Minnewawa Brook

New Hampshire

HOWE RESERVOIR DAM DAM - BREAK FLOOD ANALYSIS

March 1986

US Army Corps
of Engineers
New England Division

HOWE RESERVOIR DAM

DAM-BREAK FLOOD

ANALYSIS

SUBMITTED TO:

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION

WALTHAM, MASSACHUSETTS

SUBMITTED BY:

VOLLMER ASSOCIATES

6 ST. JAMES AVENUE 02116

CONTRACT NUMBER:

DACW 33-85-D-0006

NOVEMBER 1985

HOWE RESERVOIR DAM
DAM-BREAK FLOOD ANALYSIS

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HOWE RESERVOIR DAM
DAM-BREAK FLOOD ANALYSIS

1. INTRODUCTION AND PURPOSE

This report presents the findings of a dam-break flood analysis performed for Howe Reservoir Dam. The dam is owned, operated and maintained by the New Hampshire Water Resources Board. Included in the report are a description of pertinent features of the dam, the procedure used for the analysis, the assumed dam-break conditions, and the resulting effect on downstream flooded areas. This study was not performed because of any known likelihood of a dam-break at Howe Reservoir Dam. Its purpose is to provide quantitative information for emergency planning use.

2. DAM DESCRIPTION

Identification No.:	NH00095
Name of Dam:	Howe Reservoir Dam
Town:	Harrisville
County and State:	Cheshire, NH
Stream:	Tributary of Minnewawa Brook

Howe Reservoir Dam is located in the southwestern part of the State of New Hampshire. It is located on the northern tip of the reservoir, about one mile upstream from the village of Chesham and eight miles east of Keene, New Hampshire. The stream from Howe Reservoir flows into Russell Reservoir in Chesham, and from there to Minnewawa Brook in Marlborough, which is a tributary to the Ashuelot and Connecticut Rivers. Howe is surrounded by woods on all sides. The dam consists of dry rubble masonry, capped with concrete, and an earth fill embankment with a total length of approximately 157 feet and a maximum height of approximately 28 feet above the streambed. The portion of the dam consisting of dry rubble masonry has a vertical downstream face and an upstream face inclined about 45 degrees with a 6-inch reinforced concrete slab laid over the upstream face. On the upstream side, a cutoff trench was excavated to bedrock at the heel of the dam and filled with concrete. The top width of the masonry dam is 3.5 feet and the earth embankment is more than 20 feet wide. The spillway is located in the southern portion of the dam with a crest elevation of 1274.5 ft. NGVD. The concrete crest is approximately 1 foot wide and 75 feet long.

3. PERTINENT DATA

Data is taken from "Phase I Inspection Report" for Howe Reservoir Dam dated May 1979.

a. Drainage Area

Howe Reservoir, shown on the U.S.G.S. map, is located at a distance of eight miles east of Keene, New Hampshire. This reservoir is man made. The watershed is heavily wooded, undulated and rolling with a total drainage area of 10.5 square miles.

b. Elevation Feet (N.G.V.D.)

(1) Top of dam - 1276.5
(2) Spillway crest - 1274.5

c. Reservoir

(1) Length of normal pool - 1.4 miles

d. Storage (Acre-Feet)

(1) Top of dam - 2086 acre-feet
(2) Spillway crest - 1610 acre-feet

e. Reservoir Surface (Acres)

(1) Top of dam - 268 acres
(2) Spillway crest - 208 acres

f. Dam

(1) Type - Dry rubble masonry and earth fill

(2) Length - 157'

(3) Height - 28.5'

(4) Top Width - minimum 3.5 feet

(5) Side slopes -

a. Dry Rubble Masonry

1. upstream - 1 vertical to 1 horizontal
2. downstream - vertical

b. Rolled Earth Fill

1. upstream - flatter than 1 vertical to 2 horizontal
2. downstream - 1 vertical to 1.5 horizontal

(6) Zoning - not applicable

(7) Impervious core - none

(8) Cutoff - Heel - dry rubble masonry
Center - earth fill

(9) Grout curtain - none

g. Spillway

(1) Type - Ungated concrete weir

(2) Length of weir - 75 feet

(3) Crest Elevation - 1274.5

(4) Gates - none

(5) U/S Channel - Reservoir

h. Regulating Outlet

(1) Invert - 1267.0 ft. - NGVD

(2) Size - 12 feet wide; 9.5 feet deep; 15 feet long

(3) Description - reinforced concrete channel

(4) Control Mechanism - stop logs

(5) Other

(a) Description - 36" steel conduit

(b) Invert - 1259.0

(c) Control Mechanism - 42" gate operated manually

4. VALLEY DESCRIPTION

The river valley below Howe Reservoir is very steep and narrow to Russell Reservoir averaging approximately 370 feet per mile. Russell Reservoir is approximately 30 acres at normal pool elevation and 150 acres at the top of the dam. The dam at the reservoir is approximately

10 feet high by 100 feet long measured abutment to abutment. It is a concrete gravity dam. Below Russell Reservoir, the valley slope becomes more moderate averaging 44 feet per mile. The flow from Russell Reservoir enters Minnewawa Brook at about 0.5 miles downstream of the dam. At approximately 2.5 miles downstream from Russell Reservoir, the stream valley increases in slope to 120 feet per mile through the Town of Marlborough to the end of the study reach. The total study reach is shown on Plate 1.

5. MODEL DESCRIPTION

The Howe Reservoir dam-break analysis was made using the NWS version, dated July 1984, of the "National Weather Service Dam-Break Flood Forecasting Computer Model", developed by D.L. Fread, Research Hydrologist, Office of Hydrology, National Weather Service, NOAA, Silver Springs, Maryland 20910. Input for the model consisted of: (a) storage characteristics of the reservoir, (b) selected geometry and duration of the breach development, (c) hydraulic roughness coefficients, and (d) active and inactive flow regions. Based on the input data, the model computes the dam-break outflow hydrograph and routes it downstream. The analysis provides output on the attenuation of the flood stages, and timing of the flood wave as it progresses downstream.

6. ASSUMED DAM BREAK CONDITIONS

General: The magnitude of the flood resulting from the hypothetical failure of Howe Reservoir Dam is a function of many different parameters including size of breach, initial pool level and storage, rate of breach formation, channel and overbank roughness and antecedent flow conditions. Engineering assumptions of conditions which could be reasonably expected to exist prior to a failure of Howe Reservoir Dam which were used in the analysis are presented below:

(1) Initial Pool Level: 1278.1 feet N.G.V.D., 3.6 feet above spillway crest.

(2) Reservoir Inflow: Estimated flood of record = 1700 cfs.

(3) Breach Invert: 1256 feet N.G.V.D.

(4) Breach Base Width: 60 feet, vertical side slopes 1V:0H.

(5) Time to Complete Formation of Breach 0.5 Hour.

(6) Downstream Channel Roughness: Manning's "n" = .06 to .140.

(7) Pre-Breach River Flows: The pre-breach river flow was assumed equal to the flood of record which was estimated by using a cfs/sq. mi. value based on 1938 flood flows from other streams in the vicinity of Howe Reservoir. Inflow to Howe Reservoir was 1700 cfs.

7. RESULTS

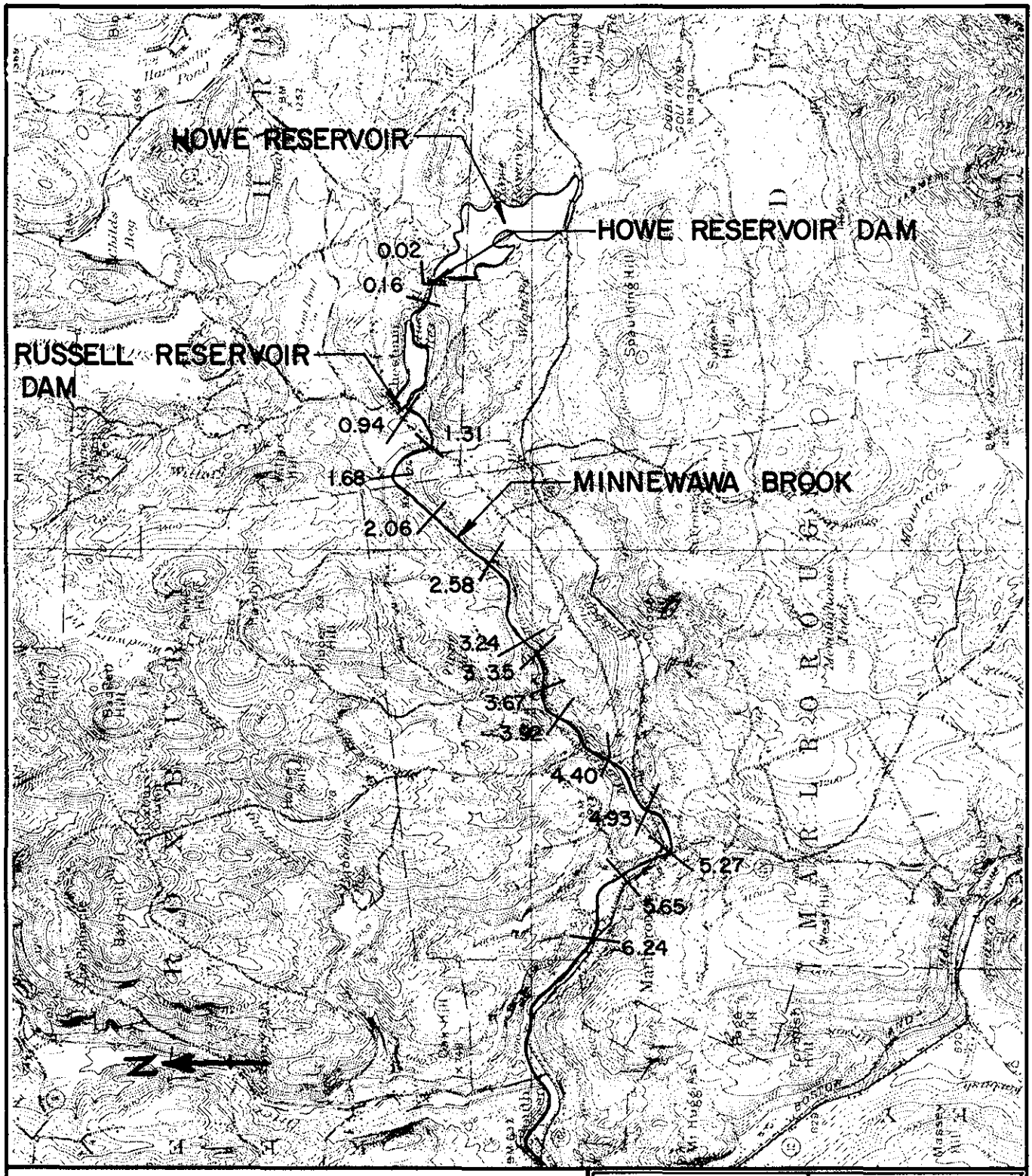
The resulting peak stage flood profiles are shown on plates 2, 3, and 4. Because of the scarcity of good topographic mapping in the area, profiles are shown in feet above normal summertime (July-August) low water (NLW). Users of the information can establish depth of flooding at particular properties by establishing its relative elevation with respect to the adjacent stream level. Variations in depth above NLW progressing downstream, is attributable to changes in natural stream hydraulic capacity as well as changes in peak discharge.

For the dam-break analysis, the stream channel below Howe Reservoir was modeled in three reaches. The first reach is from the dam at Howe Reservoir to just upstream of Russell Reservoir. The second reach extends from the dam at Russell Reservoir downstream approximately 2.3 miles to river mile 3.24. The third reach extends from mile 3.35 to the end of the study beyond the Town of Marlborough at mile 6.24. The outflow hydrograph of the first reach was used as the inflow hydrograph to the second reach. The same technique was applied for the second and third reach of the analysis. The dam at Russell Reservoir was modeled in the analysis. The outflow hydrograph from reach one was routed through Russell Reservoir without failing the dam to attain maximum pool. The dam at Russell Reservoir was subsequently failed at maximum pool. The analysis indicates that Russell Reservoir has little impact on moderating a dam failure of Howe Reservoir. The failure of the dam at Russell Reservoir also does not significantly increase the severity of the flooding caused by the failure of Howe Reservoir Dam alone.

The peak dam break discharge from Howe Reservoir Dam is 24,550 cfs producing a rise of approximately 16.8 feet above the NLW River elevation at a point 0.02 miles downstream from the dam. At a distance of 1.31 miles below Howe Reservoir Dam, peak discharge is 23,770 cfs with an associated rise over NLW stage of about 25.3 feet. At 5.27 miles below Howe Reservoir Dam, in the Town of Marlborough, the peak discharge is 21,810 cfs with an associated rise over NLW stage of 24.5 feet.

Peak discharge, stages and timing for the three stations downstream from Howe Reservoir Dam are shown on Plate 5. The stations are located 0.02, 1.31 and 5.27 miles downstream of the dam.

The input data file is in Appendix A, while Appendix B contains the output file.



MAP BASED UPON U.S.G.S.
MONADNOCK N.H. QUADRANGLE
1949

CROSS-SECTION LOCATION IN
MILES BELOW DAM

SCALE IN MILES

1MI. 0 1MI.

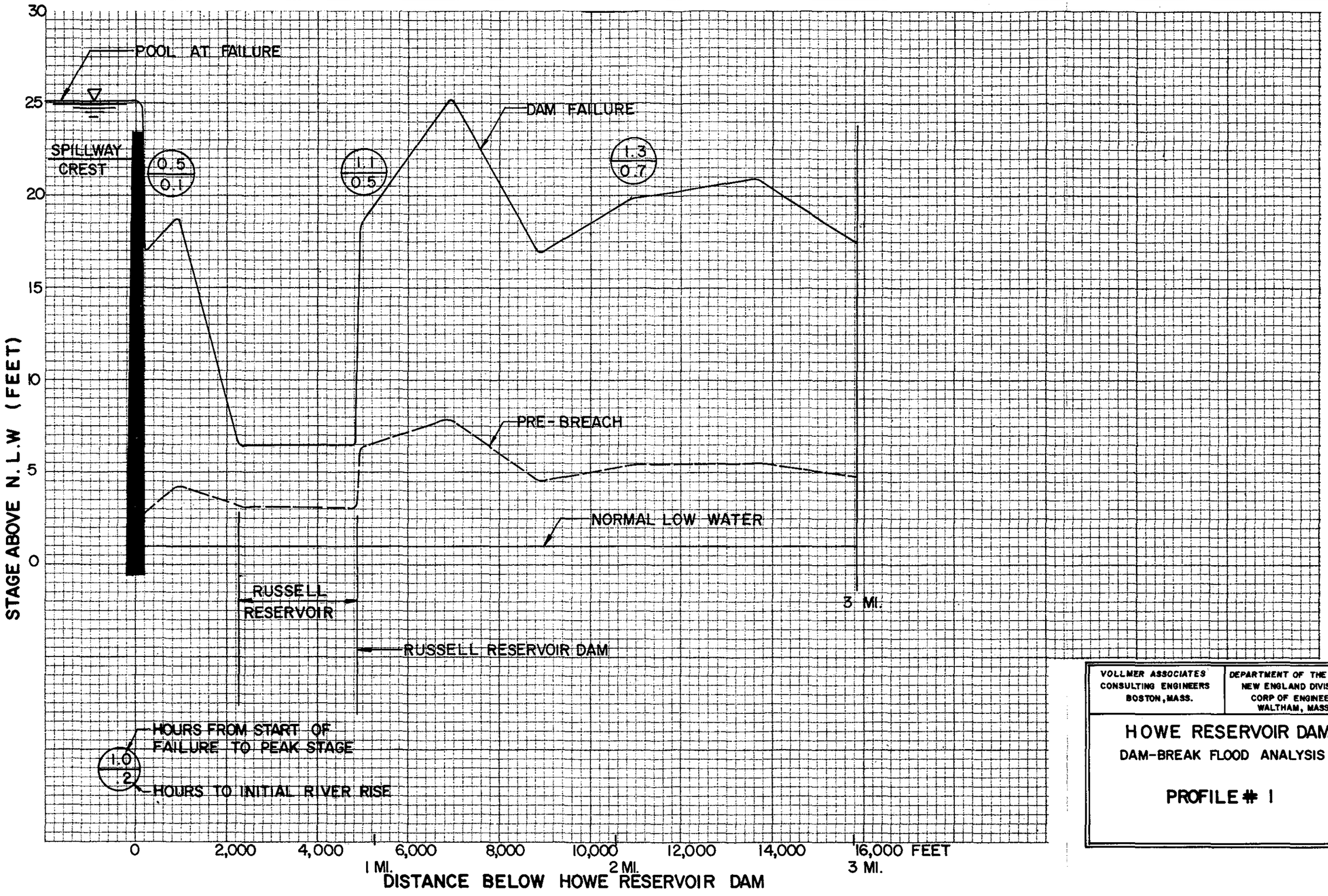
VOLLMER ASSOCIATES CONSULTING ENGINEERS BOSTON, MASS.	DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORP OF ENGINEERS WALTHAM, MASS.

HOWE RESERVOIR DAM

DAM-BREAK FLOOD ANALYSIS

INDEX MAP

PLATE 1

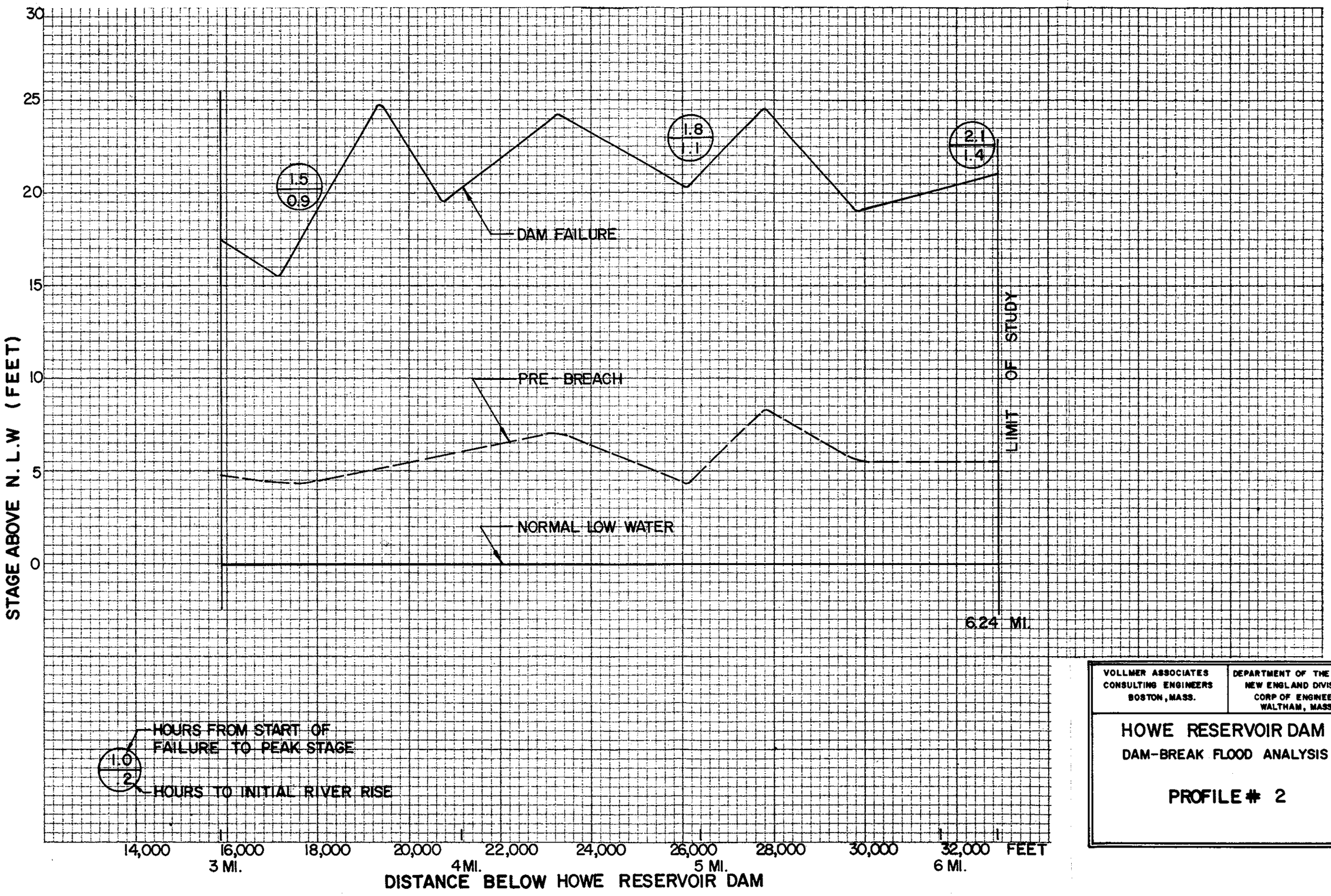


VOLLMER ASSOCIATES CONSULTING ENGINEERS BOSTON, MASS.	DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORP OF ENGINEERS WALTHAM, MASS.

