

Please note that the following topics are the focus of the NRES 250 material on the basic skills exam:

- (1.) Map reading and working with map scales
- (2.) US Public Land Survey System or Rectangular Survey System (including legal descriptions and acreages therein)
- (3.) Compass Use (including azimuths and bearings)

The material on the following pages should serve as a partial review of these topics for you.

## NRES 250 Map Reading Lab

### Objectives:

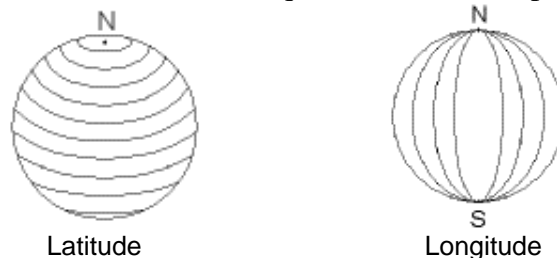
1. To provide a basis of understanding of the rectangular survey system (also known as the US Public Land Survey System), the land survey system employed throughout most of the United States.
2. To use the Rectangular Survey System to create and/or interpret legal descriptions of property ownership.
3. To use the Rectangular Survey System, Latitude-Longitude and the Universal Transverse Mercator systems to interpret quadrangle maps.

### Synopsis:

To simplify the use of maps, cartographers superimpose on a map a rectangular grid consisting of two sets of reference lines called parallels and meridians. On some maps the meridians and parallels appear as straight lines, but on some modern maps, they appear as curved lines, due to the mathematical treatment required to portray a curved surface on a flat surface. During the middle ages, the latitude and longitude system was developed. Since 1785, the Rectangular Survey System has been the basis of all land survey in the United States. This system is used to provide a description of any parcel of land that is unique only to that parcel. It, then, provides the basis for the legal description of all land ownerships. It also is one of the major “grid” systems used in the delineation and interpretation of maps. The U.S. Defense Mapping Agency adopted a special grid for military use throughout the world called the Universal Transverse Mercator (UTM) grid. This week in lab, we will be using these rectangular survey methods to interpret topographic maps.

### Introduction:

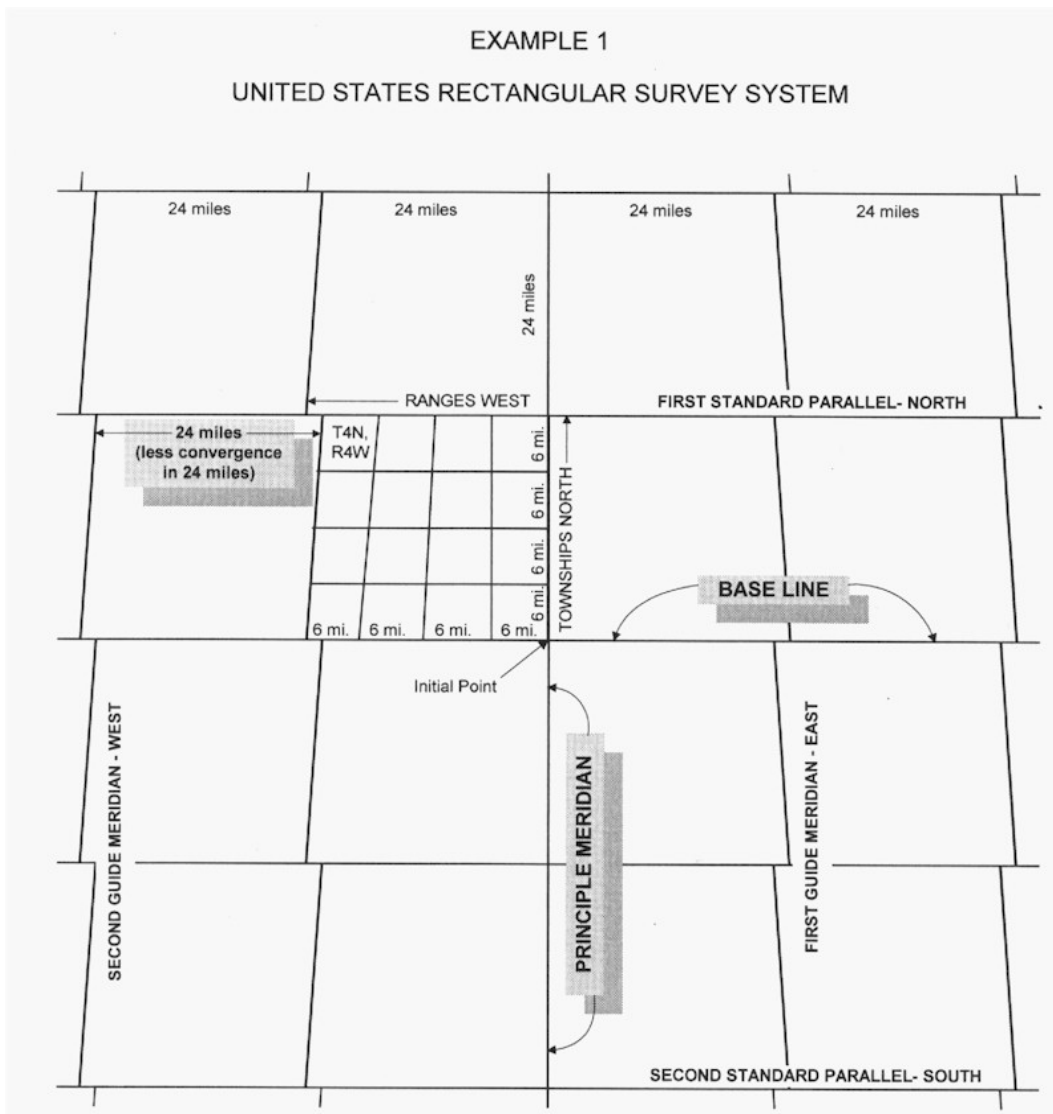
The **Latitude and longitude system** is based on degrees ( $^{\circ}$ ). Latitude lines extend horizontally (east-west) and are parallel, are equally distant from each other, approximately 69 miles (111 km) apart, with some variation due to the irregular surface of the earth. Latitude lines are numbered from  $0^{\circ}$  at the equator to  $90^{\circ}$  at the poles.

