HY8 Culvert Analysis Microcomputer Program Applications Guide

Office of Engineering
Bridge Division

Hydraulics Microcomputer
Program HY8

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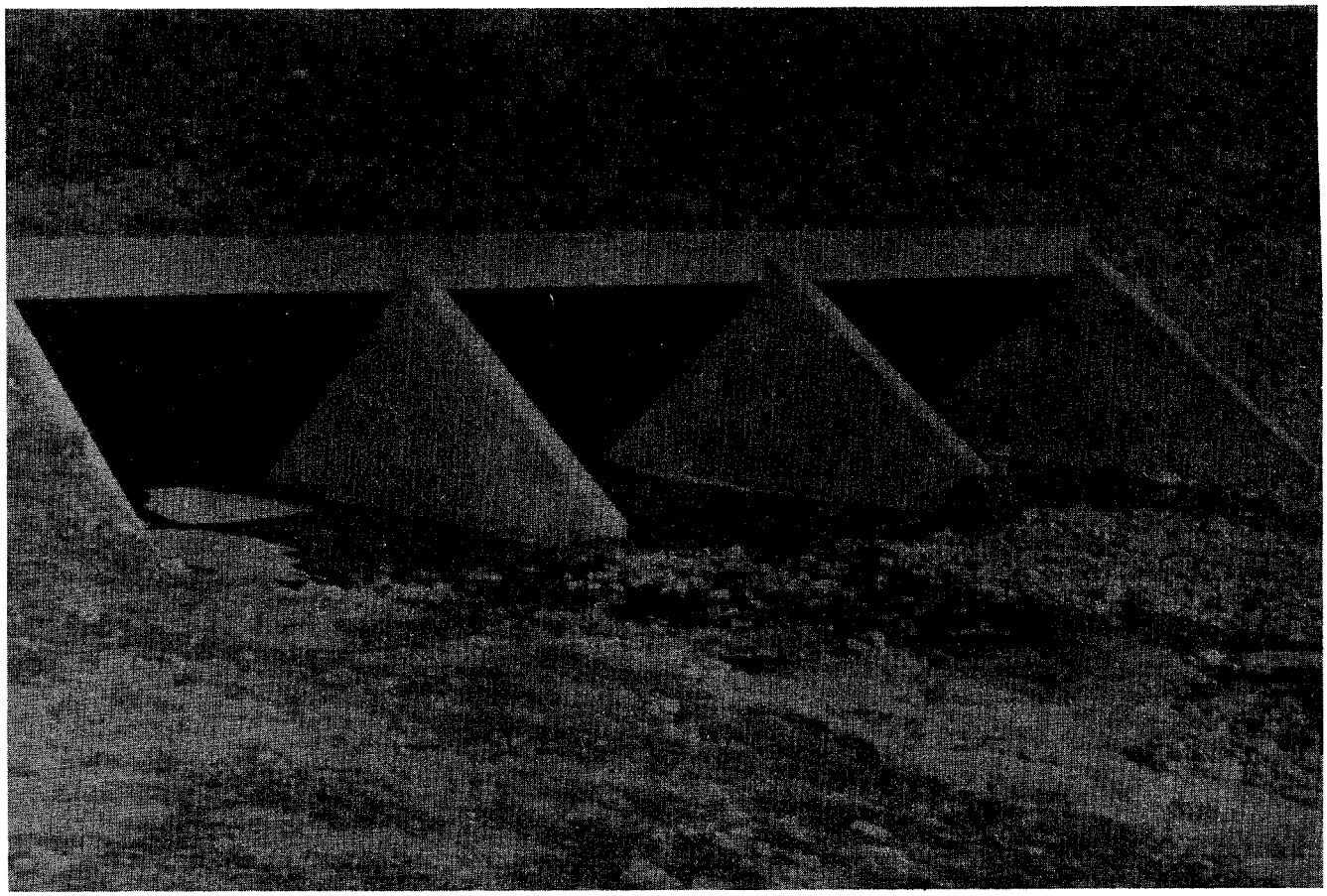
**Federal Highway
Administration**



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16. Abstract

This manual provides analysis approaches to be used with the FHWA Culvert Analysis Microcomputer Program HY8. HY8 is a BASIC program written for the IBM-PC with MS-DOS. Culvert analysis approaches are demonstrated with examples that provide instruction in data entry, file modification and culvert performance analysis. The examples illustrate the design of the following:

- o Reinforced Concrete Box Culvert
- o Irregular Culvert Cross Section
- o Multiple Indepenedent Barrels

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US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
HY8 CULVERT ANALYSIS MICROCOMPUTER PROGRAM
APPLICATIONS GUIDE

INTRODUCTION

The Federal Highway Administration Culvert Analysis microcomputer program HY8 consists of three main options: (1) Culvert Analysis, (2) Hydrograph Generation, and (3) Routing. The purpose of this manual is to provide the user with analysis approaches to be used with the Culvert Analysis portion of the program.

This is accomplished through examples which will provide instruction in data entry, file modification and culvert performance analysis. The three examples use the same site characteristics and discharge range, which are described in Example 1. The user should work through the problems on the computer while following the text so as to become familiar with the program. New users should consult the README file that accompanies the program.

HY8 has several user-friendly features which permit easy data entry, editing and comparison of several design alternatives. Pressing the F1 key will summon a Help screen that will provide additional information on how to enter data. Pressing the F5 key will stop execution of the program and return the user to the operating system.

Data is entered by selecting options on a menu or by entering numeric data at prompts. This data is periodically summarized in tables. Any incorrect entry can be changed, and design variations can be quickly analyzed.

Another feature of HY8 is that plots of irregular cross sections, rating curves and performance curves can be obtained if the terminal has graphics capabilities. The scale interval and range of values can be modified by advancing to the screen following the plot and making the desired changes.

The following three examples will be discussed:

- Example 1 - Reinforced Concrete Box Culvert Design,
- Example 2 - Irregular Culvert Cross Section,
- Example 3 - Multiple Independent Barrels

Since the program is still being developed, some of the screens shown in the examples may differ slightly from the actual screens.

