723-02A

GENERALIZED COMPUTER PROGRAM

HEC-2
WATER SURFACE PROFILES

USERS MANUAL

WITH SUPPLEMENT

NOVEMBER 1976

HEC
HYDROLOGIC ENGINEERING CENTER

U S ARMY CORPS OF ENGINEERS

COMPUTER PROGRAM 723-X6-L202A

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EXHIBITS

(The green section following Exhibit 10 contains the Users Manual Supplement for the November 1976 version of HEC-2)

FOREWORD

This Users Manual is a reprint of the Users Manual dated October 1973 and provides a description of capabilities and input requirements for the versions of HEC-2 dated August 1971 and November 1976.

The Users Manual Supplement at the back of the manual provides information on added capabilities and associated input requirements that pertain only to the version dated November 1976.

WATER-SURFACE PROFILES

THE HYDROLOGIC ENGINEERING CENTER
COMPUTER PROGRAM 723-X6-L202A

1. ORIGIN OF PROGRAM

This program is a modification of program 723-G2-L214A, developed in The Hydrologic Engineering Center, Corps of Engineers, 609 Second Street, Davis, California by Bill S. Eichert (1964 version of 723-G2-L214A was from the Tulsa District by same author). The input requirements have been modified to allow the use of many additional options, to provide for future expansion and to simplify input preparation. A supplementary program (723-G1-L202B) is available to convert data from the old program 723-G2-L214A to the new program. Other changes have been made to increase the program's flexibility to handle a wide variety of water surface profile problems. A data edit program (723-G1-L202C) which reads the data cards for program 723-X6-L202A and checks the data for various input errors is also available.

2. PURPOSE OF PROGRAM

The program computes and plots (by printer) the water surface profile for river channels of any cross section for either subcritical or supercritical flow conditions. The effects of various hydraulic structures such as bridges, culverts, weirs, embankments, and dams may be considered in the computation. The principal use of the program is for determining profiles for various frequency floods for both natural and modified conditions. The latter may include channel improvements, levees and floodways. Input may be in either English or Metric units.

3. DESCRIPTION OF EQUIPMENT

The program was written for use in the CDC 6600 computer but may be used with minor modifications on other high-speed computers having four or more magnetic tapes plus input and output units such as the IBM 360, IBM 7094, and GE 437. Various versions of the original program 723-G2-L214A can be used on smaller computers such as the IBM 1620, GE 225, and IBM 1130.

4. DESCRIPTION OF PROGRAM

a. Basic Theory. The computational procedure is similar to Method 1, Backwater Curves in River Channels, Engineering Manual 1110-2-1409, U. S. Army Corps of Engineers, 7 December 1959 (reference d). This method applies Bernoulli's Theorem for the total energy at each cross section and Manning's formula for the friction head loss between cross sections. In the program, average friction slope for a reach between two cross sections is determined in terms of the average of the conveyances at the two ends of the reach (reference f). Other losses are computed using one of several methods. The critical water surface elevation corresponding to the minimum specific energy is computed using an iterative process. Reference (a) describes this method in detail.

b. Subcritical or Supercritical Flow. The computation begins at a control section (location of known water surface elevation) in the river channel and proceeds upstream for subcritical flow or downstream for supercritical flow. The direction of flow is specified by the user on card J1 (first job card) by setting variable IDIR (direction) equal to 1 for supercritical flow or 0 (blank) for subcritical flow. In cases where flow passes from subcritical to supercritical or vice versa, during computations, it is necessary to compute the entire profile twice assuming alternately subcritical and supercritical flow. From the above results the most likely water surface profile can be determined

c. Starting Elevation. The water surface elevation for the beginning cross section may be specified in one of three ways: (1) as critical depth, (2) as a known elevation, (3) by the slope area method. By setting the variable STRT on card J1 equal to -1, critical depth will be computed and used as the starting water surface elevation. With variable STRT left blank the starting water surface elevation is specified by variable WSEL on card J1. For beginning by the slope area method STRT is set equal to the estimated slope of the energy grade line (must be a positive value) and WSEL is used as the initial estimate of the water surface elevation. The flows computed for the fixed slope and estimated depth are compared with the starting flow and the initial depth is adjusted until the computed flow is within 1% of the starting flow. The last assumption of initial water surface elevation thus determined is then used as the starting water surface elevation for water surface profile computations.

d. Flow.

(1) The river flow may be specified and altered in several ways. The starting flow is normally specified as variable Q on card J1 when only one flow is anticipated. If it is desired to use different flows for subsequent jobs using the same cross sections, variable INQ and card QT (discharge table) may be used. The flows are input in fields 2 thru 10 on the first QT card and 11 thru 20 on the second. Variable INQ for each job should equal the field number of the flow on card QT to be used for that job. Use of variable INQ and card QT overrides any flow specified for variable Q on card J1. However, variable Q on card J1 will be used until a QT card is encountered.

(2) Where it is desired to change the flow beginning at a certain cross section such as a confluence with another river or stream, variable QNEW on card X2 (second card describing specified cross section) may be used. QNEW permanently changes the flow at any cross section for which this variable is specified.

(3) Where it is necessary to increase or decrease flows specified on cards QT and X2 by a factor, variable FQ on card J1 is available. When a value

for FQ is entered, all flows on cards QT and X2 are multipled by this value and the resulting flows are used in the subsequent calculations.

e. Manning's "n".

(1) Since Manning's coefficient of roughness "n" depends on such factors as type and amount of vegetation, channel configuration and stage, several options are available to vary "n". When three "n" values are sufficient to describe the channel and overbank roughness, the first three fields of card NC ("n" value change) are used. Any of the "n" values may be permanently changed at any cross section by using another NC card. Often three values are not enough to adequately describe the lateral roughness variation in the overbanks in which case card NH ("n" value - horizontal) is used. The number of "n" values used to describe the overbank roughness is entered as variable NUMNH in the first field, and the "n" values and corresponding cross section stations are entered in subsequent fields. These "n" values will be used for all subsequent cross sections unless changed by another NH card or NC card. Normally NH card "n" values should be redefined for each cross section with new geometry.

(2) Data indicating the variation of Manning's "n" with river stage may be used in the program. Manning's "n" and the corresponding stage elevation (beginning with the lowest elevation) are entered on card NV ("n" value - vertical) beginning in the second and third field, respectively. Variable NUMNV in field 1 is the number of "n" values input on the NV cards. This option applies only to the channel area.

(3) If for subsequent runs of the same job it is desired to multiply the "n" values specified on cards NC, NH, and NV by a multiplier, variable FN on card J2 may be used. The desired multiplier is simply entered as variable FN for each job. If the variable is left blank, all "n" values will be multiplied by one. If the value of FN is negative then the factor is multiplied by the channel "n" on the NC card but the overbank "n" is not changed.

f. Solving for Manning's "n".

(1) To determine Manning's "n" from known high water marks along the river reach, the discharge, relative ratios of the "n" values for the channel and overbanks, and the water surface elevation at each cross section must be known. The "best estimate" of "n" for the first cross section must be entered on card NC since it is not possible to compute an "n" value for this cross section. The relative ratio of "n" between channel and overbank is set by the first cross section and will be used for all subsequent cross sections unless another NC card is used to change this ratio. High water marks are used for the computed water surface elevation by setting variable

NINV on card J1 equal to 1 and entering the known water surface elevation as variable WSELK on card X2 for each cross section. When an adverse slope is encountered, computations restart using n-values from the previous section, but WTN computations continue.

(2) Another method is to specify the discharge and an assumed set of "n" values, and have the program compute a water surface profile which can be compared with the high water profile. For this method WSELK may be input on card X2, without entering the computations, so that it can be easily compared with the computed water surface elevation on the output.

g. Multiple Stream Profiles. The water surface profile computations may be computed up both forks of a river or throughout a whole river basin for single or multiple profiles in a single computer run. The profile is first computed for reach 1 from the most downstream point to the end of one tributary. The data for a second tributary (reach 2), whose starting water surface elevation was determined when reach 1 was calculated, follows the data for reach 1 except that the first field of the X1 card (section number) is negative and is equal to the section number in reach 1 where the starting water surface elevation for reach 2 was determined. When a negative section number is encountered, the program will search its memory for the computed water surface elevation that corresponds to the negative section number. It will then start computing the profile for reach 2 with the previously determined water surface elevation.

h. Storage-Outflow Data. Punched cards can be obtained from HEC-2 for stream routing by the Modified Puls Method using program HEC-1. The cards punched are Y,2 and 3 cards (see program description for HEC-1). This option can be used only if multiple profiles are computed from the same cross sectional data and if the summary printout is requested. Interpolated cross sections determined by the computer may be used. Routing reach sections may not be interpolated sections. However, it may not be wise to use interpolated cross sections since a different number of cross sections might be interpolated between two given cross sections for different magnitudes of discharge which could cause inconsistencies in the incremental storage volumes. The ability to repeat the previous cross section by using only an X1 card (i.e., field 2 on the X1 card is blank) can be used where additional cross sections are needed at the ends of routing reaches and in place of the interpolated cross sections. The J4 card calls for this option.

i. Critical Depth Computation. Critical depth will not be computed for all cross sections in this program unless that option is requested on the J2 card, since this takes about half of the computation time. However, the program will check each cross section to see if the depth is close to critical. If the depth is near critical, it will calculate critical depth using subroutine DC by determining the point of minimum specific energy using a discharge weighted velocity head. Critical depth will always be computed for supercritical profile and it will be determined for low flow for the cross section upstream of a special bridge. This low flow critical depth is calculated by subroutine YCRIT for a trapezoidal section.

j. River Cross Sections.

(1) Cross sections are required at representative locations throughout the river reach. These are locations where changes occur in slope, cross sectional area, or channel roughness; locations where levees begin or end; and at bridges. In general, for rivers of flat slope and fairly uniform section (drop of three or four feet per mile) cross sections should be taken at least every mile. For steeper slopes and very irregular cross sections four or five cross sections per mile may be necessary. Where an abrupt change occurs in the cross section, several cross sections should be used to describe the change regardless of the distance. Every effort should be made to obtain cross sections that accurately represent the river geometry.

(2) Each cross section in the reach is identified and described using cards X1 (first card for a cross section) and GR. Variable SECNO on card X1 is the cross section number which may correspond to stationing along the channel, mile points, or any fictitious numbering system, since it is only used to identify output and is not used in the computations. Each point in the cross section is given a station number corresponding to the horizontal distance from the first point on the left. The station number and corresponding elevation of each point are input as variables STA(I) and EL(I) on card GR. Up to 100 points may be used. Cross sections may be oriented looking either upstream or downstream since the program considers the left side to be the lowest station number and the right side the highest. The left and right stations separating the channel from the overbank areas are specified as variables STCHL and STCHR on card X1. End points of a cross section that are too low (below the computed water surface elevation) will automatically be extended vertically by the program and a message giving the vertical distance extended will be printed.

(3) There are times when the user wishes to use the previous cross section as the current one (for uniform channels), with or without a modification, or to modify the current cross section (perhaps the surveyed cross section is moved upstream or downstream). To do this, variables NUMST, PXSECR and PXSECE on card X1 are available. A zero or blank for variable NUMST indicates that the previous cross section will be used for the current one, i.e., GR cards are omitted. When the GR cards are read in NUMST must equal the number of stations on the GR cards. When the horizontal dimensions of the previous (NUMST = 0) or current (NUMST = +) cross section are to be increased or decreased by a factor, the value of the factor is entered as variable PXSECR. All cross section stations except the first will then be multiplied by the factor. If the elevations of the previous or current cross sections are to be raised or lowered by a constant, the value is entered as variable PXSECE. During normal usage, when cross section data are read, NUMST will equal the number of stations on cards GR and PXSECR and PXSECE will be blank.

(4) Channel encroachments may be included in the analysis by using variables on card X3 (third card for cross section). ENCFP is used to specify a width between encroachment areas which is centered in the channel midway between the left and right bank stations. This width will be used for each cross section until another value of ENCFP is entered. Another method for specifying encroachments is to enter the station and elevation of the encroachment as variables STENCL and ELENCL on the left and STENCR and ELENCR on the right. If only the station is required the elevation should be omitted and it will be assumed to be very high. Other methods are presented in Exhibit 9A.

(5) The existing cross section as described by the GR cards can be modified due to the excavation of a trapezoidal channel by the use of subroutine CHIMP which is called by the CI card. The GR points are modified due to the excavation, but no fill is used. The bank elevations and stations are modified if the channel daylights outside the original bank stations. If the alignment of the excavated channel is such that two separate channels exist, the division between overbank and channel will be based on the excavated channel, and the old channel will be considered as overbank (no fill). It may be necessary to change the reach lengths for this case.

k. Multiple Profiles. Where it is desired to compute several profiles using the same cross sectional data, variable NPROF on card J2 is used. For the first profile, NPROF is set equal to 1 and all cross section cards are read in. For all remaining profiles NPROF equals the profile number, i.e., 2, 3, 4 ...., and only cards T1, T2, T3, J1 and J2 are required (cards NC through EJ are omitted). If NPROF is set equal to 15 for the last of two or more profiles, a summary printout is called for which will provide a concise summary of results for all profiles for each cross section. For a single job NPROF can be left blank, or, if the summary printout format for the single job is desired, set equal to -1.

l. Cross Sections with Levees.

(1) Levees require special consideration in computing water surface profiles because of possible overflow into areas outside the main channel. Normally the computations are based on the assumption that all area below the water surface elevation is effective in passing the discharge (IEARA = 0). However, if the water surface elevation is less than the top of levee elevation, and if the water cannot enter the overbanks upstream or downstream of that cross section, then all flow area in these overbanks should not be used in the computations. Variable IEARA on card X3 is used for this condition. By setting IEARA equal to 10 the program will consider only flow confined by the levees, unless the water surface elevation is above the top of one or both sides of the levee, in which case flow area or areas outside the levee will be included. When the water surface elevation is close to the top of the levee, it may not be possible to balance the assumed and computed water surface elevations due to the changing assumptions of flow area when just above and below the levee. When this condition occurs a note will be printed that states that the assumed and computed water surface elevations for the cross section

cannot be balanced. A water surface elevation equal to the elevation which came closest to balancing (plus 0.1 ft.) will be adopted. It is then up to the program user to determine the appropriateness of the assumed water surface elevation and start the computation over again at that cross section if required.

(2) It is important for the user to study carefully the flow pattern of the river where levees exist. If, for example, a levee were open at both ends and flow passed behind the levee without overtopping it, IEARA equals 0 or blank should be used. Also, assumptions regarding effective flow areas may change with changes in flow magnitude. Where cross section elevations outside the levee are considerably lower than the channel bottom, it may be necessary to set IEARA equal to 10 to confine the flow to the channel.

m. <u>Interpolated Cross Sections</u>. Sometimes it is necessary to insert cross sections between those specified on the GR cards because the change in velocity heads between cross sections is too great to accurately determine the hydraulic gradient. Variable HVINS on card J1 is used to specify when interpolated cross sections should be used. This variable specifies the maximum change in velocity head allowed between cross sections. If this value is exceeded, up to three interpolated cross sections will be generated between given cross sections (depending on the magnitude of ΔHV/HVINS - 1). If HVINS is left blank or equal to zero, the computer will suppress interpolated cross sections. Interpolated cross sections should be ommitted when computing several profiles on the same stream in order to use exactly the same cross sections. Interpolated cross sections are identified on the output by section numbers of 1.01, 1.02, and 1.03.

n. <u>Distance Between Cross Sections</u>. It was pointed out previously that the cross section number, SENCO on card X1, is used for identification purposes only. The actual distance between cross sections used in the computation is specified on card X1 as variables XLOBL, XLOBR and XLCH for the left overbank, right overbank, and channel, respectively. Normally these three values will be equal. There are, however, conditions where they will differ, such as at river bends, or where the channel meanders considerably and the overbanks are straight. Where the distance between corss sections for channel and overbanks are different, a discharge-weighted reach length is determined based on the discharges in the main channel and left and right overbank segments of the reach. The discharge used for each segment is an arithmetic average of the discharges determined for that segment at cross sections at each end of the reach.

o. <u>Transition Losses</u>. Expansion or contraction of flow due to changes in the channel cross section is a common cause of energy losses within a reach. Whenever this occurs, the loss may be computed by specifying on card NC the expansion and contraction coefficients as variables CEHV and CCHV respectively. The coefficients are multiplied by the absolute difference in velocity heads between the cross sections to give the energy loss caused by the transition. Where the change in river cross section is small, coefficients CEHV and CCHV are on the order of 0.3 and 0.1, respectively. When the change in cross sections is abrupt such as at bridges, CEHV and CCHV may be as high as 1.0 and 0.6. These values may be changed at any cross section by inserting a new NC card, however, these new values will be used until changed again by another NC card.

p. Bridge Losses.

(1) Energy losses caused by structures such as bridges and culverts are computed in two parts. First, the losses due to expansion and contraction of the cross section on the upstream and downstream sides of the structure are computed (see exhibits 3 and 4 for required cross sections). Variables CEHV and CCHV discussed in the previous section are used to specify the expansion and contraction coefficients. Secondly, the loss through the structure itself is computed by either the normal bridge routine or the special bridge routine.

(2) The normal routine handles the cross section at the bridge just as it would any river cross section with the exception that the area of the bridge below the water surface is subtracted from the total area and the wetted perimeter is increased where the water surface elevation exceeds the low chord. The bridge deck is described by entering the elevation of the top of roadway and low chord as variables ELTRD and ELLC respectively on card X2 or by specifying a table of roadway elevation and station and corresponding low chord elevations (BT cards). When only ELLC and ELTRD are used, these elevations are extended horizontally until they intersect the ground line. Pier losses are accounted for by the increased wetted perimeter of the piers as described on card GR. The normal routine is particularly applicable for bridges without piers, bridges under high submergence, and for low flow through circular and arch culverts. Whenever flow crosses critical depth in a structure, the special bridge routine should be used. The normal bridge is automatically used by the computer, even though data was prepared for the special bridge routine, for bridges without piers and under low flow control.

(3) The special bridge routine computes losses through the structure for low flow, weir flow and pressure flow or for any combination of these. The type of flow is determined by a series of comparisons as shown on exhibit 1 and as described below. First, the energy grade line elevations are computed assuming alternately low flow and pressure flow control. The higher energy grade line elevation determines the appropriate type of flow. If pressure flow appears to control and the energy grade line is above the minimum top of roadway elevation, then a combination of pressure flow and weir flow exists. If the energy gradient is below the minimum top of roadway then pressure flow alone controls. If low flow appears to control, and the corresponding energy

gradient elevation is above the minimum top of roadway elevation, then a combination of low flow under the bridge and weir flow over the roadway approach exists; if the energy elevation is below the minimum top of roadway, then low flow controls.

(4) Low flow is further classified as Class A, B and C depending on whether subcritical, critical, or supercritical flow occurs between bridge piers.

(a) Class A flow, identified by procedures explained in later paragraph, is solved from Yarnell's energy equation shown on sheet 010-6 of the WES Hydraulic Design Charts:

$H_3 = 2K\,(K + 10\omega - 0.6)(\alpha + 15\alpha^4)\,V_3^{\,2}/2g$ where,

H_3 = drop in water surface in feet from upstream to downstream sides of the bridge

K = pier shape coefficient (see exhibit 2)

ω = ratio of velocity head to depth downstream from the bridge

$\alpha = \dfrac{\text{obstructed area}}{\text{total unobstructed area}}$

V_3 = velocity downstream from the bridge in feet per second

The computed upstream water surface elevation is simply H_3 plus the downstream water surface elevation.

(b) Class B and C flows are handled by employing the following momentum relations proposed by Koch and Carstanjen in reference (b):

$$m_1 - m_{p1} + \frac{Q^2}{g(A_1)^2}\left(A_1 - A_{p1}\right) = m_2 + \frac{Q^2}{gA_2} = m_3 - (m_p)_3 + \frac{Q^2}{gA_3}$$

where,

m_1, m_2, m_3 = $A_1\bar{y}_1$, $A_2\bar{y}_2$ and $A_3\bar{y}_3$, respectively

m_{p1}, m_{p3} = $A_{p1}\bar{y}_{p1}$ and $A_{p3}\bar{y}_{p3}$, respectively

A_1, A_3 = unobstructed (gross) area at upstream and downstream sections, respectively

A_2 = flow area (gross area - area of piers) at a section within constricted reach

A_{p1}, A_{p3} = obstructed areas at upstream and downstream sections, respectively

$\bar{y}_1$, $\bar{y}_2$, $\bar{y}_3$ = vertical distance from water surface to center of gravity of A_1, A_2, and A_3, respectively

$\bar{y}_{p1}$, $\bar{y}_{p2}$ = vertical distance from water surface to center of gravity of A_{p1} and A_{p3}, respectively

Q = discharge

g = gravitational acceleration

(c) The three parts of the momentum equation represent the total momentum flux in the constriction expressed in terms of the channel properties and flow depths upstream, within and downstream of the constricted section, respectively. If each part of this equation is plotted as a function of the water depth, three curves are obtained, representing the total momentum flux in the constriction for various depths at each location. The desired solutions (water depths) are then readily available for any class of flow. If the water surface profile has been computed to the section at the downstream end of the pier, as is the usual case for subcritical flow, then the downstream depth is known. If the momentum flux for the constriction based on this downstream depth is greater than the momentum flux for the constriction based on critical depth, and the downstream depth is above critical depth, the flow is Class A, and the upstream depth is determined by the use of Yarnell's energy equation since the momentum method does not take into account an exit loss. The depth within the constricted section is determined by solving for the depth of flow which will provide a momentum flux equal to the downstream momentum flux. If the downstream momentum flux is less than the momentum flux for the constriction at critical depth, and the downstream depth is above critical, the flow is Class B, and the water surface elevation in the constriction is at critical depth. A new downstream depth (below critical) and the upstream depth (above critical) can be determined by finding the depths whose corresponding momentum fluxes equal the momentum flux at the constriction for critical depth. If the upstream depth is known, as is usually true for supercritical flow, and the momentum flux for the constricted section based on the upstream depth is greater than the momentum flux for the constricted section at critical depth, and the upstream depth is less than critical, the flow is Class C, and the downstream depth and the depth within the bridge section are found by determining depths corresponding to a momentum flux in the constriction based on the upstream depth. If, however, the computed momentum flux for the constricted section based on the upstream depth is less than the momentum flux for the constricted section at critical depth, the flow is Class B and the upstream depth is the depth (above critical) corresponding to the momentum flux for the constricted section at critical depth. The water surface profile must be recomputed with the upstream depth thus found as a control depth and proceeding in an upstream direction. The downstream depth (less than critical) is determined by finding the depth corresponding to the momentum flux for the constricted section at critical depth. The downstream depth thus found is used as a control depth to continue water surface computation in the downstream direction as far as downstream flow conditions permit.

(5) Weir flow is computed by the weir equation:

$Q = CLH^{3/2}$ where,

C = coefficient of discharge (see exhibit 2)

L = effective length of weir controlling flow

H = difference between the energy grade line elevation and the roadway crest elevation

Q = total flow over the weir

The approach velocity is included by using the energy grade line elevation in lieu of the upstream water surface elevation for computing the head, H. The coefficient of discharge "C" should not be greater than 3.1 for critical depth control, and in actual practice should be around 2.5 to allow for losses caused by bridge railings, etc. Where submergence by tailwater exists the coefficient "C" is reduced by the computer program according to the method indicated in reference (c). The total flow, Q, is computed by dividing the weir flow into subareas, computing L, H and Q for each subarea and summing all subareas.

(6) Pressure flow computations use the orifice flow equation of U. S. Army Engineering Manual 1110-2-1602, "Hydraulic Design of Reservoir Outlet Structures", August 1963 (reference e):

$Q = A\sqrt{\frac{2gH}{K}}$ where,

H = difference between the energy gradient elevation upstream and tailwater elevation downstream

K = total loss coefficient (see exhibit 2)

A = area of the orifice

g = gravitational acceleration

Q = total orifice flow

The total loss coefficient K, representing losses between the cross sections immediately upstream and downstream of the bridge, is equal to the sum of loss coefficients for intake, intermediate piers, friction, exit and other minor losses. See exhibit 2 for values of the loss coefficients.

(7) Often combinations of these three basic types of flow occur. In these cases a trial and error procedure is used with the equations just described to determine the amount of each type of flow. The procedure consists of assuming energy elevations and computing the total discharge until the computed discharge equals, within one percent, the discharge desired.

(8) To use the special bridge routine, variable IBRID on card X2 is set equal to 1. Variables on card SB (Special Bridge) specifiy bridge geometry and coefficients for the weir and orifice equations. Where the length of roadway for the weir equation is assumed constant for any depth of flow, variable RDLEN is set equal to that length. In cases where the length varies with depth it is necessary to input a table of roadway stations and elevations on card BT. In this case RDLEN is left blank. For some structures the user may desire to input a previously computed or estimated change in water surface elevation in which case the change is entered as variable BLOSS on card X2. When BLOSS is specified, no computations are performed for structure loss and the value entered for BLOSS is simply added to the water surface elevation for the previous cross section.

(9) Losses through culverts are handled in the same way as bridges where the culvert top (BT cards) and bottom elevation (GR cards) must be at the same horizontal stations (Normal Bridge Routine).

(10) The special bridge routine can be used for any bridge but should be used for trapezoidal bridges with piers where low flow occurs, for pressure flow through circular or arch culverts, and whenever flow passes through critical when going through a structure. The computer program will automatically shift from the special bridge routine to the normal bridge routine when there are no piers and low flow controls.

(11) Examples of input preparation for a bridge and a culvert are shown in exhibits 5 and 6. Test problems F, G, K, L, M, N, O, P, Q, R, and S of exhibit 8 involve bridges.

q. Cross Section Plot. Plots on the printer of any or all of the river cross sections to any scale may be requested by using cards J2 and X1. If all cross sections are to be plotted, set variable IPLOT on card J2 equal to 1 or 10. If only certain cross sections are desired, IPLOT on card J2 should be left blank and variable IPLOT on card X1 set equal to 1 or 10 for each individual cross section to be plotted. Vertical and horizontal scales of the plot may be specified constant for all cross sections in the job by using variables XSECV and XSECH on card J2. If the scale is not specified, the largest scale which is a multiple of 1, 2 or 5 that produces three pages of output or less will be used. For some deep river cross sections, flow may occupy only a small portion of the total cross section. In this case it may be desirable to enlarge the scale and to print only the cross section points up to the water surface elevation. This may be done by using a value of 10 for IPLOT instead of 1.

r. Profile Plot. This plot includes not only the water surface elevation, but the critical water surface elevation, energy grade line, channel invert, left and right bank elevations, and the maximum elevation of the cross section for which hydraulic properties can be computed. The vertical scale of the profile may be determined by the user using the variable PRFVS (which allows breaking the profile before the plot runs off the sheet) or by the computer (no break in the profile) if left blank. Profiles are plotted automatically for jobs using more than five cross sections. Profile plots may be suppressed by inputting a negative value for PRFVS.

s. Program Trace.

(1) It is sometimes useful to print out important variables as they are computed by the program to aid in checking, debugging and understanding the program. Two program traces are available for this purpose. The major trace prints values of variables used in the following computations:

(a) Interpolated cross sections

(b) Manning's "n" from known water surface elevations

(c) Computed water surface elevation

(d) Weir flow

(e) Critical water surface elevation

(2) The minor trace prints values of variables used in the computation of the hydraulic properties of each subarea of a cross section.

(3) ITRACE on cards J2 and X2 are used to specify the desired trace. The major trace may be called separately, ITRACE = 1, or in combination with the minor trace, ITRACE = 10. If all cross sections are to be traced, card J2 is used. If only individual cross sections are to be traced, card X2 is used.

5. INPUT

a. General. The various types of cards used for input (see exhibit 10) are identified by two characters in card columns 1 and 2. These characters are read by the computer to identify the card and corresponding variables. Exhibit 10 contains a description of each card type. Since some cards have similar purposes, it is helpful to discuss them together.

b. Data Comment Cards. These cards are optional and are used to print out description of cross sections in the data.

c. Title Cards - T1, T2, & T3. Three title cards are required for each job. The titles specified on the cards are read in alpha format and printed at the beginning of each job. Card columns 9-32 on the third title card (card T3) are reserved for the river name, which will be printed to title the cross section and profile plots.

d. Job Cards - J1, J2, J3, & J4. These cards are used to specify starting conditions, i.e., Q, water surface elevation, direction of flow, and various options for each job. Card J2, J3 and J4 are used only when the options or variables on the card apply. Cards J1 and J2 are used for each profile while cards J3 and J4 are used only on the first profile in a multiple profile run but apply to all.

e. Change Cards - NC, QT, NH, NV, CI, & ET. Card NC is required at the start of a job to initialize Manning's "n" values, and expansion and contraction coefficients. It may also be used to change these values at any cross section within a job. When the initial values are changed, they remain changed for the remainder of the job unless another change card is entered. Cards QT, NH, NV, CI and ET are also used to change starting conditions within a job. When the starting conditions are changed, the new value is used for all subsequent cross sections unless another card is used to make another change. Each change begins at the next cross section described by card X1 except for the CI card which is placed between the X1 and GR cards where the change occurs.

f. Cross Section Cards - X1, X2, X3, X4, & GR. Cards X1 and GR are required for cross sections unless NPROF on card J2 is 2 or greater in which case the cross section data read for the previous job would be used. Cards X2, X3 and X4 provide additional options that apply to the current cross section and can be used or omitted as desired. The purpose of these cross section cards is to completely describe each river cross section which is representative of the reach, and to specify program options for that cross section.

g. Bridge Cards - SB & BT. Card SB is required whenever the special bridge routine is used (IBRID = 1 on card X2). Card BT is included when stations and elevations of the top of roadway and low chord are to be read for either the normal or special bridge routines. The GR cards before and after Card SB must describe the constricted cross sections (effective section should be changed where weirflow occurs, see exhibit 3) immediately adjacent to the bridge to account for transition losses between the river cross section and the bridge. The special bridge routine computes only the losses through the bridge.

h. End of Job Card - EJ. Each job that contains any of the cards NC through GR must be ended with an end of job card, which signifies the end of input data.

i. End of Run Card - ER. Following the last card (EJ or J2) of the last job, 3 blank cards and card ER should be included. When card ER is read, control is transferred from the program by ending on a STOP.

j. Single Job. The minimum required cards for a single job using one cross section would be cards T1, T2, T3, J1, NC, X1, GR, EJ, 3 blanks and ER. The other cards are optional and would only be included if they applied.

k. Multiple Jobs. Where several jobs are to be computed during the same run (stacked jobs), the same cards are required as for a single run, except that the card following card EJ would be card T1 for the next job, and so on. Where it is desired to use the same cross sections for other jobs, variable NPROF on card J2 would be used. In this case the only cards required would be cards T1, T2, T3, J1, and J2. This option could only be used after the cross sections have been read in on the first job.

l. Card Format. Each data card is layed out in ten fields of eight columns each. One variable is used for each field except the first field, where the first two card columns are used for the card identification characters. The format specification for each data card is A2, F6.0, and 9F8.0. If decimal points are not punched in the data, all numbers must be right justified within the field. Where the user desires to punch a decimal point it may appear anywhere within the field. All blank fields are read as zeros. Minus one (-1) and plus one (1) are used in the program to specify certain program options. Any number without a sign is considered positive.

m. Tapes. All data cards are read at the beginning of the program and stored on tape 6. The tape is then rewound and the data cards are read from tape 6 individually. Tape 7 is used to store the plotted cross sections and tape 8 is used to store information used for plotting the profile. Tape 9 is used to store comment card for later printout.

6. OUTPUT

a. Cross Section Data. The first three lines of the output is the job description contained on the three title cards. Following the titles, input data on cards J1 and J2, J3, J4 (if used) are printed. The next output is four lines of variable names used to identify the output data for each cross section. A description of each variable is summarized in exhibit 9. Four lines of corresponding data follow the four lines of variables. When the normal or special bridge routines are used, a note will be printed identifying the routine, together with variable names applicable to the bridge section. These variable names are also described in exhibit 9. Following variable names for the bridge section is the corresponding bridge data. When data for the last cross section has been printed, a plot of the profile is printed.

b. Special Notes. Special notes are printed at various locations in the output to inform the user of various assumptions or options that have been used during the computation. These notes are summarized in exhibit 7.

c. Summary Data. When several jobs use the same cross section data (NPROF is equal to or greater than 2), summary data is printed to aid in comparing differences. Also differences between the water surface elevations are printed out to facilitate checking the answers. Negative differences point out trouble areas where the discharges are in increasing order.

d. Tapes. Normal output is on the printer. Additional output for the cross section plot is from tape 7.

7. EXAMPLE PROBLEMS

Listings of input and output data for several example problems are shown as exhibit 8.

8. UNITS

Water surface profiles may be computed using either the English or Metric system. English units are feet, square feet and cubic feet per second (cfs), where as the Metric system calls for meters, square meters, and cubic meters per second (cms). The only constants changed in the program are the constant in Manning's formula and the gravitational acceleration. Coefficients for computing losses through bridges and transitions are dimensionless. The only exception is in the weir flow equation, $Q = CLH^{3/2}$. The discharge coefficient "C" is a function of the square root of the gravitational acceleration. Since "C" is read as variable COFQ on card SB it may be input as a metric coefficient. In English units "C" ranges from 2.5 to 3.1. For Metric units a comparable range would be 1.39 to 1.72. Table 1 below summarizes the conversion used between English and Metric units.

TABLE 1

ITEM	ENGLISH	METRIC
Length Conversion	3.28 feet	1 meter
Area Conversion	10.76 square feet	1 square meter
	1 acre	4046.86 square meter
Flow Conversion	35.31 cubic ft/sec	1 cubic meter/second
Manning's Constant	1.49	1.00
Gravitational Acceleration (g)	32.2 ft/sec^2	9.82 m/sec^2
Coefficient "C" in Weir Formula	2.5 to 3.1	1.39 to 1.72
Coefficient of Contraction	.1 to .3	.1 to .3
Coefficient of Expansion	.3 to .5	.3 to .5

9. SUPPLEMENTAL MATERIAL

The following supporting publications and illustrations are available from HEC for computer program HEC-2, Water Surface Profiles:

a. HEC-2, Water Surface Profiles, Programmers Manual, 1976.

b. HEC Technical Paper No. 11, Survey of Programs for Water Surface Profiles (1968) by Bill S. Eichert. (Published in the Journal of the Hydraulics Division, ASCE, Vol. 96, No. HY 2, February 1970.)

c. HEC Technical Paper No. 20, Computer Determination of Flow Through Bridges (1970) by Bill S. Eichert and John Peters. (Published in the Journal of the Hydraulics Division, ASCE, Vol. 96, No. HY7, July.)

d. HEC Training Document No. 5, Floodway Determination Using Computer Program HEC-2, May 1974.

e. HEC Training Document No. 6, Computation of Water Surface Profiles Through Bridges Using HEC-2, June 1974.

f. "Water Surface Profiles," IHD Volume 6, The Hydrologic Engineering Center, 1975.

10. REFERENCES

a. Eichert, Bill S., "Critical Water Surface by Minimum Specific Energy Using the Parabolic Method," Hydrologic Engineering Center, U.S. Army Corps of Engineers.

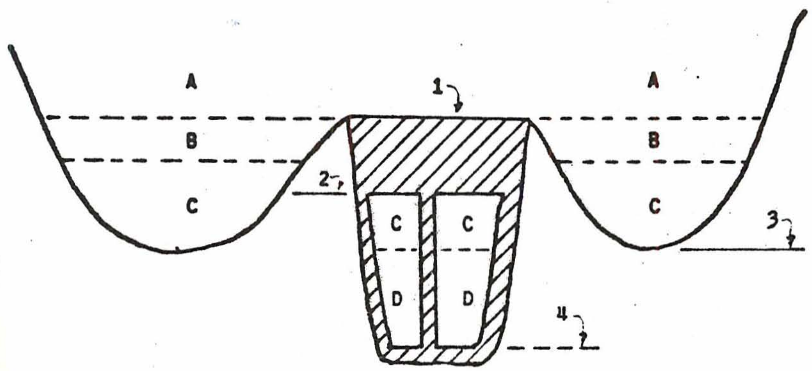
b. Koch-Carstanjen, "Von der Bewegung des Wassers und Den Dabei Auftretenden Kraften, Hydrodynamik," Berlin, 1926. A partial translation appears in Appendix I, "Report on Engineering Aspects of Flood of March 1938," U.S. Engineer Office, Los Angeles, May 1939.

c. "Hydraulic Design of Spillways," Engineering Manual 1110-2-1603, U.S. Army Corps of Engineers, 31 March 1965, Plate 33.

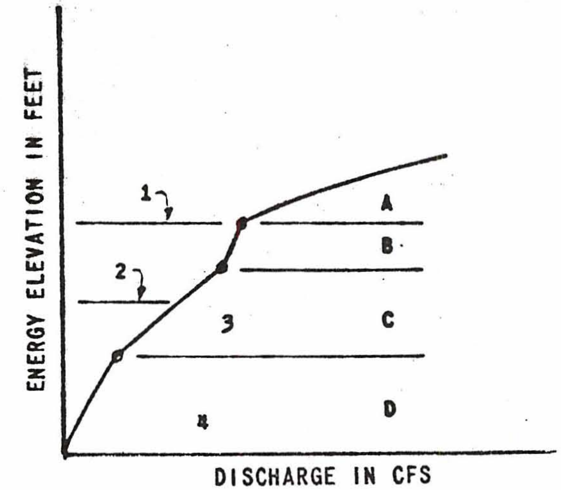
d. "Backwater Curves in River Channels," Engineering Manual 1110-2-1409, U.S. Army Corps of Engineers, 7 December 1959.

e. "Hydraulic Design of Reservoir Outlet Structures," Engineering Manual 1110-2-1602, U.S. Army Corps of Engineers, 1 August 1963.

f. "Evaluating Friction Loss in the Standard Step Method," William A. Thomas and John C. Peters.



BRIDGE CROSS SECTION



BRIDGE RATING CURVE

ELEVATIONS

1 Top of Roadway

2 Low Chord

3 Roadway Approach

4 Channel Invert

FLOW CONDITION

A - Combined pressure under bridge, weir in over banks, weir over bridge

B - Combined pressure under bridge, weir in overbanks

C - Combined low flow under bridge, weir in overbanks

D - Low flow under bridge

ILLUSTRATION OF BRIDGE FLOW TYPES

Exhibit 1

EXHIBIT 2

LOSS COEFFICIENTS

I. Pier Shape Coefficient, "K" (Variable XK)

For use in Yarnell's energy equation for Class A flow

$$H_3 = 2K\ (K + 10\omega - 0.6)\ (\alpha + 15\alpha^4)\ V_3^2/2g$$

Pier Shape	K
Semicircular nose and tail	0.90
Twin-Cylinder piers with connecting diaphragm	0.95
Twin-Cylinder piers without diaphragm	1.05
90° triangular nose and tail	1.05
Square nose and tail	1.25

II. Loss Coefficient, "K" (Variable XKOR)

This coefficient is used in the orifice flow equation, $Q = A\sqrt{2g\ H/K}$. For bridges and relatively short culverts, a value of 1.5 is suggested. For long culverts where friction losses must be considered, the value can be calculated by the sum of loss coefficients, k, shown below.

Description	k
Intake	.10
Intermediate piers	.05
Friction	k_f
	XKOR = 1.0+ Σk

The loss coefficient for friction, k_f, should be computed using Manning's equation where $k_f = \frac{29.1\ n^2L}{R^{4/3}}$ (English) or $\frac{19.6\ n^2L}{R^{4/3}}$ (Metric).

