APPENDIX B3 FORTRAN IV PROGRAMS FOR CALCULATING MIXING CURVES AND TRACER RECOVERIES

Regina M. Capuano

Earth Science Laboratory
University of Utah Research Institute
420 Chipeta Way, Suite 120
Salt Lake City, Utah 84108

INTRODUCTION

This paper presents three FORTRAN IV computer programs designed to calculate tracer recoveries from chemical analyses of solutions recovered during injection-backflow testing. A detailed description of the calculations is presented by Capuano (1983) in a companion paper. The computer code for each of these programs is listed in Appendices B3-1 through B3-3.

INJECT calculates tracer concentrations vs. time, total mass of tracer, total volume of solution, average injection concentration, and fraction of injectate in each sample. Input data required includes the concentration of tracer in each sample, reported as mg/l, and the sample collection time, relative to the start of each test.

REJECT uses the results of volume and mass calculations from INJECT to produce plots of mixing curves and the mass of tracer injected and recovered with respect to solution volume injected or backflowed. BORE, on the other hand, uses the same data from INJECT to calculate total tracer recoveries, well bore recoveries and injection volumes backflowed.

REFERENCE

Capuano, R. M., 1983, Raft River injection testing recovery curves: Earth Science Laboratory, University of Utah Research Institute Report, in press.

