APPENDIX A

HYDROLOGIC CALCULATIONS

HYDROLOGIC CALCULATIONS

Hydrologic analyses were conducted to determine peak discharges from a 100-year and a 500-year storm event for the Beartrap Creek, Mike Horse Creek, and Upper Blackfoot River drainages. Preliminary peak flow estimates were calculated using methods provided in WRI-03-4308 (Parrett, 2004). Using the regression equation for the Northwest Region of Montana, a mean annual precipitation of 18 inches (NOAA Rogers Pass weather station), and drainage basin areas, peak flows for each drainage area were calculated. Based upon the USGS regression equation, the estimated peak flows are:

Drainage Basin	Drainage Basin Area (mi^2)	100-Year Peak Flow (cfs)	500-Year Peak Flow (cfs)
Beartrap Creek	2.02	297.8	766.3
Mike Horse Creek	0.41	96.0	261.6
Upper Blackfoot River	9.9	920.6	2237.1

The Beartrap Creek Analysis applies to both the portion of Beartrap to be re-established through the Mike Horse Tailings Impoundment area, and the portion of the Creek between the impoundment and the confluence with Anaconda Creek.

An analysis was also conducted to determine preliminary estimates of floodplain dimensions for the portions of Beartrap Creek and Mike Horse Creek drainages included in the EE/CA (A similar analysis will be performed for the Upper Blackfoot River once a detailed topographic survey is completed). Depth-Duration Factors, which define the distribution of precipitation as a function of time, were obtained from WRI-97-4004 (Parrett, 1997). Once the magnitude and distribution of the 100-year and 500-year storm events with respect to time were determined, the timing and volume of resulting runoff could be determined using the HEC-1 rainfall-runoff model (Corps of Engineers, 1988). In addition to the precipitation hyetograph, new information used in conjunction with the HEC-1 model included:

- Soil-Cover Complex Curve Number of 84;
- Time of Concentration of 0.38 hours (USGS, 1996); and
- Basin Storage Coefficient of 3.27 hours (USGS, 1996).

Using the Clark Unit Hydrograph, the peak flow from the 100-yr storm is 281 cubic-feet-per-second (cfs), and the peak flow from the 500-yr storm is 486 cfs. These are similar to the results obtained using the USGS regression equation in WRI 92-4048. HEC-1 also provided estimates of flow depths, which were used to estimate the floodplain widths for both the 100-year and 500-year storm. Floodplain widths for Beartrap Creek ranged from approximately 45 feet to 25 feet, and a value of 30 feet was used in the EE/CA preliminary design.

Hydraulic calculations were also performed to determine average riprap sizes required for stream channel design for portions of Beartrap Creek and Lower Mike Horse Creek for certain removal action options (engineered channel with riprap is not proposed for the Upper Blackfoot River). Using Flowmaster® software and assuming a roughness coefficient of 0.040, channel depths between 1 and 6 feet, depending on bottom width, flow velocities were

determined for the 100-year and 500-year storms (Haestad Methods, 1994). Typical channel dimensions, velocities and average riprap dimensions are shown in the following table. More detailed analyses of channel design and riprap sizing will be completed during final design of the selected site-wide alternative.

Location	Channel Width (ft)	Channel Depth (ft)	Avg. Velocity (fps)	Avg. Riprap Size (in)*
Beartrap Creek	8	2.2-3.4	9.5-12.2	8-12
Lower Mike Horse Creek	5	1.2-1.9	9.6-12.6	8-12
Upper Blackfoot River	15	3.7-5.7	9.7-12.3	8-12

*Source: Federal Highway Administration (FHWA) 1967, Nomograph for determining the stone size based on velocity and side slope from Richardson and Julien, 1990.

References

Corps of Engineers, 1988. HEC-1 Flood Hydrograph Package.

Haestad Methods, 1994. Flowmaster Open Channel and Pipe Hydraulic Analysis Software version 5.13, Waterbury, CT.

Parrett, C., 1997. Regression Equations For Mean Values Of Annual Precipitation Maxima Region 1, USGS WRI-97-4004.

Parrett, C., Johnson, D.R., 2004. Methods for Estimating Flood Frequency in Montana Based on Data Through Water Year 1998, USGS WRI-03-4308.

Richardson, E.V., D.B. Simons, and P.Y. Julien, 1990. Highways in the River Environment, Federal Highway Administration.

U.S.G.S., 1996. Estimation of Unit Hydrographs For Large Floods at Ungaged Sites in Montana.

REGRESSION EQUATIONS FOR MEAN VALUES OF ANNUAL PRECIPITATION MAXIMA REGION 1[1]

Duration	Equation
24-hr	Mean = 1.4 +(0.18 x LAT) - (0.13 x LONG) + (0.019 x MAP)
6-hr	Mean = 0.75 +(0.87 x LAT) - (0.041 x LONG)
2-hr	Mean = 0.69 +(0.034 x LAT) - (0.029 x LONG)

LAT =	7.0248	
LONG =	12.3536	
MAP =	18	in

24-hr =	1.40	inches
6-hr =	0.85	inches
2-hr =	0.57	inches

RETURN FREQUENCY MEAN VALUE MULTIPLIERS FOR REGION 2[2]

DURATION	100	500 years
24 -HR	2.57	3.40
6-HR	2.59	3.50
2-HR	2.78	3.90

RETURN FREQUENCY (years) PRECIPITATION AMOUNTS (inches)

	100	500 years
24 -HR	3.60	4.76
12-HR	2.86	3.82
6-HR	2.21	2.99
3-HR	1.88	2.58
2-HR	1.59	2.23
1-HR	1.38	1.97
15-MIN	0.78	1.12
5-MIN	0.23	0.33

EQUATIONS USED IN ABOVE TABLE

24-HR = 24-HR average maxima x mean value multiplier
12-HR = .467 x 24-HR + .533 x 6-HR
6-HR = 6-HR average maxima x mean value multiplier
3-HR = .467 x 6-HR + .533 x 1-HR
2-HR = 2-HR average maxima x mean value multiplier
1-HR = (2-HR - 0.25 x 6-HR) / .75
15-MIN = 0.57 x 1-HR
5-MIN = 0.29 x 1-HR

[1] Table 11, USGS WRI 97-4004
[2] Figure 12, USGS WRI 97-4004

ESTIMATE OF PEAK FLOW FOR BEAR TRAP CREEK

REGIONAL FLOOD -FREQUENCY EQUATIONS BASED ON DRAINAGE-BASIN CHARACTERISTICS*

$Q_{100} = 56.4*A^{0.71}*P^{0.403}$ Northwest Region

$Q_{500} = 175*A^{0.674}*P^{0.347}$ Northwest Region

A = DRAINAGE AREA (mi^2)
P = MEAN ANNUAL PRECIPITATION (in)

A =	2.02	mi^2	
P =	18	in	FROM NOAA ROGERS PASS INFORMATION

Q_{100} =	297.8	cfs
Q_{500} =	766.3	cfs

*Parrett, C, and Johnson, D.R., 2004, Methods for Estimating Flood Frequency in Montan Based on Data Through Water Year 1998, USGS WRI-03-4308.

