S.M.I.

# 48CE

# Civil Engineering Card


A CO-OP MODULE PRODUCT

MANUAL

# SURVEYORS MODULE INC.

# CO-OP 48CE

# USER'S MANUAL

# CO-OP 48CE

# A SOFTWARE FOR SURVEYORS

# and

# CIVIL ENGINEERS

by

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*Hardware Configuration:*

1. *HP48SX Calculator/Computer*
2. *48CE Card Module or Other Card Containing the 48CE*



**Revision 1:** OCT 1990
**Revision 2:** MAR 1991

# LIST OF IMPROVEMENTS and REVISIONS

## FOR THE 48CE MODULE

1. All programs in the 48CE card except **"TMC"**, **"ANDR"**, & **"PIPES"** routines can now have their output display automatically printed. Automatic printing will occur if a compatible printer such as the HP82240B is turned on as a particular program is being executed.

2. Output for the **VERTICAL** and **HORIZONTAL CURVE** programs are now displayed at 4-decimal place accuracy. The rest of the programs can have their output accuracy varied according to the user's need. To change the displayed accuracy, simply execute the **[FIX]** command before running the program.

3. In the **DITCH** and **PIPE** analysis programs, all given and solved values are displayed and printed.

## A DISCLAIMER

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## NOTICE

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# 48CE CIVIL ENGINEERING

## Programs and Descriptions

### A. VERTICAL CURVE

(1) Finds elevation at any selected station both inside and outside of the Vertical Curve.

(2) Finds elevation at any selected station on both tangents.

(3) Automatic display of the High or Low Station and Elevation, the PVC, PVI, and PVT Station and Elevation.

(4) Automatic sequential display of Station and Elevation after entry of Station Range and interval on the Vertical Curve and on both tangents.

### B. HORIZONTAL CURVE LAYOUT - Deflection and Tangent Offset Method. Output for the Deflection Method includes:

(1) Selected Station

(2) Deflection Angle (Instr. @ P.C. B.S. @ P.I.) to any station inside the curve

(3) Long Chord - Distance from P.C. to any station entered

(4) Short Chord - Distance from the last station to the current station.

Output for the Tangent Offset Method includes:

1. Selected Station
2. Tangent - Distance from PC towards PI of a point or station on the curve perpendicular to the tangent.
3. Offset - Perpendicular distance of a point on curve to the tangent.

Both methods allow selective entry of any station,or station range and interval for automatic sequential display of output.

**NOTE:** Displays an error message if station entered is not within the curve.

C. **EARTHWORK** - Computes Volume by average end area.

(1) Features direct entry of elevation and offset of a Road Template.

(2) Computes Volume between any 2 stations or multiple stations in both cubic feet and yards.

D. **DITCH** and **OPEN CHANNEL** - Uses equation derived from Manning's Open Channel formula, and is applicable to Trapezoidal, Rectangular, and V-Shape Sections, and various materials used in the ditch's lining. Consisting of 9 Routines for solving and setting for the Rate of Flow, Velocity, Depth of Flow, Bottom Width, Slope, Left, and Right Side Slopes, Manning's Roughness Coefficient, and length of water surface.

E. **HYDRAULIC PROGRAMS** - Miscellaneous programs include:

(1) Time of Concentration for overland flow.

(2) Rate of Storm Run-off of a watershed using the Anderson Formula.

(3) Design of Multiple Pipe culvert with inlet control using a fixed Headwater depth.

(4) Full and Partial Flow in Pipes - Consisting of 9 Routines for use in the design and analysis of the different variables involved in a full and partial flow. These variables include Rate of Flow, Slope, Manning's Roughness Coefficient, Diameter of Pipe, Velocity of Flow and the Height of fluid inside the pipe expressed as a percentage of the pipe's diameter.

# ACCESSING THE 48CE PROGRAMS

Before the user can access and run the 48CE Programs, the following should be done:

1. The 48CE card or any other card containing the 48CE is in placed in one of the HP48SX card ports.

   **CAUTION**: The calculator must be **OFF** when inserting any card. Please refer to Chapter 34, Page 636, Volume II, of the Owner's Manual for details.

2. After the card is inserted turn on the HP48SX.

3. Press the left shift (**Orange**) key, then the Library Key,

   Thus: ⬑ **[LIBRARY]**.

4. A menu will appear showing the 5 main programs included in the 48CE card.

5. The user can then select one of the programs by pressing that "Softkey" found directly below each program's name.

   (These softkeys are the 6 top row keys and are labeled by alphabets A thru F).

6. From here on the user is ready to run the program. The steps to be followed when running a particular program **START** from this point. To get familiar with the execution of a program, it is suggested that the user go through the illustrated example problems.

**NOTE:** To access and run another program go to Step No. 3.

# GENERAL NOTES, REMINDERS & PROCEDURES

1. To quit the 48CE Program simply press the [VAR] key. This will put the user back to the previous directory before the 48CE was first accessed.

2. To quit or abort program execution after the user has pressed the Routine's softkey, press the [ON] key, then the right shift [↱] key, and the clear [CLR] key.

3. Three of the programs; namely, "VERT", "HORC" and "EARTH", when executed will generate names and single-letter variables that will appear in the Home Directory Menu. Not to worry, because one of the generated names will include a routine labeled "CLER" that when executed, i.e., pressing its softkey, will clear all those names and variables including the routine itself from the Home Directory Menu.

4. Most of the Programs and Routines when executed, will return or display a series of names and alphanumeric characters arranged in sequence, each having a question mark at the end. This prompts the user to respond and enter the input data (given data) being asked for in the same sequence as those data were prompted. The user must enter the given data continuously, separated only by either a comma (,) or a space [SPC] key. After the last data is entered, the [ENTER] key is pressed to signal the end of the data entry.

## PRINTING THE OUTPUT DISPLAY

All output screen and stack displays can be printed automatically if a compatible printer such as the HP82240B is ON and configured to accept infrared transmissions from the 48SX.

A routine called "**PRNT**" has been added to all the programs included in the 48CE. This routine will appear in one of the softkeys when you access any of the 5 programs. Its function is to ACTIVATE and DE-ACTIVATE automatic printing of output display during and after the program is run. [PRNT] is a non-prompting routine, therefore, you must first enter an input data before executing it.

NOTE: To activate or de-activate automatic printing of output display you must first execute "**PRNT**" before running any of the 5 programs.

To run or execute this routine, simply **ENTER** either **1** or **0** then press or execute **[PRNT]**.

Setting or clearing Flag 11 will also serve the same function as **[PRNT]**. If the output displays are arranged in the stack after running a particular program, you can print the output display even if the print mode was initially de-activated by executing the 48SX command "**PRST**".

As a reminder, programs and commands can be executed by either pressing the softkey where its name is located or by turning alpha ON and spelling its name on the screen then pressing the **[ENTER]** key.

# ABOUT THE 48CE CARD MODULE

The program listings for the 48CE were converted into a "Library" by the Manufacturer's processing system that is beyond the scope of this manual. The library thus created is "burnt" or stored into a One Time Programmable (OTP) card.

Program names and routines when converted into a Library will behave like a built-in function in the HP48SX. Furthermore, these programs can be accessed to and run from any directory; however, the program listings cannot be viewed or altered.

Three programs in the 48CE; namely, the **VERT**, **HORC**, and **EARTH** each create a temporary bank of variables and names which will appear in the Home Directory. A Routine named "**CLER**" will also appear whenever any of the 3 programs is executed. To get rid of those temporary names in the Home Directory, simply press the softkey opposite "**CLER**".

# VERTICAL CURVE AND TANGENT GRADE PROGRAMS

**DESCRIPTION:** Consist of 5 main routines including the routine called "**DATA**" for processing Vertical Curve input data. The following is a list of routines and their respective functions.

1. **DATA** - Please note that this is the **FIRST** routine to be executed before all others. Data information processed by this routine is used by the rest of the other routines. It accepts 2 modes of data entry as follows:

   (A) PVC Data - consisting of the following:

   (1) A code letter "C"
   (2) PVC Station (ST)
   (3) PVC Elevation (El)
   (4) Starting Grade (G1) - In percent, entered with a minus sign if Negative or sloping down towards the PVI, no sign if grade is positive.
   (5) Ending Grade (G2) - in percent, entered w/ a minus if sloping down towards PVT.
   (6) Length of Vertical Curve (L)

(B) PVI Data - consisting of the following:

(1) A code letter "I"
(2) PVI Station (St)
(3) PVI Elevation (El)
(4) Starting Grade (G1) in percent, preceded by a minus sign if negative, no sign if positive.
(5) Ending Grade (G2) in percent, preceded by a minus sign if negative, no sign if positive.
(6) Length of Vertical Curve (L)

2. **HL&P** - A Vertical Curve routine for displaying the High or Low Station and Elevation and also the Vertical Curve parameters consisting of the PVC, PVT and PVI stations and elevations. No input data is needed when running the routine.

