Operational Dynamic Wave Forecast Program

User's Guide

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OPERATIONAL DYNAMIC WAVE FORECAST PROGRAM USER'S GUIDE

I.--INTRODUCTION

General Description

The Operational Dynamic Wave Forecast Program (DWOPER) links a dynamic wave basic element with a data management module (see figure 1, p. I-3). The data management module provides channel configuration, boundary conditions, and initial contitions for the basic element, which performs the dynamic wave routing. A forecast guidance program displays the results in either graphical or tabular form.

Details of the dynamic wave basic element are set forth in "Theoretical Development of the Implicit Dynamic Routing Model".* This DWOPER User's Guide is intended to describe the options available with the data management and forecast guidance modules.

Commands

The data management module, dynamic wave basic element, and forecast guidance program are accessed by commands. Each command causes the program to branch to appropriate subroutines where the desired function is performed. Section IV lists and explains the available commands. Some of the commands require data. The formats for entering the data are described in section V.

The command structure of data input increases the flexibility of use of the DWOPER program. Only those functions which need to be performed are performed, and several river systems can be simulated in one job by repeating RUN commands with different datasets.

For machines with keyboard entry available (i.e. the Univac 1108 or TSO on the IBM 360/195) the command input allows the user to work interactively with the dynamic wave program. A command can be typed, the results displayed, and, if needed, changes made and the program rerun during a single terminal session.

Data Management

Preparation of the data for initial simulation of a river system using the dynamic wave program requires a substantial amount of work. The river system configuration must be determined, river cross-sections must be computed, stage and/or discharge data must be coded. This

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initial work cannot be avoided. However, the data management module does reduce the time and effort required to use the program on a day-to-day operational basis. The data initially worked up to simulate a river system are kept in mass storage and only the current day's updates need to be entered before a new simulation can be performed.

The data to be stored are of two types: stationary data (which does not change with time) and stage and discharge data (which must be updated as new observations are reported). The stationary data are stored in carryover files and the stage and discharge data are stored in hydrograph files. These two data types are described in more detail in appendix D.

Data Files

Data is kept in mass storage in two types of files. The files which contain information that does not change over time (i.e., river configurations, cross-sections, roughness, etc.) are stored in files called carryover files. Data which changes with time, and for which new values can be added daily (i.e. stage discharge data at gaging stations, and local inflows) are stored in files called hydrograph files. In order to perform a simulation with the DWOPER, the information in a hydrograph file must be combined with the information in a carryover file. The data management module combines these two types of files at run time.

Functions which can be performed on both hydrograph and carryover files are to (1) initialize a file from cards, (2) edit data on an existing file, and (3) list a file. The details of these commands are described in section V.

Labels

Labels are used in two capacities in the DWOPER to facilitate the retrieval of data in mass storage files.

The first use of labels is to give a unique name to each hydrograph or carryover file. This name is specified in the "intitialize file" command and is used to reference that file thereafter. Once a file is stored, the user does not have to know which I/O channel is used to access the data, because all I/O channels are searched until a match is found for the file requested.

The second use of labels in DWOPER is in combining data from a carryover file and a hydrograph file prior to a simulation. Each gaging station in the river system, and each point where local flow enters, is given a unique label. Since no stage or discharge data is stored in the carryover file, the appropriate stages or discharges must be obtained from the hydrograph file. Each hydrograph in the hydrograph file has a unique label which matches a label in the carryover file. It is by matching these labels

that the correct stages or discharges are associated with gaging stations and local inflow points.

These two uses of labels in the DWOPER program should not be confused. Both are applications of the concept of labelling, but the functions performed by the labels are distinct. File labels are used to locate carryover and hydrograph files in mass storage, while hydrograph labels are used to associate stage or discharge data with gaging stations and local inflow points prior to a simulation.

File Initialization

As was mentioned in the previous section, when a carryover or hydrograph file is to be listed, edited, or used in a simulation. the file is located by searching through the I/O channel numbers until a match is found for the file label. However, when a file is initialized the user must specify not only the file name but also the I/O channel number which will determine which dataset in mass storage the file will be written into.

If two, say, carryover files are written on the same I/O channel number (i.e. into the same dataset) the first file will be destroyed and over-written by the second. To avoid destroying useful files, make certain that any new carryover or hydrograph files are written only on I/O channel numbers associated with outdated or empty datasets. The HNAMES and CONAMES commands can be used to determing which file is on each I/O channel number. The default I/O channel numbers used by the DWOPER are 10 through 14 for hydrograph files and 20 through 24 for carryover files.

II.--FILE LABELS

For any particular simulation, the appropriate carryover file (containing data used to define the river system) and hydrograph file (containing stage and/or discharge data) must be selected and prepared for delivery to the dynamic wave basic element. Since any number of carryover and hydrograph files can exist in mass storage, the DWOPER must have some means of identifying the correct files. This identification is provided by the unique label given to each file when it is initialized. The name consists of four characters (alphabetic, numeric, or blank). The program also uses file labels to locate files to be edited or listed.

The DWOPER is a program capable of simulating many different river systems. There is, however, one portion of the data management module which must be unique to each river system. Whenever the option to update initial conditions (see appendix B) is used, a subroutine specific to each river system must be accessed. In order to assure that the correct subroutine is accessed for each simulation, the following conventions have been adopted for carryover files:

1. Labels of carryover files for the Ohio-Mississippi Junction (from Shawneetown and Chester to Caruthersville, and the Cumberland and Tennessee Rivers below the dams) must begin with the letters 'OM'.

2. Labels of carryover files for the Lower Mississippi (from Vicksburg to Venice) must begin with the letters 'LM'.

3. Labels of carryover files for the Middle Mississippi (from Caruthersville to Vicksburg) must begin with the letters 'MM'.

4. Only the above-mentioned river systems may have those beginning letters.

As more river systems are simulated by the DWOPER, additional specific subroutines will be added and appropriate restrictions on the first two characters of the carryover file label will be made.

The following example illustrates the use of file labels.

- 'OMJC' is the label of a carryover file containing Ohio-Mississippi Junction stationary data.

- 'OM69' and 'OM70' are the labels of two hydrograph files containing data from the years 1969 and 1970, respectively.

The single carryover file 'OMJC' can be linked, in turn, with 'OM69' or 'OM70' to produce two simulations.

