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# Introduction to **AutoCAD® 2024 for Civil Engineering Applications**

Learning to use AutoCAD® for Civil Engineering Projects



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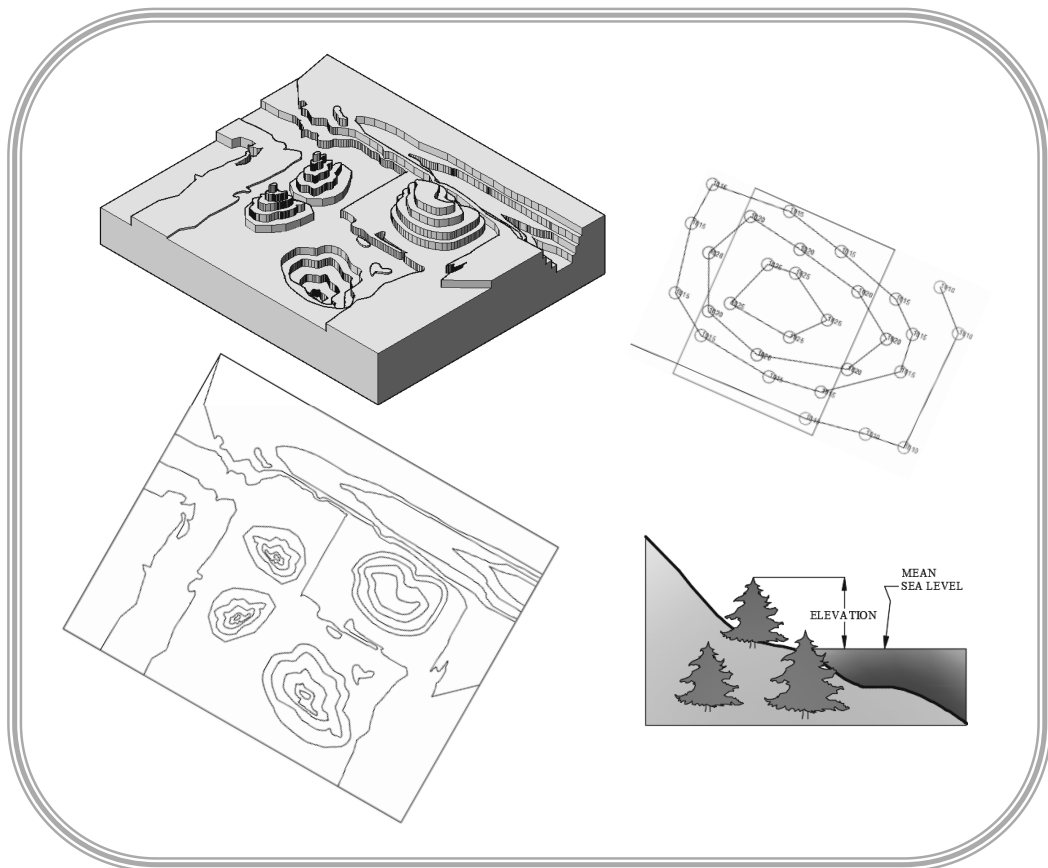
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## 12. Contours

### 12.1. Learning Objectives

After completing this chapter, you will demonstrate competency in the following areas:

- Identify on a contour map
  - Different types of contour lines, streams, ridges, peaks, depressions, saddles, steep and mild slopes
- Create a contour map
- Mark and label the index contours



## 12.2. Introduction

Consider a cup of coffee and assume that the coffee has evaporated. Figure 12-1a shows the coffee marks as circular rings in the top view and straight lines in the front view. In the coffee marks plotting, the parameter is the time when the coffee was evaporated. Similarly, isobars and isotherms are wavy or closed looped lines representing constant pressure and constant temperature, respectively. These wavy or looped lines, representing a constant value of a parameter, are called contour lines. In a land survey, a contour line is an imaginary horizontal line passing through the points of the same elevation drawn on a topographic map, Figure 12-1b. Shorelines are a good example of contour lines, since the water receding marks create non-intersecting loops, Figure 12-1c.

