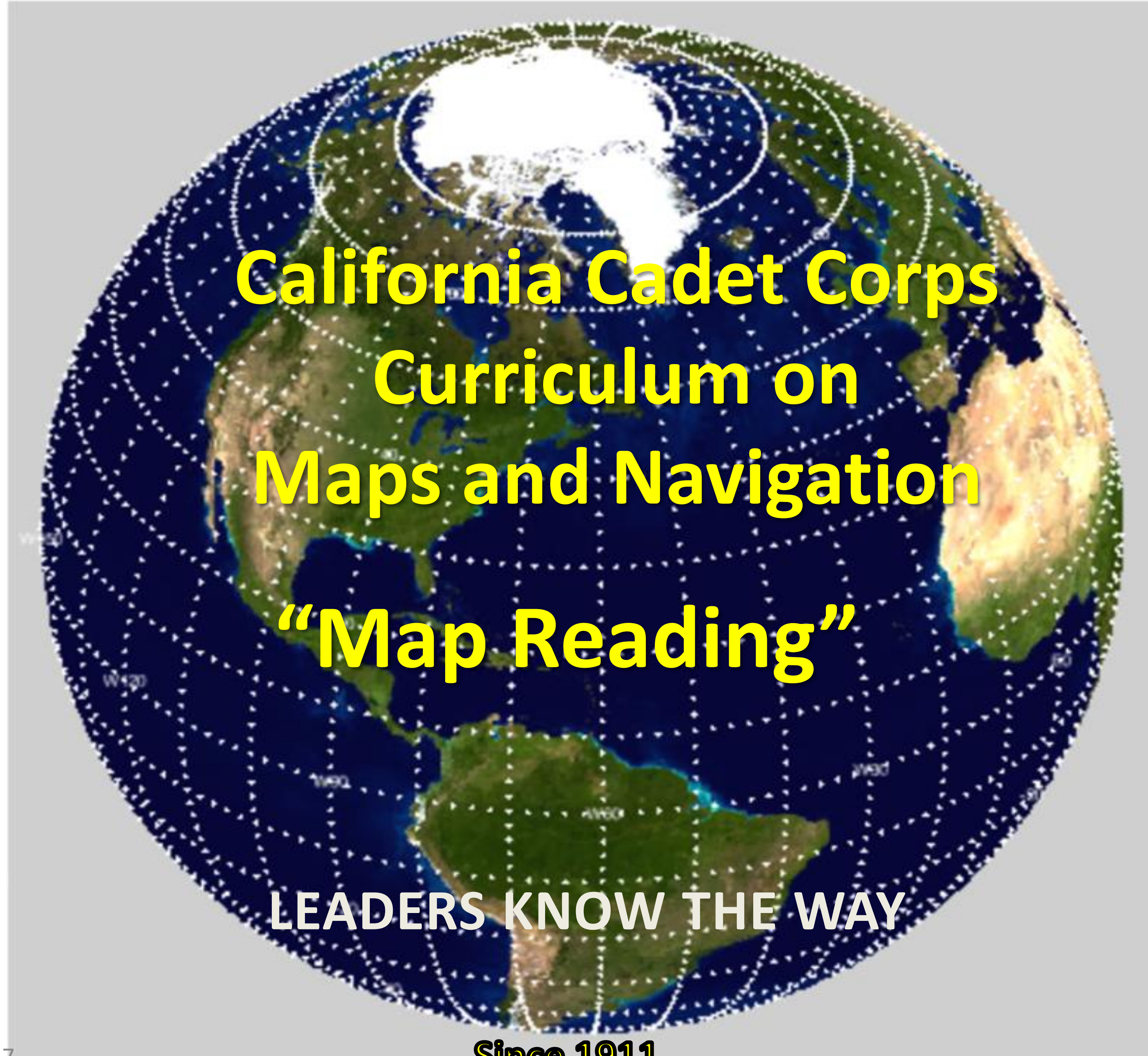

# California Cadet Corps Curriculum on Maps and Navigation

# "Map Reading"

LEADERS KNOW THE WAY

**Since 1911**

# Map Reading Agenda

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Note: This Show is over 200 slides. The Topics above are hyperlinked for quick navigation.

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# INTRODUCTION TO MAPS

A1. Describe the types of maps, what map projection is, how scale affects maps, and how latitude and longitude identify a specific location on the earth.

# Definition of a Map

A map is a graphic representation of a portion of the earth's surface drawn to scale, as seen from above; it uses colors, symbols and labels to represent features found on the ground.

# TYPES OF MAPS

- Globe
  - Latitude & Longitude
- City or State Road Maps
- Geographic Maps/Atlases
- Topographical Maps

# Globe

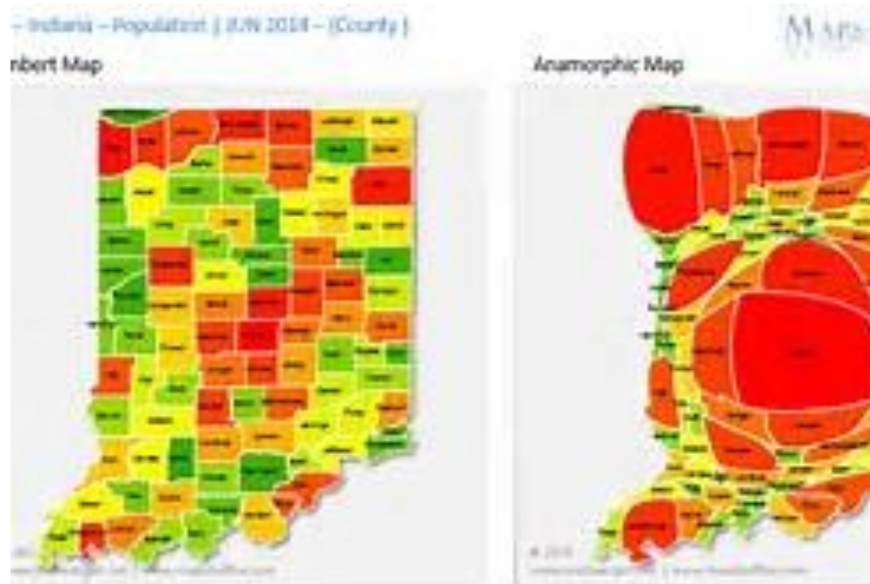
- A globe is an actual representation of the earth or other celestial body (such as a moon or planet)
- It is 3-dimensional
- It is to scale

# Road Maps

A **road map** or **route map** is a map that primarily displays roads and transport links rather than natural geographical information. It commonly includes political boundaries and labels, and points of interest, major features such as airports or prominent buildings, parks, hotels, etc.

# Geographical Maps

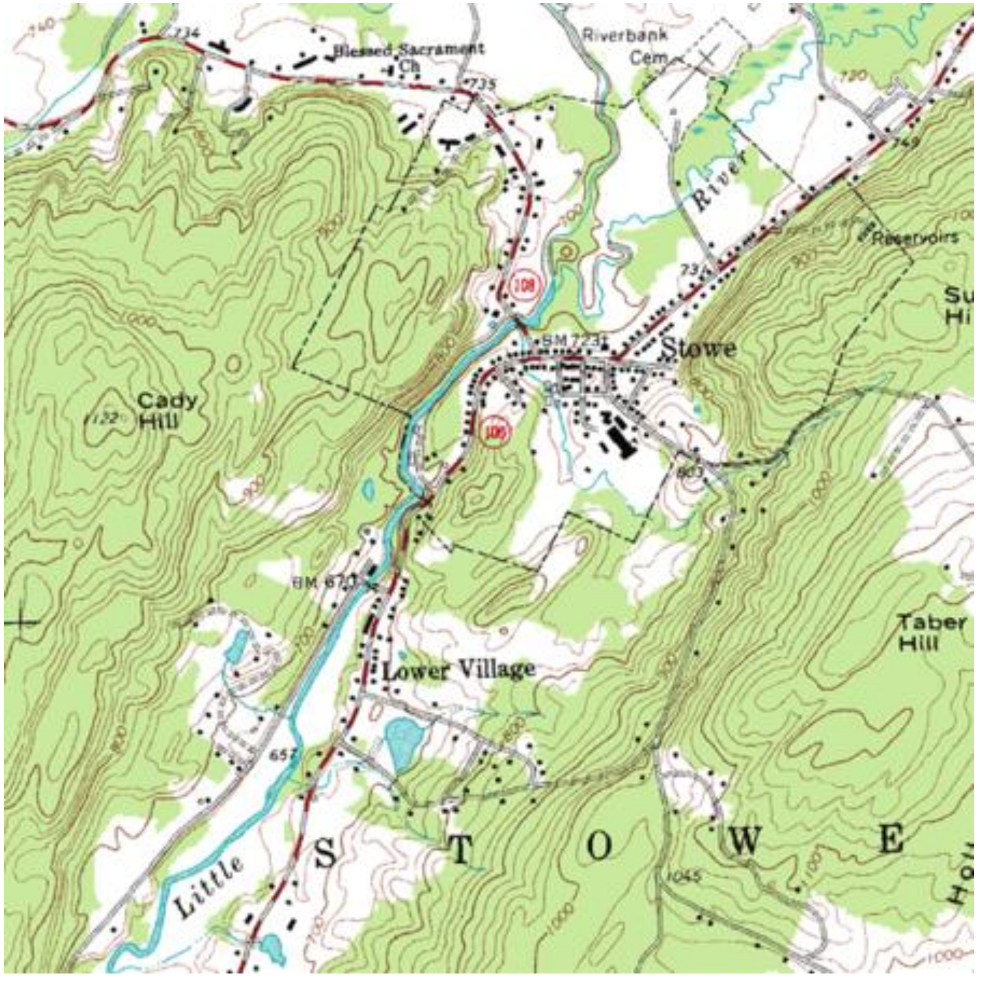
Geographical maps convey information in ways related to both physical geography and culture or size. They may not be to scale, and may not truly represent the shape of the actual area depicted.




Poplulation Density of Arizona counties

# Topographical Maps

In modern mapping, a **topographic map** is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features.

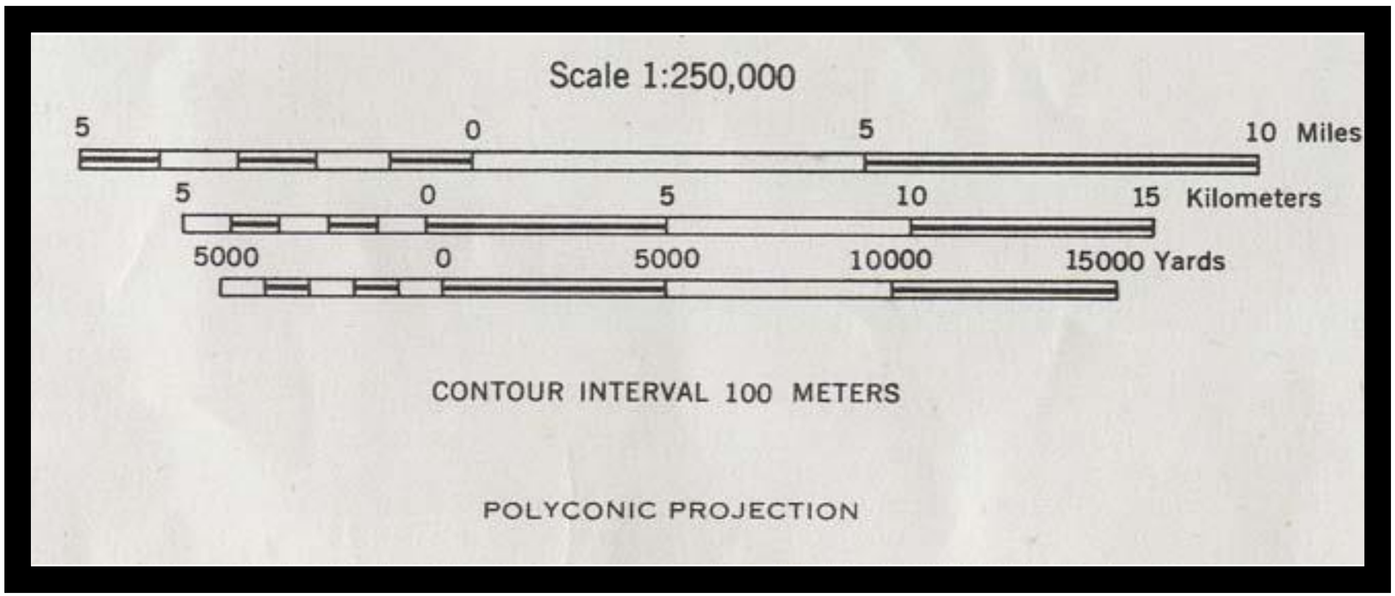


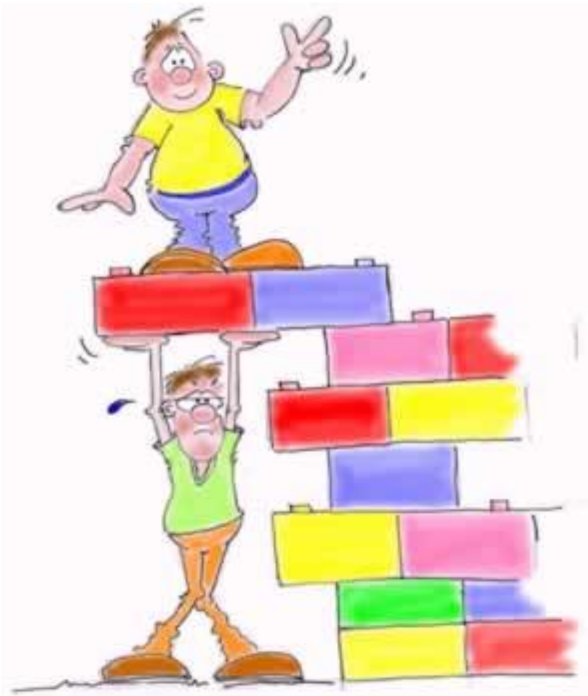

Source: Wikipedia

# Making a Spherical World Flat

- Earth is more or less spherical.
- Any attempt to convey the earth’s features on a flat map will have some distortion
- **Map Projections are different ways to portray the spherical earth on a plane (flat surface)**

# Map Scale


Scale 1:250,000
5
0
5
10 Miles
5
0
5
10
15 Kilometers
5000
0
5000
10000
15000 Yards
CONTOUR INTERVAL 100 METERS
POLYCONIC PROJECTION



# Map Scale

Map scale is the extent of reduction required to display a portion of the Earth's surface on a map

Scale determines the informational content and size of the area being represented

# Map Scales

1:25,000 Scale
1:50,000 Scale
1:100,000 Scale
1:250,000 Scale

The smaller the number on the right, the **larger the scale** of the map

Think of it like a fraction 1/25,000 is bigger than 1/250,000 !!

# Small Scale Map

Small Scale Maps have a scale of 1:1,000,000 and smaller.  These maps are used for general planning and strategic studies.

The standard small scale map is 1:1,000,000

# Medium Scale Map

Medium Scale Maps are maps of scales that are larger than 1:1,000,000 but smaller than 1:75,000. In the military, these maps are used for operational planning.

The standard medium scale map is 1:250,000

# Large Scale Map

Large Scale Maps are larger than 1:75,000. In the military, they are used to meet tactical, technical, and administrative needs of field units.

The standard large scale map is 1:50,000

# Map Scales

## Example of Scales

1:24,000 ---> 1 inch represents about 2000 feet

1:100,000 --> 1 inch represents about 1.6 miles

1:250,000 --> 1 inch represents about 4 miles

# Map Scales

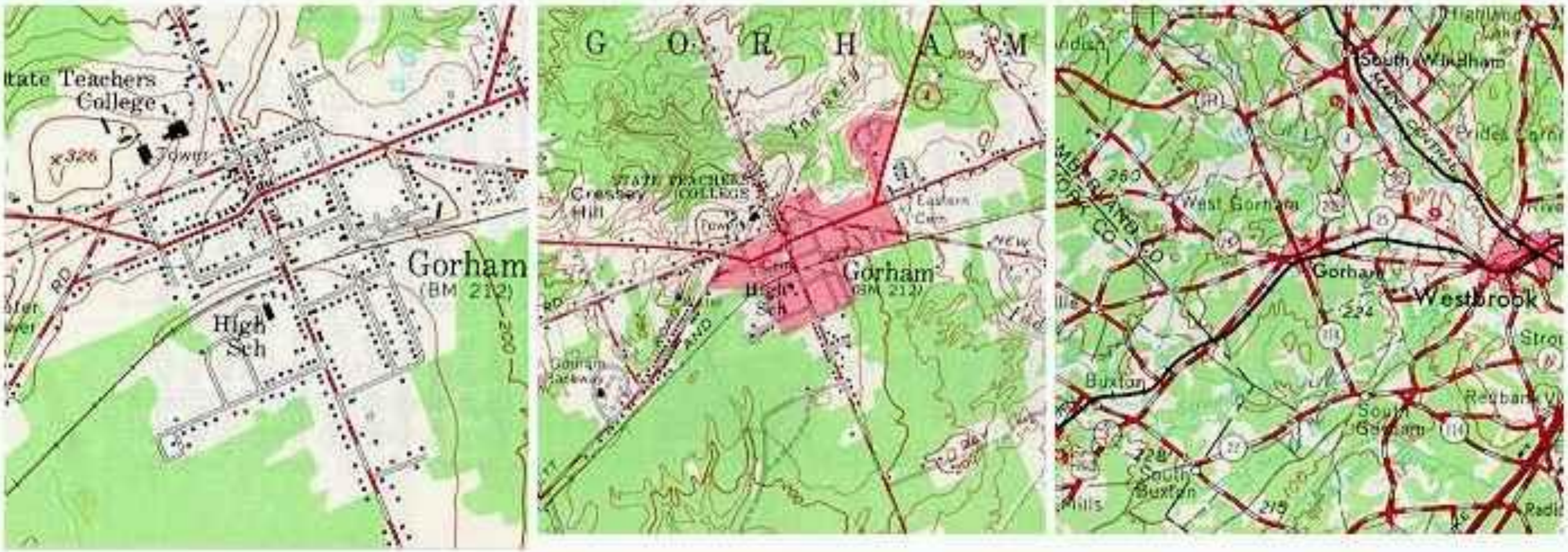



Figure 4a
Scale 1:24000
1 inch = 2000feet
Area Shown: 1 square mile

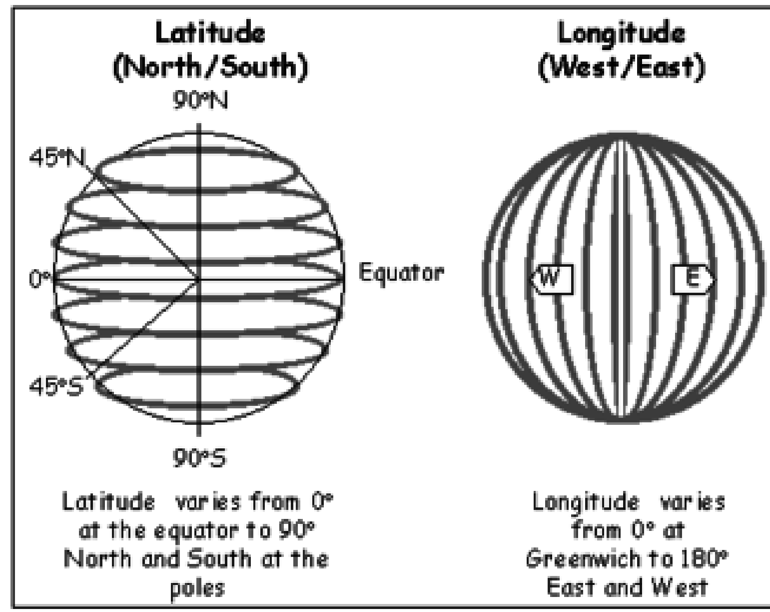
Figure 4b
Scale 1:62500
1 inch = nearly 1 mile
Area Shown: 6 3/4 square miles

Figure 4c
Scale 1:250,000
1 inch = nearly 4 miles
Area Shown: 107 square miles

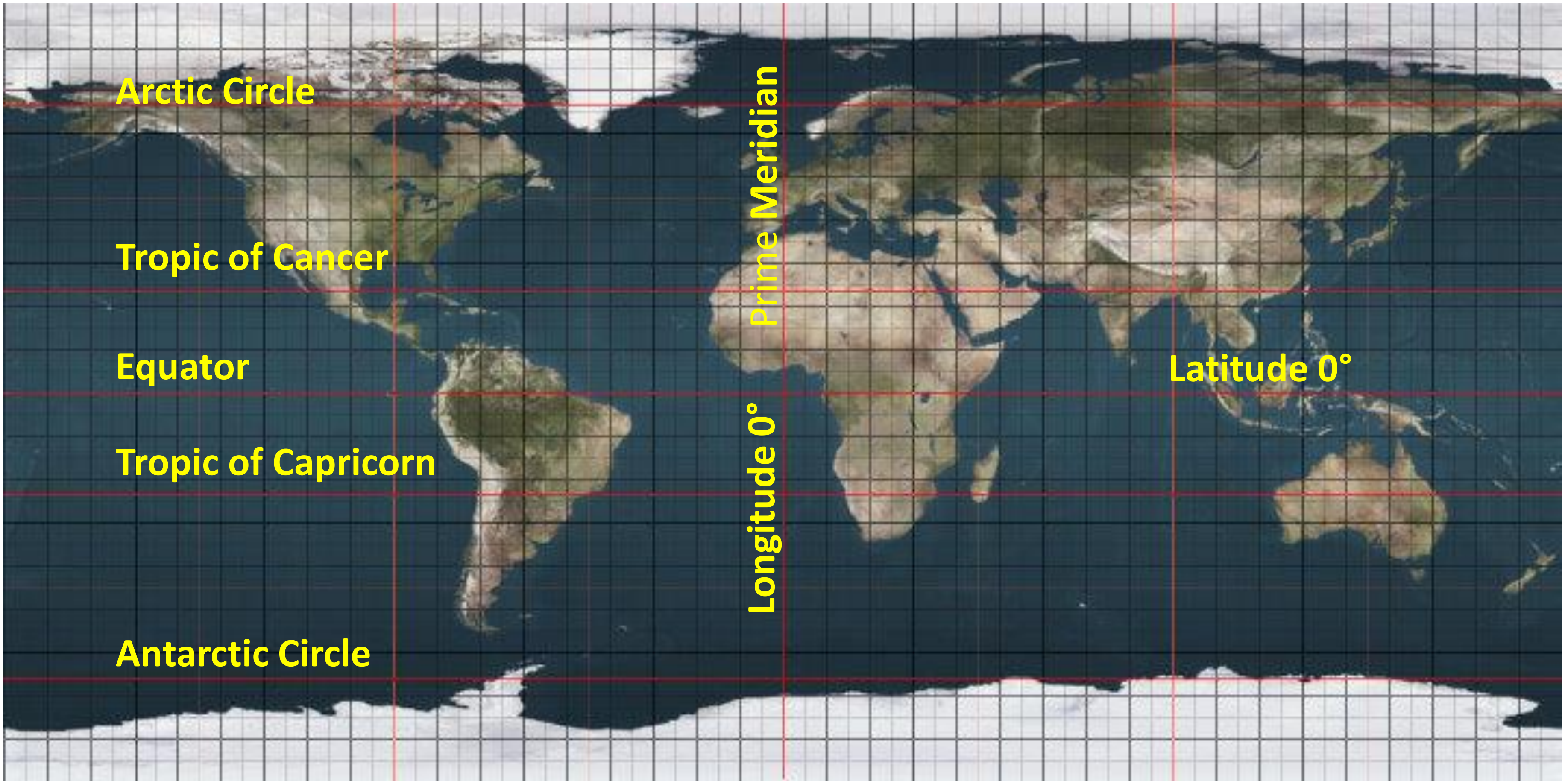
Map at three different scales

# Latitude & Longitude

**Longitude** lines are perpendicular and **latitude** lines are parallel to the equator. A geographic **coordinate** system is a **coordinate** system that enables every location on the Earth to be specified by a set of numbers or letters, or symbols.



# Latitude & Longitude



# Latitude/Longitude Coordinates

Lat/Long specifies the position of any location on the surface of Earth

N or S Only

E or W Only

| | | |
|---|---|---|
| Los Angeles, Ca | *Lat:* N 34° 03.1338′ | *Long:* W 118° 14.6208′ |
| Riverside, Ca | *Lat:* N 33° 57.2009' | *Long:* W 117° 23.7694' |
| London, UK | *Lat:* N 51° 30.0091' | *Long:* W 0° 07.5742' |
| Beijing, China | *Lat:* N 39° 54.4500′ | *Long:* **E** 116° 23.8338′ |
| Sydney, Australia | *Lat:* **S** 33° 52.0710′ | *Long:* **E** 151° 12.4392′ |

0° -90° Only

0° -180° Only

How to say it: Los Angeles: “North 34 degrees, 3.1338 minutes, West 118 degrees, 14.6208 minutes”

# Who Uses Latitude and Longitude?

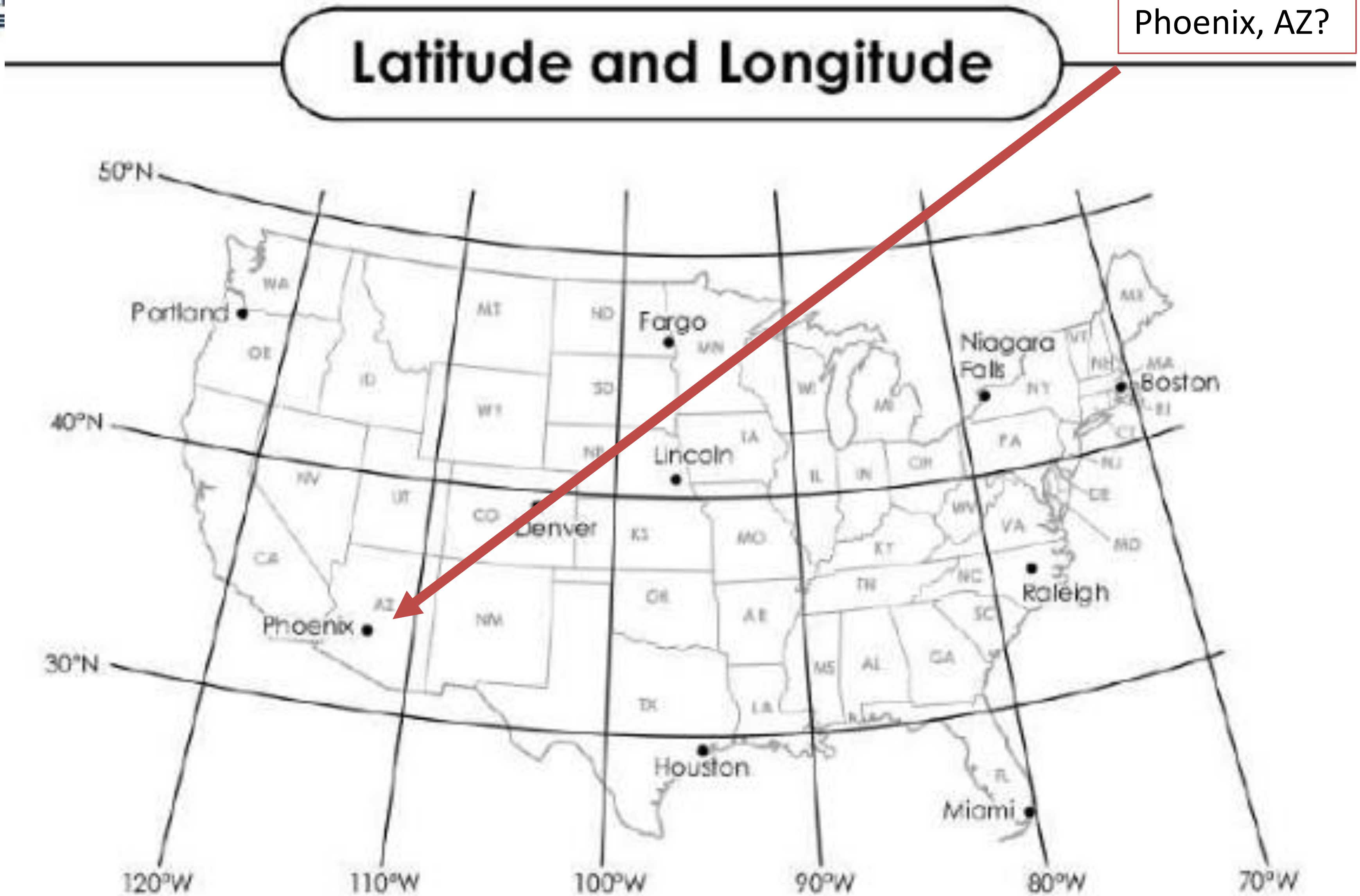
In the US Military, **aviation** and **naval** forces typically use latitude and longitude. Ships, boats, and airplanes travel at speeds called knots. 1 knot = 1 nautical mile per hour. 60 nautical miles = 1 degree of latitude. This makes it very easy to chart boat and airplane positions on sea charts and aviation charts.

# Check on Learning (1/2)

1. What type of Map has contour lines on it?
2. Why are map projections always distorted in some way?
3. How big would a map have to be if it covered an area of 1 square mile and the scale of the map was 1:1?

# Check on Learning (2/2)

What's the latitude and longitude of Phoenix, AZ?



# TOPOGRAPHIC MAPS

## Marginal Information, Colors, & Symbols

A2. Identify the meaning of colors and symbols used on a topographic map, and what the marginal information conveys.

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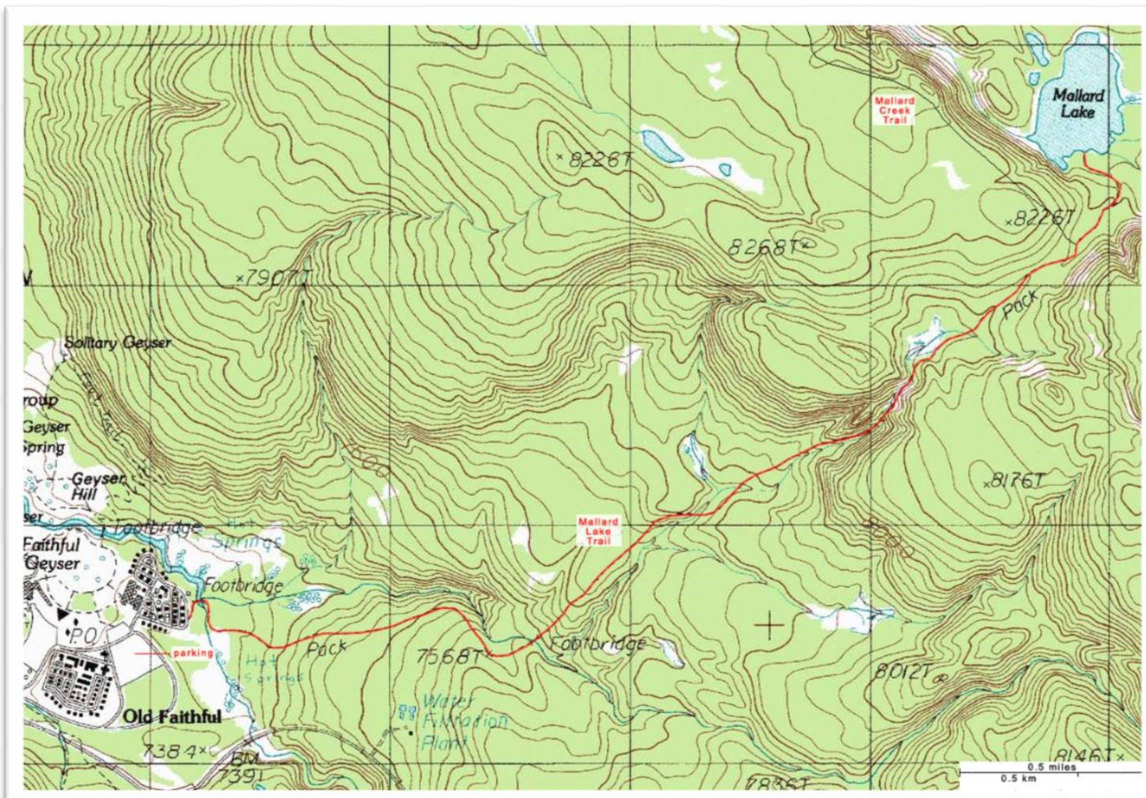
# Topographic Map

The feature that most distinguishes topographic maps from maps of other types is the use of **contour lines** to portray the shape and elevation of the land.



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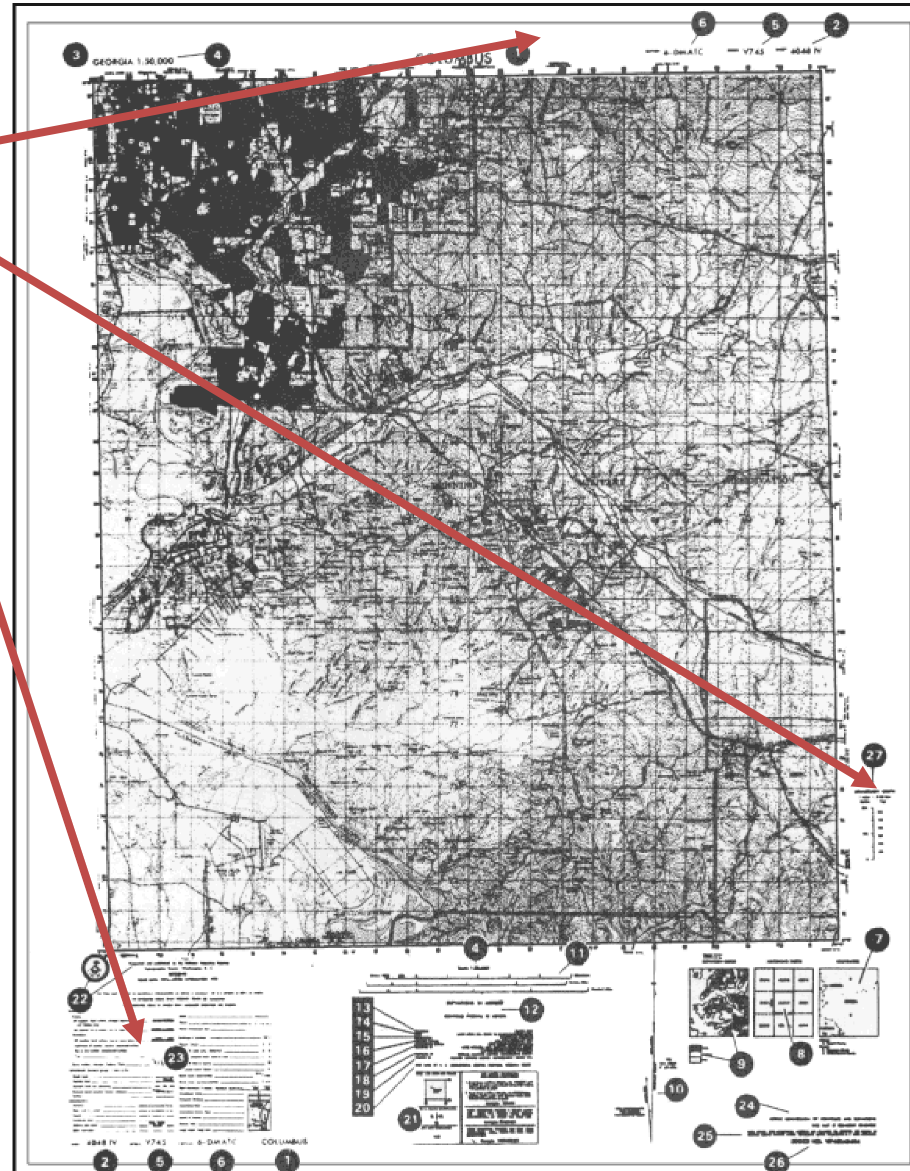
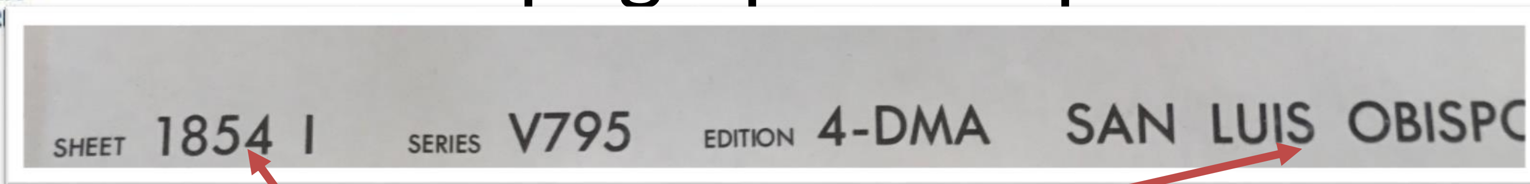
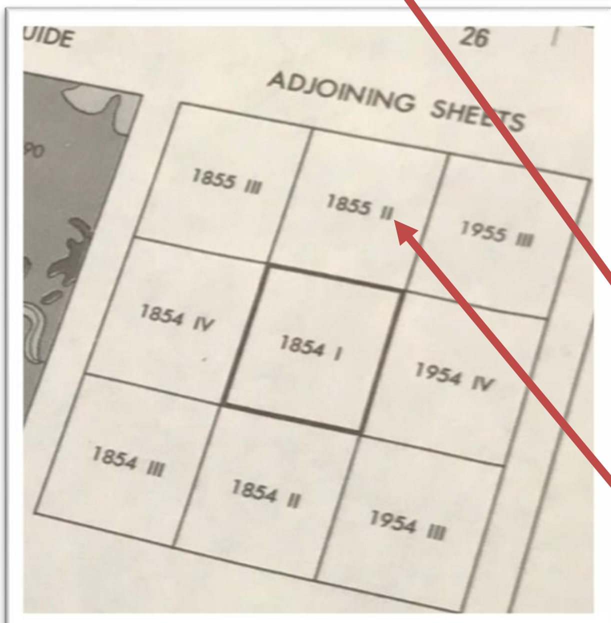
# Marginal Information

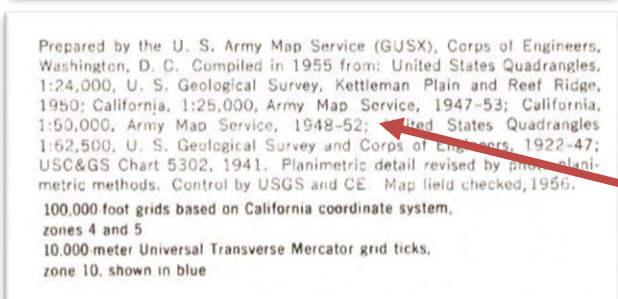
Around the margins of maps, there is a lot of information that helps you read and interpret the symbols on the map. This is called, for obvious reasons, **marginal information.**



# Marginal Information
## Topographic Maps



Prepared by the U. S. Army Map Service (GUSX), Corps of Engineers, Washington, D. C. Compiled in 1955 from: United States Quadrangles, 1:24,000, U. S. Geological Survey, Kettleman Plain and Reef Ridge, 1950; California, 1:25,000, Army Map Service, 1947-53; California, 1:50,000, Army Map Service, 1948-52; [illegible]ited States Quadrangles 1:62,500, U. S. Geological Survey and Corps of Eng[illegible]eers, 1922-47; USC&GS Chart 5302, 1941. Planimetric detail revised by ph[illegible] plani-metric methods. Control by USGS and CE. Map field checked, 1956.

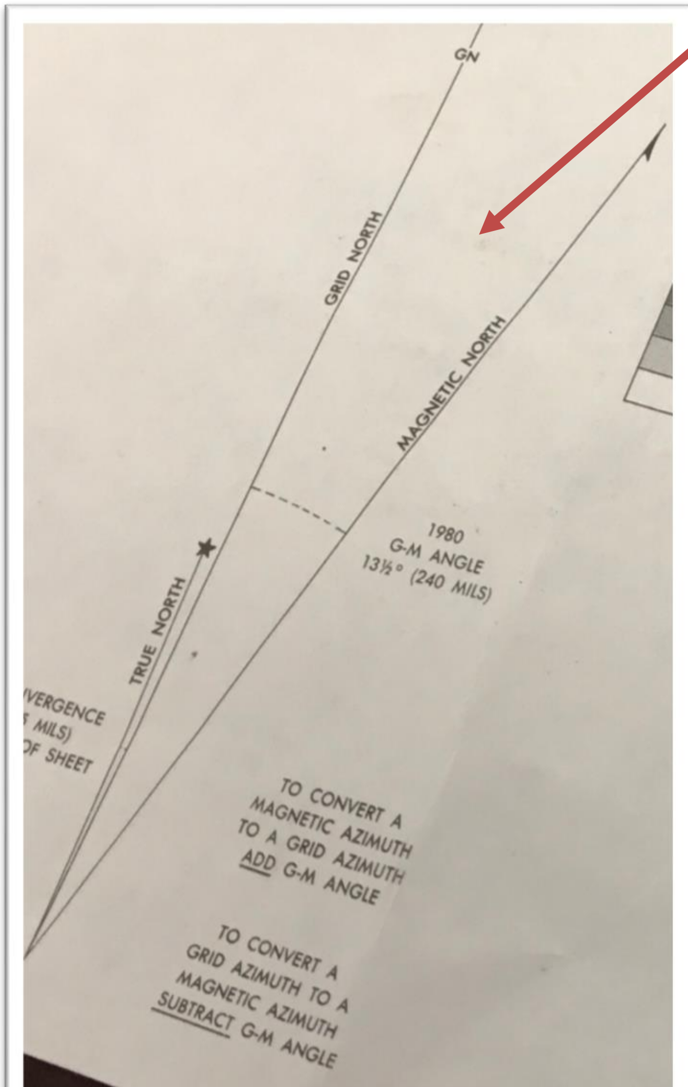
100,000-foot grids based on California coordinate system, zones 4 and 5

10,000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue

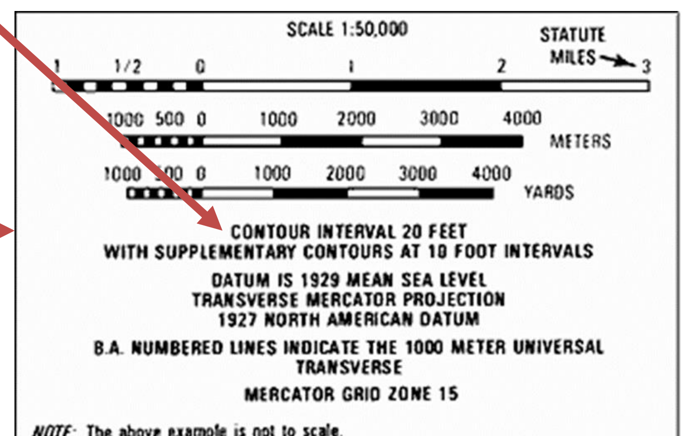
- **Sheet Name**. Like a title, in the center of the top margin. Also in the lower left margin.
- **Sheet Number**. Listed with the Sheet Name. Used as a reference number for the map sheet.
- **Adjoining Map Sheets Diagram**. Shows the 8 map sheets adjacent to this sheet, with their sheet number (at the same map scale).
- **Special Notes / Unit Imprint.**

# Marginal Information

## Topographic Maps

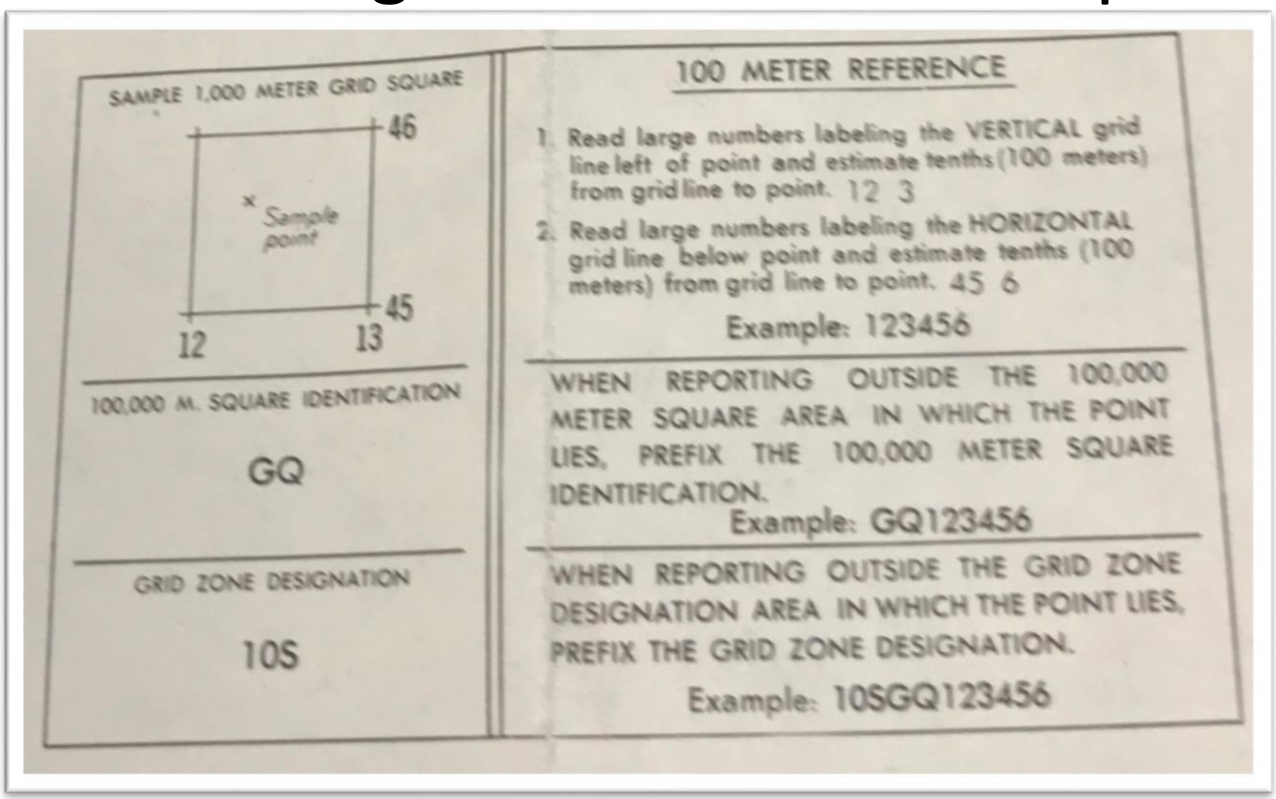



- **Declination Diagram.** Shows True, Grid, and Magnetic North, the G-M Angle, and how to convert grid to magnetic and magnetic to grid.
- **Scales.** Gives the scale used on the map. Graphically depicts distance in miles, meters, and yards.
- **Contour Interval.** Shows distance between contour lines



# Marginal Information
## Topographic Maps

- **Grid Reference Box.** Tells you the 2-digit Grid Zone Designators, and where the boundaries are between grid zones on the map.



SAMPLE 1,000 METER GRID SQUARE



100,000 M. SQUARE IDENTIFICATION

GQ

GRID ZONE DESIGNATION

10S

100 METER REFERENCE

1. Read large numbers labeling the VERTICAL grid line left of point and estimate tenths (100 meters) from grid line to point. 12 3
2. Read large numbers labeling the HORIZONTAL grid line below point and estimate tenths (100 meters) from grid line to point. 45 6

Example: 123456

WHEN REPORTING OUTSIDE THE 100,000 METER SQUARE AREA IN WHICH THE POINT LIES, PREFIX THE 100,000 METER SQUARE IDENTIFICATION.

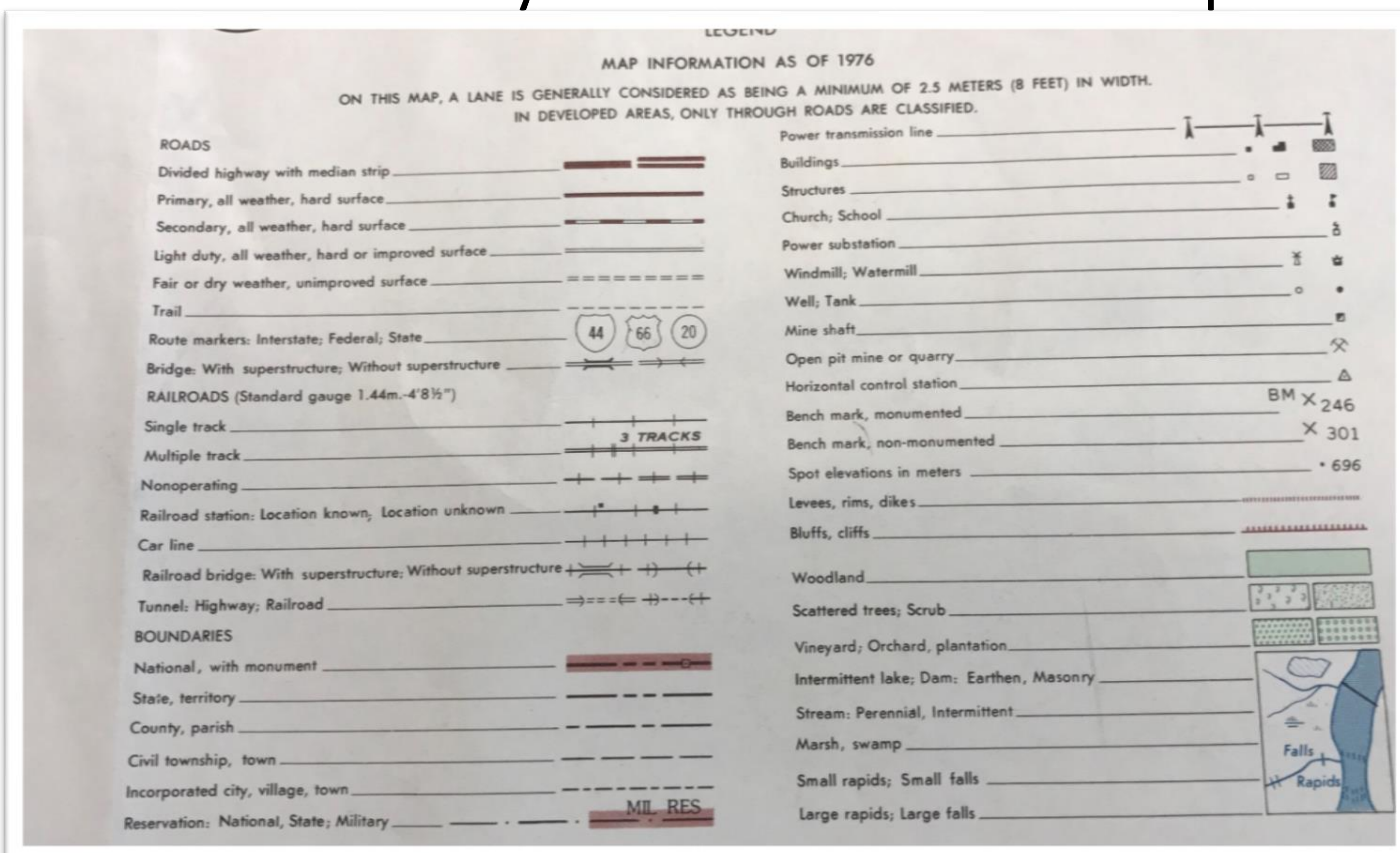
Example: GQ123456

WHEN REPORTING OUTSIDE THE GRID ZONE DESIGNATION AREA IN WHICH THE POINT LIES, PREFIX THE GRID ZONE DESIGNATION.

Example: 10SGQ123456

# Marginal Information
## Topographic Maps

- **Legend.** Gives the effective date of the map data and defines the symbols used on the map.



# Map Colors

Black - on a map is the work of humans: buildings, railroads, bridges, boundaries, names …

Blue - always means water: lakes, ponds, rivers, streams, water well, marshes …

Brown - symbols are used for relief features - contour lines and elevation …

Green - indicates forest, woodlands, orchards, and other areas of heavy vegetation.

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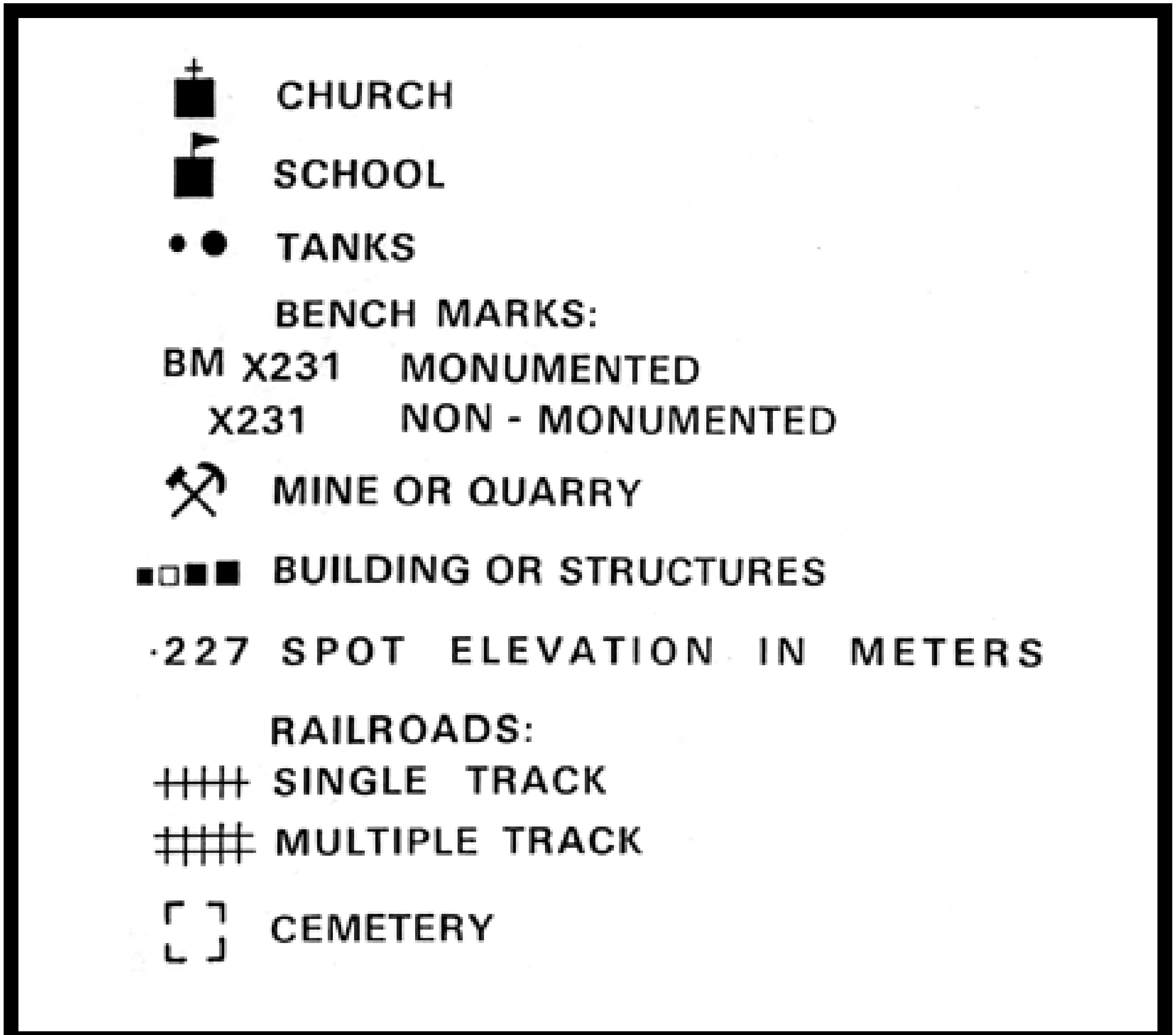
# Map Colors

- Red - is used for larger, more important roads and surveying lines.
- Purple - is for overprinting: Revisions added from aerial photographs but not yet field-checked, or planned additions.
- White - is mostly clear of trees: fields, meadows, rocky slopes, and other open country.

