MODEL I / MODEL III

TRS-80™ SURVEYING

CAT. NO.
26-1577

Radio Shack TRS-80 SOFTWARE™

CUSTOM MANUFACTURED IN USA BY RADIO SHACK, A DIVISION OF TANDY CORP.

Surveying

Radio Shack®
A DIVISION OF TANDY CORPORATION
FORT WORTH, TEXAS 76102

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10 9 8 7 6 5 4 3 2 1

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Introduction

This series of three program tapes will provide the surveyor and/or technician the ability to convert raw field data from the survey crew into a usefull coordinate system. The programs are designed for use with a TRS-80 Model I 16K Level II or Model III. The complete package consists of the following programs:

Enter Coordinates (Tapes 1, 2, and 3)
Store coordinates in memory, from keyboard entries.

Store or Load Coordinates (Tapes 1, 2, and 3)
Lets you save coordinates on a Data tape, or Load coordinates from tape.

Print Coordinates (Tapes 1, 2, and 3)
Prints all Point numbers, and the coordinates for each Point number.

Modify Point Numbers (Tapes 1, 2, and 3)
You can change the Point number of a pair of coordinates at any time.

Point to Point Traverse (Tapes 1, 2, and 3)
Used for side shots and for extending lines.

Traverse Closure (Tape 1)
Allows entry of raw Angles (or Bearings), and Distance, from field survey. Right deflection, left deflection, right or left Angles may be used. The Traverse may then be adjusted, using the Compass Method. After the Traverse is adjusted, the new coordinates are stored in memory. If a Traverse adjustment is not made, the unadjusted coordinates are stored.

Inverse (Tapes 1, 2, and 3)
Used to obtain Bearing and Distance between Points with known coordinates.

Bearing-Bearing Intersect (Tape 2)
Determines coordinates of the Point of Intersection of two known Bearings.

Distance-Distance Intersect (Tape 2)
Determines the coordinates of the Point of Intersection of two known Distances.

Bearing-Distance Intersect (Tape 2)
Determines coordinates of the Point of Intersection of a known Bearing and a known Distance.

Half-Angle (Tape 2)
Calculates the coordinates of a Point that lies on the opposite Point of Intersection of two pairs of parallel lines. The Distance between the pairs must be equal.

Arc and Curve Computations (Tape 2)
Computes the unknown values of curves if any two values are known. If desired, coordinates will be automatically computed and stored. Staking data is provided at any stationing desired.

Lot Areas — by Coordinates (Tape 3)
Determines the Area of a Closed Polygon, using the Coordinate Method.

Lot Areas and Inverses (Tape 3)
Computes the Area of a Closed Polygon by the Coordinate Method and provides the Bearing and Distance between Points. If a curve is encountered in the Polygon's perimeter, the curve's arc and radius is also provided.

The examples shown in Appendix B will be used to familiarize you with the program functions. Our beginning example will be a Traverse Closure using Example 1 on page 41.

A sketch should be made of the Traverse, with numbers assigned to each Point on the Traverse. The Point numbers must be in the range 1-190. It is best to start with number 10 as the first Point Number. This allows Points 1-9 to be repeatedly used for intermediate calculations. The Traverse Closure program will automatically increment the Point numbers (by one), beginning with the Point number at the end of the first leg of the Traverse.

It is assumed that you have a basic knowledge of surveying. This manual will not endeavor to teach that subject.

Some Important Notes Regarding the Program

Entering Points

This program will accept up to a maximum of 190 Points. Point numbers may range from 1 to 190.

Entering Bearings

Bearings must be entered as : N311424E
Leading zeros need not be entered.

For Example:

A Bearing of N 30-24-15 W is entered as : N3024 15W
A Bearing of N 19-12-00 E is entered as : N19120 0E
A Bearing of N 00-43-09 W is entered as : N4309W
(Remember, you don't need to enter leading zeros.)

Loading Instructions Model I/Model III

1. Turn on the TRS-80 Video Screen (Model I).

2. Turn on the TRS-80 Keyboard (or Model III).

3. Insert the Traverse Closure tape (Tape 1) in the cassette recorder. Rewind the tape to the start.

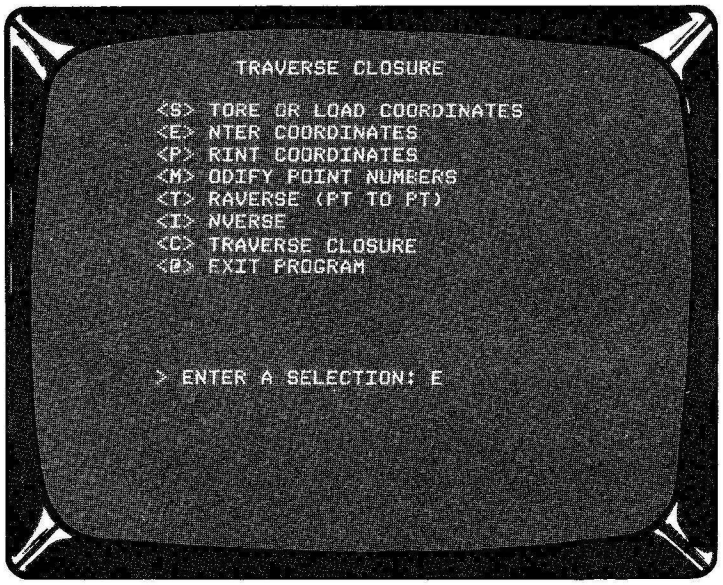
The screen will show:	You type:
Cass? (Model III only)	[L] and press [ENTER]
MEM SIZE? (Memory Size? — Mod III)	Press [ENTER]
READY	[C][L][O][A][D] and press [ENTER]

After the tape is rewound, press the "PLAY" button on the Cassette Recorder. Two asterisks will appear in the upper right corner of the screen. The right asterisk will blink if the program is loading correctly. When READY appears again, type [R][U][N] and press [ENTER].

Note: If the asterisks do not blink (or a D* appears), press the Reset button, and rewind the tape. Turn the cassette volume down a little, and repeat from the CLOAD instruction.

After the program is loaded, take the program tape out and put in a blank cassette to be used as a Data Tape.

The screen will show:



This is the Traverse Closure Program Menu. You can return to this menu at any time during the program by pressing the [@] key. Here is how you use each function:

Enter Coordinates (Using Example 1 on page 41)

Press [E].

The screen will show:

<M>ULTIPLE OR <S>INGLE ENTRY?

Since Point 10 is the only Point of known (or assumed) coordinates, press [S] for Single Entry. Type [1][0] as the Point number and press [ENTER]. The cursor (blinking block) will move to the right, and the program will request the North Coordinate. Type the coordinate value, using Feet or Meters. (Any measure may be used, but you must use the **same** measure for all entries.) Do not enter measurements using leading zeros. For example, 0423.45 feet should be entered as [4][2][3][.][4][5]. Type the North and East coordinates (1000 feet for each), pressing [ENTER] after each coordinate. Instead of entering the next Point Number, press the [@] key to return to the Program Menu. Point 10, and its coordinates, are now stored in the computer.

Traverse Closure and Adjustment

Press [C].