List of Commands

A. Data Management

1. Initialize a file

   COINIT
   HINIT

2. Edit a file

   COEDIT
   HEDIT

3. List the contents of a file

   COLIST
   HLIST

4. List file names

   CONAMES
   HNAMES

5. List initial conditions

   ICLIST

B. River System Simulation

1. Set dates

   START
   NOW
   STOP

2. Simulate (using stored data)

   RUN

3. Simulate (using card data)

   ALONE

C. Utility Functions

1. Change mass storage channel numbers from default values

   COSTART
   COEND
   COSKIP
   HSTART
   HEND
   HSKIP

2. Reset or clear program

   ZERO

3. End program execution

   EXIT

Card group	Format	Cols.	Contents	Comments
5	A4	1-4	DNLABL	Name of station at downstream boundary of river system
	19A4	5-80	UPLABL(J)	Names of stations at upstream boundaries (one per river) Leave no spaces between 4-character station names, J=1, JN
	**Use card 6 once for each station at which observed data are available.			
6	A4	1-4	BLABL(I,J)	Name of station for which observed data will be compared with simulated data, I=1,NRT1(J),J=1, JN
	F10.0	5-14	FHT	Flood level to appear on plot
	**Use card 7 once for each river with lateral inflows.			
7	20A4	1-80	QLABL(I,J)	Name of location for which lateral inflow data are available, I=1, NQL(J) J=1, JN
	**Use card 8 only if computed hydrographs are to be saved in the hydrograph file. Use only if NSAVE≠0			
	**Repeat card 8 NSAVE times			
8	A4	1-4	SLABL(I)	Name assigned to the hydrograph which is to be saved in the hydrograph file
	1X,A4	6-9	STYPE(I)	H or Q or V indicating stage or discharge or velocity hydrograph data I=1, NSAVE

Card group	Format	Cols.	Contents	Comments
	1X,I5	11-15	IRSAVE(I)	River number of station for which hydrograph is to be saved
	I5	16-20	IPSAVE(I)	Computational point number of station for which hydrograph is to be saved
	5X,A4	26-29	FILSAV(I)	Label of hydrograph file into which data will be written
	**Use card 9 only if KPL2=2. **Use a separate card for each river.			
9	8(6X,A4)	7-10 17-20 . . . 77-80	HOLABL(I,J)	Name of station for which HO's are read in (see card 45, section VII) I=1, NTIN(J), J=1, JN
10	A4	1-3	END	Last card for this command

Command HINIT--for initializing a hydrograph file

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	HINIT	
2	I5	1-5	month	Date and time when the hydrograph file is initialized
	I5	6-10	day	
	I5	11-15	hr and min	Military time
3	A4	1-4	file name	Name of hydrograph file to be initialized
	4X,I2	9-10	I/O channel number	(See File Initialization, section I)

**A new card 4 is needed whenever one or more of the following quantities change: data type, date/time of first observation, sampling interval.

4	A1	1	data type	H or Q, indicating stage or discharge data
	2-4	Blank		
	Free	5-80		Each item in free format must be followed by at least one blank column
			month	Date and time of first observation punched on card 6 (below)
			day year hr and min	Two or four digits Military time
			sampling interval (hr)	Each observation on card 6 must be sampled at this time interval

Command HEDIT--for editing a hydrograph file

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	HEDIT	
2	I5	1-5	month	Date and time when the hydrograph file is edited
	I5	6-10	day	
	I5	11-15	year	Two or four digits
	I5	16-20	hr and min	Military time
3	A4	1-4	file name	Name of the hydrograph file to be edited

**A new card 4 is needed whenever one or more of the following quantities change: data type, date/time of first observation, sampling interval.

4	A1	1	data type	H or Q, indicating stage or discharge data
		2-4	blank	
	Free	5-80		Each item in free format must be followed by at least one blank column
			month day year hr and min (military time)	Date and time of first observation to be changed by HEDIT Use this date for all types of changes (additions, replacements, deletions)
			sampling interval (hr)	Each observation on card 6 must be sampled at this time interval. Omit sampling interval when deleting data
			month day year hr and min (military time)	Date and time of last observation to be deleted by HEDIT. Use this date only when deleting data

Card group	Format	Cols.	Contents	Comments
**Repeat card 5 for each station for which data are being edited.				
5	A4	1-4	station name	Station for which data are edited (added, replaced, deleted)
		or	or	
	A4	1-3	ALL	Use 'ALL' only for deleting data. Data for the time period indicated on card 4 will be deleted for all stations of data type indicated on card 4
		5	X	"X" indicates the next card is a continuation card. All information to the right of the "X" is ignored. Omit "X" if data are being deleted.
**Repeat card 6 for each station for which data are being added or replaced. Omit card 6 if data are being deleted.				
6	Free	1-79	new data	Each item in free format must be followed by at least one blank column
		after last value on card	X	"X" indicates the next card is a continuation card. Only the last data card does not have an "X" as the last entry.
7	A4	1-3	END	Last card for this command

Command COLIST--for listing the contents of a carryover file

Card group	Format	Cols.	Contents	Comments
1	A4	1-6	COLIST	
2	A4	1-4	file name	Name of carryover file to be listed

Command HLIST--for listing the contents of a hydrograph file

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	HLIST	
2	A4	1-4	file name	Name of hydrograph file to be listed

Command ALONE--for simulating, using data read from cards

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	ALONE	This command executes the dynamic wave model using the data of card group 2 (below). Command START (see p.V-10) may be used immediately before Command ALONE
2	Card group 2 consists of card input numbers 1-46 of the input data for the dynamic wave model (See section VII).			
3	A4	1-3	END	Last card for this command

V-C.-- COMMAND FORMATS - UTILITY COMMANDS

Commands for changing the default mass storage I/O channel numbers for carryover files. The default channel numbers are 20 through 24.

Command COSTART

Card group	Format	Cols.	Contents	Comments
1	A4	1-7	COSTART	
2	I5	1-5	channel number	First carryover file channel number

Command COEND

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	COEND	
2	I5	1-5	channel number	Last carryover file channel number

Command COSKIP

Card group	Format	Cols	Contents	Comments
1	A4	1-6	COSKIP	
2	I5	1-5	increment	Increment between successive carryover file channel numbers

Commands for changing the default mass storage I/O channel numbers for hydrograph files. The default channel numbers are 10 throuth 14.

Command HSTART

Card group	Format	Cols.	Contents	Comments
1	A4	1-6	HSTART	
2	I5	1-5	channel number	First hydrograph file channel number

Command HEND

Card group	Format	Cols.	Contents	Comments
1	A4	1-4	HEND	
2	I5	1-5	channel number	Last hydrograph file channel number

Command HSKIP

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	HSKIP	
2	I5	1-5	increment	Increment between successive hydrograph file channel numbers

RUN Subcommand DISPLAY

The DWOPER normally provides output in the form of

1) graphs showing computed and observed values at gaging stations

2) a list of the numbers which are plotted, and

3) bias and root-mean-square error statistics for each station

If the DISPLAY subcommand is issued, the normal output is suppressed and three types of tabular output are available.

