UM - 27

GRAPHICAL REPRESENTATION OF FLOW DURATION CURVE

SATISH CHANDRA

DIRECTOR

STUDY GROUP

B P PARIDA
D CHALISGAONKAR

NATIONAL INSTITUTE OF HYDROLOGY
JAL VIGYAN BHAWAN
ROORKEE - 247667(UP)
INDIA

1987-88

Page

CONTENTS

LIST OF FIGURES

ABSTRACT

Flow duration curve, representating the combined effect of flow characteristics of any stream, is one of the simplest available techniques to predict the distribution of future flows. Because of its frequent use in hydrologic studies, the generalised software package 'FLOW' has specifically been developed to assist the designer for graphical representation of flow duration curve. This user manual provides documentation of the program runnable on an IBM-compatible microcomputer, including features such as:

(i) Equipment and software requirement

(ii) Data requirments and preparation

(iii) Steps for Running the program

(iv) Procedure used computation

(v) Brief description of the sub-routines

(vi) Sample Input and Output Files

Besides a flow chart showing the operation of the program has also been given in the user's manual.

1.0 INTRODUCTION

Hydrologic design problems involving reservoir studies, low flow studies, river regulation policy formulations, study of geologic characteristics of drainage basins etc., need the knowledge of integrated flow characteristics of the stream over a given period of time. Such integrated flow characteristics for a given drainage basin can be represented through a flow duration curve representing the relationship between the flows and percentage of times they are equalled or exceeded over the specified period.

This generalised software package FLOW has specifically been developed to assist the designer to construct a flow duration curve for any drainage basin and to obtain the results in tabular or graphical form or both.

It consists of a main program and three subroutines with interactive features for assisting the designer to excercise suitable options. The program is flexible and can be updated by adding further subroutines for data processing etc. as per the need of the designer or the read statements suitably modified to suit the formats of any existing data file.

2.0 MINIMUM HARDWARE AND SOFTWARE REQUIRED

The program FLOW written in FORTRAN-77 language has been developed on 16-bit IBM-compatible personal computer (PC/XT) having a floating point/numeric coprocessor (INTEL 8087) and a PROFORT compiler. Standard software LOTUS 1-2-3 is used for graphical presentation of the results which are transferred by the program to the worksheet and a graphics printer compatible to the IBM compatible personal computer has been used for printing the results in tabular and graphics form.

The logical flow chart showing the operation of FLOW is presented in Fig.1.

