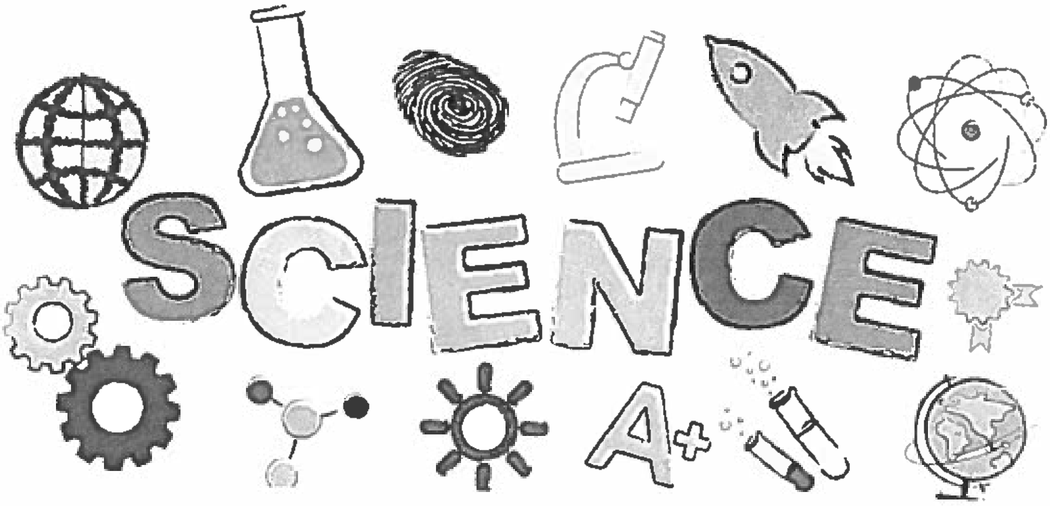
Lathrop Intermediate

7th grade Science
2nd Semester



Name: ____________________

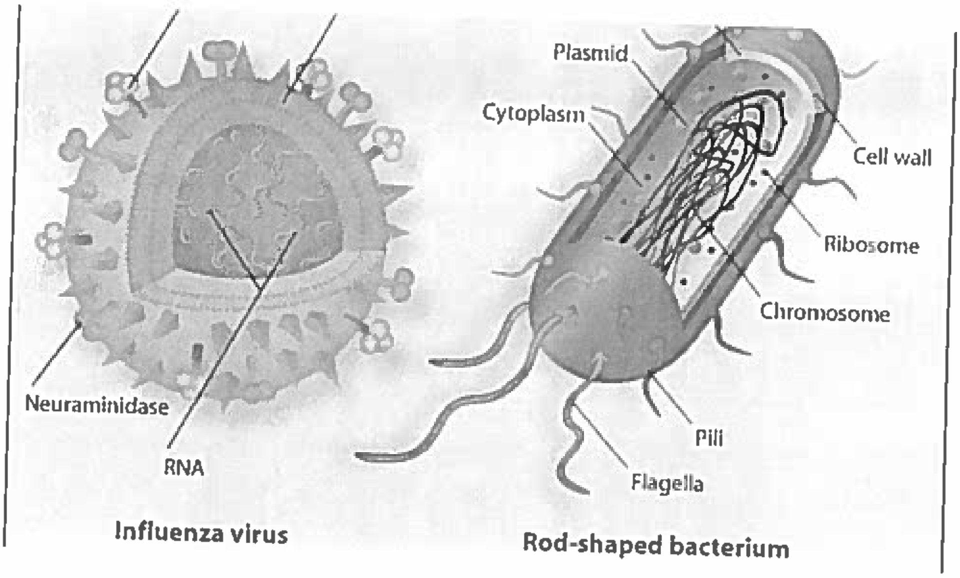
Teacher: ____________________

Period: ____________________

Lathrop Intermediate

7th grade Science

Health Unit



Lathrop Intermediate

7th grade Science
Geology/Earth's History Unit

7.4.1 - Task Card: Continental Drift

Task:

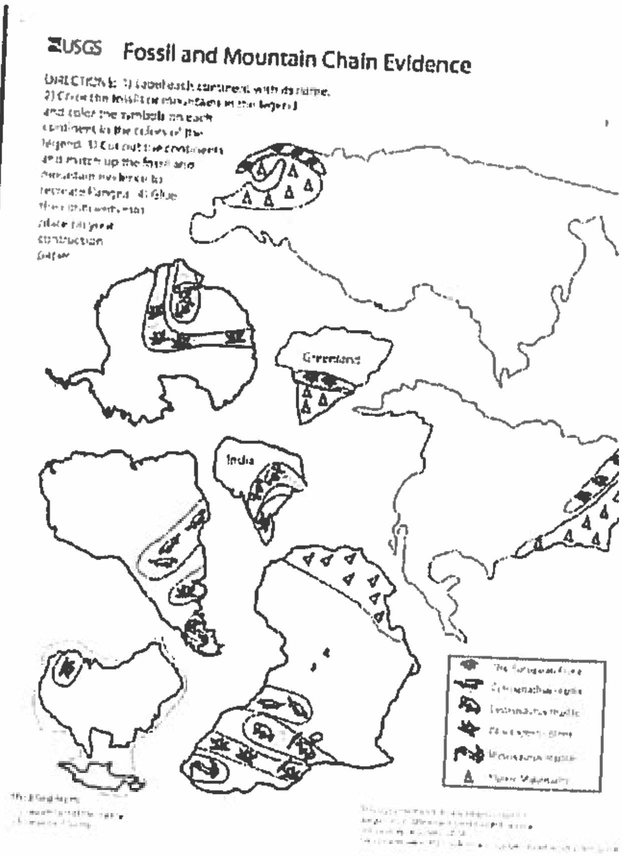
- Piece together a puzzle of the supercontinent Pangea based on rock fossil and rock evidence.
- Complete the discussion questions on the back of the card with your team
- Complete the Analyzing Evidence Worksheet

Task Steps:

1. On the puzzle pieces handout, assign a color to each type of fossil or mountain belt in the legend and color the areas on the land masses according to the legend.

2. Use scissors to cut along the borders of the continents. These are the approximate shape of the continents after Pangea broke up.

3. Place the continents on a piece of construction paper and move them around using the fossil and mountain chain evidence to match the continents together in the position they were in when they were part of Pangea. The pieces may not fit together exactly!



4. When you have assembled Pangea based on the fossil and rock locations, glue the continents onto your construction paper in the shape of the supercontinent. Glue the legend to your puzzle.

7.4.1 - Task Card: Continental Drift

Question Instructions: Working with your table, discuss the following questions. Be ready to share out.

1. What is the idea of Continental Drift?

2. Which 2 continents have the most obvious fit of the coastlines?

3. How were the fossil symbols and mountain belts helpful in deciding where to move continents?

4. Why don't the present shapes of the continents fit perfectly into a supercontinent?

5. Which fossil occurs on the most landmasses? What does this suggest about when these particular continents broke up?

7.4.1 - Task Card: Scientific Revolution

Part 1:

- Copy the chart below into your science journal.
- You will be given 8 envelopes. Don't open them until instructed.
- You will have 90 seconds to read, discuss and record the most important piece information. Try to answer one of the questions that the class posed in the warm up

Scientific Revolution

Suggestion: students build a table in their science notebooks to track important information.

A	
B	
C	
D	
E	
F	
G	
H	

7.4.1 - Task Card: Scientific Revolution

Part 2:

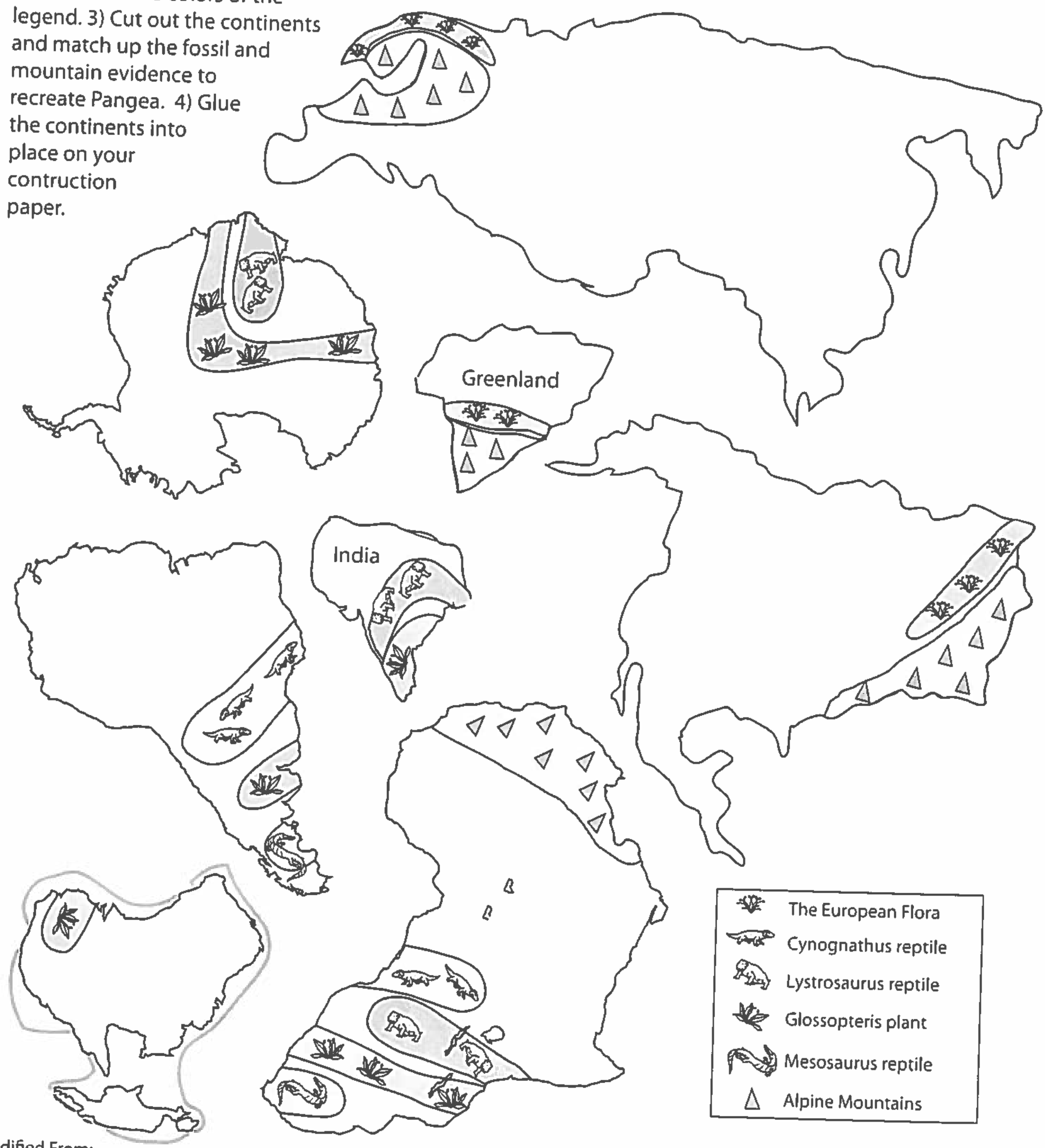
- Copy the chart below into your science journal including the question.
- Pretend you are Wegener and write a claim to answer the question, "How has earth changed over time."
- Include all of the evidence you can to support your claim.
- You may leave the reasoning blank at this time.

#2 Revised Claim/Evidence/Reasoning: The Earth's Surface Wegener data AND new knowledge after WWII

Question: Based on what you have learned, what claim can you make about how the Earth has changed over time?	
Claim:	
Evidence:	**Reasoning:**

USGS Fossil and Mountain Chain Evidence

DIRECTIONS: 1) Label each continent with its name. 2) Color the fossils or mountains in the legend and color the symbols on each continent in the colors of the legend. 3) Cut out the continents and match up the fossil and mountain evidence to recreate Pangea. 4) Glue the continents into place on your contruction paper.



Modified From:
U.S. Department of the Interior
U.S. Geological Survey

This Dynamic Planet; A Teaching Companion
Wegener's Puzzling Continental Drift Evidence
U.S. Geological Survey, 2008
For updates see <http://volcanoes.usgs.gov/about/edu/dynamicplanet>

R1

Scientific Revolution

Suggestion: students build a table in their science notebooks to track important information.

A	
B	
C	
D	
E	
F	
G	
H	

CA NGSS Roll Out #3: Tool E to 6-8 Learning Sequence.
Text adapted from: Demanche, E.L, Kyselka, W., Pottenger III, F. M., & Young, D.B. (1996). Change Over Time: FAST 3, Foundational Approaches in Science Teaching, University of Hawaii's Curriculum Research & Development Group, Honolulu, Hawai'i. Images from: http://pubs.usgs.gov/gip/dynamic/dynamic.html unless otherwise noted.

R2

Twitter Throwdown

Your name: ____

If Twitter existed in Wegner's day, what would he have tweeted?

Alfred Wegener @______________________________________ • ________

____

____

____

____

____

Twitter Throwdown

Your name: ____

If Twitter existed in Wegner's day, what would he have tweeted?

Alfred Wegener @______________________________________ • ________

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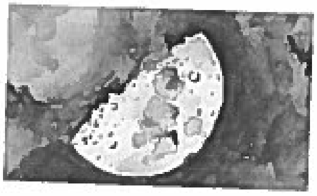
____

H12a

A Revolution Revival: Seismology

During the 20th century, worldwide improvements in technology used to study seismic events and greater use of earthquake-recording instruments *(seismographs)* enabled scientists to discover some interesting patterns! For the first time ever, better data from the *Worldwide Standardized Seismograph Network* in the 1960's allowed scientists to map earthquakes worldwide in a very accurate way.

What pattern did scientists notice?



Use your Simplified Plate Tectonic Map handout and use a small shape to mark the location of the earthquakes from the earthquake data handout given to you.

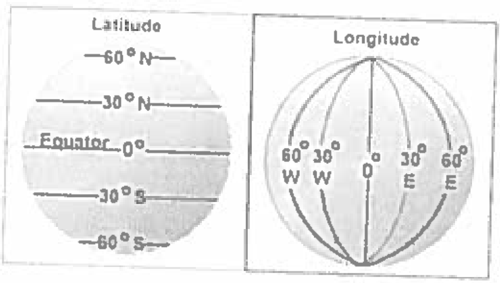
As you mark, color code the earthquakes by depth:

Orange: Shallow earthquakes are between 0 and 70 km deep
Green: intermediate earthquakes, 70 - 300 km deep
Blue: deep earthquakes, 300 - 700 km deep.

Discuss what pattern(s) your group notices and be ready to report back to your team.

Help box

In order to mark your map, you must understand the concepts of latitude and longitude. All lines of latitude run parallel to the equator. There are 90° of latitude to the north and 90° of latitude to the south of the equator. Degrees to the north are labeled as positive, while degrees to the south are labeled as negative. Each degree of latitude is approximately 111 km apart.



Source: http://www.dpc.ucar.edu/projects/revEdSite/lp3_subd_zone.html

Narrative adapted from http://pubs.usgs.gov/gip/dynamic/developing.html Emoji from http://emojipedia.org/smiling-face-with-sunglasses/

H12b

Earthquake Data

A selection of magnitude 4.5 and higher earthquakes
Southern Pacific Plate
May, 2015

Date	Magnitude	Region	Location	Depth (km)
2015-05-03	4.5	Central East Pacific Rise	13.337°S 111.776°W	4.5
2015-05-14	4.5	Easter Island Region	23.144°S 114.756°W	10.0
2015-05-19	6.7	Pacific-Antarctic Ridge	54.331°S 132.162°W	7.2
2015-05-20	6.0	WNW of Pangai, Tonga	19.302°S 175.525°W	203.0
2015-05-21	4.6	Southern East Pacific Rise	54.215°S 119.474°W	10.0
2015-05-21	4.8	Pacific-Antarctic Ridge	53.977°S 132.316°W	10.0
2015-05-25	4.7	NW of Farallon de Pajaros, Northern Mariana Islands	20.784°N 144.537°E	202.5
2015-05-28	4.5	South of the Fiji Islands	23.734°S 179.952°E	527.6
2015-05-30	7.8	WNW of Chichi-shima, Japan	27.839°N 140.493°E	664.0
2015-05-30	4.5	W of Litayan, Philippines	7.351°N 123.856°E	587.2

Link to all 4.5 and higher earthquakes (371 of them) along the Southern Pacific plate in May, 2015

USGS

Simplified Plate Tectonics Map

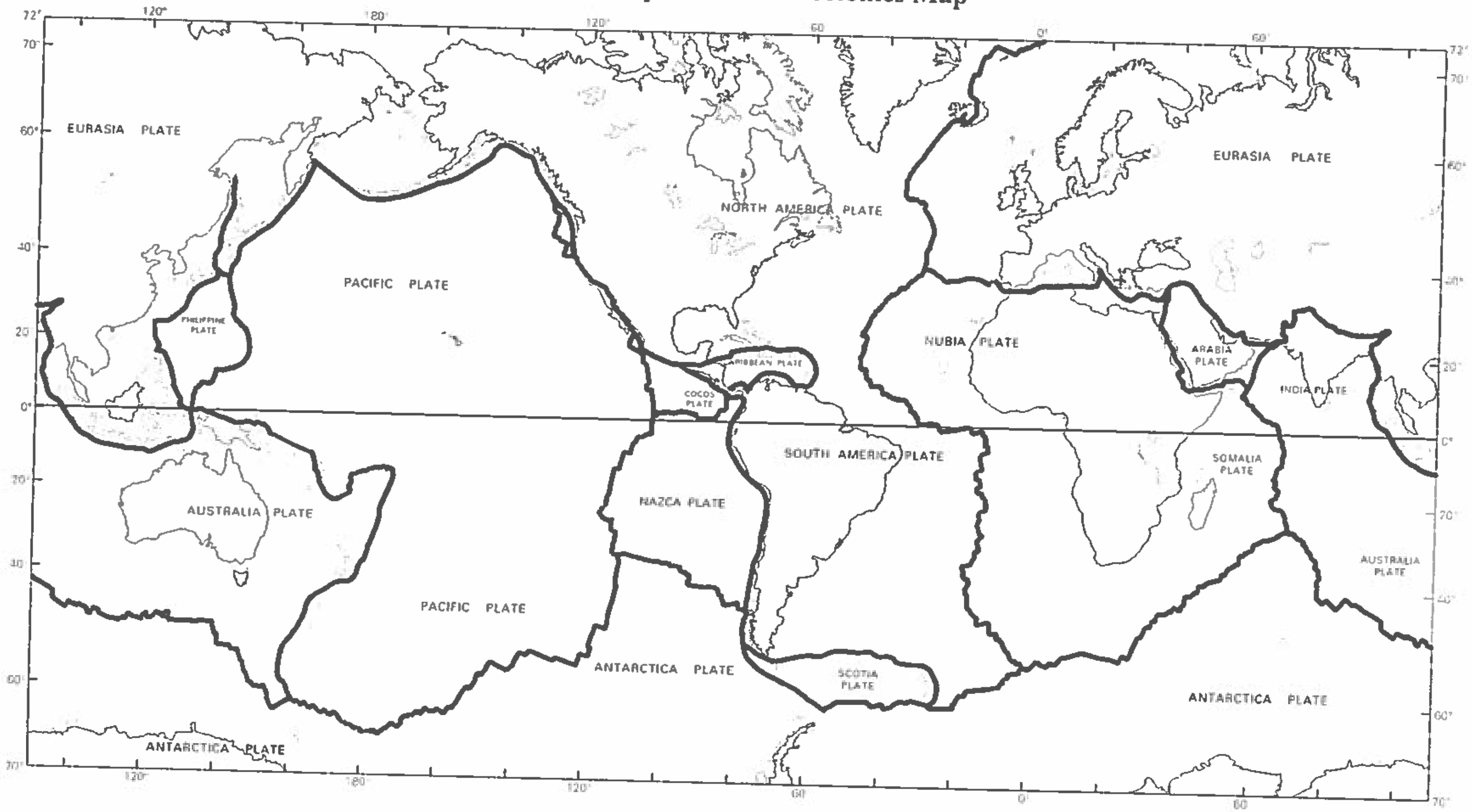


Plate boundary - Known area between two plates.

Some plate boundaries, such as the North America - South America boundary, are not shown because scientific data are inadequate to determine precise locations. See the This Dynamic Planet Map insert for more information about these regions.

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

This Dynamic Planet: A Teaching Companion
Plate Tectonics Tennis Ball Globe
U.S. Geological Survey, 2008 revised from This Dynamic Planet Map
For updates see <http://volcanoes.usgs.gov/about/edu/dynamicplanet/

A Revolution Revival: Ridges

"Modern" measurements of ocean depths greatly increased in the 19th century, when deep-sea line soundings (*bathymetric* surveys) were routinely made in the Atlantic and Caribbean. Basically, this involved lowering down a line with a weight (sounding lead) to the bottom of the ocean, and measuring the length of the line.

Simplified maps, called bathymetric chart published by U.S. Navy Lieutenant Matthew Maury revealed the first evidence of underwater mountains in the central Atlantic (which he called "Middle Ground"). This was later confirmed by survey ships laying the trans-Atlantic telegraph cable. Our picture of the ocean floor greatly sharpened after World War I (1914-18), when echo-sounding devices -- primitive sonar systems -- began to measure ocean depth by recording the time it took for a sound signal (commonly an electrically generated "ping") from the ship to bounce off the ocean floor and return. Time graphs of the returned signals revealed that the ocean floor was much more rugged than previously thought. Such echo-sounding measurements clearly demonstrated the continuity and roughness of the submarine mountain chain in the central Atlantic (later called the *Mid-Atlantic Ridge*) suggested by the earlier bathymetric measurements.

Marie working on her 1964 physiographic diagram of the Indian Ocean in Lamont's Oceanography Building. Sounding records are visible beneath her elbows and propped on a ledge in front of her.
Photo courtesy of the Lamont-Doherty Earth Observatory.

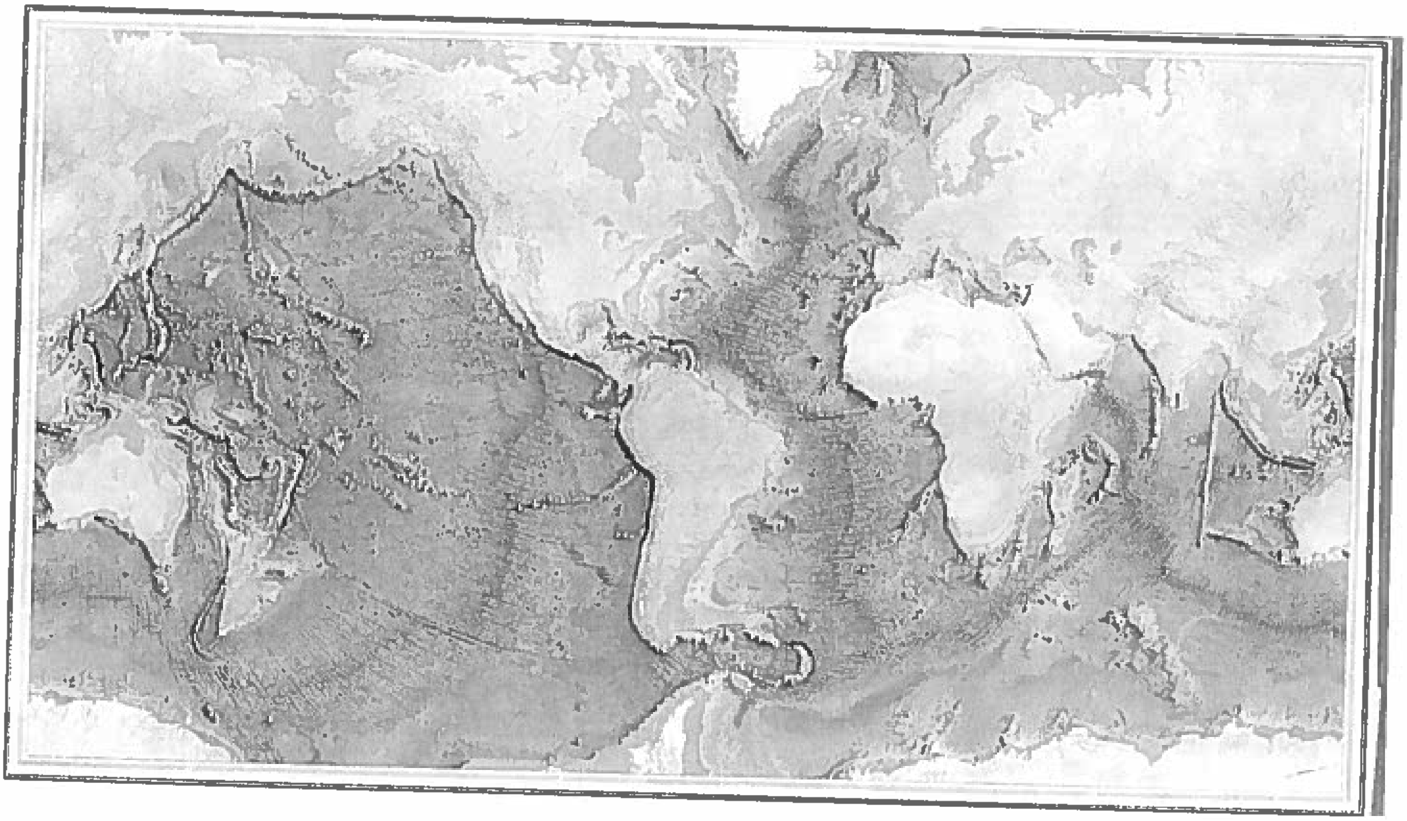
This technology improved after World War II, and the first effort to map the entire ocean floor was taken on by Marie Tharp of Columbia University's Lamont Geological Observatory in 1952. Working alongside Bruce Heezen and the artist Heinrich Berann, she created the first map of the North Atlantic in 1957, followed by a world map in 1977.

Marie's work led to the discovery of a rift valley running down the center of the Atlantic Ocean. It was also discovered other "underwater mountains", later named ridges.

Additional information adapted from: http://www.huffingtonpost.com/hali-felt/marie-tharp-map-ocean_b_1826410.html

Historic narrative adapted from http://pubs.usgs.gov/gip/dynamic/developing.html
Emoji from http://emojipedia.org/smiling-face-with-sunglasses/

A Revolution Revival: Ridges



The 1977 World Ocean Floor Panorama. It was painted by Berann and based on the previous 25 years of Marie and Bruce's work. *Image courtesy of Marie Tharp Maps.*

Examine the map closely and record your observations. Identify the three MOST IMPORTANT things you learned that will help your team revise and support your claim about how the Earth has changed over time.

A Revolution Revival: Ocean floor vs. Continent

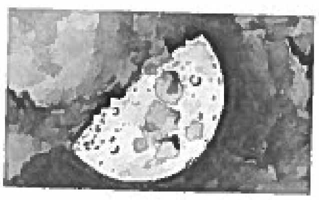
In 1947, seismologists on the U.S. research ship *Atlantis* found that the sediment layer on the floor of the Atlantic was much thinner than originally thought. Scientists had previously believed that the oceans have existed for at least 4 billion years, so they had assumed the sediment layer should have been very thick. They were surprised to find so little accumulation of sedimentary rock and debris on the ocean floor and wondered how this could be possible.

Meanwhile, an international partnership of scientists and governments joined together to create the Ocean Drilling Program, allowing scientists a unique opportunity to get samples of ocean floor rock. They expected to find rock ages similar to what we find on continental rock, but when they determined the ages of the oceanic rocks many were surprised!

Here we provide you with some rock age data that will include continental basement rock (igneous and metamorphic rock found on continents that is the foundation of the continent below sediments) and ocean floor rock.

Key
MYA = Millions of years ago
BYA = Billions of years ago
Joides = Scientific drilling ship

Discuss what pattern(s) you notice and be ready to report back to your team.



Historic narrative adapted from http://pubs.usgs.gov/gip/dynamic/developing.html and http://www.odplegacy.org/PDF/Data/Documentation/ODP_Data.pdf
Emoji from http://emojipedia.org/smiling-face-with-sunglasses/

H15b

Rock Age Data

Age of North American Continental basement rock along 34°N Latitude

Region	Location	Age of basement rock
California	34°N, 118°W	250 MYA
Arizona	34°N, 112°W	250 MYA
New Mexico	34°N, 106°W	>2.5 BYA
Oklahoma	34°N, 98°W	1.7-1.6 BYA
Arkansas	34°N, 93°W	1.5-1.3 BYA
Tennessee	34°N, 86°W	1.3-1.0 BYA
North Carolina	34°N, 79°W	250 MYA

Basement rock data determined from Stanley, Steven M. (2009) Earth System History 3rd edition (p 282). New York: W. H. Freeman and Company

Age of Oceanic basement rock at Joides Drill Holes between 32°N and 36°N Latitude

Ocean basin	Location	Age of basement rock
Pacific	33°N, 153°E	137 MYA
Pacific	33°N, 148°E	137 MYA
Pacific	32°N, 146°E	140 MYA
Atlantic	35°N, 67°W	150 MYA
Atlantic	32°N, 59°W	104 MYA
Atlantic	32°N, 52°W	77 MYA
Atlantic	34°N, 69°W	153 MYA
Atlantic	34°N, 16°W	140 MYA
Atlantic	36°N, 33°W	3.5 MYA

Source of data: Parsons, B., & Sclater, J.G. (1977). An Analysis of the Variation of Ocean Floor Bathymetry and Heat Flow with Age. Journal of Geophysical Research, 82 (5), 803-827.

If you have extra time after discussing the data and any pattern that explains it, feel free to plug the locations into Google Maps. For Oceanic data, be sure to keep zooming out until you can see land!

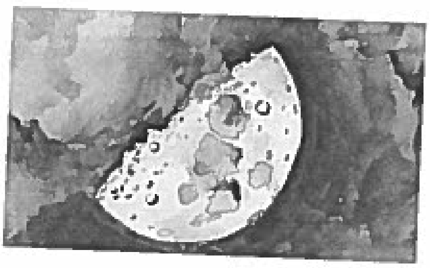
A Revolution Revival: Deep Sea Drilling Project

In the years following World War II, oil reserves on land were being used up quickly and the search for oil that could be found offshore (below ocean waters off the shore or coastline) was on. To conduct offshore exploration, oil companies built ships that had a special drilling rig and the ability to carry many kilometers of drill pipe.

This basic idea later was adapted in building a research ship, named the *Glomar Challenger,* designed specifically for marine geology studies, including the collection of drill-core samples from the deep ocean floor. In 1968, the ship went on a year-long scientific expedition, criss-crossing the Mid-Atlantic Ridge between South America and Africa and drilled for core samples at specific locations. When the paleontological ages of the samples were determined, they provided some powerful evidence (paleontological ages = the sediments ages were determined by finding the position of tiny marine fossils in the core sample and by a dating technique that involves studying the isotopes of certain elements found in the sediments).

Examine the data taken by the *Glomar Challenger*. Feel free to mark the map with information from the data table.

Discuss what pattern(s) you notice and be ready to report back to your team.



Historic narrative adapted from http://pubs.usgs.gov/gip/dynamic/developing.html
Emoji from http://emojipedia.org/smiling-face-with-sunglasses/

H14b

Core samples sites, ages, and distance from the ridge taken by the *Glomar Challenger*, Deep Sea Drilling Project Leg 3, 1968

Data and map adapted from: http://joidesresolution.org/sites/default/files/Nannofossils.pdf

Table 1
Distances and Ages of Mid-Atlantic Ridge Sites from the Axis

Site Number	Paleontological Age of Sediment (m.y.)	Distance From Ridge Axis (km)
16	11	221
15	24	422
18	26	506
17	33	718
14	40	745
19	49	1010
20	67	1303
21	76	1686

Adapted from Table 5', from Initial Reports of DSDP, Volume 3

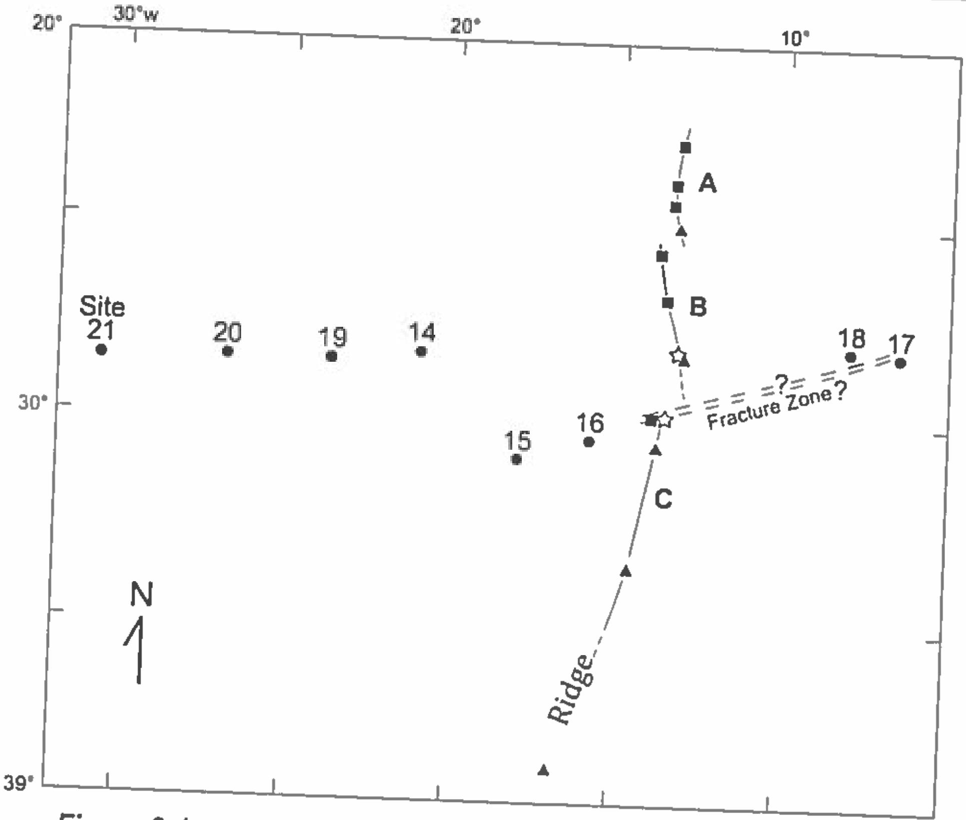


Figure 2. Location of DSDP Leg 3 drillsites relative to the axis of the Mid-Atlantic Ridge in the South Atlantic. Lines of latitude are in degrees South (i.e., 20° to 39°S)

Summary Model: Mid-Atlantic Ridge

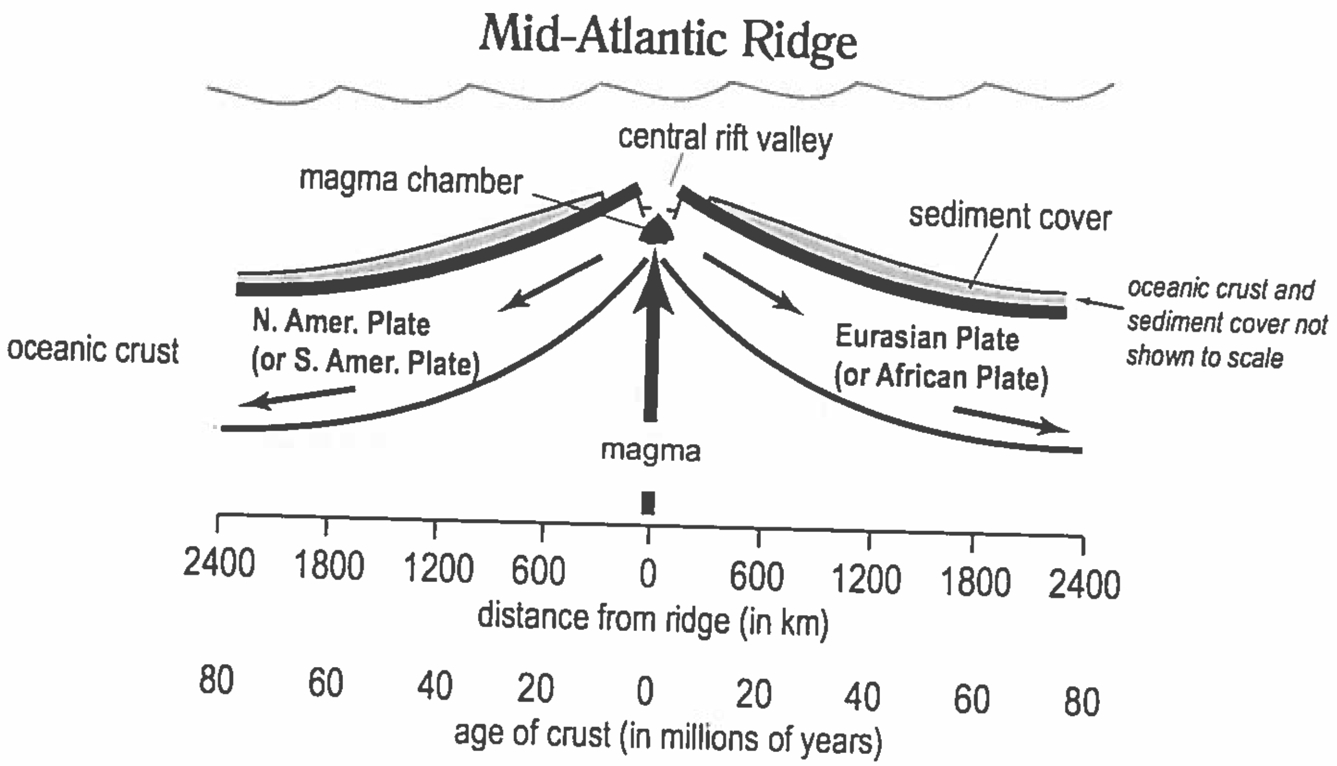


Figure 1. Relationship between ridge axis and seafloor age redrawn from Leckie and Yuretich (2003).

Image adapted from: http://joidesresolution.org/sites/default/files/5-PlateTectonicsDSDP3_hi_res.pdf

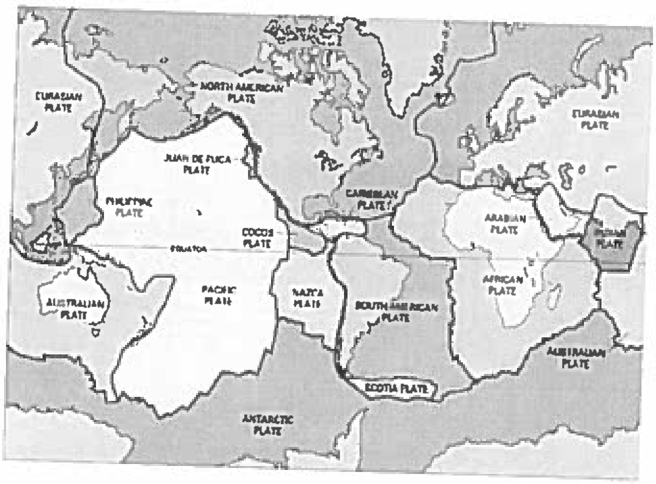
7.4.1 - 4 - Task Card: Milky Way Plate Boundary

The Earth's surface is broken into several moving plates. These plates move relative to one another on average about 10cm/year. Three types of movement are recognized at the boundaries between plates: convergent, divergent, and transform.

Task Steps:

1. Open a Milky Way and use the wrapper as a place mat.

2. Make crustal plates by making "cracks" in your Milky Way. To do this, carefully press down on the chocolate coating on the top. (You only need a few cracks, so press gently.)



To simulate the boundaries:

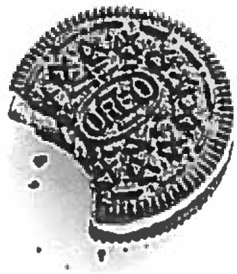
* To show convergent boundary: move two plates toward each other until they collide.
Where an oceanic plate collides with a continental plate, the oceanic plate tips down and slides beneath the continental plate forming a deep ocean trench (a long, narrow, deep basin). An example of this type of movement, called subduction, caused the big earthquake, nuclear plant disaster, and devastating Japanese tsunami in 2011. Where continental plates collide, they form major mountain systems such as the Himalayas (where the Indian plate collided into the Eurasia plate).

* To show divergent boundary: Move two plates away from each other. Where plates diverge (like at the Mid-Atlantic Ridge) hot, molten rock rises and cools adding new material to the edges of the oceanic plates. This process is known as seafloor spreading.

* To show transform boundary: move two plates horizontally past each other. The San Andreas zone where we are in California is an example of this type of plate boundary. At this boundary, the Pacific Plate (on which Los Angeles sits) is moving slowly northwest relative to the North American plate (on which San Francisco sits).
Model: Use your chart paper to create three mini-models to show your understanding of the three different plate boundaries (include diagram with labels, arrows to show movement and rationale).

Once your team is done – you may choose how you would like to dispose of your model :)

Name: ___________________________ Date: ______________



Oreo Cookies and Plate Tectonics

Amateur geologists can simulate how plates move on the Earth's surface.

The term **tectonics** originates from the Greek word "tektōn," referring to a builder or architect. **Plate tectonics** suggests that large features on Earth's surface, such as continents, ocean basins, and mountain ranges, result from interactions along the edges of large plates of Earth's outer shell. This outer shell is called the **lithosphere** from the Greek "lithos," meaning hard rock. The plates, composed of Earth's crust and uppermost mantle, ride on a warmer, softer layer of the mantle, called the **asthenosphere.**

In our experiment, the upper cookie will represent the **lithosphere**, the creamy filling the **asthenosphere**, and the lower cookie the **lower mantle**.

Plates move in <u>three basic ways</u>. Let's look at them one by one.

Choose a cookie. Don't eat it...yet!

1. First, carefully remove the upper cookie (a "twisting" motion is required).
2. Slide the upper cookie over the creamy filling. This motion simulates the movement of a rigid lithospheric plate over the softer asthenosphere.
3. Next, break the upper cookie in half. As you do so, listen to the sound it makes.

What sound do you hear? ______________________________

What does that breaking represent? ______________________________

4. Let's look at **<u>divergent plate boundaries.</u>** Divergent means ______________________________.

5. Now push down on the two broken cookie halves and slide them apart. What happens to the creamy filling?

____

6. Now let's look at **convergent plate boundaries.** Convergent means ____________________

7. Take the two cookie halves and slowly push them toward each other. What happens to the filling as the plates slide together?____________________
____

What happens to the cookies as they push against each other?____________________

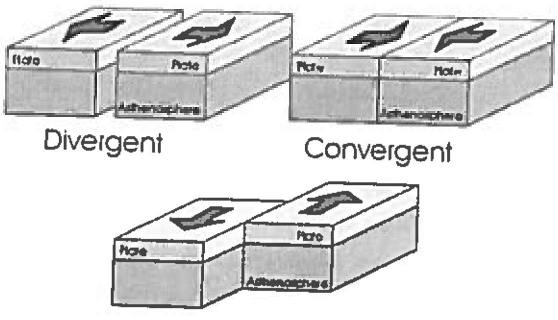
8. Now let's look at a **transform plate boundary.** Try sliding the two cookie pieces laterally past one another, over the creamy filling. What do you notice about the cookie edges?