# Topographic Symbols



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# TOPOGRAPHIC SYMBOLS

## MAN MADE OBJECTS

(RED/BROWN)

HEAVY DUTY

HARD SURFACE

(RED/BROWN)

MEDIUM DUTY

# ROADS

IMPROVED
ROAD

UNIMPROVED
ROAD

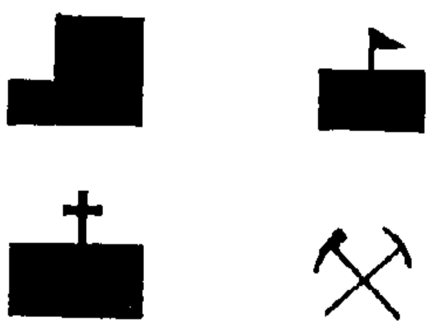
# TOPOGRAPHIC SYMBOLS
## MAN MADE OBJECTS

TRAIL

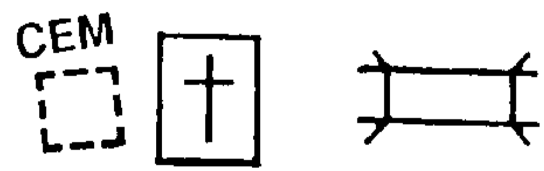
PROMINENT FENCE

SINGLE TRACK RR

DOUBLE TRACK RR



Building, Church, Mine



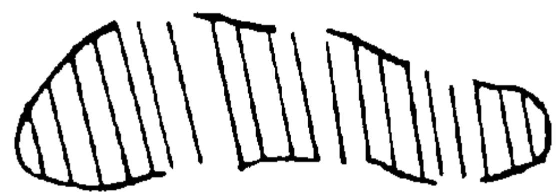

Cemetery, Bridge

# TOPOGRAPHIC SYMBOLS DRAINAGE AND VEGETATION

STREAM

INTERMITTENT STREAM

LAKE OR POND



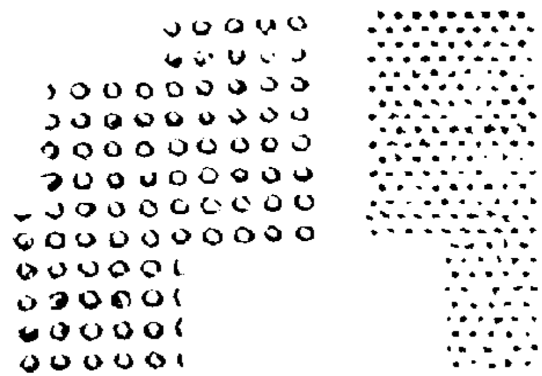
INTERMITTENT LAKE OR POND

# TOPOGRAPHIC SYMBOLS
# DRAINAGE AND VEGETATION

MARSH OR SWAMP

TROPICAL GRASS

WOODS



VINEYARD/ORCHARD

# Check on Learning

- Can you guess each of the following symbols on a topographic map?

You can figure most of them out by looking at the shape of the symbol, the color, and other identifying clues that are on the map.

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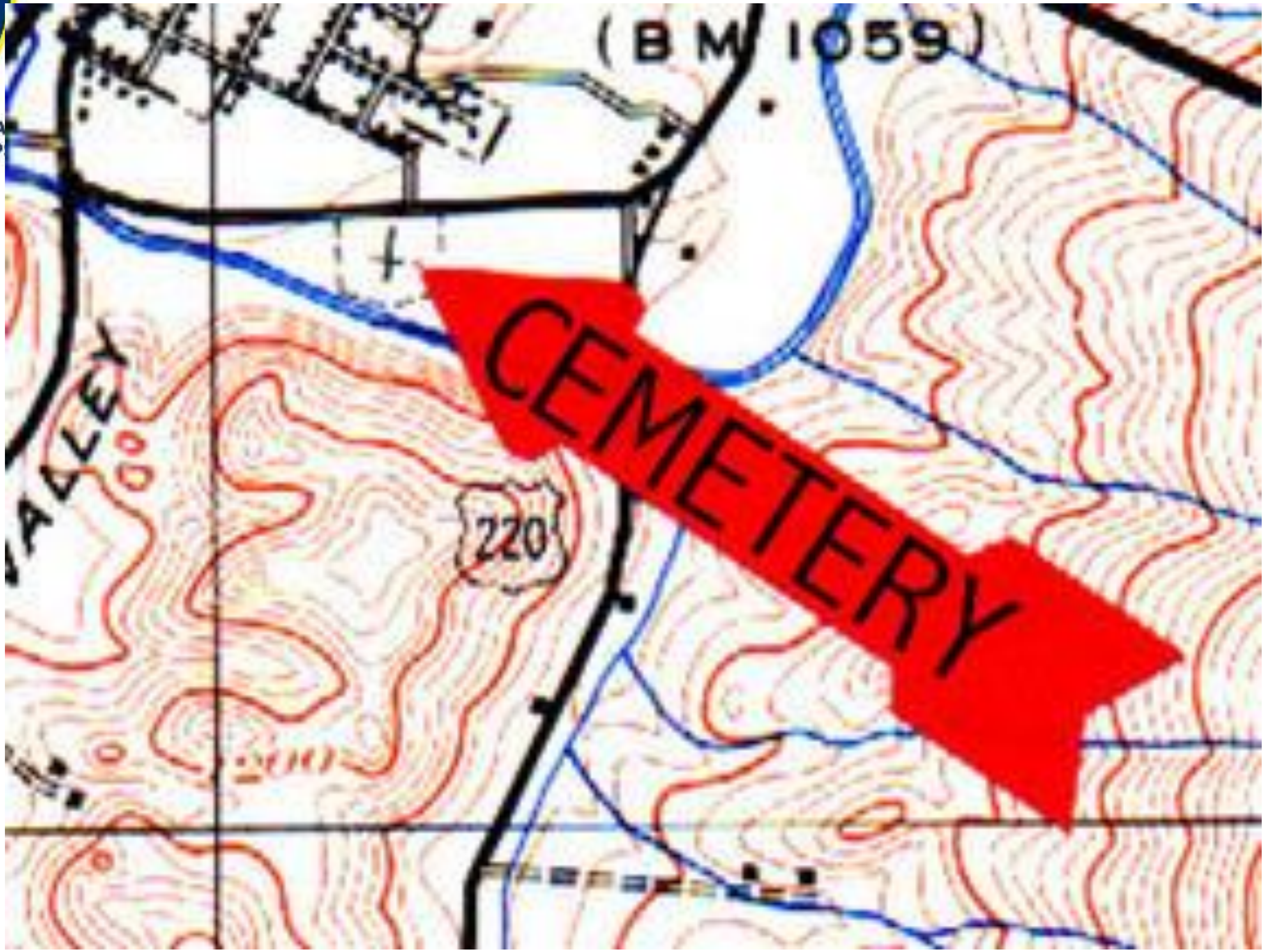
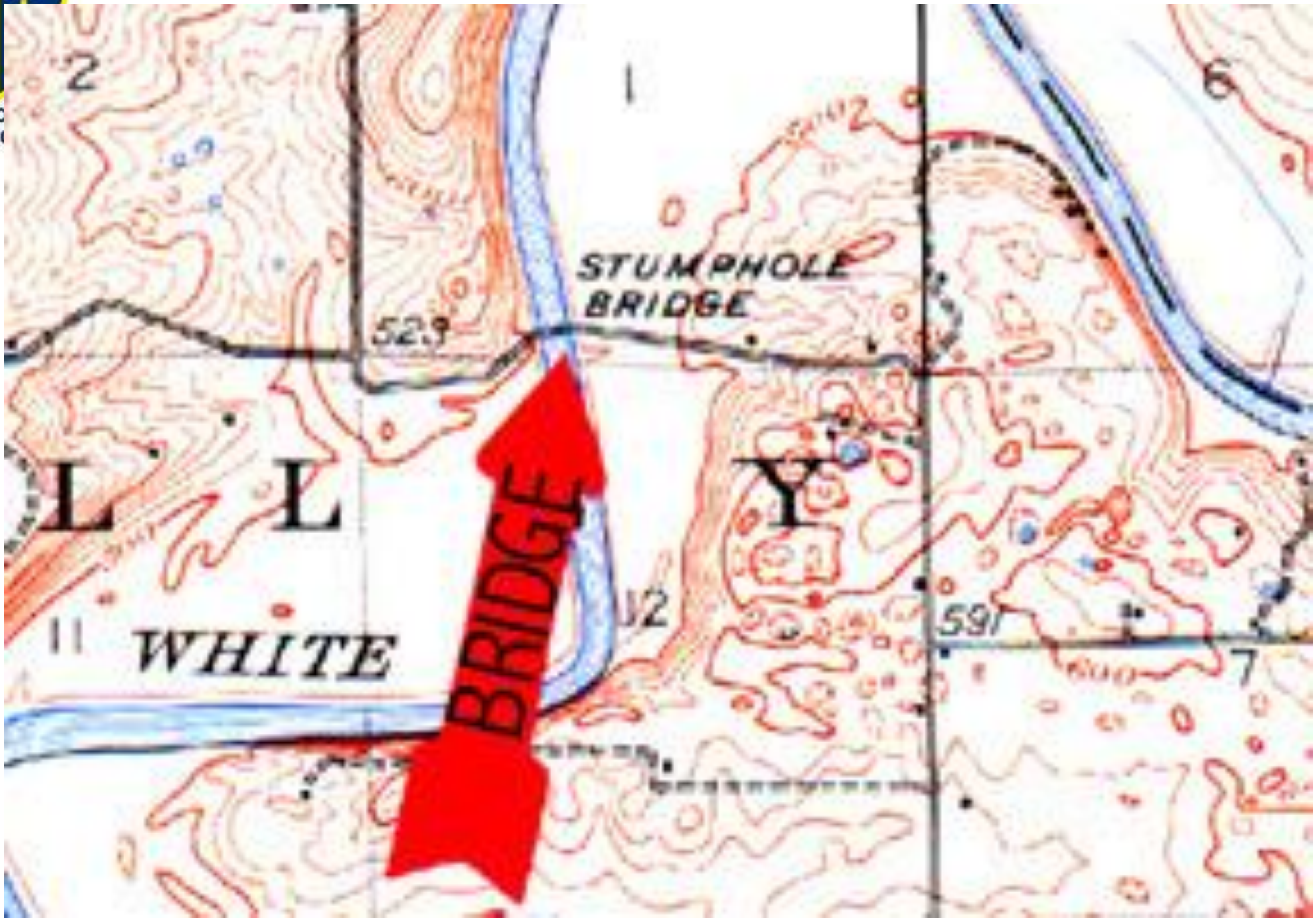
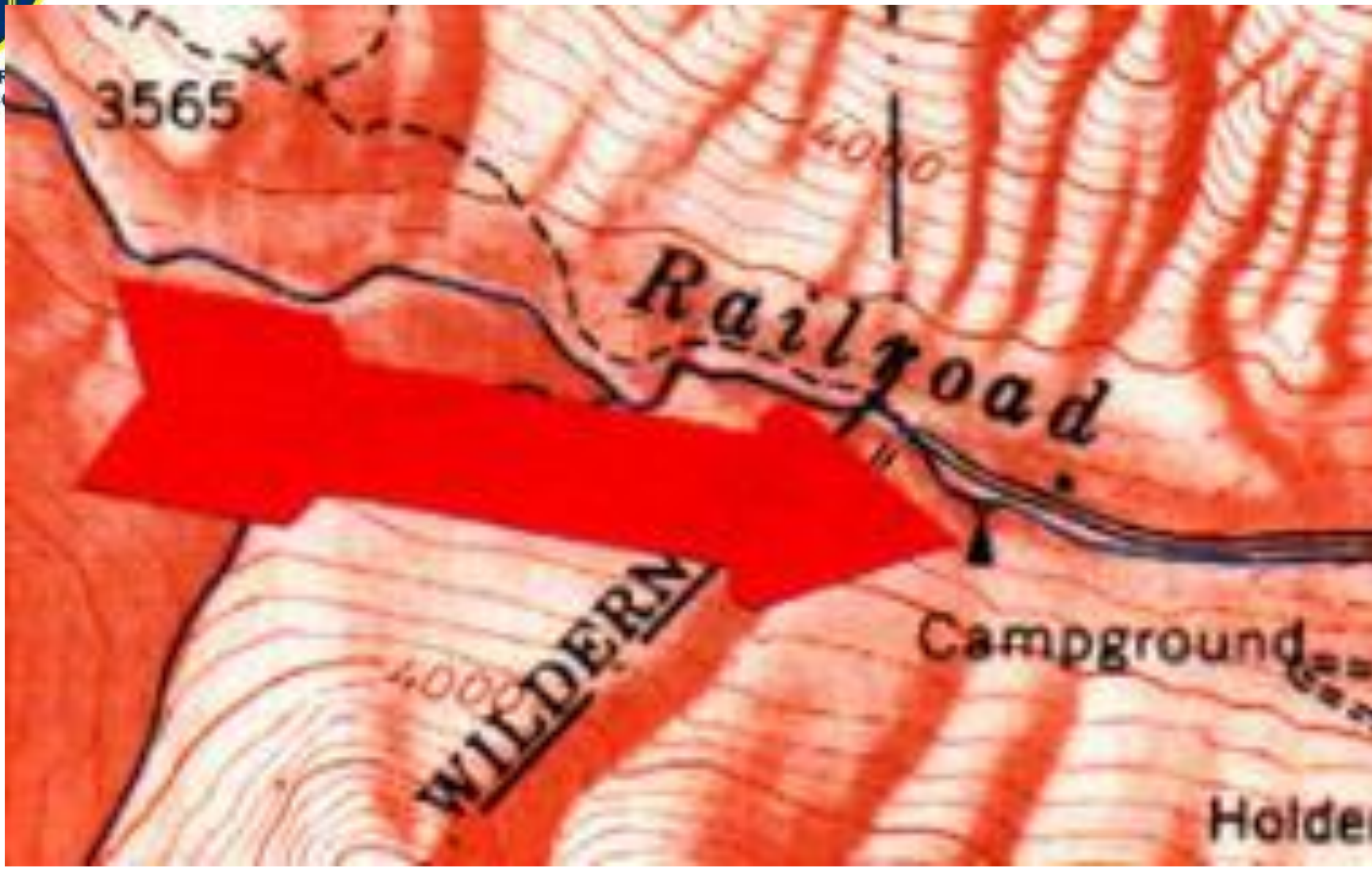
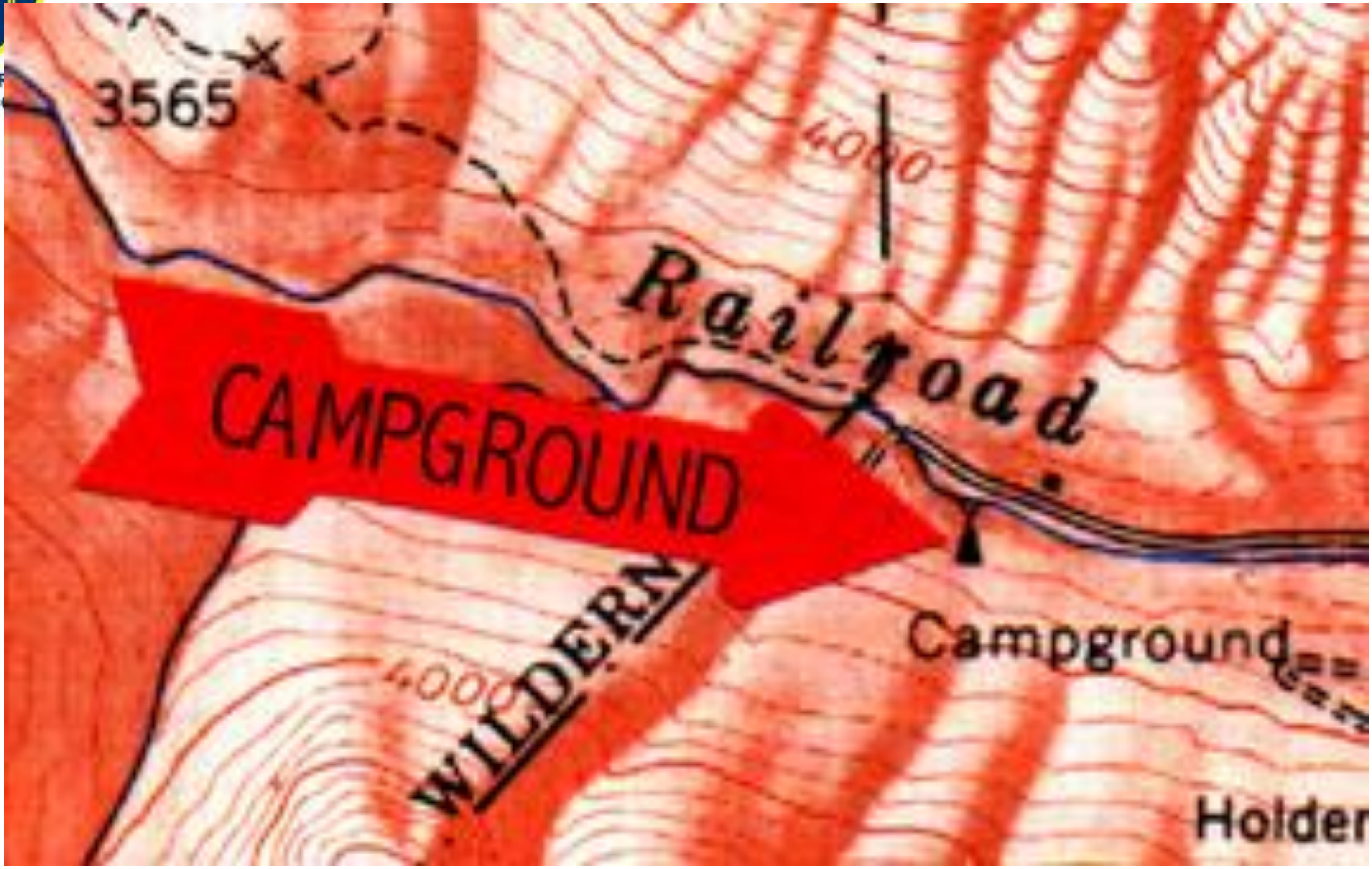



STUMPHOLE
BRIDGE
523
597
WHITE


STUMPHOLE
BRIDGE
529
591
WHITE
BRIDGE



3565
Railroad
WILDERN
4000
Campground
Holder


3565
4000
Railroad
CAMPGROUND
WILDERN
4000
Campground
Holder

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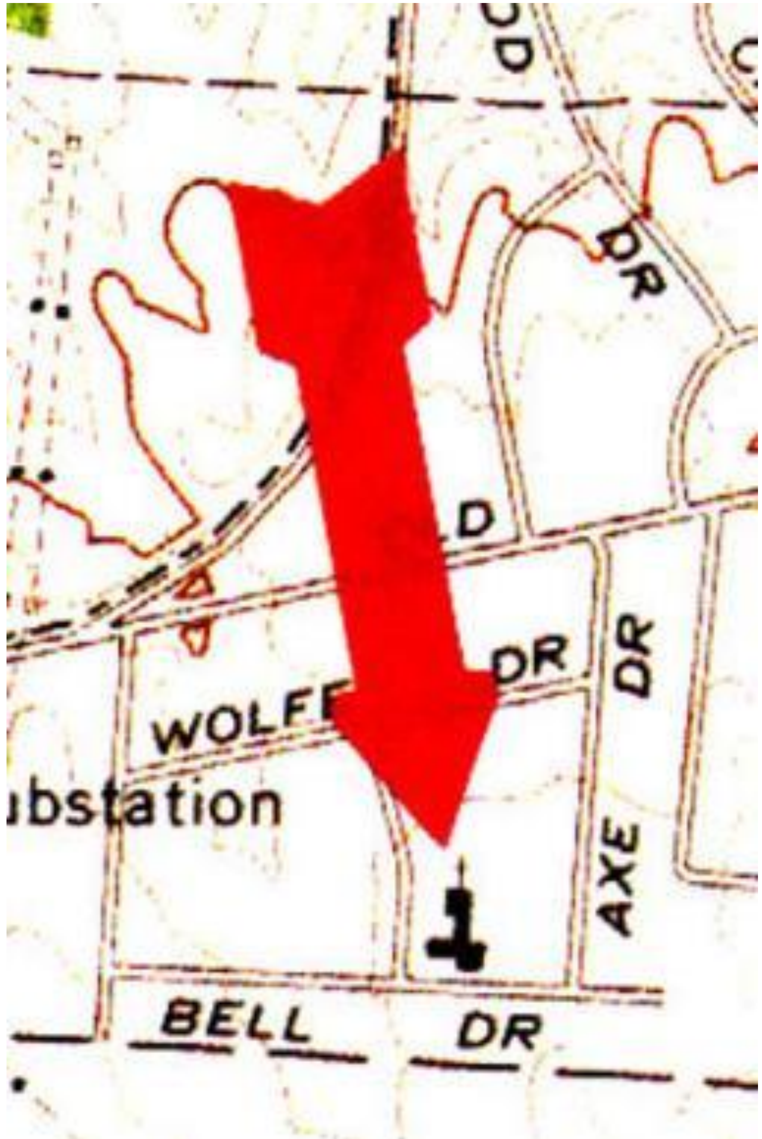

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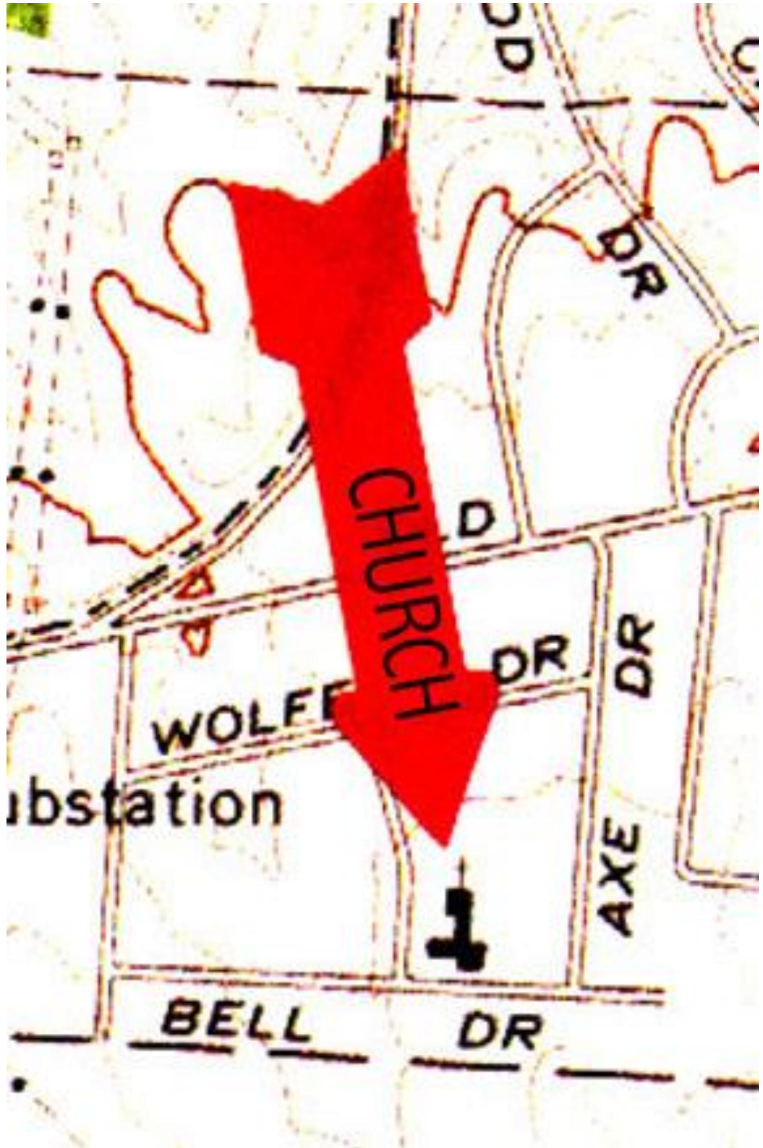

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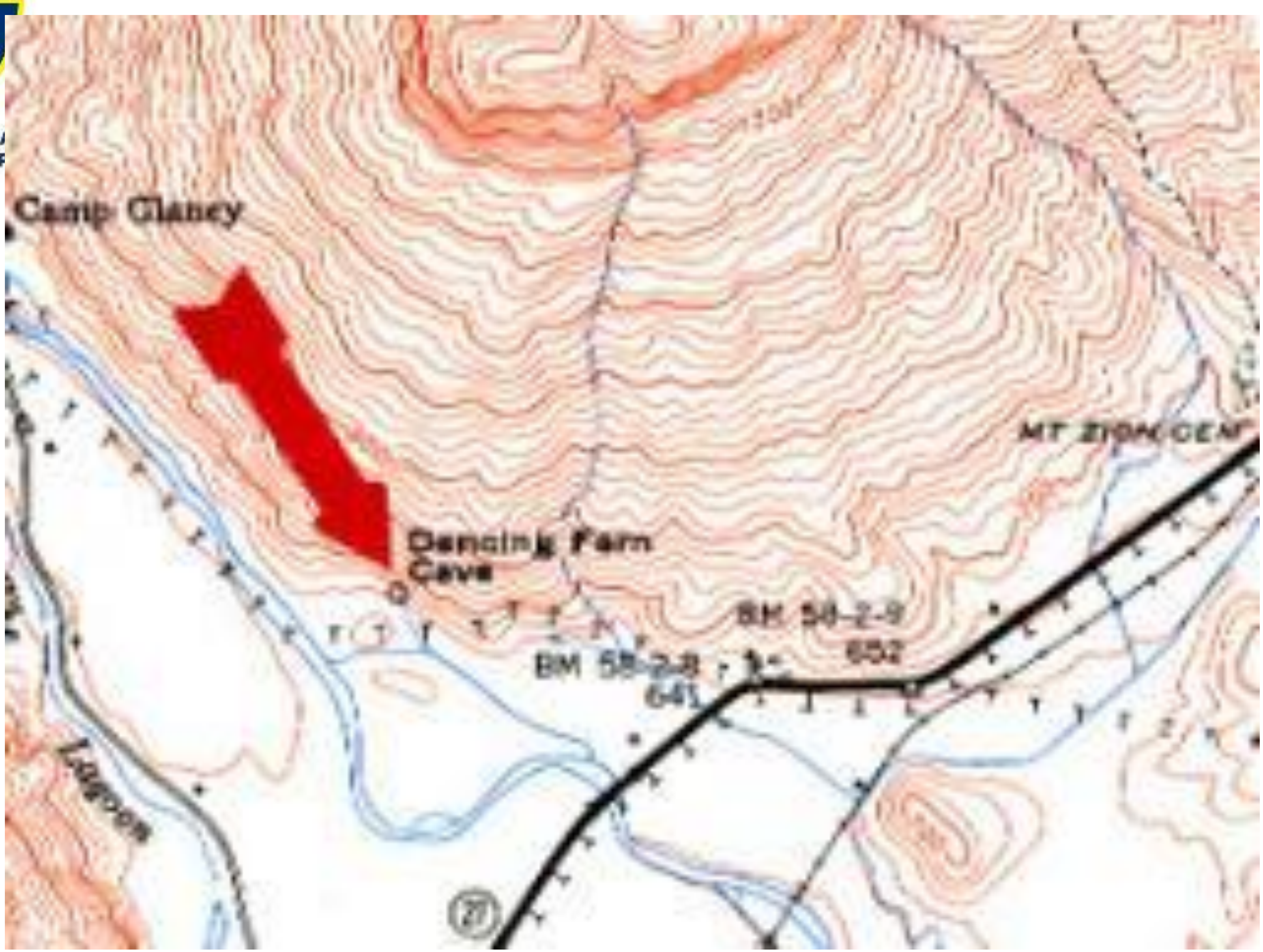

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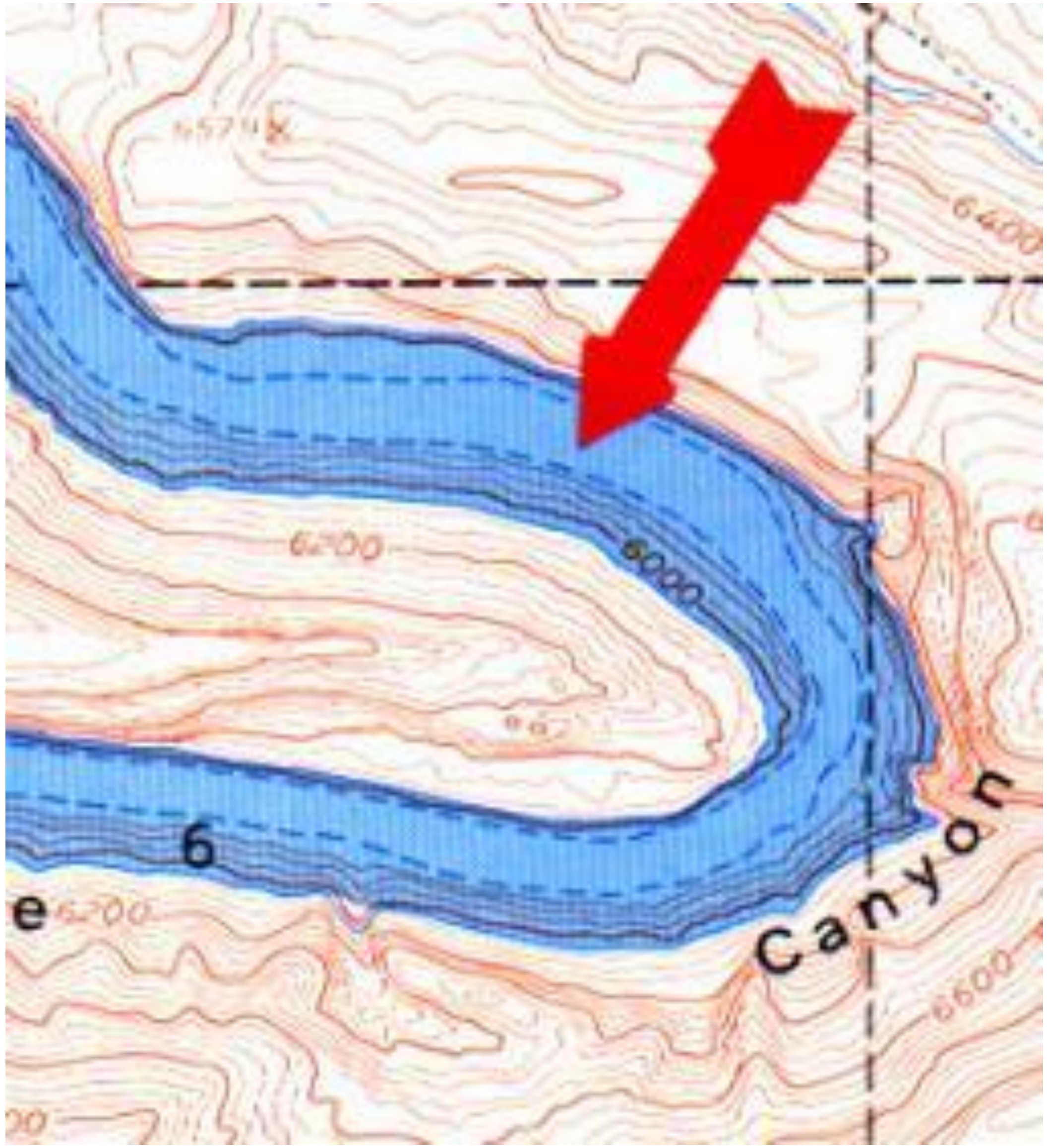
CADET CORPS



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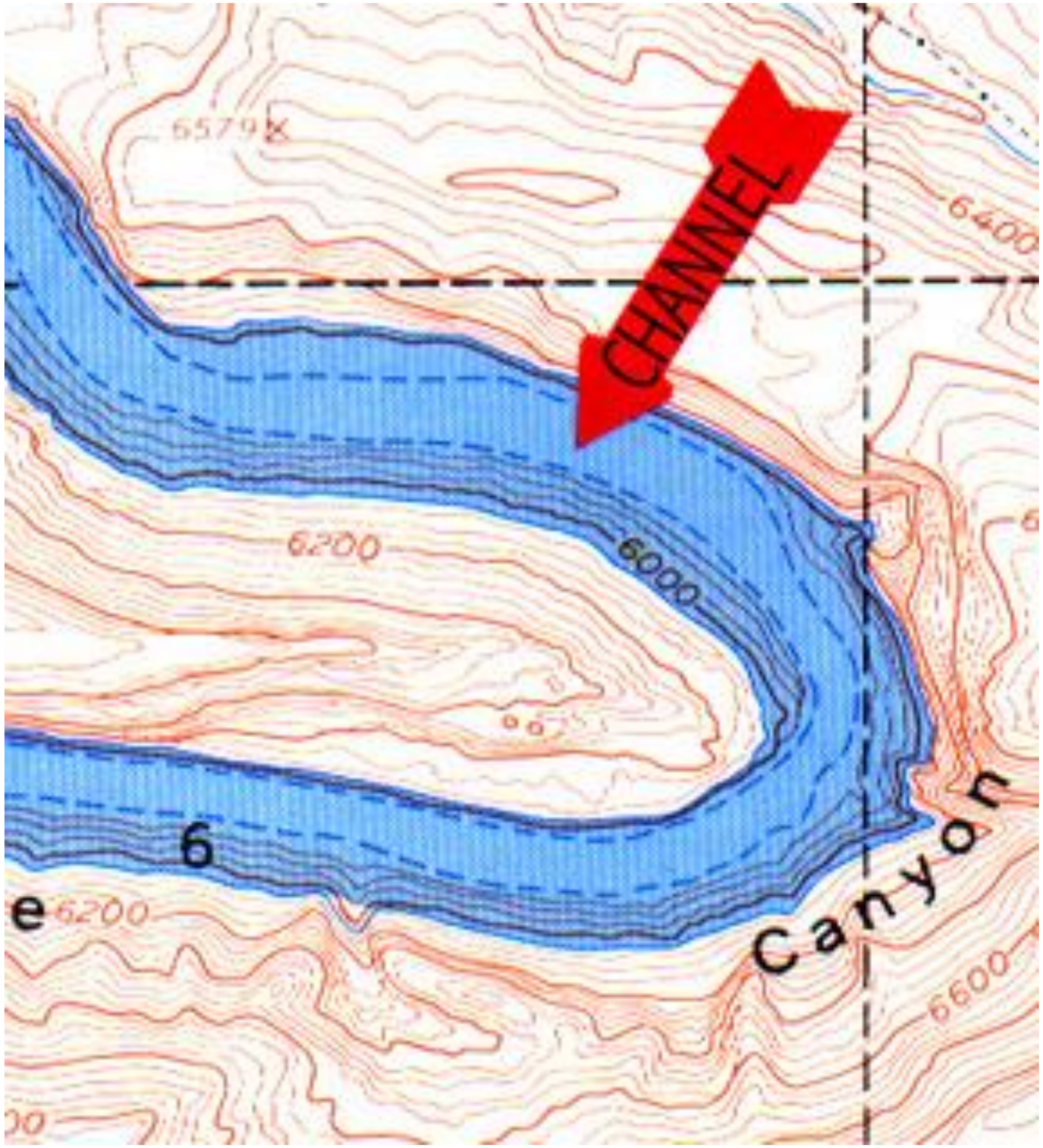
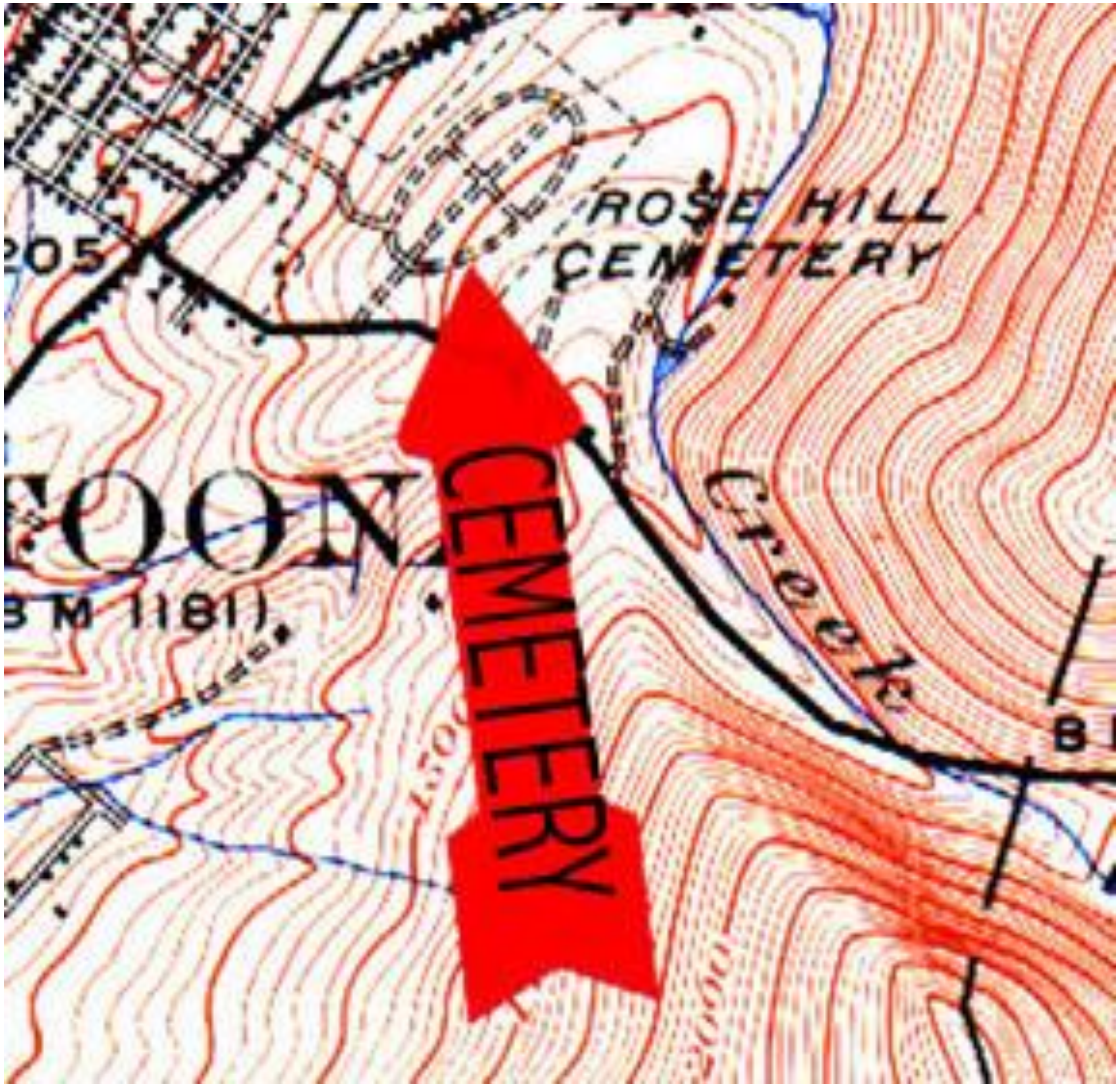
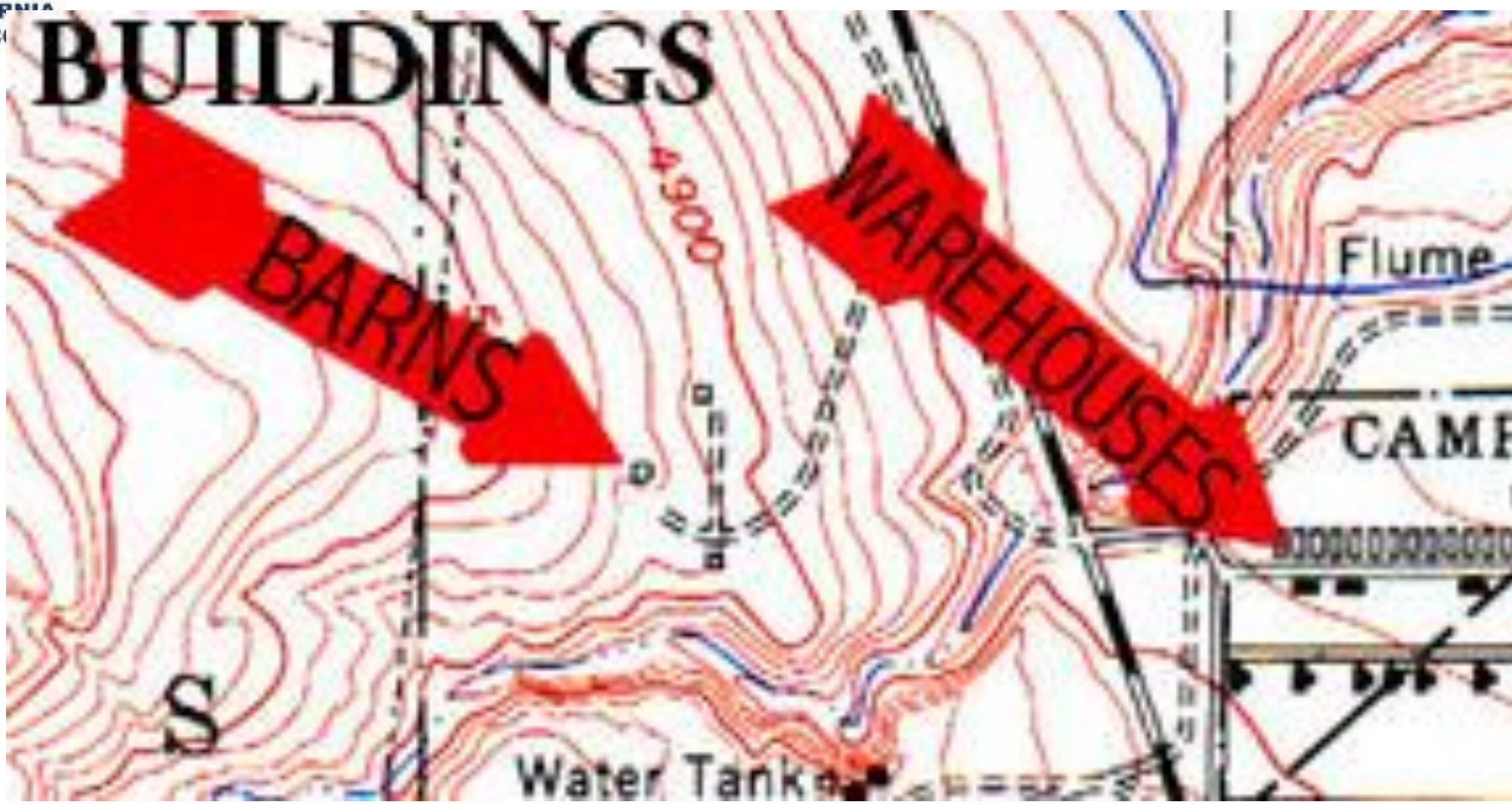



ROSE HILL
CEMETERY
Creek

CALIFORNIA
CADET CORPS




4000
Flume
CAMP
S
Water Tank


BUILDINGS
BARNS
WAREHOUSES
4900
Flume
CAMP
S
Water Tank

CALIFORNIA
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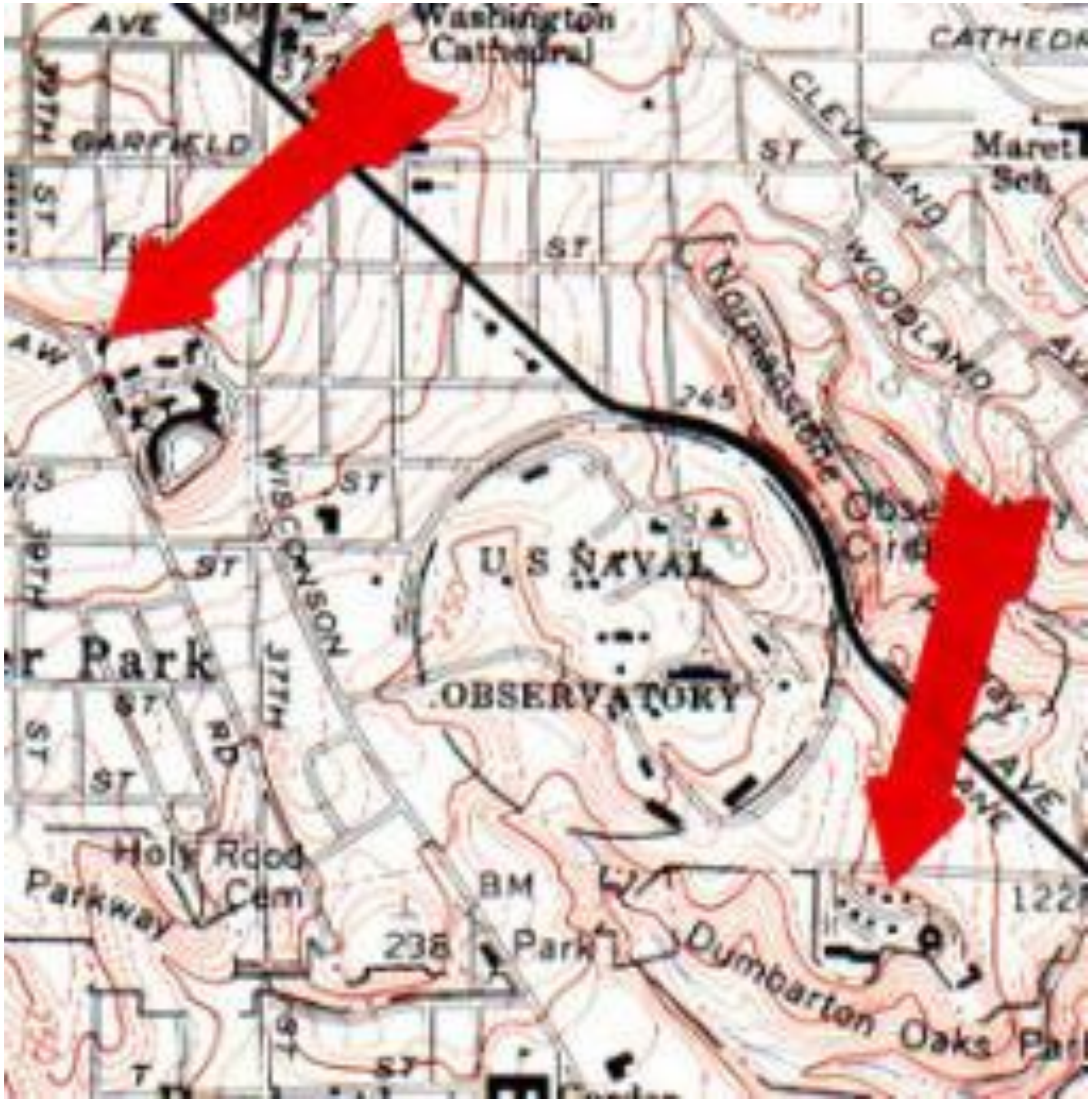
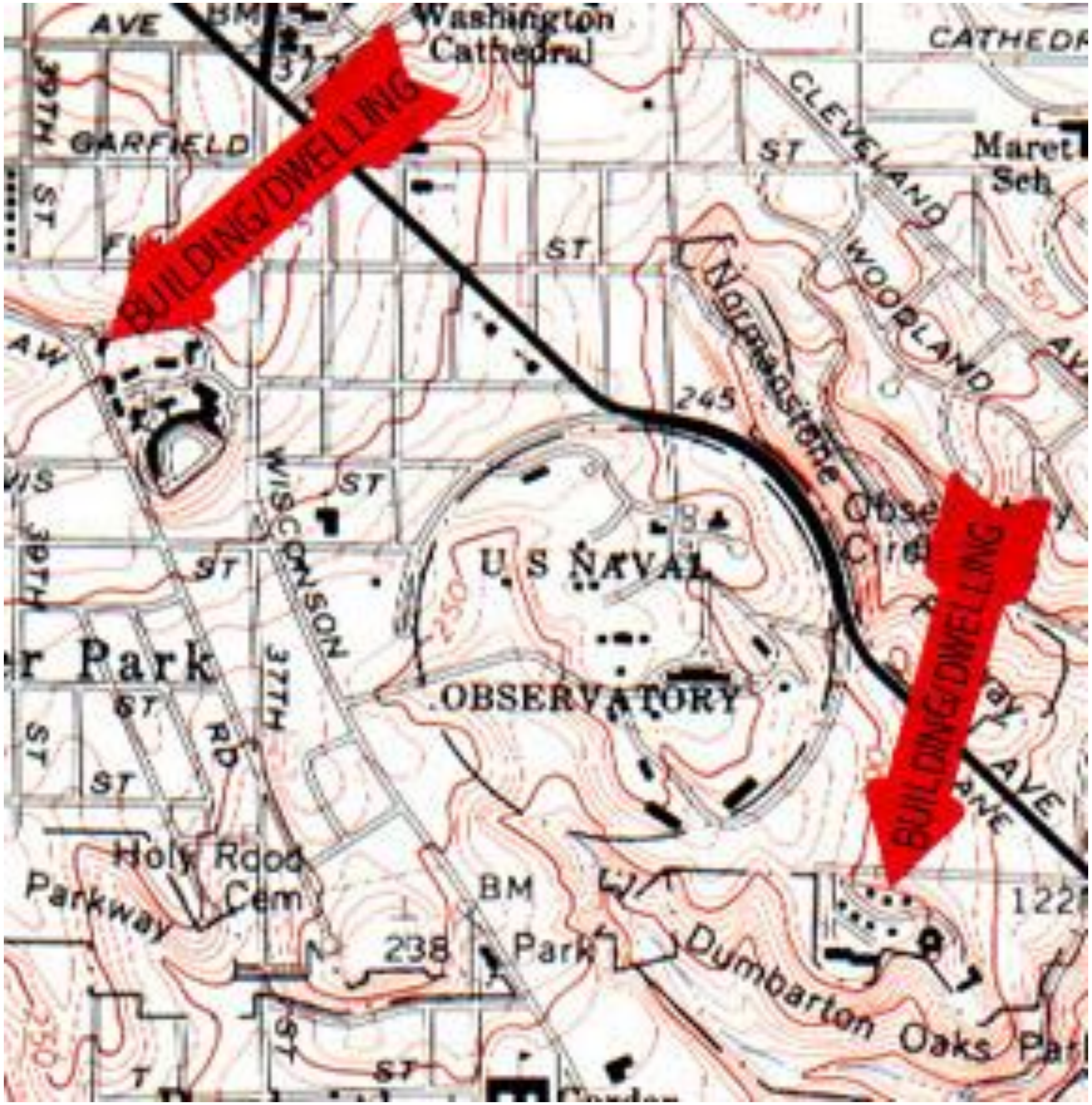
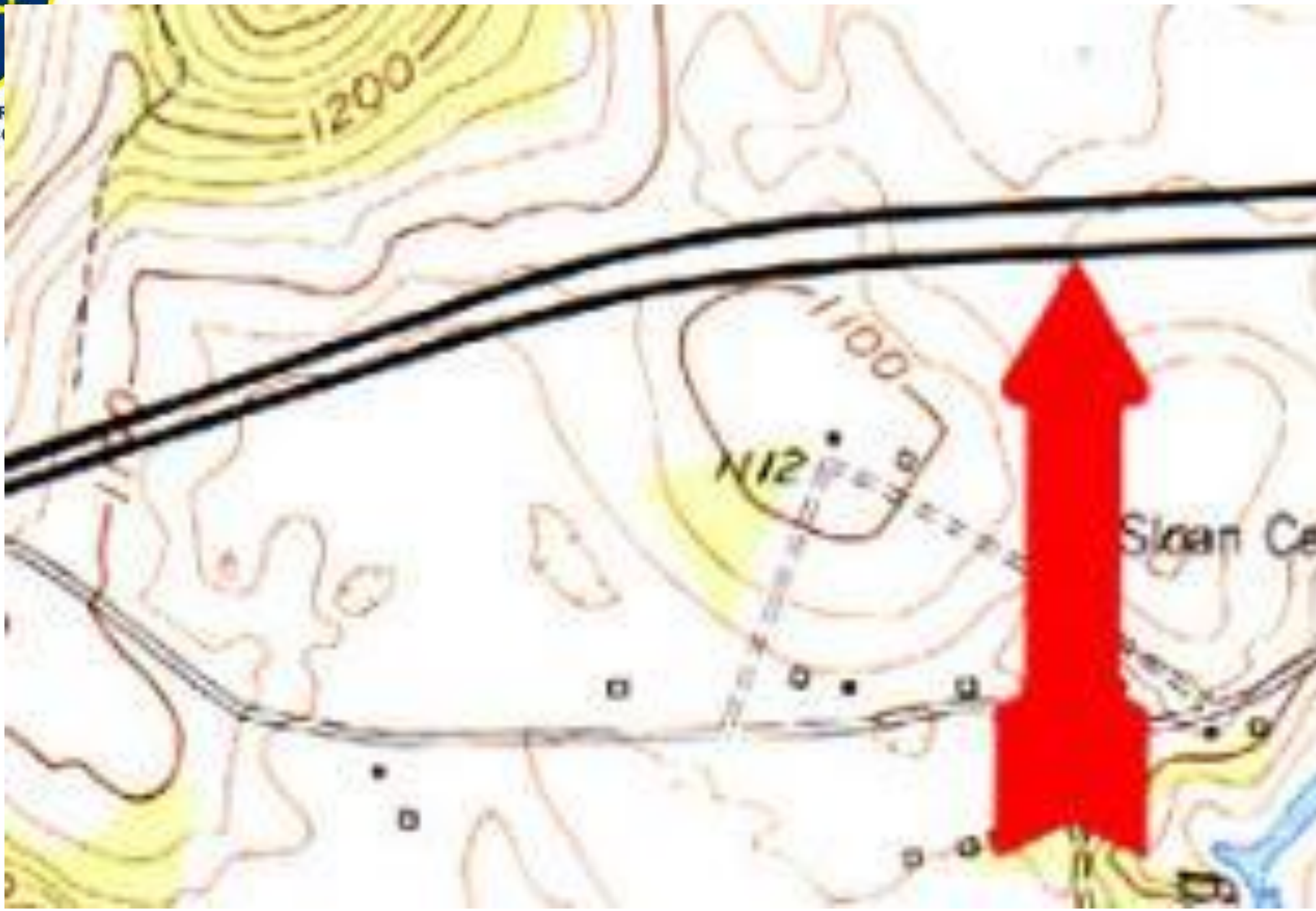
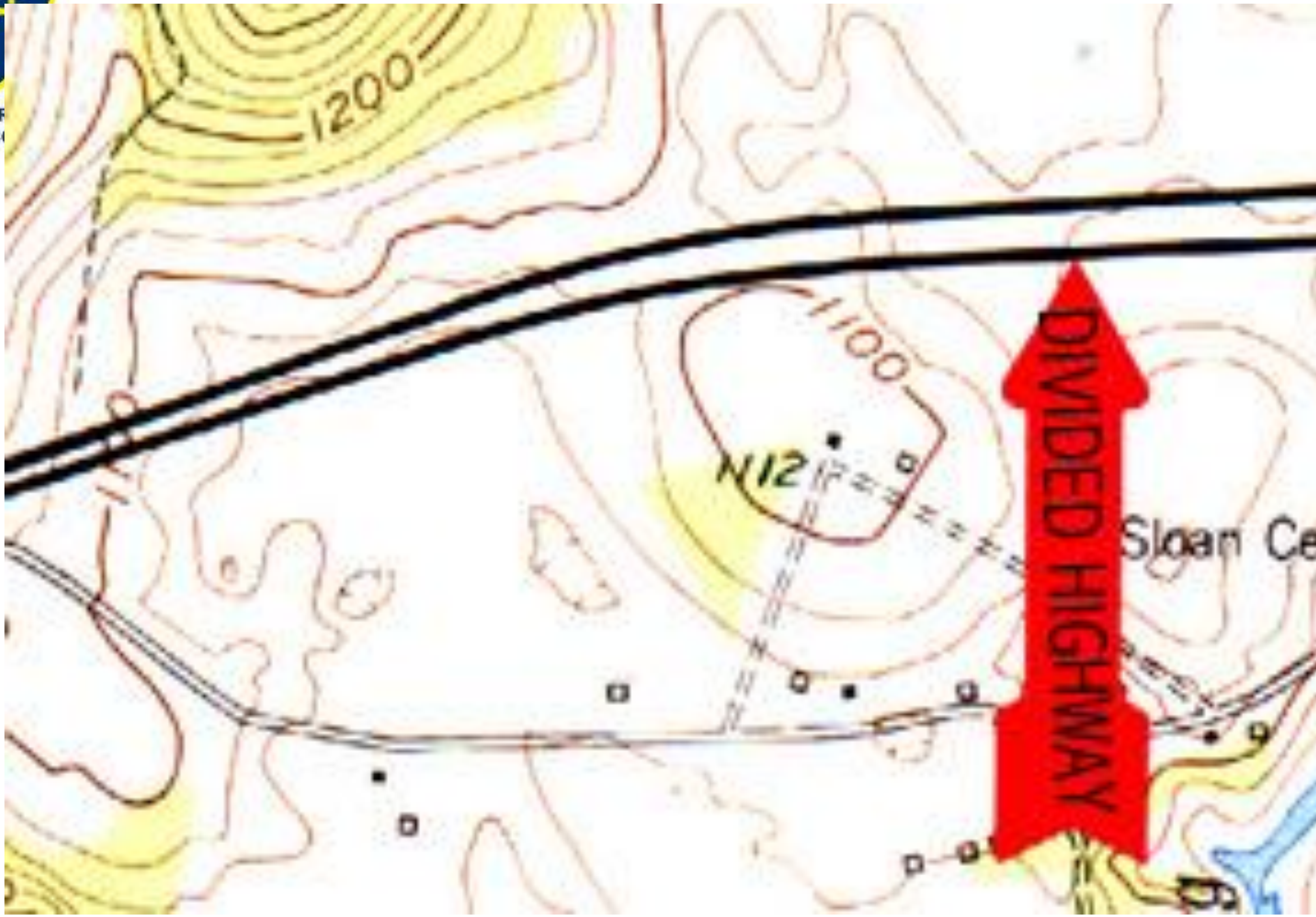