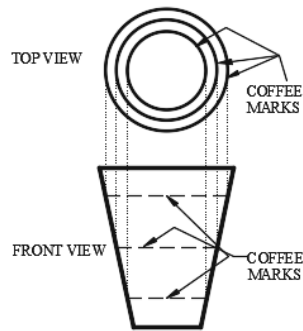


Figure 12-1a

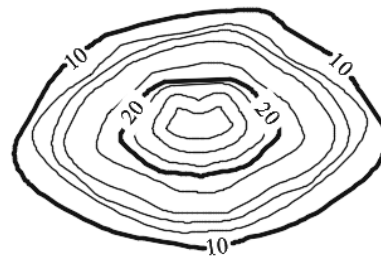


Figure 12-1b



Figure 12-1c

### 12.3. Characteristics Of A Contour Line

A contour line is an imaginary line representing a constant value of a parameter. Some of the characteristics of contour lines are listed here.

- A contour line represents a constant parameter. For example, Figure 12-1b represents elevation contours. The elevation is 10 units for every point on the loop labeled as 10 in the figure.
- If a large enough area is available, then the contour lines loop around and join themselves.
- Contour lines never end.
- Contour lines neither join with other contour lines nor bifurcate.
- Contour lines never cross each other.

### 12.4. Terminology

- Benchmark: A benchmark is a point of reference for the measurement. In a land survey, a benchmark is the point of known elevation.
- Mean sea level: The average elevation between the low and high tide of a sea is called the mean sea level.
- Elevation: The elevation of a point is the vertical distance from a benchmark, a datum line, or a reference plane. In the Figure 12-2a, the vertical distance of point *A* is 5ft from the datum line *aa*. Generally, the elevation of a geographic location is its height above (or depth below) the mean sea level. The mean sea level is the datum line. Figure 12-2b shows the elevation of one of the trees on the shore with respect to the mean sea level (datum).

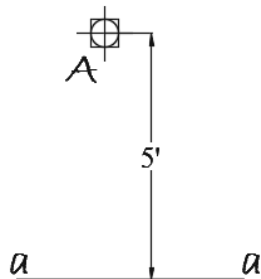


Figure 12-2a

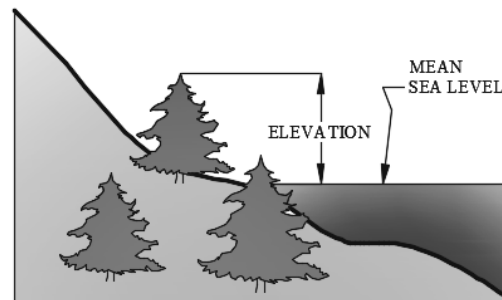


Figure 12-2b

- Contour interval: The contour interval of a map is the vertical distance between two consecutive contour lines. The contour intervals are closely related to the terrain, purpose of the map, and scale of the drawing. On a given map, the contour interval should be constant. Assuming the unit of measurement is feet, the contour interval is 2ft in Figure 12-1b.

- Types of contour lines: Contour lines can be classified into three groups.
  - Index contour: To make the reading of contour maps easy, every fifth contour is labeled. The labeled contour lines are called index contour, Figure 12-3a. The index contour line is broken at certain places and text labels are added. The labels represent the elevations with respect to the mean sea level. Usually, the index contours are drawn thicker than the other contour lines. The index contours can be marked as follows: (i) Identify the elevation of the first index contour (FIC). (ii) Specify the contour interval (CI). (iii) If the elevation is increasing, then the elevation of the second index contour (SIC) is calculated as ***Elevation of SIC = FIC + 5\*CI***. If the elevation is decreasing, then the second index contour (SIC) is calculated as ***Elevation of SIC = FIC + 5\*(-CI) = FIC - 5\*CI***. In Figure 12-3, the contour interval is 10 feet.

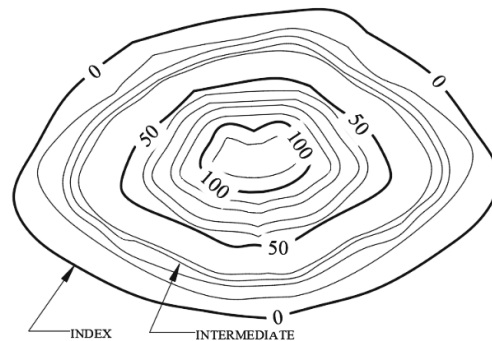


Figure 12-3a

- Intermediate contour: The unlabeled contour lines between any two index contours are called intermediate contours. Conventionally, these contours are not labeled but can be labeled in special cases. Usually, the intermediate contours are drawn lighter than the index contours, Figure 12-3a.
- Supplementary contour: The supplementary contours are the special type of contour lines and are drawn only when the contour interval is large and a user wishes to display the features between two consecutive contour lines. As a rule of thumb, the elevation of the supplementary contour is the average of the two contours on its either side, Figure 12-3b.

