NOAA Western Region Computer Programs
and Problems NWS WRCP - No. 10

FLASH-FLOOD PROCEDURE

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National Weather Service Western Region
Salt Lake City, Utah
April 1980

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PREFACE

This Western Region publication series is considered as a subset of our Technical Memorandum series. This series will be devoted exclusively to the exchange of information on and documentation of computer programs and related subjects. This series was initiated because it did not seem appropriate to publish computer program papers as Technical Memoranda; yet, we wanted to share this type of information with all Western Region forecasters in a systematic way. Another reason was our concern that in the developing AFOS-era there will be unnecessary and wasteful duplication of effort in writing computer programs in National Weather Service (NWS). Documentation and exchange of ideas and programs envisioned in this series hopefully will reduce such duplication. We also believe that by publishing the programming work of our forecasters, we will stimulate others to use these programs or develop their own programs to take advantage of the computing capabilities AFOS makes available.

We solicit computer-oriented papers and computer programs from forecasters for us to publish in this series. Simple and short programs should not be prejudged as unsuitable.

The great potential of the AFOS-era is strongly related to local computer facilities permitting meteorologists to practice in a more scientific environment. It is our hope that this new series will help in developing this potential into reality.

NOAA Western Region Computer Programs and Problems NWS WRCP

1 Standard Format for Computer Series. June 1979.
2 AFOS Crop and Soil Information Report Program. Ken Mielke, July 1979.
3 Decoder for Significant Level Transmission of Raobs. John Jannuzzi, August 1979.
4 Precipitable Water Estimate. Elizabeth Morse, October 1979.
5 Utah Recreational Temperature Program. Kenneth M. Labas, November 1979.
6 Normal Maximum/Minimum Temperature Program for Montana. Kenneth Mielke, December 1979.
7 Plotting of Ocean Wave Energy Spectral Data. John R. Zimmerman, December 1979.
8 Raob Plot and Analysis Routines. John Jannuzzi, January 1980.
9 The SWAB Program. Morris S. Webb, Jr., April 1980.

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NATIONAL OCEANIC AND
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National Weather
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FLASH-FLOOD PROCEDURE

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I. GENERAL INFORMATION

A. Summary:

This program calculates peak flows for storms that produce heavy precipitation over short periods of time, for small streamflow basins (generally less than 200 square miles).

B. Environment:

This program written in FORTRAN is currently designed to run on the Data General Eclipse. It runs in the free ground along with AFOS; however, all input is through the dasher.

C. References:

This program was written to provide a Flash-Flood procedure, documented in NOAA Technical Memorandum NWS WR-130. Maximum discharges in relation to drainage area data were found in U.S. Geological Surveys Investigation 7-73, "Magnitude and Frequency of Floods in Small Drainage Basins in Idaho."

II. APPLICATION

A. Complete Program Description

The purpose of this program is to automate a self-help procedure that could be quickly and easily used in estimating runoff from thunderstorms in small basins (generally less than 200 square miles).

B. Machine Requirements:

This program requires 10K of memory to execute and 12288 bytes for storage of the save file. If the map is desired, an additional 6447 bytes are required to store "FFMAP". Execution time is minimal. During execution the program opens 3 RDOS channels, requiring one each for output, input, and access to FFMAP (a file).

C. Structure of Software:

No subroutines are used, except those inherent in the FORTRAN package; such as FOPEN.

D. Data Base:

If a sub-basin map of the Salt Lake City River Forecast Center area of responsibility is required (available in Technical Memorandum WR-130), one file titled FFMAP is needed. This is a card image of the sub-basins.

III. PROCEDURES

A. Initiation of Program/Input Requirements:

1) Type the name of the program to enter it in core.

2) Enter input, (prompts, guide user through the TTY dasher). Example of input drainage follows:

After activation of the program, a prompt for subareas will be displayed. If the map of the subareas is desired, the program accesses file "FFMAP" and the map of the Salt Lake City River Forecast Center area of responsibility is printed. This shows the three Flash-Flood subareas referenced in Technical Memorandum NWS WR-130. The program then asks for a subarea number. By looking at the map it can be determined which subarea the basin of concern is in. When the subarea number has been entered, the program will determine which set of equations will be used for the remainder of the calculation.

The equations are based on three coaxial graphs found in NOAA Technical Memorandum NWS WR-130. They are derived using curve fittings, as defined below:

Curves are defined by the semi-log relationship

$$y = ae^{bx} \qquad (1)$$

where a and b are constants.

Calculations of a and b can be made by taking the log of (1).

$$\ln y = \ln a + bx \qquad (2)$$

Equation #3

$$a = \exp\left[\frac{\Sigma \ln y}{N} - b\,\frac{\Sigma x}{N}\right] \qquad (3)$$

$$b = \frac{\sum \ln x \ln y - \frac{\sum \ln x \cdot \sum \ln y}{N}}{\sum (\ln x)^2 - \frac{\sum (\ln x)^2}{N}} \qquad (4)$$

The program will then request the area of the basin (in square miles). If only a portion of the basin is being covered by precipitation (which can be determined from radar and observations), that portion is all that is used. The parameters are the amount of precipitation in inches and the duration of the storm in minutes. These data are then run through the set of equations, and a peak flow in cubic-feet-per-second is then printed out.

Example of output is presented below:

```
FFP
MAP OF SUBAREAS (1=YES, 2-NO) 2
SUBAREA NUMBER (1,2, or 3) 1
AREA OF BASIN, SQ MI  25
PRECIPITATION, INCHES  2.Ø
DURATION, MIN  3Ø
```

B. Output:

Peak flow calculations are output to TTY (dasher). Example of output is presented below:

```
***** FLOW *****

    1Ø15Ø. CFS

________________

ANOTHER BASIN RUN (1=YES, 2=NO) 2
STOP
R
```

C. Cautions and Restrictions:

Working with Co-axial graphs can be very frustrating especially near the origin. Near the origin answers become very subjective or equations may become unstable. The program has checks which warn the user of possible problems.

