OKLAHOMA GEOLOGICAL SURVEY
Educational Publication 7

Reading Topographic Maps

ACTIVITIES FOR Earth Science Teachers AND Students

James R. Chaplin

This publication, printed by the Oklahoma Geological Survey, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes, 1981, Sections 231–238. 500 copies have been prepared for distribution at a cost of $4,732 to the taxpayers of the State of Oklahoma. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.

PREFACE

Why Study Topographic Maps?

The purpose of this publication is to show how to read topographic maps and use them in everyday life.

As study will make clear, map reading is important in planning and construction of airports, highways, dams, pipelines, power lines, houses, and buildings for government and business. Map-reading skills are essential for geologists, engineers, fishers, campers, and rock collectors—the list seems endless. Even genealogists use topographic maps, to locate cemeteries, abandoned post offices, ghost towns, former county lines, and farms where their great-grandparents lived.

In this publication, the main text outlines the principles of maps and mapping (with guides to resources for further study); it is intended primarily for teachers but also for students and indeed anyone interested. Next comes an array of activity sheets for students. The activities require only a topographic map, a ruler, a lead pencil, and the accompanying folder *Topographic Map Symbols* (back pocket).

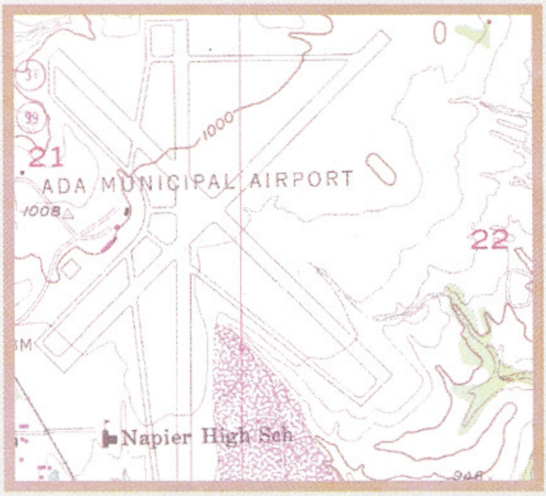
Some activities have been tailored to particular areas (among them the Oologah, Turner Falls, Bethany NE, and Ada quadrangles). However, readers in other parts of the State may find maps of their own areas more relevant, and questions and exercises provided here can be adapted, easily, to almost any geographic area and any topographic map.

Puzzles include crosswords and word searches, and their difficulty and complexity varies, thus allowing for a range of ages and grade levels. The general target is grades 6–12, but the variety of topics—map colors and symbols, contours, etc.—enable an activity to be modified as necessary.

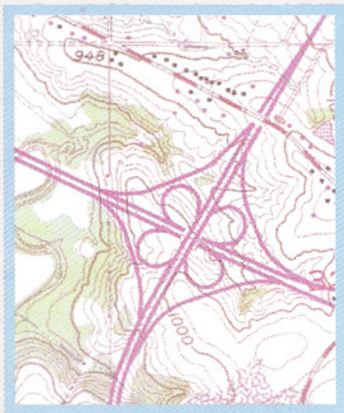
Classroom use may depend on the number and variety of maps available: students can work with a map as individuals, or as teams, and different students (or teams) can work with maps of different areas. Alternatively, some can work with maps while others devote themselves to puzzles and other exercises not requiring immediate use of a topographic map. Or a teacher may use a single map as the focus for lecture and demonstration.

James R. Chaplin

HOW ARE TOPOGRAPHIC MAPS USED?



Selecting Airport Sites



Highway Planning

Selecting Pipeline Routes

Selecting Industrial Sites

Locating Communication Facilities

Contents

Reading Topographic Maps

Activities for Earth Science Teachers and Students

James R. Chaplin
Oklahoma Geological Survey
Norman, Oklahoma

To show any part of the Earth's surface—its size and shape, and the things on it—our best tool is a map. Unlike the solid ground, a map is portable; unlike a photograph, it can be selective. Road maps, planimetric maps, thematic maps, and topographic maps serve special purposes, and we choose the one that fits our need.

Planimetric maps show boundaries, major drainage systems, roads, and buildings—but not the shape of the land.

Thematic maps emphasize specific themes such as political boundaries, soil types, population, or national forests.

Topographic maps are like planimetric maps plus contour lines, which show the shape and elevation of the terrain. These maps may concentrate more information on a sheet of paper than any other sort of map in general use: they show mountains, valleys, plains, lakes, rivers, and vegetation; they also depict artificial (manmade) works like roads, boundaries, buildings, and power lines. They show many names as well.

Maps also vary according to the scale of publication—large, medium, and small (see Table 1). Large-scale maps show more detail than those at small scale, but small-scale maps depict a larger area on the ground.

Large-scale maps, such as 1:24,000, are especially useful for highly developed areas, or for rural areas where detailed information is needed for purposes such as construction. Medium-scale maps, such as 1:62,500, may be adequate for rural areas if few details are required. Small-scale maps, such as 1:250,000, depict large areas on a single sheet and are useful for regional planning.

In general, 7.5-minute quadrangle maps (1:24,000) are the most useful of the large-scale maps, and in this guide we will use as an example one 7.5-minute quadrangle map published by the United States Geological Survey (USGS). First we'll look for information about the map itself and a few basic tools for using it, and then discuss the tools in more detail; finally we'll turn to the map and learn to read what it says about the land.

TABLE 1.—USGS Map Series and Their Essential Characteristics

Series	Scale	1 inch represents	Standard quadrangle size[a]	Map area (approx. sq. mi.)	Paper size[b] (inches)
7.5-minute	1:24,000	2,000 feet	7.5 × 7.5′	49–70	22 × 27[c]
15-minute	1:62,500	~1 mi	15 × 15′	197–282	17 × 21[c]
U.S. 1:250,000	1:250,000	~4 mi	1° × 2°	4,580–8,669	34 × 22[d]
U.S. 1:1,000,000	1:1,000,000	~16 mi	4° × 6°	73,734–102,759	27 × 27

Note: Modified from U.S. Geological Survey (Anonymous, 1969).
[a]Latitude × longitude.
[b]East–west (width) by north–south (length).
[c]South of latitude 31°, 7.5-minute sheets are 22 × 27 inches; 15-minute sheets are 18 × 24 inches.
[d]North of latitude 42°, sheets are 29 × 22 inches. Alaska sheets are 30 × 23 inches.

Starting Out

Let's suppose you live in Oologah, Rogers County, Oklahoma, and want to learn about land use in your area. A good place to begin is *Oklahoma—Index to Topographic and Other Map Coverage,* published by the USGS (see Appendix 1 and back pocket). It consists primarily of index maps, notably one showing all the State's 77 counties and the hundreds of 1:24,000-scale maps with the name of each. Near Oologah on the index map is the word OOLOGAH—the name of the quadrangle you want—and instructions for buying a copy.

On first consulting any map, begin with information in the margin of the sheet. There you'll find the map's title, the location of the area depicted, the scale of publication, who did the mapping and how, and when the map was published. (Throughout this discussion, refer to Figures 1 and 2, and consult the Glossary as necessary.)

Name.—The title of our quadrangle is found in the upper right-hand corner: "Oologah Quadrangle," further identified as in "Oklahoma—Rogers County" and "7.5 Minute Series (Topographic)" (Fig. 2). As with other quadrangles, this one has been named for a prominent place in the map area.

In the lower right-hand corner of the map sheet, the quadrangle is reidentified as "Oologah, Okla.," together with the date of original publication (1970) and "photorevised 1980" (Fig. 1). (Other lines here give in abbreviated form the latitude and longitude, and a key to the Defense Mapping Agency.)

Location.—Also in the lower right-hand corner is a small outline map of Oklahoma, with a black rectangle locating the Oologah quadrangle (Fig. 2). Close to the edge of the main map, names of adjoining quadrangles appear (in parentheses), such as the Winganon at the northeast corner (Fig. 2), the Claremore at the southeast corner (Fig. 1), and so on around.

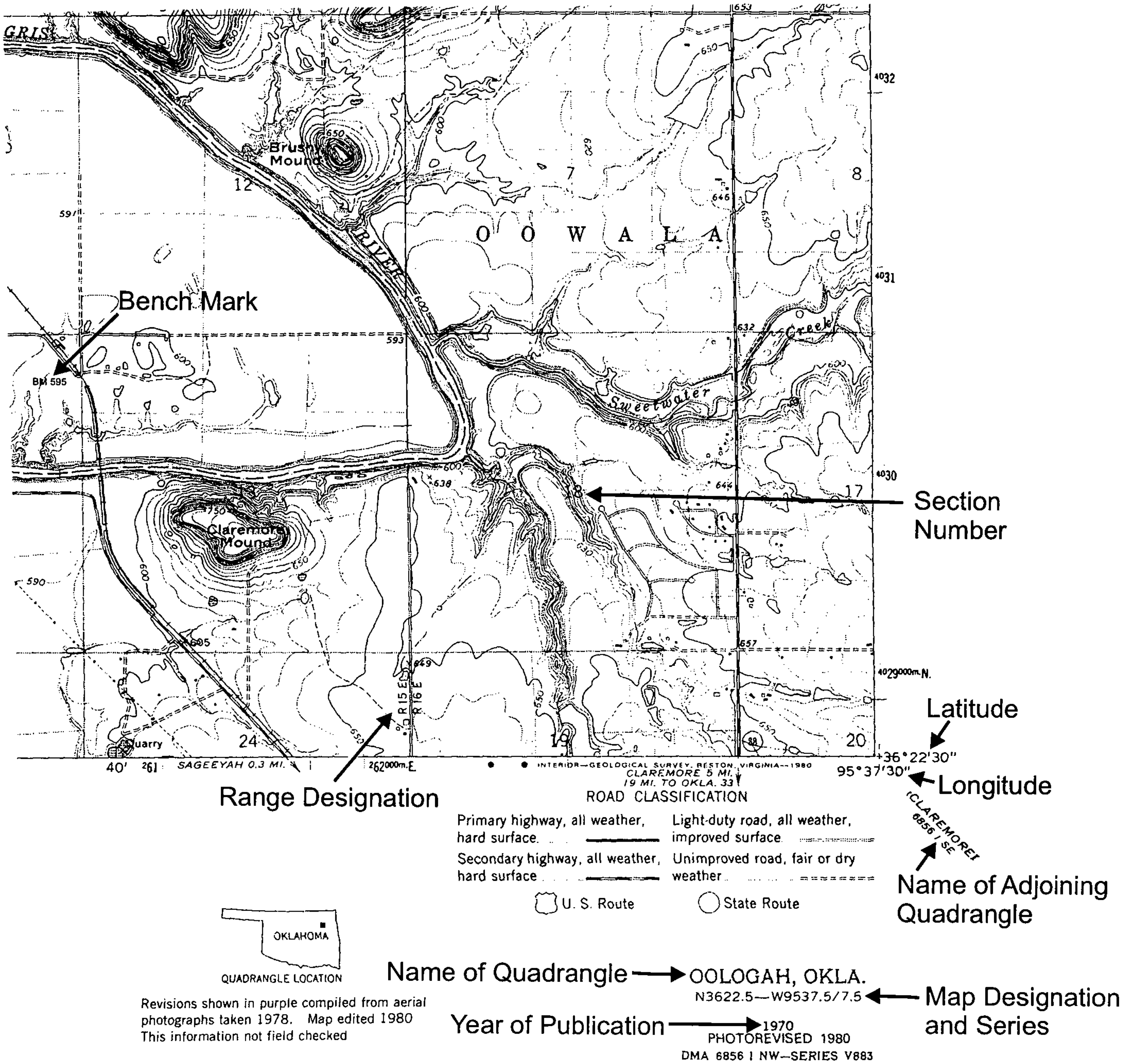


Figure 1. Information in the margin of U.S. Geological Survey topographic quadrangle maps includes latitude and longitude (at map corners) and aids to finding sections, townships, and ranges. (See also Figs. 3–6.) Note the benchmarks and their elevation, as "BM 595."

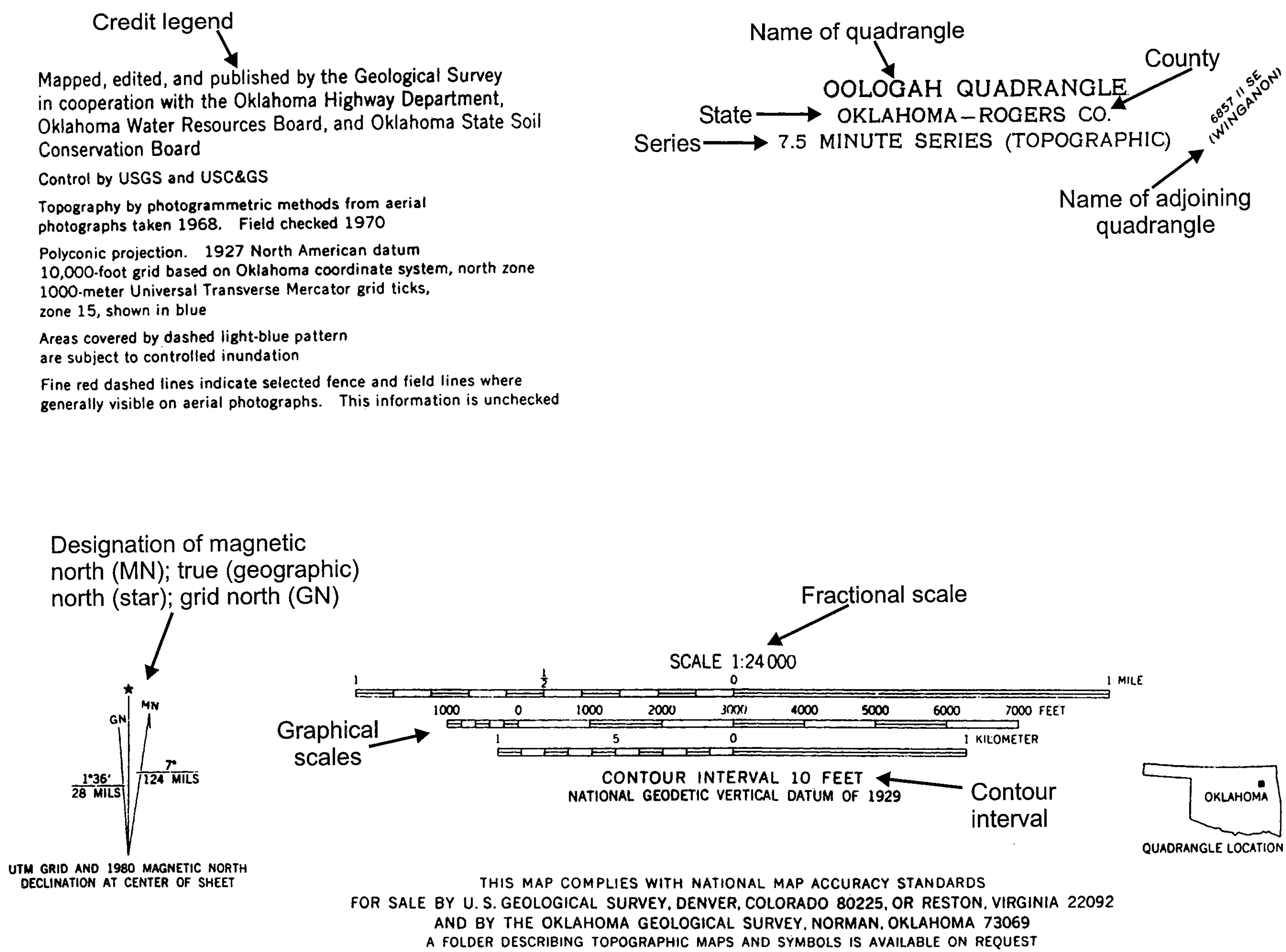


Figure 2. Information in the margin of a map sheet includes the map name, a declination diagram, and fractional and graphical scales.

Scale.—At bottom center of the sheet is the map scale, given both as a ratio (here 1:24,000) and also as bar scales in miles, feet, and kilometers, and then the contour interval (10 feet). Beneath the bar scales is a note about the datum base and another specifying the accuracy standards used, and then names of places where copies of the map are sold.

Coordinates.—At each corner of the map appear coordinates of latitude and longitude, specifying (in this example) that the northeast corner of the Oologah quadrangle lies at latitude 36°30′N, longitude 95°37′30″ west. (This designation is abbreviated; see discussion below.)

Direction.—Near the lower left-hand corner is a declination diagram: the line marked with a star points true north (or geographic north); the arrow marked MN points to magnetic north; the arrow GN points to grid north. The angles shown are called declinations, and they enable use of a compass in field work with this map.

Credits.—At the upper left-hand corner of the map sheet is the name of the publisher, here the U.S. Geological Survey, Department of the Interior. The map was produced in cooperation with another government agency; for the Oologah quadrangle, credit goes to the State of Oklahoma. At lower left is a list of agencies responsible for various aspects of mapping, editing, and publishing; also, miscellaneous technical details.

Details.—At lower right (above the quadrangle name) appears the scheme for describing road surfaces.

Supplementing the latitude and longitude as given at corners of the map, intermediate numbers are shown at tick marks a third of the way along each side. On the right side of the Oologah map they read 27′30″ and 25′ (a reader must check the corners and supply the degree numbers). In effect, these intermediate marks divide the map into nine smaller quadrangles, making it easier to find a given point—or to describe it.

Also close to the map but in the margin, Public Land Survey coordinates are printed in red, examples here being "T. 23 N." (on the right-hand side) and "R. 16 E." (near the upper-right corner); these are township and range lines, which will be discussed below.

At lower left are credits for various aspects of mapping and publication: as on the map at hand, credits usually name the mapping agency and the publisher, then add information about mapping methods and standards.

So much for basics; now for more detail, beginning with compass direction.

Finding Your Way

All maps use a true-north meridian for orientation, and almost all maps have true north at the top—the true-north meridian being a line pointing toward the North (geographic) Pole.

However, a compass needle points toward the magnetic pole, which does not coincide with the geographic pole. Nor does it stay in one place, but is constantly drifting. Thus the declination varies from time to time and from place to place. (For the topographic maps considered here, the figure for the angle is obtained from the U.S. Coast and Geodetic Survey.) In Figure 2, the magnetic declination is the angle between the star (true north) and MN (magnetic north).

Magnetic north can be either east or west of true north. When true north and magnetic north lie in exactly the same direction, the declination is zero. (The line of zero declination passes through Lake Michigan and off the west coast of Florida.) East of the zero declination line, a compass needle points west of true north; this is "westerly declination." West of the same line, a compass needle points east of true north; this is "easterly declination."

If you were using a compass in West Texas, the needle would point about 10° east of true north. In Maine, it might point about 20° west of true north.

Maps and directions are usually based on true north, so it is usually best to set your compass to read true north—especially when in the field and plotting data on a base map. (For Brunton and similar compasses, the declination is easily changed by rotating a slotted screw in the side of the case.)

Scale

Map scale is the ratio of the distance between two points on the map and the same two points on the ground. It is usually expressed as a ratio, as in 1:24,000 for the Oologah quadrangle, or as a fraction, 1/24,000.

The fraction, or representative fraction (R.F.), can be used for any measure you like, as long as the units of numerator and denominator are the same. The numerator (usually 1) represents a map distance; the denominator, the ground distance. Thus scale 1:24,000 means that any unit on the map, such as 1 inch, represents 24,000 inches on the ground. Or, 1 foot on paper represents 24,000 feet in the field.

(For units of measure in the English and metric systems, and how to convert from one to the other, see Appendix 2.)

Another way to relate map distance to ground distance is by a graphical scale—a diagram illustrating the units of distance on the map. On topographic maps, the most common form is the bar scale. Use it like this: First, measure the length of a feature on the map. For a straight line, marks on the edge of a sheet of paper will do; for a curved line such as a stream, try fitting a piece of string along the blue line. Second, lay the paper or string alongside the bar scale and read off the distance. If the scale is given in words it's called a verbal or stated scale. For example, "1 inch equals 24,000 inches." Or "1 inch equals 2,000 feet." Or "1 inch equals 0.61 kilometers."

Latitude and Longitude

To help find (or specify) a point, most topographic maps use a coordinate or grid system, usually latitude and longitude. By international agreement, the Earth's surface is divided by a series of grid lines, north–south and east–west.

The north–south lines are called lines of longitude (abbreviated long), or meridians; they represent segments of arc on the Earth's equator and are measured in degrees, minutes, and seconds. The line of zero longitude—Earth's prime meridian—passes through Greenwich, England. All other longitude lines are measured as east or west of the prime meridian to the 180° line of longitude. (The 180° line lies mostly in the Pacific Ocean, and corresponds very roughly to the International Date Line.) All meridian lines converge from the equator toward the North and South Poles (Fig. 3).

East–west lines of the grid system are called parallels of latitude (abbreviated lat); they circle the globe parallel to the equator. The equator lies at 0° latitude, dividing the Earth into the Northern and Southern Hemispheres; from there northward the number of degrees rises to 90°N at the North Pole—and southward toward 90°S at the South Pole.

Everywhere, parallels of latitude run true east and west, parallel each other, and lie about 70 miles apart. The grid system enables us to designate any point on the globe with two numbers. Degrees are only the beginning: for greater precision, a degree may be divided into 60 minutes (or 60′), and a minute into 60 seconds (or 60″). Thus the northeastern corner of Oklahoma may be described as lat 36°59′55″N, long 94°37′04″W.

A position given in latitude and longitude may be located on a map by measuring along the left or right side to the specified latitude and along the top or bottom to the specified longitude. East–west and north–south lines drawn through those two points will intersect at the position described. However, you may have to measure the distance between degree marks, divide by 60 to obtain the map distance per minute, and so interpolate the latitude (or longitude) required.

In plotting positions in latitude and longitude, note that (1) every latitude in North America is North, and that the figure for degrees rises as you move northward; (2) every longitude in North America is West, and the

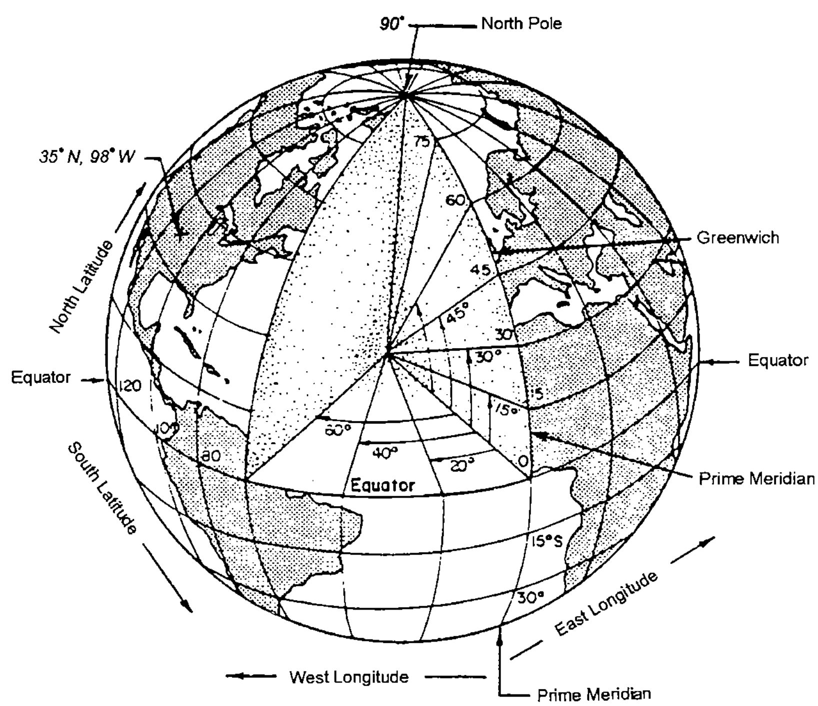


Figure 3. Here's how latitudes and longitudes relate to the Earth's surface (modified from Thomson, 1980).

figure for degrees increases as you move westward; (3) the length of a degree of latitude (always measured north–south) is 60 nautical miles (a nautical mile equals 1 degree of arc at the equator, or 6,076.1 feet, thus 60 nautical miles is slightly more than 69 statute miles; (4) the length of a degree of longitude is 60 nautical miles only at the equator—toward either Pole the actual length shortens progressively. That is why standard topographic quadrangles in the United States, although measuring 7.5 minutes of latitude by 7.5 minutes of longitude, are not square but rectangular. And yet they are not true rectangles, for the meridians at their east and west sides converge slightly toward the North Pole. Inspect closely the corners of the Oologah map: the north side is shorter than the south.

A standard quadrangle map published by the USGS is called a 7.5-minute quadrangle. Among other series published by the USGS are 15-minute quadrangles; a few older maps are 30-minute quadrangles. (See Table 1.)