Now that the first Point number is stored, continue the example for completing a typical Traverse Closure. Since the Traverse closes upon itself, the coordinates for Point 10 are also the Ending coordinates. Press [Y] (the Beginning and Ending coordinates have already been stored).

The screen will show:	You type:
BEGINNING POINT	[1][0] and press [ENTER]
ENDING POINT	[1][0] and press [ENTER]
FIRST POINT IN TRAVERSE	[1][2] and press [ENTER]
NUMBER OF COURSES	[5] and press [ENTER]
<B>EARINGS OR <A>NGLES	[A] (Don't press ENTER)
IS REFERENCE BEARING PART OF TRAVERSE (Y/N)?	[N] and press [ENTER]

The reference bearing in our example is not included in the Traverse. The Beginning Bearing in Backsight direction (away from Point 10) is N 09-30-00 W. Remember you don't need the leading zeros, spaces, or dashes. Type [N][9][3][0][0][0][W] and press [ENTER].

The Ending Bearing in Foresight direction (away from Point 15) is N 70-00-00 W. Type [N][7][0][0][0][0][0][W] and press [ENTER]. The program will request the angles and the type of angle. Use Degrees, Minutes, and Seconds for the angles. The types of angles will be: (1) Right angle, (2) Left Deflection angle, (3) Right Deflection angle, (4) Left angle. Here are the angles for the example:

Angle	DDDMMSS	Type	
1	553010	1	Right (Clockwise)
2	990000	4	Left (Counterclockwise)
3	873000	3	Left Deflection (Counterclockwise)
4	2700010	1	Right (Clockwise)
5	1164950	4	Left (Counterclockwise)

The last angle is the closing angle:

6	1021910	1	Right (Clockwise)

After the last Angle Type is entered, the program will display the amount of Angular Error (in this case: – 20 seconds of Angular Error). Assume we made an error in Angle Number 1 which should have been 553015. Press [Y] to indicate you want to change an angle. All angles entered will appear on the screen. Press [ENTER] to continue. If you press [@], you will be returned to the Menu and all Traverse Closure data will have to be entered again.

Type [1] and press [ENTER] to correct Angle number 1. The old value and angle type will appear. Type the new value ([5][5][3][0][1][5]), and press [ENTER]. The angle type will stay the same, so press [1] for the Angle Type. This is the only correction required, so press the [@] key to return.

The Angular Error has been reduced to —15 seconds. Press [N] since the error is now acceptable for this example, and no more changes are required.

The computer will then ask if you wish angle adjustment. Since you did correct an angle, type [Y].

The program will now ask for the length of each of the 5 Courses. Enter the figures shown below:

LENGTH OF COURSE 1 : [3][0][5] and press [ENTER]

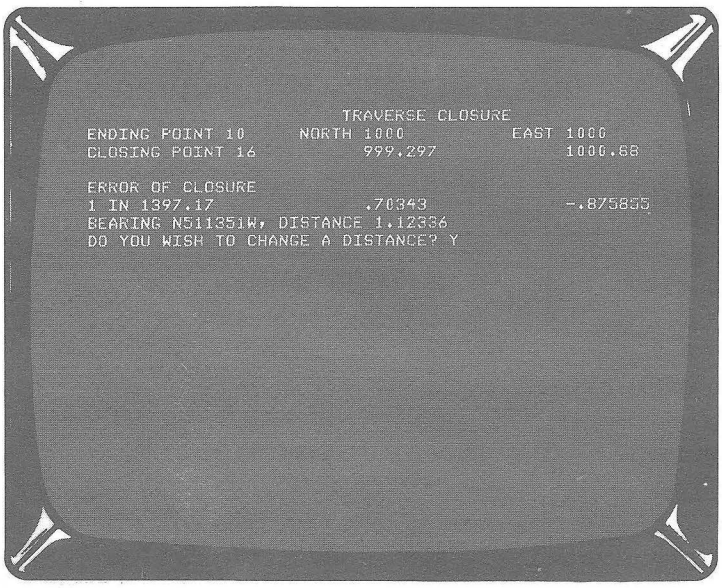
LENGTH OF COURSE 2 : [3][4][5][.][1] and press [ENTER]

LENGTH OF COURSE 3 : **4 2 7** and press **ENTER**

LENGTH OF COURSE 4 : **3 3 2 . 1** and press **ENTER**

LENGTH OF COURSE 5 : **1 6 0 . 3 2** and press **ENTER**

After you enter the length for the last course, the screen will show the following information:



The first line shows the Ending Point number and the coordinates to which the Traverse should close. The second line shows the Closing Point with the actual coordinates of Traverse. The Error of Closure is shown (in input units) below the third line. The last line of information shows the Bearing and Distance from Point 16 (the actual ending) to Point 10 (the desired ending).

The Closure is not acceptable, and a review of the data shows an error in entry of Distance 4 so press Y to change one of the distances.

Change Course 4 from 332.1 to 333.2 and press ENTER Press the @ key to leave this part. Press Y to rerun Closure.

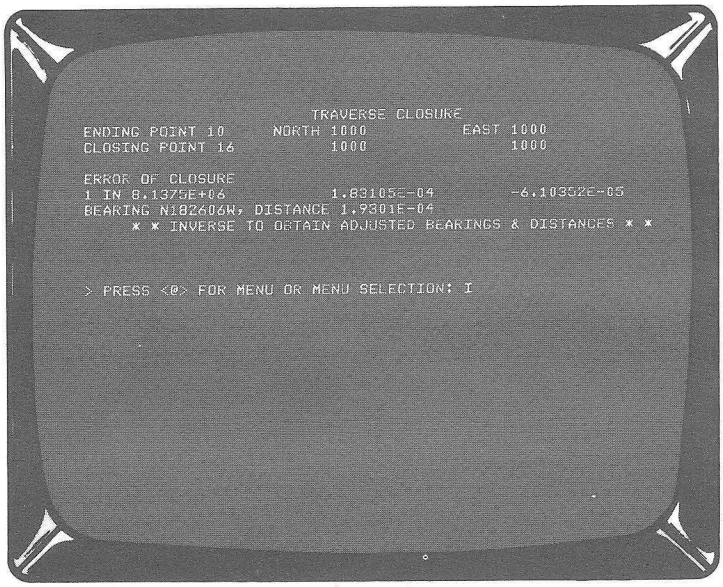
We can see the effect that changing the distance of Course 4 has had. The Error of Closure has been reduced significantly, and is now acceptable.

Press N when asked if you wish to change a distance to keep all the information as is.

Press N when asked if you want to rerun Closure.

We are now ready to adjust the Bearings and Distances. Press Y in answer to the adjustment question since a correction was made.

The screen will show:



You can now press [I] to obtain the adjusted Bearings and Distances, using the Inverse function.

Press [Y] (the coordinates are stored). Press [M] for Multiple Inverses. Start with the Inverse from Point 12. Type [1][2] and press [ENTER]. Now type [1][6] and press [ENTER]. The program will print out the Point to Point Bearings and Distances. After you have noted the adjusted figures, press [I] (for Inverse), again and we will complete the Traverse Closure section.