____

____

(You can feel and hear that the "plates" do not slide smoothly past one another, but rather stick then let go, stick then let go. The cracking sound you hear each time is like an earthquake occurring along the San Andreas Fault in California.)

9. Some of Earth's landforms are created by **hotspots** where a plate rides over a fixed "plume" of hot mantle, creating a line of volcanoes. Imagine if a piece of hot, glowing coal were imbedded in the creamy filling – a chain of "volcanoes" would be burned into the overriding cookie.



Adapted from

FUN WITH FOOD!
PLATE TECTONICS AND OUR NATIONAL PARKS*

Robert J. Lillie
Professor of Geology, Department of Geosciences
Oregon State University
Corvallis, OR, 97331-5506

7.4.1 - How Water Shapes the Earth
Stream Table ACTIVITY Task Card 1

Focus Question: How does the moving water shape the land?

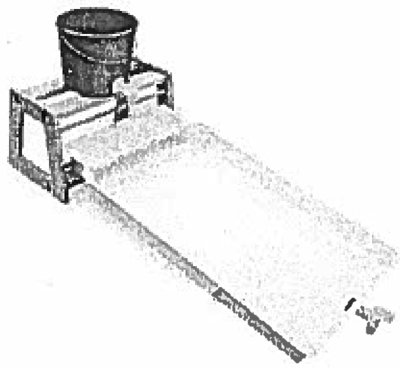
Task: In this activity, create a model of a watershed in order to explain how water shapes the lan

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials, coordinate cleanup and setup • *Inquirer* - Only person to ask questions of the teacher/others	- Stream table setup (includes stage, two buckets, the table, removable tray, and grit) - A plastic petri dish (for collecting grit at each level of the stream table) - Permanent marker - Beaker - Meter stick - Stopwatch - Watershed system glossary resource Sheet

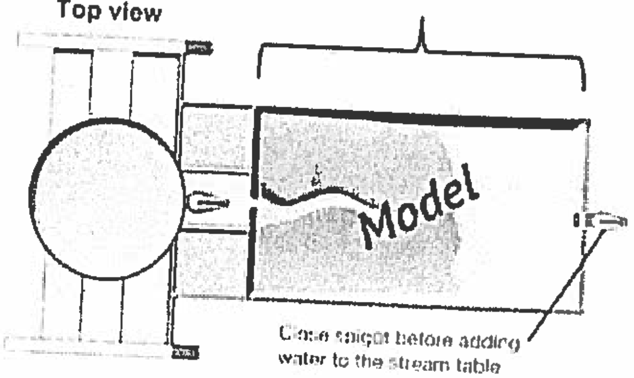
Part 1 - Setting Up your Watershed System

In groups...

1. Set up your stream table as shown in the picture at right. Make sure the table is set on the stage's second rung. The bucket on the stage should have a spigot.

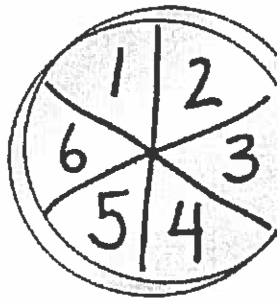


2. Using your hands, smooth the sediment (grit) in your stream table so that the bottom third of the table is empty and clear of particles. The bottom third of the table represents the ocean. The sediment should slope from the "ocean" to just below the level of the notches.
3. Use your hands to make a meandering stream channel in your sediment. **The scale factor in this stream table is such that 9 centimeters in the stream table represents 1 kilometer in the real world.** **Create a stream that is 5 kilometers long.** Dig down only halfway to the bottom of the sediment. Make sure your stream goes all the way to the "empty ocean" in your stream table.
4. Close the drain spigot at the end of the stream table. Place the bucket without the spigot unde
the drain spigot.
5. Fill the upper bucket with water.
6. Draw a model of your watershed system in your notebook with a normal pencil. Make sure it is **drawn to scale** and to label the **river, the river source** and the **ocean.** (Note: the total length of the system is 67 cm)



7. Begin SLOWLY running water into the top of the river channel. Start the stopwatch. Watch the river gradually fill with water and the sediment particles move downstream. Also note the formation of a delta at the mouth of the stream near your "ocean."

8. Stop the flow of water after TWO minutes and the stopwatch. Using a colored pencil, add your model what the watershed system looks like now. Create a **key** to demonstrate "after TWO minutes." make sure you start the stopwatch again and don't reset it.
9. Stop the flow of water/stopwatch after a total of SIX minutes. Using another colored pencil add to your model what the watershed system looks like now. Add to your key "after SIX minutes."
10. Stop the flow of water/stopwatch when your delta has spread into about half of your ocean, when the water level in the ocean rises too close to the top of the stream table wall. Using another colored pencil, add to your model what the watershed system looks like now. Recc the time from the stopwatch and add to your key "after ___ minutes."
11. Make sure the lower bucket is lined up with the drainage hole. Open the drain spigot and all the water to drain from the table into the lower bucket. Observe the general sizes of the particles remaining near the source of the river, the middle, and at the delta.
12. Use a permanent marker to divide a petri dish into 6 equal sections, labeling them from 1 through 6.



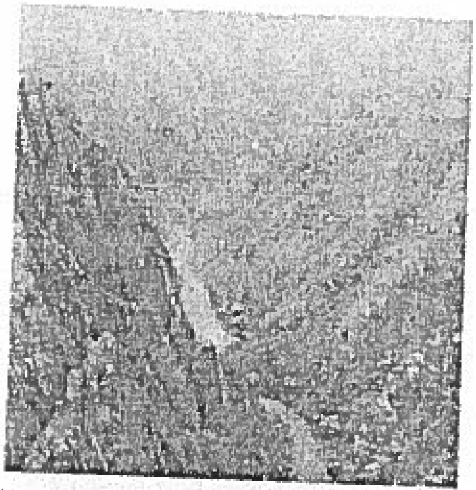
13. Take small samples (a pinch) of the sediment from the following locations and place them in the numbered sections of your petri dish. See the <u>Watershed system glossary sheet</u> for help.
    - Section 1: The river source
    - Section 2: The end of the river before the delta
    - Section 3: The middle of the delta
    - Section 4: The end of the delta
    - Section 5: The middle of the ocean bottom
    - Section 6: The far end of the ocean bottom
14. Add to your model by labeling the following: **meanders, floodplain and delta.**
15. Number your diagram showing the location of each of your six sections. For example, label your river source "1." Draw to scale the relative size of the sediment particles found at each location.

<u>Discussion Questions:</u>

16. How does the size of the particles change as you go from the river source to the far end of the ocean? Why do you think the sediment is sorted this way?
17. Where was the speed of the water fastest? Where was it the slowest? How can you explain this? Annotate these areas of fast and slow water flow on your model.
18. What do you notice about the relationship between the speed of the water flow and the size of the particles/sediment that was deposited in different areas?
19. Using your model, explain how did the moving water shape the land?

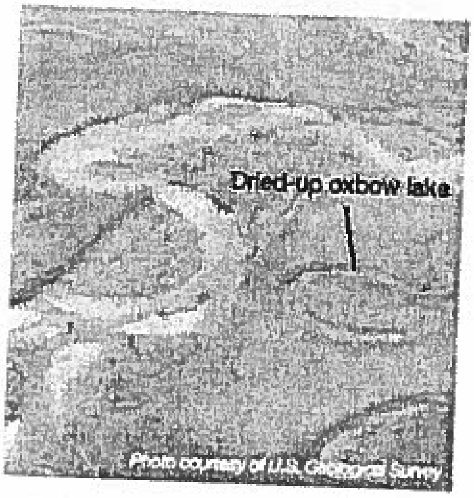
7.4.1 - How Water Shapes the Earth
Watershed System Glossary

River delta: The mouth of a river that flows into an ocean or lake.

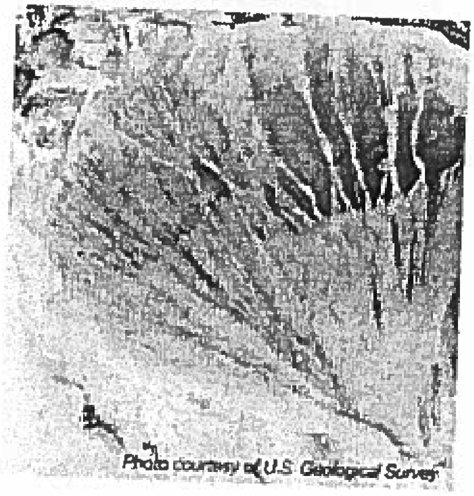


V-shape valley: When a river cuts a mountain it forms a V-shaped valley (a U-shaped valley is formed when a glacier moves through mountains).

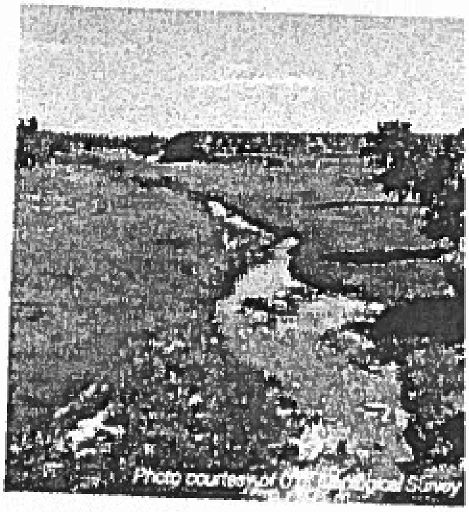
Meander: S-shaped curves in a river.



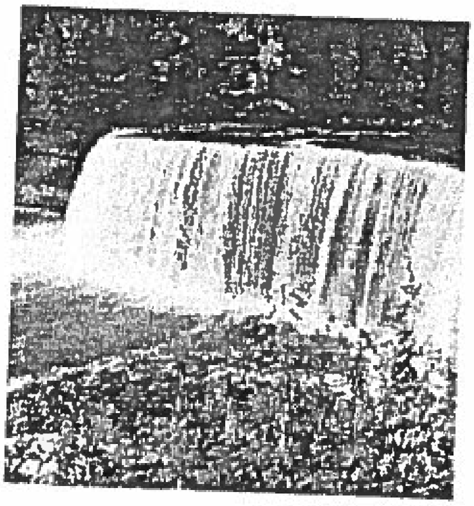
Oxbow lake: A meander that breaks off from the main river channel.



Alluvial fan: A fan-shaped area of sediment caused by a fast-flowing stream slowing down as it flows onto flatter land.

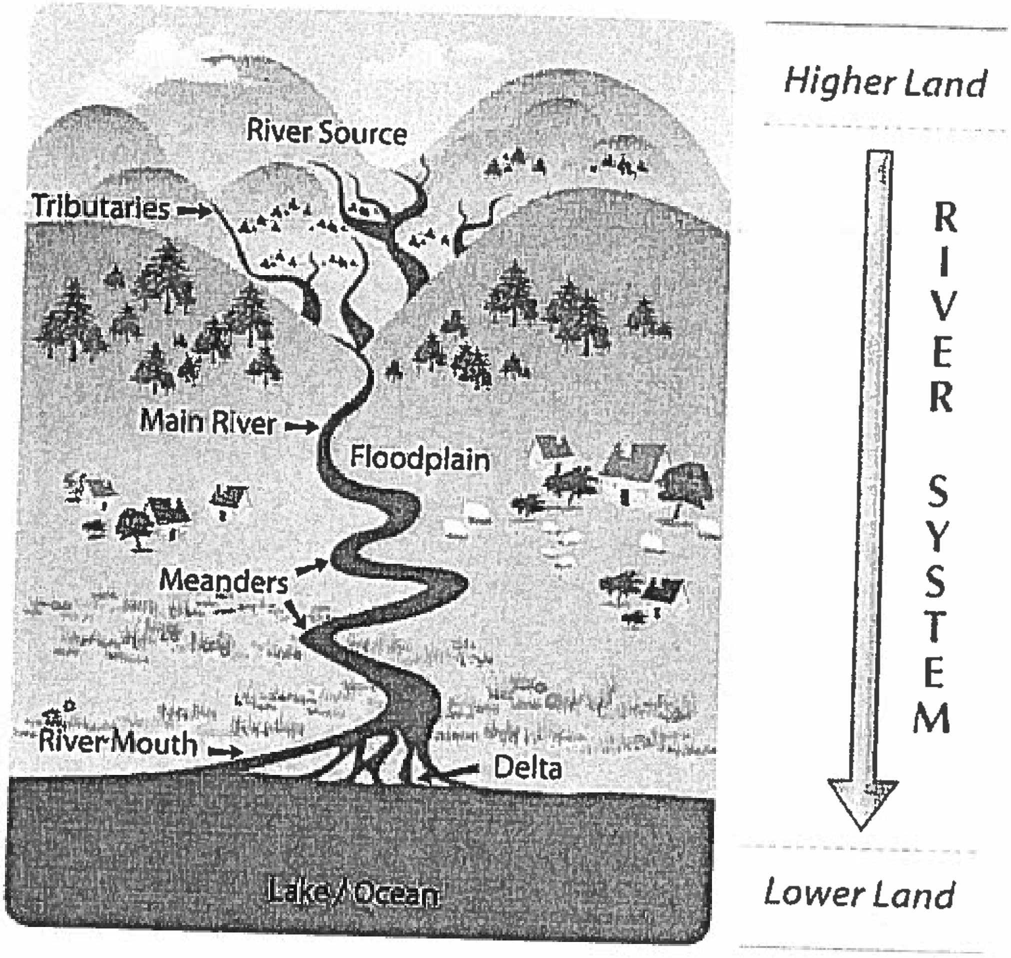


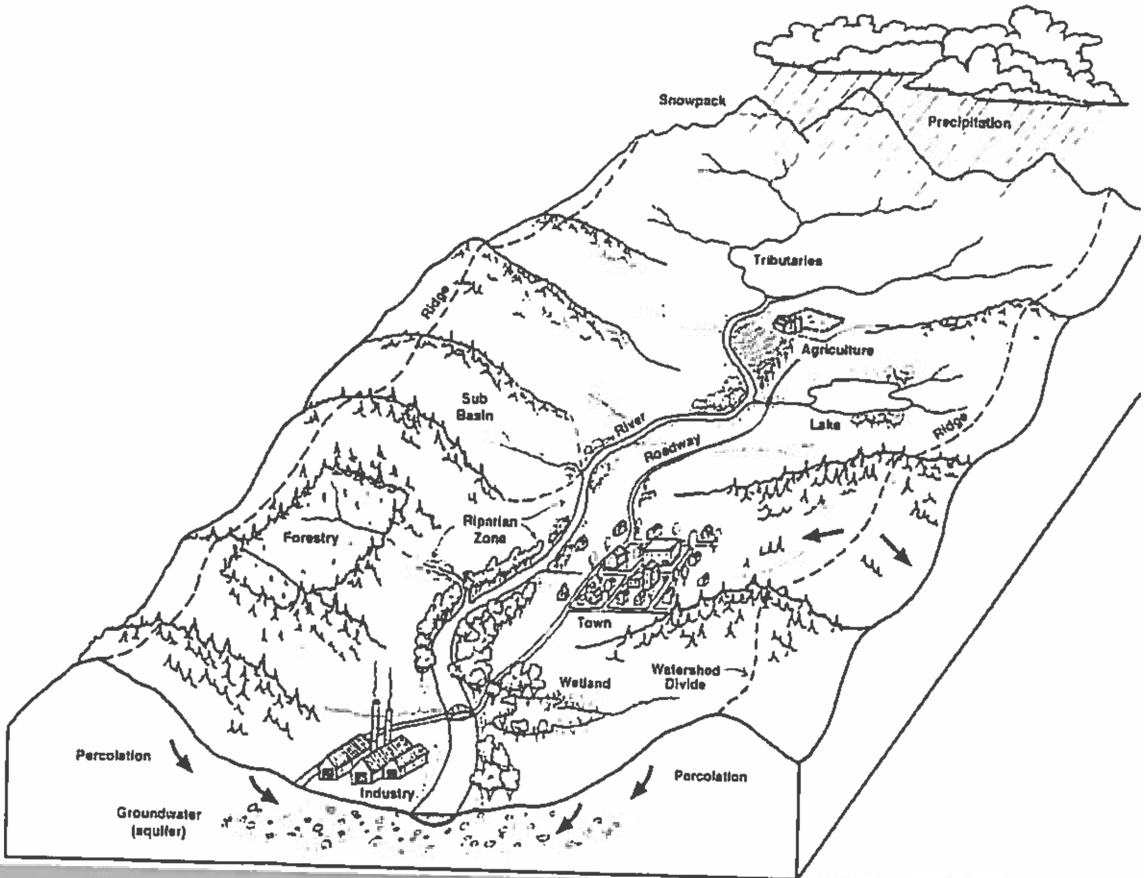
Flood plain: Flat land nearest a river that usually occurs at a distance from the source of the river. Flood plains are not good places for building because of the risk of flooding.



Waterfall: Falling water that results when a river flows from a high to a low place in its path (such as over a cliff).

Features of a River





Name ______________________________ Date ____________ Period ________

7.4.2
Scientific Reading: Sea Level Rise, Erosion and Weathering

Focus Question: How would sea level rise shape the land in Oakland? What are other ways water could reshape the land?

Temperatures Rising, Sea Levels Too

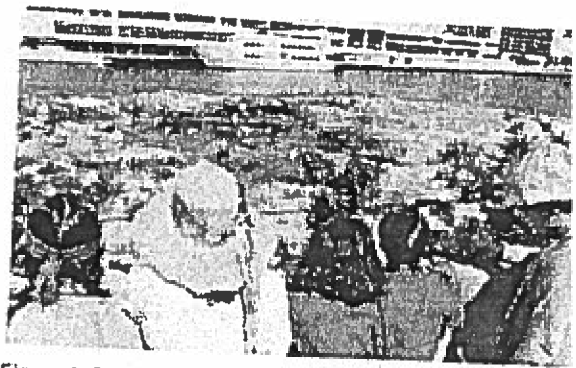


Figure 1. Students look down on the 'Miami Circle,' a site believed to be the site of a 2,000-year-old Tequesta Indian villag It was discovered last year on a construction site on the south bank of the Miami River in Florida. *Photo: AP Photo/Wilfredo Le*

Recently, archaeologists found a clue that sea levels are rising in Miami, Florida. They were looking for artifacts from the Tequesta Indians and discovered 10 bricks from the 1860s (see Figure 1). What surprised the scientists was where they uncovered the bricks. He found them about a foot under the water table, below where the dirt becomes wet from water underneath the ground. In coastal areas, a rise in sea level makes the water table level rise, too. The bricks would not have existed on land that was underwater. Therefore, they prove that sea level in the area had risen more than a foot in the last 100 years.

Scientists think rising sea levels are connected to a steady rise in temperature known as global warming. Experts believe global warming is caused by pollution accelerated by cars burning gasoline emitting even more carbon. With rising sea levels, imagine how this change could affect coastal regions like ours in Oakland?

Projecting Sea Level Rise in Oakland

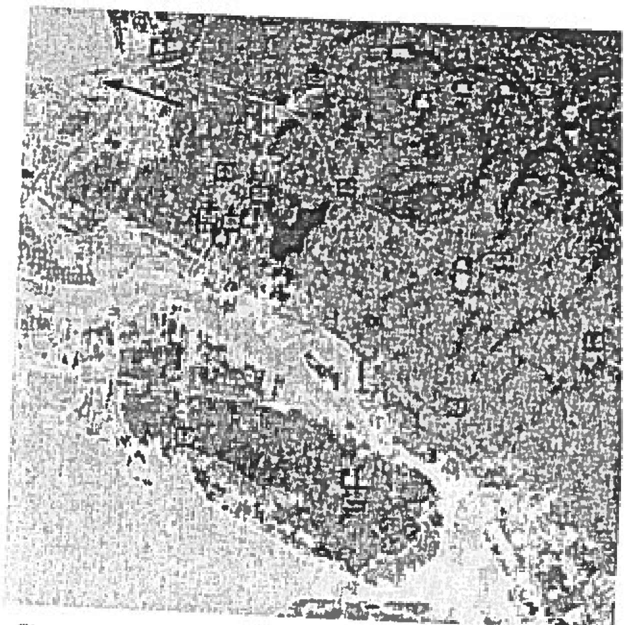


Figure 2. Map showing areas potentially flooded by a 3 4 inch rise in sea level. Arrow points to the water treatment facility in West Oakland that would be flooded. *Image from*

Many Oakland residents think that sea level rise Is a remote issue that will not likely affect them. However, there are many neighborhoods that are likely to be affected by a **flood** (when water flows over normally dry land) when the Bay's sea level rises or a global warming-induced storm occurs, according to most analyses. Because the flatlands are the lowest part of the city, they'll receive the backflow from a storm drainage system that relies on gravity when it overflows.

Name ______________________________ Date ____________ Period ________

However, when this sewer system is overwhelmed, water and whatever industrial runc or sewage is mixed with it, would flow back out of storm sewers onto streets, yards anc basements.

Sea level rise is no longer an "if" occurrence but a "when." Scientists predict a three-foc rise in waters off the U.S. West coast by the year 2100 (see Figure 2 on previous page) and, more urgently, a 35 percent chance of a climate-induced storm, anytime between now and 2030. These lead to new concerns over how this change could affect communities and the landscape.

Shaping the Land through Erosion

You have seen how water in the form of waves shape the land near coasts. However, water running downhill is the primary source of this movement of rock and soil in California. This process of water and other factors picking up and moving sediment is called **erosion**. Most of the sediment falls into the river due to the large movement of water and **runoff** (any water that is not absorbed and stays on the surface). Rock can also be worn away by the flow of water as it bumps into the bottom or sides of a stream (see Figure 3). In addition, there are other ways water shapes the land.

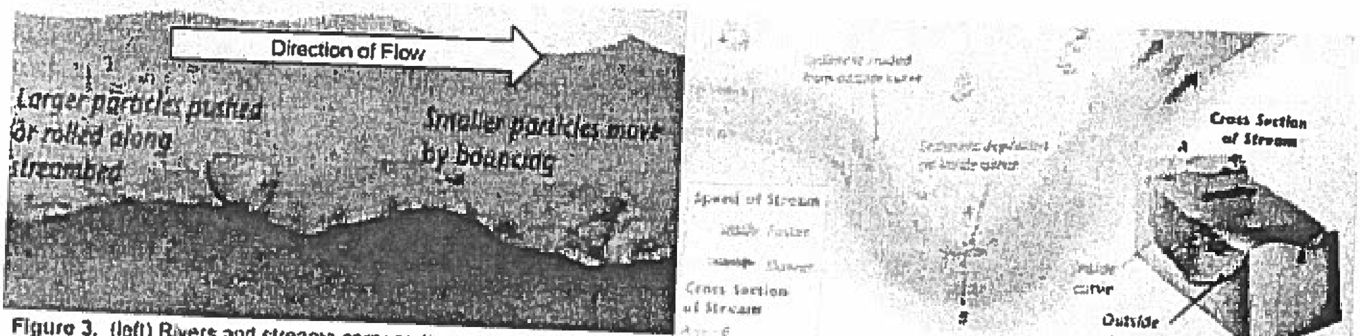


Figure 3. (left) Rivers and streams carry sediment.
(right) A river erodes sediment from its sides/banks on the outside curve and deposits its sediment on the inside curve.

Weathering Rock Physically

How is a large mountain broken down into tiny grains of sand? The process of breaking down rock is called **weathering.** Physical forces like wind and water freezing may break or chip rocks into smaller pieces. Liquid water is a physical weathering agent. Rocks break up quickly when running water knocks them against each other. Even running water alone wears away rock. Water weathers rock in other ways too. When water cools, it contracts like other matter. But just before it freezes, it expands a little bit! Say a small amount of water enters a tiny crack in the rock. When the water freezes, it

Name ________________________________ Date ____________ Period ________

expands, making the crack a little wider. More water enters the crack, freezes, and widens the crack even more. Eventually this wedging can split apart the two sides of the crack (see Figure 4).

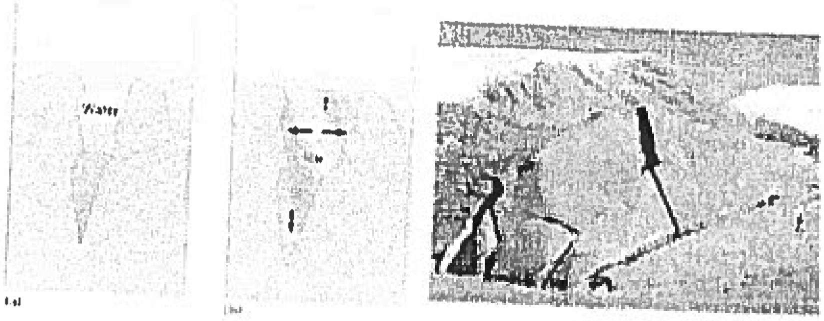


Figure 4. (left) Water seeps into a crack in the rock. (center) Water freezes, and expands a bit. (right) With repeated freezing/thawing cycles, rock brea

Weathering Rock Chemically

When rain falls and snow melts, not all the water evaporates or becomes runoff. Some water soaks into the ground, fills openings in the soil, and trickles into cracks and spaces in layers of rock. This water found underground is called **groundwater** and can also shape land underground. Groundwater can cause erosion through chemical weathering. When water sinks into the ground, it combines with carbon dioxide to form an acid called carbonic acid. This acid can react chemically with certain types of rock, e.g. limestone and break it down. Over time, the products of this reaction, including some of the rock, can be carried away by the water, creating pockets in the rock and eventually caverns. This can also result in deposits that form caverns with unique structures caused by the dripping of water (see Figure 5).

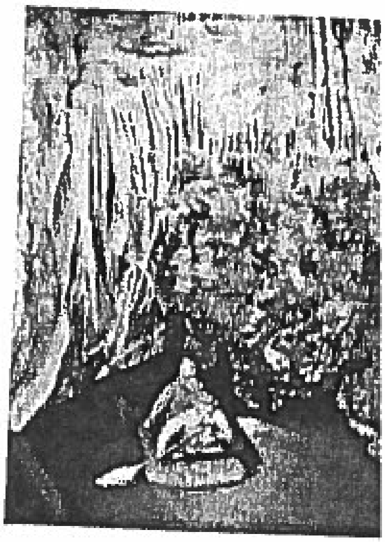
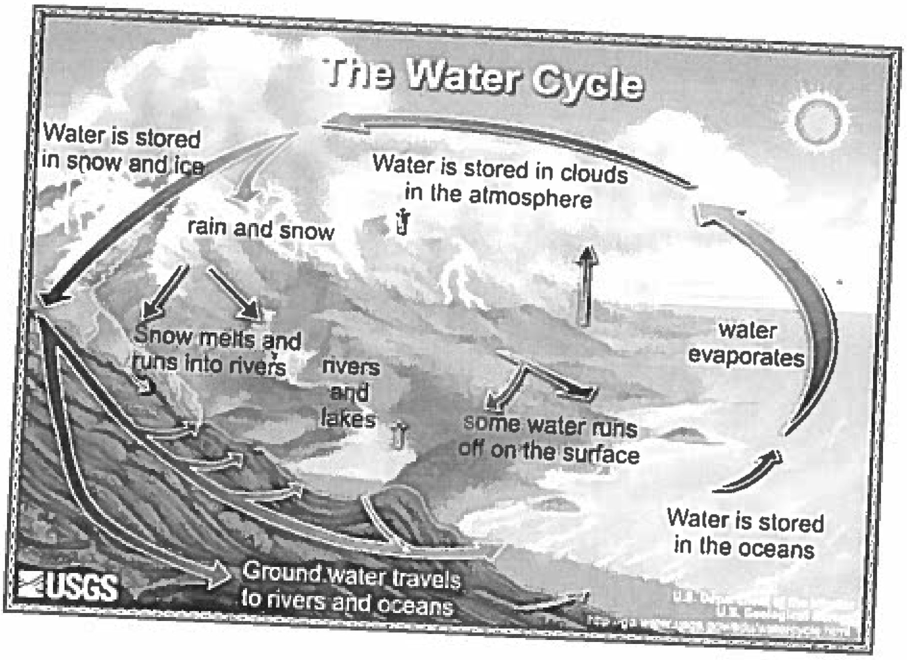


Figure 5. Underground rafting i California cavern formed from years of chemical weathering.

Plants can also cause weathering. Soil is formed as rock is broken down by weathering and mixes with other materials on the surface. Plant roots can weather the rock physically as they grow AND chemically as they release acid to break down the rock. The rate at which soil forms depends on the climate and type of rock.

Adapted from Oaklandlocal.com, NewsELA, CPO, and Prentice Hall water-cycle.gif (600×418)



7.4.1 - How Water Shapes the Earth
Stream Table MAPS and ACTIVITY Task Card 2

Focus Question: How has the water around your school shaped the land through erosion and deposition?

Introduction:

1. On a page in your notebook, draw a small square in the middle of the page to represent yo school.
2. Describe the type of land near your school, such as hilly, flat or rolling in 2-3 words. Write th words next to the square.
3. Determine the direction of north from where you are sitting with help from your teacher, if needed. Assume north is at the top of your notebook page.
4. If you traveled north 1 kilometer from your school, what type of land would you find? Choos an adjective to describe the land in that area. Write the adjective to the north of the square.
5. Repeat step 4 for areas 1 kilometer east, south, and west of your school.
6. How do you think the land came to be shaped today? (you may look back through your notebook)

Part I - Using a Topography Map

Materials:

- index cards
- colored pencils
- Creek and Watershed Map of Santa Ana

Procedures:

1. Copy the following graphic organizer into your notebook.
2. As a group, explore the map to understand its symbols and all of its key features.
3. Answer the guiding questions as a group. Be prepared to share your answers.

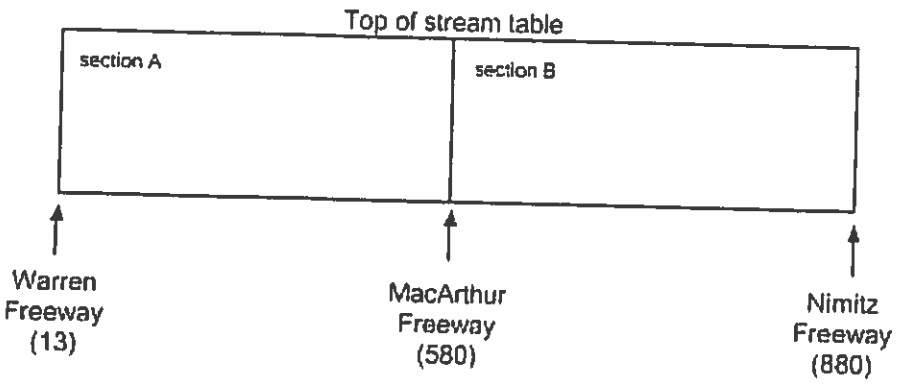
Guiding Questions

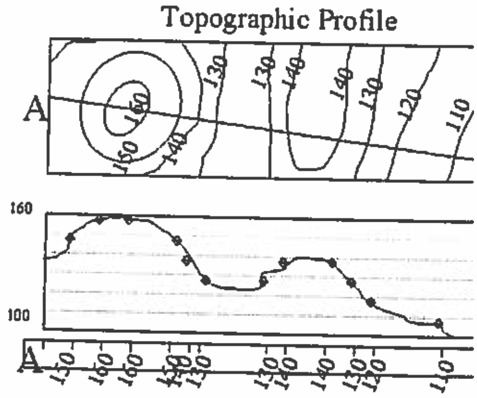
- How is scale explained on this map?
- How does this map show the direction of north?
- Find your school. Describe the area around the school. Check your answer from the introduction. (Note: the areas 1 kilometer to the north, east, south and west of your school)
- How does this map show bodies of water?
- How does this map show elevation of different landforms?
- Find Sausal creek. Does the water flow toward Alameda or away from Alameda? How can you tell?
- Where along Sausal creek would you expect to see smaller sediment being deposited? How about larger sediment? Explain your thinking.
- Look at a **culvert** connected to Sausal creek. What do you think a **culvert** is? Why do you think it is connected to a creek?
- What do you still need help understanding?
- **What is the real world meaning/importance of this map?**

Part II - Stream Table Water Erosion

You are going to build a model of one of the creeks found in Oakland, Sausal Creek, in order to understand how water shapes the land through erosion and deposition.

Use the Creeks and Watershed map to draw a model of the creek in your notebooks. Your model should be be a side or topographic **profile** view of the creek as if you were looking at the sedimer from the side. Your model will be in two sections: (1) the creek between the Warren freeway and MacArthur Freeway, and (2) the creek between the MacArthur freeway and Nimitz Freeway.





Make sure your model:
- ❑ includes elevations
- ❑ includes hills drawn with elevation changes relative to the actual land
- ❑ include the length of the creek in your model to make it drawn to scale

NOTE: For this model and activity, we will assume the culverts were the original path of the creek.

Materials:
- Stream table setup (includes stage, two buckets, the table, removable tray, and grit)
- Beaker
- Meter stick
- Stopwatch
- Clay to represent a house

Procedures:
1. Set up the stream table EXACTLY as you drew it on your model with the sediment.
2. Break the clay in four and place the pieces to represent houses in four locations:
   a. near the creek in section A
   b. near the creek in section B
   c. far from the creek in section A
   d. far from the creek in section B
3. Begin SLOWLY running water into the top of the creek channel. Start the stopwatch. Watch tl creek gradually fill with water and the sediment particles move downstream.
4. Stop the flow of water after TWO minutes and the stopwatch. Using a colored pencil, add to your model what the watershed system looks like now. Create a **key** to demonstrate "after TWO minutes." make sure you start the stopwatch/flow again and don't reset it. Annotate any observations you notice about the change in the sediment and houses,
5. Stop the flow of water/stopwatch after a total of SIX minutes. Using another colored pencil, add to your model what the creek looks like now. Add to your key "after SIX minutes."
6. Stop the flow after a total of TEN minutes. Using another colored pencil, add to your model what the system looks like now. Record the time from the stopwatch and add to your key "afte TEN minutes."

Discussion:

1. How did the land change due to the flow of water?
2. What happened to each house as more water flowed?
3. What was the difference between section A and B? How did that difference affect how wa shaped the land?
4. The stream table model is good for showing some aspects of how the water shapes the lar But it has some **limits** where it cannot show exactly what happens in real life. Give two examples of how this stream table model is different from how a stream shapes the land in real world.

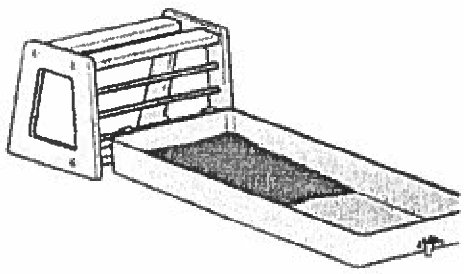
Part III - Stream Table Ocean Waves

Another important water source that shapes the land comes from the oceans. Ocean waves are tl primary force of erosion along coastlines. The beautiful cliffs along the Pacific coast are formed by this strong wave action. Waves can form as energy is transferred from wind blowing across the water's surface. In this investigation you will model how waves can shape coastal areas like we ha in the Bay Area.

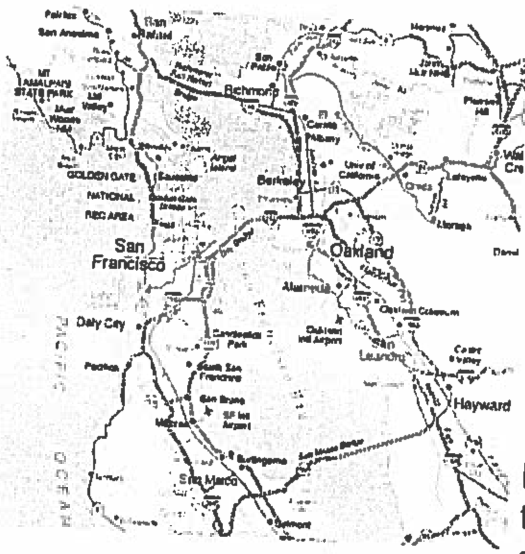
Materials:

- Stream table setup (includes stage, two buckets, the table, removable tray, and grit)
- topo lid
- small rocks and pebbles
- beaker
- colored sand
- map of Bay Area

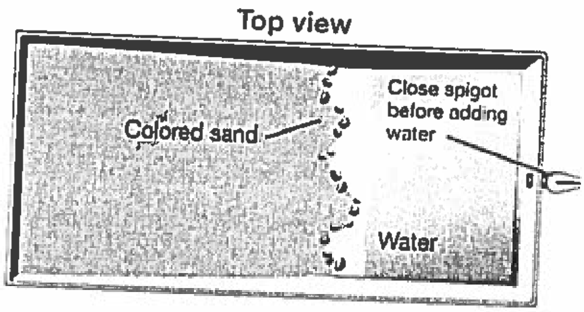
Waves and the Shore:



1. Set up your stream table so that the slope is at the lowest setting.
2. Fill the top half of your stream table with tightly packed grit. The grit should be five to seven centimeters thick. It should gradually slope down towards the middle of the stream table.



3. Create a shoreline in your sand bank. Be creative. Shorelines are rarely straight. Add small rocks and pebbles to your shoreline. Look at the map of the Bay Area to get ideas for shoreline.
4. Sprinkle the colored sand along the shoreline of your model. Make sure the spigot at the end of the stream table is closed.



5. Fill the empty half of your stream table with water until the water level begins to reach your shoreline.
6. Sketch your shoreline in your notebook as a model before completing the next step.
7. Hold the topo lid with two hands and place the lid at the end of the table in the "ocean." Push it back and forth gently to create equal sized waves.
8. Create waves in your stream table for a full minute. Take note of what happens to the colored sand and the shape of your shoreline. When you are done, drain the water to get ready for the next part. Add to the model in your notebook with a colored pencil for what happened after the waves.

Discussion:

1. What happened to the colored sand as you created waves in your model?
2. Describe the changes that the waves made to your shoreline.
3. Describe the rate of erosion along areas of shoreline that "stuck out" into the ocean. How \ erosion different here than areas (such as a bay) that were farther inland?
4. How is this ocean wave model different from how a real ocean wave shapes the land?. Wh are **limits** to this model?

Changing the Waves:

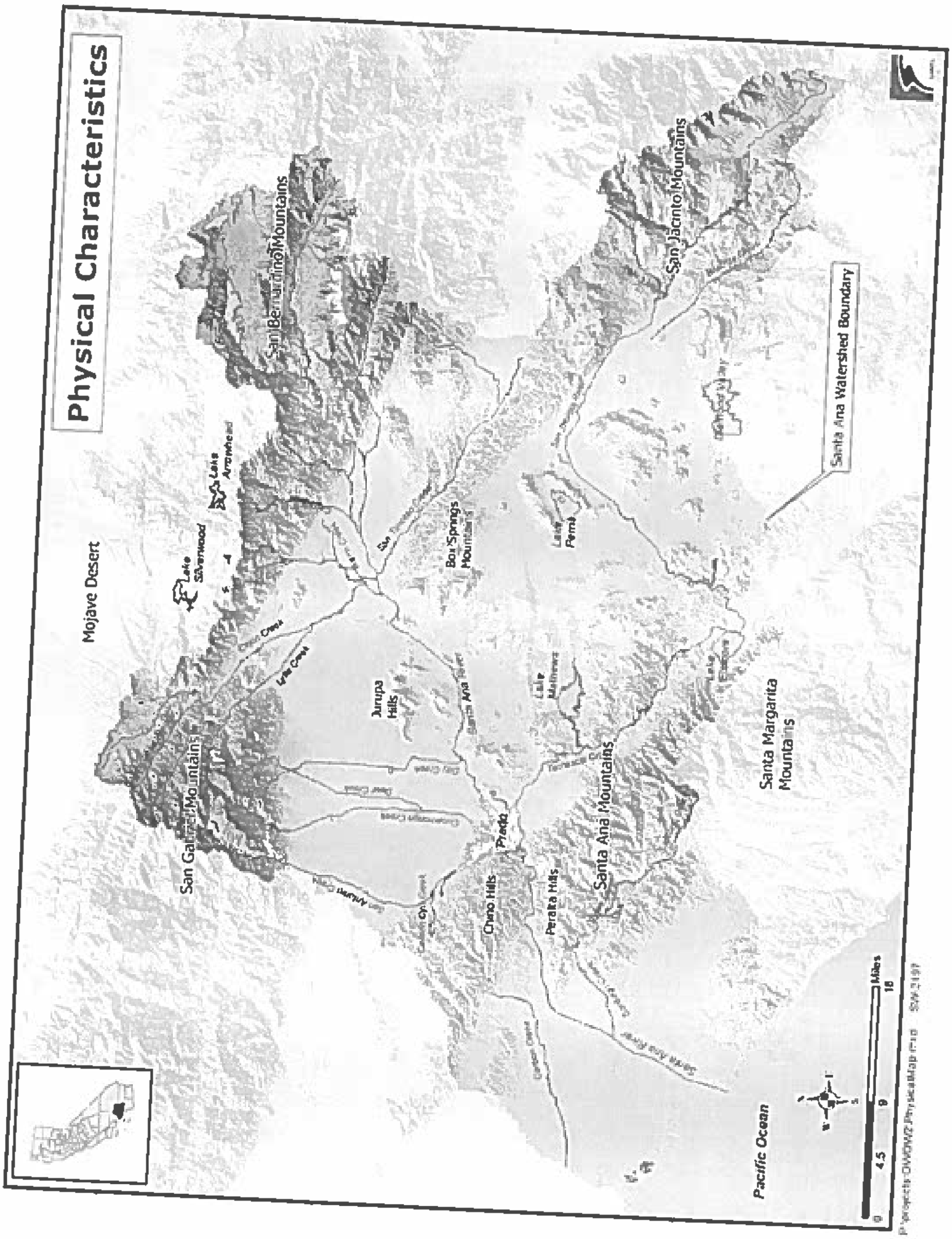
Now, you will have a chance to investigate on your own about how water flowing in waves can sh the land. Before doing so, you must design an investigation to answer the following **focus questions:**

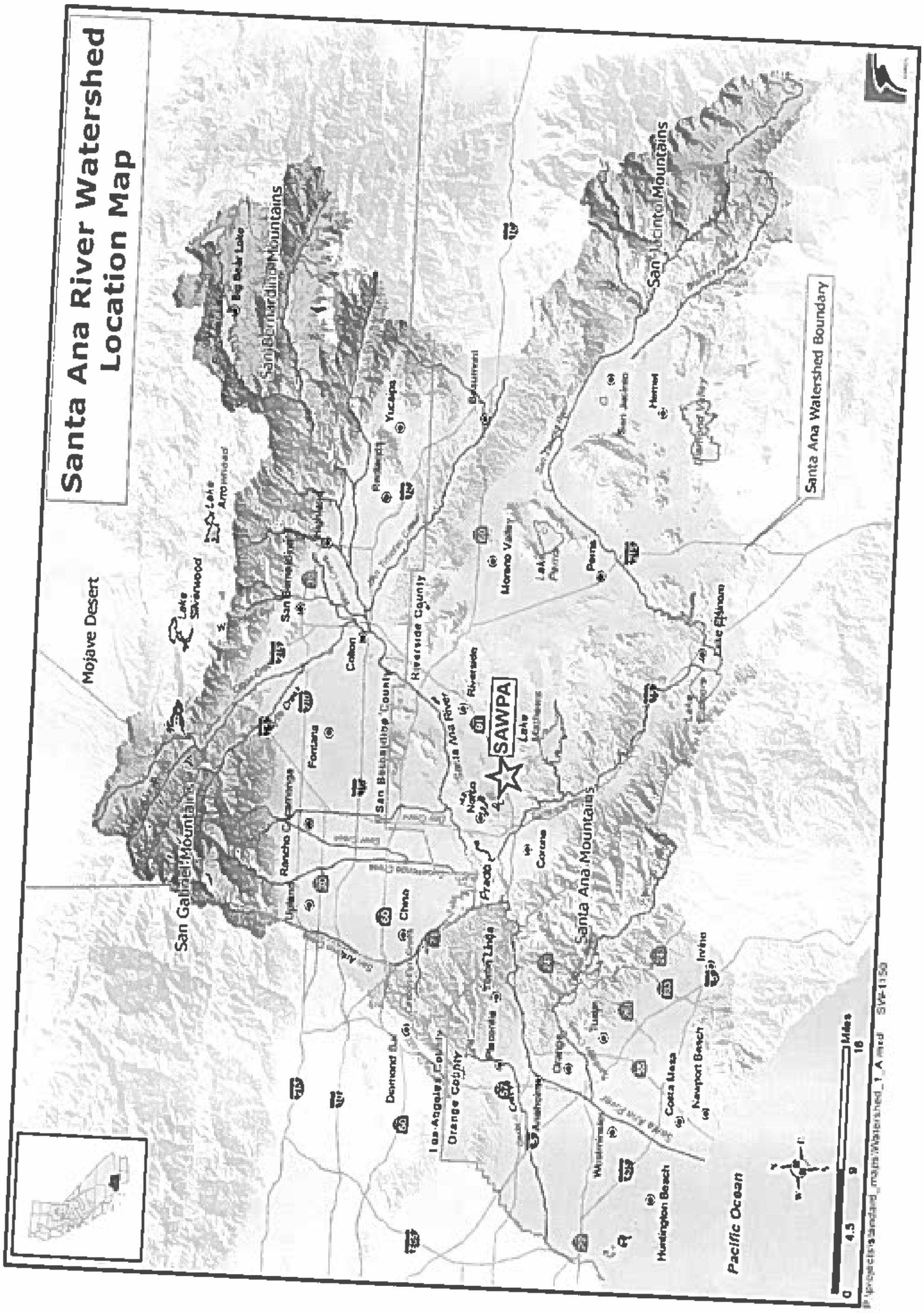
1. How did the **rate of erosion (how fast/slow)** change as you created more powerful waves
2. How did changing the angle of the waves affect the **rate of erosion of your shoreline?**
3. As waves move ashore, they pick up sediment such as sand and pebbles. How do you thin the sand and pebbles affect the **rate of erosion of coastal areas?**

Draw a model for each question in your notebook that shows what you will do to investigate and answer the question similar to the table below under "**Shoreline before waves" model.** Make sur to label different areas of your coastline as well as different features of the waves you create.