Metes and Bounds

In the Atlantic Coast States and some others, including Kentucky and Texas, land has been surveyed by metes and bounds: the surveyor selected a point on the perimeter of a parcel of land—say a prominent tree or outcrop of rock, and traced a line around the property, recording the progress as x units of distance along compass bearing y until the property line changed direction, whereupon the procedure began anew. The process was repeated until the survey line returned to the original point. Metes and bounds proved unsatisfactory because the points of reference change or disappear (trees die, rock erodes, streams change course). Old measurements were often inexact, and sometimes the magnetic declination was incorrect or not used at all.

Plots surveyed by metes and bounds often have irregular shapes, and boundaries seldom follow cardinal directions. Those areas are easily identified by road patterns, which elsewhere tend to reflect the rectangular grid of township and range.

Township and Range

For the purpose of locating property lines and land descriptions in legal documents, another system is used in most states and in some parts of Canada. It originated on April 26, 1785, when a committee headed by Thomas Jefferson produced a plan adopted by the Continental Congress. Ever since, the public land of 30 states has been surveyed by townships and ranges—the Land Office Grid System. (A different system is used by the original 13 states plus Kentucky, Tennessee, Texas, and in Indiana's Vincennes area and Clark and Floyd Counties.)

The Land Office Grid System is tied into the latitude and longitude grid system, but it functions independently. Under it, a region is subdivided by north–south lines and east–west lines. Convenient parallels of latitude (east–west lines) are chosen for base lines, and convenient meridians of longitude (north–south lines) become principal meridians (Fig. 4). The region is then marked off into north–south strips called ranges, each exactly 6 miles wide, east and west of each principal meridian. Next the same region is marked off into east–west strips, north and south of each base line. The squares in the resulting grid are called townships, each township being 6 miles on a side and covering 36 square miles. (See Fig. 4.)

Ranges are numbered east and west from their principal meridian. The first subdivision east of a principal meridian is designated Range 1 East (R. 1 E.); the second, Range 2 East (R. 2 E.) and so on. The first subdivision to the west is Range 1 West (R. 1 W.), etc. Townships are numbered likewise north and south of the base line, the first to the north being called Township 1 North (T. 1 N.), etc.

In Oklahoma (excluding the Panhandle; see Fig. 5) the base line is at lat 34°30′N., a line passing through Davis, Sulphur, and Duncan. Townships north of the base line are designated T. 1 N., T. 2 N., etc. The principal meridian is the Indian Meridian, at long 97°15′W.; it passes just west of Pauls Valley. Townships east of the Indian Meridian are designated R. 1 E., R. 2 E., etc. This numbering of townships and ranges usually ends at the state line.

Every state using this survey system is divided into squares called townships, each 6 miles on a side. Each township is likewise divided into 36 sections, with section lines between them. (For the method of numbering sections within a township, see Fig. 5.) Each section consists of 640 acres; a half section, 320 acres, and so on down (Fig. 6). Thus a point may be designated as SW¼NE¼SE¼ sec. 3, T. 7 N., R. 2 W., which is read aloud as "the southwest quarter of the northeast quarter of the southeast quarter of section 3, Township 7 North, Range 2 West." Figures 5 and 6 show legal descriptions using this method of location, a system almost always used also in designating localities of fossils, minerals, wells, buildings, and so on.

The Rectangle Method

Less accurate but much faster is the rectangle method of location. It calls for dividing a quadrangle into nine rectangles based on the

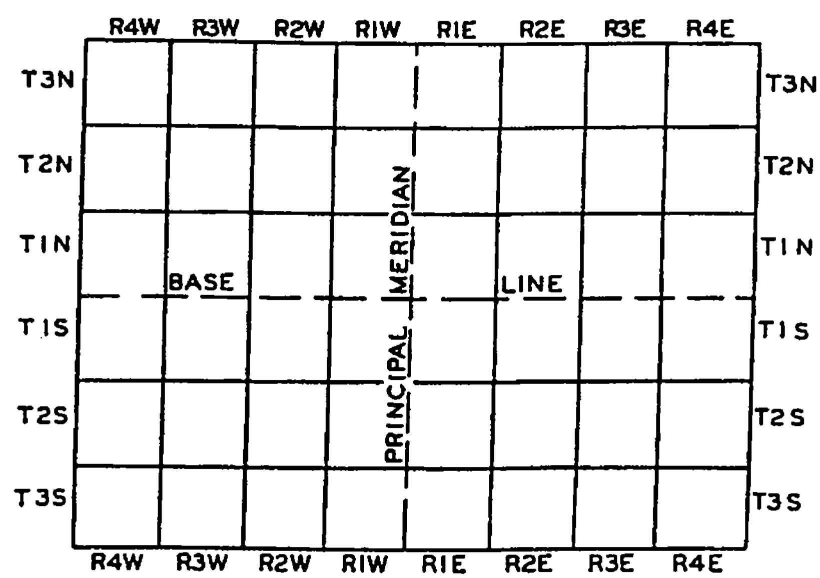
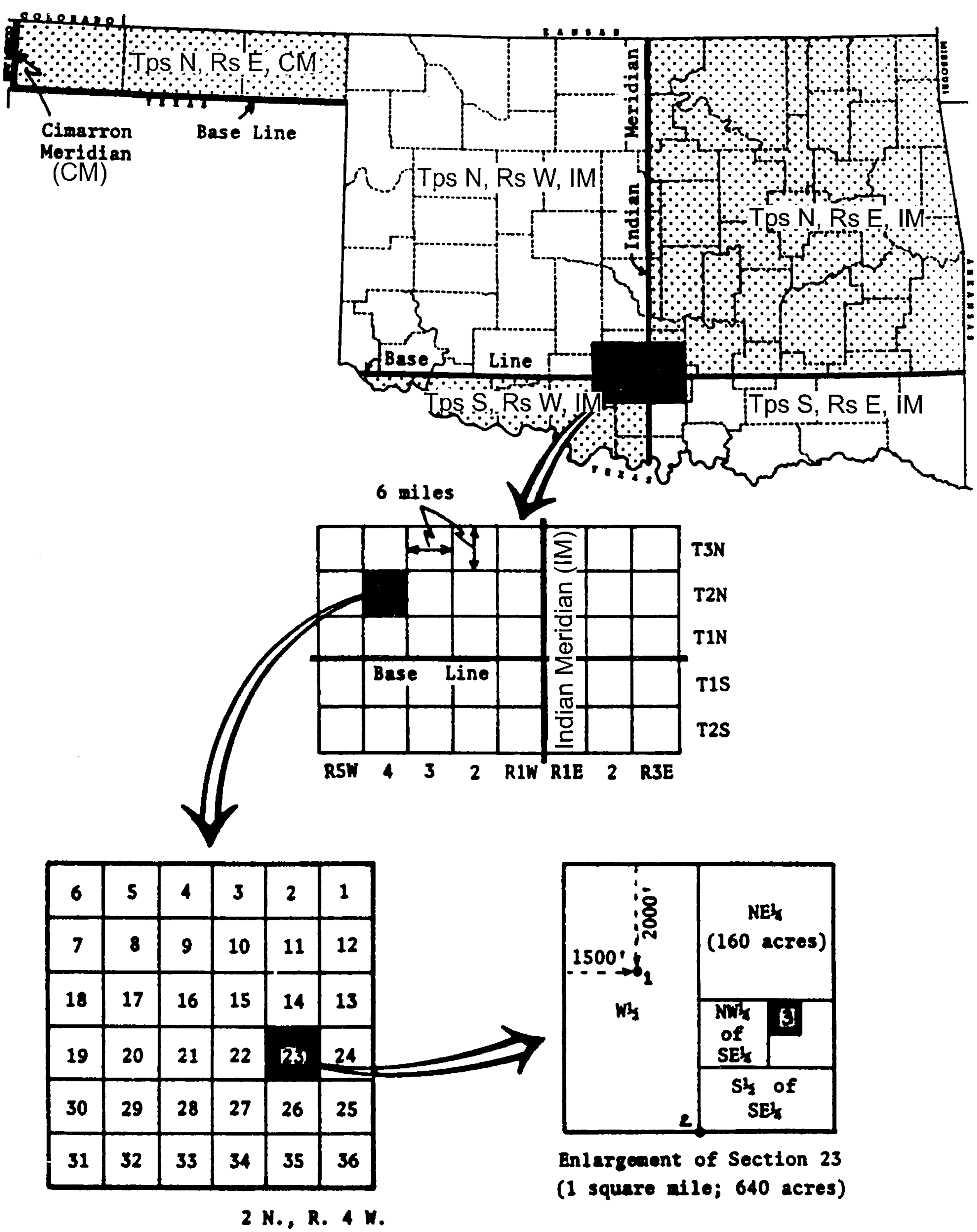


Figure 4. How townships and ranges are numbered.

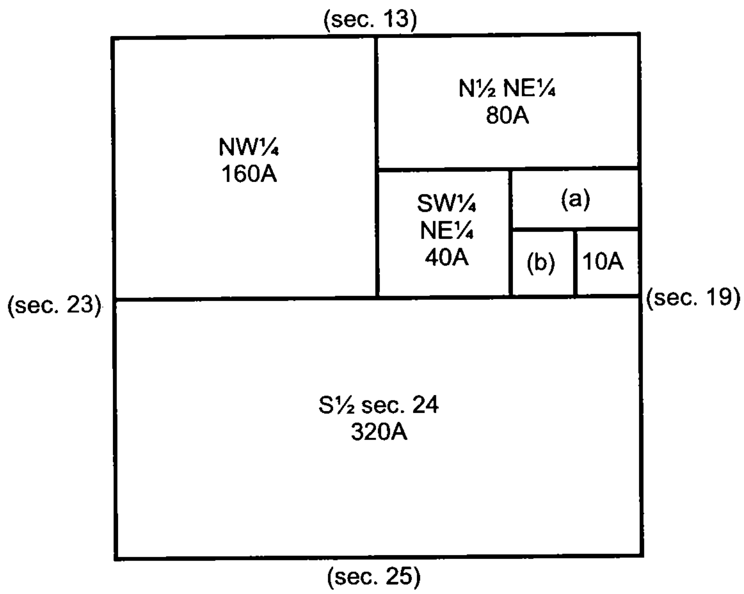


1- 1500'E & 2000'S NW cor. sec. 23, T. 2 N., R. 4 W.

2- south ¼ cor. sec. 23, T. 2 N., R. 4 W.

3- NW¼ NE¼ SE¼ sec. 23, T. 2 N., R. 4 W.

Figure 5. These land subdivisions by the Bureau of Land Management are used in surveying and mapping the State of Oklahoma. At lower right, see legal descriptions of three land parcels.



(a) N½ SE¼ NE¼ sec. 24, 20A
(b) SW¼ SE¼ NE¼ sec. 24, 10A

Figure 6. This is how a section is subdivided. (A = acres.)

intermediate (or "fractional") lines of latitude and longitude as noted along the margins of the map. The rectangles are numbered or lettered as shown in Figure 7. (For greater precision, the process may be repeated on the smaller rectangles.) To express a location, the number of the largest unit is given first, then the next smaller, etc. Thus in Figure 7, point *Y* is reported as 5,6; on the Oologah quadrangle, 5,6 might be used to find a quarry.

Another technique uses letters, calling the nine rectangles NW (northwest), NC (north central), NE (northeast), WC (west central), C (central), EC (east central), SW (southwest), SC (south central), and SE (southeast). Thus in Figure 8 point *Z* is at NE¼SE¼—the northeast quarter of the southeast quarter; on the Oologah map NE¼SE¼ would do for Lipe Mound.

The Shape of the Land

Now that we can find points and describe locations, what can we see on a topographic map? We may find features classified as culture—works such as roads, boundaries, and buildings; water—lakes, rivers, and swamps; and relief—hills, valleys, and plains.

Several devices help show such things. Color, lines, shapes, and symbols are important in the interpretation of a topographic map. Symbols make up a graphic language: their shape, size, location, and color all have meaning. Some symbols are pictographs, resembling the objects they represent; others, like contour lines, are abstractions and help show a third dimension—shape and elevation of the terrain—on flat paper. For

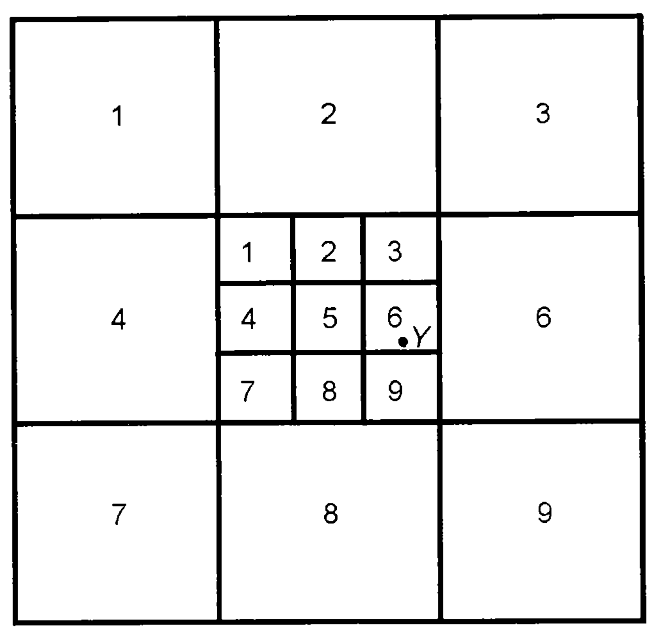


Figure 7. In the rectangle method of location (from Huffman, 1955), point *Y* is at 5,6.

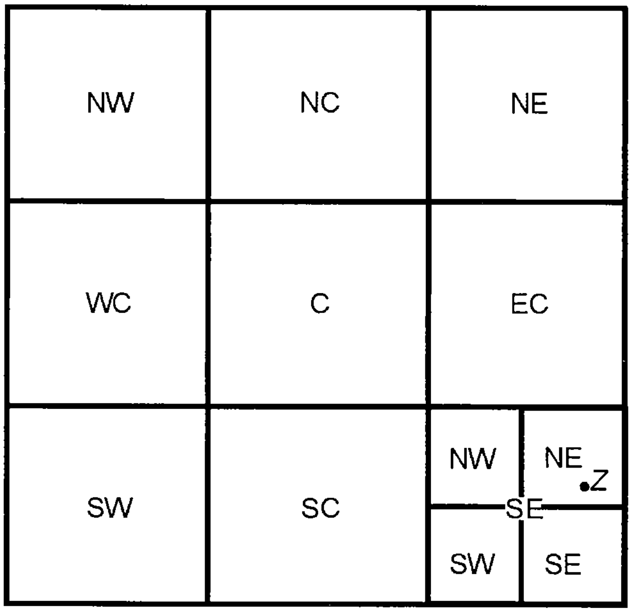


Figure 8. In another method of location (from Huffman, 1955), point *Z* is at NE¼SE¼—the northeast quarter of the southeast quarter.

standard symbols used by the U.S. Geological Survey, see the folder *Topographic Map Symbols* (back pocket).

Colors are basic, and six are standard. Black is used for artificial features like roads, buildings, place names, and political boundaries. Blue means water—streams, lakes, canals, glaciers. Green marks wooded areas, with patterns for vineyards and orchards. Red distinguishes main roads, built-up urban areas, and property lines. Purple (a recent addition to the color list) is used on maps being revised. Brown is used for most contour lines, which depict the shape and elevation of the land surface.

Much depends on elevation, defined as the vertical distance of a point above a reference plane (usually mean sea level, or M.S.L. (Fig. 9). "Spot elevations" are given on a map for many points such as crossroads, hilltops, and lake levels (rounded off to the nearest foot or meter). Bench marks are located more precisely and measured more accurately, being brass plates permanently fixed in the ground. On a map, a bench mark is marked by a cross with the elevation, printed in black (Fig. 1) with a phrase like "BM 595"—meaning "Bench mark, 595 feet" ("above mean sea level" is implied; see the vertical datum noted near the graphical scale.)

Height refers to the difference in elevation between the top of an object (e.g., hill or tower) and its base (Fig. 9); surface relief is the difference in elevation between the highest point of land and the lowest on the map or in the area concerned (Fig. 9).

Contours

A topographic map is distinguished by its contour lines and their depiction of the shape and elevation of the land surface. A contour line

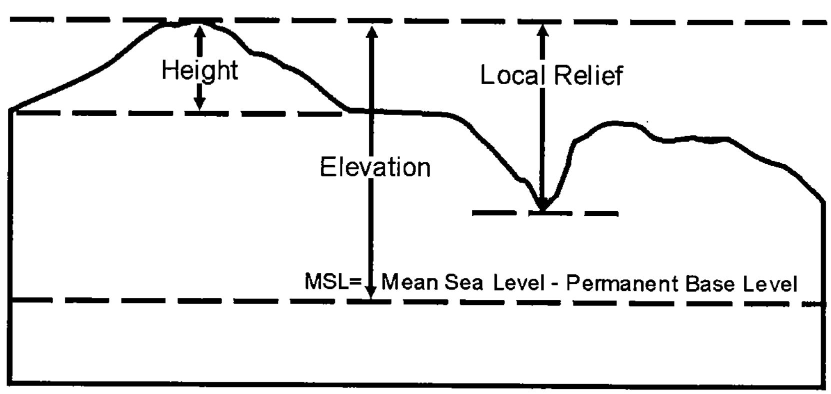


Figure 9. This cross section illustrates the terms relief, height, and elevation (modified from Thomson, 1980).

is an imaginary line connecting points of equal elevation. Or it may be described as the trace of the intersection of a level plane and the ground. Thus any shoreline amounts to a contour, its elevation being the same as the water level.

On maps like the Oogolah quadrangle, nearly all contour lines are brown. Index contours—every fifth line—are heavier than the others, and at intervals the elevation is printed at a break in the index contour.

The contour interval, or vertical distance between successive lines, is usually constant for a given map; the interval may range from 5 feet on a plain to 100 feet in mountains.

Consider these general rules:

1. Contour lines for land are brown; those under water are blue.

2. Every fifth contour line is thicker than the others, and its elevation is shown at breaks in the line.

3. Along any contour line, all points lie at the same elevation.

4. Every contour line closes on itself, even though it may continue into an adjacent map.

5. Contour lines generally do not intersect or cross, for no one point can lie at two elevations. However, a vertical cliff, as shown on a map, or as seen from directly above, has different elevations that appear as a single point; in that case, printed contours may merge. Similarly, an overhanging cliff may be shown with crossing contour lines.

6. Closed contours forming rough circles or irregular ellipses represent hills or knobs (Fig. 10).

7. Closed contours with hachures—short lines pointing downslope—represent closed depressions such as sinkholes, strip pits, and quarries (Fig. 11). Unless otherwise marked,

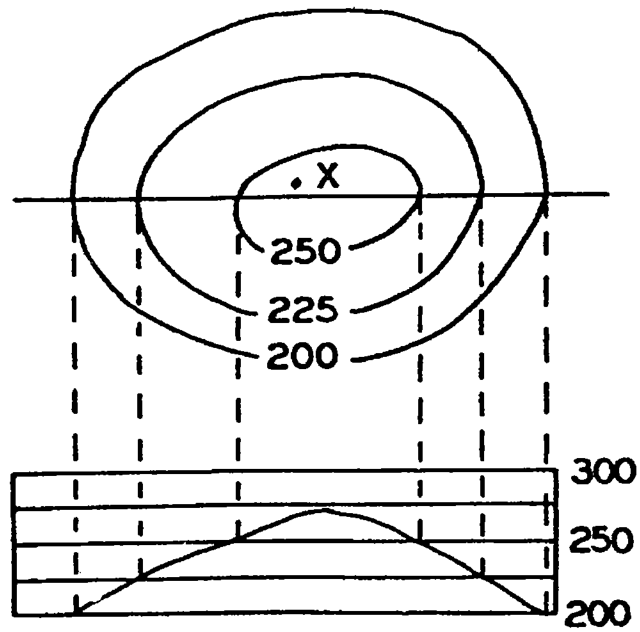


Figure 10. The elevation of a hill can be determined by counting the closed contours (from Huffman, 1955). Here the contour interval is 25 feet; the elevation of hill *X* is >250 feet but <275 feet.

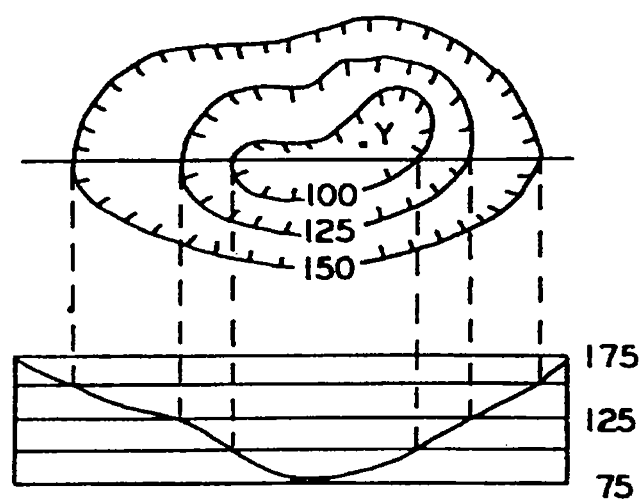


Figure 11. Here the elevation at the bottom of depression *Y* is determined by counting the closed contours (from Huffman, 1955). The elevation at *Y* is >75 feet but <100 feet.

the elevation of the outermost hachured contour line is the same as that of the nearest unhachured contour. The contour interval is the same as for contour lines without hachures.

8. To determine the elevation of a hill (its vertical distance above sea level), begin with the highest closed contour on the hill. Unless the entire hilltop is level, the summit is higher than that contour but not high enough to attain another one. Therefore the elevation of the hill marked *X* in Figure 10 is greater than 250 feet (>250 feet) but less than 275 feet (<275 feet).

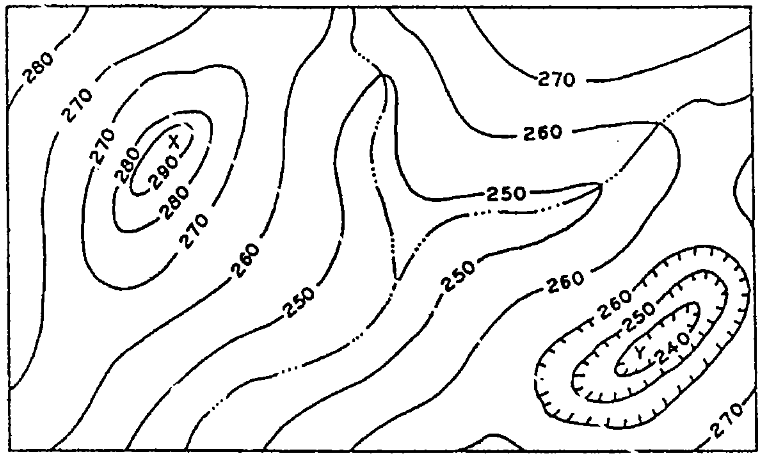


Figure 12. The problem here is to determine the height of a hill and the depth of a depression (from Huffman, 1955). The height of hill *X* is >20 feet but <30 feet. The depth of the depression *Y* is also >20 feet but <30 feet. (Each has the same number of closed contours.)

9. The elevation at the bottom of a depression is determined in the same way: the innermost closed contour must be higher than the bottom, but lower than the next lower contour would show. Thus the elevation of *Y* in Figure 11 is >75 feet but <100 feet.

10. To determine the height of a hill, add up the intervals of its closed contour lines (not the contours themselves, but the intervals between them). As neither the top of a hill nor its base lies directly on a contour, the depth must be greater than the intervals plus one interval at top and one at the bottom, or N+2 intervals. (If in doubt, see the map sheet—just beneath the bar scales—for the contour interval or C.I.) Thus the height of hill *X* in Figure 12 is >20 feet but <30 feet.

11. The depth of a depression, too, is determined by summing the contour intervals involved. As neither the bottom of the depression nor its rim lie exactly on a contour line, the depth must be greater than the total intervals but less than one more interval at rim and one at bottom (N+2 intervals). Thus the depth of depression *Y* in Figure 12 is >20 feet but <40 feet.

12. Hill and valley contours go in pairs: the same contour elevation is encountered once in going down a hill, and once again going up the hill on the other side.

13. Steepness of slope is indicated by the horizontal spacing of successive contour lines. Contours on steep slopes are spaced closely; contours on gentle slopes are spaced widely. That's assuming the map scale and contour interval are the same in both cases (Fig. 13).

14. Where contour lines cross a watercourse, they make Vs pointing upstream (Fig. 14).

In Figure 14, each lettered arrow points toward the low side of the contour it crosses.