1) Computed stages, discharges and velocities, and observed stages for all gaging stations on one river can be displayed for a single time step (Option A).

2) The computed and observed stages at a single gaging station can be displayed for a selected period up to 25 time steps (Option B-1).

3) The computed discharges and velocities at a single gaging station can be displayed for a selected period up to 25 time steps (Option B-2).

Card input formats for subcommand DISPLAY are listed on pages V1-3 and V1-4.

Subcommand DISPLAY, Option A.

Card group	Format	Cols.	Contents	Comments
1	A4	1-7	DISPLAY	
2	A4	1-4	river system name	
		5-7	blank	
	I1	8	river number	
3	I5	1-5	month	Date for which display output will be printed
	I5	6-10	day	
	I5	11-15	year	Two or four digits
	I5	16-20	hr and min	Military time
4	I2	1-2	observation interval (hr)	Number of hours between observations
5	A4	1-3	ALL	All stations on the river specified on Card 2 will be printed in the output display (15=max. no. of stations)

Subcommand DISPLAY, Option B

Card group	Format	Cols.	Contents	Comments
1	A4	1-7	DISPLAY	
2	A4	1-4	river system name	
		5-7	blank	
	I1	8	river number	
3	I5	1-5	month	Date of first observation to be printed in output table
	I5	6-10	day	
	I5	11-15	year	Two or four digits
	I5	16-20	hr and min	Military time
4	I2	1-2	observation interval (hr)	Number of hours between observations
5	A4	1-4	station name	Station for which display output will be printed
6	A2	1-2	HH or QV (type of data to be printed)	Option B-1 HH-observed and computed stage Option B-2 QV-computed discharge and velocity
7	I2	1-2	number of observations	Number of observations to be printed in output table (max 25)

Subcommand OLDCO

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	OLDCO	

Subcommand OLDCO writes the edited carryover file into mass storage over the original file, replacing the old file.

Subcommand NEWCO

Card group	Format	Cols.	Contents	Comments
1	A4	1-5	NEWCO	

Subcommand NEWCO increments the I/O channel number by one (see appendix D) and writes the edited carryover file. If the old I/O channel number was equal to COEND, the new number is set to COSTART. If a carryover file is in the mass storage data set accessed by the new I/O channel number, the file is replaced. When the NEWCO subcommand is used, the name of the carryover file being edited (CFNAME) must be changed so that each file has a unique name.

Subcommand NOCO

Card group	Format	Cols.	Contents	Comments
1	A4	1-4	NOCO	

Subcommand NOCO does not edit the carryover file in mass storage. The edited file will exist only until a ZERO command is issued or the DWOPER execution is completed.

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INPUT DATA STRUCTURE FOR DYNAMIC WAVE MODEL

Card input no. — Description

(1) EPSY, EPSQ, EPSQJ, THETA, F1, XFACT, DHF, CFNAME - 7 F 10., 4X, A 4 Format

EPSY	Depth tolerance in Newton Iteration (0.001-1.0 ft).
EPSQ	Discharge tolerance in Newton Iteration (10.-10000. cfs).
EPSQJ	Discharge tolerance in tributary iteration scheme (10.-10000. cfs).
THETA	Acceleration factor in solving tributary junction problem (0.5-1.0).
F1	θ weighting factor (normally F1=0.55, but can range from 0.5 to 1.0).
XFACT	Factor to convert units, describing the location of the computation points along the routing reach, to feet; e.g., if units are in miles, XFACT=5280.
DHF	Factor to convert time units associated with specified stage or discharge hydrograph data at the upstream or downstream boundaries into units of hours; e.g., if hydrograph data are read in as daily values, DHF=24.
CFNAME	Name identifying river system which when used in other than the ALONE command identifies carry over file in which this data is stored.

(2) JN, NU, NCT, ICD, NYQD, ITMAX, NCML - 8 I 10 Format

JN	Number of rivers that are being routed simultaneously (no tributary, JN=1; 1 tributary, JN=2, 2 tributaries, JN=3).
NU	Number of values associated with specified stage or discharge hydrographs; if mathematical function is used to describe the specified hydrographs, NU=0.
NCT	Parameter indicating type of extrapolation used in Newton Iteration to determine estimates of unknowns; if extrapolation is parabolic, NCT=2; if extrapolation is linear, NCT=1; if no extrapolation, NCT=0.
ICD	If any boundary hydrograph changes by more than the value of this parameter (in ft) from the last time step, extrapolation is not used.
NYQD	Number of sets of stage-discharge values in empirical rating curve at downstream boundary

ITMAX	Maximum number of iterations allowed in the Newton-Raphson Iteration Procedure for solving the system of nonlinear equations, if ITMAX=1, the nonlinear formulation degenerates into a linear formulation and no iterations are required in the Newton-Raphson Iteration Procedure.
NCML	Number of values in Manning's n versus stage or discharge table; this is the same for all Manning's n reaches.

(3) NCS, NCSS, NP, KTERM, KPL, KPL2, JNK, NPEND - 8 I 10 Format

NCS	Number of values in table of top widths (BS) vs. elevations (HS) referenced to mean sea level (m.s.l.).
NCSS	Number of values in table of top widths of storage sections (BSS) vs. elevations (HSS) referenced to m.s.l.
NP	Parameter indicating if Automatic Calibration option is to be used; if NP=0, no Automatic Calibration will be made; if NP≥1, Automatic Calibration will be used; when using Automatic Calibration, NP also denotes the sequence number of the first computed stage (in the computed stage hydrograph) which will be used in the statistics needed in the automatic calibration for determining the Manning n. (See note at end of data input concerning type of data required for using automatic calibration option).
KTERM	Parameter indicating if terms in equation of motion will be computed and printed as special information; if KTERM=1, they will be printed; if KTERM=0, they will <u>not</u> be printed.
KPL	Parameter indicating what information will be plotted; if KPL=0, nothing is plotted; if KPL=1, stage hydrographs are plotted; if KPL=2, discharge hydrographs are plotted.
KPL2	Parameter to denote if observed data are available for plotting at stations for which the computed results are to be plotted; if KPL2=0, no data are available; if KPL2=1, observed data are available.
JNK	Parameter indicating if computed water surface elevations, velocities, and discharges will be printed; if JNK=0, they will <u>not</u> be printed, if JNK=1, they will be printed.

(9) NB(1) - I 10 Format

NB(1) Number of stations or computational points along the main river.

If JN>1 (see card input no. 2), read in NB(J), NJUN(J), ATF(J).

