In situations where you foresee a potential evacuation on foot, where there are no roads, and no indication as to the direction of travel (i.e., road signs), it is recommended you obtain topographic maps of the area and learn how to navigate using map and compass so that you can reach a specific destination and report your exact position to rescuers. Knowing how to read a map and navigate can also be useful when conducting program activities such as surveys or exploratory missions. This appendix has been developed using materials from "Tony Field of Chasetrek," "The Backpacker's Field Manual" by Rick Curtis, and USGS fact sheet 079-99, "Finding your way with map and compass."

1. MAP READING

a) Latitude and Longitude

Maps are drawn based on latitude and longitude lines. Latitude lines run east and west and measure the distance in degrees north or south from the equator (0° latitude). Longitude lines run north and south intersecting at the geographic poles. Longitude lines measure the distance in degrees east and west from the prime meridian that runs through Greenwich, England. The grid created by latitude and longitude lines allows us to calculate an exact point using these lines as X axis and Y axis coordinates.

Both latitude and longitude are measured in degrees (°):
1° = 60 seconds
1 minute = 60 seconds
Therefore:
7 1/2 minutes = 1/8 of 60 minutes =1/8 of a degree
15 minutes = 1/4 of 60 minutes = 1/4 of a degree

b) Map Scale

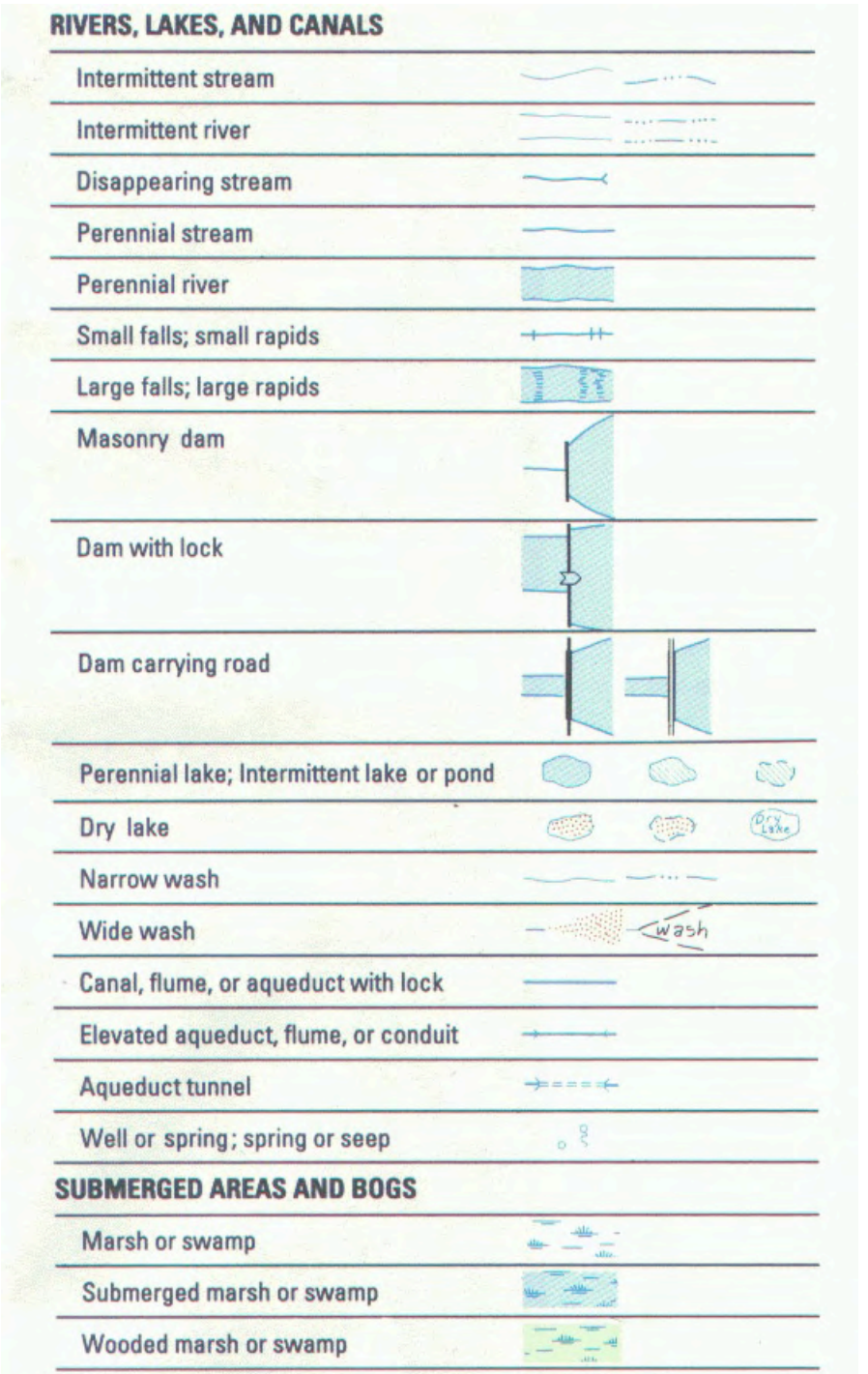
Maps are two dimensional representations of three dimensional features. They are drawn to a scale which is printed in the margin, or legend, on the map. Scales such as 1:50,000 (be it inches or centimeters) means that 1 unit on the map is the equivalent of 50,000 units in the real world. If expressed in centimeters, an object measuring 1cm on the map will be 50,000 times one cm in real life, or 0.5km.