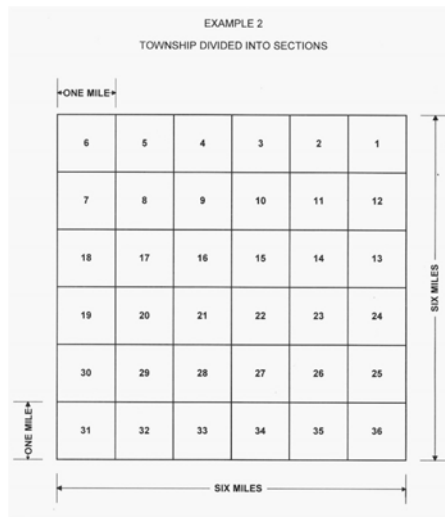


Longitude lines, also known as meridians, are approximately 69 miles (111 km) apart at the equator and converge toward the north and south poles. Zero degrees longitude, the Prime Meridian, is located at Greenwich, England. The degrees then increase eastward  $180^{\circ}$  and westward  $180^{\circ}$  from this Prime Meridian meeting at the International Date Line in the Pacific Ocean. To precisely locate points on the earth's surface, degrees longitude and latitude have been divided into minutes ( $'$ ) and seconds ( $''$ ), with 60 minutes in each degree and 60 seconds in each minute. Seconds can then be divided into tenths, hundredths, or thousandths. While lines of latitude tend to be uniformly spaced, the distance between longitude lines varies from