APPENDIX B

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APPENDIX B3-1

Program INJECT

```
C PROGRAM INJECT.FTN  REV3  3/23/83 BY REGINA M CAPUANO
C
      DIMENSION TITLE(16),TNAME(3,25),UNIT(3,25),SNUM(100),CONC(100,25),
     *RTIME(100),RTI(100),RME(100),IIDAT(4),IIRUN(4),CINJ(25),CBG(25),
     *FRATE(100)
C
C INITILIZE
      CALL KTYP('DATA FILE=@@')
      READ(1,1000)(IIDAT(I),I=1,4)
      CALL KTYP('RUN FILE=@@')
      READ(1,1000)(IIRUN(I),I=1,4)
      I=16
      CALL OPNRED(9,IIDAT,I)
      CALL OPNRED(8,IIRUN,I)
      CALL OPNNEW(10,'INJOUT',6)
      IDAT=9
      IRUN=8
      IOUT=10
C
C READ DATA FILE
      READ(IDAT,1000)(TITLE(I),I=1,16)
      READ(IDAT,1005)NSAM,NELE,INJ
      DO 50 I=1,NELE
      IF(INJ.EQ.1)GO TO 30
      READ(IDAT,1002)(TNAME(J,I),J=1,3),(UNIT(J,I),J=1,3)
      GO TO 40
 30   CONTINUE
      READ(IDAT,1003)(TNAME(J,I),J=1,3),(UNIT(J,I),J=1,3),CINJ(I),CBG(I)
 40   CONTINUE
 50   CONTINUE
C
C READ SAMPLE NAME AND CONC.
      DO 100 I=1,NSAM
      READ(IDAT,1010)SNUM(I)
      READ(IDAT,1020)(CONC(I,J),J=1,NELE)
  100 CONTINUE
C
C READ TIME (HOURS.MIN) AND RATE (GAL/MIN)
      READ(IDAT,1030)RTFAC
      DO 103 I=1,NSAM
      READ(IDAT,1035)RTIME(I),FRATE(I)
 103  CONTINUE
C
C CONVERT HOURS.MIN TO HOURS
      DO 105 I=1,NSAM
      RTI(I)=AINT(RTIME(I))
      RME(I)=RTIME(I)-RTI(I)
      RME(I)=RME(I)/.60
      RTIME(I)=RME(I)+RTI(I)
 105  CONTINUE
C
C NORMALIZE (CORRECT) RELATIVE TIME BY FACTOR
      IF (RTFAC.EQ.0) GO TO 110
      RT=AINT(RTFAC)
      RM=RTFAC-RT
      RM=RM/.60
      RTFAC=RM+RT
```

```
      DO 115 I=1,NSAM
      RTIME(I)=RTIME(I)*RTFAC
  115 CONTINUE
  110 CONTINUE
C
C SUBR TO PLOT CONC VS TIME
C
      READ(IRUN,1040)JPCT,JPCTL,JPCTS
      IF(JPCT.EQ.0) GO TO 120
      CALL PLT (TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
  120 CONTINUE
C SUBROUTINE TO PLOT LOG CONC. VS LOG TIME
C
      IF (JPCTL.EQ.0) GO TO 130
      CALL PLTLG (TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
  130 CONTINUE
C SUBR TO PLOT LOG CONC. VS TIME
      IF (JPCTS.EQ.0) GO TO 140
      CALL PLTS (TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
  140 CONTINUE
C CALCULATE AVERAGE INJECTION CONCENTRATION (WEIGHTED AVERAGE) AND
C    MASS OF ELEMENT INJECTED OR BACKFLOWED
C
      READ (IRUN,1040) ICINJ,IAREA
      IF (ICINJ.EQ.0) GO TO 150
      CALL AVERAG(CONC,RTIME,IRUN,IOUT,NSAM,TNAME,UNIT,TITLE)
  150 CONTINUE
      IF (IAREA.EQ.0) GO TO 160
      CALL AREA(CONC,RTIME,FRATE,IRUN,IOUT,CINJ,CBG,NSAM,
     *  SNUM,INJ,TITLE,TNAME,UNIT)
  160 CONTINUE
C
C FORMAT STATEMENTS
 1000 FORMAT(16A4)
 1002 FORMAT(2(3A4))
 1003 FORMAT(2(3A4),2E10.0)
 1005 FORMAT(3I5)
 1010 FORMAT(A4)
 1020 FORMAT(7E10.0)
 1030 FORMAT(E10.0)
 1035 FORMAT(2E10.0)
 1040 FORMAT(5I5)
C
C WRAP UP
      CALL CLOSEF(9)
      CALL CLOSEF(8)
      CALL CLOSEF(10)
      CALL EXIT
      END
```

```
C*****************************************SUBROUTINE PLT
C
C     SUBROTINE PLT(REV 1)
C     PLOT INITILIZATON FOR PROGRAM INJECT3.FTN
C
      SUBROUTINE PLT(TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
      DIMENSION JELE(25),PYMIN(25),PALY(25),PDY(25),Y(100),X(100),
     *XT(3),YT(4),TNAME(3,25),CONC(100,25),RTIME(100),
     *TITLE(16),UNIT(3,25),GT(6)
      DATA XT/'TIME (HOURS)'/
      DATA YT/'CONCENTRATION'/
      M1=3
      M2=4
      M22=77
      IY=0
      NX=12
      NY=13
      CSZ=.05
      CALL KTYP('INPUT PLOT DEVICE: 1=TEKTRONICS, 2=STATOS, 4=FINAL@@')
      READ (1,*)IDEV
      READ(IRUN,1305)NEP,M3,ALX,XMIN,DX
      READ(IRUN,1310)(JELE(I),I=1,NEP)
      READ(IRUN,1315)(PYMIN(I),I=1,NEP)
      READ(IRUN,1315)(PALY(I),I=1,NEP)
      READ(IRUN,1315)(PDY(I),I=1,NEP)
      DO 315 K=1,NEP
      J=JELE(K)
      YMIN=PYMIN(K)
      ALY=PALY(K)
      DY=PDY(K)
      DO 300 I=1,3
  300 GT(I)=TNAME(I,J)
      DO 302 I=1,3
  302 GT(I+3)=UNIT(I,J)
      N=0
      DO 320 I=1,NSAM
      IF (CONC(I,J).EQ.1E6) GO TO 320
      N=N+1
      X(N)=RTIME(I)
      Y(N)=CONC(I,J)
  320  CONTINUE
      ALXX=ALX+2
      ALYY=ALY+3
      ALYYY=ALY+2.3
C PLOT CONC. VS TIME
C
      CALL OPNPLT(IDEV,ALXX,ALYY)
      CALL CORTIC(0.0,0.0,ALXX,ALYY)
      CALL SYMBOL(.5,ALYYY,0.3,TITLE(1),0,25)
      CALL PLOT(1.0,1.0,-3)
      CALL LINE(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
     *  XMIN,YMIN,DX,DY,GT,CSZ)
      CALL CLOSEP
      IF (IDEV.EQ.1) READ(1,1301)IANS
  315 CONTINUE
 1300 FORMAT(I5)
 1301 FORMAT(A1)
```

```
 1305 FORMAT(2I5,3F10.0)
 1310 FORMAT(10I5)
 1315 FORMAT(7F10.0)
  120 CONTINUE
C
C WRITE SAMPLE DATA
      RETURN
      END
```

```
C**********************************************SUBROUTINE LINE
C
C     Subroutine LINE (Rev 3)
C
C
C
C     Purpose:
C
C       LINE IS A CONVERSION OF SUBROTINE XYLINE
C            XYLIN is used to create a linear-linear plot.
C
C     Usage:
C
C            CALL LINE(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,
C           *            ALX,ALY,XMIN,YMIN,DX,DY,GT,CSZ)
C
C     Description of Parameters: (All Input)
C
C            M1    = (L.I.) Mode One
C                  =        0 Plot Data Trace Only
C                  =        1 Plot Data and Y Axis
C                  =        2 Plot X Axis and Tic Marks
C                  =        3 Plot Data and all Axies and Tic Marks
C            M2    = (L.I.) Mode Two
C                  =        0 Through 128  Plot Symbol
C            M22    = SYMBOL FOR LESS THAN DETECTION LIMIT VALUES
C                  =        0 THROGH 128 PLOT SYMBOL
C            M3    = SYMBOL FOR LINE TO CONNECT POINTS
C                  =        -1 Plot Continuous Line
C                  =        -2 - - - - - - - -
C                  =        -3 -- -- -- -- --
C                  =        -4 -  -  -  -  -
C                  =        -5 --- --- --- ---
C                  =        -6 -   -   -   -
C                  =        -7 ---  ---  ---
C                  =        -8 --   --   --
C                  =        -9 -----  -----
C                  =        -10 --     --
C            IY    = (L.I.) Y Axis Location
C            X     = (F.P.) Linear X Data Array
C            Y     = (F.P.) Linear Y Data Array
C            N     = (L.I.) Number of Points (Data)
C            XT    = (A-N.) X Title Array
C            NX    = (L.I.) Number of Characters in X Title
C            YT    = (A-N.) Y Title Array
C            NY    = (L.I.) Number of Characters in Y Title
C            ALX   = (F.P.) X Axis Length in Inches
C            ALY   = (F.P.) Y Axis Length in Inches
C            XMIN  = (F.P.) Minimum X Value on Plot
C            YMIN  = (F.P.) Minimum Y Value on Plot