c) Map Symbols and Colors

USGS topographic maps use the following symbols and colors to designate different features:

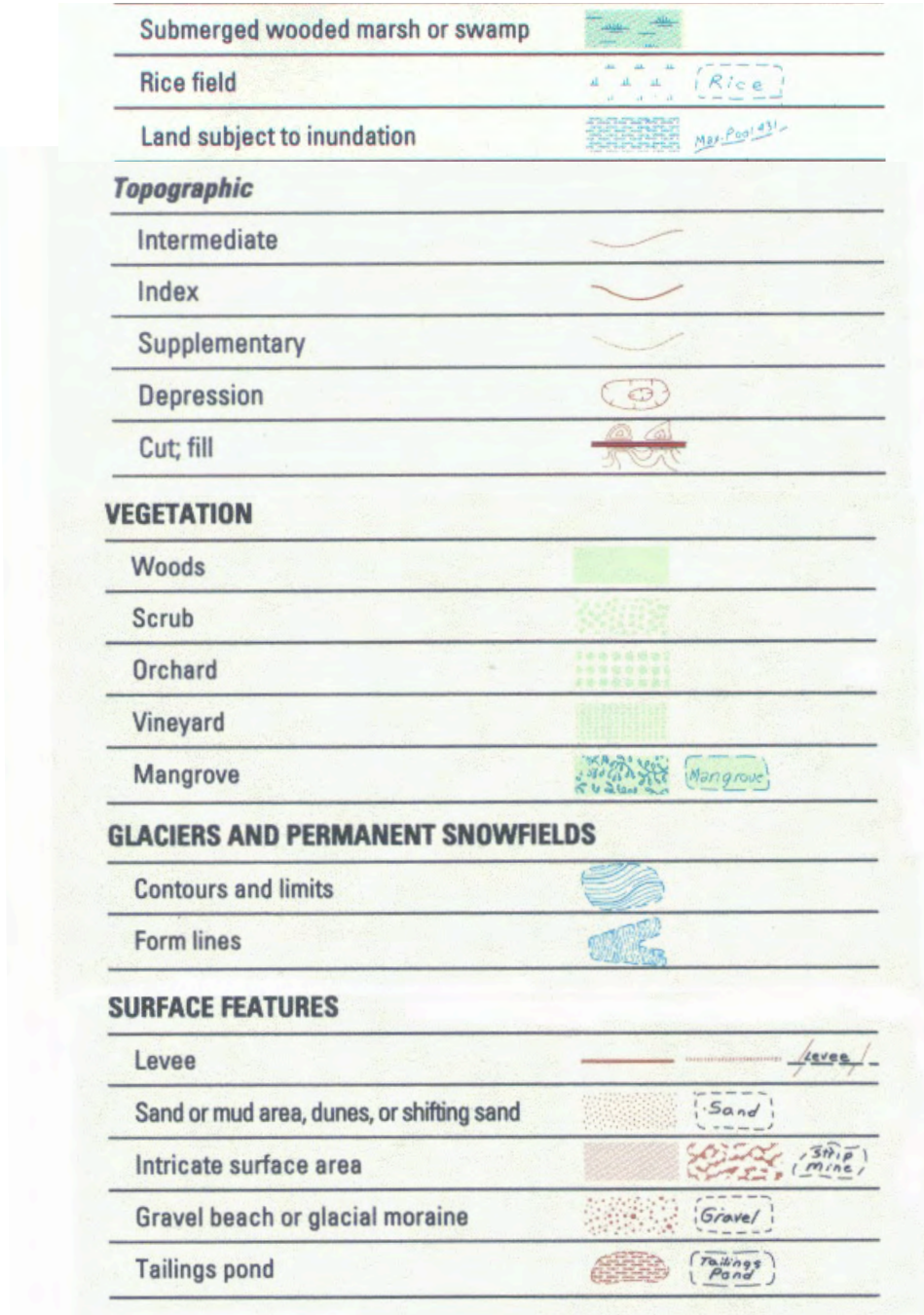
- Black - man-made features such as roads, buildings, etc.
- Blue - water, lakes, rivers, streams, etc.
- Brown - contour lines.
- Green - areas with substantial vegetation (could be forest, scrub, etc.).
- White - areas with little or no vegetation; white is also used to depict permanent snowfields and glaciers.
- Red - major highways; boundaries of public land areas.
- Purple - features added to the map since the original survey. These features are based on aerial photographs but have not been checked on land.

REFERRED TO IN CHAPTER 5
Using Map and Compass Together (continued)



Source: U.S. Geological Survey

REFERRED TO IN CHAPTER 5
Using Map and Compass Together (continued)



