From the Mountains to the Estuary: From the Schoolyard to the Bay
Excerpted Watershed Lesson Plans

Meaningful Watershed Experiences for Grade 6 Students

Created by:

Prince William County Public Schools
Providing A World-Class Education

Potomac Environmental Research and Education Center
George Mason University
perec.gmu.edu

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From the Mountains to the Estuary:
From the Schoolyard to the Bay

Prince William Science Curriculum Resource Guide
Grade 6

<u>Program Overview:</u>

- **"What is a watershed?"**
- **"Why is the state of the watershed important to people?"**
- **"How can we improve water quality in the watershed?"**

<u>PWC Objectives and Virginia Standards of Learning (SOLs):</u>

PWC Objective: 6.1 Science Process Skills

The student will plan and conduct investigations that are increasingly sophisticated and involve a refinement of science process skills. Key concepts include:

- Making observations involving fine discrimination between similar objects and organisms (SOL 6.1a)
- Recording precise and approximate measures (SOL 6.1c)
- Using scale models to estimate distance, volume, and quantity (SOL 6.1d)
- Stating hypotheses in ways that identify the independent (manipulated) and dependent (responding) variables (SOL 6.1e)
- Devising a method to test the validity of predictions and inferences (SOL 6.1f)
- Manipulating one variable over time with repeated trials (SOL 6.1g)
- Collecting, analyzing, and reporting data using appropriate metric measurement (SOL 6.1h)
- Organizing and communicating data through graphical representations (graphs, charts, diagrams) (SOL 6.1i)
- Developing and reinforcing an understanding of the nature of science (SOL 6.1k)

PWC Objective: 6.4 Nature of Matter

The student will investigate and understand that all matter is made up of atoms. Key concepts include:

- Chemical symbols (SOL 64.c)
- Chemical formulas (SOL 6.4e)
- Elements that comprise solid Earth, living matter, oceans, and atmosphere (SOL 6.4g)

PWC Objective: 6.5(b) Earth's Waters: Role in the Environment

The student will investigate and understand the role of water in the natural and human-made environment. Key concepts include:

- The origin and occurrence of water on Earth (SOL 6.5e)
- The importance of water for agriculture, power generation, and public health (SOL 6.5f)
- The importance of protecting and maintaining water resources (SOL 6.5g)

PWC Objective: 6.7 Watershed Ecology

The student will investigate and understand the natural processes and human interactions that affect watersheds systems. Key concepts include:

- The health of ecosystems and the abiotic factors of a watershed (SOL 6.7a)
- The location and structure of Virginia's regional watershed systems (SOL 6.7b)
- Divides, tributaries, river systems, and river and stream processes (SOL 6.7c)
- Wetlands (SOL 6.7d)
- Estuaries (SOL 6.7e)
- Major conservation, health, and safety issues associated with watersheds (SOL 6.7f)
- Water monitoring and analysis using field equipment including hand-held technology (SOL 6.7g)

PWC Objective: 6.9: Natural Resources and Public Policy

The student will investigate and understand public policy decisions relating to the environment. Key concepts include:

- Management of renewable resources and nonrenewable resources (SOL 6.9 a-b)
- The mitigation of land-use and environmental hazards through preventive measures (SOL 6.9c)
- Conservation policies, including consideration of costs and benefits (SOL 6.9d)

Prince William County Schools
Meaningful Watershed Experience

As part of the Chesapeake 2000 Agreement, the states of Virginia, Maryland, and Pennsylvania, along with the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency, reaffirmed their long-term commitment to "protect and restore the Chesapeake Bay's ecosystem."

By co-signing this document, Virginia agreed to accomplish specific goals, including the following regarding public education:

- Beginning with the class of 2005, provide a meaningful Bay or stream outdoor experience for every school student in the watershed before graduation from high school.

- Provide students and teachers alike with opportunities to directly participate in local restoration and protection projects and to support stewardship efforts in schools and on school property.

In April 2005, the Virginia Department of Education began collecting data on Virginia's progress toward meeting educational goals related to watersheds and related educational programs.

This program was compiled to assist sixth grade teachers in providing a meaningful watershed experience for their students.

A meaningful watershed experience should:

- Be investigative or project oriented.
- Be an integral part of the instructional program.
- Involve sustained activity.
- Be enhanced by natural resource personnel.
- Involve sharing and communication.
- Consider the watershed as a system.
- Be for all students.
- Be richly structured and of high quality design.

For more information on Meaningful Watershed Experiences please visit
http://www.deq.state.va.us/vanaturally/pdf/c2k.pdf

For more information on the Chesapeake 2000 Agreement please visit
www.chesapeakebay.net/content/publications/cbp_12081.pdf

Science literacy

What is a Watershed?

Overview:

Using Cacapon Institute web site, students will view an interactive video that describes and illustrates a watershed.

Teacher Background:

- A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place
- Watersheds vary in shapes and sizes. They cross county, state, and national boundaries.
- In the continental US, there are 2,110 watersheds; including Hawaii Alaska, and Puerto Rico, there are 2,267 watersheds.
- The Chesapeake Bay watershed stretches across more than 64,000 square miles, encompassing parts of six states — Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia — and the entire District of Columbia.
- Threading through the Chesapeake watershed are more than 100,000 streams and rivers — called tributaries — that eventually flow into the Bay. Everyone in the Bay watershed lives within a few minutes of one of these streams and rivers, which are like pipelines from our communities to the Bay.
- For more information on the Chesapeake Bay Watershed visit http://www.chesapeakebay.net/watersheds.aspx?menuitem=14603

Materials:

- Computers with internet access
- Composition Notebook for each student

Setting the Stage:

Using the composition notebook, have the students to write a brief description of a watershed, why is it important to people, and how can we improve the water quality?

Acquisition of Learning:

1. Have students visit the following web site to play the "What is a Watershed" Movie. http://www.cacaponinstitute.org/Watershed/What_Watershed.html

2. After the students have watched the video clip, have them make revisions to their description of a watershed.

Closure:

- Working together as a class, create a definition of a watershed based on the information from the website.

Creating Models

Watershed Boundaries

Overview:

Students gain an understanding of the physical aspects of watersheds and how the boundaries are determined by creating their own watershed models using paper.

