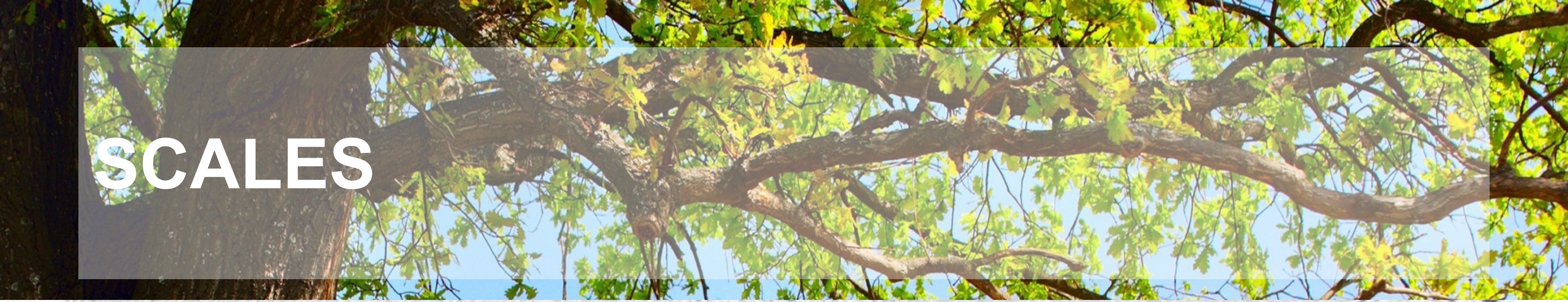
SCALES

INTRODUCTION

- *A scale is defined as the ratio of the linear dimensions of element of the object*
- *as represented in a drawing to the actual dimensions of the same element of the*
- *object itself*
- *MAP SCALE=* $\dfrac{\text{DISTANCE ON MAP}}{\text{DISTANCE ON GROUND}}$

NECESSITY OF DRAWING SCALES ON MAP

When a map is used after a considerable time or in a different climatic conditions the dimensions of paper usually get distorted. Due to distortion in the paper the numerical scales will not give accurate results. On the other hand ,if a graphical scale is drawn on the map there will also be a proportional distortion in the length of the scale and the distances from the distorted map will be accurately scaled off. This is why scales are always drawn on the maps and charts which are maintained for future references.



SCALES

The scales generally used for general engineering drawings are shown in table 4-1 [SP : 46].

TABLE 4-1

(i)	Reducing scales	1 : 2	1 : 5	1 : 10
		1 : 20	1 : 50	1 : 100
		1 : 200	1 : 500	1 : 1000
		1 : 2000	1 : 5000	1 : 10000
(ii)	Enlarging scales	50 : 1	20 : 1	10 : 1
		5 : 1	2 : 1	
(iii)	Full size scales			1 : 1

All these scales are usually 300 mm long and sub-divided throughout their lengths. The scale is indicated on the drawing at a suitable place near the title. The complete designation of a scale consists of word scale followed by the ratio, i.e. scale 1 : 1 or scale, full size.

It may not be always possible to prepare full-size drawings. They are, therefore, drawn proportionately smaller or larger. When drawings are drawn smaller than the actual size of the objects (as in case of buildings, bridges, large machines etc.) the scale used is said to be a *reducing scale* (1 : 5). Drawings of small machine parts, mathematical instruments, watches etc. are made larger than their real size. These are said to be drawn on an *enlarging scale* (5 : 1).

The scales can be expressed in the following *three* ways:

(1) **Engineer's scale:** In this case, the relation between the dimension on the drawing and the actual dimension of the object is mentioned numerically in the style as 10 mm = 5 m etc.

(2) Graphical scale: The scale is drawn on the drawing itself. As the drawing becomes old, the engineer's scale may shrink and may not give accurate results.

However, such is not the case with graphical scale because if the drawing shrinks, the scale will also shrink. Hence, the graphical scale is commonly used in survey maps.

