COMPUTER PROGRAM FOR THE REDUCTION AND PRELIMINARY ANALYSES OF RUNOFF DATA

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CONTENTS

PLEASE MAKE THE FOLLOWING CORRECTIONS

Page	Correction
7	The last six lines of table 1 should carry the heading "Station Information Card"; they pertain to the section entitled "Station Information."
12	In the first line of the last paragraph, change "indeed" to "indexed."
13	Title the figure "Figure 5.--Maximum Volume Search with no Interpolation."
27	Please note the changes to be made in the program listing, Appendix 3.
28 & 29	Change "fig. 5" to "fig. 3" in the definitions of DELT1, DELT2, HC0, HC1, HC2.
31	Change "table 3" to "table 1" in the definition of P(J).

COMPUTER PROGRAM FOR THE REDUCTION AND PRELIMINARY ANALYSES OF RUNOFF DATA [1]

D. A. Woolhiser [2] and K. E. Saxton [3]

INTRODUCTION

Electronic digital computers have been used for the reduction and analyses of runoff data for several years. Their speed and accuracy have made them extremely valuable for this purpose.

Most of the available programs have been written for computers having smaller storage capacities than those currently available. Because of their limited storage capacity, two runs are usually required with the output of the basic data-reduction program serving as input for the analyses program. In many cases, the input-output operations require more time than the computations.

This program performs the reduction and preliminary analyses of runoff data with a single pass of the data. From the time-stage data of the flow events and the station's rating information, the program computes flow rates, flow volumes, flow durations and volumes above selected rates, and maximum amounts of flow for selected time intervals.

The program was written to compute runoff from agricultural watersheds as measured by weirs and pond outlet structures. However, it is sufficiently general that it may be applied to nearly all types of flow-measuring devices having a known stage-discharge relation. Many constants within the analyses portion of the program may be easily modified to allow for specific applications.

The program was written in FORTRAN for use on a Control Data Corporation 1604 computer [4]; however, it is adaptable to most other computers. The authors have successfully adapted it, without major programming changes, to an IBM 1620 having 60,000 units of storage. This version of the program may be obtained from the authors.

Since the program is generally adaptable, its description will be useful to those engaged in hydrologic research involving field measurement of runoff. Additional clarification of the program can be obtained from either of the authors.

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[2] Formerly with Soil and Water Conservation Research Division at Columbia, Mo.; now at Cornell University, Ithaca, N.Y.

[3] Soil and Water Conservation Research Division at Columbia, Mo.

[4] Trade names are used in this publication solely to provide specific information. Mention of a trade name does not constitute a guarantee or warranty and does not signify that the product is approved to the exclusion of other comparable products.

PROGRAM FEATURES

This program computes instantaneous rates of discharge from simultaneous stage and time readings and numerically integrates these rates with respect to time to obtain runoff volumes. These volumes are summed by storms, days, months, and years. Flow volumes and durations at discharges equal to or greater than twenty specified rates are computed, and annual maximum volumes are determined for nine specified time intervals. All calculations and summaries for reduction and analyses are accomplished with a single pass of the input data.

Four optional methods of computing discharge rates are provided:

1. As a function of stage alone.
2. As a function of stage and ponding.
3. As a function of stage and ponding with the rate of ponding corrected for rain falling on the pond.
4. As a function of stage, ponding, rainfall-on-the-pond, and a variable drainage area caused by changes in the surface area of the pond as the stage changes.

A detailed description of the computer program is presented in the appendixes. A complete flow chart is shown in appendix 1. The flow chart has been separated into 14 divisions according to various functions. Some overlap is inevitable, particularly in indexing. The primary function of each division is given in appendix 2.

To complete the program's description, the FORTRAN statements are given in appendix 3 and the symbol definitions are given in appendix 4. The program statements are listed exactly as they are used in the program. Punching and stacking a deck containing these statements will produce a functional program.

INPUT

The input to the program is read from standard data processing cards. It consists principally of the following:

1. Several cards of basic time units and constants used in computing.
2. A "station card" containing codes and information for the particular type of calculations to be used for the station's data.
3. Tabular values defining the station's stage-discharge relation, stage-pondage relation, and stage-area relation. The latter two may be used optionally.
4. Data of either time-stage or time-stage-precipitation readings from recorder charts.
5. Code cards for designating specific functions.

An example of input to the program is shown to aid in understanding the program. Figure 1 shows the instrument chart of time-stage relation, and figure 2 is a list of the complete input to the program. This represents the input for a typical isolated runoff event over a weir on an intermittent stream having a small pond created by flow. Pondage is considered; however, rainfall-on-the-pond and a variable drainage area are not considered since the pond is small in relation to the drainage area. Two lines of input data, the first and fifth, have been left unfilled to illustrate that the input cards do not have to be full; two time increments, those underscored, have intentionally been made negative to illustrate the elimination of the values in error.

To adequately present each portion of the input, a detailed description follows.

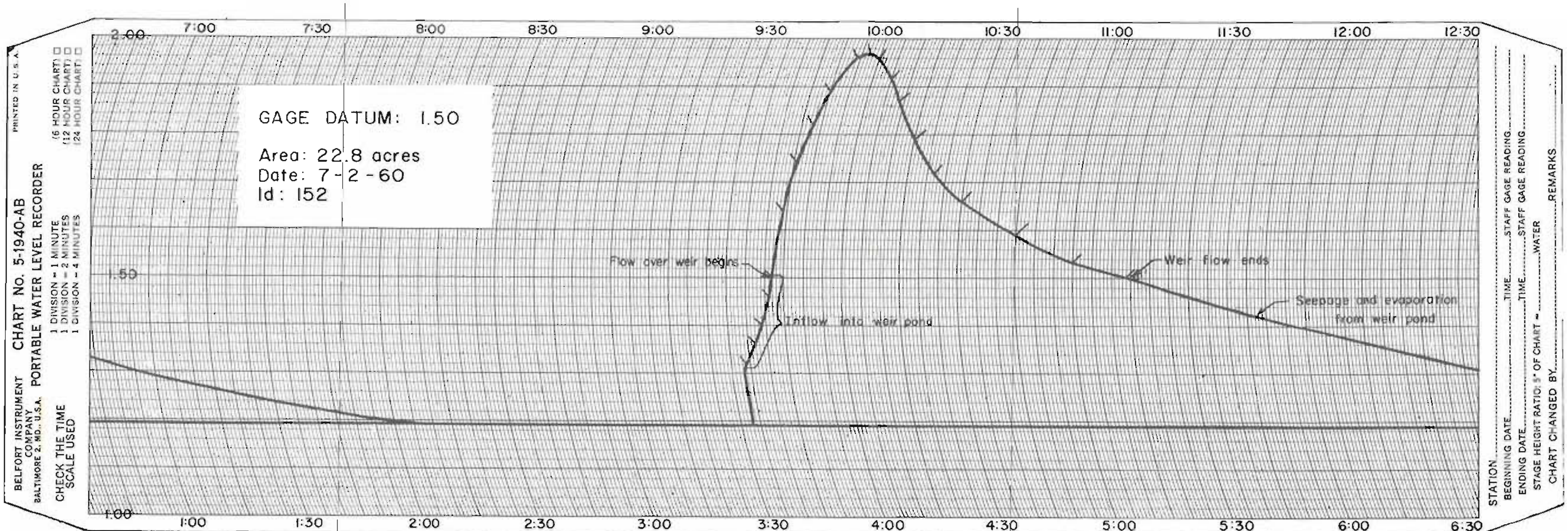


Figure 1.--Stage recorder chart showing example event.

```
Basic Constants
 0  31 059 090 120 151 181 212 243 273 304 334
 0  31 060 091 121 152 182 213 244 274 305 335
 .0010   .0016   .0025   .0040   .0063   .0100   .0160   .0250   .0400   .0630
 .1000   .1600   .2500   .4000   .6300  1.0000  1.6000  2.5000  6.3000 10.0000
 1.   2.   6.  12.  24.  48.  72. 120. 192.
Station Card
 152 1 2 2 160 150  0 .01 .01 0.0  1.50  1.10  22.8
Rating Table
   .000    .000    .000    .001    .002    .004    .006    .009    .013    .017
   .023    .030    .038    .047    .057    .068    .080    .093    .107    .122
   .138    .155    .174    .194    .216    .239    .263    .289    .316    .344
   .374    .406    .440    .474    .510    .548    .588    .630    .674    .720
   .766    .816    .867    .920    .975   1.040   1.100   1.160   1.220   1.290
  1.360   1.430   1.500   1.560   1.640   1.720   1.800   1.880   1.970   2.060
  2.150   2.240   2.340   2.440   2.540   2.640   2.740   2.860   2.960   3.080
  3.200   3.320   3.440   3.570   3.700   3.830   3.960   4.100   4.240   4.380
  4.530   4.670   4.820   4.970   5.130   5.290   5.450   5.620   5.790   5.960
  6.140   6.320   6.500   6.690   6.880   7.070   7.260   7.450   7.630   7.830
  8.030   8.240   8.450   8.670   8.890   9.110   9.340   9.570   9.800  10.100
 10.300  10.600  10.800  11.100  11.300  11.600  11.800  12.100  12.300  12.600
 12.800  13.100  13.400  13.600  13.900  14.200  14.500  14.800  15.000  15.300
 15.600  15.900  16.200  16.500  16.800  17.100  17.400  17.700  18.000  18.300
 18.600  19.000  19.400  19.800  20.100  20.500  20.900  21.300  21.700  22.100
 22.500  22.900  23.300  23.700  24.100  24.500  24.900  25.300  25.700  26.100
Pondage Table
  7.600   7.800   8.100   8.300   8.600   8.800   9.000   9.300   9.500   9.800
 10.000  10.200  10.400  10.700  10.900  11.100  11.300  11.500  11.800  12.000
 12.200  12.400  12.700  12.900  13.100  13.400  13.600  13.800  14.100  14.300
 14.500  14.700  14.900  15.200  15.400  15.600  15.800  16.000  16.300  16.500
 16.700  16.900  17.200  17.400  17.600  17.900  18.100  18.300  18.500  18.800
 19.000  19.300  19.500  19.800  20.000  20.300  20.500  20.800  21.000  21.300
 21.500  21.900  22.300  22.700  23.100  23.500  23.800  24.200  24.600  25.000
 25.400  26.000  26.500  27.100  27.700  28.200  28.800  29.400  29.900  30.500
 31.100  31.800  32.400  33.100  33.700  34.400  35.000  35.700  36.300  37.000
 37.600  38.600  39.500  40.500  41.500  42.400  43.400  44.400  45.300  46.300
 47.300  48.300  49.200  50.200  51.200  52.100  53.100  54.100  55.000  56.000
 57.000  58.000  59.000  60.000  61.000  62.000  63.000  64.000  65.000  66.000
 67.000  68.100  69.100  70.200  71.300  72.300  73.400  74.400  75.500  76.600
 77.700  78.800  79.900  81.000  82.100  83.200  84.300  85.400  86.500  87.600
 88.700  89.800  90.800  91.900  92.900  94.000  95.000  96.100  97.100  98.200
Runoff Data
+ 152 07 02+60-09. 34. 01.32 09. 37. 01.36 09. 39. 01.40
+ 152 07 02+60 09. 41. 01.46 09. 42. 01.50 09. 44. 01.64 09. 46. 01.74
+ 152 07 02+60 09. 48. 01.82 09. 50. 01.89 09. 54. 01.96 09. 57. 01.97
+ 152 07 02+60 10. 00. 01.96 10. 05. 01.92 10. 09. 01.87 10. 00. 01.79
+ 152 07 02+60 10. 22. 01.72 10. 30. 01.66 10. 25. 01.59
+ 152 07 02+60 11. 00. 01.53 11. 14. 01.50 11. 16. 01.50
+ 152 99
BLANK CARD
```

Figure 2.--Computer input of the example event.

