August 7, 2017

KUWASER Program Listing

In Fortan 90

Listed following is the KUWASER program, updated to Fortan 90 by Dr. Maria L. Chu-Agor. This listing was created by OCR from my MS thesis listing, manually corrected, and updated. It has not been fully executed and verified. See http://hdl.handle.net/10217/180995 for additional documentation.

Glenn Brown

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    PROGRAM KUWASER
!
!   THIS PROGRAM IS A KNOWN DISCHARGE, WATER AND SEDIMENT
!   ROUTING MODEL, DEVELOPED BY GLENN O. BROWN AND RUH-MING LI,
!   AT THE ENGINEERING RESEARCH CENTER, COLORADO STATE
!   UNIVERSITY, FORT COLLINS, COLORADO.
!
    COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
           COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
           COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
           COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
           COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
           DIMENSION PNR(10)
!
!   DEFINE DEVICE NUMBERS
!        I5            INPUT DEVICE FOR GENERAL DATA FILE
!        I6            DEVICE FOR PRINTED OUTPUT
!        I7            INPUT DEVICE FOR CROSS SECTION FILE
!        I8            INPUT DEVICE FOR DISCHARGE FILE
!        I9            OUTPUT DEVICE FOR YEARLY CROSS SECTION ELEVATIONS, (BINARY OUTPUT)
!        I10            OUTPUT DEVICE FOR CROSS SECTION HYDRAULIC PROPERTIES, (BINARY
OUTPUT)
!
    I5=5
           I6=6
           I7=7
           I8=8
           I9=9
           I10=10
!
!   READ IN THE SEDIMENT AND GEOMETRY DATA.
!
    CALL IN1
!
```

```
!
!   PUTS CORRECT VALUES TO THE CONSTANTS ACCORDING TO THE
!   UNIT-SYSTEM.
!
    CALL UNIT
!
!   CONVERT RIVER DISTANCES.
!
      DO 130 NR=1,NRIV
      PNR(NR)=0.5
      KU=KUP(NR)
      KD=KDOWN(NR)
           IF (NR.EQ.1) GO TO 100
           NRM1=NR-1
      IF (KD.EQ.KUP(NRM1)) KD=KD+1
 100  DO 110 K=KD,KU
          DIS=RD(K)
          CALL RIVDS (NR,DIS)
          RD(K)=DIS
 110  CONTINUE
      NT=NTRIB(NR)
      IF (NT.EQ.0) GO TO 130
      DO 120 J=1,NT
         DIS=RDT(NR,J)
         CALL RIVDS (NR,DIS)
         RDT (NR,J)=DIS
 120   CONTINUE
 130  CONTINUE
!
!   SET INITIAL VALUES
!
     DO 150 K=1,NSEC
         WSMAX(K)=0.0
         SMZWS(K)=0.0
         SMADA(K)=0.0
         SUMDA(K)=0.0
         WSK(K)=0.0
         TQ(K)=0.0
         VK(K)=0.0
         EDK(K)=0.0
         WE(K)=0.0
         ALPK(K)=0.0
         TKK(K)=0.0
         TAK(K)=0.0
```

```
!
!    SET ORIGINAL BED ELEVATIONS INTO ZO (K,L)     ARRAY.
!
         M=ND(K)
         DO 140 L=1,M
              ZO(K,L)=Z(K,L)
 140        CONTINUE
 150  CONTINUE
!
!    CALCULATE THE INITIAL HYDRAULIC PROPERTIES OF EACH CROSS SECTION
!
    DO 160 K=1,NSEC
         CALL THAL (K)
         CALL CHNGM (K)
 160  CONTINUE
!
!    ITERATE OVER EACH TIME PERIOD
!
    IF (NTIM.NE.0) GO TO 170
    WRITE (I6,310)
    STOP
 170  DO 300 I=1,NTIM
         ITIME=I
!
!    ITERATE OVER SUBROUTINE CALLS
!
    DO 290 NC=1,NCALL
         ICAL1=ICALL(NC,1)
         GO TO (180,190,200,210,220,230,240,250,260), ICAL1
!
!    DETERMINE FLOW AT EACH CROSS SECTION
!
 180     CALL FLOW
         GO TO 290
!
!    CALCULATE WATER SURFACE PROFILE FOR REACH
!
 190     CALL SUBPF(ICALL(NC,2))
         GO TO 290
!
!    COMPUTE FLOWS AND WATER SURFACE PROFILES FOR DIVIDED FLOW REACHES
!
 200     ICAL2=ICALL(NC,2)
         P=PNR(ICAL2)
```

```
      IFLAG=0
      CALL DIVDE (ICALL (NC,2),ICALL (NC,3),P)
      PNR (ICAL2)=P
      GO TO 290
!
!   CALCULATE SEDIMENT TRANSPORT AT EACH CROSS SECTION
!
210   CALL SED
      GO TO 290
!
!   CALCULATE SEDIMENT TRANSPORT OVER THE WEIR(S)
!
220   CALL WEIR (ICALL (NC,2),ICALL (NC,3))
      GO TO 290
!
!   CALCULATE TRIBUTARY SEDIMENT DISCHARGE
!
230   CALL TRIBS
      GO TO 290
!
!   ROUTE THE SEDIMENT IN THE RIVER REACH
!
240   CALL SROUT (ICALL (NC,2))
      GO TO 290
!
!   DUPLICATE PROPERTIES AT DOUBLE CROSS SECTIONS
!
250   CALL DUP (ICALL (NC,2),ICALL (NC,3))
      GO TO 290
!
!   TEST FOR MAXIMUM WATER SURFACE AT EACH CROSS SECTION
!
260   DO 270 K=1,NSEC
          IF  (WSK(K).LT.WSMAX(K)) GO TO 270
          WSMAX(K)=WSK(K)
           IMAX(K)=ITIME
270   CONTINUE
!
!   PRINT OUT THE RESULTS.
!
      CALL OUT1
      GO TO 290
!
!   DREDGE RIVER REACH
```

```
!
          CALL DREDG (ICALL (NC,2))
 290    CONTINUE
 300 CONTINUE
!
    STOP
!
 310  FORMAT (/,/,10X,38HTHE NUMBER OF TIME PERIODS EQUAL ZERO,/,10X,42H NO WATER
OR SEDIMENT ROUTING IS PERFORMED)
    END PROGRAM KUWASER
```

```
 SUBROUTINE BKWAT (K,WS,ICRI)
!
!    THIS SUBROUTINE CALCULATES THE WATER SURFACE ELEVATION AT
!    A CROSS SECTION ONCE THE CONDITIONS AT THE DOWNSTREAM
!    SECTION ARE KNOWN. THE ROUTINE USES A FIRST ORDER NEWTON
!    RAPHSON SOLUTION TO SOLVE THE TOTAL HEAD EQUATION.
!
    COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
          COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
          COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
          COMMON /SYS/ VHD,WSD,TKD,DEX
          COMMON /HYD/ V,ED,EW,ALP,TK,TA
          COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
!
!    CALCULATE THE TOTAL HEAD DOWNSTREAM.
!
    THD=VHD+WSD
!
!    ESTIMATE THE UPSTREAM WATER SURFACE ELEVATION BASED ON
!    THE DOWNSTREAM CONDITIONS.
!
    KOUNT=0
    WS=WSD+DEX*(TQ(K)/TKD)*(TQ(K)/TKD)
 100  KOUNT=KOUNT+1
!
!    DETERMINE IF ESTIMATE IS GREATER THAN THALWEG.
!
    IF (WS.LE.ZMIN(K)) WS=ZMIN(K)+FET
    CALL HYDPR(K,WS)
```

```
      IF (KOUNT.GT.MST) GO TO 140
!
!     CALCULATE VELOCITY HEAD, (VH).
!
      VH=ALP*V*V/(2.*GRAV)
      CCE=CE
      IF (VH.LT.VHD) CCE=CC
!
!     CALCULATE THE HEAD LOSS, (HL).
!
      TKA=(TKD+TK)/2.
      HLV=ABS(VH-VHD)*CCE
      HL=DEX*((TQ(K)*TQ(K))/(TKA*TKA))
!
!     CALCULATE THE ERROR.
!
      ER=VH+WS-HL-THD-HLV
!
!     TEST FOR ERROR TOLERANCE.
!
      IF (ABS(ER).LE.EPS) GO TO 150
      IF (KOUNT.GT.MST) GO TO 140
!
!     CALCULATE THE FIRST DERIVATIVE AT THE ESTIMATED DEPTH.
!
      D=WS-ZMIN(K)
      IF (WS.GT.ZOB(K)) GO TO 110
      TED1=B5(K)-2.0*B3(K)-1.0
      ATEMP=(TQ(K)*TQ(K)/(2.*GRAV))*((A5(K)/(A3(K)*A3(K)))*(B5(K)-2.0*B3(K)))*D**TED1
      ATEMP=(1.-CCE)*ATEMP
      TED1=B4(K)-1.0
      TED2=2.0*B4(K)-1.0

BNUM=(4.0*DEX*TQ(K)*TQ(K))*(2.0*TKD*A4(K)*B4(K)*D**TED1+(A4(K)*A4(K))*2.0*B4(K)*D
**TED2)
           TED1=B4(K)
      TED2=2.0*B4(K)
      BDEN=(TKD*TKD)+2.0*TKD*A4(K)*D**TED1+(A4(K)**2)*D**TED2
      GO TO 120
 110  TED1=B10(K)-2.0*B8(K)-1.0
      ATEMP=(TQ(K)*TQ(K)/(2.*GRAV))*((A10(K)/(A8(K)*A8(K)))*(B10(K)-2.0*B8(K)))*D**TED1
      ATEMP=(1.-CCE)*ATEMP
      TED1=B9(K)-1.0
      TED2=2.0*B9(K)-1.0
```

