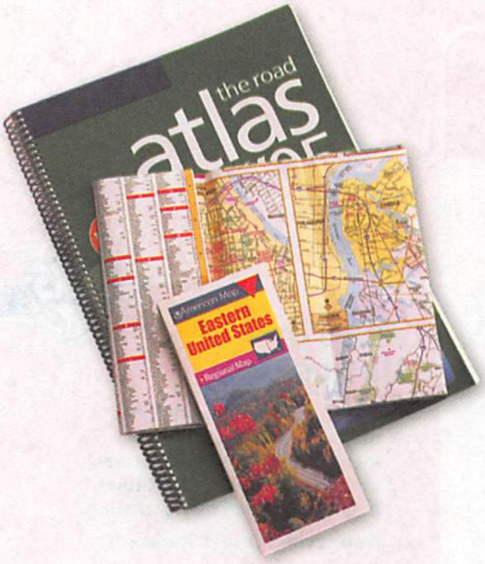

Figure 1 Road maps of counties or cities can be very detailed, but an atlas of maps of the 50 states might show only the important or main roads.

Types of Maps TEKS 8.9 (C)

If you were going to join two pieces of wood, you might use a hammer and nails. To scramble eggs you could use a whisk and a skillet. Just as there are tools for doing different jobs, there are maps for different purposes.

General-Use Maps

The first maps were hand drawn by explorers and sailors to record their trading routes. Today we use maps in a variety of situations. You might use a map to help a friend find your house or the quickest route to the mall. If you go to a park, there might be a trail map outlining the route you will hike. Some everyday maps you might use include:

- **Physical maps** use lines, shading, and color to indicate features such as mountains, lakes, and streams.
- **Relief maps** use shading and shadows to identify mountains and flat areas.
- **Political maps** show the boundaries between countries, states, counties, or townships. The boundaries can be shown as a variety of solid or dashed lines. Different colors might be used to indicate areas within the boundaries.
- **Road maps,** as shown in **Figure 1,** can show interstate highways and a range of roads from four-lane expressways to gravel roads. Maps are useful in helping you find your way.

Describe

1. Describe the four types of general-use maps.

Type: Physical	Type: Relief	Type: Political	Type: Road

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Topographic Maps

If you were hiking across the United States, you might want to follow level terrain. If you were piloting an airplane across the United States, you would definitely want to fly higher than a mountain. Showing you how high or low land features are is a feature of one kind of specialty map.

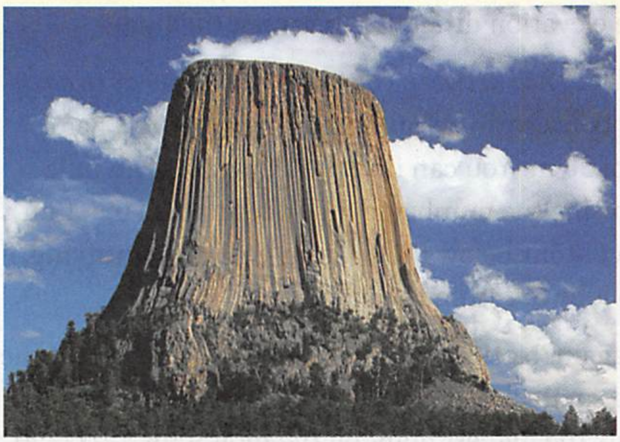
The shape of the land surface is called **topography.** *A* **topographic map** *shows the detailed shapes of Earth's surface, along with its natural and human-made features.* It helps give you a picture of what the landscape looks like without seeing it. The topographic map of Devil's Tower in **Figure 2** shows the details you cannot see in the photo.

