United States
Environmental Protection
Agency

Environmental Research
Laboratory
Athens GA 30613

EPA-600/3-82-054
September 1982

Research and Development

User's Manual for EXPLORE-I:

A River Basin Water Quality Model (Hydraulic Module Only)

EPA 600/3-82-054
May 1982

USER'S MANUAL FOR EXPLORE-I: A RIVER BASIN WATER QUALITY MODEL (HYDRAULIC MODULE ONLY)

by

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Contract No. 68-03-2613

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FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient management tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Many toxic contaminants are persistent and undergo complex interactions in the environment. As an aid to environmental decision-makers, the Chemical Migration and Risk Assessment methodology was developed to predict the occurrence and duration of pesticide concentrations in surface waters receiving runoff from agricultural lands and to assess potential acute and chronic damages to aquatic biota.

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ABSTRACT

EXPLORE-I is a computer program that simulates the dynamic hydraulic and water quality characteristics of a river basin. It can be used to study the effects of various flow conditions, waste discharge and treatment schemes on the water quality conditions of lakes, reservoirs, rivers, and estuaries. This user's manual provides input instructions for the hydraulic module of the EXPLORE-I code. Basic programming requirements of the code are also included.

Companion reports to this document are Methodology for Overland and Instream Migration and Risk Assessment of Pesticides, Mathematical Model SERATRA for Sediment-Contaminant Transport in Rivers and Its Application to Pesticide Transport in Four Mile and Wolf Creeks in Iowa, User's Manual for the Instream Sediment-Contaminant Transport Model SERATRA, and Frequency Analysis of Pesticide Concentrations for Risk Assessment (FRANCO Model).

This report was submitted in partial fulfillment of Contract No. 68-03-2613 by Battelle Pacific Northwest Laboratories under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period April 1978 to January 1980, and work was completed as of January 1980.

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INTRODUCTION

The Battelle-Northwest (BNW) water quality model, EXPLORE-I (Baca et al., 1973a,b), is a computer program which simulates the dynamic hydraulic and water quality characteristics in a river basin. It can be used to study the effects of various flow conditions, waste discharge and/or treatment schemes on the water quality levels in the river basin.

EXPLORE-I is capable of simulating a number of hydraulic regimes in either a dynamic or steady state mode. These are:

- streams and rivers,
- shallow lakes,
- estuaries or tidally influenced rivers, and
- thermally stratified reservoirs.

In addition, the behavior of the following water quality parameters can be studied:

- Carbonaceous Biochemical Oxygen Demand (BOD)
- Nitrogenous BOD
- Benthic BOD
- Total Organic Carbon (TOC)
- Refractory Organic Carbon
- Sedimentary Phosphorus
- Soluble Phosphorus
- Organic Phosphorus
- Ammonia Nitrogen
- Nitrite Nitrogen

- Nitrate Nitrogen
- Organic Nitrogen
- Toxic Compounds
- Phytoplankton
- Zooplankton
- Dissolved Oxygen

This user's manual is intended to provide the information necessary for application of the hydraulic module of EXPLORE-I to a river basin. A summary description of the hydraulic model used is provided to assist in understanding the code and selecting the necessary input values. Programming details of the code are also included.

GENERAL DESCRIPTION OF EXPLORE-I

The EXPLORE-I computer model consists of four computer program modules:

- hydraulic code for river and estuarine flow,
- quality code for river and estuary systems,
- hydrothermal code for thermally stratified reservoirs, and
- quality code for thermally stratified reservoirs.

The hydraulic and hydrothermal codes must be run first to provide flow and/or temperature patterns which are input information for the quality codes. The river basin codes are not coupled to the deep reservoir models, so quality profiles in impoundments must be analyzed separately.

EXPLORE-I River Basin Codes

As explained above, the EXPLORE-I river basin model consists of a hydraulic code and a quality code. The hydraulic code, which is executed first, produces a magnetic tape which contains all the necessary geometric and hydraulic data used by the quality code. This separation of hydraulic and quality calculations allows the user to set up and calibrate the hydraulic model while gathering data for the quality model.

Each of these codes has two parts, an input program and a calculation program. The results of the input programs are stored on magnetic tape for use by the calculational code. The input codes check the input data deck for consistency and calculate all time varying functions needed by the calculational codes. This allows the user to check his input before executing the calculational portion of the code. A diagram of the river basin code is shown in Figure 1.

The hydraulic and quality codes are set up to operate for a specified number of cycles; each calculation begins with a specific cycle and ends with a specific cycle. These are normally referred to as tidal cycles. However, the user can specify a cycle different from the tidal cycle (for example, a daily cycle) if no tidal influence occurs in the river basin being modeled. The quality code will accept two types of hydraulic input:

(1) time varying hydraulic data which in general is not cyclic in nature; and

(2) steady or cyclic varying flows.

If the user wanted to observe the effects of increased flow from an upstream source or from time varying additions and withdrawals of water from the system, option (1) would be used since these actions are not cyclic in nature. If only constant or cyclic flows (such as tidally influenced flows) were of interest, option (2) would be used. With option (2) the quality code will use the hydraulic data for one cycle again and again as it calculates the quality parameter concentrations for a number of cycles.

Since it is difficult to input all the initial velocities, depths, and flows exactly, both options allow the hydraulic code to calculate for a specified number of cycles before writing out the results of the calculations or starting to add time varying inputs. The time variables used in the hydraulic and quality codes are discussed below.

The relationship between the time bases used in the hydraulic and quality codes is most simply illustrated by time lines, as shown in Figure 2. The variables in this figure are defined as:

- Hydraulic code time variables

NQSWRT = the number of the tidal cycle where printout and writing of time varying hydraulic data begin. NQSWRT refers to a segment of time rather than to a specific point in time; it is the number of the tidal cycle at which the system establishes the proper initial conditions.

NTCYC = the number of the last tidal cycle for which the hydraulic calculations will be performed. NTCYC also refers to a time segment rather than to a specific point in time.

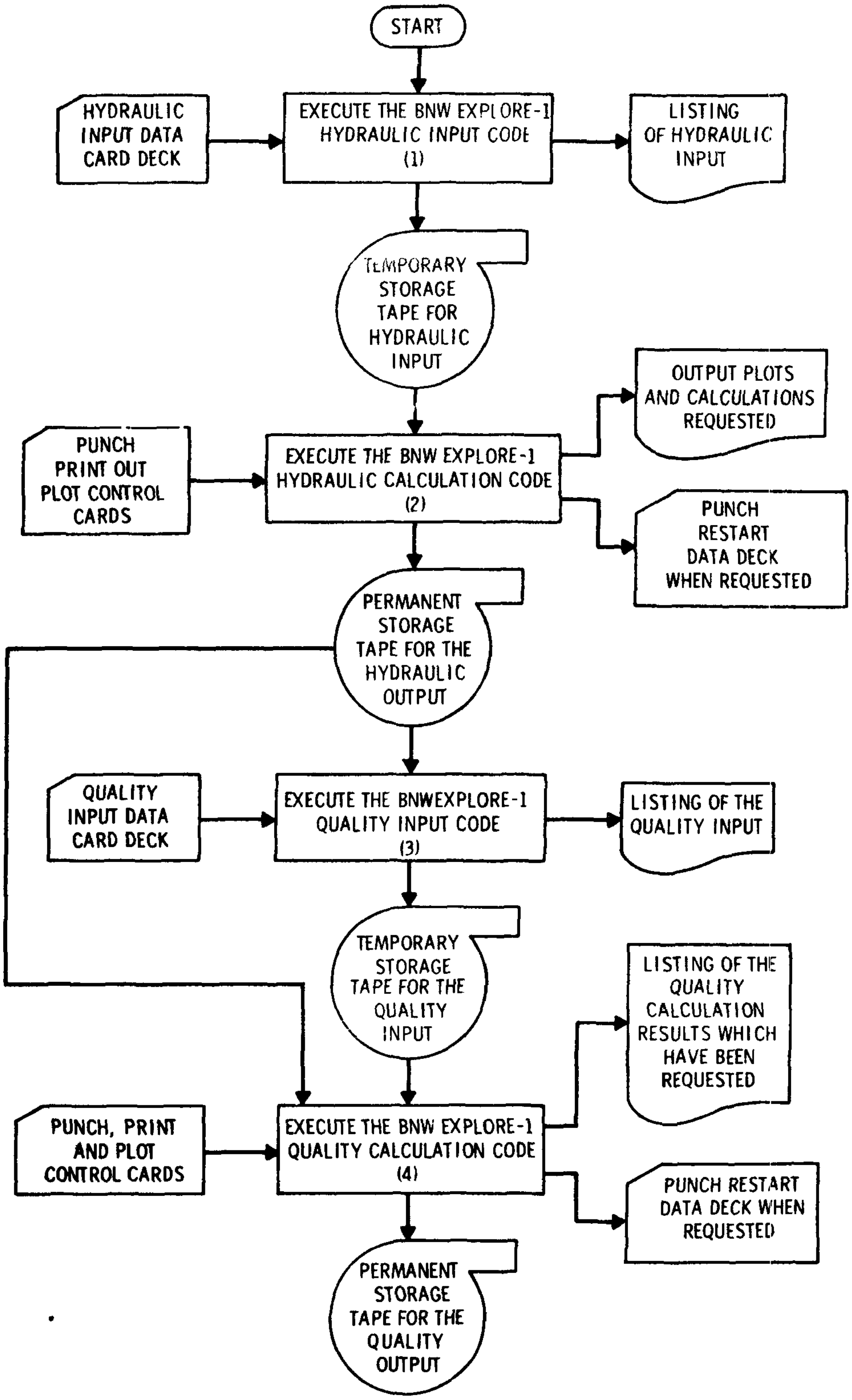
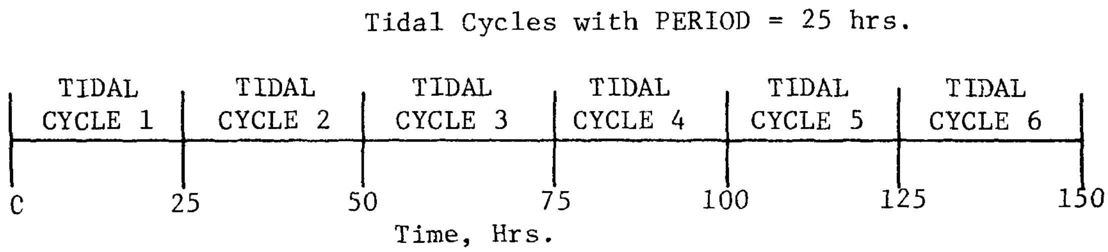


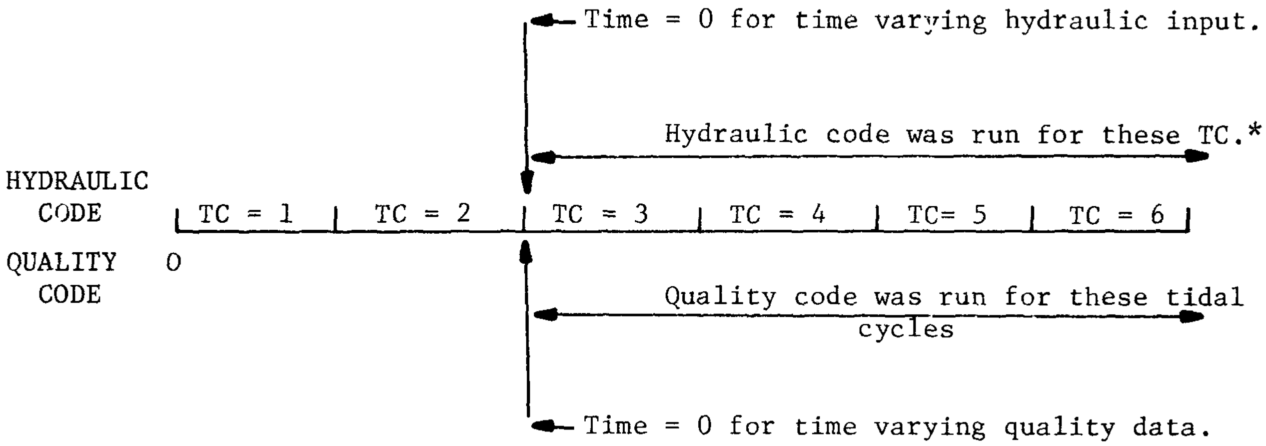
Figure 1. Overview of the BNW EXPLORE-I river basin codes.

A. Time line



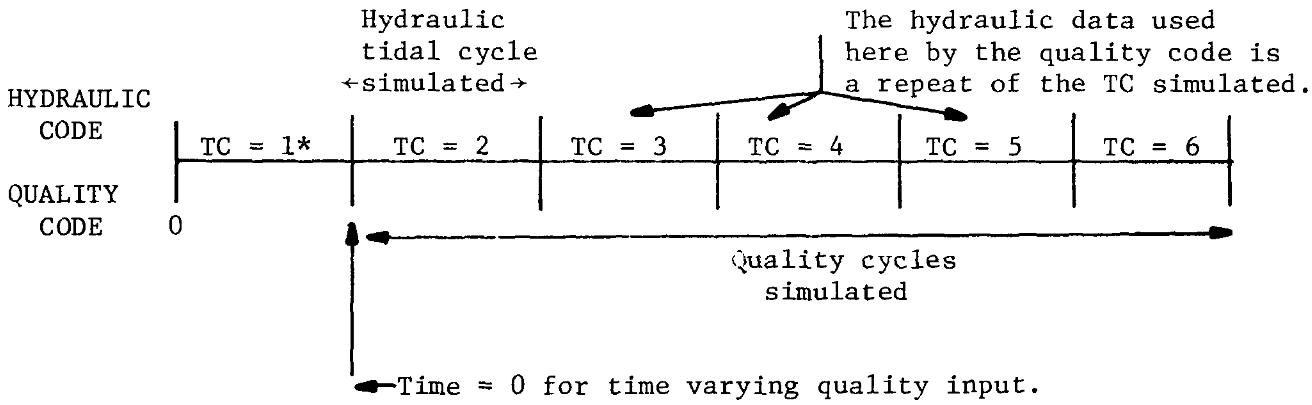
B. Time line showing NQSWRT, NTCYC, NTQCYC and zero time for the hydraulic time varying data and for the quality time varying data

(For example let NQSWRT = 3, NTCYC = 6, NTQCYC = 6, PERIOD = 25)



C. Time line showing NQSWRT, NTCYC, NTQCYC and zero time point for steady state or cyclic hydraulic data

(For example let NQSWRT = 2, NTCYC = 2, NTQCYC = 6, PERIOD = 25)



*TC = Tidal cycle

Figure 2. Relationship of time base in hydraulic and quality codes.

PERIOD = period of one tidal cycle in hours.

- Quality code time variable

NTQCYC = the number of the last tidal cycle for which the quality model will be run. The quality model will be run for the tidal cycle number starting with NQSWRT and ending with NTQCYC.

For the purposes of diurnal calculations the quality code assumes that the start of the time varying data is midnight.

HYDRAULIC CODE

The hydraulic submodel used by EXPLORE-I (Baca et al., 1973a) was originally developed for the receiving water block of the Storm Water Management Model (SWMM) by Water Resource Engineers (WRE). Because the SWMM hydraulic model has been previously applied successfully to various problems, Water Resources Engineer (1966), Callaway et al. (1969), Metcalf and Eddy (1971), it was chosen for this study. An extensive discussion of the theory appears in Callaway et al. (1969) and Baca et al. (1973a) and will not be given here.

The hydraulic code used by EXPLORE-I solves two-dimensional problems with one-dimensional equations by requiring the two-dimensional system to be described by a set of interconnected "channels" and "junctions" which represent the actual physical system. The equations of motion and continuity for a one-dimensional hydraulic system consist of two simultaneous equations referred to as the Saint Venant equations. These equations can be written in terms of the discharge, rather than velocity, as the primary kinetic variable. For flow through a channel of rectangular cross section, these equations are:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + g\frac{\partial h}{\partial x} - gS_o + gS_f - gS_w = 0 \qquad (1)$$

and

$$b\frac{\partial h}{\partial t} + \frac{\partial q}{\partial x} = 0 \qquad (2)$$

where

g = gravitational acceleration

h = water depth

u = vertically averaged velocity

b = channel width

q = discharge

S_o = bottom slope

S_f = friction slope due to bed shear stress

S_w = friction slope due to wind stress

t,x = time and space coordinates, respectively.

The code uses a modified set of one-dimensional Saint Venant equations to model the two-dimensional flow in an estuary or river basin by superimposing on the estuary or river basin a grid of junctions and channels. Only one-dimensional flow is then allowed in the channels connecting the junctions. Each junction in the system is a water and potential energy storage element which is characterized by its (1) surface area, (2) water surface elevation, (3) bottom elevation, and (4) the actual (X,Y) coordinates of the junction points. The water storage of the basin or estuary is represented by this series of junctions. Flow between these junctions is through rectangular channels which connect the junctions. A channel is described by its (1) length, (2) width, (3) Manning coefficient, (4) average bottom elevation at the midpoint, and (5) the junction numbers which lie at its end points.

Thw two Saint Venant equations are not solved simultaneously for this system. Instead, the one-dimensional equation of motion, Equation 1, is solved for each of the channels in the system on the basis of the present values of the junction heads. Velocity and flow in each of the channels are thus determined. Next, the modified equation of continuity, Equation 3:

$$A_{sj} \frac{\partial h_j}{\partial t} = \sum_{i=1}^{k} Q_i + \left(Q_j^{im} - Q_j^{ex} - Q_u^{ev} \right) \qquad (3)$$

where

A_{sj} = surface area associated with the junction j

Q_i = flow of a channel i connectivy to the junction j

Q_j^{im} = water importation rate to the junction j (source term)

Q_j^{ex} = water exportation rate from the junction j (sink term)

Q_j^{ev} = evaporation rate

is solved for each of the junctions on the basis of the predicted flows in each of the channels. This process is repeated for the duration of the simulated time period.

Hydraulic Data Input Information

An example of the nodalization of a river basin is shown in Figure 3. The selection of junctions and channel locations and the necessary data for each is discussed below.

Junction Data. The selection of junction points and the distances between them are determined by a size of a time step desired for running the hydraulic model. For a large problem a time step greater than 100 seconds would generally be used. For most estuaries and large rivers (say, flows greater than a few thousand cfs), the maximum time step, Δt, which can be used for a given channel length, L, is determined approximately from

$$\Delta t \leq \frac{L}{\sqrt{gR}} \tag{4}$$

where

R = the hydraulic radius ($R \doteq$ average water depth) of the channel

L = length

g = gravitational constant

Figure 3 shows the initial nodalization of a sample river basin. After running the model, the user might wish to add new junctions, change the locations of junctions, or remove junctions to improve the simulation results.

Figure 4 is a worksheet which can be used to gather the data necessary to describe the junctions. As indicated on the worksheet, and described in succeeding paragraphs, hydraulic data are required for:

1) the average water surface elevation for the junction point,

2) the water surface area associated with the junction point,

3) any significant inflows to the junction point from small streams, tributaries or other sources,

4) any significant outflows from the junction point,

5) the average elevation of the bottom of the river or estuary for the junction point, and

6) the cartesian coordinates of the junction point (necessary only if the effect of wind stress on channel flow is being

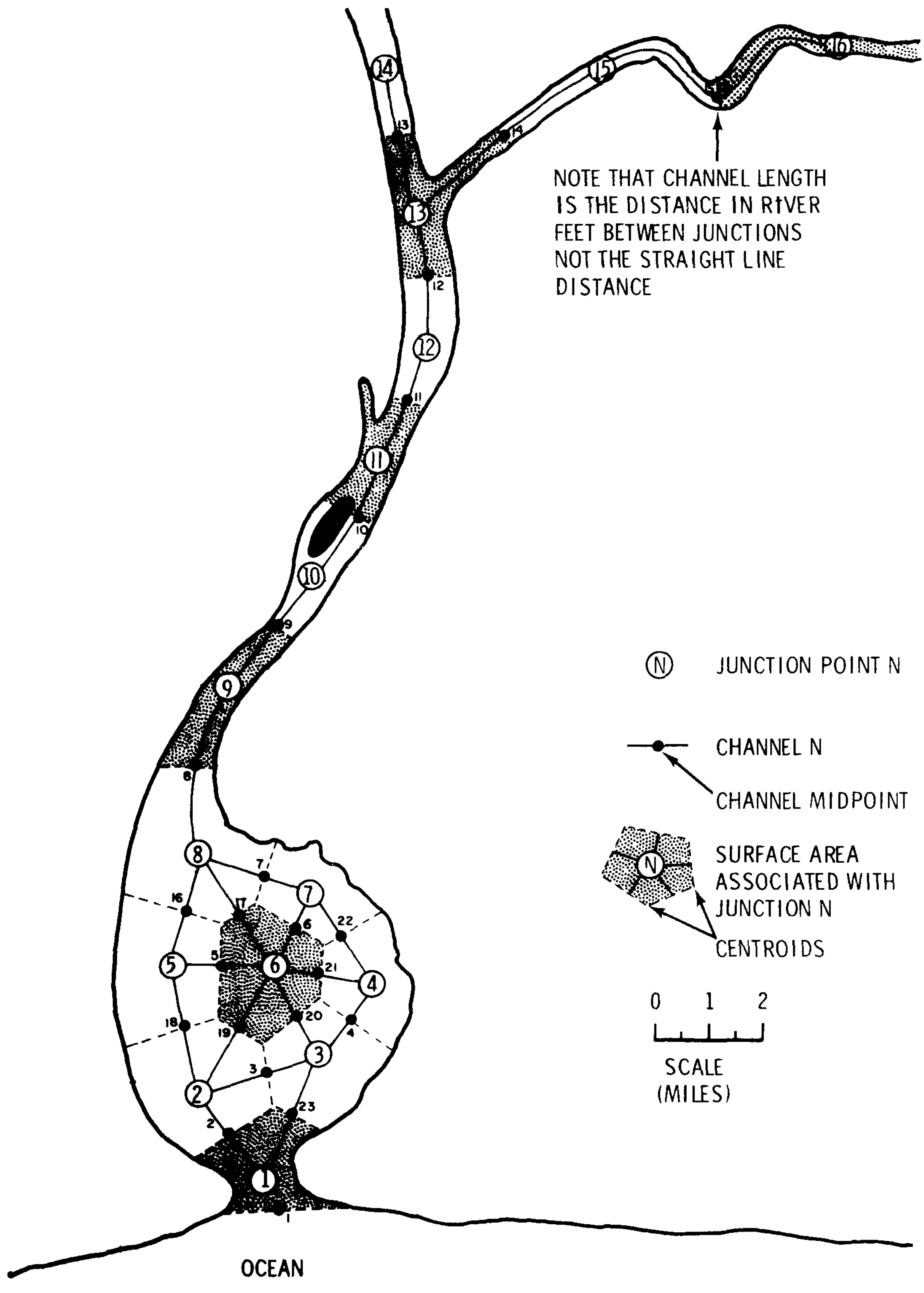


Figure 3. A sample river basin.

JUNCTION DATA
RIVER(OR STREAM) ______________________

River Mile	Input Source	Node Number (Columns 1-5)	Head (m) (Columns 6-15)	Surface Area (sq. km) (Columns 16-25)	Inflow (m^3/sec) (Columns 26-35)	Outflow (m^3/sec) (Columns 36-45)	Channel Bottom Elevation (m) (Columns 46-55)	X Thousands of meters (Columns 61-70)	Y Thousands of meters (Columns 71-80)

Figure 4. Worksheet for gathering input data to describe the problem's junction points.

calculated).

The water surface elevations need only be a reasonable guess, as the code will predict the correct head after the simulation has run a day or two. The initial head can be determined from the elevation (taken from topographic maps), by adding the known water depth at the junction point to the known elevation of the river or estuary bottom, or from other sources (e.g., Corps of Engineers records, if available).

The surface area of a junction is bounded by the lines which connect the centroids of adjacent areas. Figure 3 illustrates the method of determining the surface area of a junction for almost any kind of junction point. The surface area can be obtained by planimetering topographic or navigation maps. Junctions with tributary inflows which are not modeled should be accounted for by a representative surface area.

Inflow rates for tributaries or streams which are not modeled but contribute a significant amount of water into the junction should be specified. Outflow rates for unmodeled outflows should also be specified.

The average elevation of the river or estuary bottom for the junction point can be determined from

- physical measurements;
- navigation charts or topographic maps which give sounding contours for the river or estuary (any good method of averaging this data can be used to determine the average junction point's bottom elevation; see Callaway et al. (1969) for one method; and
- data (such as from the U. S. Corps of Engineers) available on average water depth versus river mile (the area under this curve can be integrated and divided by the channel length to determine the average water depth for the junction).

The cartesian coordinate system used to define the (X,Y) values must be a right-hand coordinate system, i.e., the positive Y axis must point north.

Channel Data. Figure 5 is a worksheet which can be used to gather the data necessary to describe the channels. As indicated by the channel worksheet and described below, hydraulic data must be gathered for:

1) channel length,

CHANNEL DATA
RIVER(OR STREAM) ____________________

COLUMNS

1-5	6-10	11-15	26-35	36-45	46-55	56-65	66-75
Channel Number	Junction at Lower End of Channel	Junction at Upper End of Channel	Length of Channel (m)	Width of Channel (m)	Average River Depth (m)	Manning Coefficient	Initial Velocity (m/sec)

Figure 5. Worksheet for gathering input data to describe the problem's channels.

2) channel width,

3) average elevation of the channel bottom,

4) Manning coefficient for the channel, and

5) initial velocity in the channel.

The length of a channel is simply the distance in river meters between the two junction points which lie at either end of the channel (see Figure 3).

The channel width is the average surface width of a river or tributary channel or the distance between centroids of adjacent areas for an estuary channel (see Figure 3).

The average elevation of the channel bottom can be estimated as the average of the bottom elevations of the junctions at the ends of the channel.

If actual measurements are not available, the Manning friction coefficient for the channel can be estimated from Table 1 below.

Table 1. A Tabulation of Representative Values of the Manning Friction Coefficient for Various Types of River Channels (Henderson 1966)

Natural River Channels	
Clean and straight	0.025-0.030
Winding, with pools and shoals	0.033-0.040
Very weedy, winding, and overgrown	0.075-0.150

The initial velocity must be supplied only for channels where a stability problem might exist. Flow and velocity in the channels are positive when the flow in the channel is from a low junction number to a high junction number. In an estuary or large river where the channels are more likely to be stable, 0 can be input for the initial velocity.

Controlled Nodes and Upstream Boundary Conditions

The solution of the hydraulic problem requires two driving functions:

- a time varying function to control the head or outflow for the downstream end point junctions (controlled nodes), and

- an upstream constant or time varying flow input for the upstream end point functions.

For the sample river system in Figure 3, constant or time varying inflows would be specified for upstream junctions 14 and 16 and a stage versus time history would be supplied for the downstream controlled node 1.

Constant inflows to upstream end point junctions are simply specified as inflows on the junction data sheets (see Figure 4). Time varying upstream inputs are handled as indicated below.

Controlled Nodes. Controlled nodes, which are required at every downstream boundary in the river system, specify the boundary conditions. When simulating an entire river basin it is likely that points of discontinuity such as dams, waterfalls and locks will occur in the hydraulic system. These are not downstream end points but they must be controlled as if they were. The original structure of the SWMM code would have required simulation of each portion of the river basin lying between two discontinuities as a separate problem. The modified code used here nodalizes the entire river basin to include these discontinuities and locates a controlled junction at each point where flow or head is to be specified. An associated controlled channel must connect this controlled junction with the next downstream junction.

Use of the controlled nodes and channels must conform to the following rules:

- Controlled junctions must be numbered first; for instance, if there are N controlled junctions in the system they must be numbered as junctions 1 through N.

- Each controlled junction (except a tidally influenced one) must have only downstream flow.

- Each controlled junction must have only one controlled channel connecting it downstream to another junction (or seaward, with no junction, in the case of a tidally influenced junction). The controlled channel must be assigned the same number as the controlled junction with which it is associated.

- No two controlled nodes can be directly connected by a channel.

Except for these restrictions, numbering of nodes and channels can be carried out in any order.

Six types of controlled nodes are allowed. They are:

1) a weir type, in which the flow over the weir and out of the controlled node is determined by the formula

$$Q = A_1(H-A_2)^{A_3} \tag{5}$$

where

Q = flow, m^3/sec

H = water surface elevation upstream of weir, m

A_1 = weir coefficient

A_2 = elevation of weir, m

A_3 = weir exponent

2) a tidally controlled node at which the stage versus time history is specified;

3) a Q versus H dam, where outflow is controlled as a function of the dam upstream water surface elevations [the user inputs an array of (H,Q) points which are fit by polynomial regression to form a function to predict Q for any value of H];

4) a dam at which head and outflow are both known functions of time [the user supplies an array of (t,Q) points and an array of (t,H) points; these arrays are fit by polynomial regression and two time functions are formed, one to predict Q as a function of time and one to predict H as a function of time];

5) a dam at which head is a known function of time [the outflow from the dam is determined via a mass balance; an array of (t,H) points is supplied by the user and a polynomial function is fit to these data points]; and

6) a dam at which outflow is a known function of time and head must be determined from a mass balance [an array of (t,Q) points is supplied and a polynomial fit of the data is performed].

<u>Time Varying Inflows or Upstream Hyraulic Inputs from Discharge Hydrographs</u>. The user can specify time varying inflows to any junction in the system by indicating the number of time varying inputs and an array of junction numbers where these inputs are to be added. In addition, the user must supply an array of (Q,t) points for each input where Q is the discharge and t is time. These arrays are then fit via polynomial regression and functions are formed so that the inflow or outflow can be

predicted for any time.

Evaporation and Wind Stress. If in the river basin being simulated evaporation or wind can significantly affect flow patterns or water quality, the gross effects of these factors can be accounted for. The user can supply an evaporation rate in (inches/month) and the average wind speed and direction for the entire basin.

Tributary Channels. The original SWMM hydraulic code was modified to allow the marking of "small tributary channels" which became necessary at every junction between a large river and a small tributary (Baca et al., 1973a,b). The original code calculates the hydraulic radius of a channel by averaging the characteristics of the nodes at the ends of the channel. In a single river or an embayment all of the channels have similar characteristics and this is a valid estimation. However, at the junction between a large river and a small side tributary the characteristics of the small tributary channel are grossly overestimated by averaging the properties of the nodes at the channel ends. The properties of the channel are most like those of the first upstream node in the tributary (except when backflow to the tributary is allowed). The changes in the hydraulic code allow the user to mark the small tributary channels and associate with each of these channels the characteristics of the first upstream node in the small tributary. The revised code then simply calculates the channel properties for the small tributary channel on the basis of the properties of the marked upstream node. If there is backflow to the tributary, channel properties are calculated in the normal manner.

Hydraulic Input Data Deck Preparation

After the river-estuary system has been nodalized as described above and the data sheets for the junctions and channels have been prepared, the input data deck is prepared. As mentioned above and in the following section, the hydraulic code consists of two separate executable programs, an input code (IMAINT and associated subroutines) and a calculation code (HMAINT and associated subroutines). Table 2 and Figure 6 indicate the input data format and the relative order of the input card deck required for running IMAINT, the input code. Modifications in Table 2 from the 1973 version of EXPLORE-I include a change from English to metric units for all variables, a maximum value for the number of data points used in defining the time varying function (see data group H9), and an additional variable, HYDEND, in the hydrograph input requirements (see data group H10). Input variables in metric units are converted to English units within the program. An additional input modification noted in the text includes the requirement of assigning the same number to a controlled node and to its associated controlled channel.

Table 2. Data Card Format for EXPLORE-I Hydraulic Input Code

Card Group	Format	Columns	Description	Variable Name	Default Value
H0	15A4	1-60	Title for run (card 1)	ALPHA (1-15)	none
	15A4	1-60	Title for run (card 2)	ALPHA (16-30)	none
			Hydraulic control card		
H1	I5	1-5	Number of the last tidal day cycle to be simulated	NTCYC	none
	3F5.0	6-10	Number of hr/tidal day cycle	PERIOD	none
		11-15	Length of quality time step, hour (must be evenly divisible into PERIOD)	QINT	none
		16-20	Length of hydraulic time-step, second (must be evenly divisible into QINT)	DELT	none
	5X				
	3F5.0	26-30	Evaporation rate (mm/month)	EVAP	none
		31-35	Wind velocity, m/sec	WIND	none
		36-40	Wind direction, clockwise, degrees from North	WDIR	none
	4I5	41-45	Tidal day number where printed output will start and the quality tape will be prepared	NQSWRT	none
		46-50	Number of junctions with time varying inflow	NJSW	none
		51-55	Number of controlled junctions	NJGW	none
		56-60	Number of tributary channels	NTRIB	none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[Junction numbers where hydrograph inflows are present]		
H2	I5	1-5	Junction number where first hydrograph inflow is present	JSW(1)	none
	I5	6-10	Junction number where second hydrograph input is present	JSW(2)	none
	. . .	. . .		. . .	. . .
			Junction number where last hydrograph input is present	JSW(NJSW)	none
			[Codes which indicate the type of controlled node (a number from 1-6) 1 means weir relationship (A1, A2, A3 needed) 2 means tidally influenced 3 means dam operated from Q vs H curve 4 means dam head and outflow determined from H vs t and Q vs t curves 5 means only dam head determined from H vs t curve 6 means only dam outflow determined from Q vs t curve]		
H3	I5	1-5	Code for the first controlled node	JGW(1)	none
	I5	6-10	Code for the second controlled node	JGW(2)	none
	. . .	. . .			
			Code for the last controlled node	JGW(NJGW)	none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[There will be NTRIB H4 data cards]		
H4	2I5	1-5	Channel number of the Ith tributary channel	ITRIB(I,1)	none
		6-10	Junction number of the first upstream node in the small tributary	ITRIB(I,2)	none
			[Repeat this card for each junction]		
			[Junction cards (maximum = 500)]		
H5	I5	1-5	Junction number	J	none
	F10.0	6-15	Water surface-elevation (m)	HEAD(J)	none
	F10.0	16-25	Surface area of junction (km^2)	AS(J)=SURF	none
	F10.0	26-35	Constant flow input to the junction (m^3/sec)	QIN(J)=QF1	none
	F10.0	36-45	Constant flow out of the junction (m^3/sec)	QOU(J)=QF2	none
	F10.0	46-55	Junction bottom elevation in m	DEP(J)=DT	none
	5X	56-60	Leave columns blank		
H6	I5	1-5	To terminate junction cards, write 99999.		none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
H7			[Repeat this card group for each channel being simulated. (maximum = 600)]		
	5I5	1-5	Channel number	N	none
		6-10	Junction at one end of channel	NTEMP(1)	none
		11-15	Junction at other end of channel	NTEMP(2)	none
	5F10.0	26-35	Length of channel (m)	ALEN	none
		36-45	Width of channel (m)	WIDTH	none
		46-55	Average elevation of channel bottom (m)	RAD	none
		56-65	Manning's coefficient for the channel	COEF	0.018
		66-75	Initial velocity (m/sec)	VEL	0.0
H8	I5	1-5	To terminate channel cards, write 99999.		none

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			[Card group H9 is used to specify the time varying and/or constant data for the controlled nodes. The type of controlled node was specified on card group H3 above. There must be one set of H9 cards for each controlled node. The first set inputs the information for the first controlled node, the second set for the second controlled node, etc. The format of the H9 cards depends upon which type of controlled node has been specified. The formats are as follows:]		
			[WEIR TYPE (code = 1)]		
H9a	20A4	1-80	Title card		
H9b	3F10.0	1-10	Weir coefficient	A0(1,J,1)	none
		11-20	Weir crest elevation, m	A0(1,J,2)	none
		21-30	Weir exponent	A0(1,J,3)	none
			[TIDALLY INFLUENCED NODE (code = 2)]		
H9a	20A4	1-80	Title card		
H9b	NAMELIST option				
		2-6	Place $CARD1 in columns 2-6.		
		7-72	KØ = (0 or 1, If 0 is used input is ignored. If 1 is used a full tidal cycle will be generated from only four points entered below), NI = (number of tidal stage data points), MAXIT = (Maximum number of iterations for curve fit, usually 50), TT = (list time points in hours separated by commas at which tidal heights will be specified), YY = (values of the tidal		

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
			stage in meters separated by commas, which correspond to the time vaulues, TT, listed above.)		
			The $CARD1 can consist of more than one card but all data and separating commas must be listed in any column between 2-72 on each card.		
H9c		2-6	Place $END in columns 2-5 to indicate the end of the data.		

The formats for the remaining four types of controlled nodes are the same.