Basic Constants

The basic constants used in the computations are listed on five cards as shown in table 1.

Cards Nos. 1 and 2 contain the accumulated days of the year at the beginning of each month. LDAY(M) is for a non-leap year and LEAP(M) is for a leap year.

Cards Nos. 3 and 4 contain the rates, CLASS(J), in inches per hour, used as limiting rates in the flow-duration computations. Volumes and durations of flow occurring at rates equal to or greater than CLASS(J) are computed. These rates may be varied as desired by changing the CLASS(J) values.

Card No. 5 contains the time periods, P(J), in hours, used when searching for maximum amounts of runoff for specified time periods. These values may also be varied as desired.

TABLE 1.--Basic constants used in computations

Accumulated days of the year (format 4)[1]

LDAY (M)	0	31	59	90	120	151	181	212	243	273	304	334
LEAP (M)	0	31	60	91	121	152	182	213	244	274	305	335

Flow-duration class rates, inches per hour (format 151)

CLASS (J) [2]	.0010	.0016	.0025	.0040	.0063	.010	.016	.025	.040	.063
	.100	.16	.25	.40	.63	1.00	1.60	2.50	6.30	10.00

Time lengths for maximum amount search, hours (format 3)

P (J) [3]	1.	2.	6.	12.	24.	48.	72.	120.	192.

1-5	6-7	8-9	10-11	12-15	16-19	20-23	24-27
+ XXXX	+X	+X	+X	+XXX	+XXX	+XXX	+.XX
ID	NA	NB	NC	NQ	NP	NAF	QI

28-31	32-35	36-42	43-49	50-56
+.XX	+X.X	+XXX.XX	+XXX.XX	+XXXXX.
PI	AI	GDE	PDE	ACRE

[1] For format statements, see FORTRAN program listing, appendix 3.
[2] CLASS (J) intervals may be modified by changing the values in this table. Those shown plot evenly on a logarithmic scale.
[3] The time lengths may be set at any selected value.

Station Information

The following is the format and definition of the constants provided on the station information card. The first line indicates the spacing across a data card; the second line represents the signs, numbers, and decimals as they would be used; and the third lists the symbol for each station constant (See appendix 4 for symbol definitions.)

Rating Table

Values of the station's discharge, in units of cubic feet per second, are read into and stored in the computer. These values are to be taken at uniform intervals of stage from the stage discharge relation, with the first value being at the station's gage datum elevation, GDE. They are punched in eight-column fields and ten fields per card (10F8.3). The decimal may be punched, or the machine will establish it as three places from the right side of the field if unpunched. All cards must be filled except the last.

The program applies a linear interpolation between tabulated values of discharge to compute the discharge rate for stages between two tabulated values. Therefore, the stage interval, QI, between the discharge rates stored should be selected so a linear interpolation will give the desired accuracy.

The amount of storage set aside in the computer for the rating table values, Q, is specified in the DIMENSION statement. This amount should be large enough to allow for the maximum number of entries expected but not excessive. The same is true for storing the pondage table values, PC, and the watershed area table values, AREA.

Pondage Correction Table

If a pondage correction is to be applied, the values are punched in the same format and under the same rules as the rating table. The unit to be used is cubic feet per second for a rate of change in stage of one foot per minute. The first value must correspond to the pond datum elevation, PDE, specified on the station information card.

Watershed Area Table

If the permeable area of a watershed varies significantly with changes in pond elevation, a variable drainage area table may be necessary. Values in acres of watershed are punched in the same format and under the same rules as the rating table. The first value must correspond to the pond datum elevation, PDE.

Data Cards

The time-stage data are punched in one of two formats depending on whether rainfall values are required.

The following shows the information required and the data card format if no rainfall values are needed; i.e., rainfall-on-the-pond correction is not applied:

1-5	6-8	9-11	12-14	15-18	19-22	23-28	29-32	33-36	37-42
+ XXXX ID	+XX M	+XX KDAY	+XX KYR	+XX. TH(1)	+XX. TM(1)	+XX.XX H(1)	+XX. TH(2)	+XX. TM(2)	+XX.XX H(2)

43-46	47-50	51-56	57-60	61-64	65-70
+ XX. TH(3)	+ XX. TM(3)	+XX.XX H(3)	+ XX. TH(4)	+ XX. TM(4)	+XX.XX H(4)

All symbols are defined in appendix 4. Note that four time-stage readings may be placed on one card. The card does not need to be full; however, all values must be in the farthest left field available. A new card is required if ID, M, KDAY, or KYR change.

The following is the information required and format to be used if rainfall values are needed; i.e., the rate of change in stage for computing the pondage rate is to be corrected for rainfall-on-the-pond.

1-5	6-8	9-11	12-14	15-18	19-22	23-28	29-33	34-37	38-41
+ XXXX ID	+ XX M	+ XX KDAY	+ XX KYR	+ XX. TH(1)	+XX. TM(1)	+XX.XX H(1)	+X.XX D(1)	+ XX. TH(2)	+XX. TM(2)

42-47	48-52	53-56	57-60	61-66	67-71
+ XX.XX H(2)	+X.XX D(2)	+XX. TH(3)	+ XX. TM(3)	+XX.XX H(3)	+X.XX D(3)

Note that only three time-stage-rainfall readings per card are possible with this format.

It may be more convenient and efficient to change the input format from that shown if the user prefers a different time or stage representation. This change would only require modifications of the input format and of those statements that convert time into decimal hours of the year and stage into head.

Codes

The following code cards and tabulating details are used in connection with data input.

1. To signify the end of a station's data:
   Use a data card containing only the station's identifying number, ID, and the code 99 in the spaces provided for M. This card causes the maximum volume search to be made on the year's data just computed and transfers control to the beginning of the program for a new station card to be read.
2. To add or subtract a constant from the stage readings:
   Insert a data card containing only the station's ID, the code 55 in the spaces provided for M, and the correction to be made, SHIFT, in the spaces provided for H(1). This correction value will be added algebraically to all subsequent gage height readings until another correction or a zero is inserted by a similar card. This value is set to zero at the beginning of the calculations for each station.
3. To set the storm total and rates to zero:
   Place a negative sign on an hour reading, TH(I). This sets the storm volume to zero and the corrected discharge at this time and the previous time to zero. A large accumulation of flow may be calculated for a time of no flow in computations involving reservoirs because the pondage rate is not exactly zero. This occurs because the pondage rate is calculated from three consecutive stage values to arrive at a rate for the central value. The pondage rate will not be zero unless all of these values are equal or the rates of change in stage before and after the central value are equal and with opposite signs. Of course, this code should not be used unless the discharge rate, inflow to a reservoir, should in fact be zero.
4. To stop the program:
   Insert a blank card.

Special Notes

Due to the method of calculation used in this program, the last time-stage reading of a station's data is not printed when changing stations or at the end of the data; i.e., when the code M=99 is used. To avoid losing this last reading, a dummy reading is added after the last actual reading. It should have a time a few minutes later and the same gage height as the last actual reading.

The first time increment of a new station year is artificial and has no significance.

No provision has been made for estimated readings, but a code such as a negative minute reading could easily be written into the routine if desired. A provision to handle estimated volumes could also be added.

If a time difference between two successive readings becomes negative because of a tabulating or punching error, the program will eliminate readings until the time increment again becomes positive. When this occurs, an error statement is printed and the computations are continued.

Order of Input Cards

The input cards must be arranged as follows:

1. Program cards (FORTRAN statements).
2. Cards that may be specified by the computer residence.
3. Basic data cards:

LDAY (M)	(one card)
LEAP (M)	(one card)
CLASS (J)	(two cards)
P (J)	(one card)

4. Station card.
5. Discharge rating table.
6. Pondage rating table (if required).
7. Variable drainage area table (if required).
8. Data (including code card M=55 if required). This may include data for more than one year for the same station.
9. Code card M=99.
10. The next station card or a blank card to stop the program.

Repeat card groups 4 through 9 for each station's data to be computed.

METHODS OF CALCULATION

The program performs three principal calculations. They are: (1) computing flow rates and integrating them with respect to time to obtain runoff volumes; (2) determining duration and volume of flow above specified rates of flow, CLASS (J); and (3) searching for maximum volumes of flow occurring during specified lengths of time, P (J). The following is a brief discussion of each of the calculations.

Flow Rates and Volumes

To determine flow volumes, V, the program first determines instantaneous flow rates for each stage reading by referring to the station's rating table. Incremental volumes are obtained by averaging two successive rates and multiplying by the increment of time between them,[5] thus:

$$\Delta V = \frac{QO + QOB}{2} x \Delta t_1,$$

as shown in figure 3.

If ponding is considered, the rate of flow is adjusted to account for the amount ponded by computing the rate of change in stage at HC1 by the relation:

$$RATE = \left[\frac{HC1 - HC0}{\Delta t_1} + \frac{HC2 - HC1}{\Delta t_2} \right] x\ 1/2$$

This approximates the slope of the tangent on the time-stage curve at HC1 by averaging the point-to-point slopes on either side of HC1. If rainfall-on-the-pond is considered, the stage readings are reduced by the amount of rainfall before RATE is calculated.

[5] A more detailed description of this method of computing flow volumes may be found on page 153 of USDA Agriculture Handbook No. 224, "Field Manual for Research in Agricultural Hydrology."

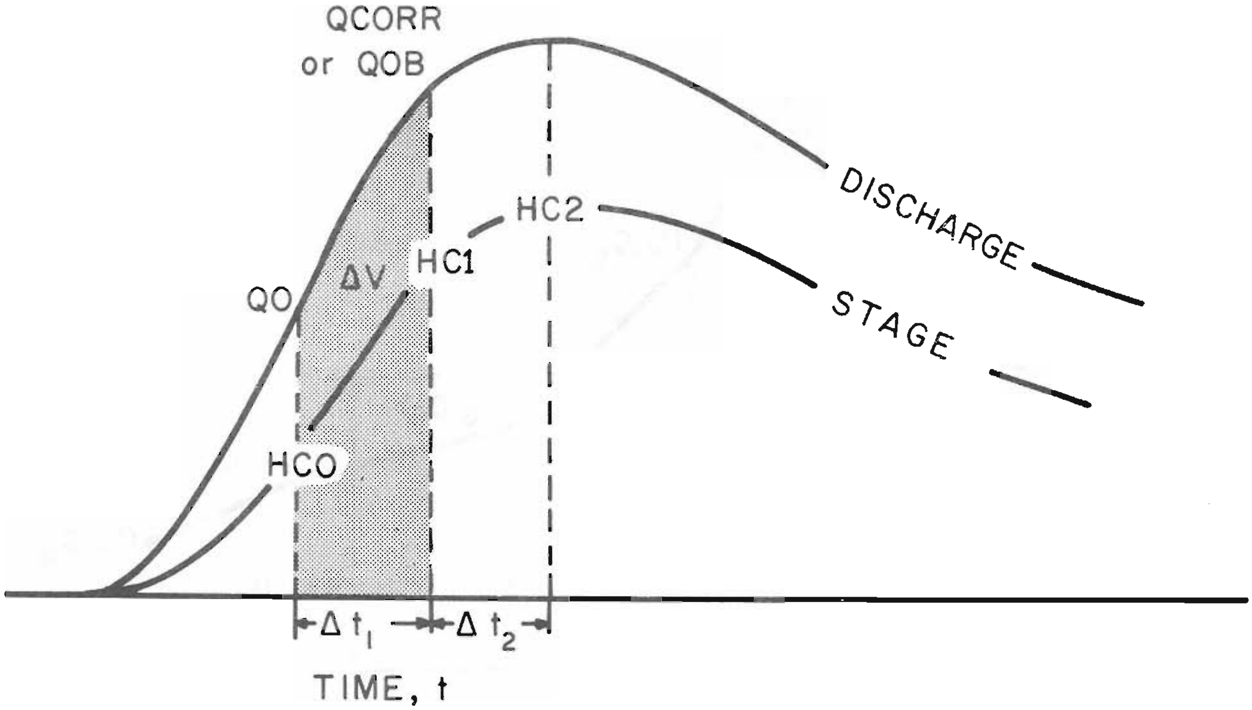


Figure 3.--Calculation of flow volumes.

