University of the Witwatersrand
Johannesburg

Analysis of SWA - Namibia rainfall data

B.F.C. Richardson & D.C. Midgley

Report No. 3/79
Hydrological Research Unit
1979

ANALYSIS OF SWA-NAMIBIA RAINFALL DATA

by

B.F.C. Richardson and D.C. Midgley

REPORT No. 3/79

Hydrological Research Unit
University of the Witwatersrand
Johannesburg

August 1979

PREFACE

Under its Flood Studies Contract with the Water Research Commission (WRC), the Hydrological Research Unit (HRU) undertook to extend its research into the arid areas of the sub-continent and with this in view acquired the daily rainfall data for the whole of SWA-Namibia. This material is being processed and analysed with the object ultimately of improving the basis for estimating flood response of arid regions to storm rainfall. An early step in this process is the analysis of point rainfall.

This report presents some of the results: first, an isohyetal map and secondly a coaxial diagram from which, given the mean annual precipitation (MAP) at a problem point, the maximum depth of precipitation of given duration appropriate to a given frequency of occurrence can be estimated. This depth-duration-frequency relationship is relevant to design flood determinations for small catchments. For larger catchments depth-area-duration-frequency relationships are needed for different regions of the country and, to develop these, storms have to be studied on an areal basis. This work is in hand and the results will form the subject of a separate HRU report.

The authors are grateful to the staff of the Weather Office, Windhoek, for patience and help during the abstraction of data from their archives, and to the firm Chunnett, Myburgh & Partners, Windhoek, for meticulous care in organising the punching of the data on computer cards, and checking and despatch of these to the HRU.

Thanks are due to the Water Research Commission and the CSIR for financial support of the project and for permission to publish the results in the HRU report series.

D C Midgley
Director, Hydrological Research Unit

August 1979

ANALYSIS OF SWA-NAMIBIA RAINFALL DATA

by B.F.C. Richardson and D.C. Midgley

1. INTRODUCTION

In 1969 the Hydrological Research Unit published its Design Flood Manual (Report no. 4/69). This contained the results of the Unit's country-wide storm studies which are basic to design flood determinations. It was felt at the time, however, that the manual did not offer adequate guidance for design storm determination in arid areas. The updated, metricated version of the Design Flood Manual (Report no. 1/72) unfortunately provided no further design information for the dry regions. Although a reprint issue of Report no. 1/72, released in February 1979, contained a revised depth-duration-frequency diagram (taken from Report no. 2/78) which incorporated results from several stations in the arid zone, there remained some hesitance about extrapolation to the dry areas of southern Africa. When, therefore, the opportunity arose for the Unit to acquire all the daily rainfall data for SWA-Namibia it was grasped in the hope that analysis of this material would yield an improved basis for arid zone design flood and storm determinations.

This report contains the results of analyses of records from daily-read rainfall stations throughout SWA-Namibia, culminating in the production of a mean annual isohyetal map, a depth-duration-frequency diagram and several useful rainfall statistics for this 824 000 km^2 territory.

2. THE DATA

Records from 572 daily-read rain gauges, in 175 *sections**, were transferred to computer cards in the Weather Office, Windhoek, by a firm of consulting engineers under direction

2/ from the ...

---

* Sections are quarter-degree squares numbered according to the system adopted by the Weather Bureau, Pretoria; rainfall station numbers comprise the section number and a suffix number based on position among the 900 possible square minutes of arc within each section.

from the Hydrological Research Unit (HRU).

Fig. 1* shows the distribution of the rainfall stations. Data from the seven official autographic recording stations in SWA-Namibia were employed in compiling the depth-duration-frequency diagram of Report 2/78 referred to earlier. These, plus two others outside the territory, were used to disaggregate daily to short-duration rainfall extremes.

Earliest records date from about 1890 and the closing date of the data set assembled is 1976. In general, the records prior to about 1910 were merely monthly totals. Most of the daily rainfall data were recorded in tenths of a millimetre but, particularly during the period January 1940 to December 1950, the unit one-hundredth of an inch was employed. In some of the records there was frequent switching of the units so that confusion was inevitable. Of the 572 stations 314 had records at times in both of these units.

An editing program was developed in the HRU to convert where necessary all records to the one-tenth millimetre unit and to point up errors, such as incorrect number of days in the month, lack of agreement between monthly totals listed and sum of the daily falls recorded for the month and various other inconsistencies in the records.

Printouts of errors or inconsistencies were returned to Windhoek for clarification where possible and there was thus much to-ing and fro-ing of data sheets before the data set was ready to be committed to magnetic tape. Copies of the final tape were made available to the Weather Bureau, Pretoria, and to the authorities in Windhoek.

3. PROCESSING OF THE DATA

Rainfall in SWA-Namibia, as is the case in the Republic, is strongly seasonal in character. Up to 80% of the year's rain normally falls during the summer months, October through March. Accordingly, for these analyses, the hydrological year 1 October - 30 September has been adopted.

3/..Programs..

* All Figures are contained in Appendix A.

A program was developed for abstracting by computer, from the taped record, the following for each station:

1. For each year of record the maximum daily total
2. The month of incidence of the maximum
3. The mean annual precipitation (MAP) based on the available records
4. The number of years of record
5. The number of years of recorded data
6. The predicted maximum 2-, 5-, 10-, 20-, 50- and 100-year one-day rainfalls (based on log-Gumbel distribution). The log-Gumbel plots with least-squares fitted lines (these provide visual checks of the adopted return periods).
7. The mean of the natural logarithms of maximum daily rainfall.
8. The standard deviation of the natural logarithms of maximum daily rainfalls.

The program also extracted the following for each section:

(a) maximum daily rainfall for the entire record
(b) station, month and year of incidence of this maximum
(c) mean annual precipitation (MAP) weighted according to length of record
(d) means and standard deviations of natural logarithms of daily maxima, also weighted as in (c).

Description and detail of the program are contained in Appendix B.

3.1 Criteria for acceptance of record

Breaks in the records, as always, present major difficulties, as also do records of differing length. Nevertheless, it is important to extract as much information as possible from the available data without invalidating the results. Accordingly, the following criteria were adopted:

A) Missing data

(i) It seemed that in 75% of the records the maximum one-day precipitation occurred between December and March and therefore if the record was missing for three or more of these months the whole year's record was rejected.

4/ (ii)...

(ii) If one or two of the records December-through-March, as well as those of four or fewer of the other months, were missing, the record was accepted as though the missing values were zero.

(iii) If one or two of the records December-through-March as well as those of five or more other months were missing the entire year's record was rejected.

B) Total for the month(MT1) recorded but daily data missing

(i) Daily data missing for three or fewer months: Max. daily rainfall (MDR) and monthly total (MT2) for the month in which the MDR occurred were computed and assessed as follows:

(a) MDR > MT1 : MDR for the year computed normally and MAP computed from monthly total

(b) MDR < MT1 < MT2 : MDR for the year computed normally and MAP computed from monthly totals

(c) MDR < MT1 > MT2 : MAP computed from monthly totals but no MDR abstracted for that year.

(ii) Daily data missing for four or more months: MAP computed from monthly totals but no MDR abstracted for the year.

3.2 Lengths of Records

Table 1 lists length-of-record statistics:

Table 1 Numbers of sections/stations according to record length

Records longer than	Sections		Stations	
	Number	% of total	Number	% of total
2 years	175	100	572	100
10 years	169	97	548	96
20 years	146	83	362	63
30 years	115	66	198	35
40 years	66	38	96	17
50 years	34	19	45	8

Clearly, from Table 1, if records as short as 10 years could be accepted, the data set would be more than twice as large as that containing only records longer than 30 years. Another problem in selecting the records to be employed in a particular analysis is the choice of epoch, i.e. records covering the same period. It was important therefore to establish the level of error likely to result from using as many as possible of the records regardless of the differing lengths and periods covered.

To this end, the means of the natural logs of MDR were abstracted from the records of stations having records between 10 and 30 years long and again for those having records longer than 30 years. These were plotted respectively against corresponding MAPs in Figs. 2 and 3.

In order to provide a basis for comparing data sets of differing record length, equations were fitted to the plotted points thus:
For the 10-30 year record:

$$\ln MDR = 0{,}39 + 0{,}58 \ln MAP \qquad \ldots\ldots\ 1)$$

For the > 30 year record:

$$\ln MDR = 0{,}25 + 0{,}60 \ln MAP \qquad \ldots\ldots\ 2)$$

The statistics in Table 2 reflect the difference between short and long records.

Table 2 Characteristics of short and long records

MAP (mm)	Mean MDR (mm)		
	10-30 yr	> 30 yr	% diff
100	21,2	20,4	4,2
200	31,7	30,8	2,6
300	40,0	39,3	1,8
400	47,3	46,8	1,2
500	53,8	53,5	0,7
600	59,9	59,6	0,4

Clearly the differences are not significant and it therefore seemed appropriate to use all records longer than 10 years to compile the mean annual isohyetal map of SWA-Namibia. Fig. 4 is the result.

4. ANALYSIS OF DATA

4.1 General

The primary objective is to provide a means of estimating the maximum depth of precipitation of given duration anywhere in SWA-Namibia and the main parameters that have been abstracted from the data to form the basis of such estimation are the MAP, the MDR and the standard deviation of the MDR (or the logarithms of these parameters). The first step therefore was to examine whether any regional groupings of the inter-relationships among these parameters could be traced.

4.2 Regionalization

Means and standard deviations of the logs of MDR were accordingly plotted against MAP on Figs. 5 and 6 respectively section by section throughout the territory and label numbers were annotated against the plotted points.

Equations were fitted to the scatter of points as follows:

For means:

$$\mu = -1{,}26 + 0{,}98 \ \ln \text{MAP} \qquad (\text{MAP} < 86 \text{ mm}) \ldots\ldots\ldots 3)$$

$$\mu = 0{,}93 + 0{,}49 \ \ln \text{MAP} \qquad (\text{MAP} > 86 \text{ mm}) \ldots\ldots\ldots 4)$$

For standard deviations:

$$\sigma = 0{,}50e^{-0{,}005 \text{ MAP}} + 0{,}30 \qquad (\text{MAP} > 50 \text{ mm}) \ldots\ldots\ldots 5)$$

As is clear from Fig. 6 the scatter of plotted standard deviations of MDR in areas of MAP below 50 mm is too wide to be approximated by a single-valued relationship. Moreover, when the plotted points lying above the fitted curves were distinguished on maps, Figs. 7 and 8, from those lying below the curves, no obvious regional groupings could be identified.

Values in sections embracing the coastal areas behave quite anomalously and these areas will be referred to again presently.

4.3 Frequency distribution of MDR

Programs were developed to plot the Gumbel extreme value distribution of MDR at all stations. Examination of these revealed that the fit of this distribution was in most cases excellent.

As the cumulative density function (c.d.f.) of the Gumbel distribution is a function of the mean and standard deviation of the extreme values, and as these parameters have been related in reasonable fashion to MAP, it follows that the frequency or return period of given MDR can be calculated from the c.d.f. once the MAP is known; given the locality the MAP can be established from Fig. 4.

The Gumbel c.d.f. is given by:

$$f(x) = e^{-a+cy} \qquad \ldots\ldots\ (6)$$

For the case in point f(x) is the MDR

$y = -\ln\left(-\ln\left(1-\frac{1}{T}\right)\right)$

T = return period

$c = \frac{\sqrt{6}}{\pi}\,\sigma$

$a = \gamma c - \mu$

σ = standard deviation

μ = mean

$\gamma = 0{,}57721$ .... (Euler's constant)

The means are calculated from equations 3 and 4.

It stands to reason that standard deviations will be more sensitive to length of record than will the means and so before accepting equation 5 for deriving standard deviation a smooth curve was drawn through the averaged ordinates on Fig. 6. As may be seen this "median" curve lies above the curve represented by equation 5, implying that the equation under-estimates the standard deviation. The reason is that extremely erratic variations in the very low rainfall areas tend to swing the curve upwards at the low MAP tail and correspondingly downwards at the high MAP tail. In an attempt to identify an improved relationship, standard deviations for stations with records longer than 30, 40 and 50 years respectively were plotted separately against MAP on Fig. 9 and equations were derived for the best-fit curves. The resulting equations in x (MAP) and y (std dev) were:

> 30-year: $y = 0{,}47\ e^{-0{,}00435x} + 0{,}30$ .... 7)

> 40-year: $y = 0{,}46\ e^{-0{,}00397x} + 0{,}30$ .... 8)

> 50-year: $y = 0{,}44\ e^{-0{,}00366x} + 0{,}30$ .... 9)

Evidently the curve representing the > 30-year records (equation 7) compares best with the "median" line. There are 198 stations for which data > 30-year records are available covering the MAP range 15 to 683 mm, i.e. the full SWA-Namibia spectrum. On the strength of the foregoing analysis the > 30-year records instead of the > 10-year records were used for standard deviation determination.

Once the MAP of a place is known (from Fig. 4) the one-day duration extreme rainfall of given probability or return period can be calculated from equations 3,4,6 and 7.

To facilitate solution of the equations a co-axial diagram, Fig. 10, has been prepared.

Table C1 in Appendix C contains values from solution of equations 3,4,6 and 7, forming the basis for construction of the coaxial diagram and Table C2 lists MDR by sections with relevant data for each station.

Table 3 reflects a numerical check on the validity of the computed return periods.

Table 3 Validity check

Return period T (years)	Percentage of sections with:	
	MDR < computed T-year value	length of record < T years
2	-	-
5	1	-
10	5	3
20	20	17
50	74	81
100	93	100

What Table 3 reflects is that if all the MDR values were to be plotted in the first quadrant of Fig. 10 it would be found that 1% would fall below the 5-year line, 5% below the 10-year line, 20% below the 20-year line, 74% below the 50-year line, and 93% below the 100-year line. Comparison of these percentages with those of corresponding record length in the final column of Table 3 indicates that the calculated return periods are not inconsistent.

At 15 stations MDRs higher than the computed 100-year values were recorded and these (comprising only 2,6% of all stations) have been plotted on the coaxial diagram, Fig. 10, to provide some guidance to the designer as to the position of the probable maximum (PMP) envelope in SWA-Namibia.

4.4 Derivation of short duration extremes

Nine autographic recording rainfall stations located as shown on Fig. 1 provided data from which relationships between MDR and maximum rainfalls of shorter duration than one day could be established. These data are listed in Table C.3.

The ratio, R, of the D-hour value of maximum rainfall for a given return period to the one-day value (MDR) of the same return period can be approximated by an equation of the following type:

$$R = DR_o/(1 + BD)^n \qquad \text{............ (10)}$$

in which R_o, B and n are constants.

With the constants evaluated for SWA-Namibia, the equation reads:

$$R = 2{,}09D/(1 + 2{,}88D)^{0{,}92} \qquad \text{............ (11)}$$

Table 4 lists values of the ratio R for discrete durations D (hours). These were used to construct the radial lines in the second quadrant of the co-axial diagram, Fig. 10.

Table 4 Relationship between duration and the ratio of the D-hour to the one-day maxima of like recurrence interval

D(h)	R
0,1	0,17
0,25	0,32
0,5	0,46
1	0,60
2	0,72
4	0,82
8	0,90
12	0,94
16	0,97
18	0,98
one day	1,00

4.5 The third quadrant of the coaxial diagram

When the MDRs of 2-, 5-,10-, 20-,50- and 100-year return period for stations with records longer than 50 years were plotted in the third quadrant of the coaxial diagram against corresponding values derived from the mathematical model, it was found that, except for the coastal strip, there was reasonable agreement; only three stations had values exceeding the model values by more than 30%.

4.6 The coastal strip

Mean annual precipitation along the west coast is everywhere well below 50 mm and is so highly erratic that it is not possible to derive even an approximate relationship between MAP and the standard deviation of ln MDR. As the c.d.f. of extreme values is also a function of standard deviation it follows that the return periods of MDRs can also not be derived from the model.

Although values derived for some short duration stations along the coast were found to agree well with those given by the model, the long-record stations (e.g. in sections 413, 734 and 735) yielded values very much higher than would be given by the coaxial diagram. For the time being therefore it has been deemed wise to excise the coastal strip (see Fig. 4) from the area of applicability of Fig. 10.

5. CONCLUSION

From an analysis of the available daily rainfall data an isohyetal map of SWA-Namibia has been compiled (Fig. 4) as well as a co-axial diagram (Fig. 10) from which, given the mean annual precipitation (MAP) at a problem point, it is possible to estimate, for given recurrence interval, the maximum likely precipitation in any period of duration between one tenth of an hour and one day, for all of SWA-Namibia excluding the narrow coastal strip.

