizes results obtained for Region P2.

Table 1

HEC-1 Parameters

Storm Parameters

ERAIN – Exponent of the rainfall relative to how storms occur over the subarea. Varies between zero and 1.0.

Basin Parameters

STRKR – Basin loss index for start of storm. Depends upon basin characteristics such as soil type, land use, and vegetative cover.

RTIOL – Ratio of loss coefficient (AK) to that AK after 10 inches more of accumulated loss. It's a function of the ability of the basin to absorb precipitation.

TC – Time of concentration. Depends upon basin size and shape, length of channel, land cover, etc.

R – Clark's storage constant. Can be taken as a fraction of TC.

Soil Moisture Parameter

DLTKR – Amount of accumulated rain loss during which the loss coefficient is initially increased. Depends primarily upon antecedent soil moisture deficit.

Gage Number	Station Name
016715	Bunch Creek
020300	Hardware River
020365	Fine Creek
020380	Falling Creek
020388.50	Holiday Creek
020551	Tinker Creek
020765	Georges Creek
031650	Chestnut Creek
032089.50	Cranes Nest River
034715	South Fork Holston River

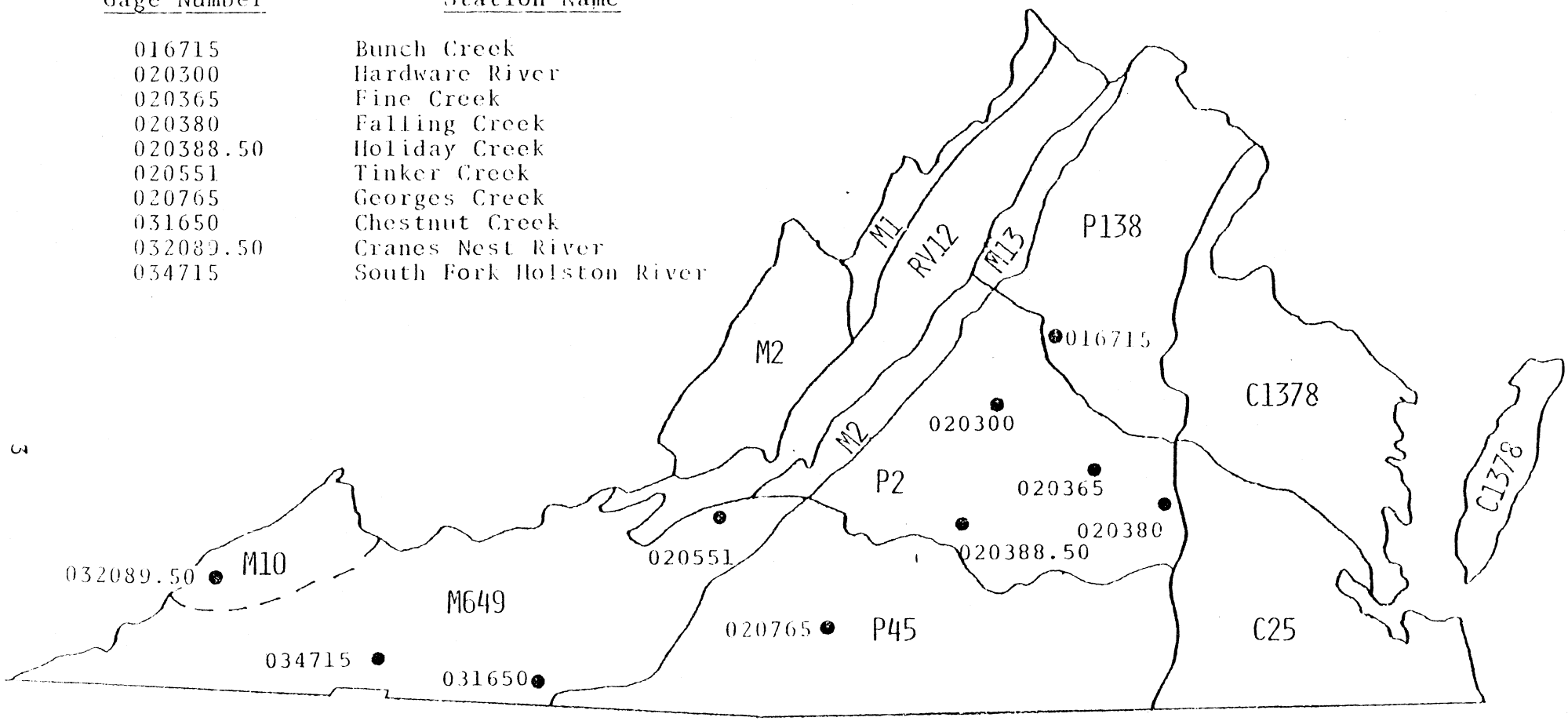


Figure 1. Hydrologic regions and HEC-1 design watersheds.

LOSS PARAMETERS FOR REGION P2

Region P2 was the first region chosen for study. For this area, four subbasins or watersheds were originally selected for HEC-1 analysis, and 33 storm events that occurred in the four watersheds were analyzed. However, it was later discovered that the gage of one of the four, Fine Creek at Fine Creek Mills, was influenced by backwater from the James River. The results obtained for Fine Creek, therefore, had to be deleted. It was then decided to replace Fine Creek with Bunch Creek near Boswell's Tavern, which is in Region P138, the Piedmont portion of the Potomac-Shenandoah, Rappahannock, and York Basins, but very close to the border of Region P2. These basins, together with their topographical characteristics, are given in Table 2.