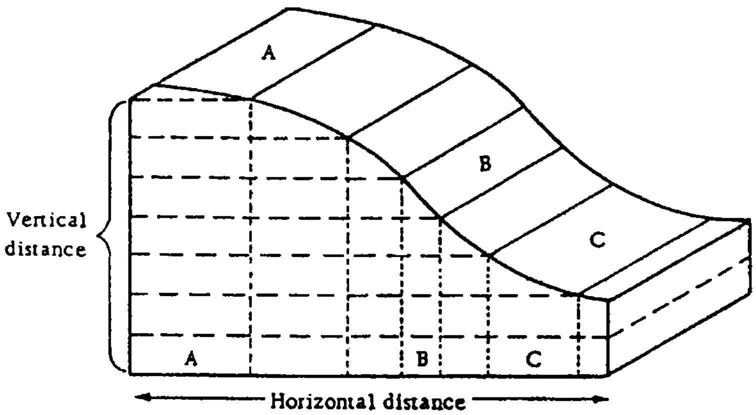


Figure 13. The diagram shows the relationship of slope to spacing of contour lines (from Romey and others, 1967). Although vertical spacing between contours (the contour interval) is constant, horizontal spacing is uneven. In a flat area (A), contour lines are few; on a steep slope (B) they are closely spaced; on a gentle slope (C) the spacing is wide.

Arrow A—The arrow crosses the contour line at 440 feet but points to the contour at 420 feet, which is lower. Arrow B—Where the contour crosses the stream, its V shape points upstream. Arrow C—Land within the closed contour is on the high side. Arrow D—To move toward water is to move downhill. Arrow E—Hachures are on the downhill side of the depression contour.

Observations after studying Figure 14: (1) The contour interval is 20 feet. (2) The closed contour *(C)* appearing as a rough circle represents a hill. (3) The elevation of the depression contour *E* is 500 feet. (4) The elevation of *A*'s arrowhead is >420 feet but <440 feet. (5) The elevation of *D*'s arrowhead is >380 feet but <400 feet. The general slope of the land is uniform, for the contour spacing is uniform.

Now you have all the basic tools for exploring the world via topographic maps. To dig deeper, see the glossary, bibliography, and appendixes. The activity sheets will give you examples and practice.

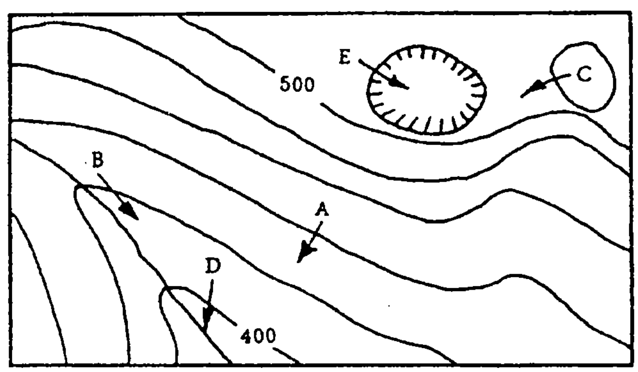


Figure 14. These contour lines show how to recognize direction of slope (from Romey and others, 1967).

BIBLIOGRAPHY

Anonymous, 1969, USGS principal map series and their essential characteristics: U.S. Geological Survey, 2 p.

Anonymous, 1981, Map scales: U.S. Geological Survey, 2 p.

Anonymous, 1987, Finding your way with map and compass: U.S. Geological Survey, folded sheet.

Anonymous, undated (a), Oklahoma—index to topographic and other map coverage: U.S. Geological Survey, folded map.

Anonymous, undated (b), Topographic map symbols: U.S. Geological Survey, 4 p.

Anonymous, undated (c), Topographic mapping: U.S. Geological Survey, 20 p.

Anonymous, undated (d), Using maps in genealogy: U.S. Geological Survey, 12 p.

Berg, J. R.; and Blythe, J. G., 1969, General geology laboratory manual: Kendall-Hunt, Dubuque, Iowa, 124 p.

Bhatt, J. J., 1966, Laboratory manual on physical geology: Stanfield, Guymon, Oklahoma, 67 p.

Chaplin, J. R.; Falls, W. R.; Lynd, B. H.; and Philley, J. C., 1963, Laboratory manual for college physical science: Wm. C. Brown, Dubuque, Iowa, 389 p.

Hamblin, W. K.; and Howard, J. D., 1989, Exercises in physical geology: Macmillan, New York, 191 p.

Huffman, G. G., 1955, A laboratory syllabus in physical geology: Bardgett, St. Louis, Missouri, 127 p.

Lyon, E. E.; Dillon, L. I.; Dooley, M. T.; and Krutak, P. R., 1971, Earth science manual: Wm. C. Brown, Dubuque, Iowa, 218 p.

Romey, W. D.; Kramer, J. R.; Muller, E. H.; and Lewis, J. R., 1967, Investigations in geology: Wm. C. Brown, Dubuque, Iowa, 282 p.

Steger, T. D., 1986, Topographic maps: U.S. Geological Survey, 27 p.

Thomson, K. C., 1980, An introduction to map reading: Missouri Speleology, v. 20, nos. 3–4, 70 p.

Zumberge, J. H.; and Rutford, R. H., 1983, Laboratory manual for physical geology: Wm. C. Brown, Dubuque, Iowa, 187 p.

GLOSSARY

altitude—see *elevation.*

bar scale—A line or bar on a map sheet, marked off at regular intervals to show how the distance between two points on the map relate to the same distance as measured on the ground. (See Figure 2.) Also called graphical scale. See *map scale.*

base line—In surveying, an east–west line specified as the base for measuring distances to its north and south; it corresponds to a line of latitude. (See Figures 4 and 5.)

bathymetry—The measurement of water depths, which are depicted on maps as blue contour lines under water.

bench mark—A surveyor's marker (often a metal disk set into rock) with precisely determined altitude above mean sea level. On a topographic map, its position is shown at "BM 595"—meaning "bench mark 595 feet above sea level."

boundary—A line marking the limits of a piece of property, or a county, city, state, etc.

contour—A line on a map connecting all points of a certain elevation on the ground mapped. If a flood raised the level of Oologah Lake to 730 feet above sea level, its shoreline would follow the 730-foot contour on the topographic map. Also called contour line, or elevation contour. (See Figures 9–12.)

contour interval—The vertical difference in elevation between any contour line and the next contour higher or lower.

control data—Measurements selected as the beginning points for further measurements in a mapped area, such as the elevation of a bench mark (vertical control), or its precise latitude and longitude (horizontal control).

coordinates—Often a pair of numbers designating lines north–south and east–west: the pair describes the point where the lines intersect. Alternatively, coordinates may specify a starting point, a compass direction, and a distance. See *latitude* and *longitude.*

datum—A reference system used as a standard for measuring or calculating distances, positions, and directions. A commonly used vertical datum is the National Geodetic Vertical Datum of 1929, used as a base in establishing elevations. A horizontal datum is usually based on latitude and longitude.

declination—On a topographic map, magnetic declination—the angle between magnetic north (as indicated by a compass needle) and true or geographic north. In the Northern Hemisphere, magnetic declination may be easterly or westerly.

depression—A sunken area on the Earth's surface, with no outlet for surface drainage. Examples are sinkholes, strip mines, quarries, and the inner surface of volcanic cones.

depression contour—A contour with *hachures* on the inner or downslope side.

DMA—The U.S. Defense Mapping Agency.

elevation, *or* **altitude**—The vertical distance that a point (say a hilltop) lies above a reference plane (usually mean sea level).

found corner—A starting point in the course of a survey; useful mainly to surveyors.

fractional scale—See *map scale.*

geographic north (GN)—Toward the North Pole, as established by the Earth's axis of rotation. (See Figure 3.) See *magnetic north.*

graphical scale—See *bar scale.*

grid north—North as indicated by lines of longitude.

hachures—A series of short lines or dashes, used to indicate the direction and steepness of a slope. On a steep slope they are short, heavy, and closely spaced; on a gentle slope, lighter and widely spaced.

horizontal control—See *control data.*

index contour—A contour line printed thicker and darker than other contour lines, and labeled with its elevation; usually every fifth contour is an index contour.

International Date Line—Where the calendar day begins, at a line in the Pacific Ocean very roughly following the 180° meridian of longitude.

isogonic chart—A map with lines connecting points of equal magnetic declination on the Earth's surface. These charts, produced and updated by the U.S. Coast and Geodetic Survey, are consulted during revision of a topographic map. See *declination.*

land grant—A distribution of public lands by the U.S. government, common in the 19th century as an encouragement to settlers, railroads, and state universities. Modern surveys often depend on records of old land grants.

Land Office Grid System—See *Public Land Survey System.*

latitude—The angular distance (in degrees and minutes etc.) that a point lies north of the equator (assuming the point is in the Northern Hemisphere). Every latitude is an east–west line. (See Figure 3.)

longitude—The angular distance (in degrees etc.) a point lies west of the Greenwich meridian in England (assuming the point is in the Western Hemisphere). Lines of longitude converge to a point at the North geographic Pole. (See Figure 3.)

magnetic declination—See *declination.*

magnetic north (MN)—In the direction of the north magnetic pole, northwest of Hudson Bay—roughly lat 77°N, long 102°W.

map scale—The relationship of two distances, one between two points on a map (or photo), and the other the same two points on the ground. On a 7.5 Minute Series topographic map as published by the U.S. Geological Survey, the scale is expressed as 1:24,000; it is also shown graphically, as a bar scale. (See Figure 2.)

Mercator projection—One of many schemes for depicting the spherical Earth on flat paper. A Mercator projection is accurate only near the equator; northward, distortion grows progressively, and Greenland appears far larger than its true area.

meridian—A "great circle" passing through the Poles and a given point on the Earth's surface—a line of longitude.

metes and bounds—The description of a parcel of land by length and direction of each line along its boundary as traversed by the surveyor.

monument—A physical marker, often of stone, marking an important survey point, and intended to be permanent. Roughly, a prominent bench mark.

National Geodetic Vertical Datum of 1929—A reference surface set up by the U.S. Coast and Geodetic Survey, the "mean sea level of 1929."

National Map Accuracy Standards—Established by the U.S. Office of Management and Budget, intended to reduce inconsistencies in maps produced by various Federal agencies.

nautical mile—A "sea mile": one minute of arc on a great circle of the Earth (see meridian), equal to 1,852 meters or 6,076.11549 feet. Or 1.15 statute miles—"statute mile" being the full name of the everyday mile.

North American Datum 1983—One of several control standards used in making topographic maps.

photogrammetry—Surveying and mapping by means of aerial photographs—the basis of photorevision of topographic maps.

polyconic projection—Yet another attempt to show a round Earth on a flat surface; this one is based on a series of flattened cones, stressing those that least distort the areas preferred.

prime meridian—Longitude 0°, the meridian at Greenwich. (See Figure 3.)

principal meridian—A line of longitude chosen as a north–south reference line for a regional survey. (See Figures 4 and 5.)

Public Land Survey System, *or* **Land Office Grid System**—The system of townships and ranges used in surveying most of the United States.

quadrangle—An area unit used in mapping, four sided and bounded by parallels of latitude and meridians of longitude. Curvature of the Earth prevents their being quite square; see corners of the Oologah quadrangle map.

range—A strip of land lying between a pair of meridian lines 6 miles apart; it makes a column of townships each 6 miles square. (See Figure 4.)

relief—The difference in elevation of two points on the land. Local relief refers to hills and nearby valleys; total relief means the difference between the highest point in an area (or on a map) and the lowest.

scale—See *map scale.*

section—Usually a mile-square subdivision of a township. (See Figure 5 for the numbering scheme.)

spot elevation—The elevation of a specific point not on a printed contour. In general use, a spot elevation is marked with an x or sawbuck and a number indicating height above sea level. The point may be a hilltop, town site, stream fork, crossroads, and the like.

stated scale—Map scale in words, such as "one inch on the map equals 24,000 inches on the ground" (1:24,000). Also called verbal scale.

statute mile—See *nautical mile.*

thematic map—A map stressing a single aspect (or a very few) such as geology, population, or rainfall.

topographic contour—The term merely stresses the role of contours in depicting topography—the shape and elevation of the land surface.

township—In map use, most often a quadrangle 6 miles on a side, one of an east–west row lying parallel to a base line. (See Figure 5.) Note that "township" is also used for a governmental subdivision of a county; in the southeast corner of the Oologah quadrangle, see "OOWALA"—Oowala Township.

true north—See *geographic north.*

Universal Transverse Mercator (UTM)—A military grid system, noted on map margins to help correlate maps produced by different agencies.

verbal scale—See *stated scale.*

vertical control—See *control data.*

witness corner—A point marked on a map as especially useful to surveyors establishing a legal description.

APPENDIX 1.—Sources of Maps

Every state, including Oklahoma, has an index that shows the topographic maps and other maps available for that state. The index shows the names of all 7.5′ topographic maps in its state. Indexes are free upon request from the map agencies listed below; the maps must be purchased. Maps must be ordered by quadrangle name.

OKLAHOMA MAPS

Walk-in purchases:
Oklahoma Geological Survey
Publication Sales
1218-B W. Rock Creek Road
Norman, Oklahoma
(405) 360-2886

Mail orders:
Oklahoma Geological Survey (main office)
Energy Center
100 E. Boyd St., Room N-131
Norman, Oklahoma 73019–0628
fax: 405-366-2882
(405) 325-3031; (800) 330-3996
e-mail: ogssales@ou.edu

Products:

1. Oklahoma—Index to topographic maps and other map coverage. Free upon request.
2. 7.5′ topographic quadrangle maps of Oklahoma.
   (1 inch on the map = 0.4 mile on the ground). Nominal charge each, plus postage per order. Contact the Oklahoma Geological Survey for current pricing.
3. 1:100,000-scale metric topographic maps of Oklahoma.
   (1 cm on the map = 1 km on the ground; 1 inch = 1.6 miles). 10-meter contour interval. Nominal charge each, plus postage per order. Contact the Oklahoma Geological Survey for current pricing.

REGIONAL MAPS

U.S. Geological Survey Map Sales
Box 25286
Federal Center, Building 810
Denver, Colorado 80225
(888) ASK-USGS
Web site: http://www.usgs.gov

Products:

1. Colorado, Wyoming, Montana, Texas, and states westward—Index to topographic and other map coverage. Free upon request.
2. 7.5′ topographic quadrangle maps. Nominal charge each, plus shipping and handling per order. Contact the U.S. Geological Survey for current pricing.

APPENDIX 2.—English and Metric Systems

ENGLISH UNITS

12 inches	=	1 foot
3 feet	=	1 yard
1 mile	=	1,760 yards, 5,280 feet, 63,360 inches
1 square mile	=	640 acres

METRIC UNITS

10 millimeters	=	1 centimeter
100 centimeters	=	1 meter
1,000 meters	=	1 kilometer

TO CONVERT ENGLISH UNITS TO METRIC UNITS

If you know	Multiply by	To find
inches	2.54	centimeters
feet	30.48	centimeters
yards	0.91	meters
miles	1.61	kilometers

TO CONVERT METRIC UNITS TO ENGLISH UNITS

If you know	Multiply by	To find
millimeters	0.04	inches
centimeters	0.4	inches
meters	3.28	feet
meters	1.09	yards
kilometers	0.62	miles

APPENDIX 3.—Internet Resources

Of the World Wide Web's resources for learning about topographic maps, this selection is only a beginning.

http://mapping.usgs.gov/

By the U.S. Geological Survey. See especially the links under "General Information" and "For Parents, Teachers, and Students."

http://www.usgs.gov/education/

For grades K–12. See "Adventures in the Learning Web," and under "Teaching in the Learning Web" the index of lessons and activities.

http://mapping.usgs.gov/mac/findmaps.html

How to find and order topographic maps from the 70,000 or so by the U.S. Geological Survey.

http://mapping.usgs.gov/digitalbackyard/

General information on topographic maps.

http://www.epa.gov/ceisweb1/ceishome/

Click on the compass star to bring up the Atlas page; then go to "Learn About Maps and Data." By the U.S. Environmental Protection Agency.

http://www.geo.ed.ac.uk/agidict/

This dictionary of geography is by the Association of Geographic Information and the University of Edinburgh.

http://geography.about.com/education/geography/

In column one of the home page, see the entries "Cartography" (which links to sections on map scales and measuring distances on maps), "GIS and GPS" (Geographic Information Systems and the Global Positioning System), "Latitude and Longitude," and "Topographic Maps" (finding, reading, and using).

http://uiowa.edu/homepage/search/

Search for the Center for Global and Regional Environments, where "Maps and References" yields many hundred links to other Web sites.

http://www.ed.gov/pubs/parents/Geography/

"Helping Your Child Learn Geography," by the U.S. Department of Education, aims at children aged 5 to 10.

http://www.wsanford.com

This, a high-school teacher's Web site, includes a detailed exercise in Global Positioning System Navigation. The exercise requires both a GPS unit and a portable computer.

http://www.omnimap.com/suremap.htm

This is a commercial source of digital U.S. Geological Survey topographic quadrangles. The maps can be downloaded.

http://mac.usgs.gov/isb/pubs/booklets/usgsmaps/usgsmaps.html/

Here's another introduction to topographic maps by the U.S. Geological Survey, and also its geologic maps, photoimagery, hydrology, and the National Atlas.

http://geonames.usgs.gov/

The Geographic Names Information System: about one screen down, click on "United States and Territories," which links to "Query Form." There, enter (for example) "Oologah" to see a list of place names each with its state, county, feature type, and other pertinent information.

Activity Sheets for Map Readers

Your own geographic area may be the key to exciting interest in interpreting topographic maps. Some of the activity sheets accompanying this discussion involve the Ada, Bethany NE, Oologah, and Turner Falls quadrangles, but they—like all the exercises—are easily adapted to other maps and other areas. See Appendix 1 for sources of maps.

Other activities include crossword puzzles, word searches, matching problems, and "geodetective" puzzles in geography. All are intended to help students understand topographic maps and their use; among the topics are map data, colors and symbols, contour lines, and location of features. The level of difficulty and complexity is deliberately varied, the object being to ease the adaption to variations in ability natural among any group. In general, the range is grades 6 to 12.

Materials required: A topographic quadrangle map, a ruler, a lead pencil, and the folder *Topographic Map Symbols* (back pocket).

Any sheet may be reproduced or modified as needed for individual classroom use only.

1

Jump-Start

Here's how to become expert in reading topographic maps: first thing, with each map, answer as many questions as you can in the check list below. Don't worry if you can't answer them all—just try again next time, and with every map go farther down the list.

1. What is the quadrangle's name?
2. Is it a 7.5-minute quadrangle? Or a 15-minute quadrangle?
3. The quadrangle area lies in what general part of the state?
4. In what county?
5. What is the magnetic declination in the map area? When was it measured?
6. What is the contour interval?
7. Find the latitude and longitude at the southeast corner.
8. What quadrangle map borders this one on the north? East? South? West? Northeast? Southeast? Southwest? Northwest?
9. What is the map's fractional scale?
10. Express the fractional scale as a verbal scale, first in miles—then in kilometers.
11. When was the map published?
12. Has it been photorevised? When?
13. Find the elevation of the highest point in the quadrangle.
14. Find the elevation of the lowest point.
15. What is the total relief within the quadrangle?
16. How many sections appear on the map?
17. What is the area of the quadrangle in square miles?
18. Find the latitude at the exact center of the quadrangle.

1 Jump-Start (continued)

19. Find the longitude at the exact center of the quadrangle.
20. What parallel—or latitude line—marks the northern boundary?
21. The southern boundary?
22. What meridian—or longitude line—marks the eastern boundary?
23. The western boundary?
24. What is the distance—in degrees, minutes, and seconds—from the northern boundary to the southern?
25. Find the distance—again in degrees, minutes, and seconds—from the western boundary to the eastern.

2

Symbols to Features

Draw a line connecting each map symbol with the feature it represents.

FEATURES

School

Church

Cemetery

Quarry

Depression

Campground, picnic area

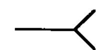
Gravel, sand, clay pit

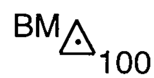
Small dwelling place (house)

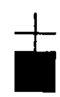
Bench mark

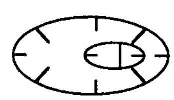
Mine tunnel or cave entrance

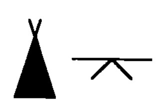
MAP SYMBOL











3

Meaning of Colors—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the page.

Across

3. The symbol on a topographic map indicates a ______________.
4. Contour lines are shown in the color_______________ .
7. The symbol BM$\triangle_{100}$ indicates a point of known elevation and position with the _____________ given to the nearest foot.
8. The symbol indicates an ____ ____ or quarry.
10. The color _________ emphasizes important roads, built-up urban areas, and property lines.
11. The symbol — ··· — ··· shown in blue indicates an intermittent _____.
12. __________ basic colors are used for different classes of map features.
15. The symbol shown in brown represents a feature with an intricate surface area such as a ______ _____.
16. A mine tunnel or ______ ______ is shown by this symbol: ⤙
17. ___________ are used to show streets, buildings, streams, and vegetation.

Down

1. Artificial features, such as buildings, are shown in the color ______.
2. Wooded areas and orchards are shown in the color ____________ on a topographic map.
4. Water features are shown in the color ________.
5. Green is used to show _________.
6. Individual ________________ are usually shown as small black squares.
9. The symbol ------------ could indicate a _________.
13. Recent changes on an updated map are shown in the color ________________.
14. The symbol † Cem indicates a _______.

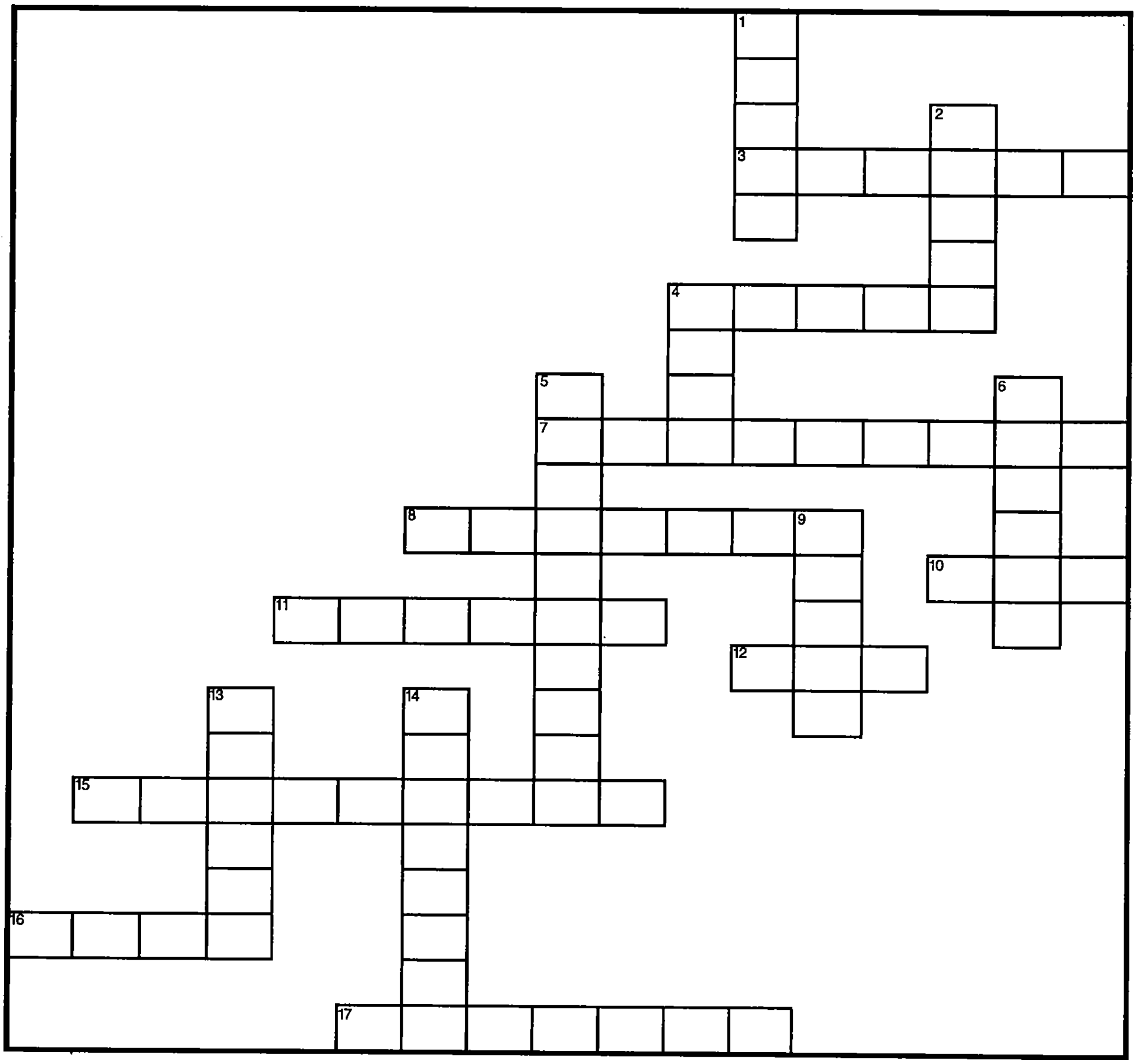
BLACK
BLUE
BROWN
CAVE
CEMETERY

CHURCH
ELEVATION
GREEN
HOUSES

OPEN PIT
PURPLE
RED
SIX

STREAM
STRIP MINE
SYMBOLS
TRAIL
VEGETATION

❸ Meaning of Colors—crossword puzzle (continued)



3

Meaning of Colors—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

S	H	C	R	U	H	C	B	M	E	V	A	C	B	R	O	W	B	D
L	C	A	L	B	U	L	A	T	R	A	N	R	R	S	E	M	E	C
O	L	B	V	L	U	A	V	E	L	E	W	G	U	T	L	R	R	E
B	M	E	C	E	L	E	V	A	T	I	O	N	H	R	P	V	E	M
M	N	E	E	R	G	P	N	E	P	O	R	A	C	E	R	F	T	E
Y	K	C	A	L	B	E	R	U	H	C	B	E	H	X	U	I	S	T
S	S	U	L	B	L	U	T	R	A	A	M	R	I	U	P	V	E	G
T	E	C	M	S	U	O	H	A	B	E	S	S	A	N	E	L	E	L
R	S	E	N	I	M	P	I	R	T	S	T	R	E	A	M	O	I	M
E	U	G	R	E	M	E	C	E	H	I	R	P	S	L	B	A	S	Y
I	O	P	I	R	T	S	R	E	B	R	O	W	Y	E	R	R	T	S
S	H	V	A	C	M	Y	S	E	E	R	G	N	M	T	P	R	U	P

BLACK
BLUE
BROWN
CAVE
CEMETERY
CHURCH
ELEVATION
GREEN
HOUSES
OPEN PIT
PURPLE
RED
SIX
STREAM
STRIP MINE
SYMBOLS
TRAIL
VEGETATION

4

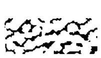
Map Language—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the next page.

