Draft: 09-14-14

Lesson Plan

Second Class: 1a. Demonstrate how a compass works and how to orient a map. Explain what map symbols mean.

Scout Instructors: Van Butcher/xxx
Adult Leader: Mr. Shoaff/Mr. Olson

References:

1. Boy Scout Handbook, pg. 354 Map symbols, pgs. 360-364 How to use a compass, how to orient a map.
2. Kjetil Kjernsomo's Illustrated Guide on How to Use a Compass. http://www.learn-orienteering.org/old/
3. http://www.magazine.ordnancesurveyleisure.co.uk/magazine/tscontent/editorials/outdoor-skills/map-and-navigation-skills/using-a-compass.html
4. U.S. Geological Survey. Topographic Map Symbols http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf
5. U.S. Geological Survey, 2001, Finding your way with map and compass: U.S. Geological Survey Fact Sheet 035–01, 2 p., available only online at http://pubs.usgs.gov/fs/2001/0035/.
6. Compass Dude. http://www.compassdude.com/default.shtml

Training Objectives:

1. Understand map symbols, map key, map scale, map colors, contour lines
2. Learn the basic parts of a magnetic compass
3. Understand the difference between true north and magnetic north.
4. Understand magnetic declination and how to adjust for it
5. Understand how to orient a map

Training Aids:

1. Hand magnetic compasses
2. Geologic survey topographic maps

Objective 1: Understand map symbols, map key, map scale, map colors, contour lines

Interpreting the colored lines, areas, and other symbols is the first step in using topographic maps. Features are shown as points, lines, or areas, depending on their size and extent. The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes. A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. (See pg. 354 of BSA Handbook and handouts)

Objective 2: Learn the basic parts of a magnetic compass

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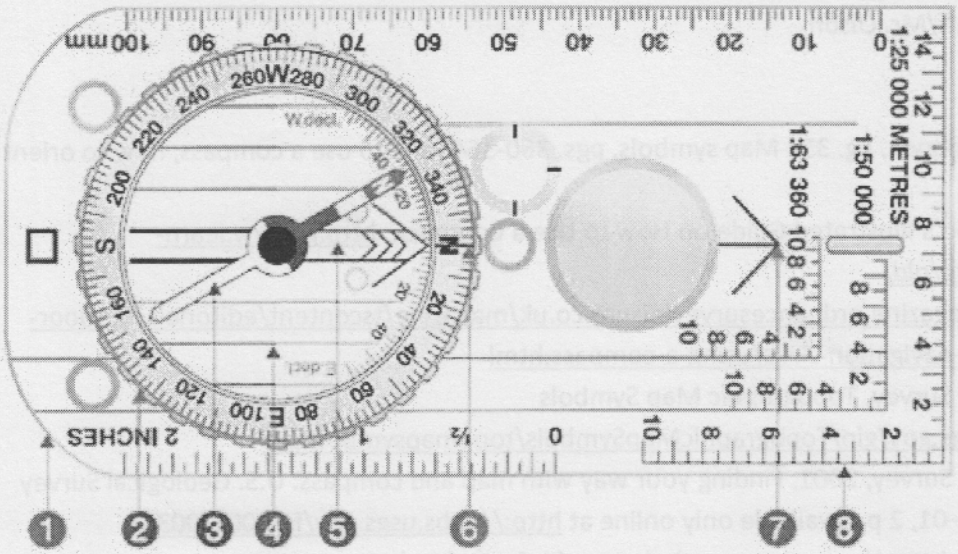
Compass features

Compasses come in many designs, but most compass features are the same as those found in an all-time classic compass like the Silva Ranger. You need to make use of some or all of the compass features for different tasks.



Before you can use a compass to navigate you need to be familiar with the main features.

