A Computerized Master Plan of Drainage, II: Software System

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Abstract

In this paper, the computerized master plan of drainage software system is presented. Composed of several subroutines linked together by a main-menu driver, the program is intended to be operated in an interactive mode where the program user accepts or rejects all analysis results as the data file is developed. In this fashion, an optimum design product is developed in the first data entry pass.

Keywords

Water Resources; Hydrologic Modeling; Master Plan of Drainage; Urban Drainage

A Rational Method Planning/Design Computer Program

Each of the rational method modeling approaches (Hromadka, 86) utilize identical submodels for estimating (1). the initial time of concentration, (2). channel or pipeflow traveltime, (3). runoff coefficients, (4). rainfall intensity values, (5). and confluence values at the junction of two or more *collection streams. Therefore, once computer program subroutines* are developed for each of these submodels, a main driver program can be developed which manipulates the individual submodels to formulate a link-node model of the watershed based on the rational method modeling strategy desired. In Table 1, descriptions are listed for the computer programs used to model the hydrologic processes which occur in a rational method study of an urban watershed. Combining *these programs using a simple main menu* which branches the program to the selected submodel will result in a totally design-interactive computer program.

TABLE 1. RATIONAL METHOD PROGRAM SUBROUTINES

Program Number	Description
1	main driver program
2	utilizes the Kirpich formula for estimating the initial subarea time of concentration Tc
3 (no input)	calculates rainfall intensities by log-log interpolation
4 (no input)	estimates a runoff coefficient
5	estimates pipeflow traveltime for a user-specified or computer estimated pipesize
6	estimates traveltime in a trapezoidal channel
7	estimates traveltime in a street section of arbitrary size
8	*estimates* traveltime in a pavement V-gutter
9	estimates confluence values
10	allows entry of user specifed data at a node
11	*permits addition of a subarea to the* collection stream

Programs 2, 3, and 4 follow directly from material presented above in the text and the referenced figure numbers. Program 5 estimates pipeflow traveltime by computing the normal depth and determining the time of travel based upon the normal depth flow *velocity. Flows which result in a normal depth greater than 0.82* of the pipe diameter are assumed to cause the pipe to flow full.

If the pipe size is not specified, this program estimates a *pipesize in 3- and 6-inch increments by utilizing a pipeflow with* a normal depth less than or equal to 0.82 of the pipe diameter. Pipe slope is based on ground slope; however, a factor is introduced such that the natural gradient of the land is reduced (usually by about 10 percent) in order to account for minor losses within the pipe. The pipesizes are estimated by assuming this adjusted gradient of the topography between two nodal points to *equal the slope of the pipe for normal depth flows. Program 6 estimates channel flow traveltime* based upon the normal *depth* flow velocity. Program 7 examines streetflow traveltime for two conditions: (1). all flow on one side of the street section, including the splitflow effects when the flowdepth exceeds the street crown, and (2). equal flow on both sides of the street section. All flows outside of the street curbs are assumed *negligible (that is, that water is in a ponded condition). Program* 9 models a confluence with up to 5 independent collection streams. It is based upon the linear confluence formula presented in the text.

The usual study approach is to subdivide the watershed into subareas such as shown in Fig. 1. Nodal points are defined at the upstream and downstream points of each subarea. Computer *results are correlated to the hydrology map by means of these* nodal point designations. The programs are intended to be combined into a menu-driven program system in which the user interacts with the program. Starting at the most upstream nodal point of a collection stream, the program user selects which submodel is to be first employed. Usually, the first model is the initial subarea program and the user enters the appropriate *hydrologic data such as subarea development type, soil group, area* size, upstream and downstream elevations, and length of the main flowpath. The submodel computes the initial subarea Tc, the corresponding runoff coefficient and rainfall intensity, and the initial subarea runoff. The program user is then displayed this information for the user to accept or reject. If the information is acceptable, the entered hydrologic data is permanently stored *in a data file; if the computed results are unacceptable, the user rejects the submodel results and the computer program returns to* the previous nodal point.

If the user had accepted the most recently computed information, then the main program returns to the menu display for the user to select the next hydrologic submodel. The main program should store the recently computed Q, Tc, and the total area. In

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this manner, should the user now select to employ the channel traveltime program, the normal depth computed will be based on the stored peak Q value, and the traveltime will be directly added to the stored Tc value, providing the time of concentration at the downstream point of the channel. Thus, the computer program directly follows the desired rational method modeling approach interactively rather than the user creating a data file to be operated upon by the program in a batch mode. Using such a computer programming approach allows the watershed to be master planned on the first study pass, and in addition, the entered hydrologic data are stored for subsequent editing and master plan updating.

In the following pages, computer listings are provided for each of the discussed submodels. The language used is FORTRAN, and the codes are directly usable on many currently available microcomputers. The data entry requirements are presented in the form of screen text pages which contain the submodel data entry prompts as well as other user-friendly program commands and features. Details of these screen text pages are discussed in the following section.

Computer-Aided Design Interaction

The computer programs were developed to aid the engineer in a computer-aided interactive mode rather than the inefficient and difficult to use batch mode that is associated to most water resources software. In this fashion, the software is formulated on a system level where the individual submodels are employed as selected by the engineer, and the computed results reviewed by the engineer prior to proceeding with the next submodel process. This type of approach can be directly applied to link-node models where the links direct the logic process in one direction only. For example, the rational method planning/design program system proceeds in the downstream direction with the entire watershed tributary to a node completely described by three variables: peak runoff rate, time of concentration, and total area. Thus the hydrologic process employed to link the next downstream node acts only upon the most recently computed values of the three characteristic variables. Because the main purpose of studying the watershed is to determine an appropriate flood control system to safely contain the peak flow rates, each link of the link-node model is properly sized and evaluated prior to proceeding to the next link or hydrologic process.

In comparison, the various submodels can be combined into a batch mode of operation where the engineer builds a data file containing all the necessary data for each hydrologic process or link used to develop a link-node model of the watershed. The program system then operates upon the data file to generate the model solutions. The user then reviews the entire model results for unacceptable conditions (e.g. such as streetflow above the top of curb, or excessively high flow velocities in a user-specified pipe size linking two nodal points, etc.) and identifies the necessary alterations in the link-node model to remedy the computer design. This procedure is repeated until the entire link-node model provides the required flood control system design, and requires considerably more computational effort, time expenditure, and frustration to the engineer.

Therefore, the engineer should develop the main driver branching program using the basic user-friendly environment as discussed in Hromadka et al. (1983c). The main program data entry sequences for each submodel should be developed such that the communication/presentation (C/P) provides an easy-to-use and self-teaching environment. Some of the major requirements for such a user-friendly environment are as follows:

(1). The C/P should present all data entry prompts and computed results in a readable manner such that any engineer can readily evaluate the information.

(2). All engineering units should be displayed.

(3). Any program system flow logic should be clearly described in the program where needed in order to reduce the first-time user learning curve.

(4). All program system commands should be consistently displayed between submodels (and between separate computer programs) so that the user can operate special data entry or editing features without confusion.

(5). All data file management operations (such as opening, closing, and saving data files) should be programmed interior to the system program in order to provide ease of use.

The submodel data entry prompts for the provided program listings are presented in a typical C/P for use on currently available microcomputers. The viewing displays are constructed as pages which contain sets of data entry prompts grouped together according to the selected submodel process. Each of the pages

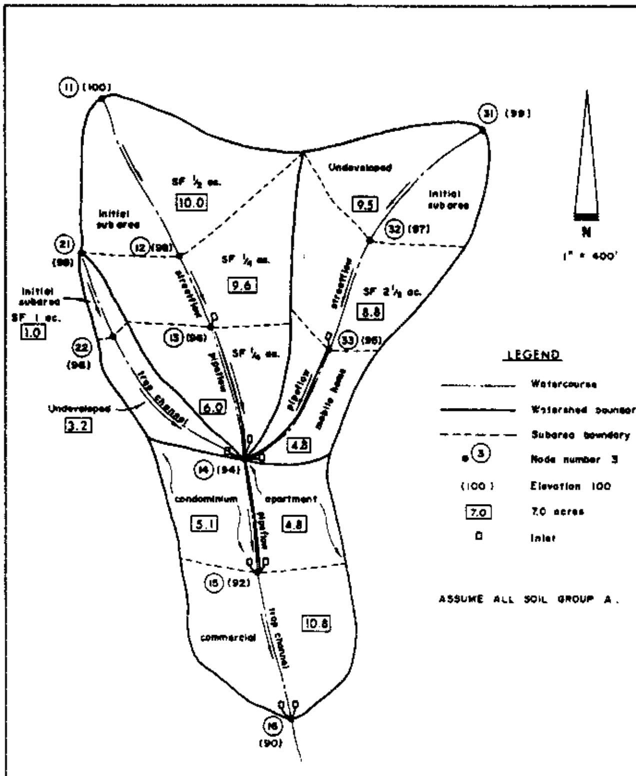

Fig. 1. EXAMPLE PROBLEM DRAINAGE SYSTEM

contain the following set of operation commands located at the bottom of the CRT screen:

(1). TOP. This command clears the screen, redisplays the page information, and returns the program to the first data entry prompt of the page.

(2). BACK. This command returns the program to the previous page (if one exists), and positions the program to the first data entry prompt.

(3). MAIN. This command performs several important tasks. First, the program system data file is properly saved and closed so that all data entries are protected, and the data file is available for later use. Second, the command terminates the submodel process in progress should the user be interior of a subroutine process. Third, the command returns the program system to the main driver program menu.

(4). EXIT. This command is identical to the MAIN command, except the program system is terminated.

It should be noted that these four commands can be entered at any time, and at any data entry prompt within the program system. Thus, if the user should wish to exit the program while entering the data needed to solve for pipeflow between two nodal points (Program 5), then the user simply enters the word EXIT at any data entry prompt. It should also be noted that the C/P pages contain a description of each data entry as well as the allowable value range for data entry. Each data entry is checked for range limits prior to proceeding to the next data entry prompt. If the entered data is outside of the allowable value range, an error message is displayed to the user and the program returns to the invalid data entry point for another data entry attempt. In this way, the data file development is error free with the first pass of the data entry sequence.

Unfortunately, there are still wide differences between computers and peripheral devices such as the CRT terminals of different manufacturers. Additionally, the internal operating systems of the computers differ. Developing a user-friendly environment for the computer program system is therefore dependent on the computer system hardware and associated software. The necessary steps in opening files, closing files, subroutine

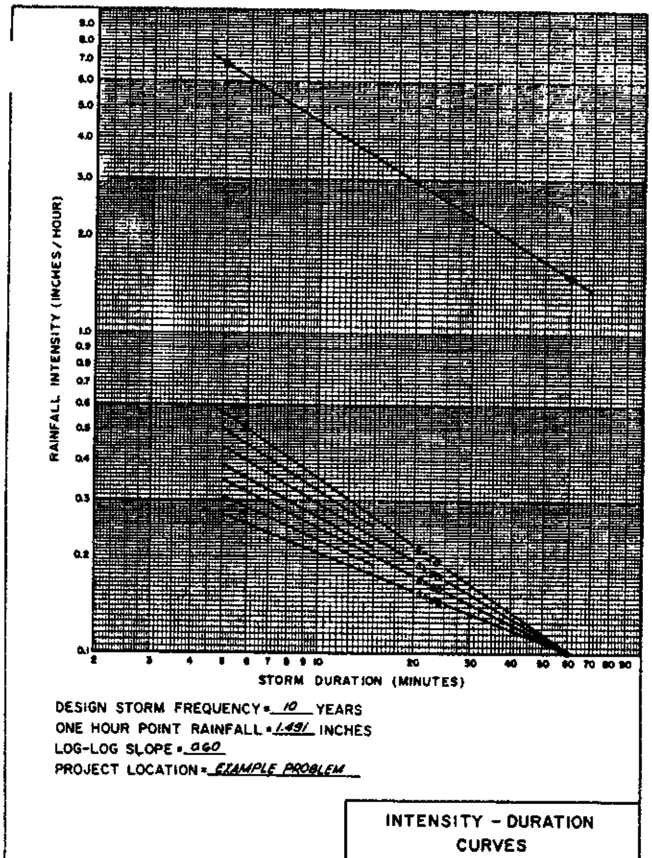

Fig. 2.

employment, overlay structuring, cursor addressing, clearing the screen, program execution and other operations must be obtained from the computer user-guides and operation manuals for each particular system.

Example 1. Rational Method Program Application

The following computer program application example problem illustrates the use of the Subarea Summation Model for rational method hydrology studies of urban watersheds. The example problem presentation contains the following information:

Figure Number	Description
1	example problem drainage system
2	example problem point rainfall
3	example problem computer program results and example tabulation form output

References

Hromadka II, T.V., Clements, J.C., and Guymon, G.L., "Guidelines for Interactive Software in Water Resources Engineering," Water Resources Bulletin, February, (1983c).

Hromadka II, T.V., "A Computerized Master Plan of Drainage, I: Development."

Fig. 3.