Across

6. The angular difference between directions to the north magnetic pole and to the true or geographic pole is called the ____________ declination.
7. In Oklahoma (not including the Panhandle), the ________ _________ is at latitude 34°30′N, a line passing through Davis, Sulphur, and Duncan.
11. Certain meridians of longitude (north–south lines) in the Land Office Grid System are called ____________ meridians.
13. Every fifth contour line—an index contour—is printed heavier than the others and bears the ____________ above sea level.
14. North–south strips called ____________ are 6 miles wide, and lie east and west of the principal meridian.
16. For purposes of locating property lines and land descriptions in legal documents, a system of ________________, used in most states, is called the Land Office Grid System (LOGS).
18. Each township is divided into 36 _____ of land, each 1 mile square.
19. Abbreviation used in the symbol for bench mark (plural).
21. Zero degrees (0°) latitude is at the __________.
22. Contours are widely spaced on _______________ slopes.
23. ______________ refers to the difference in elevation between the top of an object (a hill, tower, etc.) and its base.

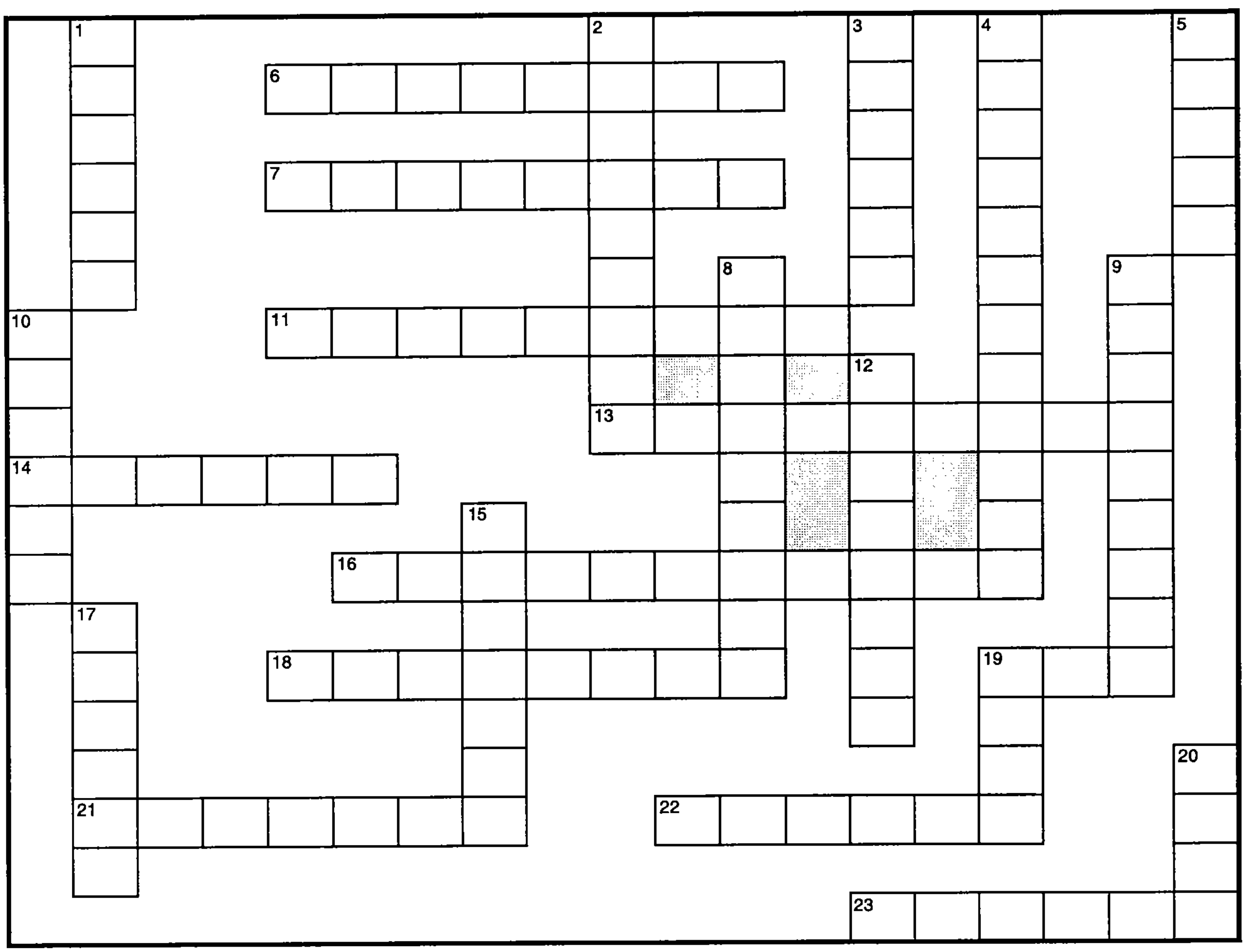
Down

1. The contour interval is determined by the ____________ of an area.
2. The symbol  shown in brown on a topographic map indicates a __________ _________.
3. Artificial features on new or revised maps are shown in _____.
4. Brown is used for ___________ ____________.
5. The relationship between a distance on the map and the true distance on the ground is called the map ___________________.
8. In the LOGS, certain parallels of latitude (east–west lines) are called ____ _____.
9. East–west strips called _______________, exactly 6 miles wide, are numbered north and south of base lines.
10. The symbol  indicates a ____________.

4 Map Language—crossword puzzle (continued)

Down

12. East–west grid lines dividing the Earth's surface are called parallels of ____________.
15. The difference in elevation between adjacent contour lines is called the ____________ interval.
17. The top of a hill is usually ____________ than the highest closed contour line.
19. Water features are shown in the color ____________.
20. ____________ elevations, often noted at road intersections and on hilltops, are usually accurate within the nearest foot or meter.



BASE LINE
BASE LINES
BLUE
CHURCH
CONTOUR
CONTOUR LINES
COORDINATES
ELEVATION
EQUATOR
GENTLE
HEIGHT
HIGHER
LATITUDE
MAGNETIC
PRINCIPAL
PURPLE
RANGES
RELIEF
SCALE
SECTIONS
SPOT
STRIP MINE
TOWNSHIPS

4

Map Language—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

M	E	A	L	B	E	G	T	O	W	N	S	H	I	P	S	R	E	C	M	U	R
B	A	S	E	L	I	N	E	S	I	C	E	E	R	L	A	O	H	O	C	U	A
B	I	E	R	U	N	O	T	C	I	C	C	I	A	S	T	U	Y	N	O	A	N
H	D	T	O	E	T	E	U	A	Q	E	T	H	P	C	E	R	A	T	P	S	G
I	O	A	M	A	R	C	H	L	A	T	I	T	U	D	E	A	N	O	M	U	E
G	E	N	T	L	E	A	R	E	A	P	O	N	R	R	E	O	I	U	B	Y	S
H	T	I	O	I	N	O	Q	U	L	E	N	B	P	U	C	E	N	R	O	M	E
E	Y	D	P	U	T	B	E	M	U	E	S	Q	L	O	R	H	G	L	E	L	A
R	J	R	O	E	L	S	A	I	G	A	V	N	E	J	U	E	N	I	T	O	S
T	N	O	E	T	N	G	O	S	C	N	E	A	T	S	E	I	E	N	U	Q	Y
O	S	O	D	E	N	L	A	U	E	Q	U	A	T	O	R	G	N	E	I	V	E
B	A	C	S	E	O	N	E	U	B	L	S	E	D	I	A	H	D	S	I	S	R
E	R	Q	T	U	E	P	O	R	E	L	I	E	F	R	O	T	U	N	L	A	D
P	R	I	N	C	I	P	A	L	B	I	C	N	E	R	S	N	A	Y	A	H	O
I	C	D	O	C	S	T	R	I	P	M	I	N	E	R	E	D	I	T	O	Y	P

BASE LINE	COORDINATES	LATITUDE	SCALE
BASE LINES	ELEVATION	MAGNETIC	SECTIONS
BLUE	EQUATOR	PRINCIPAL	STRIP MINE
CHURCH	GENTLE	PURPLE	TOWNSHIPS
CONTOUR	HEIGHT	RANGES	
CONTOUR LINES	HIGHER	RELIEF	

5

More Map Words—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the page.

Across

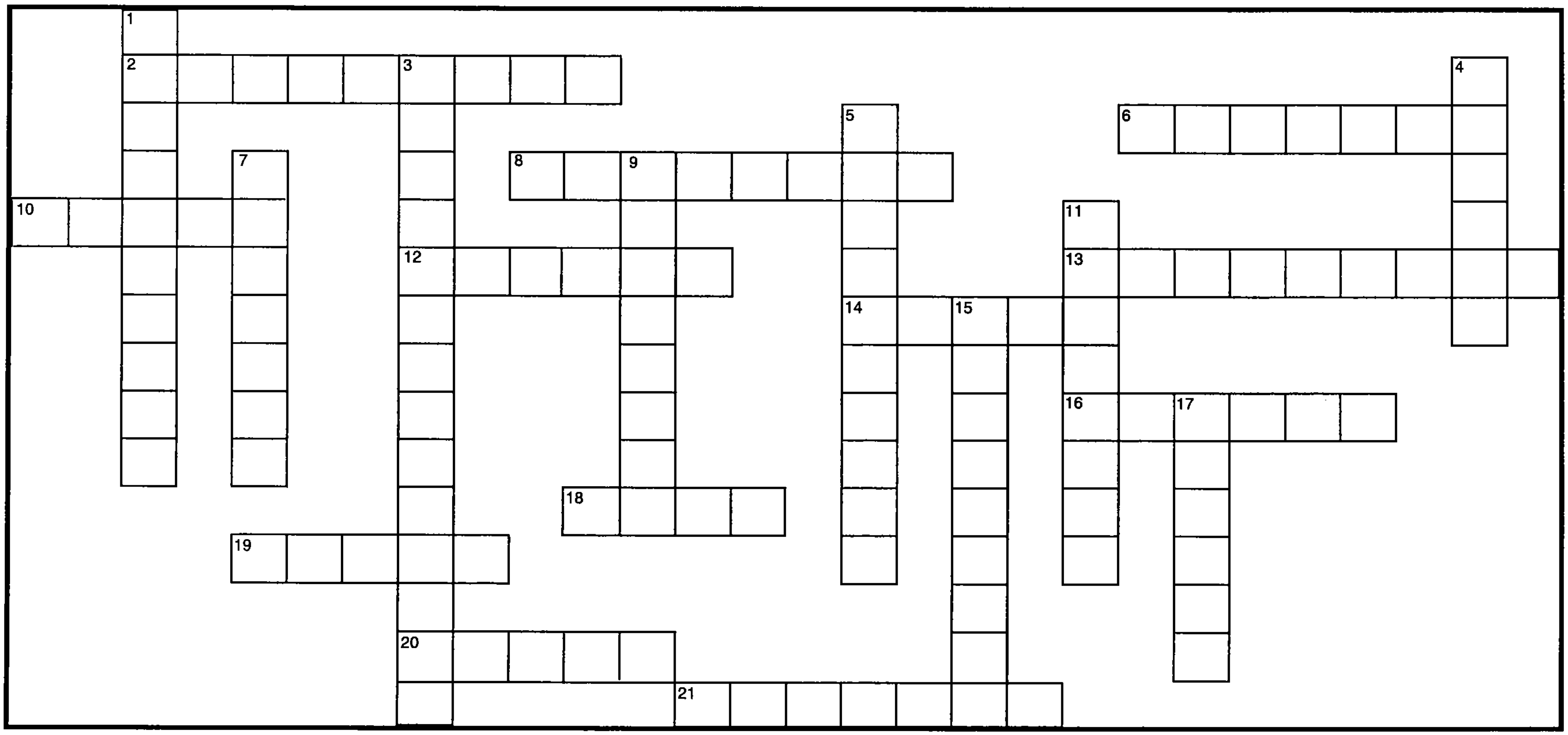
2. A contour line is an imaginary line connecting points of equal ___________.
6. The symbol  on a topographic map indicates an ______ ______ or quarry.
8. Sinkholes, strip pits, and quarries are shown with _________ contour lines.
10. Wooded areas, orchards etc., are shown in _________.
12. A map scale of 1:24,000 means that a distance of 1 unit on the map represents 24,000 of the same units on the _________.
13. The __________ meridian in Oklahoma is the Indian Meridian at longitude 97°15′W, passing just west of Pauls Valley.
14. Closed contours shown on a topographic map as ovals or circles represent _____.
16. The difference in elevation between the highest and lowest points in an area is called ___________.
18. This federal agency has been making topographic maps of the United States since 1882: __________ (abbreviation).
19. Artificial features such as buildings are shown in the color _________.
20. Each section consists of 640 _____ of land.
21. A degree may be divided into 60 parts called _____________.

Down

1. Hachured contour lines (contours with short lines on downhill side) show a _____________.
3. A map with contour lines to show the shape of the land is called a ____________ ______.
4. The symbol — ··· — ··· shown in blue indicates an intermittent ___________.
5. Accurately known elevations called ______ _______ are shown with "BM" and the distance above sea level.
7. __________ to topographic maps of Oklahoma are free from the Oklahoma Geological Survey.
9. _____________ are closely spaced on steep slopes.
11. When a contour line crosses a stream, the contour forms a V that points _________.
15. North–south grid lines dividing the Earth's surface are called lines of _________, or meridians.
17. Latitude and longitude are coordinates used to ___________ a point on a map.

ACRES	GREEN	LOCATE	RELIEF
BENCH MARKS	GROUND	LONGITUDE	STREAM
BLACK	HACHURED	MINUTES	TOPOGRAPHIC MAP
CONTOURS	HILLS	OPEN PIT	UPSTREAM
DEPRESSION	INDEXES	PRINCIPAL	USGS
ELEVATION			

5 More Map Words—crossword puzzle (continued)



5

More Map Words—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

P	O	R	U	N	L	A	D	O	H	A	Y	A	S	R	E	C	I	B	I	D	O	C	R
R	A	P	E	T	E	U	Q	O	R	T	O	L	E	R	O	P	Y	O	T	D	I	D	E
E	Z	C	A	N	D	F	A	C	I	B	L	E	S	H	I	L	L	S	T	E	Y	U	S
T	S	E	E	U	L	O	C	A	T	E	Q	O	E	R	C	S	O	E	S	R	A	L	C
A	D	E	P	R	E	S	S	I	O	N	S	R	E	C	C	O	N	T	O	U	R	S	O
U	Q	O	L	E	D	S	O	T	U	C	R	F	S	O	L	O	G	D	N	H	E	I	G
E	S	T	O	P	O	G	R	A	P	H	I	C	M	A	P	E	I	M	B	C	R	A	S
I	G	E	P	L	O	C	E	C	D	M	S	O	N	A	S	U	T	T	N	A	E	E	T
O	L	A	E	U	N	I	V	R	E	A	R	S	I	U	D	A	U	D	Y	H	L	A	V
N	O	S	N	A	I	R	A	E	T	R	Y	U	S	S	R	E	D	V	I	N	U	A	I
U	N	A	P	E	X	P	E	S	R	K	I	F	E	G	R	E	E	N	N	C	I	A	D
M	N	E	I	M	I	N	U	T	E	S	E	A	S	S	O	L	L	I	V	A	R	A	M
I	O	P	T	I	G	N	P	I	O	I	N	E	S	T	T	E	A	N	O	Y	O	E	S
F	E	D	S	E	R	S	S	A	L	L	C	O	D	N	A	R	N	E	S	N	E	Y	T
R	N	C	E	S	O	Y	T	E	S	O	L	A	U	K	N	A	E	D	E	E	S	P	O
A	N	O	C	Y	U	O	R	T	S	E	P	R	I	N	C	I	P	A	L	L	O	N	A
T	E	N	T	I	N	D	E	X	E	S	A	A	U	N	Q	A	U	E	M	A	N	D	O
J	A	B	A	R	D	T	A	E	D	N	O	I	T	A	V	E	L	E	A	N	E	L	L
O	Y	A	Q	U	E	C	M	A	D	A	C	L	A	S	E	E	S	B	U	N	N	I	V

ACRES
BENCH MARKS
BLACK
CONTOURS
DEPRESSION
ELEVATION
GREEN
GROUND
HACHURED
HILLS
INDEXES
LOCATE
LONGITUDE
MINUTES
OPEN PIT
PRINCIPAL
RELIEF
STREAM
TOPOGRAPHIC MAP
UPSTREAM
USGS

6

Finding—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the page.

Across

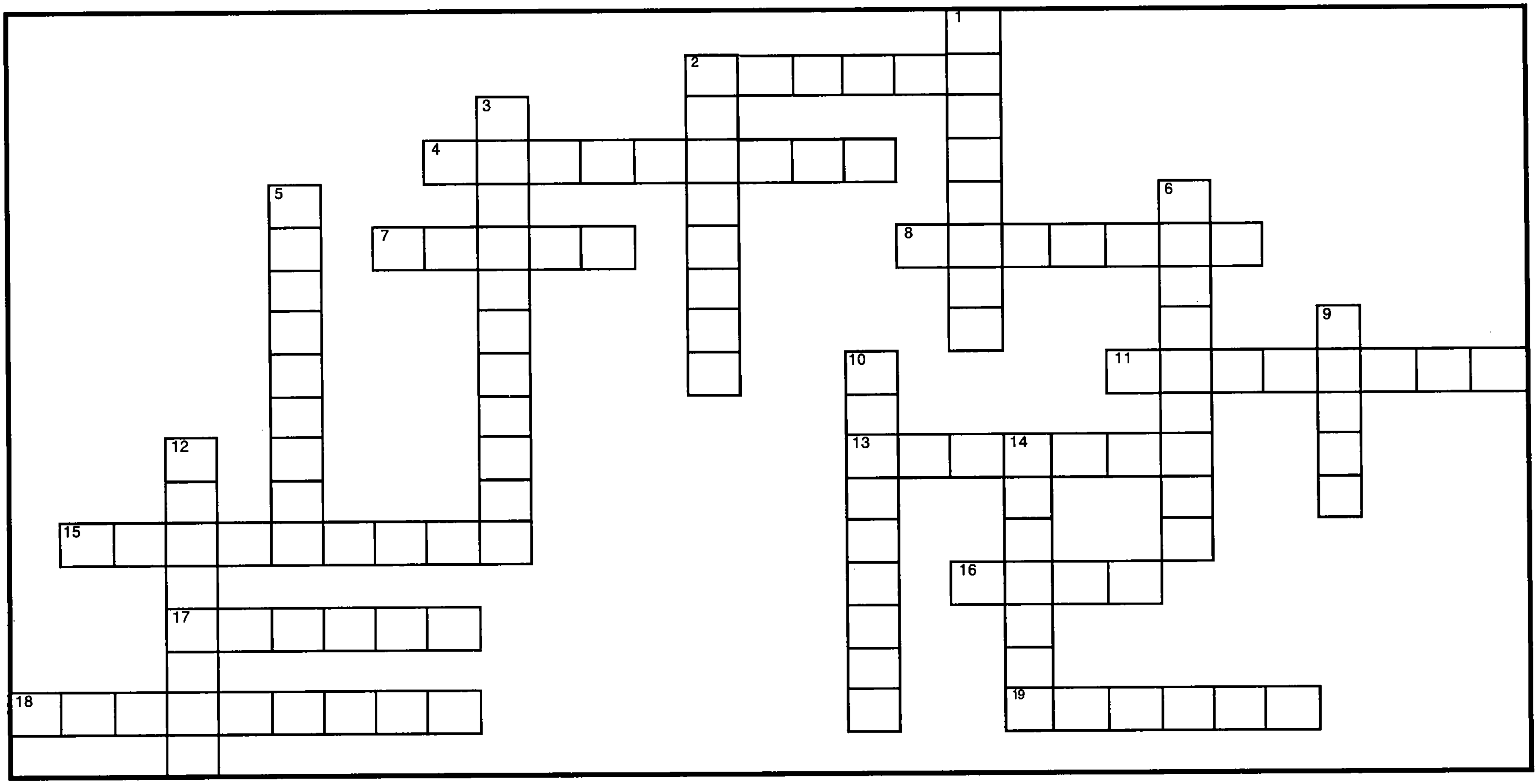
2. Latitude and longitude are coordinates used to ___________ a point on a map.
4. North–south grid lines dividing the Earth's surface are called lines of ___________, or meridians.
7. Each section consists of 640 _____ of land.
8. A degree may be divided into 60 smaller units called ______________.
11. Each township is divided into 36 _____ of land; it is 1 mile square.
13. ______________ to topographic maps of Oklahoma are free from the Oklahoma Geological Survey.
15. In the Land Office Grid System certain parallels of latitude (east–west lines) are called ______________ ______________.
16. A ___________ section of land has 320 acres.
17. Latitude and longitude are the coordinates most widely used to accurately __________ a point on a map.
18. East–west strips called _________, exactly 6 miles wide, are numbered north and south of their base line.
19. North–south strips called ____________ are exactly 6 miles wide, and lie to the east and west of their principal meridian.

Down

1. The line of zero longitude, the Earth's prime ________________, passes through Greenwich, England.
2. East–west grid lines dividing the Earth's surface are called parallels of ___________.
3. For locating property lines in legal documents, another system of __________________ used in most states is called the Land Office Grid System (LOGS).
5. Certain meridians of longitude (north–south lines) in the LOGS system are called _____ meridians.
6. In 1785, Thomas _________________ (third President of the United States) headed a committee that developed a plan for subdividing public land into rectangles.
9. The length of a degree of latitude is ______________ nautical miles (a little more than 69 statute miles).
10. The ____________meridian in Oklahoma is the Indian Meridian at longitude 97°15′W, passing just west of Pauls Valley.
12. In Oklahoma (excluding the Panhandle), the ____________ ____________ is at latitude 34°30′N, a line passing through Davis, Sulphur, and Duncan.
14. Zero degrees (0°) latitude is at the ___________ .

ACRES	HALF	LONGITUDE	SECTIONS
BASE LINE	INDEXES	MERIDIAN	SIXTY
BASE LINES	JEFFERSON	MINUTES	TOWNSHIPS
COORDINATES	LATITUDE	PRINCIPAL	
EQUATOR	LOCATE	RANGES	

6 Finding—crossword puzzle (continued)



6

Finding—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

R	R	O	T	A	U	Q	E	I	R	P	N	S	E	T	A	C	O	L
A	A	B	W	Y	T	X	I	S	R	L	A	H	Q	E	M	C	B	A
N	N	A	L	E	S	A	B	I	S	N	C	A	D	C	O	B	L	T
G	G	S	P	I	H	S	N	W	O	T	R	U	A	O	W	A	O	S
E	N	E	I	L	O	C	A	S	I	X	T	A	R	N	T	S	C	E
S	A	L	N	A	I	O	R	C	A	I	O	D	N	I	S	E	A	N
E	I	I	D	P	J	E	F	F	G	N	I	Q	T	U	E	L	H	I
X	D	N	A	C	F	M	I	N	U	N	P	U	O	Q	R	I	S	L
E	I	L	L	F	A	H	O	N	A	R	D	E	W	E	C	N	N	E
D	R	B	E	H	A	L	F	T	C	E	R	O	O	C	A	E	W	S
N	E	J	E	F	F	O	E	S	N	O	I	T	C	E	S	T	O	A
I	M	I	T	C	E	S	C	A	S	E	T	U	N	I	M	E	T	B

ACRES
BASE LINE
BASE LINES
COORDINATES
EQUATOR
HALF
INDEXES
JEFFERSON
LATITUDE
LOCATE
LONGITUDE
MERIDIAN
MINUTES
PRINCIPAL
RANGES
SECTION
SIXTY
TOWNSHIP

7

Measuring—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the page.