How did the **rate of erosion (how fast/slow)** change as you created more powerful waves?	
"Shoreline before waves" model	"Shoreline after waves" model
How did changing the angle of the waves affect the **rate of erosion of your shoreline**?	
"Shoreline before waves" model	"Shoreline after waves" model
As waves move ashore, they pick up sediment such as sand and pebbles. How do you think the sand and pebbles affect the **rate of erosion of coastal areas?**	
"Shoreline before waves" model	"Shoreline after waves" model

Complete your investigation and draw the models of the shoreline AFTER waves for each. Discuss and answer the focus questions. Afterwards, be ready to share the answers to the questions you found and your models.


Physical Characteristics
Mojave Desert
Lake Silverwood
Lake Arrowhead
San Bernardino Mountains
San Gabriel Mountains
Jurupa Hills
Box Springs Mountains
Lake Perris
Lake Mathews
Prado
Chino Hills
Peralta Hills
Santa Ana Mountains
San Jacinto Mountains
Santa Margarita Mountains
Santa Ana Watershed Boundary
Santa Ana River
Pacific Ocean
0 4.5 9 18
Miles


Santa Ana River Watershed
Location Map
Mojave Desert
San Gabriel Mountains
San Bernardino Mountains
San Jacinto Mountains
Santa Ana Mountains
SAWPA
Santa Ana Watershed Boundary
Pacific Ocean
Los Angeles County
Orange County
San Bernardino County
Riverside County
Santa Ana River
Lake Silverwood
Lake Arrowhead
Big Bear Lake
San Bernardino
Highland
Redlands
Yucaipa
Beaumont
Colton
Fontana
Rancho Cucamonga
Upland
Chino
Riverside
Norco
Prado
Corona
Moreno Valley
Lake Perris
Perris
San Jacinto
Hemet
Lake Elsinore
Yorba Linda
Placentia
Diamond Bar
Anaheim
Orange
Irvine
Newport Beach
Costa Mesa
Huntington Beach
Westminster
0
4.5
9
18
Miles

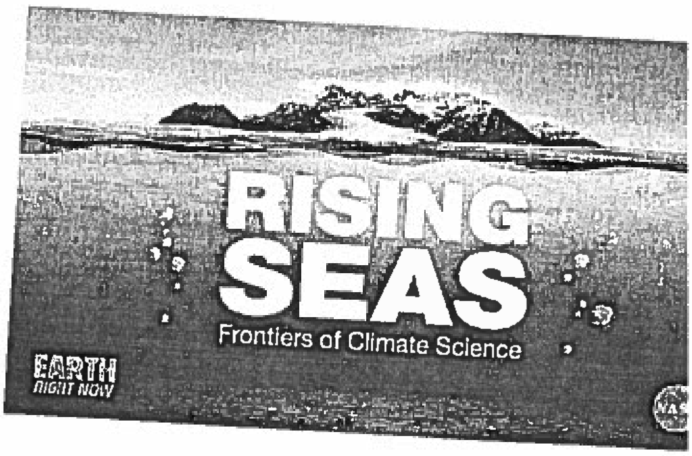
7.4.2 How Water Shapes the Earth Task
Investigation Updates Task Card

Summative Task Problem:
Find the best location for a new human settlement in Oakland. The new location must consider: a freshwater source, (2) growing food, (3) damage from natural hazards, and (4) safety from lo wildlife, including zombies. Your group will design a map of Oakland that shows considerations where to live. Each scientist will write a summary report of how your group decided where to liv

INDIVIDUAL THINKING:
Answer the focus question below.

FOCUS QUESTION: How does understanding <u>how water shapes the Earth</u> help you plan where to build a human settlement?

PART ONE - WHITEBOARD BRAINSTORM:
Brainstorm answers to the following questions on a whiteboard. Write down as many as you can. Remember, a brainstorm should show evidence of: (1) Quantity over quality, (2) Build on other's ideas, (3) Suspend judgment, and (4) Wild is wonderful.



1. What are considerations (possible risks, constraints, or things to consider) when choosing a location for settlement that you want your map to show?
2. How will your map show these considerations?

Be prepared to explain why you chose these considerations based on evidence from the readings, data analysis, activities, or maps.

PART TWO - ROUNDTABLE CONSENSUS

Copy the following graphic organizer into your notebook. Don't write any answers yet. This will help you create your map and summary report for planning your human settlement.

Considerations (possible risks, constraints, or things to consider)	**Explanation based on evidence from the readings, data analysis, activities, or maps.** *For example, risk of a volcanic eruption should be considered because... This is supported by the reading on volcanos which states...*

1. Bring your whiteboards together in the center of the table.
2. Each person will pass their whiteboard to the left, clockwise around the table. Review your group member's design. Using another colored marker, you may add to their idea, but you CANNOT cross out their idea. Place a checkmark (✓) next to any idea that you think is important for you to consider in your map model. Remember, there is NO talking or explaini
3. Keep passing designs until you get back your original design.
4. Each person will describe one of their ideas to the group, making sure to explain why they included a specific part in their model.
5. Teammates discuss the parts of the design that they think should be included in a final grou model. If there is disagreement, the team discusses the idea until there is agreement/consensus.
6. Go around until all ideas have been shared and considerations are written down in the graph organizer.

Decision Making:	**Points Possible**	**Self Score**	**Teacher Score**
❑ Each member contributes their ideas.			
❑ All members encourage each other to participate.			
❑ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.			
❑ The group identifies the best solutions that everyone can live with.			

PART THREE - DESIGNING THE MAP OVERLAY MODEL

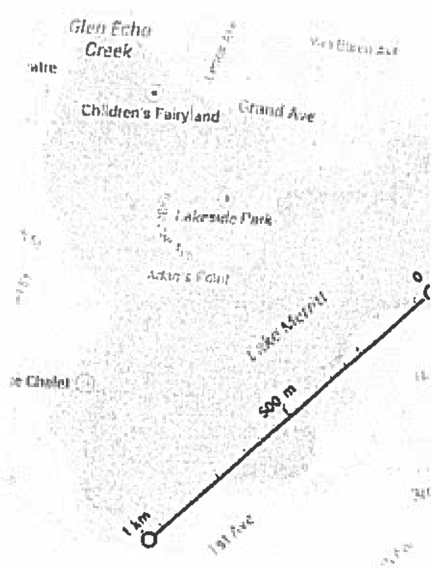
Your group will choose what to include when you design your final map. The overlays will be lik parts of a rough draft you use to create that final model of Oakland and your settlement.

Before you start your design, here are the **constraints** to consider. Use the following checklist to guide your design. Your model must meet these requirements.

- ❑ Your map model must fit on 11" x 17" paper (Note:Tracing paper is a larger than the map)
- ❑ It must be easy to read and clear.
- ❑ Symbols and color may be used to show any consideration you desire, but there must be a to explain any use of them.
- ❑ The model must be drawn to scale.
- ❑ Settlement needs to have the same area as a rectangular building with the dimensions, 0.2 km x 0.4 km.

Before you create your map overlay on tracing paper, we need to make sure you orient the map every time so the map and overlays are facing the same direction.

1. Start by finding Lake Merritt and place the overlay over the map, making sure all corners are covered by the tracing paper. Draw Lake Merritt onto your overlay as you did before.
2. Remember to use this measurement for reference for drawing the map to scale.
3. Make sure you mark the direction, "North" on the map overlay so it will be easy to orient again.
4. Add all key features and considerations necessary to your model to explain what to consider for a safe human settlement.



5. Add your settlement to the model. Draw a rectangular building in BLACK similar to the entry task. (Other shapes for a settlement could be considered as long as the settlement takes up the same area). Remember in the design process your location may change based on other considerations.

(Hint: Try to annotate your thinking - it will be your choice whether to include your annotations on you final model since you will turn in your map overlays as proof of revision and evidence building)

PART FOUR - Pros-N-Cons - BALANCING DIFFERENT CONSIDERATIONS

You now have two map overlays that you will use to plan your settlement and make your final dr
the map model. Each map overlay most likely has a different location for the settlement. If not, t
activity will still help you make your decision. In order for your group to decide where to place yo
settlement, you need to balance the considerations you have learned about and decide each
location's **pros** (benefits) and **cons** (risks). Remember to use your **decision making rubric fro**
Part II to evaluate yourself as the teacher evaluates your work. Review the **Summative task**
problem before you start.

> **Summative Task Problem:**
>
> Find the best location for a new human settlement in Oakland. The new location must consider:
> a freshwater source, (2) growing food, (3) damage from natural hazards, and (4) safety from loc
> wildlife, including zombies. Your group will design a map of Oakland that shows considerations
> where to live. Each scientist will write a summary report of how your group decided where to live

<u>YOUR LOCATION:</u>

1. The group will choose ONE of the locations to discuss for this activity.
2. ALL members of the group decide what would be an appropriate way to record the pros and cons in their notebook
3. Your group will be split into two teams:
   <u>TEAM A:</u> Discusses the **pros** (benefits) of the location.
   <u>TEAM B:</u> Discusses the **cons** (risks) of the location.
   Note: The teams do not have to be evenly split.
4. Each team will brainstorm their assigned parts for the location in 5 minutes and write in their notebooks.
5. Timed Team Share:
   a. A's present all of the Pros for a location.
   b. B's present all of the Cons for a location.

<u>SWITCHING LOCATIONS:</u>

6. Find a group that has a different location from your group and bring your map overlays and notebook. You will only talk with the other group in step 9.
7. Looking at the other team's map overlays, your group will now brainstorm the pros and cons of **<u>the other group's location</u>** for five minutes in your two teams as before. Record these in your notebook as well and label it, "Alternative location."
8. Timed Team Share: A's present the Pros, then B's present the Cons for "alternative location."
9. Choose one reporter from your group to go to the other group and share your group's Pros and Cons chart for the "alternative location," while a reporter also comes over and does the same.
10. Draw a line below your pros and cons. **C-E-R:** Reflect on your own and record below the line where you would put the location for the settlement and explain why using any of the pros and cons.
11. **Rebuttal:** Write in 2-3 sentences what you might say to someone who suggests another location and any evidence to prove your point.

7.4.2 - How Water Shapes the Earth
Topography MAPS Task Card 2

Focus Question: How has the water around your school shaped the land through erosion and deposition?

Part 1 - Using a Topography Map

Task: In this activity, you will explore the features of a topographic map.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials, coordinate cleanup and setup • *Inquirer* - Only person to ask questions of the teacher/others	- Creek and Watershed Map of Oakland and Berkeley

Task Steps:

1. As a group, explore the map to understand its symbols and all of its key features
2. Answer the guiding questions below as a group and record in your notebook. Be prepared to share your answers.
3. Record as a group what further questions you have about the map, including any features on the map or how the map developers used technical writing tools to represent real world landforms.

Guiding Questions

- How is scale explained on this map? How about directions like North, etc?
- Find your school. Describe the area around the school. Check your answer from the introduction. (Note: the areas 1 kilometer to the north, east, south and west of your school)
- How does this map show elevation of different landforms?
- Find Sausal creek. Does the water flow toward Alameda or away from Alameda? How can you tell?
- Where along Sausal creek would you expect to see smaller sediment being deposited? How about larger sediment? Explain your thinking.
- Look at a **culvert** connected to Sausal creek. What do you think a **culvert** is? Why do you think it is connected to a creek?
- What do you still need help understanding?

Name ______________________________ Date ____________ Period ________

Unit 4.2 Scientific Reading: Drought

Focus Question: How can the people of Orange County ensure a local water source?

LOS ANGELES — On Thursday, California workers poked hollow aluminum tubes into Sierra Nevada meadows to measure the snowpack. They did not find much. "We will conceivably see more years like this in the future," said Jeffrey Mount, a geologist with the Public Policy Institute of California. The Earth has been getting warmer, scientists say, and the climate is expected to keep getting warmer. Many scientists blame humans. When we burn fossil fuels like gas, oil or coal it releases gases known as greenhouse gasses. They get trapped in the atmosphere and heat up the Earth.

A Dry January

Scientists say the state's mountain snowpack could shrink as a result (see Figure 1). The snowpack is the layers of snow that build up over time. By the end of the century, more than half of the snowpack could disappear.

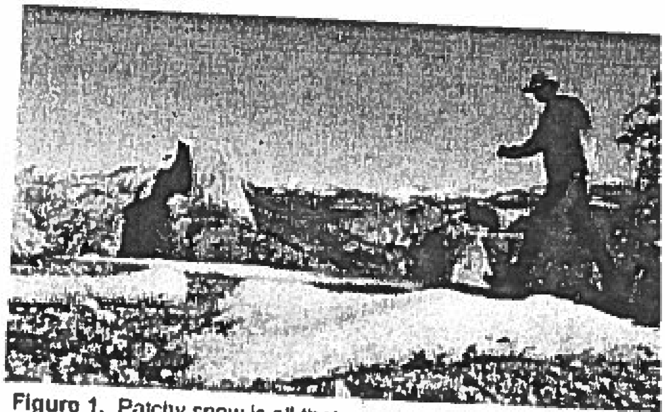


Figure 1. Patchy snow is all that remains on the ground at Glacier Point as Darrell Carlis, 55, of Fresno, California, hikes near the Panorama Trail in Yosemite National Park, Jan. 23, 2015. Photo: Brian van der Brug/Los Angeles Times/TNS

But that doesn't mean nature will provide less water to California. The latest climate studies suggest the overall amount of precipitation won't change much, and may even increase across much of California. However, more of it will fall as rain and less as snow. This change will force the state to alter the way it manages one of the world's most complicated water systems.

On Thursday, the snowpack was just 25 percent of the average for this time of year. A dry January is partly to blame, and the storms that hit the state in December dumped heavy amounts of rain, not snow. At its peak, the California snowpack holds about 15 million acre-feet of water. That is enough water to fill Shasta Lake, the state's largest reservoir, more than three times. The snow melts gradually over several months, trickling down mountains into rivers and reservoirs in the spring and early summer. The reservoirs fill just when the need for drinking water and water to irrigate farmland goes up.

Name ______________________________ Date ____________ Period ________

Changing Rules For Dams?

Rain, on the other hand, "has to be dealt with immediately. You can't wait," said Kelly Redmond, deputy director of the Western Regional Climate Center in Nevada.

Dealing with the heavy rains was not a problem in December. Because there had been three years of severe drought in the state, the reservoirs had plenty of room to absorb the water. The level of Shasta Lake rose by nearly 60 feet.

Due to climate change, though, there could soon be more rain in winter than California's water system could handle, said Dan Cayan, a climate scientist at Scripps Institution of Oceanography. Cayan added that the temperature in California has risen 1-degree Fahrenheit since the 1950s. Even that single degree increase has already cost California and the West 5 percent to 10 percent of its snowpack.

Adapting to the extra winter rainfall could literally require an act of Congress. Dams control the flow of water in and out of the reservoirs. They are operated according to a set of rules developed for each reservoir by the U.S. Army Corps of Engineers. Congress has to approve any changes. The California Department of Water Resources and the federal government together operate most of California's large dams. They are studying whether the rules should be changed because of the warming climate.

More Water Storage Needed

The state also is considering taking into account weather forecasts. If heavy rains were headed for the Sierra, for instance, water could be released from the reservoirs to make room. None of this is simple. Letting water out to make room for rain that never comes would mean less water for people. Yet, filling up reservoirs in the winter may cause flooding during spring storms. "Who wants to be the responsible person for not having that flood space in the reservoir?" asked Iris Stewart-Frey, a professor at Santa Clara University who has studied changes in the snowmelt.

Many experts say an obvious solution is to build more water storage. "I think if you want to replace 5 million acre-feet of lost snowpack, I don't see any other way than more

Name ________________________________ Date ____________ Period ________

storage," state hydrologist Maury Roos said. Hydrology is the study of water. Roos uses science and math to solve water-related problems in the state.

But should California build new reservoirs or increase groundwater storage, or both? Groundwater is water located beneath the Earth's surface, so groundwater storage is less likely to evaporate. Also, who would pay for the costs of the new storage?

The loss of snowpack is "definitely going to be a problem," said Jay Lund, director of the Center for Watershed Sciences at University of California, Davis. But if it's managed well, Lund said it should not be a disaster. And how will different cities respond?

Where Does My Water Come From? - Go Local!

Santa Ana pumps 62 percent of its water supply from its own groundwater wells, and purchases the other 38 percent from the Metropolitan Water District of Southern California, said Ray Burk, the city's water resources manager. The proportions from each source vary from year to year.

The groundwater is pretty much ready to drink as soon as it is pumped. The only treatment the city does is add a tiny (0.4 parts per million) amount of chlorine to protect against contamination, Burk said.

The water the city gets from the MWD has a higher (2 parts per million) portion of chlorine. That's because it is surface water, from the Colorado River, which requires more treatment, Burk said.

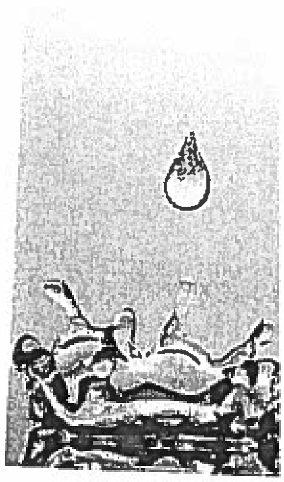
Taken from NewsELA, some adapted from Nature Conservancy, and OC Register ; images from EBMUD, calforniawaterblog, and gjfreepress

Unit 4, Learning Task 2 - Water and Rocks as Resources
Water Storage MAPS Task Card 1

Task problem:

You have been chosen to find the best location for a new human settlement in Oakland. The new location must consider: (1) a freshwater source, (2) growing food, (3) damage from natural haza e.g. landslides, and (4) safety from local wildlife, including zombies.

Given the drought crisis in California, the need for securing resources will be important for your settlement. In this activity, you will consider several factors in order to decide how you will best manage one of these resources: WATER.



Focus Question: Where in Oakland would be the best location for a new reservoir?

Materials:

- 6 examples of storage dams
- Laminated Watersheds and Creeks map of Oakland and Berkeley
- overhead markers

Introduction:

1. Look at the different dam designs for water storage. Name 3 differences between the dams.
2. How are the dams similar? Which features do all of them have in common?
3. What do you notice about the landforms seen around the dams?
4. Where do you think engineers choose to build dams based on what you observe? Explain why.

Directions:

1. Using what you learned about dams for water storage, look at the map and discuss in your groups where you think would be a possible place for storing water. (Note: You do not need t worry about filtering the water because this will be something your group will have access to. You simply need to find a freshwater source, not from the ocean.)
2. Use the laminated map and overhead marker to write down possibilities and discuss what you think in your notebook. If you need help deciding a location at your group, use the **ROUNDTABLE CONSENSUS** protocol given below to decide. Remember that your water source must be nearby (within 3 km of your settlement)
   a. Each person will describe one of their ideas to the group, making sure to explain why they chose each consideration.
   b. Teammates show thumbs up/down for the idea.
   c. If there is disagreement, the team discusses the location until there is agreement/consensus.
   d. When agreement is reached, have the next person share their location until all ideas have been shared.
   e. Come to consensus on one location and circle that area on your map. Be prepared to share out and explain why you chose that location.

Investigation Update - DESIGNING THE MAP OVERLAY MODEL

Your group will choose what to include when you design your final map. The overlays will be like parts of a rough draft you use to create that final model of Oakland and your settlement.

Before you start your design, here are some **constraints** (Limitations on the design of a solution the problem) to consider. Use the following checklist to guide your design. Your model must mee these requirements.

- ❑ Your map model must fit on 11" x 17" paper (Note:Tracing paper is a bit larger than the ma
- ❑ It must be easy to read and clear.
- ❑ Symbols and color may be used to show any consideration you desire, but there must be a to explain any use of them.
- ❑ The model must be drawn to scale.
- ❑ Settlement needs to have the same area as a rectangular building with the dimensions, 0.2 km x 0.4 km.

Before you create your map overlay on tracing paper, we need to make sure you orient the map ev time so the map and overlays are facing the same direction.

1. Start by finding Lake Merritt and place the overlay over the map, making sure all corners are covered by the tracing paper. Draw Lake Merritt onto your overlay.
2. Make sure you mark the direction, "North" on the map overlay so it will be easy to orient agai
3. Add the location of your water dam and reservoir and any other considerations you want to include about getting water for your settlement.
4. Add your settlement to the model. Draw a rectangular building in BLACK similar to the entry task. (Other shapes for a settlement could be considered as long as the settlement takes up the same area). Remember in the design process your location may change based on other considerations.

(Hint: Try to annotate your thinking - it will be your choice whether to include your annotations on you final model since you will turn in your map overlays as proof of revision and evidence building)

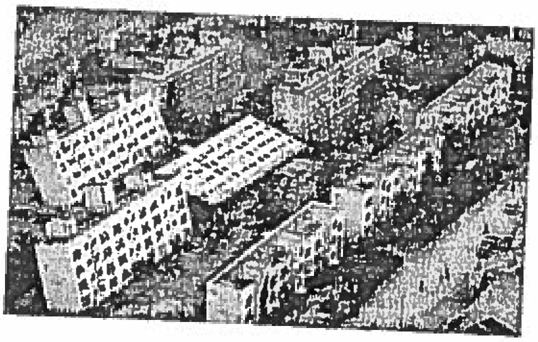
Unit 4, Learning Task 2 - Water and Rocks as Resources
Liquefaction ACTIVITY Task Card 2

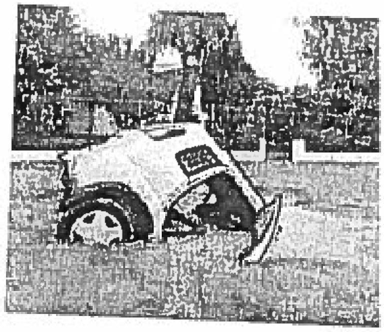
Now that you have considered how you will ensure you have access to clean water, your next ste will be to think about the rocks that you want your settlement to use and be built upon. In this acti you will test various soil types.

Focus questions: What happens to different soil types when they become disturbed by an earthquake?

Materials:

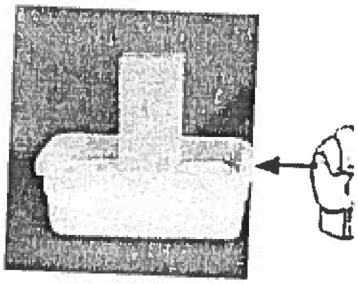
- Clear plastic container
- Sand
- Water
- Brick





Part ONE: Exploration:

1. Fill the container 2/3-full with sand.
2. Place the container on at table and pour in the water to JUST BELOW the surface of the sand.
3. Wiggle the skinny end of the brick into the wet sand so it stands up like a building would.
4. Now, very gently, repeatedly tap the side of the container with your hand and notice what happens to the sand and the brick. Record your observations in your notebook.
5. Clean off the brick and return materials to the assigned areas.



Part TWO: Discussion:

1. What happened to the sand after you hit it? What happened to the brick after you hit it?
2. In this model, what do you think the:
   a. hand and shaking represent in the real world?
   b. brick represents?
3. Where would you find soil similar to the type represented in this model?
4. Squeeze some of the wet sand in your hand. What do you think is happening to the sand as you squeeze it? What is happening to the water?
5. During a real earthquake, the squeezing of the soil and water happens very quickly...so quickl in fact that the sand "floats" in the water briefly. This is called **liquefaction,** where the stability and strength of a solid can temporarily be lost when it acts like a liquid. Do you think **liquefaction** occurs equally in all types of soil (Think about soils that are fine like sand, coarse like gravel, or more like clay)? Explain your answer.
6. How else might this model be different from what happens in a real earthquake?

Part THREE: Investigation

Now, you will explore how each soil type responds to shaking and how that affects how stable the building will be on top of the building. Each group will have one of the following soil types assign you: (1) bedrock, (2) alluvium, (3) gravel, and (4) landfill. Eventually we will rotate soil types.

Your investigation must answer the following focus questions:

1. How does what soil type the building is built on affect how much damage it takes?
2. How do different soil types move with shaking?

Materials:

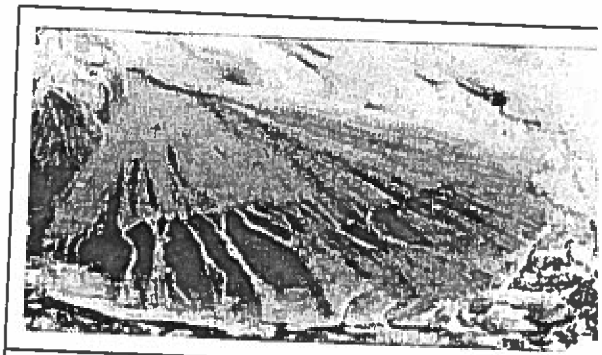
- handout of the four soil types
- Clear plastic container
- water
- brick
- homemade playdough
- Grape nuts © cereal
- Cornstarch and water mixture (Oobleck)

Directions:

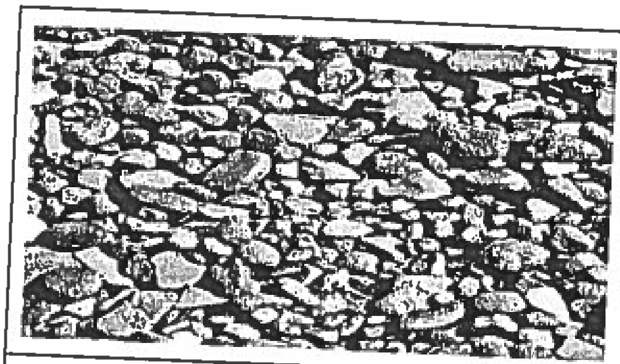
1. Read about the four soil types in the handout.
   a. Bedrock - playdough
   b. Alluvium - Grape nuts and enough water to soak them, but not fill the container
   c. Gravel - DRY Grape Nuts
   d. Landfill - Oobleck
2. Draw a labeled diagram for each showing what you will do to test the soil type with shaking. Just remember to make the investigation fair, each soil type must experience the same type of shaking.
3. Design a graphic organizer to record your observations for each soil type.
4. Perform your test with the first soil type and record your observations that help you answer the questions.
5. Clean off the brick and prepare for the next soil type to rotate to you.

Handout: Soil Types

Bedrock is the solid unweathered rock that makes up the Earth's crust. The Earth's outermost surface is called the crust. Bedrock may be composed of various elements from region to region. There are three major groups of bedrock: sedimentary, metamorphic, and igneous, each made of different sets of minerals.



Alluvium is young sediment—freshly eroded rock particles that have come off the hillside and been carried by streams. Alluvium is pounded and ground into finer and finer grains each time it moves downstream. Alluvium is typically made up of a variety of materials, including fine particles of clay and larger particles of sand and gravel.

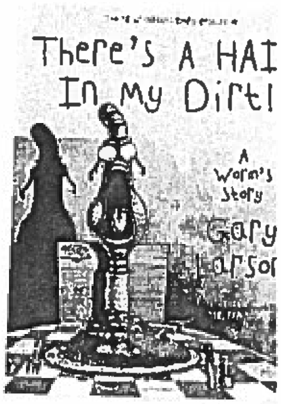


Gravel is any loose rock that is at least 2mm and no more than 75mm. It can be a mixture of sand, clay, and small pieces of rock. It is sedimentary rock and usually found where there is, or were, rivers, lakes, and glaciers. It happens where rocks have been weathered by wind or water or eroded.

A **landfill** is a site for the disposal of waste materials by burial such that it will be isolated from groundwater and will not be in contact with air. Under these conditions, trash will not decompose much. Unless landfills are stabilized, these areas may experience severe shaking in a large earthquake.

Taken from the Tech Museum

Unit 4, Learning Task 2 - Water and Rocks as Resources
Liquefaction and Landslides MAPS Task Card 3



Introduction:

Consider the following questions and write the answers in your notebook.

1. What did you learn about different soil types from the investigation?
2. How do you think scientists use information about different soil types?

Using a Simplified Geologic Map

Scientists use a special type of map called a **geologic map** to understand the geology of a particular area. Geologic maps use color to show differences between various **rock units.** A rock unit is a certain amount of ONE kind of rock from a given age range. For example, sandstone from one million years ago might be represented by a light yellow, while sandstone from another age, like 3 million years ago, might be colored bright orange. The colors on a geologic map represent the closest rocks to the surface and are NOT the actual rock colors. This specific map is simplified such that rock units are assembled together to make it easier read and focus on soil types.

-Adapted from Glencoe

Materials:

- Index cards
- Ruler
- Chromebook
- Simplified geological map of Oakland
- Overhead markers
- Historical Landslide Data in California

PART ONE - Exploration:

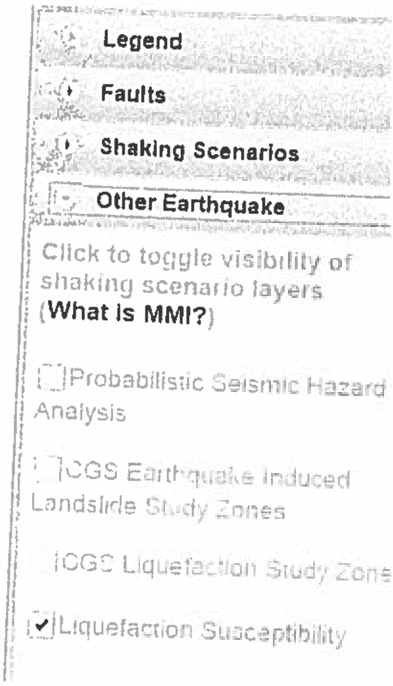
1. As a group, explore the map to understand its symbols and all of its key features.
2. Answer the guiding questions as a group. Be prepared to share your answers.

Guiding Questions:

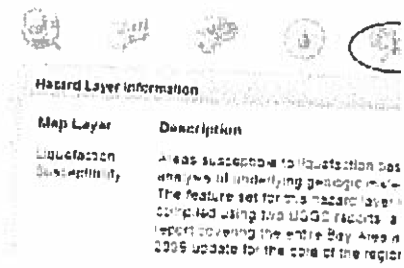
- What key features are observed on the map?
- Is there a key/legend that explains the symbols this map uses?
- There is no scale on the map.
    - What could you use as a reference point to create a scale for this map?
    - Using overhead markers, create a scale on the map as a group in any blank white space. .
- How does this map show the direction of north? Why is bedrock found closer to the hills and alluvium found closer to the shore? What geological process from task 1 could be able to explain this?
- How does this map show bodies of water?
- What do you still need help understanding?
- **What is the real world meaning/importance of this map?**
- **How do you think scientists use maps like this?**

PART TWO - Connecting the MAP to the ACTIVITY - Liquefaction:

1. Look back at your observations from the liquefaction activity. What advice do you have to builders about where to build based on what you learned about the different soil types?
2. Look at the map. Where would you expect there to be more intense movement of the soil caused by either an earthquake or heavy rainfall? Explain why.
3. In pairs using the chromebook, go the following site: http://tinyurl.com/OUSDlandslidemap
4. Click "Continue" on the disclaimer pop-up.
5. Focus on Oakland by centering the map and zooming in.
6. Look to the left at the tabs and click on "Other earthquakes" to make sure the "Liquefaction susceptibility" option is checked.
7. Look at the tabs on the left again and click on "Legend" to see what the colors mean. This will show you a map of where liquefaction is likely to occur.
8. **Answer in your notebook:** Compare this to the map of the different soil types in Oakland. What do you notice? Why do you think this exists?
    a. Look at the area near the historic Hayward fault. Why do you think there is more bedrock in this area (Hint: think about what geologic process occurs near here.)
    b. Look at the area near creeks. Why is there more gravel found in these areas?
    c. What other patterns/relationships do you notice between the soil types, liquefaction and/or other geological processes you have learned about?



IF YOU NEED HELP, you can always click on the Red Toolbox at the top for help on what the Legend descriptions mean, e.g. words like **liquefaction susceptibility**.



Part THREE - Landslides (After the Reading):

9. Go back to the "Other earthquakes" tab and uncheck the "Liquefaction susceptibility" option.
10. Then go to the "Landslides" tab and check "Existing Landslides" option.
11. Look at the tabs on the left again and click on "Legend" to see what the colors mean. This will show you a map of where landslides have occurred in the past. .
12. **Answer in your notebook:**
    a. How do scientists determine areas where landslides are more likely to occur?
    b. What conditions or events usually lead to landslides?

Options to Explore: In addition to the above, you may use this map to study the following features.

A. Debris Flow Source Areas - places that are likely to produce fast moving mudslides
B. Shaking scenarios - models where shaking would be most severe based on a earthquake in a specific fault zone at different magnitudes, e.g. Southern Hayward fault M(agnitude) 6.8.

Simplified Geologic Map of Oakland

Legend

- Historic Faults
- Holocene (Newer) Faults
- Major roads
- Roads
- Bedrock
- Alluvium
- Gravel
- Sand/Landfill

Using NEHRP Soil Types

Bedrock – Two Types

(1) Includes unweathered intrusive igneous rock. Occurs infrequently in the bay area.

(2) Includes volcanics, most Mesozoic bedrock, and some Franciscan bedrock. (Mesozoic rocks are between 245 and 64 million years old. The Franciscan Complex is a Mesozoic unit that is common in the Bay Area.) These two types do NOT contribute greatly to intensified shaking.

Alluvium

Includes some Quaternary (less than 1.8 million years old) sands, sandstones and mudstones, some Upper Tertiary (1.8 to 24 million years old) sandstones, mudstones and limestone, some Lower Tertiary (24 to 64 million years old) mudstones and sandstones, and Franciscan melange and serpentinite.

Gravel

Includes some Quaternary muds, sands, gravels, silts and mud. Significant intensified shaking by these soils is generally expected.

Sand/Landfill

Includes water-saturated mud and artificial fill. The strongest intensity of shaking is expected for this soil type.

Map and Legend adapted from USGS

Unit 4, Learning Task 2 - Water and Rocks as Resources
Historical Landslide Data in CA

Regional Events

Year	Locality	Fatalities	Damage[1]	Reference(s)
1906	San Francisco Bay region, California	11	unknown	Lawson (1908); Youd and Hoose (1978)
1934-1970	Lake Roosevelt, Washington	0	2.05 billion	Jones and others (1961); Schuster (1979)
1964	Anchorage, Alaska	0	960	Youd and Hoose (1978)
1968-1969	San Francisco Bay region, California	0	100.8	Plafker and Kachadoorian (1966); Taylor and Brabb (1972)
1969	Nelson County, Virginia	150	unknown	Williams and Guy (1973)
1978-1979	San Diego County, California	0	38	Shearer and others (1983)
1980	Six southern California counties	0	1.1 billion	Slosson and Krohn (1982)
1982	San Francisco Bay region, California	30	132	Ellen and Wieczorek (eds.) (1988)
1983	Utah, W. Colorado, E. Nevada	0	430	Anderson and others (1984)
1984	Utah, W. Colorado, E. Nevada	0	70.5	Kaliser personal communication (1984)
1989	Loma Prieta, California	0	34+	Keefer and Manson. (1989)
1989	Alani Paty, Hawaii	0	34	Baum and Reid (1992)
1994	Northridge, Southern California	6	unknown	Jibson and others (1998); Jibson and Harp (1995); Harp and Jibson (1995); Jibson and others (1994)
1995	Madison County, Virginia	0	123.2	Wieczorek and others (1995)
1995	Los Angeles and Ventura counties, California	0	unknown	O'Tousa (1995)); Harp and others (1999
1996	Hamilton County, Ohio	0	11.2	Baum and Johnson (1996); Personal communication, Rich Pohana, Engineering Geologist (2002)
1996-1997	Puget Lowland, Washington	4	unknown	Baum and others (1998)
1997-1998	El Niño storms, California	1	158	Hillhouse and Godt (ed.) (1999); Godt and Savage (1999)

[1][Damage is shown in millions of U.S. dollars unless otherwise stated, and all amounts have been converted to year 2000 doll… losses.

7.4.2

Name ______________________________ Date ____________ Period ________

Unit 4, Learning Task 2
Scientific Reading: Liquefaction and Landslides

Directions: Read the article closely and follow the instructions on your Talking to the Text and Annotating Rubric.

Focus Questions: Is the area of my settlement in danger of natural hazards caused by earth processes? How can learning about the causes of natural hazards help with building a safe settlement? What different characteristics of soil would be ideal for planting near my settlement?

What is A Natural Hazard

A **natural hazard** is an event in nature that can cause extensive damage to land and property, and that threatens human lives. In this section, you'll be introduced to natural hazards. Earth scientists can provide life-saving information in the event of a natural hazard. For example, because it is unlikely that humans will ever be able to stop an earthquake from causing intense shaking, it is important to understand how earthquakes work and what causes them. Some natural hazards, like hurricanes, can be predicted. Others, like earthquakes and volcanic eruptions, are very difficult to predict. Nonetheless, scientists who study natural hazards understand a great deal about why they occur and can judge when people should be warned.

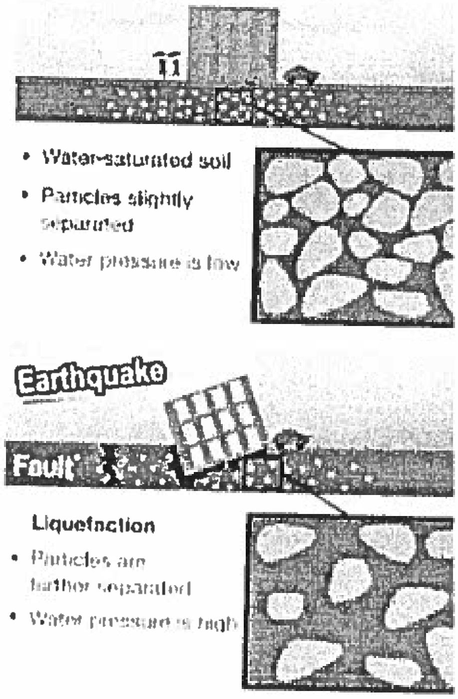


Figure 1. Liquefaction occurs when soil is saturated with water. An earthquake increases pressure on the soil so that the particles separate with water between them. The result is that the soil acts like a thick liquid!

Liquefaction

Earthquakes are the result of sudden movement in Earth's brittle crust. The energy released by this movement is carried by seismic waves and can cause sudden, violent movement when they arrive at Earth's surface. Of course, strong movements at Earth's surface cause more damage than weak movements. However, other factors also contribute to the amount of damage done by earthquakes. Soil types can affect the amount of damage caused by earthquakes. When seismic waves pass through the ground, the soil can act as a liquid.

Name ______________________________ Date ______________ Period __________

This is called **liquefaction** (see Figure 1). The 1989 Loma Prieta earthquake caused a lot of damage in San Francisco. The area most damaged had been built on top of San Francisco Bay mud.

Landslides and Slumping

When soil is dry, friction between the grains of soil keeps it firm enough that you can build a house on it. However, if the soil is wet, the spaces between the grains are full of water. The water makes the grains slippery and friction is a lot lower. Wet soil is squishy. If you have walked on wet soil, you know that your feet sink into it!

