

Topographic Mapping and Sea Level Rise

Grade level: 6 – 8

Subject: Earth Science

Duration: one class period

Group size: 30 students

Setting: classroom

OVERVIEW

This activity will help your students to read and interpret features on topographic maps, as well as understand more clearly the consequences of global warming and subsequent sea level rise on coastal environments.

CONTENT STANDARDS

California Science Content Standards for Public Schools

Earth Science: Grade 5 – 3d

Investigation and Experimentation: Grade 6 – 7d,f: Grade 7 – 7a,b,c,d,e

TEACHER BACKGROUND

A blanket of gases called the atmosphere surrounds the surface of the Earth. The energy from the sun passes through the atmosphere and about half is absorbed by the Earth's surface. Some of this heat energy is reflected back into the atmosphere and is absorbed by the gases present there. Carbon dioxide, methane, and nitrogen oxides are examples of the heat absorbing gases and these are called **greenhouse gases**. Greenhouse gases occur naturally in the atmosphere, but humans have added a lot more by burning fossil fuels and wood. More of these gases in the atmosphere means that more heat can be absorbed, which results in an increase in the temperature. This increase in the Earth's temperature is called **global warming**. The average temperature in 1990 was 59.8° F, the highest temperature yet recorded! In 1995 scientists predicted that in the next hundred years the average global temperature will increase by 2- 3.5° C (3.6- 6.3° F). Although this isn't as high as scientists had originally predicted, it is the highest rate of warming seen in the last 10,000 years. As the temperature increases, **thermal expansion** will cause sea level to rise. Warmer temperatures may cause mountain glaciers and the ice sheets covering Greenland and Antarctic to melt, also causing sea level to rise.

Sea level is simply the average height of the ocean between high and low tide. Sea level has fluctuated throughout Earth's history. For instance, during the ice ages when glaciers covered much of the land, sea level was much lower than it is now because so much water was frozen. Most of the increase in sea level as the result of global warming will be from the thermal expansion of the oceans. Thermal expansion is caused when seawater expands because of the higher temperature of the water. Since the oceans absorb heat from the atmosphere, when the atmosphere becomes warmer so will the oceans. Warm sea water has a greater volume than cold sea water. As the temperature of the ocean increases so will the total ocean volume. The increased volume will cause the level of the water in the oceans to rise. Over the next hundred years we can expect the sea level to rise from 15 to 95 centimeters (6-37 inches). This is much different than the 6-37 centimeters (4-10 inches) that the sea level rose over the last hundred years! In general, for every 1 centimeter (0.39 inches) that the sea level rises, 1 meter (39.3 inches)

of coastal land will be lost. Places with very flat coasts, like Florida, could lose up to 1,000 feet of coastal land.

If the sea level rises as predicted, freshwater will be contaminated with salt water (including much of our drinking water supply), ports will be destroyed, coastal cities will be flooded or ruined, wetlands and swamps will be damaged, coastal erosion will speed up, large numbers of plants and animals will die, hurricanes would increase in intensity and number, and precipitation patterns will change so that there would be droughts in some areas. The tourism and recreational businesses that depend upon coastal areas will collapse. The economic impacts of rising sea level due to global warming will be devastating. Rising sea level will severely affect humans and other organisms. In this activity, you will see how coastal areas and businesses may be effected by rising sea level.

MATERIALS NEEDED

One for every team of 3-4 students:

1. copy of Map A, B, C, or D
2. 1 green, 1 blue, 1 brown colored pencil or crayon

PROCEDURE

Discussion:

1. Introduce the students to the concept of sea level rise from the background information listed above. What are some of the possible causes of a sea level rise, including natural and human influenced factors? Be sure to mention the concept of thermal expansion and the melting of Greenland and Antarctic ice sheets as possible sources of the rise.

