Unsteady Solute-Transport Simulation in Streamflow Using a Finite-Difference Model

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 78-18

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.
4. Title and Subtitle UNSTEADY SOLUTE-TRANSPORT SIMULATION IN STREAMFLOW USING A FINITE-DIFFERENCE MODEL			5. Report Date May 1978 6.
7. Author(s) Larry F. Land			8. Performing Organization Rept. No. USGS/WRI-78-18
9. Performing Organization Name and Address U.S. Geological Survey, Water Resources Division Gulf Coast Hydroscience Center National Space Technology Laboratories NSTL Station, Mississippi 39529			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address U.S. Geological Survey, Water Resources Division Gulf Coast Hydroscience Center National Space Technology Laboratories NSTL Station, Mississippi 39529			13. Type of Report & Period Covered Final 14.

15. Supplementary Notes

16. Abstracts A computer program for simulating one-dimensional, unsteady solute transport in gradually varied streamflow has been developed and documented. Before using the solute-transport model, a flow model must be used to calculate and store necessary flow data at each cross section and each time step. Such a flow model is available and documented. Given the flow and solute-inflow data, the digital model will calculate a time-series of concentration values for any point in the stream. The conservative form of the mass-transport equation has been selected as the basis of the model. The solution of the equation is obtained with an implicit finite-difference method. The grid arrangement uses six nodal points and calculates the spatial and temporal derivatives at a slightly off-centered point. The off-centering is a compromise between numerical dispersion and accuracy. A tridiagonal matrix is created and solved at each time step by the Thomas algorithm. The solute-transport model allows the solute to enter the stream at an unsteady rate from the upstream boundary and tributaries. A steady inflow of solute can enter the stream with lateral seepage. An unsteady solute flux, uniform over the reach, from a source or sink can be taken into account. The solute concentration can decay by using a constant decay coefficient.

17. Key Words and Document Analysis. 17a. Descriptors

*Streams, *Model studies, *Solute transport, Computer models, Unsteady flow, Solutes, Water quality

17b. Identifiers/Open-Ended Terms

*Unsteady solute transport simulation, Digital model development

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages
No restriction on distribution.		58 p.
	20. Security Class (This Page) UNCLASSIFIED	22. Price

UNSTEADY SOLUTE-TRANSPORT SIMULATION IN STREAMFLOW USING A FINITE-DIFFERENCE MODEL

By Larry F. Land

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 78-18

May 1978

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

For additional information write to:

U.S. Geological Survey
Water Resources Division
Gulf Coast Hydroscience Center
National Space Technology Laboratories
NSTL Station, Mississippi 39529

CONTENTS

ILLUSTRATIONS

FACTORS FOR CONVERTING U.S. CUSTOMARY UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply U.S. Customary units	By	To obtain metric units
foot (ft)	0.3048	meter (m)
cubic foot per second (ft^3/s)	2.832×10^{-2}	cubic meter per second (m^3/s)
pound	453.6	gram (g)

UNSTEADY SOLUTE-TRANSPORT SIMULATION IN STREAMFLOW USING A FINITE-DIFFERENCE MODEL

By Larry F. Land

ABSTRACT

A computer program for simulating one-dimensional, unsteady solute transport in gradually varied streamflow has been developed and documented. Before using the solute-transport model, a flow model must be used to calculate and store the necessary flow data at each cross section and each time step. Such a flow model is available and documented. Given the flow and solute-inflow data, the digital model will calculate a time-series of concentration values for any point in the stream.

The conservative form of the mass-transport equation has been selected as the basis of the model. The solution of the equation is obtained with an implicit finite-difference method. The grid arrangement uses six nodal points and calculates the spatial and temporal derivatives at a slightly off-centered point. The off-centering is a compromise between numerical dispersion and accuracy. A tridiagonal matrix is created and solved at each time step by the Thomas algorithm.

The solute-transport model allows the solute to enter the stream at an unsteady rate from the upstream boundary and tributaries. A steady inflow of solute can enter the stream with lateral seepage. An unsteady solute flux, uniform over the reach, from a source or sink can be taken into account. The solute concentration can decay by using a constant decay coefficient.

INTRODUCTION

A number of investigators have simulated mass transport in unsteady streamflow using numerical methods. Many of the studies were made in estuaries. However, a very limited amount of mass-transport modeling is done outside the academic and research communities. Possibly, the lack of outside use is due to the lack of model documentation in a user's format. The purpose of this report is to document a rather simple, general purpose, one-dimensional, one-parameter, mass-transport model for field use. The model assumes a well-mixed conservative solute that may be coming from an unsteady source and is moving in unsteady streamflow. The quantity of solute being transported is in the units of concentration. Results are reported as such.

The use of a solute transport model requires that the flow characteristics be defined at each cross section at each time step. In effect, this requires a streamflow model to calculate and temporarily store the needed values for use in the transport model. The Deterministic Models Project, U.S. Geological Survey (Land, 1978), has recently documented a streamflow model that is designed to supply the needed data.

An implicit finite-difference technique is used to solve the mass transport equation. It consists of creating a tridiagonal matrix and using the Thomas algorithm to solve the matrix for the unknown concentrations at the new time step. The computer program (J880) presented in this report is designed to compute the concentration of a water-quality constituent at any point and at any preselected time in a one-dimensional stream. The model is driven by the inflowing concentration of solute at the upstream boundary and is influenced by the solute entering the stream from tributaries and lateral ground-water inflow and from a source or sink.

ACKNOWLEDGMENT

The author wishes to acknowledge T. N. Keefer of SUTRON, Inc., formerly of the U.S. Geological Survey, as the original author of the model's concept and for his early testing and development.

BASIS FOR MODEL DEVELOPMENT

The basic equation describing one-dimensional mass transport of a conservative water-quality constituent has the form

$$\frac{\partial AC}{\partial t} + \frac{\partial AUC}{\partial x} = \frac{\partial}{\partial x}\left(AD\frac{\partial C}{\partial x}\right) \tag{1}$$

where

A = cross-section area (square feet)
U = cross-section average velocity (feet per second)
C = concentration (pounds per cubic foot)
D = dispersion coefficient (square feet per second)
t = time (seconds)
x = longitudinal distance (feet)

Substituting the continuity equation of water, assuming incompressibility,

$$\frac{\partial A}{\partial t} + \frac{\partial AU}{\partial x} = 0 \tag{2}$$

into an expanded form of equation 1

$$A\frac{\partial C}{\partial t} + C\frac{\partial A}{\partial t} + AU\frac{\partial C}{\partial x} + C\frac{\partial AU}{\partial x} = \frac{\partial}{\partial x}\left(AD\frac{\partial C}{\partial x}\right) \tag{3}$$

and simplifying, the remaining terms form the equation, after dividing by A

$$\frac{\partial C}{\partial t} + U \frac{\partial C}{\partial x} = \frac{1}{A} \left[\frac{\partial}{\partial x} AD \frac{\partial C}{\partial x} \right] \tag{4}$$

Equation 4 is called the advection form without any assumptions. Equation 1 is generally known as the conservation form of the transport equation and was selected for the basic equation in this model. For a better description of field-boundary conditions, equation 1 was modified to include the solute fluxes from source or sink, lateral ground-water and tributary flow. The equation becomes:

$$\frac{\partial AC}{\partial t} + \frac{\partial UAC}{\partial x} = \frac{\partial}{\partial x} (AD \frac{\partial C}{\partial x}) + \emptyset_{ss} + \emptyset_{q} + \emptyset_{T} - KAC \tag{5}$$

where

K = decay coefficient (one per second)

$\emptyset_{ss}$ = flux of solute to source or sink per unit length of stream (pounds per foot per second)

$\emptyset_{q}$ = flux of solute from ground-water seepage per unit length of stream (pounds per foot per second)

$\emptyset_{T}$ = flux of solute from tributary (pounds per foot per second)

Since the equations are linear in the transport variable, the solution with numerical methods is rather straight forward. Most of the modeling efforts in the past have dealt with ways to minimize numerical dispersion along steep concentration fronts. The selected numerical method is very similar to the implicit finite-difference scheme originally presented by Stone and Brian (1963). It uses a centered six-point grid that considers all six points in the time derivative. However, the finite-difference scheme was slightly modified by moving the point somewhat off-centered with weighting coefficients in which to evaluate the space and time derivatives. The computation stencil for the selected scheme is shown in figure 1. The point at which the derivatives was computed was moved slightly forward in time and slightly upstream in space to reduce oscillations when sudden concentration changes occur. Even with this compromise, some oscillations may result. It is particularly noticed in the form of occasional small negative concentration values. The scheme has unconditional stability; thereby allowing a time step of reasonable length for computational efficiency. However, it is desirable for purposes of accuracy to keep the value of $U\frac{\Delta t}{\Delta x}$, often called the Courant number, equal to or less than 2.

Solving the equations for the concentrations at the new time step is accomplished by creating a tridiagonal matrix of coefficients for the unknown concentration and a vector of known values and applying the Thomas algorithm (von Rosenberg, 1969). For n grid points, n-2 linear equations are available which have the form

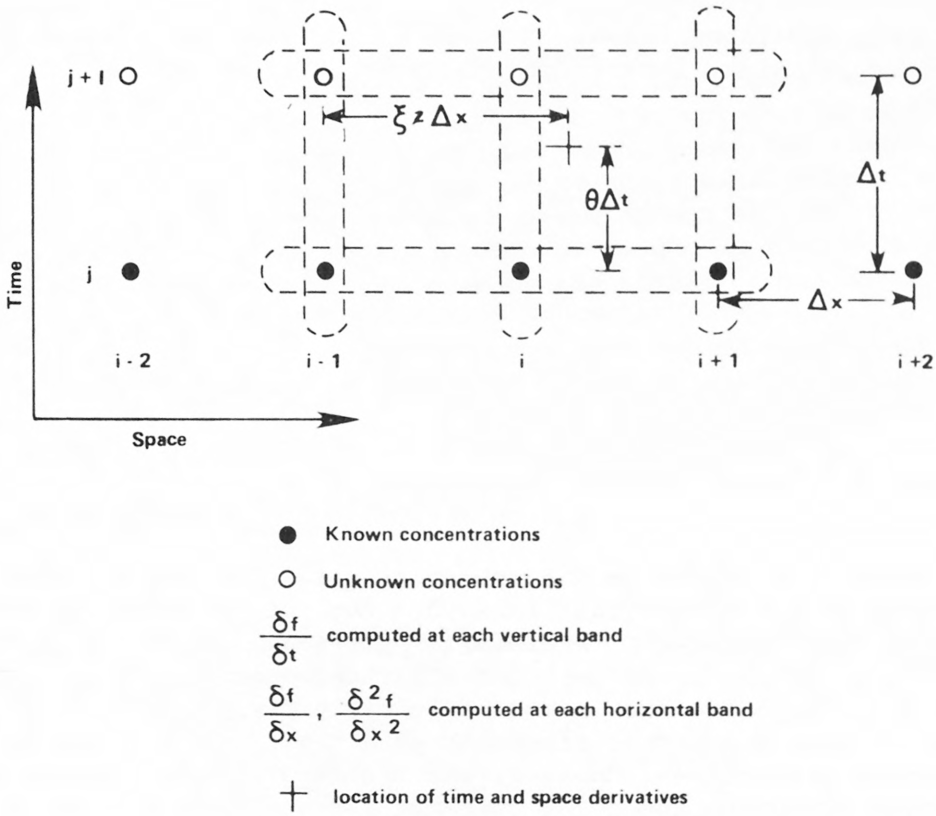


Figure 1.--Computation stencil for the finite-difference solution of the transport equation.

$$\psi_1 C_{i-1}^{j+1} + \psi_2 C_i^{j+1} + \psi_3 C_{i+1}^{j+1} = f(C_{i-1}^{j}, C_i^{j}, C_{i+1}^{j}) \quad (6)$$

where j is the finite-difference indexing in the time direction and i in the space direction. $\psi_i, i=1, 2, 3$ are coefficients that are dependent on U, A, D_x, Δx, Δt, and the weighting coefficients θ and ξ. Upstream and downstream boundary conditions produce two additional equations so that as many equations as unknowns are available. The upstream concentration is known while the downstream concentration is assumed to be equal to the concentration of the adjacent grid at the previous time step.

Use of the model requires consideration of the dispersion coefficient. As background, it is generally considered that neither equations 1 and 2 accurately represents dispersion of a slug injection until considerable mixing occurs. Fischer (1973) suggests some criteria for the length of time it takes for mixing to occur. However, it is also generally considered that dispersion is almost insignificant for steady injection rates (Sayer and Chang, 1968). As a result, use of dispersion coefficients requires some discretion.

The dispersion coefficient used with equation 1 is computed by an equation suggested by Fischer (1973). It is

$$\frac{D_x}{RU_*} = 250 \quad (7)$$

where

D_x = longitudinal dispersion coefficient (square feet per second)
U_* = shear velocity (feet per second)
R = hydraulic radius (feet)

Roache (1972) indicates that the effective numerical dispersion coefficient of a differencing scheme similar to the one used in this report is

$$D_n = 1/2\ U\ \Delta x(1 - C_o) \quad (8)$$

where

D_n = numerical dispersion coefficient

$C_o = U \dfrac{\Delta t}{\Delta x}$

In many cases the numerical dispersion is expected to equal or exceed the longitudinal dispersion. It is suggested that D_x be set to zero if D_n is greater than or approximately equal to D_x.

GENERAL MODEL DESIGN AND OPERATION

A schematic presentation of the model's design and operation is presented in the form of a generalized program flow chart in attachment A. A program listing is given in attachment B.

Use of the mass transport model must be preceded by the use of a flow model that computes the hydraulic variables for all cross sections and time steps. These results are stored on a direct-access storage device at the central computer. The transport model retrieves these data as needed during the computation process.

Use of the solute transport model begins by having all the control parameters and solute data input via computer cards. The program is initialized at time = 0 from the necessary data. The model then moves in the time dimension in one step intervals. For each time step flow data are retrieved from the direct access data set, and the concentrations are calculated for each interior cross section. At the upstream cross section, the solute concentration is given as boundary input and at the downstream the concentration is set equal to the concentration of the adjacent cross section for the previous time step. At preselected time steps the results are printed. At the conclusion of the run, line printer plots of computed concentration versus time may be obtained.

The reach design and the numbering system for the solute transport model is identical to the flow model. However, use of the transport model should influence the grid design at the lower end of the reach. For purposes of accuracy, the distance between the last two cross sections should be approximately equal to the water's velocity times the length of time step for the subreach between the last two cross sections. This is desirable because the constituent is assumed to move from the next-to-last cross section to the last one in one time step. Another consideration for purposes of accuracy is that the time step (Δt) and the distance between cross sections (Δx) should cause the Courant number, $U\frac{\Delta t}{\Delta x}$, to be less than or equal to 2. An example of a reach design and the numbering system is given in figure 2.

The computer program allows the solute to come into the reach at an unsteady rate from (1) the upstream inflow boundary, (2) tributaries, and (3) a source or sink. A steady inflow may enter the reach along the lateral boundary. The source or sink is a flux that adds or removes a specified amount of solute each second from each foot of stream.

The transport equation includes a decay coefficient that allows the solute to decay exponentially. The dimension of the coefficient is unit per second. The solute disappears in the units of mass per second per foot of channel length and is equal to KAC.

The computer program allows the solute entering the stream from the upstream boundary and tributaries to be a concentration of the inflowing water or a flux. Because the model transports the solute as a concentration, the flux is converted to concentration by dividing the flux by the discharge. The model units are: time in seconds, length in feet, and mass in any desired unit. Therefore, the concentration units are in mass per cubic foot and flux in mass per second.