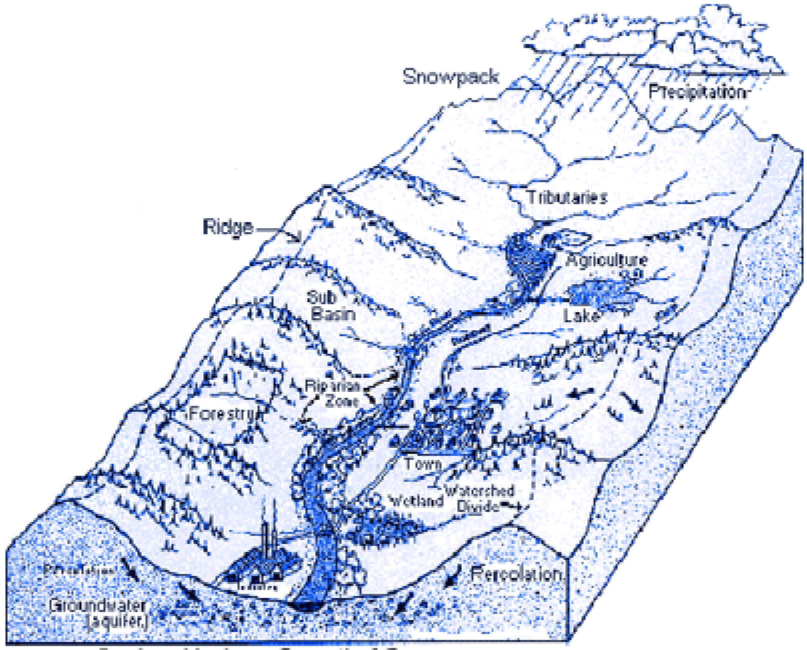
Teacher Background:

- A watershed is an area of land that drains into a water body – such as a river, lake, or bay. Watershed boundaries are defined geographically by a ridge or line of highest elevation encompassing areas of lower elevation.
- Water flowing underground ("subsurface" flow) and surface waters meet at streams and rivers, then flow to the watershed outlet, which can be a larger stream or river, a lake, a bay or even an entire ocean.
- Every place on the earth is a part of a watershed. It is mainly topography that determines where and how water flows from one area to the next.
- Watersheds can be large or small. Every stream or river has an associated watershed. Smaller "tributary" watersheds join to become larger watersheds. It is relatively easy to delineate watersheds using a topographic map that shows stream channels. Watershed boundaries follow major ridgelines around channels and meet at the lowest point where water flows out of the watershed, commonly referred to as the stream or river's mouth.
- Each large drainage basin can be broken into smaller, tributary drainage basins called sub-watersheds. The flow of water (and whatever carried with it) is influenced by large features such as continental divides, but one can also focus on drainage around an individual river. Thus, watersheds come in all shapes and sizes. This also means that almost every watershed has a sub-watershed.
- A watershed system eventually drains into the ultimate water bodies—the ocean or an inland lake or sea.

Materials:

- One 8.5" x 11" sheet of paper per student, preferably graph paper
- One sheet of cardboard or tag board per student. The dimensions of this sheet should approximate 8.5" x 11", but do not have to be precise.
- Water-soluble, non-permanent felt markers, the best colors are dark colors, such as black, brown, purple, and green.
- One blue colored pencil per student
- Spray bottles with tap water in them
- Scotch tape
- (Desirable, but not necessary:) Relief maps, topographic, and/or flat maps.

From: http://www.epa.gov/owow/watershed/whatis.html



Produced by Lane Council of Governments

Acquisition of Learning:

1. Take a sheet of plain white paper and crumple it up into a wad. The tighter the crumpling, the more complex the watershed modeling.

2. Uncrumple the paper and set it on the sheet of cardboard. Tape the edges of the paper onto the cardboard base, leaving about an inch of cardboard exposed around the perimeter. This will create a miniature landscape of mountains and valleys. Ask the students to identify the tallest mountain or the deepest canyon.

3. Have them inspect their landscape from above. Have them look at their landscape from the side as if they were on a nearby plain looking up at the mountains.

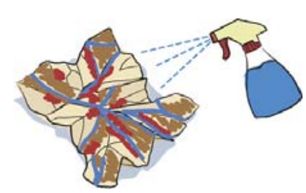
4. Use a dark-color water soluble marker, other than blue, and gently trace the tops of the “mountain” ridges and divides. Encourage the students to carefully follow ridges as far as they go. This may take a little time.

5. Take the time to explain that ridges define the boundaries of watersheds. Careful observation will also show that big watersheds are made up of smaller watersheds.

6. Ask the students to use a blue colored pencil and carefully draw where they think the rivers and lakes would be in their valleys.

7. For rivers, it is easiest to start at the bottom of a valley and follow it uphill. If there are valleys where they can not go “down” any further, that may be a place to draw a lake.

8. Although watersheds are defined by the ridges, they are named by the rivers and streams. Have students write their names on the bottom of the cardboard before the next step.



9. Now have the students that test their predictions of the paths of the rivers. Take the spray bottle and simulate rain by misting the paper watershed while it is flat on a counter. Don’t spray directly on the paper, but have the droplets fall on the paper.

10. Have students observe as the water seeps downhill through the paper. You can make different effects by adjusting how wet you make the paper. If you spray the paper heavily, actual drops will run down the sides of the paper and pool into “lakes.”

11. Let the paper watersheds dry. The paper will become even more colorful as the dark inks slowly separate into a rainbow of colors.

Closure:

Once the models are dry, have students determine whether they correctly predicted where the water would flow into rivers and lakes.

Finish by asking them again to define what a watershed is and with a new color or marker, have them outline one entire watershed on their model.

Show the students a map that has Virginia’s watersheds. Discuss how the boundaries to the watersheds are determined.

Extensions:

1. Have the students investigate the geographical features that are divides for Virginia’s watersheds.

2. Create a 2-D map using the paper watersheds: Use graph paper and have each student render a two-dimensional map that represents their three-dimensional watersheds.

Have them decide on the scale of graph paper grid lines and then have them estimate:

