

# Representation of a Scale

SE 453



The mathematical scale of a map is the ratio or fraction between the distance on a map and the corresponding distance on the surface of the earth.

$$*(scale) = map\ distance / ground\ distance.*$$



- ▶ All map scales are an expression of the numerical relationship between the MAP and the LAND that is represented. The MAP unit is always mentioned first.



- ▶ Scale is shown on maps in three ways:
  - *Verbal Scale:*
  - *Graphic or Bar Scale*
  - *Representative Fraction (RF)*

# 1. Verbal Scale:

- ▶ The verbal scale is just a sentence stating that "1 Map Unit = X Land Units". For reasons of convenience, a mixture of units is commonly used, such as
  - ▶ 1 inch = 1 mile
  - ▶ However, there are NO requirements that the units must be different! The expression "1 inch = 63,360 inches" is still a verbal scale.
  - ▶ A mixture of map and land units makes the verbal scale difficult to compare between different maps – it must be converted first to a Representative Fraction

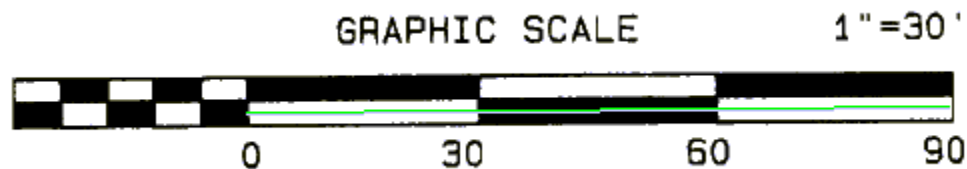
## 2. Representative Fraction (R.F.)



- ▶ An R.F. scale is a ratio, or fraction, that expresses the mathematical relationship between MAP and LAND,
- ▶ such as  $1 : 24,000$  which means "1 map unit is equivalent to 24,000 land units."
- ▶ Because an R.F. carries no units (inches, centimeters, etc.), it means that the R.F. scales can be compared between different maps.
- ▶ Converting an R.F. scale to a verbal scale is very easy; simply select ONE unit and apply it to BOTH map and land numbers.
- ▶ The above example can be written as a verbal scale as "1 inch = 24,000 inches" or "1 meter = 24,000 meters," etc

### 3. Graphic Scale:

- ▶ The graphic scale is a bar chart or "ruler" that is drawn at the bottom of a topographic map. This is the scale that you should use when asked to measure distances on the map.
- ▶ Be Careful: Note that the zero mark is not located at the left end of the graphic scale. For your convenience, the graphic scale extends to the left of the zero mark to indicate fractions of units, such as  $1/10$  of a mile. You may measure distances by marking off the 2 end points on the edge of a sheet of paper and aligning the edge of the paper against the graphic scale



- ▶ The Bar Scale is particularly important when enlarging or reducing maps by photocopy techniques because it changes with the map. If the Bar Scale is included in the photocopy, you will have an indication of the new scale.





# Converting Between Map Scale Types



- ▶ When converting a verbal scale to an R.F., the strategy is to convert from mixed units (verbal scale) to one unit (R.F.). That is the basic difference between these two types of map scales.

# example:



Example:

If your verbal scale is "1 inch = 1 mile" how is this expressed as an R.F.?

$$1 \text{ mile} \times \frac{(5,280 \text{ feet})}{(1 \text{ mile})} \times \frac{(12 \text{ inches})}{(1 \text{ foot})} = 63,360 \text{ inches}$$



- ▶ Converting an R.F. to a verbal scale is usually much easier than the reverse. ***By definition, an R.F. means that both the map and land units are the same***, so you can choose any ONE unit: 1 : 24,000 can be "1 cm = 24,000 cm" or "1 inch = 24,000," *so long as you do not use two different units. Remember, there is NO REQUIREMENT that a verbal scale must use different units!*



- ▶ To convert from RF to Verbal Scale you convert the fraction to familiar units of measurements:
  - ▶ 1:250,000  
1 inch = 250,000 inches
  - ▶ 1 inch = 250,000 inches [d] 12 inches/foot = 20,833.3 feet  
1 inch = 20,833.3 feet [d] 5280 feet/mile = 4 miles or  
1 inch = 250,000 [d] 63360 inches/mile = 4 miles  
1 inch equals 4 miles

# Relationship Between Scale & Area



- ▶ A map *scale* measures *distance*, which is a one-dimensional unit.
- ▶ *Area* is a 2-dimensional quantity, calculated by measuring "Length X Width."
- ▶ Note that *when a map scale is changed by a certain number factor, the area changes by the square of that number.*
- ▶ In other words,
  - *if the scale is 2 times larger, the area becomes 4 times larger;*
  - *if the scale is 5 times larger, the area becomes 25 times larger:*



- ▶ For example, suppose we measure a rectangular piece of property that is 3 cm by 4 cm on a map. The map is at a scale of 1:24,000. What is the area of the parcel?
- ▶ The area of the parcel on the map is 3 cm \* 4 cm = 12 cm<sup>2</sup>.

$$\begin{aligned} 3 \text{ cm map} \times 4 \text{ cm map} &= 12 \text{ cm}^2 \text{ map}^2 * \left(\frac{24,000 \text{ ground}}{1 \text{ map}}\right)^2 * \left(\frac{1 \text{ m}}{100 \text{ cm}}\right)^2 \\ &= 12 \text{ cm}^2 \text{ map}^2 * \frac{576,000,000 \text{ ground}^2}{1 \text{ map}^2} * \frac{1 \text{ m}^2}{10,000 \text{ cm}^2} \\ &= \frac{12 * 576,000,000}{10,000} \text{ m}^2 \text{ ground}^2 = 691,200 \text{ m}^2 \end{aligned}$$