

## CHAPTER 19

# LAND-USE PLANNING AND ENGINEERING GEOLOGY

### Important Concepts

1. Motives behind land-use planning include safety and the optimum uses to which the land can be put. These decisions are often based, at least in part, on geological considerations.
2. The rising global population is placing increased demands on shrinking available lands, and in the process it is changing old land-use practices and converting rural land to other specific uses.
3. Two types of land-use strategies are multiple use and sequential use. Multiple use involves using the same land for two or more purposes at the same time. Sequential use involves using the same land for two or more different purposes, one after another.
4. Planning tools available to the engineering geologist include maps, computers, and physical models. Computers have become increasingly useful because of their capacity to process large amounts of quantitative information.
5. Evaluation of a site for a specific use often requires a broad range of geological considerations, including the characteristics of the rocks and soils, the quality and quantity of surface water or ground water, and the potential of geologic hazards.
6. The presence of permafrost creates special geological engineering problems. Should the frozen ground be thawed, the result is a structurally weak, sodden mass of soil that can contribute to differential subsidence and structural support problems.

### Key Terms

multiple use  
permafrost

permafrost table  
sequential use

### Multiple Choice

1. According to the U.S. Department of Agriculture, how many acres of rural land in the United States are converted to other uses each year ?
  - a. 160,000 acres
  - b. 420,000 acres
  - c. 1,420,000 acres
  - d. 2,000,000 acres
2. Which of the following geological properties cannot be represented on a map?
  - a. bedrock geology
  - b. soil types
  - c. topography
  - d. All of the choices can be represented on a map.

3. Maps are limited by
  - a. their inability to represent geologic processes.
  - b. their inability to show present geologic hazards.
  - c. the inability of the data they contain to be transferred to computers.
  - d. problems of scale.
  
4. Of the following geologic hazards, the one causing the greatest property damage in the United States is (figure 19.9, p. 476)
  - a. floods.
  - b. earthquakes.
  - c. volcanic eruptions.
  - d. expansive soil.
  
5. Buried sections of the Trans-Alaska Pipeline were refrigerated to
  - a. prevent thawing of the permafrost.
  - b. maintain the viscosity of the oil.
  - c. reduce the rate of chemical reaction between the oil and the metallic pipeline.
  - d. prevent chemical breakdown of the oil.
  
6. The occurrence of seismic activity (Cape Ann earthquakes) in the eighteenth century has raised questions concerning the siting of nuclear power plants in
  - a. the New Madrid, Missouri region.
  - b. South Carolina.
  - c. New England.
  - d. California.
  
7. What fraction of land in the United States is controlled by the federal government?
  - a. one-tenth
  - b. one-third
  - c. one-quarter
  - d. one-half
  
8. The Leaning Tower of Pisa leans because of
  - a. poor construction practices.
  - b. an earthquake that occurred in 1370.
  - c. an underlying unstable clay layer.
  - d. soil creep.
  
9. The failure of the French to complete the construction of the Panama Canal was caused in large part by
  - a. political instability in the region.
  - b. the presence of shallow ground water.
  - c. lack of attention to geological factors.
  - d. volcanism and associated seismic activity.
  
10. What was the main complicating factor in building the Rotterdam (Holland) subway?
  - a. the presence of hard, compact rock
  - b. the presence of shallow ground water
  - c. the presence of expansive volcanic clays
  - d. differential settling of tunnel sections

11. The Tower Latino Americano in Mexico City is stabilized by pilings driven into
  - a. bedrock.
  - b. expandable clay.
  - c. a strong sand layer.
  - d. volcanic ash deposits.
  
12. The reason for the St. Francis Dam disaster was
  - a. the use of unsuitable construction materials.
  - b. the reactivation of a fault zone after the reservoir was filled.
  - c. the presence of numerous solution cavities in the bedrock upon which the dam was built.
  - d. disintegration of the surrounding rocks after the reservoir was filled.
  
13. A 1981 survey of dams in the United States by the U.S. Army Corps of Engineers revealed that the single greatest cause of unsafe dams was
  - a. poor site selection.
  - b. disregard of the geology of the chosen site.
  - c. the occurrence of active faults in the vicinities of the dams.
  - d. poorly designed spillways.
  