```
BNUM=(4.0*DEX*TQ(K)*TQ(K))*(2.0*TKD*A9(K)*B9(K)*D**TED1+(A9(K)*A9(K))*2.0*B9(K)*D
**TED2)
     TED1=B9(K)
     TED2=2.0*B9(K)
     BDEN=(TKD*TKD)+2.0*TKD*A9(K)*D**TED1+(A9(K)**2)*D**TED2
 120  DER=ATEMP+1.0+(BNUM/(BDEN**2))
!
!     ESTIMATE CORRECT WATER SURFACE BY NEWTON-RAPHSON METHOD
!
     IF (DER.LT.0.0.AND.ER.GT.0.0) GO TO 130
     WS=WS-ER/ABS(DER)
     GO TO 100
 130  D=(TQ(K)*TQ(K)*A5(K))/(A3(K)*A3(K)*GRAV)
     D=D**(1./(1.+2.*B3(K)-B5(K)))
     WS=D+ZMIN(K)+FET
     IF (WS.LT.ZOB(K)) GO TO 100
     D=(TQ(K)*TQ(K)*A10(K))/(A8(K)*A8(K)*GRAV)
     D=D**(1./(1.+2.*B8(K)-B10(K)))
     WS=D+ZMIN(K)+FET
     GO TO 100
 140  ICRI=1
     IF (IPRNT(8).NE.1) GO TO 150
     WRITE (I6,160) EPS,MST,K,ITIME
 150  IF (WS.LT.WSD) WS=WSD
     RETURN
!
 160  FORMAT (/10X,41HBACKWATER CALCULATION DID NOT CONVERGE TO,F4.1,4HIN
,I3,11H ITERATIONS,/,10X,16HAT CROSS SECTION,I4,20H, DURING TIME
PERIOD,I5,/,10X,26HCRITICAL DEPTH IS ASSUMED.)
     END SUBROUTINE BKWAT
```

```
    SUBROUTINE CHNGM (K)
!
!     THIS SUBROUTINE COMPUTES POWER RELATIONS THAT ARE USED TO
!     CALCULATE EFFECTIVE DEPTH (ED), EFFECTIVE WIDTH (EW), ALPHA
!     (ALP), TOTAL AREA (TA), AND TOTAL CONVEYANCE (TK), FOR A CROSS
!     SECTION, AS A FUNCTION OF THE WATER SURFACE ELEVATION (WS).
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
     COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
```

```
      COMMON /HYD/ V,ED,EW,ALP,TK,TA
      COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
      DIMENSION AEW(10),AALP(10),AED(10),ATA(10),ATK(10),AD(10),RCK(10),SD(10)
      DATA NAP/10/
!
!    CALCULATE THE RELATIONSHIPS FOR THE MAIN CHANNEL.
!
     ZDIF=ZOB(K)-ZMIN(K)
     IF (ZDIF.LT.ZDIFM) ZDIF=ZDIFM
     DWS=ZDIF/FLOAT(NAP)
     WS=ZMIN(K)
!
!    CALCULATE THE EXACT HYDRAULIC PROPERTIES AT (NAP) EVENLY
!    SPACED WATER SURFACE ELEVATIONS.
!
     DO 100 N=1,NAP
        WS=WS+DWS
        CALL GEOM (K,WS)
!
!    TAKE THE LOG OF THE HYDRAULIC PROPERTIES.  THESE VALUES WILL
!    BE USED IN THE LINEAR REGRESSION SUBROUTINE, SO THAT A POWER
!    FUNCTION WILL BE OBTAINED.
!
     AEW(N)=ALOG(EW)
     AED(N)=ALOG(ED)
     ATA(N)=ALOG(TA)
     ATK(N)=ALOG(TK)
     AALP(N)=ALOG(ALP)
     AD(N)=ALOG(WS-ZMIN(K))
 100  CONTINUE
!
!    CALL LEAST SQUARES LINEAR REGRESSION SUBROUTINE TO
!    CALCULATE THE HYDRAULIC POWER FUNCTIONS.
!
     CALL LSQ (NAP,AD,AEW,A1(K),B1(K),RCK(1),SD(1))
     CALL LSQ (NAP,AD,AED,A2(K),B2(K),RCK(2),SD(2))
     CALL LSQ (NAP,AD,ATA,A3(K),B3(K),RCK(3),SD(3))
     CALL LSQ (NAP,AD,ATK,A4(K),B4(K),RCK(4),SD(4))
     CALL LSQ (NAP,AD,AALP,A5(K),B5(K),RCK(5),SD(5))
     OA4(K)=A4(K)
     IF (RCK(4).GT.0.8) GO TO 110
     A5(K)=1.25
     B5(K)=0.01
!
```

```
!    CALCULATE THE RELATIONSHIP FOR OVERBANK FLOW.
!
 110  DO=ZOB(K)-ZMIN(K)
      IF(DO.LE.0.0)DO=0.1
      ADO=ALOG(DO)
      ATAO=ALOG(A3(K)*DO**B3(K))
      ATKO=ALOG(A4(K)*DO**B4(K))
      ZDIF=ZDIFM
      DWS=ZDIF/FLOAT(NAP)
      DO 120 N=1,NAP
          WS=WS+DWS
          CALL GEOM (K,WS)
!
!    TAKE THE LOG OF THE HYDRAULIC PROPERTIES.  THESE VALUES WILL
!    BE USED IN THE LINEAR REGRESSION SUBROUTINE, SO THAT A POWER
!    FUNCTION WILL BE OBTAINED.
!
          AEW(N)=ALOG(EW)
          AED(N)=ALOG(ED)
          ATA(N)=ALOG(TA)
          ATK(N)=ALOG(TK)
          AALP(N)=ALOG(ALP)
          AD(N)=ALOG(WS-ZMIN(K))
 120  CONTINUE
!
!    CALL LEAST SQUARES LINEAR REGRESSION SUBROUTINE TO
!    CALCULATE THE HYDRAULIC POWER FUNCTIONS.
!
     CALL LSQ (NAP,AD,AEW,A6(K),B6(K),RCK(6),SD(6))
     CALL LSQ (NAP,AD,AED,A7(K),B7(K),RCK(7),SD(7))
     CALL LSQF (NAP,AD,ATA,A8(K),B8(K),RCK(8),SD(8),ADO,ATAO)
     CALL LSQF (NAP,AD,ATK,A9(K),B9(K),RCK(9),SD(9),ADO,ATKO)
     CALL LSQ (NAP,AD,AALP,A10(K),B10(K),RCK(10),SD(10))
        OA9(K)=A9(K)
     IF (RCK(9).GT.0.8) GO TO 130
        A10(K)=1.25
        B10(K)=0.01
 130  IF (IPRNT(2).NE.1) RETURN
     WRITE (I6,140)
K,A1(K),B1(K),RCK(1),SD(1),A2(K),B2(K),RCK(2),SD(2),A3(K),B3(K),RCK(3),SD(3),A4(K),B4(K),RCK(
4),SD(4),A5(K),B5(K),RCK(5),SD(5)
     WRITE (I6,140)
K,A6(K),B6(K),RCK(6),SD(6),A7(K),B7(K),RCK(7),SD(7),A8(K),B8(K),RCK(8),SD(8),A9(K),B9(K),RCK(
9),SD(9),A10(K),B10(K),RCK(10),SD(10)
```

```
!
     RETURN
!
!
 140  FORMAT (2X,I3,1X,F6.2,1X,F4.2,1X,F4.2,1X,F5.3,1X,1HI,F7.2,1X,F4.2,1X,F4.2,1X
F5.3,1X,1HI,F7.2,1X,F4.2,1X,F4.2,1X,F5.3,1X,1HI,F7.0,1X,F4.2,1X,F4.2,1X,F5.3,1X,1HI,F7.3,1X,F4
.2,1X,F4.2,1X,F5.3,1X,1HI)
     END SUBROUTINE CHNGM
```

```
    SUBROUTINE CONT (NR,WS)
!
!    THIS SUBROUTINE IS USED TO COMPUTE THE WATER SURFACE
!    ELEVATION A THE DOWNSTREAM CONTROL.
!
!     DEFINITION OF TYPES OF CONTROL
!
!     ICONT (NR)        TYPE OF CONTROL
!        1          STAGE-DISCHARGE RELATIONSHIP
!        2          STAGE HYDROGRAPH
!        3          DOWNSTREAM WATER SURFACE
!        4          GREATEST OF #1 AND #2
!        5          GREATEST OF #1 AND #3
!        6          NORMAL DEPTH
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
            COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
!
!    DETERMINE TYPE OF DOWNSTREAM CONTROL.
!
     ICANT=ICONT(NR)
     GO TO (100,110,120,100,100,170), ICANT
!
!    STAGE-DISCHARGE CONTROL
!
  100 KD=KDOWN(NR)
     WSA=CX(NR)+AX(NR)*TQ(KD)**BX(NR)
     IF (ICONT(NR).EQ.4) GO TO 110
```

```
      IF (ICONT(NR).EQ.5) GO TO 120
      WS=WSA
      RETURN
!
!     STAGE HYDROGRAPH CONTROL
!
  110 WSB=STAGE
      IF (ICONT(NR).EQ.4) GO TO 130
      WS=WSB
      RETURN
!
!     DOWNSTREAM WATER SURFACE CONTROL.
!
  120 KD=KCONT(NR)
      WSC=WSK(KD)
      IF (ICONT(NR).EQ.5) GO TO 150
      WS=WSC
      RETURN
  130 IF (WSB.GT.WSA) GO TO 140
      WS=WSA
      RETURN
  140 WS=WSB
      RETURN
  150 IF (WSC.GT.WSA) GO TO 160
      WS=WSA
      RETURN
  160 WS=WSC
      RETURN
!
!     NORMAL DEPTH CALCULATIONS
!
  170 KD=KDOWN(NR)
      C=TQ(KD)/(SB(NR)**0.5)
      D=(C/A4(KD))**(1./B4(KD))
      WS=ZMIN(KD)+D
      IF (WS.LE.ZOB(KD)) RETURN
      C=TQ(KD)/(SB(NR)**0.5)
      D=(C/A9(KD))**(1./B9(KD))
      WS=ZMIN(KD)+D
!
      RETURN
      END SUBROUTINE CONT
```