ESTIMATE OF PEAK FLOW FOR MIKE HORSE CREEK

REGIONAL FLOOD -FREQUENCY EQUATIONS BASED ON DRAINAGE-BASIN CHARACTERISTICS*

$Q_{100} = 56.4*A^{0.71}*P^{0.403}$ Northwest Region

$Q_{500} = 175*A^{0.674}*P^{0.347}$ Northwest Region

A = DRAINAGE AREA (mi^2)
P = MEAN ANNUAL PRECIPITATION (in)

A =	0.41	mi^2	
P =	18	in	FROM NOAA ROGERS PASS INFORMATION

Q_{100} =	96.0	cfs
Q_{500} =	261.6	cfs

*Parrett, C, and Johnson, D.R., 2004, Methods for Estimating Flood Frequency in Montan Based on Data Through Water Year 1998, USGS WRI-03-4308.

ESTIMATE OF PEAK FLOW FOR UPPER BLACKFOOT RIVER

REGIONAL FLOOD -FREQUENCY EQUATIONS BASED ON DRAINAGE-BASIN CHARACTERISTICS*

$Q_{100} = 56.4*A^{0.71}*P^{0.403}$ Northwest Region

$Q_{500} = 175*A^{0.674}*P^{0.347}$ Northwest Region

A = DRAINAGE AREA (mi^2)
P = MEAN ANNUAL PRECIPITATION (in)

A =	9.9	mi^2	
P =	18	in	FROM NOAA ROGERS PASS INFORMATION

Q_{100} =	920.6	cfs
Q_{500} =	2237.1	cfs

*Parrett, C, and Johnson, D.R., 2004, Methods for Estimating Flood Frequency in Montan Based on Data Through Water Year 1998, USGS WRI-03-4308.

Computation for Lag Time

A= 1.98 mi^2

$TC = 0.29 * A^{0.65}$

$R = 2.90 * A^{0.31}$

Tc = 0.452096 use 20 min

R = 3.583969 use 4

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1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *               JUN   1998             *
 *            VERSION 4.1               *
 *                                      *
 *  RUN DATE   05JUN06  TIME  09:57:16  *
 *                                      *
 ****************************************
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 ************************************
 *                                  *
 *    U.S. ARMY CORPS OF ENGINEERS  *
 *    HYDROLOGIC ENGINEERING CENTER *
 *          609 SECOND STREET       *
 *       DAVIS, CALIFORNIA 95616    *
 *           (916) 756-1104         *
 *                                  *
 ************************************
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X     X  XXXXXXX   XXXXX           X
X     X  X        X     X         XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX          XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1          ID   BEAR TRAP CREEK
             2          ID   100 YEAR FLOODPLAIN ASSESMENT
             3          ID   ROUTING USING HEC-1
             4          ID   M. RHODES, HYDROMETICS INC.
             5          ID   13 MAR06
                        *
                        * *** TIME SPECIFICATION
             6          IT       2 08APR03    1200     300
                        *
                        * *** GLOBAL OUTPUT OPTIONS
             7          IO       4
                        *
                        * *** 100 YR HYETOGRAPH
                        *

             8          KK  P 100
             9          KM   PRECIP
            10          BA    1.98
            11          PH           0.00   0.23   0.78    1.38    1.59    1.88    2.21    2.86    3.60
                        *
                        * *** INFLOW TO CREEK
                        * *** CLARK'S UNIT HYDROGRAPH
                        *
            12          UC    0.33    2.88
            13          LS       0      84
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                *
                * ***
                *

   14           KK  REACH1
   15           KM   BEAR TRAP CREEK BEGIN TO 25+00 FEET DOWNSTREAM
   16           RD
   17           RC    0.08    0.07    0.08  2500.0    .208
   18           RX     0.0   100.0   200.0     203     205     300     400     500
   19           RY    6360    6340    6300    6298    6300    6315    6325    6370
                *
                * ***
                *

   20           KK  REACH2
   21           KM   CHANNEL ROUTING 25+00 TO 40+00
   22           RD
   23           RC    0.08    0.07    0.08    1500    .133
   24           RX     0.0     100     200     280     283     286     300     400
   25           RY    5720    5680    5620    5600    5597    5600    5610    5700
                *
                * ***
                *

   26           KK  REACH3
   27           KM   CHANNEL ROUTING 40+00 TO 59+00
   28           RD
   29           RC    0.08    0.07    0.08    1900    .060
   30           RX     0.0    40.0    44.0    48.0    60.0     120     140     160
   31           RY    5494    5486    5483    5486    5488    5489    5490    5491
                *
                * ***
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        LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   32           KK  REACH4
   33           KM   CHANNEL ROUTING 59+00 TO 68+00
   34           RD
   35           RC    0.08    0.07    0.08     900    .030
   36           RX     0.0    40.0    80.0     120     138     140     200     320
   37           RY    5467    5460    5453    5449    5443    5441    5465    5500
                *
                * ***
                *

   38           KK  REACH5
   39           KM   CHANNEL ROUTING 68+00 TO 78+00
   40           RD
   41           RC    0.08    0.07    0.08    1000   .030
   42           RX     0.0    40.0    80.0     136     140     144     180     240
   43           RY    5432    5429    5425    5422    5419    5422    5437    5460
                *
                * ***
                *