Across

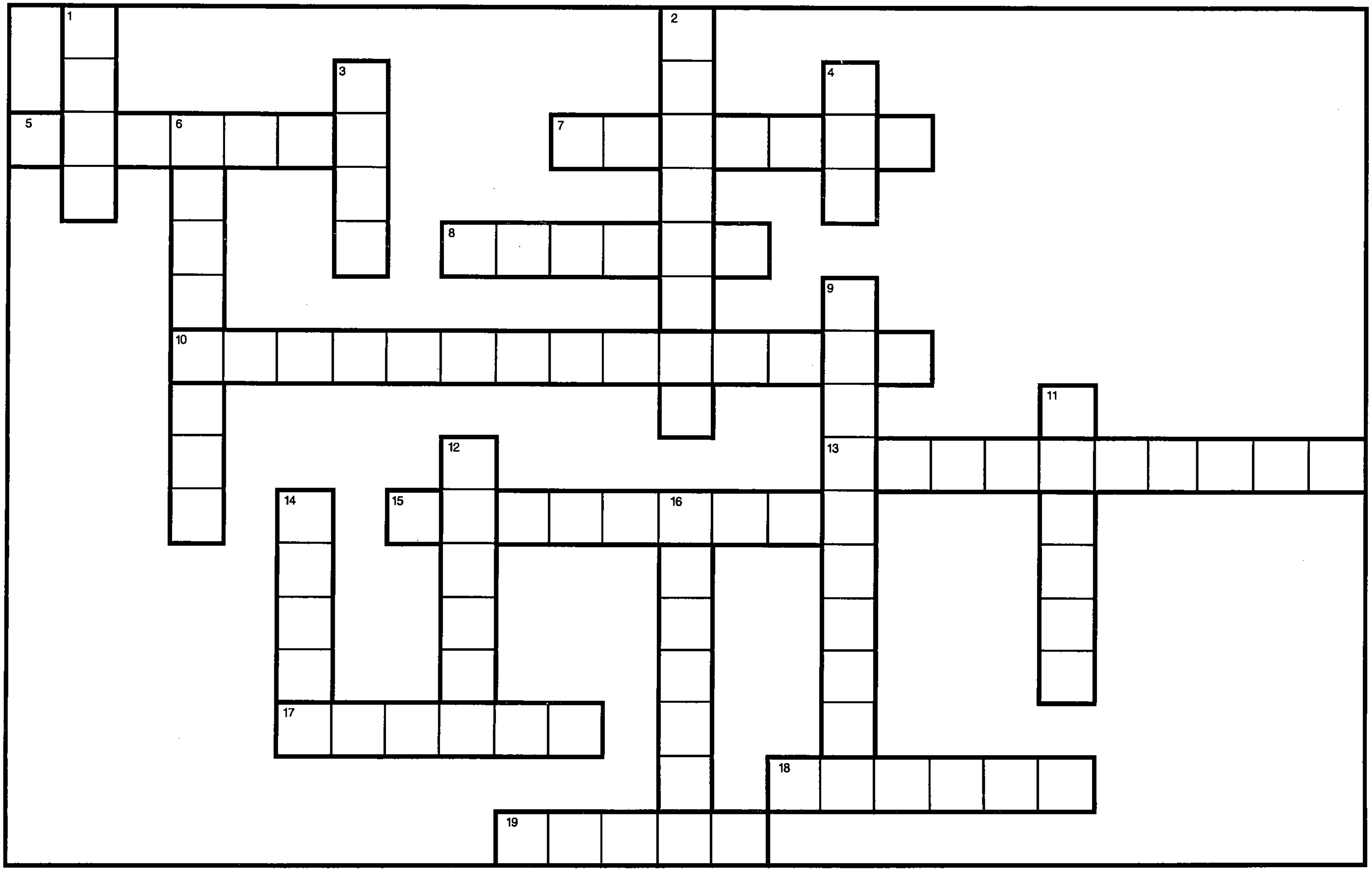
5. Maps and directions are usually based on true north, and your _________ needle should point true north.
7. Topographic maps are of prime importance in planning airports, dams, and pipelines, and in ___________ construction.
8. Map __________ are shown at the center of the bottom margin.
10. A map with contour lines, which show the shape of the land, is called a __________ ___________.
13. The north magnetic pole does not coincide with the true _________ pole.
15. A standard 7.5′ topographic map represents about _________ square miles.
17. __________ refers to the difference in elevation between the top of an object (a hill, tower, etc.) and its base.
18. The difference in elevation between the highest and lowest points in a mapped area is called __________.
19. The relationship between a distance on a map and the same distance on the ground is called the map __________.

Down

1. __________ elevations, often noted at crossroads and hilltops, and usually rounded off to the nearest foot or meter.
2. The angular difference between the north ___________ pole and the true or geographic north pole is called the declination.
3. The _________ (abbreviation), a federal agency, has been making topographic maps of the United States since 1882.
4. __________ scales in miles or kilometers are the most common graphical scale on topographic maps.
6. The __________ of the magnetic poles is constantly changing.
9. __________ _________ maps (1:24,000) are especially useful for detailed information.
11. A map scale of 1:24,000 means that a distance of 1 unit on the map represents 24,000 of the same units on the __________.
12. Topographic maps are useful in hunting, fishing, and __________.
14. Almost all maps have true _________ at the top.
16. Topographic maps usually show both _________ and artificial features.

BAR	HEIGHT	NATURAL	SCALES
COMPASS	HIGHWAY	NORTH	SPOT
FIFTY NINE	HIKING	POSITION	TOPOGRAPHIC MAP
GEOGRAPHIC	LARGE SCALE	RELIEF	USGS
GROUND	MAGNETIC	SCALE	

7 Measuring—crossword puzzle (continued)



7
Measuring—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

D	T	H	G	I	E	H	S	G	S	U	H	G	I	H	T	R	O	N
N	S	C	A	S	E	L	A	C	S	E	G	R	A	L	O	E	R	W
U	C	E	N	I	N	Y	T	F	I	F	T	I	S	O	P	L	G	C
O	A	Y	A	W	H	G	I	H	M	I	T	O	P	S	O	I	O	I
R	L	N	U	O	R	G	P	O	A	F	U	E	N	N	G	E	P	H
G	E	I	L	E	R	A	S	E	G	R	A	L	O	A	R	F	O	P
N	S	U	L	A	R	U	T	A	N	E	A	A	I	T	A	A	T	A
I	C	W	B	G	I	K	I	H	E	L	P	C	T	U	E	W	E	R
K	A	C	O	M	P	A	S	S	T	I	M	S	I	R	N	H	N	G
I	L	P	F	I	F	T	Y	N	I	N	O	C	S	E	G	G	G	O
H	O	C	S	E	G	R	A	L	C	M	C	A	O	L	A	I	A	E
T	O	P	O	G	R	A	P	H	I	C	M	A	P	I	M	H	W	G

BAR
COMPASS
FIFTY NINE
GEOGRAPHIC
GROUND
HEIGHT
HIGHWAY
HIKING
LARGE SCALE
MAGNETIC
NATURAL
NORTH
POSITION
RELIEF
SCALE
SCALES
SPOT
TOPOGRAPHIC MAP
USGS

8

Geodetectives

Fill in the blanks below. Write the first letter of each answer in the boxes at left, then spell downward to find the hidden word (or words).

1. ☐ Most land is divided into smaller parts by a grid system using east–west strips 6 miles wide called __________ and numbered north and south of a base line.
2. ☐ Crossed picks  on a topographic map designates an _________ ________.
3. ☐ ______________ meridians are north–south lines of longitude used in the Land Office Grid System.
4. ☐ The Oklahoma Geological Survey, in Norman, maintains a collection of topographic maps for all of _______________.
5. ☐ Wooded areas and orchards are shown in this color: __________.
6. ☐ The contour interval depends on the area's _________.
7. ☐ A section of land consists of 640 _______.
8. ☐ The ________ of the magnetic pole is always changing.
9. ☐ __________ is the difference in elevation between the top of a hill and its base.
10. ☐ Contour lines usually do not ________ or cross.
11. ☐ Every fifth _________ line is printed more heavily than others and is marked with its elevation.
12. ☐ The north ________ pole is not in the same place as the true geographic pole.
13. ☐ The _____________ difference between the direction to the magnetic pole and the direction to true north is the magnetic declination.
14. ☐ Recently revised areas of a topographic map are shown in this color: ____________.

ACRES	INTERSECT	PRINCIPAL
ANGULAR	MAGNETIC	PURPLE
CONTOUR	OKLAHOMA	RELIEF
GREEN	OPEN PIT	TOWNSHIPS
HEIGHT	POSITION	

9

Reading Contours

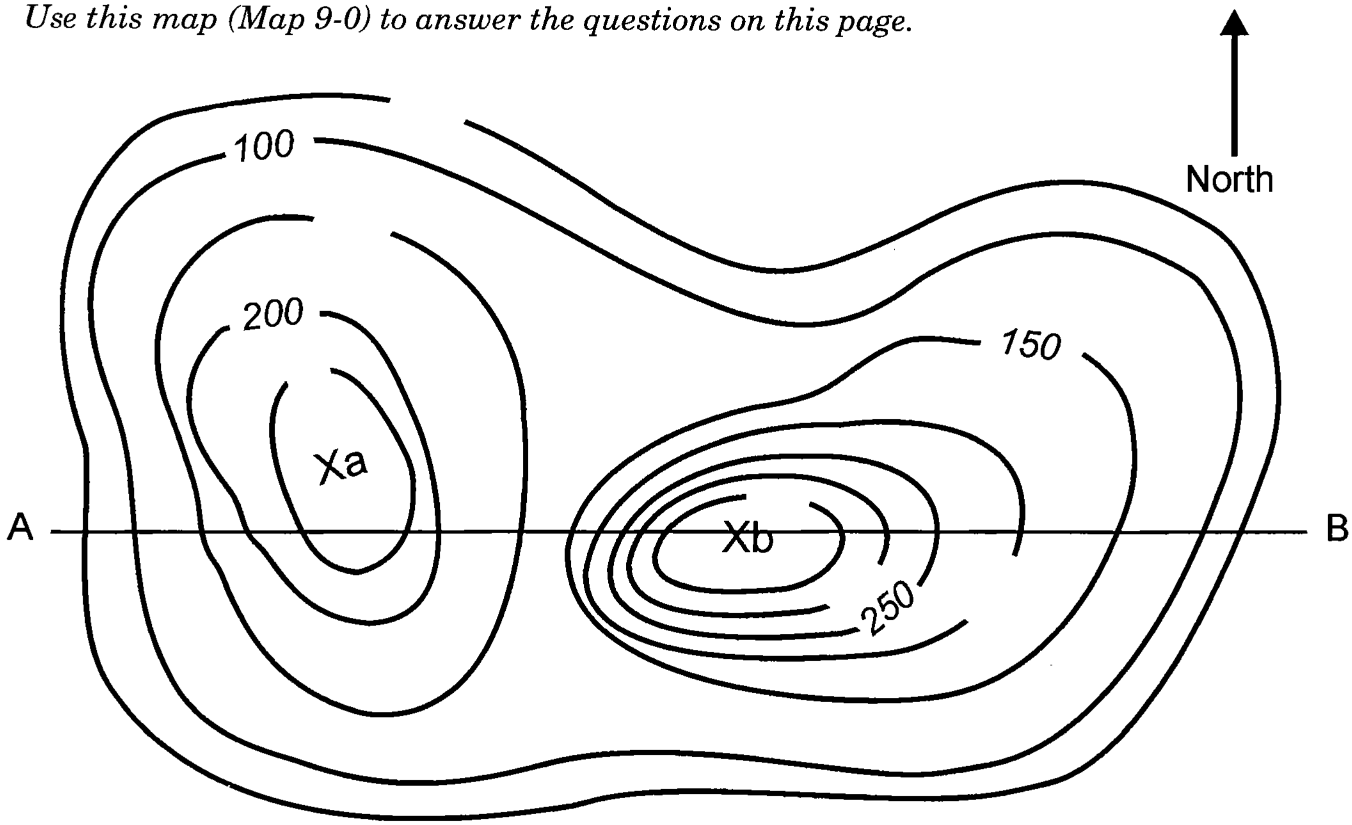
On a topographic map, features like hills and valleys are shown by contour lines. To interpret those contours, a map reader must learn to compare—and contrast—elevation and relief.

These rules for contours are basic, and make map-reading easy:

- Any contour line separates an area of higher elevations from lower elevations.
- Close spacing of contours show that the slope is steep; in contrast, if the slope is gentle the contours are widely spaced.
- Concentric closed contours represent a hill, with the highest point in the center of the pattern.
- Where contour lines cross a stream, they form a V that points upstream—toward higher elevations.
- The elevation of a hill is determined from the value of the hill's uppermost contour line: the elevation of the hilltop is greater than the value of that contour—but less than the value of the next higher contour.

9 Reading Contours (continued)

Use this map (Map 9-0) to answer the questions on this page.

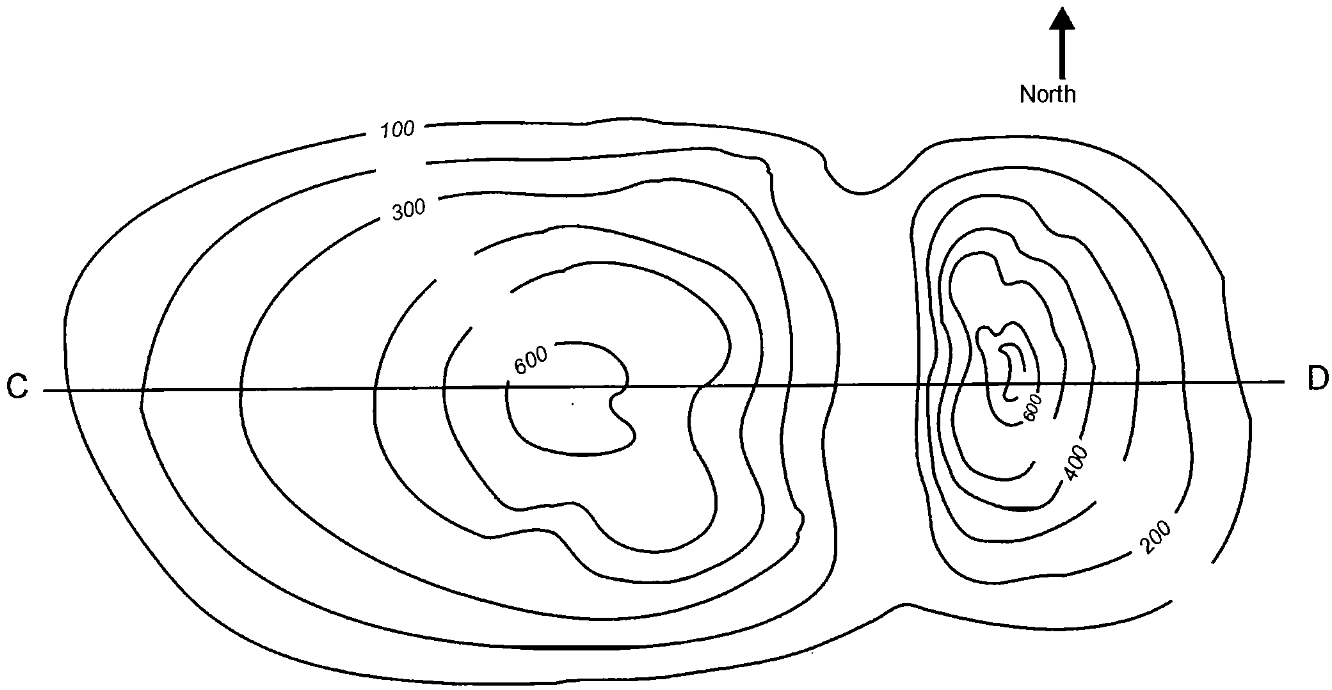


Finish labeling the contour lines. (Elevations are in feet.)

1. What is the map's contour interval? ______________________
2. What is the elevation of hill *xa* on the western side of the map? ______________________
3. What is the elevation of point *xb* on the eastern side? ______________________
4. Which hill has the steeper slopes? ______________________
5. Which side—or face—of hill *xb* is steepest? ______________________
6. Using a lead pencil (not a pen), shade in the valley. ______________________
7. What is the relief in the mapped area? ______________________
8. In the box below, use a pencil to draw a profile—a side view or cross section—of Map 9-0 as seen from the south (along the route from A to B).

9 Reading Contours (continued)

Use this map (Map 9-1) to answer the questions on this page and the next page.



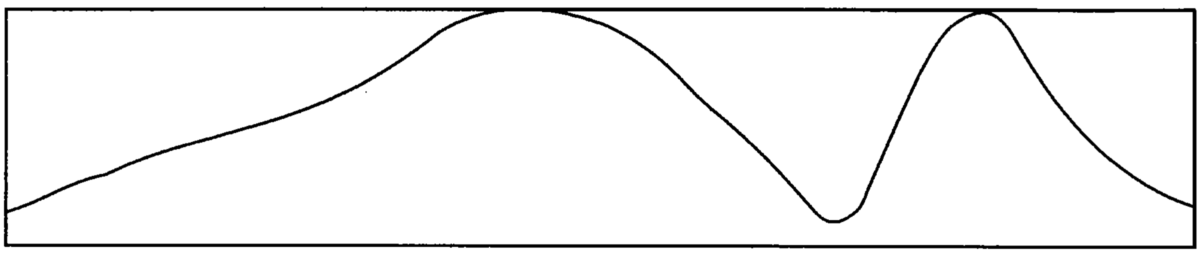
Finish labeling the contour lines in Map 9-1.

9. What is the contour interval? ________________
10. What are the two features shown by the closed contour lines? ________________
11. Using a pencil (not a pen), shade in the valley. ________________
12. What is the elevation of the hilltop on the eastern side of the map? ________________
13. Which side—or face—of the eastern hill is steepest? ________________
14. Which face of the western hill is steepest? ________________
15. Which hill has the steeper face? ________________
16. About how far above sea level is the western hilltop? ________________

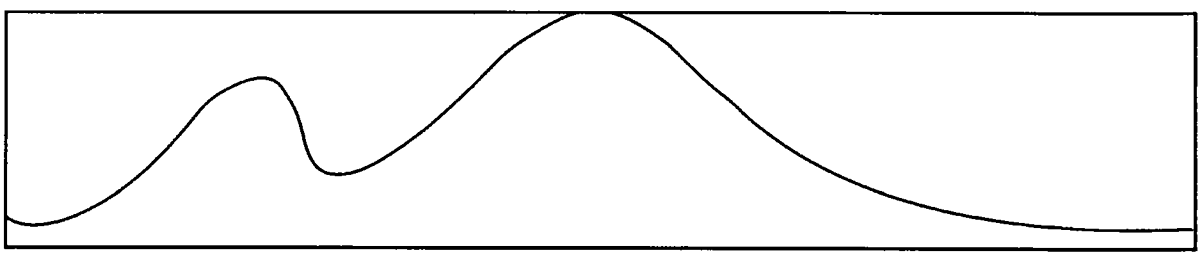
9 Reading Contours (continued)

17. Using a pencil, select the sketch below that shows the most accurate profile of the mapped area (Map 9-1) as seen from the south.

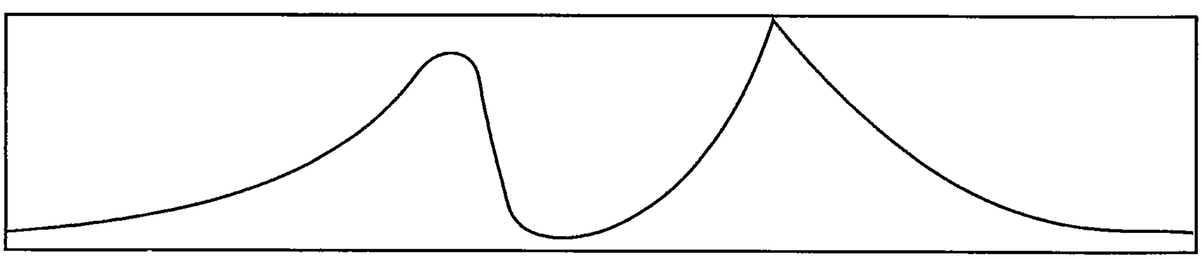
A



B



C



10

Drawing Contours #1

One way to explore the meaning of contour lines is to draw a contour map, given a set of spot elevations.

First, review the nature of topographic maps. Observe that a contour line separates an area of higher elevation from an area of lower elevation. Keep in mind that the difference in elevation between adjacent contour lines is constant and equal to the contour interval—the vertical distance between adjacent contours.

- In general all points of equal elevation must be connected by the same contour line.
- The elevation is given for many points on a map—such as road intersections, hilltops, and lake shores. They are called spot elevations, and are accurate to the nearest foot or meter.

Most spot elevations do not fall exactly on any printed contour line. Example: On a map with a contour interval of 20 feet, a 1,000-foot contour lies midway between spot elevations of 1,020 feet and 980 feet.

These terms help in reading a topographic map:

Contour interval—The vertical distance between adjacent contour lines.

Contour line—A line connecting points of equal elevation. It may be marked with its elevation in feet above sea level.

Elevation—The vertical distance of a point above a reference plane. On a topographic map, the plane is usually mean sea level.

Height—The distance in elevation between the top of an object (a hill, tower, etc.) and its base.

Relief—The difference in elevation between the highest point and the lowest in an area, or as shown on a topographic map.

Topographic map—A map showing the shape of the land surface. Commonly it also depicts forests, grasslands, and cultural features like communities, highways, and railroads.

Topography—The set of physical features—mountains, hills, valleys, and other landforms—that characterizes a landscape.

10 Drawing Contours #1 (continued)

Now consider a map with spot elevations of 250, 115, 375, 210, 325, 420, and 525 feet.

To draw a map with a contour interval of 100 feet calls for contours at 100, 200, 300, 400, and 500 feet.

Arrange the contour-line elevations in a column as shown here:

500

400

300

200

100

Now insert the value of each spot elevation in its place in the column. For example, a spot elevation of 452 feet goes between 400 and 500.

1. What contour lines will lie between 115 and 325? ____________________
2. Between 250 and 420? ____________________
3. Between 420 and 525? ____________________
4. Between 210 and 250? ____________________

11

Drawing Contours #2

The next step in constructing a topographic map is to draw contour lines based on a set of spot elevations.

Review earlier information about contours, elevations, topography, and relief—stressing that a contour line connects points of equal elevation.

1. Examine the map below (Map 9-2) for areas of generally high and low elevations.
2. Consider the spot elevations, which suggest a contour interval of 100 feet.
3. Choose one elevation—say 100 feet—and connect with a smooth line all points at that elevation.
4. Observe that concentric or closed contour lines represent a hill.