3. **STA?** - A Vertical Curve routine for computing and displaying the station and elevation of any point within the limits of the Vertical Curve and on both legs of the Tangent outside of the Vertical Curve. Please note that this particular routine **REQUIRES** an input (Station Value) before executing or pressing the **[STA?]** softkey.

4. **CBEI** - A Vertical Curve routine for displaying stations and elevations from a chosen beginning station thru a chosen ending station and a specified station interval. The first data displayed is the station and elevation of the beginning point and subsequent output is displayed by pressing any key except the **Alpha Shift** key, the 2 Shift Left and **Right** keys, and the "**ON**" key. An error message will be displayed if the user attempts to input a station outside of the Vertical Curve.

5. **TBEI** - A Tangent Grade routine for displaying stations and elevations from a chosen beginning thru ending stations, and a specified station interval, located on either tangent leg of the Vertical Curve.

## VERTICAL CURVE - PROGRAM EXECUTION

**EXAMPLE PROBLEM:**

**GIVEN:**

(1) PVC Station (St) = 1 + 00
(2) PVC Elevation (El) = 225.00
(3) Starting Grade (G1) = 2.58%
(4) Ending Grade (G2) = - 5.36%
(5) Length of V.C. (L) = 200 ft.

## FIND:

(1) Station and elevation at any point in the vertical curve and in the 2 tangents left and right of the vertical curve.
(2) Location of the high or low point and its elevation.
(3) Other vertical curve parameters.
(4) Automatic display of stations and elevations by specifying the beginning and ending stations and the station interval.

## STEPS:

1. Press **[DATA]** softkey

   **(SCREEN DISPLAY)**

   [α] C ST? EL? G1? C2? L?

   or

   I ST? EL? G1? G2? L?

2. Type the following:

   [α] C [SPC] 100 [SPC] 225 [SPC]

   2.58 [SPC] 5.36 [+/-] [SPC] 200

   [ENTER]

NOTE: Characters in brackets denote individual HP48 keys.

**(SCREEN DISPLAY)**

None

**NOTE:** At this point, the user has the option to execute any of the 4 Vertical Curve routines. For illustration purposes, let us run each one.

(A) **[HL&P] ROUTINE** - Pressing [HL&P] softkey will result in the following display:

**(SCREEN DISPLAY)**

H.P. STA. 1 + 64.9874
ELEV. = 225.8383

**INSTRUCTION "A":**

Press any key **except** the following 4 keys to continue viewing the rest of the output.

(1) Alpha Shift Key [α]
(2) Shift Left Key ↰
(3) Shift Right Key ↱
(4) ON or ATTN key [ON]

Press, say, the **[SPC]** key

(SCREEN DISPLAY)

G1(%) = 2.5800
G2(%) = –5.3600
L of V.C. = 200.0000
PVC STA. 1 + 00.00
ELEV. = 225.0000
PVT STA. 3 + 00.0000
ELEV. = 222.2200
PV1 STA. 2 + 00.00
ELEV. = 227.5800

NOTE: This ends **[HL&P]** run.

(B) **[STA?] ROUTINE** - Entering any **STATION** within the limits of the Vertical Curve and also any **STATION** on either leg of the Tangent outside of the curvė will result in the display of that **STATION** and its **ELEVATION.** Please note that on this Routine, a data must be entered first before pressing the **[STA?]** key for execution. For example, we need to find the elevation at stations located on the left tangent, on the vertical curve itself, and on the right tangent as follows: 0 + 50.00, 2 + 0.00, 3 + 50.00

Key the following:

50 **[STA?]**

(SCREEN DISPLAY)

STA. 0 + 50.00
ELEV. = 223.7100

Key the following:

200 [STA?]

(SCREEN DISPLAY)

STA. 2 + 00.0000
ELEV. = 225.5950

Key in the next station

350 [STA?]

(SCREEN DISPLAY)

STA. 3 + 50.0000
ELEV. = 219.5400

NOTE: When entering consecutive stations that do not fall within the Vertical Curve, it is necessary to press the first key TWICE so that the number will register properly.

(C) [CBE1] ROUTINE - Pressing [CBE1] softkey will prompt the user to enter the following 3 input data: This routine only accepts stations within the limits of the Vertical Curve. An error message will result if the user attempts to enter any station outside of the curve.

Sample input data for CBE1 Routine

(1) Beginning Station - usually a whole station such as 2+00.00 or 2+50.00.

(2) Ending Station - also a whole station such as 4+00.

(3) Station Interval - any distance between consecutive stations. Usually 25 or 50 feet.

Before executing [CBEI] we need to decide first the beginning & ending stations, and also the station interval to be used. For example, we need to find the stations and elevations from the PVC (STA 1 + 00) thru the PVT (STA 3 + 00) using an interval of say, 50 ft.

Now press [CBE1] softkey

(SCREEN DISPLAY)

VERTICAL CURVE
Beg. STA? End. STA?
STA. INTERVAL?

Key the following:

100 [SPC] 300 [SPC] 50 [ENTER]

(SCREEN DISPLAY)

STA. 1 + 00.00
ELEV. = 225.00

NOTE: Press any key as often as necessary to view the rest of the output. Refer to INSTRUCTION "A" for exempted keys on page 5.4.

Use the [SPC] key in this example. The succeeding displays are the following:

STA. 1 + 50.00
ELEV. = 225.79

NOTE: If the Print Mode was activated before executing CBEI, all stations and elevations would have been printed automatically.

Press [SPC]

STA. 2 + 00.00
ELEV. = 225.60

Press [SPC]

STA. 2 + 50.00
ELEV. = 224.40

Press [+]

STA. 3 + 00.00
ELEV. = 222.22

Press [SPC]

Display ends.

**RUNNING THE [TBE1] ROUTINE** - This Routine is strictly used for finding the station and elevations on either Tangent leg of the curve, using any station interval. The execution of this Routine is similar to the **[CBE1]** routine for the Vertical Curve.

**EXAMPLE PROBLEM:**

**GIVEN:**

(1) Starting Station = 0 + 00.00
(2) Ending Station = 1 + 00
(3) Interval = 50

**FIND:** (1) Tangent Stations and Elevations based on the given data.

**STEPS:**

(1) Press **[TBE1]** softkey

**(SCREEN DISPLAY)**

TANGENT GRADE

Beg. STA? End. STA?

(2) Key the following:

0 **[SPC]** 100 **[ENTER]**

**(SCREEN DISPLAY)**

STA. INTERVAL?

(3) Key the following:

50 [ENTER]

(SCREEN DISPLAY)

STA. 0 + 00.00
ELEV. = 222.42

(4) Press any key to continue

Press the [SPC] key

(SCREEN DISPLAY)

