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CITY OF GLENDALE

59th AVENUE OVER SKUNK CREEK

PROJECT A834039

HYDRAULICS REPORT

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CITY OF GLENDALE

59th AVENUE OVER SKUNK CREEK

PROJECT A834039

HYDRAULICS REPORT

MARCH 16, 1984

IECO PROJECT 3628

80.0-00-9-03|84

RECEIVED
JOHN CAROLLO ENGINEERS
MAR 19 1984

INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
MIDWEST DISTRICT OFFICE
2425 SO. COLORADO BLVD.
DENVER, COLORADO 80222

HYDROLOGY AND HYDRAULICS REPORT
59th AVENUE BRIDGE OVER SKUNK CREEK
FOR
THE CITY OF GLENDALE, ARIZONA
MARCH 1984

1. Project Purpose and Location

This project is a replacement of the existing 35-ft.-wide, 2-lane bridge at 59th Avenue, with a 101-ft.-wide, 6-lane structure.

Stream Name:	Skunk Creek
County:	Maricopa
Location:	Border of Sections 29 and 30, T4N, R2E

2. Hydrology

The hydrology of Skunk Creek between Adobe Dam and the Arizona Canal has been studied extensively and is documented on the Drainage Master Plan for the Arrowhead Ranch Project. In the hydraulics study for the 59th Avenue Bridge replacement, the 100-year discharges at various points along Skunk Creek established by the U. S. Army Corps of Engineers in 1982 have been used. These discharges are 13,000 cfs at the Arizona Canal and 70 cfs less for approximately every 500 ft. upstream. The 100-year discharge at 59th Avenue is 11,250 cfs.

3. Hydraulics

To comply with the guidelines of the Maricopa Flood Control District, it is necessary to compare the water surface profile for the existing condition with the profile resulting from the new bridge. The guidelines state that the water surface elevation shall not be raised by more than one ft. by changes in the channel.

3.1 Existing Condition

At the present time, there is no bridge at Union Hills and the channel is unimproved. The Corps of Engineers has surveyed the entire length of Skunk Creek from Adobe Dam to the Arizona Canal, and these cross-sections were used to compute the water surface profile around the existing 59th Avenue bridge.

To avoid confusion regarding the datum used, the depths at various sections will be given as well as water surface elevations. The hydraulics study uses the same channel invert elevations as the Corps in its 100-year flood plain determination.

The Corps of Engineers HEC-2 program was used to compute backwater curves. The results for both the existing condition and proposed channel changes follow the report.

The cross-sections affected by the 59th Avenue bridge are listed below:

Distance Between Sects. (ft)	Cross-Section	Invert *Elev. MSL	Water Surface Elev.	Depth (ft)	Velocity (fps)
	4.42	1256.5	1264.56	8.06	10.62
5	4.421**	1256.5	1263.63	7.13	14.92
35	4.429***	1256.7	1263.83	7.13	14.95
5	4.43	1256.6	1268.06	11.46	4.85
150	4.5	1257.4	1267.95	10.55	7.45
500	4.6	1260.0	1270.55	10.55	6.35

*Corps of Engineers Datum
**Downstream face of bridge
***Upstream face of bridge.

3.2 Proposed Channel Changes

Approximately 1700 ft. downstream of the 59th Avenue bridge, a bridge is being designed at Union Hills Drive. There will also be extensive channelization between these two bridges. The proposed channel geometry is trapezoidal with a 110-ft. bottom width and 1-1/2:1 side slopes,between the two bridges.

Ven Te Chow's "Open Channel Hydraulics", 1959, provides tables of the roughness coefficient n for natural channels on pages 112 and 113. A minor stream (top width at flood stage 100 ft.) described as "clean, straight, full stage, no rifts or deep pools" has a normal n value of 0.030. For major streams, "the n value is less than that for minor streams of similar description because banks offer less effective resistance." The channel through the bridge section has a top width greater than 100 ft. and could be described as above. For this reason, the n value for sections 4.42, 4.421, 4.429, 4.43, and 4.5 were changed from 0.035, which the Corps used in their study, to 0.030.

The bridge will be three spans with a total length of 165 ft. Allowing for abutment caps and slope protection, the top width of the channel will be 151.7 ft. There will be two piers in the channel, each 15 inches wide. To allow for the possibility of debris becoming trapped on the piers during a flood, an effective width of four ft. was assumed, for computation of backwater.

The table below compares the depths around the bridge for the existing condition and the proposed change.

Distance Between Sections (ft)			Depth (ft)		Velocity	
Existing	Proposed	Cross-Section	Existing	Proposed	Existing	Proposed
		4.42	8.06	8.67	10.62	8.97
5	5	4.421	7.13	8.24	14.92	9.99
35	100	4.429	7.13	8.37	14.95	9.83
5	5	4.43	11.46	8.39	4.85	9.29
150	95	4.5	10.55	9.77	7.45	10.51
500	500	4.6	10.55	10.22	6.35	6.90

Because the new bridge will be 101 ft. wide, the distances between the proposed sections are slightly different than between the existing ones.

The backwater condition five ft. upstream from the existing bridge overtops the banks. The proposed bridge widens the channel, providing more flow area and nearly eliminates this problem. The proposed bridge is higher than the existing one, thus the increase in water depth at sections 4.421 and 4.429 is not a cause for concern. In fact, with the raise in roadway grade, there will be one ft. of freeboard, whereas there is only 1/2 ft. now. Also, the reduction in velocity at the bridge will decrease the scour damage. A trial-and-error approach was taken to determine the optimum bridge length. If the channel is constricted, as it is now, velocities will be higher through the bridge, depths will be lower, and there will be a backwater condition up-stream. If the bridge is lengthened, velocities decrease, depths increase, and backwater effects are diminished. The 165-ft. length allows for reasonable depths and velocities both at the bridge and upstream.

4. Bridge Abutment Slope Protection

In the Concept Report submitted January 30, 1984, riprap was recommended for slope protection. However, the City of Glendale has specified that wire tied gabions rather than riprap are to be used as slope protection. The gabions will be placed at the bridge abutments to prevent streamflows from eroding the slope material which could undermine the bridge footings and lead to structural failure.

According to the Corps of Engineers, the most common reason for failure of slope protection is inadequate treatment of the toe. In particular, gabions have been known to fail because of the wires rusting and breaking, inadequate rock sizing, and erosion of the bank material below the base of the revetment. In order to provide the most reliable design, the gabions at the abutments at 59th Avenue will extend down to the scour depth and also have a 15-ft. apron tied on. This arrangement will be at the bridge location only

and is justified when considering the potential damage to the structure. The gabion configuration to be used in the channel would allow the apron to drop to fill any undermining by scour action. However, the scour action could continue to undermine the revetment on the slope. By extending the gabions to the scour line, this undermining action is negated. The revetment at the bridge will be warped upward downstream of the bridge to eventually tie into the channel gabions. The gabions will be wrapped around the upstream side of the abutment.

To further ensure the integrity of the revetment, the intermediate counterforts will be spaced at 21 ft. Conversations with engineers from the Bureau of Reclamation regarding gabion design indicated that a closer spacing is warranted. Portions of a report dealing with the spacing of intermediate counterforts is included in the reference section.

5. Scour Analysis

Using several different methods of scour analysis from "Guide for Computing Degradation and Local Scour" by E. L. Pemberton and J. M. Lara, 1982, a depth of 11 ft. below original ground was computed. This depth agrees well with the sand and gravel armoring layer results reported by ATL Testing Laboratories which varied between 10 and 15 ft. The slope protection will extend down to this depth to prevent damage to the bridge footing.

Calculation sheets showing the methods used follow the report.

6. Freeboard

The 59th Avenue bridge is in close proximity to two intersections which precludes a large raise in the grade. Lengthening the bridge did not provide enough increased flow area to significantly decrease the depth. Thus, the grade was raised 1-1/2 ft. with resulting freeboard at the upstream face of one ft.

The Colorado Department of Highways provides a formula to estimate the freeboard requirement.

$$
\begin{aligned}
F(ft) &= 0.1\ Q^{0.3} + 0.008\ V^2 \\
&= 0.1\ (11{,}250)^{0.3} + (0.008)(9.83)^2 \\
&= 1.64 + 0.77 \\
&= 2.41 \text{ ft.}
\end{aligned}
$$

Given the inability to raise the grade and the relatively clear channel, it is reasonable to allow less than two ft. of freeboard.

ADDENDUM

Thursday, March 15, 1984, John Carollo Engineers informed IECO that the Corps of Engineers was revising its estimate of the 100-year flood discharge. At the Arizona Canal, the discharge is 11,000 cfs, at Union Hills Drive, 9675 cfs, and at 59th Avenue, 9500 cfs.

A new backwater computation was made to determine the change in depths at the bridge. Preliminary figures are:

Cross-Section	Depth (ft)	Velocity (fps)
4.421	7.38	9.27
4.429	7.47	9.17

These values also reflect pier widths of 2.25 ft. as the 4 ft. width originally used was considered too conservative.

A check of the freeboard calculations follows:

$$
\begin{aligned}
F &= 0.1 \quad Q^{0.3} + \quad 0.008 \quad V^2 \\
&= 0.1 \ (9500)^{0.3} + 0.008 \ (9.17)^2 \\
&= 1.56 + 0.67 \\
&= 2.23 \text{ ft.}
\end{aligned}
$$

With a depth of 7.47 ft. at the upstream face, the freeboard is approximately 2.18 ft.

SCOUR ANALYSIS

INTERNATIONAL ENGINEERING COMPANY, INC.

Sheet 3

Project
Feature Scour Analysis
Item

Contract No.
Designed JEP
Checked AMG

File No.
Date 2/13/84
Date 2-14-84

Channel scour during peak flood flows

Reference - Guide for Computing Degradation and Local Scour by E. L. Pemberton J.M. Lara Oct. 1982

Equations 26, 27, 29, 30

(26) $d_m = 0.47 \left(\frac{Q}{f}\right)^{\frac{1}{3}}$

$d_m = 7.77$ ft ✓

$Q = 11,250$ cfs

$f = 1.76 (D_m)^{\frac{1}{2}} = 2.49$

(27) $d_{fo} = \frac{q_f^{\frac{2}{3}}}{F_{bo}^{\frac{1}{3}}}$

$q_f = \frac{11,250}{(118.5 + 131.34)/2} = 90$ cfs/ft

F_{bo} from fig. 9 $= 2.3$ ft/sec² ✓ $D_m = 2$ mm ✓ $= .0066$ ft

$d_{fo} = 15.2$ ft ✓

(29) $d_s = z\, d_m$ Lacey

$= \cancel{.5}\ 1.25 (7.8) = 3.9$ ft ✗

$1.25 (7.8) = 9.75$ ← Eldo

(30) $d_s = z\, d_{fo}$ Blench

$= .6 (15.2) = 9.1$

(34) $d_s = \frac{K H^{.2} q^{.57}}{D_{90}^{.32}} - d_m$ Schoklitsch

$= \frac{3.15 (2)^{.2} (90)^{.57}}{(9.5)^{.32}} - 8.7$ ft $= 14.1$

$D_{90} = \frac{3}{8}" = 9.5$ mm

INTERNATIONAL ENGINEERING COMPANY, INC.

Sheet 4

Project

Contract No.

File No.

Feature

Designed JEP

Date 2/14/84

Item

Checked

Date 2-14-84

Lacey 9.75 ft

Blench 9.1 ft

Schoklitsch 14.1 ft

average 11 ft

Armoring

Meyer-Peter, Muller

(2) $$D_c = \frac{dS}{K\left(\frac{n_s}{D_{90}^{\frac{1}{6}}}\right)^{\frac{3}{2}}}$$

$$= \frac{9(.0046)}{.19\left(\frac{.035}{(9.5)^{\frac{1}{6}}}\right)^{\frac{3}{2}}} = 58.4 \text{ mm} \checkmark$$

Competent bottom velocity

(3) $$D_c = 1.88\, V_m^2$$

$$= 1.88(11)^2 = 227 \text{ mm} \checkmark$$

Lane's tractive force

(4) $$T_c = \gamma_w\, dS$$

$$= (62.4)(9.1)(.0046) = 2.61 \text{ lb/ft}^2 \checkmark$$

figure 4 ~ 100 mm

Shields Diagram

(5) $$T_* = \frac{T_c}{(\gamma_s - \gamma_w) D_c} = .06$$

$$.06 = \frac{2.61}{(165-62.4) D_c} \qquad D_c = 0.42 \text{ ft} \checkmark$$

Yang incipient motion

(6) $$\frac{V_{cr}}{w} = 2.05$$

(7) $$w = 6.01\, D_c^{\frac{1}{2}}$$

(8) $$D_c = .00659\, V_{cr}^{\frac{1}{2}}$$

Yang incipient motion

trapezoidal section

$$V_c = \sqrt{\frac{b + z d_c}{b + 2z d_c} g d_c}$$

$b = 118.5$ $z = 2$ $d_c = 7.05$

$V_c = 14.3$ fps ✓

$D_c = .00659 \; V_c^2$

$= 1.35$ in ✓

average

M-P, M	58.4	mm	
CRV	227	mm	
Lane	100	mm	
Shields	.42	ft	128 mm
Yang	1.35	in	34.3 mm

