



AUM

American University Of The Middle East

**CVL203: Principles and
Practice of Geomatics**

**Lectures 17:
Mapping Surveys**

- Introduction to Mapping Surveys
- Basic Methods for Performing Mapping Surveys
- Map Scale
- Map Scale Size
- Contours
- Characteristics of Contours
- Errors in Mapping Surveys
- Mistakes in Mapping Surveys

Introduction to Mapping Surveys

Mapping surveys are made to determine the locations of *natural* and *cultural* features on the Earth's surface and to define the configuration (*relief*) of that surface. Once located, these features can be represented on maps.

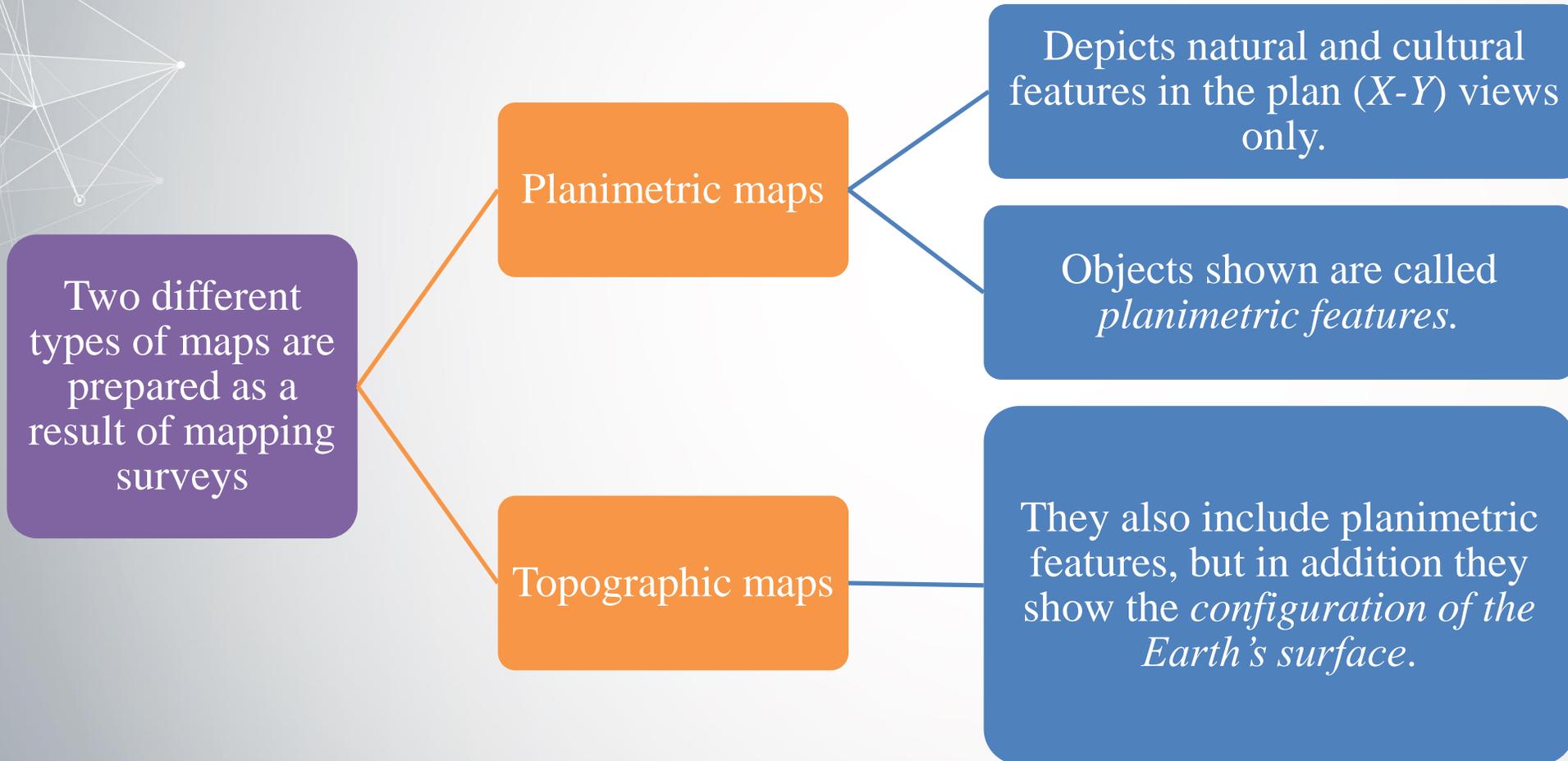
Natural features normally shown on maps include vegetation, rivers, lakes, oceans, etc.