See note following card 10

(10) NB(J), NJUN(J), ATF(J) - 2 I 10, F 10. Format

NB(J) Number of stations along the tributaries, where J is the number of tributary; tributaries are numbered from upstream to downstream along the main river commencing with the number 2.

NJUN(J) Number of station along the main river where tributary J enters (this station coincides with the upstream extremity of the small subreach which is equivalent in length to the tributary width).

ATF(J) Acute angle that the tributary makes with the main river at the confluence; ATF(J) is in degrees.

Note: Repeat card 8 for each J, J=2, JN

(11) KU(J) - 8 I 10 Format

KU(J) Parameter indicating the type of upstream boundary condition being specified for the main river or tributaries; if KU(J)=1, a stage hydrograph of if KU(J)=2, a discharge hydrograph is the upstream boundary condition; J index goes from 1 to JN.

(12) KD(J) - 8 I 10 Format

KD(J) Parameter indicating the type of downstream boundary condition being specified for the main river; if KD(J)=1, a stage hydrograph is the downstream boundary condition (in the case of tributaries, KD(J) where J goes from 2 to JN is always equal to 1); if KD(1)=2, a discharge hydrograph is the downstream boundary condition; if KD(1)=3, a single value rating curve of discharge as a function of

See note following card 16

(15) NT(K,J) - 8 I 10 Format

NT(K,J) Station number of each observed stage hydrograph; K index goes from 1 to NRT1(J).

If NRT1(J)>0 (see card input no. 13), and KPL=1 (see card input no. 3), read in GZ(K,J)

See note following card 16

(16) GZ(K,J) - 8 I 10 Format

GZ(K,J) Gage correction to convert observed stage hydrographs to mean sea level datum; K index goes from 1 to NRT1(J).

Note: Read card sequence 15 and 16 once for each J, J=1, JN.

If NRT1(J)>0 (see card input no. 13), and KPL=1 (see card input no. 3), read in STTNAM(L,I,J)

See note following card 18

(17) STTNAM(L,I,J) - 5 A 4 Format

STTNAM(L,I,J) 20-character name associated with observed stages (see card 18); L index goes from 1 to 5.

If NRT1(J)>0 (see card input no. 13), and KPL=1 (see card input no. 3), read in STT(K,I,J)

See note following card 18

(18) STT(K,I,J) - 8 F 10. Format

STT(K,I,J) Observed stages; K index goes from 1 to NU.

Note: Repeat cards 17 and 18 once for each I, I=1, NRT1(J); and repeat this sequence for each J, J=1, JN.

If NU=0 (see card input no. 2), read in TP, RHO, GAMMA, YI.

(19) TP, RHO, GAMMA, YI - 4 F 10. Format

TP	Time (hours) from initial steady flow to peak of specified upstream boundary hydrograph (used in mathematical function describing the hydrograph).
RHO	Ratio of peak value of specified hydrograph to initial value of hydrograph.
GAMMA	Ratio of time TG to TP, where TG is the time from initial steady flow to the center of gravity of the specified hydrograph (must be greater than 1).
YI	Initial steady discharge or water surface elevation at upstream boundary.

If NU>0 (see card input no. 2), read in ST1(K,J).

See note following card 21

(20) ST1(K,J) - 8 F 10. Format

ST1(K,J)	Observed stages or discharges at upstream boundary of river J; K index goes from 1 to NU.

If NU>0 (see card input no. 2), and KU(J)=1 (see card input no. 11), read in GZ1(J)

See note following card 21

(21) GZ1(J) - 8 F 10. Format

GZ1(J)	Gage correction to convert observed stages at upstream boundary of river J to m.s.l. datum.

Note: Repeat card sequence 18, 19 once for each J, J=1, JN.

If KD(J)$\leq$2 (see card input no. 12), read in STN(K,1)

(22) STN(K,1) - 8 F 10. Format

STN(K,1)	Observed stages or discharges at downstream boundary of main river; K index goes from 1 to NU with 8 values per data card.

If KD(J)=1 (see card input no. 12), or NYQD>0 (see card input no. 2), read in GZN

(23) GZN - F 10. Format

GZN	Gage correction to convert stages at downstream boundary of main river to m.s.l. datum.

If NYQD>0 (see card input no. 2), read in YQD(K)

(24) YQD(K) - 8 F 10. Format

YQD(K)	Stages used to define empirical rating curve at downstream boundary of main river; K index goes from 1 to NYQD.

If NYQD>0 (see card input no 2), read in QYQD(K)

(25) QYQD(K) - 8 F 10. Format

QYQD(K)	Discharges used to define empirical rating curve at downstream boundary of main river; K index goes from 1 to NYQD.

See note following card 28

(26) BS(K,I,J) - 8 F 10. Format

BS(K.I.J)	Top widths of channel cross section at various elevations referenced to m.s.l. datum; K index goes from 1 to NCS; I index goes from 1 to NB(J); i.e., a set of BS top widths are read in for each station along river J.

(30) HSS(K,I,J) - 8 F 10. Format

HSS(K,I,J)	Elevations (referenced to m.s.l. datum) corresponding to each top width (HSS); K index goes from 1 to NCSS.

If NCSS>0 (see card input no. 3), and NCSS1(J)>0 (see card input no. 7), read in ASS(1,I,J)

See note following card 31

(31) ASS(1,I,J) - F 10. Format

ASS(1,I,J)	Off-channel storage across sectional area below HSS(1,I,J) or lowest of HSS elevations.

Note: Repeat card sequence 29, 30, 31 for each I, I=1, NCSS1(J), and repeat this sequence for each J, J=1, JN.

If KD(J)=5 (see card input no. 12), read in SO

(32) SO - F 10.6 Format

SO	Average bottom slope of main river.

See note following card 35

(33) COFW, VWIND, WINAGL - 3 F 10.6 Format

COFW	Coefficient of wind stress (1.1×10^{-6} to $3. \times 10^{-6}$).
VWIND	Wind velocity (ft/sec); + if directed upstream; - if directed downstream.
WINAGL	Acute angle (degrees) that wind makes with the channel axis.

See note following card 35

(43) CHCTW(L,J) - 8 F 10.2 Format

CHCTW(L,J) Elevation (m.s.l.) of water surface in tailwater pool at downstream face of lock and dam; this elevation is considered the elevation at which the lock master can no longer control the flow through the dam and the flow becomes channel control; usually this elevation will be equal or slightly less than the target pool elevation; L index goes from 1 to NUMLAD(J).

(44) POOLT(K,L,J) - 8 F 10.2 Format

POOLT(K,L,J) Target pool elevation (same as POLTAR(L,J)) for each time step; if 0.0 or blank is read in, then POLTAR(L,J) is used for POOLT(K,L,J); K index goes from 1 to NU; L index goes from 1 to NUMLAD(J).