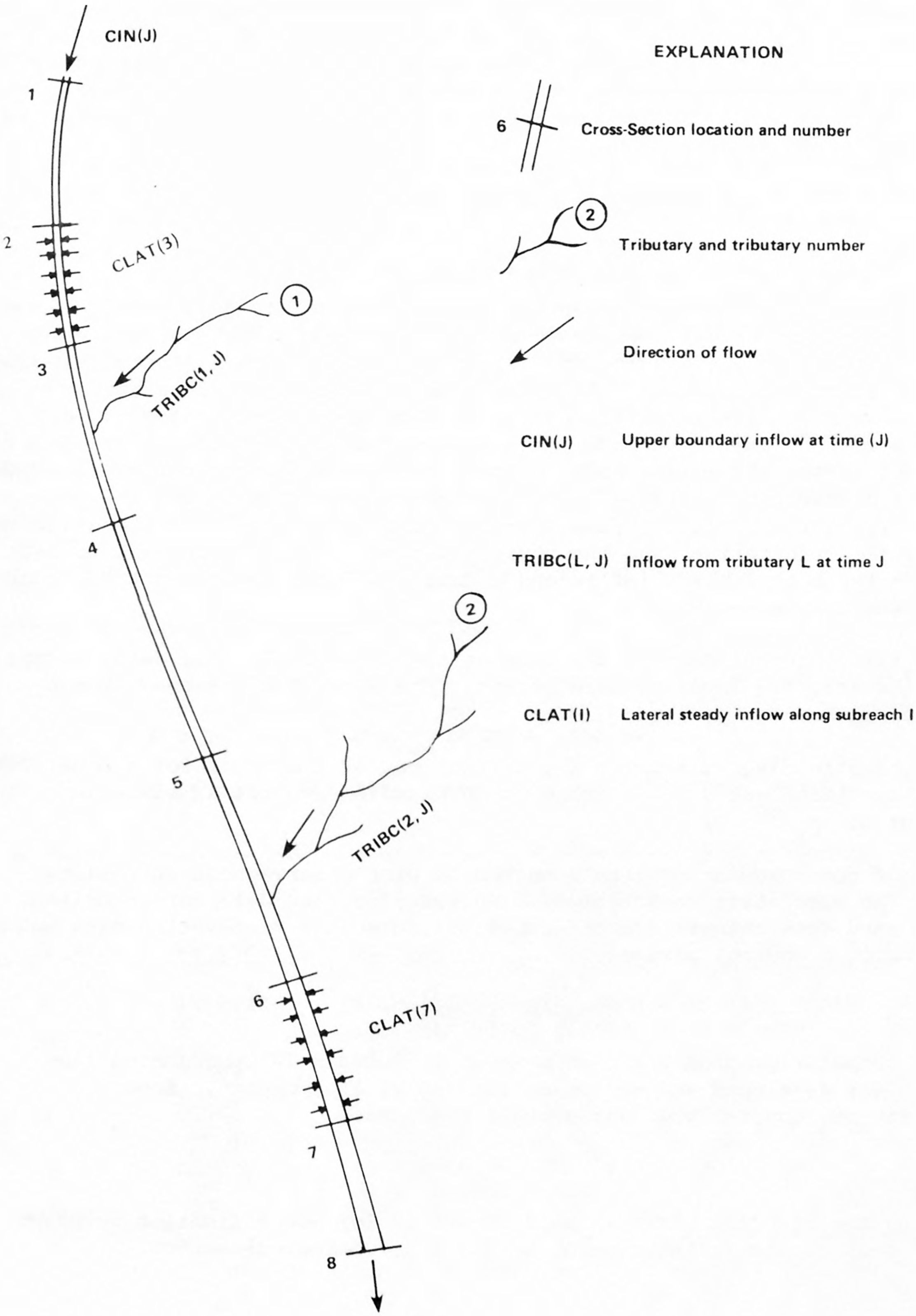


Figure 2.--Schematic diagram of grid design and numbering system used to describe a stream.

The computer program has a line printer plot routine that produces a time-series plot of concentration at five or less cross sections. The routine can also be used in a separate run to plot observed values. By laying one plot over the other, a quick and easy comparison of computed and observed values can be made during the calibration process which may be necessary to determine the concentrations of lateral inflow, and a decay coefficient.

PROGRAM RUN PREPARATION

Data

The first step in using the solute transport model is developing a data base of flow parameters at each cross section and time step. These parameters include (1) top width, (2) velocity, (3) cross-section area, (4) net tributary flow, (5) lateral inflow, and (6) depth. The suggested procedure is to use the linear implicit finite difference streamflow model, documented by Land (1978), to develop this data base. If this suggestion is followed the grid design used in the streamflow model must be used in the transport model. The other data preparation is essentially limited to preparing solute information. A time-series solute inflow data set must be prepared for the upstream boundary, all tributaries, and the source or sink. Single-value solute data are needed for each lateral inflow and a constant decay coefficient is specified for the solute decay.

The time interval must be the same as the flow model. All data, except flow parameters, are input by card format. The flow data are read from a direct access storage device.

A schematic diagram showing the arrangement of the cards for a model run is given in attachment C. A listing of an example data set is given in attachment D.

Use of the computer program's option to plot observed concentrations bypasses the simulation computations. However, to ease data card handling, the only card deck changes are the substitution of the time-series data and the coding of a control parameter.

Computer Program

The computer program has been written in FORTRAN IV programming language and was developed and tested on IBM 360/91 equipment[1/]. Some changes may be required when using other equipment.

[1/] The use of brand names in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

The program is dimensioned for 50 cross sections and 999 time steps. For simulations requiring more cross sections or time steps, these values must be increased. The program, as dimensioned, requires 240 bytes of storage on IBM 360 or 370 equipment. Compiling the program takes 5 to 8 seconds. Execution time for production runs requires 25 to 30 seconds for a reach with 50 cross sections and 999 time steps. These estimates are for the IBM H-level Fortran compiler using Opt = 2. For larger production runs, this compiler usually reduces computation time about 40 percent in comparison to the IBM G-level Fortran compiler.

DATA INPUT SPECIFICATIONS

Data are input into the computer program in two forms. Time-series flow data generated by the flow model must be made available in the form of direct-access data sets stored at the central computer. All other data are input via computer cards. Information on the control cards is input with the NAMELIST command. All variables are real or integer according to standard notation, that is A-H, O-Z for real and I-N for integer. All integers and real numbers without decimals must be right justified. The variables in the NAMELIST name block have the form

```
&name      VALUE1 = 1.0,  VALUE2 = 2.0,       VALUE3 = 3.0,     &END
```

The first ampersand must be in column 2.

To ease the data preparation, the cross-section data cards used in the flow model can be reused in this model after filling in two previously unused fields. The other data formats are also similar.

A description of the data input, sequence and arrangement follows.

SET NO. I PARAMETERS

Card No.	Variable	Description	Columns
1	INFO(20)	Information card. Generally with basin name, period of record, date of run, and etc.	1-80
2	CODE	Block name for selected codes	3-6
	ICIN	Code identifying the method of entering the solute to the stream's water. 1 = concentration 2 = flux	-
	IDISP	Compute dispersion for transport equation? 0 = No 1 = Yes	-

Card No.	Variable	Description	Columns
	ISS	Inputing an unsteady source or sink 0 = No 1 = Yes	-
	IDEBUG	Print selected arrays for error tracing purposes? 0 = No 1 = Yes	-
	NZPLOT	Run to plot observed data only? 0 = No 1 = Yes	-
3	SIZE	Block name defining size of run.	3-6
	NX	Number of cross sections.	-
	NTS	Number of time steps.	-
	NTRIB	Number of tributaries with unsteady flow	-
		Maximum of 3.	-
	DT	Length of time step, seconds	-
4	INIT	Block name defining initial boundary values.	3-6
	DIFAC	Factor adjusting self-setting dispersion from unity. Use 1.0 for no adjustment.	-
	DKCOEF	Decay coefficient	-
5	CTRL	Block name for program controls.	3-6
	NPRNT	Number of cross sections with results to be printed. 0 = all N, N=1, 2, 3, ..., NX = number of selected cross sections	-
	IPNT	Number of time steps between printouts	-
	NPLOT	Number of cross sections with results plotted on printer, Maximum of 5.	-
	IPLT	Number of time steps between adjacent points on plot.	-
6	DATE	Block name of starting date.	3-6
	IYR	Starting date - year	-
	IMON	- month	-
	IDY	- day	-
	IHR	- hour (military)	-

SET NO. II CROSS-SECTION OUTPUT

Card No.	Variable	Description	Columns
1,...	NP(I)	Cross-section number with results printed. Number of values equals NPRNT. Omit when NPRNT = 0.	1-8,9-16 ...., 73-80
1	NPP(I)	Cross-section numbers with results plotted on line printer. Number of values equals NPLOT. Maximum of 5. Omit when NPLOT = 0.	1-8,9-16 ...., 33-40

SET NO. III CROSS-SECTION DATA[1/]

Card No.	Variable	Description	Columns
1,...,NX	X(I)	Channel length in downstream direction from reference to cross section (I).	1-8
	Z(I)	Elevation of low-point in cross section(I)	9-16
	CINIT(I)	Beginning concentration at cross section(I).	57-64
	CLAT(I)	Concentration of lateral inflow between cross sections(I) and (I-1).	65-72
	LTRIB(I)	Tributary number entering subreach above cross section (I). Only one tributary per subreach. Maximum of 3 for entire reach. Numbered consecutively in downstream direction.	77-80

SET NO. IV INFLOW CONCENTRATIONS[2/]

Card No.	Variable	Description	Columns
1,2,3,4,...	CIN(J)	Magnitude of solute inflow at upstream boundary. When ICIN=1, values are concentration; ICIN=2 values are flux. The first value corresponds to time DT which is at the end of the first time step. NTS values are required.	17-24,25-32, ..., 73-80

Footnote:

[1/] Cross-section cards from flow model can be reused.

[2/] Use for normal simulation run. Omit when NZPLOT=1.

SET NO. V TRIBUTARY INFLOW CONCENTRATIONS[2/]

Card No.	Variable	Description	Columns
1,2,3,4,.. 1,2,3,4,..	TRIBC(L,J)	Magnitude of solute inflow at tributary (L) One set for each tributary, (number of sets = NTRIB). First value corresponds to time DT which is at the end of the first time step. NTS values are required for each tributary	17-24,25-32 . . . . , 73-80

SET NO. VI INFLOW FROM SOURCE[2/]

Card No.	Variable	Description	Columns
1,2,3,4,..	CSS(J)	Amount of solute entering stream from source or sink. Source (+), sink (-). The first value corresponds to time DT which is at the end of the first time step. NTS values are required. Omit when ISS = 0.	17-24,25-32 . . . . , 73-80

SET NO. VII PLOT DATA[3/]

Card No.	Variable	Description	Columns
1,2,3,4,.. 1,2,3,4,..	CSAV(I,J)	Observed concentration data. Number of sets equals NPLOT. Maximum of 5 sets. Number of values per set equals NTS.	17-24,25-32 . . . . , 73-80

Summary of card requirements:

Set No. I. Required.

II. Print card required when NOUT > 0.
Plot card required when NPLØT > 0.

III. One card for each cross section.

IV. Required when NZPLOT = 0.

V. Required when NZPLOT = 0 and NTRIB > 0. Number of sets equals NTRIB.

VI. Required when NZPLOT = 0 and ISS = 1.

VII. Required when NZPLOT = 1. Number of sets equals NPLOT.

Footnote:

[2/] Use for normal simulation run. Omit when NZPLOT=1.
[3/] Use for plot of observed data. Omit when NZPLOT=0.

PROGRAM OUTPUT

Results of calculations are printed at selected cross sections and at selected time steps. Printer plots of concentrations at selected cross sections are available for visual presentation.

To illustrate the transport model's response to a set of unsteady flow and solute loading conditions, graphs are given in figures 3 and 4 to show the flow and concentration variations in space and time. The water discharge in the stream had a base flow of 550 cubic feet per second. A temporary reservoir release added 3,500 cubic feet per second to the streamflow for a limited time. The solute inflow has a base concentration of 1 pound per cubic foot and temporary loads of 9 and 5 pounds per cubic foot. The stream also had a solute source flux other than inflow flux and a solute decay. Discharge hydrographs are given in figure 3 for the beginning, middle and ending of the 10-mile reach. Solute pollutographs are given at the same locations in figure 4.

An example of computer output in the form of tables and plots is given in attachment E.

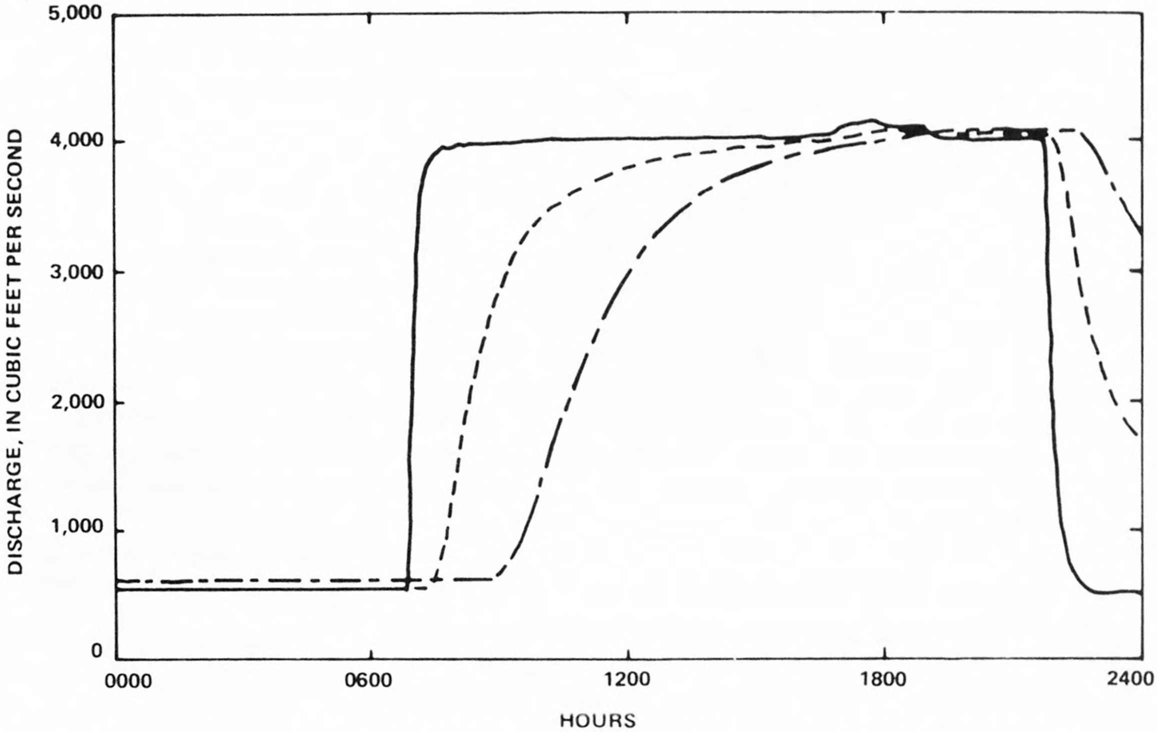


Figure 3.--Discharge hydrographs at beginning, middle, and end of a 10-mile reach used in example data set.