CALIFORNIA
CADET CORPS

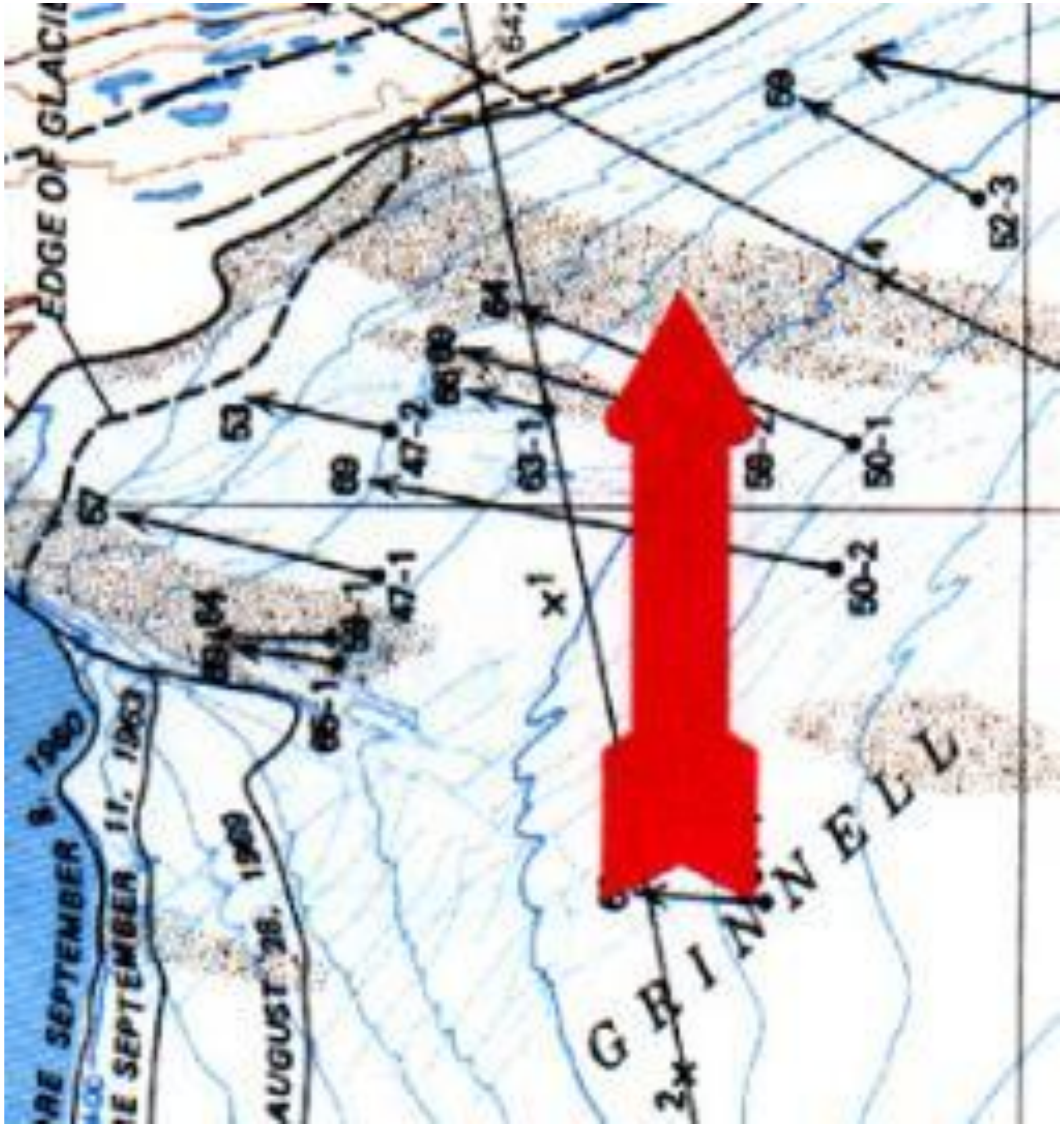


CALIFOR
CADET C




1200
1100
DIVIDED HIGHWAY

CALIFORNIA
CADET CORPS



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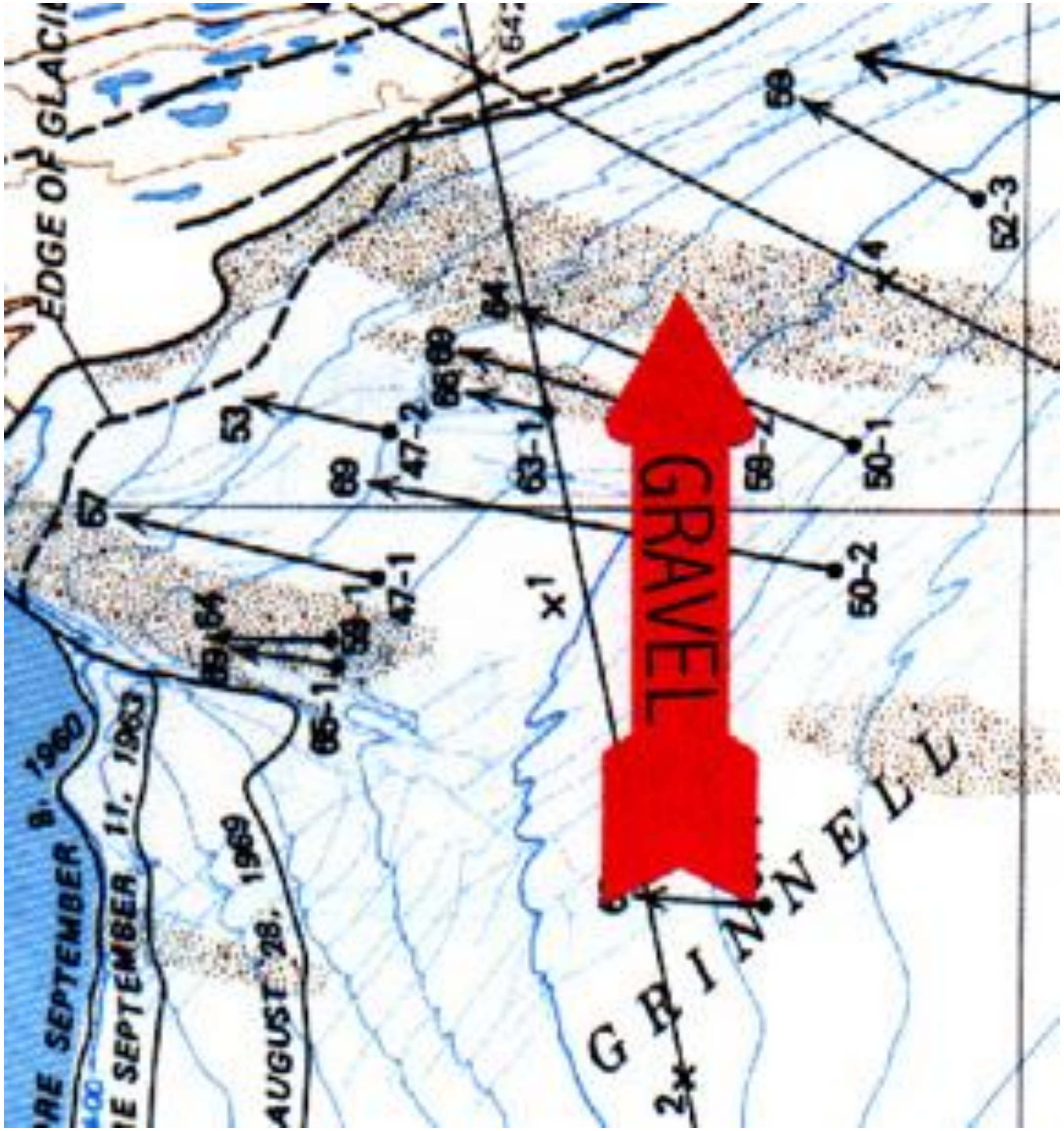
CADET CORPS



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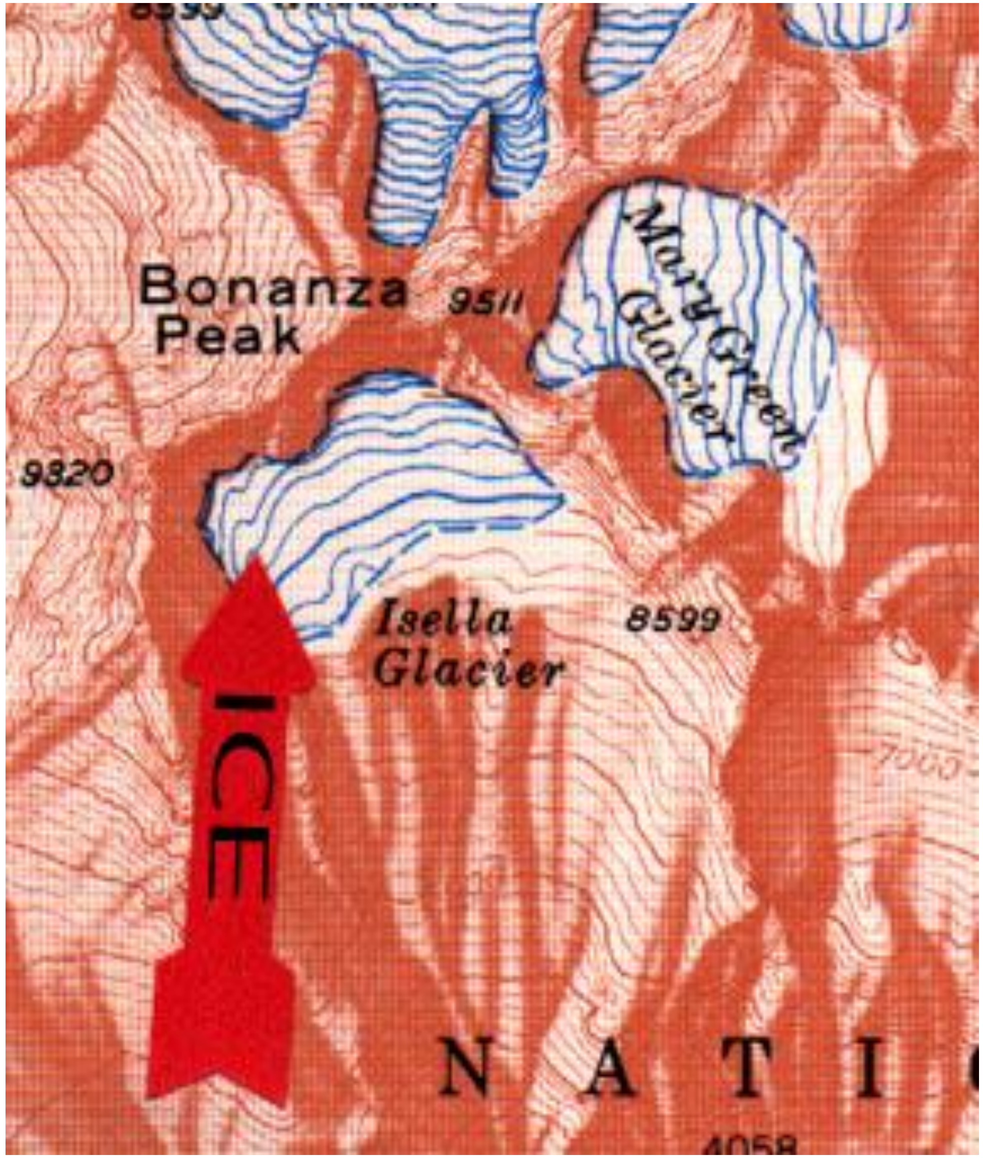
CALIFORNIA
CADET CORPS



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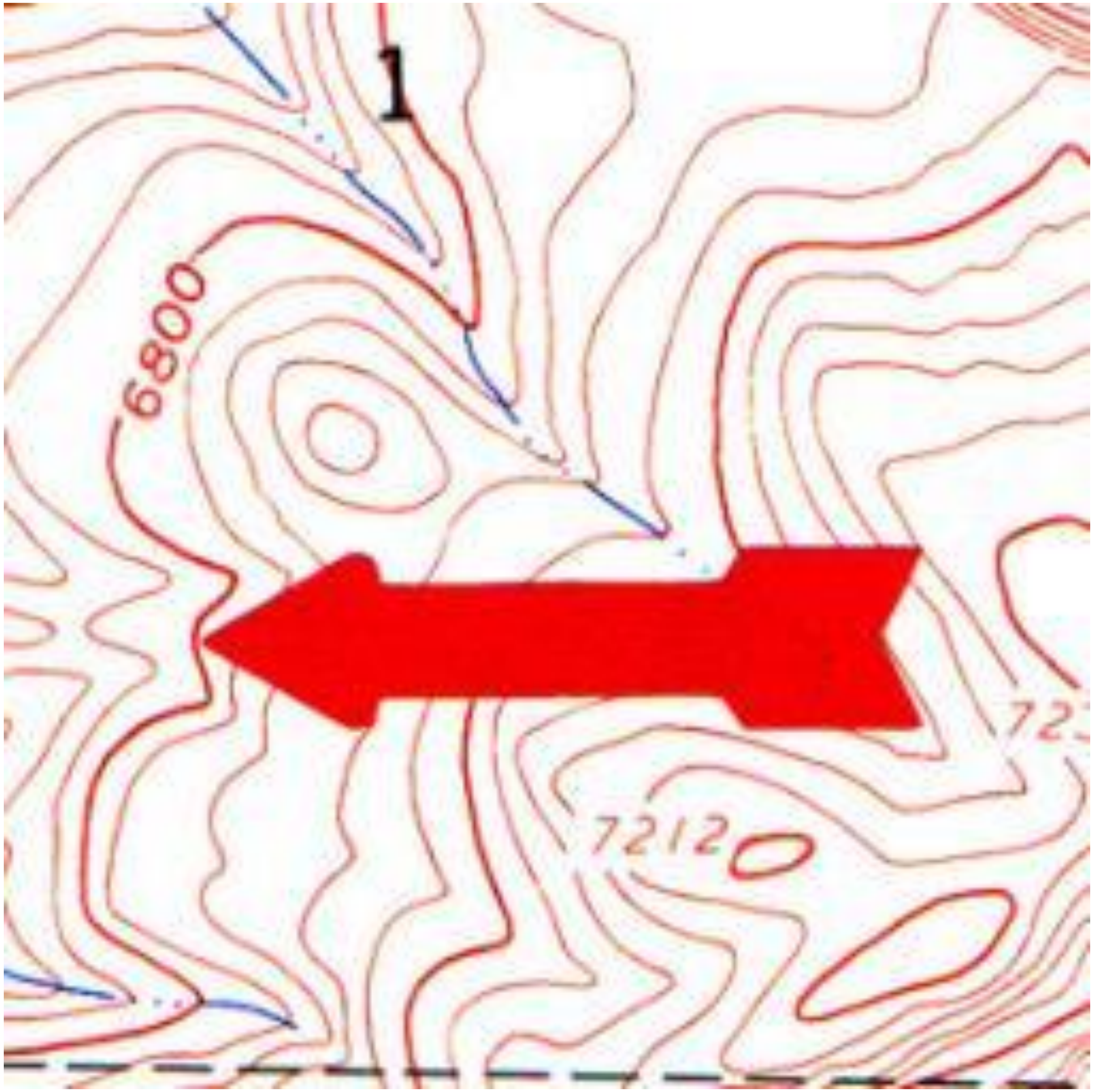

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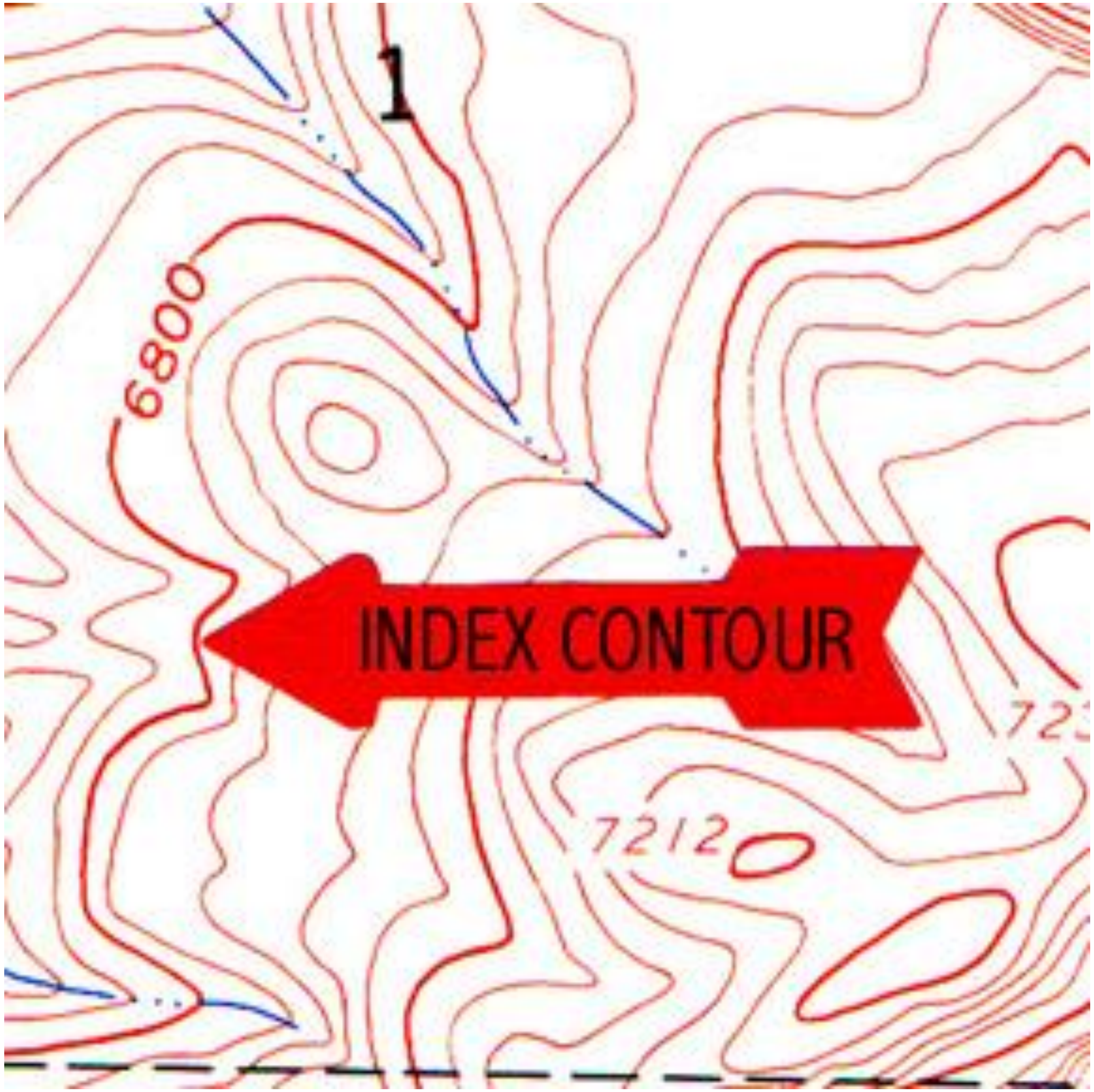

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6200
6200
6143
60
6180
CAMP

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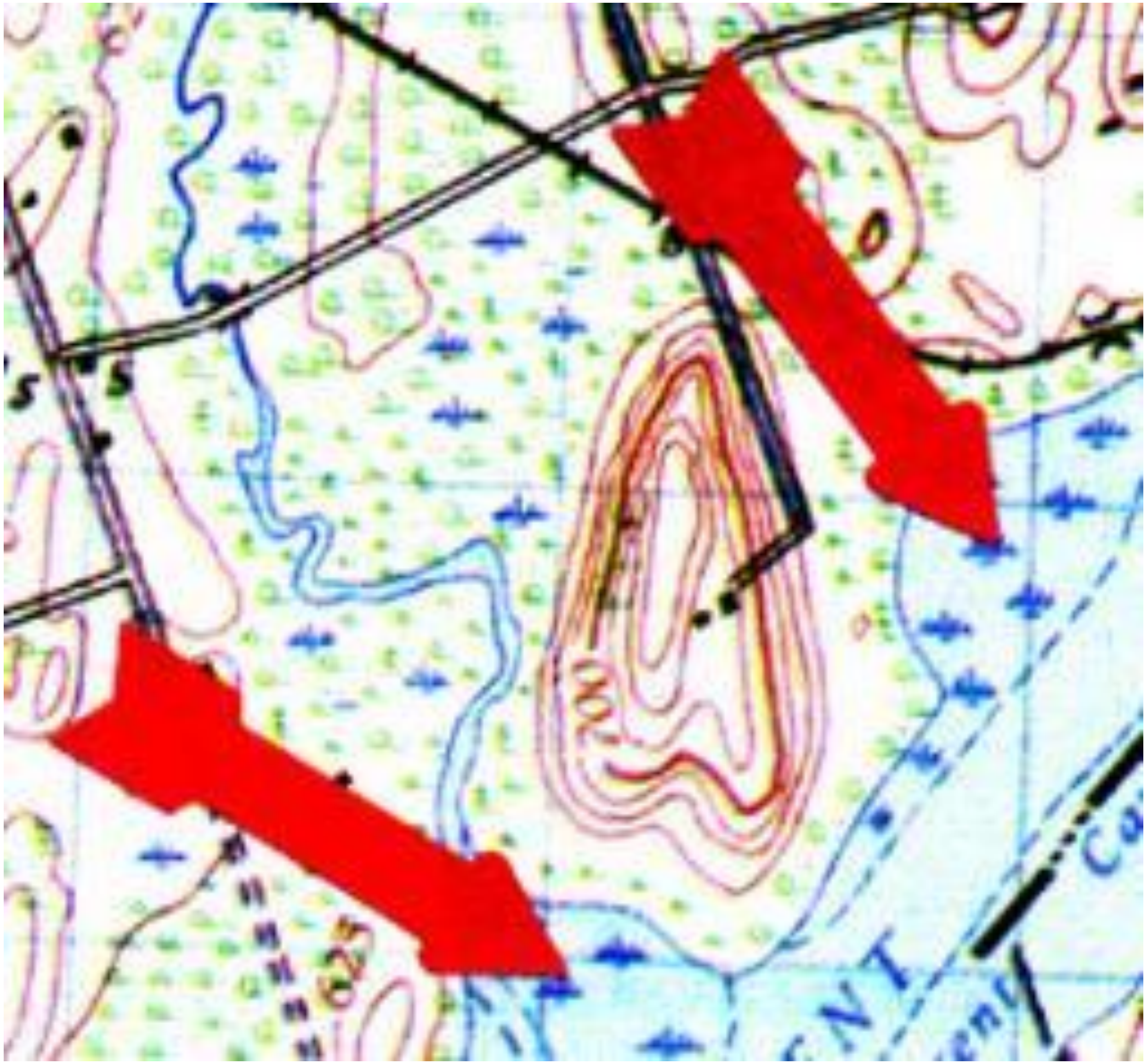
CALIFORNIA
CADET CORPS



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# 23

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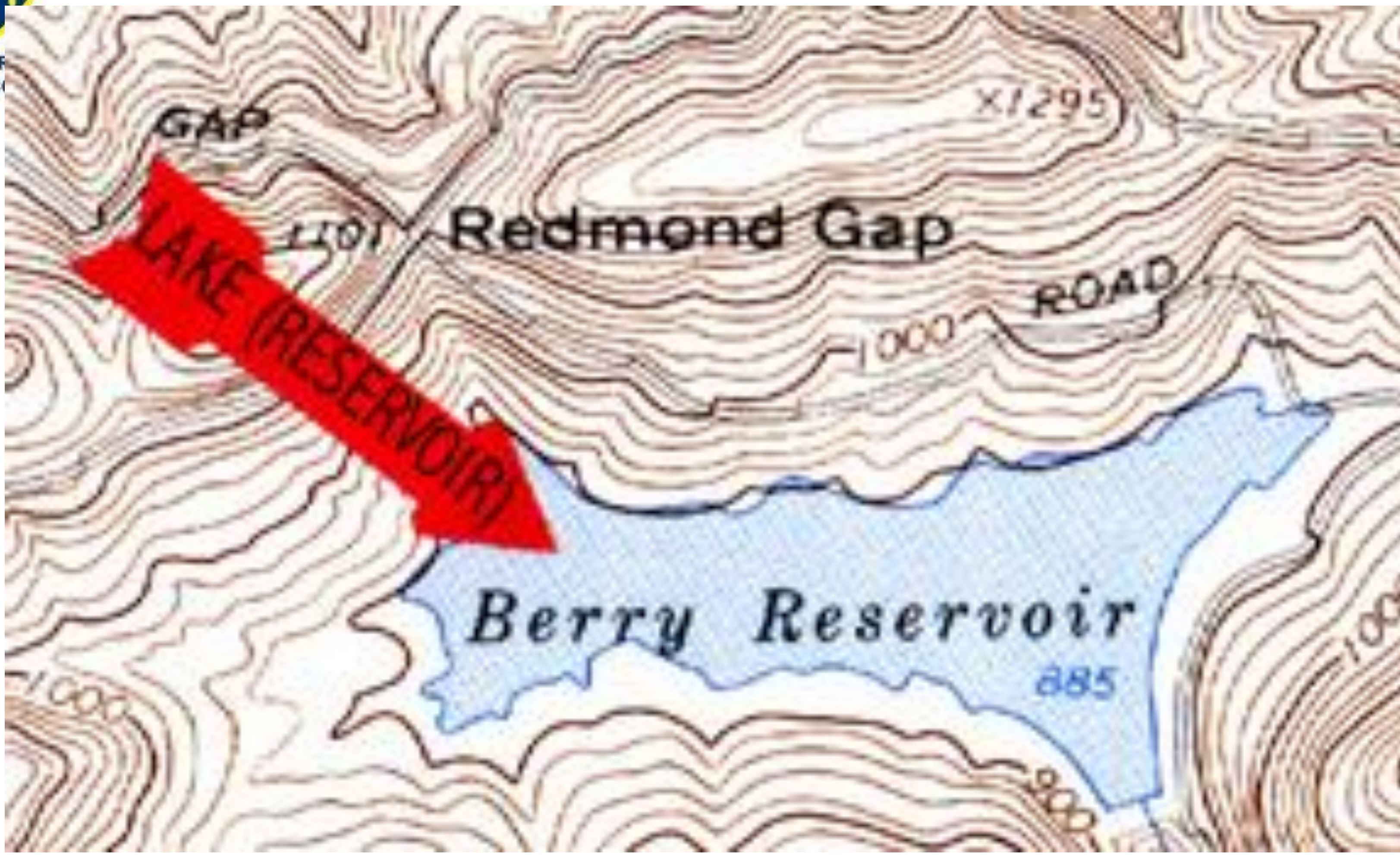

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INTERMEDIATE CONTOUR

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CADET CORPS

CALIFORNIA
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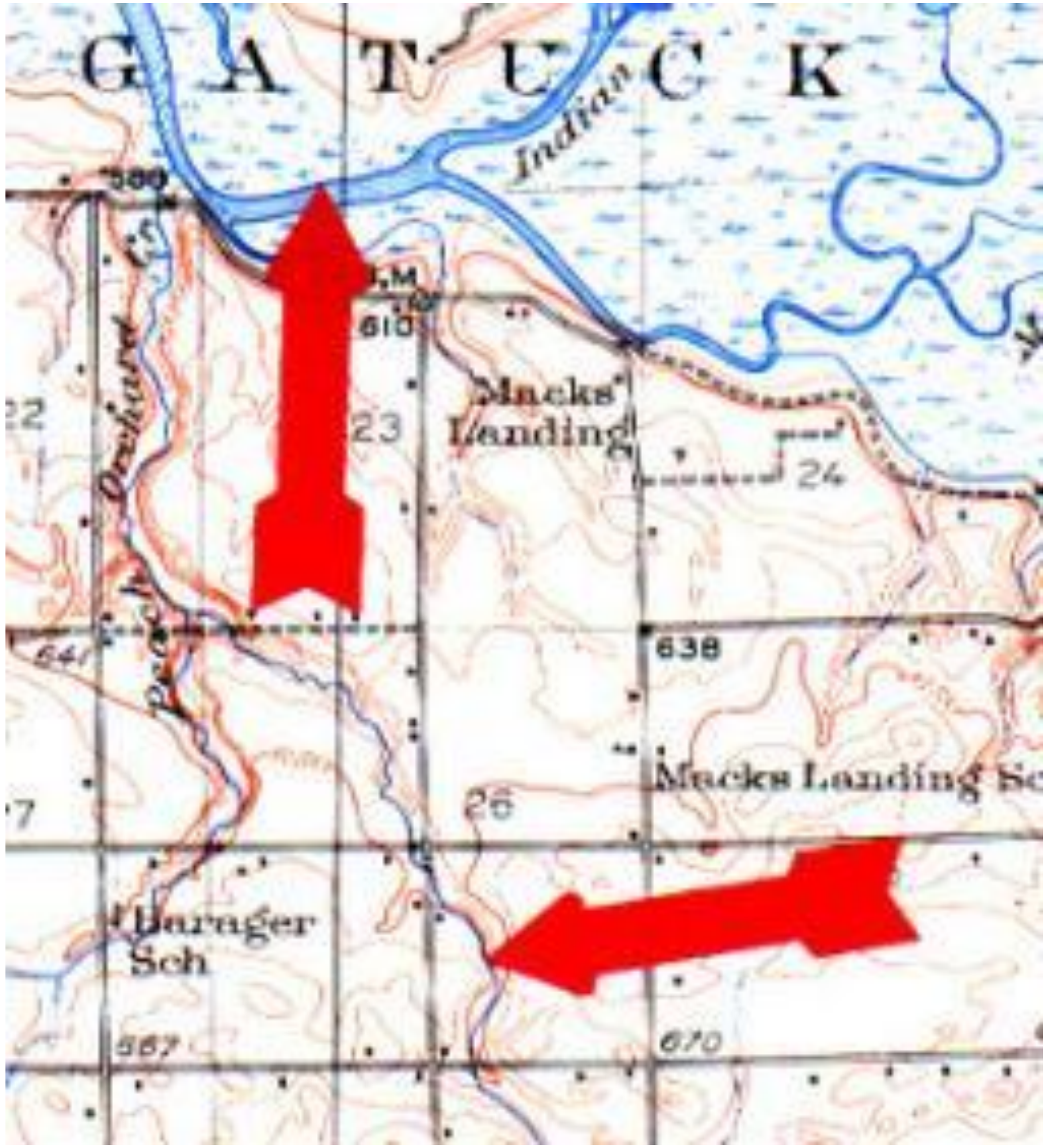
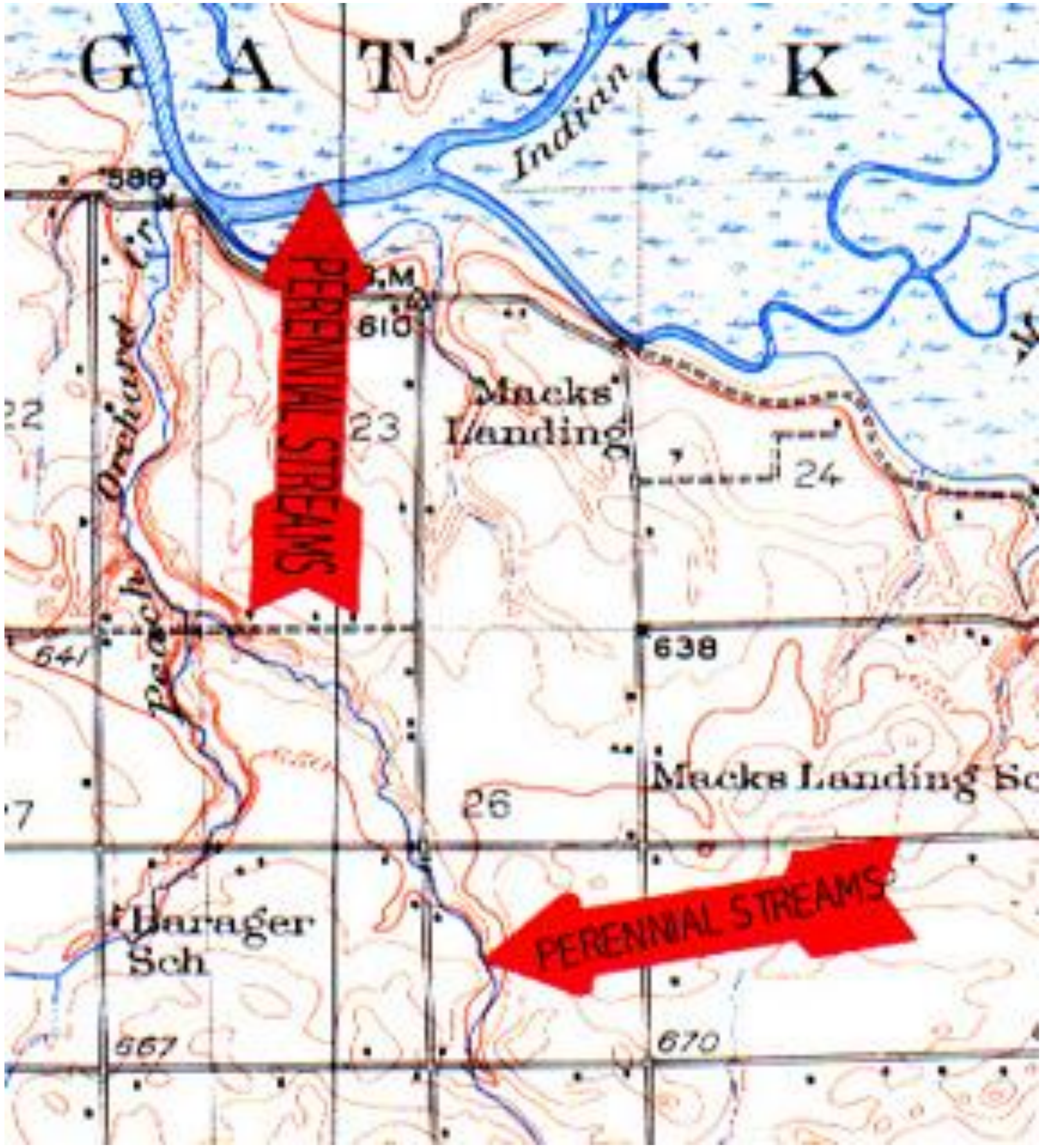
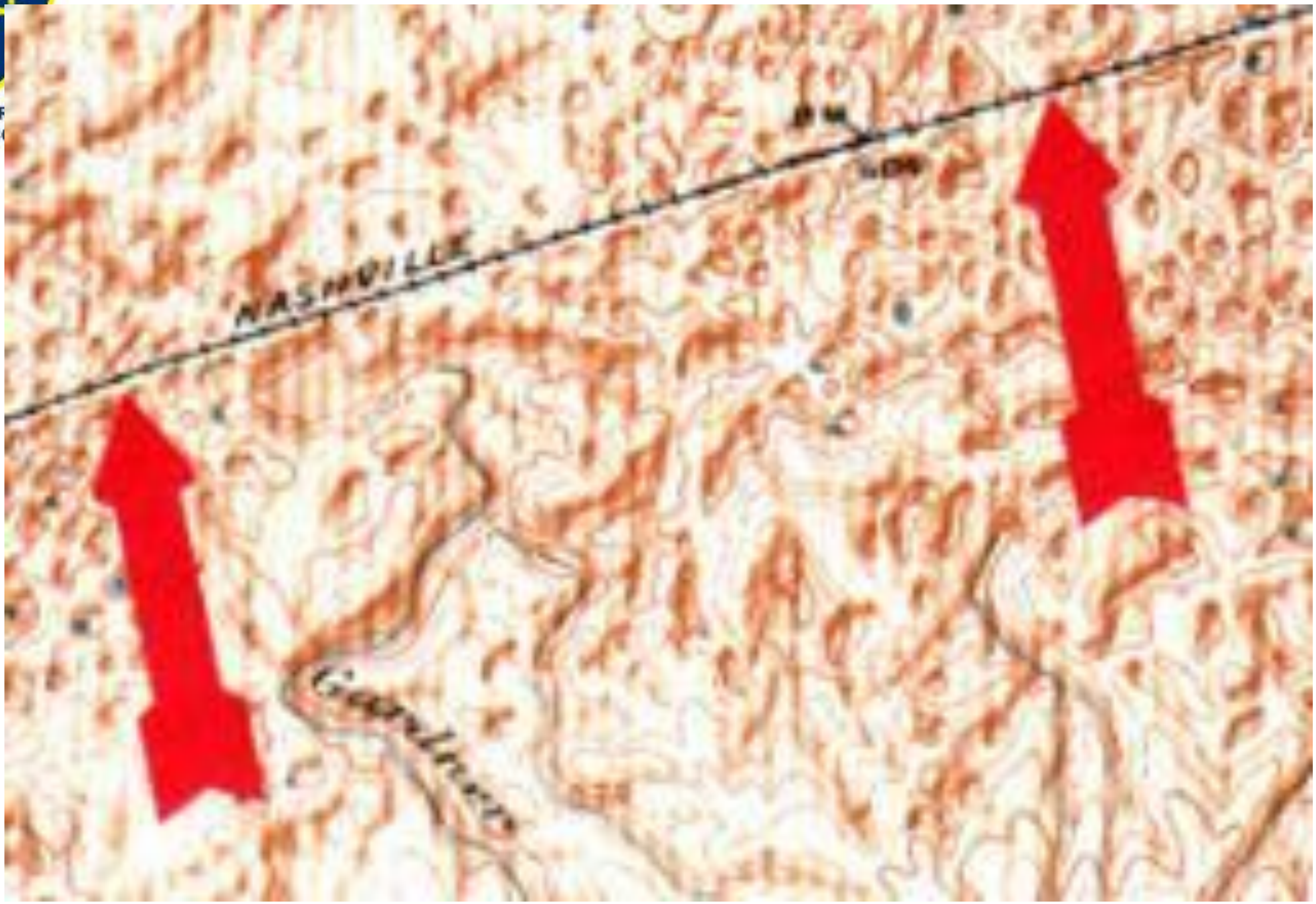
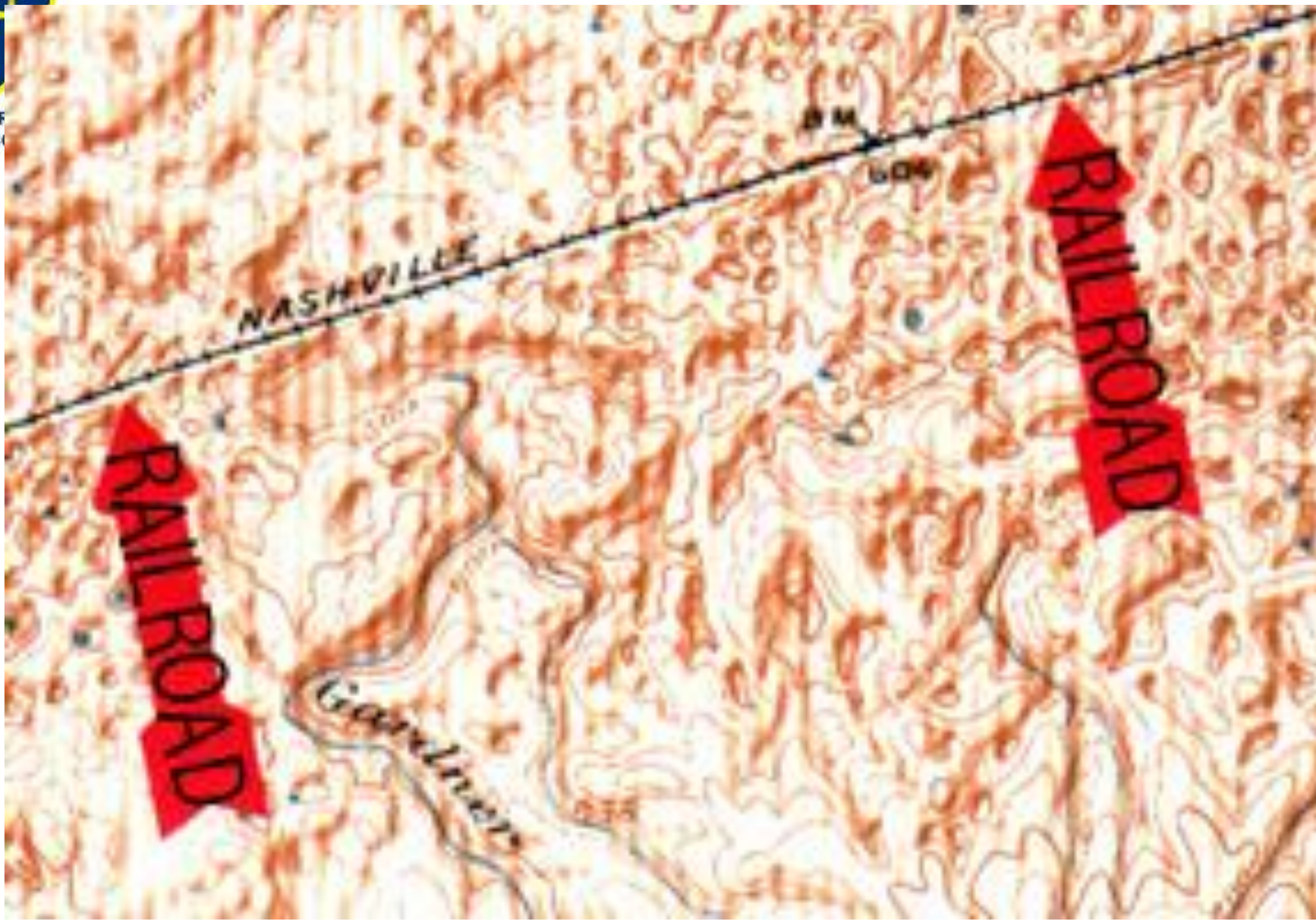
CALIFORNIA
CADET CORPS



CALIFORNIA
CADET CORPS

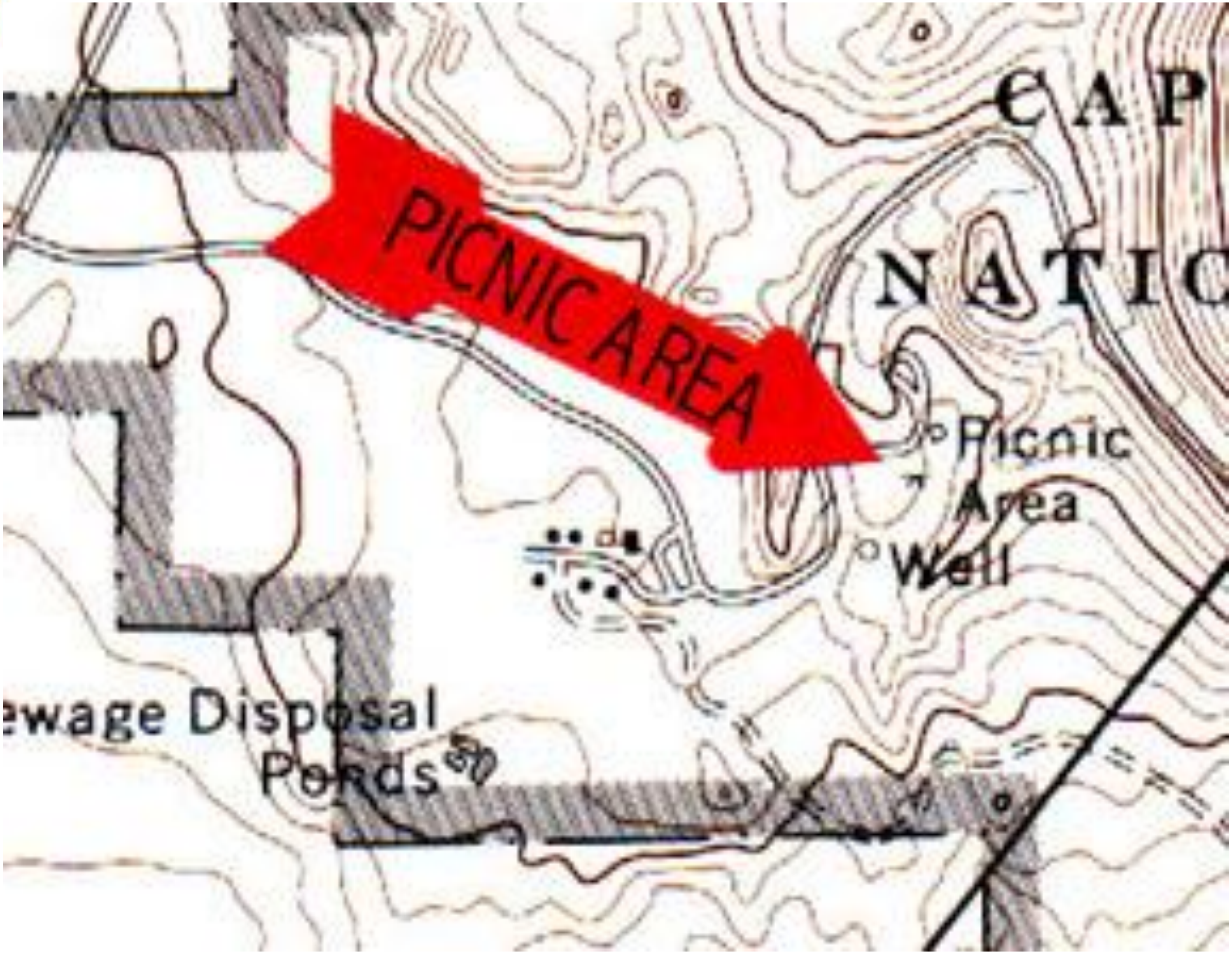



NASHVILLE


NASHVILLE
BM
RAILROAD
RAILROAD

CALIFORNIA
CADET CORPS

CALIFORNIA
CADET CORPS



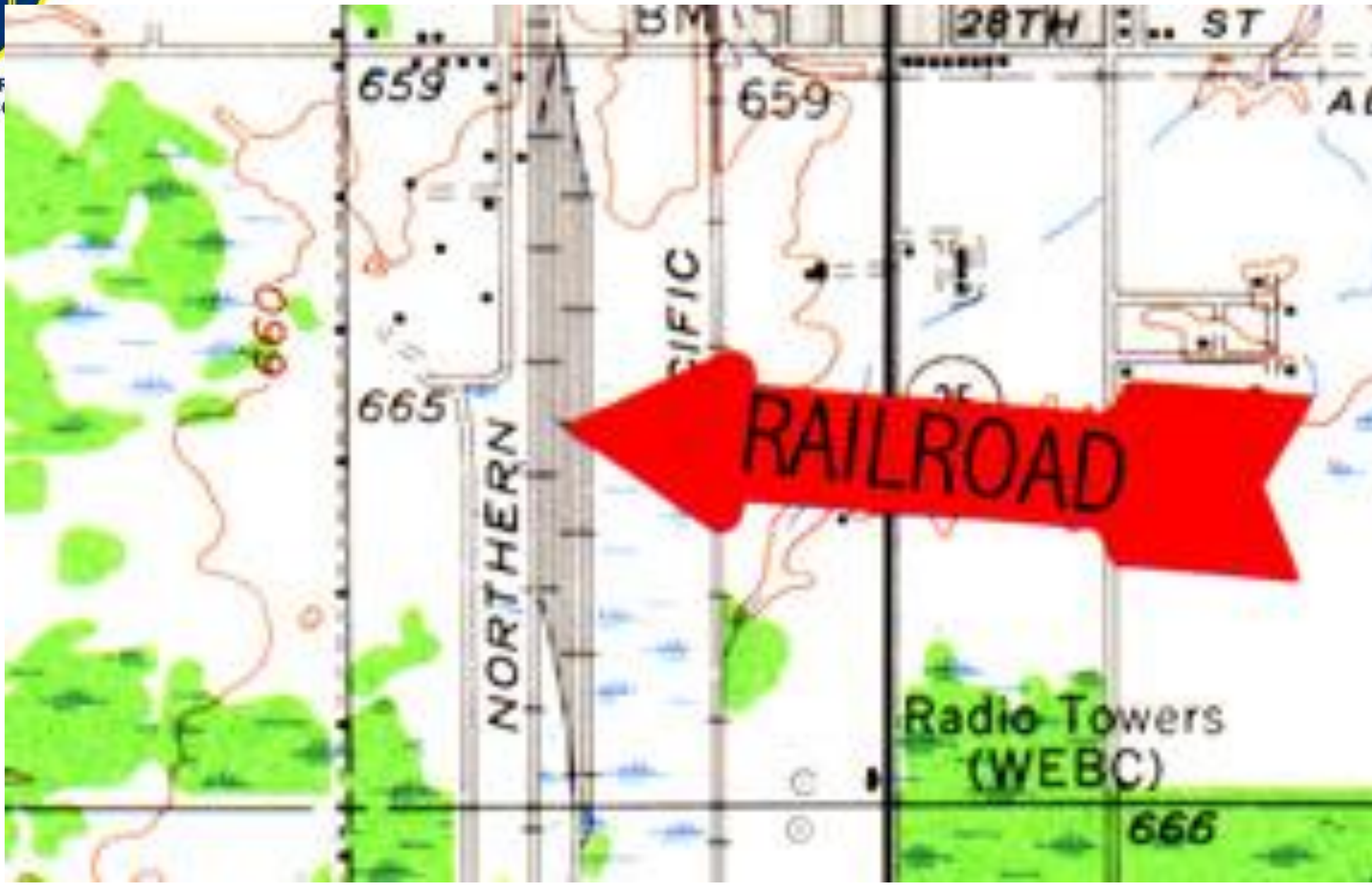
Toboggan
Slide
NORTHERN
WT
SUPE
CITY
666
662
Bluff
Woodlawn
12


RAILROAD
NORTHERN
42D AVE
Toboggan
Slide
WT
SUPER
CITY
666
662
Bluff
Woodlawn
Cem
1
6
12