Multiple Culverts:

$$Q = \sqrt{2gH} \cdot AT \sqrt{1/K_{equiv}}$$, where AT = Total Area

$$K_{equiv} = \frac{AT^2}{\left[\Sigma \sqrt{\frac{A_i^2}{K_i}}\right]^2}$$

III. Coefficient of Discharge, "C" (Variable COFQ)

Under free flow conditions (discharge independent of tailwater), the coefficient of discharge, "C", ranges from 2.5 to 3.1 (1.39 - 1.72 Metric) depending primarily upon the gross head of the crest ("C" increases with head) and resistance to flow caused by obstructions such as bridge railings, curbs, and other barriers. For road approaches with a trapezoidal shaped cross section, a coefficient of 3.0 would be reasonable. For flow over bridge decks, a value of 2.5 could be used.

When submerged flow (discharge affected by tailwater) occurs, the coefficient "C" should be reduced. This is done automatically by the computer program using Waterways Experiment Station Design Chart 111-4 for an ogee shaped weir.

IV. Expansion and Contraction Coefficients

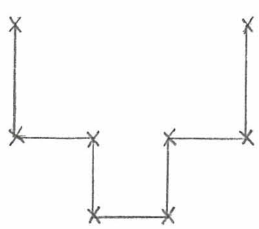
These coefficients are used to compute losses caused by changes in the river cross sections. For long gradual transitions, the coefficients are small. For short abrupt transitions, they are large. The transition loss is computed as the coefficient times the difference in velocity head between cross sections.

	Coefficient	
	Expansion	Contraction
No transition	0.0	0.0
Gradual transitions	0.3	0.1
Abrupt transitions	0.8	0.6

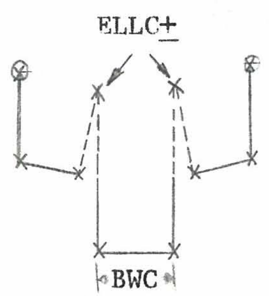
EXHIBIT 3

REQUIRED CROSS SECTIONS FOR SPECIAL BRIDGE ROUTINE

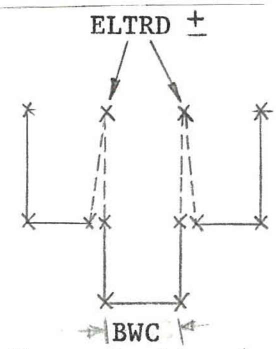
The cross sections below show the points required on cards GR when using the special bridge routine. Cross sections 1, 2, 5, 6 are taken in the river channel upstream and downstream from the bridge and should represent the full cross section unaffected by the bridge. Cross section 3 is adjacent to the bridge on the downstream side and includes the elevations and stations of an artificial levee whose top is about equal to the low chord elevation (ELLC). The points defining the artificial levee can be omitted if the elevations where the effective area changes are shown on the X3 card (eighth and ninth fields), thus cross section 3 could resemble cross sections 1 and 2. Cross section 4 is adjacent to the bridge on the upstream side and includes the elevation and station of an artificial levee (or an X3 card with elevations in eighth and ninth fields) whose top elevation is approximately equal to the top of roadway elevation (ELTRD). No cross section is provided through the bridge, but data describing the bridge are entered on cards SB, X2 and BT (optional). Therefore, when using the special bridge routine cross sections 3 and 4 should describe the channel cross section (excluding any roadway embankment) immediately downstream and upstream from the bridge. The top of roadway embankment should be described on card X2 or BT.



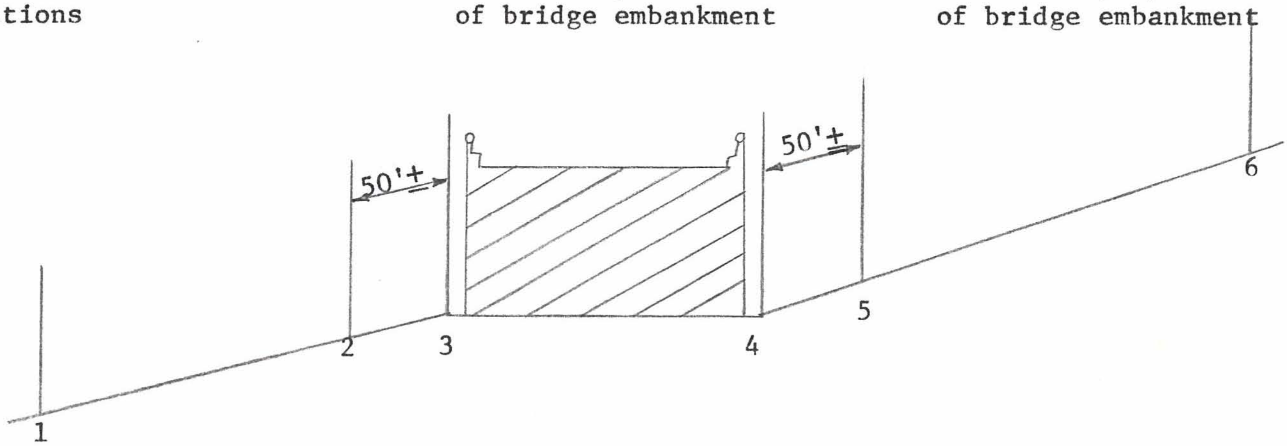
Cross Sections 1, 2, 5, 6
Full natural river cross sections



Cross Section 3
Immediately downstream of bridge embankment



Cross Section 4
Immediately upstream of bridge embankment

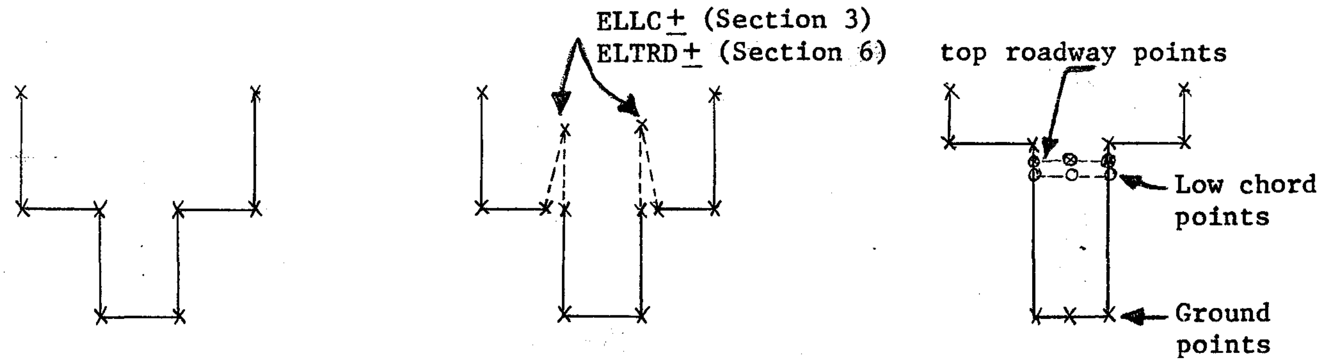


The artificial levees (or the elevations on the X3 card) are included in the cross section points in order to confine the flow to the channel area when the water flows under the bridge low chord and to allow the use of the overbank flow area for flows over the road. The left and right bank stations must be equal to stations at the top of the artificial levees. Variable IEARA on card X3 must equal 10 for this condition.

EXHIBIT 4

REQUIRED CROSS SECTIONS FOR NORMAL BRIDGE ROUTINE

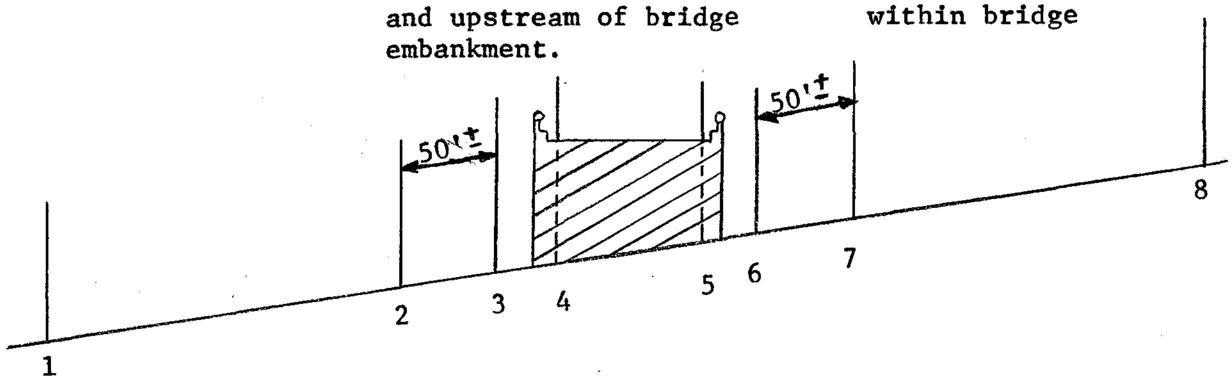
The cross sections below show the points required on cards GR when using the normal bridge routine. Cross sections 1, 2, 7, 8 describe the natural river channel. Cross sections 3 and 6 are adjacent to the bridge on the downstream and upstream sides respectively and include elevations and stations of an artificial levee* whose top is approximately equal to the low chord elevation (ELLC) and top of roadway elevation (ELTRD) respectively. The artificial levee is included in the cross section points to confine the flow to the channel area (bridge area) when the water flows under the low chord, and to allow the overbank area to be used for flows over the roadway. The left and right bank stations must be equal to the station at the top of the artificial levees.



Cross Sections 1, 2, 7, 8
Full natural cross sections

Cross Sections 3 and 6
Immediately downstream and upstream of bridge embankment.

Cross Sections 4 and 5
within bridge



Variable IEARA on card X3 must equal 10 for cross sections 3 and 6. Cross sections 4 and 5 are within the bridge and BT (or X2) cards are used to describe the low chord and top or roadway points. All stations used on the BT cards should also appear on the GR cards.

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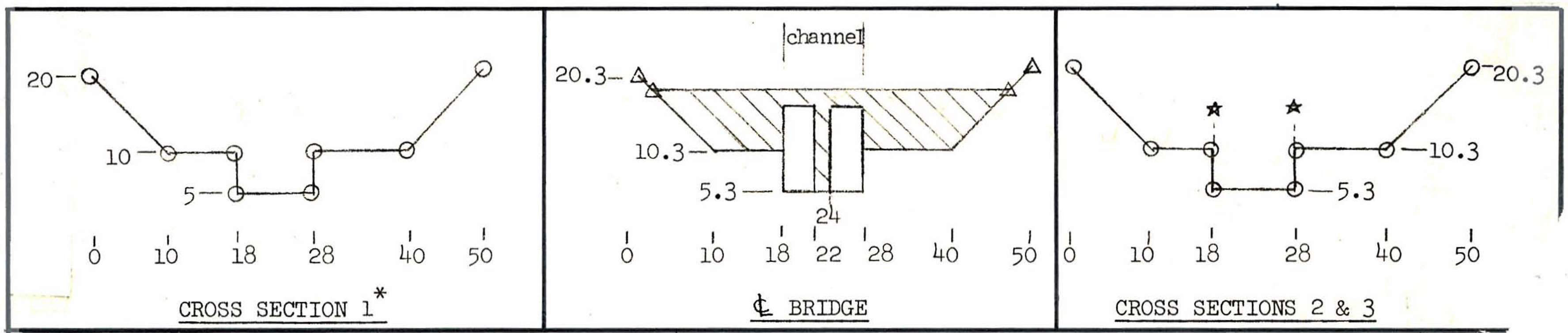
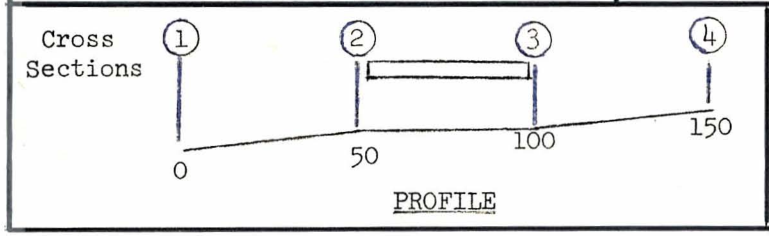
*The points defining the artificial levee can be omitted if the elevations where the effective area changes are shown on the X3 cards (eighth and ninth fields). Thus cross sections 3 and 6 could resemble cross sections 2 and 7.

EXAMPLE INPUT PREPARATION

FOR A BRIDGE

Exhibit 5





NOTES

* Cross section 4 is .6 ft above no. 1

⊙ GR Card points

△ BT Card - top of roadway elevation

★ Top of artificial levees

	1	2	3	4	5	6	7	8	9	10
T1	EXAMPLE INPUT PREPARATIØN - SPECIAL BRIDGE RØUTINE									
T2	TWØ FØØT BRIDGE PIER									
T3	ARTIFICIAL LEVEES BY X3 CARD									
J1	-1			0	0		-1	700	14	
NC	.043	.043	.043	.3	.5					
X1	1	8	18	28	0	0	0			
GR	20	0	10	10	10	18	5	18	5	28
GR	10	28	10	40	20	50				
X1	2	0	0	0	50	50	50	1	.3	
X3	10							16	16	
SB	.9	1.5	2.5	0	10	2	85.6	0		
X1	3	0	0	0	50	50	50	1	0	
X2			1	16	18	0				
X3	10							18	18	
BT	4	0	20.3		2.3	18		47.3	18	
BT	50	20.3								
X1	4	0	0	0	50	50	50	1	.3	
EJ										

Exhibit 5

GENERAL PURPOSE DATA FORM

(8 COLUMN FIELDS)

PROGRAM: HEC 2 WATER SURFACE PROFILES | DATE:
REQUESTED BY: | PREPARED BY: BSE | CHECKED BY: | PAGE: OF

Card	1	2	3	4	5	6	7	8	9	10
T1	EXAMPLE INPUT PREPARATIØN - NØRMAL BRIDGE RØUTINE - HEC 2									
T2										
T3										
J1										
NC										
X1	1	SAME AS FOR SPECIAL BRIDGE ROUTINE								
GR										
GR										
X1	2									
X3	10									
NC	.015	.015	.015	.3	.5					
X1	2.1	12	18	28	1	1	1			
X2				16	18					
GR	20.3	0	18	2.3	18	18	5.3	18	5.3	22
GR	18	22	18	24	5.3	24	5.3	28	18	28
GR	18	47.3	20.3	50						
X1	2.9	0	0	0	48	48	48	1	0	
X2				16	18					
NC	.043	.043	.043	.3	.5					
X1	3	8	18	20	1	1	1	1	0	
X3	10							18	18	
GR	20.3	0	10.3	10	10.3	18	5.3	18	5.3	28
GR	10.3	28	10.3	40	20.3	50				
X1	4	0						1	.3	
EJ										

SPK Form 321
1 Jul 66

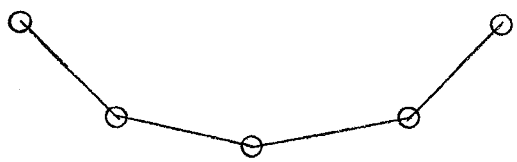
(Previous editions are obsolete)

Exhibit 5

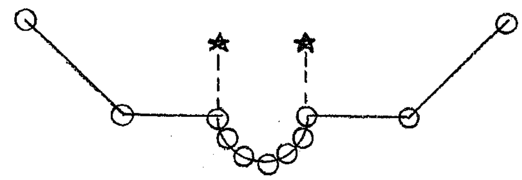
EXAMPLE INPUT PREPARATION

FOR A CULVERT

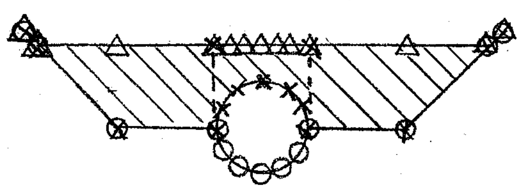
Exhibit 6



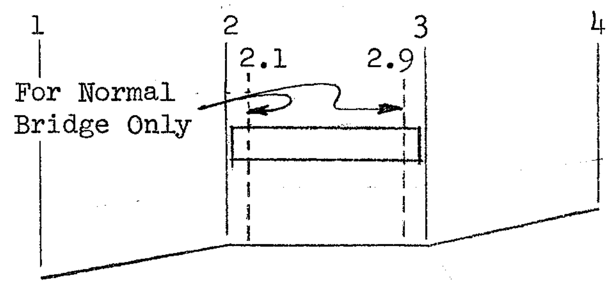
CROSS SECTIONS 1 & 4



CROSS SECTION 2



CROSS SECTION 3*



PROFILE

LEGEND

- ⊙ GR Card points
- X BT Card - low chord elevation
- △ BT Card - top of roadway elevation
- ✯ Top of artificial levees

*Note: Also sections 2.1 and 2.9 for normal bridge routine.

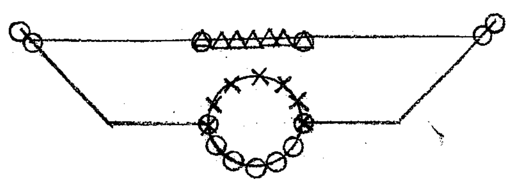
SPECIAL BRIDGE ROUTINE
(and Normal Bridge Routine for Low Flow)

CARDS	FIELD 1	FIELD 2	COMMENTS
Cross Section: T1 T2			
T3 J1			
NC #1: X1	1	5	5 points
GR #2: X1	2	11	11 points
X3 GR	10		Use 8th and 9th fields
GR GR			
SB #3: X1	3	0	Use previous X sect's GR cards
X2 X3	 10		Use 3rd, 4th and 5th fields Use 8th and 9th fields
X4 BT	2 13		Points at top of roadway 13 points
BT BT			
BT #4: X1	4	5	5 points
GR EJ			

NORMAL BRIDGE ROUTINE (only)

CARD		FIELD 1	FIELD 2	COMMENTS
Cross Section	T1 T2			Same as Special Bridge
	T3 J1			
#1	NC X1	1	5	
	GR X1	2	11	
#2	X3 GR	10		
	GR GR			
#2.1	NC X1	2.1	0	Use n for concrete Use previous GR cards
	X4 BT	2 13		Points at top roadway
	BT BT			Same as Special Bridge
#2.9	BT X1	2.9	0	Use previous GR cards
	X2 NC			Repeat bridge Change n back
#3	X1 X3	3 10	0	Use previous GR cards Use 8th and 9th fields
#4	X1 GR EJ	4	5	Same as Special Bridge

ALTERNATE CROSS SECTION
FOR NORMAL BRIDGE (ONLY)



No. of GR Card points = 13
No. of BT Card points = 7

EXHIBIT 7

SPECIAL NOTES

This exhibit explains special notes which are not explained as part of the normal output. The special notes should be carefully reviewed to assure an accurate profile. If these notes are not satisfactorily explained, the job should be rerun obtaining intermediate printout (ITRACE = 1). If the reason is still not evident, please contact The Hydrologic Engineering Center.

Statement Number	Notes and Remarks
1340	CARD NOT RECOGNIZED. First two columns of input card read did not correspond to any of the standard alphabetic characters used to identify cards.
1362	XKOR INCREASED TO 1.2. The orifice coefficient was zero or minus and was therefore changed to 1.2 since 1.0 is the minimum value.
1365	SB CARD, BWP = 0. On the special bridge routine card SB, the pier width is omitted. If there is no intermediate pier this is satisfactory.
1366	SB CARD, BAREA = 0. On the special bridge routine card SB, the area of the bridge when flowing full is omitted and therefore this job has been terminated.
1400	CCHV =, CEHV = . A change in contraction and expansion losses have been made.
1415	INQ EXCEEDS NUMQ. The field of the QT cards to be used for the current Q, specified by variable INQ, contained no flow data.
1445	Q EXCEEDS 19. The number of discharges on card QT exceeded the maximum allowable number of 19.
1452	NV CARDS EXCEED 4. The number of items specified on the NV card exceeded the allowable.
1455	NV CARD USED. A table of Manning's "n" value and corresponding elevation was used in the channel.
1481	EL(N) DON'T INCREASE. The elevations on the NV cards must increase when the channel roughness is varied with elevation and therefore the job has been terminated.

Statement Number	Notes and Remarks
1490	NH CARD USED. Manning's "n" value varied horizontally in accordance with values on NH card.
1518	NH CARD STATIONS NOT INCREASING. The stations on the NH card specifying changes in Manning's roughness must increase and therefore the job has been terminated.
1525	NH VALUES EXCEED 20. Manning's roughness coefficient specified on the NH card exceeded the allowable number.
1535	Q = 0. The discharge was not specified on the J1 card.
1537	START TRIB COMP. Since a negative section number was used, the profile is to be computed on a tributary starting with the water surface elevation which was computed for the same section number on the main stem.
1553	STARTING NC CARD OMITTED. The starting values on the NC card were not given. The roughness values assumed were very small (.00001).
1645	INT SEC ADDED BY RAISING SEC X, Y, FT AND MULTIPLYING BY Z. An intermediate cross section was calculated by the computer and inserted between two cross sections specified by input data. This interpolated cross section was calculated by all horizontal stations, and hence the cross sectional area, by Y.
1707	STCHL OR X, GREATER THAN Y. The station of the left bank was given larger than the station of the right bank and therefore was assumed equal to the first station.
1807	BT CARDS EXCEED 50 PTS. Number of points describing the bridge (Card BT) exceeded allowable.
1857	BT CARD, STA DON'T INCREASE. The roadway station on the BT card should increase. Data should be corrected.
1860	XLCEL OF X, EXCEEDS RDEL OF Y. The low chord elevation of X exceeds the corresponding value of the top of roadway Y. Data should be corrected.
1912	GR CARDS, STATIONS CON'T INCREASE. The ground profile points don't increase in horizontal station. The data should be corrected.
2020	NUMBER EL, STA, PTS EXCEED 100. The number of points used to describe the ground profile for the current cross section exceeded the allowable.

Statement Number	Notes and Remarks
2096	WSEL NOT GIVEN, AVG OR MAX, MIN USED. The starting water surface elevation wasn't given and therefore has been assumed as halfway between the maximum and minimum elevation in the cross section.
2725	WSEL EXCEEDS LIMITS OF TABLE FOR MANNING'S "n". An assumed water surface elevation fell outside the elevation limits which specified Manning's "n" values on NV cards. Table values were extrapolated for "n" value.
2620	NO IMPROVEMENT MADE TO THIS SECTION. The subroutine CHIMP has been requested by the CI card and the excavation described will not cut the existing cross section.
2750	NUMBER OF COMPUTED POINTS EXCEED 100. The number of points added by subroutine CHIMP have caused the total to exceed 100. Reduce the number of points on the GR card.
3073	NEGATIVE SLOPE, WSEL = , EG = , PCWSE = , XEG = , WLEN = RESTART COMPUTATIONS AT SECNO = , USING N-VALUES COMPUTED FOR SECNP = . A negative slope of the energy gradient has been computed while trying to calculate roughness values that will exactly duplicate the observed high water mark. Due to this condition, the computations will start over again using the previous section's roughness values.
3075	SET S = SAVE. The computed slope at this section was negative or zero. The slope was set equal to the computed average slope between this and the previous section.
3235	SLOPE TOO STEEP, EXCEEDS X. The computed slope of the energy grade line exceeded X, and critical depth has probably been crossed. If this cross section is a bridge, the special bridge routine should be used in lieu of the normal bridge.
3265	DIVIDED FLOW. The area below the computed water surface elevation is divided into two or more segments by high ground. If this condition occurs for three or more cross sections consecutively, then separate profiles should be run up each leg of the divided flow as the water surfaces are not necessarily the same elevation across the cross section.
3280	CROSS SECTION EXTENDED X FEET. The cross sections ends have been projected vertically 50 feet in order to calculate the hydraulic properties of the cross section. Exactly X feet of this extension were used. If this vertical assumption could produce unreasonable results, the input data should be corrected.

Statement Number	Notes and Remarks
3301	HV CHANGED MORE THAN HVINS. The differences between velocity heads computed for the current and previous cross sections exceeded the allowable specified by input as HVINS (or .5 feet if HVINS = -1).
3370	NORMAL BRIDGE, NRD = X, MIN ELTRD = Y, MAX ELLC = Z. The normal bridge routine was used for this cross section. The number of point used in describing the bridge deck are given as X, the minimum top of roadway elevation is Y and the maximum low chord elevation is Z.
3377	BLOSS READ IN. The diffenence in water surface elevation between the previous and current cross section was given by input data.
3420	BRIDGE W.S. = X, BRIDGE VELOCITY = Y. The water surface elevation under the bridge is specified by X and the velocity through the bridge is Y.
3470	ENCROACHMENT STATIONS = X, Y. The left bank encroachment station is specified by X and the right bank encroachment station is specified by Y. Only the flow area between X and Y is considered effective.
3495	OVERBANK AREA ASSUMED NONEFFECTIVE, XLBEL = X, RBEL = Y. The effective area option (IEARA) was used and the computed water surface elevation was below at least one of the bank elevations specified by X and Y and therefore this flow area was assumed noneffective.
3685	20 TRIALS USED WSEL, CWSEL. The number of trials in balancing the assumed and computed water surface elevations for the normal step procedure of backwater has exceeded 20. Check the assumed water elevation for reasonableness.
3693	PROBABLE MINIMUM SPECIFIC ENERGY. This note is similar to 7185 except it is not certain (only probable), that critical depth has been crossed. It is known that no depth of flow assumed in any of the trials produced an energy grade line elevation as high as the minimum energy at critical depth.
3710	WSEL ASSUMED BASED ON MIN DIFF +.1. At the conclusion of 30 trials the assumed water surface elevation will be made equal to .1 of a foot above the elevation that came the closest to balancing. This condition usually occurs near the top of banks when IEARA = 10. Check results for reasonableness.

Statement Number	Notes and Remarks
3720	ASSUMED CRITICAL DEPTH. Critical depth has been assumed for this cross section. This assumption should be verified by inspection of channel properties. Additional cross sections may need to be inserted in order to preserve the assumption of gradually varying flow.
3790	DATA ERROR. JOB DUMPED. The computer detected an error in input and terminated that particular job (profile), but continued on with the next job of the input data.
3800	PREVIOUS ST GREATER THAN CURRENT. Either an input error caused the stations of the GR card to not increase or a programming error has been found.
3810	HT IS -. The height (HT), determined by subtracting the ground elevation from the assumed water surface elevation, has been found to be negative. Corrections for bridge deck (ELTRD - ELLC) used in normal bridge routine will have caused this note if any ELLC is greater than the corresponding ELTRD. If this is not the case a program error has been found, and a trace should be run to determine the source of the error.
3820	STA(N) GREATER STMAX. One of the stations of the points on the current ground profile cards (GR) was greater than the maximum station for this profile.
3830	AROB OR ALOB IS -. A negative area in the left or right overbank has been computed. A program error probably has been detected. A trace should be run.
3840	SECTION NOT HIGH ENOUGH. The computed water surface elevation exceeds the maximum specified on input cards, therefore, the cross section ends have been vertically raised 50 feet.
3875	SUMMARY PRINTOUT FOR MULTIPLE PROFILES.
3956	VOL NOT ON J3 CARD. The J3 and J4 cards have both been used. The J4 card requires that variable VOL and TIME be requested on the J3 card.
3959	TIME NOT ON J3 CARD. Same as note 3956.
3965	REACH OF - NOT EQUAL TO SECNO OF -. The J4 card has been used to specify routing reaches which must be equal to the section numbers (SECNO) on the first field of the X1 card. The section numbers must also be in increasing order.

Statement Number	Notes and Remarks
4020	80 TRIALS NOT ENOUGH FOR CRITICAL DEPTH. This note indicates a data error or program error has been detected. If no data error is detected, job should be rerun, with ITRACE equal to one, in order to obtain reason for failure of parabolic optimization process.
4575	CRITICAL DEPTH ASSUMED BELOW ELLC OF - EGLC = - EGC = - WSEL = -. Critical depth is being computed in a bridge section and the minimum energy below the low chord is less than the minimum energy above the top of the bridge.
5020	SPECIAL BRIDGE. The input has specified that the bridge routine to be used for this cross section is a special bridge routine.
5070	VARIABLE ELCHU OR ELCHD ON CARD SB NOT SPECIFIED. The elevations of the channel upstream and downstream of the bridge are not specified on input fields and have therefore been assumed equal to the previous cross sections minimum elevation.
5227	DOWNSTREAM ELEV IS X, NOT Y, HYDRAULIC JUMP OCCURS DOWNSTREAM. The upstream momentum is so great that the water downstream of the bridge is supercritical and not subcritical.
5290	UPSTREAM ELEVATION IS X NOT Y, NEW BACKWATER REQUIRED. Since supercritical flow was assumed by input and since the bridge obstruction drowns out the supercritical flow upstream of the bridge, new backwater is required, from the bridge upstream.
5470	ERROR DS DEPTH WRONG SIDE CRITICAL. The calculated depth in the low-flow routine was determined on the wrong side of critical depth. If this error occurs, a programming error has been discovered. Run with ITRACE = 1 and determine the cause.
5730	See note 3710.
6070	LOW FLOW BY NORMAL BRIDGE. When the pier width is specified as zero for the special bridge routine and when low flow controls, the friction loss for the bottom and sides of the channel are computed using the normal bridge routine instead of the special bridge routine.
6110	EGLWC OF X LESS THAN XEG OF Y. The energy gradient elevation for the controlling low flow is less than the previous cross section's energy gradient indicating negative losses. The energy gradient elevation for the current cross section is therefore assumed equal to the previous energy gradient (no loss) and the run has been continued.

Statement Number	Notes and Remarks
6400	TRIAL AND ERROR FOR CHANNEL Q FAILED. For the low flow and weir flow combination, the discharge through the channel must be determined. In trying to determine the discharge through the channel by an iterative process, the assumed and computed discharges do not agree in 50 trials. The allowable error of 1 percent is too severe for the computation or a programming inadequacy has been detected.
6790	**20 TRIALS OF EG NOT ENOUGH. In determining the energy grade line elevation for a combination of weir flow and low flow, the discharge computed for an assumed energy grade line elevation could not balance with the actual discharge to be used in the water surface profile determination. When this condition occurs, the job should be rerun using the trace feature and the cause of this failure determined.**
6840	FLOW IS BY WEIR AND LOW FLOW. The minimum top of roadway in one or both overbank dips below the low chord over the bridge and the resulting water surface elevation, which is below the low chord over the bridge, was computed using Class A low flow under the bridge and weir flow in the low overbanks.
6870	D.S. ENERGY OF X HIGHER THAN COMPUTED ENERGY OF Y. The previous cross section's downstream energy grade line elevation of X is higher than the current cross section's computed energy grade line elevation of Y. The current energy grade line elevation was computed for a combination of weir and low flow or weir and pressure flow. The energy grade line elevation for this cross section has been assumed equal to the previous energy elevation in order to eliminate negative losses. The weir coefficients used apparently were too efficient.
7185	MIN SPECIFIC ENERGY. The computer determined that it was impossible to procede from the previous cross section to the current cross section without crossing critical depth and therefore, critical depth has been assumed for the current cross section. In other words, maximum losses cannot produce an energy elevation as high as the minimum energy at critical depth. If this note occurs for several consecutive cross sections, it is apparent that the wrong type of flow (IDIR) has been assumed for this segment of the profile. The cross section should be reversed, IDIR changed and the profile run.

Statement Number	Notes and Remarks
7230	SLOPE-AREA TRIALS EXCEED 100. In determining the starting water surface elevation using the slope of the energy grade line from input, 100 trials were not sufficient to balance the calculated discharge with the actual discharge (Q). If this condition occurs, an error in the input data or a programming error has been encountered. Rerun with trace feature if input data appears satisfactory.
8190	PLOTTED POINTS (BY PRIORITY). - - - ETC. This note gives the priority for plotting the values for the cross section. If two or more points are close enough together that a single space of the printer cannot distinguish between them then only the last point plotted will be seen on the output. For instance, the energy gradient elevation (E) will hide the water surface elevation (W) for very small velocity heads.
8560	XSEC POINT - , X, EL, ST - Y, Z. The subscript computed for the current point was too low or too high to be plotted and is therefore not shown on the cross section plot. The X indicates the type of point being plotted (X for ground point). The elevation and station of this point are printed out as Y and Z.
8930	RDST NOT ON GR CARD. The roadway station printed out here does not appear on the ground profile card (GR). For the normal bridge routine all stations on the BT card must also appear on the BR card. This note can be ignored for the special bridge routine.

EXHIBIT 8

TEST PROBLEMS

Test	Description	Page
A	Normal backwater - starting depth less than depth - 3 interpolated cross sections. North Buffalo Creek	1
B	N values vary by horizontal table (NH cards) start at critical depth, GR cards omitted for cross section 150, cross section modified by (X1.8 - X1.9). Discharge varied by X2 card for single profile, no interpolated cross sections.	3
C	N values vary with elevation in channel, NV card used. Davis Creek	5
D	Start by slope area method. Desired energy slope and estimated elevation given. Davis Creek	6
E	Supercritical flow profile - starting depth above critical, GR points from cross section 1180 repeated for cross sections 1380 - 1580, profile plot suppressed, change in velocity head fixed. Salt Lake City streams	8
F	Flow through a circular culvert - 4 ft. diameter, 5 per cent slope, supercritical flow - start at critical depth.	10
G	Special Bridge Routine - data for weir flow only (no X3 cards), input and output in metric units, no interpolated cross sections. North Buffalo Creek	13
H	Encroachment tests (1) encroachment width given, (2) stations given, (3) stations and elevations given, (4) encroachment width repeated from previous sections ENCFP (X3.3).	15
I	Channel improvement (subprogram CHIMP). First profile is natural (IBW-8), (BW-.01). Discharge read from 12th field (INQ) of QT cards. Catalpa Creek	17

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T1      TEST A NORMAL BACKWATER-GIVEN STARTING DEPTH LESS THAN CRITICAL DEPTH-
T2      3 INTERPOLATED CROSS SECTIONS
T3      NORTH BUFFALO CREEK

J1   ICHECK      INQ        NINV       IDIR       STRT       METRIC      HVINS      Q          WSEL       FQ

        -0        -0         -0         -0         -0         -0         .5      7570.    674.000        -0

NC        .100       .100       .050       .300       .400        -0         -0         -0         -0         -0

X1     109.000      8.000    480.000    520.000        -0         -0         -0         -0         -0         -0
GR     690.000          0    680.000    120.000    670.500    480.000    661.400    485.000    661.400    515.000
GR     670.500    520.000    680.000   1150.000    690.000   1330.000        -0         -0         -0         -0

X1     112.000     12.000    185.000    255.000   1520.000   1520.000   2100.000        -0         -0         -0
GR     695.000          0    693.000     20.000    686.700     70.000    676.800    135.000    675.500    185.000
GR     662.700    200.000    663.400    240.000    673.800    255.000    677.700    490.000    680.800    520.000
GR     687.100    570.000    695.000    670.000        -0         -0         -0         -0         -0         -0
EJ          -0         -0         -0         -0         -0         -0         -0         -0         -0         -0
```

CCHV= .300 CEHV= .400

3720 ASSUMED CRITICAL DEPTH

SECNO / Q / TIME / SLOPE	DEPTH / QLOB / VLOB / XLOBL	CWSEL / QCH / VCH / XLCH	CRIWS / QROB / VROB / XLOBR	WSELK / ALOB / XNL / ITRIAL	EG / ACH / XNCH / IDC	HV / AROB / XNR / ICONT	HL / VOL / WTN / CORAR	OLOSS / TWA / ELMIN / TOPWID	BANK ELEV / LEFT/RIGHT / SSTA / ENDST
109.00	12.90	674.30	674.30	674.00	676.24	1.95	0	0	670.50
7570.	598.	5926.	1046.	273.	470.	478.	0	0	670.50
0	2.19	12.60	2.19	.100	.050	.100	0	661.40	336.13
.009234	=0	=0	=0	0	7	1	0	435.63	771.77

1645 INT SEC ADDED BY RAISING SEC 112.00, =.975FT AND MULTIPLYING BY .751

3301 HV CHANGED MORE THAN HVINS

1.01	16.41	678.14	0	0	679.11	.97	2.58	.29	674.53
7570.	210.	6211.	1150.	125.	714.	602.	14.	3.	672.83
.02	1.68	8.70	1.91	.100	.050	.100	.053	661.73	89.94
.003324	380.	525.	380.	3	0	1	0	288.32	378.26

1645 INT SEC ADDED BY RAISING SEC 1.01, .325FT AND MULTIPLYING BY 1.111

1.02	17.79	679.84	0	0	680.35	.50	1.09	.14	674.85
7570.	317.	5681.	1572.	218.	873.	961.	31.	6.	673.15
.04	1.45	6.51	1.64	.100	.050	.100	.053	662.05	92.37
.001579	380.	525.	380.	3	0	1	0	338.80	431.16

1645 INT SEC ADDED BY RAISING SEC 1.02, .325FT AND MULTIPLYING BY 1.100

SECNO / Q / TIME / SLOPE	DEPTH / QLOB / VLOB / XLOBL	CWSEL / QCH / VCH / XLCH	CRIWS / QROB / VROB / XLOBR	WSELK / ALOB / XNL / ITRIAL	EG / ACH / XNCH / IDC	HV / AROB / XNR / ICONT	HL / VOL / WTN / CORAR	OLOSS / TWA / ELMIN / TOPWID	BANK ELEV / LEFT/RIGHT / SSTA / ENDST
1.03	18.28	680.66	0	0	681.02	.36	.63	.04	675.18
7570.	351.	5525.	1694.	274.	992.	1176.	54.	10.	673.48
.07	1.28	5.57	1.44	.100	.050	.100	.053	662.38	98.59
.001078	380.	525.	380.	2	0	1	0	379.59	478.18

1645 INT SEC ADDED BY RAISING SEC 1.03, .325FT AND MULTIPLYING BY 1.091

112.00	18.51	681.21	0	0	681.50	.29	.46	.02	675.50
7570.	365.	5465.	1740.	317.	1097.	1343.	80.	13.	673.80
.11	1.15	4.98	1.30	.100	.050	.100	.053	662.70	106.03
.000826	380.	525.	380.	2	0	1	0	417.25	523.28

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**************************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
**************************************************


T1      TEST 8 N VALUES VARY BY HUR TABLE(NH CARDS)-START AT CRITICAL (J1,5)-
T2      GR CARDS OMITTED FOR XSEC 150,XSEC MODIFIED BY (X1,8-X1,9)
T3      DISCHARGE VARIED BY X2 CARD(X2,1) FOR SINGLE PROFILE-NO INTER XSEC(J1,7)

J1   ICHECK     INQ       NINV       IDIR       STRT      METRIC     HVINS      Q        WSEL      FQ

        -0         -0         -0         -0 -1.000000       -0         -0    12000.   110.000       -0

NC       .015       .015       .015       .100       .300         -0         -0         -0         -0         -0


X1    100.000      4.000    150.000    250.000         -0         -0         -0         -0         -0         -0
GR    149.500          0     99.500    150.000     99.500    250.000    149.500    400.000         -0         -0
NC       .020       .020       .010         -0         -0         -0         -0         -0         -0         -0

X1    150.000         -0         -0         -0     50.000     50.000     50.000       .900       .250         -0
X2   5000.000         -0         -0         -0         -0         -0         -0         -0         -0         -0
NH      6.000       .010     25.000       .015     40.000       .030     60.000       .040     80.000       .015
NH     90.000       .010    100.010         -0         -0         -0         -0         -0         -0         -0

X1    200.000     10.000          0    100.010     50.000     50.000     50.000         -0         -0         -0
GR    115.000          0    100.000          0    100.000     25.000    100.000     40.000    100.000     60.000
GR    100.000     80.000    100.000     90.000    100.000    100.000    115.000    100.000    115.000    100.010
EJ         -0         -0         -0         -0         -0         -0         -0         -0         -0         -0
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3720 ASSUMED CRITICAL DEPTH

CCHV= .100 CEHV= .300

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
100.00	7.18	106.68	106.68	110.00	109.82	3.15	0	0	99.50
12000.	695.	10611.	695.	77.	718.	77.	0	0	99.50
0	8.99	14.78	8.99	.015	.015	.015	0	99.50	128.47
.001608	-0	-0	-0	0	13	1	0	143.06	271.53

3301 HV CHANGED MORE THAN HVINS

150.00	9.99	109.74	0	0	110.12	.37	.02	.28	99.75
5000.	207.	4585.	207.	135.	899.	135.	1.	0.	99.75
.00	1.54	5.10	1.54	.020	.010	.020	.010	99.75	108.04
.000055	50.	50.	50.	3	0	1	0	143.92	251.96

1490 NH CARD USED

200.00	9.72	109.72	0	0	110.13	.41	.00	.01	115.00
5000.	0	5000.	0	0	972.	0	2.	0.	115.00
.01	0	5.14	0	.020	.020	.020	.010	100.00	0
.000192	50.	50.	50.	2	0	1	0	100.00	100.00

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*************************************************


T1       TEST C   =N VALUES VARY WITH ELEVATION IN CHANNEL=
T2       NV CARD USED
T3       DAVIS CREEK

J1  ICHECK     INQ       NINV      IDIR      STRT     METRIC     HVINS      Q        WSEL      FQ

       -0        -0        -0        -0        -0        -0        -0    5000.    65.000        -0

NC      .050      .060      .030         0         0        -0        -0        -0        -0        -0
NV     4.000      .010    40.000      .020    50.000      .030    60.000      .040    70.000        -0

X1     1.000     8.000    50.000   200.000        -0        -0        -0        -0        -0        -0
GR   100.000         0    50.000         0    50.000    50.000    40.000   100.000    40.000   150.000
GR    50.000   200.000    50.000   250.000   100.000   250.000        -0        -0        -0        -0

X1     2.000         0         0         0   100.000   100.000   100.000        -0     2.000        -0
EJ        -0        -0        -0        -0        -0        -0        -0        -0        -0        -0


 1455 NV CARD USED
   SECNO     DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB       ACH       AROB      VOL      TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL        XNCH      XNR       WTN      ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL     IDC       ICONT     CORAR    TOPWID     ENDST

    1.00     25.00     65.00         0     65.00     65.02       .02         0         0     50.00
   5000.      447.     4180.      373.      750.     3250.      750.         0         0     50.00
       0       .60      1.29       .59      .050      .035      .060         0     40.00         0
 .000015        -0        -0        -0         0         0         1         0    250.00    250.00

    2.00     23.00     65.00         0         0     65.02       .03       .00         0     52.00
   5000.      427.     4217.      356.      650.     2950.      650.       10.        1.     52.00
     .02       .66      1.43       .55      .050      .035      .060      .035     42.00         0
 .000022      100.      100.      100.         0         0         1         0    250.00    250.00
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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
**************************************************


T1       TEST D START BY SLOPE-AREA METHOD
T2       DESIRED ENERGY SLOPE(J1,5) ESTIMATED ELEV,(J1,9)
T3       DAVIS CREEK

J1   ICHECK      INQ       NINV      IDIR      STRT      METRIC     HVINS       Q        WSEL      FQ

         -0        -0        -0        -0   .000400          -0        -0   20000.  1020.000        -0

NC       .055      .055      .025      .100      .300          -0        -0        -0        -0        -0


X1    670.720    39.000  5600.000  6360.000         0         0         0        -0        -0        -0
GR   1100.000         0  1080.000   200.000  1060.000   500.000  1040.000   900.000  1030.000  4100.000
GR   1025.000  4150.000  1020.000  4200.000  1015.000  4230.000  1010.000  4260.000  1005.000  4290.000
GR   1000.000  4320.000   995.000  4960.000   990.000  5220.000   988.400  5600.000   985.800  5640.000
GR    986.600  5680.000   979.400  5870.000   978.400  6000.000   981.200  6160.000   978.500  6270.000
GR    990.000  6360.000   995.000  6410.000   995.000  7210.000  1000.000  7420.000  1004.000  7680.000
GR   1000.000  7940.000  1000.000  9070.000   995.000  9890.000  1000.000 10430.000  1005.000 10730.000
GR   1010.000 10820.000  1015.000 10970.000  1020.000 11090.000  1025.000 11170.000  1030.000 11260.000
GR   1040.000 11290.000  1060.000 11690.000  1080.000 12490.000  1100.000 13290.000        -0        -0

X1    672.000    34.000  1600.000  2270.000  7200.000  5000.000  6760.000        -0        -0        -0
GR   1100.000         0  1080.000   200.000  1060.000   400.000  1040.000  1200.000  1030.000  1420.000
GR   1025.000  1460.000  1020.000  1500.000  1015.000  1520.000  1010.000  1540.000  1005.000  1560.000
GR   1000.000  1580.000   995.700  1600.000   978.400  1630.000   983.400  1800.000   988.600  1990.000
GR    990.400  2090.000   989.500  2260.000   995.600  2270.000   995.000  2400.000  1000.000  3000.000
GR   1002.000  3680.000  1000.000  4050.000  1000.000  4600.000  1005.000  4640.000  1005.000  8670.000
GR   1010.000  8870.000  1015.000  9500.000  1020.000  9600.000  1025.000  9720.000  1030.000  9820.000
GR   1040.000 10150.000  1060.000 10750.000  1080.000 11400.000  1100.000 12250.000        -0        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
```