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==========================================================================
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM

==========================================================================
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
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**********DESCRIPTION OF RESULTS*******************************************
*                                                                        *
*                            EXAMPLE PROBLEM                             *
*                                                                        *
**************************************************************************

--------------------------------------------------------------------------
   USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
--------------------------------------------------------------------------
   USER SPECIFIED STORM EVENT(YEAR) =   25.00
   SPECIFIED MINIMUM PIPE SIZE(INCH) =  24.00
   SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE =  .90
   10-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.270
   100-YEAR STORM 60-MINUTE INTENSITY(INCH/HOUR) =  1.900
   COMPUTED RAINFALL INTENSITY DATA:
   STORM EVENT =   25.00   1-HOUR INTENSITY(INCH/HOUR) = 1.4910
   SLOPE OF INTENSITY DURATION CURVE =  .6000


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**************************************************************************
   FLOW PROCESS FROM NODE    11.00 TO NODE    12.00 IS CODE =   2
--------------------------------------------------------------------------
   >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==========================================================================
         ASSUMED INITIAL SUBAREA UNIFORM
         DEVELOPMENT IS SINGLE FAMILY(1/2 ACRE)
   TC = K*[(LENGTH**3)/(ELEVATION CHANGE)]**.2
   INITIAL SUBAREA FLOW-LENGTH =   800.00
   UPSTREAM ELEVATION =    100.00
   DOWNSTREAM ELEVATION =     98.00
   ELEVATION DIFFERENCE =      2.00
   TC =  .422*[(  800.00**3)/(      2.00)]**.2 =   20.280
     25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.858
   SOIL CLASSIFICATION IS "A"
   SINGLE-FAMILY(1/2 ACRE LOT) RUNOFF COEFFICIENT = .7180
   SUBAREA RUNOFF(CFS) =      20.52
   TOTAL AREA(ACRES) =      10.00   TOTAL RUNOFF(CFS) =      20.52

**************************************************************************
   FLOW PROCESS FROM NODE    12.00 TO NODE    13.00 IS CODE =   6
--------------------------------------------------------------------------
   >>>>>COMPUTE STREETFLOW TRAVELTIME THRU SUBAREA<<<<<
==========================================================================
   UPSTREAM ELEVATION =     98.00   DOWNSTREAM ELEVATION =     96.00
   STREET LENGTH(FEET) =   350.00   CURB HEIGTH(INCHES) = 8.
   STREET HALFWIDTH(FEET) = 22.00   STREET CROSSFALL(DECIMAL) = .0200
   SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
         **TRAVELTIME COMPUTED USING MEAN FLOW(CFS) =   30.03
             ***STREET FLOWING FULL***
         STREET FLOWDEPTH(FEET) =   .61
         HALFSTREET FLOODWIDTH(FEET) =   22.00
         AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.86
         PRODUCT OF DEPTH&VELOCITY =    1.74
   STREETFLOW TRAVELTIME(MIN) =   2.04   TC(MIN) =  22.32

     25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.699
   SOIL CLASSIFICATION IS "A"
   SINGLE-FAMILY(1/4 ACRE LOT) RUNOFF COEFFICIENT = .7335
   SUBAREA AREA(ACRES) =    9.60   SUBAREA RUNOFF(CFS) =   19.00
   SUMMED AREA(ACRES) =   19.60   TOTAL RUNOFF(CFS) =     39.53
   END OF SUBAREA STREETFLOW HYDRAULICS:
   DEPTH(FEET) =  .65   HALFSTREET FLOODWIDTH(FEET) = 22.00
   FLOW VELOCITY(FEET/SEC.) =  3.24   DEPTH*VELOCITY =   2.10

**************************************************************************
   FLOW PROCESS FROM NODE    13.00 TO NODE    14.00 IS CODE =   3
--------------------------------------------------------------------------
   >>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
   >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==========================================================================
   DEPTH OF FLOW IN  39.0 INCH PIPE IS  29.2 INCHES
   PIPEFLOW VELOCITY(FEET/SEC.) =    5.9
   UPSTREAM NODE ELEVATION =    96.00
   DOWNSTREAM NODE ELEVATION =    94.00
   FLOWLENGTH(FEET) =   650.00   MANNINGS N =  .013
   ESTIMATED PIPE DIAMETER(INCH) =  39.00    NUMBER OF PIPES =   1
   PIPEFLOW THRU SUBAREA(CFS) =     39.53
   TRAVEL TIME(MIN.) =   1.83    TC(MIN.) =  24.14

**************************************************************************
   FLOW PROCESS FROM NODE    14.00 TO NODE    14.00 IS CODE =   8
--------------------------------------------------------------------------
   >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
==========================================================================
```

```
  25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.575
SOIL CLASSIFICATION IS "A"
SINGLE-FAMILY(1/4 ACRE LOT) RUNOFF COEFFICIENT = .7278
SUBAREA AREA(ACRES) =     6.00   SUBAREA RUNOFF(CFS) =    11.24
TOTAL AREA(ACRES) =    25.60   TOTAL RUNOFF(CFS) =    50.77
TC(MIN) =  24.14

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     14.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
 TIME OF CONCENTRATION(MINUTES) =  24.14
 RAINFALL INTENSITY (INCH./HOUR) =   2.57
 TOTAL STREAM AREA (ACRES) =   25.60
 TOTAL STREAM RUNOFF(CFS) AT CONFLUENCE =      50.77

****************************************************************************
 FLOW PROCESS FROM NODE     21.00 TO NODE     22.00 IS CODE =   2
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
        ASSUMED INITIAL SUBAREA UNIFORM
        DEVELOPMENT IS SINGLE FAMILY(1-ACRE)
 TC = K*[(LENGTH**3)/(ELEVATION CHANGE)]**.2
 INITIAL SUBAREA FLOW-LENGTH =    400.00
 UPSTREAM ELEVATION =      99.00
 DOWNSTREAM ELEVATION =      96.00
 ELEVATION DIFFERENCE =       3.00
 TC =  .469*[(  400.00**3)/(      3.00)]**.2 =   13.717
  25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.614
 SOIL CLASSIFICATION IS "A"
 SINGLE-FAMILY(1-ACRE LOT) RUNOFF COEFFICIENT = .7108
 SUBAREA RUNOFF(CFS) =       2.57
 TOTAL AREA(ACRES) =       1.00   TOTAL RUNOFF(CFS) =        2.57

****************************************************************************
 FLOW PROCESS FROM NODE     22.00 TO NODE     14.00 IS CODE =   5
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL-CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 UPSTREAM NODE ELEVATION =        96.00
 DOWNSTREAM NODE ELEVATION =       94.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =    850.00
 CHANNEL BASE(FEET) =       .50   "Z" FACTOR =    1.000
 MANNINGS FACTOR =  .030   MAXIMUM DEPTH(FEET) =    2.00
 CHANNEL FLOW THRU SUBAREA(CFS) =       2.57
 FLOW VELOCITY(FEET/SEC) =    1.51   FLOW DEPTH(FEET) =    1.08
 TRAVEL TIME(MIN.) =    9.38   TC(MIN.) =  23.10

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     14.00 IS CODE =   8
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.644
 SOIL CLASSIFICATION IS "A"
 UNDEVELOPED WATERSHED RUNOFF COEFFICIENT = .6121
 SUBAREA AREA(ACRES) =     3.20   SUBAREA RUNOFF(CFS) =     5.18
 TOTAL AREA(ACRES) =     4.20   TOTAL RUNOFF(CFS) =      7.75
 TC(MIN) =  23.10

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     14.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
 TIME OF CONCENTRATION(MINUTES) =  23.10
 RAINFALL INTENSITY (INCH./HOUR) =   2.64
 TOTAL STREAM AREA (ACRES) =    4.20
 TOTAL STREAM RUNOFF(CFS) AT CONFLUENCE =       7.75

****************************************************************************
 FLOW PROCESS FROM NODE     31.00 TO NODE     32.00 IS CODE =   2
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
        ASSUMED INITIAL SUBAREA UNIFORM
        DEVELOPMENT IS: UNDEVELOPED WITH GOOD COVER
 TC = K*[(LENGTH**3)/(ELEVATION CHANGE)]**.2
 INITIAL SUBAREA FLOW-LENGTH =    750.00
 UPSTREAM ELEVATION =      99.00
 DOWNSTREAM ELEVATION =      97.00
 ELEVATION DIFFERENCE =       2.00
 TC =  .937*[(  750.00**3)/(      2.00)]**.2 =   43.326
  25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.813
 SOIL CLASSIFICATION IS "A"
 UNDEVELOPED WATERSHED RUNOFF COEFFICIENT = .5030
 SUBAREA RUNOFF(CFS) =       8.66
 TOTAL AREA(ACRES) =       9.50   TOTAL RUNOFF(CFS) =        8.66

****************************************************************************
 FLOW PROCESS FROM NODE     32.00 TO NODE     33.00 IS CODE =   6
----------------------------------------------------------------------------
 >>>>>COMPUTE STREETFLOW TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 UPSTREAM ELEVATION =      97.00   DOWNSTREAM ELEVATION =       95.00
 STREET LENGTH(FEET) =    550.00   CURB HEIGTH(INCHES) =  8.
 STREET HALFWIDTH(FEET) =  22.00   STREET CROSSFALL(DECIMAL) = .0200
 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
        **TRAVELTIME COMPUTED USING MEAN FLOW(CFS) =     12.53
          STREET FLOWDEPTH(FEET) =    .50
          HALFSTREET FLOODWIDTH(FEET) =    17.31
          AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.97
          PRODUCT OF DEPTH&VELOCITY =      .99
 STREETFLOW TRAVELTIME(MIN) =    4.66   TC(MIN) =  47.99

   25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.705
 SOIL CLASSIFICATION IS "A"
 SINGLE-FAMILY(2.5-ACRE LOT) RUNOFF COEFFICIENT = .5179
 SUBAREA AREA(ACRES) =     8.80   SUBAREA RUNOFF(CFS) =     7.77
 SUMMED AREA(ACRES) =    18.30   TOTAL RUNOFF(CFS) =     16.43
 END OF SUBAREA STREETFLOW HYDRAULICS:
 DEPTH(FEET) =   .55   HALFSTREET FLOODWIDTH(FEET) = 19.81
 FLOW VELOCITY(FEET/SEC.) =  2.00   DEPTH*VELOCITY =   1.11

****************************************************************************
 FLOW PROCESS FROM NODE     33.00 TO NODE     14.00 IS CODE =   3
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 DEPTH OF FLOW IN  33.0 INCH PIPE IS  23.7 INCHES
 PIPEFLOW VELOCITY(FEET/SEC.) =    3.6
 UPSTREAM NODE ELEVATION =     95.00
 DOWNSTREAM NODE ELEVATION =     94.00
 FLOWLENGTH(FEET) =    700.00   MANNINGS N =  .013
 ESTIMATED PIPE DIAMETER(INCH) =  33.00    NUMBER OF PIPES =   1
 PIPEFLOW THRU SUBAREA(CFS) =     16.43
 TRAVEL TIME(MIN.) =    3.25    TC(MIN.) =  51.24

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     14.00 IS CODE =   8
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  1.639
 SOIL CLASSIFICATION IS "A"
 MOBILE HOME PARK DEVELOPMENT RUNOFF COEFFICIENT = .7541
 SUBAREA AREA(ACRES) =     4.80   SUBAREA RUNOFF(CFS) =     5.93
 TOTAL AREA(ACRES) =    23.10   TOTAL RUNOFF(CFS) =    22.36
 TC(MIN) =  51.24

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     14.00 IS CODE =   1
----------------------------------------------------------------------------
 >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  3 ARE:
 TIME OF CONCENTRATION(MINUTES) =  51.24
 RAINFALL INTENSITY (INCH./HOUR) =   1.64
 TOTAL STREAM AREA (ACRES) =   23.10
 TOTAL STREAM RUNOFF(CFS) AT CONFLUENCE =      22.36

 CONFLUENCE INFORMATION:
 STREAM   RUNOFF      TIME   INTENSITY
 NUMBER    (CFS)     (MIN.) (INCH/HOUR)
----------------------------------------------------------------------------
   1       50.77      24.14     2.575
   2        7.75      23.10     2.644
   3       22.36      51.24     1.639

 RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 FORMULA      USED FOR  3 STREAMS.
 VARIOUS CONFLUENCED RUNOFF VALUES ARE AS FOLLOWS:
       68.85     66.41    59.49
 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 RUNOFF(CFS) =      68.85   TIME(MINUTES) =   24.142
 TOTAL AREA(ACRES) =     52.90

****************************************************************************
 FLOW PROCESS FROM NODE     14.00 TO NODE     15.00 IS CODE =   3
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPEFLOW TRAVELTIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 DEPTH OF FLOW IN  45.0 INCH PIPE IS  36.7 INCHES
 PIPEFLOW VELOCITY(FEET/SEC.) =    7.1
 UPSTREAM NODE ELEVATION =     94.00
 DOWNSTREAM NODE ELEVATION =     92.00
 FLOWLENGTH(FEET) =    550.00   MANNINGS N =  .013
 ESTIMATED PIPE DIAMETER(INCH) =  45.00    NUMBER OF PIPES =   1
 PIPEFLOW THRU SUBAREA(CFS) =     68.85
 TRAVEL TIME(MIN.) =    1.28    TC(MIN.) =  25.43

****************************************************************************
 FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =   8
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.496
 SOIL CLASSIFICATION IS "A"
 CONDOMINIUM DEVELOPMENT RUNOFF COEFFICIENT = .7618
 SUBAREA AREA(ACRES) =     5.10   SUBAREA RUNOFF(CFS) =     9.70
 TOTAL AREA(ACRES) =    58.00   TOTAL RUNOFF(CFS) =    78.55
 TC(MIN) =  25.43

****************************************************************************
 FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =   8
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.496
 SOIL CLASSIFICATION IS "A"
 APARTMENT DEVELOPMENT RUNOFF COEFFICIENT = .7996
 SUBAREA AREA(ACRES) =     4.80   SUBAREA RUNOFF(CFS) =     9.58
 TOTAL AREA(ACRES) =    62.80   TOTAL RUNOFF(CFS) =    88.13
 TC(MIN) =  25.43

****************************************************************************
 FLOW PROCESS FROM NODE     15.00 TO NODE     16.00 IS CODE =   5
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL-CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA<<<<<
============================================================================
 UPSTREAM NODE ELEVATION =       92.00
 DOWNSTREAM NODE ELEVATION =      90.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =    700.00
 CHANNEL BASE(FEET) =      2.00   "Z" FACTOR =    2.000
```