APPENDIX A FIGURES

Contents

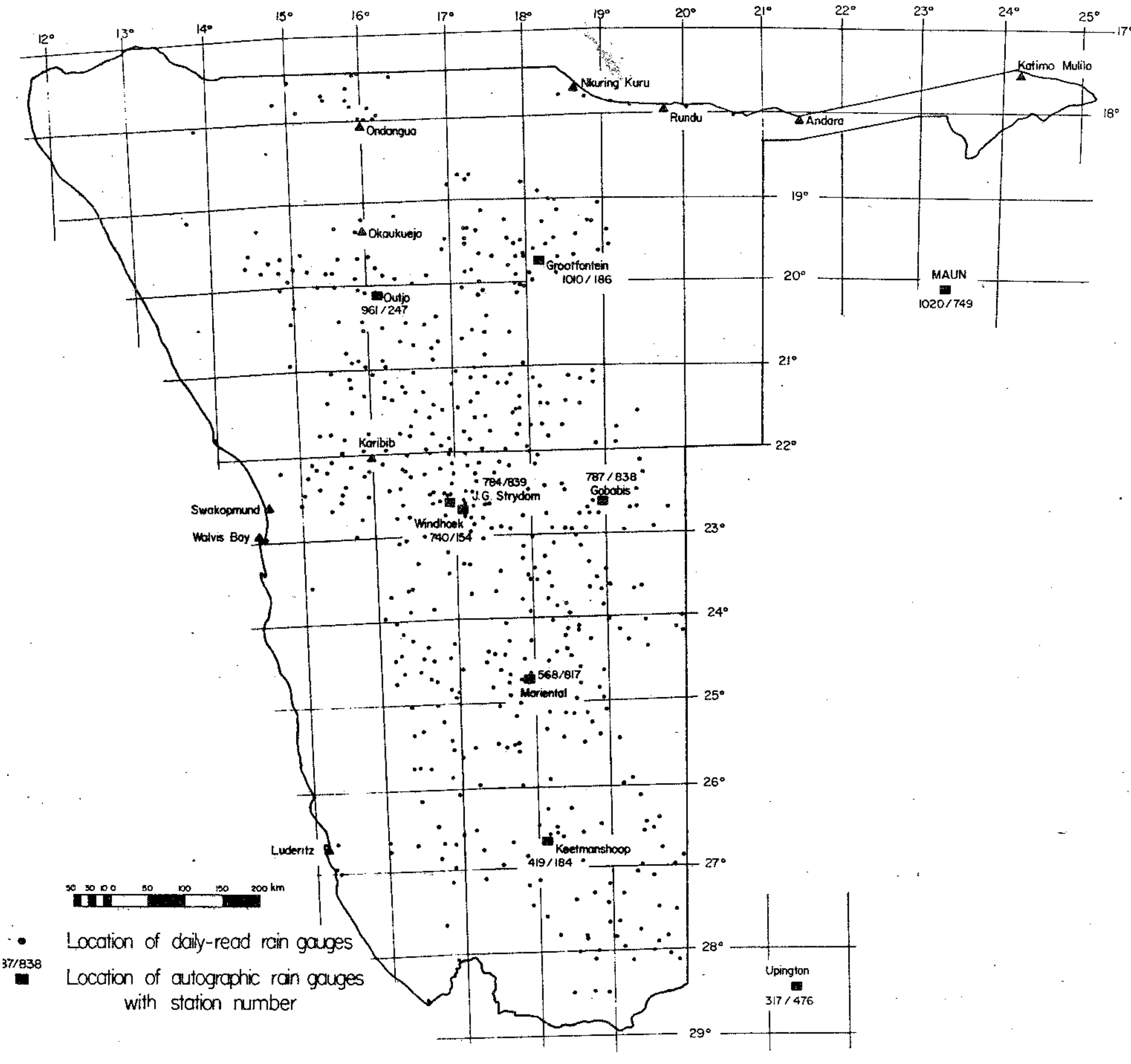


Fig. 1 SWA/Namibia : Distribution of rainfall stations

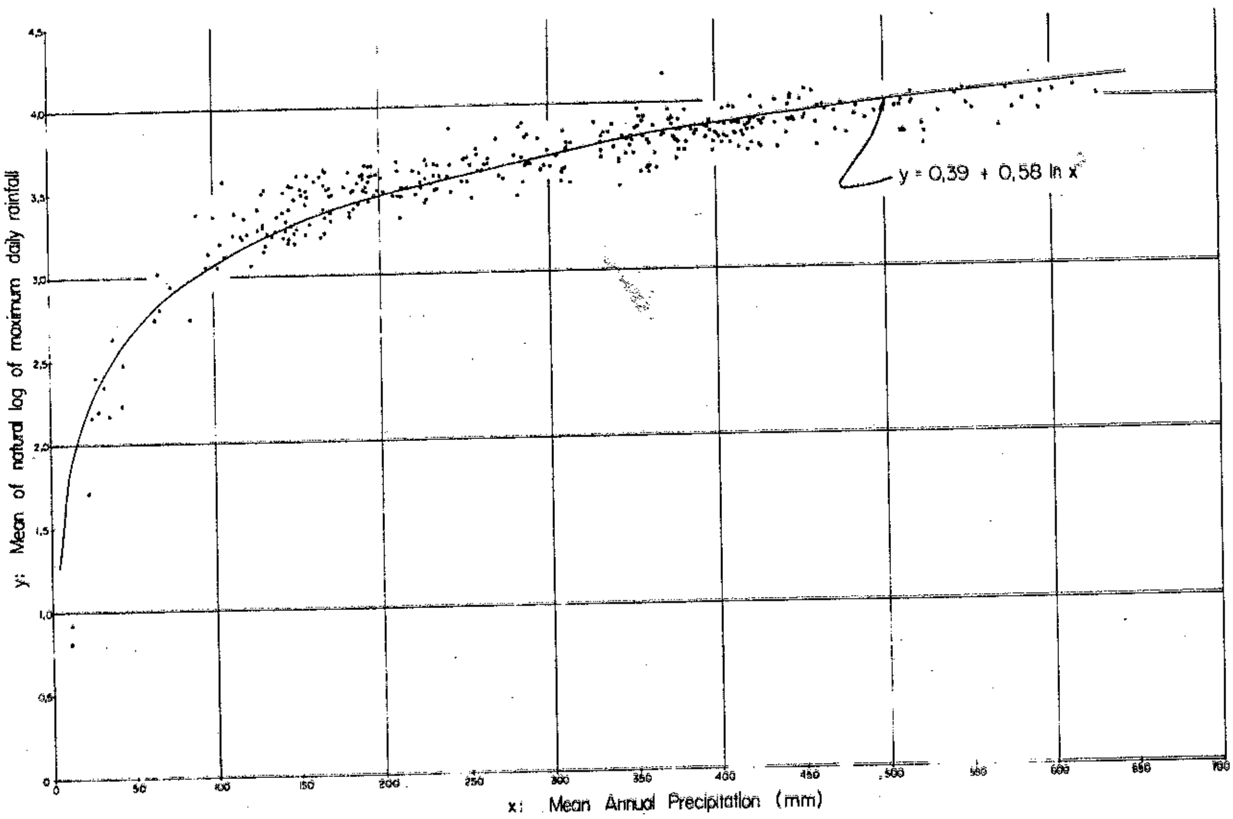


Fig. 2 Relationship between MAP and mean of natural log of maximum daily rainfall for records less than 30 years.

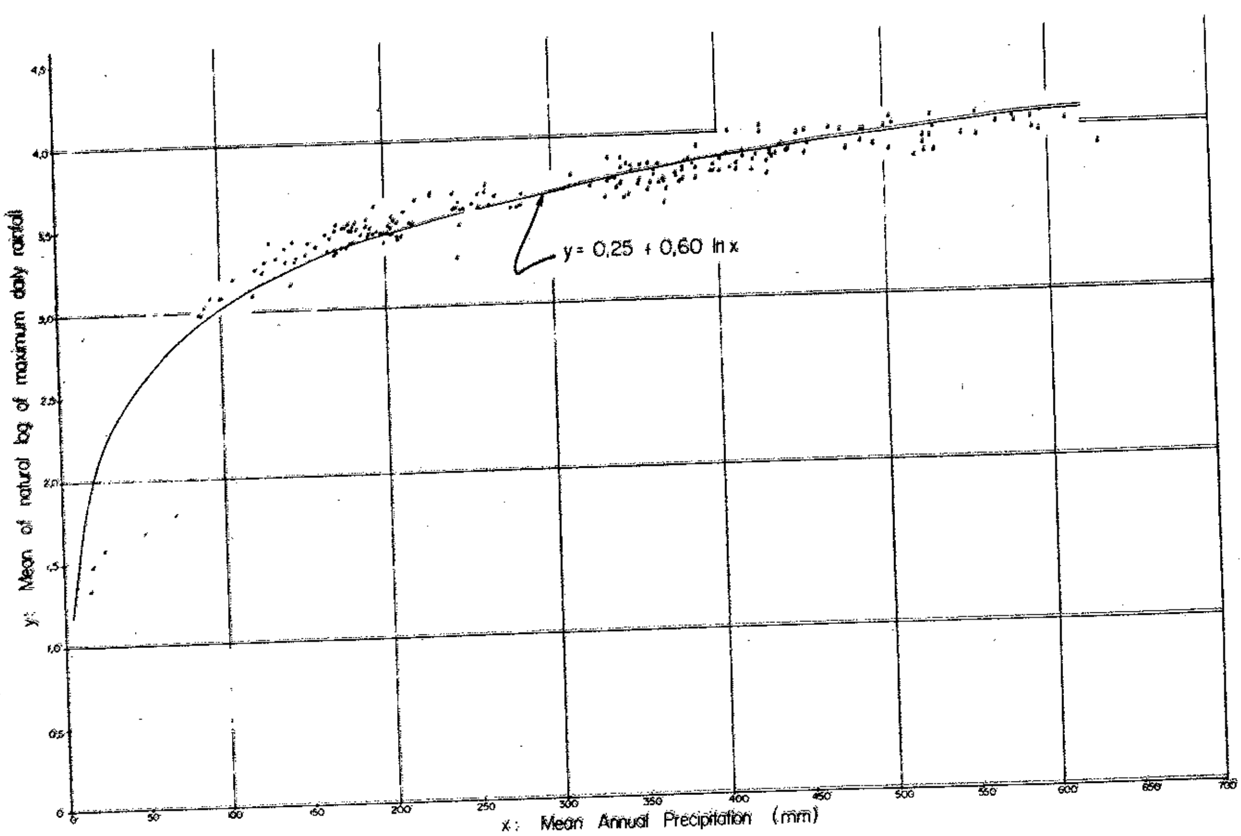


Fig. 3 Relationship between MAP and mean of natural log of maximum daily rainfall for records longer than 30 years.

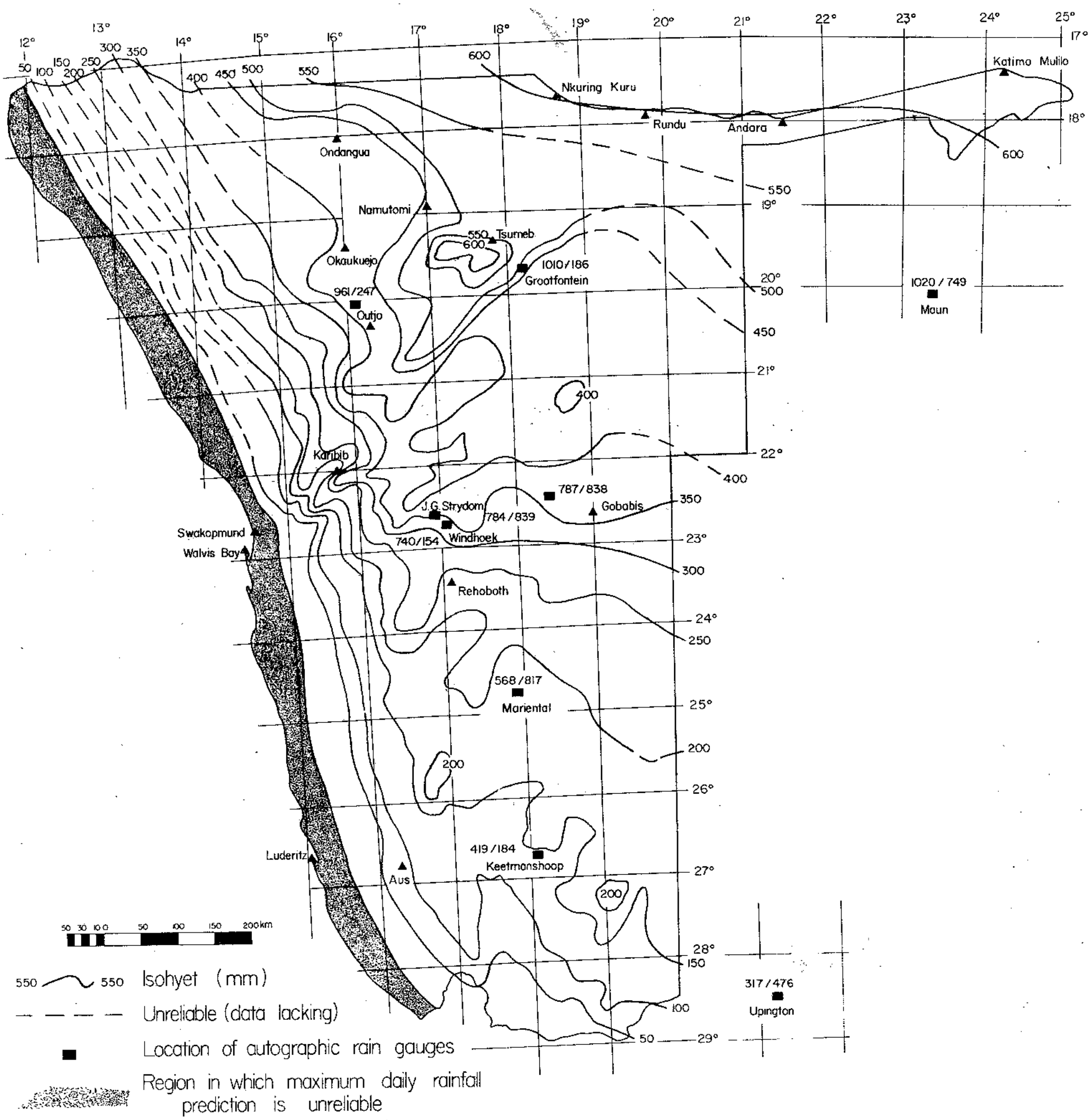


Fig. 4. SWA/Namibia: Isohyetal map

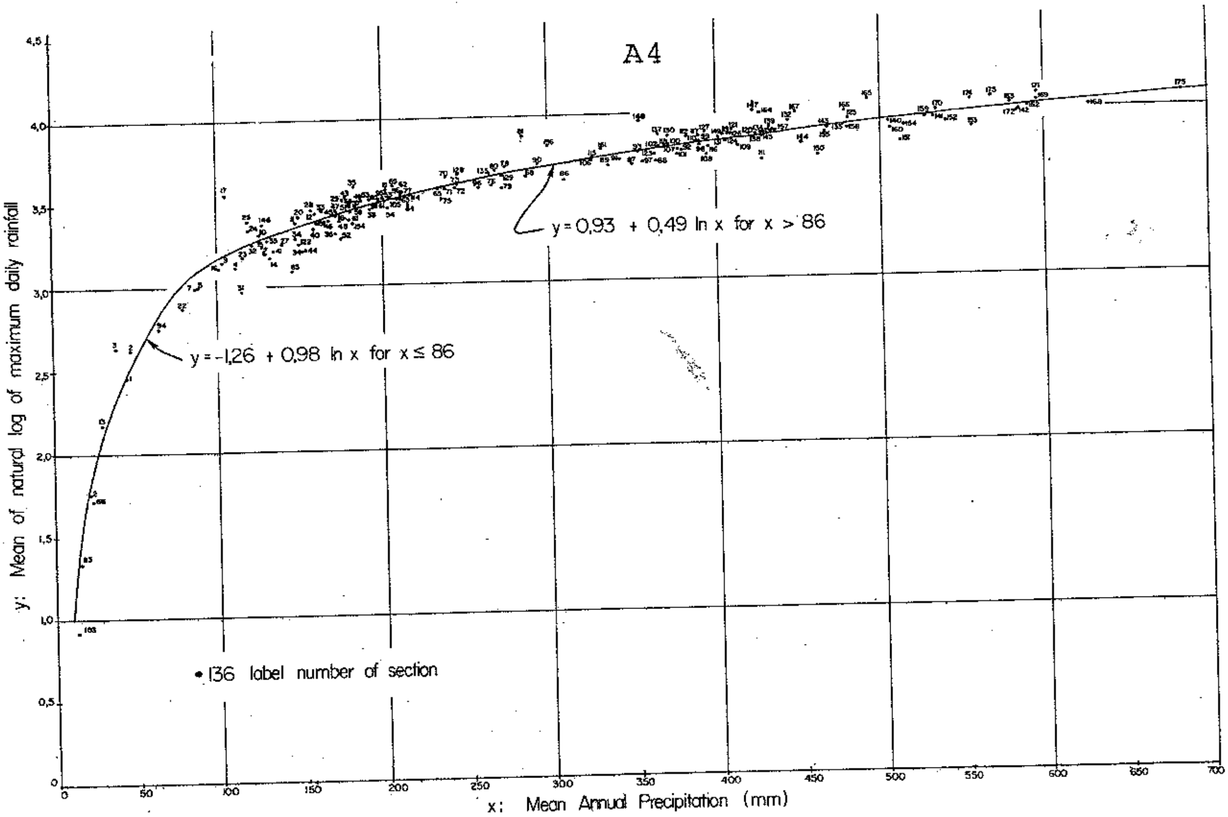


Fig. 5 Relationship between MAP and mean of natural log of maximum daily rainfall for sections

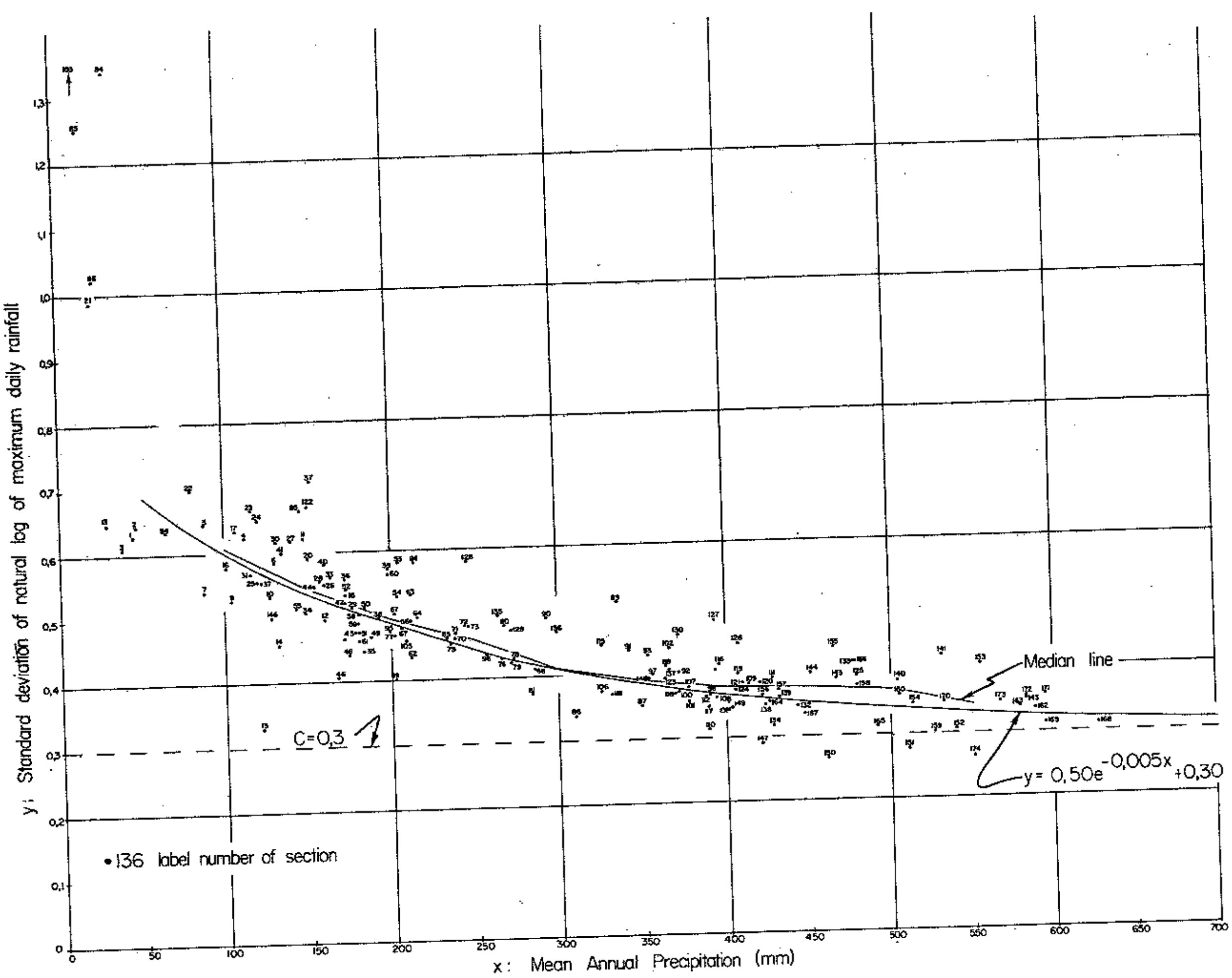


Fig. 6 Relationship between MAP and standard deviation of natural log of maximum daily rainfall for sections