SPOT ELEVATIONS (MAP 9-2)

12

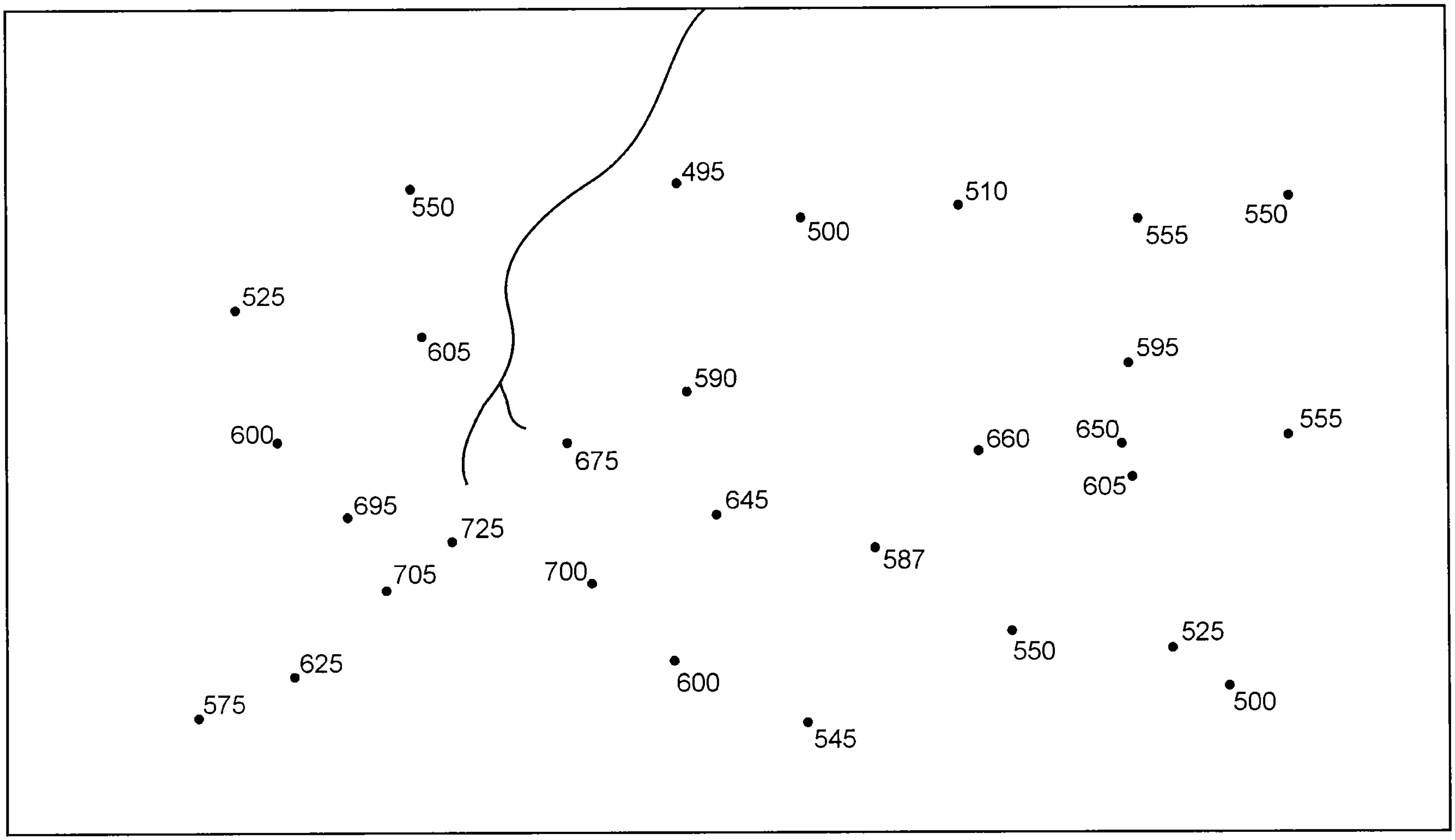
Drawing Contours #3

Drawing contour lines isn't particularly difficult, but practice makes it easier—and also helps in reading topographic maps.

Review earlier discussion of spot elevations, relief, and contour lines.

1. Examine the map (Map 9-3) on the next page, looking for areas of generally high and low elevations. Mark any point surrounded by lower elevations. Because the entire area surrounding any such point is lower, it must be enclosed by at least one contour line at a measured elevation above sea level.
2. Make the contour interval 50 feet. Thus your map will have contour lines marked 500, 550, 600, 650, and 700.
3. Use a pencil and sketch lightly so you can change contours easily. Beginning with the 500-foot contour, draw contour lines and label each one with its elevation.
4. Because few of the spot elevations fall exactly on a contour line, you will have to run contours between known points. For example, a spot elevation of 545 feet lies closer to the 550-foot contour than to the 500-foot contour, and a spot elevation of 525 feet lies midway between the 500- and 550-foot contours.
5. Continue sketching until the entire map is contoured.

12 Drawing Contours #3 (continued)



North

MAP WITH SPOT ELEVATIONS (MAP 9-3)
Contour Interval = 50 feet

13

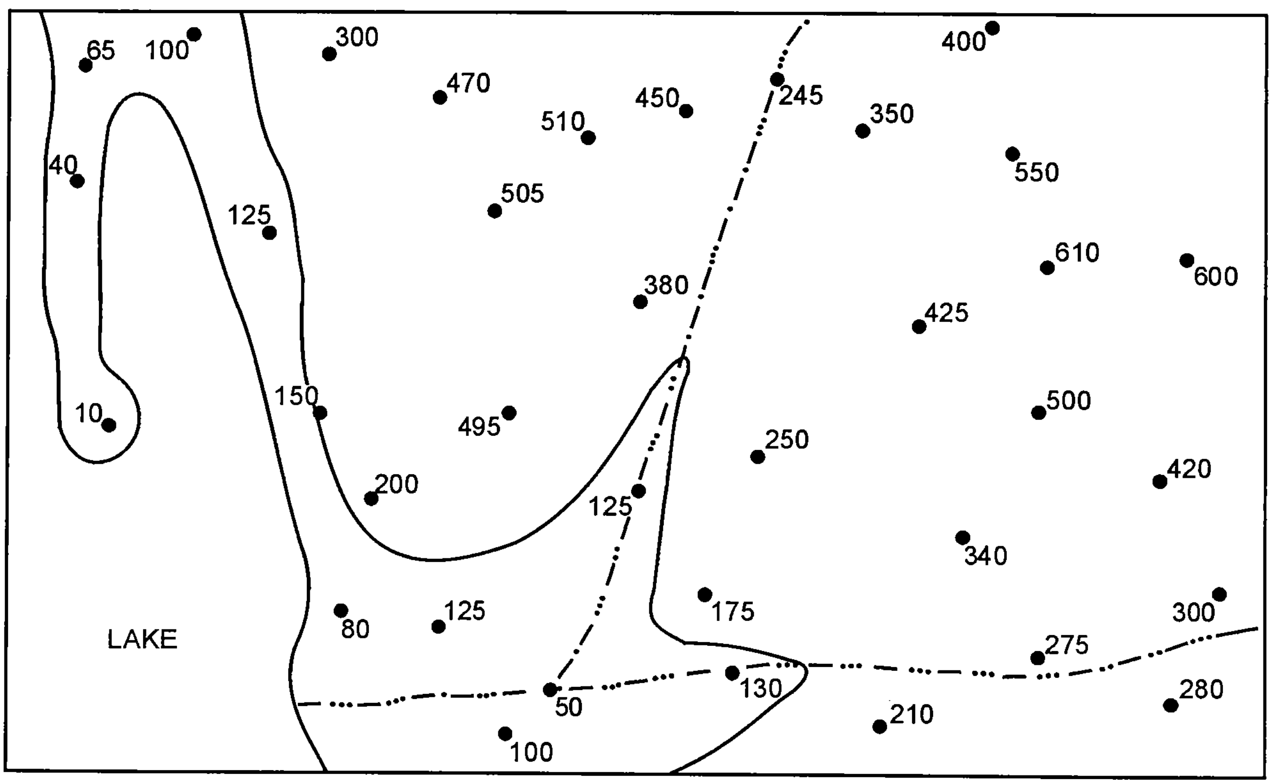
Drawing Contours #4

Lakes and stream courses help in reading a topographic map, and they also help in drawing contours. The entire shoreline of a lake lies—like a contour line on a map—at the same elevation. And where a contour line crosses a stream, it must point uphill.

Review the rules for contouring, and then study the incomplete Map 9-4 below.

1. Observe the lake and intermittent streams. Seek areas of generally high and low elevation. Mark any point surrounded by lower elevations; because the entire area around any such point is lower, it must be enclosed by at least one contour.
2. Make the contour interval 50 feet, and plan to draw contours at elevations of 50 feet and 100, 150, 200, 250, and so on.
3. Begin with the contour line already drawn at 150 feet. Use a pencil, and sketch lightly.
4. Because few of the spot elevations fall exactly on a map's contour line, you must run contours between known points. For example, a spot elevation of 125 feet lies midway between the 100- and 150-foot contours.
5. Continue contouring at successively higher elevations; then go back to the 150-foot contour and work downward.

Map 9-4



14

Contour Talk—crossword puzzle

Complete the crossword puzzle, using the folder *Topographic Map Symbols*. If you need hints, refer to the list of words at the bottom of the page.

Across

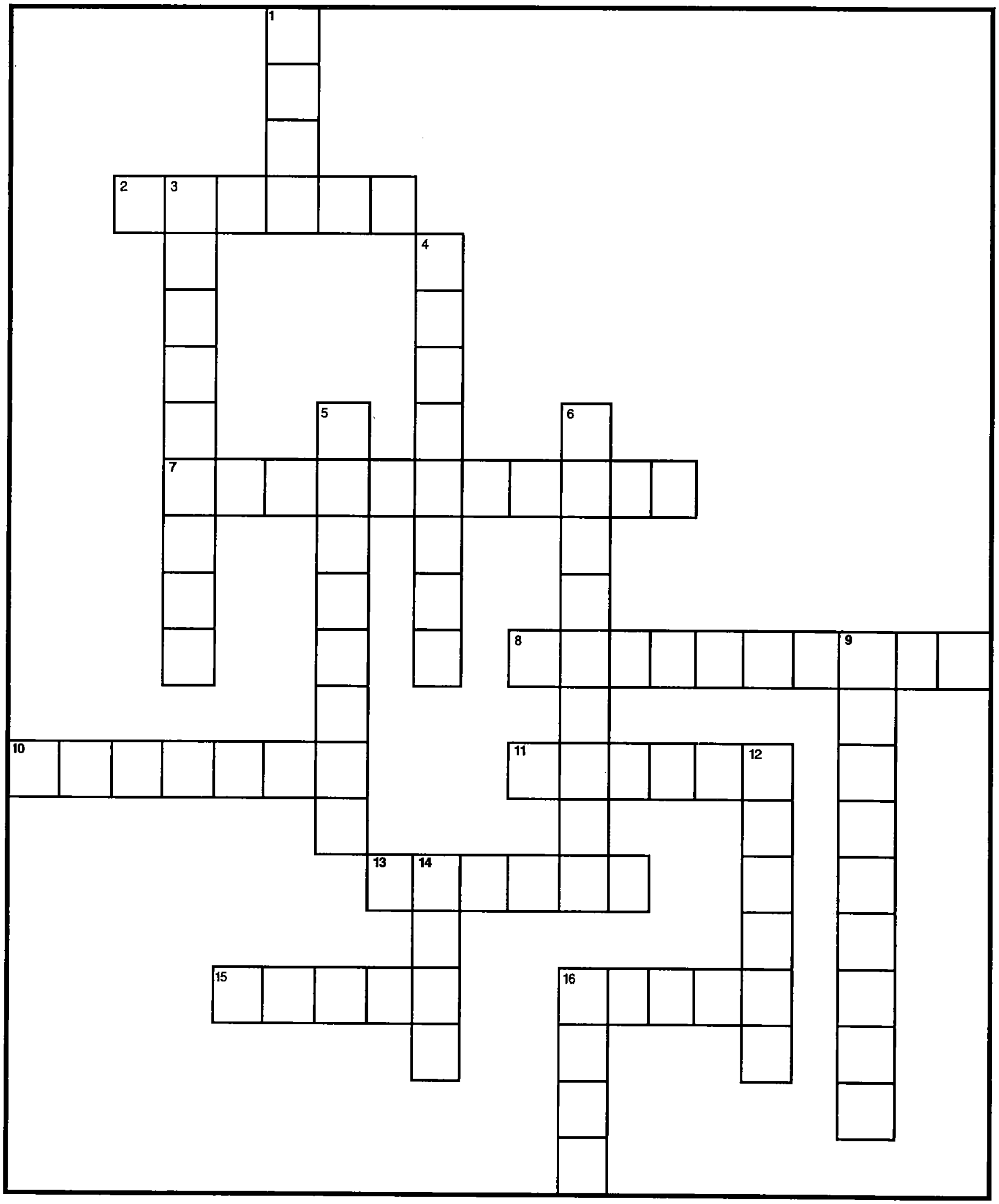
2. Contours are widely spaced on ______________ slopes.
7. Brown is used on _______________ maps to show contour lines.
8. Hachured contour lines—contour lines with short lines on the downhill side—are used to show a ____________.
10. The difference in elevation between adjacent contour lines is called the ________ interval.
11. The top of a hill is ________________ than the highest closed contour line.
13. The elevation of the hilltop or summit is greater than the elevation of the last ____________ contour.
15. Closed contours shown on a topographic map as ellipses or closed circles represent ________________.
16. Contour lines show the general _____________ of the ground surface mapped.

Down

1. A map of a relatively ___________ area may have a contour interval of 10 feet or less.
3. A contour line is an imaginary line on the ground surface connecting points of equal ________________.
4. When a contour line crosses a stream, the contour bends to form a V that points _________ .
5. On steep slopes, ______________ are closely spaced.
6. The _______________ is, in effect, a contour line representing zero elevation, or sea level.
9. Contour lines usually do not _______________ or cross.
12. The contour interval is determined by the _______________ of an area.
14. The elevation of a hill is indicated by the value of the ________________ closed contour that encloses the hill.
16. All points on the ________________ contour line lie at equal elevation.

CLOSED	FLAT	INTERSECT	SHAPE
CONTOUR	GENTLE	LAST	SHORELINE
CONTOURS	HIGHER	RELIEF	TOPOGRAPHIC
DEPRESSION	HILLS	SAME	UPSTREAM
ELEVATION			

14 Contour Talk—crossword puzzle (continued)



14

Contour Talk—word search

Search the puzzle for the words listed below. A word may read forward, backward, across, down, or diagonally. Any word may be used more than once.

T	S	R	U	O	T	N	O	C	I	H	P	A	R	G	O	P	O	T
S	H	O	R	E	F	E	I	L	E	R	E	H	G	I	H	I	A	O
A	E	I	L	E	R	P	P	E	D	N	E	D	E	P	R	M	L	P
L	T	C	E	S	R	E	T	N	I	W	E	S	E	T	A	L	F	O
C	L	O	S	A	O	R	E	L	I	P	L	L	A	E	S	A	M	E
R	A	N	A	M	T	J	E	A	R	L	E	S	R	T	S	P	U	L
G	U	T	M	E	N	R	L	E	I	V	O	T	S	H	C	L	O	T
O	E	O	H	O	O	F	S	H	A	H	S	H	A	E	T	N	I	N
P	L	U	T	H	C	S	K	T	O	P	H	P	L	V	R	C	R	E
O	E	R	S	S	I	L	I	L	U	G	E	N	F	R	E	P	A	G
T	S	H	I	O	S	O	L	C	O	N	T	O	U	S	A	L	E	O
C	L	O	N	B	N	P	E	D	E	S	O	L	C	N	E	G	E	D

CLOSED
CONTOUR
CONTOURS
DEPRESSION
ELEVATION

FLAT
GENTLE
HIGHER
HILLS

INTERSECT
LAST
RELIEF
SAME

SHAPE
SHORELINE
TOPOGRAPHIC
UPSTREAM

15

The Ada Quadrangle

Please do not mark on the map. If it is necessary to touch the map, use the eraser of a pencil. Consult the folder *Topographic Map Symbols.*

1. The area shown on this map is in what part of Oklahoma? ____________________

2. In what county (or counties) is the mapped area? ____________________

3. What State agency sells topographic maps of the State?

   ____

4. What area is represented by this 7.5′ map? About ________ square miles.

5. Find East Central University on the map, and gives its location by quarter section, township, and range. ____________________

6. What do these colors represent on the map? Green ____________ Blue ____________ Brown ____________ Purple ____________ Black ____________

7. Using the folder *Topographic Map Symbols*, find on the map the features listed below, and draw the symbol for each one. School ________ Church ________ Cemetery ________ Gravel pit ________ Oil or gas well ________ Quarry ________ Bench mark ________

8. How far above sea level is the football field (the semi-circular area enclosed in dashes) at East Central University? ____________

9. If you walked from the football field to the administration building (marked with a school symbol), how many feet would you rise? ____________

10. How far is Hayes School from Washington School? ____________ feet; ________ miles

11. Find the highway cloverleaf west of Ada. How much ground (roughly) does the interchange cover? ____________________

12. What is the name of the topographic map bordering the Ada quadrangle on the east?

    ____

15 The Ada Quadrangle (continued)

13. What is the approximate elevation of the hilltop just north of Fords, on the eastern margin of the map? ____________________

14. In what general direction does Canadian Sandy Creek flow? ____________________

15. What is the cultural feature in the SE¼ sec. 12, T. 4 N., R. 5 E? ____________________

16. What is the map scale? __________
    1 inch on the map = ______ inches on the ground. (To find what 1 inch on the map represents on the ground, in feet, divide the right-hand side of the ratio by 12.)
    1 inch on the map = ______ feet on the ground.

17. What is the total relief in the map area? ________ feet

18. Has this map been photorevised? ________ If yes, when? ________

19. If the source of Turkey Creek is at SE¼ sec. 14, T. 4 N., R. 5 E. (where the stream is shown as intermittent), find how far the stream falls to the point where it empties into the Canadian River (SW¼ sec. 13, T. 5 N., R. 6 E.): ______ feet

20. What is the elevation of the bench mark at Fords (SE¼SW¼ sec. 13, T. 4 N., R. 6 E.)? __________ feet. The bench mark is near what artificial feature? ____________________

21. Explain the stippled (dotted) pattern along the Canadian River. ____________________

22. What are the features in the SE¼SW¼ sec. 9, T. 4 N., R. 6 E.? ____________________

23. Explain the purple tint around the city of Ada. ____________________

24. Ada City Lake (southeast rectangle) covers about ______________ acres.

25. Explain the concentric contour pattern in the NW¼NE¼ sec. 1, T. 3 N., R. 5 E. ________

16

The Bethany NE Quadrangle

Please do not mark on the map. If it is necessary to touch the map, use the eraser of a pencil. Consult the folder *Topographic Map Symbols.*

Colors

1. Artificial features such as roads and buildings, and geographic names and political boundaries, are shown in the color ____________.
2. The color ______________ is used to show wooded areas, with typical patterns to indicate orchards. Observe the general lack of vegetation in the Bethany NE quadrangle.
3. The color _________ is used for contour lines, which reveal the shape and elevation of the land surface.
4. Water bodies, such as lakes, rivers, ponds, streams, and canals, are shown in the color ______________.
5. All classes of features shown in photorevised areas are shown in the color ____________.
6. ________ indicates important roads, built-up urban areas, and property lines.
7. Where is most green color on this map? ________________________

Location

8. Does the Bethany NE quadrangle lie east or west of the Earth's prime meridian? _______
9. Is the map area east or west of the region's principal meridian? ___________
10. Is the map area north or south of its base line? _________________
11. Does MacArthur Avenue run parallel to the Indian Meridian, or to the base line? ________________________
12. Does Portland Avenue run parallel to lines of longitude, or perpendicular to them? ________________________
13. Deer Creek school is in which principal rectangle of this map? ________________
14. Find the arithmetic difference (in degrees, minutes, and seconds) between the west and east borders of the map. ________________

16 The Bethany NE Quadrangle (continued)

15. Find the value (in degrees and minutes) of the grid line that forms the north boundary of the map. ________________
16. Is the grid line that forms the west boundary of the map a parallel, or a meridian?
____
17. Find the intersection of 35°42′30″ N and 97°35′W. What geologic feature lies there?
____
18. Find the intersection of 35°40′ N. and 97°32′30″ W. What is the feature? _______________
19. Find the coordinates—the latitude and longitude—of Deer Creek School (west central, or WC). Measure to the nearest minute. ______________________________
20. Find the features listed below. Using the township and range method, describe the location of each to the nearest quarter section.
a. Deer Creek School (WC) _________________________________
b. Higbee Community Hall (SE)_______________________________
c. Edmond Sewage Disposal site (EC) __________________________
d. Bethel Church (NC) _____________________________________
e. Gas Processing Plant (SC) _________________________________
21. The settling basin (blue) at the Bethany Sewage Disposal site (WC) occupies about __________ acres.
22. Without using the map's bar scale, find the distance from Deer Creek School to Western Avenue: _________ miles.

Symbols

23. A power line is shown in the center of the map. Draw its map symbol. ___________
24. Draw the symbol for a pipeline. _______________
25. What is the cultural feature in the SE¼ sec. 31, T. 14 N., R. 3 W.? ____________________
26. Draw the symbol for Deer Creek School. _____________
27. Is Bloody Rush Creek (NW) an intermittent stream, or perennial? _______________
Draw the symbol for an intermittent stream. ______________________
28. What cultural feature is shown in purple in the N½ sec. 21, T. 14 N., R. 3 W.?
____

16 The Bethany NE Quadrangle (continued)

29. What cultural feature do you find in the NE¼NW¼ sec. 3, T. 14 N., R. 4 W.? ________________________ Draw the symbol for that feature. ______________________

30. A pipeline runs through the southwestern rectangle of the quadrangle. Judging by other information on the map, why was the pipeline built there?__________________________
____

31. Find the bench mark in the SE¼SE¼ sec. 21, T. 14 N, R. 4 W., and give its symbol and elevation here: ____________________

32. What kind of surface was used for the road leading into the Bethany Sewage Disposal site? (SW¼ sec. 23, T. 14 N., R. 4 W.) _____________ Draw the symbol _______________

33. Draw the symbol for an oil well: _________

General Data

34. The Bethany NE quadrangle lies in what part of Oklahoma? ________________

35. When was the map photorevised? _________

36. What topographic quadrangle map adjoins Bethany NE to the south? _____________

37. In what county (or counties) is the Bethany NE quadrangle? ________________________

38. The magnetic declination in this map area is _______.

39. The names of Oklahoma's principal meridians are __________ and _______________.

40. Find the lakes in sec. 18, T. 14 N., R. 3 W.; explain the straight sections of shoreline, each near contour 1050. ____

Scale

41. What is the representative fraction (R.F.) of the Bethany NE quadrangle? _____________

42. Using a ruler or the edge of a sheet of paper, determine the straight-line distance from Deer Creek School to the Bethany Sewage Disposal Site. _______ miles; ________ feet; _______ kilometers.

43. One inch on this map equals __________ inches on the ground.

44. Give a verbal scale of this map, in inches and feet. ________________________________

16 The Bethany NE Quadrangle (continued)

45. Using a ruler or the edge of a sheet of paper, determine the straight-line distance between Higbee Community Hall (SE) and Deer Creek School (WC). _____ miles; __________ feet; ________ meters

46. A map of unknown scale shows two transmitting towers. On the map they are 1.2 inches apart; the actual ground distance is 1,000 feet. What is the map's fractional scale? _______

47. The land area shown on the Bethany NE map is roughly ______________ square miles.

Contours and Relief

48. The contour interval of the Bethany NE quadrangle is ____________.

49. What is the lowest elevation shown on this map? (Reflect that water runs downhill.) _____________ What natural feature is found there? ________________

50. What is the highest elevation found on the map? (Look for hills, as in the NE rectangle.) ____________________________

51. The relief in this area—the difference between the highest elevation and the lowest—is ______________________.

52. The approximate elevation of the hill in the NW¼ sec. 22, T. 14 N., R. 3 W., is __________.

53. Which way does Deer Creek flow? ______________________________________

54. What do we call the kind of contour line enclosing the lake at NW¼ sec. 18, T. 14 N., R. 3 W.? ____________________ What is the elevation of the outside edge of the depression? ______________ About how deep is the depression? ________________________

55. Name other kinds of depressions shown with hachures on topographic maps. ____

56. Find the spot elevation at the intersection of Broadway and NE 206th Street. What is the elevation? _______________________

57. Describe the rise and fall of the road as you walk along MacArthur Avenue from Hopewell Church to Deer Creek School. ____
____
____
____

17

Oologah Field Trip

Please do not mark on the map. If it is necessary to touch the map, use the eraser of a pencil. Consult the folder *Topographic Map Symbols.*

This is a guide for a field trip though the area shown on the Oologah quadrangle topographic map—a chance for you to compare symbols on the map with the real thing on the ground. Along the route you are to make observations, collect rocks, minerals, and fossils, and take part in a dinosaur dig.

Your job is to keep track of distances and directions both on paper and also on the road, to identify features and describe their locations, and to relate contour lines to the shape of the land.

The starting point is the junction of Highways 88 and 169, at the south side of the city of Oologah.

1. Go east on Highway 88, turn south to the first road (shown on the map in purple) that goes east, and on it go to a quarry for rock collecting. Here draw the symbol for a quarry: ______. Give the name of the sedimentary rock quarried here for use as agricultural lime, road gravel, and cement: ______________ In what county is the map area? ______________

2. Return to Highway 88 and continue south. Find the radio tower west of the highway; what is the elevation at its base? ______________ Continue south, crossing Oologah dam. What river was dammed to form Oologah Lake? ____________________ What are some uses for the lake?______________________________________

3. Stay on Highway 88 as it turns east; cross the bridge near Lipe Mound, and stop to collect fossils at the top of the mound. What is the elevation in feet at the bridge? ______________ How many feet will you climb to reach the top of Lipe Mound? ____________ Which side of the mound is steepest? ______________The most gentle? ____________ What is the contour interval on the Oologah map? ____________

4. Back on Highway 88, go east and then south to just north of the crossroads—spot elevation 653 feet—and turn sharply north. How does the map classify this road's surface? ______________ If the lake level is low enough, continue north about 1.3 miles to the island in Oologah Lake. Describe the location of the island, using the Land Office Grid System: Section ________, Township _______, Range ________. What is the island's relief? _________________

17 Oologah Field Trip (continued)

5. Return to Highway 88 and go south about 1.2 miles, to Sweetwater Creek. Which direction does the stream flow? ______________ Continue south on Highway 88 to the edge of the map. Explain the brown tick marks on both sides of the highway symbol at this point. ____________________

6. Turn around and go back north on Highway 88 to Oologah and the starting point of the field trip. Turn north onto Highway 169 and go to Fourmile Creek crossing. At this point, how far have you come on Highway 169? ______ miles; ______ kilometers. Which way does Fourmile Creek flow? ________________________________

7. Continue north on Highway 169 to the road intersection marked on the map as at elevation 658 feet; turn left. What direction do you now face? __________ Consider the small streams just crossed; why does the map show them as broken blue lines?