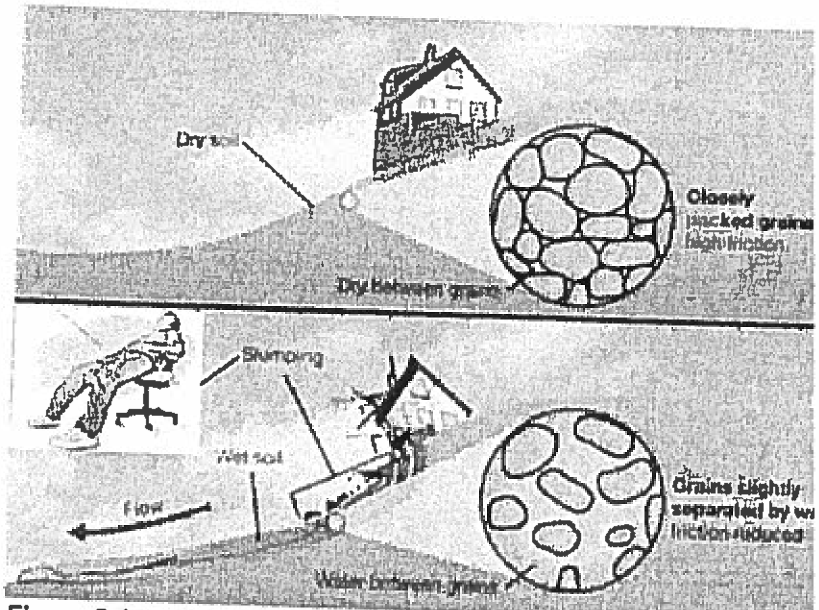


Figure 2. Loose soil experiences slumping, similar to a person slumpir in a chair.

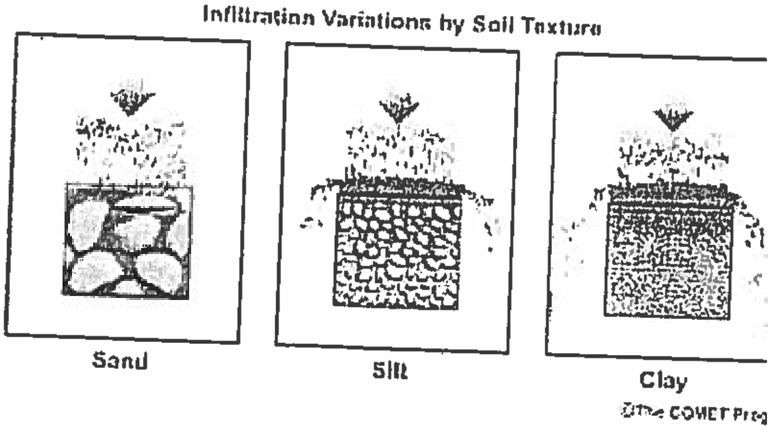
Slumping is a natural hazard that describes what happens when loose soil becomes wet and slides or "slumps" like a tired person (see Figure 2). As with flooding, slumping can happen after a period of very heavy rainfall. Houses are at risk of being destroyed by slumping when they are built on steep, loose soil or below hills that are made of loose soil. A house could be destroyed if it slides down with the soil or if the soil on a hill above falls on the house!

Another natural hazard related to slumping is a **landslide.** A landslide occurs when a LARGE mass of soil or rock on a steep slope slides down and away. Landslides are common on certain types of volcanoes because they have areas where the slope is steep and the material is loose. Landslides may cause 25 to 50 deaths in a year in the United States and billions of dollars in economic losses, in addition to changing the environment and damaging surrounding habitats (see example in Figure 3). The likelihood of a landslide in an area can be influenced by three factors: the soil type of the area, history of landslides in the area, and the topography of the land.


Figure 3. A landslide that occurred in La Conchita, California in 1995.

Name ______________________________ Date ____________ Period ________

Rocks as Resources



Scientists have other uses for the rocks other than learning about natural hazards. Soil types are important for plant growth as well. Soil type is defined by the how much of the following the soil contains: clay, silt and sand. These three ingredients form a '**loam**'. There are many variations of loam so you may well find your soil falls somewhere in-between the types described below.

Clay soil - Clay soils are composed of lots of tiny mineral particles which reduces the air space in the soil. This causes the soil to retain water and become easily compacted. These soils are very fertile but require some improvement to 'unlock' the nutrients for plants to use.

Silt soil - Silt soils have slightly bigger particles than clay soils so are more free-draining but are still at risk of compaction. They are fertile and drain more effectively than clay but hold more moisture than sandy soils. It won't hold its shape as easily as clay and will crack or crumble if rolled too thinly between the palms of your hand.

Sandy soil - Sandy soils have the largest particles (up to 1000 times bigger than clay) and are very free-draining due to the big air spaces between particles. Although easy to work and cultivate, sandy soils dry out very easily and often have poor fertility as the nutrients are simply washed away.

What plants can I grow?

With the addition of organic matter, any plant could potentially be grown in your garden soil. However, some plants prefer, or can cope with, the extremes of a clay or sandy soil better than others.

Adapted from *CPO and Thompson-Morgan.com*

Seismic Hazard Maps Show Some O.C. Areas With Liquefaction Risk

Safety: New state program requires property owners to disclose the potential danger to buyers

October 09, 1996|KENNETH REICH | TIMES STAFF WRITERS

LOS ANGELES — State geologists released the first seismic hazard maps for parts of Orange Coun on Tuesday under a new program requiring geologic investigations and mitigation measures for ne building projects in zones subject to ground liquefaction in big quakes.

Once the maps become official in about six months, homeowners in a seismically hazardous zone v sell their properties will be required to disclose the potential danger to buyers.

The preliminary maps issued Tuesday were for a 120-square-mile area from Buena Park and Fuller south through Anaheim to Newport Beach.

Public comment will be accepted by the Division of Mines and Geology in the state Department of Conservation until Jan. 7, and the official maps will be released in March, state officials said. Preliminary maps for much of the rest of the county will be issued in early 1997.

Liquefaction is a process by which water-saturated soils turn to jelly under heavy shaking, jeopardizing building foundations. It was a particular cause of heavy damage in the 1985 Mexico City quake and in the Marina District of San Francisco during the 1989 Loma Prieta earthquake.

Orange County has escaped major quake damage in the 20th century. The largest quake close to the county, the magnitude 6.3 Long Beach quake of 1933, occurred on a segment of the Newport-Inglewood fault that lies outside the county.

But a major rupture of the southern segment of this fault lying within the county, or of an offshore thrust fault, is certainly conceivable, scientists say.

The maps released Tuesday show that more than half of the area detailed falls in what scientists believe to be liquefaction zones, a proportion much higher than is the case in the city of San Francisco.

Charles Real, the supervising geologist for the project, explained that much of the area lies within varying historic and prehistoric beds of the Santa Ana River, where sand and silt is common and water tables come within 40 feet of the surface.

Also, certain coastal areas, such as the Balboa Peninsula and other areas adjacent to Newport harb are in the liquefaction zones.

The geologists decided that all such zones should be considered subject to liquefaction, although th caution on each map that not all areas subject to the process may be shown.

They also caution, "A single earthquake capable of causing liquefaction . . . will not uniformly affect the entire area."

Not shown on any of the maps released Tuesday were major fault lines, such as the Newport-Inglewood fault, where heavy shaking could cause extensive damage in areas outside the designated liquefaction zones.

Real said that seismologists and engineers have not yet been able to agree on criteria for bringing these zones under the designation as seismic hazard zones.

But, he noted, for the most part shaking damage is regulated under building codes, while these hazardous zones are designed more to reduce dangers from underlying special geological conditions Real said work has yet to be completed in the Orange County areas mapped thus far on designating localities subject to quake-caused landslides. These areas too will ultimately be designated hazardou zones.

Being designated a hazardous zone triggers the state mandate that local governments require both geotechnical investigations and mitigation measures for any commercial project or any housing project containing more than four dwelling units.

Construction of just one housing unit will not be subject to the requirement, but single units will fall under the disclosure requirements at time of sale.

Real said that a common mitigation step in an area subject to liquefaction may be strengthening of foundations.

He said that putting in $1,000 to $2,000 more steel in the foundation could save money later wh quake comes.

"You don't have to restrict development under this program," he said. "You just have to know wha do to make things safe."

He acknowledged, as is often the case with state mandates, the investigations will have to be done local expense, although he said that in most cases the cost probably would be passed on by the municipalities to developers.

There are no penalties written into the law for municipalities that do not adhere to the new requirements, but so far most local officials have shown a willingness to cooperate, he said.

Another Hazard

Liquefaction, the process by which water-saturated soil can turn to jelly during an earthquake and threaten building foundations, is possible in a large swath of Orange County. Here's a look at the ar at risk, where much of the soil is sand and silt, and the water table is within 40 feet of the surface. Only this 120-square-mile area of the county was studied:

Source: California Department of Conservation

Unit 4, Learning Task 2 - Water and Rocks as Resources
Planting MAPS and DATA Task Card 4

Introduction:

Consider the following questions and write the answers in your notebook.

1. What information would you need to know to be able to provide food for 1,000 people in your new settlement?
2. If you were in charge of what food to grow for your survival, which plants would you choose?

In this next activity, you will be planning your community garden.

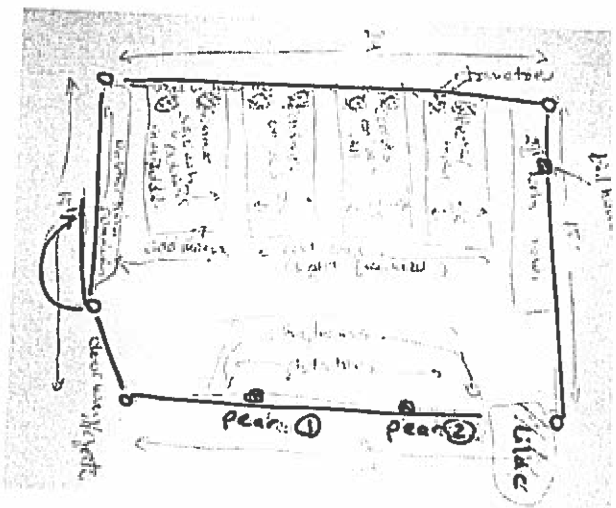
Focus Question: How can I plan for a garden that can feed 1,000 people?

Materials:

- chromebook for Google maps (Google Earth view)
- Simplified geological map of Oakland
- Ruler
- Community Garden Guide

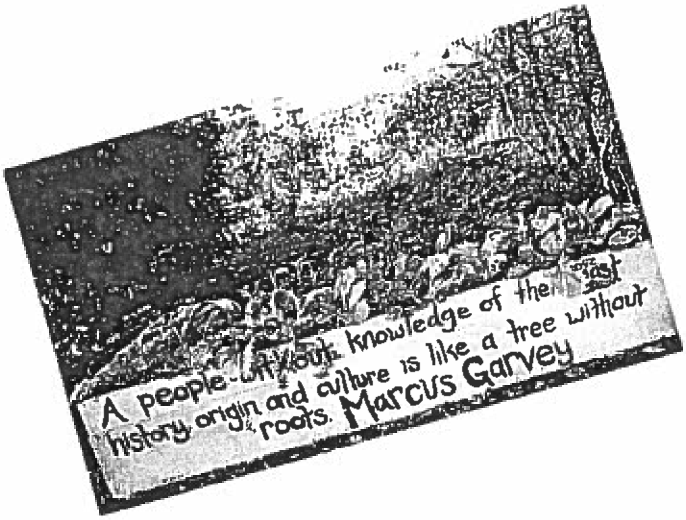
PART ONE - Planning your Community Garden:

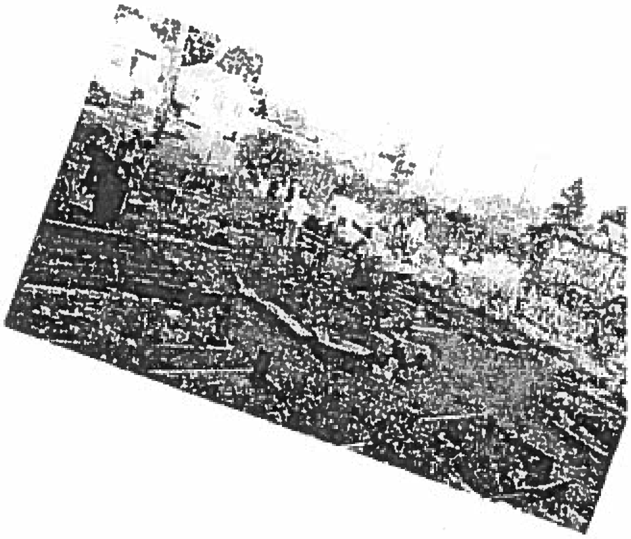
1. Look at the list of vegetables you may grow in your garden found in Table 1 of the Communit Garden Guide. Brainstorm as a group what vegetables you would want and come to consensus on the 7 types of vegetables you will grow. (For now, we are only growing vegetables to simplify the garden)
2. Once you have decided what plants you will grow (though that may change), you are ready t begin planning your community garden.
3. Some constraints for your model of the garden:
   - ❑ Your garden must be big enough to feed your group, but not too large that it becomes hard to maintain. You decide what size it must be and its location.
   - ❑ It must be drawn to scale on your map overlay.
   - ❑ It must be close to your settlement, within 2 km.
   - ❑ The garden must also be found close to a water source.
4. Each person must show the calculations for their garden plans in their notebook.
5. Read over the Community Garden Guide.
6. When you are ready to begin your calculations for your garden, follow the steps using Table 1 of the guide. An example with calculations is given on page 4 and 5 of the guide.



7. Draw a model of your garden as a 2D shape similar to the example in your notebook with its measurements.
8. When deciding where to build your garden, use the Simplified Geologic Map of Oakland to know more about soil type, as well as Google maps (Google Earth view) to find areas suitable for growing plants.
   a. Note areas where **vegetation** (bushes, trees, forests, grassy areas, etc.) to possibly avoid so that you do not disturb other plants' growth.
   b. Areas of soil without buildings, streets or vegetation might be ideal for growing.

7.4.3 - Water and Rocks as Resources
Community Garden Guide





Garden Shape and Preparation

The shape of a garden area can have an effect on how easy it is to manage. You may consider a rectangular shaped garden, making it easier to take care of your crops in rows. Gardens that will be worked only by hand tools may be square in shape. Your garden may be any 2-D shape where you can show the actual area of the garden. Examples given in Figure 1.

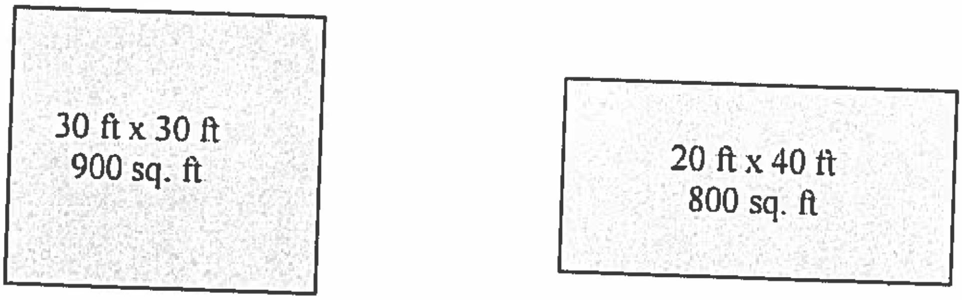


Figure 1. Options for garden shape

Garden Sizing

Some gardeners prepare a garden site and size it based on available space. Gardens can also be sized to accommodate production of an estimated amount of food a family or community will consume in a year (Tables 1, 2 and 3). If garden space is limited or if there is uncertainty on how large of a garden to make, it may be useful to calculate the garden area required based on vegetable production goals. Tables 1 and 2 provide information and a procedure for determining garden size. Plan a mix of vegetable varieties and space allocation in the garden to suit personal preferences and quantities of produce desired.

Example: Determining Vegetable Garden Size

Garden Planner Worksheet

Row	Crop	Pounds Needed Per Person (See Table 1)		Number of People		Yield per Foot of Row (See Table 1)		Row Length (ft)	Row Spacing (ft) From Table 1
1	*Snap Beans*	*8*	x	*3*	÷	*1*	=	*24*	*1.5*
2	*Carrots*	*10*	x	*3*	÷	*1*	=	*30*	*1.5*
3	*Tomato*	*20*	x	*3*	÷	*2.5*	=	*24*	*3*
4	*Onions*	*10*	x	*3*	÷	*1.5*	=	*20*	*1.5*
5	*Summer Sq.*	*7*	x	*3*	÷	*2*	=	*10.5*	*4*
							Total	*108.5 ft Ave. 22 ft*[1]	*11.5 (≈12 ft)*[2]

[1]an additional 5 feet of headland space added to each end on garden.
[2]an additional 4 feet of border edge added to each side of garden.

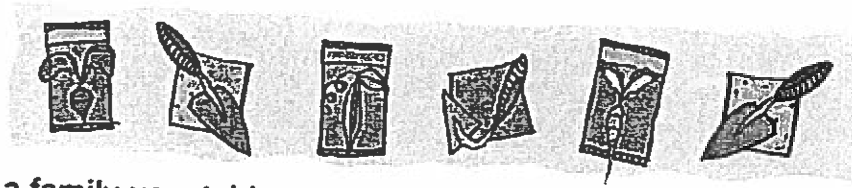
Garden Length Adjustment

Based on the information calculated above there are several decisions that can be made. Generall is advisable to use average row length as a basis for determining approximately how long the gard should be. In this case it is reasonable to plan a garden about 22 feet in length (Col. F). To accommodate the planned garden length the onions, carrot, tomatoes and snap beans could each planted in four rows 22-ft long to accommodate the planned row length without a significant change expected total yield. The summer squash row could be extended to 22 feet which will more than double the planned amount. Another option is to fill in the remaining space with more of any of the other crops.

Garden Width

The border area can be used to absorb the differences in row spacing as calculated above. For example the width of the garden calculated above does not allow for the fact that tomatoes require three feet of space on both sides of the plants and summer squash requires four feet of row space c each side. The garden width could be increased by 1.5 feet or the garden borders could be reduced by 0.75 feet on each side to allow for the additional 1.5 feet of space needed for the tomato row. No that the placement of the onion row with the minimum 1.5 feet spacing requirement is overshadowe by the larger required row spacing of the tomatoes and summer squash.

Table 1. Family Garden Planning Guide



Here are some general guidelines you can use when planning a family vegetable garden. These are estimates only and have been compiled from a variety of sources. To use this guide:

1. Decide which vegetables you would like to plant and whether you want only enough to eat fresh or enough for extra to preserve.
2. Review the suggested quantities needed per person and compare with your own family. Adjust down or up based on your family's likes and dislikes.
3. If you use the recommended estimates in column 2, you can use column 3 to determine the amount to plant following traditional plant spacing guidelines. (You will need a planting guide to determine recommended spacing, depth etc. Contact your extension office if you need a guide.)
4. If you've made adjustments to the per person needs in column 2, you can estimate the amount to plant using column 4.

   Pounds needed per person ÷ column 4 = amount of row (feet) to plant per person

5. If you plan to can or freeze excess, use column 5 to plan how much preserved food you'll get from your fresh produce.

1 Vegetable	2 Estimated need (lbs) per person		3 Approximate row length to plant per person		4 Approximate yield (lbs) per foot of row	5 Amount of fresh produce (lbs) needed For 1 quart preserved *	
	Fresh	If Preserving	Fresh	If Preserving		Canned	Frozen
Asparagus	6	6	10 ft	10 ft	0.6	4	2-3
Bean, lima (bush)	2-4	4-5	7-13 ft	13-17 ft	.30 (shelled)	4-5	4-5
Snap, Dry & Pole Beans	8	8-15	8 ft	8-15 ft	1	1.5-2	1.5-2
Beets	5-10	10-15	5-10 ft	10-15 ft	1	2.5-3	2.5-3
Broccoli	8	8-10	10 ft	10-13 ft	0.8	-	2-3
Cabbage	10	10-15	5 ft	5-8 ft	2	3 (sauerkraut)	-
Carrots	5-10	10-15	5-10 ft	10-15 ft	1	2.5-3	2.5-3
Cauliflower	8	8-10	10 ft	10-13 ft	0.8	-	2-3
Chard	3-5	5-6	2-3 ft	3-4 ft	1.5	2-6	2-6
Corn, Sweet	12-24 (ears)	24-60 (ears)	6-12 ft	12-30 ft	2 (ears)	4-5	4-5

Vegetable ❶	Estimated need (lbs) per person ❷		Approximate row length to plant per person ❸		Approximate yield (lbs) per foot of Row ❹	Amount of fresh produce (lbs) Needed for 1 quart preserved * ❺	
	Fresh	If Preserving	Fresh	If Preserving		Canned	Frozen
Cucumbers	5-10	10-15	5-10 ft	10-15 ft	1	1.5-2	-
Lettuce	5-10	-	10-20 ft	-	0.5	-	-
Onions	5-10	10-15	3-7 ft	7-10 ft	1.5	2-3	2-3
Peas, pod	3-5	5-10	4-6 ft	6-13 ft	0.8	-	4-5
Peas, shelled	3-5	5-10	6-10 ft	10-20 ft	0.5	4-5	4-5
Peppers	3	3-10	2 ft	2-7 ft	1.5	2	2
Potatoes	50-100	50-100	25-50 ft	25-50 ft	2	5	-
Pumpkins, Rutabaga	10-20	10-20	5-10 ft	5-10 ft	2	2-2.5	2-2.5
Spinach	2-5	5-8	3-6 ft	6-10 ft	0.8	2-3	2-3
Squash, summer	5-7	7-10	3-4 ft	4-5 ft	2	2.5-3	2-3
Squash, winter	10-20	10-20	5-10 ft	5-10 ft	2	2	3
Tomato	20	20-40	8 ft	8-16 ft	2.5	3	-
Turnip	5-10	5-10	3-5 ft	3-5 ft	2	-	2.5-3
Watermelon	10-15	-	5-8 ft	-	2	-	-

Blank lines indicate that freezing/canning is not recommended for this vegetable or that there are better means of preserving.

Table 2. Row spacing (ft) for selected Vegetables

Beans, Snap	1-1.5	Lettuce	1-1.5
Beans, Pole	3-4	Melon	5
Beans, Dry	2-3	Onion	1-1.5
Beets	1-1.5	Parsnip	1-1.5
Broccoli	2.5	Peas, Snap & Snow	3-5
Brussels Sprouts	2-2.5	Pepper	2-3
Cabbage	2-2.5	Pumpkin	6
Carrots	1.5-2	Radish	1.5
Chard	1.5-2	Spinach	1-1.5
Cucumber	4	Squash, Summer	4
Eggplant	2.5-3	Squash, Winter	4-6
Herbs	1-1.5	Tomato	3
Kale	2	Turnip, Rutabaga	1.5
Kohlrabi	2	Watermelon	5
Leek	2		

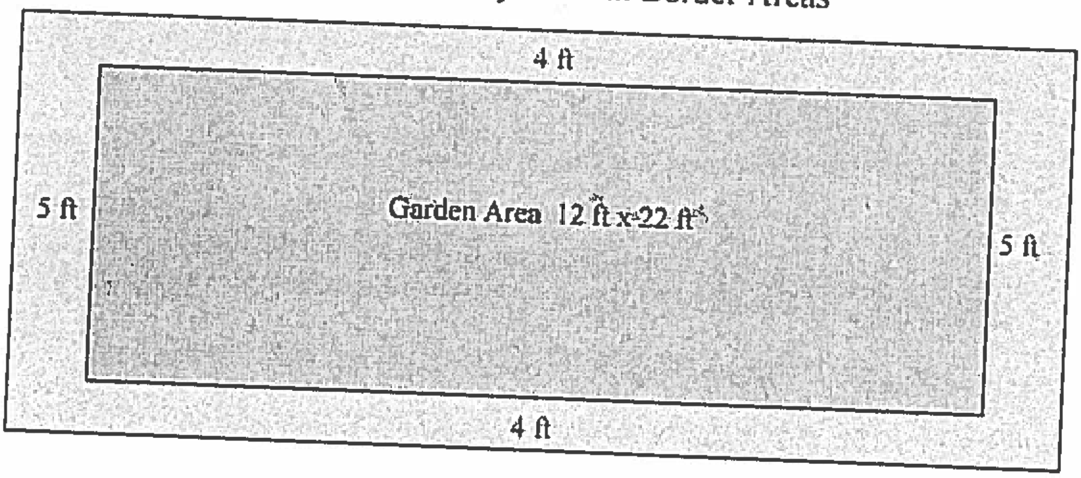
Profile layout of garden rows:

SB = Snap Beans C = Carrots T = Tomato O = Onion SS = Summer Squash

4 feet border SB *1.5 feet* C *1.5 feet** / *3 feet** T *3 feet* O *4 feet* SS *4 feet* border = 18 ft
= 19.5 ft
(revised width)

*As planned spacing
*As modified spacing

Planned Garden Layout with Border Areas



Total Garden size 20 ft x 32 ft

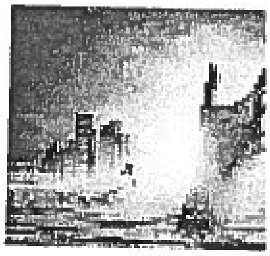
Table 3. Garden Planner Worksheet (Maximum of 7 plants):

Row	Crop	Pounds Needed Per Person		# of People		Yield Per Foot of Row		Row Length (ft)	Row Spacing (ft)
1			X		÷		=		
2			X		÷		=		
3			X		÷		=		
4			X		÷		=		
5			X		÷		=		
6			X		÷		=		
7			X		÷		=		
							TOTAL		

Adapted from USDA National Resources Conservation Service

Name ______________________________ Date __________ Period ______

INTRODUCTION TO SUMMATIVE TASK



It is 2020 and the war is finally over. News has spread that the last of the zombie hordes have finally been eliminated, but not before wiping out nearly every human being on the planet. The effort to dispose of the bodies and clean the area has just been finished. Throughout the Bay Area, you are one of only 1,000 people to survive the war and your survival depends on finding a place to live.

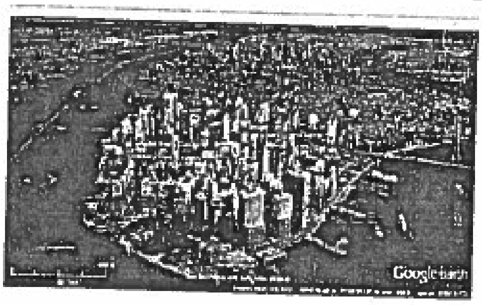
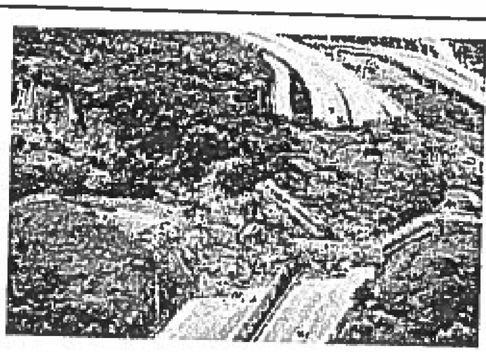
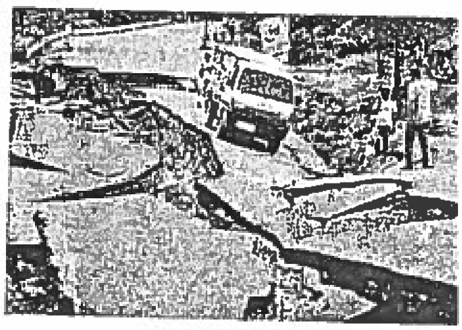
You have been chosen to find the best location for a new human settlement in Oakland. However, there are many things you need to consider in order to survive in this new world. As one of the fe scientists to survive the zombie plague, you must use your knowledge of how the Earth was forme and is currently changing to help your people survive.

The new location must consider the following:

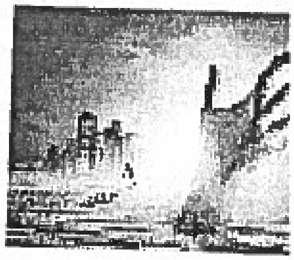
- Have a nearby reliable source of clean water in a time of drought
- Include an area to grow food that is close by
- Minimize risk from earthquakes, landslides, and the rise of sea water
- A plan to keep people safe from local wildlife and any stray zombies that survived

Complete the following:

1. Draw a rectangular building in BLACK for a place to live on this map. The ACTUAL size of t building will be **200-meters by 400-meters**. (You may build over roads, but the area must b relatively flat) On the back of your map, explain why you chose this location as your claim ar support your ideas with evidence and reasoning.
2. Add your settlement to the key. -
3. If you lived in this area, what would be the most likely natural hazards of the three seen belo to pose a threat to you? Explain why. (Write your answer on the back of your map.)

Sea Level Rise	Landslides	Earthquakes
		

Unit 3 Summative Task -
Oakland: Settlement After The Zombie Wars



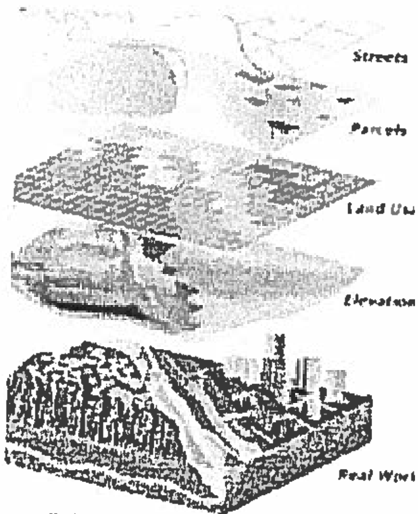
It is 2020 and the war is finally over. News has spread that the last of the zombie hordes have finally been eliminated, but not before wiping out nearly every human being on the planet. The effort to dispose of the bodies and clean the area has just been finished. However, most of the existing physical structures, i.e. buildings and homes, are either completely destroyed or are too damaged to be used. Throughout the Bay Area, you are one of only 1,000 people to survive the war and your existence depends on finding a place to live.

The Ruling Council of Survivors has chosen your team to find the best location for a new human settlement in Oakland. However, there are many things you need to consider in order to survive in this new world. As one of the few scientists to survive the zombie plague, you must use your knowledge of how the Earth was formed and is currently changing to help your people survive.

Your group of scientists must create **TWO parts** for your proposal to the council:

(1) As a group, design a **final map model** of your settlement in Oakland. Use the map overlays you created from the previous tasks to help you develop the final model for your proposal.

Your model should include:
- ❑ Areas at risk of earthquakes, landslides, and sea level rise
- ❑ Proposed settlement location drawn to scale with:
  - ❑ A nearby, reliable source of clean freshwater
  - ❑ An area to grow food that is close by
- ❑ Other relevant map features like key, direction, bodies of water, landforms, wooded/grassy areas, etc.



Original map on the bottom with different overlays on top

(2) In addition to the map, each scientist will present their suggestions in an **individual summary report** that:
- ❑ Proposes a specific location for the settlement as their claim
- ❑ Supports their argument with evidence from the figures, data, maps, and/or visuals from th investigation updates
- ❑ Explains the reasoning behind choosing a particular location
- ❑ Predicts how the choice of settlement location will minimize risk from hazards in the future
- ❑ Includes a plan to keep the settlement safe from wildlife and any stray zombies
- ❑ Argues against another proposed location for the settlement (rebuttal)
- ❑ Is clear, persuasive, and scientifically accurate

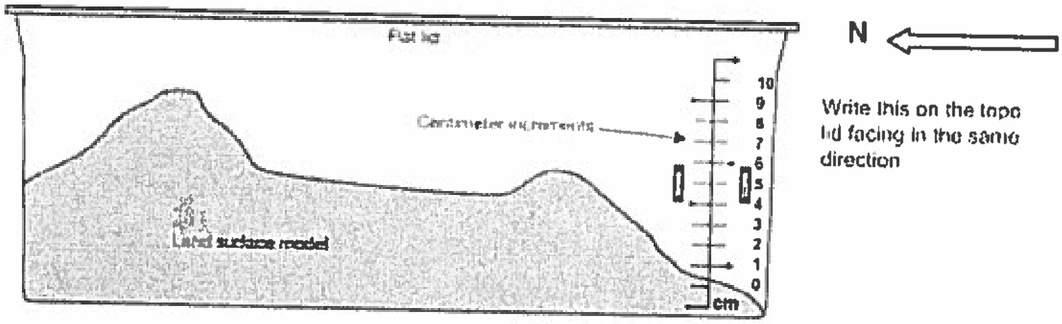
7.4.3 Task Card: Mapping as Modeling (Print 2 copies and place in plastic sleeves)

Guiding Question: *Where the best location to live?*

Task problem: Imagine you have just moved to Oakland. You must decide the best location for a place to live. In this task, you will consider several things when choosing a permanent location based on a map of the area.

Materials:

- GeoBox with the topo form (white land surface model) and topo lid (the flat lid)
- Container to hold water (or use a bucket from the stream table)
- Beaker to transfer water between containers
- Overhead projector markers (thin)
- Pencil
- Tracing paper
- Water colored with food coloring
- A metric ruler
- Clay



Procedures:

1. Look at the side of the GeoBox with the scale. With the marker, number each centimeter above sea level. Use the sketch above to help you with this step. Pour water into the GeoBox up to the first centimeter line.

2. Using a small piece of clay, place the clay in a location you think is best to live on the white land surface model (topo form). In your notebooks, provide reasoning for your location.

3. Place the topo lid on the GeoBox. Stand over the GeoBox so that you are looking down on the topo form. With the overhead projector marker, outline the perimeter of the land surface onto the lid. This will be considered "sea level," or the 0-centimeter contour line.

4. Use the marker to draw an arrow pointing North on the topo lid.

5. Remove the topo lid and add water until the water level reaches the 1-centimeter mark. Replace the lid. Trace the "coastline," the line along which the water and land meet, onto the lid. All points on this line are 1 cm above sea level. They form a **contour** line. Keep in mind that some lines may be cut off because of the map area (as seen on the right in dotted lines).

6. Add water to the level of the 2-centimeter mark. Replace the lid and again, trace the "coastline." All points on this line are 2-centimeter above sea level.

7.4.3 Task Card: Mapping as Modeling (Print 2 copies and place in plastic sleeves)

7. Continue this procedure until the topo form is covered with water.

8. Mark the location of the clay on the topo lid and remove the clay. You now have your topographic model. Each person in your team takes tracing paper and traces the markings the lid onto their tracing paper.

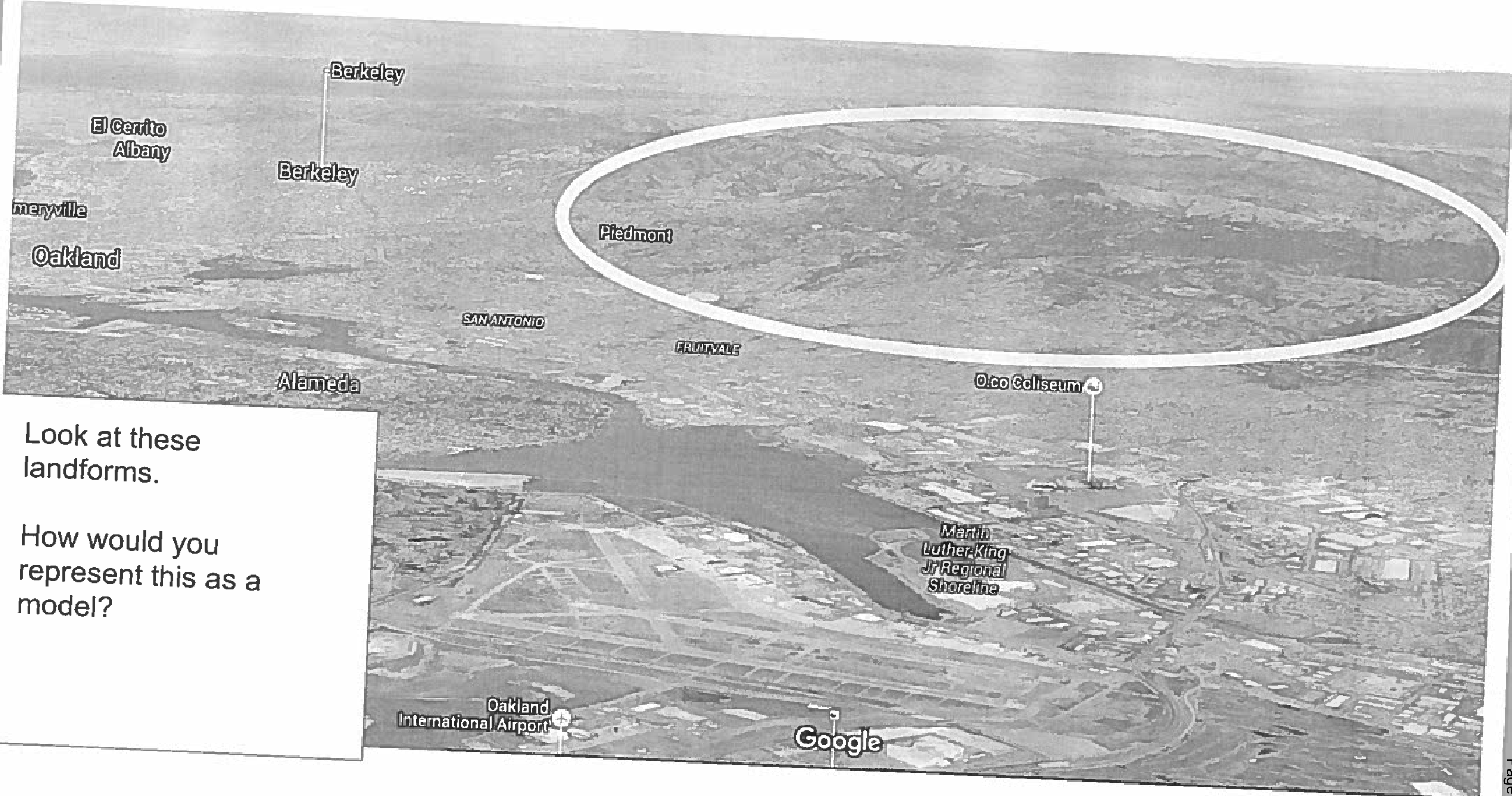
9. In your team, discuss how the raising water level impacted your settlement. Update your notebook entry with what you observed as well as questions that came up.

10. **Clean Up:** Take off the topo lid with contour lines first and keep in a dry area you will need i later. Pour out the water to the correct container chosen by your teacher, leaving the topo f in the box. Using a beaker, pour enough water back into the GeoBox to go up to sea level, 0-cm line. Bring the GeoBox back to your table.

Mercator Projection
WGS84
USNG Zone 10SEG
CalTopo.com

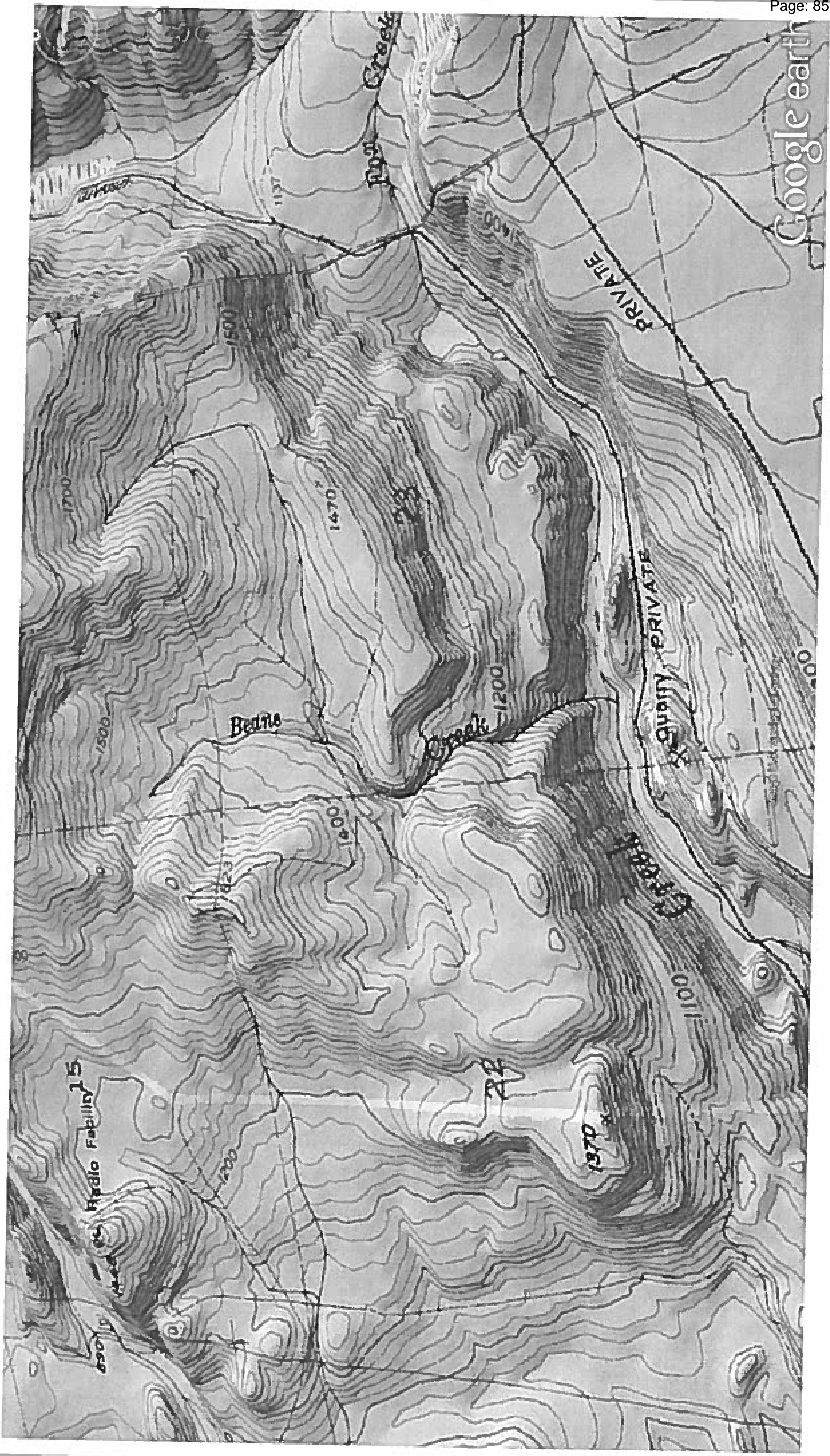
0.1 0.2 0.3 0.4 0.5 0.6 0.7 km
0.1 0.2 0.3 0.4 mi
Scale 1:6398 1 inch = 533 feet

N MN 14°



Look at these landforms.

How would you represent this as a model?