Cultural (*artificial*) features are the products of people and include roads, railroads, buildings, bridges, canals, boundary lines, etc.

The relief of the Earth includes its hills, valleys, plains, and other surface irregularities.

Lines and symbols are used to depict features shown on maps. Names and legends are added to identify the different objects shown.

Conducting the surveys necessary for preparing maps and the production of the maps from the survey data are the mainstay of many surveying businesses.



Introduction to Mapping Surveys

Both types
are used
by:

Engineers and
planners

To determine the most desirable and economical locations of highways, railroads, canals, pipelines, transmission lines, reservoirs, and other facilities.

Geologists

To investigate mineral, oil, water, and other resources.

Foresters

To locate access- or haul-roads, fire-control routes, and observation towers.

Architects

Housing and landscape design.

Agriculturists

Soil conservation work.

Archaeologists,
geographers, and
scientists

A variety of fields

Basic Methods for Performing Mapping Surveys

- Mapping surveys are conducted by one of two basic methods:
 - *aerial* (photogrammetric) techniques
 - *ground* (field) techniques
 - or a combination of both

- Refined equipment and procedures available today have made photogrammetry very accurate and economical. Hence, almost all mapping projects covering large areas now employ this method.

- Ground surveys are still commonly used in preparing large-scale maps of smaller areas. Even when photogrammetry mapping is utilized, ground surveys are necessary to establish control and to field-check mapped features for accuracy.

- This chapter concentrates on ground methods, while photogrammetry and airborne laser mapping are discussed in the next chapter.

Map scale is the ratio of the length of an object or feature on a map to the true length of the object or feature.

Map scales are given in three ways:

1. by ratio or representative fraction, such as 1:2000 or 1/2000

In giving scale by ratio or representative fraction, the same units are used for the map distance and the corresponding object distance, and thus 1:1200 could mean 1 in. on the map is equivalent to 1200 in. on the object, but any other units would also apply.

2. by an equivalence, for example, 1 in = 100 ft

An equivalence scale of 1 in./100 ft indicates that 1 in. on the map is equivalent to 100 ft on the object.

3. by graphically using either a bar scale or labelled grid lines spaced throughout the map at uniform distances apart.

Graphic scales permit accurate measurements to be made on maps, even though the paper upon which the map is printed may change dimensions.

- It is possible to convert from an equivalence scale to a ratio, and vice versa. As an example, is converted to a ratio by multiplying 100 ft by 12, which converts it to inches and gives a ratio of 1:1200.
- Those engaged in surveying (geomatics) and engineering generally prefer an equivalence scale and grid lines on their maps, while geographers often utilize a representative fraction and bar scale.
- **Choice of scale depends on:**
 - 1) Purpose
 - 2) Size
 - 3) Required precision of the map
 - 4) Dimensions of a standard map sheet
 - 5) Type and number of topographic symbols used
 - 6) Accuracy requirements for scaling distances from the map

- Maps produced using the English system of units usually have their scales selected to be compatible with one of the standard graduations on engineer's scales. These standard graduations have 10, 20, 30, 40, 50, or 60 units per inch.
 - Scales of 1 in. = 100 ft. and 1 in. = 1000 ft. are compatible with the 10 scale.
 - Scales of 1 in. = 200 ft. and 1 in. = 2000 ft. are compatible with the 20 scale.

- In the metric system, ratios or representative fractions such as 1:1000, 1:2000, 1:5000, and so on are usually employed.