1. Baseplate - the plastic base.
2. Compass housing - also known as the compass wheel, with a mark every two degrees covering 360 degrees, and N-S-E-W (the 'cardinal points').
3. Magnetic needle - red end for north, white for south.
4. Compass lines - on the bottom of the baseplate (also called 'orienting lines'.
5. Orienting arrow - fixed and aligned to north within the compass housing
6. Index line - extension of the direction of travel arrow.
7. Direction of travel arrow - the big arrow at the end of the baseplate.
8. Map scales 1:25 000, 1:50 000 and metric measurer (known as Romer scales).

The main working part of a compass is the magnetic 'needle' that floats on a central pivot. The red end always points to the Earth's magnetic north pole and the outer ring is marked with the cardinal points of the compass (N-S-E-W) and every 2 degrees. These markings are used to get bearings (the direction from where you are, to where you want to go).

If you rotate the ring to line-up the red north of the needle to the red arrow on the baseplate, a bearing can be be taken from the compass ring.

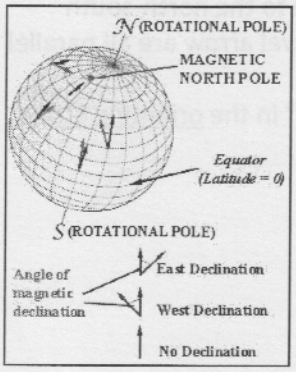
Credit: Ordnance Survey Magazine:
http://www.magazine.ordnancesurveyleisure.co.uk/magazine/tscontent/editorials/outdoor-skills/map-and-navigation-skills/using-a-compass.html

Objective 3: Understand the difference between true north and magnetic north.

There are two North Poles: the geographical (also known as True North) and the magnetic North Pole.

- True north is a constant and refers to the geographic North Pole.
- Magnetic north tends to shift and refers to the pole of the Earth's magnetic field.

The geographical pole is the point at 90° northern latitude. It is very near to the point at which the rotation axis of the earth passes through the surface. This is the North Pole that is shown on most maps. Grid lines on a map are oriented to True north. A gyroscopic compass points to true north.
The magnetic pole is the point where the magnetic field lines are vertical and enter the earth. This pole wanders around and is currently somewhere off Western Greenland. A magnetic compass points to magnetic north. To find True north and to convert a magnetic bearing to an object you have to know the *declination* (also known as *variation*) for the area where you are.

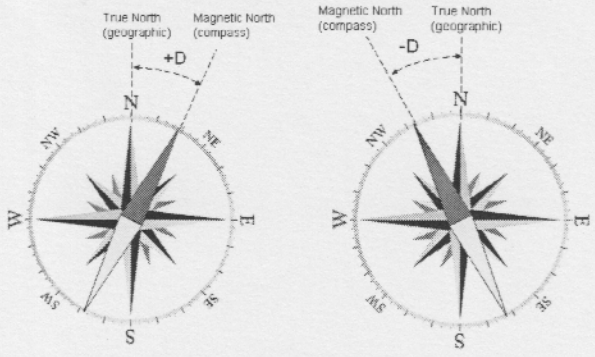


Objective 4: Understand magnetic declination (variation) and how to adjust for it

Declination is an angle that measures the difference between true north and magnetic north. The angle varies depending on where you are on the planet (because the earth's magnetic field is different in different places) and it changes over time (because the magnetic pole shifts). So you need to use an up to date map. Your map will tell you the declination. When you make your navigation calculations, you add or subtract that angle from the magnetic compass bearing numbers.

There is also something called magnetic *deviation.* Ferrous (Iron and steel) objects can influence where a magnetic compass points. If you are on a steel ship you have to correct for deviation. If you are in the field you just need to make sure you don't have ferrous objects near the compass.

By convention the declination is positive when magnetic north is east of true north, and negative when it is to the west. Memory aid: "East is least and West is best". Which means if declination is to the East (positive) you have to **subtract** to get to 000^0True from a magnetic bearing (heading) and **add** if declination is to the West (negative).