Google earth
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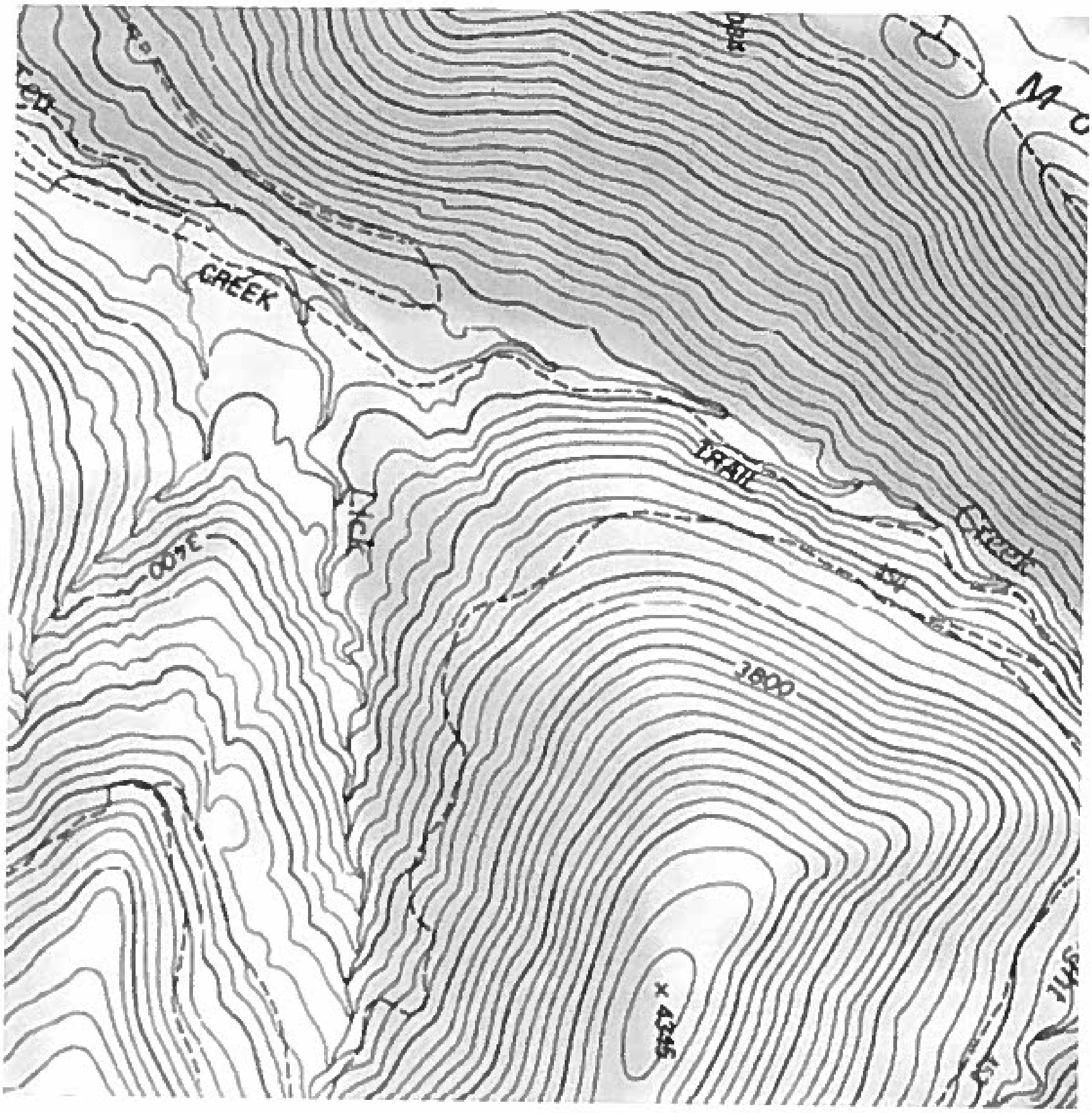
CREEK
TRAIL
Creek
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× 4346

Name: ______________________________ Period: ____ Date: __________

7.4.3 - Output Sheet

Using a Map for Planning

Focus Question: *How can we use maps for everyday activities?*

Materials:

- topographic map of Oakland / per student

Directions:

1. Look at the topographic map of Oakland. Can you recognize where it is and any of the landmarks there?

Use the map to answer these questions.

2. What is the approximate elevation at the corner of 35th Ave and MacArthur Blvd (in feet)

3. Would you be walking uphill or downhill if you started from the corner of Midvale Avenue and Kiwanis Street and walked to where MacArthur Blvd meets Midvale Avenue? Provide your reasoning.

4. Your friend wants to meet you at Avenue Terrace Park near the corner of Jordan Road and Guido Street. You are tired and want to choose the path that has the easiest, most gentle slope. If you started at the corner of Midvale Avenue and Wisconsin Street, which path would you take: Route 1 or Route 2?

Route 1	Route 2
1. Walk northwest toward Norton Ave. 2. Take a right on Norton Ave. 3. Take a right on Jordan Road and the park is on your left.	1. Walk southeast toward 35th Ave. 2. Take a left onto 35th Ave. 3. Take a left on Jordan Road and the park is on your right.

5. Are there any rivers, creeks or other bodies of water on this map? How can you tell?

Name: ______________________________ Period: ____ Date: __________

6. Notice that this topographic map's contour lines do not all have numbers written on ther Just like a ruler, not all the lines are marked. Complete the following to understand contour intervals:
   a. Use a ruler to draw a line from the 200-foot contour on Florida street to the 400-foot contour on Eastake Ave. Draw a point at both ends and label them 200 and 400 appropriately.
   b. Follow the line from 200 to 400 and add a point on the line every time you come across a contour line.
   c. If the line starts at 200-feet, goes up to 400-feet, and crosses 4 lines, how much does each line increase by to get to 400? Provide your reasoning.

7. What is the elevation at the corner of 35th Ave and Arizona Street? Provide your reasoning.

8. Given what you learned about contour intervals, what is a better estimate for the elevation at the corner of 35th Ave and MacArthur Blvd? Provide your reasoning.

9. Where do you think you might find a hill on this map? Explain how you know?

10. What is the elevation of the highest point on this map? How do you know? Mark this point with a STAR☆.

11. Create a legend/key to identify any symbols used on your map.

USGS
science for a changing world

How to make a topo salad-tray model

http://online.wr.usgs.gov/outreach/topo_instructions.html

1. Select a feature that you would like to model. Islands work well because they have well-defined boundaries. Mountains, canyons, or any feature with enough topographic relief will work.

2. Get a topographic map of the feature you want to model. Digital topographic maps can be downloaded free from the USGS Store. Go to http://store.usgs.gov and click on "Map Locator".

3. Get some clear plastic salad containers (salad trays) or pie covers (any clear, stackable plastic with a flat surface will do). You will need at least 7 or 8 plus a few extras in case of mistakes. They can be purchased at restaurant supply stores or any business that uses them for salads and take-out food. Or save them from your meals. Square salad trays are easier to work with than round trays or pie covers.

4. Use a reducing/enlarging photocopier to adjust the size of the feature you are modeling so it is almost as large as the flat bottom of the plastic salad tray.

5. Once you have the correctly sized photocopy, use a marker to darken just those contour lines you want to transfer to the salad trays. In picking the contour lines to transfer, remember two things:

- The difference in elevation between adjacent pairs of contour lines should always be the same. This difference is called the contour interval. The contour interval for the darkened lines on the back of this page for Angel Island, California is 100 feet.
- The models seem to work best if you use a total of 7 or 8 contour lines (one per salad tray).

6. Let's call the photocopy with the darkened contour lines the "master copy." Using scissors, trim the master copy so that it just fits the flat bottom of the inside of a salad tray. Getting the fit as tight as possible will help you put the master copy in the same position in each salad tray, and this will help the contour lines on the salad trays line up properly.

7. Position the master copy in the bottom of a salad tray, with the darkened contour lines against the plastic. Secure with tape so the master copy won't move while you are tracing.

8. Looking through the bottom of the salad tray at the master copy, use a permanent marker (black seems to work best) to trace one contour line onto the salad tray.

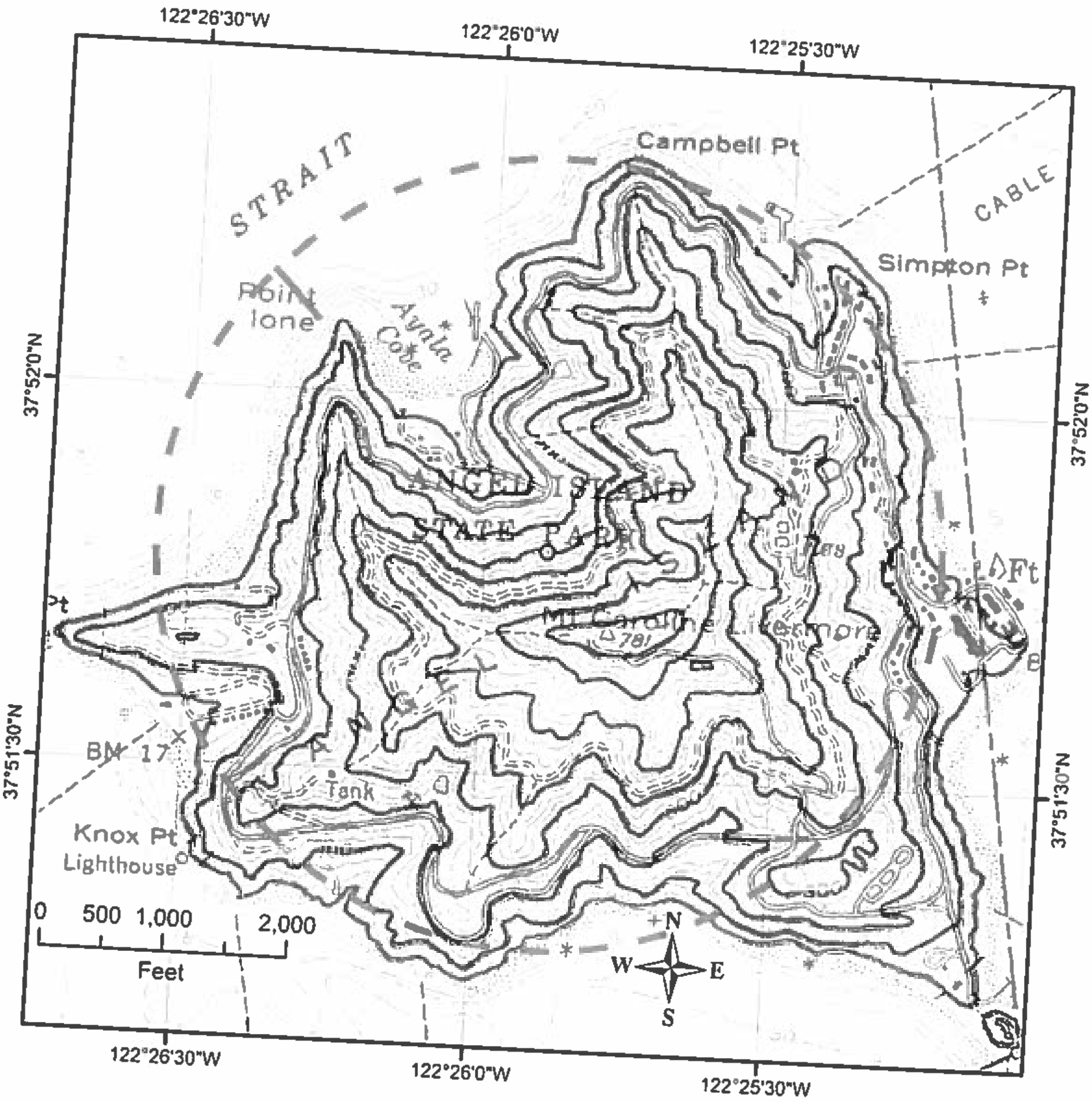
9. Remove the master copy and position it in a second tray. Trace another contour line onto the second salad tray.

10. Continue until you have a different contour line on each salad tray. Add the name of the feature, a scale bar (showing how long a mile is, for example), and a north arrow on the top or bottom salad tray. Label each tray with the elevation of the contour line on that tray. Stack them up and be amazed!

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

Science Education Handout
February 2010

Angel Island
San Francisco Bay, California



TOPOGRAPHIC MAPS

MAP
2-D REPRESENTATION OF THE EARTH'S SURFACE

TOPOGRAPHIC MAP
A graphic representation of the 3-D configuration of the earth's surface. This is it shows elevations (third dimension). It provides a plane view of the land (the perspective of someone who is looking straight down at the ground from an airplane. In the USA the organization in charge of making standard topographic maps is the USGS (since 1882).

	RELIEF	(brown)	Hills, valleys, mountains, plains, etc.
	WATER FEATURES	(blue)	Lakes, ponds, rivers, canals, lagoons, etc.
FEATURES (symbols) p. 97	**MAN-MADE STRUCTURES**	(black, red)	Road, railroads, land boundaries, etc.
	CULTURAL FEATURES	(black, red, yellow)	Towns, cities, etc.
	VEGETATION	(green)	Forest, etc. (not in all maps)

ELEMENTS	**SCALE**
	DIRECTION AND LOCATION
	TOPOGRAPHY

SCALE
Ration between two points on the map and the distance between the same two points on the ground.

Represents: **AMOUNT OF REDUCTION**. All topographic maps show a portion of the earth's surface in much smaller size that the surface area they represent.

USE:
MEANS TO DETERMINE:

A) **DISTANCE** between any two points.
B) The **AREA** represented.

Updated 10/6/2003

SCALE –3 Forms

1. **VERBAL**

Verbally expressed
1 inch = 10 miles or (1 inch equals 10 miles)
1 cm = 10 km

The actual ground distance is compared of equated to a smaller dimension representing it on the map

2. **GRAPHIC or Bar**

1 mile

0 1/2 1 km

The scale is laid out graphically as a calibrated line or bar divided into a number of segments

3. **FRACTIONAL, RATIO or REPRESENTATIVE FRACTION (R.F.)**

1:24,000 **1/24,000** $\frac{1}{24,000}$

Has no specific units.
The portion of the earth shown in the map has been reduced 24,000 times

UNITS OF MEASUREMENT

English System:	Distance in miles	Elevation in ft
Metric System: (International)	Distance in kilometers	Elevation in m

SCALE CONVERSION

PROBLEMS:

1. Convert a **R.F.** scale of **1:125,000** to a **Verbal scale.**

This R.F. scale means that:

1 unit on the map is equal to 125,000 units on the ground

If we use the English System it means that:

1 inch = 125,000 inches
one inch on the map represents 125,000 inches on the ground

(1mile = 5,280 in; 1ft=12 therefore 1 mile =5,280 x 12 = 63,360 in)

1 in = 125,000 / 63,360 miles

Verbal Scale: 1 in = 1.97 miles

2. Convert a Verbal scale of **1 in = 1.5 miles** to a **R.F. scale.**

1 in = 1.5 x 5280 x 12 in

1 in = 1.5 x 63360 in

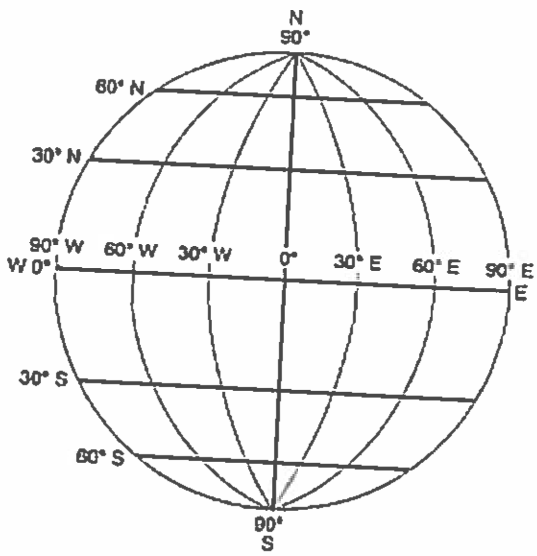
1 in = 95040 in

R. F. Scale 1: 95040

ORIENTATION / LOCATION

Most topographic maps use two arrows that meet at a common point to indicate direction (**TRUE NORTH** and **MAGNETIC NORTH**). The angle between these two arrows is the **MAGNETIC DECLINATION**. If not shown on a map it is assumed that the map is oriented with north up.

One way to indicate **LOCATION** is by **LATITUDE and LONGITUDE**
LATITUDE measured north or south of the equator along parallels.
LONGITUDE measured east to west of the Prime or Zero (Greenwich) meridian.



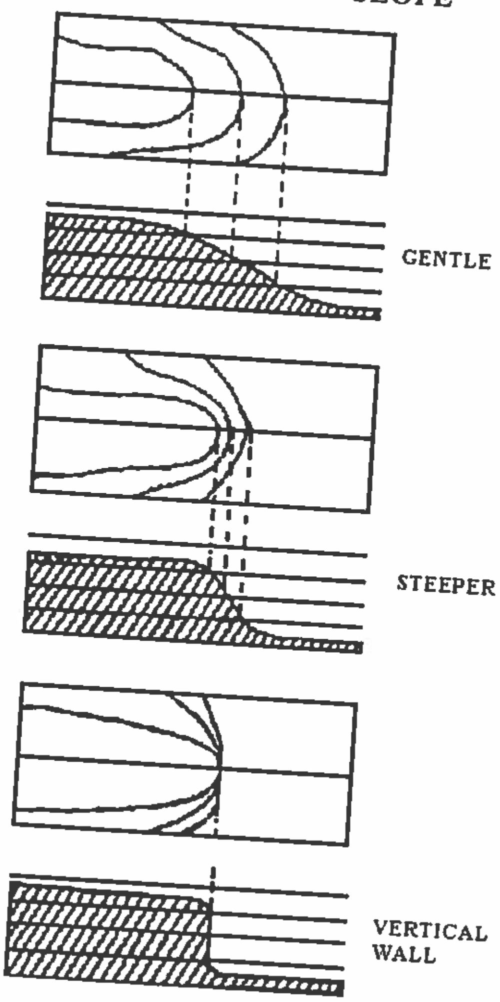
Example: New Orleans, LA 29° 57' North; 90° 04' West

TOPOGRAPHY

Contour Line. Imaginary line that connects points of equal elevation. Shown in brown in standard USGS maps.
Contour lines can be thought of as an intersection of the topography with a horizontal plane.

CONTOUR LINES -BASIC RULES

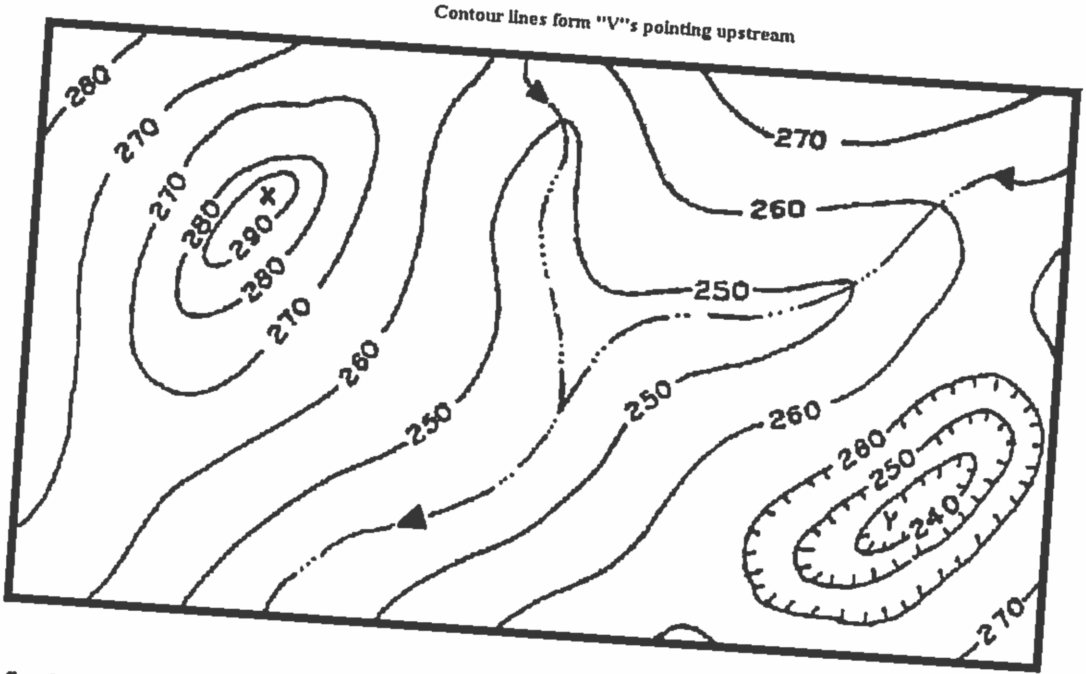
1. Contour lines **CONNECT POINTS OF EQUAL ELEVATION.**
2. **DIFFERENT** contour lines **DO NOT CROSS.**
3. **SPACING** between contour lines is related to the **STEEPNESS** of a slope.
   WIDELY SPACED = GENTLE SLOPE
   CLOSELY SPACED = STEEP SLOPE



Updated 10/6/2003

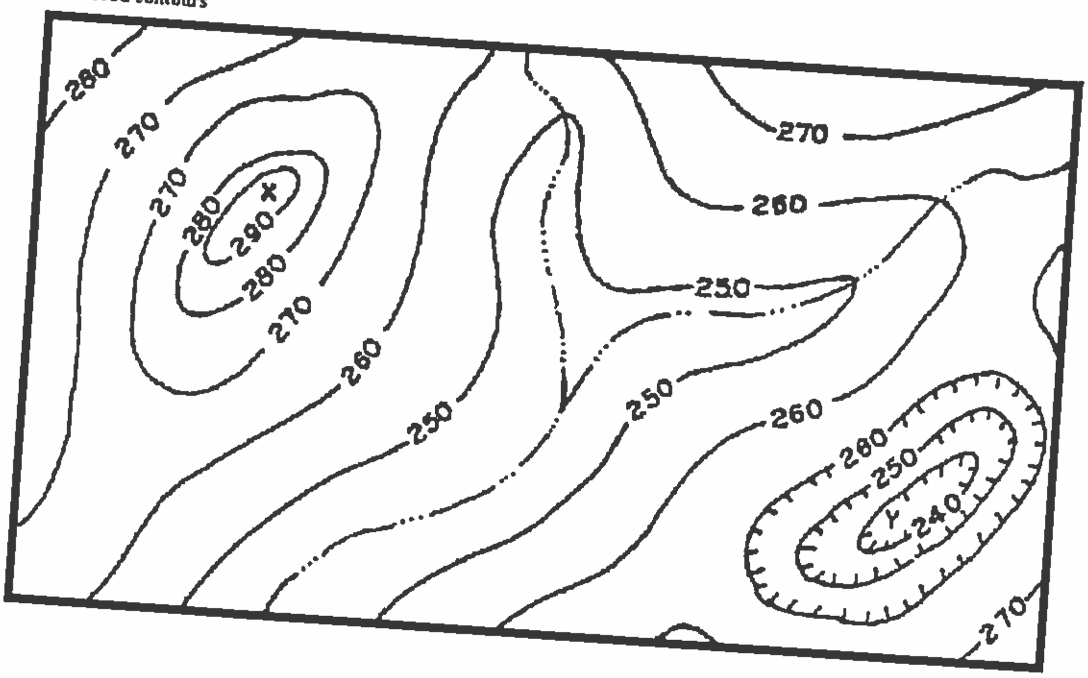
4. When contour lines **GO ACROSS STREAM VALLEYS** they form **Vs**, with their apices **POINTING UPSTREAM.**

"V"s
Contour lines form "V"s pointing upstream

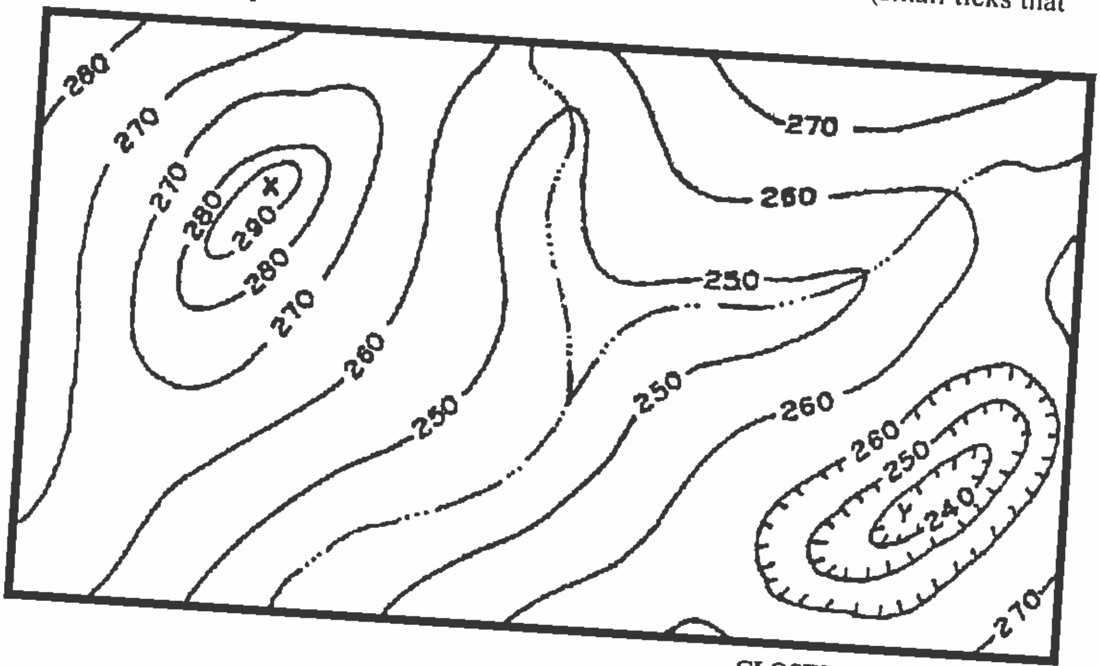


5. **HILLS, KNOBS, MOUNTAINS,** etc., are represented by **CLOSED CONTOURS.**

HILLS, KNOBS or MOUNTAINS
Closed contours

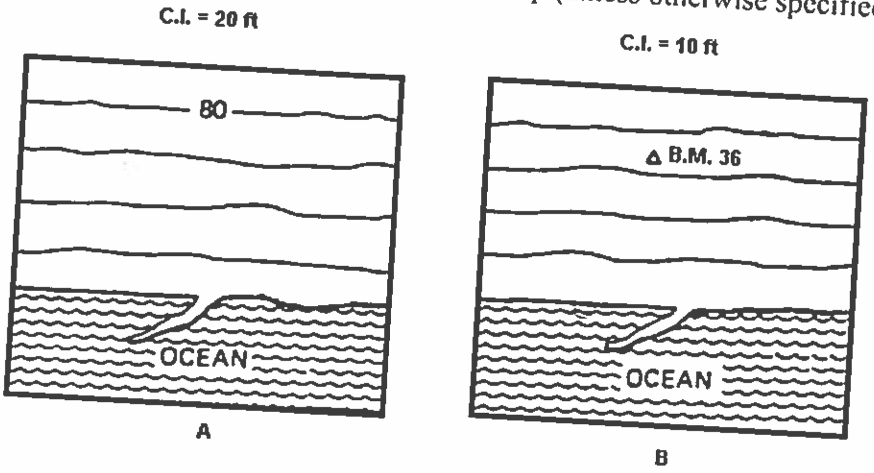


6. **CLOSED DEPRESSIONS** such as Volcanic and Meteor Craters, sinkholes, etc., are represented by **CLOSED CONTOURS** with **HACHURES** (small ticks that point downslope.



CLOSED DEPRESSION
Closed contour with hachures (ticks)

CONTOUR INTERVAL (C.I.) is the difference in elevation between any two adjacent contour lines. It's always constant in a map (unless otherwise specified).

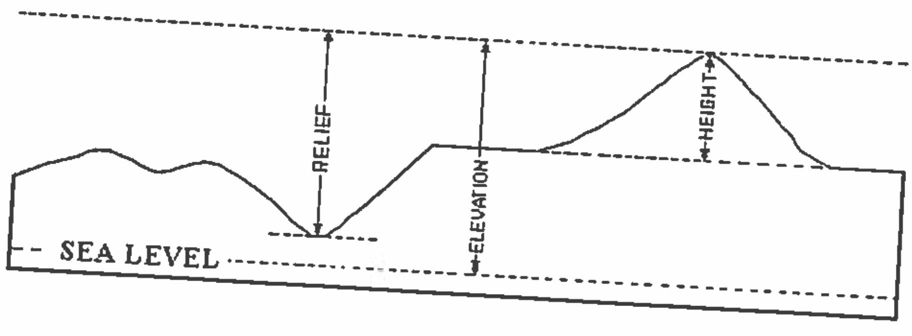


ELEVATION (ALTITUDE) is given in feet or meters above mean sea level. It's the vertical distance of a point above sea level.

BENCH MARK (B.M.) Place where the elevation has been determined accurately. Mark by a brass place fixed to the ground.

RELIEF is the difference in elevation between the lowest and the highest point of a given area.

HEIGHT is the difference in elevation between an elevated topographic feature (i.e. a mountain) and its immediately adjacent base.

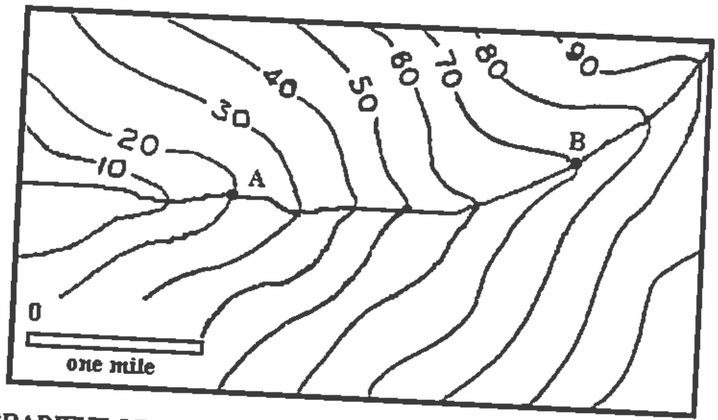


GRADIENT or SLOPE

Inclination of the Earth's Surface with respect to the horizontal.

Gradient = $\dfrac{\textbf{Difference in elevation}}{\textbf{Horizontal separation on the map}}$ (in feet or meters) / (in miles or km)

Units: **ft/mile** (feet per mile) or **m/km** (meter per kilometer)



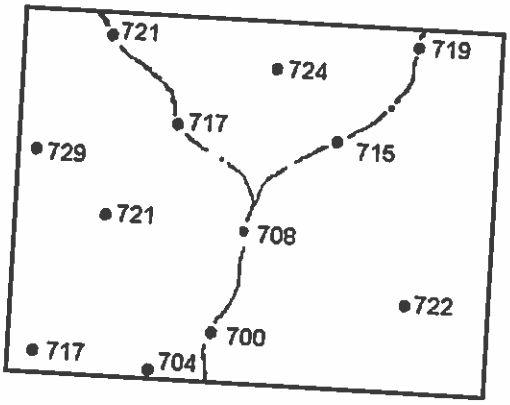
GRADIENT OR SLOPE = DIFFERENCE IN ELEVATION / DISTANCE [feet / mile]

Gradient B-A = (70-20) ft / 2 miles

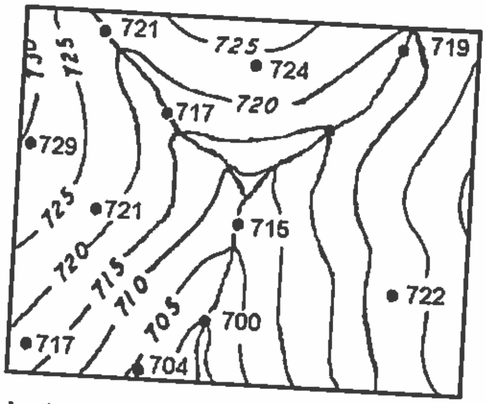
Gradient B-A = 50 ft / 2 miles

Gradient B-A = 25 ft/mile

CONSTRUCTION OF TOPOGRAPHIC MAPS



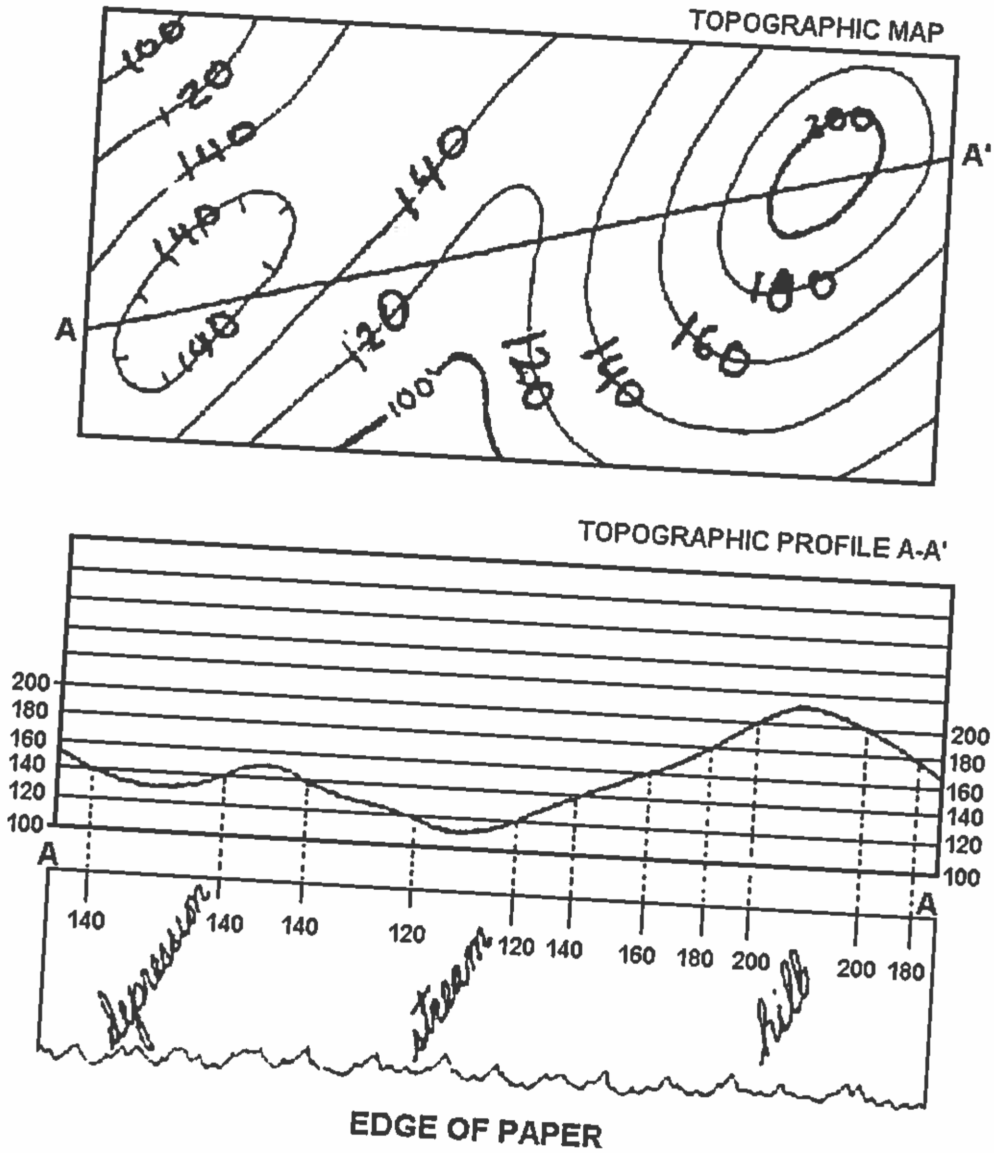
Map showing streams and elevations



Map showing interpolation points and completed contours

C.I. = 5 feet
(MULTIPLES OF 5

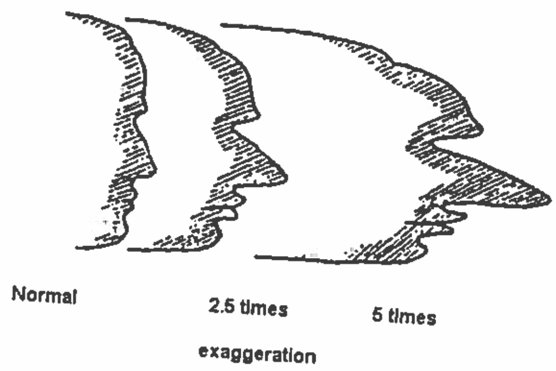
TOPOGRAPHIC PROFILE or CROSS SECTION. *(p.101)*
Diagram that shows change in elevation of the land surface along a given line. (side-view, silhouette or skyline). It is formed by the intersection of a vertical plane and the earth's surface.



Updated 10/6/2003

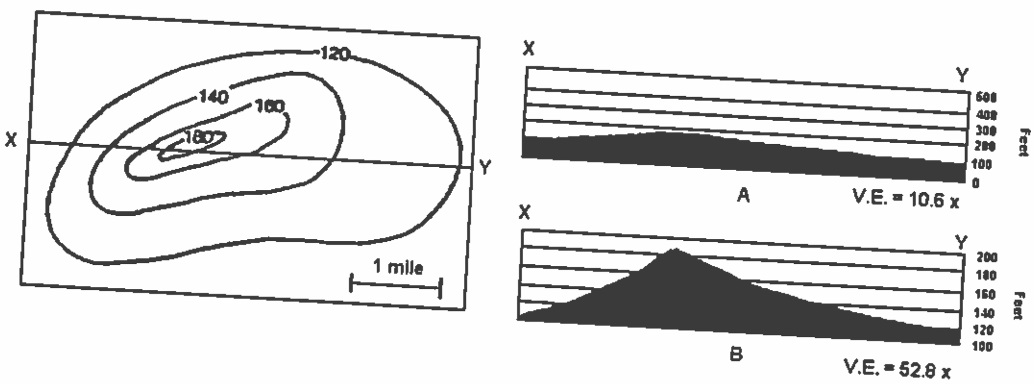
VERTICAL EXXAGERATION. (V.E.) *(p.102)*
Is used to emphasize topographic variations.
V.E. = Vertical (grid) scale / Map (horizontal) scale.
(both have to be in R.F. form)

Example: 1:4,800 /1:63,360 = 13.2 x



Vertical Exaggeration = $\frac{\text{vertical grid scale}}{\text{map scale}}$

V.E. = $\frac{1:1,200}{1:62,500} = \frac{62,500}{1,200}$ = 52 x.



Updated 10/6/2003

CHARACTERISTICS OF CONTOUR LINES (Figure 9.5, p.150)

The following characteristics of contour lines govern the construction and reading of contour maps:

1.. Every point on the same contour line has the same elevation.

2. A contour line always rejoins or closes upon itself to form a loop, although this may or may not occur within the map area. Thus, if you walked along a contour, you would eventually get back to your starting point.

3. Contour lines never split.

4. Contour lines never cross one another; however, if there is a steep cliff, they may appear to overlap because they are superimposed on one another.

5. Slopes rise or descend at right angles to any contour line.

• Evenly spaced contours indicate a uniform slope

• Closely spaced contours indicate a steep slope

• Widely spaced contours indicate a gentle slope

• Unevenly spaced contours indicate a variable or irregular slope

6. Contours usually encircle a hilltop; if the hill falls within the map area, the high point will be inside the innermost contour (however, see discussion of depression contours).

7. Contour lines near the tops of hills or bottoms of valleys always occur in pairs having the same elevation on either side of the hill or valley.

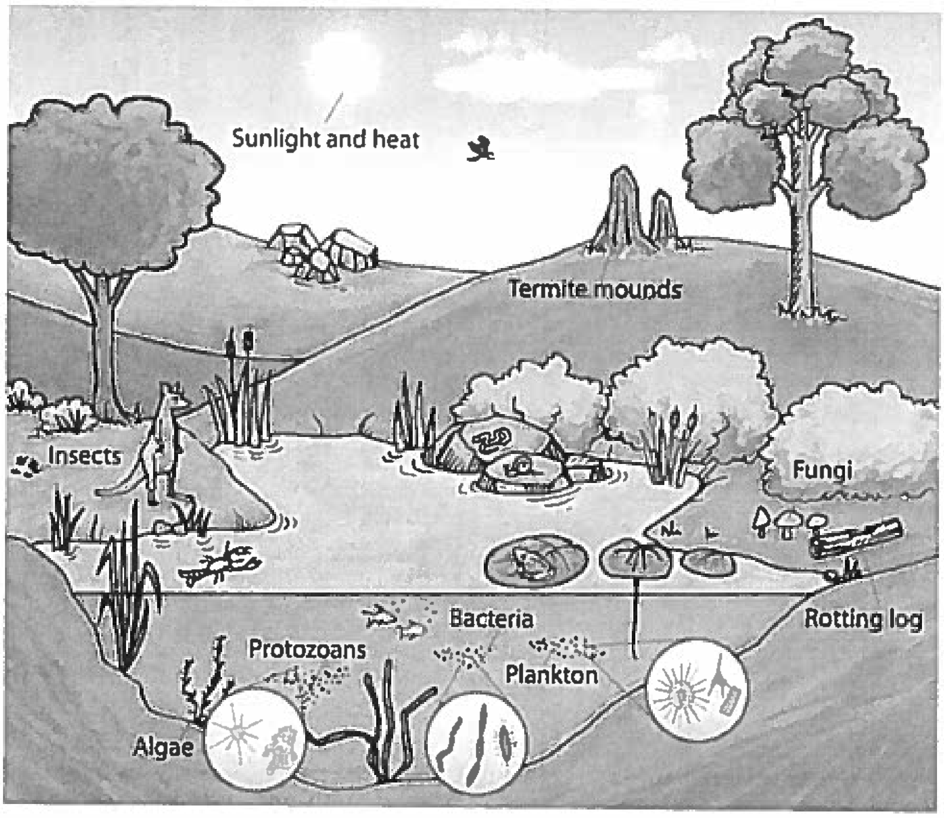
8. Contours always bend upstream where they cross stream valleys.

9. If two adjacent contour lines have the same elevation, a change in slope occurs between them. For example, adjacent contours with the same elevation would be found on both sides of a valley bottom or ridge top.

10. Small depressions may be encircled by contours with hachures (short lines perpendicular to the contour line) on the downhill side. A hachured contour has the same elevation as the normal (unhachured) contour immediately downhill from it.

Lathrop Intermediate

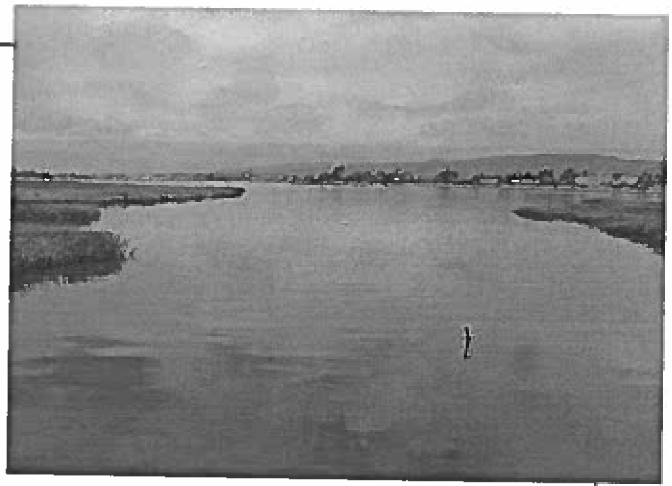
7th grade Science
Ecosystems Unit



7.5.0 - Resource Sheet

Summing up Week 1: Letter Writing

Focus Question: *What makes wetlands so valuable?*



Your task: Imagine that you work for the local water management district, EBMUD.