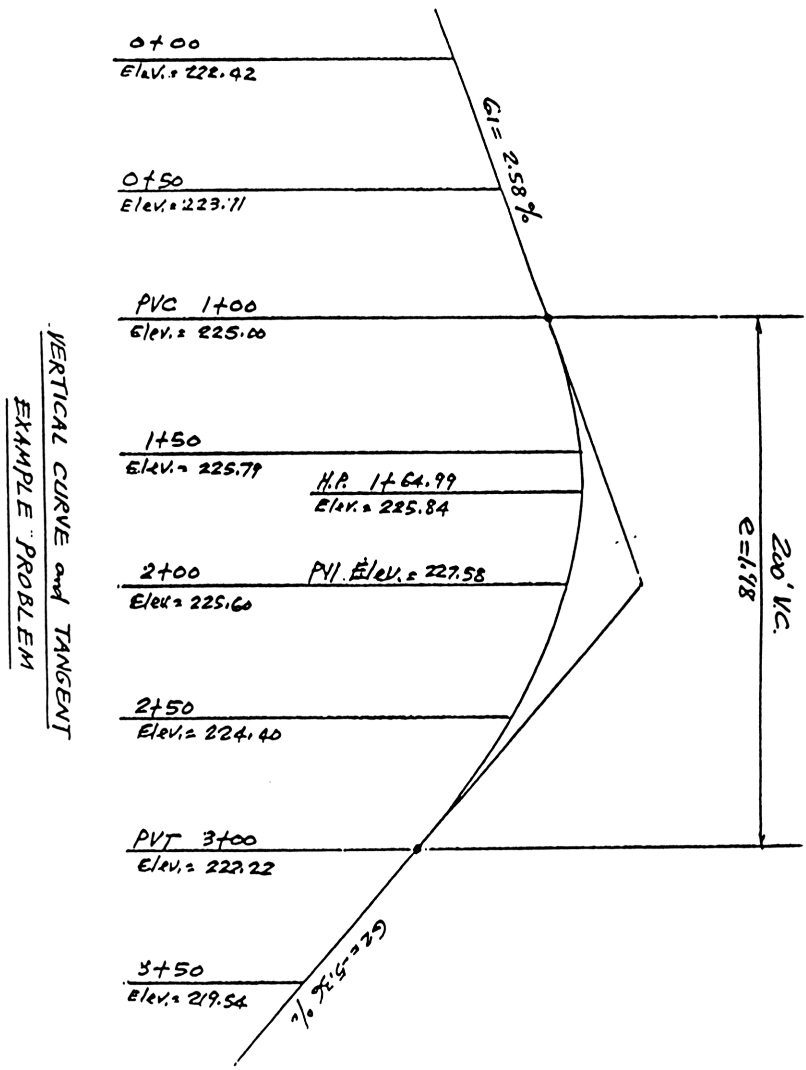
STA. 0 + 50.00
ELEV. = 223.71

(5) Press [SPC] key to continue.

(SCREEN DISPLAY)

STA. 1 + 00.00
ELEV. = 225.00

(6) Pressing the [SPC] key ends the routine.


VERTICAL CURVE and TANGENT
EXAMPLE PROBLEM
0+00
Elev. = 222.42
0+50
Elev. = 223.71
G1 = 2.58%
PVC 1+00
Elev. = 225.00
1+50
Elev. = 225.79
H.P. 1+64.99
Elev. = 225.84
2+00
Elev. = 225.60
PVI Elev. = 227.58
2+50
Elev. = 224.40
PVT 3+00
Elev. = 222.22
3+50
Elev. = 219.54
G2 = -5.36%
e = 1.98
200' V.C.

# HORIZONTAL CURVE LAYOUT PROGRAM

**DESCRIPTION:** Consisting of 2 curve layout methods; namely, the P.C. Deflection and the Tangent Offset Methods. The following are the lists of the Main Routines and their respective functions:

1. **HCL** - Stands for Horizontal Curve Layout. The purpose of this Routine is to accept input data for either the P.C. Deflection or Tangent Offset Method. This routine shall be the FIRST to be executed before all others. When you press its softkey to execute this routine, it will prompt for 3 things; namely, the Radius, the Delta, and the Station at the P.C. Output display will show the following:

   (1) Radius
   (2) Delta
   (3) Degree of Curve
   (4) P.C. Station
   (5) P.T. Station
   (6) P.I. Station

NOTE: A message will tell the user to enter the next station and branch out to either of the 2 curve layout methods.

2. **PCDF1** - Stands for P.C. Deflection One. Note that the user must enter the station first before pressing the PCDF1 softkey. Its main function is to accept any station within the curve in order to obtain the following output display:

(1) Station Value (station currently entered).

(2) Deflection Angle - angle between tangent line and current station.

(3) Long Chord - distance from P.C. to current station.

(4) Short Chord - distance between the previous station and the current station.

3. **PCDF2** - Pressing the PCDF2 softkey will prompt the user to enter the following input data:

(1) Starting Station

(2) Ending Station

(3) Interval - A fixed Separation distance between consecutive stations.

**NOTE:** Station, deflection angle, long chord, and short chord information are automatically computed and tabulated from the Starting Station thru the Ending Station selected.

4. **TOFF1** - Stands for Tangent Offset One.
Note that the user must enter the Station first before pressing the [TOFF1] softkey. Output will show the following:

(1) Station Value - current station entered.
(2) Tangent - distance from P.C. to current station along the tangent line.
(3) Offset - perpendicular distance from current station to tangent line.

5. **TOFF2** - Pressing the [TOFF2] softkey will prompt the user to enter the following input data:

(1) Starting Station
(2) Ending Station
(3) Interval - A fixed separation distance between consecutive stations.

**NOTE:** Tangent and offset information will be automatically computed from the starting station thru the ending station selected.

# HORIZONTAL CURVE LAYOUT - PROGRAM EXECUTION

## EXAMPLE PROBLEM:

## GIVEN:

Radius = 650.00
Delta = 21° 25' 42" (entered as 21.2542)
P.C. Station = 1 + 19.35 (entered as 119.35)
Station Interval = any station interval at the option of the user.

## REQUIRED:

(1) Curve layout using both P.C. Deflection and Tangent offset methods.

NOTE: The first key to press is the [HCL] softkey.

## STEPS:

1. Press the [HCL] softkey

(SCREEN DISPLAY)

Radius? Delta? PC Sta?

2. Enter the following:

650 [SPC] 21.2542 [SPC] 119.35 [ENTER]

(SCREEN DISPLAY)

RADIUS = 650.0000
DELTA = 21° 25' 42"
D.C. = 8° 48' 53"
PC STA 1 + 19.35
PT STA 3 + 62.4467
P1 STA 2 + 42.3352

Enter Next **STATION** then

Press [PCDF1] or [TOFF1]

**NOTE:** Select the P.C. Deflection method first.

3. Note that the first full station next to the PC Station (1 + 19.35) will be 1 + 25.

Press the following keys:

125 [PCDF1]

(SCREEN DISPLAY)

STA 1 + 25.00
Defl. Angle = 0° 14' 56"
Long chd. = 5.6500
Short chd. = 5.6500

4. Enter the next station = 1 + 50

   Press the following keys:

   150 [PCDF1]

   (SCREEN DISPLAY)

   STA 1 + 50.00
   Defl. Angle = 1° 21' 3"
   Long chd. = 30.6472
   Short chd. = 25.9985

**COMMENTS:** From this point on, the user can consecutively enter the Station or enter any station to obtain the same display as in Step No. 4. If the Long chord distances are used exclusively in a particular curve layout, the user can enter any station to obtain the Deflection angle and the distance from the P.C. to the current station. However, if the Short chord distances are used the input of the stations should be consecutive.

## RUNNING THE PCDF2 ROUTINE

The PCDF2 routine is used to automatically compute the Deflection angle, the Long chord and the Short chord distances from the starting station thru the ending station by specifying any station interval.

Let's say the starting station is 1 + 50 and the ending station is 3 + 50. The following are the **STEPS** to be followed when executing **PCDF2.**

## STEPS:

1. Press [PCDF2] softkey

   (SCREEN DISPLAY)

   Enter Starting, Ending

   Stations & Interval

2. Enter the following:

   150 [SPC] 350 [SPC] 50 [ENTER]

**NOTE:** Entering station values **NOT** inside the curve will result in an error message.

(SCREEN DISPLAY)

STA 1 + 50.00
Defl. Angle + 1° 21' 3"
Long chd. = 30.6472
Short chd. = 30.6472

**NOTE:** The next station to be displayed will be 2 + 00 since the interval chosen is 50. Press any key to continue. (Suggest using [SPC] key).

3. Press the [SPC] key.

(SCREEN DISPLAY)

STA 2 + 0.00
Defl. Angle = 3° 33' 16"
Long chd. = 80.5983
Short chd. = 49.9877

4. Repeat Step No. 3 until the last station (3 + 50) is reached.

**COMMENTS:** This ends the execution for PC Deflection. The execution of the Tangent Offset routines is similar to the PC Deflection routines except for the output.

## TANGENT OFFSET METHOD

Sample execution steps using the same input data for the P.C. Deflection method.

## RUNNING THE TOFF1 ROUTINE

STEPS:

1. Enter the following:

   125 [TOFF1]

   (SCREEN DISPLAY)

   STA 1 + 25.00
   Tangent = 5.6499
   Offset = 0.0246

2. Enter the next station 1+50:

   150 [TOFF1]

   (SCREEN DISPLAY)

   STA 1 + 50.00
   Tangent = 30.6386
   Offset = 0.7225

NOTE: Any station that falls within the horizontal curve limits can be a valid input; otherwise, the Routine will display an error message.