54

CCHV= .100 CEHV= .300

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
670.72	9.63	988.03	0	1020.00	988.30	.27	0	0	988.40
20000.	0	20000.	0	0	4828.	0	0	0	990.00
0	0	4.14	0	.055	.025	.055	0	978.40	5605.64
.000398	0	0	0	0	0	9	0	738.97	6344.61
672.00	13.35	991.75	0	0	992.23	.47	3.87	.06	995.70
20000.	0	20000.	0	0	3626.	0	656.	108.	995.60
.34	0	5.52	0	.055	.025	.055	.025	978.40	1606.85
.000890	7200.	6760.	5000.	2	0	1	0	656.84	2263.69

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HEC2 VERSION UPDATED AUG 1976
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T1      TEST E SUPERCRITICAL FLOW PROFILE(J1,4)=STARTING DEPTH ABOVE CRITICAL=
T2      GR POINTS FROM XSEC1180 REPEATED FOR XSECS 1380-1580*PRO SUPRESSED(J2,3)
T3      SALT LAKE CITY STREAMS=CHANGE IN VELOCITY HEAD FIXED(J1,7)

J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC    HVINS      Q       WSEL       FQ

      -0        -0        -0        1.        -0        -0      50.0     900.  5889.000      -0

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH       FN     ALLDC     IBW      CHNIM     ITRACE

       -0        -0    -1.000        -0        -0        -0        -0        -0        -0        -0

NC       .012      .012      .012      .100      .300        -0        -0        -0        -0        -0

X1   1000.000  - 9.000         0    18.000    30.000    30.000    30.000        -0        -0        -0
GR   5889.000         0  5884.000         0  5884.000     8.000  5889.000     8.000  5889.000    10.000
GR   5884.000    10.000  5884.000    18.000  5889.000    18.000  5889.000    20.000        -0        -0

X1   1030.000     9.000         0    18.000     2.000     2.000     2.000        -0        -0        -0
GR   5889.000         0  5875.720         0  5875.720     8.000  5889.000     8.000  5889.000    10.000
GR   5875.700    10.000  5875.720    18.000  5889.000    18.000  5889.000    20.000        -0        -0

X1   1032.000     5.000         0    18.000   148.000   148.000   148.000         0        -0        -0
GR   5889.000         0  5875.170         0  5875.170    18.000  5889.000    18.000  5889.000    20.000

X1   1180.000     5.000         0     6.000   200.000   200.000   200.000        -0      .320        -0
GR   5889.000         0  5834.000         0  5834.000     6.000  5889.000     6.000  5889.000    20.000

X1   1380.000         0         0         0   200.000   200.000   200.000        -0   -55.200        -0

X1   1580.000         0         0         0    25.000    25.000    25.000        -0   -55.200        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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CCHV=     .100 CEHV=     .300

3720 ASSUMED CRITICAL DEPTH

3265 DIVIDED FLOW

   SECNO      DEPTH      CWSEL      CRIWS      WSELK       EG         HV         HL        OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB        ACH        AROB       VOL       TWA    LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL         XNCH       XNR        WTN       ELMIN        SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL      IDC        ICONT      CORAR     TOPWID       ENDST

  1000.00      4.61    5888.61    5888.61    5889.00    5890.92      2.31         0          0    5889.00
   900.           0       900.          0          0        74.         0         0          0    5889.00
     0            0      12.20          0       .012       .012      .012         0    5884.00          0
  .003517         0          0          0          0         12         1         0      16.00      18.00


3265 DIVIDED FLOW

  1030.00      2.04    5877.74    5880.32          0    5889.71     11.98       .24        .97    5889.00
   900.           0       900.          0          0        32.         0        0.         0.    5889.00
     .00          0      27.77          0       .012       .012      .012      .012    5875.70          0
  .033886       30.        30.        30.          7          5         1         0      16.00      18.00

  1032.00      1.75    5876.92    5879.42          0    5889.58     12.66       .07        .07    5889.00
   900.           0       900.          0          0        32.         0        0.         0.    5889.00
     .00          0      28.56          0       .012       .012      .012      .011    5875.17          0
  .031936        2.         2.         2.          8         11         1         0      18.00      18.00

  1180.00      2.89    5837.21    5843.16          0    5878.85     41.64      7.83       2.90    5889.32
   900.           0       900.          0          0        17.         0        0.         0.    5889.32
     .00          0      51.78          0       .012       .012      .012      .012    5834.32          0
  .104259      148.       148.       148.          9         17         1         0       6.00       6.00

   SECNO      DEPTH      CWSEL      CRIWS      WSELK       EG         HV         HL        OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB        ACH        AROB       VOL       TWA    LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL         XNCH       XNR        WTN       ELMIN        SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL      IDC        ICONT      CORAR     TOPWID       ENDST

  1380.00      2.29    5781.41    5787.97          0    5848.28     66.88     28.04       2.52    5834.12
   900.           0       900.          0          0        14.         0        0.         0.    5834.12
     .00          0      65.63          0       .012       .012      .012      .012    5779.12          0
  .198509      200.       200.       200.          6          5         1         0       6.00       6.00

  1580.00      2.13    5726.05    5732.77          0    5803.43     77.38     43.81       1.05    5778.92
   900.           0       900.          0          0        13.         0        0.         0.    5778.92
     .00          0      70.59          0       .012       .012      .012      .012    5723.92          0
  .242926      200.       200.       200.          7          5         1         0       6.00       6.00
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T1      TEST F FLOW THROUGH A CIRCULAR CULVERT
T2      4 FT. DIAMETER, 5 PERCENT SLOPE-SUPERCRITICAL FLOW(J1,4)-
T3      START AT CRITICAL DEPTH(J1,5)

J1  ICHECK    INQ      NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

       -0        -0        -0    1. -1.000000        -0        -0     100.        -0        -0

NC       .015      .015      .015        -0        -0        -0        -0        -0        -0        -0

X1      1.000     7.000     1.000     5.000        -0        -0        -0        -0        -0        -0
BT      7.000     1.000   120.000   102.000     1.200   120.000   103.000     2.100   120.000   103.800
BT      3.000   120.000   104.000     3.900   120.000   103.800     4.800   120.000   103.000     5.000
BT    120.000   102.000        -0        -0        -0        -0        -0        -0        -0        -0
GR    102.000     1.000   101.000     1.200   100.200     2.100   100.000     3.000   100.200     3.900
GR    101.000     4.800   102.000     5.000        -0        -0        -0        -0        -0        -0

X1      2.000        -0        -0        -0     5.000     5.000     5.000        -0     -.250        -0
X2         -0        -0        -0        -0        -0        -0     1.000        -0        -0        -0

X1      3.000        -0        -0        -0    10.000    10.000    10.000        -0     -.250        -0
X2         -0        -0        -0        -0        -0        -0     1.000        -0        -0        -0

X1      4.000        -0        -0        -0        -0        -0        -0        -0     -.500        -0
X2         -0        -0        -0        -0        -0        -0     1.000        -0        -0        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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3720/ ASSUMED CRITICAL DEPTH

2096 WSEL NUT GIVEN,AVG OF MAX,MIN USED
3280 CRUSS SECTION      1.00 EXTENDED       .95 FEET

   SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS   BANK ELEV
   Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
   TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST

NORMAL BRIDGE,NRD= 7 MIN ELTRD=  120.00 MAX ELLC=  104.00

      1.00     2.95   102.95   102.95      -0   104.58     1.63        0        0   102.00
      100.        0     100.        0       0      10.        0        0        0   102.00
         0        0    10.25        0    .015     .015     .015        0   100.00     1.00
   .007196        0        0        0       0       18        1     -.19     4.00     5.00

3280 CRUSS SECTION      2.00 EXTENDED       .56 FEET


3301 HV CHANGED MORE THAN HVINS

NORMAL BRIDGE,NRD= 7 MIN ELTRD=  120.00 MAX ELLC=  103.75

      2.00     2.56   102.31   102.70       0   104.58     2.27        0        0   101.75
      100.        0     100.        0       0       8.        0        0        0   101.75
         0        0    12.10        0    .015     .015     .015        0    99.75     1.00
   .011608       -0       -0       -0       6       18        1     -.11     4.00     5.00

3280 CROSS SECTION      3.00 EXTENDED       .42 FEET


NORMAL BRIDGE,NRD= 7 MIN ELTRD=  120.00 MAX ELLC=  103.50

      3.00     2.42   101.92   102.45       0   104.52     2.60      .06        0   101.50
      100.        0     100.        0       0       8.        0       0.       0.   101.50
       .00        0    12.94        0    .015     .015     .015     .011    99.50     1.00
   .014116       5.       5.       5.       7       18        1     -.08     4.00     5.00

3280 CROSS SECTION      4.00 EXTENDED       .24 FEET
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3301 HV CHANGED MORE THAN HVINS

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

NORMAL BRIDGE,NRD= 7 MIN ELTRD= 120.00 MAX ELLC= 103.00

4.00	2.23	101.23	101.95	0	104.36	3.13	.16	0	101.00
100.	0	100.	0	0	7.	0	0.	0.	101.00
.00	0	14.20	0	.015	.015	.015	.013	99.00	1.00
.018559	10.	10.	10.	5	18	1	-.05	4.00	5.00

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**************************************************


T1      TEST G SPECIAL BRIDGE ROUTINE-DATA FOR WEIR FLOW ONLY(NO X3 CARDS)-
T2      INPUT/OUTPUT IN METRIC UNITS(J1,6) - NO INTERPOLATED XSEC(J1,7)-
T3      NORTH BUFFALO CREEK

J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC     HVINS      Q        WSEL      FQ

       -0       -0        -0        -0        -0      1.00        -0     214.    205.440      -0

NC       .100      .100      .050      .300      .400        -0        -0        -0        -0        -0

X1    109.000     8.000   146.300   158.500        -0        -0        -0        -0        -0        -0
GR    210.310         0   207.270    36.580   204.370   146.300   201.600   147.830   201.600   156.970
GR    204.370   158.500   207.270   350.520   210.310   405.380        -0        -0        -0        -0

X1    112.000    12.000    56.390    77.720   463.300   463.300   640.080        -0        -0        -0
GR    211.840         0   211.230     6.100   209.310    21.340   206.290    41.150   205.890    56.390
GR    201.990    60.960   202.210    73.150   205.380    77.720   206.560   149.350   207.510   158.500
GR    209.430   173.740   211.840   204.220        -0        -0        -0        -0        -0        -0
SB      1.250     1.250     1.390   121.920    17.370     1.220    79.530         0   202.080   202.080

X1    114.000    10.000   114.300   131.060    60.960    60.960    60.960         0        -0        -0
X2         -0        -0     1.000   206.960   207.420        -0        -0        -0        -0        -0
GR    211.840         0   209.610    30.480   207.170    91.440   205.560   114.300   202.540   115.820
GR    202.510   128.020   205.040   131.060   205.190   164.590   206.660   193.550   211.840   213.360
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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CCHV= .300 CEHV= .400

3720 ASSUMED CRITICAL DEPTH

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
109.00	3.93	205.53	205.53	205.44	206.12	.59	0	0	204.37
214.	17.	168.	29.	25.	44.	44.	0	0	204.37
0	.67	3.84	.67	.100	.050	.100	0	201.60	102.57
.009244	-0	-0	-0	0	7	1	0	132.46	235.03
112.00	5.50	207.49	0	0	207.59	.10	1.32	.15	205.89
214.	9.	159.	46.	26.	99.	113.	94.	63.	205.38
.13	.36	1.61	.40	.100	.050	.100	.053	201.99	33.28
.000969	463.	640.	463.	5	0	1	0	125.03	158.31

SPECIAL BRIDGE

SB XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
1.25	1.25	1.39	121.92	17.37	1.22	79.53	0	202.08	202.08

PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELTRD
207.95	207.60	.01	39.	175.	80.	79.	206.96	207.42

114.00	5.21	207.72	0	0	207.80	.08	.21	0	205.56
214.	12.	128.	74.	35.	81.	141.	109.	70.	205.04
.14	.35	1.58	.53	.100	.050	.100	.053	202.51	77.79
.000937	61.	61.	61.	2	0	3	0	119.80	197.59

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T1      TEST H ENCROACHMENT TEST (1) ENCROACHMENT WIDTH GIVEN (X3,3)
T2      (2)STATIONS GIVEN(X3,4+X3,6) (3)STATIONS AND ELEVATIONS GIVEN(X3,4-X3,7)
T3      (4)ENCROACHMENT WIDTH REPEATED FROM PREVIOUS SECTION(X3,3)

J1  ICHECK    ING       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

       -0        -0        -0        -0        -0        -0        -0     5000.    65.000       -0

NC       .050      .050      .030      .100      .300        -0        -0        -0        -0        -0

X1      1.000    10.000    50.000   200.000        -0        -0        -0        -0        -0        -0
X3         -0        -0   200.000        -0        -0        -0        -0        -0        -0        -0
GR    100.000         0    50.000         0    50.000    25.000    50.000    50.000    40.000   100.000
GR     40.000   150.000    50.000   200.000    50.000   225.000    50.000   250.000   100.000   250.000

X1      2.000         0         0         0    50.000    50.000    50.000        -0     2.000        -0
X3         -0        -0   200.000    10.000         0   240.000         0        -0        -0        -0

X1      3.000    12.000    50.000   200.000    50.000    50.000    50.000        -0        -0        -0
X3         -0        -0   200.000    25.000    55.000   225.000    55.000        -0        -0        -0
GR    100.000         0    50.000         0    50.000    24.000    50.000    25.000    50.000    50.000
GR     40.000   100.000    40.000   150.000    50.000   200.000    50.000   225.000    50.000   226.000
GR     50.000   250.000   100.000   250.000        -0        -0        -0        -0        -0        -0

X1      4.000         0         0         0    50.000    50.000    50.000        -0     2.000        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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CCHV=    .100 CEHV=     .300
   SECNO      DEPTH      CWSEL       CRIWS       WSELK       EG          HV          HL          OLOSS    BANK ELEV
   Q          QLOB       QCH         QROB        ALOB        ACH         AROB        VOL         TWA    LEFT/RIGHT
   TIME       VLOB       VCH         VROB        XNL         XNCH        XNR         WTN         ELMIN       SSTA
   SLOPE      XLOBL      XLCH        XLOBR       ITRIAL      IDC         ICONT       CURAR       TOPWID      ENDST


3470 ENCROACHMENT STATIONS=         25.0       225.0     TYPE=       2   TARGET=        200.000
      1.00      25.00      65.00        0.       65.00      65.03        .03           0           0       50.00
     5000.       185.      4630.      185.        375.      3250.       375.           0           0       50.00
         0        .49       1.42       .49        .050       .030       .050           0       40.00       25.00
   .000014         -0         -0        -0           0          0          1           0      200.00      225.00


3470 ENCROACHMENT STATIONS=         10.0       240.0     TYPE=       1   TARGET=        230.000
      2.00      23.00      65.00        0.           0      65.03        .03         .00         .00       52.00
     5000.       309.      4381.      309.        520.      2950.       520.          5.          0.       52.00
       .01        .60       1.49       .60        .050       .030       .050        .029       42.00       10.00
   .000017        50.        50.       50.           0          0          1           0      230.00      240.00


3470 ENCROACHMENT STATIONS=         25.0       225.0     TYPE=       1   TARGET=        200.000
 ELENCL=        55.00  ELENCR=     55.00
      3.00      25.01      65.01        0.           0      65.03        .03         .00         .00       50.00
     5000.       310.      4381.      310.        625.      3250.       625.          9.          1.       50.00
       .02        .50       1.35       .50        .050       .030       .050        .029       40.00           0
   .000012        50.        50.       50.           0          0          1           0      250.00      250.00


3470 ENCROACHMENT STATIONS=         25.0       225.0     TYPE=       0   TARGET=        200.000
      4.00      23.00      65.00        0.           0      65.04        .04         .00         .00       52.00
     5000.       178.      4644.      178.        325.      2950.       325.         14.          1.       52.00
       .03        .55       1.57       .55        .050       .030       .050        .029       42.00       25.00
   .000019        50.        50.       50.           0          0          1           0      200.00      225.00
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T1      TEST I CHANNEL IMPROVEMENT, SUBROUTINE CHIMP
T2      1ST PROFILE IS NATURAL (IBW=8,J2.8),(BW=.01,CI.8)
T3      CATALPA CREEK - DISCHARGE READ FROM 12TH FIELD(INQ)OF QT CARDS(J1,2)

J1  ICHECK    INQ      NINV      IDIR      STRT     METRIC     HVINS      Q        WSEL      FQ

      -0      12.        -0        -0        -0        -0        -0        -0   168.100        -0

J2  NPROF    IPLOT    PRFVS     XSECV     XSECH       FN      ALLDC     IBW      CHNIM     ITRACE

    1.000       -0   -1.000        -0        -0        -0        -0    8.000    30.000        -0

J3      1.000      2.000      4.000      6.000      7.000     14.000     17.000         -0         -0         -0
NC       .120       .120       .037       .100       .300         -0         -0         -0         -0         -0
QT     11.000    450.000    600.000    900.000   1200.000   1500.000   2300.000   5000.000   6700.000   9400.000
QT  15000.000  25000.000         -0         -0         -0         -0         -0         -0         -0         -0

X1      1.050     38.000  18150.000  18448.000         -0         -0         -0         -0      -.850         -0
GR    200.000  12000.000    180.000  12200.000    170.000  13000.000    170.000  13200.000    170.000  13500.000
GR    170.000  14000.000    170.000  14400.000    165.000  14500.000    170.000  14600.000    170.000  15950.000
GR    165.000  18149.000    165.000  18150.000    165.000  18151.000    165.000  18168.000    160.000  18179.000
GR    149.000  18180.000    155.000  18201.000    158.000  18209.000    159.800  18229.000    159.900  18234.000
GR    159.900  18237.000    160.000  18255.000    157.500  18259.000    157.000  18260.000    145.000  18282.000
GR    144.800  18308.000    144.800  18309.000    145.000  18310.000    145.000  18324.000    150.000  18341.000
GR    155.000  18353.000    162.000  18364.000    163.000  18429.000    164.000  18447.000    167.000  18448.000
GR    172.800  18449.000    180.000  19250.000    200.000  20600.000         -0         -0         -0         -0

X1      1.550         -0         -0         -0   1200.000   1300.000   3684.000         -0      3.140         -0
CI  18300.000    147.090       .025      3.000      3.000     10.000     20.000       .010         -0         -0

X1      1.820         -0         -0         -0   1400.000   1250.000   1450.000         -0      1.700         -0
CI     -1.000     -1.000       .025      3.000      3.000     10.000     20.000       .010         -0         -0

X1      2.100         -0         -0         -0   1400.000   1250.000   1450.000         -0      1.760         -0
EJ         -0         -0         -0         -0         -0         -0         -0         -0         -0         -0
```

CCHV= .100 CEHV= .300

3265 DIVIDED FLOW

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
1.05	24.15	168.10	0	168.10	168.64	.54	0	0	164.15
25000.	2194.	22806.	0.	3747.	3682.	0.	0	0	166.15
0	.59	6.19	.11	.120	.037	.120	0	143.95	14421.00
.000901	-0	-0	-0	0	0	1	0	2194.55	18448.34

3265 DIVIDED FLOW

1.55	24.14	171.23	0	0	171.78	.55	3.13	.00	167.29
25000.	2178.	22822.	0.	3719.	3677.	0.	414.	77.	169.29
.17	.59	6.21	.11	.120	.037	.120	.039	147.09	14421.30
.000906	1200.	3684.	1300.	2	0	1	0	2187.44	18448.33

3265 DIVIDED FLOW

1.82	23.79	172.58	0	0	173.19	.61	1.39	.02	168.99
25000.	1818.	23182.	0.	3099.	3575.	0.	644.	145.	170.99
.23	.59	6.48	.10	.120	.037	.120	.039	148.79	14428.16
.001027	1400.	1450.	1250.	2	0	1	0	2022.62	18448.27

3265 DIVIDED FLOW

2.10	23.55	174.10	0	0	174.75	.65	1.55	.01	170.75
25000.	1580.	23420.	0.	2699.	3503.	0.	855.	209.	172.75
.30	.59	6.68	.10	.120	.037	.120	.038	150.55	14432.96
.001121	1400.	1450.	1250.	2	0	1	0	1907.48	18448.23

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
**********************************************


T1      TEST J SECOND PROFILE USING CHANNEL IMPROVEMENT (IBW=0,BW=10)
T2      SUMMARY PRINTOUT FOR MULTIPLE PROFILES(J2,1)
T3      CATALPA CREEK

J1  ICHECK     INQ      NINV     IDIR     STRT     METRIC    HVINS     Q        WSEL      FQ

      -0       12.       -0       -0       -0       -0        -0       -0   168.100      -0

J2  NPROF     IPLOT     PRFVS    XSECV    XSECH     FN       ALLDC     IBW     CHNIM     ITRACE

   15.000       -0     -1.000      -0       -0       -0        -0       -0    30.000      -0
```

```
CCHV=     .100 CEHV=     .300

3265 DIVIDED FLOW

     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN        SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


      1.05     24.15    168.10         0    168.10    168.64       .54         0         0    164.15
    25000.     2194.    22806.        0.     3747.     3682.        0.         0         0    166.15
         0       .59      6.19       .11      .120      .037      .120         0    143.95  14421.00
   .000901        -0        -0        -0         0         0         1         0   2194.55  18448.34

CHIMP CLSTA=  18300.00 CELCH=     147.09 BW=      10.00 STCHL=  18150.00 STCHR=  18448.00
2136 NH VALUES          .120   18120.000         .025   18478.000          .120   20600.010

3265 DIVIDED FLOW

      1.55     23.34    170.43         0         0    171.14       .70      2.44       .05    167.29
    25000.     1204.    23785.       11.     2435.     3453.       42.      387.       73.    169.29
       .15       .49      6.89       .26      .098      .025      .093      .026    147.09  14437.15
   .000553     1200.     3684.     1300.         2         0         1         0   1891.32  18545.85

CHIMP CLSTA=  18299.00 CELCH=     148.79 BW=      10.00 STCHL=  18150.00 STCHR=  18448.00
2136 NH VALUES          .120   18120.000         .025   18478.000          .120   20600.010

3265 DIVIDED FLOW

      1.82     22.45    171.24         0         0    172.12       .88       .93       .05    168.99
    25000.      629.    24371.        0.     1264.     3190.        2.      558.      127.    170.99
       .20       .50      7.64       .11      .091      .025      .093      .026    148.79  14455.07
   .000755     1400.     1450.     1250.         2         0         1         0   1408.82  18492.65

CHIMP CLSTA=  18299.00 CELCH=     150.55 BW=      10.00 STCHL=  18150.00 STCHR=  18448.00
2136 NH VALUES          .120   18120.000         .025   18478.000          .120   20600.010

3265 DIVIDED FLOW

      2.10     21.80    172.35         0         0    173.39      1.04      1.22       .05    170.75
    25000.      321.    24679.         0      656.     2998.         0      692.      167.    172.75
       .25       .49      8.23         0      .084      .025      .093      .026    150.55  14467.96
   .000951     1400.     1450.     1250.         2         0         1         0   1087.28  18447.87
```

SUMMARY PRINTOUT FOR MULTIPLE PROFILES

CATALPA CREEK

SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE (CFS)	CWSEL	CRIWS	TOPWID	TIME	VOL	QCH	K*XNCH
1.05	0	0	0	143.95	25000.00	168.10	0	2194.55	0	0	22806.34	37.00
1.05	0	0	0	143.95	25000.00	168.10	0	2194.55	0	0	22806.34	37.00
1.55	3684.00	0	0	147.09	25000.00	171.23	0	2187.44	.17	414.03	22822.32	37.00
1.55	3684.00	0	0	147.09	25000.00	170.43	0	1891.32	.15	387.49	23785.41	25.00
1.82	1450.00	0	0	148.79	25000.00	172.58	0	2022.62	.23	644.30	23182.23	37.00
1.82	1450.00	0	0	148.79	25000.00	171.24	0	1408.82	.20	558.13	24371.00	25.00
2.10	1450.00	0	0	150.55	25000.00	174.10	0	1907.48	.30	855.28	23420.20	37.00
2.10	1450.00	0	0	150.55	25000.00	172.35	0	1087.28	.25	692.02	24679.01	25.00

SECTION NUMBER	DISCHARGE CFS	CWSEL	CWSEL DIFF EACH Q	CWSEL DIFF EACH SECTION	CWSEL-WSELK	TOPWID	T.W. DIFF	LENGTH
1.050	25000.000	168.100	0	0	0	2194.546	0	-0
1.050	25000.000	168.100	0	0	0	2194.546	0	-0
1.550	25000.000	171.230	0	3.130	0	2187.436	0	3684.000
1.550	25000.000	170.434	-.796	2.334	0	1891.324	296.112	3684.000
1.820	25000.000	172.582	0	1.352	0	2022.616	0	1450.000
1.820	25000.000	171.236	-1.345	.803	0	1408.822	613.794	1450.000
2.100	25000.000	174.102	0	1.520	0	1907.483	0	1450.000
2.100	25000.000	172.352	-1.750	1.115	0	1087.277	820.207	1450.000

DATA FOR LAST CROSS SECTION

PROFILE	TYPE ENC	TARGET	TOP WIDTH AREA-ACRES	TOP WIDTH AREA-DIFF
1	0	0	208.845	0
2	0	0	167.004	-41.840

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
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T1      TEST K SPECIAL BRIDGE ROUTINE - EFFECTIVE AREA (X3,1)-
T2      TWO FOOT BRIDGE PIERS(SB,6)
T3      ARTIFICAL LEVEES BY ELLEA AND ELREA(X3,8+X3,9)

J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q        WSEL      FQ

        -0        -0        -0        -0        -0        -0        -0     700.    14.000       -0

NC      .043      .043      .043      .300      .500        -0        -0        -0        -0        -0

X1     1.000     8.000    18.000    28.000         0         0         0        -0        -0        -0
GR    20.000         0    10.000    10.000    10.000    18.000     5.000    18.000     5.000    28.000
GR    10.000    28.000    10.000    40.000    20.000    50.000        -0        -0        -0        -0

X1     2.000         0         0         0    50.000    50.000    50.000        -0      .300        -0
X3    10.000        -0        -0        -0        -0        -0        -0    16.000    16.000        -0
SB      .900     1.500     2.500         0    10.000     2.000    85.600         0        -0        -0

X1     3.000         0         0         0    50.000    50.000    50.000        -0        -0        -0
X2        -0        -0     1.000    16.000    18.000         0        -0        -0        -0        -0
X3    10.000        -0        -0        -0        -0        -0        -0    18.000    18.000        -0
BT     4.000         0    20.300        -0     2.300    18.000        -0    47.300    18.000        -0
BT    50.000    20.300        -0        -0        -0        -0        -0        -0        -0        -0

X1     4.000         0         0         0    50.000    50.000    50.000        -0      .300        -0
EJ        -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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CCHV=     .300 CEHV=     .500
    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST

     1.00       9.00      14.00          0      14.00      14.22        .22          0          0      10.00
     700.       136.       368.       196.        40.        90.        56.          0          0      10.00
        0       3.40       4.09       3.51       .043       .043       .043          0       5.00       6.00
  .001881          0          0          0          0          0          1          0      38.00      44.00


3301 HV CHANGED MORE THAN HVINS


OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=       16.00 ELREA=      16.00

     2.00       8.47      13.77          0          0      14.83       1.06        .18        .42      10.30
     700.          0       700.          0          0        85.          0         0.         0.      10.30
      .00          0       8.27          0       .043       .043       .043       .042       5.30      18.00
  .010339        50.        50.        50.          2          0          1          0      10.00      28.00


SPECIAL BRIDGE

5070,VARIABLE ELCHU OR ELCHD ON CARD SB NOT SPECIFIED
SB  XK          XKOR        COFQ        RDLEN       BWC         BWP         BAREA       SS          ELCHU       ELCHD
      .90        1.50        2.50           0       10.00        2.00       85.60           0        5.30        5.30

CLASS A LOW FLOW

BRIDGE W.S.=      12.25  BRIDGE VELOCITY=      12.59      CALCULATED CHANNEL AREA=         56.

 EGPRS       EGLWC        H3          QWEIR        QPR         BAREA    TRAPEZOID      ELLC        ELTRD
                                                                          AREA
         0      15.34        .66           0       700.         86.        86.       16.00       18.00


OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=       18.00 ELREA=      18.00

     3.00       9.13      14.43          0          0      15.34        .91        .52          0      10.30
     700.          0       700.          0          0        91.          0         0.         0.      10.30
      .00          0       7.67          0       .043       .043       .043       .042       5.30      18.00
  .008345        50.        50.        50.          0          0          1          0      10.00      28.00


3301 HV CHANGED MORE THAN HVINS

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST

     4.00       9.93      15.53          0          0      15.69        .16        .12        .23      10.60
     700.       151.       332.       217.        52.        99.        71.         0.         0.      10.60
      .01       2.93       3.34       3.04       .043       .043       .043       .042       5.60       5.06
  .001099        50.        50.        50.          2          0          1          0      39.87      44.94
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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
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T1      TEST L SPECIAL BRIDGE-CLASS A LOW FLOW CONTROLLING-
T2      RECTANGULAR CHANNEL   **PRINTOUT OF INPUT DATA (J1,1)**
T3      FLAT CREEK

J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC     HVINS      Q        WSEL      FQ

        -0        -0        -0        -0        -0        -0        -0   16000.  1215.000       -0

NC      .015      .015      .015      .100      .300         0        -0        -0        -0        -0


X1     1.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
GR  1300.000        -0  1200.000        -0  1200.000   100.000  1300.000   100.000        -0        -0
SB      .900     1.250     3.100   100.000   100.000    10.000  1350.000         0  1200.000  1200.000

X1     2.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
X2        -0        -0     1.000  1220.000  1225.000        -0        -0        -0        -0        -0
GR  1230.000        -0  1200.000        -0  1200.000   100.000  1230.000   100.000        -0        -0
EJ        -0        -0        -0        -0        -0        -0        -0        -0        -0        -0

CCHV=    .100 CEHV=     .300
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


     1.00     15.00   1215.00        0   1215.00   1216.77      1.77        0         0   1300.00
   16000.        0    16000.         0         0     1500.        0         0         0   1300.00
        0        0     10.67         0      .015      .015      .015        0   1200.00         0
  .000445       -0        -0        -0         0         0         1        0    100.00    100.00


SPECIAL BRIDGE

SB  XK        XKOR      COFQ      RDLEN     BWC       BWP       BAREA     SS        ELCHU     ELCHD
     .90      1.25      3.10    100.00    100.00     10.00   1350.00         0   1200.00   1200.00

CLASS A LOW FLOW

BRIDGE W.S.=   1214.35  BRIDGE VELOCITY=     12.39       CALCULATED CHANNEL AREA=      1292.

 EGPRS      EGLWC       H3        QWEIR      QPR       BAREA    TRAPEZOID     ELLC      ELTRD
                                                                  AREA
        0   1217.14       .48         0    16000.     1350.     1800.      1220.00   1225.00

     2.00     15.48   1215.48        0         0   1217.14      1.66       .37         0   1230.00
   16000.        0    16000.         0         0     1548.        0         0         0   1230.00
        0        0     10.34         0      .015      .015      .015        0   1200.00         0
  .000404       -0        -0        -0         0         0         1        0    100.00    100.00
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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
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T1      TEST M SPECIAL BRIDGE-CLASS B LOW FLOW CONTROLLING-
T2      RECTANGULAR CHANNEL
T3      FLAT CREEK

J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC    HVINS      Q        WSEL      FQ

       -0        -0        -0        -0        -0        -0        -0   16000.  1210.000       -0

NC       .015      .015      .015      .100      .300         0        -0        -0        -0        -0

X1      1.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
GR   1230.000        -0  1200.000        -0  1200.000   100.000  1230.000   100.000        -0        -0
SB       .900     1.250     3.100   100.000   100.000    10.000  1350.000         0  1200.000  1200.000

X1      2.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
X2         -0        -0     1.000  1215.000  1225.000        -0        -0        -0        -0        -0
GR   1230.000        -0  1200.000        -0  1200.000   100.000  1230.000   100.000        -0        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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```
CCHV=     .100 CEHV=     .300
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST

     1.00      10.00   1210.00          0    1210.00    1213.98       3.98          0          0    1230.00
   16000.          0   16000.           0          0     1000.           0          0          0    1230.00
        0          0     16.00          0       .015       .015       .015          0    1200.00          0
  .001544         -0        -0         -0          0          0          1          0     100.00     100.00


SPECIAL BRIDGE

5227 DOWNSTREAM ELEV IS   1207.25 ,NOT   1210.00 HYDRAULIC JUMP OCCURS DOWNSTREAM (IF LOW FLOW CONTROLS)

SB  XK         XKOR       COFQ       RDLEN      BWC        BWP        BAREA      SS         ELCHU      ELCHD
       .90       1.25       3.10     100.00     100.00      10.00    1350.00          0    1200.00    1200.00

3301 HV CHANGED MORE THAN HVINS

CLASS B LOW FLOW

BRIDGE W.S.=    1209.94  BRIDGE VELOCITY=      17.89      CALCULATED CHANNEL AREA=       895.