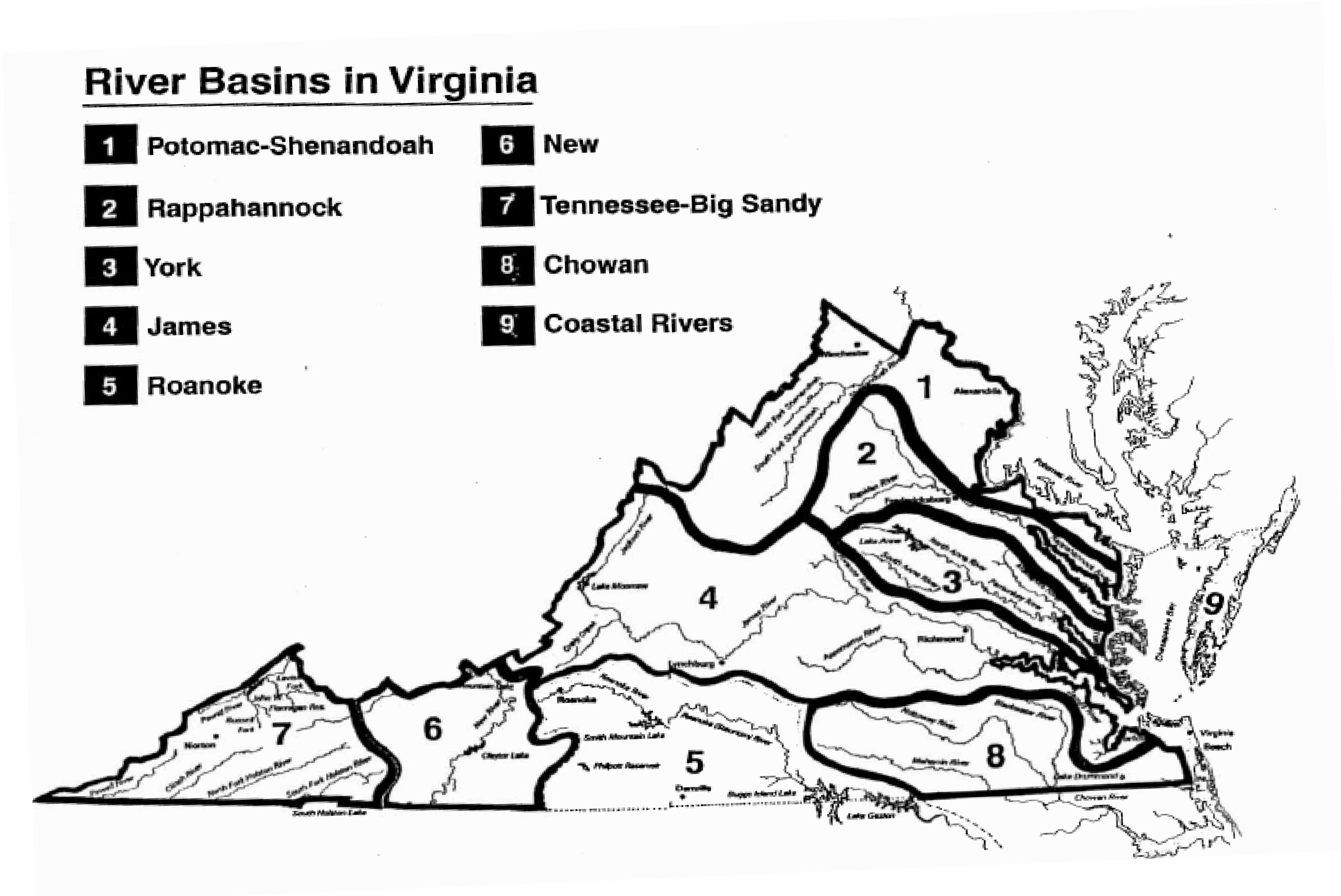
- The lengths of the rivers
- The heights of the mountains
- The area of the valleys
- The volume of water that would enter the watershed if one inch of rain fell in one of those valleys.

3. Explore global watersheds: Ask students to find their location on a globe of the Earth (or Google Maps), then guess in which ocean’s watershed they live. (i.e., To what ocean does water eventually go if you pour it on the ground outside our building?) This can be repeated for other cities around the globe.

Next, have students explore the globe in search of isolated lakes and inland seas, i.e., those that have no river outlet or strait connecting them directly – or indirectly – to any ocean.

Have each student [or team of students] identify as many inland seas and isolated lakes as they can by name [+1 point for each] on the globe, without including lakes with outlets into an ocean-bound river [-1 point for each]. Where there’s ambiguity, students can research via Wikipedia [or just count as 0 points].

Hint: The North American and East African Great Lakes flow into northbound rivers, as do many Western European lakes; Salt Lake in Utah, Lake Chad in West Africa, and the big water bodies East of the Black Sea in Asia [Aral Sean, Caspian Sea and Lake Baikal – the largest-volume lake on Earth] are all inland lakes and seas.


River Basins in Virginia
1 Potomac-Shenandoah
2 Rappahannock
3 York
4 James
5 Roanoke
6 New
7 Tennessee-Big Sandy
8 Chowan
9 Coastal Rivers

Topographic Map Investigation

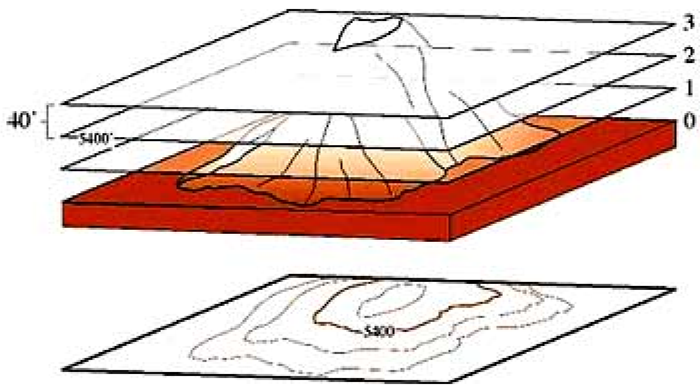
"Play Dough Mountain"

Overview:

In this activity students will create their own topographic map using play dough.

Teacher Background:

- A topographic map shows elevation change in an area. It is a two-dimensional surface that represents 3-dimensional objects like hills, mountains, and valleys, as shown in the diagram below.



- Contour lines placed on the topographic map connect points of equal elevation.
- The contour interval of the topographic map shows the difference in elevation from one contour line to the next. The contour interval is indicated at the bottom of the map.
- Topographic maps can be used to determine the size and location of regional watershed systems. Areas of higher elevation, such as ridges or divides, separate watersheds.

Materials:

- Can of play dough
- Ruler
- Pencil
- 30 cm piece of thread or fishing line cut
- Sheet of plain white paper

Setting the Stage:

Group students into pairs. Each pair should have the materials listed above. Ask the students what is the difference between a street map and a topographic map. Show an example of a topographic map. Explain that topographic maps are 2-dimensional surfaces that represent 3-dimensional objects.

Acquisition of Learning:

1. Using the play dough, have students make a mountain and put it in the middle of their sheet of white paper.
2. Using the ruler and pencil point, have students put small holes in the mountain in a straight line at 1 cm intervals.
3. The students should put an "X" on the paper at the bottom of the line of pencil holes and then follow the following steps:
4. Trace the bottom of the mountain on the paper.
5. Wrap the thread evenly around the mountain at the first centimeter mark and pull both ends to cut through the dough.
6. Place the lower separated layer of play dough off to the side.
7. Place the rest of the mountain top on the white sheet of paper, be sure the holes line up with the "X"
8. Again, trace the mountain on the paper.
9. Wrap the thread evenly around the play dough at the second mark and pull both ends to cut through the play dough.
10. Place the lower separated piece of play dough on top of the first piece that was placed off to the side, aligning them as they were originally.
11. Repeat steps #7-10 until there aren't any sections left to cut with the thread.