CALIFORNIA
CADET CORPS

CALIFORNIA
CADET CORPS

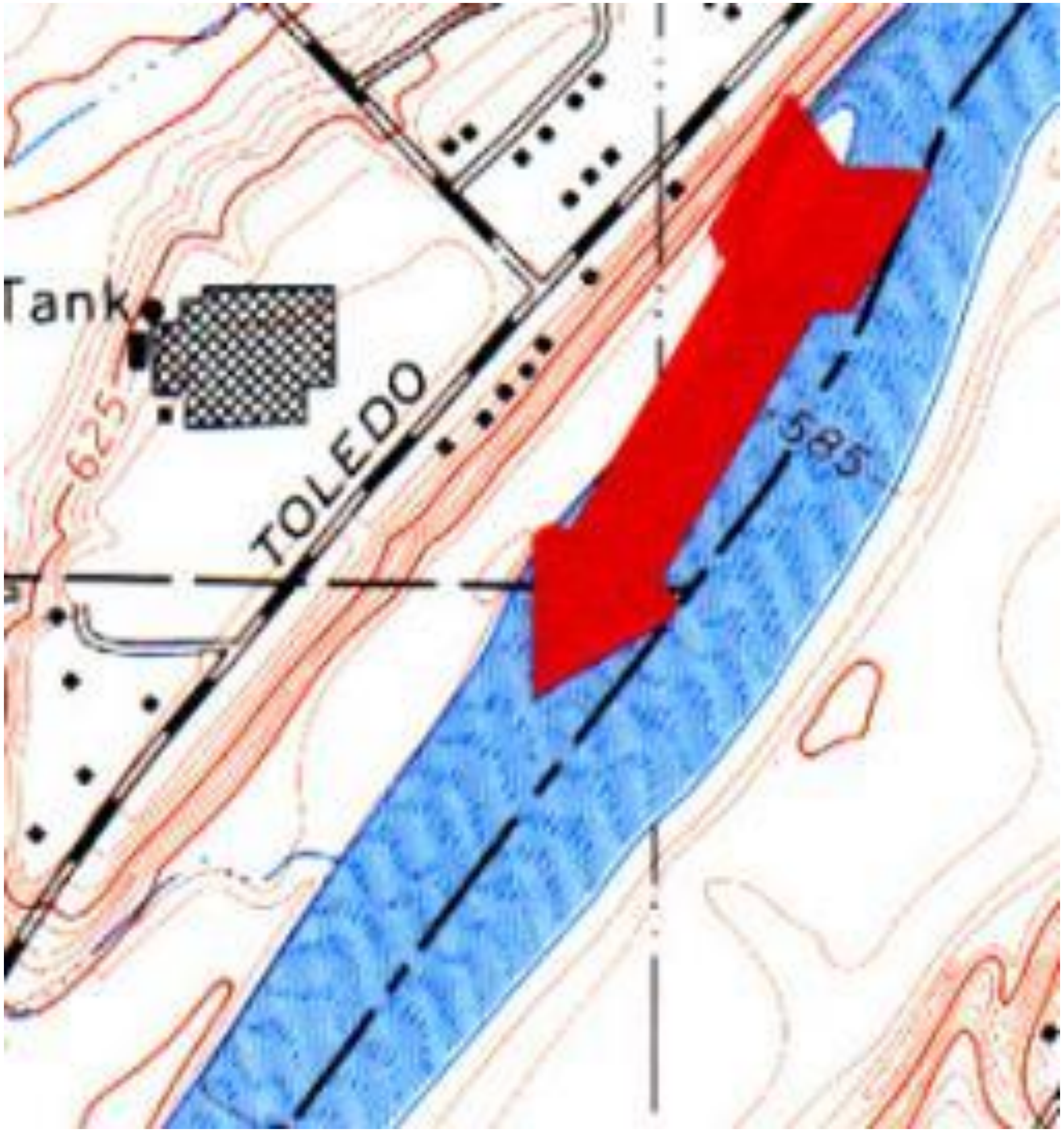
BM
28TH ST
659
659
650
665
NORTHERN
IFIC
Radio Towers
(WEBC)
666


BM
28TH ST
659
659
660
665
NORTHERN
CIFIC
RAILROAD
Radio Towers
(WEBC)
666

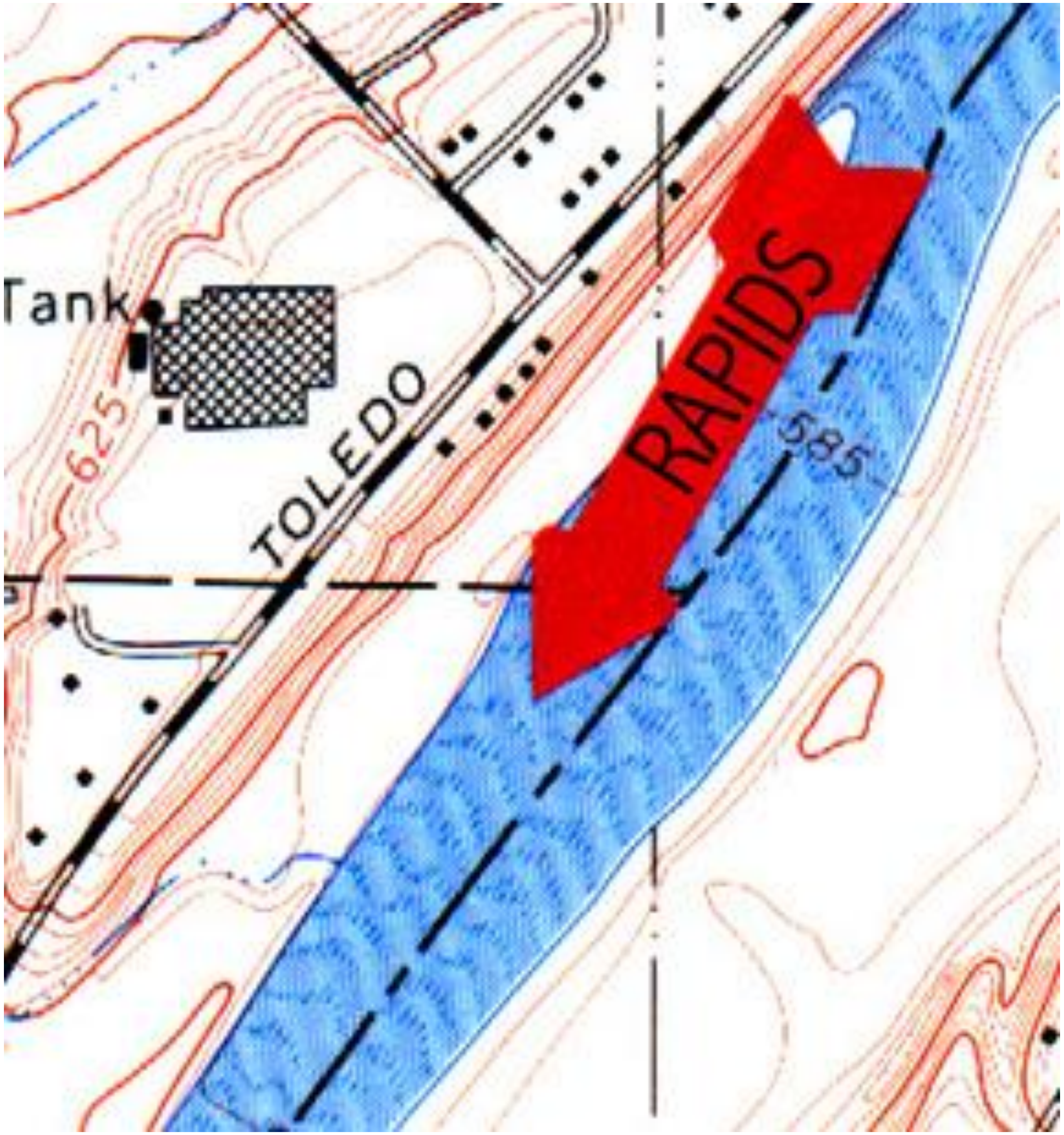
CALIFOR
CADET C

# HARD SURFACE ROAD

CALIFORNIA
CADET CORPS



CALIFORNIA
CADET CORPS



CALIFORNIA
CADET CORPS

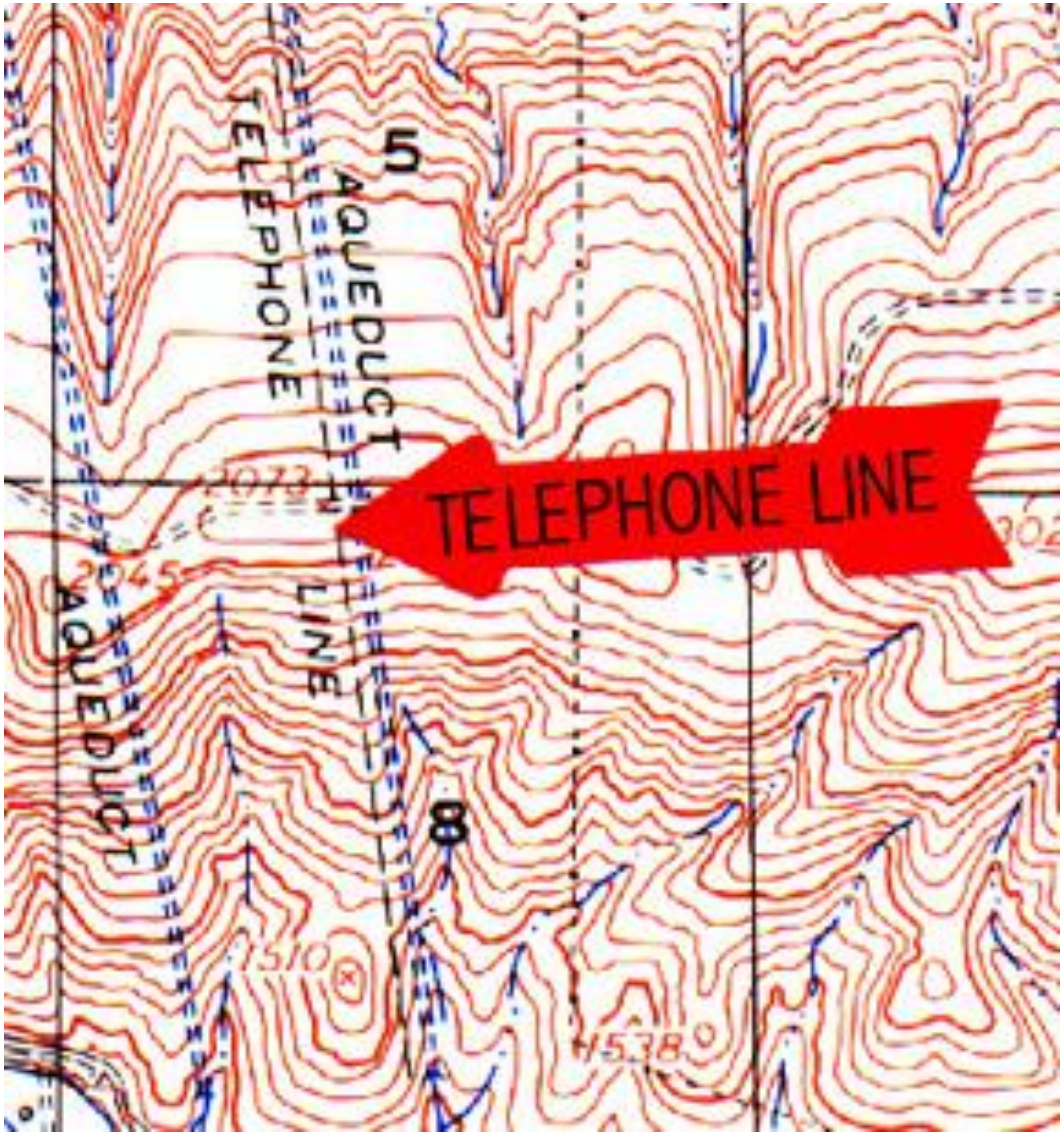
CALIFORNIA
CADET CORPS


550
509
Lake
671
Twin Lakes

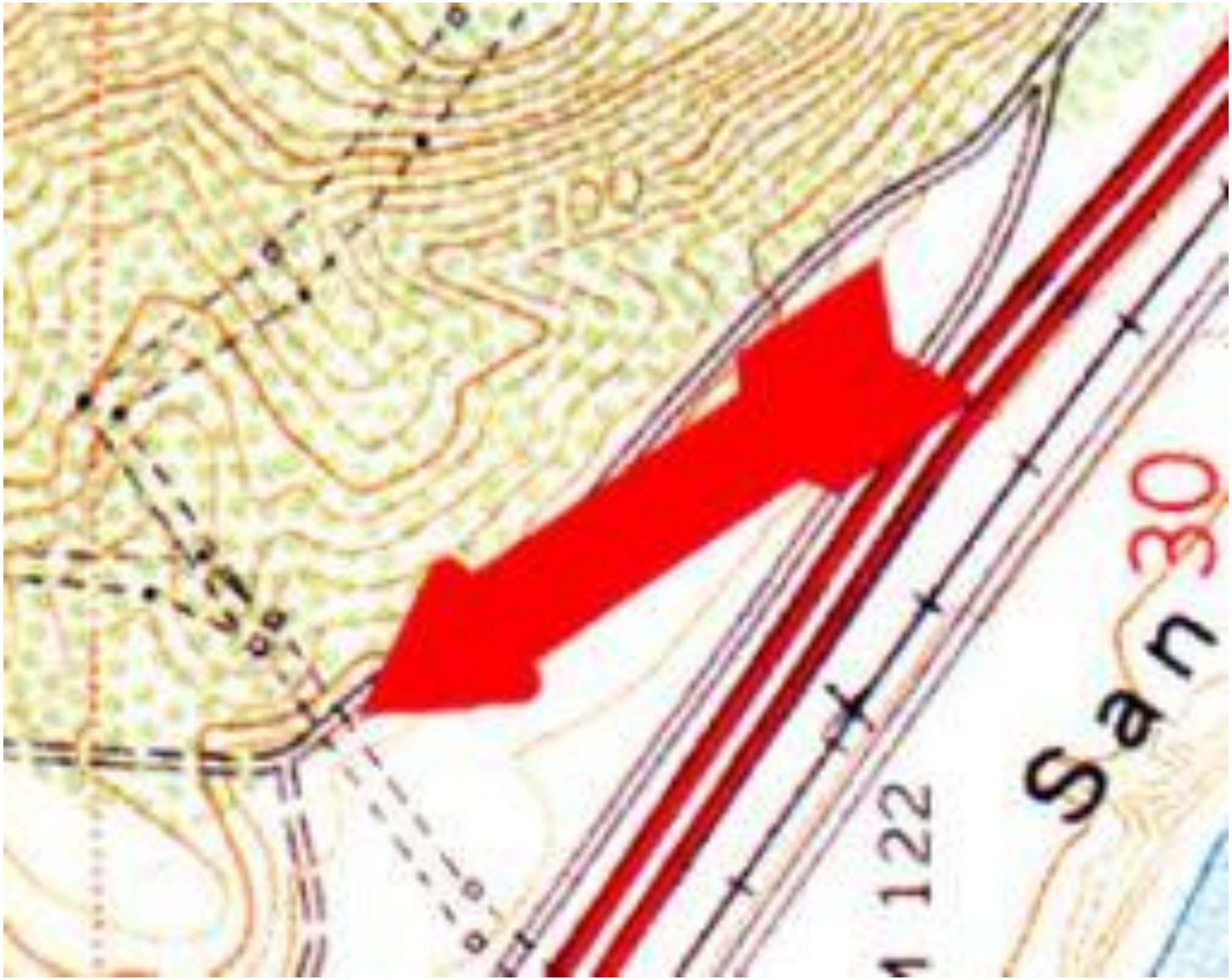
CALIFOR
CADET C

CALIFORNIA
CADET CORPS

CALIFORNIA
CADET CORPS



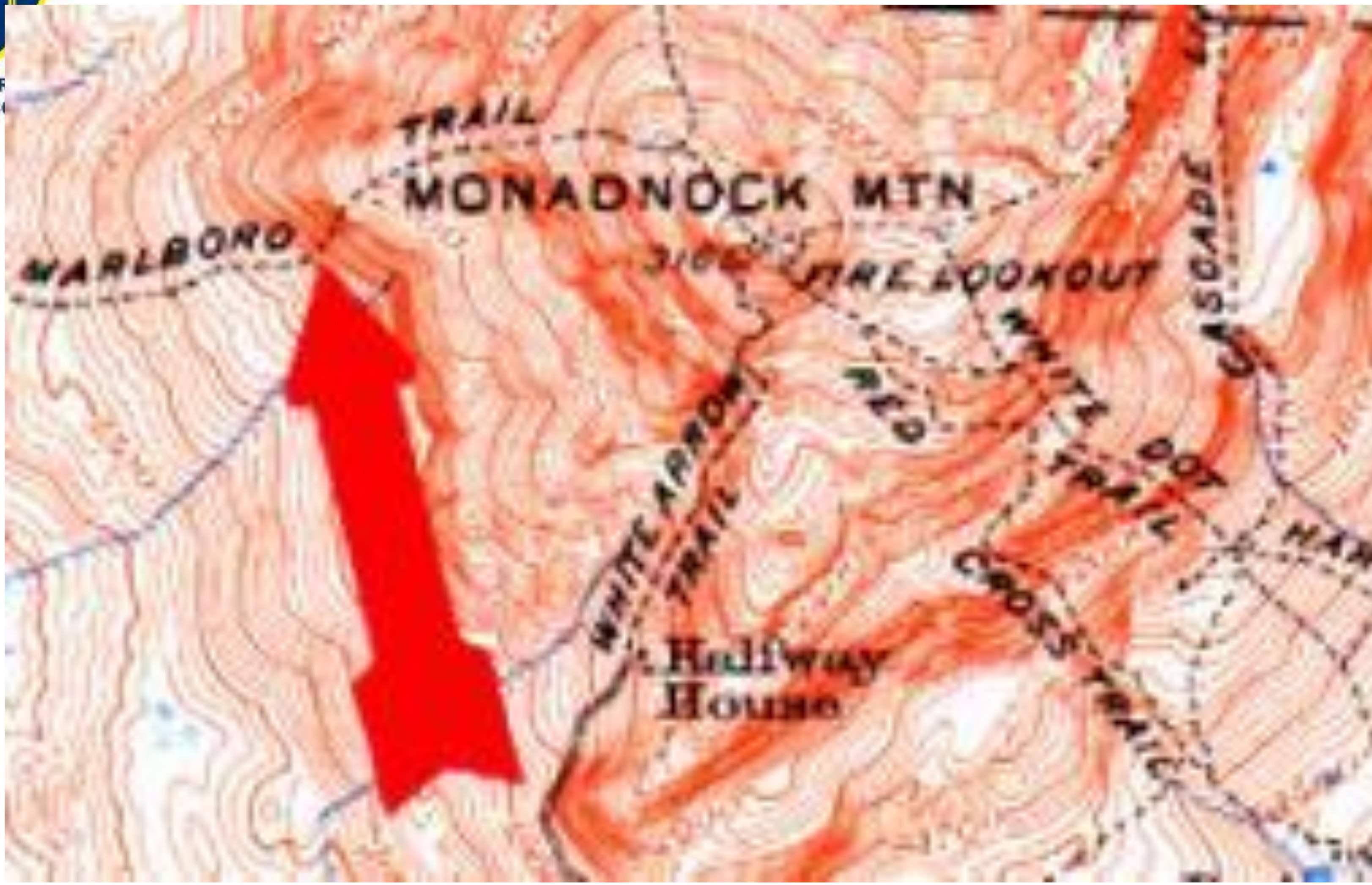
CALIFORNIA
CADET CORPS



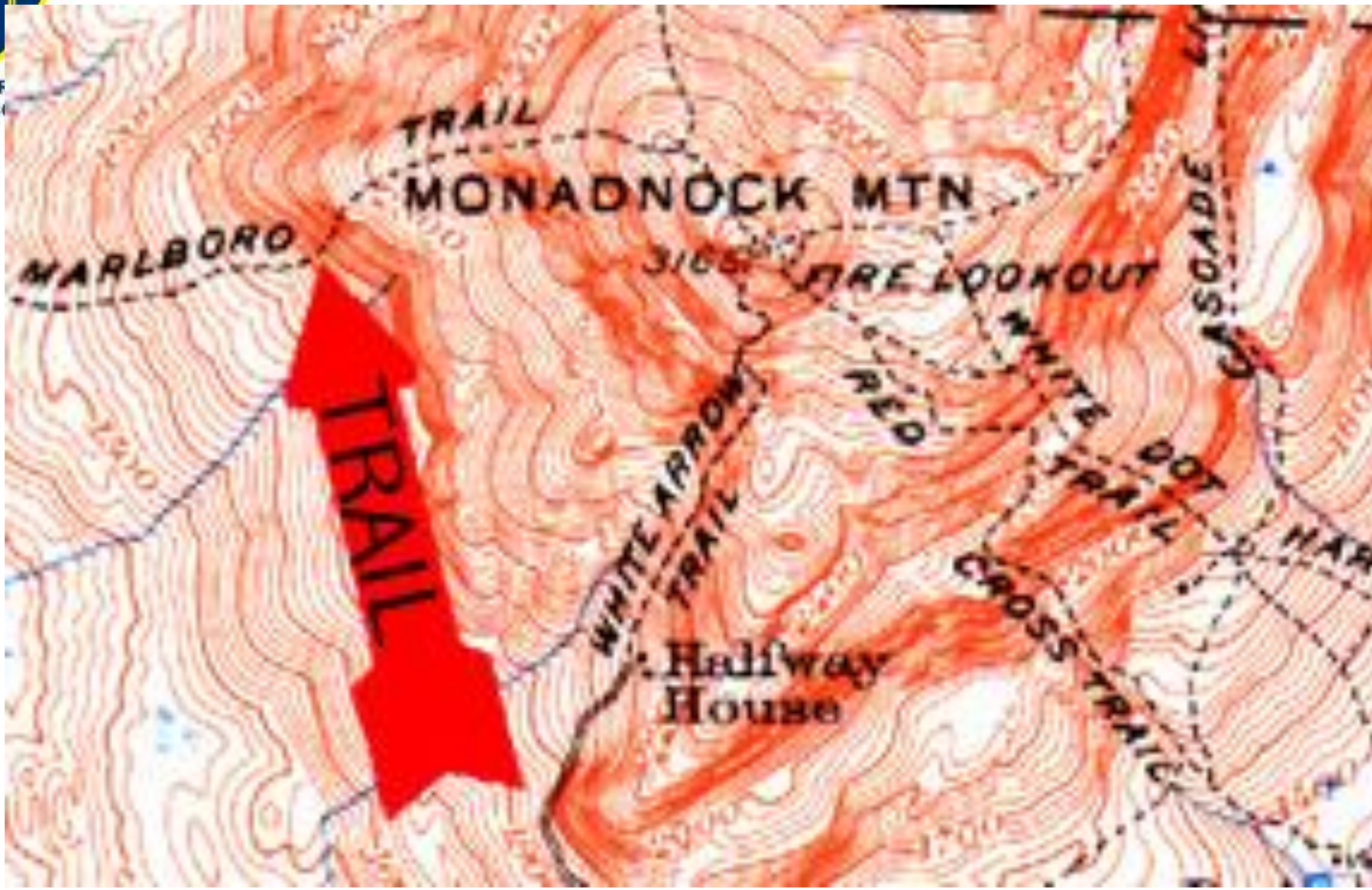

POWER LINE
700
San
30
122


Great Pond
LANDS
BICYCLE
P R O I
Pasture Pond
5
10


Great Pond
LANDS
BICYCLE
P R O I
Pasture Pond
SAND
5
10

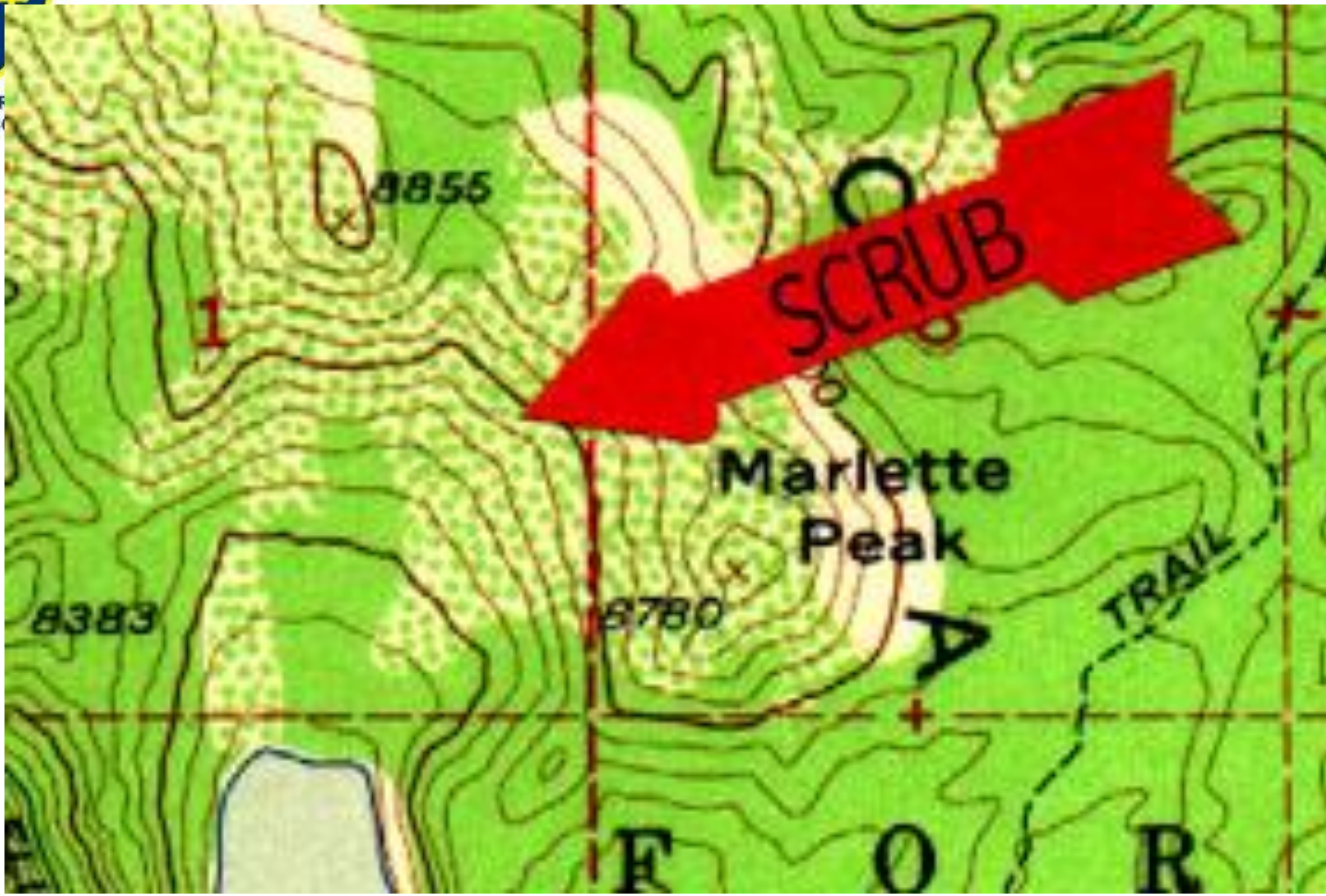

TRAIL
MONADNOCK MTN
MARLBORO
FIRE LOOKOUT
CASCADE
RED
WHITE DOT TRAIL
WHITE ARROW TRAIL
CROSS TRAIL
Halfway House

CALIFOR
CADET C

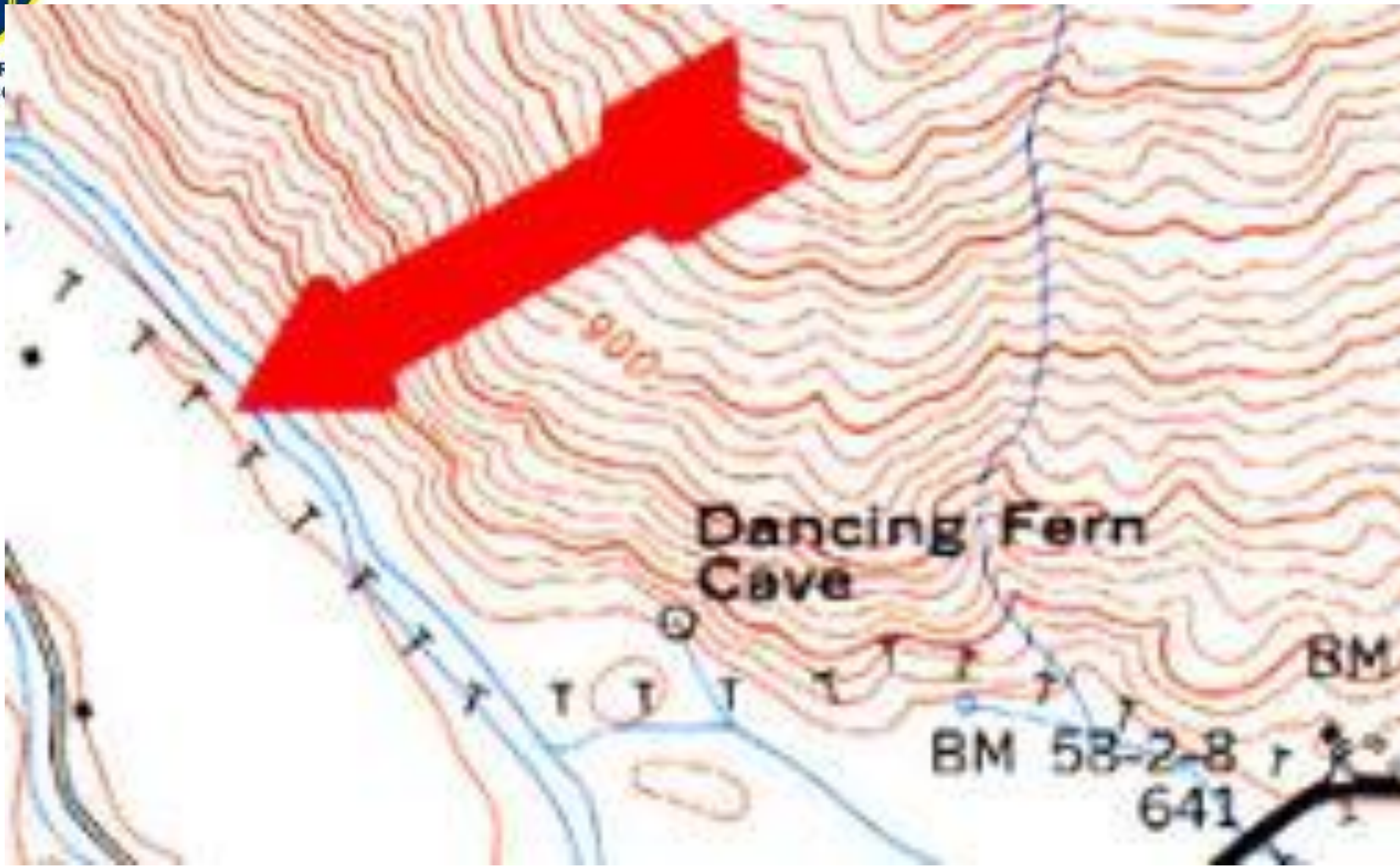



8855
1
O
Marlette
Peak
8383
A
TRAIL
F O R

CALIFOR
CADET CO



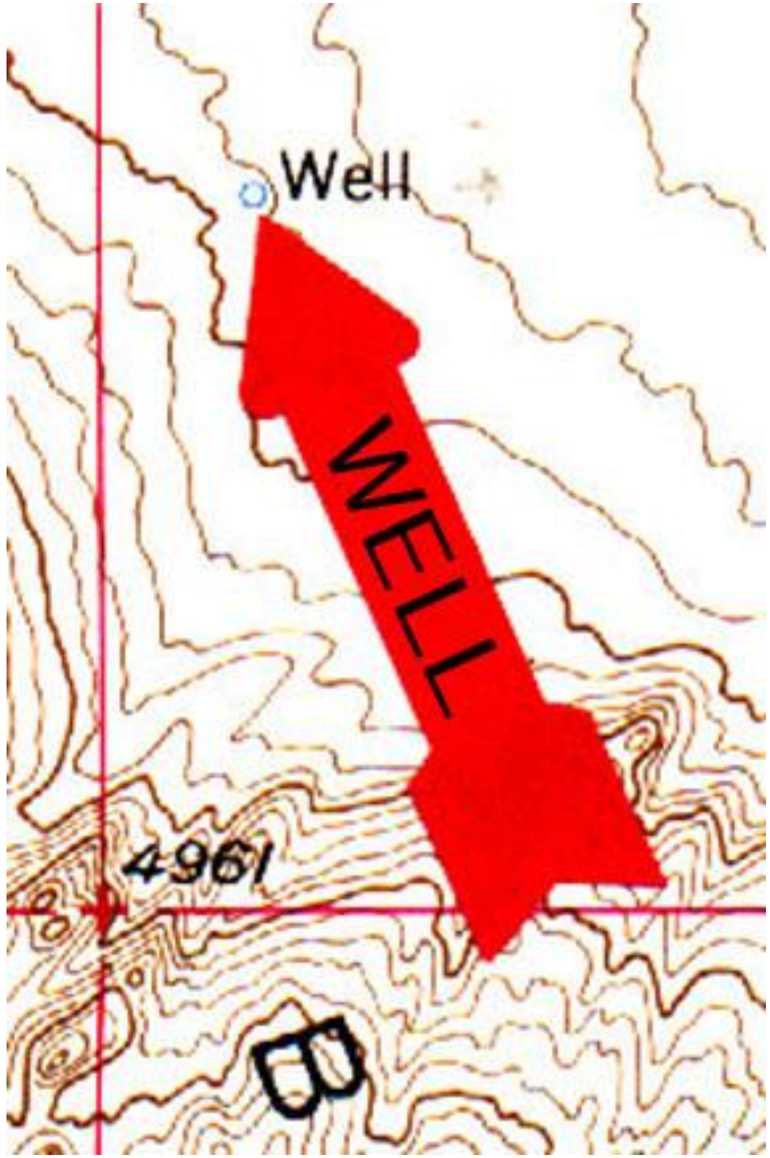
CALIFOR
CADET C



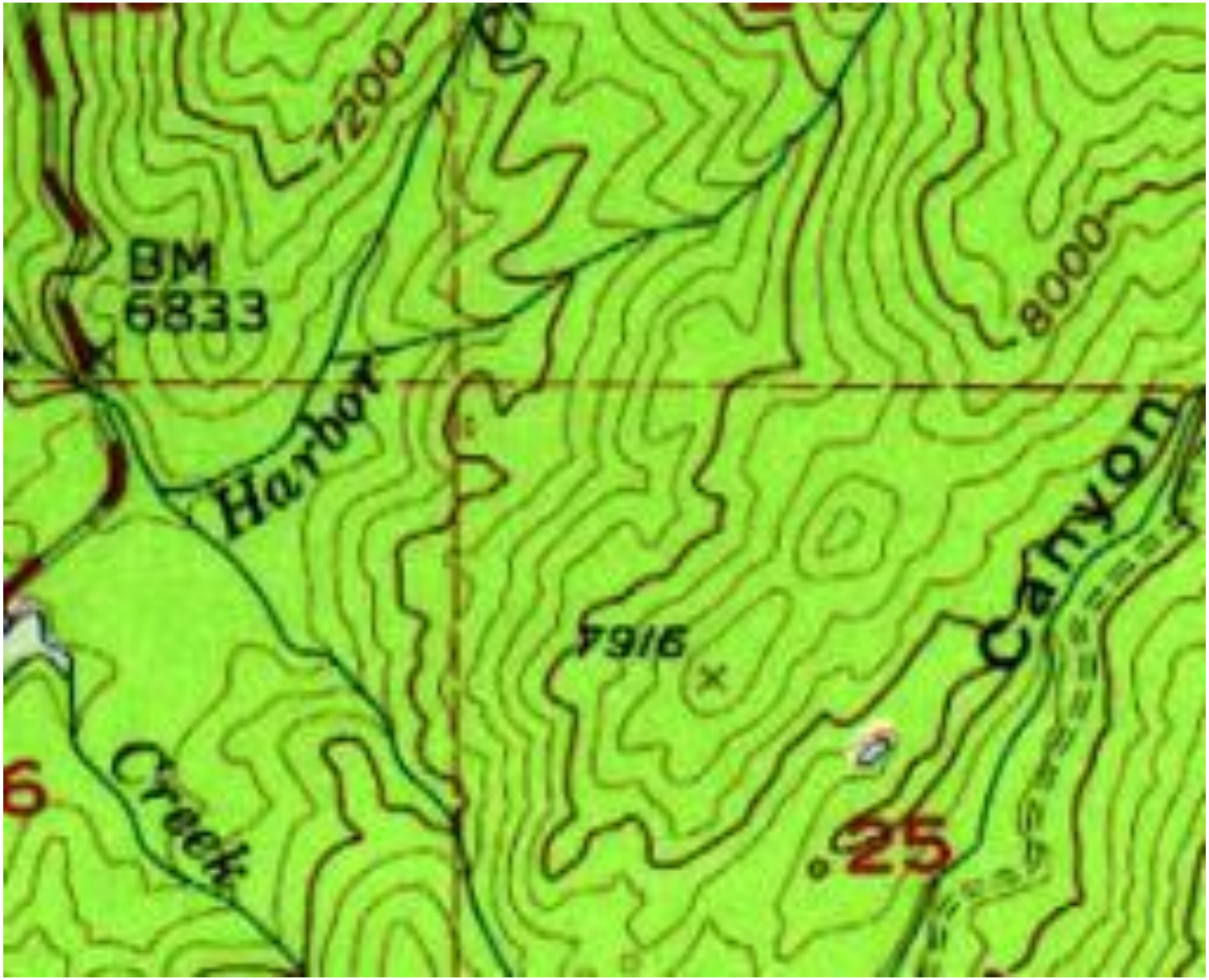

POWER LINE
900
Dancing Fern
Cave
BM
BM 58-2-8
641


Well
4961
B

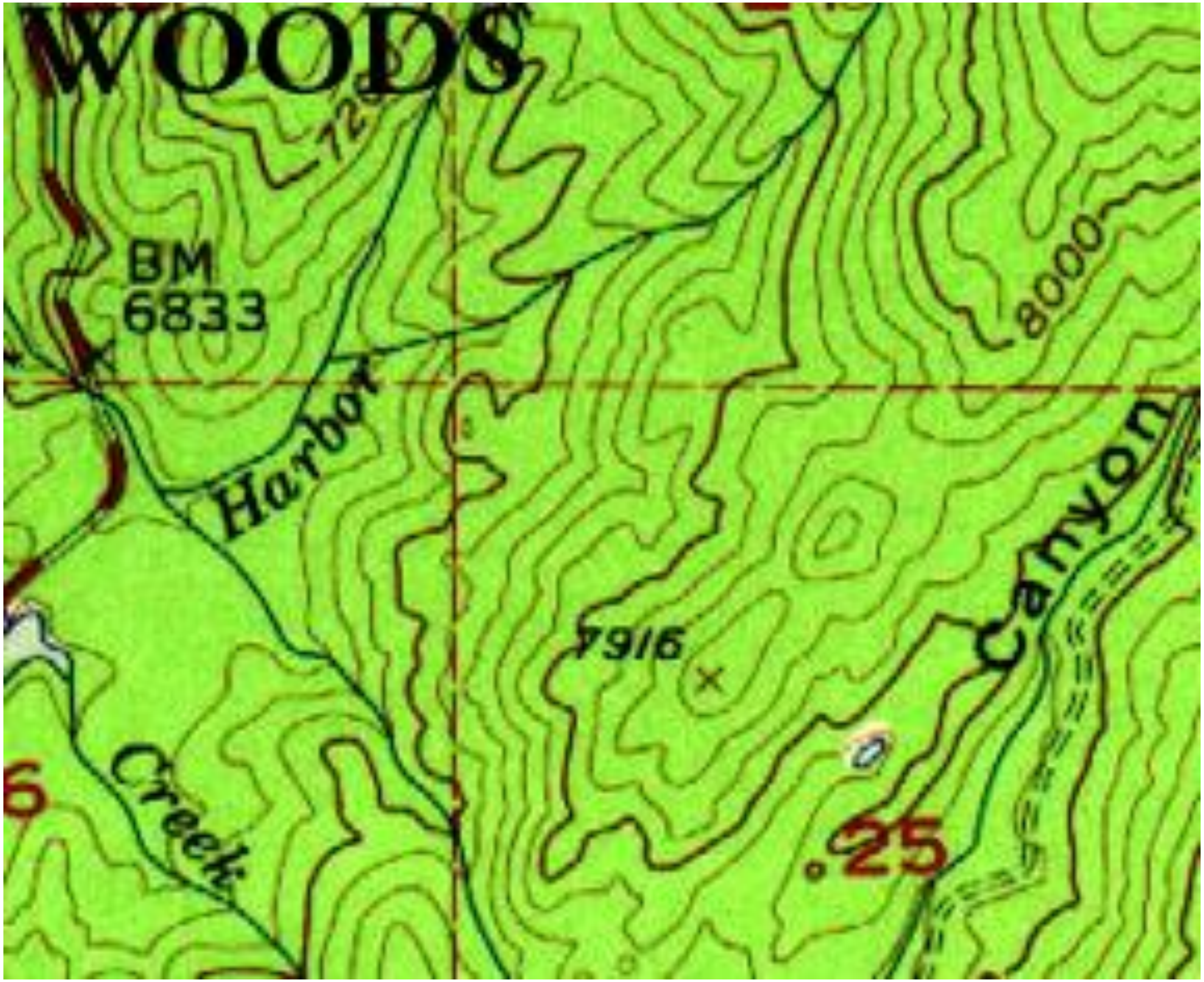
CALIFORNIA
CADET CORPS



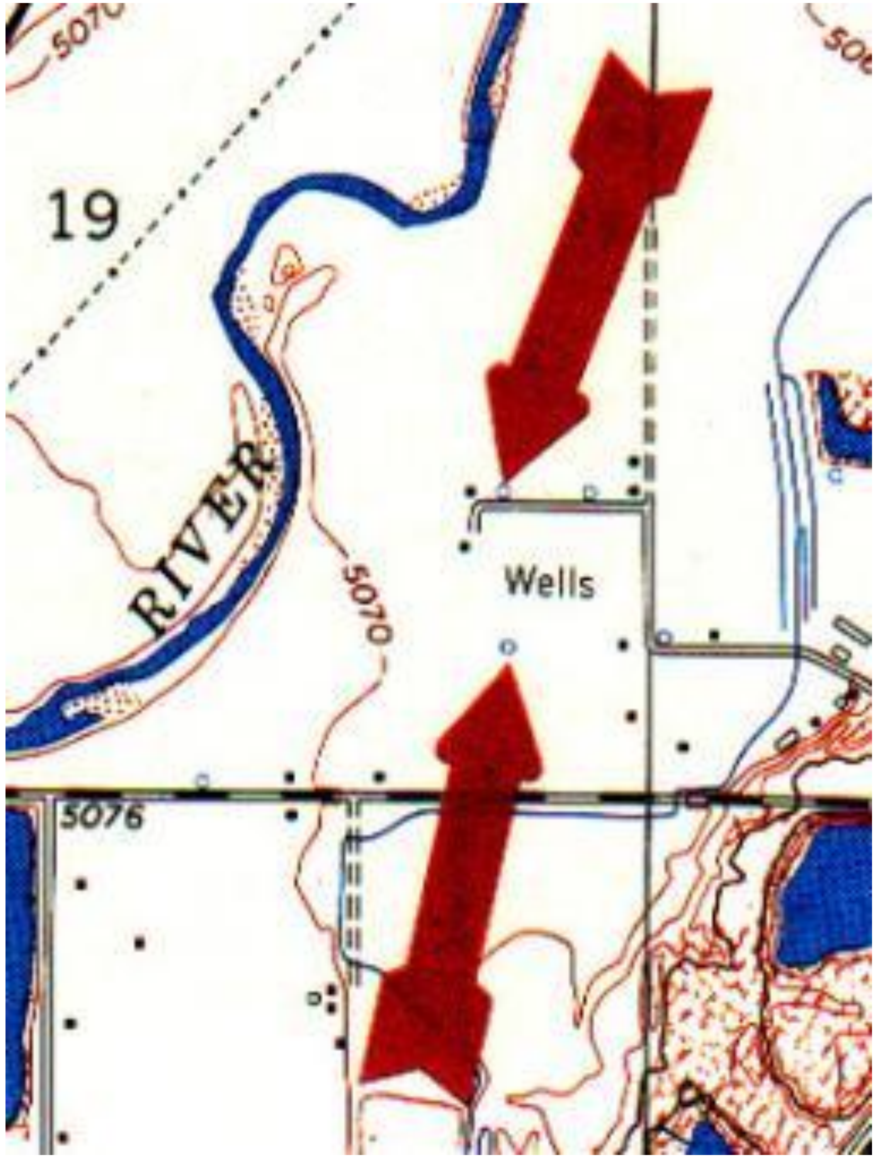
CALIFORNIA
CADET CORPS



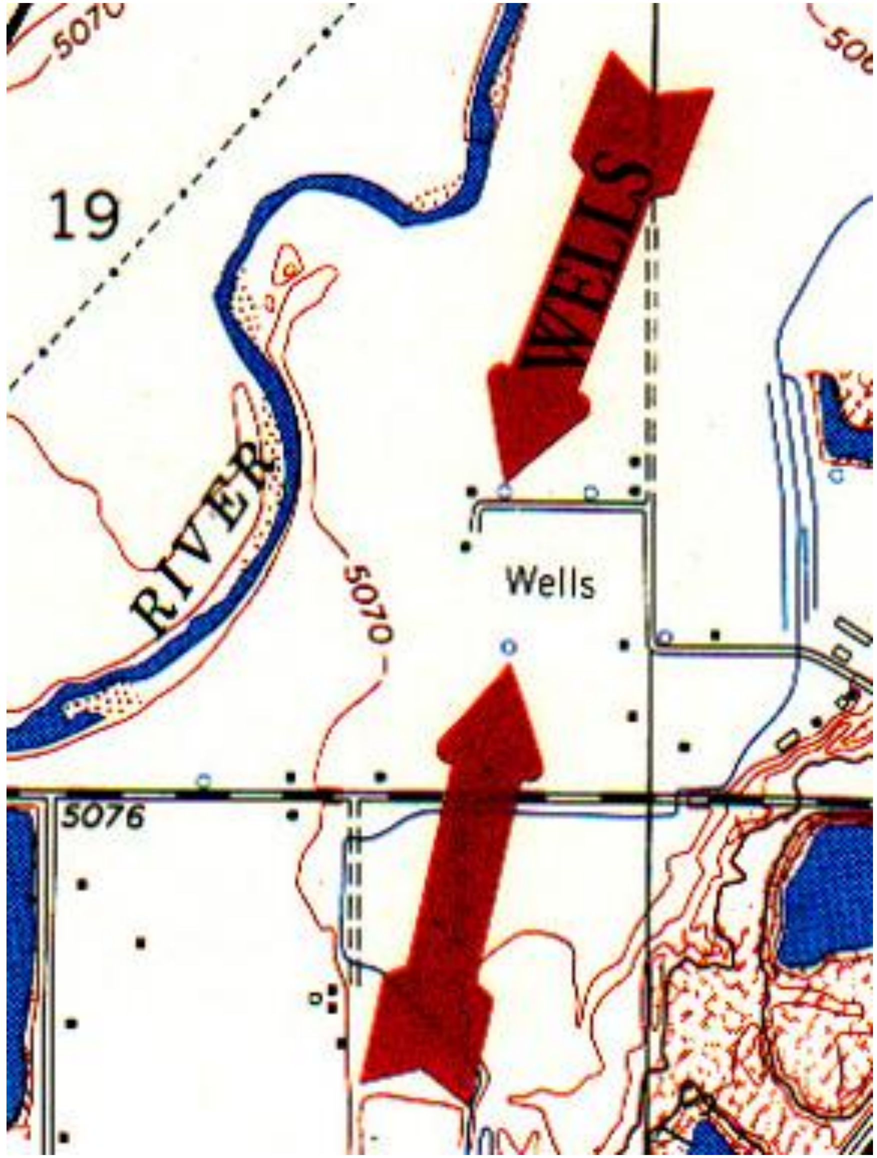
CALIFORNIA
CADET CORPS

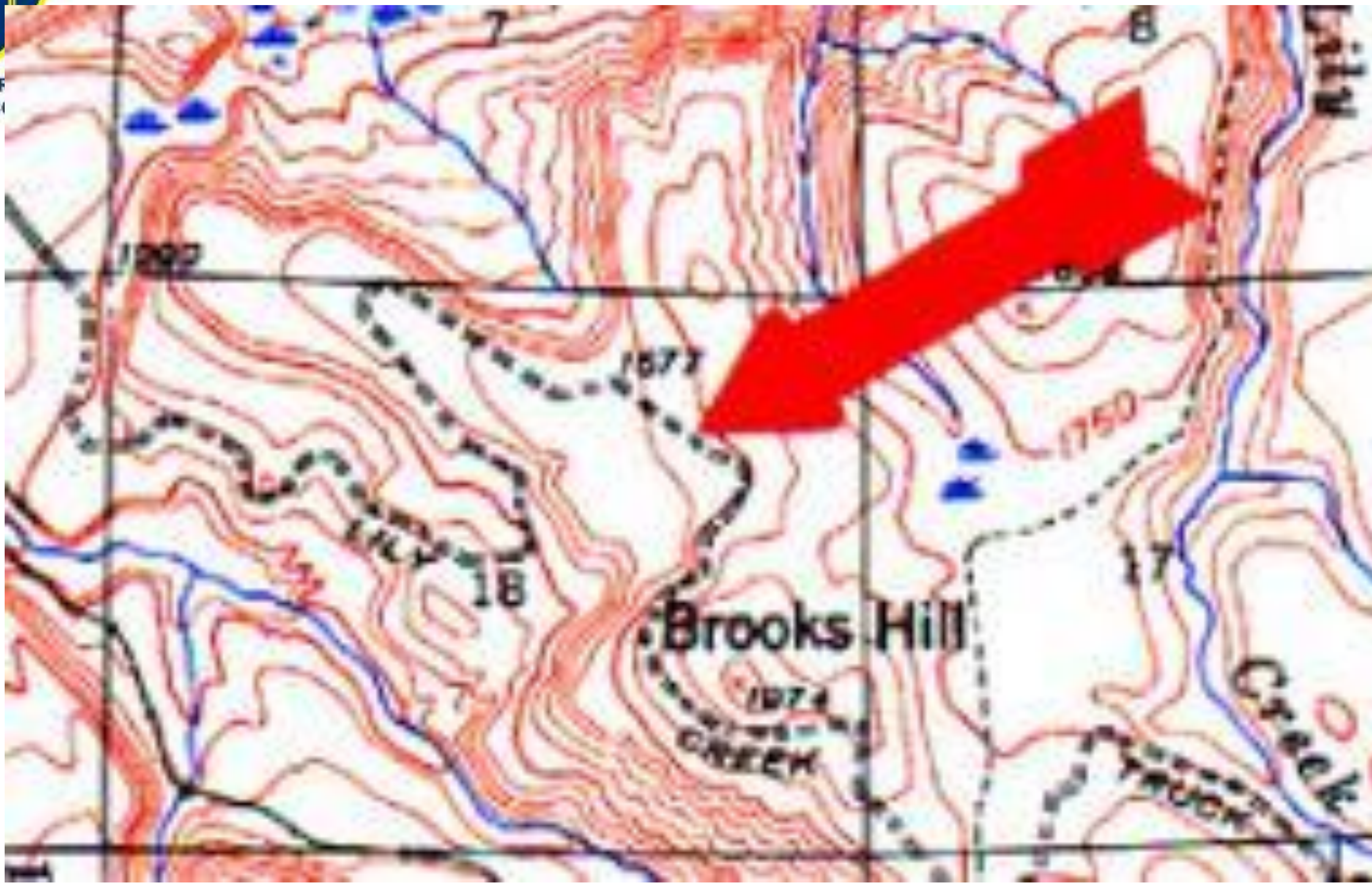


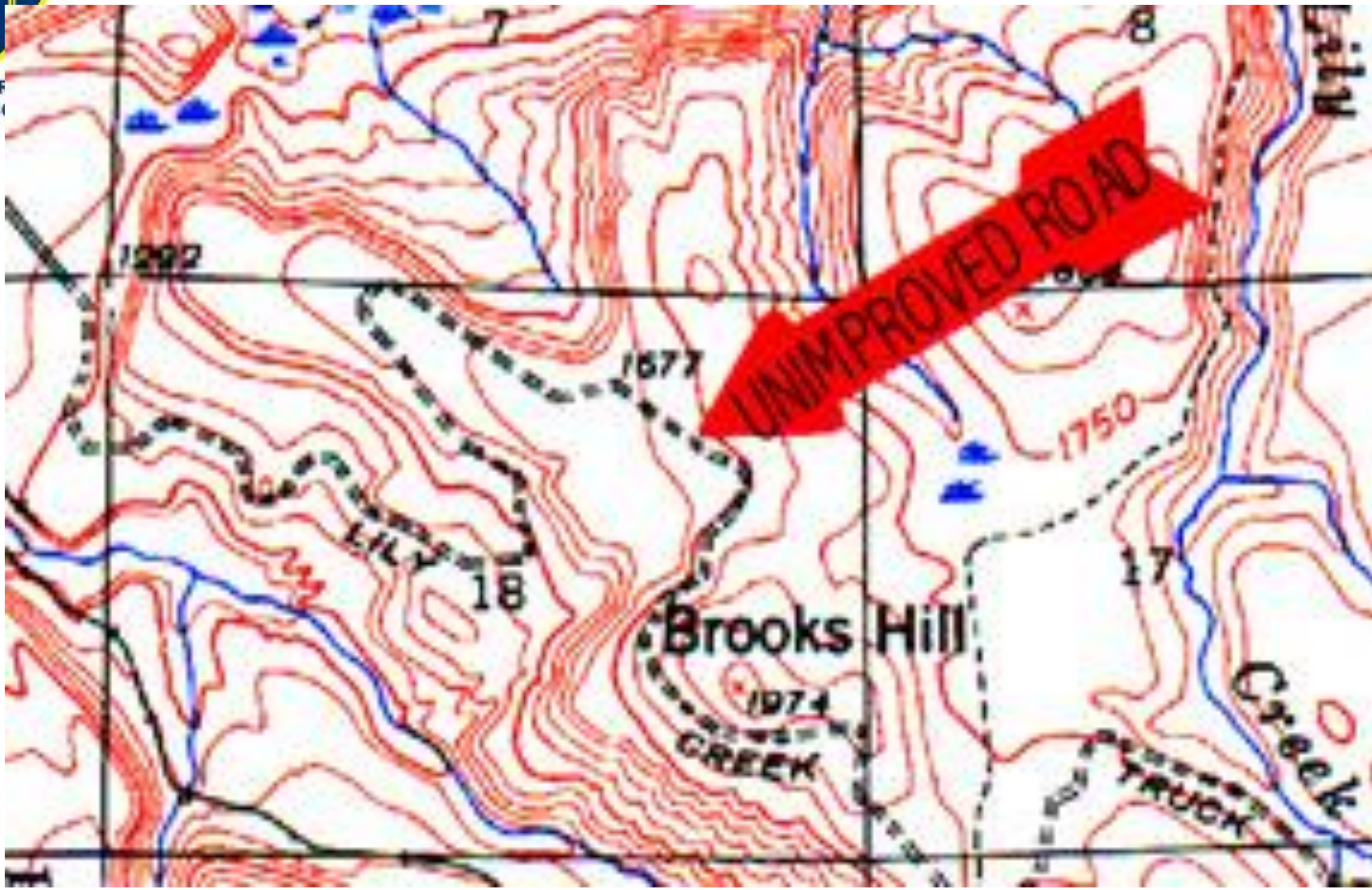
CALIFORNIA
CADET CORPS



CALIFORNIA
CADET CORPS



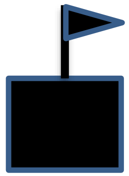

7
8
1677
1750
LILY
16
17
Brooks Hill
CREEK
TRUCK
Creek



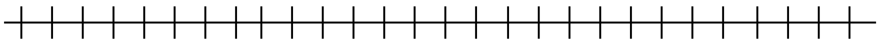
UNIMPROVED ROAD
7
8
1677
1750
LILY
18
17
Brooks Hill
1974
CREEK
TRUCK
Creek

# Check on Learning

1. What color represents water features on a map?
2. What does the color brown symbolize on a map?
3. What does this symbol mean:



4. What does this symbol mean?



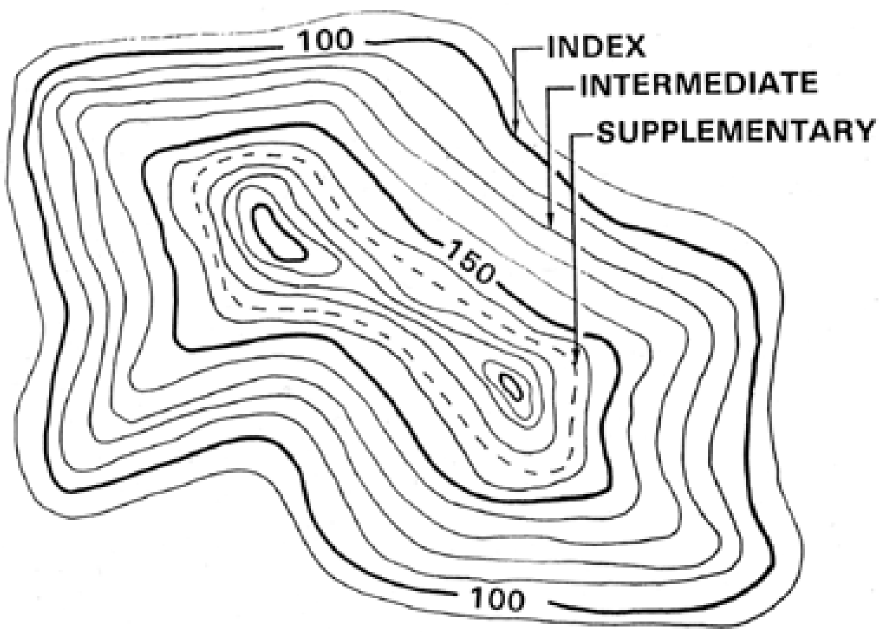
5. How do you determine the scale of a map?