Activity:

2. Divide your students into cooperative learning groups, the size of which will be dictated by your overall class size. There are four different maps for this activity. You can divide your students into four large groups each using a different map or have more groups with fewer students. The scenario with more than four groups means that two or more groups will use the same map version (e.g., Map A) and questions.
3. Hand out a copy of Map A, B, C, or D and their respective questions to each group. If students have never used topographic maps before, have them do the "How to" handout on topographic maps first. Display an actual topographic map either on the board or spread out on a table so that your students can gather around to look at it.
4. Tell each group how many feet the water will rise in their map area. The students will color the outline of the old shoreline brown, the land area green, and the ocean area blue, including the area of land that will now be under water. The purpose of coloring the old shoreline is so the change in sea level can more readily be seen.
5. Instruct your students to answer the questions corresponding to their topographic map after they have finished coloring.

Conclusion:

6. Have a spokesperson from each group share with the class what happened in their

area when the sea level rose and how their area was affected economically by the sea level rise.

7. Discuss the changes that occurred in the four different areas. Besides the elevation, the shape of the coastline will greatly affect how much damage the sea level changes will have. For the same amount of seawater rise, more land will be covered on a gently sloping beach than on vertical rock cliff. Some predictions call for a maximal 100 cm rise in the sea level over the next 100 years. The present shoreline will be 100 meters (1/16 mile) further inland than it now is. That means that about 3,900 feet or three-fourths of a mile of coastline will be lost. The beaches we now visit will be underwater and much of the land area would be greatly reduced. Additionally, your students should have noted these consequences of rising ocean water: houses and businesses flooded; property destroyed; docks, roads, and bridges underwater; well water contaminated with salt water; and wetlands flooded or submerged resulting in loss of nursery areas for commercially fished species.

EXTENTIONS

1. Give students a topographic map of southern California. Have each student mark on the map the town they live in. Depending upon the grade, have students complete research to find out how many feet above sea level their town is. (The teacher may have to find this information for them.) Ask students to describe their neighborhood. Are there any rivers or streams nearby? Do they live near the ocean? What type of buildings do they live near? Have students draw a map of their house and the land and environment around it (ex. forest, pond, shopping mall, etc). Ask students to imagine what would happen if the water in the ocean or in the nearby rivers or streams overflowed their banks. How would this affect their community? What problems would occur? Help students realize that many things would be effected. The sewer system, drinking water, plants and animals, and buildings would all be affected. If they live near the ocean how would the rise in sea level affect the coastline? What features of the coastline would be underwater? What organisms would be affected by the rising sea level?
2. After the students have finished this activity, now have them imagine that they live in Washington D.C., perhaps along the Potomac River. Compare the sea level in the Washington D.C. with that of southern California. Would this area around the Potomac River be affected by sea level rise? Using an overhead projector, display the aerial map of the Potomac River near the National Monuments that includes topographic information. Now ask some questions, such as: What it would be like if Potomac River overflowed its banks? Which areas would be affected most? Reinforce to students the connection between global warming and the rising sea level.
3. Have students write poems or stories about what it would be like to live in a place that has experienced a rise in sea level. They should also include what they think could be done to help prevent something like this from occurring (global warming solutions).