Closure:

Ask students what is the contour interval of the topographic map they created? *(1 cm)* What is represented when the contour lines are close together? *(steep slope)* What is represented when the contour lines are farther apart? *(flatter areas)*

Extension:

Have students exchange the topographic maps that they created. Using the maps, ask students to find the correct play dough mountain the map represents.

Overview of the Chesapeake Bay

Exploring Our Watershed

Overview:
Students will learn about the Chesapeake Bay Watershed and some of the issues this estuary faces.

Teacher Background:

Visit www.livebinders.com/edit?id=1925 and click on the Chesapeake Bay link for lots of great information on the Chesapeake Bay.

Materials:

- LCD projector or smart board to display power point
- Chesapeake Bay Overview power point from CD or http://school2bay.pbworks.com/6th-Grade
- Composition Notebook for each student

Setting the Stage:

Ask students if they know the name of the watershed they live in. Have them write the name in their notebook.

Acquisition of Learning:

1. Ask someone to tell the class the name of the large watershed we live in. (*Chesapeake Bay)*
2. Explain that the Chesapeake Bay is a very important estuary. (*where fresh and salt water mix)*
3. As you present power point, have the students write down five important facts from the presentation.
4. After the presentation is complete, have the students work in cooperative groups and compare their five important facts.
5. Have each group come up with the fact that they think is the most important and report it to the class.
6. Record the answers on the board and ask the group to explain why they choose that particular fact.

Closure:
Have students summarize the class findings in their composition notebook.

Field Experience: E.A.G.L.E.S. Center

Watershed Investigation

Part 1: Where's My Watershed?

Overview:
In Part 1, students will use topographic maps to determine their watershed address. In Part 2, students will investigate how different substrates and pollutants effect erosion and water quality.

Teacher Background: Watersheds

- A watershed is an area of land that allows water to flow over or under its surface to a particular body of water.
- The watershed of any large river, lake, or estuary can be divided into smaller local watersheds.
- Since water flows downhill, watersheds are defined by topography, contour lines on topographic maps indicate the direction of water flow.
- The water system transports water, organisms, nutrients and other materials within the system.

Teacher Background: Chesapeake Bay Watershed

- The Chesapeake Bay is the largest estuary in the U.S. and represents a complex and valuable ecosystem.
- The watershed (all the land from which water drains into the bay) extends from Cooperstown, N.Y. to its mouth at Norfolk, VA.
- The Chesapeake Bay watershed covers 64,000 square miles; approximately 37 percent of the watershed lies in Virginia.
- In Virginia, the rivers that drain into the bay include the Potomac, Rappahannock, York, and James. These waterways drain about 56 percent of Virginia's land.
- Nine river basins, or watersheds, occur in Virginia. These watersheds include the Potomac, Shenandoah, Rappahannock, York, James, Roanoke, New, Tennessee-Big Sandy, Chowan, and Coastal Rivers (see River Basin map).
- The Chesapeake Bay ecosystem includes commercially valuable organisms such as crabs, oysters, striped bass, shad, and many others.
- A decline in the number of these organisms have resulted from diminished water quality, over-harvesting, reductions in habitats including submerged aquatic grasses, and spread of disease.
- In 1983 Virginia, Maryland, Pennsylvania, and the District of Columbia signed the Chesapeake Bay Agreement. This agreement deals with restoring water quality and habitat and has been refined over the years since it was first signed.
- Restoring the water quality of tributaries that feed the bay will lead to restoration of water quality, habitat and living resources of the Bay.
- The surface drainage of Virginia's river system can be divided into two drainage patterns: the land west of Roanoke (about one-fourth of state) drains into Gulf of Mexico; and the other three quarters of the state drains into the Atlantic Ocean.

Teacher Background: Human Activities

- The rivers of a watershed are constantly eroding the highlands that it contains.
- Human activities can accelerate this process. These activities include land clearing, dam building, farming and industrial development.
- Human activities can also decelerate the process. These activities include planting trees, installing barriers, protecting riparian buffers.
- Lateral movement of water is runoff.
- Runoff is the dominant way that water flows from one location to another. Many pollutants find their way into water through runoff. These pollutants are known as “non-point sources”.
- Insecticides, fertilizers, animal wastes, oils, transmission fluids, and wastes are washed off by runoff into the streams, rivers and lakes.

Materials:

- Topographic maps of local watershed area
- Aerial photographs of local area
- Pans- 2 per student group
- Variety of substrates including pebbles, sand, soil, clay
- Pieces of artificial turf
- Pieces of netting
- Assorted plastic plants
- Sticks
- 5- 1000 mL Graduated cylinders
- Stop watches
- 5- 1000 mL beakers
- Blocks
- Paper, pencil for recording times & turbidity
- Containers for waste
- Bucket for waste water
- 2 containers with fresh water placed outside for rinsing pans

Part 1: Questions for Topographic Maps in Watershed Investigation

Setting the Stage:

Divide students into three groups. Each table should have a copy of the Washington area topographic map. Ask students if they know what the difference is between a topographic map and a street map. Explain that topography maps show elevation and area features.

Acquisition of Learning:

1. Have students use magnifying glasses to investigate topographic map.

   Question: How is elevation shown? (*Red lines are contour lines. Each line represents area with equal elevation. The contour lines never cross but curve instead.)*

2. Have students follow one contour line. Show general shape of the land.

3. Have the students find their approximate location.

   Question: What is the elevation here?
   Question: Can anyone find any other numbers on the contour lines? *(Allow for answers.)*
   Question: Can you find the Bull Run Mountains? What do you notice about the contour lines there? *(The lines are very close together; there is more of a difference in elevation.)*
   Question: What is the difference between lines is known as? *(A contour interval.)*

4. Question: Can anyone find the contour interval of this map? (*The contour interval is 20 meters and is located at the bottom of the map.)*

5. Topographic maps show the general shape of the land- the topography of the land determines how water will flow- water will flow from higher elevation to lower elevation.