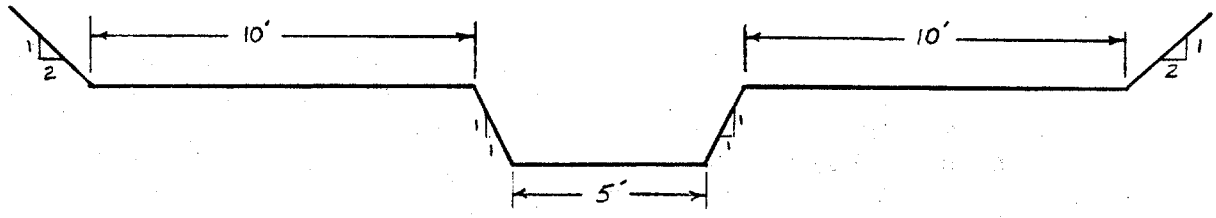
The culvert alternatives for these examples were chosen to illustrate the features of the software and do not necessarily represent cost effective designs.

EXAMPLE 1 - REINFORCED CONCRETE BOX CULVERT DESIGN

Problem Statement

Given the following site conditions, find a reinforced concrete box culvert that will pass the 50-year flow rate of 400 cfs with a design headwater elevation of 195 feet. Determine if the road will overtop at the 100 year flow rate of 500 cfs.

The natural stream channel consists of a main channel in rock having a Manning's roughness of 0.03 and overbanks having a roughness of 0.08. The channel is on a 5% slope. A typical cross-section is shown below:



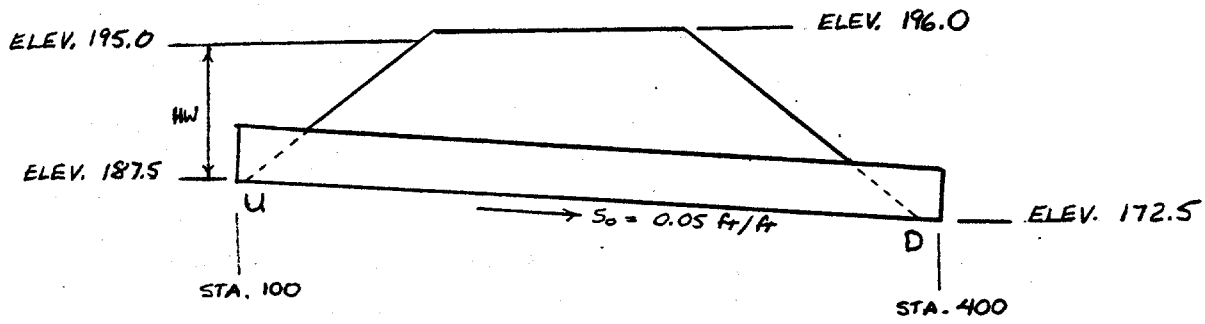
The cross-section can be described by the following coordinates:

Horizontal Station, ft.	Elevation, ft.
12	180
22	175
32	174.5
34	172.5
39	172.5
41	174.5
51	175
61	180

The roadway profile near the culvert is a sag vertical curve. The road is paved, with an embankment width of 50 feet. The following is a list of coordinates which describe the vertical curve:

Horizontal Station, ft.	Elevation, ft.
0	199.2
100	197.5
200	196.5
300	196.0
360	196.0
400	196.2
500	197.0
600	198.5
720	201.0

A profile of the culvert with the culvert invert data is shown below:



Data Input

After creating a file, the user will be prompted for discharge range, culvert invert data and culvert shape, material and inlet type. The discharge range for this example will be from 0 to 500 cfs. The site data can be entered by providing either culvert invert data or embankment data. If embankment catch points (U) and (D) shown above are input, the program will fit the culvert in the fill and subtract the appropriate length.

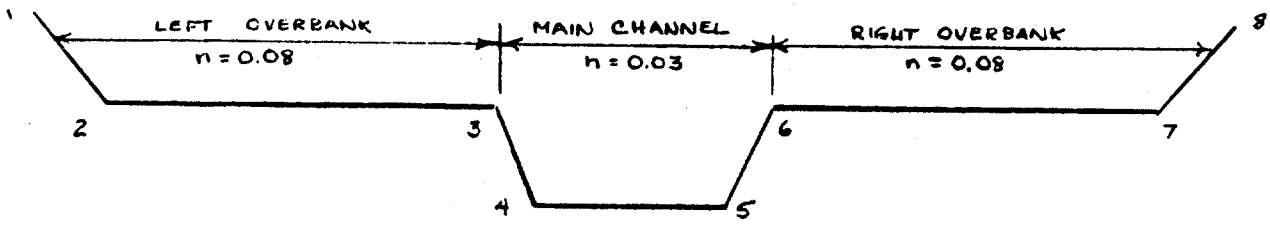
Culvert Data

As an initial size estimate, try a 5'x 5' box culvert. For the culvert assume that a conventional inlet with 1:1 bevels and 45 degree wingwalls will be used. As each group of data is entered the user is allowed to edit any incorrect entries. The following is how the screen that summarizes the culvert information will look.