   44           KK  REACH6
   45           KM   CHANNEL ROUTING 78+00 TO 92+00
   46           RD
   47           RC    0.08    0.07    0.08    1400    .030
   48           RX     0.0    20.0    37.0    40.0    44.0      64     100     120
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           49          RY    5416    5412    5410    5408    5409    5410    5412    5414
                       *
                       * ***
                       *
           50          ZZ
1*************************************                    *************************************
 *                                   *                    *                                   *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998             *                  *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1               *                  *         609 SECOND STREET           *
 *                                     *                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   05JUN06  TIME  09:57:16   *                *          (916) 756-1104             *
 *                                     *                  *                                     *
 *************************************                    *************************************



                        BEAR TRAP CREEK
                        100 YEAR FLOODPLAIN ASSESMENT
                        ROUTING USING HEC-1
                        M. RHODES, HYDROMETICS INC.
                        13 MAR06

   7 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           4  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT           HYDROGRAPH TIME DATA
                       NMIN           2  MINUTES IN COMPUTATION INTERVAL
                      IDATE      8APR 3  STARTING DATE
                      ITIME        1200  STARTING TIME
                         NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      8APR 3  ENDING DATE
                      NDTIME        2158  ENDING TIME
                      ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .03 HOURS
                         TOTAL TIME BASE    9.97 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT


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


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               *            *
   8 KK        *    P 100   *
               *            *
               **************
                         PRECIP
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SUBBASIN RUNOFF DATA

10 BA SUBBASIN CHARACTERISTICS

TAREA	1.98	SUBBASIN AREA

PRECIPITATION DATA

11 PH DEPTHS FOR 0-PERCENT HYPOTHETICAL STORM

..... HYDRO-35			..... TP-40					..... TP-49			
5-MIN	15-MIN	60-MIN	2-HR	3-HR	6-HR	12-HR	24-HR	2-DAY	4-DAY	7-DAY	10-DAY
.23	.78	1.38	1.59	1.88	2.21	2.86	3.60	.00	.00	.00	.00

STORM AREA = 1.98

13 LS SCS LOSS RATE

STRTL	.38	INITIAL ABSTRACTION
CRVNBR	84.00	CURVE NUMBER
RTIMP	.00	PERCENT IMPERVIOUS AREA

12 UC CLARK UNITGRAPH

TC	.33	TIME OF CONCENTRATION
R	2.88	STORAGE COEFFICIENT

SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

***

UNIT HYDROGRAPH PARAMETERS
CLARK TC= .33 HR, R= 2.88 HR
SNYDER TP= .35 HR, CP= .11

UNIT HYDROGRAPH
300 END-OF-PERIOD ORDINATES
VOLUME = .97

10.	38.	80.	131.	189.	250.	307.	354.	391.	412.
416.	411.	407.	402.	397.	393.	388.	384.	379.	375.
371.	366.	362.	358.	354.	350.	346.	342.	338.	334.
330.	326.	323.	319.	315.	312.	308.	305.	301.	298.
294.	291.	287.	284.	281.	278.	274.	271.	268.	265.
262.	259.	256.	253.	250.	247.	244.	242.	239.	236.
233.	231.	228.	225.	223.	220.	218.	215.	213.	210.
208.	205.	203.	201.	198.	196.	194.	192.	189.	187.
185.	183.	181.	179.	177.	175.	173.	171.	169.	167.
165.	163.	161.	159.	157.	156.	154.	152.	150.	149.
147.	145.	144.	142.	140.	139.	137.	135.	134.	132.
131.	129.	128.	126.	125.	123.	122.	121.	119.	118.
117.	115.	114.	113.	111.	110.	109.	107.	106.	105.
104.	103.	101.	100.	99.	98.	97.	96.	95.	94.
92.	91.	90.	89.	88.	87.	86.	85.	84.	83.
82.	81.	80.	80.	79.	78.	77.	76.	75.	74.
73.	72.	72.	71.	70.	69.	68.	68.	67.	66.
65.	65.	64.	63.	62.	62.	61.	60.	60.	59.
58.	58.	57.	56.	56.	55.	54.	54.	53.	52.
52.	51.	51.	50.	49.	49.	48.	48.	47.	47.
46.	46.	45.	45.	44.	44.	43.	43.	42.	42.
41.	41.	40.	40.	39.	39.	38.	38.	37.	37.
37.	36.	36.	35.	35.	35.	34.	34.	33.	33.
33.	32.	32.	32.	31.	31.	30.	30.	30.	29.
29.	29.	28.	28.	28.	27.	27.	27.	26.	26.
26.	26.	25.	25.	25.	24.	24.	24.	24.	23.
23.	23.	23.	22.	22.	22.	22.	21.	21.	21.
21.	20.	20.	20.	20.	19.	19.	19.	19.	19.
18.	18.	18.	18.	17.	17.	17.	17.	17.	16.

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              16.       16.       16.       16.       16.       15.       15.       15.       15.       15.


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           **************
           *            *
  14 KK    *   REACH1   *
           *            *
           **************
                    BEAR TRAP CREEK BEGIN TO 25+00 FEET DOWNSTREAM

             HYDROGRAPH ROUTING DATA

  16 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

  17 RC        NORMAL DEPTH CHANNEL
                 ANL        .080  LEFT OVERBANK N-VALUE
                ANCH        .070  MAIN CHANNEL N-VALUE
                 ANR        .080  RIGHT OVERBANK N-VALUE
               RLNTH       2500.  REACH LENGTH
                 SEL       .2080  ENERGY SLOPE
               ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                    --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  19 RY      ELEVATION   6360.00   6340.00   6300.00   6298.00   6300.00   6315.00   6325.00   6370.00
  18 RX      DISTANCE        .00    100.00    200.00    203.00    205.00    300.00    400.00    500.00
                                                          ***

                                   COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

           STORAGE         .00      1.61      9.78     25.22     47.95     78.36    118.71    169.36    227.86    290.31
           OUTFLOW         .00    315.01   3345.21  11793.04  27751.13  55578.52  97983.77 155250.00 231008.70 323088.30
         ELEVATION     6298.00   6301.79   6305.58   6309.37   6313.16   6316.95   6320.74   6324.53   6328.32   6332.11

           STORAGE      356.64    426.87    501.85    582.78    669.67    762.50    861.29    965.19   1071.19   1179.02
           OUTFLOW   430883.10 554365.80 688479.60 840420.701011174.001201287.001411372.001655681.001927651.002219160.00
         ELEVATION     6335.90   6339.69   6343.47   6347.26   6351.05   6354.84   6358.63   6362.42   6366.21   6370.00