## RUNNING THE TOFF2 ROUTINE

STEPS:

1. Press [TOFF2] softkey

   (SCREEN DISPLAY)

   Enter starting, ending stations & interval

NOTE: For illustration purposes use Starting Sta. = 150, Ending Sta. = 350, Interval = 50.

2. Press the following keys:

   150 [SPC] [350 SPC] 50 [ENTER]

NOTE: Entering Station Values not inside the curve will result in the display of an error message.

(SCREEN DISPLAY)

STA 1 + 50.00
Tangent = 30.6386
Offset = 0.7225

3. Press any key to continue. Suggest using the [SPC] key.

   [SPC]

   (SCREEN DISPLAY)

   STA 2 + 0.00
   Tangent = 80.4432
   Offset = 4.9970

4. Press [SPC] key

   (SCREEN DISPLAY)

   STA 2 + 50.00
   Tangent = 129.7720
   Offset = 13.0862

5. Press the [SPC] key as often as necessary until the ending station is reached.

**NOTE:** Any starting and ending station and any chosen interval is valid input provided that these stations are within the limits of the Horizontal Curve; otherwise, an error message will be displayed.

# EARTHWORK

DESCRIPTION: Determining volume by average end area and station interval method. Both cross sectional areas must either be an **all cut** or an **all fill** section in order for the computed volume to be valid. The following are the 2 programs and their descriptions.

1. **[VOL1]** - Computes the volume of the initial 2 stations, or any 2 separate stations. Input data consist of the starting station, elevations and offsets defining the shape of the cross section.

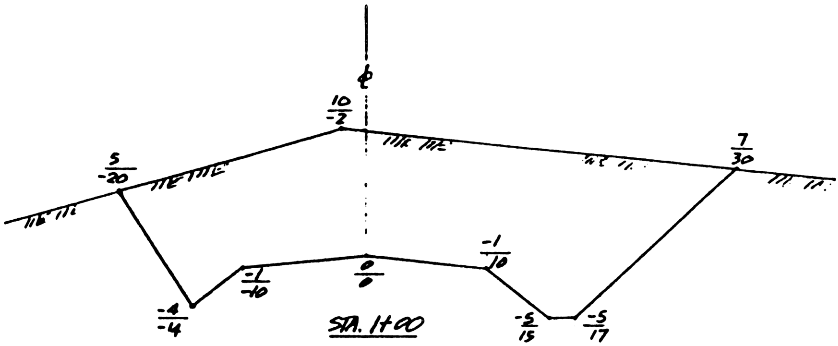
2. **[VOL2]** - Computes the volume between the last station in program "VOL1" and the next station entered in "VOL2". It also computes the accumulated volume from the starting station thru the last station entered in this program.

NOTE: **[VOL1]** shall be the **first** to be executed. It is only used ONCE for the initial 2 stations, while [VOL2] is used **repeatedly** as long as there are stations to be entered.

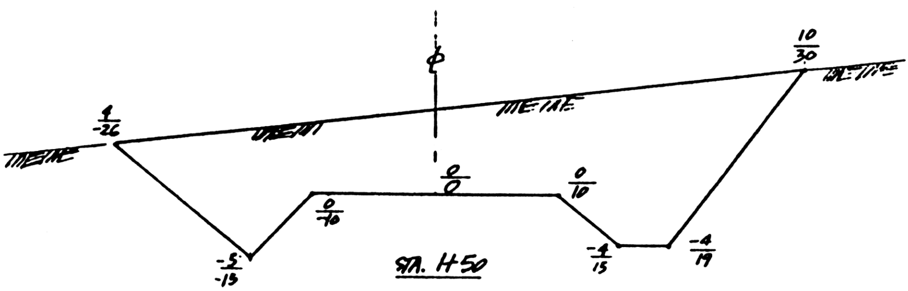
The following is a sample Earthwork Data, consisting of 3 all cut sections showing the elevations and offsets with respect to the centerline datum. The problem is to find the following:

(1) Volume between any 2 sections.
(2) Accumulated volume for the 3 sections.

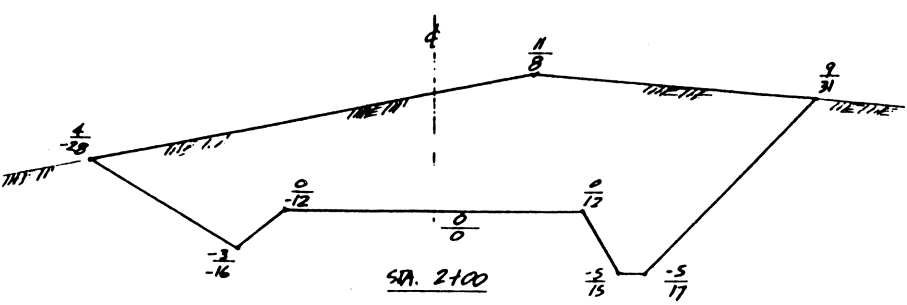
# EARTHWORK PROGRAM
## EXAMPLE PROBLEM




STA. 1+00




STA. 1+50




STA. 2+00

## STEPS FOR RUNNING THE EARTHWORK PROGRAM

1. Press the [VOL1] softkey.

   (SCREEN DISPLAY)

   Starting station?

2. Press the following:

   100 [ENTER]

   (SCREEN DISPLAY)

   ELEVATIONS? & OFFSETS?

3. Press the following:

   0 [SPC] 0 [SPC] 1 [+/-] [SPC] 10 [+/-] [SPC] 4 [+/-] [SPC] 14 [+/-] [SPC] 5 [SPC] 20 [+/-] [SPC] 10 [SPC] 2 [+/-] [SPC] 7 [SPC] 30 [SPC] 5 [+/-] [SPC] 17 [SPC] 5 [+/-] [SPC] 15 [SPC] 1 [+/-] [SPC] 10 [ENTER]

   (SCREEN DISPLAY)

   X - AREA = 436.00

   Press any key to cont.

**NOTE:** Elevations and offsets are entered separated by the space [SPC] key. The [ENTER] key is used to terminate data input.

(SCREEN DISPLAY)

NEXT STATION?

4. Press the following:

150 [ENTER]

(SCREEN DISPLAY)

ELEVATIONS? & OFFSETS?

5. Press the following:

0 [SPC] 10 [+/-] [SPC] 5 [+/-] [SPC] 15

[+/] [SPC] 4 [SPC] 26 [+/-] [SPC] 10 [SPC]

30 [SPC] 4 [+/-] [SPC] 19 [SPC] 4 [+/-]

15 [SPC] 0 [SPC] 10 [ENTER]

(SCREEN DISPLAY)
X - Area = 403.00
Press any key to cont.

(SCREEN DISPLAY)
Cu. Ft. = 20975.00
Cu. Yd. = 776.85

NOTE: If there are more than 2 sections to be entered, the next Routine [VOL2] shall be used repeatedly until the last section is reached.

6. Press the [VOL2] softkey.

(SCREEN DISPLAY)

NEXT STATION?

7. Press the following:

200 [ENTER]

(SCREEN DISPLAY)

ELEVATIONS? & OFFSETS?

8. Press the following:

0 [SPC] 12 [+/-] [SPC] 3 [+/-] [SPC] 16 [+/]
[SPC] 4 [SPC] 28 [+/-] [SPC] 11 [SPC] 8
[SPC] 9 [SPC] 31 [SPC] 5 [+/-] [SPC] 17
[SPC] 5 [+/-] [SPC] 15 [SPC] 0 [SPC] 12
[ENTER]

**(SCREEN DISPLAY)**

X - AREA = 489.50

Press any key to cont.

(SCREEN DISPLAY)

Cu. Ft. = 22312.50
Cu. Yd. = 826.39

**COMMENTS:** Volume between STA 1 + 50 & STA 2 + 00.

T. Cu. Ft. = 43287.50
T. Cu. Yd. = 1603.24

**COMMENTS:** Total accumulated volume from STA 1 + 00 thru Station 2 + 00.

**NOTE:** If there are some more stations and sections to be entered, repeat **Step No. 6** above.

# OPEN CHANNEL - DITCH DESIGN FOR TRAPEZOIDAL, V-SHAPE, AND RECTANGULAR SECTION

**PROGRAM NAME: DITCH**

**DESCRIPTION:** Consist of 9 routines applicable to the 3 types of sections as mentioned above. The equations used in these routines are derived from Manning's Open Channel formula and the Hydraulic continuity formula. When executed all these routines will **PROMPT** the user for the required input data. The following are the variables used in entering these data and its description:

(1) Q = Rate of flow of water carried by the channel in cubic feet per second (cfs).