For the 4 watersheds shown in Table 2, 28 storm events were analyzed. Of these, 9 storms were eliminated for various reasons, leaving 19 for the final analysis.

SUMMARY OF RESULTS

The results of the HEC-1 analyses of the 19 storm events are summarized below.

i) Parameters ERAIN and DLTKR exhibited relatively little variability from subbasin to subbasin. It was therefore decided to recommend regionwide values of 0.50 and 1.54 for these respective parameters.

ii) The other four parameters – RTIOL, STRKR, R, and TC – all showed significant variations from subbasin to subbasin. The average values for all storm events tested for each subbasin, together with the values for ERAIN and DLTKR, are given in Table 3.

iii) The parameter selection curves developed for RTIOL, STRKR, R, and TC, which relate each of these parameters to appropriate basin characteristics, are shown in Figures 2 through 5.

In each of the figures, the line of best fit (solid line) is drawn through the average value of the parameter. The areas between the dashed lines on the sides of the solid line represent an

Table 2

Test Watersheds in Region P2 with Topographical Characteristics*

Subbasin or Watershed	Drainage Area, $mi.^2$	Length, ft.	Length to Basin Centroid, ft.	Avg. Stream Slope, ft.	$\frac{(LL_{ca})^{.3}}{\sqrt{S_{ST}}}$
Hardware River near Scottsville	119.00	106,000	64,000	0.0042	1.10
Holiday Creek near Andersonville	8.53	29,000	10,000	0.0094	0.29
Falling Creek near Chesterfield	32.80	74,962	30,812	0.00169	1.26
Bunch Creek near Boswell's Tavern	4.37	24,100	12,800	0.0055	0.38

*Bunch Creek is in Region P138, but very close to the border with Region P2.