```
      SUBROUTINE DIVDE(NR1,NR2,P)
!
```

```
!     THIS SUBROUTINE USES A SECOND ORDER CURVE FITTING ALGORITHM
!     TO FIND THE RATIO OF FLOWS "P" IN DIVIDED FLOW REACHES
!
     COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
           COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
           DIMENSION E(3), Y(3)
           DATA XLOL,XUPL/0.0,1.0/
!
           XA=P
           NC=0
           DX=0.2
 100 CALL SPLIT (NR1,NR2,VALUE,XA)
     P=XA
     IF (VALUE.LE.(EPS*EPS)) GO TO 270
     A=VALUE
     XB=XA+DX
     IF (XB.LE.XUPL) GO TO 110
     XB=XUPL
 110 CALL SPLIT (NR1,NR2,VALUE,XB)
     P=XB
     IF (VALUE.LE.(EPS*EPS)) GO TO 270
     B=VALUE
!
!     DETERMINE THE THIRD POINT REQUIRED FOR APPROXIMATION
!
      IF (A.GT.B) GO TO 150
 120 XC=XA-DX
      IF (XC.GE.XLOL) GO TO 130
     XC=XLOL
 130 CALL SPLIT (NR1,NR2,VALUE,XC)
     P=XC
     IF (VALUE.LE.(EPS*EPS)) GO TO 270
     C=VALUE
     Y(1)=XC
     Y(2)=XA
     Y(3)=XB
     E(1)=C
     E(2)=A
     E(3)=B
     IF (C.LT.A) GO TO 140
     XINF=XA
     FINF=A
     GO TO 180
```

```
 140 XINF=XC
    FINF=C
    GO TO 180
 150 XC=XA+2.*DX
    IF (XC.LE.XUPL) GO TO 160
    XC=XUPL
 160 CALL SPLIT (NR1,NR2,VALUE,XC)
    P=XC
    IF (VALUE.LE.(EPS*EPS)) GO TO 270
    C=VALUE
    Y(1)=XA
    Y(2)=XB
    Y(3)=XC
    E(1)=A
    E(2)=B
    E(3)=C
    IF (C.LT.B) GO TO 170
    XINF=XB
    FINF=B
           GO TO 180
 170 XINF=XC
    FINF=C
!
!    ELIMINATE PREMATURE TERMINATION DUE TO EQUAL VALUES AT
!    TWO END POINTS IN THE FIRST SEARCH
!
 180 YDEF=Y(3)-2.*Y(2)+Y(1)
    EDEF=E(1)-E(3)
    IF (NC.GT.0.OR.ABS(YDEF).GT.EPS.OR.ABS(EDEF).GT.EPS) GO TO 190
    DX=0.5*DX
    Y(2)=Y(1)+DX
    IF (Y(2).GT.XUPL) Y(2)=XUPL
    CALL SPLIT (NR1,NR2,VALUE,Y(2))
    P=Y(2)
!
    IF (VALUE.LE.(EPS*EPS)) GO TO 270
    E(2)=VALUE
    Y(3)=XINF
    E(3)=FINF
    EDEF=E(1)-E(3)
    IF (E(2).GT.FINF) GO TO 190
    XINF=Y(2)
    FINF=E(2)
!
```

```
!     CHECK THE CONVEXITY OF THE QUADRATIC FUNCTION
!
 190 A1=(Y(1)-Y(2))*(Y(2)-Y(3))*(Y(1)-Y(3))
     IF (ABS(A1).EQ.0.) GO TO 200
     A2=E(1)*(Y(2)-Y(3))+E(2)*(Y(3)-Y(1))+E(3)*(Y(1)-Y(2))
     SA=A2/A1
     IF (SA.GE.0.0) GO TO 210
     DX=Y(3)-Y(1)
     XA=Y(1)
     A=E(1)
     XB=Y(3)
     B=E(3)
     IF (EDEF.GT.0.) GO TO 150
     GO TO 120
 200 XSTA=XINF
     FSTA=FINF
     GO TO 270
!
!     DETERMINE THE MINIMUM OF THE QUADRATIC FUNCTION
!
 210 SB=(E(1)-E(2))/(Y(1)-Y(2))-SA*(Y(1)+Y(2))
     XSTA=-SB/(2.*SA)
     IF (XSTA.GE.XLOL.AND.XSTA.LE.XUPL) GO TO 230
     IF (EDEF.GT.0.0) GO TO 220
     XSTA=XLOL
     GO TO 230
 220 XSTA=XUPL
 230 NC=NC+1
     CALL SPLIT (NR1,NR2,VALUE,XSTA)
     P=XSTA
     IF (VALUE.LE.(EPS*EPS)) GO TO 270
     FSTA=VALUE
     XTEM=XSTA
     FTEM=FSTA
     IF (FSTA.LE.FINF) GO TO 240
     XTEM=XINF
     FTEM=FINF
 240 IF(ABS(1.-FSTA/FINF).GT.EPS) GO TO 250
     XSTA=XTEM
     FSTA=FTEM
     GO TO 270
 250 IF (NC.LT.MST) GO TO 260
     IF(IPRNT(8).NE.1) RETURN
     WRITE (I6,280) NR1,NR2,ITIME
```

```
      RETURN
  260 DL=ABS(XINF-XSTA)
      IF (DL.LT.DX) DX=DL
      XA=XTEM
      GO TO 100
!
!     A MINIMUM HAS BEEN FOUND
!
  270 RETURN
!
  280 FORMAT(/,10X,42HDIVIDED FLOW CALCULATIONS DID NOT CONVERGE,/,10X, 11HFOR
REACHES,I3,4H AND,I3,18HDURING TIME PERIOD,I3)
      END SUBROUTINE DIVDE
```

```
      SUBROUTINE DREDG (NR)
!
!     THIS SUBROUTINE SIMULATES DREDGING BY LOWERING EACH
!     CROSS SECTION IN A REACH TO ITS ORIGINAL ELEVATION (ZO).
!     ONLY CROSS SECTION POINTS IN THE MAIN CHANNEL ARE LOWERED.
!
      COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
            COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
            COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
      OPEN (UNIT=I9, FILE='T:\Research\Mud\Kuwaser Output
Files\I9.txt',STATUS='REPLACE',FORM='BINARY')
!
      KU=KUP(NR)
      KD=KDOWN(NR)
      DO 110 K=KD,KU
         IFLG=0
         M=ND(K)
         DO 100 L=1,M
            IF (X(K,L).LT.DROB(K)) GO TO 100
            IF (X(K,L).GT.DLOB(K)) GO TO 100
            IF (Z(K,L).LE.ZO(K,L)) GO TO 100
              Z(K,L)=ZO(K,L)
```

```
                IFLG=1
 100     CONTINUE
         IF (IFLG.EQ.0) GO TO 110
         CALL THAL(K)
         CALL CHNGM (K)
 110 CONTINUE
    WRITE (I9) ((Z(K,L),K=KD,KU),L=1,22)
    RETURN
!
    END SUBROUTINE DREDG
```

```
    SUBROUTINE DUP (K1,K2)
!
!    THIS SUBROUTINE IS USED IN DIVIDE FLOW PROBLEMS WHEN
!    A CROSS SECTION IS USED BY TWO DIFFERENT RIVER REACHES.
!    IT CHANGES THE BED ELEVATION OF THE DUPLICATE CROSS
!    SECTION, (K2), TO MATCH THE BED ELEVATION OF THE ORIGINAL
!    SECTION, (K1), AFTER SEDIMENT ROUTING.
!
    COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
          COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
!
    N=ND(K1)
    DO 100 L=1,N
        Z(K2,L)=Z(K1,L)
 100 CONTINUE
    ZMIN(K2)=ZMIN(K1)
    IZMIN(K2)=IZMIN(K1)
    A1(K2)=A1(K1)
    A2(K2)=A2(K1)
    A3(K2)=A3(K1)
    A4(K2)=A4(K1)
    A5(K2)=A5(K1)
    A6(K2)=A6(K1)
    A7(K2)=A7(K1)
    A8(K2)=A8(K1)
    A9(K2)=A9(K1)
    A10(K2)=A10(K1)
    B1(K2)=B1(K1)
```

```
      B2(K2)=B2(K1)
      B3(K2)=B3(K1)
      B4(K2)=B4(K1)
      B5(K2)=B5(K1)
      B6(K2)=B6(K1)
      B7(K2)=B7(K1)
      B8(K2)=B8(K1)
      B9(K2)=B9(K1)
      B10(K2)=B10(K1)
      OA4(K2)=OA4(K1)
      OA9(K2)=OA9(K1)
!
      RETURN
      END SUBROUTINE DUP
```

```
      SUBROUTINE FLOW
!
!     THIS SUBROUTINE CALCULATES THE WATER DISCHARGE AT EACH CROSS SECTION.
!
      COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
           COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
           OPEN (UNIT=I8, FILE='T:\Research\Mud\Kuwaser Input Files\I8.txt',STATUS='OLD')
!
!      READ IN THE FLOWS AND THE TIME PERIOD LENGTH.
!
       READ (I8,130) (TQ(K),K = 1,NQI),DT
       IF (EOF(I8)) 100,110,100
  100  WRITE (I6,120) I8,ITIME
            STOP
  110  RETURN
!
  120 FORMAT (10X, 24HEND OF FILE READ ON FILE,I2,19H DURING TIME PERIOD, I5)
  130 FORMAT (F6.0)
!
      END SUBROUTINE FLOW
```

```
      SUBROUTINE GEOM (K,WS)
!
!     THIS SUBROUTINE CALCULATES THE EXACT HYDRAULIC PROPERTIES
```

```
!    OF A CROSS SECTION, ONCE GIVEN THE CHANNEL GEOMETRY AND THE
!    WATER SURFACE ELEVATION.
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
     COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
           COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
           COMMON /HYD/ V,ED,EW,ALP,TK,TA
!
     N=ND(K)
     NP=N-1
     IFLAG=0
     TA=0.
     TK=0.
     SUMWK=0.
     SUMD1=0.
     SUMD2=0.
     SUMD3=0.
     DO 100 I=1,NP
          WD(I)=0.
  100 CONTINUE
!
!    ITERATE OVER EACH CROSS SECTION POINT
!
     DO 170 I=2,N
!
!    CALCULATE DISTANCE AND MANNINGS N BETWEEN CROSS SECTION
!    POINTS.
!
       XB=(X(K,I)-X(K,I-1))+1.0E-6
       FM=0.5*(F(K,I-1)+F(K,I))
       IF (Z(K,I).GE.WS) GO TO 120
       IF (Z(K,I-1).GE.WS) GO TO 110
!
!    CALCULATE AREA OF FLOW, WETTED PERIMETER, AND DEPTH.
!
       DA=WS-0.5*(Z(K,I-1)+Z(K,I))
```