Since coordinates of points have already been entered, press [Y] when asked by the computer.

Press [S] for Single Inverse. You will Single Inverse from 10 to 12 and from 15 to 10. This provides the last required information of adjusted Bearings and Distances to complete the Traverse Closure. Press [@] to return to the Menu. Store the coordinates on a data tape for later use.

Press [@] to exit the program after you've stored the data. Remove the Traverse tape and CLOAD the Miscellaneous Computations tape.

For example:

If the first Point number is 10, and the end of the first Course is 23, the program assigns Point numbers as follows:

Beginning Point	:	10 (Entered by you)
End of First Leg	:	23 (Entered by you)
Next Point Number	:	24 (Assigned by the program)
Next Point Number	:	25 (Assigned by the program)
Etc.		

In computing Closures, the program assigns a number to the closing Point that is one number greater than the last Point on the Traverse.

For example:

If the last Course is from Point 45 to Point 10, then a temporary number of 46 will be assigned to the end of the Traverse. After the adjustment is made, this temporary number 46 is deleted.

DO NOT ASSIGN A COORDINATE POINT NUMBER GREATER THAN THE LAST NUMBER ON THE TRAVERSE UNTIL CLOSURE IS COMPLETE.

On page 38, Closure is made using the Compass Method. The formula for this method is as follows:

C = Correction to be applied
Ll = Length of course
Lt = Total length of traverse
EL = Total error in latitude
ED = Total error in departure

Correction to latitude of course: C = EL * Ll/Lt
Correction to departure of course: C = ED * Ll/Lt

With the Menu on the screen, type [S], and set up your data tape to load. Press [L] and enter [1][0] as the starting point and [1][5] as the ending point when prompted on the screen.

Inverse

Press [I].

Computes and displays Inverses between Points of known coordinates.

Multiple Inverses

If Multiple Inverse is desired, press [M]. Now enter the two Point numbers. Inverses are then automatically done for each consecutive pair of points. For Example: If Point numbers 10 and 12 are entered, Inverses are done for 10-11 and 11-12.

Single Inverses

If Single Inverse is desired, press [S]. An Inverse is performed between the two Points entered. For Example: If Point numbers 10 and 12 are entered, a Single Inverse is performed from Point 10 to Point 12. (See Figure 2 on page 35.)

Half-Angle (On Tape 2)

Press [H].

Determines the Angle and Distance from a Point of Intersection to the opposite Point of Intersection of equally-spaced, parallel lines. The coordinates of the opposite Point of Intersection are also computed. (See Figure 12 on page 40.)

Note: Point numbers must be entered in a clockwise direction.

Point to Point Traverse

Press [T].

Calculates coordinates for a Point, if the Bearing and Distance from another Point is given. In Single Traverse, the known Point number, and the new Point number, must be entered. In Multi-Traverse, the last new Point computed becomes the known Point. Only the new Point number is required. (See Figure 3 on page 35.)

Modify Point Number

Press [M].

Assigns the coordinates of an existing Point number to a new Point number. The coordinates of the existing Point number are set to 0.

Distance-Distance Intersect (On Tape 2)

Press [D].

Gives the Bearings of the Intersecting lines and the coordinates of the Point of Intersection of lines of known length. A Check Inverse is made for one line to check the accuracy of the Intersect.

It must be known whether the Point of Intersection lies left or right of a line from the first Originating Point to the second Originating Point. (See Figure 6 on page 37.)

The third side of the triangle is computed by Inversing between the known coordinates. With three sides of the triangle known, the formula:

$$\sin A = (2 * \text{square root } (s(s-a)(s-b)(s-c))/bc$$

is applicable. Once the Angles in the triangle are determined, the coordinates of the Intersection are computed.

Bearing-Distance Intersect (On Tape 2)

Press [X].

Finds the Bearing of the line of known Distance, the Distance of the line of known Bearing, and the coordinates of the Point of Intersection. A Check Inverse is made for the line of known Distance to check the accuracy of the Intersect.

It must be known whether the Point of Intersection is the closest or furthermost Point from the Point of Origin of the known Bearing. (See Figure 5 on page 36.)

An Inverse is performed between the known Points. This gives a triangle with 2 sides and an Angle. The formula for solving the remainder of the triangle is:

$$\text{Sin } B = b(\text{Sin } A)/a$$
$$C = 180 - (A + B)$$

Bearing-Bearing Intersect (On Tape 2)

Press [B].

Gives the Distances of lines of known Bearing to the Point of Intersection and the coordinates of the Point of Intersection. A Check Inverse is made for one line to check the accuracy of the Intersect. Bearings must be entered in the direction asked. (See Figure 4 on page 36.)

The Distance between the known Points is obtained by Inverse and the formula for triangles with 2 Angles and included side is used. This formula is:

$$b = a/\text{Sin } A * \text{Sin } B$$
$$c = a/\text{Sin } A * \text{Sin } C$$

Arc and Curve Computations (On Tape 2)

Press [A].

Determines the unknown values of curve data if any two values are known. If coordinates are known of the Point of Intersection, and a Point on each of the two Lines of Tangency, only one value need be known.

If the Coordinate Method is used, the coordinates of the Point of Curvature, Point of Tangency, and the Center Point of the Curve are computed. The appropriate trigonometrical formula is applied to compute the unknowns, depending on the information given.

After the computation of the curve data, staking information may be obtained for arcs of equal length or unequal length. The Deflection Angle from the Point of Curvature and the Chord Distance is given for each arc length. (See Figure 7 on page 37.)

Lot Areas (On Tape 3)

Press [R].

Finds the Area of a Closed Polygon, using the Coordinate Method. (See formula.) Point numbers are entered clockwise. If a curve is encountered in the perimeter, the first Point number on the curve is entered, then the Point number of the Center of the Curve is entered (with the suffix C), then the last Point number on the curve is entered. Enter [0] after the last Point number on the Perimeter. The Area of the Polygon is given in square feet and acres.

Lot Areas and Inverses (On Tape 3)

Press [L].

Gives Bearings, Distances, and Arc Lengths for the Perimeter of a Polygon, along with the Area. It uses the Area Program as a subroutine. Enter [0] after the last Point number on the Perimeter has been entered.

Appendix A — Accuracy

Accuracy

The algorithms used for computation of sines and cosines produce some error near three of the Cardinal directions. The accuracy limits are as follows:

Sin 0° to 0°0′41″ — accurate to three decimal places
Sin 179°59′18″ to 180° — accurate to three decimal places
Sin 359°59′57″ to 360° — accurate to four decimal places
Cos 89°59′57″ to 90° — accurate to four decimal places
Cos 269°59′18″ to 270° — accurate to three decimal places

The computation for Arcsine and Arccosine produces the following errors.

Arccos .99999 — error is 07″
Arccos .999999 — error is 27″
Arccos .99999999 — error is 02′04″
Arcsin .99999 — error is 07″
Arcsin .999999 — error is 24″
Arcsin .99999999 — error is 02′04″

The accuracy of Level II Basic is six significant figures. To obtain second decimal accuracy, input must be limited to four places left of the decimal point.