A local developer wants to build new shopping centers with several new businesses on the wetlands in Oakland.

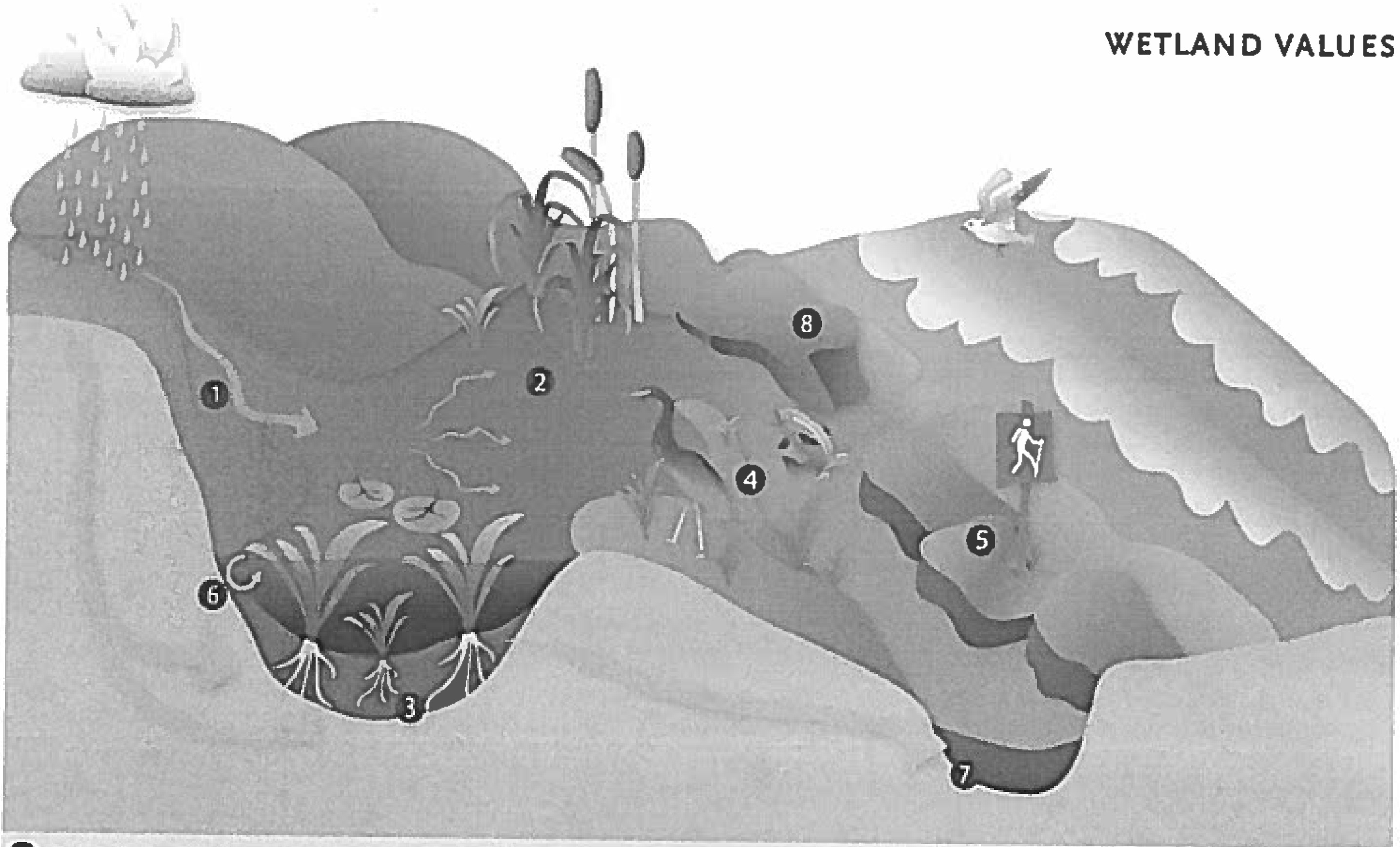
You must help the developer and the public understand:
(1) why wetlands are unique and more valuable than a new shopping center,
(2) why are wetlands important to biodiversity, and
(3) how have humans impacted the wetlands connected to Lake Merritt?

Write a letter to a representative that explains your answers to the above questions, making a strong argument. Use specific evidence from the readings, RRR, and your notebook diagrams, to support your argument.

Letter Evaluation Criteria:

Categories	Required evidence:
Engaging in Argument from Evidence	❑ Construct an argument with at least three relevant pieces of evidence to support the claim ❑ Evidence 1 ____________ ❑ Evidence 2 ____________ ❑ Evidence 3 ____________ ❑ Consider and refute counterclaims with evidence ❑ Counterclaim 1____________ ❑ Refute ____________ ❑ Counterclaim 2____________ ❑ Refute ____________
Ecosystem Dynamics	❑ Explain how changing the wetland ecosystem affects the biotic and abiotic components of the system ❑ Explain how human activity can disrupt an ecosystem and threaten biodiversity
Sentence structure and dynamics	❑ Proper sentence structure, punctuation, and spelling.

WETLAND VALUES

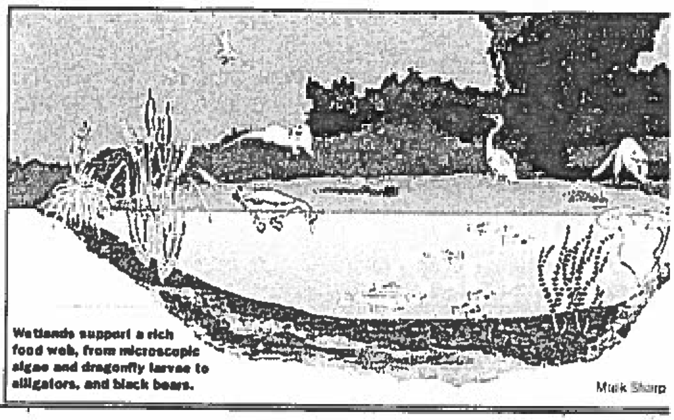


❶ DISSIPATE ENERGY: DURING HEAVY RAINFALL WETLANDS REDUCE STREAM SPEED AND ACT AS NATURAL SPONGES THAT ABSORB WATER ❷ IMPROVE WATER QUALITY: WETLANDS PURIFY WATER, FILTERING OUT SEDIMENTS AND CONTAMINANTS ❸ CONTROL EROSION: WETLANDS BUFFER SHORELINES AGAINST EROSION AND BIND THE SOIL WITH THEIR ROOTS ❹ PROVIDE FISH & WILDLIFE HABITAT ❺ PROVIDE RECREATION, OPEN SPACE AND AESTHETIC VALUE: PEOPLE HUNT, FISH, HIKE, BOAT, AND PHOTOGRAPH IN WETLANDS ❻ SUPPLY GROUNDWATER FLOW: WETLANDS CONTRIBUTE TO BASE FLOW OF STREAMS ❼ REDUCE FLOODING: WETLANDS SOAK UP AND STORE WATER AND SLOWLY RELEASE INTO STREAMS ❽ PROTECT THE COAST FROM STORMS: COASTAL WETLANDS BUFFER WAVE ENERGY

7.5.0 - Wetland Metaphors Task Card (Print 2 copies and place in plastic sleeves)

Focus Question: *What makes a wetland unique compared to other ecosystems?*

Task: In this activity, you will be given objects with unique functions that represent the natural functions of wetlands and your group will need to explain each metaphor.



Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused, and ensure • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- Science notebook - Various objects: pillow, sponge, egg beater, strainer/colander, coffee filter, picture of crib, antacid tablets, soap, cereal

Task Steps (Investigation - 20 min):

In groups…

1. Read the task card out loud and assign group roles.
2. Copy the following table into your notebooks.

Make 8 rows

Object Name	**Function** of this item related to wetlands	Parts of the wetland that perform this function	What would happen **if this function was lost or removed** because part of the wetland was destroyed or changed by humans?
1.			
2.			
3.			
8.			

3. For each object, consider how does the item's function relates to what wetlands do.
4. Identify the part of the wetland that performs the function.
5. Describe what would happen if that function was lost or removed.
6. Record your notes in the notebook.

Evaluation Criteria:

Engaging in Argument from Evidence

- ❑ Identify evidence you could use in your letter

Ecosystem Dynamics

- ❑ Explain how changing the wetland ecosystem affects the biotic and abiotic components of the system

7.5.1 - Modeling a Wetland Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How could wetlands have prevented flooding disasters?*

Task: In this activity, you will build a physical 3D model of a wetland habitat that demonstrates how a wetland functions, specifically to store water, filter materials, and act as a buffer from flooding.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused, and ensure • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- Modeling Clay - Paint Tray - Sponges

Task Steps: Building a Physical 3D Model - 15 min

In groups...

1. Read the task card out loud and assign group roles.
2. Using the materials above, come to consensus for the design of the wetland physical model from your individual designs <u>that will store as much water as possible</u>.

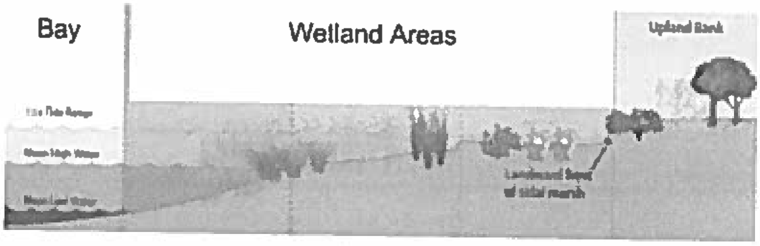


Image adapted from Virginia Institute of Marine Science

3. Consider the following constraints in your design:
   a. Your habitat must have an upland area.
   b. The upland area must allow water to flow down to the bay.
   c. Ensure as much water as possible flows through the wetlands from the upland area into the bay.
4. Build your physical 3D model of wetland habitat.

Individually...

5. Revise your individual written annotated model to match the group's model of the wetland habitat.

7.5.1 - Modeling a Wetland Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How could wetlands have prevented flooding disasters?*

Testing the Model - 15 min

Materials:
- Cup of soil
- Spray bottle
- Colored drink mix
- Measuring cup
- Graduated cylinder
- Water
- Small piece of cardboard

***Task:** In groups, test how the **presence** and **absence** of the wetlands affects how the wetlands serves each of these three ecosystem services. Decide what data you will collect each time to support any claims made.*

Service #1 - Wetlands store water

1. Design a test for the effect of the wetlands on **storing water** after rainfall.
2. Record your observations and data in your notebook, including what happened to the rain downstream.
3. Return the model to your original design before testing.

Service #2 - Wetlands filter materials -

1. Design a test for the effect of the wetlands on **filtering materials**, like sediment from soil or pollutants, during rainfall. (HINT: colored drink mix can act as the pollutant).
2. Record your observations and data in your notebook.
3. Return the model to your original design before testing.

Service #3 - Wetlands act as a buffer -

1. Design a test for the effect of the wetlands on **buffering different size waves**.
2. Record your observations and data in your notebook.
3. Return the model to your original design before testing.
4. Clean up your area and return materials in the same condition as you received them.

Individually...

4. Revise your written annotated model to show **how** wetlands perform their functions of: (1) water storage, (2) filtering, and (3) buffering from oceanic waves or flooding.

Evaluation Criteria:

Develop a System Model
- ❑ Includes all components and processes important to wetland function
- ❑ Show how the water flows through and interacts with different components of the model as an input and output
- ❑ Revise the model based on tests from investigations

Ecosystem Dynamics and Structure and Function
- ❑ Explain how removing the wetlands affects the biotic and abiotic components of the system (upstream and downstream)

Adapted from Save The Bay's Wetlands in A Pan

Wetland Metaphors Information Table

Name ___________________

Date ___________________

Period

Name of the Item	**Function of this item** that could be related to wetlands	**Abiotic parts** of a wetland that perform this function	**Biotic Parts** of a wetland that perform this function	What would happen if this function was **lost or removed** because one of the biotic or abiotic factors was destroyed or changed by human actions? What would happen to specific plants of animals?

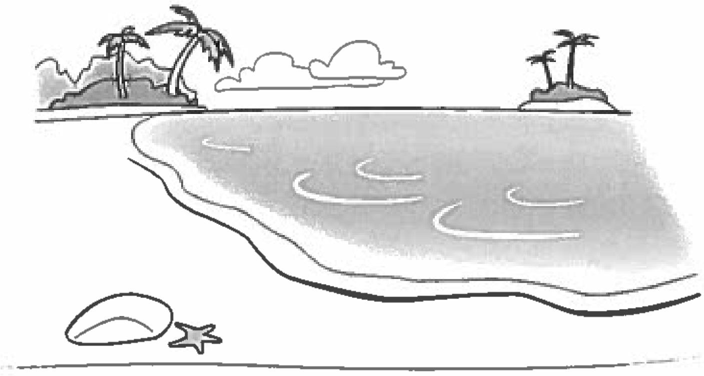
Name ____________________
Date ____________________
Period ____________________

Think about reasons why wetlands may be very valuable to everyone in Florida even though they are inconvenient, stinky and yucky sometimes.

Imagine that you work for the St. Johns River Water Management District. A local developer wants to build a new strip mall with 17 businesses right on wetlands that border the St. Johns River. Your job is to help the public and the developer understand why the wetlands are more valuable as wetlands and not a new mall. Next month, the public will have a chance to vote on wetlands should be developed.

Write and explain to the voters of Clay County why this valuable riverfront property is more valuable to Clay County as a wetland rather than as a mall. Use information and specific examples and details from your reading and from the Wetland Metaphor activity to support your ideas.

No More Plants



Four friends visited an island. The island was far away from the mainland. No humans lived on the island. The friends talked about what would happen if all the plants disappeared on the island. This is what they said:

Harold: "I think all the animals on the island would eventually die."

Jeff: "I think the animals that eat plants would eventually die but the animals that eat both plants and animals would live."

Salma: "I think only the predators on the island would live."

Misha: "I think eventually all the animals on the island will become meat eaters, and they will survive without plants."

Which friend do you agree with the most? ________________ Explain why you agree.

____

____

____

____

____

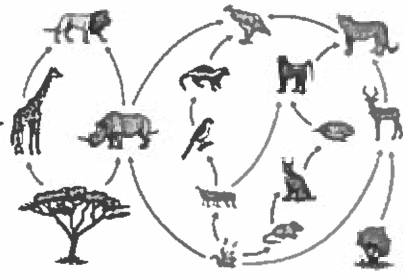
____

____

7.5.2 - Building a Wetland Food Web Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How does matter cycle and energy flow in an ecosystem?*

Task: In this activity, you will build a model that shows how matter and energy flows in an ecosystem.



Food web from Siyavula Education

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused, and ensure equity • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- Sets of Organism Cards Food Chains #1-4 - Arrows - Notebooks - Large whiteboards - Dry erase markers

Task Steps: Building a Food Web from Individual Food Chains - 15 min

In groups…

1. Read the task card out loud and assign group roles.
2. Distribute sets of organisms cards, one group per person.

Individually...

3. Take your group of Organism cards with arrows and build a food chain.
4. Record your food chain into your notebook. Include the names of the organisms and label them as producers or consumers. Make sure to show all arrows.

In groups…

5. Build a wetland food web by connecting each of your group's food chains together. Each student takes turns placing one organism from their food chain down at a time and shows all connections. Only the student who worked on the food chain may touch their own organisms, but other students may advise from the group.
6. Students continue until all organisms are added to the web.

Making the Model- 20 min

In groups...

7. Use the large whiteboard to record your food web.
8. Add the following organisms onto your food web. →
9. Discuss where did your group decide to place these organisms and how they are connected to other organisms in this ecosystem.
10. Record your new food web in your notebooks with the title, <u>Wetland Food Web Model</u>.

Organisms Cards adapted from Erin Baumgartner at WOU

7.5.2 - Building a Wetland Food Web Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How does matter cycle and energy flow in an ecosystem?*

Reading and Revision - 45 min

Individually...

11. Read *The Importance of Chemical Reactions* resource sheet using CHAT to the text
    a. Try to focus on adding unanswered questions as your annotations

In groups...

12. One at a time share your questions and any responses that could help you to improve and revise your model.

Individually...

13. Read the article one more time, focused on finding information that could help you answer the focus question, especially identifying any key components or processes involved in the cycling of nutrients or flow of energy in your model.

In groups...

14. Using the Silent Graffiti Wall protocol, silently share any information that you could use to improve how your model demonstrates the cycling of nutrients and the flow of energy, especially processes where energy transfers without the flow of nutrients or nutrients flow without the transfer of energy.
15. Revise your group model from yesterday to include information from the reading and be prepared to show your group model to others.

Evaluation Criteria:

Building a Wetland Food Web Model

- ❑ Includes all organisms and observable and unobservable processes important to show how matter as nutrients flow and how energy transfers in the ecosystem
- ❑ Shows how decomposers, producers and consumers relate with one another in the ecosystem
- ❑ Includes technical writing tools to indicate the flow of matter as nutrients AND the transfer of energy

Group collaboration

- ❑ Show interdependence by sharing information and involving all members in completing the task

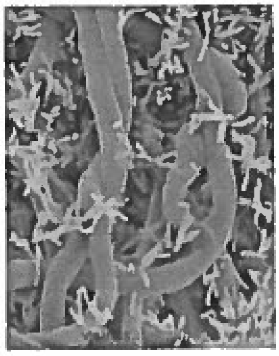
7.5.2 - Resource Sheet

The Importance of Chemical Reactions

***Focus Question:** How do chemical reactions support the cycling of matter and transfer of energy in a wetland ecosystem and an oceanic ecosystem?*

The Special Role of Decomposers in Nutrient Cycling

Organisms need various nutrients to grow and carry out the needed processes for survival, such as body growth and development. Any nonliving matter that an organism needs can be called a **nutrient**. However, most nutrients can only be used if they are changed into a form organisms can use.



Bacteria in the shape of rice on a fungus.

Source: Visualsunlimited.com

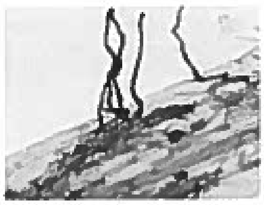
Bacteria are organisms that happen to be very good at performing the needed chemical reactions to change substances into nutrients other living things can use. Bacteria are tiny, one-celled organisms that live in virtually every ecosystem on Earth, and play key roles in our oceans and thriving in our wetlands.

Most bacteria are **decomposers** that break down dead material and waste into nutrients and release carbon dioxide into the air. In this chemical reaction, bacteria convert material that could be poisonous, like waste, into forms useful to other organisms, especially plants, phytoplankton, and other producers. Decomposers are especially important in keeping nutrients in their cells, which prevents the loss of these nutrients, such as nitrogen, to the environment.

Some bacteria are **mutualists**, that form partnerships with plants. The most well-known of these are the nitrogen-fixing bacteria. The plant supplies simple chemicals that the bacteria needs. In turn, the bacteria, through chemical reactions, convert the nitrogen (N_2) and hydrogen (H_2) from the air into ammonia (NH_3), a nutrient the plant can use. Bacteria can be found next to and in the roots of plants across many ecosystems. Some bacteria can increase plant growth and can even help stop certain diseases from hurting plants.

Fungus covering and decomposing a moth. Credit: edtechlens.com

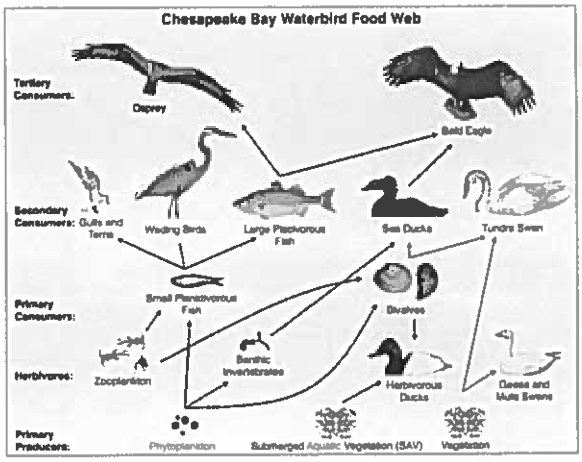
Along with bacteria, **fungi** act as decomposers to convert hard-to-digest organic material into forms that other organisms can use in many food webs. Like bacteria, fungi are important for keeping nutrients in the environment. Some fungi can help plants by exchanging nutrients with plant roots or in root cells. Many plants depend on fungi to help extract nutrients from the soil. However, other fungi have been known to cause damage or even death to a plant when they colonize roots and other organisms.



Fungi growing in the cells of a plant's roots.
Credit: archive.bio.ac.uk

The Flow of Energy in Ecosystems

All organisms need energy to perform the processes for life, e.g. energy is needed to grow and develop, produce offspring, and simply to stay alive. However, energy cannot be created or destroyed. Energy simply changes form as it moves through ecosystems. The Sun powers most of the ecosystems on Earth and this energy flows from one living thing to another. Producers alone can capture sunlight and store it as chemical energy in molecules like glucose using photosynthesis. Consumers get some of that energy when they eat producers and pass some of the energy on to other consumers when they are eaten. One can easily see how energy flows between organisms in food chains and food webs.

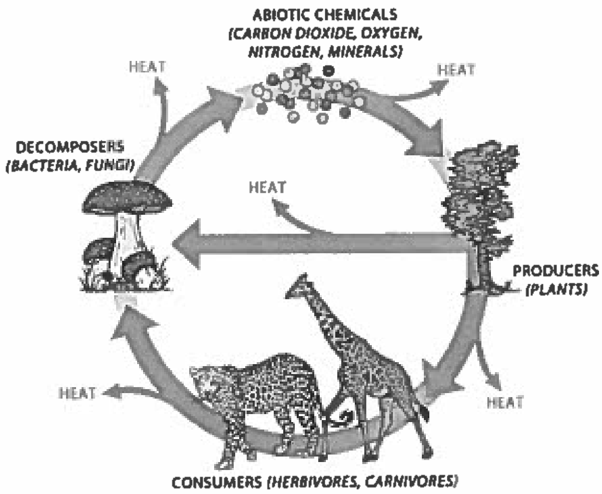


Credit: Matthew C. Perry - US Geological Survey.

Why Energy Cannot Cycle Completely

Unlike energy, matter is recycled in ecosystems. Look at the figure below to compare how energy flows as opposed to matter:

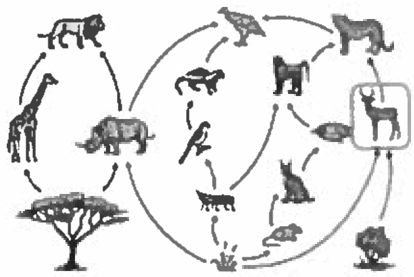
- Decomposers release nutrients when they break down dead organisms.
- The nutrients are taken up by plants through their roots.
- The nutrients pass to consumers when they eat plants.
- The nutrients pass to higher level consumers when they eat lower level consumers.
- When living things die, the cycle repeats.
- Notice that energy is lost as heat into the environment whenever energy is transferred between organisms



[Taken from ck12 - Earth Science Concepts For Middle School]

7.5.2 - Role Playing Task Card

(Print 2 copies and place in plastic sleeves)



Food web from Siyavula Education
https://www.flickr.com/photos/121935927@N06/13578885414/in/photostream/

Focus Question: *How are organisms connected to each other and their environment?*

Task: In this activity, you will play the role of a specific organism and explain how you depend on other organisms and the environment for survival.

Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused, and ensure equity • *Timekeeper* - Keep time, report to group time left during task • *Inquirer* - Only person to ask questions of the teacher/others	- Food web models in your notebooks - Organism Cards

Task Steps: Role Play as an Organism

In groups…

1. Read the task card out loud and assign roles.
2. Place all the organism cards face down on the table. One at a time, each person chooses one card. For the remainder of this activity, you will speak from this organism's perspective.

In pairs…

3. Using your food web model, take turns explaining how your organism is directly connected to another organism. Be mindful top use the academic vocabulary to strengthen your explanation.
4. As the listener, record silently how many times the speaker used each of the vocabulary terms

Whole class…

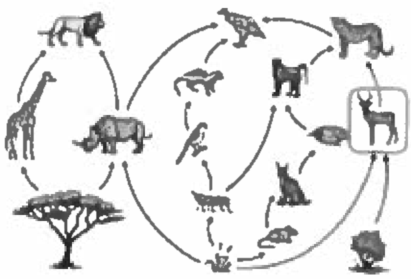
4. Find a partner, explain
    a. Organism
    b. Direct Connection directly using language
    c. Indirect connection
    d. How are you connected to a nonliving thing in your ecosystem?

Organisms Cards adapted from Erin Baumgartner at WOU

7.5.2 - Role Playing Task Card

(Print 2 copies and place in plastic sleeves)

Focus Question: *How are organisms connected to each other and their environment?*



Food web from Siyavula Education

Evaluation Criteria:

Assessment and self assessment	Self Asse		
Person 1			
Person 2			
Group patterns			
Strengths and challenges			
Whole class rounds			

Share and erase

Name: ______________________________ Period: ____ Date: __________

Organism Role Play - Stronger and Clearer Each Time - Output Sheet

Directions: Use your food web model to do the following:

1. On the back of this paper in the top half, explain in a paragraph:

   How are you dependent on other organisms AND your environment for energy?

2. In the space below under ME, write 2-3 key words/phrases you used in your paragraph on the back.
3. After each conversation with a partner, build from and borrow your partner's ideas and language to make your answer *stronger AND clearer each time* with better and better evidence, examples, and explanations by writing 2-3 key words/phrases below. You will have three conversations.

Name	**Thoughts on the concept**
Me (Orginal):	
1st person I spoke to:	
2nd person I spoke to:	
3rd person I spoke to:	

Final explanation:

After the activity, write your final stronger and clearer paragraph on the bottom half (after folding it to avoid looking at your pre-activity response). You can use your notes from this side to craft the response. After you finish, compare the two responses and notice if and how the second paragraph became stronger (more evidence and detail) and clearer (better language).

Self-assessment (1 - not really, 2 - somewhat, 3 - definitely and I can prove it):

_____ During the activity, my ideas became *stronger & clearer*. I borrowed language and built on ideas from my partners to strengthen and clarify my ideas. Explain below:

_____ I used the model to explain how an organism depends on other organisms and its environment for energy.

Adapted from Zwiers "Stronger and Clearer Each Time"

7.5.2 - Ocean Connection Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How do organisms respond to changes in their environment to survive?*

Task: In this activity, you will compare your food web model in a wetland to that of an ocean food web to find patterns and predict effects.

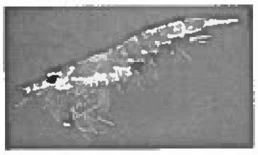
Group Roles:	Materials:
• *Facilitator* - Read Task Card out loud, keep group focused, and ensure equity • *Timekeeper* - Keep time, report to group time left during task • *Resource Manager* - Manage collection/appropriate use/return of activity materials • *Inquirer* - Only person to ask questions of the teacher/others	- Wetland Food Web Model in your notebooks - Ocean Food Web

Task Steps: Compare and Contrast Food Webs - 20 min

In pairs…

1. Read the task card out loud and assign group roles.
2. Look at ocean food web. Identify producers and consumers.
3. Discuss:
   a. How does this food web compare to the wetland food web? List similarities and differences.

In groups...



4. Imagine that the local population of krill died due to a new disease. The krill are known as primary consumers because they are the first to consume producers in this food web.
   a. Considering the krill's role as primary consumer, predict how their deaths would affect the other organisms in the environment. Use the terms, "predation" and "competition" and record your response in the notebook.

5. Look back at the wetland food web model you created in your notebooks. Identify a primary consumer in the wetland food web.
   a. Imagine that a similar change happened where the population of a primary consumer died due to disease. Predict how their deaths would affect the other organisms in the environment. Use the terms, "predation" and "competition" and record your response in the notebook.

7.5.2 - Ocean Connection Task Card (Print 2 copies and place in plastic sleeves)\

Focus Question: *How do organisms respond to changes in their environment to survive?*

Connecting the Two Food Webs - 30 min

In groups...

6. Consider how to connect and combine the two food webs to create one model for how organisms interact across the ecosystems. Discuss how you could revise the model to show this.

After combining food webs into one model...

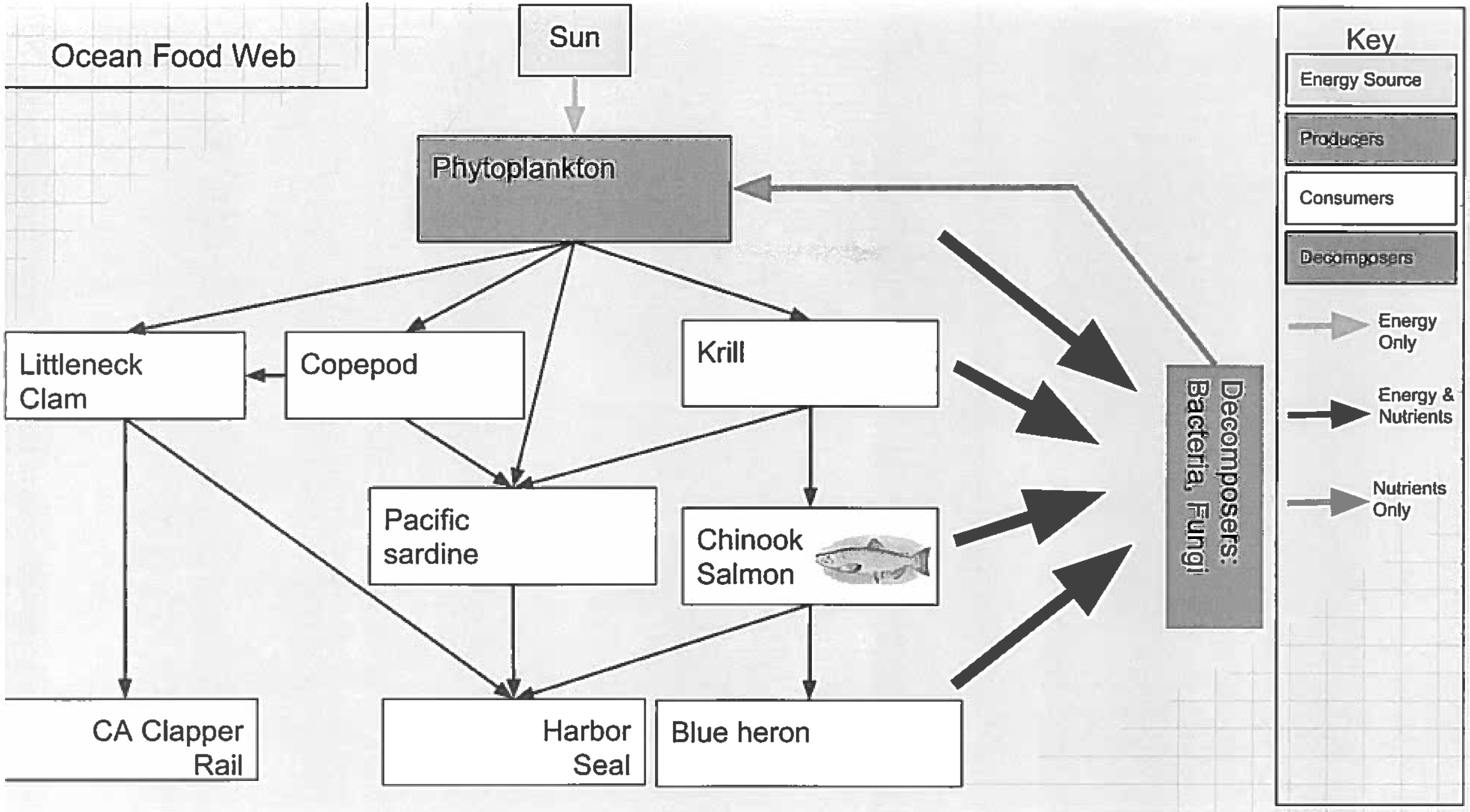
7. Use the new model to predict how the following events would cause changes to predation and competition in the two ecosystems (ocean and wetland):
   a. A new group of fishermen are overfishing in this ecosystem and **killing all the chinook salmon.**
   b. Massive amounts of oil has spilled all over the water in the ocean ecosystem **cutting off all sunlight** to any organisms below the water's surface.

Evaluation Criteria:

Using a Model
- ❑ Use the model to explain relationships between organisms and the environment
- ❑ Uses the availability of resources to explain changes to populations

Cause and Effect and Stability and Change:
- ❑ Describe how the connections between organisms can be used to predict responses to change.

Group collaboration
- ❑ Show interdependence by sharing information and involving all members in completing the task


Ocean Food Web
Sun
Phytoplankton
Littleneck Clam
Copepod
Krill
Pacific sardine
Chinook Salmon
CA Clapper Rail
Harbor Seal
Blue heron
Decomposers: Bacteria, Fungi
Key
Energy Source
Producers
Consumers
Decomposers
Energy Only
Energy & Nutrients
Nutrients Only

7.5.2 - Resource Sheet

Impact of the Mysterious Mussel Resource Sheet

Focus Question: *How do organisms respond to changes in their environment for survival?*

Task Description: You are an environmental scientist explaining to others the potential impact of a new species in the San Francisco Bay ecosystem.

Using the food web and nutrient cycling models you created, predict how the introduction of a new species, the Atlantic Ribbed Mussel, will affect the ocean AND wetland ecosystem interactions.

Atlantic Ribbed Mussel

Consumes: phytoplankton, copepod and amphipod

Consumed by: California Clapper Rails and Harbor Seals

Key Facts about the Atlantic Ribbed Mussel:

- Attaches itself to marsh plants in muddy habitats
- Directly competes for food with clams and other mussels, often outcompeting all the others for resources
- Blamed for injuring and killing California Clapper Rails by closing their shells on the bird's feet or beaks
- Thrives in a wide range of environmental conditions, including polluted waters

Adapted from Aquatic Invaders booklet from Elkhorn Slough NERR

Prediction Evaluation Criteria:

Categories	Required evidence:
Patterns	❑ Uses patterns of ecosystem interactions as evidence to predict and identify causal relationships within ecosystems
Cause and Effect	❑ Identify cause and effect relationships in the ecosystem models
Developing and Using a model **Construct Explanations**	❑ Use cause and effect relationships from the food web models of the wetland and ocean ecosystems to predict changes other components in the wetland and ocean ecosystems ❑ Use patterns as evidence to construct explanations/predictions
Interdependence in Ecosystems	❑ Explains how organisms depend on their interactions with biotic and abiotic components in the ecosystem and across ecosystems through matter cycles and energy flows ❑ Uses the availability of resources to predicts interactions of competition and predation as evidence

OUSD Science

How California is turning drainage canals back to rivers

Under new legislation, long stretches of the river's flood control channel will have trails and parks.

Louis Sahan

The Santa Ana River, born of snowmelt and natural springs near Big Bear Lake, flows through Southern California as one of the region's most scenic rivers — until it hits Orange County.

After cutting through a deep, lush canyon and flowing through the city of Riverside, the Santa Ana spills into riprap and the county's dreary concrete flood control channel extending 26 miles to the Pacific Ocean.

The conditions have made the Santa Ana, like other Southern California rivers, a gritty anachronism especially in a state that prides itself as an environmental leader nationwide. But now, joining a tren that began elsewhere some four decades ago, the Santa Ana is catching up.

"People want their streams back — all of them, including the Santa Ana," said Stephen Mitchell, a science librarian and co-coordinator of the nonprofit UC Riverside Friends of the Santa Ana River.

Under recently approved legislation, long stretches of the flood control channel's banks will have trails, parks and natural areas, and portions of the river itself will be cleared of boulders, low-hangin limbs and other entanglements to open the waterway to kayaking and rafting.

The wonder is that it has taken so long. Many American cities have cleaned up blighted rivers and turned their banks into parks or greenways with entry points that invite visitors to launch canoes, kayaks and boats.

In Reno, the Truckee River Whitewater Park runs through the downtown hotel-casino district. Kayakers paddle New York City's Bronx River. The Willamette River is now an inviting escape for residents of Portland, Ore.

In Southern California, however, the Santa Ana and half a dozen other once beautiful rivers and streams have remained drainage channels. Their purpose is to prevent the flooding that devastated the region in the middle decades of the last century when flash storms in the San Gabriel Mountains sent massive amounts of water into communities unable to handle the deluge. Too much open land had been developed and paved.

Converting the rivers into efficient drainage channels all but ended the flooding, and for more than half a century, government flood control agencies fought any changes that would diminish carrying capacity, even as environmentalists and river advocates began calling for ecological restoration and recreational improvements in the 1980s.

"They are the last open space we have in working-class and park-poor communities for healthy recreational goals such as walking, hiking and biking trails," said D.J. Waldie, an author and expert the local landscape and culture.

But the U.S. Army Corps of Engineers and other flood control agencies wouldn't budge until the last decade, when commercial interests joined with community activists along the Santa Ana, Los Angele and San Gabriel rivers — and tributaries including the Rio Hondo, Arroyo Seco and Compton Creek to demand change.

"The realization that concrete channels can also support park amenities is rising hand in hand with environmental justice concerns," said Steve Evans, a political consultant for Friends of the River and the California Wilderness Coalition.

"Minority communities, particularly Latino communities along these river systems, are exercising their political power to improve conditions in otherwise park-poor areas," Evans said.

On the commercial front, the region has grown so dense that river corridors have become frontiers. Industry has been phasing out along the channels and commercial interests have stepped in, seeing opportunities for new housing, retail and office development.

Flood control agencies have for the most part acquiesced, agreeing to improvements that will not reduce carrying capacity during rainstorms.

The Los Angeles River is the best example. It is in the early stages of a renaissance, especially along 1 miles just north of downtown. Now it's the Santa Ana's turn.

Under the legislation by state Sen. Lou Correa (D-Santa Ana), the Santa Ana River Conservancy Program will operate within the state Coastal Conservancy to improve conditions for wildlife and provide amenities for hiking, biking, picnicking, fishing, horseback riding and other activities in one of the fastest-growing regions in the nation.

Correa's measure was modeled after a 17-year-old Coastal Conservancy program dedicated to improving public access to open space and wildlife habitat in the Bay Area.

The Santa Ana, formally known in Orange County as Flood Control Channel EO 1, has numerous hidden, shady places that support a remarkably rich variety of species.

The 2,150 acres of wetlands behind Prado Dam near the Orange-Riverside county border, for instance, comprise a labyrinth of channels, ponds and forests. Despite a development boom in neighboring Chino, Corona and Norco, the wetlands area is still a haven for threatened and federal endangered species including red-sided garter snakes and least Bell's vireos.

High on Correa's wish list of recreational projects is construction of 30 miles of trail to complete a 110-mile-long trail from Big Bear Lake to Huntington Beach.

Ultimately, the trail could link a network of river-bottom parks. The city of Redlands, for example, plans to develop riverside green space beneath the San Bernardino Mountains to attract hikers and bicyclists, some of whom would shop and dine in its nearby historic downtown district.

David Myers, executive director of the nonprofit Wildlands Conservancy, and other naturalists recently obtained permission from state parks officials to navigate the stretch of river flanked by Chino Hills State Park on the north and the Cleveland National Forest on the south. They wanted to explore the possibilities of improving public access and recreational opportunities.

The rafters made their way down two miles of river, pulling their way through a tunnel in dense overhanging willow branches, often leaping overboard to give their boats a shove.

Finally they reached a point where the vegetation was impenetrable. They dragged the rafts onto a sandy bank, sopping and exhilarated.

"This place has great potential," Myers said. "In five or six years, much of this river could be beautifu riparian forests with shady trails."

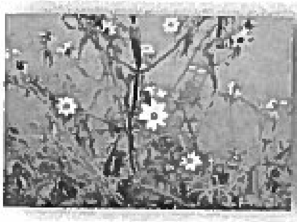
Prado Wetlands

The Orange County Groundwater Basin is managed by the Orange County Water District (OCWD; the District) and provides 72 percent of the water for 2.4 million residents in north and central Orange County. OCWD owns 2,150 acres behind Prado Dam in Riverside County where it operates the Prado Wetlands, the largest constructed wetlands on the west coast of the United States. The wetlands naturally remove nitrates and other contaminants from Santa Ana River (SAR) flows.

Restoring Water Quality

- The Santa Ana River flow, during non-storm seasons, consists primarily of highly-treated wastewater from upstream communities. Half of the Santa Ana River flow is captured behind Prado Dam and is routed through a specially-constructed wetland area. By putting the river water through this network of ponds behind Prado Dam, OCWD has created a natural, cost-effective process for reducing nitrate levels and purifying the water for future percolation into the groundwater basin.
- OCWD's Prado Wetlands include 45 shallow ponds that are constructed in the 450-acre treatment wetland on OCWD land behind Prado Dam.

Prado Wetlands



Native Marigold Habitat

- In the early 1990s, research was conducted to determine what water quality benefits would occur if part of the Santa Ana River flow passed through the wetlands. Research conducted by scientists from Northwestern University and the University of California, Berkeley investigated the effectiveness of the wetlands to naturally remove nitrate, the fate of the nitrogen removed, and the effects of various wetland modifications. The results from the studies indicated that the wetlands are a very effective and economical means for nitrate removal. Nitrate removal at a conventional treatment plant would cost approximately $15 per pound, compared to about $0.85 per pound using the natural wetlands process. The wetlands currently remove nearly 175 tons per year from the Santa Ana River.
- The wetlands project allows OCWD to improve water quality beyond regulatory requirements. By taking this proactive and innovative approach, OCWD improves groundwater quality, enhances the environment and minimizes treatment costs. A permit from the Corps allows half of the flow of the Santa Ana River, about 80 cubic feet per second (cfs), to be diverted through the wetlands. In the late-1990s, OCWD reconstructed its wetlands to maximize the capability to treat river flows and to improve operational efficiency.
- The proximity of the wetlands to the SAR in the Prado Basin is necessary for conveyance of water through treatment ponds, but exposes the ponds to flooding from storm flows in the Santa Ana River. Rain events in late December 2010 dramatically increased the storm flows and the stage height of the river rose by 12 feet. This caused the levees protecting the ponds to fail in several locations, resulting in river flow entering the wetlands via the diversion channel. The consequential floodwaters and impoundment behind Prado Dam deposited debris and sediment in the diversion channel and ponds. OCWD removed deposited sediment, using this material to reconstruct damaged roads and levees, and rebuilt the wetlands to their original configuration.

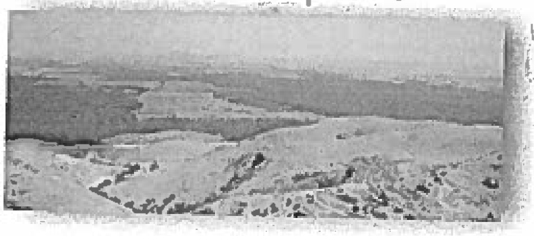
Groundwater Management

Aerial View of Prado Wetlands

• As water is withdrawn from Orange County's groundwater basin, OCWD uses Santa Ana River water as a primary source of groundwater replenishment. Water from the river is comprised of stormwater, recycled water and other natural sources.