 EGPRS      EGLWC       H3         QWEIR       QPR        BAREA     TRAPEZOID     ELLC       ELTRD
                                                                      AREA
  1212.73    1215.54         0          0     16000.      1350.      1350.     1215.00    1225.00


     2.00      13.29   1213.29          0          0    1215.54       2.25       1.57          0    1230.00
   16000.          0   16000.           0          0     1329.           0          0          0    1230.00
        0          0     12.04          0       .015       .015       .015          0    1200.00          0
  .000642         -0        -0         -0          0          0          1          0     100.00     100.00
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7V

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
**************************************************


T1      TEST N SPECIAL BRIDGE-PRESSURE FLOW CONTROLLING-
T2      RECTANGULAR CHANNEL
T3      FLAT CREEK

J1  ICHECK     INQ        NINV       IDIR       STRT       METRIC     HVINS     Q          WSEL       FQ

        .0         .0         .0         .0         .0         .0         .0    16000.   1215.000       .0

NC        .015       .015       .015       .100       .300          0         .0         .0         .0         .0

X1       1.000      4.000         .0    100.000         .0         .0         .0         .0         .0         .0
GR    1230.000         .0   1200.000         .0   1200.000    100.000   1230.000    100.000         .0         .0
SB        .900      1.250      3.100    100.000    100.000     10.000    900.000          0   1200.000   1200.000

X1       2.000      4.000         .0    100.000         .0         .0         .0         .0         .0         .0
X2          .0         .0      1.000   1210.000   1225.000         .0         .0         .0         .0         .0
GR    1230.000         .0   1200.000         .0   1200.000    100.000   1230.000    100.000         .0         .0
EJ          .0         .0         .0         .0         .0         .0         .0         .0         .0         .0
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```
CCHV=    .100 CEHV=    .300
   SECNO    DEPTH    CWSEL    CRIWS    WSELK     EG       HV       HL      OLOSS   BANK ELEV
   Q        QLOB     QCH      QROB     ALOB      ACH      AROB     VOL     TWA    LEFT/RIGHT
   TIME     VLOB     VCH      VROB     XNL       XNCH     XNR      WTN     ELMIN      SSTA
   SLOPE    XLOBL    XLCH     XLOBR    ITRIAL    IDC      ICONT    CORAR   TOPWID     ENDST

    1.00    15.00  1215.00        0  1215.00  1216.77     1.77        0        0  1230.00
  16000.        0   16000.        0        0    1500.        0        0        0  1230.00
       0        0    10.67        0     .015     .015     .015        0  1200.00        0
 .000445       -0       -0       -0        0        0        1        0   100.00   100.00


SPECIAL BRIDGE

SB  XK       XKOR      COFQ     RDLEN      BWC       BWP      BAREA      SS      ELCHU     ELCHD
     .90     1.25      3.10    100.00    100.00     10.00    900.00        0   1200.00   1200.00

3301 HV CHANGED MORE THAN HVINS

PRESSURE FLOW

 EGPRS     EGLWC       H3      QWEIR       QPR      BAREA   TRAPEZOID     ELLC     ELTRD
                                                               AREA
 1221.13   1217.14     .48         0    16000.      900.      900.     1210.00   1225.00

    2.00    20.16  1220.16        0        0  1221.13      .98     4.37        0  1230.00
  16000.        0   16000.        0        0    2016.        0        0        0  1230.00
       0        0     7.94        0     .015     .015     .015        0  1200.00        0
 .000184       -0       -0       -0        2        0        1        0   100.00   100.00
```

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*********************************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*********************************************************


T1      TEST O SPECIAL BRIDGE-WEIR AND PRESSURE FLOW CONTROLLING-
T2      TOP OF ROADWAY AND LOW CHORD READ FROM BT CARDS
T3      FLAT CREEK TEST O         ***CROSS SECTIONS PLOTTED (J2,2)***

J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

        -0        -0        -0        -0        -0        -0        -0   16000.   1215.000       -0

J2  NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

        -0     1.000        -0        -0        -0        -0    -1.000        -0        -0        -0

NC        .015      .015      .015      .100      .300         0        -0        -0        -0        -0

X1       1.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
GR    1230.000        -0  1200.000        -0  1200.000   100.000  1230.000   100.000        -0        -0
SB        .900     1.250     3.100   100.000   100.000    10.000   900.000         0  1200.000  1200.000

X1       2.000     4.000        -0   100.000        -0        -0        -0        -0        -0        -0
X2          -0        -0     1.000  1210.000  1212.000        -0        -0        -0        -0        -0
BT       6.000         0  1230.000  1210.000   100.000  1218.000  1210.000   200.000  1215.000  1210.000
BT     300.000  1212.000  1210.000   400.000  1215.000  1210.000   500.000  1230.000  1210.000        -0
GR    1230.000        -0  1200.000        -0  1200.000   100.000  1230.000   100.000        -0        -0
EJ          -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
```

```
CCHV=     .100 CEHV=     .300
    SECNO      DEPTH     CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
    Q          QLOB      QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
    TIME       VLOB      VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
    SLOPE      XLOBL     XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST


      1.00     15.00   1215.00    1209.23    1215.00    1216.77      1.77          0          0   1230.00
    16000.         0    16000.          0          0     1500.          0          0          0   1230.00
         0         0     10.67          0       .015       .015       .015          0    1200.00         0
   .000445        -0        -0         -0          0         13          1          0     100.00    100.00


SPECIAL BRIDGE

SB  XK          XKOR      COFQ       RDLEN      BWC        BWP        BAREA      SS         ELCHU      ELCHD
       .90      1.25      3.10     100.00     100.00      10.00     900.00          0    1200.00   1200.00

PRESSURE AND WEIR FLOW

 EGPRS       EGLWC        H3       QWEIR       QPR        BAREA    TRAPEZOID      ELLC       ELTRD
                                                                     AREA
  1221.13    1217.24       .48      5613.     10479.       900.      900.      1210.00    1212.00


      2.00     16.10   1216.10          0          0    1217.63      1.53        .86          0   1230.00
    16000.         0    16000.          0          0     1610.          0          0          0   1230.00
         0         0      9.94          0       .015       .015       .015          0    1200.00         0
   .000359        -0        -0         -0          3          0          2          0     100.00    100.00
```

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*****************************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*****************************************************


T1      TEST P SPECIAL BRIDGE-CLASS C+B LOW FLOW CONTROLLING-
T2      SUPER CRITICAL FLOW (J1.4),NO INTERPOLATED CROSS SECTIONS (J1.7)
T3      UPPER RIO HONDO RIVER   (2 BRIDGE PIERS SKEWED) *PROFILE PLOTTED*

J1  ICHECK     ING       NINV      IDIR      STRT     METRIC    HVINS      Q        WSEL      FG

        -0        -0        -0        1.        -0        -0        -0   31000.    15.620       -0

NC        .014      .014      .014        -0        -0        -0        -0        -0        -0        -0


X1  70936.000     4.000         0   190.000         0         0    86.000        -0        -0        -0
GR     25.000         0     5.000    45.000     5.000   145.000    25.000   190.000        -0        -0

X1  70850.000     4.000         0   190.000        -0        -0    50.000        -0        -0        -0
GR     24.750         0     4.750    45.000     4.750   145.000    24.750   190.000        -0        -0

X1  70800.000     4.000         0   200.000        -0        -0    50.000        -0        -0        -0
GR     24.610         0     4.610    45.000     4.610   155.000    24.610   200.000        -0        -0

X1  70750.000     4.000         0   210.000        -0        -0    50.000        -0        -0        -0
GR     24.470         0     4.470    45.000     4.470   165.000    24.470   210.000        -0        -0

X1  70700.000     4.000         0   220.000        -0        -0   110.000        -0        -0        -0
GR     24.330         0     4.330    45.000     4.330   175.000    24.330   220.000        -0        -0

X1  70590.000     4.000         0   220.000        -0        -0    50.000        -0        -0        -0
GR     24.010         0     4.010    45.000     4.010   175.000    24.010   220.000        -0        -0
SB       .900     2.040     3.000   300.000   130.000     9.100  3320.000     2.250     4.010     3.860

X1  70540.000     4.000         0   220.000        -0        -0    35.000        -0        -0        -0
X2         -0        -0     1.000    20.000    22.000        -0        -0        -0        -0        -0
GR     23.860         0     3.860    45.000     3.860   175.000    23.860   220.000        -0        -0

X1  70505.000     4.000         0   220.000        -0        -0         0        -0        -0        -0
X2         -0        -0        -0    20.000    22.000        -0        -0        -0        -0        -0
GR     23.760         0     3.760    45.000     3.760   175.000    23.760   220.000        -0        -0
SB       .900     2.040     3.000   300.000   130.000     9.100  3320.000     2.250     3.760     3.640

X1  70455.000     4.000         0   220.000        -0        -0    50.000        -0        -0        -0
X2         -0        -0     1.000    20.000    22.000        -0        -0        -0        -0        -0
GR     23.620         0     3.620    45.000     3.620   175.000    23.620   220.000        -0        -0

X1  70019.000     4.000         0   220.000        -0        -0   436.000        -0        -0        -0
GR     22.350         0     2.350    45.000     2.350   175.000    22.350   220.000        -0        -0
EJ         -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

  70936.00     10.62     15.62     17.94     15.62     24.24      8.62         0         0     25.00
    31000.         0    31000.         0         0     1316.         0         0         0     25.00
         0         0     23.56         0      .014      .014      .014         0      5.00     21.11
   .002779         0         0         0         0        10         1         0    147.79    168.90

  70850.00     10.63     15.38     17.70         0     24.00      8.62       .24         0     24.75
    31000.         0    31000.         0         0     1316.         0        3.        0.     24.75
       .00         0     23.56         0      .014      .014      .014      .014      4.75     21.11
   .002780         0       86.         0         3         5         1         0    147.78    168.89


3301 HV CHANGED MORE THAN HVINS

  70800.00      9.39     14.00     16.97         0     23.84      9.84       .16         0     24.61
    31000.         0    31000.         0         0     1231.         0        4.        0.     24.61
       .00         0     25.17         0      .014      .014      .014      .014      4.61     23.87
   .003586        -0       50.        -0         7         8         1         0    152.26    176.13


3301 HV CHANGED MORE THAN HVINS

  70750.00      8.50     12.97     16.27         0     23.65     10.68       .20         0     24.47
    31000.         0    31000.         0         0     1182.         0        5.        1.     24.47
       .00         0     26.22         0      .014      .014      .014      .014      4.47     25.88
   .004306        -0       50.        -0         6         8         1         0    158.24    184.12


3301 HV CHANGED MORE THAN HVINS

  70700.00      7.79     12.12     15.61         0     23.42     11.29       .23         0     24.33
    31000.         0    31000.         0         0     1149.         0        7.        1.     24.33
       .00         0     26.97         0      .014      .014      .014      .014      4.33     27.47
   .004984        -0       50.        -0         6         8         1         0    165.06    192.53

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

  70590.00      7.89     11.90     15.26         0     22.88     10.98       .54         0     24.01
    31000.         0    31000.         0         0     1166.         0       10.        1.     24.01
       .00         0     26.59         0      .014      .014      .014      .014      4.01     27.24
   .004771        -0      110.        -0         4         5         1         0    165.51    192.76


SPECIAL BRIDGE

SB  XK        XKOR      COFQ      RDLEN     BWC       BWP       BAREA     SS        ELCHU     ELCHD
       .90      2.04      3.00    300.00    130.00      9.10   3320.00      2.25      4.01      3.86
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3301 HV CHANGED MORE THAN HVINS

CLASS C LOW FLOW

BRIDGE W.S.=      13.45  BRIDGE VELOCITY=     22.88       CALCULATED CHANNEL AREA=      1343.

 EGPRS        EGLWC        H3        QWEIR        QPR        BAREA   TRAPEZOID      ELLC       ELTRD
                                                                       AREA
    14.66      21.47          0          0     31000.      3320.     2508.        20.00       22.00


 70540.00       8.63      12.49         0          0      21.47       8.98       1.41          0       23.86
   31000.          0     31000.         0          0      1289.          0        11.         1.       23.86
      .00          0      24.04         0       .014       .014       .014       .014       3.86       25.59
  .003511         -0        50.        -0          0          0          1          0     168.83      194.41


NORMAL BRIDGE,NRD= 0 MIN ELTRD=   22.00 MAX ELLC=   20.00

 70505.00       8.65      12.41     15.00          0      21.34       8.94        .12          0       23.76
   31000.          0     31000.         0          0      1292.          0        12.         2.       23.76
      .00          0      23.99         0       .014       .014       .014       .014       3.76       25.55
  .003487         -0        35.        -0          3         16          1          0     168.91      194.45


SPECIAL BRIDGE

5290 UPSTREAM ELEV IS      18.14 ,NOT     12.41 NEW BACKWATER REQUIRED

SB   XK          XKOR       COFQ       RDLEN       BWC        BWP        BAREA       SS        ELCHU       ELCHD
      .90         2.04       3.00      500.00     130.00       9.10     3320.00      2.25       3.76        3.64

3301 HV CHANGED MORE THAN HVINS

CLASS B LOW FLOW

BRIDGE W.S.=      15.45  BRIDGE VELOCITY=     17.91       CALCULATED CHANNEL AREA=      1720.

 EGPRS        EGLWC        H3        QWEIR        QPR        BAREA   TRAPEZOID      ELLC       ELTRD
                                                                       AREA
    15.17      20.29          0          0     31000.      3320.     2557.        20.00       22.00


 70455.00       9.56      13.18         0          0      20.29       7.12       1.05          0       23.62
   31000.          0     31000.         0          0      1448.          0        12.         2.       23.62
      .00          0      21.41         0       .014       .014       .014       .014       3.62       23.50
  .002469         -0          0        -0          0          0          1          0     173.01      196.50


3840 SECTION NOT HIGH ENOUGH     74.697     72.350     2.350     72.350     12.396          2

3301 HV CHANGED MORE THAN HVINS

   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS   BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA   LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST


 70019.00       8.49      10.84     13.60          0      20.15       9.50        .15          0       22.35
   31000.          0     31000.         0          0      1267.          0        14.         2.       22.35
      .01          0      24.48         0       .014       .014       .014       .014       2.35       25.89
  .003706         -0        50.        -0          5         20          1          0     168.22      194.11
```

PROFILE FOR RIVER UPPER RIO HONDO RIVER

PLOTTED POINTS (BY PRIORITY)=E=ENERGY,W=WATER SURFACE,I=INVERT,C=CRITICAL W.S.,L=LEFT BANK,R=RIGHT BANK,M=LOWER END STA

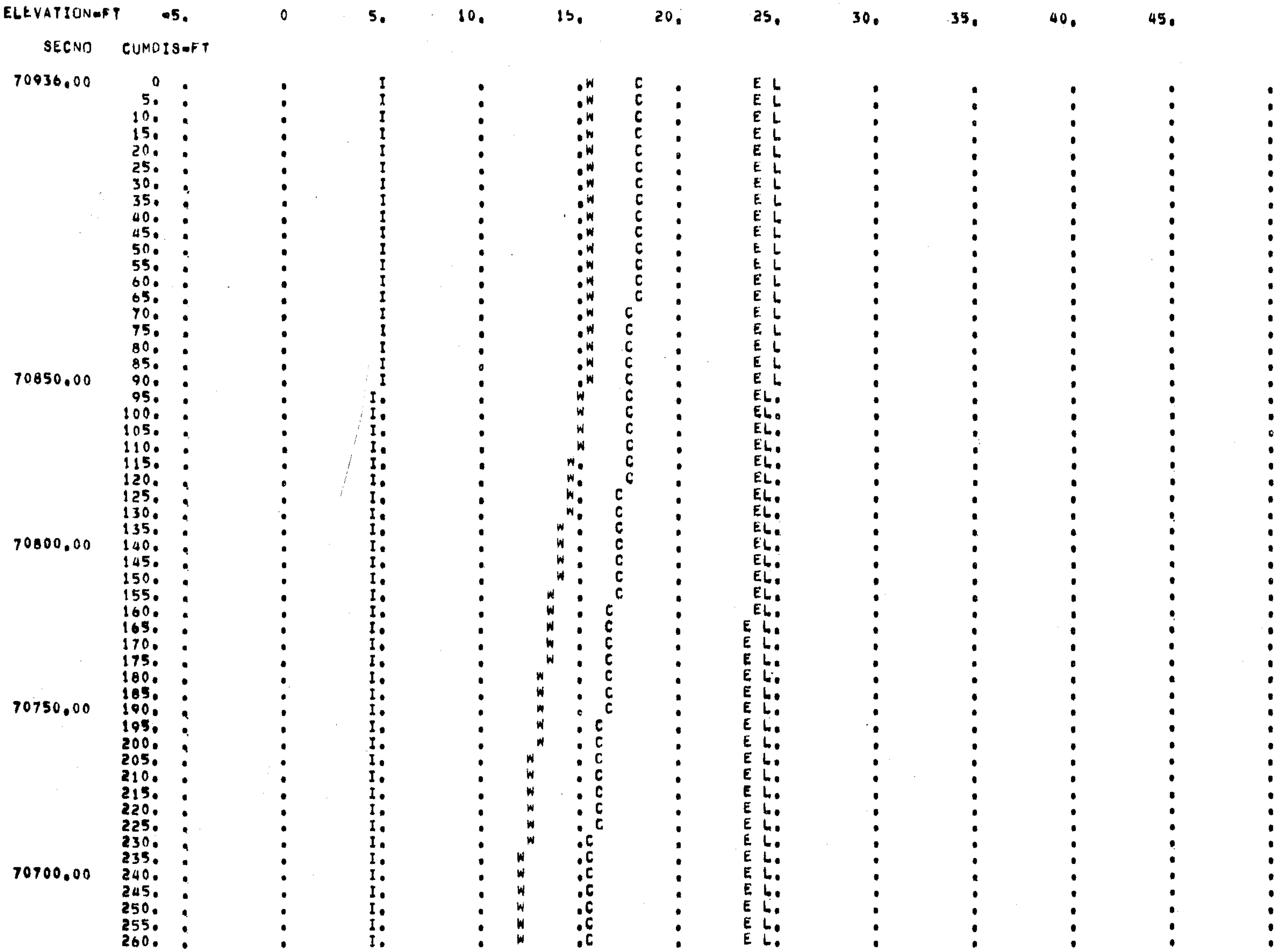

EXHIBIT 8
Page 34 of 59


265. 270. 275. 280. 285. 290. 295. 300. 305. 310. 315. 320. 325. 330. 335. 340. 345. 350. 355. 360. 365. 370. 375. 380. 385. 390. 395. 400. 405. 410. 415. 420. 425. 430. 435. 440. 445. 450. 455. 460. 465. 470. 475. 480. 485.
70590.00
70540.00
70505.00
70455.00
70019.00

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**************************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
**************************************************


T1      TEST Q SPECIAL BRIDGE-CLASS C LOW FLOW CONTROLLING-
T2      SUPERCRITICAL FLOW
T3      FLAT CREEK

J1  ICHECK      INQ       NINV       IDIR       STRT     METRIC     HVINS       Q         WSEL       FQ

        -0        -0        -0         1.         -0         -0        -0    19000.      9.630        -0

NC        .012      .012      .012         -0         -0         -0         -0         -0         -0         -0

X1  72300.000     4.000         0    240.000         -0         -0     97.000         -0         -0         -0
GR     25.000         0     5.000     40.000      5.000    200.000     25.000    240.000         -0         -0

X1  72203.000     4.000         0    240.000         -0         -0     50.000         -0         -0         -0
GR     24.640         0     4.640     40.000      4.640    200.000     24.640    240.000         -0         -0
SB       .900     2.040     3.000    300.000    160.000     18.000   3204.000      2.000      4.640      4.440

X1  72153.000     4.000         0    240.000         -0         -0    452.000         -0         -0         -0
X2         -0        -0     1.000     18.000     20.000         -0         -0         -0         -0         -0
GR     24.450         0     4.450     40.000      4.450    200.000     24.450    240.000         -0         -0

X1  71701.000     4.000         0    240.000         -0         -0          0         -0         -0         -0
GR     22.770         0     2.720     40.000      2.770    200.000     22.770    240.000         -0         -0
EJ         -0        -0        -0         -0         -0         -0         -0         -0         -0         -0
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 SECNO      DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
 Q          QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
 TIME       VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
 SLOPE      XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

72300.00     4.63      9.63     12.33      9.63     18.76      9.13         0         0     25.00
 19000.         0    19000.         0         0      784.         0         0         0     25.00
      0         0     24.24         0      .012      .012      .012         0      5.00     30.74
.005420         0         0         0         0        13         1         0    178.52    209.26

72203.00     4.68      9.32     11.98         0     18.24      8.93       .52         0     24.64
 19000.         0    19000.         0         0      792.         0        2.        0.     24.64
    .00         0     23.98         0      .012      .012      .012      .012      4.64     30.64
.005230        -0       97.        -0         5         5         1         0    178.72    209.36


SPECIAL BRIDGE

SB   XK        XKOR       COFQ      RDLEN      BWC       BWP       BAREA      SS       ELCHU      ELCHD
      .90       2.04       3.00     300.00    160.00     18.00    3204.00     2.00      4.64       4.44

3301 HV CHANGED MORE THAN HVINS

CLASS C LOW FLOW

BRIDGE W.S.=       11.07   BRIDGE VELOCITY=     18.76       CALCULATED CHANNEL AREA=      996.

  EGPRS        EGLWC        H3        QWEIR       QPR        BAREA    TRAPEZOID     ELLC      ELTRD
                                                                        AREA
        0       16.41         0          0     19000.      3204.      2254.        18.00     20.00


72153.00     5.42      9.87         0         0     16.41      6.54      1.83         0     24.45
 19000.         0    19000.         0         0      926.         0        3.        1.     24.45
    .00         0     20.52         0      .012      .012      .012      .012      4.45     29.16
.003190        -0       50.        -0         0         0         1         0    181.68    210.84

3840 SECTION NOT HIGH ENOUGH      75.445    72.770     2.720     72.770     9.340         2
71701.00     5.32      8.04     10.09         0     14.91      6.87      1.50         0     22.77
 19000.         0    19000.         0         0      903.         0       12.        2.     22.77
    .01         0     21.03         0      .012      .012      .012      .012      2.72     29.38
.003448        -0      452.        -0         6        20         1         0    181.16    210.54
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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
************************************************


T1      TEST R SPECIAL BRIDGE-WEIR FLOW AND LOW FLOW CONTROLLING*
T2      LOW BRIDGE APPROACHES FOR OVERBANK (WEIR FLOW) FROM BT CARDS
T3      SMALL CREEK

J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC     HVINS     Q        WSEL      FQ

        -0        -0        -0        -0        -0        -0        -0   12000.    80.000       -0

NC        .080      .080      .030      .100      .300        -0        -0        -0        -0        -0

X1       1.000     8.000   200.000   300.000        -0        -0        -0        -0        -0        -0
GR     150.000         0    60.000   100.000    95.000   200.000    50.000   200.000    50.000   300.000
GR      95.000   300.000    60.000   400.000   150.000   500.000        -0        -0        -0        -0
SB        .900     2.040     2.700         0   100.000     5.000  4000.000         0    50.000    50.000

X1       2.000        -0        -0        -0        -0        -0        -0        -0        -0        -0
X2          -0        -0     1.000    90.000    60.000        -0        -0        -0        -0        -0
BT       6.000         0   150.000   150.000   100.000    60.000    60.000   200.000    95.000    90.000
BT     300.000    95.000    90.000   400.000    60.000    60.000   500.000   150.000   150.000        -0

X1       3.000        -0        -0        -0        -0        -0        -0        -0        -0        -0
EJ          -0        -0        -0        -0        -0        -0        -0        -0        -0        -0
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CCHV= .100 CEHV= .300

3265 DIVIDED FLOW

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
1.00	30.00	80.00	0	80.00	80.18	.18	0	0	95.00
12000.	645.	10711.	645.	794.	3000.	794.	0	0	95.00
0	.81	3.57	.81	.080	.030	.080	0	50.00	77.78
.000104	=0	=0	=0	0	0	1	0	258.73	422.22

SPECIAL BRIDGE

SB XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
.90	2.04	2.70	0	100.00	5.00	4000.00	0	50.00	50.00

6840,FLOW IS BY WEIR AND LOW FLOW

3265 DIVIDED FLOW

BRIDGE W.S.= 80.01 BRIDGE VELOCITY= 3.50 CALCULATED CHANNEL AREA= 2851.

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELTRD
90.00	80.20	.01	2070.	9974.	4000.	3800.	90.00	60.00

2.00	30.02	80.02	0	0	80.20	.18	.02	0	95.00
12000.	646.	10709.	646.	795.	3002.	795.	0	0	95.00
0	.81	3.57	.81	.080	.030	.080	0	50.00	77.76
.000104	=0	=0	=0	2	0	4	0	258.88	422.24

3265 DIVIDED FLOW

3.00	30.02	80.02	0	0	80.20	.18	0	0	95.00
12000.	646.	10709.	646.	795.	3002.	795.	0	0	95.00
0	.81	3.57	.81	.080	.030	.080	0	50.00	77.76
.000104	=0	=0	=0	0	0	1	0	258.88	422.24

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
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T1      TEST 8 COMPUTATIONS USING NORMAL BRIDGE ROUTINE (X2,4=5)
T2      CRITICAL DEPTH ABOVE TOP OF BRIDGE=ROADWAY XSECS 27975 AND 27997=
T3      BIG COTTONWOOD CREEK

J1   ICHECK     INQ      NINV      IDIR      STRT      METRIC     HVINS      Q        WSEL      FQ

        =0        =0        =0        =0        =0        =0        =0    4500.  4346.790      =0

NC        .050      .050      .030      .300      .500        =0        =0        =0        =0        =0

X1   27900.000    17.000  1945.000  2020.000        =0        =0        =0        =0        =0        =0
GR    4360.000   600.000  4350.000  1460.000  4348.000  1630.000  4346.000  1690.000  4345.600  1740.000
GR    4345.100  1870.000  4344.000  1945.000  4342.000  1985.000  4341.000  1995.000  4341.000  2012.000
GR    4342.000  2015.000  4344.000  2020.000  4346.000  2070.000  4348.000  2080.000  4350.000  2200.000
GR    4350.800  2260.000  4359.000  2400.000        =0        =0        =0        =0        =0        =0

X1   27975.000    16.000  1988.000  2012.000    75.000    75.000    75.000        =0        =0        =0
X2          =0        =0        =0  4346.000  4349.700        =0        =0        =0        =0        =0
GR    4360.000   200.000  4352.000  1380.000  4351.100  1470.000  4350.000  1550.000  4349.300  1630.000
GR    4348.900  1820.000  4348.100  1900.000  4349.700  1988.000  4341.500  1988.000  4341.500  2012.000
GR    4349.700  2012.000  4350.000  2065.000  4352.000  2150.000  4354.000  2200.000  4357.500  2280.000
GR    4360.000  2500.000        =0        =0        =0        =0        =0        =0        =0        =0

X1   27997.000         0         0         0    22.000    22.000    22.000        =0        =0        =0
X2          =0        =0        =0  4346.000  4349.700        =0        =0        =0        =0        =0

X1   28060.000    22.000   970.000  1013.000    90.000    40.000    63.000        =0        =0        =0
GR    4360.000         0  4352.000   345.000  4350.100   385.000  4352.000   415.000  4352.600   500.000
GR    4352.000   565.000  4351.500   585.000  4350.000   665.000  4349.700   740.000  4348.600   850.000
GR    4348.000   940.000  4348.000   970.000  4346.000   983.000  4343.000   990.000  4343.000  1008.000
GR    4346.000  1013.000  4347.600  1035.000  4348.000  1065.000  4355.500  1066.000  4356.000  1160.000
GR    4357.500  1300.000  4360.000  1800.000        =0        =0        =0        =0        =0        =0
EJ          =0        =0        =0        =0        =0        =0        =0        =0        =0        =0
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```
CCHV=     .300 CEHV=      .500
   SECNO       DEPTH      CWSEL      CRIWS      WSELK         EG         HV         HL      OLOSS   BANK ELEV
   Q           QLOB       QCH        QROB       ALOB         ACH       AROB        VOL       TWA   LEFT/RIGHT
   TIME        VLOB       VCH        VROB       XNL         XNCH        XNR        WTN     ELMIN        SSTA
   SLOPE       XLOBL      XLCH       XLOBR      ITRIAL       IDC      ICONT      CURAR    TOPWID       ENDST

 27900.00       5.79    4346.79          0    4346.79    4347.70        .91          0          0   4344.00
   4500.       1166.      3067.       267.       414.       338.        91.          0          0   4344.00
       0        2.82       9.08       2.93       .050       .030       .050          0    4341.00   1666.30
 .004571          -0         -0         -0          0          0          1          0     407.65   2073.95

3685 20 TRIALS USED WSEL,CWSEL

7185 MIN SPECIFIC ENERGY

3720 ASSUMED CRITICAL DEPTH

   SECNO       DEPTH      CWSEL      CRIWS      WSELK         EG         HV         HL      OLOSS   BANK ELEV
   Q           QLOB       QCH        QROB       ALOB         ACH       AROB        VOL       TWA   LEFT/RIGHT
   TIME        VLOB       VCH        VROB       XNL         XNCH        XNR        WTN     ELMIN        SSTA
   SLOPE       XLOBL      XLCH       XLOBR      ITRIAL       IDC      ICONT      CURAR    TOPWID       ENDST

NORMAL BRIDGE,NRD= 0 MIN ELTRD= 4349.70 MAX ELLC= 4346.00

 27975.00       9.50    4351.00    4351.00          0    4351.65        .65        .63          0   4349.70
   4500.       2846.      1317.       337.       594.       139.        82.         1.         1.   4349.70
     .00        4.79       9.46       4.10       .050       .030       .050       .030    4341.50   1477.26
 .019922         75.        75.        75.         30         10          1    -385.20     630.25   2107.51

NORMAL BRIDGE,NRD= 0 MIN ELTRD= 4349.70 MAX ELLC= 4346.00

 27997.00      10.28    4351.78          0          0    4351.98        .19        .19        .14   4349.70
   4500.       3248.       796.       455.      1023.       158.       170.         2.         1.   4349.70
     .01        3.18       5.04       2.68       .050       .030       .050       .029    4341.50   1401.61
 .004772         22.        22.        22.          3          0          1    -385.20     739.20   2140.81

3265 DIVIDED FLOW

   SECNO       DEPTH      CWSEL      CRIWS      WSELK         EG         HV         HL      OLOSS   BANK ELEV
   Q           QLOB       QCH        QROB       ALOB         ACH       AROB        VOL       TWA   LEFT/RIGHT
   TIME        VLOB       VCH        VROB       XNL         XNCH        XNR        WTN     ELMIN        SSTA
   SLOPE       XLOBL      XLCH       XLOBR      ITRIAL       IDC      ICONT      CURAR    TOPWID       ENDST

 28060.00       8.90    4351.90          0          0    4352.17        .27        .15        .04   4348.00
   4500.       2002.      1866.       632.      1051.       313.       236.         5.         2.   4346.00
     .01        1.90       5.97       2.68       .050       .030       .050       .027    4343.00    347.16
 .001082         90.        63.        40.          3          0          1          0     562.65   1065.52
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*********************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*********************************************


T1       TEST T  FLOOD WIDTH DETERMINATION
T2      100 YEAR FLOOD NATURAL PROFILE
T3       NORTH BUFFALO CR TEST T

J1   ICHECK      INQ       NINV      IDIR       STRT      METRIC     HVINS       Q         WSEL      FQ

        -0        2.         -0        -0         -0         -0         -0        -0   698.300        -0

J2   NPROF      IPLOT      PRFVS     XSECV      XSECH       FN        ALLDC      IBW       CHNIM     ITRACE

          -0         -0    -1.000        -0         -0         -0         -0        -0        -0    15.000

J3       9.000     27.000     28.000      1.000     36.000      4.000     34.000        -0        -0        -0
NC        .120       .120       .055       .100       .300         -0         -0        -0        -0        -0
QT       7.000   8000.000   8000.000   8000.000   8000.000   8000.000   8000.000  8000.000        -0        -0
ET          -0         -0    250.200     12.300     10.400         -0         -0        -0        -0        -0

X1   29900.000     23.000    460.000    508.000         -0         -0         -0        -0        -0        -0
GR     712.000          0    708.000     10.000    703.200     28.000    701.200    35.000   699.200    42.000
GR     697.200     57.000    695.200     71.000    693.200    110.000    691.200   150.000   691.000   400.000
GR     689.200    460.000    681.200    470.000    681.200    495.000    689.200   508.000   691.200   512.000
GR     693.200    530.000    695.200    563.000    697.200    570.000    699.200   580.000   701.200   595.000
GR     703.200    601.000    709.000    612.000    712.000    630.000         -0        -0        -0        -0

X1   33700.000     22.000    245.000    285.000   3000.000   3000.000   3800.000        -0        -0        -0
GR     713.000          0    709.200     20.000    705.200     35.000    703.200    50.000   701.200    63.000
GR     699.200     75.000    697.200     90.000    695.200    130.000    695.200   240.000   693.200   245.000
GR     685.000    250.000    685.000    280.000    693.200    285.000    695.200   292.000   695.200   410.000
GR     697.200    457.000    699.200    500.000    701.200    510.000    703.200   535.000   705.200   560.000
GR     708.700    573.000    713.000    590.000         -0         -0         -0        -0        -0        -0

X1   35100.000     19.000    115.000    150.000   1000.000   1500.000   1400.000        -0        -0        -0
GR     714.000          0    710.100     23.000    706.700     36.000    705.200    48.000   703.200    64.000
GR     701.200     76.000    699.200     92.000    689.200    115.000    686.000   116.000   686.000   136.000
GR     689.200    140.000    691.200    145.000    693.200    150.000    695.200   160.000   695.200   360.000
GR     697.200    370.000    699.200    375.000    709.200    395.000    714.200   410.000        -0        -0

X1   36950.000     22.000    193.000    233.000   1600.000   1600.000   1850.000        -0        -0        -0
GR     715.000          0    709.200     25.000    707.200     31.000    705.200    40.000   703.200    50.000
GR     701.200     61.000    699.200     87.000    697.200    180.000    693.200   193.000   688.000   198.000
GR     688.000    228.000    693.200    233.000    695.200    245.000    697.200   250.000   697.200   290.000
GR     699.200    310.000    701.200    370.000    703.200    410.000    705.200   445.000   707.200   465.000
GR     709.200    500.000    715.200    512.000         -0         -0         -0        -0        -0        -0
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X1	40150.000	22.000	95.000	145.000	2800.000	2800.000	3200.000	-0	-0	-0
GR	720.200	0	719.200	22.000	717.200	30.000	715.200	40.000	713.200	50.000
GR	711.200	58.000	709.200	70.000	699.200	95.000	693.000	105.000	693.000	135.000
GR	699.200	145.000	701.200	150.000	701.200	220.000	703.200	240.000	705.200	255.000
GR	707.200	270.000	709.200	290.000	711.200	310.000	713.200	325.000	715.200	350.000
GR	717.200	370.000	719.200	390.000	-0	-0	-0	-0	-0	-0
X1	40800.000	0	0	0	650.000	650.000	650.000	-0	3.000	-0
EJ	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

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```
CCHV=    .100 CEHV=    .300
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 29900.00    17.10    698.30        0     698.30    698.50      .20        0         0    689.20
   8000.     4002.     3654.      344.     2730.      729.      295.        0         0    689.20
      0      1.47      5.01      1.16      .120      .055      .120        0    681.20     48.75
 .001047       -0        -0        -0         0         0         1        0    526.75    575.50

FLOW DISTRIBUTION

STA=      49.      57.      71.     110.     150.     400.     460.     508.     512.     530.     563.     570.     575.
  PER Q=      .0        .2       2.1      4.1     33.6     10.0     45.7       .6      1.8      1.7       .1       .0
   AREA=     4.5      29.4     159.9    244.0   1800.0    492.0    728.8     32.4    109.8    135.3     14.7      3.0
    VEL=      .3        .7       1.0      1.3      1.5      1.6      5.0      1.5      1.3      1.0       .6       .3

 33700.00    17.37    702.37        0         0    702.64      .27      4.12       .02    693.20
   8000.     1944.     3769.     2286.     1170.      654.     1403.      253.       35.    693.20
     .26     1.66      5.77      1.63      .120      .055      .120      .062    685.00     55.39
 .001447     3000.     3800.     3000.        2         0         1         0    469.24    524.63

FLOW DISTRIBUTION

STA=      55.     130.     240.     245.     285.     410.     457.     525.
  PER Q=     6.1      17.3       .9     47.1     19.9      5.7      3.0
   AREA=   339.9     788.8     40.9    653.8    903.3    290.0    209.6
    VEL=     1.4       1.8      1.8      5.8      1.8      1.6      1.1

 35100.00    18.28    704.28        0         0    704.55      .27      1.91       .00    689.20
   8000.      557.     3447.     3997.      327.      580.     2054.      350.       47.    693.20
     .37     1.70      5.94      1.95      .120      .055      .120      .060    686.00     55.34
 .001334     1000.     1400.     1500.        2         0         1         0    329.83    385.17

FLOW DISTRIBUTION

STA=      55.      64.      76.      92.     115.     150.     160.     360.     370.     375.     385.
  PER Q=      .0        .2        .9      5.8     43.1      2.6     44.7      1.8       .5       .3
   AREA=     4.7      25.0      65.3    231.9    579.9    100.8   1816.5     80.8     30.4     25.8
    VEL=      .3        .7       1.1      2.0      5.9      2.1      2.0      1.8      1.4       .8

   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

 36950.00    18.37    706.37        0         0    706.65      .28      2.09       .00    693.20
   8000.     1852.     4053.     2095.     1135.      709.     1346.      466.       61.    693.20
     .50     1.63      5.72      1.56      .120      .055      .120      .060    688.00     34.75
 .001116     1600.     1850.     1600.        2         0         1         0    421.90    456.66
```

FLOW DISTRIBUTION

STA=	35.	87.	180.	193.	233.	245.	290.	310.	370.	457.
PER Q=	3.6	15.9	3.6	50.7	4.0	9.5	3.4	6.4	2.9	
AREA=	230.8	759.4	145.2	708.6	146.0	417.5	163.3	369.9	249.2	
VEL=	1.2	1.7	2.0	5.7	2.2	1.8	1.7	1.4	.9	

40150.00	17.38	710.38	0	0	710.90	.53	4.18	.08	699.20
8000.	257.	5547.	2196.	159.	807.	1062.	641.	83.	699.20
.65	1.62	6.88	2.07	.120	.055	.120	.059	693.00	62.95
.001739	2800.	3200.	2800.	2	0	1	0	238.81	301.76

FLOW DISTRIBUTION

STA=	63.	70.	95.	145.	150.	220.	240.	255.	270.	290.	302.
PER Q=	.0	3.2	69.3	1.5	18.2	4.3	2.0	1.0	.5	.0	
AREA=	4.1	154.4	806.8	50.9	642.3	163.5	92.6	62.6	43.5	6.9	
VEL=	.4	1.7	6.9	2.3	2.3	2.1	1.7	1.3	.9	.4	

40800.00	15.62	711.62	0	0	712.42	.80	1.44	.08	702.20
8000.	198.	5911.	1891.	111.	719.	803.	668.	86.	702.20
.68	1.78	8.22	2.35	.120	.055	.120	.059	696.00	71.44
.002896	650.	650.	650.	2	0	1	0	212.81	284.25

FLOW DISTRIBUTION

STA=	71.	95.	145.	150.	220.	240.	255.	270.	284.
PER Q=	2.5	73.9	1.4	16.5	3.7	1.5	.5	.1	
AREA=	111.0	719.2	42.1	519.7	128.5	66.4	36.4	10.1	
VEL=	1.8	8.2	2.6	2.5	2.3	1.8	1.2	.5	

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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*************************************************


T1      TEST T  FLOOD WIDTH DETERMINATION
T2      100 YEAR FLOOD  METHOD 2  ENCROACHMENT
T3      NORTH BUFFALO CR TEST T

J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

        =0        3.        =0        =0        =0        =0        =0        =0   699.300        =0

J2  NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     2.000        =0    =1.000        =0        =0        =0        =0        =0        =0        =0
```

```
CCHV=     .100 CEHV=     .300
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA    LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST


3470 ENCROACHMENT STATIONS=       359.0      609.0   TYPE=      2   TARGET=      250.000
 29900.00      18.10     699.30         0     698.30     699.83       .53          0          0     689.20
   8000.       1953.      5421.      626.       892.       777.      365.          0          0     689.20
      0         2.19       6.98      1.72       .120       .055      .120          0     681.20     359.00
  .001863        -0         -0        -0          0          0         1          0     221.75     580.75


3470 ENCROACHMENT STATIONS=       140.0      390.0   TYPE=      2   TARGET=      250.000
 33700.00      19.73     704.73         0     702.37     705.03       .30       5.17        .02     693.20
   8000.       1839.      4314.     1847.      1005.       748.     1007.       179.        17.     693.20
     .24        1.83       5.77      1.83       .120       .055      .120       .060     685.00     140.00
  .001210      3000.      3800.     3000.          2          0         1          0     250.00     390.00


3470 ENCROACHMENT STATIONS=         7.5      257.5   TYPE=      2   TARGET=      250.000
 35100.00      20.44     706.44         0     704.28     706.85       .41       1.79        .03     689.20
   8000.        913.      4385.     2701.       474.       655.     1218.       257.        24.     693.20
     .33        1.93       6.69      2.22       .120       .055      .120       .059     686.00      38.08
  .001436      1000.      1400.     1500.          2          0         1          0     219.42     257.50


3470 ENCROACHMENT STATIONS=        88.0      338.0   TYPE=      2   TARGET=      250.000
 36950.00      20.48     708.48         0     706.37     708.73       .25       1.86        .02     693.20
   8000.       1836.      4223.     1941.      1119.       793.     1136.       360.        33.     693.20
     .46        1.64       5.32      1.71       .120       .055      .120       .059     688.00      88.00
  .000832      1600.      1850.     1600.          2          0         1          0     250.00     338.00