Appendix B — Sample Run

Load Traverse Closure tape.

```
                    TRAVERSE CLOSURE

            <S> TORE OR LOAD COORDINATES
            <E> NTER COORDINATES
            <P> RINT COORDINATES
            <M> ODIFY POINT NUMBERS
            <T> RAVERSE (PT TO PT)
            <I> NVERSE
            <C> TRAVERSE CLOSURE
            <@> EXIT PROGRAM



            > ENTER A SELECTION: E
```

```
                    ENTER COORDINATES
<M>ULTIPLE OR <S>INGLE ENTRY? S
```

```
                    SINGLE ENTRY
POINT NUMBER     NORTH COORDINATE     EAST COORDINATE
    10                1000                 1000
    @
```

```
                    TRAVERSE CLOSURE

            <S> TORE OR LOAD COORDINATES
            <E> NTER COORDINATES
            <P> RINT COORDINATES
            <M> ODIFY POINT NUMBERS
            <T> RAVERSE (PT TO PT)
            <I> NVERSE
            <C> TRAVERSE CLOSURE
            <@> EXIT PROGRAM



            > ENTER A SELECTION: C
```

```
                    TRAVERSE CLOSURE

ARE BEGINNING AND ENDING COORDINATES ENTERED? Y
```

```
                    TRAVERSE CLOSURE

BEGINNING POINT                    : 10
ENDING POINT                       : 10
FIRST POINT IN TRAVERSE            : 12
NUMBER OF COURSES                  : 5
<B>EARINGS OR <A>NGLES             : A
IS REFERENCE BEARING PART OF TRAVERSE (Y/N) ?N
INITIAL BEARING - BACKSIGHT DIRECTION    : N93000W
CLOSING BEARING - FORESIGHT DIRECTION    : N700000W
```

```
                    TRAVERSE CLOSURE
      1=RIGHT, 2=LEFT DEFL, 3=RIGHT DEFL, 4=LEFT
              ANGLE        DDDMMSS    TYPE
                 1         553010       1
                 2         990000       4
                 3         873000       3
                 4         2700010      1
                 5         1164950      4
                 6         1021910      1
```

```
                    TRAVERSE CLOSURE

ANGULAR ERROR IS 0 : 0 :-20

DO YOU WISH TO CHANGE AN ANGLE? Y
```

```
                    TRAVERSE CLOSURE
          ANGLE    1= 553010 TYPE 1
          ANGLE    2= 990000 TYPE 4
          ANGLE    3= 873000 TYPE 3
          ANGLE    4=2700010 TYPE 1
          ANGLE    5=1164950 TYPE 4
          ANGLE    6=1021910 TYPE 1


PRESS <ENTER> TO CONTINUE, @ TO EXIT [ENTER]
```

```
                    TRAVERSE CLOSURE
     1=RIGHT, 2=LEFT DEFL, 3=RIGHT DEFL, 4=LEFT
        ANGLE        OLD              NEW
                  VALUE/TYPE     VALUE/TYPE
          1     553010/1       553015 /1
          @
```

```
                    TRAVERSE CLOSURE

ANGULAR ERROR IS 0 : 0 :-15

DO YOU WISH TO CHANGE AN ANGLE? N
```

```
                    TRAVERSE CLOSURE

DO YOU WISH ANGLE ADJUSTMENT? Y
```

```
                    TRAVERSE CLOSURE
     LENGTH OF COURSE 1     : 305
     LENGTH OF COURSE 2     : 345.1
     LENGTH OF COURSE 3     : 427
     LENGTH OF COURSE 4     : 332.1
     LENGTH OF COURSE 5     : 160.32
```

```
                    TRAVERSE CLOSURE
ENDING POINT 10     NORTH 1000          EAST 1000
CLOSING POINT 16          999.297             1000.88

ERROR OF CLOSURE
1 IN 1397.17              .70343              -.875855
BEARING N511351W, DISTANCE 1.12336
DO YOU WISH TO CHANGE A DISTANCE? Y
```

```
                    TRAVERSE CLOSURE
          LENGTH OF COURSE 1 IS 305
          LENGTH OF COURSE 2 IS 345.1
          LENGTH OF COURSE 3 IS 427
          LENGTH OF COURSE 4 IS 332.1
          LENGTH OF COURSE 5 IS 160.32

PRESS <ENTER> TO CONTINUE, @ TO EXIT [ENTER]
```

```
                    TRAVERSE CLOSURE
          COURSE     OLD        NEW
            4        332.1      333.2
            @
```

```
                    TRAVERSE CLOSURE

DO YOU WISH TO RERUN CLOSURE? Y
```

```
                    TRAVERSE CLOSURE
ENDING POINT 10     NORTH 1000          EAST 1000
CLOSING POINT 16          999.92              999.969

ERROR OF CLOSURE
1 IN 18298.8              .0802002             .0305786
BEARING N205215E, DISTANCE .085832
DO YOU WISH TO CHANGE A DISTANCE? N
```

```
                    TRAVERSE CLOSURE

DO YOU WISH TO RERUN CLOSURE? N
```

```
                    TRAVERSE CLOSURE

DO YOU WISH TO ADJUST DISTANCES? Y
```

```
                    TRAVERSE CLOSURE
ENDING POINT 10      NORTH 1000          EAST 1000
CLOSING POINT 16           1000                1000

ERROR OF CLOSURE
1 IN 8.1375E+06            1.83105E-04         -6.10352E-05
BEARING N182606W, DISTANCE 1.9301E-04
     * * INVERSE TO OBTAIN ADJUSTED BEARINGS & DISTANCES * *


> PRESS <@> FOR MENU OR MENU SELECTION: I
```

```
                    INVERSE
ARE COORDINATES OF POINTS ENTERED? Y
```

```
                    INVERSE
<M>ULTIPLE OR <S>INGLE INVERSE? M
```

```
                                INVERSE
INVERSE SEQUENTIALLY FROM POINT: 12  TO POINT: 15


                 INVERSE FROM POINT 12 TO 15
          FROM       TO
         POINT     POINT          BEARING          DISTANCE
           12        13           S525951E          345.095
           13        14           S343026W          426.977
           14        15           N552913W          333.204
           15        16           N074050E          160.329


> PRESS <@> FOR MENU OR MENU SELECTION: I
```

```
                                INVERSE
ARE COORDINATES OF POINTS ENTERED? Y
```

```
                                INVERSE
<M>ULTIPLE OR <S>INGLE INVERSE? S


                                INVERSE
          FROM       TO
         POINT     POINT          BEARING          DISTANCE
          10        12            N460013E          305.015
          15        10            N074050E          160.329
          @
```

```
                    TRAVERSE CLOSURE

            <S> TORE OR LOAD COORDINATES
            <E> NTER COORDINATES
            <P> RINT COORDINATES
            <M> ODIFY POINT NUMBERS
            <T> RAVERSE (PT TO PT)
            <I> NVERSE
            <C> TRAVERSE CLOSURE
            <@> EXIT PROGRAM

            > ENTER A SELECTION: S
```

```
                SAVE/LOAD COORDINATES

            <S> AVE COORDINATES TO TAPE
            <L> OAD COORDINATES FROM TAPE
            <@> EXIT TO MAIN MENU

             > ENTER A SELECTION : S
```

```
STARTING POINT: 10

ENDING POINT:   15

LOAD TAPE, PRESS PLAY & RECORD, PRESS <ENTER>: [ENTER]
```

```
SAVING POINT  15

STARTING POINT: 10

ENDING POINT:   15

LOAD TAPE, PRESS PLAY & RECORD, PRESS <ENTER>: [ENTER]
```

```
REMOVE AND SAVE TAPE
> PRESS <@> FOR MENU OR MENU SELECTION: @
```