```
MANNINGS FACTOR = .015   MAXIMUM DEPTH(FEET) =   3.00
CHANNEL FLOW THRU SUBAREA(CFS) =       88.13
FLOW VELOCITY(FEET/SEC) =    5.97   FLOW DEPTH(FEET) =   2.26
TRAVEL TIME(MIN.) =   1.95    TC(MIN.) =  27.38

****************************************************************************
FLOW PROCESS FROM NODE      16.00 TO NODE      16.00 IS CODE =   8
----------------------------------------------------------------------------
>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  25.00 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.387
SOIL CLASSIFICATION IS "A"
COMMERCIAL DEVELOPMENT RUNOFF COEFFICIENT = .8237
SUBAREA AREA(ACRES) =    10.80   SUBAREA RUNOFF(CFS) =    21.24
TOTAL AREA(ACRES) =    73.60    TOTAL RUNOFF(CFS) =  109.36
TC(MIN) =   27.38
============================================================================
END OF RATIONAL METHOD ANALYSIS
```

STUDY NAME: | CALCULATED BY: | CHECKED BY:

25.0 YEAP STORM 1-HOUR RAINFALL(inch)= 1.49; INTENSITY SLOPE = .600 | PAGE NUMBER OF

ADVANCED ENGINEERING SOFTWARE

CONCENTRATION POINT NUMBER	SOIL TYPE	DEV. TYPE	AREA (ACRES)	I In/h	C	Q (SUB)	Q TOTAL	SLOPE ft/ft	SECTION	V fps.	PATH ft.	T min.	Tc min.	HYDRAULICS AND NOTES
								.0025			400	20.3		INITIAL SUBAREA
12.00	1	6	10.0	2.86	.716	20.5							20.3	
44.ft STREET flow to PT.#							20.5	.0057	street	3.2	350	2.0		*Qavg= 30.0cfs Dn= .61 W= 22.0 X-fall= .02000
13.00	1	5	9.6	2.70	.733	19.0							22.3	
							39.5	.0031	D= 39.*	5.9	650	1.8		n=.0130 Dn= 2.4
14.00	1	5	6.0	2.57	.728	11.2							24.1	
14.00			25.6	2.57			50.8						24.1	Stream Summary
								.0075			400	13.7		INITIAL SUBAREA
22.00	1	7	1.0	3.61	.711	2.6							13.7	
							2.6	.0024	B= .5	1.5	850	9.4		n=.0300 Dn= 1.1 Z= 1.0 Fr= .33
14.00	1	9	3.2	2.64	.612	5.2							23.1	
14.00			4.2	2.64			7.7						23.1	Stream Summary
								.0027			750	43.3		INITIAL SUBAREA
12.00	1	11	9.5	1.81	.501	8.7							43.3	
44.ft STREET flow to PT.#							8.7	.0036	street	2.0	550	4.7		*Qavg= 12.5cfs Dn= .50 W= 17.3 X-fall= .02000
33.00	1	8	8.8	1.70	.518	7.8							48.0	
							16.4	.0014	D= 33.*	3.6	700	3.2		n=.0130 Dn= 2.0
14.00	1	3	4.8	1.64	.754	5.9							51.2	
CONFLUENCE ANALYSIS FOR POINT# 14.00	TC#1= 24.1 TC#2= 23.1 TC#3= 51.2 TC#4= .0 TC#5= .0 Q#1= 50.8 Q#2= 7.7 Q#3= 22.4 Q#4= .0 Q#5= .0 I#1= 2.57 I#2= 2.64 I#3= 1.64 I#4= .00 I#5= .00 Q1 = 68.9 Q2 = 66.4 Q3 = 59.5 Q4 = .0 Q5 = .0													LARGEST CONFLUENCE Q= 68.9
							68.9	.0036	D= 45.*	7.1	550	1.3		n=.0130 Dn= 3.1

DEVELOPMENT TYPES:1=COM,2=APT,3=MH,4=CONDO,5=SF(1/4-AC),6=SF(1/2-AC)   SOIL TYPES:1=A,2=B,3=C,4=D,
7=SF(1-AC),8=SF(2.5-AC),9=UNDEV(POOR COV),10=UNDEV(FAIR COV),11=UNDEV(GOOD COV) 0,5=SPECIFIED COEFFICIENT

STUDY NAME: | CALCULATED BY: | CHECKED BY:

25.0 YEAR STORM 1-HOUR RAINFALL(inch)= 1.49; INTENSITY SLOPE = .600 | PAGE NUMBER OF

ADVANCED ENGINEERING SOFTWARE

CONCENTRATION POINT NUMBER	SOIL TYPE	DEV. TYPE	AREA (ACRES)	I In/h	C	Q (SUB)	Q TOTAL	SLOPE ft/ft	SECTION	V fps.	PATH ft.	T min.	Tc min.	HYDRAULICS AND NOTES
15.00	1	4	5.1	2.50	.762	9.7							25.4	
15.00	1	2	4.8	2.50	.800	9.6							25.4	
							88.1	.0029	B= 2.0	6.0	700	2.0		n=.0150 Dn= 2.3 Z= 2.0 Fr= .91
16.00	1	1	10.8	2.39	.824	21.2							27.4	
16.00			73.6	2.39			109.4						27.4	Stream Summary

DEVELOPMENT TYPES:1=COM,2=APT,3=MH,4=CONDO,5=SF(1/4-AC),6=SF(1/2-AC)   SOIL TYPES:1=A,2=B,3=C,4=D,
7=SF(1-AC),8=SF(2.5-AC),9=UNDEV(POOR COV),10=UNDEV(FAIR COV),11=UNDEV(GOOD COV) 0,5=SPECIFIED COEFFICIENT

PROGRAM 1: DATA ENTRY

```
Enter Rational Method storm event year............... ===>    "YR"
:ALLOWABLE VALUES ARE [1] TO [1000  ]


Enter Logarithm slope of intensity-duration curve... ===>    "RSLOPE"
:ALLOWABLE VALUES ARE [.01   ] TO [1.0   ]
(NOTE:     SUGGESTED VALUES ARE:
                                VALLEY AREA, SLOPE= 0.6
                                DESERT AREA, SLOPE= 0.7)

----------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
Enter 10-year storm 60-minute rainfall(INCHES)...... ===>    "R60T"
:ALLOWABLE VALUES ARE [.1    ] TO [9.95  ]


Enter 100-year storm 60-minute rainfall(INCHES)..... ===>    "R60H"
:ALLOWABLE VALUES ARE [.1    ] TO [15.0  ]

----------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
The computer program estimates design pipe sizes.
Enter MINIMUM pipe size acceptable(INCHES).......... ===>    "PIPMIN"
:ALLOWABLE VALUES ARE [3] TO [240   ]

The computer program estimates a design pipe size through
a subarea using the Mannings equation, with the friction
slope set equal to the gradient of the land.  The program
determines a CONSTRUCTABLE pipe size such that non-pressure
flow occurs.  The user can specify a percentage of the
land-gradient to be used for the pipeflow friction slope.
(SUGGESTION:
            Use [.95] for pipesystems with FEW minor losses
            Use [.85] for pipesystems with CONSIDERABLE minor
                      losses

Enter percentage of subarea land-gradient to be used for
the pipeflow friction slope(DECIMAL)................ ===>    "PERCNT"
:ALLOWABLE VALUES ARE [.001  ] TO [1.00  ]

----------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
SUBAREA RUNOFF-COEFFICIENT OPTIONS:
    1: Use SBC soil group (A) thru (D) runoff
       coefficients
    2: Use a constant (default) runoff-coefficient
       for the entire study
Select option desired............................... ===>    "CV"

Enter default runoff-coefficient(DECIMAL)........... ===>    "CVAL"
:ALLOWABLE VALUES ARE [.05   ] TO [.99   ]

----------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
Enter upstream node number.......................... ===>    "ZN1"
:ALLOWABLE VALUES ARE [0.00  ] TO [9999.99   ]

Enter downstream node number........................ ===>    "ZN2"
:ALLOWABLE VALUES ARE [0.00  ] TO [9999.99   ]

SUBAREA HYDROLOGIC PROCESSES:
    1: Confluence analysis at node
    2: Initial subarea analysis
    3: Pipeflow traveltime (COMPUTER ESTIMATED pipesize)
    4: Pipeflow traveltime ....(USER SPECIFIED pipesize)
    5: Trapezoidal channel travel time
    6: Street-Flow analysis thru subarea
    7: User-specified information at node
    8: Addition of subarea runoff to mainline
    9: V-gutter flow thru subarea
Select subarea hydrologic process .................. ===>    "KODE"

----------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
      MAIN to go to main menu
```

PROGRAM 1

```
C   -------------------------------------------------------------------
C         PROGRAM RATION
C   -------------------------------------------------------------------
C
C
C   EXECUTIVE DRIVER FOR RATIONAL BATCH SYSTEM
C
          COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
          COMMON/CALC1/E1,E2,XL,K,IS,AREA,XXI,XP,KI,RIYR,RSLOPE
          COMMON/CALC2/TCON(5),TOTALA(5),XINT(5),QJN(5),QBAR(5),ZCON(5)
C   INITIALIZE
          NUT=6
          DO 3 I=1,5
          TCON(I)=0.
          TOTALA(I)=0.
          XINT(I)=0.
          QJN(I)=0.
          QBAR(I)=0.
          ZCON(I)=0.
3         CONTINUE
C   OPEN FILES
          OPEN 5,"RAT.DAT"
          OPEN 6,"RAT.ANS"
C
C   PROCESS DATA FILE
C
C   PROBLEM CONTROLS FIRST
          READ FREE(5) YR,RSLOPE,R60T,R60H,PIPMIN,PERCNT,CVAL
C
C   SUBAREAS
100       READ FREE(5,END=1000)ZN1,ZN2,KODE
          WRITE(NUT,601)
          WRITE(NUT,600)ZN1,ZN2,KODE
          WRITE(NUT,601)
C   PROCESSES
          IERR=0
          IF(KODE.EQ.1)CALL CONFB(Q,TC,SUMA,IERR)
          IF(KODE.EQ.2)CALL INITRU(Q,TC,SUMA,IERR)
          IF(KODE.EQ.3)CALL PIPEFR(Q,TC,SUMA,IERR,PIPMIN,PERCNT)
          IF(KODE.EQ.4)CALL PIPEFR(Q,TC,SUMA,IERR,PIPMIN,PERCNT)
          IF(KODE.EQ.5)CALL TRAPZR(Q,TC,SUMA,IERR)
          IF(KODE.EQ.6)CALL STREET(Q,TC,SUMA,IERR)
          IF(KODE.EQ.7)CALL USEROR(Q,TC,SUMA,IERR)
          IF(KODE.EQ.8)CALL SUBTOB(Q,TC,SUMA,IERR)
          IF(KODE.EQ.9)CALL VGUTTR(Q,TC,SUMA,IERR)
          IF(KODE.EQ.999)GO TO 1000
          IF(IERR.NE.0)GO TO 50
          GO TO 100
C
C   ERROR PROCESSING
50        WRITE(NUT,602)
1000      CONTINUE
```

```
C  FORMATS
 '      FORMAT(3X,'FLOW PROCESS FROM NODE ',F8.2,' TO NODE ',F8.2,
       ' IS CODE = ',I3)
        FORMAT(1X,76('*'))
002     FORMAT(1X'***FATAL ERROR - CHECK DATA INPUT***')
        RETURN
        END
C  -----------------------------------------------------------------
        SUBROUTINE ADJUST(A,B,YR)
C  -----------------------------------------------------------------
        IF(A.LE.0.)A=.01
        B=A
        IF(YR.LE.2.OR.YR.GE.50)GOTO 200
C
        IF(YR.GE.2.OR.YR.LE.5.)B=1.+(YR-2.)*.008467
        IF(YR.GT.5..AND.YR.LE.10.)B=1.0254-(YR-5.)*.00308
        IF(YR.GT.10..AND.YR.LE.25)B=1.01-(YR-10.)*.00197
        IF(YR.GT.25..AND.YR.LT.50.)B=.98052+(YR-25.)*.00078
        B=B*A
200     CONTINUE
C
        RETURN
        END
```

PROGRAM 2: DATA ENTRY

```
---DATA ENTRY FOR INITIAL SUBAREA ANALYSIS---PAGE 1


Enter upstream node      1.00 elevation(FEET)........ ===>    "E1"
:ALLOWABLE VALUES ARE [.01    ] TO [99999.99  ]

Enter downstream node     2.00 elevation(FEET)...... ===>    "E2"
:ALLOWABLE VALUES ARE [0      ] TO [99999.99  ]

Enter runoff travel-length through subarea(FEET).... ===>    "XL"
:ALLOWABLE VALUES ARE [.01    ] TO [10000 ]
(NOTE: SUGGESTED RANGE(FEET) IS [0] TO [1000])



--------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR INITIAL SUBAREA ANALYSIS---PAGE 2

SUBAREA LAND USE OR DEVELOPMENT TYPE:

    1= Commercial
    2= Apartment
    3= Mobile home park
    4= Condominium
    5= Single family (1/4 ACRE lot)
    6= Single family (1/2 ACRE lot)
    7= Single family (  1-ACRE lot)
    8= Single family (2.5-ACRE lot)
    9= Undeveloped with POOR cover
   10= Undeveloped with FAIR cover
   11= Undeveloped with GOOD cover

Select subarea development classification number.... ===>    "K"


--------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                             ; BACK to go back one page
```

```
---DATA ENTRY FOR INITIAL SUBAREA ANALYSIS---PAGE 3

SUBAREA RUNOFF COEFFICIENT OPTIONS:

    1= Assume soil group A
    2= Assume soil group B
    3= Assume soil group C
    4= Assume soil group D
    5= User to specify runoff coefficient

Select runoff coefficient option number............. ===>    "FSOIL"

Enter SUBAREA runoff coefficient.................... ===>    "C"
:ALLOWABLE VALUES ARE [.01    ] TO [.99    ]

Enter subarea area(ACRES)........................... ===>    "AREA"
:ALLOWABLE VALUES ARE [0] TO [1000  ]
(NOTE: SUGGESTED AREA IS BETWEEN [0] AND [10]


--------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                             ; BACK to go back one page
```

PROGRAM 2

```
C  -----------------------------------------------------------------
        SUBROUTINE INITRU(Q,TC,SUMA,IERR)
C  -----------------------------------------------------------------
C
C     INITIAL SUBAREA ANALYSIS
C
        COMMON /NUT/NUT
        COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
        COMMON/CALC1/E1,E2,XL,K,IS,AREA,XXI,XP,XI,RIYR,RSLOPE
C
C
C..READ DATA INPUT
        READ FREE(5)E1,E2,XL,K,FSOIL,AREA
        IS=FSOIL
        C=FSOIL-5.0
C
        WRITE(NUT,1007)
1007    FORMAT(3X,'>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<')
        WRITE(NUT,403)
C
        CALL INITAR(E1,E2,XL,K,TC,NUT)
C
        IGUESS=0
C
        CALL INTENR(YR,TC,XI,IGUESS,ERROR,NUT,RIYR,RSLOPE)
        IF(ERROR.NE.1.)GO TO 9990
        IERR=9
        GO TO 10000
C
9990    CALL COEFAR(XI,IS,K,C,IGUESS,CVAL,NUT)
C
        DELQ=C*XI*AREA
        SUMA=AREA
        Q=DELQ
        WRITE(NUT,1010)DELQ,SUMA,Q
1010    FORMAT(3X,'SUBAREA RUNOFF(CFS) = ',F9.2,/,
     C  3X,'TOTAL AREA(ACRES) = ',F9.2,3X,'TOTAL RUNOFF(CFS) = ',F9.2)
403     FORMAT(1X,76('='))
C
10000   CONTINUE
C
        RETURN
        END
C
C
C  -----------------------------------------------------------------
        SUBROUTINE INITAR(E1,E2,XL,K,TC,NUT)
C  -----------------------------------------------------------------
C
        DIMENSION XXK(7,11),KK(8),RK(11)
        DATA XXK/'COMM','ERCI','AL  ','    ','    ','    ','    ',
     .           'APAR','TMEN','T   ','    ','    ','    ','    ',
     .           'MOBI','LE H','OME ','PARK','    ','    ','    ',
     .           'COND','OMIN','IUM ','    ','    ','    ','    ',
     .           'SING','LE F','AMIL','Y (1','/4 A','CRE)','    ',
     .           'SING','LE F','AMIL','Y (1','/2 A','CRE)','    ',
     .           'SING','LE F','AMIL','Y (1','-ACR','E)  ','    ',
     .           'SING','LE F','AMIL','Y (2','.5-A','CRE)','    ',
     .           'UNDE','VELO','PED ','WITH',' POO','R CO','VER ',
     .           'UNDE','VELO','PED ','WITH',' FAI','R CO','VER ',
     .           'UNDE','VELO','PED ','WITH',' GOO','D CO','VER '/
        DATA RK/.3031,.3227,.3359,.3592,.3926,.4221,.4693,.5,.5326,
     .  .7094,.9374/
        DATA KK/'DE','VE','LO','PM','EN','T ','IS',': '/
C
C
        WRITE(NUT,6)
6       FORMAT(10X,'ASSUMED INITIAL SUBAREA UNIFORM')
        H=E1-E2
        XK=RK(K)
        WRITE(NUT,100)KK,(XXK(J,K),J=1,7)
100     FORMAT(10X,8A2,7A4)
C
        TC=XK*((XL**3.)/H)**0.2
C
        WRITE(NUT,250)
250     FORMAT(3X,'TC = K*[(LENGTH**3)/(ELEVATION CHANGE)]**.2')
        WRITE(NUT,201)XL,E1,E2,H
201     FORMAT(3X,'INITIAL SUBAREA FLOW-LENGTH = ',F8.2,/,
     13X,'UPSTREAM ELEVATION = ',F9.2,/,
```

```
     13X,'DOWNSTREAM ELEVATION = ',F9.2,/,
     13X,'ELEVATION DIFFERENCE = ',F9.2)
      WRITE(NUT,255)XX,XL,H,TC
255   FORMAT(3X,'TC = ',F5.3,'*[(',F8.2,'**3)/(',F9.2,')]**.2 = ',
     C F8.3)
C
      IF(TC.GT.5.)GOTO 300
      WRITE(NUT,310)
310   FORMAT(3X,'COMPUTED TIME OF CONCENTRATION INCREASED TO 5 MIN.')
      TC=5.
C
300   CONTINUE
C
      RETURN
      END
```

PROGRAM 3

```
C
C
C  -------------------------------------------------------------------
      SUBROUTINE INTENR(YR,TC,XI,IGUESS,ERROR,NUT,RIYR,RSLOPE)
C  -------------------------------------------------------------------
C
C
      ERROR=0.
      XI=-RSLOPE*ALOG(TC)+ALOG(RIYR)+RSLOPE*4.094345
      XI=EXP(XI)
      IF(XI.LT. .01)XI=.01
      IF(XI.EQ. .01 .AND. IGUESS.NE.1)WRITE(NUT,101)
101   FORMAT(3X,'** MINIMUM DEFAULT RAINFALL INTENSITY USED **')
      IF(IGUESS.NE.1)WRITE(NUT,100)YR,XI
100   FORMAT(3X,F7.2,' YEAR RAINFALL INTENSITY(INCH/HOUR) = ',F6.3)
C
      RETURN
      END
```

PROGRAM 4

```
C  -------------------------------------------------------------------
      SUBROUTINE COEFAR(XXI,ISOIL,KK,C,IGUESS,CVAL,NUT)
C  -------------------------------------------------------------------
C
      DIMENSION XXK(12,9),RF(4),RK(9),MK(4)
      DATA XXK/'COMM','ERCI','AL D','EVEL','OPME','NT R','UNOF',
     .        'F CO','EFFI','CIEN','T = ','    ',
     .        'APAR','TMEN','T DE','VELO','PMEN','T RU','NOFF',
     .        ' COE','FFIC','IENT',' =  ','    ',
     .        'MOBI','LE H','OME ','PARK',' DEV','ELOP','MENT',
     .        ' RUN','OFF ','COEF','FICI','ENT=',
     .        'COND','OMIN','IUM ','DEVE','LOPM','ENT ','RUNO',
     .        'FF C','OEFF','ICIE','NT =','    ',
     .        'SING','LE-F','AMIL','Y(1/','4 AC','RE L','OT) ',
     .        'RUNO','FF C','OEFF','ICIE','NT =',
     .        'SING','LE-F','AMIL','Y(1/','2 AC','RE L','OT) ',
     .        'RUNO','FF C','OEFF','ICIE','NT =',
     .        'SING','LE-F','AMIL','Y(1-','ACRE',' LOT',') RU',
     .        'NOFF',' COE','FFIC','IENT',' =  ',
     .        'SING','LE-F','AMIL','Y(2.','5-AC','RE L','OT) ',
     .        'RUNO','FF C','OEFF','ICIE','NT =',
     .        'UNDE','VELO','PED ','WATE','RSHE','D RU','NOFF',
     .        ' COE','FFIC','IENT',' =  ','    '/
      DATA RF/32.,56.,69.,75./
      DATA RK/.1,.2,.25,.35,.5,.6,.8,.9,1./
      DATA MK/'A ','B ','C ','D '/
      XI=XXI
      IF(XI.LT. .5)XI=.5
      K=KK
      IF(K.GT.9)K=9
      IF(CVAL.EQ.0.)GOTO 20
      C=CVAL
      IF(IGUESS.NE.0)GO TO 1000
      WRITE(NUT,21)
21    FORMAT(3X,'*USER SPECIFIED(GLOBAL):')
      GOTO 900
20    CONTINUE
      IF(ISOIL.NE.5)GO TO 23
      IF(IGUESS.EQ.0)WRITE(NUT,24)
24    FORMAT(3X,'*USER SPECIFIED(SUBAREA):')
      GO TO 900
23    A=.35
      IF(K.GT.0)A=RK(K)
30    FORMAT(3X,'**NOTE: SOIL GROUP "D" USED AS DEFAULT VALUE**')
      F=0.
      IF(ISOIL.GT.0)F=RF(ISOIL)
      IF(F.EQ.0 .AND. IGUESS.EQ.0)WRITE(NUT,30)
      IF(F.EQ.0)F=75.
      SP=-8.+800./F
      F=(XI*SP)/(SP+6.*XI)
      B=1.-A
      C=0.9*((B+(XI-F)/XI*A))
      IF(IGUESS.EQ.1)GO TO 1000
      IF(ISOIL.GT.0)WRITE(NUT,100)MK(ISOIL)
100   FORMAT(3X,'SOIL CLASSIFICATION IS "',A1,'"')
900   IF(K.GT.0)WRITE(NUT,110)(XXK(J,K),J=1,12),C
110   FORMAT(3X,12A4,1X,F5.4)
1000  CONTINUE
      RETURN
      END
```

PROGRAM 5: DATA ENTRY

```
---DATA ENTRY FOR PIPE-FLOW TRAVEL TIME THROUGH SUBAREA---PAGE 1

Enter upstream node     1.00 elevation(FEET)........ ===>    "E1"
:ALLOWABLE VALUES ARE [.01    ] TO [99999.99  ]

Enter downstream node     2.00 elevation(FEET)...... ===>    "E2"
:ALLOWABLE VALUES ARE [0      ] TO [99999.99  ]

Enter pipe length through subarea(FEET)............. ===>    "XL"
:ALLOWABLE VALUES ARE [.01    ] TO [10000 ]

Enter Mannings friction factor for pipe............. ===>    "XN"
(NOTE: FOR RCP USE n = .013
       FOR CSP(or CMP) USE n = .024)
:ALLOWABLE VALUES ARE [.005   ] TO [.9999 ]


------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR PIPE-FLOW TRAVEL TIME THROUGH SUBAREA---PAGE 2

Enter diameter of given pipe size(INCHES)........... ===>    "DIAM"
:ALLOWABLE VALUES ARE [       3.00] TO [240        ]

Enter number of pipes in subarea reach.............. ===>    "NUMPI"
:ALLOWABLE VALUES ARE GREATER THAN [0      ]