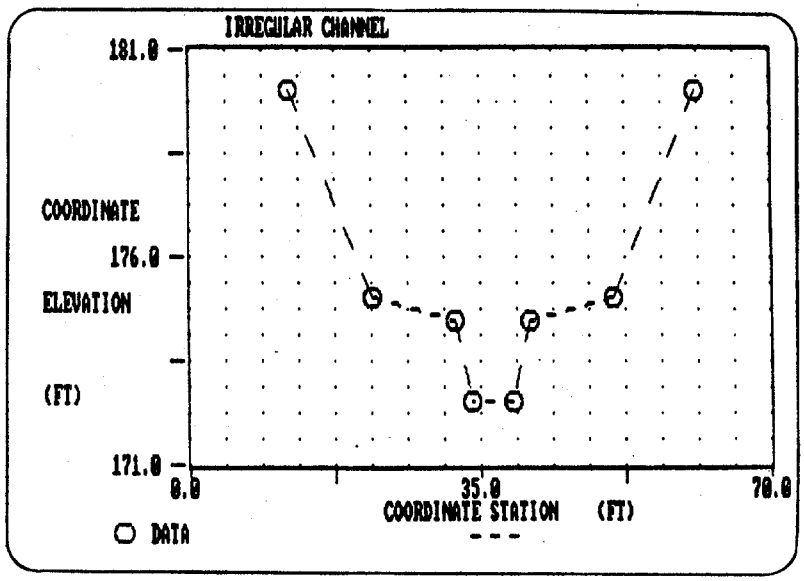
```
CULVERT ANALYSIS 1.1          DATE: 4/20/87
CULVERT FILE :5X5             CULVERT NO.  1

     ITEM                        SELECTED CULVERT

(1) BARREL SHAPE:              BOX
                               5  FT X  5  FT

(2) BARREL MATERIAL:           (1) CONCRETE N =  .012

(3) INLET TYPE:                (1) CONVENTIONAL

(4) INLET EDGE AND WALL:       (8) 1:1 BEVEL (45 DEG. FLARE)

(5) INLET DEPRESSION:          NONE


    TYPE ITEM NO. TO EDIT ITEM:
    (RET) TO CONTINUE DATA LISTING
```

Channel Data

Next the program will prompt for data pertaining to the channel so that tail water elevations can be determined. Referring to the problem statement, the channel is irregularly shaped and can be described by the 8 coordinates listed. After opening the irregular channel file the user will be prompted for channel slope, number of cross-section coordinates and subchannel option. The subchannel option in this case would be option (2), left and right overbanks and main channel.



The next prompt, for channel boundaries, refers to the number of the coordinate pair defining the left subchannel boundary and the number of the coordinate pair defining the right subchannel boundary. The boundaries for this example are the 3rd and 6th coordinates. After this is input, the program prompts for channel coordinates. Once these are entered, pressing (V) will cause the computer to display the channel cross-section shown below:



The user can easily identify any input errors by glancing at the plot. To return to the data input screens, press any key. If data is correct press (return). You can then enter the roughness data for the main channel and overbanks.

The program now has enough information to develop a uniform flow rating curve for the channel and provide the user with a list of options. Selecting option (U) on the Irregular Channel Data Menu will tell the computer to develop rating curve data. Selecting option (I) will permit the user to interpolate data between calculated points. Selecting Option (T) will display the following table:

TAILWATER RATING CURVE

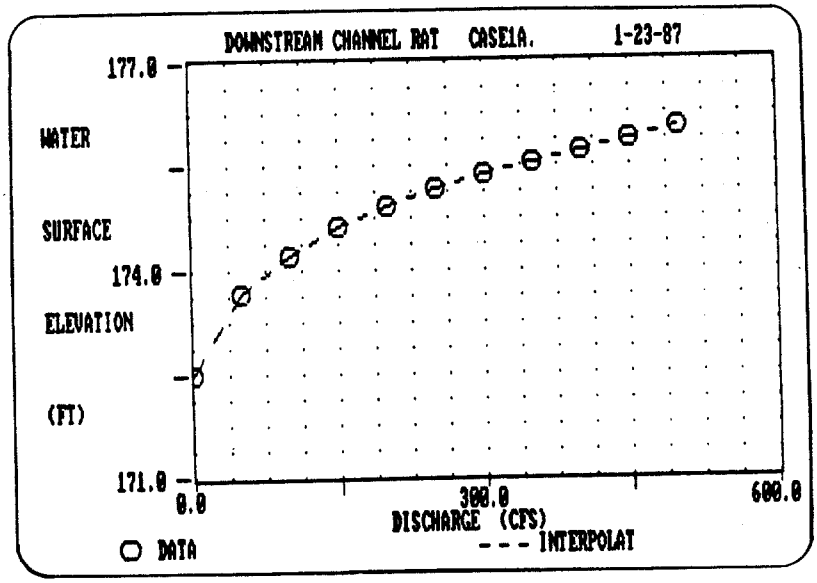
IRREGULAR CHANNEL FILE: CASTUDY

NO.	FLOW(CFS)	T.W.E.(FT)	VEL.(FPS)	SHEAR(PSF)
1	0.00	172.50	0.00	0.00
2	50.00	173.44	8.97	2.27
3	100.00	173.91	11.10	3.13
4	150.00	174.27	12.50	3.74
5	200.00	174.57	13.69	4.29
6	250.00	174.79	14.91	4.87
7	300.00	174.99	15.92	5.38
8	350.00	175.15	16.78	5.82
9	400.00	175.30	17.51	6.20
10	450.00	175.43	18.17	6.56
11	500.00	175.56	18.79	6.90

TYPE :
(P) TO PLOT RATING CURVE
(R) TO RELIST CROSS-SECTION DATA
(RET) TO CONTINUE
(ESC) FOR TAILWATER MENU

The Tailwater Rating Curve table consists of tailwater elevation (T.W.E.) at normal depth, natural channel velocity (Vel.) in feet per second, and the shear stress in pounds per square foot on the bottom for various flow rates. At the design flowrate of 400 cfs, the tailwater elevation will be 175.30 feet. The channel velocity will be 17.51 fps, and the shear will be 6.20 psf. This information will be useful in the design of channel linings if they are needed.