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           **************
           *            *
  20 KK    *   REACH2   *
           *            *
           **************
                    CHANNEL ROUTING 25+00 TO 40+00

             HYDROGRAPH ROUTING DATA

  22 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

  23 RC        NORMAL DEPTH CHANNEL
                 ANL        .080  LEFT OVERBANK N-VALUE
                ANCH        .070  MAIN CHANNEL N-VALUE
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                    ANR        .080  RIGHT OVERBANK N-VALUE
                  RLNTH       1500.  REACH LENGTH
                    SEL       .1330  ENERGY SLOPE
                  ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
25 RY       ELEVATION   5720.00   5680.00   5620.00   5600.00   5597.00   5600.00   5610.00   5700.00
24 RX       DISTANCE        .00    100.00    200.00    280.00    283.00    286.00    300.00    400.00

                                                ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00      2.15     11.56     28.57     52.61     81.18    113.75    150.33    190.93    235.53
          OUTFLOW        .00    816.31   7552.93  25360.65  60857.84 116845.60 190205.90 281548.50 391588.20 521092.70
        ELEVATION    5597.00   5603.47   5609.95   5616.42   5622.89   5629.37   5635.84   5642.32   5648.79   5655.26

          STORAGE     284.13    336.75    393.38    454.03    519.49    590.16    666.04    746.19    829.94    917.31
          OUTFLOW  670855.10 841680.401034376.001248901.001484287.001746382.002038086.002376225.002743994.003141973.00
        ELEVATION    5661.74   5668.21   5674.68   5681.16   5687.63   5694.10   5700.58   5707.05   5713.53   5720.00



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          *            *
26 KK     *    REACH3  *
          *            *
          **************
                        CHANNEL ROUTING 40+00 TO 59+00

             HYDROGRAPH ROUTING DATA

28 RD          MUSKINGUM-CUNGE CHANNEL ROUTING

29 RC          NORMAL DEPTH CHANNEL
                      ANL        .080  LEFT OVERBANK N-VALUE
                     ANCH        .070  MAIN CHANNEL N-VALUE
                      ANR        .080  RIGHT OVERBANK N-VALUE
                    RLNTH       1900.  REACH LENGTH
                      SEL       .0600  ENERGY SLOPE
                    ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                        --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
31 RY       ELEVATION   5494.00   5486.00   5483.00   5486.00   5488.00   5489.00   5490.00   5491.00
30 RX       DISTANCE        .00     40.00     44.00     48.00     60.00    120.00    140.00    160.00

                                                ***

                                  COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .02       .08       .18       .31       .49       .74      1.16      1.73      2.52
          OUTFLOW        .00       .82      5.23     15.43     33.24     60.26     89.40    148.05    244.05    336.75
        ELEVATION    5483.00   5483.58   5484.16   5484.74   5485.32   5485.90   5486.47   5487.05   5487.63   5488.21

          STORAGE       4.10      6.52      9.33     12.51     16.06     19.77     23.55     27.41     31.35     35.35
          OUTFLOW     533.61    987.80   1664.42   2530.10   3599.11   4895.64   6381.14   8047.70   9889.78  11903.82
        ELEVATION    5488.79   5489.37   5489.95   5490.53   5491.11   5491.69   5492.27   5492.84   5493.42   5494.00
```

*** ***

```
          **************
          *            *
 32 KK    *    REACH4  *
          *            *
          **************
                        CHANNEL ROUTING 59+00 TO 68+00

             HYDROGRAPH ROUTING DATA

 34 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

 35 RC         NORMAL DEPTH CHANNEL
                      ANL        .080  LEFT OVERBANK N-VALUE
                     ANCH        .070  MAIN CHANNEL N-VALUE
                      ANR        .080  RIGHT OVERBANK N-VALUE
                    RLNTH        900.  REACH LENGTH
                      SEL       .0300  ENERGY SLOPE
                    ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                    CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 37 RY       ELEVATION   5467.00   5460.00   5453.00   5449.00   5443.00   5441.00   5465.00   5500.00
 36 RX       DISTANCE        .00     40.00     80.00    120.00    138.00    140.00    200.00    320.00

                                                  ***

                                       COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .37      1.76      4.37      9.23     16.04     24.50     34.59     46.32     59.60
          OUTFLOW        .00     71.25    552.45   1708.35   4388.24   9776.03  17572.48  28027.92  41302.52  58171.38
        ELEVATION    5441.00   5444.11   5447.21   5450.32   5453.42   5456.53   5459.63   5462.74   5465.84   5468.95

          STORAGE      73.64     88.37    103.78    119.87    136.64    154.10    172.25    191.07    210.58    230.77
          OUTFLOW   78695.67 102452.20 129417.70 159593.10 192994.30 229647.30 269584.90 312844.90 359469.00 409508.10
        ELEVATION    5472.05   5475.16   5478.27   5481.37   5484.48   5487.58   5490.69   5493.79   5496.90   5500.00
```

*** ***

```
          **************
          *            *
 38 KK    *    REACH5  *
          *            *
          **************
                        CHANNEL ROUTING 68+00 TO 78+00

             HYDROGRAPH ROUTING DATA

 40 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

 41 RC         NORMAL DEPTH CHANNEL
                       ANL        .080  LEFT OVERBANK N-VALUE
                      ANCH        .070  MAIN CHANNEL N-VALUE
```

```
                  ANR        .080  RIGHT OVERBANK N-VALUE
                RLNTH       1000.  REACH LENGTH
                  SEL       .0300  ENERGY SLOPE
                ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                              CROSS-SECTION DATA
                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 43 RY       ELEVATION   5432.00   5429.00   5425.00   5422.00   5419.00   5422.00   5437.00   5460.00
 42 RX       DISTANCE        .00     40.00     80.00    136.00    140.00    144.00    180.00    240.00

                                               ***

                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE        .00       .14       .94      3.81      8.29     14.12     21.56     30.00     38.70     47.66
            OUTFLOW        .00     20.75    158.40   1023.51   3204.80   6647.74  11552.70  18530.17  27074.96  37077.04
          ELEVATION    5419.00   5421.16   5423.32   5425.47   5427.63   5429.79   5431.95   5434.10   5436.26   5438.42