```
      A=XB*DA
      ZB=ABS(Z(K,I)-Z(K,I-1))
      P=SQRT(XB*XB+ZB*ZB)
      GO TO 160
 110   ZB=WS-Z(K,I)
      XB=XB*ZB/(Z(K,I-1)-Z(K,I))
      GO TO 150
 120   IF (Z(K,I-1).GE.WS) GO TO 170
      IF (I.LT.IZMIN(K).AND.WS.LT.(ZOB(K)+.001)) GO TO 130
      ZB=WS-Z(K,I-1)
      XB=XB*ZB/(Z(K,I)-Z(K,I-1))
      IF (WS.LT.(ZOB(K)+.001)) IFLAG=1
      GO TO 150
!
!    SET OVER BANK FLOWS TO ZERO IF WATER SURFACE IS NOT ABOVE
!    OVER BANK ELEVATION.
!
 130 TA=0
      TK=0.
      SUMWK=0.
      SUMD1=0.
      SUMD2=0.
      SUMD3=0.
      IM1=I-1
      DO 140 II=1,IM1
           WD(II)=0.
 140 CONTINUE
      GO TO 170
 150 A=0.5*XB*ZB
      P=SQRT(XB*XB+ZB*ZB)
      DA=0.5*ZB
 160 R=A/P
      C=1.486*A*R**(2./3.)/FM
!
!    SUM FLOWS BETWEEN CROSS SECTION POINTS.
!
            TA=TA+A
            TK=TK+C
            SUMWK=SUMWK+C**3./A**2.
            SUMD1=SUMD1+DA**1.6666*A/FM
            SUMD2=SUMD2+DA**0.6666*A/FM
            SUMD3=SUMD3+DA**0.6666*A
            WD(I-1)=C
            IF (IFLAG.EQ.1) GO TO 180
```

```
 170 CONTINUE
 180 ALP=SUMWK*TA**2./TK**3.
    ED=SUMD1/SUMD2
    EW=SUMD3/ED**1.6666
    DO 190 I=1,NP
      WD(I)=WD(I)/TK
 190 CONTINUE
!
    RETURN
    END SUBROUTINE GEOM
```

```
    SUBROUTINE HYDPR (K,WS)
!
!   THIS SUBROUTINE CALCULATES THE HYDRAULIC PROPERTIES OF THE
!   (K)TH CROSS SECTION GIVEN THE WATER SURFACE ELEVATION (WS).
!
    COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
    COMMON /HYD/ V,ED,EW,ALP,TK,TA
!
!   CALCULATE THE DEPTH OF FLOW
!
    DEPTH=WS-ZMIN(K)
!
!   IF THE WATER SURFACE IS ABOVE THE OVERBANK USE THE
!   OVERBANK EQUATIONS.
!
    IF (WS.GT.ZOB(K)) GO TO 100
!
!   CALCULATE EFFECTIVE WIDTH
!
    EW=A1(K)*DEPTH**B1(K)
!
!   CALCULATE EFFECTIVE DEPTH
!
    ED=A2(K)*DEPTH**B2(K)
!
!   CALCULATE AREA
    TA=A3(K)*DEPTH**B3(K)
!
!   CALCULATE THE CONVEYANCE
!
```

```
     TK=A4(K)*DEPTH**B4(K)
!
!    CALCULATE ALPHA
!
     ALP=A5(K)*DEPTH**B5(K)
     IF (ALP.GT.1.5) ALP=1.5
     IF (ALP.LT.1.15) ALP=1.15
!
!    CALCULATE THE VELOCITY
!
     V=TQ(K)/TA
     RETURN
!
!    CALCULATE EFFECTIVE WIDTH
!
 100 EW=A6(K)*DEPTH**B6(K)
!
!    CALCULATE EFFECTIVE DEPTH
!
     ED=A7(K)*DEPTH**B7(K)
!
!    CALCULATE AREA
!
     TA=A8(K)*DEPTH**B8(K)
!
!    CALCULATE THE CONVEYANCE
!
     TK=A9(K)*DEPTH**B9(K)
!
!    CALCULATE ALPHA
!
     ALP=A10(K)*DEPTH**B10(K)
     IF (ALP.GT.1.5) ALP=1.5
     IF (ALP.LT.1.15) ALP=1.15
!
!    CALCULATE THE VELOCITY
!
     V=TQ(K)/TA
!
     RETURN
     END SUBROUTINE HYDPR
```

```
     SUBROUTINE IN1
!
!    THIS SUBROUTINE READS IN THE SEDIMENT AND GEOMETRY DATA.
```

```
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
          COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
     COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
          COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
          COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
          COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
          DIMENSION TITLE(20)
!
     OPEN (UNIT=I5, FILE='T:\Research\Mud\Kuwaser Input Files\I5.txt', STATUS='OLD')
          OPEN (UNIT=I6, FILE='T:\Research\Mud\Kuwaser Output Files\I6.txt',
STATUS='REPLACE')
          OPEN (UNIT=I7, FILE='T:\Research\Mud\Kuwaser Input Files\I7.txt', STATUS='OLD')
!
!    READ TITLE
!
     READ (I5,260) (TITLE(M2),M2=1,20)
!
!    READ THE PRINT CONTROL
!
     READ (I5,270) (IPRNT(M1),M1=1,8)
!
!    READ IN THE MAXIMUM NUMBER OF ITERATIONS FOR THE
!    BACKWATER CURVE, (MST), THE MAXIMUM ERROR IN TOTAL HEAD,
!    (EPS), THE SEDIMENT DEPOSIT POROSITY, (PORM), THE COEFFICIENTS
!    OF EXPANSION AND CONTRACTION LOSSES, (CE,CC), AND THE UNIT
!    SYSTEM FLAG, (IUNIT).
!
     READ (I5,280) MST,EPS,PORM,CE,CC,IUNIT
!
!    READ IN THE NUMBER OF CROSS SECTIONS, (NSEC), THE NUMBER OF
!    TIME PERIODS, (NTIM), THE NUMBER OF RIVER SEGMENTS, (NRIV), THE
!    NUMBER OF INPUT DISCHARGES, (NQI), AND THE NUMBER OF
!    SUBROUTINE CALLS, (NCALL).
!
```

```
      READ (I5,290) NSEC,NTIM,NRIV,NQI,NCALL
!
!     READ IN THE SEQUENCE OF THE SUBROUTINE CALLS, (ICALL(NC,NN)).
!
      DO 100 NC=1,NCALL
          READ (I5,290) (ICALL(NC,NN),NN=1,3)
  100 CONTINUE
!
!     ITERATE OVER EACH RIVER SEGMENT.
!
      DO 120 NR=1,NRIV
!
!     FOR EACH RIVER SEGMENT, READ IN THE NUMBER OF THE
!     DOWNSTREAM CROSS SECTION, (KDOWN(NR)), THE NUMBER OF THE
!     UPSTREAM CROSS SECTION, (KUP(NR)), THE NUMBR OF TRIBUTARIES,
!     (NTRIB(NR)), THE TYPE OF DOWNSTREAM CONTROL, (ICONT(NR)), THE
!     NUMBER OF THE DOWNSTREAM WATER SURFACE CONTROL CROSS
!     SECTION, (KCONT(NR)), THE COEFFICIENTS OF THE DOWNSTREAM
!     STAGE DISCHARGE RELATIONSHIP, (AX(NR),BX(NR),CX(NR)), THE
!     COEFFICIENTS OF THE CONVEYANCE EQUATION, (AN(NR),BN(NR)),
!     AND THE NORMAL DEPTH SLOPE, (SB(NR)).
!
      READ (I5,300)
KDOWN(NR),KUP(NR),NTRIB(NR),ICONT(NR),KCONT(NR),IROUT(NR),AX(NR),BX(NR),CX(NR),AN
(NR),BN(NR),SB(NR)
            NT=NTRIB(NR)
!
!     FOR EACH TRIBUTARY READ IN THE MAINSTEM RIVER DISTANCE OF
!     THE CONFLUENCE, (RDT(NR,J)), THE TYPE OR TRIBUTARY, (ITRIB(NR,J)),
!     THE NUMBER OF THE DISCHARGE CROSS SECTION FOR THE
!     TRIBUTARY, (KTRIB(NR,J)), AND THE COEFFICIENTS OF THE
!     TRIBUTARYS SEDIMENT RATING CURVE, (AT(NR,J),BT(NR,J)).
!
          IF (NT.EQ.0) GO TO 120
          DO 110 J=1,NT
              READ (I5,310) RDT(NR,J),ITRIB(NR,J),KTRIB(NR,J),AT(NR,J),BT(NR,J)
  110 CONTINUE
  120 CONTINUE
!
!     FOR EACH CROSS SECTION READ IN THE NUMBER OF SECTION POINTS,
!     (ND(K)), AND THE RIVER DISTANCE, (RD(K)).
!
      DO 160 K=1,NSEC
          READ (I7,320) ND(K),RD(K)
```

```
        M=ND(K)
!
!    FOR EACH SECTION POINT READ IN THE HORIZONTAL DISTANCE,
!    (X(K,L)), AND THE ELEVATION, (Z(K,L)).
!
        READ (I7,330) (X(K,L),Z(K,L),L=1,M)
!
!    FOR EACH CROSS SECTION READ IN THE DISTANCE OF THE RIGHT AND
!    LEFT OVERBANKS, (DROB,DLOB), THE MANNINGS N FOR THE RIGHT
!    OVERBANK, MAIN CHANNEL, AND LEFT OVERBANK, (FROB,FMC,FLOB).
!    AND THE OVERBANK ELEVATION (ZOB(K)).
!
        READ (I7,340) DROB(K),DLOB(K),FROB,FMC,FLOB,ZOB(K)
        DO 150 L=1,M
            IF (X(K,L).GT.DROB(K)) GO TO 130
            F(K,L)=FROB
            GO TO 150
 130        IF(X(K,L).GE.DLOB(K)) GO TO 140
            F(K,L)=FMC
            GO TO 150
 140        F(K,L)=FLOB
 150    CONTINUE
 160 CONTINUE
!
!       PRINT OUT INPUT DATA
!
       IF (IPRNT(1).EQ.1) GO TO 170
       IF (IPRNT(2).EQ.1) GO TO 170
       IF (IPRNT(3).EQ.1) GO TO 170
       IF (IPRNT(4).EQ.1) GO TO 170
       IF (IPRNT(6).EQ.1) GO TO 170
      GO TO 180
 170 WRITE(I6,350)
      WRITE(I6,360) (TITLE(M2),M2=1,20)
 180 CONTINUE
      IF (IPRNT(1).NE.1) GO TO 240
      WRITE (I6,370) MST,EPS,PORM,CC,CE,IUNIT
      WRITE (I6,380) NSEC,NTIM,NRIV,NQI,NCALL
      WRITE (I6,390)
       DO 190 NC=1,NCALL
        WRITE (I6,400) NC,(ICALL(NC,NN),NN=1,3)
 190 CONTINUE
      DO 210 NR=1,NRIV
```