Average 110 mm = 4.3 in. ✓

assume scour limited by stable slope rather than armoring

HEC - 2 RUN

EXISTING CONDITION

```
LNHF=FILEOUT=FILEOUT

 EOI ENCOUNTERED.
C>TGET,FILEOUT

C>REWIND,FILEOUT

C>LNH,F=FILEOUT

$*****************************************************                                    ****************************************

        PAGE     1


                                                                                  THIS RUN EXECUTED  84/01/26.   11.39.46.

 ***************************************************
   HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
   ERROR CORR -  01,02,03,04,05
   MODIFICATION -  50,51,52,53,54,55
 ***************************************************


 T1    CITY OF GLENDALE  BRIDGE OVER SKUNK CREEK AT 59TH AVE.
 T2          100 YEAR FLOOD
 T3          [illegible] 100 FT BOTTOM WIDTH  2:1 SIDE SLOPES

 J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

        0.       2.        0.        0.    .004500     0.00      0.0       0.   1240.450    0.000

 J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

      -1.000    0.000    -1.000    0.000     0.000     0.000    -1.000    0.000     0.000     15.000


 NC       .045      .045      .035      .100      .300     0.000     0.000     0.000     0.000     0.000
 QT      2.000 11880.000  8280.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
 X1      3.500    15.000  9900.000 10100.000     0.000     0.000     0.000     0.000     0.000     0.000
 X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
 GR   1242.000  9090.000  1240.000  9120.000  1240.000  9900.000  1234.000  9920.000  1232.000  9960.000
 GR   1230.000  9980.000  1230.000  9981.000  1232.000 10030.000  1234.000 10075.000  1240.600 10100.000
 GR   1240.000 10260.000  1241.000 10340.000  1242.000 10500.000  1244.000 10660.000  1244.000 10950.000

 QT      2.000 11810.000     0.000     0.000 11810.000     0.000     0.000     0.000     0.000     0.000
 ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
 X1      3.600    17.000  9920.000 10030.000   545.000   500.000   525.000     0.000     0.000     0.000
 X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
 GR   1246.900  8150.000  1246.000  8320.000  1244.000  8870.000  1242.000  9070.000  1241.500  9920.000
 GR   1234.000  9940.000  1233.500  9965.000  1234.000  9975.000  1235.000 10045.000  1236.000 10055.000
 GR   1241.800 10080.000  1242.000 10200.000  1244.000 10590.000  1244.800 11120.000  1244.300 11570.000
 GR   1246.000 11960.000  1246.900 12110.000     0.000     0.000     0.000     0.000     0.000     0.000

 QT      2.000 11740.000     0.000     0.000 11740.000     0.000     0.000     0.000     0.000     0.000
 ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
 X1      3.700    20.000  9925.000 10180.000   530.000   500.000   530.000     0.000     0.000     0.000
 X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
 GR   1249.000  8069.000  1248.000  8816.000  1247.000  8925.000  1244.000  9200.000  1246.000  9800.000
 GR   1244.000  9393.000  1246.000  9925.000  1239.000  9950.000  1240.000 10000.000  1240.000 10020.000
 GR   1238.000 10050.000  1244.000 10060.000  1243.000 10110.000  1244.000 10150.000  1246.500 10180.000
 GR   1246.000 10310.000  1246.800 10610.000  1248.000 11010.000  1248.000 11520.000  1248.000 11775.000
```

QT	2.[illegible]	11670.000	0.000	0.000	11670.000	[illegible]00	0.000	0.000	0.000	0.000
X1	3.800	17.000	9930.000	10075.000	570.000	43[illegible].000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1252.000	8840.000	1250.000	9020.000	1248.000	9100.000	1247.600	9300.000	1247.000	9670.000
GR	1249.000	9900.000	1249.000	9930.000	1248.000	9955.000	1240.500	9980.000	1240.500	10050.000
GR	1248.000	10060.000	1250.700	10075.000	1248.000	10085.000	1247.000	10170.000	1248.000	10550.000
GR	1250.000	10930.000	1250.800	11270.000	1252.000	11420.000	1252.000	11450.000	0.000	0.000

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QT	2.000	11600.000	0.000	0.000	11600.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	3.900	17.000	9860.000	10072.000	430.000	640.000	530.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1255.000	8500.000	1252.000	8870.000	1252.000	8975.000	1250.000	9040.000	1249.800	9650.000
GR	1249.500	9360.000	1244.000	9890.000	1248.700	9915.000	1244.000	9930.000	1242.000	10040.000
GR	1252.000	10072.000	1250.000	10080.000	1249.700	10270.000	1250.000	10480.000	1252.000	10530.000
GR	1254.000	10540.000	1255.000	10900.000	0.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11530.000	0.000	0.000	11530.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.000	24.000	9925.000	10090.000	400.000	670.000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1256.000	8250.000	1255.700	8390.000	1256.000	8600.000	1254.000	8745.000	1252.000	8805.000
GR	1250.000	9760.000	1249.000	9795.000	1250.000	9820.000	1252.000	9890.000	1256.000	9925.000
GR	1245.000	9950.000	1245.000	10075.000	1250.000	10090.000	1248.000	10130.000	1248.000	10170.000
GR	1250.000	10215.000	1252.000	10350.000	1254.000	10600.000	1254.900	10620.000	1256.000	10650.000
GR	1256.000	10655.000	1257.900	10930.000	1257.500	11260.000	1258.000	11410.000	0.000	0.000
QT	2.000	11460.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.100	20.000	9920.000	10100.000	490.000	570.000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1258.000	8290.000	1256.000	8630.000	1254.000	8820.000	1253.700	9170.000	1254.000	9545.000
GR	1252.000	9630.000	1252.000	9680.000	1258.500	9920.000	1248.000	9942.000	1247.800	10028.000
GR	1248.000	10070.000	1250.000	10100.000	1252.000	10210.000	1254.000	10235.000	1255.400	10260.000
GR	1254.500	10355.000	1256.000	10650.000	1258.000	10880.000	1260.000	11265.000	1261.000	11400.000
QT	2.000	11390.000	0.000	0.000	11390.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.200	22.000	9920.000	10075.000	470.000	550.000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1263.000	7450.000	1262.000	7530.000	1260.000	8390.000	1259.200	8430.000	1260.000	8565.000
GR	1262.000	8620.000	1260.000	8680.000	1258.000	8790.000	1256.000	9680.000	1254.000	9695.000
GR	1254.000	9900.000	1257.000	9920.000	1250.500	9945.000	1250.500	10060.000	1260.000	10075.000
GR	1256.000	10185.000	1254.000	10210.000	1256.000	10325.000	1258.000	10660.000	1260.000	10810.000
GR	1262.000	11020.000	1263.000	11035.000	0.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11320.000	0.000	0.000	11320.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.300	30.000	9890.000	10130.000	430.000	560.000	530.000	0.000	0.000	0.000
GR	1264.400	8130.000	1264.000	8170.000	1264.000	8250.000	1266.000	8900.000	1264.000	8950.000
GR	1262.000	9255.000	1260.000	9670.000	1260.000	9710.000	1260.000	9740.000	1260.000	9820.000
GR	1260.000	9890.000	1258.000	9900.000	1256.000	9940.000	1254.000	9950.000	1252.600	9951.000
GR	1252.600	10059.000	1254.000	10060.000	1256.000	10075.000	1258.000	10085.000	1260.000	10130.000
GR	1260.000	10220.000	1260.000	10250.000	1260.000	10310.000	1260.000	10380.000	1260.000	10470.000
GR	1260.000	10540.000	1260.000	10650.000	1262.000	10670.000	1264.000	10695.000	1264.400	10700.000

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QT	2.000	11250.000	0.000	0.000	11250.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.035	.300	.500	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.400	20.000	9880.000	10140.000	450.000	550.000	530.000	0.000	0.000	0.000
GR	1257.000	9350.000	1264.000	9380.000	1263.300	9650.000	1262.000	9880.000	1260.000	9925.000
GR	1258.000	9935.000	1256.000	9990.000	1254.000	10020.000	1254.000	10040.000	1256.000	10050.000
GR	1256.000	10130.000	1262.500	10140.000	1260.000	10170.000	1262.000	10180.000	1263.500	10200.000
GR	1262.000	10250.000	1262.000	10600.000	1264.000	10750.000	1256.000	11000.000	1268.000	11020.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.420	17.000	9920.000	10035.000	180.000	300.000	320.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	1267.000	1264.000	0.000
GR	1269.000	7900.000	1269.000	7960.000	1269.000	7970.000	1267.000	9340.000	1266.000	9500.000
GR	1266.000	9870.000	1266.000	9920.000	1256.500	9920.100	1256.500	10000.000	1256.500	10034.900
GR	1264.000	10035.000	1264.000	10150.000	1266.000	10200.000	1262.000	10250.000	1264.000	10500.000
GR	1266.000	10950.000	1268.000	11330.000	0.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.020	.300	.500	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.421	36.000	9920.000	10035.000	5.000	5.000	5.000	0.000	0.000	1.000
BT	14.000	9490.000	1267.500	1264.000	9650.000	1268.000	1265.000	9760.000	1269.000	1266.000
BT	9920.000	1269.000	1268.100	10035.000	1269.000	1268.100	10055.000	1269.000	1264.000	10130.000
BT	1269.000	1264.000	10165.000	1267.000	1266.000	10205.000	1266.000	1266.000	10255.000	1265.500
BT	1262.000	10355.000	1265.300	1262.700	10530.000	1266.000	1264.000	10800.000	1266.000	1265.300
BT	11235.000	1268.000	1268.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1269.000	7970.000	1267.000	9340.000	1264.000	9490.000	1265.000	9650.000	1266.000	9760.000
GR	1266.000	9870.000	1266.000	9920.000	1256.500	9920.010	1256.500	9938.700	1268.100	9938.710
GR	1268.100	9941.000	1256.500	9941.010	1256.500	9963.700	1268.100	9963.710	1268.100	9966.000
GR	1256.500	9966.010	1256.500	9988.700	1268.100	9938.710	1268.100	9991.000	1256.500	9991.010
GR	1256.500	10013.700	1268.100	10013.710	1268.100	10016.000	1256.500	10016.010	1256.500	10034.900
GR	1264.000	10035.000	1264.000	10055.000	1264.000	10130.000	1266.000	10165.000	1266.000	10205.000
GR	1262.000	10255.000	1262.700	10355.000	1264.000	10530.000	1265.300	10800.000	1266.000	10950.000
GR	1268.000	11235.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.429	0.000	0.000	0.000	35.000	35.000	35.000	0.000	.200	0.000
X2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.330	0.000	0.000
NC	.045	.045	.035	.300	.500	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000
X1	4.430	12.000	9920.000	10035.000	5.000	5.000	5.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	1267.500	1265.300	0.000
GR	1268.000	9350.000	1268.000	9515.000	1267.400	9560.000	1266.000	9630.000	1266.000	9910.000
GR	1256.600	9920.000	1256.600	10035.000	1264.500	10050.000	1266.000	10810.000	1268.000	11400.000
GR	1270.000	11410.000	1272.000	11620.000	0.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11180.000	0.000	0.000	11180.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.035	.100	.300	0.000	0.000	0.000	0.000	0.000
NH	2.000	.055	10070.000	.055	11650.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	0.000	0.000	10.400	0.000	0.000	0.000	0.000	0.000	0.000

X1	4.500	12.000	9945.000	10070.000	200.000	120.000	150.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1272.000	8300.000	1270.000	9100.000	1268.000	9610.000	1266.000	9710.000	1266.000	9945.000
GR	1257.400	9975.000	1257.400	10030.000	1265.400	10070.000	1268.000	10815.000	1268.000	11410.000
GR	1270.000	11420.000	1272.000	11650.000	0.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11110.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NH	2.000	.055	10200.000	.055	11500.000	0.000	0.000	0.000	0.000	0.000

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ET      0.[illegible]     0.000     0.000     0.000    10.400     [illegible]00     0.000     0.000     0.000     0.000
X1      4.600    20.000  9920.000 10170.000   500.000   420.000   530.000     0.000     0.000     0.000
X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1272.500  7900.000  1272.000  7901.000  1272.000  7902.000  1272.000  7903.000  1272.000  7904.000
GR   1271.000  9295.000  1271.000  9550.000  1270.100  9570.000  1270.000  9635.000  1268.500  9690.000
GR   1269.000  9825.000  1269.500  9920.000  1262.000  9945.000  1260.000 10020.000  1260.000 10040.000
GR   1268.000 10110.000  1271.000 10170.000  1268.000 10230.000  1268.000 10870.000  1270.000 11500.000

QT      2.000 11040.000     0.000     0.000 11040.000     0.000     0.000     0.000     0.000     0.000
NH      2.000      .055 10230.000      .055 11950.000     0.000     0.000     0.000     0.000     0.000
ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
X1      4.700    19.000  9900.000 10160.000   500.000   490.000   530.000     0.000     0.000     0.000
X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1276.000  8160.000  1276.000  8161.000  1276.000  8162.000  1276.000  8600.000  1274.000  9000.000
GR   1272.800  9595.000  1272.000  9650.000  1272.000  9900.000  1270.000  9960.000  1264.000  9980.000
GR   1264.000 10065.000  1274.800 10160.000  1272.000 10185.000  1270.000 10280.000  1268.600 10480.000
GR   1270.000 10900.000  1272.000 11650.000  1272.800 11730.000  1274.000 11950.000     0.000     0.000

QT      2.000 10970.000     0.000     0.000 10970.000     0.000     0.000     0.000     0.000     0.000
NC       .045      .045      .035      .100      .300     0.000     0.000     0.000     0.000     0.000
ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
X1      4.800    13.000  9920.000 10048.000   550.000   460.000   530.000     0.000     0.000     0.000
X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1276.400  9290.000  1276.000  9570.000  1274.700  9920.000  1266.000  9962.000  1266.000 10000.000
GR   1274.000 10048.000  1270.000 10135.000  1272.000 10162.000  1274.000 10220.000  1274.000 10400.000
GR   1274.000 10800.000  1274.000 11230.000  1276.000 11300.000     0.000     0.000     0.000     0.000

QT      2.000 10900.000     0.000     0.000 10900.000     0.000     0.000     0.000     0.000     0.000
ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
X1      4.900    16.000  9950.000 10050.000   550.000   350.000   520.000     0.000     0.000     0.000
X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1280.000  9700.000  1278.000  9800.000  1276.600  9950.000  1270.000  9965.000  1268.000  9975.000
GR   1270.000 10025.000  1274.000 10050.000  1274.000 10152.000  1274.000 10175.000  1276.000 10185.000
GR   1276.900 10230.000  1276.900 10385.000  1276.000 10455.000  1276.000 10630.000  1277.000 11300.000
GR   1278.000 11750.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

QT      2.000 10830.000     0.000     0.000 10830.000     0.000     0.000     0.000     0.000     0.000
ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
X1      5.000    15.000  9868.000 10030.000   530.000   510.000   520.000     0.000     0.000     0.000
X3     10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1280.000  9520.000  1279.000  9700.000  1278.000  9830.000  1278.500  9868.000  1278.000  9890.000
GR   1273.000  9930.000  1273.000 10010.000  1274.000 10022.000  1278.000 10030.000  1278.000 10100.000
GR   1278.500 10205.000  1278.000 10370.000  1278.000 10570.000  1280.000 11000.000  1282.000 11050.000
1
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QT      2.000 10760.000     0.000     0.000 10760.000     0.000     0.000     0.000     0.000     0.000
ET      0.000     0.000     0.000     0.000    10.400     0.000     0.000     0.000     0.000     0.000
EJ      0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST
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CCHV=     .100 CEHV=     .300
*SECNO 3.500

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1240.00 ELREA=     1240.60

      3.50      9.34  1239.34  1237.71  1240.45  1240.80      1.46      0.00      0.00  1240.00
    11380.        0.   11380.       0.       0.    1226.        0.        0.        0.   1240.60
      0.00      0.00      9.69     0.00     .045     .035     .045     0.000  1230.00  9902.20
   .004487        0.        0.       0.        0       18         4      0.00    193.04 10095.23
0
FLOW DISTRIBUTION FOR SECNO=      3.50          CWSEL=   1239.34