(45) ITWT(K,L,J) - 8 I 10 Format

ITWT(K,L,J) Parameter indicating if gates control the flow; if 0 or blank, flow is controlled by gates, if 1, flow is not controlled by gates, e.g., the entire dam is removed such as the low lift dams on the Lower Ohio River and the flow becomes channel controlled; K index goes from 1 to NU; L index goes from 1 to NUMLAD(J).

Note: Cards 41, 42, 43, 44, and 45 are read in for each river as J goes from 1 to JN if NUMLAD(J)>0.

(46) TE, TM, KITPR - 2 F 10.2, I 10 Format

TE Time (hours) at which routing computations will terminate.

TM Maximum size Δt computational time step size (hours).

KITPR Number of Δt time step intervals at which computed values are stored for plotting or printed out Length of time step times KITPR equals interval at which plots are generated; e.g., if 6-hr time steps are taken and a plot is desired each day, set KITPR=4.

(47) YDI(I,J) - 8 F 10. Format

YDI(I,J) Initial water surface elevations referenced to m.s.l. datum at each station; I index goes from 1 to NB(J); if blank or zeros are used for all the YDI(I,J) values, the program will generate the YDI's via linear interpolation between gaging stations (this is allowed when using the automatic calibration option or when gaging stations exist at the upstream extremities of all rivers and the downstream extremity of the main stem); if the upstream extremity does not have an observed hydrograph, this YDI value must be supplied along with all the zero's for the other YDI's;if zeros or blanks are used for all the YDI's except at the downstream extremity of the main stem river where the actual YDI is read in, the program will generate the YDI's via a solution of the steady flow backwater equation.

(48) QDI(I,J) - 8 F 10. Format

QDI(I,J) Initial discharge (cfs) at each station; I index goes from 1 to NB(J); if blank or zeros are used for all the QDI's (I,J) values except at the upstream extr mity of each river, the program will generate the QDI's by summation of the flows from the upstream to downstream boundaries including tributary inflow to the main stem and lateral inflow occurring along either the main stem or tributaries.

Note: Repeat cards 47, and 48 once for each J, J=1, JN.

See note following card 50

(49) YQCM(L,K,J) - 8 F 10. Format

YQCM(L,K,J) Water surface elevations referenced to m.s.l. datum or discharges associated with n; L index goes from 1 to NCML.

Note: Repeat card 49 for each K, K=1, NRCM1(J); repeat sets of card 49 for each J, J=1, JN.

See note following card 50

(50) CM(L,K,J) - 8 F 10. Format

CM(L,K,J)	Manning's n; L index goes from 1 to NCML corresponding to each YQCM(L,K,J) value.

Note: Repeat card 50 for each K, K=1, NRCM1(J); repeat sets of 50 for each J, J=1, JN.

Note: If KD(1)=4 or KD(1)=5, the values for YQCM(L,NRCM1(1),) and CM(L,NRCM1(1),) (the last values for the main river) are used in the loop rating curve or Manning's equation to compute the downstream boundary condition.

(51) MESAGE - 20 A 4 Format

MESAGE	Up to an 80-character message which will be written at the end of the input data deck.

(52) END - A 4 Format

END	Indicates end of input data deck.

Automatic Calibration Note: The following data must be included when using the Automation Calibration Option: Upstream boundary condition consisting of a discharge hydrograph for each river, i.e., KU(J)=2; observed stage hydrographs STT(K,I,J) at upstream and downstream ends of each reach wherein the Manning n is to be determined; and a downstream boundary condition consisting of a stage hydrograph, i.e., KD(J)=1;(the stage hydrograph STN(K,I,J) is required for the main stem river, only, since the model can provide the downstream stage hydrograph for each tributary via linear interpolation between observed stage hydrographs along the main stem which are adjacent to the tributary junction.)

NOTE

The examples included in Appendices A and C are part of the original version of this writeup, released in December 1976. Copies of the revised examples (based on the June 1978 version of the DWOPER program) are not presently available. This note applies to Appendices A and C only.

June 1978

INITIALIZE AND LIST A CARRYOVER FILE

```
   dimensions card
COSTART
    51
COINIT
    12    15 1400
   cards 1-46, dynamic wave model input data
     3     8 1200     0   1992.
CRMOSHILBDKYKDKYCEIL
FFKY   0.0
GOIL   0.0
PUK    0.0
METR   0.0
MDIL   0.0
CIR    0.0
NMMO   0.0
REDR   0.0
GRAN   0.0
CGI    0.0
PRIC   0.0
END
ZERO
COLIST
OMJO
EXIT
```

INITIALIZE AND LIST A HYDROGRAPH FILE

```
   dimensions card
HSTART
    13
HINIT
    12    15 1430
H70A
H    3 8 1200 24
BDKY 319.14
KDKY 310.03
CIR  X
   data
SHIL X
   data
Q    3 8 1200 24
BDKY X
   data
KDKY X
   data
END
ZERO
HLIST
H70A
EXIT
```

EDIT AND LIST A CARRYOVER FILE

```
  dimensions card
COEDIT
    12    15 1500
OM70
CM
              5              3              4
       9999.
CFNAME
TEST
AS
              3              3
         0.0
ITMAX
       33333
JNK
           777
NCM
              3              1
          8888
HOLABL
              5              1
XXXX
END
COLIST
OM70
EXIT
```

EDIT AND LIST A HYDROGRAPH FILE

dimensions card

```
HEDIT
   12   15  1530
H70A
H   3 9 1200  3 9 1200
ALL
Q   3 9 1200  3 9 1200
ALL
H   4 22 1200 24
PUK X
99.99 99.99 99.99 99.99 99.99
CIR X
99.99 99.99 99.99 99.99 99.99
H   4 9 1200  4 21 1200
NMMO
H   5 31 1200  24
CIR X
99.99
Q   5 10 1200  24
BDKY X
9999. 9999. 9999. 9999. 9999.    X
9999. 9999. 9999. 9999. 9999.
END
HLIST
H70A
EXIT
```

SIMULATE USING MASS STORAGE DATA

```
  dimensions card
START
     3      10  1200
NOW
     3      12  1200
STOP
     3      24  1200
RUN
OMJ0
H70A
ICSAVE
     3      13  1200
DISPLAY
OMJ0   4                  one river
     3      15  1200      one time
24
ALL                       all stations
GO                           observed stage
EXIT                         computed stage
                             computed discharge
                             computed velocity
```

SIMULATE USING MASS STORAGE DATA

```
   dimensions card
START
     3    10  1200
NOW
     3    12  1200
STOP
     3    24  1200
RUN
OMJ0
H70A
ICSAVE
     3    13  1200
DISPLAY
OMJ0   4
     3    13  1200
24
METR                    one station
HH                      observed and computed stage
 7                      7 days of data
GO
EXIT
```