C            DX    = (F.P.) Units/Inch on X Axis
C            DY    = (F.P.) Units/Inch on Y Axis
C            GT    = (A-N.) Graph Title Array
C            CSZ   = (F.P.) Symbol Character or Dash Size
C
C     Subroutine Variables:
C
```

```
C               MM = (I.I.) Dash Selection Number
C               XX = (F.P.) X Value in Inches
C               YY = (F.P.) Y Value in Inches
C
C     Subroutines or Functions Required: (Library Name in Brackets)
C
C               AXIS (UUPLT)
C               IABS (FTN)
C               PLTDSH (UUPLT)
C               SETDSH (UUPLT)
C               SYMBOL (UUPLT)
C               TICPLT (UUPLT)
C               TSTPNT (UUPLT)
C
C     References:
C
C              Revised from XYLINP by
C                  John W Atwood (Rev 1  April 1980)
C              Revised from UUPLT.XYLIN by
C                  Regina Capuano - March 1983
C
C
C.....................................................................
C
      SUBROUTINE LINE(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,ALX,
     *                ALY,XMIN,YMIN,DX,DY,GT,CSZ)
      DIMENSION X(1),Y(1),XT(1),YT(1),GT(6)
C
C-----If M1 Equals 2 Plot the X Axis Only
C
      IF(M1 .EQ. 2) GO TO 200
C
C-----If M2 is Out of Symbol Range Plot Line
C
      IF((M2 .LT. 0) .OR. (M2 .GT. 128)) GO TO 100
C
C-----Plot Individual Data Points
C
      IF(N .LT. 1) GO TO 200
      DO 10 I=1,N
          XX = (X(I) - XMIN) / DX
          IF (Y(I).LE.0) GO TO 50
          YY = (Y(I) - YMIN) / DY
C
C                                 Check to See if XX and YY are
C                                 Within Plot Range
C
          CALL TSTPNT(K,XX,YY,ALX,ALY)
          IF(K .EQ. 1) GO TO 10
          CALL SYMBOL(XX,YY,CSZ,M2,0.0,-1)
          GO TO 10
50        Y(I) = ABS(Y(I))
          YY = (Y(I)-YMIN) / DY
          CALL TSTPNT(K,XX,YY,ALX,ALY)
          IF (K.EQ.1) GO TO 10
          CALL SYMBOL(XX,YY,CSZ,M22,0.0,-1)
   10 CONTINUE
```

```
C
C-----Plot Connecting Line Graph
C
  100 CONTINUE
      IF (M3.GE.0) GO TO 200
      IF(N .LT. 2) GO TO 200
      MM = IABS(M3)
      XX = (X(1) - XMIN) / DX
      YY = (ABS(Y(1)) - YMIN) / DY
      CALL SETDSH(XX,YY,CSZ,MM,ALX,ALY)
      DO 120 I=2,N
          XX = (X(I) - XMIN) / DX
          YY = (ABS(Y(I)) - YMIN) / DY
          CALL PLTDSH(XX,YY)
  120 CONTINUE
  200 CONTINUE
C
C-----If M1 Equals 0 Do Not Plot Axies
C
      IF(M1 .EQ. 0) RETURN
C
C-----Plot Axies, Tic Marks, and Titles
C
      XX = IY * (-0.7)
      CALL AXIS(XX,0.0,YT,NY,ALY,90.0,YMIN,DY)
C
C-----If M1 Equals 1 Do Not Plot X Axis
C
      IF(M1 .EQ. 1) RETURN
  300 CONTINUE
      CALL AXIS(0.0,0.0,XT,-NX,ALX,0.0,XMIN,DX)
C
C-----Plot Tic Marks at Inch Intervals at Right and Top of Plot
C
      CALL TICPLT(ALX,1.0,ALY,1.0)
C
C-----Plot Graph Title
C
      XX = -0.5
      YY = ALY + 0.7
      CALL SYMBOL(XX,YY,0.2,GT(1),0.0,24)
  400 CONTINUE
      RETURN
      END
C
```

```
C*****************************************SUBROUTINE PLTLG
C
C     SUBROTINE PLTLG(REV 3)
C     PLOT INITILIZATON FOR PROGRAM INJECT.FTN
C        FOR PLOTTING LOG CONCENTRATION VS LOG TIME
C
      SUBROUTINE PLTLG(TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
      DIMENSION JELE(25),PYSTR(25),PALY(25),NNCY(25),Y(100),X(100),
     *XT(4),YT(5),TNAME(3,25),UNIT(3,25),CONC(100,25),RTIME(100),
     *TITLE(16),GT(6)
      DATA XT/'LOG TIME (HOURS)'/
      DATA YT/'LOG CONCENTRATION'/
      M1=3
      M2=4
      M22=77
      IY=0
      NX=16
      NY=17
      NG=4
      CSZ=.05
      CALL KTYP('INPUT PLOT DEVICE: 1=TECTRONICS, 2=STATOS, 4=FINAL@@')
      READ (1,*)IDEV
      READ(IRUN,1305)NEP,M3,ALX,XSTR,NCX
      READ(IRUN,1310)(JELE(I),I=1,NEP)
      READ(IRUN,1315)(PYSTR(I),I=1,NEP)
      READ(IRUN,1315)(PALY(I),I=1,NEP)
      READ(IRUN,1320)(NNCY(I),I=1,NEP)
      DO 315 K=1,NEP
      J=JELE(K)
      YSTR=PYSTR(K)
      ALY=PALY(K)
      NCY=NNCY(K)
      DO 300 I=1,3
  300 GT(I)=TNAME(I,J)
      DO 302 I=1,3
  302 GT(I+3)=UNIT(I,J)
      N=0
      DO 320 I=1,NSAM
      IF (CONC(I,J).EQ.1E6) GO TO 320
      N=N+1
      X(N)=RTIME(I)
      Y(N)=CONC(I,J)
  320  CONTINUE
      ALXX=ALX+2
      ALYY=ALY+3
      ALYYY=ALY+2.3
C  PLOT LOG CONC.VS LOG TIME
C
      CALL OPNPLT(IDEV,ALXX,ALYY)
      CALL CORTIC(0.0,0.0,ALXX,ALYY)
      CALL SYMBOL(.5,ALYYY,0.3,TITLE(1),0,25)
      CALL PLOT(1.0,1.0,-3)
      CALL LINLG(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
     *  XSTR,YSTR,NCX,NCY,GT,CSZ)
      CALL CLOSEP
      IF (IDEV.EQ.1) READ(1,1301)IANS
  315 CONTINUE
```

```
 1300 FORMAT(I5)
 1301 FORMAT(A1)
 1305 FORMAT(2I5,2F10.0,I5)
 1310 FORMAT(10I5)
 1315 FORMAT(7F10.0)
 1320 FORMAT(7I10)
 120  CONTINUE
C
C WRITE SAMPLE DATA
      RETURN
      END
```

```
C*****************************************************************LINLG
C
C     Subroutine LINLG (Rev 3)
C
C
C
C     Purpose:
C
C        LINLG IS A CONVERSION OF SUBROUTINE XYLOG
C             XYLOG is used to create a log-log plot.
C
C     Usage:
C
C           CALL LINLG(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
C          *           XSTR,YSTR,NCX,NCY,GT,CSZ)
C
C    Description of Parameters: (All Input)
C
C            M1    = (L.I.) Mode One
C                  =        0 Plot Data Trace Only
C                  =        1 Plot Data and Y Axis
C                  =        2 Plot X Axis and Tic Marks
C                  =        3 Plot Data and all Axies and Tic Marks
C            M2    = (L.I.) Mode Two
C                  =        0 Through 128  Plot Symbol
C          M22     =        SYMBOL FOR LESS THAN VALUES
C                           0 THROUGH 128 PLOT SYMBOL
C          M3      =        0 NO LINE PLOTTED
C                  =        -1 Plot Continuous Line
C                  =        -2 - - - - - - - -
C                  =        -3 -- -- -- -- --
C                  =        -4 -  -  -  -  -
C                  =        -5 --- --- --- ---
C                  =        -6 -   -   -   -
C                  =        -7 ---  ---  ---
C                  =        -8 --   --   --
C                  =        -9 -----  -----
C                  =        -10 --     --
C              IY    = (L.I.) Y Axis Location
C              X     = (F.P.) Linear X Data Array
C              Y     = (F.P.) Linear Y Data Array
C              N     = (L.I.) Number of Points (Data)
C              XT    = (A-N.) X Title Array
C              NX    = (L.I.) Number of Characters in X Title
C              YT    = (A-N.) Y Title Array
C              NY    = (L.I.) Number of Characters in Y Title