This rate of change in stage, RATE, is then multiplied by the value in the pondage table corresponding to stage HC1 to obtain a pondage correction flow rate, QP. This value is added algebraically to the observed rate, QOB, to obtain a corrected rate, QCORR. Therefore:

$$QCORR = QOB + QP$$

and

$$\Delta V = \frac{QCORR + QO}{2} \times \Delta t_1$$

These increments of volume are then accumulated to provide the storm, daily, monthly, and annual totals. The accumulated annual volumes and their corresponding times, in hours from the beginning of the year, are stored for the entire year to be used in the search for maximum volumes for specified time intervals.

Flow Durations and Volumes

After each incremental volume is computed, the portion of the volume ΔV and its corresponding time Δt_1 that occur above a flow rate CLASS (J) are accumulated as VOLD (J) and DUR (J). Therefore, by using several flow rates, CLASS (J), as specified in the basic data cards, a flow-duration series is computed.

Consider the hydrograph shown in figure 4. The volume of flow at rates equal to or greater than the rate CLASS (J) is shaded. A straight-line variation of discharge between tabulated points

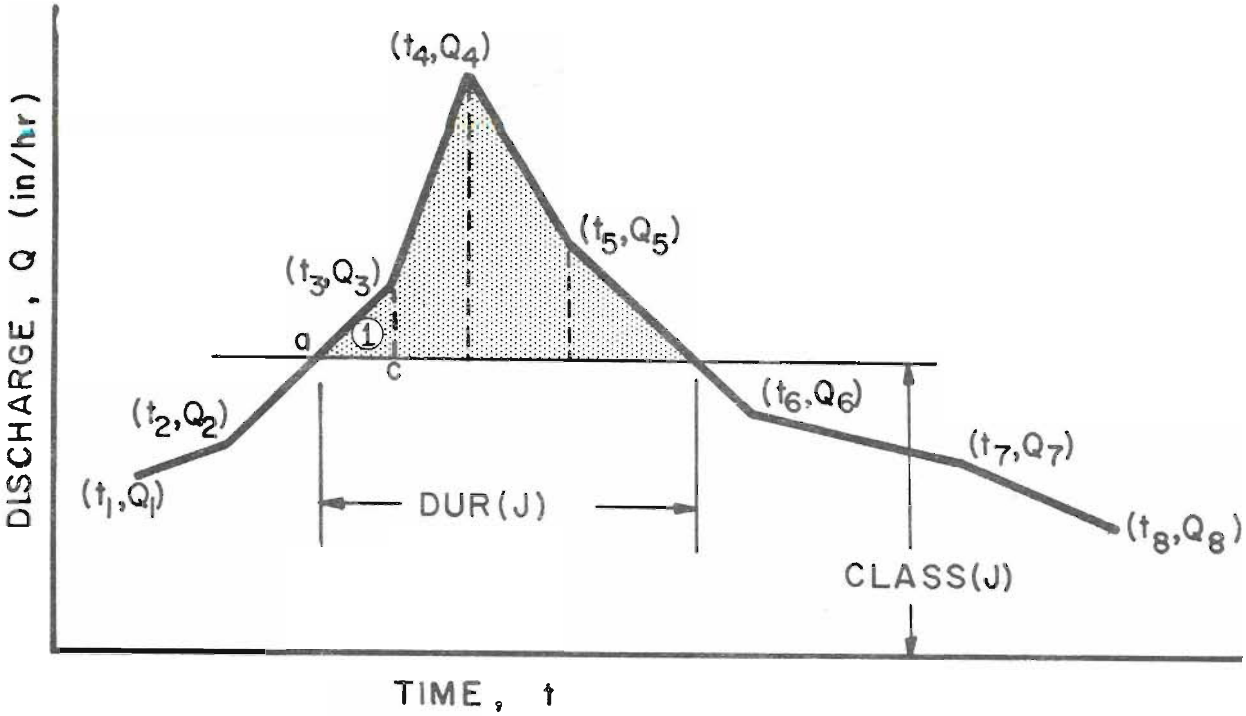


Figure 4.--Hydrograph for determining flow-duration values.

is assumed and the incremental volumes and durations are computed on this basis. For example, the equation for the incremental duration in triangle (1) is:

$$\text{Length (ac)} = \frac{[Q_3 - \text{CLASS (J)}] \times (t_3 - t_2)}{Q_3 - Q_2}$$

and the incremental volume is:

$$\text{Area (1)} = \frac{[Q_3 - \text{CLASS (J)}]^2 \times (t_3 - t_2)}{2(Q_3 - Q_2)}$$

Maximum Volumes

Annual maximum volumes of runoff occurring within the selected time intervals P (J) are determined by a search of the previously calculated data. Two indexed variables, V(L) and T(L), are utilized. V(L) is the accumulated runoff in inches, and T(L) is its corresponding time in hours from the beginning of the calendar year.

The limit of storage in the computer available for storing these values is set in the DIMENSION statement. Since one unit of storage for each variable is required for each input reading, an estimate can be made of the maximum number needed. This represents a sizable amount of storage on the smaller computers; therefore, it may be necessary to store fewer values, search more often, and combine the results.

A mesh of time length P (J) is set up to make this search. The mesh is indeed at J = 1, which sets its length equal to the first value specified in the basic constants. This mesh is then shifted through the stored data to obtain the maximum volume accumulated during this length of time and the time of the beginning of this maximum amount. The mesh is reindexed and the procedure repeated for each successive length of time.

For making this search, LL indexes the leading edge of this mesh and LT the trailing edge. These indices are assigned values equal to the index of a time value. The time value used is the one at which the mesh edge occurs if the mesh edge is coincidental with a time value, or the one immediately following if the mesh edge occurs between two time values. This substitution was made in the following three equations when incorporating them into the program.

There are three possible positions of the search mesh with respect to the stored values of time as it is shifted through the data:

Case A.--The leading and trailing edges exactly coincide with the stored time values T_L as shown in figure 5. Thus no interpolation is required and the volume V_J in the time period P (J) is given by:

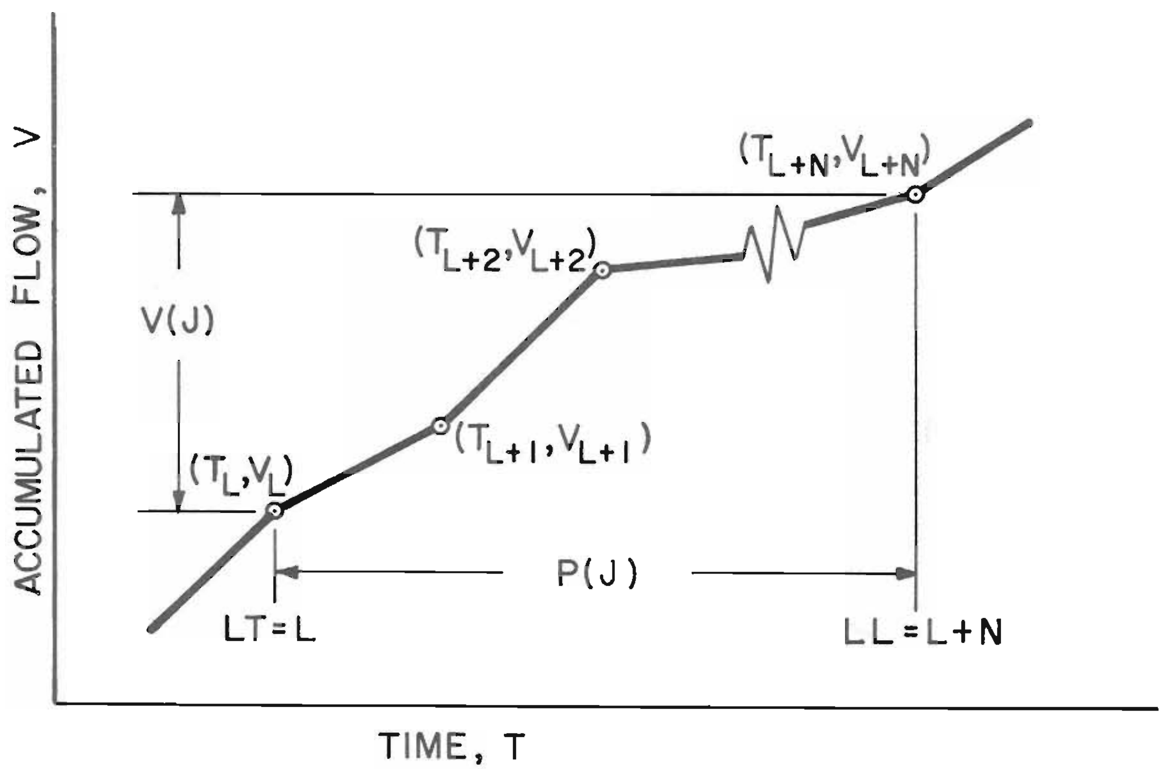
$$V_J = V_{L+N} - V_L$$

Case B.--The leading edge falls between two time values as shown in figure 6. An interpolation is required at the leading edge of the mesh and the volume V_J is given by:

$$V_J = V_{L+N-1} + \frac{P(J) - T_{L+N-1} + T_L}{T_{L+N} - T_{L+N-1}} x \left(V_{L+N} - V_{L+N-1}\right) - V_L$$

Case C.--The trailing edge falls between two time values, as shown in figure 7. Here an interpolation is required at the trailing edge of the mesh; thus, the volume V_J is given by:

$$V_J = V_{L+N} - V_L + \frac{T_{L+N} - T_L - P(J)}{T_{L+N} - T_L} x \left(V_{L+1} - V_L\right)$$