SIMULATE USING MASS STORAGE DATA

dimensions card

RUN

OMJO

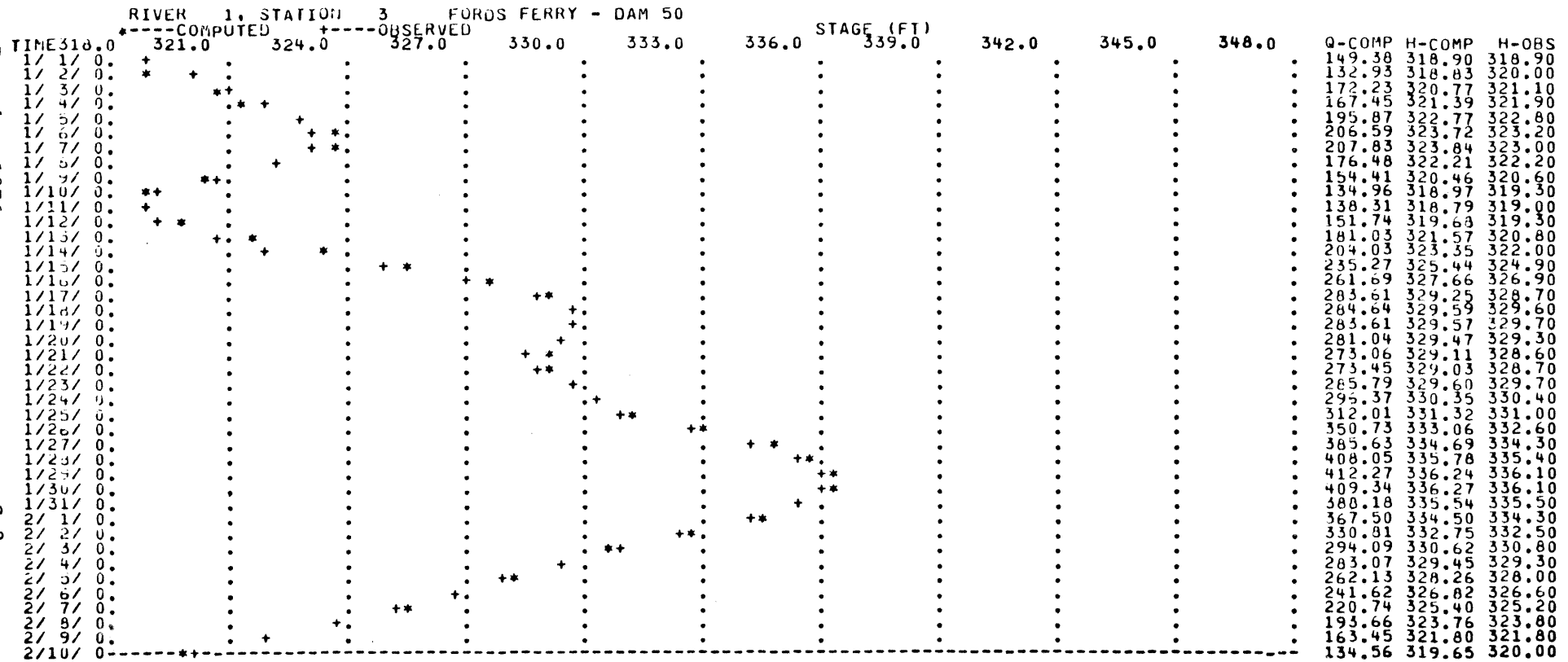
H70A

GO default output

EXIT

2. The HOLABL corresponding to any HO which is initially read in as zero must not match a hydrograph name in the hydrograph file. Subroutines specific to each river system interpolate between non-zero HO values to generate water surface elevations for HO values originally read in as zeros.

3. If a match is not found for an HOLABL which is not interpolated by the specific subroutines, the water surface elevation will be set to zero. This situation should be avoided.



TIME	Q-COMP	H-COMP	H-OBS
1/ 1/ 0.	149.38	318.90	318.90
1/ 2/ 0.	132.93	318.83	320.00
1/ 3/ 0.	172.23	320.77	321.10
1/ 4/ 0.	167.45	321.39	321.90
1/ 5/ 0.	195.87	322.77	322.80
1/ 6/ 0.	206.59	323.72	323.20
1/ 7/ 0.	207.83	323.84	323.00
1/ 8/ 0.	176.48	322.21	322.20
1/ 9/ 0.	154.41	320.46	320.60
1/10/ 0.	134.96	318.97	319.30
1/11/ 0.	138.31	318.79	319.00
1/12/ 0.	151.74	319.68	319.30
1/13/ 0.	181.03	321.57	320.80
1/14/ 0.	204.03	323.35	322.00
1/15/ 0.	235.27	325.44	324.90
1/16/ 0.	261.69	327.66	326.90
1/17/ 0.	283.61	329.25	328.70
1/18/ 0.	284.64	329.59	329.60
1/19/ 0.	283.61	329.57	329.70
1/20/ 0.	281.04	329.47	329.30
1/21/ 0.	273.06	329.11	328.60
1/22/ 0.	273.45	329.03	328.70
1/23/ 0.	285.79	329.60	329.70
1/24/ 0.	295.37	330.35	330.40
1/25/ 0.	312.01	331.32	331.00
1/26/ 0.	350.73	333.06	332.60
1/27/ 0.	385.63	334.69	334.30
1/28/ 0.	408.05	335.78	335.40
1/29/ 0.	412.27	336.24	336.10
1/30/ 0.	409.34	336.27	336.10
1/31/ 0.	380.18	335.54	335.50
2/ 1/ 0.	367.50	334.50	334.30
2/ 2/ 0.	330.81	332.75	332.50
2/ 3/ 0.	294.09	330.62	330.80
2/ 4/ 0.	283.07	329.45	329.30
2/ 5/ 0.	262.13	328.26	328.00
2/ 6/ 0.	241.62	326.82	326.60
2/ 7/ 0.	220.74	325.40	325.20
2/ 8/ 0.	193.66	323.76	323.80
2/ 9/ 0.	163.45	321.80	321.80
2/10/ 0.	134.56	319.65	320.00

RIVER 1, STATION 3 FORDS FERRY - DAM 50
RMS ERROR = 0.445 BIAS = 0.154

Default Output: Graph and Statistics for All Stations.