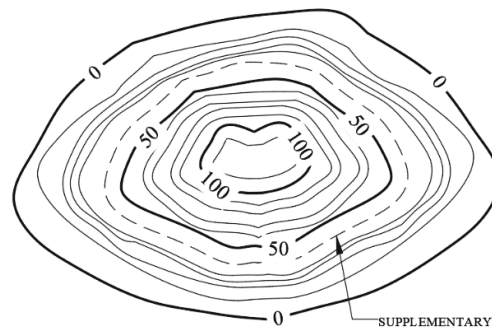


Figure 12-3b

- ***Slope versus space:*** The closely spaced contour lines represent steep slope and widely spaced contour lines represent mild slope. The top portion of Figure 12-4a shows a contour map and the lower parts show the profile indicating slope. On the left side of the top part, the contour lines are closely spaced, and its lower parts show the profile indicating the steep slope. Similarly, on the right side of the top part, the contour lines are widely spaced, and its lower parts show the profile indicating the mild slope. Figure 12-4b shows the corresponding 3D contour map.

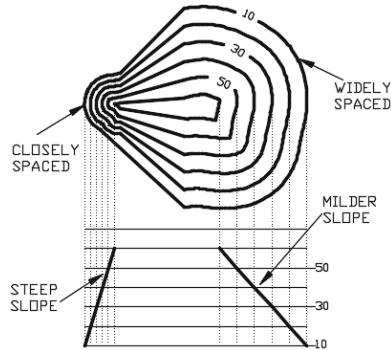


Figure 12-4a



Figure 12-4b

- ***Peak:*** The peak of a hill or mountain is shown by the closed looped contour lines of decreasing diameters and increasing elevation. Figure 12-5a shows the contour map of a peak and Figure 12-5b shows the corresponding peak in a 3D contour map.

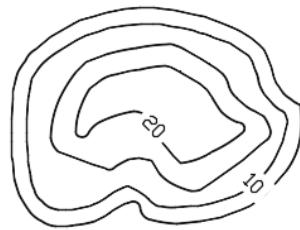


Figure 12-5a

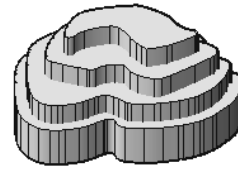


Figure 12-5b

- ***Depression:*** A depression (hole or excavation pit without any drainage outlets) is shown by the closed looped contour lines of decreasing diameters and decreasing elevation. Figure 12-6a shows the contour map of a depression and Figure 12-6b shows the corresponding depression in a 3D contour map. The innermost circle is marked with small lines on the inside, Figure 12-6a. These small lines are called hachures.
- ***Saddle:*** Two peaks side by side form a saddle. Figure 12-7a shows the contour map of a saddle and Figure 12-7b shows the corresponding peaks in a 3D contour map. In Figure 12-6a, the arrow shows the downward slope.