------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

PROGRAM 5

```
C  -------------------------------------------------------------------
      SUBROUTINE PIPEFR(Q,TC,SUMA,IERR,PIPMIN,PERCNT)
C  -------------------------------------------------------------------
C
C
C  PIPE-FLOW ANALYSIS
C
      COMMON /NUT/NUT
      COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
      COMMON/CALC1/E1,E2,XL,K,IS,AREA,XKI,XP,KI,RIYR,RSLOPE
C
C..READ DATA INPUT
      READ FREE(5) KODE,E1,E2,XL,XN
C  READ MORE IF USER SPECIFIED PIPESIZE
      IF(KODE.EQ.4)READ FREE(5) DIAM,NUMPI
C
C     PROCESS FLOW
C
      IF(KODE.EQ.4)GO TO 2052
2050  WRITE(NUT,2105)
2105 FORMAT(3X,'>>>>>COMPUTE PIPEFLOW TRAVELTIME THRO SUBAREA<<<<<',/,
    C 3X,'>>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)',
    . '<<<<<')
      GO TO 2053
C
2052  WRITE(NUT,2106)
2053  CONTINUE
C
2106 FORMAT(3X,'>>>>>COMPUTE PIPEFLOW TRAVELTIME THRO SUBAREA<<<<<',/,
    C 3X,'>>>>>USING USER-SPECIFIED PIPESIZE<<<<<')
      WRITE(NUT,403)
      DIAM=DIAM/12.
      S1=(E1-E2)/XL*PERCNT
C
      IF(KODE.EQ.4)GO TO 2200
C
      CALL LETFLA(S1,Q,SIZE1,NUMPI,XN)
      DIAM=SIZE1*12.
      IF(DIAM.LT.PIPMIN)WRITE(NUT,2110)PIPMIN
2110  FORMAT(3X,'ESTIMATED PIPE DIAMETER(INCH) INCREASED TO ',F6.3)
      IF(DIAM.LT.PIPMIN)DIAM=PIPMIN
      DIAM=DIAM/12.
C
2200  QQ=NUMPI
      QQ=Q/QQ
C
      CALL PNORMA(DIAM,QQ,S1,V,XN,NUT)
```

```
C
      DIAM=DIAM*12.
      WRITE(NUT,2300)E1,E2,XL,XN
2300  FORMAT(3X,'UPSTREAM NODE ELEVATION = ',F8.2,/,
     C 3X,'DOWNSTREAM NODE ELEVATION = ',F8.2,/,
     C 3X,'FLOWLENGTH(FEET) = ',F8.2,3X,'MANNINGS N = ',F5.3)
      IF(KODE.EQ.4)GO TO 2057
C
      WRITE(NUT,2315)DIAM,NUMPI
      GO TO 2058
2315  FORMAT(3X,'ESTIMATED PIPE DIAMETER(INCH) = ',F6.2,4X,
     C 'NUMBER OF PIPES = ',I3)
2057  WRITE(NUT,2310)DIAM,NUMPI
2310  FORMAT(3X,'GIVEN PIPE DIAMETER(INCH) = ',F6.2,4X,
     C 'NUMBER OF PIPES = ',I3)
2058  TRAVEL=XL/60./V
      TC=TC+TRAVEL
      WRITE(NUT,2317)Q
2317  FORMAT(3X,'PIPEFLOW THRU SUBAREA(CFS) = ',F9.2)
      WRITE(NUT,2320)TRAVEL,TC
2320  FORMAT(3X,'TRAVEL TIME(MIN.) = ',F6.2,4X,'TC(MIN.) = ',F6.2)
C
C
3020  CONTINUE
C
C  FORMATS
C
403   FORMAT(1X,76('='))
C
      RETURN
      END
C
C
C ------------------------------------------------------------------
      SUBROUTINE PNORMA(D,Q,S0,V,XXN,NUT)
C ------------------------------------------------------------------
C
C
C     TEST FOR FULL PIPE-FLOW
C
      DN=D*12.
      XK=.4631646/XXN*S0**.5
      QFULL=XK*D**(8./3.)
      IF(Q.GE.QFULL)GO TO 200
C
      XK=1.486/XXN*(S0**0.5)
      KTEST=0
      THETAU=2.2643743
      THETAL=0.
100   THETA=(THETAU+THETAL)/2.
      KTEST=KTEST+1
      IF(KTEST.GE.101)WRITE(NUT,110)
110   FORMAT(3X,'ASSUME FULL-FLOWING PIPELINE')
      IF(KTEST.GE.101) GO TO 200
      XF=THETA*2.
      XS=SIN(XF)
      AREA=D*D/4.*(THETA-0.5*XS)
      RH=D/4.*(1.-(XS/XF))
      QTEST=XK*AREA*RH**(.66667)
      FACTOR=Q-QTEST
      IF(FACTOR.GE.0.)THETAL=THETA
      IF(FACTOR.LE.0.)THETAU=THETA
      IF(ABS(FACTOR).LT..005)GO TO 150
      GO TO 100
150   IF(THETA.GE.1.570796)DN=D/2.+(SIN(THETA-1.570796))*D/2.
      IF(THETA.LT.1.570796)DN=D/2.-(COS(THETA))*D/2.
      DN=DN*12.
      D1=D*12.
      WRITE(NUT,120)D1,DN
120   FORMAT(3X,'DEPTH OF FLOW IN ',F5.1,' INCH PIPE IS ',F5.1,
     C ' INCHES')
200   CONTINUE
      AREAF=.7854*D*D
      IF(Q.GE.QFULL.OR.KTEST.GE.101)V=Q/AREAF
      IF(Q.LT.QFULL)V=Q/AREA
      WRITE(NUT,300)V
300   FORMAT(3X,'PIPEFLOW VELOCITY(FEET/SEC.) = ',F5.1)
C
      RETURN
      END
C
C
C ------------------------------------------------------------------
      SUBROUTINE LETFLA(S0,QQ,SIZE1,NUMPI,XN)
C ------------------------------------------------------------------
C
C
      NTEST=0
      QQQ=QQ
      NUMPI=1
700   Q=QQQ
      XK=Q/(S0**0.5)
      XD=(XK/.4631644*XN)**0.375
      XINCH=XD*12.
      TEST=XINCH/3.
      ITEST=TEST
      XTEST=ITEST
      DEL=1.
      XDEL=TEST-XTEST
      IF(XDEL.EQ.0.)DEL=0.
      PIPE=XTEST+DEL
      SIZE=PIPE*3.
      SIZE1=SIZE/12.
      IF(SIZE1.LE.8.)GO TO 500
      TEST=XINCH/6.
      ITEST=TEST
      XTEST=ITEST
      DEL=1.
      IF(XDEL.EQ.0.)DEL=0.
      PIPE=XTEST+DEL
      SIZE=PIPE*6.
      SIZE1=SIZE/12.
500   CONTINUE
      IF(SIZE1.LE.12.)GO TO 1000
      NTEST=1
      NUMPI=NUMPI+1
      Z=NUMPI
      QQQ=QQ/Z
      GO TO 700
1000  CONTINUE
C
      RETURN
      END
```

PROGRAM 6: DATA ENTRY

```
---DATA ENTRY FOR TRAPEZOIDAL CHANNEL TRAVEL TIME---PAGE 1

Enter upstream node     1.00 elevation(FEET)........ ===>    "E1"
:ALLOWABLE VALUES ARE [.01   ] TO [99999.99  ]

Enter downstream node     2.00 elevation(FEET)...... ===>    "E2"
:ALLOWABLE VALUES ARE [0     ] TO [99999.99  ]

Enter channel length through subarea(FEET).......... ===>    "XL"
:ALLOWABLE VALUES ARE [.01   ] TO [10000 ]

Enter Mannings friction factor for channel.......... ===>    "XN"
(NOTE: FOR CONCRETE SECTIONS,   USE n = .015
       FOR GOOD EARTH CHANNELS, USE n = .03
 SEE COUNTY MANUAL FOR MORE INFORMATION)
:ALLOWABLE VALUES ARE [.005  ] TO [.9999 ]

-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR TRAPEZOIDAL CHANNEL TRAVEL TIME---PAGE 2

Enter horizontal base width of channel(FEET)........ ===>    "B"
:ALLOWABLE VALUES ARE [0] TO [1000. ]

Enter uniform symmetrical channel "Z" factor........ ===>    "Z"
(NOTE: THE CHANNEL "Z" FACTOR IS THE SIDE SLOPE
       RATIO OF [HORIZONTAL/VERTICAL]
 EXAMPLE: FOR A 2:1 SIDE SLOPE, "Z"=2)
:ALLOWABLE VALUES ARE [0] TO [99.99 ]

Enter maximum allowable depth of flow
in channel(FEET).................................... ===>    "DMAX"
:ALLOWABLE VALUES ARE [.001  ] TO [500   ]

-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

PROGRAM 6

```
C ------------------------------------------------------------------
      SUBROUTINE TRAPZR(Q,TC,SUMA,IERR)
C ------------------------------------------------------------------
C
C  TRAPEZOIDAL CHANNEL HYDRAULICS (TRAVEL TIME)
C
      COMMON /NUT/NUT
      COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
      COMMON/CALC1/E1,E2,XL,K,IS,AREA,XXI,XP,KI,RIYR,RSLOPE
C
C
C..READ DATA INPUT
      READ FREE(5)E1,E2,XL,XN,B,Z,DMAX
C
C  PROCESS TRAPEZOIDAL CHANNEL TRAVEL TIME
C
      WRITE(NUT,3190)
3190  FORMAT(3X,'>>>>>COMPUTE TRAPEZOIDAL-CHANNEL FLOW<<<<<',
     C /,3X,'>>>>>TRAVELTIME THRU SUBAREA<<<<<')
      WRITE(NUT,403)
      QQ=Q
      S1=(E1-E2)/XL
      WRITE(NUT,3200)E1,E2,XL,B,Z,XN,DMAX,QQ
3200  FORMAT(3X,'UPSTREAM NODE ELEVATION = ',F9.2,/,3X,
     C 'DOWNSTREAM NODE ELEVATION = ',F9.2,/,3X,
     C 'CHANNEL LENGTH THRU SUBAREA(FEET) = ',F8.2,/,3X,
     C 'CHANNEL BASE(FEET) = ',F7.2,3X,'"Z" FACTOR = ',F7.3,/,
     C 3X,'MANNINGS FACTOR = ',F5.3,3X,'MAXIMUM DEPTH(FEET) = ',
     C F6.2,/,3X,'CHANNEL FLOW THRU SUBAREA(CFS) = ',F9.2)
C
      CALL TNORMA(S1,QQ,Z,B,XN,V,NUT,DN,DMAX)
C
```

```
      TRAVEL=XL/60./V
      TC=TC+TRAVEL
      WRITE(NUT,3300)V,DN,TRAVEL,TC
3300  FORMAT(3X,'FLOW VELOCITY(FEET/SEC) = ',F6.2,3X,
    C 'FLOW DEPTH(FEET) = ',F6.2,/,3X,'TRAVEL TIME(MIN.) = ',
    C F6.2,3X,'TC(MIN.) = ',F6.2)
      IF(DN.GE.DMAX)WRITE(NUT,3350)
3350  FORMAT(/,3X,'==>FLOWDEPTH EXCEEDS MAXIMUM ALLOWABLE DEPTH',/)
C
3020  CONTINUE
C
C FORMATS
C
403   FORMAT(1X,76('='))
C
C
      RETURN
      END
C
C
C  ------------------------------------------------------------------
      SUBROUTINE TNORMA(S0,Q,Z,B,XN,V,NUT,DN,DMAX)
C  ------------------------------------------------------------------
C
C
      DN=DMAX/2.
      YMIN=0.
      YMAX=DMAX
      FUN=1.-Q*XN*(B+2.*DMAX*SQRT(Z*Z+1.))**.6667/(1.486*((B+Z*DMAX)
    C *DMAX)**1.6667*SQRT(S0))
      IF(FUN)450,500,500
450   WRITE(NUT,460)
460   FORMAT(/,10X,'==>>ERROR: FLOW IN CHANNEL EXCEEDS CHANNEL',/,
    C 14X,'CAPACITY( NORMAL DEPTH EQUAL TO SPECIFIED MAXIMUM ',/,
    C 14X,'ALLOWABLE DEPTH).',
    C /,14X,'AS AN APPROXIMATION, FLOWDEPTH IS SET AT MAXIMUM',/,
   C14X,'ALLOWABLE DEPTH AND IS USED FOR TRAVELTIME CALCULATIONS.',/)
      DN=DMAX
      GOTO 570
500   I=0
510   I=I+1
      IF(I.GT.30)GO TO 560
      FUN=1.-Q*XN*(B+2.*DN*SQRT(Z*Z+1))**.6667/(1.486*((B+Z*DN)
   C*DN)**1.6667*SQRT(S0))
      IF(FUN)520,540,530
520   YMIN=DN
      GO TO 540
530   YMAX=DN
540   DN1=(YMIN+YMAX)/2.
      IF(ABS(DN-DN1).LT..01)GO TO 570
      DN=DN1
550   GO TO 510
560   WRITE(NUT,2010)
2010  FORMAT(/,10X,'==>>ERROR: NO CONVERGENCE IN PROGRAM TO NORMAL ',
    . 'DEPTH.',
    C /,14X,'AS AN APPROXIMATION, FLOWDEPTH IS SET AT MAXIMUM ',
    . 'ALLOWABLE',/,
    C 14X,'DEPTH AND IS USED FOR TRAVELTIME CALCULATIONS.',/)
      DN=DMAX
570   CONTINUE
      TA=(DN*Z+B)*DN
      V=Q/TA
3000  CONTINUE
C
      RETURN
      END
```

PROGRAM 7: DATA ENTRY

```
---DATA ENTRY FOR STREET FLOW THROUGH SUBAREA---PAGE 1


Enter upstream node     1.00 elevation(FEET)........ ===>    "E1"
:ALLOWABLE VALUES ARE [.01    ] TO [99999.99  ]

Enter downstream node     2.00 elevation(FEET)...... ===>    "E2"
:ALLOWABLE VALUES ARE [0      ] TO [99999.99  ]

Enter runoff travel-length through subarea(FEET).... ===>    "XL"
:ALLOWABLE VALUES ARE [.01    ] TO [10000 ]


-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR STREET FLOW THROUGH SUBAREA---PAGE 2

SUBAREA LAND USE OR DEVELOPMENT TYPE:

    1= Commercial
    2= Apartment
    3= Mobile home park
    4= Condominium
    5= Single family (1/4 ACRE lot)
    6= Single family (1/2 ACRE lot)
    7= Single family (  1-ACRE lot)
    8= Single family (2.5-ACRE lot)
    9= Undeveloped


Select subarea development classification number.... ===>    "K"


-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
---DATA ENTRY FOR STREET FLOW THROUGH SUBAREA---PAGE 3

SUBAREA RUNOFF COEFFICIENT OPTIONS:

    1= Assume soil group A
    2= Assume soil group B
    3= Assume soil group C
    4= Assume soil group D
    5= User to specify runoff coefficient

Select runoff coefficient option number.............. ===>    "FSOIL"

Enter SUBAREA runoff coefficient..................... ===>    "C"
:ALLOWABLE VALUES ARE [.01    ] TO [.99    ]

Enter subarea area(ACRES)............................ ===>    "AREA"
:ALLOWABLE VALUES ARE [0] TO [1000  ]


-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
---DATA ENTRY FOR STREET FLOW THROUGH SUBAREA---PAGE 4


Enter standard curb height(INCHES).................. ===>    "CURB"
:ALLOWABLE VALUES ARE [6] OR [8]

Enter symmetrical street crossfall[DECIMAL NOTATION] ===>    "XFALL"
:ALLOWABLE VALUES ARE [.001  ] TO [.9999 ]

Enter the symmetrical street halfwidth(FEET)........ ===>    "HWIDTH"
:ALLOWABLE VALUES ARE [5     ] TO [99.99 ]

STREETFLOW OPTIONS:
    1: Runoff flows on one side of the street
    2: Runoff flows evenly on both sides of the street
Select streetflow option desired.................... ===>    "IWIDTH"


-------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

PROGRAM 7

```
C  ------------------------------------------------------------------
      SUBROUTINE STREER(Q,TC,SUMA,IERR)
C  ------------------------------------------------------------------
C
C  STREET FLOW THRU SUBAREA
C
      COMMON /NUT/NUT
      COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
      COMMON/CALC1/E1,E2,XL,K,IS,AREA,XKI,XP,KI,RIYR,RSLOPE
C
C
C..READ DATA INPUT
      READ FREE(5)E1,E2,XL,K,FSOIL,AREA,CURB,XFALL,HWIDTH,
    . IWIDTH
      IS=FSOIL
      C=FSOIL-5.0
C
C
```