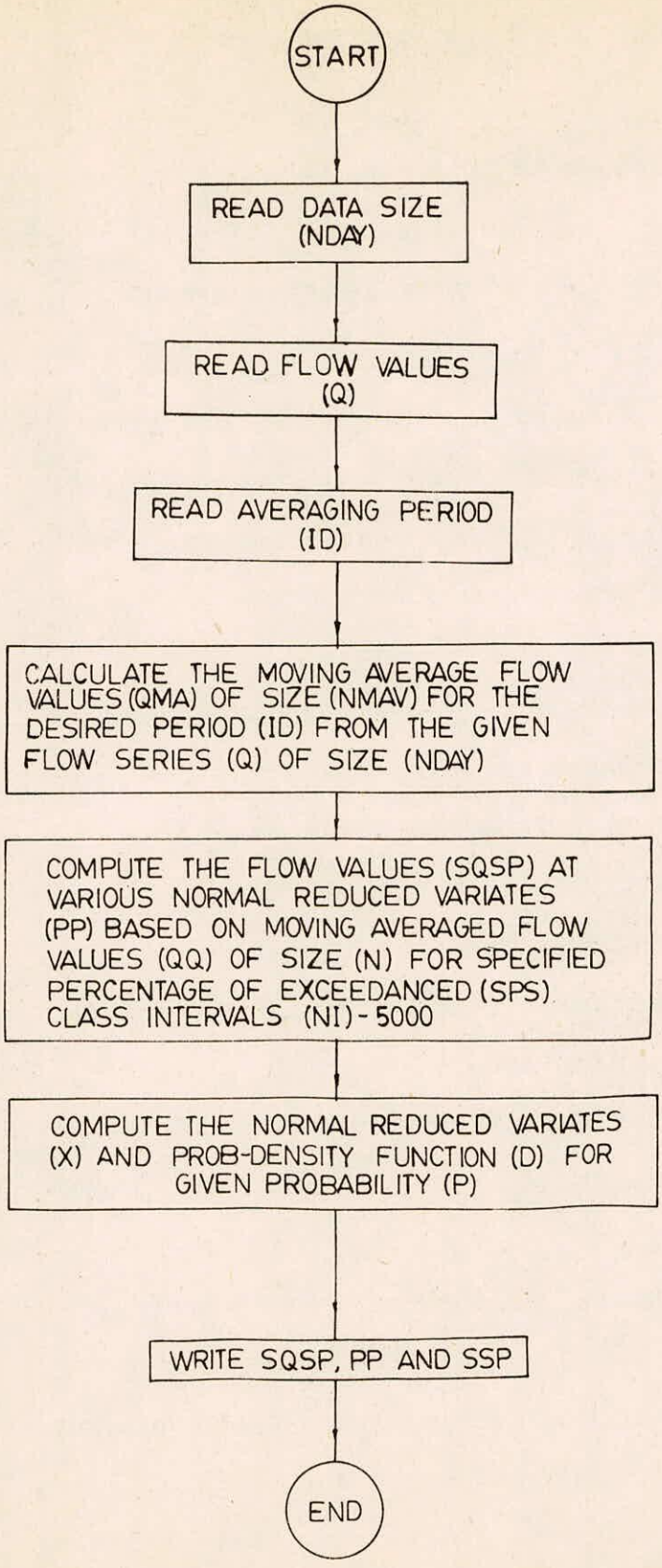


FIG.1. FLOWCHART SHOWING THE OPERATION OF FLOW

3.0 RUNNING FLOW ON MICRO-COMPUTER

After successful compilation and linking, the file FLOW.EXE is created. Data file FLOW.DAT is then created as per Section 4.0 in the same directory containing the file FLOW.EXE. The program is then invoked by typing FLOW followed by RETURN key.

For obtaining the graphical presentation of results the following sequence of operation are followed.

1. Set the directory containing the LOTUS application as the default directory.
2. Execute LOTUS.
3. Select the option 1-2-3 from the menu.
4. Type/(slash) to enter the LOTUS commands
5. Select FILE from the LOTUS menu
6. Select IMPORT from the FILE menu.
7. Select NUMBER from the IMPORT menu.
   The message 'Enter name of the file to import' will be displayed.
8. Type the name of the file containing data for plotting with directory name (C:\ PROFORT\ FLOW.WKS) and return.
9. Type/(Slash) to get the lotus menu
10. Select GRAPH option from this menu
11. Select TYPE option from Graph and set XY as the type of graph using the submenu.
12. Select the axes and specify their ranges
13. Select OPTIONS from GRAPH submenu.

14. Select TITLE from OPTIONS submenu.

15. Select FIRST from TITLE submenu and type the title of the graph.

16. Select TITLE from OPTIONS submenu.

17. Select X-AXIS from TITLE submenu and type the X-axis title.

18. Select TITLE from OPTIONS submenu.

19. Select Y-Axis from TITLE submenu and type Y-axis title.

20. Use SAVE option from the GRAPH submenu and give a name to the graph file as C:\PROFORT\FLOW.PIC.

21. Use the VIEW option from the graph submenu to display the graph on the monitor.

22. To print the graph on printer use the PRINTGRAPH submenu from the LOTUS menu.

23. Define the hardware and graph setting using the SETTING submenu and save the settings if required using the SAVE menu.

24. Select graph for printing using IMAGE SELECT menu.

25. Select the GO menu. The graph will be printed on paper.

4.0 DATA REQUIREMENTS AND PREPARATION

To construct a flow duration curve generally the daily, weekly or monthly unregulated flows of a drainage basin under more or less stable, physical conditions during a given period are necessary.

For data preparation, usually the total period concept is used, in which data for the period under consideration must pertain to complete calender years which need not essentially be the consecutive ones. The data however may begin with the beginning of the calender year, the climatic year or the water year and continue for a 12-month period. Any missing value or missing spells duration the continuous 12-month period suitable techniques and where such spells are large, the data for that 12-month period be excluded from the data file.

The prepared data can then be put into the input file with the name FLOW.DAT.

5.0 PROCEDURE USED IN FLOW

The procedure for construction of flow duration curve is based on the consideration of all the discharges in the data file together and placing them in classes in order of their magnitude beginning with the highest class interval.

This can be represented through the following steps:

(i) Read the size of data (NDAY)

(ii) Read the flow values (Q_i, i=1,.....,NDAY)

(iii) Compute the moving average flow values (QQ_i, i=1,.....NDAY + 1 - ID) for the desired averaging period (ID) if necessary for the study, otherwise input ID = 1.

(iv) Rank the averaged flow series from highest to lowest and determine the range or total interval.

(v) Divide the total interval into a large number of small class intervals (for easy interpolation of flow values at desired percentage of exceedances) say 5000 as adopted in this programe and write bottom flow value of each class interval in descending order.

(vi) Tally and count the number of flow values lying within each class interval (n_i) and write them against the bottom flow value of the corresponding class interval.

(vii) Compute from the top, cumulative number of flow values based on number of flow values against each

class interval.

(viii) Divide the cumulated figures against each class interval by the total averaged flow values (NDAY+1-D) to obtain the percentage of exceedances.