   Question: What is an area of land that allows water to flow over or under it to a particular body of water? (*A watershed.)*

6. Show poster with the aerial photo of the Chesapeake Bay watershed. Determined by topography of the land.

Explain that students are going to make models of their own watersheds. Student challenge: They are builders and want to put a house on the top of a hill or mountain which overlooks a river. They need to be good stewards of their watershed so they need to minimize erosion, runoff, and pollution (*how can this be done in an ecologically correct manner?)*. Playing this Watershed Game onscreen where you help protect the watershed around parks, agriculture, neighborhoods and cities may help them visualize the building process
http://www.bellmuseum.org/distancelearning/watershed/watershed2.html

Part 2: How Humans Influence Watershed

Setting the Stage:

Using the materials provided, students will build their own watershed. Their goal is to build a watershed where there is minimal erosion, runoff, and pollution.

Acquisition of Learning:

1. Go over the list of materials that are available for the students to use for to construct the watersheds.
2. Student groups should take a few minutes to discuss the type of watershed they would like to build. Students need to decide how much human disturbance is present and how much pollution.
3. Each group should begin construction of their watershed using one or more of the substrate choices. They should be reminded that watersheds go from higher elevation areas to lower.
4. The students can add items from the materials list above.
5. After their watershed is complete, students should elevate one side of the pan using blocks.
6. The students should then take 300 mL of water and begin to pour it onto the elevated side of the model watershed. If they want to simulate rain, they can put water in squirt bottles.
7. Students should take the stopwatch to time how long the water takes to reach the bottom of the pan.
8. The water at the bottom should be collected in the eye dropper and checked for turbidity (tell students to estimate, using a rough 1-5 scale, with 1 being clear and 5 being very turbid).
9. Compare the water that is collected from each group.
10. What is independent variable in this experiment? *Type of watershed model*
11. What is the dependent variable? *Turbidity of runoff*
12. Allow about 10 minutes for students to clean up and put away materials.

Closure:

Have students report to the other groups about what they added and how it affected the runoff of the watershed. What factors increased erosion, what factors decreased erosion? Were the pollutants carried into the watershed?

Watershed Management Game

“Where Has All the Water Gone?”

Overview

During this team activity, the students will discover how many groups depend on water for their survival. They will discover that these groups must work together to insure that there is an adequate supply of water now and in the future. The obstacle course activity should be set up in an open area outside.

Teacher Background: Watershed Management and Land-Use

- In order to manage a watershed well, the water users must be identified. Users may include fish and other water-dwellers, wildlife, and humans. Humans use water for recreation, as a renewable energy source for business, industry, and urban use; for rural and agricultural purposes, and navigation.
- Watershed management must take into account and meet the needs of individuals and groups. Watershed management should consider the “4 R’s”: right cost, right amount, right time, and right quality.
- The U.S. consumes water at twice the rate of other industrialized nations.
- In the U.S. water treatment plants treat 34 billion gallons of water a day.
- Two thirds of the water used in the home is used in the bathroom.

Materials

- four 1-gallon jugs filled with water
- two small coffee cans filled with water
- 20 pieces of string about 2 feet long
- large rubber bands big enough to fit around coffee can
- eight chairs
- four boards to go across chairs
- cones
- large stakes to hold signs
- 2 sets of name cards depicting water usage
- (recreation, navigation, fish & wildlife, renewable energy, business, industry, agriculture, households, landscaping, earth systems)
- 1000 mL graduated cylinders

Before class, set up an obstacle course outside. Set up cones that students have to weave through (*to represent pollution);* long boards across two chairs (*to represent different water levels)*; cones or string on the ground that students travel through *(to represent tributaries)*; and various obstacles to climb over *(to represent hydroelectric dams) etc..* Attach ten strings to one rubber band. (You will need one rubber band for each team.)

Setting the Stage

Divide the class into two groups of approximately equal number of students.

Ask students to list the different ways water can be used in a watershed. Have students give examples of each type of use.

As students provide answers, hand them the corresponding name card for them to wear. *(Recreation, navigation, fish & wildlife, renewable energy, business, industry, agriculture, households, landscaping, earth systems)*

Give other name card to student in second group.

After all the name cards are distributed, take class outside to the area where the watershed obstacle course is set up.

Acquisition of Learning

1. Have students measure out 500 mL of water in a graduated cylinder and pour it into coffee can.
2. Explain that the water in the coffee can represents a portion of the water in the watershed.
3. Show the large rubber band with the strings attached. Each string represents one of the water users.
4. Explain that <u>the students can only touch the string</u> that represents their nametag. They can not touch the can or the rubber band.
5. Working as a team, the students need to problem solve to determine the best way to move the water in the can downstream and not lose all of it.
6. If the can falls out of the rubber band, or all of the water spills, the team should go back to the beginning of the course and start again.
7. Students need to negotiate through the obstacles along the way.
8. Have students begin course. Emphasize that this is not a race among groups (although the students will probably treat it as one. This can be addressed later.) The goal is to get the most water to the mouth of the river.
9. Encourage students as they go through the course.
10. When both teams have completed the course, measure the amount of water left in each can. The team with the most water (not the fastest time) wins the challenge.

12. If time allows, have the students run the course again.

Closure

Discuss experiences the students had as they ran the course. Where did the teams have the most difficulty? Was it easy working with so many other people? Did it help if the group was trying to go fast? Could they decrease the number of water users? (*Probably not, but through conservation could decrease the amount of water they required.*

Extension: Water Usage Matching Game

Have students try to match water usage amounts with the correct product. Use cards that are provided.

1. Divide students into two groups.
2. Half the students should stand in a line and hold the cards with the amounts of water on them. The other half of the class should hold the cards with the water uses.
3. Students with the water usages should try to find the correct match.
4. After everyone is paired up, identify which answers are correct.
5. Have the students that have incorrect matches try again.
6. Continue until everyone has found the correct match.
7. Discuss ways students can conserve water.

   Water usage for each product:

   - 39,000 gallons to produce 1 car
   - 800,000 gallons to grow one acre of cotton
   - 100 gallons/day for a leaking faucet
   - 26 gallons/day for flushing the toilet
   - 55 gallons/day for a 10 minute shower
   - 100 gallons to produce 40 sheets of paper
   - 1, 800 gallons to produce one pair of jeans made from cotton
   - 4,000 gallons to produce one LB of hamburger
   - 16.5 gallons to produce one 12 oz. soda
   - 1,000 gallons to make one loaf of bread

Demonstration

Modeling

A Drop in the Bucket

Overview

In this activity adapted from *WOW: The Wonders of Wetlands,* students discover that fresh water is a renewable resource but that it is available in limited amounts so conservation of this resource is important.

Teacher Background

- 71 percent of the planet earth is covered with water.
- Only 3 percent of the water is fresh; only 0.6% is non-frozen.
- Only 0.00003 percent is not polluted, trapped in soil or groundwater too far underground.
- On a global scale only a small percentage of water is available for use.
- Geography, climate, and weather effect water distribution.
- Land and water use for agriculture, industry, and homes affect the quantity and quality of available fresh water. This in turn affects our watersheds and wetlands.