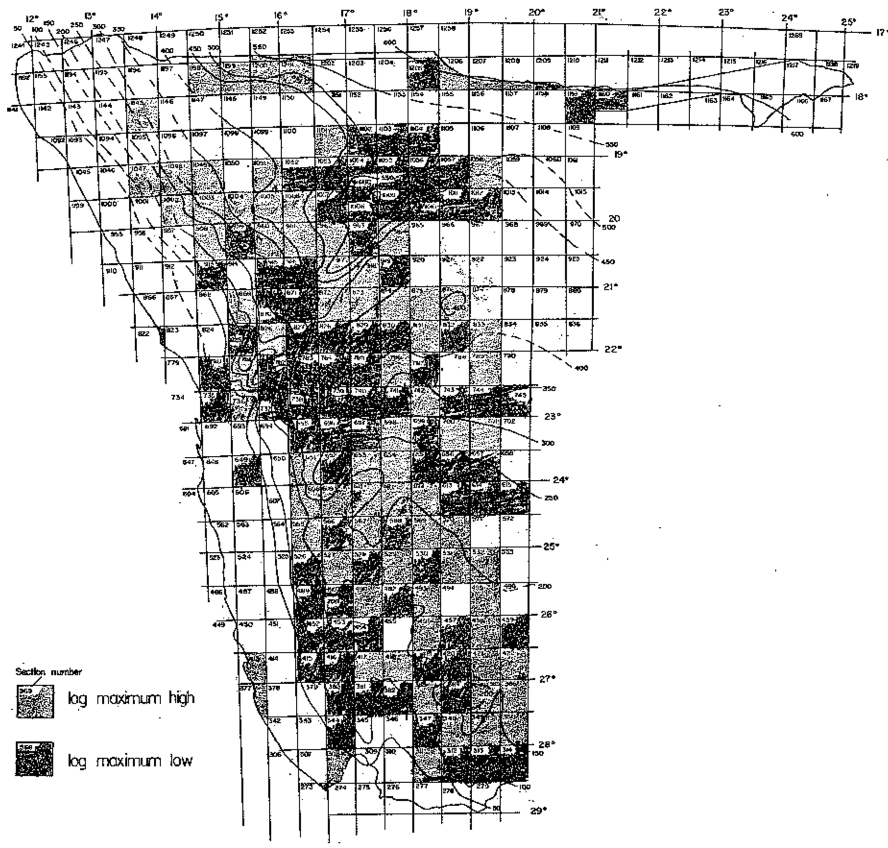


Fig. 7 Search for regional patterns (mean of log of maximum daily rainfall as a function of mean annual precipitation).

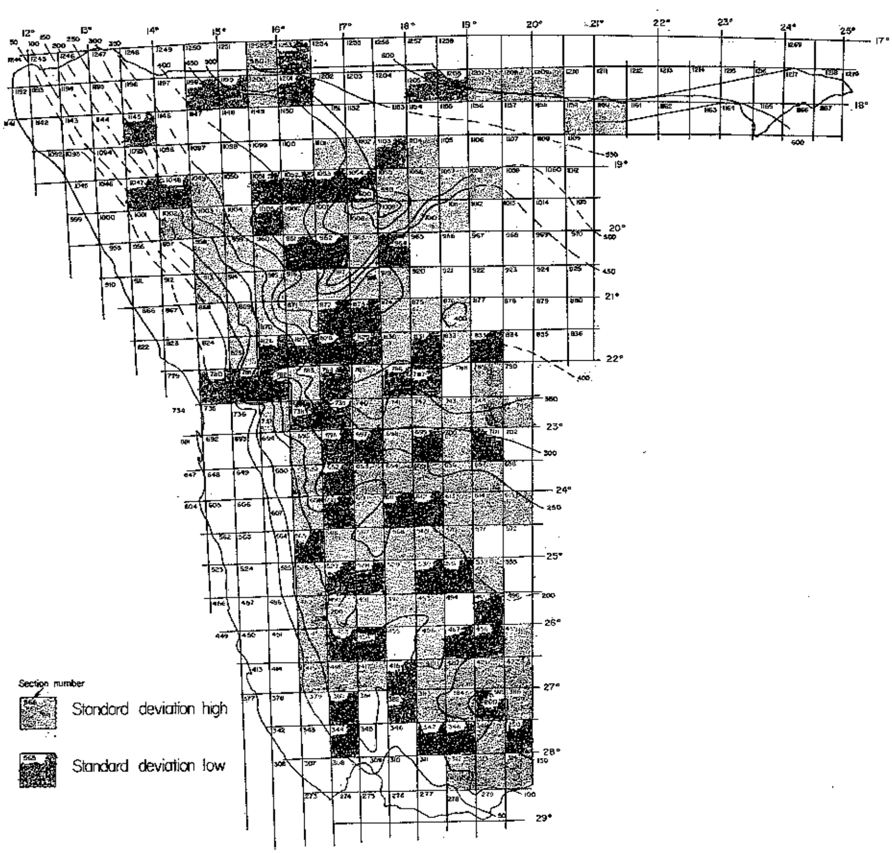


Fig. 8 Search for regional patterns (standard deviation of log of maximum daily rainfall as a function of mean annual precipitation)

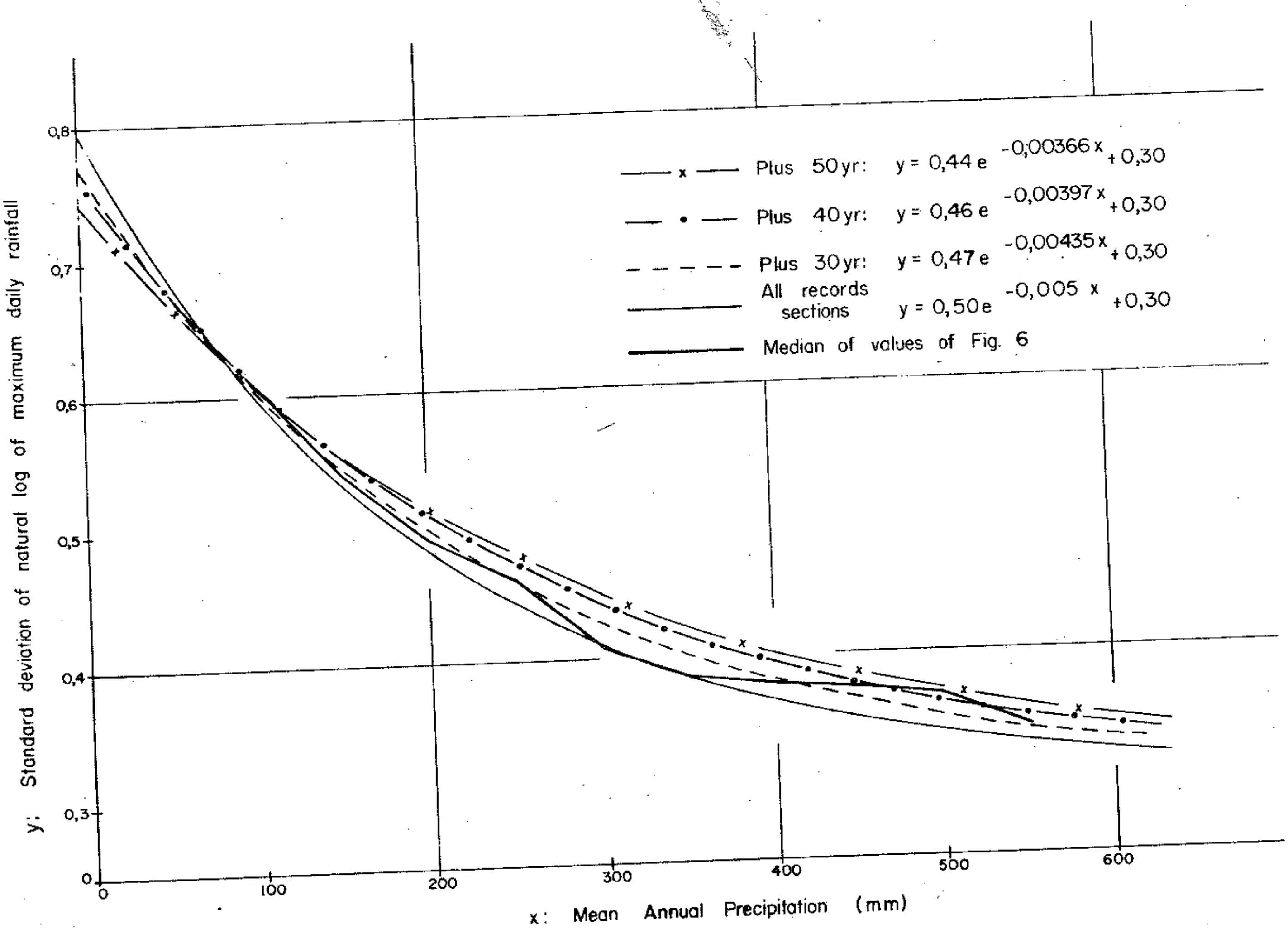
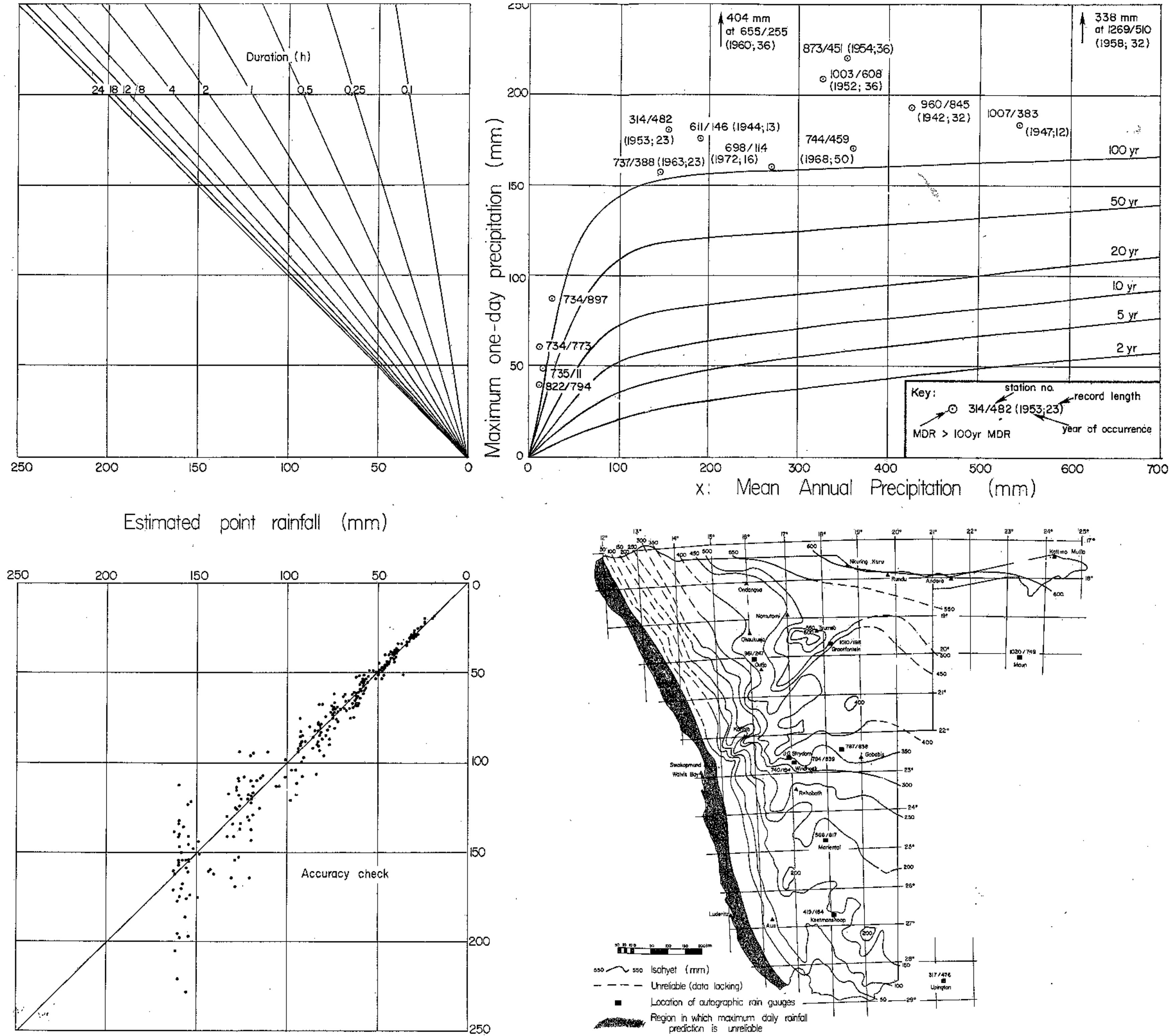


Fig. 9 Relationship between MAP and standard deviation of natural log of maximum daily rainfall. Comparison between station records of various length, median of sectional records and fitted curve of sectional records.



30
30
30
30

.son
ın
ıal

APPENDIX B

SWAPGM : PROGRAM TO ANALYSE SWA-NAMIBIA RAINFALL DATA

Contents — Page

B.1 PROGRAM DESCRIPTION

1. INTRODUCTION

SWAPGM reads records from 572 rain gauges in 175 sections in SWA-Namibia from the magnetic tape SWADRN.

1.1 Tape SWADRN

The tape SWADRN, created at the HRU, incorporates the edited and corrected data from the 572 rain gauges.

The tape is labelled, the labels corresponding to the 175 sections arranged in ascending order of magnitude.

With each of these labels, the stations are ranked according to their suffix number in ascending numerical order. However, the station numbers are NOT labelled - thus the user has access to any particular section (label) or set of sections but not to a single station to the exclusion of all other stations within a particular section (label).

The full listing of the volume of contents of tape SWADRN giving all section numbers and their corresponding labels appears in paragraph 7.

2. DATA DESCRIPTION

The data statements, as transferred onto computer cards at the Weather Office, Windhoek, and subsequently onto the magnetic tape SWADRN at the HRU, consist of 3 card types viz.

1) The header card
2) Rainfall record card(s)
3) The break-in-record card.

These occur in the following general order for any station:

First header card

.
.
. Rainfall records for the period given
. on the first header card
.
.

Break-in-record card

Second header card

.
.
. Rainfall records for the period given
. on the second header card
.
.

etc. .
.
.

Last header card

.
.
. Rainfall records for the period given
. on the last header card
.
.
.

First header card
for the next station in the section

.
.

2.1 The header card

The header card carries 6 variables described in the following table

VARIABLE	UNIT	FORMAT	DESCRIPTION
ISEC	Integer	I4	The Section number according to the quarter-degree square adopted by the Weather Bureau, Pretoria
IPOS	Integer	I4	The position of the station among the 900 possible square minutes of arc within ISEC
IYR	Integer	I5	Year of commencement of data-recording
IMON	Integer	I3	Month of commencement of data-recording
JJYR	Integer	I5	Last year of record prior to data-recording having been interrupted or having ceased
JJMON	Integer	I5	Last month of record prior to data-recording having been interrupted or having ceased

2.2 Rainfall record cards

All rainfall data stored on the tape are in tenths of a millimetre. The monthly/daily measurements appear on a single record as follows:

VARIABLE	UNIT	FORMAT	COLUMN POSITION	DESCRIPTION	CARD CONDITION
JYR	Integer	I2	1-2	Year of current record	Always
MON	Integer	I2	3-4	Month of current record	Always
JTOT	Integer	I6	5-10	Total rainfall recorded during MON	Always
ND	Integer	I3	11-80	Day of MON	
NP	Integer	I4		Amount of rainfall measured on day ND	

Due to the fact that SWA-Namibia is a sparse-rainfall region, the convention adopted was that only positive measurements, and their corresponding day numbers appear in the record. Furthermore, if no rainfall was recorded throughout an entire month, no record was created for that month.

Note: (a) Where no data is recorded, zeros need not be punched although zeros do appear on the tape.

(b) If records prior to 1900 exist, the year allocations are shown as negative values taking 1900 as year 0.

A single card can contain a maximum of 10 daily records. In the event that more than ten days of rainfall were recorded during a particular month, a second record is created with columns 1 - 10 identical to the previous record, columns 11 - 80 then containing the further daily records for that month.

By repeating this procedure, a maximum of 4 records constitutes the complete rainfall record for a single month.