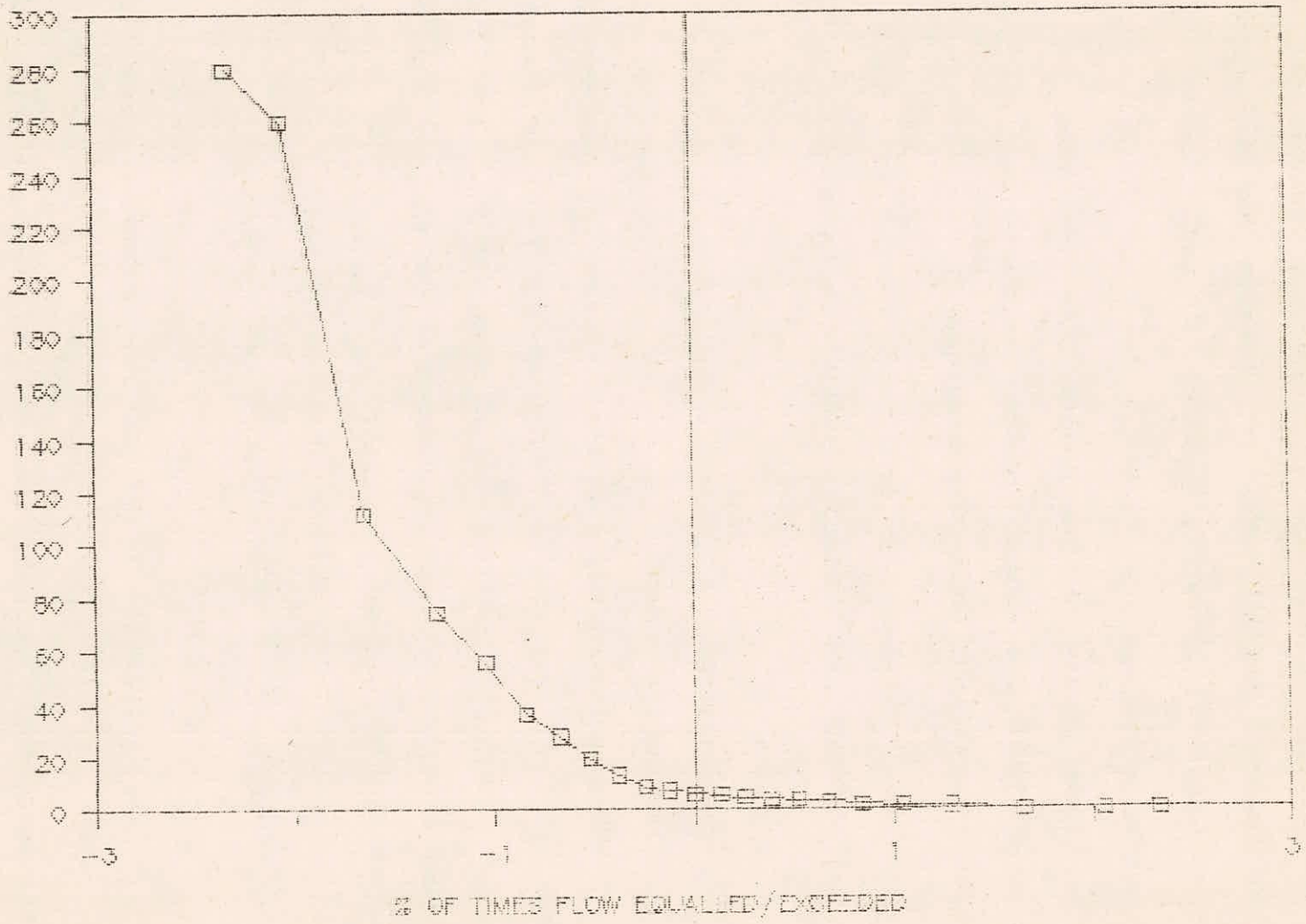
(ix) Interpolate the bottom of class interval flow values corresponding to specified percentage of exceedances such as 1,2,5,10,15,20,25,.....90,95,98,99.

(x) Compute the normal reduced for the specified percentage of exceedances and tabulate the interpolated flow values ($SQSP_i$), the normal reduced variates (PP_i) and the specified percentage of times the interpolated flows are equalled or exceeded(SPS_i)

(xi) Plot $SQSP_i$ against PP_i (I = 1,....,23) on linear scales or plot $SQSP_i$ against SPS_i (Normal prob.scales) to obtain the flow duration curve for the desired drainage basin.

The results till step (viii) are obtained from the output file FLOW.OUT and the results from step (x) are obtained from output file FLOW.RES. Results from step (xi) are presented in Fig. 2.

FIG 2.FLOW DURATION CURVE FOR TEST DATA



6.0 COMPUTER PROGRAM FLOW

Much of the program is explained by comment cards and defination of variables. However, subroutines used in the package are explained in details for reference of the user for future possible undation, if any.