            STORAGE      56.90     66.42     76.21     86.29     96.64    107.28    118.19    129.38    140.85    152.60
            OUTFLOW   48498.60  61315.91  75508.02  91061.41 107967.80 126222.90 145825.30 166775.80 189077.20 212733.70
          ELEVATION    5440.58   5442.73   5444.89   5447.05   5449.21   5451.37   5453.52   5455.68   5457.84   5460.00


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

            **************
            *            *
 44 KK      *   REACH6   *
            *            *
            **************
                      CHANNEL ROUTING 78+00 TO 92+00

              HYDROGRAPH ROUTING DATA

 46 RD          MUSKINGUM-CUNGE CHANNEL ROUTING

 47 RC          NORMAL DEPTH CHANNEL
                  ANL        .080  LEFT OVERBANK N-VALUE
                 ANCH        .070  MAIN CHANNEL N-VALUE
                  ANR        .080  RIGHT OVERBANK N-VALUE
                RLNTH       1400.  REACH LENGTH
                  SEL       .0300  ENERGY SLOPE
                ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                              CROSS-SECTION DATA
                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 49 RY       ELEVATION   5416.00   5412.00   5410.00   5408.00   5409.00   5410.00   5412.00   5414.00
 48 RX       DISTANCE        .00     20.00     37.00     40.00     44.00     64.00    100.00    120.00

                                               ***

                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE        .00       .02       .06       .16       .37       .71      1.18      1.81      2.59      3.52
            OUTFLOW        .00       .60      3.84     10.26     28.66     68.60    142.66    248.36    390.70    574.16
          ELEVATION    5408.00   5408.42   5408.84   5409.26   5409.68   5410.10   5410.53   5410.95   5411.37   5411.79

            STORAGE       4.60      5.76      7.02      8.36      9.78     11.27     12.80     14.35     15.93     17.54
            OUTFLOW     807.73   1092.07   1422.43   1799.82   2225.43   2727.41   3288.49   3898.57   4556.88   5262.85
          ELEVATION    5412.21   5412.63   5413.05   5413.47   5413.89   5414.31   5414.73   5415.16   5415.58   5416.00
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT	P 100	281.	5.70	184.	111.	111.	1.98		
+	ROUTED TO	REACH1	281.	5.77	182.	110.	110.	1.98		
+	ROUTED TO	REACH2	281.	5.80	181.	109.	109.	1.98		
+	ROUTED TO	REACH3	281.	5.87	179.	108.	108.	1.98		
+	ROUTED TO	REACH4	281.	5.93	177.	106.	106.	1.98		
+	ROUTED TO	REACH5	281.	6.00	174.	105.	105.	1.98		
+	ROUTED TO	REACH6	281.	6.07	171.	103.	103.	1.98		

1

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
REACH1	MANE	2.00	280.70	346.00	.86	2.00	280.70	346.00	.86

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9140E+02 EXCESS= .0000E+00 OUTFLOW= .9060E+02 BASIN STORAGE= .8307E+00 PERCENT ERROR= .0

REACH2	MANE	1.94	280.70	347.92	.85	2.00	280.70	348.00	.85

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9031E+02 EXCESS= .0000E+00 OUTFLOW= .8987E+02 BASIN STORAGE= .4308E+00 PERCENT ERROR= .0

REACH3	MANE	2.00	280.66	352.00	.84	2.00	280.66	352.00	.84

CONTINUITY SUMMARY (AC-FT) - INFLOW= .9017E+02 EXCESS= .0000E+00 OUTFLOW= .8885E+02 BASIN STORAGE= .1256E+01 PERCENT ERROR= .1

REACH4	MANE	2.00	280.66	356.00	.83	2.00	280.66	356.00	.83

CONTINUITY SUMMARY (AC-FT) - INFLOW= .8885E+02 EXCESS= .0000E+00 OUTFLOW= .8785E+02 BASIN STORAGE= .6467E+00 PERCENT ERROR= .4

```
            REACH5  MANE         2.00    280.64    360.00       .82      2.00    280.64    360.00         .82

CONTINUITY SUMMARY (AC-FT) - INFLOW= .8785E+02 EXCESS= .0000E+00 OUTFLOW= .8674E+02 BASIN STORAGE= .9646E+00 PERCENT ERROR=    .2

            REACH6  MANE         2.00    280.63    364.00       .81      2.00    280.63    364.00         .81

CONTINUITY SUMMARY (AC-FT) - INFLOW= .8674E+02 EXCESS= .0000E+00 OUTFLOW= .8525E+02 BASIN STORAGE= .1339E+01 PERCENT ERROR=    .2


*** NORMAL END OF HEC-1 ***
```

```
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   05JUN06  TIME  09:57:36  *
 *                                      *
 ****************************************
```


```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```


```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID   BEAR TRAP CREEK
   2          ID   500 YEAR FLOODPLAIN ASSESMENT
   3          ID   ROUTING USING HEC-1
   4          ID   M. RHODES, HYDROMETICS INC.
   5          ID   13 MAR06
                   *
                   * *** TIME SPECIFICATION
   6          IT       2 08APR03    1200     300
                   *
                   * *** GLOBAL OUTPUT OPTIONS
   7          IO       4
                   *
                   * *** 500 YR HYETOGRAPH
                   *

   8          KK  P 500
   9          KM   PRECIP
  10          BA    1.98
  11          PH            0.00   0.33   1.12    1.97    2.23    2.58    2.99    3.82    4.76
                   *
                   * *** INFLOW TO CREEK
                   * *** CLARK'S UNIT HYDROGRAPH
                   *
  12          UC    0.33    2.88
  13          LS       0      84
                   *
                   * ***
                   *

  14          KK  REACH1
  15          KM   BEAR TRAP CREEK BEGIN TO 25+00 FEET DOWNSTREAM
  16          RD
```

```
             17           RC    0.08    0.07    0.08  2500.0    .208
             18           RX     0.0   100.0   200.0     203     205     300     400     500
             19           RY    6360    6340    6300    6298    6300    6315    6325    6370
                          *
                          * ***
                          *

             20           KK  REACH2
             21           KM   CHANNEL ROUTING 25+00 TO 40+00
             22           RD
             23           RC    0.08    0.07    0.08    1500    .133
             24           RX     0.0     100     200     280     283     286     300     400
             25           RY    5720    5680    5620    5600    5597    5600    5610    5700
                          *
                          * ***
                          *