3470 ENCROACHMENT STATIONS=          .0      245.0   TYPE=      2   TARGET=      250.000
 40150.00      18.54     711.54         0     710.38     712.01       .47       3.21        .06     699.20
   8000.        313.      5558.     2129.       200.       865.     1008.       532.        47.     699.20
     .63        1.57       6.42      2.11       .120       .055      .120       .059     693.00      56.62
  .001383      2800.      3200.     2800.          2          0         1          0     188.38     245.00


3470 ENCROACHMENT STATIONS=          .0      245.0   TYPE=      2   TARGET=      250.000
 40800.00      16.53     712.53         0     711.62     713.22       .69       1.14        .07     702.20
   8000.        231.      5857.     1912.       134.       765.      807.       561.        50.     702.20
     .66        1.73       7.66      2.37       .120       .055      .120       .058     696.00      68.00
  .002319       650.       650.      650.          2          0         1          0     177.00     245.00
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EXHIBIT 8
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HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
*************************************************


T1      TEST T  FLOOD WIDTH DETERMINATION
T2      100 YEAR FLOOD  METHOD 3  ENCROACHMENT
T3      NORTH BUFFALO CR TEST T

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

       =0       4.       =0       =0       =0       =0       =0       =0  699.300       =0

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

      3.000      =0   =1.000       =0       =0       =0       =0       =0       =0       =0
```

```
CCHV=     .100 CEHV=     .300
 2800 NAT Q1=    2472.20  WSEL=     698.30  ENC Q1=   2175.54  WSEL=    698.30  RATIO=   .1200
 NAT Q1=    2472.  RATIOS LOB,CH,ROB=   .5002    .4568    .0430  WSEL=    698.30
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA     LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN        SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID       ENDST


3470 ENCROACHMENT STATIONS=       155.2      508.0  TYPE=      3  TARGET=        .120
 29900.00      18.10     699.30         0    698.30    699.49      .19          0          0     689.20
    8000.      4285.      3715.         0     2560.      777.       0.          0          0     689.20
        0       1.67       4.78         0      .120      .055     .120          0     681.20     155.20
  .001104         =0         =0        =0         0         0        1          0     352.80     508.00


 2800 NAT Q1=    2104.51  WSEL=     702.37  ENC Q1=   1851.97  WSEL=    702.37  RATIO=   .1200
 NAT Q1=    2105.  RATIOS LOB,CH,ROB=   .2431    .4711    .2858  WSEL=    702.37

3470 ENCROACHMENT STATIONS=       129.1      432.9  TYPE=      3  TARGET=        .120
 33700.00      18.38     703.38         0    702.37    703.67      .29       4.15        .03     693.20
    8000.      1765.      4052.     2183.      953.      694.     1206.      227.        23.     693.20
      .24       1.85       5.84      1.81      .120      .055     .120       .062     685.00     129.09
  .001369      3000.      3800.     3000.         3         0        1          0     303.77     432.86


 2800 NAT Q1=    2190.23  WSEL=     704.28  ENC Q1=   1927.40  WSEL=    704.28  RATIO=   .1200
 NAT Q1=    2190.  RATIOS LOB,CH,ROB=   .0696    .4308    .4996  WSEL=    704.28

3470 ENCROACHMENT STATIONS=       111.3      350.9  TYPE=      3  TARGET=        .120
 35100.00      19.25     705.25         0    704.28    705.57      .32       1.89        .01     689.20
    8000.        54.      3793.     4154.       56.      613.     2028.      315.        32.     693.20
      .34        .95       6.18      2.05      .120      .055     .120       .060     686.00     111.31
  .001340      1000.      1400.     1500.         2         0        1          0     239.60     350.91


 2800 NAT Q1=    2395.89  WSEL=     706.37  ENC Q1=   2108.38  WSEL=    706.37  RATIO=   .1200
 NAT Q1=    2396.  RATIOS LOB,CH,ROB=   .2315    .5065    .2619  WSEL=    706.37

3470 ENCROACHMENT STATIONS=        97.9      341.1  TYPE=      3  TARGET=        .120
 36950.00      19.36     707.36         0    706.37    707.68      .33       2.11        .00     693.20
    8000.      1638.      4441.     1921.      919.      748.     1040.      418.        41.     693.20
      .46       1.78       5.94      1.85      .120      .055     .120       .060     688.00      97.88
  .001119      1600.      1850.     1600.         2         0        1          0     243.22     341.10


 2800 NAT Q1=    1918.57  WSEL=     710.38  ENC Q1=   1688.34  WSEL=    710.38  RATIO=   .1200
 NAT Q1=    1919.  RATIOS LOB,CH,ROB=   .0321    .6933    .2746  WSEL=    710.38
   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA     LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN        SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID       ENDST
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3470 ENCROACHMENT STATIONS=       95.0      221.7  TYPE=      3  TARGET=          .120
 40150.00     18.68    711.68        0    710.38    712.23       .55      4.48       .07    699.20
   8000.         0     5888.     2112.        0.      872.      809.      566.       53.    699.20
     .61         0      6.75     2.61      .120      .055      .120      .059    693.00     95.00
 .001999     2800.     3200.     2800.        3         0         1         0    126.68    221.68

 2800 NAT Q1=    1486.40  WSEL=     711.62  ENC Q1=    1308.03  WSEL=    711.62  RATIO=    .1200
 NAT Q1=    1486.  RATIOS LOB,CH,ROB=    .0247     .7389     .2364  WSEL=    711.62

3470 ENCROACHMENT STATIONS=       95.0      208.9  TYPE=      3  TARGET=          .120
 40800.00     17.09    713.09        0    711.62    713.93       .84      1.61       .09    702.20
   8000.         0     6422.     1578.        0.      792.      573.      589.       55.    702.20
     .63         0      8.10     2.75      .120      .055      .120      .059    696.00     95.00
 .003167      650.      650.      650.        2         0         1         0    113.95    208.95
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************************************************
HEC2 VERSION UPDATED AUG 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09,10
MODIFICATIONS 52,53,54,55,56,57,58,59
************************************************


T1       TEST T  FLOOD WIDTH DETERMINATION
T2       100 YEAR FLOOD  METHOD 4  ENCROACHMENT
T3       NORTH BUFFALO CR TEST T

J1   ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

          =0       5.        =0        =0        =0        =0        =0        =0   699.300        =0

J2   NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

       15.000        =0    =1.000        =0        =0        =0        =0        =0        =0        =0
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EXHIBIT 8
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CCHV=    .100 CEHV=    .300
 2800 NAT Q1=  2472.20  WSEL=    698.30  ENC Q1=   2472.20  WSEL=    699.30  RATIO=        0
 NAT Q1=   2950.  RATIOS LOB,CH,ROB=   .5250    .4258    .0492  WSEL=    699.30
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


3470 ENCROACHMENT STATIONS=     172.9     508.0  TYPE=     4  TARGET=        .162
 29900.00     18.10    699.30        0    698.30    699.50      .20         0         0    689.20
    8000.     4171.     3829.        0     2416.      777.       0.         0         0    689.20
        0      1.73      4.93        0      .120      .055     .120         0    681.20    172.90
  .001173        -0        -0       -0         0         0        1         0    335.10    508.00


 2800 NAT Q1=  2103.39  WSEL=    702.37  ENC Q1=   2103.39  WSEL=    703.37  RATIO=        0
 NAT Q1=   2511.  RATIOS LOB,CH,ROB=   .2582    .4358    .3060  WSEL=    703.37

3470 ENCROACHMENT STATIONS=     132.4     424.8  TYPE=     4  TARGET=        .162
 33700.00     18.54    703.54        0    702.37    703.85      .30      4.31       .03    693.20
    8000.     1708.     4132.    2159.      945.      701.    1169.      220.       22.    693.20
      .24      1.81      5.90     1.85      .120      .055     .120      .061    685.00    132.37
  .001379     3000.     3800.    3000.         3         0        1         0    292.40    424.77


 2800 NAT Q1=  2190.08  WSEL=    704.28  ENC Q1=   2190.08  WSEL=    705.28  RATIO=        0
 NAT Q1=   2536.  RATIOS LOB,CH,ROB=   .0748    .4103    .5149  WSEL=    705.28

3470 ENCROACHMENT STATIONS=     112.3     349.5  TYPE=     4  TARGET=        .136
 35100.00     19.41    705.41        0    704.28    705.72      .31      1.87       .00    689.20
    8000.       34.     3795.    4171.       42.      619.    2045.      308.       31.    693.20
      .34       .79      6.13     2.04      .120      .055     .120      .060    686.00    112.28
  .001302     1000.     1400.    1500.         2         0        1         0    237.26    349.54


 2800 NAT Q1=  2394.66  WSEL=    706.37  ENC Q1=   2394.66  WSEL=    707.37  RATIO=        0
 NAT Q1=   2793.  RATIOS LOB,CH,ROB=   .2432    .4761    .2806  WSEL=    707.37

3470 ENCROACHMENT STATIONS=      99.8     343.9  TYPE=     4  TARGET=        .143
 36950.00     19.46    707.46        0    706.37    707.78      .32      2.05       .00    693.20
    8000.     1617.     4423.    1960.      913.      752.    1072.      412.       40.    693.20
      .46      1.77      5.88     1.83      .120      .055     .120      .059    688.00     99.83
  .001089     1600.     1850.    1600.         3         0        1         0    244.06    343.90


 2800 NAT Q1=  1918.37  WSEL=    710.38  ENC Q1=   1918.37  WSEL=    711.38  RATIO=   -.0000
 NAT Q1=   2196.  RATIOS LOB,CH,ROB=   .0367    .6697    .2936  WSEL=    711.38
   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST
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3470 ENCROACHMENT STATIONS=       95.0     220.3   TYPE=      4  TARGET=       .126
 40150.00     18.70     711.70        0    710.38   712.25     .55      4.41      .07    699.20
   8000.          0      5894.    2106.        0.     873.    795.      561.      52.     699.20
     .61          0      6.75     2.65      .120     .055    .120      .059   693.00     95.00
 .001996      2800.     3200.    2800.         3        0       1         0   125.25    220.25

 2800 NAT Q1=   1486.52  WSEL=     711.62  ENC Q1=   1486.52  WSEL=    712.62  RATIO=        0
 NAT Q1=   1724.  RATIOS LOB,CH,RUB=   .0286    .7124    .2590  WSEL=    712.62

3470 ENCROACHMENT STATIONS=       95.0     209.5   TYPE=      4  TARGET=       .138
 40800.00     17.11     713.11        0    711.62   713.94     .83      1.61      .09    702.20
   8000.          0      6409.    1591.        0.     794.    579.      584.      54.     702.20
     .63          0      8.08     2.75      .120     .055    .120      .059   696.00     95.00
 .003142       650.      650.     650.         2        0       1         0   114.45    209.45
```

SUMMARY PRINTOUT FOR MULTIPLE PROFILES

NORTH BUFFALO CR TEST T

SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE (CFS)	WSELK	STENCL	STENCR	CWSEL	PERENC	TOPWID	TQ
29900.00	0	0	0	681.20	8000.00	698.30	0	0	698.30	0	526.75	2472.20
29900.00	0	0	0	681.20	8000.00	698.30	359.00	609.00	699.30	250.00	221.75	1853.50
29900.00	0	0	0	681.20	8000.00	698.30	155.20	508.00	699.30	.12	352.80	2407.86
29900.00	0	0	0	681.20	8000.00	698.30	172.90	508.00	699.30	.16	335.10	2336.07
33700.00	3800.00	0	0	685.00	8000.00	0	0	0	702.37	0	469.24	2103.39
33700.00	3800.00	0	0	685.00	8000.00	702.37	140.00	390.00	704.73	250.00	250.00	2299.91
33700.00	3800.00	0	0	685.00	8000.00	702.37	129.09	432.86	703.38	.12	303.77	2162.44
33700.00	3800.00	0	0	685.00	8000.00	702.37	132.37	424.77	703.54	.16	292.40	2154.42
35100.00	1400.00	0	0	686.00	8000.00	0	0	0	704.28	0	329.83	2190.08
35100.00	1400.00	0	0	686.00	8000.00	704.28	7.50	257.50	706.44	250.00	219.42	2110.78
35100.00	1400.00	0	0	686.00	8000.00	704.28	111.31	350.91	705.25	.12	239.60	2185.77
35100.00	1400.00	0	0	686.00	8000.00	704.28	112.28	349.54	705.41	.14	237.26	2217.35
36950.00	1850.00	0	0	688.00	8000.00	0	0	0	706.37	0	421.90	2394.66
36950.00	1850.00	0	0	688.00	8000.00	706.37	88.00	338.00	708.48	250.00	250.00	2772.98
36950.00	1850.00	0	0	688.00	8000.00	706.37	97.88	341.10	707.36	.12	243.22	2391.18
36950.00	1850.00	0	0	688.00	8000.00	706.37	99.83	343.90	707.46	.14	244.06	2424.55
40150.00	3200.00	0	0	693.00	8000.00	0	0	0	710.38	0	238.81	1918.37
40150.00	3200.00	0	0	693.00	8000.00	710.38	.01	245.00	711.54	250.00	188.38	2151.19
40150.00	3200.00	0	0	693.00	8000.00	710.38	95.00	221.68	711.68	.12	126.68	1789.13
40150.00	3200.00	0	0	693.00	8000.00	710.38	95.00	220.25	711.70	.13	125.25	1790.48
40800.00	650.00	0	0	696.00	8000.00	0	0	0	711.62	0	212.81	1486.52
40800.00	650.00	0	0	696.00	8000.00	711.62	.01	245.00	712.53	250.00	177.00	1661.28
40800.00	650.00	0	0	696.00	8000.00	711.62	95.00	208.95	713.09	.12	113.95	1421.57
40800.00	650.00	0	0	696.00	8000.00	711.62	95.00	209.45	713.11	.14	114.45	1427.22

SECTION NUMBER	DISCHARGE CFS	CWSEL	CWSEL DIFF EACH Q	CWSEL DIFF EACH SECTION	CWSEL-WSELK	TOPWID	T.W. DIFF	LENGTH
29900.000	8000.000	698.300	0	0	0	526.750	0	-0
29900.000	8000.000	699.300	1.000	0	0	221.750	305.000	-0
29900.000	8000.000	699.300	0	0	0	352.802	173.948	-0
29900.000	8000.000	699.300	0	0	0	335.103	191.647	-0
33700.000	8000.000	702.374	0	4.074	0	469.243	0	3800.000
33700.000	8000.000	704.729	2.356	5.429	2.356	249.999	219.244	3800.000
33700.000	8000.000	703.379	-1.350	4.079	1.006	303.768	165.475	3800.000
33700.000	8000.000	703.545	.166	4.245	1.171	292.402	176.841	3800.000
35100.000	8000.000	704.283	0	1.910	0	329.827	0	1400.000
35100.000	8000.000	706.441	2.157	1.712	2.157	219.423	110.404	1400.000
35100.000	8000.000	705.251	-1.189	1.872	.968	239.601	90.226	1400.000
35100.000	8000.000	705.410	.158	1.865	1.127	237.259	92.567	1400.000
36950.000	8000.000	706.369	0	2.086	0	421.902	0	1850.000
36950.000	8000.000	708.479	2.110	2.038	2.110	249.999	171.903	1850.000
36950.000	8000.000	707.356	-1.123	2.105	.987	243.221	178.680	1850.000
36950.000	8000.000	707.457	.101	2.047	1.088	244.065	177.837	1850.000

40150.000	8000.000	710.376	0	4.007	0	238.809	0	3200.000
40150.000	8000.000	711.545	1.168	3.066	1.168	188.377	50.432	3200.000
40150.000	8000.000	711.681	.136	4.325	1.304	126.683	112.126	3200.000
40150.000	8000.000	711.702	.021	4.245	1.326	125.251	113.558	3200.000
40800.000	8000.000	711.624	0	1.248	0	212.807	0	650.000
40800.000	8000.000	712.533	.909	.988	.909	176.996	35.811	650.000
40800.000	8000.000	713.090	.557	1.409	1.466	113.946	98.861	650.000
40800.000	8000.000	713.110	.020	1.408	1.486	114.450	98.357	650.000

DATA FOR LAST CROSS SECTION

PROFILE	TYPE ENC	TARGET	TOP WIDTH AREA-ACRES	TOP WIDTH AREA-DIFF
1	0	0	86.385	0
2	2.000	250.000	50.070	-36.316
3	3.000	.120	55.180	-31.206
4	4.000	.138	53.914	-32.471

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CROSS SECTION       1.00
RIVER  FLAT CREEK TEST 0
DISCHARGE=     16000.

PLOTTED POINTS (BY PRIORITY)=B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL

ELEV 1200.    1205.     1210.     1215.     1220.     1225.     1230.     1235.     1240.     1245.     1250.

    STA=FEET

3    0  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX         .         .         .         .         .     BANK,
     2. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
     4. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
     6. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
     8. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    10. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    12. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    14. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    16. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    18. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    20. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    22. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    24. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    26. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    28. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    30. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    32. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    34. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    36. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    38. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    40. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    42. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    44. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    46. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    48. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    50. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    52. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    54. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    56. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    58. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    60. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    62. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    64. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    66. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    68. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    70. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    72. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    74. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    76. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    78. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    80. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    82. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    84. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    86. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    88. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    90. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    92. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    94. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    96. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
    98. X         .       C .         W   E     .         .         .         .         .         .         .         .         .
5  100. XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX         .         .         .         .         .     BANK,
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NRD=        0 ELLC=  9999999.00 ELTRD=  9999999.00

  EL(I),STA(I)
   1230.00          -0      1200.00          0      1200.00      100.00      1230.00      100.00
```
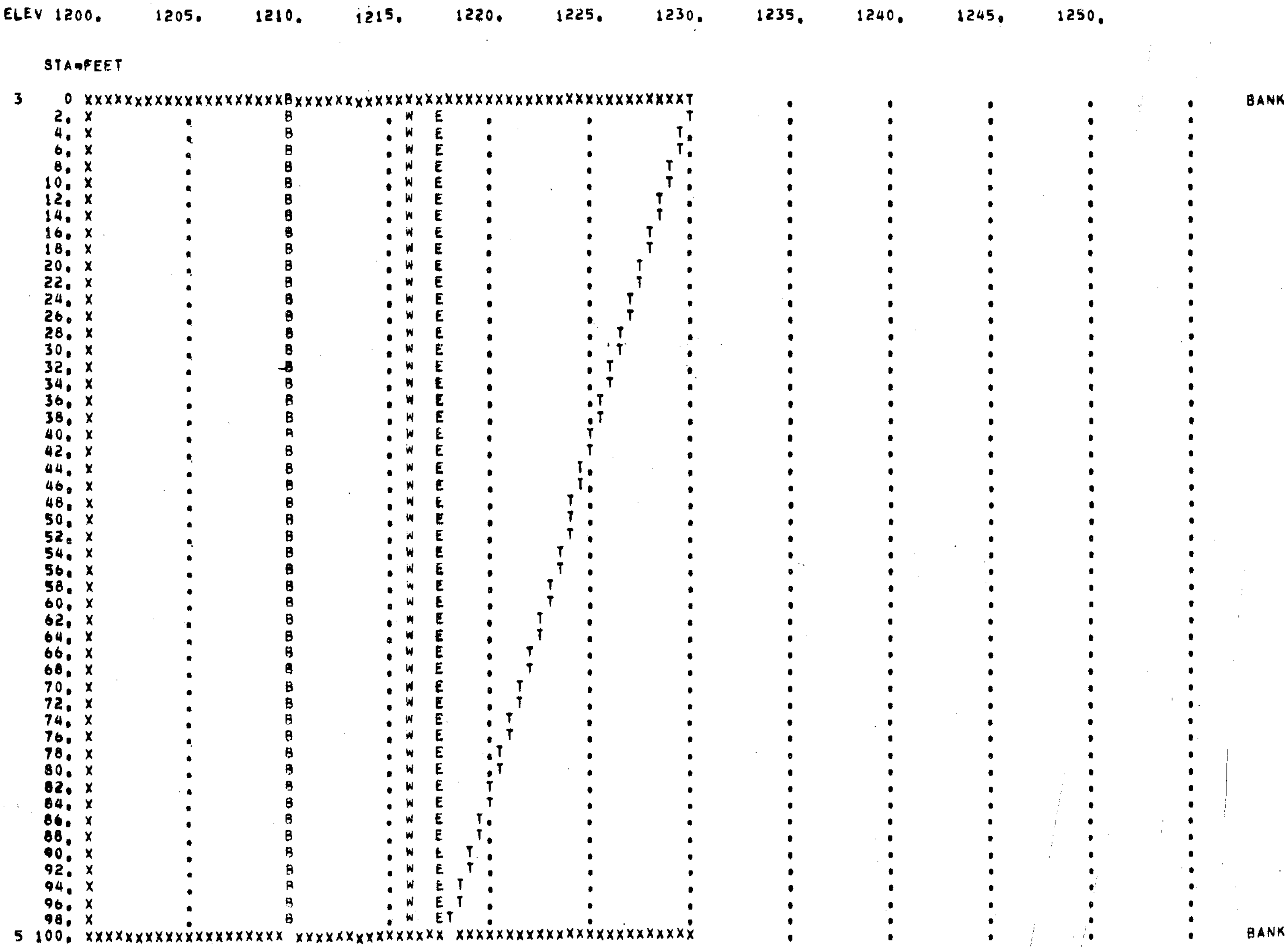

CROSS SECTION 2.00
RIVER FLAT CREEK TEST O
DISCHARGE= 16000.

PLOTTED POINTS (BY PRIORITY)=B=BOTTOM BRIDGE,T=TOP BRIDGE,X=GROUND,W=WATER SUR,E=ENERGY GRADIENT,C=CRITICAL WSEL



104

```
NRD=        8 ELLC=     1210.00 ELTRD=      1212.00

        0   1210.00   1230.00   100.00   1210.00   1218.00   200.00   1210.00   1215.00
   300.00   1210.00   1212.00   400.00   1210.00   1215.00   500.00   1210.00   1230.00
 EL(I),STA(I)
   1230.00       -0    1200.00        0   1200.00    100.00   1230.00    100.00
```


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EXHIBIT 9

OUTPUT DATA DESCRIPTION

A. All variables discussed below apply to the cross section identified by SECNO.

Variable	Description
*SECNO	Identifying cross section number. Equal to the number in first field of card X1.
*DEPTH	Depth of flow.
*CWSEL	Computed water surface elevation.
*CRIWS	Critical water surface elevation.
*WSELK	Known water surface elevation from high water mark.
*EG	Mean energy gradient elevation across the entire cross section which is equal to the computed water surface elevation CWSEL plus the mean velocity head HV.
*HV	Mean velocity head across the entire cross section.
*HL	Energy loss due to friction.
*OLOSS	Energy loss due to minor losses such as transition losses.
*Q	Total flow in the cross section.
*QLOB	Amount of flow in the left overbank.
*QCH	Amount of flow in the channel.
*QROB	Amount of flow in the right overbank.
ALOB	Cross section area of the left overbank.
*ACH	Cross section area of the channel.
AROB	Cross section area of the right overbank.

*Variables that can be printed in the summary.

Variable	Description
*VOL	Cumulative volume (acre-feet or 1000 cubic meters) of water in the river since the first cross section.
TWA	Cumulative surface area (acres or 1000 square meters) of the river since the first cross section.
*TIME	Travel time from the first cross section to the present cross section in hours.
VLOB	Mean velocity in the left overbank.
*VCH	Mean velocity in the channel.
VROB	Mean velocity in the right overbank.
**XNL	Manning's "n" for the left overbank area.
**XNCH	Manning's "n" for the channel area.
**XNR	Manning's "n" for the right overbank area.
**WTN	Weighted value of Manning's "n" for the channel based on the distance between cross sections and channel flow from the first cross section. Used when computing Manning's "n" from high water marks.
*ELMIN	Minimum elevation in the cross section.
*SLOPE	Slope of the energy grade line. (The summary printout value has been multiplied by 10,000.)
XLOBL	Distance in the left overbank between the previous cross section and the current cross section.
*XLCH	Distance in the channel between the previous cross section and the current cross section.
XLOBR	Distance in the right overbank between the previous cross section and the current cross section.
ITRIAL	Number of trials required to balance the assumed and computed water surface elevations.

** The summary printout value has been multiplied by 1,000.

Variable	Description
IDC	Number of trials required to determine critical depth.
ICONT	Number of trials to determine the water surface elevation by the slope area method or the number of trials to balance the energy gradient in the special bridge routine.
CORAR	Area of the bridge deck subtracted from the total cross sectional area in the normal bridge routine.
*TOPWID	Cross section width at the assumed water surface elevation.
EGPRS	The energy grade line elevation computed assuming pressure flow.
EGLWC	The energy grade line elevation computed assuming low flow control.
H3	Drop in water surface elevation from upstream to downstream sides of the bridge computed using Yarnell's equation assuming Class A low flow.
QWEIR	Total weir flow at the bridge.
QPR	Total pressure flow at the bridge.
BAREA	Net area of the bridge opening below the low chord. Equals BAREA entered on Card SB.
*ELLC	Elevation of the bridge low chord. Equals ELLC entered on card X2 if used, otherwise it equals the maximum low chord in the BT table.
*ELTRD	Elevation of the top of roadway. Equals ELTRD entered on card X2 if used, otherwise it equals the minimum top of road in the BT table.
CLASS	The controlling type of flow is identified using the following coded values for this variable: 1. Low Flow - Class A 2. Low Flow - Class B 3. Low Flow - Class C 10. Pressure Flow Alone 15. Weir Flow (Overbank) and Class A Low Flow (Bridge) 30. Weir Pressure Flow (Bridge)

Variable	Description
SSTA	The station on the GR cards where the water surface intersects the ground on the left side.
STEND	The station on the GR cards where the water surface intersects the ground on the right side.
*XLBEL	Left bank elevation.
*RBEL	Right bank elevation.

B. The following variables can be printed out with the summary printout option along with those variables from the previous list that have an asterisk (*):

Variable	Description
*CASE	A variable indicating how the water surface elevation was computed. Values of -1, -2, and 0 indicate assumptions of critical depth, minimum difference or a balance between the computed and assumed water surface elevations.
STCHL	Station of the left bank.
STCHR	Station of the right bank.
STENCL	The station of the left encroachment.
STENCR	The station of the right encroachment.
CLSTA	The centerline station of the trapezoidal excavation.
BW	The bottom width of the trapezoidal excavation.

FEBRUARY 1972

HEC-2 WATER SURFACE PROFILES

USERS MANUAL SUPPLEMENT

FOR

FLOODWAY DETERMINATIONS

HEC-2 METHODS OF SPECIFYING AND ESTABLISHING FLOOD PLAIN ENCROACHMENTS

Method 1. Stations and elevations of the left and/or right encroachment can be specified on the X3 card for individual cross sections as desired. Stations can also be specified differently for each profile by using the ET card. A 9.1 in the INQ field (J1.2) of the ET card would indicate that method 1 is being used (for the next cross section only) and the left and right encroachment stations are specified on fields 9 and 10 of the ET card. See figures on pages 3-5.

Method 2. A fixed topwidth can be specified on an ET or X3 card which will be used for all cross sections until changed by another X3 or ET card. The left and right encroachment stations are made equidistant from the centerline of the channel, which is half way between the left and right bank stations. Card ET is used to specify different topwidths for each profile of a multiple profile run. A 200.2 indicates a 200 foot width will be used for method 2. No provision is made to insure that all of the channel area is retained as flow area.

Method 3. Encroachments can be specified by percentages which indicate the desired proportional reduction in the natural (first profile) discharge carrying capacity (conveyance) of each cross section. This conveyance option is requested by percentages on the ET cards (variable INQ indicates which field of the ET cards is used for each profile), and are changed by inserting another ET card ahead of the appropriate cross section. A 10.3 value (the three indicates method 3) on the ET card for the second profile would indicate that 5 percent of the flow carrying capacity (if possible), based on the first profile, will be eliminated on each side of the main channel as long as the encroachments do not fall within the main channel. If one side cannot carry the 5 percent reduction, a reduction of more than 5 percent will be attempted on the other side. The first profile is for natural conditions; different sets of ratios can be specified for all subsequent profiles. The computed water surface elevation (code 1) must be requested if a J3 card is used.

Method 4. Backwater can be performed using encroachments that are determined so that each modified cross section will have the same discharge carrying capacity (at some higher elevation) as the natural cross section. This higher elevation is specified on the ET card as a fixed amount above the natural (e.g., 100 year) profile and by computing the natural profile as the first computer run. The discharge carrying capability for each natural cross section is stored from the first profile by requesting the conveyance (TQ-code = 34) along with the computed water surface elevation (CWSEL-code = 1) on the J3 card. The encroachments are determined so that an equal loss of conveyance (at the higher elevation) occurs on each side of the channel if possible. If half of the loss cannot be obtained on one overbank, the difference will be made up, if possible, by the other overbank, except that encroachments will not be allowed to fall within the main channel. A 10.4 on the ET card indicates that a 1-foot rise (value is in tenths of a foot on the left side of the decimal point) will be used for method 4 to determine the encroachments based on equal conveyances. The first profile is for natural conditions and subsequent profiles can be computed for different amounts of rise.

Method 5. The encroachment stations can be established based on the topwidth limits of a previously computed base flood profile. A typical series of profiles are shown below for two different base floods. The codes shown must appear on the third field of the J1 card.

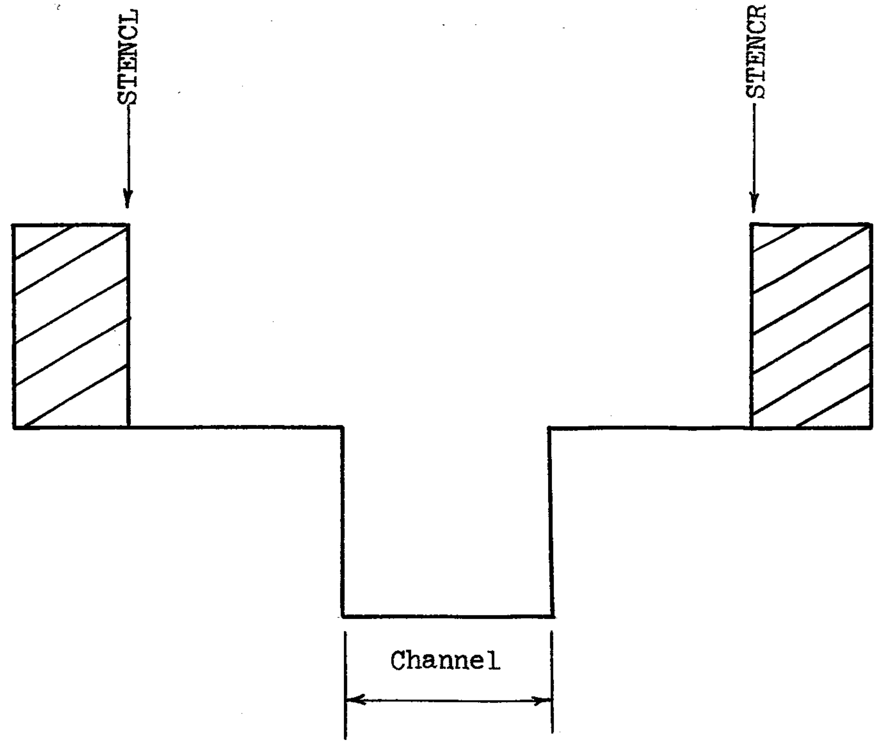
Profile	NINV Code	Description
1	-201	100 year flood - natural
2	-202	50 year flood - natural
3	-203	100 year flood using 50 year topwidths
4	-202	30 year flood - natural
5	-203	100 year flood using 30 year topwidths
6	-204	SPF using 30 year topwidths
7	-201	SPF natural

Profiles 2 and 3 or 4 and 5 may be computed without the others since the natural profiles for 1 and 7 (code= - 201) are for comparison only. The topwidths from profile 2 and 4 (code= -202) are used as encroachments for profiles 3 and 5 (code= -203) respectively. If desired, the computed water elevations and topwidths from a code of -203 can be used to evaluate the effects on a larger flood that is computed using a -204 code. The first profile must have a J3 card which contains the identification codes 27, 28, 31, and 32.

FLOW DISTRIBUTION

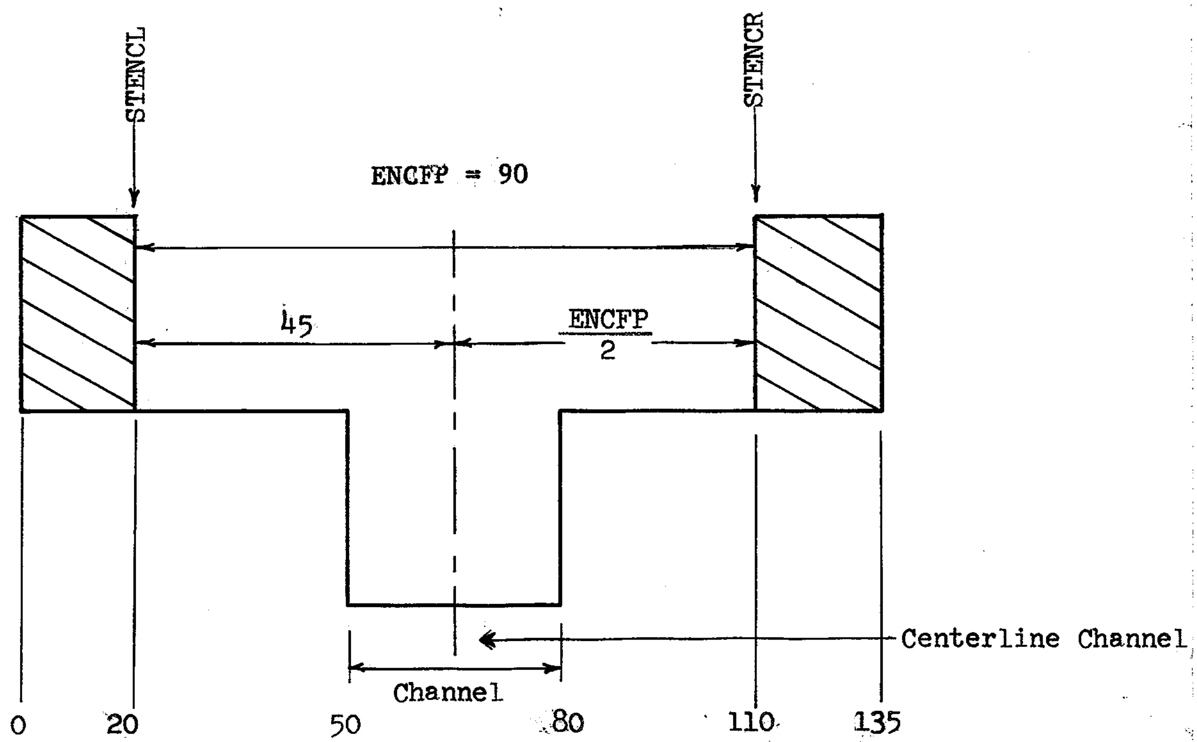
The horizontal distribution of area, velocity and discharge will be printed for the overbank subareas (formed by points on the GR card) and for the channel if variable ITRACE (J2.10 or X2.10) is equal to 15. If the number of subareas carrying flow in the overbanks is less than 11, the distribution using all subareas will be printed. Otherwise, the distribution will be based on subareas that carry more than 3 percent of the flow.

METHOD 1



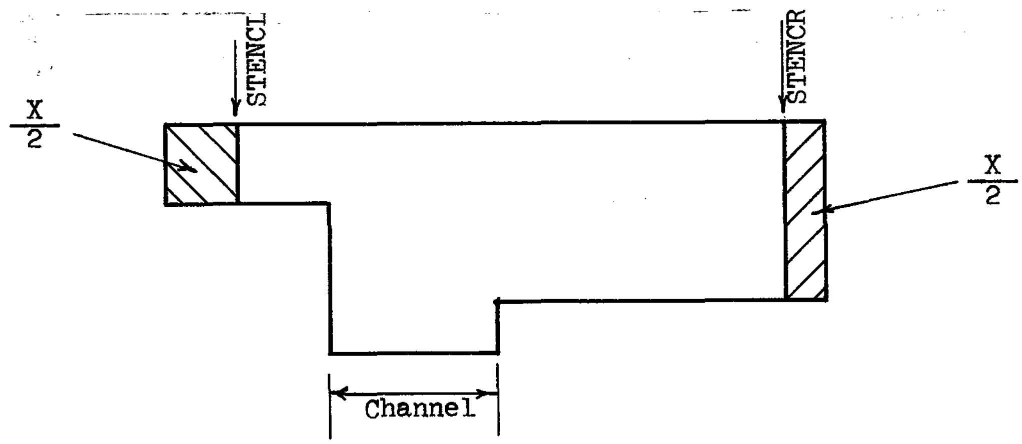
Encroachment stations STENCL and STENCR are specified on X3 or ET cards

METHOD 2



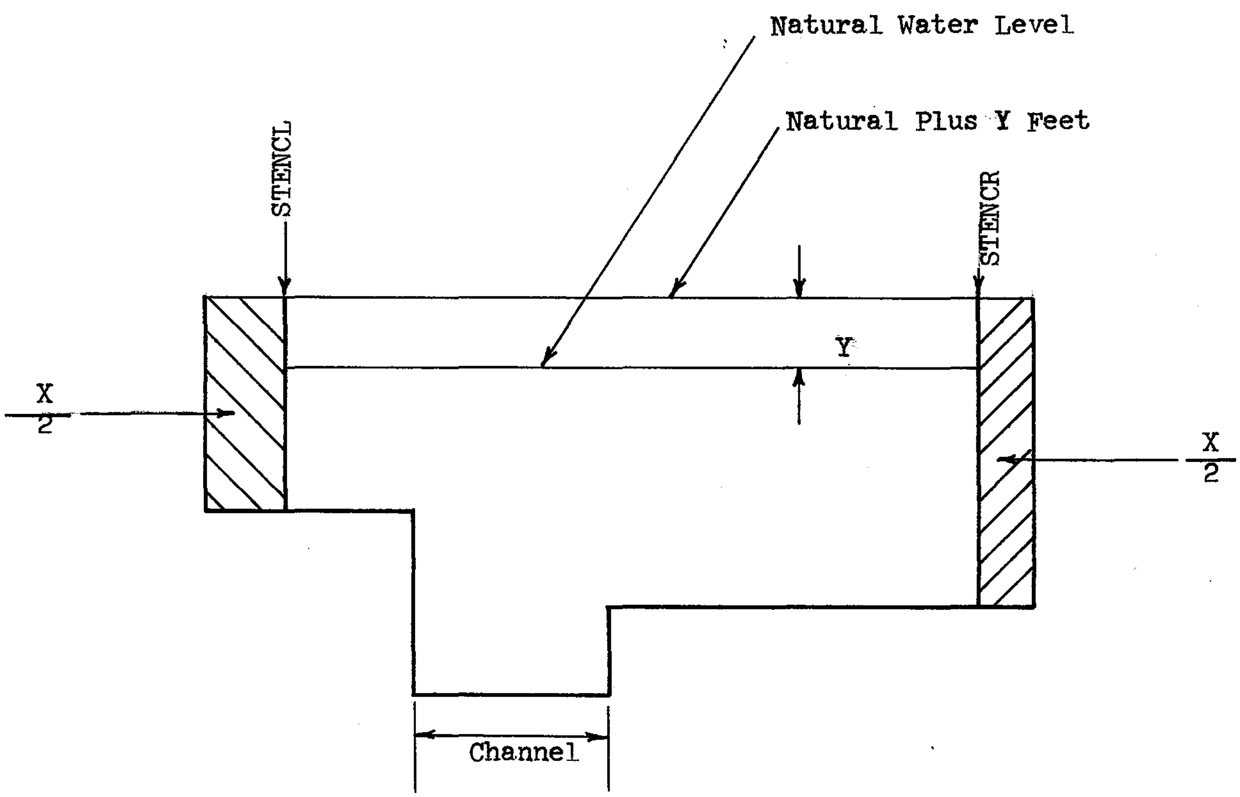
Encroachment stations are computed from the width ENCFP which is centered on the midpoint of the left and right bank stations. ENCFP is read on the X3 or ET card.