The rest of the controlled node types and the flow hydrograph inputs specify inputs which can be time varying functions. The following NAMELIST option is used for these inputs. For each variable the input format is one set of cards as follows:

Title card
$CARD1
$END

Columns 20-80 of the title card is used as a free field to identify the data. If the word CONST is placed in columns 2-6 of the title card then the $CARD1 and $END cards will not be used. Instead the number listed in columns 7-18 of the title card will be used as a constant value for the variable. If the input is to specify a time varying function (i.e. CONST does not appear in columns 2-6 of the title card) the $CARD1 must be present and have the following form:

(continued on next page)

Table 2. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
		Column 2-6	$CARD1		
		Column 7-72	M = (number [integer] of data points used; maximum value = 20), MIN = (number [integer] giving minimum order of polynomial to be used to fit data), MAX = (number [integer] giving maximum order of polynominal to be used to fit data), X = (a list of time values separated by commas), Y = (a list of the values, separated by commas, of the function corresponding to the time values specified by X above)		
		The $CARD1 can consist of more than one card but all data (including the separating commas) must be listed between columns 2-72 on each card.			
			[Q vs H Dam (code = 3)]		
H9a-c	NAMELIST Option		Values of flows and heads (the head corresponds to X = in the discussion above and the flow to Y =)		
			[H vs t and Q vs t Dam (code = 4)]		
H9a-c	NAMELIST Option		Values of head and times		
H9b-c	NAMELIST Option		Values of flow and times		
			[H vs t Dam (code = 5)]		
H9a-c	NAMELIST Option		Values of head and times		
			[Q vs t Dam (code = 6)]		
H9a-c	NAMELIST Option		Values of flow and times		

Table 2. (continued)

Data Group	Format	Columns	Description	Variable Name	Default Value
	Hydrograph input cards. One set of H10 cards must be present for each input node, specified on card H2 above. The first set of hydrograph input cards is for the first input node above, the second for the second node, etc. The NAMELIST option is used on these cards and is discussed above.				
H10	–		The values of flow (Y =) must be followed by the following variable: HYDEND = (time in seconds that designates end of hydrograph input)		
H10a	20AX	1-80	TITLE CARD		
H10b	NAMELIST Option				
		2-6	Place $CARD1 in column 2-6		
		7-72	M = (number Integer of data point used), MIN = (number Integer giving minimum order of polynomial to be used to fit data. This number is disregarded by the program), MAX = (number Integer giving maximum order of polynomial to be used to fit data. This number is disregarded by the program) X = (a list of time values in hours, separated by commas), Y = (a list of flow rates in m^3/sec, separated by commas)		
H11	Must contain all asterisks and is the terminator card for the hydrodynamic input deck.				

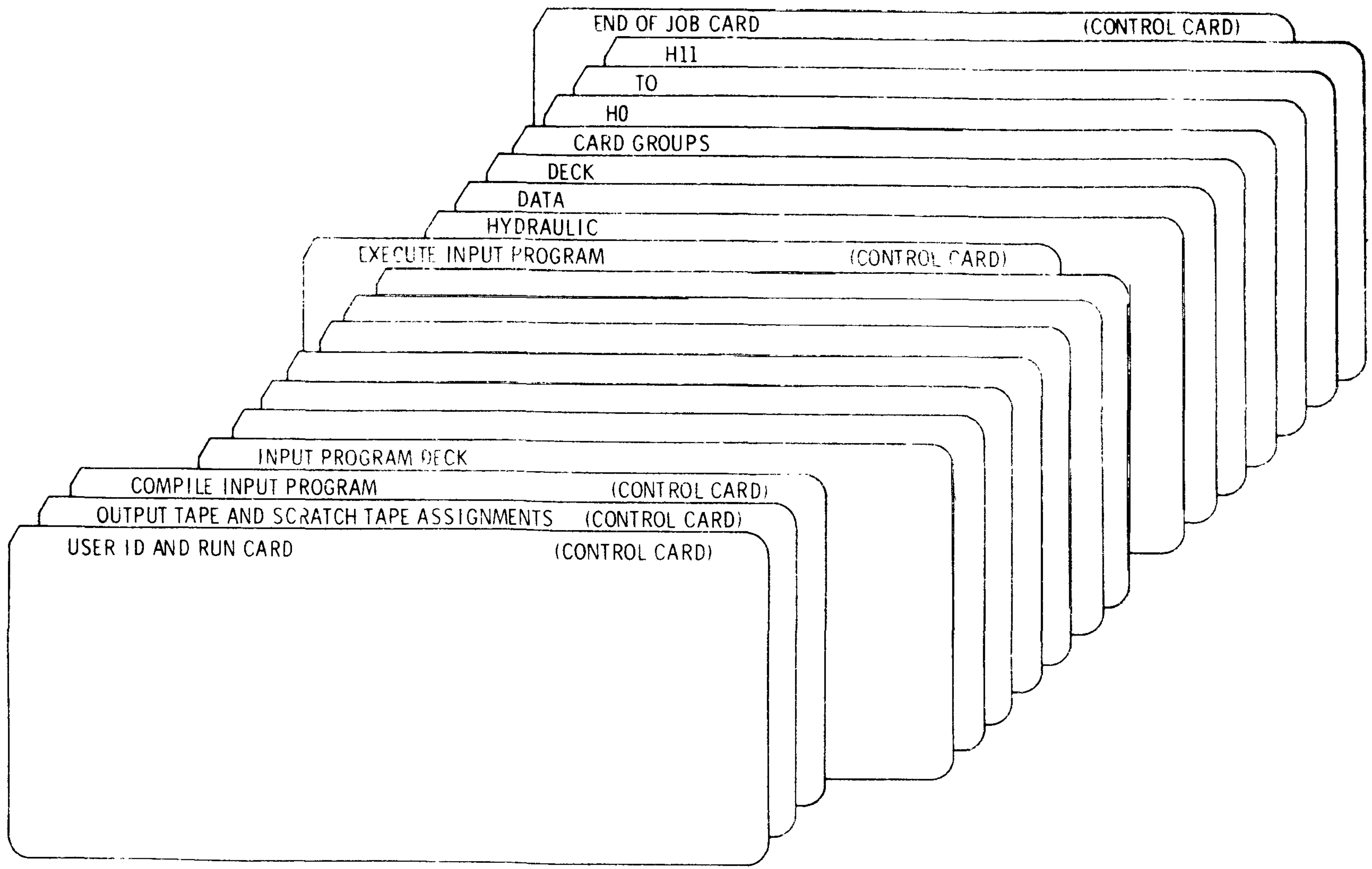


Figure 6. Sample data deck construction for executing the BNW EXPLORE-I hydraulic input code.

Table 3 and Figure 7 provide input specifications for the additional cards required for running and receiving output from the calculation code. No output is printed or plotted while the hydraulic code is running. As the program is run, a scratch file of the time history of the flows, velocities, heads, inflow, outflow, and volumes for all the junctions and channels is written to tape. These values are output once, as average values, for each quality time step. This scratch file begins with tidal day NQSWRT and is written through tidal day NTCYC. Since a hydraulic model of a river basin can produce voluminous output, the code has been set up to allow selection of junctions and channels in user-grouped and labeled sets of 20 or less for print and/or lineprinter plot output. Any particular or conti uous set of 7 or less simulated tidal days starting with tidal day NQSWRT can be specified. Limiting the output to groups of 20 or fewer junctions and channels will prevent production of unwanted volumes of printout. However, since at times the user may want printout for more than 20 junctions and channels, as many groups of 20 or less as are needed may be requested. An advantage of this method is that the output can be ordered into reaches or tributaries.

Data card group P1 allows the user to request the punching of a restart hydraulic deck. The restart deck includes the H group of data cards, with revised values for the initial water surface elevations of the junctions and for the initial channel velocities.

Figures 8 and 9 provide an example application of the hydraulic component of EXPLORE-I to Four Mile and Wolf Creeks in Iowa. For this case, EXPLORE-I was run by a UNIVAC 1100 computer. Figure 8 is a stick diagram of the physical layout of the system. Figure 9 is an annotated listing of the input data used in this application and described in Tables 2 and 3. As can be seen from Figures 8 and 9, junction 1 and associated channel 1 are the downstream controls, with the control being a dam with a constant head of 1.0 m (option 5). Junctions 2 and 26 have constant inflows; a hydrograph input exists at junction 14. The simulation runs for 2 days (NTCYC = 2). Printed output will be obtainable for each hour of the two days output values and plots for all 57 junctions and channels. The accuracy of the input data for the initial channel velocities indicates that the listed input is the result of a restart deck.

PROGRAMMING INFORMATION

This section describes the two separate executable programs - the input code and the calculation code - which constitute the hydraulic module of EXPLORE-I. Figure 10 shows the relationship of these programs, which must be executed in sequence. A

Table 3. Control Cards for Requesting Punch, Print and Plot Output From Hydraulic Calculation Code

Card Group	Format	Columns	Description	Variable Name	Default Value
P1	I5	1-5	Switch to request the punching of a restart deck. Any number other than 0 causes a restart deck to be punched.	IDECK	none
	Card groups P2 - P8 are repeated for each group of 20 or less junctions and channels to be printed and/or plotted.				
P2	20A4	1-80	Descriptive title for the group of junction and channel data to be printed and/or plotted	RUNTIT(I) I=1, 20	none
P3	2I10	1-10	The number of tidal day where printing and/or plotting will commence (NQSWRT ≤ IDAY1 ≤ IDAYL)	IDAY1	none
		11-20	The number of the last tidal day to be printed and/or plotted (note IDAYL - IDAY1 is limited to be ≤ 7) (NQSWRT ≤ IDAYL ≤ NTCYC)	IDAYL	none
P4	I10	1-10	The number of junctions for which print and/or plot information is requested (≤20)	NJP	none
P5	20I5	1-4 5-8 9-12 . . . 76-80	Array of NJP junction numbers for which printout is desired (the junction printout will be in the order dictated by this array)	NJW(1) NJW(2) NJW(3) . . . NJW(20)	none

Table 3. (continued)

Card Group	Format	Columns	Description	Variable Name	Default Value
P6	I10	1-10	The number of channels for which print and/or plot information is requested (≤ 20)	NCP	none
P7	20I4	1-4 5-8 9-12 . . . 77-80	Array of NCP channel numbers for which print and/or plot information is desired (The channel printout will be in the order dictated by this array.)	NCW(1) NCW(2) NCW(3) . . . NCW(20)	none
P8	I5	1-5	Switch to request plots for the channel flows and junction heads (NPLOTS = 0, then suppress the plots)	NPLOTS	none

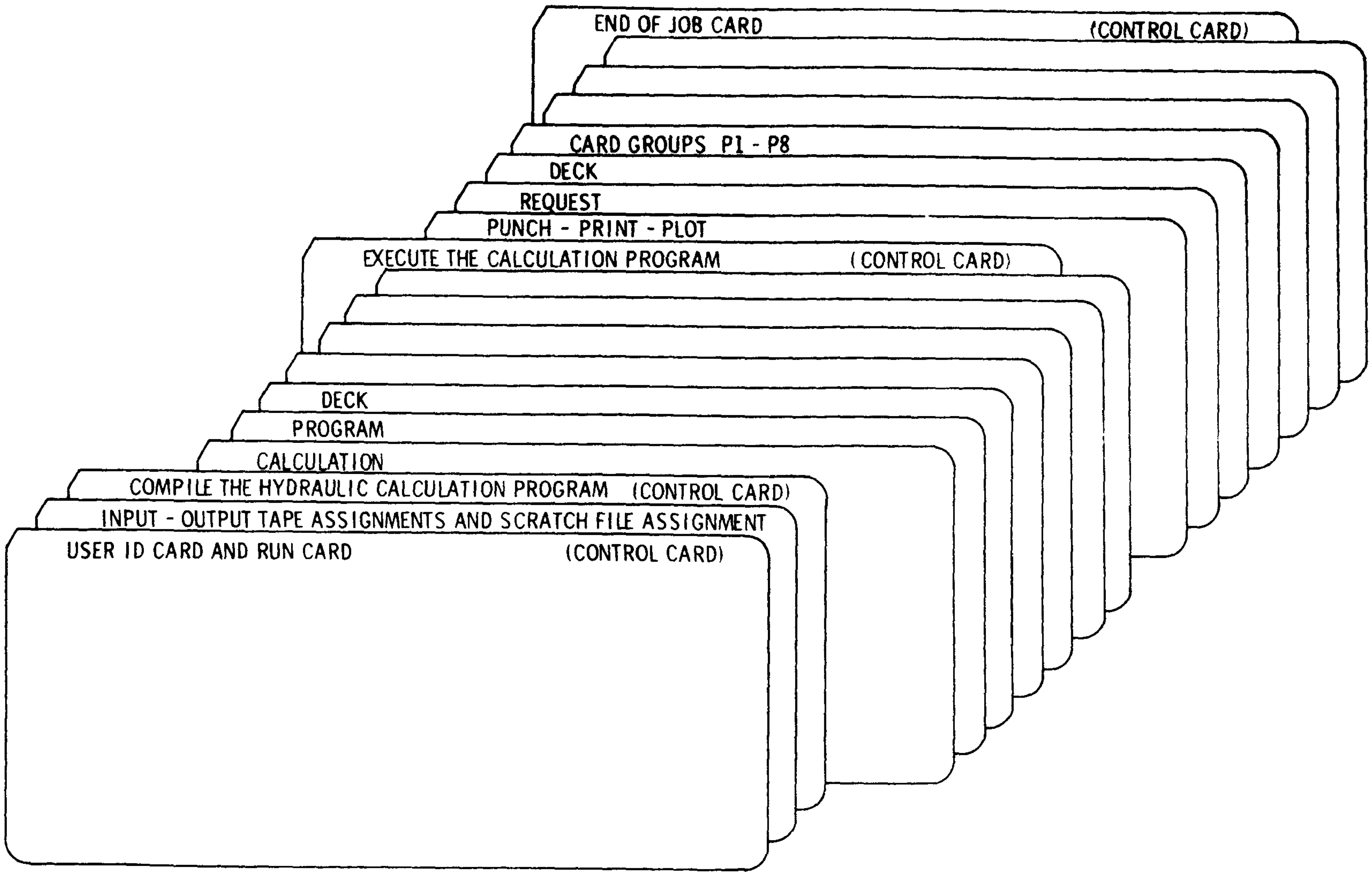


Figure 7. Sample data deck construction for executing the BNW EXPLORE-I hydraulic calculation code.

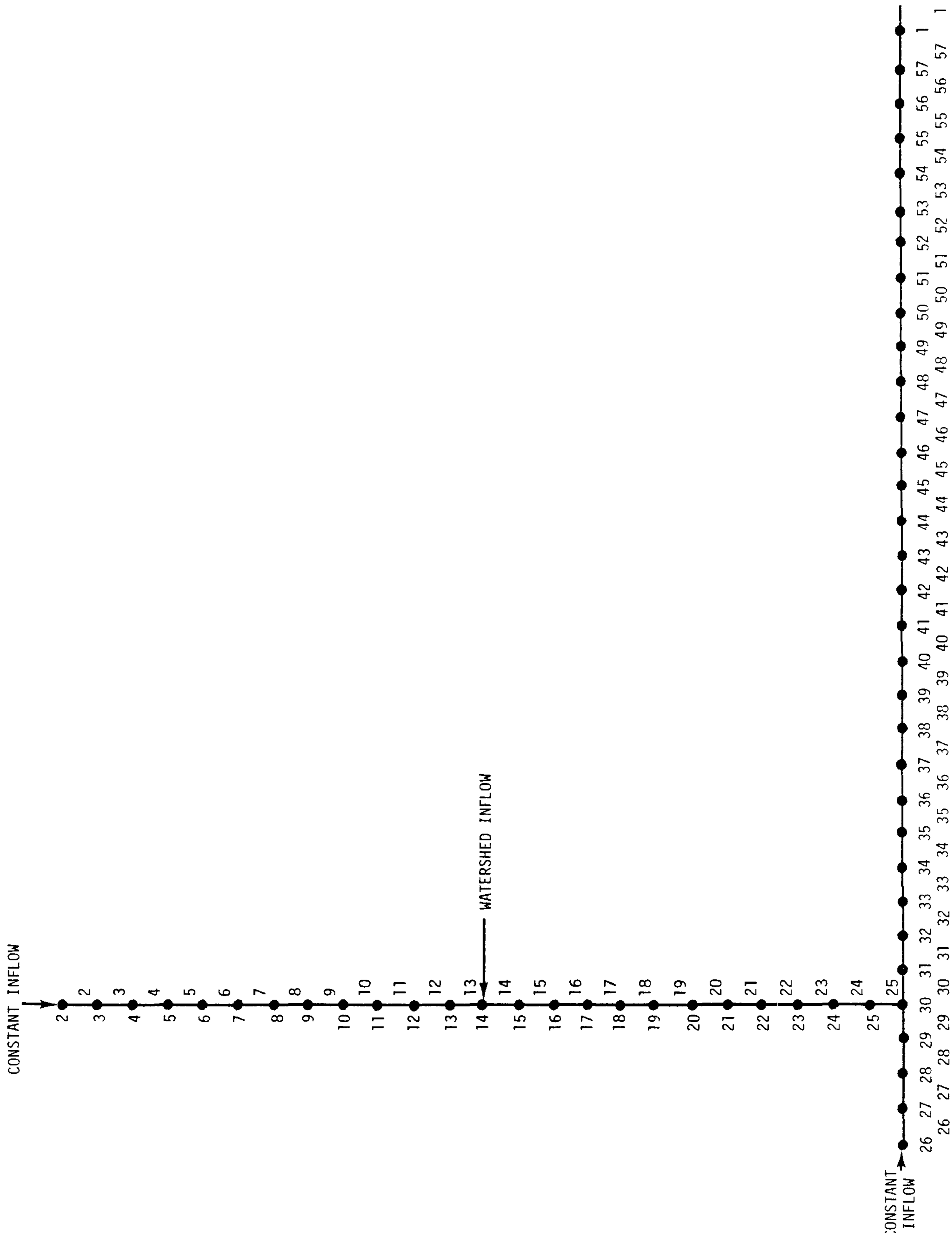


Figure 8. Layout of example system.

Computer dependent control cards

```
USER RUN AND ID CARD
ASSIGN UNIT 1 TO A SCRATCH FILE OR SCRATCH TAPE

ASSIGN UNIT 2 TO A PERMANENT FILE OR USER OWNED OR RENTED TAPE
     ( THE HYDRAULIC OUTPUT FOR THE QUALITY CODE WILL BE STORED ON UNIT 2)

UNIT 5 IS THE CARD READER
UNIT 6 IS THE LINE PRINTER

COMPILE THE INPUT PROGRAM
```

The hydraulic input code and hydraulic calculation code require these unit assignments

```
     FORTRAN  CARD DECK OF THE HYDRAULIC INPUT CODE
```

Computer Control Card

```
EXECUTE THE INPUT PROGRAM
```


Card Group											
HØ	FOUR MILE AND WOLF CREEK SYSTEM										
	1973,SEPT 21 AND 22										
H1	2	24.	1.	100.	0.	0.	0.	1	1	1	1
H2	14										
H3	5										
H4	25	25									
H5	1	1.000	.08829	.00	.00	.00					
	2	64.698	.00564	2.00	.00	64.00					
	3	63.622	.00575	.00	.00	62.93					
	4	62.548	.00587	.00	.00	61.87					
	5	61.473	.00598	.00	.00	60.80					
	6	60.398	.00609	.00	.00	59.73					
	7	59.324	.00620	.00	.00	58.67					
	8	58.250	.00632	.00	.00	57.60					
	9	57.176	.00643	.00	.00	56.53					
	10	56.103	.00654	.00	.00	55.46					
	11	55.029	.00665	.00	.00	54.40					
	12	53.950	.00677	.00	.00	53.33					

JUNCTION CARDS

Figure 9. Listing of sample input data deck for hydraulic code.

	13	52.882		.00688	.00	.00	52.26			
	14	51.811		.00699	.00	.00	51.20			
	15	50.736		.00710	.00	.00	50.13			
	16	49.668		.00721	.00	.00	49.06			
	17	48.586		.00733	.00	.00	48.00			
	18	47.532		.00744	.00	.00	46.93			
	19	46.424		.00755	.00	.00	45.86			
	20	45.421		.00766	.00	.00	44.79			
	21	44.219		.00778	.00	.00	43.73			
	22	43.417		.00789	.00	.00	42.66			
	23	43.343		.00800	.00	.00	41.59			
	24	43.333		.00811	.00	.00	40.53			
	25	39.752		.00823	.00	.00	39.46			
	26	44.519		.04415	5.00	.00	43.88			
	27	43.108		.04415	.00	.00	42.51			
	28	41.807		.04415	.00	.00	41.13			
	29	40.317		.04415	.00	.00	39.76			
	30	39.156		.04829	.00	.00	38.39			
	31	37.764		.04636	.00	.00	37.02			
	32	36.373		.04856	.00	.00	35.65			
	33	34.983		.05077	.00	.00	34.28			
	34	33.595		.05298	.00	.00	32.91			
	35	32.206		.05519	.00	.00	31.54			
	36	30.820		.05739	.00	.00	30.17			
	37	29.435		.05960	.00	.00	28.80			
	38	28.051		.06181	.00	.00	27.42			
	39	26.666		.06401	.00	.00	26.05			
	40	25.282		.06622	.00	.00	24.68			
	41	23.898		.06843	.00	.00	23.31			
	42	22.519		.07064	.00	.00	21.94			
	43	21.137		.07284	.00	.00	20.57			
	44	19.757		.07505	.00	.00	19.20			
	45	18.376		.07726	.00	.00	17.82			
	46	16.999		.07947	.00	.00	16.45			
	47	15.618		.08168	.00	.00	15.08			
	43	14.245		.08388	.00	.00	13.71			
	49	12.860		.08609	.00	.00	12.34			
	50	11.497		.08829	.00	.00	10.97			
	51	10.114		.08829	.00	.00	9.60			
	52	8.778		.08829	.00	.00	8.23			
	53	7.367		.08829	.00	.00	6.86			
	54	6.081		.08829	.00	.00	5.48			
	55	4.591		.08829	.00	.00	4.11			
	56	3.435		.08829	.00	.00	2.74			
	57	1.733		.08829	.00	.00	1.37			
H6	99999									
H7	1	0	1		2414.0000	36.5760	.0000	.0400	.0000	CHANNEL CARDS
	2	2	3		804.7000	7.0800	63.4680	.0700	.4085	
	3	3	4		804.7000	7.2200	62.4010	.0700	.4053	

Figure 9. (continued)

4	4	5	804.7000	7.3590	61.3340	.0700	.4022
5	5	6	804.7000	7.4990	60.2670	.0700	.3992
6	6	7	804.7000	7.6390	59.2000	.0700	.3962
7	7	8	804.7000	7.7790	58.1330	.0700	.3933
8	8	9	804.7000	7.9190	57.0660	.0700	.3905
9	9	10	804.7000	8.0590	55.9990	.0700	.3877
10	10	11	804.7000	8.1980	54.9320	.0700	.3851
11	11	12	804.7000	8.3380	53.8650	.0700	.3824
12	12	13	804.7000	8.4770	52.7980	.0700	.3800
13	13	14	804.7000	8.6170	51.7310	.0700	.3773
14	14	15	804.7000	8.7560	50.6640	.0700	.3753
15	15	16	804.7000	8.8960	49.5970	.0700	.3721
16	16	17	804.7000	9.0350	48.5300	.0700	.3712
17	17	18	804.7000	9.1750	47.4630	.0700	.3662
18	18	19	804.7000	9.3150	46.3960	.0700	.3693
19	19	20	804.7000	9.4550	45.3290	.0700	.3566
20	20	21	804.7000	9.5950	44.2620	.0700	.3738
21	21	22	804.7000	9.7350	43.1950	.0700	.3300
22	22	23	804.7000	9.8740	42.1280	.0700	.1619
23	23	24	804.7000	10.0140	41.0610	.0700	.0878
24	24	25	804.7000	10.1540	39.9940	.0700	.1275
25	25	30	804.7000	10.2940	38.9270	.0700	.2512
26	26	27	2414.0000	18.2880	43.1920	.0400	.4401
27	27	23	2414.0000	18.2880	41.8210	.0400	.4299
28	28	29	2414.0000	18.2880	40.4500	.0400	.4471
29	29	30	2414.0000	18.2880	39.0790	.0400	.4159
30	30	31	2414.0000	18.7460	37.7080	.0400	.4970
31	31	32	2414.0000	19.6600	36.3370	.0400	.4872
32	32	33	2414.0000	20.5750	34.9660	.0400	.4784
33	33	34	2414.0000	21.4890	33.5950	.0400	.4699
34	34	35	2414.0000	22.4040	32.2240	.0400	.4623
35	35	36	2414.0000	23.3180	30.8520	.0400	.4547
36	36	37	2414.0000	24.2330	29.4810	.0400	.4478
37	37	38	2414.0000	25.1470	28.1100	.0400	.4411
38	38	39	2414.0000	26.0610	26.7390	.0400	.4350
39	39	40	2414.0000	26.9750	25.3670	.0400	.4291
40	40	41	2414.0000	27.8900	23.9950	.0400	.4236
41	41	42	2414.0000	28.8040	22.6240	.0400	.4179
42	42	43	2414.0000	29.7190	21.2540	.0400	.4133
43	43	44	2414.0000	30.6330	19.8820	.0400	.4084
44	44	45	2414.0000	31.5480	18.5110	.0400	.4041
45	45	46	2414.0000	32.4620	17.1400	.0400	.3998
46	46	47	2414.0000	33.3770	15.7690	.0400	.3964
47	47	48	2414.0000	34.2910	14.3980	.0400	.3922
48	48	49	2414.0000	35.2050	13.0270	.0400	.3901
49	49	50	2414.0000	36.1190	11.6550	.0400	.3859
50	50	51	2414.0000	36.5760	10.2840	.0400	.3876
51	51	52	2414.0000	36.5760	8.9130	.0400	.3868
52	52	53	2414.0000	36.5760	7.5420	.0400	.3961
53	53	54	2414.0000	36.5760	6.1710	.0400	.3893
54	54	55	2414.0000	36.5760	4.8000	.0400	.4095
55	55	56	2414.0000	36.5760	3.4280	.0400	.3837
56	56	57	2414.0000	36.5760	2.0570	.0400	.4315
57	1	57	2414.0000	36.5760	.6860	.0400	-.3396

H8 9999

Figure 9. (continued)

```
H9a     CONST            1.0                                          Constant head controlled no
H10a    WATERSHED INFLOW                                              Hydrograph input
   b    MCARD1 M=19,MIN=6,MAX=6
        X=0.,1.,2.,3.,4.,5.,6.,7.,8.,9.,10.,11.,12.,13.,14.,15.,16.,17.,18.,
        Y=.436,3.26,11.941,17.728,20.786,16.011,1.306,1.084,1.013,.948,.886,
          .829,.776,.725,.678,.634,.593,.554,0.,HYDEND=68400.
   c    $END
H11     ****************************************************************************
```

Computer Control Card COMPILE THE CALCULATION PROGRAM

FORTRAN C.P.) DEC OF THE HYDRAULIC CALCULATION CODE

Computer Control Card EXECUTE THE CALCULATION PROGRAM

```
P1        0
P2     FOUR MILE CREEK AND WOLF CREEK
P3            1         7
P4           20
P5       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
P6           20
P7       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
P8        1
       FOUR MILE CREEK AND WOLF CREEK                                                      Repeat of P2-P8
              1         7
             20
        21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
             20
        21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
          1
       FOUR MILE CREEK AND WOLF CREEK
              1         7
             17
        41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57
             17
        41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57
          1
```

COMPUTER CONTROL CARD END OF RUN

Figure 9. (continued)

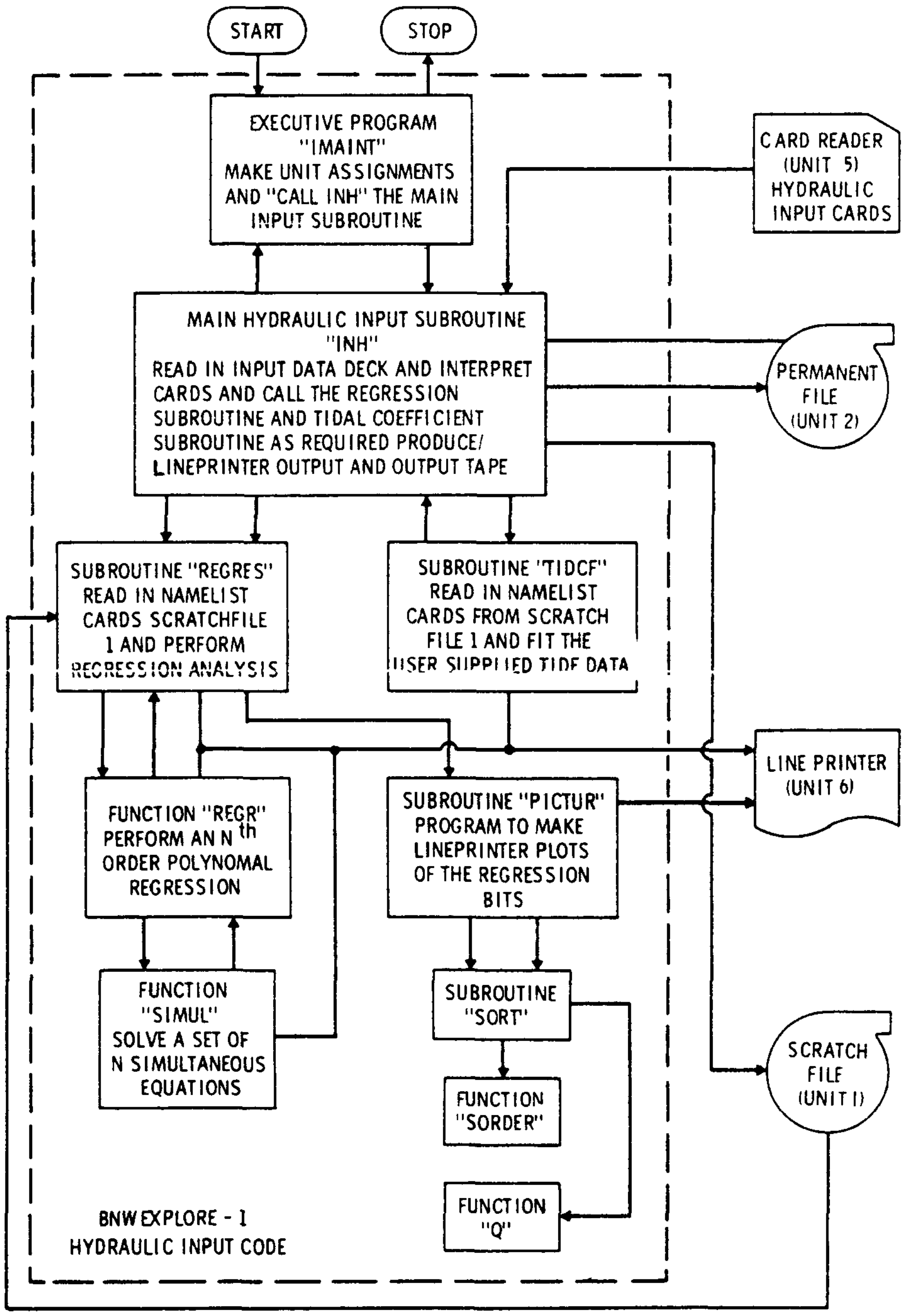


Figure 10. Relationship of the hydraulic input, calculation and output codes.

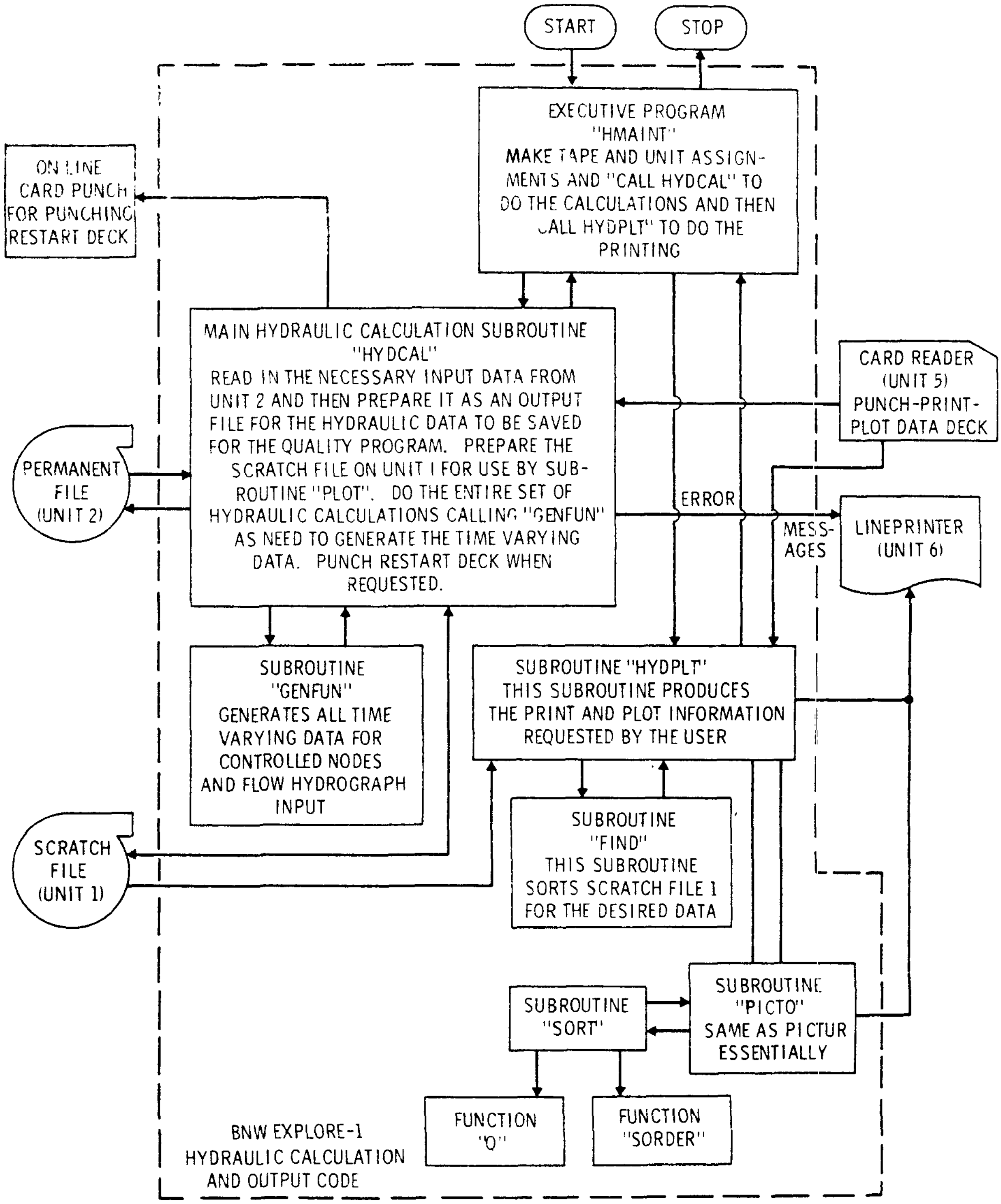


Figure 10. (continued).

listing of the two codes may be found in Appendix A. The variables used in the hydraulic program and their definitions are given in Table 4.

Hydraulic Input Program (IMAINT) Description

The executive program is MAIN (formerly IMAINT). This program serves only to make I/O device assignments and to call the main input subroutine INH. Subroutine INH reads in the input data necessary for the hydraulic calculations. INH calls subroutine TIDE (formerly TIDCF) when a fit of the stage versus time data is required and subroutine REGRES when it is necessary to fit time varying data on controlled nodes or flow hydrographs. Figure 11 shows a flow chart for subroutine INH.

Subroutine REGRES is a standard polynomial regression program taken from Reference 6. This program reads in an array of M ordered data points and does a user-specified set of Nth order polynomial regressions ($1 \leq N \leq 9$). In each case print and plot data indicating the quality of the fit are produced. REGRES calls on functions REGR and SIMUL for the regressions and on subroutine PICTUR for the line-printer plots. Details of this subroutine can be found in Reference 6.

Subroutine TIDE calculates the coefficients of the tidal function H(t) = A1 + A2*SIN(t) + A3*SIN(2t) + A4*SIN(3t) + A5*COS(t) + A6*COS(2t) + A7*COS(3t) from input values of H and T by a least squares procedure. Figure 12 is a flow chart of TIDE.

Subroutine PICTUR prepares a lineprinter plot of a set of N data points. Figure 13 shows a flow chart of PICTUR. This subroutine uses subroutine SORT and functions SORDER and Q to sort the plot points according to descending values of Y.

Hydraulic Calculations Program (HMAINT) Description

Executive Program MAIN (formerly HMAINT) serves only to make I/O device assignments and to call the calculation subroutine HYDCAL and the print-plot program HYDPLT.

Subroutine HYDCAL, the hydraulic calculation program, receives its input data from tape unit 2 and carries out the hydraulic computations. HYDCAL calls subroutine GENFUN as required to generate all time varying input functions and to solve the weir formula. Figure 14 shows a flow diagram of HYDCAL.