# ELEVATION & TERRAIN FEATURES
# CONTOUR LINES

A3. Define contour lines. Identify the five major and three minor terrain features from contour line patterns. Determine the elevation of a point using contour lines.

# CONTOUR LINES

A way of graphically depicting elevation and the shape of the land




**Contours are lines that connect points of equal elevation on the earth's surface.**

# Relief

- The representation of the shapes of hills, valleys, streams and other features of the earth's surface
- Can be represented by colors for different elevations (called layer tinting), form (dashed) lines to show the basic shape of land, and shading (where the darker the color, the steeper the land)
- Most often, relief is shown by CONTOUR LINES

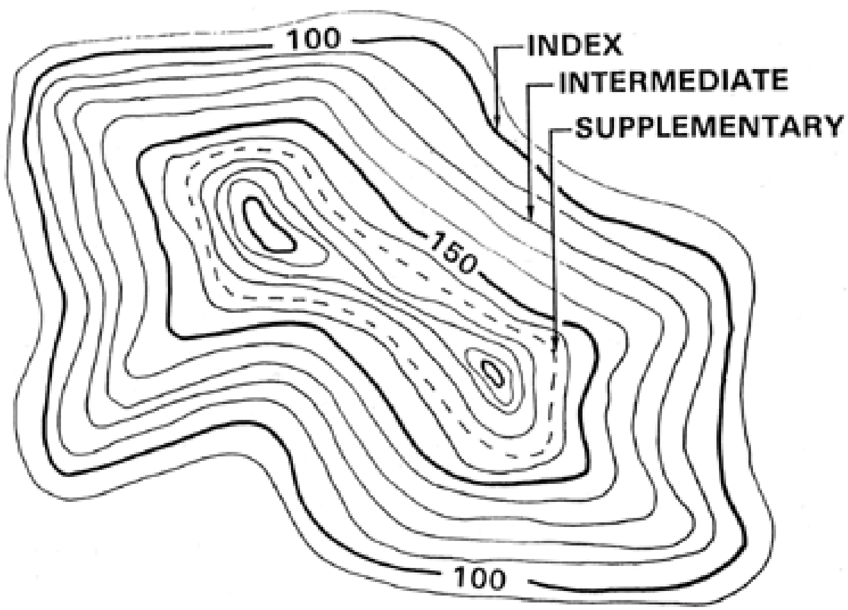
# What are contour lines?

- Imaginary lines that represent the same elevation above or below sea level
- All points along a contour line are the same elevation

# Contour Lines

Contour lines are what makes a map the equivalent of 3D. They are lines that connect points of equal elevation on the earth's surface, and are used to illustrate topography, or relief, on a map. On American maps, they are usually in feet. Numerous contour lines that are close together indicate hilly or mountainous terrain; when far apart, they represent a gentler slope.

# Three types of contour lines




**Index** lines are the HEAVY or DARK colored contours, generally every fifth contour line; they show an elevation number.

Four **intermediate** contour lines fall between the index contours and do NOT show their elevation.

**Supplementary** contour lines are generally DASHED lines that show one-half the contour interval. They are often used on maps where the contour interval is large, and the terrain somewhat featureless overall.

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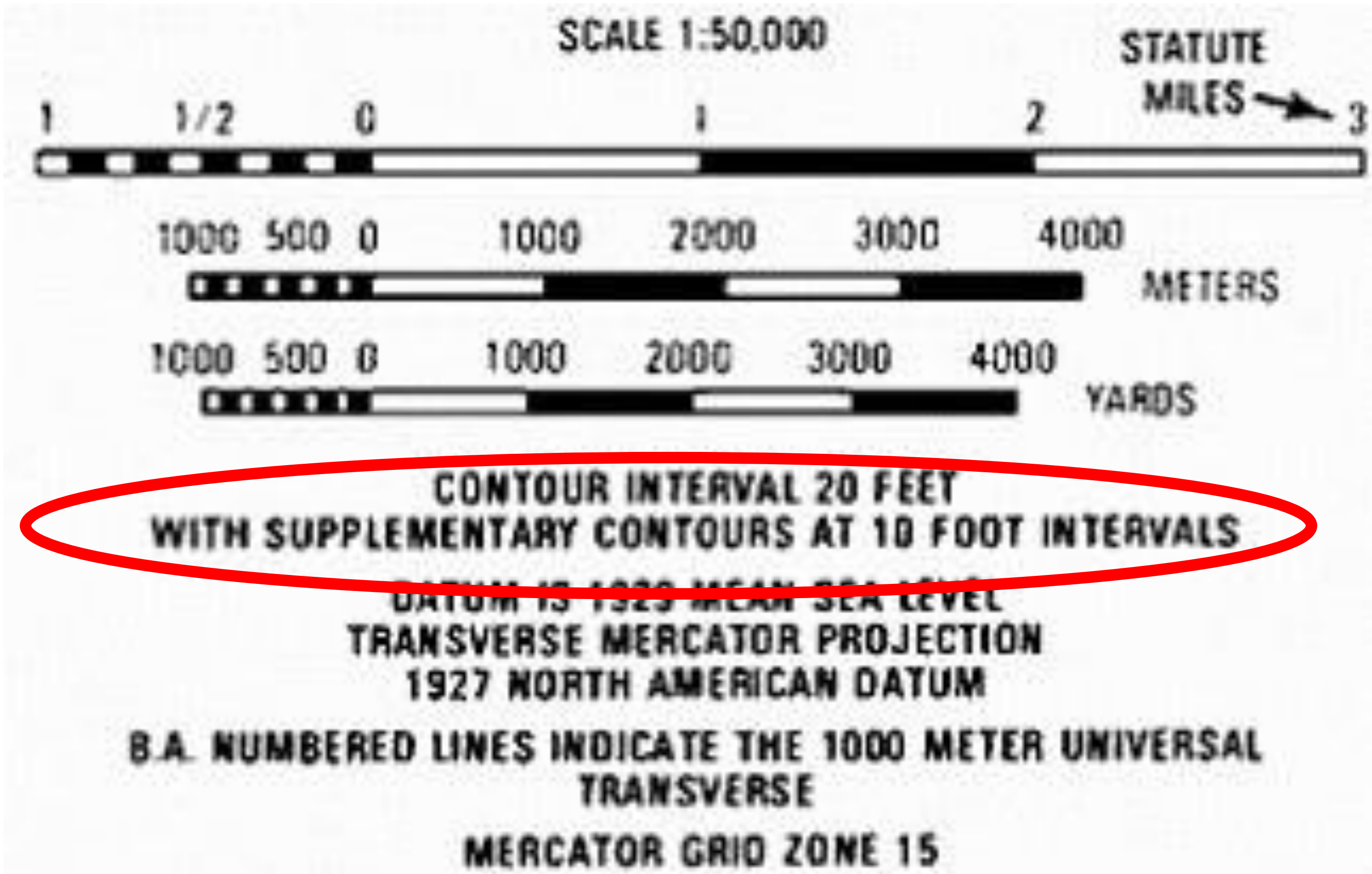
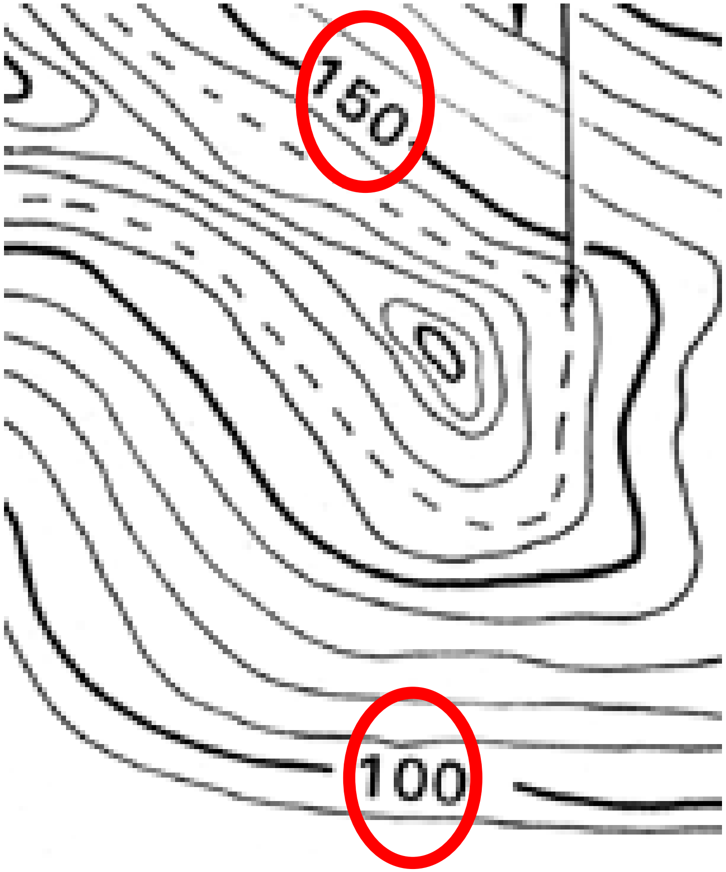
# Contour Interval

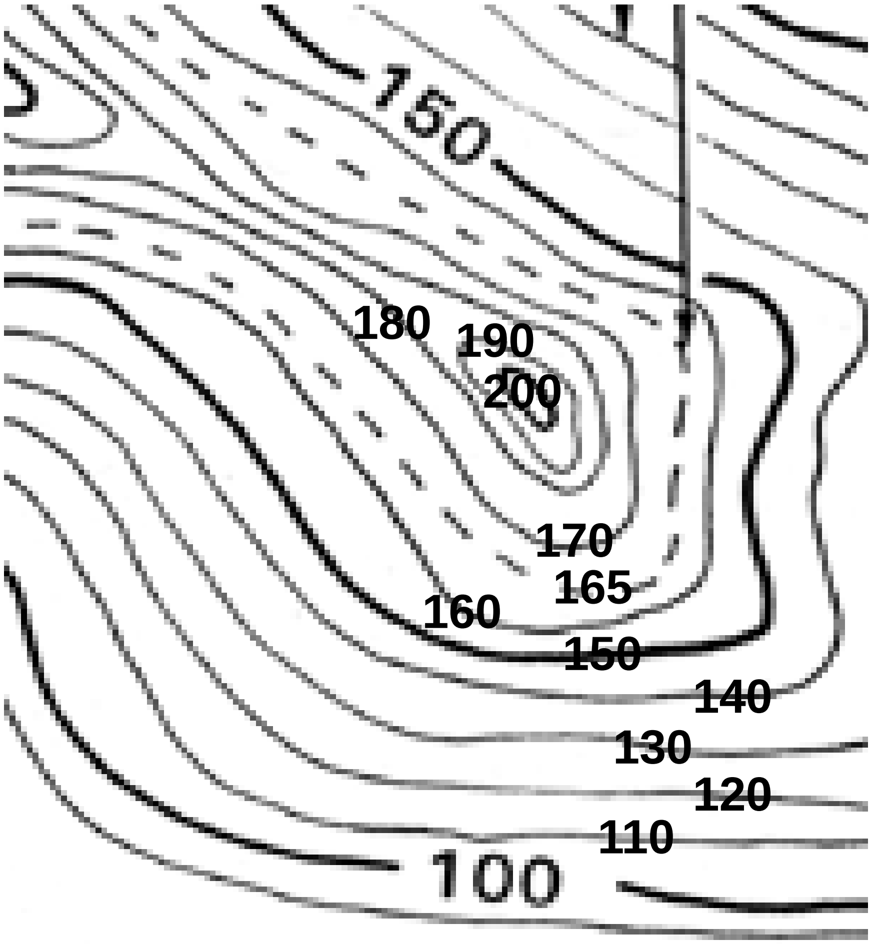


# Contour Interval

The contour interval measurement, given in the map's marginal information, is the vertical distance between adjacent contour lines.  The numbered Index contour lines, which are circled in red in the example on the right, give that particular line's elevation.

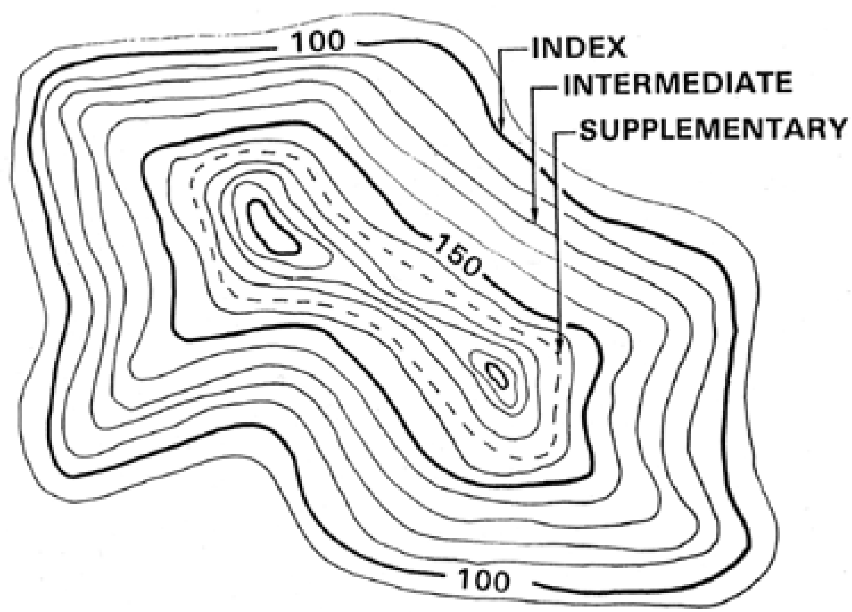


If every contour line was numbered on a map, it might look like this:



# Determining an elevation

- Find the contour interval on the marginal map info
- Find the nearest INDEX contour and its elevation
- Determine if you are going lower or higher to the point you are concerned about
- Count up or down to determine the correct elevation



# Determining an elevation

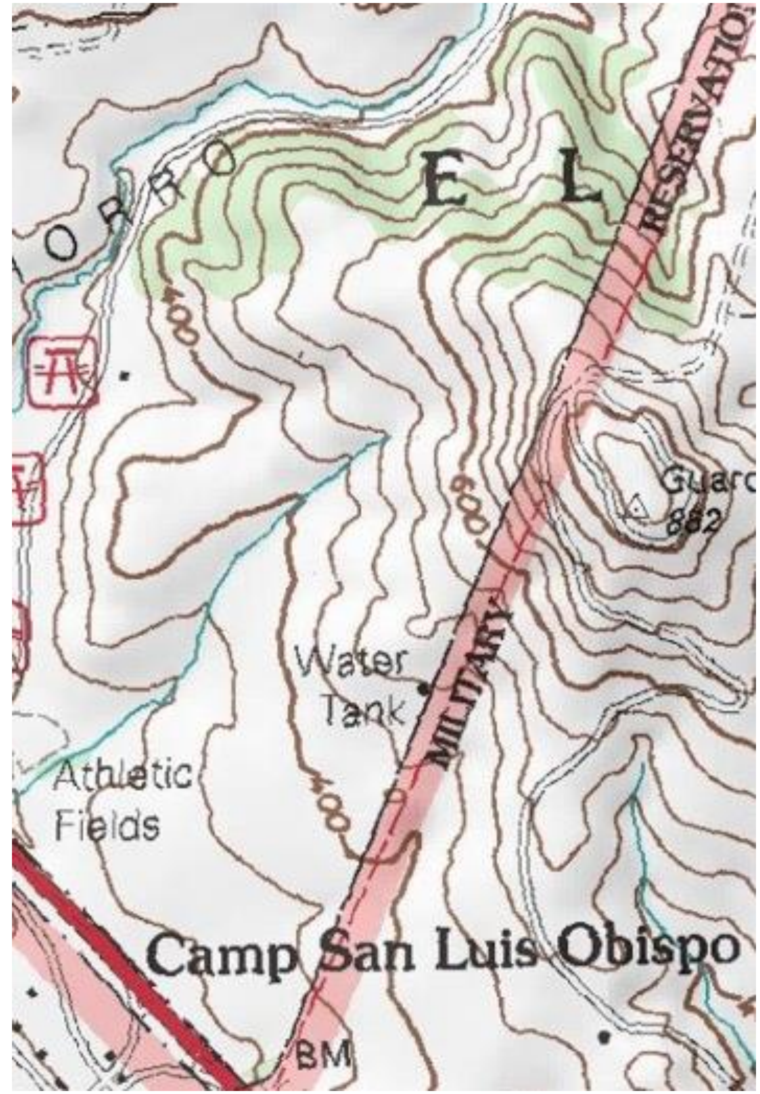
What's the contour interval on this map? Even though we don't have the marginal information, you can tell by comparing the Index contour lines.

You can see a 400' Index Contour, then a 600' Index Contour.

600-400 = 200 feet between Index Lines.
200 ÷ 5 = 40'

So the Contour Interval is 40 feet. Each contour line represents a point that's 40 feet higher than the contour line below it.

Can you determine the elevation of the Water Tank?

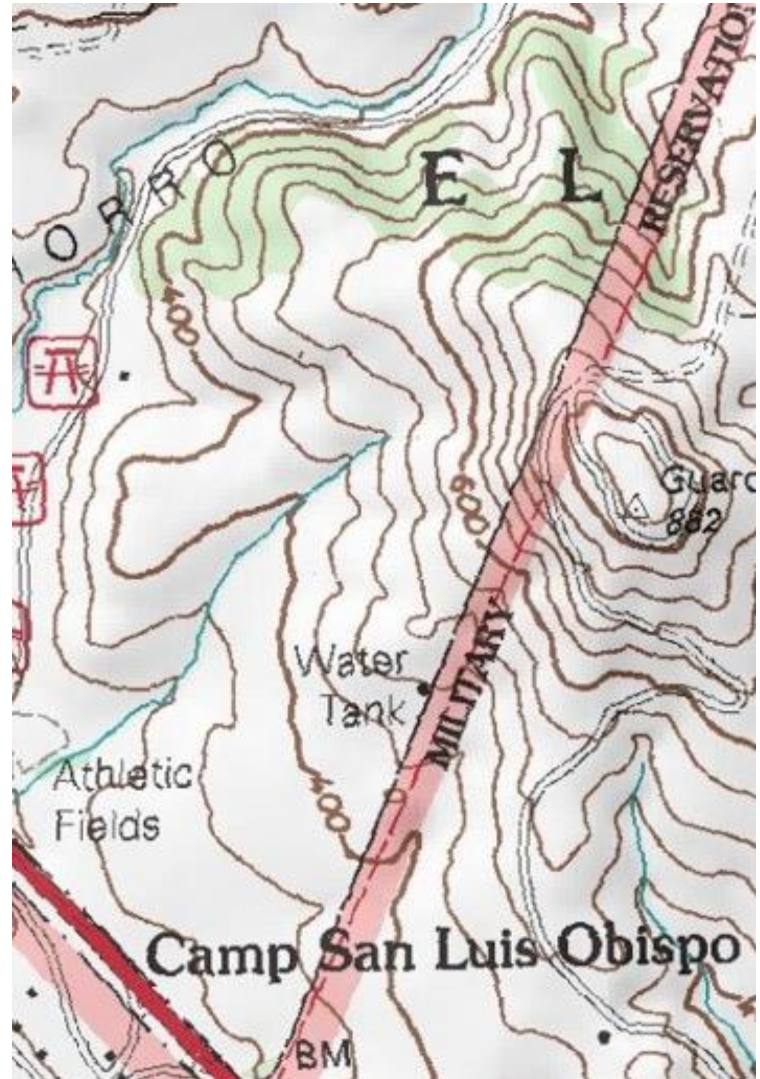


# Determining an elevation

The Water Tank is on the second contour line up from the 400' Index, so it's 480 feet.

How about the hilltop ?

The map actually gives you the hilltop's elevation: 882 feet!



# Hilltops and Depressions

- For points at the top of hills, add half the contour interval.  In this example, you would estimate the hilltop at 360 feet.
- For points at the bottom of depressions, subtract half the contour interval.

# Benchmarks

Sometimes, you will see a notation such as X BM 214 on a map. That means that map makers have measured that particular spot on the earth's surface to be exactly 214 feet above sea level

# Terrain Features

Terrain features are identified in the same manner on all maps, regardless of the contour interval, but you must realize that a hill in the Rocky Mountains will be much bigger than one in south Florida. You must be able to recognize all the terrain features to locate a point on the ground or to navigate from one point to another.

The five major terrain features are: Hill, Ridge, Valley, Saddle, and Depression.

The three minor terrain features are: Draw, Spur and Cliff.

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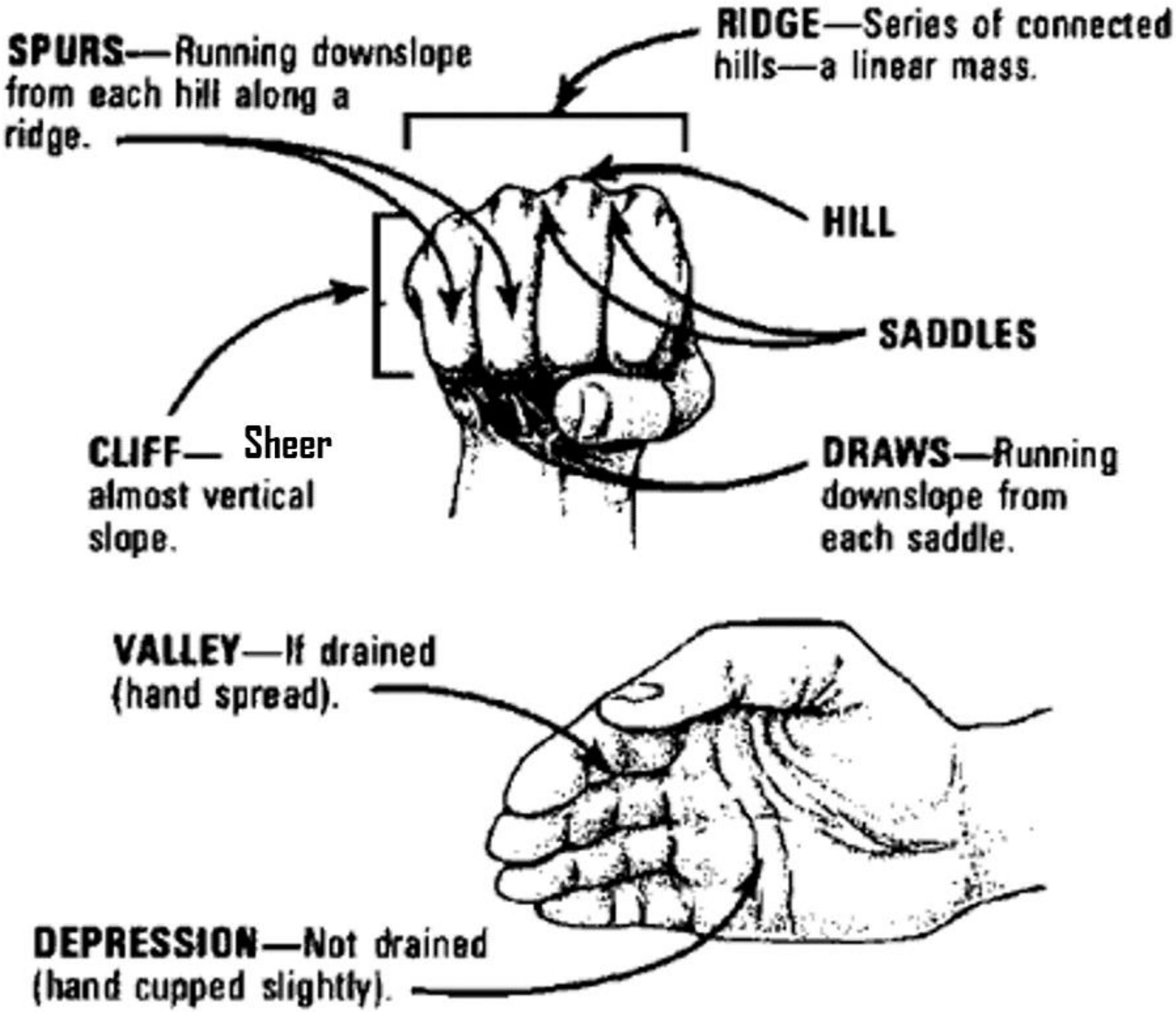
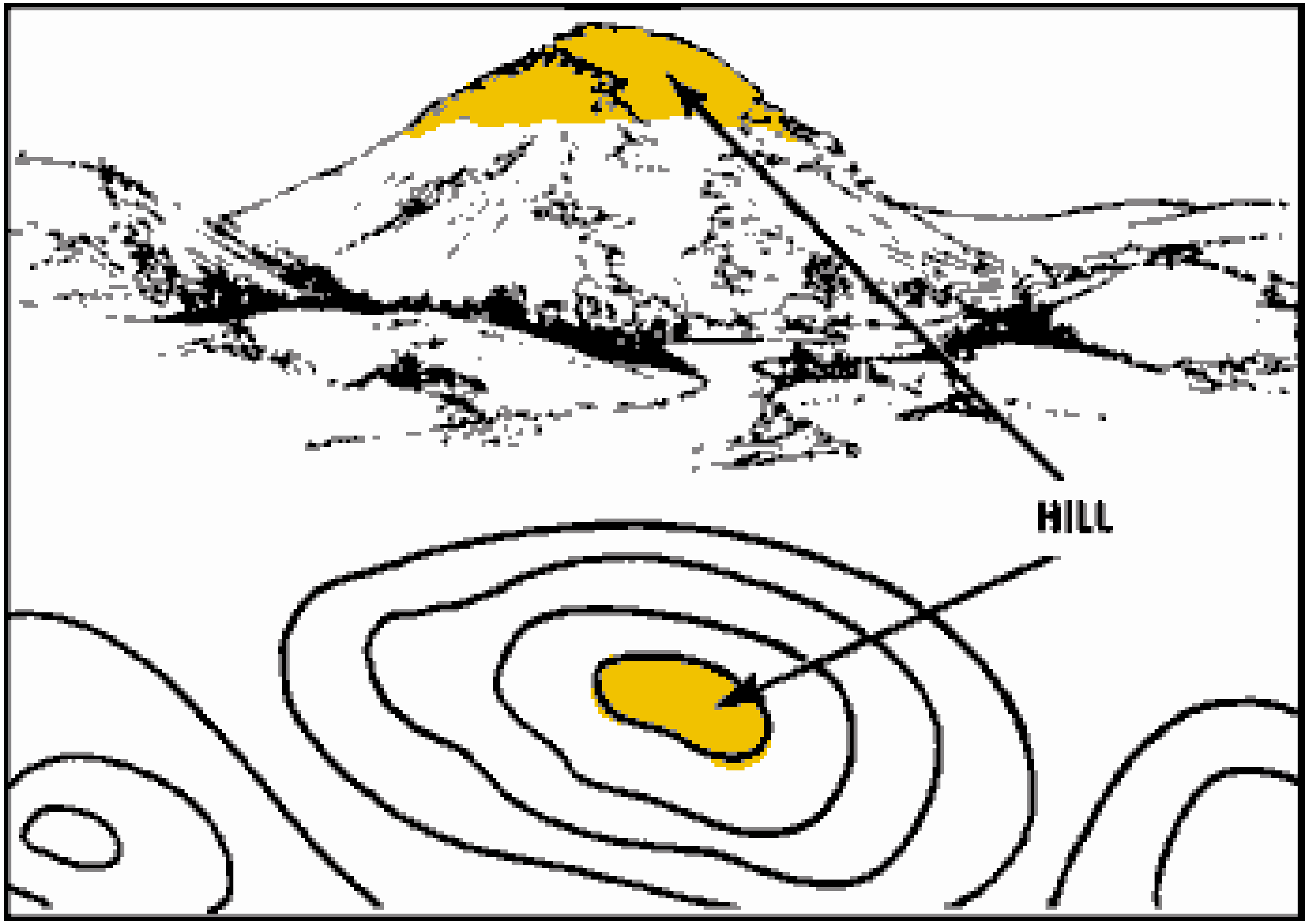
Terrain features can be learned using the fist or hand to show what each would look like on the ground

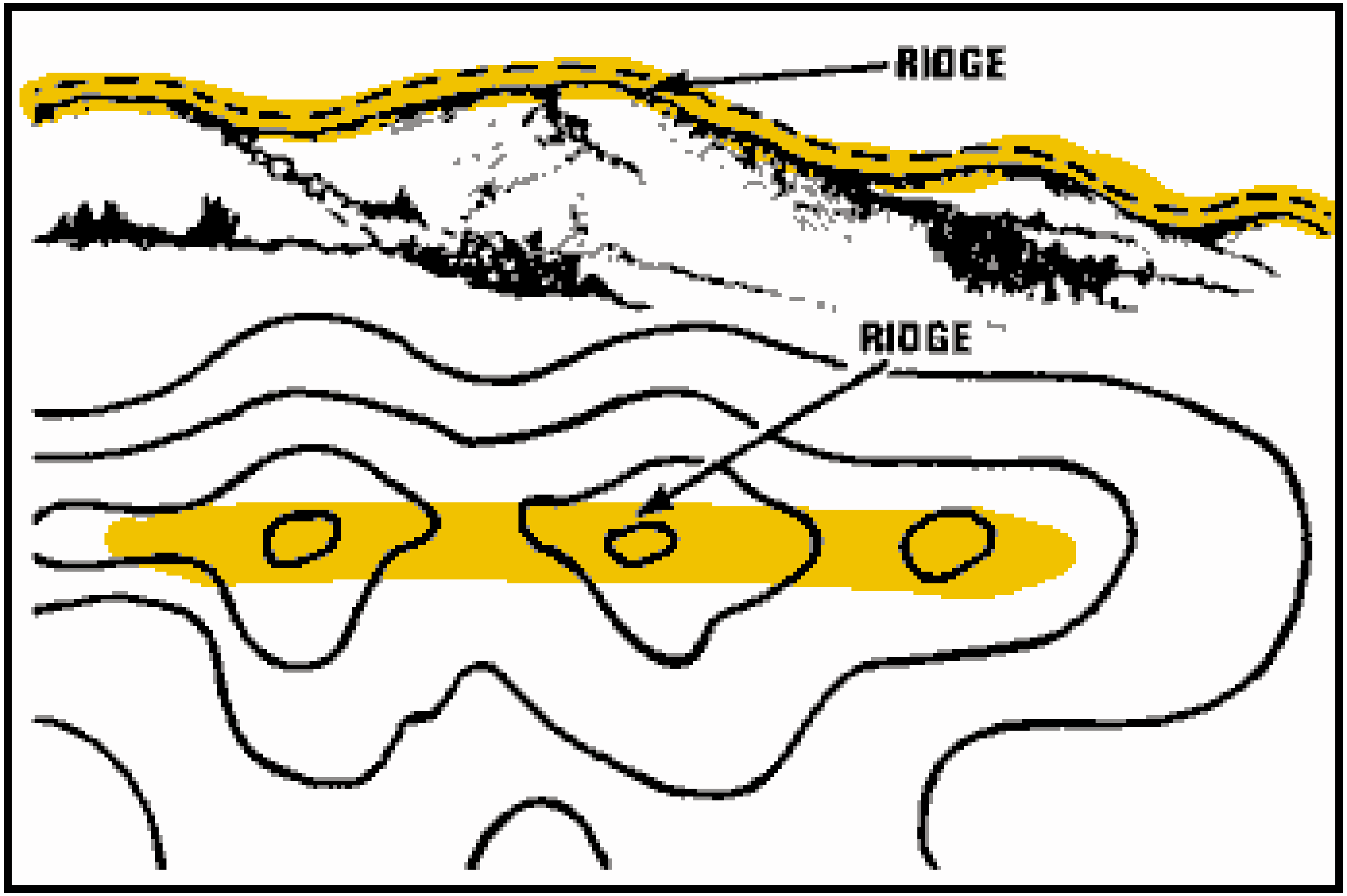


# Hill



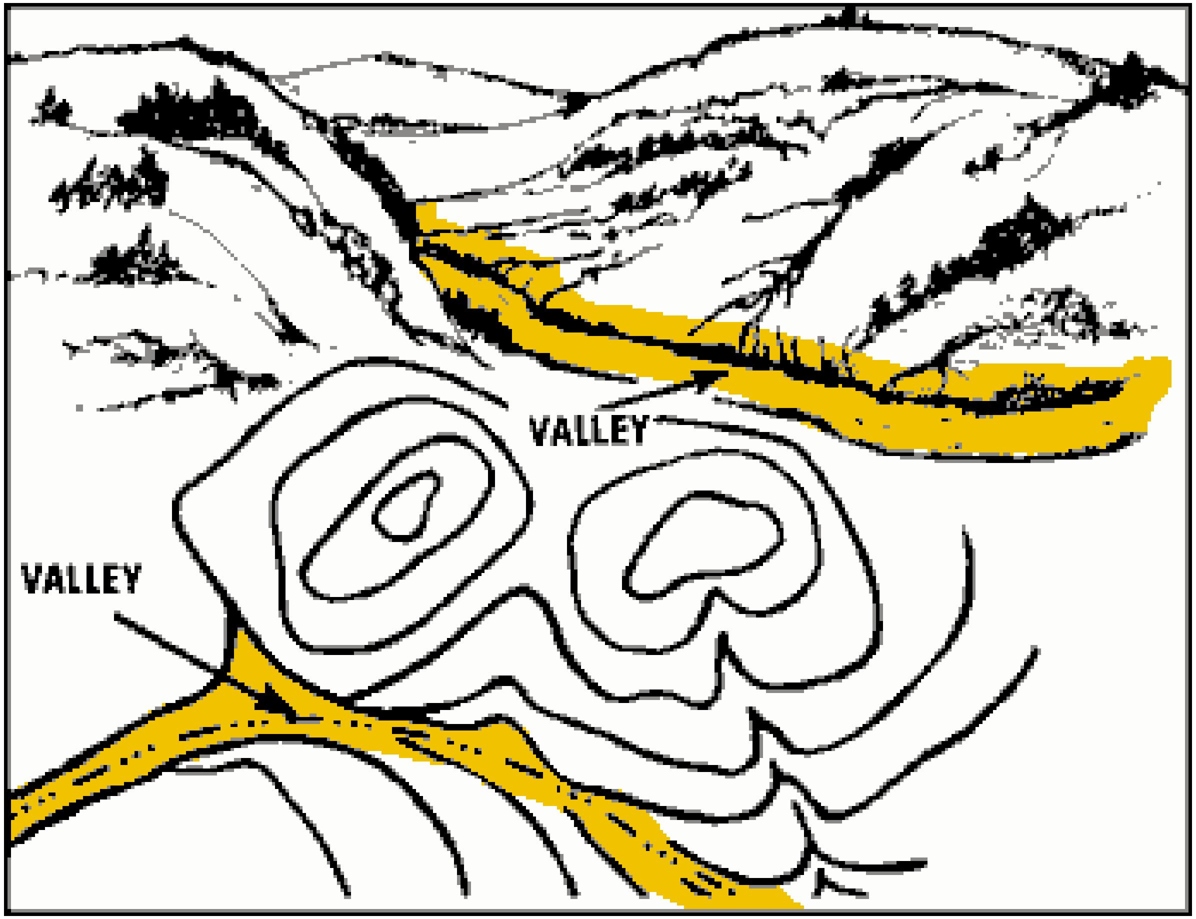

A point or small area of high ground. When you are on a hilltop, the ground slopes down in all directions.

# Ridge



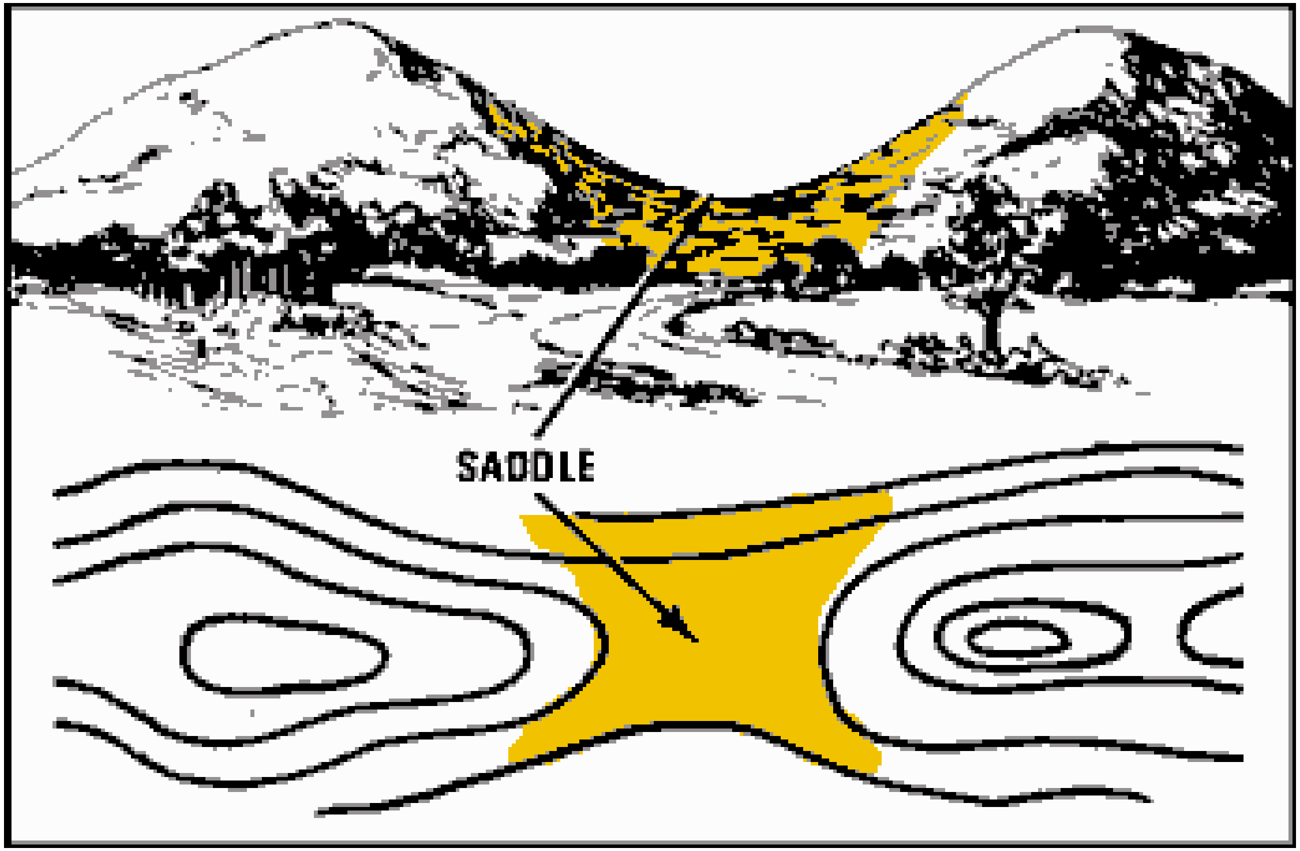

A line of high ground with height variations along its crest. The ridge is not simply a line of hills; all points of the ridge crest are higher than the ground on both sides of the ridge.

# Valley



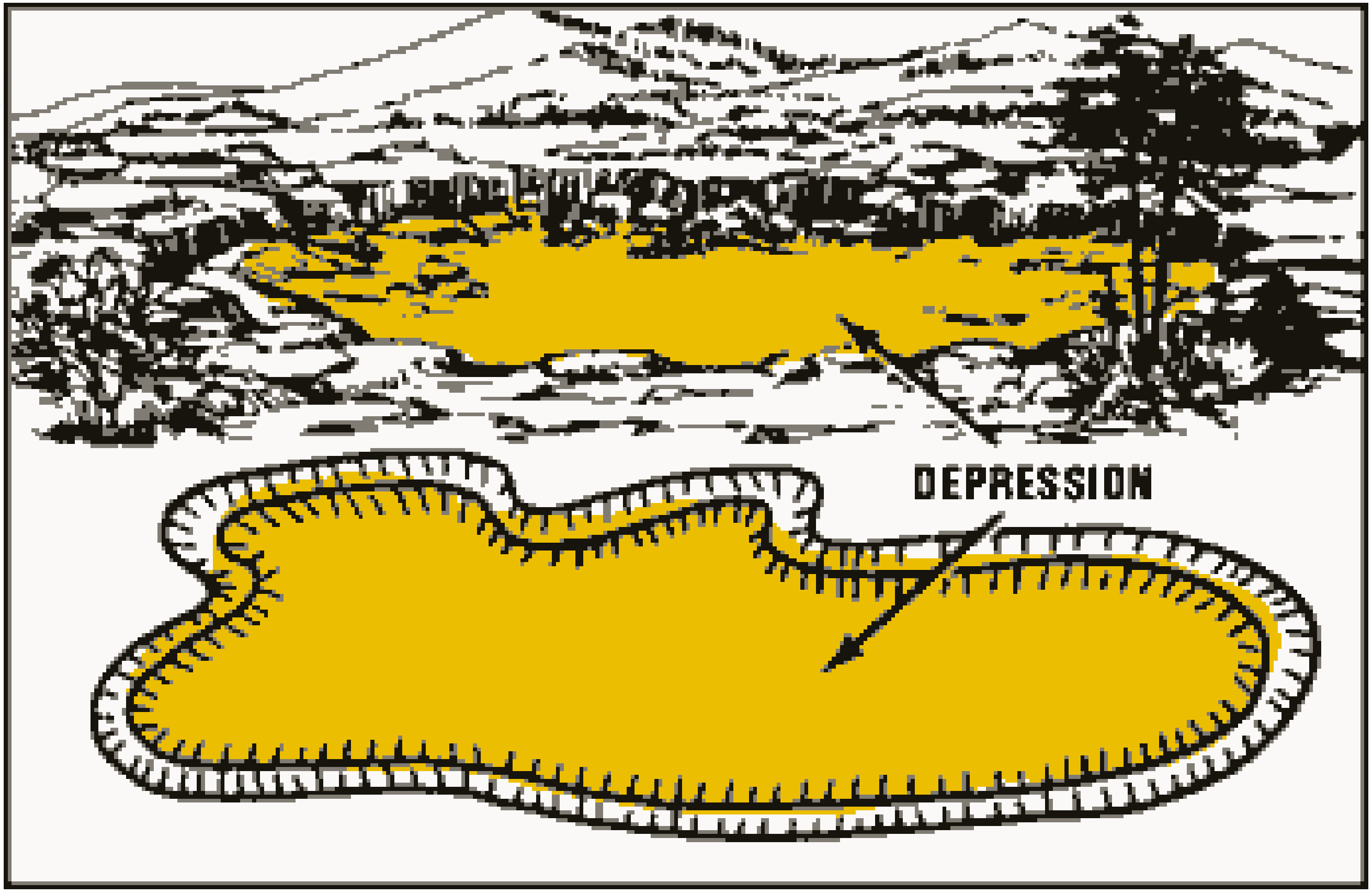

Reasonably level ground bordered on the sides by higher ground. A valley may or may not contain a stream course. Contour lines indicating a valley are U-shaped and tend to parallel a stream before crossing it.

# Saddle



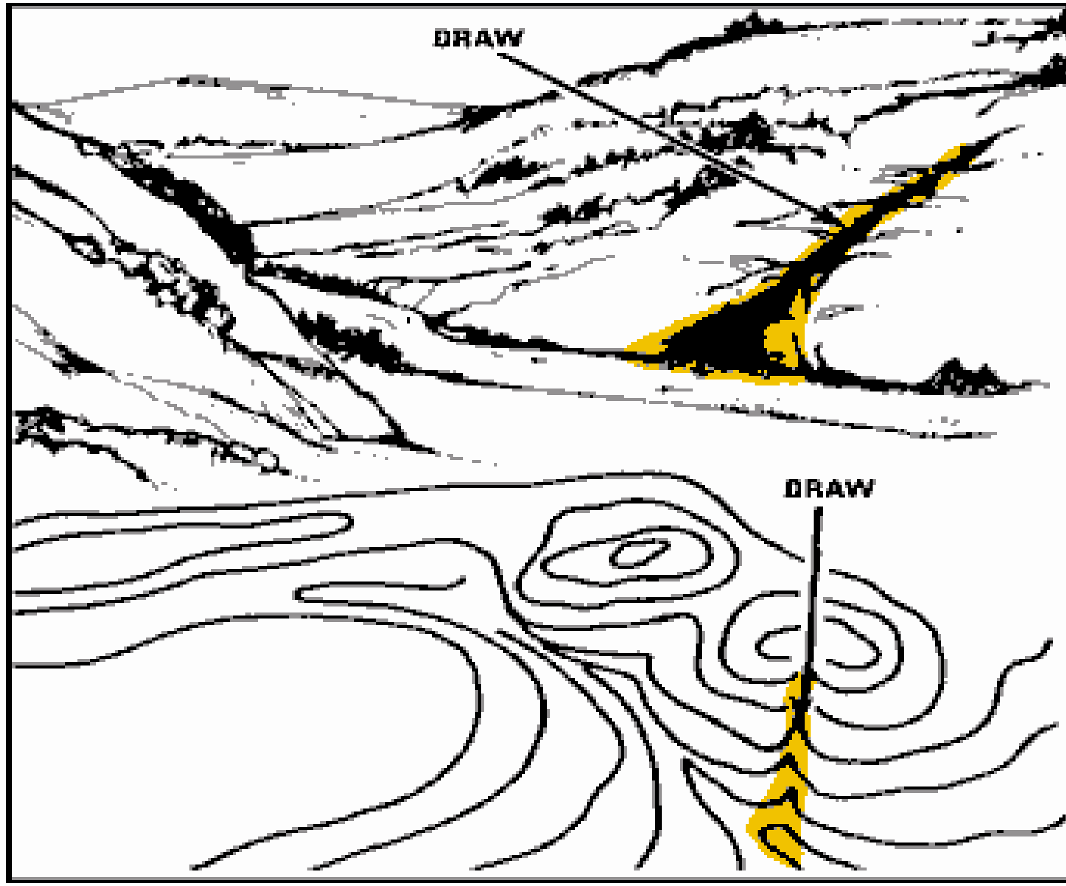

A dip or low point along the crest of a ridge. A saddle is not necessarily the lower ground between two hilltops; it may be a break along an otherwise level ridge crest.

# Depression



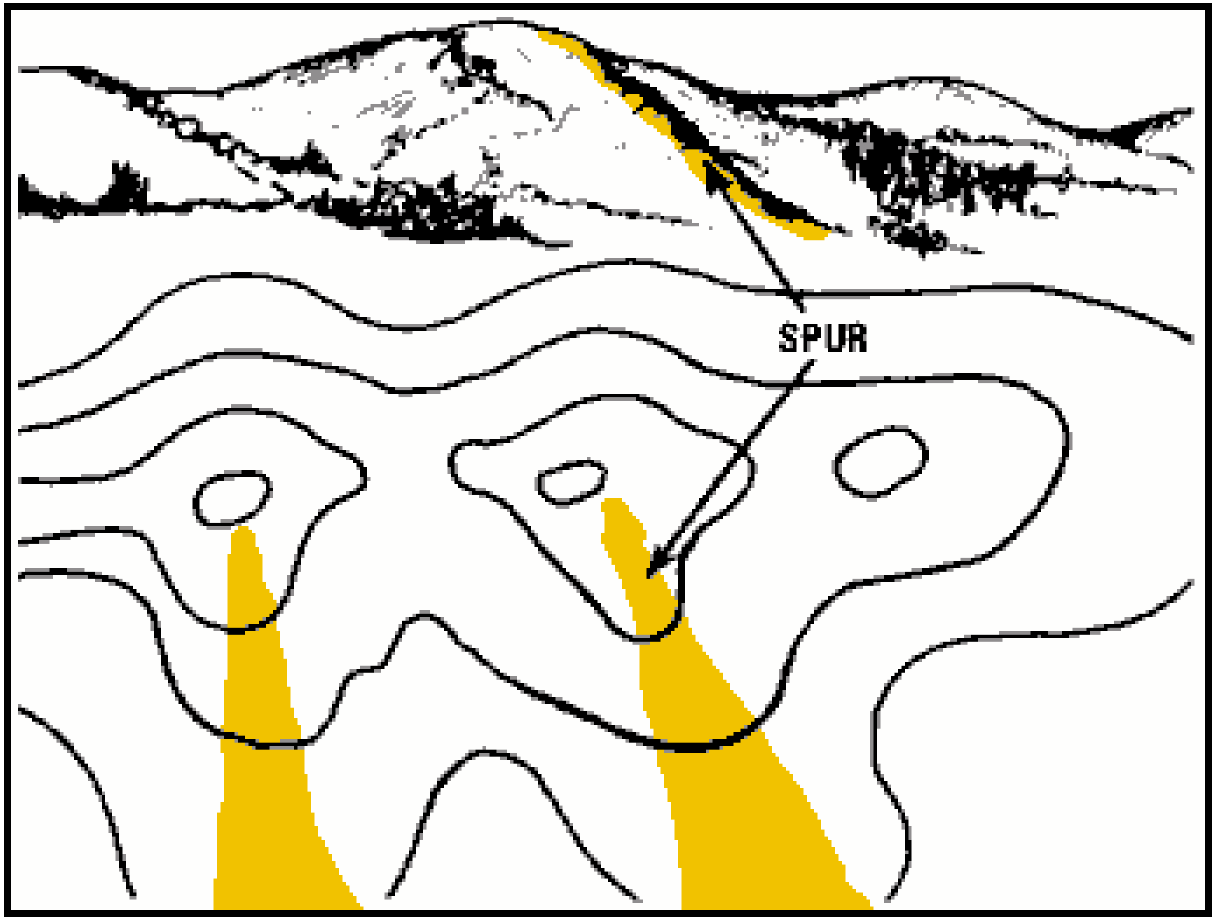

A low point or hole in the ground, surrounded on all sides by higher ground.

# Draw



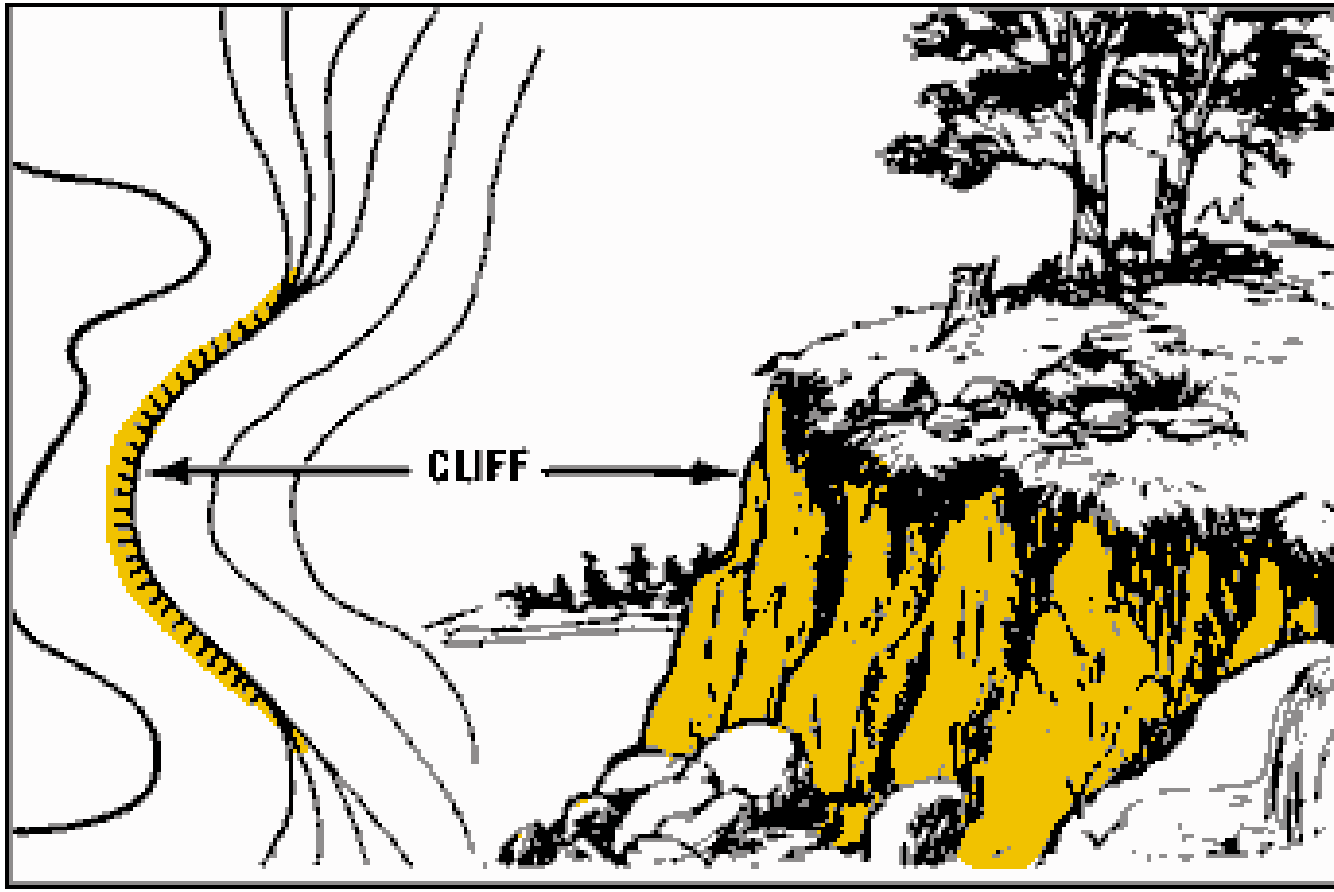

Similar to a valley, except that it normally is a less developed stream course in which there is generally no level ground and, therefore, little or no maneuver room. The ground slopes upward on each side and toward the head of the draw.