OM70 SYSTEM RIVER NO. 1 5/10/1200

STATION	H(OBS) STAGE	H(COM) STAGE	Q(COM) 1000CFS	V(COM) FT/SEC
FORD	36.50	36.06	379.5	3.34
GOLC	36.30	36.46	407.3	3.70
PADU	37.90	38.39	628.5	3.69
METR	46.14	46.14	636.6	3.90
GRAC	47.00	46.85	649.2	3.61
CAIR	47.30	46.81	658.8	4.17
NEWM	36.80	36.93	1113.4	4.49

DISPLAY, Option A: Tabular Observed Stage and Computed Stage, Discharge, and Velocity for All Stations on One River at One Time.

OM70 SYSTEM RIVER NO. 1 STATION METR
FRO-1 5/10/1200 TO 5/23/1200 INTERVAL = 24 HOURS

H(OBS) STAGE	46.14	44.68	42.57	40.38	38.29	36.35	34.57	34.66	35.90
	36.07	36.17	36.00	35.44	34.69				
H(COM) STAGE	46.14	43.88	41.50	38.35	35.12	33.50	32.59	32.99	34.25
	35.33	35.95	36.09	35.87	35.41				

DISPLAY, Option B-1: Tabular Observed and Computed Stage for One Station Over a Specified Period of Time.

FROM OM70 SYSTEM 5/10/1200 TO 5/23/1200 RIVER NO. 1 STATION METR
INTERVAL = 24 HOURS

Q(COM) 1000CFS	636.6	579.4	526.3	461.9	396.9	357.2	335.1	358.3	361.3
	346.3	325.9	302.3	287.6	274.0				
V(COM) FT/SEC	3.90	3.81	3.71	3.60	3.45	3.29	3.20	3.37	3.24
	2.99	2.75	2.54	2.44	2.36				

DISPLAY, Option B-2: Tabular Computed Discharge and Velocity for One Station Over a Specified Period of Time.

B. Carryover Mass Storage Data Set Structure (Unformatted)

See section VII for additional discussion of the variables

Record A: CFNAME,(KTIMEC(I),I=1,4),(VER(I),I=1,3),TFCST

CFNAME = 4-character file name denoting the river system to which this file applies

KTIMEC(4) = date/time this file was created (e.g., 5 19 1970 0700 to denote 0700 May 19 1970)

VER(3) = 12-character version label to point to the version of the dynamic wave model to which this file applies

TFCST = default forecast period in hours

Record B: NCOH,JN,(NB(J),KU(J),KD(J),NQL(J),NRT1(J),UPLABL(J), GZ1(J),NNYQ(J),J=1,JN),NSAVE,DNLABL,GZN,NYQD, (YQD(J),QYQD(J),J=1,NYQD),SO,TE,TM,KITPR

NCOH = number of carryover hydrographs in this file. (Max=K13)

JN = number of rivers in this system. (Max=K1)

NB(J) = number of computational points in river J (J=1 denotes main river; J>1 denotes tributaries)

KU(J) See card 9, section VII.

KD(J) See card 10, section VII.

NQL(J) = number of lateral inflows into river J

NRT1(J) = number of stations along river J where observed stage hydrographs may be available

UPLABL(J) = 4-character label for upstream hydrograph for river J

GZ1(J) See card 19, section VII.

NNYQ(J) = parameter indicating if Manning's η is a function of water surface elevation or discharge. (See card 11, section VII.)

NSAVE = number of computed hydrographs to be saved in the hydrograph file

DNLABL = 4-character label for downstream hydrograph

GZN See card 21, section VII.

NYQD See card 2, section VII.

YQD(J) See card 22, section VII.

QYQD(J) See card 23, section VII.

SO = Bottom slope of main river.
(See card 30, section VII.)

TE See card 36, section VII.

TM = Computational time step size, hrs.
(See card 36, section VII.)

KITPR See card 36, section VII.

Record C: (BNAMEC(I),BTYPEC(I),I=1, NCOH)

BNAMEC(I) = 4-character label for hydrograph I

BTYPEC(I) = H or Q left justified in A4 format to denote hydrograph type

Record D: (BLABL(K,J),GZ(K,J),NT(K,J),FHT(K,J),K=1,NRT1(J))

BLABL(K,J) = 4-character label for observed stage hydrograph at the K-th station along river J

GZ(K,J) See card 14, section VII.

NT(K,J) See card 13, section VII.

FHT(K,J) Flood level to appear in plot

Note: A separate record is required for each J. No record is used for any J having NRT1(J) = 0.

Record E: (QLABL(K,J),LQ(K,J),VQX(K,J),K=1,NQL(J))

QLABL(K,J) = 4-character label for lateral inflow to sub-reach K along river J

LQ(K,J) See card 34, section VII.

VQX(K,J) Dummy parameter for future additions

Note: A separate record is required for each J. No record is used for any J having NQL(J) = 0.

Record F: NINIT,(MINIT(I),I=1,NINIT)

NINIT = number of initial conditions (Max=5)

MINIT(I) = minutes since beginning of the year for this initial condition

Note: MINIT(1) is the earliest value of MINIT(I) and the hydrograph data in Record C start at this time.

Record G: (YINIT(I,K,J),QINIT(I,K,J),K=1,NB(J))

YINIT(I,K,J) = Initial water surface elevation at station K on river J for the I-th initial condition

QINIT(I,K,J) = Initial discharge at station K on river J for the I-th initial condition

Note: A separate record is required for each station.

Record H: (SLABL(I),STYPE(I),IRSAVE(I),IPSAVE(I),FILSAV(I),I=1,NSAVE)

SLABL(I) = 4-character hydrograph label. This must correspond to some BLABL (K,J)

STYPE(I) = H, Q or V left justified in A4 format to denote hydrograph type

IRSAVE(I) = River number of hydrograph to be saved

IPSAVE(I) = Computational point number of hydrograph to be saved

FILSAV(I) = Label of hydrograph file into which hydrograph will be saved

Note: If NSAVE=0 no records will be written. Max value of NSAVE=K12.

Record I: EPSY,EPSQ,EPSQJ,THETA,F1,XFACT,DHF,ZH,ICD,NCS,NCSS,
NP,KTERM,KPL,KPL2,JNK,NCT,ITMAX,(MSTART(I),I=1,4),
NCML

See section VII for definitions of the variables.

Record J: NCSS1(J),(NCSSS(K,J),K=1,NCSS1(J))

See cards 5 and 6, section VII.

This record is used only if NCSS>0.
A separate record is needed for each J=1,JN.

Record K: (NJUN(J),ATF(J),J=2,JN)

See card 8, section VII.

This record is used only if JN>1.

Record L: (NRCM1(J),NCM(K,J),K=1,NRCM1(J))

See cards 11 and 12, section VII.

A separate record is needed for each J=1,JN.