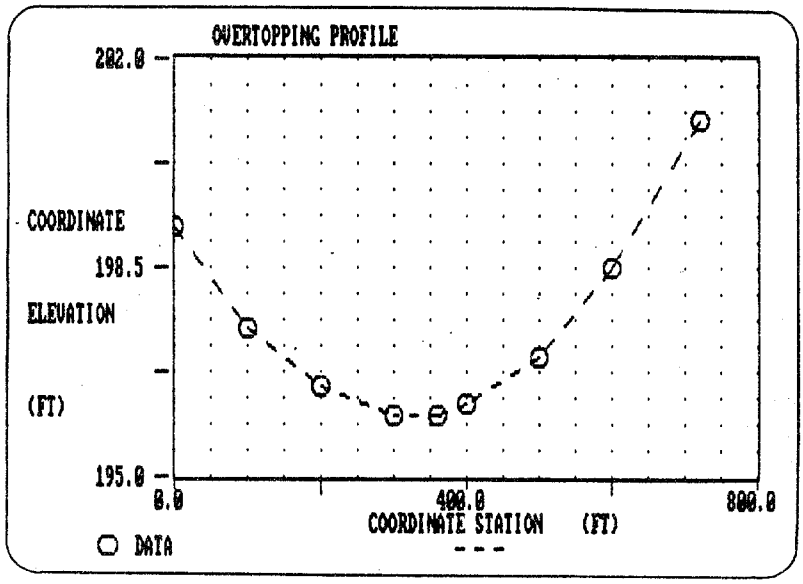
Entering (P) will cause the computer to display the rating curve for the channel. This curve, shown below, is a plot of tailwater elevation vs. flow rate at the exit of the culvert.



If information is desired for flow rates other than those listed, after pressing (R) to return to the Irregular Channel Menu, option (I) can be selected to interpolate values. This will generate a table similar to the previous table but with the addition of a Froude number column. The user is asked to select the variables for which the interpolation should be performed.

Roadway Overtopping Data

The next prompts are for the roadway profile, so that an overtopping analysis can be performed. Referring to the problem statement, the roadway profile is a sag vertical curve, which will require nine coordinates to define. Once these coordinates are input, the profile will be displayed when (V) is entered, as illustrated below. The other data required for overtopping analysis are roadway surface or weir coefficient and the embankment top width. For this example, the roadway is paved with an embankment width of 50 feet.



Alternative Analysis

All the data has now been entered and the summary table is displayed on the screen as shown below. At this point any of the data can be changed or the user can continue by pressing (Return), which will bring up the Culvert Program Options Menu.

```
CULVERT ANALYSIS 1.0                                    DATE: 4/20/87
CULVERT FILE NAME: 5X5                                  SUMMARY TABLE

| C |    A - SITE DATA                  | B - CULVERT SHAPE, MATERIAL, INLET
| U |-----------------------------------|-------------------------------------------------------
| L | INLET    OUTLET    CULVERT        | BARRELS   SPAN   RISE   MANN.    INLET
| V | ELEV.    ELEV.     LENGTH         | SHAPE                    N       TYPE
|NO.| (FT)     (FT)      (FT)           | MATERIAL  (IN)   (IN)
| 1 | 187.50   172.50     300          | 1 -RCB      60     60    0.012   CONVENTIONAL
| 2 |
| 3 |
| 4 |
| 5 |
| 6 |

TO EDIT DATA PRESS (A) FOR SITE DATA
                  (B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
                  (C) FOR DISCHARGE RANGE,
                  (D) FOR TAILWATER DATA,
                  (E) FOR OVERTOPPING DATA,
                  (F) TO ADD OR DELETE CULVERTS,
                  (RET) TO CONTINUE ANALYSIS.
```

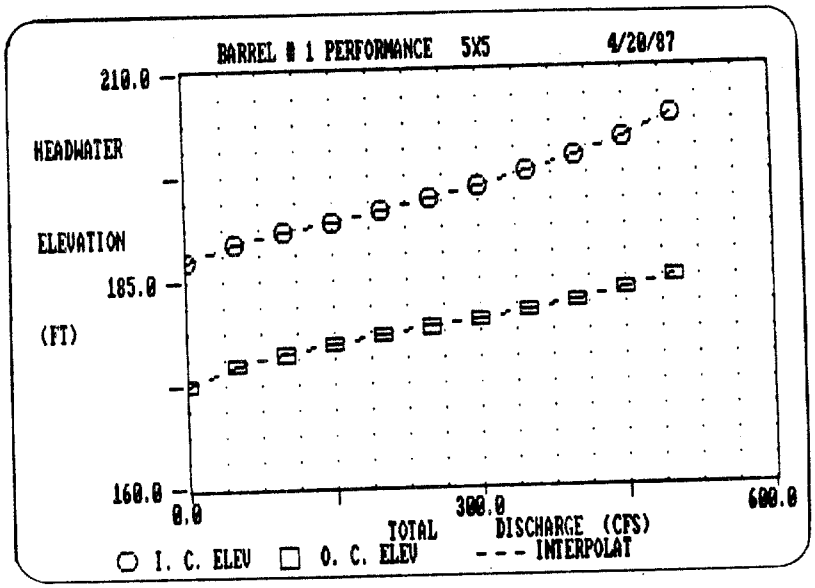
At this point the data file can be saved or renamed using option (S) or the culvert performance curve table can be obtained using option (P). When option (P) is selected, the user will be asked whether embankment overtopping should be considered in the analysis. Since this 5'x 5' culvert is a preliminary estimate, it will be better to see how the culvert performs without considering overtopping. The culvert performance table will look like this:

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	187.50	172.50	0.00	-15.00	0.00	0.00
50.00	189.58	173.44	2.08	-12.68	0.94	10.64
100.00	190.91	173.91	3.41	-11.31	1.41	14.18
150.00	192.11	174.27	4.61	-10.16	1.77	16.95
200.00	193.30	174.57	5.80	-9.14	2.07	19.32
250.00	194.59	174.79	7.09	-8.19	2.29	21.83
300.00	196.04	174.99	8.54	-7.31	2.49	24.10
350.00	197.71	175.15	10.21	-6.37	2.65	26.42
400.00	199.62	175.30	12.12	-5.25	2.80	28.57
450.00	201.77	175.43	14.27	-3.98	2.93	29.83
500.00	204.41	175.56	16.91	-2.57	3.06	30.54

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

This table indicates the controlling headwater elevation (HW), the tailwater elevation and the headwater elevations associated with all the possible control sections of the culvert. It is apparent from the table that at 400 cfs the headwater (HW) is 199.62 ft, which exceeds the design headwater of 195 feet. Consequently, the 5'x 5' box culvert is inadequate for the site conditions. The following plot of inlet and outlet control headwaters can be obtained by entering (V). In this example, the culvert is operating in inlet control (the upper curve) throughout the discharge range.