Source: U.S. Geological Survey

REFERRED TO IN CHAPTER 5
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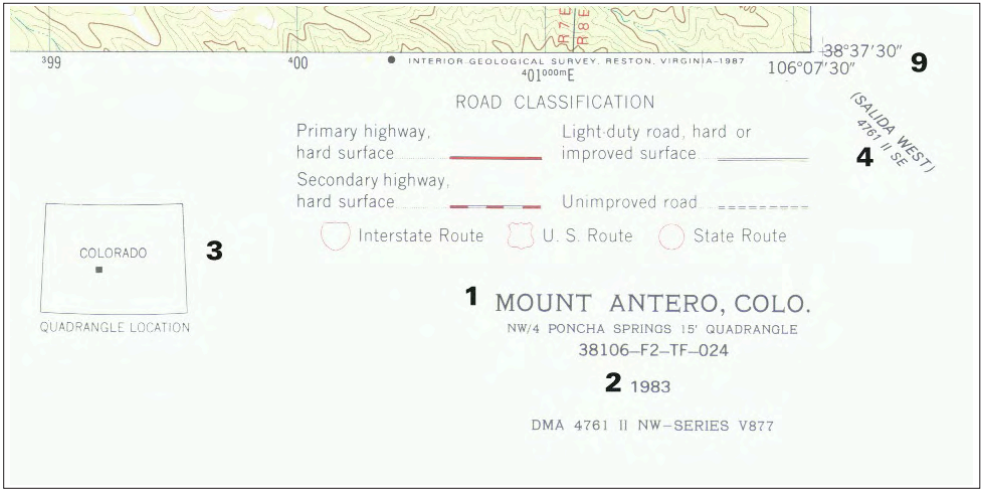
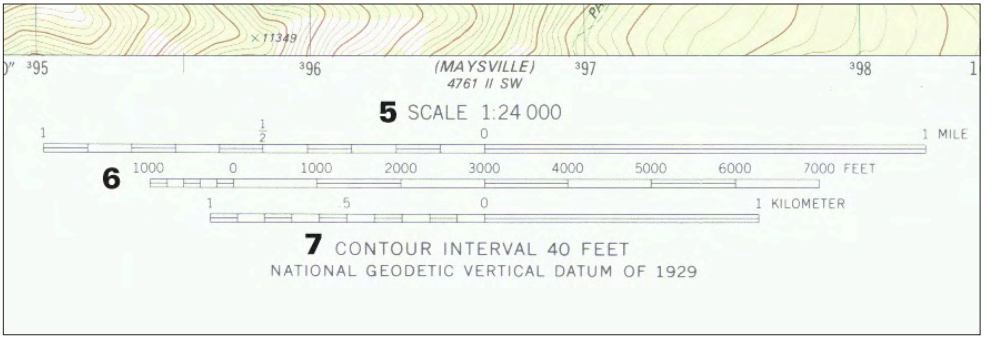
d) Map Legend

The map legend contains a number of important details. The figures below display a standard USGS map legend. In addition, a USGS map includes latitude and longitude as well as the names of the adjacent maps (depicted on the top, bottom, left side, right side and the four corners of the map). The major features on the map legend are shown in the figures below:

1. Map name.
2. Year of production and revision.
3. General location in state.
4. Next adjacent quadrangle map.
5. Map scale.
6. Distance scale.
7. Contour interval.
8. Magnetic declination.
9. Latitude and longitude.