Subroutine GENFUN, a flow diagram of which is shown in Figure 15, is used to solve the weir formula and to generate the functional values of all input variables which were fit via polynomial regression.

Table 4. Variable Definition for Hydraulic Code

Variable Name	Location	Description
A(500)	C	Channel cross-section area at start of time-step (HYDCAL,INH)
AK(600)	C	Modified friction factor (HYDCAL,INH)
ALPHA(30)	C	Title for printing (HYDCAL,INH)
ALEN		Channel length (INH)
ARRAY(33)		Dummy array used in printing (HYDCAL,INH)
AREA		Computed nodal area to find initial nodal volume (HYDCAL)
AS(500)	C	Node surface area (HYDCAL,INH)
AT(600)	C	Channel cross-section at midpoint of time-step (HYDCAL,INH)
A(3,20,10)	C	Array used to store the regression coefficients and wier constants (HYDCAL,INH)
ATEMP(10)		Variable to pass the regression constants (INH)
ASTERK		Variable containing asterisk (HYDCAL,INH)
ATOT		Total surface area of receiving water (INH)
ASTER		Variable containing asterisk
A1 A2 A3 A4 A5 A6 A7		Coefficients of the expression H(WT) = A + A2*COS(WT) + A3*COS(2WT) + A4*COS(3WT) + A5*SIN(WT) + A6*SIN(2WT) + A7*SIN(3WT) + A8*SIN(4WT) for tidal input

Table 4. (continued)

Variable Name	Location	Description
B(600)	C	Channel width (HYDCAL,INH)
BLANK		Variable containing blank (INH)
COEF		Manning's coefficient for channel (INH)
DEL		Temporary variable
{DELH, DELHH}		Increment of head of a junction for a time-step (HYDCAL)
DELMAX		Maximum difference between the calculated and stage input
DELTA		Maximum allowable difference between the calculated and input tidal stage
DELT	C	Time-step increment (HYDCAL,INH)
DELTH		Temporary variable (HYDCAL)
DELTQ	C	Length of quality time-step (usually an hour); (HYDCAL,INH)
DELT2		1/2 time-step increment (HYDCAL)
{DELV1, DELV2}		Component of velocity change during a time-step (HYDCAL)
DEP(500)	C	Depth of water of a junction at zero datum (HYDCAL,INH)
DEPTH		Computed depth of node at a junction for initial volume (HYDCAL)
DIFF		Difference between the calculated and input tidal stage
DT		Junction depth (INH)
DVOL		Volume change in a time-step (HYDCAL)
EVAP	C	Evaporation rate for whole system converted from ft/mo (HYDCAL,INH)
EWIND(600)	C	Drag force due to wind (HYDCAL,INH)

Table 4. (continued)

Variable Name	Location	Description
FJ1		Internal variable
FJ3		Internal variable
H(500)	C	Head at junction at beginning of time-step (HYDCAL,INH)
HAVE(500)	C	Junction average head during a daily cycle (HYDCAL)
HBAR(500)	C	Junction average head during a quality cycle (HYDCAL)
HEAD		Distance water surface is from datum plane (INH)
HN(500)	C	Junction head at end of time-step (HYDCAL)
HOUR		Time-hours
HYDRAD(600)	C	Hydraulic radius (INH)
HT(500)	C	Junction head at end of 1/2 time-step (HYDCAL)
IDELT		Length of hydraulic cycle (integration step) (INH)
IDECK		Switch variable to request restart deck be punched (HYDCAL)
I II IHJN IL IJK IJN		Index numbers (HYDCAL,INH)
IFLAG		Variable to indicate small tributary channel (INH)
IPERID		Length of tidal cycle (INH)
IPOINT(500,6)	C	Pointer array containing node to node connections (HYDCAL,INH)
IQINT		Length of quality cycle (INH)
IT		Iteration counter

Table 4. (continued)

Variable Name	Location	Description
ITRIB(50,2)	C	Array containing the channel numbers of the small tributary channels and also the associated junction numbers (HYDCAL,INH)
J		Index variable (HYDCAL,INH)
JGW(20)	C	Array indicating the type of controlled node I is (HYDCAL,INH)
JSW(20)	C	Array of junction numbers which have time varying flow input (HYDCAL,INH)
K		Index variable (HYDCAL,INH)
KO		Switch to cause generation of a full tide from HHW, LLW, HLW, LHW
LEN(600)	C	Channel length (HYDCAL,INH)
M		Index variable (HYDCAL,INH)
MAXIT		Maximum number of iterations in tidal curve fit, usually 50
N		Index variable (HYDCAL,INH)
NC	C	Number of channels (HYDCAL,INH)
NCHAN(500,6)	C	Channels associated with nodes (HYDCAL,INH)
NCLOS(600)	C	If equal to 1 channel dry, otherwise no effect (INH,HYDCAL)
NDRY		Number of dry junctions (HYDCAL)
NEXIT	C	Set equal to 1 when error condition exists (HYDCAL,INH)
NH		Node at channel end (HYDCAL)
NHH		Hydraulic cycle counter (HYDCAL)
NHCYC	C	Number of time-steps per quality cycle (HYDCAL,INH)
NI		Number of tidal input values
NINT		Number of hydraulic cycles per tidal cycle (INH)

Table 4. (continued)

Variable Name	Location	Description
NJGW	C	Number of controlled nodes (HYDCAL,INH)
NJ	C	Number of junctions (HYDCAL,INH)
NJ2		Temporary variables
NJGW1		NJGW+1 (HYDCAL)
NJSW	C	Number of junctions with time varying flow hydrograph input (HYDCAL,INH)
NJUNC(600,2)	C	Nodes at channel ends (HYDCAL,INH)
NL		Node at channel end (HYDCAL)
NQ		Quality cycle counter (HYDCAL)
NQCYC	C	Number of quality cycles per day (HYDCAL,INH)
NQSWRT	C	Number of daily cycles at which printing will start (HYDCAL,INH)
NT	C	Daily cycle number (HYDCAL,INH)
NTCYC	C	Number of daily cycles to be simulated (HYDCAL,INH)
NTEMP(6)	C	Temporary array of channels entering a node (HYDCAL,INH)
NTIMS		Number of times through drying up connection (HYDCAL)
NTRIB	C	Number of small tributary channels (HYDCAL,INH)
NTT		Temporary variables
NX		Temporary variable (HYDCAL)
N5	C	Card reader of equivalent (HYDCAL,INH)
N6	C	Lineprinter (HYDCAL,INH)
N7	C	(Fake printer) scratch file or permanent file (INH)
N20	C	Hydraulic input and output file (HYDCAL,INH)

Table 4. (continued)

Variable Name	Location	Description
N22	C	Scratch file (equal to N20 in HYDCAL)
N24	C	Scratch file
PERIOD	C	Period in hours of daily cycle (HYDCAL,INH,TIDCF)
Q(600)	C	Channel flow (HYDCAL,INH)
QAVE(600)	C	Daily cycle average flow (HYDCAL)
QBAR(600)	C	Quality cycle average flow (HYDCAL)
QF1		Temporary storage for junction inflow (INH)
QF2		Temporary storage for junction outflow (INH)
QIN(500)	C	Inflows to junctions (HYDCAL,INH)
QUINBAR(500)	C	Quality cycle average junction inflow (HYDCAL)
QINST(20)	C	Array for storing the constant inflow at junctions with flow hydrograph input (HYDCAL)
QUINT	C	Quality time-step interval (HYDCAL,INH)
QJ2		Temporary variable (HYDCAL)
QOU(500)	C	Outflow from junction (HYDCAL,INH)
QOUBAR(500)	C	Quality cycle average junction outflow (HYDCAL,INH)
R1(600)	C	Hydraulic radius (HYDCAL,INH)
RAD		Channel depth measured from datum (HYDCAL,INH)
RES		Accumulative difference between the calculated and input tidal stage
RNT		Temporary hydraulic radius at 1/2 time-step (HYDCAL)
SURF		Temporary storage for junction surface area (HYDCAL)

Table 4. (continued)

Variable Name	Location	Description
SUM		Computed tidal stage
SUMQ		Total flow leaving junction (HYDCAL)
SXX(10,10)		Matrix used for least square tidal fit
SXY(10)		Vector used for least square tidal fit
TITLE(33)		Title array read from cards
T		Time counter for whole analysis (HYDCAL)
TT(50)		Time from start of storm of input for tidal condition and from hydrograph file
T2		T + 1/2 Δt (HYDCAL)
TEMP		Simplifying variable used during solution of velocities (HYDCAL)
TF		Estimate maximum time-step for channel (INH)
TIME		Time counter for time varying input
TIM2		Time + 1/2 Δt
TRBDEP(50)	C	Small tributary channels mid-point depth measured from datum (HYDCAL,INH)
VEL		Temporary storage of velocity (INH)
V(600)	C	Channel velocity at start of time-step (HYDCAL,INH)
VBAR(600)	C	Average velocity during quality cycle (HYDCAL)
VOL(500)	C	Nodal volume (HYDCAL,INH)
VOLUME		Initial nodal volume (HYDCAL)

Table 4. (continued)

Variable Name	Location	Description
VT(600)	C	Channel velocity at 1/2 time-step (HYDCAL)
V2		Velocity during a half hydraulic time-step (HYDCAL)
W	C	Fundamental frequency of daily tidal variation (HYDCAL,INH)
WDIR	C	Wind direction in degrees from north (HYDCAL,INH)
WIDTH		Width of channel (INH)
WIND	C	Wind force (HYDCAL,INH)
X(J)	C	X coordinate of junctions (HYDCAL,INH)
X1		Temporary storage x coordinate (INH)
XMK		Blank or asterisk depending on whether estimated maximum time-step is satisfied (INH)
XX(10)		Vector used in least square tidal fit
Y(J)	C	Y coordinate of junctions (HYDCAL,INH)
Y1		Temporary storage for y coordinate (INH)

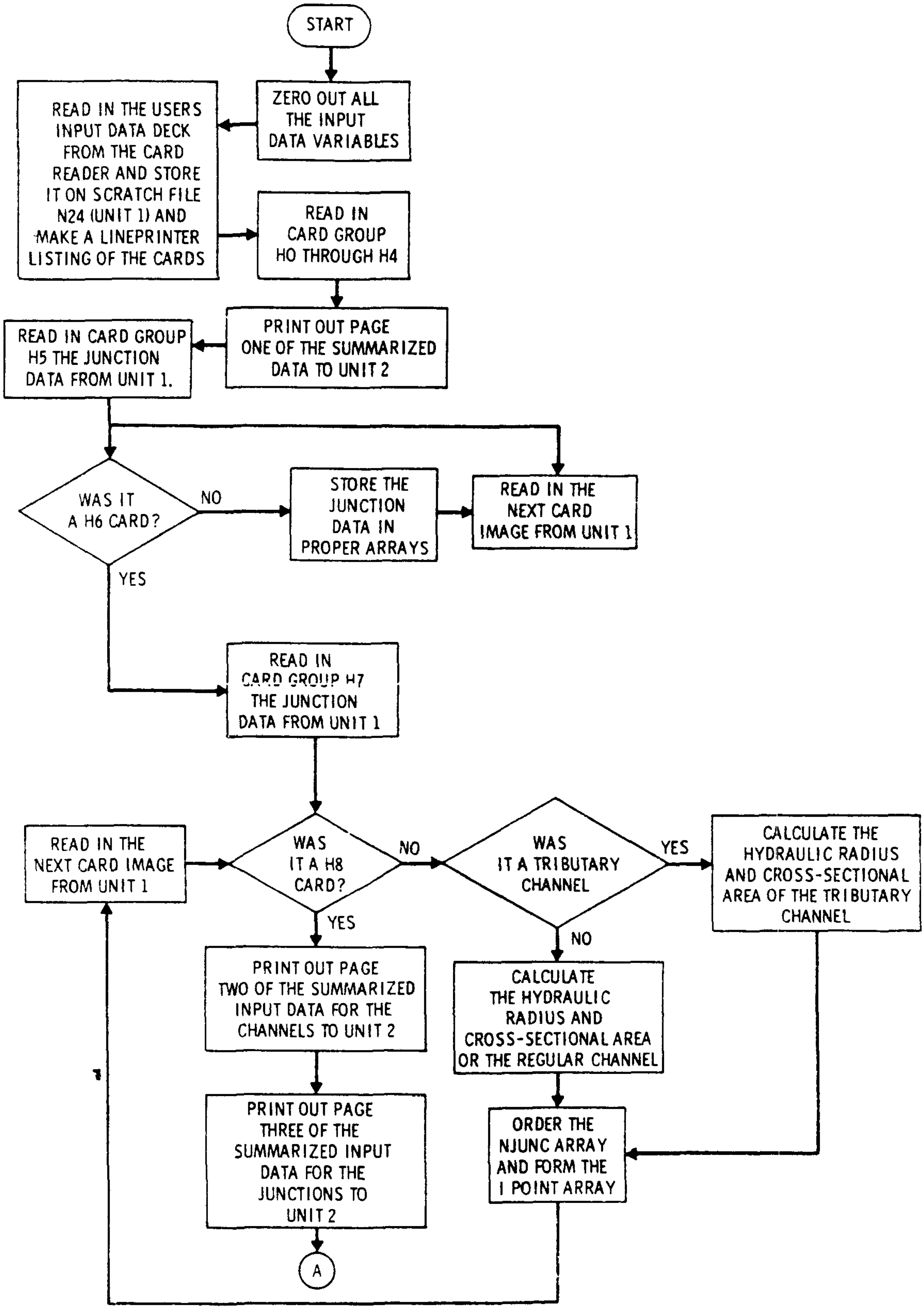


Figure 11. Flow chart of subroutine INH.

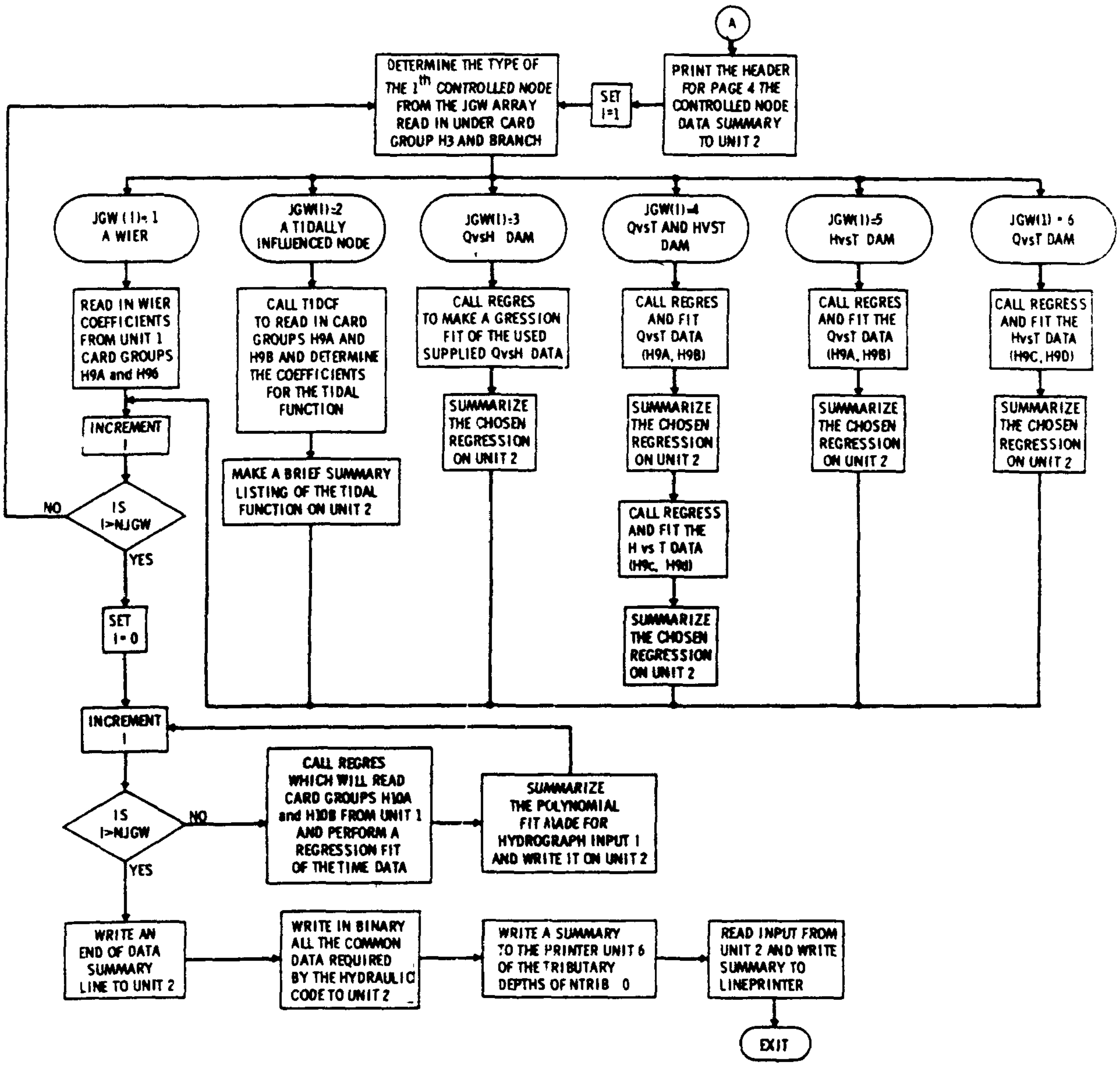


Figure 11. (continued).

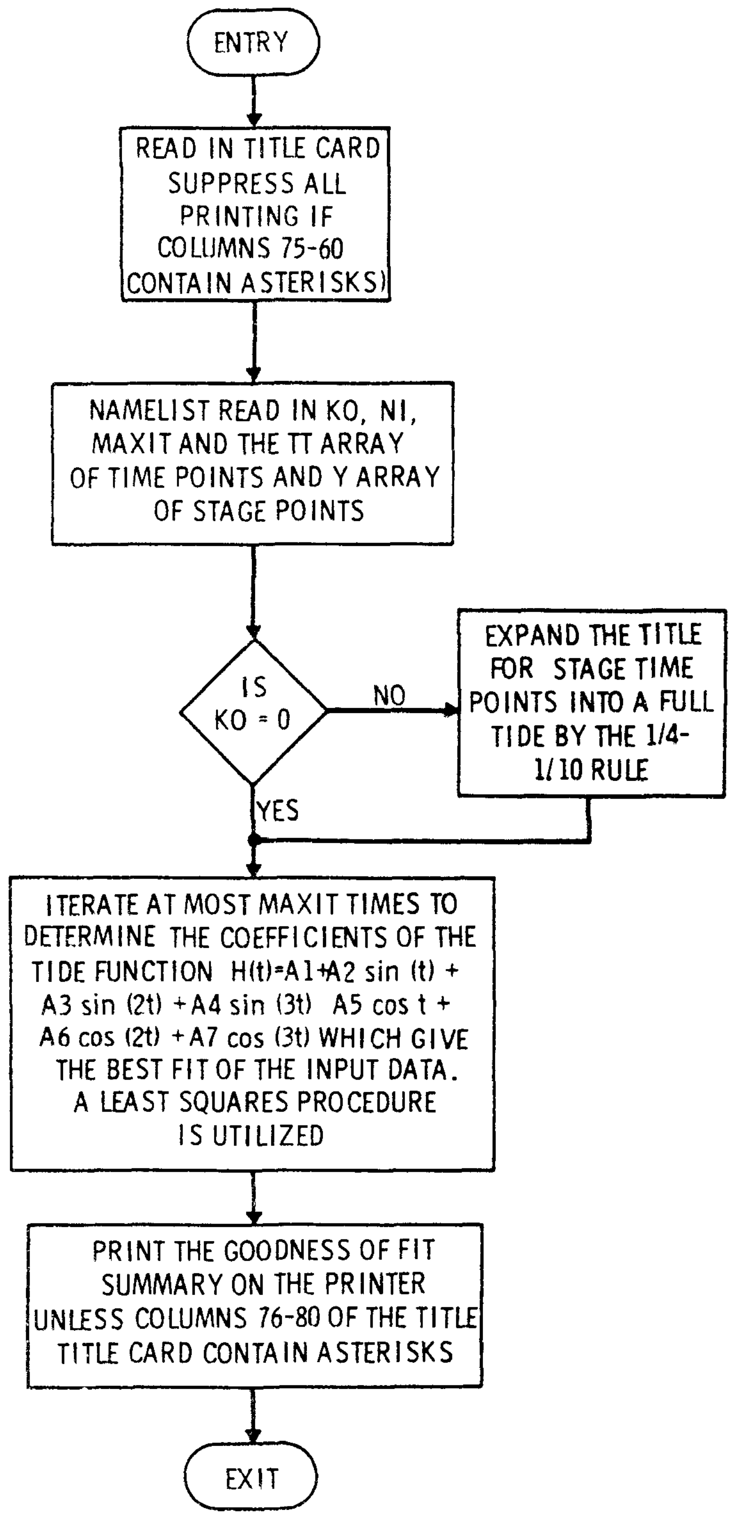


Figure 12. Flow chart of TIDE.

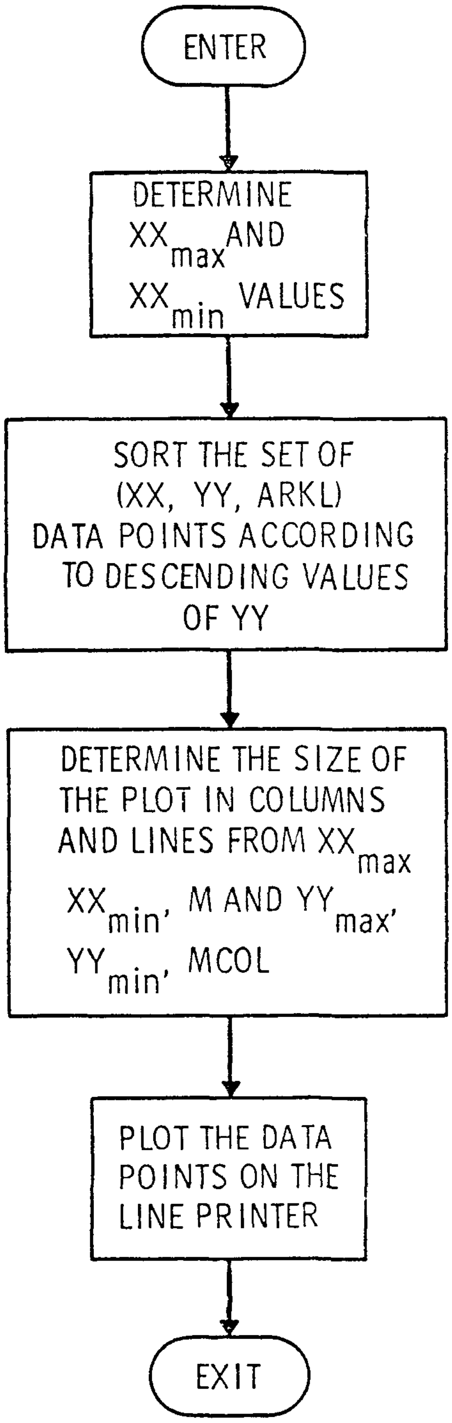


Figure 13. Flow chart of subroutine PICTUR.

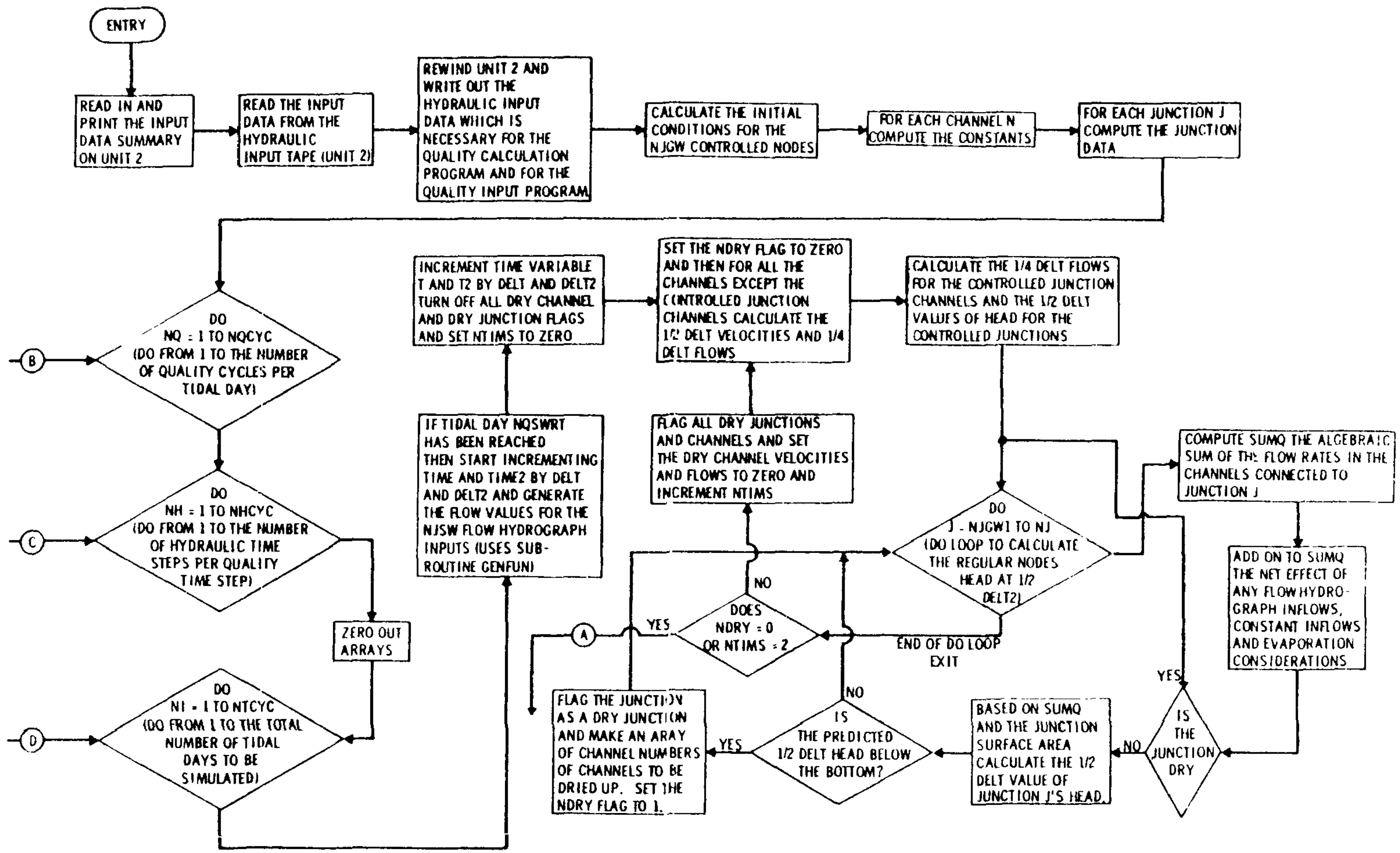


Figure 14. Flow chart of subroutine HYDCAL.

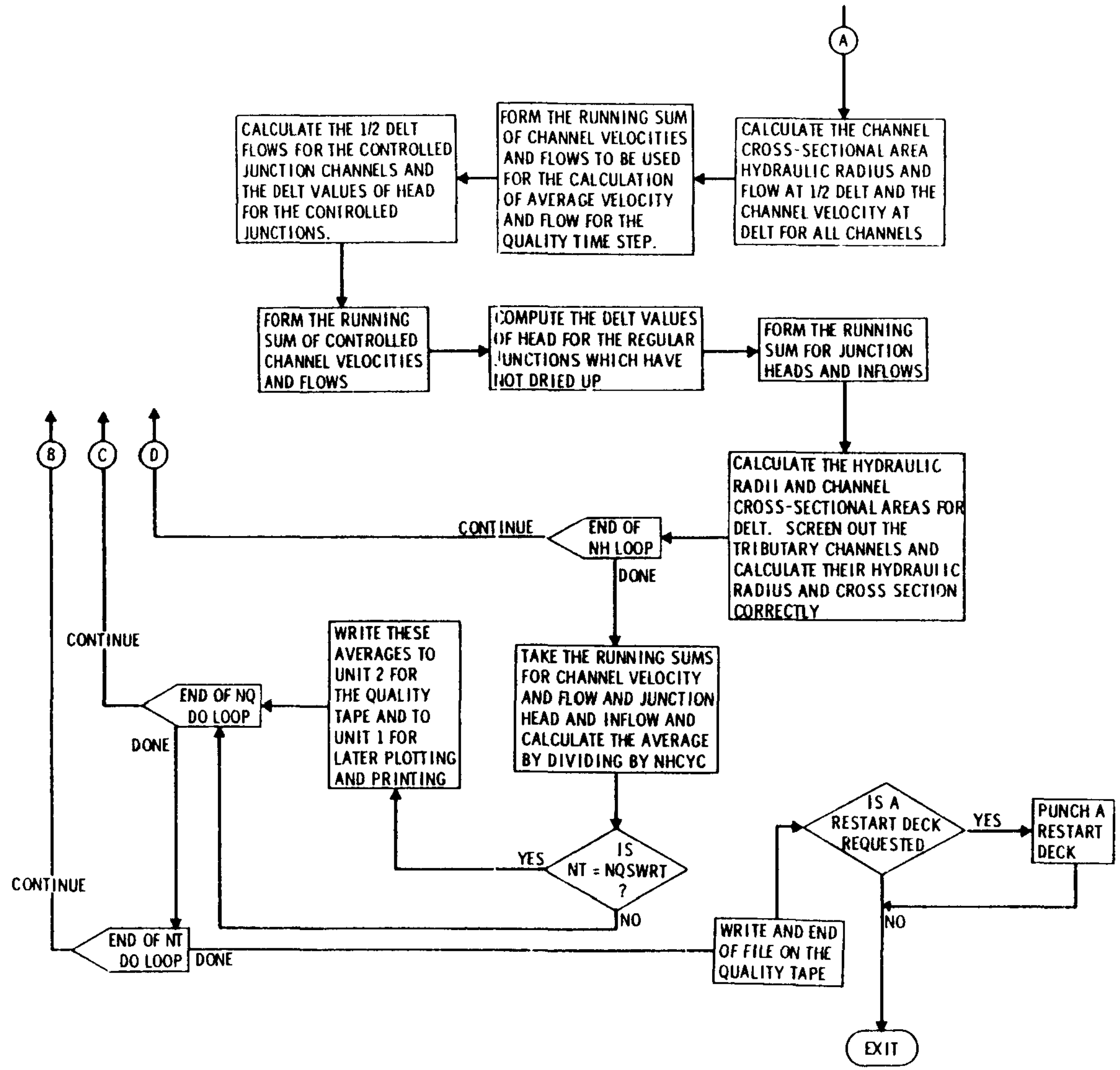


Figure 14. (continued).

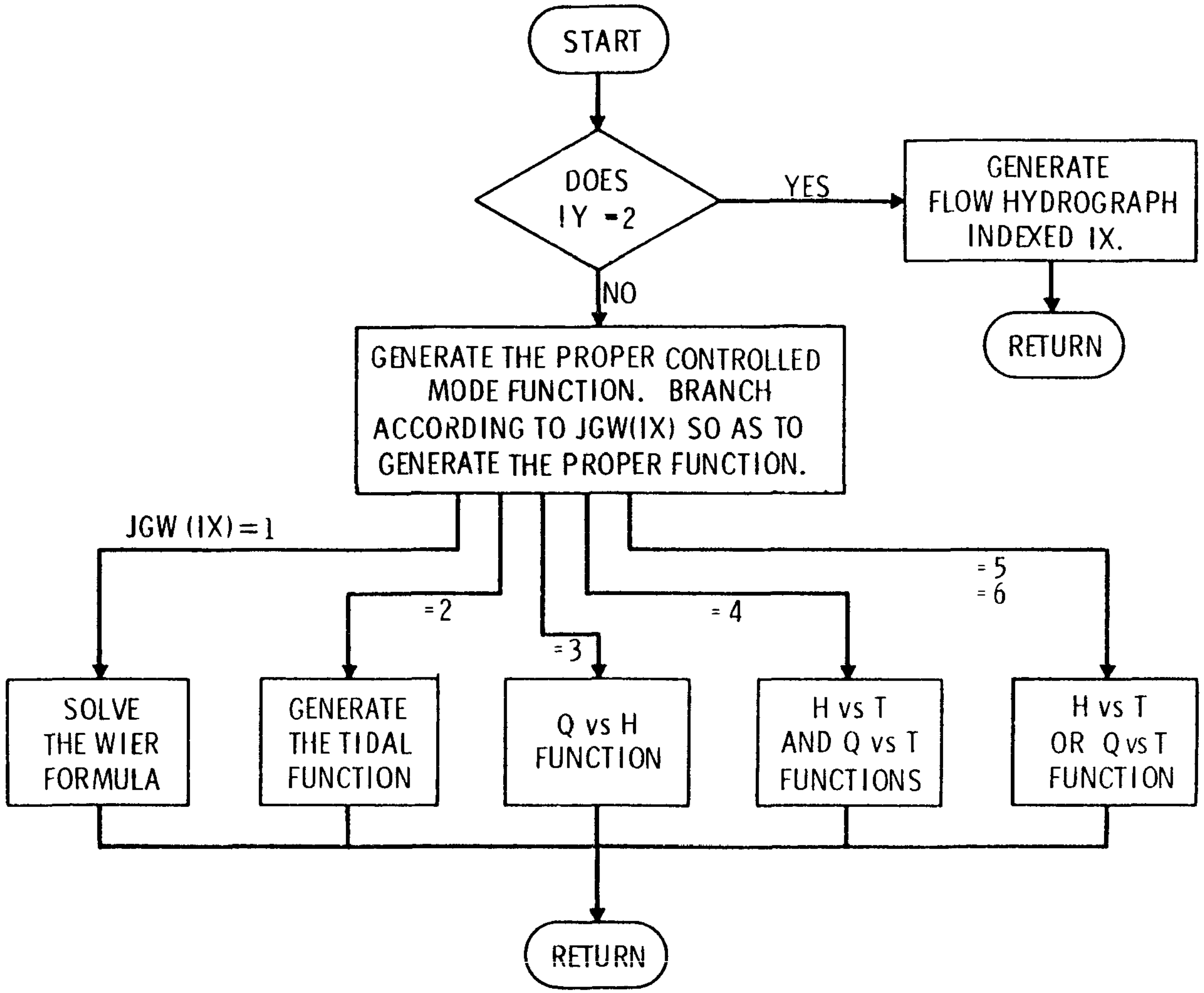


Figure 15. Flow diagram of subroutine GENFUN.

Subroutine HYDPLT is used to print out the hydraulic information calculated by HYDCAL for the user-requested sets of junctions and channels. Figure 16 is a flow diagram of subroutine HYDPLT. The plotting program PICTO used by HYDPLT is identical to PICTUR, except that titles are printed on the plots and a check insures that the data plotted covers 75% or more of the X axis.

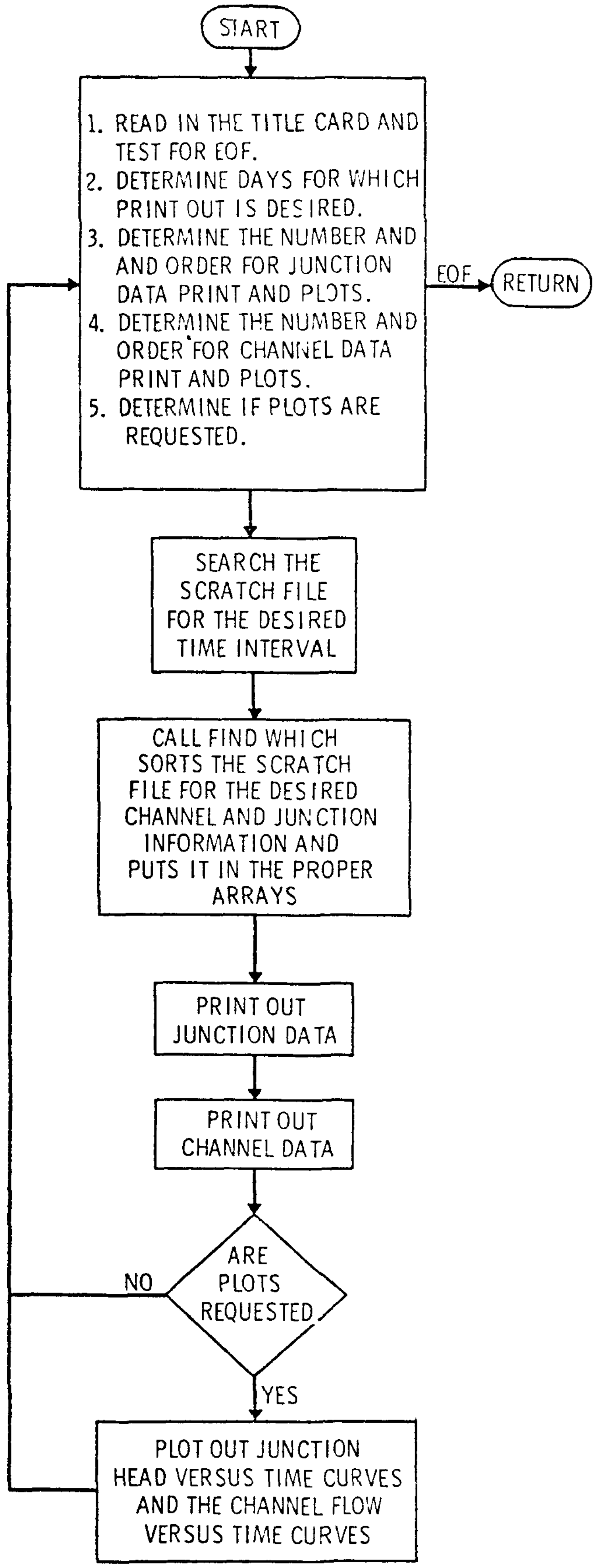


Figure 16. Flow diagram of subroutine HYDPLT

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1. Baca, R. G., W. W. Waddel, C. R. Cole, A. Brandstetter and D. B. Cearlock. EXPLORE-I: A River Basin Water Quality Model. Prepared for the U.S. Environmental Protection Agency by Battelle, Pacific Northwest Laboratories, Richland, WA, 1973a.