The user can easily modify the existing program file to analyze a larger barrel. Suppose a 6'x 6' culvert is tried. Hit any key to return to the Culvert Data Summary Table and enter (B) to modify culvert shape. The prompts will be the same as they were for the 5 x 5 culvert, and the user will be returned to the Culvert Data Summary Table directly without going through the tailwater and overtopping menus again. Pressing (return) will bring up the Culvert Program Options menu, with which the new file can be renamed and saved. Now the performance of this culvert can be checked by selecting option (P) without overtopping. The following table will appear:

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	187.50	172.50	0.00	-15.00	0.00	0.00
50.00	189.34	173.44	1.84	-12.95	0.94	8.87
100.00	190.43	173.91	2.93	-11.74	1.41	11.82
150.00	191.44	174.27	3.94	-10.72	1.77	14.12
200.00	192.37	174.57	4.87	-9.81	2.07	16.10
250.00	193.27	174.79	5.77	-8.98	2.29	18.20
300.00	194.18	174.99	6.68	-8.19	2.49	20.08
350.00	195.12	175.15	7.62	-7.46	2.65	22.01
400.00	196.12	175.30	8.62	-6.75	2.80	23.81
450.00	197.21	175.43	9.71	-6.08	2.93	25.60
500.00	198.40	175.56	10.90	-5.42	3.06	27.23

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

Since the design headwater criterion has still not been met, another size must be selected. Try a 7'x 6' culvert, and modify the file accordingly. The resulting performance table shown below indicates that the design headwater will not be exceeded at 400 cfs. However, the headwater elevation of 196.74 feet at 500 cfs indicates that some overtopping will occur due to the 100-year storm.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	187.50	172.50	0.00	-15.00	0.00	0.00
50.00	189.16	173.44	1.66	-13.15	0.94	7.60
100.00	190.14	173.91	2.64	-12.06	1.41	10.13
150.00	191.02	174.27	3.52	-11.14	1.77	12.11
200.00	191.85	174.57	4.35	-10.32	2.07	13.80
250.00	192.63	174.79	5.13	-9.57	2.29	15.60
300.00	193.40	174.99	5.90	-8.86	2.49	17.21
350.00	194.18	175.15	6.68	-8.19	2.65	18.87
400.00	194.98	175.30	7.48	-7.56	2.80	20.41
450.00	195.83	175.43	8.33	-6.95	2.93	21.94
500.00	196.74	175.56	9.24	-6.36	3.06	23.34

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

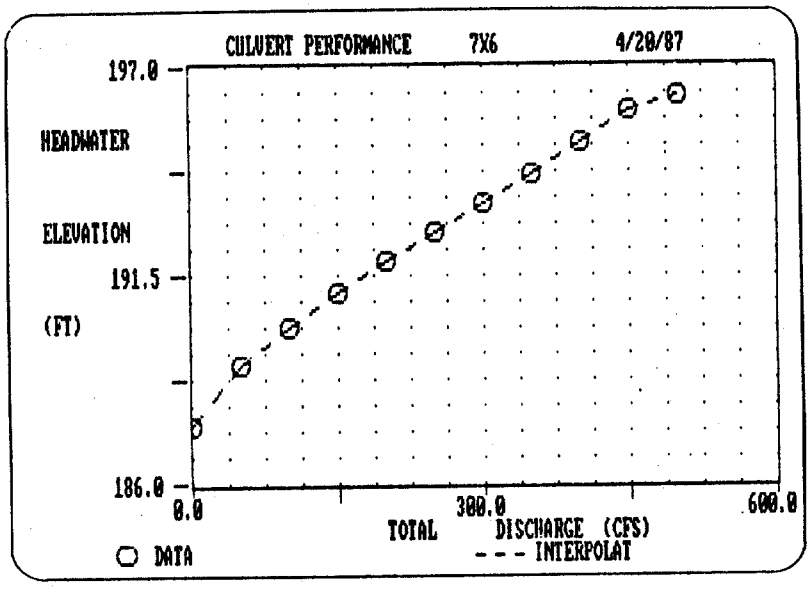
To determine the amount of overtopping and the actual headwater, press (return), and then select (P), and (Y) for overtopping. A Summary of Culvert Flows will appear on the screen, as shown below:

SUMMARY OF CULVERT FLOWS (CFS) file: 7X6 date:4/20/87

ELEV (FT)	TOTAL	1	2	3	4	5	6	OVERTOP	ITER
187.50	0	0	0	0	0	0	0	0	0
189.16	50	50	0	0	0	0	0	0	2
190.14	100	100	0	0	0	0	0	0	2
191.02	150	150	0	0	0	0	0	0	2
191.85	200	200	0	0	0	0	0	0	2
192.63	250	250	0	0	0	0	0	0	2
193.40	300	300	0	0	0	0	0	0	2
194.18	350	350	0	0	0	0	0	0	2
194.98	400	400	0	0	0	0	0	0	2
195.83	450	450	0	0	0	0	0	0	2
196.26	500	474	0	0	0	0	0	36	6

PRESS:
(1) TO PLOT TOTAL RATING CURVE
(2) TO DETERMINE SPECIFIC INFORMATION ABOUT EACH CULVERT
(3) TO SEE MULTIPLE CULVERT COMPUTATIONAL ERROR TABLE
(ENTER) TO RETURN FOR NEW RUN OR EXIT

This computation table is used when overtopping and/or multiple culvert barrels are used (see example 3). It shows the headwater, total flow rate, the flow through each barrel and overtopping flow, and the number of iterations it took to balance the flows. From this information a total (culvert and overtopping) performance curve, shown below, can be obtained by selecting option (1).



This curve is a plot of the headwater elevation vs. the total flow rate which indicates how the culvert or group of culverts will perform over the selected range of discharges. It is especially useful for comparing the effects of various combinations of culverts.