             26           KK  REACH3
             27           KM   CHANNEL ROUTING 40+00 TO 59+00
             28           RD
             29           RC    0.08    0.07    0.08    1900    .060
             30           RX     0.0    40.0    44.0    48.0    60.0     120     140     160
             31           RY    5494    5486    5483    5486    5488    5489    5490    5491
                          *
                          * ***
                          *
```



```
          LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             32           KK  REACH4
             33           KM   CHANNEL ROUTING 59+00 TO 68+00
             34           RD
             35           RC    0.08    0.07    0.08     900    .030
             36           RX     0.0    40.0    80.0     120     138     140     200     320
             37           RY    5467    5460    5453    5449    5443    5441    5465    5500
                          *
                          * ***
                          *

             38           KK  REACH5
             39           KM   CHANNEL ROUTING 68+00 TO 78+00
             40           RD
             41           RC    0.08    0.07    0.08    1000   .030
             42           RX     0.0    40.0    80.0     136     140     144     180     240
             43           RY    5432    5429    5425    5422    5419    5422    5437    5460
                          *
                          * ***
                          *

             44           KK  REACH6
             45           KM   CHANNEL ROUTING 78+00 TO 92+00
             46           RD
             47           RC    0.08    0.07    0.08    1400    .030
             48           RX     0.0    20.0    37.0    40.0    44.0      64     100     120
             49           RY    5416    5412    5410    5408    5409    5410    5412    5414
                          *
                          * ***
                          *
             50           ZZ
```

```
1*************************************                 *************************************
 *                                   *                 *                                   *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *             *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998           *                 *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1            *                 *          609 SECOND STREET          *
 *                                   *                 *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   05JUN06  TIME  09:57:36   *             *          (916) 756-1104             *
 *                                   *                 *                                   *
 *************************************                 *************************************
```

```
                        BEAR TRAP CREEK
                        500 YEAR FLOODPLAIN ASSESMENT
                        ROUTING USING HEC-1
                        M. RHODES, HYDROMETICS INC.
                        13 MAR06

  7 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           4  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN           2  MINUTES IN COMPUTATION INTERVAL
                      IDATE      8APR 3  STARTING DATE
                      ITIME        1200  STARTING TIME
                         NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      8APR 3  ENDING DATE
                      NDTIME        2158  ENDING TIME
                      ICENT           19  CENTURY MARK

                COMPUTATION INTERVAL     .03 HOURS
                     TOTAL TIME BASE    9.97 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
             LENGTH, ELEVATION     FEET
             FLOW                  CUBIC FEET PER SECOND
             STORAGE VOLUME        ACRE-FEET
             SURFACE AREA          ACRES
             TEMPERATURE           DEGREES FAHRENHEIT


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


          **************
          *            *
  8 KK    *    P 500   *
          *            *
          **************
                        PRECIP

             SUBBASIN RUNOFF DATA

 10 BA         SUBBASIN CHARACTERISTICS
                     TAREA        1.98  SUBBASIN AREA

               PRECIPITATION DATA

 11 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 .....   ............... TP-40 ...............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 .33    1.12    1.97    2.23    2.58    2.99    3.82    4.76     .00     .00     .00     .00

                                                 STORM AREA =    1.98

 13 LS         SCS LOSS RATE
                    STRTL         .38  INITIAL ABSTRACTION
                   CRVNBR       84.00  CURVE NUMBER
                    RTIMP         .00  PERCENT IMPERVIOUS AREA

 12 UC         CLARK UNITGRAPH
                      TC         .33  TIME OF CONCENTRATION
```

```
              R        2.88  STORAGE COEFFICIENT

          SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                ***

                                        UNIT HYDROGRAPH PARAMETERS
                                  CLARK   TC=   .33 HR,       R=  2.88 HR
                                 SNYDER   TP=   .35 HR,      CP=   .11

                                             UNIT HYDROGRAPH
                                     300 END-OF-PERIOD ORDINATES
                                            VOLUME =  .97
         10.       38.       80.      131.      189.      250.      307.      354.      391.      412.
        416.      411.      407.      402.      397.      393.      388.      384.      379.      375.
        371.      366.      362.      358.      354.      350.      346.      342.      338.      334.
        330.      326.      323.      319.      315.      312.      308.      305.      301.      298.
        294.      291.      287.      284.      281.      278.      274.      271.      268.      265.
        262.      259.      256.      253.      250.      247.      244.      242.      239.      236.
        233.      231.      228.      225.      223.      220.      218.      215.      213.      210.
        208.      205.      203.      201.      198.      196.      194.      192.      189.      187.
        185.      183.      181.      179.      177.      175.      173.      171.      169.      167.
        165.      163.      161.      159.      157.      156.      154.      152.      150.      149.
        147.      145.      144.      142.      140.      139.      137.      135.      134.      132.
        131.      129.      128.      126.      125.      123.      122.      121.      119.      118.
        117.      115.      114.      113.      111.      110.      109.      107.      106.      105.
        104.      103.      101.      100.       99.       98.       97.       96.       95.       94.
         92.       91.       90.       89.       88.       87.       86.       85.       84.       83.
         82.       81.       80.       80.       79.       78.       77.       76.       75.       74.
         73.       72.       72.       71.       70.       69.       68.       68.       67.       66.
         65.       65.       64.       63.       62.       62.       61.       60.       60.       59.
         58.       58.       57.       56.       56.       55.       54.       54.       53.       52.
         52.       51.       51.       50.       49.       49.       48.       48.       47.       47.
         46.       46.       45.       45.       44.       44.       43.       43.       42.       42.
         41.       41.       40.       40.       39.       39.       38.       38.       37.       37.
         37.       36.       36.       35.       35.       35.       34.       34.       33.       33.
         33.       32.       32.       32.       31.       31.       30.       30.       30.       29.
         29.       29.       28.       28.       28.       27.       27.       27.       26.       26.
         26.       26.       25.       25.       25.       24.       24.       24.       24.       23.
         23.       23.       23.       22.       22.       22.       22.       21.       21.       21.
         21.       20.       20.       20.       20.       19.       19.       19.       19.       19.
         18.       18.       18.       18.       17.       17.       17.       17.       17.       16.
         16.       16.       16.       16.       16.       15.       15.       15.       15.       15.