2. Baca, R. G., W. W. Waddel, C. R. Cole, A. Brandstetter, and D. B. Cearlock. Appendix B. User's Manual for EXPLORE-I: A River Basin Water Quality Model, Prepared for the Environmental Protection Agency, Battelle, Pacific Northwest Laboratories, Richland, WA, August 1973b.

3. Water Resource Engineers, "A Hydraulic Water Quality Model of Suisan and San Pablo Bays." Report to EPA, March 1966.

4. Metcalf and Eddy, Inc. "Storm Water Management Model." Palo Alto, CA, Prepared as EPA Report No. 11024DOC08/71, August 1971.

5. Callaway, R. J., K. V. Bysam and G. R. Ditsworth. "Mathematical Model of the Columbia River from the Pacific Ocean to Bonneville Dam." Federal Water Pollution Central Administration, Pacific Northwest Laboratory, November 1969.

6. Henderson, F. M. Open Channel Flow, Macmillan Company, 1966.

7. Carnahan, B., H. A. Luther, and J. O. Wilkes. Applied Numerical Methods. John Wiley and Sons Inc., 1969.

APPENDIX A

LISTING OF THE EXPLORE-I HYDRAULIC CODE

Hydraulic Input Computer Program
IMAINT

Hydraulic Calculational Computer Program
HMAINT

****** GAUSS ******

@ELT,L IMAINT.GAUSS

```
000    SUBROUTINE GAUSS (A,X)
000 C       THIS ROUTINE IS CALLED BY TIDE
000         DIMENSION A(8,9),X(8)
000         N=8
000         M=9
000         L=7
000         DO 12 K=1,L
000         JJ=K
000         BIG=ABS(A(K,K))
000         KP1=K+1
000 C     SEARCH FOR LARGEST PIVOT ELEMENT
000         DO 7 I=KP1,N
000         AB=ABS(A(I,K))
000         IF(BIG-AB) 6,7,7
000       6 BIG=AB
000         JJ=I
000       7 CONTINUE
000 C     DECIDE WHETHER ROW INTERCHANGE IS NECESSARY
000         IF(JJ-K) 8,10,8
000 C     INTERCHANGE ROWS
000       8 DO 9 J=K,M
000         TEMP=A(JJ,J)
000         A(JJ,J)=A(K,J)
000       9 A(K,J)=TEMP
000 C     CALCULATE ELEMENTS OF NEW MATRIX
000    10   DO 11 I=KP1,N
000         QUOT=A(I,K)/A(K,K)
000         DO 11 J=KP1,M
000      11 A(I,J)=A(I,J)-QUOT*A(K,J)
000         DO 12 I=KP1,N
000      12 A(I,K)=0.
000 C     FIRST STEP IN BACK SUBSTITUTION
000         X(N)=A(N,M)/A(N,N)
000         DO 14 NN=1,L
000         SUM=0.
000         I=N-NN
000         IP1=I+1
000         DO 13 J=IP1,N
000      13 SUM=SUM+A(I,J)*X(J)
000      14 X(I)=(A(I,M)-SUM)/A(I,I)
000         CONTINUE
000         RETURN
000         END
```

END ELT.

@HDG,P ****** TDH ******

****** INH ******

@ELT,L IMAINT.INH

```
      SUBROUTINE INH
C     ************** INPUT PROGRAM FOR EXPLORE-1               *************
C
C     ************** BATTELLE NORTHWEST 11/9/71                *************
C     *********************************************************************
C      THIS ROUTINE IS CALLED BY IMAINV (OR IMAINT)
C      AND CALLS TIDE AND REGRES
C
C     ************** ASSIGN THE COMMON  DATA                   *************
      COMMON /TAPES/N5,N6,N20,N22,N24
      COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
C
C     ************** CONTROL AND TITLE INFORMATION             *************
      COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
     1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
      COMMON/QUAL/NCHAN(70,6),LEN(100),NJUNC(100,2),JGW(20)
      COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,      NHCYC,NT,ICYC,NCYC,W,
     1NEXIT,JSW(20),         A0(3,20,10)
C
C     ************** JUNCTION INFORMATION                      *************
C
      COMMON/H50/H(70),VOL(70),X(70),Y(70),
     1QIN(70),QOU(70),QINST(20)
C
C     ************** CHANNEL INFORMATION                       *************
C
      COMMON/B72/B(100),R(100),A(100),AK(100),Q(100),V(100),
     1FWIND(100),NTEMP(6),NCLOS(100)
      DIMENSION HYDRAD(100),ITRIB(50,2),TRBDEP(50)
C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
      COMMON /NEW/ IJK,CHK,XM(20),YM(20),HYDEND
C
      REAL LEN
      DIMENSION ARRAY(33),ATEMP(10)
      DIMENSION ALFNM(100),WIDTHM(100),RADM(100),VELM(100),AM(100),
     1HYDRAM(100)
      DIMENSION HEADM(70),SURFM(70),QF1M(70),QF2M(70)
      DIMENSION ATIDE(8)
      DATA ASTERK,BLANK/4H****,4H
C     **************                     END                   *************
C     *********************************************************************
C
C     ************** ZERO ALL THE INPUT DATA VARIABLES         *************
      NTCYC=0
      PERIOD=0
      QINT=0.
      DELT=0.
      WIND=0.
      WDIR=0.
      NQSWRT=0
      NJSW=0
      NJGW=0
      NQCYC=0
```

```
000          NHCYC=0
000          NT=0
000          DELTQ=0.
000          ICYC=0
000          NCYC=0
000          NEXIT=0
000          NJ=0
000          NC=0
000          NTRIB=0
000          DO 100 I=1,50
000          TRBDEP(I)=0.
000          ITRIB(I,1)=0
000     100  ITRIB(I,2)=0
000          DO 120 L=1,IZ12
000          DO 110 II=1,10
000          A0(1,L,II)=0.
000          A0(2,L,II)=0.
000     110  A0(3,L,II)=0.
000          QINST(L)=0.
000     120  JSW(L)=0
000          DO 130 I=1,IZ13
000     130  JGW(I)=0
000          DO 140 I=1,30
000     140  ALPHA(I)=BLANK
000          DO 160 J=1,IZ5
000          H(J)=0.
000          AS(J)=0.
000          VOL(J)=0
000          X(J)=0.
000          Y(J)=0.
000          DEP(J)=0.
000          QIN(J)=0.
000          QOU(J)=0.
000          DO 150 K=1,IZ6
000          NTEMP(K)=0
000          IPOINT(J,K)=0
000     150  NCHAN(J,K)=0
000     160  CONTINUE
000          DO 170 I=1,IZ9
000          LEN(I)=0.
000          NJUNC(I,1)=0
000          NJUNC(I,2)=0
000          B(I)=0.
000          R(I)=0.
000          A(I)=0.
000          AK(I)=0.
000          Q(I)=0.
000          V(I)=0.
000          FWIND(I)=0.
000          NCLOS(I)=0
000     170  CONTINUE
000     C
000     C    **************                 END                    *************
000     C    ***********************************************************************
000     C    ************** START OF THE INPUT PROGRAM             *************
000     C    ***********************************************************************
000     C
```

****** IDH ******

```
000            N7=N20                                                              106
000     180    CONTINUE                                                            107
000     C         READ ALL HYDRAULIC DATA CARDS AND ECHO WRITE THEM
000            READ (N5,740) (ALPHA(I),I=1,20)                                     108
000            WRITE (N6,750) (ALPHA(I),I=1,20)                                    109
000     C         IS THIS THE END OF THE DATA DECK?
000            IF (ALPHA(1).EQ.ASTERK) GO TO 190                                   110
000     C      WRITE DATA TO SCRATCH FILE N24 TO BE USED FOR INPUT TO
000     C                                                             THE CODE
000            WRITE (N24,740) (ALPHA(I),I=1,20)                                   111
000            GO TO 180                                                           112
000     190    CONTINUE                                                            113
000            WRITE (N6,760)                                                      114
000            END FILE N24                                                        115
000     C         REWIND SCRATCH FILE SO THAT THE CODE CAN READ FROM IT
000            REWIND N24                                                          116
000     C         SET UP EQUIVALENCE SO THAT READING IS DONE FROM SCRATCH FILE
000            N5=N24                                                              117
000     C                                                                          11
000     C      ************** READ IN CARD GROUP H0                  *************  11
000     C            TITLE CARD 2
000            READ (N5,770) ALPHA                                                 12
000     C      **************                  END                   *************  12
000     C                                                                          12
000     C      **************  READ IN CARD GROUP H1                 *************  12
000     C            HYDRAULIC CONTROL CARD
000            READ (N5,780) NTCYC,PERIOD,QINT,DELT,EVAP,WIND,WDIR,NQSWRT,N        12
000           1JSW,NJGW,NTRIB                                                      12
000            EVAPM=EVAP
000     C               CONVERT EVAP FROM MM/MONTH TO INCHES/MONTH
000            EVAP=.03937*EVAP
000            WINDM=WIND
000     C               CONVERT WIND FROM METERS/SEC TO MPH
000            WIND=2.236*WIND
000            IF (NTRIB.LE.50) GO TO 200                                          12
000            WRITE (6,650) NTRIB                                                 12
000            STOP                                                                12
000     200    CONTINUE                                                            12
000            IPERID=PERIOD+0.1                                                   13
000            IQINT=QINT*3600.+0.1                                                1
000            IDELT=DELT+0.1                                                      1
000            NQCYC=(IPERID*3600)/IQINT                                           13
000            NHCYC=IQINT/IDELT                                                   1
000            NINT=(IPERID*3600)/IDELT                                            1
000            NPDEL=(NINT+50)/100                                                 1
000            DELTQ=DELT*FLOAT(NHCYC)                                             1
000     C      **************                  END                   *************  1
000     C                                                                          1
000     C      ************** READ IN CARD GROUP H2                  *************  1
000     C            A LIST OF NJSW JUNCTION NUMBERS WHERE TIME-VARYING INFLOWS
000     C                  ARE LOCATED
000            IF (NJSW.LE.0) GO TO 210                                            1
000            READ (N5,790) (JSW(L),L=1,NJSW)                                     1
000     210    CONTINUE                                                            1
000     C      **************                  END                   *************  1
000     C                                                                          1
000     C      ************** READ IN CARD GROUP H3                  *************  1
```

```
000  C         SPECIFY NJGW CONTROLLED NODE TYPES
000            READ (N5,790) (JGW(I),I=1,NJGW)                                        147
000  C         **************              END                    *************   148
000  C                                                                            149
000  C         ************** READ IN CARD GROUP H4               *************   150
000  C         ********* ARE THERE ANY TIDAL FLATS *******************************
000            IF (NTRIB.LE.0) GO TO 230                                              151
000            DO 220 I=1,NTRIB                                                       152
000  C         ***** SPECIFY THE CHANNEL AND JUNCTION NUMBERS FOR THE TIDAL FLATS ***
000            READ (N5,660) ITRIB(I,1),ITRIB(I,2)                                    153
000  220       CONTINUE                                                               154
000  230       CONTINUE                                                               155
000  C         **************                        END          *************   156
000  C                                                                            157
000  C         ************** PRINT OUT PAGE ONE  THE CONTROL DATA  *************   158
000            WRITE (N7,800) ALPHA                                                   159
000            WRITE (N7,810) NTCYC                                                   160
000            WRITE (N7,820) NOCYC                                                   161
000            WRITE (N7,830) NHCYC                                                   162
000            WRITE (N7,840) DELT                                                    163
000            WRITE (N7,710) EVAPM
000  C
000            EVAP=EVAP/(12.*30.*86400.)                                             166
000            WRITE (N7,860) WINDM,WDIR
000            WRITE (N7,870) NOSWRT                                                  168
000            IF (NTRIB.LE.0) GO TO 240                                              169
000            WRITE (N7,670) NTRIB                                                   170
000            WRITE (N7,680) (ITRIB(I,1),ITRIB(I,2),I=1,NTRIB)                       171
000  240       CONTINUE                                                               172
000  C         **************              END                    *************   173
000  C                                                                            174
000  C         ***************************************************************   175
000  C         ************** READ  CARD GROUP H5                  *************   176
000  C         ************** READ IN THE JUNCTION INFORMATION     *************   177
000  C         ***************************************************************   178
000            NJ=0                                                                   179
000            DO 250 I=1,175                                                         180
000            READ(N5,880) J,HEAD,SURF,QF1,QF2,DT
000  C         ************** DID WE READ IN A CARD GROUP H6 CARD  *************   183
000            IF (J.GT.175) GO TO 260                                                184
000            DT=-DT                                                                 182
000            HEADM(J)=HEAD
000  C                 CONVERT HEAD FROM METERS TO FEET
000            HEAD=3.28*HEAD
000            SURFM(J)=SURF
000  C                 CONVERT SURF FROM KM**2 TO MILLIONS OF SQ FEET
000            SURF=10.744*SURF
000            QF1M(J)=QF1
000            QF2M(J)=QF2
000  C                 CONVERT QF1 AND QF2 FROM CUBIC METERS/SEC TO CFS
000            QF1=35.314*QF1
000            QF2=35.314*QF2
000            DTM=DT
000  C                 CONVERT DT FROM METERS TO FEET
000            DT=3.28*DT
000            NJ=NJ+1                                                                185
000            IF (J.NE.NJ) WRITE (N6,720)                                            186
```

```
000        H(J)=HEAD                                                             187
000        AS(J)=SURF                                                            188
000        QIN(J)=QF1                                                            189
000        QOU(J)=QF2                                                            190
000   C       NOTE THAT VARIABLE DEP IS NOT RIVER DEPTH
000        DEP(J)=DT                                                             193
000   250  CONTINUE                                                              194
000   260  CONTINUE                                                              195
000   C       ARE THERE ANY JUNCTIONS WITH TIME-VARYING INFLOWS?
000        IF (NJSW.LE.0) GO TO 280                                              196
000        DO 270 L=1,NJSW                                                       197
000        J=JSW(L)                                                              198
000   270  QINST(L)=QIN(J)                                                       199
000   280  CONTINUE                                                              200
000   C    **************               END                  *************       201
000   C                                                                          202
000   C    ******************************************************************    203
000   C    ************** READ  CARD GROUP H7                    *************    204
000   C    ************** READ IN THE CHANNEL INFORMATION        *************    205
000   C    ******************************************************************    206
000        NC=0                                                                  207
000        DO 360 I=1,I79                                                        208
000        READ (N5,890) N,(NTEMP(K),K=1,2),ALEN,WIDTH,RAD,COEF,VEL              209
000   C    ************** DID WE READ IN A CARD GROUP H8 CARD   *************    211
000        IF (N.GT.I79) GO TO 370                                               212
000        RAD=-RAD                                                              210
000        ALENM(I)=ALEN
000   C       CONVERT ALEN FROM METERS TO FEET
000        ALEN=3.28*ALEN
000        WIDTHM(I)=WIDTH
000   C          CONVERT WIDTH FROM METERS TO FEET
000        WIDTH=3.28*WIDTH
000        RADM(I)=RAD
000   C          CONVERT RAD FROM METERS TO FEET
000        RAD=3.28*RAD
000        VELM(I)=VEL
000   C          CONVERT VEL FROM METERS/SEC TO FPS
000        VEL=3.28*VEL
000        NC=NC+1                                                               213
000        IF (N.NE.NC) WRITE (N6,900)                                           214
000        N=NC                                                                  215
000        LEN(N)=ALEN                                                           216
000        B(N)=WIDTH                                                            217
000        K=MAX0(NTEMP(1),NTEMP(2))                                             218
000   C       CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE RIVER BOTTOM
000   C            ELEVATION (RAD), WHEREAS HEAD (WATER SURFACE ELEVATION)
000   C            AND WATER DEPTH ARE POSITIVE
000   C       RIVER DEPTH IS EQUAL TO HEAD MINUS BOTTOM ELEVATION, BUT BECAUSE
000   C            OF THE SIGN CONVENTION FOR THE LATTER (RAD), THE TWO TERMS
000   C            ARE ADDED
000        HYDRAD(N)=RAD+H(K)                                                    219
000   C       CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000        HYDRAM(N) =HYDRAD(N)/3.28
000        IFLAG=0                                                               220
000        IF (NTRIB.LE.0) GO TO 310                                             221
000        DO 290 II=1,NTRIB                                                     222
000        IF (N.EQ.ITRIB(II,1)) GO TO 300                                       223
```

```
000   290   CONTINUE                                                               224
000         GO TO 310                                                              225
000   300   IFLAG=1                                                                226
000         IJN=ITRIB(IL,2)                                                        227
000         TRBDEP(IL)=RAD
000   C         CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE JUNCTION BOTTOM
000   C              ELEVATION (DT=DEP), WHEREAS HEAD (WATER SURFACE ELEVATION)
000   C              AND WATER DEPTH ARE POSITIVE
000   C         RIVER DEPTH IS EQUAL TO HEAD MINUS BOTTOM ELEVATION, BUT BECAUSE
000   C              OF THE SIGN CONVENTION FOR THE LATTER (DEP), THE TWO TERMS
000   C              ARE ADDED
000         HYDRAD(N)=H(IJN)+DEP(IJN)                                              229
000   C         CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000         HYDRAM(N)= HYDRAD(N)/3.28
000   310   CONTINUE                                                               230
000   C         CROSS-SECTIONAL AREA = DEPTH*WIDTH
000         A(N)=HYDRAD(N)*WIDTH                                                   231
000         AM(N)=A(N)/10.744
000         R(N)=RAD                                                               232
000         AK(N)=COEF                                                             233
000         V(N)=VEL                                                               234
000   C         STORE THE NUMBERS OF THE JUNCTIONS AT EACH END OF CHANNEL N
000   C              IN ARRAY NJUNC(N,I)
000         NJUNC(N,1)=MIN0(NTEMP(1),NTEMP(2))                                     235
000         NJUNC(N,2)=MAX0(NTEMP(1),NTEMP(2))                                     236
000         K=NJUNC(N,1)                                                           237
000         IF (K.EQ.0) GO TO 360                                                  238
000         J=NJUNC(N,2)                                                           239
000         IF (IFLAG.EQ.1) GO TO 320                                              240
000   C         CONVENTION USED ASSIGNS A NEGATIVE VALUE TO THE RIVER BOTTOM
000   C              FLEVATION (RAD), WHEREAS HEAD (WATER SURFACE ELEVATION)
000   C              AND WATER DEPTH ARE POSITIVE
000         HYDRAD(N)=RAD+(H(J)+H(K))/2.0                                          241
000   C         CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000         HYDRAM(N)= HYDRAD(N)/3.28
000   C         CROSS-SECTIONAL AREA = DEPTH*WIDTH
000         A(N)=HYDRAD(N)*WIDTH                                                   242
000         AM(N)=A(N)/10.744
000   320   CONTINUE                                                               243
000         DO 330 J=1,I26                                                         244
000         IF (IPOINT(K,J).EQ.NJUNC(N,2)) GO TO 350                               245
000         IF (IPOINT(K,J).EQ.0) GO TO 340                                        246
000   330   CONTINUE                                                               247
000   340   IPOINT(K,J)=NJUNC(N,2)                                                 248
000         NCHAN(K,J)=NC                                                          249
000         GO TO 360                                                              250
000   C     **************    THERE IS A REDUNDANT CHANNEL      *************     251
000   350   NC=NC-1                                                                252
000         WRITE (N6,730) N,M                                                     253
000         M=NCHAN(K,J)                                                           254
000         LEN(M)=ALEN                                                            255
000         B(M)=B(M)+WIDTH                                                        256
000         R(M)=RAD                                                               257
000   C         CROSS-SECTIONAL AREA = DEPTH*WIDTH
000         A(M)=HYDRAD(N)*B(M)                                                    258
000         AM(M)=A(N)/10.744
000         HYDRAD(M)=HYDRAD(N)                                                    259
```

```
000   C        CONVERT HYDRAD TO METRIC UNITS FOR OUTPUT
000            HYDRAM(N)= HYDRAD(N)/3.28
000            AK(M)=COFF
000            V(M)=VFL
000     360    CONTINUE
000     370    CONTINUE
000   C        **************              END                   *************
000   C
000   C        ************** OUTPUT PAGE TWO THE CHANNEL INFORMATION ***********
000            WRITE (N7,800) ALPHA
000            WRITE (N7,910)
000            DO 460 N=1,NC
000   C           ASSIGN DEFAULT VALUE OF 0.018 TO MANNING'S COEFFICIENT, UNLESS
000   C                IT HAS BEEN PREVIOUSLY SPECIFIED
000            IF (AK(N).LE.0.0) AK(N)=0.018
000   C           DOES THIS CHANNEL HAVE A WIDTH GREATER THAN ZERO?
000            IF (B(N).GT.0.) GO TO 400
000            K=NJUNC(N,1)
000            NJUNC(N,1)=0
000            IDEL=0
000            DO 390 J=1,IZ6
000            IF (IPOINT(K,J).EQ.0) GO TO 390
000            IF (IPOINT(K,J).NE.NJUNC(N,2)) GO TO 380
000            WRITE (N7,920) N,K,NJUNC(N,2)
000            NCHAN(K,J)=0
000            IPOINT(K,J)=0
000            NJUNC(N,2)=0
000            GO TO 460
000     380    CONTINUE
000     390    CONTINUE
000     400    CONTINUE
000            K=NJUNC(N,2)
000            DO 430 J=1,IZ6
000            IF (IPOINT(K,J).EQ.NJUNC(N,1)) GO TO 410
000            GO TO 420
000     410    CONTINUE
000            IF (NJUNC(N,1).NE.0) GO TO 450
000     420    CONTINUE
000            IF (IPOINT(K,J).EQ.0) GO TO 440
000     430    CONTINUE
000     440    CONTINUE
000            IPOINT(K,J)=NJUNC(N,1)
000            NCHAN(K,J)=N
000     450    CONTINUE
000            TF=1000.
000            IF (R(N).GT.-2.) TF=0.75*LEN(N)/SQRT(32.2*(R(N)+2.))
000            XMK=BLANK
000            IF (TF.LT.DELT) XMK=ASTERK
000   C           WRITE CHANNEL DATA
000            WRITE (N7,930) N,ALENM(N),WIDTHM(N),AM(N),AK(N),VELM(N),HYDRAM(N)
000           1,(NJUNC(N,K),K=1,2),TF,XMK
000     460    CONTINUE
000   C        **************              END                   *************
000   C
000   C        ************** OUTPUT PAGE THREE JUNCTION INFORMATION*************
000            WRITE (N7,800) ALPHA
000            WRITE (N7,940)
```

```
000         ATOT=0.                                                                    311
000         DO 470 J=1,NJ                                                              312
000   C         USE ATOT TO SUM SURFACE AREAS
000         ATOT=ATOT+AS(J)                                                            313
000   C         WRITE JUNCTION DATA
000         WRITE (N7,950) J,HEADM(J),SURFM(J),QF1M(J),QF2M(J),(NCHAN(J,K),K=1
000        1,I26)
000   470   CONTINUE                                                                   316
000   C         WRITE TOTAL SURFACE AREA
000         ATOM=ATOT/10.744
000         WRITE(N7,960) ATOM
000   C     **************              END                     *************           318
000   C                                                                                 319
000   C     ************** OUTPUT PAGE FOUR , CONTROL NODE INFORMATION *******           320
000         WRITE (N7,800) ALPHA                                                       321
000   C         THERE ARE NJGW CONTROLLED NODES
000         WRITE (N7,970) NJGW                                                        322
000         DO 580 J=1,NJGW                                                            323
000         DO 480 II=1,10                                                             324
000         A0(2,J,II)=0.                                                              325
000   C         ZERO OUT ARRAY A0
000   480   A0(1,J,II)=0.                                                              326
000         WRITE (N7,980) J                                                           327
000         IJK=JGW(J)                                                                 328
000   C         WHAT TYPE OF CONTROLLED NODE?
000         GO TO (490,500,510,520,540,550), IJK                                       329
000   C                                                                                 330
000   C     **************          WIER TYPE CONTROLLED NODE      *************        331
000   C         READ A TITLE CARD AND A DATA CARD
000   490   READ (N5,990) (ARRAY(I),I=1,20),A0(1,J,1),A0(1,J,2),A0(1,J,3)               332
000         WRITE (N6,1000) (ARRAY(I),I=1,20),A0(1,J,1),A0(1,J,2),A0(1,J,3)            333
000         WRITE (N7,1010) A0(1,J,1),A0(1,J,2),A0(1,J,3)                              334
000         CONTINUE
000         GO TO 580                                                                  335
000   C     **************              END                     *************           336
000   C                                                                                 337
000   C     ************** A TIDALLY CONTROLLED NODE            *************           338
000   C
000   C         CALL TIDE TO READ DATA AND GENERATE REGRESSION COEFFICIENTS TO
000   C              SIMULATE A TIDAL CYCLE
000    500  CALL TIDE(ATEMP)
000   C
000   C         WRITE COEFFICIENTS
000         DO 499 I=1,8
000    499  ATIDE(I)=ATEMP(I)/3.28
000         WRITE(N7,1020) (ATIDE(I),I=1,8)
000         GO TO 560                                                                  341
000   C     **************              END                     *************           342
000   C                                                                                 343
000   C     ************** DAM WHICH IS OPERATED VIA A Q VS H POLICY *********           344
000   C
000   C         CALL REGRES TO READ DATA AND PERFORM REGRESSION
000   510   CALL REGRES (ATEMP)                                                        345
000   C
000   C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000         A1=ATEMP(1)/35.314
000         A2=ATEMP(2)/10.758
```

```
******   IDH   ******

000       A3=ATEMP(3)/3.28
000       A4=ATEMP(4)
000       A5=ATEMP(5)*3.28
000       A6=ATEMP(6)*10.758
000       A8=ATEMP(8)*115.83
000       A7=ATEMP(7)*35.314
000       A9=ATEMP(9)*379.92
000       A10=ATEMP(10)*1246.14
000   C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000       WRITE(N7,1030) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000       GO TO 560                                                           347
000   C   **************              END              *************          348
000   C                                                                       349
000   C   **************  DAM WHERE THE Q VS T AND H VS T CURVES ARE KNOWN**  350
000   C    FIND H VS T FUNCTION
000   C
000   520 CHK=1.
000   C         CALL REGRES TO READ DATA AND PERFORM REGRESSION
000       CALL REGRES (ATEMP)                                                 351
000       CHK=0.
000   C
000   C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000       A1=ATEMP(1)/3.28
000       A2=ATEMP(2)/3.28
000       A3=ATEMP(3)/3.28
000       A4=ATEMP(4)/3.28
000       A5=ATEMP(5)/3.28
000       A6=ATEMP(6)/3.28
000       A7=ATEMP(7)/3.28
000       A8=ATEMP(8)/3.28
000       A9=ATEMP(9)/3.28
000       A10=ATEMP(10)/3.28
000   C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000       WRITE(N7,1040) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000       DO 530 I=1,10                                                       353
000   530 A0(2,J,I)=ATEMP(I)                                                  354
000   C   ************************************************************        355
000   C    FIND Q VS T FUNCTION
000   C
000       CHK=2.
000   C         CALL REGRES TO READ DATA AND PERFORM REGRESSION
000       CALL REGRES (ATEMP)                                                 356
000       CHK=0.
000   C
000   C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000       A1=ATEMP(1)/35.314
000       A2=ATEMP(2)/35.314
000       A3=ATEMP(3)/35.314
000       A4=ATEMP(4)/35.314
000       A5=ATEMP(5)/35.314
000       A6=ATEMP(6)/35.314
000       A7=ATEMP(7)/35.314
000       A8=ATEMP(8)/35.314
000       A9=ATEMP(9)/35.314
000       A10=ATEMP(10)/35.314
000   C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000       WRITE(N7,1050) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
```