```
            WRITE (I6,410)
NR,KDOWN(NR),KUP(NR),NTRIB(NR),ICONT(NR),KCONT(NR),IROUT(NR),AX(NR),BX(NR),CX(NR)
,AN(NR),BN(NR),SB(NR)
        NT=NTRIB(NR)
        IF (NT.EQ.0) GO TO 210
        DO 200 J=1,NT
            WRITE (I6,420) J,RDT(NR,J),ITRIB(NR,J),KTRIB(NR,J),AT(NR,J),BT(NR,J)
 200      CONTINUE
 210 CONTINUE
      DO 230 K=1,NSEC
        WRITE (I6,430) K,ND(K),RD(K),ZOB(K)
        WRITE (I6,440)
        M=ND(K)
        DO 220 L=1,M
            WRITE (I6,450) L,X(K,L),Z(K,L),F(K,L)
 220    CONTINUE
 230 CONTINUE
 240 CONTINUE
      IF (IPRNT(2).NE.1) GO TO 250
      WRITE (I6,460)
      WRITE (I6,470)
!
 250 RETURN
!
 260 FORMAT (20A4)
 270 FORMAT (8I2)
 280 FORMAT (I5,4F10.5,I5)
 290 FORMAT (5I5)
 300 FORMAT (6I5,5F8.4,F8.6)
 310 FORMAT (F10.2,2I5,2E10.2)
 320 FORMAT (2X,I3,F7.2)
 330 FORMAT ((8X,6(F6.0,F6.1)))
 340 FORMAT (6F10.4)
 350 FORMAT (1HI,/,10X,13HK U W A S E R,/,10X,25HKNOWN DISCHARGE SEDIMENT
,7HROUTING,/,10X,35HDEVELOPED BY G.O. BROWN AND R.M. LI,/,10X,37HAT COLORADO
STATE UNIVERSITY, FOR THE,/,10X,48HU.S. ARMY COPRS OF ENGINEERS, VICKSBURG
DISTRICT)
 360 FORMAT
(///,10X,82(1H*),/,10X,1H*80X,1H*,/,10X,1H*,20A4,1H*,/,10X,1H*,80X,1H*,/10X,82(1H*),///)
 370 FORMAT (10X,47HMAXIMUM NUMBER OF ITERATIONS FOR CALCULATIONS ,6HMST =
,I5,/,10X,42HACCURACY OF BACKWATER CALCULATIONS, EPS = ,F10.5,/,10X,38HPOROSITY OF
SEDIMENT DEPOSITS, PORM = ,F10.5,/,10X,53HCOEFFICIENT OF CONTRACTION VELOCITY
HEAD LOSSES, CC = ,F10.5,/,10X, 52HCOEFFICIENT OF EXPANSION VELOCITY HEAD LOSSES, CE
= ,F10.5,/,10X, 26HUNIT SYSTEM FLAG, IUNIT = ,I5,//)
```

```
  380 FORMAT (10X,31HTHE NUMBER OF RIVER SECTIONS = ,I5,/,10X,29H THE NUMBER OF
TIME PERIODS = ,I5,/,10X,28HTHE NUMBER OF RIVER SEGMENTS,3H= ,I5,/,10X,33HTHE
NUMBER OF INPUT DISCHARGES = ,I5,/,10X,33HTHE NUMBER OF SUBROUTINE CALLS = ,I5)
  390 FORMAT (/,10X,22HNCALL  ICALL (1 10 3),)
  400 FORMAT (8X,4(2X,I5))
  410 FORMAT (//,10X,14H RIVER SEGMENT ,I5,/,10X,34HDOWNSTREAM CROSS SECTION
NUMBER = ,I5,/,10X,32HUPSTREAM CROSS SECTION NUMBER = ,I5,/,10X,24HNUMBER OF
TRIBUTARIES = ,I5,/,10X,39HTYPE OF WATER SURFACE CONTROL, ICONT =
,I5,/,10X,35HNUMBER OF CONTROL SECTION, KCONT = ,I5,/,10X,44HTYPE OF DOWNSTREAM
SEDIMENT ROUTING, IROUT = ,I5,/,10X,45HCOEFFICIENTS OF STAGE DISCHARGE
RELATIONSHIP,/,13X,5HAX = ,F8.4,/,13X,5HBX = ,F8.4,/,13X,5HCX =
,F8.4,/,10X,40HCOEFFICIENT OF MANNINGS N RELATIONSHIP ,/,13X, 5HAN = ,F8.4,/,13X,5HBN
= ,F8.4,/,10X, 25HNORMAL DEPTH SLOPE, SB = ,F8.6)
  420 FORMAT (/,15X,10HTRIBUTARY ,I5,/,15X,17HRIVER DISTANCE = ,F7.2,/,15X,27HTYPE OF
TRIBUTARY, ITRIB = ,I5,/,15X,47HNUMBER OF TRIBUTARY DISCHARGE SECTION, KTRIB =
,I5,/,15X,47HCOEFFICIENTS OF TRIBUTARY SEDIMENT RELATIONSHIP,/,18X,5HAT =
,F10.3,/,18X,5HBT = ,F10.2)
  430 FORMAT (///,10X,15HSECTION NUMBER ,I4,/,10X,40HTHE NUMBER OF CROSS SECTION
POINTS IS = ,I2,/,10X,24HTHE RIVER DISTANCE IS = ,F10.2,/,10X,25HTHE OVERBANK
ELEVATION = ,F10.2)
  440 FORMAT (/,10X,48HPOINT     HORIZONTAL     ELEVATION      N VALUE,/)
  450 FORMAT (8X, I5, 3(5X, F10.4))
  460 FORMAT (1HI,/,4H NO.,4X,15HEFFECTIVE WIDTH,6X,1HI,4X,15HEFFECTIVE
DEPTH,5X,1HI,6X,10HTOTAL AREA,8X,1HI,4X,16HTOTAL CONVEYANCE,4X,1H
,8X,5HALPHA,11X,1H1,/29X,1H1,4(24X,1HI))
  470 FORMAT (5X,5(4X,1HA,4X,1HB,2X,13HCO COEF ERR I)/29X,1HI,4(24X,1HI))
!
    END SUBROUTINE IN1
```

```
    SUBROUTINE LSQ (N,XX,Y,EA,B,RC,SBAR)
!
!    THIS SUBROUTINE DERIVES THE COEFFICIENTS OF THE HYDRAULIC
!    POWER FUNCTIONS, BY USING A LEAST SQUARE REGRESSION.
!
    DIMENSION XX(10),Y(10),YB(10)
!
    SUMX=0.
    SUMXX=0.
    SUMY=0.
    SUMXY=0.
    SUMA=0.
    SUMB=0.
    SUMC=0.
    SUMD=0.
    DO 100 I=1,N
```

```
        SUMX=SUMX+XX(I)
        SUMY=SUMY+Y(I)
        SUMXX=SUMXX+XX(I)*XX(I)
        SUMXY=SUMXY+XX(I)*Y(I)
 100 CONTINUE
      FX=SUMX/FLOAT(N)
      FY=SUMY/FLOAT(N)
!
!    DERIVE THE EQUATION.
!
    B=(SUMXY-FLOAT(N)*FX*FY)/(SUMXX-FLOAT(N)*FX*FX)
    A=FY-B*FX
!
!    RAISE E TO THE (A) POWER. THE VALUE, (EA), WILL BE USED IN
!    THE POWER FUCNTIONS.
!
    EA=EXP(A)
!
!    CALCULATE THE COEFFICIENT OF CORRELATION.
!
    DO 110 I=1,N
        SUMA=SUMA+(XX(I)-FX)*(Y(I)-FY)
        SUMB=SUMB+(XX(I)-FX)**2
        YB(I)=A+B*XX(I)
        SUMC=SUMC+(Y(I)-FY)**2
 110 CONTINUE
      RC=SUMA/SQRT(SUMB*SUMC)
!
!    CALCULATE THE STANDARD ERROR OF ESTIMATE.
!
    DO 120 I=1,N
        SUMD=SUMD+(Y(I)-YB(I))**2
 120 CONTINUE
      SBAR=SQRT(SUMD/(FLOAT(N)-2.))
!
    RETURN
    END SUBROUTINE LSQ
```

```
    SUBROUTINE LSQF (N,XX,Y,EA,B,RC,SBAR,XO,YO)
!
!    THIS SUBROUTINE DERIVES THE COEFFICIENTS OF THE HYDRAULIC
!    POWER FUNCTIONS, FOR OVERBANK FLOW, BY USING A LEAST
!    SQUARES REGRESSION FORCED THROUGH THE POINT (XO,YO).
!
    DIMENSION XX(10),Y(10),YB(10)
```