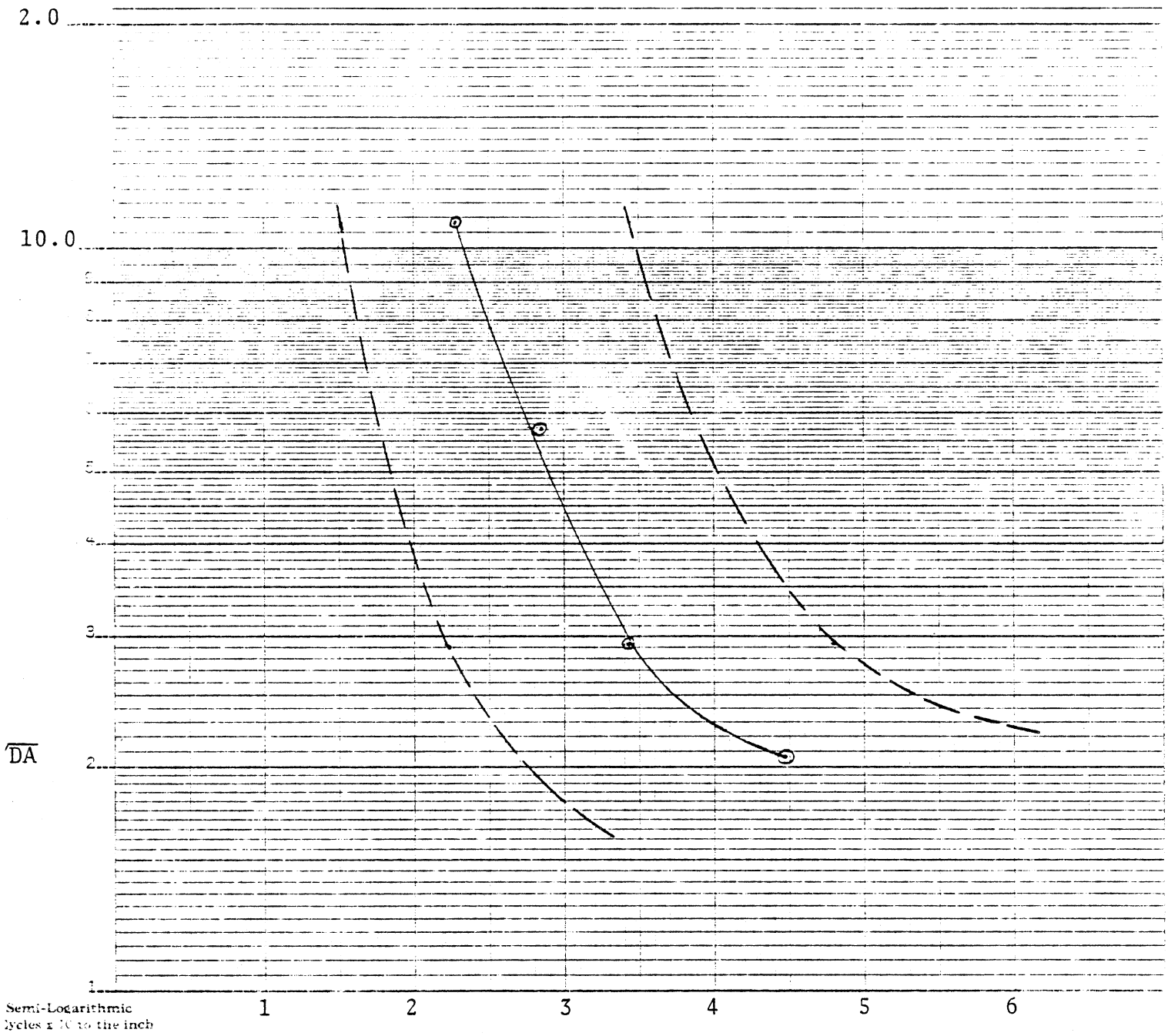
Table 3

Loss Parameters for Region P2

Basin	ERAIN*	RTIOL	STRKR	DLTKR**	R	TC
Hardware River near Scottsville	0.50	2.28	0.44	1.85	9.16	15.90
Holiday Creek near Andersonville	0.50	3.41	0.24	1.42	4.71	3.90
Falling Creek near Chesterfield	0.50	2.81	0.28	1.30	10.50	10.66
Bunch Creek near Boswell's Tavern	0.50	4.48	0.32	1.58	4.04	4.71