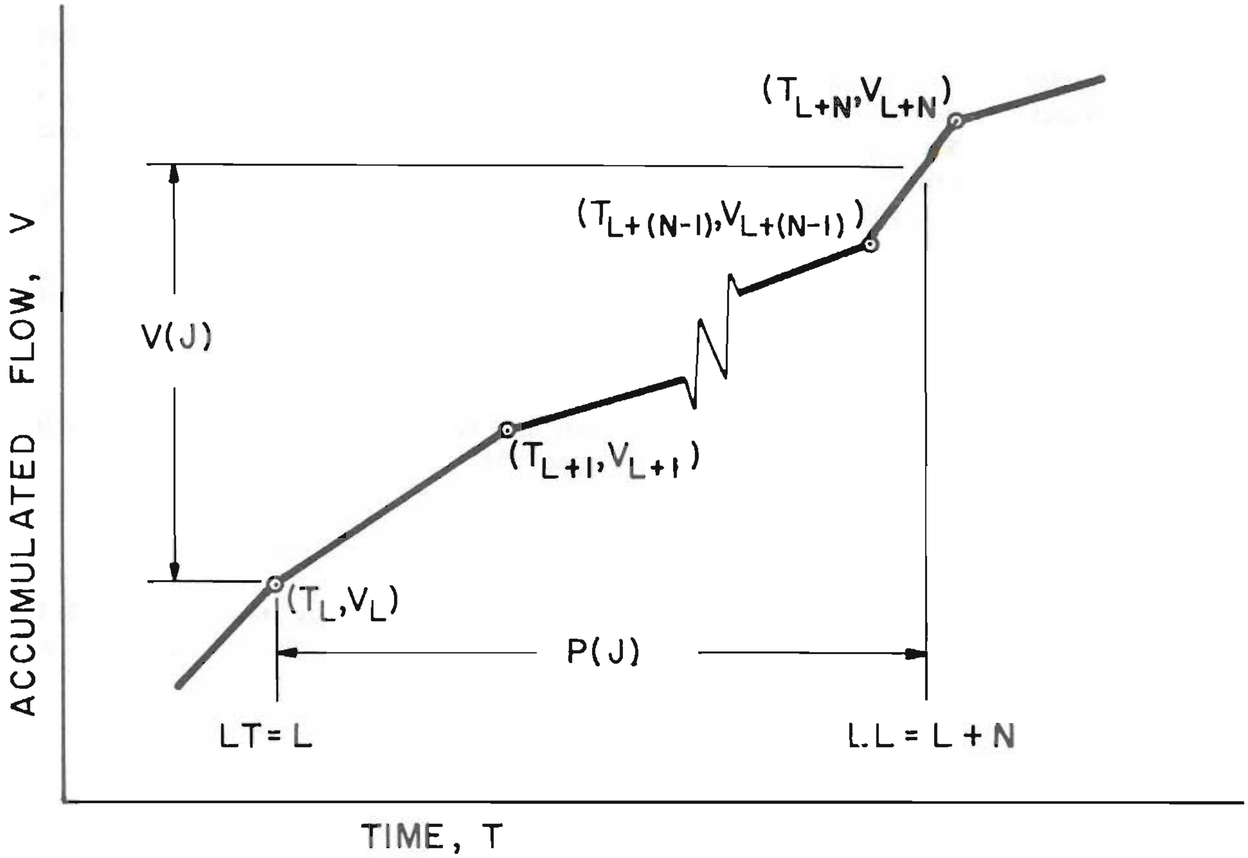


Figure 6.--Maximum volume search with leading edge interpolation.

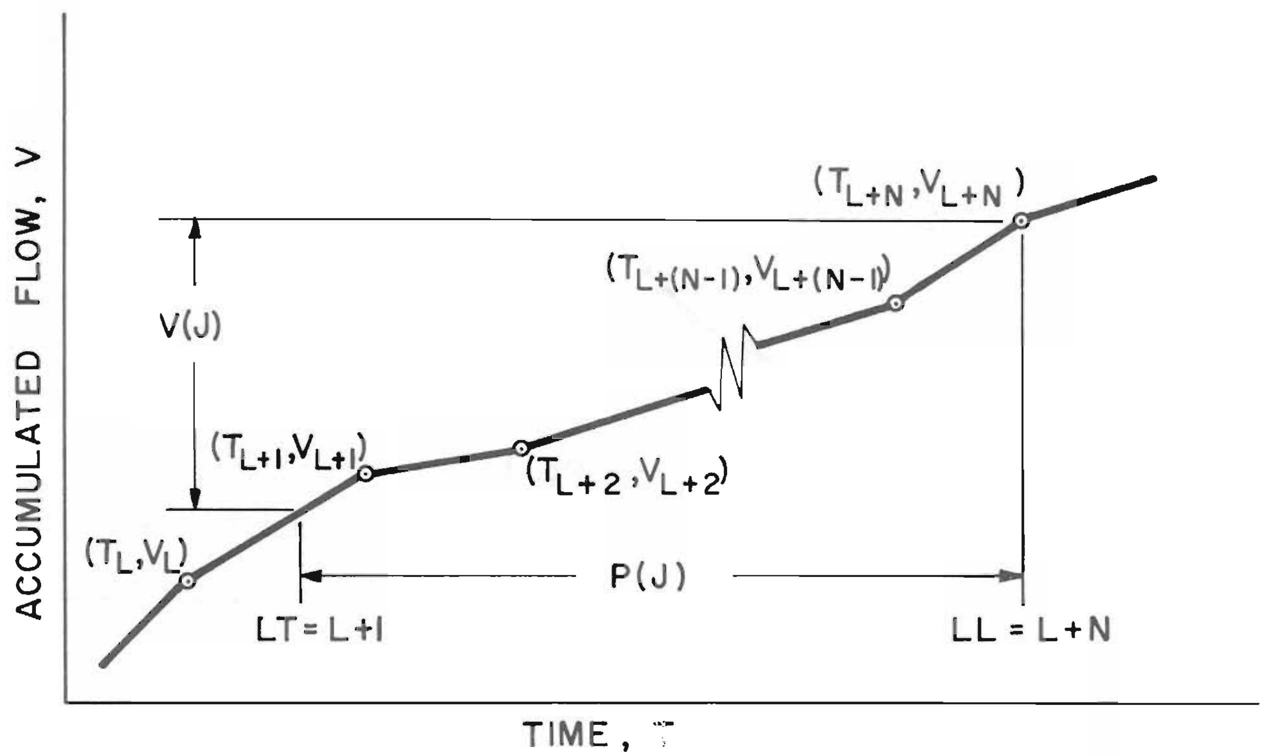


Figure 7.--Maximum volume search with trailing edge interpolation.

OUTPUT

The output of the program includes a line of data for each time-stage reading. Figure 8 shows an example of output obtained from the input example shown in figure 2.

Included in each line are:

1. An identifying number.
2. The month, day, year, and time of the reading.
3. The time increment between readings--hours.
4. The corrected stage--feet.
5. The rate of change in stage--feet per minute.
6. The pondage correction--cubic feet per second.
7. The observed discharge--cubic feet per second.
8. The observed discharge corrected for pondage--cubic feet per second and inches per hour.
9. Accumulated storm, daily, monthly, and annual flow volumes--inches.

The error statements indicate where the difference between two time readings became negative and the latter reading was omitted.

At the end of the year's data or when the code card M=99 is inserted to signify the end of a station's data, the maximum volumes occurring within the selected time intervals P (J) are printed as inches of runoff. The time intervals used in the example shown were arbitrarily selected.

Flow-duration information is printed after the maximum volumes. This includes the times, in hours, and the volumes, in inches, that the flow was equal to or greater than the twenty selected discharge rates.

ID	MO	DAY	YR	HOUR	MIN	DELTTIME	HEAD	DHDT	PONDCOR	QOB(CFS)	CFS	Q(IPH)	STORM	DAILY	MONTHLY	ANNUAL
152	7	2	60	9.	34.	.0167	1.32	.0000	.00	.00	.00	.0000	.0000	.0000	.0000	.0000
152	7	2	60	9.	37.	.0500	1.36	.0167	.23	.00	.23	.0099	.0002	.0002	.0002	.0002
152	7	2	60	9.	39.	.0333	1.40	.0250	.36	.00	.36	.0158	.0007	.0007	.0007	.0007
152	7	2	60	9.	41.	.0333	1.46	.0350	.55	.00	.55	.0241	.0013	.0013	.0013	.0013
152	7	2	60	9.	42.	.0167	1.50	.0550	.92	.00	.92	.0400	.0019	.0019	.0019	.0019
152	7	2	60	9.	44.	.0333	1.64	.0600	1.20	.06	1.26	.0547	.0034	.0034	.0034	.0034
152	7	2	60	9.	46.	.0333	1.74	.0450	1.04	.22	1.26	.0546	.0053	.0053	.0053	.0053
152	7	2	60	9.	48.	.0333	1.82	.0375	.99	.44	1.43	.0624	.0072	.0072	.0072	.0072
152	7	2	60	9.	50.	.0333	1.89	.0262	.80	.72	1.52	.0662	.0094	.0094	.0094	.0094
152	7	2	60	9.	54.	.0667	1.96	.0104	.36	1.10	1.46	.0637	.0137	.0137	.0137	.0137
152	7	2	60	9.	57.	.0500	1.97	-.0000	-.00	1.16	1.16	.0505	.0165	.0165	.0165	.0165
152	7	2	60	10.	0.	.0500	1.96	-.0057	-.20	1.10	.90	.0392	.0188	.0188	.0188	.0188
152	7	2	60	10.	5.	.0833	1.92	-.0103	-.33	.87	.53	.0233	.0214	.0214	.0214	.0214
NEGATIVE DELT TIME INCURRED AFTER NEXT READING																
152	7	2	60	10.	9.	.0667	1.87	-.0120	-.35	.63	.28	.0120	.0226	.0226	.0226	.0226
152	7	2	60	10.	22.	.2167	1.72	-.0095	-.21	.17	.00	.0000	.0239	.0239	.0239	.0239
NEGATIVE DELT TIME INCURRED AFTER NEXT READING																
152	7	2	60	10.	30.	.1333	1.66	-.0059	-.12	.08	.00	.0000	.0239	.0239	.0239	.0239
152	7	2	60	11.	0.	.5000	1.53	-.0032	-.06	.00	.00	.0000	.0239	.0239	.0239	.0239
152	7	2	60	11.	14.	.2333	1.50	-.0011	-.02	.00	.00	.0000	.0239	.0239	.0239	.0239
152	7	2	60	11.	16.	.0333	1.50	.0000	.00	.00	.00	.0000	.0239	.0239	.0239	.0239

ANNUAL FLOW SUMMARY ID= 152 YEAR= 60

MAXIMUM FLOWS

ID	INTER	MO	DAY	HOUR	VOLUME
152	1.	7	2	9.57	.024
152	2.	0	0	.00	.000
152	6.	0	0	.00	.000
152	12.	0	0	.00	.000
152	24.	0	0	.00	.000
152	48.	0	0	.00	.000
152	72.	0	0	.00	.000
152	120.	0	0	.00	.000
152	192.	0	0	.00	.000