- Map scales may be classified as *large*, *medium*, and *small*:

Large scale, 1 in. = 200 ft (1:2400) or larger

Medium scale, 1 in. = 200 ft to 1 in. = 1000 ft (1:2400 to 1:12,000)

Small scale, 1 in. = 1000 ft (1:12,000) smaller

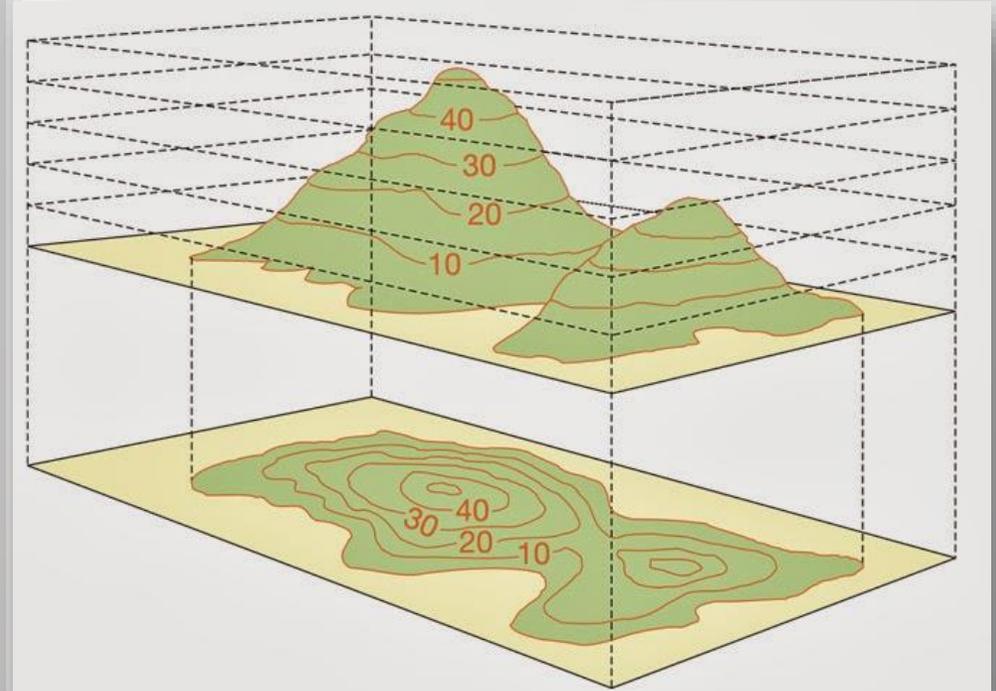
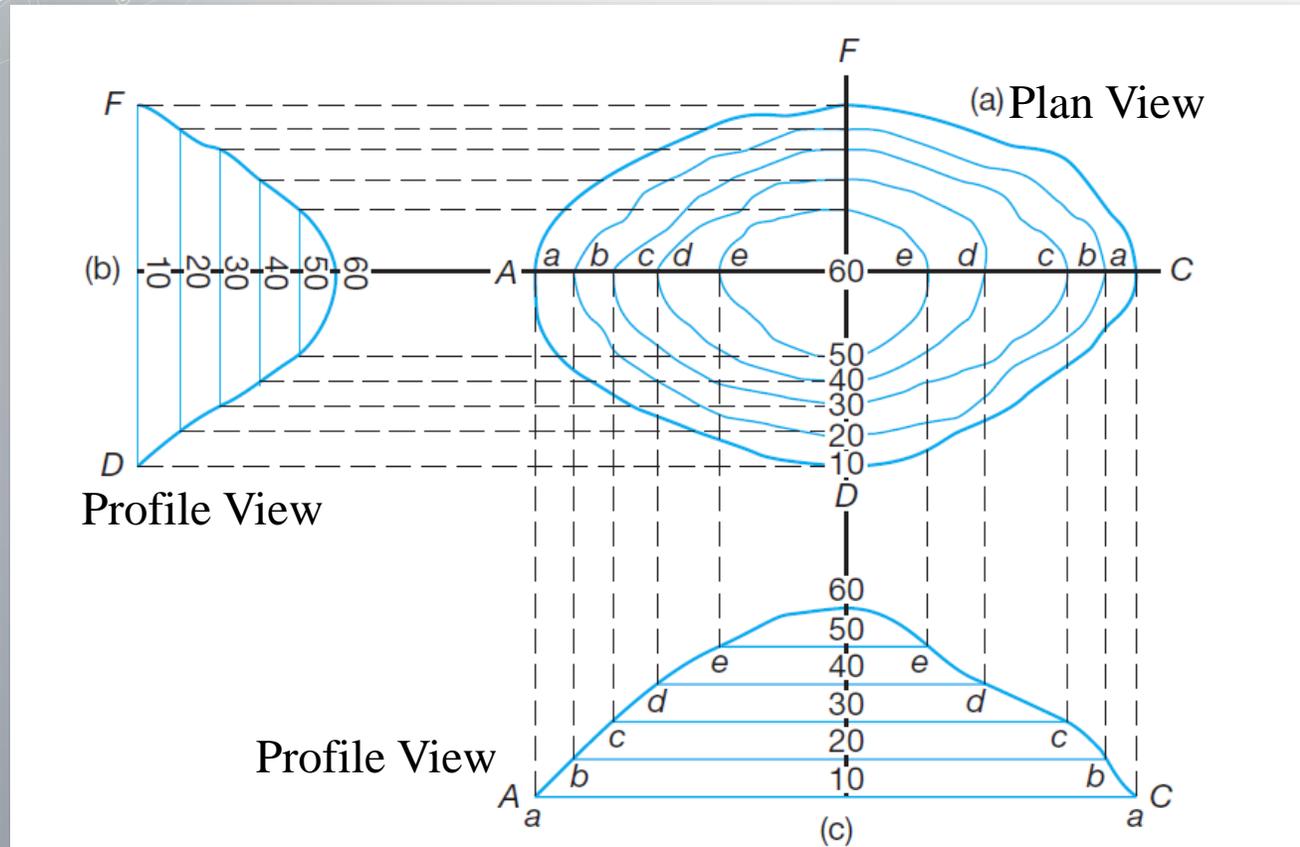
- Large-scale maps** are applied where relatively high accuracy is needed over limited areas:
subdivision design and the design of engineering projects like roads, dams, airports, and water and sewage systems.
- Medium scales** are often used for applications such as general preliminary planning where larger areas are covered but only moderate accuracy is needed.
mapping the general layout of potential construction sites, proposed transportation systems, and existing facilities.
- Small-scale maps** are commonly used for mapping large areas where a lower order of accuracy will suffice.
general topographic coverage, applications in site-suitability analysis, preliminary layout of expansive proposed construction projects, and for special applications in forestry, geology, environmental impact and management, etc.