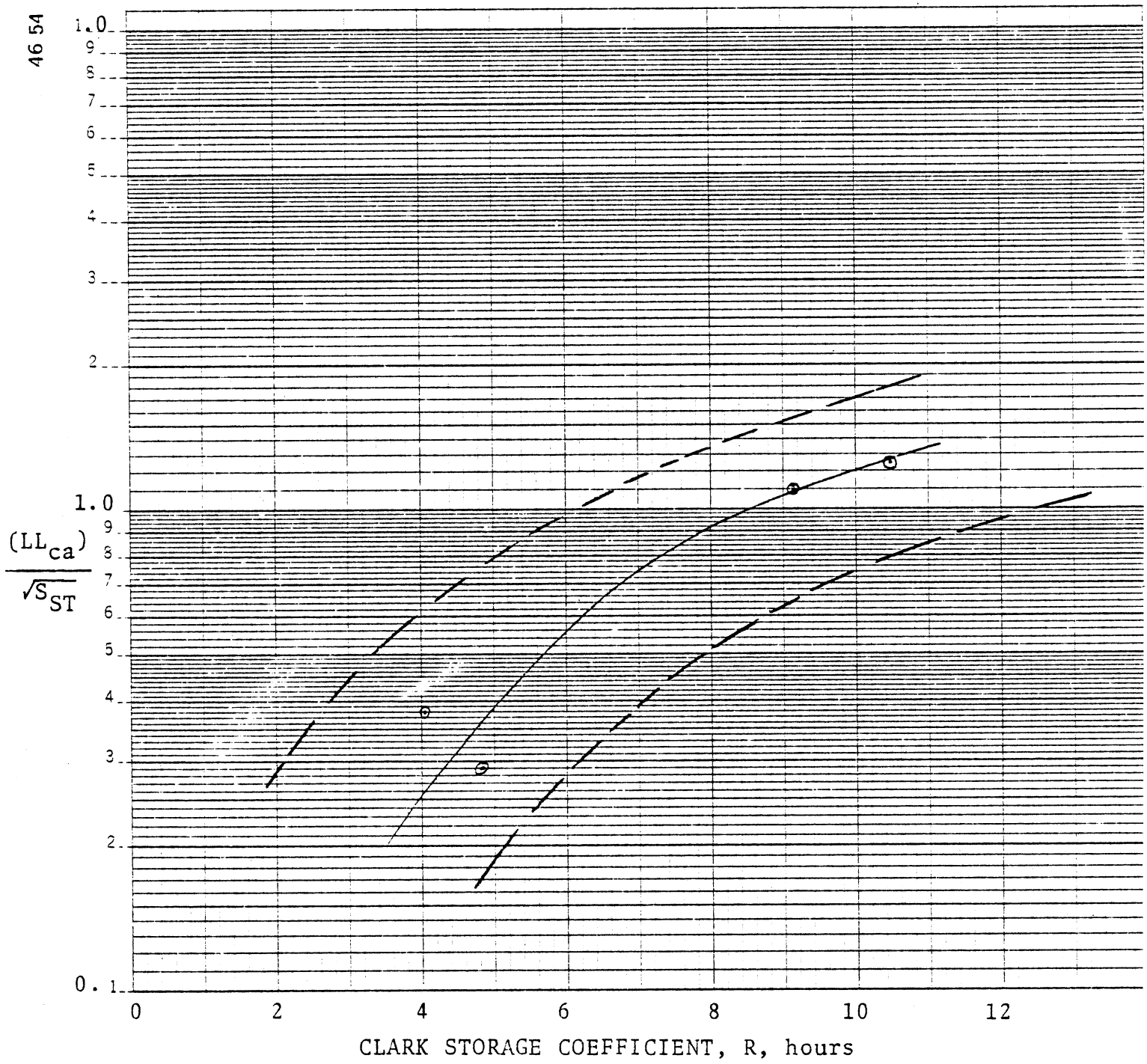
* ERAIN = 0.50 for entire region.