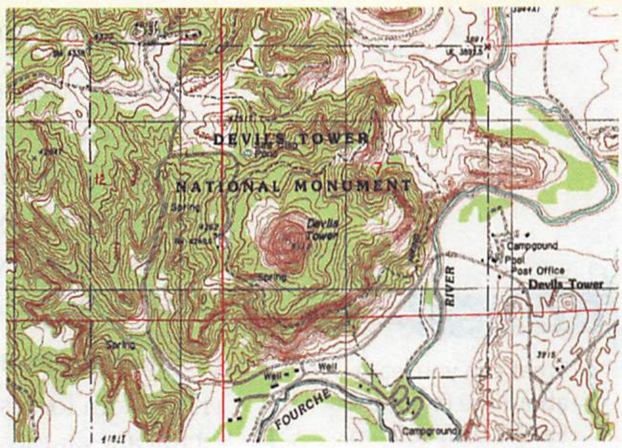
Word Origin

topography
from Greek *topos,* means "place"; and *graphein,* means "to write"

Topographic Map

Figure 2 Contour lines on the topographic map show differences in elevation on this volcanic tower. Where contour lines are closely spaced, the topography is much steeper.





Elevation and Relief *The height above sea level of any point on Earth's surface is its* **elevation.** For example, Mt. Rainier in Washington is 4,392 m above sea level. The city of Olympia, Washington, is about 43 m above sea level. *The difference in elevation between the highest and lowest point in an area is called* **relief.** For example, the relief between Mt. Rainier and Olympia is calculated 4,392 m − 43 m = 4,349 m.

Contour lines *are lines on a topographic map that connect points of equal elevation.* Similar to lines of latitude and longitude, contour lines do not really exist on Earth's surface. Using contour lines, you can measure elevation and relief on a topographic map. If the top of Devil's Tower is 5,112 ft and the base is 4,400 ft, what is the relief?

Connect

2. Discuss how contour lines are similar to lines of latitude and longitude. Write your response in your interactive notebook.

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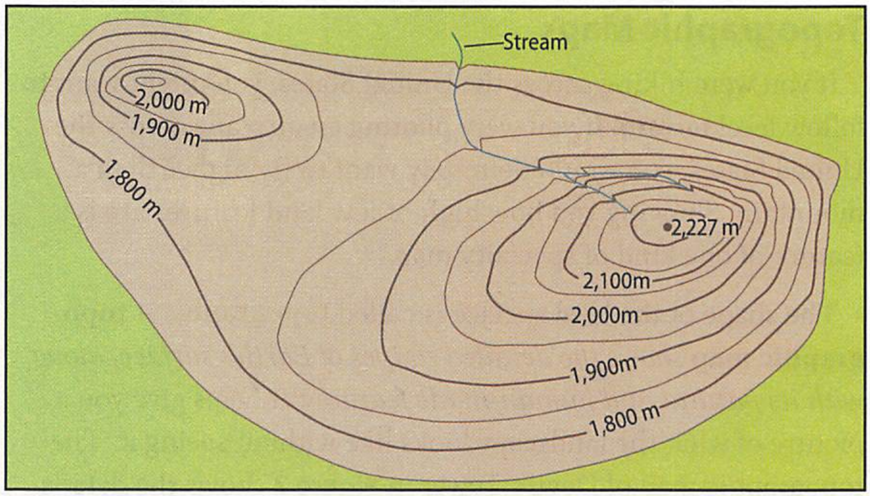
Figure 3 Contour lines connect points of equal elevation. This means that if you physically followed a countour line, your elevation would remain constant.



LAB Manager

MiniLAB: *Can you construct a topographic profile?*

TEKS 8.2(A), (C), (E); 8.9(C)

Interpreting Contours Contour lines that represent a mountain are shown in **Figure 3.** Notice that the elevation is not written on every contour line. The darker contour lines, called index contours, are labeled with the elevation. How do you find the elevation of contours other than by using index contours? You need to know the elevation difference between the lines.

The elevation difference between contours that are next to each other is called the **contour interval.** The map in **Figure 3** has a contour interval of 50 m. You can find the elevation of an unlabeled contour by using the numbered index contours. First, find the closest index contour below the contour you are identifying. Then count up to it by 50s from the index contour.

Study **Figure 3** again. Notice that a contour line at the top of the mountain forms a small closed loop with a dot in the middle of it. This dot represents the highest point on the mountain—2,227 m. The V-shaped contours pointing downhill indicate ridges. A small V pointing uphill indicates a stream valley or drainage.

The spacing of contours indicates slope. **Slope** *is a measure of the steepness of the land.* If the contours are spaced far apart, the slope is gradual or flat. If the contours are close together, the slope is steep.