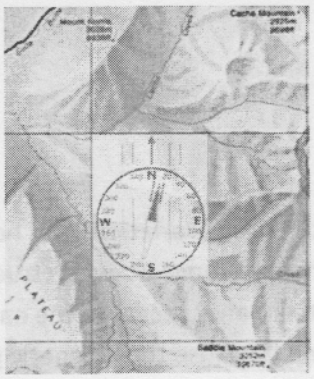
Objective 5: Understand how to orient a map

Draft: 09-14-14

A map represents the real world. By orienting a map, you are positioning it so its North is actually pointing north. When you orient a map and know where you are on the map, you can look in a certain direction and see a real landmark and find it on the map.

Orienting, or aligning, the map is really easy with just 3 steps:

- Lay your map out on a relatively flat, smooth surface.
- Turn your declination-adjusted compass dial so due North is at the index pointer.
- Place your compass on your map with the edge of the baseplate parallel to the north-south meridians on the map. Notice the orienteering lines and direction-of-travel arrow are all parallel with the map lines.
- Turn the map and compass together until the compass needle is "boxed" in the orienting arrow (**Red in the Shed**).



Now, the map is oriented to the real world. If you know where you are on the map, you should be able to look in any direction and see the objects represented on the map in the same direction.

If you know where you are on your map, you can also orient your map by distant features. If you can see a known mountain in one direction and a lake off another way, then just lay the map out and turn it so the corresponding marks on the map align with the distant features.

Credit: Compass Dude: http://www.compassdude.com/compass-map-orienting.shtml

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Finding Your Way with Map and Compass

Part of a 7.5-minute topographic map at 1:24,000 scale.

A topographic map tells you where things are and how to get to them, whether you're hiking, biking, hunting, fishing, or just interested in the world around you. These maps describe the shape of the land. They define and locate natural and manmade features like woodlands, waterways, important buildings, and bridges. They show the distance between any two places, and they also show the direction from one point to another.

Distances and directions take a bit of figuring, but the topography and features of the land are easy to determine. The topography is shown by contours. These are imaginary lines that follow the ground surface at a constant elevation; they are usually printed in brown, in two thicknesses. The heavier lines are called index contours, and they are usually marked with numbers that give the height in feet or meters. The contour interval, a set difference in elevation between the brown lines, varies from map to map; its value is given in the margin of each map. Contour lines that are close together represent steep slopes.

Natural and manmade features are represented by colored areas and by a set of standard symbols on all U.S. Geological Survey (USGS) topographic maps. Woodlands, for instance, are shown in a green tint; waterways, in blue. Buildings may be shown on the map as black squares or outlines. Recent changes in an area may be shown by a purple overprint. A road may be printed in red or black solid or dashed lines, depending on its size and surface. A list of symbols is available from the Earth Science Information Center (ESIC).

From Near to Far: Distance

Maps are made to scale; that is, there is a direct relationship, a ratio, between a unit of measurement on the map and the actual distance that same unit of measurement represents on the ground. If, for instance, 1 inch on the map represents 1 mile (which converts to 63,360 inches) on the ground, the map's scale is 1:63,360. Below is a listing of the scales at which some of the more popular USGS maps are compiled.