A further facility built into the data accounts for the case where, for a number of days, rainfall records were not made although rainfall may or may not have occurred. The first day of no record is indicated in the data by NP having a value of -9. The subsequent day number in the record represents the end of this period, and its associated daily total (i.e. NP value) is in fact the amount of rainfall accumulated over this period.

For example, a rainfall record reading

58 1 234 5 34 16 -9 19 200

implies that in January 1958, 23,4 mm of rain were recorded of which 3,4 mm were measured on the 5th and 20,0 mm were accumulated from the 16th to the 19th. All other days had 0,0 mm rainfall.

It should be noted that these accumulated totals, when they arise, are ignored in the calculation of the daily maxima but are included in the MAP calculation.

2.3 Break-in-record card

In format this card is identical to the header card. Here the years/months indicate the period during which no data-recording was performed.

This card is immediately followed by a new header card.

Note: It is recommended that the header and break-in-record cards be checked by the user for, if they are incorrect, some of the dimension restrictions in SWAPGM may be violated and/or output from SWAPGM affected.

3. OUTPUT

3.1 Station results

SWAPGM abstracts the following for each station:

1) The maximum daily rainfall recorded during each hydrological year in the record.
2) The month of incidence of this maximum.
3) The mean annual precipitation (MAP) based on the available records.
4) The number of years of record.
5) The number of years of actual recorded data.
6) The number of years of the record during which no data was recorded.
7) The predicted maximum 2-, 5-,10-,20-,50- and 100-year one-day rainfalls (based on the Log-Gumbel distribution).
8) The mean and standard deviation of the natural logarithms of maximum daily rainfalls.
9) A plot, using Log-Gumbel axes, of the predicted and observed maximum one-day rainfalls.

3.2 Section results

SWAPGM abstracts the following for each section:

1) The number of stations in the section.
2) The maximum daily rainfall recorded within the section.
3) The station, year and month of incidence of this maximum.

4) The mean and standard deviation of the natural logarithms of daily maxima weighted according to length of record.
5) The mean annual precipitation (MAP) also weighted as in (4).

4. CRITERIA FOR ACCEPTANCE OF DATA

SWAPGM analyses complete hydrological years (i.e. 1 October to 30 September) only. Since data recording may begin during any of the 12 months, SWAPGM establishes the first acceptable hydro. year of data by the criterion that if there are less than 7 months of data on the first October encountered, these data are rejected. The same criterion is employed when the end of the data set for the station is encountered. The number of months of recorded data since the previous hydro year ended is calculated and the last few records are either accepted or rejected. In both the foregoing instances, the number of months of accepted record is adjusted accordingly.

As described previously it is necessary to distinguish between a header or "break" card and a rainfall record. In order to achieve this, each data record subsequent to the first is read twice. On the second reading the distinguishing feature, viz. a blank in column 27 (a rainfall record never has a blank in col. 27), is sought.

Further criteria adopted were the following:

(a) No data recorded
   (i) It seemed that in 75% of the records the maximum one-day precipitation occurred between December and March and therefore if the record was missing for three or more of these months the whole year's record was rejected.
   (ii) If one or two of the records December-through-March, as well as four or fewer of the other months, were missing, the record was accepted as though the missing values were zero.
   (iii) If one or two of the records December-through-March as well as those of five or more other months were missing the entire year's record was rejected.

(b) Total for the month (JTOT) recorded but no daily data

(i) Daily data missing for three or fewer months: Max. daily rainfall MAX(K) and monthly total MMTOT(N) for the month in which the MDR occurred were computed and assessed as follows:

(a) MAX(K) > JTOT : MAX(K) for the year computed normally and MAP computed from monthly total

(b) MAX(K) < JTOT < MMTOT(N) : MAX(K) for the year computed normally and MAP computed from monthly totals

(c) MAX(K) < JTOT > MMTOT(N) : MAP computed from monthly totals but no MAX(K) abstracted for that year.

(ii) Daily data missing for four or more months: MAP computed from monthly totals but no MAX(K) abstracted for the year.

5. LIST OF INTERNAL VARIABLES USED IN SWAPGM

Units Real * 4: A - H, Ø - Z
Integer I - N

VARIABLE	DESCRIPTION
AMESS	The matrix containing the alphameric characters which constitute the messages printed in "station" table of the output.
AMAP	Mean annual precipitation for a station. Indexed by NS
ANP	Annual precipitation in mm for a station. Indexed by N
B, BL	Defined to be 4 blank spaces
DAYMAX	The vector containing all the maximum daily measurements for each hydrological year of record for a station
IANP	Annual precipitation in tenths of a mm for a station. Indexed by N
IAP	Sum of monthly rainfall measurements in tenths of a mm
IAPTOT	Sum of annual precipitation totals. Indexed by NS.
ICOND	ICOND = 1 if IANP (N) = 0 or if a change in calendar years has occurred due to the fact that records were not created because they were zero values.
IEND	IEND = 1 indicates that the end of the data set has been attained and that section results must be calculated and printed.

VARIABLE	DESCRIPTION
IFIRST	The number of months in the first hydrological year for a station
IMON	Month of commencement of data recording
IND	IND=1 indicates that the program is currently analysing a break-in-record card
INDM9	INDM9 = -9 indicates that the next rainfall total in the record is an accumulated total See paragraph 2.2.
IPOS	The position of the station among the 900 possible square minutes of arc within ISEC
ISEC	The quarter-degree square numbered according to the system adopted by the Weather Bureau, Pretoria.
ISECMM	Month of incidence of ISECMX
ISECMX	The maximum daily rainfall recorded in the section in tenths of mm.
ISECYR	Year of incidence of ISECMX
ISKIP	Maintains a check on years of data omitted due to data being zero.
ISTMAX	Maximum daily rainfall recorded for a station Indexed by NS
ISTMOM	Month of incidence of ISTMAX Indexed by NS
ISTYOM	Year of incidence of ISTMAX Indexed by NS
ISW	Switch to indicate the incidence of a new hydrological year ISW = 0 => processing continues for the same hydrological year ISW = 1 => first record for the next hydrological year has been read ISW = 2 => print results for the previous hydrological year and continue processing data for the new hydro. year until calendar year changes when ISW reverts back to 0.
IYR	Year of commencement of data recording
JJMON	Last month prior to data recording having been interrupted or ceasing
JJYR	Last year prior to data recording having been interrupted or ceasing

VARIABLE	DESCRIPTION
JYR	Year of current data record. Indexed by K.
JTOT	Total rainfall recorded during the month of the current record. Indexed by K.
JYRHYD	The 4 digit hydro year JYRHYD = NYR1*100 + NYR2 Indexed by N
K	The number of records contained in a hydrological year $K \leq 30$
KKMON	The months enumerated in the "Break" procedure
KKYR	The years enumerated in the "Break" procedure
KMON	Month of commencement of data interrupt
KPOS	Same as IPOS
KSEC	Same as ISEC
KYR	Year of commencement of data interrupt
LASTYR	Number of months in the last hydrological year of data for a station
LL	Message number. Indexed by N
LMON	Last month of "Break" prior to data recording recommencing.
LYR	Last year of "Break" prior to data recording recommending
MAX	Maximum daily rainfall recorded per record. Indexed by K.
MCOUNT	Counts the number of months of missing data in a hydrological year
MM	Month of incidence of MMAX. Indexed by N.
MMAX	Maximum daily rainfall in tenths of a mm recorded per hydrological year. Indexed by N.
MMTOT	The monthly total rainfall associated with MM. Indexed by N.
MON	Month of the current data record. Indexed by K.
N	The hydrological year number in a station record.
ND	The day of the month on which an amount NP of rainfall was measured.
NEXT	NEXT = 1 indicates that the first header card for the next station in the section has been read.
NMDTM	Counts the number of months missing during the period December-March for each hydrological year
NMMIS	Counts the number of months of missing data throughout a station record

VARIABLE	DESCRIPTION
NMREC	Counts the number of months of acceptable recorded data throughout a station record
NODAY	Counts the number of months ina hydrological year for which there is no daily data available
NP	The amount of rainfall recorded on day ND
NSECST	Station at which SECMAX was recorded
NS	The station number in the section NS ≤ 25
NSTA	Equivalent to IPOS Indexed by NS
NYR1	The last 2 digits of the first calendar year comprising the hydrological year
NYR2	The last 2 digits of the second calendar year comprising the hydrological year
PERIOD	Return period = (N+1)/RANK
RANK	Rank as returned by the IMSL subroutine NMRANK which ranks from smallest to largest
RANKMX	RANKMX(I) = - DAYMAX(I) Used as input to the IMSL subroutine NMRANK
SDEVY	Standard deviation of Y
SECAPT	Total precipitation recorded in a section
SECMAP	Mean annual precipitation for a section
SECMAX	Maximum daily rainfall recorded in the section in mm.
SECMLD	The mean of the natural logarithms of daily maxima weighted according to length of record
SECREC	The number of years of acceptable recorded data in a section
SECSDV	The standard deviation of the natural logarithms of daily maxima weighted according to length of record
STMAX	Maximum daily rainfall recorded for a station. Indexed by NS.
STMIS	Number of years of missing data for a station. Indexed by NS
STREC	Number of years of accepted data for a station. Indexed by NS.
STYRS	Total number of years in record for a station. Indexed by NS.
TOT	$TOT(I) = \log_{10} (TOTAL(I))$

VARIABLE	DESCRIPTION
TOTAL	$TOTAL(I) = \exp(-A - C \ln(\ln \frac{TP}{TP-1}))$ where A = 0,57721*C - YBARNL C = 2,4494897*SDEVY/π
TP	Return period TP(1) = 2 TP(2) = 5 TP(3) = 10 TP(4) = 20 TP(5) = 50 TP(6) = 100
TPL	TPL(I) = -ln (-ln(1 - 1/TP(I)))
XX	XX(I) = - ln (-ln(1-1/PERIOD(I)))
Y,YY	Y(I) YY(I) = $\log_{10}$(DAYMAX(I))
YBARNL	$YBARNL(NS) = \frac{1}{N} \sum_{i=1}^{N} Y(I)$
YNSBAR	$YNSBAR(NS) = \frac{1}{N} \sum_{i=1}^{N}$ Y(I)**2

6. LIST OF INTERNAL VARIABLES USED IN SUBROUTINE "PLOT"

VARIABLE	DESCRIPTION
DAILY	Input vector for the Y-axis (ie total precipitation)
DELTAX	Automatically calculated X-increment
DELTAY	Automatically calculated Y-increment
IBLANK	Defined to be 2 blank spaces
IDX	IDX = 1 =>X-scale is automatically calculated = 2 =>X-scale is user supplied
IDY	IDY = 1 =>Y-scale is automatically calculated = 2 =>Y-scale is user supplied
INDEX	INDEX = 1 =>reset graph, plot points but do not print the graph INDEX = 2 =>reset graph, plot points and print graph INDEX = 3 =>do not reset graph, plot points but do not print graph INDEX = 4 =>do not reset graph, plot points and print the graph
IPOSIT	Same as IPOS in the main program
ISECT	Same as ISEC in the main program
MAP	Matrix containing the points to be plotted. and is of size 51 x 101
N	The number of points to be plotted
NSYM	The index of the plot symbol NSYM = 1 . = 2 + = 3 * = 4 - = 5 $ = 6 x
PER	Input vector for the X-axis (ie return period)

7. DIMENSION RESTRICTIONS

The following dimension restrictions have been imposed; however the user may adjust these to suit his own purposes.

1) AMESS (5,14)

   Only 5 messages of 14 fields each have been built into the program.

2) ND(I), NP(I), I = 1,10

   A maximum of 10 daily measurements per record are allowed.

3) $NS \leqslant 25$

   The program can handle a maximum of 25 stations per section.

4) $K \leqslant 30$

   Each hydrological year may comprise a maximum of 30 records.

5) $N \leqslant 100$

   Each station may contain a maximum of 100 hydrological years of record.

6) The maximum consecutive break-in-record period permitted is 500 months.

B.2. TAPE VOLUME (TABLE OF CONTENTS) B14

TAPE VOLUME <TABLE OF CONTENTS> AS ON 79264

VOLUME SERIAL NUMBER= SWADRN
OWNERID =

LABEL	DSNAME	CRDTE	EXPDTE	SYSTEM CODE	RECFM	BLKSIZE	LRECL	DEN	JOB	STEP	BLKCNT	FE
01	SECT273	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
02	SECT308	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
03	SECT311	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
04	SECT312	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000018	7
05	SECT313	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000004	1
06	SECT314	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000012	4
07	SECT344	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
08	SECT346	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
09	SECT347	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	2
10	SECT348	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	2
11	SECT349	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	4
12	SECT350	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000011	4
13	SECT377	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
14	SECT380	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
15	SECT381	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
16	SECT382	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
17	SECT383	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
18	SECT384	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	4
19	SECT385	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	2
20	SECT386	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
21	SECT413	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	2
22	SECT415	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000008	3
23	SECT416	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000009	3
24	SECT417	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
25	SECT418	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000007	2
26	SECT419	79186	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000012	4
27	SECT420	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	2
28	SECT421	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	2
29	SECT422	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	5
30	SECT452	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	[illegible]
31	SECT453	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
32	SECT454	79187	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	2
33	SECT456	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	4
34	SECT457	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
35	SECT458	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	1
36	SECT459	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
37	SECT489	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000007	2
38	SECT490	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000015	5
39	SECT491	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	4
40	SECT492	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000008	3
41	SECT493	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000004	1
42	SECT494	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
43	SECT495	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	[illegible]
44	SECT526	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	[illegible]
45	SECT527	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	[illegible]
46	SECT528	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
47	SECT529	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000015	[illegible]
48	SECT530	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000007	[illegible]
49	SECT531	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
50	SECT532	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000004	[illegible]
51	SECT565	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	[illegible]
52	SECT566	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000020	[illegible]
53	SECT567	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000013	[illegible]
54	SECT568	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
55	SECT569	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
56	SECT570	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000016	[illegible]
57	SECT571	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
58	SECT608	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000008	[illegible]
59	SECT609	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000021	[illegible]
60	SECT610	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	[illegible]
61	SECT611	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	[illegible]
62	SECT612	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000018	[illegible]
63	SECT613	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000008	[illegible]
64	SECT614	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000012	[illegible]
65	SECT615	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	[illegible]
66	SECT649	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
67	SECT651	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000009	[illegible]
68	SECT652	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000002	
69	SECT653	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000007	[illegible]
70	SECT654	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000012	[illegible]
71	SECT655	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
72	SECT656	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
73	SECT657	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000012	[illegible]
74	SECT694	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000001	
75	SECT695	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000005	[illegible]
76	SECT696	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
77	SECT697	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000014	[illegible]
78	SECT698	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000010	[illegible]
79	SECT699	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000019	[illegible]
80	SECT700	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000009	[illegible]
81	SECT701	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000003	[illegible]
82	SECT734	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000006	[illegible]
83	SECT735	79190	00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY	/	000004	[illegible]

84	SECT736	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
85	SECT737	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000008	3,2
86	SECT738	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000006	2,5
87	SECT739	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
88	SECT740	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000094	36,7
89	SECT741	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000013	5,1
90	SECT742	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000007	2,8
91	SECT743	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000030	11,7
92	SECT744	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
93	SECT745	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000005	2,1
94	SECT780	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
95	SECT781	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000014	5,5
96	SECT782	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000026	10,1
97	SECT783	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000020	7,8
98	SECT784	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000044	17,0
99	SECT785	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000024	9,4
00	SECT786	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000016	6,3
01	SECT787	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000026	10,1
02	SECT789	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000009	3,6
03	SECT822	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
04	SECT825	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
05	SECT826	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
06	SECT827	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
07	SECT828	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000028	10,9
08	SECT829	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000024	9,4
09	SECT830	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000013	5,1
10	SECT831	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000009	3,6
11	SECT832	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
12	SECT833	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
13	SECT868	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000001	,5
14	SECT869	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000008	3,2
15	SECT870	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
16	SECT871	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000017	6,7
17	SECT872	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
18	SECT873	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000021	8,2
19	SECT874	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000015	5,9
20	SECT875	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000019	7,4
21	SECT876	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
22	SECT913	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
23	SECT915	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000013	5,1
24	SECT916	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
25	SECT917	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
26	SECT918	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000014	5,5
27	SECT919	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
28	SECT958	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
29	SECT959	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000006	2,5
30	SECT960	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
31	SECT961	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000007	2,8
32	SECT962	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
33	SECT963	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
34	SECT964	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000009	3,6
35	SECT1002	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000003	1,3
36	SECT1003	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
37	SECT1004	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
38	SECT1005	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
39	SECT1006	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
40	SECT1007	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000008	3,2
41	SECT1008	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000019	7,4
42	SECT1009	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000030	11,7
43	SECT1010	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000020	7,8
44	SECT1011	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000006	2,5
45	SECT1012	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
46	SECT1047	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000001	,5
47	SECT1048	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
48	SECT1049	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000003	1,3
49	SECT1051	79190 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000010	4,0
50	SECT1052	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
51	SECT1053	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000003	1,3
52	SECT1054	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000018	7,1
53	SECT1055	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000017	6,7
54	SECT1056	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000012	4,8
55	SECT1057	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000011	4,4
56	SECT1058	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
57	SECT1101	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
58	SECT1102	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000009	3,6
59	SECT1103	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000004	1,7
60	SECT1104	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000009	3,6
61	SECT1145	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
62	SECT1159	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000006	2,5
63	SECT1160	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000005	2,1
64	SECT1198	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000006	2,5
65	SECT1199	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000014	5,5
66	SECT1200	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000018	7,1
67	SECT1201	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000014	5,5
68	SECT1205	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
69	SECT1206	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000008	3,2
70	SECT1207	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000005	2,1
71	SECT1208	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000005	2,1
72	SECT1209	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000003	1,3
73	SECT1252	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000007	2,8
74	SECT1253	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000002	,9
75	SECT1269	79191 00000	IBM OS/VS 370	FB	06400	00080	3	HRUCOPY /	000005	2,1