Topographic Profiles The physical features on Earth can vary from tall mountains to low valleys to flat plains. The information contour lines provide on a topographic map of these areas can be used to draw an accurate profile of the surface. Topographic profiles can also be used to identify erosional features created by wind, water, and glaciers. These features, such as landslides, slumps, valleys, and peaks, can be interpreted by analyzing the countour line spacing.

Explore

3. What can you learn about the features on Earth's surface from studying contour lines?

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Watch

Go Online!

Table 1 USGS Topographic Map Symbols

Description	Symbol
Primary highway	
Secondary highway	
Unimproved road	
Railroad	
Buildings	
Urban area	
Index contour	100
Intermediate contour	
Perennial streams	
Intermittent streams	
Wooded marsh	
Woods or brushwood	

Symbols on Topographic Maps The United States Geological Survey (USGS) has been responsible for mapping the United States since the late 1800s. Most topographic maps that you see are made by the USGS. A topographic map shows more than contours. **Table 1** shows some of the symbols used on these maps. Features are represented on maps as points, lines, or areas, depending on their size. The colors of the lines or areas usually indicate similar classes of information. For example, green indicates vegetation, such as woods. Water in rivers, lakes, or oceans is shown in blue.

Interpret

4. Why is it important for a topographic map to have a legend?

FOLDABLES®

Cut out the Lesson 8.2 Foldable in the back of the book. Use it to collect information that you just learned about topographic maps.

Tape here

Topographic Maps

Write about it

Write about it

Write about it

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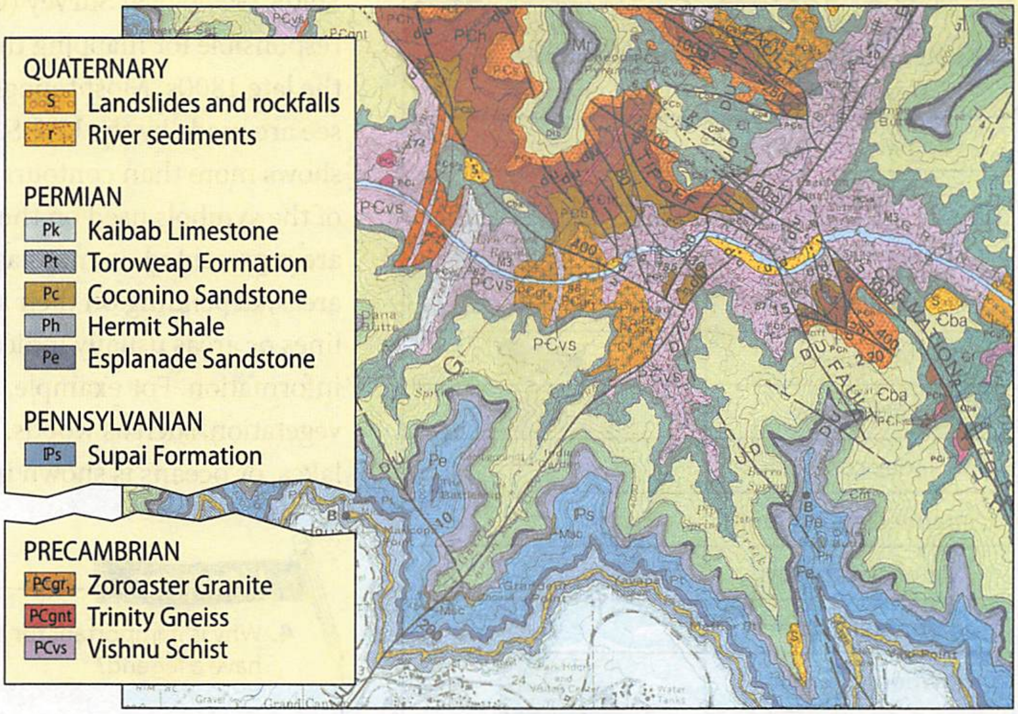
Geologic Map

Figure 4 The different colors represent different rock types or formations on a geologic map.