- The scale at which a map will be plotted directly affects the choice of instruments and procedures used in performing the mapping survey.
- The accuracy with which the position of an object is depicted on a map is related to the map's scale, which in turn dictates the accuracy with which features must be surveyed.
- **Example:** a map plotted at a scale of 1 in. = 20 ft. If distances and locations can be scaled from the map to within say 1/50th in., this represents a scaling error of $(1/50)20 = \pm 0.4$ ft. To ensure that the accuracy of the surveyed data does not limit the accuracy with which information can be scaled from a map, features must be located on the map to an accuracy better than ± 0.4 ft.
- As a safety factor, many surveying and mapping agencies apply a rule of thumb in which they require features to be located in the field to at least twice the scaling accuracy, which in this instance would require accuracy to within ± 0.2 ft. or better.

- Another consideration regarding map scale that affects surveying accuracy is the thicknesses of lines used to plot features.
- **Example:** Assume that line widths on a map with a scale of 1:2000 are 0.3 mm. This means that each line represents $0.3(2000) = 600 \text{ mm} = 0.6 \text{ m}$. on the object. Therefore, to accurately depict an object on a map with this line width, the survey needs to be accurate to at least half the line width, or $\pm 0.3 \text{ m}$. Obviously, the equipment and procedures used for the mapping work must be selected so that these accuracies are met.
- Even though the first map produced for a particular project may be a small-scale reconnaissance map:
 - It is possible that as the project progresses, medium-scale planning maps and largescale design maps will be needed, and that some or all of the data collected could also be used for these maps.
 - Thus, even though relaxed accuracies may suffice for the reconnaissance map, for efficiency, the data should be collected to accuracy suitable for other maps that may follow.

A contour is a line connecting points of equal elevation.