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000        GO TO 560                                                                  358
000   C    **************              END                    *************           359
000   C                                                                               360
000   C    ************** DAM WHERE THE H VS T CURVE IS KNOWN     *************       361
000   C
000   C        CALL REGRES TO READ DATA AND PERFORM REGRESSION
000   540  CALL REGRES (ATEMP)                                                        362
000   C
000   C  CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000        A1=ATEMP(1)/3.28
000        A2=ATEMP(2)/3.28
000        A3=ATEMP(3)/3.28
000        A4=ATEMP(4)/3.28
000        A5=ATEMP(5)/3.28
000        A6=ATEMP(6)/3.28
000        A7=ATEMP(7)/3.28
000        A8=ATEMP(8)/3.28
000        A9=ATEMP(9)/3.28
000        A10=ATEMP(10)/3.28
000   C  PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000        WRITE(N7,1060) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000        GO TO 560                                                                  364
000   C    **************              END                    *************           365
000   C                                                                               366
000   C    **************  DAM WHERE THE Q VS T CURVE IS KNOWN    *************       367
000   C
000   C        CALL REGRES TO READ DATA AND PERFORM REGRESSION
000   550  CALL REGRES (ATEMP)                                                        368
000   C
000   C  CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000        A1=ATEMP(1)/35.314
000        A2=ATEMP(2)/35.314
000        A3=ATEMP(3)/35.314
000        A4=ATEMP(4)/35.314
000        A5=ATEMP(5)/35.314
000        A6=ATEMP(6)/35.314
000        A7=ATEMP(7)/35.314
000        A8=ATEMP(8)/35.314
000        A9=ATEMP(9)/35.314
000        A10=ATEMP(10)/35.314
000   C  PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000        WRITE(N7,1070) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000   C    **************              END                    *************           370
000   C                                                                               371
000   560  DO 570 I=1,10                                                              372
000   C        TRANSFER REGRESSION COEFFICIENTS TO ARRAY A0
000   570  A0(1,J,I)=ATEMP(I)                                                         373
000   580  CONTINUE                                                                   374
000   C    ***************************************************************           375
000   C    **************              END                    *************           376
000   C    ***************************************************************           377
000   C                                                                               378
000   C                                                                               379
000   C    ************** OUTPUT PAGE FIVE .HYDROGRAPH NODE INFORMATION *****        380
000   C        ARE THERE TIME-VARYING INPUT NODES?
000        IF (NJSW.LE.0) GO TO 610                                                   381
000        WRITE (N7,600) ALPHA                                                       382
```

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000          WRITE (N7,1080) NJSW                                                                  383
000          DO 600 L=1,NJSW                                                                       384
000          J=JSW(L)                                                                              385
000          WRITE (N7,1090) J                                                                     386
000     C
000          CHK=3.
000     C         CALL REGRES TO READ DATA AND PERFORM REGRESSION
000          CALL REGRES (ATEMP)                                                                   387
000          CHK=0.
000     C
000     C   CONVERT COEFFICIENTS SO THAT THEY CORRESPOND TO METRIC VALUES
000          A1=ATEMP(1)/35.314
000          A2=ATEMP(2)/35.314
000          A3=ATEMP(3)/35.314
000          A4=ATEMP(4)/35.314
000          A5=ATEMP(5)/35.314
000          A6=ATEMP(6)/35.314
000          A7=ATEMP(7)/35.314
000          A8=ATEMP(8)/35.314
000          A9=ATEMP(9)/35.314
000          A10=ATEMP(10)/35.314
000     C   PRINT THE METRIC EQUIVALENTS OF THE REGRESSION COEFFICIENTS
000          WRITE(N7,1100) A1,A2,A3,A4,A5,A6,A7,A8,A9,A10
000          DO 590 I=1,10                                                                         389
000     C         TRANSFER REGRESSION COEFFICIENTS TO ARRAY A0
000     590  A0(3,L,I)=ATEMP(I)                                                                    390
000     600  CONTINUE                                                                              391
000     610  CONTINUE                                                                              392
000     C    **************              END                       *************                  393
000     C                                                                                          394
000     C    **************  PREPARE HYDRODYNAMIC INPUT TAPE       *************                  395
000          WRITE (N7,1110) ASTERK                                                                396
000          WRITE (N7) NTCYC,PERIOD,QINT,DELT,WIND,WDIR,NQSWRT,NJSW,NJGW                          397
000         1,(JSW(L),QINST(L),((A0(I,L,N),I=1,3),N=1,10),L=1,IZ12),(JGW(L),L=1                    398
000         2,IZ13),(ALPHA(I),I=1,30),NQCYC,NHCYC,NT,DELTQ,ICYC,NCYC,NEXIT,NJ,N                    399
000         3C,((NCHAN(I,II),IPOINT(I,II),II=1,IZ6),H(I),H(I),H(I),H(I),H(I),AS                    400
000         4(I),VOL(I),X(I),Y(I),DEP(I),QIN(I),QOU(I),QIN(I),QOU(I),I=1,NJ),((                    401
000         5NJUNC(N,L),L=1,2),LEN(N),B(N),R(N),A(N),A(N),AK(N),Q(N),Q(N),Q(N),                    402
000         6V(N),V(N),V(N),FWIND(N),NCLOS(N),N=1,NC),EVAP,NTRIB,(TRBDEP(I),ITR                    403
000         7IB(I,1),ITRIB(I,2),I=1,50),HYDEND
000     C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          IF (NTRIB .EQ. 0) GO TO 621
000          WRITE(6,690) NTRIB
000          DO 620 I=1,NTRIB                                                                      406
000          TRBDM=TRBDEP(I)/3.28
000          WRITE(6,700) ITRIB(I,1),ITRIB(I,2),TRBDM
000      620 CONTINUE
000      621 CONTINUE
000       .  END FILE N7                                                                           409
000          REWIND N7                                                                             410
000     C    **************              END                       *************                  411
000     C                                                                                          412
000     C                                                                                          413
000     C           PRINT OUT THE HYDRODYNAMIC INPUT DATA
000          READ(N7,1110)ZDUMMY
000     630  READ (N7,1120) ARRAY                                                                  416
000          IF (ARRAY(1).EQ.ASTERK) GO TO 640                                                     417
```

```
000      WRITE (N6,1120) ARRAY                                                    418
000      GO TO 630                                                                419
000  640 WRITE (N6,1130)                                                          420
000      N5=5                                                                     421
000      RETURN
000  C                                                                            425
000  C                                                                            426
000  C   ************** FORMAT STATEMENT 950 MUST BE CHANGED  *************       427
000  C   ************** WHENEVER PARAMETER I76 IS CHANGED     *************       428
000  C                                                                            429
000  C                                                                            430
000  C                                                                            431
000  650 FORMAT (' YOU REQUESTED TOO MANY TIDE FLATS' /,I5,' TO BE EXACT(JO
000     1B ABORTED) '//)                                                          433
000  660 FORMAT (2I5)                                                             434
000  670 FORMAT(' THIS PROBLEM HAS',I5,' TIDE FLAT CHANNEL(S).'/'   THEY(IT
000     1) ARE(IS)'/' CHANNEL NO.    CHARACTERISTIC'/15X,'JUNCTION NUMBER         436
000     2 '//)                                                                    437
000  680 FORMAT (I10,10X,I5)                                                      438
000  690 FORMAT(//,1X,'THERE ARE',I5,' TIDE FLAT CHANNELS',/)
000  700 FORMAT(3X,'CHANNEL',I3,' IS A TIDE FLAT CHANNEL, WITH NODE',I3,' B
000     1EING THE TIDE FLAT.',2X,' BOTTOM ELEVATION OF THE CHANNEL IS '
000     2,1PE12.5  )
000  710 FORMAT (1H0,'THE EVAPORATION RATE IS ',1PE10.3,'    (MM/MONTH)')
000  720 FORMAT (' THE JUNCTION INFORMATION IS OUT OF ORDER')                     442
000  730 FORMAT ('CHANNELS',I5,' AND',I5,' ARE REDUNDANT')                        443
000  740 FORMAT (20A4)                                                            444
000  750 FORMAT (26X,20A4)                                                        445
000  760 FORMAT (1H1)                                                             446
000  770 FORMAT (15A4)                                                            447
000  780 FORMAT (I5,3F5.0,5X,3F5.0,4I5)                                           448
000  790 FORMAT (20I5)                                                            449
000  800 FORMAT (1H1,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH       450
000     1LAND, WASHINGTON,/,80X,20H HYDRODYNAMIC MODEL ,//)                       451
000  810 FORMAT (15H0DAYS SIMULATED,I4)                                           452
000  820 FORMAT (29H0WATER QUALITY CYCLES PER DAY,I4)                             453
000  830 FORMAT (43H0INTEGRATION CYCLES PER WATER QUALITY CYCLE,I4)               454
000  840 FORMAT (30H0LENGTH OF INTEGRATION STEP IS,F6.0,8H SECONDS)               455
000  860 FORMAT (15H0WIND VELOCITY,F5.0,22H M/SEC WIND DIRECTION,F5.0,19H D       457
000     1EGREES FROM NORTH)                                                       458
000  870 FORMAT (26H0WRITE CYCLE STARTS AT THE,I4,11H TIME CYCLE//)               459
000  880 FORMAT (I5,F10.2,-6PF10.2,0P2F10.2,F10.2)
000  890 FORMAT (3I5,10X,5F10.0)                                                  461
000  900 FORMAT (45H CHANNEL INPUT INFORMATION OUT OF ORDER       )               462
000  910 FORMAT (108H CHANNEL   LENGTH   WIDTH    AREA     MANNING  VELOCI        463
000     1TY   HYD RADIUS            JUNCTIONS AT ENDS   MAX INT/67H  NUMBER       464
000     2     (M)        (M)       (M**2)      COFF.       (MPS)         (M)/,31X,'   465
000     3X .001'/)                                                                466
000  920 FORMAT (8H CHANNEL,I4,8H JOINING,I4,4H AND,I4,38H DELETED DUE TO Z       467
000     1ERO OR NEGATIVE WIDTH)                                                   468
000  930 FORMAT (I5,F11.0,F8.0,-3PF10.0,0PF9.3,F10.2,F13.1,I19,I6,F16.0,1X,       469
000     1A4)                                                                      470
000  940 FORMAT (124H JUNCTION   INITIAL HEAD   SURFACE AREA    INPUT    OU       471
000     1TPUT                CHANNELS ENTERING JUNCTION
000     2    /122H  NUMBER           (M)             (SQUARE KM)     (CMS)      (CMS
000     3)                                                                  /
000     4)                                                                        475
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000   950   FORMAT (I7,F13.2,-6PF15.2,0P2F10.0,I10,5I6)
000   960   FORMAT (E20.6)                                                         477
000   970   FORMAT (//,18H THIS PROBLEM HAS ,I5,20H CONTROLLED NODES   ,/)         478
000   980   FORMAT (16H0JUNCTION NUMBER,I5)                                        479
000   990   FORMAT (20A4,/3F10.0)                                                  480
000  1000   FORMAT (1H1,20A4/30H THE INPUT WEIR CONSTANTS ARE /5H A1= ,E10.4,2     481
000         1X,5H A2= ,E10.4,2X,5H A3= ,E10.4//)                                   482
000  1010   FORMAT (1H+,22X,10H IS A WEIR/34H THE CONTROLLING WEIR FORMULA IS      483
000         1 ,' DELH=DELT/AREA*(INFLOW-A1*(HEAD-A2+DELH/2)**A3)',/,1X,'WHERE A
000         21 = ',E12.5,' ,A2 = ',E12.5,' ,A3 = ',E12.5,/,1X,'AND THE CONSTANT
000         3S CORRESPOND TO METRIC DATA')
000  1020   FORMAT (1H+,22X,30H IS A TIDALLY INFLUENCED NODE /50H THE PERIODIC     486
000         1 STAGE-TIME HISTORY IS GIVEN BY      /' H(T)=0.5*A1 + A2*COS(T) +
000         2A3*COS(2*T) + A4*COS(3*T) + A5*SIN(T) + A6*SIN(2*T) + A7*SIN(3*T)
000         3+ A8*SIN(4*T) ',/,' WHERE A1=',F10.4,',  A2=',E10.4,',  A3=',E10.4
000         4,',  A4=',E10.4,',  A5=',E10.4,',  A6=',E10.4,',  A7=',E10.4,',  A
000         58=',E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO METRIC DATA')
000  1030   FORMAT (1H+,22X,55H IS A DAM WHICH IS OPERATED ACCORDING TO A Q VS     491
000         1 H CURVE/62H THE CONTROLLING Q VS H CURVE IS FIT BY THE FOLLOWING     492
000         2FUNCTION/76H Q=A1+A2*H+A3*H**2+A4*H**3+A5*H**4+A6*H**5+A7*H**6+A8*    493
000         3H**7+A9*H**8+A10*H**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3=    494
000         4 ,E10.4,6H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E1    495
000         50.4,6H, A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CO
000         6NSTANTS CORRESPOND TO METRIC DATA')
000  1040   FORMAT (1H+,22X,60H IS A DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNC     49
000         1TIONS OF TIME,/57H THE HEAD VS TIME CURVE IS FIT BY THE FOLLOWING     49
000         2FUNCTION /76H H=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8    49
000         3*T**7+A9*T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3    50
000         4= ,E10.4,6H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E    50
000         510.4,6H, A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE C
000         6ONSTANTS CORRESPOND TO METRIC DATA')
000  1050   FORMAT (39H THE OUTFLOW VS TIME CURVE IS FIT BY   /76H Q=A1+A2*T+A     50
000         13*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*T**8+A10*T**9 /1    50
000         21H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,6H, A4= ,E10.4,6    50
000         3H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H, A8= ,E10.4,6H, A    50
000         49= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO ME
000         5TRIC DATA')
000  1060   FORMAT (1H+,22X,50H IS A DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIM     50
000         1E  ,/57H THE HEAD VS TIME CURVE IS FIT BY THE FOLLOWING FUNCTION ,    50
000         2/76H H=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*    51
000         3T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,    51
000         46H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H,     51
000         5A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS
000         6CORRESPOND TO METRIC DATA')
000  1070   FORMAT (1H+,22X,50H IS A DAM WHOSE FLOW IS A KNOWN FUNCTION OF TIM     51
000         1E  ,/57H THE FLOW VS TIME CURVE IS FIT BY THE FOLLOWING FUNCTION ,    51
000         2/76H Q=A1+A2*T+A3*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*    51
000         3T**8+A10*T**9 /11H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,    51
000         46H, A4= ,E10.4,6H, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H,     51
000         5A8= ,E10.4,6H, A9= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS
000         6CORRESPOND TO METRIC DATA')
000  1080   FORMAT (//,18H THIS PROBLEM HAS ,I5,21H HYDROGRAPH INPUTS   ,/)        52
000  1090   FORMAT (16H0JUNCTION NUMBER,I5)                                        52
000  1100   FORMAT (1H+,22X,30H IS A HYDROGRAPH INPUT NODE   /62H THE HYDROGRA     52
000         1PH INPUT CURVE IS FIT BY THE FOLLOWING FUNCTION  /76H Q=A1+A2*T+A3    52
000         2*T**2+A4*T**3+A5*T**4+A6*T**5+A7*T**6+A8*T**7+A9*T**8+A10*T**9 /11    52
000         3H WHERE A1= ,E10.4,6H, A2= ,E10.4,6H, A3= ,E10.4,6H, A4= ,E10.4,6H    52
```

```
000        4, A5= ,E10.4,/7X,4HA6= ,E10.4,6H, A7= ,E10.4,6H, A8= ,E10.4,6H, A9     526
000        5= ,E10.4,7H, A10= ,E10.4,/,1X,'AND THE CONSTANTS CORRESPOND TO MET
000        6RIC DATA')
000   1110  FORMAT (A4)                                                              528
000   1120  FORMAT (33A4)                                                            529
000   1130  FORMAT (35HIEND OF HYDRODYNAMIC INPUT PROGRAM )                          530
000         END
```

END ELT.

@HDG,P ****** MAIN ******

****** MAIN ******

@ELT,L IMAINT.MAIN

```
000  C       ************** MAIN PROGRAM FOR EXPLORE-1 INPUT       *************
000  C       ************** BATTELLE NORTHWEST 11/9/71             *************
000  C       ***************************************************************
000  C        THIS PROGRAM CALLS INH
000  C
000  C           THIS EXECUTIVE PROGRAM MAKES I/O ASSIGNMENTS AND CALLS
000  C                THE MAIN INPUT SUBROUTINE INH
000  C
000  C
000  C       ************** ASSIGN THE COMMON  DATA                *************
000          COMMON /TAPES/N5,N6,N20,N22,N24
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000  C
000  C       ************** CONTROL AND TITLE INFORMATION           *************
000          COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
000         1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
000          COMMON/QUAL/NCHAN(70,6),LEN(100),NJUNC(100,2),JGW(20)
000  C
000          REAL LEN
000  C
000  C       *************  ASSIGN THE UNIT NUMBERS AND REWIND      *************
000  C
000          IZ5=70
000          IZ6=6
000          IZ9=100
000          IZ12=20
000          IZ13=20
000  C
000          N5=5
000          N6=6
000          N20=2
000  C       THE UNIVAC 1100 DOES NOT ALLOW THE USE OF LOGICAL UNIT 1 SINCE IT IS
000  C       THE SYSTEM PUNCH FILE.
000          N24 = 4
000  C
000          REWIND N20
000          REWIND N24
000  C       *************                 END                      *************
000  C
000  C       *************      HYDRAULIC INPUT                     *************
000  C
000          CALL INH
000  C
000          REWIND N24
000          REWIND N20
000  C       *************                 END                      *************
000          STOP
000          END
```

END ELT.

@HDG,P ****** PICTUR ******

****** PICTUR ******

@ELT,L IMAINT.PICTUR

```
000       SUBROUTINE PICTUR (N,M,MCOL,XX,YY,ARK,ISYM,CARD1)
000  C     THIS ROUTINE IS CALLED BY REGRES AND CALLS SORT AND SORDER
000  C    PROGRAMMED BY JE SCHLOSSER  1965  MODIFIED BY CA OSTER  1966              2
000  C    PRESENTS A PICTURE OF DATA ON PRINTED OUTPUT, TWO OPTIONS BEING           3
000  C    AVAILABLE                                                                 4
000  C       1   MCOL POSITIVE                                                      5
000  C       2   MCOL NEGATIVE, IN WHICH CASE XINCREMENTS ARE TAKEN AS EQUAL        6
000  C           TO Y INCREMENTS AS DETERMINED BY M                                 7
000  C                                                                              8
000  C    DICTIONARY                                                                9
000  C                                                                             10
000  C       VARIABLE    DEFINITION                                                11
000  C          N        NUMBER OF POINTS TO PLOT      (MAXIMUM OF 500)            12
000  C          M        MAXIMUM NUMBER OF LINES                                   13
000  C          MCOL     MAXIMUM NUMBER OF COLUMNS                                 14
000  C                                                                             15
000  C        XX(I)      X COORDINATE FOR ITH POINT                                16
000  C        YY(I)      Y COORDINATE FOR ITH POINT                                17
000  C        ARK(I)     MARKER FOR ITH POINT                                      18
000  C        ISYM(I)    PRIORITY DESIGNATOR FOR MARKER USED ON I-TH POINT         19
000  C                        (LOWER SUBSCRIPT INDICATES HIGHER PRIORITY)          20
000  C                                                                             21
000  C                                                                             22
000       DIMENSION XX(2),YY(2),XYM(3,500),PX(6),ALF(107),ARK(2),                  23
000      1ILF(107),ISYM(5),IXYM(3,500)                                             24
000       DIMENSION CARD1(20)
000       EQUIVALENCE (ILF,ALF),(BLANK,LANKBA),(IXYM,XYM)                          26
000  C                                                                             27
000       EXTERNAL SORDER                                                          30
000       DATA BLANK/1H  /                                                         28
000  C                                                                             29
000       N=MAX0(MIN0(500,N),2)                                                    31
000       XYM(1,2)=1.01                                                            32
000       XYM(2,2)=1.01                                                            33
000       XYM(3,2)=BLANK                                                           34
000       XMIN=1.0E37                                                              35
000       XMAX=-1.0E37                                                             36
000       DO 100 I=1,N                                                             37
000       XYM(1,I)=XX(I)                                                           38
000       XYM(2,I)=YY(I)                                                           39
000       XYM(3,I)=ARK(I)                                                          40
000       XMIN=AMIN1(XMIN,XYM(1,I))                                                41
000       XMAX=AMAX1(XMAX,XYM(1,I))                                                42
000  100  CONTINUE                                                                 43
000       CALL SORT (XYM,N,3,SORDER)                                               44
000       YMIN=XYM(2,N)                                                            45
000       YMAX=XYM(2,1)                                                            46
000       DYLOG=ALOG10(10./FLOAT(M)*1.0E5)                                         47
000       IF ((YMAX-YMIN).EQ.0.) GO TO 110                                         48
000       DYLOG=ALOG10((YMAX-YMIN)/FLOAT(M)*1.0E5)                                 49
000  110  CONTINUE                                                                 50
000       APPROX=DYLOG-AINT(DYLOG)                                                 51
000       DO 120 J=2,10                                                            52
```

```
000          FI=I
000          IF (APPROX-ALOG10(FI)) 130,130,120
000    120   CONTINUE
000    130   EXACT=FI*10.0**(INT(DYLOG)-5)
000          IF (MCOL) 200,140,140
000    140   DXLOG=ALOG10((XMAX-XMIN)/FLOAT(MCOL/2)*1.0E5)
000          XAPROX=DXLOG-AINT(DXLOG)
000          IF (XAPROX-.3010) 150,150,160
000    150   XEXACT=2.0*10.0**(INT(DXLOG)-5)
000          GO TO 190
000    160   IF (XAPROX-.6990) 170,170,180
000    170   XEXACT=5.0*10.0**(INT(DXLOG)-5)
000          GO TO 190
000    180   XEXACT=10.0**(INT(DXLOG)-4)
000    190   CONTINUE
000          XACT=XEXACT/2.0
000          GO TO 210
000    200   XACT=EXACT/2.0
000    210   TENX=20.0*XACT
000          TENE=10.0*EXACT
000          MAXYI=(YMAX/TENE)+(0.5+SIGN(0.5,YMAX))
000          MAXXI=(XMAX/TENX)+(0.5+SIGN(0.5,XMAX))
000          MINYI=(YMIN/TENE)-(0.5+SIGN(0.5,-YMIN))
000          MINXI=(XMIN/TENX)-(0.5+SIGN(0.5,-XMIN))
000          YFIRST=TENE*FLOAT(MAXYI)
000          XFIRST=TENX*FLOAT(MINXI)
000          LINES=10*(MAXYI-MINYI)+1
000          KOLS=20*(MAXXI-MINXI)
000          IF (KOLS-500) 230,230,220
000    220   WRITE (6,490) KOLS
000          KOLS=500
000    230   IF (LINES-401) 250,250,240
000    240   WRITE (6,500)
000          RETURN
000    250   CONTINUE
000          LEAF=(KOLS+99)/100
000          DO 430 L=1,LEAF
000          DO 260 I=1,6
000          PX(I)=5.*TENX*FLOAT(L-1)+TENX*FLOAT(I-1)+XFIRST
000    260   CONTINUE
000          WRITE (6,440) CARD1
000          WRITE (6,480) PX
000          WRITE (6,470)
000          DEX=XACT/2.0
000          DEL=EXACT/2.0
000          DDD=DEX+2.0*XACT
000          J=1
000          DO 420 I=1,LINES
000          YPLOT=YFIRST-EXACT*FLOAT(I-1)
000          DO 270 JKL=1,107
000    270   ALF(JKL)=BLANK
000    280   IF (J-N) 290,290,380
000    290   IF (XYM(1,J)-PX(1)) 370,300,300
000    300   CONTINUE
000          IF (XYM(2,J)-(YPLOT+DEL)) 310,310,380
000    310   IF (XYM(2,J)-(YPLOT-DEL)) 380,320,320
000    320   CONTINUE
```

****** PICTUR ******

```
000          IF (XYM(1,J)-PX(6)-DDD) 330,330,370
000    330   CONTINUE
000          KOL=INT((XYM(1,J)+DEX-PX(1))/XACT)+4
000          IF ((KOL.GT.107).OR.(KOL.LT.1)) GO TO 370
000          IXYM3J=IXYM(3,J)
000          ILFKOL=ILF(KOL)
000          IF (ILFKOL.EQ.LANKBA) GO TO 360
000          ISYM1=0
000          ISYM2=0
000          DO 340 IIYY=1,5
000          IF (ILFKOL.EQ.ISYM(IIYY)) ISYM1=IIYY
000          IF (IXYM3J.EQ.ISYM(IIYY)) ISYM2=IIYY
000    340   CONTINUE
000          ISYMM=MIN0(ISYM1,ISYM2)
000          IF (ISYMM) 370,370,350
000    350   ILF(KOL)=ISYM(ISYMM)
000          GO TO 370
000    360   ALF(KOL)=XYM(3,J)
000    370   J=J+1
000          GO TO 280
000    380   CONTINUE
000          IF (MOD(I-1,10).NE.0) GO TO 390
000          WRITE (6,450) YPLOT,ALF
000          GO TO 410
000    390   IF (MOD(I-1,5).NE.0) GO TO 400
000          WRITE (6,510) ALF
000          GO TO 410
000    400   WRITE (6,460) ALF
000    410   CONTINUE
000    420   CONTINUE
000          WRITE (6,470)
000          WRITE (6,480) PX
000    430   CONTINUE
000          RETURN
000    C
000    C
000    C
000    440   FORMAT (///////10X,19A4,A2///)
000    450   FORMAT (1X,F9.3,2H *,107A1,1H*)
000    460   FORMAT (11X,1HI,107A1,1HI)
000    470   FORMAT (1H0,14X,1H*,5(20H - - - - + - - - - *),/,1H )
000    480   FORMAT (11X,F7.2,5(13X,F7.2))
000    490   FORMAT (48H0ONLY THE FIRST 500 COLUMNS OF A PLOT REQUIRING I3,25H
000         1COLUMNS WILL BE PRINTED.)
000    500   FORMAT(1X,'THERE IS A LIMIT OF 400 LINES')
000    510   FORMAT (11X,1H+,107A1,1H+)
000          END                                                              -

END ELT.

@HDG,P ****** Q ******
```

```
 ******  Q  ******

@ELT,L IMAINT.Q

        000          FUNCTION Q (B,C)
        000    C      THIS FUNCTION IS CALLED BY SORT
        000          DIMENSION B(5), C(5)                                      2
        000          Q=C(2)-B(2)                                               3
        000          RETURN                                                    4
        000          END                                                       .

END ELT.

@HDG,P  ******  REGR  ******
```

REGR

@ELT,L IMAINT.REGR

```
      FUNCTION REGR(M,X,Y,N,A,B)
C      THIS FUNCTION IS CALLED BY REGRES AND CALLS SIMUL
C        FUNCTION REGR, WHICH CARRIES OUT AN NTH-ORDER POLYNOMIAL
C        REGRESSION ON M DATA POINTS CONTAINED IN THE X AND Y ARRAYS.
C        THE FUNCTION NORMALLY RETURNS THE STANDARD DEVIATION S OF THE
C        POINTS ABOUT THE REGRESSION CURVE.  THE REGRESSION COEFFICIENTS
C        ARE PLACED IN A AND B(1)...B(N).   HOWEVER, IF THE SIMULTANEOUS
C        EQUATION SOLVING ROUTINE SIMUL ENCOUNTERS A NEAR-SINGULAR
C        MATRIX, THE FUNCTION RETURNS THE VALUE 0.0
C
C     C........MATRIX CONTAINING THE COEFFICIENTS
C     CYX......C(I,Y) VECTOR
C     CYY......C(Y,Y) VECTOR
C     DET......DETERMINANT OF THE COEFFICIENT MATRIX C.
C     EPS......TOLERANCE USED BY THE FUNCTION SIMUL
C     SIMUL....FUNCTION FOR SOLVING SIMULTANEOUS EQUATIONS
C     SX,SYX...VECTOR CONTAINING SUMMATIONS X**I AND X**I * Y
C     SY,SYY...VECTOR CONTAINING SUMMATIONS Y AND Y**2
C
      DIMENSION C(51,51),SX(100),SYX(51),CYX(51),X(100),Y(100),B(51)
      DATA EPS/ 1.0E-20/
      DATA MM/100/,NN/51/
C
C     ..... COMPUTE SUMS OF POWERS AND PRODUCTS .....
      NTWO=2*N
      NP1=N+1
      SY=0.0
      SYY=0.0
      DO 100 I=1,N
      NPI=N+I
      SX(I)=0.0
      SX(NPI)=0.0
  100 SYX(I)=0.0
      DO 120 I=1,M
      SY=SY+Y(I)
      SYY=SYY+Y(I)**2
      DUM=1.0
      DO 110 J=1,N
      DUM=DUM*X(I)
      SX(J)=SX(J)+DUM
  110 SYX(J)=SYX(J)+Y(I)*DUM
      DO 120 J=NP1,NTWO
      DUM=DUM*X(I)
  120 SX(J)=SX(J)+DUM
C
C     ..... COMPUTE COEFFICIENTS C(I,J) .....
      FM=FLOAT(M)
      CYY=SYY-SY*SY/FM
      DO 130 I=1,N
      CYX(I)=SYX(I)-SY*SX(I)/FM
      C(I,NP1)=CYX(I)
      DO 130 J=1,N
      IPJ=I+J
```

****** REGR ******

```
000     130   C(I,J)=SX(IPJ)-SX(I)*SX(J)/FM
000     C
000     C     ..... CALL ON SIMUL TO SOLVE SIMULTANEOUS EQUATIONS .....
000           DET=SIMUL(N,C,B,EPS,1,NN)
000           WRITE (6,160) DET
000           IF (DET.NE.0.0) GO TO 140
000           REGR=0.0
000           RETURN
000     C
000     C     ..... COMPUTE INTERCEPT A AND STANDARD DEVIATION S .....
000     140   DUM=SY
000           TEMP=CYY
000           DO 150 I=1,N
000           DUM=DUM-B(I)*SX(I)
000     150   TEMP=TEMP-B(I)*CYX(I)
000           A=DUM/FM
000           DENOM=FLOAT(M)-FLOAT(N)-1.0
000           S=ABS(TEMP/DENOM)
000           S=DSQRT(S)
000           IF (S.EQ.0.) S=EPS
000           REGR=S
000           RETURN
000     C
000     C
000     C
000     160   FORMAT (13H0       DET = ,E14.8)
000           END
```

END ELT.

@HDG,P ****** REGRES ******

****** REGRES ******

@ELT,L IMAINT.REGRES

```
000          SUBROUTINE REGRES (ATEMP)
000    C      THIS ROUTINE IS CALLED BY INH AND CALLS PICTUR AND REGR
000    C        POLYNOMIAL REGRESSION WITH PLOTTING.
000    C
000    C        THIS MAIN PROGRAM READS THE HORIZONTAL AND VERTICAL COORDINATES
000    C        OF M DATA POINTS INTO THE X AND Y ARRAYS.   THE LEAST AND
000    C        GREATEST VALUES OF X SHOULD BE STORED IN X(1) AND X(M) RESPEC-
000    C        TIVELY.   THE FUNCTION REGR IS USED TO PERFORM SUCCESSIVE NTH-
000    C        ORDER REGRESSIONS, FROM N = MIN THROUGH N = MAX.   IN EACH
000    C        CASE, THE REGRESSION CURVE IS PLOTTED AGAINST THE ORIGINAL
000    C        DATA POINTS.
000    C
000    C     A........REGRESSION COEFFICIENT(INTERCEPT)
000    C     B........VECTOR CONTAINING REGRESSION COEFFICIENTS
000    C     DELTAX...X-SPACING FOR 26 POINTS ON THE REGRESSION CURVE
000    C     M........NUMBER OF DATA POINTS
000    C     MAX,MIN..UPPER AND LOWER LIMITS ON ORDER OF REGRESSION
000    C     N........ORDER, N, OF POLYNOMIAL REGRESSION
000    C     REGR.....FUNCTION FOR PERFORMING NTH ORDER REGRESSION
000    C     S........STANDARD DEVIATION OF THE POINTS ABOUT THE REGRESSION
000    C              LINE.  IF SIMUL ENCOUNTERS A NEAR-SINGULAR MATRIX, S IS
000    C              RETURNED ZERO AS A WARNING.
000    C     X,Y......VECTORS CONTAINING THE X AND Y COORDINATES OF THE DATA
000    C              POINTS.
000    C
000          COMMON /TAPES/N5,N6,N7,N18,N20,N22,N24
000    C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          COMMON /NEW/ IJK,CHK,XM(20),YM(20),HYDEND
000          DIMENSION ARRAY(50)
000          DIMENSION X(100),Y(100),B(55),ARK(100),ISYM(5),CARD4(20)
000          DIMENSION ATEMP(10)
000    C   *** HYDEND IS A SPECIAL CASE FOR THE EPA PESTICIDE STUDY ***
000          NAMELIST /CARD1/ M,MIN,MAX,X,Y,HYDEND
000          DATA  STAR/1H*/
000          DATA ASTER/4H****/
000          DATA CONST/4H CON/
000          DATA ARRAY/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,2H10,2H11,2H12,2H13
000         1,2H14,2H15,2H16,2H17,2H18,2H19,2H20,2H21,2H22,2H23,2H24,2H25,2H26,
000         22H27,2H28,2H29,2H30,2H31,2H32,2H33,2H34,2H35,2H36,2H37,2H38,2H39,2
000         3H40,2H41,2H42,2H43,2H44,2H45,2H46,2H47,2H48,2H49,2H50/
000          DATA MMM/100/,NN/55/,III/25/,JJJ/100/
000    C
000    C      CARD1 IS TITLE CARD FOR PLOTTING
000    C      READ AND CHECK COORDINATES X(1)...X(M), Y(1)...Y(M),
000    C      AND LOWEST AND HIGHEST ORDERS MIN AND MAX
000    C
000    C      CHK IS A DUMMY VARIABLE
000    C      CHK = 1 REGRES WAS CALLED TO FIND H FOR Q VS T AND H VS T DAM
000    C      CHK = 2 REGRES WAS CALLED TO FIND Q FOR Q VS T AND H VS T DAM
000    C      CHK = 3 REGRES WAS CALLED TO EVALUATE HYDROGRAPH NODES
000          A=0.0
000          DO 100 I=1,NN
000    100   B(I)=0.0
```

```
000          READ (N5,310) CARD4                                                   46
000          WRITE (6,310) CARD4                                                   47
000          IF(CARD4(1).NE.CONST) GO TO 110
000          DECODE (18,220,CARD4(1)) A
001          IF(CHK.EQ.3.)  GO TO 105
001          GO TO (200,200,101,102,103,104),IJK
001    C
001    C     Q IS CONSTANT (Q VS H)
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000      101 AM=A
000          A=35.314*A
000          GO TO 200
000    C
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000      102 AM=A
000          IF (CHK .EQ. 2.) GO TO 202
000    C      H IS CONSTANT (Q VS T AND H VS T)
000          A=3.28*A
000          GO TO 200
000    C
000    C      Q IS CONSTANT (Q VS T AND H VS T)
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000     202  A=35.314*A
000          GO TO 200
000    C
000    C      H IS CONSTANT (H VS T)
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000      103 AM=A
000          A=3.28*A
000          GO TO 200
000    C
000    C      Q IS CONSTANT (Q VS T)
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000      104 AM=A
000          A=35.314*A
000          GO TO 200
000    C
000    C      HYDROGRAPH INPUT IS CONSTANT
000    C      STORE METRIC VALUE IN AM, CONVERT A TO ENGLISH UNITS
000      105 AM=A
000          A=35.314*A
000          GO TO 200                                                             50
000    C*****THE FOLLOWING ELEMENT MUST BE REMADE IN THE PROGRAM,SEE APPENDIX
000    C*****G.7 IN FORTRAN(ASCII) MANUAL, TO ALLOW A NAMELIST READ FROM A
000    C*****LOGICAL UNIT OTHER THAN 5 ON THE UNIVAC 1100.
000    C*****  @ASM,SI IMAINT.F2SCT
000    C*****          F*SCT   33,111,0
000    C*****          END
000    110   READ (N5,CARD1,ERR=211,END=212)                                       51
000          IF (MAX.LT.MIN) MAX=MIN                                               52
000          IF (MIN.GE.(M-1)) GO TO 120                                           53
000          IF (MAX.GE.(M-1)) MAX=M-1                                             54
000          GO TO 1201
000    120   MAX=M-1                                                               56
000          MIN=MAX                                                               57
000    1201  IF (CHK .EQ. 3.) GO TO 125
000    C      CHECK THE TYPE OF CONTROLLED NODE
```

```
000         GO TO (130,130,121,122,123,124), IJK
000     121 CONTINUE
000   C      Q VS H
000         DO 221 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000         X(I)=3.28*X(I)
000     221 Y(I)=35.314*Y(I)
000         GO TO 130
000     122 CONTINUE
000   C      H VS T AND Q VS T
000         IF(CHK .GT. 1.) GO TO 322
000   C       CONVERT H FROM METERS TO FEET
000         DO 222 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000     222 X(I)=3.28*X(I)
000         GO TO 130
000     322 CONTINUE
000         IF (CHK .GT. 2.) GO TO 125
000   C       CONVERT Q FROM CMS TO CFS
000         DO 422 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000     422 X(I)=35.314*X(I)
000         GO TO 130
000     123 CONTINUE
000   C      H VS T
000   C       CONVERT H FROM METERS TO FEET
000         DO 223 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000     223 X(I)=3.28*X(I)
000         GO TO 130
000     124 CONTINUE
000   C      Q VS T
000   C       CONVERT Q FROM CMS TO CFS
000         DO 224 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000     224 X(I)=35.314*X(I)
000         GO TO 130
000     125  CONTINUE
000   C      HYDROGRAPH NODE INFORMATION
000   C       CONVERT FLOWS FROM CMS TO CFS
000         DO 225 I=1,M
000         XM(I)=X(I)
000         YM(I)=Y(I)
000   225   Y(I)=35.314*Y(I)
000   130   CONTINUE                                                  58
000         IF (MIN.LE.0) MIN=1                                       59
000         IF (MAX.LE.0) MAX=1                                       60
000         IF(CARD4(19).EQ.ASTER) GO TO 140
000   C                                                               62
000         WRITE(6,260) M,(XM(I),YM(I),I=1,M)
000         WRITE (6,270) MIN,MAX
000   140   CONTINUE                                                  65
```

```
000          DO 150 I=1,M
000     150  ARK(I)=STAR
000          ISYM(1)=STAR
000          DO 190 N=MIN,MAX
000          IF(CARD4(19).EQ.ASTER) GO TO 160
000          WRITE (6,250) CARD4
000          WRITE (6,280) N
000     160  CONTINUE
000     C
000     C     USE FUNCTION REGR TO PERFORM NTH-ORDER REGRESSION
000     C
000          S=REGR(M,X,Y,N,A,B)
000          IF (S.NE.0.0) GO TO 170
000          WRITE (6,290) CARD4
000          GO TO 190
000     170  CONTINUE
000          IF(CARD4(19).EQ.ASTER) GO TO 190
000          WRITE(6,300) S,AM,(I,B(I),I=1,N)
000     C
000     C     COMPUTE 26 POINTS LYING ON REGRESSION CURVE
000     C
000          DELTAX=(X(M)-X(1))/25.0
000          MP1=M+1
000          MP26=M+26
000          DO 180 I=MP1,MP26
000          STEPS=FLOAT(I)-FLOAT(M)-1.0
000          X(I)=X(1)+STEPS*DELTAX
000          Y(I)=A
000          ARK(I)=ARRAY(N)
000          DO 180 J=1,N
000     180  Y(I)=Y(I)+B(J)*X(I)**J
000          ISYM(2)=ARRAY(N)
000     C
000     C     PLOT REGRESSION CURVE AGAINST ORIGINAL POINTS
000     C
000          CALL PICTUR (M+26,III,JJJ,X,Y,ARK,ISYM,CARD4)
000     190  CONTINUE
000     200  CONTINUE
000          ATEMP(1)=A
000          DO 210 I=2,10
000     210  ATEMP(I)=B(I-1)
000          RETURN
000     211  WRITE (6,230) CARD4
000          STOP
000     212  WRITE (6,240) CARD4
000          STOP
000     C
000     C     FORMATS FOR INPUT AND OUTPUT STATEMENTS
000     C
000     C
000     C
000     220  FORMAT (6X,F12.1)
000     230  FORMAT (' ERROR IN NAMELIST INPUT TO REGRES '/,20A4)
000     240  FORMAT (' END OF FILE ENCOUNTERED IN REGRES '/,20A4)
000     250  FORMAT (1H ,20A4)
000     260  FORMAT (34H  POLYNOMIAL REGRESSION, WITH M = ,I2,12H DATA POINTS//
000         18X,5H X(I),8X,5H Y(I)//(2F13.2))
```

```
 ******  REGRES  ******

     000   270   FORMAT (58H0 THE LOWEST AND HIGHEST ORDER POLYNOMIALS TO BE TRIED      123
     000        1ARE//6X,7H MIN = ,I3,5X,7H MAX = ,I3)                                 124
     000   280   FORMAT (32H  POLYNOMIAL REGRESSION OF ORDER/1H0,5X,7H N    = ,I3)     125
     000   290   FORMAT (69H0 MATRIX C IS NEAR-SINGULAR.   REGRESSION COEFFICIENTS     126
     000        1NOT DETERMINED/1H 20A4)
     000   300   FORMAT (1H0,5X,5H S = ,F10.6/6X,5H A = ,F10.6//(6X,3H B(,I2,4H) =    128
     000        1,F11.6))                                                              129
     000   310   FORMAT (20A4)
     000         END

END ELT.

@HDG,P  ******  SIMUL  ******
```