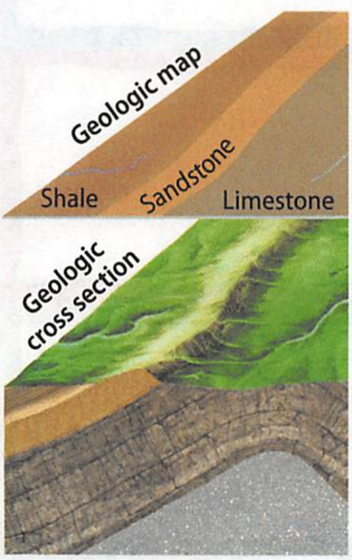


Geologic Maps

Another kind of specialty map is a geologic map. **Geologic maps** *show the surface geology of the mapped area.* This can include the rock types, their ages, and locations of faults. The geologic map in **Figure 4** shows the geology of the Grand Canyon.

Geologic Formations On a geologic map, different colors and symbols represent different geologic formations. A geologic formation is a rock unit with similar origins, rock type, and age. The map legend lists the colors and symbols along with the age of the rock formation. The colors do not indicate the rock's true colors; they show the many formations on the map. Find the Kaibab formation in the map legend of **Figure 4.** It tells you this limestone rock was made during the Permian period.

Figure 5 A cross section of a geologic map shows a vertical slice through the rocks below the surface.



Geologic Cross Sections Sometimes geologists need to know what the rocks are like underground as well as on the surface. Information can be gathered by drilling for samples, studying earthquake waves, or looking at cliffs. A cliff face is like a profile view of the ground. Geologists use this information to produce a profile view of the rocks below the ground. *The resulting diagram, showing a vertical slice through the rocks below the surface, is called a* **cross section.** **Figure 5** shows a cross section of a geologic map.

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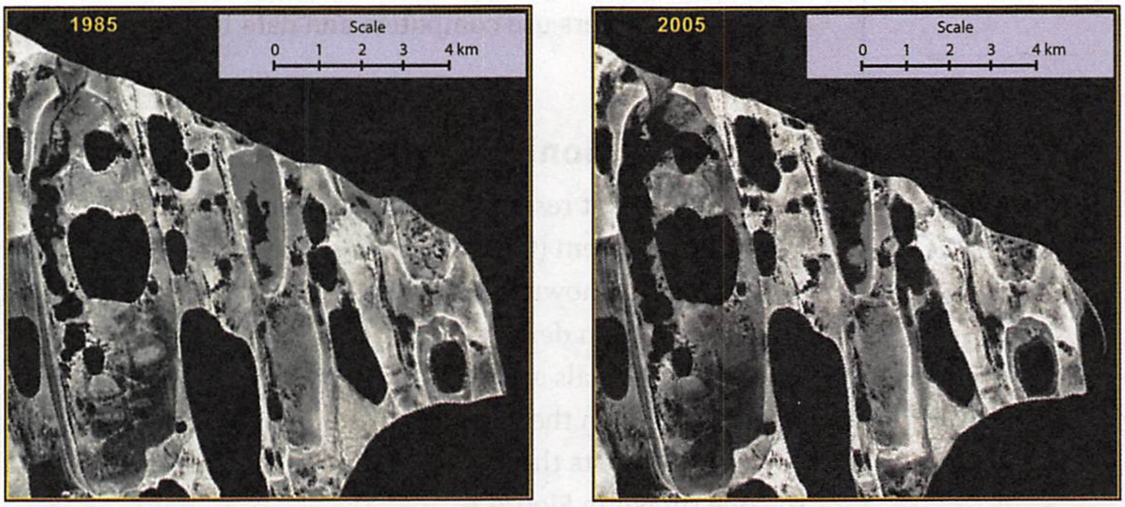
Organize it!

Interpret The images below were taken by the *Landsat 5* satellite and show the lake evolution and coastline erosion of Cape Halkett, Alaska, from 1985 to 2005. Describe how the coastline and lakes have changed over the past 30 years. TEKS 8.9 (C)



Predict what this area will look like in 2025. Explain your reasoning.

Read the next section, *Making Maps Today.* Determine which type of technology would be most helpful in interpreting what this area will look like in the future. Explain your reasoning.