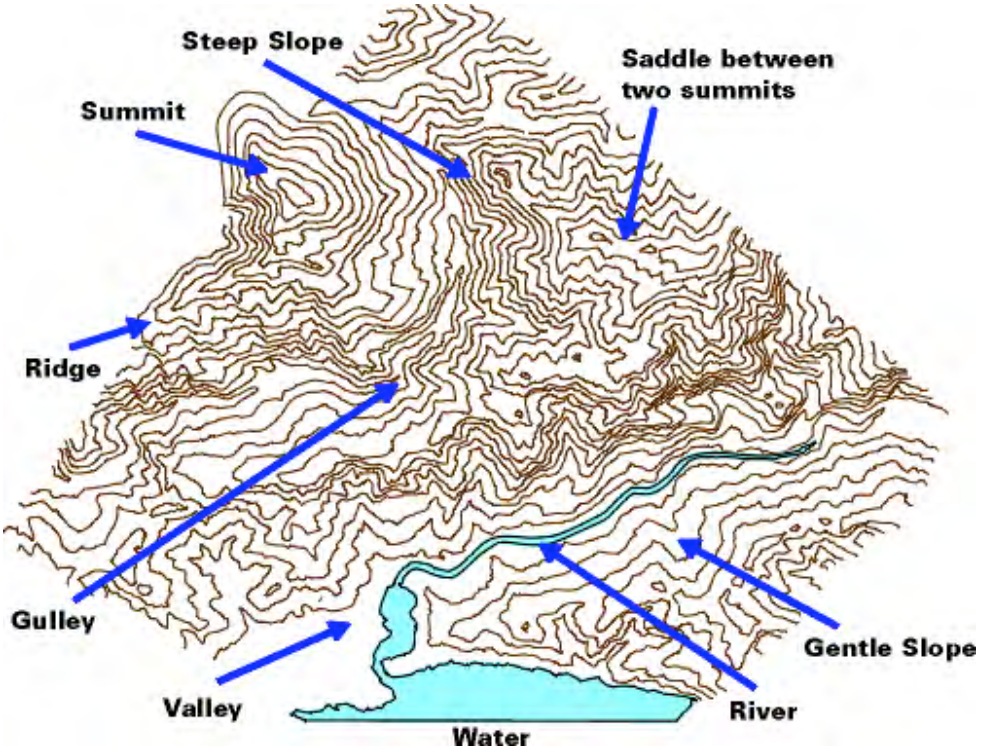




e) Contour Lines

A contour line is a continuous line of the same elevation (or height) around the edge of a feature. Each line gives an outline of what a feature looks like at regular intervals of elevation. The closer together the lines are, the steeper the slope. The spread out contour lines indicate a more gentle slope. The interval of contour lines varies with maps, and it is important to check the interval to interpret the map. As an example UK maps are at 10 meter intervals; that is, each line represents an outline of the mountain 10 meters higher than the line below it. Contour lines are usually printed in brown with every 4th or 5th line thicker. This line will carry a number somewhere along its length which tells you the height above sea level.

- Steep slopes - contours are closely spaced.
- Gentle slopes - contours are less closely spaced.
- Valleys - contours form a V-shape pointing up the hill. These V's are always an indication of a drainage path which could also be a stream or river.
- Ridges - contours form a V-shape pointing down the hill.
- Summits - contours forming circles.