METHOD 3



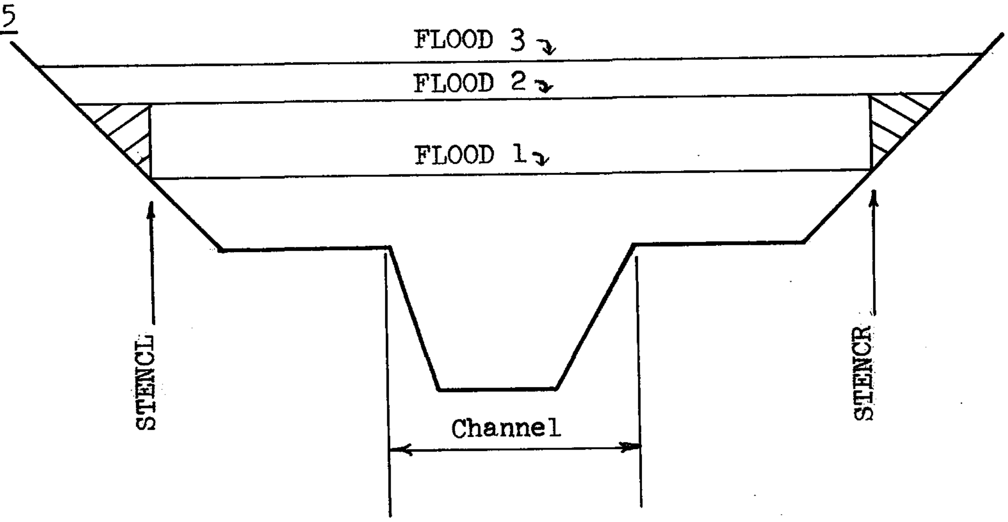
Encroachment stations are determined from the percent (X) reduction in conveyance specified on the ET card such that the total conveyance for each cross-section of the natural profile is reduced by "X" percent if possible. One-half the reduction is made on each side (if possible) as long as the encroachments do not infringe on the main channel. The flow area will be limited to the channel if the percentage X requires a greater reduction than is available from the natural overbanks.

METHOD 4



Encroachment stations are determined, when requested by the ET card, so that the conveyance of the cross section with encroachments and a water level Y feet above the natural profile is the same as the conveyance of the unmodified cross-section for the natural water level.

METHOD 5



Encroachment stations for Floods 2 and 3 are determined from the topwidth limits of the profile for Flood 1. The elevation for Flood 2 becomes the elevation of encroachment for the profile for Flood 3. The J1 and J3 cards are used to request this method.

INPUT INSTRUCTIONS

CARD J1

The slope area method of starting should not be used for the encroachment profile. STRT(J1.5) must be 0. Variable NINV(J1.3) is used for Method 5, see page 2.

CARD J2

Field	Variable	Value	Description
10	ITRACE	0	No trace for this job unless specified by individual cross sections using ITRACE on Card X2(X2.10).
		1	Trace of all major loops for all cross sections.
		10	Trace of major and minor loops for all cross sections. (Large amount of output.)
		15	Flow distribution printout for all cross sections (no major or minor trace for all cross sections).

USE OF J3 CARD FOR CHANNEL ENCROACHMENTS

The following additional variables have been added to the previous list of 30 variables that can be selected for the summary output. Only seven of the 37 variables can be selected.

CODE NUMBER	VARIABLE	DEFINITION
31	ELENCL	Elevation of left encroachment
32	ELENCR	Elevation of right encroachment
33	CHSLOP	Channel slope
34	TQ	The total discharge (index Q) carried with $S^{1/2}$=.01
35	ITYENC	Type of encroachment desired (see ET card)
36	PERENC	The target of encroachment requested on ET card
37	TWA	The cumulative topwidth area

The following 7 variables are recommended for use with the encroachment types indicated. Those variables with *astericks are required.

	Encroachment Method		
Order No.	3	4	5
1	1*	1*	27*
2	36	34*	28*
3	3	36	31*
4	4	4	32*
5	27	27	1
6	28	28	4
7	9	9	9

Card ET (Encroachment Table)

An additional input card ET may be inserted with other change cards (NC, QT, NH, or NV) in front of the X1 card where the change is applicable. This card specifies the method of encroachment selected (1-4) and the target of the encroachment. This method and target will be used until changed by another ET card (except for method 1). A zero on the first ET card indicates no encroachment, while a zero on succeeding ET cards indicates no change in encroachment. The field of the ET card that is used for a particular profile is the value of INQ on the second field of the J1 card. Encroachment methods 3-4 require a natural profile for the first profile and thus require reading a zero on the ET card in the "INQ" field for the first profile. If methods 2-4 are used with the ET card for first few cross sections and it is desired to stop the encroachment option, use method 1 with the encroachment stations specified near the two ends of the cross section.

Field	Variable	Value	Description
0	IA	ET	Card identification characters.
1	none	none	Blank field.
2-10	ENCFP(N)	0	No encroachment.
		+	Encroachment option is used. The number XXX.Y is used to specify that method Y is being used and XXX is the target to be used for that method. Up to 9 values may be specified. The encroachment method or target may be changed at any cross section or on different profiles. Targets used for the methods are as follows:

Method	Value	
1	X.1	The Xth and Xth+1 fields of the ET card will be used for the encroachment stations STENCL and STENCR.
2	X.2	The topwidth of X will determine encroachments stations such that the center of the topwidth will be centered half way between bank stations.
3	X.3	The natural cross section will be modified so that X percent of the total conveyance will be eliminated. The J3 card must have code 1.
4	X.4	The natural cross section will be modified so that with a (X/10) foot increase the modified cross section will have the same conveyance. A one foot increase would require a 10.4 and a .5 foot increase would require a 5.4. The J3 card must have codes 1 and 34.

COMPUTER OUTPUT FOR FLOODWAY DETERMINATION

1. NOTES IN NORMAL OUTPUT

a. 3470 ENCROACHMENT STATIONS = W, X TYPE = Y, TARGET = Z. The values of STENCL and STENCR (left and right encroachment stations) are W and X. The method used in determining these stations is method Y and the specified target (width or percent) for that method is Z. If the target is a percent, a ratio less than one is used instead of percent so that a percent target can be distinguished from a topwidth target.

b. 2800 NATURAL Q1 = A, WSEL = B, ENC Q1 = C, WSEL = D, RATIO = E. This note is printed out for encroachment types 3 and 4 only. The index discharge (Q assuming $S^{1/2}$ = .01) is equal to A for the natural profile at the water elevation of B. The index discharge for the encroached cross section is equal to C at elevation D. Elevation D is equal to B for method 3, but is higher for method 4. The reduction ratio of 1-(C/A) is shown as E. This ratio for type 3 is normally equal to the target for note 3470 which is based on the input percentage on the ET card. E will be less than the target if the overbanks do not carry the target percentage of flow. This ratio is normally equal to zero for type 4 (the target on note 3470 will be the equivalent ratio for method 3), since there is no reduction in the flow carrying capability except for the raise in water elevation from B to D. When this reduction ratio, E, is negative, there is an increase in the index Q using only the channel area.

2. SECOND SUMMARY PRINTOUT

Immediately following the standard summary printout, a second summary is printed. The column headings for the second summary printout are described below. Part of this second summary is for the encroachment routines.

a. SECTION NUMBER

b. DISCHARGE - CFS

c. CWSEL. The computed water surface elevation.

d. CWSEL DIFF-EACH Q. For a given cross section, the difference between the computed water elevations for each succeeding pair of profiles is shown.

e. CWSEL DIFF-EACH SECTION. The difference between the computed water elevations for this and the preceding cross section (same profile).

f. CWSEL-WSELK. The difference between the computed water elevations for each profile and the first profile (which should be the natural profile for encroachment options).

g. TOPWID. The topwidth for each profile.

h. T.W. DIFF. The difference between the topwidths for each profile and the first profile.

i. LENGTH. The channel length between cross sections.

3. SUMMARY OF TOPWIDTH AREAS

Following the second summary printout is the note: DATA FOR LAST CROSS SECTION, which is followed by the following five columns:

a. PROFILE. Order number of profile.

b. TYPE OF ENC. The code for the type of encroachment used on the last cross section (see input description).

c. TARGET. The target specified by input for the above type of encroachment for the last cross section.

d. TOPWIDTH AREA - ACRES. The cumulative surface area (in acres) of the water from the first to the last cross section based on cumulating the product of the average topwidths and the overbank and channel distances.

e. TOPWIDTH AREA - DIFF. The difference between the topwidth areas (column d) for each profile and the first profile. This shows the amount of land that is removed from the floodway by each different encroachment scheme.

EXHIBIT 10

INPUT DATA DESCRIPTION

This exhibit contains a detailed description of each variable on each input card. It also contains a Functional Use Index which can be used to determine which input variables are required for specific tasks. The Summary of Input Cards shows the sequential arrangement of cards.

Variable locations for each input card are shown by field number. Each card is divided into ten fields of eight columns each except field 1. Variables occuring in field 1 may only occupy card columns 3-8 since card columns 1 and 2 (called field 0 for simplicity) are reserved for required identification characters. The different values a variable may assume and the conditions for each are described for each variable. Some variables simply indicate whether a program option is to be used or not by using the numbers -1, 0, 1. Other variables contain numbers which express the variable magnitude. For these a + sign is shown in the description under "value" and the numerical value of the variable is entered as input. Where the variable value is to be zero the variable may be left blank since a blank field is read as zero.

If decimal points are not punched in the data, all numbers must be right justified in the field. Any number without a sign is considered positive.

TABLE OF CONTENTS

FUNCTIONAL USE INDEX

Task	Cards Used
1. Basic Applications	T1, T2, T3, J1(4-9), NC, X1(1-9) GR, EJ, ER*
2. Multiple Profiles, Summary Printout	J2(1), J3
3. Optional Cards for Roughness Description	J2(6), NH, NV
4. Optional Cards for Specifying Discharge	J1(2,10), X2(1), QT
5. Bridge Losses	X2(3,6,9), BT, SB
6. Specification of Ineffective Flow Areas	X3, ET
7. Direct Solution for Manning's n	J1(3), X2(2)
8. Additional Ground Points	X4
9. Plots of Cross Sections and Profiles	J2(2-5), X1(10)
10. Traces and Data Printout	J1(1), X2(10), J2(10)
11. Data Comment Cards	C_
12. Critical Depth Option	J2(7)
13. Channel Modification Due to Excavation	J2(8,9), CI
14. Storage-Discharge Output	J4

*Numbers in parentheses refer to card fields 1-10.

C

DATA COMMENT CARDS

CARDS C_ - OPTIONAL CARD

Title cards (for labeling cross sections) which appear immediately ahead of the T1 card will be printed just ahead of the cross section whose number appears in field 1 of cards 3-100. At least 3 comment cards are required since the first two are not printed.

Card Number	Field	Variable	Value	Description
1	0	IA	C_	Card identification characters (C, blank).
1	1-10	--	--	Blank.
2	0	IA	C_	Card identification characters.
2	1	NUMCT	+	Number of data comment cards to be printed (up to 98).
2	2-10	--	--	Blank.
3-100	0	IA	C_	Card identification characters.
	1	CNOS		Cross section number (field 1 of X1 card) where title is to be printed.
3-100	2-10	COCD		Title to be printed ahead of cross section number CNOS.

T

JOB OUTPUT

TITLE CARDS - REQUIRED CARDS

CARDS T1, T2, T3

a. CARD T1

Title card for output title. This card is required for each job.

Field	Variable	Value	Description
0	IA	T1	Card identification characters.
1-10	none		Numbers and alphabetical characters for title.

b. CARD T2

Title card for output title. This card is required for each job.

Field	Variable	Value	Description
0	IA	T2	Card identification characters.
1-10	none		Numbers and alphabetical characters for title.

c. CARD T3

Title card for output title. The river name should be entered in card columns 9-32 for output in the title of the cross section and profile plots. This card is required for each job.

Field	Variable	Value	Description
0	IA	T3	Card identification characters.
1		0	Not used.
2,3,4	TITLE		Title for cross section and profile plots.
5-10	none		Numbers and alphabetical characters for title.

JOB CARDS

CARD J1

Job card specifying starting conditions and program options for this job. This card is required for each job.

Field	Variable	Value	Description
0	IA	J1	Card identification characters.

DATA PRINTOUT

Field	Variable	Value	Description
1	ELRAN	-10	Do not print data cards NC-EJ.
		0 or -1	Print data cards NC-EJ before execution.
		+	Specified allowable maximum elevation minus minimum elevation range for BT and GR cards. (For use in Data Edit Program only.)

OPTION FOR SPECIFYING DISCHARGE

Field	Variable	Value	Description
2	INQ	0	Card QT or ET is not used.
		2 to 20	Field number of flow on Card QT and ET to be used for job.

OPTION FOR DIRECT SOLUTION OF "n"

Field	Variable	Value	Description
3	NINV	0	Option to compute Manning's "n" from known high water marks will not be used.
		1	Manning's "n" will be computed from known high water marks. Enter known water surface elevation as variable WSELK on second field of Card X2(X2.2) for each cross section.
		-201 Thru -204	Method 5 encroachment. See J3 and ET cards (pages 10 and 20 of Exhibit 10) for additional information. This method is not available in the November 1976 version of HEC-2.

REQUIRED BASIC DATA

Field	Variable	Value	Description
4	IDIR	0	Subcritical flow. Cross sectional data (GR cards) are read starting at the downstream end.
		1	Supercritical flow. Cross sectional data are read starting at the upstream end.
5	STRT	-1	Start computations at critical depth. Enter approximate WSEL in field 9.
		0	Start with known water surface elevation. Enter WSEL in field 9.
		+	Start by slope-area method. Enter estimated energy slope here. Enter approximate WSEL in field 9.
6	METRIC	0	Input and output in English units.
		1	Input and output in Metric units.
7	HVINS	0 or -1	No interpolated cross sections to be inserted by computer.
		+	Enter maximum allowable change in velocity head between cross sections. If this value is exceeded, interpolated cross sections will be inserted by computer.
8	Q	0	Only if INQ(J1.2) is 2 or greater.
		+	Starting river flow.
9	WSEL	+	If STRT(J1.5) is zero enter known starting water surface elevation. If STRT is + or - enter approximate water surface elevation.

OPTION FOR CHANGING JOB DISCHARGES

Field	Variable	Value	Description
10	FQ	0	A factor of 1.0 will be used.
		+	Factor to multiply all flows by.

MULTIPLE PROFILES

CARD J2 - OPTIONAL CARD

Field	Variable	Value	Description
0	IA	J2	Card identification characters.
1	NPROF	0 or 1	Cross section cards (X1 and GR) will be read.
		-1	Calls for summary printout for a single-profile job.
		2-14	Profile number using cross section data from previous job (omit cards NC through EJ). Up to 14 profiles using 300* cross sections on each can be computed without re-entering cards NC through EJ.
		15 or greater	Same as above except this is last profile, and therefore the summary printout will be called.

PLOTS OF CROSS SECTIONS AND PROFILES

Field	Variable	Value	Description
2	IPLOT	0	No cross sections will be plotted for this job unless individual plots are specified by using IPLOT on Card X1(X1.10).
		1	Plot all points of all job cross sections.
		10	Plot cross section points up to water surface elevation for all cross sections.
3	PRFVS	0	Computer selects vertical scale of profile plot for current profile based on an elevation spread not exceeding 12 inches.
		+	User selects vertical scale to be used for current profile. Enter number of elevation units per inch.
		-	No profile will be plotted.
4	XSECV	0	Computer selects vertical scale of cross section plot for each cross section individually.

*NOTE: The November 1976 version will compute up to 14 profiles using 800 cross sections.

CARD J2 (cont)

Field	Variable	Value	Description
		+	User selects vertical scale to be used for all cross sections. Enter number of elevation units per inch.
5	XSECH	0	Computer selects horizontal scale of cross section plot for each cross section infividually.
		+	User selects horizontal scale to be used for all cross sections. Enter number of horizontal units (feet or meters) per line of output. If the vertical scale of the profile (PRFVS) is given, then the value of XSECH will be used for the horizontal scale of both the cross sections and profiles.

OPTIONAL CHANGE OF ROUGHNESS

Field	Variable	Value	Description
6	FN	0	A factor of 1.0 will be used.
		+	Factor to multiply all Manning's "n" values by.
		-	Factor to multiply channel "n" by. No change in overbank "n".

CRITICAL DEPTH OPTION

Field	Variable	Value	Description
7	ALLDC	-1	Critical depth will be computed for all cross sections using an allowable error of 2.5 percent of the depth.
		-	Critical depth will be computed for all cross sections using an allowable error of ALLDC percent of the depth.*
		0	Critical depth will not be computed unless the actual depth is close to critical (except when low flow occurs for the special bridge routine and when super critical flow profiles are computed). When critical depth is computed, the allowable error of 2.5 percent of the depth will be used.
		+	Critical depth will not be computed unless the actual depth is close to critical. When critical depth is computed, the allowable error of ALLDC percent will be used.

*NOTE: This capability is only in the November 1976 version of HEC-2.

CARD J2 (cont)

CHANNEL MODIFICATION DUE TO EXCAVATION

Through the use of subroutine CHIMP the existing cross section (as described by GR cards) may be modified by a trapezoidal channel excavation as specified by the use of the optional card CI and the 8th and 9th fields of the J2 card. The CI card should be located after the X1 card of the cross sections where the improvement applies. The trapezoidal modification will start on the first cross section that has a CI card and will continue on each cross section until a CI card is read that has .01 for the channel bottom. Any changes in the variables on the CI card must be made by another CI card. Only those variables that change need to be shown on the CI card.

Field	Variable	Value	Description
8	IBW	0	If a CI card is read, the 6th field of the CI card will be used to describe the bottom width of the improvement.
		6-10	Field number of channel bottom width on CI card to be used for this profile.
9	CHNIM	0	Overbank N values are unchanged.
		+	NH card (horizontal n value variation) is simulated by computer so that the channel n value is used for a distance of CHNIM on each side of the left or right bank stations (which may be modified by the channel excavation described by the CI card).

TRACES AND DATA PRINTOUT

Field	Variable	Value	Description
10	ITRACE	0	No trace for this job unless specified by individual cross sections using ITRACE on Card X2(X2.10).
		1	Major trace for all cross sections.
		10	Major and minor trace for all cross sections. (Large amount of output.)
		15	Flow distribution printout for all cross sections (no major or minor trace for all cross sections).

MULTIPLE PROFILES, SUMMARY PRINTOUT

CARD J3

Optional card. Used on first profile of a multiple profile run.

Job card specifying option of selecting from 7 to 9 variables for summary printout (see J2.1) which are different from the seven standard variables. The 6 variables SECNO, XLCH, ELTRD, ELLC, ELMIN, Q will normally be printed. The first seven variables shown below will also be printed if this card is omitted. If one or more of the variables 8-37 are desired, then the seven numbers corresponding to the desired variables should be placed in fields 1-7. Variables of ELTRD and ELLC can be replaced by two other variables (selected by fields 8 and 9) if they do not vary with each profile (generally the variables with *).

Code Number	Variable Name	Description
1	CWSEL	Computed water surface elevation.
2	CRIWS	Critical water surface elevation.
3	EG	Mean energy gradient elevation across the entire cross section which is equal to the computed water surface elevation CWSEL plus the mean velocity head HV.
4	TOPWID	Cross section width at the assumed water surface elevation.
5	SLOPE	Slope of the energy grade line for the current section.
6	TIME	Travel time from the first cross section to the present cross section in hours.
7	VOL	Cumulative volume of water in the river since the first cross section in acre-feet.
8	DEPTH	Depth of flow.
9	WSELK	Known water surface elevation from high water mark.
10	HV	Mean velocity head across the entire cross section.
11	HL	Energy loss due to friction.

*For the November 1976 version of HEC-2 refer to page 27 in the Supplement (green pages) following this exhibit.

CARD J3 (cont)

Code Number	Variable Name	Description
12	OLOSS	Energy loss due to minor losses such as transition losses.
13	QLOB	Amount of flow in the left overbank.
14	QCH	Amount of flow in the channel.
15	QROB	Amount of flow in the right overbank.
16	XNL*	Manning's "n" for the left overbank area.
17	XNCH*	Manning's "n" for the channel area.
18	XNR*	Manning's "n" for the right overbank area.
19	WTN	Weighted value of Manning's "n" for the channel based on the distance between cross sections and channel flow from the first cross section. Used when computing Manning's "n" from high water marks.
20	CASE	A variable indicating how the water surface elevation was computed. Values of -1, -2, -3, and 0 indicate assumptions of critical depth, minimum difference a fixed change (X5 card) or a balance between the computed and assumed water surface elevations.
21	STCHL*	Station of the left bank.
22	STCHR*	Station of the right bank.
23	XLBEL*	Left bank elevation.
24	RBEL*	Right bank elevation.
25	ACH	Cross section area of the channel.
26	VCH	Mean velocity in the channel.
27	STENCL*	The station of the left encroachment.
28	STENCR*	The station of the right encroachment.
29	CLSTA*	The centerline station of the trapezoidal excavation.

CARD J3 (cont)

Code Number	Variable Name	Description
30	BW*	The bottom width of the trapezoidal excavation.
31	ELENCL	Elevation of left encroachment.
32	ELENCR	Elevation of right encroachment.
33	CHSLOP	Channel slope.
34	TQ	The total discharge (index Q) carried with $S^{\frac{1}{2}}$ =.01 (equivalent to .01 times conveyance).
35	ITYENC	Type of encroachment desired (see ET card).
36	PERENC	The target of encroachment requested on ET card.
37	TWA	The cumulative topwidth area.

The following 7 variables are recommended for use with the encroachment types indicated. Those variables with *astericks are required.

	Encroachment Method		
Order No.	3	4	5
1	1*	1*	27*
2	36	34*	28*
3	3	3	31*
4	4	4	32*
5	27	27	1
6	28	28	4
7	9	9	9

Field	Variable	Value	Description
0	IA	J3	Card identification characters.
1-7	IVAR(I)	+	Seven code numbers which correspond to the variables that are desired to be printed in the summary table.
8-9		0	ELLC and ELTRD will be used in summary table.
		+	Numbers corresponding to variables which will replace ELTRD and ELLC in the summary table. These variables cannot vary each profile.

STORAGE-DISCHARGE OUTPUT

CARD J4

Optional card used only on first profile of a series. This card provides punched cards for routing by Modified Puls using program HEC-1. The cards punched are Y,2 and 3 cards (see program description for HEC-1). This option can be used only if multiple profiles are computed and if the summary printout is requested. Routing reach cross section numbers (REACH(I)) must be on X1 cards.

If a J3 card is used to change variables used in the summary printout, then variables 6(TIME) and 7(VOL) must be shown on that card. This card requests punched routing cards.

Field	Variable	Value	Description
0	IA	J4	Card identification characters.
1	RTLEN	+	Ratio (usually=1) used to determine the number of subreaches for each routing reach. Equal to the ratio of the travel time (K) to the product of the time interval (ΔT) and the number of routing subreache steps (NSTPS). Use +1 when K=ΔT for NSTPS=1, K=2ΔT for NSTPS=2, etc. A value of 2 would provide one step when K=2ΔT.
2	HYDINT	+	Computation and tabulation interval in minutes for HEC-1.
3	NUMRT	+	Number of values of REACH(I) to be read on remainder of this card.
4-10	REACH(I)	+	Reach or section numbers where outflow values are needed. Each reach number is equal to the section number (X1.1) of the cross section at the downstream end of a routing reach except the last number which is the beginning of the upstream reach. Up to 100 values may be used.

REQUIRED CARD FOR FIRST CROSS SECTION

CARD NC

Manning's "n" and the expansion and contraction coefficients for transition losses are entered for starting each job, or for changing values previously specified.

Field	Variable	Value	Description
0	IA	NC	Card identification characters.
1	XNL	0	No change in Manning's "n" value for the left overbank.
		+	Manning's "n" value for the left overbank.
2	XNR	0	No change in Manning's "n" value for the right overbank.
		+	Manning's "n" value for the right overbank reach length which is half way between the previous and current and future and current cross sections.
3	XNCH	0	No change in Manning's "n" value for the channel.
		+	Manning's "n" value for the channel.
4	CCHV	0	No change in contraction coefficient.
		+	Contraction coefficient used in computing transition losses.
5	CEHV	0	No change in expansion coefficient.
		+	Expansion coefficient used in computing transition losses.
6-10			Not used.

OPTIONAL CARD FOR SPECIFYING DISCHARGE

CARD QT

Specified a table of flows for use in computing a series of water surface profiles. The field of the flow being used for this job is specified by variable INQ(J1.2).

Field	Variable	Value	Description
0	IA	QT	Card identification characters.
1	NUMQ	+	Total number of flows (maximum nineteen) entered on the QT cards. If two QT cards are used, field 1 on the second card would contain a flow value.
2-10	Q(N)	+	Flow values to be used for multiple profiles. Variable INQ(J1.2) indicates which field is used for this job. INQ may range from 2 to 20.

OPTIONAL CARD FOR ROUGHNESS DESCRIPTION

CARD NH

Used to permanently change the roughness coefficients (Manning's n) to values which vary with the norizontal distances from the left side of the cross section Normally the roughness coefficients should be redefined for each cross section with new geometry.

Field	Variable	Value	Description
0	IA	NH	Card identification characters.
1	NUMNH	+	Total number of Manning's "n" values entered on NH cards (maximum twenty). If more than one NH card is used, field 1 on the other cards would contain a STN(N) value.
2,4,6.. 20	VALN(N)	+	Manning's "n" coefficient between stations STN(N-1) and STN(N). The first "n" value applies from the starting left station up to STN(1). (Field 3)
3,5,7.. 19	STN(N)	+	Station corresponding to VALN(N). Each station should equal one of the stations on the next GR cards. Stations must be in increasing order.

OPTIONAL CARD FOR ROUGHNESS DESCRIPTION

CARD NV

Used to change the channel roughness coefficient "n" based on water surface elevations. Program interpolates channel "n" value for each assumed water surface elevation based on "n" vs elevation data.

Field	Variable	Value	Description
0	IA	NV	Card Identification characters.
1	NUMNV	+	Total number of Manning's "n" values entered on NV cards (maximum twenty). If more than one NV card is used, field 1 on the other cards would contain an EL(N) value.
2,4,6,. 20	VALN(N)	+	Manning's "n" coefficient for area below ELN(N). The overbank "n" values specified on Card NC will be used for the overbank roughness regardless of the values in this table.
3,5,7,. 21	ELN(N)	+	Elevation of the water surface corresponding to VALN(N) in increasing order.

ENCROACHMENT TABLE

CARD ET - OPTIONAL CARD

An additional input card ET may be inserted with other change cards (NC, QT, NH, or NV) in front of the X1 card where the change is applicable. This card specified the method of encroachment selected (1-4) and the target of the encroachment. This method and target will be used until changed by another ET card (except for method 1). A zero on the first ET card indicates no encroachment, while a zero on succeeding ET cards indicates no change in encroachment. The field of the ET card that is used for a particular profile is the value of INQ on the second field of the J1 card. Encroachment methods 3-4 require a natural profile for the first profile and thus require reading a zero on the ET card in the "INQ" field for the first profile. If methods 2-4 are used with the ET card for first few cross sections and it is desired to stop the encroachment option, use method 1 with the encroachment stations specified near the two ends of the cross section.

Field	Variable	Value	Description
0	IA	ET	Card identification characters.
1	none	none	Blank field.
2-10	ENCFP(N)	0	No encroachment.
		+	Encroachment option is used. The number XXX.Y is used to specify that method Y is being used and XXX is the target to be used for that method. Up to 9 values may be specified. The encroachment method or target may be changed at any cross section or on different profiles. Targets used for the methods are as follows:

Method	ET card Value	Description
1	X.1	The Xth and Xth+1 fields of the ET card will be used for the encroachment stations STENCL and STENCR. STENCL should not be 0.
2	X.2	The topwidth of X will determine encroachments stations such that the center of the topwidth will be centered half way between bank stations.
3	X.3	The natural cross section will be modified so that X percent of the total conveyance will be eliminated. The J3 card must have code 1.

*For the November 1976 version of HEC-2 refer to page 37 in the Supplement (green pages) following this exhibit.

CARD ET (cont)

Method	ET card Value	Description
4	X.4	The natural cross section will be modified so that with a (X/10) foot increase the modified cross section will have the same conveyance. A one foot increase would require a 10.4 and a .5 foot increase would require a 5.4. The J3 card must have codes 1 and 34. X = Raise in feet x 10 i.e., 0.5' = 5.4.
5	0	ET card not used. Instead NINV of J1 card is used. The encroachment stations can be established based on the topwidth limits of a previously computed base flood profile. A typical series of profiles are shown below for two different base floods. The codes shown must appear on the third field of the J1 card.

Profile	NINV Code	Description
1	-201	100 year flood - natural
2	-202	50 year flood - natural
3	-203	100 year flood using 50 year topwidths
4	-202	30 year flood - natural
5	-203	100 year flood using 30 year topwidths
6	-204	SPF using 30 year topwidths
7	-201	SPF natural

Profiles 2 and 3 or 4 and 5 may be computed without the others since the natural profiles for 1 and 7 (code= -201) are for comparison only. The topwidths from profile 2 and 4 (code= -202) are used for encroachments for profiles 3 and 5 (code= -203) respectively. If desired, the computed water elevations and topwidths from a code of -203 can be used to evaluate the effects on a larger flood that is computed using a -204 code. The first profile must have a J3 card which contains the identification codes 27, 28, 31, and 32.

BRIDGE LOSSES

CARD SB - OPTIONAL CARD

This special bridge card is used to specify data for use in the special bridge routine and is only required when using the special bridge routine. This card should be entered between cross sections that are upstream and downstream of the bridge.

Field	Variable	Value	Description
0	IA	SB	Card identification characters.
1	XK	+	Pier shape coefficient, "K", for use in Yarnell's energy equation for Class A flow.
2	XKOR	+	Total loss coefficient, "K", between cross sections on either side of bridge, for use in orifice flow equation.
3	COFQ	+	Coefficient of discharge "C" for use in weir flow equation.
4	RDLEN	0	Flow over roadway is not being considered or a table of roadway elevations and corresponding stations will be read in on Card BT for determining "L" in the weir flow equation.
		+	Average length of roadway "L" in feet for use in the weir flow equation. Use a constant value of "L" only if the length of weir does not change with depth of flow. Otherwise use Card BT to read in the top of roadway.
5	BWC	+	Bottom width of bridge opening including any obstruction in feet or meters.
6	BWP	0	No obstruction through the bridge. Normal bridge routine will be used in this case if low flow controls.
		+	Total width of obstruction (piers) in feet or meters.
7	BAREA	+	Net area of bridge opening below the low chord in square feet or square meters.

CARD SB (cont)

Field	Variable	Value	Description
8	SS	0	Vertical side slopes.
		+	Number of horizontal units per 1 vertical unit for the side slope of the trapezoidal channel under the bridge.
9	ELCHU	0	Channel invert beneath bridge will be equal to the minimum elevation in the previous cross section.
		+	Elevation of the channel invert at the upstream side of the bridge.
10	ELCHD	0	Channel invert will be assumed equal to the minimum elevation in the previous cross section.
		+	Elevation of the channel invert at the downstream side of the bridge.

Note: Variables BWC, BWP, SS, ELCHU, and ELCHD define a trapezoidal approximation of the bridge opening for use in the low flow solutions. If BWP is zero, normal bridge calculations will be used for low flow. Variable BAREA is the area used in the orifice equation for pressure flow calculations.

REQUIRED CARD FOR EACH CROSS SECTION

CARD X1

This card is required for each cross section (300 cross sections can be used for each profile) and is used to specify the cross section geometry and program options applicable to that cross section.

Field	Variable	Value	Description
0	IA	X1	Card identification characters.
1	SECNO	+	Cross section identification number.
		-	Start new tributary backwater at this cross section.
2	NUMST	0	Previous cross section is used for current section. Next GR cards are omitted.
		+	Total number of stations on the next GR cards.
3	STCHL	0	May be omitted if NUMST(X1.2) is 0.
		+	The station of the left bank of the channel. Must be equal to one of the STA(N) on next GR cards.
4	STCHR	0	May be omitted if NUMST(X1.2) is 0.
		+	The station of the right bank of the channel. Must be equal to one of the STA(N) on GR cards and equal to or greater than STCHL.
5	XLOBL	+	Length of reach between current cross section and next downstream cross section of the left overbank. Zero for first cross section if IDIR=0 (Subcritical flow).
6	XLOBR	+	Length of reach between current cross section and next downstream cross section for the right overbank. Zero for first cross section if IDIR=0.
7	XLCH	+	Length of reach between current cross section and next downstream cross section for the channel. Zero for first cross section if IDIR=0.

CARD X1 (cont)

Field	Variable	Value	Description
8	PXSECR	0	Cross section stations will not be changed by the factor PXSECR.
		+	Factor by which all cross section stations, except the first station, will be multiplied by to increase or decrease area. The factor can apply to a repeated cross section or a current one. A 1.1 would increase area by 10 percent not considering any change by PXSECE. (See X2 card, field 9, to modify BT data.)
9	PXSECE	0	Cross section elevations will not be changed.
		+ -	Constant to be added (+) or subtracted (-) from all cross section elevations (either previous or current).

OPTIONAL PLOTS OF CROSS SECTION

Field	Variable	Value	Description
10	IPLOT	0	Current cross section will not be plotted, unless all cross sections were requested by Card J2.
		1	Plot current cross section using all points.
		10	Plot current cross section using only those points up to the water surface elevation.

CHANNEL MODIFICATION DUE TO EXCAVATION

CARD CI - OPTIONAL CARD

Field	Variable	Value	Description
0	IA	CI	First 2 columns of card for card identification.
1	CLSTA	0	Value on previous CI card is used.
		+	Station of the centerline of the trapezoidal channel excavation which is expressed in terms of the stations used in the natural cross section description (GR cards).
		-1	CLSTA is determined by computer as half way between bank stations.
2	CELCH	0	Value on previous CI card is used.
		+	Elevation of channel invert.
		-1	Elevation of channel invert is equal to minimum elevation in cross section.
3	CNCH	0	Value of previous CI card is used.
		+	New channel "n" value.
4	XLSS	0	Value on previous CI card is used.
		+	Left side slope of channel expressed as horizontal divided by vertical (2.0 for 2 horizontal to 1 vertical).
5	RSS	0	Value of previous CI card is used.
		+	Right side slope of channel expressed as horizontal divided by vertical.
6-10	BW	0	Value on previous CI card is used.
		.01	No channel improvement until another CI card is read.
		>.01	Bottom width of trapezoidal channel in feet. Field used (6-10) for this profile corresponds to field specified on 8th field of J2 card.

X2

CROSS SECTION CARD-OPTIONAL

CARD X2

Field	Variable	Value	Description
0	IA	X2	Card identification characters.
1	QNEW	0	No change in flow.
		+	Value of the new flow in the river. This value will be used for all remaining cross sections unless changed by another X2 card or by a QT card.
2	WSELK	0	High water mark elevations are not being used.
		+	Elevation of known high water mark at this cross section. Required if NINV(J1.3) equals one.
3	IBRID	0	Special bridge routine will not be used.
		1	Special bridge routine will be used. Card SB is required just ahead of the X1 card for the current cross section.
4	ELLC	0	Special or normal bridge routines are not being used <u>or</u> a bridge table is read on Card BT and (for the special bridge routine only) the maximum low chord value on the BT cards is within the main bridge span.*
		+	Elevation of a constant low chord for the bridge for use by the normal bridge routine <u>or</u> (for the special bridge routine) the maximum upstream low chord elevation within the bridge span which is used to help distinguish between pressure flow and low flow.
5	ELTRD	0	Special or normal bridge routines are not being used <u>or</u> a bridge table is read on Card BT.
		+	Elevation of a constant top of roadway for use by the normal bridge routine <u>or</u> (for the special bridge routine) the minimum roadway elevation on the BT cards which is used to determine if weir flow exists.

*It is recommended that a value for ELLC be included for the special bridge routine.

CARD X2 (cont)

Field	Variable	Value	Description
6	BLOSS	0	Change in water surface elevation will not be entered.
		+	Change in water surface elevation to be used between current and previous cross sections.
7	REPBT	0	Do not repeat bridge table (BT cards) used from previous cross section.
		1	If current cross section is based on previous (field 2 of Card X1=0), use bridge table from previous cross section for the current but add PXSECE(X1.9) to all low chord elevations (top of roadways, remain same). This option used in describing top of fixed diameter culvert for several cross sections. Horizontal stations are not changed when a bridge section is repeated.
8	CMOM	0	Drag coefficient for calculating pier losses with momentum equation is equal to 2.00.
		+	Drag coefficient to be used for calculating pier losses with momentum equations.
9	BSQ	0	No bridge skew is used. Factor of 1.0 will be used.
		+	This factor is multiplied by all horizontal stations (RDST) used to describe the bridge profile (BT cards). (See X1 card, field 8, to modify GR data).

TRACE AND DATA PRINTOUT

Field	Variable	Value	Description
10	ITRACE	0	No trace for this cross section unless ITRACE on Card J2(J2.10) is specified.
		1	Major trace for current cross section.
		10	Major and minor trace for current cross section.
		15	Flow distribution printout for current cross section.

SPECIFICATION OF INEFFECTIVE FLOW AREAS

CARD X3 - OPTIONAL CARD

Field	Variable	Value	Description
0	IA	X3	Card identification characters.
1	IEARA	0	Total area of cross section described on GR cards below the water surface elevation is used in the computations.
		10	Only the cross sectional area confined by levees below the water surface elevation is used in the computations, unless the water surface elevation is above the top of levee (elevations corresponding to STCHL(X1.3) and STCHR(X1.4), in which case flow areas outside the levee will be included.
2	ELSED	0	A sediment elevation is not specified.
		+	Elevation of sediment desposition. This elevation is extended horizontally until it intersects the cross section and the area below this elevation is not considered to carry flow.
3	ENCFP	0	Width between encroachments is not changed or is not specified.
		+	Width between encroachments is centered in the channel, midway between the left and right overbanks. Flow areas outside this width are not included in the computations. This width will be used for all cross sections unless changed by a positive ENCFP on Card X3 of another cross section or Card ET or unless overridden by the use of STENCL(X3.4).
4	STENCL	0	Encroachments by specifying station and/or elevation will not be used on the left overbank.
		+	Station of the left encroachment. Flow areas to the left of (less than) this station and below ELENCL are not included in the computations. This option will override the option using ENCFP when both are used.

CARD X3 (cont)

Field	Variable	Value	Description
5	ELENCL	0	An encroachment elevation on the left side is not applicable and is therefore assumed very high.
		+	Elevation of the left encroachment. Flow areas below this elevation and less than STENCL are not included in the computations.
6	STENCR	0	An encroachment station on the right is not used.
		+	Station of the right encroachment. Flow areas to the right of (greater than) this station and below ELENCR are not included in the computations.
7	ELENCR	0	An encroachment elevation on the right side is not applicable and is therefore assumed very high.
		+	Elevation of the right encroachment. Flow areas below this elevation and greater than STENCR are not included in the computations.
8	ELLEA	0	The elevation (XLBEL) on the GR cards corresponding to STCHL (Card X1) is used to decide if the left flow area is effective or not when using the effective area option (IEARA=10).
		+	This elevation is used instead of XLBEL. When this value is used, artificial levees are defined.
9	ELREA	0	Same as ELLEA except for right bank flows.
		+	Same as ELLEA except for right bank flows. Left bank value (ELLEA) must be + for program to use right bank value.
10			Not used.