(3) Representative fraction: The ratio of the length of the object represented on drawing to the actual length of the object represented is called the Representative Fraction (i.e. R.F.).

$$\text{R.F.} = \frac{\text{Length of the drawing}}{\text{Actual length of object}}$$

When a 1 cm long line in a drawing represents 1 metre length of the object, the R.F. is equal to $\frac{1\text{ cm}}{1\text{ m}} = \frac{1\text{ cm}}{1 \times 100\text{ cm}} = \frac{1}{100}$ and the scale of the drawing will be 1 : 100 or $\frac{1}{100}$ full size. *The R.F. of a drawing is greater than unity when it is drawn on an enlarging scale.* For example, when a 2 mm long edge of an object is shown in a drawing by a line 1 cm long, the R.F. is $\frac{1\text{ cm}}{2\text{ mm}} = \frac{10\text{ mm}}{2\text{ mm}} = 5$. Such a drawing is said to be drawn on scale 5 : 1 or *five times full-size*.

SCALES ON DRAWING

When an unusual scale is used, it is constructed on the drawing sheet. To construct a scale the following information is essential:

(1) The R.F. of the scale.

(2) The units which it must represent, for example, millimetres and centimetres, or feet and inches etc.

(3) The maximum length which it must show.

The length of the scale is determined by the formula:

Length of the scale = R.F. × maximum length required to be measured.

It may not be always possible to draw as long a scale as to measure the longest length in the drawing. The scale is therefore drawn 15 cm to 30 cm long, longer lengths being measured by marking them off in parts.

TYPES OF SCALES

The scales used in practice are classified as under:

(1) Plain scales

(2) Diagonal scales

(3) Comparative scales

(4) Vernier scales

(5) Scale of chords.

(1) Plain scales: A plain scale consists of a line divided into suitable number of equal parts or units, the first of which is sub-divided into smaller parts. Plain scales represent either two units or a unit and its sub-division.

In every scale,

(i) The zero should be placed at the end of the first main division, i.e. between the unit and its sub-divisions.

(ii) From the zero mark, the units should be numbered to the right and its sub-divisions to the left.

(iii) The names of the units and the sub-divisions should be stated clearly below or at the respective ends.

(iv) The name of the scale (e.g. scale, 1 : 10) or its R.F. should be mentioned below the scale.

Problem 4-1. (fig. 4-1): *Construct a scale of 1 : 4 to show centimetres and long enough to measure upto 5 decimetres.*

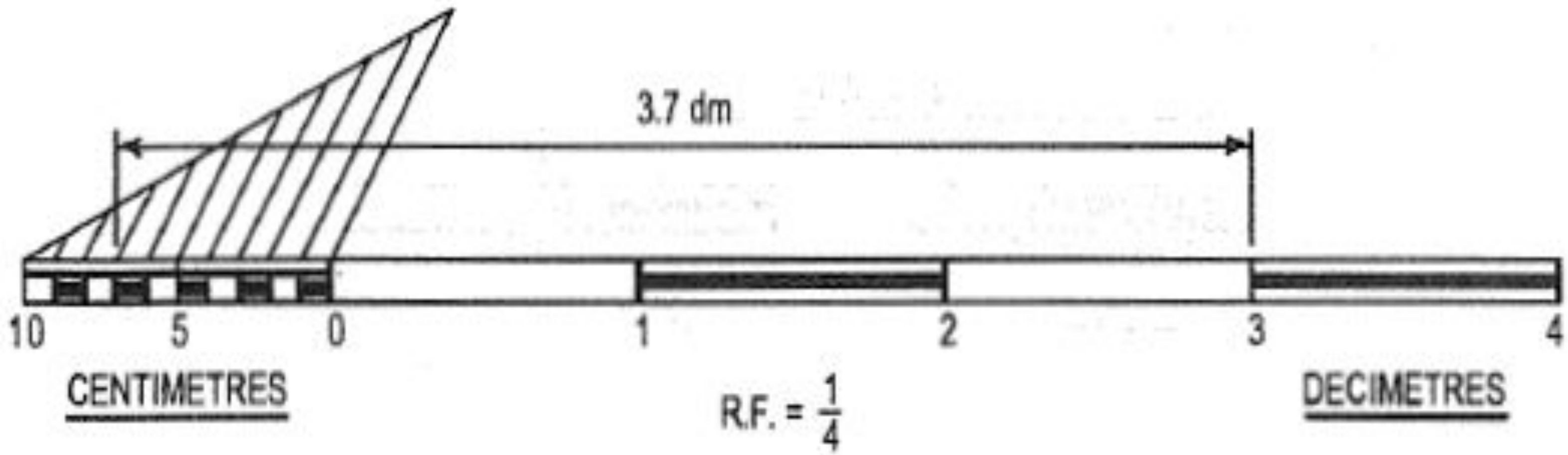


FIG. 4-1

(i) Determine R.F. of the scale. Here it is $\frac{1}{4}$.