- Depressions - are indicated by circular contour with lines radiating to the center.



REFERRED TO IN CHAPTER 5
Using Map and Compass Together (continued)

f) Measuring Distances

There are a number of ways to measure distance accurately on a map. One is to use a piece of string or flexible wire to trace the intended route. After tracing out your route, pull the string straight and measure it against the scale line in the map legend.

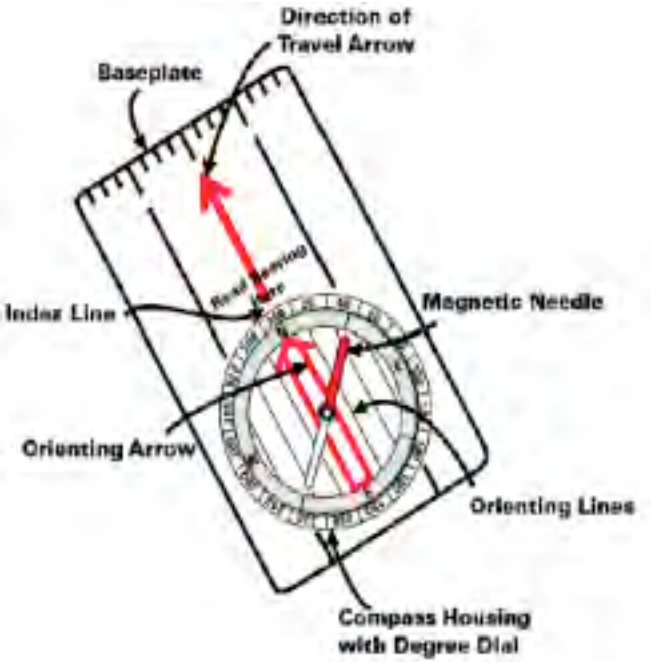
2. USING MAP AND COMPASS

Using both the map and compass together enables you to reach distant places accurately. The map contains a scale picture of our surroundings. The compass informs us which way is north. By putting the two together we can align the map to the real world and so make sense of what a map is telling us.

a) Buying a Compass

A basic orienteering compass (i.e. Silva "Starter model 1-2-3" or "explorer model 203") corresponds to our needs. It is composed of the following parts:

- Base plate.
- Straight edge and ruler.
- Direction of travel arrow.
- Compass housing with 360 degree markings.
- North label.
- Index line.
- Orienting arrow.
- Magnetic needle (north end is red).



b) What is north?