HOWE RESERVOIR DAM

DAM-BREAK FLOOD ANALYSIS

PROFILE # 1

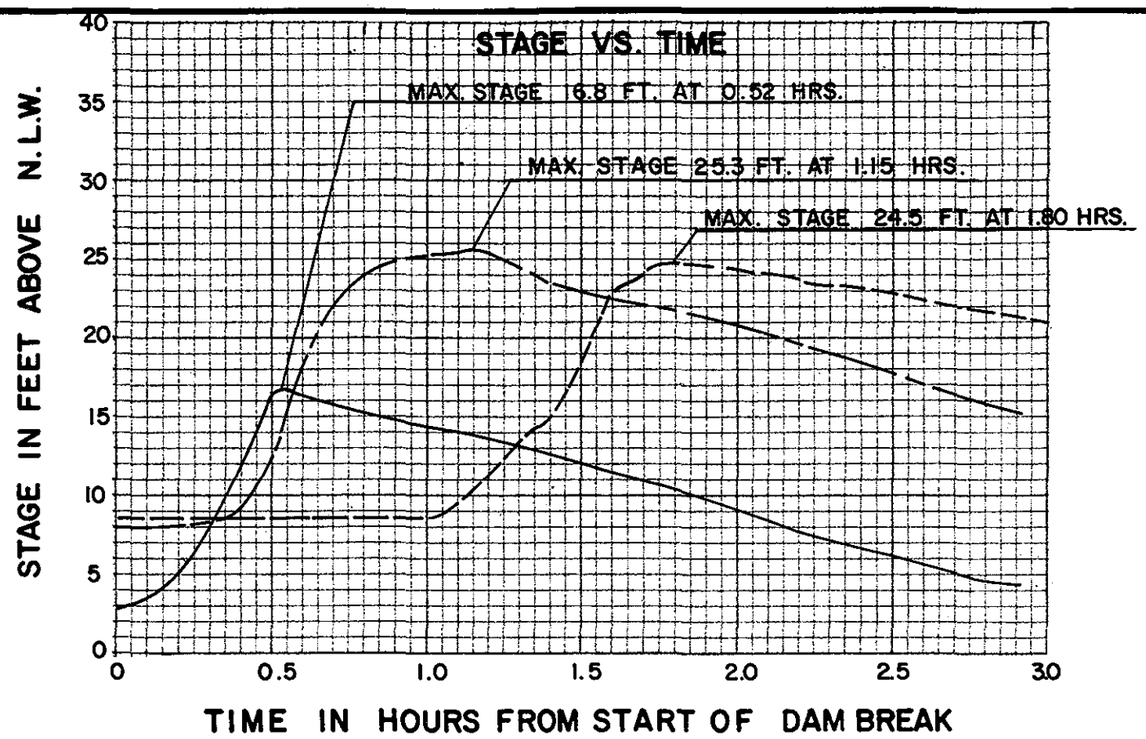


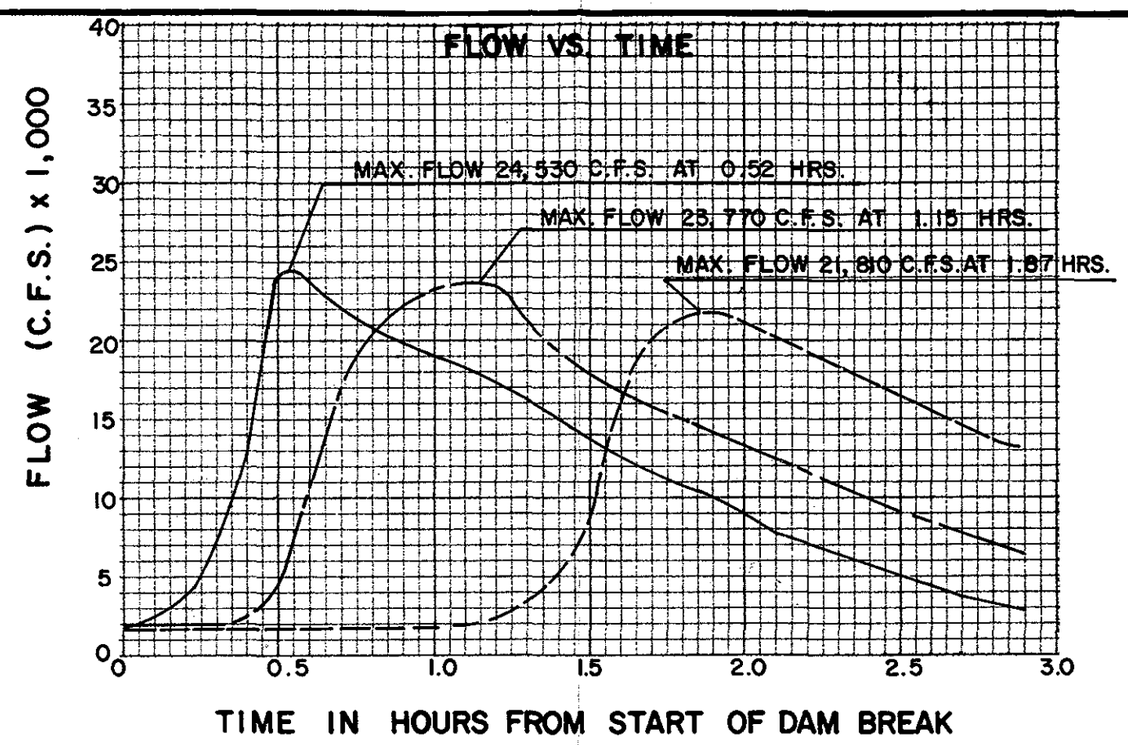
VOLLMER ASSOCIATES CONSULTING ENGINEERS BOSTON, MASS.	DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORP OF ENGINEERS WALTHAM, MASS.

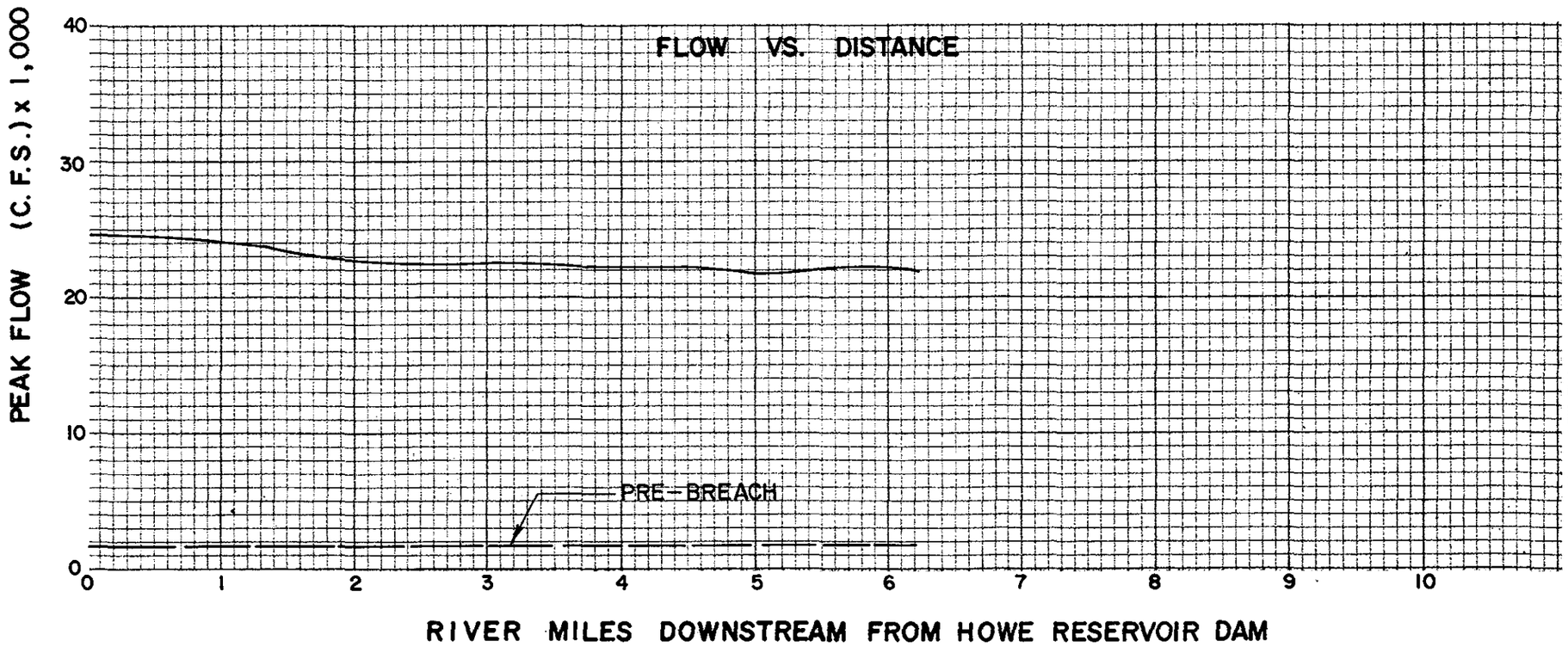
HOWE RESERVOIR DAM

DAM-BREAK FLOOD ANALYSIS

PROFILE # 2







N.L.W. DATUM (FT. N.G.V.D.)

STA. 1 R.M. 0.02 = 1253.0 ————
STA. 2 R.M. 1.31 = 1140.0 — — — —
STA. 3 R.M. 5.27 = 705.6 - - - - - -

VOLLMER ASSOCIATES CONSULTING ENGINEERS BOSTON, MASS.	DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORP OF ENGINEERS WALTHAM, MASS.

HOWE RESERVOIR DAM

DAM-BREAK FLOOD ANALYSIS

BASE FLOOD DISCHARGES
STAGES & TIMING

APPENDIX A
INPUT DATA FILE

HOWE RESERVOIR DAM MINNEWAWA BROOK VOLLMER ASSOCIATES
BOSTON, MA 02116 OCTOBER 17, 1985 #DB1

1	0	0	0	4	0	0	0
2230	1610	1215	826	528	298	126	0
1277.5	1274.5	1272.5	1270	1267.5	1265	1262.5	1259.5
1.8	1278.1	0	1256	60	0.5	1256	1
1278.1	1276.5	1274.5	0	0	0	0	0
0	50	250	450	650	850	1600	2500
0	0.5	1	1.5	2	2.5	3.5	4.5
1	3						
1700	1700	1700	1700				
2	4	2	4	0	0	0	
1	2						
0.02							
1251.2	1253	1272	1300				
0	42	95	898				
0.16							
1199	1200	1220	1240				
0	25	106	317				
0.075	0.085	0.100	0.140				
0.050							
0							
0	0	0.0	0.0	370	0	0	0

```
RUSSELL RES. DAM    MINNEWAWA BROOK     VOLLMER ASSOCIATES
BOSTON, MA 02116                        NOVEMBER 1, 1985 #081
       1        0        0        0       11        0        0        0
    1753      353      200        0
    1200     1180     1177     1167
    0.51  1180.08        0     1167       90      0.5     1167        1
  1183.5   1179.5     1177        0        0        0        0        0
       0      300      849     1186     1587     2923    47698
       0        1        2      2.5        3        4       10
     0.0        3
    1694     2074     3675     6996    12699    24649    23603    19082
    9017     5107     2950
       0      0.1      0.2      0.3      0.4    0.525      0.6      1.0
     2.0      2.5      3.0
       6        4        6        4        0        0        0
       1        2        3        4        5        6
0.94 0.02
    1159     1160     1165     1185
       0       25      120     1368

1.31 0.39
    1139     1140   1152.7     1170
       0       22       75      398

1.68 0.76
    1127     1130     1140     1160
       0       35      581      950

2.06 1.14
    1117     1120     1140     1160
       0       30      370      528

2.58 1.66
    1097     1100     1120     1140
       0       30      211      422

3.24 2.32
    1057     1060     1080     1100
       0       40      475      792

   0.060    0.075    0.100    0.140
   0.060    0.075    0.100    0.140
   0.060    0.075    0.100    0.140
   0.060    0.075    0.100    0.140
   0.075    0.085    0.110    0.140
    0.05     0.05     0.05     0.05     0.05
       0        0        0        0        0
       0        0     0.00     0.00       43        0        0        0
```

```
REACH THREE          MINNEWAWA BROOK     VOLLMER ASSOCIATES
BOSTON, MA 02116                         NOVEMBER 4, 1985 #0B1
        9        0        0        0       14        0        0        0
      0.0        3
     1696     1696     1699     1719     1840     2858    13730    20303
    21755    22256    20784    14709     9854     9000
        0      0.5      0.6      0.7      0.8      0.9      1.1      1.3
      1.4      1.5      1.7      2.3      2.9      3.0
        8        4        6        4        0        0        0
        1        3        5        6        7        8
3.35 2.43
      978      980     1000     1020
        0       30      264      317

3.67 2.75
      918      920      940      960
        0       30      106      211

3.92 3.00
      878      880      890      900
        0       30       80      581

4.40 3.48
      798      800      813      830
        0       30       80      784

4.93 4.01
      758      760      772      785
        0       40       70      987

5.27 4.35
    703.6    705.6      716      731
        0       22       55      334

5.65 4.73
      678      680      690      700
        0       30       75      792

6.24 5.32
      638      640      653      662
        0       30       90      789

    0.075    0.090    0.140    0.140
    0.075    0.090    0.140    0.140
    0.075    0.090    0.140    0.140
    0.075    0.090    0.140    0.140
    0.075    0.090    0.140    0.140
    0.070    0.080    0.120    0.120
    0.060    0.070    0.080    0.100
     0.02     0.02     0.10     0.10     0.10     0.10     0.10
        0        0        0        0        0        0        0        0
        0        0     0.00     0.00      170        0        0        0
```

APPENDIX B
OUTPUT DATA FILE

PROGRAM DAMBRK---VERSION-07/18/84

ANALYSIS OF THE DOWNSTREAM FLOOD HYDROGRAPH

PRODUCED BY THE DAM BREAK OF

HOWE RESERVOIR DAM

ON

MINNEWAWA BROOK

ANALYSIS BY

VOLLMER ASSOCIATES
BOSTON, MA 02116
OCTOBER 17, 1985 #081

BASED ON PROCEDURE DEVELOPED BY

DANNY L. FREAD, PH.D., RESEARCH HYDROLOGIST

HYDROLOGIC RESEARCH LABORATORY
W23, OFFICE OF HYDROLOGY
NOAA, NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

1

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*******************************
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***                         ***
***  SUMMARY OF INPUT DATA  ***
***                         ***
*******************************
*******************************
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INPUT CONTROL PARAMETERS FOR HOWE RESERVOIR DAM

PARAMETER	VARIABLE	VALUE
NUMBER OF DYNAMIC ROUTING REACHES	KKN	1
TYPE OF RESERVOIR ROUTING	KUI	0
MULTIPLE DAM INDICATOR	MULDAM	0
PRINTING INSTRUCTIONS FOR INPUT SUMMARY	KOMP	0
NO. OF RESERVOIR INFLOW HYDROGRAPH POINTS	ITEH	4
INTERVAL OF CROSS-SECTION INFO PRINTED OUT WHEN JNK=9	NPRT	0
FLOOD-PLAIN MODEL PARAMETER	KFLP	0
LANDSLIDE PARAMETER	KSL	0

HOWE RESERVOIR DAM RESERVOIR

TABLE OF ELEVATION VS VOLUME

VOLUME (ACRE-FEET) SA(K)	ELEVATION (FT) HSA(K)

2230.0	1277.50
1610.0	1274.50
1215.0	1272.50
826.0	1270.00
528.0	1267.50
298.0	1265.00
126.0	1262.50
.0	1259.50

HOWE RESERVOIR DAM RESERVOIR

TABLE OF ELEVATION VS SURFACE AREA

SURFACE AREA (ACRES) SA(K)	ELEVATION (FT) HSA(K)
220.5	1277.50
192.8	1274.50
202.2	1272.50
109.0	1270.00
129.4	1267.50
54.6	1265.00
83.0	1262.50
1.0	1259.50

1

HOWE RESERVOIR DAM RESERVOIR AND BREACH PARAMETERS

PARAMETER	UNITS	VARIABLE	VALUE
LENGTH OF RESERVOIR	MI	RLM	1.80
ELEVATION OF WATER SURFACE	FT	YO	1278.10
SIDE SLOPE OF BREACH		Z	.00
ELEVATION OF BOTTOM OF BREACH	FT	YBMIN	1256.00
WIDTH OF BASE OF BREACH	FT	BB	60.00
TIME TO MAXIMUM BREACH SIZE	HR	TFH	.50
ELEVATION (MSL) OF BOTTOM OF DAM	FT	DATUM	1256.00
VOLUME-SURFACE AREA PARAMETER		VOL	1.00

ELEVATION OF WATER WHEN BREACHED	FT	HF	1278.10
ELEVATION OF TOP OF DAM	FT	HD	1276.50
ELEVATION OF UNCONTROLLED SPILLWAY CREST	FT	HSP	1274.50
ELEVATION OF CENTER OF GATE OPENINGS	FT	HGT	.00
DISCHARGE COEF. FOR UNCONTROLLED SPILLWAY		CS	.00
DISCHARGE COEF. FOR GATE FLOW		CG	.00
DISCHARGE COEF. FOR UNCONTROLLED WEIR FLOW		CDO	.00
DISCHARGE THRU TURBINES	CFS	QT	.00

CDO SHOULD NOT BE 0.00 IF OVERTOPPING MAY OCCUR

QSPILL(K,1)	HEAD(K,1)
0.	.0
50.	.5
250.	1.0
450.	1.5
650.	2.0
850.	2.5
1600.	3.5
2500.	4.5

DHF(INTERVAL BETWEEN INPUT HYDROGRAPH ORDINATES) = 1.00 HRS.

TEH(TIME AT WHICH COMPUTATIONS TERMINATE) = 3.0000 HRS.