C              ALX   = (F.P.) X Axis Length in Inches
C              ALY   = (F.P.) Y Axis Length in Inches
C              XSTR  = (F.P.) Power of 10 Starting Point on X Axis
C              YSTR  = (F.P.) Power of 10 Starting Point on Y Axis
C              NCX   = (L.I.) Number of Log Cycles on X Axis
C              NCY   = (L.I.) Number of Log Cycles on Y Axis
C              GT    = (A-N.) Graph Title Array
C              CSZ   = (F.P.) Symbol Character or Dash Size
C
C    Subroutine Variables:
C
```

```
C               MM      = (L.I.) Dash Selection Number
C               XSCALE  = (F.P.) Inches per Cycle on X Axis
C               XX      = (F.P.) X Value in Inches
C               YSCALE  = (F.P.) Inches per Cycle on Y Axis
C               YY      = (F.P.) Y Value in Inches
C
C     Subroutines or Functions Required: (Library Name in Brackets)
C
C               IABS (FTN)
C               LGAXIS (UUPLT)
C               PLTDSH (UUPLT)
C               SCXYLL (UUPLT)
C               SETDSH (UUPLT)
C               SYMBOL (UUPLT)
C               TICPLT (UUPLT)
C               TSTPNT (UUPLT)
C
C     References:
C
C               Revised from XYLINP by
C                    John W Atwood (Rev 1, April 1980)
C               REVISED FROM XYLIN BY
C                    REGINA M CAPUANO (REV1 MARCH 1983)
C
C
C.....................................................................
C
      SUBROUTINE LINLG(M1,M2,M22,M3,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
     *                 XSTR,YSTR,NCX,NCY,GT,CSZ)
      DIMENSION X(1),Y(1),XT(1),YT(1),GT(1)
C
C-----If M1 Equals 2 Plot X Axis Only
C
      IF(M1 .EQ. 2) GO TO 300
C
C-----Set XSCALE and YSCALE
C
      XSCALE = ALX / NCX
      YSCALE = ALY / NCY
C
C-----If M2 Out of Symbol Range Plot Line Plot
C
      IF((M2 .LT. 0) .OR. (M2 .GT. 128)) GO TO 100
C
C-----Plot Individual Data Points
C
      IF(N .LT. 1) GO TO 200
      DO 10 I=1,N
      IF (Y(I).LE.0) GO TO 50
C
C                              Change X and Y to Inches then
C                              Check to See if XX and YY are
C                              Within Plot Range
C
      CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
      CALL TSTPNT(K,XX,YY,ALX,ALY)
      IF(K .EQ. 1) GO TO 10
```

```
            CALL SYMBOL(XX,YY,CSZ,M2,0.0,-1)
          GO TO 10
   50     Y(I)=ABS(Y(I))
          CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
          CALL TSTPNT(K,XX,YY,ALX,ALY)
          IF(K.EQ.1) GO TO 10
          CALL SYMBOL(XX,YY,CSZ,M22,0.0,-1)
     10 CONTINUE
C
C-----Plot Connecting Line Graph
C
    100 CONTINUE
          IF (M3.GE.0) GO TO 200
          IF(N .LT. 2) GO TO 200
          CALL SCXYLL(X(1),Y(1),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
          MM = IABS(M2)
          CALL SETDSH(XX,YY,CSZ,MM,ALX,ALY)
          DO 120 I=2,N
             CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
             CALL RLTDSH(XX,YY)
    120 CONTINUE
    200 CONTINUE
C
C-----If M1 Equals 0 Do Not Plot Axies
C
          IF(M1 .EQ. 0) RETURN
C
C-----Plot Axies, Tick Marks, and Titles
C
          XX = IY * (-0.7)
          CALL LGAXIS(XX,0.0,YT,NY,ALY,90.0,YSTR,NCY)
C
C-----If M1 Equals 1 Do Not Plot X Axis
C
          IF(M1 .EQ. 1) RETURN
    300 CONTINUE
          CALL LGAXIS(0.0,0.0,XT,-NX,ALX,0.0,XSTR,NCX)
C
C-----Plot Tic Marks at Log Cycles at Right and Top of Plot
C
          CALL TICPLT(ALX,XSCALE,ALY,YSCALE)
C
C-----Plot Graph Title
C
          XX = -0.5
          YY = ALY + 0.7
          CALL SYMBOL(XX,YY,0.2,GT(1),0.0,24)
          RETURN
          END
C
```

```
C*****************************************SUBROUTINE PLTS
C
C     SUBROTINE PLTS(REV 3)
C     PLOT INITILIZATON FOR PROGRAM INJECT.FTN
C     FOR PLOTTING LOG CONCENTRATION VS  TIME
C
      SUBROUTINE PLTS(TNAME,UNIT,NSAM,CONC,RTIME,TITLE,IRUN)
      DIMENSION JELE(25),PYSTR(25),PALY(25),PYNCY(25),Y(100),X(100),
     *XT(3),YT(5),TNAME(3,25),UNIT(3,25),CONC(100,25),RTIME(100),
     *TITLE(16),GT(6)
      DATA XT/'TIME (HOURS)'/
      DATA YT/'LOG CONCENTRATION'/
      M1=3
      M2=4
      M22=77
      M3=1
      IY=0
      NX=12
      NY=17
      NG=4
      CSZ=.05
      CALL KTYP('INPUT PLOT DEVICE: 1=TECTRONICS, 2=STATOS, 4=FINAL@@')
      READ (1,*)IDEV
      READ(IRUN,1305)NEP,M33,ALX,XMIN,DX
      READ(IRUN,1310)(JELE(I),I=1,NEP)
      READ(IRUN,1315)(PYSTR(I),I=1,NEP)
      READ(IRUN,1315)(PALY(I),I=1,NEP)
      READ(IRUN,1315)(PYNCY(I),I=1,NEP)
      DO 315 K=1,NEP
      J=JELE(K)
      YSTR=PYSTR(K)
      ALY=PALY(K)
      YNCY=PYNCY(K)
      DO 300 I=1,3
  300 GT(I)=TNAME(I,J)
      DO 302 I=1,3
  302 GT(I+3)=UNIT(I,J)
      N=0
      DO 320 I=1,NSAM
      IF (CONC(I,J).EQ.1E6) GO TO 320
      N=N+1
      X(N)=RTIME(I)
      Y(N)=CONC(I,J)
  320  CONTINUE
      ALXX=ALX+2
      ALYY=ALY+3
      ALYYY=ALY+2.3
C PLOT CONC. VS TIME
C
      CALL OPNPLT(IDEV,ALXX,ALYY)
      CALL CORTIC(0.0,0.0,ALXX,ALYY)
      CALL SYMBOL(.5,ALYYY,0.3,TITLE(1),0,25)
      CALL PLOT(1.0,1.0,-3)
      CALL SEM(M1,M2,M22,M3,M33,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
     *  XMIN,YSTR,DX,YNCY,GT,CSZ)
      CALL CLOSEP
      IF (IDEV.EQ.1) READ(1,1301)IANS
```

```
  315  CONTINUE
 1300 FORMAT(I5)
 1301 FORMAT(A1)
 1305 FORMAT(2I5,3F10.0)
 1310 FORMAT(10I5)
 1315 FORMAT(7F10.0)
  120  CONTINUE
C
C WRITE SAMPLE DATA
      RETURN
      END
```

```
C*************************************************************SEM
C
C     Subroutine SEM (Rev 3)
C
C
C
C     Purpose:
C          SEM IS A CONVERSON OF SUBROUTINE XYSEM
C
C               XYSEM is used to create a semi-Log plot.
C
C
C     Usage:
C
C               CALL SEM(M1,M2,M22,M3,M33,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
C              *           XSTR,YSTR,XNCX,YNCY,GT,CSZ)
C
C
C    Description of Parameters: (All Input)
C
C               M1   = (L.I.) Mode One
C                    =        0 Plot Data Trace Only
C                    =        1 Plot Data and Y Axis
C                    =        2 Plot X Axis and Tic Marks
C                    =        3 Plot Data and all Axies and Tic Marks
C               M2   = (L.I.) Mode Two
C                    =        0 Through 128  Plot Symbol
C               M22  =SYMBOL FOR LESS THAN DCTECTION VALUES
C               M33  =PLOT LINE TO CONNECT POINTS
C                    =           0 NO LINE PLOTTED
C                    =        -1 Plot Continuous Line
C                    =        -2 - - - - - - - -
C                    =        -3 -- -- -- -- --
C                    =        -4 -  -  -  -  -
C                    =        -5 --- --- --- ---