# Spur



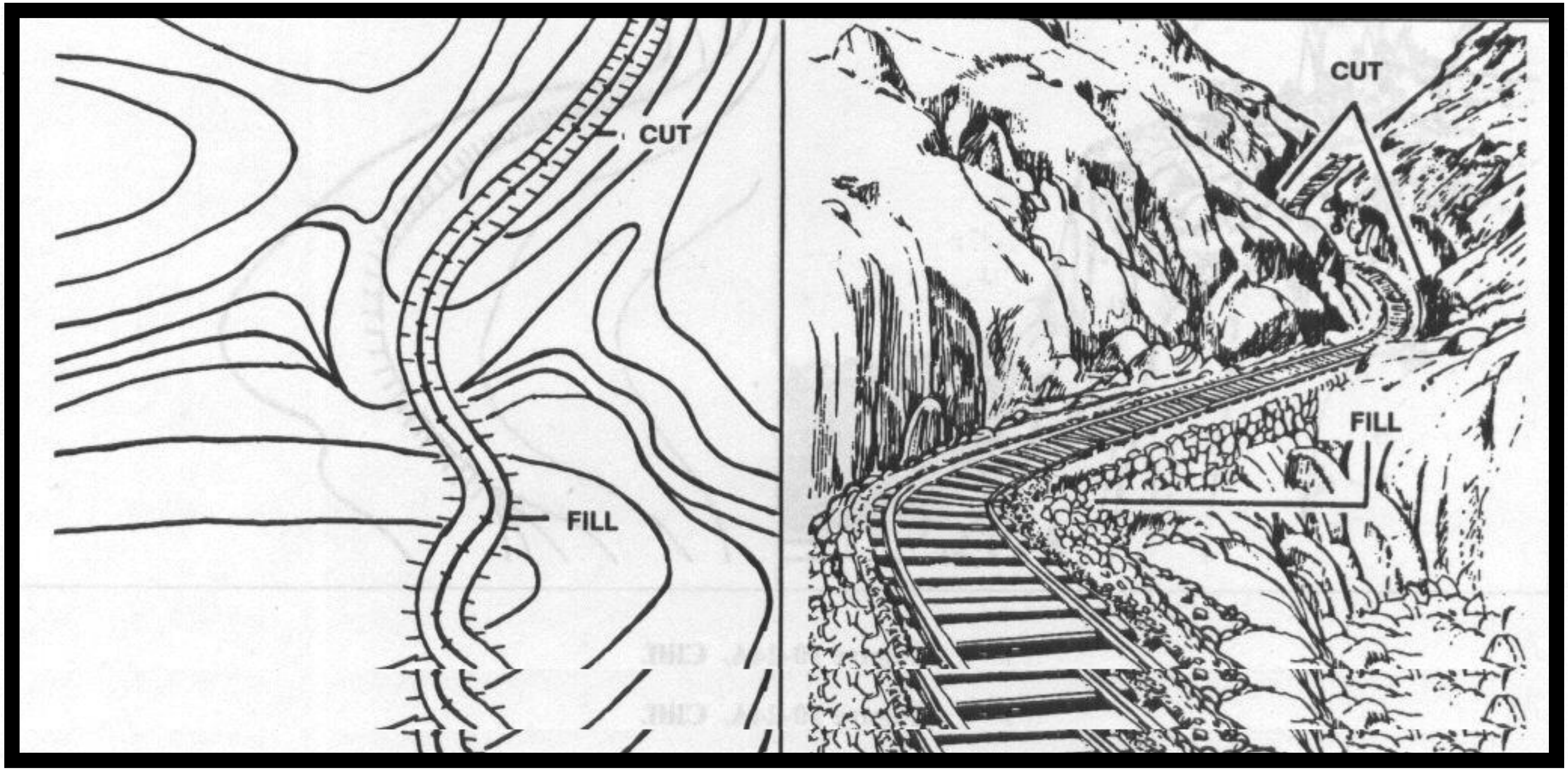

A usually short, continuously sloping line of higher ground, normally jutting out from the side of a ridge. A spur is often formed by two thoroughly parallel streams cutting draws down the side of a ridge

# Cliff




A vertical or near-vertical slope. A cliff may be shown on a map by contour lines being close together, touching, or by a ticked "carrying" contour line. The ticks always point toward lower ground.

# Cut and Fill

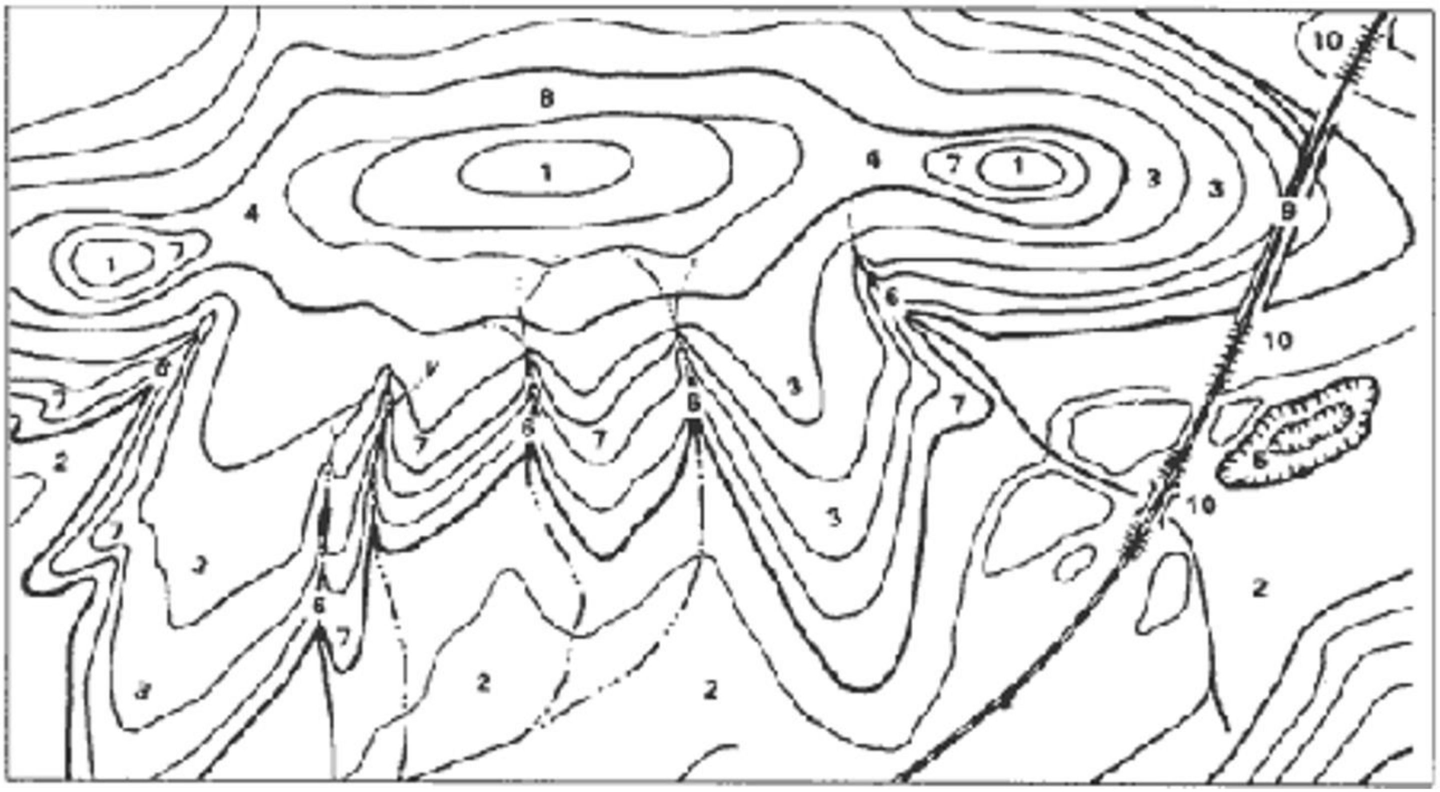



A feature where terrain has been cut away – essentially a minor cliff, and where it has been filled in, creating more level ground than would normally be seen on the natural terrain feature. Often done to create a stable platform for a road or railroad.

# Identify terrain features by SOSES

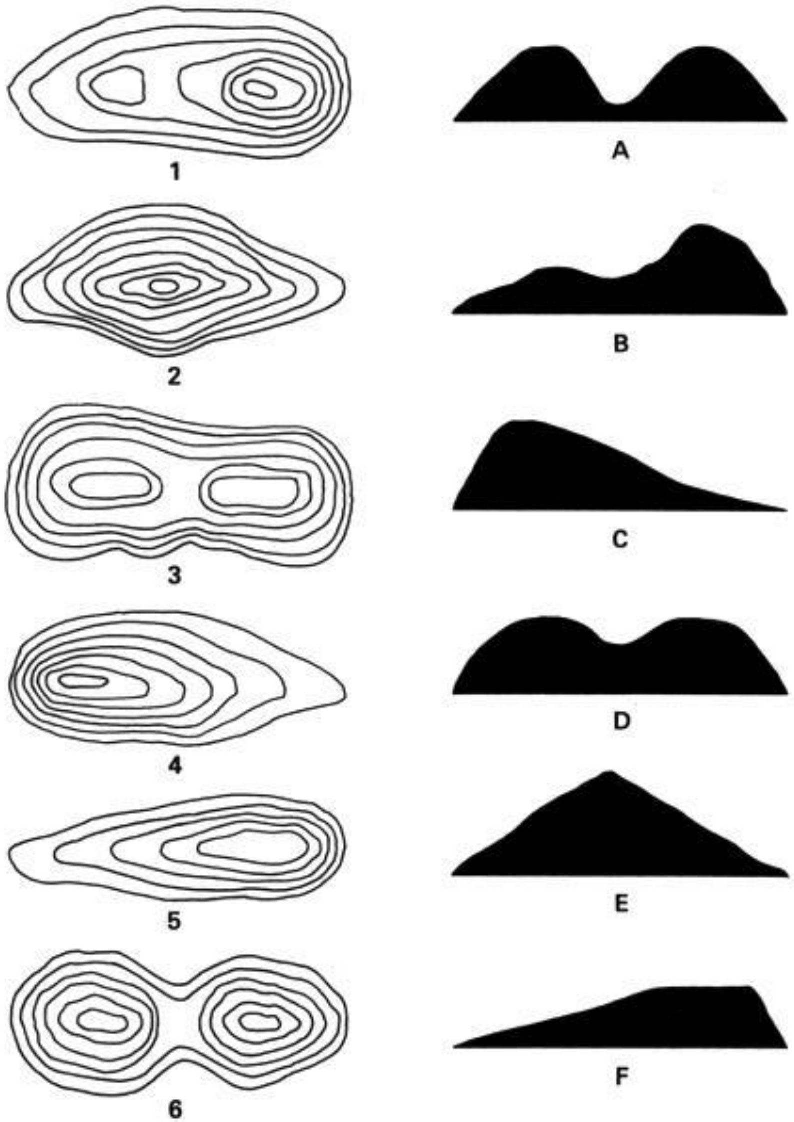
- Shape of the feature at its base
- Orientation of the object from your viewpoint
- Size of the feature
- Elevation of the feature
- Slope of the sides of the feature

# Identify Terrain Features



1. HILL
2. VALLEY
3. RIDGE
4. SADDLE
5. DEPRESSION
6. DRAW
7. SPUR
8. CLIFF
9. CUT
10. FILL

# Check on Learning




1. ___
2. ___
3. ___
4. ___
5. ___
6. ___

# GRID COORDINATES

A4. Determine a 4-, 6-, or 8-digit grid coordinate for a point on a topographic map with a protractor.

# Grid Lines

- A series of straight lines intersecting at right angles forming squares
- Horizontal grid lines are numbered west to east
- Vertical grid lines are numbered south to north

**BASIC RULE**

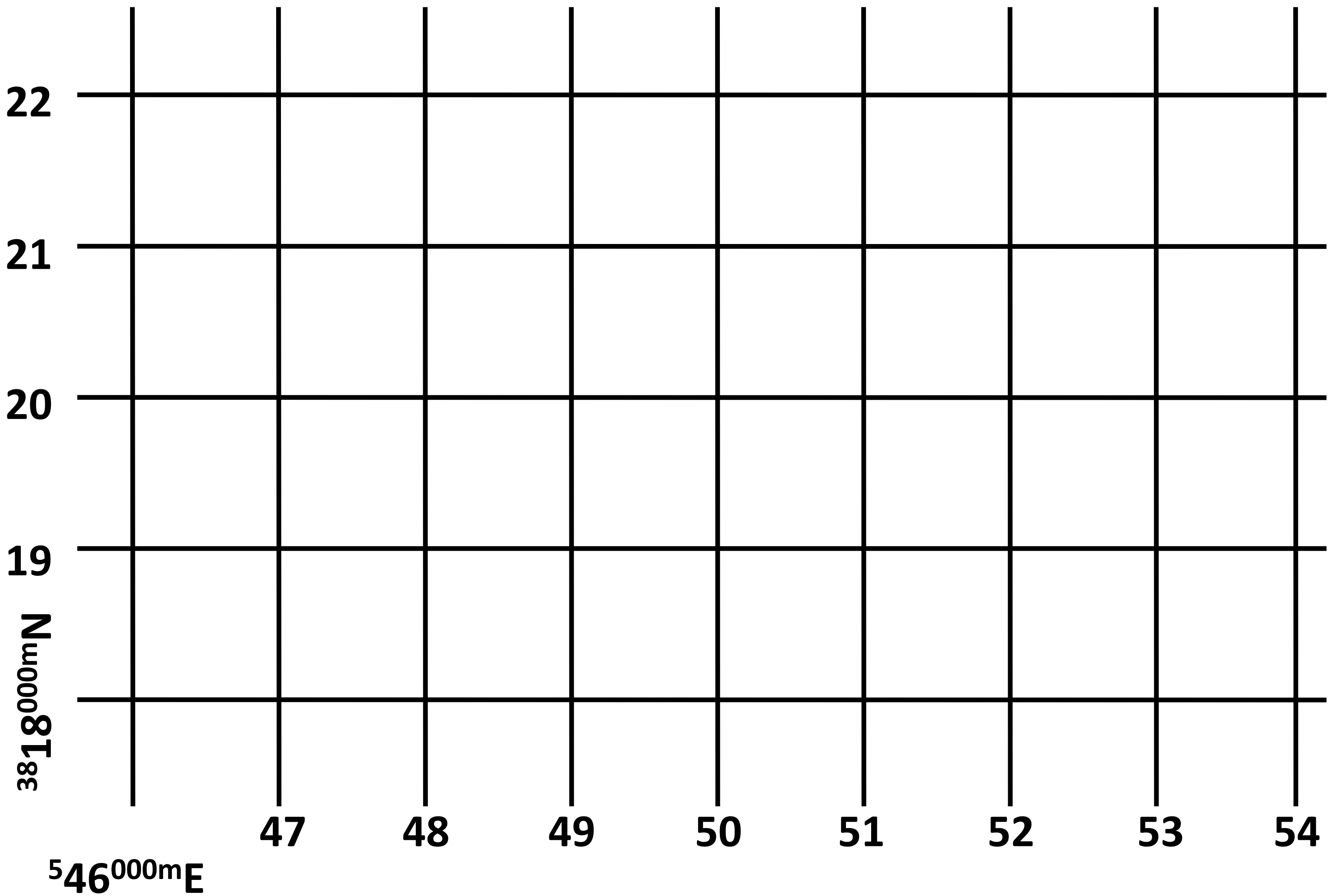
Read right on the vertical lines, then up on the horizontal grid lines, or “Read Right then Up”

# Grid Coordinates

The map has vertical lines (top to bottom) and horizontal lines (left to right). These lines form small squares 1,000 meters on each side called grid squares.

The lines that form grid squares are numbered along the outside edge of the map picture. No two grid squares have the same number.

# Grid Lines

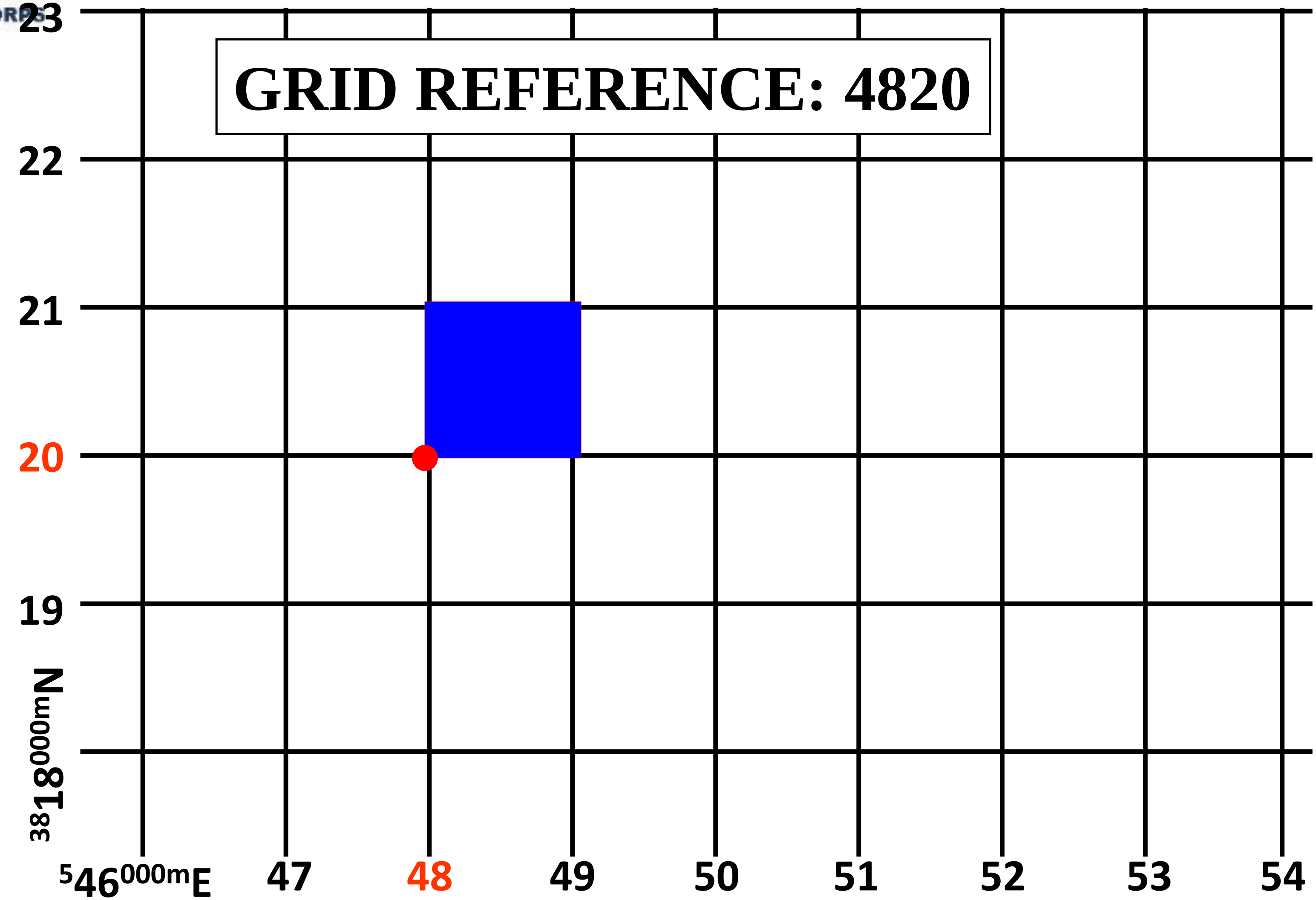


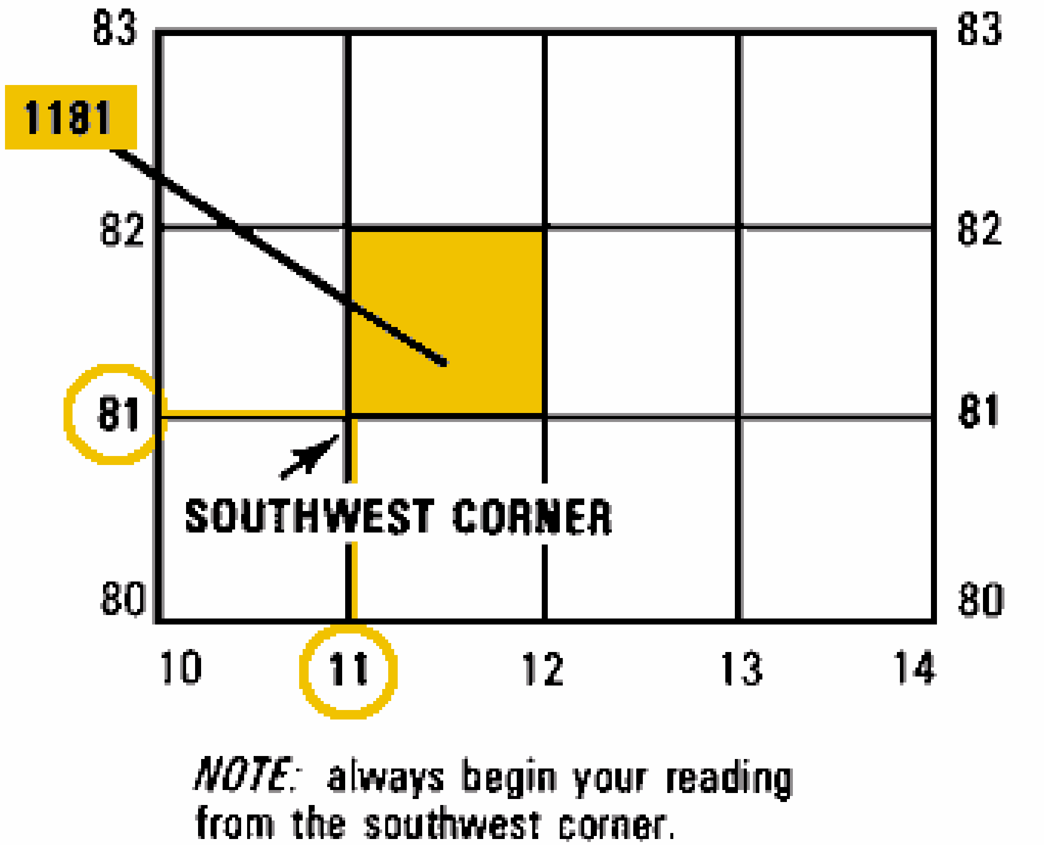
# Grid Coordinate

A grid square's coordinates are found by combining the identities of the horizontal and vertical grid lines that intersect at the lower left hand corner of the grid.

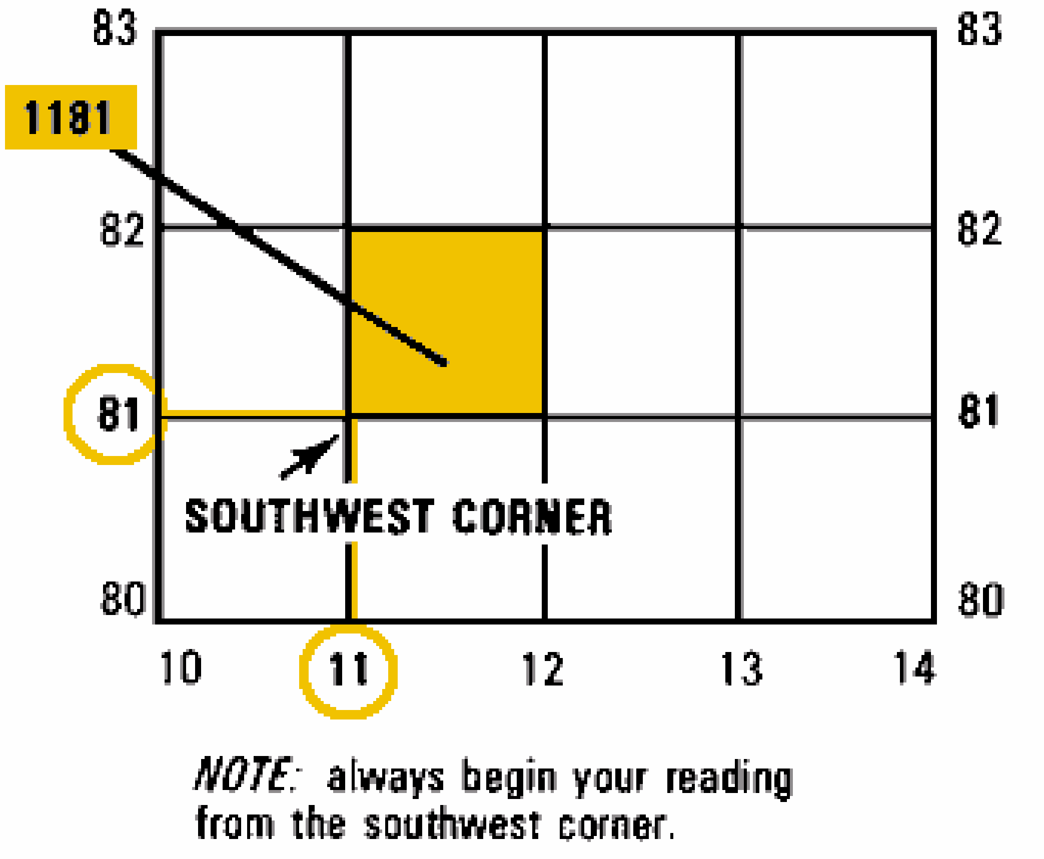
The more digits you put in a grid coordinate, the more precise it is. A 4-digit grid coordinate gets you within 1000 meters of your point. A 6-digit grid coordinate gets you within 100 meters of your point. And an 8-digit grid coordinate gets you within 10 meters of your point.

# Finding a 4-Digit Grid Coordinate

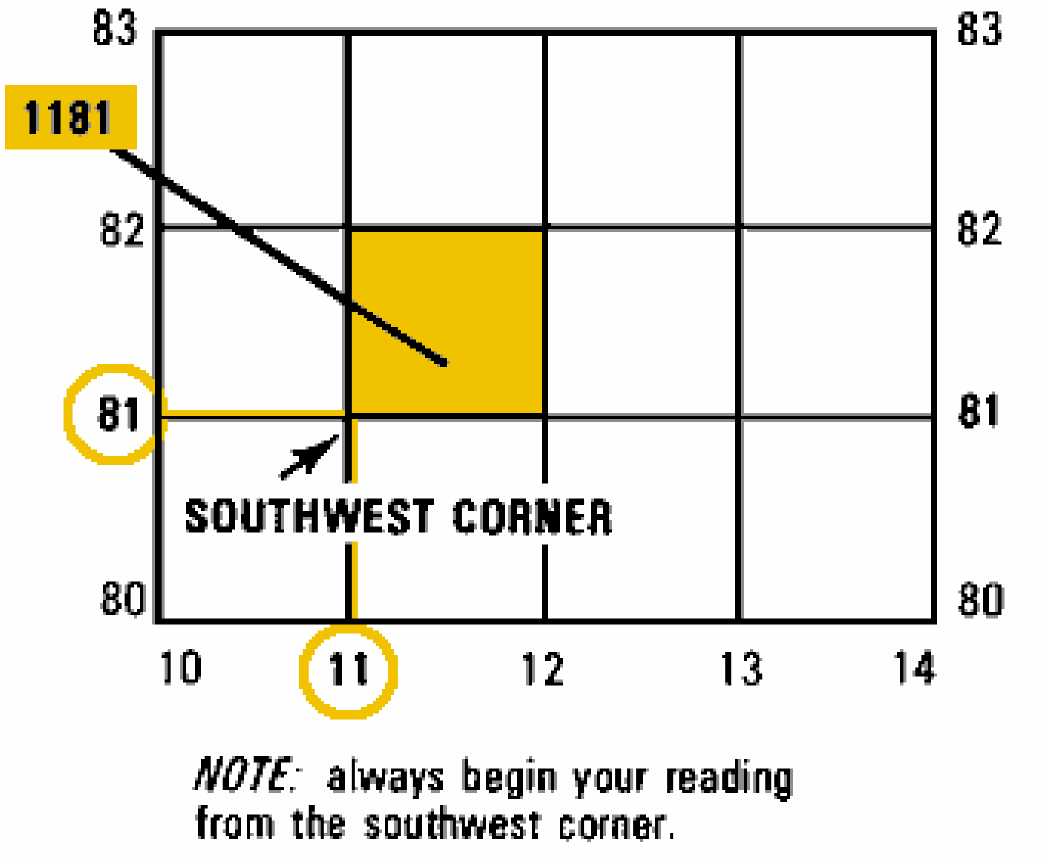




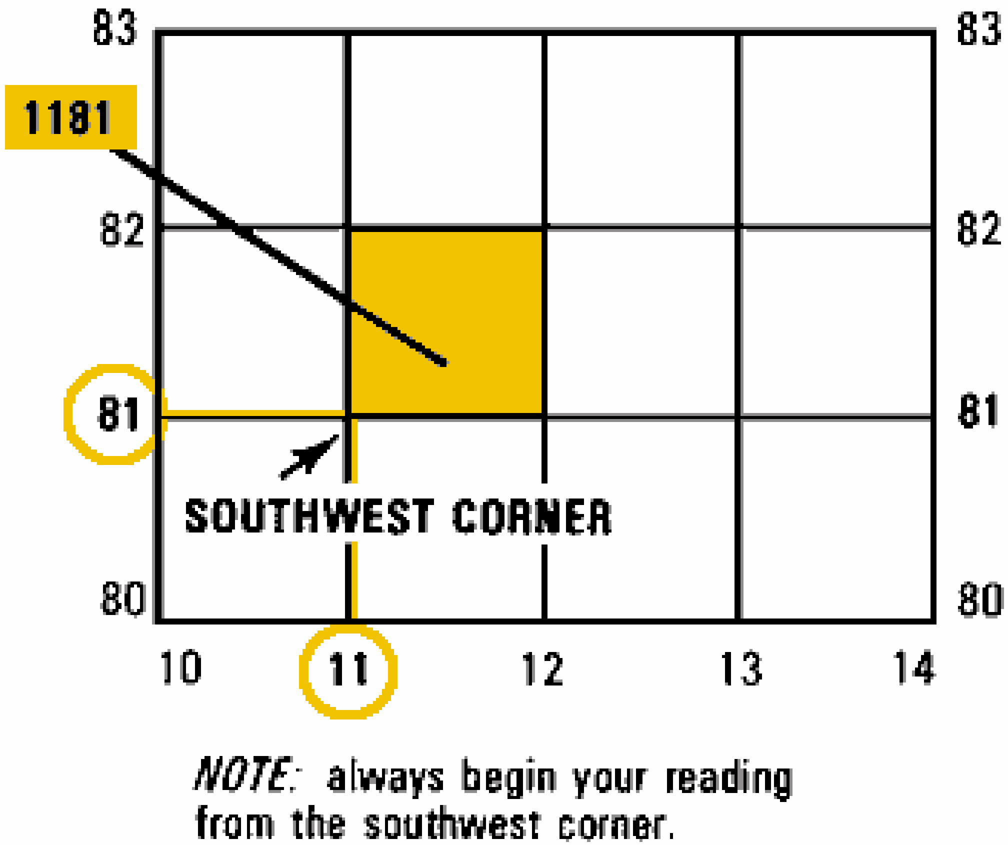

Your address is grid square **1181**. How do you know this? Start from the left and read right until you come to 11, the first half of your address. Then read up to 81, the other half. Your address is somewhere in grid square 1181.




Grid square 1181 gives your general neighborhood, but there is a lot of ground inside that grid square. To make your address more accurate, just add another number to the first half and another number to the second half - so your address has six numbers instead of four.



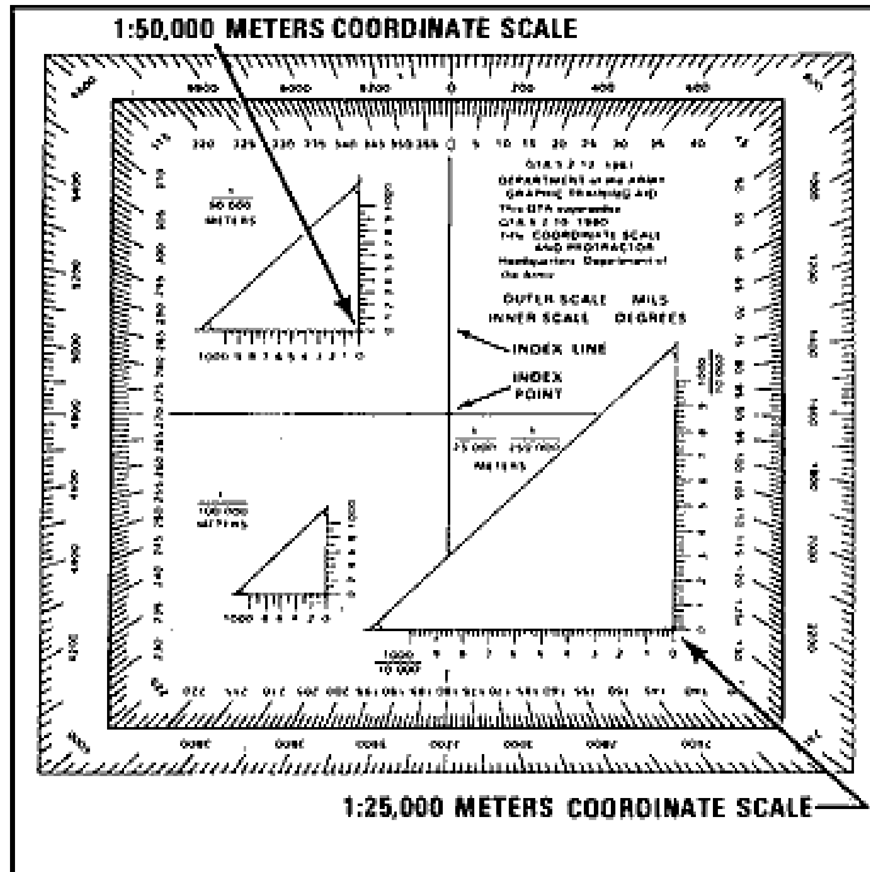

To get those extra numbers, pretend that each grid square has ten lines inside it running north and south, and another 10 running east and west. This makes 100 smaller squares. You can estimate where these imaginary lines are.




Suppose you are halfway between grid line 11 and grid line 12. Then the next number is 5 and the first half of your address is 115. Now suppose you are also 3/10 of the way between grid line 81 and grid line 82. Then the second half of your address is 813. Your address is **115813**.

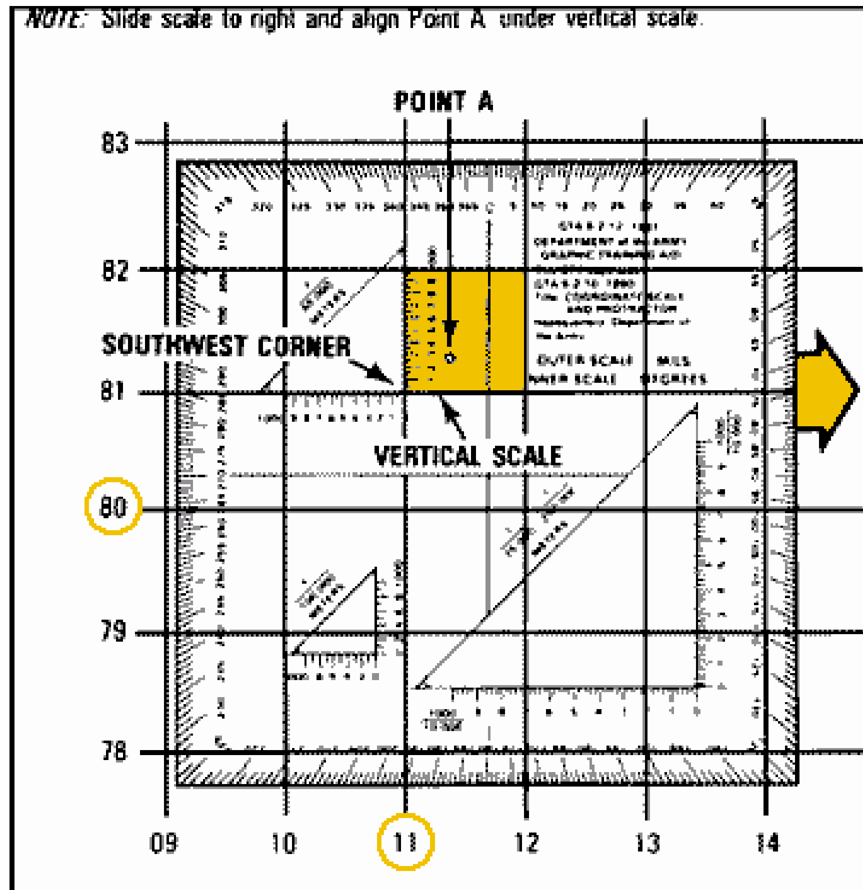
# Grid Coordinate Scale

The most accurate way to determine the coordinates of a point on a map is to use a coordinate scale. You do not have to use imaginary lines; you can find the exact coordinates using a Coordinate Scale and Protractor.



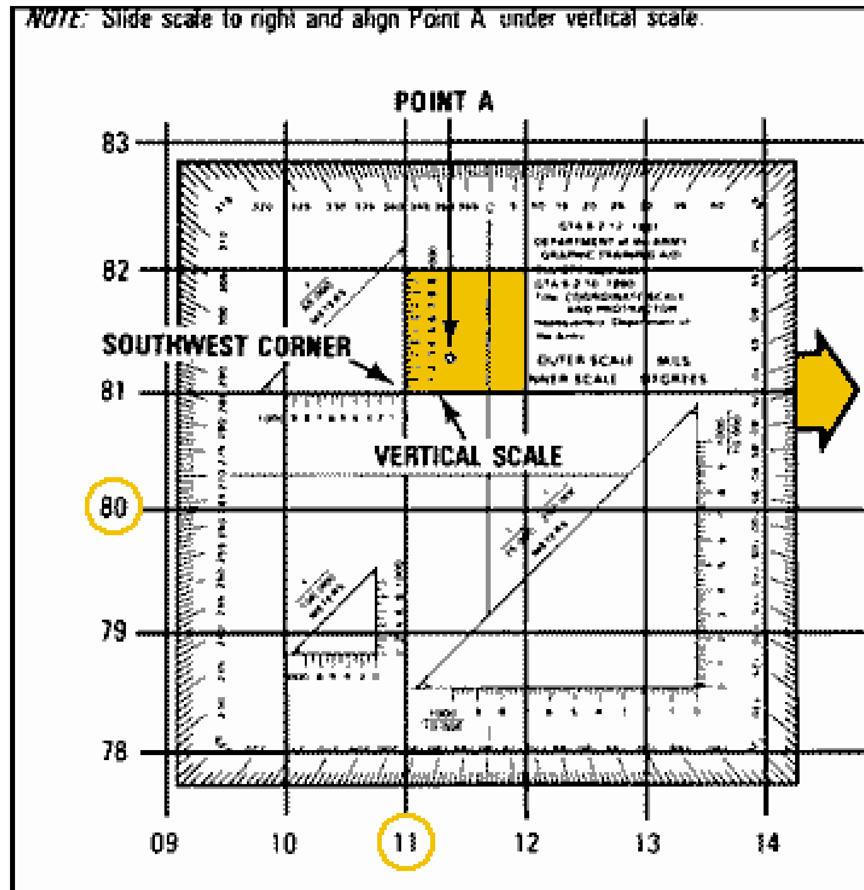
# Identifying a Grid Coordinate

First, locate the grid square in which the point is located. The number of the vertical grid line on the left (west) side of the grid square is the first and second digits of the coordinates.



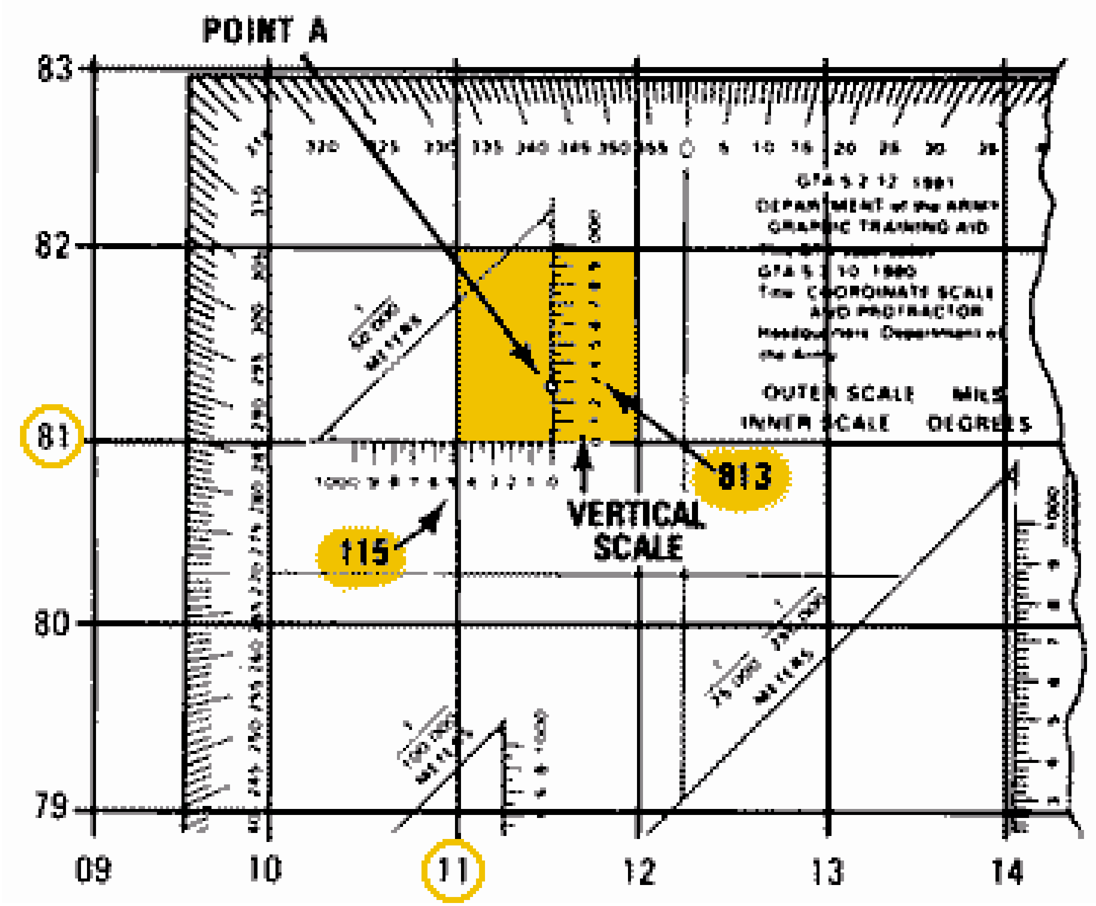
# Identifying a Grid Coordinate

The number of the horizontal grid line on the bottom (south) side of the grid square is the fourth and fifth digits of the coordinates.



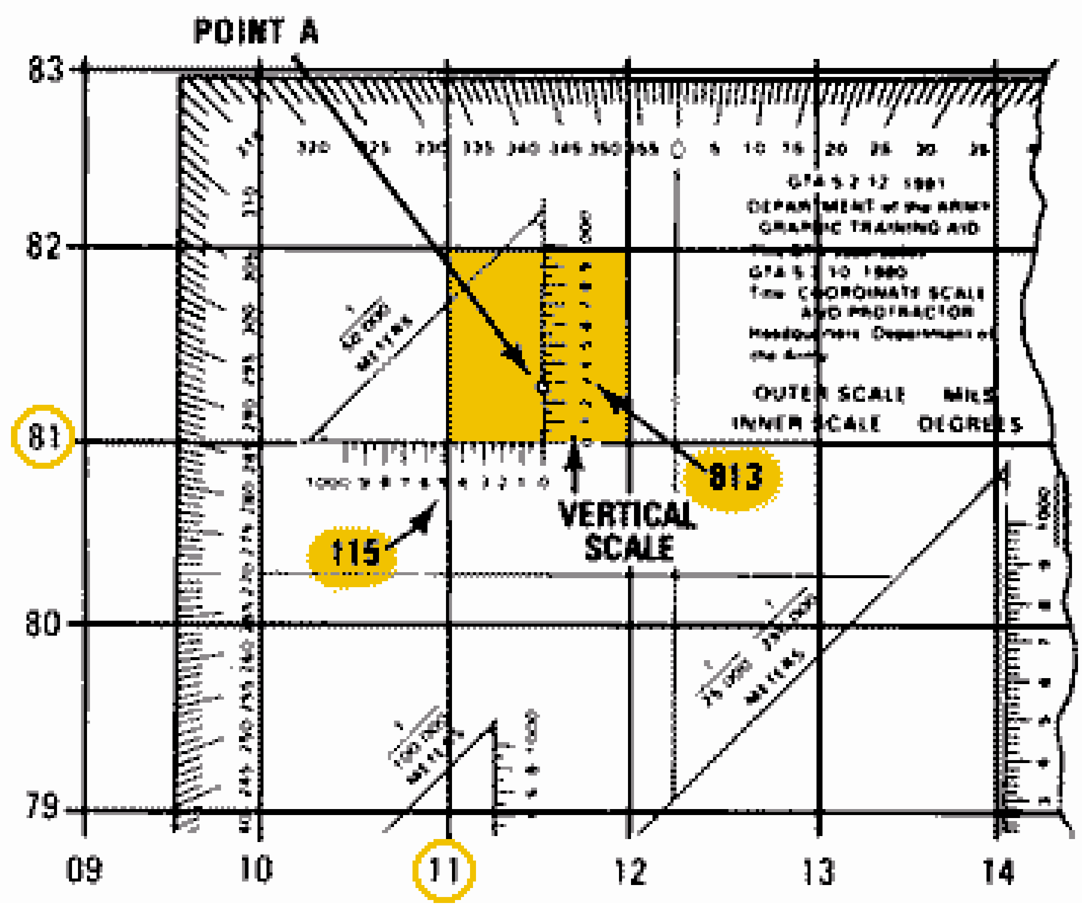
# Identifying a Grid Coordinate

To determine the third and sixth digits of the coordinates, place the coordinate scale on the bottom horizontal grid line of the grid square containing Point A, with the vertical scale going through the point.



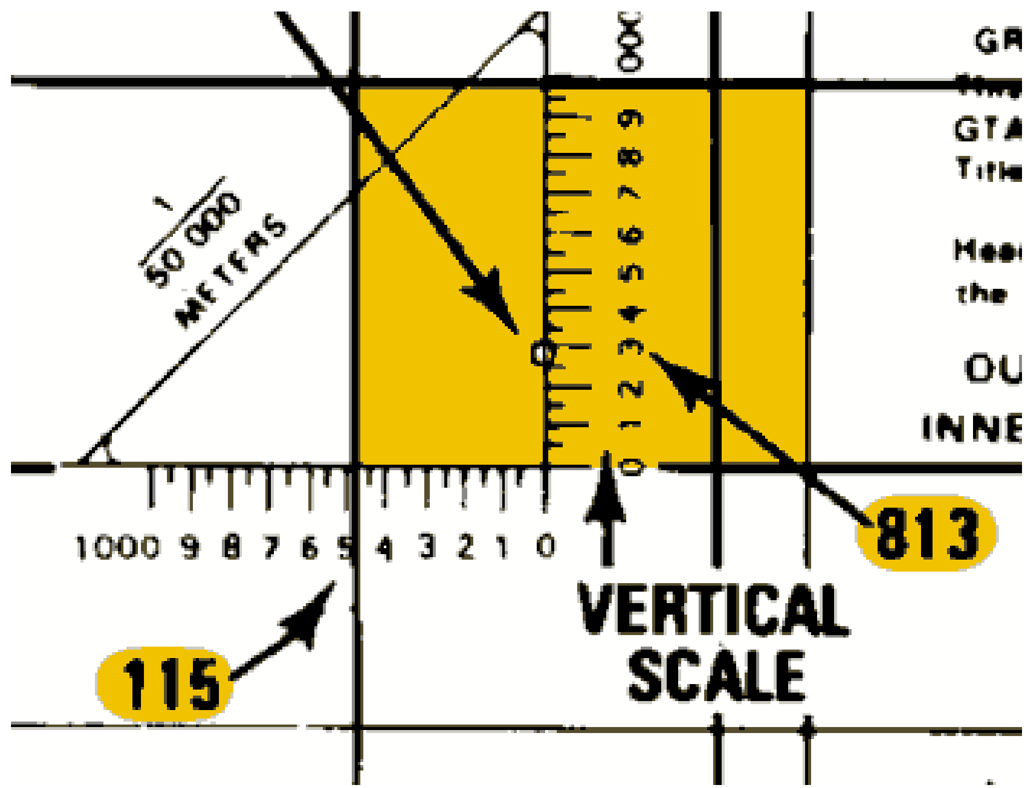
# Identifying a Grid Coordinate

Line up the vertical line so it goes through your point, leaving the horizontal line along the horizontal grid line.



# Identifying a Grid Coordinate

On the bottom scale, the 100 meter mark nearest the vertical grid line provides the third digit, 5. On the vertical scale, the 100 meter mark nearest Point A provides the sixth digit, 3. Therefore the six-digit grid coordinate is 115813



# Grid Precision

Grid squares are 1000 meters.

They are subdivided into 100 meter and 10 meter marks

The Grid Coordinate Scale helps you measure the grid square and determine a more accurate grid coordinate

A 4-digit grid coordinate is accurate to 1000 meters
A 6-digit grid coordinate is accurate to 100 meters
An 8-digit grid coordinate is accurate to 10 meters

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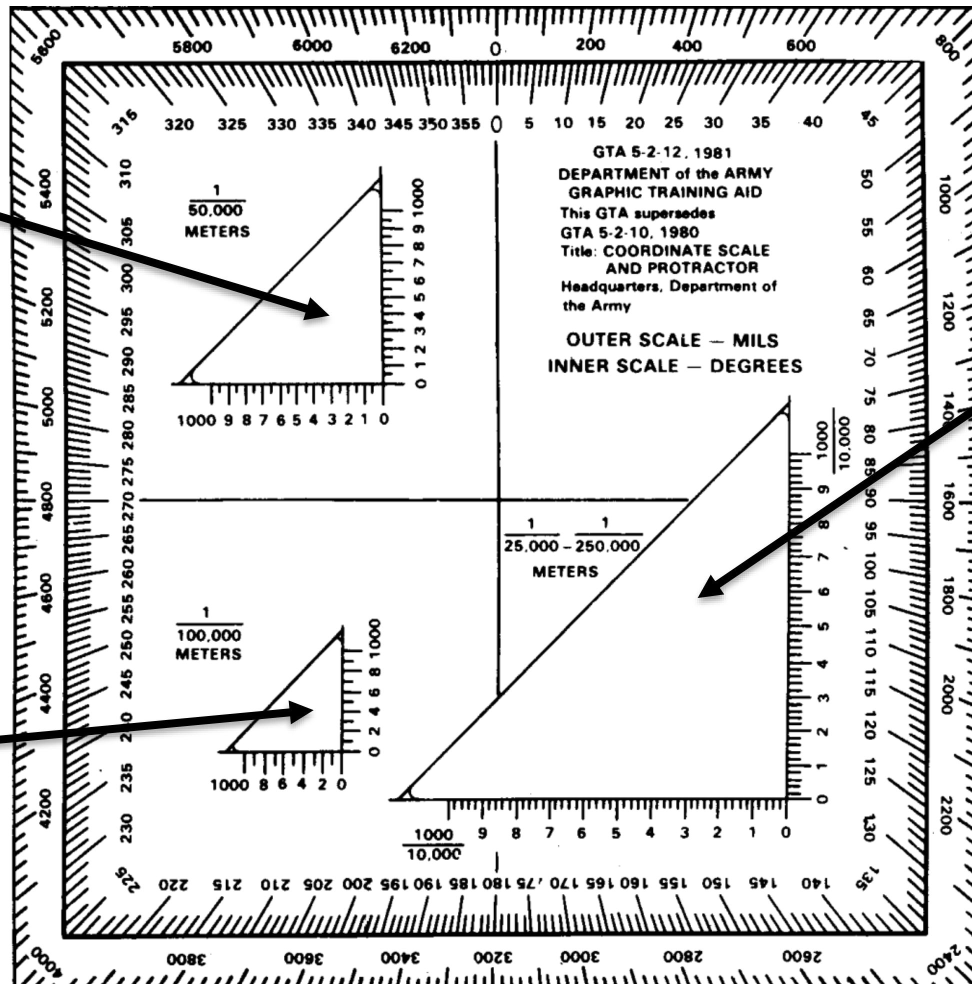
# Grid Coordinate Scale and Protractor

1:50,000 Scale

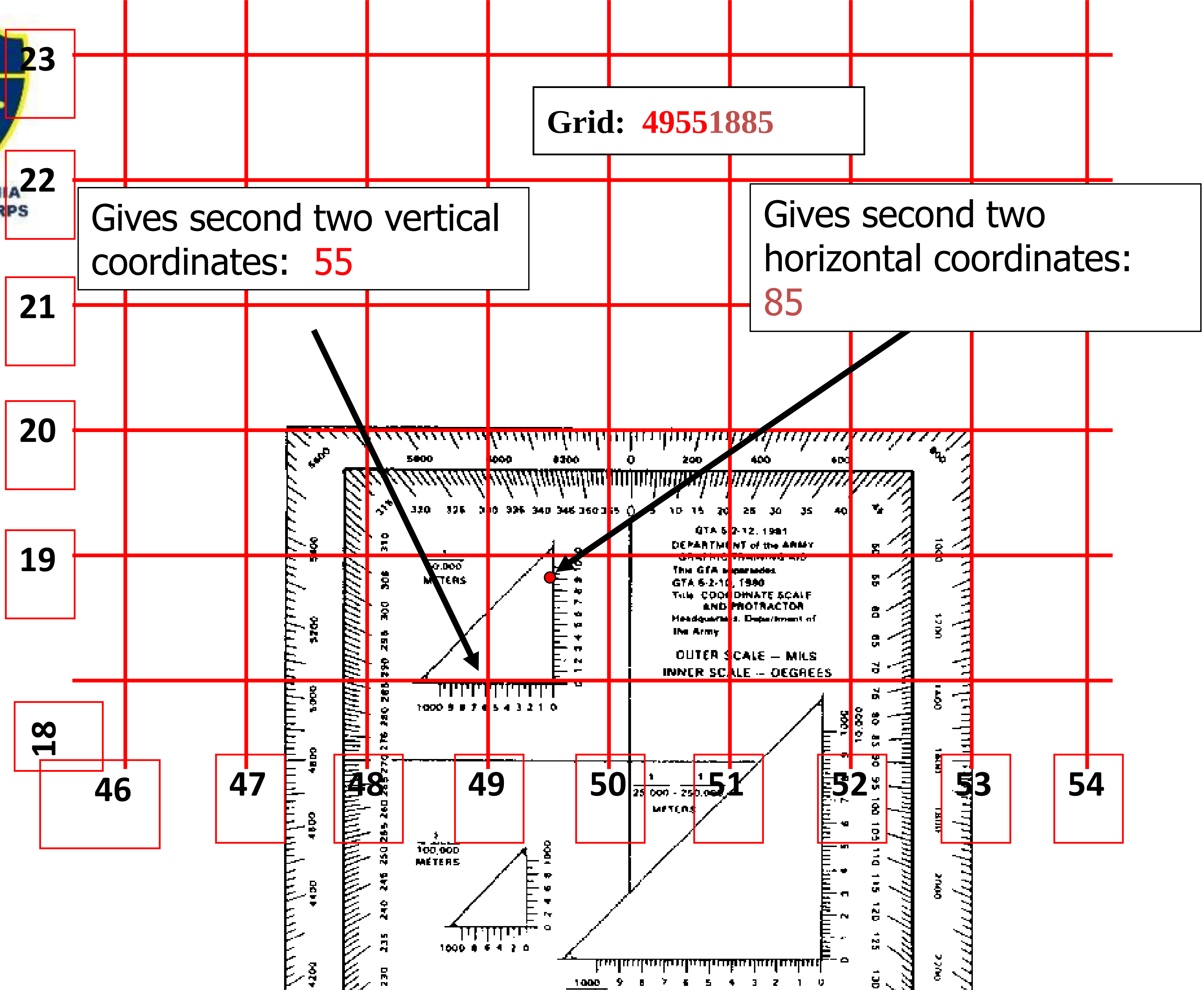
1:25,000 or 1:250,000 Scale




1:100,000 Scale

# Finding the Grid Coordinate of a Point

- Determine the scale of your map. Find the correct scale to use on your protractor.
- Determine the grid square the point is in. This gives 4 digits: **12**xx**56**xx.
- Next, using the correct scale on your protractor, align the bottom right corner of the protractor scale to the bottom right corner of the grid square.
  - Slide the protractor to the left until the line forming the right edge of the scale intersects the point.
  - Read off the horizontal and vertical position:
    - 12**34**56**78**

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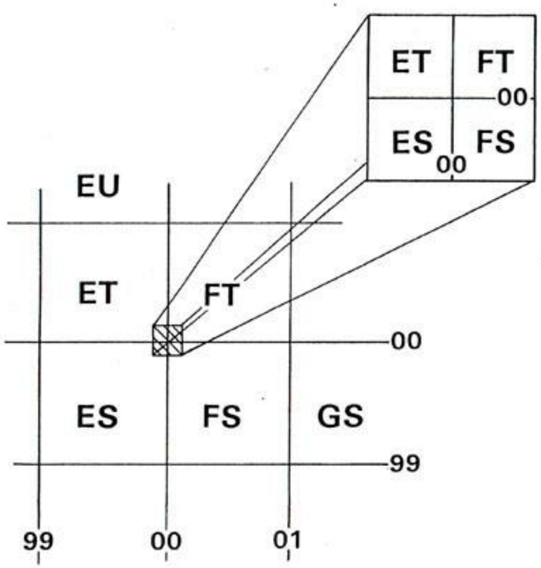
# Grid Zone Designator

- A 2-letter designation that is unique to a 100,000 meter area.
- This is where the grid numbers start over again at 00.
- The Grid Reference Box in the Marginal Data shows the Grid Zones that are on that map.
- The correct depiction of a grid coordinate ALWAYS includes the Grid Zone.
- i.e.  ET 99450076, which is 100,000 meters from FT 99450076.