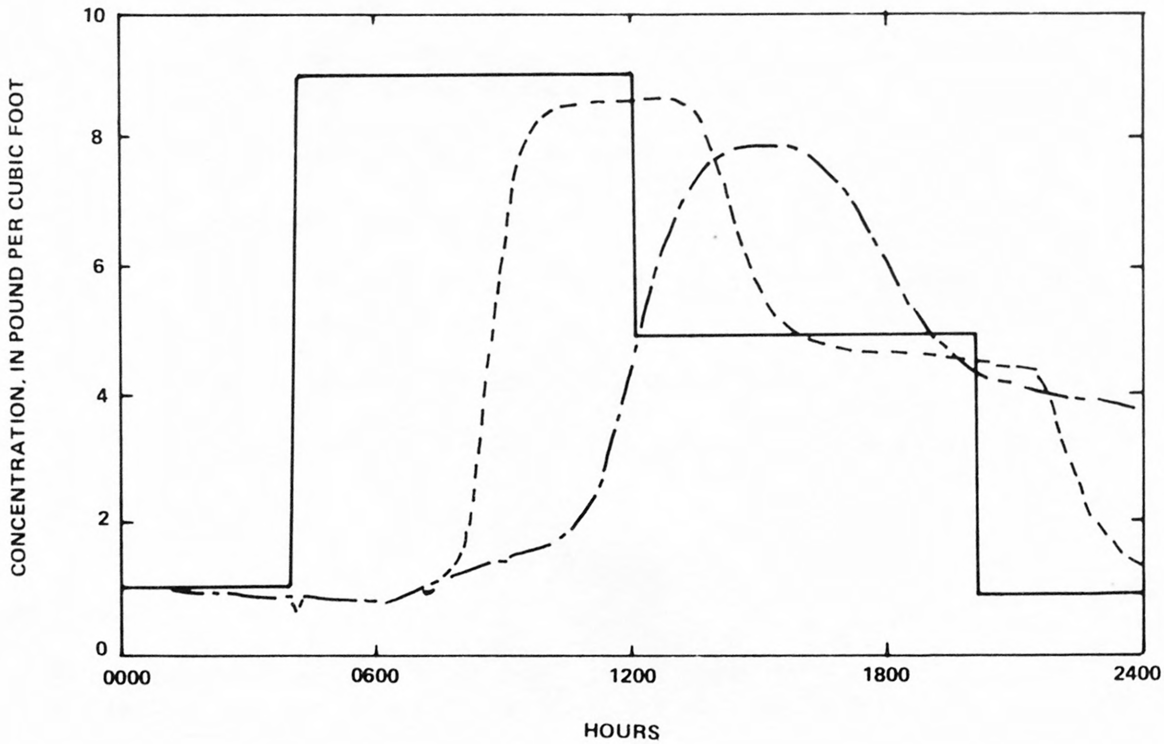


Figure 4.--Solute pollutographs computed by transport model at corresponding locations in figure 3.

REFERENCES

Fisher, H. B., 1973, Longitudinal dispersion and turbulent mixing in open-channel flow: Annual Review of Fluid Mechanics, p. 59-78.

Land, L. F., 1978, Unsteady streamflow simulation using a linear implicit finite-difference model: U.S. Geol. Survey Water-Resources Inv.

Roache, P. J., 1972, Computational fluid dynamics: Hermosa Publishers, Albuquerque, New Mexico, p. 32-33, 65.

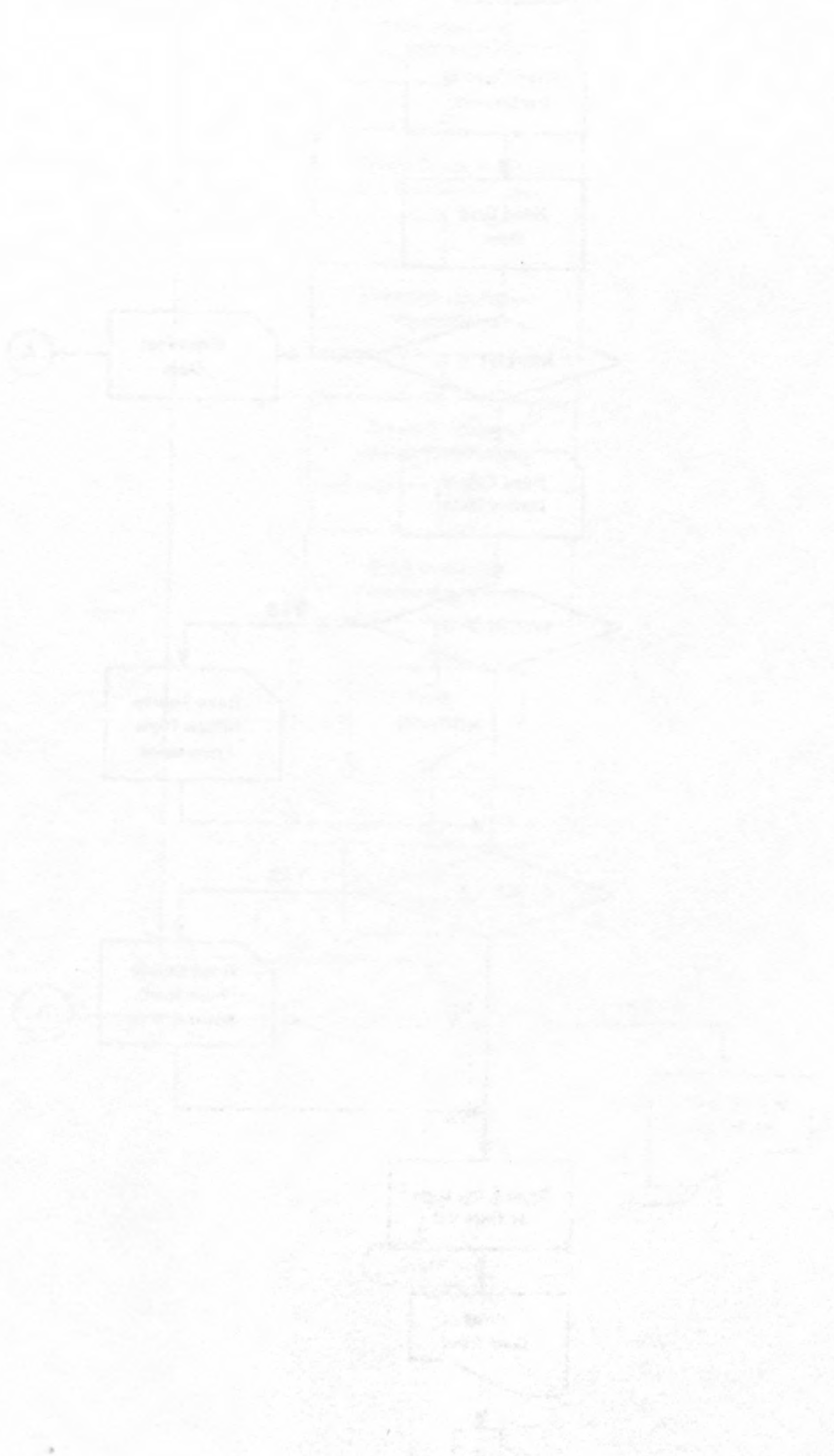
Sayre, W. W. and Chang, F. M., 1968, A laboratory investigation of open-channel dispersion processes for dissolved, suspended, and floating dispersants: U.S. Geol. Survey Professional Paper 433-E, 71 p.

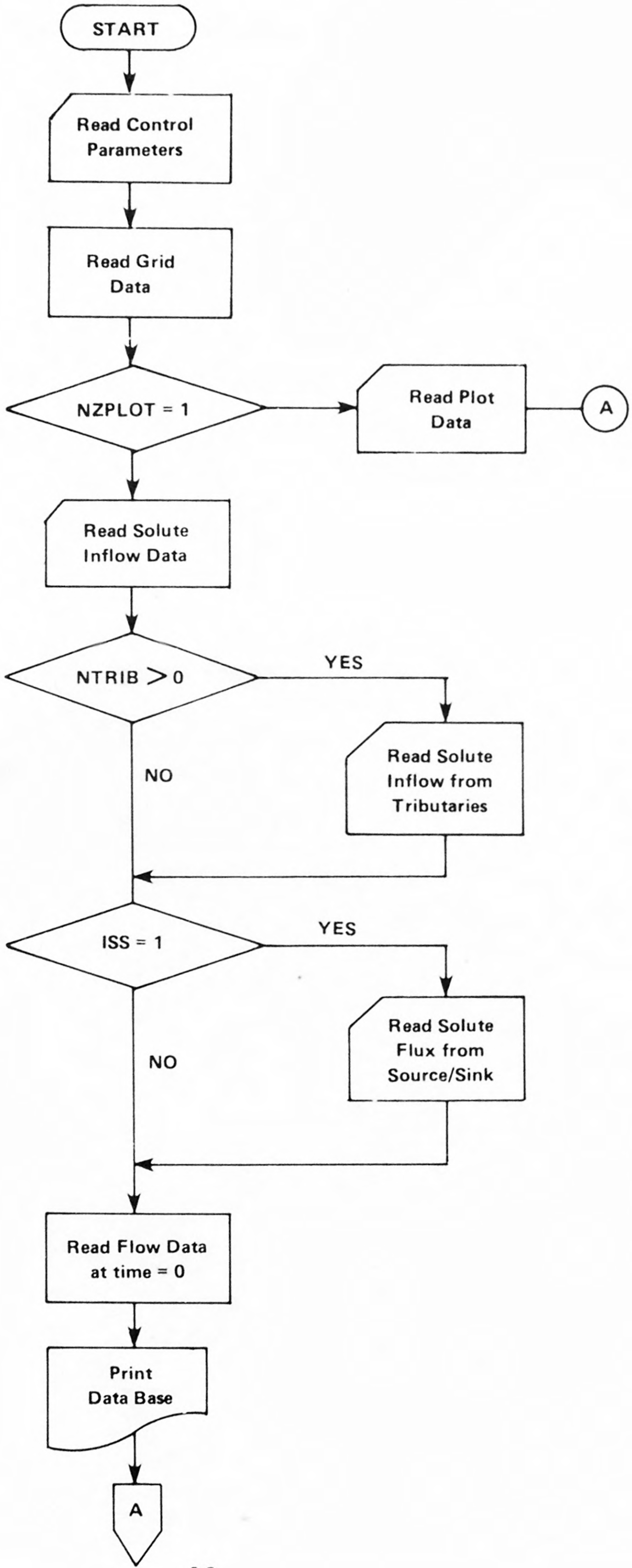
Stone, H. L. and Brian, P. L. T., 1963, Numerical solution of convective transport problems: Jour. Am. Inst. Chem. Eng., v. 9, no. 5, p. 681-688.

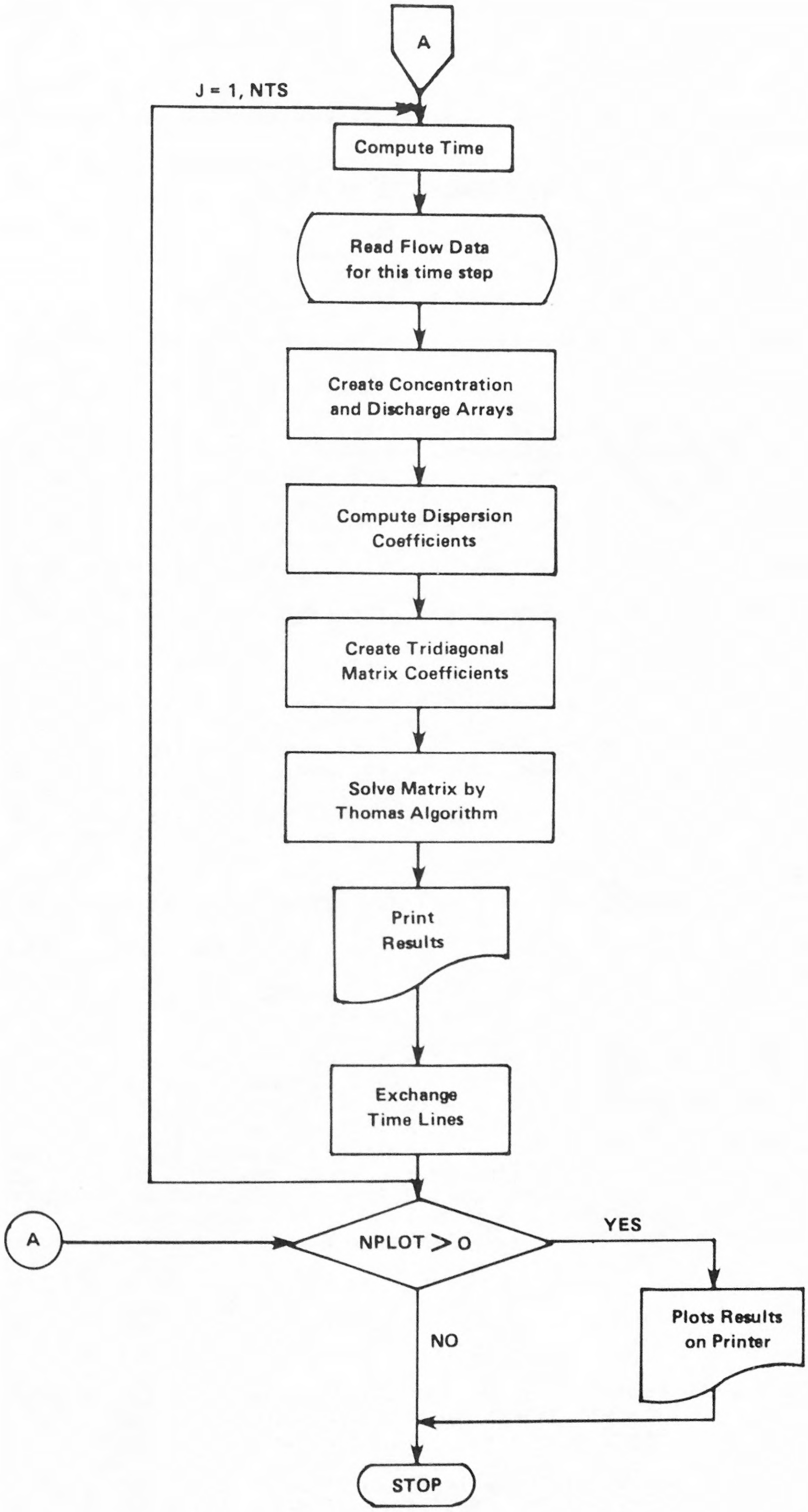
von Rosenberg, D. U., 1969, Methods for the numerical solution of partial differential equations: American Elsevier Publishing Company, New York, New York, p. 8, 113.