6.1. Main Program

Data inputs to the program are read from the data file (FLOW.DAT) and input for the moverage average period (ID) are read through an interactive querry.

Data transfers to and from subroutines MOVAV and DUR are carried out through COMMON blocks a ABC and BCD.

6.2 Sub-Program

6.2.1 Subroutine MOVAV

This subroutine calculates the moving average flow values (QMA) of size (NMAV) for the desired period (ID) from the given flow series (Q) of size (NDAY). The inputs to the subroutine and ouputs from the sub-routine are performed through the common block ABC.

Input - NDAY, ID (Integer);Q(Real)

Output - NMAV (Integer);QMA(Real)

6.2.2 Subroutine DUR

This subroutine based on the moving averaged flow values (QQ) of size (N) computes the flow values (SQSP) at various normal reduced variates (PP) for specified percentage of (SPS) based on 5000 class intervals (NI). The Inputs to and outputs from the Subroutine are performed through

common blocks ABC and BCD. This Subroutine internally calls Subroutine NDTRI for computation of reduced variates (PP)

Input - NMAV (Integer); QQ (Real)

Output - SQSP,PP,SPS (Real)

6.2.3 Subroutine NDTRI (P,X,D,IE)

This subroutine computes the normal reduced variates (X) and prob. density function (D) for given probability (P). In case of errors the error code (IE) is activated in which case values other than zero are passed.

Input - P(Real)

Output - IE (Integer); X, D(Real)

REFERENCES

1. Institute of Hydrology, Wallingford, 1980, LOW FLOW Studies Research Report No. 1-4, U.K.

2. Parida, B.P., 1984. Estimation of Low Flow Indices for Ungauged Catchments. Unpublished M.Sc. (Engg. Hydrology) thesis, National University of Ireland, Galway.

3. Searcy, James K., 1963. Flow Duration Curves - Manual of Hydrology : Part 2. Low-Flow Techniques, Geological Survey of Water-Supply Paper 1542-A., U.S. Deptt. of the Interior Washington.

APPENDIX - A

FLOW DAT

TEST DATA FOR THE COMPUTATION OF FLOW DURATION CURVE

365

0007.30 0005.50 0004.90 0005.80 0006.20 0006.10 0006.10 0006.00 0006.00 0006.40
0006.80 0006.20 0006.20 0008.30 0005.40 0005.50 0005.10 0005.10 0005.20 0005.80
0005.60 0004.80 0004.50 0004.60 0005.10 0004.30 0004.50 0004.30 0004.30 0004.50
0006.80 0006.70 0005.40 0017.10 0010.30 0015.00 0006.00 0005.70 0008.60 0007.30
0009.40 0005.40 0004.80 0005.00 0005.00 0003.50 0004.10 0004.80 0005.00 0005.00
0005.00 0004.20 0003.80 0003.80 0004.10 0004.20 0003.60 0004.00 0003.70 0003.90
0003.50 0003.40 0003.40 0003.30 0006.50 0007.70 0009.20 0004.60 0003.40 0003.00
0003.10 0003.00 0002.80 0002.30 0002.20 0002.50 0002.90 0003.10 0002.50 0002.50
0002.40 0002.50 0002.20 0002.50 0002.90 0002.50 0002.60 0002.80 0002.00 0002.10
0001.90 0001.90 0002.00 0001.80 0001.90 0002.10 0002.10 0001.70 0002.30 0001.50
0001.50 0001.90 0001.70 0001.50 0001.70 0001.70 0001.50 0017.40 0004.20 0003.70
0003.90 0003.30 0002.80 0002.00 0002.30 0001.80 0001.70 0002.00 0001.60 0001.50
0001.50 0003.60 0007.40 0007.70 0005.50 0006.20 0004.80 0003.00 0003.30 0002.40
0002.80 0002.20 0002.00 0001.90 0002.00 0004.60 0003.80 0001.30 0000.60 0000.40
0000.30 0000.30 0000.30 0000.20 0000.20 0000.20 0000.20 0000.10 0000.10 0000.20
0000.10 0000.20 0000.20 0000.20 0000.20 0000.20 0000.20 0000.20 0000.50 0000.40
0000.90 0000.90 0029.00 0024.30 0023.60 0021.10 0018.80 0003.90 0001.60 0001.50
0001.30 0001.00 0037.60 0032.40 0011.60 0003.00 0002.00 0001.20 0001.20 0001.00
0003.00 0002.20 0001.80 0001.00 0001.40 0001.30 0001.10 0060.00 0022.50 0059.00
0064.00 0112.00 0056.60 0029.50 0014.20 0010.70 0009.90 0008.50 0010.10 0009.90
0007.70 0008.10 0007.40 0008.00 0006.00 0008.50 0045.50 0021.20 0013.60 0009.70
0009.20 0006.50 0005.80 0005.50 0005.10 0004.70 0006.60 0006.70 0011.00 0009.20
0007.90 0006.30 0004.50 0003.20 0003.30 0004.00 0004.00 0003.60 0003.40 0003.30
0004.30 0004.10 0004.50 0004.30 0005.00 0004.30 0003.50 0003.30 0003.60 0003.50
0011.50 0280.00 0075.00 0092.00 0048.00 0062.00 0012.50 0012.10 0011.70 0007.60
0006.00 0006.50 0006.30 0006.00 0007.00 0005.90 0005.40 0005.30 0004.10 0005.60
0190.00 0197.50 0585.00 0320.00 0088.00 0050.00 0635.00 0245.00 0350.00 0488.00
0170.00 0088.00 0066.00 0034.80 0056.00 0134.00 0068.00 0092.50 0075.00 0175.00
0140.00 0080.00 0052.00 0040.00 0038.50 0024.30 0022.70 0025.90 0020.00 0072.10
0042.50 0190.00 0140.00 0087.00 0052.00 0038.00 0046.60 0040.00 0055.10 0092.50
0066.00 0051.10 0035.00 0035.10 0025.50 0031.20 0021.30 0022.60 0021.50 0020.00
0022.50 0022.70 0030.70 0017.10 0036.00 0034.80 0022.00 0020.00 0020.60 0057.50
0038.10 0022.70 0019.20 0019.00 0066.00 0056.00 0042.10 0035.30 0032.90 0028.80
0025.50 0019.00 0020.00 0265.00 0188.00 0147.00 0216.00 0103.00 0085.00 0063.50
0058.50 0065.00 0062.50 0053.00 0044.50 0025.00 0020.00 0014.10 0023.50 0019.50
0016.60 0014.00 0010.00 0009.80 0009.60 0009.80 0009.40 0008.90 0008.00 0007.20
0006.40 0006.80 0007.20 0007.00 0007.70