(ii) Determine length of the scale.

Length of the scale = R.F. × maximum length = $\frac{1}{4}$ × 5 dm = 12.5 cm.

(iii) Draw a line 12.5 cm long and divide it into 5 equal divisions, each representing 1 dm.

(iv) Mark 0 at the end of the first division and 1, 2, 3 and 4 at the end of each subsequent division to its right.

(v) Divide the first division into 10 equal sub-divisions, each representing 1 cm.

(vi) Mark cms to the left of 0 as shown in the figure.

Problem 4-3. (fig. 4-3): *Construct a scale of 1.5 inches = 1 foot to show inches and long enough to measure upto 4 feet.*

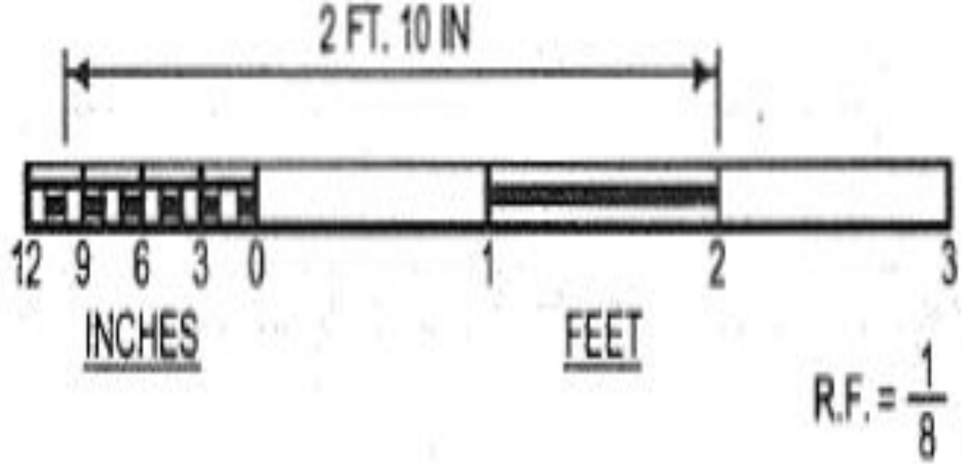


FIG. 4-3

(i) Determine R.F. of the scale. R.F. = $\frac{1.5 \text{ inches}}{1 \times 12 \text{ inches}} = \frac{1}{8}$.

(ii) Draw a line, 1.5 × 4 = 6 inches long.

(iii) Divide it into four equal parts, each part representing one foot.

(iv) Divide the first division into 12 equal parts, each representing 1". Complete the scale as explained in problem 4-1. The distance 2'-10" is shown measured in the figure.

DIAGONAL SCALE

(2) **Diagonal scales:** A diagonal scale is used when very minute distances such as 0.1 mm etc. are to be accurately measured or when measurements are required in three units; for example, dm, cm and mm, or yard, foot and inch.

Small divisions of short lines are obtained by the principle of diagonal division, as explained below.

Principle of diagonal scale: To obtain divisions of a given short line *AB* in multiples of $\frac{1}{10}$ its length, e.g. 0.1 *AB*, 0.2 *AB*, 0.3 *AB* etc. (fig. 4-6).

(i) At one end, say *B*, draw a line perpendicular to *AB* and along it, step-off ten equal divisions of any length, starting from *B* and ending at *C*.

(ii) Number the division-points, 9, 8, 7,.....1 as shown.

(iii) Join *A* with *C*.

(iv) Through the points 1, 2 etc. draw lines parallel to *AB* and cutting *AC* at 1', 2' etc. It is evident that triangles 1'1*C* , 2'2*C* ... *ABC* are similar.

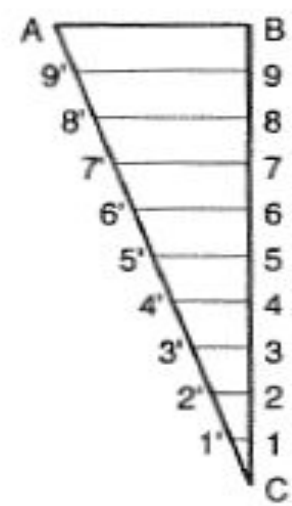


FIG. 4-6

Since *C*5 = 0.5*BC*, the line 5'5 = 0.5*AB*.