STA=    9902.   10100.
  PER Q=    100.0
   AREA=   1225.5
    VEL=      9.7

*SECNO 3.600
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
      3.60      9.17  1242.67  1242.67     0.00  1243.74      1.07      1.98       .04  1241.50
    11810.     1416.   10203.     187.     303.    1149.     137.       20.        9.   1241.80
      .02      1.73      3.38     1.36     .045     .035     .045     0.000  1233.50  9002.60
   .003214     545.      525.     500.        0        8        0      0.00  1323.84 10331.44
0
FLOW DISTRIBUTION FOR SECNO=      3.60          CWSEL=   1242.67

STA=    9003.    9070.    9920.   10080.   10200.   10331.
  PER Q=       .2      11.8      36.4      1.2       .3
   AREA=     22.7     785.4    1149.1     92.9     44.3
    VEL=       .9       1.3       8.9      1.6       .9

*SECNO 3.700
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1246.00 ELREA=     1246.50

      3.70      8.10  1246.10  1246.10     0.00  1246.99       .89      2.25       .02  1246.00
    11740.     2674.    9066.       0.     997.    1066.        0.       45.       24.   1246.50
      .04      2.63      8.51     0.00     .045     .035     .045     0.000  1239.00  9007.75
   .005899     530.      530.     500.        0        9        0      0.00  1167.42 10175.17
0
1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       APOB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

FLOW DISTRIBUTION FOR SECNO=      3.70          CWSEL=   1246.10

STA=    9008.    9200.    9800.    9898.    9925.   10180.
  PER Q=       4.5      15.1       2.5       .7      77.2
   AREA=     201.6     653.4     107.5     29.6    1065.8
    VEL=       2.6       2.7       2.7      2.7       8.5

*SECNO 3.800
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7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      1249.00 ELREA=      1250.70

      3.80      8.66  1249.16  1249.16      0.00  1250.17      1.01      2.92       .03  1249.00
    11670.     3968.     7702.       0.     1257.     798.        0.       71.       38.  1250.70
       .06      3.16      9.65     0.00      .045     .035      .045     0.000  1240.50  9053.69
   .005034      570.      520.     480.         0        8         0      0.00  1012.74 10066.43
0
FLOW DISTRIBUTION FOR SECNO=       3.80          CWSEL=   1249.16

STA=    9054.    9100.    9300.    9670.    9900.    9930.   10075.
  PER Q=        .4       6.7     21.0      5.9        .0     66.0
   AREA=      26.8     271.5    687.3    265.3       4.7    798.0
    VEL=       1.6       2.9      3.6      2.6        .7      9.7

*SECNO 3.900

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      1249.50 ELREA=      1252.00

      3.90      9.21  1251.21  1250.38      0.00  1251.82       .61      1.61       .04  1249.50
    11600.     2192.     9408.       0.     1152.    1367.        0.       96.       49.  1252.00
       .08      1.90      6.88     0.00      .045     .035      .045     0.000  1242.00  9000.62
   .002195      430.      530.     640.         2        8         0      0.00  1068.85 10069.48
0
FLOW DISTRIBUTION FOR SECNO=       3.90          CWSEL=   1251.21

STA=    9001.    9040.    9650.    9860.   10072.
  PER Q=        .2      12.8      5.9     81.1
   AREA=      23.9     800.1    327.9    1367.4
    VEL=       1.1       1.9      2.1       6.9

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

*SECNO 4.000

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      1256.00 ELREA=      1250.00

      4.00      7.37  1252.37  1251.07      0.00  1253.30       .93      1.38       .10  1256.00
    11530.        0.     9005.    2525.        0.    1057.     657.      121.       58.  1250.00
       .10      0.00      8.52     3.84      .045     .035      .045     0.000  1245.00  9933.23
   .003223      400.      520.     670.         2       20         0      0.00   463.85 10397.09
0
FLOW DISTRIBUTION FOR SECNO=       4.00          CWSEL=   1252.37

STA=    9933.   10090.   10130.   10170.   10215.   10350.   10397.
  PER Q=      78.1       4.9      7.6      5.6      3.7       .0
   AREA=    1057.1     135.1    175.1    152.0    185.9      8.9
    VEL=       8.5       4.2      5.0      4.2      2.3       .6

*SECNO 4.100

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      1258.50 ELREA=      1250.00
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      4.10      6.41  1254.21  1253.34     0.00  1255.46     1.25      .07      .10  1258.50
    11460.        0.     9611.     1849.       0.     1006.      385.     140.      62.   1250.00
       .12      0.00     9.56     4.81     .045      .035     .045    0.000  1247.80  9928.97
   .004831      480.     520.     570.        2        19        0     0.00   309.89 10238.87
0
 FLOW DISTRIBUTION FOR SECNO=      4.10          CWSEL=   1254.21

 STA=    9929.   10100.   10210.   10235.   10239.
   PER Q=      83.9      15.4       .7       .0
    AREA=    1005.5     353.8     30.4       .4
     VEL=       9.6       5.0      2.6       .5

 *SECNO 4.200
 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE/ELLEA=     1257.00 ELREA=     1260.00

      4.20      6.76  1257.26  1257.26     0.00  1258.07      .82     2.19      .04  1257.00
    11390.     3729.     7661.       0.    1089.      901.       0.      160.      70.   1260.00
       .14      3.43     8.50     0.00     .045      .035     .045    0.000  1250.50  9120.43
   .003789      470.     520.     550.        0        10        0     0.00   950.24 10070.67
0
1
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
    Q         GLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     COPAR     TOPWID      ENDST


 FLOW DISTRIBUTION FOR SECNO=      4.20          CWSEL=   1257.26

 STA=    9120.    9680.    9695.    9900.    9920.   10075.
   PER Q=       4.6       1.0      26.2       .9      67.3
    AREA=     351.8      33.9     667.8     35.1     900.8
     VEL=       1.5       3.5      4.5      2.9       8.5

 *SECNO 4.300

 3301 HV CHANGED MORE THAN HVINS

      4.30      6.78  1259.38  1259.17     0.00  1261.37     1.99     2.95      .35  1260.00
    11320.        0.    11320.       0.       0.     1001.       0.      177.      76.   1260.00
       .15      0.00    11.31     0.00     .045      .035     .045    0.000  1252.60  9893.07
   .009727      430.     530.     560.        2         8        0     0.00   223.13 10116.20
0
 FLOW DISTRIBUTION FOR SECNO=      4.30          CWSEL=   1259.38

 STA=    9893.   10130.
   PER Q=     100.0
    AREA=    1000.6
     VEL=      11.3

 CCHV=     .300 CEHV=     .500
 *SECNO 4.400

 3265 DIVIDED FLOW
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3301 HV CHANGED MORE THAN HVINS

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      4.40       9.22  1263.22  1260.62      0.00  1263.77       .55      1.97       .43  1262.00
    11250.        136.   10127.     987.      131.     1614.      597.      197.       83.  1262.50
       .18       1.04      6.28     1.65      .045      .035      .045     0.000  1254.00  9664.92
   .001940       450.      530.     550.         2         8         0      0.00  1012.99 10691.18
0
 FLOW DISTRIBUTION FOR SECNO=      4.40          CWSEL=   1263.22

 STA=     9665.    9830.   10140.   10170.   10180.   10196.   10250.   10600.   10691.
   PER Q=      1.2     90.0      1.2       .5       .1       .2      6.3       .5
    AREA=    130.7   1613.6     59.0     22.2      9.9     24.6    425.5     55.4
     VEL=      1.0      6.3      2.3      2.4      1.0      1.0      1.7      1.0

1
  84/01/26.   11.39.46.                                                                    PAGE   10

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

 *SECNO 4.420

 3265 DIVIDED FLOW

 3301 HV CHANGED MORE THAN HVINS

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1267.00 ELREA=     1264.00

      4.42       8.06  1264.56  1264.56      0.00  1266.10      1.54       .90       .50  1266.00
    11250.         0.     9835.    1415.        0.     926.      534.      211.       89.  1264.00
       .19       0.00     10.62     2.65      .045      .035      .045     0.000  1256.50  9920.02
   .004531       180.      320.     300.         0        12         0      0.00   651.94 10625.96
0
 FLOW DISTRIBUTION FOR SECNO=      4.42          CWSEL=   1264.56

 STA=     9920.   10035.   10150.   10164.   10250.   10500.   10626.
   PER Q=     87.4       .9       .0      1.0     10.4       .3
    AREA=    926.0     64.4      3.9     41.0    390.0     35.3
     VEL=     10.6      1.5      1.0      2.6      3.0      1.0

 CCHV=     .300 CEHV=     .500
 *SECNO 4.421

 3265 DIVIDED FLOW

 3301 HV CHANGED MORE THAN HVINS

 3370 NORMAL BRIDGE,NRD= 14 MIN ELTRD= 1265.30 MAX ELLC= 1268.10

      4.42       7.13  1263.63  1263.50      0.00  1267.09      3.45       .03       .96  1266.00
    11250.         0.    11250.       0.        0.     754.        0.      211.       89.  1264.00
       .19       0.00     14.92     0.00      .045      .020      .045     0.000  1256.50  9920.00
   .003833         5.        5.       5.         3        16         0  -203.71   351.90 10430.68
0
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
     SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

FLOW DISTRIBUTION FOR SECNO=      4.42          CWSEL=   1263.63

STA=    9920.   10035.
  PER Q=    100.0
   AREA=    754.2
    VEL=     14.9

*SECNO 4.429

3265 DIVIDED FLOW

3370 NORMAL BRIDGE/NRD= 14 MIN ELTRD= 1265.30 MAX ELLC= 1268.30

      4.43      7.13  1263.83  1263.71      0.00  1267.30      3.47       .20       .01  1266.20
    11250.        0.   11250.       0.        0.     753.        0.      211.       89.   1264.20
       .19      0.00     14.95     0.00      .045     .020      .045     0.000  1256.70   9920.00
   .005867       35.       35.       35.         1       18         0  -200.14    349.76 10478.72
0
FLOW DISTRIBUTION FOR SECNO=      4.43          CWSEL=   1263.83

STA=    9920.   10035.
  PER Q=    100.0
   AREA=    752.7
    VEL=     14.9

CCHV=    .300 CEHV=    .500
*SECNO 4.430
3280 CROSS SECTION      4.43 EXTENDED       .06 FEET


3301 HV CHANGED MORE THAN HVINS

      4.43     11.46  1268.06  1263.25      0.00  1268.28       .22       .01       .97  1256.60
    11250.      931.     6391.     3929.      765.     1318.     2871.      212.       89.   1256.60
       .19      1.22      4.35      1.37      .045      .035      .045     0.000  1256.60   9350.00
   .000505        5.        5.        5.         4        11         0      0.00  2050.29 11400.29
0
FLOW DISTRIBUTION FOR SECNO=      4.43          CWSEL=   1268.06

STA=    9350.    9560.    9630.    9910.    9920.   10035.   10050.   10810.   11400.
  PER Q=       .1       .8      6.2      1.3     56.8      2.6     28.0      4.3
   AREA=     25.7     95.1    576.2     67.6   1317.7    112.6   2134.0    624.2
    VEL=       .3       .9      1.2      2.1      4.9      2.6      1.5       .8
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     SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
     Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
     TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
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    SLOPE      LOBL     XLCH     XLOBR    ITRIAL    IDC      ICONT     AR     TOPWID     ENDST

  CEHV=    .100 CEHV=    .300
  1490 NH CARD USED
  *SECNO 4.500
       4.50     10.55  1267.95  1267.24     0.00  1268.57      .62      .17      .12  1266.00
    11180.     1490.     7673.     2017.     552.     1029.     929.     224.     95.  1265.40
       .19      2.70      7.45      2.17     .055      .055     .055    0.000  1257.40  9612.66
   .004675      200.      150.      120.        3         9        0     0.00  1187.09 10799.75
0
 FLOW DISTRIBUTION FOR SECNO=      4.50          CWSEL=   1267.95

 STA=     9613.     9710.     9945.    10070.    10300.
   PER Q=      1.5      11.8      68.6      18.0
    AREA=     94.7     457.5    1029.3     929.3
     VEL=      1.8       2.9       7.5       2.2

 1490 NH CARD USED
 *SECNO 4.500
 3280 CROSS SECTION      4.60 EXTENDED       .55 FEET

 7185 MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1269.50 ELREA=     1271.00

       4.60     10.55  1270.55  1270.55     0.00  1271.12      .57     2.39      .00  1269.50
    11110.     1125.     9985.        0.     474.     1571.       0.     250.     104.  1271.00
       .22      2.37      6.35     0.00     .055      .055     .055    0.000  1260.00  9559.95
   .004534      500.      530.      420.        0         8        0     0.00   601.10 10161.05
0.
 FLOW DISTRIBUTION FOR SECNO=      4.60          CWSEL=   1270.55

 STA=     9560.     9570.     9635.     9690.     9825.     9920.    10170.
   PER Q=       .0        .3       1.4       5.9       2.4      89.9
    AREA=      2.3      32.6      71.6     243.3     123.7    1571.3
     VEL=       .7       1.2       2.2       2.7       2.2       6.4

 1490 NH CARD USED
 *SECNO 4.700

 3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1272.00 ELREA=     1274.80

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  84/01/26.    11.39.46.                                                                    PAGE   13


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


       4.70      9.31  1273.31  1270.99     0.00  1274.00      .70     2.84      .04  1272.00
    11040.     1004.    10036.        0.     441.     1437.       0.     274.     113.  1274.80
       .24      2.28      6.98     0.00     .055      .055     .055    0.000  1264.00  9343.13
   .006432      500.      530.      490.        2        17        0     0.00   803.74 10146.88
0
 FLOW DISTRIBUTION FOR SECNO=      4.70          CWSEL=   1273.31

 STA=     9343.     9595.     9650.     9900.    10160.
   PER Q=       5        .9       7.7      90.9
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    AREA=      4.0      49.9     327.0    1436.9
     VEL=       .9       2.0       2.6       7.0

  CEHV=    .100 CEHV=    .300
  *SECNO 4.300
       4.80      9.44  1275.44  1274.97      0.00  1275.91      .47      1.88      .02  1274.70
     10970.       59.     5919.     4992.      72.     833.    2041.     302.     126.  1274.00
        .27       .82      7.11      2.45     .045     .035     .045    0.000  1266.00  9723.10
    .002347      550.      530.      460.        2       10        0     0.00  1556.99 11280.10
0
  FLOW DISTRIBUTION FOR SECNO=      4.80          CWSEL=   1275.44