****** SIMUL ******

@ELT,L IMAINT.SIMUL

```
000          FUNCTION SIMUL (N,A,X,EPS,INDIC,NRC)
000     C     THIS FUNCTION IS CALLED BY REGR
000     C
000     C       WHEN INDIC IS NEGATIVE, SIMUL COMPUTES THE INVERSE OF THE N BY
000     C       N MATRIX A IN PLACE.  WHEN INDIC IS ZERO, SIMUL COMPUTES THE
000     C       N SOLUTIONS X(1)...X(N) CORRESPONDING TO THE SET OF LINEAR
000     C       EQUATIONS WITH AUGMENTED MATRIX OF COEFFICIENTS IN THE N BY
000     C       N+1 ARRAY A AND IN ADDITION COMPUTES THE INVERSE OF THE
000     C       COEFFICIENT MATRIX IN PLACE AS ABOVE.  IF INDIC IS POSITIVE,
000     C       THE SET OF LINEAR EQUATIONS IS SOLVED BUT THE INVERSE IS NOT
000     C       COMPUTED IN PLACE. THE GAUSS-JORDAN COMPLETE ELIMINATION METHOD
000     C       IS EMPLOYED WITH THE MAXIMUM PIVOT STRATEGY.  ROW AND COLUMN
000     C       SUBSCRIPTS OF SUCCESSIVE PIVOT ELEMENTS ARE SAVED IN ORDER IN
000     C       THE IROW AND JCOL ARRAYS RESPECTIVELY.  K IS THE PIVOT COUNTER,
000     C       PIVOT THE ALGEBRAIC VALUE OF THE PIVOT ELEMENT, MAX
000     C       THE NUMBER OF COLUMNS IN A AND DETER THE DETERMINANT OF THE
000     C       COEFFICIENT MATRIX.  THE SOLUTIONS ARE COMPUTED IN THE (N+1)TH
000     C       COLUMN OF A AND THEN UNSCRAMBLED AND PUT IN PROPER ORDER IN
000     C       X(1)...X(N) USING THE PIVOT SUBSCRIPT INFORMATION AVAILABLE
000     C       IN THE IROW AND JCOL ARRAYS.  THE SIGN OF THE DETERMINANT IS
000     C       ADJUSTED, IF NECESSARY, BY DETERMINING IF AN ODD OR EVEN NUMBER
000     C       OF PAIRWISE INTERCHANGES IS REQUIRED TO PUT THE ELEMENTS OF THE
000     C       JORD ARRAY IN ASCENDING SEQUENCE WHERE JORD(IROW(I)) = JCOL(I).
000     C       IF THE INVERSE IS REQUIRED, IT IS UNSCRAMBLED IN PLACE USING
000     C       Y(1)...Y(N) AS TEMPORARY STORAGE.  THE VALUE OF THE DETERMINANT
000     C       IS RETURNED AS THE VALUE OF THE FUNCTION.  SHOULD THE POTENTIAL
000     C       PIVOT OF LARGEST MAGNITUDE BE SMALLER IN MAGNITUDE THAN EPS,
000     C       THE MATRIX IS CONSIDERED TO BE SINGULAR AND A TRUE ZERO IS
000     C       RETURNED AS THE VALUE OF THE FUNCTION.
000     C
000     C    A........AUGMENTED MATRIX OF COEFFICIENTS, A=(AIJ)
000     C    DETER....DETERMINANT OF THE ORIGINAL COEFFICIENT MATRIX
000     C    EPS......MINIMUM ALLOWABLE MAGNITUDE FOR A PIVOT ELEMENT
000     C    I,J......ROW AND COLUMN SUBSCRIPTS,RESP.
000     C    INDIC....COMPUTATIONAL SWITCH
000     C    MAX......NUMBER OF COLUMNS IN A,EITHER N OR N+1
000     C    N........NUMBER OF ROWS IN A
000     C    X........VECTOR OF SOLUTIONS
000     C
000     C    AIJCK....AIC(K)
000     C    INTCH....NUMD
000     C    INTCH....NUMBER OF PAIRWISE INTERCHANGES REQ'D TO ORDER J-VECTOR
000     C    IP1,KM1,NM1...I+1, K-1, AND N-1, RESP.
000     C    IROW.....VECTOR OF PIVOT ELEMENT ROW SUBSCRIPTS, R(K)
000     C    ICOL.....VECTOR OF PIVOT ELEMENT COLUMN SUBSCRIPTS, C(K)
000     C    IROWI,IROWJ,IROWK
000     C    JCOLI,JCOLJ,JCOLK...R(I),R(J),R(K),C(I),C(J),C(K), RESP.
000     C    ISCAN,JSCAN...INDICES USED IN PIVOT SEARCH OF VECTORS C AND R
000     C    JORD.....THE J VECTOR
000     C    JTEMP....TEMPORARY VARIABLE USED IN ORDERING THE J VECTOR
000     C    K........CYCLE COUNTER AND PIVOT ELEMENT SUBSCRIPT
000     C    NRC......ROW AND COLUMN DIMENSIONS OF STORAGE FOR THE A-MATRIX
000     C    PIVOT....PIVOT ELEMENT
```

```
000   C      Y........VECTOR USED IN UNSCRAMBLING THE INVERSE MATRIX
000   C
000          DIMENSION IROW(50),JCOL(50),JORD(50),Y(50),A(NRC,NRC),X(50)
000   C
000          MAX=N
000          IF (INDIC.GE.0) MAX=N+1
000   C
000   C      .....IS N LARGER THAN 50 .....
000          IF (N.LE.50) GO TO 100
000          WRITE (6,250)
000          SIMUL=0.
000          RETURN
000   C
000   C      ..... BEGIN ELIMINATION PROCEDURE .....
000   100    DETER=1.
000          DO 170 K=1,N
000          KM1=K-1
000   C
000   C      ..... SEARCH FOR THE PIVOT ELEMENT .....
000          PIVOT=0.
000          DO 130 I=1,N
000          DO 130 J=1,N
000   C      ..... SCAN IROW AND JCOL ARRAYS FOR INVALID PIVOT SUBSCRIPTS .....
000          IF (K.EQ.1) GO TO 120
000          DO 110 ISCAN=1,KM1
000          DO 110 JSCAN=1,KM1
000          IF (I.EQ.IROW(ISCAN)) GO TO 130
000   110    IF (J.EQ.JCOL(JSCAN)) GO TO 130
000   120    IF (DABS(A(I,J)).LE.DABS(PIVOT)) GO TO 130
000          PIVOT=A(I,J)
000          IROW(K)=I
000          JCOL(K)=J
000   130    CONTINUE
000   C
000   C      ..... INSURE THAT SELECTED PIVOT IS LARGER THAN EPS .....
000          IF (DABS(PIVOT).GT.EPS) GO TO 140
000          SIMUL=0.
000          RETURN
000   C
000   C      ..... UPDATE THE DETERMINANT VALUE .....
000   140    IROWK=IROW(K)
000          JCOLK=JCOL(K)
000          DETER=DETER*PIVOT
000   C
000   C      ..... NORMALIZE PIVOT ROW ELEMENTS .....
000          DO 150 J=1,MAX
000   150    A(IROWK,J)=A(IROWK,J)/PIVOT
000   C
000   C      ..... CARRY OUT ELIMINATION AND DEVELOP INVERSE .....
000          A(IROWK,JCOLK)=1./PIVOT
000          DO 170 I=1,N
000          AIJCK=A(I,JCOLK)
000          IF (I.EQ.IROWK) GO TO 170
000          A(I,JCOLK)=-AIJCK/PIVOT
000          DO 160 J=1,MAX
000   160    IF (J.NE.JCOLK) A(I,J)=A(I,J)-AIJCK*A(IROWK,J)
000   170    CONTINUE
```

```
000   C
000   C        ..... ORDER SOLUTION VALUES (IF ANY) AND CREATE JORD ARRAY .....
000            DO 180 I=1,N
000            IROWI=IROW(I)
000            JCOLI=JCOL(I)
000            JORD(IROWI)=JCOLI
000   180      IF (INDIC.GE.0) X(JCOLI)=A(IROWI,MAX)
000   C
000   C        ..... ADJUST SIGN OF DETERMINANT .....
000            INTCH=0
000            NM1=N-1
000            DO 190 I=1,NM1
000            IP1=I+1
000            DO 190 J=IP1,N
000            IF (JORD(J).GE.JORD(I)) GO TO 190
000            JTEMP=JORD(J)
000            JORD(J)=JORD(I)
000            JORD(I)=JTEMP
000            INTCH=INTCH+1
000   190      CONTINUE
000            IF (INTCH/2*2.NE.INTCH) DETER=-DETER
000   C
000   C        ..... IF INDIC IS POSITIVE RETURN WITH RESULTS .....
000            IF (INDIC.LE.0) GO TO 200
000            SIMUL=DETER
000            RETURN
000   C
000   C        ..... IF INDIC IS NEGATIVE OR ZERO, UNSCRAMBLE THE INVERSE
000   C              FIRST BY ROWS .....
000   200      DO 220 J=1,N
000            DO 210 I=1,N
000            IROWI=IROW(I)
000            JCOLI=JCOL(I)
000   210      Y(JCOLI)=A(IROWI,J)
000            DO 220 I=1,N
000   220      A(I,J)=Y(I)
000   C        ..... THEN BY COLUMNS .....
000            DO 240 I=1,N
000            DO 230 J=1,N
000            IROWJ=IROW(J)
000            JCOLJ=JCOL(J)
000   230      Y(IROWJ)=A(I,JCOLJ)
000            DO 240 J=1,N
000   240      A(I,J)=Y(J)
000   C
000   C        ..... RETURN FOR INDIC NEGATIVE OR ZERO .....
000            SIMUL=DETER
000            RETURN
000   C
000   C        ..... FORMAT FOR OUTPUT STATEMENT .....
000   C
000   C
000   C
000   250      FORMAT (10H0N TOO BIG)
000            END
```

END ELT.

```
****** SORDER ******

@ELT,L IMAINT.SORDER


000          FUNCTION SORDER (FIRST,SECOND)
000    C      THIS FUNCTION IS CALLED BY SORT
000          DIMENSION FIRST(3),SECOND(3)                2
000          SORDER=FIRST(2)-SECOND(2)                   3
000          RETURN                                      4
000          END                                         -

END ELT.


@HDG,P  ******  SORT  ******
```

****** SORT ******

@ELT,L IMAINT.SORT

```
000         SUBROUTINE SORT (M,N,ITEM,Q)
000   C      THIS ROUTINE IS CALLED BY PICTUR AND CALLS Q AND SORDER
000   C
000   C     ALGORITHM 245 -  TREESORT 3   FROM ACM, DEC. 1964
000   C                                          VOL 7   NUMBER 12, PAGE 701
000   C
000   C     PROGRAMMED BY JE SCHLOSSER
000   C
000   C
000   C     GENERAL PURPOSE INTERNAL SORT SUBROUTINE
000   C
000   C     EXAMPLE OF USE - - -   ASSUME -   N ITEMS OF 5 WORDS EACH
000   C                                       TO BE SORTED IN ASCENDING
000   C                                       ORDER ON THE SECOND WORD.
000   C     MAIN PROGRAM
000   C     DIMENSION A(5,1000)     N IS LESS THAN OR EQUAL TO 1000
000   C                             A CONTAINS THE ITEMS TO BE SORTED
000   C
000   C     EXTERNAL Q          Q IS A FUNCTION SUBROUTINE WHICH WILL RETURN
000   C      .                  A POSITIVE NUMBER IF THE FIRST ITEM (FIRST
000   C      .                  ARGUMENT) IS TO SORT AHEAD OF THE  SECOND
000   C      .                  ITEM (SECOND ARGUMENT).   SEE EXAMPLE BELOW.
000   C
000   C     CALL SORT (A,N,5,Q)    ARGUMENT    MEANING
000   C      .                      FIRST      ARRAY CONTAINING ITEMS
000   C      .                      SECOND     NUMBER OF ITEMS
000   C      .                      THIRD      NUMBER OF WORDS PER ITEM
000   C      .                      FOURTH     FUNCTION SUBROUTINE TO
000   C      .                                       DEFINE SORT ORDER
000   C
000   C     FUNCTION Q(B,C)          WRITE A FUNCTION SUBROUTINE SUCH AS THIS.
000   C     DIMENSION B(5),C(5)      IT SHOULD RETURN A POSITIVE RESULT IF
000   C     Q=C(2)-B(2)              THE FIRST ARGUMENT SHOULD SORT AHEAD
000   C     RETURN                   OF THE SECOND ARGUMENT.  THIS ROUTINE
000   C     END                      PRODUCES AN ASCENDING SORT ON THE SECOND
000   C                              WORD  OF THE ITEMS.
000   C
000   C     NOTE - -  THE MAXIMUM NUMBER OF WORDS PER ITEM IS LIMITED
000   C     BY THE DIMENSION OF KOPY.     THIS LIMIT IS PRESENTLY 100.
000   C
000   C     APPROXIMATE SPEED IS 250 ITEMS PER SECOND.
000         INTEGER Q
000         DIMENSION KOPY (100)
000         DIMENSION M(ITEM,N)
000         IF (N-1) 320,320,100
000   100   K=N/2+1
000         L=N/2-1
000         IF (L) 210,210,110
000   110   CONTINUE
000         DO 200 II=1,L
000         I=K-II
000         IS=I
000         US=0
```

****** SORT ******

```
000          DO 120 IQ=1,ITEM
000    120   KOPY(IQ)=M(IQ,IS)
000    130   J=2*IS
000          IF (J.GT.NS) GO TO 180
000          IF (J.GE.NS) GO TO 150
000          IF (Q(M(1,J+1),M(1,J))) 140,150,150
000    140   J=J+1
000    150   IF (Q(M(1,J),KOPY)) 160,180,180
000    160   DO 170 IQ=1,ITEM
000    170   M(IQ,IS)=M(IQ,J)
000          IS=J
000          GO TO 130
000    180   DO 190 IQ=1,ITEM
000    190   M(IQ,IS)=KOPY(IQ)
000    200   CONTINUE
000    210   NPLUS=N+2
000          DO 310 II=2,N
000          I=NPLUS-II
000          IS=1
000          NS=I
000          DO 220 IQ=1,ITEM
000    220   KOPY(IQ)=M(IQ,IS)
000    230   J=2*IS
000          IF (J.GT.NS) GO TO 280
000          IF (J.GE.NS) GO TO 250
000          IF (Q(M(1,J+1),M(1,J))) 240,250,250
000    240   J=J+1
000    250   IF (Q(M(1,J),KOPY)) 260,280,280
000     260   DO 270 IQ=1,ITEM
000    270   M(IQ,IS)=M(IQ,J)
000          IS=J
000          GO TO 230
000    280   DO 290 IQ=1,ITEM
000    290   M(IQ,IS)=KOPY(IQ)
000          DO 300 IT=1,ITEM
000          LAZY=M(IT,1)
000          M(IT,1)=M(IT,I)
000          M(IT,I)=LAZY
000    300   CONTINUE
000    310   CONTINUE
000    320   CONTINUE
000          RETURN
000          END
```

END ELT.

HDG,P ****** TIDE ******

****** TIDE ******

@FLT,L IMAINT.TIDE

```
000          SUBROUTINE TIDE (FEET)
000   C        THIS ROUTINE IS CALLED BY INH AND CALLS GAUSS
000   C    THIS PROGRAM USES GAUSSIAN ELIMINATION TO GENERATE
000   C    AN EXPRESSION FOR TIDAL HEIGHT
000   C
000   C
000   C      INPUT CONSISTS OF TCYC, THE LENGTH OF THE TIDAL CYCLE IN HOURS,
000   C      AS WELL AS THE HEIGHT IN METERS OF THE HIGH HIGH, LOW LOW,
000   C      LOW HIGH, AND HIGH LOW TIDES.  THE TIMES AT WHICH THESE TIDES
000   C      OCCUR ARE INPUT IN DECIMAL FORM AND STORED IN THE ARRAY 'T',
000   C      WHILE THE HEIGHTS ARE STORED IN THE ARRAY 'TIDH'
000          DIMENSION A(8,9), T(4), TIDH(4), THETA(4), RESULT(8),FEET(8)
000          DIMENSION TITLE(33),TT(50),YY(50)
000          COMMON /PTINT/ NJ,NC,NJGW,NTCYC,NQSWRT,NQCYC,DELTQ,PERIOD,
000         1ALPHA(30),DEP(70),IPOINT(70,6),AS(70),EVAP
000          COMMON/NEW/IJK,CHK,XM(20),YM(20)
000          EQUIVALENCE (TT(4),T(4)),(TIDH(4),YY(4))
000   C      ************** NAMELIST CARDS FOR INPUT OF DATA      *************
000          NAMELIST /CARD1/ TT,YY
000   C         SET N5=1 SO THAT INPUT WILL BE FROM SCRATCH FILE
000          N5=1
000          N6=6
000   C         SET LENGTH OF CYCLE
000          TCYC=PERIOD
000          READ (N5,320) (TITLE(I),I=1,20)
000          WRITE (N6,330) (TITLE(I),I=1,20)
000          READ (N5,CARD1,ERR=291,END=292)
000   C      CONVERT TIMES TO ANGLES IN RADIANS
000          DO 10 IA=1,4
000       10 THETA(IA)=T(IA)*2.*3.14159/TCYC
000   C    SET UP MATRIX 'A' OF COEFFICIENTS
000          DO 30 IB=1,8
000          IC=IB-4
000          IF(IC .LE. 0) GO TO 20
000   C    FOR EQUATIONS USING F'(X)
000          A(IB,1)=0.0
000          A(IB,2)=-SIN(THETA(IC))
000          A(IB,3)=-2.*SIN(2.*THETA(IC))
000          A(IB,4)=-3.*SIN(3.*THETA(IC))
000          A(IB,5)=COS(THETA(IC))
000          A(IB,6)=2.*COS(2.*THETA(IC))
000          A(IB,7)=3.*COS(3.*THETA(IC))
000          A(IB,8)=4.*COS(4.*THETA(IC))
000          A(IB,9)=0.0
000          GO TO 30
000   C    FOR EQUATIONS USING F(X)
000       20 A(IB,1)=0.5
000          A(IB,2)=COS(THETA(IB))
000          A(IB,3)=COS(2.*THETA(IB))
000          A(IB,4)=COS(3.*THETA(IB))
000          A(IB,5)=SIN(THETA(IB))
000          A(IB,6)=SIN(2.*THETA(IB))
000          A(IB,7)=SIN(3.*THETA(IB))
```

```
000          A(IB,8)=SIN(4.*THETA(IB))
000          A(IB,9)=TIDH(IB)
000       30 CONTINUE
000     C
000          CALL GAUSS (A,RESULT)
000     C
000          DO 35 I=1,8
000      35  FEET(I)=RESULT(I)*3.28
000          WRITE(6,200) TCYC
000          DO 40 ID=1,4
000       40 WRITE(6,300) T(ID), TIDH(ID)
000     C   WRITE OUT THE CALCULATED COEFFICIENTS
000          WRITE(6,400) RESULT
000          WRITE(6,500)
000     C   CALCULATE TIDE HEIGHTS FOR 10 DEGREE INTERVALS THROUGH A FULL TIDE CYCLE
000          DO 50 IC=1,36
000          ANGLE=FLOAT(10*IC)
000          BANGLE=ANGLE*2.*3.14159/360.
000          VALUE=0.5*RESULT(1)+COS(BANGLE)*RESULT(2)+COS(2.*BANGLE)*RESULT(3)
000         1       +COS(3.*BANGLE)*RESULT(4)+SIN(BANGLE)*RESULT(5)+SIN(2.*
000         2       BANGLE)*RESULT(6)+SIN(3.*BANGLE)*RESULT(7)+SIN(4.*BANGLE)*
000         3       RESULT(8)
000          ATIME=(ANGLE/360.)*TCYC
000      50  WRITE(6,600) ANGLE,ATIME,VALUE
000          WRITE(6,601)
000          GO TO 293
000     291  CONTINUE
000          WRITE(6,602)
000     602  FORMAT(2X,'ERROR IN NAMELIST---NO FUNCTION GENERATED')
000          GO TO 293
000     292  CONTINUE
000          WRITE(6,603)
000     603  FORMAT(2X,'END OF FILE ENCOUNTERED IN READING DATA---NO FUNCTION G
000         1ENERATED')
000     293  CONTINUE
000          RETURN
000     320  FORMAT(20A4)
000     330  FORMAT(1H ,20A4)
000     200  FORMAT(2X,'TIDAL CYCLE LASTS',F7.2,1X,'HOURS',///,1X,
000         1'INPUT STAGE TIME PAIRS',/,6X,'HOURS',5X,'METERS')
000     400  FORMAT(1H0,'COEFFICIENTS FOR AN EQUATION OF FORM',6X,'F(X) = 0.5*A
000         11 + A2*COS(THETA) + A3*COS(2*THETA)',/,45X,' + A4*COS(3*THETA) + A
000         25*SIN(THETA) + A6*SIN(2*THETA)',/,45X,' + A7*SIN(3*THETA) + A8*SIN
000         3(4*THETA)','//,40X,'WHERE F(X) HAS UNITS OF METERS, ARE AS FOLLOWS
000         4',/,5X,'A1 = ',F8.3,/,5X,'A2 = ',F8.3,/,5X,'A3 = ',F8.3,/,5X,
000         5'A4 = ',F8.3,/,5X,'A5 = ',F8.3,/,5X,'A6 = ',F8.3,/,5X,
000         6'A7 = ',F8.3,/,5X,'A8 = ',F8.3)
000     500  FORMAT(48H1FUNCTION VALUES LISTED FOR 10 DEGREE INCREMENTS,//,
000         19X,'DEGREES',13X,'TIME(HRS)',5X,'HEIGHT(METERS)')
000     600  FORMAT(1H ,5X,F12.2,2(5X,F12.4))
000     601  FORMAT(1H1)
000     300  FORMAT(4(1H ,2X,2F10.2))
000          END

END ELT.
```

****** FIND ******

@ELT,L HMAINT.FIND

```
000              SUBROUTINE FIND(ILAST,NJP,DUM,NJW,HP,NJ)
000      C        THIS ROUTINE IS CALLED BY HYDPLT
000              COMMON /TAPES/N5,N6,N20,N22,N24
000              DIMENSION DUM(600),NJW(20),HP(20,200)
000              READ (N24) (DUM(I),I=1,NJ)
000              DO 100 I=1,NJP
000              NP=NJW(I)
000              HP(I,ILAST)=DUM(NP)
000      100     CONTINUE
000              RETURN
000              END
```

END ELT.

@HDG,P ****** GENFUN ******

```
******  GENFUN  ******

@ELT,L HMAINT.GENFUN

000          SUBROUTINE GENFUN (Z1,Z2,IY,IX,Z3)
000     C
000     C    ************** BATTELLE NORTHWEST 11/9/71              *************
000     C    *****************************************************************
000     C     THIS ROUTINE IS CALLED BY HYDCAL
000     C
000     C    ************** ASSIGN THE COMMON  DATA                 *************
000          COMMON /TAPES/N5,N6,N20,N22,N24
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000     C
000     C    ************** CONTROL AND TITLE INFORMATION           *************
000          COMMON /PRINT/ NJ,NC,NTCYC,NQCYC,DELTQ,PERIOD,ALPHA(30),
000         1DEP(70),NQSWRT
000          COMMON/QUAL/NCHAN(70,6),AS(70),LEN(100),NJUNC(100,2)
000          COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,NJGW,NHCYC,NT,ICYC,NCYC,W,
000         1NEXIT,JSW(20),JGW(20),A0(3,20,10)
000     C
000     C    ************** JUNCTION INFORMATION                    *************
000     C
000          COMMON/H50/H(70),HN(70),HT(70),HBAR(70),HAVE(70),
000         1IPOINT(70,6),VOL(70),X(70),Y(70),QIN(70),QOU(70),
000         2QINST(20),QINBAR(70),QOUBAR(70)
000     C
000     C    ************** CHANNEL INFORMATION                     *************
000     C
000          COMMON/B72/B(100),R(100),A(100),AT(100),AK(100),Q(100),QBAR(100),
000         1QAVE(100),V(100),VT(100),VBAR(100),FWIND(100),NTEMP(6),
000         2NCLOS(100)
000     C
000          REAL LEN
000     C    **************                 END                     *************
000     C    *****************************************************************
000     C
000     C
000          IF (IY.EQ.2) GO TO 200
000     C
000     C    **************  CONTROLLED NODE FUNCTIONS DESIRED      *************
000          IJK=JGW(IX)
000          GO TO (100,120,130,170,140,140), IJK
000     C
000     C    **************    WIER FORMULA DESIRED                 *************
000     100  CONTINUE
000          Z2M=0.
000          CON=Z3/AS(IX)
000          DHLM=0.
000          DO 110 ICT=1,12
000          CM=CON*10.744
000          DHM=(Z2M+DHLM)/2.
000          DHLM=Z2M
000          Z2M=-CM*Z1/35.314
000          H2M=(H(IX)/3.28)+DHM/2.-A0(1,IX,2)
000          IF (H2M .LE. 0) GO TO 110
000          Z2M=CM*(-Z1/35.314-A0(1,IX,1)*(H2M)**A0(1,IX,3))
```

GENFUN

```
000        Z2=Z2M*3.28
000  110   CONTINUE
000        RETURN
000  C     **************                  END                        *************
000  C
000  C     **************    TIDAL CONTROLLED NODE                    *************
000   120  Z2=0.5*A0(1,IX,1)+A0(1,IX,2)*COS(W*Z1)+A0(1,IX,3)*COS(2.*W*Z1)+
000       1A0(1,IX,4)*COS(3.*W*Z1)+A0(1,IX,5)*SIN(W*Z1)+A0(1,IX,6)*SIN(2.*W*Z
000       21)+A0(1,IX,7)*SIN(3.*W*Z1)+A0(1,IX,8)*SIN(4.*W*Z1)
000        RETURN
000  C     **************                  END                        *************
000  C
000  C     **************              Q VS H NODE                     ************
000  130   TX=Z1
000        GO TO 150
000  C     **************                END                          *************
000  C     **************         HVS T AND Q VS T NODES              *************
000  140   CONTINUE
000        TX=Z1/3600.
000  150   I1=1
000        I2=IX
000        IRETUR=1
000        GO TO 220
000  160   CONTINUE
000        Z2=ZZ
000        RETURN
000  C     **************                 END                         *************
000  C
000  C
000  C     **************    THIS IS THE H VS T AND Q VS T NODE       *************
000  170   CONTINUE
000        TX=Z3/3600.
000        I1=1
000        I2=IX
000        IRETUR=2
000        GO TO 220
000  180   CONTINUE
000        Z2=ZZ
000        I1=2
000        IRETUR=3
000        GO TO 220
000  190   CONTINUE
000        Z1=ZZ
000        RETURN
000  C     **************               END                           *************
000  C
000  C
000  C     **************   GENERATE THE HYDROGRAPH OUTPUTS            *************
000  200   CONTINUE
000        TX=Z1/3600.
000        I1=3
000        I2=IX
000        IRETUR=4
000        GO TO 220
000  210   CONTINUE
000        Z2=ZZ
000        RETURN
```

****** GENFUN ******

```
000    C      **************                   END                       *************
000    C
000    C
000    C      ************** GENERATE  THE FUNCTION                      *************
000    220    CONTINUE
000           ZZ=A0(I1,I2,1)+A0(I1,I2,2)*TX+A0(I1,I2,3)*TX**2+A0(I1,I2,4)*TX**3+
000          1A0(I1,I2,5)*TX**4+A0(I1,I2,6)*TX**5+A0(I1,I2,7)*TX**6+A0(I1,I2,8)*
000          2TX**7+A0(I1,I2,9)*TX**8+A0(I1,I2,10)*TX**9
000           GO TO (160,180,190,210), IRETUR
000    C      **************                      END                    *************
000    C
000           END
```

END ELT.