Copyright © McGraw-Hill Education John Mars/U.S. Geological Survey

Explain

5. What is GPS and how is it used by mapmakers?

Making Maps Today **TEKS** 8.3(D); 8.9(C)

For centuries mapmakers made observations of Earth and gathered information from explorers. First, mapmakers and explorers used instruments such as a compass, a telescope, and a sextant, which is used to find latitude, to make and record measurements. Then, mapmakers carefully drew new maps by hand. Today, mapmakers use computers and data from satellites to make maps.

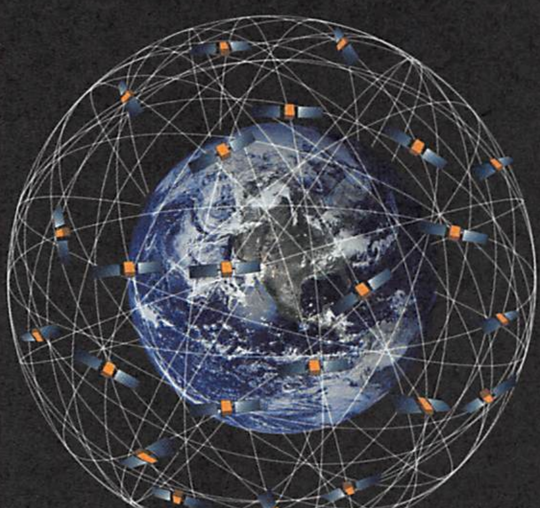
Global Positioning System

One important resource for mapmakers today is the Global Positioning System (GPS). GPS is a group of satellites used for navigation. As shown in **Figure 6,** 24 GPS satellites orbit Earth. Signals sent from devices on the surface are returned to Earth. The relayed signals are used to calculate the distance to the satellite based on the average time of the signal. The devices may be handheld units the size of a cell phone or larger units such as the one shown in **Figure 7.**

At any given time, a GPS unit receives signals from three or four different satellites. Then the receiver quickly calculates its location—its latitude, longitude, and altitude. GPS is used by mapmakers to accurately locate reference points.

Global Positioning System

Figure 6 GPS receivers detect signals from the 24 GPS satellites orbiting Earth. Using signals from at least three satellites, the receiver can calculate its location within 10 m.



1 **The information from one satellite tells the GPS receiver that it is somewhere on a sphere surrounding that satellite. Suppose the distance to the satellite is 20,000 km. This limits the possible location of the receiver to a spherical radius of 20,000 km from the satellite. If the receiver is on Earth, that limits the location to a large circle somewhere on Earth.**

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Originally designed for military purposes, it is now a continuously available service for everyone worldwide. Airplanes, ships, and cars have navigational systems that use GPS technology. People can find their way to restaurants, hotels, or sporting events and home again. Other uses include tracking wildlife for scientific data collection, detecting earthquakes, hiking, biking, and land surveying. **Figure 7** shows a portable GPS receiver you might use while traveling in a car.

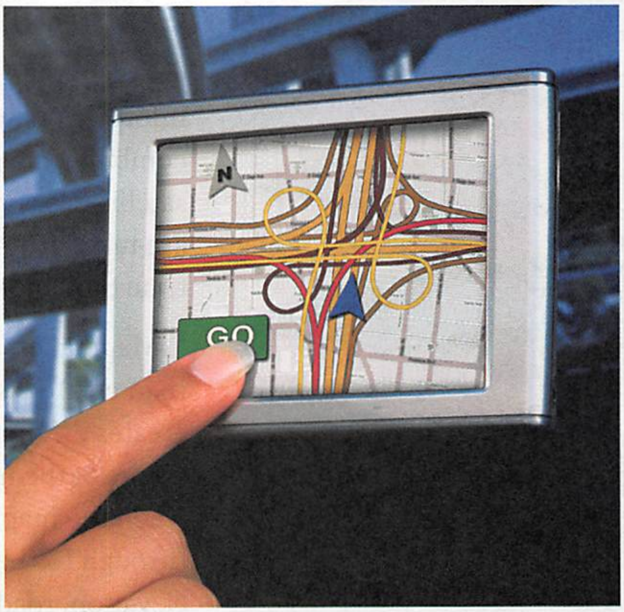


Figure 7 Portable GPS receivers like this one can be used to help find your way.