14. The use of physical models to understand the behavior of geological systems
  - a. has been supplanted by the use of computers.
  - b. has been shown to be unreliable.
  - c. is an important tool in the design of safe structures in high-risk areas.
  - d. is of limited value because geological systems cannot be simulated in the laboratory.

### Fill In the Blanks

1. \_\_\_\_\_ planning attempts to make the best use of each parcel of land.
2. \_\_\_\_\_ geology is concerned with making structures safe and stable by taking a site's geology into account.
3. \_\_\_\_\_ \_\_\_\_\_ is a land-use strategy in which the same land is used for two or more purposes at the same time.
4. \_\_\_\_\_ \_\_\_\_\_ is a land-use strategy in which the same land is used for two or more different purposes, one after another
5. \_\_\_\_\_ play an important role in land-use planning because of their capacity to manipulate large volumes of quantitative information.
6. \_\_\_\_\_ is a condition in which the ground remains frozen year-round.
7. The \_\_\_\_\_ \_\_\_\_\_ is the top of the permafrost zone.
8. A \_\_\_\_\_ allows water to flow over or around a dam.

## True or False

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- \_\_\_\_\_ 1. Because land-use planning is often based, at least in part, on geologic conditions, land-use planning and engineering geology overlap.
- \_\_\_\_\_ 2. The use of an abandoned underground mine to cultivate mushrooms would be an example of multiple use.
- \_\_\_\_\_ 3. The suitability of a particular site for a specific land use cannot always be determined by examining a map.
- \_\_\_\_\_ 4. The structural damage to homes, commercial buildings, pavements, and utilities in the United States due to the problem of expansive clay soils amounts to over \$2.2 billion annually.
- \_\_\_\_\_ 5. The Trans-Alaska Pipeline was designed to withstand the stresses of thermal expansion and contraction, earthquakes, ground displacement, and permafrost.
- \_\_\_\_\_ 6. Early federal land-use policies tended to emphasize resource development over preservation.
- \_\_\_\_\_ 7. A problem with the multiple use concept occurs when the uses are not compatible.
- \_\_\_\_\_ 8. Part of the difficulty in constructing the Panama Canal was the constant threat of the formation of sinkholes along many sections of the canal.
- \_\_\_\_\_ 9. The majority of the dams built in the United States are constructed on faults.

## Review Questions

1. How are geologic maps useful in land-use planning? What are the limitations of this tool?
2. Why did the St. Francis Dam fail? How could we have avoided this disaster?
3. List the geologic considerations that might be important in siting an apartment complex. Will the same considerations also apply to the construction of a parking lot?
4. What is permafrost? What special considerations are necessary for construction in an area covered by permafrost?
5. Discuss the geologic problems encountered during the construction of the Panama Canal.

## **Surfing the Net**

Photographic examples of a variety of geologic hazards (NASA):

[http://stargate.jpl.nasa.gov:1080/hazards/hz1\\_1.html](http://stargate.jpl.nasa.gov:1080/hazards/hz1_1.html)

Information on geologic hazards contained in the Natural Hazards Data Resources Directory (U.S. National Geophysical Data Center):

<http://www.ngdc.noaa.gov/seg/hazard>

An excellent compilation of information on land use and development in the United States (U.S.D.A.'s Natural Resources Conservation Service):

<http://www.nhq.nrcs.usda.gov/NRI/1997/>

## CHAPTER 19 ANSWER KEY

### Multiple Choice

- |      |      |       |       |
|------|------|-------|-------|
| 1. d | 5. a | 9. c  | 13. d |
| 2. d | 6. c | 10. b | 14. c |
| 3. d | 7. b | 11. c |       |
| 4. d | 8. c | 12. d |       |

### Fill In the Blanks

- |                   |                     |
|-------------------|---------------------|
| 1. Land-use       | 5. Computers        |
| 2. Engineering    | 6. Permafrost       |
| 3. Multiple use   | 7. permafrost table |
| 4. Sequential use | 8. spillway         |

### True or False

1. True
2. False. The use of an abandoned underground mine to cultivate mushrooms would be an example of sequential use.
3. True
4. True
5. True
6. True
7. True
8. False. Part of the difficulty in constructing the Panama Canal was the constant threat of landslides along many sections of the canal.
9. False. The majority of the 50,000 dams built in the United States are not constructed on faults.