  STA=    9723.    9920.   10048.   10135.   10162.   10220.   10400.   10800.   11230.   11280.
    PER Q=       .5      54.0       9.9       4.7       3.7       4.8      10.6      11.4       .4
     AREA=     72.0     332.5     298.5     119.6     141.0     257.6     572.5     615.5      35.9
      VEL=       .8       7.1       3.6       4.3       2.9       2.0       2.0       2.0       1.3

  *SECNO 4.900
  7185 MINIMUM SPECIFIC ENERGY
  3720 CRITICAL DEPTH ASSUMED
       4.90      9.43  1277.48  1277.48      0.00  1278.30      .82      1.27      .11  1276.60
     10900.       47.     6489.     4364.      41.     708.    1635.     326.     140.  1274.00
        .29      1.13      9.16      2.67     .045     .035     .045    0.000  1268.00  9855.74
    .003509      550.      520.      350.        0        5        0     0.00  1660.17 11515.90
0
  FLOW DISTRIBUTION FOR SECNO=      4.90          CWSEL=   1277.48

  STA=    9856.    9950.   10050.   10152.   10175.   10185.   10230.   10385.   10455.   10630.   11300.   11516.
    PER Q=       .4      59.5      14.6       3.3       .8       .8      1.1       1.3       6.0      11.6       .4
     AREA=     41.5     708.5     354.9      80.0      24.8      46.3      89.9      72.1     259.0     656.5      51.8
      VEL=      1.1       9.2       4.5       4.5       3.5       2.0       1.4       2.0       2.5       1.9       .8

1
  84/01/26.   11.39.46.                                                                                PAGE   14


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


  *SECNO 5.000
  7185 MINIMUM SPECIFIC ENERGY
  3720 CRITICAL DEPTH ASSUMED
       5.00      6.74  1279.74  1279.74      0.00  1280.46      .73      1.99      .01  1278.50
     10830.      611.     7002.     3217.     266.     846.    1195.     354.     158.  1278.00
        .31      2.29      8.28      2.69     .045     .035     .045    0.000  1273.00  9567.32
    .004240      530.      520.      510.        0       14        0     0.00  1376.16 10943.48
0
  FLOW DISTRIBUTION FOR SECNO=      5.00          CWSEL=   1279.74

  STA=    9567.    9700.    9830.    9868.   10030.   10100.   10205.   10370.   10570.   10943.
    PER Q=       .5       3.7       1.5      64.7       3.5       4.0       6.3      10.0       5.9
     AREA=     48.9     160.8      56.5     845.9     121.6     156.1     245.4     347.4     324.4
      VEL=      1.1       2.5       2.8       8.3       3.1       2.8       2.8       3.1       2.0

1
  CROSS SECTION       4.42
  STREAM                      100 FT
  DISCHARGE=     11250.
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HEC - 2 RUN

PROPOSED CONDITION

THIS RUN EXECUTED 84/03/12. 13.42.54.

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*************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
  ERROR CORR -  01,02,03,04,05
  MODIFICATION -  50,51,52,53,54,55
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T1 CITY OF GLENDALE BRIDGE OVER SKUNK CREEK AT 59TH AVE.
T2 100 YEAR FLOOD
T3 2 PIERS ~~134.3~~ 131.6 FT BOTTOM WIDTH 1/2:1 SIDE SLOPES

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	2.	0.	0.	.004500	0.00	0.0	0.	1247.450	0.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	-1.000	0.000	-1.000	0.000	0.000	0.000	-1.000	0.000	0.000	15.000

NC	.045	.045	.035	.100	.300	0.000	0.000	0.000	0.000	0.000
QT	2.000	11880.000	26000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	3.500	15.000	9900.000	10100.000	0.000	0.000	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1242.000	9090.000	1240.000	9120.000	1240.000	9900.000	1234.000	9920.000	1232.000	9960.000
GR	1230.000	9980.000	1230.000	9981.000	1232.000	10030.000	1234.000	10075.000	1240.600	10100.000
GR	1240.000	10260.000	1241.000	10340.000	1242.000	10500.000	1244.000	10660.000	1244.000	10950.000
QT	2.000	11810.000	0.000	0.000	11810.000	0.000	0.000	0.000	0.000	0.000
X1	3.600	17.000	9920.000	10080.000	545.000	500.000	525.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1246.900	8150.000	1246.000	8320.000	1244.000	8870.000	1242.000	9070.000	1241.500	9920.000
GR	1234.000	9940.000	1233.500	9965.000	1234.000	9975.000	1235.000	10045.000	1236.000	10055.000
GR	1241.300	10030.000	1242.000	10200.000	1244.000	10590.000	1244.800	11120.000	1244.300	11570.000
GR	1246.000	11960.000	1246.900	12110.000	0.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11740.000	0.000	0.000	11740.000	0.000	0.000	0.000	0.000	0.000
X1	3.700	20.000	9925.000	10180.000	530.000	500.000	530.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1249.000	8069.000	1248.000	8316.000	1247.000	8925.000	1244.000	9200.000	1246.000	9800.000
GR	1244.000	9898.000	1246.000	9925.000	1239.000	9950.000	1240.000	10000.000	1240.000	10020.000
GR	1238.000	10050.000	1244.000	10060.000	1243.000	10110.000	1244.000	10150.000	1246.500	10180.000
GR	1245.000	10310.000	1246.800	10610.000	1248.000	11010.000	1248.000	11520.000	1248.000	11775.000
QT	2.000	11670.000	0.000	0.000	11670.000	0.000	0.000	0.000	0.000	0.000
X1	3.800	19.000	9930.000	10075.000	570.000	480.000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1252.000	8840.000	1250.000	9020.000	1248.000	9100.000	1247.600	9300.000	1247.000	9670.000
GR	1249.000	9900.000	1249.000	9930.000	1248.000	9955.000	1240.500	9980.000	1240.500	10050.000
GR	1248.000	10060.000	1250.700	10075.000	1248.000	10085.000	1247.000	10170.000	1248.000	10550.000
GR	1250.000	10930.000	1250.800	11270.000	1252.000	11420.000	1252.000	11450.000	0.000	0.000

QT	2.000	11600.000	0.000	0.000	11600.000	0.000	0.000	0.000	0.000	0.000
X1	3.900	4.000	9980.500	10129.500	430.000	640.000	530.000	0.000	0.000	0.000
GR	1255.300	9980.500	1242.770	10000.000	1242.770	10110.000	1255.770	10129.500	0.000	0.000
QT	2.000	11530.000	7930.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.000	0.000	0.000	0.000	400.000	670.000	540.000	0.000	2.430	0.000
QT	2.000	11460.000	7860.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.035	.300	.500	0.000	0.000	0.000	0.000	0.000
X1	4.100	0.000	0.000	0.000	545.000	565.000	555.000	0.000	2.500	0.000
X1	4.110	9.000	9980.500	10129.500	5.000	5.000	5.000	0.000	0.000	0.000
GR	1260.700	9980.500	1247.720	10000.000	1247.720	10010.000	1260.000	10010.100	1260.000	10018.000
GR	1247.700	10018.100	1247.720	10019.000	1247.720	10110.000	1260.720	10129.500	0.000	0.000
X1	4.150	19.000	9980.500	10129.500	210.000	230.000	220.000	0.000	0.000	0.000
GR	1261.300	9980.500	1248.750	10000.000	1248.750	10010.000	1261.000	10010.100	1261.000	10018.000
GR	1248.300	10018.100	1248.750	10019.000	1248.750	10045.000	1261.000	10046.100	1261.000	10054.000
GR	1248.300	10054.100	1248.750	10055.000	1248.750	10082.000	1261.000	10082.100	1261.000	10090.000
GR	1248.800	10090.100	1248.750	10091.000	1248.750	10110.000	1261.750	10129.500	0.000	0.000
X1	4.180	9.000	9980.500	10129.500	210.000	230.000	220.000	0.000	0.000	0.000
GR	1263.000	9974.000	1249.770	10000.000	1249.770	10082.000	1263.000	10082.100	1263.000	10090.000
GR	1249.800	10090.100	1249.770	10091.000	1249.770	10110.000	1263.000	10129.500	0.000	0.000
X1	4.190	4.000	9980.500	10129.500	5.000	5.000	5.000	0.000	0.000	0.000
GR	1263.000	9980.500	1250.000	10000.000	1250.000	10110.000	1263.000	10129.500	0.000	0.000
QT	2.000	11390.000	7790.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.030	.100	.300	0.000	0.000	0.000	0.000	0.000
X1	4.200	4.000	9980.500	10129.500	45.000	65.000	55.000	0.000	0.000	0.000
GR	1263.000	9980.500	1250.050	10000.000	1250.050	10110.000	1263.000	10129.500	0.000	0.000
QT	2.000	11320.000	7720.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.300	0.000	0.000	0.000	520.000	540.000	530.000	0.000	2.470	0.000
QT	2.000	11250.000	7650.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.400	4.000	9980.500	10129.500	520.000	540.000	530.000	0.000	0.000	0.000
GR	1268.000	9980.500	1254.990	10000.000	1254.990	10110.000	1267.990	10129.500	0.000	0.000
NC	.045	.045	.030	.300	.500	0.000	0.000	0.000	0.000	0.000
X1	4.420	4.000	9980.500	10151.100	290.000	290.000	290.000	0.000	0.000	0.000
GR	1269.200	9980.500	1256.200	10000.000	1256.200	10131.600	1269.200	10151.100	0.000	0.000
X1	4.421	16.000	9984.540	10147.060	5.000	5.000	5.000	0.000	0.000	0.000
GR	1266.100	9984.540	1265.000	9985.550	1265.000	9987.250	1256.500	10000.000	1256.500	10020.000
GR	1266.100	10020.010	1266.100	10024.000	1256.500	10024.010	1256.500	10110.800	1266.100	10110.810
GR	1266.100	10114.800	1256.500	10114.810	1256.500	10131.600	1264.100	10144.350	1265.000	10147.050
GR	1266.100	10147.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

X1	4.429	16.000	84.540	10147.060	100.000	100.000	100.000	0.000	0.000	0.000
GR	1266.100	9984.540	1265.000	9984.550	1265.000	9987.250	1256.800	10000.000	1256.800	10020.000
GR	1266.100	10020.010	1266.100	10024.000	1256.300	10024.010	1256.300	10110.300	1266.100	10110.810
GR	1266.100	10114.800	1256.800	10114.810	1256.300	10131.600	1265.000	10144.350	1265.000	10147.050
GR	1265.100	10147.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.430	4.000	9980.500	10151.100	5.000	5.000	5.000	0.000	0.000	0.000
GR	1270.000	9980.500	1257.000	10000.000	1257.000	10131.600	1270.000	10151.100	0.000	0.000
NC	.045	.045	.030	.100	.300	0.000	0.000	0.000	0.000	0.000
QT	2.000	11180.000	7580.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.500	12.000	9945.000	10070.000	95.000	95.000	95.000	0.000	0.000	0.000
GR	1272.000	8300.000	1270.000	9100.000	1263.000	9610.000	1266.000	9710.000	1266.000	9945.000
GR	1257.400	9975.000	1257.400	10030.000	1265.400	10070.000	1268.000	10815.000	1268.000	11410.000
GR	1270.000	11420.000	1272.000	11650.000	0.000	0.000	0.000	0.000	0.000	0.000
NH	2.000	.055	10200.000	.055	11500.000	0.000	0.000	0.000	0.000	0.000
QT	2.000	11110.000	7510.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	4.600	20.000	9920.000	10170.000	500.000	420.000	530.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1272.500	7900.000	1272.000	7901.000	1272.000	7902.000	1272.000	7903.000	1272.000	7904.000
GR	1271.000	9295.000	1271.000	9550.000	1270.100	9570.000	1270.000	9635.000	1268.500	9690.000
GR	1269.000	9825.000	1269.500	9920.000	1262.000	9945.000	1260.000	10020.000	1260.000	10040.000
GR	1268.000	10110.000	1271.000	10170.000	1268.000	10200.000	1268.000	10870.000	1270.000	11500.000
QT	2.000	11040.000	0.000	0.000	11040.000	0.000	0.000	0.000	0.000	0.000
NH	2.000	.055	10280.000	.055	11950.000	0.000	0.000	0.000	0.000	0.000
X1	4.700	19.000	9900.000	10160.000	500.000	490.000	530.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1276.000	8160.000	1276.000	8161.000	1276.000	8162.000	1276.000	8600.000	1274.000	9000.000
GR	1272.800	9595.000	1272.000	9650.000	1272.000	9900.000	1270.000	9960.000	1264.000	9980.000
GR	1264.000	10065.000	1274.800	10160.000	1272.000	10185.000	1270.000	10280.000	1268.600	10480.000
GR	1270.000	10900.000	1272.000	11650.000	1272.800	11730.000	1274.000	11950.000	0.000	0.000
QT	2.000	10970.000	0.000	0.000	10970.000	0.000	0.000	0.000	0.000	0.000
NC	.045	.045	.035	.100	.300	0.000	0.000	0.000	0.000	0.000
X1	4.800	13.000	9920.000	10048.000	550.000	460.000	530.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1276.400	9290.000	1276.000	9570.000	1274.700	9920.000	1266.000	9962.000	1266.000	10000.000
GR	1274.000	10048.000	1270.000	10135.000	1272.000	10162.000	1274.000	10220.000	1274.000	10400.000
GR	1274.000	10800.000	1274.000	11230.000	1276.000	11300.000	0.000	0.000	0.000	0.000
QT	2.000	10900.000	0.000	0.000	10900.000	0.000	0.000	0.000	0.000	0.000
X1	4.900	16.000	9950.000	10050.000	550.000	350.000	520.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1280.000	9700.000	1278.000	9800.000	1276.600	9950.000	1270.000	9965.000	1268.000	9975.000
GR	1270.000	10025.000	1274.000	10050.000	1274.000	10152.000	1274.000	10175.000	1276.000	10185.000
GR	1276.900	10230.000	1276.900	10385.000	1276.000	10455.000	1276.000	10630.000	1277.000	11300.000
GR	1278.000	11750.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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QT      2.000  10830.000      0.000      0.000  10830.000      0.000      0.000      0.000      0.000      0.000
X1      5.000     15.000   9868.000  10030.000    530.000    510.000    520.000      0.000      0.000      0.000
X3     10.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
GR   1280.000   9520.000   1279.000   9700.000   1278.000   9830.000   1278.500   9868.000   1278.000   9890.000
GR   1273.000   9930.000   1273.000  10010.000   1274.000  10022.000   1278.000  10030.000   1278.000  10100.000
GR   1278.500  10205.000   1278.000  10370.000   1278.000  10570.000   1280.000  11000.000   1282.000  11050.000