From the Summary table, when the total flow is 500 cfs, 474 cfs passes through the culvert and 36 cfs flows over the road. The headwater elevation will be 196.26 feet. Assume that in this case overtopping at 100-year frequency can be tolerated, and the 7'x 6' culvert will be used. Referring back to the performance curve data, the outlet velocity at 400 cfs is 20.41 fps. Since the tailwater rating curve generated previously indicates that the natural channel velocity at 400 cfs is 17.51 fps, an energy dissipator will not be warranted.

When overtopping occurs, the performance of the culvert will differ from that without overtopping. By selecting option (2), the culvert performance data can be obtained. The user also has the option to plot this data.

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	187.50	172.50	0.00	-15.00	0.00	0.00
50.00	189.16	173.44	1.66	-13.15	0.94	7.60
100.00	190.14	173.91	2.64	-12.06	1.41	10.13
150.00	191.02	174.27	3.52	-11.14	1.77	12.11
200.00	191.85	174.57	4.35	-10.32	2.07	13.80
250.00	192.63	174.79	5.13	-9.57	2.29	15.60
300.00	193.40	174.99	5.90	-8.86	2.49	17.21
350.00	194.18	175.15	6.68	-8.19	2.65	18.87
400.00	194.98	175.30	7.48	-7.56	2.80	20.41
450.00	195.83	175.43	8.33	-6.95	2.93	21.94
474.03	196.26	175.56	8.76	-6.67	3.06	22.13

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

By pressing (return) to display the Summary of Culvert Flows and selecting option (3), a Summary of Iterative Solution Errors is produced. This table, shown below, lists the amount of error present in the solution for a flow rate of 500 cfs as 10 cfs.

SUMMARY OF ITERATIVE SOLUTION ERRORS file: 7X6 date:4/20/87

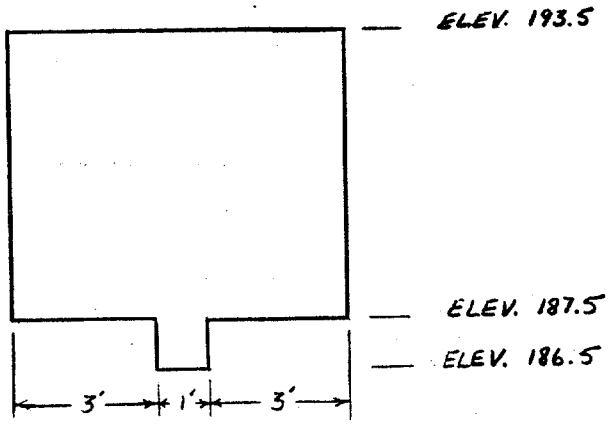
HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
187.50	0.00	0	0	0.00
189.16	0.00	50	0	0.00
190.14	0.00	100	0	0.00
191.02	0.00	150	0	0.00
191.85	0.00	200	0	0.00
192.63	0.00	250	0	0.00
193.40	0.00	300	0	0.00
194.18	0.00	350	0	0.00
194.98	0.00	400	0	0.00
195.83	0.00	450	0	0.00
196.26	0.00	500	10	1.92

PRESS (ENTER) TO CONTINUE

EXAMPLE 2 - IRREGULAR CULVERT CROSS SECTION

Problem Statement

During environmental review, it was determined that the 7' x 6' box culvert from Example 1 is not conducive to the migration of fish during low flow periods. Therefore, the shape will be modified to the one shown below:



Data Entry

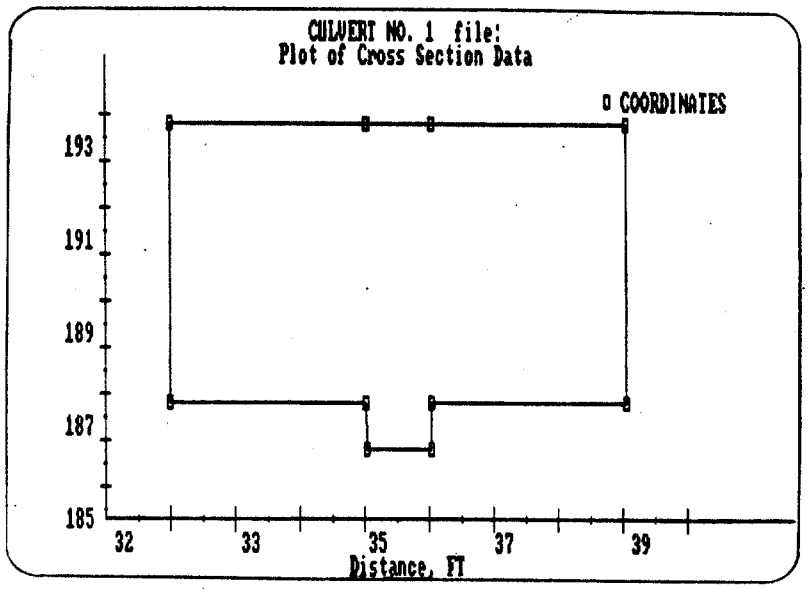
The previous file can be modified to accommodate this shape. Since a 1 foot notch is added to the bottom, the invert elevations must be lowered 1 foot. This is done by selecting option (A), Site Data, on the Culvert Data Summary Table menu. Once the data is updated, the user will be returned to the Culvert Data Summary Menu. Now enter (B) to change the shape. This shape is an irregular shape that can be defined by six coordinates. Coordinate entries for irregular cross-sections are defined by an x-coordinate for horizontal position followed by a y-coordinate for the point on the upper edge of the shape and a y-coordinate for the point on the lower edge of the shape. The coordinates for this shape would be entered as follows (the x-coordinates were chosen so that the culvert and channel centerlines coincide):

IRREGULAR CULVERT CROSS-SECTION CULVERT NO. 1

COODINATE NUMBER	X (FT)	Y-TOP (FT)	Y-BOTTOM (FT)
1	33	193.5	187.5
2	36	193.5	187.5
3	36.01	193.5	186.5
4	37	193.5	186.5
5	37.01	193.5	187.5
6	40	193.5	187.5

TYPE COORD. NO. TO EDIT COORD.
(I) OR (D) TO INSERT OR DELETE
(RET) TO CONTINUE LISTING *
(V) TO VIEW CROSS-SECTION

A display of the section can be obtained by pressing (V). This is shown below:



For the inlet conditions, assume a bevelled edge. The rest of the site data will be the same as that in Example 1 and will not have to be re-entered. However, be sure to rename this file if you wish to save the data.