- Since water assumes a level surface, the shoreline of a lake is a visible contour, but in general, contours cannot be seen in nature.
- On maps, contours represent the planimetric locations of the traces of level surfaces for different elevations.

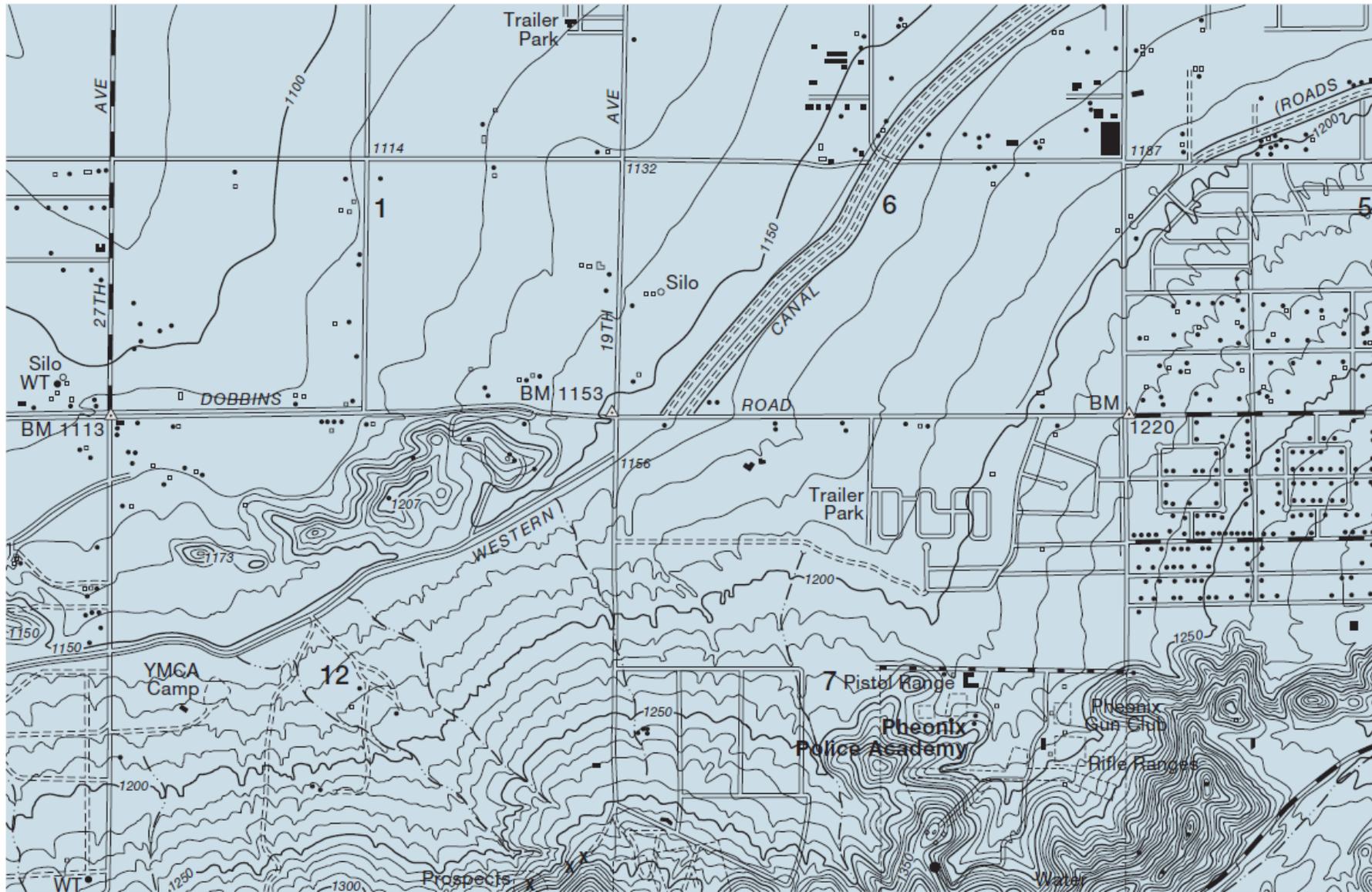


- Contours are drawn on maps by interpolating between points whose positions and elevations have been observed and plotted.
- Computerized mapping and contouring systems are replacing manual plotting methods, but the principles of plotting terrain points and of interpolating contours are still basically the same in either method.
- The vertical distance between consecutive level surfaces forming the contours on a map (the elevation difference represented between adjacent contours) is called the *contour interval*.
- In the metric system, a contour interval of 0.5, 1, 2, 5, or 10 m is generally selected.
- The contour interval selected depends on a map's purpose and scale, and upon the diversity of relief in the area.