INFLOW HYDROGRAPH TO HOWE RESERVOIR DAM
****

1700.00 1700.00 1700.00 1700.00

TIME OF INFLOW HYDROGRAPH ORDINATES

.0000 1.0000 2.0000 3.0000

1

CROSS-SECTIONAL PARAMETERS FOR MINNEWAWA BROOK
BELOW HOWE RESERVOIR DAM

PARAMETER	VARIABLE	VALUE
NUMBER OF CROSS-SECTIONS	NS	2
MAXIMUM NUMBER OF TOP WIDTHS	NCS	4
NUMBER OF CROSS-SECTIONAL HYDROGRAPHS TO PLOT	NTT	2
TYPE OF OUTPUT OTHER THAN HYDROGRAPH PLOTS	JNK	4
CROSS-SECTIONAL SMOOTHING PARAMETER	KSA	0
DOWNSTREAM SUPERCRITICAL OR NOT	KSUPC	0
NO. OF LATERAL INFLOW HYDROGRAPHS	LQ	0
NO. OF POINTS IN GATE CONTROL CURVE	KCG	0

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)

1 2

CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW HOWE RESERVOIR DAM

PARAMETER	UNITS	VARIABLE
LOCATION OF CROSS-SECTION	MI	XS(I)
ELEVATION (MSL) OF FLOODING AT CROSS-SECTION	FT	FSTG(I)
ELEV CORRESPONDING TO EACH TOP WIDTH	FT	HS(K,I)

```
TOP WIDTH CORRESPONDING TO EACH ELEV        FT     BS(K,I)
     (ACTIVE FLOW PORTION)
TOP WIDTH CORRESPONDING TO EACH ELEV        FT    BSS(K,I)
     (OFF-CHANNEL PORTION)

SURFACE AREA CORRESPONDING TO EACH ELEV    ACRES   OSA(K,I)
     (ACTIVE FLOW PORTION)
SURFACE AREA CORRESPONDING TO EACH ELEV    ACRES   SSA(K,I)
     (OFF-CHANNEL PORTION)

NUMBER OF CROSS-SECTION                             I
NUMBER OF ELEVATION LEVEL                           K
```

```
CROSS-SECTION NUMBER  1
*************************

XS(I) =    .020   FSTG(I) =     .00         XSL(I) =      .0         XSR(I) =      .0


HS  ...   1251.2  1253.0  1272.0  1300.0
BS  ...      .0    42.0    95.0   898.0
BSS ...      .0      .0      .0      .0
```

```
CROSS-SECTION NUMBER  2
*************************

XS(I) =    .160   FSTG(I) =     .00         XSL(I) =      .0         XSR(I) =      .0


HS  ...   1199.0  1200.0  1220.0  1240.0
BS  ...      .0    25.0   106.0   317.0
BSS ...      .0      .0      .0      .0
```

```
MANNING N ROUGHNESS COEFFICIENTS FOR THE GIVEN REACHES
       (CM(K,I),K=1,NCS) WHERE I = REACH NUMBER
*****************************************************

REACH  1 ...  .075   .085   .100   .140
```

CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW HOWE RESERVOIR DAM

PARAMETER	UNITS	VARIABLE
MINIMUM COMPUTATIONAL DISTANCE USED BETWEEN CROSS-SECTIONS	MI	DXM(I)
CONTRACTION - EXPANSION COEFFICIENTS BETWEEN CROSS-SECTIONS		FKC(I)

REACH NUMBER	DXM(I)	FKC(I)
1	.050	.000

1

DOWNSTREAM FLOW PARAMETERS FOR MINNEWAWA BROOK
BELOW HOWE RESERVOIR DAM

PARAMETER	UNITS	VARIABLE	VALUE
MAX DISCHARGE AT DOWNSTREAM EXTREMITY	CFS	QMAXD	.0
MAX LATERAL OUTFLOW PRODUCING LOSSES	CFS/FT	QLL	.000
INITIAL SIZE OF TIME STEP	HR	DTHM	.0000
INITIAL WATER SURFACE ELEVATION DOWNSTREAM	FT	YDN	.00
SLOPE OF CHANNEL DOWNSTREAM OF DAM	FT/MI	SOM	370.00
THETA WEIGHTING FACTOR		THETA	.00
CONVERGENCE CRITERION FOR STAGE	FT	EPSY	.000
TIME AT WHICH DAM STARTS TO FAIL	HR	TFI	3.00

1

```
*******************************
*******************************
***                         ***
***  SUMMARY OF OUTPUT DATA  ***
***                         ***
*******************************
*******************************
```

CROSS-SECTION NO.	MILE	BOTTOM ELEVATION FEET	REACH NO.	REACH LENGTH MILES	SLOPE FT/MI	MESAGE
1	.02	1251.20				
2	.16	1199.00	1	.14	372.86	

TOTAL NUMBER OF CROSS SECTIONS (ORIGINAL+INTERPOLATED) (N) = 3 (MAXIMUM ALLOWABLE = 200

SLOPE INFORMATION FOR INPUT REACHES

REACH NO.	WATER ELEVATION FEET	HYDRAULIC DEPTH FEET	BOTTOM SLOPE FT/MI	DYNAMIC SLOPE FT/MI	TOTAL SLOPE FT/MI	CRITICAL SLOPE FT/MI	MANNING'S N
1	1225.10	.38	372.86	.48	373.34	1233.53	.108
1	1226.50	.75	372.86	.65	373.50	1072.25	.112
1	1246.00	13.24	372.86	2.01	374.87	468.66	.120
1	1270.00	17.11	372.86	2.46	375.31	585.64	.140

TOTAL VOLUME IN RESERVOIR BEHIND
HOWE RESERVOIR DAM = 2230.0 ACRE-FEET

DEFINITION OF VARIABLES IN RESERVOIR DEPLETION TABLE

PARAMETER	UNITS	VARIABLE
TIME STEP FROM START OF ANALYSIS		I
ITERATIONS NECESSARY TO SOLVE FLOW EQUATIONS		K
ELAPSED TIME FROM START OF ANALYSIS	HRS	TTP(I)
TOTAL OUTFLOW FROM DAM	CFS	Q(I)
ELEVATION OF WATER SURFACE AT DAM	FT	H2
ELEVATION OF BOTTOM OF BREACH	FT	YB
EST DEPTH OF FLOW IMMEDIATELY DOWNSTREAM	FT	D
SUBMERGENCE COEFFICIENT		SUB
VELOCITY CORRECTION		VCOR
TOTAL VOLUME DISCHARGED FROM TIME OF BREACH	AC-FT	OUTVOL
BREACH WIDTH FT BB		
RECTANGULAR BREACH DISCHARGE COEFFICIENT		COFR
INFLOW TO RESERVOIR	CFS	QI(I)
BREACH OUTFLOW	CFS	QBRECH
SPILLWAY OUTFLOW	CFS	QSPIL

RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****

1	0	.000	1689	1278.10	1276.50	1256.07	1.00	1.00	.0	.0	3.10	1700.	0.	1690.
2	1	.010	1700	1278.10	1276.09	1256.08	1.00	1.01	1.4	1.2	3.10	1700.	11.	1690.
3	1	.020	1718	1278.10	1275.68	1256.11	1.00	1.01	2.8	2.4	3.10	1700.	28.	1690.
4	1	.030	1743	1278.10	1275.27	1256.14	1.00	1.01	4.2	3.6	3.10	1700.	54.	1690.
5	1	.040	1777	1278.10	1274.86	1256.19	1.00	1.01	5.7	4.8	3.10	1700.	88.	1690.
6	1	.050	1820	1278.10	1274.45	1256.25	1.00	1.01	7.2	6.0	3.10	1700.	131.	1689.
7	1	.060	1873	1278.10	1274.04	1256.32	1.00	1.01	8.7	7.2	3.10	1700.	184.	1689.
8	1	.070	1936	1278.10	1273.63	1256.40	1.00	1.01	10.3	8.4	3.10	1700.	248.	1688.
9	1	.080	2010	1278.10	1273.22	1256.50	1.00	1.01	11.9	9.6	3.10	1700.	323.	1687.
10	1	.090	2096	1278.10	1272.81	1256.61	1.00	1.01	13.6	10.8	3.10	1700.	410.	1686.
11	1	.100	2194	1278.09	1272.40	1256.73	1.00	1.01	15.4	12.0	3.10	1700.	510.	1685.
12	1	.110	2305	1278.09	1271.99	1256.87	1.00	1.01	17.2	13.2	3.10	1700.	622.	1683.
13	1	.120	2428	1278.09	1271.58	1257.02	1.00	1.01	19.2	14.4	3.10	1700.	748.	1681.
14	1	.130	2566	1278.09	1271.17	1257.18	1.00	1.01	21.3	15.6	3.10	1700.	888.	1678.
15	1	.140	2717	1278.08	1270.76	1257.35	1.00	1.01	23.5	16.8	3.10	1700.	1042.	1675.
16	1	.150	2882	1278.08	1270.35	1257.54	1.00	1.01	25.8	18.0	3.10	1700.	1212.	1671.
17	1	.160	3063	1278.07	1269.94	1257.74	1.00	1.01	28.2	19.2	3.10	1700.	1396.	1667.
18	1	.170	3259	1278.07	1269.53	1257.95	1.00	1.01	30.8	20.4	3.10	1700.	1597.	1662.
19	1	.180	3470	1278.06	1269.12	1258.17	1.00	1.01	33.6	21.6	3.10	1700.	1814.	1657.
20	1	.190	3698	1278.06	1268.71	1258.40	1.00	1.02	36.6	22.8	3.10	1700.	2048.	1651.
21	1	.200	3942	1278.05	1268.30	1258.64	1.00	1.02	39.7	24.0	3.10	1700.	2299.	1644.
22	1	.210	4204	1278.04	1267.89	1258.89	1.00	1.02	43.1	25.2	3.10	1700.	2568.	1636.
23	1	.220	4482	1278.03	1267.48	1259.15	1.00	1.02	46.7	26.4	3.10	1700.	2856.	1627.
24	1	.230	4779	1278.02	1267.07	1259.43	1.00	1.02	50.5	27.6	3.10	1700.	3162.	1617.
25	1	.240	5094	1278.01	1266.66	1259.71	1.00	1.02	54.6	28.8	3.10	1700.	3488.	1607.
26	1	.250	5429	1277.99	1266.25	1260.01	1.00	1.03	58.9	30.0	3.10	1700.	3834.	1596.
27	1	.260	5784	1277.98	1265.84	1260.32	1.00	1.03	63.6	31.2	3.10	1700.	4200.	1585.
28	1	.270	6160	1277.96	1265.43	1260.63	1.00	1.03	68.5	32.4	3.10	1700.	4588.	1573.
29	1	.280	6557	1277.95	1265.02	1260.96	1.00	1.04	73.8	33.6	3.10	1700.	4997.	1560.
30	1	.290	6976	1277.93	1264.61	1261.29	1.00	1.04	79.4	34.8	3.10	1700.	5430.	1546.
31	1	.300	7417	1277.91	1264.20	1261.64	1.00	1.04	85.3	36.0	3.10	1700.	5886.	1531.
32	1	.310	7881	1277.89	1263.79	1261.99	1.00	1.05	91.6	37.2	3.10	1700.	6367.	1515.
33	1	.320	8370	1277.86	1263.38	1262.35	1.00	1.05	98.4	38.4	3.10	1700.	6873.	1497.
34	1	.330	8884	1277.84	1262.97	1262.72	1.00	1.06	105.5	39.6	3.10	1700.	7406.	1478.
35	1	.340	9424	1277.81	1262.56	1263.10	1.00	1.06	113.0	40.8	3.10	1700.	7967.	1457.
36	1	.350	9992	1277.78	1262.15	1263.49	1.00	1.07	121.1	42.0	3.10	1700.	8558.	1435.
37	1	.360	10591	1277.75	1261.74	1263.89	1.00	1.08	129.6	43.2	3.10	1700.	9180.	1411.
38	1	.370	11220	1277.71	1261.33	1264.30	1.00	1.09	138.6	44.4	3.10	1700.	9835.	1385.
39	1	.380	11883	1277.68	1260.92	1264.73	1.00	1.09	148.1	45.6	3.10	1700.	10526.	1358.
40	1	.390	12582	1277.64	1260.51	1265.16	1.00	1.10	158.2	46.8	3.10	1700.	11254.	1329.
41	1	.400	13320	1277.60	1260.10	1265.61	1.00	1.12	169.0	48.0	3.10	1700.	12023.	1297.
42	1	.410	14100	1277.55	1259.69	1266.08	1.00	1.13	180.3	49.2	3.10	1700.	12837.	1263.
43	1	.420	14927	1277.50	1259.28	1266.55	1.00	1.14	192.3	50.4	3.10	1700.	13700.	1227.
44	1	.430	15806	1277.45	1258.87	1267.05	1.00	1.16	205.0	51.6	3.10	1700.	14617.	1189.
45	1	.440	16742	1277.40	1258.46	1267.57	1.00	1.17	218.4	52.8	3.10	1700.	15595.	1148.
46	1	.450	17744	1277.34	1258.05	1268.11	1.00	1.19	232.7	54.0	3.10	1700.	16640.	1104.
47	1	.460	18820	1277.28	1257.64	1268.67	1.00	1.22	247.8	55.2	3.10	1700.	17764.	1057.
48	1	.470	19983	1277.21	1257.23	1269.27	1.00	1.24	263.8	56.4	3.10	1700.	18977.	1007.
49	1	.480	21249	1277.14	1256.82	1269.90	1.00	1.27	280.9	57.6	3.10	1700.	20297.	953.
50	1	.490	22635	1277.06	1256.41	1270.57	1.00	1.31	299.0	58.8	3.10	1700.	21741.	895.

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****
51	1	.500	24066	1276.98	1256.00	1271.25	.99	1.35	318.3	60.0	3.10	1700.	23225.	841.
52	1	.510	24474	1276.89	1256.00	1271.44	.99	1.36	338.4	60.0	3.10	1700.	23669.	806.
53	1	.520	24555	1276.80	1256.00	1271.47	.99	1.37	358.6	60.0	3.10	1700.	23785.	771.
54	1	.530	24497	1276.71	1256.00	1271.44	.99	1.38	378.9	60.0	3.10	1700.	23762.	736.
55	1	.540	24381	1276.63	1256.00	1271.39	.99	1.38	399.1	60.0	3.10	1700.	23681.	700.
56	1	.550	24241	1276.54	1256.00	1271.32	.99	1.38	419.2	60.0	3.10	1700.	23576.	665.
57	1	.560	24091	1276.45	1256.00	1271.26	.99	1.38	439.1	60.0	3.10	1700.	23462.	630.
58	1	.570	23938	1276.36	1256.00	1271.18	.99	1.38	459.0	60.0	3.10	1700.	23344.	595.
59	1	.580	23784	1276.27	1256.00	1271.11	.99	1.39	478.7	60.0	3.10	1700.	23225.	560.
60	1	.590	23630	1276.19	1256.00	1271.04	.99	1.39	498.3	60.0	3.10	1700.	23105.	525.
61	1	.600	23476	1276.10	1256.00	1270.97	.99	1.39	517.8	60.0	3.10	1700.	22986.	490.
62	1	.610	23322	1276.01	1256.00	1270.89	.99	1.39	537.1	60.0	3.10	1700.	22867.	456.
63	1	.620	23168	1275.93	1256.00	1270.82	.99	1.39	556.3	60.0	3.10	1700.	22748.	421.
64	1	.630	23016	1275.84	1256.00	1270.75	.99	1.39	575.4	60.0	3.10	1700.	22629.	387.
65	1	.640	22863	1275.76	1256.00	1270.68	.99	1.39	594.4	60.0	3.10	1700.	22511.	353.
66	1	.650	22712	1275.67	1256.00	1270.60	.99	1.40	613.2	60.0	3.10	1700.	22394.	318.
67	1	.660	22560	1275.59	1256.00	1270.53	.99	1.40	631.9	60.0	3.10	1700.	22276.	284.
68	1	.670	22409	1275.50	1256.00	1270.46	.99	1.40	650.5	60.0	3.10	1700.	22160.	250.
69	1	.680	22259	1275.42	1256.00	1270.39	.99	1.40	668.9	60.0	3.10	1700.	22043.	217.
70	1	.690	22109	1275.33	1256.00	1270.31	.99	1.40	687.3	60.0	3.10	1700.	21927.	183.
71	1	.700	21960	1275.25	1256.00	1270.24	.99	1.40	705.5	60.0	3.10	1700.	21811.	149.
72	1	.710	21811	1275.16	1256.00	1270.17	.99	1.40	723.6	60.0	3.10	1700.	21696.	116.
73	1	.720	21663	1275.08	1256.00	1270.10	.99	1.41	741.5	60.0	3.10	1700.	21581.	82.
74	1	.730	21515	1275.00	1256.00	1270.03	.99	1.41	759.4	60.0	3.10	1700.	21466.	50.
75	1	.740	21388	1274.92	1256.00	1269.96	.99	1.41	777.1	60.0	3.10	1700.	21347.	42.
76	1	.750	21271	1274.83	1256.00	1269.91	.99	1.41	794.7	60.0	3.10	1700.	21238.	33.
77	1	.760	21159	1274.75	1256.00	1269.85	.99	1.41	812.3	60.0	3.10	1700.	21134.	25.
78	1	.770	21049	1274.67	1256.00	1269.80	.99	1.42	829.7	60.0	3.10	1700.	21033.	17.
79	1	.780	20941	1274.59	1256.00	1269.74	.99	1.42	847.1	60.0	3.10	1700.	20933.	9.
80	1	.790	20833	1274.50	1256.00	1269.69	.99	1.42	864.3	60.0	3.10	1700.	20833.	0.
81	1	.800	20733	1274.42	1256.00	1269.64	.99	1.43	881.5	60.0	3.10	1700.	20734.	0.
82	1	.810	20637	1274.34	1256.00	1269.59	.99	1.43	898.6	60.0	3.10	1700.	20638.	0.
83	1	.820	20544	1274.26	1256.00	1269.55	.99	1.43	915.6	60.0	3.10	1700.	20545.	0.
84	1	.830	20453	1274.18	1256.00	1269.50	.99	1.44	932.6	60.0	3.10	1700.	20453.	0.
85	1	.840	20362	1274.10	1256.00	1269.45	.99	1.44	949.4	60.0	3.10	1700.	20363.	0.
86	1	.850	20273	1274.02	1256.00	1269.41	.99	1.44	966.2	60.0	3.10	1700.	20273.	0.
87	1	.860	20184	1273.94	1256.00	1269.36	.99	1.45	982.9	60.0	3.10	1700.	20185.	0.
88	1	.870	20097	1273.86	1256.00	1269.32	.99	1.45	999.6	60.0	3.10	1700.	20097.	0.
89	1	.880	20010	1273.79	1256.00	1269.28	.99	1.46	1016.2	60.0	3.10	1700.	20010.	0.
90	1	.890	19923	1273.71	1256.00	1269.23	.99	1.46	1032.7	60.0	3.10	1700.	19924.	0.
91	1	.900	19838	1273.63	1256.00	1269.19	.99	1.46	1049.1	60.0	3.10	1700.	19838.	0.
92	1	.910	19753	1273.56	1256.00	1269.15	.99	1.47	1065.5	60.0	3.10	1700.	19753.	0.
93	1	.920	19669	1273.48	1256.00	1269.10	.99	1.47	1081.7	60.0	3.10	1700.	19669.	0.
94	1	.930	19585	1273.41	1256.00	1269.06	.99	1.47	1098.0	60.0	3.10	1700.	19586.	0.
95	1	.940	19502	1273.33	1256.00	1269.02	.99	1.48	1114.1	60.0	3.10	1700.	19503.	0.