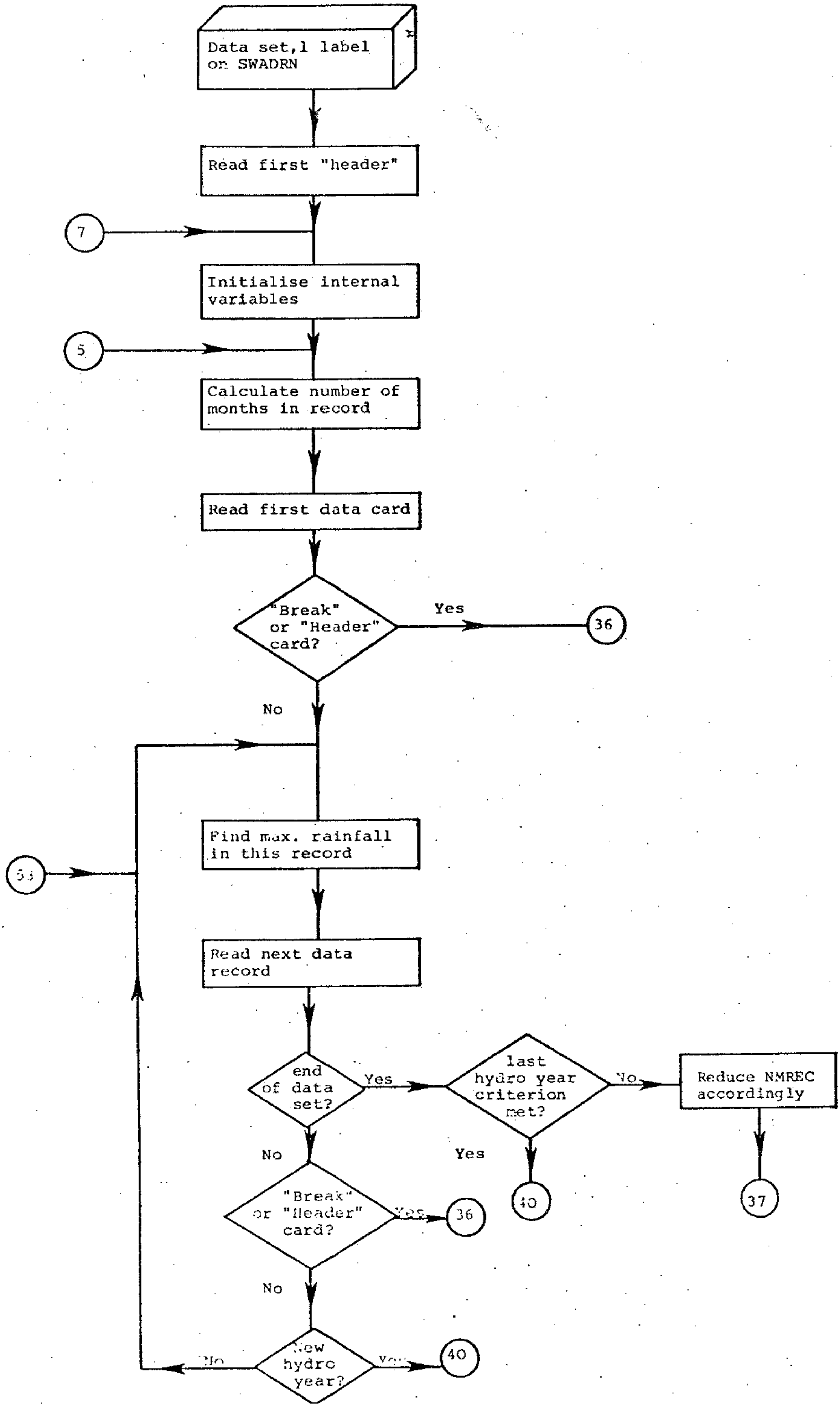
B3 . JOB CONTROL STATEMENTS USED TO RUN SWAPGM FOR 3 SECTIONS

The computer-compiled version of SWAPGM is stored on the data set ACM.HRUØ12.LOAD under the name SWAMAP.

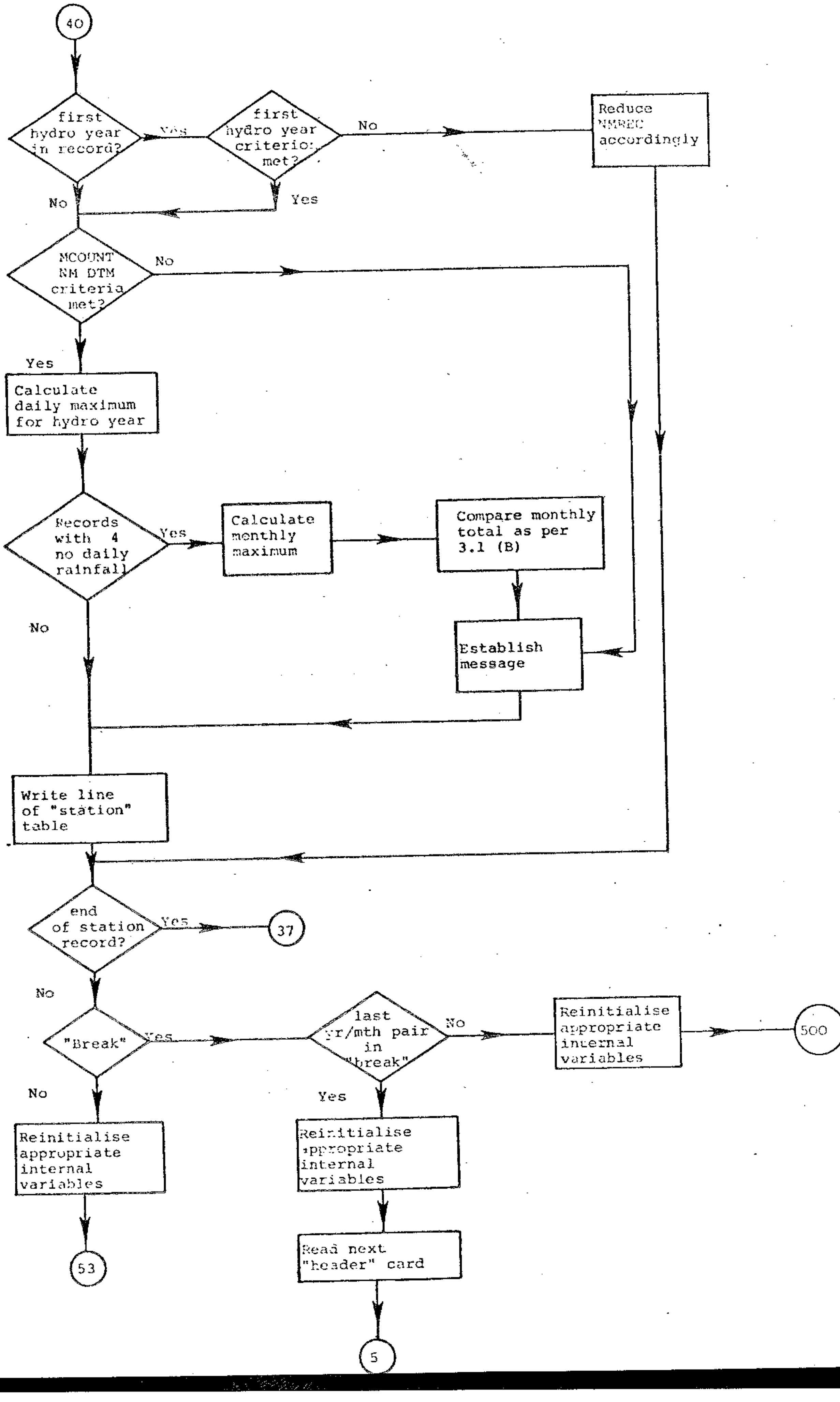
The following JCL is used to run SWAPGM for sections 312,740 and 1252.

```
//RAMSWA JOB 12,CLASS=B
/*JOBPARM R=43,LINES=99999
/*SETUP         TAPE=(SWADRN,NO-RING,SL)
//SWACOPY PROC SECT=STUFF,LABEL=999
// EXEC PGM=SWAMAP,TIME=3
//STEPLIB DD DSN=ACM.HRUØ12.LOAD,DISP=SHR,UNIT=SYSDA
//FTØ1FØØ1 DD DSN=&SECT,LABEL=(&LABEL,SL),UNIT=TAPE,
// DISP=OLD,DCB=(RECFM=FB,LRECL=80,BLKSIZE=6400),
// VOL=(,RETAIN,,SER=SWADRN)
//FTØ6FØØ1 DD SYSOUT=A
//END PEND
// EXEC SWACOPY,SECT=SECT312,LABEL=4
// EXEC SWACOPY,SECT=SECT740,LABEL=88
// EXEC SWACOPY,SECT=SECT1252,LABEL=173
//
```