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


            **************
            *            *
  14 KK     *    REACH1  *
            *            *
            **************
                   BEAR TRAP CREEK BEGIN TO 25+00 FEET DOWNSTREAM

             HYDROGRAPH ROUTING DATA

  16 RD       MUSKINGUM-CUNGE CHANNEL ROUTING

  17 RC       NORMAL DEPTH CHANNEL
                      ANL        .080  LEFT OVERBANK N-VALUE
                     ANCH        .070  MAIN CHANNEL N-VALUE
                      ANR        .080  RIGHT OVERBANK N-VALUE
                    RLNTH       2500.  REACH LENGTH
                      SEL       .2080  ENERGY SLOPE
                    ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                  CROSS-SECTION DATA
                      --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
```

```
 19 RY        ELEVATION   6360.00   6340.00   6300.00   6298.00   6300.00   6315.00   6325.00   6370.00
 18 RX        DISTANCE        .00    100.00    200.00    203.00    205.00    300.00    400.00    500.00
```

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	1.61	9.78	25.22	47.95	78.36	118.71	169.36	227.86	290.31
OUTFLOW	.00	315.01	3345.21	11793.04	27751.13	55578.52	97983.77	155250.00	231008.70	323088.30
ELEVATION	6298.00	6301.79	6305.58	6309.37	6313.16	6316.95	6320.74	6324.53	6328.32	6332.11
STORAGE	356.64	426.87	501.85	582.78	669.67	762.50	861.29	965.19	1071.19	1179.02
OUTFLOW	430883.10	554365.80	688479.60	840420.70	1011174.00	1201287.00	1411372.00	1655681.00	1927651.00	2219160.00
ELEVATION	6335.90	6339.69	6343.47	6347.26	6351.05	6354.84	6358.63	6362.42	6366.21	6370.00

*** ***

```
          **************
          *            *
 20 KK    *    REACH2  *
          *            *
          **************
                        CHANNEL ROUTING 25+00 TO 40+00

             HYDROGRAPH ROUTING DATA

 22 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

 23 RC         NORMAL DEPTH CHANNEL
                     ANL        .080  LEFT OVERBANK N-VALUE
                    ANCH        .070  MAIN CHANNEL N-VALUE
                     ANR        .080  RIGHT OVERBANK N-VALUE
                   RLNTH       1500.  REACH LENGTH
                     SEL       .1330  ENERGY SLOPE
                   ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                    CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 25 RY        ELEVATION   5720.00   5680.00   5620.00   5600.00   5597.00   5600.00   5610.00   5700.00
 24 RX        DISTANCE        .00    100.00    200.00    280.00    283.00    286.00    300.00    400.00
```

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	2.15	11.56	28.57	52.61	81.18	113.75	150.33	190.93	235.53
OUTFLOW	.00	816.31	7552.93	25360.65	60857.84	116845.60	190205.90	281548.50	391588.20	521092.70
ELEVATION	5597.00	5603.47	5609.95	5616.42	5622.89	5629.37	5635.84	5642.32	5648.79	5655.26
STORAGE	284.13	336.75	393.38	454.03	519.49	590.16	666.04	746.19	829.94	917.31
OUTFLOW	670855.10	841680.40	1034376.00	1248901.00	1484287.00	1746382.00	2038086.00	2376225.00	2743994.00	3141973.00
ELEVATION	5661.74	5668.21	5674.68	5681.16	5687.63	5694.10	5700.58	5707.05	5713.53	5720.00

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          *            *
 26 KK    *    REACH3  *
          *            *
          **************
                        CHANNEL ROUTING 40+00 TO 59+00
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             HYDROGRAPH ROUTING DATA

  28 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

  29 RC        NORMAL DEPTH CHANNEL
                        ANL        .080  LEFT OVERBANK N-VALUE
                       ANCH        .070  MAIN CHANNEL N-VALUE
                        ANR        .080  RIGHT OVERBANK N-VALUE
                      RLNTH       1900.  REACH LENGTH
                        SEL       .0600  ENERGY SLOPE
                      ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                       CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  31 RY        ELEVATION   5494.00   5486.00   5483.00   5486.00   5488.00   5489.00   5490.00   5491.00
  30 RX        DISTANCE        .00     40.00     44.00     48.00     60.00    120.00    140.00    160.00

                                                                ***

                                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .02       .08       .18       .31       .49       .74      1.16      1.73      2.52
          OUTFLOW        .00       .82      5.23     15.43     33.24     60.26     89.40    148.05    244.05    336.75
        ELEVATION    5483.00   5483.58   5484.16   5484.74   5485.32   5485.90   5486.47   5487.05   5487.63   5488.21

          STORAGE       4.10      6.52      9.33     12.51     16.06     19.77     23.55     27.41     31.35     35.35
          OUTFLOW     533.61    987.80   1664.42   2530.10   3599.11   4895.64   6381.14   8047.70   9889.78  11903.82
        ELEVATION    5488.79   5489.37   5489.95   5490.53   5491.11   5491.69   5492.27   5492.84   5493.42   5494.00


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          *            *
  32 KK   *    REACH4  *
          *            *
          **************
                    CHANNEL ROUTING 59+00 TO 68+00

             HYDROGRAPH ROUTING DATA

  34 RD        MUSKINGUM-CUNGE CHANNEL ROUTING

  35 RC        NORMAL DEPTH CHANNEL
                        ANL        .080  LEFT OVERBANK N-VALUE
                       ANCH        .070  MAIN CHANNEL N-VALUE
                        ANR        .080  RIGHT OVERBANK N-VALUE
                      RLNTH        900.  REACH LENGTH
                        SEL       .0300  ENERGY SLOPE
                      ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                       CROSS-SECTION DATA
                          --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
  37 RY        ELEVATION   5467.00   5460.00   5453.00   5449.00   5443.00   5441.00   5465.00   5500.00
  36 RX        DISTANCE        .00     40.00     80.00    120.00    138.00    140.00    200.00    320.00

                                                                ***

                                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .37      1.76      4.37      9.23     16.04     24.50     34.59     46.32     59.60
          OUTFLOW        .00     71.25    552.45   1708.35   4388.24   9776.03  17572.48  28027.92  41302.52  58171.38
        ELEVATION    5441.00   5444.11   5447.21   5450.32   5453.42   5456.53   5459.63   5462.74   5465.84   5468.95

          STORAGE      73.64     88.37    103.78    119.87    136.64    154.10    172.25    191.07    210.58    230.77
          OUTFLOW   78695.67 102452.20 129417.70 159593.10 192994.30 229647.30 269584.90 312844.90 359469.00 409508.10
        ELEVATION    5472.05   5475.16   5478.27   5481.37   5484.48   5487.58   5490.69   5493.79   5496.90   5500.00
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          **************
          *            *
 38 KK    *    REACH5  *
          *            *
          **************
                        CHANNEL ROUTING 68+00 TO 78+00

             HYDROGRAPH ROUTING DATA

 40 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

 41 RC         NORMAL DEPTH CHANNEL
                      ANL        .080  LEFT OVERBANK N-VALUE
                     ANCH        .070  MAIN CHANNEL N-VALUE
                      ANR        .080  RIGHT OVERBANK N-VALUE
                    RLNTH       1000.  REACH LENGTH
                      SEL       .0300  ENERGY SLOPE
                    ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                    CROSS-SECTION DATA
                           --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
 43 RY       ELEVATION   5432.00   5429.00   5425.00   5422.00   5419.00   5422.00   5437.00   5460.00
 42 RX       DISTANCE        .00     40.00     80.00    136.00    140.00    144.00    180.00    240.00

                                                  ***

                                    COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .14       .94      3.81      8.29     14.12     21.56     30.00     38.70     47.66
          OUTFLOW        .00     20.75    158.40   1023.51   3204.80   6647.74  11552.70  18530.17  27074.96  37077.04
        ELEVATION    5419.00   5421.16   5423.32   5425.47   5427.63   5429.79   5431.95   5434.10   5436.26   5438.42

          STORAGE      56.90     66.42     76.21     86.29     96.64    107.28    118.19    129.38    140.85    152.60
          OUTFLOW   48498.60  61315.91  75508.02  91061.41 107967.80 126222.90 145825.30 166775.80 189077.20 212733.70
        ELEVATION    5440.58   5442.73   5444.89   5447.05   5449.21   5451.37   5453.52   5455.68   5457.84   5460.00
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          **************
          *            *
 44 KK    *    REACH6  *
          *            *
          **************
                        CHANNEL ROUTING 78+00 TO 92+00

             HYDROGRAPH ROUTING DATA

 46 RD         MUSKINGUM-CUNGE CHANNEL ROUTING

 47 RC         NORMAL DEPTH CHANNEL
                      ANL        .080  LEFT OVERBANK N-VALUE
                     ANCH        .070  MAIN CHANNEL N-VALUE
                      ANR        .080  RIGHT OVERBANK N-VALUE
                    RLNTH       1400.  REACH LENGTH
                      SEL       .0300  ENERGY SLOPE
                    ELMAX          .0  MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

                                    CROSS-SECTION DATA
                           --- LEFT OVERBANK --- + ------ MAIN CHANNEL ------- + --- RIGHT OVERBANK ---
```