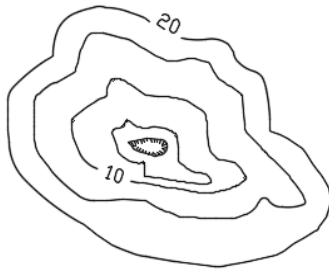


Figure 12-6a

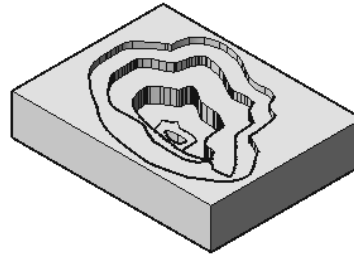


Figure 12-6b

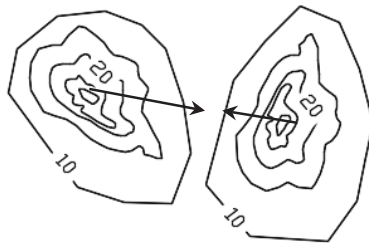


Figure 12-7a

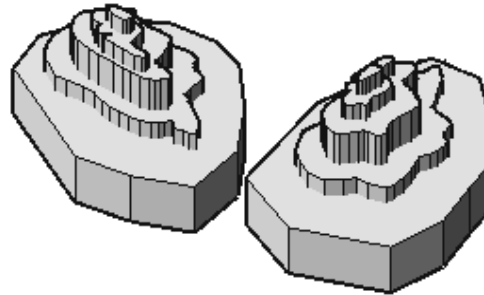


Figure 12-7b

- **Streams:** Contour lines are roughly parallel to stream. The contour lines cross the streambed upstream by creating V's with the closed end of the V's pointing upstream and the open end of the V's pointing downstream. Figure 12-8a shows a contour map of a stream, and Figure 12-8b shows the corresponding stream in a 3D contour map.

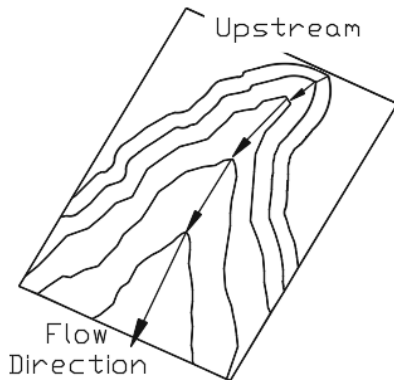


Figure 12-8a

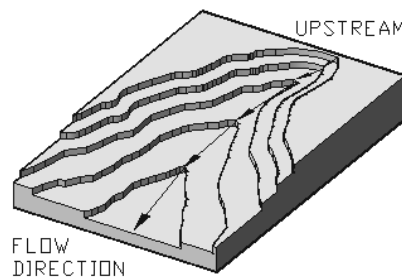


Figure 12-8b

- **Ridge or hill or mountain:** Contour lines are roughly parallel to a ridge, and the contour lines cross the ridge downstream by creating V's or U's. The closed end of the V's or U's points downstream and the open end of the V's or U's points upstream. Figure 12-9a shows a contour map of a stream and ridge line and Figure 12-9b shows the corresponding stream and ridge in a 3D contour map.



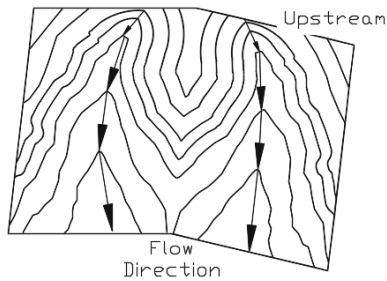


Figure 12-9a

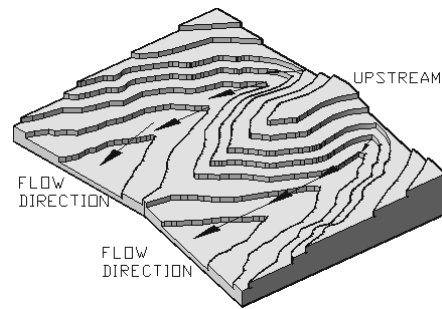


Figure 12-9b

- **Topographic map:** A topographic (contour) map is a two-dimensional representation of the three-dimensional earth. The three dimensions are the longitude, latitude, and the elevation. A topographic map is used to represent the shape of the earth using contour lines. On these maps, the contour interval depends upon the gradient of the land, and it is represented on the map. A typical map is shown in Figure 12-10. In these maps the contour lines are shown in brown color, water bodies (lakes, rivers, streams, etc.) in blue color, man-made structures (buildings, roads, etc.) in black color, and woodlands in green color.