Similarly, 1'1 = 0.1*AB*, 2'2 = 0.2*AB* etc.

Thus, each horizontal line below *AB* becomes progressively shorter in length by $\frac{1}{10}$ *AB* giving lengths in multiples of 0.1*AB*.

Problem 4-7. (fig. 4-8): *Construct a diagonal scale of R.F. = $\frac{1}{4000}$ to show metres and long enough to measure upto 500 metres.*

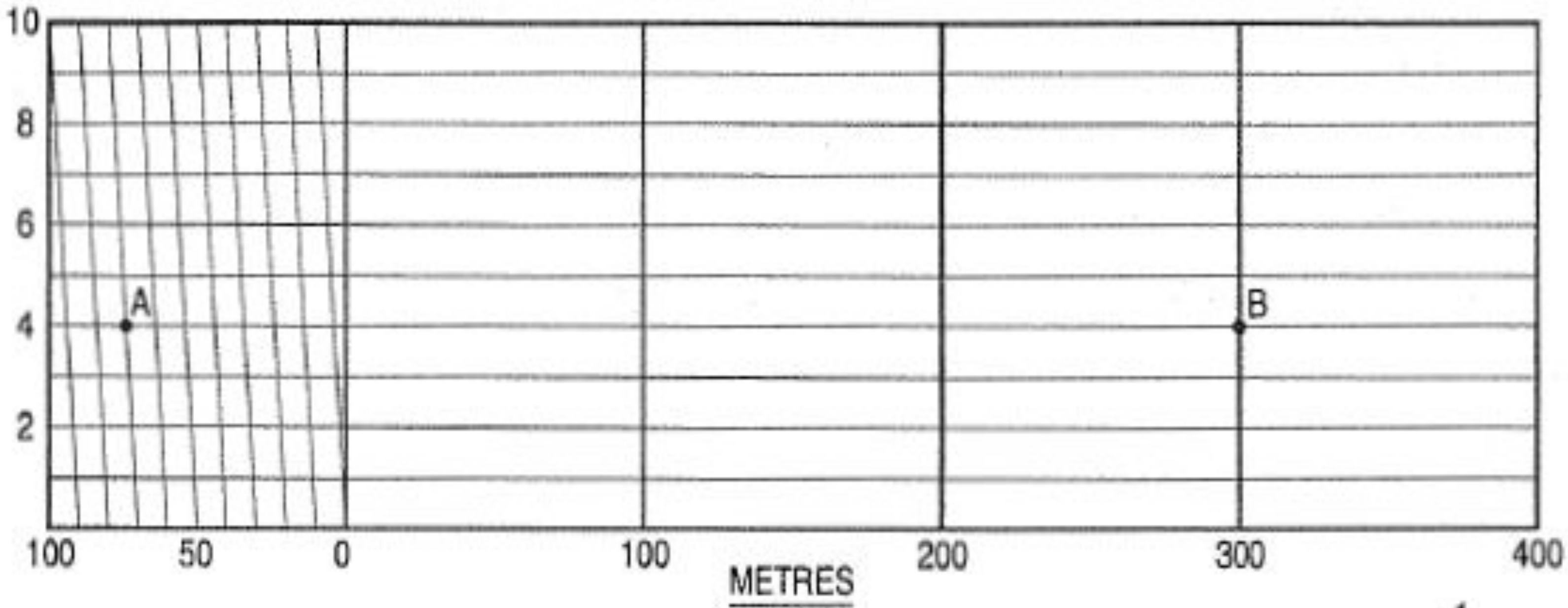


FIG. 4-8

Length of the scale = $\frac{1}{4000} \times 500$ m = $\frac{1}{8}$ metre = 12.5 cm.

(i) Draw a line 12.5 cm long and divide it into 5 equal parts. Each part will show 100 metres.

(ii) Divide the first part into ten equal divisions. Each division will show 10 metres.

(iii) At the left-hand end, erect a perpendicular and on it, step-off 10 equal divisions of any length.

(iv) Draw the rectangle and complete the scale as explained in problem 4-6.

The distance between points *A* and *B* shows 374 metres.

Problem 4-9. (fig. 4-10): *Construct a diagonal scale of R.F.* $= \frac{1}{32}$ *showing yards, feet and inches and to measure upto 4 yards.*

Length of the scale $= \frac{1}{32} \times 4$ **yd = 18 yd** $= 4\frac{1}{2}"$.