(2) V = Velocity of flow in feet per second (fps).

(3) n = Manning's Roughness Coefficient (no unit) varies with the type of material used in channel's lining.

(4) S = Slope along the Channel's length in percent.

(5) W = Width of the bottom of the channel in feet
W = O for a V-shape section.

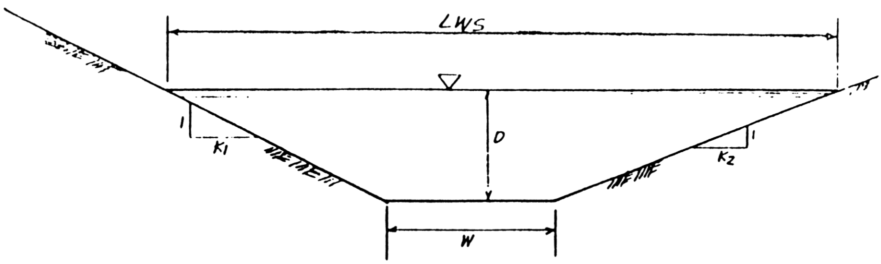
(6) **D** = Depth of flow (in feet) or height between the bottom of the channel and the water surface.

(7) **K1** = Horizontal component of the left side slope (no unit) with the vertical component equal to 1.

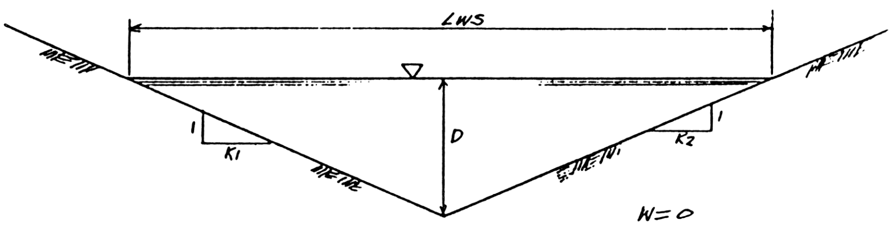
(8) **K2** = Horizontal component of the right side slope (no unit) with the vertical component equal to 1. K1 & K2 are entered as zero for Rectangular. Section.

(9) **LWS** = Length of the Water Surface in feet measured across the width of the channel.

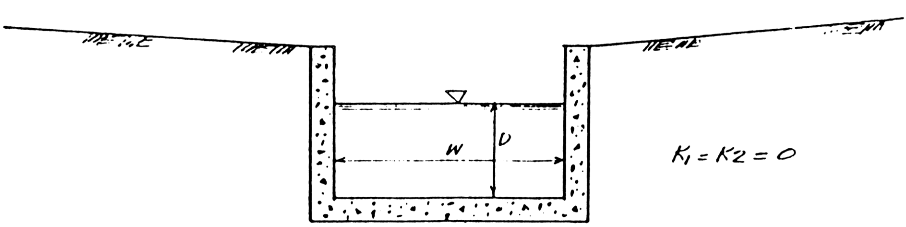
OPEN CHANNEL SECTIONS




TRAPEZOIDAL




V- SHAPE




RECTANGULAR

The following are the 9 Routines used for solving and setting variables. Please note that the first 3 letters in each Routine's name correspond to the 3 variables being solved. For example, the Routine VSLQ will compute the Velocity of flow (V), the Slope (S) of the Channel and Length of Water Surface (LWS). The last letter Q is one of the given variables used in the solution.

(1) **QVLD** - Solves for: **Q, V, & LWS**
Given: **D, n, S, W, K1 & K2**

(2) **QSLV** - Solves for: Q, S, & LWS
Given: V, D, n, W, K1 & K2

(3) **QWLV** - Solves for: Q, W, & LWS
Given: V, n, S, D, K1 & K2

(4) **QDLV** - Solves for: Q, D, & LWS
Given: V, n, S, W, K1 & K2

(5) **VSLQ** - Solves for: V, S, & LWS
Given: Q, D, n, W, K1 & K2

(6) **VWLQ** - Solves for: V, W, & LWS
Given: Q, n, S, D, K1 & K2

(7) **VDLQ** - Solves for: V, D, & LWS
Given: Q, n, S, W, K1 & K2

(8) **SWLQ** - Solves for: S, W, & LWS
Given: Q, V, n, D, K1 & K2

(9) **SDLQ** - Solves for: S, D, & LWS
Given: Q, V, n, W, K1 & K2

## RUNNING THE DITCH PROGRAM

All the Routines included in the Ditch Program will prompt for the required input data. There are 6 input data that must be entered in the same sequence as the displayed prompt. These data are entered continuously and must be separated either by a comma or a space. After the last data is typed, press **[ENTER]** to end data entry. Allow approximately 5 to 10 seconds before the output data is displayed.

## Example Problem No. 1

Given the following input data:

Q = 100 cfs Rate of flow in a Trapezoidal Channel
n = 0.03 (stone rip rap lined channel)
S = 1% slope along length of channel
W = 5 bottom width
K1 = 3 left side slope (3:1)
K2 = 4 right side slope (4:1)

**FIND:**

(1) V = ? Velocity of flow
(2) D = ? Depth of flow
(3) LWS = ? Length of water surface

**STEPS:**

(1) Press [VDLQ] softkey.

**(SCREEN DISPLAY)**

Q? n? S?(%) W? K1? K2?

(2) Press the following keys:

100 [SPC] .03 [SPC] 1 [SPC] 5 [SPC]

3 [SPC] 4 [ENTER]

(SCREEN DISPLAY)

| | |
|---|---|
| Q (cfs): | 100.00 |
| n: | 0.03 |
| S(%): | 1.00 |
| B. WIDTH(ft): | 5.00 |
| RT. SS: | 3.00 |
| LT. SS: | 4.00 |
| DEPTH(ft): | 1.73 |
| V(fps): | 5.23* |
| LWS(ft): | 17.10 |

END OF RUN

*Degree of accuracy of the displayed results can be carried to more than 2 decimal places, say 4, by pressing the following keys:

⮢ [MODES] 4 [FIX] ⮣ [MENU]

## Example Problem No. 2

Given the same input data in Example Problem No. 1 find the Velocity of flow (V), Depth of flow (D), and the Length of water surface (LWS) for a **V-SHAPE** Ditch Section.

**NOTE:** W = O in a V-Shape Section

**STEPS:**

1. Press **[VDLQ]** Softkey

   **(SCREEN DISPLAY)**

   Q? n? S?(%) W? K1? K2?

2. Press the following keys:

   100 **[SPC]** .03 **[SPC]** 1 **[SPC]** 0 **[SPC]**

   3 **[SPC]** 4 **[ENTER]**

   **(SCREEN DISPLAY)**

| | |
|---|---|
| Q(cfs): | 100.00 |
| n: | 0.03 |
| S(%): | 1.00 |
| B. WIDTH(ft): | 0.00 |
| RT. SS: | 3.00 |
| LT. SS: | 4.00 |
| DEPTH(ft): | 2.32 |
| V(fps): | 5.32 |
| LWS(ft): | 16.22 |

## Example Problem No. 3

Given the same input data in Example Problem No. 1 find the following using a Rectangular Ditch Section:

(1) Velocity of flow (V)
(2) Depth of flow (D)
(3) Length of water surface (LWS)

**NOTE:** In a rectangular section both side slopes are vertical; therefore, K1 = K2 = O and the length of water surface is the same as the bottom width or LWS = W

STEPS:

(1) Press **[VDLQ]** softkey

(SCREEN DISPLAY)

Q? n? S?(%) W? K1? K2?