** DLTKR = 1.54 for entire region.



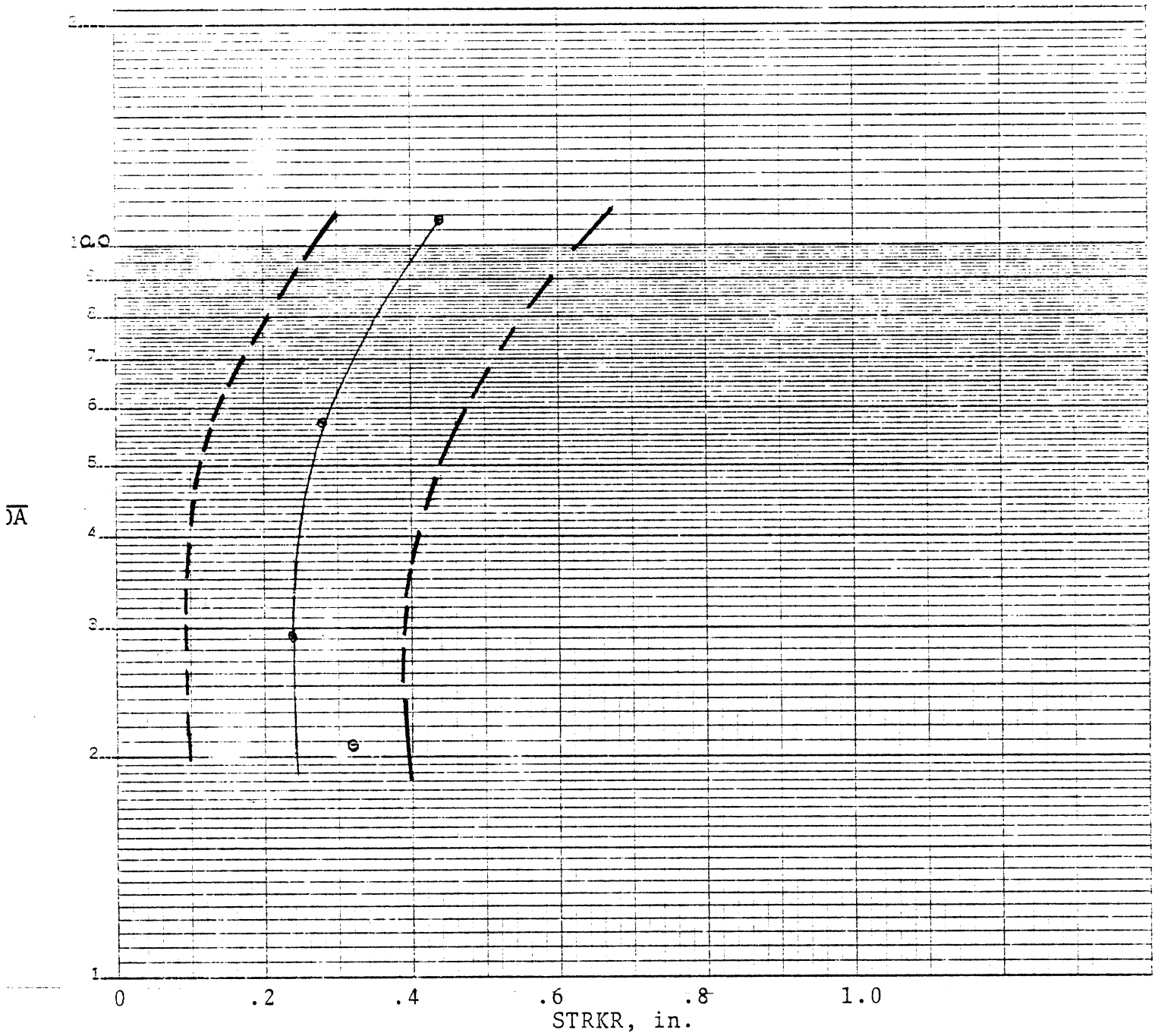
DETERMINATION OF RAINFALL LOSSES IN VIRGINIA
Region P2