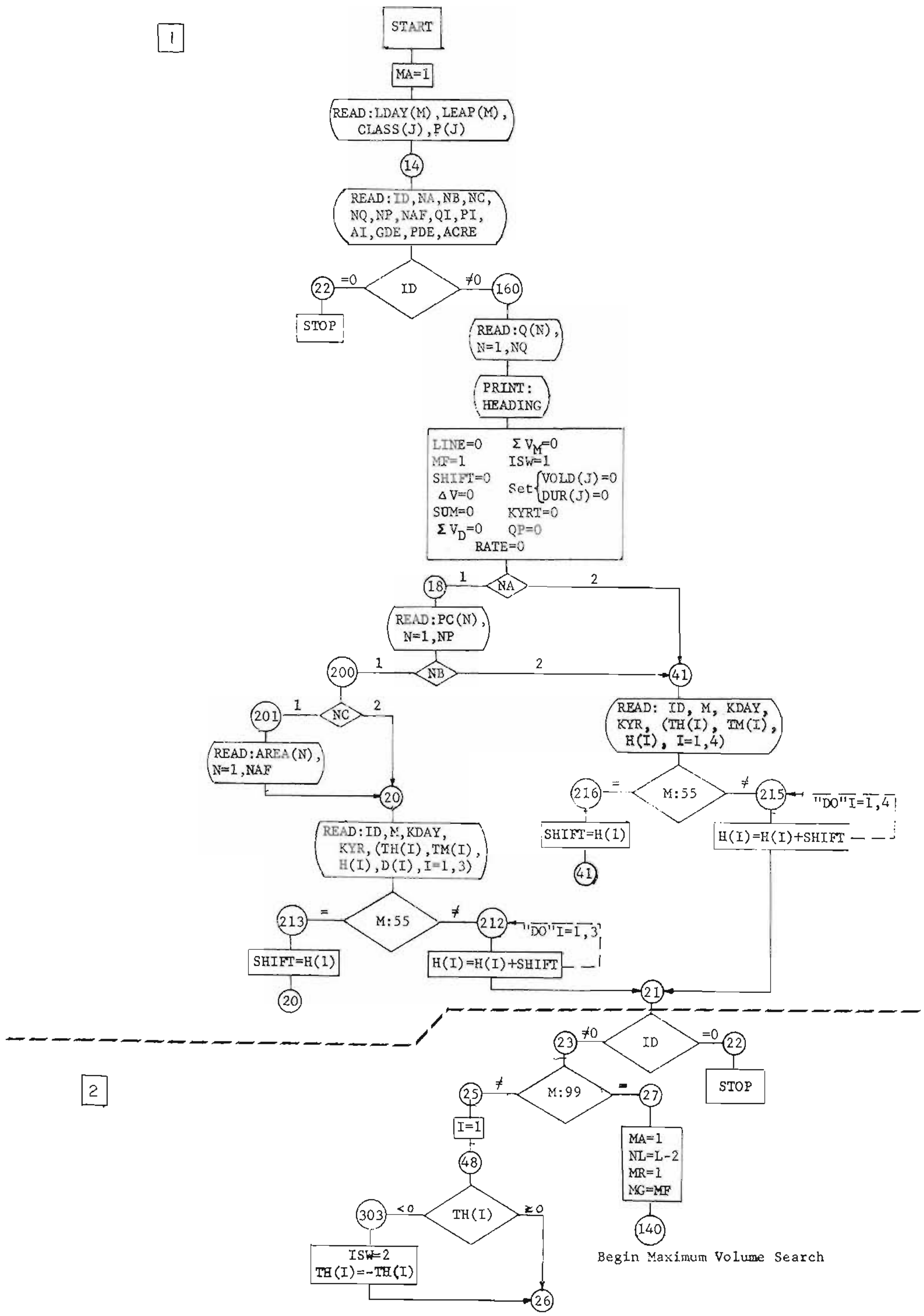
DURATION OF FLOW RATES

RATE	HOURS	VOLUME
.0010	.78	.023
.0016	.76	.023
.0025	.74	.022
.0040	.71	.021
.0063	.65	.019
.0100	.57	.017
.0160	.48	.014
.0250	.39	.010
.0400	.30	.005
.0630	.10	.000
.1000	.00	.000
.1600	.00	.000
.2500	.00	.000
.4000	.00	.000
.6300	.00	.000
1.0000	.00	.000
1.6000	.00	.000
2.5000	.00	.000
6.3000	.00	.000
10.0000	.00	.000

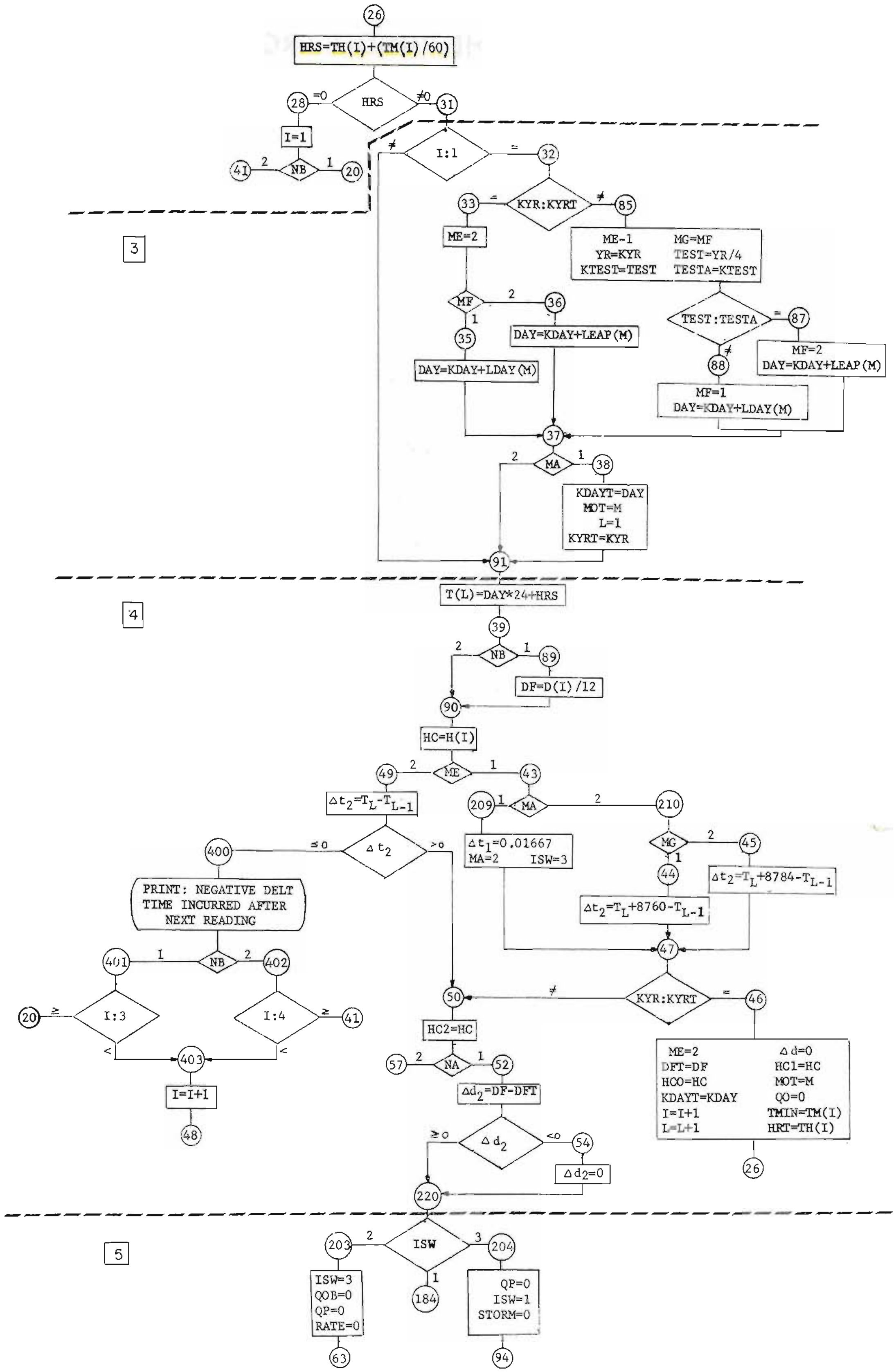
Figure 8.--Example of output obtained from the input shown in figure 2.