ATTACHMENTS

A. GENERALIZED FLOW CHART




START
Read Control Parameters
Read Grid Data
NZPLOT = 1
Read Plot Data
A
Read Solute Inflow Data
NTRIB > 0
YES
NO
Read Solute Inflow from Tributaries
ISS = 1
YES
NO
Read Solute Flux from Source/Sink
Read Flow Data at time = 0
Print Data Base
A


A
J = 1, NTS
Compute Time
Read Flow Data
for this time step
Create Concentration
and Discharge Arrays
Compute Dispersion
Coefficients
Create Tridiagonal
Matrix Coefficients
Solve Matrix by
Thomas Algorithm
Print
Results
Exchange
Time Lines
A
NPLOT > O
YES
NO
Plots Results
on Printer
STOP

B. COMPUTER PROGRAM

```
C     ******************************************************************
C     *                                                                *
C     *      J880--MASS TRANSPORT SIMULATION USING AN                  *
C     *                        IMPLICIT FINITE DIFFERENCE MODEL        *
C     *                                                                *
C     *                  OPERATIONAL MODELS PROJECT                    *
C     *                 GULF COAST HYDROSCIENCE CENTER                 *
C     *                  U. S. GEOLOGICAL SURVEY - WRD                 *
C     *             DATE OF LAST PROGRAM REVISION: FEB 21, 1978        *
C     *                                                                *
C     ******************************************************************
C
      DEFINE FILE 20(1000,1200,L,ID1)
C
      DIMENSION CIN(1000), CSS(1000), TRIBC(3,1000), CSAV(5,1000)
      DIMENSION CTRBNW(50), CTRBNX(50), CSSNW(50), CSSNX(50), CNW(50), C
     1NX(50), QNW(50), QNX(50), YNW(50), YNX(50)
      DIMENSION DATANW(6,50), DATANX(6,50)
      DIMENSION X(96), Z(96), CINIT(50), CLAT(50), LTRIB(50), DELX(50),
     1QLAT(50), NP(50)
      DIMENSION A(3,50), D(50), DI(50), DIP1(50), AI(50), AIP1(50), BETA
     1(50), GAMA(50)
      DIMENSION MONTH(12), INFO(20), IMAGE(2450), NSCALE(5), IRNG(12), N
     1PP(5)
      LOGICAL*1 LETTER(5)
C
      DATA THETA,ZI,FLUXUP,CRAT/0.65,0.65,0.037,1.00/
      DATA LETTER/'A','B','C','D','E'/
      DATA MONTH/31,28,31,30,31,30,31,31,30,31,30,31/
      DATA IRNG/1,2,5,10,15,50,100,250,500,1000,2500,10000/
      DATA NZPLOT,IREC/0,1/
      DATA NSCALE/1,0,3,0,1/
      DATA NPP/1,2,3,4,5/
C
C
C     *****************DEFINITION OF INPUT PARAMETERS******************
C
C     INFO  :  INFORMATION CARD
C
C                        NAMELIST PARAMETERS
C                        -------------------
C     CODE ----
C     ICIN   :  CODE IDENTIFYING THE METHOD OF ENTERING THE SOLUTE
C               TO THE STREAM'S WATER.
C                 1=CONCENTRATION (MASS PER CUBIC FOOT OF INFLOW)
C                 2=FLUX OF CONSTITUENT (MASS PER UNIT TIME)
C     IDISP  :  DISPERSION COEFFICIENT:          0=ZERO,    1=SELF-SETTING
C     ISS    :  ALLOW AN UNSTEADY SOURCE/SINK?   0=NO,      1=YES
C     IDEBUG:   PRINT SELECTED COEFFICIENTS AND
C               PARAMETERS FOR ERROR TRACING.    0=NO,      1=YES
C     NZPLOT:   RUN TO PLOT OBSERVED DATA ONLY?  0=NO,      1=YES
C     SIZE ----
C     NX     :  NUMBER OF CROSS-SECTIONS
C     NTS    :  NUMBER OF TIME STEPS
C     NTRIB  :  NUMBER OF TRIBUTARIES
C     DT     :  LENGTH OF TIME STEP IN SECONDS
C     INIT ----
C     DIFAC  :  MULTIPLYING FACTOR ADJUSTING SELF-SETTING DISPERSION COEF
C     DKCOEF:   DECAY COEFFICIENT, K VALUE IN KAC TERM
C                  0.0 = NO DECAY          + = SOME DECAY
C     CTRL ----
C     NPRNT  :  NUMBER OF X-SECTIONS PRINTED CODE:    0=ALL
C     IPNT   :  NUMBER OF TIME STEPS BETWEEN PRINTOUTS
C     NPLOT  :  NUMBER OF X-SECTIONS WITH CONCENTRATION PLOTS
```

```
C       IPLT   :  NUMBER OF TIME STEPS BETWEEN POINTS ON PLOT
C       DATE ----
C       IYR    :  STARTING DATE - YEAR
C       IMON   :                  MONTH
C       IDY    :                  DAY
C       IHR    :                  HOUR (MILITARY)
C
C                          SELECTING OUTPUT
C                          ----------------
C       NP(K)        :  X-SEC NOS. WITH RESULTS PRINTED
C       NPP(K)       :  X-SEC NOS. WITH CONCENTRATION PLOTTED
C
C                          CROSS-SECTION PARAMETERS
C                          ------------------------
C       X(I)         :  CHANNEL LENGTH FROM BEGINNING TO X-SEC(I)
C       Z(I)         :  ELEVATION OF LOW-POINT IN X-SEC(I)
C                       NOTE -- X AND Z ARRAYS ARE ALSO USED FOR PLOTTING
C                               PURPOSES. DIMENSION TO A MINIMUM OF 96.
C       CINIT(I)     :  BEGINNING CONCENTRATION AT X-SEC(I)
C       CLAT(I)      :  CONCENTRATION OF LATERAL INFLOW BETWEEN
C                       X-SEC(I-1) AND X-SEC(I)
C       LTRIB(I)     :  TRIB NO. AT X-SEC(I); NO. CONSEC. IN D.S. DIRECTION
C
C
C                          TIME SERIES DATA
C                          ----------------
C       CIN(J)      :  QUALITY OF INFLOWING WATER
C                      CONCENTRATION (MASS/CU.FT.) WHEN    ICIN=1
C                      FLUX OF SOLUTE (MASS/SEC) WHEN      ICIN=2
C       TRIBC(L,J):    QUALITY OF TRIB(L) WATER
C                      CONCENTRATION (MASS/CU.FT.) WHEN    ICIN=1
C                      FLUX OF SOLUTE (MASS/SEC) WHEN      ICIN=2
C       CSS(J)      :  SOLUTE FLUX TO SOURCE/SINK (MASS/SEC/FT)
C       CSAV(-,J)   :  CONCENTRATIONS TO BE PLOTTED; UP TO 5 X-SECTIONS.
C
C                          MISC. PARAMETER DEFINITION
C                          --------------------------
C       DATAN*(1-6,I): SELECTED RESULTS AT X-SEC(I)
C                        1=TOP WIDTH
C                        2=VELOCITY
C                        3=AREA
C                        4=NET TRIBUTARY FLOW
C                        5=LATERAL INFLOW
C                        6=DEPTH
C       QN*(I)      :  DISCHARGE AT X-SEC(I)
C       YN*(I)      :  DEPTH AT X-SEC(I)
C       CN*(I)      :  CONCENTRATION AT X-SEC(I)
C       CTRBN*(I)   :  CONCENTRATION OF TRIBUTARY WATER AT X-SEC(I)
C       CSSN*(I)    :  FLUX OF CONSTITUENT AT X-SEC(I)
C                      NOTE: --N*(I)      --NW(I)  NOW OR OLD TIME LEVEL
C                                         --NX(I)  NEXT OR NEW TIME LEVEL
C
C       THETA        :  VELOCITY TERM CENTERING COEFFICIENT. (MOVES POINT OF
C                       TIME DERIVATIVE)
C                       SUGGEST 0.50-0.65, POSSIBLE 0.51-1.0
C                       LOW VALUE CAUSES ABRUPT CONCENTRATION CHANGES AND
C                       MINOR OSCILLATIONS.  HIGH VALUE CAUSES SMOOTHING.
C       ZI           :  UPWIND/DOWNWIND COEFFICIENT. (MOVES POINT OF SPACE
C                        DERIVATIVE)
C                       SUGGEST 0.60-0.65, POSSIBLE 0.51-1.0.
C                       SAME EFFECTS AS THETA VALUE.
C       FLUXUP       :  FLUX BALANCING COEFFICIENT (STABILIZES CONC. VALUES)
C       ICYCL        :  CYCLIC CODE FOR TIME TERM IN NUMERICAL TECHNIQUE
C       A( ,I)       :  TRIDIAGONAL COEF MATRIX OF UNKNOWNS
```

```
C       D(I)           :  VECTOR OF KNOWN VALUES
C       DI(I)          :  DISPERSION COEFFICIENT UPSTREAM OF X-SEC(I)
C       DIP1(I)        :  DISPERSION COEFFICIENT DOWNSTREAM OF X-SEC(I)
C       AI(I)          :  AVERAGE AREA UPSTREAM OF X-SEC(I)
C       AIP1(I)        :  AVERAGE AREA DOWNSTREAM OF X-SEC(I)
C
C                                  MODEL UNITS
C                                  -----------
C       LENGTH            FEET
C       TIME              SECONDS
C       FLOW RATE         CUBIC FEET PER SECOND
C       CONCENTRATION     MASS PER CUBIC FOOT
C       FLUX              MASS PER SECOND
C
C
        NAMELIST /CODE/ ICIN,IDISP,ISS,IDEBUG,NZPLOT
        NAMELIST /SIZE/ NX,NTS,NTRIB,DT
        NAMELIST /INIT/ DIFAC,DKCOEF
        NAMELIST /CTRL/ NPRNT,IPNT,NPLOT,IPLT
        NAMELIST /DATE/ IYR,IMON,IDY,IHR
C
C                                   READ DATA CARDS
C                                   ---------------
C                                         MISC.
        READ (5,830) INFO
        READ (5,CODE)
        READ (5,SIZE)
        READ (5,INIT)
        READ (5,CTRL)
        READ (5,DATE)
        IF (NPRNT.LT.0.OR.NPRNT.GT.NX) NPRNT=0
        IF (IPNT.LE.0) IPNT=1
        IF (IPLT.LE.0) IPLT=1
        IF (NPRNT.GT.0) READ (5,820) (NP(I),I=1,NPRNT)
        IF (NPLOT.GT.0) READ (5,820) (NPP(I),I=1,5)
        IF (MOD(IYR,4).EQ.0) MONTH(2)=29
        NTSP1=NTS+1
C                                         CROSS-SECTION
        DO 10 I=1,NX
     10 READ (5,720) X(I),Z(I),CINIT(I),CLAT(I),LTRIB(I)
        IF (NZPLOT.GT.0) GO TO 60
C                                         UPSTREAM TIME-SERIES DATA
        READ (5,800) (CIN(I),I=2,NTSP1)
        CIN(1)=CIN(2)
        IF (NTRIB.EQ.0) GO TO 30
C                                         TRIBUTARY TIME-SERIES DATA
        DO 20 I=1,NTRIB
        READ (5,800) (TRIBC(I,J),J=2,NTSP1)
     20 TRIBC(I,1)=TRIBC(I,2)
     30 IF (ISS.LE.0) GO TO 40
C                                         SOURCE/SINK TIME-SERIES DATA
        READ (5,800) (CSS(I),I=2,NTSP1)
        CSS(1)=CSS(2)
        GO TO 80
     40 DO 50 I=1,NTSP1
     50 CSS(I)=0.0
        GO TO 80
C                                         OBSERVED DATA FOR PLOTTING
     60 DO 70 L=1,NPLOT
     70 READ (5,800) (CSAV(L,J),J=2,NTSP1)
        GO TO 170
     80 CONTINUE
C
```

```
C                         READ DATA FROM DISK
C                         --------------------
      READ (20'IREC) DATANW
C
C                                      DEFINE SELECTED ARRAYS
      QLAT(1)=0.0
      DELX(1)=0.0
      QNW(1)=DATANW(2,1)*DATANW(3,1)
      YNW(1)=DATANW(6,1)
      DO 90 I=2,NX
      QNW(I)=DATANW(2,I)*DATANW(3,I)
      YNW(I)=DATANW(6,I)
      DELX(I)=X(I)-X(I-1)
   90 QLAT(I)=DATANW(5,I)*DELX(I)
C                                      ZERO CONCENTRATION ARRAYS
      DO 100 I=1,NX
      CNW(I)=0.0
      CTRBNW(I)=0.0
      CTRBNX(I)=0.0
      CSSNW(I)=0.0
      CSSNX(I)=0.0
      AI(I)=0.0
      AIP1(I)=0.0
      DI(I)=0.0
  100 DIP1(I)=0.0
C                                      SET FIRST CONCENTRATION
      IF (ICIN.EQ.2) GO TO 120
      DO 110 I=1,NX
      CNW(I)=CINIT(I)
      IF (LTRIB(I).NE.0) CTRBNW(I)=TRIBC(LTRIB(I),1)
  110 CSSNW(I)=CSS(1)
      GO TO 150
  120 CONTINUE
      DO 140 I=1,NX
      CNW(I)=CINIT(I)
      IF (LTRIB(I).EQ.0) GO TO 140
      IF (DATANW(4,I).GT.0.0) GO TO 130
      WRITE (6,1020) IMON,IDY,IYR,IHR
      CTRBNW(I)=0.0
      GO TO 140
  130 CTRBNW(I)=TRIBC(LTRIB(I),1)/DATANW(4,I)
  140 CSSNW(I)=CSS(1)
C
  150 HR=FLOAT(IHR)
      SZERO=(Z(1)-Z(NX))/(X(NX)-X(1))
      ICYCL=0
      NXM1=NX-1
      IF (NPRNT.GT.0) GO TO 170
      DO 160 I=1,NX
  160 NP(I)=I
      NPRNT=NX
  170 DTMIN=DT/60.
C                                 PRINT DATA
C                                 ----------
      WRITE (6,840)
      WRITE (6,810) INFO
      WRITE (6,850) ICIN,ISS,IDISP
      WRITE (6,860) IMON,IDY,IYR
      WRITE (6,870) NX,NTS,DTMIN,NTRIB
      IF (NZPLOT.LE.0) GO TO 190
      WRITE (6,950)
      DO 180 N=1,NPLOT
      WRITE (6,970) NPP(N)
```

```
  180 WRITE (6,980) (CSAV(N,J),J=2,NTSP1)
      GO TO 450
  190 WRITE (6,880) DIFAC
      WRITE (6,890) DKCOEF
      WRITE (6,930)
      DO 200 I=1,NX
  200 WRITE (6,940) I,X(I),DELX(I),Z(I),QNW(I),CINIT(I),QLAT(I),CLAT(I),
     1LTRIB(I)
      DO 210 I=2,NX
      DX=X(I)-X(I-1)
      IF (DX.GT.0.0) GO TO 210
      WRITE (6,960) I
      STOP
  210 CONTINUE
      WRITE (6,900) (CIN(I),I=2,NTSP1)
      IF (NTRIB.EQ.0) GO TO 230
      DO 220 K=1,NTRIB
  220 WRITE (6,920) K,(TRIBC(K,I),I=2,NTSP1)
  230 IF (ISS.GE.1) WRITE (6,910) (CSS(I),I=2,NTSP1)
      WRITE (6,1040)
C
      WRITE (6,730) IMON,IDY,IYR,IHR
      M1=1
      M2=13
  240 IF (M2.GT.NPRNT) M2=NPRNT
      WRITE (6,740) (NP(I),I=M1,M2)
      WRITE (6,750) (DATANW(2,NP(I)),I=M1,M2)
      WRITE (6,760) (YNW(NP(I)),I=M1,M2)
      WRITE (6,770) (QNW(NP(I)),I=M1,M2)
      WRITE (6,780) (CNW(I),I=M1,M2)
      WRITE (6,790)
      IF (M2.EQ.NPRNT) GO TO 250
      M1=M2+1
      M2=M2+13
      GO TO 240
  250 CONTINUE
C
C         *     *     *     *     *     *     *     *     *     *     *     *     *
C     **************BEGIN LOOPING THROUGH MODEL IN TIME*****************
      DO 430 J=1,NTS
      JP=J+1
      HR=HR+DT/60.
      IHR=INT(HR)
      IF (MOD(IHR,100).LT.60) GO TO 260
      IHR=IHR/100*100+100
      HR=FLOAT(IHR)