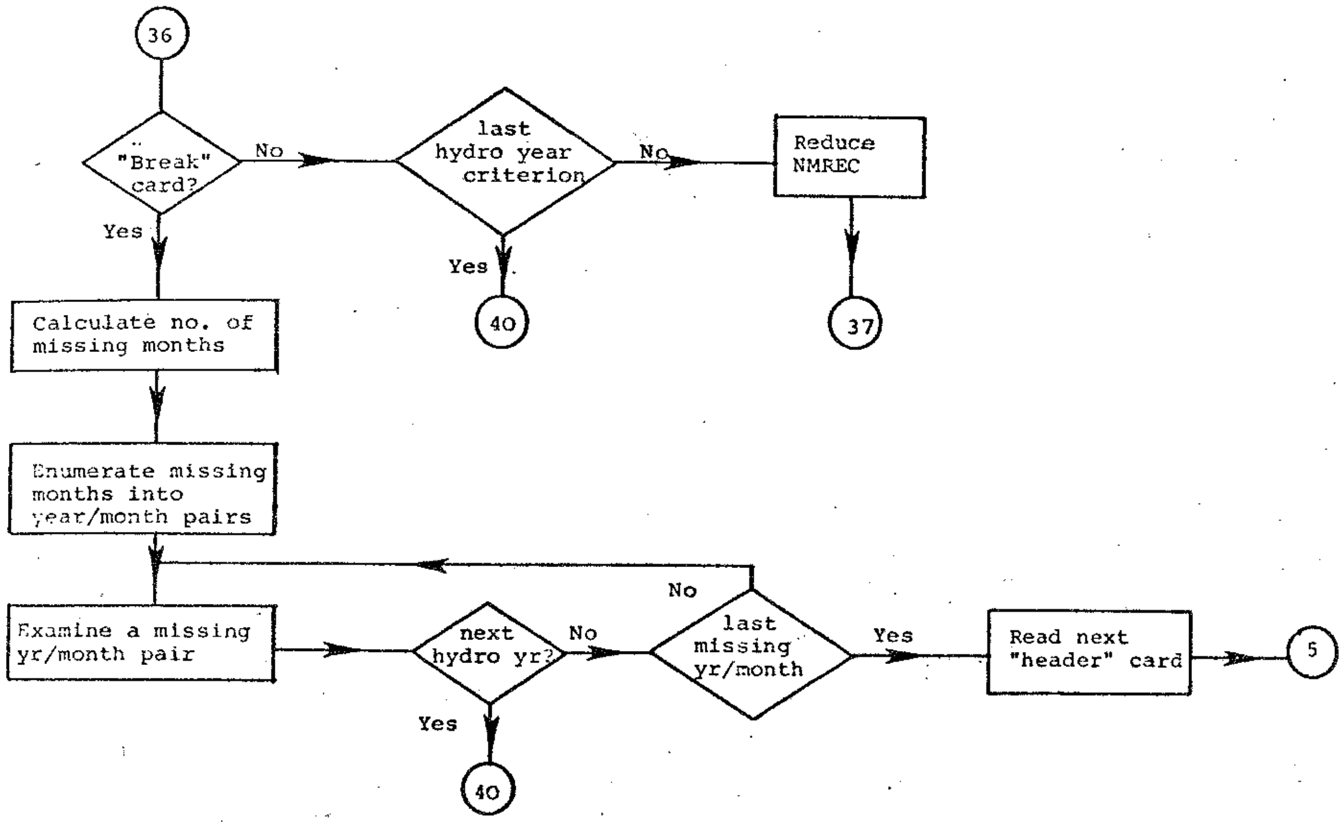
START OF PROGRAM



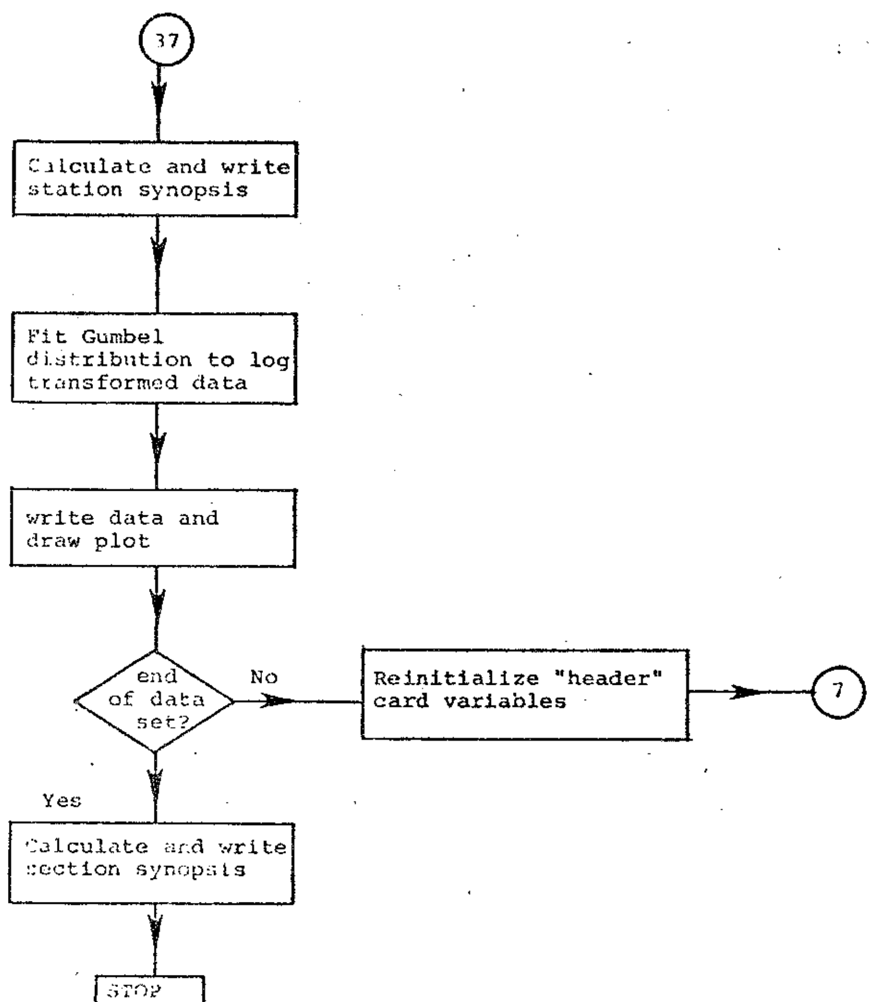
(40) WRITING PROCEDURE



36 "BREAK' OR "HEADER" CARD



37 Station synopsis, Plot of station results and section synopsis



B5 PROGRAM LISTING

```
C
C
C                 **************
C                 **************
C                 **  SWAPGM  **
C                 **************
C                 **************
C
C
C     INPUT DATA
C     **********
C
C     HEADER CARD
C     ===========
C
C     ISEC     SECTION NUMBER
C     IPOS     POSITION WITHIN ISEC
C     IYR      YEAR OF COMMENCEMENT OF DATA RECORD
C     IMON     MONTH OF COMMENCEMENT OF DATA RECORD
C     JJYR     LAST YEAR PRIOR TO A DATA INTERRUPT
C     JJMON    LAST MONTH PRIOR TO A DATA INTERRUPT
C
C
C     RAINFALL RECORD CARD
C     ====================
C
C     JYR      YEAR OF CURRENT RECORD
C     MON      MONTH OF CURRENT RECORD
C     JTOT     TOTAL RAINFALL RECORDED DURING MON
C     ND       DAY OF MON
C     NP       AMOUNT OF RAINFALL MEASURED ON DAY ND
C
C
C     BREAK-IN-RECORD CARD
C     ====================
C
C     THIS IS IDENTICAL IN FORMAT TO THE HEADER CARD
C
C     ************************************************************************
C
C
      DIMENSION JYR(30),MON(30),JTOT(30),ND(10),NP(10),
     *          MMAX(100),MM(100),JYRHYD(100),IAPTOT(25),
     *          STREC(25),STMIS(25),STYRS(25),AMESS(5,14)
      DIMENSION NSTA(25),AMAP(25),ISTMAX(25),ISTMOM(25), ISTYOM(25)
      DIMENSION MAX(30), IANP(100),KKYR(500),KKMON(500),LL(100),
     *          MMTOT(100)
      DIMENSION DAYMAX(100),ANP(100),STMAX(25),Y(100),TOTAL(6),TP(6)
      DIMENSION RANKMX(100),PERIOD(100),IR(100),R(100),XX(100),YY(100)
      DIMENSION TOT(6),RANK(100),IPL(6)
      DIMENSION YBARNL(25),YNSBAR(25),SDEVY(25)
      DATA XLAB /4HFREC/, YLAB /4HRAIN/
      DATA AMESS /
     *  4HNO L,4HNO D,4HNO D,4HCOL.,4HCOL.,
     *  4HATA ,4HATA ,4HATA ,4H2 IS,4H2 IS,
     *  4HAVAI,4HFOR ,4HFOR ,4H MAX,4H MAX,
     *  4HLABL,4H3 OR,4H>4 M,4H.MON,4H.MON,
     *  4HE FO,4H NOR,4HONTH,4HTHLY,4HTHLY,
     *  4HR FO,4HE MO,4HS IN,4H TOT,4H TOT,
     *  4HUR O,4HNTHS,4H YR ,4HAL A,4HAL A,
     *  4HR NO,4H BET,4HS 1/,4HS NO,4HS SO,
     *  4HRE M,4H9 DE,4H2 DE,4H DAI,4HMB M,
     *  4HONTH,4HC & ,4HC - ,4HLY D,4HAX. ,
     *  4HS  -,4HMAR-,4HMAR-,4HATA ,4HDAIL,
     *  4HYEAR,4HYEAR,4HYEAR,4HFOR ,4HIES ,
     *  4H IGN,4H IGN,4H IGN,4H>4 M,4HMISS,
     *  4HORED,4HORED,4HORED,4HNTHS,4HING /
      INTEGER B/'    '/,BL/'    '/
C
C
C     READ FIRST HEADER CARD
C     ======================
C
      NS = 0
    6 READ(1,31)ISEC,IPOS,IYR,IMON,JJYR,JJMON
   31 FORMAT(2I4,2(I5,I3))
```

```
C
C      INITIALISATION OF INTERNAL VARIABLES
C      ================================
C
7      NS = NS + 1
       K = 0
       N = 0
       I = 0
       IAP = 0
       ISW = 0
       IND = 0
       NEXT= 0
       IEND= 0
       NYR1= 0
       NYR2= 0
       I1ST= 0
       LAST= 0
       ICOND = 0
       NODAY = 0
       NMREC = 0
       INDM9 = 1
       NMMIS = 0
       IIMON = 0
       NMDTM = 0
       LL(1) = 0
       ISYR1 = 0
       ISYR2 = 0
       MCOUNT= 0
       NOOFBL= 0
       NSTA(NS)=IPOS
       IF (IMON.GE.10) ISW=2
C
C      WRITE PAGE HEADINGS FOR STATION TABLE
C      =================================
C
       WRITE(6,30)ISEC,IPOS
30     FORMAT('1',T3,16('*')/T3,'*',T5,'SECTION ',I4,T18,'*',
      *  T23,'HYDRO.',T31,'MAX.DAILY',T42,' MONTH OF',T54,
      *  '    ANNUAL'/T3,'*',T5,'STATION ',I4,T18,'*',T23,
      *  'YEAR',T31,'RAINFALL ',T42,'OCCURRENCE',T54,
      *  'PRECIPITATION',T80,'REMARKS'/T3,16('*'),T23,5('='),
      *  T31,9('='),T42,10('='),T54,13('='),T80,7('=')/)
5      NMREC = NMREC + 12*(JJYR-IYR)+JJMON-IMON+1
C
C      READ FIRST DATA CARD
C      ==================
C
8      K = K+1
       READ(1,21,END=100)JYR(K),MON(K),JTOT(K),(ND(I),NP(I),I=1,10),
      *                    KSEC,KPOS,KYR,KMON,LYR,LMON,B
21     FORMAT(2I2,I6,10(I3,I4),T1,2I4,2(I5,I3),2X,A1)
       IF (JYR(K).GT.80) JYR(K)=JYR(K)-100
C
C      CHECK FOR "BREAK" OR "HEADER" CARD
C      ==============================
C
       IF (B.EQ.BL) GO TO 36
       IF (K.NE.1) GO TO 13
53     IAP = JTOT(K)
C
C      FIND THE MAXIMUM RAINFALL IN THIS RECORD &
C      COUNT THE NUMBER OF MONTHS WITH NO DAILY DATA
C      =========================================
C
52     MAX(K) = 0
       DO 55 II=1,10
       IF (INDM9.EQ.(-9)) GO TO 58
       IF (NP(II).GT.MAX(K)) MAX(K)=NP(II)
58     INDM9 = NP(II)
55     CONTINUE
       IF (MAX(K).EQ.0) NODAY=NODAY+1
```

```
C
C       READ NEXT DATA CARD
C       =================
C
9       K = K+1
14      READ(1,21,END=100)JYR(K),MON(K),JTOT(K),(ND(I),NP(I),I=1,10),
     *                      KSEC,KPOS,KYR,KMON,LYR,LMON,B
        IF (JYR(K).GT.80) JYR(K)=JYR(K)-100
C
C       CHECK FOR "BREAK" OR "HEADER" CARD
C       ==============================
C
13      IF (B.EQ.BL) GO TO 36
        IF (ISW.GT.1) GO TO 11
C
C       CHECK FOR NEW HYDROLOGICAL YEAR
C       ============================
C
        IF ((MON(K).GT.9).OR.(JYR(K).GT.JYR(K-1))) ISW = 1
        IF (ISW.EQ.1) GO TO 40
11      ISKIP = JYR(K-1)+1
        IF (ISKIP.GT.80)ISKIP=ISKIP-100
        IF (JYR(K).EQ.ISKIP .AND. MON(K).LT.10) GO TO 60
        IF (JYR(K).EQ.JYR(K-1)) GO TO 62
        ICOND = 1
        GO TO 40
60      ISW = 0
62      IF (MON(K)-MON(K-1)) 15,52,15
15      IAP = IAP+JTOT(K)
        GO TO 52
C
C       WRITING PROCEDURE FOR STATION TABLE
C       **********************************
C
40      N = N+1
        ISW=2
        IF (N.NE.1) GO TO 41
C
C       CHECK FIRST HYDRO. YEAR CRITERION
C       ============================
C
        IFIRST=(JYR(K-1)-IYR+1900)*12-IMON+10
        MMTOT(N)=0
        IF (IFIRST.GE.7) GO TO 41
        NMREC=NMREC-IFIRST
        IANP(N)=0
        DAYMAX(N)=0.01
        LL(N)=10
        NOOFBL=NOOFBL+1
        GO TO 18
41      IANP(N) = IAP
        IF (IANP(N).EQ.0) ICOND=1
        MMTOT(N)=0
        KK = K-1
C
C       CHECK "MCOUNT","NNDTM" CRITERIA & ESTABLISH APPROPRIATE MESSAGES
C       ==========================================================
C
        IF (NNDTM.EQ.0 .AND. MCOUNT.GT.4) GO TO 90
        IF (NNDTM.GE.3) GO TO 91
        IF (((NNDTM.EQ.1).OR.(NNDTM.EQ.2)).AND.(MCOUNT.GT.4))GO TO 92
        GO TO 3000
90      LL(N)=1
95      IANP(N)=BL
        MMAX(N)=BL
        MM(N) = BL
        GO TO 760
91      LL(N)=2
        GO TO 95
92      LL(N)=3
        GO TO 95
3000    IF (NODAY.LT.4) GO TO 3001
        DO 27 IL=1,KK
27      MAX(IL) = JTOT(IL)
        LL(N)=4
3001    MMAX(N) = 0
        DO 80 L=1,KK
        IF (MAX(L).LE.MMAX(N)) GO TO 80
        MMAX(N) = MAX(L)
        MM(N) = MON(L)
        MMTOT(N) = JTOT(L)
80      CONTINUE
```

```
C
C     FOR 1,2 OR 3 NO DAILY DATA, COMPARE MONTHLY TOTAL WITH
C     1.) MMAX(N) I.E. THE MAX DAILY FOUND
C     2.) THE MONTHLY TOTAL FOR THE MONTH OF MMAX(N)
C     ================================================
C
      DO 28 LI=1,KK
      IF (MAX(LI).GT.0) GO TO 28
      IF (JTOT(LI).LE.MMAX(N)) GO TO 28
      IF ((JTOT(LI).GT.MMAX(N)).AND.(JTOT(LI).GT.MMTOT(N))) GO TO 29
      IF ((JTOT(LI).GT.MMAX(N)).AND.(JTOT(LI).LE.MMTOT(N))) GO TO 28
29    MMAX(N) = JTOT(LI)
      MM(N) = MON(LI)
      LL(N) = 5
28    CONTINUE
700   IF (JYR(1).LT.0) JYR(1)=JYR(1)+100
      IF (JYR(KK).LT.0)JYR(KK)=JYR(KK)+100
      IF (ICOND.EQ.1) GO TO 701
      IF (JYR(1).EQ.JYR(KK)) JYR(1) = JYR(KK)-1
      IF (KK.NE.1) GO TO 713
701   NYR1 = JYR(1)
      NYR2 = NYR1+1
      IF (IANP(N).NE.0) GO TO 714
      MM(N)=BL
      LL(N)=7
      GO TO 714
713   NYR1 = JYR(1)
      NYR2 = JYR(KK)
714   IF (NYR1.LT.0) NYR1=NYR1+100
      IF (NYR2.LT.0)NYR2=NYR2+100
      JYRHYD(N) = NYR1*100 + NYR2
      IF (MMAX(N).EQ.BL) GO TO 716
      DAYMAX(N)=MMAX(N)*0.1
      ANP(N)    =IANP(N)*0.1
      GO TO 715
716   DAYMAX(N)=0.01
715   IF (LL(N).NE.0) GO TO 71
      WRITE(6,33)NYR1,NYR2,DAYMAX(N),MM(N),ANP(N)
33    FORMAT(T23,I2,'/',I2,T33,F5.1,T46,I2,T56,F7.1)
      GO TO 18
71    NOOFBL=NOOFBL+1
      IF (LL(N).EQ.7) GO TO 777
      IF (LL(N).GE.4) GO TO 72
      WRITE(6,38)NYR1,NYR2,MMAX(N),MM(N),IANP(N),
     *            (AMESS(LL(N),J),J=1,14)
38    FORMAT(T23,I2,'/',I2,T33,A1,T46,A1,T56,A1,T72,14A4)
      GO TO 18
72    WRITE(6,34)NYR1,NYR2,DAYMAX(N),MM(N),ANP(N),
     *            (AMESS(LL(N),J),J=1,14)
34    FORMAT(T23,I2,'/',I2,T33,F5.1,T46,I2,T56,F7.1,T72,14A4)
      GO TO 18
777   WRITE(6,333)NYR1,NYR2,DAYMAX(N),MM(N),ANP(N)
333   FORMAT(T23,I2,'/',I2,T33,F5.1,T46,A1,T56,F7.1)
C
C     CHECK FOR END OF STATION RECORD CONDITION &
C     REINITIALISE APPROPRIATE INTERNAL VARIABLES
C     ========================================
C
18    IF (NEXT) 19,19,37
19    LL(N+1) = 0
      INDMS = 1
      IF (KK.EQ.1)JYR(1)=JYR(1)+1
      ISKIP=JYR(K-1)+1
      IF (KK.EQ.1 .AND. ICOND.EQ.1)ISKIP=ISKIP-1
      IF (IND.EQ.1) GO TO 702
      IF (JYR(K-1).GT.60)JYR(K-1)=JYR(K-1)-100
      IF (LL(N).EQ.10) GO TO 440
      IF (ISKIP.GT.80)ISKIP=ISKIP-100
430   IF (MON(K).LT.10) ISW=0
440   JYR(1) = JYR(K)
442   MON(1) = MON(K)
      JTOT(1)= JTOT(K)
      ICOND  =.0
      NODAY  = 0
      NNDTN  = 0
      NCOUNT = 0
      K = 1
      GO TO 53
```

```
702     IF (I-NM) 146,553,553
553     JYR(1)  = KKYR(NM)
        MON(1)  = KKMON(NM)
        JTOT(1) = 0
        MAX(1)  = 0
        IAP = 0
        NMDTM = 0
        IF ((MON(1).EQ.12).OR.(MON(1).EQ.1).OR.
       * (MON(1).EQ.2).OR.(MON(1).EQ.3)) NMDTM = 1
        MCOUNT = 1
        K = 1
        GO TO 555
146     JYR(1) = KKYR(I)
        MON(1) = KKMON(I)
        MAX(1) = -1
        JTOT(1)= -1
        K = 1
        IAP = 0
        MCOUNT = 0
        NMDTM  = 0
        IF (MON(1).LT.10) ISW=0
        GO TO 500
C
C       "BREAK" OR "HEADER" CARD PROCEDURE
C       ********************************
C
36      IF (KPOS.EQ.IPOS) GO TO 39
C
C       CHECK LAST HYDRO. YEAR CRITERION
C       ==============================
C
25      IJYR=JJYR-1900
        LASTYR = (IJYR-JYR(1))*12+JJMON-9
        IF (LASTYR.LT.7) GO TO 24
        NEXT = 1
        GO TO 40
24      NMREC = NMREC-IABS(LASTYR)
        GO TO 37
C
C       THE FOLLOWING DEALS WITH THE "BREAK-IN-RECORD" CARD
C       ================================================
C
39      NM = 12*(LYR-KYR)+LMON-KMON+1
        NMMIS = NMMIS + NM
C
C       ENUMERATE MISSING YEARS & MONTHS
C       ==============================
C
        DO 45 I=1,NM
54      KKYR(I) = KYR-1900
        KKMON(I)  = KMON+I-1
        IF (KKMON(I).GT.12) GO TO 61
        GO TO 45
61      KYR = KYR+1
        KMON = KMON-12
        GO TO 54
45      CONTINUE
        K=K-1
        I=0
600     I=I+1
        K=K+1
        JYR(K)=KKYR(I)
        MON(K)=KKMON(I)
        MAX(K)=-1
        JTOT(K)=-1
        IF (ISW.EQ.2 .AND. KKYR(I).EQ.JYR(K-1)) GO TO 500
        IF (ISW.EQ.2 .AND. KKYR(I).GT.JYR(K-1)) GO TO 501
C
C       CHECK FOR NEW HYDROLOGICAL YEAR
C       ===========================
C
        IF (ISW.EQ.0 .AND. KKYR(I).EQ.JYR(K-1)
       * .AND. KKMON(I).GT.9) GO TO 502
        IF (ISW.EQ.0 .AND. KKYR(I).GT.JYR(K-1)) GO TO 502
        GO TO 500
502     ISW = 1
        IND = 1
        GO TO 40
501     ISW = 0
500     IF ((KKMON(I).EQ.12).OR.(KKMON(I).EQ.1).OR.
       * (KKMON(I).EQ.2).OR.(KKMON(I).EQ.3)) NMDTM = NMDTM+1
503     MCOUNT = MCOUNT+1
```

```
C
C      CHECK FCR END OF "BREAK" PERIOD
C      ===============================
C
       IF (I-NN) 600,555,555
C
C      READ NEW HEADER CARD
C      ====================
C
555    READ(1,31)ISEC,IPOS,IYR,IMON,JJYR,JJMON
       IND = 0
       GO TO 5
C
C      WRITE STATION SYNOPSIS
C      **********************
C
37     ISTMAX(NS) = 0
       DO 66 J=1,N
       IF (MMAX(J).EQ.BL .OR. MM(J).EQ.BL .OR. LL(J).GT.0) GO TO 66
       IF (MMAX(J).LE.ISTMAX(NS)) GO TO 66
       ISTMAX(NS) = MMAX(J)
       ISTMON(NS) = MM(J)
       ISTYOM(NS) = JYRHYD(J)
66     CONTINUE
       STMAX(NS) = ISTMAX(NS)*0.1
       IIST = ISTYOM(NS)/100
       LAST = IIST+1
       IAPTOT(NS) = 0
       DO 76 JJ=1,N
       IF (IANP(JJ).EQ.BL) GO TO 76
       IAPTOT(NS) = IAPTOT(NS) + IANP(JJ)
76     CONTINUE
       AMAP(NS) = (1.2*IAPTOT(NS))/(NMREC*1.)
       STREC(NS) = NMREC*1./12.
       STMIS(NS) = NMMIS*1./12.
       STYRS(NS) = STREC(NS) + STMIS(NS)
C
C      COMPRESS DAYMAX
C      ---------------
C
       J=0
       I=0
125    J=J+1
120    I=I+1
       IF (I.GT.N) GO TO 127
       IF (LL(I).NE.0 .OR. ANP(I).EQ. 0.0) GO TO 120
       DAYMAX(J)=DAYMAX(I)
       GO TO 125
127    N=N-NOOFBL
```

```
C
C      FIT A GUMBEL DISTRIBUTION TO THE LOG-TRANSFORMED DATA
C      ==================================================
C
       DO 200 IJP=1,N
       Y(IJP) = ALOG(DAYMAX(IJP))
200    CONTINUE
       SUM1 = 0.
       SUM2 = 0.
       DO 203 IL=1,N
       SUM1 = SUM1 + Y(IL)
203    SUM2 = SUM2 +(Y(IL)**2)
       YBARNL(NS) = SUM1/N
       YNSBAR(NS) = SUM2/N
       SDEVY(NS)  = SQRT(YNSBAR(NS) - (YBARNL(NS)**2))
       C = (2.4494897*SDEVY(NS))/3.141592654
       A = (0.57721*C) - YBARNL(NS)
       DO 205 KLM=1,6
       IF (KLM.EQ.1) TP(KLM)=2.
       IF (KLM.EQ.2) TP(KLM)=5.
       IF (KLM.EQ.3) TP(KLM)=10.
       IF (KLM.EQ.4) TP(KLM)=20.
       IF (KLM.EQ.5) TP(KLM)=50.
       IF (KLM.EQ.6) TP(KLM)=100.
       YK = TP(KLM)/(TP(KLM)-1.)
       YL = ALOG(YK)
       YP = ALOG(YL)
       XP = -A-(C*YP)
205    TOTAL(KLM) = EXP(XP)
       WRITE(6,78)ISEC,IPOS,STYRS(NS),STREC(NS),STMIS(NS),
      *               STMAX(NS),ISTMOM(NS),I1ST,LAST,AMAP(NS)
78     FORMAT('1'/////T24,40('=')/T24,'|',T26,'SYNOPSIS FOR STATION  ',
      *  I4,I4,T63,'|'/T24,'|',T26,30('='),T63,'|'/T24,'|',T63,'|'/
      *  T24,'|',T26,
      *  'TOTAL NO. OF YEARS IN RECORD = ',F5.1,T63,'|'/T24,'|',
      *  T26,'NO.OF YEARS OF RECORDED DATA = ',F5.1,T63,'|'/
      *  T24,'|',T26,'NO.OF YEARS OF MISSING  DATA = ',F5.1,
      *  T63,'|'/T24,'|',T63,'|'/T24,'|',T63,'|'/T24,'|',T26,
      *  'MAX. DAILY RAINFALL OF',F6.1,T63,'|'/T24,'|',T26,
      *  'OCCURRED DURING MONTH ',I6,T63,'|'/T24,'|',T26,
      *  'OF HYDROLOGICAL YEAR    ',I2,'/',I2,T63,'|'/T24,'|',T63,'|'/
      *  T24,'|',T26,'M.A.P. = ',F5.1,T63,'|'/T24,'|',T63,'|')
       WRITE(6,1000)(TOTAL(KLN),KLN=1,6),YBARNL(NS),SDEVY(NS),A,C
1000   FORMAT(T24,'|',38('-'),T63,' ',
      *  /T24,'|',T63,'|'/T24,'|',T26,'DURATION =  1 DAY',T63,
      *  '|'/T24,'|',T63,'|'/T24,'|',T26,'RETURN PERIOD',T51,'TOTAL(MM)',
      *  T63,'|'/T24,'|',T26,13('='),T51,9('='),T63,'|'/T24,'|',T63,
      *  '|'/T24,'|',T26,'  2 YEARS',T52,F5.1,T63,'|'/T24,'|',T26,
      *  '  5 YEARS',T52,F5.1,T63,'|'/T24,'|',T26,' 10 YEARS',T52,
      *  F5.1,T63,'|'/T24,'|',T26,' 20 YEARS',T52,F5.1,T63,'|'/T24,
      *  '|',T26,' 50 YEARS',T52,F5.1,T63,'|'/T24,'|',T26,'100 YEARS',
      *  T52,F5.1,T63,'|'/T24,'|',T63,'|'/T24,'|',T26,'LOG-GUMBEL',
      *  T41,'    MEAN =',F7.3,T63,'|'/T24,'|',T26,10('='),T41,
      *  'STD.DEV =',F7.3,T63,'|'/T24,'|',T63,'|'/T24,'|',T41,
      *  'WITH  A =',F7.3,T63,'|'/T24,'|',T47,'C =',F7.3,T63,'|'/T24,
      *  '|',T63,'|'/T24,40('='))
```

```
C
C     DRAW THE PLOT
C     =============
C
      DO 85 IIJ=1,N
85    RANKMX(IIJ)=-DAYMAX(IIJ)
      CALL MMRANK(RANKMX,N,0.0001,IR,R,RANK,S,T)
      WRITE(6,1113) N
1113  FORMAT('1',T11,'THE NO. OF "MAX. DAILY" VALUES'/
     *      T11,'INCLUDED IN THE LOG-GUMBEL FIT:  N =',I3//)
      WRITE(6,1112)
1112  FORMAT(T17,'MAX.DAILY',T28,'RETURN PERIOD',T45,'FREQ: XX =',
     *  T62,'RAIN: YY ='/T11,'RANK',T17,'RAINFALL',T29,
     *  'T=(N+1)/RANK',T43,'-LN(-LN(1-1/T))',T60,'LOG10(MAX.DAILY)'/
     *  T11,4('='),T17,9('='),T28,13('='),T43,15('='),T60,16('=')/)
      DO 86 JJI=1,N
      PERIOD(JJI) = (1.*(N+1))/RANK(JJI)
      XX(JJI) = -ALOG(-ALOG(1.-(1./PERIOD(JJI))))
      YY(JJI) = ALOG10(DAYMAX(JJI))
      WRITE(6,1111)RANK(JJI),DAYMAX(JJI),PERIOD(JJI),XX(JJI),
     *  YY(JJI)
1111  FORMAT(T12,F3.0,T19,F5.1,T31,F6.3,T46,F7.3,T64,F7.3)
86    CONTINUE
      CALL PLOT(N,XX,YY,XLAB,YLAB,2,1,2,2,3.0,0.0,4.6,-1.3,
     *    ISEC,IPOS)
      DO 87 JIJ=1,6
      TPL(JIJ) = -ALOG(-ALOG(1.-(1./TP(JIJ))))
87    TOT(JIJ) = ALOG10(TOTAL(JIJ))
      WRITE(6,1114)
1114  FORMAT(/T11,'* * * * *   POINTS FOR LEAST SQUARES ',T48,
     * 'FITTED LINE    * * * * *'/T23,36('-')/)
      WRITE(6,1115)(TOTAL(JJJ),TP(JJJ),TPL(JJJ),TOT(JJJ),JJJ=1,6)
1115  FORMAT(T19,F5.1,T30,F7.3,T46,F7.3,T64,F7.3)
      CALL PLOT(6,TPL,TOT,XLAB,YLAB,3,4,2,2,3.0,0.0,4.6,-1.3,
     *  ISEC,IPOS)
      IF (IEND.EQ.1) GO TO 104
C
C     REINITIALISE HEADER CARD VARIABLES
C     ==================================
C
      ISEC = KSEC
      IPOS = KPOS
      IYR  = KYR
      IMON = KMON
      JJYR = LYR
      JJMON= LMON
      GO TO 7
C
C     WRITE SECTION SYNOPSIS
C     **********************
C
100   IEND = 1
      GO TO 25
104   SECREC = 0.
      SECAPT = 0.
      SECTLD = 0.
      SECTSD = 0.
      DO 101 I=1,NS
      SECAPT = SECAPT + (IAPTOT(I)*0.1)
      SECTLD = SECTLD + (STREC(I)*YBARNL(I))
      SECTSD = SECTSD + (STREC(I)*SDEVY(I))
101   SECREC = SECREC + STREC(I)
      SECMLD = SECTLD/SECREC
      SECSDV = SECTSD/SECREC
      SECMAP = SECAPT/SECREC
      ISECMX = 0
      DO 102 I=1,NS
      IF (ISTMAX(I).LE.ISECMX) GO TO 102
      ISECMX = ISTMAX(I)
      ISECMM = ISTMOX(I)
      ISECYR = ISTYOM(I)
      NSECST = NSTA(I)
102   CONTINUE
      SECMAX = ISECMX*0.1
      ISYR1 = ISECYR/100
      ISYR2 = ISYR1+1
      WRITE(6,103)ISEC,NS,SECMAP,SECMLD,SECSDV,SECMAX,ISECMM,
     *         ISYR1,ISYR2,NSECST
103   FORMAT('1'///////T26,36('*')/T26,'*',T61,'*'/
     *  T26,'*',T28,'SYNOPSIS FOR SECTION ',I4,T61,'*'/T26,'*',T28,
     *  25('='),T61,'*'/T26,'*',T61,'*'/T26,'*',T61,'*'/T26,'*',T28,
     *  'NO. OF STATIONS IN SECTION = ',I2,T61,'*'/T26,'*',T28,
     *  'M.A.P. FOR THIS SECTION =',F6.1,T61,'*'/T26,'*',
     *  T28,'MEAN(LOG.MAX.DAILIES)    =',F6.3,T61,'*'/
     *  T26,'*',T28,'STD.DEV(  "    "     "  )    ='F6.3,T61,'*'/
     *  T26,'*',T61,'*'/T26,'*',T28,'MAX. DAILY RAINFALL OF ',F5.1,T61,
     *  '*'/T26,'*',T28,'OCCURRED DURING MONTH  ',I5,T61,'*'/T26,'*',
     *  T28,'OF HYDROLOGICAL YEAR    ',I2,'/',I2,T61,'*'/T26,'*',T28,
     *  'AT STATION',14X,I4,T61,'*'/T26,'*',T61,'*'/T26,36('*'))
      STOP
```

```
C
C
C
C                         ************************
C                         ************************
C                         **   SUBROUTINE PLOT  **
C                         ************************
C                         ************************
C
C
      SUBROUTINE PLOT (N,PER,DAILY,XLABEL,YLABEL,NSYM,INDEX,
     *                 IDX,IDY,YMAX,YMIN,XMAX,XMIN,ISECT,IPOSIT)
C
C
      DIMENSION MAP(51,101),XSCALE(6),PER(80),DAILY(80),ISYM(6)
      DATA ISYM /2H. ,2H+ ,2H* ,2H- ,2HS ,2HX /,IBLANK/2H  /
      DATA NWR/6/
      IF (IDX.EQ.2) GO TO 200
      XMAX=0.
      XMIN=0.
      DO 100 I=1,N
      XMAX = AMAX1(XMAX,PER(I))
100   XMIN = AMIN1(XMIN,PER(I))
200   CONTINUE
      IF (IDY.EQ.2) GO TO 400
      YMAX=0.
      YMIN=0.
      DO 300 J=1,N
      YMAX = AMAX1(YMAX,DAILY(J))
300   YMIN = AMIN1(YMIN,DAILY(J))
400   CONTINUE
      GO TO (1,1,3,3),INDEX
1     DO 2 I=1,51
      DO 2 J=1,101
2     MAP(I,J) = IBLANK
3     DELTAX = (XMAX-XMIN)/100.
      DELTAY = (YMAX-YMIN)/50.
      DO 4 I=1,N
      NX = (PER(I)-XMIN)/DELTAX + 1. + 0.5
      IF (NX.LT.1 .OR. NX.GT.101) GO TO 4
      NY = (DAILY(I)-YMIN)/DELTAY + 1. + 0.5
      IF (NY.LT.1 .OR. NY.GT.51) GO TO 4
      MAP(NY,NX)=ISYM(NSYM)
4     CONTINUE
      GO TO (14,5,14,5),INDEX
5     WRITE(NWR,6) ISECT,IPOSIT,YLABEL
6     FORMAT(1H1,//62X,8HSTATION ,I4,I4/62X,16H****************//
     *  8X,A4,T27,1H+,10(10H---------+))
      DO 10 I=1,51
      J=52-I
      IF (MOD(I,5).NE.1) GO TO 8
      AI=I-1
      SCALE=YMAX-AI*DELTAY
      WRITE(NWR,7) SCALE,(MAP(J,K),K=1,101)
7     FORMAT(13X,F11.2,1X,1H+,101A1,1H+)
      GO TO 10
8     WRITE(NWR,9)(MAP(J,K),K=1,101)
9     FORMAT(25X,1HI,101A1,1HI)
10    CONTINUE
      WRITE(NWR,11)
11    FORMAT(1H,25X,1H+,10(10H---------+))
      DO 12 I=1,6
      AI=20.0*(I-1)
12    XSCALE(I)=XMIN+AI*DELTAX
      WRITE(NWR,13) XSCALE,XLABEL
13    FORMAT(19X,F11.2,5(9X,F11.2)///71X,A10)
14    RETURN
      END
```