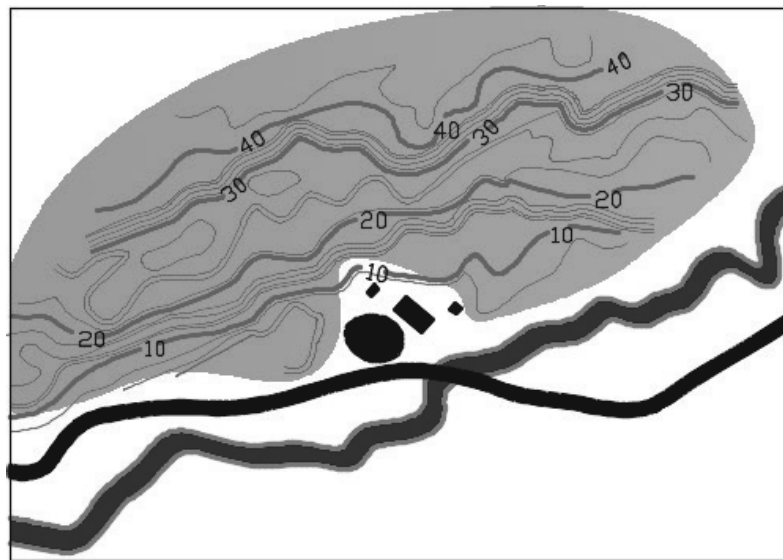


Figure 12-10

## 12.5. AutoCAD And Contour Map

In AutoCAD contour maps can be created by drawing polylines through the elevation data. This section assumes that the user has interpolated the field data and has created a script file. To draw a contour map, the color of the point is not important. However, for better understanding, every elevation is assigned its distinct color. The remainder of this section provides step-by-step instructions to create a contour map.

### 12.5.1. Create Script file

- Create a script file or download the script files. The script file is saved with “.scr” extension and can be created in *Notepad*. The Figure 12-11a shows part of a script (Script.scr) file and Figure 12-11b explains the contents of the script file.

### 12.5.2. Create layers

- Launch AutoCAD 2024.
- Open a new portrait file (your template file for the ANSI units).
- (i) Create a *Data* layer for the elevation data points. (ii) Create a *Contour* layer for the contour lines. (iii) Create a *Label* layer for the contours’ labels.

<pre>color 20 point 13.20,8.80,00.00 text 13.20,8.80 0.20 0 930 point 12.00,9.67,00.00 text 12.00,9.67 0.20 0 930</pre>	<ul style="list-style-type: none"> <li>• “color 20” assigns color to a point</li> <li>• “point” activates the <i>Point</i> command</li> <li>• “13.20,8.80,00.00” (no spaces) are the coordinates of the point</li> <li>• “text” activates the <i>Text</i> command</li> <li>• “13.20,8.80” is the coordinate of the first corner of the text box</li> <li>• “0.20” is the text height</li> <li>• “0” is the rotation of the text</li> <li>• “930” is the text that appears in the text box.</li> <li>• .....</li> </ul>
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Figure 12-11a

Figure 12-11b

### 12.5.3. Change point style

- From the *Home* tab and the expanded *Utilities* panel click at *Point Style...* tool. This opens the *Point Style* dialog box.
- Change point style to circle (second style in the second row), Figure 12-12.
- Change the point size to 0.5 *Units*.
- Select the *Set Size in Absolute Units* option.
- Press the *OK* button.

### 12.5.4. Read the script files

- Make the *Data* layer to be the current layer.
- Read the script file by activating the script command.
  - Command line method: Type “script,” “Script” or “SCRIPT” on the command line and press the *Enter* key.
- Figure 12-13a shows the close-up of the selected elevation data points.
- The complete elevation data is shown in Figure 12-13b.