SOURCE

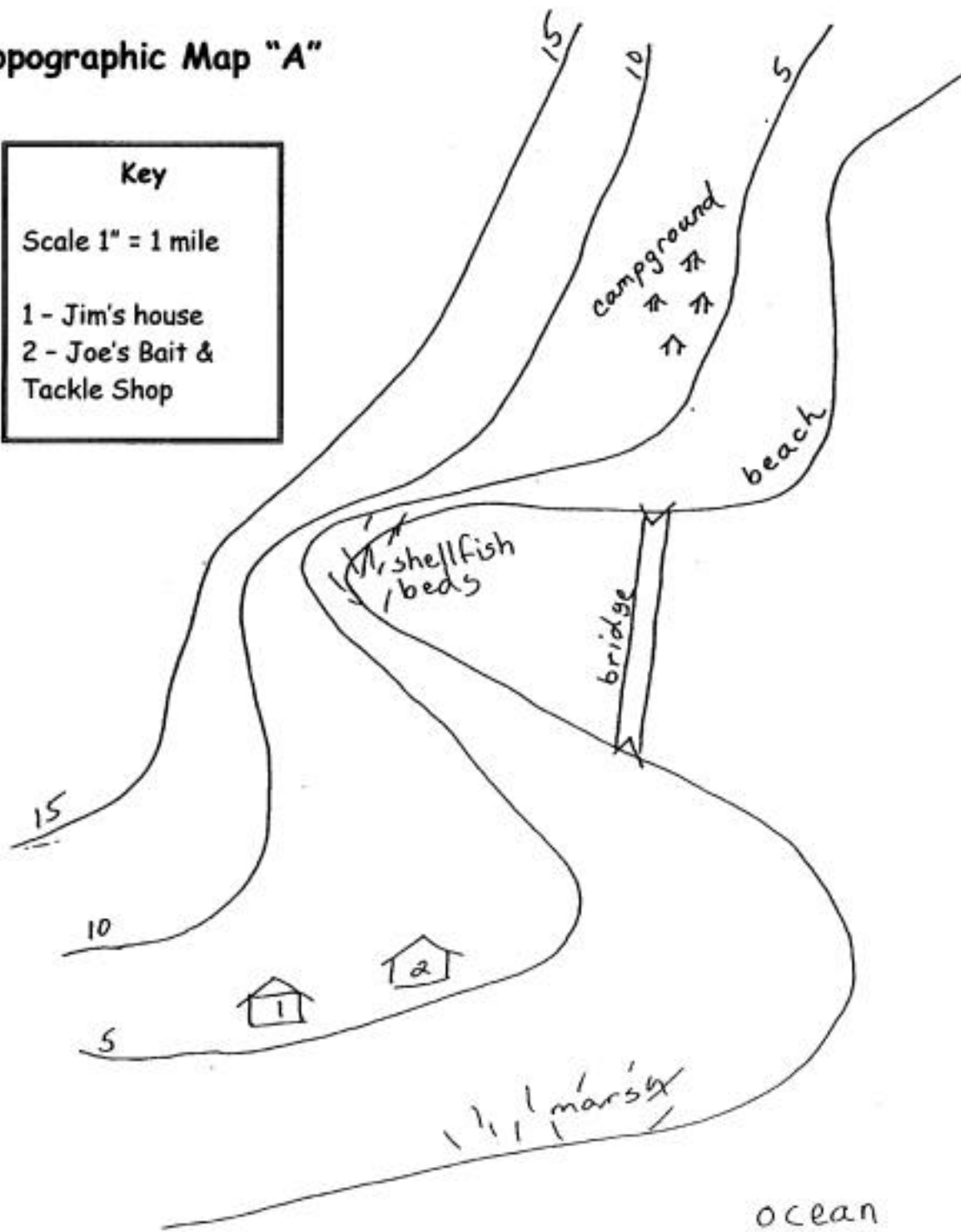
Adapted from University of Rhode Island, Office of Marine Programs at <http://omp.gso.uri.edu/does/teacher/pdf/act16.pdf>

Topographic Map "A"