   ____

8. Continue west to the strip mines, where you can collect plant fossils. What do you think has been extracted from these pits? ___________ What is its main use? ________________ If you continue west off the Oologah map, what topographic quadrangle map will you need? ____

9. Turn around and go east, back to Highway 169. Turn right; which direction do you now face? __________ Go 2 miles and turn left. What direction are you now traveling? __________________ Go onward to Will Rogers' Home, and locate it by the LOGS method to the nearest quarter quarter section. ____ Identify the areas mapped as a pattern of blue dashes along the shore of Oologah Lake: ____________________________________ See the ridge in sections 6, 7, and 18 of the Rogers home; what is its approximate relief? _______________ How long is the ridge? About ______________ miles, or ________________ kilometers. Explain the closely spaced contours along the shore. _____________________________________

10. Return to Highway 169 and turn south for Oologah. Stop there, and draw the map symbols for these features: School ___________. Cemetery _________. Pipeline _________. Gravel pit _________. Oil well _______. Bench mark ___________. Railroad ___________.

17 Oologah Field Trip (continued)

11. The next stop is for a dinosaur dig at Claremore Mound. From Oologah, go about 1 mile southwesterly on Highway 169 and turn due south onto a secondary highway ("all weather, hard surface") where the map shows a spot elevation of 613 feet. Go about 2 miles due south; turn east, and go about 3 miles to a bridge crossing the Verdigris River. See the white areas (with few contour lines) along the river; what is the natural feature? ______________________ Would these areas be a good place for a housing subdivision? ______ Why or why not? ____

12. Continue about 1.5 miles to an "unimproved road, fair or dry weather"; turn left. What direction do you face? ____________ Go to the base of Claremore Mound and the dinosaur dig. What is the mound's relief? ________________ What is the elevation at the summit? ______________ Why is an area shown in green? ______________________________________ ________________________

13. Go back south to the secondary highway. Identify the commercial feature about 0.4 mile southwest of the intersection, in the SW¼NW¼ sec. 24, T. 22 N, R. 15 E: ____________ There you can collect quartz crystals.

14. Return to the secondary highway, turn left, and return to the starting point—Oologah. Where are most gravel pits shown on this map? ____________________________________ Why are they numerous in this area? (What geologic agent could have transported the sand and gravel and deposited them here?) _________________________________

Here ends the field trip.

18

Turner Falls Quadrangle

Please do not mark on the map. If it is necessary to touch the map, use the eraser of a pencil. Consult the folder *Topographic Map Symbols.*

1. What do we call a map like this one? ______________________________
2. What is this map's name? ______________________________
3. Where in Oklahoma is the map area? ____________________
4. What is this map's fractional scale? __________ Its verbal scale? __________
5. What is the contour interval? __________
6. The mapped area covers about __________ square miles.
7. What federal agency publishes topographic maps like this one? __________
8. What State agency sells topographic maps of areas in Oklahoma? __________
9. How does the map show heavy-duty roads? ____________________
10. What feature is shown in blue just east of Classen Falls? __________
11. What does the color green represent? ____________________
12. The brown lines are called __________ __________; they show __________ above sea level.
13. Identify the small black squares at Camp Classen. __________
14. Find a waterfall on the map. Give its location: __________ Draw the map symbol: ______ Give its name: ____________________
15. Locate by section, township, and range the radio towers in the southeast corner: ______
16. Explain the wide spacing of the contour lines in the northeast corner. __________

    ____
17. The difference in elevation between two adjacent contour lines is known as the __________ __________. On this map, it is ________ feet.
18. Give the elevation of the radio tower in sec. 1, T. 2 S., R. 1 E., in feet above sea level.

    ____
19. Explain the close spacing of the contour lines in Turner Falls Park, in the east-central part of the map. ______________________________
20. How many feet would you climb during a hike from Turner Falls (east-central) to the radio tower in sec. 1, T. 2 S., R. 1 E.? __________
21. Find the bench mark in sec. 11, T. 1 S., R. 1 E. What is its elevation above sea level?

    ____

19

Maps in Work and Play

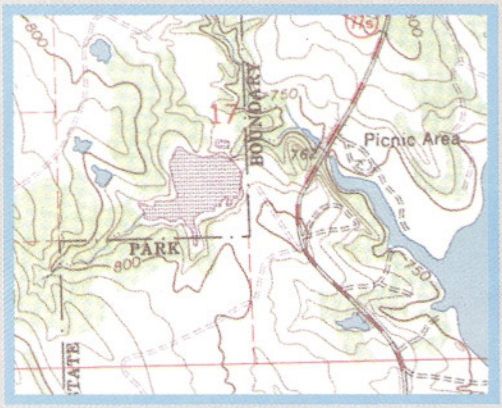
How would you use a topographic map if you wanted:

A route for a hike?

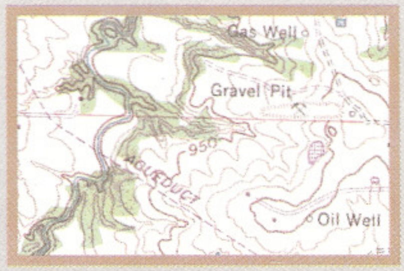
The best location for an airport?

A route for a new highway?

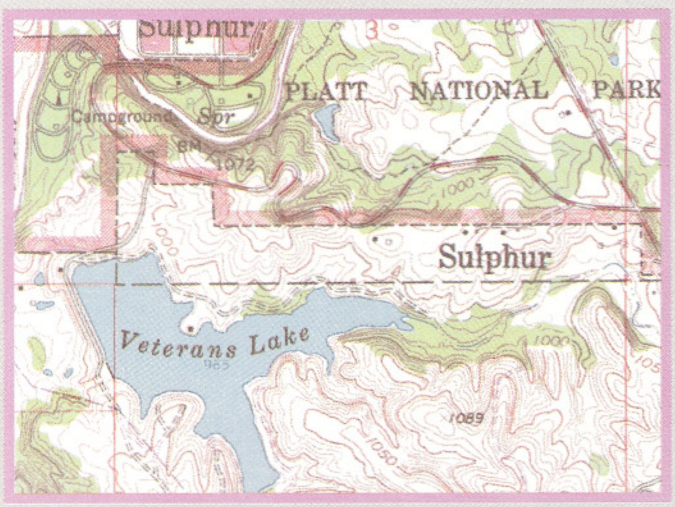
HOW ARE TOPOGRAPHIC MAPS USED?

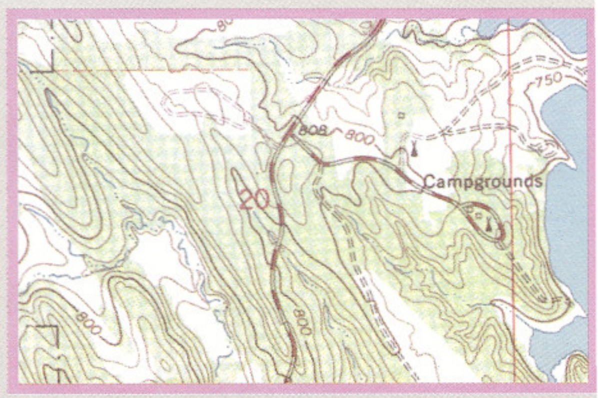


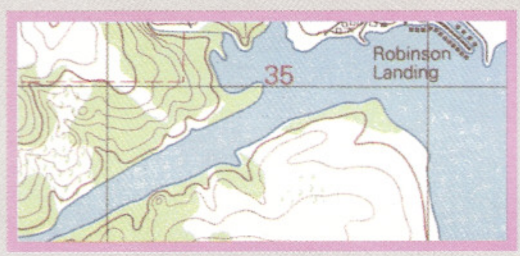
Making Property Surveys



Assessing Natural Resources







Planning Recreation Areas

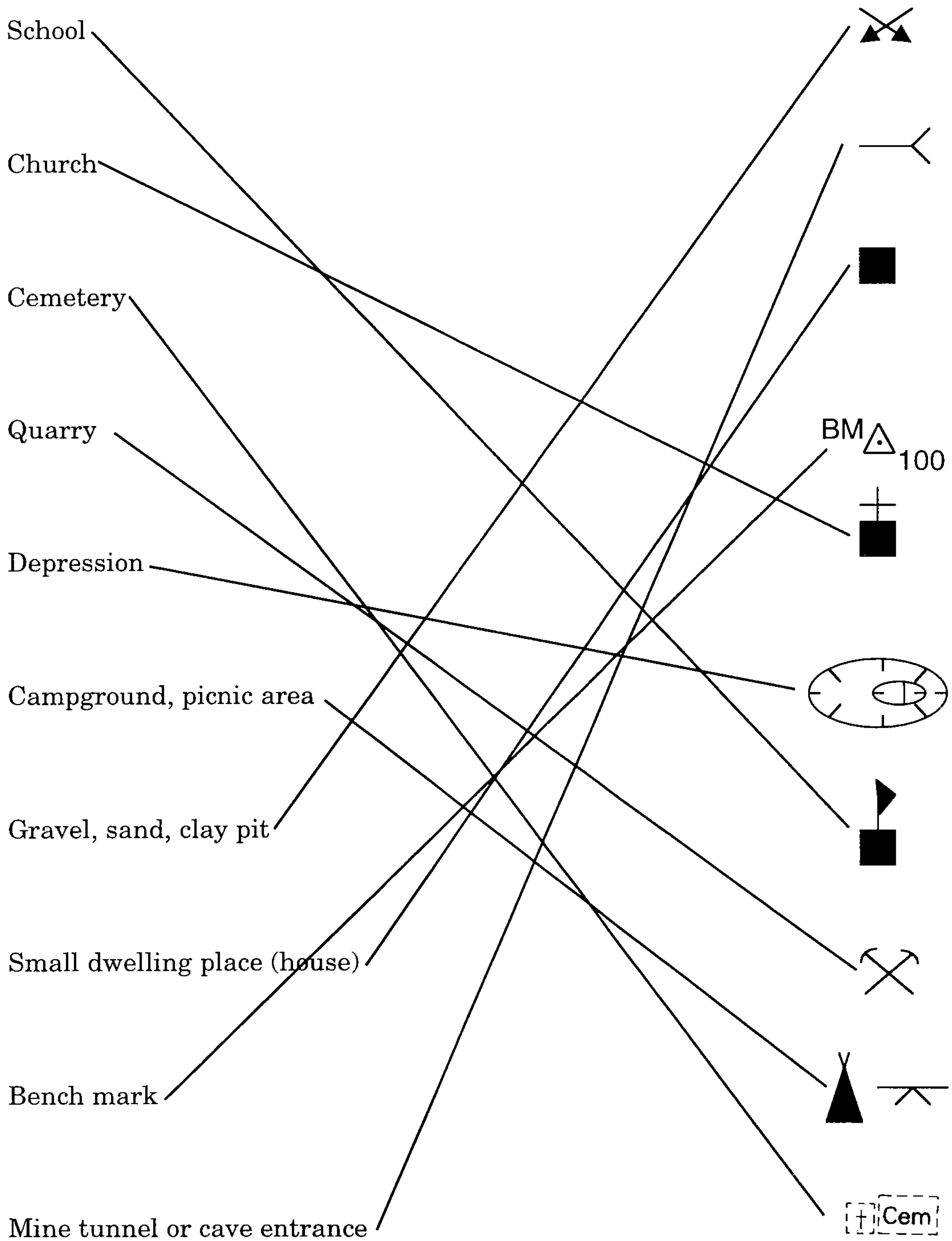
Answers for Activities

1. Jump-Start, pages 24–25

Answers will vary, depending on map.

---

2. Symbols to Features, page 26



3. Meaning of Colors—crossword puzzle, pages 27–28

Across

3. church
4. brown
7. elevation
8. open pit
10. red
11. stream
12. six
15. strip mine
16. cave
17. symbols

Down

1. black
2. green
4. blue
5. vegetation
6. houses
9. trail
13. purple
14. cemetery

---

3. Meaning of Colors—word search, page 29

S	H	C	R	U	H	C	B	M	E	V	A	C	B	R	O	W	B	D
L	C	A	L	B	U	L	A	T	R	A	N	R	R	S	E	M	E	C
O	L	B	V	L	U	A	V	E	L	E	W	G	U	T	L	R	R	E
B	M	E	C	E	L	E	V	A	T	I	O	N	H	R	P	V	E	M
M	N	E	E	R	G	P	N	E	P	O	R	A	C	E	R	F	T	E
Y	K	C	A	L	B	E	R	U	H	C	B	E	H	X	U	I	S	T
S	S	U	L	B	L	U	T	R	A	A	M	R	I	U	P	V	E	G
T	E	C	M	S	U	O	H	A	B	E	S	S	A	N	E	L	E	L
R	S	E	N	I	M	P	I	R	T	S	T	R	E	A	M	O	I	M
E	U	G	R	E	M	E	C	E	H	I	R	P	S	L	B	A	S	Y
I	O	P	I	R	T	S	R	E	B	R	O	W	Y	E	R	R	T	S
S	H	V	A	C	M	Y	S	E	E	R	G	N	M	T	P	R	U	P

4. Map Language—crossword puzzle, pages 30–31

Across

6. magnetic
7. base line
11. principal
13. elevation
14. ranges
16. coordinates
18. sections
19. BMs
21. equator
22. gentle
23. height

Down

1. relief
2. strip mine
3. purple
4. contour lines
5. scale
8. base lines
9. townships
10. church
12. latitude
15. contour
17. higher
19. blue
20. spot

---

4. Map Language—word search, page 32

M	E	A	L	B	E	G	T	O	W	N	S	H	I	P	S	R	E	C	M	U	R
B	A	S	E	L	I	N	E	S	I	C	E	E	R	L	A	O	H	O	C	U	A
B	I	E	R	U	N	O	T	C	I	C	C	I	A	S	T	U	Y	N	O	A	N
H	D	T	O	E	T	E	U	A	Q	E	T	H	P	C	E	R	A	T	P	S	G
I	O	A	M	A	R	C	H	L	A	T	I	T	U	D	E	A	N	O	M	U	E
G	E	N	T	L	E	A	R	E	A	P	O	N	R	R	E	O	I	U	B	Y	S
H	T	I	O	I	N	O	Q	U	L	E	N	B	P	U	C	E	N	R	O	M	E
E	Y	D	P	U	T	B	E	M	U	E	S	Q	L	O	R	H	G	L	E	L	A
R	J	R	O	E	L	S	A	I	G	A	V	N	E	J	U	E	N	I	T	O	S
T	N	O	E	T	N	G	O	S	C	N	E	A	T	S	E	I	E	N	U	Q	Y
O	S	O	D	E	N	L	A	U	E	Q	U	A	T	O	R	G	N	E	I	V	E
B	A	C	S	E	O	N	E	U	B	L	S	E	D	I	A	H	D	S	I	S	R
E	R	Q	T	U	E	P	O	R	E	L	I	E	F	R	O	T	U	N	L	A	D
P	R	I	N	C	I	P	A	L	B	I	C	N	E	R	S	N	A	Y	A	H	O
I	C	D	O	C	S	T	R	I	P	M	I	N	E	R	E	D	I	T	O	Y	P

5. More Map Words—crossword puzzle, pages 33–34

Across

2. elevation
6. open pit
8. hachured
10. green
12. ground
13. principal
14. hills
16. relief
18. USGS
19. black
20. acres
21. minutes

Down

1. depression
3. topographic map
4. stream
5. bench marks
7. indexes
9. contours
11. upstream
15. longitude
17. locate

5. More Map Words—word search, page 35

P	O	R	U	N	L	A	D	O	H	A	Y	A	S	R	E	C	I	B	I	D	O	C	R
R	A	P	E	T	E	U	Q	O	R	T	O	L	E	R	O	P	Y	O	T	D	I	D	E
E	Z	C	A	N	D	F	A	C	I	B	L	E	S	H	I	L	L	S	T	E	Y	U	S
T	S	E	E	U	L	O	C	A	T	E	Q	O	E	R	C	S	O	E	S	R	A	L	C
A	D	E	P	R	E	S	S	I	O	N	S	R	E	C	C	O	N	T	O	U	R	S	O
U	Q	O	L	E	D	S	O	T	U	C	R	F	S	O	L	O	G	D	N	H	E	I	G
E	S	T	O	P	O	G	R	A	P	H	I	C	M	A	P	E	I	M	B	C	R	A	S
I	G	E	P	L	O	C	E	C	D	M	S	O	N	A	S	U	T	T	N	A	E	E	T
O	L	A	E	U	N	I	V	R	E	A	R	S	I	U	D	A	U	D	Y	H	L	A	V
N	O	S	N	A	I	R	A	E	T	R	Y	U	S	S	R	E	D	V	I	N	U	A	I
U	N	A	P	E	X	P	E	S	R	K	I	F	E	G	R	E	E	N	N	C	I	A	D
M	N	E	I	M	I	N	U	T	E	S	E	A	S	S	O	L	L	I	V	A	R	A	M
I	O	P	T	I	G	N	P	I	O	I	N	E	S	T	T	E	A	N	O	Y	O	E	S
F	E	D	S	E	R	S	S	A	L	L	C	O	D	N	A	R	N	E	S	N	E	Y	T
R	N	C	E	S	O	Y	T	E	S	O	L	A	U	K	N	A	E	D	E	E	S	P	O
A	N	O	C	Y	U	O	R	T	S	E	P	R	I	N	C	I	P	A	L	L	O	N	A
T	E	N	T	I	N	D	E	X	E	S	A	A	U	N	Q	A	U	E	M	A	N	D	O
J	A	B	A	R	D	T	A	E	D	N	O	I	T	A	V	E	L	E	A	N	E	L	L
O	Y	A	Q	U	E	C	M	A	D	A	C	L	A	S	E	E	S	B	U	N	N	I	V

6. Finding—crossword puzzle, pages 36–37

Across

2. locate
4. longitude
7. acres
8. minutes
11. sections
13. indexes
15. base lines
16. half
17. locate
18. townships
19. ranges

Down

1. meridian
2. latitude
3. coordinates
5. principal
6. Jefferson
9. sixty
10. principal
12. base line
14. equator

---

6. Finding—word search, page 38

R	R	O	T	A	U	Q	E	I	R	P	N	S	E	T	A	C	O	L
A	A	B	W	Y	T	X	I	S	R	L	A	H	Q	E	M	C	B	A
N	N	A	L	E	S	A	B	I	S	N	C	A	D	C	O	B	L	T
G	G	S	P	I	H	S	N	W	O	T	R	U	A	O	W	A	O	S
E	N	E	I	L	O	C	A	S	I	X	T	A	R	N	T	S	C	E
S	A	L	N	A	I	O	R	C	A	I	O	D	N	I	S	E	A	N
E	I	I	D	P	J	E	F	F	G	N	I	Q	T	U	E	L	H	I
X	D	N	A	C	F	M	I	N	U	N	P	U	O	Q	R	I	S	L
E	I	L	L	F	A	H	O	N	A	R	D	E	W	E	C	N	N	E
D	R	B	E	H	A	L	F	T	C	E	R	O	O	C	A	E	W	S
N	E	J	E	F	F	O	E	S	N	O	I	T	C	E	S	T	O	A
I	M	I	T	C	E	S	C	A	S	E	T	U	N	I	M	E	T	B

7. Measuring—crossword puzzle, pages 39–40

Across

5. compass
7. highway
8. scales
10. topographic map
13. geographic
15. fifty nine
17. height
18. relief
19. scale

Down

1. spot
2. magnetic
3. USGS
4. bar
6. position
9. large scale
11. ground
12. hiking
14. north
16. natural

---

7. Measuring—word search, page 41

D	T	H	G	I	E	H	S	G	S	U	H	G	I	H	T	R	O	N
N	S	C	A	S	E	L	A	C	S	E	G	R	A	L	O	E	R	W
U	C	E	N	I	N	Y	T	F	I	F	T	I	S	O	P	L	G	C
O	A	Y	A	W	H	G	I	H	M	I	T	O	P	S	O	I	O	I
R	L	N	U	O	R	G	P	O	A	F	U	E	N	N	G	E	P	H
G	E	I	L	E	R	A	S	E	G	R	A	L	O	A	R	F	O	P
N	S	U	L	A	R	U	T	A	N	E	A	A	I	T	A	A	T	A
I	C	W	B	G	I	K	I	H	E	L	P	C	T	U	E	W	E	R
K	A	C	O	M	P	A	S	S	T	I	M	S	I	R	N	H	N	G
I	L	P	F	I	F	T	Y	N	I	N	O	C	S	E	G	G	G	O
H	O	C	S	E	G	R	A	L	C	M	C	A	O	L	A	I	A	E
T	O	P	O	G	R	A	P	H	I	C	M	A	P	I	M	H	W	G

---

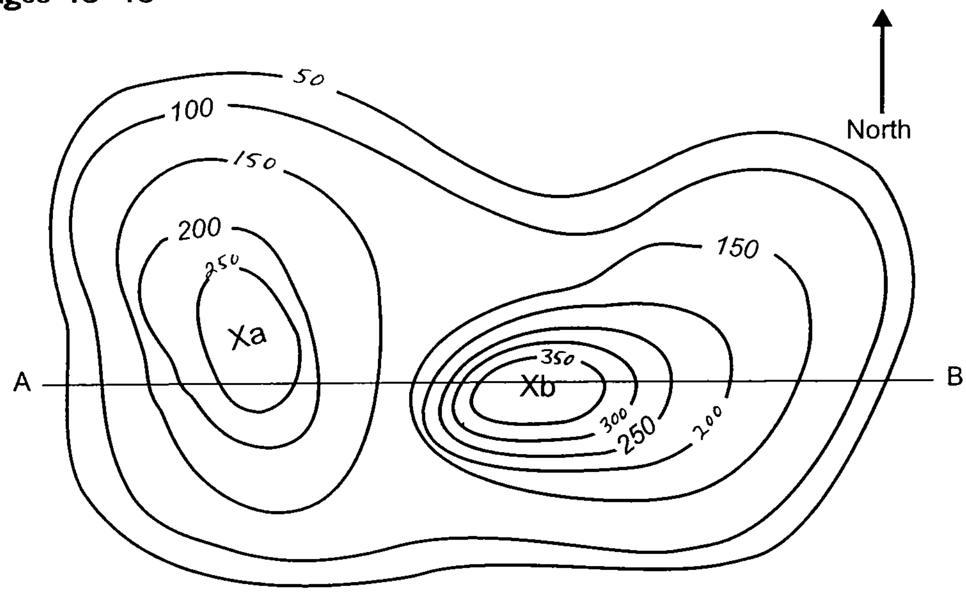
8. Geodetectives, page 42

1. **T**ownships
2. **O**pen pit
3. **P**rincipal
4. **O**klahoma
5. **G**reen
6. **R**elief
7. **A**cres
8. **P**osition
9. **H**eight
10. **I**ntersect
11. **C**ontour
12. **M**agnetic
13. **A**ngular
14. **P**urple

Hidden words:
TOPOGRAPHIC MAP

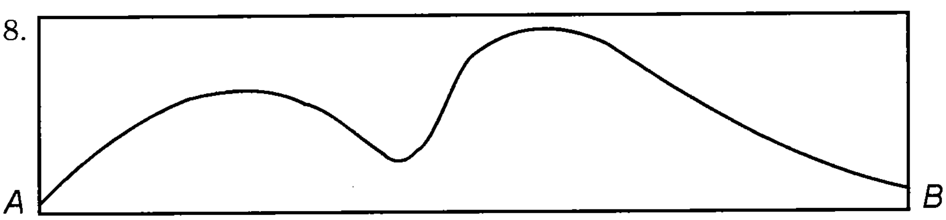
9. Reading Contours, pages 43–46

1. 50 feet
2. Greater than 250 feet but less than 300 feet
3. Greater than 350 feet but less than 400 feet
4. *xb:* contours are closer together on the western slope
5. West
6. The valley lies between the hills
7. 300 feet

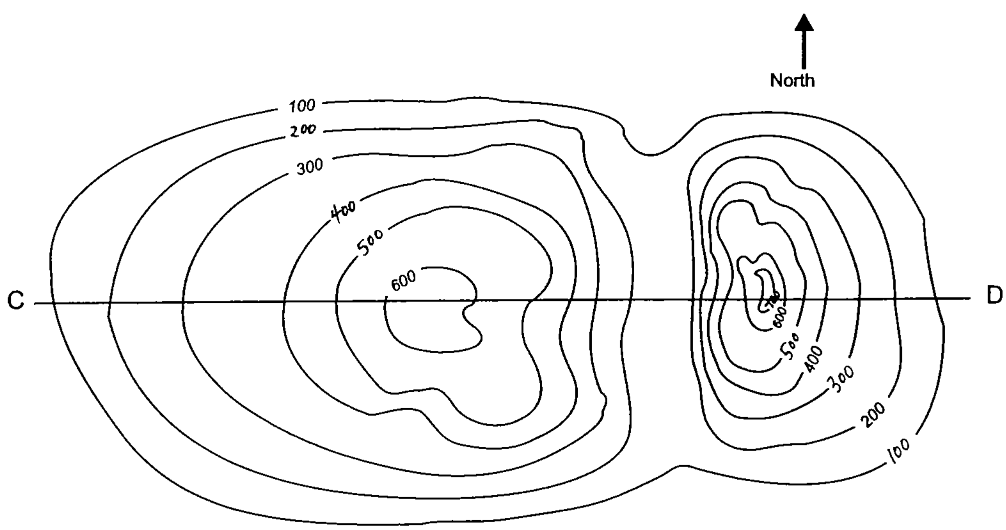


Map 9-0

8.