- Smaller contour interval will normally be necessary to adequately depict gently rolling terrain with only moderate elevation differences,
- Rugged areas with large elevation differences normally require a larger contour interval so that the contours do not become too congested on the map.
- In general, reducing the contour interval requires more costly and precise fieldwork.
- In regions where both flat coastal areas and mountainous terrain are included in a map, supplementary contours, at one half or one fourth the basic contour interval, are often drawn (and shown with dashed lines).

- Topographic mapping convention calls for drawing only those contours that are evenly divisible by the contour interval:
 - for the 10-ft contour interval on the map in this figure (next slide), contours such as the 1100, 1110, 1120, and 1130 are shown.
- Elevations are shown in breaks in the contour lines, and to avoid confusion, at least every fifth contour is labeled.
- To aid in reading topographic maps, every fifth contour (each that is evenly divisible by five times the contour interval) is drawn using a heavier line:
 - In the figure shown in the next slide the 1100, 1150, 1200, and so on contours are drawn more heavily.

Contours



Characteristics of Contours

- 1) Contour lines must close on themselves, either on or off a map. They cannot dead end.
- 2) Contours are perpendicular to the direction of maximum slope.
- 3) The slope between adjacent contour lines is assumed to be uniform. (Thus, it is necessary that breaks (changes) in grade be located in topographic surveys.)
- 4) The distance between contours indicates the steepness of a slope. Wide separation denotes gentle slopes; close spacing, steep slopes; even and parallel spacing, uniform slope.
- 5) Irregular contours signify rough, rugged country. Smooth lines imply more uniformly rolling terrain.
- 6) Concentric closed contours that increase in elevation represent hills. A contour forming a closed loop around lower ground is called a depression contour (Spot elevations and hachures inside the lowest contour and pointing to the bottom of a hole or sink with no outlet make map reading easier.)

- 7) Contours of different elevations never meet except on a vertical surface such as a wall, cliff, or natural bridge. They cross only in the rare case of a cave or overhanging shelf. Knife-edge conditions are never found in natural formations.
- 8) A contour cannot branch into two contours of the same elevation.
- 9) Contour lines crossing a stream point upstream and form V's; they point down the ridge and form U's when crossing a ridge crest.
- 10) Contour lines go in pairs up valleys and along the sides of ridge tops.
- 11) A single contour of a given elevation cannot exist between two equal-height contours of higher or lower elevation. For example, an 820-ft contour cannot exist alone between two 810- or two 830-ft contours.
- 12) Cuts and fills for earth dams, levees, highways, railroads, canals, etc., produce straight or geometrically curved contour lines with uniform, or uniformly graduated spacing. Contours cross sloping or crowned streets in typical V- or U-shaped lines.

Some sources of error in planimetric and topographic surveys are:

- 1) Instrumental errors, especially an index error that affects vertical and zenith angles.
- 2) Errors in reading instruments.
- 3) Control not established, checked, and adjusted before beginning to collect details.
- 4) Control points too far apart and poorly selected for proper coverage of an area.
- 5) Sights taken on detail points which are too far away.
- 6) Poor selection of points for contour delineation.

Some typical mistakes in planimetric and topographic surveys are:

- 1) Unsatisfactory equipment or field method for particular survey and terrain conditions.
- 2) Mistakes in instrument reading and data recording.
- 3) Failure to periodically check azimuth orientation when many detail points are located from one instrument station.
- 4) Too few (or too many) contour points taken.
- 5) Failure to collect some mapping details.
- 6) Mistakes in entering point identifiers, drawing designators, and symbols when using field-to-finish surveying and mapping systems.

End of Lecture 17: Mapping Surveys