APPENDIX - B

FLOW FOR

```
C       PROGRAM FOR COMPUTATION OF FLOW DURATION CURVE
C       FOR DESIRED MOVING-AVERAGE VALUES.
C
C       Q = FLOW VALUES IN QMECS
C       NDAY = SIZE OF FLOW DATA
C       QQ; QMA = MOVING AVERAGED FLOW SERIES IN CUMECS
C       ID = MOVING AVERAGED PERIOD
C       NI = NO. OF CLASS INTERVALS(5000)
C       SPS = SPECIFIED PERCENTAGE OF TIMES FLOW EQUALLED OR
C       EXCEEDED
C       PP = NORMAL REDUCED VARIATE CORRESPONDING TO SPS
C       SQSP = FLOW IN CUMECS AT SPECIFIED PERCNTAGE OF
C       EXCEEDANCE.
C
        CHARACTER*80 TITLE
        COMMON/ABC/NMAV,NDAY,ID,Q(9000),QMA(9000)
        COMMON/BCD/SQSP(23),SPS(23),PP(23)
        OPEN(UNIT=1,FILE='FLOW.DAT', STATUS='OLD')
        OPEN(UNIT=2,FILE='FLOW.RES',STATUS='NEW')
        OPEN(UNIT=3,FILE='FLOW.OUT',STATUS='NEW')
        OPEN(UNIT=4,FILE='FLOW.WKS',STATUS='NEW')
C
        READ(1,33)TITLE
33      FORMAT(A)
        READ(1,1) NDAY
1       FORMAT(I4)
        READ(1,2)  (Q(I),I=1,NDAY)
2       FORMAT(10(F7.2,1X))
        PRINT*,'INPUT MOVING AVG PERIOD : '
        READ(*,1)ID
        CALL MOVAV
        CALL DUR
        PRINT*,'      *TO PLOT THE RESULTS CHANGE DIRECTORY*'
        PRINT*,'            *TO LOTUS AND RUN LOTUS*'
        STOP
        END
C
        SUBROUTINE MOVAV
        COMMON/ABC/NMAV,NDAY,ID,Q(9000),QMA(9000)
        J=1
        IC1=1
        IC2=IC1+ID-1
1       SUM=0.0
        DO 2 I=IC1,IC2
        SUM=SUM+Q(I)
2       CONTINUE
        QMA(J)=SUM/ID
        IC1=IC1+1
        IC2=IC2+1
        J=J+1
```

```
      IF(IC2.LE.NDAY) GO TO 1
      NMAV=J-1
      RETURN
      END
C
      SUBROUTINE DUR
      DIMENSION II(9000),MSUM(9000),SUM(9000),QI(9000),NSUM(9000),
     1MAM(9000)
      COMMON/ABC/NMAV,NDAY,ID,Q(9000),QQ(9000)
      COMMON/BCD/SQSP(23),SPS(23),PP(23)
      N=NMAV
      SU=0.
      DO 1 I=1,N
      SU=SU+Q(I)
1     CONTINUE
      QBAR=SU/FLOAT(N)
      JL=0
      NI=5000
      DO 5 KK=1,N
      JK=N-KK
      DO 5 LL=1,JK
      IF(QQ(LL).LE.QQ(LL+1)) GO TO 5
      TEMP=QQ(LL)
      QQ(LL)=QQ(LL+1)
      QQ(LL+1)=TEMP
5     CONTINUE
      QMAX=QQ(N)
      QMIN=QQ(1)
      QINT=(QMAX-QMIN)/NI
      DO 3 J=1,NI
      QI(J)=QMAX-QINT*J
3     CONTINUE
      DO 4 J=1,N
      QQ(J)=((QQ(J)-QMIN)/QINT)+1
      II(J)=QQ(J)
      IF(II(J).LT.NI) GO TO 11
      II(J)=NI
11    IA=II(J)
      NSUM(IA)=NSUM(IA)+1
4     CONTINUE
      DO 6 J=1,NI
      MSUM(J)=NSUM(NI-J+1)
6     CONTINUE
      MAM(1)=MSUM(1)
      DO 8 J=2,NI
      MAM(J)=MSUM(J)+MAM(J-1)
8     CONTINUE
      AM=MAM(NI)
      DO 9 J=1,NI
      SUM(J)=(MAM(J)/AM)*100
```

```
9       CONTINUE