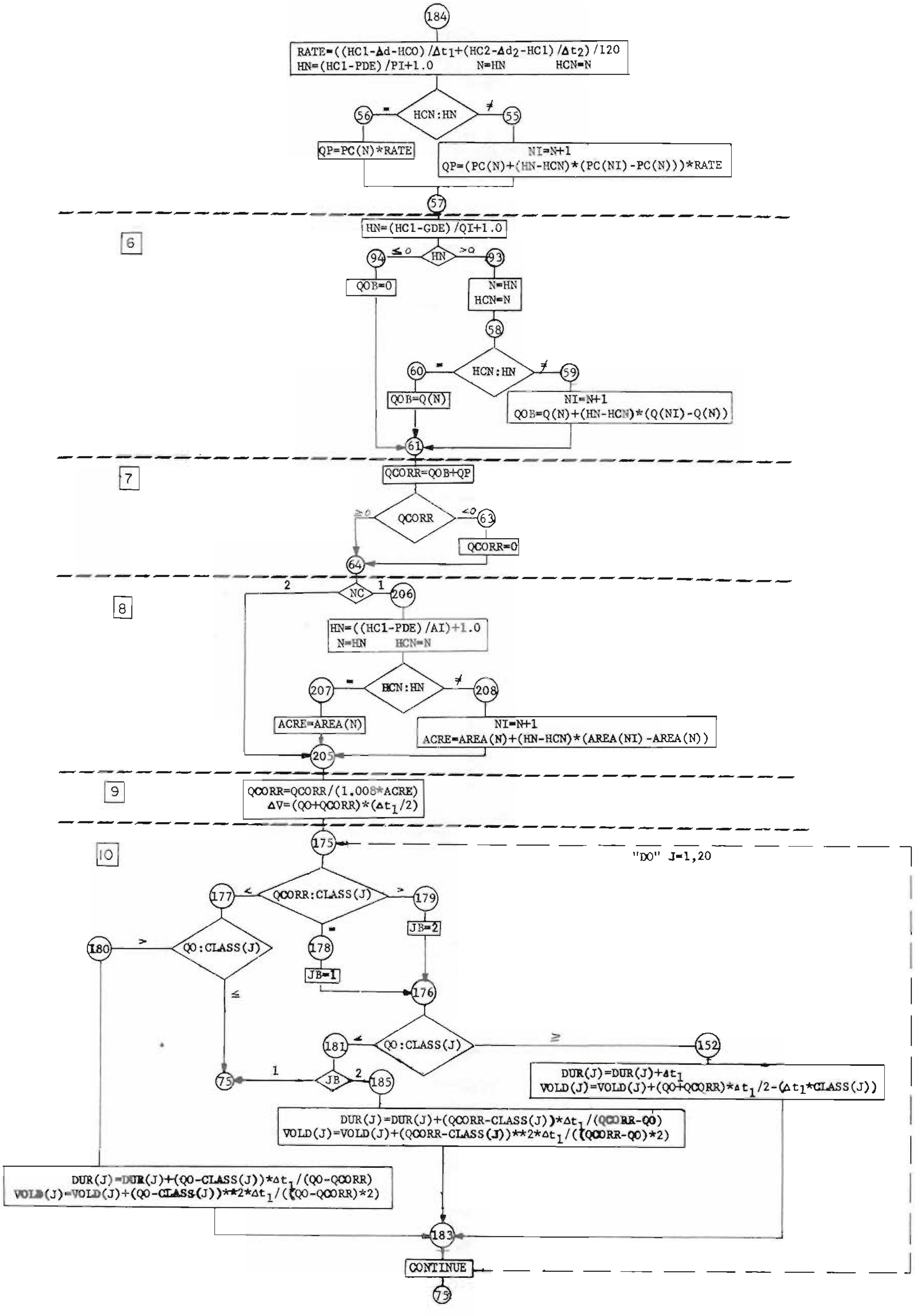
APPENDIX 1

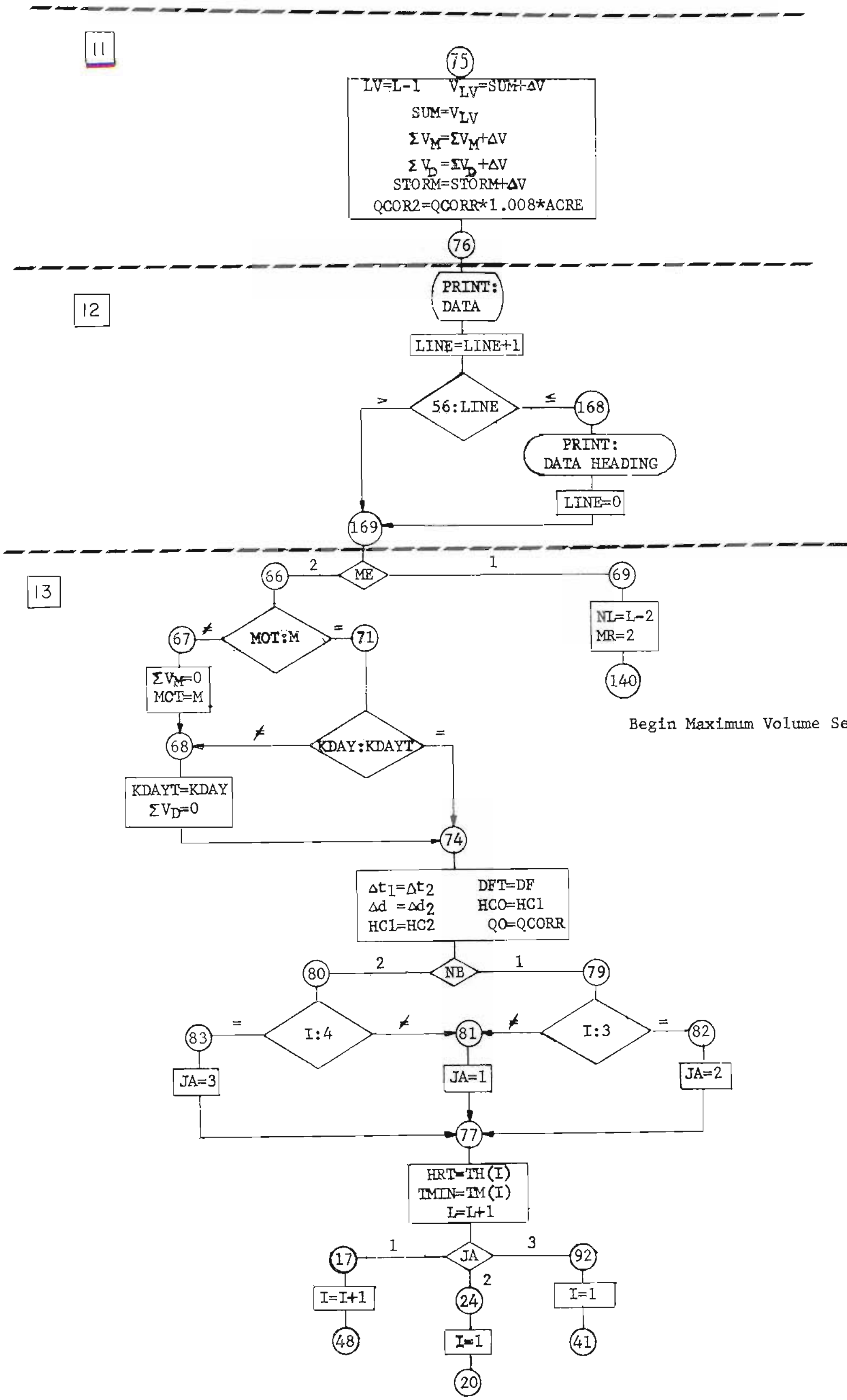
FLOW CHART OF THE RUNOFF PROGRAM



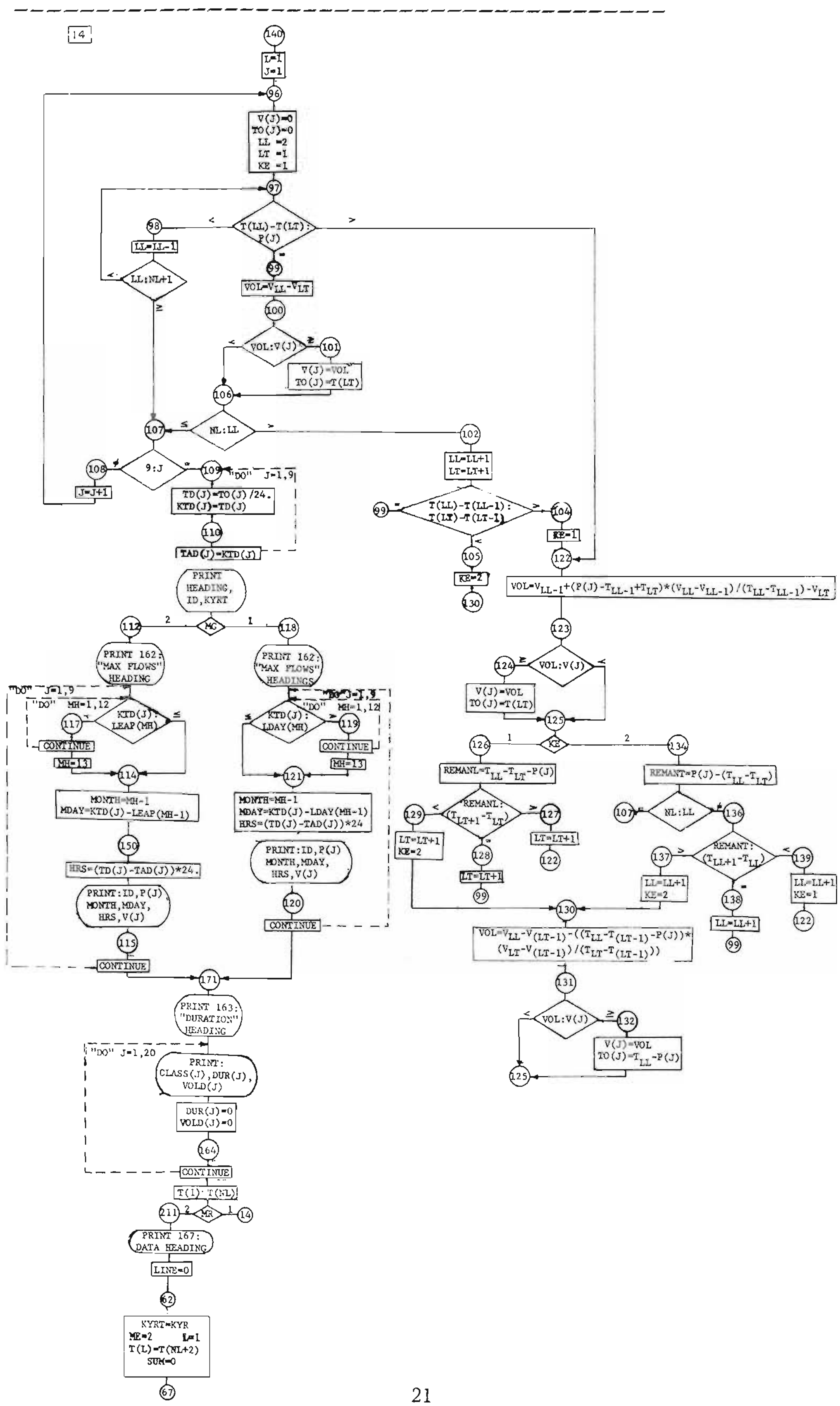
APPENDIX 1--CONTINUED




184
RATE=((HC1-Δd-HCO)/Δt1+(HC2-Δd2-HC1)/Δt2)/120
HN=(HC1-PDE)/PI+1.0 N=HN HCN=N
56
HCN:HN
55
QP=PC(N)*RATE
NI=N+1
QP=(PC(N)+(HN-HCN)*(PC(NI)-PC(N)))*RATE
57
6
HN=(HC1-GDE)/QI+1.0
94
HN
93
QOB=0
N=HN
HCN=N
58
60
HCN:HN
59
QOB=Q(N)
NI=N+1
QOB=Q(N)+(HN-HCN)*(Q(NI)-Q(N))
61
7
QCORR=QOB+QP
QCORR
63
QCORR=0
64
8
NC
206
HN=((HC1-PDE)/AI)+1.0
N=HN HCN=N
207
HCN:HN
208
ACRE=AREA(N)
NI=N+1
ACRE=AREA(N)+(HN-HCN)*(AREA(NI)-AREA(N))
205
9
QCORR=QCORR/(1.008*ACRE)
ΔV=(QO+QCORR)*(Δt1/2)
10
175
"DO" J=1,20
177
QCORR:CLASS(J)
179
JB=2
180
QO:CLASS(J)
178
JB=1
176
181
QO:CLASS(J)
152
DUR(J)=DUR(J)+Δt1
VOLD(J)=VOLD(J)+(QO+QCORR)*Δt1/2-(Δt1*CLASS(J))
75
JB
185
DUR(J)=DUR(J)+(QCORR-CLASS(J))*Δt1/(QCORR-QO)
VOLD(J)=VOLD(J)+(QCORR-CLASS(J))**2*Δt1/((QCORR-QO)*2)
DUR(J)=DUR(J)+(QO-CLASS(J))*Δt1/(QO-QCORR)
VOLD(J)=VOLD(J)+(QO-CLASS(J))**2*Δt1/((QO-QCORR)*2)
183
CONTINUE
75



Begin Maximum Volume Search


14
L=1
J=1
V(J)=0
TO(J)=0
LL =2
LT =1
KE =1
T(LL)-T(LT):
P(J)
LL=LL-1
LL:NL+1
VOL=V_LL-V_LT
VOL:V(J)
V(J)=VOL
TO(J)=T(LT)
NL:LL
9:J
J=J+1
"DO" J=1,9
TD(J)=TO(J)/24.
KTD(J)=TD(J)
TAD(J)=KTD(J)
PRINT HEADING, ID,KYRT
MC
LL=LL+1
LT=LT+1
T(LL)-T(LL-1):
T(LT)-T(LT-1)
KE=1
KE=2
VOL=V_LL-1+(P(J)-T_LL-1+T_LT)*(V_LL-V_LL-1)/(T_LL-T_LL-1)-V_LT
PRINT 162: "MAX FLOWS" HEADING
"DO" J=1,9
"DO" MH=1,12
KTD(J): LEAP(MH)
CONTINUE
MH=13
MONTH=MH-1
MDAY=KTD(J)-LEAP(MH-1)
HRS=(TD(J)-TAD(J))*24.
PRINT:ID,P(J) MONTH,MDAY, HRS,V(J)
PRINT 162: "MAX FLOWS" HEADINGS
KTD(J): LDAY(MH)
MONTH=MH-1
MDAY=KTD(J)-LDAY(MH-1)
HRS=(TD(J)-TAD(J))*24
PRINT:ID,P(J) MONTH,MDAY, HRS,V(J)
VOL:V(J)
V(J)=VOL
TO(J)=T(LT)
KE
REMANL=T_LL-T_LT-P(J)
REMANT=P(J)-(T_LL-T_LT)
REMANL: (T_LT+1-T_LT)
LT=LT+1
KE=2
NL:LL
REMANT: (T_LL+1-T_LL)
LL=LL+1
KE=2
KE=1
VOL=V_LL-V(LT-1)-((T_LL-T(LT-1)-P(J))*
(V_LT-V(LT-1))/(T_LT-T(LT-1)))
VOL:V(J)
V(J)=VOL
TO(J)=T_LL-P(J)
PRINT 163: "DURATION" HEADING
"DO" J=1,20
PRINT: CLASS(J),DUR(J), VOLD(J)
DUR(J)=0
VOLD(J)=0
CONTINUE
T(1)=T(NL)
MR
PRINT 167: DATA HEADING
LINE=0
KYRT=KYR
ME=2 L=1
T(L)=T(NL+2)
SUM=0

APPENDIX 2

DIVISION OF THE PROGRAM BY FUNCTIONS

Division number[6]	Program functions
1.	Initializing and input.
2.	Converting time and making preliminary decisions.
3.	Determining whether year is leap year.
4.	Computing time increments and indexing stage readings.
5.	Computing pondage rate.
6.	Computing observed discharge.
7.	Combining pondage and observed rates.
8.	Correcting for variable drainage area.
9.	Computing flow volume.
10.	Determining flow durations and volumes.
11.	Accumulating volumes.
12.	Printing answers.
13.	Re-indexing and returning to: 1) read a new card, 2) next value on last card read, or 3) maximum volume search.
14.	Maximum volume search.

[6] Corresponding to divisions on the flow chart, appendix 1.