There are two types of north:

- True north: (also known as geographic north or map north - marked as H on a topographic map is the geographic North Pole where all longitude lines meet. All maps are laid out with true north directly at the top. Unfortunately for the wilderness traveler, true north is not at the same point on the earth as the magnetic North Pole which is where your compass points.
- Magnetic north: Think of the earth as a giant magnet (it is actually). The shape of the earth's magnetic field is roughly the same shape as the field of a bar magnet. However, the earth's magnetic field is inclined at about 11° from the axis of rotation of the earth, so this means that the earth's magnetic pole doesn't correspond to the geographic North Pole and because the earth's core is molten, the magnetic field is always shifting slightly. The red end of your compass needle is magnetized and wherever you are, the earth's magnetic field causes the needle to rotate until it lies in the same direction as the earth's magnetic field. This is magnetic north (marked as MN on a topographic map).

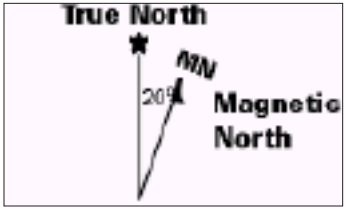
c) Declination

You can see that location makes a great deal of difference in where the compass points. The angular difference between true north and magnetic north is known as the declination and is marked in degrees on your map as shown in the figures below. Depending on where you are, the angle between true north and magnetic north is different. The magnetic field lines of the earth are constantly changing, moving slowly westward (1/2 to 1 degree every five years). This is why it is important to have a recent map. An old map will show a declination that is no longer accurate, and all your calculations using that declination angle will be incorrect. As you will see, understanding this distinction becomes important when navigating with a map and a compass.

d) Taking a Compass Bearing from a Map

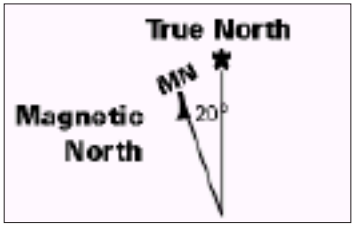
1. Draw a straight line on the map passing through your location and your destination and extending across any one of the map borders.

East Declination



Magnetic North is > True North

West Declination



Magnetic North is < True North

REFERRED TO IN CHAPTER 5
Using Map and Compass Together (continued)

2. Center the compass where your drawn line intersects the map border, align the compass axis N-S with the border line, and read on the compass circle the true bearing of your drawn line. Be careful to get the bearing in the correct sense because a straight line will have two values 180° apart. Remember north is 0, east is 90, and so on.
3. To use this bearing, you must compensate for magnetic declination. If the MN arrow on the map magnetic declination diagram is to the right of the true north line (east declination), subtract the MN value. If the arrow is to the left of the line (west declination), add the value.

Drawing a straight line over the map edge.

Reading the compass on the map.

e) Walking a Bearing Taken from the Map

Compass readings are affected by the presence of iron and steel objects. Be sure to keep the compass away from pocket knives, belt buckles, railroad tracks, trucks, electrical lines and so forth when using a compass in the field.

1. To walk a bearing taken from the map, you need to correct for declination (see previous page). Once you have corrected for declination, hold the compass level and in front of you, so that the direction of travel arrow points to the destination.
2. Rotate your whole body until the magnetic needle lies directly over the orienting arrow. Make sure the north end of the magnetic needle points to N on the compass housing. The direction of travel arrow points to the destination.
3. Site a prominent feature to which your direction of travel arrow points. Walk to that feature. Continue to sight on other features along the bearing and walk to them, until you reach your destination.

Sometimes the terrain does not allow you to follow your bearing in a straight line, so there are a number of techniques to use when traveling on a bearing. Line of sight walk to an obvious landmark—a tree or boulder that is directly on the bearing. Then take another bearing on the next obvious landmark and walk to that. Keep it up until you reach your destination. By going to intermediate landmarks, you minimize the chances of veering off your bearing.