        SP=1
15      DO 16 J=1,NI
        IF(SP.GT.SUM(J)) GO TO 16
        JP=J-1
        GO TO 17
16      CONTINUE
17      IF(JP.EQ.0)QI(JP)=QMAX
        TOP=QI(JP)-QI(JP+1)
        BOT=SUM(JP+1)-SUM(JP)
        QSP=QI(JP)-(TOP/BOT)*(SP-SUM(JP))
        JL=JL+1
        SPS(JL)=SP
        SQSP(JL)=QSP
        IF(SP.LT.2) GO TO 18
        IF(SP.EQ.2) GO TO 19
        IF(SP.GE.5.AND.SP.LT.95) GO TO 20
        IF(SP.EQ.95.AND.SP.LT.98) GO TO 19
        IF(SP.EQ.98) GO TO 18
19      SP=SP+3
        GO TO 21
20      SP=SP+5
        GO TO 21
18      SP=SP+1
        GO TO 21
21      IF(SP.GT.99) GO TO 22
        GO TO 15
22      NI2=23
        WRITE(2,23)
        WRITE(2,24)
        WRITE(2,27)QBAR
        WRITE(2,54)QMAX,QMIN
        WRITE(2,57)
        WRITE(2,24)
        WRITE(2,25)
        WRITE(2,24)
        DO 14 I = 1,NI2
        P = (SPS(I)/100)
        CALL NDTRI(P,PK,D,IE)
        PP(I) = PK
14      CONTINUE
        WRITE(2,26) (SQSP(J),PP(J),SPS(J),J=1,NI2)
        WRITE(2,24)
        WRITE(2,59)ID
        DO 12 J = 1,NI2
        WRITE(4,10) SQSP(J),PP(J)
10      FORMAT(2X,F8.2,5X,F6.2)
12      CONTINUE
        WRITE(3,31)
        WRITE(3,24)
```

```
      WRITE(3,27)QBAR
      WRITE(3,24)
      WRITE(3,28)
      WRITE(3,24)
      DO 13 J=1,NI
      IF(MSUM(J).GT.0)WRITE(3,30) QI(J),MSUM(J),MAM(J),SUM(J)
13    CONTINUE
      WRITE(2,24)
27    FORMAT(14X,'MEAN FLOW IS:',F8.2,'CUMECS',/)
54    FORMAT(5X,'MAX FLOW IS:',F8.2,7X,'MIN FLOW IS:',F8.2)
57    FORMAT(17X,' CUMECS',19X,' CUMECS')
28    FORMAT(5X,'BOTTOM OF',5X,'TOTAL IN ',4X,'NUMBER.GT.',3X,
     1'PERCT.GT.',/,4X,'CLASS INTV.',3X,'CLASS INTV.',2X,
     2'BOTTOM C.I.',2X,'CLASS INTV.')
30    FORMAT(4X,F8.2,7X,I5,7X,I5,8X,F8.2)
24    FORMAT(4X,50('-'))
23    FORMAT(/////,18X,' FLOW IN CUMECS
     1 VRS',/,9X,'PERCENTAGE OF TIMES
     2 THE FLOW IS EXCEEDED')
25    FORMAT(10X,'FLOW',8X,'NORMAL',8X,'PERCENTAGE OF',
     1/,10X,'IN',10X,'REDUCED',7X,'TIMES FLOW IS',
     1/,10X,'CUMECS',6X,'VARIATE',7X,'EXCEEDED')
26    FORMAT(8X,F8.2,5X,F8.2,5X,F8.2)
31    FORMAT(1H1,//////)
59    FORMAT(6X,I3,' DAY MOV.AVERAGE FLOWS CHOSEN FOR ANALYSIS')
      RETURN
      END
C
      SUBROUTINE NDTRI(P,X,D,IE)
      X=.99999E+37
      D=X
      IF(P)1,4,2
1     IE=-1
      GO TO 12
2     IF(P-1.0)7,5,1
4     X=-0.999999E+37
5     D=0.0
      GO TO 12
7     D=P
      IF(D-0.5)9,9,8
8     D=1.0-D
9     T2=ALOG(1.0/(D*D))
      T=SQRT(T2)
      X=T-(2.515517+0.802853*T+0.010328*T2)/(1.0+1.432788*T+
     10.189269*T2+0.001308*T*T2)
      IF(P-0.5)10,10,11
10    X=-X
11    D=0.3989423*EXP(-X*X/2.0)
12    RETURN
      END
```