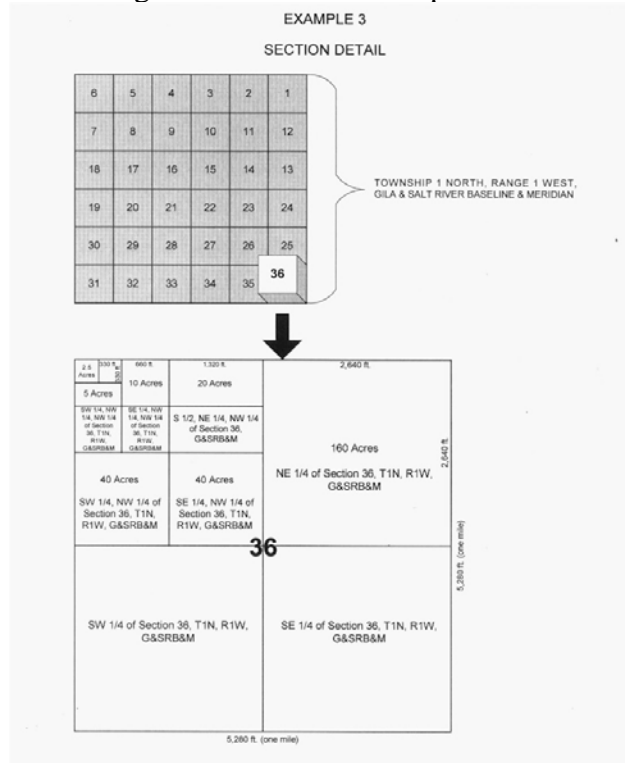
about 69 miles (111 km) at the equator to zero at the poles. While this system works well to identify locations on earth, it is not conducive to plotting linear and areal relationships. Latitude and longitude is designated in degrees, minutes and seconds on 7.5-minute topographic maps.

The System that has become known as the **Rectangular Survey System** (or **US Public Land Survey System**) was approved by the Continental Congress in 1785. It establishes a “gridwork” of rectangles (actually squares) which cover the land. In this system, there are 3 divisions: the first resulting in 24-mile by 24-mile blocks, each of which is divided into 16 6-mile by 6-mile townships, each of which is divided into 36 1-mile by 1-mile sections. The primary unit of the grid is the *section*, an area that is 1 mi<sup>2</sup> or 640 acres in size.





Each section is uniquely identifiable and may be further subdivided by fractional components. Therefore, any parcel of land in the United States (with some exceptions) may be specifically identified using this system. Thus its boundaries may be physically located on the ground and its ownership may be established and recorded. An understanding of land survey is critical to land managers. To practice land management, one must first be able to identify and locate the land that is to be managed. While such a statement may appear to be simple and obvious, failures in this regard will prove to have significant financial and professional implications.

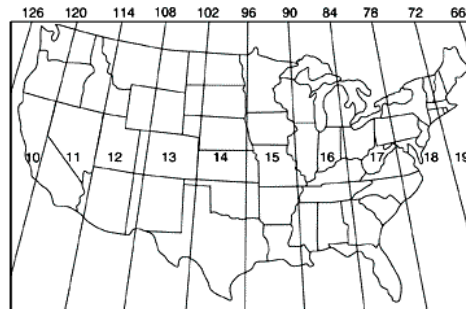


Township and range designations are indicated in red on the margins of 7.5-minute topographic maps. Section numbers are generally positioned centrally and are red.

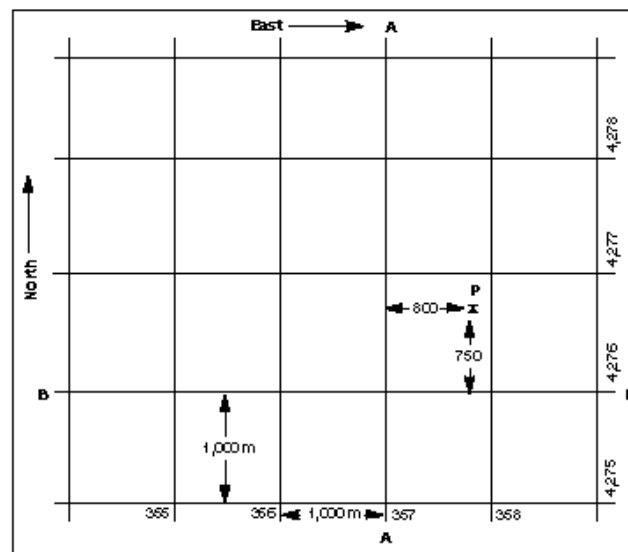
One can use a map called a **Plat Map** to determine ownership within the US Public Land Survey (or Rectangular Survey System) Plat maps (or plat books) are maps (or books) that show/include land ownership information with respect to the US Public Land Survey (or Rectangular Survey System). They are available for viewing at county courthouses, or parish courthouses if you are in Louisiana as Louisiana has parishes and not counties. One essentially locates the area denoted by the legal description and then can determine who or what owns the land in question.