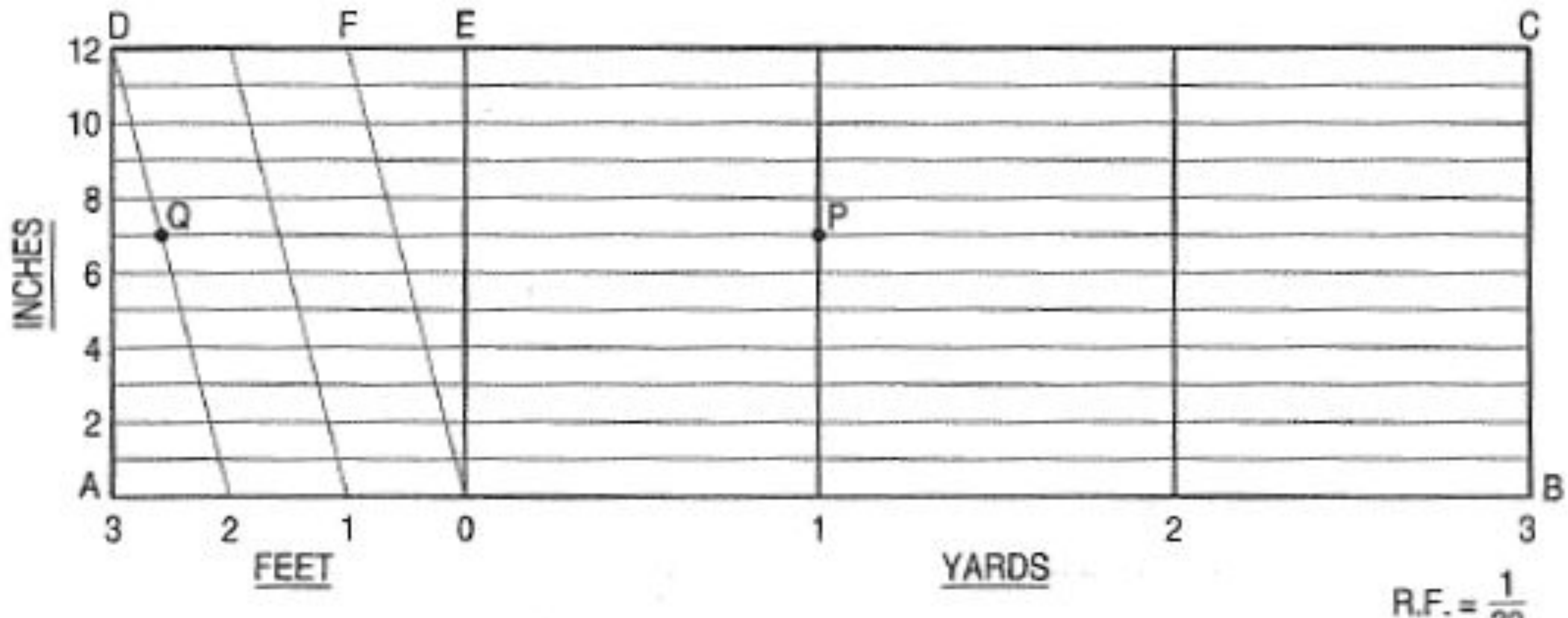


FIG. 4-10

(i) Draw a line *AB* $4\frac{1}{2}"$ long.

(ii) Divide it into 4 equal parts to show yards. Divide the first part *A*0 into 3 equal divisions showing feet.

(iii) At *A*, erect a perpendicular and step-off along it, 12 equal divisions of any length, ending at *D*. Complete the scale as explained in problem 4-6.

To show a distance of 1 yard, 2 feet and 7 inches, place one leg of the divider at *P*, where the horizontal through 7" meets the vertical from 1 yard and the other leg at Q where the diagonal through 2' meets the same horizontal.

PRECISION IN SURVEYING

The degree of precision required in surveying mainly depends upon the purpose and scale of the maps. Larger the scale better the precision required and vice versa.