APPENDIX - C -
FLOW OUT

MEAN FLOW IS: 28.53CUMECS

BOTTOM OF CLASS INTV.	TOTAL IN CLASS INTV.	NUMBER.GT. BOTTOM C.I.	PERCT.GT. CLASS INTV.
377.52	1	1	0.28
359.56	1	2	0.55
341.59	1	3	0.83
279.54	1	4	1.11
276.06	1	5	1.39
273.57	1	6	1.66
268.14	1	7	1.94
259.61	1	8	2.22
254.10	1	9	2.49
232.35	1	10	2.77
196.42	1	11	3.05
183.36	1	12	3.32
169.32	1	13	3.60
166.75	1	14	3.88
147.35	1	15	4.16
127.34	1	16	4.43
122.89	1	17	4.71
112.47	1	18	4.99
111.34	1	19	5.26
110.06	1	20	5.54
108.85	1	21	5.82
106.28	1	22	6.09
105.15	1	23	6.37
104.39	1	24	6.65
103.04	1	25	6.93
102.28	1	26	7.20
101.37	1	27	7.48
101.30	1	28	7.76
97.37	1	29	8.03
92.92	1	30	8.31
92.39	1	31	8.59
85.07	1	32	8.86
82.95	1	33	9.14
80.46	1	34	9.42
76.99	1	35	9.70
75.71	1	36	9.97

74.95	1	37	10.25
74.65	1	38	10.53
72.69	1	39	10.80
71.71	1	40	11.08
71.63	1	41	11.36
70.05	2	43	11.91
66.87	1	44	12.19
64.16	1	45	12.47
63.48	1	46	12.74
62.80	1	47	13.02
60.91	1	48	13.30
60.46	1	49	13.57
60.31	1	50	13.85
60.01	1	51	14.13
59.93	1	52	14.40
57.89	1	53	14.68
56.68	1	54	14.96
55.93	1	55	15.24
55.25	1	56	15.51
54.42	1	57	15.79
52.68	1	58	16.07
49.96	1	59	16.34
46.95	1	60	16.62
46.42	1	61	16.90
46.27	1	62	17.17
45.28	1	63	17.45
44.53	1	64	17.73
43.62	1	65	18.01
42.49	1	66	18.28
42.04	1	67	18.56
41.28	1	68	18.84
40.98	1	69	19.11
40.45	1	70	19.39
39.02	1	71	19.67
36.60	1	72	19.94
36.53	1	73	20.22
35.55	1	74	20.50
35.47	1	75	20.78
32.98	2	77	21.33
32.90	1	78	21.61
31.77	1	79	21.88
31.62	1	80	22.16
31.54	1	81	22.44
31.32	1	82	22.71
31.24	1	83	22.99
30.94	1	84	23.27
30.26	1	85	23.55
29.58	1	86	23.82
29.20	1	87	24.10
28.75	1	88	24.38