# Check on Learning

## Determine the Grid Coordinate for the Given Point

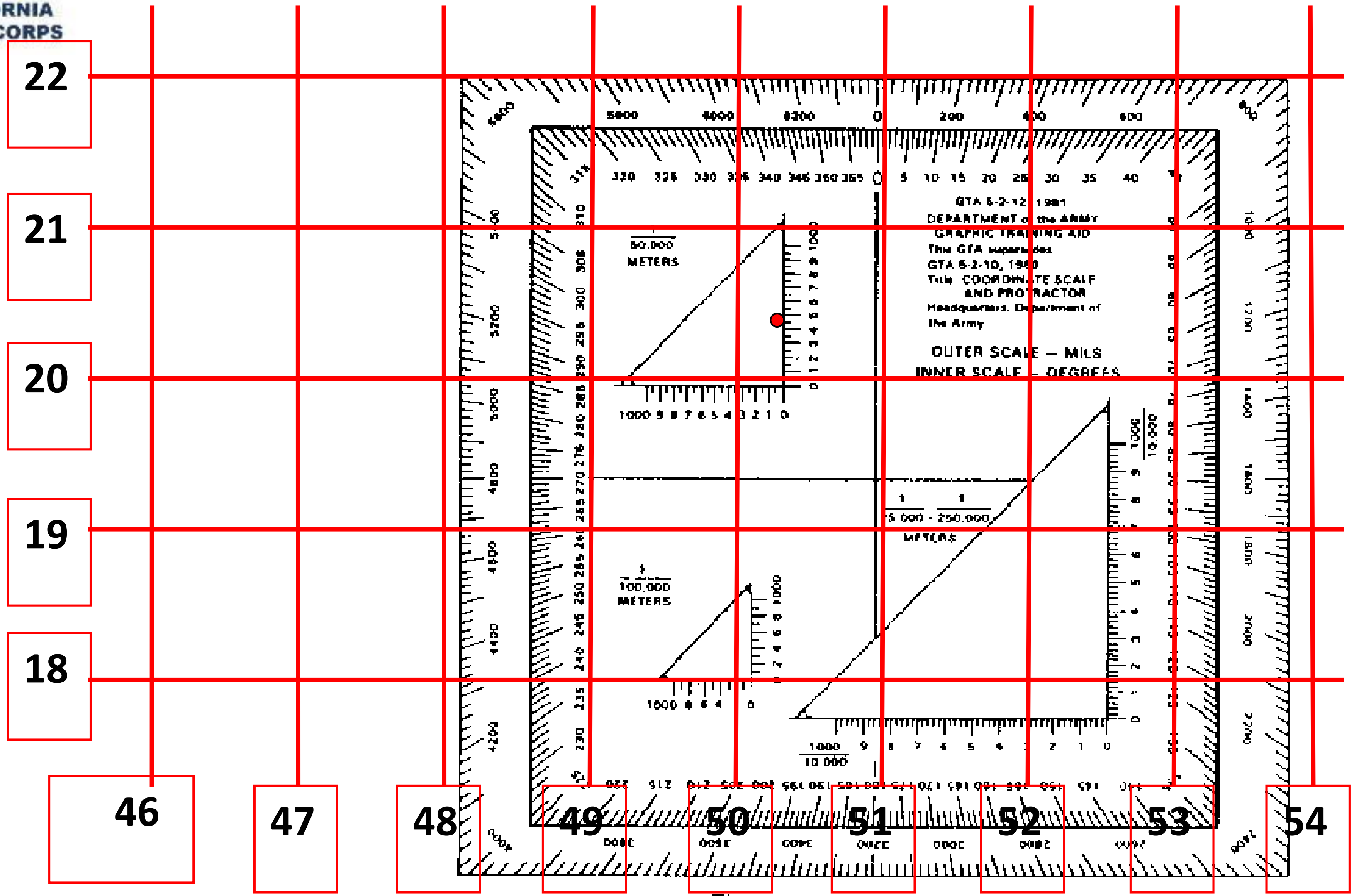



Figure 4-14. Coordinate scales.

# Check on Learning

If you have maps and protractors in your classroom, the instructor should give the students several points to determine 6- and 8-digit grid coordinates.

The instructor should also give out several grid coordinates and have the students locate and identify the point on the map.

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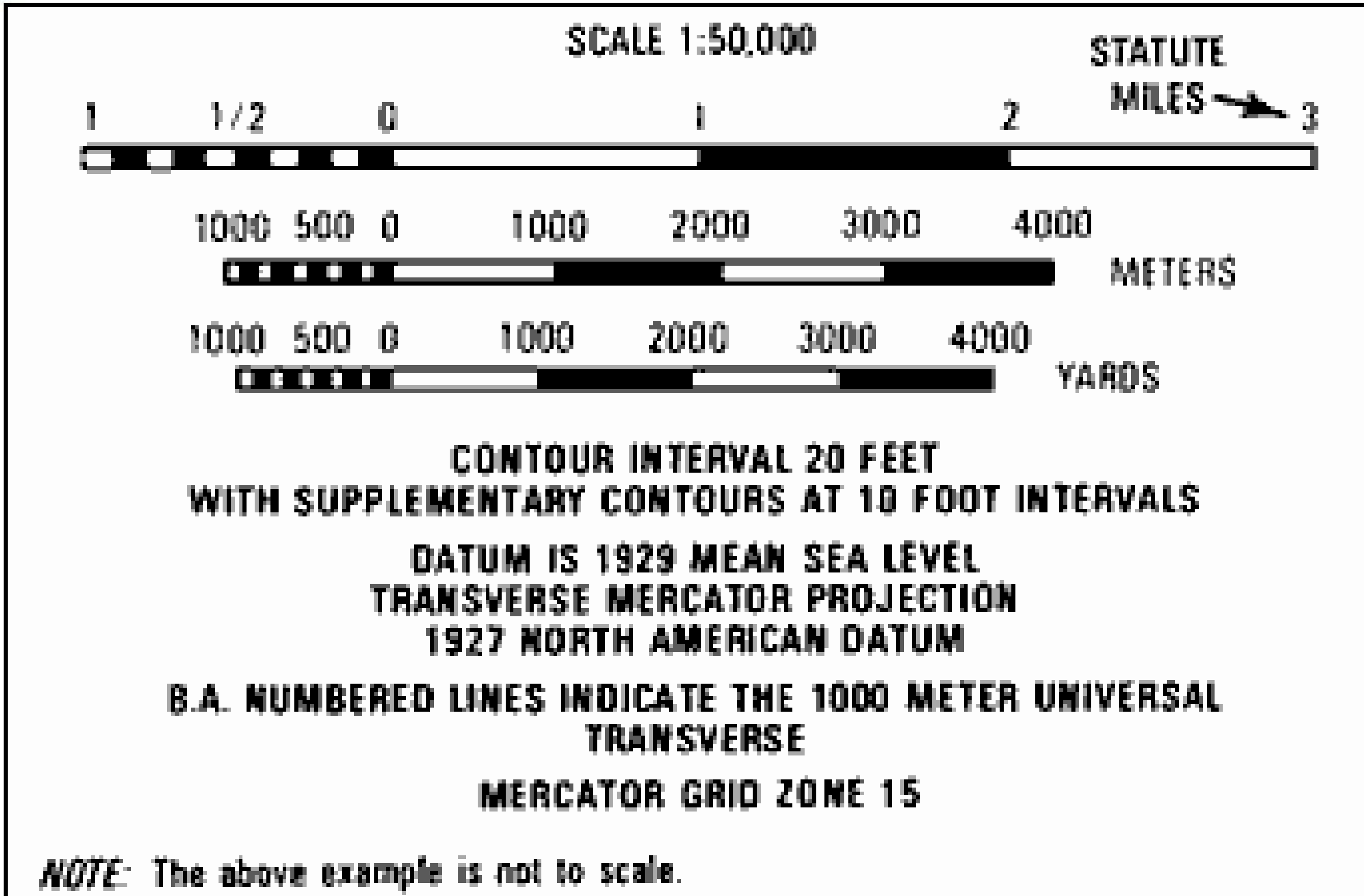
# MEASURING DISTANCE

A5. Measure distance on a topographical map using the map scale and a straight edge. Students should be able to measure distance of a straight line and of a curving road to within 50 meters.

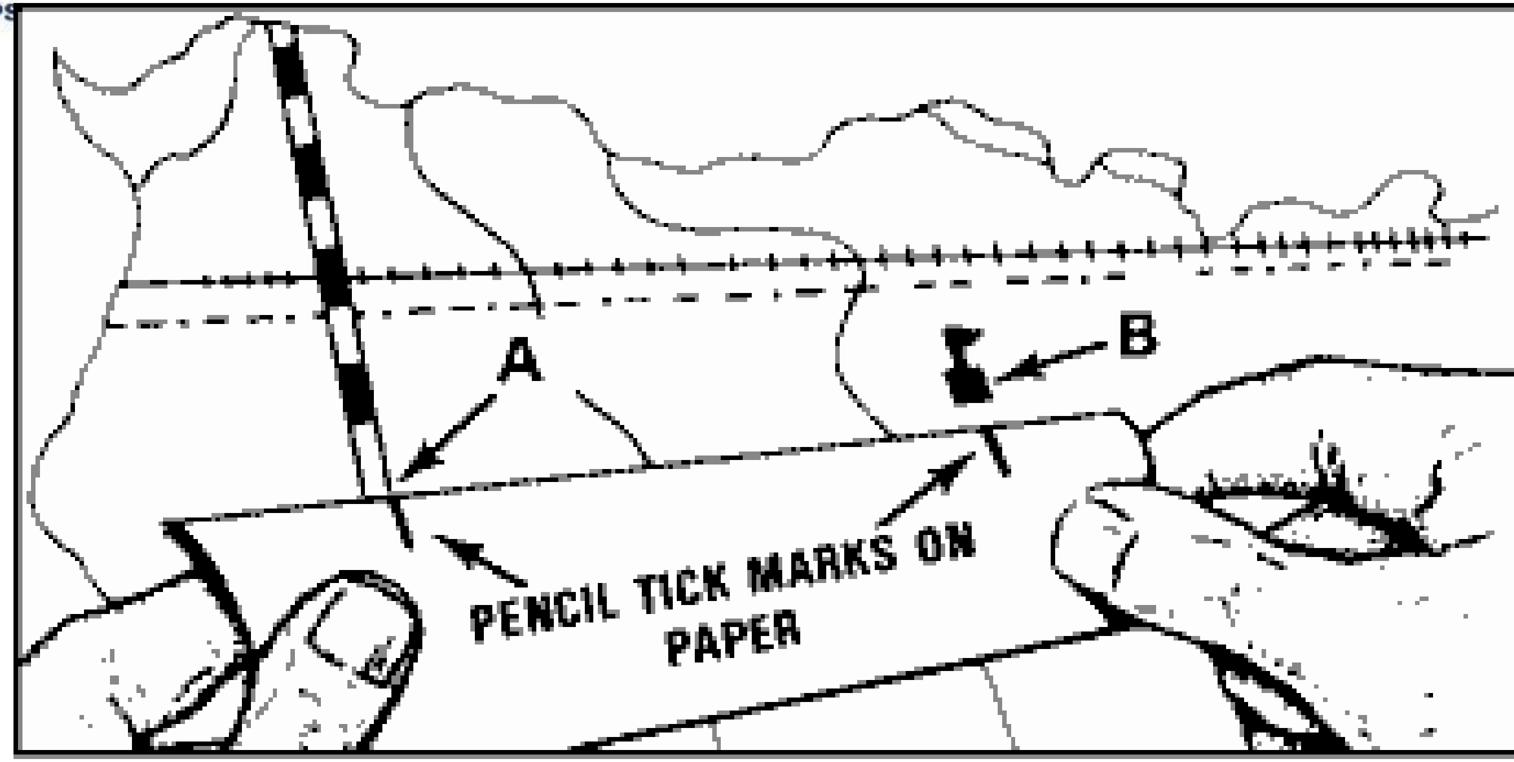
# Measure Distance

You can use your map to measure the distance between two places. The maps are drawn to scale. This means that a certain distance on a map equals a certain distance on the earth. The scale is printed at the bottom and top of each map (i.e. Scale 1:50,000). This means that 1 inch on the map equals 50,000 inches on the ground. To change map distance to miles, meters, or yards, use the bar scales at the bottom of the map.

# Measure Distance

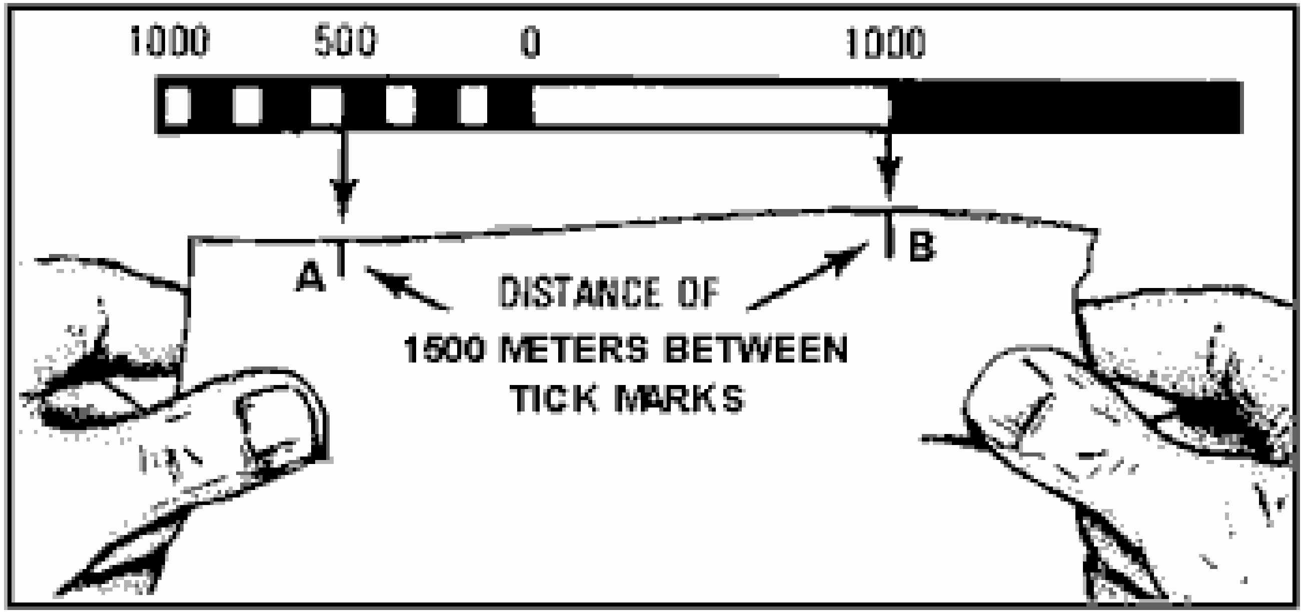


# Measure Distance




Take a ruler or the edge of a paper and mark on it the straight line distance between your two points.

# Measure Distance




Then, put the ruler or the paper just under one of the bar scales and read the ground distance, in miles, meters, or yards. The bar scale here shows a ground distance of 1500 meters.

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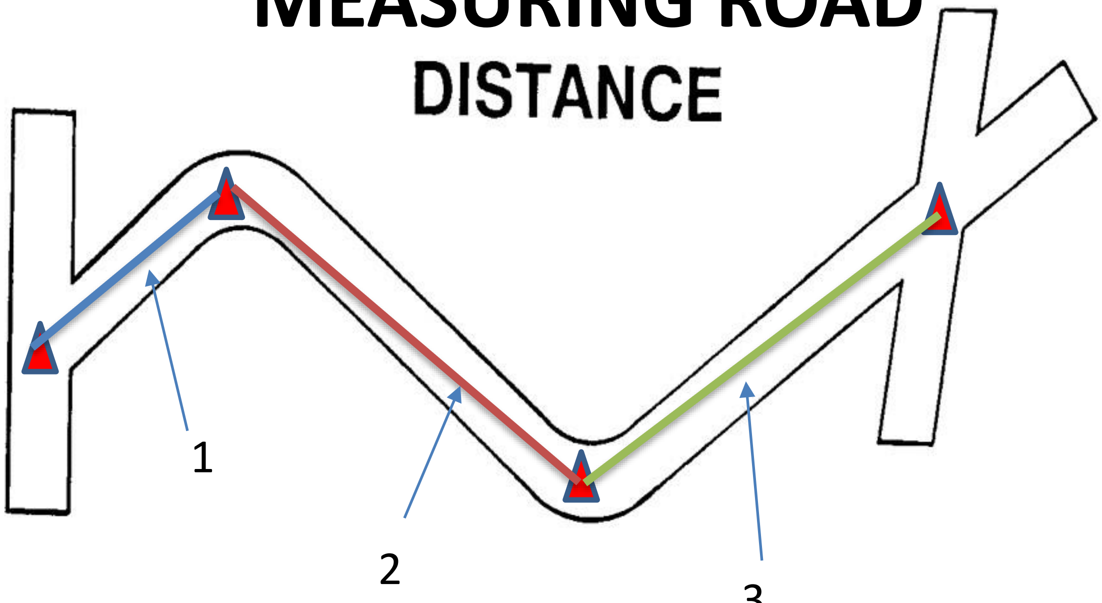
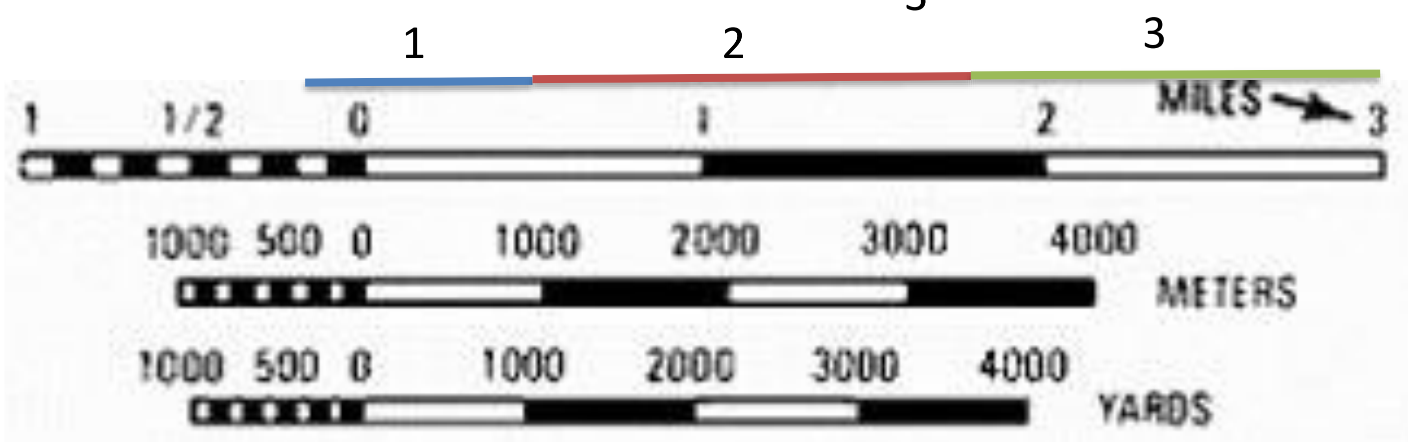
# MEASURING ROAD DISTANCE




**1 + 2 + 3 = 3.2 Miles**

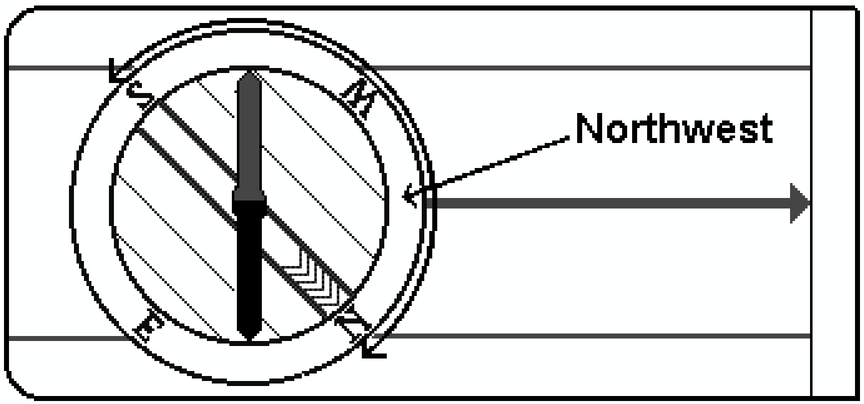
# Check on Learning

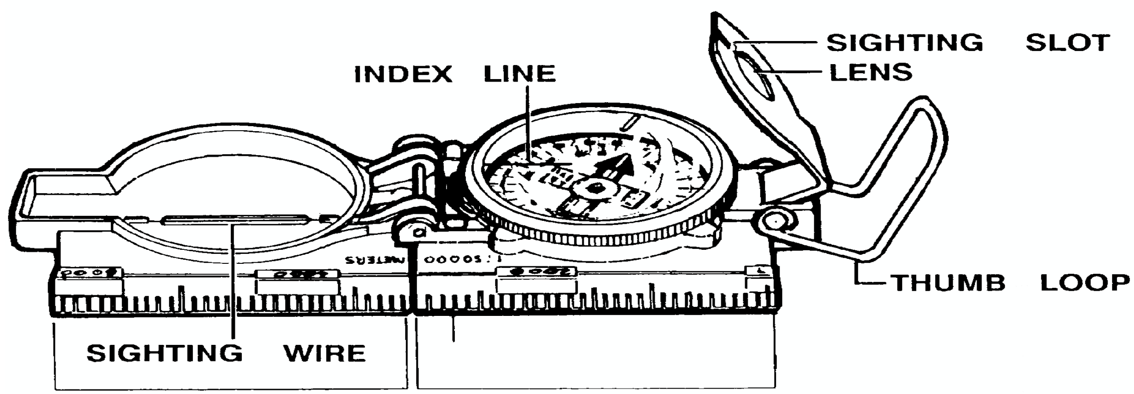
1. Select a road between two points on your map and determine the distance.
2. Select two points on your map and determine the distance in both meters and feet.

# DETERMINING DIRECTION

A6. Name the three types of north on a topographic map.  Determine a magnetic azimuth to a point using a compass.  Plot a grid azimuth on a topographic map.

# DIRECTION ON A MAP and HOW TO USE A COMPASS



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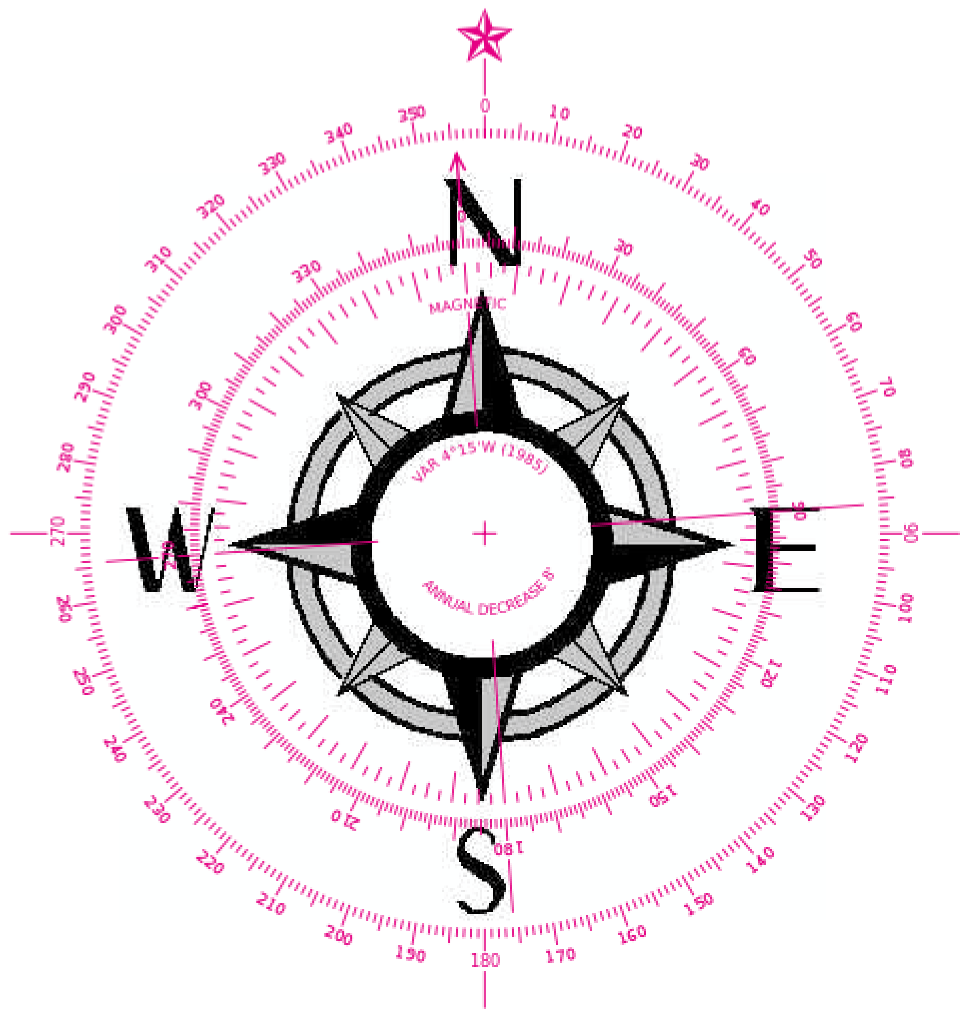
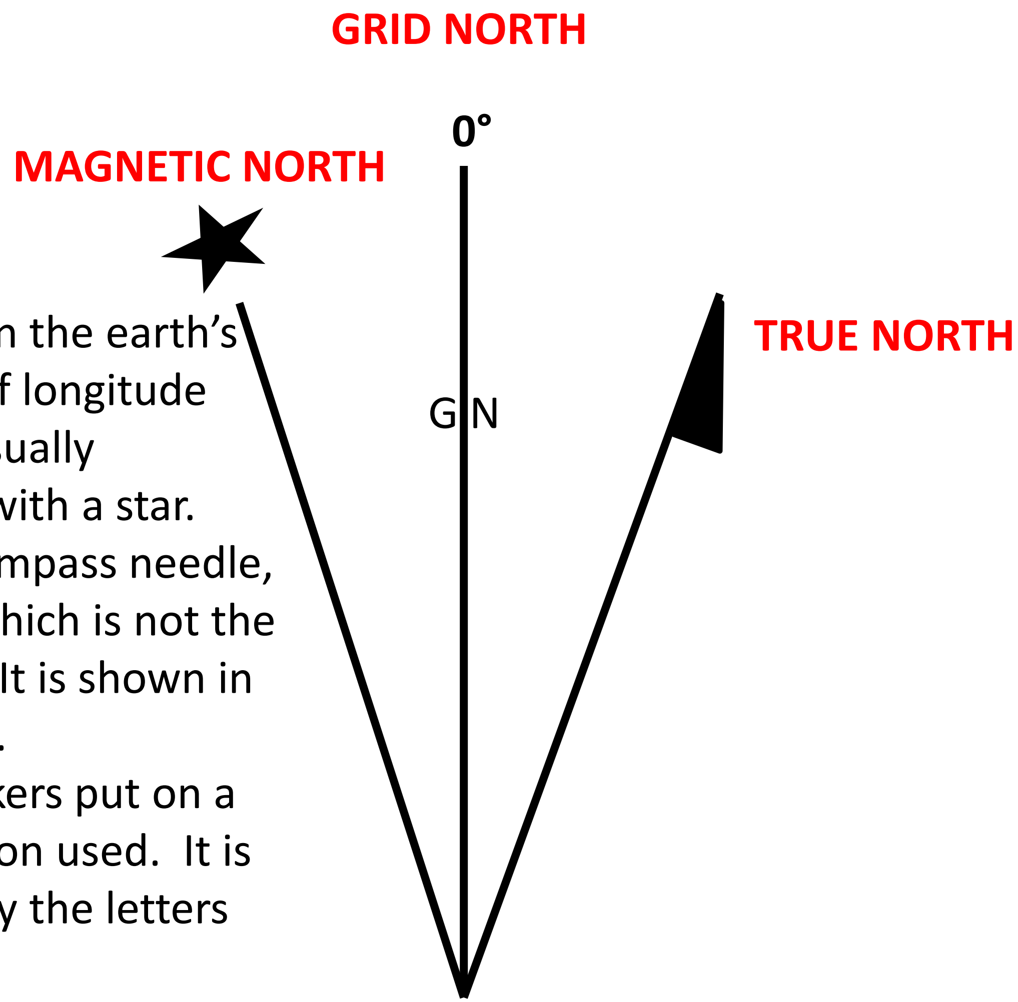
# Directions

- Direction – a course along which someone or something moves – is usually expressed in map reading as a **degree** or **azimuth**, or as a variant of **North, South, East**, and **West**.
- From any point on a plane, there are 360 degrees leading out from it in a circle.



# The Three Norths




- **True North** is a line from any point on the earth's surface to the North Pole. All lines of longitude are true north lines. True North is usually symbolized in marginal information with a star.
- **Magnetic North**, as shown by the compass needle, points to the north magnetic pole, which is not the same as the geographic North Pole. It is shown in marginal information as a half-arrow.
- **Grid North** is the north that mapmakers put on a map, dependent of the map projection used. It is shown in the marginal information by the letters GN on a vertical line.

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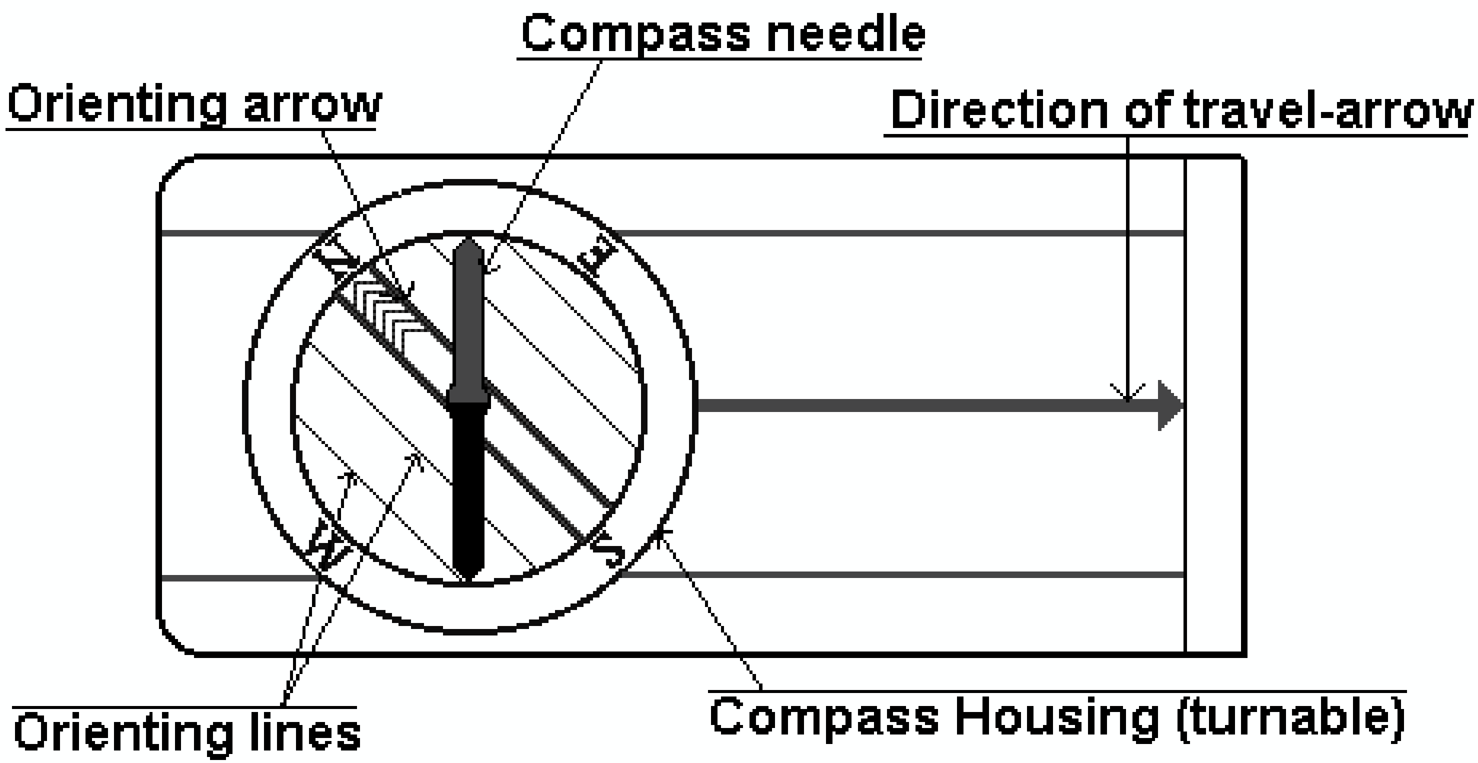
# The Compass

These are the two types of compass you'll see most often.


Lensatic Compass

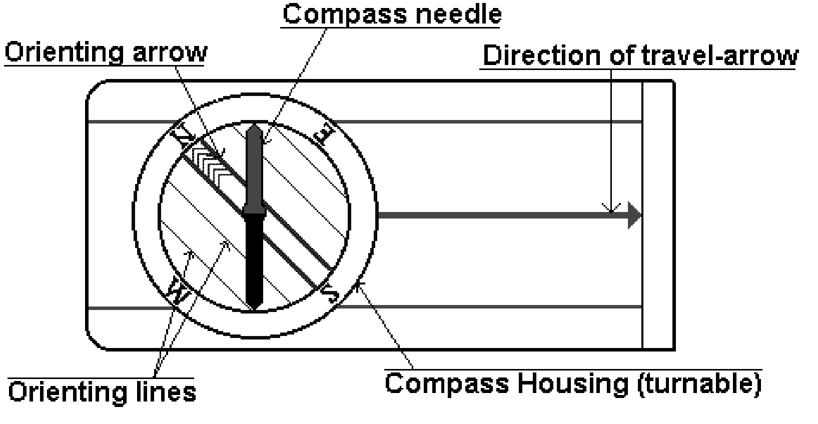

Silva Compass

# THE SILVA COMPASS



# Finding North

- You see the red and black arrow?
- We call it the *compass needle*.
- On some compasses it might be red and white
- But, **the red part of it is always pointing towards the earth's magnetic north pole.**



# Finding other Directions

- You've got a dial that turns on your compass. We call it the
- *Compass housing (or bezel ring)*.
- On the edge of the compass housing, you will probably have a scale from 0 to 360.
- Those are the degrees or the *azimuth* (or you may also call it the bearing in some contexts).
- And you might have the letters N, S, W and E for North, South, West and East.
- If you want to go in a direction between two of these, you would combine them. If you would like to go in a direction just between North and West, you simply say: *"I would like to go Northwest "*.

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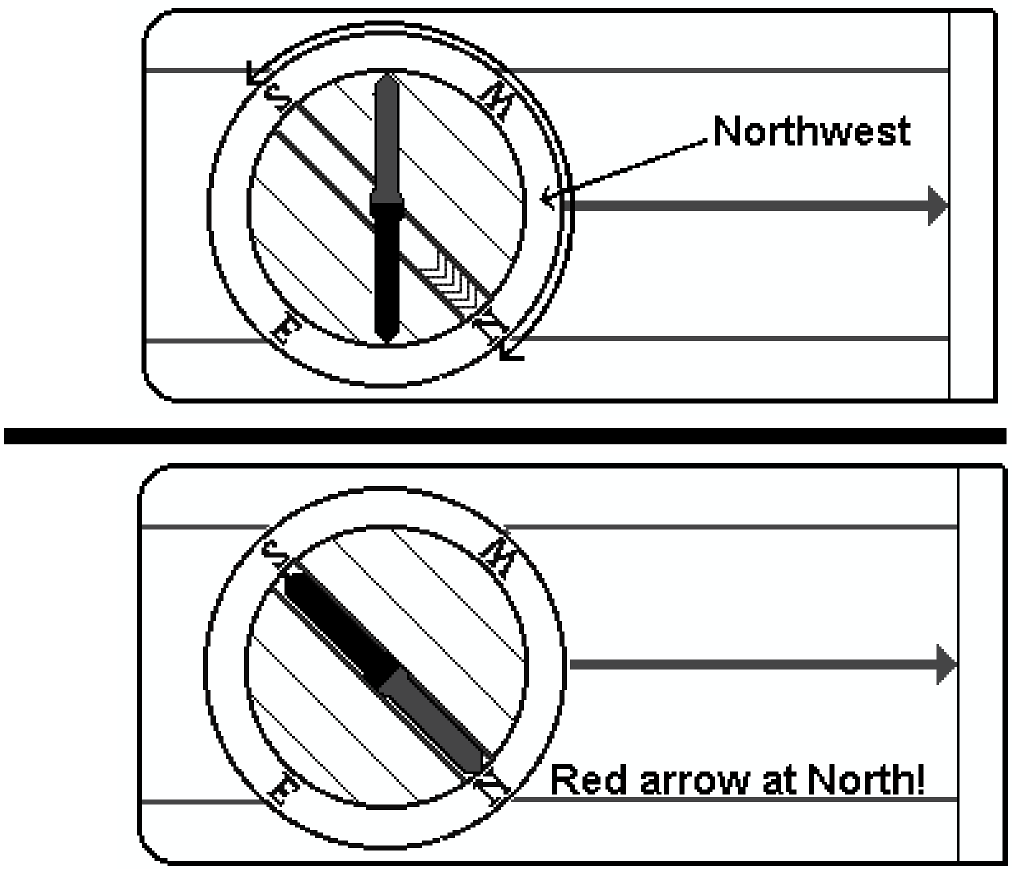
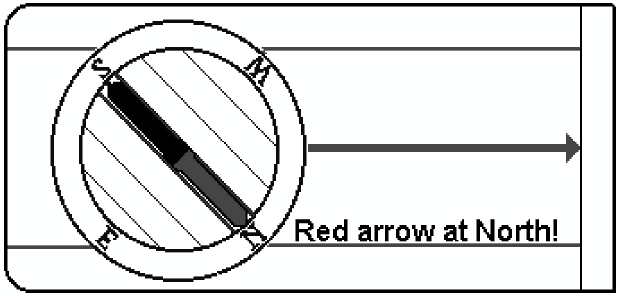
# Let's use Northwest as an example:
# Find out where on the compass housing northwest is.



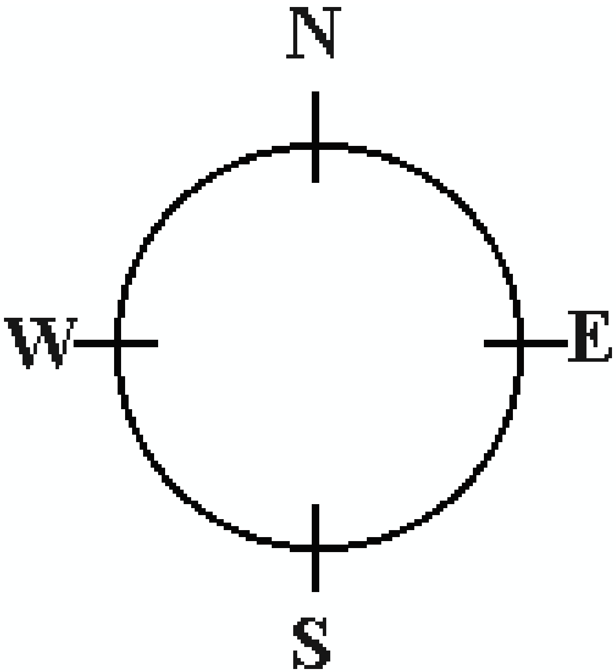

- Turn the compass housing so that northwest on the housing comes exactly there where the large *direction of travel-arrow* meets the housing.
- Hold the compass in your hand. And you'll have to hold it quite flat, so that the compass needle can turn.
- Then turn yourself, your hand, the entire compass, just make sure the compass housing doesn't turn, and turn it until the compass needle is aligned with the lines inside the compass housing.

# Still working on finding NorthWest . . .

- Now, time to **be careful!**. It is e*xtremely* important that the red, north part of the compass needle points at north in the compass housing. If south points at north, you would walk off in the exact opposite direction of what you want! And it's a very common mistake among beginners. So always take a second look to make sure you did it right!
- A second problem might be local magnetic attractions. If you are carrying something of iron or something like that, it might disturb the arrow. Even a staple in your map might be a problem. Make sure there is nothing of the sort around.



# Almost there!

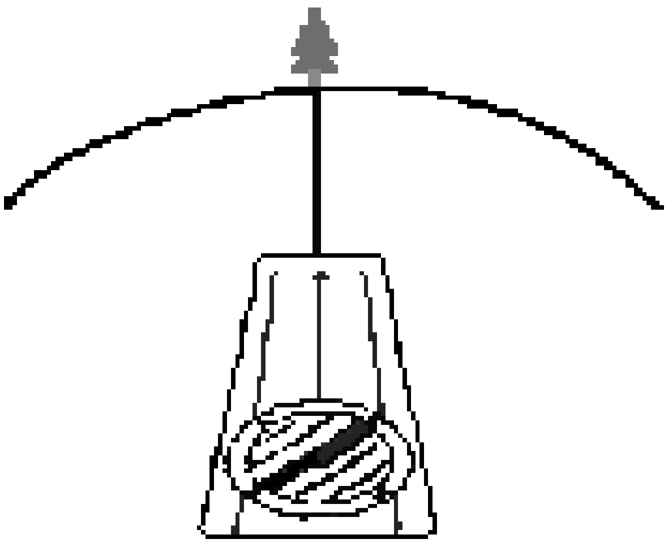



- When you are sure you've got it right, walk off in the direction the direction of travel-arrow is pointing. To avoid getting off the course, make sure to look at the compass every hundred steps or so.
- Once you have the direction, aim on some point in the distance, and go there without staring down at the compass.

# When do you need this technique?

- If you are out there without a map, and you don't know exactly where you are, but you know from your experience in the area that there is a road, trail, stream, river or something long and big you can't miss if you go in the right direction…
- Then all you need to do is to turn the compass housing so that the direction you want to go in is where the direction of travel-arrow meets the housing. And follow the steps you were just shown.
- But why isn't this sufficient? First, it is not very accurate. You are going in the right direction, and you won't go around in circles, but you're very lucky if you hit a small spot this way.
- And, this requires you to have a mental image of the area you are in and what direction those landmarks might be in.
- That’s why using the compass with a map is much, much better.

# How to “Shoot an Azimuth” in 3 Easy Steps



1. Turn the dial of the compass to the given azimuth
2. Keep the compass flat in front of you with the “Direction of Travel Arrow” pointing straight ahead.
3. Turn your body so the red (north pointing) needle of the compass lines up inside the red housing on the base of the compass.

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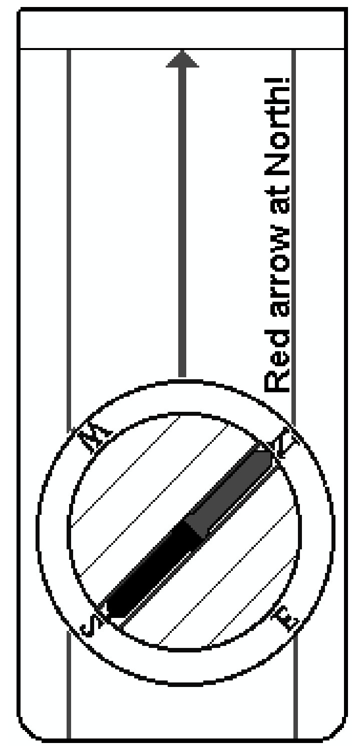
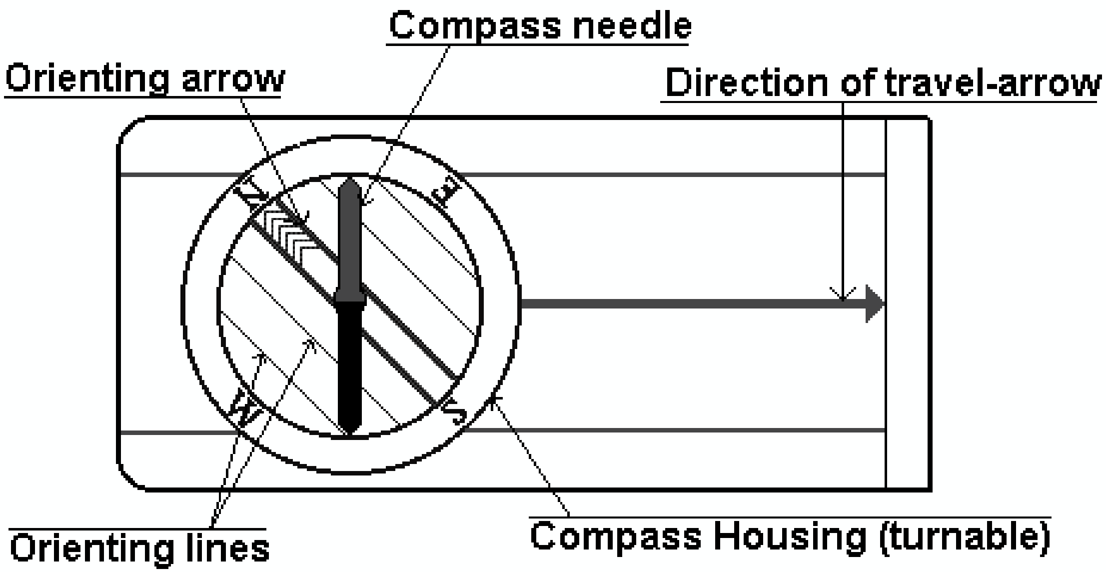
# Let’s try an example: Shoot an Azimuth of 350°

1. First, turn the dial to 150.
2. Then be sure the compass is laying flat and the Direction of Travel Arrow is pointing straight ahead of you.
3. Then turn your body so the red magnetic arrow is lined up within the red arrow on the compass casing.



# Try these with your instructor:




- 10º
- 35º
- 125º
- 65º
- 320º
- 178º
- 143º
- 219º

# Types of Azimuth

There are three kinds of azimuth:

- Magnetic Azimuth: direction expressed as the angular difference between Magnetic North and the direction line (i.e. 140°)
- Grid Azimuth: the angle measured between Grid North and a line plotted between two points on a map.
- Back Azimuth: the opposite direction of an azimuth. The back azimuth is 180° from an azimuth. For azimuths more than 180°, subtract 180. For azimuths less than 180°, add 180. A back azimuth of 180° is either 0° or 360°.

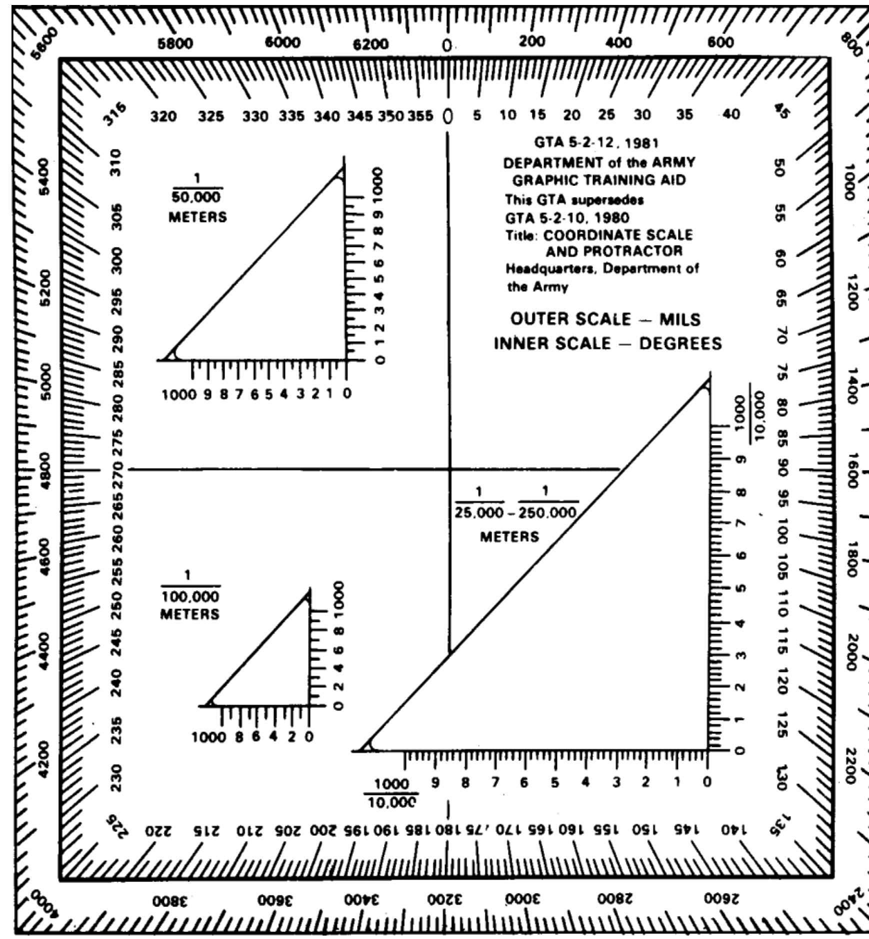
# Using a Protractor

- There are several types of protractors – circular, half-circle, square, and rectangular.
- All have a scale around the outer edge and an index mark in the middle.
- On military protractors, you read the inner of the two scales because it is broken into degrees from 0 to 360.  Each tick mark on the degree scale represents one degree.

# Using a Protractor

Coordinate Scale and Protractor
(Commonly called a Protractor)

- Coordinate Scale for measuring grid coordinates
- Index – where the N/S and E/W lines cross in the middle. It's the central point from which you measure an azimuth.
- 360 Degrees - usually the inner of two types of direction marks
- Mils – the outer measuring marks found on Army protractors. Used in field artillery plotting. You can ignore them (or even carefully cut them off your protractor!)