B6 SAMPLE OF INPUT DATA

```
 312 417 1898   1 1903  10
-2 1  216   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 2  244   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 3  226   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 4  122   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 5  114   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 6   10   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-2 8   10   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-1 1  650   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
-1 2  676   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
                                           .
                                           .
                                           .
 4 6  104   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 4 7  124   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 4 9   13   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 312 417 1904  10 1905   9
 312 417 1905  10 1914   5
 510  142   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 511  117   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
                                           .
                                           .
                                           .
62 8   16  26  16   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
6211   70   2  70   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
63 1  166   3  21  13   2  19  10  27 115  28  18   0   0   0   0   0   0   0   0   0   0
63 2   43  18  43   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
63 3  288   1  -9   7 285  27   3   0   0   0   0   0   0   0   0   0   0   0   0   0   0
63 4  399   2  24  10  55  11 115  12 205   0   0   0   0   0   0   0   0   0   0   0   0
63 5   38   7  38   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
63 7   11   9  11   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
                                           .
                                           .
                                           .
76 4  135  15 110  26  25   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
76 5   75  23  12  24  13  28  20  29  30   0   0   0   0   0   0   0   0   0   0   0   0
76 6   29   2  25  18   4   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
76 7   39   8  15   9   4  25  20   0   0   0   0   0   0   0   0   0   0   0   0   0   0
76 8   16  11  16   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
7610  115  12  20  13  25  24  70   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 312 422 1923   1 1976  12
23 1  100  26 100   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
23 2  155  10  30  16 125   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
23 3  470   9  30  12  90  13 230  16 120   0   0   0   0   0   0   0   0   0   0   0   0
23 5  490   2  10   3 480   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
                                           .
                                           .
                                           .
49 5   53   9  25  10  28   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
49 6   15  12  15   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
4912  178  11 178   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
50 2  521   7  30   8 112  17 104  23 274   0   0   0   0   0   0   0   0   0   0   0   0
50 3  531   1  58   7  51   8  15  11  15  12  28  15  66  16  30  20  15  22  36  24 104
50 3  531  25 112   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
50 4  587   3 229   4 127   9  30  13  46  14   8  23 147   0   0   0   0   0   0   0   0
50 5   97   8  25  12  71   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
```

B7 SAMPLE OUTPUT FOR STATION

```
****************
* SECTION  312 *
* STATION  417 *
****************
```

HYDRO. YEAR	MAX.DAILY RAINFALL	MONTH OF OCCURRENCE	ANNUAL PRECIPITATION	REMARKS
97/98	24.4	2	94.2	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
98/99	67.6	2	231.6	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
99/ 0	55.9	4	111.5	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
0/ 1	14.0	4	34.0	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
1/ 2	13.2	9	37.3	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
2/ 3	23.6	2	36.9	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
3/ 4	68.3	2	193.8	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
4/ 5				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
5/ 6	14.2	10	47.2	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
6/ 7	51.6	3	137.8	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
7/ 8	8.4	7	16.6	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
8/ 9	20.8	2	64.0	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
9/10	32.8	2	28.0	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
10/11	45.5	3	97.3	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
11/12	27.7	2	84.0	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
12/13	28.2	3	93.2	COL.2 IS MAX.MONTHLY TOTAL AS NO DAILY DATA FOR >4 MNTHS
13/14	27.2	3	126.8	
14/15				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
15/16				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
16/17				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
17/18				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
18/19	26.2	4	120.5	
19/20	23.6	2	48.8	
20/21				NO DATA FOR 3 OR MORE MONTHS BETW DEC & MAR-YEAR IGNORED
21/22	36.3	2	47.8	
22/23				NO DATA FOR >4 MONTHS IN YR & 1/2 DEC - MAR-YEAR IGNORED
23/24	5.1	2	10.5	
24/25	33.5	3	124.6	
25/26	36.1	12	48.6	
26/27	7.1	4	43.6	
27/28	17.8	3	128.3	
28/29	26.9	3	70.5	
29/30	18.8	3	86.3	
30/31	41.9	3	109.6	
31/32	17.0	2	60.7	
32/33	10.7	6	41.5	
33/34	19.0	3	97.4	
34/35	11.4	12	60.6	
35/36	7.6	3	35.0	
36/37	42.4	12	82.7	
37/38	31.0	2	98.0	
38/39	17.0	2	99.3	
39/40	35.6	2	97.2	
40/41	20.1	1	94.0	
41/42	17.3	3	89.9	
42/43	12.4	10	49.7	
43/44	21.1	3	84.9	
44/45	13.0	3	60.5	
45/46	8.9	4	26.0	
46/47	12.7	1	69.8	
47/48	32.3	4	92.4	
48/49	13.5	2	55.9	
49/50	17.5	4	128.6	
50/51	36.1	11	52.9	
51/52	25.4	2	61.5	
52/53	9.9	2	45.8	
53/54	31.0	12	135.1	
54/55	30.0	6	82.6	
55/56	52.0	3	276.4	
56/57	33.0	12	100.7	
57/58	19.3	12	59.7	
58/59	6.0	12	34.6	
59/60	17.0	12	74.8	
60/61	84.6	4	169.1	
61/62	8.0	1	39.5	
62/63	20.5	4	110.2	
63/64	6.0	12	23.0	
64/65	7.8	3	41.4	
65/66	17.2	2	41.3	
66/67	90.5	4	149.6	
67/68	50.2	3	148.3	
68/69	28.0	2	89.6	
69/70	8.5	4	40.0	
70/71	44.0	10	180.4	
71/72	26.0	1	55.3	
72/73	18.5	3	85.1	
73/74	57.0	2	192.0	
74/75	20.0	3	75.3	