9. 100 feet
10. Hills
11. A valley lies between the hills
12. Greater than 700 feet but less than 800 feet
13. West
14. East
15. Eastern
16. 600 feet
17. *A* is the most accurate profile



Map 9-1

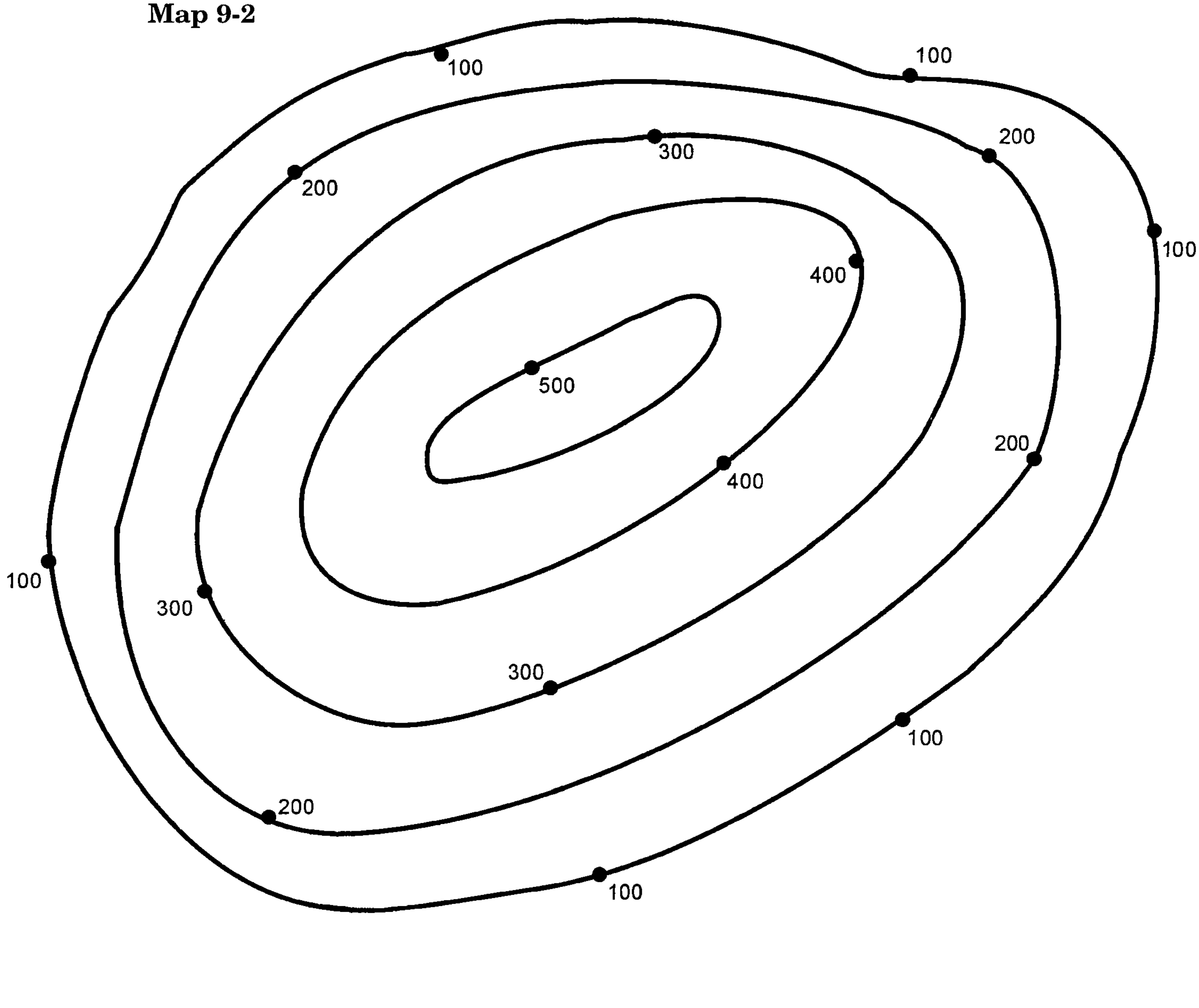
10. Drawing Contours #1, pages 47–48

1. 200 and 300
2. 300 and 400
3. 500
4. None

---

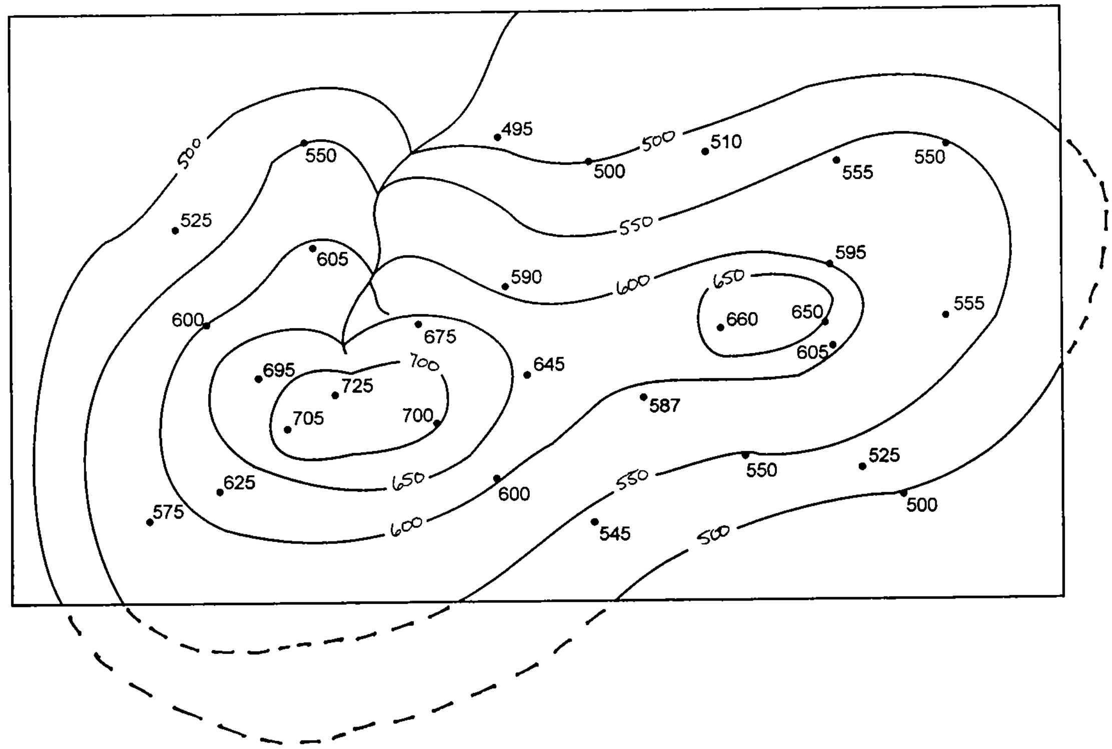
11. Drawing Contours #2, page 49

Map 9-2



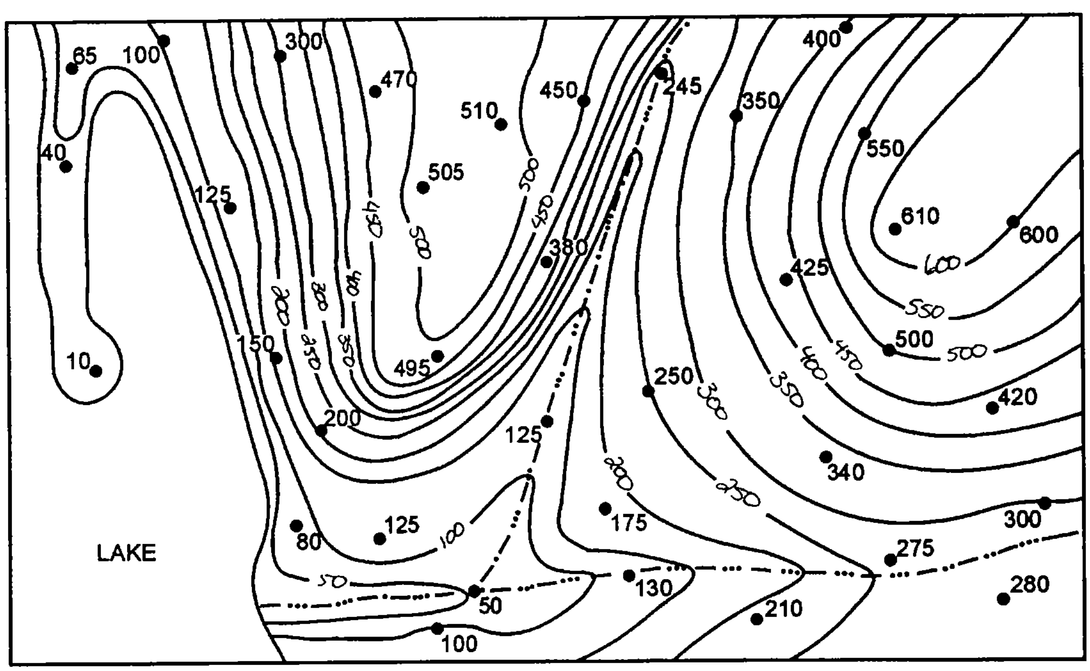
12. Drawing Contours #3, pages 50–51

Map 9-3



13. Drawing Contours #4, page 52

Map 9-4



14. Contour Talk—crossword puzzle, pages 53–54

Across

2. gentle
7. topographic
8. depression
10. contour
11. higher
13. closed
15. hills
16. shape

Down

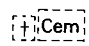
1. flat
3. elevation
4. upstream
5. contours
6. shoreline
9. intersect
12. relief
14. last
16. same

---

14. Contour Talk—word search, page 55

T	S	R	U	O	T	N	O	C	I	H	P	A	R	G	O	P	O	T
S	H	O	R	E	F	E	I	L	E	R	E	H	G	I	H	I	A	O
A	E	I	L	E	R	P	P	E	D	N	E	D	E	P	R	M	L	P
L	T	C	E	S	R	E	T	N	I	W	E	S	E	T	A	L	F	O
C	L	O	S	A	O	R	E	L	I	P	L	L	A	E	S	A	M	E
R	A	N	A	M	T	J	E	A	R	L	E	S	R	T	S	P	U	L
G	U	T	M	E	N	R	L	E	I	V	O	T	S	H	C	L	O	T
O	E	O	H	O	O	F	S	H	A	H	S	H	A	E	T	N	I	N
P	L	U	T	H	C	S	K	T	O	P	H	P	L	V	R	C	R	E
O	E	R	S	S	I	L	I	L	U	G	E	N	F	R	E	P	A	G
T	S	H	I	O	S	O	L	C	O	N	T	O	U	S	A	L	E	O
C	L	O	N	B	N	P	E	D	E	S	O	L	C	N	E	G	E	D

15. The Ada Quadrangle, pages 56–57

1. South-central
2. Pontotoc and Seminole Counties
3. Oklahoma Geological Survey
4. 56 square miles
5. SW¼, sec. 34, T. 4 N., R. 6 E.
6. Green, vegetation; blue, water; brown, contours; purple, revisions; black, cultural features.
7. School:  Church:  Cemetery: 
   Gravel pit:  Oil or gas well: ○
   Quarry:  Bench mark: BM△ 100
8. 940–950 feet
9. 80 to 90 feet
10. 5,000 feet; nearly 1 mile
11. About 33–45 acres
12. Francis Quadrangle
13. greater than 1040 feet but less than 1050 feet
14. Northward
15. Egypt Cemetery
16. 1:24,000; 2,000 feet
17. 230 feet
18. yes; 1993
19. 130 feet
20. 1,002 feet; railroad
21. sand deposits
22. Oil tanks
23. Extension of urban area
24. 20–30 acres
25. A hill

---

16. The Bethany NE Quadrangle, pages 58–61

Colors

1. Black
2. Green
3. Brown
4. Blue
5. Purple
6. Red
7. Along streams

Location

8. West
9. West
10. North
11. Indian Meridian
12. Parallel
13. West Central (WC)
14. 7′30″ (97°37′30″ – 97°30′ = 7′30″)
15. 35°45′
16. A meridian; 97°37′30″
17. A low flat area near an intermittent stream
18. A pond or lake, behind a dam
19. 35°41′N, 97°37′W

20a. SE¼ sec. 16, T. 14 N., R. 4 W.
20b. NW¼ sec. 28, T. 14 N., R. 3 W.
20c. NW¼ sec. 16, T. 14 N., R. 3 W.

Answers continue on page 80

16. The Bethany NE Quadrangle, pages 58–61 (continued)

20d. NE¼ sec. 7, T. 14 N., R. 3 W.

20e. SE¼ sec. 31, T. 14 N., R. 3 W.

21. About 20 acres

22. 5 miles (5 sections)

Symbols

23. --- ■ --- ■ --- ■ ---

24. _ _ _ _ _Pipeline

25. A gas-processing plant

26. 

27. Intermittent stream

—— · · · —— · · · —— (blue)

28. A landing strip

29. Christner Cemetery; [†]Cem

30. The pipeline transports gas from a point west of Bethany NE quadrangle— perhaps in the West Edmond Oil & Gas Field

31. $BM_{\times}$ 1041

32. unimproved; = = = = = = = =

33. ○

General Data

34. Central Oklahoma

35. 1983

36. Britton Quadrangle

37. Logan and Oklahoma Counties

38. 7½ degrees

39. Indian and Cimarron meridians

40. Each of the straight sections crosses a stream, and must be a dam

Scale

41. 1:24,000, or 1/24,000

42. 1.6 miles; 8,300 feet; 2.6 kilometers

43. 24,000

44. One inch equals 2,000 feet

45. 5.2 miles; 27,456 feet; 8,580 meters

46. 1:10,000

1.2 inches on map divided by 1,000 × 12 in./ft on ground = 1.2 in. divided by 12,000
= 1.2/1.2 divided by 12,000/1.2
= 1/10,000
= 1:10,000

47. 56 to 63 square miles (7 sections E–W; 8 to 9 sections N–S)

48. 10 feet

49. 990 feet; Deer Creek

50. 1,170 feet

51. 180 feet (1,170 feet minus 990 feet)

52. Greater than 1,140 feet but less than 1,150 feet

53. Southwest to northeast

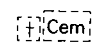
54. A hachured or depression contour; 1,050 feet; less than 20 feet

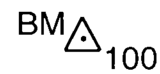
55. Sinkholes, sand and gravel pits, strip mines, quarries

56. 1,096 feet

57. From Hopewell Church to Walnut Creek, you go downhill (1,085 feet to 1,041 feet). From Walnut Creek to the light-duty road, uphill (1,041 feet to 1,060 feet). From the light-duty road to the intermittent stream at MacArthur Avenue, downhill (1,060 feet to 1,040 feet). From the intermittent stream to Deer Creek School, uphill (1,040 feet to 1,078 feet).

17. Oologah Field Trip, pages 62–64

1. Quarry: 
   Quarry product: limestone
   County: Rogers
2. Elevation at radio tower: >680<690 feet
   River dammed: Verdigris
   Lake use: water supply, recreation, flood control
3. Elevation of bridge at Lipe Mound: 690 feet
   Climb to top of Lipe Mound: 120 feet
   Steepest side of Lipe Mound: SW
   Gentlest side of Lipe Mound: NE
   Contour interval: 10 feet
4. Road surface: Light-duty road, all weather, improved surface
   Island location: sec. 31, T. 23 N., R. 16 E.
   Relief: 170 feet
5. Sweetwater Creek flows: west
   Tick marks along Highway 88: artificial fill (an embankment)
6. Along Highway 169 to Fourmile Creek: 1.8 miles; 2.9 kilometers
   Fourmile Creek flows southerly in general; here, southwesterly
7. At spot elevation 685: facing west
   Small streams here are intermittent
8. Strip mines yielded: coal
   Main use of coal: energy
   Next map to the west: Collinsville NE quadrangle
9. Back at Highway 169, facing: south
   After 2 miles, facing: east
   Will Rogers' Home: SW¼SW¼ sec. 13, T. 23 N., R. 15 E.
   Dashed light-blue pattern: areas subject to flooding
   Ridge height: 160 feet
   Ridge length: 2.6 miles; 4.2 kilometers
   Close spacing of contours means: steep slopes
10. School:  Cemetery: 

   Pipeline: _ _ _ _ _Pipeline Gravel pit: 
   Oil well: ○ Bench mark: 

   Railroad: ++++++
11. White areas along the Verdigris River: floodplain
   Development? No—because of flooding
12. About 1.5 miles farther, facing: north
   Relief of Claremore Mound: about 180 feet
   Elevation at the summit: greater than 780 feet, less than 790 feet
   Green area: vegetation
13. Feature in sec. 24, T. 22 N., R. 15 E.: quarry
14. Most gravel pits: along the Verdigris River
   Why there: carried by the river

18. Turner Falls Quadrangle, page 65

1. 7.5′ topographic quadrangle map
2. Turner Falls Quadrangle
3. south-central Oklahoma
4. 1:24,000; 1 inch = 2,000 feet
5. 10 feet
6. 56 to 63 square miles
7. U.S. Geological Survey, Department of the Interior
8. Oklahoma Geological Survey
9. Solid red lines
10. A lake
11. Woodland, vegetation, orchards
12. Contour lines; elevations
13. Buildings
14. East-central; (blue)
    Classen, Lick Creek, Turner Falls
15. Sec. 1, T. 2 S., R. 1 E.
16. Flat land, or very low relief
17. Contour interval; 10 feet
18. 1,377 feet
19. Steep slopes
20. 457 feet
21. 983 feet

---

19. Maps in Work and Play, page 66

Before a hike, consider:

- Steep slopes vs. flat land
- Drinking water
- Emergency help
- Sun and shade
- Compass setting

For an airport site, think about:

- Long runways
- Flight patterns and obstructions
- Cost of moving earth
- Service roads
- Transmission lines
- Railroads

In routing a highway, keep in mind:

- Cost of
  - buying right of way
  - cutting through hills
  - filling in low areas
  - building bridges
- Straight roads vs. curves
- Risk of flooding
- Quarries for construction material
- Hazards such as pipelines

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.

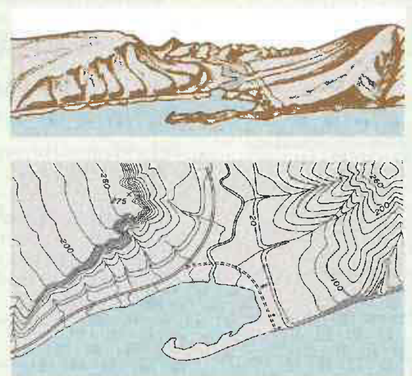
The first features usually noticed on a topographic map are the area features such as vegetation (green), water (blue), some information added during update (purple), and densely built-up areas (gray or red).

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 kinds or classes of information: topographic contours (brown); lakes, streams, irrigation ditches, etc. (blue); land grids and important roads (red); other roads and trails, railroads, boundaries, etc. (black); and some features that have been updated using aerial photography, but not field verified (purple).

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 also 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



Ground configuration shown by contours

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.

Topographic Map Information

For more information about topographic maps produced by the USGS, please call 1-888-ASK-USGS

ISBN 0-607-84384-5
9 780607 843842

Topographic Map Symbols

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

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 woods. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or to 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 type styles. On one type of large-scale topographic map, called provisional, some symbols and lettering are hand drawn.

The cover, a portion of the Elizabethtown, Kentucky, area, demonstrates how map symbols represent features on the Earth's surface. The bottom third, an aerial photograph, shows the Earth as seen from above; the middle part portrays some of the features on the aerial photograph that will be symbolized on the map; and the top third shows the finished map.

CONTROL DATA AND MONUMENTS

Aerial photograph roll and frame number* 3-20

Horizontal control

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

Vertical control

- Third order or better, with tablet
- Third order or better, recoverable mark
- Bench mark at found section corner
- Spot elevation

Boundary monument

- With tablet
- Without tablet
- With number and elevation

U.S. mineral or location monument

CONTOURS

Topographic

- Intermediate
- Index
- Supplementary
- Depression
- Cut; fill

Bathymetric

- Intermediate
- Index
- Primary
- Index Primary
- Supplementary

BOUNDARIES

- National
- State or territorial
- County or equivalent
- Civil township or equivalent
- Incorporated city or equivalent
- Park, reservation, or monument
- Small park

*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.

LAND SURVEY SYSTEMS

U.S. Public Land Survey System

- Township or range line
  - Location doubtful
- Section line
  - Location doubtful
- Found section corner; found closing corner
- Witness corner; meander corner

Other land surveys

- Township or range line
- Section line
- Land grant or mining claim; monument
- Fence line

SURFACE FEATURES

- Levee
- Sand or mud area, dunes, or shifting sand
- Intricate surface area
- Gravel beach or glacial moraine
- Tailings pond

MINES AND CAVES

- Quarry or open pit mine
- Gravel, sand, clay, or borrow pit
- Mine tunnel or cave entrance
- Prospect; mine shaft
- Mine dump
- Tailings

VEGETATION

- Woods
- Scrub
- Orchard
- Vineyard
- Mangrove

GLACIERS AND PERMANENT SNOWFIELDS

- Contours and limits
- Form lines

MARINE SHORELINE

Topographic maps

- Approximate mean high water
- Indefinite or unsurveyed

Topographic-bathymetric maps

- Mean high water
- Apparent (edge of vegetation)

COASTAL FEATURES

- Foreshore flat
- Rock or coral reef
- Rock bare or awash
- Group of rocks bare or awash
- Exposed wreck
- Depth curve; sounding
- Breakwater, pier, jetty, or wharf
- Seawall

BATHYMETRIC FEATURES

- Area exposed at mean low tide; sounding datum
- Channel
- Offshore oil or gas: well; platform
- Sunken rock

RIVERS, LAKES, AND CANALS

- Intermittent stream
- Intermittent river
- Disappearing stream
- Perennial stream
- Perennial river
- Small falls; small rapids
- Large falls; large rapids
- Masonry dam
- Dam with lock
- Dam carrying road
- Perennial lake; Intermittent lake or pond
- Dry lake
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Well or spring; spring or seep

SUBMERGED AREAS AND BOGS

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

BUILDINGS AND RELATED FEATURES

- Building
- School; church
- Built-up Area
- Racetrack
- Airport
- Landing strip
- Well (other than water); windmill
- Tanks
- Covered reservoir
- Gaging station
- Landmark object (feature as labeled)
- Campground; picnic area
- Cemetery: small; large

ROADS AND RELATED FEATURES

Roads on Provisional edition maps are not classified as primary, secondary, or light duty. They are all symbolized as light duty roads.

- Primary highway
- Secondary highway
- Light duty road
- Unimproved road
- Trail
- Dual highway
- Dual highway with median strip
- Road under construction
- Underpass; overpass
- Bridge
- Drawbridge
- Tunnel

RAILROADS AND RELATED FEATURES

- Standard gauge single track; station
- Standard gauge multiple track
- Abandoned
- Under construction
- Narrow gauge single track
- Narrow gauge multiple track
- Railroad in street
- Juxtaposition
- Roundhouse and turntable

TRANSMISSION LINES AND PIPELINES

- Power transmission line: pole; tower
- Telephone line
- Aboveground oil or gas pipeline
- Underground oil or gas pipeline