Possible warnings which can be printed:

*** Precip amount is too small to compute on graph *

*** Equations may be unstable for areas less than 5 SQ MI ***

D. Complete Program Listing:

```
C
C     **********************
C     *                    *
C     *  FFP PGM  SLC RFC  *
C     *                    *
C     **********************
C
C
C     FLASH-FLOOD PROCEDURE (NOAA TECH MEMO NWS WR-130)
C         WRITTEN BY..... RALPH C. HATCH AND GERALD WILLIAMS
C                          SALT LAKE CITY RIVER FORECAST CENTER
C
C
C     DATA INITIALIZATION
C
      DIMENSION MAP(40),DUR(10),ARA(7),A2(7),B(7),B1(10,3),A1(10,3)
      COMMON /X1/AQ,BQ,DUR,ARA,A2,B,B1,A1
      DATA AQ,BQ/11390.15,.593700/
      DATA B/.4926,.3885,.3809,.3429,.3146,.3061,.2453/
      DATA A2/1.0180,.9238,.8117,.6741,.4402,.3530,.2486/
      DATA DUR/5.,10.,15.,30.,60.,120.,180.,360.,720.,1440./
      DATA ARA/1.,10.,25.,50.,100.,200.,500./
      DATA B1/.1321,.1717,.214,.3172,.39456,.4489,.4713,.529,.5566,
     * .633,.0814,.1114,.1346,.1902,.2399,.2725,.3042,.3833,.4517,
     * .506,.0753,.094,.1111,.1538,.2101,.2163,.233,.298,.3549,.387/
      DATA A1/.242,.4164,.5433,.6594,.8787,.9242,1.023,1.0776,
     * 1.3342,1.3908,.225,.3115,.435,.4955,.6525,.7275,.763,.8325,
     * .89,.99,.1083,.2291,.324,.4279,.5328,.6288,.6888,.7383,.7984,
     * .925/
C
C     FORMATS
C
  100 FORMAT(40A2)
  110 FORMAT(2X,40A2)
  115 FORMAT(///1X,'***** FLOW *****',//2X,F10.0,' CFS',//20(1H_),/)
  120 FORMAT(///1X,'**** PRECIP AMOUNT IS TO SMALL TO COMPUTE ON GRAPH
     *',//)
  125 FORMAT(//1X,'*** EQUATIONS MAYBE UNSTABLE FOR AREAS LESS THAN
     * 5 SQ MI ***',//)
C
C     START OF MAIN PROGRAM
C
C
C
C     DISPLAY MAP
C
      ACCEPT "MAP OF SUBAREAS (1=YES, 2=NO) ",KEY
      IF(KEY.GE.2) GO TO 20
      CALL FOPEN(2,"FFMAP",80)
   10 READ(2,100,END=20) MAP
      WRITE(10,110) MAP
      GO TO 10
C
C     INPUT DATA FROM TTY
C
   20 ACCEPT "SUBAREA NUMBER (1,2, OR 3) ",ISA
      ACCEPT "AREA OF BASIN, SQ MI  ",AREA
      ACCEPT "PRECIPITATION, INCHES  ", PRECIP
      ACCEPT "DURATION, MIN  ",DURTN
      IF(AREA.LE.5.0) WRITE(10,125)
C
C     CALCULATIONS ON TOP OF GRAPH
C
      DO 200 I=1,10
      K=I
      IF(DURTN.EQ.DUR(I)) GO TO 210
  200 CONTINUE
      DO 205 I=1,9
      K=I+1
      IF(DURTN.GT.DUR(K)) GO TO 205
      TEMP=(DURTN-DUR(I))/(DUR(K)-DUR(I))
      BB=B1(I,ISA)+(TEMP*(B1(K,ISA)-B1(I,ISA)))
      A=A1(I,ISA)+(TEMP*(A1(K,ISA)-A1(I,ISA)))
      GO TO 215
```

```
205     CONTINUE
210     BB=B1(K,ISA)
        A=A1(K,ISA)
215     X=(PRECIP-A)/BB
        IF(X.LT.0) GO TO 240
C
C       CALCULATIONS ON BOTTOM SECTION OF GRAPH
C
        DO 220 I=1,7
        K=I
        IF(AREA.EQ.ARA(I)) GO TO 230
220     CONTINUE
        DO 225 I=1,6
        K=I+1
        IF(AREA.GT.ARA(K)) GO TO 225
        TEMP=(ARA(K)-AREA)/(ARA(K)-ARA(I))
        Y1=A2(I)*EXP(B(I)*X)
        Y2=A2(K)*EXP(B(K)*X)
        TEMP=TEMP*(Y1-Y2)
        Y=Y2+TEMP
        GO TO 235
225     CONTINUE
230     Y=A2(K)*EXP(B(K)*X)
235     Y=Y*100.*AREA
C
C       SETS LIMIT ON MAXIMUM DISCHARGE VS. DRAINAGE AREA
C       FROM STUDY OF MATTHAI, 1969 ----- USGS
C
        YT=AQ*AREA**BQ
        IF(Y.GT.YT) Y=YT
C
C       OUTPUT ANSWER
C
        WRITE(10,115) Y
        GO TO 245
240     WRITE(10,120)
245     ACCEPT"ANOTHER BASIN RUN (1=YES, 2=NO)   ",KEY
        IF(KEY.LT.2) GO TO 20
        STOP
        END
```

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