Record M: ((BS(K,I,J),HS(K,I,J),K=1,NCS),AS(1,I,J),I=1,NB(J))

See cards 24, 25, and 26, section VII.

A separate record is needed for each J=1,JN.

Record N: ((BSS(K,I,J),HSS(K,I,J),K=1,NCSS),ASS(1,I,J),I=1,
NCSS1(J))

See cards 26, 27, and 28, section VII.

A separate record is needed for each J=1,JN, but a record
is present only if NCSS1(J)>0.

Record O: (X(I,J),FKC(I,J),I=1,NB(J))

See cards 31 and 32, section VII.

A separate record is needed for each J=1,JN.

Record P: ((YQCM(L,K,J),CM(L,K,J),L=1,NCML),K=1,NRCM1(J))

See cards 39 and 40, section VII.

A separate record is needed for each J=1,JN.

Record Q: NU,TP,RHO,GAMMA,YI,COFW,VWIND,WINAGL

NU See card 2, section VII.

TP,RHO,GAMMA,YI See card 16, section VII.

COFW,VWIND,WINAGL See card 30, section VII.

Record R: ((STTNAM(L,K,J),L=1,5),K=1,NRT1(J))

See card 15, section VII.

A separate record is needed for each J=1,JN, but a record is present only if NRT1(J)>0

Record S: MESAGE(I),I=1,20

MESAGE = A message printed at the end of the basic calibration data deck.

Record T: WTOB,(NTIN(J),J=1,JN)

WTOB See card 41, section VII.

NTIN See card 42, section VII.

Record U: NTI(K,J),GZI(K,J),HO(K,J),HOLABL(K,J),K=1,NTIN(J)

NTI See card 43, section VII.

GZI See card 44, section VII.

HO See card 45, section VII.

HOLABL = 4 character label corresponding to HO's

A separate record is needed for each J=1, JN

Records T and U will be written only if KPL2=2

C. Hydrograph Mass Storage Data Set Structure (Unformatted)

Record A: FNAME, (KKTIM(I), I=1,3), NHYD

FNAME = 4-character file name by which this hydrograph file is accessed.

KKTIM(4) = date/time this file was created (e.g., 5 19 1970 0700 to denote 0700 May 19 1970)

NHYD = number of hydrographs (there will be NHYD records following this record). (Max=K13)

Record B: BNAME(I),BTYPE(I),NDP(I),
(LTIME(L,I), X(L,I), L=1,NDP(I))

BNAME(I) = 4-character label for hydrograph I

BTYPE(I) = H or Q left justified in A4 format to denote hydrograph type

NDP(I) = number of data points for hydrograph I (Max=K3)

LTIME(L,I) = time in minutes since the beginning of the year corresponding to X(L,I)

X(L,I) = L-th data value for hydrograph I

Note: Record B occurs NHYD times.

APPENDIX E - VARIABLE DIMENSIONING

The most recent version (6/78) of the DWOPER is programmed with a feature called variable dimensioning. This means that the size of subscripted variables can be changed from one execution of the DWOPER to another. There is a maximum total size for the sum of all arrays, but within that bound the allocation of space among variables is flexible.

For example, when the Ohio-Mississippi Junction (OMJ) is simulated, space must be available for four rivers, with a maximum of 31 computational points on a river. The same space can also be allocated so that for the Lower Mississippi, where only one river is simulated, 36 computational points can be used. Actually the space for the Lower Mississippi is still less than for the OMJ so, for instance, more time steps could be used.

The dimensions of all arrays are set at the start of each execution of the DWOPER. A single card with 14 values (K1 through K14) sets the maximum dimensions needed. The dimensions which must be set at the start of each execution are

K1	The number of rivers
K2	The maximum number of computational points on any river
K3	The number of time steps
K4	The maximum number of gaging stations on any river
K5	The maximum number of HO values on any river
K6	The number of values in the downstream rating curve
K7	The maximum number of Manning η reaches on any river
K8	The maximum number of Manning η values in any Manning η reach
K9	The maximum number of water surface elevation vs top width values at any cross-section
K10	The maximum number of lateral inflows on any river
K11	The maximum number of sets of initial conditions to be stored in the carryover file (set to 5)
K12	The maximum number of computed hydrographs to be saved after simulation
K13	The total number of stage and discharge hydrographs in any hydrograph file which will be accessed
K14	The maximum number of water surface elevation vs top width values for any off-channel storage
K15	Is set internally to two times K2 and need not be read in

The value "one" is the minimum value which should be assigned to any of these dimensions. If a zero is read in, the following default values will apply:

K1	=	4
K2	=	24
K3	=	92
K4	=	9
K5	=	15
K6	=	10
K7	=	10
K8	=	12
K9	=	8
K10	=	4
K11	=	5
K12	=	1
K13	=	22
K14	=	8
K15	=	48

These dimensions will suffice for the OMJ, or any river system which requires smaller dimensions.

APPENDIX F - VARIABLES CHANGED BY COEDIT

Name	Dimensions	Name	Dimensions	Name	Dimensions
AS	K2, K1	JN		NTI	K5, K1
ASS	K2, K1	JNK		NTIN	K1
ATF	K1	KD	K1	NU	
BLABL	K4, K1	KITPR		NYQD	
BS	K9, K2, K1	KPL		QDI	K2, K1
BSS	K14,K2, K1	KPL2		QLABL	K10,K1
CFNAME		KTERM		QYQD	K6
CM	K8, K7, K1	*KTIMEC	4	RHO	
COFW		KU	K1	SO	
DHF		LQ	K10, K1	STTNAM	K5, K4, K1
DNLABL		*MESAGE	20	TE	
EPSQ		*MSTART	4	TFCST	
EPSQJ		NB	K1	THETA	
EPSY		NCM	K7, K1	TM	
F1		NCML		TP	
FHT	K4, K1	NCS		UPLABL	K1
FKC	K2, K1	NCSS		*VER	3
GAMMA		NCSS1	K1	VWIND	
GZ	K4, K1	NCSSS	K2, K1	WINAGL	
GZ1	K1	NCT		WTOB	
GZI	K5, K1	NJUN	K1	X	K2, K1
GZN		NNYQ	K1	XFACT	
HO	K2, K1	NP		YDI	K2, K1
HOLABL	K2, K1	NQL	K1	YI	
HS	K9, K2, K1	NRCM1	K1	YQCM	K8, K7, K1
HSS	K14,K2, K1	NRT1	K1	YQD	K6
ICD		NSAVE		ZH	
ITMAX		NT	K4, K1		

*All values of these variables must be changed. Treat as non-subscripted variables when editing.

See appendix E for definitions of the K's.

Variable names with no corresponding dimensions in the list above refer to non-subscripted variables.