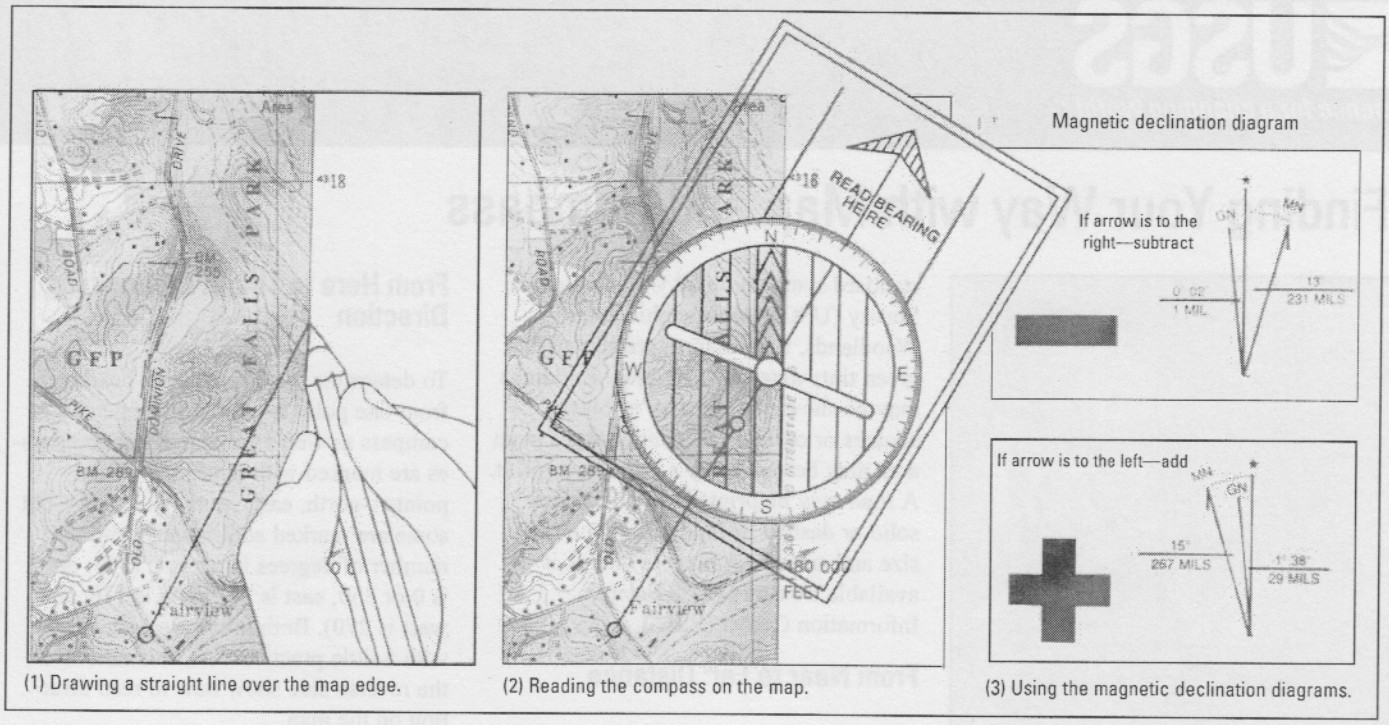
A convenient way of representing map distance is by the use of a graphic scale bar. Most USGS topographic maps have scale bars in the map margin that represent distances on the map in miles, feet, and kilometers. The table below shows the corresponding area of coverage for each scale and the linear distance that each scale represents in inches and centimeters.

From Here to There: Determining Direction

To determine the direction, or bearing, from one point to another, you need a compass as well as a map. Most compasses are marked with the four cardinal points—north, east, south, and west—but some are marked additionally with the number of degrees in a circle (360: north is 0 or 360, east is 90, south is 180, and west is 270). Both kinds are easy to use with a little practice. The illustrations on the reverse side show how to read direction on the map.

One thing to remember is that a compass does not really point to true north, except by coincidence in some areas. The compass needle is attracted by magnetic force, which varies in different parts of the world and is constantly changing. When you read north on a compass, you're really reading the direction of the magnetic north pole. A diagram in the map margin will show the difference (declination) at the center of the map between compass north (magnetic north indicated by the MN symbol) and true north (polar north indicated by the "star" symbol). This diagram also provides the declination between true north and the orientation of the Universal Transverse Mercator (UTM) grid north (indicated by the GN symbol). The declination diagram is only representational, and true values of the angles of declination should be taken from the

Map Series Name	Scale	1 inch represents	1 centimeter represents	Map area (approximate square miles)
Puerto Rico 7.5-minute	1:20,000	1,667 feet	200 meters	71
7.5-minute	1:24,000	2,000 feet	240 meters	49 to 70
7.5- by 15-minute	1:25,000	2,083	250 meters (about)	98 to 140
Alaska	1:63,360	1 mile	634 meters (about)	207 to 281
Intermediate	1:50,000	0.8 mile	500 meters (about)	County
Intermediate	1:100,000	1.6 miles	1 kilometer (about)	1,568 to 2,240
United States	1:250,000	4 miles	2.5 kilometers (about)	4,580 to 8,669



(1) Drawing a straight line over the map edge.