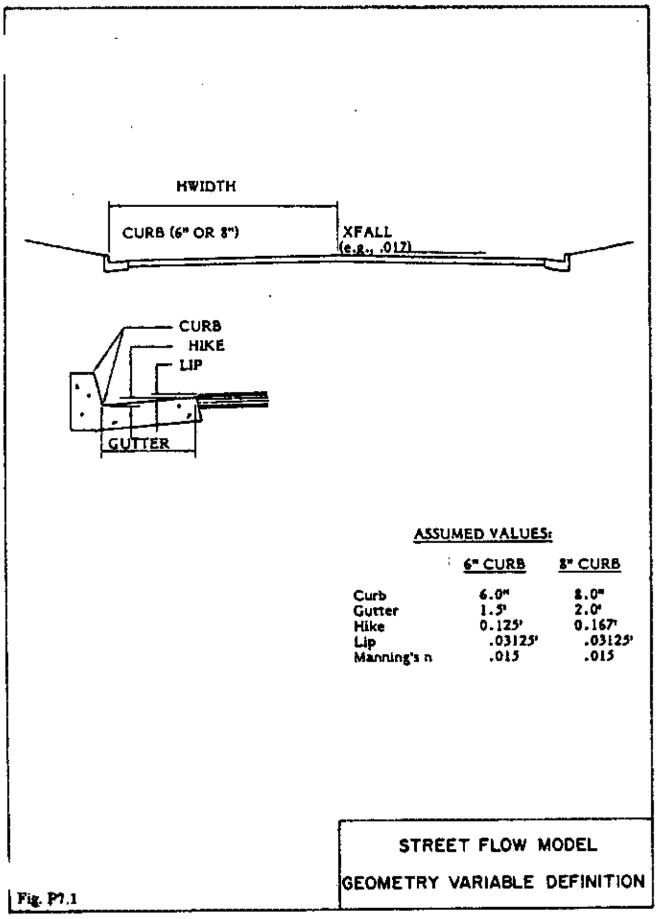


Fig. P7.1

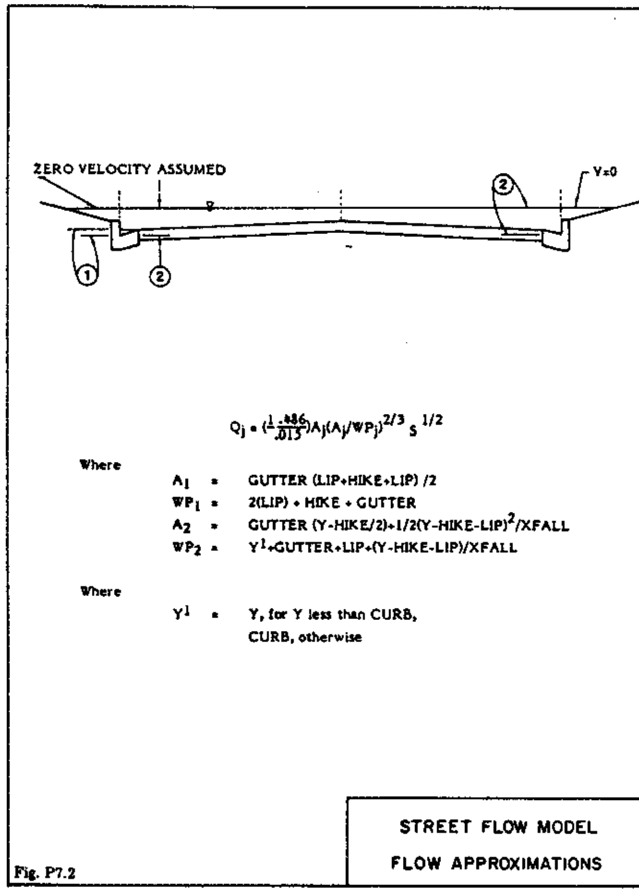


Fig. P7.2

```
      WRITE(NUT,4093)
4093 FORMAT(3X,'>>>>>COMPUTE STREETFLOW TRAVELTIME THRU SUBAREA<<<<<')
      WRITE(NUT,403)
      WRITE(NUT,4095)E1,E2,XL,CURB,HWIDTH,XFALL,IWIDTH
4095 FORMAT(3X,'UPSTREAM ELEVATION = ',F9.2,
    C 3X,'DOWNSTREAM ELEVATION = ',F9.2,/,
    C 3X,'STREET LENGTH(FEET) = ',F8.2,
    C 3X,'CURB HEIGTH(INCHES) = ',F2.0,/,
    C 3X,'STREET HALFWIDTH(FEET) =',F6.2,
    C 3X,'STREET CROSSFALL(DECIMAL) =',F6.4,/,
    C 3X,'SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF = ',I2)
4103  QAVG=Q/SUMA
      QQ=Q+QAVG/2.*AREA
      S1=(E1-E2)/XL
      ITER=0
      IGUESS=1
C
4100  IF(CURB.EQ.6.)CALL SNORMA(S1,QQ,.5,XFALL,HWIDTH,.015,.03125,
    C 1.5,.125,IWIDTH,FWIDTH,V,DN,ERR,NUT,ITER,DATA,SD1,SW1)
      IF(CURB.EQ.8.)CALL SNORMA(S1,QQ,.6667,XFALL,HWIDTH,.015,
    C.03125,2.,.167,IWIDTH,FWIDTH,V,DN,ERR,NUT,ITER,DATA,SD1,SW1)
C
      IF(ITER.EQ.2)GO TO 4150
      TRAVEL=XL/60./V
      TCA=TC+TRAVEL
C
      IF(ITER.EQ.1)WRITE(NUT,4137)TRAVEL,TCA
C
      CALL INTENR(YR,TCA,XI,IGUESS,ERR,NUT,RIYR,RSLOPE)
      IF(ERR.NE.1.)GO TO 4105
      IERR=9
      GO TO 3022
C
4105  CALL COEFAR(XI,IS,K,C,IGUESS,CVAL,NUT)
C
      IF(ITER.EQ.1.OR.ITER.EQ.2)GOTO 4130
      IGUESS=0
      ITER=1
      QQ=C*XI*AREA/2.+Q
      GOTO 4100
4130  IF(ITER.EQ.2)GOTO 4150
C     QAVG=QQ
      SD1=DN
      SD2=FWIDTH
C
      TC=TCA
C
```

```
4137  FORMAT(3X,'STREETFLOW TRAVELTIME(MIN) = ',F6.2,3X,
    C 'TC(MIN) = ',F6.2,/)
      DELQ=XI*C*AREA
      Q=Q+DELQ
      SUMA=SUMA+AREA
      WRITE(NUT,4140)AREA,DELQ,SUMA,Q
4140  FORMAT(3X,'SUBAREA AREA(ACRES) = ',F7.2,3X,'SUBAREA RUNOFF',
    .'(CFS) = ',
    CF7.2,/,3X,'SUMMED AREA(ACRES) = ',F7.2,3X,'TOTAL RUNOFF(CFS) = ',
    C F9.2)
      ITER=2
      IGUESS=1
      QQ=Q
      GOTO 4100
C
4150  DV=DN*V
      WRITE(NUT,4160)DN,FWIDTH,V,DV
4160  FORMAT(3X,'END OF SUBAREA STREETFLOW HYDRAULICS:',/,3X,
    C'DEPTH(FEET) = ',F4.2,3X,'HALFSTREET FLOODWIDTH(FEET) = ',F5.2,/,
    C3X,'FLOW VELOCITY(FEET/SEC.) = ',F5.2,3X,'DEPTH*VELOCITY = ',F6.2)
C
3019  CONTINUE
      GO TO 3020
3021  IERR=3
      GO TO 3020
3022  IERR=9
      GO TO 3020
C
C
3020  CONTINUE
C
C
403   FORMAT(1X,76('='))
4110  FORMAT('**ERROR-NO SOLUTION FROM STREETFLOW MODEL: RECHECK',
    . ' YOUR DATA')
C
C
      RETURN
      END
C
C
C --------------------------------------------------------------------
      SUBROUTINE SNORMA(S0,QQ,CURB,XFALL,HWIDTH,XN,XLIP,GUTTER,
    . GHIKE,IWIDTH,FWIDTH,V,DN,ERROR,NUT,ITER)
C --------------------------------------------------------------------
C
C
C
```

```
      IF(ITER.EQ.1)WRITE(NUT,3120)QQ
3120  FORMAT(10X,'**TRAVELTIME COMPUTED USING MEAN FLOW(CFS) = ',
     . F7.2)
      ERROR=0.
      FACTOR=SQRT(1.+XFALL*XFALL)
      ISPLIT=0
      HR=A1/WP1
      XK1=1.486/XN*A1*HR**.6667
      CROWN=(HWIDTH-GUTTER)*XFALL+XLIP+GHIKE
      A2=GUTTER*(CROWN-GHIKE/2.)+(HWIDTH-GUTTER)*.5*(CROWN-GHIKE-XLIP)
      WP2=WP1+CROWN-XLIP-GUTTER+(HWIDTH-GUTTER)*FACTOR
      HR=A2/WP2
      XK2=1.486/XN*A2*HR**.6667
      Q=QQ
      IF(IWIDTH.EQ.2)Q=QQ/2.
      TESTK=Q/S0**.5
      IF(TESTK.GT.XK1)GO TO 300
C-------GUTTER FLOW MODEL
      V=Q/A1
      FWIDTH=GUTTER
      DN=XLIP+GHIKE
      GO TO 3000
300   IF(TESTK.GT.XK2)GO TO 400
C-------FLOW IS LESS THAN CROWN
      YTEST1=0.
      YMAX=CROWN
      SET=XLIP+GHIKE
      YMIN=SET
      I=0
350   I=I+1
      YTEST=(YMAX+YMIN)*.5
      A=GUTTER*(YTEST-GHIKE/2.)+((YTEST-SET)**2.)/XFALL/2.
      WP=WP1+YTEST-SET+((YTEST-SET)/XFALL)*FACTOR
      HR=A/WP
      XK=1.486/XN*A*HR**.6667
      TEST=TESTK-XK
      IF(TEST)360,380,365
360   YMAX=YTEST
      GO TO 370
365   YMIN=YTEST
370   TEST=ABS(YTEST1-YTEST)
      IF(TEST.LT..01)GO TO 380
      IF(I.GT.50)GO TO 2900
      YTEST1=YTEST
      GO TO 350
380   V=Q/A
      DN=YTEST
      FWIDTH=GUTTER+(DN-SET)/XFALL
      IF(ISPLIT.EQ.1)GOTO 437
      GO TO 3000
400   CONTINUE
C-------FLOW EXCEEDS CROWN
      IF(IWIDTH.EQ.2)GO TO 440
      CFULLK=2.*XK2
      IF(TESTK.LT.CFULLK)GO TO 430
      Q=Q/2.
      TESTK=Q/S0**.5
      GO TO 440
430   DN=CROWN
C-------FLOW SPLITS AND IS LESS THAN FULL(CROWN) STREET
      FWIDTH=HWIDTH
      Q1=XK2*S0**.5
      V1=Q1/A2
      IF(ITER.EQ.1)WRITE(NUT,435)
435   FORMAT(14X,'***STREETFLOW SPLITS OVER STREET-CROWN***')
      ISPLIT=1
      Q=Q-Q1
      TESTK=Q/S0**.5
      GOTO 300
437   IF(ITER.EQ.1)WRITE(NUT,438)CROWN,HWIDTH,V1,DN,FWIDTH,V
438   FORMAT(10X,'FULL DEPTH(FEET) = ',F7.2,3X,'FLOODWIDTH(FEET) = ',
     . F7.2,
     C /,10X,'FULL HALF-STREET VELOCITY(FEET/SEC.) = ',F7.2,/,
     C 10X,'SPLIT DEPTH(FEET) = ',F7.2,3X,'SPLIT FLOODWIDTH(FEET) = ',
     . F7.2,
     C /,10X,'SPLIT VELOCITY(FEET/SEC.) = ',F7.2)
      V=V1
      DN=CROWN
      FWIDTH=HWIDTH
      GOTO 3000
440   IF(ITER.EQ.1)WRITE(NUT,441)
441   FORMAT(14X,'***STREET FLOWING FULL***')
      DMAX=CROWN+5.
      X=DMAX-CROWN
      A=HWIDTH*X+A2
      HR=A/WP2
      XK=1.486/XN*A*HR**.6667
      IF(TESTK.GE.XK)GOTO 3001
      DMIN=CROWN
      DO 450 I=1,12
      TEST=.5*(DMAX+DMIN)
      X=TEST-CROWN
      DN=CROWN+X
      A=HWIDTH*X+A2
      WP=WP2
      IF(DN.LE.CURB)WP=X+WP2
      HR=A/WP
      XK=1.486/XN*A*HR**.6667
      XZ=XK-TESTK
      XD=DN-DMAX
      IF(ABS(XD).LT..01)GOTO 3090
      IF(XZ)443,3090,445
443   DMIN=TEST
      GOTO 450
445   DMAX=TEST
450   CONTINUE
      GO TO 3000
480   FWIDTH=HWIDTH
      V=Q/A
      GO TO 3000
2900  IF(ITER.EQ.1)WRITE(NUT,2901)
2901  FORMAT(/,10X,'==>>ERROR:"BELOW-CROWN" STREETFLOW MODEL FAILS.')
      GOTO 3006
3000  CONTINUE
      GOTO 3100
3001  WRITE(NUT,3005)
3005  FORMAT(10X,'==>>ERROR: FLOW DEPTH EXCEEDS 5-FEET ABOVE STREET ',
     . 'CROWN')
3006  IF(ITER.EQ.1)WRITE(NUT,3007)
3007  FORMAT(14X,'AS AN APPROXIMATION, TRAVELTIME ESTIMATES ARE BASED'
     C,/,14X,'ON A DEFAULT VELOCITY OF [10] FEET PER SECOND.'/)
      V=10.
      DN=0.
      FWIDTH=0.
      GOTO 4000
3090  FWIDTH=HWIDTH
      V=Q/A
      DV=V*DN
3100  CONTINUE
      IF(DN.LE.CURB)GOTO 3109
      IF(ITER.EQ.1)WRITE(NUT,3107)
3107  FORMAT(10X,'NOTE: STREETFLOW EXCEEDS TOP OF CURB.',/,
     C 10X,'THE FOLLOWING STREETFLOW RESULTS ARE BASED ON THE ',
     . 'ASSUMPTION',
     C/,10X,'THAT NEGLIBLE FLOW OCCURS OUTSIDE OF THE STREET CHANNEL.'
     . ,/,
     C 10X,'THAT IS, ALL FLOW ALONG THE PARKWAY, ETC., IS NEGLECTED.')
3109  CONTINUE
      DV=DN*V
      IF(ITER.EQ.1)WRITE(NUT,3110)DN,FWIDTH,V,DV
3110  FORMAT(
     C 10X,'STREET FLOWDEPTH(FEET) = ',F5.2,/,
     C 10X,'HALFSTREET FLOODWIDTH(FEET) = ',F7.2,/,
     C 10X,'AVERAGE FLOW VELOCITY(FEET/SEC.) = ',F7.2,/,
     C 10X,'PRODUCT OF DEPTH&VELOCITY = ',F7.2)
4000  CONTINUE
C
      RETURN
      END
```