• A significant portion of the Santa Ana River flow is directed through OCWD's Prado Wetland, to naturally improve water quality, before entering Orange County and being captured in the Orange County Groundwater Basin. Prado Basin supports fish and bird habitats.

Stormwater Capture



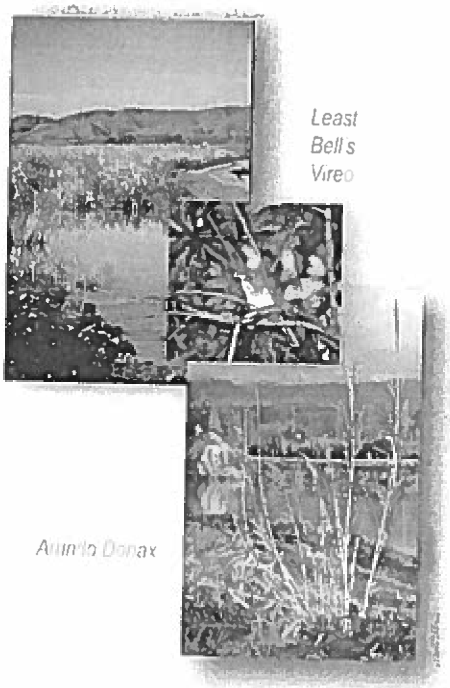
View of Prado Wetlands from San Bernardino Mountains

• Prado Dam is the primary flood control facility along the Santa Ana River. When the dam was completed in 1941, the Corps, which owns and manages it, considered conservation an incidental function of the dam. Initially, the water conservation level behind the dam was limited to a small amount, which increased through time.

• In 1993, an agreement with OCWD, the Corps and USFWS allowed for increased water conservation from March through September each year to store up to 26,000 acre-feet of water at elevation 505 feet. In 2006, an agreement was reached between OCWD and the Corps to store more water from October through February each year by increasing the conservation pool from elevation 494 feet to 498 feet. The additional water captured behind the dam is used to recharge the groundwater basin. The added storage capacity allows OCWD to increase its use of local water resources, saving water users millions of dollars in imported water purchases. The District is currently working with the Corps to complete a feasibility study to increase storage levels to 505 feet year-round.

Endangered Species & Habitat Conservation

Prado Wetlands



Least Bell's Vireo

Arundo Donax

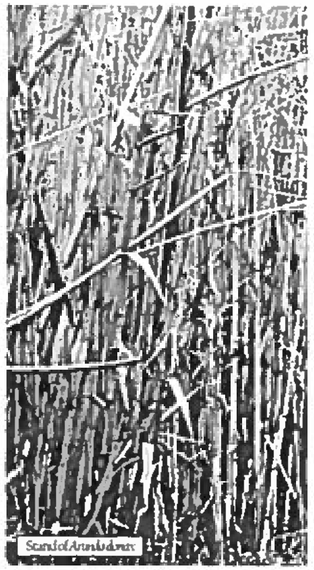
• Prado Basin is home to several rare and endangered birds and waterfowl species. As part of a conservation agreement with the Army Corps of Engineers (the Corps) and the U.S. Fish and Wildlife Service (USFWS), OCWD has restored thousands of acres of habitat for the endangered least Bell's vireo and Southwestern Willow Flycatcher, and has funded more than $3 million in mitigation and monitoring measures for the vireo program.

• OCWD's vireo program has been one of California's great environmental success stories. The program includes restoration of vireo habitat and the trapping of cowbirds that invade the vireo nests. When the three agencies first began discussions in 1986, there were only 19 pairs of vireo song birds in the Prado Basin. Today, the number of male territories is more than 1,000 throughout the watershed and continues to grow as more fledglings are produced and reach maturity.

• OCWD contributed $1 million to help create the Santa Ana Watershed Association (SAWA) to lead the removal of a non-native plant, Arundo donax, that had overrun the watershed. Arundo is a major threat to the wildlife of the entire Santa Ana River watershed. Its removal effectively restores and enhances the environment. Since its inception, SAWA has raised more than $35 million and has removed 5,000 acres of Arundo.

THINK NATIVE IN SOUTHERN CALIFORNIA AND STOP GROWING ARUNDO!

WHY SOUTHERN CALIFORNIANS SHOULD STOP PLANTING AND START GETTING RID OF *ARUNDO DONAX*



Stand of *Arundo donax*

ARUNDO CAUSES HARM TO NATIVE WILDLIFE

Arundo is not native to southern California and has no natural enemies in this part of the world. Therefore, it readily invades habitat near rivers and streams, quickly overtaking large areas and effectively killing native species through competition. Since *Arundo* does not provide significant food or nesting habitat for native animals, it causes harm to threatened and endangered species such as the least Bell's vireo and the southwestern willow flycatcher.

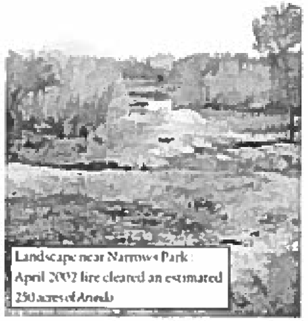
ARUNDO HOGS WATER

Arundo uses large amounts of water that would otherwise be available to native plants and surrounding areas. Drought-prone southern California cannot afford to support a plant that uses three times the water of native riparian species.

Why should we get rid *Arundo* in our yards?

ARUNDO CAN TAKE OVER YOUR YARD

Arundo can grow up to 2 - 4 inches per day. *Arundo* can overwhelm carefully landscaped vegetation in your yard, infesting an entire yard over time.



Landscape near Narrows Park: April 2002 fire cleared an estimated 250 acres of *Arundo*

ARUNDO INCREASES RISK OF FIRE

Arundo is highly combustible, increasing risk of fire frequency and intensity. Southern California suffers notoriously destructive wildfires. Homeowners with *Arundo* in their yard face a higher risk of property damage and threat to personal safety than those without it. Catastrophic fires fueled by the invasion of *Arundo* throughout the Santa Ana Watershed burden local and state fire departments. For example, one *Arundo*-fueled fire in April 2002 swept through over 250 acres of riverbed near Anza Narrows Park in Riverside County.

Is it illegal to buy and sell *Arundo*?

Not yet. *Arundo* is still sold commercially as a bank stabilizing and ornamental species throughout the United States. However, current regulatory measures are underway to classify *Arundo* as a "Noxious Weed" in the state of California. Depending upon the outcome of this classification, it could soon be illegal to sell *Arundo* in all or parts of the State. The California Exotic Pest Plant Council places *Arundo* on its "List A: Most Invasive Wildland Pest Plants" because of its invasive habits.

SOUTHERN CALIFORNIA CAN'T AFFORD TO KEEP GROWING ARUNDO!

Arundo donax costs southern Californians millions of dollars each year.

This invasive plant:

- *Is a fire hazard*
- *Hogs water*
- *Harms native wildlife*
- *Destroys bridges*
- *Clogs channels*
- *Causes flooding*
- *Is expensive to remove*

Who should we contact if we're interested in removing Arundo from our yards?

There are a number of current removal programs underway in the Watershed. If you have questions, please contact:

Where can I get more information about *Arundo*?

- Santa Ana Watershed Project Authority (SAWPA) www.sawpa.org/arundo
- The Nature Conservancy http://tncweeds.ucdavis.edu/esadocs/documnts/arundon.html
- United States Forest Service http://svinet2.fs.fed.us/database/feis/plants/graminoid/arudon/all.html
- Team Arundo del Norte http://ceres.ca.gov/tadn/

What could I plant instead of *Arundo*?

Plant Native!

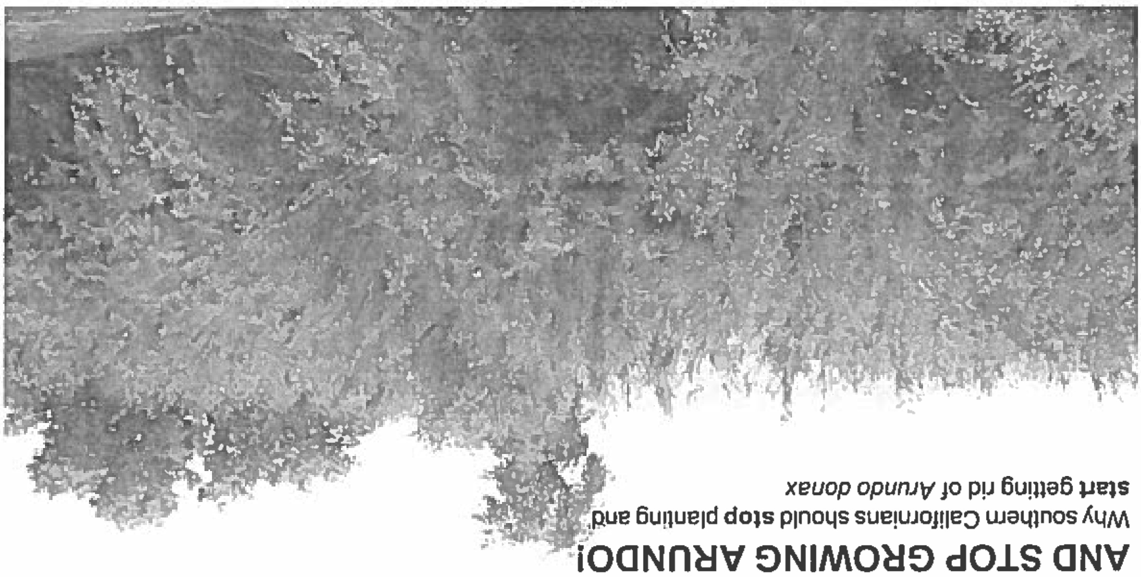
- Mulefat
- Cottonwood
- Willow
- Elderberry

Or contact the California Native Plant Society for more ideas. Ph.916.447.2677 (www.cnps.org)

Specific questions? Email Alison Shilling of the Riverside/San Bernardino NPS Chapter: awshilling@earthlink.net

Native option: *Salix lasiolepis* (bushy willow)

Prepared by EIP Associates, August 2002. www.eipassociates.com EIP



THINK NATIVE IN SOUTHERN CALIFORNIA AND STOP GROWING ARUNDO!

Why southern Californians should **stop** planting and **start** getting rid of *Arundo donax*

Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, California 92503

Arundo donax, also called giant cane, is a hardy aquatic plant that resembles bamboo. This plant, which can grow to heights of up to 20 feet, is not native to southern California—it's exotic and invasive.

What's wrong with *Arundo?*

ARUNDO COSTS TAXPAYERS A LOT OF MONEY

Within the Santa Ana Watershed (parts of Orange, Riverside, and San Bernardino Counties) alone, local agencies will spend over $20 million to remove *Arundo donax* during the next three years. In addition, Riverside County's River Road Bridge near Norco was damaged by *Arundo* twice within 3 years, causing almost $1 million in damage. Unlike native plants, which are adapted to survive southern California flooding events by bending rather than breaking, *Arundo donax* plants break when subjected to rising floodwaters. Arundo surges downstream, combining with trash and other debris to damage bridges, clog river channels, and re-direct river flows, thereby flooding neighboring areas. In addition, the plants wash up on local beaches, incurring high beach cleanup costs.

Prepared by EIP Associates, August 2002, www.eipassociates.com

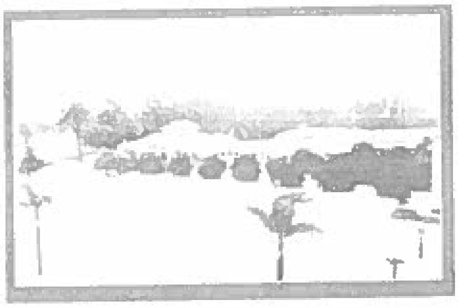
History of the Santa Ana River

People have lived along the Santa Ana River for approximately 9,000 years. Four distinct tribal groups lived within the watershed; however, it was the Tongva/Gabrielino and Yuharetum/Serrano people who inhabited the banks of the River. The Serrano were mountain people that lived as high as 9,000 feet in the San Bernardinos. The Tongva inhabited most of the Los Angeles Basin, including what we know today as

1938 flood >>

The first European contact with the watershed occurred in 1542 when Juan Rodriguez Cabrillo sailed past the River's mouth on his way to setting anchor on the Channel Islands off the coast of Ventura. Juan Gaspar de Portola was the first European to set foot in the watershed in 1769.

Portola's party named the River after the Santa Ana Mountains, which they had just named in honor of Saint Anne's Day. To this day, in many places along the Santa Ana River, signs along the River use the original spelling of "Santa Anna."



<< Santa Ana River Flooding

Father Serra, who traveled with Portola, established nine missions in California. While none were in the Santa Ana River Watershed, two missions claimed land within it. Mission San Gabriel, established in 1771, claimed much of the upper watershed, while lands of the lower watershed were under the control of the Mission San Juan Capistrano.

Santa Ana River as flood control channel

Each mission had outposts in their respective lands within the Santa Ana River Watershed, and forced the local tribes to leave their villages and traditional ways to live under Mission authority. The Spanish dominated the Santa Ana River Watershed for more than 50 years. By 1834 the missions had been stripped of their power and their lands. During the following period of Mexican rule, various ranches were deeded by Spain for Rancho Santiago de Santa Ana through a land grant to Juan Pablo Grijalva in 1811. Following the Bear Flag Revolt of 1846 and the end of the Mexican American War in 1848, the area became a free state. It was added to the United States in 1850 as part of the State of California.

Agriculture quickly spread and row crops replaced cattle grazing as the chief form of farming in the region, though several large cattle operations continued in the mountains and foothills of the area. The Santa Ana Watershed also played a role in the gold rush. Though it was never mined, it supported the 1860's mining boom with lumber and sustaining industries. By 1900, citrus was central in the lower watershed, so much so that the County's founding fathers chose the name "Orange County" to recognize this important industry.

Spurred by the success of the agricultural industry, the human population of the Santa Ana River Watershed continued to grow during the twentieth century. As settlement around the Santa Ana River increased, so did flood concerns. In 1938, a flash flood along the Santa Ana River resulted in 19 dead, 2,000 homeless, and 68,400 acres of flooded area. The magnitude of the event served as the impetus for the construction of the Prado Dam, thus paving the way for the post-World War II building boom which began the conversion from large agricultural operations to housing and commercial development projects.

In 1969, a significant flood along the Santa Ana River Watershed caused damage on tributaries including San Timoteo and Santiago Creeks. The U.S. Army Corps of Engineers declared the Santa Ana River to be the greatest flood threat west of the Mississippi River, thus spurring the creation of the Santa Ana River Mainstem Project, which installed the concrete lining in the river channel. In the 1970's, property values jumped, spurring heavy residential, commercial, and industrial development along the Santa Ana River, with little thought given to the River itself other than as a flood control channel. However, the creation and work of the Santa Ana River Task Force, will lead Santa Ana's efforts to preserve and enhance the River's recreational, environmental and economic development features to increase community pride and quality of life.

Historical Timeline of Santa Ana River

The Santa Ana River has gone through a series of transformational events. Identified here are some of the key dates in the history of the River.

1769 - The priests accompanying Captain Gaspar de Portola's party as it passes through Orange County names the Santa Ana River "Nombre Dulce de Jesus De Los Temblores" or "Sweet Name of Jesus of the Earthquakes." The name makes mention of the first recorded earthquake in Orange County. The military officers in the party subsequently change the name to Santa Anna in honor of Saint Anne, which they had recently celebrated.

1810 - First recorded flood of the Santa Ana River.

1825 - The Balboa peninsula is formed by a Santa Ana River flood.

1860 - The U.S. Coast Survey makes its first attempt to survey the Santa Ana River estuary.

1862 - The Santa Ana River floods after 30 days of rain.

1869 - William Spurgeon purchases 70 acres from the Yorba Family and establishes the city of Santa Ana. The Santa Ana River forms the western boundary of the new city.

1886 - The City of Santa Ana incorporates.

1896 - Southern California Power Company acquires the rights to the upper Santa Ana River and builds the power station known as Santa Ana No. 1.

1899 - The Santa Ana River line goes into service carrying power from Santa Ana No.1 to Los Angeles No.1. The line moves 33,000 volts a distance of 83 miles, making it the highest voltage, longest transmission line in the country.

1903 - James T. Talbert forms a drainage district that oversees the first man-made channeling of the wandering Santa Ana River.

1906 - Hiram Kellogg is appointed Engineer of Newport Protection District, making him responsible for flood control of the Santa Ana River, from Santa Ana to the Pacific Ocean. His family home is later donated and moved next to Centennial Park to house the Centennial Heritage Museum programs.

1915 - The first known mentions of the Santa Ana River Trail in historical documents and maps are made.

1916 - Two storms within one month overwhelm Orange County with floods. The Santa Ana River and Santiago Creek overflow their banks, causing damage and washing out bridges.

1920 - The Santa Ana River is re-channeled by the building of the Bitter Point Dam in Newport Beach. The River bypasses Newport Bay with a direct outlet to the sea.

1933 - The Orange County Water District is formed to protect the County's water rights to the Santa Ana River. Later the District's mission is expanded to manage the underground aquifer, making optimum use of local supplies and augmenting those with imported supplies provided through the County's Metropolitan Water District member agencies.

1938 - A flash flood along the Santa Ana River results in 19 dead, 2,000 homeless, and 68,400 acres of flooded area.

1941 - The Prado Dam is constructed near the City of Corona.

1955 - Orange County adopts its first water pollution ordinance.

1964 - The Santa Ana River Mainstem Project is initiated. The Mainstem Project proposes flood control improvements along the Santa Ana River from the headwaters to the Pacific Ocean, covering some 75 miles.

1969 - A significant flood along the Santa Ana River Watershed caused damage on tributaries including San Timoteo and Santiago Creeks.

1975 - Orange County Flood Control District prepares the Santa Ana Survey Report on Santa Ana River flood hazards and proposed flood protection improvements.

1978 - The Santa Ana River Survey Report is submitted to Congress for consideration of funding.

1980 - The Army Corps of Engineers completes the Phase I General Design Memorandum for the Santa Ana River Mainstem Project.

1986 - Construction of the Santa Ana River is authorized by Congress by Section 401a of the Water Resources Development Act.

1989 - Construction of the Santa Ana River Mainstem Project begins.

1992 - The Santa Ana Watershed Project Authority is formed as a joint powers agency of five major water districts to focus ways to reduce salinization and promote water conservation.

1993 - Phase 1 of the Lower Santa Ana River Main Stem Project is completed, consisting of 3.2 miles of reinforced channel.

1999 - Construction of the Seven Oaks Dam is completed a few miles north of the City of Redlands.

2004 - On November 15, City Council approves the formation of the Santa Ana River Task Force.

2005 - On May 2, City Council approves the members to the Santa Ana River Task Force; the first meeting is convened on October 11.

2005 - Southern California experiences one of the wettest periods in recent history, placing unusual stress on the Santa Ana River system. Prado Dam, which is under construction for expansion, begins to crack, and residents of the local communities of Corona and Yorba Linda are evacuated as a precaution. The dam is damaged, but no major flooding results, and evacuees are allowed to return.

2006 - The Santa Ana River Vision Plan is finalized.

Name ______________________

Video Guide: Wolves in Yellowstone

	True	False
1. Wolves had disappeared from Yellowstone National Park and were brought back to the area by park rangers.		
2. Local cattle ranchers are concerned about wolves killing their cows.		
3. Wolves in Yellowstone stay inside of the park's boundaries.		
4. Some people moving into the area are building more houses and reducing open space.		
5. Wolves may eat cows, sheep, elk, and bison.		
6. The Yellowstone environment includes mountains, lakes, and grasslands.		

KWL "People + Animals Interacting"

Name ______________________________

Yellowstone Food Web Information

Animal	Diet
Beaver	Bark from trees such as willow, aspen, birch and maple; also plants such as pondweed and cattails
Bison	Low-growing grasses
Cowbird	Seeds, fruits, and insects, including ticks
Coyote	Small and large mammals, usually plant-eaters
Elk	All kinds of plants
Gray wolf	Large and small animals
Grizzly bear	Seeds, berries, grasses, fish, large mammals such as bison and elk
Snowshoe hare	Grasses and twigs from trees such as willow, aspen, and maple
Winter tick	Blood from large plant-eaters

Name ______________________

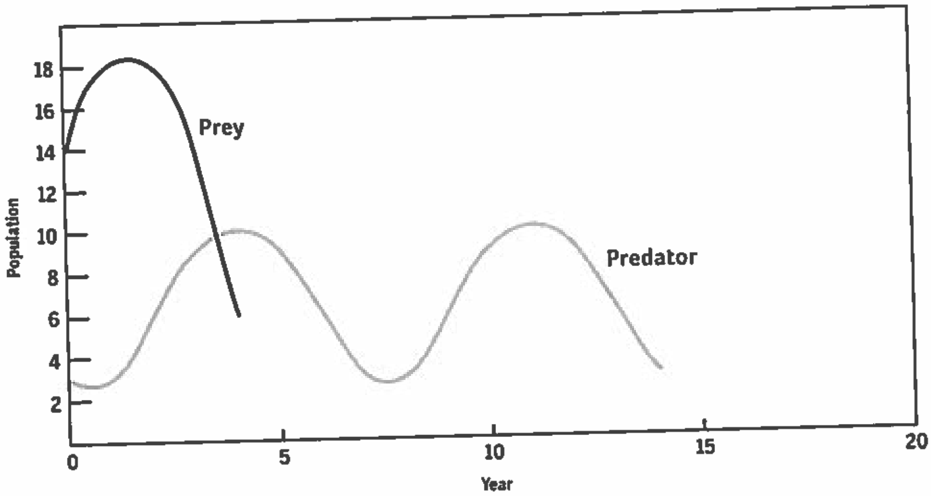
Types of Interactions

Pattern of Interaction		My Group's Definition	Video Example	Revised Definition	Additional Examples
Predator–prey					
Competition					
Symbiosis	Commensalism				
	Mutualism				
	Parasitism				

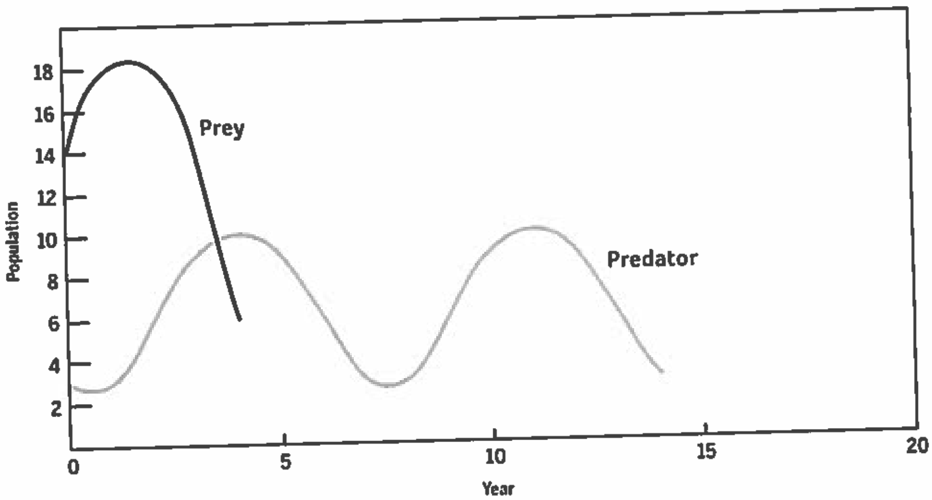
Name ______________________________

Predicting Predator-Prey Interactions

Prediction: Predator and Prey Populations Over Time



Ecological Model: Predator and Prey Populations Over Time



Compare your prediction to the ecological model of predator-prey interactions. If your ideas changed, explain how they changed. If your ideas stayed the same, explain what you understand about predator-prey relationships.

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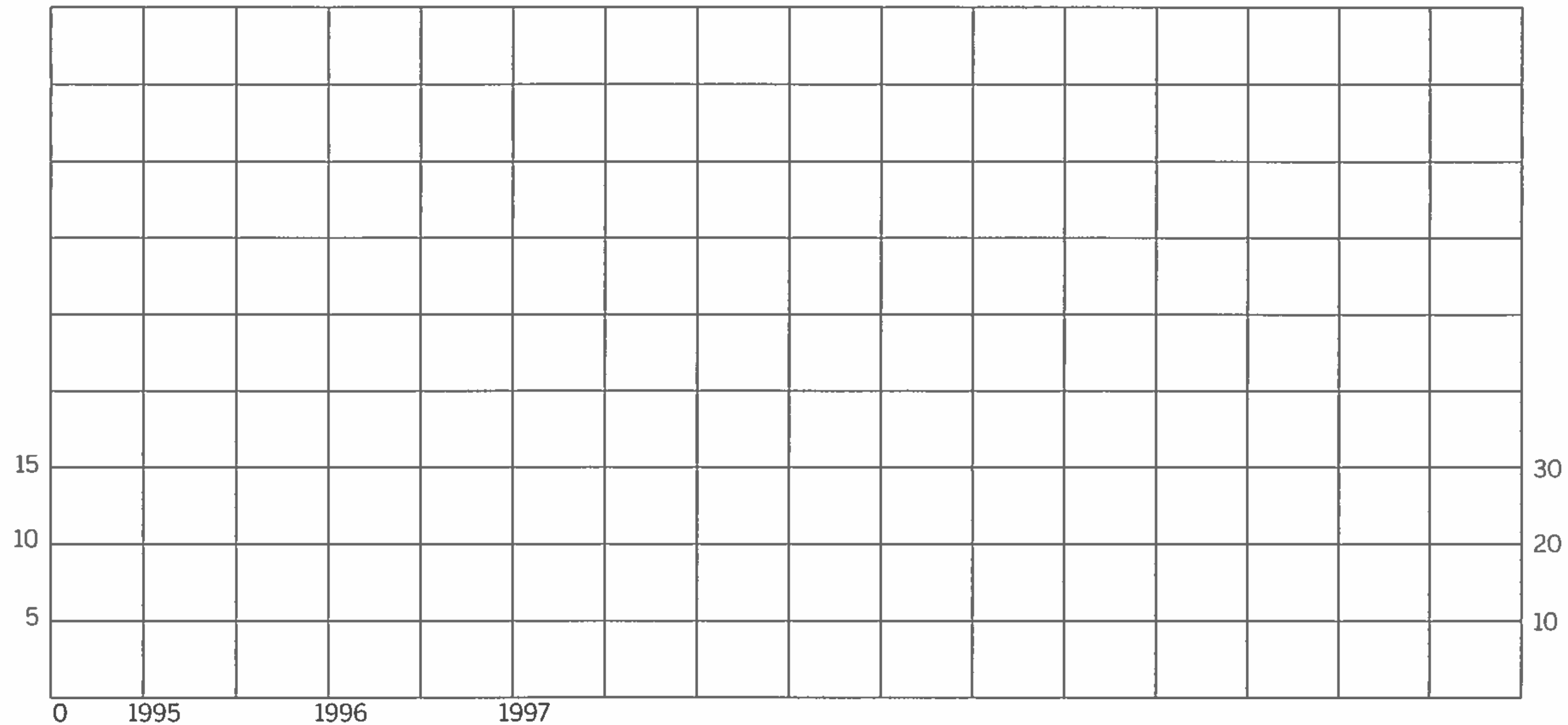
Name ____________________

Graphing Rainfall and Fawn Survival Data

Title: ____________________



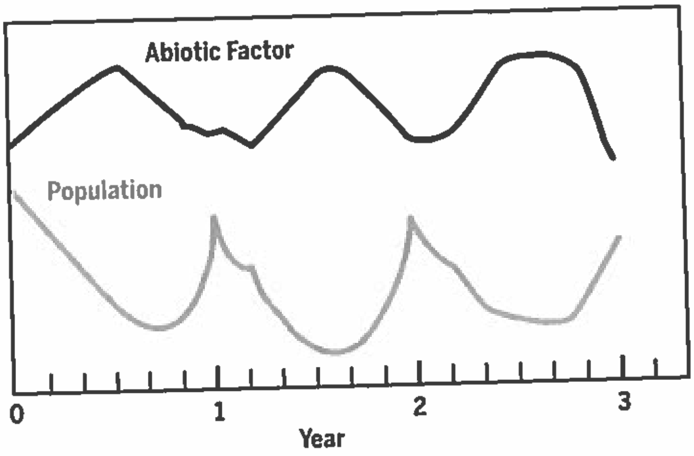
KEY
Rainfall (cm):

Fawn survival rate(fawns per 100 females):

Name ________________________________

Patterns of Interaction

Graph A



Scenario: ________________________________

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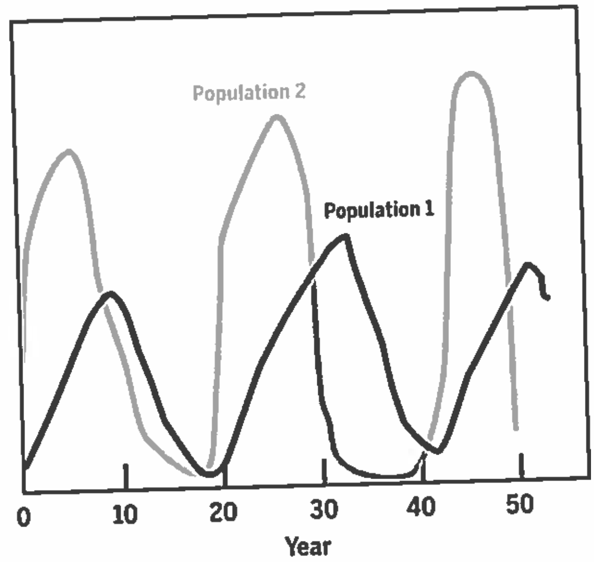
Graph B



Scenario: ________________________________

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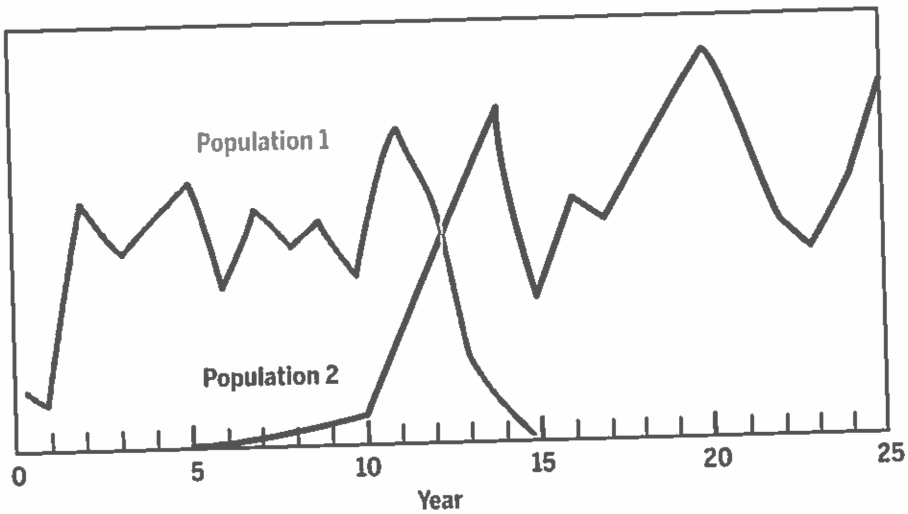
Graph C



Scenario: ________________________________

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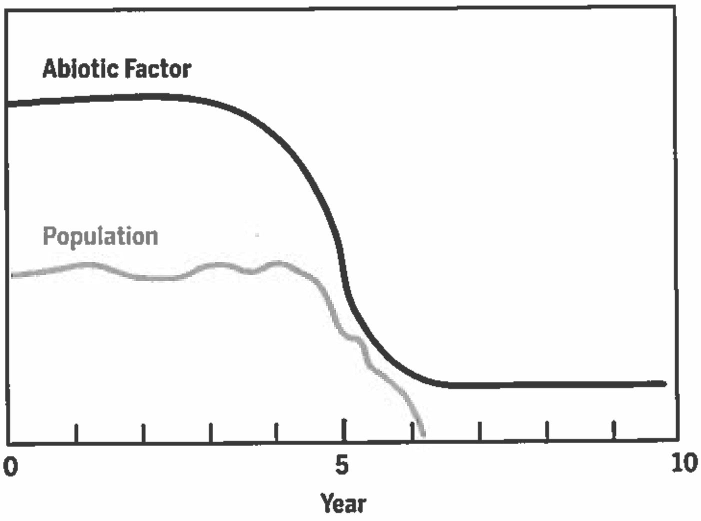
Patterns of Interactions
Continued

Name ______________________________

Graph D



Scenario: ______________________________

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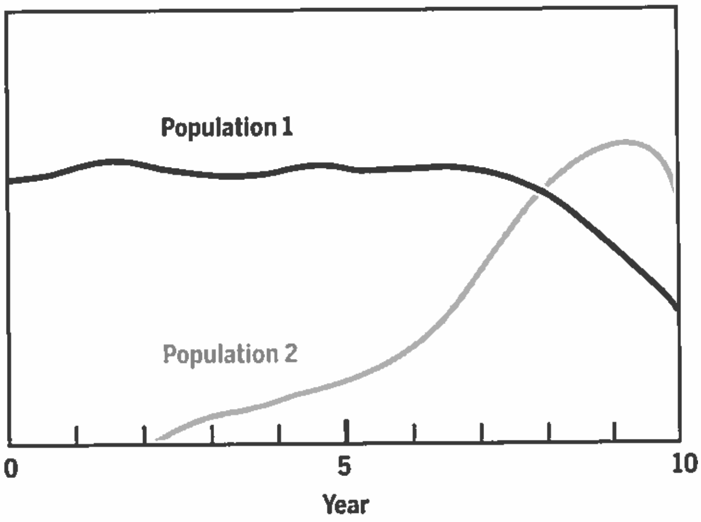
Graph E



Scenario: ______________________________

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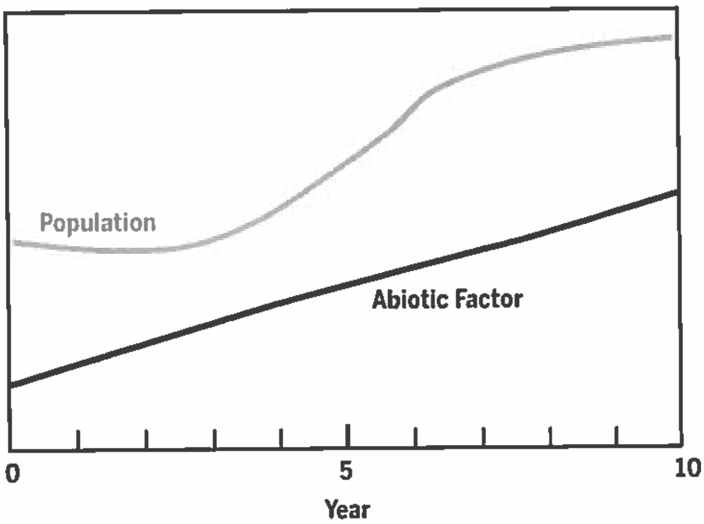
Graph F



Scenario: ______________________________

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Name ______________________________

Explanation Tool

Question What is the scientific question you are investigating?

Evidence What are the science observations or data that address your question?	**Science Concepts** What science concepts are connected to the evidence and might help answer the question?

Scientific Reasoning How do the science concepts connect to the evidence and to the question you are trying to answer?

Claim What claim can you make based on the evidence and reasoning?

Explanation Tool
Continued

Name ______________________

Construct a Scientific Explanation

Using the information in the boxes you have completed, write a scientific explanation that includes:

- The scientific question
- Your claim
- Relevant evidence that supports your claim
- Science concepts that are connected to the evidence
- Scientific reasoning that links the evidence and science concepts to the claim

Scientific Explanation

Name ____________________

DART: Reading Support for Activity 1.6

1. As you read, determine if the following statements are true or false. If the statement is false, correct it so that it becomes true.

	True	False
a. Today, there are large populations of deer in the northeastern U.S. because they have few predators.		
b. Bears killed almost 6.5 million deer in 2013.		
c. Depending on what they eat, deer can help plants grow up to 3 kilometers from their original site.		
d. Large populations of deer in a small area result in a healthy forest with lots of plants.		
e. Each year, deer cost people a lot of money because they are kept as pets.		
f. People have proposed controlling the deer populations by letting them die of starvation.		

2. Look for an example of each of the following patterns of interaction in the reading. If there is no appropriate example, write "none."

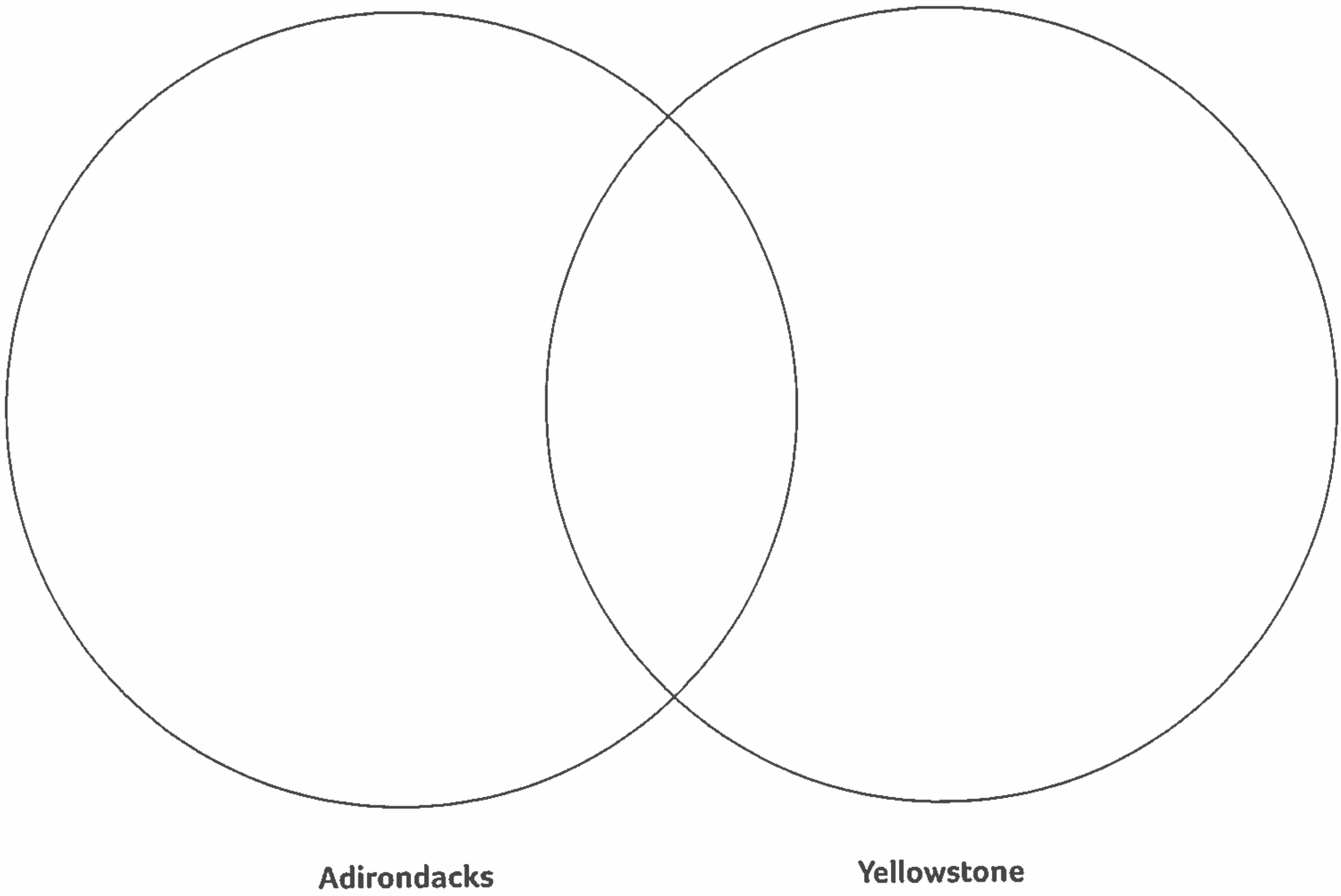
Pattern of Interaction		Example
Predator-prey		
Competition		
Symbiosis	mutualism	
	commensalism	
	parasatism	

DART: Reading Support for Activity 1.6

Continued

Name ______________________

3. Fill in the Venn diagram shown below by identifying common organisms found in each ecosystem. Be sure to include plants as well as animals.



Name ______________________

Chapter 1 Assessment Student Checklist

1a. ☐ Describes 6 relationships

1b. ☐ An X is in one of the boxes

☐ There is an explanation next to one of the incorrect graphs

☐ There is an explanation next to the other incorrect graph

1c. ☐ Claim

☐ Evidence (numbers or trends from graph)

☐ Science Concept

☐ Reasoning

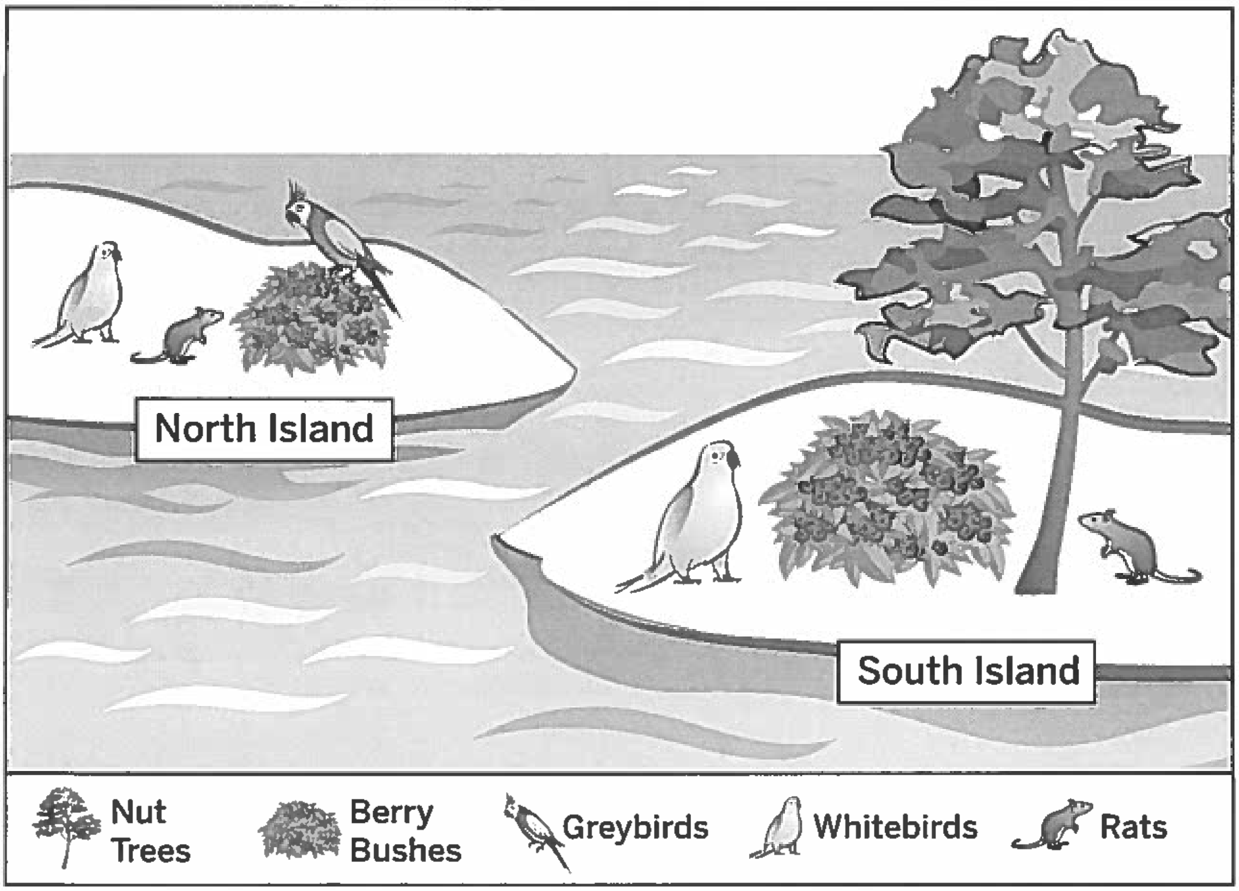
Name ______________________

Chapter 1 Assessment

1. Graybirds and whitebirds live on North Island. Both types of birds eat the berries of the berry bush. The seeds of the berry bush grow best after the berries are eaten by birds and dropped elsewhere around the island.