APPENDIX 3

FORTRAN PROGRAM LISTING

```
RØGRAM RUNØFF
)DIMENSIØN Q(200), PC(200), LDAY(12),
   LEAP(12), TH(4), TM(4), H(4), D(4),
   1T(1200), SUMV(1200), V(9), TØ(9),
   KTD(9), TD(9), TAD(9), P(12),
  2 CLASS(20), DUR(20), VØLD(20),
       AREA(50)
  3 FØRMAT(9F5.0)
  4 FØRMAT (12I4)
  5 FØRMAT (I5, 3I2, 3I4, 2F4.2, F4.1,
       2F7.2, F7.0)
  6 FØRMAT (10F8.3)
  8 FØRMAT (I5, 3I3, 3(2F4.0, F6.2,
       F5.2))
  7 FØRMAT (49H NEGATIVE DELT TIME
       INCURRED AFTER NEXT READ-
       ING)
 30 FØRMAT (F9.3, F8.4)
  9 FØRMAT (I5, 3I3, 4 (2F4.0, F6.2))
153 FØRMAT (23X, F8.4, F10.2, F10.3)
 15 FØRMAT (20X, I5, F5.0, 2I3, F6.2,
       F7.3)
173 FØRMAT (27H =ANNUAL FLØW SUM-
       MARY ID= I4, 8H YEAR = I3, ///)
163 FØRMAT (53H DURATIØN ØF FLØW
       RATES RATE HØURS VØLUME)
162 FØRMAT (51H MAXIMUM FLØWS ID
       INTER MØ DAY HØUR VØLUME)
1670 FØRMAT (113H=ID MØ DAY YR HØUR
       MIN DELTTIME HEAD DHDT
       PØNDCØR QØ 1B(CFS) CFS Q(IPH)
       STØRM DAILY MØNTHLY
       ANNUAL)
151 FØRMAT (10F8.4)
    MA =1
 11 FØRMAT (I5, 3I3, 2F4.0, F9.4, F6.2,
       F7.4, 3F8.2, 5F9.4)
    READ 4, (LDAY(M), M= 1, 12)
    READ 4, (LEAP(M), M= 1, 12)
    READ 151, (CLASS(J), J= 1, 20)
    READ 3, (P(J), J =1, 9)
 14 READ 5, ID, NA, NB, NC, NQ, NP,
       NAF, QI, PI, AI, GDE, PDE, ACRE
    IF(ID) 160, 22, 160
160 READ 6, (Q(N), N= 1, NQ)
    PRINT 167
    LINE = 0
    MF = 1
    SHIFT= 0.
    DELV= 0.
    SUM =0.
    SUMVD = 0.
    SUMVM =0.
    ISW = 1
    DØ 154 J= 1, 20
    VØLD(J)= 0.
154 DUR(J)= 0.
    KYRT =0.
    QP= 0.
    RATE =0.
    GØ TØ (18, 41), NA
 18 READ 6, (PC(N), N= 1, NP)
    GØ TØ (200, 41), NB
200 GØ TØ (201, 20), NC
201 READ 6, (AREA(N), N= 1, NAF)
    GØ TØ 20
 41 READ 9, ID, M, KDAY KYR, (TH(I),
       TM(I), H(I), I=1, 4)
    IF (M-55) 215, 216, 215
215 DØ 217 I =1, 4
217 H(I) =H(I)+SHIFT
    GØ TØ 21
216 SHIFT =H(1)
    GØ TØ 41
 20 READ 8, ID, M, KDAY, KYR, (TH(I),
       TM(I), H(I), D(I), I= 1, 3)
    IF(M-55) 212, 213, 212
212 DØ 214 I =1, 3
214 H(I)=H(I)+SHIFT
    GØ TØ 21
213 SHIFT = H(1)
    GØ TØ 20
 21 IF (ID) 23, 22, 23
 22 STØP
 23 IF (M-99) 25, 27, 25
 27 MA =1
    NL = L-2
    MR = 1
    MG =MF
    GØ TØ 140
 25 I =1
 48 IF(TH(I)) 303, 26, 26
```

```
303 ISW=2
    TH(I)=-TH(I)
 26 HRS=TH(I)+(TM(I)/60.)
    IF (HRS) 31, 28, 31
 28 I=1
    GØ TØ (20, 41), NB
 31 IF(I-1) 91, 32, 91
 32 IF(KYR-KYRT) 85, 33, 85
 33 ME = 2
    GØ TØ (35, 36), MF
 35 DAY=KDAY+LDAY(M)
    GØ TØ 37
 36 DAY=KDAY+LEAP(M)
 37 GØ TØ (38, 91), MA
 38 KYRT=KYR
    MØT= M
    KDAYT= KDAY
    L=1
 91 T(L)=(DAY*24.)+HRS
 39 GØ TØ (89, 90), NB
 89 DF = D(I)/12.0
 90 HC = H(I)
    GØ TØ (43, 49), ME
 43 GØ TØ (209, 210), MA
209 DELT1=0.01667
    MA=2
    ISW= 3
    GØ TØ 47
210 GØ TØ (44, 45), MG
 44 DELT2 = T(L)+8760.-T(L-1)
    GØ TØ 47
 45 DELT2 = T(L)+8784.-T(L-1)
 47 IF(KYR-KYRT) 50, 46, 50
 46 ME=2
    DELD=0.
    DFT=DF
    HC1= HC
    HCO= HC
    KDAYT=KDAY
    MØT = M
    QØ= 0.
    TMIN= TM(I)
    HRT=TH(I)
    I=I+1
    L= L+1
    GØ TØ 26
 49 DELT2= T(L)-T(L-1)
    IF(DELT2) 400, 400, 50
400 PRINT 7
    GØ TØ (401, 402), NB
401 IF(I-3) 403, 20, 20
402 IF(I-4) 403, 41, 41
403 I = I+1
    GO TO 48
 50 HC2 = HC
    GØ TØ (52, 57), NA
 52 DELD2 = DF-DFT
    IF(DELD2) 54, 220, 220
 54 DELD2= 0.
220 GØ TØ (184, 203, 204), ISW
203 ISW = 3
    QØB = 0.
    QP= 0.
    RATE = 0.
    GØ TØ 63
204 QP= 0.
    ISW = 1
    STØRM = 0.0
    GØ TØ 94
184 RATE =((HC1-DELD-HCO)/DELT1+
        (HC2-DELD2-HC1)/DELT2)/120.
    HN = (HC1-PDE)/PI+1.0
    N = HN
    HCN = N
    IF (HCN-HN) 55, 56, 55
 55 NI = N+1
    QP=(PC(N)+(HN-HCN)*(PC(NI)-PC(N)))
        *RATE
    GØ TØ 57
 56 QP = PC(N)*RATE
 57 HN = (HC1-GDE)/QI+1.0
    IF(HN) 94, 94, 93
 93 N = HN
    HCN= N
 58 IF(HCN-HN) 59, 60, 59
 94 QØB= 0.
    GØ TØ 61
 59 NI = N+1
    QØB = Q(N)+(HN-HCN)*(Q(NI)-Q(N))
    GØ TØ 61
 60 QØB = Q(N)
 61 QCØRR = QØB+QP
    IF(QCØRR) 63, 64, 64
 63 QCØRR = 0.
 64 GØ TØ (206, 205), NC
206 HN = (HC1-PDE)/AI+1.0
    N = HN
    HCN = N
    IF(HCN-HN) 208, 207, 208
207 ACRE = AREA(N)
    GØ TØ 205
```

```
208 NI = N+1
    ACRE = AREA(N)+(HN-HCN)*(AREA
       (NI)-AREA(N))
205 QCØRR = QCØRR/(1.008*ACRE)
    DELV = (QØ+QCØRR)*DELT1/2.
    DØ 183 J=1, 20
175 IF(QCØRR-CLASS(J)) 177, 178, 179
177 IF(QØ-CLASS(J)) 75, 75, 180
180 DUR(J) =DUR(J)+(QØ-CLASS(J)) * DELT1/
       (QØ-QCØRR)
    VØLD(J) = VØLD(J)+(QØ-CLASS(J))*
       (QØ-CLASS(J))*DELT1/((QØ-
       QCØRR)*2.)
    GØ TØ 183
178 JB = 1
    GØ TØ 176
179 JB   2
176 IF(QØ-CLASS(J)) 181, 152, 152
181 GØ TØ (75, 185), JB
185 DUR(J) = DUR(J)+(QCØRR-CLASS(J))
       *DELT1/(QCØRR-QØ)
    OVØLD(J) = VØLD(J)+(QCØRR-CLASS
       (J))* (QCØRR-CLASS(J))*DELT1/
       ((QCØRR-QØ1)*2.)
    GØ TØ 183
152 DUR(J) = DUR(J)+DELT1
    VØLD(J) = VØLD(J)+(QØ+QCØRR)*
       DELT1/2.-DELT1*CLASS(J)
183 CØNTINUE
 75 LV = L-1
    SUMV(LV = SUM + DELV
    SUM= SUMV(LV)
    SUMVM= SUMVM+DELV
    SUMVD =SUMVD+DELV
    STØRM= STØRM+DELV
    QCØR2= QCØRR * 1.008 * ACRE
760 PRINT 11, ID, MØT, KDAYT, KYRT,
       HRT, TMIN, DELT1, HC1, RATE,
       QP, QØB, QCØR2, 1QCØRR, STØRM,
       SUMVD, SUMVM, SUM
    LINE = LINE + 1
    IF (56-LINE) 168, 168, 169
169 GØ TØ (69, 66), ME
168 PRINT 167
    LINE = 0
    GØ TØ 169
 69 NL = L-1
    MR = 2
    GØ TØ 140
 62 KYRT =KYR
    ME= 2
    L= 1
    T(L) = T(NL+2)
    SUM =0.
 67 SUMVM= 0.
    MØT= M
 68 KDAYT= KDAY
    SUMVD= 0.
    GØ TØ 74
 66 IF(MOT-M) 67, 71, 67
 71 IF (KDAY-KDAYT) 68, 74, 68
 74 DELT1 =DELT2
    DFT = DF
    DELD= DELD2
    HCO = HC1
    HC1 = HC2
    QØ =QCØRR
    GØ TØ (79, 80), NE
 79 IF (I-3) 81, 82, 81
 80 IF (I-4) 81, 83, 81
 81 JA= 1
 77 HRT = TH(I)
    TMIN =TM(I)
    L =L+1
    GØ TØ (17, 24, 92), JA
 82 JA= 2
    GØ TØ 77
 83 JA= 3
    GØ TØ 77
 17 I =I+1
    GØ TØ 48
 24 I =1
    GØ TØ 20
 92 I =1
    GØ TØ 41
 85 ME = 1
    MG = MF
    YR = KYR
    TEST =YR/4.
    KTEST = TEST
    TESTA = KTEST
    IF(TEST-TESTA) 88, 87, 88
 87 MF = 2
    DAY= KDAY+LEAP(M)
    GØ TØ 37
 88 MF = 1
    DAY= KDAY+LDAY(M)
    GØ TØ 37
```

```
140 L = 1
    J = 1
 96 V(J) = 0.
    TØ(J)=0.
    LL= 2
    LT= 1
    KE= 1
 97 IF ((T(LL)-T(LT))-P(J))98,99,122
 98 LL =LL +1
    IF (LL-NL-1) 97, 107, 107
 99 VØL =SUMV(LL)-SUMV(LT)
100 IF (VØL-V(J)) 106, 101, 101
101 V(J)=VØL
    TØ(J)= T(LT)
106 IF(NL-LL) 107, 107, 102
102 LL =LL+1
    LT =LT+1
    IF (T(L L)- T(L L - 1)-T(L T)+ T(L T-1))
        105, 99, 104
104 KE =1
    GØ TØ 122
105 KE =2
    GØ TØ 130
107 IF(9 - J) 108, 109, 108
108 J = J +1
    GØ TØ 96
109 DØ 110 J = 1, 9
    TD(J) =TØ(J)/24.
    KTD(J) = TD(J)
110 TAD(J) = KTD(J)
    PRINT 173, ID, KYRT
    GØ TØ (118, 112), MG
112 PRINT 162
    DØ 115 J = 1, 9
    IF (TD(J)) 545, 545, 546
545 MØNTH = 0
    MDAY= 0
    HRS = 0.
    GØ TØ 547
546 DØ 117 MH= 1, 12
    IF (KTD(J)-LEAP(MH)) 114, 114, 117
117 CØNTINUE
    MH=13
114 MØNTH= MH-1
    MDAY=KTD(J)-LEAP(MH-1)
150 HRS = (TD(J)-TAD(J)) * 24.
547 PRINT 15, ID, P(J), MØNTH, MDAY,
        HRS, V(J)
115 CØNTINUE
    GØ TØ 171
118 PRINT 162
    DØ 120 J =1, 9
    IF (TD(J)) 542, 542, 543
542 MØNTH= 0
    MDAY= 0
    HRS = 0.
    GØ TØ 544
543 DØ 119 MH=1, 12
    IF (KTD(J)-LDAY(MH)) 121, 121, 119
119 CØNTINUE
    MH=13
121 MØNTH = MH-1
    MDAY=KTD(J)-LDAY(MH-1)
    HRS=(TD(J)-TAD(J))*24.
544 PRINT 15, ID, P(J), MØNTH, MDAY,
        HRS, V(J)
120 CØNTINUE
171 PRINT 163
    DØ 164 J=1, 20
    PRINT 153, CLASS(J), DUR(J), VØLD(J)
    VØLD(J)= 0.
    DUR(J)= 0.
164 CØNTINUE
    T(1)=T(NL)
    GØ TØ (14, 211), MR
211 PRINT 167
    LINE = 0
    GØ TØ 62
127 LT=LT+1
1220 V Ø L= S U M V(L L - 1) +(P(J)-T(L L-1)+
        T(LT))*(SUMV(L L)-SUMV(LL-1))/
        (T(LL)-1T(LL-1))-SUMV(LT)
123 IF (VØL-V(J)) 125, 124, 124
124 V(J) = VØL
    TØ(J)=T(LT)
125 GØ TØ (126, 134), KE
126 REMANL=T(LL)-T(LT)-P(J)
    IF (REMANL-T(LT+1)+T(LT)) 129, 128,
        127
128 LT=LT+1
    GØ TØ 99
129 LT= LT+1
    KE 2
1300 VØL=SUMV(L L)-SUMV(L T-1)-(T(LL)-
        T(LT-1)-P(J))*(S U M V(L T)-SUMV
        (LT-1))1/(T(LT)-T(LT-1))
131 IF (VØL-V(J)) 125, 132, 132
132 V(J)=VØL
    TØ(J)=T(LL)-P(J)
    GØ TØ 125
```

```
134 REMANT=P(J)-T(LL)+T(LT)
    IF (NL-LL) 136, 107, 136
136 IF (REMANT-T(LL+1)+T(LL)) 139, 138,
       137
137 LL = LL+1
    KE = 2
    GØ TØ 130
138 LL=LL+1
    GØ TØ 99
139 LL = LL+1
    KE = 1
    GØ TØ 122
    END
    END
```