      IF (IHR.LE.2400) GO TO 260
      HR=HR-2400.
      IHR=MOD(IHR,2400)
      IDY=IDY+1
      IF (IDY.LE.MONTH(IMON)) GO TO 260
      IDY=1
      IMON=IMON+1
      IF (IMON.LE.12) GO TO 260
      IMON=1
      IYR=IYR+1
  260 CONTINUE
      TIME=TIME+DT
      IREC=IREC+1
      ICYCL=ICYCL+1
      IF (ICYCL.GE.4) ICYCL=1
```

```
C                          READ DATA FROM DISK
C                          -------------------
      READ (20'IREC) DATANX
C
C                             COMPUTE DISCHARGE AND CONCENTRATION ARRAYS
      CNX(1)=CIN(JP)
      DO 270 I=1,NX
      QNX(I)=DATANX(2,I)*DATANX(3,I)
      YNX(I)=DATANX(6,I)
      IF (LTRIB(I).NE.0) CTRBNX(I)=TRIBC(LTRIB(I),JP)
  270 CSSNX(I)=CSS(JP)
      IF (ICIN.EQ.1) GO TO 310
C                                     COMPUTE CONCENTRATIONS FROM MASS VALUES
      IF (CNX(1).EQ.0.0) GO TO 280
      IF (QNX(1).LE.0.0) GO TO 440
      CNX(1)=CNX(1)/QNX(1)
  280 CONTINUE
      IF (NTRIB.EQ.0) GO TO 310
      DO 300 I=1,NX
      IF (CTRBNX(I).EQ.0.0) GO TO 300
      IF (LTRIB(I).EQ.0) GO TO 300
      IF (DATANX(4,I).GT.0.0) GO TO 290
      WRITE (6,1020) IMON,IDY,IYR,IHR
      CTRBNX(I)=0.0
      GO TO 300
  290 CTRBNX(I)=CTRBNX(I)/DATANX(4,I)
  300 CONTINUE
  310 CONTINUE
C                             COMPUTE DISPERSION COEFFICIENTS
      IF (IDISP.EQ.0) GO TO 330
      AI(1)=0.
      AIP1(1)=0.
      DI(1)=0.
      DIP1(1)=0.
      AN1=DATANX(3,1)
      AN2=DATANW(3,1)
      AC1=DATANX(3,2)
      AC2=DATANW(3,2)
      DN1=DIFAC*250.*YNX(1)*(32.2*YNX(1)*SZERO)**0.5
      DN2=DIFAC*250.*YNW(1)*(32.2*YNW(1)*SZERO)**0.5
      DC1=DIFAC*250.*YNX(2)*(32.2*YNX(2)*SZERO)**0.5
      DC2=DIFAC*250.*YNW(2)*(32.2*YNW(2)*SZERO)**0.5
C                              COMPUTE VALUES FOR INTERIOR X-SECTIONS
      DO 320 K=2,NXM1
      AP1=DATANX(3,K+1)
      AP2=DATANW(3,K+1)
      DP1=DIFAC*250.*YNX(K+1)*(32.2*YNX(K+1)*SZERO)**0.5
      DP2=DIFAC*250.*YNW(K+1)*(32.2*YNW(K+1)*SZERO)**0.5
      AI(K)=(AN1+AC1+AC2+AN2)/4.
      AIP1(K)=(AC2+AC1+AP2+AP1)/4.
      DI(K)=(DN1+DN2+DC1+DC2)/4.
      DIP1(K)=(DC1+DC2+DP1+DP2)/4.
      AN1=AC1
      AN2=AC2
      AC1=AP1
      AC2=AP2
      DN1=DC1
      DN2=DC2
      DC1=DP1
      DC2=DP2
  320 CONTINUE
```

```
C                     CREATE TRI-DIAGONAL MATRIX
C                     --------------------------
  330 A(1,1)=0.0
      A(2,1)=1.0
      A(3,1)=0.0
      A(1,NX)=0.0
      A(2,NX)=1.0
      A(3,NX)=0.0
      D(1)=CNX(1)
C                                   BEGIN X-SEC LOOP
      DO 340 K=2,NXM1
      DIST=DELX(K)+DELX(K+1)
      EPS=DELX(K)/DIST
      DELM=1./(DIST*DELX(K))
      DELP=1./(DIST*DELX(K+1))
      DMIN=DELM*AI(K)*DI(K)
      DPLS=DELP*AIP1(K)*DIP1(K)
      DCEN=DMIN+DPLS
C                                   SELECT CYCLIC COEF
      IF (ICYCL.EQ.1) RHO=0.1250/DT
      IF (ICYCL.EQ.2) RHO=0.4145/DT
      IF (ICYCL.EQ.3) RHO=0.4605/DT
      OMR=(1./DT)-RHO
C                                COMPUTE SUM OF LAT, TRIBS + SOURCE/SINK
      FIF=DATANX(4,K)*CTRBNX(K)+QLAT(K)*CLAT(K)+CSSNX(K)*DELX(K)
      FIP1F=DATANX(4,K+1)*CTRBNX(K+1)+QLAT(K+1)*CLAT(K+1)+CSSNX(K+1)*DEL
     1X(K+1)
      FIB=DATANW(4,K)*CTRBNW(K)+QLAT(K)*CLAT(K)+CSSNW(K)*DELX(K)
      FIP1B=DATANW(4,K+1)*CTRBNW(K+1)+QLAT(K+1)*CLAT(K+1)+CSSNW(K+1)*DEL
     1X(K+1)
C
C                     CREATE INTERNAL MATRIX COEFFICIENTS
C                                   A MATRIX
      A(1,K)=RHO*(1.-EPS)*DATANX(3,K-1)-(ZI*THETA/DELX(K))*QNX(K-1)-DMIN
     1+DKCOEF/2.*ZI*THETA*DATANX(3,K-1)
      A(2,K)=OMR*DATANX(3,K)+THETA*((ZI/DELX(K))-((1.-ZI)/DELX(K+1)))*QN
     1X(K)+DCEN+DKCOEF/2.*(ZI*THETA+(1.-ZI)*THETA)*DATANX(3,K)
      A(3,K)=RHO*EPS*DATANX(3,K+1)+((1.-ZI)*THETA/DELX(K+1))*QNX(K+1)-DP
     1LS+DKCOEF/2.*(1.-ZI)*THETA*DATANX(3,K+1)
C                                   D VECTOR
      D1K=(RHO*(1.-EPS)*DATANW(3,K-1)+(ZI*(1.-THETA)/DELX(K))*QNW(K-1)+D
     1MIN)*CNW(K-1)-DKCOEF/2.*ZI*(1.-THETA)*DATANW(3,K-1)*CNW(K-1)
      D2K=(OMR*DATANW(3,K)+(1.-THETA)*((1.-ZI)/DELX(K+1)-(ZI/DELX(K)))*Q
     1NW(K)-DCEN)*CNW(K)-DKCOEF/2.*(ZI*(1.-THETA)+(1.-ZI)*(1.-THETA))*DA
     2TANW(3,K)*CNW(K)
      D3K=(RHO*EPS*DATANW(3,K+1)-((1.-ZI)*(1.-THETA)/DELX(K+1))*QNW(K+1)
     1+DPLS)*CNW(K+1)-DKCOEF/2.*(1.-ZI)*(1.-THETA)*DATANW(3,K+1)*CNW(K+1
     2)
      D(K)=D1K+D2K+D3K
C                                  ADD FLUXES OF LAT AND TRIB Q'S
      DC1=-(ZI*THETA/DELX(K))*FIF
      DC2=-(ZI*(1.-THETA)/DELX(K))*FIB
      DC3=-((1.-ZI)*THETA/DELX(K+1))*FIP1F
      DC4=-((1.-ZI)*(1.-THETA)/DELX(K+1))*FIP1B
      D(K)=D(K)-DC1-DC2-DC3-DC4
C                                  FLUX BALANCING CORRECTION FACTOR
      D(K)=D(K)-FLUXUP*ABS(QNX(K)-QNW(K))*CNW(K)/DELX(K)
  340 CONTINUE
      D(NX)=CNW(NXM1)*CRAT-DKCOEF*DATANW(3,NXM1)*CNW(NXM1)
C                    END OF TRI-DIAGONAL MATRIX CREATION
C
```

```
C                               THOMAS ALGORITHM
C                               ----------------
      BETA(1)=A(2,1)
      GAMA(1)=D(1)/A(2,1)
      DO 350 I=2,NX
      BETA(I)=A(2,I)-(A(1,I)*A(3,I-1)/BETA(I-1))
      GAMA(I)=(D(I)-A(1,I)*GAMA(I-1))/BETA(I)
      IF (GAMA(I).GT.1.0E-75) GO TO 350
      GAMA(I)=0.0
  350 CONTINUE
      CNX(NX)=GAMA(NX)
      KK=NX
      DO 360 I=1,NXM1
      KK=KK-1
      CNX(KK)=GAMA(KK)-(A(3,KK)*CNX(KK+1)/BETA(KK))
  360 CONTINUE
C
      IF (MOD(J,IPNT).NE.0) GO TO 390
C
C                        PRINT MODEL RESULTS AT SELECTED TIME STEPS
C                        ------------------------------------------
      WRITE (6,730) IMON,IDY,IYR,IHR
      M1=1
      M2=13
  370 IF (M2.GT.NPRNT) M2=NPRNT
      WRITE (6,740) (NP(I),I=M1,M2)
      WRITE (6,750) (DATANX(2,NP(I)),I=M1,M2)
      WRITE (6,760) (YNX(NP(I)),I=M1,M2)
      WRITE (6,770) (QNX(NP(I)),I=M1,M2)
      WRITE (6,780) (CNX(NP(I)),I=M1,M2)
      IF (IDEBUG.LE.0) GO TO 380
C                  SET OF WRITE STATEMENTS FOR TROUBLE-SHOOTING PURPOSES
      WRITE (6,620) (A(1,NP(I)),I=M1,M2)
      WRITE (6,630) (A(2,NP(I)),I=M1,M2)
      WRITE (6,640) (A(3,NP(I)),I=M1,M2)
      WRITE (6,650) (D(NP(I)),I=M1,M2)
      WRITE (6,660) (BETA(NP(I)),I=M1,M2)
      WRITE (6,670) (GAMA(NP(I)),I=M1,M2)
      WRITE (6,680) (DI(NP(I)),I=M1,M2)
      WRITE (6,690) (DIP1(NP(I)),I=M1,M2)
      WRITE (6,700) (AI(NP(I)),I=M1,M2)
      WRITE (6,710) (AIP1(NP(I)),I=M1,M2)
  380 WRITE (6,790)
      IF (M2.EQ.NPRNT) GO TO 390
      M1=M2+1
      M2=M2+13
      GO TO 370
  390 CONTINUE
C                                       EXCHANGE TIME LEVELS
      DO 410 I=1,NX
      DO 400 L=1,6
      DATANW(L,I)=DATANX(L,I)
  400 CONTINUE
      YNW(I)=YNX(I)
      QNW(I)=QNX(I)
      CNW(I)=CNX(I)
      CTRBNW(I)=CTRBNX(I)
      CSSNW(I)=CSSNX(I)
  410 CONTINUE
      IF (NPLOT.EQ.0) GO TO 430
      DO 420 L=1,NPLOT
      K=NPP(L)
  420 CSAV(L,JP)=CNX(K)
```

```
C
  430 CONTINUE
      GO TO 450
C                              END TIME LOOP
C        *     *     *     *     *     *     *     *     *     *     *     *     *
C
  440 WRITE (6,1010) IMON,IDY,IYR,IHR
      STOP
C                                PLOT DATA ON PRINTER
C                                --------------------
  450 CONTINUE
      IF (NPLOT.LE.0) GO TO 610
      DPI=DT/86400.*IPLT
      IPLT1=IPLT+1
      XMX=CSAV(1,2)
      DO 470 I=1,NPLOT
      K1=0
      DO 460 K=IPLT1,NTSP1,IPLT
      K1=K1+1
      CSAV(I,K1)=CSAV(I,K)
      IF (CSAV(I,K1).GT.XMX) XMX=CSAV(I,K1)
  460 CONTINUE
  470 CONTINUE
C                                             COMPUTE MAXIMUM GRAPH RANGE
      IXMAX=INT(XMX)
      DO 480 I=1,12
      IUP=IRNG(I)
      IF (IUP.GE.IXMAX) GO TO 490
  480 CONTINUE
  490 CONTINUE
      XMAX=IRNG(I)
      XMIN=0.0
C                                             BEGIN PLOTTING
      CALL PLOT1 (NSCALE,8,12,10,10)
      WRITE (6,1030)
      M1=1
      M2=96
  500 IF (M2.GT.K1) M2=K1
      NOPTS=M2-M1+1
      DO 510 I=1,NOPTS
  510 Z(I)=(I+M1-1)*DPI
      IF (M1.GT.1) GO TO 520
      YMIN=Z(M1)-DPI
      YMAX=Z(M2)
  520 CONTINUE
      CALL PLOT2 (IMAGE,XMAX,XMIN,YMIN,YMAX,6)
      DO 590 I=1,NPLOT
      DO 530 K=1,NOPTS
  530 X(K)=CSAV(I,K+M1-1)
      GO TO (540,550,560,570,580), I
      GO TO (540,550,560,570,580), I
  540 CALL PLOT3 ('A',X,Z,NOPTS)
      GO TO 590
  550 CALL PLOT3 ('B',X,Z,NOPTS)
      GO TO 590
  560 CALL PLOT3 ('C',X,Z,NOPTS)
      GO TO 590
  570 CALL PLOT3 ('D',X,Z,NOPTS)
      GO TO 590
  580 CALL PLOT3 ('E',X,Z,NOPTS)
  590 CONTINUE
```

```
      IF (M2.GE.K1) GO TO 600
      CALL OMIT (5)
      CALL PLOT4 (17,'      TIME IN DAYS')
      M1=M2+1
      M2=M2+96
      YDEL=YMAX-YMIN
      YMIN=YMAX
      YMAX=YMAX+YDEL
      GO TO 500
  600 CALL OMIT (-3)
      CALL PLOT4 (17,'      TIME IN DAYS')
      WRITE (6,990)
      WRITE (6,1000) (LETTER(I),NPP(I),I=1,NPLOT)
  610 STOP
C
C        *         *         *         *         *         *         *         *         *         *         *
C
C                              FORMAT STATEMENTS
C
C
  620 FORMAT (' ',10X,'A(1, )',13F8.4)
  630 FORMAT (' ',10X,'A(2, )',13F8.4)
  640 FORMAT (' ',10X,'A(3, )',13F8.4)
  650 FORMAT (' ',15X,'D',13F8.4)
  660 FORMAT (' ',12X,'BETA',13F8.4)
  670 FORMAT (' ',12X,'GAMA',13F8.4)
  680 FORMAT (' ',14X,'DI',13F8.1)
  690 FORMAT (' ',12X,'DIP1',13F8.1)
  700 FORMAT (' ',14X,'AI',13F8.1)
  710 FORMAT (' ',12X,'AIP1',13F8.1)
  720 FORMAT (2F8.0,40X,2F8.0,4X,I4)
  730 FORMAT (' ',I2,'/',I2,'/',I4,3X,I4,2X,13(5(1H-),3X))
  740 FORMAT (' ',12X,'XSEC',13(3X,I2,3X))
  750 FORMAT (1H ,8X,'VELOCITY',13F8.2)
  760 FORMAT (1H ,11X,'DEPTH',13F8.2)
  770 FORMAT (1H ,7X,'DISCHARGE',13F8.0)
  780 FORMAT (1H ,3X,'CONCENTRATION',1X,13F8.3)
  790 FORMAT (1H )
  800 FORMAT (16X,8F8.2)
  810 FORMAT ('0',//10X,20A4,//1X)
  820 FORMAT (10I8)
  830 FORMAT (20A4)
  840 FORMAT ('0',130(1H*),//,25X,'J880--MASS TRANSPORT SIMULATION USING
     1 AN IMPLICIT FINITE DIFFERENCE MODEL.',//,1X,130(1H*))
  850 FORMAT ('0',10X,'CONSTITUENT INFLOW CODE; (1) CONCENTRATION  (2) F
     1LUX',6(1H-),I7/11X,'SOURCE/SINK CODE; (0) NO  (1) YES',25(1H-),I7/
     211X,'DISPERSION CODE;  (0) ZERO  (1) SELF-SETTING',14(1H-),I7)
  860 FORMAT (' ',10X,'STARTING DATE',45(1H-),I4,'/',I2,'/',I4)
  870 FORMAT (' ',10X,'NUMBER OF CROSS-SECTIONS',34(1H-),I7/11X,'NUMBER
     1OF TIME STEPS',38(1H-),I7/11X,'LENGTH OF TIME STEP (MINUTES)',29(1
     2H-),F9.1/11X,'NUMBER OF TRIBUTARIES',37(1H-),I7)
  880 FORMAT (' ',10X,'MULTIPLIER FOR SELF-SETTING DISPERSION COEFFICIEN
     1T',8(1H-),F10.2)
  890 FORMAT (' ',10X,'DECAY COEFFICIENT',41(1H-),F14.6)
  900 FORMAT ('1',40X,'VALUES OF INFLOWING CONSTITUENT'/1X,120(1H-)/1X,1
     12F10.2/(1X,12F10.2))
  910 FORMAT ('1',40X,'VALUES OF SOURCE (+) OR SINK (-) FLUX'/1X,120(1H-
     1)/1X,12F10.2/(1X,12F10.2))
  920 FORMAT ('1',40X,'VALUES OF INFLOWING CONSTITUENT FROM TRIBUTARY NO
     1.',I2/1X,120(1H-)/1X,12F10.2/(1X,12F10.2))
```

```
 930 FORMAT ('1',10X,31(1H-),'CROSS-SECTION AND INITIAL FLOW DATA',31(1
    1H-)//,1X,10X,'X-SEC            X              DELX          Z       STREAMFLOW
    2 STREAM     LATERAL INFLOW    LATERAL Q      TRIB'/1X,10X,'  NO
    3 (FT)          (FT)          (FT)          (CFS)  CONCENTRATION        (CFS)
    4  CONCENTRATION     NO'/1X)
 940 FORMAT (' ',I14,F12.0,F11.0,F10.2,F11.1,F13.3,F12.1,F17.3,I7)
 950 FORMAT ('0',/////,21X,'OBJECTIVE OF THIS COMPUTER RUN IS TO PLOT K
    1NOWN HYDROGRAPH DATA')
 960 FORMAT ('0','JOB ABORTED.  INCORRECT CHANNEL LENGTH AT CROSS-SECTI
    1ON',I4)
 970 FORMAT ('1',40X,'CROSS-SECTION NUMBER',I3)
 980 FORMAT ('0','OBSERVED CONSTITUENT VALUES'/1X,12F10.2/(1X,12F10.2))
 990 FORMAT ('0',50X,'CONCENTRATION IN MASS PER UNIT VOLUME')
1000 FORMAT (' ',10X,'EXPLANATION:  SYMBOL     X-SECT'/28X,A1,8X,I3/(28X
    1,A1,8X,I3))
1010 FORMAT ('0','JOB ABORTED AT TIME = ',I2,'/',I2,'/',I4,':',I4,' INF
    1LOW INTO REACH WAS 0.0 OR LESS.'/1X,'CONCENTRATION WAS BEING COMPU
    2TED FOR A CONSTITUENT FLUX.')
1020 FORMAT ('0','AT TIME = ',I2,'/',I2,'/',I4,':',I4,', A TRIBUTARY FL
    1OW WAS 0.0 OR LESS.  THE CONCENTRATION FROM THIS TRIBUTARY WAS SET
    2 TO 0.0')
1030 FORMAT ('1',27(1H*),'GRAPH OF CONCENTRATION VS TIME AT SELECTED CR
    1OSS-SECTIONS',27(1H*)//1X)
1040 FORMAT ('1',30(1H*),'FLOW DATA AND CONCENTRATION RESULTS AT SELECT
    1ED CROSS-SECTIONS',30(1H*)//4X,'DATE        HOURS'/1X)
     END
```