(2) Reading the compass on the map.

(3) Using the magnetic declination diagrams.

numbers provided rather than from the directional lines. Because the magnetic declination is computed at the time the map is made, and because the position of magnetic north is constantly changing, the declination factor provided on any given map may not be current. To obtain current and historical magnetic declination information for any place in the United States, contact:

National Geomagnetic Information Center
Phone: 303-273-8486
E-mail: jcaldwell@usgs.gov
Web site: geomag.usgs.gov

or

National Geophysical Data Center
Phone: 303-497-6826
E-mail: info@ngdc.noaa.gov
Web site: www.ngdc.noaa.gov/ or www.ngdc.noaa.gov/seg/potfld/geomag.shtml

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.

(2) Center the compass where your drawn line intersects the map border, align the compass axis N-S or E-W 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, subtract the MN value. If the arrow is to the left of the line, add the value. Then, standing on your location on the ground, set the compass so that "zero degrees or North" aligns with the magnetic north needle, read the magnetic bearing that you have determined by this procedure, and head off in the direction of this bearing to reach your destination.

A Word of Caution

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

Information

For information on these and other USGS products and services, call 1-888-ASK-USGS, use the Ask.USGS fax service, which is available 24 hours a day at 703-648-4888, or visit the general interest publications Web site on mapping, geography, and related topics at mac.usgs.gov/mac/isb/pubs/pubslists/index.html.

For additional information, visit the ask.usgs.gov Web site or the USGS home page at www.usgs.gov.

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Topographic Map Symbols

What is a Topographic Map?

A map is a representation of the Earth, or part of it. The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes.

A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce production cost.

Consequently, within the same series, maps may have slightly different symbols for the same feature. Examples of symbols that have changed include built-up areas, roads, intermittent drainage, and some lettering styles. On one type of large-scale topographic map, called provisional, some symbols and lettering are hand-drawn.

U.S. Department of the Interior
U.S. Geological Survey

Reading Topographic Maps

Interpreting the colored lines, areas, and other symbols is the first step in using topographic maps. Features are shown as points, lines, or areas, depending on their size and extent. For example, individual houses may be shown as small black squares. For larger buildings, the actual shapes are mapped. In densely built-up areas, most individual buildings are omitted and an area tint is shown. On some maps, post offices, churches, city halls, and other landmark buildings are shown within the tinted area.

The first features usually noticed on a topographic map are the area features, such as vegetation (green), water (blue), and densely built-up areas (gray or red).

Many features are shown by lines that may be straight, curved, solid, dashed, dotted, or in any combination. The colors of the lines usually indicate similar classes of information: topographic contours (brown); lakes, streams, irrigation ditches, and other hydrographic features (blue); land grids and important roads (red); and other roads and trails, railroads, boundaries, and other cultural features (black). At one time, purple was used as a revision color to show all feature changes. Currently, purple is not used in our revision program, but purple features are still present on many existing maps.

Various point symbols are used to depict features such as buildings, campgrounds, springs, water tanks, mines, survey control points, and wells. Names of places and features are shown in a color corresponding to the type of feature. Many features are identified by labels, such as "Substation" or "Golf Course."

Topographic contours are shown in brown by lines of different widths. Each contour is a line of equal elevation; therefore, contours never cross. They show the general shape of the terrain. To help the user determine elevations, index contours are wider. Elevation values are printed in several places along these lines. The narrower intermediate and supplementary contours found between the index contours help to show more details of the land surface shape. Contours that are very close together represent steep slopes. Widely spaced contours or an absence of contours means that the ground slope is relatively level. The elevation difference between adjacent contour lines, called the contour interval, is selected to best show the general shape of the terrain. A map of a relatively flat area may have a contour interval of 10 feet or less. Maps in mountainous areas may have contour intervals of 100 feet or more. The contour interval is printed in the margin of each U.S. Geological Survey (USGS) map.