C                    =        -6 -   -   -   -
C                    =        -7 ---  ---  ---
C                    =        -8 --   --   --
C                    =        -9 -----  -----
C                    =        -10 --     --
C               M3   = (L.I.) Mode Three
C                    =        0 Log Axis is Horizontal X Axis
C                    =        1 Log Axis is Vertical Y Axis
C               IY   = (L.I.) Y Axis Location
C               X    = (F.P.) Linear X Data Array
C               Y    = (F.P.) Linear Y Data Array
C               N    = (L.I.) Number of Points (Data)
C               XT   = (A-N.) X Title Array
C               NX   = (L.I.) Number of Characters in X Title
C               YT   = (A-N.) Y Title Array
C               NY   = (L.I.) Number of Characters in Y Title
C               ALX  = (F.P.) X Axis Length in Inches
C               ALY  = (F.P.) Y Axis Length in Inches
C               XSTR = (F.P.) Power of 10 Starting Point on X Axis
C                             or Minimum X Value on Plot
C               YSTR = (F.P.) Power of 10 Starting Point on Y Axis
C                             or Minimum Y Value on Plot
C               XNCX = (F.P.) Number of Log Cycles on X Axis
C                             or Units/Inch on X Axis
C
```

```
C               YNCY = (F.P.) Numoer of Log Cycles on Y Axis
C                              or Units/Inch on Y Axis
C               GT   = (A-N.) Graph Title Array
C               CSZ  = (F.P.) Symbol Character or Dash Size
C
C     Subroutine Variables:
C
C               MM     = (L.I.) Dash Selection Number
C               NCX    = (L.I.) Integerized Value of XNCX
C               NCY    = (L.I.) Integerized Value of YNCY
C               XSCALE = (F.P.) Inches per Cycle on X Axis
C               XX     = (F.P.) X Value in Inches
C               YSCALE = (F.P.) Inches per Cycle on Y Axis
C               YY     = (F.P.) Y Value in Inches
C
C     Subroutines or Functions Required: (Library Name in Brackets)
C
C               AXIS (UUPLT)
C               IABS (FTN)
C               LGAXIS (UUPLT)
C               PLTDSH (UUPLT)
C               SCXYLL (UUPLT)
C               SETDSH (UUPLT)
C               SYMBOL (UUPLT)
C               TICPLT (UUPLT)
C               TSTPNT (UUPLT)
C
C     References:
C
C               Revised from XYLINP by
C                   John W Atwood (Rev 1  April 1980)
C               REVISED FROM XYSEM BY
C                   REGNA M CAPUANO (REV 1  MARCH 1983)
C
C
C.....................................................................
C
      SUBROUTINE SEM(M1,M2,M22,M3,M33,IY,X,Y,N,XT,NX,YT,NY,ALX,ALY,
C
     *                   XSTR,YSTR,XNCX,YNCY,GT,CSZ)
      DIMENSION X(1),Y(1),XT(1),YT(1),GT(1)
C
C-----If M1 Equals 2 Plot X Axis Only
C
      IF(M1 .EQ. 2) GO TO 200
C
C-----Set XSCALE and YSCALE
C
      NCX = XNCX + 0.5
      IF(XNCX .LT. 0.0) NCX = XNCX - 0.5
      NCY = YNCY + 0.5
      IF(YNCY .LT. 0.0) NCY = YNCY - 0.5
      XSCALE = ALX / XNCX
      IF(M3 .NE. 0) XSCALE = 1.0
      YSCALE = ALY / YNCY
      IF(M3 .EQ. 0) YSCALE = 1.0
C
```

```
C-----If M2 is Out of Symbol Range Plot Line Plot
C
      IF((M2 .LT. 0) .OR. (M2 .GT. 128)) GO TO 100
C
C-----Plot Individual Points
C
      IF(N .LT. 1) GO TO 200
      DO 20 I=1,N
      IF(Y(I).LE.0) GO TO 50
C
C                           Change X and Y to Inches then
C                           Test XX and YY to See if They
C                           are Within the Plot Limits
C                           If M3 Equals 0 Change YY to Linear
C                           If M3 Equals 1 Change XX to Linear
C
C
          CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
          IF(M3 .NE. 0) GO TO 10
          YY = (Y(I) - YSTR) / YNCY
          GO TO 15
   10     CONTINUE
          XX = (X(I) - XSTR) / XNCX
   15     CONTINUE
          CALL TSTPNT(K,XX,YY,ALX,ALY)
          IF(K .EQ. 1) GO TO 20
          CALL SYMBOL(XX,YY,CSZ,M2,0.0,-1)
      GO TO 20
   50 Y(I)=ABS(Y(I))
      CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
      IF(M3.NE.0) GO TO 40
      YY = (Y(I)-YSTR)/YNCY
      GO TO 45
   40 CONTINUE
      XX = (X(I)-XSTR)/ XNCX
   45 CONTINUE
      CALL TSTPNT(K,XX,YY,ALX,ALY)
      IF(K.EQ.1) GO TO 20
      CALL SYMBOL (XX,YY,CSZ,M22,0.0,-1)
   20 CONTINUE
C
C-----Plot Connecting Line Plot
C
  100 CONTINUE
      IF(M33.GE.0) GO TO 200
      IF(N .LT. 2) GO TO 200
      MM = IABS(M33)
      CALL SCXYLL(X(1),Y(1),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
      IF(M3 .NE. 0) GO TO 102
      YY = (Y(1) - YSTR) / YNCY
      GO TO 104
  102 CONTINUE
      XX = (X(1) - XSTR) / XNCX
  104 CONTINUE
      CALL SETOSH(XX,YY,CSZ,MM,ALX,ALY)
      DO 130 I=2,N
          CALL SCXYLL(X(I),Y(I),XSCALE,XSTR,YSCALE,YSTR,XX,YY)
          IF(M3 .NE. 0) GO TO 110
```

```
            YY = (Y(I) - YSTR) / YNCY
            GO TO 115
  110       CONTINUE
            XX = (X(I) - XSTR) / XNCX
  115       CONTINUE
            CALL PLTOSH(XX,YY)
  130 CONTINUE
C
C-----If M3 Equals 1 The Y Axis is Log
C
  200 CONTINUE
C
C-----If M1 Equals 0 Do Not Plot Axies
C
      IF(M1 .EQ. 0) RETURN
      XX = IY * (-0.7)
      IF(M3 .NE. 0) GO TO 250
C
C-----Plot Axies, X as Log Y as Linear
C
      IF(M1 .EQ. 2) GO TO 210
      CALL AXIS(XX,0.0,YT,NY,ALY,90.0,YSTR,YNCY)
      IF(M1 .EQ. 1) RETURN
  210 CONTINUE
      IF(IY .NE. 0) GO TO 400
      CALL LGAXIS(0.0,0.0,XT,-NX,ALX,0.0,XSTR,NCX)
      GO TO 300
C
C-----Plot Axies Y as Log X as Linear
C
  250 CONTINUE
      IF(M1 .EQ. 2) GO TO 260
      CALL LGAXIS(XX,0.0,YT,NY,ALY,90.0,YSTR,NCY)
      IF(M1 .EQ. 1) RETURN
  260 CONTINUE
      IF(IY .NE. 0) GO TO 400
      CALL AXIS(0.0,0.0,XT,-NX,ALX,0.0,XSTR,XNCX)
C
C-----Plot Tic Marks at Right and Top of Plot
C
  300 CONTINUE
      CALL TICPLT(ALX,XSCALE,ALY,YSCALE)
C
C-----Plot Graph Title
C
      XX = -0.5
      YY = ALY + 0.7
      CALL SYMBOL(XX,YY,0.2,GT(1),0.0,24)
  400 CONTINUE
      RETURN
      END
C
```

```
C **AVERAG** SUBROUTINE FOR INJECT.FTN
C       REV.2      5-13-83
C CALCULATES AVERAGE INJECTION CONCENTRATION(WEIGHTED AVERAGE)
C
C
      SUBROUTINE AVERAG(CONC,RTIME,IRUN,IOUT,NSAM,TNAME,UNIT,
     *    TITLE)
      DIMENSION CONC(100,25),RTIME(100),JELE(25),T(100),CINJ(25),
     * TNAME(3,25),UNIT(3,25),TITLE(16),CON(100,25),RTIM(100),
     * T1(25),T2(25)
      READ(IRUN,1405) NEAV
      READ(IRUN,1410)(JELE(I),I=1,NEAV)
      READ (IRUN,1415)(T1(I),I=1,NEAV)
      READ (IRUN,1415)(T2(I),I=1,NEAV)
      WRITE (IOUT,1000) (TITLE(I),I=1,16)
      WRITE (IOUT,1430)