```
!
     SUMX=0.
     SUMXX=0.
     SUMY=0.
     SUMXY=0.
     SUMA=0.
     SUMB=0.
     SUMC=0.
     SUMD=0.
     DO 100 I=1,N
         XP=XX(I)-XO
         YP=Y(I)-YO
         SUMX=SUMX+XX(I)
         SUMY=SUMY+Y(I)
         SUMXX=SUMXX+XP*XP
         SUMXY=SUMXY+XP*YP
  100 CONTINUE
       FX=SUMX/FLOAT(N)
       FY=SUMY/FLOAT(N)
!
!    DERIVE THE EQUATION
!
     B=SUMXY/SUMXX
     A=YO-B*XO
!
!    RAISE E TO THE (A) POWER.  THE VALUE, (EA), WILL BE USED IN
!    THE POWER FUNCTIONS.
!
     EA=EXP(A)
!
!    CALCULATE THE COEFFICIENT OF CORRELATION
!
     DO 110 I=1,N
         SUMA=SUMA+(XX(I)-FX)*(Y(I)-FY)
         SUMB=SUMB+(XX(I)-FX)**2
         YB(I)=A+B*XX(I)
         SUMC=SUMC+(Y(I)-FY)**2
  110 CONTINUE
       RC=SUMA/SQRT(SUMB*SUMC)
!
!    CALCULATE THE STANDARD ERROR OF ESTIMATE.
!
     DO 120 I=1,N
         SUMD=SUMD+(Y(I)-YB(I))**2
```

```
 120 CONTINUE
       SBAR=SQRT(SUMD/(FLOAT(N)-1.))
!
     RETURN
     END SUBROUTINE LSQF
```

```
     SUBROUTINE NVAL (NR)
!
!     THIS SUBROUTINE CALCULATES THE COEFFICIENT OF THE
!     CONVEYANCE EQUATION FOR THE CURRENT DISCHARGE.
!
!     THIS ALLOWS MANNING'S N TO BE A FUNCTION OF DISCHARGE.
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
     DATA RNMAX,RNMIN/1.4,0.67/
!
     KD=KDOWN(NR)
     KU=KUP(NR)
!
!     ITERATE OVER EACH CROSS SECTION IN THE REACH.
!
     DO 100 K=KD,KU
        IF (TQ(K).EQ.0.0) GO TO 100
!
!     CALCULATE CORRECTION FACTOR
!
        RN=AN(NR)*ABS(TQ(K))**BN(NR)
!
!     TEST FOR VALUE WITHIN LIMITS
!
         IF (RN.GT.RNMAX) RN=RNMAX
         IF (RN.LT.RNMIN) RN=RNMIN
         A4(K)=OA4(K)/RN
         A9(K)=OA9(K)/RN
 100 CONTINUE
!
     RETURN
```

```
      END SUBROUTINE NVAL
```

```
    SUBROUTINE OUT1
!
!     THIS SUBROUTINE OUTPUTS THE VARIOUS RESULTS OF THE
!     SIMULATION MODEL.
!
      COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
      COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
            COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
            COMMON /PRT/ IPRNT(8),I5,I6,I7,I8,I9,I10
            DIMENSION DZF(22)
!
      OPEN (UNIT=I10, FILE='T:\Research\Mud\Kuwaser Output Files\I10.txt',
STATUS='REPLACE',FORM='BINARY')

!     PRINT CROSS SECTION NUMBER, EFFECTIVE WIDTH, EFFECTIVE DEPTH,
!     TOTAL AREA, TOTAL CONVEYANCE, ALPHA, VELOCITY, WATER
!     SURFACE ELEVATION, SEDIMENT TRANSPORT, DISCHARGE AND
!     MINIMUM BED ELEVATION FOR EACH TIME PERIOD.
!
      IF (IPRNT(6).NE.1) GO TO 100
      WRITE (I6,200) ITIME,DT
      WRITE (I6,210)
(K,WE(K),EDK(K),TAK(K),TKK(K),ALPK(K),VK(K),WSK(K),G(K),TQ(K),ZMIN(K),K=1,NSEC)
  100 IF (ITIME.NE.NTIM) GO TO 150
!
!     PRINT MAXIMUM WATER SURFACE ELEVATION AND THE TIME PERIOD
!     OF  OCCURANCE FOR EACH CROSS SECTION.
      IF (IPRNT(4).NE.1) GO TO 110
      WRITE (I6,220)
      WRITE (I6,230) (K,WSMAX(K),IMAX(K),K=1,NSEC)
!
!     PRINT MINMUM BED ELEVATION FOR EACH CROSS SECTION AT THE
!     END OF THE SIMULATION.
```

```
!
 110 IF (IPRNT(5).NE.1) GO TO 120
       WRITE (I6,240)
       WRITE (I6 ,250) (K,ZMIN(K),K=1,NSEC)
 120 CONTINUE
!
!     PRINT OUT THE BED ELEVATION AND THE CHANGE IN BED ELEVATION
!     AT EACH POINT.
!
     IF (IPRNT(3).NE.1) GO TO 150
     WRITE (I6,190)
     DO 140 K=1,NSEC
         N=ND(K)
         DO 130 L=1,N
             DZF(L)=Z(K,L)-ZO(K,L)
 130    CONTINUE
         WRITE (I6,170) K
         WRITE (I6,180) (L,X(K,L),Z(K,L),DZF(L),L=1,N)
 140 CONTINUE
!
!     BINARY OUTPUT
!
 150 IF (IPRNT(7).NE.1) RETURN
!
!     PRINT CROSS SECTION NUMBER, EFFECTIVE WIDTH, EFFECTIVE DEPTH,
!     TOTAL AREA, TOTAL CONVEYANCE, ALPHA, VELOCITY, WATER
!     SURFACE ELEVATION, SEDIMENT TRANSPORT, DISCHARGE AND
!     MINIMUM BED ELEVATION FOR EACH TIME PERIOD.
!
     WRITE (I10)
(WE(K),EDK(K),TAK(K),TKK(K),ALPK(K),VK(K),WSK(K),G(K),ZMIN(K),K=1,NSEC),(TQ(KI),KI=1,NQI),
((QSL(N,J),J=1,5),N=1,NRIV)
!
!     DETERMINE IF THE CURENT TIME PERIOD IS THE END OF A YEAR.
!
     RI=FLOAT(ITIME)
     RI=RI/52.18
     RI=RI-AINT(RI)
     IF (RI.GT.0.9904.OR.RI.LT.0.00958) GO TO 160
     RETURN
!
!     PRINT OUT THE BED ELEVATION AT EACH POINT
!
 160 CONTINUE
```

```
      WRITE (I9) ((Z(K,L),K=1,NSEC),L=1,22)
      RETURN
!
!
  170 FORMAT (//,20X,17HCROSS SECTION NO.,I5,/,20X,17HPOINT  HORIZONTAL,24H
ELEVATION  DELTA ELEV.,/)
  180 FORMAT (21X,I2,5X,F6.0,5X,F6.1,5X,F6.1)
  190 FORMAT (1HI,19X,46HF I N A L  B E D  E L E V A T I O N S ,  A N D,/,20X,47HT O T A L  C H A
N G E  A T  E A C H  P O I N T)
  200 FORMAT (//,10X,47HC R O S S   S E C T I O N   P R O P E R T I E
S,/,10X,4HTIME,I5,F10.2,/,12X,108HSECTION  EFFECTIVE EFFECTIVE   TOTAL    TOTAL    ALPHA
VELOCITY    WATER   SEDIMENT    FLOW     THALWEG,/,23X,37HWIDTH     DEPTH     AREA
CONVEYANCE,22X,17HSURFACE TRANSPORT,15X,9HELEVATION,/)
  210 FORMAT (13X,I3,3X,2F10.1,2F10.0,2F10.4,F10.2,F10.6,F10.2,F10.2)
  220 FORMAT (1HI,8X,3HMAX,7X,4HTIME,/,9X,5HWATER,5X,2HOF,/,8H
SECTION,1X,9HELEVATION,1X,3HMAX,/)
  230 FORMAT (1H ,I4,F10.2,2X,I4)
  240 FORMAT (1HI,8X,3HMIN,/,9X,3HBED,/,18H SECTION ELEVATION,/)
  250 FORMAT (1H ,I4,3X,F10.2)
      END SUBROUTINE OUT1
```

```
    SUBROUTINE RIVDS (NR,DIS)
!    THIS SUBROUTINE CONVERTS THE RIVER DISTANCE FROM MILES
!    TO FEET, OR FROM KILOMETERS TO METERS.
!
!    IT MAY BE USED TO CORRECT FOR CUTTOFFS OR CHANGES IN RIVER
!    ALIGNMENT BY ADDING SPECIAL LOGIC.
!
     COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
!
     DIS=DIS*CORDS
!
     RETURN
     END SUBROUTINE RIVDS
```

```
     SUBROUTINE SED
!
!    THIS SUBROUTINE CALCULATES SEDIMENT TRANSPORT USING THE
!    GENERALIZED FORMULA DEVELOPED FRO THE YAZOO RIVER.
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
```

```
          COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
    COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
    COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
!
!    ITERATE OVER EACH RIVER REACH
!
    DO 120 NR=1,NRIV
        KU=KUP(NR)
        KD=KDOWN(NR)
!
!    ITERATE OVER EACH CROSS SECTION IN THE REACH
!
        DO 110 K=KD,KU
            IF (TQ(K).EQ.0.0) GO TO 100
!
!    CALCULATE THE SEDIMENT TRANSPORT FOR THE CROSS SECTION
!
            G(K)=ABS(VK(K)**3.16*EDK(K)**0.96*WE(K)*4.48E-06)
            IF (TQ(K).LT.0.0) G(K)=-1.*G(K)
            GO TO 110
 100        G(K)=0.
 110     CONTINUE
 120 CONTINUE
!
    RETURN
    END SUBROUTINE SED
```

```
    SUBROUTINE SPLIT (NR1,NR2,ERROR,P)
!
!    THIS SUBROUTINE IS USED IN DIVIDED FLOW PROBLEMS TO SPLIT THE
!    DISCHARGE BETWEEN TWO CHANNELS.
!
    COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
          COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
```