96	1	.950	19420	1273.26	1256.00	1268.98	.98	1.48	1130.2	60.0	3.10	1700.	19421.	0.
97	1	.960	19339	1273.19	1256.00	1268.94	.98	1.49	1146.2	60.0	3.10	1700.	19339.	0.
98	1	.970	19258	1273.11	1256.00	1268.89	.98	1.49	1162.2	60.0	3.10	1700.	19258.	0.
99	1	.980	19177	1273.04	1256.00	1268.85	.98	1.49	1178.0	60.0	3.10	1700.	19178.	0.
100	1	.990	19098	1272.97	1256.00	1268.81	.98	1.50	1193.9	60.0	3.10	1700.	19098.	0.

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****
101	1	1.000	19019	1272.90	1256.00	1268.77	.98	1.50	1209.6	60.0	3.10	1700.	19019.	0.
102	1	1.010	18940	1272.83	1256.00	1268.73	.98	1.51	1225.3	60.0	3.10	1700.	18941.	0.
103	1	1.021	18850	1272.75	1256.00	1268.69	.98	1.51	1242.5	60.0	3.10	1700.	18851.	0.
104	1	1.033	18751	1272.66	1256.00	1268.64	.98	1.52	1261.3	60.0	3.10	1700.	18751.	0.
105	1	1.046	18641	1272.57	1256.00	1268.58	.98	1.52	1281.8	60.0	3.10	1700.	18642.	0.
106	1	1.061	18522	1272.47	1256.00	1268.52	.98	1.53	1304.3	60.0	3.10	1700.	18522.	0.
107	2	1.077	18383	1272.36	1256.00	1268.44	.98	1.53	1328.9	60.0	3.10	1700.	18383.	0.
108	2	1.095	18239	1272.23	1256.00	1268.37	.98	1.54	1355.7	60.0	3.10	1700.	18239.	0.
109	2	1.114	18074	1272.09	1256.00	1268.28	.98	1.55	1384.9	60.0	3.10	1700.	18075.	0.
110	2	1.136	17889	1271.94	1256.00	1268.18	.98	1.56	1416.8	60.0	3.10	1700.	17889.	0.
111	2	1.159	17680	1271.76	1256.00	1268.07	.98	1.57	1451.5	60.0	3.10	1700.	17680.	0.
112	2	1.185	17443	1271.56	1256.00	1267.94	.97	1.58	1489.1	60.0	3.10	1700.	17444.	0.
113	2	1.214	17175	1271.33	1256.00	1267.80	.97	1.60	1529.9	60.0	3.10	1700.	17175.	0.
114	2	1.245	16868	1271.08	1256.00	1267.63	.97	1.61	1574.1	60.0	3.10	1700.	16868.	0.
115	2	1.280	16492	1270.78	1256.00	1267.43	.97	1.62	1621.7	60.0	3.10	1700.	16493.	0.
116	2	1.318	16025	1270.43	1256.00	1267.17	.97	1.64	1672.7	60.0	3.10	1700.	16025.	0.
117	2	1.359	15471	1270.02	1256.00	1266.86	.97	1.66	1727.1	60.0	3.10	1700.	15472.	0.
118	2	1.405	14870	1269.56	1256.00	1266.52	.97	1.68	1784.7	60.0	3.10	1700.	14870.	0.
119	1	1.456	14273	1269.09	1256.00	1266.18	.97	1.70	1845.5	60.0	3.10	1700.	14273.	0.
120	1	1.512	13676	1268.61	1256.00	1265.83	.96	1.73	1909.7	60.0	3.10	1700.	13676.	0.
121	1	1.573	13079	1268.13	1256.00	1265.47	.96	1.76	1977.4	60.0	3.10	1700.	13080.	0.
122	1	1.640	12484	1267.64	1256.00	1265.11	.96	1.79	2048.4	60.0	3.10	1700.	12485.	0.
123	2	1.714	11854	1267.12	1256.00	1264.71	.96	1.83	2122.9	60.0	3.10	1700.	11855.	0.
124	2	1.795	11119	1266.52	1256.00	1264.24	.96	1.87	2200.1	60.0	3.10	1700.	11120.	0.
125	2	1.885	10216	1265.77	1256.00	1263.66	.96	1.94	2279.1	60.0	3.10	1700.	10217.	0.
126	3	1.983	9092	1264.81	1256.00	1262.87	.96	2.00	2357.7	60.0	3.10	1700.	9093.	0.
127	2	2.092	7928	1263.83	1256.00	1262.02	.97	2.00	2433.9	60.0	3.10	1700.	7928.	0.
128	2	2.211	6895	1263.05	1256.00	1261.22	.99	2.00	2506.9	60.0	3.10	1700.	6896.	0.
129	2	2.342	6007	1262.39	1256.00	1260.51	1.00	2.00	2576.8	60.0	3.10	1700.	6008.	0.
130	1	2.486	5126	1261.75	1256.00	1259.73	1.00	2.00	2643.2	60.0	3.10	1700.	5126.	0.
131	2	2.645	4171	1261.01	1256.00	1258.86	1.00	2.00	2704.1	60.0	3.10	1700.	4171.	0.
132	3	2.819	3057	1260.07	1256.00	1257.73	1.00	2.00	2756.2	60.0	3.10	1700.	3057.	0.
133	0	3.20	2751											

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PARAMETER	UNITS	VARIABLE	VALUE
INITIAL FLOW	CFS	Q(1)	1690.
MAX FLOW	CFS	QM	24556.
FINAL FLOW	CFS	Q(NU)	2751.
TIME TO MAX FLOW	HRS	TP	.52
NUMBER OF TIME STEPS		NNU	133
TOTAL VOLUME DISCHARGED FROM RESERVOIR	AC-FT	DISVOL	2756.

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INITIAL CONDITIONS

I	K	X(I)	YD(I)	QDI(I)	FRD	SOM
3	3	.160	1204.30	1689.98	.98	372.857
3	0	.160	1204.30	1689.98		
2	3	.090	1230.04	1689.98	.96	
1	3	.020	1255.80	1689.98	.98	

I	X(I)	YD(I)	YNORM(I)
1	.02	1255.80	1255.80
2	.09	1230.04	1230.04
3	.16	1204.30	1204.30

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TIME PARAMETERS OF OUTFLOW HYDROGRAPH IMMEDIATELY DOWNSTREAM OF DAM

PARAMETER	UNITS	VARIABLE	VALUE
TIME TO FAILURE	HR	TFH	.500
TIME TO START OF RISING LIMB OF HYDROGRAPH	HR	TFO	.020
TIME TO PEAK	HR	TP	.520

TIME STEP SIZE HR DTHI .025

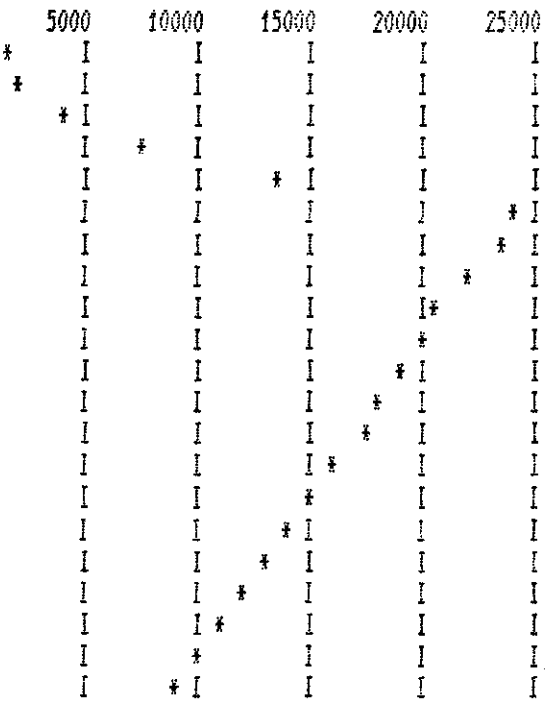
PROFILE OF CRESTS AND TIMES FOR MINNEWAWA BROOK
BELOW HOWE RESERVOIR DAM

RVR MILE FROM DAM	MAX ELEV (FT)	MAX FLOW (CFS)	TIME MAX ELEV(HR)	MAX VEL (FT/SEC)	FLOOD ELEV (FT)	TIME FLOOD ELEV(HR)
********	********	********	********	********	**********	**********
.020	1269.79	24526	.525	21.59	.00	.00
.090	1244.19	24663	.525	21.37	.00	.00
.160	1218.85	24649	.525	20.49	.00	.00

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 1
BELOW HOWE RESERVOIR DAM AT MILE .02

GAGE ZERO = 1251.20 MAX ELEVATION REACHED BY FLOOD WAVE = 1269.79
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 18.59 AT TIME = .525 HOURS
MAX FLOW = 24527 AT TIME = .525 HOURS

HR	STAGE	FLOW
.0	4.6	1690
.1	5.2	2194
.2	7.1	3943
.3	9.8	7417
.4	13.4	13320
.5	18.4	24066
.6	18.2	23476
.7	17.6	21960
.8	17.0	20734
.9	16.6	19838
1.0	16.3	19019
1.1	15.9	18196
1.2	15.5	17305
1.3	14.9	16243
1.4	14.3	14942
1.5	13.7	13803
1.6	13.2	12839
1.7	12.7	11974
1.8	12.2	11071
1.9	11.6	10043
2.0	10.9	8916



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2.1   10.2    7868 I        I     *  I        I        I        I
2.2    9.5    6999 I        I   *    I        I        I        I
2.3    9.0    6293 I        I  *     I        I        I        I
2.4    8.5    5654 I        I*       I        I        I        I
2.5    8.0    5044 I        *        I        I        I        I
2.6    7.5    4442 I       *I        I        I        I        I
2.7    7.0    3820 I      * I        I        I        I        I
2.8    6.3    3187 I    *   I        I        I        I        I
2.9    6.1    2993 I    *   I        I        I        I        I
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DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 3
BELOW HOWE RESERVOIR DAM AT MILE .16

GAGE ZERO = 1199.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1218.85
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 19.85 AT TIME = .525 HOURS
MAX FLOW = 24649 AT TIME = .525 HOURS

```
HR   STAGE     FLOW 0      5000     10000     15000     20000     25000
 .0    5.3     1694 I *      I        I        I        I        I
 .1    5.9     2074 I  *     I        I        I        I        I
 .2    7.8     3675 I     *  I        I        I        I        I
 .3   10.8     6996 I        I   *    I        I        I        I
 .4   14.4    12699 I        I        I    *   I        I        I
 .5   19.2    22972 I        I        I        I        I     *  I
 .6   19.5    23603 I        I        I        I        I      * I
 .7   18.9    22077 I        I        I        I        I   *    I
 .8   18.4    20815 I        I        I        I        I *      I
 .9   18.0    19905 I        I        I        I        *        I
1.0   17.6    19082 I        I        I        I       * I       I
1.1   17.2    18261 I        I        I        I      *  I       I
1.2   16.8    17380 I        I        I        I    *    I       I
1.3   16.3    16341 I        I        I        I  *      I       I
1.4   15.7    15050 I        I        I        *         I       I
1.5   15.1    13891 I        I        I       * I        I       I
1.6   14.6    12915 I        I        I     *   I        I       I
1.7   14.1    12048 I        I        I   *     I        I       I
1.8   13.6    11153 I        I        I *       I        I       I
1.9   13.0    10141 I        I        *         I        I       I
2.0   12.3     9017 I        I      * I         I        I       I
2.1   11.5     7960 I        I     *  I         I        I       I
2.2   10.9     7080 I        I   *    I         I        I       I
2.3   10.3     6361 I        I  *     I         I        I       I
2.4    9.8     5716 I        I*       I         I        I       I
2.5    9.3     5107 I        *        I         I        I       I
2.6    8.7     4506 I       *I        I         I        I       I
2.7    8.1     3891 I      * I        I         I        I       I
2.8    7.4     3258 I     *  I        I         I        I       I
2.9    7.1     3003 I    *   I        I         I        I       I
```

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DATE: 10/30/85
FILE: HRD1DB1.DAT

DAMBRK - Version..10/25/84

CPU Time (HH:MM:SS)....00:02:22

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PROGRAM DAMBRK---VERSION-07/18/84

ANALYSIS OF THE DOWNSTREAM FLOOD HYDROGRAPH

PRODUCED BY THE DAM BREAK OF

RUSSELL RES. DAM

ON

MINNEWAWA BROOK

ANALYSIS BY

VOLLMER ASSOCIATES
BOSTON, MA 02116
NOVEMBER 1, 1985 #DB1

BASED ON PROCEDURE DEVELOPED BY

DANNY L. FREAD, PH.D., RESEARCH HYDROLOGIST
HYDROLOGIC RESEARCH LABORATORY
W23, OFFICE OF HYDROLOGY

NOAA, NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

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***                        ***
***  SUMMARY OF INPUT DATA ***
***                        ***
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INPUT CONTROL PARAMETERS FOR RUSSELL RES. DAM

PARAMETER	VARIABLE	VALUE
NUMBER OF DYNAMIC ROUTING REACHES	KKN	1
TYPE OF RESERVOIR ROUTING	KUI	0
MULTIPLE DAM INDICATOR	MULDAM	0
PRINTING INSTRUCTIONS FOR INPUT SUMMARY	KDMP	0
NO. OF RESERVOIR INFLOW HYDROGRAPH POINTS	ITEH	11
INTERVAL OF CROSS-SECTION INFO PRINTED OUT WHEN JNK=9	NPRT	0
FLOOD-PLAIN MODEL PARAMETER	KFLP	0
LANDSLIDE PARAMETER	KSL	0

RUSSELL RES. DAM RESERVOIR

TABLE OF ELEVATION VS VOLUME

VOLUME (ACRE-FEET) SA(K)	ELEVATION (FT) HSA(K)
1753.0	1200.00
353.0	1180.00

200.0	1177.00
.0	1167.00
.0	.00
.0	.00
.0	.00
.0	.00

RUSSELL RES. DAM RESERVOIR

TABLE OF ELEVATION VS SURFACE AREA

SURFACE AREA (ACRES) SA(K)	ELEVATION (FT) HSA(K)
77.0	1200.00
63.0	1180.00
39.0	1177.00
1.0	1167.00
.0	.00
.0	.00
.0	.00
.0	.00

1

RUSSELL RES. DAM RESERVOIR AND BREACH PARAMETERS

PARAMETER	UNITS	VARIABLE	VALUE
LENGTH OF RESERVOIR	MI	RLM	.51
ELEVATION OF WATER SURFACE	FT	YO	1180.08
SIDE SLOPE OF BREACH		Z	.00
ELEVATION OF BOTTOM OF BREACH	FT	YBMIN	1167.00
WIDTH OF BASE OF BREACH	FT	BB	90.00
TIME TO MAXIMUM BREACH SIZE	HR	TFH	.50
ELEVATION (MSL) OF BOTTOM OF DAM	FT	DATUM	1167.00
VOLUME-SURFACE AREA PARAMETER		VOL	1.00

ELEVATION OF WATER WHEN BREACHED	FT	HF	1183.50
ELEVATION OF TOP OF DAM	FT	HD	1179.50
ELEVATION OF UNCONTROLLED SPILLWAY CREST	FT	HSP	1177.00
ELEVATION OF CENTER OF GATE OPENINGS	FT	HGT	.00
DISCHARGE COEF. FOR UNCONTROLLED SPILLWAY		CS	.00
DISCHARGE COEF. FOR GATE FLOW		CG	.00
DISCHARGE COEF. FOR UNCONTROLLED WEIR FLOW		CDO	.00
DISCHARGE THRU TURBINES	CFS	QT	.00

CDO SHOULD NOT BE 0.00 IF OVERTOPPING MAY OCCUR

QSPILL(K,1)	HEAD(K,1)
0.	.0
300.	1.0
849.	2.0
1186.	2.5
1587.	3.0
2923.	4.0
47698.	10.0
0.	.0

DHF(INTERVAL BETWEEN INPUT HYDROGRAPH ORDINATES) = .00 HRS.

TEH(TIME AT WHICH COMPUTATIONS TERMINATE) = 3.0000 HRS.

INFLOW HYDROGRAPH TO RUSSELL RES. DAM
****

1694.00	2074.00	3675.00	6996.00	12699.00	24649.00	23603.00	19082.00
9017.00	5107.00	2950.00					

TIME OF INFLOW HYDROGRAPH ORDINATES

.0000	.1000	.2000	.3000	.4000	.5250	.6000	1.0000
2.0000	2.5000	3.0000					

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CROSS-SECTIONAL PARAMETERS FOR MINNEWAWA BROOK
BELOW RUSSELL RES. DAM

PARAMETER	VARIABLE	VALUE
NUMBER OF CROSS-SECTIONS	NS	6
MAXIMUM NUMBER OF TOP WIDTHS	NCS	4
NUMBER OF CROSS-SECTIONAL HYDROGRAPHS TO PLOT	NTT	6
TYPE OF OUTPUT OTHER THAN HYDROGRAPH PLOTS	JNK	4
CROSS-SECTIONAL SMOOTHING PARAMETER	KSA	0
DOWNSTREAM SUPERCRITICAL OR NOT	KSUPC	0
NO. OF LATERAL INFLOW HYDROGRAPHS	LQ	0
NO. OF POINTS IN GATE CONTROL CURVE	KCG	0

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)

1 2 3 4 5 6

CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW RUSSELL RES. DAM

PARAMETER	UNITS	VARIABLE
LOCATION OF CROSS-SECTION	MI	XS(I)
ELEVATION (MSL) OF FLOODING AT CROSS-SECTION	FT	FSTG(I)
ELEV CORRESPONDING TO EACH TOP WIDTH	FT	HS(K,I)

```
TOP WIDTH CORRESPONDING TO EACH ELEV        FT     BS(K,I)
     (ACTIVE FLOW PORTION)
TOP WIDTH CORRESPONDING TO EACH ELEV        FT    BSS(K,I)
     (OFF-CHANNEL PORTION)

SURFACE AREA CORRESPONDING TO EACH ELEV   ACRES   DSA(K,I)
     (ACTIVE FLOW PORTION)
SURFACE AREA CORRESPONDING TO EACH ELEV   ACRES   SSA(K,I)
     (OFF-CHANNEL PORTION)

NUMBER OF CROSS-SECTION                           I
NUMBER OF ELEVATION LEVEL                         K
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CROSS-SECTION NUMBER  1
*************************

XS(I) =    .020   FSTG(I) =     .00        XSL(I) =      .0        XSR(I) =      .0


HS  ...   1159.0  1160.0  1165.0  1185.0
BS  ...      .0    25.0   120.0  1368.0
BSS ...      .0      .0      .0      .0


CROSS-SECTION NUMBER  2
*************************

XS(I) =    .390   FSTG(I) =     .00        XSL(I) =      .0        XSR(I) =      .0


HS  ...   1139.0  1140.0  1152.7  1170.0
BS  ...      .0    22.0    75.0   398.0
BSS ...      .0      .0      .0      .0


CROSS-SECTION NUMBER  3
*************************

XS(I) =    .760   FSTG(I) =     .00        XSL(I) =      .0        XSR(I) =      .0


HS  ...   1127.0  1130.0  1140.0  1160.0
```

```
BS  ...      .0    35.0   581.0   950.0
BSS ...      .0      .0      .0      .0
```