(2) Press the following keys:

100 **[SPC]** .03 **[SPC]** 1 **[SPC]** 5 **[SPC]**

0 **[SPC]** 0 [ENTER]

**(SCREEN DISPLAY)**

| | |
|---|---|
| Q(cfs): | 100.00 |
| n: | 0.03 |
| S(%): | 1.00 |
| B. WIDTH(ft): | 5.00 |
| RT. SS: | 0.00 |
| LT. SS: | 0.00 |
| DEPTH(ft): | 3.22 |
| V(fps): | 6.22 |
| LWS(ft): | 5.00 |

END OF RUN

NOTE: To run another Routine whose name does not show in the current menu, press the **[NXT]** key until that Routine's name appears then press the softkey directly below it.

# MISCELLANEOUS HYDRAULIC PROGRAMS

## PROGRAM NAME: "HYDRA"

**DESCRIPTION:** Consist of 12 miscellaneous programs, 9 of which pertain to the analysis of any Pipe flowing Full or Partially Full. The other 3 are independent programs for determining the Time of Concentration for overland flow, Rate of Run-off calculation using the Anderson Method, and Design of pipe culverts.

## PROGRAM NAME: "TMC"

**DESCRIPTION:** Program to determine the Time of Concentration on overland flow. This program uses the Kinematic Wave Formula and can be used in lieu of the Nomograph. This program is intended only as an aid in computing for the time of concentration, and it is up to the designer to select the correct values for the different parameters.

The following are the parameters involved in the formula:

Tc = Time of concentration in minutes
L = Length of strip in feet
n = Manning's roughness coefficient
i = Rainfall intensity in inches per hour
S = Slope in feet per feet

## RUNNING THE "TMC" PROGRAM

GIVEN DATA:

L = 500 feet
n = 0.20 (lawn surface)
i = 6.00 inches/hr.
S = 0.02 feet/feet

FIND: Tc

STEPS:

1. Press the [TMC] softkey

   (SCREEN DISPLAY)

   Rainfall intensity

   in inches per hour = ?

2. Press the following:

   6 [ENTER]

   (SCREEN DISPLAY)

   Length of strip

   in feet = ?

3. Press the following:

**500 [ENTER]**

**(SCREEN DISPLAY)**

Manning's n = ?

4. Press the following:

**.2 [ENTER]**

**(SCREEN DISPLAY)**

Slope in ft./ft. = ?

5. Press the following:

**.02 [ENTER]**

**(SCREEN DISPLAY)**

L (ft): 500.00
n: 0.20
I (in/hr): 6.00
S: 0.02
Tc (min): 23.28

END OF RUN

**PROGRAM NAME: "ANDR"**

**DESCRIPTION:** This program is used to determine the amount of storm discharge or run-off, and is applicable to urban developed and natural rural areas. The formula used in this program was developed by Daniel G. Anderson, U.S.G.S., Water Resources Division - 1968, and applies to drainage area up to 570 square miles.

It is assumed that the user of this program should have been familiar with the various parameters used in the Anderson Formula. For more information on this subject, please refer to the Drainage Manual, Virginia DOT, Page 1-35. A comprehensive text about the Anderson Method can be obtained from the U. S. Printing Office in Washington D.C. The title of this text is, "Effects of Urban Development on Floods in Northern Virginia", Geological Survey Water - Supply Paper 2001-C. Library of Congress, Catalog Card No. 74-608062.

The following example will illustrate the steps involved in the program execution:

**GIVEN DATA:**

(1) Elev. @ 85% of the channel length = 395.00 ft.

(2) Elev. @ 10% of the channel length = 282.00 ft.

(3) Length of channel (L) = 3.40 miles

(4) Area of drainage basin = 2.81 sq. miles

(5) Percentage of soil imperviousness = 40%

(6) Flood frequency ratio = 2.34 taken from a graph involving recurrence interval (25 years) percent impervious, (40%) and flood frequency ratio. (R)

(7) Use class B **(Developed Basin)** where Lag time (T)

is given by the formula

$$T = 0.9 \left( \frac{L}{\sqrt{S}} \right)^{0.5}$$

Where 0.50 is the exponent and 0.90 is the constant prompted in the input data.

## STEPS TO FOLLOW FOR PROGRAM EXECUTION

1. Press the softkey labeled "ANDR"

   (SCREEN DISPLAY)

   EL? (85% L) EL? (10% L)
   L? (in miles)

2. Type in the following:

395 [SPC] 282 [SPC] 3.4 **[ENTER]**

(SCREEN DISPLAY)

Expnt? Const?

NOTE: The above prompt refers to the exponent and the constant respectively in the formula for determining lag time, for a Class B or Developed Basin, shown on page 9.4

3. Type in the following:

0.5 [SPC] 0.9 [ENTER]

(SCREEN DISPLAY)

A? (sq. mi.) I? (%)

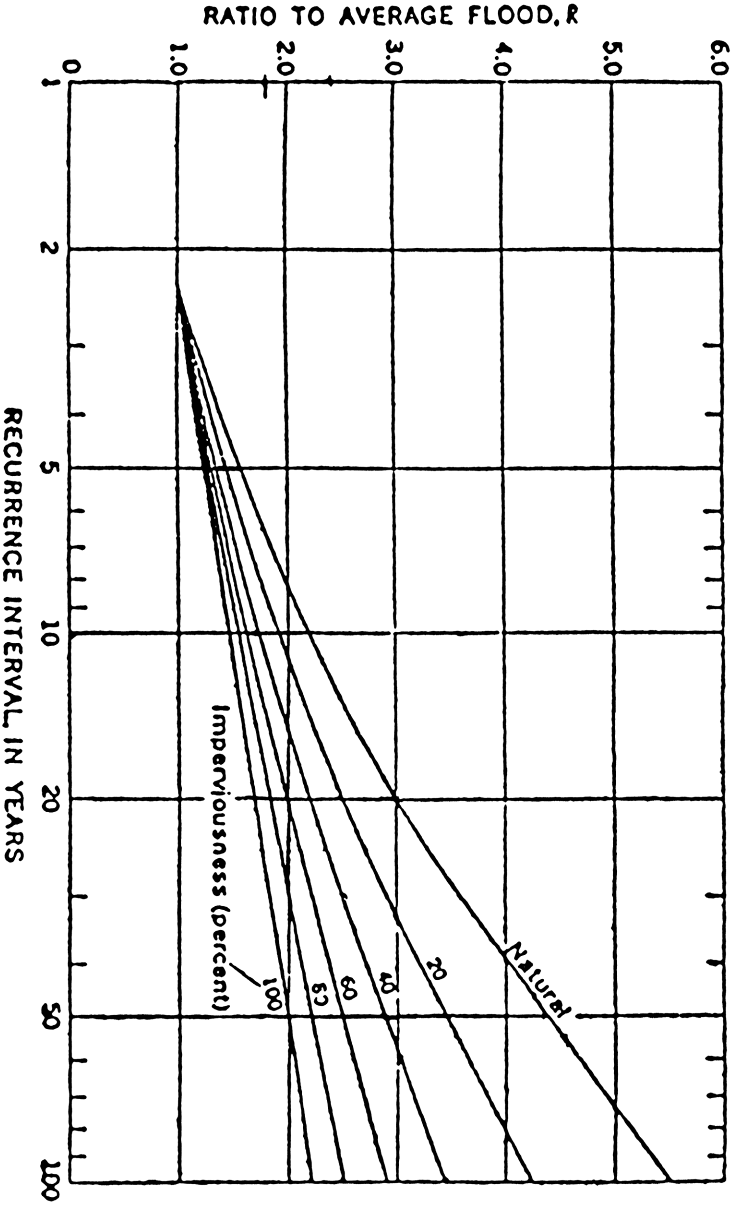



FIGURE 5.—Flood-frequency curves for selected degrees of basin imperviousness.

## ANDERSON METHOD FORMULA

A method used to determine PEAK DISCHARGE of a drainage basin up to 570 square miles in area. This method is applicable both in urban developed areas and in natural rural areas.

$$Q = 230\ RK(A)^{.82}\ (T)^{-.48}$$

Where:

$Q$ = Peak discharge in cfs at a given site usually along the lowest point of the watercourse.

$R$ = Flood frequency ratio, determined from a graph involving 2 other parameters, namely; (a) Recurrence interval in years (i.e. 25-year storm), (b) Area of impervious surface for the whole basin in percent.