      DO 110 K=1,NEAV
      J = JELE(K)
C PREPARE CONCENTRATION/TIME MATRIX VOID OF ANALYSES NOT DONE AND
C   WITH LESS THAN DETECTION LIMIT VALUES  AS .5 THE DETECTION LIMIT
      MSAM=0
      DO 100 I=1,NSAM
C TRUNCATE MATRIX
      IF (T1(K).EQ.0) GO TO 20
      IF (RTIME(I).LT.T1(K))GO TO 100
   20 IF (T2(K).EQ.0) GO TO 30
      IF (RTIME(I).GT.T2(K))GO TO 100
   30 CONTINUE
C DELETE NOT DONE ANALYSES
      IF(CONC(I,J).EQ.1.E6) GO TO 100
C HALVE LESS THAN VALUES
      IF (CONC(I,J).GE.0) GO TO 130
      CONC(I,J)=ABS(CONC(I,J))*.5
  130 CONTINUE
      MSAM=MSAM+1
      CON(MSAM,J) = CONC(I,J)
      RTIM(MSAM) = RTIME(I)
  100 CONTINUE
C CALCULATE AVERAGE INJECTION CONCENTRATION
      CINJ(J) = 0.0
      TTOT = 0.0
      MMSAM=MSAM-1
      DO 120 I=1,MMSAM
      T(I)=RTIM(I+1) - RTIM(I)
      TTOT = TTOT + T(I)
      CINJ(J) = (((CON(I+1,J) + CON(I,J))/2)*T(I)) + CINJ(J)
  120 CONTINUE
      CINJ(J) = CINJ(J) / TTOT
      WRITE (IOUT,1420)(TNAME(N,J),N=1,3),CINJ(J),(UNIT(N,J),N=1,3)
      WRITE (IOUT,1440) T1(K),T2(K)
  110 CONTINUE
 1000 FORMAT (16A4)
 1405 FORMAT (5I5)
 1410 FORMAT(10I5)
 1415 FORMAT(10F5.0)
 1420 FORMAT (10X,3A4,2X,E10.4,2X,3A4)
 1430 FORMAT(1X,32H AVERAGE INJECTION CONCENTRATION)
```

```
 1440 FORMAT(15X,5HFROM ,F6.4,4H TO ,F6.4,6H HOURS)
 200  CONTINUE
C
C
      RETURN
      END
```

```
C *** AREA *** SUBROUTINE FOR INJECT.FTN 6/13/83
C
C
C CALCULATES MASS OF ELEMENT INJECTED OR RECOVERED
C
      SUBROUTINE AREA(CONC,RTIME,FRATE,IRUN,IOUT,CINJ,CBG,NSAM,
     *  SNUM,INJ,TITLE,TNAME,UNIT)
      DIMENSION CONC(100,25),RTIME(100),FRATE(100),CINJ(25),
     *  CBG(25),CON(100,25),RTIM(100),AREAI(100,25),
     *  AREAS(100,25),SNUM(100),FRAC(100,25),C(100,25),
     *  FRAT(100),ZMASSI(100,25),ZMASSS(100,25),TITLE(16),
     *  JELE(25),TNAME(3,25),UNIT(3,25),VOL(100),SSNUM(100),
     *  IOUTAR(4),T(100)
C
C  INITILIZE
      CALL KTYP('OUTPUT FILE FOR AREA DATA = @@')
      READ (1,1000)(IOUTAR(I),I =1,4)
      I = 16
      CALL OPNNEW(11,IOUTAR,I)
      IOUTA = 11
C READ RUN FILE
      READ(IRUN,1405)NEAR
      READ(IRUN,1406)(JELE(I),I=1,NEAR)
      WRITE (IOUTA,1000)(TITLE(I),I=1,16)
      WRITE(IOUTA,1410)
      WRITE (IOUTA,1411)
      WRITE (IOUTA,1412)NEAR
      DO 200 K=1,NEAR
      J=JELE(K)
C
C  CALCULATE VOLUME (LITERS) OF SOLUTION BACKFLOWED FOR FULL MATRIX
C    (NOTE: GAL/MIN X 227.1 = LITERS/HR)
C
      NNSAM = NSAM
      VOL(1) = 0.0
      DO 101 I = 1,NNSAM
      T(I+1) = RTIME(I+1) - RTIME(I)
      VOL(I+1) = T(I+1) * FRATE(I+1) * 227.1
      VOL(I+1) = VOL(I) + VOL(I+1)
 101  CONTINUE
C
C PREPARE CONCENTRATION/TIME MATRIX VOID OF ANALSES NOT DONE
C    AND WITH LESS THAN DETECTION LIMIT VALUES AS 0.0
C    LIMIT
      MSAM = 0
      DO 100 I=1,NSAM
      IF (CONC(I,J).EQ.1.E6) GO TO 100
      IF (CONC(I,J).GE.0) GO TO 130
      CONC(I,J) = 0.0
 130  CONTINUE
      MSAM =MSAM + 1
      SSNUM(MSAM) = SNUM(I)
      CON(MSAM,J) = CONC(I,J)
      RTIM(MSAM) = RTIME(I)
      FRAT(MSAM) = FRATE(I)
      VOL(MSAM) = VOL(I)
 100  CONTINUE
```

```
C *** AREA *** SUBROUTINE FOR PIPES
C
C
C CALCULATE AREA
      IF (INJ.EQ.0) GO TO 210
      IF (CINJ(J).EQ.CBG(J)) GO TO 210
      GO TO 310
 210  CONTINUE
C
C
C   CALCULATE SIMPLE AREA UNDER CONC. VS TIME
C   CURVE(NO MIXING CONSIDERED
      AREAS(1,J) = 0.0
      AREAI(1,J) = 0.0
      FRAC(1,J) = 1.0
      MMSAM=MSAM-1
      DO 220 I=1,MMSAM
      AREAI(I+1,J) =(RTIM(I+1)-RTIM(I))*(CON(I,J)+CON(I+1,J))*.5
      AREAS(I+1,J) = AREAS(I,J) + AREAI(I+1,J)
      FRAC(I+1,J) = 1.0
 220  CONTINUE
      GO TO 400
 310  CONTINUE
C
C   CALCULATE AREA UNDER CONCENTRATION VS TIME CURVE, HOWEVER
C   CORRECT FOR MIXING WITH RESERVOIR WATER.
C
C     CALCULATE PRECENT MIXING(FRAC = FRACTION OF INJECTED WATER)
C
      DO 300 I=1,MSAM
C
C       SPECIAL CASE 1
C
      IF (CINJ(J).LT.CBG(J)) GO TO 301
      IF (CINJ(J).GT.CON(I,J)) GO TO 390
      FRAC(I,J) = 1.0
      GO TO 300
 390  CONTINUE
      IF (CON(I,J).GT.CBG(J)) GO TO 311
      FRAC(I,J) = 0.0
      GO TO 300
 301  CONTINUE
C
C       SPECIAL CASE 2
C
      IF (CINJ(J).LT.CON(I,J)) GO TO 391
      FRAC(I,J) = 1.0
      GO TO 300
 391  CONTINUE
      IF (CON(I,J).LT.CBG(J)) GO TO 311
      FRAC(I,J) =0.0
      GO TO 300
 311  CONTINUE
C
C     CALCULATE FRACTION OF INJECTED WATER (IF NO SEPCIAL CASES APPLY
C
C--------IF LESS THAN VALUE (IE C(I,J) = 0.0) SET FRAC TO 0.0
C
```

```
C *** AREA ***********
      IF (CON(I,J).GT.0.0) GO TO 312
      FRAC(I,J) = 0.0
      GO TO 300
  312 CONTINUE
      FRAC(I,J) = (CON(I,J)-CBG(J))/(CINJ(J) - CBG(J))
  300 CONTINUE
C
C     CALCULATE AREA USING FRAC
C
      DO 330 I=1,MSAM
      IF (FRAC(I,J).NE.1.0) GO TO 315
      C(I,J) = CON(I,J)
      GO TO 330
  315 CONTINUE
      C(I,J) = CINJ(J) * FRAC(I,J)
  330 CONTINUE
      AREAI(1,J) = 0.0
      AREAS(1,J) = 0.0
      MMSAM=MSAM-1
      DO 340 I=1,MMSAM
      AREAI(I+1,J)=(RTIM(I+1)-RTIM(I))*(C(I+1,J) + C(I,J)) * .5
      AREAS(I+1,J) = AREAS(I,J) + AREAI(I+1,J)
  340 CONTINUE
  400 CONTINUE
C
C
C CALCULATE MASS USING FLOW RATES
C [(MG*HR/L)(GAL/MIN)2.2705E-4(KG/MG,L/G,MIN/HR)=KG]
      ZMASSS(1,J) =0.0
      DO 410 I=1,MMSAM
      ZMASSI(I+1,J) = AREAI(I+1,J)*FRAT(I+1)*2.2705E-4
      ZMASSS(I+1,J) = ZMASSS(I,J) + ZMASSI(I+1,J)
  410 CONTINUE
C
C WRITE RESULTS
C
      WRITE(IOUTA,1420) (TNAME(I,J),I=1,3),MSAM
      WRITE(IOUTA,1430) CINJ(J),(UNIT(I,J),I=1,3)
      WRITE(IOUTA,1440) CBG(J),(UNIT(I,J),I=1,3)
      WRITE(IOUTA,1450)
      WRITE(IOUTA,1460)
      WRITE(IOUTA,1470)
      DO 420 I=1,MSAM
      WRITE(IOUTA,1480)I,SSNUM(I),CON(I,J),RTIM(I),AREAS(I,J),FRAT(I),
     *ZMASSS(I,J),VOL(I),FRAC(I,J)
  420 CONTINUE
  200 CONTINUE
C
C FORMAT STATEMENTS
C
 1000 FORMAT(16A4)
 1405 FORMAT(5I5)
 1406 FORMAT(10I5)
 1410 FORMAT(/,17X,38H MASS OF ELEMENT INJECTED OR RECOVERED)
 1411 FORMAT(19X,34H (AREA UNDER CONC. VS. TIME CURVE))
 1412 FORMAT(30X,12H**********,I4)
 1420 FORMAT(/,1X,8HELEMENT:,2X,3A4,2X,1H(,I4,13H NO. SAMPLES))
```

```
 1430 FORMAT(/,5X,34HINJECTION CONCENTRATION (AVERAGE):,3X,E10.5,2X,3A4)
 1440 FORMAT(5X,35HBACKGROUND CONCENTRATION (AVERAGE):,2X,E10.5,2X,3A4)
 1450 FORMAT(/,6X,77HSAMPLE   CONC.       TIME       AREA       FLOW       M
     *ASS     VOL. SOL.  FRACTION)
 1460 FORMAT(8X,3HNO.,13X,59HRELATIVE    CUM.       RATE      TRACER    BAC
     *KFLOWED INJECTED)
 1470 FORMAT(15X,66H(MG/L)      (HR)     (MG*HR/L) (GAL/MIN)    (KG)       (
     *LITERS)  WATER)
 1480 FORMAT(2X,I3,2X,A4,1X,F11.4,1X,F8.3,1X,E11.4,1X,F7.2,1X,E11.4,1X,E
     *10.4,2X,F6.4)
C
C  CLOSE UP
C
      CALL CLOSEF(11)
      RETURN
      END
```