QT      2.000  10760.000      0.000      0.000  10760.000      0.000      0.000      0.000      0.000      0.000
EJ      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
*PROF 1

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


CCHV=    .100 CEHV=    .300
*SECNO 3.500

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1240.00 ELREA=     1240.60

     3.50      9.34  1239.34  1237.71  1247.45  1240.80      1.46      0.00      0.00  1240.00
   11830.        0.  11830.        0.        0.    1225.        0.        0.        0.   1240.60
     0.00      0.00      9.70      0.00      .045      .035      .045     0.000  1230.00  9902.21
  .004496        0.        0.        0.         0        18         8      0.00    193.01 10095.22


FLOW DISTRIBUTION FOR SECNO=      3.50          CWSEL=   1239.34

STA=    9902.   10100.
  PER Q=    100.0
   AREA=   1224.7
    VEL=      9.7

*SECNO 3.600
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
     3.60      9.17  1242.67  1242.67      0.00  1243.74      1.07      1.99       .04  1241.50
   11810.    1415.   10209.     187.      808.    1149.      137.       20.        9.   1241.80
      .02      1.75      8.88      1.36      .045      .035      .045     0.000  1233.50  9002.65
  .003216      545.      525.      500.         0         8         0      0.00  1328.69 10331.34


FLOW DISTRIBUTION FOR SECNO=      3.60          CWSEL=   1242.67

STA=    9003.    9070.    9920.   10080.   10200.   10331.
  PER Q=       .2      11.8      86.4       1.2        .3
   AREA=     22.7     735.0    1149.0      92.8      44.2
    VEL=       .9       1.8       8.9       1.6        .9

*SECNO 3.700
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1246.00 ELREA=     1246.50

     3.70      3.10  1246.10  1246.10      0.00  1246.99       .89      2.25       .02  1246.00
   11740.    2673.     9067.        0.      997.    1066.        0.       45.       24.   1246.50
      .04      2.68      8.51      0.00      .045      .035      .045     0.000  1238.00  9007.80
  .005903      530.      530.      500.         0         9         0      0.00  1167.36 10175.16
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
   SLOPE     XLOPL     XLCH      XLOBP     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST

FLOW DISTRIBUTION FOR SECNO=      3.70          CWSEL=   1246.10

STA=    9008.    9200.    9800.    9898.    9925.   10180.
  PER Q=      4.5     15.1      2.5       .7     77.2
   AREA=    201.5    658.0    107.5     29.6   1065.6
    VEL=      2.6      2.7      2.7      2.7      8.5

*SECNO 3.800
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1249.00 ELREA=     1250.70

     3.80     8.66  1249.16  1249.16     0.00  1250.17     1.01     2.92      .03  1249.00
   11670.    3968.    7702.       0.    1257.     798.       0.      71.      38.   1250.70
      .03     3.16     9.65     0.00     .045     .035     .045    0.000  1240.50  9053.68
  .005381     570.     520.     480.        0        8        0     0.00  1012.76 10066.43

FLOW DISTRIBUTION FOR SECNO=      3.80          CWSEL=   1249.16

STA=    9054.    9100.    9300.    9670.    9930.    9930.   10075.
  PER Q=       .4      6.7     21.0      5.9       .0     66.0
   AREA=     26.8    271.6    687.5    266.4      4.7    798.0
    VEL=      1.6      2.9      3.6      2.6       .7      9.7

*SECNO 3.900

3301 HV CHANGED MORE THAN HVINS

     3.90     8.30  1251.07  1249.54     0.00  1253.09     2.02     2.62      .30  1255.80
   11600.       0.   11600.       0.       0.    1016.       0.      88.      44.   1255.77
      .07     0.00    11.42     0.00     .045     .035     .045    0.000  1242.77  9987.58
  .005139     430.     530.     640.        2       15        0     0.00   134.87 10122.45

FLOW DISTRIBUTION FOR SECNO=      3.90          CWSEL=   1251.07

STA=    9988.   10130.
  PER Q=    100.0
   AREA=   1016.1
    VEL=     11.4
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

*SECNO 4.000
     4.00      8.66  1253.86  1251.94      0.00  1255.68      1.82      2.57       .02  1258.23
   11530.        0.  11530.        0.        0.    1064.        0.      101.       46.   1258.20
      .09      0.00     10.83      0.00      .045      .035      .045     0.000  1245.20  9987.05
  .004404      400.      540.      670.         2        15         0      0.00   135.94 10122.98

FLOW DISTRIBUTION FOR SECNO=      4.00          CWSEL=   1253.86

STA=     9937.   10130.
  PER Q=     100.0
   AREA=    1064.3
    VEL=      10.8

CCHV=     .300 CEHV=     .500
*SECNO 4.100
     4.10      8.61  1256.31  1254.42      0.00  1258.13      1.82      2.45       .00  1260.73
   11460.        0.  11460.        0.        0.    1058.        0.      115.       48.   1260.70
      .10      0.00     10.83      0.00      .045      .035      .045     0.000  1247.70  9987.12
  .004431      545.      555.      565.         2        15         0      0.00   135.80 10122.91

FLOW DISTRIBUTION FOR SECNO=      4.10          CWSEL=   1256.31

STA=     9937.   10130.
  PER Q=     100.0
   AREA=    1058.0
    VEL=      10.8

*SECNO 4.110

3265 DIVIDED FLOW

     4.11      8.45  1256.15  1254.76      0.00  1258.34      2.18       .03       .18  1260.70
   11460.        0.  11460.        0.        0.     967.        0.      115.       48.   1260.72
      .10      0.00     11.85      0.00      .045      .035      .045     0.000  1247.70  9987.33
  .006449        5.        5.        5.         2        15         0      0.00   127.36 10122.65

FLOW DISTRIBUTION FOR SECNO=      4.11          CWSEL=   1256.15

STA=     9937.   10130.
  PER Q=     100.0
   AREA=     967.0
    VEL=      11.9
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

*SECNO 4.130

3255 DIVIDED FLOW

      4.15      8.97  1257.72  1256.55      0.00  1260.29      2.56      1.76       .19  1261.80
    11460.        0.  11460.        0.        0.     892.        0.      120.       48.  1261.75
       .10      0.00     12.85      0.00      .045      .035      .045     0.000  1248.75  9986.59
   .010188      210.      220.      230.         2        11         0      0.00   113.01 10123.46

FLOW DISTRIBUTION FOR SECNO=       4.15          CWSEL=   1257.72

STA=     9987.   10130.
  PER Q=     100.0
   AREA=     891.7
    VEL=      12.9

*SECNO 4.180

3255 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

      4.18     10.77  1260.54  1256.77      0.00  1261.75      1.21      1.06       .41  1313.00
    11460.        0.  11460.        0.        0.    1298.        0.      125.       49.  1263.00
       .11      0.00      8.83      0.00      .045      .035      .045     0.000  1249.77  9978.83
   .002794      210.      220.      230.         3        15         0      0.00   139.11 10125.88

FLOW DISTRIBUTION FOR SECNO=       4.18          CWSEL=   1260.54

STA=     9979.   10130.
  PER Q=     100.0
   AREA=    1298.0
    VEL=       8.8

*SECNO 4.190
      4.19     10.66  1260.66  1256.72      0.00  1261.79      1.13       .01       .02  1263.00
    11460.        0.  11460.        0.        0.    1343.        0.      125.       49.  1263.00
       .11      0.00      8.54      0.00      .045      .035      .045     0.000  1250.00  9984.01
   .002144        5.        5.        5.         2        14         0      0.00   141.97 10125.99
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICCNT     COPAR     TOPWID      ENDST

FLOW DISTRIBUTION FOR SECNO=      4.19          CWSEL=   1260.66

STA=    9934.   10130.
  PER Q=    100.0
   AREA=   1342.7
    VEL=      8.5

CCHV=    .100 CEHV=    .300
*SECNO 4.200
     4.20     10.74  1260.79  1256.74      0.00  1261.89      1.10       .10       .00  1263.00
   11390.        0.  11390.        0.        0.    1356.        0.      127.       49.  1263.00
      .11      0.00      8.40      0.00      .045      .030      .045     0.000  1250.05  9983.82
  .001513       45.       55.       65.         0        14         0      0.00   142.35 10126.18

FLOW DISTRIBUTION FOR SECNO=      4.20          CWSEL=   1260.79

STA=    9984.   10130.
  PER Q=    100.0
   AREA=   1355.5
    VEL=      8.4

*SECNO 4.300

3301 HV CHANGED MORE THAN HVINS

     4.30      8.96  1261.48  1259.18      0.00  1263.11      1.62      1.06       .16  1265.47
   11320.        0.  11320.        0.        0.    1107.        0.      142.       51.  1265.47
      .13      0.00     10.22      0.00      .045      .030      .045     0.000  1252.52  9986.50
  .002765      520.      530.      540.         2        14         0      0.00   137.00 10123.50

FLOW DISTRIBUTION FOR SECNO=      4.30          CWSEL=   1261.48

STA=    9986.   10130.
  PER Q=    100.0
   AREA=   1107.2
    VEL=     10.2

*SECNO 4.400
     4.40      7.93  1262.92  1261.63      0.00  1265.02      2.10      1.77       .14  1268.00
   11250.        0.  11250.        0.        0.     967.        0.      155.       53.  1267.99
      .14      0.00     11.63      0.00      .045      .030      .045     0.000  1254.99  9988.11
  .004133      520.      530.      540.         2        15         0      0.00   133.80 10121.90
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

FLOW DISTRIBUTION FOR SECNO=      4.40          CWSEL=   1262.92

STA=    9988.   10130.
  PER Q=     100.0
   AREA=     967.3
    VEL=      11.6

CCHV=     .300 CEHV=     .500
*SECNO 4.420

3301 HV CHANGED MORE THAN HVINS

     4.42      8.67  1264.87  1262.14      0.00  1266.12      1.25       .84       .25  1269.20
   11250.        0.   11250.       0.        0.    1254.       0.      162.       54.   1269.20
      .15      0.00      8.97     0.00      .045      .030     .045     0.000  1256.20  9987.00
  .002159      290.      290.     290.         3        15        0      0.00   157.61 10144.60

FLOW DISTRIBUTION FOR SECNO=      4.42          CWSEL=   1264.87

STA=    9987.   10151.
  PER Q=     100.0
   AREA=    1253.6
    VEL=       9.0

*SECNO 4.421

3265 DIVIDED FLOW

     4.42      8.24  1264.74  1262.67      0.00  1266.29      1.55       .01       .15  1266.10
   11250.        0.   11250.       0.        0.    1126.       0.      162.       54.   1266.10
      .15      0.00      9.99     0.00      .045      .030     .045     0.000  1256.50  9987.65
  .003746        5.        5.       5.         2        19        0      0.00   150.63 10146.26

FLOW DISTRIBUTION FOR SECNO=      4.42          CWSEL=   1264.74

STA=    9988.   10147.
  PER Q=     100.0
   AREA=    1126.0
    VEL=      10.0
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   SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS   BANK ELEV
   Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA   LEFT/RIGHT
   TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
   SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


*SECNO 4.429

3265 DIVIDED FLOW

     4.43      8.37  1265.17  1262.97      0.00  1266.67      1.50       .37       .01  1316.10
   11250.        0.  11250.       0.        0.    1145.        0.      165.       54.   1266.10
      .15      0.00      9.83     0.00      .045      .030      .045    0.000  1256.80  9984.55
  .003671      100.      100.     100.         3        15         0     0.00   154.52 10147.05


FLOW DISTRIBUTION FOR SECNO=      4.43          CWSEL=   1265.17

STA=    9985.   10147.
  PER Q=     100.0
   AREA=    1144.5
    VEL=       9.8

*SECNO 4.430
     4.43      8.39  1265.39  1262.96      0.00  1266.73      1.34       .01       .05  1270.00
   11250.        0.  11250.       0.        0.    1211.        0.      165.       54.   1270.00
      .15      0.00      9.29     0.00      .045      .030      .045    0.000  1257.00  9987.41
  .002406        5.        5.       5.         2        15         0     0.00   156.79 10144.19


FLOW DISTRIBUTION FOR SECNO=      4.43          CWSEL=   1265.39

STA=    9987.   10151.
  PER Q=     100.0
   AREA=    1210.6
    VEL=       9.3

CCHV=     .100 CEHV=     .300
*SECNO 4.500
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
     4.50      9.77  1267.17  1267.17      0.00  1268.68      1.51       .26       .05  1266.00
   11180.      612.     9798.     770.      310.      933.      450.      168.       55.   1265.40
      .16      1.98     10.51     1.71      .045      .030      .045    0.000  1257.40  9651.40
  .003153       95.       95.      95.         0        12         0     0.00   926.36 10577.76


FLOW DISTRIBUTION FOR SECNO=      4.50          CWSEL=   1267.17

STA=    9651.    9710.    9945.   10070.   10578.
  PER Q=        .4       5.1      87.6       6.9
   AREA=      34.3     275.4     932.5     449.9
    VEL=       1.3       2.1      10.5       1.7
```

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


1490 NH CARD USED
*SECNO 4.600
3280 CROSS SECTION      4.60 EXTENDED        .22 FEET


3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1269.50 ELREA=     1271.00

      4.60     10.22  1270.22  1267.14      0.00  1270.92       .69      2.15       .08  1269.50
    11110.      810.   10300.       0.      354.    1492.        0.      189.       64.   1271.00
       .18      2.29      6.90     0.00      .055      .055      .045     0.000  1260.00  9567.39
   .005587      500.      530.     420.         3        11         0      0.00   586.96 10154.35


FLOW DISTRIBUTION FOR SECNO=      4.60          CWSEL=   1270.22

STA=    9567.    9635.    9690.    9825.    9920.   10170.
  PER Q=        .1       .9      4.7      1.6     92.7
   AREA=      11.0     53.2    198.1     91.9   1491.7
    VEL=        .6      2.0      2.6      2.0      6.9

1490 NH CARD USED
*SECNO 4.700

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=     1272.00 ELREA=     1274.80

      4.70      9.35  1273.35  1270.99      0.00  1274.03       .68      3.11       .00  1272.00
    11040.     1053.    9987.       0.      464.    1447.        0.      211.       72.   1274.80
       .20      2.27      6.90     0.00      .055      .055      .055     0.000  1264.00  9322.84
   .006235      500.      530.     490.         2        14         0      0.00   824.39 10147.24


FLOW DISTRIBUTION FOR SECNO=      4.70          CWSEL=   1273.35

STA=    9323.    9595.    9650.    9900.   10160.
  PER Q=        .6      1.0      8.0     90.5
   AREA=      74.7     52.2    337.2   1447.0
    VEL=        .9      2.1      2.6      6.9

CCHV=     .100 CEHV=     .300
```