The **Universal Transverse Mercator (UTM)** grid that was developed for use by the military lends itself readily to distance and areal measurements and therefore it is used by natural resource professionals who must base management or research decisions on those parameters. For instance, most wildlife telemetry studies involving determination of movements and home ranges of animals rely on UTM's for recording the data.

The UTM grid divides the world into 60 north-south zones, each covering a strip 6° wide in longitude. These zones, which are numbered consecutively, begin with Zone 1 between 180° and 174° west longitude and progress eastward to zone 60 between 174° and 180° east longitude. Thus the conterminous 48 states are covered by 10 of the zones.



Wisconsin is covered by the eastern portion of zone 15 and western portion of zone 16. Within each zone, coordinates are measured north and east in meters. Northing values are measured continuously from the Equator in a northerly direction. Easting values are measured continuously from the western boundary of the zone.



In the example above, the grid value of line A-A is 357,000 meters east. The grid value of line B-B is 4,276,000 meters north. Point P is 800 meters east and 750 meters north of the grid lines, therefore the grid coordinates of point P are east 357,800 and north 4,276,750 (designated as  $x = 357.8$ ,  $y = 4276.7$ ) UTM grids are designated on 7.5-minute topographic maps by thin black grid lines numbered at the map margins.

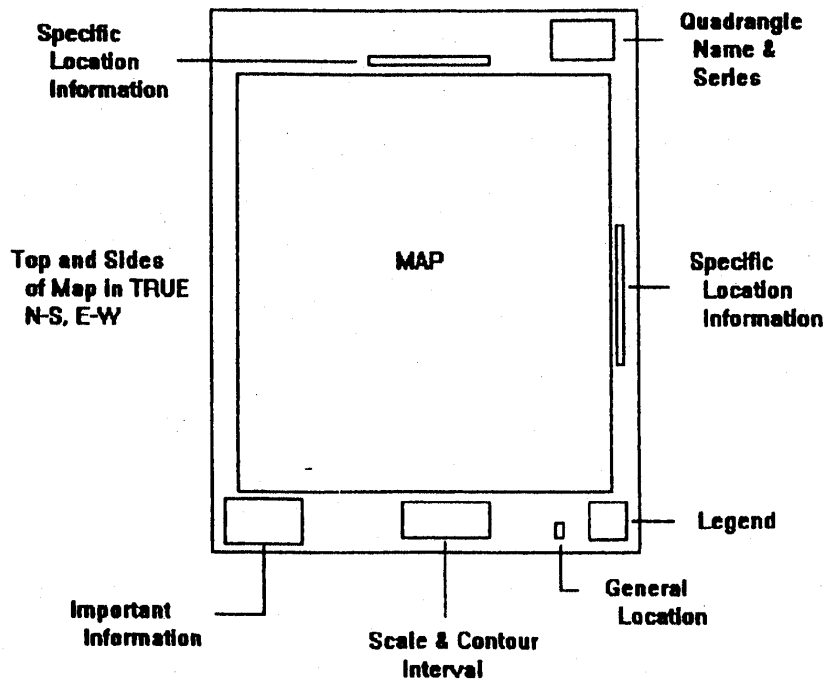
**Materials:**

- Topographic maps
- Topographic map key
- Ruler

**Methods:**

In lab this week we will review the rectangular land survey system and its use in constructing and interpreting legal descriptions of specific parcels of land. Topographic maps will be used to exemplify the 3 mapping systems described, and we will use USGS map symbol keys to interpret the topographic maps.

Reading a Quadrangle (Topographic) map:



NATURAL RESOURCES 250  
RECTANGULAR LAND SURVEY AND MAP READING USING THE HARRISON QUADRANGLE  
(ANSWERS AT END)

Questions:

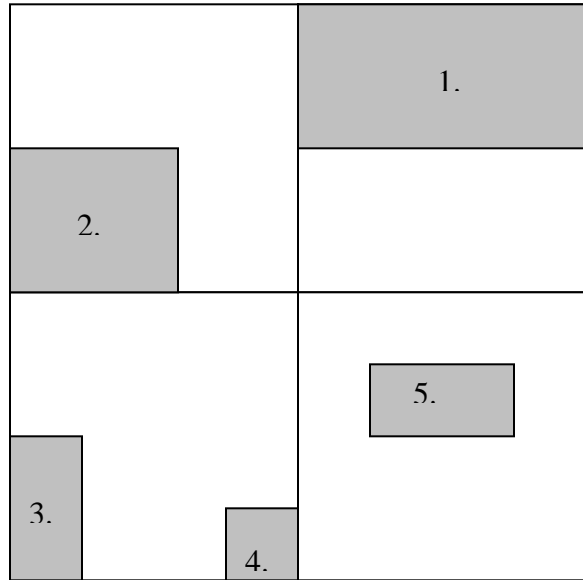
1. What is the name of the quadrangle map located just to the east of the Harrison Quadrangle map?
2. What is located at NE $\frac{1}{4}$  NE $\frac{1}{4}$  Sec. 27 T34N R7E Lincoln County, WI?
3. What are the latitude and longitude (to the nearest 30 seconds) of Miller Lake (S $\frac{1}{2}$  Sec. 6 T34N, R8E Lincoln County, WI)?
4. What is located at UTM coordinates 302.5 and 5037.7?
5. What is the legal description (down to 40 acres) of Bass Lake (located just south of Lake Alice)?
6. How long is Otter Lake along its longest axis, measured in feet on the land surface (SW $\frac{1}{4}$  Sect. 7, T34N, R8E Lincoln County, WI)?
7. Is Big Pine Creek, which is located at the southeast corner of Lake Alice (near the corner of County Highways H and D), an inlet or outlet?
8. What is the elevation of the bridge on Highway H at the junction of Big Pine Creek and Lake Alice?
9. What is the slope (feet of rise/feet of run) of the segment of Grundy Road from its intersection with Horn Road eastward to the location where Grundy Road turns to the South (look in Sec. 11 T34N R7E Lincoln County, WI) ?
10. What is the approximate elevation at the top of the hill just to the east of Lost Lake (NE $\frac{1}{4}$  NW $\frac{1}{4}$  Sec. 24, T34N, R7E Lincoln County, WI)?
11. How deep is Lost Lake?
12. What are the surface elevation and depth of Pickerel Lake (Sect. 16, T34N, R8E Lincoln County, WI)?

13. In what section is Jackknife Lake (northwest of Pickerel Lake) located?
14. What is the distance (on the ground in feet) from the westernmost edge of Ghost Lake to the center of the island in Pickerel Lake (look for these lakes in Sec. 17 T34N R8E Lincoln County WI and Sec. 16 T34N R8E, respectively Lincoln County, WI)?
15. What is the surface elevation of Bughouse Lake (southwest of Pickerel Lake) measured in feet above sea level?
16. What is the slope (measured in feet of rise/feet of run) of the land from the center of the hilltop east of Roothouse Lake to the easternmost point on the shore of Roothouse Lake?
17. What is located at the NE  $\frac{1}{4}$  NE  $\frac{1}{4}$  NE  $\frac{1}{4}$  Sec. 17, T34N, R8E, Lincoln County, WI?
18. Symbols that are similar to those found in section 17 are also found in the E  $\frac{1}{2}$  NW  $\frac{1}{4}$  Sec. 30, T34N, R8E, Lincoln County, WI. In what way do the two areas differ?
19. What is the length of South Silver Lake Rd. from the intersection with Highway H in Sect. 33 and its terminus at Silver Lake in Sect. 28, T34N, R7E, Lincoln County, Wisconsin?
20. How far and in what direction is the city of Tomahawk from the intersection of County highways D and H in Sect. 33, T35N, R7E, Lincoln County, Wisconsin?
21. What are the UTM coordinates for the Harrison School (in section 32 T35N R8E, Lincoln County, WI)?
22. What is the name of the township in which Lake Alice is located?
23. In section 9 T34N R7E, Lincoln County, WI is an object represented on the topographic map by parallel dashes and dots. What is this object?
24. What is located at UTM coordinates  $x=304.0$ ,  $y = 5039.56$ ?
25. Is the object identified in question number 24 surrounded by woods?

RECTANGULAR SURVEY  
Practice Problems  
(ANSWERS AT END)

Provide the legal description and acreage for each of the five parcels of land indicated in the diagram for Sec. 22, T.23N. R.8E. Portage County, Wisconsin below.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



On the diagram for Sec. 22, T.23N. R.8E. Portage County, Wisconsin below, locate the parcels of land having the following legal descriptions. How many acres are in each parcel?