PROGRAM 8: DATA ENTRY

```
---DATA ENTRY FOR PAVEMENT "V" DITCH FLOW THROUGH SUBAREA---PAGE 1


Enter upstream node     1.00 elevation(FEET)........ ===>    "E1"
:ALLOWABLE VALUES ARE [.01    ] TO [99999.99  ]

Enter downstream node     2.00 elevation(FEET)...... ===>    "E2"
:ALLOWABLE VALUES ARE [0      ] TO [99999.99  ]

Enter runoff travel-length through subarea(FEET).... ===>    "XL"
:ALLOWABLE VALUES ARE [.01    ] TO [10000 ]

-----------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR PAVEMENT "V" DITCH FLOW THROUGH SUBAREA---PAGE 2

SUBAREA LAND USE OR DEVELOPMENT TYPE:

    1= Commercial
    2= Apartment
    3= Mobile home park
    4= Condominium
    5= Single family (1/4 ACRE lot)
    6= Single family (1/2 ACRE lot)
    7= Single family (  1-ACRE lot)
    8= Single family (2.5-ACRE lot)
    9= Undeveloped


Select subarea development classification number.... ===>    "K"

-----------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
---DATA ENTRY FOR PAVEMENT "V" DITCH FLOW THROUGH SUBAREA---PAGE 3

SUBAREA RUNOFF COEFFICIENT OPTIONS:

    1= Assume soil group A
    2= Assume soil group B
    3= Assume soil group C
    4= Assume soil group D
    5= User to specify runoff coefficient

Select runoff coefficient option number............. ===>    "FSOIL"

Enter SUBAREA runoff coefficient.................... ===>    "C"
:ALLOWABLE VALUES ARE [.01   ] TO [.99   ]

Enter subarea area(ACRES)........................... ===>    "AREA"
:ALLOWABLE VALUES ARE [0] TO [1000  ]

------------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

```
---DATA ENTRY FOR PAVEMENT "V" DITCH FLOW THROUGH SUBAREA---PAGE 4

Enter "V" gutter width(FEET)........................ ===>    "W"
:ALLOWABLE VALUES ARE [.001  ] TO [100   ]

Enter "V" gutter-hike(FEET)......................... ===>    "HIKE"
:ALLOWABLE VALUES ARE [.001  ] TO [10    ]

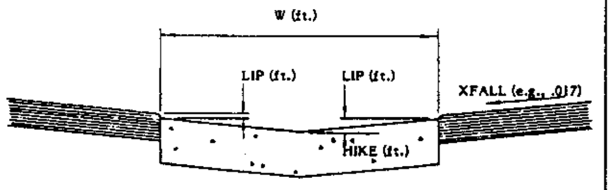
Enter pavement lip(FEET)............................ ===>    "XLIP"
:ALLOWABLE VALUES ARE [.001  ] TO [10    ]

Enter assumed uniform Mannings friction factor...... ===>    "XN"
(NOTE: SUGGESTED VALUE FOR MANNINGS n IS [.0153])
:ALLOWABLE VALUES ARE [.005  ] TO [.9999 ]

Enter symmetric pavement crossfall[DECIMAL NOTATION] ===>    "XFALL"
:ALLOWABLE VALUES ARE [.00001] TO [.9999 ]

Enter maximium allowable depth of flow(FEET)........ ===>    "DMAX"
:ALLOWABLE VALUES ARE [.001      ] TO [100      ]

------------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```



DMAX = MAXIMUM ALLOWABLE DEPTH OF FLOW

GUTTER MODEL

GEOMETRIC VARIABLE DEFINITION

Fig. P8.1

PROGRAM 8

```
C    -----------------------------------------------------------------
       SUBROUTINE VGUTTR(Q,TC,SUMA,IERR)
C    -----------------------------------------------------------------
C
C    PAVEMENT "V" DITCH FLOW
C
       COMMON/NUT/NUT
       COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
       COMMON/CALC1/E1,E2,XL,K,IS,AREA,XKI,XP,KI,RIYR,RSLOPE
C
C
C..READ DATA INPUT
       READ FREE(5)E1,E2,XL,K,FSOIL,AREA,W,HIKE,XLIP,XN,XFALL,DMAX
       IS=FSOIL
       C=FSOIL-5.0
C
C    PROCESS FLOW THRU SUBAREA
C
       WRITE(NUT,7080)
7080   FORMAT(3X,'>>>>>COMPUTE "V" GUTTER FLOW TRAVELTIME THRU SUBAREA',
     . '<<<<<')
       WRITE(NUT,403)
       WRITE(NUT,7105)E1,E2,XL
7105   FORMAT(3X,'UPSTREAM NODE ELEVATION = ',F9.2,/,3X,
     . 'DOWNSTREAM NODE ELEVATION = ',F9.2,/,3X,
     . 'CHANNEL LENGTH THRU SUBAREA(FEET) = ',F8.2)
       WRITE(NUT,7100)W,HIKE,XLIP,XN,XFALL,DMAX
7100   FORMAT(3X,'"V" GUTTER WIDTH(FEET) = ',F6.2,3X,'GUTTER HIKE(FEET)',
     .' = ',
     CF6.3,/,3X,'PAVEMENT LIP(FEET) = ',F6.3,3X,'MANNINGS N = ',F5.4,/,
     C  3X,'PAVEMENT CROSSFALL(DECIMAL NOTATION) = ',F6.2,/,
     C  3X,'MAXIMUM DEPTH(FEET) = ',F6.2)
       QAVG=Q/SUMA
       ITER=0
       QQ=Q+QAVG/2.*AREA
       S1=(E1-E2)/XL
       IGUESS=1
7140   DS=0.
C
       CALL GNORMA(W,HIKE,XLIP,XN,XFALL,S1,QQ,DMAX,Y,DS,V,IGUESS,
     . NUT)
C
       IF(ITER.EQ.2)GO TO 7200
C
       TRAVEL=XL/60./V
       TCA=TC+TRAVEL
       CALL INTENR(YR,TCA,XI,IGUESS,ERROR,NUT,RIYR,RSLOPE)
       IF(ERROR.NE.1.)GO TO 7203
       IERR=9
       GO TO 3020
C
7203   CALL COEFAR(XI,IS,K,C,IGUESS,CVAL,NUT)
       IF(ITER.EQ.1.OR.ITER.EQ.2)GOTO 7200
       IGUESS=0
       ITER=1
       QQ=C*XI*AREA/2.+Q
       GOTO 7140
C
7200   IF(ITER.EQ.2)GOTO 7300
C
       QAVG=QQ
       SD1=Y
       SW1=W
C
       IF(DS.LE.W)DS=0.
       DS=W+2.*DS
       WRITE(NUT,7250)V,Y,DS
7250   FORMAT(3X,'TRAVELTIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC) = '
     C  ,F6.2,/,3X,'AVERAGE FLOWDEPTH(FEET) = ',F6.2,3X,'FLOODWIDTH',
     C  '(FEET) = ',F7.2)
       TC=TCA
       WRITE(NUT,7260)TRAVEL,TC
7260   FORMAT(3X,'"V" GUTTER FLOW TRAVEL TIME(MIN) = ',F6.2,3X,
     C  'TC(MIN) = ',F6.2)
       DELQ=C*XI*AREA
       Q=Q+DELQ
       SUMA=SUMA+AREA
       WRITE(NUT,4140)AREA,DELQ,SUMA,Q
4140   FORMAT(3X,'SUBAREA AREA(ACRES) = ',F7.2,3X,'SUBAREA RUNOFF',
     .'(CFS) = ',
     .F7.2,/,3X,'SUMMED AREA(ACRES) = ',F7.2,3X,'TOTAL RUNOFF(CFS) = ',
     . F9.2)
       ITER=2
       IGUESS=1
       QQ=Q
       GOTO 7140
7300   DV=Y*V
       IF(DS.LE.W)DS=0.
       DS=W+2.*DS
       WRITE(NUT,7350)Y,DS,V,DV
7350   FORMAT(3X,'END OF SUBAREA "V" GUTTER HYDRAULICS:',/,3X,
     C  'DEPTH(FEET) = ',F5.2,3X,'FLOODWIDTH(FEET) = ',F5.2,/,
     C3X,'FLOW VELOCITY(FEET/SEC.) = ',F6.2,3X,'DEPTH*VELOCITY = ',F6.2)
C
```

```
3019    CONTINUE
        GO TO 3020
3021    IERR=3
C
3020    CONTINUE
C
C
C  FORMATS
C
403     FORMAT(1X,76('='))
7150    FORMAT('**ERROR-FLOW DEPTH EXCEEDS ALLOWABLE DEPTH: RECHECK ',
     .  ,'YOUR DATA')
7160    FORMAT('**ERROR-NO SOLUTION FROM GUTTER MODEL: RECHECK YOUR',
     .  ' DATA')
C
        RETURN
        END
C
C
C  --------------------------------------------------------------------
        SUBROUTINE GNORMA(W,GHIKE,XLIP,XN,SLOPE,S0,Q,DMAX,Y,DS,
     .  V,IGUESS,NUT)
C  --------------------------------------------------------------------
C
C
C
        A1=.5*GHIKE*W
        WP1=2.*SQRT(W*W/4.+GHIKE*GHIKE)
        HR=A1/WP1
        XK1=1.486/XN*A1*HR**.6667
        WP2=W + 2.*XLIP
        A2=A1+XLIP*W
        HR=A2/WP2
        XK2=1.486/XN*A2*HR**.6667
        TESTK=Q/S0**.5
        IF(TESTK.GT.XK1)GO TO 100
        QFULL=XK1*S0**.5
        DS=W
        Y=GHIKE
        V=QFULL/A1
        WRITE(NUT,90)
90    FORMAT(/,10X,'NOTE:TRAVELTIME ESTIMATES BASED ON NORMAL DEPTH',/,
     C  10X,'IN A FLOWING-FULL GUTTER(NORMAL DEPTH = GUTTER HIKE)',/)
        GO TO 1000
100     IF(TESTK.GT.XK2)GO TO 200
        QFULL=XK2*S0**.5
        V=QFULL/A2
        DS=W
        Y=GHIKE+XLIP
        WRITE(NUT,190)
190     FORMAT(/,10X,'NOTE:TRAVELTIME ESTIMATES BASED ON NORMAL',/,
     C  10X,'DEPTH EQUAL TO [GUTTER-HIKE + PAVEMENT LIP]')
        GO TO 1000
200     I=0
        YMAX=DMAX
        Y1=0.
        SET=GHIKE+XLIP
        YMIN=SET
        DS=(DMAX-SET)/SLOPE
        AS=.5*DS*(DMAX-SET)
        HR=AS/SQRT((DMAX-SET)*(DMAX-SET)+DS*DS)
        XKA=1.486/XN*AS*HR**.6667
        AM=(DMAX-SET)*W+A2
        HR=AM/WP2
        XKM=1.486/XN*AM*HR**.6667
        XKT=2.*XKA+XKM
        IF(TESTK.GT.XKT)GO TO 600
201     I=I+1
        IF(I.GT.50)GO TO 500
        Y=.5*(YMAX+YMIN)
        DS=(Y-SET)/SLOPE
        AS=.5*DS*(Y-SET)
        HR=AS/SQRT((Y-SET)*(Y-SET)+DS*DS)
        XKA=1.486/XN*AS*HR**.6667
        AM=(Y-SET)*W+A2
        HR=AM/WP2
        XKM=1.486/XN*AM*HR**.6667
        XKT=2.*XKA+XKM
        IF(TESTK-XKT)300,900,400
300     YMAX=Y
        GO TO 450
400     YMIN=Y
450     TEST=ABS(Y-Y1)
        IF(TEST.LT..01)GO TO 900
        Y1=Y
        GO TO 201
500     WRITE(NUT,501)
501     FORMAT(/,10X,'==>>ERROR:NO CONVERGENCE IN V-GUTTER PROGRAM.',/,
     C  14X,'AS AN APPROXIMATION, TRAVELTIME CALCULATIONS ARE BASED',/,
     C  14X,'ON FLOWDEPTH EQUAL TO THE SPECIFIED MAXIMUM ALLOWABLE ',
     .  'DEPTH.',/)
        GOTO 650
600     WRITE(NUT,610)
610   FORMAT(/,10X,'==>>ERROR:FLOW EXCEEDS CAPACITY OF CHANNEL WITH',/,
     C14X,'NORMAL DEPTH EQUAL TO SPECIFIED MAXIMUM ALLOWABLE DEPTH.',/,
     C  14X,'AS AN APPROXIMATION, TRAVELTIME CALCULATIONS ARE BASED',/,
     C  14X,'ON FLOWDEPTH EQUAL TO THE SPECIFIED MAXIMUM ALLOWABLE ',
     .  'DEPTH.',/)
650     Y=DMAX
        DS=(DMAX-SET)/SLOPE*2.+W
        V=Q/(AM+2.*AS)
        GOTO 1000
900     AT=2.*AS+AM
        V=Q/AT
1000    CONTINUE
C
        RETURN
        END
```