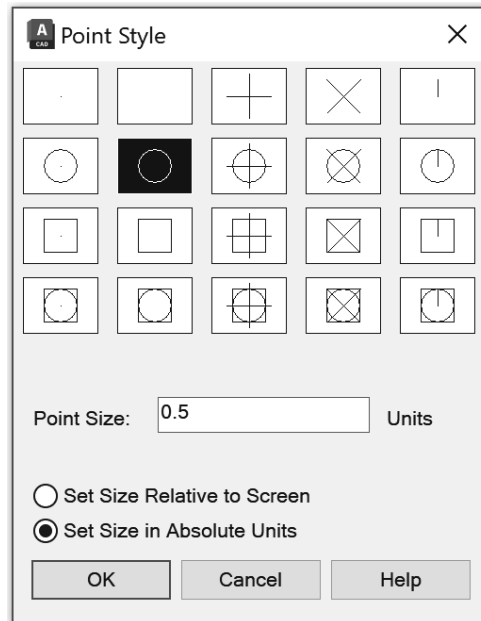


Figure 12-12

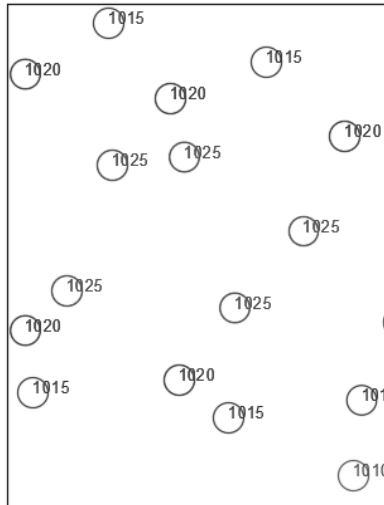


Figure 12-13a

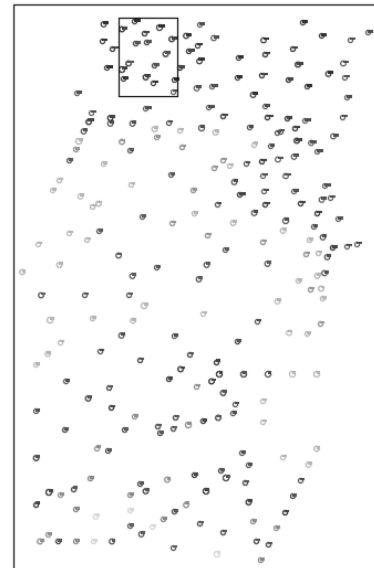
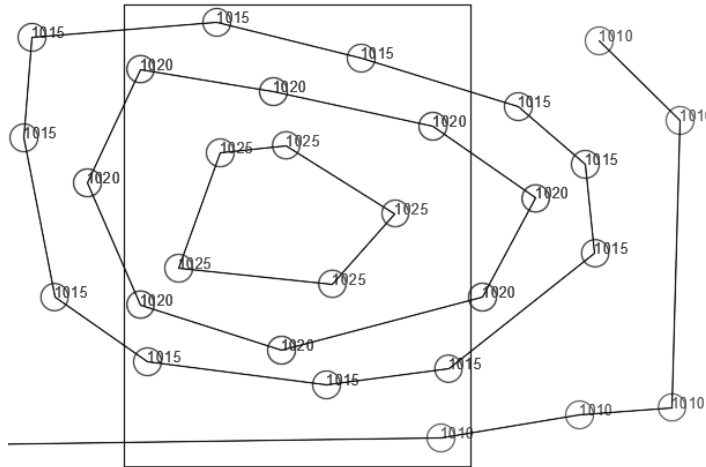


Figure 12-13b

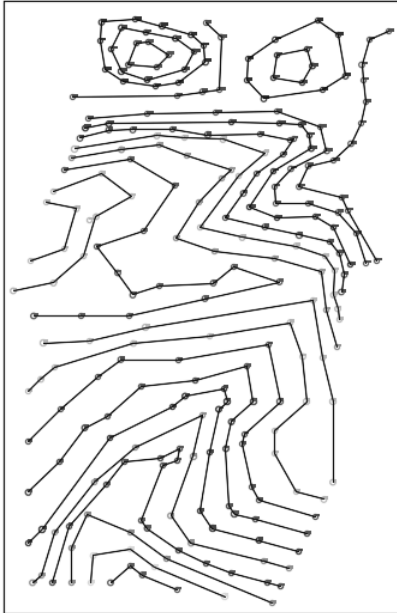
### 12.5.5. Create the contour map

- Select the 'Contour' layer.
- Activate the *Polyline* command and draw a polyline through the points of the same elevation without intersecting any contour line. Figure 12-14a shows the contour line for the points shown in 11-13a.

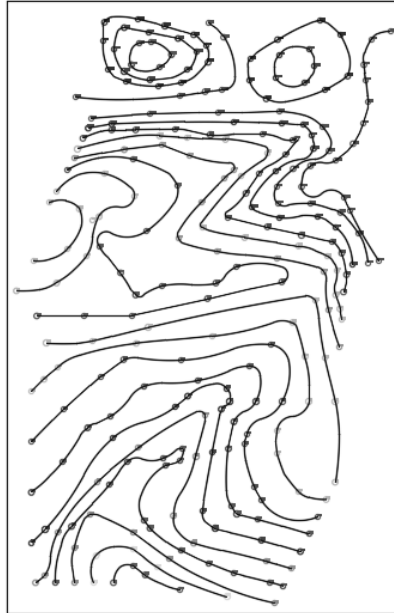
- Repeat the process with the remaining data points, Figure 12-14b.
- Fit a curve through each polyline, Figure 12-14c. Curve fitting is discussed in the next section.
- If polylines are created in the multiple activations of the command, then first join the line and then perform the curve fitting operation. The *Join* operation is described in detail in *Chapter 4*.