Key

Scale 1" = 1 mile

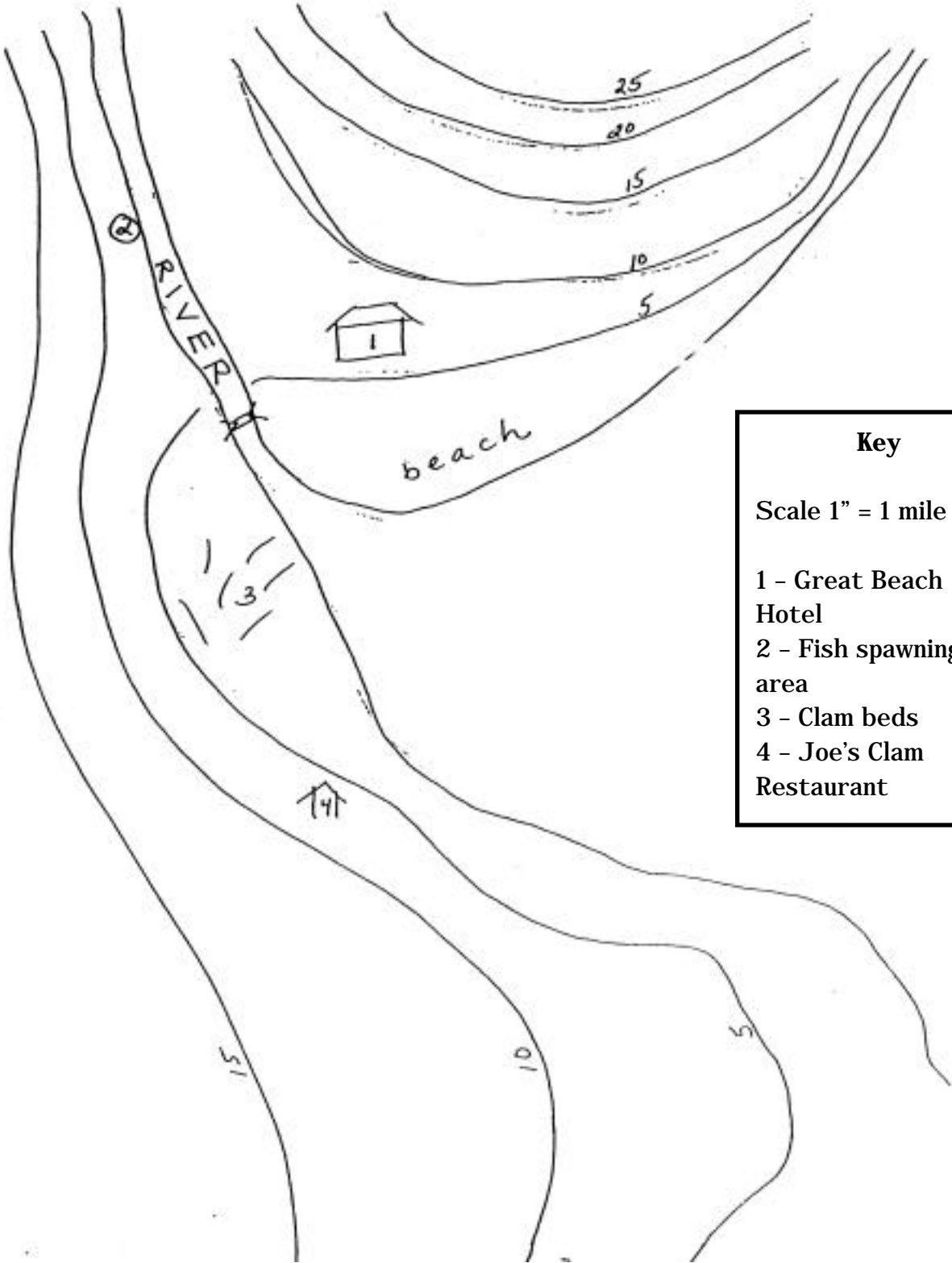
1 - Jim's house
2 - Joe's Bait & Tackle Shop



Topographic Map A Questions

1. On Topographic Map A, were all parts of the coastline affected equally by the rising sea level?
2. How many buildings were lost due to the higher sea level? Do you think the bridge was affected by the higher water level?
3. What organisms were affected by the higher sea level? (Hint: Think of what animals or plants might live in the three different coastal environments that are shown on the map.)
4. How do you think the economy of this area was affected by the higher sea level? List the businesses that were affected.

Topographic Map "B"



Key

Scale 1" = 1 mile

- 1 - Great Beach Hotel
- 2 - Fish spawning area
- 3 - Clam beds
- 4 - Joe's Clam Restaurant