Materials

- 2 colors of construction paper
- scissors
- markers
- water
- 1000 mL beaker
- 100 mL graduated cylinder
- Small dish
- Salt
- globe
- large sheet of white paper
- bucket

Setting the Stage

Tell students they are going to estimate the proportion of potable (drinkable) and non-potable water.

Acquisition of Learning

1. Have students work in small groups. Each group should draw a large circle on the white paper.

2. Give each group two sheets of construction paper of two different colors. One color represents potable water; the other, non-potable water (the rest of the water on the planet).

3. Have the students tear the construction paper into 100 small pieces.

4. Have the students estimate how many will represent potable water and how many will represent non-potable- place those pieces within the circle.

5. Show the class 1000 mL of water. This represents all of the water on earth.

   Question: Where is most of the water on earth located? *(About 97percent of all water is in the ocean.)* Use the globe to demonstrate.

6. Pour 30 mL of water into the 100mL cylinder. Add salt to the 1000 mL beaker to show that this is unsuitable for human consumption.

   Question: Where is most of the fresh water on the planet? *(About 80 % frozen in ice caps or glaciers.)*

7. Pour 6 ml of water into a dish. This is the only non-frozen fresh water.

8. Remove a single drop of water from the dish using an eye dropper. This water, about 1.5 mL is surface water- the rest is groundwater.

9. Drop that drop of water into bucket- represents 0.00003% of total!

Closure

Ask students about their initial estimates of potable water to non-potable water. Was anyone close to the true amount? Since there is so little fresh water that can be consumed by humans it is very important to conserve and protect the water we have.

Problem Solving

Water Conservation

Saving a Precious Resource

Overview

Students will calculate how much water they use in their schools and in their homes. They will then come up with ideas to conserve water.

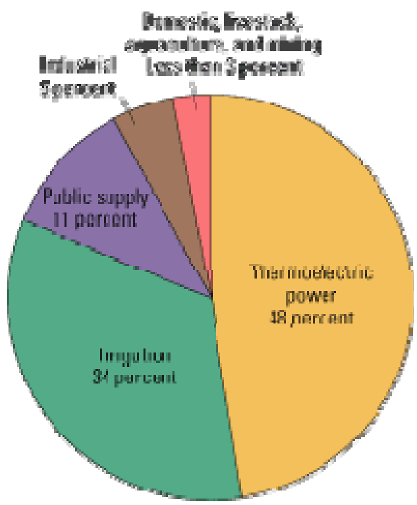
Materials

- Data sheets
- Composition Notebook

Teacher Background

From http://ga.water.usgs.gov/edu/wateruse2000.html

> “A report by the U. S. Geological Survey (USGS), "*Estimated use of water in the United States in 2000*" (USGS Circular 1268), shows that about **408 billion gallons of water per day** were withdrawn for use in the United States during 2000. Withdrawals in 1990 averaged nearly 1,620 gallons per day per person; in 2000, the per capita average had declined to about 1,430 gallons per day. During the same decade, the United States experienced a population increase of about 33 million. Total withdrawals increased steadily from 1950 to 1980 but have varied less than 3 percent since 1985.”



Setting the Stage

Begin by showing the class one gallon of water. Asking students to estimate the amount of water they use each day. Have students write down their estimates and put them aside for future reference.

Acquisition of Learning

1. In cooperative groups of three students, ask the class to brainstorm all the ways they can think of that they use water every day. Have them record the information in their notebooks.

2. Compile a class list of the answers the groups made.

3. Ask the students to share the amounts of water they estimated they used at the beginning of class.

Chart of Water Use by Fixture

Fixture	Fixture Rate
Non low-flow toilet (old)	5 gallons per flush
Low-flow toilet (new)	3.5 gallons per flush
Ultra low-flow toilet	1.5 gallons per flush
Regular shower head	7 gallons per minute
Low-flow shower head	2 gallons per minute
Bathtub filling	3.0 gallons per minute
Clothes washer	37 gallons average load
Dish washer	15 gallons average load
Faucet	3 gallons per minute

4. Show the gallon jug again; explain that two-thirds of the people in the world use just thirteen gallons of water each day. Ask how this compares with their estimates.
5. Explain that they are going to estimate the number of gallons the students at the school use each day. Have the students write down a prediction in their notebooks.
6. Next, let the students brainstorm to figure out what information they need to calculate the amount of water the school uses in one day.
7. *(Information should include: # of students in the school; Average number of times student uses bathroom; # of minutes wash hands; # of gallons used by flushing toilet; # of gallons used by washing hands; # of students that drink from water fountains; Amount of water from water fountain)*
8. The students can use estimates or actually measure quantities like amount from faucets and water fountains.
9. Have the students calculate the estimated number of gallons used by the students at the school each day.
10. Discuss the number that the students calculate. Is it lower or higher then what they calculated? What other ways is water being used at the school that they didn't figure into the equation? (*cafeteria, teachers, lawn care, generating electricity…*)
10. Now explain that they are also going to calculate the number of gallons of water their family uses in one day.
11. Give each student a worksheet to take home to record their information.

Closure

Discuss the results that discovered at home. Explain that in the US most people use about 80-100 gallons of water per day. Is their average the same or higher or lower?

Have the students write in their composition book five ways that they can conserve water.

Extensions

Have students research where their drinking water comes from at their home and school. Is it pulled out of a local river or well? If so, which one? How much does water cost per month for each person at home or school?

Student Page

Name: ___________________________

Example Worksheet:

Bathroom:

Toilet: 18 flushes X 5 gal/flush = 90 gal

Sink: 6 minutes X 3 gal/min = 18 gal

Shower: 25 minutes X 5 gal/min = 125 gal

Kitchen:

Sink: 6 minutes X 3 gal/min = 18 gal

Dishwasher: 1 cycle X 15 gal/use = 15 gal

Other:

Laundry: 1 cycle X 37 gal/use = 37 gal

90
+
18
+
125
+
18
+
15
+
37
=
303 gal Total Use

Per-person Rate = 303 gal / 3 people = 101 gallons per person

****

Student Worksheet Keep a tally of the items listed below. Insert the gallons used for each activity and multiple to find the total number of gallons used for each item.