   Whitebirds are also found on nearby South Island. The whitebirds on South Island eat berries and the nuts of the nut tree.

   Rats are found on both islands. The rats eat berries and bird eggs.



Chapter 1 Assessment
Continued

Name ______________________________

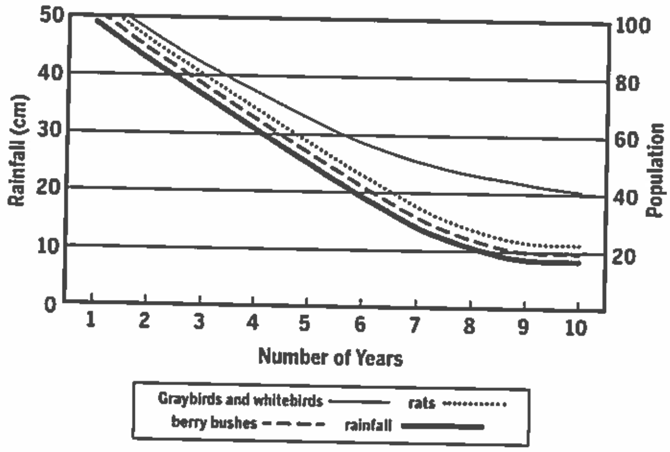
1a. Identify examples of competition, predator-prey, and mutualism between species on each island.

North Island	South Island
Example of competition: Why is this an example of competition?	Example of competition: Why is this an example of competition?
Example of predator-prey: Why is this an example of predator-prey?	Example of predator-prey: Why is this an example of predator-prey?
Example of mutualism: Why is this an example of mutualism?	Example of mutualism: Why is this an example of mutualism?

Chapter 1 Assessment
Continued

Name ______________________________

1b. Berry bushes need lots of rainfall. Make an X in the box next to the graph below that best predicts what would happen to the populations on the **North Island** during a 10-year period of decreasing rain. Using the space to the right of the other two graphs, explain why these graphs are not the best predictions of what would happen during the period of decreasing rain. You do not need to write anything next to the graph you chose as the best prediction.



A. ☐

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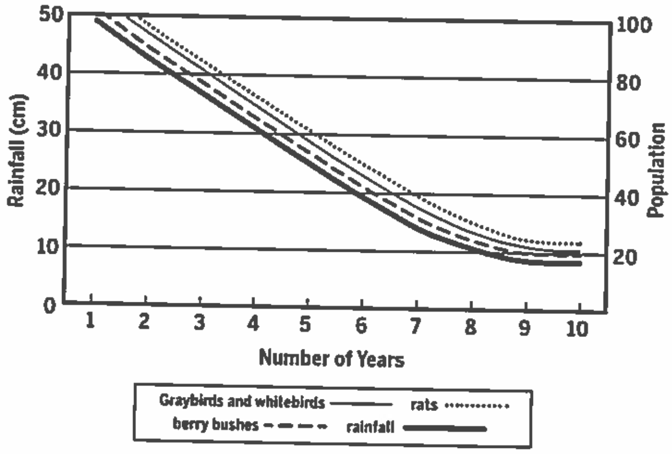

B. ☐

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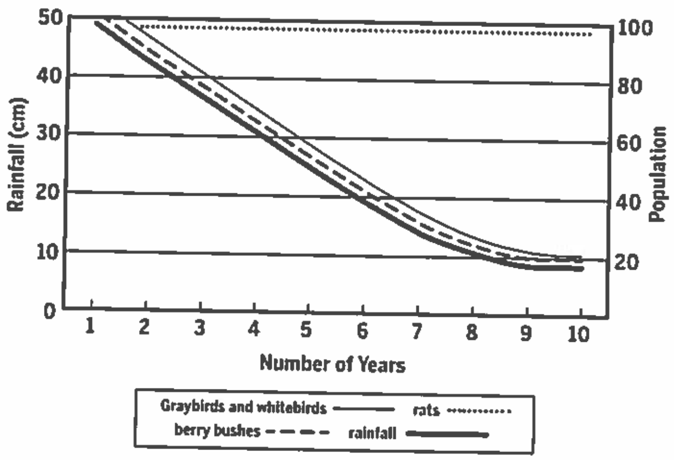

C. ☐

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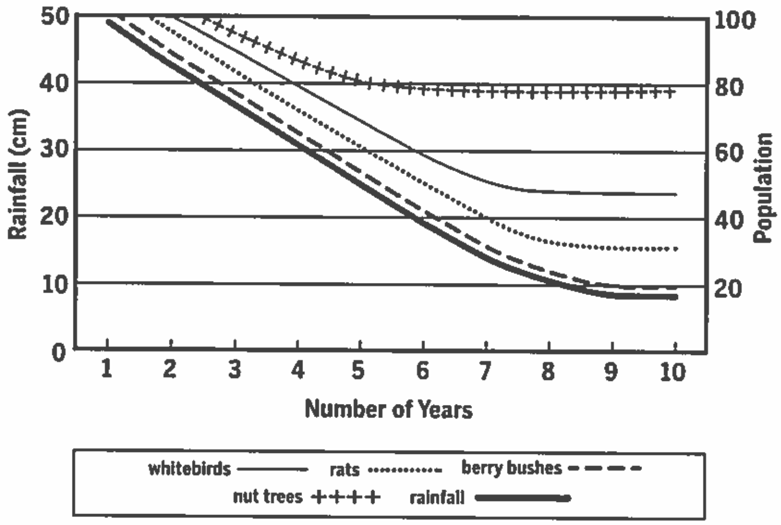
Chapter 1 Assessment

Continued

Name ____________________

1c. The graph below shows how the populations on the South Island changed during the same 10-year period of decreasing rain. Nut trees do not need a lot of rain. Construct a complete scientific explanation that answers the question, "Why did the population of whitebirds decrease to about half of what it was before?"



Your explanation should include the following:

- The scientific question
- Your claim
- The relevant evidence that supports your claim
- The science concepts that support the evidence
- Your scientific reasoning that links the evidence and science concepts to the claim

Name ________________________________

Anticipation Guide: Matter and Energy in Ecosystems

Before	After	Statement
_____	_____	1. A tree gets most of the matter (or "stuff") it needs to grow from the soil.
_____	_____	2. All living things have sugars and other matter made of carbon in their bodies. The carbon moves back and forth from living to nonliving things. For example, the carbon that makes up a tree can end up in the air, a plant, or even in a 6th grader.
_____	_____	3. All the plants and animals in an ecosystem depend on decomposers like bacteria and fungi to break down dead plants and animals and their wastes.
_____	_____	4. Matter and energy both **cycle**—move continuously back and forth—between biotic (living) and abiotic (non-living) parts of the ecosystem.
_____	_____	5. Light from the Sun is one of many energy sources for plants. Other energy sources include soil, water, and air.
_____	_____	6. Both plants and animals get the energy they need by breaking down food.
_____	_____	7. Energy flows in one direction within a food chain, from plants to animals and decomposers.
_____	_____	8. In a food chain, most of the energy stored in organisms is transfered to the non-living environment.

Name ______________________________

Explanation Tool

Question What is the scientific question you are investigating?

Evidence What are the science observations or data that address your question?	**Science Concepts** What science concepts are connected to the evidence and might help answer the question?

Scientific Reasoning How do the science concepts connect to the evidence and to the question you are trying to answer?

Claim What claim can you make based on the evidence and reasoning?

Explanation Tool
Continued

Name ______________________________

Construct a Scientific Explanation

Using the information in the boxes you have completed, write a scientific explanation that includes:

- The scientific question
- Your claim
- Relevant evidence that supports your claim
- Science concepts that are connected to the evidence
- Scientific reasoning that links the evidence and science concepts to the claim

Scientific Explanation

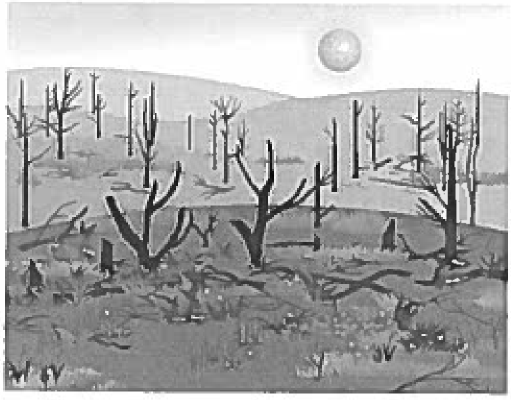
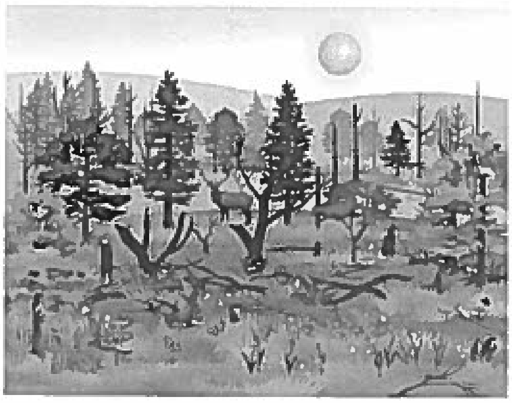
Name ______________________

Changes Due to Fire in a Forest Ecosystem

Forest Change	Caption
	Description: Matter: Energy:
	Description: Matter: Energy:
	Description: Matter: Energy:

Changes Due to Fire in a Forest Ecosystem
Continued

Name ______________________________

Forest Change	Caption
	Description: Matter: Energy:
	Description: Matter: Energy:
	Description: Matter: Energy:

Name ______________________________

Energy Units

Name ______________________

Explanation Tool

Question

What is the scientific question you are investigating?

Evidence What are the science observations or data that address your question?	Science Concepts What science concepts are connected to the evidence and might help answer the question?

Scientific Reasoning

How do the science concepts connect to the evidence and to the question you are trying to answer?

Claim

What claim can you make based on the evidence and reasoning?

Explanation Tool
Continued

Name ____________________

Construct a Scientific Explanation

Using the information in the boxes you have completed, write a scientific explanation that includes:

- The scientific question
- Your claim
- Relevant evidence that supports your claim
- Science concepts that are connected to the evidence
- Scientific reasoning that links the evidence and science concepts to the claim

Scientific Explanation

Name ______________________

Chapter 2 Assessment Student Checklist

1. ☐ Model includes all of the living organisms from the table
   ☐ Model has producers, consumers, and decomposers labeled
   ☐ Model shows the transfer of matter between organisms with arrows that are correct
   ☐ Answer explains whether matter is conserved

2. ☐ Model shows transfer of energy between organisms
   ☐ Model shows transfer of energy between organisms and nonliving environment.
   ☐ Model includes a legend

3. ☐ Model includes water
   ☐ Model includes CO_2 (in air)

4. ☐ Claim
   ☐ Evidence (cite specific relationships in the ecosystem model)
   ☐ Science Concept(s)
   ☐ Reasoning

Name ___________________________

Chapter 2 Assessment

1. Using the information in the table below, draw a model of the entire ecosystem. Use an energy pyramid as the basis for your drawing. Read all of the questions below before you plan and draw your model.

Organism	What It Eats
Molds/Bacteria/Fungi	Dead and decaying organisms
Grasshoppers	Grass
Rabbits	Grass and wheat
Garter snakes	Grasshoppers
Eagles	Garter snakes and rabbits
Grass and wheat	Plants don't eat. They make their own food.

On your model:

a. Label the producers, consumers, and decomposers in your model.

b. Use one color to draw arrows on your model showing the transfer of **matter** between organisms.

c. Is matter conserved within this ecosystem model? Use your model to show your answer. You may do this by writing a caption or labeling arrows.

2. On your model:

a. Use arrows of a different color to show how **energy** transfers between living and nonliving components of the ecosystem.

b. Create a legend to show what colors you used for energy and matter.

3. Using your model, show how the following nonliving components interact with the living components in the ecosystem. You may add them to your labeled drawing or include captions for your answers.

a. Sunlight

b. Carbon dioxide (in air)

Name ______________________________

Chapter 2 Assessment

4. Suppose there were a large volcanic eruption and a thick cloud of ash blocked most sunlight from reaching the ecosystem for several months. Use the model you made in the first three questions to construct an explanation for what would happen in the ecosystem.

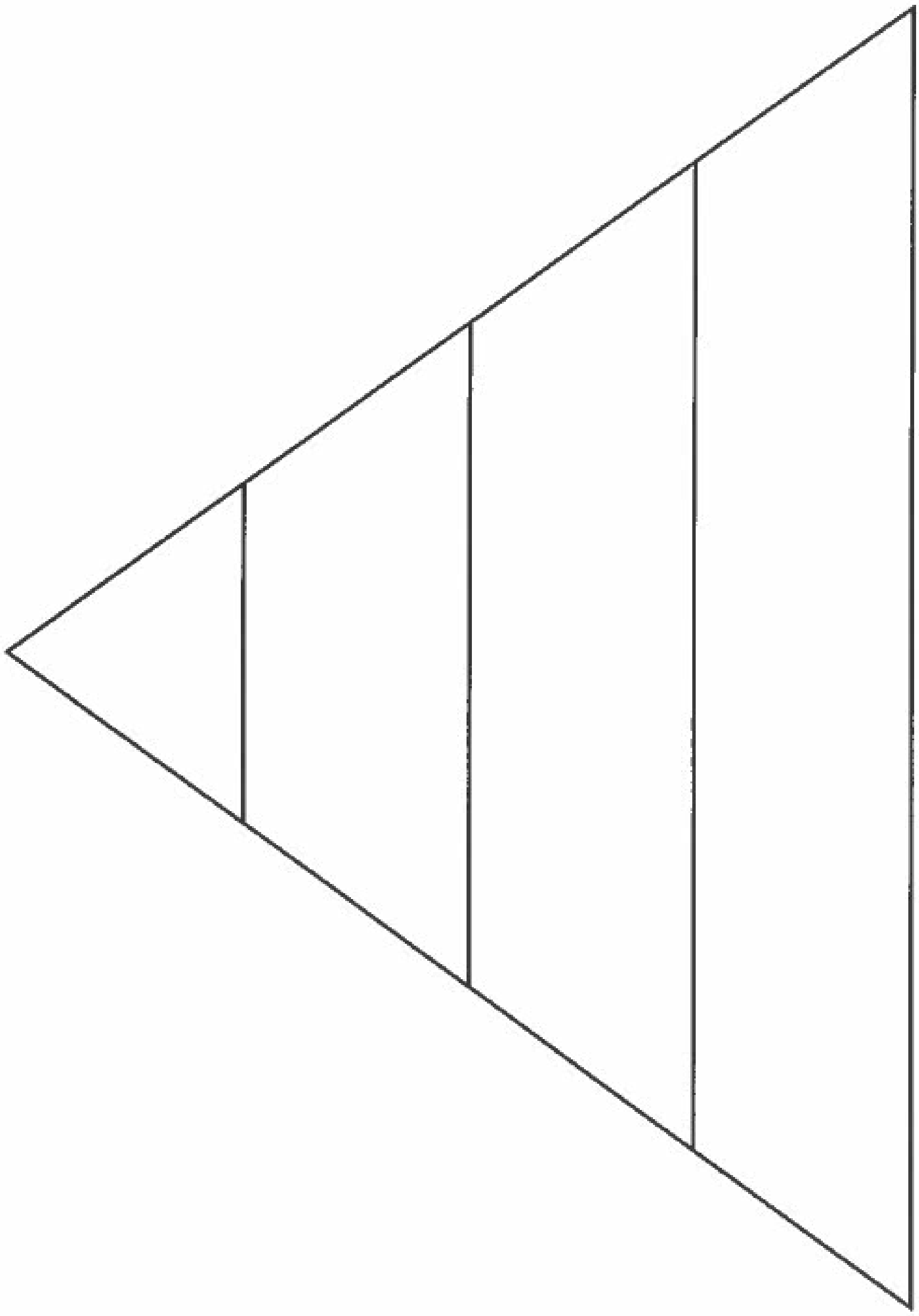
Construct a complete scientific explanation that answers the question, "How would an ash cloud from a volcano affect organisms and the transfer of matter and energy in the ecosystem?"

Your explanation should include the following:

- The scientific question
- Your claim
- The relevant evidence that supports your claim (use evidence from your model)
- The science concepts that support the evidence
- Your scientific reasoning that links the evidence and science concepts to the claim

Chapter 2 Assessment
Continued

Name ______________________



Name ____________________

Populations Over Time

Game A: What's your fishing limit? ____________________

Round #	Starting # of Fish in Blue Bay		# of Fish You Caught		$ You Earned ($1 per extra orange fish caught, $2 per yellow fish)
	Orange	Yellow	Orange	Yellow	
1					$
2					$
3					$
4					$
Total					$

End Result (what's going on in Blue Bay):

____

____

Populations Over Time
Continued

Name ______________________

Game B: What's your fishing limit? ______________________

Round #	Starting # of Fish in Blue Bay		# of Fish You Caught		$ You Earned ($1 per extra orange fish caught, $2 per yellow fish)
	Orange	Yellow	Orange	Yellow	
1					$
2					$
3					$
4					$
Total					$

End Result (what's going on in Blue Bay):

____

____

Populations Over Time
Continued

Name ____________________

Game C: What's your fishing limit? ____________________

Round #	Starting # of Fish in Blue Bay		# of Fish You Caught		$ You Earned ($1 per extra orange fish caught, $2 per yellow fish)	Ecosystem Conditions
	Orange	Yellow	Orange	Yellow		
1					$	
2					$	
3					$	
4					$	
Total					$	

End Result (what's going on in Blue Bay):

____

____

Name ____________________

Argument Tool

Question
What is the question that you are investigating?

Claim A	Claim B
What is a claim you could argue?	What is a claim you could argue?
The evidence that supports this claim is . . .	**The evidence that supports this claim is . . .**

Scientific Reasoning: Evaluating the Evidence and Claim

Critique the quality and strength of the evidence that supports this claim.	Critique the quality and strength of the evidence that supports this claim.

Argument Tool
Continued

Name ___________________________

Constructing a Scientific Argument

Decide which claim you think is best supported by the evidence and scientific reasoning. Using the criteria below and the information in the boxes you have completed, write a scientific argument that includes:

- The scientific question
- Your claim (that is best supported by evidence and reasoning)
- Relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

Scientific Argument

Critique of the Rebuttal

Other people might claim _______________. I think the problem with this argument is _____________.

Name ______________________

Explanation Tool

Question
What is the scientific question you are investigating?

Evidence	Science Concepts
What are the science observations or data that address your question?	What science concepts are connected to the evidence and might help answer the question?

Scientific Reasoning
How do the science concepts connect to the evidence and to the question you are trying to answer?

Claim
What claim can you make based on the evidence and reasoning?

Explanation Tool
Continued

Name ______________________________

Construct a Scientific Explanation

Using the information in the boxes you have completed, write a scientific explanation that includes:

- The scientific question
- Your claim
- Relevant evidence that supports your claim
- Science concepts that are connected to the evidence
- Scientific reasoning that links the evidence and science concepts to the claim

Scientific Explanation

Name ______________________

Argument Tool

Question
What is the question that you are investigating?

Claim A	Claim B
What is a claim you could argue?	What is a claim you could argue?
The evidence that supports this claim is . . .	**The evidence that supports this claim is . . .**

Scientific Reasoning: Evaluating the Evidence and Claim

Critique the quality and strength of the evidence that supports this claim.	Critique the quality and strength of the evidence that supports this claim.

Argument Tool
Continued

Name ______________________________

Constructing a Scientific Argument

Decide which claim you think is best supported by the evidence and scientific reasoning. Using the criteria below and the information in the boxes you have completed, write a scientific argument that includes:

- The scientific question
- Your claim (that is best supported by evidence and reasoning)
- Relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

Scientific Argument

Critique of the Rebuttal

Other people might claim ______________. I think the problem with this argument is ______________.

Name ______________________________

Chapter 3 Assessment Student Checklist

1a. ☐ I have included **data from the table** that shows what happens to the deer population after Year 4

1b. ☐ I have included **data from the table** that shows what happens to the deer population after Year 11

2a. ☐ Claim

☐ Evidence (numbers or trends from graphs or tables)

☐ Reasoning

2b. ☐ I have written a claim that is different than my initial claim

2c. ☐ I have pointed out a problem with the hypothetical classmate's claim or argument

Name ______________________________

Chapter 3 Assessment

1. The table below shows the population of deer in a grassland ecosystem over a period of fifteen years. Use the information below and the table to help you answer the questions that follow.

- At the end of Year 4, 80% of the grassland is converted to farmland and fenced to keep the deer out.
- People do not hunt the deer.
- In Year 11, there is a very harsh winter and the deer have very little access to food.

Year	Deer Population	Average Mass (kg)	Number of deer births	% malnourished (severely underweight) deer
1	100	30	30	5
2	110	31	25	3
3	97	29	30	4
4	105	31	15	3
5	83	29	5	46
6	57	27	7	32
7	56	23	6	25
8	58	20	8	18
9	55	19	7	15
10	58	20	5	10
11	35	15	3	72
12	40	18	4	43
13	45	20	7	26
14	48	21	7	10
15	53	21	8	7

Chapter 3 Assessment
Continued

Name ______________________________

1a. Use the data to describe the effect of the grassland being converted to farmland in Year 4 on the deer population.

____

____

____

____

1b. Use the data to describe the effect of the harsh winter in Year 11 on the deer population.

____

____

____

____

2a. Construct a scientific argument that argues the question:
"Should the farmland be converted back to grassland?"

Your argument should include the following:

- The scientific question
- Your claim (which is best supported by evidence and reasoning)
- The relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

____

____

____

____

____

____

____

____

____

Chapter 3 Assessment
Continued

Name ______________________

2b. Imagine that you have a classmate who disagrees with your claim. What claim might your classmate make?

2c. What is the problem with your classmate's claim or the argument based on that claim?

KWL: Gulf of Mexico, Great Lakes, Hudson River

K	W	L

Name ______________________________

Argument Tool

Question
What is the question that you are investigating?

Claim A What is a claim you could argue?	Claim B What is a claim you could argue?
The evidence that supports this claim is . . .	**The evidence that supports this claim is . . .**

Scientific Reasoning: Evaluating the Evidence and Claim

Critique the quality and strength of the evidence that supports this claim.	Critique the quality and strength of the evidence that supports this claim.

Argument Tool
Continued

Name ______________________________

Constructing a Scientific Argument

Decide which claim you think is best supported by the evidence and scientific reasoning. Using the criteria below and the information in the boxes you have completed, write a scientific argument that includes:

- The scientific question
- Your claim (that is best supported by evidence and reasoning)
- Relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

Scientific Argument

Critique of the Rebuttal

Other people might claim ______________ . I think the problem with this argument is ______________.

Name ______________________

Argument Tool

Question
What is the question that you are investigating?

Claim A	Claim B
What is a claim you could argue?	What is a claim you could argue?
The evidence that supports this claim is . . .	**The evidence that supports this claim is . . .**

Scientific Reasoning: Evaluating the Evidence and Claim

Critique the quality and strength of the evidence that supports this claim.	Critique the quality and strength of the evidence that supports this claim.

Argument Tool

Continued

Name ______________________

Constructing a Scientific Argument

Decide which claim you think is best supported by the evidence and scientific reasoning. Using the criteria below and the information in the boxes you have completed, write a scientific argument that includes:

- The scientific question
- Your claim (that is best supported by evidence and reasoning)
- Relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

Scientific Argument

Critique of the Rebuttal

Other people might claim ____________. I think the problem with this argument is ____________.

Name ____________________

Chapter 4 Assessment Student Checklist

1. ☐ I have described changes to site 1
   ☐ I have described changes to site 2
   ☐ I have described changes to site 3

2. ☐ Claim
   ☐ Evidence (numbers or trends from graphs or tables)
   ☐ Reasoning

2b. ☐ I have written a claim that is different than my initial claim

2c. ☐ I have pointed out a problem with the hypothetical classmate's claim or argument

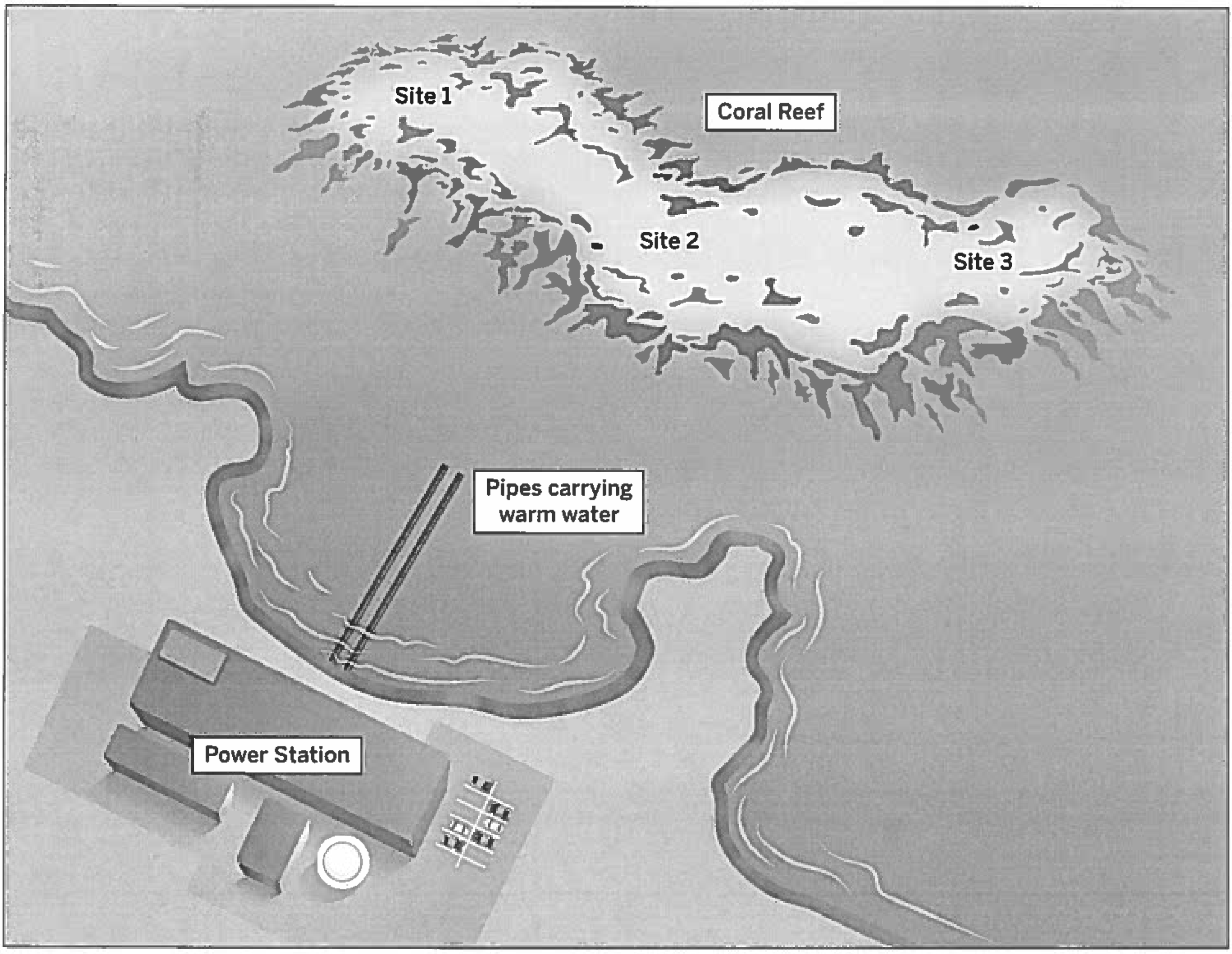
Name ______________________

Chapter 4 Assessment

1. There is a large coral reef off the coast of an island. Many organisms find food and live in and around the coral reef. The local energy company has built a new power station to meet the energy needs of the growing island population. The power station produces warm water that must be released. Pipes have been built to release warm, clean water into the ocean and 1 kilometer from the edge of the reef.

Algae are an invasive species that can be found near the reef. They use sunlight to make food. When large amounts of algae grow together they can form algal mats. These mats can float on the surface of the water. The mats can block sunlight from reaching the coral reef. Like the algae, coral needs sunlight to grow.

The data tables on pages 2 and 3 show data about water temperature and reef populations in the years following the construction of the power station.



Chapter 4 Assessment
Continued

Name ____________________

Data from Site 1

Year	Water Temperature (°C)	Size of Coral Reef (square meters)	Size of Algal Mats (square meters)	Total Number of Species living at Site 1 (not including algae)	Estimated Number of Organisms living at Site 1 (not including algae)
1	28	98	0	21	1,200
2	28	97	0	21	1,200
3	31	81	10	19	1,100
4	32	75	15	18	1,000
5	32	71	17	18	900

Data from Site 2

Year	Water Temperature (°C)	Size of Coral Reef (square meters)	Size of Algal Mats (square meters)	Total Number of Species living at Site 2 (not including algae)	Estimated Number of Organisms living at Site 2 (not including algae)
1	28	100	0	20	1,300
2	28	101	0	20	1,300
3	31	83	10	19	1,200
4	31	78	15	18	1,100
5	32	71	20	17	1,000

Chapter 4 Assessment
Continued

Name ______________________

Data from Site 3

Year	Water Temperature (°C)	Size of Coral Reef (square meters)	Size of Algal Mats (square meters)	Total Number of Species living at Site 3 (not including algae)	Estimated Number of Organisms living at Site 3 (not including algae)
1	28	99	0	22	1,250
2	28	99	0	22	1,300
3	29	98	0	22	1,250
4	28	98	0	22	1,300
5	29	98	0	22	1,250

1. Describe the changes that occurred at the three coral reef sites.

	Describe the changes (if any)
Site 1	
Site 2	
Site 3	

Chapter 4 Assessment
Continued

Name ______________________________

2a. Construct a scientific argument that answers the question:
"Did the power station cause large changes in the populations of organisms living on the coral reef?"

Your argument should include the following:

- The scientific question
- Your claim (which is best supported by evidence and reasoning)
- The relevant evidence that supports your claim
- Scientific reasoning that critiques the evidence and evaluates your claim

Chapter 4 Assessment
Continued

Name ______________________________

2b. Imagine that you have a classmate who disagrees with your claim. What claim might your classmate make?

2c. What is the problem with your classmate's claim or the argument based on that claim?

Name ________________________________

Control Methods

A) Chemical control

A pesticide would be sprayed on the plants and the soil. The pesticide is very effective at killing any beetles that it touches. It is also poisonous to many other insects and some small animals. The effectiveness of the pesticide decreases rapidly over time. The insecticide would have to be reapplied frequently over a two-month period.

Advantages	Disadvantages

B) Relocate the farm

Holly, her parents, and her two younger brothers would move to a new location several hundred miles away. This would involve selling the farm and leaving her school and friends behind. It is uncertain if the farm could be sold for enough money to buy another farm in the new location. If not, then Holly's parents would have to find different jobs.

Advantages	Disadvantages

Control Methods
Continued

Name ________________

C) Biological control

Toads will be used to control the beetles. The toads eat many types of small organisms, such as frogs, lizards, snakes, mice, snails, and insects. They have been used successfully to control insect pests in several other countries. The toads are not native to the area. Thirty toads will be brought to the farm and released in the fields.

Advantages	Disadvantages

D) Physical removal

All of the fields would be burned. This would kill all of the crops but would also kill the insects, including the grubs that live in the soil. The fields would be left bare for one year. Workers would be hired to monitor the fields and trap and remove any of the beetles that were found there. After one year, the crops would be replanted. Workers would continue to monitor the fields for the beetles until the crops could be harvested later in the year.

Advantages	Disadvantages

Name ______________________

Score Sheet

Area managed (circle one): Lake River Forest Gulf

Round	Turn	Event	Environmental points	Economic points	Social points	Total points
Start	0		10	10	10	30
Round 1	1					
	2					
	3					
	4					
Carry the score on to the next round						
Round 2	1					
	2					
	3					
	4					
Carry the score on to the next round						
Round 3	1					
	2					
	3					
	4					

Name ________________________________

Analyzing the Insect Solutions

Solution to Insect Problem	Economic Impact	Social Impact	Environmental Impact
A. Chemical Control			
B. Relocate the Farm			
C. Biological Control			
D. Physical Removal			

Name ____________________

Designing a Solution

1. Describe the problem.	
2. Describe the needs that the solution is to address.	
3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution

Continued

Name ______________________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.
6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name ______________________________

Possible Solutions

Environmental Problem 1 – Potential Solutions

A. Employ divers to find the crown-of-thorns starfish and inject them with a fluid that kills them.

B. Create a protected area around the reef where no fishing is allowed.

C. Ask people to monitor and report the number of starfish.

D. Introduce a new predator that eats the eggs and the young starfish.

E. Employ fishermen to remove the crown-of-thorn starfish and move them to other areas.

Notes:

Name ______________________________

Possible Solutions

Environmental Problem 2 – Potential Solutions

A. Enforce policing of the protected area and apply heavy fines for misuse.

B. Move the people in the village to a new area far away from the lake.

C. Offer more educational opportunities to teach the villagers new skills.

D. Help the villagers to change their crops to ones that need less space to grow.

E. Employ the villagers to clean the sediment from the lake.

Notes:

Name ______________________________

Possible Solutions

Environmental Problem 3 – Potential Solutions

A. Increase the frequency of monitoring the lake and nearby rivers for the presence of zebra mussels.

B. Ban all boats from lakes and rivers within 25 miles of Yellowstone National Park.

C. Require all boat owners to inspect their boats and certify that they are clear of zebra mussels before entering the park.

D. Introduce a zebra mussel predator into Yellowstone Lake so that if the mussel arrives, it will be eaten.

E. Apply a low-dosage of chemicals to the lake to prevent zebra mussel colonies from becoming established.

F. Educate the people who live in and around the park to recognize zebra mussels and how to prevent their spread.

G. Have mandatory inspection points on all roads that lead to the park. All boats would be sprayed with chemicals at the inspection points

Notes:

Name ______________________

Possible Solutions

Environmental Problem 4 – Potential Solutions

A. Ban the harvesting of oysters until the oyster population has recovered to what it was 100 years ago.

B. Introduce a larger, fast-growing oyster from Asia that can filter the waters and can also be harvested and sold.

C. Ban the use of substances such as fertilizer in communities close to the rivers and streams that drain into the bay.

D. Install filtering systems at the mouths of the rivers and streams that drain into the bay.

E. Retrain the people who rely on the oyster fishery to catch and sell other organisms, such as crabs, instead.

Notes:

Name ______________________________

Designing a Solution

1. Describe the problem.	
2. Describe the needs that the solution is to address.	
3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution
Continued

Name ______________________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.
6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name Enviromental Problem 1

Designing a Solution

1. Describe the problem.	
2. Describe the needs that the solution is to address.	
3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution

Continued

Name ____________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.
6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name Environmental Problem 2

Designing a Solution

1. Describe the problem.

2. Describe the needs that the solution is to address.

3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution

Continued

Name ______________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.
6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name Environmental Problem

Designing a Solution

1. Describe the problem.	
2. Describe the needs that the solution is to address.	
3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution
Continued

Name ____________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.

6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name Environmental Problem

Designing a Solution

1. Describe the problem.	
2. Describe the needs that the solution is to address.	
3. Identify the constraints that the solution must meet.	4. Identify the criteria that apply to the solution.

Designing a Solution

Continued

Name ______________________________

5. Which of the proposed solutions, or combinations of solutions, best meets the criteria and constraints? Make sure to provide your reasoning.
6. How could the solution be improved? (You may adjust the criteria and the solutions)

Name ______________________

Chapter 5 Assessment Student Checklist

1. ☐ Claim
   ☐ Evidence (numbers or trends from graphs or tables)
   ☐ Science concept
   ☐ Reasoning (logic statement that uses if, then, because, therefore)

1b. ☐ Claim
   ☐ Evidence (numbers or trends from proposed solutions)
   ☐ Reasoning

1c. ☐ New solution is proposed (needs to be different than initial solutions)
   ☐ Explains why solution is better than previous solution

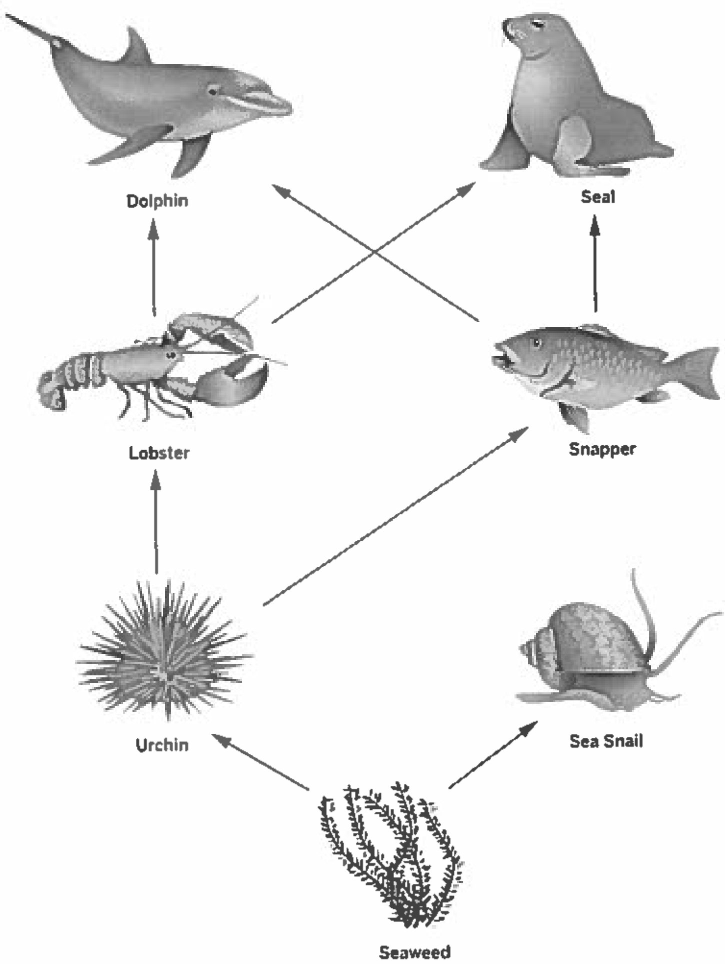
Name ______________________

Chapter 5 Assessment

1. Seaside City has been a popular vacation spot for the past 25 years. Each year more tourists visit and more people come to live there. A wide range of organisms can be found in the sea near the city. The following food web shows you the feeding relationships between some of these organisms. Seaweed also provides a safe environment for many types of organisms not shown on the food web below.

Visitors love to watch the seals and dolphins. Both tourists and residents enjoy eating lobster or snapper at local restaurants. However, the increasing human population has led to increased demand for lobster and snapper. The table below provides data about the sea near Seaside City. The data indicate that both species have become overfished.

Seaside City Food Web



Year	Number of species in the sea near Seaside City	Number of lobsters per 10 square meters	Number of snappers per 10 square meters	Number of sea urchins per 10 square meters	Percentage of the sea with seaweed
1990	325	5	5	10	50
1995	324	3	3	15	40
2000	320	2	2	20	30
2005	315	1	1	25	25
2010	305	1	0.5	30	20
2015	285	0.5	0.5	35	15

Chapter 5 Assessment
Continued

Name ______________________

a. Construct an explanation about how the overfishing of lobsters and snappers affects the amount of seaweed in the ecosystem. Support your claim with evidence from the table.

____
____
____
____
____
____
____
____
____
____
____

b. In 2015 the people of Seaside City decided that the changes in this ecosystem were a problem. Two solutions were proposed. A short list of criteria and constraints were also developed by Seaside City. You were selected as one of the team of scientists and engineers to examine the solutions. The solutions, criteria, and constraints are described on the next page.

Read the proposed solutions and **construct an argument that answers the question, "Which is the best proposed solution, based on the criteria, and why?"**

Proposed Solution A

The sea near Seaside City would become a protected area, where no fishing is allowed. The area would extend 5 km (about 3 miles) out to sea and around the city. The cost of creating the protected area would be 1.5 millions dollars. Scientists estimate that it will take at least 20 years for the numbers of lobsters and snappers to recover to the 1990 levels. It is estimated that 250 fishing jobs would be lost. However, it is believed that tourism will increase by 20% because of the protected area. As the number of tourists increases, new hotels could be built, creating more jobs. New businesses, such as boat trips for tourists and scuba diving, could also be developed. It is estimated that at least 100 new jobs would be created over the next 5 years. Scientists expect that the number of species in the protected area will take about 30 years to recover to the level that it was in the year 2000.

Chapter 5 Assessment
Continued

Name ______________________________

Proposed Solution B

Five hundred lobsters and one thousand snappers will be brought from other parts of the country. The cost of introducing the species would be $200,000. They will be added to the ocean near Seaside City. They are different, but related, species from the lobsters and snappers that are found near Seaside City. The introduced species are larger and grow more quickly than the existing species. Sales tax will be increased by 1% to cover the cost of the bringing in the new lobsters and snappers. Divers will be used to catch and remove at least fifty percent of the sea urchins. There will not be a total ban on fishing, but fishing boats will only be allowed to fish during one week each month. It is estimated that 50 fishing jobs would be lost. It is expected to take about 10 years for the area to recover to the level that it was in the year 2005. Tourism is expected to remain the same during that time.

Constraint: The solution must cost less than 2 million dollars.

Criteria:
1. Best recovery of the biodiversity of the ecosystem.
2. Lowest chance of introducing species that may become invasive.
3. Smallest number of job losses.
4. Shortest time for the ecosystem to recover.

Chapter 5 Assessment
Continued

Name ______________________________

c. Design your own solution. You may change the criteria but make sure that you describe any changes that you make. Explain why your solution is better than the solutions proposed by Seaside City.