@HDG,P ****** HYDCAL ******

****** HYDCAL ******

@ELT,L HMAINT.HYDCAL

```
      SUBROUTINE HYDCAL
C      THIS ROUTINE IS CALLED BY HMAINV (OR HMAINT)
C       AND CALLS GENFUN
C                            BATTELLE NORTHWEST 11/9/71
C
C
C                            ASSIGN THE COMMON DATA
      COMMON /TAPES/N5,N6,N20,N22,N24
      COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
C
C                            CONTROL AND TITLE INFORMATION
      COMMON /PRINT/ NJ,NC,NTCYC,NQCYC,DELTQ,PERIOD,ALPHA(30),
     1DEP(70),NOSWRT
      COMMON/QUAL/NCHAN(70,6),AS(70),LEN(100),NJUNC(100,2)
      COMMON/QIN/QINT,DELT,WIND,WDIR,NJSW,NJGW,NHCYC,NT,ICYC,NCYC,W,
     1NEXIT,JSW(20),JGW(20),A0(3,20,10)
C
C                            JUNCTION INFORMATION
C
      COMMON/H50/H(70),HN(70),HT(70),HBAR(70),HAVE(70),
     1IPOINT(70,6),VOL(70),X(70),Y(70),QIN(70),QOU(70),
     2QINST(20),QINBAR(70),QOUBAR(70)
C
C                            CHANNEL INFORMATION
C
      COMMON/B72/B(100),R(100),A(100),AT(100),AK(100),Q(100),QBAR(100),
     1QAVE(100),V(100),VT(100),VBAR(100),FWIND(100),NTEMP(6),
     2NCLOS(100)
      COMMON/NTR/NTRIB,TRBDEP(50),ITRIB(50,2)
C
      REAL LEN
      REAL LAM
      DIMENSION ARRAY(33)
      DIMENSION RSAV(100)
C                                      END
C
C
      DATA ASTERK/4H****/
C
C
C                            INPUT AND PRINT THE INPUT HYDRAULIC DATA
C
  100 CONTINUE
      READ (N20,1100) ARRAY
      IF (ARRAY(1).EQ.ASTERK) GO TO 110
      WRITE (N6,1100) ARRAY
      GO TO 100
  110 CONTINUE
      READ (N20) NTCYC,PERIOD,QINT,DELT,WIND,WDIR,NOSWRT,NJSW,NJGW
     1,(JSW(L),QINST(L),((A0(I,L,N),I=1,3),N=1,10),L=1,IZ12),(JGW(L),L=1
     2,IZ13),(ALPHA(I),I=1,30),NQCYC,NHCYC,NT,DELTQ,ICYC,NCYC,NEXIT,NJ,N
     3C,((NCHAN(I,II),IPOINT(I,II),II=1,IZ6),H(I),HN(I),HT(I),HBAR(I),HA
     4VE(I),AS(I),VOL(I),X(I),Y(I),DEP(I),QIN(I),QOU(I),QINBAR(I),QOUBAR
```

```
000        5(I),I=1,NJ),((NJUNC(N,L),L=1,2),LEN(N),B(N),R(N),A(N),AT(N),AK(N),     52
000        6Q(N),QBAR(N),QAVE(N),V(N),VT(N),VBAR(N),FWIND(N),NCLOS(N),N=1,NC),     53
000        7 EVAP,NTRIB,(TRBDEP(I),ITRIB(I,1),ITRIB(I,2),I=1,50),HYDEND
000   C   *** HYDEND IS A SPECIAL CASE - EPA PESTICIDE STUDY ***
000   C                                 END
000   C                                                                            56
000   C                                                                            57
000   C                     WRITE OUT HYDRAULIC DATA TO QUALITY TAPE
000         REWIND N22                                                             59
000         WRITE (N22) (ALPHA(I),I=1,30),NJ,NC,NQCYC,DELTQ,NTCYC,NQSWRT,NJGW,     60
000        1EVAP,((NCHAN(J,K),K=1,IZ6),DEP(J),AS(J),J=1,NJ),(LEN(N),(NJUNC(N,K     61
000        2),K=1,2),N=1,NC),PERIOD,(JGW(I),I=1,NJGW)                              62
000         WRITE (N22) ((IPOINT(J,K),K=1,IZ6),J=1,NJ)                              63
000   C                                 END
000   C                                                                            65
000   C                          INITIALIZATION
000         NJGW1=NJGW+1                                                           67
000         DELT2=DELT/2.0                                                         68
000         W=6.2832/(3600.*PERIOD)                                                70
000         T=0.0                                                                   71
000         TIME=0.                                                                72
000   C                                 END
000   C                                                                            74
000   C       THIS LOOP CALCULATES THE CONTROLLED NODE INITIAL CONDITIONS
000         DO 180 J=1,NJGW                                                        77
000         IJK=JGW(J)                                                             78
000         GO TO (180,120,130,140,150,160), IJK                                   79
000   C     WIER RELATIONS  REQUIRE NO CALCULATION AT THIS POINT                   80
000   C     1801                                                                   81
000   C     TIDAL CONTROL STAGE                                                    82
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   120   CALL GENFUN (T,H(J),1,J,T)                                             83
000   C
000         Q(J)=0.                                                                84
000         GO TO 170                                                              85
000   C     DAM IS OPERATED VIA A Q VS H CURVE                                     86
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   130   CALL GENFUN (H(J),Q(J),1,J,TIME)                                       87
000   C
000         GO TO 170                                                              88
000   C     DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME                 89
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   140   CALL GENFUN (H(J),Q(J),1,J,TIME)                                       90
000   C
000         GO TO 170                                                              91
000   C     DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTFLOW IS        92
000   C     DETERMINED FROM A MASS BALANCE                                         93
000   C
000   C      USE GENFUN TO CALCULATE INITIAL VALUES
000   150   CALL GENFUN (TIME,H(J),1,J,TIME)                                       94
000   C
000         Q(J)=0.                                                                95
000         GO TO 170                                                              96
000   C     DAM WHOSE OUTFLOW IS A KNOWN FUNCTION OF TIME AND WHOSE HEAD IS        97
```

```
000   C      DETERMINED FROM A MASS BALANCE                                                     98
000   C
000   C       USE GENFUN TO CALCULATE INITIAL VALUES
000   160    CALL GENFUN (TIME,Q(J),1,J,TIME)                                                  99
000   C
000   170    V(J)=0.                                                                          100
000   180    CONTINUE                                                                         101
000   C                                     END
000   C                                                                                       103
000   C       COMPUTE THE CHANNEL CONSTANTS
000          DO 241 N=1,NC
000   241    RSAV(N)=-R(N)
000          DO 240 N=1,NC                                                                    105
000   C       CHECK TO BE SURE THAT IF THERE IS NO NODE NUMBER ASSIGNED TO
000   C         THE END OF A GIVEN CHANNEL THAT THE CHANNEL IS ADJACENT TO
000   C         A CONTROLLED NODE
000          IF ((NJUNC(N,1).EQ.0).AND.(N.LE.NJGW)) GO TO 190                                 106
000          IF (NJUNC(N,1).LE.0) GO TO 240                                                   107
000   190    CONTINUE                                                                         108
000   C       MODIFY MANNING'S COEFFICIENT
000          AK(N)=32.1739*AK(N)**2/2.208196                                                  109
000          NL=NJUNC(N,1)                                                                    110
000          NH=NJUNC(N,2)                                                                    111
000          IF (N.LE.NJGW) NL=NH                                                             112
000   C       COMPUTE AVG RIVER DEPTH IN CHANNEL USING AVG HEAD (FROM NODES)
000   C         AND RIVER BOTTOM ELEVATION (NOTE THAT SIGN CONVENTION
000   C         MAKES BOTTOM ELEVATION NEGATIVE)
000          R(N)=R(N)+(H(NL)+H(NH))/2.                                                       113
000   C      ********* ARE THERE ANY TIDAL FLATS ******************************
000          IF (NTRIB.LE.0) GO TO 220                                                        114
000          DO 200 I=1,NTRIB                                                                 115
000          IF (N.EQ.ITRIB(I,1)) GO TO 210                                                   116
000   200    CONTINUE                                                                         117
000          GO TO 220                                                                        118
000   210    IJN=ITRIB(I,2)                                                                   119
000          IF (IJN.EQ.NL) IHJN=NH                                                           120
000          IF (IJN.EQ.NH) IHJN=NL                                                           121
000   C       RIVER DEPTH IS THE DIFFERENCE BETWEEN HEAD AND BOTTOM
000   C         ELEVATION (NOTE THAT DEP IS NEGATIVE)
000          R(N)=H(IJN)+TRBDEP(I)
000          IF (H(IHJN).LT.H(IJN)) GO TO 220                                                 123
000   C       COMPUTE AVG RIVER DEPTH (NOTE SIGN CONVENTION)
000          R(N)=(H(IHJN)+H(IJN))/2.+TRBDEP(I)
000   220    CONTINUE                                                                         125
000   C       AREA = WIDTH*DEPTH
000          A(N)=B(N)*R(N)                                                                   126
000          IF (WIND.LE.0.0) GO TO 230                                                       127
000   C       CALCULATE WIND FORCE
000          FWIND(N)=-WIND**2*COS(WDIR/57.-ATAN2((X(NH)-X(NL)),(Y(NH)-Y(NL))))               128
000         1*8.64E-6                                                                         129
000   230    CONTINUE                                                                         130
000          AT(N)=A(N)                                                                       131
000          QAVE(N)=0.                                                                       132
000   240    CONTINUE                                                                         133
000   C                                     END
000   C                                                                                       135
000   C      **************     COMPUTE THE NODAL VOLUMES          *************              136
```

```
000          DO 260 J=1,NJ
000          VOL(J)=0.
000          IF (AS(J).EQ.0.) GO TO 260
000          VOL(J)=(H(J)+DEP(J))*AS(J)
000    260   CONTINUE
000    C     **************              END                       *************
000    C
000    C
000    C     ************* START OF OUTER DO LOOP *****************************
000    C     ******************************************************************
000    C     NT=THE DAILY CYCLE NUMBER
000    C     NTCYC=THE NUMBER OF DAILY CYCLES TO BE SIMULATED
000    C     ******************************************************************
000    C     ******************************************************************
000    C
000    C
000          DO 910 NT=1,NTCYC
000          HOUR=0.0
000    C
000    C
000    C     ************* START OF THE 2ND OF THREE NESTED DO LOOPS **********
000    C     ******************************************************************
000    C     NQ=THE QUALITY CYCLE NUMBER
000    C     NQCYC=THE NUMBER OF QUALITY CYCLES PER DAILY CYCLE
000    C     ******************************************************************
000    C     ******************************************************************
000    C
000    C
000          DO 900 NQ=1,NQCYC
000    C
000    C     ************** INITIALIZE THE OUTPUT ARRAYS FOR THE SWQUAL ROUTINE
000          DO 270 N=1,NC
000          VBAR(N)=0.
000    270   QBAR(N)=0.
000          DO 280 J=1,NJ
000          HBAR(J)=0.
000          QINBAR(J)=0.
000          QOUBAR(J)=0.
000    280   CONTINUE
000    C     **************              END                       *************
000    C
000    C
000    C     ************* START OF THE THIRD OF THREE  NESTED DO LOOPS *******
000    C     ******************************************************************
000    C     NHH=THE HYDRAULIC CYCLE COUNTER
000    C     NHCYC=THE NUMBER OF HYDRAULIC CYCLES PER QUALITY CYCLE
000    C     ******************************************************************
000    C     ******************************************************************
000    C
000    C
000          DO 860 NHH=1,NHCYC
000    C     ******************************************************************
000    C     TIME IS THE TIMING VARIABLE THAT BEGINS AFTER THE FLOW PATTERNS
000    C     HAVE REACHED EQUILIBRIUM
000    C     ******************************************************************
000          IF (NT.LT.NQSWRT) GO TO 300
000          TIME=TIME+DELT
```

```
      TIM2=TIME-DELT2
C
C     *********** HYDROGRAPH INPUTS ************************************
      IF (NJSW.EQ.0) GO TO 300
      DO 290 L=1,NJSW
      J=JSW(L)
C
C ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
      CALL GENFUN (TIME,QIN(J),2,L,TIME)
C  *** SPECIAL CASE - EPA PESTICIDE STUDY
C      THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
      IF (TIME.GT.HYDEND.AND.HYDEND.NE. 0.0) QIN(J) = 0.0
      IF(QIN(J).LT.0.0) QIN(J) = 0.0                                PEST
C
  290 QIN(J)=QINST(L)+QIN(J)
C     **************              END                 *************
C
C
C     **************          INITIALIZATION          *************
  300 CONTINUE
      T2=T+DELT2
      T=T+DELT
      DO 310 N=1,NC
      NCLOS(N)=0
      DO 310 M=1,2
  310 NJUNC(N,M)=IABS(NJUNC(N,M))
      DO 320 J=1,NJ
      AS(J)=ABS(AS(J))
      DO 320 K=1,IZ6
  320 NCHAN(J,K)=IABS(NCHAN(J,K))
      NTIMS=0
C     **************              END                 *************
C
C     ************** COMPUTATION OF VELOCITIES  AT 1/2 DELT  **********
C     ************** AND FLOWS AT 1/4 DELT                  ***********
  330 CONTINUE
      NDRY=0
      NTIMS=NTIMS+1
C ****** THE FIRST NJGW CHANNELS ARE CONNECTED TO THE NJGW CONTROLLED
C ******       NODES AND MUST BE TREATED SEPARATELY.  CHECK THE REST
C ******       OF THE CHANNELS TO SEE IF THEY HAVE DRIED UP, AND, IF THEY
C ******       HAVE, SKIP THE CALCULATIONS. ******
      DO 380 N=NJGW1,NC
      IF (NJUNC(N,1).LE.0) GO TO 380
C ****** DRY CHANNEL CHECK (DRY IMPLYING THAT DEPTH IS LESS THAN 0.01
C ******       METERS OR 0.033 FEET) ******
      IF(R(N).GE.0.001)  GO TO 340
      VT(N)=0.0
      Q(N)=0.0
      GO TO 380
  340 CONTINUE
      NL=NJUNC(N,1)
      NH=NJUNC(N,2)
C ****** DELTH = DIFFERENCE BETWEEN HEADS AT THE NODES AT EACH END OF THE
C ******       CHANNEL (BEGINNING OF TIMESTEP) ******
      DELTH=H(NH)-H(NL)
      DELTZ=DEP(NL)-DEP(NH)
```

```
000          DELH=0.5*(H(NH)-HT(NH)+H(NL)-HT(NL))
000          DELTY=DELTH-DELTZ
000   C  ++++++ ARE THERE ANY TRIBUTARY CHANNELS? ++++++
000          IF (NTRIB.LE.0) GO TO 370                                          245
000          DO 350 IL=1,NTRIB                                                  246
000   C  ++++++ IS CHANNEL N A TRIBUTARY CHANNEL? ++++++
000          IF (N.EQ.ITRIB(IL,1)) GO TO 360                                    247
000   350    CONTINUE                                                           248
000          GO TO 370                                                          249
000   C      ****** IJN=NUMBER OF THE TIDE FLAT NODE **************************
000   360    IJN=ITRIB(IL,2)                                                    250
000          IF (IJN.EQ.NL) IHJN=NH                                             251
000          IF (IJN.EQ.NH) IHJN=NL                                             252
000          DELTZ=2.*(DEP(IJN)-TRBDEP(IL))
000          IF(IHJN.LT.IJN) DELTZ=-DELTZ
000          DELTY=DELTH-DELTZ
000          IF(H (IJN).GT.H (IHJN))  DELH=H (IJN)-HT (IJN)
000          IF(H (IJN).GT.H (IHJN))  DELTY=0.0
000          IF(H(IJN).GT.H(IHJN))  R(N)=H(IJN )+TRBDEP(IL)
000          IF(H(IJN).GT.H(IHJN))  A(N)=R(N)*B(N)
000   370    CONTINUE                                                           256
000   C
000          TEMP=AK(N)/(R(N)**1.3333)
000          TEMP=TEMP*DELT2
000          HCHAN=(H(NH)+H(NL))/2.
000   C
000          DELV1= V(N)/R(N)*(DELH/DELT2+V(N)*DELTY/LEN(N))
000          V2=V(N)+DELT2*DELV1
000   C
000          DELV2=-32.1739*DELTZ/LEN(N)
000          V2=V2+DELT2*DELV2
000   C
000          DELV4=-32.1739*(DELTH-DELTZ)/LEN(N)
000          V2=V2+DELT2*DELV4
000   C
000          DELV3=0.5*((1./TEMP+2.*ABS(V2))-SQRT((1./TEMP+ABS(2.*V2))**2-4.*V2
000         1**2))
000          DELV3=-SIGN(DELV3,V2)
000          VT(N)=V2+DELV3
000   C
000   C
000          Q(N)=VT(N)*A(N)                                                    265
000   380    CONTINUE                                                           266
000   C      **************              END              *************         267
000   C                                                                         268
000   C      ************* CONTROLLED NODE CALCULATIONS **********************  269
000   C      ************** FLOW AT 1/4 DELT AND HEAD AT 1/2 DELT ************  270
000   C      ***************************************************************** 271
000          DO 470 J=1,NJGW                                                    272
000   C
000   C  ++++++ CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000   C  ++++++        CALCULATED IN ADJACENT CHANNELS ++++++
000          SUMQ=0.                                                            273
000          DO 400 K=1,I76                                                     274
000          IF (NCHAN(J,K).EQ.J) GO TO 400                                     275
000          IF (NCHAN(J,K).LE.0) GO TO 400                                     276
000          N=NCHAN(J,K)                                                       277
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000    IF (J.NE.NJUNC(N,1)) GO TO 390                                   278
000    SUMQ=SUMQ+Q(N)                                                   279
000    GO TO 400                                                        280
000 390 SUMQ=SUMQ-Q(N)                                                  281
000 400 CONTINUE                                                        282
000 C
000 C  ++++++ NET FLOW OUT ++++++
000    SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                               283
000    IJK=JGW(J)                                                       284
000 C  ++++++ WHAT TYPE OF CONTROLLED NODE? ++++++
000    GO TO (410,420,430,440,450,460), IJK                             285
000 C      WEIR RELATIONSHIP                                            286
000 C
000 C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++
000 410 CALL GENFUN (SUMQ,DELHH,1,J,DELT2)                              287
000 C
000    Q(J)=-DELHH*AS(J)/DELT2-SUMQ                                     288
000    IF (Q(J).LT.0.) Q(J)=0.                                          289
000    VT(J)=0.                                                         290
000 C  ++++++ CHANGE HEAD TO ACCOMODATE NET FLOW ++++++
000    HT(J)=H(J)+DELHH                                                 291
000    GO TO 470                                                        292
000 C      TIDAL CONTROL STAGE                                          293
000 C
000 C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++
000 420 CALL GENFUN (T2,HT(J),1,J,T2)                                   294
000 C
000    Q(J)=-SUMQ-(HT(J)-H(J))*AS(J)/DELT2                              295
000    VT(J)=0.                                                         296
000    GO TO 470                                                        297
000 C      DAM IS OPERATED ACCORDING TO A Q VS H OPERATION POLICY       298
000 C
000 C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++
000 430 CALL GENFUN (H(J),Q(J),1,J,TIM2)                                299
000 C
000 C  ++++++ NET FLOW +++++
000    SUMQ=SUMQ+Q(J)                                                   300
000 C  ++++++ CHANGE HEAD TO ACCOMODATE NET FLOW ++++++
000    HT(J)=H(J)-DELT2*SUMQ/AS(J)                                      301
000    VT(J)=0.                                                         302
000    GO TO 470                                                        303
000 C      DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME       304
000 C
000 C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++
000 440 CALL GENFUN (HT(J),Q(J),1,J,TIM2)                               305
000 C
000    VT(J)=0.                                                         306
000    GO TO 470                                                        307
000 C      DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTPUT IS  308
000 C      DETERMINED FROM A MASS BALANCE                               309
000 C
000 C  ++++++ USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ++++++
000 450 CALL GENFUN (TIM2,HT(J),1,J,TIM2)                               310
000 C
000    Q(J)=-SUMQ-(HT(J)-H(J))*AS(J)/DELT2                              311
000    IF (Q(J).LT.0.) Q(J)=0.                                          312
000    VT(J)=0.                                                         313
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000          GO TO 470                                                        314
000   C      DAM WHOSE OUTFLOW IS A KNOW FUNCTION OF TIME AND WHOSE HEAD IS   315
000   C      DETERMINED FROM A MASS BALANCE                                   316
000   C
000   C  ****** USE SUBROUTINE GENFUN TO GENERATE FUNCTIONAL VALUES ******
000   460    CALL GENFUN (TIM2,Q(J),1,J,TIM2)                                 317
000   C
000   C  ****** NET FLOW *****
000          SUMQ=SUMQ+Q(J)                                                   318
000   C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000          HT(J)=H(J)-DELT2*SUMQ/AS(J)                                      319
000          VT(J)=0.                                                         320
000   470    CONTINUE                                                         321
000   C      **************            END               *************        322
000   C      ************************************************************     323
000   C                                                                       324
000   C      ************* REGULAR NODES STAGE AT 1/2 DELT      *************  325
000          DO 510 J=NJGW1,NJ                                                326
000   C
000   C  ****** CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000   C  ******       CALCULATED IN ADJACENT CHANNELS ******
000          SUMQ=0.                                                          327
000          DO 490 K=1,I76                                                   328
000          IF (NCHAN(J,K).LE.0) GO TO 490                                   329
000          N=NCHAN(J,K)                                                     330
000          IF (J.NE.NJUNC(N,1)) GO TO 480                                   331
000          SUMQ=SUMQ+Q(N)                                                   332
000          GO TO 490                                                        333
000   480    SUMQ=SUMQ-Q(N)                                                   334
000   490    CONTINUE                                                         335
000   C
000          IF (AS(J).LE.0.) GO TO 510                                       336
000   C  ****** NET FLOW OUT ******
000          SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                               337
000   C  ****** CHANGE HEAD TO ACCOMODATE NET FLOW ******
000          HT(J)=H(J)-DELT2*SUMQ/AS(J)                                      338
000   C  ****** IS HEAD GREATER THAN BOTTOM ELEVATION (IS THERE WATER PRESENT)? *
000          IF (HT(J)+DEP(J).GT.0.) GO TO 510                                339
000   C  ****** NODE IS DRY, SO SET HEAD EQUAL TO BOTTOM ELEVATION
000   C  ******       (BUT CHANGE SIGN) ******
000          HT(J)=-DEP(J)                                                    340
000          VOL(J)=0.                                                        341
000          AS(J)=-AS(J)                                                     342
000          DO 500 K=1,I76                                                   343
000          NX=NCHAN(J,K)                                                    344
000          IF (NX.LE.0) GO TO 500                                           345
000          IF (NX.LE.NJGW) GO TO 500                                        346
000   C  ****** MARK AS A DRY CHANNEL ******
000          NCLOS(NX)=1                                                      347
000   500    CONTINUE                                                         348
000   C  ****** MARK AS A DRY NODE ******
000          NDRY=NDRY+1                                                      349
000   510    CONTINUE                                                         350
000          IF (NDRY.EQ.0) GO TO 560                                         351
000          IF (NTIMS.GT.2) GO TO 560                                        352
000          DO 550 N=NJGW1,NC                                                353
000          IF (NJUNC(N,1).LE.0) GO TO 550                                   354
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000              IF (NCLOS(N).NE.1) GO TO 550
000              Q(N)=0.                                                       355
000              V(N)=0.                                                       356
000              VT(N)=0.0                                                     357
000              DO 540 I=1,2
000              II=NJUNC(N,I)                                                 358
000              DO 520 J=1,IZ6                                                359
000              IF (NCHAN(II,J).EQ.N) GO TO 530                               360
000        520   CONTINUE                                                      361
000              GO TO 540                                                     362
000        530   NCHAN(II,J)=-N                                                363
000        540   NJUNC(N,I)=-II                                                364
000        550   CONTINUE                                                      365
000              GO TO 330                                                     366
000        560   CONTINUE                                                      367
000        C     ***************              END              *************   368
000        C                                                                   369
000        C     ************** COMPUTATION OF CROSSECTIONAL AREA AND FLOW AT 1/2 D   370
000        C     ************** AND VELOCITIES AT THE FULL DELT    *************   371
000              DO 630 N=NJGW1,NC                                             372
000              IF (NJUNC(N,1).LE.0) GO TO 630                                373
000              NL=NJUNC(N,1)                                                 374
000              NH=NJUNC(N,2)                                                 375
000        C  ++++++ HEAD INCREMENT = AVG OF THE CHANGE IN HEAD OVER ONE-HALF   376
000        C  ++++++       TIMESTEP AT THE TWO CHANNEL ENDS ++++++
000              DELH=0.5*(HT(NH)-H(NH)+HT(NL)-H(NL))
000              DELTH=HT(NH)-HT(NL)                                           377
000              DELTZ=DEP(NL)-DEP(NH)
000              DELTY=DELTH-DELTZ
000              RNT=R(N)+DELH
000              HCHAN=(HT(NH)+HT(NL))/2.
000              AT(N)=A(N)+B(N)*DELH
000        C     ********* ARE THERE ANY TIDAL FLATS ******************************
000              IF (NTRIB.LE.0) GO TO 590
000              DO 570 IL=1,NTRIB                                             379
000        C     ****** IS CHANNEL N A TIDE FLAT CHANNEL *************************   380
000              IF (N.EQ.ITRIB(IL,1)) GO TO 580
000        570   CONTINUE                                                      381
000              GO TO 590                                                     382
000        580   IJN=ITRIB(IL,2)                                               383
000              IF (IJN.EQ.NH) IHJN=NL                                        384
000              IF (IJN .EQ. NL) IHJN=NH                                      385
000              DELTZ=2.*(DEP(IJN)-TRBDEP(IL))
000              IF(IHJN.LT.IJN) DELTZ=-DELTZ
000              DELTY=DELTH-DELTZ
000              IF(HT(IJN).GT.HT(IHJN))  DELTY=0.0
000              IF(HT(IJN).GT.HT(IHJN))  DELH=HT(IJN)-H  (IJN)
000              RNT=HT(IJN)+TRBDEP(IL)
000              IF(HT(IJN).GT.HT(IHJN))  RNT=(HT(IHJN)+HT(IJN))/2.+TRBDEP(IL)
000              AT(N)=B(N)*RNT
000        590   CONTINUE
000        C     ************** DRY CHANNEL CHECK  (UNDER 0.1 FEET)  *************   391
000        C  ++++++ IF CHANNEL IS DRY, SET VELOCITY AND FLOW TO ZERO ++++++   394
000              IF(RNT.GT.0.001)  GO TO 600
000              V(N)=0.                                                       396
000              Q(N)=0.                                                       397
000              GO TO 610                                                     398
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000  600   CONTINUE                                                                    399
000        TEMP=AK(N)/(RNT**1.3333)
000        TEMP=TEMP*DELT
000   C
000        DELV1=(VT(N)/RNT)*(DELH/DELTZ+VT(N)*DELTY/LEN(N))
000        V(N)=V(N)+DELT*DELV1
000   C
000        DELV2=-32.1739*DELTZ/LEN(N)
000        V(N)=V(N)+DELT*DELV2
000   C
000        DELV4=-32.1739*(DELTH-DELTZ)/LEN(N)
000        V(N)=V(N)+DELT*DELV4
000   C
000        DELV3=0.5*((1./TEMP+2.*ABS(V(N)))-SQRT((1./TEMP+2.*ABS(V(N)))**2-
000       14.*V(N)**2))
000        DELV3=-SIGN(DELV3,V(N))
000        V(N)=V(N)+DELV3
000   C
000   C
000   C
000   C  ++++++ CALCULATE FLOW BASED ON NEW VELOCITY (AVERAGE PREVIOUS
000   C  ++++++       FLOW AND CURRENT VALUE ++++++
000        Q(N)=0.5*(Q(N)+V(N)*AT(N))                                                  408
000  610   CONTINUE                                                                    409
000   C    ************** SUM THE CHANNEL FLOWS                      *************     410
000   C  ++++++ NT = DAILY CYCLE NUMBER ++++++
000        IF (NT.LT.NQSWRT) GO TO 620                                                 411
000        QBAR(N)=QBAR(N)+Q(N)                                                        412
000        VBAR(N)=VBAR(N)+V(N)                                                        413
000  620   CONTINUE                                                                    414
000   C    ************** CHECK FOR EXCESSIVE VELOCITIES             *************     415
000        RAN=R(N)/3.28
000        VAN=V(N)/3.28
000        IF (ABS(VAN) .LT. 10.0) GO TO 630
000        WRITE(N6,1110) NT,NQ,NHH,RAN,VAN,N
000  630   CONTINUE                                                                    418
000   C    **************                END                         *************     419
000   C                                                                                420
000   C    ************* CONTROLLED NODE CALCULATIONS AT FULL TIME STEP *****         421
000   C    ****************************************************************          422
000        DO 740 J=1,NJGW                                                             423
000   C
000   C  ++++++ CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000   C  ++++++       CALCULATED IN ADJACENT CHANNELS ++++++
000        SUMQ=0.                                                                     424
000        DO 650 K=1,I76                                                              425
000        IF (NCHAN(J,K).EQ.J) GO TO 650                                              426
000        IF (NCHAN(J,K).LE.0) GO TO 650                                              427
000        N=NCHAN(J,K)                                                                428
000        IF (J.NE.NJUNC(N,1)) GO TO 640                                              429
000        SUMQ=SUMQ+Q(N)                                                              430
000        GO TO 650                                                                   431
000  640   SUMQ=SUMQ-Q(N)                                                              432
000  650   CONTINUE                                                                    433
000   C
000   C  ++++++ NET FLOW OUT ++++++
000        SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                                          434
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000            IJK=JGW(J)                                                  435
000      C  ++++++ WHAT TYPE OF CONTROLLED NODE? ++++++
000            GO TO (660,680,690,700,710,720), IJK                        436
000      C     WEIR RELATIONSHIP                                           437
000      C
000      C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000      660   CALL GENFUN (SUMQ,DELHH,1,J,DELT)                           438
000      C
000            Q(J)=-DELHH*AS(J)/DELT-SUMQ                                 439
000            IF (Q(J).LT.0.) Q(J)=0.                                     440
000            V(J)=0.                                                     441
000      C  ++++++ CHANGE HEAD TO ACCOMMODATE NET FLOW ++++++
000            HN(J)=H(J)+DELHH                                            442
000      C  ++++++ CALCULATE VOLUME CHANGE ++++++
000      670   DVOL=(HN(J)-H(J))*AS(J)                                     443
000      C  ++++++ NEW VOLUME ++++++
000            VOL(J)=VOL(J)+DVOL                                          444
000            GO TO 730                                                   445
000      C     TIDAL CONTROL STAGE                                         446
000      C
000      C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000      680   CALL GENFUN (T,HN(J),1,J,T)                                 447
000      C
000            Q(J)=-SUMQ-(HN(J)-H(J))*AS(J)/DELT                          448
000            V(J)=0.                                                     449
000            GO TO 670                                                   450
000      C     DAM OPERATED ACCORDING TO A Q VS H OPERATING POLICY         451
000      C
000      C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000      690   CALL GENFUN (HT(J),QJ2,1,J,TIME)                            452
000      C
000            Q(J)=(Q(J)+QJ2)/2.                                          453
000      C  ++++++ NET FLOW OUT ++++++
000            SUMQ=SUMQ+Q(J)                                              454
000      C  ++++++ CHANGE HEAD TO ACCOMMODATE NET FLOW ++++++
000            HN(J)=H(J)-DELT*SUMQ/AS(J)                                  455
000            V(J)=0.                                                     456
000            GO TO 670                                                   457
000      C     DAM WHOSE HEAD AND OUTFLOW ARE KNOWN FUNCTIONS OF TIME      458
000      C
000      C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000      700   CALL GENFUN (HN(J),QJ2,1,J,TIME)                            459
000      C
000            Q(J)=(Q(J)+QJ2)/2.                                          460
000            V(J)=0.                                                     461
000            GO TO 670                                                   462
000      C     DAM WHOSE HEAD IS A KNOWN FUNCTION OF TIME AND WHOSE OUTFLOW   463
000      C     IS DETERMINED FROM A MASS BALANCE                           464
000      C
000      C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000      710   CALL GENFUN (TIME,HN(J),1,J,TIME)                           465
000      C
000            Q(J)=-SUMQ-(HN(J)-H(J))*AS(J)/DELT                          466
000            IF (Q(J).LT.0.) Q(J)=0.                                     467
000            V(J)=0.                                                     468
000            GO TO 670                                                   469
000      C     DAM WHOSE OUTFLOW IS A KNOWN FUNCTION OF TIME AND WHOSE HEAD IS   470
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000  C       COMPUTED FROM A MASS BALANCE                                                     471
000  C
000  C  ++++++ USE GENFUN TO CALCULATE FUNCTIONAL VALUES ++++++
000  720     CALL GENFUN (TIME,QJ2,1,J,TIME)                                                  472
000  C
000          Q(J)=(Q(J)+QJ2)/2.                                                               473
000  C  ++++++ NET FLOW OUT ++++++
000          SUMQ=SUMQ+Q(J)                                                                   474
000  C  ++++++ CHANGE HEAD TO ACCOMMODATE NET FLOW ++++++
000          HN(J)=H(J)-DELT*SUMQ/AS(J)                                                       475
000          V(J)=0.                                                                          476
000          GO TO 670                                                                        477
000  C                                                                                        478
000  C       ************** SUM THE CHANNEL FLOWS FOR THE CONTROL NODES *******                479
000  730     IF (NT.LT.NQSWRT) GO TO 740                                                      480
000          QBAR(J)=QBAR(J)+Q(J)                                                             481
000          VBAR(J)=VBAR(J)+V(J)                                                             482
000  C       **************                END                          *************         483
000  C                                                                                        484
000  740     CONTINUE                                                                         485
000  C       **************                END                          *************         486
000  C       *************************************************************************        487
000  C                                                                                        488
000  C       ************** COMPUTATION OF NODAL STAGE AND VOLUME AT FULL DELT                 489
000          DO 770 J=NJGW1,NJ                                                                490
000  C
000  C  ++++++ CALCULATE NET FLOW OUT OF NODE (SUMQ) DUE TO FLOWS
000  C  ++++++      CALCULATED IN ADJACENT CHANNELS ++++++
000          SUMQ=0.                                                                          491
000          HN(J)=-DEP(J)                                                                    492
000          IF (AS(J).LE.0.) GO TO 770                                                       493
000          DO 760 K=1,IZ6                                                                   494
000          IF (NCHAN(J,K).LE.0) GO TO 760                                                   495
000          N=NCHAN(J,K)                                                                     496
000          IF (J.NE.NJUNC(N,1)) GO TO 750                                                   497
000          SUMQ=SUMQ+Q(N)                                                                   498
000          GO TO 760                                                                        499
000  750     SUMQ=SUMQ-Q(N)                                                                   500
000  760     CONTINUE                                                                         501
000  C
000  C  ++++++ NET FLOW OUT ++++++
000          SUMQ=SUMQ+QOU(J)-QIN(J)+EVAP*AS(J)                                               502
000  C  ++++++ CHANGE HEAD BASED ON CALCULATED NET FLOW ++++++
000          HN(J)=H(J)-DELT*SUMQ/AS(J)                                                       503
000          HT(J)=0.5*(HN(J)+H(J))
000          VOL(J)=VOL(J)-DELT*SUMQ                                                          504
000  770     CONTINUE                                                                         505
000  C       **************                END                          *************         506
000  C                                                                                        507
000  C       ************** SUM NODAL VOLUMES AND FLOWS                 *************         508
000          IF (NT.LT.NQSWRT) GO TO 790                                                      509
000          DO 780 J=1,NJ                                                                    510
000          HBAR(J)=HBAR(J)+HN(J)                                                            511
000          QINBAR(J)=QINBAR(J)+QIN(J)                                                       512
000          QOUBAR(J)=QOUBAR(J)+QOU(J)                                                       513
000  780     CONTINUE                                                                         514
000  790     CONTINUE                                                                         515
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000  C      **************               END                     *************   516
000  C                                                                           517
000  C      ************** CALCULATE THE HYDRAULIC RADIUS AND CHANNEL CROSSECT   518
000  C      ************** AREA AT THE FULL DELT                 *************   519
000         DO 840 N=NJGW1,NC                                                    520
000         IF (NJUNC(N,1).EQ.0) GO TO 840                                       521
000         NL=IABS(NJUNC(N,1))                                                  522
000         NH=IABS(NJUNC(N,2))                                                  523
000  C ++++++ CALCULATE HEAD INCREMENT AS THE AVERAGE OF THE CHANGE
000  C ++++++       IN HEAD AT EACH END OF THE CHANNEL OVER ONE-HALF TIMESTEP ++
000         DELH=0.5*(HN(NH)-H(NH)+HN(NL)-H(NL))                                 524
000  C      ********* ARE THERE ANY TIDAL FLATS ******************************
000         IF (NTRIB.LE.0) GO TO 830                                            525
000         DO 800 IL=1,NTRIB                                                    526
000  C      ****** IS CHANNEL N A TIDE FLAT CHANNEL **************************
000         IF (N.EQ.ITRIB(IL,1)) GO TO 810                                      527
000  800    CONTINUE                                                             528
000         GO TO 830                                                            529
000  810    IJN=ITRIB(IL,2)                                                      530
000         IF (IJN.EQ.NL) IHJN=NH                                               531
000         IF (IJN.EQ.NH) IHJN=NL                                               532
000         R(N)=HN(IJN)+TRBDEP(IL)
000         IF(HN(IHJN).GT.HN(IJN)) R(N)=(HN(IHJN)+HN(IJN))/2.+TRBDEP(IL)
000  C ++++++ CALCULATE CROSS-SECTIONAL AREA BASED ON NEW RADIUS ++++++
000         A(N)=B(N)*R(N)                                                       535
000         GO TO 840                                                            536
000  830    CONTINUE                                                             540
000  C ++++++ CALCULATE NEW RADIUS BY ADDING HEAD INCREMENT TO OLD VALUE ++++++
000         R(N)=R(N)+DELH                                                       541
000  C ++++++ CALCULATE NEW CROSS-SECTIONAL AREA BASED ON HEAD INCREMENT ++++++
000         A(N)=A(N)+B(N)*DELH                                                  542
000  840    CONTINUE                                                             543
000  C      **************               END                     *************   544
000  C                                                                           545
000  C      ************** SHIFT THE NODAL ARRAYS                *************   546
000         DO 850 J=1,NJ                                                        547
000  850    H(J)=HN(J)                                                           548
000  C      **************               END                     *************   549
000  C                                                                           550
000  C                                                                           551
000  C      ************** STATEMENT 860 IS THE END OF ONE HYDRAULIC CYCLE ****   552
000  860    CONTINUE                                                             553
000  C      *****************************************************************   554
000  C                                                                           555
000  C      ************** AVERAGE THE FLOWS AND VELOCITIES      *************   556
000  C      ************** FOR USE BY THE PRINTOUT AND SWQUAL    *************   557
000  C ++++++ IF NQSWRT DAILY CYCLES HAVE NOT ELAPSED, DO NOT BEGIN PRINTING ++
000         IF (NT.LT.NQSWRT) GO TO 900                                          558
000         DO 880 N=1,NC                                                        559
000  C ++++++ THE  AVERAGE  FLOW FOR THIS QUALITY  CYCLE ++++++
000         QBAR(N)=QBAR(N)/FLOAT(NHCYC)                                         563
000  C ++++++ THE AVERAGE VELOCITY FOR THIS QUALITY CYCLE ++++++
000         VBAR(N)=VBAR(N)/FLOAT(NHCYC)                                         564
000  C ++++++ QAVE = DAILY CYCLE AVERAGE FLOW ++++++
000         QAVE(N)=QAVE(N)+QBAR(N)/FLOAT(NQCYC)                                 565
000  880    CONTINUE                                                             566
000         DO 890 J=1,NJ                                                        567
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C ++++++ QUALITY CYCLE AVERAGE FLOW INTO THE NODE ++++++
      QINBAR(J)=QINBAR(J)/FLOAT(NHCYC)                                     568
C ++++++ QUALITY CYCLE AVERAGE FLOW OUT  OF  THE  NODE ++++++
      QOUBAR(J)=QOUBAR(J)/FLOAT(NHCYC)                                     569
C ++++++ AVERAGE  HEAD AT THE NODE DURING A QUALITY CYCLE ++++++
      HBAR(J)=HBAR(J)/FLOAT(NHCYC)                                         570
C
C ++++++ EVALUATE THE MAGNITUDE AND SIGN OF THE NET FLOW ++++++
      IF (QINBAR(J).EQ.0.) GO TO 890                                       571
      IF (QOUBAR(J).EQ.0.) GO TO 890                                       572
      QINBAR(J)=QINBAR(J)-QOUBAR(J)                                        573
      QOUNAR(J)=0.                                                         574
      IF (QINBAR(J).GT.0.) GO TO 890                                       575
      QOUBAR(J)=-QINBAR(J)                                                 576
      QINBAR(J)=0.                                                         577
C
890   CONTINUE                                                             578
C     **************               END                    *************    579
C                                                                          580
C     ************** WRITE OUT THE HYDRAULIC INFORMATION  *************    581
C     ************** FOR USE BY THE SWQUAL PROGRAM        *************    582
      WRITE (N22) NT,NQ,(HBAR(J),VOL(J),QINBAR(J),QOUBAR(J),J=1,NJ),(QBA   583
     1R(N),VBAR(N),N=1,NC)                                                 584
C     **************              END                     *************    585
C                                                                          586
C     ************** WRITE THE HYDRAULIC INFORMATION      *************    587
C     ************** TO FAST DRUM FOR LATER USE           *************    588
C     ************** BY THE PRINTING AND PLOT PROGRAM     *************    589
      WRITE (N24) NT,NQ                                                    590
      WRITE (N24) (HBAR(J),J=1,NJ)                                         591
      WRITE (N24) (VOL(J),J=1,NJ)                                          592
      WRITE (N24) (QINBAR(J),J=1,NJ)                                       593
      WRITE (N24) (QOUBAR(J),J=1,NJ)                                       594
      WRITE (N24) (QBAR(N),N=1,NC)                                         595
      WRITE (N24) (VBAR(N),N=1,NC)                                         596
C     **************                 END                  *************    597
C                                                                          598
C     ************* STATEMENT  900 IS THE END OF ONE QUALITY CYCLE *****   599
900   CONTINUE                                                             600
C     ***************************************************************      601
C                                                                          602
C                                                                          603
C     ************* STATEMENT  910 IS THE END OF ONE DAILY CYCLE********   604
910   CONTINUE                                                             605
C     ***************************************************************      606
C                                                                          607
C                                                                          608
      END FILE N22                                                         609
      REWIND N20                                                           610
      REWIND N22                                                           611
      READ (5,1020) IDECK                                                  612
      IF (IDECK.EQ.0) GO TO 1010                                           613
      PUNCH 1030, (ALPHA(I),I=1,30)                                        614
      EVAPM=EVAP/0.03937
      WINDM=WIND/2.236
      PUNCH 1040, NTCYC,PERIOD,QINT,DELT,EVAPM,WINDM,WDIR,NQSWRT,NJSW,
     1NJGW,NTRIB
```

```
000          IF (NJSW.LE.0) GO TO 920                                    617
000          PUNCH 1050, (JSW(L),L=1,NJSW)                               618
000   920    CONTINUE                                                    619
000          PUNCH 1050, (JGW(L),L=1,NJGW)                               620
000          IF (NTRIB.LE.0) GO TO 940                                   621
000          DO 930 I=1,NTRIB                                            622
000          PUNCH 1060, ITRIB(I,1),ITRIB(I,2)                           623
000   930    CONTINUE                                                    624
000   940    CONTINUE                                                    625
000          DO 950 J=1,NJ                                               626
000          RAD=-DEP(J)                                                 627
000          HAM=H(J)/3.28
000          AS(J)=ABS(AS(J))
000          ASM=AS(J)/10.744
000          QIM=QIN(J)/35.314
000          QOM=QOU(J)/35.314
000          RAM=-DEP(J)/3.28
000          PUNCH 1070, J,HAM,ASM,QIM,QOM,RAM,X(J),Y(J)
000   950    CONTINUE                                                    629
000          PUNCH 1080                                                  630
000          DO 1000 N=1,NC                                              631
000          IF (NTRIB.LE.0) GO TO 980                                   632
000          DO 960 IL=1,NTRIB                                           633
000          IF (ITRIB(IL,1).EQ.N) GO TO 970                             634
000   960    CONTINUE                                                    635
000          GO TO 980                                                   636
000   970    IJN=ITRIB(IL,2)                                             637
000          RAD=0.5*(-DEP(IJN)-TRBDEP(IL))                              638
000          GO TO 990                                                   639
000   980    NH=NJUNC(N,1)                                               640
000          NL=NJUNC(N,2)                                               641
000          IF (NH.EQ.0) NH=NL                                          642
000          IF (NL.EQ.0) NL=NH                                          643
000          RAD=0.5*(-DEP(NL)-DEP(NH))                                  644
000   990    CONTINUE                                                    645
000          AK(N)=ABS(AK(N))
000          B(N)=ABS(B(N))
000          NJUNC(N,1)=IABS(NJUNC(N,1))
000          NJUNC(N,2)=IABS(NJUNC(N,2))
000          LEN(N)=ABS(LEN(N))
000          RAD=RSAV(N)
000          AK(N)=SQRT(AK(N)*2.208196/32.1739)                          646
000          LAM=LEN(N)/3.28
000          WAM=B(N)/3.28
000          RAM=RAD/3.28
000          VAM=V(N)/3.28
000          PUNCH 1090, N,NJUNC(N,1),NJUNC(N,2),LAM,WAM,RAM,AK(N),VAM
000   1000   CONTINUE                                                    648
000          PUNCH 1080                                                  649
000   1010   CONTINUE                                                    650
000          WRITE (N6,1120)                                             651
000   C      **************         END         *************            652
000   C      **************         END         *************            653
000   C      **************         END         *************            654
000   C      **************         END         *************            655
000          RETURN                                                      656
000   C                                                                  657
```

```
 ******  HYDCAL  ******

  000   C
  000   C
  000   1020  FORMAT (I5)
  000   1030  FORMAT (15A4)
  000   1040  FORMAT (I5,3F5.0,5X,3F5.0,4I5)
  000   1050  FORMAT (20I5)
  000   1060  FORMAT (2I5)
  000   1070  FORMAT (I5,F10.3,-6PF10.5,0P2F10.2,F10.2,5X,-3P2F10.3)          PEST
  000   1080  FORMAT (5H99999)
  000   1090  FORMAT (3I5,10X,5F10.4)                                          PEST
  000   1100  FORMAT (33A4)
  000    1110 FORMAT('0 V OVER 10 MPS, TIDAL CYCLE',I4,' QUAL CYCLE',I4,' HYDRO
  000          1 CYCLE',I4,' DEPTH',E10.4,'    V',E10.4,' CHANNEL',I5)
  000   1120  FORMAT (38H0COMPLETION OF THE HYDRAULIC PROGRAM  )
  000         END

END ELT.

@HDG,P  ******  HYDPLT  ******
```