**Figure 12-14a**



**Figure 12-14b**



**Figure 12-14c**

### 12.5.6. Curve fitting

Curve fitting is optional; however, this section explains the curve fitting technique.

- Select a polyline for the elevation 930 (the grip points appear), Figure 12-15a.
- Press the right button of the mouse, and the options list appears.
- Choose the *Polyline* from the list, Figure 12-15a.
- Another list of options appears; choose the *Curve Fit* option, Figure 12-15a.
- The *Curve Fit* option passes the curve through the data points. A smooth curve is drawn through the points, Figure 12-15b.
- Repeat the process with the other contour lines, Figure 12-14c.

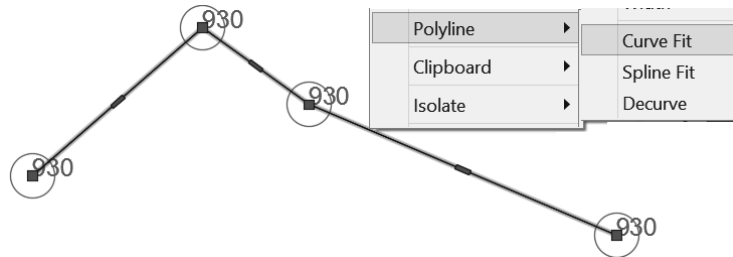


Figure 12-15a

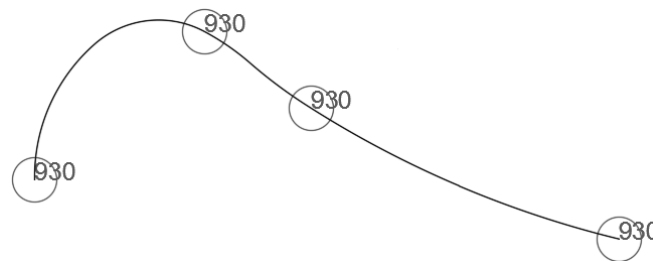
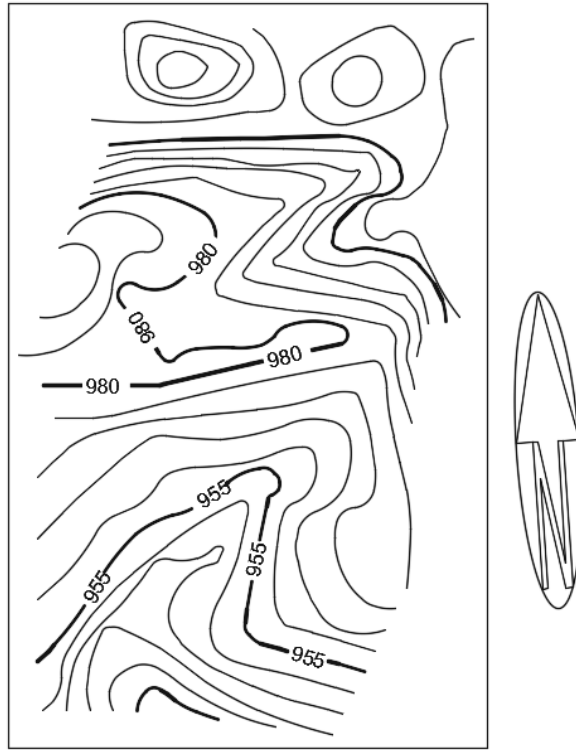


Figure 12-15b

### 12.5.7. Add the labels to the index contours

- If polylines are created in the multiple activations of the commands, then first join the line, and then perform the labeling and masking operation. The *Join* operation is discussed in detail in *Chapter 4*.
- Mark the index contours (that is, increase the lineweight for the index contours).
- Use the *Annotative Text* command from the *Home* tab and *Annotate* panel to create the text of the label. The text should be parallel to the polyline. If necessary, use the *Rotate* command from the *Home* tab and *Modify* panel to rotate the text.
- The Figure 12-16 shows a contour map with only two labeled index contours.
- Similarly add labels to the other contours.
- Hide the contour line behind the label using the *Background mask* option from the *Properties* palette. The *Background mask* command is discussed in *Chapter 5*.
- Finally, add the *North* direction block from the *Design Center* → *Landscaping.dwg* → *North Arrow*; scale the north block appropriately, Figure 12-16.



**Figure 12-16**

**Notes:**