X4

ADDITIONAL GROUND POINTS

CARD X4 - OPTIONAL CARD

An additional input card X4 may be inserted following cards X1, X2, or X3 in order to add additional points to describe the ground profile of the cross section. This option is useful when modifying data cards for a proposed levee as it allows points to be added anywhere in the cross section. The X4 card may not be used to describe the artificial levees required for bridges since the values of STCHL and STCHR must be on the GR cards.

Field	Variable	Value	Description
0	IA	X4	Card identification characters.
1	NELT	+	Number of additional points to supplement the next set of GR cards read in describing the ground profile of the cross section.
2	ELT(1)	+	Elevation of first additional ground point.
3	STAT(1)	+	Station of first additional ground point. All stations must be less than the maximum station on the GR cards. The pairs of elevations and stations do not have to be in any particular order.
4,5 etc.			Additional pairs of elevation and station values. Maximum of 20 pairs.

USE OF INPUT WATER ELEVATION

CARD X5 - OPTIONAL

An X5 card is used to input a water surface elevation at a cross section, or to input an increment of elevation to be added to the water surface elevation of the previous cross section to obtain the water surface elevation of the cross section. The X5 card can be inserted for any cross section, including a bridge cross section, and the desired elevation or elevation increment can be specified differently for each profile of a multiple profile job. The field of the X5 card that is used for a particular profile is controlled by variable INQ(J1.2). Input instructions are as follows:

Card Columns	Variable	Value	Description
1,2	IA	X5	Card identification characters.
3-8	N	+	Number of fields used on X5 card for desired water surface elevations.
		-	Number of fields used on X5 card for desired increments of water surface elevation.
9-16 17-24 etc.			Water surface elevation (or increment in water surface elevation from previous cross section if N = -) desired for cross section described by preceding X1 card. Variable INQ(J1.2) indicates which field is used for a particular run. INQ may range from 2-20.

BRIDGE PROFILES

CARD BT - OPTIONAL CARD

The bridge geometry described by this card may be used by either the normal bridge routine or the special bridge routine. For the normal bridge routine, data from the BT cards are used in conjunction with data from GR cards to define a section through a bridge or culvert. Each station on the BT card should correspond to a station on the GR card. The road elevation (RDEL) defines the top of road, and the low chord elevation (XCEL) defines the low chord in the bridge span.

For the normal bridge routine, the program eliminates the area between the top of road profile and the low chord profile for the full length of the bridge described on the BT cards. The program achieves this by subtracting the height of the obstruction from the water depth for each station on the GR card. No reduction in area is made outside the range of data supplied on the BT cards. If the ground profile and the top of road profile are the same in the overbanks, then the overbank portions of the cross section do not have to be coded on the BT cards because no reduction is required. If the overbank portions of the cross section are coded on the BT cards because the top of road and ground profiles are not identical, it is necessary to set values of XLCEL equal to the ground elevations in the overbanks.

The special bridge routine uses the BT card data to define the weir profile for weir flow calculations. If the program cannot revert to the normal bridge routine (because BWP > 0) and the variables ELLC and ELTRD are defined on the X2 card, only the top of road profile need be defined on the BT card and the BT stations do not have to coincide with GR stations. However, if BWP = 0, which causes the program to transfer from the special bridge to the normal bridge routine for low flow solutions, the BT cards should be prepared as described in the first paragraph.

Field	Variable	Value	Description
0	IA	BT	Card identification characters.
1	NRD	+	Number of points describing the bridge roadway and low chord to be read on Card BT. Entered only on first BT card. The maximum number of points is 50.*
2	RDST(1)	+	Roadway station corresponding to RDEL(1) and XLCEL(1).
3	RDEL(1)	+	Top of roadway elevation at station RDST(1). Should be greater than the estimated energy elevation.

*For the November 1976 version with Modification 53, the maximum number of points is 100.

Field	Variable	Value	Description
4	XLCEL(1)	+	Low chord elevation at station RDST(1).
5	RDST(2)	+	Roadway station corresponding to RDEL(2) and XLCEL(2).
6	RDEL(2)	+	Top of roadway elevation at station RDST(2).
7	XLCEL(2)	+	Low chord elevation at station RDST(2).
8	RDST(3)	+	Roadway station corresponding to RDEL(3) and XLCEL(3).
9	RDEL(3)	+	Top of roadway elevation at station RDST(3).
10	XLCEL(3)	+	Low chord elevation at station RDST(3).

Continue on in field 1 of additional BT cards up to RDST(NRD), RDEL(NRD), and XLCEL(NRD). The last roadway elevation RDEL(NRD) should be greater than the estimated energy elevation.

GR

GROUND PROFILE

CARD GR

This card specifies the elevation and station of each point in a cross section used to describe the ground profile, and is required for each X1 card unless NUMST(X1.2) is zero. The points outside of the channel determine the subdivision of the cross section which corrects for the nonuniform velocity distribution.

Field	Variable	Value	Description
0	IA	GR	Card identification characters.
1	EL(1)	+ −	Elevation of cross section point 1 at station STA(1). May be positive or negative.
2	STA(1)	+	Station of cross section point 1.
3	EL(2)	+ −	Elevation of cross section point 2 at STA(2).
4	STA(2)	+	Station of cross section point 2.

Continue with additional GR cards using up to 100 points to describe the cross section. Stations should be in increasing order.

END OF JOB CARD

CARD EJ - REQUIRED

Required following the last cross section for each job. This card is omitted for all but the first profile for multiple profile jobs because the cross section cards are read for the first profile only. Each group of cards beginning with Card T1 is considered a job.

Field	Variable	Value	Description
0	IA	EJ	Card identification characters.
1-10			Not used.

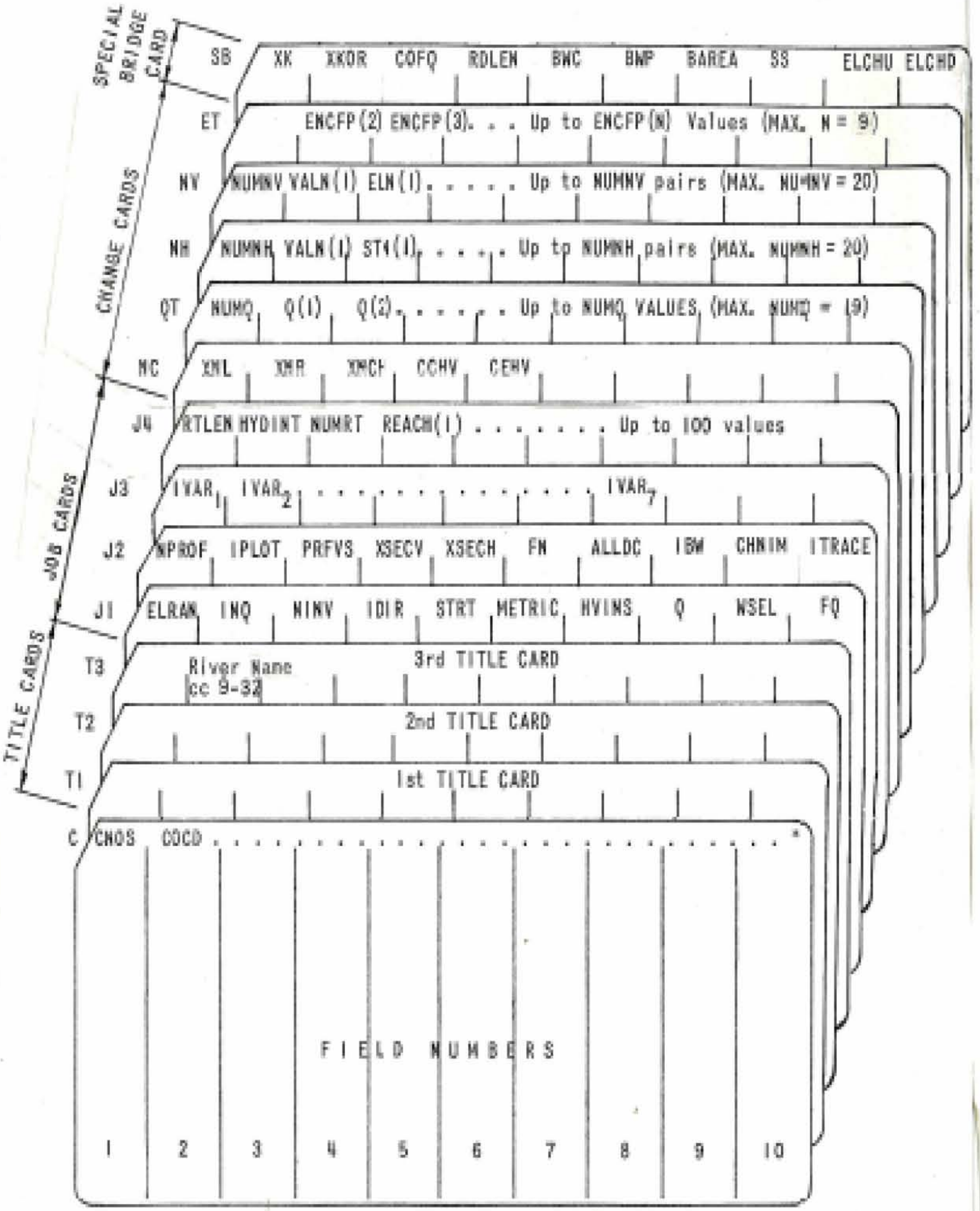
ER

END OF RUN

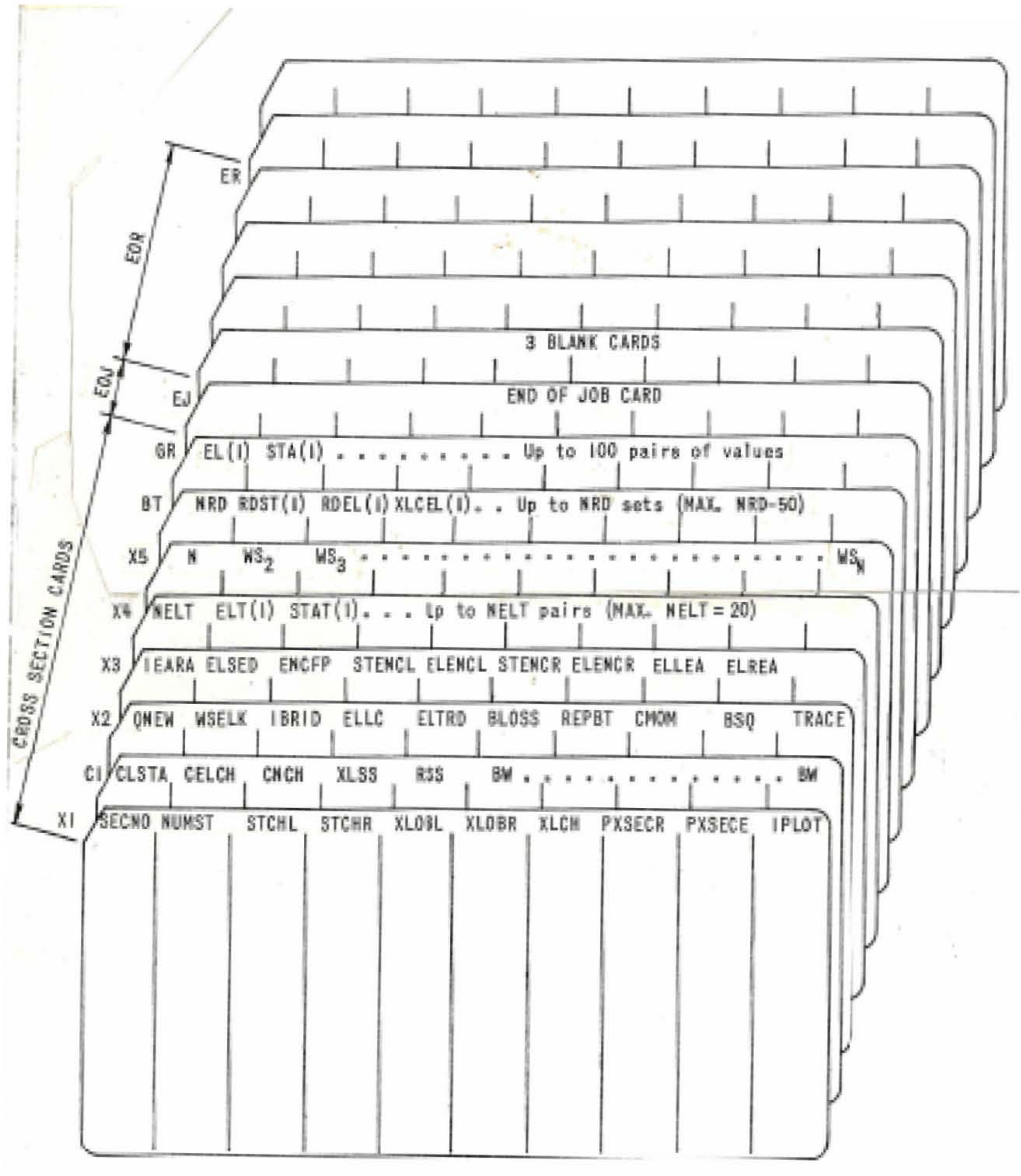
CARD ER - REQUIRED CARD

Required at the end of a run consisting of one or more jobs in order to end computation on stop command. Three blank cards after the EJ card of the last job are required followed by the ER card.

Field	Variable	Value	Description
0	IA	ER	Card identification characters.
1-10			Not used.



* Optional cards which may be used to label cross sections. At least three are required since the first two are not printed.


CROSS SECTION CARDS
EOR
EOJ
ER
EJ
3 BLANK CARDS
END OF JOB CARD
GR EL(I) STA(I) . . . . Up to 100 pairs of values
BT NRD RDST(I) RDEL(I) XLCEL(I). . Up to NRD sets (MAX. NRD=50)
X5 N WS2 WS3 . . . . WSN
X4 NELT ELT(I) STAT(I). . . Up to NELT pairs (MAX. NELT = 20)
X3 IEARA ELSED ENCFP STENCL ELENCL STENCR ELENCR ELLEA ELREA
X2 QNEW WSELK IBRID ELLC ELTRD BLOSS REPBT CMOM BSQ TRACE
C1 CLSTA CELCH CNCH XLSS RSS BW . . . . BW
X1 SECNO NUMST STCHL STCHR XLOBL XLOBR XLCH PXSECR PXSECE IPLOT

HEC-2
USERS MANUAL SUPPLEMENT

NOVEMBER 1977

THE HYDROLOGIC ENGINEERING CENTER
CORPS OF ENGINEERS, U.S. ARMY
609 SECOND STREET
DAVIS, CALIFORNIA 95616
(916) 440-2105
FTS 448-2105

HEC-2

USERS MANUAL SUPPLEMENT

HEC-2 Version Dated November 1976

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November 1977

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SUMMARY OF SUPPLEMENTAL CAPABILITIES

The HEC-2 version dated November 1976 is intended to replace the version dated August 1971 with its associated modifications and error corrections. The basic computational capabilities for calculating water surface profiles are essentially unchanged. Input prepared for the previous version (except for optional card J3) is fully compatible with the new version. The new version, however, has the following features:

1. NEW ENCROACHMENT OPTIONS (METHODS 5 AND 6)

   Encroachment Methods 5 and 6 use an optimization scheme to obtain a desired target elevation difference between natural and encroached conditions. Method 5 uses a target based on a change in water surface elevation. Method 6 uses a target based on a change in energy grade line elevation. For further details of these methods, refer to page 3. These methods are intended for use in flood insurance studies.

2. EXPANDED SUMMARY OUTPUT CAPABILITY

   a. User-Defined Summary Tables. Sixty-three variables are available for printout in summary tables. The user may select and print up to thirteen variables in any order for a single summary. Up to five different summaries can be obtained for each run. If desired, the detailed section by section printout may be suppressed so that only the summary tables are printed.

   b. Pre-Defined Tables. Separate pre-defined tables can be requested to summarize data for bridges, encroachments and channel improvements. A Floodway Data Table similar to FIA Table 1* can be requested which summarizes information on floodway widths, mean velocities and water surface elevations as required for flood insurance studies. A Flood Insurance Zone Data Table similar to FIA Table 2* can be requested to facilitate determination of flood hazard factors and reaches as required for flood insurance studies. For an illustration of pre-defined tables, refer to pages 4 - 16.

*Flood Insurance Study, Guidelines and Specifications, U.S. Department of Housing and Urban Development, January 1976, Federal Insurance Administration.

3. ARCHIVAL OPTION

This option will create a permanent record of study results in computer readable form. Details of the archival option are given on pages 17 - 20.

4. FRICTION LOSS EQUATION OPTION

This option provides the user with a choice of five alternative methods for evaluating friction losses. The option is described on pages 21 - 23.

5. POTENTIAL FOR USAGE WITH INTERACTIVE COMPUTER TERMINALS

Although HEC-2 is not an interactive program and should normally be executed in the batch mode, several new features in the program provide capability for reviewing output through an interactive terminal. In many computing systems this will enable the user to perform several executions to debug a data deck before full line printer output is obtained. The user-defined summary tables (see page 1), coupled with suppression of most of the detailed output (with the J5 card), can be used to obtain output that will print conveniently on 72 or 80 column terminals. Labels generated by the program in the detailed ouput for each profiles (e.g., *PROF 2) and each cross section (e.g., *SECNO 21.100) allow easy location of specific results using commonly available system text editors.

6. REDUCED STORAGE REQUIREMENTS

Execution core storage requirements have been reduced to less than 32,000 decimal words (32 bits or larger), which is approximately one-half the previous requirement. Limits on the number of profiles and cross sections have been set to 14 and 800, respectively.

Information provided on the following pages is intended to supplement the October 1973 Users Manual for HEC-2 to allow the use of added capabilities in the November 1976 version of the program.

ENCROACHMENT METHODS 5 AND 6

INTRODUCTION

Two encroachment methods have been developed that use an optimization scheme to obtain a desired target elevation difference between natural and encroached conditions. Encroachment Method 5 is based on a target difference in water surface elevation. Encroachment Method 6 is based on a target difference in energy grade line elevation. A maximum of twenty-one trials are allowed in attempting a solution. The routine uses the percent reduction in conveyance as the objective function to be optimized to obtain the desired target difference. Convergence is usually obtained in three or four trials. The number of trials processed is printed under the variable name ICONT. It is not always possible to achieve the desired target difference because of hydraulic conditions such as the occurrence of critical depth or flow conditions in the vicinity of bridges. Methods 5 and 6 add to the array of techniques already available and are not to replace or make obsolete the existing methods. Both provide results that may be useful for flood insurance studies.

INPUT REQUIREMENTS

Input for methods 5 and 6 is specified on the ET card in the same way as for method 4. A 10.5 or a 10.6 indicate a floodway with a target of one foot difference in water surface elevations or energy elevations, respectively. The methods can be changed at any cross section like methods 1 through 4. Also, as with methods 3 and 4, the first profile must be for natural (unencroached) conditions and subsequent profiles can be computed for different targets.

Method 4 should be used for the first cross section even through method 6 is used thereafter, because EG is not properly defined at the first cross section.

ILLUSTRATIONS OF PRE-DEFINED TABLES

The following tables are available to summarize results relating to bridges, encroachments, channel improvements, floodways and flood insurance zone studies.

Table Number	Table Output
100	Bridge data table (single section for each special bridge).
105	Bridge data table (four sections for each special bridge).
110	Encroachment data table.
120	Channel improvement data table.
150	Standard summary (two tables produced).
200	Floodway data table (FIA Table 1).
201	Flood insurance zone data table (FIA Table 2).

Example output for each table is provided on the following pages.

TABLE 100

THIS RUN EXECUTED 08 NOV 77 09.10.31

```
******************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
  ERROR CORR -  01,02
  MODIFICATION -  50,51,52,53
******************************************************
```

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

LEACH CREEK

SUMMARY PRINTOUT TABLE 100

SECNO	EGLWC	ELLC	EGPRS	ELTRD	QPR	QWEIR	CLASS	H3	DEPTH	CWSEL	VCH	EG
9890.000	4573.45	4574.00	0.00	4575.50	1325.00	0.00	59.00	0.00	7.28	4572.28	10.12	4573.87
9890.000	4578.88	4574.00	4591.85	4575.50	1119.82	2884.87	30.00	0.00	12.73	4577.73	10.61	4578.88
12530.000	4589.31	4587.00	4586.95	4591.00	1450.00	0.00	1.00	.85	11.34	4587.34	11.27	4589.31
12530.000	4594.85	4587.00	4596.29	4591.00	2190.64	1814.13	30.00	.29	17.09	4593.09	10.87	4594.56

LEACH CREEK

SUMMARY PRINTOUT TABLE 105

	SECNO	CWSEL	HL	OLOSS	TOPWID	QLOB	QCH	QROB
	9805.000	4571.59	1.44	.19	42.92	0.00	1325.00	0.00
*	9805.000	4574.70	.79	.63	90.00	91.17	3864.04	44.79
	9855.000	4571.39	.47	.29	18.00	0.00	1325.00	0.00
*	9855.000	4577.65	.36	.12	200.00	830.92	2477.97	691.10
	9890.000	4572.28	.37	.05	18.00	0.00	1325.00	0.00
	9890.000	4577.73	0.00	0.00	200.00	856.11	2431.47	712.42
	9940.000	4573.59	.25	.10	47.92	0.00	1380.00	0.00
	9940.000	4578.74	.09	.08	180.00	1150.51	2554.04	295.45
	12450.000	4582.43	2.60	.21	37.57	0.00	1450.00	0.00
*	12450.000	4585.68	2.77	.46	54.32	0.00	4000.00	0.00
*	12500.000	4586.50	.65	.37	20.99	0.00	1450.00	0.00
*	12500.000	4592.87	.44	.11	150.00	274.39	3228.88	496.73
	12530.000	4587.34	.13	0.00	22.68	0.00	1450.00	0.00
	12530.000	4593.09	0.00	0.00	150.00	315.39	3127.23	557.38
	12580.000	4589.45	.03	.19	78.89	0.00	1355.39	94.61
	12580.000	4594.53	.03	.13	110.00	352.28	3279.21	368.51

SUMMARY OF ERRORS

```
CAUTION  SECNO= 9805.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO= 9805.000  PROFILE= 2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO= 9805.000  PROFILE= 2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO= 9855.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO= 9855.000  PROFILE= 2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO= 9855.000  PROFILE= 2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO=12450.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=12450.000  PROFILE= 2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=12450.000  PROFILE= 2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION  SECNO=12500.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=12500.000  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=12500.000  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION  SECNO=12500.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=12500.000  PROFILE= 2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=12500.000  PROFILE= 2  20 TRIALS ATTEMPTED TO BALANCE WSEL
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THIS RUN EXECUTED 08 NOV 77 10.49.46

```
*****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
  ERROR CORR = 01,02
  MODIFICATION = 50,51,52,53
*****************************************************
```

NOTE= ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

LEACH CREEK

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
	9500.000	4573.50	0.00	4573.86	200.00	1189.27	1936.71	274.02	0.00	0.00	100.00	151.00	0.00
	9500.000	4574.50	1.00	4575.00	110.98	963.76	2436.24	0.00	.27	40.02	100.00	151.00	151.00
*	9805.000	4573.91	0.00	4576.33	59.77	49.58	3350.42	0.00	0.00	0.00	100.00	150.00	0.00
	9805.000	4574.36	.45	4576.51	50.00	0.00	3400.00	0.00	.01	100.00	100.00	150.00	150.00
*	9855.000	4577.29	0.00	4578.49	200.00	598.66	2304.59	496.75	0.00	0.00	100.00	118.00	0.00
*	9855.000	4577.43	.13	4578.90	145.30	514.11	2494.02	391.88	.10	27.93	100.00	118.00	173.23
	9890.000	4577.45	0.00	4578.49	200.00	650.89	2208.43	540.68	0.00	0.00	100.00	118.00	0.00
	9890.000	4577.45	.00	4578.90	145.30	521.19	2481.57	397.25	.05	27.93	100.00	118.00	173.23
	9940.000	4578.38	0.00	4578.65	180.00	940.82	2221.81	237.37	0.00	0.00	100.00	150.00	0.00
	9940.000	4578.75	.36	4579.10	130.00	557.86	2546.91	295.23	150.00	50.00	100.00	150.00	200.00
*	10500.000	4578.76	0.00	4580.67	133.54	51.82	3337.30	10.88	0.00	0.00	100.00	153.00	0.00
	10500.000	4578.77	.01	4580.69	108.81	42.04	3346.70	11.26	110.00	65.00	100.00	153.00	175.00
	11000.000	4581.92	0.00	4583.19	70.00	216.59	3152.95	30.46	0.00	0.00	100.00	140.00	0.00
	11000.000	4581.93	.01	4583.20	70.00	217.71	3151.27	31.02	0.00	0.00	100.00	140.00	0.00
*	11500.000	4583.81	0.00	4586.31	70.00	111.24	3228.12	60.63	0.00	0.00	100.00	136.00	0.00
	11500.000	4583.44	-.37	4586.69	36.00	0.00	3400.00	0.00	.05	100.00	100.00	136.00	136.00
	12000.000	4587.45	0.00	4588.08	110.00	133.98	3185.61	80.41	0.00	0.00	100.00	160.00	0.00
	12000.000	4587.94	.49	4588.58	67.81	61.05	3338.77	.18	.05	92.33	100.00	160.00	160.15
	12450.000	4588.18	0.00	4589.08	100.00	0.00	3396.80	3.20	0.00	0.00	100.00	162.00	0.00
	12450.000	4588.63	.46	4589.43	62.00	0.00	3400.00	0.00	.00	100.00	100.00	162.00	162.00
*	12500.000	4592.33	0.00	4594.05	150.00	142.55	2971.92	285.52	0.00	0.00	100.00	130.00	0.00
*	12500.000	4592.52	.19	4594.07	146.18	167.51	2904.05	328.44	.00	53.21	100.00	130.00	199.39
	12530.000	4592.67	0.00	4594.05	150.00	200.78	2825.40	373.82	0.00	0.00	100.00	130.00	0.00
*	12530.000	4592.77	.10	4594.26	146.18	176.06	2882.18	341.76	.05	53.21	100.00	130.00	199.39
	12580.000	4594.05	0.00	4594.21	110.00	288.36	2805.48	306.15	0.00	0.00	130.00	190.00	0.00
	12580.000	4594.28	.22	4594.43	109.35	288.29	2801.63	310.08	.00	100.65	130.00	190.00	212.66

TABLE 120

THIS RUN EXECUTED 08 NOV 77 09.55.51

```
*****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
  ERROR CORR -  01,02
  MODIFICATION -  50,51,52,53
*****************************************************
```

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

LEACH CREEK

SUMMARY PRINTOUT TABLE 120

	SECNO	CWSEL	EG	VCH	10K*S	DEPTH	TOPWID	CLSTA	BW	STCHL	XLBEL	STCHR	RBEL
	9500.000	4570.59	4571.06	5.90	32.62	6.59	146.77	0.00	0.00	100.00	4570.00	151.00	4572.00
	9500.000	4574.50	4574.81	5.54	12.35	10.50	200.00	0.00	0.00	100.00	4570.00	151.00	4572.00
	9805.000	4571.59	4572.69	8.40	73.51	6.59	42.92	0.00	0.00	100.00	4572.00	150.00	4574.00
*	9805.000	4574.70	4577.10	12.64	84.83	9.70	90.00	0.00	0.00	100.00	4572.00	150.00	4574.00
	9855.000	4571.39	4573.45	11.52	126.90	6.39	18.00	0.00	0.00	100.00	4575.50	118.00	4575.50
*	9855.000	4577.65	4578.88	10.88	62.44	12.65	200.00	0.00	0.00	100.00	4575.50	118.00	4575.50
	9890.000	4572.28	4573.87	10.12	88.70	7.28	18.00	0.00	0.00	100.00	4575.50	118.00	4575.50
	9890.000	4577.73	4578.88	10.61	58.90	12.73	200.00	0.00	0.00	100.00	4575.50	118.00	4575.50
	9940.000	4573.59	4574.22	6.37	33.45	7.59	47.92	0.00	0.00	100.00	4574.00	150.00	4574.00
	9940.000	4578.74	4579.06	5.39	8.94	12.74	180.00	0.00	0.00	100.00	4574.00	150.00	4574.00
	10500.000	4575.25	4575.77	5.80	23.25	7.25	48.99	126.50	20.00	96.44	4578.03	156.78	4578.14
	10500.000	4579.14	4579.84	6.80	16.95	11.14	140.00	126.50	30.00	91.36	4578.07	162.18	4578.34
	11000.000	4576.53	4577.23	6.72	34.83	6.53	46.12	120.00	20.00	92.94	4578.53	152.00	4581.00
	11000.000	4580.00	4581.00	8.02	27.47	10.00	67.93	120.00	30.00	87.06	4578.97	157.00	4581.00
	11500.000	4578.33	4579.10	7.01	39.21	6.33	45.33	118.00	20.00	87.37	4582.32	150.00	4583.00
	11500.000	4581.43	4582.60	8.68	35.32	9.43	67.71	118.00	30.00	82.11	4582.45	155.00	4583.00
	12000.000	4580.30	4581.08	7.05	39.91	6.30	45.21	130.00	20.00	100.00	4584.00	160.00	4584.00
	12000.000	4583.22	4584.46	8.96	38.51	9.22	66.87	130.00	30.00	94.44	4584.28	169.00	4586.00
	12450.000	4582.43	4583.89	9.70	91.38	6.68	37.57	0.00	.01	100.00	4586.00	162.00	4588.00
*	12450.000	4585.68	4588.46	13.40	113.27	9.93	54.32	0.00	.01	100.00	4586.00	162.00	4588.00
*	12500.000	4586.50	4589.19	13.16	200.99	10.50	20.99	0.00	.01	100.00	4591.00	130.00	4591.00
*	12500.000	4592.87	4594.56	11.48	70.52	16.87	150.00	0.00	.01	100.00	4591.00	130.00	4591.00
	12530.000	4587.34	4589.31	11.27	132.94	11.34	22.68	0.00	.01	100.00	4591.00	130.00	4591.00
	12530.000	4593.09	4594.56	10.87	61.21	17.09	150.00	0.00	.01	100.00	4591.00	130.00	4591.00
	12580.000	4589.45	4589.53	2.44	1.86	13.35	78.89	0.00	.01	130.00	4586.00	190.00	4580.00
	12580.000	4594.53	4594.73	3.81	2.42	18.43	110.00	0.00	.01	130.00	4586.00	190.00	4580.00

LEACH CREEK

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
	9500.000	500.00	0.00	0.00	4564.00	1285.00	4570.59	0.00	4571.06	32.62	5.90	294.07	224.98
	9500.000	500.00	0.00	0.00	4564.00	4000.00	4574.50	0.00	4574.81	12.35	5.54	1053.00	1138.45
	9805.000	305.00	0.00	0.00	4565.00	1325.00	4571.59	0.00	4572.69	73.51	8.40	157.75	154.54
*	9805.000	305.00	0.00	0.00	4565.00	4000.00	4574.70	4574.70	4577.10	84.83	12.64	348.56	434.29
	9855.000	50.00	0.00	0.00	4565.00	1325.00	4571.39	0.00	4573.45	126.90	11.52	115.04	117.62
*	9855.000	50.00	0.00	0.00	4565.00	4000.00	4577.65	4577.65	4578.88	62.44	10.88	619.51	506.19
	9890.000	35.00	4575.50	4574.00	4565.00	1325.00	4572.28	0.00	4573.87	88.70	10.12	130.98	140.68
	9890.000	35.00	4575.50	4574.00	4565.00	4000.00	4577.73	0.00	4578.88	58.90	10.61	635.19	521.21
	9940.000	50.00	0.00	0.00	4566.00	1380.00	4573.59	0.00	4574.22	33.45	6.37	216.63	238.59
	9940.000	50.00	0.00	0.00	4566.00	4000.00	4578.74	0.00	4579.06	8.94	5.39	1074.40	1338.00
	10500.000	560.00	0.00	0.00	4568.00	1450.00	4575.25	0.00	4575.77	23.25	5.80	249.96	300.72
	10500.000	560.00	0.00	0.00	4568.00	4000.00	4579.14	0.00	4579.84	16.95	6.80	632.32	971.60
	11000.000	500.00	0.00	0.00	4570.00	1450.00	4576.53	0.00	4577.23	34.83	6.72	215.90	245.69
	11000.000	500.00	0.00	0.00	4570.00	4000.00	4580.00	0.00	4581.00	27.47	8.02	498.71	763.15
	11500.000	500.00	0.00	0.00	4572.00	1450.00	4578.33	0.00	4579.10	39.21	7.01	206.85	231.56
	11500.000	500.00	0.00	0.00	4572.00	4000.00	4581.43	0.00	4582.60	35.32	8.68	460.64	673.02
	12000.000	500.00	0.00	0.00	4574.00	1450.00	4580.30	0.00	4581.08	39.91	7.05	205.54	229.53
	12000.000	500.00	0.00	0.00	4574.00	4000.00	4583.22	0.00	4584.46	38.51	8.96	446.50	644.54
	12450.000	450.00	0.00	0.00	4575.75	1450.00	4582.43	0.00	4583.89	91.38	9.70	149.49	151.68
*	12450.000	450.00	0.00	0.00	4575.75	4000.00	4585.68	4585.68	4588.46	113.27	13.40	298.45	375.84
*	12500.000	50.00	0.00	0.00	4576.00	1450.00	4586.50	4586.50	4589.19	200.99	13.16	110.16	102.28
*	12500.000	50.00	0.00	0.00	4576.00	4000.00	4592.87	4592.87	4594.56	70.52	11.48	493.28	476.32
	12530.000	30.00	4591.00	4587.00	4576.00	1450.00	4587.34	0.00	4589.31	132.94	11.27	128.61	125.76
	12530.000	30.00	4591.00	4587.00	4576.00	4000.00	4593.09	0.00	4594.56	61.21	10.87	526.44	511.29
	12580.000	50.00	0.00	0.00	4576.10	1450.00	4589.45	0.00	4589.53	1.86	2.44	644.47	1062.50
	12580.000	50.00	0.00	0.00	4576.10	4000.00	4594.53	0.00	4594.73	2.42	3.81	1277.45	2568.94
	13000.000	420.00	0.00	0.00	4578.00	1450.00	4589.52	0.00	4589.62	2.29	2.57	598.54	958.76
	13000.000	420.00	0.00	0.00	4578.00	4000.00	4594.65	0.00	4594.83	2.23	3.50	1294.82	2678.02

LEACH CREEK

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	9500.000	1285.00	4570.59	0.00	0.00	0.00	146.77	500.00
	9500.000	4000.00	4574.50	3.91	0.00	0.00	200.00	500.00
	9805.000	1325.00	4571.59	0.00	1.00	0.00	42.92	305.00
*	9805.000	4000.00	4574.70	3.10	.20	0.00	90.00	305.00
	9855.000	1325.00	4571.39	0.00	-.20	0.00	18.00	50.00
*	9855.000	4000.00	4577.65	6.26	2.96	0.00	200.00	50.00
	9890.000	1325.00	4572.28	0.00	.89	0.00	18.00	35.00
	9890.000	4000.00	4577.73	5.45	.07	0.00	200.00	35.00
	9940.000	1380.00	4573.59	0.00	1.31	0.00	47.92	50.00
	9940.000	4000.00	4578.74	5.15	1.01	0.00	180.00	50.00
	10500.000	1450.00	4575.25	0.00	1.66	0.00	48.99	560.00
	10500.000	4000.00	4579.14	3.89	.40	0.00	140.00	560.00
	11000.000	1450.00	4576.53	0.00	1.28	0.00	46.12	500.00
	11000.000	4000.00	4580.00	3.47	.86	0.00	67.93	500.00
	11500.000	1450.00	4578.33	0.00	1.80	0.00	45.33	500.00
	11500.000	4000.00	4581.43	3.09	1.43	0.00	67.71	500.00
	12000.000	1450.00	4580.30	0.00	1.97	0.00	45.21	500.00
	12000.000	4000.00	4583.22	2.91	1.79	0.00	66.87	500.00
	12450.000	1450.00	4582.43	0.00	2.12	0.00	37.57	450.00
*	12450.000	4000.00	4585.68	3.25	2.46	0.00	54.32	450.00
*	12500.000	1450.00	4586.50	0.00	4.07	0.00	20.99	50.00
*	12500.000	4000.00	4592.87	6.38	7.20	0.00	150.00	50.00
	12530.000	1450.00	4587.34	0.00	.85	0.00	22.68	30.00
	12530.000	4000.00	4593.09	5.75	.21	0.00	150.00	30.00
	12580.000	1450.00	4589.45	0.00	2.10	0.00	78.89	50.00
	12580.000	4000.00	4594.53	5.09	1.45	0.00	110.00	50.00
	13000.000	1450.00	4589.52	0.00	.08	0.00	94.25	420.00
	13000.000	4000.00	4594.65	5.13	.12	0.00	125.00	420.00

SUMMARY OF ERRORS

CAUTION SECNO= 9805.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 9805.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 9805.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 9855.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 9855.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 9855.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL

TABLE 200

The Floodway Data Table provides the WIDTH, SECTION AREA, and MEAN VELOCITY for each floodway profile plus the computed WATER SURFACE ELEVATION for WITH and WITHOUT FLOODWAY, and their DIFFERENCE. The information is tabulated, in the format required under current FIA Guidelines, for every cross section. To obtain this table, input the code 200 on the J3 card, and compute a natural, and one or more encroached (floodway) profiles. Remember to request a summary printout on the last profile. An example output is shown below.

FLOODWAY DATA, LEACH CREEK
PROFILE NO. 2

	------- FLOODWAY -------			WATER SURFACE ELEVATION		
STATION	WIDTH (FT)	SECTION AREA	MEAN VELOCITY	WITH FLOODWAY	WITHOUT FLOODWAY	DIFFERENCE
9500.000	111.	669.	5.1	4574.5	4573.5	1.0
9805.000	50.	289.	11.8	4574.3	4573.9	.4
9855.000	145.	469.	7.3	4577.4	4577.3	.1
9890.000	145.	473.	7.2	4577.5	4577.5	0.0
9940.000	130.	839.	4.1	4578.8	4578.4	.4
10500.000	109.	329.	10.3	4578.8	4578.8	0.0
11000.000	70.	415.	8.2	4581.9	4581.9	0.0
11500.000	36.	235.	14.5	4583.5	4583.8	-.3
12000.000	68.	543.	6.3	4588.0	4587.5	.5
12450.000	62.	474.	7.2	4588.7	4588.2	.5
12500.000	146.	436.	7.8	4592.5	4592.3	.2
12530.000	146.	444.	7.7	4592.8	4592.7	.1
12580.000	109.	1245.	2.7	4594.3	4594.1	.2
13000.000	123.	1014.	3.4	4594.3	4594.1	.2

TABLE 201

The Flood Insurance Zone Data Table provides for the computation of Flood Hazard Factors (FHF), Zones, and weighted average differences between the 100 year dlood (Base Flood) and the 10, 50, and 500 year flood profiles. The program first computes and prints the required information for the entire reach (input data set). If 80% of the reach is not within a specified range around the weighted average value for the difference between the 10 year and the 100 year profiles, the program will segment the reach by a constant incremental length and compute and print the FHF continuously by increment. This second approach will provide information that will help make the determination of where to subdivide the reach to meet the 80% criterion.

To obtain the Zone Data, code 201 on the J3 card and set up the data cards to compute the 10, 50, 100, and 500 year profiles in that order. Remember to request summary printout on the last profile.

FLOOD HAZARD FACTOR FOR ENTIRE REACH USING SECTIONS

This table is the computation of the FHF for the entire reach using the computed water surface profiles. For each cross section (SECTION NUMBER) the CUMULATIVE DISTANCE, and the computed ELEVATION DIFFERENCE BETWEEN BASE FLOOD (the 100 year - profile 3) and: 10% (10 year - profile 1), 2% (50 year - profile 2), and 0.2% (500 year - profile 4) FLOODS are shown. At the end of this table the WEIGHTED AVG FOR REACH is shown for the three difference categories. Also shown are the FHF, the precentage of the reach that is within the FIA specified range and the ZONE for the reach based on the computed FHF. If the reach has 80% or more of the weighted 10% difference values within the specified range, the computed FHF, ZONE, and weighted average differences satisfy the required FIA criteria for the entire reach. If the differences are not within the 80% limit, the program will proceed with the computation of the FHF by even increments, shown in a second table which is described in the next section. The following table shows the output for a reach that does not meet the 80% criterion.

EXAMPLE OF TABLE 201 (FIRST PART)

FLOOD INSURANCE ZONE DATA FOR LEACH CREEK

FLOOD HAZARD FACTOR FOR ENTIRE REACH USING SECTIONS

SECTION NUMBER	CUMULATIVE DISTANCE	ELEVATION DIFFERENCE BETWEEN BASE FLOOD AND#		
		10%	2%	0.2%
9500.000	0.	-2.49	-.29	3.91
9805.000	305.	-2.52	-.24	2.31
9855.000	355.	-2.03	-.09	5.90
9890.000	390.	-2.83	-.46	5.17
9940.000	440.	-4.09	-.79	4.80
10500.000	1000.	-3.55	-.74	3.12
11000.000	1500.	-4.43	-1.04	3.46
11500.000	2000.	-4.01	-.93	3.13
12000.000	2500.	-4.67	-1.04	3.42
12450.000	2950.	-4.55	-1.00	3.24
12500.000	3000.	-4.67	-1.10	5.79
12530.000	3030.	-5.01	-1.19	5.31
12580.000	3080.	-5.89	-1.40	4.60
13000.000	3500.	-5.84	-1.39	4.60
13570.000	4070.	-3.66	-.73	3.74
13620.000	4120.	-4.45	-1.03	4.12
13630.000	4130.	-4.45	-1.03	4.24
13680.000	4180.	-3.54	-.78	4.54
14000.000	4500.	-3.26	-.66	2.89
14500.000	5000.	-2.27	-.48	2.16
WEIGHTED AVG FOR REACH		-4.07	-.88	3.62

FHF FOR THE REACH = 040 WITH 72.8% OF THE REACH WITHIN 1.0 FEET

ZONE FOR THE REACH = A 8

CONTINUOUS FLOOD HAZARD FACTORS BY EVEN INCREMENTS

This table is the result of segmenting the total reach by even increments. By using even increments, the Flood Hazard Factor can be continuously computed for the reach up to the current increment. The output information in this table should be sufficient to determine where the reach could be subdivided to meet the FIA requirements for at least 80% of each reach being within a specific range (based on the magnitude of the weighted average difference between the 10 and 100 year flood profiles). A description of each output column follows.

INC NO. is the increment number for the even intervals used to subdivide the total reach.

TOTAL LENGTH is the channel length from the first section to the current increment. The length shown for the first increment is the constant interval length used by the program to subdivide the reach.

AVG ELEVATION DATA represent average values within each increment; 10% is the water surface elevation for the 10 year flood (Profile 1). 1% is the water surface elevation from the 100 year flood (Profile 3). Increment elevations are linearly interpolated from cross section results.

DIFF. is the difference between elevations for profiles 1 and 3.

WTD. AVG. is the length-weighted average elevation difference from the beginning of the reach to the current increment.

FHF is the flood hazard factor based on the weighted average difference; therefore, it represents the FHF for the reach up to the current increment.

PERCENT WITHIN represents the portion of the reach (from the beginning to the current increment) that is within the specified range for the current FHF.

Within the printout for even increments the cross section numbers are printed as they are located within the reach. The numbers are printed within the data output on the right side of the table as: SEC. XXX.XXX.

At the end of the output there is a statement explaining how the reach can be subdivided. For example, the reach in this example could be subdivided by coding 202 32 49. The program would divide the total reach into two reaches; one ending with increment 32 and the second ending with increment 49. As coded above, all of the incremental data will be printed plus the results for the two reaches. If only the results for each reach are desired, the first increment number could be coded with a minus sign. This will suppress all of the intermediate results. For example, 202 -32 49 will give the results shown on page 15.

EXAMPLE OF TABLE 201 (SECOND PART)

CONTINUOUS FLOOD HAZARD FACTORS BY FVEN INCREMENTS

INC NO.	TOTAL LENGTH	AVG ELEVATION DATA 10¢	1¢	DIFF.	WTD. AVG.	FHF	PERCENT WITHIN
	0.					SEC.	9500.000
1	100.	4568.26	4570.75	-2.49	-2.49	025	100.
2	200.	4568.58	4571.08	-2.50	-2.49	025	100.
3	300.	4568.90	4571.41	-2.51	-2.50	025	100.
	305.					SEC.	9805.000
	355.					SEC.	9855.000
	390.					SEC.	9890.000
4	400.	4569.26	4572.06	-2.80	-2.57	025	100.
	440.					SEC.	9940.000
5	500.	4569.62	4573.17	-3.55	-2.77	030	100.
6	600.	4570.01	4573.99	-3.98	-2.97	030	83.
7	700.	4570.47	4574.36	-3.89	-3.10	030	100.
8	800.	4570.94	4574.73	-3.79	-3.19	030	100.
9	900.	4571.40	4575.09	-3.69	-3.24	030	100.
	1000.					SEC.	10500.000
10	1000.	4571.86	4575.46	-3.60	-3.28	035	100.
11	1100.	4572.29	4575.93	-3.64	-3.31	035	100.
12	1200.	4572.67	4576.49	-3.82	-3.35	035	100.
13	1300.	4573.06	4577.05	-3.99	-3.40	035	100.
14	1400.	4573.45	4577.61	-4.16	-3.46	035	100.
	1500.					SEC.	11000.000
15	1500.	4573.83	4578.17	-4.34	-3.52	035	80.
16	1600.	4574.29	4578.68	-4.39	-3.57	035	81.
17	1700.	4574.82	4579.12	-4.30	-3.61	035	82.
18	1800.	4575.35	4579.57	-4.22	-3.65	035	83.
19	1900.	4575.87	4580.01	-4.14	-3.67	035	84.
	2000.					SEC.	11500.000
20	2000.	4576.40	4580.46	-4.06	-3.69	035	85.
21	2100.	4576.94	4581.01	-4.07	-3.71	035	86.
22	2200.	4577.47	4581.69	-4.22	-3.73	035	86.
23	2300.	4578.01	4582.36	-4.35	-3.76	040	87.
24	2400.	4578.55	4583.03	-4.48	-3.79	040	88.
	2500.					SEC.	12000.000
25	2500.	4579.09	4583.70	-4.61	-3.82	040	84.
26	2600.	4579.47	4584.13	-4.66	-3.86	040	85.
27	2700.	4579.70	4584.34	-4.64	-3.88	040	85.
28	2800.	4579.93	4584.54	-4.61	-3.91	040	86.
29	2900.	4580.16	4584.74	-4.58	-3.93	040	86.
	2950.					SEC.	12450.000
30	3000.	4581.08	4585.69	-4.61	-3.96	040	87.
	3000.					SEC.	12500.000
	3030.					SEC.	12530.000
	3080.					SEC.	12580.000
31	3100.	4582.72	4588.00	-5.28	-4.00	040	84.
32	3200.	4583.58	4589.46	-5.88	-4.06	040	81.
33	3300.	4583.60	4589.48	-5.88	-4.11	040	79.
34	3400.	4583.63	4589.49	-5.86	-4.16	040	76.
	3500.					SEC.	13000.000
35	3500.	4583.66	4589.51	-5.85	-4.21	040	74.
36	3600.	4583.95	4589.61	-5.66	-4.25	045	72.
37	3700.	4584.52	4589.79	-5.27	-4.28	045	76.
38	3800.	4585.09	4589.98	-4.89	-4.30	045	76.
39	3900.	4585.66	4590.16	-4.50	-4.30	045	77.
40	4000.	4586.23	4590.35	-4.12	-4.30	045	78.
	4070.					SEC.	13570.000
41	4100.	4587.12	4591.15	-4.03	-4.29	045	78.
	4120.					SEC.	13620.000
	4130.					SEC.	13630.000
	4180.					SEC.	13680.000
42	4200.	4588.23	4592.07	-3.84	-4.28	045	79.
43	4300.	4589.28	4592.77	-3.49	-4.26	045	74.
44	4400.	4590.38	4593.77	-3.39	-4.24	040	75.
	4500.					SEC.	14000.000
45	4500.	4591.47	4594.77	-3.30	-4.22	040	76.
46	4600.	4592.29	4595.45	-3.16	-4.20	040	74.
47	4700.	4592.84	4595.80	-2.96	-4.17	040	72.
48	4800.	4593.38	4596.15	-2.77	-4.14	040	73.
49	4900.	4593.93	4596.50	-2.57	-4.11	040	71.
	5000.					SEC.	14500.000

THIS REACH CAN BE SURDIVIDED BY INC NO. TO MEET FIA REQUIREMENTS
INPUT 20N WHERE N IS THE NUMBER OF REACHES AND THEN INPUT THE END
OF EACH REACH BY INC NO. FOR EXAMPLE# 202 32 49
A NEGATIVE INC NO. WILL SUPPRESS INTERMEDIATE INC OUTPUT.

As coded on the previous page, all of the incremental data will be printed plus the results for the two reaches. If only the results for each reach are desired, the first increment number could be coded with a minus sign. This will suppress all of the intermediate results. For example, 202 -32 49 will give the results shown below.