28.30	1	89	24.65
28.22	1	90	24.93
28.07	1	91	25.21
27.09	1	92	25.48
26.64	1	93	25.76
26.26	1	94	26.04
25.96	1	95	26.32
25.73	1	96	26.59
25.35	1	97	26.87
25.20	1	98	27.15
24.37	1	99	27.42
24.15	1	100	27.70
23.47	1	101	27.98
23.39	1	102	28.25
23.32	1	103	28.53
22.56	1	104	28.81
21.81	1	105	29.09
21.58	1	106	29.36
21.13	1	107	29.64
20.37	1	108	29.92
19.84	1	109	30.19
19.77	1	110	30.47
19.69	1	111	30.75
18.94	1	112	31.02
18.71	1	113	31.30
18.41	1	114	31.58
17.81	1	115	31.86
17.50	1	116	32.13
17.28	1	117	32.41
17.20	1	118	32.69
17.05	1	119	32.96
16.75	1	120	33.24
16.67	1	121	33.52
15.77	1	122	33.80
15.01	1	123	34.07
14.71	1	124	34.35
14.56	1	125	34.63
13.96	1	126	34.90
13.73	1	127	35.18
12.90	1	128	35.46
12.45	1	129	35.73
12.37	1	130	36.01
12.29	1	131	36.29
11.99	2	133	36.84
11.16	1	134	37.12
10.86	1	135	37.40
10.71	1	136	37.67
10.63	2	138	38.23
10.03	1	139	38.50
9.95	1	140	38.78

9.80	1	141	39.06
9.65	1	142	39.34
9.43	1	143	39.61
9.35	1	144	39.89
9.20	1	145	40.17
9.12	1	146	40.44
8.90	2	148	41.00
8.82	1	149	41.27
8.75	1	150	41.55
8.60	3	153	42.38
8.22	3	156	43.21
8.07	1	157	43.49
7.92	1	158	43.77
7.76	2	160	44.32
7.61	3	163	45.15
7.54	1	164	45.43
7.46	1	165	45.71
7.39	2	167	46.26
7.31	1	168	46.54
7.09	1	169	46.81
7.01	1	170	47.09
6.86	1	171	47.37
6.78	1	172	47.65
6.71	2	174	48.20
6.56	1	175	48.48
6.48	1	176	48.75
6.41	2	178	49.31
6.33	3	181	50.14
6.25	7	188	52.08
6.18	1	189	52.35
6.10	3	192	53.19
6.03	4	196	54.29
5.95	1	197	54.57
5.88	4	201	55.68
5.80	1	202	55.96
5.65	3	205	56.79
5.58	1	206	57.06
5.50	4	210	58.17
5.42	1	211	58.45
5.35	2	213	59.00
5.27	4	217	60.11
5.20	2	219	60.66
5.12	2	221	61.22
5.05	3	224	62.05
4.90	1	225	62.33
4.82	2	227	62.88
4.75	3	230	63.71
4.67	1	231	63.99
4.59	4	235	65.10
4.52	2	237	65.65

4.44	5	242	67.04
4.37	3	245	67.87
4.29	3	248	68.70
4.22	1	249	68.98
4.14	1	250	69.25
4.07	2	252	69.81
3.99	2	254	70.36
3.91	5	259	71.75
3.84	2	261	72.30
3.76	2	263	72.85
3.69	4	267	73.96
3.61	4	271	75.07
3.54	2	273	75.62
3.46	1	274	75.90
3.39	1	275	76.18
3.08	3	278	77.01
3.01	1	279	77.29
2.86	2	281	77.84
2.78	1	282	78.12
2.71	1	283	78.39
2.63	5	288	79.78
2.56	5	293	81.16
2.48	5	298	82.55
2.40	4	302	83.66
2.33	2	304	84.21
2.25	1	305	84.49
2.10	3	308	85.32
2.03	2	310	85.87
1.95	5	315	87.26
1.88	7	322	89.20
1.80	3	325	90.03
1.73	3	328	90.86
1.65	7	335	92.80
1.57	2	337	93.35
1.50	1	338	93.63
1.27	2	340	94.18
0.52	2	342	94.74
0.37	2	344	95.29
0.29	2	346	95.84
0.22	4	350	96.95
0.14	11	361	100.00

APPENDIX - C

FLOW RES

FLOW IN CUMECS VRS
PERCENTAGE OF TIMES THE FLOW IS EXCEEDED

MEAN FLOW IS: 28.53CUMECS

MAX FLOW IS: 377.60 CUMECS

MIN FLOW IS: 0.14 CUMECS

FLOW IN CUMECS	NORMAL REDUCED VARIATE	PERCENTAGE OF TIMES FLOW IS EXCEEDED
279.57	-2.33	1.00
259.66	-2.05	2.00
111.41	-1.65	5.00
75.02	-1.28	10.00
55.99	-1.04	15.00
36.59	-0.84	20.00
28.13	-0.67	25.00
19.90	-0.52	30.00
13.78	-0.38	35.00
9.24	-0.25	40.00
7.63	-0.13	45.00
6.34	0.00	50.00
5.92	0.13	55.00
5.28	0.25	60.00
4.60	0.38	65.00
4.04	0.52	70.00
3.62	0.67	75.00
2.62	0.84	80.00
2.13	1.04	85.00
1.80	1.28	90.00
0.41	1.65	95.00
0.19	2.05	98.00
0.16	2.33	99.00

5 DAY MOV.AVERAGE FLOWS CHOSEN FOR ANALYSIS