Figure 2. RTI0L vs. $\sqrt{DA}$



DETERMINATION OF RAINFALL LOSSES IN VIRGINIA
Region P2

Figure 3. R vs. $\frac{(LL_{ca})^{.3}}{\sqrt{S_{ST}}}$



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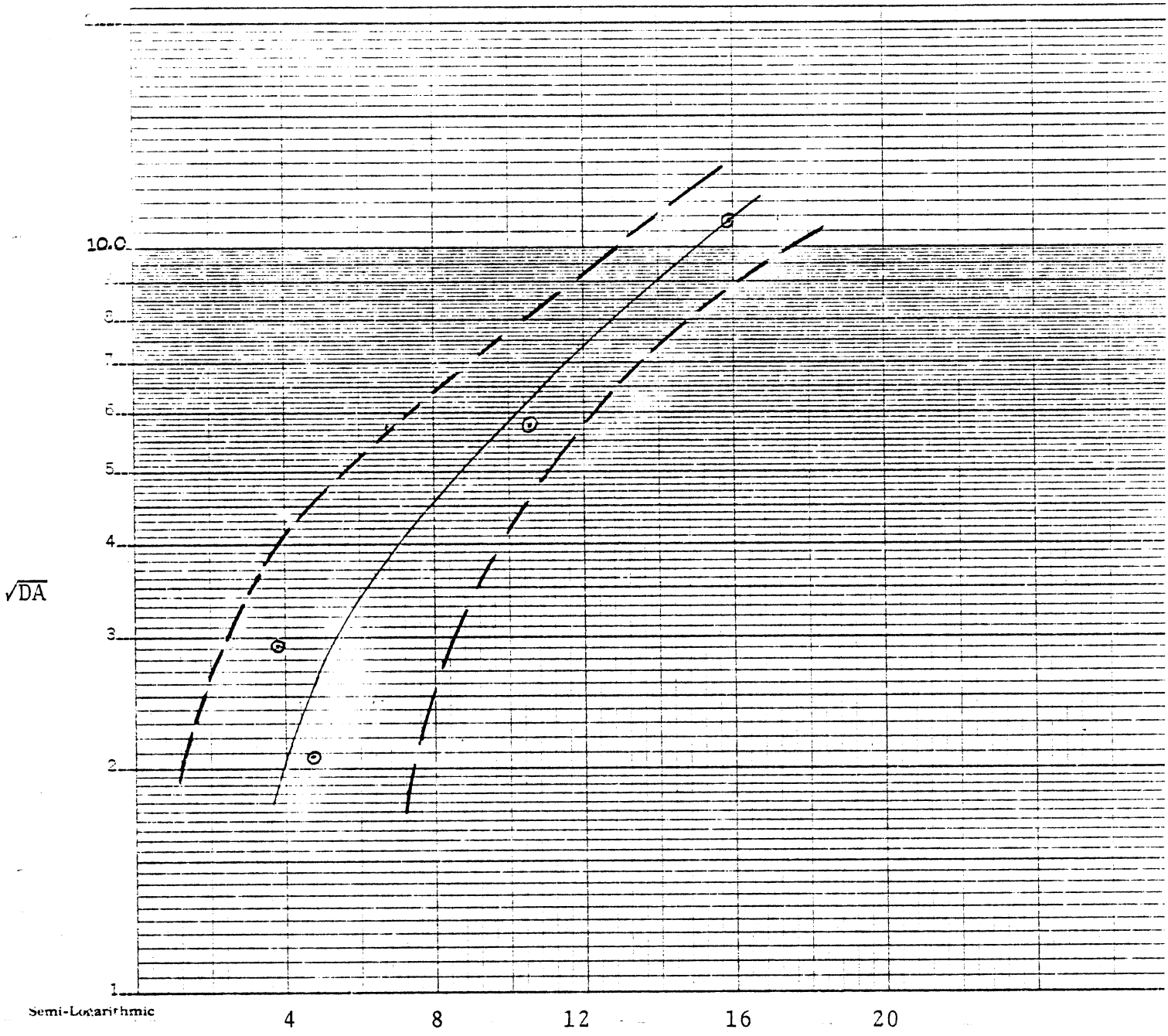
REGION P2

Figure 4. STRKR vs. $\sqrt{DA}$



DETERMINATION OF RAINFALL LOSSES IN VIRGINIA
REGION P2

Figure 5. TC vs. $\sqrt{DA}$

"envelope" that contains 17 of the 19 total data points. In other words, about 90% of the storm events gave parameter values that fell within the range bounded by these lines.

When utilizing these parameter selection curves, care should be taken not to extend them outside the range of the data from which they were developed. With more data available, these selection curves could be better defined.

RECOMMENDATIONS

Based on the preliminary results described above, the following recommendations are made with respect to region P2.

1. Regional values of parameters ERAIN and DLTKR are recommended for use throughout the P2 region. These values, 0.50 and 1.54, respectively, are averages for the four watersheds analyzed. It might be advisable, therefore, to use a more conservative value for DLTKR in design situations.

2. Parameter selection curves are recommended for use in selecting values of RTIOL, STRKR, TC, and R. These curves are given in Figures 2-5.

3. The recommended curves are based on a small sample of a very limited range of data and should not be extended outside this range. Since these curves are also based on average values in each case, it might be advisable to use more conservative values in some design situations. The envelope curves given on each figure should aid in this selection.