```
CONTINUOUS FLOOD HAZARD FACTORS BY EVEN INCREMENTS


INC     TOTAL     WEIGHTED AVG DIFFERENCE
NO.     LENGTH     BETWEEN BASE FLOOD AND
                    10%      1%        0.2%

 32      3200.     -3.75    -1.14        .82

FHF FOR REACH    1 = 040 WITH    81.% OF THE REACH WITHIN 1.0 FEET
ZONE FOR THE REACH = A 8
=====================================================================

 49      4900.     -4.23     -.96        .74

FHF FOR REACH    2 = 040 WITH    47.% OF THE REACH WITHIN 1.0 FEET
ZONE FOR THE REACH = A 8
=====================================================================
```

When there is uncertainty as to where to subdivide the reach, the user should code several alternatives on the J3 card and another run should be made. For example, (J3 202 -32 49 203 -32 40 49), would provide for two different subdivisions. The first is the same as the previous example and the second is for three reaches ending with increments 32, 40, and 49, as the example shows below.

```
CONTINUOUS FLOOD HAZARD FACTORS BY EVEN INCREMENTS


INC     TOTAL     WEIGHTED AVG DIFFERENCE
NO.     LENGTH     BETWEEN BASE FLOOD AND
                    10%      1%        0.2%

 32      3200.     -3.75    -1.14        .82

FHF FOR REACH    1 = 040 WITH    81.% OF THE REACH WITHIN 1.0 FEET
ZONE FOR THE REACH = A 8
=====================================================================

 40      4000.     -5.30    -1.27        .52

FHF FOR REACH    2 = 055 WITH    88.% OF THE REACH WITHIN 1.0 FEET
ZONE FOR THE REACH = A11
=====================================================================

 49      4900.     -3.28     -.69        .94

FHF FOR REACH    3 = 035 WITH   100.% OF THE REACH WITHIN 1.0 FEET
ZONE FOR THE REACH = A 7
=====================================================================
```

ARCHIVAL OPTION

The Archival Option is a useful feature when it is desired to create a permanent record (on tape) of study results in computer readable form. The input data and all computed results are written in compact form on tape. At some future time this tape can be used, with appropriate software, as a basis for further analysis. For example, additional profile plots can be generated, new output tables can be produced using any of the variables available for summary printout (J3 card), and cross section data can be verified. This may be particularly valuable when analysis is required to determine encroachments or floodways within the study area. In addition this tape can be useful when studies of adjoining river reaches are being performed.

The archival tape is structured as follows:

Section a. Input data cards
Section b. Header block showing program version
Section c. Number of output variables and cross sections
Section d. Alphanumeric names of output variables
Section e. Output variables for each cross section

Sections of the output defined above are separated by numeric delineators. Section a is terminated by a 130 character line of 1's. Section b, c, and d are terminated, respectively, by line of 2's, 3's, and 4's. This is followed by the values of all sixty-three variables for each cross section. Each profile is terminated by a line of 5's. The tape is terminated by a line of 6's. This is illustrated by the example on pages 19 - 20.

At the beginning of the normal output for archival executions the following line will appear:

```
THIS IS AN ARCHIVAL RUN ALL DATA AND RESULTS ARE SAVED ON UNIT    96
```

This indicates the unit number (in this example unit 96) on which the file is written. It is the users responsibility to provide the required job control statements to insure that the file written on unit 96 will appear on magnetic tape or otherwise be saved by the system after execution.

The information written to the tape is formatted 130 character lines. This will allow the tape to be listed directly on a line printer. It should be noted that the tape will contain characters in column one that are not intended as line printer carriage control. Thus for direct tape listing the lines should be shifted one column.

On an archival execution cross section plots should not be requested. Also the maximum number of summary tables is reduced by two for an archival run. The following example shows the type of information that may be appropriate.

```
AC
AC              AC CARDS ARE UTIIIZED TO EMPLOY THE ARCHIVAL TAPE OPTION
AC              THFY MAY ALSO RE USED TO PROVIDE ADDITIONAL DOCUMENTATION
AC                                 (FOR INSTANCE)
AC                              RFD FOX RIVER INVESTIGATION
AC                        THE STOUTT COUNTY PLANNING COMMISSION
AC                        A.B.C.FNGINEERS,INC.SALT WELLS,NEVADA
AC               ANALYSIS PERFORMED BETWEEN RIVER MILE 9.2 TO 25.6
AC                             NOVEMBER 12,1976
AC
T1      ARCHIVAL EXAMPLE
T2      2 PROFILES, 3 CROSS SECTIONS
T3      RED FOX RIVER
J1     -1       2                                                   5709
NC                        0.1     0.3
QT      3    5000    7500   10000
NH      5     0.1     415    0.05     650    0.03     710    0.05   1020     0.1
NH   1635
X1      1      26     650     710
GR   5726      20    5724      30    5722      45    5720      60   5718     110
GR   5717     415    5716     630    5714     650  5713.7     655   5713     660
GR   5702     670    5701     675    5700     690  5700.1     697 5700.8     700
GR   5701     710    5713     710  5713.5     940    5714    1020   5714    1215
GR   5712    1235    5712    1575    5714    1590    5716    1615   5720    1630
GR   5725    1635
NH      4     0.1     415    0.05     575    0.03     640     0.1   1250
X1      2      22     575     640     500     500     500
GR   5725      30    5724      40    5722      50    5720     110   5720     200
GR   5718     295    5717     415    5716     455    5713     505 5709.5     575
GR   5705     585  5704.2     595  5704.5     615    5716     635   5718     640
GR5718.5      940    5718    1130    5718    1195    5720    1205   5722    1225
GR   5724    1245    5725    1250
NH      4     0.1     260     0.1     370   0.036     600    0.05    875
X1      3      16     260     600     400     400     400
GR   5725      40    5724      90    5722     260    5720     330 5718.7     370
GR   5715     420  5711.2     460  5707.1     500  5707.5     530   5712     550
GR5717.3      580    5719     590    5720     600    5722     850   5724     865
GR   5725     875
EJ
T1      RED FOX RIVER  TEST DATA
T2      Q:7500CFS
T3      RED FOX RIVER
J1    -10       3                  0.0072                           5710
J2     15


ER
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1


 *****************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
   ERROR CORR - 01.02
   MODIFICATION - 50,51,52,53
 *****************************************************
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2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
     65       3
3333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333333
     CWSEL           CRIWS           EG              TOPWID          10K*S           TIME            VOL             DEPTH
     WSELK           HV              HL              QLOSS           QLOB            QCH             QROB            K*XNL
     K*XNCH          K*XNR           K*WTN           CASE            STCHL           STCHR           XLBEL           RBEL
     AREA            VCH             STENCL          STENCR          CLSTA           BW              ELENCL          ELENCR
     K*CHSL          .01K            QCH0            PERENC          TWA             SECNO           XLCH            ELTRD
     ELLC            ELMIN           Q               EGPRS           EGLWC           QWEIR           QPR             H3
     CLASS           DIFWSP          DIFWSX          DIFKWS          SSTA            ENDST           VLOB            VROB
     ALPHA           KRATIO          QLOB0           QROB0           DIFEG           IHLEQ           TELMX

4444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444
 .57090000E+04   0.              .57120532E+04   .46363636E+02   .70619315E+02   0.              0.              .90000000E+01
 .57090000E+04   .30532170E+01   0.              0.              0.              .49999992E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   0.              0.              .65000000E+03   .71000000E+03   .57140000E+04   .57130000E+04
 .35657273E+03   .14022382E+02   0.              0.              0.              0.              0.              0.
0.               .59498806E+03   0.              0.              0.              .10000000E+01   0.              0.
0.               .57000000E+04   .50000000E+04   0.              0.              0.              0.              0.
0.               0.              0.              0.              .66363636E+03   .71000000E+03   0.              0.
 .99999950E+00   0.              0.              .99999983E+02   0.              0.              .57250000E+04   0.
0.
 .57129264E+04   .57127879E+04   .57151600E+04   .12321240E+03   .52403591E+02   .11823766E-01   .48636510E+01   .87264280E+01
0.               .22335684E+01   .30248146E+01   .81964861E-01   .36173204E+03   .46382672E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   .99800399E-02   0.              .57500000E+03   .64000000E+03   .57095000E+04   .57180000E+04
 .49086982E+03   .12422587E+02   0.              0.              0.              0.              0.              0.
 .84000000E+01   .69070004E+03   .72346409E+01   0.              .97323256E+00   .20000000E+01   .50000000E+03   0.
0.               .57042000E+04   .50000000E+04   0.              0.              0.              0.              0.
0.               0.              .39264280E+01   0.              .50644459E+03   .62965699E+03   .30786725E+01   0.
 .13863656E+01   .11608637E+01   0.              .92765345E+02   0.              0.              .57250000E+04   0.
0.
 .57161464E+04   0.              .57166800E+04   .16899919E+03   .23536903E+02   .30777046E-01   .11033381E+02   .90463543E+01
0.               .53365481E+00   .13500212E+01   .16999136E+00   0.              .49999995E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   .99778271E-02   0.              .26000000E+03   .60000000E+03   .57220000E+04   .57200000E+04
 .85289741E+03   .58623692E+01   0.              0.              0.              0.              0.              0.
 .72500000E+01   .10306124E+04   0.              0.              .23148836E+01   .30000000E+01   .40000000E+03   0.
0.               .57071000E+04   .50000000E+04   0.              0.              0.              0.              0.
0.               0.              .32199262E+01   0.              .40448195E+03   .57348114E+03   0.              0.
 .99999971E+00   .14921273E+01   0.              .99999990E+02   0.              0.              .57250000E+04   0.
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 .57113488E+04   0.              .57153371E+04   .48498950E+02   .72519471E+02   0.              0.              .11348845E+02
 .57100000E+04   .39882209E+01   0.              0.              0.              .74999991E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   0.              0.              .65000000E+03   .71000000E+03   .57140000E+04   .57130000E+04
 .46798147E+03   .16026274E+02   0.              0.              0.              0.              0.              0.
0.               .88071207E+03   0.              0.              0.              .10000000E+01   0.              0.
0.               .57000000E+04   .75000000E+04   0.              0.              0.              0.              0.
0.               0.              0.              .13488446E+01   .66150105E+03   .71000000E+03   0.              0.
 .99999966E+00   0.              0.              .99999989E+02   0.              0.              .57250000E+04   0.
0.
 .57162105E+04   0.              .57175630E+04   .18887949E+03   .24552593E+02   .15555574E+01   .83994277E+01   .12010499E+02
0.               .13525414E+01   .19624074E+01   .26356795E+00   .16653138E+04   .58346857E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   .99800399E-02   0.              .57500000E+03   .64000000E+03   .57095000E+04   .57180000E+04
 .99553482E+03   .10380335E+02   0.              0.              0.              0.              0.              0.
 .84000000E+01   .15136051E+04   .22204184E+02   0.              .13623648E+01   .20000000E+01   .50000000E+03   0.
0.               .57042000E+04   .75000000E+04   0.              0.              0.              0.              0.
0.               0.              .48616548E+01   0.              .44664284E+03   .63552232E+03   .38420461E+01   0.
 .15347118E+01   .17186151E+01   0.              .77795809E+02   0.              0.              .57250000E+04   0.
0.
 .57179573E+04   0.              .57185739E+04   .20383931E+03   .22388061E+02   .33187114E-01   .18434614E+02   .10857280E+02
0.               .61666411E+00   .93731539E+00   .73587732E-01   0.              .74999995E+04   0.              .10000000E-01
 .10000000E-01   .10000000E-01   .99778271E-02   0.              .26000000E+03   .60000000E+03   .57220000E+04   .57200000E+04
 .11901288E+04   .63018387E+01   0.              0.              0.              0.              0.              0.
 .72500000E+01   .15850867E+04   0.              0.              .31654814E+01   .30000000E+01   .40000000E+03   0.
0.               .57071000E+04   .75000000E+04   0.              0.              0.              0.              0.
0.               0.              .17467804E+01   0.              .38002999E+03   .58386930E+03   0.              0.
 .99999981E+00   .10472261E+01   0.              .99999994E+02   0.              0.              .57250000E+04   0.
0.
5555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555555
6666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666666
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FRICTION LOSS EQUATION OPTION

1. A key aspect of water surface profile computation is the estimation of friction losses. A number of equations have been proposed for calculating frictions losses[1], four of which are as follows:

AVERAGE CONVEYANCE EQUATION

$$HL = L\left(\frac{Q_1 + Q_2}{K_1 + K_2}\right)^2 \qquad (1)$$

AVERAGE FRICTION SLOPE EQUATION

$$HL = L\left(\frac{S_1 + S_2}{2}\right) \qquad (2)$$

GEOMETRIC MEAN FRICTION SLOPE EQUATION

$$HL = L\,(S_1 S_2)^{0.5} \qquad (3)$$

HARMONIC MEAN FRICTION SLOPE EQUATION

$$HL = L\left(\frac{2\,S_1 S_2}{S_1 + S_2}\right) \qquad (4)$$

Where:

HL = friction loss for reach

L = discharge-weighted reach length

Q_1 = total discharge at upstream end of reach

Q_2 = total discharge at downstream end of reach

K_1 = total conveyance at upstream end of reach

K_2 = total conveyance at downstream end of reach

S_1 = friction slope at upstream end of reach

S_2 = friction slope at downstream end of reach

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[1] Reed, J.R. and Wolfkill, A. J., "Evaluation of Friction Slope Models," Rivers 76, Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions, Colorado State University, August 1976.

2. Equation (1) is the same equation as used in all HEC-2 source decks dated August 1971 that contain Modification 56. Prior HEC-2 source decks utilized equation (2). Equation (1) is recommended for general application until such time as research results clearly demonstrate that an alternative equation or set of equations is more suitable for general application to natural rivers, including reaches where flow is expanding or contracting.

Equation (2) is a commonly used equation that has been shown[1] to be most suitable for M1 profiles. Equation (3) is the friction loss formulation presently used in the USGS computer program for calculating profiles. Equation (4) has been shown[1] to be most suitable for M2 profiles.

3. The November 1976 version of HEC-2 provides an option to enable use of any of the above equations, (1) through (4), for a run. Another aspect of the option, described subsequently, permits the program to select one of equations (2), (3), or (4), on a reach-by-reach basis, depending on flow conditions within the reach. The friction loss equation option is controlled by variable IHLEQ in field 1 of the J6 card as follows:

Value of IHLEQ	Friction Loss Equation
0	Equation (1) is used.
1	Program selects equation based on flow conditions.
2	Equation (2) is used.
3	Equation (3) is used.
4	Equation (4) is used.

4. If IHLEQ is set equal to 1, the program selects a friction loss equation for a reach in accordance with criteria in Table 1.

TABLE 1

Profile Type	Is friction slope at current cross section greater than friction slope at preceding cross section?	Equation Used
Subcritical (M1, S1)	Yes	(2)
Subcritical (M2)	No	(4)
Supercritical (S2)	Yes	(2)
Supercritical (M3, S3)	No	(3)

[1] Ibid.

Criteria in Table 1 are based, in large measure, on results reported by Reed and Wolfkill[1]. The criteria are intended to select the 'best' equation for M1, M2, S2 and S3 profiles. Also, the criteria select the 'second best' equation for a M3 profile. The criteria do not select a 'best' equation for a S1 profile, nor do they result in selection of the best equation for flow expansions such as can occur downstream of bridge openings.

When using this option, it is appropriate to also use a J3 card to request printout of the variable IHLEQ to identify the equation used for each reach. The J3 card code number for IHLEQ is 62.

5. Experience to date indicates that application of criteria in Table 1 produces water surface profiles that only rarely differ by more than 0.2 feet from profiles determined with equation (1). In a few instances, application of criteria in Table 1 enabled determination of 'balanced' water surface elevations at cross sections for which equation (1) could not produce a solution to the energy equation. Any of the alternative friction loss equations will produce satisfactory estimates provided that reach lengths are not too long. The advantage that is sought in alternative friction loss formulations is to be able to maximize reach lengths without sacrificing profile accuracy.

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[1] Ibid.

REVISED INPUT REQUIREMENTS

The input requirements have remained basically unchanged with the exception of a modified J3 card and new J5, J6, and AC cards. Also input for the ET card has been expanded to include the new encroachment methods. The J3 card defines the summary output requirements and the J5 card controls the amount of printout for a job. The J6 card permits the user to select friction loss equations and allows the program to transfer control of summary output storage devices to system control cards. The AC card activates the new Archival Option.

AC

AC Card (Archival Option)

To invoke the Archival Option, one or more AC cards should be inserted at the beginning of a data deck (i.e., before C cards or first T1 card if C cards are not used). Columns 3 through 80 of each AC card are available for alphanumeric comments. This may be used to document the Archive tape. As many AC cards as required may be used.

Card Number	Field	Variable	Value	Description
1	0	IA	AC	Card identification characters.
2 - as many cards necessary	0	IA	AC	Alphanumeric comments to document the Archival tape.

J3 CARD

Optional card (up to five cards may be used). Used on first profile of a multiple profile run to select variables for the summary printout. If a summary printout is requested (J2.1) and a J3 card is not supplied a pre-defined table 150 is printed.

Field	Variable	Value	Description
0	IA	J3	Card identification characters.
1-10	IVAR(I)	+	Codes to specify summary tables. Pre-defined tables may be called as shown below (100 and 200 series). User-defined tables may be generated by specifying up to thirteen variable codes per table. For multiple user-defined tables specify a zero code between tables. Tables are printed in order specified. Pre-defined tables are printed in numerical order after any user-defined table. A maximum of five tables may be generated.

CODES FOR PRE-DEFINED TABLES

Code	Table
100	Cross-section output at bridges (SB only).
105	4 cross-section output at bridges (SB only).
110	Encroachment data.
120	Channel improvement data.
150	Standard summary (2 tables produced).
200	Floodway data (FIA Table 1).
201	Flood insurance zone data (FIA Table 2).

J3 CARD (continued)

VARIABLE CODES FOR USER DEFINED TABLES

Variable Name	Code Number
Cross Section and Reach Variables from Input	
SECNO	38
STCHL	21
STCHR	22
XLBEL	23
RBEL	24
ELMIN	42
XLCH	39
CHSLOP	33
Velocity Variables	
VLOB	55
VROB	56
VCH	26
HV	10
Calculated Geometric Variables	
DEPTH	8
TOPWID	4
AREA	25
TWA	37
VOL	7
SSTA	53
ENDST	54
TELMX	63
Hydraulic Parameters	
CASE	20
SLOPE (10K*S)	5
KRATIO	58
Water Surface and Energy Related Variables	
CWSEL	1
CRIWS	2
WSELK	9
EG	3
HL	11
OLOSS	12
IHLEQ	62
Difference Variables	
DIFEG	61
DIFWSP	50
DIFWSX	51
DIFKWS	52

Variable Name	Code Number
Discharge Variables	
Q	43
QLOB	13
QCH	14
QROB	15
QLOB%	35
QCH%	60
QROB%	59
ALPHA	57
.01K	34
TIME	6
Manning's n Variables	
XNL	16
XNR	18
XNCH	17
WNT	19
Bridge Variables	
CLASS	49
QWEIR	46
QPR	47
EGPRS	44
EGLWC	45
H3	48
ELTRD	40
ELLC	41
Encroachment Variables	
PERENC	36
STENCL	27
STENCR	28
ELENCL	31
ELENCR	32
Channel Improvement (CHIMP) Variables	
CLSTA	29
BW	30

See following pages for descriptions of variables.

J3 CARD (continued)

SUMMARY PRINTOUT DATA DESCRIPTION

Variable Name	Code Number	Description
	Cross Section and Reach Variables from Input	
SECNO	38	The cross section identification number.
STCHL	21	Station of the left bank.
STCHR	22	Station of the right bank.
XLBEL	23	Left bank elevation
RBEL	24	Right bank elevation.
ELMIN	42	Minimum elevation in cross section.
XLCH	39	Channel reach length.
CHSLOP	33	Channel slope.
	Velocity Variables	
VLOB	55	Average velocity in the left overbank area.
VROB	56	Average velocity in the right overbank area.
VCH	26	Mean velocity in the channel.
HV	10	Mean velocity head across the entire cross section.
	Calculated Geometric Variables	
DEPTH	8	Depth of flow.
TOPWID	4	Cross section width at the calculated water surface elevation.
AREA	25	Cross section area.
TWA	37	The cumulative topwidth area.
VOL	7	Cumulative volume of water in the river since the first cross section in acre-feet.

SUMMARY PRINTOUT DATA DESCRIPTION (continued)

Variable Name	Code Number	Description
SSTA	53	Starting station where the water surface intersects the ground.
ENDST	54	Ending station where the water surface intersects the ground on the right side.
TELMX	63	Elevation of the lower of the two end points of the cross section.
	Hydraulic Parameters	
CASE	20	A variable indicating how the water surface elevation was computed. Values of -1, -2, -3, and 0 indicate assumptions of critical depth, minimum difference a fixed change (X5 card) or a balance between the computed and assumed water surface elevations.
SLOPE (10K*S)	5	Slope of the energy grade line for the current section.
KRATIO	58	Ratio of the upstream to downstream conveyance.
	Water Surface and Energy Related Variables	
CWSEL	1	Computed water surface elevation.
CRIWS	2	Critical water surface elevation.
WSELK	9	Known water surface elevation from high water mark.
EG	3	Mean energy gradient elevation across the entire cross section which is equal to the computed water surface elevation CWSEL plus the mean velocity head HV.
HL	11	Energy loss due to friction.
OLOSS	12	Energy loss due to minor losses such as transition losses.
IHLEQ	62	Friction loss equation index.

SUMMARY PRINTOUT DATA DESCRIPTION (continued)

Variable Name	Code Number	Description
	Difference Variables	
DIFEG	61	Difference in energy elevation for each profile.
DIFWSP	50	Difference in water surface elevation for each profile.
DIFWSX	51	Difference in water surface elevation between sections.
DIFKWS	52	Difference in water surface elevation between known and computed.
	Discharge Variables	
Q	43	Discharge.
QLOB	13	Amount of flow in the left overbank.
QCH	14	Amount of flow in the channel.
QROB	15	Amount of flow in the right overbank.
QLOB%	35	Percent of flow in the left overbank.
QCH%	60	Percent of flow in the channel.
QROB%	59	Percent of flow in the right overbank.
ALPHA	57	Velocity head coefficient.
.01K	34	The total discharge (index Q) carried with S = .01 (equivalent to .01 times conveyance). conveyance).
TIME	6	Travel time from the first cross section to the present cross section in hours.

J3 CARD (continued)

SUMMARY PRINTOUT DATA DESCRIPTION (continued)

Variable Name	Code Number	Description
	Manning's n Variables	
XNL	16	Manning's "n" for the left overbank area.
XNR	18	Manning's "n" for the right overbank area.
XNCH	17	Manning's "n" for the channel area.
WNT	19	Weighted value of Manning's "n" for the channel based on the distance between cross sections and channel flow from the first cross section. Used when computing Manning's "n" from high water marks.
	Bridge Variables	
CLASS	49	Controlling flow type for bridge solution.
QWEIR	46	Total weir flow at the bridge.
QPR	47	Total pressure flow at the bridge.
EGPRS	44	Energy elevation assuming pressure flow.
EGLWC	45	Energy elevation assuming low flow.
H3	48	Change in water surface elevation from Yarnell's equation.
ELTRD	40	Minimum elevation for top of road profile.
ELLC	41	Maximum low chord elevation.

J3 CARD (continued)

SUMMARY PRINTOUT DATA DESCRIPTION (continued)

Variable Name	Code Number	Description
	Encroachment Variables	
PERENC	36	The target of encroachment requested on ET card.
STENCL	27	The station of the left encroachment.
STENCR	28	The station of the right encroachment.
ELENCL	31	Elevation of left encroachment.
ELENCR	32	Elevation of right encroachment.
	Channel Improvement (CHIMP) Variables	
CLSTA	29	The centerline station of the trapezoidal excavation.
BW	30	The bottom width of the trapezoidal excavation.

J5 CARD (Printout Control)

The optional J5 card can be used to suppress detailed (cross section by cross section) and summary printout. The J5 card(s) may be used for single or multiple profile jobs. For multiple profile jobs, the J5 card(s) is inserted with job cards for the first profile. Printout of the data input list, flow distribution data, and profile and cross section plots are unaffected by this option. For printout control of these options refer to the J1, J2, X1, and X2 cards. Use of the J5 card for various printout options is illustrated in the following table.

Field					
0 (IA)	1 (LPRNT)	2 (NUMSEC)	3 (SECNOS(I))	4 ... N	Desired Printout
J5	-10	-10			Summary printout only for all cross sections.
J5	-10		X		Detailed and summary printout beginning at cross section X.
J5	-10	N	X_1	$X_2 \ldots X_n$	Detailed and summary printout for N cross sections (X_1, X_2, ... X_n).

Field	Variable	Value	Description
0	IA	J5	Card identification.
1	LPRNT	-10	and NUMSEC = -10, suppress detailed printout for all cross sections.
			and NUMSEC = 0 or +, print detailed and summary printout for only those cross sections indicated by NUMSEC and SECNOS(I) (J5.2 and J5.3).
		-1	Same as -10 except a list of cross section numbers is furnished to aid in debugging runs that do not run to completion.

J5 CARD (continued)

Field	Variable	Value	Description
2	NUMSEC	-10	Suppress detailed printout for all cross sections. Requested summary printout is not suppressed.
		0	Suppress all detailed and summary printout from the first cross section to the cross section indicated in J5.3.
		+	Total number of cross sections for which detailed and summary printout are desired. This variable is ignored if J4 card is used.
3-10	SECNOS(I)	-,0,+	If NUMSEC is +, 100 cross section numbers can be specified. If additional cards are required, all ten fields should be used for SECNOS(I). These variables are ignored if J4 card is used.

J6 (Optional Card)

The J6 card is an optional card which can be utilized (a) to select equations for computation of friction losses and (b) to transfer control of output print files to computer system control cards. These options may be used for single or multiple profile jobs. For multiple profiles the J6 card is inserted with job cards for the first profile.

These options are described further on pages 21 - 23 of the friction loss equation option.

Field	Variable	Value	Description
0	IA	J6	Card identification.
1	IHLEQ	0	Average conveyance equation used to compute friction losses. This equation has been utilized in the preceding version of HEC-2 and is recommended for general application.
		1	Program selects, on a reach by reach basis, one of the following equations: average friction slope, geometric mean friction slope, or harmonic mean friction slope. Selection is based on flow conditions. See pages 3 - 5 for details.
		2	Average friction slope equation used to compute friction losses.
		3	Geometric mean friction slope equation used to compute friction losses.
		4	Harmonic mean friction slope equation used to compute friction losses.
2	ICOPY	0	The program will internally handle the disk/tape units containing the output print files.
		1	The program will transfer control of disk/tape units for output print files to computer system control cards. See Programmers Manual for details.

ET (Optional Card for Specifying Encroachment Methods)

This card is used to specify the method (1 - 6) and target of the encroachment. This method and target will be used until changed by another ET card, except for Method 1, which only applies to the next cross section. A zero on the first ET card indicates no encroachment, while a zero on succeeding ET cards indicates no change in encroachment. The field of the ET card that is being used for a particular profile is specified by variable INQ (J1.2). Methods 3 - 6 require a natural profile for the first profile and thus require reading a zero on the ET card of the "INQ" field of the first profile. If Methods 2 - 6 are being used and it is desired to terminate the encroachment option, use Method 1 with the encroachment stations specified near the two ends of the cross section. Each method is capable of evaluating the effects of encroachments on bridges.

Field	Variable	Value	Description
0	IA	IT	Card identification characters.
1	None	None	Blank field.
2 - 10	ENCFP(N)	0	No encroachment or no change in encroachment.
		+ or -	Encroachment method used. The number X.Y is used to specify that method Y is being used and X is the target to be used for that method. Up to nine values may be specified. The encroachment method or target may be changed at any cross section or on different profiles.
			Positive values of X.Y for methods 3 through 6 provide an encroachment based on a reduction of conveyance equally in both overbanks. Negative values of X.Y for methods 3 and 4 provide an encroachment based on a reduction of conveyance in proportion to the distribution of natural overbank conveyance. For instance, if the natural cross section had twice as much conveyance in the left overbank as in the right overbank, a 10.3 would reduce five percent conveyance in each overbank, whereas a -10.3 would reduce 6.7 percent from the left overbank and 3.3 percent from the right overbank.

ET CARD (continued)

Field	Variable	Value	Description
2 - 10	ENCFP(N)	+ or -	Bridge encroachments may be evaluated by adding .01 to the code X.Y for any of the methods. Thus a 9.11, 100.21, 10.31, 10.41, 10.51, or 10.61 would request the bridge encroachments for Method 1 - 6, while a 9.1, 100.2, 10.3, 10.4, 10.5, or 10.6 would not. The following table describes how each method handles encroachments on bridges.

Method	Description
1	Bridge encroachments set as indicated by target values of Method 1.
2	Bridge encroachments set as indicated by target values of Method 2.
3 - 6	Bridge encroachments defined by encroachments determined at the cross section immediately downstream of the bridge.

Further details of the targets and methods are given below.

Method	ET Card Value	Description
1	X.1 or X.11	The Xth and Xth + 1 fields of the ET card will be used for the encroachment stations STENCL and STENCR. STENCL should not be 0.
2	X.2 or X.21	The top width of X will determine encroachment stations such that the center of the top width will be centered halfway between bank stations.
3	X.3 or X.31	The natural cross section will be encroached so that X percent of the total conveyance will be eliminated equally (X/2 percent) from each overbank.
	-X.3 or -X.31	Same as X.3 except the reduction of conveyance in each overbank will be in proportion to the conveyance in the overbanks.
4	X.4 or X.41	The natural cross section will be encroached so that a (X/10) foot increase in water surface elevation will occur. The reduction of conveyance will be

ET CARD (continued)

Method	ET Card Value	Description
		equal in both overbanks. A one foot increase in water surface elevation would require a 10.4 and a .5 foot increase would require a 5.4.
	-X.4 or -X.41	Same as X.4 except the reduction of conveyance in each overbank will be in proportion to the conveyance in the overbanks.
5	X.5 or X.51	Operates much like Method 4 except that an optimization scheme is used to obtain the desired difference in water surface elevations as closely as possible to the specified target difference. Input to Method 5 is exactly like Method 4 in that a 10.5 would mean a target of one foot difference in water surface elevations.
6	X.6 or X.61	Uses an optimization scheme to obtain a desired difference in energy grade line elevations between natural and encroached conditions as closely as possible to the specified target. Input to Method 6 is exactly like Method 4 in that a 10.6 would mean a target of one foot difference in energy elevations.