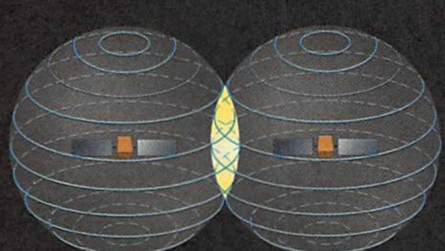
GPS technology continues to improve. Land-based units used in combination with satellites are already being used to pinpoint people and places to the centimeter. Future improvement will include additional civil channels projected to improve safety and rescue operations and eventually could be used to guide self-driven automobiles.

Infer

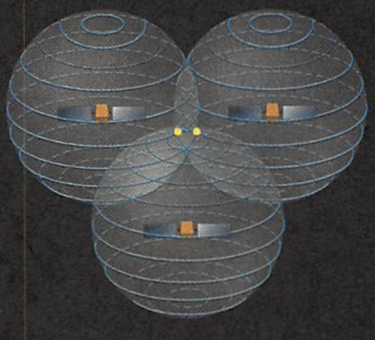
6. Underline some common uses of GPS technology.

Watch

Go Online!



2 Next, the receiver measures the distance to a second satellite. Suppose this distance is calculated to be 21,000 km away. The location of the receiver has to be somewhere within the area where the two spheres intersect, shown here in yellow.



3 Finally, the distance to a third satellite is calculated. Using this information, the location of the receiver can be narrowed even further. By adding a third sphere, the location can be calculated to be one of two points as shown. Often one of these points can be rejected as an improbable or impossible location. Information from a fourth satellite can be used to tell elevation above Earth's surface. A pilot or a climber might find this useful.

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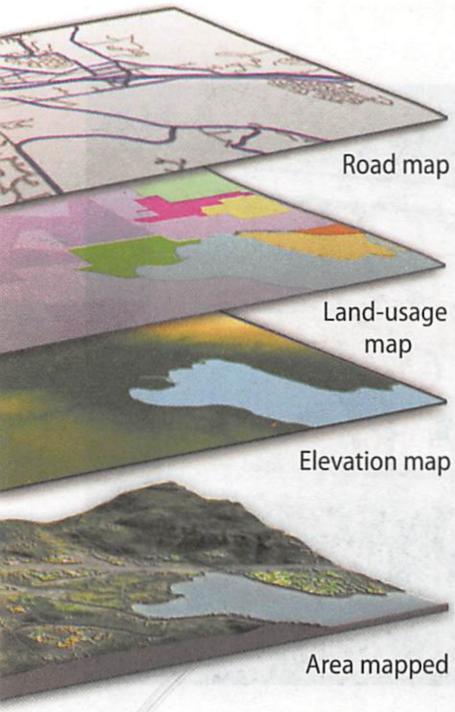

Figure 8 GIS combines the data from many maps to give detailed information about a mapped area.

Geographic Information Systems

Geographic Information Systems (GIS) are computerized information systems used to store and analyze map data. GIS combine data collected from many different sources, including satellites, scanners, and **aerial** photographs. Aerial photographs are taken from above the ground. Data collection that at one time took months now takes hours or minutes.

Mapmakers use GIS to analyze and organize those data and then create digital maps. One of the features of GIS is that it creates different map layers of the same location. As shown in **Figure 8,** the map layers are like the layers of a cake. However, when the map layers are placed on top of each other, you can see through to the lower layers. Different layers can show land use, elevation, roads, streams and lakes, or the type of soil on the ground.

Three Views Imagine setting up a model for an airplane that is landing under certain weather conditions using GIS.

- Database view begins the process by assembling information from existing databases on winds, airplane flight, landing procedures, and airport layouts.
- Map view would draw from a set of interactive, digital maps that show features and their relationship to Earth's surface.
- Model view then would pull all the information together so you could run simulations under changing weather conditions.

Academic Vocabulary

aerial ***(adjective)***
operating or occurring overhead

Apply it! TEKS 8.9C

Is it stable? Imagine you are a geologist working for a construction company. The company would like to build houses along the Rio Grande River in Laredo, Texas. They have hired you to determine whether the topography of the land is stable enough to build the houses. Your job is to interpret the topographic maps to find any mass erosion features.