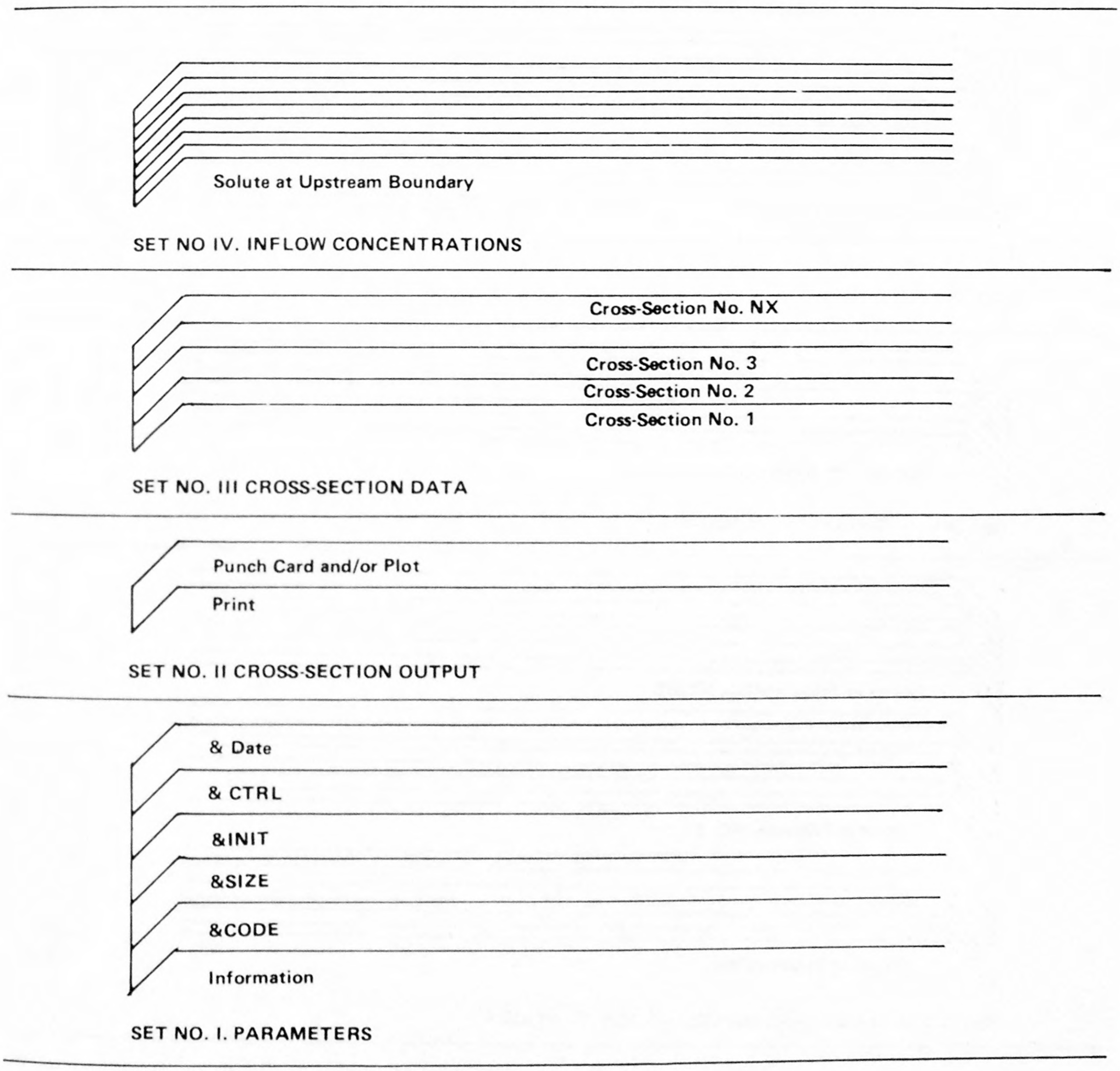
```
      SUBROUTINE PRPLOT
C
C     PRPLOT- SUBPROGRAM OF ENTRIES TO CONSTRUCT A CONTINUOUS
C             PRINTER PLOT OF TIME SERIES DATA.
C
      IMPLICIT LOGICAL*1(W),LOGICAL*1(K)
      DIMENSION NSCALE(5), ABNOS(26), X(1), Y(1)
      LOGICAL*1 NOS(10)/'0','1','2','3','4','5','6','7','8','9'/
      LOGICAL*1 IMAGE(1).CH,LABEL(1),ERR1,ERR3,ERR5
      LOGICAL*1 VC,HC,FOR1(19),FOR2(15),FOR3(19),NC,BL,HF,HF1
      REAL*8 FOX1(3),FOX2(2),FOX3(3)
      INTEGER*2 VCR
      EQUIVALENCE (FOR1(1),FOX1(1)), (FOR2(1),FOX2(1)), (FOR3(1),FOX3(1)
     1), (VC,VCR)
      INTEGER FILE
      DATA HC/'-'/,NC/'+'/,BL/' '/,HF/'F'/,HF1/'.'/
      DATA FOX1/'(1XA1,F9','.2,   121','A1)      '/
      DATA FOX2/'(1XA1, 9','X121A1) '/
      DATA FOX3/'(1H0F   .',' ,  F    ','. )      '/
      DATA VCR/Z4F00/
      DATA KPLOT1/.FALSE./,KPLOT2/.FALSE./
      DATA KABSC,KORD,KBOTGL/3*.FALSE./
C
      ENTRY PLOT1(NSCALE,NHL,NSBH,NVL,NSBV)
      ERR1=.FALSE.
      ERR3=.FALSE.
      ERR5=.FALSE.
      KPLOT1=.TRUE.
      KPLOT2=.FALSE.
      NH=IABS(NHL)
      NSH=IABS(NSBH)
      NV=IABS(NVL)
      NSV=IABS(NSBV)
      NSCL=NSCALE(1)
      IF (NH*NSH*NV*NSV.NE.0) GO TO 10
      KPLOT=.FALSE.
      ERR1=.TRUE.
      RETURN
   10 KPLOT=.TRUE.
      IF (NV.LE.25) GO TO 20
      KPLOT=.FALSE.
      ERR3=.TRUE.
      RETURN
   20 CONTINUE
      NVM=NV-1
      NVP=NV+1
      NDH=NH*NSH
      NDHP=NDH+1
      NDV=NV*NSV
      NDVP=NDV+1
      NIMG=(NDHP*NDVP)
      IF (NDV.LE.120) GO TO 30
      KPLOT=.FALSE.
      ERR5=.TRUE.
      RETURN
   30 CONTINUE
      IF (NSCL.EQ.0) GO TO 40
      FSY=10.**NSCALE(2)
      FSX=10.**NSCALE(4)
      IY=MIN0(IABS(NSCALE(3)),7)+1
      IX=MIN0(IABS(NSCALE(5)),9)+1
      GO TO 50
```

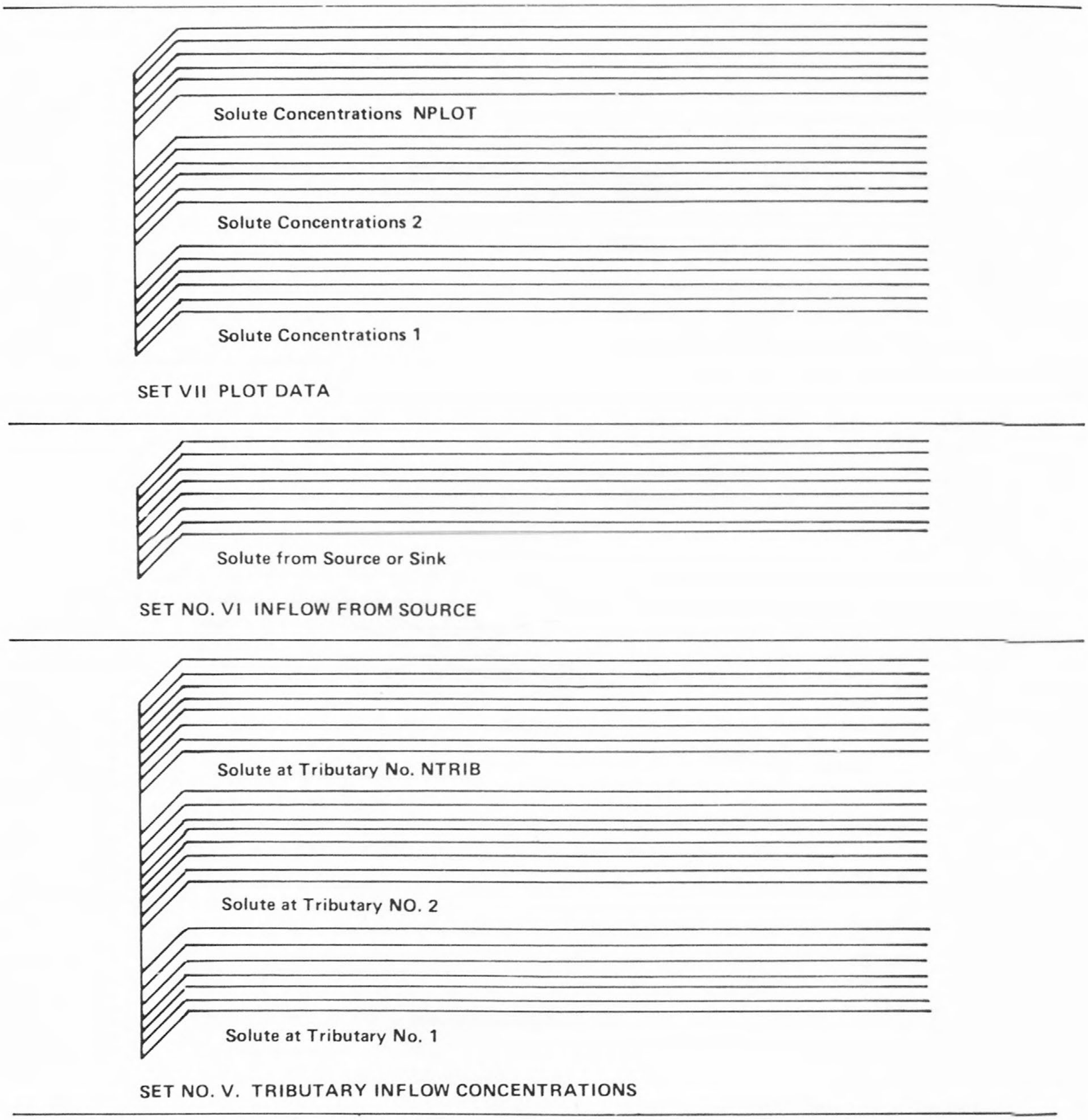
```
   40 FSY=1.
      FSX=1.
      IY=4
      IX=4
   50 FOR1(10)=NOS(IY)
      NA=MINO(IX,NSV)-1
      NS=NA-MINO(NA,120-NDV)
      NB=11-NS+NA
      I1=NB/10
      I2=NB-I1*10
      FOR3(6)=NOS(I1+1)
      FOR3(7)=NOS(I2+1)
      FOR3(9)=NOS(NA+1)
      IF (NV.GT.0) GO TO 70
      DO 60 J=11,18
   60 FOR3(J)=BL
      GO TO 80
   70 I1=NV/10
      I2=NV-I1*10
      FOR3(11)=NOS(I1+1)
      FOR3(12)=NOS(I2+1)
      FOR3(13)=HF
      I1=NSV/100
      I3=NSV-I1*100
      I2=I3/10
      I3=I3-I2*10
      FOR3(14)=NOS(I1+1)
      FOR3(15)=NOS(I2+1)
      FOR3(16)=NOS(I3+1)
      FOR3(17)=HF1
      FOR3(18)=FOR3(9)
   80 IF (KPLOT1) RETURN
      KPLOT1=.TRUE.
C
      ENTRY PLOT2(IMAGE,XMAX,XMIN,YMAX,YMIN,FILE)
      IFL=FILE
      KPLOT2=.TRUE.
      IF (KPLOT1) GO TO 90
      NSCL=0
      NH=5
      NSH=10
      NV=10
      NSV=10
      GO TO 10
   90 CONTINUE
      IF (KPLOT) GO TO 100
      IF (ERR1) WRITE (IFL,300)
      IF (ERR3) WRITE (IFL,310)
      IF (ERR5) WRITE (IFL,320)
      RETURN
  100 YMX=YMAX
      DH=(YMAX-YMIN)/FLOAT(NDH)
      DV=(XMAX-XMIN)/FLOAT(NDV)
      DO 110 I=1,NVP
  110 ABNOS(I)=(XMIN+FLOAT((I-1)*NSV)*DV)*FSX
      DO 120 I=1,NIMG
  120 IMAGE(I)=BL
      DO 160 I=1,NDHP
      I2=I*NDVP
      I1=I2-NDV
      KNHOR=MOD(I-1,NSH).NE.0
      IF (KNHOR) GO TO 140
```

```
      DO 130 J=I1,I2
  130 IMAGE(J)=HC
  140 CONTINUE
      DO 160 J=I1,I2,NSV
      IF (KNHOR) GO TO 150
      IMAGE(J)=NC
      GO TO 160
  150 IMAGE(J)=VC
  160 CONTINUE
      XMIN1=XMIN-DV/2.
      YMIN1=YMIN-DH/2.
      RETURN
C
      ENTRY PLOT3(CH,X,Y,N3)
      IF (KPLOT2) GO TO 180
  170 WRITE (IFL,330)
  180 CONTINUE
      IF (.NOT.KPLOT) RETURN
      IF (N3.GT.0) GO TO 190
      KPLOT=.FALSE.
      WRITE (IFL,340)
      RETURN
  190 DO 260 I=1,N3
      IF (DV) 210,200,210
  200 DUM1=0
      GO TO 220
  210 CONTINUE
      DUM1=(X(I)-XMIN1)/DV
  220 IF (DH) 240,230,240
  230 DUM2=0
      GO TO 250
  240 CONTINUE
      DUM2=(Y(I)-YMIN1)/DH
  250 CONTINUE
      IF (DUM1.LT.0..OR.DUM2.LT.0.) GO TO 260
      IF (DUM1.GE.NDVP.OR.DUM2.GE.NDHP) GO TO 260
      NX=1+INT(DUM1)
      NY=1+INT(DUM2)
      J=(NDHP-NY)*NDVP+NX
      IMAGE(J)=CH
  260 CONTINUE
      RETURN
C
      ENTRY PLOT4(NL,LABEL)
      ENTRY FPLOT4(NL,LABEL)
      IF (.NOT.KPLOT) RETURN
      IF (.NOT.KPLOT2) GO TO 170
      DO 280 I=1,NDHP
      IF (I.EQ.NDHP.AND.KBOTGL) GO TO 280
      WL=BL
      IF (I.LE.NL) WL=LABEL(I)
      I2=I*NDVP
      I1=I2-NDV
      IF (MOD(I-1,NSH).EQ.0.AND..NOT.KORD) GO TO 270
      WRITE (IFL,FOR2) WL,(IMAGE(J),J=I1,I2)
      GO TO 280
  270 CONTINUE
      ORDNO=(YMX-FLOAT(I-1)*DH)*FSY
      IF (I.EQ.NDHP) ORDNO=YMIN
      WRITE (IFL,FOR1) WL,ORDNO,(IMAGE(J),J=I1,I2)
  280 CONTINUE
      IF (KABSC) GO TO 290
      WRITE (IFL,FOR3) (ABNOS(J),J=1,NVP)
```

```
  290 RETURN
C
      ENTRY OMIT(LSW)
      KABSC=MOD(LSW,2).EQ.1
      KORD=MOD(LSW,4).GE.2
      KBOTGL=LSW.GE.4
      RETURN
C
C
  300 FORMAT (T5,'SOME PLOT1 ARG. ILLEGALLY 0')
  310 FORMAT (T5,'NO. OF VERTICAL LINES >25')
  320 FORMAT (T5,'WIDTH OF GRAPH >121')
  330 FORMAT (T5,'PLOT2 MUST BE CALLED')
  340 FORMAT (T5,'PLOT3, ARG2 ) 0')
      END
```