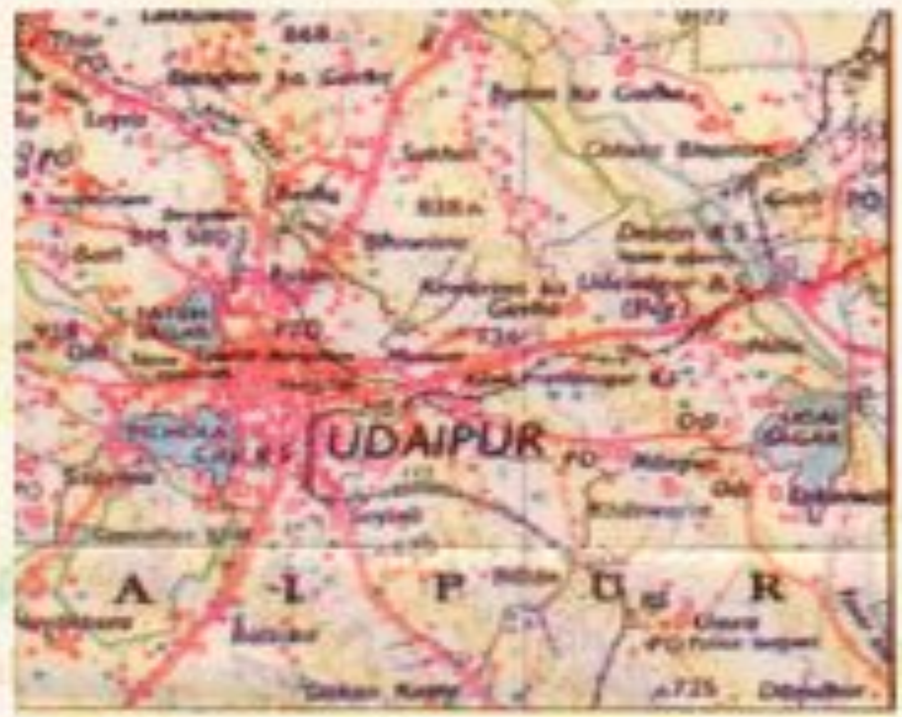
If a map is required to be on scale 1cm = 1km and the plotted permissible error on the map is 0.25mm it is therefore necessary to have a precision in linear measurement to 25 meters. i.e. an error of 25m in linear measurements of a line doesn't affect the accuracy of the map. On the other hand if the scale is 1cm= 5m the plotted permissible error on the map is given by 0.5x0.25 = 0.125m i.e. an error of 12.5 cm can hardly be tolerated.

FACTORS AFFECTING MAP SCALE

Before commencing a survey work the surveyor must therefore, consider the following factor , decide the method to be adopted and instruments best suited to the particular case:

1. Purpose of surveying
2. Degree of precision required
3. Scale of the map
4. Extent of the area
5. Nature of the country
6. Time available
7. Fund available for Survey

PLASTIC RELIEF MAPS	DISTRICT PLANNING MAP SERIES
GENERAL WALL MAPS	ROUTE & TREKKING MAPS
TOPOGRAPHICAL MAPS Scale 1:25,000 (coverage 7'30"x7'30", appx. Area 175 Sq Km) This is more detailed map and is widely used for planning and development purpose by the administrators and town planners.	**TOPOGRAPHICAL MAPS** Scale 1:250,000(coverage 1°x1°, Appx. Area 11140 Sq Km) An extremely useful map series for general planning.



STATE MAPS	TOURIST MAPS
MISCELLANEOUS (PUBLICATION)	DISCOVER INDIA MAPS
ROAD MAP Scale:1:2,500,000 One of the popular examples of Geographical map is Road Map of India. The map is invaluable for motoring public. It also highlights places of tourist interest.	**ANTIQUE MAPS** A portion of SKETCH of the ENVIRONS of DELHI made by Mr. F.S.White, Surveyor in the year 1807 on scale 1:79,200 (1 inch=1 1/4 miles).
	

INTERNATIONAL MAPS OF THE WORLD SERIES

Scale 1:1,000,000 (coverage 4°x6° Appx. Area 270,450 Sq Km) Total number of 26 maps cover India. These are prepared as per International specifications and prove very handy for regional planning.

GUIDE MAPS

Scale 1:20,000 Guide maps have been brought out for all major towns and places oftourists interests. These are invaluable to the tourists. In the absence of other large scale maps, town planners also make considerable use of these maps.

TOPOGRAPHICAL MAPS

Scale 1:50,000 (Coverage 15'x15', Appx. Area 700 SqKm) This is a general purpose map and is used by administrators planners and engineers. In fact, it is the most popular map for all activities of the Govt.

PROJECT MAPS

These maps are specially prepared to serve the needs of project authorities. The scale and contour interval depends upon the nature of the terrain (country) and the purpose of the Survey.