Load Miscellaneous Computation Tape.

```
SURVEYING - MISCELLANEOUS COMPUTATONS

   <S> TORE OR LOAD COORDINATES
   <E> NTER COORDINATES
   <P> RINT COORDINATES
   <M> ODIFY POINT NUMBERS
   <T> RAVERSE (PT TO PT)
   <I> NVERSE
   <A> RC & CURVE COMPUTATIONS
   <B> EARING - BEARING INTERSECT
   <D> ISTANCE - DISTANCE INTERSECT
   <X> BEARING - DISTANCE INTERSECT
   <H> ALF-ANGLE
   <@> EXIT PROGRAM

   > ENTER A SELECTION: S
```

```
SAVE/LOAD COORDINATES

<S> AVE COORDINATES TO TAPE
<L> OAD COORDINATES FROM TAPE
<@> EXIT TO MAIN MENU

> ENTER A SELECTION : L
```

```
STARTING POINT: 10

ENDING POINT:   15

LOAD TAPE, PRESS PLAY, PRESS <ENTER>: [ENTER]
```

```
LOADING POINT  15

STARTING POINT: 10

ENDING POINT:   15

LOAD TAPE, PRESS PLAY, PRESS <ENTER>: [ENTER]
```

```
REMOVE AND SAVE TAPE
> PRESS <@> FOR MENU OR MENU SELECTION: I
```

```
                              INVERSE
 ARE COORDINATES OF POINTS ENTERED? Y
```

```
                              INVERSE
 <M>ULTIPLE OR <S>INGLE INVERSE? S
```

```
                              INVERSE
          FROM        TO
         POINT       POINT          BEARING          DISTANCE
          10          12            N460010E           305.015
          15          10            N074050E           160.328
          @
```

```
SURVEYING - MISCELLANEOUS COMPUTATONS

   <S> TORE OR LOAD COORDINATES
   <E> NTER COORDINATES
   <P> RINT COORDINATES
   <M> ODIFY POINT NUMBERS
   <T> RAVERSE (PT TO PT)
   <I> NVERSE
   <A> RC & CURVE COMPUTATIONS
   <B> EARING - BEARING INTERSECT
   <D> ISTANCE - DISTANCE INTERSECT
   <X> BEARING - DISTANCE INTERSECT
   <H> ALF-ANGLE
   <@> EXIT PROGRAM

   > ENTER A SELECTION: I
```

```
                              INVERSE
ARE COORDINATES OF POINTS ENTERED? Y
```

```
                              INVERSE
<M>ULTIPLE OR <S>INGLE INVERSE? M
```

```
                              INVERSE
INVERSE SEQUENTIALLY FROM POINT: 12  TO POINT: 15
```

```
                    INVERSE FROM POINT 12 TO 15
        FROM        TO
       POINT       POINT          BEARING          DISTANCE
         12          13           S525950E           345.101
         13          14           S343028W           426.978
         14          15           N552913W           333.203


 > PRESS <@> FOR MENU OR MENU SELECTION: H
```

```
                                HALF-ANGLE

 ** ENTER BEARINGS IN CLOCKWISE DIRECTION **


 DISTANCE BETWEEN LINES                    : 40
 FIRST BEARING                             : N460010E
 SECOND BEARING                            : S525950E
 POINT OF INTERSECTION                     : 12
 OPPOSITE INTERSECTION NUMBER              : 11
 IS POINT 11 <L>EFT OR <R>IGHT OF POINT 12 ? L
 POINT        NORTH          EAST            ANGLE          DIST
  11         1264.38        1216.21     130 : 30 : 0      52.6035

 > PRESS <@> FOR MENU OR MENU SELECTION: T
```

```
                                TRAVERSE
<S>INGLE OR <C>ONTINUOUS TRAVERSE? S
```

```
                                TRAVERSE
FROM      TO       BEARING                          NORTH        EAST
POINT    POINT   (?DDMMSS?)     DISTANCE            COORD        COORD
 13       16      N525950W       225               1139.590     1315.330
 13       18      S343028W       140                888.803     1415.710
 18       19      S343028W       175                744.595     1316.570
 14       22      N552913W       100                708.979     1170.730
 @
```

```
SURVEYING - MISCELLANEOUS COMPUTATONS

   <S> TORE OR LOAD COORDINATES
   <E> NTER COORDINATES
   <P> RINT COORDINATES
   <M> ODIFY POINT NUMBERS
   <T> RAVERSE (PT TO PT)
   <I> NVERSE
   <A> RC & CURVE COMPUTATIONS
   <B> EARING - BEARING INTERSECT
   <D> ISTANCE - DISTANCE INTERSECT
   <X> BEARING - DISTANCE INTERSECT
   <H> ALF-ANGLE
   <@> EXIT PROGRAM

   > ENTER A SELECTION: D
```

```
DISTANCE - DISTANCE INTERSECT

FIRST POINT NUMBER                : 18
SECOND POINT NUMBER               : 16
INTERSECTION POINT NUMBER         : 17
DISTANCE FROM 18 TO 17            : 190
DISTANCE FROM 17 TO 16            : 140

IS POINT 17 <R>IGHT OR <L>EFT OF LINE 18 - 16 ? L

FROM 18 TO 17 - BEARING IS N511005W, DISTANCE IS 190 FEET
FROM 17 TO 16 - BEARING IS N195330E, DISTANCE IS 139.999 FEET
INVERSE DISTANCE = 139.999


> PRESS <@> FOR MENU OR MENU SELECTION: X
```

```
                    BEARING - DISTANCE INTERSECT

POINT NUMBER OF BEARING ORIGIN        : 19
POINT NUMBER OF DISTANCE ORIGIN       : 17
POINT NUMBER AT INTERSECTION          : 20

BEARING FROM 19 TO 20                 : N450000W
DISTANCE FROM 20 TO 17                : 155

IS 20 CLOSEST INTERSECTION TO 19 ? Y

FROM 17 TO 20 - BEARING IS S330504W, DISTANCE IS 154.999 FEET
FROM 19 TO 20 - BEARING IS N450000W, DISTANCE IS 188.765 FEET


> PRESS <@> FOR MENU OR MENU SELECTION: B
```

```
                    BEARING - BEARING INTERSECT

FIRST POINT NUMBER                    : 19
SECOND POINT NUMBER                   : 22
INTERSECTION POINT NUMBER             : 21
BEARING FROM 19 TO 21                 : N450000W
BEARING FROM 21 TO 22                 : S300000W

DISTANCE FROM 19 TO 21 IS 112.317 FEET
DISTANCE FROM 22 TO 21 IS 132.832 FEET
CHECK INVERSE FROM 22 TO 21 :
BEARING S300000W, DISTANCE 132.833 FEET


> PRESS <@> FOR MENU OR MENU SELECTION: A
```

```
                    ARC AND CURVE COMPUTATIONS

** POINT NUMBERS MUST BE ENTERED CLOCKWISE **

ARC LENGTH                                  : 0
RADIUS                                      : 0
DELTA                                       : 0
TANGENT                                     : 120.093

FIRST POINT NUMBER                          : 10
POINT NUMBER OF CURVE INTERSECTION          : 12
LAST POINT NUMBER                           : 13

POINT OF CURVATURE                          : 23
POINT OF TANGENCY                           : 16
CENTER POINT                                : 24
```

```
                    ARC AND CURVE COMPUTATIONS

                    DELTA        81: 0: 0
                    ARC LENGTH   198.784
                    RADIUS       140.611
                    TANGENT      120.093

DO YOU WISH STAKING DATA? Y

STATIONING DESIRED 25
```

```
                    ARC AND CURVE COMPUTATIONS
FROM        TO            DEF <          CHORD        ARC
PC           1             5: 5:36      24.9671       25
PC           2            10:11:13      24.9671       25
PC           3            15:16:49      24.9671       25
PC           4            20:22:26      24.9671       25
PC           5            25:28: 2      24.9671       25
PC           6            30:33:39      24.9671       25
PC           7            35:39:15      24.9671       25
PC           8            40:30: 0      23.7556       23.7839


> PRESS <@> FOR MENU OR MENU SELECTION: S
```

```
SAVE/LOAD COORDINATES

<S> AVE COORDINATES TO TAPE
<L> OAD COORDINATES FROM TAPE
<@> EXIT TO MAIN MENU

 > ENTER A SELECTION : S
```

```
STARTING POINT: 10

ENDING POINT:   24

LOAD TAPE, PRESS PLAY & RECORD, PRESS <ENTER>: [ENTER]
```