CROSS-SECTION NUMBER 4
****

```
XS(I) =  1.140   FSTG(I) =    .00        XSL(I) =     .0        XSR(I) =     .0

HS  ...  1117.0  1120.0  1140.0  1160.0
BS  ...     .0    30.0   370.0   528.0
BSS ...     .0      .0      .0      .0
```

1

CROSS-SECTION NUMBER 5
****

```
XS(I) =  1.660   FSTG(I) =    .00        XSL(I) =     .0        XSR(I) =     .0

HS  ...  1097.0  1100.0  1120.0  1140.0
BS  ...     .0    30.0   211.0   422.0
BSS ...     .0      .0      .0      .0
```

CROSS-SECTION NUMBER 6
****

```
XS(I) =  2.320   FSTG(I) =    .00        XSL(I) =     .0        XSR(I) =     .0

HS  ...  1057.0  1060.0  1080.0  1100.0
BS  ...     .0    40.0   475.0   792.0
BSS ...     .0      .0      .0      .0
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MANNING N ROUGHNESS COEFFICIENTS FOR THE GIVEN REACHES
(CM(K,I),K=1,NCS) WHERE I = REACH NUMBER

****

REACH 1 ...	.060	.075	.100	.140
REACH 2 ...	.060	.075	.100	.140
REACH 3 ...	.060	.075	.100	.140
REACH 4 ...	.060	.075	.100	.140
REACH 5 ...	.075	.085	.110	.140

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CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW RUSSELL RES. DAM

PARAMETER	UNITS	VARIABLE
MINIMUM COMPUTATIONAL DISTANCE USED BETWEEN CROSS-SECTIONS	MI	DXM(I)
CONTRACTION - EXPANSION COEFFICIENTS BETWEEN CROSS-SECTIONS		FKC(I)

REACH NUMBER	DXM(I)	FKC(I)
1	.050	.000
2	.050	.000
3	.050	.000
4	.050	.000
5	.050	.000

1

DOWNSTREAM FLOW PARAMETERS FOR MINNEWAWA BROOK
BELOW RUSSELL RES. DAM

PARAMETER	UNITS	VARIABLE	VALUE
MAX DISCHARGE AT DOWNSTREAM EXTREMITY	CFS	QMAXD	.0
MAX LATERAL OUTFLOW PRODUCING LOSSES	CFS/FT	QLL	.000
INITIAL SIZE OF TIME STEP	HR	DTHM	.0000
INITIAL WATER SURFACE ELEVATION DOWNSTREAM	FT	YDN	.00
SLOPE OF CHANNEL DOWNSTREAM OF DAM	FT/MI	SOM	43.00
THETA WEIGHTING FACTOR		THETA	.00
CONVERGENCE CRITERION FOR STAGE	FT	EPSY	.000
TIME AT WHICH DAM STARTS TO FAIL	HR	TFI	3.00

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***                         ***
***  SUMMARY OF OUTPUT DATA ***
***                         ***
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CROSS-SECTION NO.	MILE	BOTTOM ELEVATION FEET	REACH NO.	REACH LENGTH MILES	SLOPE FT/MI	MESAGE
1	.02	1159.00				
2	.39	1139.00	1	.37	54.05	
3	.76	1127.00	2	.37	32.43	
4	1.14	1117.00	3	.38	26.32	
5	1.66	1097.00	4	.52	38.46	
6	2.32	1057.00	5	.66	60.61	

TOTAL NUMBER OF CROSS SECTIONS (ORIGINAL+INTERPOLATED) (N) = 45 (MAXIMUM ALLOWABLE = 200

SLOPE INFORMATION FOR INPUT REACHES

REACH NO.	WATER ELEVATION FEET	HYDRAULIC DEPTH FEET	BOTTOM SLOPE FT/MI	DYNAMIC SLOPE FT/MI	TOTAL SLOPE FT/MI	CRITICAL SLOPE FT/MI	MANNING'S N
1	1149.00	.25	54.05	.96	55.02	1222.30	.100
1	1150.00	.50	54.05	1.31	55.36	1121.12	.108
1	1158.85	5.14	54.05	3.22	57.27	642.56	.120
1	1177.50	11.31	54.05	4.90	58.95	672.35	.140
2	1133.00	.56	32.43	1.62	34.06	935.84	.100
2	1135.00	1.11	32.43	2.21	34.64	858.37	.108
2	1146.35	5.73	32.43	4.32	36.75	619.60	.120
2	1165.00	17.18	32.43	7.36	39.80	584.87	.140
3	1122.00	.75	26.32	2.00	28.31	847.49	.100
3	1125.00	1.50	26.32	2.72	29.04	777.34	.108
3	1140.00	7.55	26.32	5.30	31.61	565.27	.120
3	1160.00	21.29	26.32	8.90	35.22	544.52	.140
4	1107.00	.75	38.46	1.65	40.11	847.49	.100
4	1110.00	1.50	38.46	2.24	40.71	777.34	.108
4	1130.00	11.19	38.46	4.98	43.44	495.76	.120
4	1150.00	22.96	38.46	7.44	45.91	531.01	.140
5	1077.00	.75	60.61	1.42	62.02	979.39	.108
5	1080.00	1.50	60.61	1.87	62.48	851.33	.112
5	1100.00	11.17	60.61	4.14	64.74	538.16	.125
5	1120.00	21.96	60.61	5.83	66.43	538.90	.140

TOTAL VOLUME IN RESERVOIR BEHIND
RUSSELL RES. DAM = 577.6 ACRE-FEET

DEFINITION OF VARIABLES IN RESERVOIR DEPLETION TABLE

PARAMETER	UNITS	VARIABLE
TIME STEP FROM START OF ANALYSIS		I
ITERATIONS NECESSARY TO SOLVE FLOW EQUATIONS		K
ELAPSED TIME FROM START OF ANALYSIS	HRS	TTP(I)
TOTAL OUTFLOW FROM DAM	CFS	Q(I)
ELEVATION OF WATER SURFACE AT DAM	FT	H2
ELEVATION OF BOTTOM OF BREACH	FT	YB
EST DEPTH OF FLOW IMMEDIATELY DOWNSTREAM	FT	D
SUBMERGENCE COEFFICIENT		SUB
VELOCITY CORRECTION		VCOR
TOTAL VOLUME DISCHARGED FROM TIME OF BREACH	AC-FT	OUTVOL
BREACH WIDTH FT BB		
RECTANGULAR BREACH DISCHARGE COEFFICIENT		COFR
INFLOW TO RESERVOIR	CFS	QI(I)
BREACH OUTFLOW	CFS	QBRECH
SPILLWAY OUTFLOW	CFS	QSPIL

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****

1	0	.000	1693	1180.08	1179.50	1166.60	1.00	1.00	.0	.0	3.10	1694.	0.	1694.
2	1	.026	1696	1180.08	1179.50	1166.59	1.00	1.00	.0	.0	3.10	1794.	0.	1696.
3	1	.052	1702	1180.09	1179.50	1166.59	1.00	1.00	.0	.0	3.10	1894.	0.	1703.
4	1	.079	1713	1180.09	1179.50	1166.61	1.00	1.00	.0	.0	3.10	1993.	0.	1714.
5	1	.105	1729	1180.11	1179.50	1166.64	1.00	1.00	.0	.0	3.10	2154.	0.	1730.
6	1	.131	1758	1180.13	1179.50	1166.67	1.00	1.00	.0	.0	3.10	2574.	0.	1758.
7	2	.157	1804	1180.16	1179.50	1166.76	1.00	1.00	.0	.0	3.10	2995.	0.	1804.
8	2	.184	1867	1180.21	1179.50	1166.86	1.00	1.00	.0	.0	3.10	3415.	0.	1867.
9	2	.210	1949	1180.27	1179.50	1166.98	1.00	1.00	.0	.0	3.10	4007.	0.	1950.
10	2	.236	2061	1180.36	1179.50	1167.13	1.00	1.00	.0	.0	3.10	4879.	0.	2062.
11	2	.263	2207	1180.46	1179.50	1167.32	1.00	1.00	.0	.0	3.10	5751.	0.	2207.
12	2	.289	2385	1180.60	1179.50	1167.54	1.00	1.00	.0	.0	3.10	6622.	0.	2385.
13	2	.315	2601	1180.76	1179.50	1167.78	1.00	1.00	.0	.0	3.10	7851.	0.	2602.
14	2	.341	2868	1180.96	1179.50	1168.06	1.00	1.00	.0	.0	3.10	9348.	0.	2869.
15	2	.368	4277	1181.18	1179.50	1169.26	1.00	1.01	.0	.0	3.10	10846.	0.	4278.
16	1	.394	5923	1181.40	1179.50	1170.34	1.00	1.01	.0	.0	3.10	12343.	0.	5923.
17	1	.420	7617	1181.63	1179.50	1171.22	1.00	1.02	.0	.0	3.10	14611.	0.	7618.
18	2	.446	9464	1181.88	1179.50	1172.11	1.00	1.03	.0	.0	3.10	17121.	0.	9464.
19	2	.473	11453	1182.14	1179.50	1172.92	1.00	1.04	.0	.0	3.10	19630.	0.	11454.
20	2	.499	13554	1182.42	1179.50	1173.68	1.00	1.04	.0	.0	3.10	22140.	0.	13554.
21	2	.525	15739	1182.72	1179.50	1174.41	1.00	1.05	.0	.0	3.10	24649.	0.	15740.
22	2	.551	17672	1182.98	1179.50	1175.00	1.00	1.05	.0	.0	3.10	24283.	0.	17673.
23	2	.578	19093	1183.17	1179.50	1175.41	1.00	1.06	.0	.0	3.10	23917.	0.	19093.
24	2	.604	20118	1183.30	1179.50	1175.69	1.00	1.06	.0	.0	3.10	23561.	0.	20118.
25	2	.630	20844	1183.40	1179.50	1175.89	1.00	1.06	.0	.0	3.10	23264.	0.	20844.
26	2	.640	21105	1183.43	1179.25	1175.96	1.00	1.10	17.3	1.8	3.10	23151.	51.	21055.
27	1	.650	21346	1183.45	1179.00	1176.03	1.00	1.09	34.9	3.6	3.10	23038.	115.	21231.
28	1	.660	21562	1183.47	1178.75	1176.09	1.00	1.09	52.6	5.4	3.10	22925.	188.	21375.
29	1	.670	21759	1183.49	1178.50	1176.14	1.00	1.09	70.5	7.2	3.10	22812.	271.	21489.
30	1	.680	21938	1183.50	1178.25	1176.18	1.00	1.08	88.6	9.0	3.10	22699.	364.	21574.
31	1	.690	22101	1183.51	1178.00	1176.22	1.00	1.08	106.8	10.8	3.10	22586.	468.	21633.
32	1	.700	22249	1183.51	1177.75	1176.26	1.00	1.08	125.1	12.6	3.10	22473.	583.	21666.
33	1	.710	22384	1183.51	1177.50	1176.30	1.00	1.07	143.5	14.4	3.10	22360.	709.	21676.
34	1	.720	22507	1183.51	1177.25	1176.33	1.00	1.07	162.1	16.2	3.10	22247.	845.	21662.
35	1	.730	22619	1183.51	1177.00	1176.36	1.00	1.07	180.7	18.0	3.10	22134.	993.	21627.
36	1	.740	22722	1183.50	1176.75	1176.38	1.00	1.07	199.5	19.8	3.10	22021.	1152.	21571.
37	1	.750	22816	1183.49	1176.50	1176.41	1.00	1.07	218.3	21.6	3.10	21908.	1322.	21495.
38	1	.760	22903	1183.48	1176.25	1176.43	1.00	1.07	237.2	23.4	3.10	21795.	1503.	21400.
39	1	.770	22982	1183.46	1176.00	1176.45	1.00	1.06	256.1	25.2	3.10	21682.	1696.	21287.
40	1	.780	23055	1183.44	1175.75	1176.47	1.00	1.06	275.2	27.0	3.10	21569.	1900.	21155.
41	1	.790	23122	1183.42	1175.50	1176.48	1.00	1.06	294.2	28.8	3.10	21456.	2116.	21006.
42	1	.800	23184	1183.40	1175.25	1176.50	1.00	1.06	313.4	30.6	3.10	21343.	2344.	20841.
43	1	.810	23242	1183.38	1175.00	1176.51	1.00	1.06	332.6	32.4	3.10	21229.	2583.	20659.
44	1	.820	23295	1183.35	1174.75	1176.52	1.00	1.06	351.8	34.2	3.10	21116.	2834.	20461.
45	1	.830	23344	1183.32	1174.50	1176.54	1.00	1.06	371.1	36.0	3.10	21003.	3097.	20248.
46	1	.840	23390	1183.29	1174.25	1176.55	1.00	1.06	390.4	37.8	3.10	20890.	3371.	20019.
47	1	.850	23433	1183.26	1174.00	1176.56	1.00	1.06	409.7	39.6	3.10	20777.	3658.	19776.
48	1	.860	23473	1183.22	1173.75	1176.57	1.00	1.06	429.1	41.4	3.10	20664.	3956.	19518.
49	1	.870	23511	1183.19	1173.50	1176.58	1.00	1.06	448.5	43.2	3.10	20551.	4266.	19245.
50	1	.880	23546	1183.15	1173.25	1176.59	1.00	1.06	468.0	45.0	3.10	20438.	4588.	18958.

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****
51	1	.890	23579	1183.11	1173.00	1176.60	1.00	1.06	487.4	46.8	3.10	20325.	4923.	18657.
52	1	.900	23611	1183.07	1172.75	1176.60	1.00	1.06	506.9	48.6	3.10	20212.	5269.	18342.
53	1	.910	23640	1183.02	1172.50	1176.61	1.00	1.06	526.5	50.4	3.10	20099.	5627.	18014.
54	1	.920	23669	1182.98	1172.25	1176.62	1.00	1.05	546.0	52.2	3.10	19986.	5998.	17671.
55	1	.930	23695	1182.93	1172.00	1176.62	1.00	1.05	565.6	54.0	3.10	19873.	6380.	17316.
56	1	.940	23721	1182.88	1171.75	1176.63	1.00	1.05	585.2	55.8	3.10	19760.	6775.	16947.
57	1	.950	23745	1182.83	1171.50	1176.64	1.00	1.05	604.8	57.6	3.10	19647.	7181.	16564.
58	1	.960	23768	1182.78	1171.25	1176.64	1.00	1.05	624.4	59.4	3.10	19534.	7600.	16169.
59	1	.970	23790	1182.72	1171.00	1176.65	1.00	1.06	644.1	61.2	3.10	19421.	8031.	15760.
60	1	.980	23812	1182.66	1170.75	1176.65	1.00	1.06	663.8	63.0	3.10	19308.	8474.	15338.
61	1	.990	23832	1182.61	1170.50	1176.66	1.00	1.06	683.4	64.8	3.10	19195.	8929.	14904.
62	1	1.000	23852	1182.55	1170.25	1176.66	1.00	1.06	703.2	66.6	3.10	19082.	9396.	14456.
63	1	1.010	23871	1182.48	1170.00	1176.67	1.00	1.06	722.9	68.4	3.10	18981.	9876.	13996.
64	1	1.020	23891	1182.42	1169.75	1176.67	1.00	1.06	742.6	70.2	3.10	18881.	10367.	13524.
65	1	1.030	23912	1182.36	1169.50	1176.68	1.00	1.06	762.4	72.0	3.10	18780.	10872.	13041.
66	1	1.040	23933	1182.29	1169.25	1176.68	1.00	1.06	782.1	73.8	3.10	18679.	11388.	12545.
67	1	1.050	23954	1182.22	1169.00	1176.69	1.00	1.06	801.9	75.6	3.10	18579.	11918.	12037.
68	1	1.060	23976	1182.15	1168.75	1176.69	1.00	1.06	821.7	77.4	3.10	18478.	12459.	11518.
69	1	1.070	23999	1182.08	1168.50	1176.70	1.00	1.06	841.6	79.2	3.10	18377.	13013.	10986.
70	1	1.080	24021	1182.01	1168.25	1176.70	1.00	1.06	861.4	81.0	3.10	18277.	13580.	10442.
71	1	1.090	24044	1181.93	1168.00	1176.71	1.00	1.06	881.3	82.8	3.10	18176.	14159.	9886.
72	1	1.100	24068	1181.86	1167.75	1176.72	1.00	1.06	901.1	84.6	3.10	18076.	14751.	9317.
73	1	1.110	24091	1181.78	1167.50	1176.72	1.00	1.06	921.0	86.4	3.10	17975.	15356.	8736.
74	1	1.120	24115	1181.70	1167.25	1176.73	1.00	1.06	941.0	88.2	3.10	17874.	15973.	8142.
75	1	1.130	24140	1181.62	1167.00	1176.73	1.00	1.07	960.9	90.0	3.10	17774.	16604.	7537.
76	1	1.140	23442	1181.54	1167.00	1176.55	1.00	1.06	980.6	90.0	3.10	17673.	16490.	6953.
77	1	1.150	22768	1181.47	1167.00	1176.37	1.00	1.06	999.7	90.0	3.10	17572.	16344.	6425.
78	1	1.160	22157	1181.41	1167.00	1176.21	1.00	1.06	1018.2	90.0	3.10	17472.	16209.	5949.
79	1	1.170	21604	1181.35	1167.00	1176.07	1.00	1.06	1036.3	90.0	3.10	17371.	16086.	5519.
80	1	1.180	21104	1181.30	1167.00	1175.94	1.00	1.06	1054.0	90.0	3.10	17270.	15975.	5129.
81	1	1.190	20650	1181.25	1167.00	1175.82	1.00	1.06	1071.2	90.0	3.10	17170.	15875.	4776.
82	1	1.200	20238	1181.21	1167.00	1175.71	1.00	1.06	1088.1	90.0	3.10	17069.	15783.	4455.
83	1	1.210	19861	1181.17	1167.00	1175.61	1.00	1.05	1104.7	90.0	3.10	16968.	15700.	4162.
84	1	1.220	19517	1181.13	1167.00	1175.52	1.00	1.05	1121.0	90.0	3.10	16868.	15623.	3894.
85	1	1.230	19202	1181.10	1167.00	1175.43	1.00	1.05	1137.0	90.0	3.10	16767.	15554.	3649.
86	1	1.240	18911	1181.07	1167.00	1175.35	1.00	1.05	1152.7	90.0	3.10	16666.	15489.	3422.
87	1	1.250	18643	1181.04	1167.00	1175.27	1.00	1.05	1168.2	90.0	3.10	16566.	15430.	3213.
88	1	1.260	18394	1181.01	1167.00	1175.20	1.00	1.05	1183.5	90.0	3.10	16465.	15375.	3019.
89	1	1.270	18230	1180.99	1167.00	1175.16	1.00	1.05	1198.7	90.0	3.10	16364.	15323.	2907.
90	1	1.280	18152	1180.96	1167.00	1175.14	1.00	1.05	1213.7	90.0	3.10	16264.	15278.	2875.
91	1	1.290	18081	1180.94	1167.00	1175.12	1.00	1.05	1228.7	90.0	3.10	16163.	15239.	2842.
92	1	1.300	18008	1180.91	1167.00	1175.09	1.00	1.05	1243.6	90.0	3.10	16063.	15200.	2808.
93	1	1.310	17935	1180.89	1167.00	1175.07	1.00	1.05	1258.4	90.0	3.10	15962.	15161.	2774.
94	1	1.320	17860	1180.86	1167.00	1175.05	1.00	1.05	1273.2	90.0	3.10	15861.	15121.	2740.
95	1	1.330	17785	1180.84	1167.00	1175.03	1.00	1.05	1288.0	90.0	3.10	15761.	15081.	2705.
96	1	1.340	17709	1180.81	1167.00	1175.01	1.00	1.05	1302.6	90.0	3.10	15660.	15040.	2669.

97	1	1.350	17631	1180.78	1167.00	1174.98	1.00	1.05	1317.2	90.0	3.10	15559.	14998.	2634.
98	1	1.360	17553	1180.76	1167.00	1174.96	1.00	1.05	1331.8	90.0	3.10	15459.	14957.	2597.
99	1	1.370	17475	1180.73	1167.00	1174.94	1.00	1.05	1346.2	90.0	3.10	15358.	14914.	2561.
100	1	1.380	17395	1180.70	1167.00	1174.91	1.00	1.05	1360.6	90.0	3.10	15257.	14872.	2524.

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****
101	1	1.390	17315	1180.67	1167.00	1174.89	1.00	1.05	1375.0	90.0	3.10	15157.	14829.	2486.
102	1	1.400	17233	1180.65	1167.00	1174.87	1.00	1.05	1389.3	90.0	3.10	15056.	14785.	2449.
103	1	1.410	17152	1180.62	1167.00	1174.84	1.00	1.05	1403.5	90.0	3.10	14955.	14741.	2411.
104	1	1.420	17069	1180.59	1167.00	1174.82	1.00	1.05	1417.6	90.0	3.10	14855.	14697.	2372.
105	1	1.430	16986	1180.56	1167.00	1174.79	1.00	1.05	1431.7	90.0	3.10	14754.	14653.	2334.
106	1	1.440	16902	1180.53	1167.00	1174.77	1.00	1.05	1445.7	90.0	3.10	14653.	14608.	2295.
107	1	1.450	16818	1180.50	1167.00	1174.74	1.00	1.05	1459.6	90.0	3.10	14553.	14563.	2255.
108	1	1.460	16733	1180.47	1167.00	1174.71	1.00	1.05	1473.5	90.0	3.10	14452.	14518.	2216.
109	1	1.470	16647	1180.44	1167.00	1174.69	1.00	1.05	1487.3	90.0	3.10	14351.	14472.	2176.
110	1	1.480	16561	1180.41	1167.00	1174.66	1.00	1.05	1501.0	90.0	3.10	14251.	14426.	2135.
111	1	1.490	16474	1180.38	1167.00	1174.64	1.00	1.05	1514.7	90.0	3.10	14150.	14380.	2095.
112	1	1.500	16387	1180.35	1167.00	1174.61	1.00	1.05	1528.2	90.0	3.10	14050.	14333.	2054.
113	1	1.510	16300	1180.32	1167.00	1174.58	1.00	1.05	1541.7	90.0	3.10	13949.	14287.	2013.
114	1	1.520	16211	1180.29	1167.00	1174.55	1.00	1.05	1555.2	90.0	3.10	13848.	14240.	1972.
115	1	1.530	16123	1180.26	1167.00	1174.53	1.00	1.05	1568.5	90.0	3.10	13748.	14193.	1931.
116	1	1.540	16034	1180.23	1167.00	1174.50	1.00	1.05	1581.8	90.0	3.10	13647.	14145.	1889.
117	1	1.550	15944	1180.19	1167.00	1174.47	1.00	1.05	1595.0	90.0	3.10	13546.	14098.	1847.
118	1	1.560	15855	1180.16	1167.00	1174.44	1.00	1.05	1608.2	90.0	3.10	13446.	14050.	1805.
119	1	1.570	15764	1180.13	1167.00	1174.41	1.00	1.05	1621.3	90.0	3.10	13345.	14002.	1763.
120	1	1.580	15674	1180.10	1167.00	1174.39	1.00	1.06	1634.2	90.0	3.10	13244.	13954.	1721.
121	1	1.590	15583	1180.07	1167.00	1174.36	1.00	1.06	1647.2	90.0	3.10	13144.	13905.	1678.
122	1	1.600	15492	1180.04	1167.00	1174.33	1.00	1.06	1660.0	90.0	3.10	13043.	13857.	1635.
123	1	1.610	15400	1180.00	1167.00	1174.30	1.00	1.06	1672.8	90.0	3.10	12942.	13808.	1592.
124	1	1.620	15323	1179.97	1167.00	1174.27	1.00	1.06	1685.5	90.0	3.10	12842.	13759.	1564.
125	1	1.630	15248	1179.94	1167.00	1174.25	1.00	1.06	1698.1	90.0	3.10	12741.	13711.	1538.
126	1	1.640	15173	1179.91	1167.00	1174.22	1.00	1.06	1710.7	90.0	3.10	12640.	13663.	1511.
127	1	1.651	15088	1179.87	1167.00	1174.20	1.00	1.06	1724.4	90.0	3.10	12530.	13608.	1481.
128	1	1.663	14994	1179.83	1167.00	1174.17	1.00	1.06	1739.5	90.0	3.10	12408.	13547.	1448.
129	1	1.676	14889	1179.78	1167.00	1174.14	1.00	1.06	1755.9	90.0	3.10	12274.	13479.	1410.
130	1	1.691	14771	1179.73	1167.00	1174.10	1.00	1.06	1773.8	90.0	3.10	12127.	13403.	1368.
131	1	1.707	14639	1179.67	1167.00	1174.05	1.00	1.06	1793.4	90.0	3.10	11964.	13318.	1322.
132	1	1.725	14491	1179.60	1167.00	1174.01	1.00	1.06	1814.7	90.0	3.10	11786.	13223.	1269.
133	1	1.744	14326	1179.53	1167.00	1173.95	1.00	1.06	1838.0	90.0	3.10	11590.	13117.	1210.
134	1	1.766	14147	1179.45	1167.00	1173.89	1.00	1.06	1863.2	90.0	3.10	11374.	12997.	1150.
135	2	1.789	13950	1179.35	1167.00	1173.82	1.00	1.06	1890.6	90.0	3.10	11137.	12863.	1087.
136	2	1.815	13728	1179.25	1167.00	1173.74	1.00	1.06	1920.2	90.0	3.10	10876.	12713.	1016.
137	2	1.844	13478	1179.13	1167.00	1173.66	1.00	1.07	1952.3	90.0	3.10	10589.	12544.	935.
138	2	1.875	13197	1178.99	1167.00	1173.56	1.00	1.07	1986.9	90.0	3.10	10273.	12353.	845.
139	2	1.910	12896	1178.84	1167.00	1173.45	1.00	1.07	2024.1	90.0	3.10	9925.	12137.	760.

140	2	1.948	12555	1178.66	1167.00	1173.33	1.00	1.07	2064.1	90.0	3.10	9543.	11893.	662.
141	2	1.989	12167	1178.46	1167.00	1173.19	1.00	1.08	2106.7	90.0	3.10	9123.	11617.	551.
142	2	2.035	11731	1178.23	1167.00	1173.02	1.00	1.08	2152.1	90.0	3.10	8740.	11307.	424.
143	2	2.086	11256	1177.97	1167.00	1172.84	1.00	1.09	2200.1	90.0	3.10	8345.	10966.	290.
144	2	2.142	10788	1177.68	1167.00	1172.66	1.00	1.10	2250.8	90.0	3.10	7910.	10586.	203.
145	2	2.203	10268	1177.34	1167.00	1172.45	1.00	1.11	2304.0	90.0	3.10	7432.	10166.	102.
146	2	2.270	9693	1176.95	1167.00	1172.20	1.00	1.12	2359.5	90.0	3.10	6905.	9693.	0.
147	2	2.344	9161	1176.50	1167.00	1171.97	1.00	1.15	2417.1	90.0	3.10	6327.	9162.	0.
148	2	2.425	8587	1175.97	1167.00	1171.71	1.00	1.19	2476.8	90.0	3.10	5690.	8588.	0.
149	2	2.515	7963	1175.33	1167.00	1171.42	1.00	1.26	2538.1	90.0	3.10	5042.	7963.	0.
150	2	2.613	7344	1174.59	1167.00	1171.11	1.00	1.39	2600.4	90.0	3.10	4617.	7345.	0.

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RESERVOIR DEPLETION TABLE

I	K	TTP(I)	Q(I)	H2	YB	D	SUB	VCOR	OUTVOL	BB	COFR	QI(I)	QBRECH	QSPIL
***	**	******	********	*******	*******	*******	****	****	*********	****	****	*****	******	*****
151	2	2.722	6798	1173.74	1167.00	1170.83	1.00	1.68	2663.7	90.0	3.10	4150.	6799.	0.
152	2	2.841	6333	1172.67	1167.00	1170.57	1.00	2.00	2728.4	90.0	3.10	3636.	6334.	0.
153	2	2.972	5130	1171.39	1167.00	1169.85	1.00	2.00	2790.5	90.0	3.10	3070.	5131.	0.
154	2	3.116	3303	1170.27	1167.00	1168.47	1.00	2.00	2840.7	90.0	3.10	2448.	3303.	0.

1

PARAMETER	UNITS	VARIABLE	VALUE
**********	*******	******	**********
INITIAL FLOW	CFS	Q(1)	1694.
MAX FLOW	CFS	QM	24140.
FINAL FLOW	CFS	Q(NU)	3303.
TIME TO MAX FLOW	HRS	TP	1.13
NUMBER OF TIME STEPS		NNU	154
TOTAL VOLUME DISCHARGED FROM RESERVOIR	AC-FT	DISVOL	2841.

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INITIAL CONDITIONS

I	K	X(I)	YD(I)	QDI(I)	FRD	SOM
45	3	2.320	1064.33	1693.82	.38	60.606
45	0	2.320	1064.33	1693.82		
44	2	2.269	1067.44	1693.82	.38	
43	3	2.218	1070.60	1693.82	.38	
42	3	2.168	1073.75	1693.82	.39	
41	3	2.117	1076.91	1693.82	.39	
40	3	2.066	1080.07	1693.82	.39	
39	3	2.015	1083.24	1693.82	.39	
38	3	1.965	1086.41	1693.82	.39	
37	3	1.914	1089.59	1693.82	.39	
36	3	1.863	1092.77	1693.82	.39	
35	3	1.812	1095.97	1693.82	.39	
34	3	1.762	1099.17	1693.82	.40	
33	3	1.711	1102.38	1693.82	.40	
32	3	1.660	1105.60	1693.82	.40	
31	3	1.608	1107.98	1693.82	.35	
30	3	1.556	1109.98	1693.82	.34	
29	2	1.504	1111.92	1693.82	.34	
28	3	1.452	1113.84	1693.82	.34	
27	3	1.400	1115.77	1693.82	.34	
26	3	1.348	1117.70	1693.82	.34	
25	3	1.296	1119.63	1693.82	.34	
24	2	1.244	1121.56	1693.82	.34	
23	2	1.192	1123.50	1693.82	.34	
22	2	1.140	1125.44	1693.82	.34	
21	3	1.086	1127.18	1693.82	.28	
20	3	1.031	1128.53	1693.82	.26	
19	3	.977	1129.78	1693.82	.25	
18	3	.923	1131.00	1693.82	.24	
17	3	.869	1132.19	1693.82	.24	
16	3	.814	1133.39	1693.82	.24	
15	3	.760	1134.57	1693.82	.23	
14	3	.707	1135.90	1693.82	.28	
13	2	.654	1137.59	1693.82	.29	
12	3	.601	1139.37	1693.82	.30	
11	3	.549	1141.23	1693.82	.31	
10	3	.496	1143.20	1693.82	.32	
9	4	.443	1145.35	1693.82	.35	
8	4	.390	1147.86	1693.82	.40	
7	4	.337	1150.73	1693.82	.37	
6	3	.284	1153.37	1693.82	.35	
5	3	.231	1155.96	1693.82	.34	
4	3	.179	1158.54	1693.82	.33	
3	4	.126	1161.10	1693.82	.32	
2	3	.073	1163.83	1693.82	.31	
1	3	.020	1166.46	1693.82	.28	

TIME PARAMETERS OF OUTFLOW HYDROGRAPH IMMEDIATELY DOWNSTREAM OF DAM

PARAMETER	UNITS	VARIABLE	VALUE
TIME TO FAILURE	HR	TFH	.500
TIME TO START OF RISING LIMB OF HYDROGRAPH	HR	TFO	.630
TIME TO PEAK	HR	TP	1.130
TIME STEP SIZE	HR	DTHI	.025

PROFILE OF CRESTS AND TIMES FOR MINNEWAWA BROOK
BELOW RUSSELL RES. DAM

	RVR MILE FROM DAM	MAX ELEV (FT)	MAX FLOW (CFS)	TIME MAX ELEV(HR)	MAX VEL (FT/SEC)	FLOOD ELEV (FT)	TIME FLOOD ELEV(HR)
0.94	.020	1178.52	24137	1.129	3.63	.00	.00
	.073	1177.27	24069	1.129	3.69	.00	.00
	.126	1176.04	24000	1.129	3.91	.00	.00
	.179	1174.77	23931	1.129	4.35	.00	.00
	.231	1173.40	23865	1.154	4.80	.00	.00
	.284	1171.78	23804	1.154	5.28	.00	.00
	.337	1169.56	23787	1.154	5.92	.00	.00
1.31	.390	1165.29	23768	1.154	8.15	.00	.00
	.443	1160.09	23747	1.179	7.39	.00	.00
	.496	1156.16	23725	1.179	6.78	.00	.00
	.549	1153.07	23708	1.179	6.16	.00	.00
	.601	1150.65	23666	1.204	5.57	.00	.00
	.654	1148.87	23589	1.229	5.00	.00	.00
	.707	1147.68	23495	1.254	4.35	.00	.00
1.68	.760	1146.96	23368	1.254	3.46	.00	.00
	.814	1146.27	23228	1.254	3.62	.00	.00
	.869	1145.53	23114	1.279	3.80	.00	.00
	.923	1144.72	23002	1.279	3.98	.00	.00
	.977	1143.81	22921	1.279	4.18	.00	.00
	1.031	1142.77	22838	1.304	4.48	.00	.00
	1.086	1141.53	22786	1.304	4.97	.00	.00

2.06	1.140	1139.92	22723	1.329	5.79	.00	.00
	1.192	1138.30	22684	1.329	5.82	.00	.00
	1.244	1136.69	22634	1.354	5.86	.00	.00
	1.296	1135.09	22588	1.354	5.90	.00	.00
	1.348	1133.49	22546	1.354	5.94	.00	.00
	1.400	1131.86	22499	1.379	6.00	.00	.00
	1.452	1130.17	22471	1.379	6.11	.00	.00
	1.504	1128.37	22434	1.379	6.31	.00	.00
	1.556	1126.38	22416	1.379	6.65	.00	.00
	1.608	1124.05	22398	1.404	7.24	.00	.00
2.58	1.660	1120.95	22380	1.404	8.42	.00	.00
	1.711	1117.19	22377	1.404	8.21	.00	.00
	1.762	1113.51	22369	1.404	8.01	.00	.00
	1.812	1109.89	22353	1.429	7.83	.00	.00
	1.863	1106.32	22348	1.429	7.67	.00	.00
	1.914	1102.79	22340	1.429	7.53	.00	.00
	1.965	1099.30	22325	1.454	7.41	.00	.00
	2.015	1095.83	22317	1.454	7.29	.00	.00
	2.066	1092.39	22310	1.454	7.18	.00	.00
	2.117	1088.98	22295	1.479	7.08	.00	.00
	2.168	1085.58	22286	1.479	6.99	.00	.00
	2.218	1082.21	22278	1.479	6.91	.00	.00
	2.269	1078.85	22262	1.504	6.83	.00	.00
3.24	2.320	1075.52	22256	1.504	6.75	.00	.00