Topographic Map B Questions

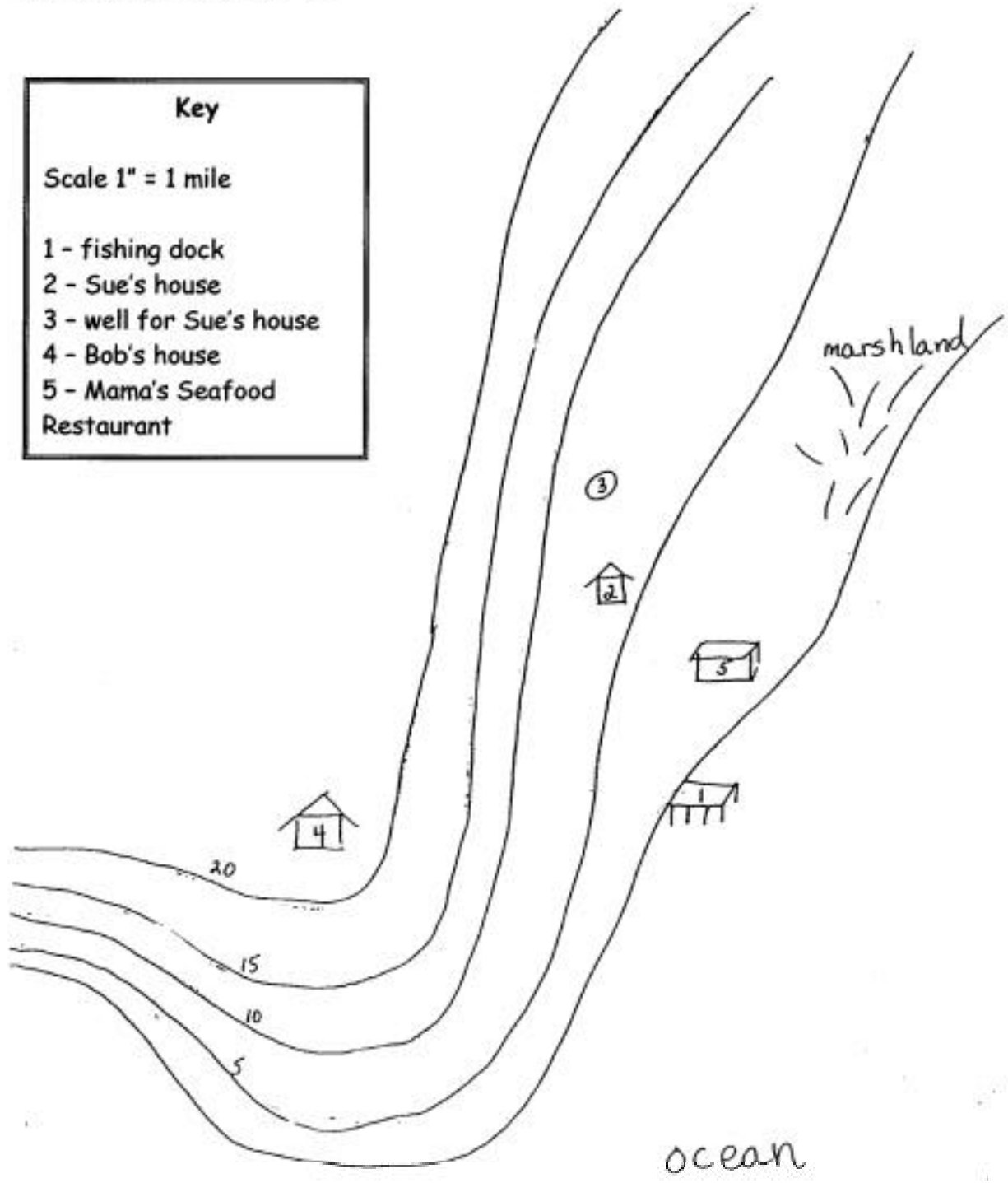
1. On Map B, were all parts of the coastline affected equally by the rising sea level? Which parts were affected the most?
2. Were any buildings lost due to the higher sea level? Did the water rise enough to affect the bridge?
3. Were any natural areas (ecosystems) besides the beach affected by the higher sea level? If so, what do you think happened to those areas and the animals and plants that lived there?
4. Was the economy of your map area affected in any way by the changes that occurred when the sea level rose?