Remove Data Tape.

Load Lot Tape.

```
LOT

<S> TORE OR LOAD COORDINATES
<E> NTER COORDINATES
<P> RINT COORDINATES
<M> ODIFY POINT NUMBERS
<T> RAVERSE (PT TO PT)
<I> NVERSE
<R> LOT AREAS
<L> OT AREAS AND INVERSES

> ENTER A SELECTION: S
```

```
SAVE/LOAD COORDINATES

<S> AVE COORDINATES TO TAPE
<L> OAD COORDINATES FROM TAPE
<@> EXIT TO MAIN MENU

 > ENTER A SELECTION : L
```

```
STARTING POINT: 10

ENDING POINT:   24

LOAD TAPE, PRESS PLAY, PRESS <ENTER>: [ENTER]
```

```
LOADING POINT  24

STARTING POINT: 10

ENDING POINT:   24

LOAD TAPE, PRESS PLAY, PRESS <ENTER>: [ENTER]


REMOVE AND SAVE TAPE
> PRESS <@> OR MENU SELECTION: L
```

```
                    LOT AREA AND INVERSES

** ENTER POINTS IN A CLOCKWISE DIRECTION **

ENTER TRACT NAME: OVERALL
```

```
                      ENTER POINT NUMBERS
                    FIRST POINT : 10
                    NEXT POINT  : 12
                    NEXT POINT  : 13
                    NEXT POINT  : 14
                    NEXT POINT  : 15
                    NEXT POINT  : @
```

```
                    TRACT OVERALL
FROM      TO        BEARING          DISTANCE
 10       12        N460010E          305.015
 12       13        S525950E          345.101
 13       14        S343028W          426.978
 14       15        N552913W          333.203
 15       10        N074050E          160.328

              AREA 162400 SQ FT, 3.72819 ACRES

> PRESS <@> OR MENU SELECTION: R
```

```
                         LOT AREAS

** ENTER POINTS IN A CLOCKWISE DIRECTION **

ENTER TRACT NAME: LOT-1
```

```
                  ENTER POINT NUMBERS
                FIRST POINT : 16
                NEXT POINT  : 13
                NEXT POINT  : 18
                NEXT POINT  : 17
                NEXT POINT  : @
```

```
                        TRACT LOT-1

              AREA 28315.3 SQ FT, .650029 ACRES

> PRESS <@> OR MENU SELECTION: L
```

```
                    LOT AREA AND INVERSES

** ENTER POINTS IN A CLOCKWISE DIRECTION **

ENTER TRACT NAME: BDRY - 2
```

```
                  ENTER POINT NUMBERS
                FIRST POINT : 10
                NEXT POINT  : 23
                NEXT POINT  : 24C
                NEXT POINT  : 16
                NEXT POINT  : 13
                NEXT POINT  : 14
                NEXT POINT  : 15
                NEXT POINT  : @
```

```
                      TRACT BDRY - 2
FROM      TO        BEARING          DISTANCE
 10       23        N460013E          184.923
 23       16    ARC 198.786   RADIUS 140.61
 16       13        S525950E          225.005
 13       14        S343026W          426.978
 14       15        N552913W          333.203
 15       10        N074050E          160.328

                 AREA 159489 SQ FT, 3.66136 ACRES

> PRESS <@> OR MENU SELECTION: P
```

```
                     PRINT COORDINATES
<M>ULTIPLE OR <S>INGLE PRINT? M
```

```
                    PRINT COORDINATES
               FROM POINT 10  TO POINT 24
POINT NUMBER          NORTH COORD     EAST COORD
     10                   1000            1000
     11                   1264.38         1216.21
     12                   1211.87         1219.42
     13                   1004.17         1495.02
     14                   652.319         1253.13
     15                   841.11          978.572
     16                   1139.59         1315.33
     17                   1007.94         1267.7
     18                   888.803         1415.71
     19                   744.595         1316.57
     20                   878.073         1183.09
     21                   824.015         1237.15
PRESS <ENTER> TO CONTINUE, @ TO EXIT [ENTER]
```

```
                    PRINT COORDINATES
               FROM POINT 10  TO POINT 24
POINT NUMBER          NORTH COORD     EAST COORD
     22                   708.979         1170.73
     23                   1128.45         1133.03
     24                   1027.3          1230.7

> PRESS <@> OR MENU SELECTION: @
```

```
                    LOT

               <S> TORE OR LOAD COORDINATES
               <E> NTER COORDINATES
               <P> RINT COORDINATES
               <M> ODIFY POINT NUMBERS
               <T> RAVERSE (PT TO PT)
               <I> NVERSE
               <R> LOT AREAS
               <L> OT AREAS AND INVERSES


               > ENTER A SELECTION: @
```

Appendix C — Formulas and Data

Formulas and Data

Formulas Used in the Surveying Program

Curve Formulas (Figure 1)

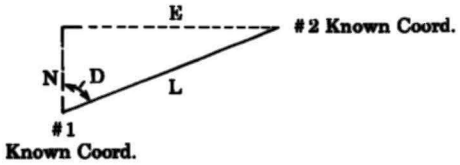
R = Radius
L = Length of Curve
T = Tangent
C = Curve
D = Delta

$$R = \frac{T}{\text{Tan } \frac{D}{2}}$$

$$Lc = R * D(\text{radians})$$

$$C = 2 * R(\text{Sin } \frac{D}{2})$$

Inverse Function (Figure 2)