1. E 1/2 NE 1/4 Sec. 22
2. NE 1/4 NW 1/4 Sec. 22
3. S 1/2 SW 1/4 SE 1/4 Sec. 22
4. NW 1/4 NW 1/4 SE 1/4 Sec. 22
5. SW 1/4 NW 1/4, NW 1/4 SW 1/4 Sec. 22



NATURAL RESOURCES 250  
RECTANGULAR LAND SURVEY AND MAP READING

Questions:

1. What is the name of the quadrangle map located just to the east of the Harrison Quadrangle map?  
**Parrish**

2. What is located at NE $\frac{1}{4}$  NE $\frac{1}{4}$  Sec. 27 T34N R7E Lincoln County, WI?

**Porcupine Mountain**

3. What are the latitude and longitude (to the nearest 30 seconds) of Miller Lake (S1/2 Sec. 6 T34N, R8E Lincoln County, WI)?

**Latitude = 45° 27' 30"      Longitude = 89° 32' 00"**

4. What is located at UTM coordinates 302.5 and 5037.7?

**Gravel Pit**

5. What is the legal description (down to 40 acres) of Bass Lake (located just south of Lake Alice)?

**SW  $\frac{1}{4}$  SW  $\frac{1}{4}$  Sec. 34 T35N R7E Lincoln County, WI**

6. How long is Otter Lake along its longest axis, measured in feet on the land surface (SW $\frac{1}{4}$  Sect. 7, T34N, R8E Lincoln County, WI)?

**~2,250 ft.**

7. Is Big Pine Creek, which is located at the southeast corner of Lake Alice (near the corner of County Highways H and D), an inlet or outlet?

**Inlet (flows into the lake)**

8. What is the elevation of the bridge on Highway H at the junction of Big Pine Creek and Lake Alice?

**1,462 ft. above sea level**

9. What is the slope (feet of rise/feet of run) of the segment of Grundy Road from its intersection with Horn Road eastward to the location where Grundy Road turns to the South (look in Sec. 11 T34N R7E Lincoln County, WI) ?

**Rise: ~ 30 feet      Run: ~1,250 ft.      Slope = 0.024 or 2.4%**

10. What is the approximate elevation at the top of the hill just to the east of Lost Lake (NE $\frac{1}{4}$  NW $\frac{1}{4}$  Sec. 24, T34N, R7E Lincoln County, WI)?

**~ 1,710 ft. above sea level**

11. How deep is Lost Lake?

**Not indicated on the map**

12. What are the surface elevation and depth of Pickerel Lake (Sect. 16, T34N, R8E Lincoln County, WI)?

**Surface = 1,738 ft. above sea level      Depth = at least 10 ft, but less than 15 ft.**

13. In what section is Jackknife Lake (northwest of Pickerel Lake) located?

**Section 8**

14. What is the distance (on the ground in feet) from the westernmost edge of Ghost Lake to the center of the island in Pickerel Lake (look for these lakes in Sec. 17 T34N R8E Lincoln County WI and Sec. 16 T34N R8E, respectively Lincoln County, WI)?

**~3,125 ft.**

15. What is the surface elevation of Bughouse Lake (southwest of Pickerel Lake) measured in feet above sea level?

**~1,744 ft.**

16. What is the slope (measured in feet of rise/feet of run) of the land from the center of the hilltop east of Roothouse Lake to the easternmost point on the shore of Roothouse Lake?

**Rise: ~110 ft. Run: ~625 ft. Slope: ~0.176 or 17.6%**

17. What is located at the NE ¼ NE ¼ NE ¼ Sec. 17, T34N, R8E, Lincoln County, WI?

**Wooded Marsh or Wooded Swamp**

18. Symbols that are similar to those found in section 17 are also found in the E ½ NW ¼ Sec. 30, T34N, R8E, Lincoln County, WI. In what way do the two areas differ?

**The area in section 30 is a non-wooded marsh or swamp**

19. What is the length of South Silver Lake Rd. from the intersection with Highway H in Sect. 33 and its terminus at Silver Lake in Sect. 28, T34N, R7E, Lincoln County, Wisconsin?