C. SCHEMATIC DIAGRAM OF CARD DECK FOR SOLUTE-TRANSPORT SIMULATION


Solute at Upstream Boundary
SET NO IV. INFLOW CONCENTRATIONS
Cross-Section No. NX
Cross-Section No. 3
Cross-Section No. 2
Cross-Section No. 1
SET NO. III CROSS-SECTION DATA
Punch Card and/or Plot
Print
SET NO. II CROSS-SECTION OUTPUT
& Date
& CTRL
&INIT
&SIZE
&CODE
Information
SET NO. I. PARAMETERS


Solute Concentrations NPLOT
Solute Concentrations 2
Solute Concentrations 1
SET VII PLOT DATA
Solute from Source or Sink
SET NO. VI INFLOW FROM SOURCE
Solute at Tributary No. NTRIB
Solute at Tributary NO. 2
Solute at Tributary No. 1
SET NO. V. TRIBUTARY INFLOW CONCENTRATIONS

D. LISTING OF CARD DECK FOR SOLUTE-TRANSPORT SIMULATION

```
     EXAMPLE: J880 MASS TRANSPORT MODEL SIMULATION
&CODE    ICIN=1,    IDISP=1,   ISS=1,     IDEBUG=0, NZPLOT=0                    &END
&SIZE    NX=30,     NTS=288,   NTRIB=1,   DT=300.                               &END
&INIT    DIFAC=1.0,            DKCOEF=0.00001                                   &END
&CTRL    NPRNT=13,  IPNT=24,   NPLOT=3,   IPLT=3                                &END
&DATE    IYR=1976,  IMON=4,    IDY=1,     IHR=0                                 &END
       1         2         4         7        10        13        16        19        22        25
      28        29        30
       1        15        30
   1584.  910.54   0.060   0.0      0.0      0.0       1.000     1.0                 9
   2217.  909.53   0.086   0.0      0.0      0.0       1.000     1.0                 9
   3000.  908.10   0.054   0.0      0.0      0.0       1.000     1.0                 9
   4000.  906.13   0.056   0.0      0.0      0.0       1.000     1.0                 9
   5121.  903.76   0.051   0.0      0.0      0.0       1.000     1.0                 9
   6969.  901.15   0.038   0.0      0.0      0.0       1.000     1.0                 9
   9873.  898.04   0.026   0.0      0.0      0.0       1.000     1.0                 9
  12302.  896.96   0.025   0.0      0.0      0.0       1.000     1.0                 9
  13675.  895.97   0.035  -0.001    0.0      0.0       1.000     1.0                 9
  14361.  895.87   0.048  -0.001    0.0      0.0       1.000     1.0                 9
  15153.  894.16   0.037  -0.001    0.0      0.0       1.000     1.0                 9    1
  17793.  897.65   0.021   0.0      0.0      0.0       1.000     1.0                 9
  18585.  897.55   0.021   0.0      0.0      0.0       1.000     1.0                 9
  19536.  897.45   0.018   0.0      0.0      0.0       1.000     1.0                 9
  22334.  897.03   0.018   0.0      0.0      0.0       1.000     1.0                 9
  25291.  900.52   0.030   0.0      0.0      0.0       1.000     1.0                 9
  27350.  899.61   0.030   0.0      0.0      0.0       1.000     1.0                 9
  30888.  898.90   0.030  -0.002    0.0      0.0       1.000     1.0                 9
  32419.  897.49   0.065  -0.005    0.0      0.0       1.000     1.0                 9
  33686.  895.59   0.099  -0.005    0.0    0.005785    1.000     1.0       1.0       9
  35481.  894.48   0.107  -0.004    0.0      0.0       1.000     1.0                 9
  37066.  893.27   0.110   0.0      0.0    0.015773    1.000     1.0       1.0       9
  39758.  891.46   0.088   0.0      0.0      0.0       1.000     1.0                 9
  43349.  890.85   0.058   0.0      0.0      0.0       1.000     1.0                 9
  45038.  887.84   0.026   0.0      0.0      0.0       1.000     1.0                 9
  46517.  888.26   0.016   0.0      0.0      0.0       1.000     1.0                 9
  48101.  890.39   0.019   0.0      0.0      0.0       1.000     1.0                 9
  49685.  890.21   0.023   0.0      0.0      0.0       1.000     1.0                 9
  51533.  889.44   0.023   0.0      0.0      0.0       1.000     1.0                 9
  52747.  889.36   0.026   0.0      0.0      0.0       1.000     1.0                 9
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           9.        9.        9.        9.        9.        9.        9.        9.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
```



```
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           5.        5.        5.        5.        5.        5.        5.        5.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
   BUFORD DAM           1.        1.        1.        1.        1.        1.        1.        1.
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  TRIB. NO. 1          1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .00       .00       .00       .00       .00       .00       .00       .00
  SOURCE / SINK        .05       .05       .05       .05       .05       .05       .05       .05
  SOURCE / SINK        .05       .05       .05       .05       .05       .05       .05       .05
  SOURCE / SINK        .05       .05       .05       .05       .05       .05       .05       .05
  SOURCE / SINK        .05       .05       .05       .05       .05       .05       .05       .05
  SOURCE / SINK        .05       .05       .05       .05       .05       .05       .05       .05
```

SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.10	.10	.10	.10	.10	.10	.10	.10
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.05	.05	.05	.05	.05	.05	.05	.05
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00
SOURCE / SINK	.00	.00	.00	.00	.00	.00	.00	.00

E. OUTPUT EXAMPLE

EXAMPLE: J880 MASS TRANSPORT MODEL SIMULATION

```
CONSTITUENT INFLOW CODE; (1) CONCENTRATION  (2) FLUX------        1
SOURCE/SINK CODE; (0) NO  (1) YES--------------------------        1
DISPERSION CODE;  (0) ZERO  (1) SELF-SETTING--------------        1
STARTING DATE-------------------------------------------------  4/ 1/1976
NUMBER OF CROSS-SECTIONS--------------------------------------    30
NUMBER OF TIME STEPS------------------------------------------   288
LENGTH OF TIME STEP (MINUTES)---------------------------------     5.0
NUMBER OF TRIBUTARIES-----------------------------------------     1
MULTIPLIER FOR SELF-SETTING DISPERSION COEFFICIENT--------        1.00
DECAY COEFFICIENT---------------------------------------------     0.000010
```

-----------------------------CROSS-SECTION AND INITIAL FLOW DATA-----------------------------

X-SEC NO	X (FT)	DELX (FT)	Z (FT)	STREAMFLOW (CFS)	STREAM CONCENTRATION	LATERAL INFLOW (CFS)	LATERAL Q CONCENTRATION	TRIB NO
1	1584.	0.	910.54	550.0	1.000	0.0	0.0	0
2	2217.	633.	909.53	550.0	1.000	0.0	0.0	0
3	3000.	783.	908.10	550.0	1.000	0.0	0.0	0
4	4000.	1000.	906.13	550.0	1.000	0.0	0.0	0
5	5121.	1121.	903.76	550.0	1.000	0.0	0.0	0
6	6969.	1848.	901.15	550.0	1.000	0.0	0.0	0
7	9873.	2904.	898.04	550.0	1.000	0.0	0.0	0
8	12302.	2429.	896.96	550.0	1.000	0.0	0.0	0
9	13575.	1373.	895.97	550.0	1.000	0.0	0.0	0
10	14361.	686.	895.87	550.0	1.000	0.0	0.0	0
11	15153.	792.	894.16	590.0	1.000	0.0	0.0	1
12	17793.	2640.	897.65	590.0	1.000	0.0	0.0	0
13	18585.	792.	897.55	590.0	1.000	0.0	0.0	0
14	19536.	951.	897.45	590.0	1.000	0.0	0.0	0
15	22334.	2798.	897.03	590.0	1.000	0.0	0.0	0
16	25291.	2957.	900.52	590.0	1.000	0.0	0.0	0
17	27350.	2059.	899.61	590.0	1.000	0.0	0.0	0
18	30888.	3538.	898.90	590.0	1.000	0.0	0.0	0
19	32419.	1531.	897.49	590.0	1.000	0.0	0.0	0
20	33586.	1267.	895.59	610.0	1.000	20.0	1.000	0
21	35481.	1795.	894.48	610.0	1.000	0.0	0.0	0
22	37066.	1585.	893.27	635.0	1.000	25.0	1.000	0
23	39758.	2692.	891.46	635.0	1.000	0.0	0.0	0
24	43349.	3591.	890.85	635.0	1.000	0.0	0.0	0
25	45038.	1689.	887.84	635.0	1.000	0.0	0.0	0
26	46517.	1479.	888.26	635.0	1.000	0.0	0.0	0
27	48101.	1584.	890.39	635.0	1.000	0.0	0.0	0
28	49685.	1584.	890.21	635.0	1.000	0.0	0.0	0
29	51533.	1848.	889.44	635.0	1.000	0.0	0.0	0
30	52747.	1214.	889.36	635.0	1.000	0.0	0.0	0

VALUES OF INFLOWING CONSTITUENT

1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

VALUES OF INFLOWING CONSTITUENT FROM TRIBUTARY NO. 1

1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

VALUES OF SOURCE (+) OR SINK (-) FLUX

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**********************************FLOW DATA AND CONCENTRATION RESULTS AT SELECTED CROSS-SECTIONS**********************************

DATE	HOURS														
4/ 1/1976	0		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
		XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
		VELOCITY	1.09	1.33	1.80	0.73	0.46	0.86	1.28	1.50	0.87	0.92	1.89	1.44	1.65
		DEPTH	2.02	2.02	1.70	5.20	7.33	5.60	2.20	2.87	4.33	5.16	2.21	2.59	2.40
		DISCHARGE	550.	550.	550.	550.	550.	590.	590.	590.	635.	635.	635.	635.	635.
		CONCENTRATION	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4/ 1/1976	200		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
		XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
		VELOCITY	0.77	1.33	1.79	0.73	0.46	0.86	1.28	1.50	0.87	0.85	1.38	0.99	1.04
		DEPTH	2.84	2.02	1.71	5.21	7.32	5.59	2.20	2.86	4.31	5.49	2.85	3.48	3.49
		DISCHARGE	550.	550.	550.	549.	549.	588.	586.	585.	631.	624.	602.	590.	582.
		CONCENTRATION	1.000	0.994	0.984	0.947	0.936	0.930	0.927	0.927	0.933	0.926	0.922	0.925	0.922
4/ 1/1976	400		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
		XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
		VELOCITY	0.77	1.33	1.79	0.73	0.46	0.86	1.28	1.50	0.87	0.84	1.37	1.01	1.06
		DEPTH	2.84	2.02	1.71	5.21	7.33	5.60	2.21	2.86	4.30	5.50	2.98	3.61	3.62
		DISCHARGE	550.	550.	550.	550.	549.	589.	589.	588.	632.	629.	624.	621.	620.
		CONCENTRATION	1.000	0.994	0.984	0.935	0.891	0.876	0.864	0.862	0.871	0.867	0.862	0.862	0.860
4/ 1/1976	600		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
		XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
		VELOCITY	0.77	1.33	1.79	0.73	0.46	0.86	1.28	1.50	0.87	0.84	1.37	1.01	1.07
		DEPTH	2.84	2.02	1.71	5.21	7.33	5.60	2.21	2.87	4.31	5.63	3.01	3.65	3.66
		DISCHARGE	550.	550.	550.	550.	550.	590.	590.	589.	634.	632.	631.	630.	629.
		CONCENTRATION	9.000	8.950	8.860	5.605	1.179	0.848	0.815	0.806	0.815	0.810	0.806	0.807	0.804
4/ 1/1976	800		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
		XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
		VELOCITY	2.65	2.99	3.61	3.14	1.91	2.63	2.12	1.68	0.88	0.84	1.37	1.01	1.07
		DEPTH	5.98	6.39	6.07	7.77	9.33	7.21	3.26	3.09	4.34	5.64	3.02	3.66	3.67
		DISCHARGE	3964.	3963.	3942.	3568.	2931.	2349.	1443.	712.	649.	634.	633.	633.	633.
		CONCENTRATION	9.000	8.985	8.962	9.324	6.849	3.796	1.444	1.547	1.415	1.318	1.322	1.344	1.315