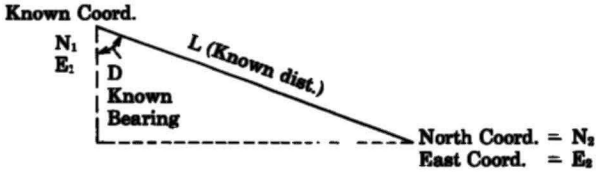


N = difference in North Coord. (#2-#1)
E = difference in East Coord. (#2-#1)

$$\text{Tan } D = \frac{E}{N}$$

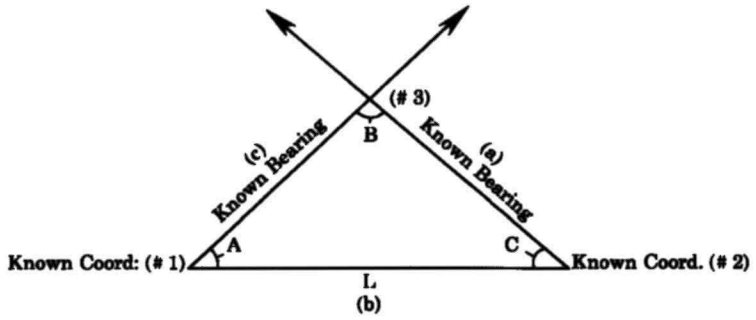
$$L = \frac{E}{\text{Sin } D} \text{ or } \frac{N}{\text{Cos } D}$$

Traverse Function (Figure 3)



$$N_2 = N_1 + \text{Cos } D(L)$$
$$E_2 = E_1 + \text{Sin } D(L)$$

Bearing-Bearing Intersection (Figure 4)



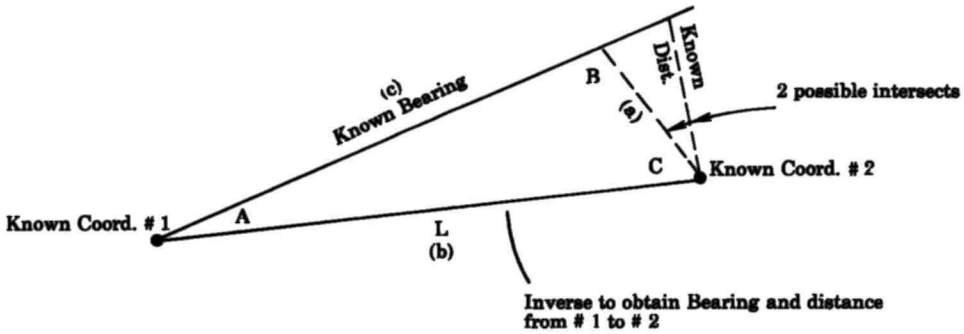
Inverse to obtain bearing from #1 to #2 and distance L.
Use bearings to obtain angles A, B, & C.

c = b/Sin B * Sin C

a = b/Sin * Sin A

Traverse from #1 or #2 to find #3.

Bearing-Distance Intersection (Figure 5)

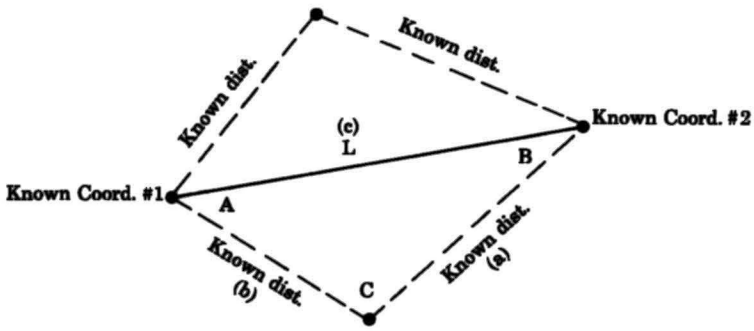


$$\text{Sin B} = \frac{b(\text{Sin A})}{a}$$

C = 180° – (A + B)

(If near intersection, B = 180 – B)

Distance-Distance Intersection (Figure 6)

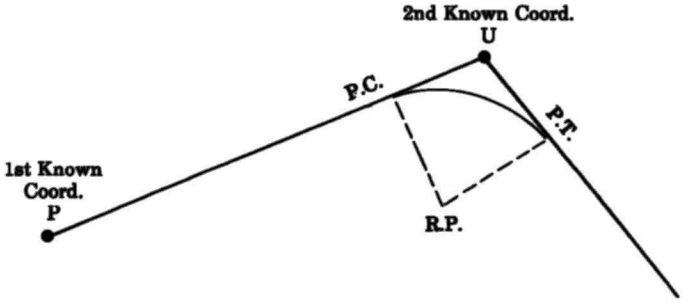


Inverse to obtain bearing and distance from #1 to #2

$$\text{Sin } A = \frac{2\sqrt{s(s-a)(s-b)(s-c)}}{bc} \qquad s = a + b + c$$

Angle A is either to left or right of Line #1-#2

Arc and Curve Data (Figure 7)



If these coordinates are known and any two of the following are known except arc length and tangent, then coordinates of P.C., P.T. and R.P. are computed along with unknown curve data.

Arc length
Delta
Tangent
Radius

If coordinates are not needed, enter any 2 of the above except arc length and tangent, then missing curve data is computed. If desired stake-out data may be displayed using arc length of operator's choice. Output is deflection ∡ , chord length and arc length.

Input requests are self-explanatory.

Traverse Closure and Adjustment (Adjustment is by Compass Method. Transit Method and Crandall Method can be added.) (Figure 8)

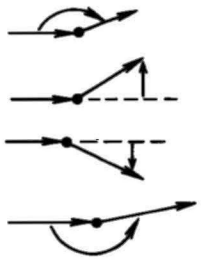
Bearings or raw angles may be used for input. If angles are used then the following codes must be entered when type of angle is asked for.

Rt. ∡ — 1

Left Def. ∡ — 2

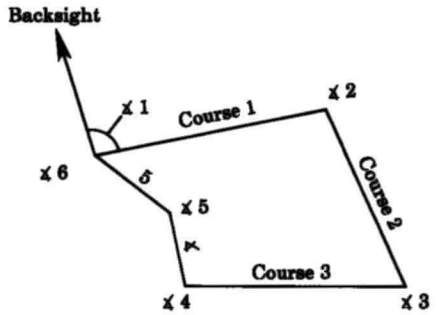
Rt. Def. ∡ — 3

Left ∡ — 4



— RUN IN CLOCKWISE DIRECTION —

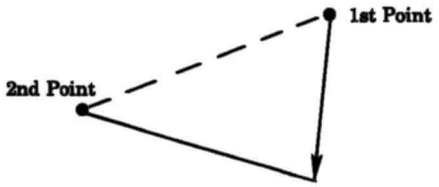
Angles and courses of traverse should be numbered on drawing to allow quick changes to data in computer. The computer numbers data as follows:



Bearing-Bearing Intersect (Figure 9)

Enter in clockwise direction.

i.e.