```
DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK      ... STATION NUMBER   1
            BELOW RUSSELL RES. DAM     AT MILE      .02

GAGE ZERO = 1159.00     MAX ELEVATION REACHED BY FLOOD WAVE = 1178.52
                     FLOOD STAGE NOT AVAILABLE
            MAX STAGE =   19.52     AT TIME =    1.129 HOURS
            MAX FLOW =    24137    AT TIME =    1.129 HOURS

HR   STAGE     FLOW  0      5000     10000     15000     20000     25000
 .0    7.5     1694  I  *     I         I         I         I         I
 .1    7.5     1727  I  *     I         I         I         I         I
 .2    7.8     1918  I   *    I         I         I         I         I
 .3    8.5     2478  I    *   I         I         I         I         I
 .4   11.2     6327  I        I  *      I         I         I         I
 .5   14.7    13658  I        I         I      *  I         I         I
 .6   17.2    19972  I        I         I         I         *         I
 .7   18.4    22242  I        I         I         I         I   *     I
 .8   18.9    23182  I        I         I         I         I     *   I
 .9   19.2    23610  I        I         I         I         I      *  I
1.0   19.4    23852  I        I         I         I         I       * I
1.1   19.5    24068  I        I         I         I         I       * I
1.2   18.8    20258  I        I         I         I         I*        I
1.3   17.9    18008  I        I         I         I     *   I         I
1.4   17.5    17234  I        I         I         I   *     I         I
1.5   17.1    16387  I        I         I         I  *      I         I
```

```
1.6   16.7    15492 I         I         I         I*        I         I
1.7   16.4    14698 I         I         I        *I         I         I
1.8   16.0    13859 I         I         I       * I         I         I
1.9   15.7    12980 I         I         I     *   I         I         I
2.0   15.3    12068 I         I         I   *     I         I         I
2.1   14.8    11138 I         I         I *       I         I         I
2.2   14.4    10291 I         I         I*        I         I         I
2.3   14.0     9478 I         I        *I         I         I         I
2.4   13.6     8767 I         I       * I         I         I         I
2.5   13.2     8068 I         I     *   I         I         I         I
2.6   12.9     7429 I         I    *    I         I         I         I
2.7   12.5     6909 I         I   *     I         I         I         I
2.8   12.2     6493 I         I  *      I         I         I         I
2.9   11.8     5792 I         I *       I         I         I         I
```

1

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 8
BELOW RUSSELL RES. DAM AT MILE .39

GAGE ZERO = 1139.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1165.29
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 26.29 AT TIME = 1.154 HOURS
MAX FLOW = 23769 AT TIME = 1.154 HOURS

```
HR   STAGE     FLOW 0      5000     10000     15000     20000     25000
 .0    8.9     1694 I *      I         I         I         I         I
 .1    8.9     1695 I *      I         I         I         I         I
 .2    8.9     1727 I *      I         I         I         I         I
 .3    9.2     1880 I  *     I         I         I         I         I
 .4   10.1     2350 I   *    I         I         I         I         I
 .5   13.2     4586 I      *I         I         I         I         I
 .6   19.7    11127 I        I         I *       I         I         I
 .7   23.3    17246 I        I         I         I  *      I         I
 .8   24.9    20585 I        I         I         I         I*        I
 .9   25.7    22281 I        I         I         I         I    *    I
1.0   26.0    23145 I        I         I         I         I     *   I
1.1   26.2    23613 I        I         I         I         I      *  I
1.2   26.2    23449 I        I         I         I         I      *  I
1.3   25.3    21102 I        I         I         I         I *       I
1.4   24.4    19116 I        I         I         I       * I         I
1.5   23.9    17843 I        I         I         I     *   I         I
1.6   23.4    16829 I        I         I         I  *      I         I
1.7   22.9    15908 I        I         I         I *       I         I
1.8   22.5    15058 I        I         I         *         I         I
1.9   22.0    14216 I        I         I       * I         I         I
2.0   21.5    13354 I        I         I      *  I         I         I
2.1   21.0    12460 I        I         I    *    I         I         I
2.2   20.4    11563 I        I         I  *      I         I         I
2.3   19.8    10699 I        I         I*        I         I         I
2.4   19.2     9884 I        I         *         I         I         I
2.5   18.7     9138 I        I       * I         I         I         I
```