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

*SECNO 4.800
     4.80      9.44  1275.44  1274.96      0.00  1275.90       .46      1.85       .02  1274.70
   10970.       60.     5905.    5004.       73.     833.     2050.      240.      85.   1274.00
      .23       .82      7.09     2.44     .045      .035      .045    0.000  1266.00  9721.12
  .002327      550.      530.     460.        3        10         0     0.00  1559.23 11280.35

FLOW DISTRIBUTION FOR SECNO=      4.80          CWSEL=   1275.44

STA=     9721.    9920.   10048.   10135.   10162.   10220.   10400.   10800.   11230.   11280.
  PER Q=       .5      53.8      9.9      4.7      3.7      4.8     10.7     11.4       .4
   AREA=     73.5     833.5    299.2    119.8    141.4    259.0    575.5    618.6     36.2
    VEL=       .8       7.1      3.6      4.3      2.9      2.0      2.0      2.0      1.3

*SECNO 4.900
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
     4.90      9.48  1277.48  1277.48      0.00  1278.30       .82      1.26       .11  1276.60
   10900.       47.     6485.    4367.       42.     709.     1638.      264.     100.   1274.00
      .25      1.13      9.15     2.67     .045      .035      .045    0.000  1268.00  9855.56
  .003502      550.      520.     350.        0         5         0     0.00  1661.11 11516.66

FLOW DISTRIBUTION FOR SECNO=      4.90          CWSEL=   1277.48

STA=     9856.    9950.   10050.   10152.   10175.   10185.   10230.   10385.   10455.   10630.   11300.   11517.
  PER Q=       .4      59.5     14.6      3.3       .8       .8      1.1      1.3      6.0     11.6       .4
   AREA=     41.6     708.6    355.1     80.1     24.8     46.4     90.1     72.2    259.3    657.6     52.2
    VEL=      1.1       9.2      4.5      4.5      3.5      2.0      1.4      2.0      2.5      1.9       .8

*SECNO 5.000
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
     5.00      6.74  1279.74  1279.74      0.00  1280.46       .73      1.99       .01  1278.50
   10830.      611.     7001.    3218.      266.     846.     1195.      292.     117.   1278.00
      .27      2.29      8.27     2.69     .045      .035      .045    0.000  1273.00  9567.21
  .004237      530.      520.     510.        0        14         0     0.00  1376.40 10943.61

FLOW DISTRIBUTION FOR SECNO=      5.00          CWSEL=   1279.74

STA=     9567.    9700.    9830.    9868.   10030.   10100.   10205.   10370.   10570.   10944.
  PER Q=       .5       3.7      1.5     64.6      3.5      4.0      6.3     10.0      5.9
   AREA=     49.0     160.9     56.5    846.0    121.6    156.2    245.5    347.5    324.6
    VEL=      1.1       2.5      2.8      8.3      3.1      2.8      2.8      3.1      2.0
```

THIS RUN EXECUTED 84/03/12. 13.42.56.

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*************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
  ERROR CORR -  01,02,03,04,05
  MODIFICATION -  50,51,52,53,54,55
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

2 PIERS 134.3 FT BOTTO

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
	3.500	0.00	0.00	0.00	1230.00	11880.00	1239.34	1237.71	1240.80	44.96	9.70	1224.70	1771.83
*	3.600	525.00	0.00	0.00	1233.50	11810.00	1242.67	1242.67	1243.74	32.16	8.88	2093.73	2082.61
*	3.700	530.00	0.00	0.00	1238.00	11740.00	1246.10	1246.10	1246.99	59.03	8.51	2062.29	1528.06
*	3.800	520.00	0.00	0.00	1240.50	11670.00	1249.16	1249.16	1250.17	50.81	9.65	2055.04	1637.14
	3.900	530.00	0.00	0.00	1242.77	11600.00	1251.07	1249.54	1253.09	51.39	11.42	1016.12	1618.12
	4.000	540.00	0.00	0.00	1245.20	11530.00	1253.86	1251.94	1255.68	44.04	10.83	1064.29	1737.39
	4.100	555.00	0.00	0.00	1247.70	11460.00	1256.31	1254.42	1258.13	44.31	10.83	1057.98	1721.60
	4.110	5.00	0.00	0.00	1247.70	11460.00	1256.15	1254.76	1258.34	64.49	11.85	966.96	1427.05
	4.150	220.00	0.00	0.00	1248.75	11460.00	1257.72	1256.55	1260.29	101.88	12.85	891.73	1135.37
	4.130	220.00	0.00	0.00	1249.77	11460.00	1260.54	1256.77	1261.75	27.94	8.83	1298.04	2168.24
	4.190	5.00	0.00	0.00	1250.00	11460.00	1260.66	1256.72	1261.79	21.44	8.54	1342.70	2475.18
	4.200	55.00	0.00	0.00	1250.05	11390.00	1260.79	1256.74	1261.89	15.13	8.40	1355.52	2928.41
	4.300	530.00	0.00	0.00	1252.52	11320.00	1261.48	1259.18	1263.11	27.65	10.22	1107.23	2152.59
	4.400	530.00	0.00	0.00	1254.99	11250.00	1262.92	1261.63	1265.02	41.33	11.63	967.32	1749.95
	4.420	290.00	0.00	0.00	1256.20	11250.00	1264.87	1262.14	1266.12	21.59	8.97	1253.64	2421.09
	4.421	5.00	0.00	0.00	1256.50	11250.00	1264.74	1262.67	1266.29	37.46	9.99	1125.99	1838.06
	4.429	100.00	0.00	0.00	1256.80	11250.00	1265.17	1262.97	1266.67	36.71	9.83	1144.52	1856.68

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
	4.430	5.00	0.00	0.00	1257.00	11250.00	1265.39	1262.96	1266.73	24.06	9.29	1210.60	2293.41
*	4.500	95.00	0.00	0.00	1257.40	11180.00	1267.17	1267.17	1268.68	31.53	10.51	1692.17	1991.15
	4.600	530.00	0.00	0.00	1260.00	11110.00	1270.22	1267.14	1270.92	55.87	6.90	1845.99	1486.34
	4.700	530.00	0.00	0.00	1264.00	11040.00	1273.35	1270.99	1274.03	62.35	6.90	1911.07	1398.17
	4.800	530.00	0.00	0.00	1266.00	10970.00	1275.44	1274.96	1275.90	23.27	7.09	2956.66	2273.91
*	4.900	520.00	0.00	0.00	1268.00	10900.00	1277.48	1277.48	1278.30	35.02	9.15	2388.02	1841.95
*	5.000	520.00	0.00	0.00	1273.00	10830.00	1279.74	1279.74	1280.46	42.37	8.27	2307.90	1663.80

2 PIERS 134.3 FT BOTTO

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	3.500	11880.00	1239.34	0.00	0.00	-8.11	193.01	0.00
*	3.600	11810.00	1242.67	0.00	3.34	0.00	1328.69	525.00
*	3.700	11740.00	1246.10	0.00	3.42	0.00	1167.36	530.00
*	3.800	11670.00	1249.16	0.00	3.06	0.00	1012.76	520.00
	3.900	11600.00	1251.07	0.00	1.91	0.00	134.87	530.00
	4.000	11530.00	1253.86	0.00	2.79	0.00	135.94	540.00
	4.100	11460.00	1256.31	0.00	2.45	0.00	135.80	555.00
	4.110	11460.00	1256.15	0.00	-.15	0.00	127.36	5.00
	4.150	11460.00	1257.72	0.00	1.57	0.00	113.01	220.00
	4.180	11460.00	1260.54	0.00	2.82	0.00	139.11	220.00
	4.190	11460.00	1260.66	0.00	.12	0.00	141.97	5.00
	4.200	11390.00	1260.79	0.00	.14	0.00	142.35	55.00
	4.300	11320.00	1261.48	0.00	.69	0.00	137.00	530.00
	4.400	11250.00	1262.92	0.00	1.44	0.00	133.80	530.00
	4.420	11250.00	1264.87	0.00	1.95	0.00	157.61	290.00
	4.421	11250.00	1264.74	0.00	-.14	0.00	150.63	5.00
	4.429	11250.00	1265.17	0.00	.44	0.00	154.52	100.00
	4.430	11250.00	1265.39	0.00	.22	0.00	156.79	5.00
*	4.500	11180.00	1267.17	0.00	1.78	0.00	926.36	95.00
	4.600	11110.00	1270.22	0.00	3.05	0.00	586.96	530.00
	4.700	11040.00	1273.35	0.00	3.13	0.00	824.39	530.00
	4.800	10970.00	1275.44	0.00	2.09	0.00	1559.23	530.00
*	4.900	10900.00	1277.48	0.00	2.04	0.00	1561.11	520.00
*	5.000	10830.00	1279.74	0.00	2.26	0.00	1376.40	520.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION  SECNO=   3.600  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   3.600  PROFILE= 1  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   3.700  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   3.700  PROFILE= 1  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   3.800  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   3.800  PROFILE= 1  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   4.500  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   4.500  PROFILE= 1  MINIMUM SPECIFIC ENERGY

CAUTION  SECNO=   4.900  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   4.900  PROFILE= 1  MINIMUM SPECIFIC ENERGY

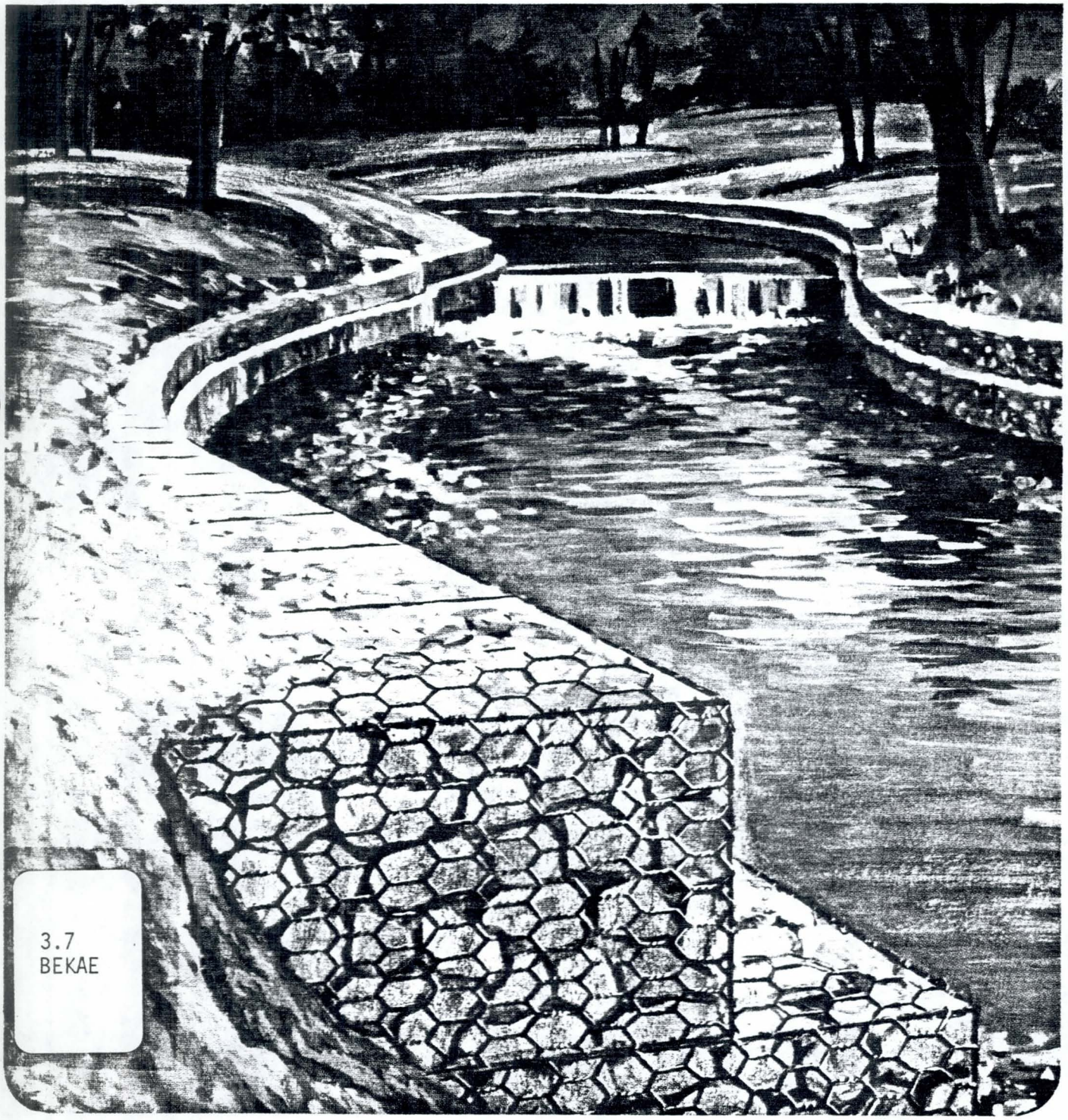
CAUTION  SECNO=   5.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   5.000  PROFILE= 1  MINIMUM SPECIFIC ENERGY
```