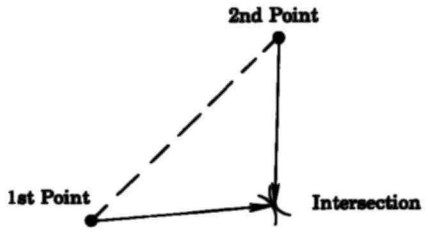
If ∡'s of triangle do not equal 180° an error message is printed. This is caused by entry of wrong quadrand for bearings.

An inverse is made to check computations and is displayed as CHECK INVERSE **(one leg only).**

Distance-Distance Intersection (Figure 10)

Enter in clockwise direction.

i.e.

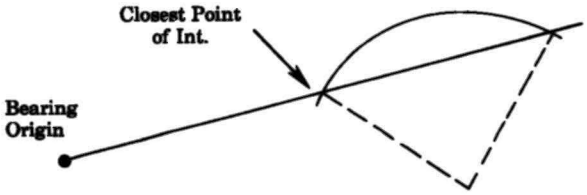


If distances are such that intersection is not possible then computer displays INTERSECTION NOT POSSIBLE **and returns to start of program for correct data.**

An inverse is made to check computations and is displayed as INVERSE DISTANCE **(one leg only).**

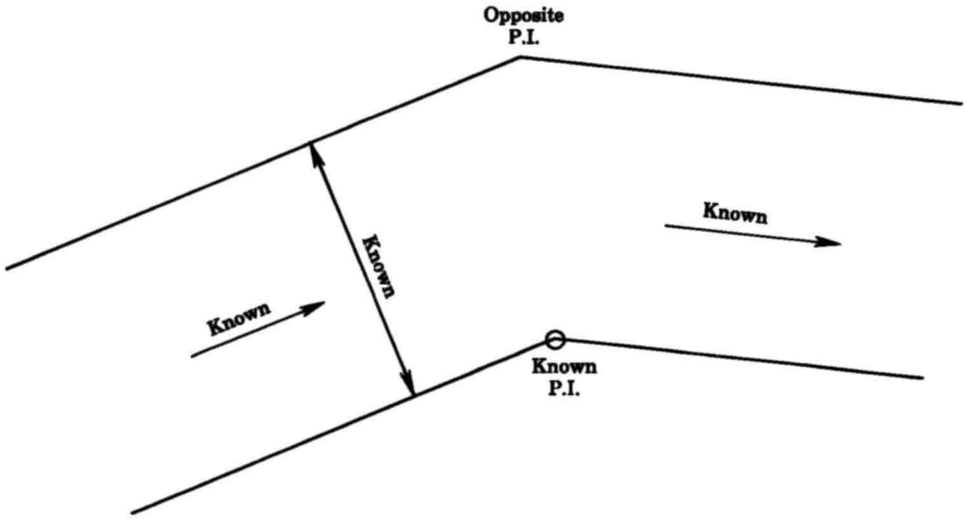
Bearing-Distance Intersection (Figure 11)

Input requests are self-explanatory.

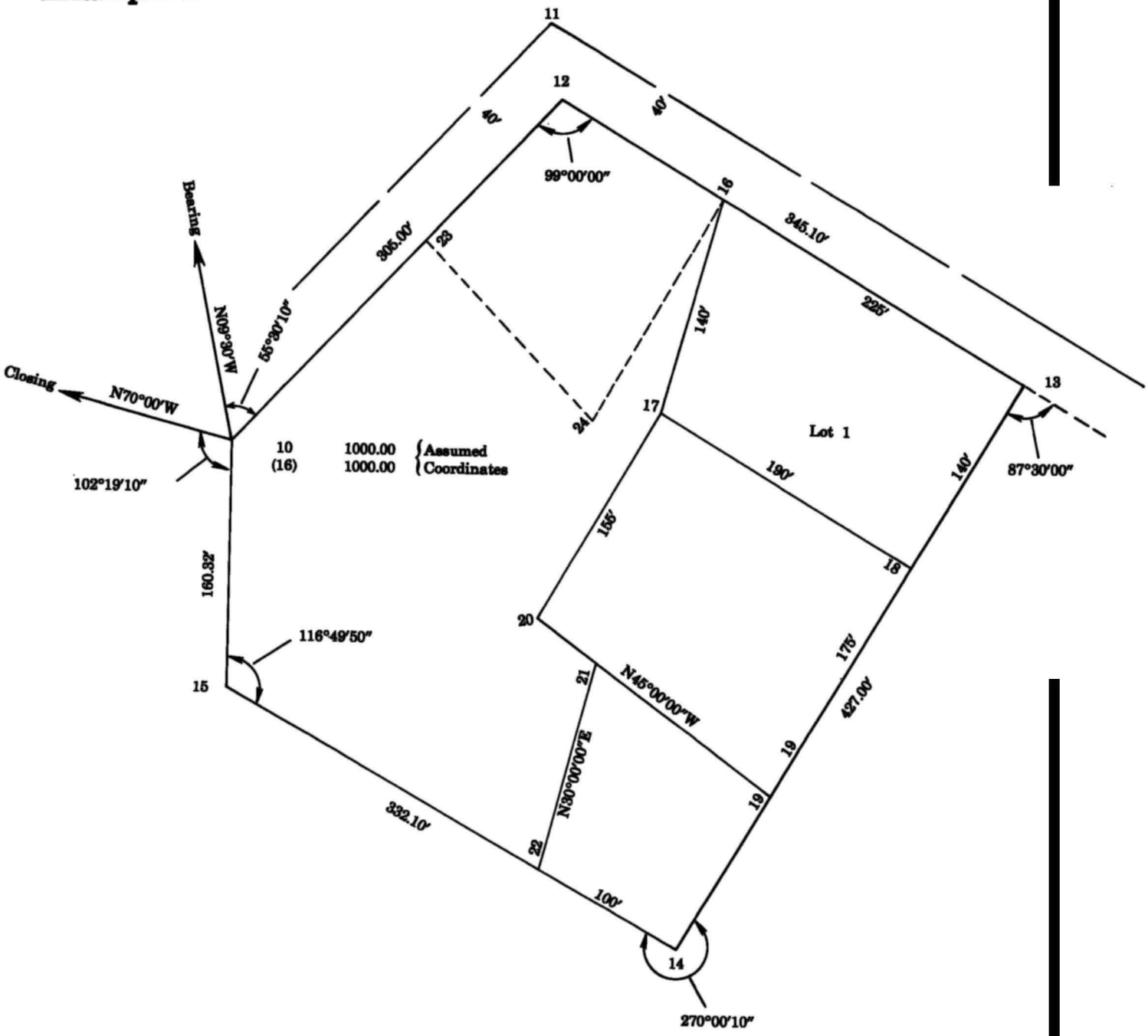


Half-Angle (Figure 12)

Computes coordinates of opposite P.I. if coordinate of P.I. and bearings on each side of P.I. and right of way width are known.



Example 1



Sketch Showing Known Data
(Not to Scale)

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