Performance Analysis

The culvert performance table is shown below:

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	186.50	172.50	0.00	-14.00	1.00	0.00
50.00	188.81	173.44	2.31	-12.29	1.94	6.60
100.00	189.67	173.91	3.17	-11.20	2.41	9.20
150.00	190.50	174.27	4.00	-10.28	2.77	11.20
200.00	191.27	174.57	4.77	-9.46	3.07	12.91
250.00	191.92	174.79	5.42	-8.71	3.29	14.68
300.00	192.50	174.99	6.00	-8.00	3.49	16.28
350.00	193.07	175.15	6.57	-7.33	3.65	17.90
400.00	193.66	175.30	7.16	-6.70	3.80	19.42
450.00	194.28	175.43	7.78	-6.09	3.93	20.92
500.00	194.95	175.56	8.45	-5.50	4.06	22.30

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

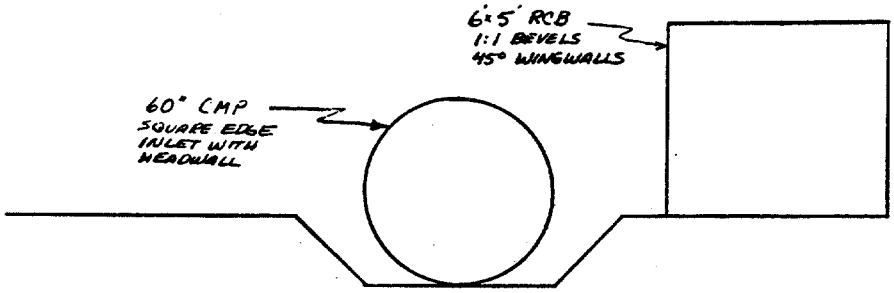
At 400 cfs the headwater is 193.66 feet, which is below the design headwater. Also, note that the road will not overtop at 500 cfs. Therefore, this modified 7'x 6' shape is acceptable.

EXAMPLE 3 - MULTIPLE INDEPENDENT BARRELS

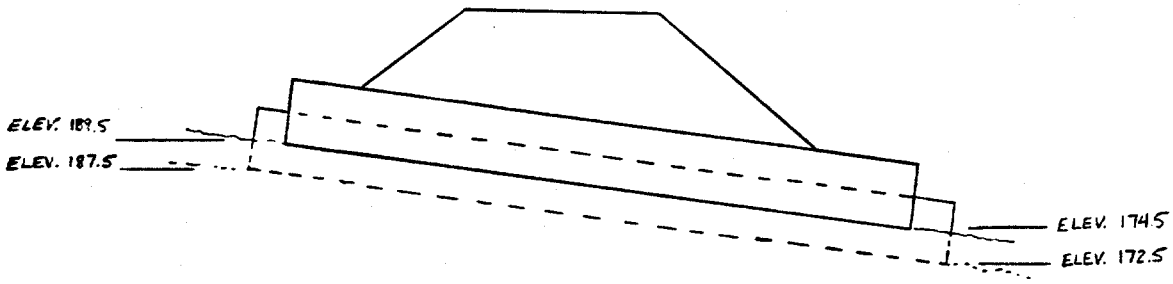
Problem Statement

If sediment deposition is a problem at the site previously under consideration, the use of two barrels may be warranted. A 6'x 5' RCB culvert and a 5' corrugated metal pipe are considered in the following configuration:

ELEVATION



PROFILE



Data Entry

For this problem, use the original 5' x 5' RCB file, or modify the shape data of one of the other files to that for the 5' x 5' RCB. Starting at the Culvert Data Summary Table for the 5' x 5' RCB, select option (F) to Add a Culvert. There will be prompts for all the culvert data for the circular pipe. When the data has been entered the Summary Table will look like this:

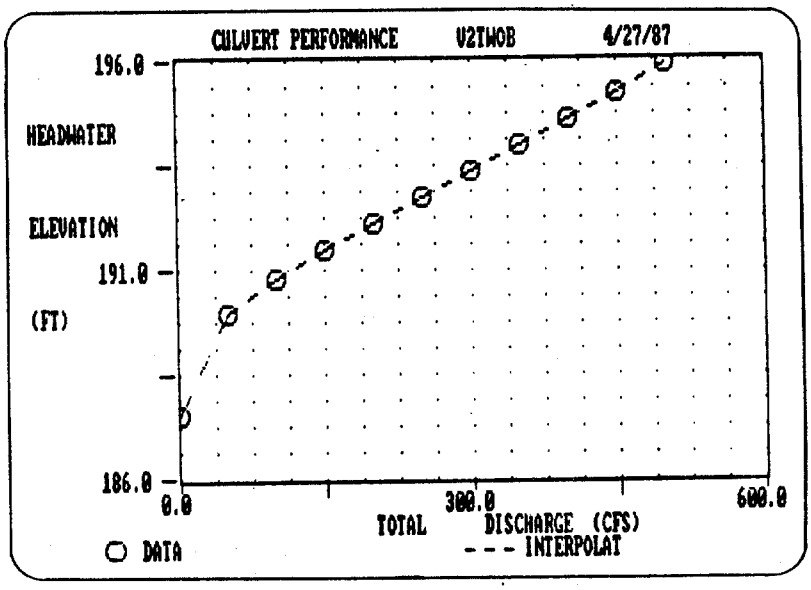
```
CULVERT ANALYSIS 1.0                                    DATE: 4/27/87
CULVERT FILE NAME: V2TWOB                               SUMMARY TABLE

: C :    A - SITE DATA          : B - CULVERT SHAPE, MATERIAL, INLET
: U :---------------------------:-------------------------------------
: L : INLET   OUTLET   CULVERT: BARRELS   SPAN   RISE   MANN.   INLET
: V : ELEV.   ELEV.    LENGTH : SHAPE                    N      TYPE
:NO.: (FT)    (FT)     (FT)   : MATERIAL  (IN)   (IN)
: 1 : 189.50   174.50    300  : 1 -RCB      72     60   0.012  CONVENTIONAL
: 2 : 187.50   172.50    300  : 1 -CSP      60     60   0.024  CONVENTIONAL
: 3 :
: 4 :
: 5 :
: 6 :

TO EDIT DATA PRESS (A) FOR SITE DATA
                   (B) FOR CULVERT SHAPE, MATERIAL, OR INLET DATA,
                   (C) FOR DISCHARGE RANGE,
                   (D) FOR TAILWATER DATA,
                   (E) FOR OVERTOPPING DATA,
                   (F) TO ADD OR DELETE CULVERTS,
                   (RET) TO CONTINUE ANALYSIS.
```