REFERENCES

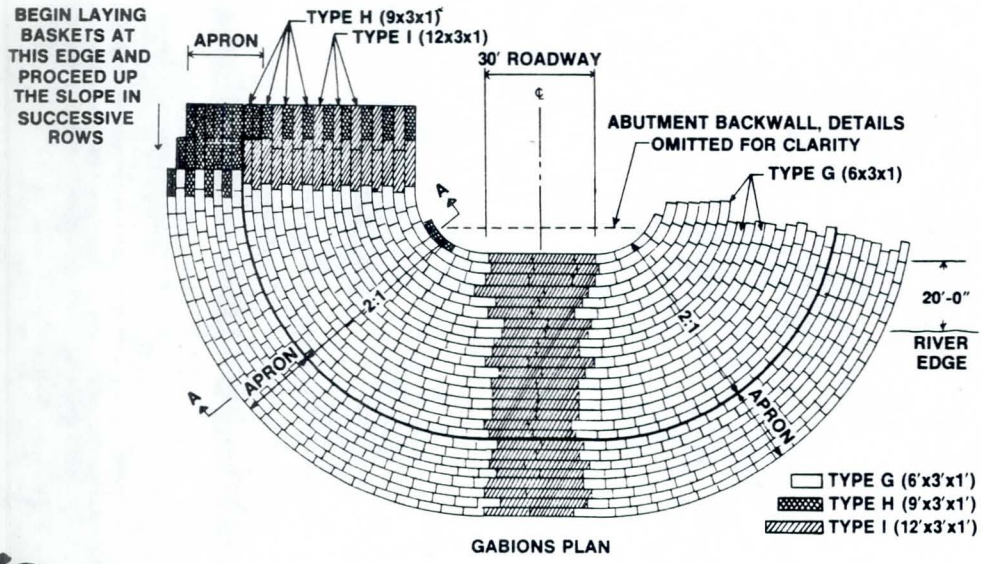
Library

BEKAERT GABIONS

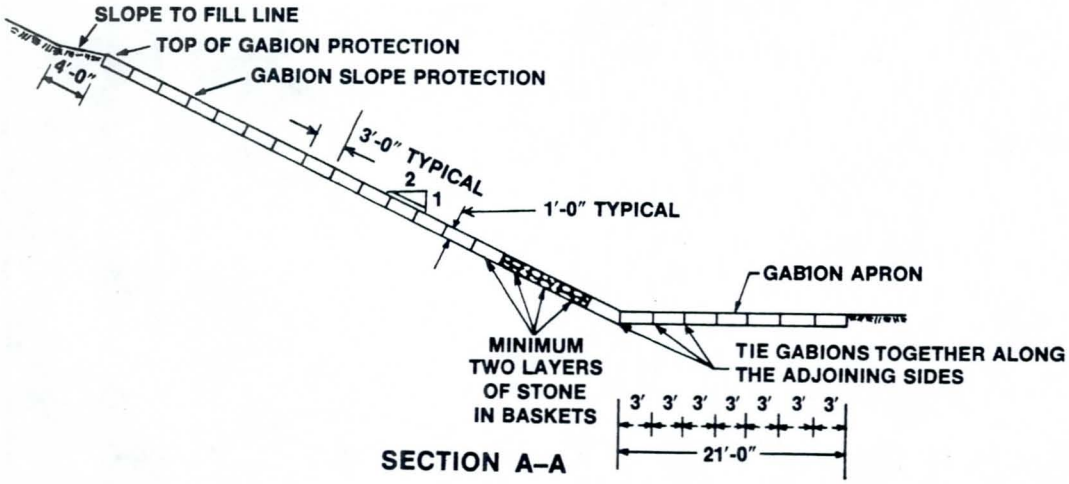
☐ FOR TRAINING WALLS ☐ REVETMENTS ☐ WEIRS ☐ GROINS ☐ CHANNEL LINING ☐ RETAINING WALLS ☐ BRIDGE ABUTMENTS ☐ CULVERT AND OUTLET PROTECTION ☐ MARINAS AND BOAT RAMPS ☐ SEA WALLS AND JETTIES ☐ LANDSCAPING



3.7
BEKAE

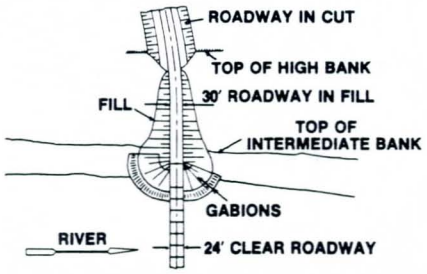


GABIONS PLAN



SECTION A–A

Figs. 49, 49A and 49B.
Plan and sections show arrangement of gabions used in protecting bridge abutments.



ROCK AND RIPRAP DESIGN MANUAL FOR CHANNEL EROSION PROTECTION

by

William C. Hughes

University of Colorado

This manual prepared under Grant No. 16-525-CA from the Eisenhower Consortium for the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

VI - WIRE ENCASED ROCK

Wire encased rock refers to rocks that are bound together with wire so that they act as a single unit. In essence it amounts to making a large rock by binding many small rocks together with wire, and in fact, this is one of the major advantages of wire encased rock - it provides an alternative in situations where available rock sizes are too small for dumped riprap. Another advantage is the versatility that results from the regular geometric shapes of wire encased rock. Rectangular blocks, rectangular mats and cylinders can be fashioned into almost any shape that can be formed with concrete. It is far more flexible than concrete, yet maintains its structural integrity better than dumped riprap. Wire encased rock, like riprap, is porous and, thus, not subject to uplift pressures. Again, like riprap, it should be founded on an appropriate filter to prevent leaching of the bed material. As stated in Chapter IV, channels with bottom slopes greater than or equal to 10 percent should be lined with wire encased rock rather than dumped riprap. This rather arbitrary rule stems first, from the feeling that at slopes of about this degree the required size of dumped riprap becomes uneconomically large and second, that the structural integrity of wire bound rock is far superior to dumped riprap - even using stones two to three times larger.

This is not true. In fact it is blatantly false

At the best gabions are a poor substitute for a well designed riprap

The durability of wire encased rock is generally limited by the service life of the galvanized binding wire which, under normal conditions, is considered to be about 15 years. Water carrying silt can be very abrasive and reduce the service life of the wire; also water which rolls, or otherwise moves cobbles and large stones breaks the wire with a hammer and anvil effect and considerably shortens the life of the wire. The latter can be partially overcome by capping key points - weir lips, drop structure aprons, etc. - with concrete; also providing toe protection for wire encased rock side slopes with dumped riprap has proven to be an effective protection. The wire has been found to be susceptible to corrosion by various chemical agents and is particularly affected by high sulfate soils. If corrosive agents are known to be in the water or soil, a plastic coated wire should be specified.

Wire encased rock is not maintenance free and must be periodically inspected to determine whether the wire is sound. If breaks are found while still relatively small, they may be patched by weaving new strans of wire into the wire cage. In any case, a design should account for possible wire failure, either by a regular maintenance program or by arranging the wire encased rock so that failure of the wire will not result in a complete failure of the structure.

Wire baskets for encasing rock are commercially available in two basic configurations (50)(57). The revetment mattress, a basket made from 14 guage (.079") wire is 6'6" wide and comes in lengths of 8', 10' and 12', and heights of 6" or 9". The revetment mattress is intended primarily for lining channels. The gabion, a rectangular basket made from 11 guage (≈ .12") wire is 3' wide and is available in 6', 9' and 12' lengths and heights of 12", 18" and 36". The size, shape and mass of the latter is more suited for situations where the structure must serve as a retaining wall as well as erosion protection.

Another configuration which is not commercially available is a cylindrical wire basket, often referred to as a "rock sausage", which is formed with cylindrically wound wire (as used for chain link fences) and when laid parallel to the flow, provides a stable channel lining, even in steep channels. The cylindrical wirebound rock, or "rock sausage", is not as versatile as the rectangular shape but has the advantage that it has a somewhat more manageable size and weight. The latter makes it possible to manufacture the cylindrically wirebound rock at an off-site construction yard and then haul them to the site by truck. The finished rock cylinders are then rolled or lifted into place and tied together with wire.

Although bound rock for erosion protection and channel stabilization was used by the early Egyptians, surprisingly little design information is available. The Maccaferri Gabion Technical Handbook (57) and Bekaert Gabion Handbook (50) provide a number of examples of successful channel stabilization configurations and some general design rules. These design rules, which are summarized below, should be considered rules of thumb. Whether these design rules are used or not, the design should include a check to determine whether each wire encased unit which makes up the channel protection structure is secure from movement due to impinging water and, as stated previously, founded on an adequate filter.

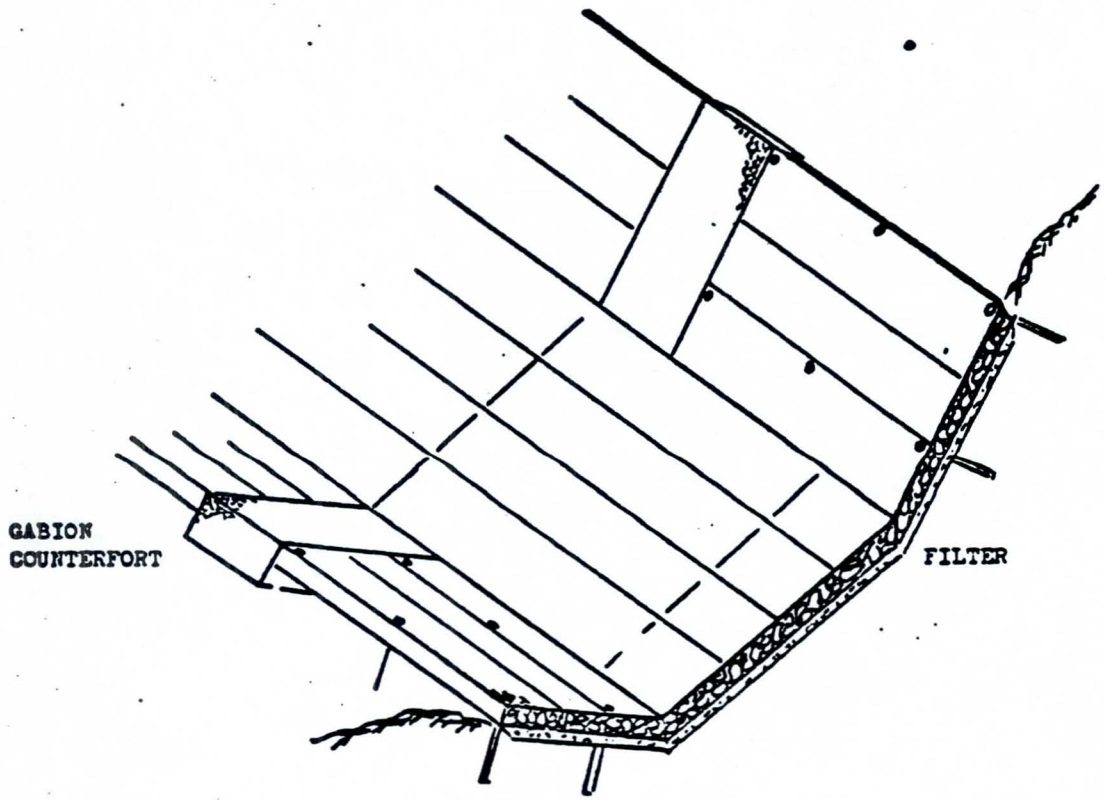
Suggested Design Rules

A.) Channel Linings -- uniform channels with low to moderate turbulence and mean velocity less than 10 fps.

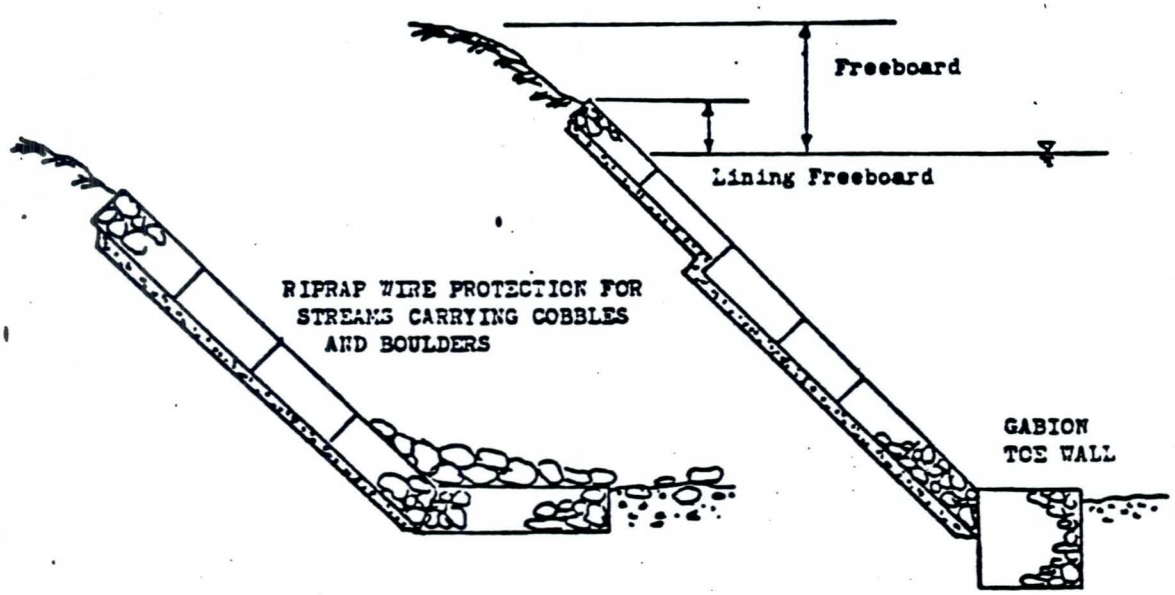
1. Side slopes 2:1 - 12" min. mattress thickness
2. Side slopes 1:1 - 18" min. matress thickness with gabion toe wall if only banks are lined.
3. Side slopes 1:1 - design as a retaining wall using gabions.
4. Channel linings should be tied to the channel banks with gabion counter-forts at least every 21 feet (every 9 feet for higher velocities).

Counterforts should be keyed at least 12 inches into the existing bank.

5. Mattresses on channel side slopes need to be tied to the banks by 1/2 inch steel stakes driven 4 feet into tight soil (clay) and 6 feet into loose soil (sand). This is primarily to stabilize the baskets while they are erected and filled with rock. Suggested spacing of the stakes is every six feet along the slope and every eight feet down the slope for slopes 2-1/2:1 and steeper; every 12 feet along the slope as well as down the slope for slopes in excess of 6:1. No stakes are required for slopes of 6:1 and less. Stakes should be placed at basket connection points if possible and should be an integral part of the basket wall, not simply tied to the basket with wire.



REVETMENT MATTRESS LINING



REVETMENT MATTRESS LINING CONFIGURATIONS

DESIGN AND PERFORMANCE OF ROCK REVETMENT TOES

by Walter M. Linder, Chief, Hydrologic Engineering
Branch, U.S. Army, Corps of Engineers, Kansas City District

ABSTRACT

One of the major causes of failure of rock riprap revetments is undercutting or erosion of bank material below the base of the revetment. When this occurs, rock from the side slope migrates downward and exposes areas of unprotected bank, subjecting the entire revetment to progressive destruction. The author has been involved in several model and prototype tests of the performance of various shapes of revetment toes. This paper describes these investigations and presents conclusions that can be drawn from the studies. The studies indicate that while shape is important, the volume of reserve rock provided in the revetment toe is probably more significant. Rock from a revetment toe generally migrates downward on approximately a 1Vertical on 2Horizontal slope to form a protective layer one to two rock diameters in thickness. Protection will continue as long as there is sufficient rock remaining in the toe structure to prevent separation of the side-slope protection

INTRODUCTION

Many methods of bank protection have been developed and used depending upon the availability of labor, materials, economics, and maintenance requirements. One of the more common methods of bank protection is a layer of broken stone or riprap. Failure of the riprap placed on the upper slope can be avoided by using rock that is sufficiently large to prevent its being transported by the force of the moving water and by the use of a properly designed filter between the riprap and the bank in order to prevent the loss of fine grained bank material through the rock. One of the major causes of failure is due to erosion undermining the base of the revetment. When this occurs, rock from the side slope migrates downward and exposes areas of unprotected bank. The entire revetment then becomes subject to progressive destruction.