```
!
 100 KD1=KDOWN(NR1)
       KU1=KUP(NR1)
       KDP1=KD1+1
       KUM1=KU1-1
       NT=NTRIB(NR1)
!
!    CALCULATE THE FLOW IN THE FIRST REACH
!
     DO 130 K=KDP1,KUM1
         TQ(K)=TQ(KD1)*P
         IF (NT.LE.2) GO TO 130
!
!    ADD TRIBUTARY FLOW IF ANY
!
         NTM1=NT-1
         DO 120 J=2,NTM1
             IF (RD(K).GE.RDT(NR1,J)) GO TO 120
             KT=KTRIB(NR1,J)
             IF (ITRIB(NR1,J).GT.2) GO TO 110
             TQ(K)=TQ(K)+TQ(KT)
             GO TO 120
 110         TQ(K)=TQ(K)-TQ(KT)
 120     CONTINUE
 130 CONTINUE
!
!    SET THE UPSTREAM AND DOWNSTREAM FLOW OF BOTH REACHES
!    EQUAL.
!
     KD2=KDOWN(NR2)
     KU2=KUP(NR2)
     KDP1=KD2+1
     KUM1=KU2-1
     TQ(KD2)=TQ(KD1)
     TQ(KU2)=TQ(KU1)
     NT=NTRIB(NR2)
!
!    CALCULATE THE FLOW IN THE SECOND REACH
!
     DO 160 K=KDP1,KUM1
         TQ(K)=TQ(KU1)*(1.-P)
         IF (NT.LE.2) GO TO 160
!
!    ADD TRIBUTARY FLOW IF ANY
```

```
!
         NTM1=NT-1
         DO 150 J=2,NTM1
             IF (RD(K).GE.RDT(NR2,J)) GO TO 150
             KT=KTRIB(NR2,J)
             IF (ITRIB(NR2,J).GT.2) GO TO 140
             TQ(K)=TQ(K)+TQ(KT)
             GO TO 150
 140           TQ(K)=TQ(K)-TQ(KT)
 150     CONTINUE
 160 CONTINUE
!
!    CALCULATE THE WATER PROFILE IN BOTH REACHES
!
     CALL SUBPF (NR1)
     CALL SUBPF (NR2)
!
!    COMPUTE THE ERROR IN THE WATER SURFACE ELEVATION.
!
     ERROR=WSK(KU1)-WSK(KU2)
     ERROR=ERROR*ERROR
!
     RETURN
     END SUBROUTINE SPLIT
```

```
     SUBROUTINE SROUT (NR)
!
!    THIS SUBROUTINE ROUTES THE SEDIMENT, CALCULATES THE
!    APPROXIMATE BED ELEVATION CHANGE, AND IF NECESSARY,
!    DISTRIBUTES THE AGGRADATION OR DEGRADATION THROUGH
!    THE CROSS SECTION.
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
          COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
          COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
          COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
```

```
           COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
     DIMENSION DV(100)
!
!     ITERATE OVER EACH CROSS SECTION IN THE RIVER SEGMENT.
!
     KU=KUP(NR)
     KD=KDOWN(NR)
     KDP1=KD+1
     KUM1=KU-1
     DO 120 K=KD,KUM1
         KP1=K+1
!
!     CALCULATE THE VOLUME OF SEDIMENT DEPOSITED, OR ERODED.
!
         DV(K)=(G(KP1)-G(K))*86400.*DT
!
!      ADD IN LATERAL SEDIMENT INFLOW IF ANY.
!
         JT=NTRIB(NR)
         IF (JT.EQ.0) GO TO 110
         DO 100 J=1,JT
             IF (RDT(NR,J).GE.RD(K).AND.RDT(NR,J).LT.RD(KP1))
DV(K)=DV(K)+QSL(NR,J)*86400.0*DT
  100    CONTINUE
  110    DV(K)=(DV(K)/(1.0-PORM))
  120 CONTINUE
       DXUP=RD(KDP1)-RD(KD)
       DO 210 K=KD,KUM1
         IF (ABS(TQ(K)).EQ.0.0) GO TO 210
         KM1=K-1
         KP1=K+1
         DXDWN=DXUP
         DXUP=RD(KP1)-RD(K)
!
!     TEST FOR WEIRS
!
         IF ((DXDWN/CORDS).LT.0.001) GO TO 210
         IF ((DXUP/CORDS).LT.0.001) GO TO 210
         IF (K.GT.KD) GO TO 140
         IROOT=IROUT(NR)
         GO TO (210,140,130), IROOT
!
```

```
!    CALCULATE THE CHANGE IN THE AREA AT THE CROSS SECTION.
!
 130     DA=0.5*DV(K)/DXUP
         GO TO 150
 140      DA=(1.5*DV(K)+0.5*DV(KM1))/(DXUP+DXDWN)
 150      SUMDA(K)=SUMDA(K)+DA
!
!    CALCULATE THE APPROXIMATE BED ELEVATION CHANGE
!    SINCE THE LAST DISTRIBUTION OF SEDIMENT.
!
        SUMDZ=SUMDA(K)/WE(K)
        SMZWS(K)=SMZWS(K)+WSK(K)*ABS(DA)
        SMADA(K)=SMADA(K)+ABS(DA)
!
!    TEST TO SEE IF THE BED ELEVATION HAS CHANGED ENOUGH TO
!    REQUIRE DISTRIBUTING THE SEDIMENT THROUGH THE CROSS SECTION
!
        ADZ=ABS(SUMDZ)
        IF (ADZ.GT.DZMAX) GO TO 160
        IF (ITIME.EQ.NTIM.AND.SMADA(K).GT.0.) GO TO 160
        GO TO 210
!
!    USE THE WEIGHTED AVERAGE OF WATER SURFACE ELEVATION FOR
!    DISTRIBUTING THE SEDIMENT.
!
 160    NDIS=IFIX(ADZ/(DZMAX*4.))
        IF (NDIS.LT.1) NDIS=1
        SDA=SUMDA(K)/FLOAT(NDIS)
        WS=SMZWS(K)/SMADA(K)
        DO 200 NDS=1,NDIS
            ZMP3=ZMIN(K)+3.
            IF (WS.LT.ZMP3) WS=ZMP3
            CALL GEOM (K,WS)
            N=ND(K)
            NP=N-1
!
!    ADD IN CHANGE IN BED ELEVATION, AT EACH POINT, TO
!    CROSS SECTION GEOMETRY.
!
            DX=X(K,2)-X(K,1)
            IF (DX.EQ.0.) GO TO 170
            Z(K,1)=Z(K,1)+(SDA*WD(1))/DX
 170        DO 180 L=2,NP
                DX=X(K,L+1)-X(K,L-1)
```

```
                 IF (DX.EQ.0.) GO TO 180
                 Z(K,L)=Z(K,L)+(SDA*(WD(L)+WD(L-1)))/DX
 180        CONTINUE
              DX=X(K,N)-X(K,N-1)
              IF (DX.EQ.0.) GO TO 190
              Z(K,N)=Z(K,N)+(SDA*WD(N-1))/DX
 190        CALL THAL(K)
 200    CONTINUE
!
!     CALCULATE POWER FUNCTIONS FOR THE CHANGED SECTION.
!
         CALL CHNGM(K)
!
!     SET SMADA(K), SMZWS(K), AND SUMDA(K), BACK TO ZERO.
!
         SMADA(K)=0.
         SMZWS(K)=0.
         SUMDA(K)=0.
 210 CONTINUE
!
      RETURN
      END SUBROUTINE SROUT
```

```
      SUBROUTINE SUBPF (NR)
!
!     THIS SUBROUTINE CALLS THE VARIOUS OTHER SOUBROUTINES
!     NEEDED TO CALCULATE THE SUBCRITICAL WATER SURFACE
!     ELEVATION AT EACH SECTION.
!
      COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
            COMMON /HYD/ V,ED,EW,ALP,TK,TA
            COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
      COMMON /SYS/ VHD,WSD,TKD,DEX
!
!     DETERMINE THE COEFFICIENT OF THE CONVEYANCE EQUATION FOR
!     THE CURRENT DISCHARGE.
!
      CALL NVAL(NR)
```

```
!
!    CALCULATE THE WATER SURFACE ELEVATION AT THE DOWNSTREAM
!    SECTION, BY USING THE CONTROL CONDITIONS.
!
     CALL CONT (NR,WS)
     K=KDOWN (NR)
     IF (WS.LE.ZMIN(K)) GO TO 100
     CALL HYDPR (K,WS)
!
!    TEST FOR CRITICAL FLOW
!
     CRT=TQ(K)/((GRAV/ALP)**.5)
     ZSQ=TA*((TA/EW)**.5)
     IF (CRT.LT.ZSQ) GO TO 130
!
!     CALCULATE CRITICAL DEPTH
!
 100 IF (TQ(K).GT.0.0) GO TO 110
       WS=WSD
       ED=0.0
       EW=0.0
       TA=0.0
       TK=0.0
       ALP=0.0
       V=0.0
 110 D=(TQ(K)*TQ(K)*A5(K))/(A3(K)*A3(K)*GRAV)
       D=D**(1./(1.+2.*B3(K)-B5(K)))
       WS=D+ZMIN(K)
       IF (WS.LT.ZOB(K)) GO TO 120
       D=(TQ(K)*TQ(K)*A10(K))/(A8(K)*A8(K)*GRAV)
       D=D**(1./(1.+2.*B8(K)-B10(K)))
       WS=D+ZMIN(K)
!
!    CALCULATE THE HYDRAULIC PROPERTIES OF THE SECTION.
!
 120 CALL HYDPR (K,WS)
 130    WE(K)=EW
       WSK(K)=WS
       TAK(K)=TA
       EDK(K)=ED
       TKK(K)=TK
       ALPK(K)=ALP
       VK(K)=V
!
```

```
!     ITERATE OVER THE REMAINDER OF THE SECTIONS, BY WORKING
!     UPSTREAM ONE SECTION AT A TIME.
!
      KU=KUP(NR)
      K2=KDOWN(NR)+1
      DO 220 K=K2,KU
          ICRI=0
!
!     SET THE  LAST SECTIONS HYDRAULIC PROPERTIES AS THE
!     DOWNSTREAM CONDITIONS.
!
      KD=K-1
      DEX=RD(K)-RD(KD)
      VHD=ALP*V*V/(2.*GRAV)
      WSD=WS
      TKD=TK
      IF (TQ(K).GT.0.0) GO TO 150
      WS=WSD
      IF (WS.LE.ZMIN(K)) GO TO 140
      CALL HYDPR (K,WS)
      GO TO 210
  140 EW=0.0
        ED=0.0
        TA=0.0
        TK=0.0
        ALP=0.0
        V=0.0
        GO TO 210
!
!     TEST FOR WEIR SECTION
!
  150 IF (DEX.GT.0.00001) GO TO 160
!
!     CALCULATE THE WATER SURFACE AT THE UPSTREAM WEIR SECTION.
!
        CALL WEIR (K,WS)
        GO TO 210
!
!     CALCULATE THE WATER SURFACE ELEVATION AT SECTION(K).
!
  160 CALL BKWAT (K,WS,ICRI)
!
!     TEST FOR CRITICAL FLOW
!
```