Bathymetric contours are shown in blue or black, depending on their location. They show the shape and slope of the ocean bottom surface. The bathymetric contour interval may vary on each map and is explained in the map margin.

BATHYMETRIC FEATURES

- Area exposed at mean low tide; sounding datum line***
- Channel***
- Sunken rock***

BOUNDARIES

- National
- State or territorial
- County or equivalent
- Civil township or equivalent
- Incorporated city or equivalent
- Federally administered park, reservation, or monument (external)
- Federally administered park, reservation, or monument (internal)
- State forest, park, reservation, or monument and large county park
- Forest Service administrative area*
- Forest Service ranger district*
- National Forest System land status, Forest Service lands*
- National Forest System land status, non-Forest Service lands*
- Small park (county or city)

BUILDINGS AND RELATED FEATURES

- Building
- School; house of worship
- Athletic field
- Built-up area
- Forest headquarters*
- Ranger district office*
- Guard station or work center*
- Racetrack or raceway
- Airport, paved landing strip, runway, taxiway, or apron
- Unpaved landing strip
- Well (other than water), windmill or wind generator
- Tanks
- Covered reservoir
- Gaging station
- Located or landmark object (feature as labeled)
- Boat ramp or boat access*
- Roadside park or rest area
- Picnic area
- Campground
- Winter recreation area*
- Cemetery

COASTAL FEATURES

- Foreshore flat
- Coral or rock reef
- Rock, bare or awash; dangerous to navigation
- Group of rocks, bare or awash
- Exposed wreck
- Depth curve; sounding
- Breakwater, pier, jetty, or wharf
- Seawall
- Oil or gas well; platform

CONTOURS

Topographic

- Index
- Approximate or indefinite
- Intermediate
- Approximate or indefinite
- Supplementary
- Depression
- Cut
- Fill
- Continental divide

Bathymetric

- Index***
- Intermediate***
- Index primary***
- Primary***
- Supplementary***

CONTROL DATA AND MONUMENTS

- Principal point**
- U.S. mineral or location monument
- River mileage marker

Boundary monument

- Third-order or better elevation, with tablet
- Third-order or better elevation, recoverable mark, no tablet
- With number and elevation

Horizontal control

- Third-order or better, permanent mark
- With third-order or better elevation
- With checked spot elevation
- Coincident with found section corner
- Unmonumented**

CONTROL DATA AND MONUMENTS – *continued*

Vertical control

- Third-order or better elevation, with tablet — BM × 5280
- Third-order or better elevation, recoverable mark, no tablet — × 528
- Bench mark coincident with found section corner — BM + 5280
- Spot elevation — × 7523

GLACIERS AND PERMANENT SNOWFIELDS

- Contours and limits
- Formlines
- Glacial advance
- Glacial retreat

LAND SURVEYS

Public land survey system

- Range or Township line
  - Location approximate
  - Location doubtful
  - Protracted
  - Protracted (AK 1:63,360-scale)
  - Range or Township labels — R1E T2N R3W T4S
- Section line
  - Location approximate
  - Location doubtful
  - Protracted
  - Protracted (AK 1:63,360-scale)
  - Section numbers — 1 - 36 1 - 36
- Found section corner
- Found closing corner
- Witness corner — WC
- Meander corner — MC
- Weak corner*

Other land surveys

- Range or Township line
- Section line
- Land grant, mining claim, donation land claim, or tract
- Land grant, homestead, mineral, or other special survey monument
- Fence or field lines

MARINE SHORELINES

- Shoreline
- Apparent (edge of vegetation)***
- Indefinite or unsurveyed

MINES AND CAVES

- Quarry or open pit mine
- Gravel, sand, clay, or borrow pit
- Mine tunnel or cave entrance
- Mine shaft
- Prospect
- Tailings — Tailings
- Mine dump
- Former disposal site or mine