Obtain topographic maps of this region and analyze the topography of the land to determine whether the houses will be stable.

1. Predict which areas are most susceptible to weathering.

____

____

2. Where would you recommend the company place the houses? Explain your reasoning.

____

____

Apply it!

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Remote Sensing

A cup of hot chocolate looks very hot. You place your hand over it and feel the heat from the liquid. Without even touching it, you know it's still too hot to drink. You have just avoided burning your mouth by using remote sensing.

Remote sensing *is the process of collecting information about an area without coming into physical contact with it.* There are many applications for remote sensing. This process produces maps that show detailed information about agriculture, forestry, geology, land use, and many other subjects. Often these maps cover huge areas.

Mapmaking was transformed when it became possible to take aerial photographs from airplanes. Now an even more powerful type of remote sensing is being used. Since the 1970s, satellites orbiting thousands of kilometers above Earth's surface have been used to collect data.

Monitoring Change with Remote Sensing Remote sensing can be used to analyze and map large, remote areas. Satellites orbit Earth repeatedly. This means images of a location made at different times can be used to study change. Comparing satellite images allows scientists to observe how an area has changed over time and whether it has been effected by erosion. For example, in 2005, Hurricane Katrina struck the Gulf Coast. Before and after images of the Mississippi River delta region are shown in **Figure 9.** Images like these help mapmakers quickly make maps of areas affected by natural disasters. The maps are then interpreted and used to monitor damage and to help organize rescue efforts. Remote sensing technology also allows for the creation of more accurate topographic maps.

Summarize

7. How can remote sensing be an advantage to mapmakers?

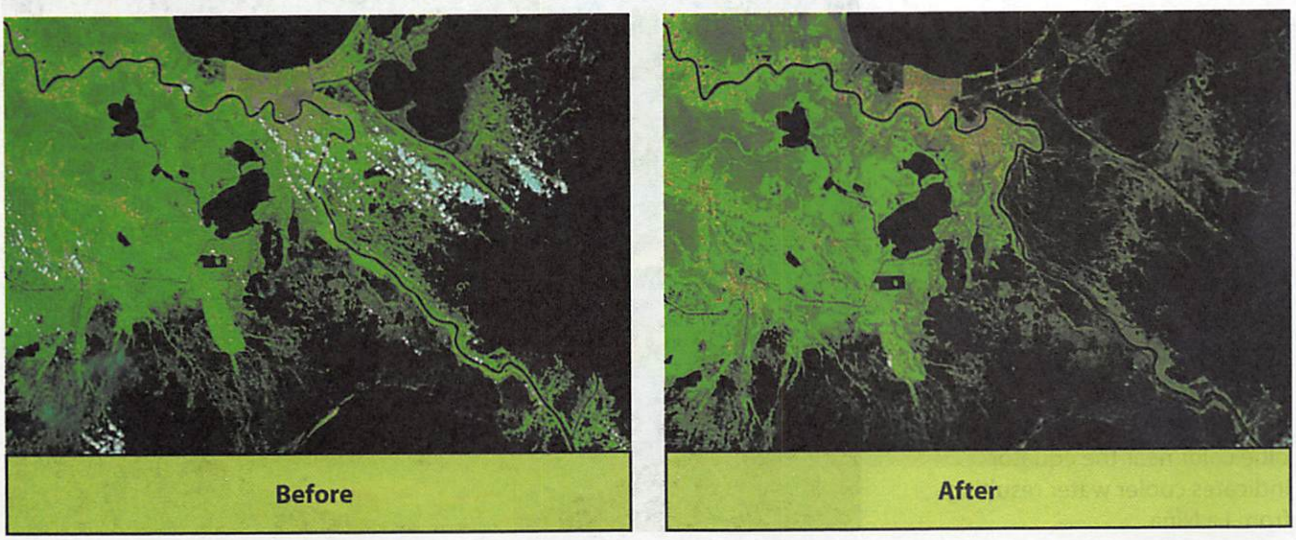

Figure 9 These satellite images show the delta region of the Mississippi River before and after Hurricane Katrina hit the Gulf Coast in 2005. The after image shows the flooding that destroyed much of the coastal wetlands.