SYNOPSIS FOR STATION 312 417

TOTAL NO. OF YEARS IN RECORD = 78.7
NO.OF YEARS OF RECORDED DATA = 70.6
NO.OF YEARS OF MISSING DATA = 8.2

MAX. DAILY RAINFALL OF 90.5
OCCURRED DURING MONTH 4
OF HYDROLOGICAL YEAR 66/67

M.A.P. = 89.4

DURATION = 1 DAY

RETURN PERIOD	TOTAL(MM)
2 YEARS	18.6
5 YEARS	33.2
10 YEARS	48.7
20 YEARS	70.4
50 YEARS	113.2
100 YEARS	161.7

LOG-GUMBEL

MEAN = 3.033
STD.DEV = 0.654

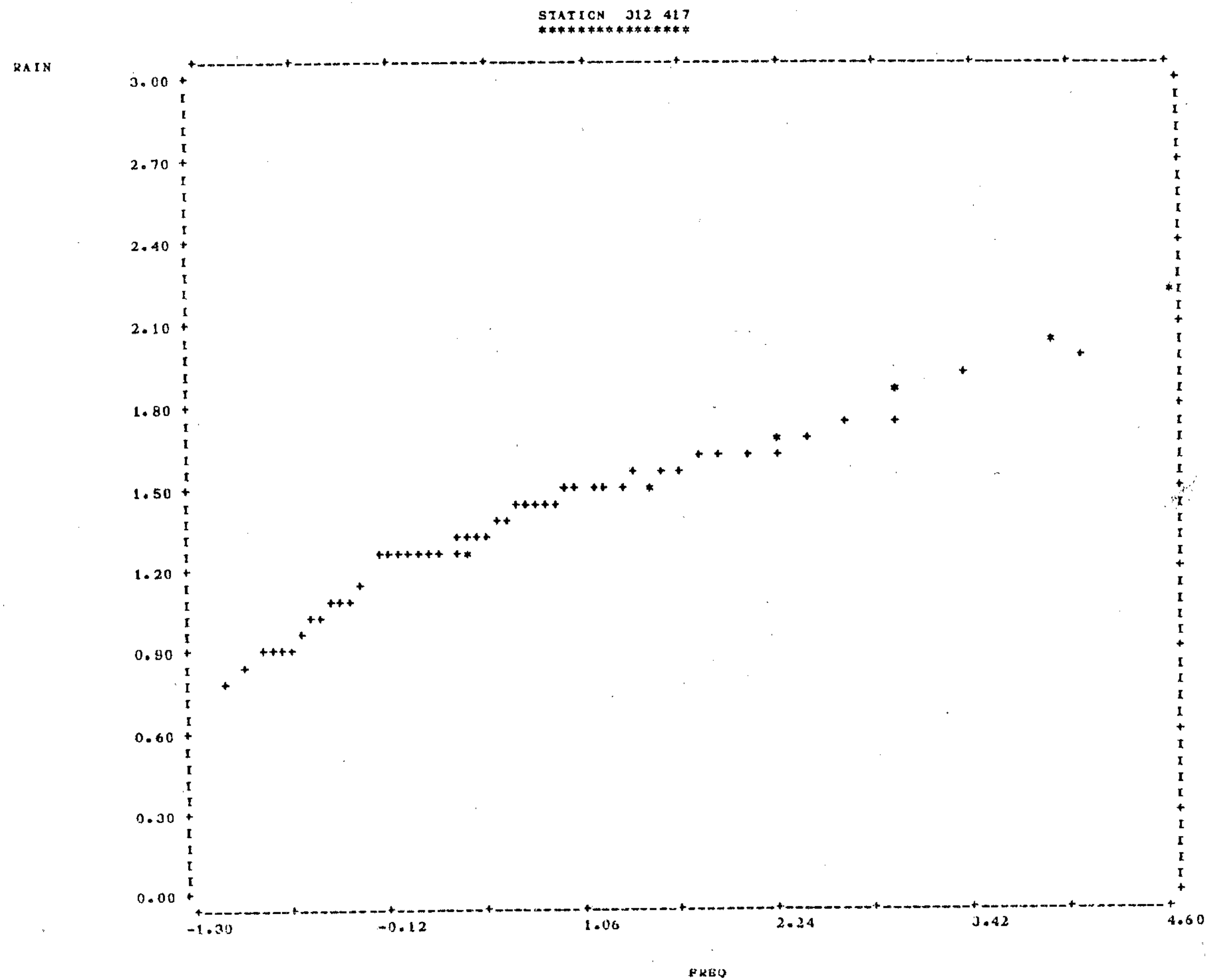
WITH A = -2.738
C = 0.510

THE NO. OF "MAX. DAILY" VALUES
INCLUDED IN THE LOG-GUMBEL FIT: N = 57

RANK	MAX.DAILY RAINFALL	RETURN PERIOD T=(N+1)/RANK	FREQ: XX = -LN(-LN(1-1/T))	RAIN: YY = LOG10(MAX.DAILY)
21.	27.2	2.762	0.800	1.435
23.	26.2	2.522	0.683	1.418
26.	23.6	2.231	0.520	1.373
10.	36.3	5.800	1.665	1.560
57.	5.1	1.018	-1.401	0.708
14.	33.5	4.143	1.286	1.525
12.	36.1	5.043	1.510	1.558
54.	7.1	1.074	-0.984	0.851
36.	17.8	1.611	0.031	1.250
22.	26.9	2.636	0.740	1.430
34.	18.8	1.706	0.125	1.274
8.	41.9	7.250	1.908	1.622
41.	17.0	1.415	-0.205	1.230
47.	10.7	1.234	-0.508	1.029
33.	19.0	1.785	0.196	1.279
46.	11.4	1.261	-0.455	1.057
53.	7.6	1.094	-0.896	0.881
7.	42.4	8.286	2.051	1.627
18.	31.0	3.314	1.024	1.491
41.	17.0	1.415	-0.205	1.230
13.	35.6	4.462	1.371	1.551
29.	20.1	2.000	0.367	1.303
38.	17.3	1.526	-0.063	1.238
45.	12.4	1.289	-0.402	1.093
27.	21.1	2.148	0.468	1.324
33.	19.0	1.785	0.196	1.279
49.	8.9	1.184	-0.622	0.949
44.	12.7	1.318	-0.352	1.104
16.	32.3	3.625	1.131	1.509
43.	13.5	1.349	-0.302	1.130
37.	17.5	1.568	-0.016	1.243
12.	36.1	5.043	1.510	1.558
25.	25.4	2.320	0.573	1.405
48.	9.9	1.208	-0.564	0.996
18.	31.0	3.314	1.024	1.491
19.	30.0	3.053	0.924	1.477
4.	52.0	14.500	2.639	1.716
15.	33.0	3.867	1.206	1.519
31.	19.3	1.871	0.268	1.286
56.	6.0	1.045	-1.146	0.778
41.	17.0	1.415	-0.205	1.230
2.	84.6	29.000	3.350	1.927
51.	8.0	1.137	-0.749	0.903
28.	20.5	2.071	0.417	1.312
56.	6.0	1.045	-1.146	0.778
52.	7.8	1.115	-0.819	0.832
39.	17.2	1.487	-0.110	1.236
1.	90.5	58.000	4.052	1.957
5.	50.2	11.600	2.406	1.701
20.	28.0	2.900	0.861	1.447
50.	8.5	1.160	-0.684	0.929
6.	44.0	9.667	2.215	1.643
24.	26.0	2.417	0.627	1.415
35.	18.5	1.657	0.078	1.267
3.	57.0	19.333	2.935	1.756
30.	20.0	1.933	0.317	1.301
9.	40.1	6.444	1.780	1.603

* * * * * POINTS FOR LEAST SQUARES FITTED LINE * * * * *

18.6	2.000	0.367	1.270
33.2	5.000	1.500	1.522
48.7	10.000	2.250	1.688
70.4	20.000	2.970	1.847
113.2	50.000	3.902	2.054
161.7	100.000	4.600	2.209


STATICN 312 417
RAIN
3.00
2.70
2.40
2.10
1.80
1.50
1.20
0.90
0.60
0.30
0.00
-1.30
-0.12
1.06
2.24
3.42
4.60
FREQ

B.8. SAMPLE OUTPUT FOR SECTION

```
************************************
*                                  *
* SYNOPSIS FOR SECTION   312       *
* ========================         *
*                                  *
*                                  *
* NO. OF STATIONS IN SECTION =  5  *
* M.A.P. FOR THIS SECTION = 110.5  *
* MEAN(LOG.MAX.DAILIES)    = 3.143 *
* STD.DEV( "    "    "  )  = 0.623 *
*                                  *
* MAX. DAILY RAINFALL OF 102.0     *
* OCCURRED DURING MONTH     2      *
* OF HYDROLOGICAL YEAR   75/76     *
* AT STATION               422     *
*                                  *
************************************
```

APPENDIX C

TABLES

Contents

TABLE C.1 Computed one-day duration extreme rainfall for various return periods vs. MAP

MAP (mm)	ln Mean	ln Std. Dev.	Computed one-day duration extreme rainfall (mm) for return periods of 2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
50	2,56	0,68	12	21	31	46	75	109
100	3,16	0,61	21	37	52	73	113	158
150	3,36	0,55	26	43	59	80	118	159
200	3,50	0,50	30	47	63	84	120	157
250	3,61	0,46	34	51	67	87	121	155
300	3,69	0,43	38	55	70	89	122	154
350	3,77	0,40	41	58	73	92	123	153
400	3,83	0,38	43	61	76	95	125	154
450	3,89	0,37	46	64	79	97	127	155
500	3,94	0,35	49	67	82	100	129	156
550	3,99	0,34	51	69	84	102	131	158
600	4,03	0,34	53	72	87	105	134	161
650	4,07	0,33	55	74	90	108	137	164
700	4,11	0,32	58	77	92	111	140	167

TABLE C.2 Observed MDR per section

Section	Station where Max. occurred	Max. daily rainfall (mm) recorded	MAP for station of max. (mm)	No. of stns. in section
273	754	38,0	44,6	1
308	701	40,5	46,8	1
311	868	30,0	38,0	1
312	422	102,0	124,4	5
313	457	66,5	87,9	1
314	482	180,5	155,3	3
344	370	58,5	86,2	1
346	549	45,0	76,5	1
347	527	87,5	107,1	2
348	233	123,5	100,0	3
349	238	111,5	129,5	5
350	542	143,0	164,4	4
377	554	30,0	28,5	2
380	519	55,0	131,8	1
381	457	42,0	120,7	1
382	612	71,0	116,1	2
383	8	125,0	105,5	1
384	852	137,5	201,6	4
385	516	92,5	193,8	2
386	68	120,5	149,4	1
413	403	49,8	32,7	3
415	551	93,8	93,1	3
416	597	101,0	106,5	5
417	405	136,0	119,0	1
418	529	120,6	112,6	3
419	665	122,0	190,0	4
420	214	110,0	122,5	2
421	696	150,5	138,7	2
422	32	107,0	170,0	4
452	817	85,0	130,0	1
453	845	45,0	145,7	2
454	270	90,2	121,2	1
456	795	105,0	147,7	4
457	715	60,5	147,0	1
458	639	82,0	195,1	2

Section	Station where Max. occurred	Max.daily rainfall(mm) recorded	MAP for station of max.(mm)	No. of stns.in section
459	200	62,8	171,1	1
489	793	101,1	146,2	3
490	623	110,0	188,3	3
491	357	123,0	195,2	3
492	153	150,0	169,6	3
493	233	122,0	133,9	1
494	252	79,0	207,6	1
495	534	93,0	174,8	2
526	665	57,5	156,3	2
527	332	88,5	152,7	4
528	899	55,0	166,7	1
529	452	122,0	188,1	6
530	189	114,0	180,4	4
531	618	115,6	193,2	6
532	173	117,1	182,3	1
565	666	90,0	189,7	2
566	860	93,5	170,7	6
567	738	150,4	202,5	3
568	95	108,0	206,9	6
569	271	65,0	191,9	1
570	637	113,0	251,5	6
571	78	136,0	233,4	1
608	268	118,3	220,3	5
609	168	127,3	178,5	5
610	884	101,5	191,2	2
611	146	176,0	190,1	5
612	733	101,5	214,1	6
613	375	110,0	216,6	3
614	406	93,0	198,6	4
615	824	80,0	191,3	4
649	64	30,8	22,7	1
651	192	140,5	167,7	5
652	289	80,0	285,8	1
653	881	125,5	200,2	2
654	802	109,5	239,3	3
655	255	404,0	259,2	5
656	28	132,0	244,8	5

Section	Station where Max. occurred	Max. daily rainfall (mm)	MAP for station of max. (mm)	No. of stns. in section
657	582	113,0	254,8	4
694	733	76,5	104,8	1
695	396	85,0	239,5	2
696	504	77,8	260,8	4
697	139	113,4	241,6	3
698	114	160,0	268,8	4
699	52	95,0	265,5	5
700	218	124,4	285,5	3
701	24	137,5	283,5	1
734	897	86,4	24,5	3
735	11	49,0	15,5	1
736	4	36,3	27,3	2
737	388	157,5	145,8	3
738	794	137,7	355,1	3
739	366	106,5	340,5	4
740	224	125,5	350,2	23
741	326	135,0	334,8	3
742	746	109,0	231,9	3
743	117	122,5	333,4	7
744	459	170,5	361,0	3
745	145	108,0	359,6	2
780	312	44,0	64,5	1
781	108	122,0	157,0	7
782	873	121,0	337,7	7
783	768	102,5	387,1	7
784	723	157,5	432,1	13
785	490	118,0	414,9	7
786	283	150,5	387,1	5
787	712	97,1	361,4	6
789	798	111,0	356,4	3
822	794	40,0	11,5	1
825	824	105,2	212,2	2
826	198	83,0	257,0	5
827	848	98,0	373,7	4
828	739	132,5	415,3	7
829	290	101,9	375,2	6

Section	Station where Max. occurred	Max. daily rainfall (mm)	MAP for station of max. (mm)	No. of stns. in section
830	238	142,0	416,3	5
831	439	104,0	344,0	4
832	685	76,5	426,8	1
833	222	120,0	387,7	3
868	435	54,5	115,1	1
869	712	95,3	180,6	2
870	403	110,0	341,4	4
871	278	110,0	401,9	7
872	689	108,0	327,3	6
873	451	220,0	356,9	7
874	343	125,0	417,2	6
875	893	146,0	374,7	5
876	576	122,0	410,4	4
913	744	85,0	149,2	1
915	446	142,0	346,4	5
916	698	103,4	451,2	3
917	433	125,0	505,8	4
918	393	124,7	515,9	5
919	505	115,0	400,8	2
958	833	102,0	240,7	2
959	13	113,0	280,8	2
960	845	192,8	425,8	5
961	329	92,7	366,1	2
962	297	123,2	447,6	3
963	862	162,1	498,9	4
964	601	115,0	441,9	4
1002	763	75,0	279,2	3
1003	608	208,5	333,1	5
1004	14	120,8	341,1	4
1005	535	146,0	419,4	4
1006	136	121,9	437,7	4
1007	383	183,4	541,9	3
1008	302	138,5	613,2	5
1009	850	146,0	593,4	7
1010	154	116,0	529,1	7
1011	788	137,0	481,7	2

Section	Station where Max, occurred	Max. daily rainfall (mm)	MAP for station of max. (mm)	No. of stns. in section
1012	94	117,0	426,0	1
1047	248	60,0	126,7	1
1048	853	96,5	420,6	1
1049	107	123,5	353,1	1
1051	560	98,0	407,5	4
1052	641	60,0	460,3	1
1053	807	75,0	510,3	1
1054	329	139,0	600,7	5
1055	374	123,4	529,2	3
1056	697	96,0	502,0	5
1057	616	135,0	420,0	4
1058	53	80,0	420,6	1
1101	828	81,5	430,5	1
1102	402	128,5	508,2	3
1103	797	105,0	526,4	1
1104	535	135,0	588,4	3
1145	573	77,5	331,0	1
1159	211	128,3	588,3	1
1160	814	116,0	578,4	1
1198	675	147,0	425,5	1
1199	820	151,6	527,6	4
1200	866	126,5	466,0	5
1201	29	129,0	406,3	4
1205	766	81,5	627,5	1
1206	187	135,0	609,3	2
1207	141	105,0	546,4	2
1208	475	120,2	594,6	1
1209	54	90,3	582,9	1
1252	774	124,0	554,6	2
1253	599	105,9	550,4	1
1269	510	338,0	683,2	1

TABLE C.3 Data of 9 relevant autographic stations

Station no.	Name	First year	Last year	M A P
317/476	UPINGTON	1951	1976	287 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	9	13	17	22	30	37
30	13	18	23	28	37	45
45	16	21	26	32	41	50
60	17	23	28	34	44	53
1440	28	41	53	68	94	119

Station no.	Name	First year	Last year	M A P
419/184	KEETMANSHOOP	1956	1976	163 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	9	15	22	30	47	65
30	13	22	32	46	73	102
45	15	26	38	55	87	124
60	16	28	42	61	98	141
1440	13	40	84	173	436	874

Station no.	Name	First year	Last year	M A P
568/817	MARIENTAL	1960	1971	180 mm

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	10	13	17	19	24	29
30	12	17	21	26	35	44
45	14	20	27	34	48	62
60	15	23	30	39	55	72
1440	25	39	52	68	97	127

TABLE C.3 - cont.

Station no.	Name	First year	Last year	M A P
740/154	WINDHOEK	1956	1976	367 mm

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	13	20	27	36	51	66
30	19	30	41	55	81	108
45	22	35	49	68	102	138
60	23	38	53	73	110	151
1440	35	57	81	111	170	232

Station no.	Name	First year	Last year	M A P
784/839	J.G. Strydom	1967	1976	380 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10yr	20 yr	50 yr	100 yr
15	13	16	17	19	22	24
30	20	24	26	29	33	37
45	22	26	29	32	37	42
60	23	27	30	33	38	42
1440	38	51	61	74	94	113

Station no.	Name	First year	Last year	M A P
787/838	GOBABIS	1960	1971	350 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	12	14	17	19	23	27
30	16	20	23	27	33	38
45	18	23	27	32	39	46
60	19	25	30	35	43	51
1440	35	44	51	58	70	81

TABLE C.3 - cont.

Station no.	Name	First year	Last year	M A P
961/247	OUTJO	1960	1969	409 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	14	17	20	22	27	30
30	19	24	28	33	40	47
45	22	29	34	40	49	57
60	23	31	37	44	55	66
1440	37	50	61	73	93	112

Station no.	Name	First year	Last year	M A P
1010/186	GROOTFONTEIN	1969	1976	510 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	13	19	23	29	38	47
30	21	30	37	46	62	76
45	24	34	43	54	71	88
60	26	38	49	62	85	107
1440	51	66	78	92	113	133

Station no.	Name	First year	Last year	M A P
1020/749	MAUN	1952	1963	469 mm.

Duration in minutes	Totals for return periods in mm/h					
	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
15	17	22	27	32	41	49
30	24	32	39	47	59	71
45	29	40	48	58	75	90
60	33	45	55	67	88	106
1440	45	62	77	95	125	153

TABLE C.4 Allocation of label numbers to sections

Section No.	Label No.	Section No.	Label No.	Section No.	Label No.
273	1	489	37	657	73
308	2	490	38	694	74
311	3	491	39	695	75
312	4	492	40	696	76
313	5	493	41	697	77
314	6	494	42	698	78
344	7	495	43	699	79
346	8	526	44	700	80
347	9	527	45	701	81
348	10	528	46	734	82
349	11	529	47	735	83
350	12	530	48	736	84
377	13	531	49	737	85
380	14	532	50	738	86
381	15	565	51	739	87
382	16	566	52	740	88
383	17	567	53	741	89
384	18	568	54	742	90
385	19	569	55	743	91
386	20	570	56	744	92
413	21	571	57	745	93
415	22	608	58	780	94
416	23	609	59	781	95
417	24	610	60	782	96
418	25	611	61	783	97
419	26	612	62	784	98
420	27	613	63	785	99
421	28	614	64	786	100
422	29	615	65	787	101
452	30	649	66	789	102
453	31	651	67	822	103
454	32	652	68	825	104
456	33	653	69	826	105
457	34	654	70	827	106
458	35	655	71	825	107
459	36	656	72	829	108

TABLE C. 4 - cont.

Section No.	Label No.	Section No.	Label No.
830	109	1008	141
831	110	1009	142
832	111	1010	143
833	112	1011	144
868	113	1012	145
869	114	1047	146
870	115	1048	147
871	116	1049	148
872	117	1051	149
873	118	1052	150
874	119	1053	151
875	120	1054	152
876	121	1055	153
913	122	1056	154
915	123	1057	155
916	124	1058	156
917	125	1101	157
918	126	1102	158
919	127	1103	159
958	128	1104	160
959	129	1145	161
960	130	1159	162
961	131	1160	163
962	132	1198	164
963	133	1199	165
964	134	1200	166
1002	135	1201	167
1003	136	1205	168
1004	137	1206	169
1005	138	1207	170
1006	139	1208	171
1007	140	1209	172
		1252	173
		1253	174
		1269	175