PROGRAM 9: DATA ENTRY

```
DATA ENTRY FOR CONFLUENCE OF INDEPENDENT STREAMS AT A NODAL POINT

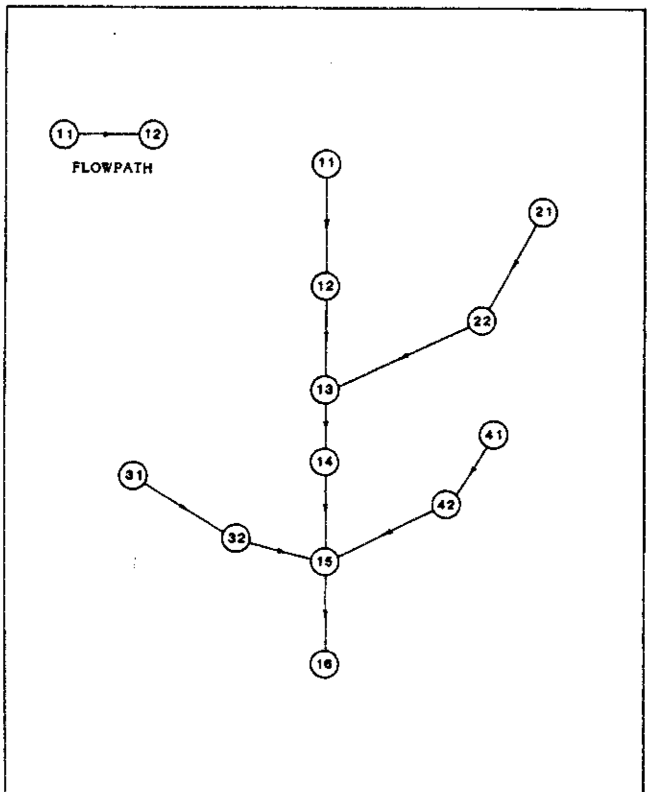

Enter the total number of independent streams
to confluence.......................................... ===>    "NUMBER"
:ALLOWABLE VALUES ARE [1] TO [5     ]

Enter a number for THIS independent stream.......... ===>    "N"
(NOTE: STREAM NUMBERS MUST BE USED IN INCREASING
 ORDER FROM 1 TO 5)
:ALLOWABLE VALUES ARE [1] TO [5     ]

------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

PROGRAM 9

```
C  --------------------------------------------------------------------
        SUBROUTINE CONFB(Q,TC,SUMA,IERR)
C  --------------------------------------------------------------------
C
C
C       CONFLUENCE ANALYSIS
C
        COMMON /NUT/NUT
        COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
        COMMON/CALC1/E1,E2,XL,K,IS,AREA,XKI,XP,KI,RIYR,RSLOPE
        COMMON/CALC2/TCON(5),TOTALA(5),XINT(5),QJN(5),QBAR(5),ZCON(5)
C
C
C..READ DATA INPUT
        READ FREE(5)N,NUMBER
C
C-------PROCESS CONFLUENCE ANALYSIS
C
        IF(N.LT.NUMBER)WRITE(NUT,531)
531   FORMAT(3X,'>>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<')
        IF(N.EQ.NUMBER)WRITE(NUT,532)
532   FORMAT(3X,'>>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<',
     C  /,3X,'>>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<')
        WRITE(NUT,403)
        TCON(N)=TC
        IGUESS = 1
C
        CALL INTENR(YR,TC,XI,IGUESS,ERROR,NUT,RIYR,RSLOPE)
        IF(ERROR.EQ.1.)IERR=9
        IF(ERROR.EQ.1.)GOTO 3019
C
        XINT(N)=XI
        TOTALA(N)=SUMA
        QJN(N)=Q
        WRITE(NUT,550)N,TC,XI,SUMA,Q
550     FORMAT(3X,'CONFLUENCE VALUES USED FOR INDEPENDENT STREAM ',I2,
     C  ' ARE:',/,3X,'TIME OF CONCENTRATION(MINUTES) = ',F6.2,/,
     C  3X,'RAINFALL INTENSITY (INCH./HOUR) = ',F6.2,/,
     C  3X,'TOTAL STREAM AREA (ACRES) = ',F7.2,/,
     C  3X,'TOTAL STREAM RUNOFF(CFS) AT CONFLUENCE = ',F9.2)
C
        IF(N.LT.NUMBER)GOTO 2000
552     CONTINUE
        WRITE(NUT,560)
560     FORMAT(/,3X,'CONFLUENCE INFORMATION:',/,3X,'STREAM',3X,
     C  'RUNOFF',6X,'TIME',3X,'INTENSITY',/,3X,'NUMBER',4X,
     .  '(CFS)',5X,'(MIN.)',1X,'(INCH/HOUR)')
        WRITE(NUT,401)
        WRITE(NUT,570)(I,QJN(I),TCON(I),XINT(I),I=1,NUMBER)
570     FORMAT(3X,I3,3X,F9.2,4X,F6.2,6X,F6.3)
        SUMAJN=0.
C
        DO 575 I=1,NUMBER
        SUMAJN=SUMAJN+TOTALA(I)
575     QBAR(I)=0.
C
        DO 580 I=1,NUMBER
        DO 580 J=1,NUMBER
        IF(XINT(J).LE.0.)GOTO 597
        FACTTC=TCON(I)/TCON(J)
        FACTOR=XINT(I)/XINT(J)
        IF(FACTOR.LE.0..OR. FACTTC.LE.0.)GO TO 597
        IF(FACTOR.GT.1.)FACTOR=1.
        IF(FACTTC.GT.1.)FACTTC=1.
        QBAR(I)=QBAR(I)+FACTOR*FACTTC*QJN(J)
580     CONTINUE
C
        WRITE(NUT,585)NUMBER
585   FORMAT(/,3X,'RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO',
     .  /,3X,'FORMULA USED FOR ',I2,' STREAMS.')
        WRITE(NUT,587)(QBAR(I),I=1,NUMBER)
587     FORMAT(3X,'VARIOUS CONFLUENCED RUNOFF VALUES ARE AS FOLLOWS:',
     C  /,5X,5F9.2,/)
        MAX=1
        QMAX=QBAR(1)
C
```



MAIN-LINE CONFIGURATION REQUIRING ONE CONFLUENCE

Fig. P9.1

```
      DO 590 I=1,NUMBER
      QMAX=QBAR(MAX)
      IF(QBAR(I).GT.QMAX)MAX=I
590   CONTINUE
C
      TC=TCON(MAX)
      Q=QBAR(MAX)
      SUMA=SUMAJN
      WRITE(NUT,595)Q,TC,SUMA
595   FORMAT(3X,'COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:',/,
    C 3X,'RUNOFF(CFS) = ',F9.2,3X,'TIME(MINUTES) = ',F8.3,/,3X,
    C 'TOTAL AREA(ACRES) = ',F9.2)
301   II=NUMBER+1
      IF(II.GT.5)GO TO 2000
302   CONTINUE
303   CONTINUE
C
597   WRITE(NUT,598)
598   FORMAT(3X,'[FATAL ERROR: INVALID CONFLUENCE VALUES: SEE USERS ',
    . 'MANUAL]')
C
2000  CONTINUE
3019  CONTINUE
3020  CONTINUE
C
C  FORMATS
C
403   FORMAT(1X,76('='))
401   FORMAT(1X,76('-'))
C
      RETURN
      END
```

PROGRAM 10: DATA ENTRY

```
---DATA ENTRY FOR SPECIFICATION OF HYDROLOGY DATA AT A NODE---

Enter user-specified time of concentration(MIN.).... ===>    "TC"
:ALLOWABLE VALUES ARE [5] TO [1000  ]

Enter user-specified total area(ACRES) tributary
to node............................................. ===>    "SUMA"
:ALLOWABLE VALUES ARE [.0001 ] TO [10000 ]

Enter user-specified total runoff(CFS).............. ===>    "Q"
:ALLOWABLE VALUES ARE [.0001 ] TO [100000]



---------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

PROGRAM 10

```
C  ------------------------------------------------------------------
      SUBROUTINE OSEROR(Q,TC,SUMA,IERR)
C  ------------------------------------------------------------------
C
C
C  USER SPECIFICATION OF HYDROLOGY
C
      COMMON /NUT/NUT
      COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
      COMMON/CALC1/E1,E2,XL,K,IS,AREA,XXI,XP,KI,RIYR,RSLOPE
C
C
C...READ DATA INPUT
      READ FREE(5) TC,SUMA,Q
C
      WRITE(NUT,5143)
5143  FORMAT(3X,'>>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE',
    . '<<<<<')
      WRITE(NUT,403)
C
      CALL INTENR(YR,TC,XI,1,ERROR,NUT,RIYR,RSLOPE)
      IF(ERROR.NE.1.)GO TO 5150
      IERR=9
      GO TO 3019
C
5150  WRITE(NUT,5160)TC,XI,SUMA,Q
5160  FORMAT(3X,'USER-SPECIFIED VALUES ARE AS FOLLOWS:',/,3X,
    C 'TC(MIN) = ',F6.2,3X,'RAIN INTENSITY(INCH/HOUR) = ',F5.2,/,
    C 3X,'TOTAL AREA(ACRES) = ',F8.2,3X,'TOTAL RUNOFF(CFS) = ',F9.2)
C
3019  CONTINUE
C
3020  CONTINUE
C
C  FORMATS
C
403   FORMAT(1X,76('='))
C
      RETURN
      END
```

PROGRAM 11: DATA ENTRY

```
---DATA ENTRY FOR ADDITION OF SUBAREA TO MAINLINE RUNOFF
   AT MAINLINE TIME OF CONCENTRATION---PAGE 1

SUBAREA LAND USE OR DEVELOPMENT TYPE:

    1: Commercial
    2: Apartment
    3: Mobile home park
    4: Condominium
    5: Single family(1/4 ACRE lot)
    6: Single family(1/2 ACRE lot)
    7: Single family(  1-ACRE lot)
    8: Single family(2.5-ACRE lot)
    9: Undeveloped


Specify assumed uniform subarea land use/development ===>    "K"


---------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
```

```
---DATA ENTRY FOR ADDITION OF SUBAREA TO MAINLINE RUNOFF
   AT MAINLINE TIME OF CONCENTRATION---PAGE 2
SUBAREA RUNOFF COEFFICIENT OPTIONS:

    1= Assume soil group A
    2= Assume soil group B
    3= Assume soil group C
    4= Assume soil group D
    5= User to specify runoff coefficient

Select runoff coefficient option number.............. ===>    "FSOIL"

Enter SUBAREA runoff coefficient..................... ===>    "C"
:ALLOWABLE VALUES ARE [.01   ] TO [.99   ]

Enter subarea area(ACRES)............................ ===>    "AREA"
:ALLOWABLE VALUES ARE [0] TO [1000  ]



------------------------------------------------------------------------
TYPE: EXIT to leave program ; TOP  to go to top of page
                            ; BACK to go back one page
```

PROGRAM 11

```
C    -----------------------------------------------------------------
        SUBROUTINE SUBTOB(Q,TC,SUMA,IERR)
C    -----------------------------------------------------------------
C
C  ADDITION OF SUBAREA TO MAINLINE RUNOFF
C
        COMMON /NUT/NUT
        COMMON/CALC/YR,XI,OPTN,NR,C,CVAL,V,Y,IGUESS,DS,XN
        COMMON /CALC1/E1,E2,XL,K,IS,AREA,XKI,XP,KI,RIYR,RSLOPE
C
C
C..READ DATA INPUT
        READ FREE(5)K,FSOIL,AREA
        IS=FSOIL
        C=FSOIL-5.0
C
C  PROCESS SUBAREA ADDITION TO MAINLINE FLOW
C
        WRITE(NUT,6160)
6160    FORMAT(3X,'>>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<')
        WRITE(NUT,403)
C
        CALL INTENR(YR,TC,XI,0,ERROR,NUT,RIYR,RSLOPE)
        IF(ERROR.NE.1.)GO TO 6162
        IERR=9
        GO TO 3019
C
6162    CALL COEFAR(XI,IS,K,C,0,CVAL,NUT)
C
        DELQ=C*XI*AREA
        SUMA=SUMA+AREA
        Q=Q+DELQ
        WRITE(NUT,6200)AREA,DELQ,SUMA,Q,TC
6200    FORMAT(3X,'SUBAREA AREA(ACRES) = ',F7.2,3X,'SUBAREA RUNOFF',
     .  '(CFS) = ',
     C  F7.2,/,3X,'TOTAL AREA(ACRES) = ',F7.2,3X,'TOTAL RUNOFF(CFS) = ',
     C  F7.2,/,3X,'TC(MIN) = ',F6.2)
C
3020    CONTINUE
C
C  FORMATS
C
403     FORMAT(1X,76('='))
C
        RETURN
        END
```