Copyright © McGraw-Hill Education NASA images courtesy the MODIS Rapid Response Team at NASA GSFC.

Recognize

8. What are some methods used to collect remote sensing data?

Landsat *Landsat* satellites have taken photographs of Earth's surface and surrounding coastal areas for more than three decades. This remote sensing technology has allowed scientists to study changes on Earth's surface caused by natural processes and human practices. *Landsat 7,* launched in 1999, completes a scan of Earth's entire surface every 16 days. *Landsat* satellite images were used to evaluate the coastal damage to Galveston, Texas, after Hurricane Ike. By comparing before and after images of the coastline, scientists were able to see the areas that were most damaged by storm-surge flooding.

TOPEX/Jason-1 A pair of satellites—*TOPEX* and its successor, *Jason-1*—have been used to determine ocean topography, circulation, sea level, tides, and now climate change. Using radar, a signal is bounced off the ocean surface to measure bulges and valleys to within 3 m. **Figure 10** shows ocean surface changes due to El Niño and La Niña.

Sea Beam A device that uses sonar to map the bottom of the ocean is Sea Beam. Sea Beam is mounted onboard a ship. Computers calculate the time a sound wave takes to bounce off the ocean floor and return to the ship. This gives the operators an accurate image of the seafloor and the depth of the ocean at that point. Sea Beam is used by fishing fleets, drilling operations, and various scientists.

LAB Manager

LAB: *Seeing Double?*

TEKS 8.2(A), (C), (E); 8.3(C); 8.9(C)

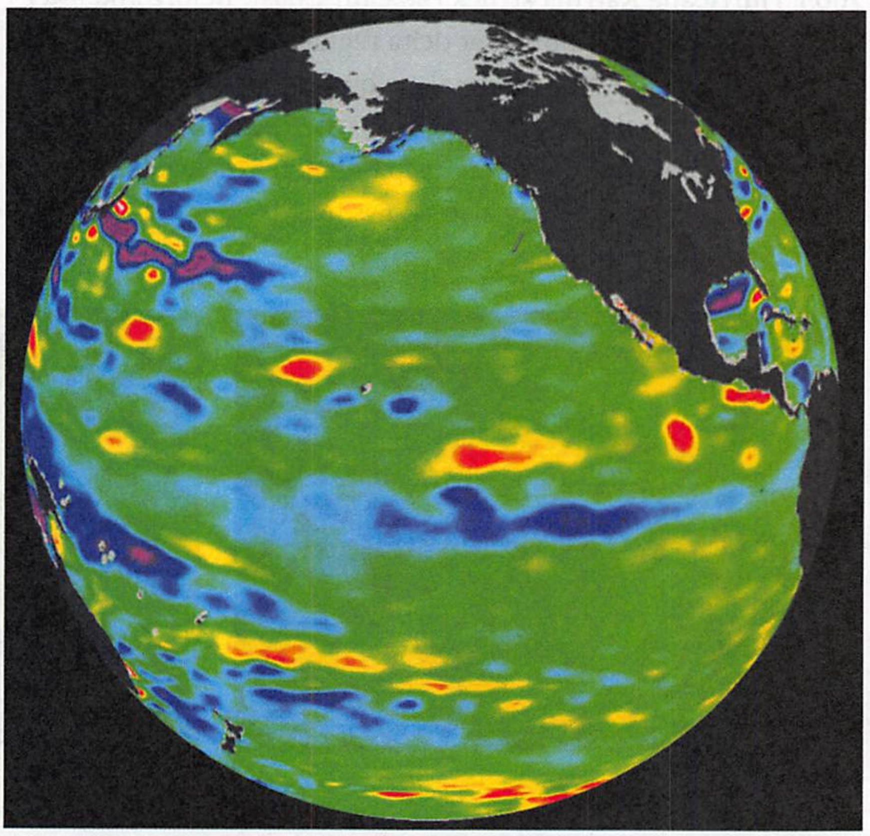

Figure 10 This image of the Pacific was captured by the pair of satellites *TOPEX/Jason-1*. The blue color near the equator indicates cooler water resulting from La Niña.

Copyright © McGraw-Hill Education NASA/JPL Ocean Surface Topography Team