Performance Analysis

When the performance curve is requested, the Summary of Multiple Culvert Flows will appear. The flow through each barrel and the headwater will be determined for each total flow rate. When the computations are complete, the screen will be as shown below:

```
SUMMARY OF CULVERT FLOWS (CFS)     file: V2TWOB date:4/27/87

ELEV (FT)    TOTAL      1      2      3      4      5      6    OVERTOP   ITER
   187.50        0      0      0      0      0      0      0          0      0
   189.96       50      6     44      0      0      0      0          0      5
   190.78      100     29     71      0      0      0      0          0      6
   191.46      150     55     95      0      0      0      0          0      6
   192.08      200     82    118      0      0      0      0          0      5
   192.71      250    111    139      0      0      0      0          0      5
   193.34      300    141    160      0      0      0      0          0      5
   193.95      350    172    178      0      0      0      0          0      6
   194.59      400    205    195      0      0      0      0          0      6
   195.26      450    238    212      0      0      0      0          0      6
   195.96      500    272    228      0      0      0      0          0      6

            PRESS:
              (1)  TO PLOT TOTAL RATING CURVE
              (2)  TO DETERMINE SPECIFIC INFORMATION ABOUT EACH CULVERT
              (3)  TO SEE MULTIPLE CULVERT COMPUTATIONAL ERROR TABLE
              (ENTER) TO RETURN FOR NEW RUN OR EXIT
```

When the total flow rate is 400 cfs, 205 cfs goes through Barrel 1 and 195 cfs goes through Barrel 2. Selecting option (1) will yield the following curve, which indicates headwater vs. total flow rate.



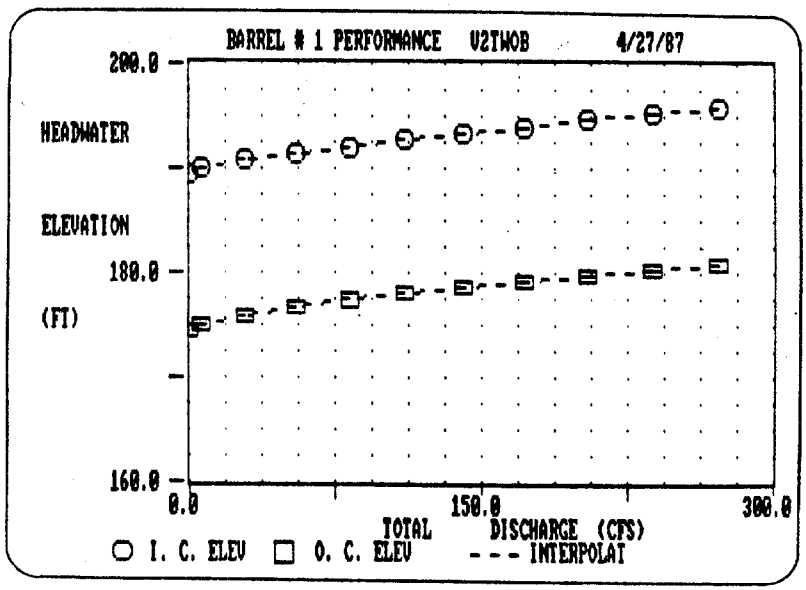
Pressing any key to return to the Summary table and selecting option (2) will yield a performance curve table for Barrel 1 (the 6' x 5' RCB culvert).

CULVERT # 1 PERFORMANCE CURVE
FOR 1 BARRELS

Q	HW	TWE	ICH	OCH	TWH	VO
(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(fps)
0.00	189.50	172.50	0.00	-15.00	0.00	0.00
6.28	189.96	173.44	0.46	-14.50	0.07	15.78
28.91	190.78	173.91	1.28	-13.58	0.31	15.78
54.81	191.46	174.27	1.96	-12.82	0.54	16.87
82.45	192.08	174.57	2.58	-12.13	0.69	19.78
110.70	192.71	174.79	3.21	-11.51	0.85	21.67
140.73	193.33	174.99	3.83	-10.90	1.01	22.04
172.01	193.95	175.15	4.45	-10.31	1.15	23.51
204.56	194.59	175.30	5.09	-9.73	1.30	24.67
237.84	195.26	175.43	5.76	-9.17	1.45	25.67
271.58	195.96	175.56	6.46	-8.63	1.59	26.64

PRESS <V> TO PLOT PRESS <ENTER> TO CONTINUE

The inlet and outlet control headwater curves will be plotted when (V) is pressed. The curves for Barrel 1 are show below. Information for Barrel 2 (the 60" CMP) can be obtained by pressing (enter). Similarly a performance curve can be obtained by pressing (V).



Since the headwater elevation is only 194.59 feet for 400 cfs, this combination of culverts will be satisfactory. At this headwater elevation, culvert 1 above conveys 205 cfs in inlet control and culvert 2 below conveys 195 cfs in inlet control.