```
2.6   18.0     8435 I        I      * I        I        I        I
2.7   17.4     7787 I        I     *  I        I        I        I
2.8   16.9     7226 I        I   *    I        I        I        I
2.9   16.3     6740 I        I  *     I        I        I        I
```

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 15
BELOW RUSSELL RES. DAM AT MILE .76

GAGE ZERO = 1127.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1146.96
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 19.96 AT TIME = 1.254 HOURS
MAX FLOW = 23369 AT TIME = 1.204 HOURS

```
HR   STAGE     FLOW 0     5000     10000     15000     20000     25000
 .0    7.6     1694 I *     I        I        I        I        I
 .1    7.6     1694 I *     I        I        I        I        I
 .2    7.6     1696 I *     I        I        I        I        I
 .3    7.6     1725 I *     I        I        I        I        I
 .4    7.7     1856 I  *    I        I        I        I        I
 .5    8.2     2366 I   *   I        I        I        I        I
 .6   10.1     5129 I       *        I        I        I        I
 .7   13.6    11911 I       I        I   *    I        I        I
 .8   16.2    17468 I       I        I        I   *    I        I
 .9   17.8    20361 I       I        I        I        I*       I
1.0   18.9    21948 I       I        I        I        I   *    I
1.1   19.5    22857 I       I        I        I        I    *   I
1.2   19.9    23359 I       I        I        I        I     *  I
1.3   19.9    22472 I       I        I        I        I   *    I
1.4   19.5    20569 I       I        I        I        I*       I
1.5   18.9    19039 I       I        I        I      * I        I
1.6   18.4    17855 I       I        I        I    *   I        I
1.7   17.9    16833 I       I        I        I  *     I        I
1.8   17.4    15910 I       I        I        I *      I        I
1.9   17.0    15039 I       I        I        *        I        I
2.0   16.6    14180 I       I        I      * I        I        I
2.1   16.2    13308 I       I        I     *  I        I        I
2.2   15.8    12418 I       I        I   *    I        I        I
2.3   15.3    11538 I       I        I  *     I        I        I
2.4   14.9    10690 I       I        I*       I        I        I
2.5   14.5     9895 I       I        *        I        I        I
2.6   14.1     9173 I       I      * I        I        I        I
2.7   13.6     8494 I       I     *  I        I        I        I
2.8   13.2     7864 I       I    *   I        I        I        I
2.9   12.9     7311 I       I   *    I        I        I        I
```

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 22
BELOW RUSSELL RES. DAM AT MILE 1.14

GAGE ZERO = 1117.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1139.92
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 22.92 AT TIME = 1.329 HOURS
MAX FLOW = 22723 AT TIME = 1.279 HOURS

HR	STAGE	FLOW	0	5000	10000	15000	20000	25000
.0	8.4	1694	I *	I	I	I	I	I
.1	8.4	1694	I *	I	I	I	I	I
.2	8.4	1694	I *	I	I	I	I	I
.3	8.4	1695	I *	I	I	I	I	I
.4	8.5	1711	I *	I	I	I	I	I
.5	8.6	1791	I *	I	I	I	I	I
.6	9.1	2171	I *	I	I	I	I	I
.7	11.5	4402	I	*I	I	I	I	I
.8	15.7	10104	I	I	*	I	I	I
.9	18.9	15471	I	I	I	I*	I	I
1.0	20.8	18910	I	I	I	I	* I	I
1.1	21.9	20988	I	I	I	I	I *	I
1.2	22.6	22233	I	I	I	I	I *	I
1.3	22.9	22721	I	I	I	I	I *	I
1.4	22.8	21982	I	I	I	I	I *	I
1.5	22.3	20675	I	I	I	I	I*	I
1.6	21.7	19380	I	I	I	I	*I	I
1.7	21.2	18232	I	I	I	I *	I	I
1.8	20.6	17193	I	I	I	I *	I	I
1.9	20.1	16239	I	I	I	I *	I	I
2.0	19.7	15352	I	I	I	I*	I	I
2.1	19.2	14480	I	I	I	*I	I	I
2.2	18.7	13618	I	I	I	* I	I	I
2.3	18.2	12748	I	I	I *	I	I	I
2.4	17.7	11893	I	I	I *	I	I	I
2.5	17.2	11060	I	I	I *	I	I	I
2.6	16.7	10277	I	I	I*	I	I	I
2.7	16.2	9542	I	I	*I	I	I	I
2.8	15.8	8854	I	I	* I	I	I	I
2.9	15.3	8213	I	I	* I	I	I	I

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DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 32
BELOW RUSSELL RES. DAM AT MILE 1.66

GAGE ZERO = 1097.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1120.95
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 23.95 AT TIME = 1.404 HOURS
MAX FLOW = 22381 AT TIME = 1.404 HOURS

HR	STAGE	FLOW	0	5000	10000	15000	20000	25000
.0	8.6	1694	I *	I	I	I	I	I
.1	8.6	1694	I *	I	I	I	I	I
.2	8.6	1694	I *	I	I	I	I	I

```
 .3   8.6    1694 I *     I        I        I        I        I
 .4   8.6    1694 I *     I        I        I        I        I
 .5   8.6    1704 I *     I        I        I        I        I
 .6   8.7    1757 I  *    I        I        I        I        I
 .7   9.2    2040 I  *    I        I        I        I        I
 .8  11.7    3948 I      * I       I        I        I        I
 .9  16.5    9281 I       I      *I        I        I        I
1.0  20.0   14635 I       I       I       *I        I        I
1.1  21.9   18286 I       I       I        I     *  I        I
1.2  23.0   20545 I       I       I        I       I*        I
1.3  23.7   21918 I       I       I        I       I  *      I
1.4  24.0   22380 I       I       I        I       I   *     I
1.5  23.7   21828 I       I       I        I       I  *      I
1.6  23.3   20735 I       I       I        I       I*        I
1.7  22.7   19528 I       I       I        I      *I         I
1.8  22.2   18386 I       I       I        I     *  I        I
1.9  21.6   17329 I       I       I        I   *    I        I
2.0  21.2   16364 I       I       I        I  *     I        I
2.1  20.7   15465 I       I       I        I*       I        I
2.2  20.2   14592 I       I       I       *I        I        I
2.3  19.7   13732 I       I       I     *  I        I        I
2.4  19.2   12873 I       I       I    *   I        I        I
2.5  18.7   12026 I       I       I  *     I        I        I
2.6  18.2   11203 I       I       I *      I        I        I
2.7  17.7   10422 I       I       I*       I        I        I
2.8  17.2    9687 I       I      *I        I        I        I
2.9  16.7    8998 I       I     * I        I        I        I
```

1

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 45
BELOW RUSSELL RES. DAM AT MILE 2.32

GAGE ZERO = 1057.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1075.52
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 18.52 AT TIME = 1.504 HOURS
MAX FLOW = 22256 AT TIME = 1.504 HOURS

```
HR   STAGE    FLOW 0     5000     10000    15000    20000    25000
 .0    7.3    1696 I *     I        I        I        I        I
 .1    7.3    1696 I *     I        I        I        I        I
 .2    7.3    1696 I *     I        I        I        I        I
 .3    7.3    1696 I *     I        I        I        I        I
 .4    7.3    1696 I *     I        I        I        I        I
 .5    7.3    1696 I *     I        I        I        I        I
 .6    7.3    1699 I *     I        I        I        I        I
 .7    7.3    1719 I *     I        I        I        I        I
 .8    7.5    1840 I  *    I        I        I        I        I
 .9    8.7    2858 I    *  I        I        I        I        I
1.0   12.3    7709 I       I   *    I        I        I        I
1.1   15.2   13730 I       I        I     *  I        I        I
1.2   16.9   17822 I       I        I        I    *   I        I
```

```
    1.3   17.8    20303 I         I         I         I         I*        I
    1.4   18.3    21755 I         I         I         I         I   *     I
    1.5   18.5    22253 I         I         I         I         I    *    I
    1.6   18.4    21797 I         I         I         I         I   *     I
    1.7   18.1    20784 I         I         I         I         I *       I
    1.8   17.7    19618 I         I         I         I        *I         I
    1.9   17.3    18489 I         I         I         I      *  I         I
    2.0   16.9    17438 I         I         I         I    *    I         I
    2.1   16.6    16474 I         I         I         I  *      I         I
    2.2   16.2    15575 I         I         I         I*        I         I
    2.3   15.9    14709 I         I         I        *I         I         I
    2.4   15.6    13857 I         I         I       * I         I         I
    2.5   15.2    13010 I         I         I     *   I         I         I
    2.6   14.8    12174 I         I         I   *     I         I         I
    2.7   14.5    11362 I         I         I  *      I         I         I
    2.8   14.1    10586 I         I         I*        I         I         I
    2.9   13.7     9854 I         I         *         I         I         I
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DATE: 11/01/85
FILE: HRDDB2.DAT

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DAMBRK - Version..10/25/84

CPU Time (HH:MM:SS)....00:11:07

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PROGRAM DAMBRK---VERSION-07/18/84

ANALYSIS OF THE DOWNSTREAM FLOOD HYDROGRAPH

PRODUCED BY THE DAM BREAK OF

REACH THREE

ON

MINNEWAWA BROOK

ANALYSIS BY

VOLLMER ASSOCIATES
BOSTON, MA 02116
NOVEMBER 4, 1985 #081

BASED ON PROCEDURE DEVELOPED BY

DANNY L. FREAD, PH.D., RESEARCH HYDROLOGIST
HYDROLOGIC RESEARCH LABORATORY
W23, OFFICE OF HYDROLOGY

NOAA, NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

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***                         ***
***  SUMMARY OF INPUT DATA  ***
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INPUT CONTROL PARAMETERS FOR REACH THREE

PARAMETER	VARIABLE	VALUE
NUMBER OF DYNAMIC ROUTING REACHES	KKN	9
TYPE OF RESERVOIR ROUTING	KUI	0
MULTIPLE DAM INDICATOR	MULDAM	0
PRINTING INSTRUCTIONS FOR INPUT SUMMARY	KDMP	0
NO. OF RESERVOIR INFLOW HYDROGRAPH POINTS	ITEH	14
INTERVAL OF CROSS-SECTION INFO PRINTED OUT WHEN JNK=9	NPRT	0
FLOOD-PLAIN MODEL PARAMETER	KFLP	0
LANDSLIDE PARAMETER	KSL	0

DHF(INTERVAL BETWEEN INPUT HYDROGRAPH ORDINATES) = .00 HRS.

TEH(TIME AT WHICH COMPUTATIONS TERMINATE) = 3.0000 HRS.

INFLOW HYDROGRAPH TO REACH THREE
****

1696.00	1696.00	1699.00	1719.00	1840.00	2858.00	13730.00	20303.00
21755.00	22256.00	20784.00	14709.00	9854.00	9000.00		

TIME OF INFLOW HYDROGRAPH ORDINATES

.0000	.5000	.6000	.7000	.8000	.9000	1.1000	1.3000
1.4000	1.5000	1.7000	2.3000	2.9000	3.0000		

CROSS-SECTIONAL PARAMETERS FOR MINNEWAWA BROOK
BELOW REACH THREE

PARAMETER	VARIABLE	VALUE
NUMBER OF CROSS-SECTIONS	NS	8
MAXIMUM NUMBER OF TOP WIDTHS	NCS	4
NUMBER OF CROSS-SECTIONAL HYDROGRAPHS TO PLOT	NTT	6
TYPE OF OUTPUT OTHER THAN HYDROGRAPH PLOTS	JNK	4
CROSS-SECTIONAL SMOOTHING PARAMETER	KSA	0
DOWNSTREAM SUPERCRITICAL OR NOT	KSUPC	0
NO. OF LATERAL INFLOW HYDROGRAPHS	LQ	0
NO. OF POINTS IN GATE CONTROL CURVE	KCG	0

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)
****

1 3 5 6 7 8

CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW REACH THREE

PARAMETER	UNITS	VARIABLE
LOCATION OF CROSS-SECTION	MI	XS(I)
ELEVATION (MSL) OF FLOODING AT CROSS-SECTION	FT	FSTG(I)
ELEV CORRESPONDING TO EACH TOP WIDTH	FT	HS(K,I)
TOP WIDTH CORRESPONDING TO EACH ELEV (ACTIVE FLOW PORTION)	FT	BS(K,I)
TOP WIDTH CORRESPONDING TO EACH ELEV (OFF-CHANNEL PORTION)	FT	BSS(K,I)
SURFACE AREA CORRESPONDING TO EACH ELEV (ACTIVE FLOW PORTION)	ACRES	OSA(K,I)
SURFACE AREA CORRESPONDING TO EACH ELEV (OFF-CHANNEL PORTION)	ACRES	SSA(K,I)
NUMBER OF CROSS-SECTION		I
NUMBER OF ELEVATION LEVEL		K

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CROSS-SECTION NUMBER 1

XS(I) = 2.430 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	978.0	980.0	1000.0	1020.0
BS ...	.0	30.0	264.0	317.0
BSS ...	.0	.0	.0	.0

CROSS-SECTION NUMBER 2

XS(I) = 2.750 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	918.0	920.0	940.0	960.0
BS ...	.0	30.0	106.0	211.0
BSS ...	.0	.0	.0	.0

CROSS-SECTION NUMBER 3
****

XS(I) = 3.000 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	878.0	880.0	890.0	900.0
BS ...	.0	30.0	80.0	581.0
BSS ...	.0	.0	.0	.0

CROSS-SECTION NUMBER 4
****

XS(I) = 3.480 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	798.0	800.0	813.0	830.0
BS ...	.0	30.0	80.0	784.0
BSS ...	.0	.0	.0	.0

CROSS-SECTION NUMBER 5
****

XS(I) = 4.010 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	758.0	760.0	772.0	785.0
BS ...	.0	40.0	70.0	987.0
BSS ...	.0	.0	.0	.0

CROSS-SECTION NUMBER 6
****

XS(I) = 4.350 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

HS ...	703.6	705.6	716.0	731.0

```
BS  ...      .0    22.0    55.0   334.0
BSS ...      .0      .0      .0      .0
```

CROSS-SECTION NUMBER 7
****

```
XS(I) =   4.730   FSTG(I) =     .00        XSL(I) =      .0        XSR(I) =      .0

HS  ...    678.0   680.0   690.0   700.0
BS  ...      .0    30.0    75.0   792.0
BSS ...      .0      .0      .0      .0
```

CROSS-SECTION NUMBER 8
****

```
XS(I) =   5.320   FSTG(I) =     .00        XSL(I) =      .0        XSR(I) =      .0

HS  ...    638.0   640.0   653.0   662.0
BS  ...      .0    30.0    90.0   789.0
BSS ...      .0      .0      .0      .0
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MANNING N ROUGHNESS COEFFICIENTS FOR THE GIVEN REACHES
(CM(K,I),K=1,NCS) WHERE I = REACH NUMBER
****

```
REACH  1 ...  .075   .090   .140   .140

REACH  2 ...  .075   .090   .140   .140

REACH  3 ...  .075   .090   .140   .140

REACH  4 ...  .075   .090   .140   .140

REACH  5 ...  .075   .090   .140   .140

REACH  6 ...  .070   .080   .120   .120

REACH  7 ...  .060   .070   .080   .100
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CROSS-SECTIONAL VARIABLES FOR MINNEWAWA BROOK
BELOW REACH THREE

PARAMETER	UNITS	VARIABLE
MINIMUM COMPUTATIONAL DISTANCE USED BETWEEN CROSS-SECTIONS	MI	DXM(I)
CONTRACTION - EXPANSION COEFFICIENTS BETWEEN CROSS-SECTIONS		FKC(I)

REACH NUMBER	DXM(I)	FKC(I)
1	.020	.000
2	.020	.000
3	.100	.000
4	.100	.000
5	.100	.000
6	.100	.000
7	.100	.000

DOWNSTREAM FLOW PARAMETERS FOR MINNEWAWA BROOK
BELOW REACH THREE

PARAMETER	UNITS	VARIABLE	VALUE
MAX DISCHARGE AT DOWNSTREAM EXTREMITY	CFS	QMAXD	.0
MAX LATERAL OUTFLOW PRODUCING LOSSES	CFS/FT	QLL	.000

INITIAL SIZE OF TIME STEP	HR	DTHM	.0009
INITIAL WATER SURFACE ELEVATION DOWNSTREAM	FT	YDN	.00
SLOPE OF CHANNEL DOWNSTREAM OF DAM	FT/MI	SDM	170.00
THETA WEIGHTING FACTOR		THETA	.00
CONVERGENCE CRITERION FOR STAGE	FT	EPSY	.000
TIME AT WHICH DAM STARTS TO FAIL	HR	TFI	3.00

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***                         ***
***  SUMMARY OF OUTPUT DATA ***
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CROSS-SECTION NO.	MILE	BOTTOM ELEVATION FEET	REACH NO.	REACH LENGTH MILES	SLOPE FT/MI	MESAGE
1	2.43	978.00				
2	2.75	918.00	1	.32	187.50	
3	3.00	878.00	2	.25	160.00	
4	3.48	798.00	3	.48	166.67	
5	4.01	758.00	4	.53	75.47	
6	4.35	703.60	5	.34	160.00	
7	4.73	678.00	6	.38	67.37	
8	5.32	638.00	7	.59	67.80	

TOTAL NUMBER OF CROSS SECTIONS (ORIGINAL+INTERPOLATED) (N) = 49 (MAXIMUM ALLOWABLE = 200

SLOPE INFORMATION FOR INPUT REACHES

REACH NO.	WATER ELEVATION FEET	HYDRAULIC DEPTH FEET	BOTTOM SLOPE FT/MI	DYNAMIC SLOPE FT/MI	TOTAL SLOPE FT/MI	CRITICAL SLOPE FT/MI	MANNING'S N
1	948.00	.50	187.50	.24	187.74	1121.12	.108
1	950.00	1.00	187.50	.33	187.83	1018.33	.115
1	970.00	11.78	187.50	.93	188.43	663.21	.140
1	990.00	25.27	187.50	1.23	188.73	514.33	.140
2	898.00	.50	160.00	.26	160.26	1121.12	.108
2	900.00	1.00	160.00	.35	160.35	1018.33	.115
2	915.00	10.59	160.00	.96	160.96	687.22	.140
2	930.00	10.66	160.00	.96	160.96	685.68	.140
3	838.00	.50	166.67	.25	166.92	1121.12	.108
3	840.00	1.00	166.67	.34	167.01	1018.33	.115
3	851.50	8.28	166.67	.86	167.53	745.96	.140
3	865.00	8.77	166.67	.88	167.55	731.78	.140
4	778.00	.50	75.47	.37	75.84	1121.12	.108
4	780.00	1.00	75.47	.50	75.97	1018.33	.115
4	792.50	9.63	75.47	1.31	76.78	709.29	.140
4	807.50	8.84	75.47	1.27	76.74	729.84	.140
5	730.80	.50	160.00	.26	160.26	1121.12	.108
5	732.80	1.00	160.00	.35	160.35	1018.33	.115
5	744.00	8.98	160.00	.90	160.90	726.11	.140
5	758.00	8.26	160.00	.88	160.88	746.62	.140
6	690.80	.50	67.37	.35	67.71	875.55	.095
6	692.80	1.00	67.37	.46	67.83	770.00	.100
6	703.00	7.52	67.37	1.09	68.46	565.99	.120
6	715.50	7.31	67.37	1.08	68.45	571.35	.120
7	658.00	.50	67.80	.29	68.09	620.89	.080
7	660.00	1.00	67.80	.39	68.19	556.33	.085
7	671.50	8.27	67.80	.87	68.67	308.38	.090