PROJECTION AND GRIDS

- Neatline — 39°15′ 90°37′30″
- Graticule tick — 55′
- Graticule intersection
- Datum shift tick

State plane coordinate systems

- Primary zone tick — 640 000 FEET
- Secondary zone tick — 247 500 METERS
- Tertiary zone tick — 260 000 FEET
- Quaternary zone tick — 98 500 METERS
- Quintary zone tick — 320 000 FEET

Universal transverse metcator grid

- UTM grid (full grid) — 273
- UTM grid ticks* — 269

RAILROADS AND RELATED FEATURES

- Standard guage railroad, single track
- Standard guage railroad, multiple track
- Narrow guage railroad, single track
- Narrow guage railroad, multiple track
- Railroad siding
- Railroad in highway
- Railroad in road
- Railroad in light duty road*
- Railroad underpass; overpass
- Railroad bridge; drawbridge
- Railroad tunnel
- Railroad yard
- Railroad turntable; roundhouse

RIVERS, LAKES, AND CANALS

- Perennial stream
- Perennial river
- Intermittent stream
- Intermittent river
- Disappearing stream
- Falls, small
- Falls, large
- Rapids, small
- Rapids, large
- Masonry dam
- Dam with lock
- Dam carrying road

RIVERS, LAKES, AND CANALS – *continued*

- Perennial lake/pond
- Intermittent lake/pond
- Dry lake/pond
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Water well, geyser, fumarole, or mud pot
- Spring or seep

ROADS AND RELATED FEATURES

Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

- Primary highway
- Secondary highway
- Light duty road
- Light duty road, paved*
- Light duty road, gravel*
- Light duty road, dirt*
- Light duty road, unspecified*
- Unimproved road
- Unimproved road*
- 4WD road
- 4WD road*
- Trail
- Highway or road with median strip
- Highway or road under construction
- Highway or road underpass; overpass
- Highway or road bridge; drawbridge
- Highway or road tunnel
- Road block, berm, or barrier*
- Gate on road*
- Trailhead*

SUBMERGED AREAS AND BOGS

- Marsh or swamp
- Submerged marsh or swamp
- Wooded marsh or swamp
- Submerged wooded marsh or swamp
- Land subject to inundation

SURFACE FEATURES

- Levee
- Sand or mud
- Disturbed surface
- Gravel beach or glacial moraine
- Tailings pond

TRANSMISSION LINES AND PIPELINES

- Power transmission line; pole; tower
- Telephone line
- Aboveground pipeline
- Underground pipeline

VEGETATION

- Woodland
- Shrubland
- Orchard
- Vineyard
- Mangrove

* USGS-USDA Forest Service Single-Edition Quadrangle maps only.
In August 1993, the U.S. Geological Survey and the U.S. Department of Agriculture's Forest Service signed an Interagency Agreement to begin a single-edition joint mapping program. This agreement established the coordination for producing and maintaining single-edition primary series topographic maps for quadrangles containing National Forest System lands. The joint mapping program eliminates duplication of effort by the agencies and results in a more frequent revision cycle for quadrangles containing National Forests. Maps are revised on the basis of jointly developed standards and contain normal features mapped by the USGS, as well as additional features required for efficient management of National Forest System lands. Single-edition maps look slightly different but meet the content, accuracy, and quality criteria of other USGS products.

** Provisional-Edition maps only.
Provisional-edition maps were established to expedite completion of the remaining large-scale topographic quadrangles of the conterminous United States. They contain essentially the same level of information as the standard series maps. This series can be easily recognized by the title "Provisional Edition" in the lower right-hand corner.

*** Topographic Bathymetric maps only.

Topographic Map Information

For more information about topographic maps produced by the USGS, please call:
1-888-ASK-USGS or visit us at http://ask.usgs.gov/

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