Bathroom:

Toilet ___ flushes X ___ gal/flush = ___ gal

Sink ___ minutes X __ gal/min = ___ gal

Shower ___ minutes X __ gal/min = ___ gal

Kitchen:

Sink ___ minutes X __ gal/min = ___ gal

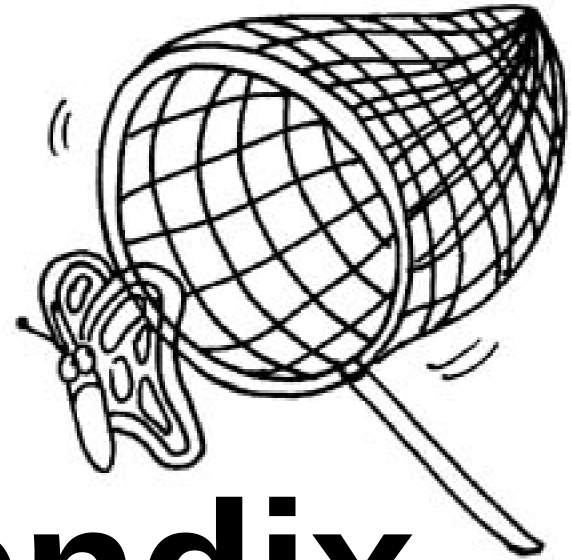
Dishwasher ___ cycle X __ gal/use = ___ gal

Other:

Laundry ___ cycle X __ gal/use = ___ gal

Total Use ____ gal

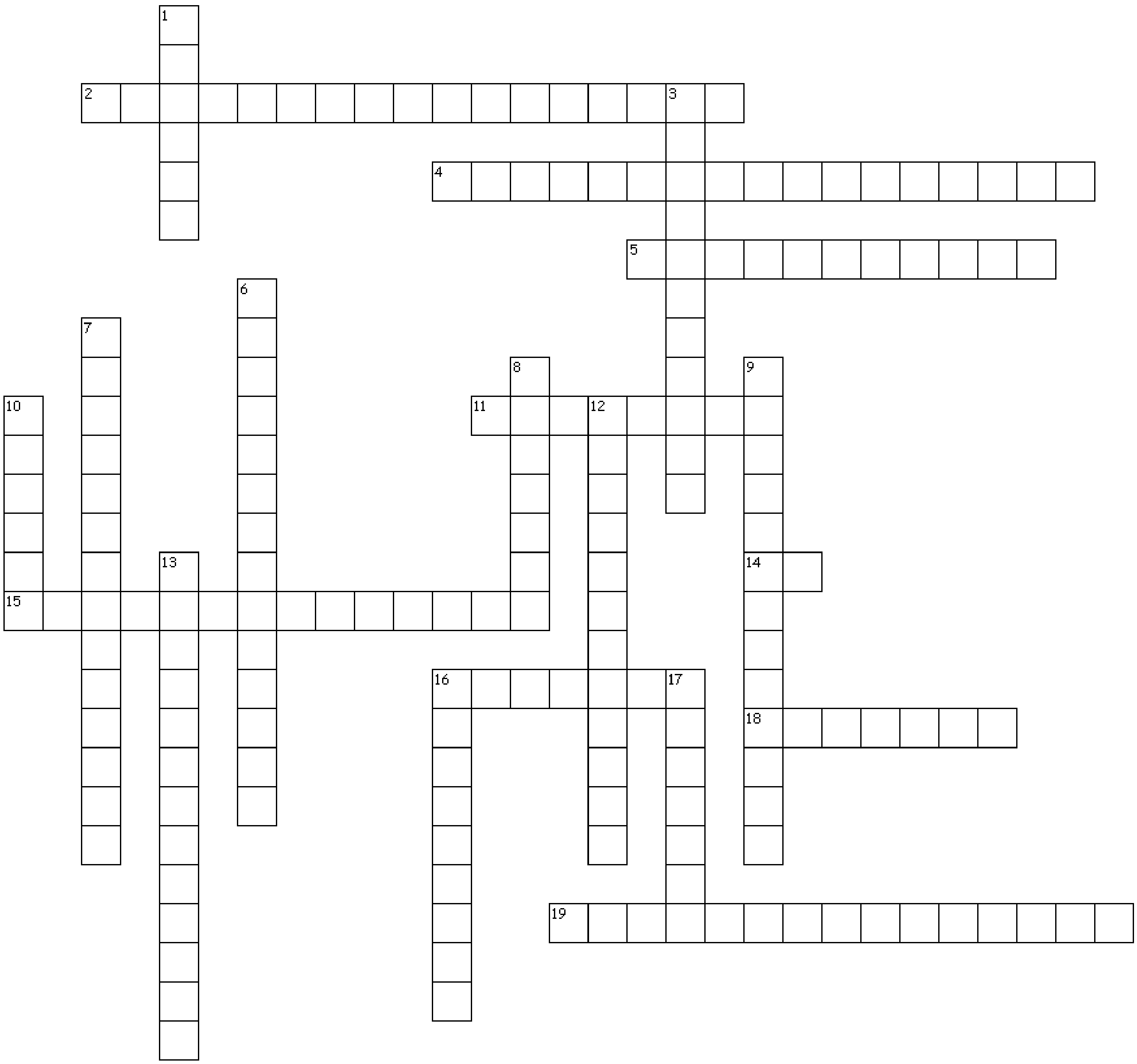
Per-person Rate ____ gal / ____ people =____ gallons per person



Appendix

Student Page

Wonders of Watersheds Vocabulary



Student Page

Puzzle Clues: Wonders of Watersheds Vocabulary

Across

2. A resource that is naturally replaced in a relatively short time.
4. Organisms without a backbone that are large enough to see with the naked eye.
5. A specific source of pollution that can be identified, such as a pipe.
11. Water that is partly salty and partly fresh, characteristic of estuaries.
14. How acidic or basic a substance is, measured on a scale from 1-very acidic, to 14-very basic.
15. The process by which nutrients in a lake build up over time, causing an increase in the growth of algae.
16. An area of land that is covered by a shallow layer of water during some or all of the year.
18. A substance composed of a single kind of atom, which cannot be broken down into other substances.
19. The difference in elevation from one contour line to the next.

Down

1. Water that flows over the ground surface rather than soaking into the ground.
3. A line on a topographic map that connects points of equal elevation.
6. A map that shows the surface features of an area.
7. A widely spread source of pollution such as road runoff, which is difficult to link to a specific origin.
8. The process by which water, wind, ice, or gravity moves fragments of rock and soil.
9. The largest estuary in the United States.
10. A ridge of land that separates one watershed from another.
12. The process of using a resource wisely so it will not be used up.
13. The amount of one substance in a certain volume of another substance.
16. The area of land that supplies water to a river system.
17. A water shortage caused by periods of low precipitation.