7	681.00	6.11	67.80	.86	68.65	421.25	.100

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INITIAL CONDITIONS

I	K	X(I)	YD(I)	QDI(I)	FRD	SOM
49	2	5.320	645.48	1696.00	.52	67.797
49	0	5.320	645.48	1696.00		
48	2	5.202	653.49	1696.00	.52	
47	2	5.084	661.50	1696.00	.52	
46	2	4.966	669.52	1696.00	.52	
45	2	4.848	677.53	1696.00	.51	
44	2	4.730	685.55	1696.00	.51	
43	6	4.603	696.24	1696.00	.34	
42	5	4.477	704.58	1696.00	.39	
41	5	4.350	713.96	1696.00	.37	
40	6	4.237	729.04	1696.00	.61	
39	5	4.123	747.64	1696.00	.46	
38	5	4.010	764.32	1696.00	.59	
37	5	3.904	774.97	1696.00	.32	
36	5	3.798	782.26	1696.00	.39	
35	4	3.692	790.73	1696.00	.36	
34	4	3.586	798.84	1696.00	.37	
33	4	3.480	807.07	1696.00	.36	
32	5	3.360	823.97	1696.00	.83	
31	5	3.240	846.38	1696.00	.42	
30	5	3.120	864.69	1696.00	.65	
29	5	3.000	885.99	1696.00	.45	
28	4	2.979	888.84	1696.00	.51	
27	4	2.958	892.14	1696.00	.52	
26	3	2.937	895.43	1696.00	.53	
25	3	2.917	898.73	1696.00	.54	
24	3	2.896	902.03	1696.00	.54	
23	3	2.875	905.33	1696.00	.55	
22	3	2.854	908.64	1696.00	.55	
21	3	2.833	911.95	1696.00	.56	
20	3	2.812	915.27	1696.00	.56	

19	3	2.792	918.58	1696.00	.57
18	3	2.771	921.90	1696.00	.57
17	3	2.750	925.22	1696.00	.57
16	3	2.730	928.62	1696.00	.62
15	3	2.710	932.40	1696.00	.61
14	3	2.690	936.09	1696.00	.61
13	3	2.670	939.80	1696.00	.61
12	3	2.650	943.51	1696.00	.61
11	3	2.630	947.22	1696.00	.61
10	3	2.610	950.93	1696.00	.60
9	3	2.590	954.65	1696.00	.60
8	3	2.570	958.36	1696.00	.60
7	3	2.550	962.07	1696.00	.60
6	3	2.530	965.79	1696.00	.60
5	3	2.510	969.51	1696.00	.60
4	3	2.490	973.22	1696.00	.60
3	3	2.470	976.94	1696.00	.60
2	3	2.450	980.66	1696.00	.60
1	3	2.430	984.38	1696.00	.60

TIME PARAMETERS OF OUTFLOW HYDROGRAPH IMMEDIATELY DOWNSTREAM OF DAM

PARAMETER	UNITS	VARIABLE	VALUE
TIME TO FAILURE	HR	TFH	1.500
TIME TO START OF RISING LIMB OF HYDROGRAPH	HR	TFO	.000
TIME TO PEAK	HR	TP	1.500
TIME STEP SIZE	HR	DTHI	.075

PROFILE OF CRESTS AND TIMES FOR MINNEWAWA BROOK
BELOW REACH THREE

RVR MILE FROM DAM	MAX ELEV (FT)	MAX FLOW (CFS)	TIME MAX ELEV(HR)	MAX VEL (FT/SEC)	FLOOD ELEV (FT)	TIME FLOOD ELEV(HR)
********	********	********	********	********	**********	**********

3.35	2.430	997.64	22255	1.500	9.35	.00	.00
	2.450	994.17	22249	1.500	9.40	.00	.00
	2.470	990.72	22240	1.500	9.44	.00	.00
	2.490	987.29	22230	1.500	9.49	.00	.00
	2.510	983.88	22218	1.500	9.54	.00	.00
	2.530	980.49	22207	1.500	9.59	.00	.00
	2.550	977.11	22196	1.500	9.65	.00	.00
	2.570	973.72	22185	1.500	9.76	.00	.00
	2.590	970.33	22175	1.500	9.89	.00	.00
	2.610	966.98	22163	1.500	10.02	.00	.00
	2.630	963.70	22153	1.500	10.15	.00	.00
	2.650	960.47	22143	1.500	10.26	.00	.00
	2.670	957.32	22132	1.500	10.37	.00	.00
	2.690	954.23	22119	1.500	10.47	.00	.00
	2.710	951.18	22107	1.500	10.61	.00	.00
	2.730	948.11	22095	1.500	10.82	.00	.00
3.67	2.750	944.85	22084	1.500	11.23	.00	.00
	2.771	941.57	22072	1.500	10.89	.00	.00
	2.792	938.19	22059	1.575	10.52	.00	.00
	2.812	934.69	22051	1.575	10.13	.00	.00
	2.833	931.06	22059	1.575	9.73	.00	.00
	2.854	927.31	22065	1.575	9.35	.00	.00
	2.875	923.45	22071	1.575	8.98	.00	.00
	2.896	919.49	22077	1.575	8.62	.00	.00
	2.917	915.44	22081	1.575	8.29	.00	.00
	2.937	911.32	22085	1.575	7.96	.00	.00
	2.958	907.14	22088	1.575	7.65	.00	.00
	2.979	902.86	22090	1.575	7.40	.00	.00
3.92	3.000	899.58	22088	1.575	6.63	.00	.00
	3.120	879.55	22068	1.575	7.62	.00	.00
	3.240	861.58	21995	1.650	7.00	.00	.00
	3.360	840.06	22011	1.650	9.82	.00	.00
4.40	3.480	824.27	22012	1.650	5.88	.00	.00
	3.586	815.79	21938	1.725	5.90	.00	.00
	3.692	807.40	21919	1.725	5.90	.00	.00
	3.798	798.73	21900	1.725	5.97	.00	.00
	3.904	790.94	21807	1.800	5.74	.00	.00
4.93	4.010	780.33	21836	1.800	8.52	.00	.00
	4.123	762.87	21805	1.800	7.69	.00	.00
	4.237	745.57	21784	1.875	8.00	.00	.00
5.27	4.350	730.13	21812	1.800	7.23	.00	.00
	4.477	719.43	21703	1.875	6.35	.00	.00
	4.603	709.64	21987	1.950	5.44	.00	.00
5.65	4.730	699.07	22106	1.875	8.08	.00	.00
	4.848	691.54	22181	1.800	8.10	.00	.00
	4.966	684.01	22650	1.875	8.16	.00	.00
	5.084	676.35	22173	1.950	16.90	.00	.00
	5.202	668.74	22843	2.025	8.65	.00	.00
6.24	5.32	661.03	21948	2.100	8.54	.00	.00

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 1

BELOW REACH THREE AT MILE 2.43

GAGE ZERO = 978.00 MAX ELEVATION REACHED BY FLOOD WAVE = 997.64
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 19.64 AT TIME = 1.500 HOURS
MAX FLOW = 22256 AT TIME = 1.500 HOURS

HR	STAGE	FLOW	0	5000	10000	15000	20000	25000
.0	6.4	1696	I *	I	I	I	I	I
.1	6.4	1696	I *	I	I	I	I	I
.2	6.4	1696	I *	I	I	I	I	I
.3	6.4	1696	I *	I	I	I	I	I
.4	6.4	1696	I *	I	I	I	I	I
.5	6.4	1697	I *	I	I	I	I	I
.6	6.4	1699	I *	I	I	I	I	I
.7	6.4	1736	I *	I	I	I	I	I
.8	6.8	1990	I *	I	I	I	I	I
.9	7.9	2858	I *	I	I	I	I	I
1.0	12.5	8294	I	I	* I	I	I	I
1.1	15.6	13551	I	I	I	* I	I	I
1.2	17.3	17017	I	I	I	I *	I	I
1.3	18.7	19997	I	I	I	I	*	I
1.4	19.4	21597	I	I	I	I	I *	I
1.5	19.6	22256	I	I	I	I	I *	I
1.6	19.4	21520	I	I	I	I	I *	I
1.7	19.0	20738	I	I	I	I	I*	I
1.8	18.6	19771	I	I	I	I	*	I
1.9	18.2	18759	I	I	I	I	* I	I
2.0	17.7	17746	I	I	I	I *	I	I
2.1	17.3	16734	I	I	I	I *	I	I
2.2	16.8	15722	I	I	I	I*	I	I
2.3	16.3	14743	I	I	I	*I	I	I
2.4	15.9	13900	I	I	I	* I	I	I
2.5	15.5	13091	I	I	I *	I	I	I
2.6	15.0	12282	I	I	I *	I	I	I
2.7	14.6	11472	I	I	I *	I	I	I
2.8	14.1	10663	I	I	I*	I	I	I
2.9	13.6	9847	I	I	*	I	I	I

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DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 29
BELOW REACH THREE AT MILE 3.00

GAGE ZERO = 878.00 MAX ELEVATION REACHED BY FLOOD WAVE = 899.58
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 21.58 AT TIME = 1.575 HOURS
MAX FLOW = 22089 AT TIME = 1.575 HOURS

HR	STAGE	FLOW	0	5000	10000	15000	20000	25000
.0	8.0	1696	I *	I	I	I	I	I
.1	8.0	1696	I *	I	I	I	I	I

```
 .2   8.0    1696 I *     I        I        I        I        I
 .3   8.0    1696 I *     I        I        I        I        I
 .4   8.0    1696 I *     I        I        I        I        I
 .5   8.0    1696 I *     I        I        I        I        I
 .6   8.0    1697 I *     I        I        I        I        I
 .7   8.0    1705 I *     I        I        I        I        I
 .8   8.1    1764 I  *    I        I        I        I        I
 .9   8.7    2052 I  *    I        I        I        I        I
1.0  12.4    3782 I     * I        I        I        I        I
1.1  17.0    8499 I       I      * I        I        I        I
1.2  19.2   13969 I       I        I      * I        I        I
1.3  20.4   17714 I       I        I        I   *    I        I
1.4  21.2   20425 I       I        I        I        I*       I
1.5  21.5   21876 I       I        I        I        I   *    I
1.6  21.6   21971 I       I        I        I        I   *    I
1.7  21.4   21317 I       I        I        I        I  *     I
1.8  21.2   20474 I       I        I        I        I*       I
1.9  21.0   19516 I       I        I        I       *I        I
2.0  20.7   18508 I       I        I        I     *  I        I
2.1  20.5   17514 I       I        I        I   *    I        I
2.2  20.2   16517 I       I        I        I  *     I        I
2.3  19.9   15527 I       I        I        I*       I        I
2.4  19.7   14586 I       I        I       *I        I        I
2.5  19.4   13759 I       I        I      * I        I        I
2.6  19.1   12965 I       I        I    *   I        I        I
2.7  18.9   12166 I       I        I  *     I        I        I
2.8  18.6   11367 I       I        I *      I        I        I
2.9  18.3   10567 I       I        I*       I        I        I
```

1

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 38
BELOW REACH THREE AT MILE 4.01

GAGE ZERO = 758.00 MAX ELEVATION REACHED BY FLOOD WAVE = 780.33
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 22.33 AT TIME = 1.800 HOURS
MAX FLOW = 21836 AT TIME = 1.800 HOURS

```
HR   STAGE    FLOW 0     5000     10000     15000     20000     25000
 .0    6.3    1696 I *     I        I        I        I        I
 .1    6.3    1696 I *     I        I        I        I        I
 .2    6.3    1696 I *     I        I        I        I        I
 .3    6.3    1696 I *     I        I        I        I        I
 .4    6.3    1696 I *     I        I        I        I        I
 .5    6.3    1696 I *     I        I        I        I        I
 .6    6.3    1696 I *     I        I        I        I        I
 .7    6.3    1696 I *     I        I        I        I        I
 .8    6.3    1699 I *     I        I        I        I        I
 .9    6.4    1715 I *     I        I        I        I        I
1.0    6.6    1828 I  *    I        I        I        I        I
1.1    7.7    2348 I   *   I        I        I        I        I
```

```
1.2   9.8    3399 I      * I        I        I        I        I
1.3  11.0    4088 I       * I       I        I        I        I
1.4  16.2    7842 I         I    *  I   *    I        I        I
1.5  20.9   16265 I         I       I        I  *     I        I
1.6  21.8   19649 I         I       I        I       *I        I
1.7  22.2   21349 I         I       I        I        I  *     I
1.8  22.3   21836 I         I       I        I        I   *    I
1.9  22.2   21355 I         I       I        I        I  *     I
2.0  22.1   20555 I         I       I        I        I*       I
2.1  21.9   19677 I         I       I        I       *I        I
2.2  21.6   18694 I         I       I        I     *  I        I
2.3  21.4   17729 I         I       I        I   *    I        I
2.4  21.1   16782 I         I       I        I  *     I        I
2.5  20.9   15822 I         I       I        I *      I        I
2.6  20.6   14917 I         I       I        *        I        I
2.7  20.4   14075 I         I       I      * I        I        I
2.8  20.1   13287 I         I       I     *  I        I        I
2.9  19.9   12523 I         I       I   *    I        I        I
```

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DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 41
BELOW REACH THREE AT MILE 4.35

GAGE ZERO = 703.60 MAX ELEVATION REACHED BY FLOOD WAVE = 730.13
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 26.53 AT TIME = 1.800 HOURS
MAX FLOW = 21812 AT TIME = 1.875 HOURS

```
HR   STAGE    FLOW  0      5000     10000     15000     20000     25000
 .0  10.4     1696  I  *     I         I         I         I         I
 .1  10.4     1696  I  *     I         I         I         I         I
 .2  10.4     1696  I  *     I         I         I         I         I
 .3  10.4     1696  I  *     I         I         I         I         I
 .4  10.4     1696  I  *     I         I         I         I         I
 .5  10.4     1696  I  *     I         I         I         I         I
 .6  10.4     1696  I  *     I         I         I         I         I
 .7  10.4     1696  I  *     I         I         I         I         I
 .8  10.4     1697  I  *     I         I         I         I         I
 .9  10.4     1704  I  *     I         I         I         I         I
1.0  10.5     1751  I   *    I         I         I         I         I
1.1  11.2     1999  I   *    I         I         I         I         I
1.2  13.3     2699  I    *   I         I         I         I         I
1.3  15.8     3597  I      * I         I         I         I         I
1.4  16.9     4265  I       *I         I         I         I         I
1.5  20.4     8480  I        I      *  I         I         I         I
1.6  24.7    17125  I        I         I         I  *      I         I
1.7  26.0    20395  I        I         I         I         I*        I
1.8  26.5    21637  I        I         I         I         I  *      I
1.9  26.4    21671  I        I         I         I         I  *      I
2.0  26.3    21092  I        I         I         I         I *       I
2.1  26.1    20187  I        I         I         I         *         I
```

```
2.2   25.7    19330 I         I         I         I        *I         I
2.3   25.4    18365 I         I         I         I      *  I         I
2.4   25.0    17380 I         I         I         I    *    I         I
2.5   24.7    16459 I         I         I         I  *      I         I
2.6   24.3    15528 I         I         I         I*        I         I
2.7   23.9    14638 I         I         I        *I         I         I
2.8   23.6    13833 I         I         I       * I         I         I
2.9   23.2    13060 I         I         I     *   I         I         I
```

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 44
BELOW REACH THREE AT MILE 4.73

GAGE ZERO = 678.00 MAX ELEVATION REACHED BY FLOOD WAVE = 699.07
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 21.07 AT TIME = 1.875 HOURS
MAX FLOW = 22106 AT TIME = 1.950 HOURS

```
HR   STAGE     FLOW  0      5000     10000     15000     20000     25000
 .0    7.5     1696  I  *     I         I         I         I         I
 .1    7.5     1696  I  *     I         I         I         I         I
 .2    7.5     1696  I  *     I         I         I         I         I
 .3    7.5     1696  I  *     I         I         I         I         I
 .4    7.6     1696  I  *     I         I         I         I         I
 .5    7.6     1696  I  *     I         I         I         I         I
 .6    7.6     1696  I  *     I         I         I         I         I
 .7    7.6     1696  I  *     I         I         I         I         I
 .8    7.6     1696  I  *     I         I         I         I         I
 .9    7.6     1698  I  *     I         I         I         I         I
1.0    7.6     1712  I  *     I         I         I         I         I
1.1    7.7     1796  I   *    I         I         I         I         I
1.2    8.4     2134  I   *    I         I         I         I         I
1.3    9.1     2511  I    *   I         I         I         I         I
1.4    9.8     2973  I     *  I         I         I         I         I
1.5   12.1     4518  I       *I         I         I         I         I
1.6   16.8     9458  I        I        *I         I         I         I
1.7   19.9    17395  I        I         I         I    *    I         I
1.8   20.4    21179  I        I         I         I         I *       I
1.9   21.0    21424  I        I         I         I         I  *      I
2.0   20.9    21403  I        I         I         I         I  *      I
2.1   20.7    21113  I        I         I         I         I *       I
2.2   20.5    19905  I        I         I         I         *         I
2.3   20.3    19048  I        I         I         I       * I         I
2.4   20.1    18188  I        I         I         I     *   I         I
2.5   19.8    17158  I        I         I         I   *     I         I
2.6   19.6    16243  I        I         I         I *       I         I
2.7   19.3    15353  I        I         I         I*        I         I
2.8   19.1    14485  I        I         I        *I         I         I
2.9   18.8    13690  I        I         I      * I         I         I
```

DISCHARGE HYDROGRAPH FOR MINNEWAWA BROOK ... STATION NUMBER 49
BELOW REACH THREE AT MILE 5.32

GAGE ZERO = 638.00 MAX ELEVATION REACHED BY FLOOD WAVE = 661.03
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 23.03 AT TIME = 2.100 HOURS
MAX FLOW = 21948 AT TIME = 2.100 HOURS

HR	STAGE	FLOW	0	5000	10000	15000	20000	25000
.0	7.5	1696	*					
.1	7.5	1696	*					
.2	7.5	1696	*					
.3	7.5	1696	*					
.4	7.5	1696	*					
.5	7.5	1696	*					
.6	7.5	1696	*					
.7	7.5	1696	*					
.8	7.5	1696	*					
.9	7.5	1697	*					
1.0	7.5	1700	*					
1.1	7.5	1721	*					
1.2	7.8	1837	*					
1.3	8.3	2148	*					
1.4	9.0	2535	*					
1.5	10.0	3166	*					
1.6	11.7	4430	*					
1.7	15.9	6414	*					
1.8	19.7	11509	*					
1.9	22.0	18374	*					
2.0	22.8	20821	*					
2.1	23.0	21948	*					
2.2	22.9	20925	*					
2.3	22.8	20304	*					
2.4	22.6	19588	*					
2.5	22.3	18511	*					
2.6	22.1	17611	*					
2.7	21.8	16715	*					
2.8	21.6	15786	*					
2.9	21.3	14928	*					

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