$K$ = Coefficient of imperviousness. Expressed in a formula as

$$K = 1 + 0.015(I)$$

Where I is expressed as a percentage of the basin covered with impervious surface:

$A$ = Area of drainage basin in square miles, determined by planimeter or other means from a map

$T$ = Lag time in hours, defined as the average time between the centroids of rainfall excess and direct runoff. T varies with the type of basin being considered as follows:

(a) $T = 4.64\ (L/\sqrt{S})^{0.42}$ for natural rural basins

(b) $T = 0.90\ (L/\sqrt{S})^{0.50}$ for partially channeled developed basins

(c) $T = 0.56\ (L/\sqrt{S})^{0.52}$ for completely sewered & developed basins

$L$ = Total length of the stream or watercourse in miles within the limits of the drainage basin boundary. L is determined by scaling from a map.

$S$ = Slope of the bed of the stream in feet per mile. Defined as a ratio of the difference of the high and low elevations between 85% of L and 10% of L respectively over the difference between 85% of L and 10% of L. In formula form:

$$S = \frac{\text{Elev. @ 85\% of L} - \text{Elev. @ 10\% of L}}{\text{85\% of L} - \text{10\% of L}} \qquad S = \frac{EL_{85} - EL_{10}}{0.75L}$$

Where $EL_{85}$ = Elevation of stream bed at 85% of L determined from a topo map or actual field survey of the upper portion of the stream.

$EL_{10}$ = Elevation of stream bed at 10% of L determined from a topo map or actual field survey of the lower portion of the stream.

4. Type in the following:

   2.81 [SPC] 40 [ENTER]

   (SCREEN DISPLAY)

   R? (see graph)

NOTE: R = 2.34 was taken from the graph involving 2 parameters; namely, the Recurrence interval in years and Percent Imperviousness of the watershed. See page 9.51.

5. Type in

   2.34 [ENTER]

   (SCREEN DISPLAY)

   EL (85%L): 395.00
   EL (10%L): 282.00
   L (mi): 3.40
   A (sq mi): 2.81
   I (%): 40.00
   R: 2.34
   T (hrs): 0.64
   Q (cfs): 2483.11

COMMENTS: For a fully developed Basin (Class U) the exponent is 0.52 and the constant is 0.56. For Natural Basin, (Class N) exponent is 0.42 and the constant is 4.64. (See page 9.52 for details.)

PROGRAM NAME: "PIPES"

DESCRIPTION: Program to determine the size and the number of pipe culverts required to be installed under a roadway or an embankment so that the water level will not exceed a fixed Headwater depth (Hw) and a given Rate of flow (Q) from a storm run-off. This program eliminates most of the trial and error process in that any trial pipe size selected will always satisfy a given and fixed Headwater depth. For example, four 84-inch diameter pipes or three 108-inch diameter pipes will both satisfy a given rate of flow of Q = 2010 cfs and a headwater depth of HW = 12 feet. It is up to the designer to decide which size and number of pipes are best suited for the purpose. The actual Headwater depth and Velocity is computed based on the pipe size selected and the actual or rounded number of pipes. The use of a **NOMOGRAPH** is necessary to execute this program. See page 9.111.

The following is a sample problem to illustrate the steps for program execution:

GIVEN:

(1) Q = 2010 cfs.
(2) Hw = 12 ft.
(3) Trial pipe size = 84"

FIND:

(1) Actual number of 84" pipe
(2) Actual Headwater depth
(3) Actual Velocity of flow

## NOTES:

(1) Use square edge inlet control with Headwall Nomograph for Headwater depth for concrete pipe culverts.

(2) Nomograph used published by the Bureau of Public Roads, Jan. 1963, Headwater Scales 2 & 3 revised May 1964. (See page 9.111.)

## STEPS:

1. Press the **[PIPES]** softkey

   **(SCREEN DISPLAY)**

   (1) Q? (total)
   (2) Hw?
   (3) Trial D? (inches)

2. Type in the following:

   2010 **[SPC]** 12 [SPC] 84 [ENTER]

   **(SCREEN DISPLAY)**

   Hw/D = 1.71

   Key **ENTER**

3. Press [ENTER] Key

(SCREEN DISPLAY)

Enter Q (fr. graph)
Using Hw/D obtained

NOTE: From the nomograph, a Q of 510 cfs is obtained using Hw/D = 1.71 and Pipe Size = 84"

4. Press the following:

510 [ENTER]

(SCREEN DISPLAY)

Pipes required = 3.94

Press any key to cont.

5. Press any one key, say the [+] key

(SCREEN DISPLAY)

Actual no. of Pipes?

6. Press the following:

   **4 [ENTER]**

   **NOTE:** The theoretical number of pipes required was 3.94. Therefore, this should be rounded up to the next higher whole pipe number which is 4.

   **(SCREEN DISPLAY)**

   Qa = 502.50

   Key ENTER

7. Press the **[ENTER]** Key

   **(SCREEN DISPLAY)**

   Enter **Hw/D** (fr. graph)

   Using actual Qa

   **NOTE:** Referring to the same nomograph, use Q = 502.50 and Pipe Size = 84" to obtain Hw/D = 1.68

8. Press the following:

1.68 [ENTER]

(SCREEN DISPLAY)

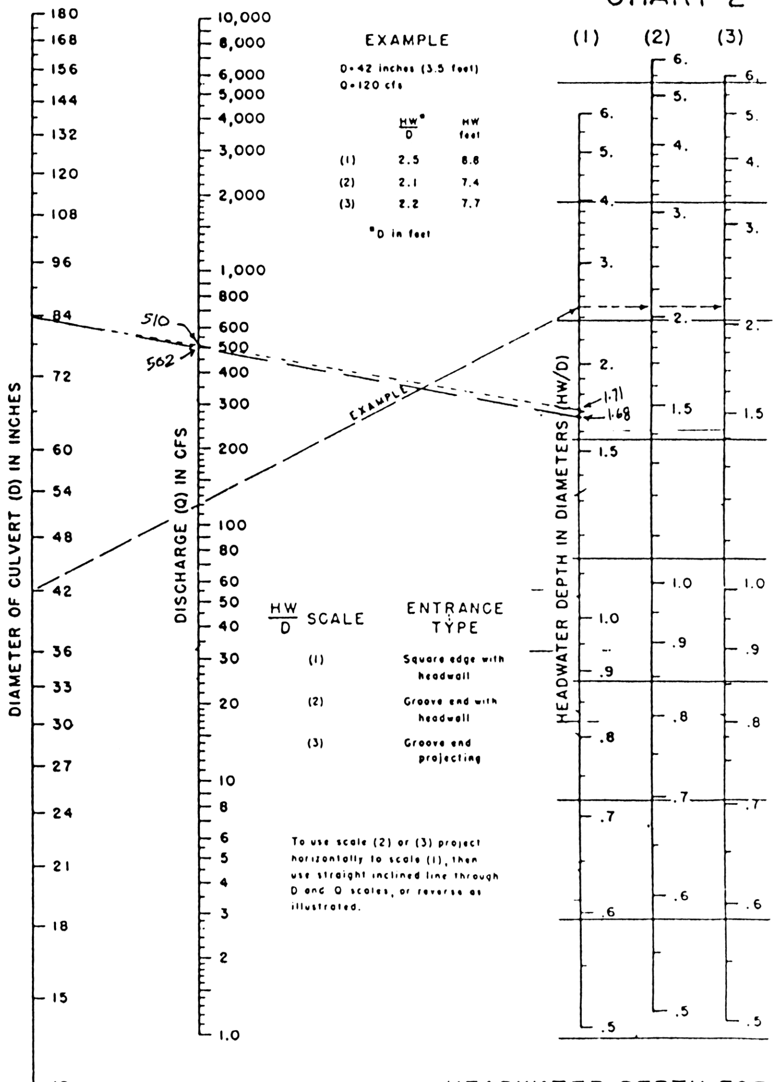
Q (cfs): 2010.00
Max. Hw (ft): 12.00
DIAM (in): 84.00
PIPE No.: 4.00
HWa (ft): 11.76
Vel (fps): 13.06

END OF RUN

COMMENTS:

Any pipe size selected by the user will always satisfy the given Q and Hw depth. The Headwater obtained as shown in the preceding example will not exceed the given Headwater as long as the number of pipes obtained is rounded up to the next higher whole number. The actual Headwater obtained: Hw = 11.76 is less than the given Headwater of 12.00.