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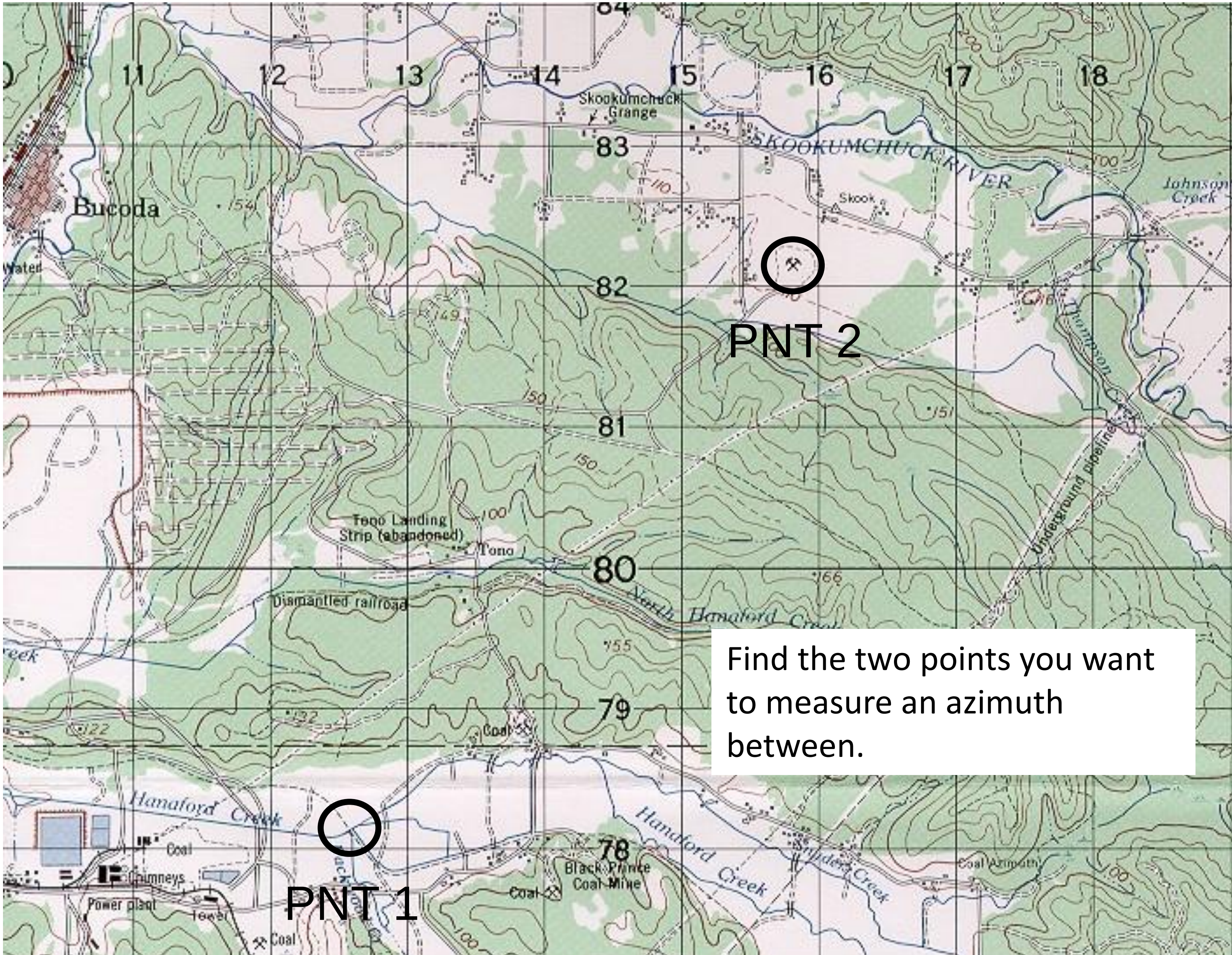


Find the two points you want to measure an azimuth between.

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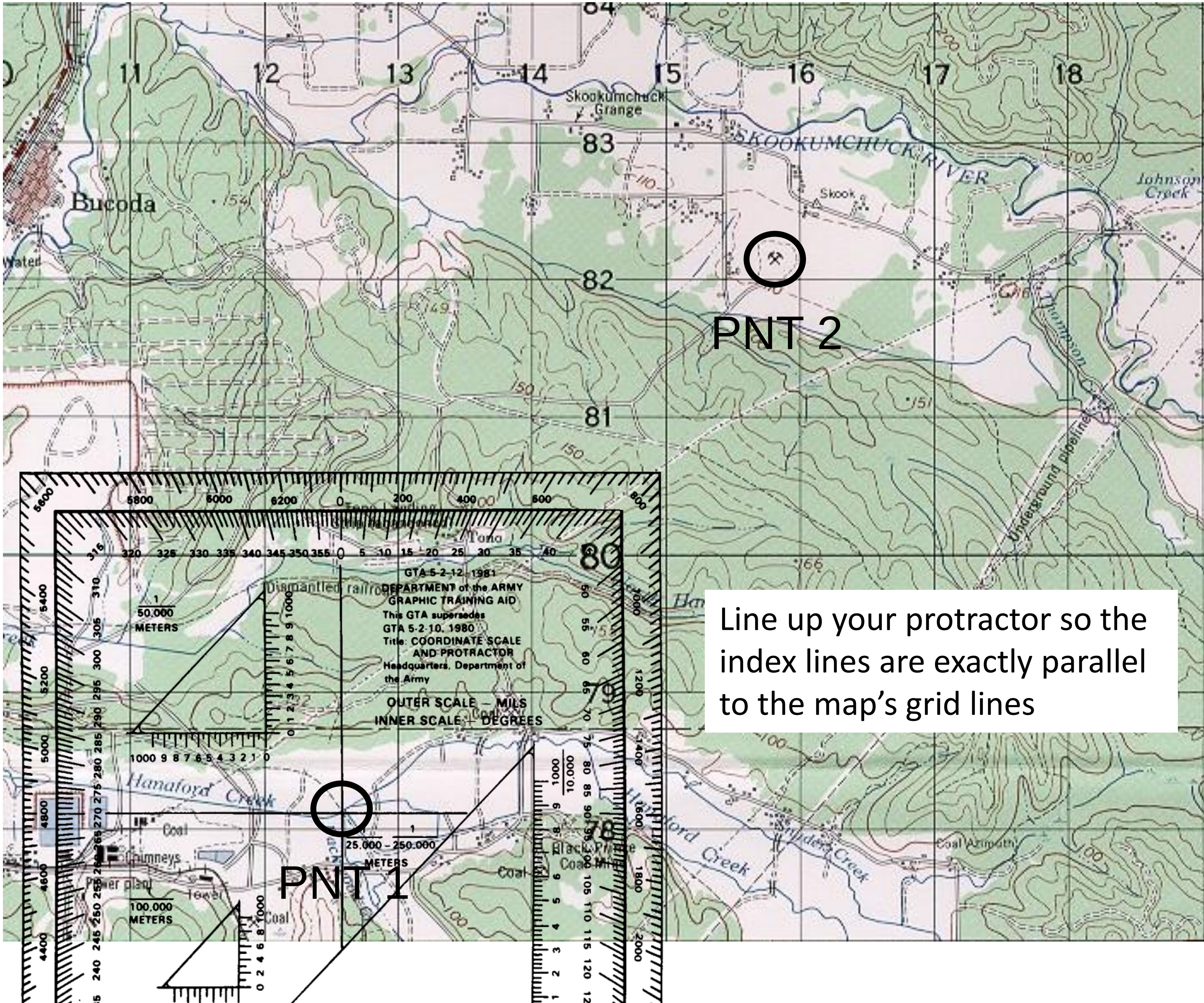
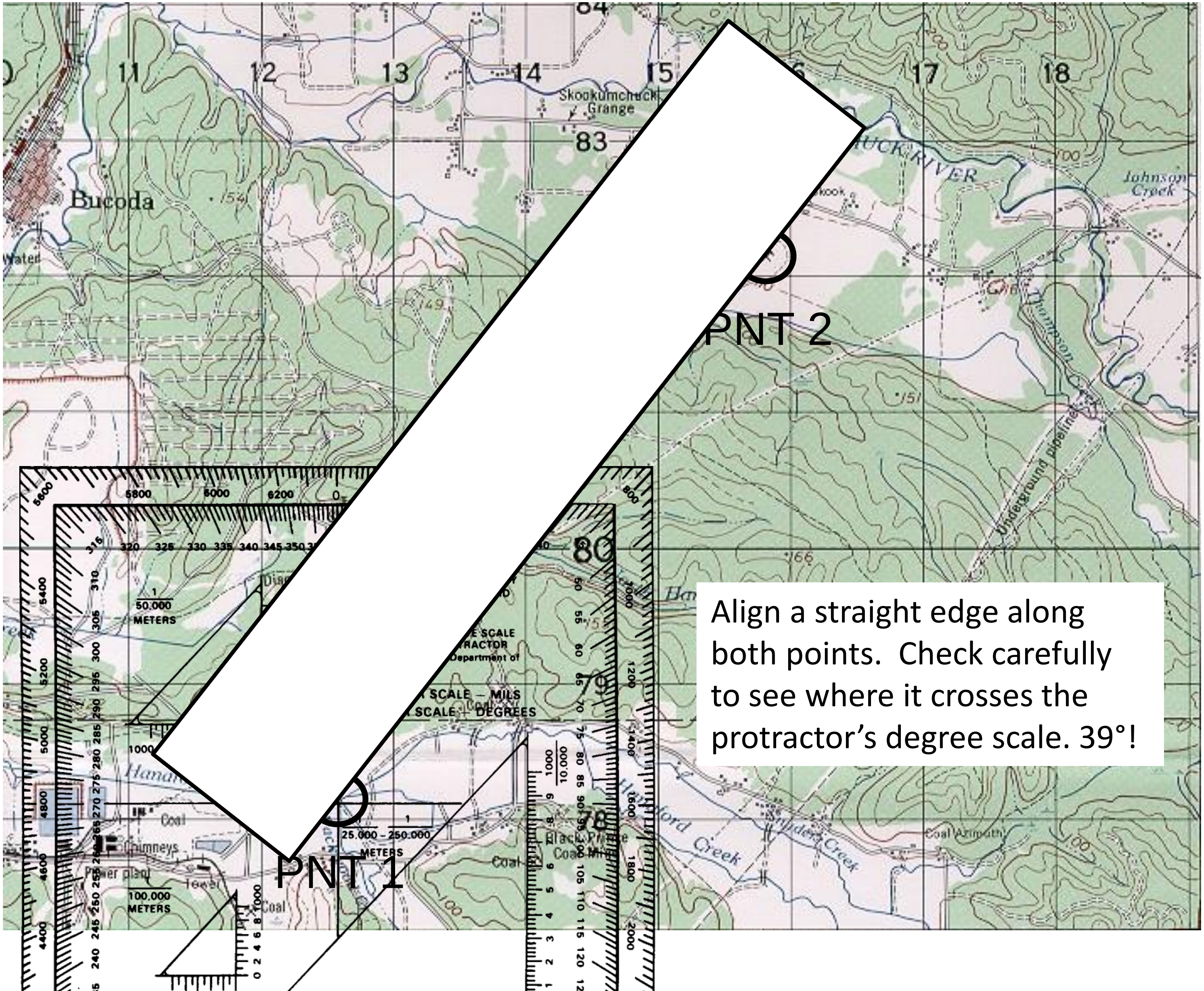



Line up your protractor so the index lines are exactly parallel to the map's grid lines




Align a straight edge along both points. Check carefully to see where it crosses the protractor's degree scale. 39°!

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If you have maps and protractors in your classroom, practice plotting some azimuths between points on your map!

# Check on Learning

1. What are the three types of north?
2. How many degrees are there on a protractor?
3. Do you need the outer scale on a military protractor?

# DETERMINING POLAR COORDINATES

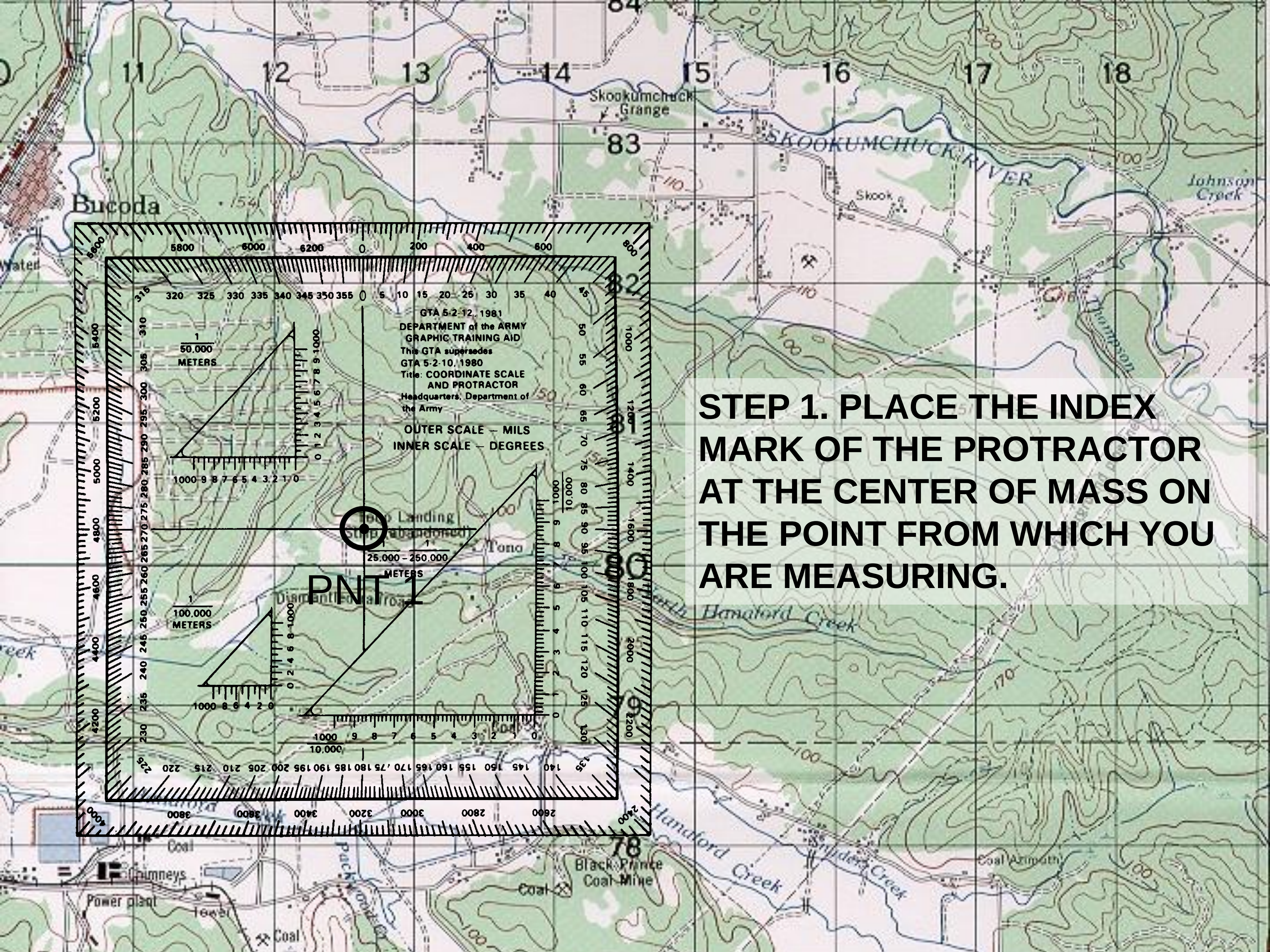
A7. Given a known point, a distance and direction, determine an unknown point on a topographic map.

# Polar Coordinates

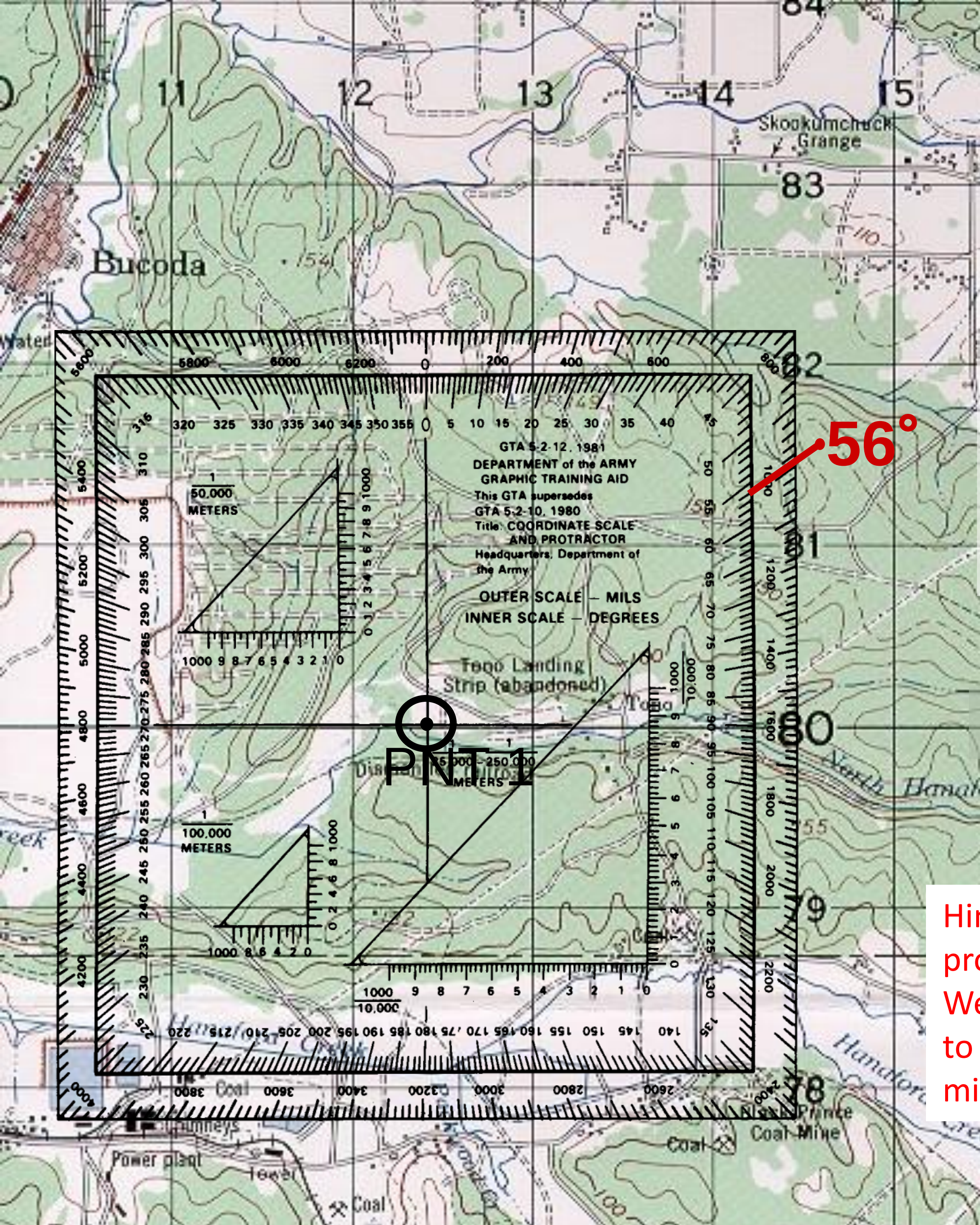
A method of locating or plotting an unknown position from a known point by giving a direction and a distance along that direction line is called polar coordinates. The following elements must be present when using polar coordinates.

- Current known location on the map
- Azimuth (grid or magnetic)
- Distance (in meters)

This is a common task on a land nav course!




**STEP 1. PLACE THE INDEX MARK OF THE PROTRACTOR AT THE CENTER OF MASS ON THE POINT FROM WHICH YOU ARE MEASURING.**

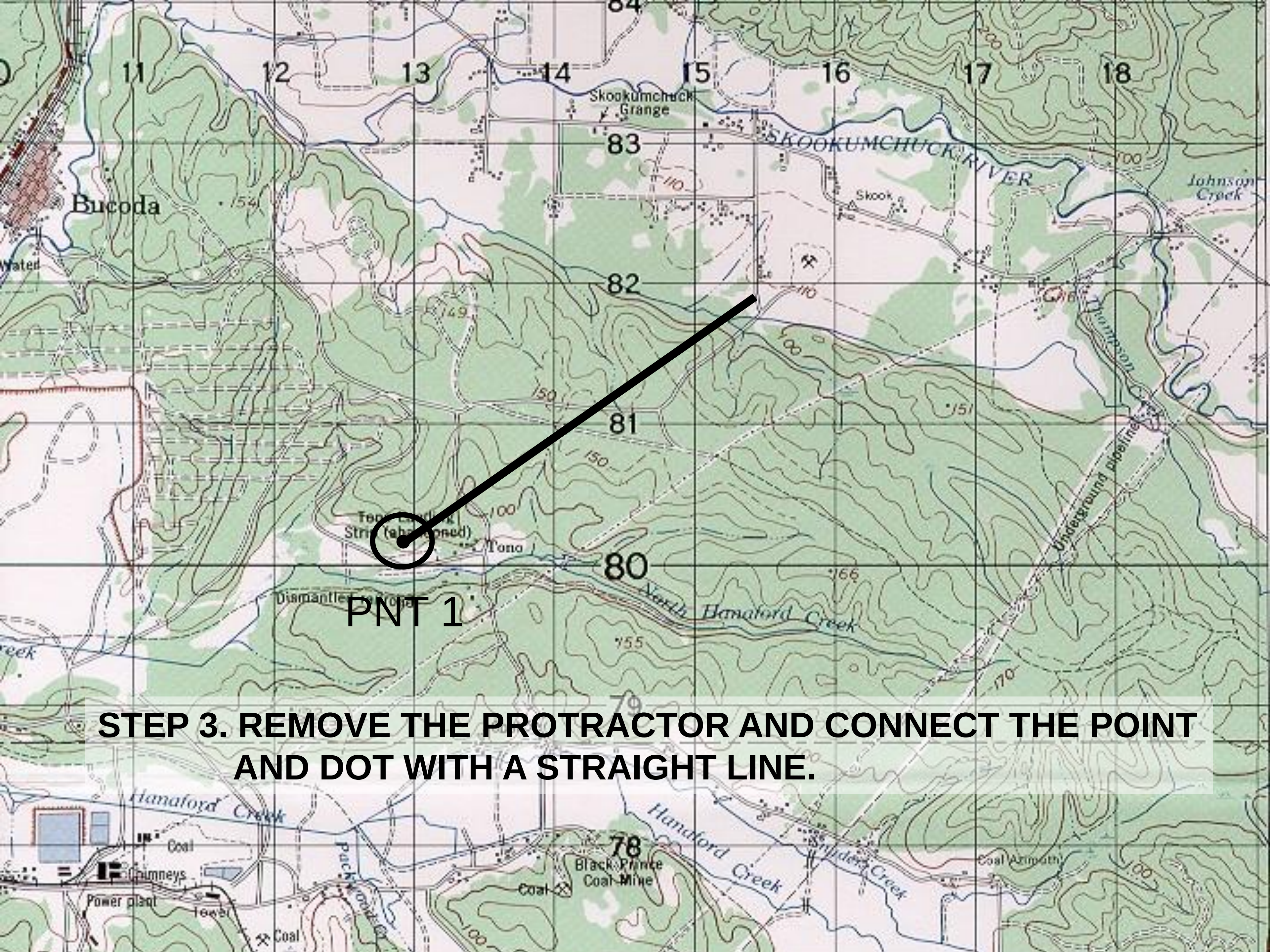



**STEP 2. LOCATE THE DESIRED AZIMUTH ON THE PROTRACTOR SCALE AND PLACE A DOT ON THE MAP AT THIS AZIMUTH.**

**EXAMPLE: 56 DEGREES**

Hint: It's a lot easier to use your protractor if you trim the outside edge. We don't use the mils, and it's easier to work with the degrees without the mils being there.

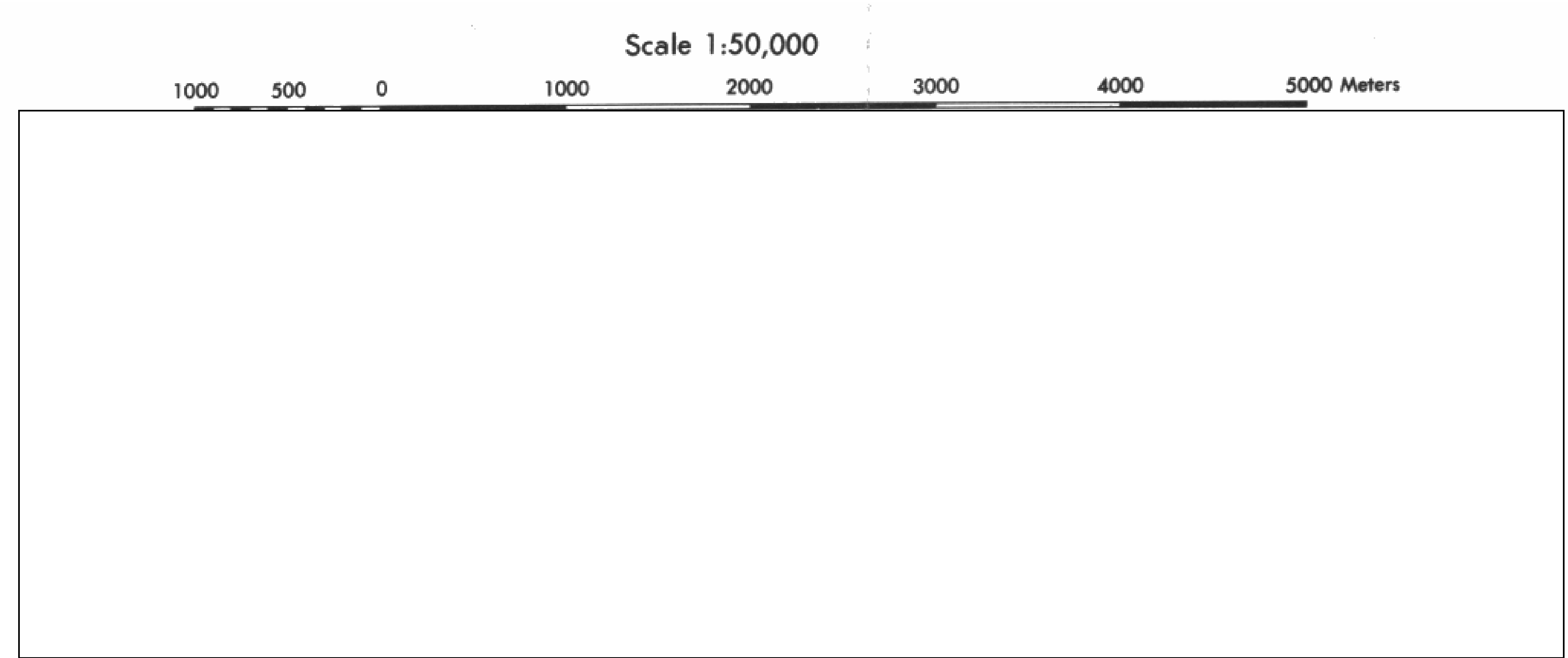
**STEP 3. REMOVE THE PROTRACTOR AND CONNECT THE POINT AND DOT WITH A STRAIGHT LINE.**




**STEP 3. REMOVE THE PROTRACTOR AND CONNECT THE POINT AND DOT WITH A STRAIGHT LINE.**

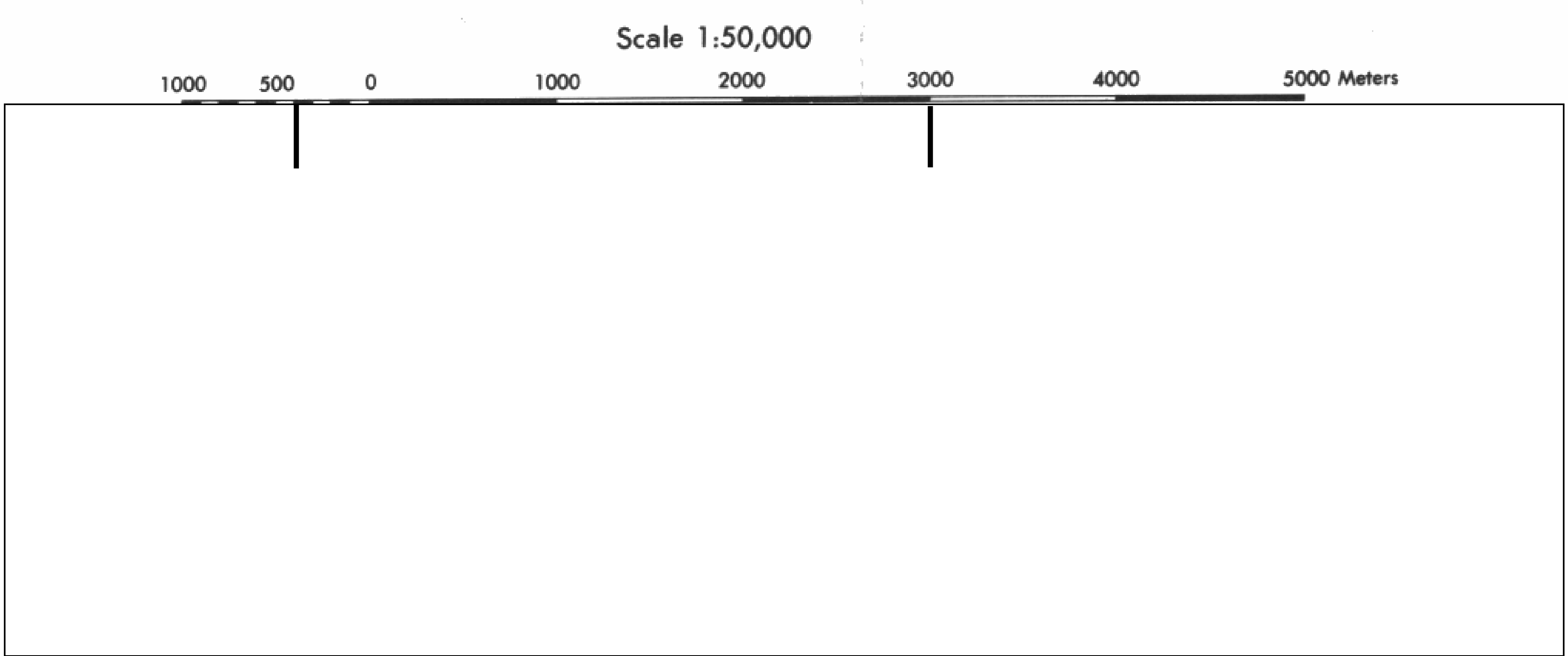
## STEP 4. SELECT THE APPROPRIATE SCALE MEASUREMENT AND PLACE A PAPER STRAIGHT EDGE ON THE SCALE.

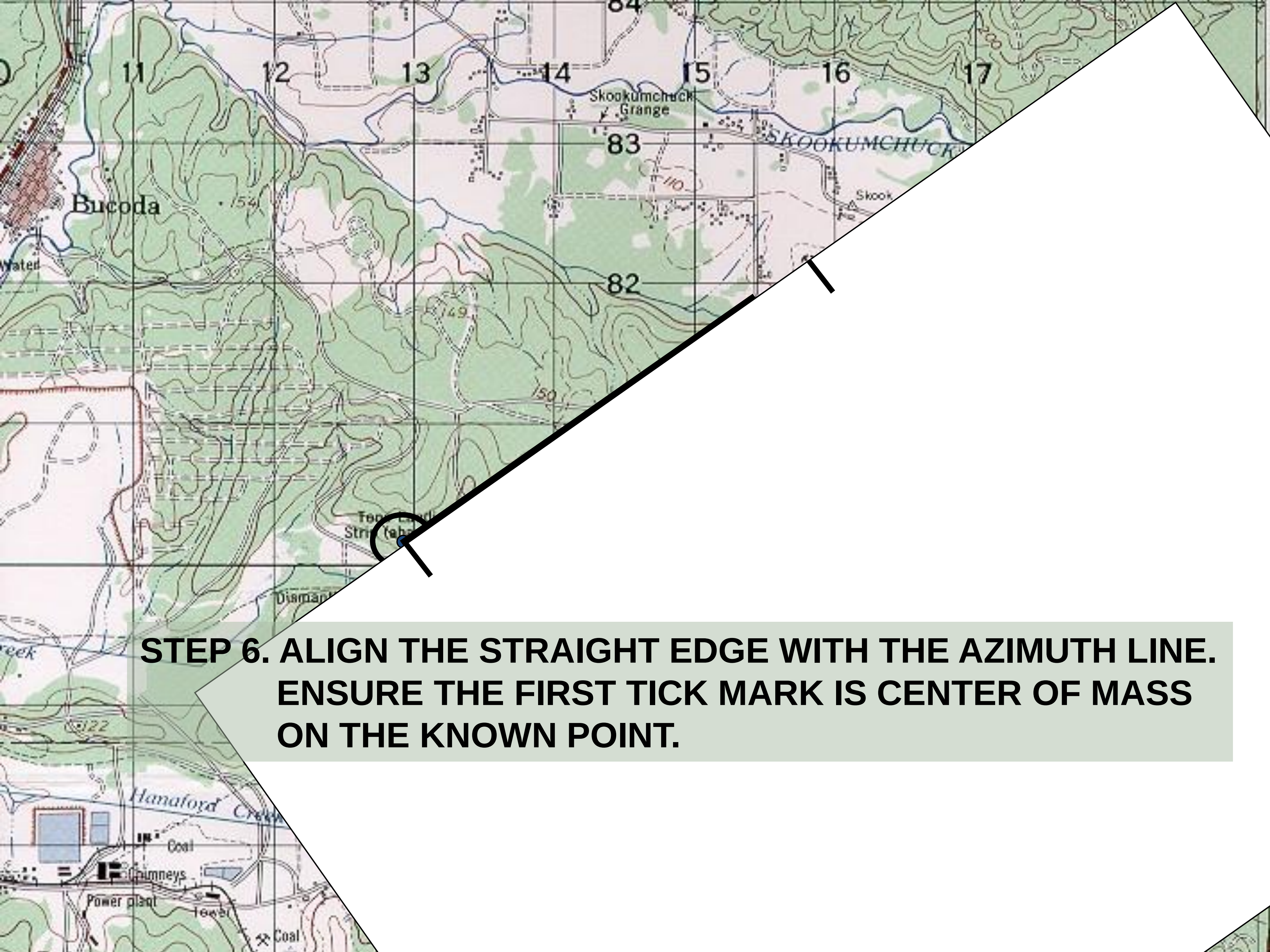
**EXAMPLE: DISTANCE IN METERS**



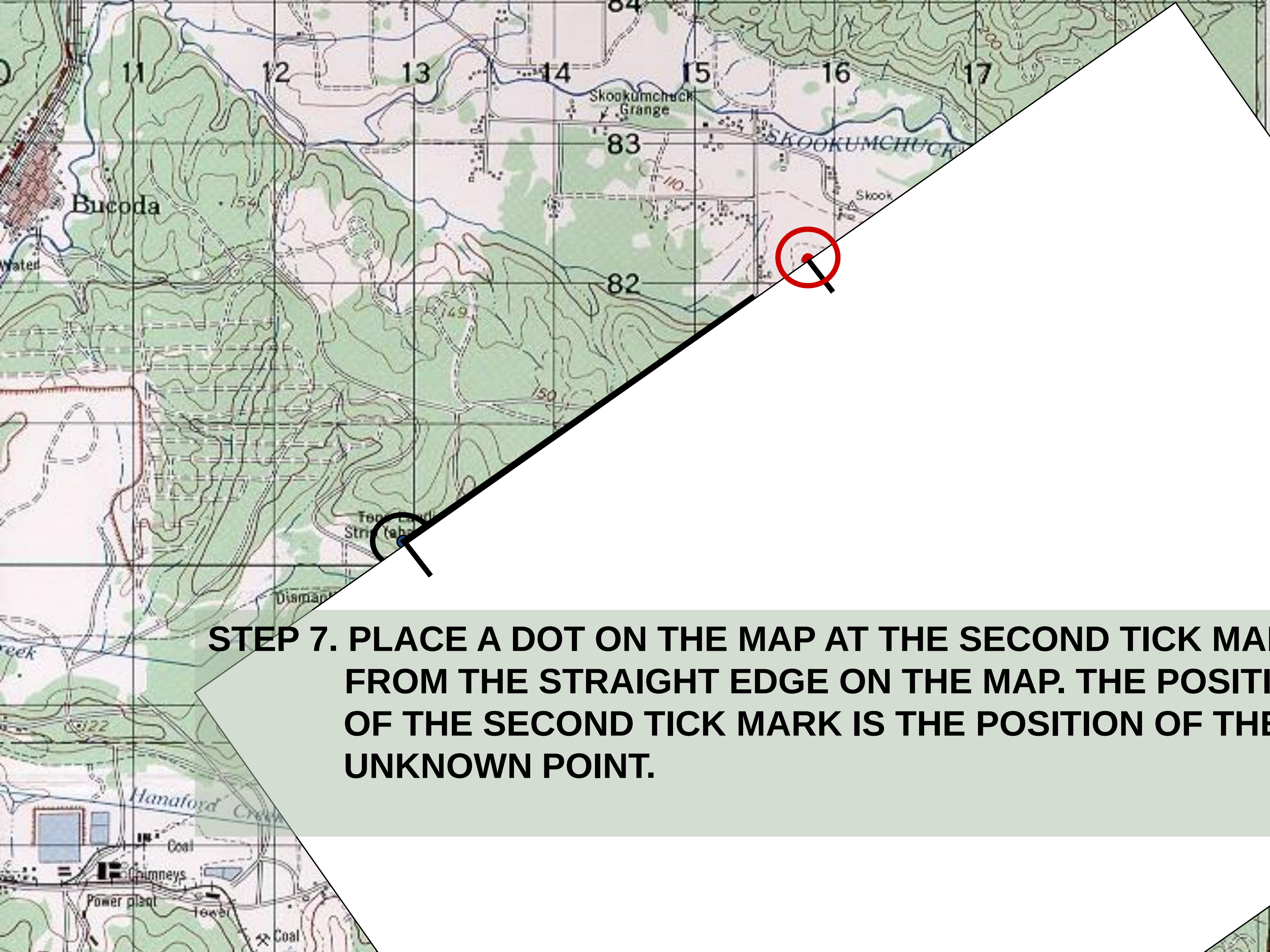
**STEP 5. DETERMINE THE DESIRED DISTANCE TO MEASURE FROM THE SCALE AND MARK THE PAPER AT THIS DISTANCE USING TICK MARKS.**

**EXAMPLE: 3400 METERS**

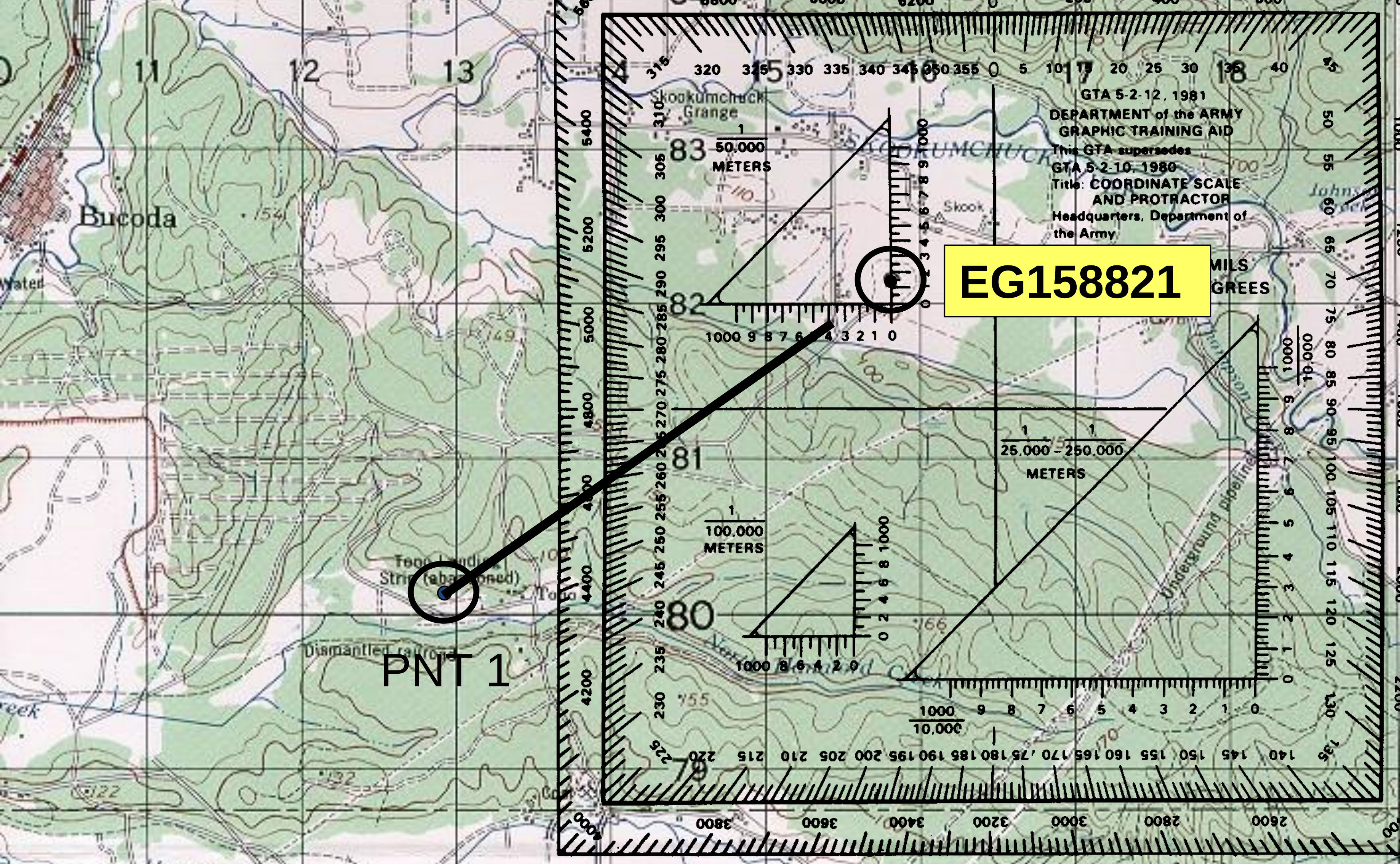





**STEP 6. ALIGN THE STRAIGHT EDGE WITH THE AZIMUTH LINE. ENSURE THE FIRST TICK MARK IS CENTER OF MASS ON THE KNOWN POINT.**




**STEP 7. PLACE A DOT ON THE MAP AT THE SECOND TICK MA**
**FROM THE STRAIGHT EDGE ON THE MAP. THE POSITI**
**OF THE SECOND TICK MARK IS THE POSITION OF THE**
**UNKNOWN POINT.**




**STEP 8. REMOVE THE STRAIGHT EDGE AND DETERMINE THE GRID COORDINATE TO THE SECOND POINT.**

# Check on Learning

Put the following steps in order:

- Connect the point and dot with a straight line
- Place the protractor’s index mark on a known point
- Plot the distance from the scale on your direction line
- Mark the distance on a straight edge from the map scale
- Determine the grid coordinate of your unknown point
- Locate the desired azimuth and mark the map

# THE G-M ANGLE
## DECLINATION DIAGRAM

A8. Use a Declination Diagram to convert a grid azimuth to a magnetic azimuth and vice versa.

# Declination Diagram

- If you're going to use a map and compass together, you must know how to make the information compatible
- The map shows Grid North
- The compass shows Magnetic North
- The Declination Diagram on the marginal information shows the relationship between the three norths, and how to determine the G-M Angle

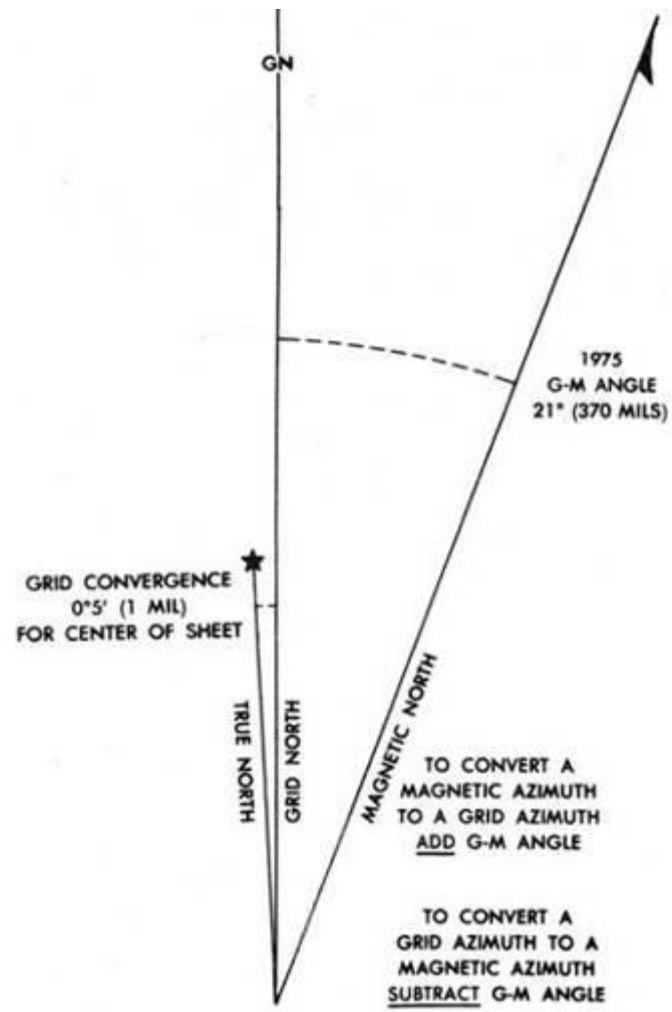
# Declination Diagram

- Shows the 3 norths
- Tells you the G-M Angle (21° in this case)
- Tells you how to convert:

  <u>East G-M Angle</u>:
  - ➢ Magnetic to Grid – ADD
  - ➢ Grid to Magnetic – SUBTRACT

  <u>West G-M Angle</u>:
  - ➢ Magnetic to Grid – SUBTRACT
  - ➢ Grid to Magnetic – ADD

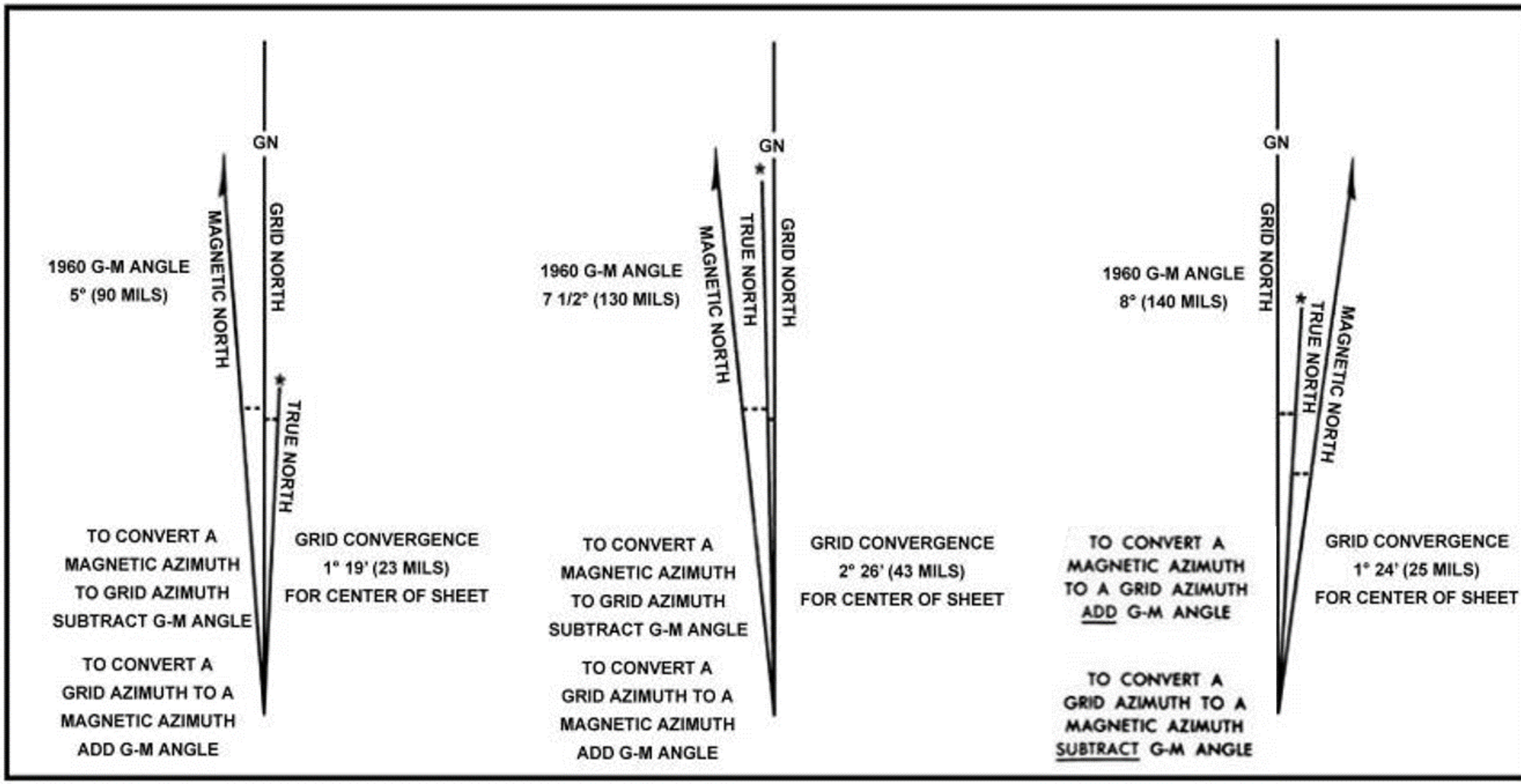
This example is an EAST G-M Angle
(the Magnetic North is east of Grid North)



# Why You Need It

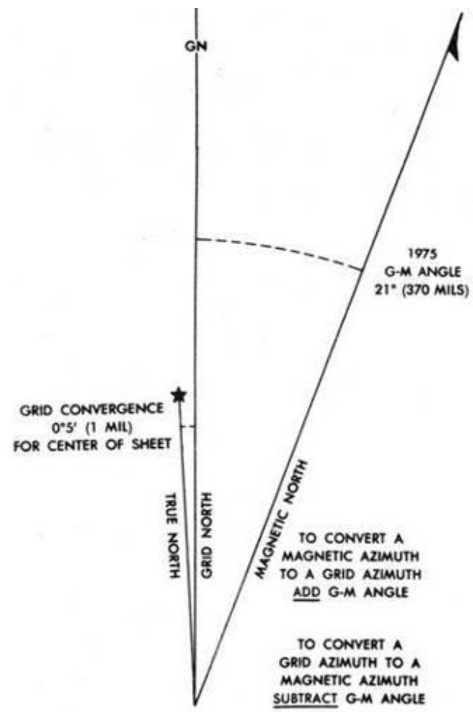
- Why does every map need a declination diagram?
- Because different parts of the globe have different declinations (and they also change over time). For example, the declination varies from 16 degrees west in Maine, to 6 in Florida, to 0 degrees in Louisiana, to 4 degrees east in Texas.
- Without knowing the G-M Angle, you can't really use a map and compass together
- If MN is West of GN, you subtract when going from magnetic to grid
- If MN is East of GN, you add when going from magnetic to grid
- And going from grid to magnetic you do the opposite!
- It's very handy to have this spelled out on your map!

# Declination Diagrams



# Check on Learning

1. You shoot a magnetic azimuth of 215°. Your G-M Angle is 21° East. Convert your magnetic azimuth to a grid azimuth.

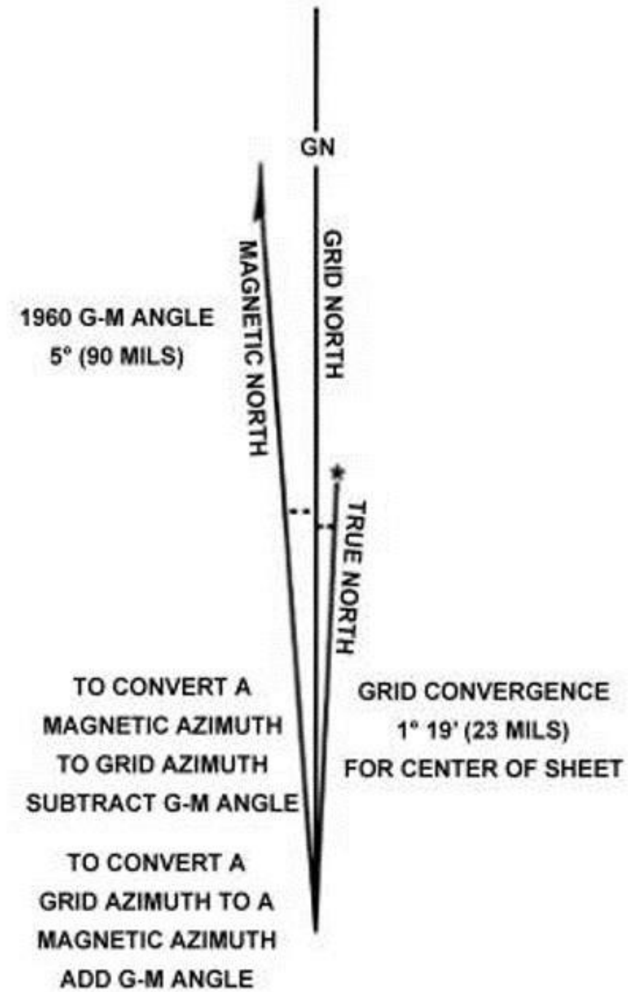


# Answer

- Magnet to Grid – Add in the East.
- 215 + 21 = 236°

# Check on Learning

2. You have a grid azimuth of 95°. Your G-M Angle is 5° West. Convert your grid azimuth to a magnetic azimuth.

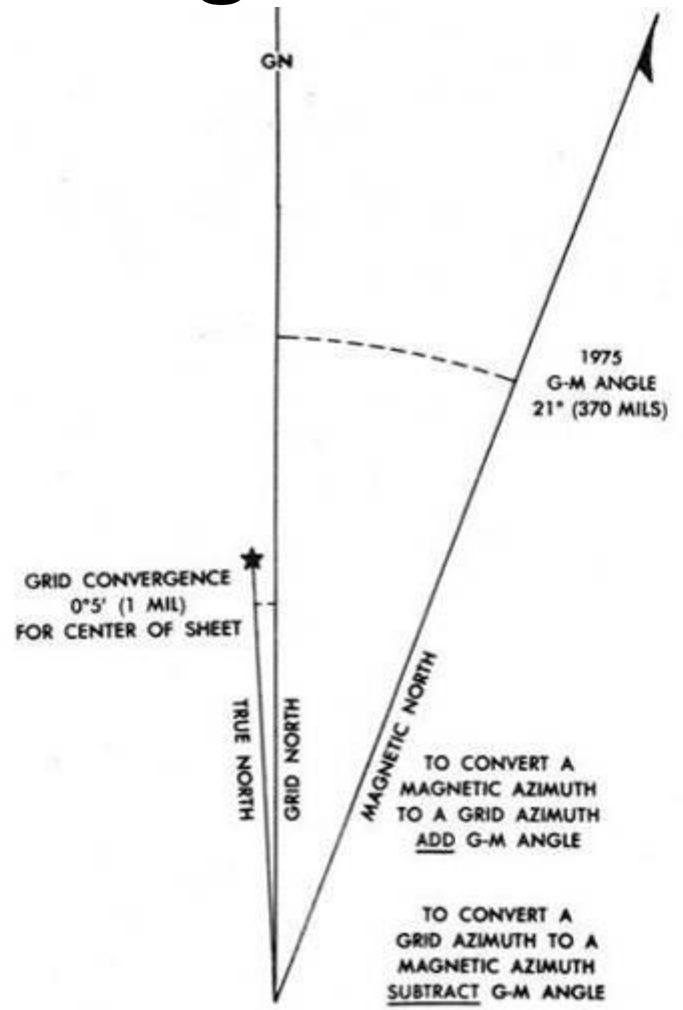


# Answer

- Grid to Magnetic – Add in the West
- 95 + 5 = 100 °

# Check on Learning

3. You have a grid azimuth of 5°. Your G-M Angle is 21° East. Convert your grid azimuth to a magnetic azimuth.



# Answer

- Grid to Magnetic – Subtract in the East
- 5° is the same as 365°
- 365 – 21 = 344°

# Summary

- A1. Introduction to Maps
- A2. Topographical Map Basics
- A3. Elevation and Terrain Features
- A4. Grid Coordinates
- A5. Measuring Distance
- A6. Direction
- A7. Polar Coordinates
- A8.  G-M Angle: Declination Diagram