**~0.8 miles**

20. How far and in what direction is the city of Tomahawk from the intersection of County highways D and H in Sect. 33, T35N, R7E, Lincoln County, Wisconsin?

**~5.54 miles west**

21. What are the UTM coordinates for the Harrison School (in section 32 T35N R8E, Lincoln County, WI)?

**x = 303.7 , y = 5038.8**

22. What is the name of the township in which Lake Alice is located?

**King**

23. In section 9 T34N R7E, Lincoln County, WI is an object represented on the topographic map by parallel dashes and dots. What is this object?

**Power Transmission Line**

24. What is located at UTM coordinates x=304.0, y = 5039.56?

**Cemetery**

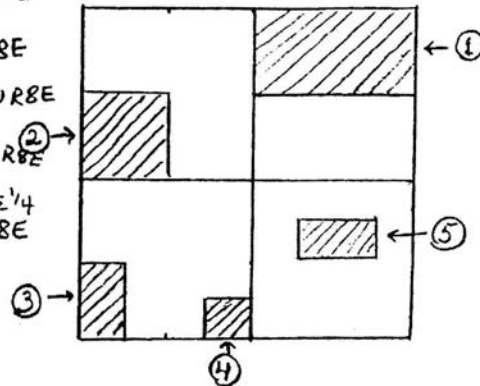
25. Is the object identified in question number 24 surrounded by woods?

**No**

Key  
RECTANGULAR SURVEY  
Practice Problems

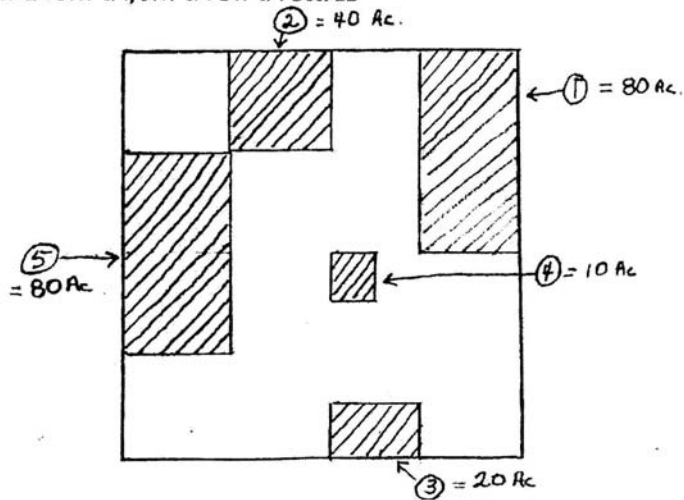
Provide the legal description and acreage for each of the five parcels of land indicated in the diagram for Sec. 22, T.23N. R.8E. below.

1. N 1/2 NE 1/4 Sec. 22, T.23N R.8E
2. SW 1/4 NW 1/4 Sec. 22, T.23N R.8E
3. W 1/2 SW 1/4 SW 1/4 Sec. 22, T.23N R.8E
4. SE 1/4 SE 1/4 SW 1/4 Sec. 22, T.23N R.8E
5. SW 1/4 NE 1/4 SE 1/4, SE 1/4 NW 1/4 SE 1/4 Sec. 22, T.23N R.8E



On the diagram for Sec. 22, T.23N. R.8E. below, locate the parcels of land having the following legal descriptions. How many acres are in each parcel?

1. E 1/2 NE 1/4 Sec. 22
2. NE 1/4 NW 1/4 Sec. 22
3. S 1/2 SW 1/4 SE 1/4 Sec. 22
4. NW 1/4 NW 1/4 SE 1/4 Sec. 22
5. SW 1/4 NW 1/4, NW 1/4 SW 1/4 Sec. 22



**NOTE THAT FOR SPACE REASONS, THE COUNTY AND STATE WAS NOT INCLUDED IN THE ABOVE LEGAL DESCRIPTIONS. TO BE 100% CORRECT, THE COUNTY AND STATE SHOULD APPEAR AT THE END OF EACH LEGAL DESCRIPTION**

## Natural Resources 250

### Direction and Distance – Compass and Pace

#### Objectives:

The students will:

1. Learn the basics of angular measure using Bearings and Azimuths;
2. Become familiar with the use of the compass for performing angular measurements or following lines of travel in the field;
3. Learn the basic principles of distance measure using Pacing; and
4. Apply compass and pacing techniques in a field exercise.