Undermining of bank protection can result from a general degradation of the bed; impingment of high velocity currents against the bank; and concentration of flow along a concave bank. Undercutting can be prevented by extending the revetment down to the maximum expected depth of erosion. However, this often requires deep underwater excavation and rock placement which is very costly. An alternative is to provide a reservoir of rock or a toe structure at the existing bed grade. Rock from this reservoir will slough down and continue to protect the bank as the bed degrades. Various toe geometries have been developed and used by the various organizations involved in bank stabilization and flood control. Design manuals suggest various toe geometries, but little guidance is given as to what shape works best under a given condition or how much rock should be provided for the anticipated depth of scour.

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LEGEND

——→ Net direction of littoral drift.

(2.1) Storm setup value for selected Stations on the Great Lakes

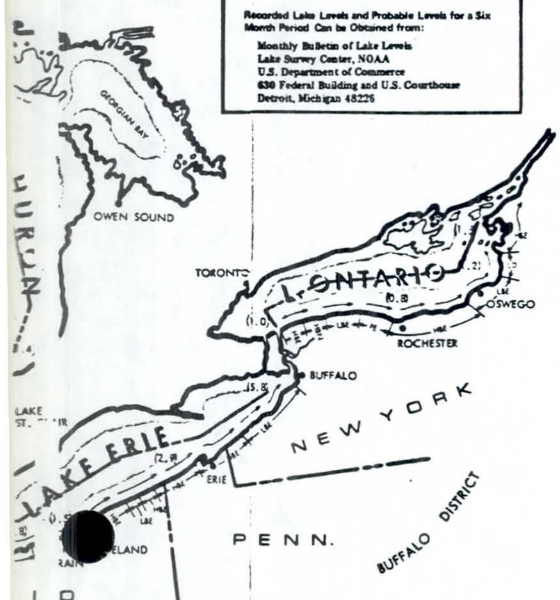
The categories of upland shore types are.

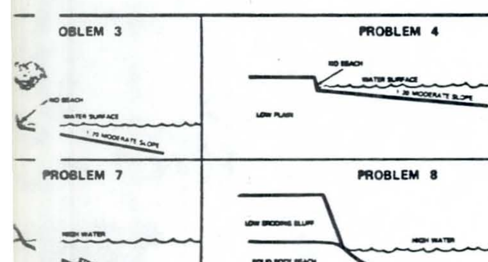
A	Artificial Fill Area
HBE	High Bluff Erodible, 30 Ft. or Higher
HBN	High Bluff Non-Erodible, 30 Ft. or Higher
LBE	Low Bluff Erodible, Less than 30 Ft. High
LBN	Low Bluff Non-Erodible, Less than 30 Ft. High
HD	High Sand Dune, 30 Ft. Higher
LD	Low Sand Dune, Less than 30 Ft. High
PE	Erodible Low Plain
PN	Non-Erodible Low Plain
W	Wetlands

The data on shore-forms is generalized. Local conditions will vary from that shown on the map.

Recorded Lake Levels and Probable Levels for a Six Month Period Can be Obtained from:

Monthly Bulletin of Lake Levels
Lake Survey Center, NOAA
U.S. Department of Commerce
630 Federal Building and U.S. Courthouse
Detroit, Michigan 48226





...n Fla	High Steep	Low Mod	Low Mod	High Mod	Low Flat	Low Steep	Low Rock
1	2	3	4	5	6	7	8
Yes	Yes[1]	Yes	Yes	Yes[1]	Yes	Yes	No (Structural)
Yes	Yes[1]	Yes	Yes	Yes[1]	Yes	Yes	No (Structural)
Yes	No	Yes	Yes	Yes[1]	Yes	No	Yes
Yes	Yes[1]	Yes	Yes	Yes[1]	Yes	Yes	No (Structural)
Yes	No (Mat'l Size)	No (Mat'l Size)	No (Mat'l Size)	No (Mat'l Size)	Yes	No (Mat'l Size)	Yes
Yes[2]	No (Cost)	Yes[2]	Yes[2]	Yes[2]	Yes[2]	No (Cost)	No (Ineffective)
Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

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...ions of the lakes (Storm set ...logical disturbances and may ... te... few days. Wind and ... e t... ...ake surface to tilt as ...unt... storm set up depends ...ese... ...es are shown in ( ) ...ele... stations on the Great ...up values are added to the ... determine the design water surface for the protective works illustrated in this brochure. This computation is described on the reverse side of the brochure.

WHY THE LAKE LEVELS ARE HIGH

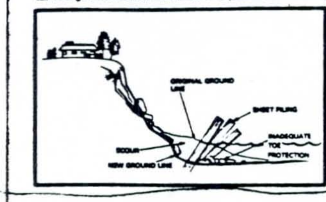
The Great Lakes act similar to a system of reservoirs, but their size makes them unique. When the net supply to one of the lakes exceeds the outflow, its level rises. When the net supply is less than the outflow its level falls. The lake levels are now approaching record highs because the precipitation, in recent years, (supply) over the Great Lakes Basin exceeded the basin averages. The probable maximum levels for the summer of 1973 are given in the following tabulation.

CONSTRUCTION GUIDELINES

The following rules must be followed for any shore protection works built on the Great Lakes. If they are not followed the construction will not last and a private property owner might as well not have spent his money and effort in the first place.

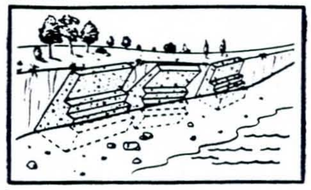
PROVIDE ADEQUATE PROTECTION FOR THE TOE OF THE STRUCTURE SO THAT IT WILL NOT BE UNDERMINED.

Most failures of shore protection works have resulted from "toe failure", or erosion under the lowest part of the structure. The failure of the bulkhead could have been prevented with adequate toe protection. Toe protection must be substantial enough to prevent the original ground under it from washing through the toe protection blanket, and extend far enough lakeward of the structure to prevent undermining.



CHECK FOUNDATION CONDITIONS.

The type of foundation may govern the selection of the type of protection. For example, a rock bottom will not permit the use of sheet piling. A filter material must be placed on a highly erodible embankment to prevent the fine material from washing through the voids in the structure. A soft foundation material will result in excessive settlement of the structure. Clay underlayers may allow all or part of structure to slide.



USE MATERIAL THAT IS HEAVY AND DENSE ENOUGH THAT WAVES WILL NOT MOVE INDIVIDUAL PIECES OF THE PROTECTION.

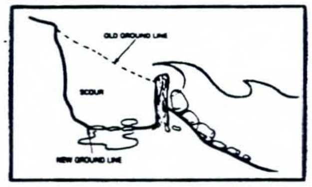
The second most common failure is to use undersized material; waves have tremendous power and can move a lot of material in a short time. Small stones, or pieces of concrete, will be moved around and carried away by small waves. Larger waves will do it even faster. This bank revetment was constructed of undersized stone that was carried down the slope by large waves.

SECURE BOTH ENDS OF THE SHORE PROTECTION WORKS AGAINST FLANKING.

Otherwise, erosion will continue adjacent to your works. If there is no structure in place, build one with more material at the ends than in the center and place it well back into the bluff. If an existing structure has been flanked, such as the one shown below, correct it by placing additional material at the ends and tying your works directly into the bluff.

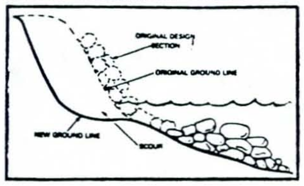
BUILD THE STRUCTURE HIGH ENOUGH THAT WAVES CANNOT OVERTOP IT (SPRAY OVERTOPPING IS ALL RIGHT, BUT NOT "GREEN" WATER).

Many failures have happened because the structure was not built high enough and erosion could then continue behind the structure as if it weren't there.

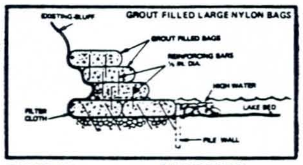


MAKE SURE THAT VOIDS BETWEEN INDIVIDUAL PIECES OF PROTECTION MATERIAL ARE SMALL ENOUGH THAT UNDERLYING MATERIAL IS NOT WASHED OUT BY WAVES.

The protection materials must be thick enough to make a long passage for wave energy to reach the underlying materials. A layer or two of filter material may be required between the underlying ground and the protective material.



CONSTRUCTION ALTERNATIVES-PROS, CONS AND COSTS



ADVANTAGES

Moderate first cost.

Adaptable to stage construction.

Suitable for all shoreforms.

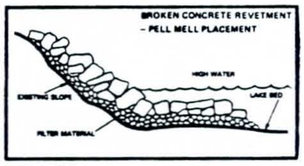
Can be accomplished without heavy construction equipment.

DISADVANTAGES

Subject to scour flanking and foundation failures.

More subject to cast as tropic failure unless positive toe protection is provided.

COST/LIN. FT. – $80 to $115



ADVANTAGES

Inexpensive.

Easy construction.

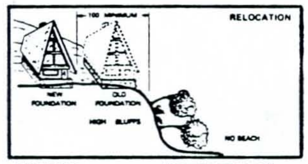
DISADVANTAGES

Large concrete pieces are difficult to obtain.

Large pieces required for underlying filter layer because of large void.

Extremely unattractive appearance, unless special care is taken in construction.

COST/LIN. FT. – $25 to $ 85



ADVANTAGES

It is permanent. In the long run it may be the best method of protection.

Adaptable to short reaches of shoreline.

Can be accomplished by the individual without coordination through contract with a house mover.

No maintenance required.

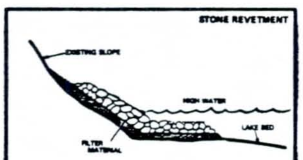
DISADVANTAGES

Special skills and equipment required.

Area must be available for relocation of the house.

Does not stop erosion.

COST/LIN. FT. – $70



ADVANTAGES

Most effective structure for absorbing wave energy.

Flexible – not weakened by slight movements.

Natural rough surface reduces wave runup.

Lends itself to stage construction.

Easily repaired – low maintenance cost.

The preferred method of protection when rock is readily available at a low cost.

DISADVANTAGES

Heavy equipment required for construction.

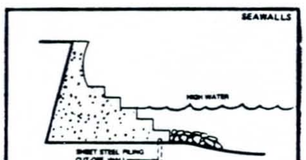
Subject to flanking and moderate scour.

Limits access to beach.

Moderately high first cost.

Difficult construction where access is limited.

COST/LIN. FT. – $28 to $100



ADVANTAGES

Provides protection both from wave action and stabilizes the backshore.

Low maintenance cost.

Readily lends itself to concrete steps to beach.

Stabilizes the backshore.

DISADVANTAGES

Extremely high first cost.

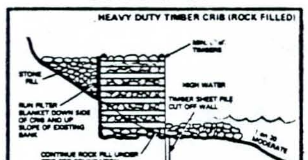
Subject to full wave forces, fail from scour, flanking of foundation.

Not easily repaired.

Complex design and construction problem. Qualified engineer is essential.

Slope design is most important.

More subject to catastrophic failure unless positive toe protection is provided.



ADVANTAGES

Lends itself to protecting short reaches.

Do it yourself project. No special equipment required.

Moderate first cost.

Can be constructed of materials that are readily available.

Structure can be disassembled and materials stockpiled.

Structure is easily repaired.

DISADVANTAGES

Temporary protection.

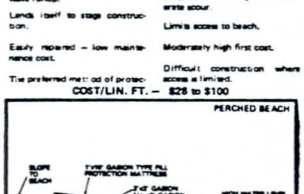
High maintenance costs. Structure is difficult to repair.

Subject to failure from flanking, scouring, or overtopping.

More subject to catastrophic failure unless positive toe protection is provided.

Limits access to beach.

COST/LIN. FT. – $40 to $ 48



ADVANTAGES

Provide a recreational beach.

Aesthetically pleasing appearance.

Requires less beach-fill than a beach-fill without a retaining structure.

DISADVANTAGES

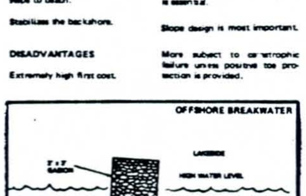
Beach nourishment required to maintain sand and gravel fill– sand or gravel must be readily available.

Does not stop erosion lakeward of structure.

A navigation warning system may be required to prevent collisions with the submerged structure.

Difficult to repair.

COST/LIN. FT. – $225



ADVANTAGES

Beneficial effect can extend over a considerable length of shoreline.

Maintain or enhances recreational value of a beach.

The structure is not subject to flanking – it can be built in separate reaches.

Structure maintenance costs are lower than similar structures designed for other purposes.

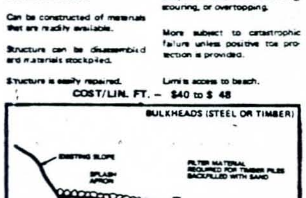
DISADVANTAGES

May modify beachline and cause erosion in downdrift areas.

Structure is subject to foundation and scour failures, floating plant and heavy equipment maybe required for construction.

Extremely difficult to repair.

COST/LIN. FT. – $40 to $50



ADVANTAGES

Provides positive protection.

Maintains shoreline in fixed position.

Low maintenance cost.

Materials are available locally.

DISADVANTAGES

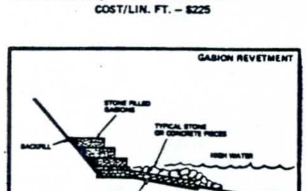
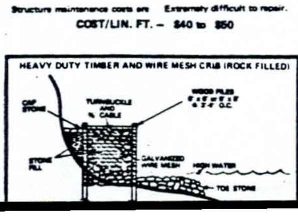
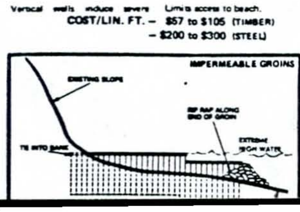
Vertical walls induce severe beach scouring. Adequate toe protection required.

High first cost.

Subject to flanking; bulkheads must be tied back securely.

Pile driving requires special skill and heavy construction equipment.

Complex engineering design problem.

Limits access to beach.

COST/LIN. FT. – $57 to $105 (TIMBER)
– $200 to $300 (STEEL)