CHART 2




HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

# PIPES FLOWING FULL and PARTIALLY FULL

**DESCRIPTION:** There are 9 Routines available for solving and setting variables used in the design of pipes. The equations used in these routines were derived from the Manning's Formula and are not applicable to fluid flow in pipes under pressure. All these Routines when executed will prompt the user for the necessary input data. The following are the Variables used in entering these data and their Descriptions:

(1) **Q** = Rate of flow carried by the pipe flowing full or partially full in cubic feet per second (cfs).

(2) **V** = Velocity of flow in feet per second (fps).

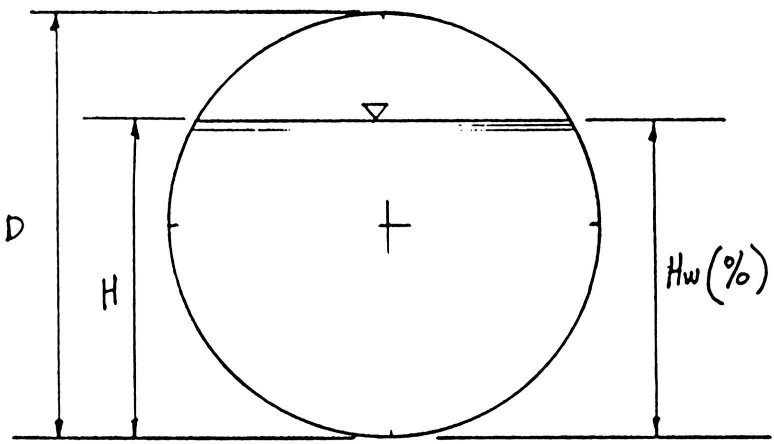
(3) **n** = Manning's Roughness Coefficient (no units) varies with the type of material used in the pipe's lining.

(4) **S** = Slope along the pipe's length in percent (%).

(5) **Hw** = Height of water or fluid inside the pipe expressed as a ratio of that height and the pipe's inside diameter in **PERCENT**, or **Hw** is equal to the height over the diameter times 100. When prompted by the Routine to input **Hw**, the user should enter a value ranging between 1 and 100 percent. An entry of **Hw = 100** indicates that the pipe is **FLOWING FULL.**

(6) **D** = Diameter of pipe in inches.

**NOTE:** Any 2 of the 6 variables except **n** can be determined if the remaining 4 are given or are assigned values. The names of these Routines consist of 4 letters, and these letters correspond to the 4 given variables being used to solve for the missing 2 variables. For example, the Routine **"QHSN"** indicates that the Rate of flow (**Q**), Height of water in percent (**Hw**), Slope in percent (**S**), and Manning's Roughness Coefficient (**n**), are variables whose given values will solve for the 2 variables. These 2 variables are Velocity of flow (**V**) and Diameter of pipe in inches (**D**).




PARTIAL FLOW IN A PIPE

$$Hw = \frac{H}{D} 100$$

WHERE:

H = Height or depth of fluid flowing inside the pipe
D = Inside Diameter of Pipe
Hw = Ratio of the depth over the pipe's diameter multiplied by 100 expressed in percent

NOTE: Both H and D should have the same units.

The following is a list of the Routines and the variables being solved and given:

(1) **QVDN** - Solving for: S & Hw Given: Q, V, D, & n

(2) **QVHN** - Solving for: S & D Given: Q, V, Hw, & n

(3) **QSDN** - Solving for: V & Hw Given: Q, S, D, & n

(4) **QHSN** - Solving for: V & D Given: Q, H, S, & n

(5) **QDHN** - Solving for: V & S Given: Q, D, H, & n

(6) **VSDN** - Solving for: Q & Hw Given: V, S, D, & n

(7) **VHSN** - Solving for: Q & D Given: V, H, S, & n

(8) **VDHN** - Solving for: Q & S Given: V, D, H, & n

(9) **DHSN** - Solving for: Q & V Given: D, H, S, & n

## RUNNING THE PIPE PROGRAMS

All the Pipe Routines listed above can be executed by pressing their respective softkeys (keys labeled A thru F) found directly below each Routine's name. When a softkey is pressed, the routine will prompt for the necessary input data. These data must be supplied in the same sequence as they were prompted and must be entered continuously, separated only by either a [SPC] key or a comma (,). After the last data is typed, the [ENTER] key is pressed. Allow approximately 5 to 10 seconds before the output data is displayed.

## Example Problem No. 1

Using the [DHSN] Routine

**GIVEN:**

(1) Diameter of Pipe (D) = 24 inches
(2) Ratio of Height over Diameter (Hw) = 90%
(3) Slope (S) = 1.55%
(4) Manning's Roughness Coeff. (n) = 0.013

**FIND:**
(1) Rate of flow (Q)
(2) Velocity of flow (V)

**STEPS:**
(1) Press [DHSN]

(SCREEN DISPLAY)

D? (in) Hw?(%) S?(%) n?

(2) Press the following keys:

24 [SPC] 90 [SPC] 1.55 [SPC]
.013 [ENTER]

(SCREEN DISPLAY)
D (in): 24.00
Hw (%): 90.00
S (%): 1.55
n: 0.013
V (fps): 10.08
Q (cfs): 30.02
END OF RUN

## Example Problem No. 2

Using the [VDHN] Routine

Given the same data as in Example Problem No. 1

**Solving For:** Q in cubic feet per second and Slope in percent

**STEPS:**

(1) Press **[VDHN]** softkey

**(SCREEN DISPLAY)**

V = ? D = ? (in) Hw = ?(%) n?

(2) Press the following keys:

10.08 **[SPC]** 24 **[SPC]** 90 **[SPC]**

.013 **[ENTER]**

**(SCREEN DISPLAY)**

V (fps): 10.08
D (in): 24.00
Hw (%): 90.00
n: 0.013
Q (cfs): 30.02
S (%): 1.55

END OF RUN

## Example Problem No. 3

Using the [VHSN] Routine

Given the same data obtained in Example Problem No. 1

**Solving for:** Rate of flow (Q) and Diameter (D)

**STEPS:**

(1) Press **[VHSN]** softkey

**(SCREEN DISPLAY)**

V = ?    Hw = ?(%)    S = ?(%)    n = ?

(2) Press the following keys:

10.08 **[SPC]** 90 **[SPC]** 1.55 **[SPC]** .013 **[ENTER]**

**(SCREEN DISPLAY)**

V (fps): 10.08
Hw (%): 90.00
S (%): 1.55
n: 0.013
Q (cfs): 30.02
D (in): 24.00

END OF RUN

NOTE: Repeat Problem No. 3 with the same data but change Hw = 100% (Pipe is flowing full).

GIVEN: V = 10.08 Hw = 100 S = 1.55 n = .013

(SCREEN DISPLAY)

V (fps): 10.08
Hw (%): 100.00
S (%): 1.55
n: 0.013
Q (cfs): 45.01
D (in): 28.61 ←
(use 30" pipe)

END OF RUN

NOTE: To run another Routine whose name does not show in the current menu, press the [NXT] key until that Routine's name appears then press the softkey directly below it.

## Other Surveying Cards Available:

### 48BC Basic Coordinate Geometry Surveying Card

- Stores 1200 points by point number without additional memory.
- Compute curves and intersections.
- Translate, rotate and scale any set of points.
- Compute perpendicular offset from a line.
- Compass rule adjustment.
- Compute acres, square feet, and perimeter by point number.

### 48SC Standard Coordinate Geometry Surveying Card

Contains all of the features of the 48BC plus the following features:

- Built in sunshot program that develops its own ephemeris.
- Store elevations as well as coordinates.
- The stake program gives GO and COME values. If elevations are on it gives CUT and FILL.
- Pre-determined area by hinge and slide method.
- ASCII data to PC.

### 48AC Advanced Coordinate Geometry Surveying Card

Contains all of the features of the 48AC plus the following features:

- Notes and /or codes.
- Angle adjustment including side shots.
- Compass rule adjustment including side shots.
- Mean reciprocal leveling from both ends of a line.
- An offset program for road centerline offsets etc.
- Stake a line from a remote point.
- ASCII files to or from PC in 41S, 48S, space, or comma format.

### 48DC Data Collection for Land Surveyors

Includes hardware and software. Contains all of the features of the 48AC plus the following features:

- Both manual and electronic data collection.
- Electronically collects data from Lietz, Nikon's Top Gun, Topcon, Wild and Zeiss Electronic Total Stations.
- Hardware included: HP 48SX, tripod mount, environmental case, cable to PC, cable to Instrument. Video training tape, overlay and manuals.