APPENDIX B3-2

Program REJECT

```
C PROGRAM --- REJECT.FTN ---  REV 1  6-13-83  BY R. M. CAPUANO
C
C
      DIMENSION IIINJ(4),IIBAC(4),TITLB(6),TNAMI(3),TNAMB(3),
     *UNIT(3),ZMASSB(100),ZMASSI(100),VOLB(100),VOLI(100),
     *YTT(5),FRAC(100),YT1(2),YT2(11),XT(5),TITLI(6),TITLP(6)
C
      DATA YT1/'KG OF'/
      DATA YT2/'FRACTION OF INJECTATE IN BACKFLOW SOLUTION'/
      DATA XT/'LITERS OF SOLUTION'/
C
C  INITILIZE
C
      CALL KTYP('INJECTION DATA FILE = @@')
      READ(1,1000)(IIINJ(I),I=1,4)
      CALL KTYP('BACKFLOW DATA FILE = @@')
      READ(1,1000)(IIBAC(I),I=1,4)
      CALL KTYP('PLOT TITLE (24 CHAR.) = @@')
      READ(1,1000)(TITLP(I),I=1,6)
      I=16
      CALL OPNRED(9,IIINJ,I)
      CALL OPNRED(8,IIBAC,I)
      CALL OPNNEW(10,'INJOUT',6)
      IINJ =9
      IBAC = 8
      IOUT = 10
C
C  INITILIZE PLOT PARAMETERS
C
      CALL KTYP('INPUT PLOT DEVICE:1=TECTRONICS, 2=STATOS, 4=ZETA@@')
      READ(1,*)IDEV
      NX =18
      NY2 = 42
      XMIN = 0.0
      ALX = 9.0
      ALXX = ALX + 2.5
      YMIN = 0.0
      ALY = 7.0
      ALYY = ALY + 2.0
      ALYYY = ALY + 0.5
      DY2 = 1.0 / ALY
      NY1 = 20
      CSZP = 0.07
      NG = 24
C
C  READ DATA FILES
C
      READ(IBAC,1000)(TITLB(I),I=1,6)
      READ(IINJ,1000)(TITLI(I),I=1,6)
      READ(IBAC,1010)NEARB
      READ(IINJ,1010)NEARI
      IF(NEARB.NE.NEARI) GO TO 210
C
C------WRITE TITLES AS CHECK TO INJOUT
C
      WRITE(IOUT,1001)(TITLI(I),I=1,6)
      WRITE(IOUT,1001)(TITLB(I),I=1,6)
```

```
C PROGRAM
      DO 200 J = 1,NEARI
      READ(IINJ,1020)(TNAMI(I),I=1,3),MSAMI
      READ(IBAC,1025)(TNAMB(I),I=1,3),MSAMB
C
C-----WRITE TITLES TO INJOUT AS CHECK
C
      WRITE(IOUT,1021)(TNAMI(I),I=1,3)
      WRITE(IOUT,1021)(TNAMB(I),I=1,3)
      READ(IINJ,1030)(UNIT(I),I=1,3)
      DO 110 I=1,MSAMI
      READ(IINJ,1040)ZMASSI(I),VOLI(I)
  110 CONTINUE
      DO 120 I=1,MSAMB
      READ(IBAC,1050)ZMASSB(I),VOLB(I),FRAC(I)
  120 CONTINUE
C
C-----IF ONLY 1 OR LESS BACKFLOW SAMPLES NO NOT PLOT
C
      IF (MSAMB.LE.1) GO TO 220
C
C---INVERT INJECTION DATA
C
      DO 130 I=1,MSAMI
      ZMASSI(I) = ZMASSI(MSAMI) - ZMASSI(I)
      VOLI(I) = VOLI(MSAMI) - VOLI(I)
  130 CONTINUE
C
C---PLOT
C
C----CREATE X AXIS TITLE (KG OF ELEMENT)
C
      DO 140 I=1,2
      YTT(I) = YT1(I)
  140 CONTINUE
      DO 150 I=1,3
      YTT(I+2) = TNAMI(I)
  150 CONTINUE
C
C----SET UNITS PER INCH FOR X AXIS
C
      DX = VOLB(MSAMB)/ALX
C
C----SET UNITS PER INCH FOR Y AXIS
C
      DYY1B = ZMASSB(1)
      MS = MSAMB - 1
      DO 160 I = 1,MS
      IF (ZMASSB(I).GE.ZMASSB(I+1)) GO TO 160
      DYY1B = ZMASSB(I+1)
  160 CONTINUE
      DYY1I = ZMASSI(1)
      MS = MSAMI - 1
      DO 180 I=1,MS
      IF (ZMASSI(I).GE.ZMASSI(I+1)) GO TO 180
      DYY1I = ZMASSI(I+1)
  180 CONTINUE
      IF (DYY1B.GT.DYY1I) GO TO 190
```

```
C PROGRAM      SUBROUTINE
      DYY1 = DYY1I
      GO TO 195
  190 CONTINUE
      DYY1 = DYY1B
  195 CONTINUE
      IF (DYY1.GT.0.0) GO TO 196
      DYY1 = 1
  196 CONTINUE
      DY1 = DYY1 / ALY
C
C----OPENPLT
C
      CALL OPNPLT(IDEV,ALXX,ALYY)
C
C----SET ORIGIN
C
      CALL PLOT(1.5,1.0,-3)
C
C----DRAW CORNER TICS
C
      CALL CORTIC(-1.5,-0.6,ALXX,ALYY)
C
C----TITLE
C
      CALL SYMBOL(.05,ALYYY,0.3,TITLP(1),0.0,24)
C
C----1ST PLOT--KG INJECTION (DATA  AND Y AXIS)
C
C------PLOT POINTS
C
      M1 = 1
      M2 = 35
      IY = 1
      CALL XYLIN(M1,M2,IY,VOLI,ZMASSI,MSAMI,XT,NX,YTT,
     * NY1,ALX,ALY,XMIN,YMIN,DX,DY1,TITLP(1),24,CSZP)
C
C-------PLOT LINES
C
      M1 = 0
      M2 = -1
      CALL XYLIN(M1,M2,IY,VOLI,ZMASSI,MSAMI,XT,NX,YTT,
     *NY1,ALX,ALY,XMIN,YMIN,DX,DY1,TITLP(1),0,0.0)
C
C----2ND PLOT (BACKFLOW-DATA ONLY)
C
C-----POINTS
C
      M1 = 0
      M2 = 19
      CALL XYLIN(M1,M2,IY,VOLB,ZMASSB,MSAMB,XT,NX,YTT,
     *NY1,ALX,ALY,XMIN,YMIN,DX,DY1,TITLP(1),0,CSZP)
C
C-----LINE
C
      M1 = 0
      M2 = -2
      CALL XYLIN(M1,M2,IY,VOLB,ZMASSB,MSAMB,XT,NX,YTT,
```

```
C PROGRAM ...
     *NY1,ALX,ALY,XMIN,YMIN,DX,DY1,TITLP(1),0,0.1)
C
C----3RD PLOT (MIXING--- DATA AND X AND Y AXIS)
C
C-----POINTS
C
      M1 = 3
      M2 = 32
      IY = 0
      CALL XYLIN(M1,M2,IY,VOLB,FRAC,MSAMB,XT,NX,YT2,
     *NY2,ALX,ALY,XMIN,YMIN,DX,DY2,TITLP(1),0,CSZP)
C
C-----LINE
C
      M1=0
      M2 = -5
      CALL XYLIN(M1,M2,IY,VOLB,FRAC,MSAMB,XT,NX,YT2,
     *NY2,ALX,ALY,XMIN,YMIN,DX,DY2,TITLP(1),0,0.1)
C
C---CLOSE PLOT
C
      CALL CLOSEP
      IF(IDEV.EQ.1) READ(1,1301)IANS
     GO TO 200
 210  CONTINUE
      WRITE(IOUT,2000)
 220  CONTINUE
      WRITE(IOUT,2002)
 200  CONTINUE
C
C---FORMAT STATEMENTS
C
 1000 FORMAT(16A4)
 1001 FORMAT(16A4,/)
 1010 FORMAT(3(/),42X,I4)
 1020 FORMAT(/,11X,3A4,3X,I4)
 1021 FORMAT(11X,3A4)
 1025 FORMAT(/,11X,3A4,3X,I4,7(/))
 1030 FORMAT(/,54X,3A4,5(/))
 1040 FORMAT(53X,E11.4,1X,E10.4)
 1050 FORMAT(53X,E11.4,1X,E10.4,2X,F6.4)
 1301 FORMAT(A1)
C
C---ERROR FORMAT STATMENTS
C
 2000 FORMAT(2X,55HNO. OF ELEMENTS IN BACKFLOW AND INJECTION MUST BE EQU
     *AL)
 2002 FORMAT(11X,30HLESS THAN 1 DATA POINT-NO PLOT)
C
C----WRAP UP PROGRAM
C
      CALL CLOSEF(9)
      CALL CLOSEF(8)
      CALL CLOSEF(10)
      CALL EXIT
      END
```