#### Synopsis:

In this exercise, students will be introduced to the basic principles of angular measurement, using both bearing and azimuth systems, and to the system of distance measurement using pacing.

#### Introduction:

One of the most important requirements of natural resources management is the ability to determine distance and direction in field applications. Direction is measured with a compass and distance is measured either with a tape (or chain) or by pacing. Since most fieldwork involves fast estimates, pacing is used often for distance measure.

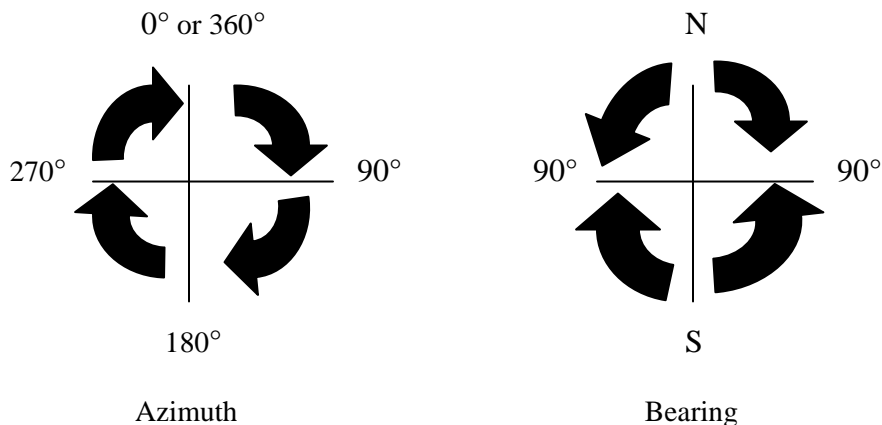
#### Direction

Direction is determined as an angular measure referenced to the north/south, east/west ordinal base. Because maps usually are drawn referenced to "True North", measures of angles in the field are usually adjusted to that basis. Angular measures are usually stated in terms of the Azimuth or Bearing systems.

The *azimuth system* measures the acute angles clockwise from true North, in units of degrees (0-360). For example, an azimuth may be stated as  $77^\circ$  or  $327^\circ$ .

The *bearing system* measures the acute angle from the true meridian (either North or South) to the desired line and is referenced to the ordinates. For example, a bearing may be stated as  $S85^\circ W$  or  $N22^\circ E$ . A bearing cannot be stated in excess of  $90^\circ$ .

Both azimuths and bearings describe the same direction, they only express it differently.



### Declination

All angles are measured from a "true" meridian. However, the compass needle is oriented or attracted to magnetic north. The difference between True North and Magnetic North is called *declination*. Declination varies from place to place and even varies slowly over time. Factors such as the tilt of the Earth on its axis, sunspots, magma movement, etc. all influence declination. Points on the Earth's surface, which have equal declinations, are connected by what we refer to as *isogonic lines*. A special isogonic line, connecting all points of zero declination, is called the *agonic line*.

Many compasses are adjustable to compensate for declination. Regardless, before using a compass in an area, you should determine the declination and either allow for it mentally or adjust your compass to compensate. Failure to compensate for declination can result in significant errors in field practice. Keep in mind, an error of 1° in line of travel will result in 93 feet of error in 1 mile. These errors are compounded. That is, 93 feet of error will occur for each 1°, for each mile.

Practice Problems:

Convert the listed azimuth to a bearing (or the listed bearing to an azimuth).

<u>Azimuth or Bearing</u>	<u>Converted Answer</u>
a.) N 15° W	_____
b.) 25°	_____
c.) S 13° E	_____
d.) 146°	_____
e.) N 6° E	_____
f.) N 6° W	_____
g.) 180°	_____

Answers on the next page...

Practice Problem Answers:

Convert the listed azimuth to a bearing (or the listed bearing to an azimuth).

<u>Azimuth or Bearing</u>	<u>Converted Answer</u>
a.) N 15° W	<u>345°</u>
b.) 25°	<u>N 25° E</u>
c.) S 13° E	<u>167°</u>
d.) 146°	<u>S 34° E</u>
e.) N 6° E	<u>6°</u>
f.) N 6° W	<u>354°</u>
g.) 180°	<u>Due South</u>