Created by *Puzzlemaker* at DiscoverySchool.com

Teacher Answer Key

Puzzle Clues: Wonders of Watersheds Vocabulary

Across

2. A resource that is naturally replaced in a relatively short time. – <u>renewable resource</u>
4. Organisms without a backbone that are large enough to see with the naked eye.- <u>macroinvertebrate</u>
5. A specific source of pollution that can be identified, such as a pipe.-<u>point source</u>
11. Water that is partly salty and partly fresh, characteristic of estuaries.-<u>brackish</u>
14. How acidic or basic a substance is, measured on a scale from 1, very acidic, to 14, very basic.-<u>pH</u>
15. The process by which nutrients in a lake build up over time, causing an increase in the growth of algae.-<u>eutrophication</u>
16. An area of land that is covered by a shallow layer of water during some or all of the year.-<u>wetlands</u>
18. A substance composed of a single kind of atom, which cannot be broken down into other substances.-<u>element</u>
19. The difference in elevation from one contour line to the next.-<u>contour interval</u>

Down

1. Water that flows over the ground surface rather than soaking into the ground.-<u>runoff</u>
3. A line on a topographic map that connects points of equal elevation.-<u>contour line</u>
6. A map that shows the surface features of an area.-<u>topographic map</u>
7. A widely spread source of pollution such as road runoff, which is difficult to link to a specific origin.-<u>nonpoint source</u>
8. The process by which water, wind, ice, or gravity moves fragments of rock and soil.- <u>erosion</u>
9. The largest estuary in the United States.-<u>Chesapeake Bay</u>
10. A ridge of land that separates one watershed from another.- <u>divide</u>
12. The process of using a resource wisely so it will not be used up.-<u>conservation</u>
13. The amount of one substance in a certain volume of another substance.-<u>concentration</u>
16. The area of land that supplies water to a river system. –<u>watershed</u>
17. A water shortage caused by periods of low precipitation.-<u>drought</u>

Essential Vocabulary

Watershed Systems Board Game

Adapted from a lesson by Anthony Futyma, Belville Middle School

Overview

Students will use vocabulary associated with water concepts and watersheds to create their own board game.

Materials

- dice
- poster board or drawing paper
- markers
- list of watershed and freshwater terms (below)
- index cards
- objects for playing pieces (e.g. coins or buttons)

WATERSHED TERMS		FRESHWATER TERMS	
headwaters	waterfall	water vapor	irrigation
rapids	river	water cycle	precipitation
tributary	creek	evaporation	transpiration
meander	flood plain	condensation	water table
wetland	delta	ground water	aquifer
beach	lake	spring	artesian well
pond	divide	turbidity	salinity
estuary	Chesapeake Bay	pH value	
pollution			

Setting the Stage

Explain that each pair (or group) of students will create their own **Water Systems Board Game** using terms that you have been covering in class.
In the game, the players will be a water molecule traveling through their watershed.
Each group must incorporate ten terms from each list above, for a total of 20 terms.

Acquisition of Learning

1. In the game, the players will move from start to finish. The group will devise the rules. Encourage the students to be creative! The students may include traps in the game board (e.g. player gets stuck in the groundwater, miss a turn; or player falls into an aquifer, go back two spaces. You may also include items to advance the players several spaces; (e.g. water molecule evaporates- move ahead three) (player encounters a waterfall- take another turn).
2. Students can use index cards to write rules, or write them on the board.
3. The teacher should check to be sure the terms are being used in the correct context.
4. Students should give their game a title…for example: **River Run.**
5. When complete, the teacher should assess for accuracy, and then the students should play each others games!

Closure

Review flow of water through watershed and water cycle.

Review

For a good review of the water cycle show the ***Water Cycle*** Movie Clip on the Mountains to the Estuary CD

Student Page

Creating Analogies

River Talk Analogies of a Watershed

Directions: Write down the definition of each of the watershed vocabulary. Then use your logic to figure out the relationship between the first pair of words, and apply that same relationship to fill in the blank in the second pair of words.

Watershed vocabulary:

aquifer, arid, catchment, condensation, dam, drainage basin, drought, ecosystem, evaporation, floodplain, ground water, headwaters, hydrologist, main stem, mouth, precipitation, recharge, reservoir, riparian, runoff, sub basin, transpiration, tributary, watercourse, watershed

1. inhalation: exhalation / precipitation: ______________________ *(hint: leads to)*
2. ranch: barn / __________________ : river or body of water *(hint: dwells next to)*
3. condensation: ________________ / headwaters: mouth *(hint: is the opposite of)*
4. tributary: __________________________ / branches : tree *(hint: connects to)*
5. drought: ______________________________ / hunger: food *(hint: is a lack of)*
6. dam: __________________________ / stoplight: traffic *(hint: regulates)*
7. aquifer: ____________________________ / refrigerator: food *(hint: stores)*
8. ecosystem: watershed / musicians : _____________________ *(hint: makes up)*
9. _________________________: water / doctor: medicine *(hint: one who studies)*
10. humid: _____________________________ / wet: dry *(hint: is the opposite of)*
11. sub basin: ______________________________ / team: league *(hint: is part of)*
12. recharge: ________________________ / deposits: bank account *(hint: adds to)*
13. dam: __________________________ / plug: bath *(hint: holds back)*
14. watercourse: _______________________ / highway: traffic *(hint: is where)*
15. catchment: ________________________ / glove: baseball *(hint: is used for)*

Teacher Answer Key

Creating Analogies

River Talk Analogies of a Watershed

1. inhalation: exhalation / precipitation: ______transpiration______ *(hint: leads to)*
2. ranch: barn / ________riparian_____ : river or body of water *(hint: dwells next to)*
3. condensation: __evaporation______ / headwaters: mouth *(hint: is the opposite of)*
4. tributary: ________main stem__________ / branches : tree *(hint: connects to)*
5. drought:______precipitation___________ / hunger: food *(hint: is a lack of)*
6. dam: ____________river_____________ / stoplight: traffic *(hint: regulates)*
7. aquifer: _________water_______________ / refrigerator: food *(hint: stores)*
8. ecosystem: watershed / musicians : _____orchestra; band_____ *(hint: makes up)*
9. ____hydrologist_______: water / doctor: medicine *(hint: one who studies)*
10. humid: ________arid______________ / wet: dry *(hint: is the opposite of)*
11. sub basin: _________basin_____________ / team: league *(hint: is part of)*
12. recharge: _______groundwater_________ / deposits: bank account *(hint: adds to)*
13. dam: ________reservoir_____________ / plug: bath *(hint: holds back)*
14. watercourse: _______water___________ _/ highway: traffic *(hint: is where)*
15. catchment: ________watershed___________ _/ glove: baseball *(hint: is used for)*

Source: Discover A Watershed: Watershed Manager Educators Guide, 2009