PLEASE MAKE THE FOLLOWING CHANGES IN THE FORTRAN PROGRAM LISTING, APPENDIX 3

Location	Comment
1st statement	Begin in column 7
2nd statement	Begin DIMENSIØN in column 7 and put on 3 cards, the second card beginning with T(1200) and the third card with CLASS(20)
162 + 2 lines	Should be statement 167; begin second card with B(CFS)
154 + 1 line	Remove decimal from 0.
179	Should read JB=2
185 + 2 lines	Begin VØLD(J) in column 7 and put)*2.) on a second card
75 + 1 line	Should read SUMV(LV)=SUM+DELV
75 + 7 lines	Should be statement 76; begin second card with QCØRR
74 + 6 lines	Change NE to NB
542 to 547	Statements associated with these numbers are not shown on flow chart
127 + 1 line	Should be statement 122; put T(LL-1)-SUMV(LT) on a second card
129 + 2 lines	Should be statement 130; begin second card with /(T(LT)

APPENDIX 4

DEFINITION OF PROGRAM SYMBOLS

Flow chart[7] symbol	FORTRAN symbol	Definition
	ACRE	Drainage area in acres.
	AI	Stage interval in feet between items in the variable drainage area correction table.
	AREA (N)	Area of the watershed in acres tabulated at uniform stage increments AI, beginning at PDE.
	CLASS (J)	Runoff rate in inches per hour. Defines 20 points on the duration curve. Suggested values are shown in table 1.
	DAY	Day of year.
$\triangle V$	DELV	Differential volume of runoff in inches in time period $\triangle t_1$.
$\triangle d$	DELD	Incremental depth of precipitation falling in time period $\triangle t_1$.
$\triangle d_2$	DELD2	Incremental depth of precipitation falling in time increment $\triangle t_2$.
$\triangle t_1$	DELT1	Time increment in hours. (See fig. 5.)
$\triangle t_2$	DELT2	Time increment in hours. (See fig. 5.)
	DF	Accumulated depth of precipitation in feet. DF = D(I)/12.
	DFT	The $(i-1)^{th}$ depth of accumulated rainfall in feet.
	D(I)	Accumulated depth of precipitation recorded by a nearby raingage (inches).
	DUR (J)	The time in hours that the discharge rate is equal to or greater than the value specified by CLASS(J).
	GDE	Gage datum elevation. Elevation of zero discharge and first item in rating table.
	HRT	Time in hours of previous reading.

[7] If different from FORTRAN symbol.

APPENDIX 4--CONTINUED

Flow chart symbol	FORTRAN symbol	Definition
	H(I)	Gage height reading.
	HRS	Hours of the day of the current gage height reading.
	HC	Equivalent to H(I).
HC_0	HCO	Gage height reading. (See fig. 5.)
HC_1	HC1	Gage height reading. (See fig. 5.)
HC_2	HC2	Gage height reading. (See fig. 5.)
	HCN	Decimal equivalent of N.
	HN	Position in discharge rating table, pondage correction table, or area correction table.
	I	Integer variable indexing TH(I), TM(I), H(I), and D(I).
	ID	Identification number of station.
	IDT	Identification number of previous card.
	ISW	Code used in branching instructions. Normal value is 1. At coded beginning of event (TH(I) is negative), ISW is set to 2. Its value then progresses to 3 and is reset to 1.
	J	Integer variable used as an index.
	JA	Code used in branching instruction. May have values of 1, 2, or 3.
	JB	Code used in branching instruction. May have values of 1 or 2.
	KDAY	A two-digit integer designating the day of reading.
	KDAYT	Day of previous card.
	KYR	Year of readings (last two digits).
	KYRT	The year of previous card.
	KE	Integer variable with possible values of 1 or 2 for branching.

Flow chart symbol	FORTRAN symbol	Definition
	KTEST	Integer which equated to YR drops off the decimal portion of YR.
	KTD(J)	The day of year associated with the beginning of a period of maximum volume, V(J).
	L	Integer index for storing cumulative volumes and times.
	LDAY(M)	The day of the year of the first day of month, M, in a non-leap year.
	LEAP(M)	The day of the year of the first day of month, M, in a leap year.
	LINE	Count of lines of print on each output sheet.
	LL	Integer variable indicating the Δt_L in which the leading edge of search mesh is located.
	LT	Integer variable indicating the Δt_L in which the trailing edge of search mesh is located.
	LV	Index equal to L-1.
	M	A two-digit integer designating the month of reading.
	MA	Integer variable having possible values of 1 or 2. If 1, card is first for a particular station.
	MDAY	Day of month of beginning of period of maximum volume, V(J).
	ME	Integer variable having possible values of 1 or 2. If 1, reading is first of new year.
	MF	Integer variable having possible values of 1 or 2. If 2, current year is a leap year.
	MG	Integer variable having possible values of 1 or 2. If 2, previous year was a leap year.
	MH	Integer index; refers to month of year.
	MØNTH	Month of beginning of period of maximum volume, V(J).
	MØT	Month of previous card.

Flow chart symbol	FORTRAN symbol	Definition
	MR	Integer variable having possible values of 1 or 2. Used in branching instruction.
	N	Integer equivalent of HN (truncates decimal portion of HN). Lower limit of interpolation interval in rating tables.
	NA	A one-digit integer having possible values of 1 or 2. If 1, pondage correction is to be applied.
	NAF	A three-digit integer designating the number of items in the variable drainage area correction table.
	NB	A one-digit integer having possible values of 1 or 2. If 1, correction is made for rainfall-on-the-pond.
	NC	A one-digit integer having possible values of 1 or 2. If 1, correction is made for varying drainage area as pond stage changes.
	NI	Upper limit of interpolation interval in rating tables.
	NL	Terminating value of L.
	NP	A three-digit integer designating the number of items in the pondage correction table.
	NQ	A three-digit integer designating the number of items in the discharge rating table.
	PC(N)	Pondage correction in cfs for a rate of change in stage of one foot per minute.
	PC(NI)	Same as PC(N), except that NI = N+1.
	PDE	Pond datum elevation. Elevation of first item in pondage correction table.
	PI	Stage interval in feet between items in the pondage correction table.
	P(J)	The time period in hours for which maximum volumes are computed. (See table 3.)
QØ	QØ	Discharge rate in cfs corresponding to HCO.
QCØRR	QCØRR	Discharge rate corrected for pondage.

Flow chart symbol	FORTRAN symbol	Definition
	QCOR2	Discharge rate corrected for pondage, cubic feet per second
	QI	Stage interval in feet between items in the discharge rating table.
	Q(N)	Discharge values in cfs in rating table.
	Q(NI)	Same as Q(N) except that NI = N+1.
	QØB	Discharge rate in cfs for a specified head reading. Not corrected for pondage.
	QP	Pondage correction in cfs for a computed rate of change in stage.
	RATE	Rate of change in stage, feet per minute
	REMANL	Defined as: REMANL = T(LL) - T(LT) - P(J).
	REMANT	Defined as: REMANT = P(J) - T(LL) + T(LT).
	SHIFT	A correction to be added algebraically to all head readings.
V_S	STØRM	Accumulated storm flow in inches.
	SUM	Accumulated annual flow volume in inches.
V_D	SUMVD	Accumulated daily flow volume in inches.
V_L	SUMV(L)	Accumulated flow in inches, indexed and stored for maximum volume search.
V_M	SUMVM	Accumulated monthly flow volume in inches.
	TAD(J)	Decimal equivalent of KTD(J).
	TD(J)	Defined as: TD(J) = TO(J)/24.
	TEST	YR divided by 4 (used in test for leap year).
	TESTA	Decimal variable corresponding to KTEST.
	TH(I)	Military time in hours of i^{th} reading.

Flow chart symbol	FORTRAN symbol	Definition
	T(L)	Time, in hours of the year, associated with accumulative flow values.
	T(LL)	Time, in hours of year, associated with the leading edge of the search mesh.
	T(LT)	Time, in hours of year, associated with the trailing edge of the search mesh.
	TM(I)	Time in minutes of $i^{\underline{th}}$ reading.
	TMIN	Time in minutes of previous reading.
	T(NL)	Same as T(L). NL is the terminating value of L.
	TØ(J)	Time in hours of year of beginning of period of maximum volume, V(J).
	V(J)	Maximum flow volume occurring in time interval P(J).
	VOL	A flow volume occurring in time interval P(J).
	VOLD(J)	Volume of flow in inches occurring at rates = CLASS (J).
	YR	Decimal variable corresponding to KYR.

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