49 RY	ELEVATION	5416.00	5412.00	5410.00	5408.00	5409.00	5410.00	5412.00	5414.00
48 RX	DISTANCE	.00	20.00	37.00	40.00	44.00	64.00	100.00	120.00

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COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.02	.06	.16	.37	.71	1.18	1.81	2.59	3.52
OUTFLOW	.00	.60	3.84	10.26	28.66	68.60	142.66	248.36	390.70	574.16
ELEVATION	5408.00	5408.42	5408.84	5409.26	5409.68	5410.10	5410.53	5410.95	5411.37	5411.79
STORAGE	4.60	5.76	7.02	8.36	9.78	11.27	12.80	14.35	15.93	17.54
OUTFLOW	807.73	1092.07	1422.43	1799.82	2225.43	2727.41	3288.49	3898.57	4556.88	5262.85
ELEVATION	5412.21	5412.63	5413.05	5413.47	5413.89	5414.31	5414.73	5415.16	5415.58	5416.00

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT									
+		P 500	486.	5.67	302.	182.	182.	1.98		
	ROUTED TO									
+		REACH1	486.	5.73	299.	181.	181.	1.98		
	ROUTED TO									
+		REACH2	486.	5.77	298.	180.	180.	1.98		
	ROUTED TO									
+		REACH3	486.	5.87	295.	177.	177.	1.98		
	ROUTED TO									
+		REACH4	486.	5.90	292.	176.	176.	1.98		
	ROUTED TO									
+		REACH5	486.	5.97	289.	174.	174.	1.98		
	ROUTED TO									
+		REACH6	485.	6.03	285.	171.	171.	1.98		

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SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
REACH1	MANE	2.00	485.91	344.00	1.41	2.00	485.91	344.00	1.41

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1502E+03 EXCESS= .0000E+00 OUTFLOW= .1490E+03 BASIN STORAGE= .1264E+01 PERCENT ERROR= .0

REACH2	MANE	1.94	485.79	345.10	1.40	2.00	485.71	346.00	1.40

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1487E+03 EXCESS= .0000E+00 OUTFLOW= .1481E+03 BASIN STORAGE= .6558E+00 PERCENT ERROR= .0

REACH3	MANE	2.00	485.68	352.00	1.38	2.00	485.68	352.00	1.38

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1484E+03 EXCESS= .0000E+00 OUTFLOW= .1465E+03 BASIN STORAGE= .1789E+01 PERCENT ERROR= .0

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            REACH4  MANE         2.00    485.65    354.00      1.37      2.00    485.65    354.00        1.37

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1465E+03 EXCESS= .0000E+00 OUTFLOW= .1451E+03 BASIN STORAGE= .8975E+00 PERCENT ERROR=    .3

            REACH5  MANE         2.00    485.54    358.00      1.36      2.00    485.54    358.00        1.36

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1451E+03 EXCESS= .0000E+00 OUTFLOW= .1436E+03 BASIN STORAGE= .1256E+01 PERCENT ERROR=    .2

            REACH6  MANE         2.00    485.48    362.00      1.34      2.00    485.48    362.00        1.34

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1436E+03 EXCESS= .0000E+00 OUTFLOW= .1416E+03 BASIN STORAGE= .1864E+01 PERCENT ERROR=    .1


*** NORMAL END OF HEC-1 ***
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