4/ 1/1976 1000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.67	2.99	3.49	2.57	1.87	2.88	2.54	2.93	1.58	2.01	2.12	1.44	1.35
DEPTH	6.03	6.49	6.40	10.26	12.11	10.10	6.45	7.65	9.59	7.54	4.71	5.32	5.32
DISCHARGE	4023.	4023.	4018.	3916.	3774.	3687.	3481.	3144.	2800.	2064.	1553.	1316.	1165.
CONCENTRATION	9.000	8.985	8.963	8.885	8.761	8.625	8.220	6.819	4.308	2.073	1.832	1.804	1.765

4/ 1/1976 1200	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.67	2.99	3.41	2.45	1.82	2.82	2.46	2.90	1.78	2.09	2.17	1.83	1.89
DEPTH	6.04	6.53	6.56	10.97	12.85	10.88	7.35	9.08	11.66	11.28	8.66	9.33	9.33
DISCHARGE	4035.	4035.	4032.	3992.	3938.	3931.	3852.	3731.	3665.	3377.	3102.	2982.	2910.
CONCENTRATION	9.000	8.996	8.993	8.975	8.840	8.726	8.641	8.559	8.272	7.236	5.938	5.208	4.897

4/ 1/1976 1400	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.68	2.98	3.38	2.40	1.80	2.79	2.42	2.87	1.78	2.05	2.18	1.95	2.04
DEPTH	6.05	6.55	6.65	11.26	13.17	11.21	7.71	9.59	12.37	12.64	10.05	10.73	10.73
DISCHARGE	4047.	4047.	4044.	4021.	3995.	4014.	3978.	3924.	3922.	3813.	3715.	3674.	3650.
CONCENTRATION	5.000	5.004	5.022	5.073	5.728	6.572	7.983	8.539	8.458	8.313	8.144	8.033	7.850

4/ 1/1976 1600	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.57	2.98	3.36	2.37	1.79	2.77	2.40	2.86	1.78	2.05	2.19	1.99	2.10
DEPTH	6.04	6.55	6.68	11.39	13.31	11.36	7.88	9.82	12.68	13.13	10.55	11.22	11.23
DISCHARGE	4035.	4039.	4041.	4034.	4023.	4052.	4036.	4011.	4035.	3991.	3952.	3936.	3927.
CONCENTRATION	5.000	4.998	4.993	4.965	4.904	4.895	5.090	5.650	6.464	7.610	7.921	7.971	7.842

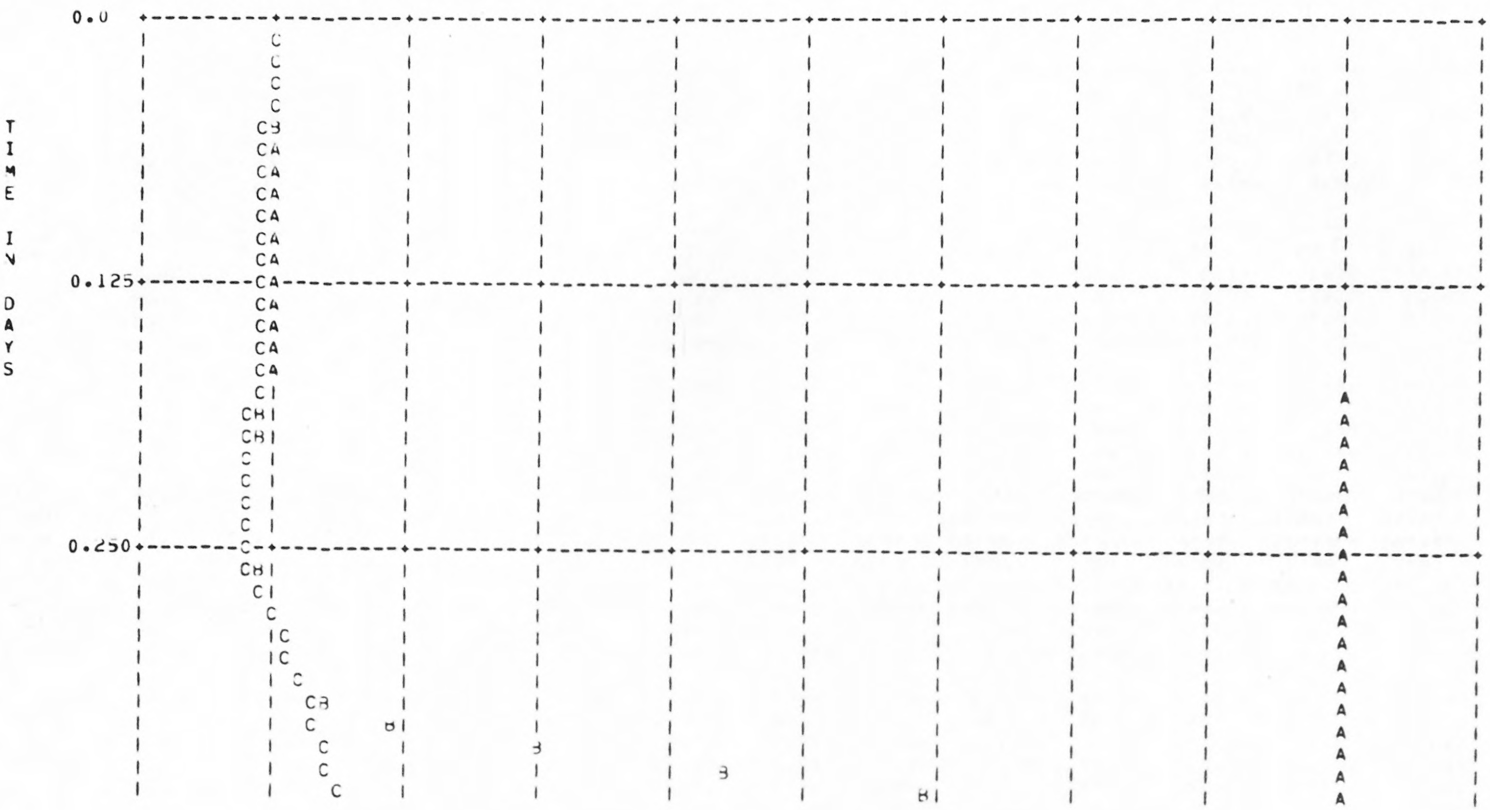
4/ 1/1976 1800	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.71	3.01	3.39	2.41	1.82	2.81	2.41	2.88	1.79	2.06	2.19	2.00	2.12
DEPTH	6.14	6.57	6.83	11.54	13.45	11.49	8.01	9.96	12.85	13.34	10.76	11.44	11.44
DISCHARGE	4154.	4158.	4164.	4154.	4137.	4160.	4134.	4100.	4121.	4086.	4062.	4053.	4047.
CONCENTRATION	5.000	4.997	4.993	4.965	4.875	4.818	4.783	4.780	4.812	5.268	5.773	6.030	6.003

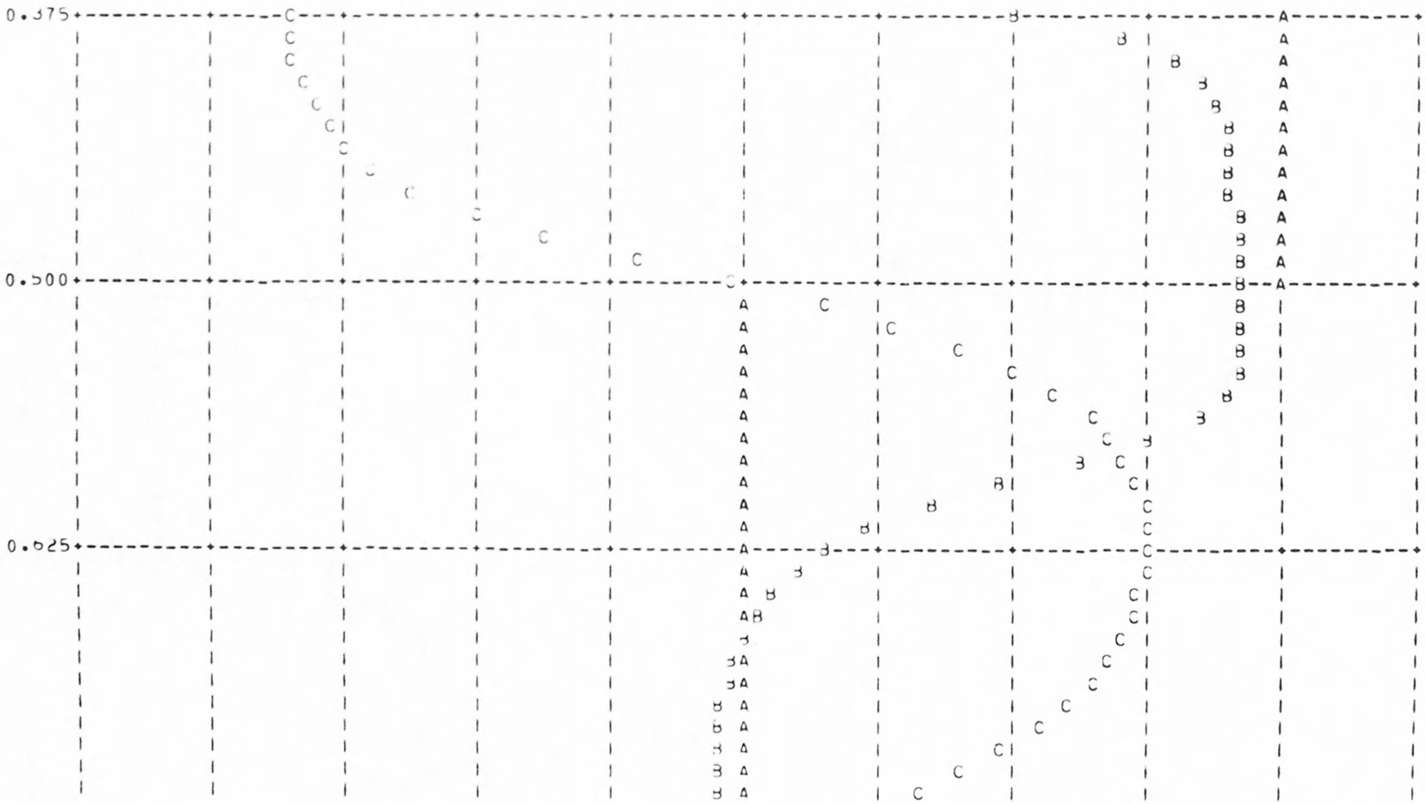
4/ 1/1976 2000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.58	2.98	3.34	2.35	1.79	2.76	2.38	2.86	1.79	2.06	2.20	2.02	2.13
DEPTH	6.05	6.56	6.73	11.54	13.47	11.52	8.05	10.04	12.96	13.50	10.92	11.59	11.59
DISCHARGE	4047.	4044.	4044.	4049.	4054.	4099.	4106.	4112.	4159.	4153.	4143.	4139.	4136.
CONCENTRATION	5.000	4.987	4.962	4.860	4.730	4.645	4.582	4.526	4.454	4.438	4.482	4.524	4.459

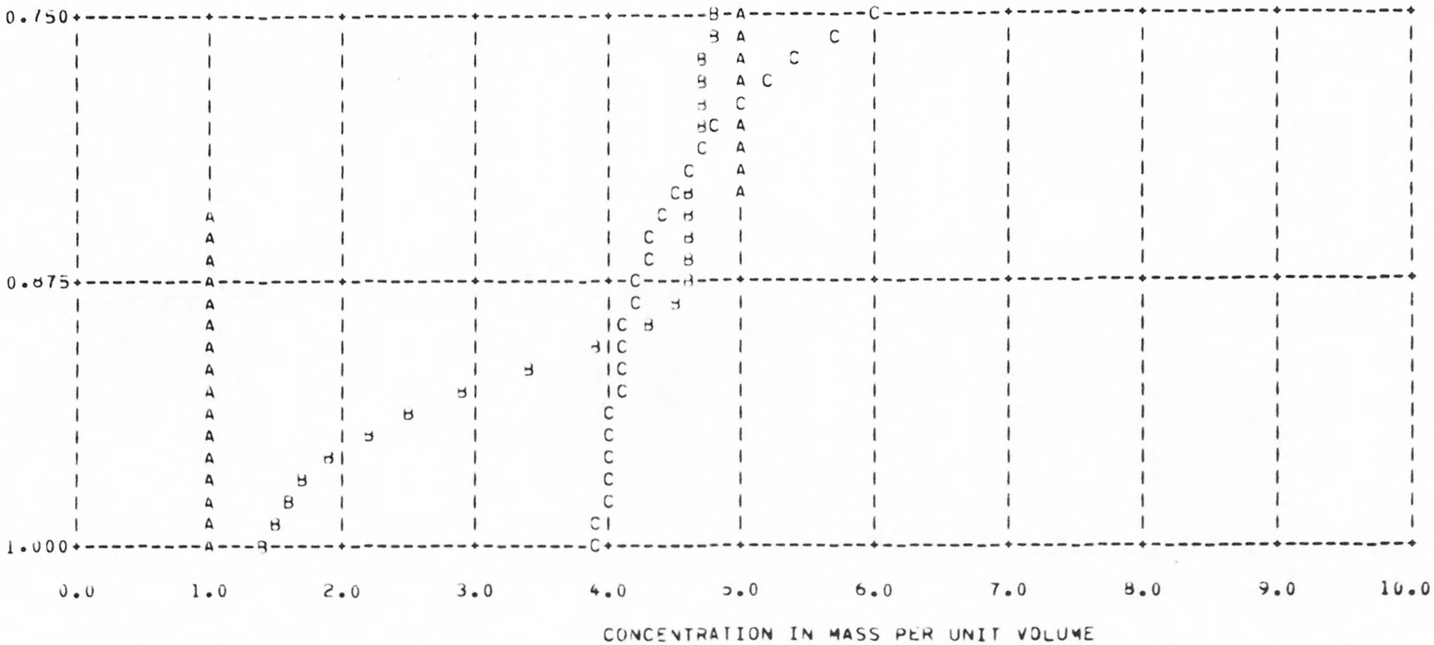
4/ 1/1976 2200	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	2.27	2.51	3.11	2.29	1.76	2.74	2.37	2.86	1.79	2.05	2.19	2.02	2.13
DEPTH	5.06	5.89	6.40	11.47	13.42	11.48	8.03	10.02	12.94	13.51	10.93	11.60	11.61
DISCHARGE	2871.	3173.	3587.	3924.	3977.	4060.	4079.	4089.	4137.	4141.	4142.	4143.	4143.
CONCENTRATION	1.000	1.014	1.006	0.985	1.702	2.562	3.873	4.323	4.284	4.206	4.171	4.158	4.082

4/ 1/1976 2400	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
XSEC	1	2	4	7	10	13	16	19	22	25	28	29	30
VELOCITY	0.77	1.32	1.67	0.67	0.62	1.25	1.51	2.03	1.37	1.66	2.00	1.86	2.01
DEPTH	2.84	2.03	1.85	8.10	10.24	8.49	5.27	7.45	10.38	12.27	9.72	10.40	10.41
DISCHARGE	550.	550.	555.	800.	1050.	1330.	1674.	2120.	2494.	2974.	3274.	3398.	3472.
CONCENTRATION	1.000	0.995	0.983	0.958	1.089	1.196	1.645	2.373	3.097	3.787	3.925	3.942	3.886

****************************GRAPH OF CONCENTRATION VS TIME AT SELECTED CROSS-SECTIONS****************************




0.375
0.500
0.625



EXPLANATION: SYMBOL X-SECT

A	1
B	15
C	30