APPENDIX B3-3

Program BORE

```
C PROGRAM --- BORE.FTN ---  REV 1  8-23-83  BY R. M. CAPUANO
C
C
      DIMENSION IIINJ(4),IIBAC(4),TITLB(6),TNAMI(3,25),TNAMB(3,25),
     *UNIT(3,25),ZMASSB(100,25),ZMASSI(100,25),VOLB(100,25),
     *FRAC(100,25),TITLI(6),VIBOR(2,25),VBBOR(2,25),ZMIBOR(2,25),
     *ZMBBOR(2,25),VOLX(100,25),MSAMB(25),MSAMI(25),VOLI(100,25),
     *VLI(100,25),ZMAXI(25),ZMAXB(25),RATMAX(25),ZMI(100,25)
C
C  INITILIZE
C
      CALL KTYP('INJECTION DATA FILE = @@')
      READ(1,1000)(IIINJ(I),I=1,4)
      CALL KTYP('BACKFLOW DATA FILE = @@')
      READ(1,1000)(IIBAC(I),I=1,4)
      I=16
      CALL OPNRED(9,IIINJ,I)
      CALL OPNRED(8,IIBAC,I)
      CALL OPNNEW(10,'INJOUT',6)
      IINJ =9
      IBAC = 8
      IOUT = 10
C
C  READ WELL BORE VOLUME
C
      CALL KTYP('INPUT WELL BORE VOLUME IN LITERS(E10 FORMAT)@@')
      READ(1,*)BORV
C
C  READ DATA FILES
C
      READ(IBAC,1000)(TITLB(I),I=1,6)
      READ(IINJ,1000)(TITLI(I),I=1,6)
      READ(IBAC,1010)NEARB
      READ(IINJ,1010)NEARI
      IF(NEARB.NE.NEARI) GO TO 210
C
C------WRITE HEADER INFORMATION
C
      WRITE(IOUT,1001)(TITLI(I),I=1,6)
      WRITE(IOUT,1001)(TITLB(I),I=1,6)
      WRITE (IOUT,1060) BORV
      WRITE (IOUT,1070)
      WRITE (IOUT,1080)
C
C ======START CALCULATIONS FOR EACH INDIVIDUAL ELEMENT ==========
C
      DO 200 J = 1,NEARI
      READ(IINJ,1020)(TNAMI(I,J),I=1,3),MSAMI(J)
      READ(IBAC,1025)(TNAMB(I,J),I=1,3),MSAMB(J)
      MI = MSAMI(J)
      MB =MSAMB(J)
      READ(IINJ,1030)(UNIT(I,J),I=1,3)
      DO 110 I=1,MI
      READ(IINJ,1040)ZMASSI(I,J),VOLI(I,J)
  110 CONTINUE
      DO 120 I=1,MB
      READ(IBAC,1050)ZMASSB(I,J),VOLB(I,J),FRAC(I,J)
```

```
  120  CONTINUE
C
C-----IF ONLY 1 OR LESS BACKFLOW SAMPLES NO NOT CALCULATE
C
      IF (MB.LE.1) GO TO 220
      IF(MI.LE.1)GO TO 220
C
C---INVERT INJECTION DATA
C
C -----FIRST SAVE OLD FORMAT OF VOLUME AND MASS DATA
C
      DO 125 I= 1,MI
      VLI(I,J) = VOLI(I,J)
      ZMI(I,J) = ZMASSI(I,J)
  125 CONTINUE
C
C -----THEN INVERT
C
      DO 130 I=1,MI
      ZMASSI(I,J) = ZMASSI(MI,J) - ZMASSI(I,J)
      VOLI(I,J) = VOLI(MI,J) - VOLI(I,J)
  130 CONTINUE
C
C     DETERMINE SAMPLE JUST BEFORE AND AFTER WELL BORE FILLED
C
      DO 140 I=1,MI
      IF (VOLI(I,J).LT.BORV) GO TO 140
      IF (I.EQ.1) GO TO 142
      VIBOR(1,J)=VOLI(I-1,J)
      VIBOR(2,J)=VOLI(I,J)
      ZMIBOR(1,J)=ZMASSI(I-1,J)
      ZMIBOR(2,J)=ZMASSI(I,J)
  142 CONTINUE
      VIBOR(1,J)=0.0
      ZMIBOR(1,J)=0.0
      VIBOR(2,J)=VOLI(I,J)
      ZMIBOR(2,J)=ZMASSI(I,J)
      GO TO 146
  140 CONTINUE
  146 CONTINUE
      DO 150 I=1,MB
      IF (VOLB(I,J).LT.BORV) GO TO 150
      IF (I.EQ.1) GO TO 152
      VBBOR(1,J)=VOLB(I-1,J)
      VBBOR(2,J)=VOLB(I,J)
      ZMBBOR(1,J)=ZMASSB(I-1,J)
      ZMBBOR(2,J)=ZMASSB(I,J)
  152 CONTINUE
      VBBOR(1,J)=0.0
      ZMBBOR(1,J)=0.0
      VBBOR(2,J)=VOLB(I,J)
      ZMBBOR(2,J)=ZMASSB(I,J)
      GO TO 156
  150 CONTINUE
  156 CONTINUE
C
C---- CALCULATE SLOPE AND Y INTERCEPT
```

```
C PROGRAM --- CORE.F IN
      ZMAXI(J) = ZMI(MI,J)
      ZMAXB(J) = ZMASSB(MB,J)
      RATMAX(J) = ZMAXB(J)/ZMAXI(J)
      WRITE(IOUT,4010)(TNAMB(I,J),I=1,3),ZMAXI(J),ZMAXB(J),RATMAX(J)
  500 CONTINUE
C
C
C=========CALCULATE NORMALIZED RECOVERY=========
C     V(X) = V-V(B)/V(1) - V(B)
C
C
C
C  ---CALCULATE----
C
      DO 400 J=1,NEARI
      MI = MSAMI(J)
      VI=VLI(MI,J)
      VIB=VI-BORV
      IF (VIB.EQ.0) GO TO 401
      MB = MSAMB(J)
      DO 330 I = 1,MB
      VOLX(I,J) = (VOLB(I,J) - BORV)/VIB
  330 CONTINUE
C
C  -----WRITE RESULTS---
C
      WRITE(IOUT,3000)(TNAMI(I,J),I=1,3),(TNAMB(I,J),I=1,3)
      WRITE(IOUT,3005) VI,BORV
      WRITE(IOUT,3010)
      WRITE(IOUT,3011)
      DO 340 I=1,MB
      WRITE(IOUT,3015) VOLX(I,J),FRAC(I,J)
  340 CONTINUE
      GO TO 400
  401 CONTINUE
      WRITE(IOUT,5000)
  400 CONTINUE
C---FORMAT STATEMENTS
C
 1000 FORMAT(16A4)
 1001 FORMAT(16A4,/)
 1010 FORMAT(3(/),42X,I4)
 1020 FORMAT(/,11X,3A4,3X,I4)
 1021 FORMAT(11X,3A4)
 1025 FORMAT(/,11X,3A4,3X,I4,7(/))
 1030 FORMAT(/,54X,3A4,5(/))
 1040 FORMAT(53X,E11.4,1X,E10.4)
 1050 FORMAT(53X,E11.4,1X,E10.4,2X,F6.4)
 1060 FORMAT(19H  WELL BORE VOLUME ,E12.6,2X,6HLITERS,/)
 1070 FORMAT(2X,7HELEMENT,7X,15HKG IN WELL BORE,8X,12H RATIO DIFF.)
 1080 FORMAT(14X,35HINJECTION   BACKFLOW       BACK/INJ,/)
 1090 FORMAT(3A4)
 1100 FORMAT(3A4,2X,E10.4,2X,E10.4,3X,F10.4)
 1301 FORMAT(A1)
 3000 FORMAT(3A4,2X,3A4)
 3005 FORMAT(2X,21HVOLUME OF: INJECTION=,E10.4,2X,10HWELL BORE=,E10.4)
 3010 FORMAT(2X,29HFRACTION INJECTION   FRACTION)
```

```
C PROGRAM --- BORE.F[illegible]

C
C     ----INJECTION
C
      IF(ZMIBOR(2,J).EQ.ZMIBOR(1,J))GO TO 160
      IF(VIBOR(2,J).EQ.VIBOR(1,J))GO TO 160
      SLOPEI=(ZMIBOR(2,J)-ZMIBOR(1,J))/(VIBOR(2,J)-VIBOR(1,J))
      BI=ZMIBOR(1,J)-(SLOPEI*VIBOR(1,J))
      BORVI=(SLOPEI*BORV) + BI
      GO TO 164
 160  CONTINUE
      WRITE(IOUT,2003)
      BORVI=0.0
 164  CONTINUE
C
C    -----BACKFLOW
C
      IF(ZMBBOR(2,J).EQ.ZMBBOR(1,J)) GO TO 170
      IF(VBBOR(2,J).EQ.VBBOR(1,J)) GO TO 170
      SLOPEB=(ZMBBOR(2,J)-ZMBBOR(1,J))/(VBBOR(2,J)-VBBOR(1,J))
      BB=ZMBBOR(1,J)-(SLOPEB*VBBOR(1,J))
      BORVB=(SLOPEB*BORV)+BB
      GO TO 174
 170  CONTINUE
      WRITE (IOUT,2003)
      BORVB=0.0
 174  CONTINUE
C
C     CALULATE PERCENT DIFFERENCE INJECT/BACKFLOW
C
      IF (BORVI.EQ.0.0) GO TO 180
      IF (BORVB.EQ.0.0) GO TO 180
      PREBOR=BORVB/BORVI
      GO TO 185
 180  CONTINUE
      PREBOR=0.0
 185  CONTINUE
C
C     WRITE RESULTS
C
      WRITE (IOUT,1090)(TNAMI(I,J),I=1,3)
      WRITE (IOUT,1100)(TNAMB(I,J),I=1,3),BORVI, BORVB, PREBOR
      GO TO 200
 210  CONTINUE
      WRITE(IOUT,2000)
 220  CONTINUE
      WRITE(IOUT,2002)
 200  CONTINUE
C=============PRINT TOTAL MASS INJECTED AND BACKFLOWED
C                  THEN CALCULATE RATIO BACK/INJ
C--------------WRITE HEADER
      WRITE(IOUT,4000)
      WRITE(IOUT,4005)
      WRITE(IOUT,4006)
C----------WRITE TOTAL MASS AND RATIO
      DO 500 J = 1,NEARI
      MI= MSAMI(J)
      MB= MSAMB(J)
```

```
 3011 FORMAT(2X,30HVOLUME BACKFLOWED     INJECTATE)
 3015 FORMAT(5X,E10.4,9X,F10.4)
 4000 FORMAT(//,1X,32HTOTAL MASS INJECTED OR RECOVERED,/)
 4005 FORMAT(2X,7HELEMENT,5X,8HTOTAL KG,5X,8HTOTAL KG)
 4006 FORMAT(14X,35HINJECTED     BACKFLOWED      BACK/INJ,/)
 4010 FORMAT(3A4,2X,E10.4,2X,E10.4,3X,F10.4)
C
C---ERROR FORMAT STATMENTS
C
 2000 FORMAT(2X,55HNO. OF ELEMENTS IN BACKFLOW AND INJECTION MUST BE EQU
     *AL)
 2002 FORMAT(11X,37HLESS THAN 1 DATA POINT-NO CALCULATION)
 2003 FORMAT(29HZERO CHANGE IN VOLUME OR MASS)
 5000 FORMAT(2X,40HINJECTION VOLUME EQUALS WELL BORE VOLUME)
C
C----WRAP UP PROGRAM
C
      CALL CLOSEF(9)
      CALL CLOSEF(8)
      CALL CLOSEF(10)
      CALL EXIT
      END
```