****** HYDPLT ******

@ELT,L HMAINT.HYDPLT

```
000         SUBROUTINE HYDPLT
000   C      THIS ROUTINE IS CALLED BY HMAINV (OR HMAINT)
000   C      AND CALLS FIND AND PICTO
000   C     ************** HYDRAULIC PROGRAM PRINTING             *************
000   C     ************** AND PLOTTING PROGRAM                   *************
000   C
000   C     ************** BATTELLE NORTHWEST 11/9/71             *************
000   C     ****************************************************************
000   C
000   C
000   C     ************** ASSIGN THE COMMON  DATA                *************
000         COMMON /TAPES/N5,N6,N20,N22,N24
000         COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13
000   C
000   C     ************** CONTROL AND TITLE INFORMATION          *************
000         COMMON /PRINT/ NJ,NC,NTCYC,NOCYC,DELTQ,PERIOD,ALPHA(30),
000        1DEP(70),NOSWRT
000         COMMON/NT/NTP,NQP,DUM(600),HP(20,200),VOLP(20,200),TIMEP(200),
000        1QINP(20,200),QOUP(20,200),QP(20,200),VP(20,200),XX(400),YY(400),
000        2ARK(400),XYM(3,500)
000         DIMENSION ICH(6),SPACE(6),NJW(20),NCW(20),ISYM(5)
000         DIMENSION CARD1(66)
000         DIMENSION RUNTIT(20)
000         DATA STAR/1H*/,PERID/1H./,VEE/1HV/,QUU/1HQ/
000         DATA (SPACE(I),I=1,6)/6*1H /
000         DATA BLANK/1H /
000   C
000   C
000   C     ************** ASK THE USER WHICH INFORMATION         *************
000   C     ************** HE WISHES TO PRINT AND PLOT            *************
000   100   CONTINUE
000         READ (N5,450,END=110) RUNTIT
000         GO TO 120
000   110   RETURN
000   120   CONTINUE
000         READ (N5,510) IDAY1,IDAYL,NJP
000         IF (IDAY1.LE.0) IDAY1=1
000         IF (IDAY1.LT.NOSWRT) IDAY1=NOSWRT
000         IF (IDAYL.GT.NTCYC) IDAYL=NTCYC
000         IF ((IDAYL-IDAY1).GT.6) IDAYL=IDAY1+6
000         IF (IDAY1.GT.IDAYL) IDAYL=IDAY1
000         IF (NJP.GT.20) WRITE (N6,500)
000         NJP=MIN0(20,NJP)
000         READ (N5,520) (NJW(I),I=1,NJP)
000         READ (N5,530) NCP
000         IF (NCP.GT.20) WRITE (N6,540)
000         NCP=MIN0(20,NCP)
000         READ (N5,520) (NCW(I),I=1,NCP)
000         READ (N5,460) NPLOTS
000         WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000         WRITE (6,480) ALPHA
000         WRITE (N6,550) IDAY1,IDAYL,NJP,(NJW(I),I=1,NJP)
000         WRITE (N6,560) NCP,(NCW(I),I=1,NCP)
```

```
000          IF (NPLOTS.EQ.0) WRITE (6,490)
000   C      **************                 END                   *************
000   C
000   C
000   C      ************** SEARCH FOR THE DESIRED TIME INTERVAL  *************
000          REWIND N24
000   130    READ (N24) NTP,NQP
000          IF (NTP.GE.IDAY1) GO TO 140
000          READ (N24)
000          READ (N24)
000          READ (N24)
000          READ (N24)
000          READ (N24)
000          READ (N24)
000          GO TO 130
000   140    CONTINUE
000          DO 160 ND=IDAY1,IDAYL
000          DO 150 NQC=1,NQCYC
000          ILAST=(NTP-IDAY1)*NQCYC+NQP
000          TIMEP(ILAST)=(FLOAT((NTP-1)*NQCYC+NQP)-0.5)/FLOAT(NQCYC)
000          CALL FIND (ILAST,NJP,DUM,NJW,HP,NJ)
000          CALL FIND (ILAST,NJP,DUM,NJW,VOLP,NJ)
000          CALL FIND (ILAST,NJP,DUM,NJW,QINP,NJ)
000          CALL FIND (ILAST,NJP,DUM,NJW,QOUP,NJ)
000          CALL FIND (ILAST,NCP,DUM,NCW,QP,NC)
000          CALL FIND (ILAST,NCP,DUM,NCW,VP,NC)
000          IF ((ND.EQ.IDAYL).AND.(NQC.EQ.NQCYC)) GO TO 170
000          READ (N24) NTP,NQP
000   150    CONTINUE
000          IF (ND.EQ.IDAYL) GO TO 170
000   160    CONTINUE
000   C      **************                 END                   *************
000   C
000   C
000   C      ************** WRITE OUT THE JUNCTION DATA TO PRINTER ************
000   170    CONTINUE
000          IWHOLE=NJP/3
000          IPART=NJP-IWHOLE*3
000          IF (IWHOLE.EQ.0) GO TO 210
000          DO 200 I=1,IWHOLE
000          IL=(I-1)*3
000          WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000          WRITE (6,480) ALPHA
000          DO 180 IK=1,3
000   180    ICH(IK)=NJW(IL+IK)
000          WRITE (N6,570) (SPACE(L),ICH(L),L=1,3)
000          WRITE (N6,580) (SPACE(L),L=1,3)
000          WRITE (N6,590) (SPACE(L),L=1,3)
000          DO 190 IDAY=IDAY1,IDAYL
000          IL1=IL+1
000          IL3=IL+3
000          ID=(IDAY-IDAY1)*NQCYC+1
000          IDL=ID-1+NQCYC
000          DO 188 I1=IL1,IL3
000          DO 188 L=ID,IDL
000          HP(I1,L)=HP(I1,L)/3.28
000          VOLP(I1,L)=VOLP(I1,L)/35.314
```

```
000           QINP(I1,L)=QINP(I1,L)/35.314
000     188   QOUP(I1,L)=QOUP(I1,L)/35.314
000           WRITE(N6,600) IDAY
000           WRITE(N6,610) (TIMEP(L),(HP(I1,L),VOLP(I1,L),QINP(I1,L),QOUP(I1,L)
000          1,I1=IL1,IL3),L=ID,IDL)
000           DO 189 I1=IL1,IL3
000           DO 189 L=ID,IDL
000           HP(I1,L)=HP(I1,L)*3.28
000           VOLP(I1,L)=VOLP(I1,L)*35.314
000           QINP(I1,L)=QINP(I1,L)*35.314
000     189   QOUP(I1,L)=QOUP(I1,L)*35.314
000    190    CONTINUE                                                        110
000    200    CONTINUE                                                        111
000           IF (IPART.LE.0) GO TO 260                                       112
000    210    ILL=IWHOLE*3+IPART                                              113
000           IL1=IWHOLE*3+1                                                  114
000           DO 220 I=IL1,ILL                                                115
000           J=I-IL1+1                                                       116
000    220    ICH(J)=NJW(I)                                                   117
000           WRITE (6,470) (RUNTIT(KITE),KITE=1,20)                          118
000           WRITE (6,480) ALPHA                                             119
000           WRITE (N6,570) (SPACE(L),ICH(L),L=1,IPART)                      120
000           WRITE (N6,580) (SPACE(L),L=1,IPART)                             121
000           WRITE (N6,590) (SPACE(L),L=1,IPART)                             122
000           DO 250 IDAY=IDAY1,IDAYL                                         123
000           IL1=IWHOLE*3+1                                                  124
000           ILL=IWHOLE*3+IPART                                              125
000           ID=(IDAY-IDAY1)*NQCYC+1                                         126
000           IDL=ID-1+NQCYC                                                  127
000           WRITE(N6,600) IDAY
000           GO TO (230,240), IPART                                          129
000     230   CONTINUE
000           DO 231 L=ID,IDL
000           HP(IL1,L)=HP(IL1,L)/3.28
000           VOLP(IL1,L)=VOLP(IL1,L)/35.314
000           QINP(IL1,L)=QINP(IL1,L)/35.314
000     231   QOUP(IL1,L)=QINP(IL1,L)/35.314
000           WRITE(N6,620) (TIMEP(L),HP(IL1,L),VOLP(IL1,L),QINP(IL1,L),QOUP(IL1
000          1,L),L=ID,IDL)
000           DO 232 L=ID,IDL
000           HP(IL1,L)=HP(IL1,L)*3.28
000           VOLP(IL1,L)=VOLP(IL1,L)*35.314
000           QINP(IL1,L)=QINP(IL1,L)*35.314
000     232   QOUP(IL1,L)=QINP(IL1,L)*35.314
000           GO TO 250                                                       132
000     240   CONTINUE
000           DO 241 I1=IL1,ILL
000           DO 241 L=ID,IDL
000           HP(I1,L)=HP(I1,L)/3.28
000           VOLP(I1,L)=VOLP(I1,L)/35.314
000           QINP(I1,L)=QINP(I1,L)/35.314
000     241   QOUP(I1,L)=QOUP(I1,L)/35.314
000           WRITE(N6,630) (TIMEP(L),(HP(I1,L),VOLP(I1,L),QINP(I1,L),QOUP(I1,L)
000          1,I1=IL1,ILL),L=ID,IDL)
000           DO 242 I1=IL1,ILL
000           DO 242 L=ID,IDL
000           HP(I1,L)=HP(I1,L)*3.28
```

```
000         VOLP(I1,L)=VOLP(I1,L)*35.314
000         QINP(I1,L)=QINP(I1,L)*35.314
000     242 QOUP(I1,L)=QOUP(I1,L)*35.314
000   250   CONTINUE                                                                     135
000   260   CONTINUE                                                                     136
000   C     **************              END                          *************   137
000   C                                                                                  138
000   C                                                                                  139
000   C     ************** WRITE OUT THE CHANNEL DATA TO THE PRINTER *********           140
000         IWHOLE=NCP/6                                                                 141
000         IPART=NCP-IWHOLE*6                                                           142
000         IF (IWHOLE.EQ.0) GO TO 300                                                   143
000         DO 290 I=1,IWHOLE                                                            144
000         WRITE (6,470) (RUNTIT(KITE),KITE=1,20)                                       145
000         WRITE (6,480) ALPHA                                                          146
000         IL=(I-1)*6                                                                   147
000         DO 270 IK=1,6                                                                148
000   270   ICH(IK)=NCW(IL+IK)                                                           149
000         WRITE (N6,640) (SPACE(L),ICH(L),L=1,6)                                       150
000         WRITE (N6,650) (SPACE(L),L=1,6)                                              151
000         WRITE (N6,660) (SPACE(L),L=1,6)                                              152
000         DO 280 IDAY=IDAY1,IDAYL                                                      153
000         IL1=IL+1                                                                     154
000         IL3=IL+6                                                                     155
000         ID=(IDAY-IDAY1)*NQCYC+1                                                      156
000         IDL=ID-1+NQCYC                                                               157
000         DO 278 I1=IL1,IL3
000         DO 278 L=ID,IDL
000         QP(I1,L)=QP(I1,L)/35.314
000     278 VP(I1,L)=VP(I1,L)/3.28
000         WRITE(N6,600) IDAY
000         WRITE(N6,670) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,IL3),L=ID,IDL)
000         DO 279 I1=IL1,IL3
000         DO 279 L=ID,IDL
000         QP(I1,L)=QP(I1,L)*35.314
000     279 VP(I1,L)=VP(I1,L)*3.28
000   280   CONTINUE                                                                     160
000   290   CONTINUE                                                                     161
000         IF (IPART.LE.0) GO TO 380                                                    162
000   300   ILL=IWHOLE*6+IPART                                                           163
000         IL1=IWHOLE*6+1                                                               164
000         DO 310 I=IL1,ILL                                                             165
000         J=I-IL1+1                                                                    166
000   310   ICH(J)=NCW(I)                                                                167
000         WRITE (6,470) (RUNTIT(KITE),KITE=1,20)                                       168
000         WRITE (6,480) ALPHA                                                          169
000         WRITE (N6,640) (SPACE(L),ICH(L),L=1,IPART)                                   170
000         WRITE (N6,650) (SPACE(L),L=1,IPART)                                          171
000         WRITE (N6,660) (SPACE(L),L=1,IPART)                                          172
000         DO 370 IDAY=IDAY1,IDAYL                                                      173
000         ID=(IDAY-IDAY1)*NQCYC+1                                                      174
000         IDL=ID-1+NQCYC                                                               175
000         DO 318 I1=IL1,ILL
000         DO 318 L=ID,IDL
000         QP(I1,L)=QP(I1,L)/35.314
000     318 VP(I1,L)=VP(I1,L)/3.28
000         WRITE(N6,600) IDAY
```

```
000        GO TO (320,330,340,350,360), IPART                                          177
000   320  CONTINUE                                                                    178
000        WRITE(N6,680) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000        GO TO 368
000   330  CONTINUE                                                                    181
000        WRITE(N6,690) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000        GO TO 368
000   340  CONTINUE                                                                    184
000        WRITE(N6,700) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000        GO TO 368
000   350  CONTINUE                                                                    187
000        WRITE(N6,710) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000        GO TO 368
000   360  CONTINUE                                                                    190
000        WRITE(N6,720) (TIMEP(L),(QP(I1,L),VP(I1,L),I1=IL1,ILL),L=ID,IDL)
000    368 CONTINUE
000        DO 369 I1=IL1,ILL
000        DO 369 L=ID,IDL
000        QP(I1,L)=QP(I1,L)*35.314
000    369 VP(I1,L)=VP(I1,L)*3.28
000   370  CONTINUE                                                                    192
000   380  CONTINUE                                                                    193
000   C    **************                END                         *************    194
000   C                                                                                195
000   C                                                                                196
000   C    ************** CALCULATE THE NUMBER OF POINTS TO BE PLOTTED ******          197
000        IF (NPLOTS.EQ.0) GO TO 100                                                  198
000        NPOINT=(IDAYL-IDAY1+1)*NQCYC                                                199
000   C    **************              END                           *************    200
000   C                                                                                201
000   C    ************** SET UP THE SYMBOL PRIORITIES FOR PICTUR ***********          202
000        DO 390 I=1,4                                                                203
000   390  ISYM(I)=STAR                                                                204
000        ISYM(5)=BLANK                                                               205
000   C    **************              END                           *************    206
000   C                                                                                207
000   C                                                                                208
000   C    ************** SET UP THE OUTER DO LOOP FOR THE JUNCTION PLOTS ***          209
000        DO 410 J=1,NJP                                                              210
000   C                                                                                211
000   C    ************** SET UP THE ARRAYS AND ALPHA NECESSARY ************           212
000   C    **************   FOR THE PICTUR SUBROUTINE              ************         213
000        IJUNC=NJW(J)                                                                214
000        HMAX=0.                                                                     215
000        DO 400 K=1,NPOINT                                                           216
000        XX(K)=TIMEP(K)                                                              217
000        YY(K)=HP(J,K)                                                               218
000        HMAX=AMAX1(HMAX,ABS(HP(J,K)))                                               219
000   400  ARK(K)=STAR                                                                 220
000        XX(NPOINT+1)=XX(NPOINT)                                                     221
000        XX(NPOINT+2)=XX(NPOINT)                                                     222
000        YY(NPOINT+1)=1.5*HMAX                                                       223
000        YY(NPOINT+2)=-1.5*HMAX                                                      224
000        ARK(NPOINT+1)=BLANK                                                         225
000        ARK(NPOINT+2)=BLANK                                                         226
000        NPOIN=NPOINT+2
000        DO 405 IJI=1,NPOIN
```

```
000  405  YY(IJI)=YY(IJI)/3.28
000  C    **************                    END                       *************
000  C
000            ENCODE (53,730,CARD1) IJUNC
000            ENCODE (45,740,CARD1(34)) IJUNC
000            CALL PICTO (NPOIN,25,50,ISYM,CARD1,RUNTIT)
000  410       CONTINUE
000  C    **************                    END                       *************
000  C
000  C    ************** SET UP THE SYMBOL PRIORITIES FOR PICTUR ***********
000            ISYM(1)=STAR
000  C    **************                    END                       *************
000  C
000  C
000  C    ************** SET UP THE OUTER DO LOOP FOR THE CHANNEL PLOTS ****
000            DO 440 J=1,NCP
000  C    ************** SEARCH FOR QMAX AND VMAX                     *************
000            QMAX=0.0
000            DO 420 I=1,NPOINT
000            QMAX=AMAX1(ABS(QP(J,I)),QMAX)
000  420       CONTINUE
000  C    **************               END                            *************
000  C
000  C    ************** SET UP THE ARRAYS AND ALPHA NECESSARY ************
000  C    **************   FOR THE PICTUR SUBROUTINE                   ************
000            ICHN=NCW(J)
000            DO 430 K=1,NPOINT
000            YY(K)=QP(J,K)/1000.
000            ARK(K)=STAR
000  430       CONTINUE
000            YY(NPOINT+1)=1.50*QMAX/1000.
000            YY(NPOINT+2)=-1.50*QMAX/1000.
000            IN=NPOINT+2
000            DO 435 I=1,IN
000  435       YY(I)=YY(I)/35.314
000  C
000  C    **************                    END                       *************
000  C
000            ENCODE (53,750,CARD1) ICHN
000            ENCODE (47,760,CARD1(34)) ICHN
000            CALL PICTO (NPOIN,25,50,ISYM,CARD1,RUNTIT)
000  440       CONTINUE
000  C    **************               END                            *************
000  C
000  C
000            GO TO 100
000  C    **************                    END                       *************
000  C
000  C
000  C
000  450       FORMAT (20A4)
000  460       FORMAT (I5)
000  470       FORMAT (1H1,25X,20A4)
000  480       FORMAT (1H0,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH
000           1LAND, WASHINGTON,/,81X,20HEXPLORE-1 CODE      ,/81X,20HHYDRODYNAMI
000           2C MODEL  ,/)
000  490       FORMAT (' AS REQUESTED THE PLOTS WILL BE SUPRESSED.')
```

```
000   500   FORMAT (' YOU CANNOT MONITOR MORE THAN 20 NODES AT ONE TIME '/)
000   510   FORMAT (2I10,/I10)
000   520   FORMAT (20I4)
000   530   FORMAT (I10)
000   540   FORMAT (' YOU CANNOT MONITOR MORE THAN 20 CHANNELS AT ONE TIME '/)
000   550   FORMAT (1H0,'FOR WHAT SPAN OF DAYS DO YOU WISH LINEPRINTER AND PLO
000        1T INFORMATION'/' I WISH TO LOOK AT THE DATA STARTING WITH DAY',I5,
000        2' AND ENDING WITH DAY',I5,//' HOW MANY NODAL POINTS DO YOU WISH TO
000        3 MONITOR'/' I WISH TO MONITOR ',I5,' NODES'//' FOR WHICH NODES DO
000        4 YOU WISH LINEPRINTER AND PLOT INFORMATION'/' I WISH TO MONITOR TH
000        5E FOLLOWING NODES '/20I5,/20I5)
000   560   FORMAT (//,' HOW MANY CHANNELS DO YOU WISH TO MONITOR '/' I WISH T
000        1O MONITOR ',I5,' CHANNELS '//' FOR WHICH CHANNELS DO YOU WISH LINE
000        2PRINTER AND PLOT INFORMATION '/' I DESIRE PLOT AND LINEPRINTER INF
000        3ORMATION FOR THE FOLLOWING CHANNELS '/20I5/20I5)
000   570   FORMAT(22X,A1,'JUNCTION',I4,A1,27X,'JUNCTION',I4,A1,27X,'JUNCTION'
000        $,I4,/)
000   580   FORMAT(6X,A1,'TIME',4X,'HEAD',6X,'VOLUME',4X,'INFLOW',3X,'OUTFLOW'
000        $,A1,3X,'HEAD',6X,'VOLUME',4X,'INFLOW',3X,'OUTFLOW',A1,3X,'HEAD',6X
000        $,'VOLUME',4X,'INFLOW',3X,'OUTFLOW')
000   590   FORMAT(5X,A1,'(DAYS)     (M)          (M**3)        (CMS)      (CMS)',A1,'
000        $  (M)          (M**3)        (CMS)      (CMS)',A1,'        (M)          (M**3)
000        $  (CMS)      (CMS)')
000   600   FORMAT (1H0,11HDAY NUMBER ,I4,/)
000   610   FORMAT (1PE12.4,2E11.4,2E9.2,2E11.4,2E9.2,2E11.4,2E9.2)
000   620   FORMAT (1PE12.4,2E11.4,2E9.2)
000   630   FORMAT (1PE12.4,2E11.4,2E9.2,2E11.4,2E9.2)
000   640   FORMAT (1H0,16X,A1,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANN
000        1EL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4,A1,7X,8HCHANNEL ,I4
000        2)
000   650   FORMAT (7X,A1,4HTIME,18H      FLOW VELOCITY,A1,19H       FLOW VELOCI
000        1TY,A1,19H       FLOW VELOCITY,A1,19H       FLOW VELOCITY,A1,19H
000        2 FLOW VELOCITY,A1,19H       FLOW VELOCITY)
000   660   FORMAT(5X,A1,'(DAYS)       (CMS)    (M/SEC)',A1,'       (CMS)    (M/SEC)',
000        1A1,'       (CMS)    (M/SEC)',A1,'       (CMS)    (M/SEC)',A1,'       (CMS)
000        2(M/SEC)',A1,'       (CMS)    (M/SEC)')
000   670   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
000   680   FORMAT (E12.4,2E9.3)
000   690   FORMAT (E12.4,2E9.3,2X,2E9.3)
000   700   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3)
000   710   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
000   720   FORMAT (E12.4,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3,2X,2E9.3)
000   730   FORMAT (' PLOT OF THE HEAD VERSUS TIME CURVE FOR JUNCTION ',I4)
000   740   FORMAT(' (HEAD IS IN METERS AND THE TIME IS IN DAYS) ')
000   750   FORMAT (' PLOT OF THE FLOW VERSUS TIME CURVE FOR CHANNEL',I4,'   ')
000   760   FORMAT('  FLOW IN (THOUSANDS OF CMS) AND TIME IN (DAYS)')
000         END
```

END ELT.

****** MAIN ******

@ELT,I HMAINr.MAIN

```
000    C      MAIN PROGRAM TO COORDINATE THE CALCULATION AND PLOTTING PROGRAM
000    C      THIS PROGRAM CALLS HYDCAL AND HYDPLT
000    C     SCRATCH UNITS ARE SCRATCH TAPES                                         2
000    C
000    C
000    C          THIS EXECUTIVE PROGRAM MAKES I/O ASSIGNMENTS AND CALLS THE
000    C               CALCULATION SUBROUTINE HYDCAL AND THE PRINT-PLOT
000    C               PROGRAM HYDPLT
000    C
000    C
000          COMMON /TAPES/N5,N6,N20,N22,N24                                         3
000          COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13                                     4
000    C                                                                             5
000          N5=5                                                                    6
000          N6=6                                                                    7
000    C                                                                             8
000          IZ5=70
000          IZ6=6                                                                   10
000          IZ9=100
000          IZ12=20                                                                 12
000          IZ13=20                                                                 13
000          N20=2                                                                   14
000          N22=N20                                                                 15
000          N24=4
000          REWIND N20                                                              17
000          REWIND N22                                                              18
000          REWIND N24                                                              19
000    C
000          CALL HYDCAL                                                             20
000    C
000          CALL HYDPLT                                                             21
000    C
000          STOP                                                                    22
000          END                                                                     -
```

END ELT.

@HDG,P ****** PICTO ******

****** PICTO ******

@ELT,L HMAINT.PICTO

```
      SUBROUTINE PICTO (N,M,MCOL,ISYM,CARD1,RUNTIT)
C     THIS ROUTINE IS CALLED BY HYDPLT AND CALLS SORT
C    PROGRAMMED BY JE SCHLOSSER  1965  MODIFIED BY CA OSTER  1966          2
C    PRESENTS A PICTURE OF DATA ON PRINTED OUTPUT, TWO OPTIONS BEING       3
C    AVAILABLE                                                             4
C       1   MCOL POSITIVE                                                  5
C       2   MCOL NEGATIVE, IN WHICH CASE XINCREMENTS ARE TAKEN AS EQUAL    6
C             TO Y INCREMENTS AS DETERMINED BY M                           7
C                                                                          8
C    DICTIONARY                                                            9
C                                                                         10
C       VARIABLE    DEFINITION                                            11
C          N        NUMBER OF POINTS TO PLOT      (MAXIMUM OF 500)        12
C          M        MAXIMUM NUMBER OF LINES                               13
C          MCOL     MAXIMUM NUMBER OF COLUMNS                             14
C                                                                         15
C        XX(I)      X COORDINATE FOR ITH POINT                            16
C        YY(I)      Y COORDINATE FOR ITH POINT                            17
C        ARK(I)     MARKER FOR ITH POINT                                  18
C        ISYM(I)    PRIORITY DESIGNATOR FOR MARKER USED ON I-TH POINT     19
C                         (LOWER SUBSCRIPT INDICATES HIGHER PRIORITY)     20
C                                                                         21
C                                                                         22
C    ************** BATTELLE NORTHWEST 11/9/71          *************    23
C    *****************************************************************    24
C                                                                         25
C                                                                         26
C    ************** ASSIGN THE COMMON  DATA              *************    27
     COMMON /TAPES/N5,N6,N20,N22,N24                                      28
     COMMON/PARAMS/IZ5,IZ6,IZ9,IZ12,IZ13                                  29
C                                                                         30
C    ************** CONTROL AND TITLE INFORMATION        *************    31
     COMMON /PRINT/ NJ,NC,NTCYC,NOCYC,DELTQ,PERIOD,ALPHA(30),              32
    1DEP(70),NQSWRT
     COMMON/NT/NTP,NQP,DUM(600),HP(20,200),VOLP(20,200),TIMEP(200),
    1Q1NP(20,200),QOUP(20,200),QP(20,200),VP(20,200),XX(400),YY(400),
    2ARK(400),XYM(3,500)
     DIMENSION IXYM(3,500)                                                37
     EQUIVALENCE (IXYM,XYM)                                               38
     DIMENSION PX(6),ALF(107),ILF(107),ISYM(5)                            39
     DIMENSION CARD1(66)
     DIMENSION RUNTIT(20)                                                 41
     EQUIVALENCE (ILF,ALF),(BLANK,LANKBA)                                 42
     EXTERNAL SORDER                                                      46
C                                                                         43
     DATA BLANK/1H /                                                      44
C                                                                         45
     KILL=0                                                               47
     U=MAX0(MIN0(500,N),2)                                                48
     XYM(1,2)=1.01                                                        49
     XYM(2,2)=1.01                                                        50
     XYM(3,2)=BLANK                                                       51
     XMIN=1.0E37                                                          52
```

```
000          XMAX=-1.0E37
000          DO 100 I=1,N
000          XYM(1,I)=XX(I)
000          XYM(2,I)=YY(I)
000          XYM(3,I)=ARK(I)
000          XMIN=AMIN1(XMIN,XYM(1,I))
000          XMAX=AMAX1(XMAX,XYM(1,I))
000    100   CONTINUE
000          CALL SOFT (XYM,N,3,SORDER)
000          YMIN=XYM(2,N)
000          YMAX=XYM(2,1)
000          DYLOG=ALOG10((YMAX-YMIN)/FLOAT(M)*1.0E5)
000          APROX=DYLOG-AINT(DYLOG)
000          DO 110 I=2,10
000          FI=I
000          IF (APROX-ALOG10(FI)) 120,120,110
000    110   CONTINUE
000    120   EXACT=FI*10.0**(INT(DYLOG)-5)
000    130   IF (MCOL) 200,140,140
000    140   DXLOG=ALOG10((XMAX-XMIN)/FLOAT(MCOL/2)*1.0E5)
000          XAPROX=DXLOG-AINT(DXLOG)
000          IF (XAPROX-.3010) 150,150,160
000    150   XEXACT=2.0*10.0**(INT(DXLOG)-5)
000          GO TO 190
000    160   IF (XAPPOX-.6990) 170,170,180
000    170   XEXACT=5.0*10.0**(INT(DXLOG)-5)
000          GO TO 190
000    180   XEXACT=10.0**(INT(DXLOG)-4)
000    190   CONTINUE
000          XACT=XEXACT/2.0
000          GO TO 210
000    200   XACT=EXACT/2.0
000    210   TENX=20.0*XACT
000          TENE=10.0*EXACT
000          MAXYI=(YMAX/TENE)+(0.5+SIGN(0.5,YMAX))
000          MAXXI=(XMAX/TENX)+(0.5+SIGN(0.5,XMAX))
000          MINYI=(YMIN/TENE)-(0.5+SIGN(0.5,-YMIN))
000          MINXI=(XMIN/TENX)-(0.5+SIGN(0.5,-XMIN))
000          YFIRST=TENE*FLOAT(MAXYI)
000          XFIRST=TENX*FLOAT(MINXI)
000          LINES=10*(MAXYI-MINYI)+1
000          KOLS=20*(MAXXI-MINXI)
000          IF (KOLS-500) 230,230,220
000    220   WRITE (6,530) KOLS
000          KOLS=500
000    230   IF (LINES-401) 250,250,240
000    240   WRITE (6,540)
000          RETURN
000    250   CONTINUE
000          KILL=KILL+1
000          IF (KILL.GT.500) GO TO 260
000          IF (KOLS.GE.75) GO TO 260
000          MCOL=MCOL+1
000          GO TO 130
000    260   LEAF=(KOLS+99)/100
000          IF (LEAF.LE.1) GO TO 270
000          MCOL=MCOL-1
```

```
000         GO TO 130
000    270  DO 450 L=1,LEAF
000         DO 280 I=1,6
000         PX(I)=5.*TENX*FLOAT(L-1)+TENX*FLOAT(I-1)+XFIRST
000    280  CONTINUE
000         WRITE (6,470) (RUNTIT(KITE),KITE=1,20)
000         WRITE (6,460) ALPHA
000         WRITE (6,480) (CARD1(ISTAT),ISTAT=1,66)
000         WRITE (6,520) PX
000         WRITE (6,510)
000         DEX=XACT/2.0
000         DEL=EXACT/2.0
000         DDD=DEX+2.0*XACT
000         J=1
000         DO 440 I=1,LINES
000         YPLOT=YFIRST-EXACT*FLOAT(I-1)
000         DO 290 JKL=1,107
000    290  ALF(JKL)=BLANK
000    300  IF (J-N) 310,310,400
000    310  IF (XYM(1,J)-PX(1)) 390,320,320
000    320  CONTINUE
000         IF (XYM(2,J)-(YPLOT+DEL)) 330,330,400
000    330  IF (XYM(2,J)-(YPLOT-DEL)) 400,340,340
000    340  CONTINUE
000         IF (XYM(1,J)-PX(6)-DDD) 350,350,390
000    350  CONTINUE
000         KOL=INT((XYM(1,J)+DEX-PX(1))/XACT)+4
000         IF ((KOL.GT.107).OR.(KOL.LT.1)) GO TO 390
000         IXYM3J=IXYM(3,J)
000         ILFKOL=ILF(KOL)
000         IF (ILFKOL.EQ.LANKBA) GO TO 380
000         ISYM1=0
000         ISYM2=0
000         DO 360 IIYY=1,5
000         IF (ILFKOL.EQ.ISYM(IIYY)) ISYM1=IIYY
000         IF (IXYM3J.EQ.ISYM(IIYY)) ISYM2=IIYY
000    360  CONTINUE
000         ISYMM=MIN0(ISYM1,ISYM2)
000         IF (ISYMM) 390,390,370
000    370  ILF(KOL)=ISYM(ISYMM)
000         GO TO 390
000    380  ALF(KOL)=XYM(3,J)
000    390  J=J+1
000         GO TO 300
000    400  CONTINUE
000         IF (MOD(I-1,10).NE.0) GO TO 410
000         WRITE (6,490) YPLOT,ALF
000         GO TO 430
000    410  IF (MOD(I-1,5).NE.0) GO TO 420
000         WRITE(6,550) ALF
000         GO TO 430
000    420  WRITE (6,500) ALF
000    430  CONTINUE
000    440  CONTINUE
000         WRITE (6,510)
000         WRITE (6,520) PX
000    450  CONTINUE
```

****** PICTO ******

```
000         RETURN
000   C
000   C
000   C
000   460   FORMAT (1H0,15A4,20X,20HBATTELLE NORTHWEST  ,/1X,15A4,19X,21H RICH
000        1LAND, WASHINGTON,/,81X,20HEXPLORE-1 CODE      ,/81X,20HHYDRODYNAMI
000        2C MODEL  ,/)
000   470   FORMAT (1H1,25X,20A4)
000   480   FORMAT (1H0,//33A4,/33A4///)
000   490   FORMAT (1X,F9.3,2H *,107A1,1H*)
000   500   FORMAT (11X,1HI,107A1,1HI)
000   510   FORMAT (1H0,14X,1H*,    5(20H - - - - + - - - - *),/,1H )
000   520   FORMAT (11X,F7.2,5(13X,F7.2))
000   530   FORMAT (48H0ONLY THE FIRST 500 COLUMNS OF A PLOT REQUIRING I3,25H
000        1COLUMNS WILL BE PRINTED.)
000    540  FORMAT(1X,'THERE IS A LIMIT OF 400 LINES')
000   550   FORMAT (11X,1H+,107A1,1H+)
000         END
000
000
```

END ELT.

@HDG,P ****** SORDER ******

****** SORDER ******

@ELT,L HMAINT.SORDER

```
000     FUNCTION SORDER (FIRST,SECOND)
000  C   THIS FUNCTION IS CALLED BY SORT
000     DIMENSION FIRST(3),SECOND(3)                    2
000     SORDER=FIRST(2)-SECOND(2)                       3
000     RETURN                                          4
000     END                                             -
```

END ELT.

@HDG,P ****** SORT ******

****** SORT ******

@ELT,L HMAINT.SORT

```
000          SUBROUTINE SORT (M,N,ITEM,Q)
000     C     THIS ROUTINE IS CALLED BY PICTUR AND CALLS Q AND SORDER
000     C
000     C    ALGORITHM 245 -  TREESORT 3   FROM ACM, DEC. 1964
000     C                                        VOL 7   NUMBER 12, PAGE 701
000     C
000     C    PROGRAMMED BY JE SCHLOSSER
000     C
000     C
000     C    GENERAL PURPOSE INTERNAL SORT SUBROUTINE
000     C
000     C    EXAMPLE OF USE - - -   ASSUME -   N ITEMS OF 5 WORDS EACH
000     C                                      TO BE SORTED IN ASCENDING
000     C                                      ORDER ON THE SECOND WORD.
000     C    MAIN PROGRAM
000     C    DIMENSION A(5,1000)     N IS LESS THAN OR EQUAL TO 1000
000     C                            A CONTAINS THE ITEMS TO BE SORTED
000     C
000     C    EXTERNAL Q          Q IS A FUNCTION SUBROUTINE WHICH WILL RETURN
000     C     .                  A POSITIVE NUMBER IF THE FIRST ITEM (FIRST
000     C     .                  ARGUMENT) IS TO SORT AHEAD OF THE  SECOND
000     C     .                  ITEM (SECOND ARGUMENT).   SEE EXAMPLE BELOW.
000     C
000     C    CALL SORT (A,N,5,Q)    ARGUMENT     MEANING
000     C     .                      FIRST       ARRAY CONTAINING ITEMS
000     C     .                      SECOND      NUMBER OF ITEMS
000     C     .                      THIRD       NUMBER OF WORDS PER ITEM
000     C     .                      FOURTH      FUNCTION SUBROUTINE TO
000     C     .                                        DEFINE SORT ORDER
000     C
000     C    FUNCTION Q(B,C)          WRITE A FUNCTION SUBROUTINE SUCH AS THIS.
000     C    DIMENSION B(5),C(5)      IT SHOULD RETURN A POSITIVE RESULT IF
000     C    Q=C(2)-B(2)              THE FIRST ARGUMENT SHOULD SORT AHEAD
000     C    RETURN                   OF THE SECOND ARGUMENT.  THIS ROUTINE
000     C    END                      PRODUCES AN ASCENDING SORT ON THE SECOND
000     C                             WORD  OF THE ITEMS.
000     C
000     C    NOTE - -  THE MAXIMUM NUMBER OF WORDS PER ITEM IS LIMITED
000     C    BY THE DIMENSION OF KOPY.     THIS LIMIT IS PRESENTLY 100.
000     C
000     C    APPROXIMATE SPEED IS 250 ITEMS PER SECOND.
000          INTEGER Q
000          DIMENSION KOPY (100)
000          DIMENSION M(ITEM,N)
000          IF (N-1) 320,320,100
000     100  K=N/2+1
000          L=N/2-1
000          IF (L) 210,210,110
000     110  CONTINUE
000          DO 200 II=1,L
000          I=K-II
000          IS=I
000          NS=N
```

****** SORT ******

```
000          DO 120 IQ=1,ITEM
000   120    KOPY(IQ)=M(IQ,IS)
000   130    J=2*IS
000          IF (J.GT.NS) GO TO 180
000          IF (J.GE.NS) GO TO 150
000          IF (Q(M(1,J+1),M(1,J))) 140,150,150
000   140    J=J+1
000   150    IF (Q(M(1,J),KOPY)) 160,180,180
000   160    DO 170 IQ=1,ITEM
000   170    M(IQ,IS)=M(IQ,J)
000          IS=J
000          GO TO 130
000   180    DO 190 IQ=1,ITEM
000   190    M(IQ,IS)=KOPY(IQ)
000   200    CONTINUE
000   210    NPLUS=N+2
000          DO 310 II=2,N
000          I=NPLUS-II
000          IS=1
000          NS=I
000          DO 220 IQ=1,ITEM
000   220    KOPY(IQ)=M(IQ,IS)
000   230    J=2*IS
000          IF (J.GT.NS) GO TO 280
000          IF (J.GE.NS) GO TO 250
000          IF (Q(M(1,J+1),M(1,J))) 240,250,250
000   240    J=J+1
000   250    IF (Q(M(1,J),KOPY)) 260,280,280
000    260    DO 270 IQ=1,ITEM
000   270    M(IQ,IS)=M(IQ,J)
000          IS=J
000          GO TO 230
000   280    DO 290 IQ=1,ITEM
000   290    M(IQ,IS)=KOPY(IQ)
000          DO 300 IT=1,ITEM
000          LAZY=M(IT,1)
000          M(IT,1)=M(IT,I)
000          M(IT,I)=LAZY
000   300    CONTINUE
000   310    CONTINUE
000   320    CONTINUE
000          RETURN
000          END
```

END ELT.

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