Topographic Map "C"

Key

Scale 1" = 1 mile

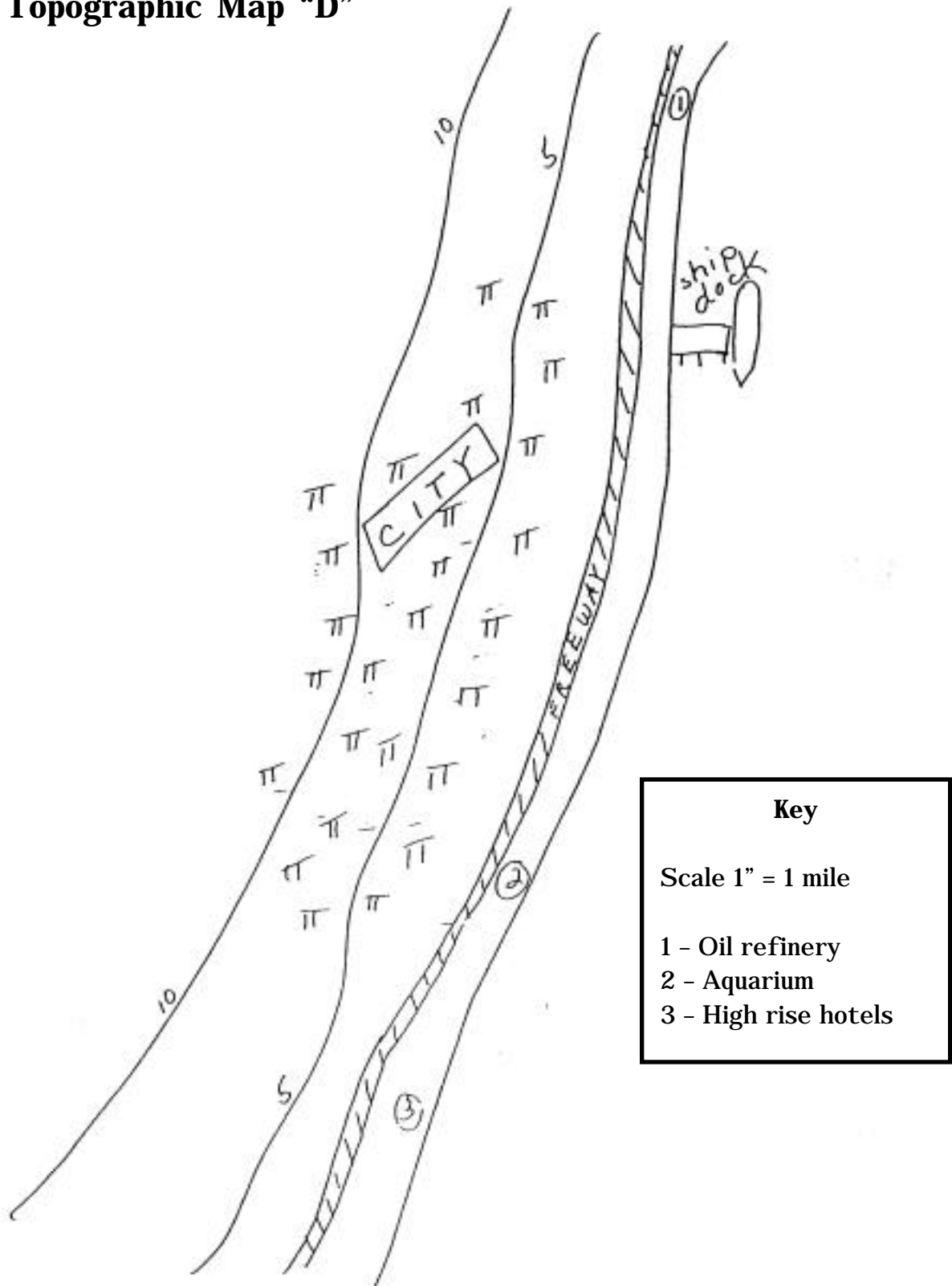
- 1 - fishing dock
- 2 - Sue's house
- 3 - well for Sue's house
- 4 - Bob's house
- 5 - Mama's Seafood Restaurant



Topographic Map C Questions

1. Were all parts of the coastline on Map C affected equally by the rising sea level?
2. Were any buildings or structures lost due to the higher sea level?
3. How many types of organisms were affected by the higher sea level?
4. List the economic effects of the changes that occurred on Map C when the sea level became higher.

Topographic Map "D"



Topographic Map D Questions

1. On Map D, were all parts of the coastline affected equally by the rising sea level?
2. How many buildings or structures were lost because of the higher sea level?
3. Were any plants or animals affected by the higher sea level?
4. How was the area on Map D affected economically by the rising sea level?