```
     IF (ICRI.EQ.1) GO TO 170
     CRT=TQ(K)/((GRAV/ALP)**.5)
     ZSQ=TA*((TA/EW)**.5)
     IF (CRT.LE.ZSQ) GO TO 210
!
!    CALCULATE CRITICAL DEPTH
!
 170 D=(TQ(K)*TQ(K)*A5(K))/(A3(K)*A3(K)*GRAV)
       D=D**(1./(1.+2.*B3(K)-B5(K)))
       WS=D+ZMIN(K)
       IF (WS.LT.ZOB(K)) GO TO 180
       D=(TQ(K)*TQ(K)*A10(K))/(A8(K)*A8(K)*GRAV)
       D=D**(1./(1.+2.*B8(K)-B10(K)))
       WS=D+ZMIN(K)
 180 IF (WS.LT.WSD) WS=WSD
       CALL HYDPR (K,WS)
       IF (V.LT.VVAL) GO TO 210
!
!    CALCULATE NORMAL DEPTH
!
       C=TQ(K)/SB(NR)**.5
       D=(C/A4(K))**(1./B4(K))
       WS=ZMIN(K)+D+.001
       IF (WS.LT.WSD) WS=WSD
       IF(WS.LT.ZOB(K)) GO TO 190
       D=(C/A9(K))**(1./B9(K))
       WS=ZMIN(K)+D+.001
                     IF (WS.LT.WSD) WS=WSD
190    CALL HYDPR (K,WS)
       IF (V.LT.VVAL) GO TO 210
!
!    VELOCITY LIMITED
!
       D=(TQ(K)/(VVAL*A3(K)))**(1.0/B3(K))
       WS=D+ZMIN(K)
       IF (WS.LT.WSD) WS=WSD
       IF (WS.LT.ZOB(K)) GO TO 200
       D= (TQ(K)/(VVAL*A8(K)))**(1.0/B8(K))
       WS=D+ZMIN(K)
       IF (WS.LT.WSD) WS=WSD
 200 CALL HYDPR (K,WS)
!
!    SET CROSS SECTION HYDRAULIC PROPERTIES INTO ARRAYS.
!
```

```
  210 WE(K)=EW
        WSK(K)=WS
        TAK(K)=TA
        EDK(K)=ED
        TKK(K)=TK
        ALPK(K)=ALP
        VK(K)=V
  220 CONTINUE
!
      RETURN
      END SUBROUTINE SUBPF
```

```
      SUBROUTINE THAL (K)
!
!     THIS SUBROUTINE DETERMINES THE CROSS SECTION THALWEG
!     ELEVATION.
!
      COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
            COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
!
!     TEST EACH CROSS SECTION POINT TO FIND THE MINIMUM ELEVATION,
!     (ZMIN(K)).
!
      M=ND(K)
      ZMIN(K)=Z(K,1)
      IZMIN(K)=1
      DO 100 L=1,M
         IF (Z(K,L).GE.ZMIN(K)) GO TO 100
         ZMIN(K)=Z(K,L)
         IZMIN(K)=L
  100 CONTINUE
!
      RETURN
      END SUBROUTINE THAL
```

```
      SUBROUTINE TRIBS
!
!     THIS SUBROUTINE DETERMINES THE SEDIMENT DISCHARGE FOR
!     EACH TRIBUTARY.
```

```
!
!    DEFINITIONS OF TYPES OF  TRIBUTARIES
!
!    ITRIB(NR,J)      TYPE OF TRIBUTARY
!
!       1           POINT SOURCE IN
!       2           MAJOR TRIBUTARY IN
!       3           POINT SOURCE OUT
!       4           MAJOR TRIBUTARY OUT
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /SEC2/
X(100,22),Z(100,22),ZO(100,22),DLOB(100),DROB(100),F(100,22),ND(100),SUMDA(100),SMAD
A(100),SMZWS(100),IZMIN(100),G(100)
     COMMON /INF/
NSEC,NTIM,DT,IDRG,CE,CC,PORM,STAGE,ITIME,NQI,NCALL,ICALL(30,3),MST,EPS
           COMMON /RIV/
NRIV,KUP(10),KDOWN(10),NTRIB(10),ICONT(10),QSL(10,5),AX(10),BX(10),CX(10),RDT(10,5),ITR
IB(10,5),KTRIB(10,5),AT(10,5),BT(10,5),KCONT(10),IROUT(10),SB(10),AN(10),BN(10)
!
!    ITERATE OVER EACH RIVER SEGMENT
!
     DO 150 NR=1,NRIV
         NT=NTRIB(NR)
         IF (NT.EQ.0) GO TO 150
         DO 140 J=1,NT
             K=KTRIB(NR,J)
!
!    DETERMINE THE TYPE OF TRIBUTARY
!
             ITRYB=ITRIB(NR,J)
             GO TO (100,110,120,130), ITRYB
!
!    CALCULATE SEDIMENT DISCHARGE FOR POINT SOURCE BY RATING CURVE.
!
  100        QSL(NR,J)=AT(NR,J)*TQ(K)**BT(NR,J)
             GO TO 140
!
!    FOR MAJOR TRIBUTARIES SET SEDIMENT DISCHARGE TO SEDIMENT
!    TRANSPORT AT DOWNSTREAM TRIBUTARY SECTION.
```

```
!
 110        QSL(NR,J)=G(K)
            GO TO 140
!
!    POINT SOURCE
!
 120        QSL(NR,J)=AT(NR,J)*TQ(K)**BT(NR,J)
            QSL(NR,J)=-QSL(NR,J)
            GO TO 140
!
!    MAJOR TRIBUTARY OUT
!
 130        QSL(NR,J)=-G(K)
 140      CONTINUE
 150 CONTINUE
!
    RETURN
    END SUBROUTINE TRIBS
```

```
    SUBROUTINE UNIT
!
!    THIS SUBROUTINE ASSIGNS THE CORRECT VALUES TO THE CONSTANTS ACCORDING TO
THE UNIT-SYSTEM USED.
!
!             IUNIT           UNITS
!               1       ENGLISH UNIT-SYSTEM
!               2       METRIC  SYSTEM   (SI)
!
    COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
!
    IF (IUNIT.NE.1) GO TO 100
    CORDS=5820.
    ZDIFM=10.
    GRAV=32.2
    VVAL=10.
    FET=5.
    CONV=1.486
    DZMAX=0.5
    RETURN
 100 CORDS=1000.
      ZDIFM=3.0
      GRAV=9.81
      VVAL=3.3
      FET=1.5
      CONV=1.0
```

```
      DZMAX=0.15
!
      RETURN
      END  SUBROUTINE UNIT
```

```
     SUBROUTINE WEIR(K,WS)
!
!     THIS SUBROUTINE IS USED TO CALCULATE THE GREATER OF THE
!     DOWNSTREAM WATER SURFACE OR THE CRITICAL DEPTH AT THE
!     WEIR.
!
     COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /SYS/ VHD,WSD,TKD,DEX
           COMMON /HYD/ V,ED,EW,ALP,TK,TA
           DATA WID/200.0/
!
!     CALCULATE DEPTH BY WEIR EQUATION.
!
     D= (TQ(K)/(WID*2.85))**0.666666
     WS=D+ZMIN(K)+0.001
!
!     TEST FOR GREATEST OF DOWNSTREAM OR WEIR WATER SURFACE
!     ELEVATIONS.
!
     IF (WS.LT.WSD) WS=WSD
     CALL HYDPR (K,WS)
!
!     SET HYDRAULIC PROPERTIES EQUAL AT THE WEIR CROSS SECTIONS.
!
     KM1=K-1
     WSK(KM1)=WS
     VK(KM1)=V
     TAK(KM1)=TA
     TKK(KM1)=TK
     EDK(KM1)=ED
     WE(KM1)=EW
     ALPK(KM1)=ALP
!
     RETURN
     END SUBROUTINE WEIR
```

```
      SUBROUTINE WEIRS
!
!     THIS SUBROUTINE IS USED TO CALCULATE THE PERCENTAGE
!     OF UPSTREAM SEDIMENT THAT IS TRANSPORTED OVER THE WEIR.
!
        COMMON /SEC1/
WD(22),RD(100),TQ(125),WSK(100),WE(100),ZMIN(100),ZOB(100),A1(100),A2(100),A3(100),A
4(100),A5(100),A6(100),A7(100),A8(100),A9(100),A10(100),B1(100),B2(100),B3(100),B4(100),B
5(100),B6(100),B7(100),B8(100),B9(100),B10(100),OA4(100),OA9(100),EDK(100),TAK(100),TKK
(100),ALPK(100),VK(100),WSMAX(100),IMAX(100)
           COMMON /SYS/ VHD,WSD,TKD,DEX
           COMMON /HYD/ V,ED,EW,ALP,TK,TA
        COMMON /UNITS/ IUNIT,CORDS,ZDIFM,GRAV,VVAL,FET,CONV,DZMAX
           DATA WID/200.0/
!
!     CALCULATE DEPTH BY WEIR EQUATION.
!
      D= (TQ(K)/(WID*2.85))**0.666666
      WS=D+ZMIN(K)+0.001
!
!     CALCULATE DARCY-WEISBACH FRICTION FACTOR (DF).
!
      DF = (HL/EW) * (4*R*2*GRAV)/(V*V)
!
!     CALCULATE THE SHEAR VELOCITY (US).
!
      US = V/(8/DF)**.5
!
!     SET VALUES FOR PARTICLE FALL VELOCITY (W) AND
!     AND VON KARMAN CONSTANT (K).
!
      W = 0.122402
      K = 0.70
!
!     CALCULATE PERCENTAGE OF UPSTREAM SEDIMENT TRANSPORT (PC)
!     WHICH PASSES OVER THE WEIR.
!
      EO = EXP((-6*W)/(K*US))
      EY = EXP((-6*W)/(K*US)*(D-ED))
      PC = (EO-EY)/(EO-1)
!
      END SUBROUTINE WEIRS
```